FLUXGATE MAGNETOMETER CALIBRATION FOR

R O S E T T A

RO–IGM–TR–0003

Issue: 1   Revision: 1

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Analysis of the

FGM

Calibration

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Contents

1 Introduction

This document summarizes the DC analysis results of the ROSETTA FGM calibration. The analysis is faced to the FM and FS DPUs connected to the IB and OB sensors. The calibration was performed at the Magnetsrode facility of the Institute of Geophysics and Meteorology in Braunschweig from March 19 to May 2, 2001. Additional temperature measurements took place from August 28th until September 13th. The analysis results were obtained using a software packet developed by Holger Kügler (formerly at IGM Braunschweig, now at IABG Munich).

Related documents:

- CL2–IGM–TP–0001: in detail description of all calibration steps for the CLUSTER mission

- MR-IGM–TN–0004: MRode s/w Manual

- RO–IGM–TR–0002: calibration report

- CL2–IGM–TN–0014: methods of analysis

- RO–IWF–TR0001: ROSETTA sample rate and frequency response analysis (by IWF Graz)

2 Summary of Results

2.1 Sample rate and digital frequency response

The AC analysis has been performed by the IWF team from Graz. Their results are reported in RO–IWF–TR0001. The sample frequencies as obtained by IWF are:

- 19.9810 ± 0.0001Hz for DPU-FM,

- 19.9807 ± 0.0001Hz for DPU-FS

2.2   DC analysis results

2.2.1   Offsets

2.2.1.1   Room temperature Measurements

Page	Exp.	Offset X nT Temperature °C			Offset Y nT Temperature °C			Offset Z nT Temperature °C		
		9...30	−35...−33	60...63	9...30	−35...−33	60...63	9...30	−35...−33	60...63
15	M M I B-O1	0.0	-	-	0.0	-	-	0.0	-	-
30	M M O B-O1	166.0	-	-	-70.5	-	-	452.4	-	-
45	M S I B-O1	33.5	-	-	-92.1	-	-	519.5	-	-
54	M S O B-O1	222.1	-	-	-14.2	-	-	481.6	-	-
64	S M I B-O1	70.4	-	-	-103.7	-	-	397.9	-	-
74	S M O B-O1	160.9	-	-	-94.8	-	-	350.2	-	-
88	S S I B-O1	14.9	-	-	-141.0	-	-	455.0	-	-
111	S S O B-O1	169.7	-	-	-37.8	-	-	408.8	-	-

2.2.1.2   Temperature behaviour

The temperature behaviour of the sensors has been derived from the temperature cycle measurements. During these cycles linear varying fields have been applied. For the investigation of the offset behaviour just the time intervals of applied zero field have been cut out and the corresponding sensor readings have been extracted. These sensor readings include sensor offsets as well as the coil facility residual field, which has been nulled at the beginning of the calibration. Therefore, it was in the order of only a few nanotesla during the whole calibration. This can also be proved by comparing the offsets, achieved by the standard offset measurement procedure (refer to page 2), and the sensor reading at room temperature during this temperature test.

The following paragraphs show the results for the FM and FS sensors. The behaviour can be described by a linear temperature model in the shape of

$$\underline{B}^{off}(T) = \underline{a}_0 + \underline{a}_1 \cdot T - \underline{B}^{res} \quad [\text{nT,}^\circ \text{C}]$$

The really huge variations are definitely caused by the sensors itself, and are not originated by external variations or the coil facility. This has been checked with the data of the coil facility backup magnetometer (Zopfmag) which recorded all the data in parallel. Therefore, it is for sure, that the residual field of the facility $\underline{B}^{res}$ was stable.

As the the variations were suspicious high the T–cycle has been repeated for the combination DPU–FS / Sensor–FS and also for the most likely flight configuration DPU–FS / Sensor–FM.

2.2.1.2.1 DPU: FM — Sensor: FM–IB

a0 [nT]	a1 [nT/K]
98.5	-0.374
-79.7	0.466
493.6	-1.846

Temperature Dependence of OFFSET+RESIDUAL for FM–IB
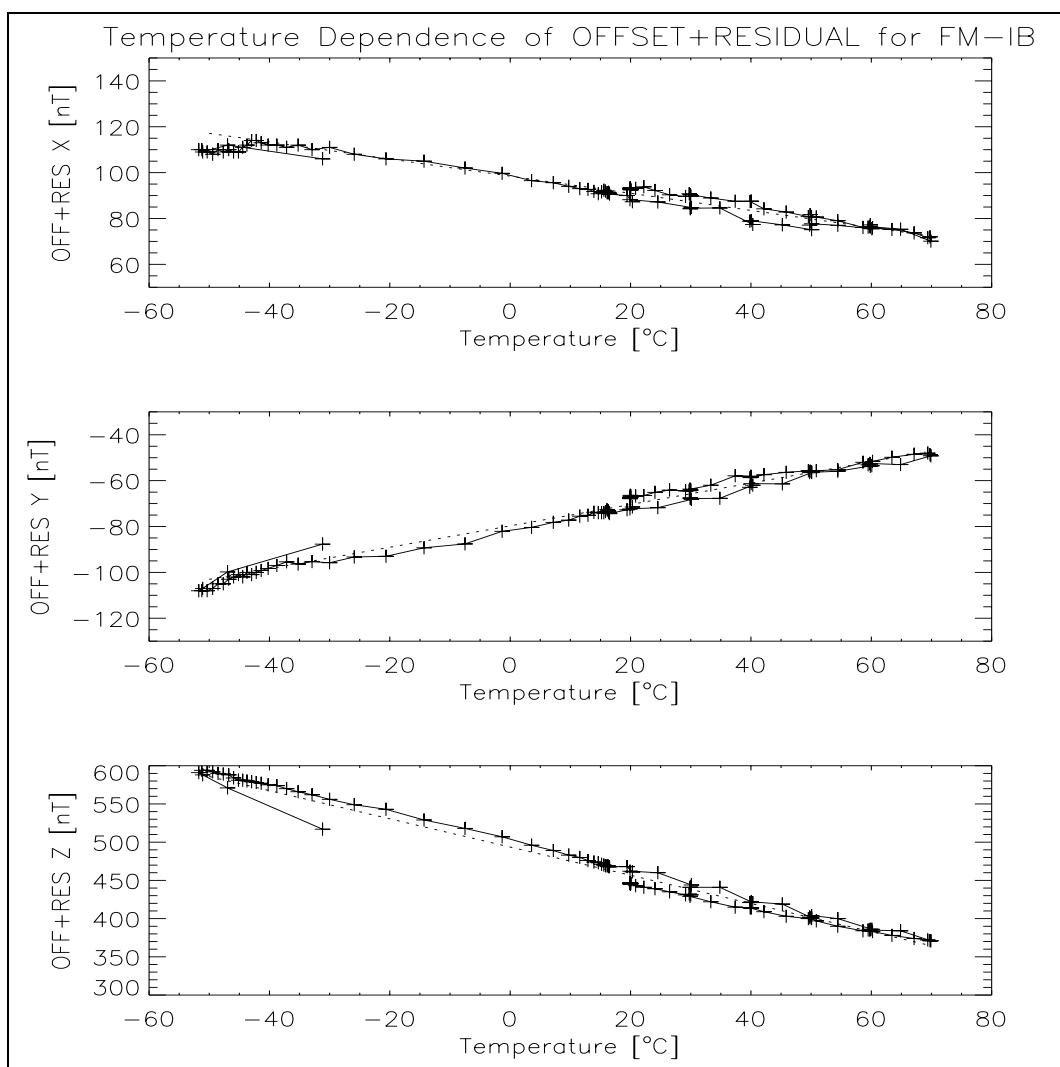
2.2.1.2.2   DPU: FM — Sensor: FM–OB

a0 [nT]	a1 [nT/K]
181.2	-0.901
-66.1	0.002
465.2	-1.979

Temperature Dependence of OFFSET+RESIDUAL for FM–OB
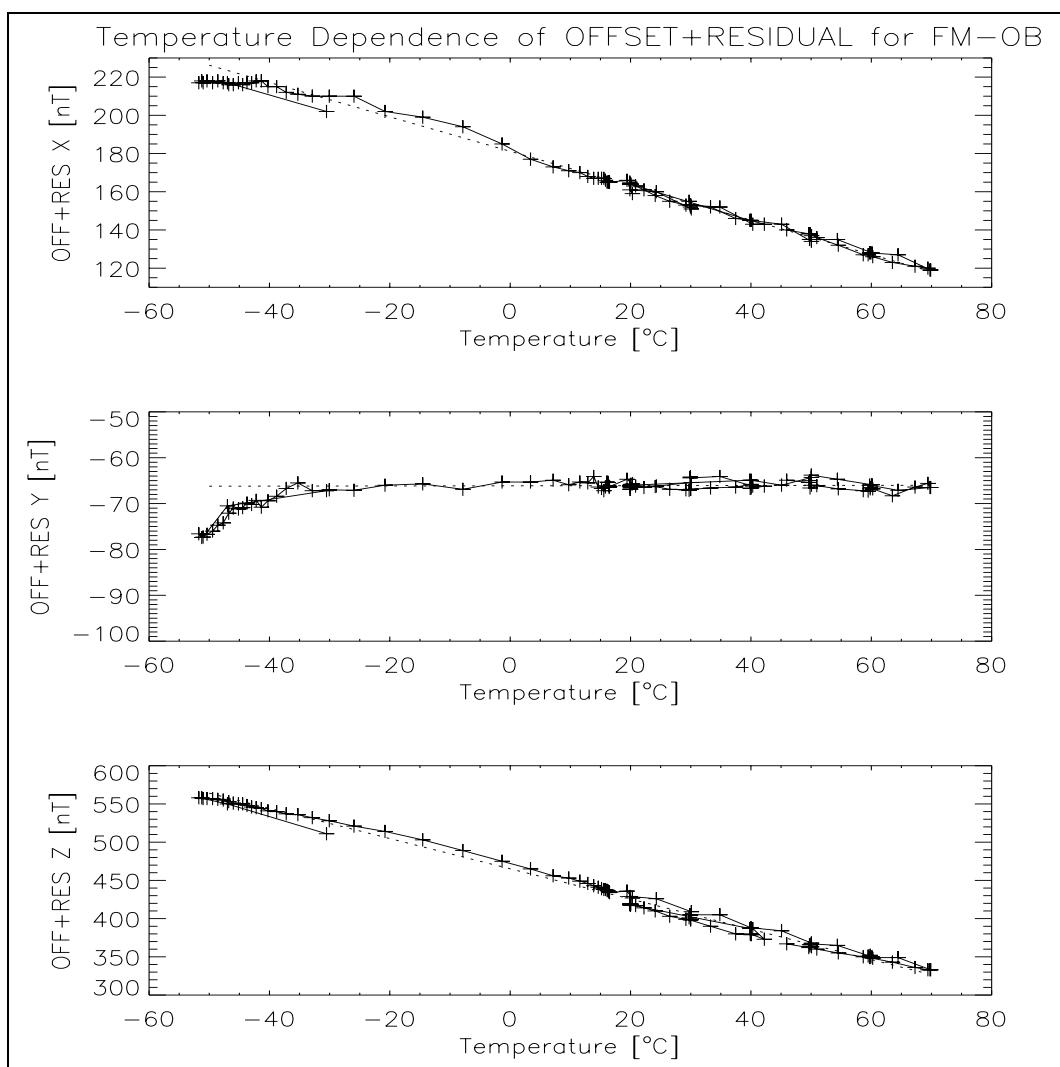
2.2.1.2.3   DPU: FS — Sensor: FM–IB

a0 [nT]	a1 [nT/K]
114.3	-0.565
-119.8	0.731
494.0	-1.673
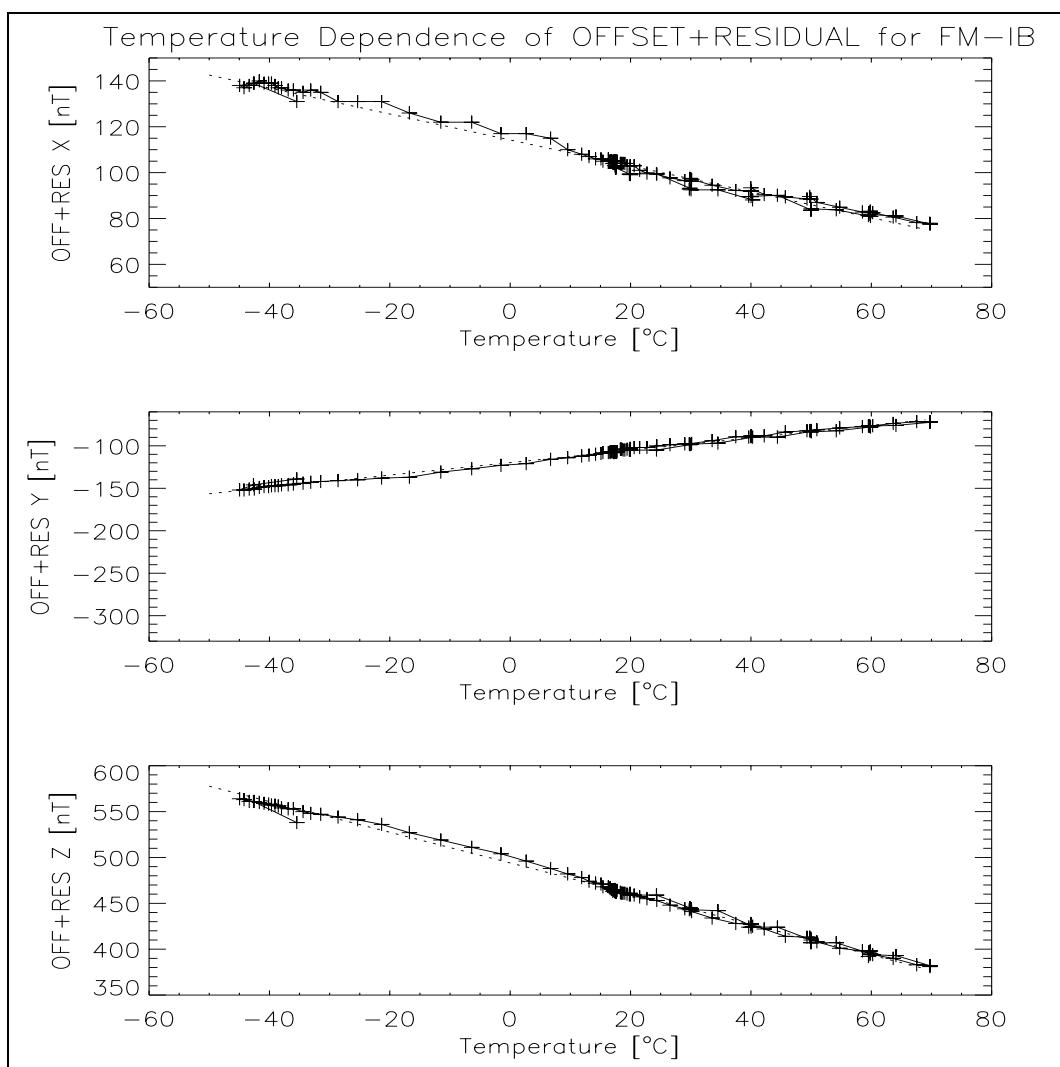
2.2.1.2.4   DPU: FS — Sensor: FM–OB

a0 [nT]	a1 [nT/K]
214.5	-1.053
-79.9	0.073
384.7	-1.657

Temperature Dependence of OFFSET+RESIDUAL for FM–OB
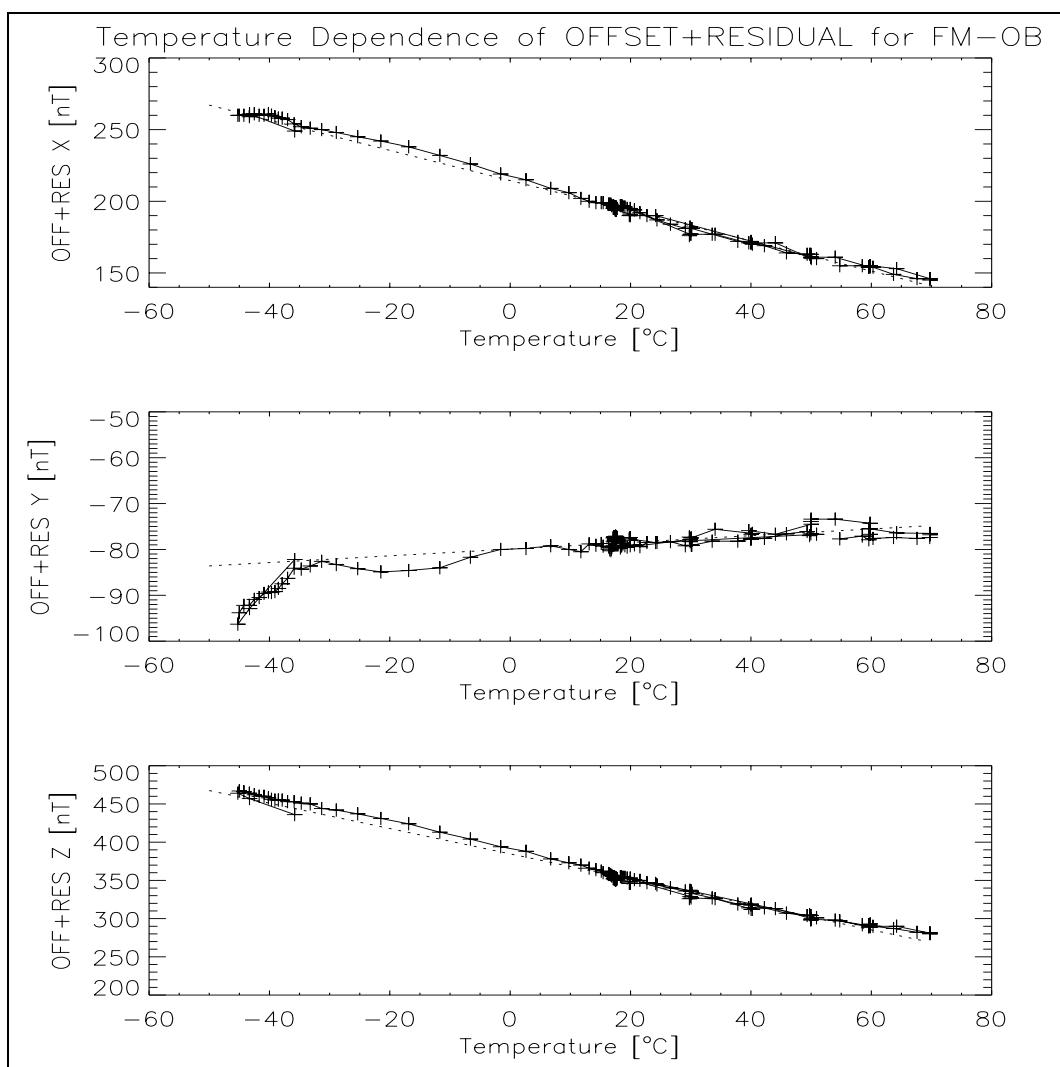
2.2.1.2.5   DPU: FS — Sensor: FS–IB, 1. Run

a0 [nT]	a1 [nT/K]
24.4	-0.194
-152.1	0.253
485.9	-2.145

Temperature Dependence of OFFSET+RESIDUAL for FS−IB
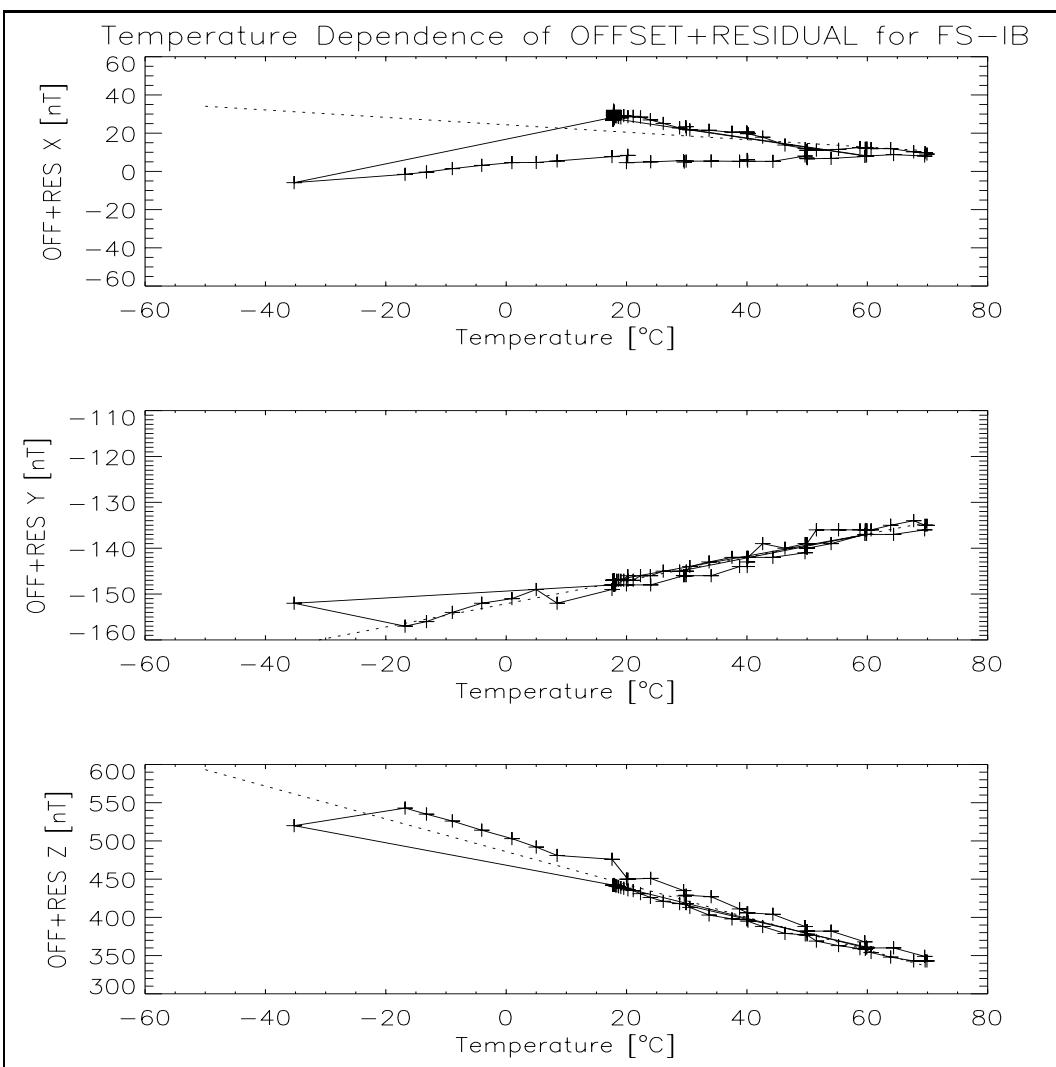
2.2.1.2.6   DPU: FS — Sensor: FS–OB, 1. Run

a0 [nT]	a1 [nT/K]
193.7	-0.982
-49.8	0.010
424.7	-1.669

Temperature Dependence of OFFSET+RESIDUAL for FS–OB
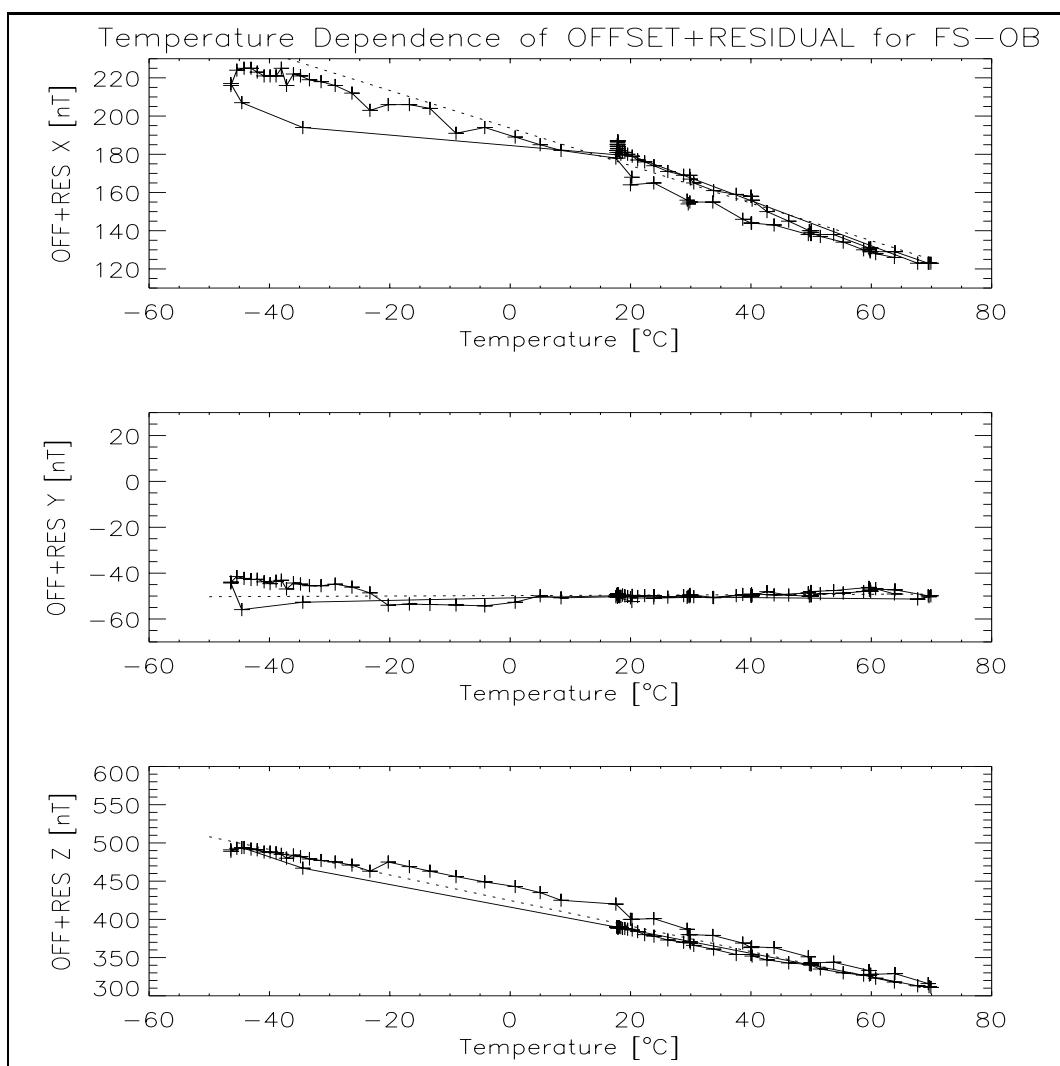
2.2.1.2.7   DPU: FS — Sensor: FS–IB, 2. Run

a0 [nT]	a1 [nT/K]
46.5	-0.284
-147.4	0.647
532.4	-1.823

Temperature Dependence of OFFSET+RESIDUAL for FS–IB
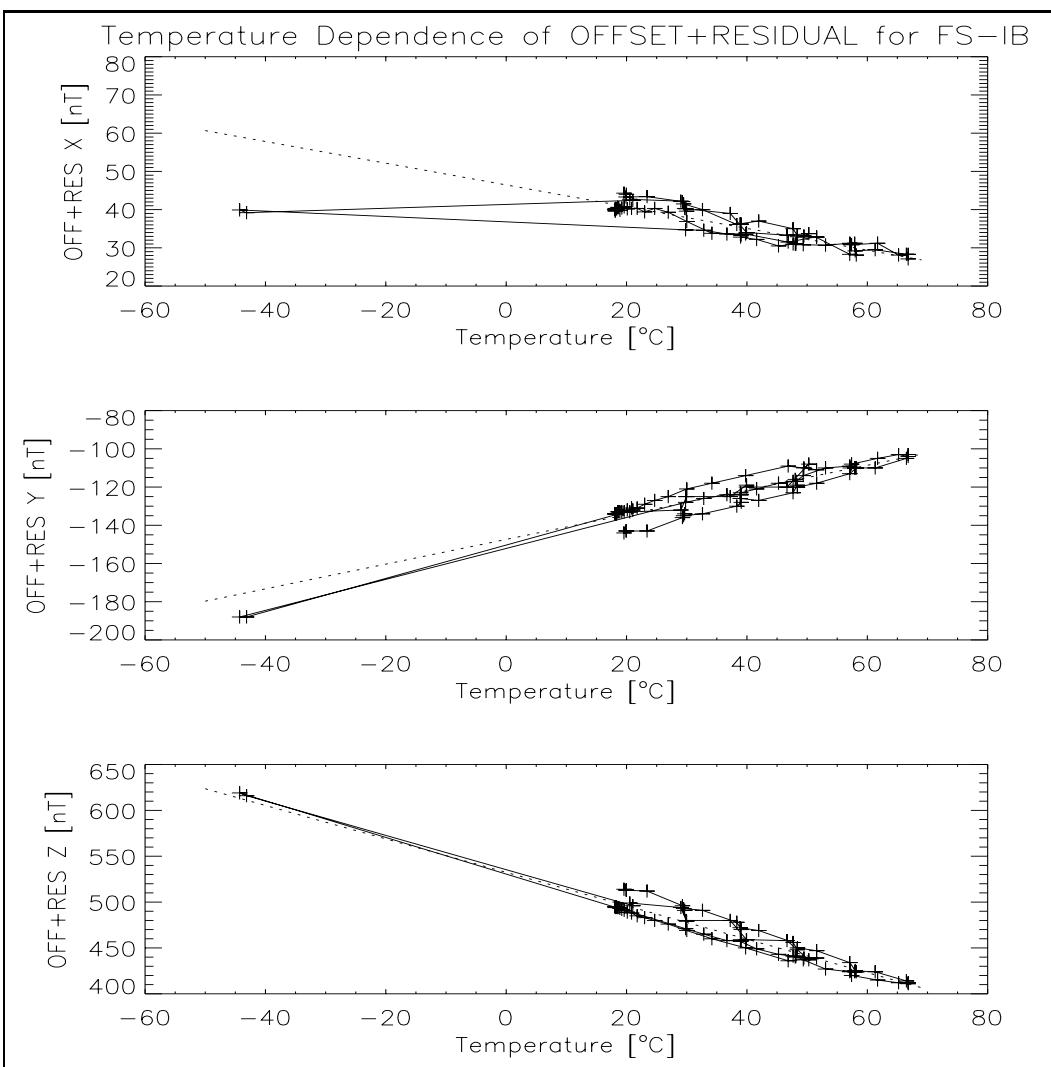
2.2.1.2.8   DPU: FS — Sensor: FS–OB, 2. Run

a0 [nT]	a1 [nT/K]
242.5	-1.099
-29.5	0.406
400.4	-1.448

Temperature Dependence of OFFSET+RESIDUAL for FS–OB
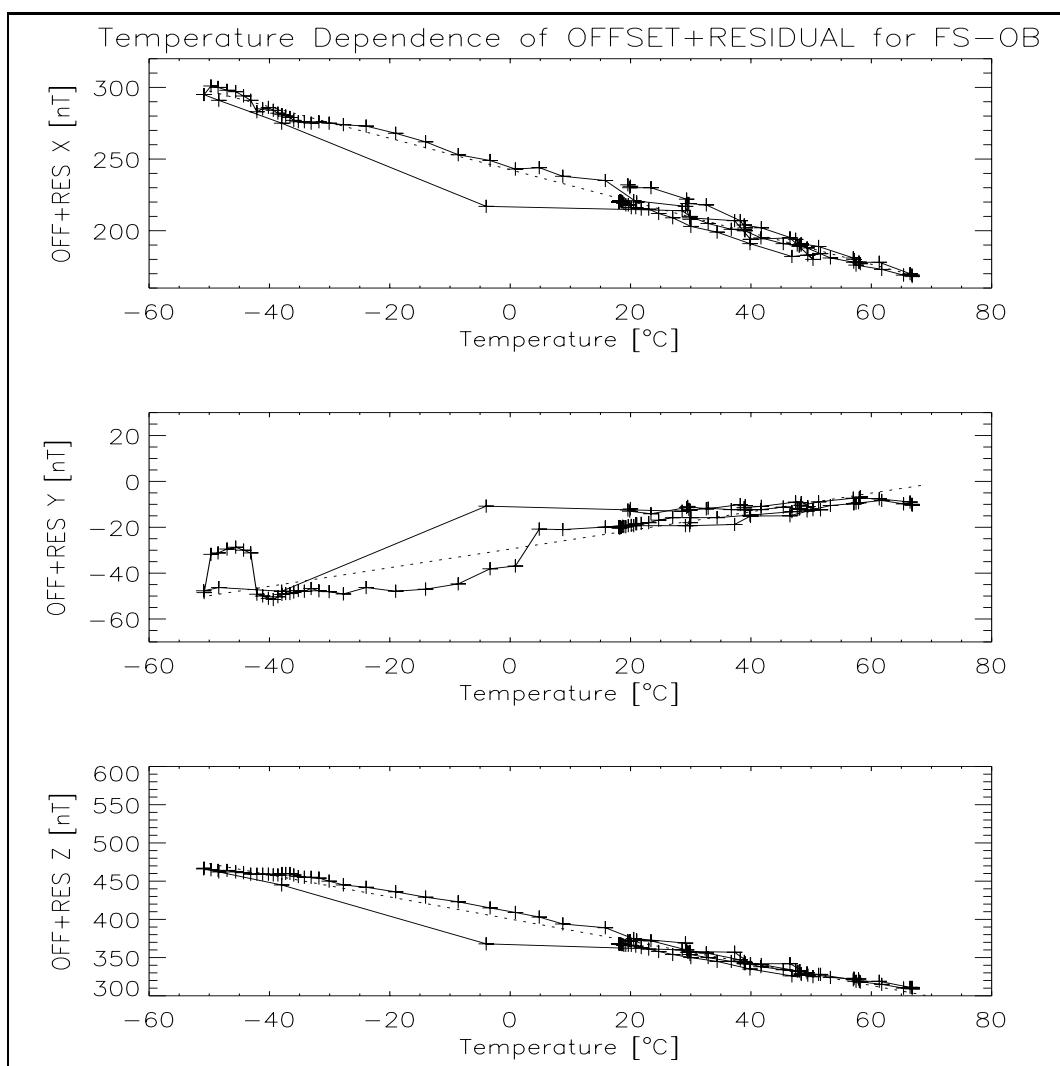
2.2.2 Sensitivities

Page	Exp.	Sensitivity Sensor X Temperature °C			Sensitivity Sensor Y Temperature °C			Sensitivity Sensor Z Temperature °C		
		9...30	−35...−33	60...63	9...30	−35...−33	60...63	9...30	−35...−33	60...63
15	M M I B-L1	1.09015	-	-	1.09408	-	-	1.09350	-	-
16	M M I B-L2	1.09015	-	-	1.09409	-	-	1.09352	-	-
18	M M I B-LB	1.08978	-	-	1.09327	-	-	1.09285	-	-
19	M M I B-LA	1.08975	-	-	1.09326	-	-	1.09283	-	-
22	M M I B-S1	1.09015	-	-	1.09408	-	-	1.09351	-	-
23	M M I B-S2	1.09015	-	-	1.09408	-	-	1.09351	-	-
24	M M I B-S3	1.09015	-	-	1.09408	-	-	1.09351	-	-
26	M M I B-T1	1.08978	1.09041	1.08918	1.09327	1.09364	1.09289	1.09285	1.09321	1.09246
30	MMOB-L1	1.09047	-	-	1.09305	-	-	1.09214	-	-
31	MMOB-L2	1.09048	-	-	1.09306	-	-	1.09214	-	-
33	MMOB-LB	1.09026	-	-	1.09204	-	-	1.09144	-	-
34	MMOB-LA	1.09024	-	-	1.09206	-	-	1.09144	-	-
37	MMOB-S1	1.09048	-	-	1.09305	-	-	1.09215	-	-
38	MMOB-S2	1.09047	-	-	1.09305	-	-	1.09214	-	-
39	MMOB-S3	1.09048	-	-	1.09305	-	-	1.09215	-	-
41	MMOB-T1	1.09026	1.09081	1.08975	1.09204	1.09246	1.09175	1.09144	1.09174	1.09113
45	M S I B-L1	1.09495	-	-	1.09188	-	-	1.09158	-	-
46	M S I B-L2	1.09496	-	-	1.09188	-	-	1.09158	-	-
48	M S I B-S1	1.09496	-	-	1.09188	-	-	1.09158	-	-
49	M S I B-S3	1.09497	-	-	1.09188	-	-	1.09158	-	-
51	M S I B-S2	1.09496	-	-	1.09188	-	-	1.09157	-	-
52	M S I B-S4	1.09497	-	-	1.09188	-	-	1.09158	-	-
55	M S OB-L1	1.08368	-	-	1.09460	-	-	1.09204	-	-
56	M S OB-L2	1.08367	-	-	1.09460	-	-	1.09202	-	-
58	M S OB-S1	1.08367	-	-	1.09460	-	-	1.09203	-	-
59	M S OB-S3	1.08368	-	-	1.09460	-	-	1.09203	-	-
61	M S OB-S2	1.08366	-	-	1.09461	-	-	1.09203	-	-
62	M S OB-S4	1.08367	-	-	1.09460	-	-	1.09203	-	-
65	S M I B-L1	1.09046	-	-	1.09419	-	-	1.09398	-	-
66	S M I B-LB	1.09000	-	-	1.09340	-	-	1.09324	-	-
68	S M I B-S1	1.09045	-	-	1.09418	-	-	1.09398	-	-
69	S M I B-T4	1.09002	1.09068	1.08940	1.09337	1.09382	1.09299	1.09322	1.09361	1.09284
74	S MOB-L1	1.09080	-	-	1.09337	-	-	1.09277	-	-
75	S MOB-L2	1.09080	-	-	1.09339	-	-	1.09277	-	-
77	S MOB-LB	1.09041	-	-	1.09238	-	-	1.09206	-	-
78	S MOB-S1	1.09079	-	-	1.09338	-	-	1.09278	-	-
81	S MOB-S2	1.09079	-	-	1.09338	-	-	1.09277	-	-
82	S MOB-S3	1.09079	-	-	1.09338	-	-	1.09277	-	-
83	S MOB-T4	1.09046	1.09101	1.08995	1.09235	1.09276	1.09202	1.09208	1.09238	1.09176
88	S S I B-L1	1.09523	-	-	1.09201	-	-	1.09201	-	-
89	S S I B-L2	1.09523	-	-	1.09201	-	-	1.09201	-	-
91	S S I B-LB	1.09477	-	-	1.09118	-	-	1.09144	-	-
92	S S I B-LA	1.09483	-	-	1.09118	-	-	1.09146	-	-
95	S S I B-LV	1.09472	-	-	1.09121	-	-	1.09135	-	-
96	S S I B-S1	1.09522	-	-	1.09201	-	-	1.09202	-	-
97	S S I B-S3	1.09523	-	-	1.09202	-	-	1.09201	-	-
99	S S I B-S2	1.09523	-	-	1.09201	-	-	1.09202	-	-
100	S S I B-S4	1.09522	-	-	1.09201	-	-	1.09201	-	-
102	S S I B-T1	1.09477	1.09548	1.09423	1.09118	1.09155	1.09084	1.09144	1.09183	1.09111
107	S S I B-T3	1.09472	1.09536	1.09421	1.09119	1.09157	1.09085	1.09136	1.09171	1.09102
111	S S OB-L1	1.08387	-	-	1.09489	-	-	1.09270	-	-
112	S S OB-L2	1.08390	-	-	1.09490	-	-	1.09271	-	-
114	S S OB-LB	1.08352	-	-	1.09396	-	-	1.09215	-	-
115	S S OB-LA	1.08361	-	-	1.09396	-	-	1.09216	-	-
118	S S OB-LV	1.08347	-	-	1.09399	-	-	1.09204	-	-
119	S S OB-S1	1.08388	-	-	1.09489	-	-	1.09271	-	-
120	S S OB-S3	1.08390	-	-	1.09489	-	-	1.09271	-	-
122	S S OB-S2	1.08387	-	-	1.09489	-	-	1.09271	-	-
123	S S OB-S4	1.08390	-	-	1.09489	-	-	1.09271	-	-
125	S S OB-T1	1.08352	1.08429	1.08298	1.09396	1.09420	1.09375	1.09215	1.09251	1.09184
130	S S OB-T3	1.08347	1.08431	1.08290	1.09396	1.09380	1.09385	1.09204	1.09265	1.09167

- The standard linearity and cross–talk measurements have been performed with optical aligned sensors. The linearity measurements before, during, and after the temperature cycle, however, have been executed with shifted sensors(in $\pm X_c$–direction) as both sensors were calibrated at the same time in the thermal box. Therefore, both kinds of measurements show different results.

- The variation of the sensitivity for all the different measurements of the same kind is in the order of $\pm 1.0 \cdot 10^{-5}$.
  Exception: the differences of the sensitivities before and after the thermal cycle of the FS–IB is about $6.0 \cdot 10^{-5}$ and of the FS–OB is $0.9 \cdot 10^{-5}$.

- Remark:
  For CLUSTER the sensitivity variation before and after the T–cycle was in the order of $1.0 \cdot 10^{-3}$.

- The temperature coefficients of the sensitivity are of the order of $-1 \cdot 10^{-5}/\mathrm{K}$ for all sensors.
  For details of the temperature dependence refer to the pages indicated in the first column.

2.2.3 Internal Alignment

Page	Exp.	Internal Sensor Alignment X,Y Temperature °C			Internal Sensor Alignment X,Z Temperature °C			Internal Sensor Alignment Y,Z Temperature °C		
		9...30	−35...−33	60...63	9...30	−35...−33	60...63	9...30	−35...−33	60...63
15	MM I B-L1	90°03'	-	-	89°57'	-	-	89°57'	-	-
16	MM I B-L2	90°03'	-	-	89°57'	-	-	89°57'	-	-
18	MM I B-LB	90°02'	-	-	89°58'	-	-	89°57'	-	-
19	MM I B-LA	90°02'	-	-	89°58'	-	-	89°57'	-	-
22	MM I B-S1	90°03'	-	-	89°57'	-	-	89°57'	-	-
23	MM I B-S2	90°03'	-	-	89°57'	-	-	89°57'	-	-
24	MM I B-S3	90°03'	-	-	89°57'	-	-	89°57'	-	-
26	MM I B-T1	90°02'	90°02'	90°02'	89°58'	89°58'	89°58'	89°57'	89°57'	89°57'
30	MMOB-L1	90°04'	-	-	90°01'	-	-	90°04'	-	-
31	MMOB-L2	90°04'	-	-	90°01'	-	-	90°04'	-	-
33	MMOB-LB	90°04'	-	-	90°02'	-	-	90°02'	-	-
34	MMOB-LA	90°04'	-	-	90°02'	-	-	90°02'	-	-
37	MMOB-S1	90°04'	-	-	90°01'	-	-	90°04'	-	-
38	MMOB-S2	90°04'	-	-	90°01'	-	-	90°04'	-	-
39	MMOB-S3	90°04'	-	-	90°01'	-	-	90°04'	-	-
41	MMOB-T1	90°04'	90°04'	90°04'	90°02'	90°03'	90°02'	90°02'	90°02'	90°02'
45	M S I B-L1	90°01'	-	-	89°54'	-	-	89°59'	-	-
46	M S I B-L2	90°01'	-	-	89°54'	-	-	89°59'	-	-
48	M S I B-S1	90°01'	-	-	89°54'	-	-	89°59'	-	-
49	M S I B-S3	90°01'	-	-	89°54'	-	-	89°59'	-	-
51	M S I B-S2	90°01'	-	-	89°54'	-	-	89°59'	-	-
52	M S I B-S4	90°01'	-	-	89°54'	-	-	89°59'	-	-
55	M S OB-L1	90°03'	-	-	89°52'	-	-	90°06'	-	-
56	M S OB-L2	90°03'	-	-	89°52'	-	-	90°06'	-	-
58	M S OB-S1	90°03'	-	-	89°52'	-	-	90°06'	-	-
59	M S OB-S3	90°03'	-	-	89°52'	-	-	90°06'	-	-
61	M S OB-S2	90°03'	-	-	89°52'	-	-	90°06'	-	-
62	M S OB-S4	90°03'	-	-	89°52'	-	-	90°06'	-	-
65	S M I B-L1	90°03'	-	-	89°56'	-	-	89°57'	-	-
66	S M I B-LB	90°02'	-	-	89°58'	-	-	89°57'	-	-
68	S M I B-S1	90°03'	-	-	89°56'	-	-	89°57'	-	-
69	S M I B-T4	90°02'	90°02'	90°02'	89°58'	89°57'	89°58'	89°57'	89°56'	89°57'
74	S MOB-L1	90°04'	-	-	90°01'	-	-	90°04'	-	-
75	S MOB-L2	90°04'	-	-	90°01'	-	-	90°03'	-	-
77	S MOB-LB	90°04'	-	-	90°02'	-	-	90°02'	-	-
78	S MOB-S1	90°04'	-	-	90°01'	-	-	90°03'	-	-
81	S MOB-S2	90°04'	-	-	90°01'	-	-	90°03'	-	-
82	S MOB-S3	90°04'	-	-	90°01'	-	-	90°03'	-	-
83	S MOB-T4	90°04'	90°04'	90°04'	90°02'	90°02'	90°02'	90°02'	90°02'	90°02'
88	S S I B-L1	90°01'	-	-	89°54'	-	-	89°59'	-	-
89	S S I B-L2	90°01'	-	-	89°54'	-	-	89°59'	-	-
91	S S I B-LB	90°00'	-	-	89°55'	-	-	89°58'	-	-
92	S S I B-LA	90°00'	-	-	89°55'	-	-	89°58'	-	-
95	S S I B-LV	89°59'	-	-	89°55'	-	-	89°58'	-	-
96	S S I B-S1	90°01'	-	-	89°54'	-	-	89°59'	-	-
97	S S I B-S3	90°01'	-	-	89°54'	-	-	89°59'	-	-
99	S S I B-S2	90°01'	-	-	89°54'	-	-	89°59'	-	-
100	S S I B-S4	90°01'	-	-	89°54'	-	-	89°59'	-	-
102	S S I B-T1	90°00'	90°00'	90°00'	89°55'	89°55'	89°55'	89°58'	89°58'	89°58'
107	S S I B-T3	90°00'	90°00'	89°59'	89°55'	89°55'	89°55'	89°58'	89°58'	89°58'
111	S S OB-L1	90°03'	-	-	89°52'	-	-	90°05'	-	-
112	S S OB-L2	90°03'	-	-	89°52'	-	-	90°05'	-	-
114	S S OB-LB	90°02'	-	-	89°53'	-	-	90°04'	-	-
115	S S OB-LA	90°02'	-	-	89°53'	-	-	90°04'	-	-
118	S S OB-LV	90°02'	-	-	89°53'	-	-	90°04'	-	-
119	S S OB-S1	90°03'	-	-	89°52'	-	-	90°05'	-	-
120	S S OB-S3	90°03'	-	-	89°52'	-	-	90°05'	-	-
122	S S OB-S2	90°03'	-	-	89°52'	-	-	90°05'	-	-
123	S S OB-S4	90°03'	-	-	89°52'	-	-	90°05'	-	-
125	S S OB-T1	90°02'	90°02'	90°02'	89°53'	89°54'	89°53'	90°04'	90°04'	90°04'
130	S S OB-T3	90°02'	90°02'	90°02'	89°54'	89°54'	89°53'	90°04'	90°04'	90°04'

- The variation of the Alignment is less then one arc minute.

- The maximum absolute values of the alignment temperature coefficients are of the order of $5 \cdot 10^{-3}$'/K for all sensors.
  For details of the temperature dependence refer to the pages indicated in the first column.

- Remark:
  For CLUSTER the maximum absolute values of the alignment temperature coefficients were of the order of 0.1'/K.

3   DPU: FM

3.1   SENSOR: FM

3.1.1   Inboard Sensor (IB)

3.1.1.1   Offset before T-cycle

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Summary Sheet (Offset Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFM\IB\O\D03-19\MMIO001.aut
Comment     : ROS DPU-FM SEN-FM-IB OFF
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset        : +0.0000000 +0.0000000 +0.0000000

Date        : 19/03
Time        : 15:14:43 - 16:12:22
Quality of Input Data:
Mean Temperature: -99.990
                Xc        Yc        Zc        T
Mean stddev: +0.143    +0.247    +0.136     -99.990



Result:
          Offset        Residual field
    X     +9.40e+01        +1.96e+00
    Y     -7.40e+01        +1.76e-02
    Z     +4.77e+02        +2.10e-01
```

3.1.1.2   Calibration on Axes

3.1.1.2.1   First Measurement

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFM\IB\L\D03-22\MMIL001.aut
Comment     : ROS DPU-FM SEN-FM-IB LIN
Date        : 22/03
Time        : 18:56:55 - 20:28:45
Facility Parameter:
```

```
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +16.969 [deg C]
Mean stddev xp [nT]:+0.149   yp [nT]:+0.215    zp [nT]:+0.118    T [C]:+0.047


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter      ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1          1.09015    --------      --------      --------      --------
   m1,2        -1.37354e-004 --------     --------      --------      --------
   m1,3         2.32044e-003 --------     --------      --------      --------
   m2,1        -7.76120e-004 --------     --------      --------      --------
   m2,2          1.09408    --------      --------      --------      --------
   m2,3        -4.15682e-003 --------     --------      --------      --------
   m3,1        -1.36379e-003 --------     --------      --------      --------
   m3,2         4.98561e-003 --------     --------      --------      --------
   m3,3          1.09349    --------      --------      --------      --------
               ^0[nT]       Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp          --------     --------      --------      --------
   yp          --------     --------      --------      --------
   zp          --------     --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  2'53.9   x,z:  89 56'58.3   y,z:  89 57'23.0
Sensitivity [1]          x: 1.090150733   y: 1.094083955   z: 1.093504615


Static Setup              xf             yf             zf
   xp [deg,','']          0  7'18.4      89 59'32.1     90  7'17.6
   yp [deg,','']         89 57'32.1       0 13'17.6     89 46'56.2
   zp [deg,','']         89 55'42.6      90 15'39.8      0 16'14.4
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):                Orthogonality (O^-1):
    1.09015     0.00000     0.00000      1.00000  -8.434e-004  8.807e-004
    0.00000     1.09408     0.00000      0.00000   9.999e-001  7.615e-004
    0.00000     0.00000     1.09350      0.00000   0.00000     9.999e-001
Rotation (R^-1):
 9.999e-001 -7.122e-004  1.240e-003  Rot. about X axis:-   0 15'39.7
-7.119e-004  9.999e-001 -4.562e-003  Rot. about Y axis:   0  4'18.0
-1.251e-003 -4.556e-003  9.999e-001  Rot. about Z axis:   0  2'26.8
Determinant (R^-1):  9.999e-001


Quality of Fit:       Xp          Yp          Zp
Residual Min  [nT]: -2.468e-01  -5.166e-01  -5.064e-01
         Max  [nT]: +1.950e-01  +4.604e-01  +1.198e-01
         Mean [nT]: -3.466e-02  +3.356e-02  -6.730e-02
         Std  [nT]: +1.053e-01  +1.781e-01  +1.316e-01
```

3.1.1.2.2 Second Measurement

```
Summary Sheet (Global Mode)



Program    : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFM\IB\L\D03-23\MMIL001.aut
```
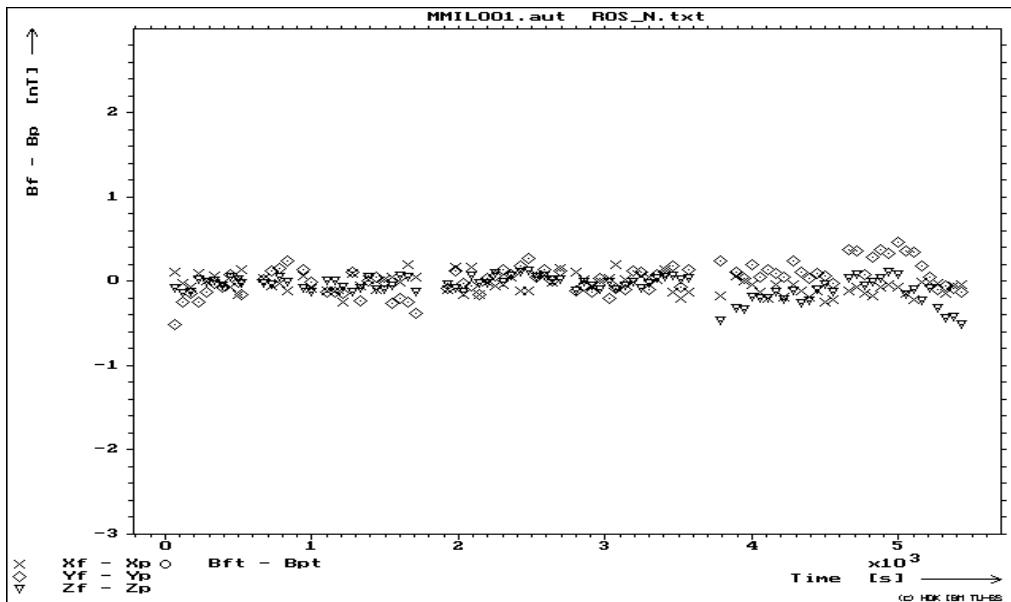
```
Comment      : ROS DPU-FM SEN-FM-IB LIN
Date         : 23/03
Time         : 04:55:23 - 06:28:49
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset [nT]  : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +16.916 [deg C]
Mean stddev xp [nT]:+0.152   yp [nT]:+0.220    zp [nT]:+0.117    T [C]:+0.037

Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)
```

Parameter	^1[1]	^2[nT^-1]	^3[nT^-2]	^4[nT^-3]	^5[nT^-4]
m1,1	1.09014	--------	--------	--------	--------
m1,2	-1.36680e-004	--------	--------	--------	--------
m1,3	2.31654e-003	--------	--------	--------	--------
m2,1	-7.80927e-004	--------	--------	--------	--------
m2,2	1.09408	--------	--------	--------	--------
m2,3	-4.16807e-003	--------	--------	--------	--------
m3,1	-1.36744e-003	--------	--------	--------	--------
m3,2	4.99421e-003	--------	--------	--------	--------
m3,3	1.09350	--------	--------	--------	--------
	^0[nT]	Tx[C^-1]	Ty[C^-1]	Tz[C^-1]	
xp	--------	--------	--------	--------	
yp	--------	--------	--------	--------	
zp	--------	--------	--------	--------	

```
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90 2'54.7  x,z:  89 56'59.7   y,z:  89 57'23.5
Sensitivity [1]      x: 1.090147029   y: 1.094086360   z: 1.093515560
```

```
Static Setup              xf               yf               zf
  xp [deg,','']        0  7'17.7       89 59'32.2       90  7'16.8
  yp [deg,','']       89 57'31.2        0 13'19.8       89 46'54.1
  zp [deg,','']       89 55'41.9       90 15'41.5        0 16'16.2
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):                 Orthogonality (O^-1):
     1.09015      0.00000      0.00000       1.00000 -8.472e-004  8.738e-004
     0.00000      1.09409      0.00000       0.00000  9.999e-001  7.591e-004
     0.00000      0.00000      1.09352       0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001 -7.166e-004  1.244e-003  Rot. about X axis:-   0 15'41.3
-7.163e-004  9.999e-001 -4.570e-003  Rot. about Y axis:    0  4'18.7
-1.254e-003 -4.564e-003  9.999e-001  Rot. about Z axis:    0  2'27.7
Determinant (R^-1):  9.999e-001


Quality of Fit:         Xp          Yp          Zp
Residual Min  [nT]: -2.762e-01  -6.522e-01  -5.129e-01
         Max  [nT]: +1.602e-01  +3.647e-01  +1.885e-01
         Mean [nT]: -4.240e-02  -7.318e-02  -2.406e-02
         Std  [nT]: +8.602e-02  +2.152e-01  +1.432e-01
```
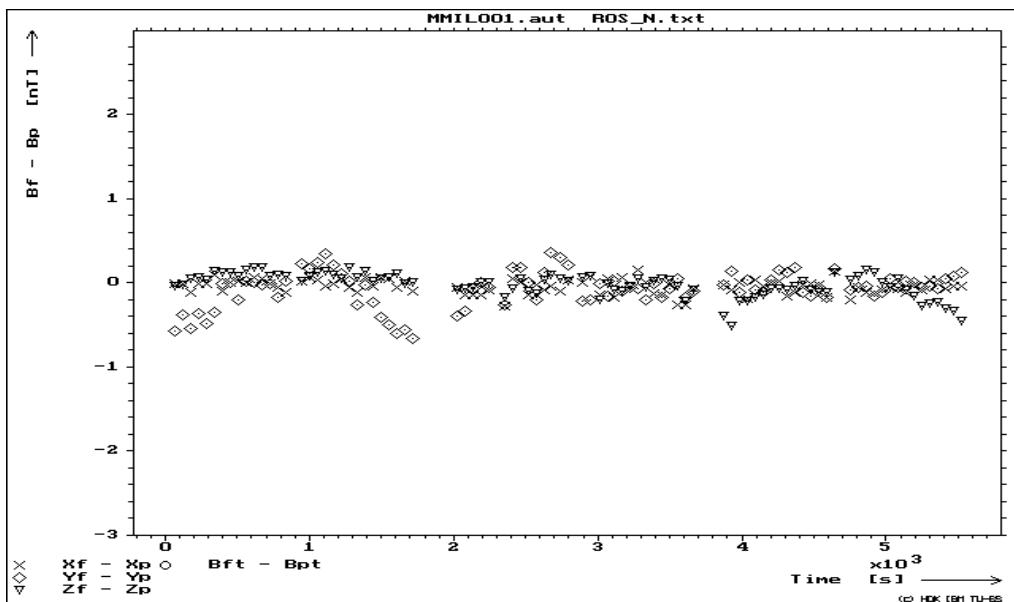

3.1.1.2.3   Measurement just before T–cycle

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFM\IB\L\D03-23\MMITL001.aut
Comment      : ROS DPU-FM SEN-FM-IB T-LIN
Date         : 23/03
Time         : 12:40:58 - 13:19:07
```

```
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): +17.415 [deg C]
Mean stddev xp [nT]:+0.135    yp [nT]:+0.195     zp [nT]:+0.119    T [C]:+0.063


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]         ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1           1.08977     --------      --------      --------      --------
   m1,2        -4.48825e-003  --------      --------      --------      --------
   m1,3         1.95700e-003  --------      --------      --------      --------
   m2,1         3.90543e-003  --------      --------      --------      --------
   m2,2           1.09326     --------      --------      --------      --------
   m2,3        -3.74214e-003  --------      --------      --------      --------
   m3,1        -1.27072e-003  --------      --------      --------      --------
   m3,2         4.71117e-003  --------      --------      --------      --------
   m3,3           1.09284     --------      --------      --------      --------
                 ^0[nT]       Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp           --------      --------      --------      --------
   yp           --------      --------      --------      --------
   zp           --------      --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  1'53.9  x,z:  89 57'53.0  y,z:  89 56'57.6
Sensitivity [1]        x: 1.089779924   y: 1.093274094   z: 1.092850012


Static Setup              xf            yf            zf
   xp [deg,','']       0 15'24.1    89 45'51.6      90  6' 6.4
   yp [deg,','']      90 12'18.3     0 17' 2.6      89 48'12.3
   zp [deg,','']      89 55'56.3    90 14'47.8       0 15'20.6
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):            Orthogonality (O^-1):
    1.08978     0.00000     0.00000      1.00000 -5.523e-004  6.152e-004
    0.00000     1.09327     0.00000      0.00000  9.999e-001  8.841e-004
    0.00000     0.00000     1.09285      0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  3.557e-003  1.178e-003  Rot. about X axis:-  0 14'48.7
 3.583e-003  9.999e-001 -4.310e-003  Rot. about Y axis:   0  4' 0.5
-1.166e-003 -4.304e-003  9.999e-001  Rot. about Z axis:-  0 12'19.1
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -9.513e-02  -2.436e-01  -4.646e-01
        Max   [nT]: +2.618e-01  +3.694e-01  +1.573e-01
        Mean  [nT]: +3.152e-02  +8.910e-02  -3.875e-02
        Std   [nT]: +8.053e-02  +1.331e-01  +1.247e-01
```

3.1.1.2.4   Measurement just after T–cycle

```
Summary Sheet (Global Mode)


Program    : kalt.exe Version 4.00
```
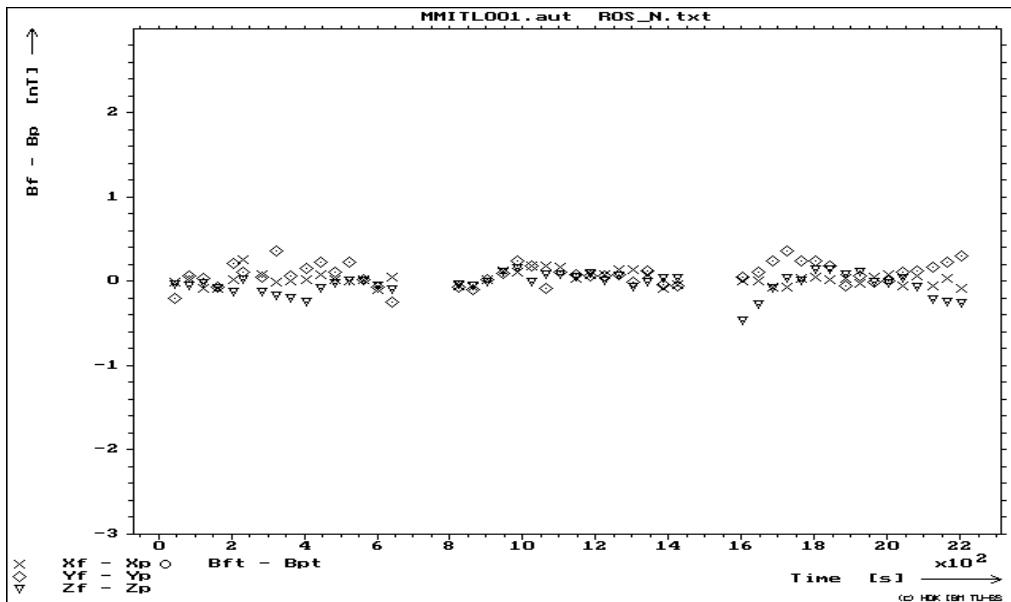
```
Input files : o:\fgm\a\ROS\DPUFM\SFM\IB\L\D03-28\MMITL002.aut
Comment     : ROS DPU-FM SEN-FM-IB T-LIN
Date        : 28/03
Time        : 09:04:25 - 09:42:28
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset [nT]  : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +19.942 [deg C]
Mean stddev xp [nT]:+0.146   yp [nT]:+0.237    zp [nT]:+0.126    T [C]:+0.067

Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter     ^1[1]         ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1           1.08973    --------      --------      --------      --------
   m1,2      -6.43935e-003   --------      --------      --------      --------
   m1,3       2.47510e-003   --------      --------      --------      --------
   m2,1       5.81848e-003   --------      --------      --------      --------
   m2,2           1.09324    --------      --------      --------      --------
   m2,3      -2.69469e-003   --------      --------      --------      --------
   m3,1      -1.78490e-003   --------      --------      --------      --------
   m3,2       3.68788e-003   --------      --------      --------      --------
   m3,3           1.09282    --------      --------      --------      --------
                 ^0[nT]      Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp            --------    --------      --------      --------
   yp            --------    --------      --------      --------
   zp            --------    --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90 2' 2.2  x,z:   89 57'52.5  y,z:   89 56'54.1
Sensitivity [1]        x: 1.089750209  y: 1.093257979   z: 1.092831414
```

```
Static Setup             xf              yf              zf
  xp [deg,','']       0 21'42.0      89 39'43.5      90  7'44.1
  yp [deg,','']      90 18'20.4       0 20'13.3      89 51'28.9
  zp [deg,','']      89 54'18.4      90 11'33.7       0 12'53.3
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):                 Orthogonality (O^-1):
    1.08975     0.00000     0.00000     1.00000 -5.924e-004  6.180e-004
    0.00000     1.09326     0.00000     0.00000  9.999e-001  9.014e-004
    0.00000     0.00000     1.09283     0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  5.303e-003  1.651e-003  Rot. about X axis:-   0 11'35.5
 5.339e-003  9.999e-001 -3.370e-003  Rot. about Y axis:    0  5'37.8
-1.637e-003 -3.363e-003  9.999e-001  Rot. about Z axis:-   0 18'21.3
Determinant (R^-1):  9.999e-001

Quality of Fit:         Xp          Yp          Zp
Residual Min  [nT]: -1.497e-01  -4.852e-01  -3.665e-01
         Max  [nT]: +1.370e-01  +1.773e-01  +1.778e-01
         Mean [nT]: -2.936e-02  -8.050e-03  -5.830e-02
         Std  [nT]: +6.776e-02  +1.405e-01  +1.153e-01
```
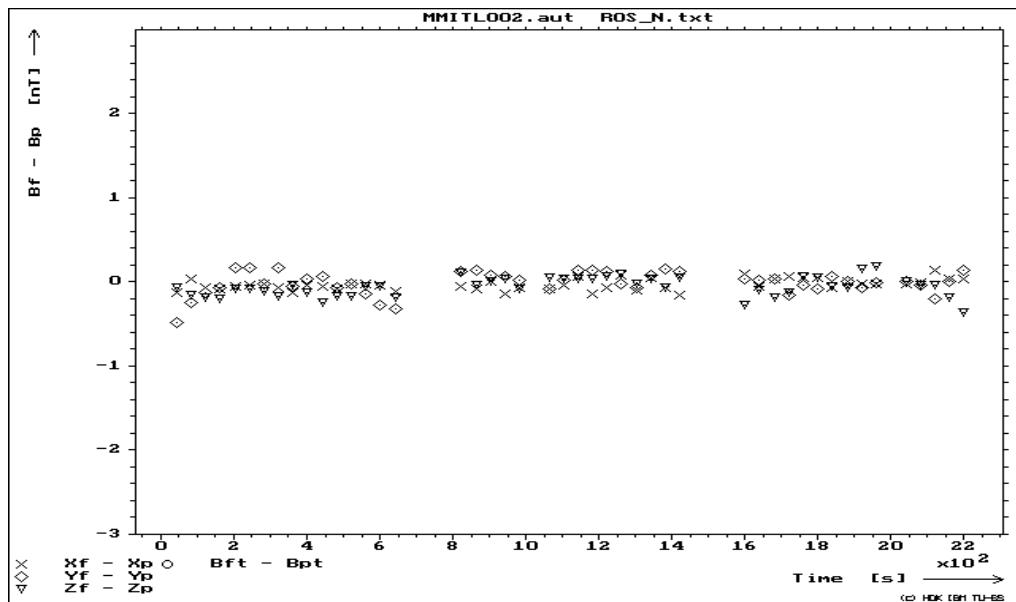
3.1.1.3   Calibration on a Spiral Sphere

```
Summary Sheet (Global Mode)



Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFM\IB\S\D03-22\MMIS001.aut
Comment      : ROS DPU-FM SEN-FM-IB SPHERE
Date         : 22/03
Time         : 20:30:06 - 00:21:34
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +16.968 [deg C]
Mean stddev xp [nT]:+0.162   yp [nT]:+0.216    zp [nT]:+0.130    T [C]:+0.047


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter      ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
  m1,1           1.09015    --------      --------      --------      --------
  m1,2      -1.34906e-004   --------      --------      --------      --------
  m1,3       2.31697e-003   --------      --------      --------      --------
  m2,1      -7.77302e-004   --------      --------      --------      --------
  m2,2           1.09407    --------      --------      --------      --------
  m2,3      -4.15970e-003   --------      --------      --------      --------
  m3,1      -1.36018e-003   --------      --------      --------      --------
  m3,2       4.98672e-003   --------      --------      --------      --------
  m3,3           1.09350    --------      --------      --------      --------
                ^0[nT]      Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
  xp          --------      --------      --------      --------
  yp          --------      --------      --------      --------
  zp          --------      --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,','']  x,y:  90  2'53.7  x,z:  89 56'58.3   y,z:  89 57'23.4
Sensitivity [1]       x: 1.090153590   y: 1.094075606    z: 1.093510034


Static Setup            xf              yf              zf
  xp [deg,','']         0  7'17.8      89 59'32.5      90  7'16.9
  yp [deg,','']        89 57'31.9       0 13'18.1      89 46'55.6
  zp [deg,','']        89 55'43.3      90 15'40.1       0 16'14.5
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):            Orthogonality (O^-1):
    1.09015     0.00000    0.00000     1.00000 -8.422e-004  8.809e-004
    0.00000     1.09408    0.00000     0.00000  9.999e-001  7.599e-004
    0.00000     0.00000    1.09351     0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001 -7.133e-004  1.237e-003  Rot. about X axis:-  0 15'39.9
-7.130e-004  9.999e-001 -4.563e-003  Rot. about Y axis:   0  4'17.3
-1.247e-003 -4.557e-003  9.999e-001  Rot. about Z axis:   0  2'27.0
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -3.889e-01  -6.361e-01  -3.554e-01
        Max  [nT]: +4.979e-01  +3.479e-01  +3.973e-01
        Mean [nT]: +7.248e-03  -9.294e-02  -5.833e-02
        Std  [nT]: +1.589e-01  +1.745e-01  +1.594e-01
```
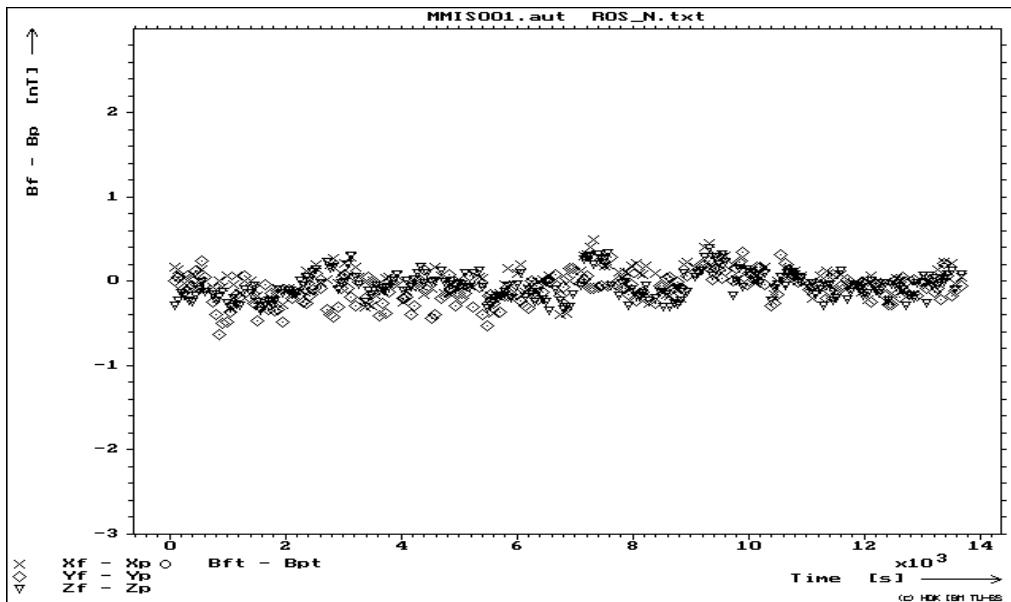
3.1.1.4   Calibration on a Sphere

3.1.1.4.1   First Measurement

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFM\IB\S\D03-23\MMIS001.aut
Comment      : ROS DPU-FM SEN-FM-IB SPHERE
Date         : 23/03
Time         : 00:23:47 - 04:54:07
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): +16.951 [deg C]
Mean stddev xp [nT]:+0.151   yp [nT]:+0.190    zp [nT]:+0.127    T [C]:+0.050


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter     ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
  m1,1          1.09015    --------      --------      --------      --------
  m1,2       -1.33743e-004 --------      --------      --------      --------
  m1,3        2.31730e-003 --------      --------      --------      --------
  m2,1       -7.74811e-004 --------      --------      --------      --------
  m2,2          1.09407    --------      --------      --------      --------
```

```
m2,3      -4.16179e-003    --------    --------    --------    --------
m3,1      -1.35734e-003    --------    --------    --------    --------
m3,2       4.98749e-003    --------    --------    --------    --------
m3,3       1.09350          --------    --------    --------    --------
                ^0[nT]      Tx[C^-1]    Ty[C^-1]    Tz[C^-1]
xp          --------        --------    --------    --------
yp          --------        --------    --------    --------
zp          --------        --------    --------    --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,','']  x,y:   90  2'53.0   x,z:   89 56'57.7   y,z:   89 57'23.6
Sensitivity [1]        x: 1.090154136    y: 1.094075016    z: 1.093508131

Static Setup              xf              yf              zf
  xp [deg,','']           0  7'17.8      89 59'32.7       90  7'17.0
  yp [deg,','']          89 57'32.4       0 13'18.4       89 46'55.2
  zp [deg,','']          89 55'43.8      90 15'40.2        0 16'14.5
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):               Orthogonality (O^-1):
    1.09015     0.00000     0.00000       1.00000 -8.389e-004  8.838e-004
    0.00000     1.09408     0.00000       0.00000  9.999e-001  7.586e-004
    0.00000     0.00000     1.09351       0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001 -7.110e-004  1.234e-003  Rot. about X axis:-   0 15'40.0
-7.107e-004  9.999e-001 -4.563e-003  Rot. about Y axis:    0  4'16.8
-1.245e-003 -4.558e-003  9.999e-001  Rot. about Z axis:    0  2'26.6
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp          Yp          Zp
Residual Min [nT]: -2.930e-01  -5.681e-01  -3.796e-01
         Max  [nT]: +3.844e-01  +2.704e-01  +3.091e-01
         Mean [nT]: +2.540e-02  -5.478e-02  -2.296e-02
         Std  [nT]: +1.284e-01  +1.674e-01  +1.388e-01
```
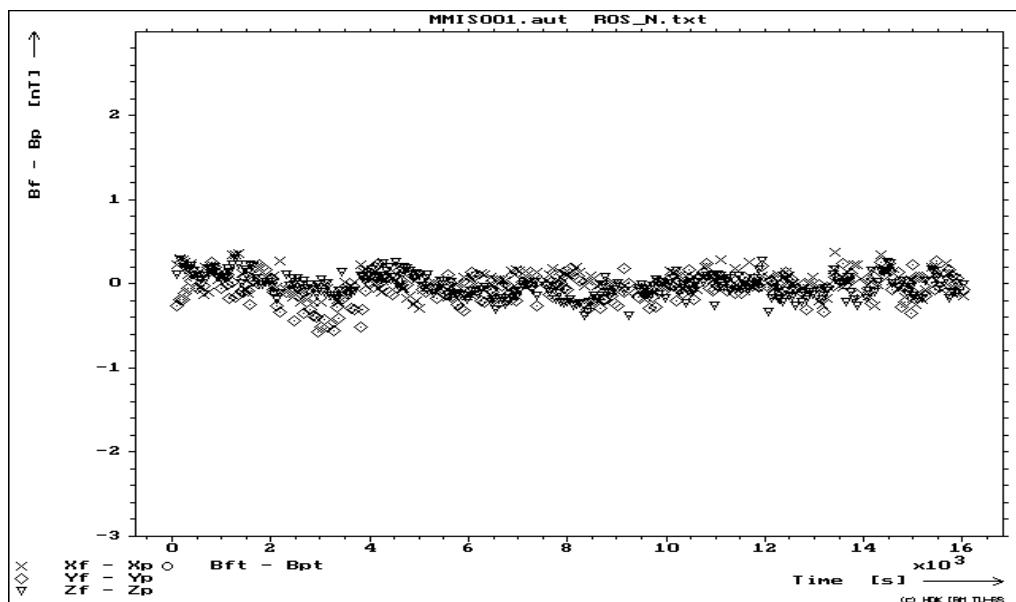
3.1.1.4.2   Second Measurement

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files  : o:\fgm\a\ROS\DPUFM\SFM\IB\S\D03-23\MMIS002.aut
Comment      : ROS DPU-FM SEN-FM-IB SPHERE
Date         : 23/03
Time         : 06:31:11 - 11:01:27
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): +16.929 [deg C]
Mean stddev xp [nT]:+0.156    yp [nT]:+0.213    zp [nT]:+0.123    T [C]:+0.048


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter     ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1          1.09015    --------      --------      --------      --------
   m1,2       -1.34788e-004 --------      --------      --------      --------
   m1,3        2.31929e-003 --------      --------      --------      --------
   m2,1       -7.81178e-004 --------      --------      --------      --------
   m2,2          1.09407    --------      --------      --------      --------
   m2,3       -4.15725e-003 --------      --------      --------      --------
   m3,1       -1.36181e-003 --------      --------      --------      --------
   m3,2        4.98535e-003 --------      --------      --------      --------
   m3,3          1.09350    --------      --------      --------      --------
                 ^0[nT]     Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp          --------     --------      --------      --------
   yp          --------     --------      --------      --------
   zp          --------     --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  2'54.4  x,z:   89 56'58.1   y,z:   89 57'23.2
Sensitivity [1]        x: 1.090154916   y: 1.094076485   z: 1.093508792


Static Setup            xf              yf              zf
   xp [deg,','']       0  7'18.2      89 59'32.6      90  7'17.3
   yp [deg,','']      89 57'31.2       0 13'17.8      89 46'56.1
   zp [deg,','']      89 55'43.0      90 15'39.8       0 16'14.3
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):              Orthogonality (O^-1):
    1.09015     0.00000     0.00000      1.00000 -8.457e-004  8.815e-004
    0.00000     1.09408     0.00000      0.00000  9.999e-001  7.609e-004
    0.00000     0.00000     1.09351      0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001 -7.168e-004  1.238e-003  Rot. about X axis:-   0 15'39.6
-7.165e-004  9.999e-001 -4.562e-003  Rot. about Y axis:    0  4'17.6
-1.249e-003 -4.556e-003  9.999e-001  Rot. about Z axis:    0  2'27.8
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp         Yp         Zp
Residual Min  [nT]: -3.980e-01 -6.732e-01 -9.435e-01
         Max  [nT]: +3.132e-01 +2.863e-01 +2.101e-01
         Mean [nT]: -2.878e-02 -1.030e-01 -6.981e-02
         Std  [nT]: +1.259e-01 +1.625e-01 +1.511e-01
```
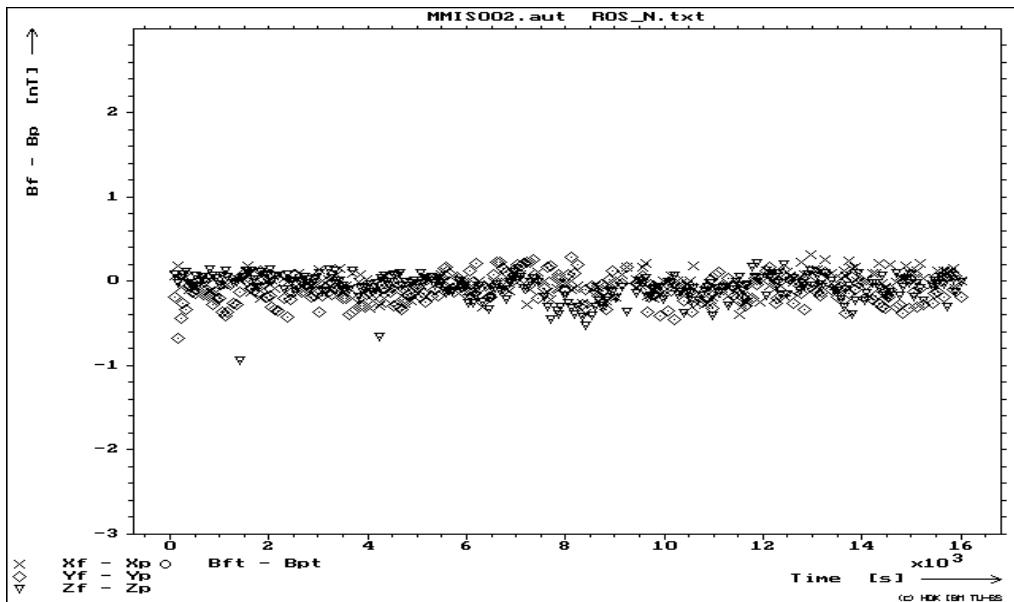
3.1.1.5   Temperature Calibration

```
Summary Sheet (Temperature)


Program      : merf.exe Version 4.0
Input files : o:\fgm\a\ROS\DPUFM\SFM\IB\T\SUM\MMITS001.kas
Comment      :
Date         : 23/03     - 28/03
Time         : 16:21:47 - 08:12:16
Temperature  :   -51.75 -    69.89
Std temp. :        0.0 -        1.98
Std temp. mean :  4.41e-001
Std temp. std. :  4.54e-001


Results:

Measurements : 96 of 101

                  Offset [1]     Slope [1/K]     Correlation [1]
Sensitivity X [1]:       1.09    -1.36786e-005   -9.99190e-001
Sensitivity Y [1]:       1.09339 -8.37337e-006   -9.87906e-001
Sensitivity Z [1]:       1.09296 -8.40135e-006   -9.95704e-001
                  Offset [']     Slope ['/K]     Correlation [1]
Alignment   XY [']:      1.93018  4.32951e-003    9.91231e-001
Alignment   XZ [']:     -2.10678  2.05714e-003    7.21901e-001
Alignment   YZ [']:     -3.12752  7.03332e-003    9.50128e-001


Statistical Parameter:

                  Min            Max             Mean        Std
```

```
Sensitivity X [1]:        1.08901        1.09073        1.08981    4.93041e-004
Sensitivity Y [1]:        1.0927         1.09376        1.09327    3.05262e-004
Sensitivity Z [1]:        1.09229        1.09336        1.09284    3.03883e-004
Alignment   XY [']:       1.64568        2.26752        1.99136    1.57308e-001
Alignment   XZ [']:      -2.21546       -1.83146       -2.07772    1.02629e-001
Alignment   YZ [']:      -3.41381       -2.46114       -3.02814    2.66603e-001
```
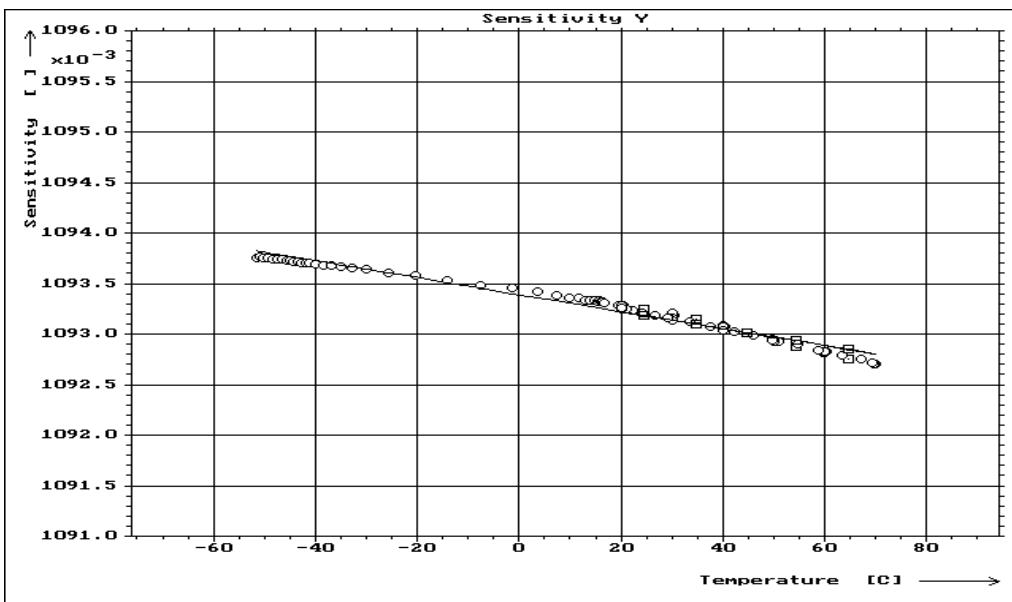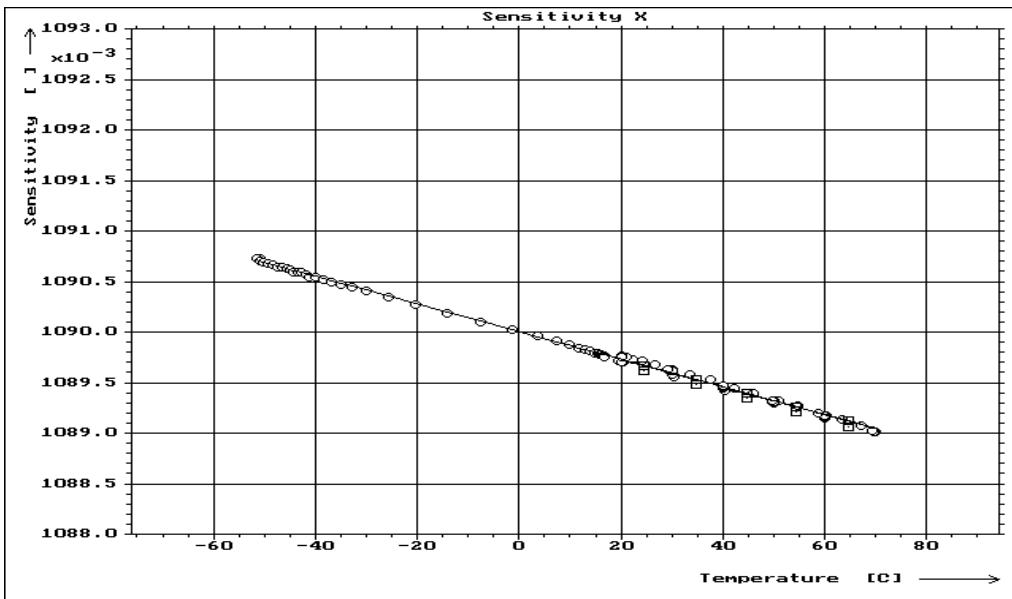
Sensitivity Z

Alignment XY

Alignment XZ
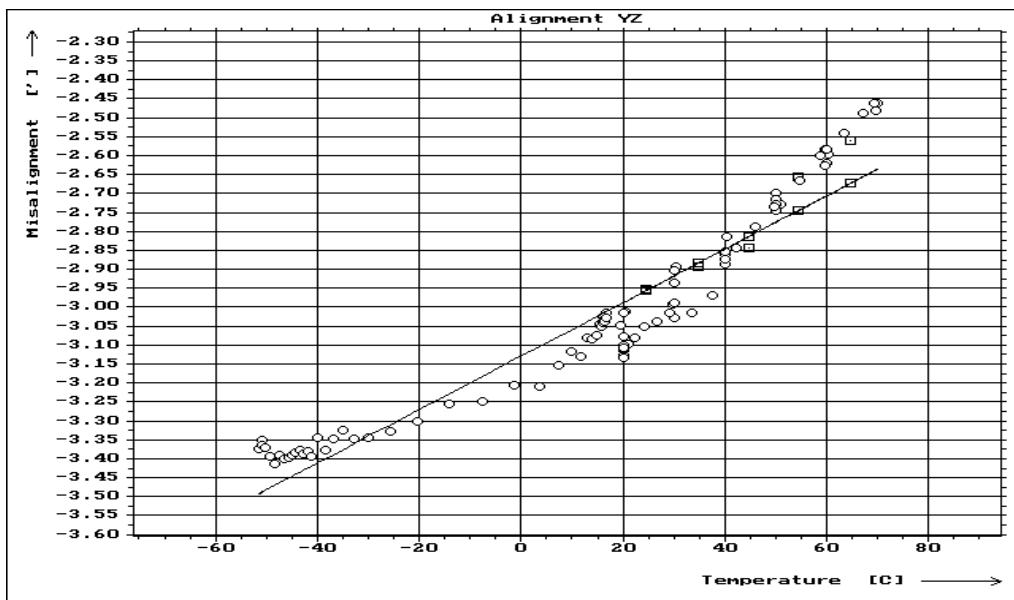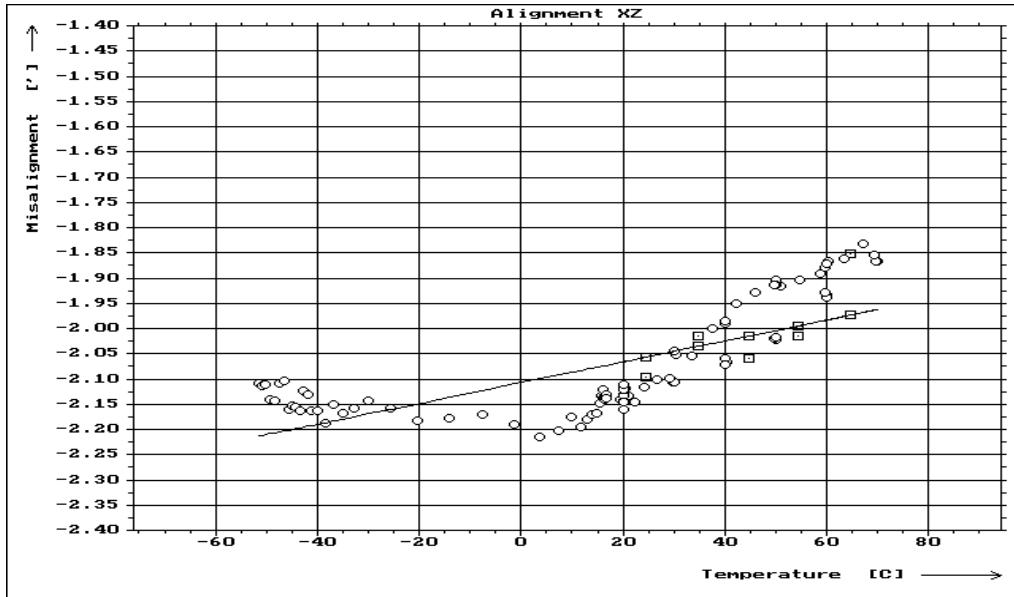
Alignment YZ

3.1.2   Outboard Sensor (OB)

3.1.2.1   Offset before T-cycle

```
Summary Sheet (Offset Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFM\OB\O\D03-19\MMO0001.aut
Comment     : ROS DPU-FM SEN-FM-OB OFF
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset        : +0.0000000 +0.0000000 +0.0000000

Date        : 19/03
Time        : 15:10:36 - 16:05:23
Quality of Input Data:
Mean Temperature: -99.990
                Xc        Yc        Zc        T
Mean stddev: +0.171     +0.221    +0.180     -99.990



Result:
        Offset        Residual field
    X    +1.66e+02        -7.80e-01
    Y    -7.05e+01        -5.51e+00
    Z    +4.52e+02        +2.50e+00
```

3.1.2.2   Calibration on Axes

3.1.2.2.1   First Measurement

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFM\OB\L\D03-21\MMOL001.aut
Comment     : ROS DPU-FM SEN-FM-OB LIN
Date        : 21/03
Time        : 19:10:55 - 20:42:41
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset [nT]  : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +16.846 [deg C]
Mean stddev xp [nT]:+0.183   yp [nT]:+0.216    zp [nT]:+0.158    T [C]:+0.133
```

```
Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter     ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
  m1,1           1.09045    --------      --------      --------      --------
  m1,2       3.11080e-003   --------      --------      --------      --------
  m1,3       6.01839e-003   --------      --------      --------      --------
  m2,1      -4.48464e-003   --------      --------      --------      --------
  m2,2           1.09302    --------      --------      --------      --------
  m2,3      -6.27939e-003   --------      --------      --------      --------
  m3,1      -6.50578e-003   --------      --------      --------      --------
  m3,2       5.12229e-003   --------      --------      --------      --------
  m3,3           1.09211    --------      --------      --------      --------
               ^0[nT]       Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
  xp          --------      --------      --------      --------
  yp          --------      --------      --------      --------
  zp          --------      --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  4'24.4  x,z:   90  1'27.5   y,z:   90  3'32.4
Sensitivity [1]         x: 1.090468051   y: 1.093050511    z: 1.092137080


Static Setup               xf              yf              zf
  xp [deg,','']          0 21'19.8       90  9'41.6       90 19' 0.0
  yp [deg,','']         89 45'44.6        0 24'18.4       89 40'18.7
  zp [deg,','']         89 39'33.4       90 16'10.1        0 26' 3.8
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):                 Orthogonality (O^-1):
    1.09047     0.00000     0.00000     1.00000 -1.281e-003 -4.245e-004
    0.00000     1.09305     0.00000     0.00000  9.999e-001 -1.030e-003
    0.00000     0.00000     1.09214     0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001 -4.099e-003  5.939e-003  Rot. about X axis:-  0 16' 5.0
-4.112e-003  9.999e-001 -4.720e-003  Rot. about Y axis:   0 20'30.5
-5.966e-003 -4.703e-003  9.999e-001  Rot. about Z axis:   0 14' 8.3
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -3.659e-01  -4.449e-01  -3.920e-01
        Max   [nT]: +3.577e-01  +2.585e-01  +3.536e-01
        Mean  [nT]: -1.071e-02  -2.956e-02  +3.045e-02
        Std   [nT]: +1.410e-01  +1.487e-01  +1.362e-01
```

3.1.2.2.2   Second Measurement

```
Summary Sheet (Global Mode)



Program      : kalt.exe Version 4.00
Input files  : o:\fgm\a\ROS\DPUFM\SFM\OB\L\D03-22\MMOL001.aut
Comment      : ROS DPU-FM SEN-FM-OB LIN
Date         : 22/03
Time         : 05:09:22 - 06:41:08
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000
```
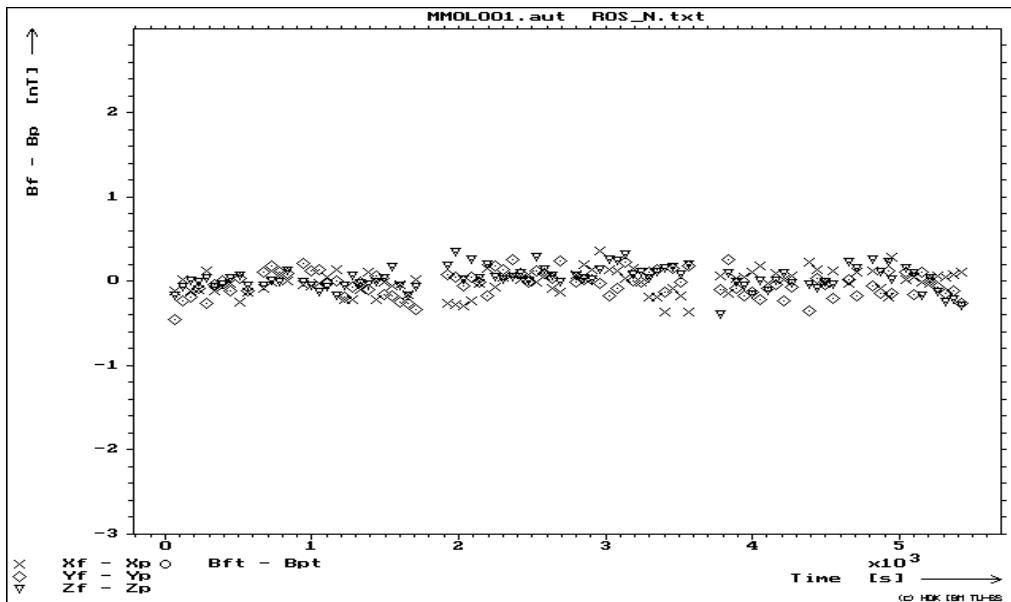
```
Quality of Input Data:
Mean Temperature (T): +16.894 [deg C]
Mean stddev xp [nT]:+0.181   yp [nT]:+0.243     zp [nT]:+0.149    T [C]:+0.024


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter      ^1[1]          ^2[nT^-1]      ^3[nT^-2]      ^4[nT^-3]      ^5[nT^-4]
   m1,1        1.09046        --------       --------       --------       --------
   m1,2        3.10786e-003   --------       --------       --------       --------
   m1,3        6.03054e-003   --------       --------       --------       --------
   m2,1       -4.48723e-003   --------       --------       --------       --------
   m2,2        1.09303        --------       --------       --------       --------
   m2,3       -6.27449e-003   --------       --------       --------       --------
   m3,1       -6.50872e-003   --------       --------       --------       --------
   m3,2        5.12117e-003   --------       --------       --------       --------
   m3,3        1.09211        --------       --------       --------       --------
                ^0[nT]        Tx[C^-1]       Ty[C^-1]       Tz[C^-1]
   xp          --------       --------       --------       --------
   yp          --------       --------       --------       --------
   zp          --------       --------       --------       --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  4'25.4  x,z:   90  1'25.8  y,z:   90  3'31.7
Sensitivity [1]        x: 1.090481099   y: 1.093059467     z: 1.092140324


Static Setup          xf              yf              zf
   xp [deg,','']        0 21'21.6      90  9'41.1      90 19' 2.3
   yp [deg,','']       89 45'44.2       0 24'17.9      89 40'19.7
   zp [deg,','']       89 39'32.8      90 16' 9.8       0 26' 4.1
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):                   Orthogonality (O^-1):
    1.09048    0.00000    0.00000        1.00000  -1.286e-003  -4.161e-004
    0.00000    1.09306    0.00000        0.00000   9.999e-001  -1.027e-003
    0.00000    0.00000    1.09214        0.00000   0.00000    9.999e-001
```

```
Rotation (R^-1):
 9.999e-001 -4.102e-003  5.942e-003  Rot. about X axis:-   0 16' 4.8
-4.114e-003  9.999e-001 -4.719e-003  Rot. about Y axis:    0 20'31.1
-5.968e-003 -4.702e-003  9.999e-001  Rot. about Z axis:    0 14' 8.7
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp         Yp         Zp
Residual Min  [nT]: -2.846e-01  -4.096e-01  -3.773e-01
         Max  [nT]: +3.231e-01  +3.950e-01  +2.545e-01
         Mean [nT]: +7.220e-03  -1.945e-02  -1.917e-02
         Std  [nT]: +1.227e-01  +1.792e-01  +1.095e-01
```
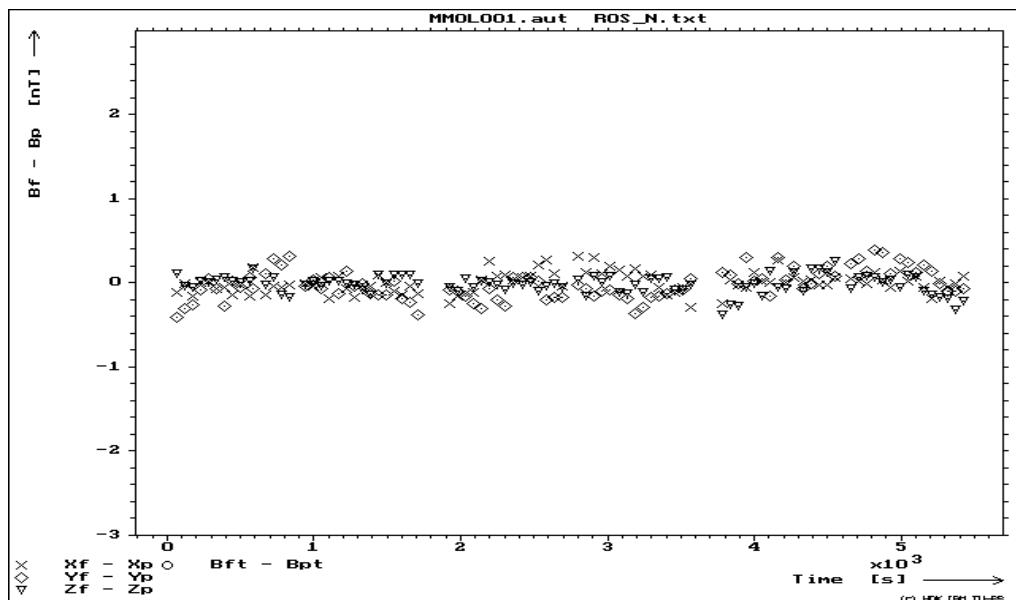

3.1.2.2.3   Measurement just before T–cycle

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files  : o:\fgm\a\ROS\DPUFM\SFM\OB\L\D03-23\MMOTL001.aut
Comment      : ROS DPU-FM SEN-FM-OB T-LIN
Date         : 23/03
Time         : 12:40:58 - 13:19:07
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +17.415 [deg C]
Mean stddev xp [nT]:+0.166   yp [nT]:+0.203    zp [nT]:+0.170    T [C]:+0.063
```

```
Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter     ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1          1.09024    --------      --------      --------      --------
   m1,2      -4.99098e-003  --------      --------      --------      --------
   m1,3       2.71819e-003  --------      --------      --------      --------
   m2,1       3.81208e-003  --------      --------      --------      --------
   m2,2          1.09201    --------      --------      --------      --------
   m2,3      -7.76942e-003  --------      --------      --------      --------
   m3,1      -3.41596e-003  --------      --------      --------      --------
   m3,2       7.09460e-003  --------      --------      --------      --------
   m3,3          1.09141    --------      --------      --------      --------
                 ^0[nT]     Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp         --------      --------      --------      --------
   yp         --------      --------      --------      --------
   zp         --------      --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,','']  x,y:   90  3'47.8  x,z:   90  2'17.4   y,z:   90  2' 8.9
Sensitivity [1]        x: 1.090257275    y: 1.092040273    z: 1.091439672


Static Setup              xf               yf               zf
   xp [deg,','']        0 17'53.2       89 44'13.9        90  8'26.9
   yp [deg,','']       90 11'56.5        0 27'15.4        89 35'29.9
   zp [deg,','']       89 49' 9.0       90 22'17.0         0 24'47.1
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):                  Orthogonality (O^-1):
     1.09026     0.00000     0.00000     1.00000 -1.104e-003 -6.663e-004
     0.00000     1.09204     0.00000     0.00000  9.999e-001 -6.260e-004
     0.00000     0.00000     1.09144     0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  3.486e-003  3.154e-003  Rot. about X axis:-   0 22'19.3
 3.496e-003  9.999e-001 -6.490e-003  Rot. about Y axis:    0 10'46.2
-3.133e-003 -6.482e-003  9.999e-001  Rot. about Z axis:-   0 12' 1.2
Determinant (R^-1):  9.999e-001


Quality of Fit:         Xp          Yp          Zp
Residual Min  [nT]: -1.497e-01  -2.280e-01  -5.910e-01
         Max  [nT]: +2.908e-01  +3.669e-01  +4.564e-01
         Mean [nT]: +4.897e-02  +8.263e-02  -4.677e-02
         Std  [nT]: +1.072e-01  +1.291e-01  +1.888e-01
```

3.1.2.2.4   Measurement just after T–cycle

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFM\OB\L\D03-28\MMOTL002.aut
Comment      : ROS DPU-FM SEN-FM-OB T-LIN
Date         : 28/03
Time         : 09:04:25 - 09:42:28
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000
```
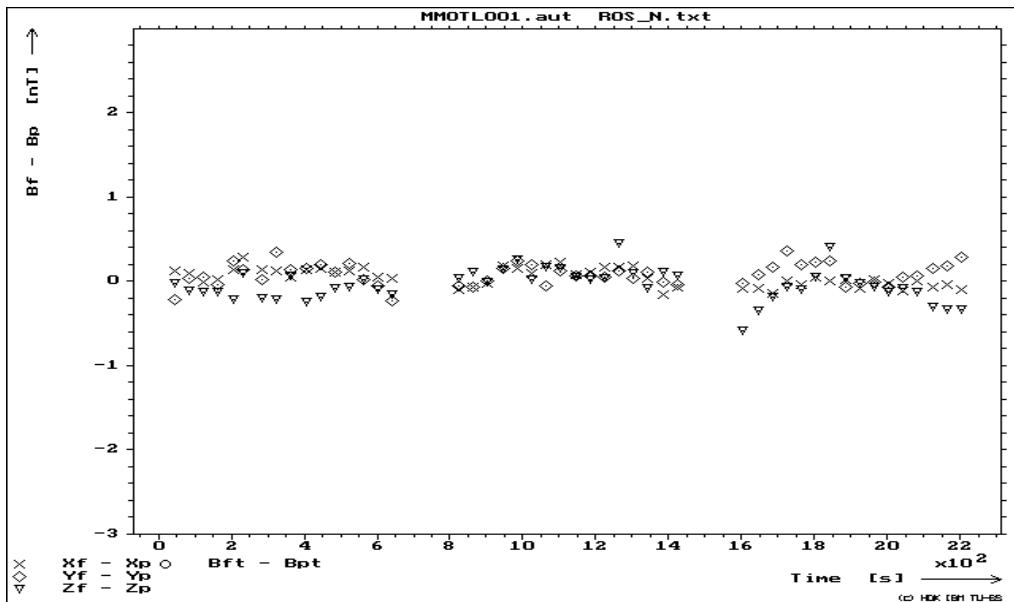
```
Quality of Input Data:
Mean Temperature (T): +19.942 [deg C]
Mean stddev xp [nT]:+0.164    yp [nT]:+0.238     zp [nT]:+0.161    T [C]:+0.067


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter     ^1[1]          ^2[nT^-1]      ^3[nT^-2]      ^4[nT^-3]      ^5[nT^-4]
   m1,1           1.09022     --------       --------       --------       --------
   m1,2       -6.53675e-003   --------       --------       --------       --------
   m1,3        2.89371e-003   --------       --------       --------       --------
   m2,1        5.35967e-003   --------       --------       --------       --------
   m2,2           1.09203     --------       --------       --------       --------
   m2,3       -7.08337e-003   --------       --------       --------       --------
   m3,1       -3.57092e-003   --------       --------       --------       --------
   m3,2        6.44138e-003   --------       --------       --------       --------
   m3,3           1.09141     --------       --------       --------       --------
                 ^0[nT]       Tx[C^-1]       Ty[C^-1]       Tz[C^-1]
   xp           --------      --------       --------       --------
   yp           --------      --------       --------       --------
   zp           --------      --------       --------       --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  3'47.9  x,z:   90  2'14.6   y,z:   90  2' 3.8
Sensitivity [1]        x: 1.090239959   y: 1.092062327     z: 1.091438014


Static Setup           xf             yf             zf
   xp [deg,','']         0 22'30.0      89 39'22.1       90  8'58.8
   yp [deg,','']        90 16'49.6       0 27'58.8       89 37'38.6
   zp [deg,','']        89 48'38.4      90 20'12.5        0 23'10.9
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):              Orthogonality (O^-1):
   1.09024   0.00000   0.00000      1.00000 -1.104e-003 -6.529e-004
   0.00000   1.09206   0.00000      0.00000  9.999e-001 -6.013e-004
```

```
        0.00000      0.00000     1.09144          0.00000      0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  4.900e-003  3.301e-003   Rot. about X axis:-   0 20'15.8
 4.916e-003  9.999e-001 -5.885e-003   Rot. about Y axis:    0 11'15.5
-3.275e-003 -5.878e-003  9.999e-001   Rot. about Z axis:-   0 16'54.0
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -1.984e-01  -6.310e-01  -3.463e-01
         Max  [nT]: +2.453e-01  +4.959e-01  +4.612e-01
         Mean [nT]: -3.092e-03  -1.400e-02  -3.826e-02
         Std  [nT]: +1.131e-01  +2.587e-01  +1.901e-01
```
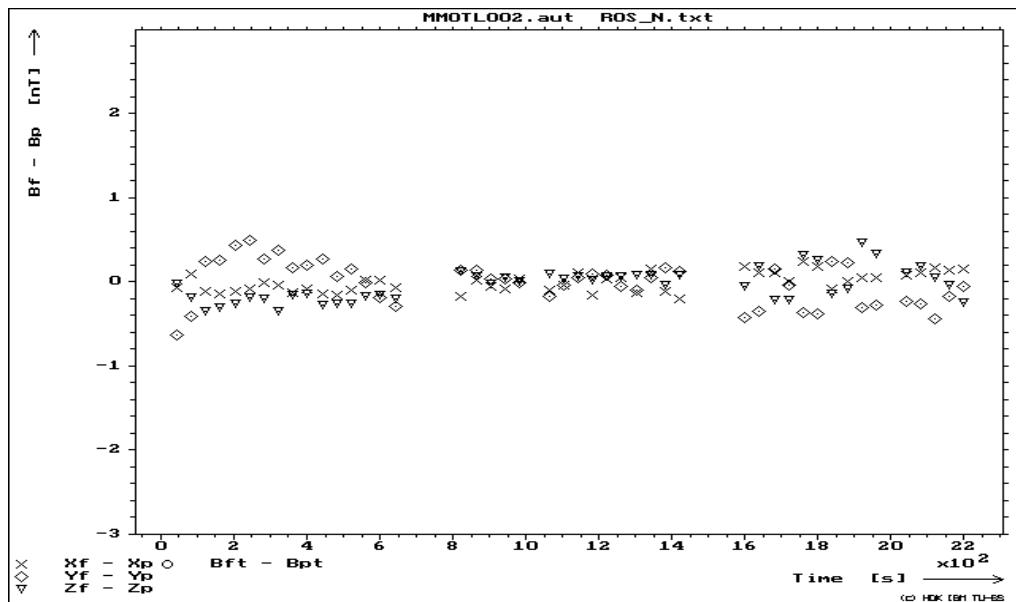
3.1.2.3 Calibration on a Spiral Sphere

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFM\OB\S\D03-21\MMOS001.aut
Comment      : ROS DPU-FM SEN-FM-OB SPHERE
Date         : 21/03
Time         : 20:44:05 - 00:35:31
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): +16.880 [deg C]
Mean stddev xp [nT]:+0.181   yp [nT]:+0.233    zp [nT]:+0.159    T [C]:+0.092


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter     ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
  m1,1           1.09045    --------      --------      --------      --------
  m1,2        3.10088e-003  --------      --------      --------      --------
  m1,3        6.02072e-003  --------      --------      --------      --------
  m2,1       -4.48355e-003  --------      --------      --------      --------
  m2,2           1.09302    --------      --------      --------      --------
  m2,3       -6.28350e-003  --------      --------      --------      --------
  m3,1       -6.50550e-003  --------      --------      --------      --------
  m3,2        5.11388e-003  --------      --------      --------      --------
  m3,3           1.09211    --------      --------      --------      --------
                ^0[nT]      Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
  xp           --------     --------      --------      --------
  yp           --------     --------      --------      --------
  zp           --------     --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  4'26.0   x,z:   90  1'27.0   y,z:   90  3'34.8
Sensitivity [1]        x: 1.090475446   y: 1.093048265    z: 1.092145775


Static Setup             xf              yf              zf
  xp [deg,','']        0 21'19.3       90  9'39.8       90 19' 0.4
  yp [deg,','']       89 45'44.8        0 24'18.9       89 40'17.9
  zp [deg,','']       89 39'33.4       90 16' 8.5        0 26' 2.8
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):              Orthogonality (O^-1):
    1.09048     0.00000    0.00000      1.00000 -1.290e-003 -4.221e-004
    0.00000     1.09305    0.00000      0.00000  9.999e-001 -1.042e-003
    0.00000     0.00000    1.09215      0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001 -4.099e-003  5.939e-003  Rot. about X axis:-   0 16' 3.4
-4.111e-003  9.999e-001 -4.712e-003  Rot. about Y axis:    0 20'30.5
-5.965e-003 -4.695e-003  9.999e-001  Rot. about Z axis:    0 14' 8.0
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -3.683e-01  -5.759e-01  -5.302e-01
         Max  [nT]: +2.688e-01  +4.877e-01  +3.470e-01
         Mean [nT]: -3.904e-02  -1.130e-01  -7.958e-02
         Std  [nT]: +1.355e-01  +1.725e-01  +1.529e-01
```
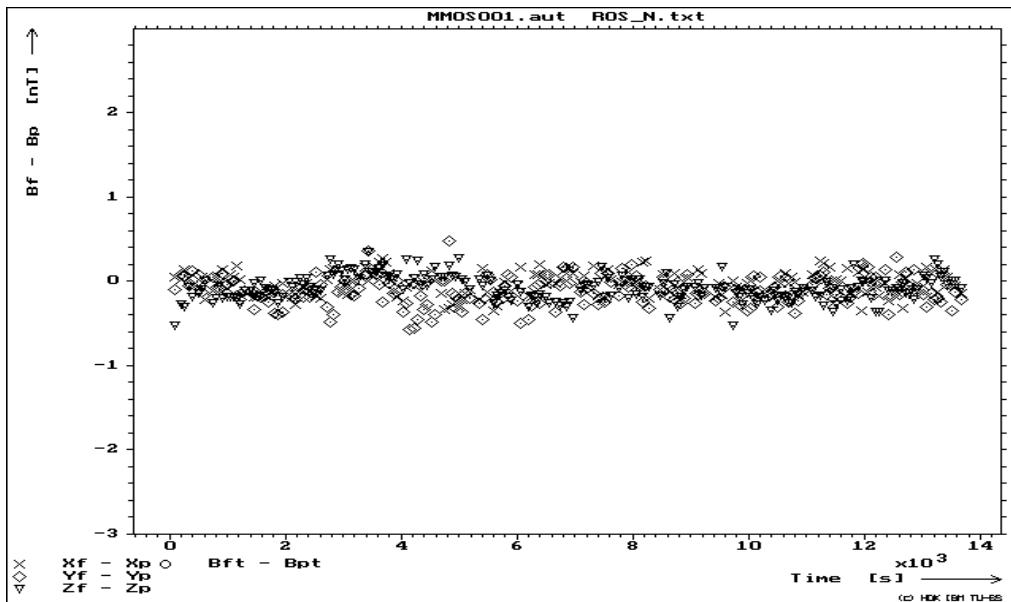
3.1.2.4 Calibration on a Sphere

3.1.2.4.1 First Measurement

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFM\OB\S\D03-22\MMOS001.aut
Comment     : ROS DPU-FM SEN-FM-OB SPHERE
Date        : 22/03
Time        : 00:37:46 - 05:08:04
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +16.875 [deg C]
Mean stddev xp [nT]:+0.180   yp [nT]:+0.210     zp [nT]:+0.161    T [C]:+0.046


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]        ^2[nT^-1]      ^3[nT^-2]      ^4[nT^-3]      ^5[nT^-4]
   m1,1         1.09045      --------       --------       --------       --------
   m1,2         3.10279e-003 --------       --------       --------       --------
   m1,3         6.02590e-003 --------       --------       --------       --------
   m2,1        -4.48662e-003 --------       --------       --------       --------
   m2,2         1.09302      --------       --------       --------       --------
```

```
m2,3     -6.28077e-003   --------   --------   --------   --------
m3,1     -6.50595e-003   --------   --------   --------   --------
m3,2      5.11774e-003   --------   --------   --------   --------
m3,3          1.09211    --------   --------   --------   --------
              ^0[nT]     Tx[C^-1]   Ty[C^-1]   Tz[C^-1]
xp           --------    --------   --------   --------
yp           --------    --------   --------   --------
zp           --------    --------   --------   --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  4'26.3  x,z:  90  1'26.1  y,z:  90  3'33.6
Sensitivity [1]       x: 1.090474435    y: 1.093050613    z: 1.092142366

Static Setup            xf              yf              zf
 xp [deg,','']      0 21'20.4       90  9'40.1       90 19' 1.4
 yp [deg,','']     89 45'44.3        0 24'18.8       89 40'18.5
 zp [deg,','']     89 39'33.3       90 16' 9.2        0 26' 3.3
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):             Orthogonality (O^-1):
    1.09047    0.00000    0.00000    1.00000 -1.291e-003 -4.178e-004
    0.00000    1.09305    0.00000    0.00000  9.999e-001 -1.036e-003
    0.00000    0.00000    1.09214    0.00000    0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001 -4.101e-003  5.939e-003  Rot. about X axis:-  0 16' 4.1
-4.114e-003  9.999e-001 -4.716e-003  Rot. about Y axis:   0 20'30.6
-5.966e-003 -4.698e-003  9.999e-001  Rot. about Z axis:   0 14' 8.6
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp         Yp         Zp
Residual Min [nT]: -5.259e-01  -5.271e-01  -4.849e-01
        Max  [nT]: +7.005e-01  +5.843e-01  +3.165e-01
        Mean [nT]: -1.054e-01  -1.363e-01  -6.353e-02
        Std  [nT]: +1.796e-01  +1.898e-01  +1.402e-01
```
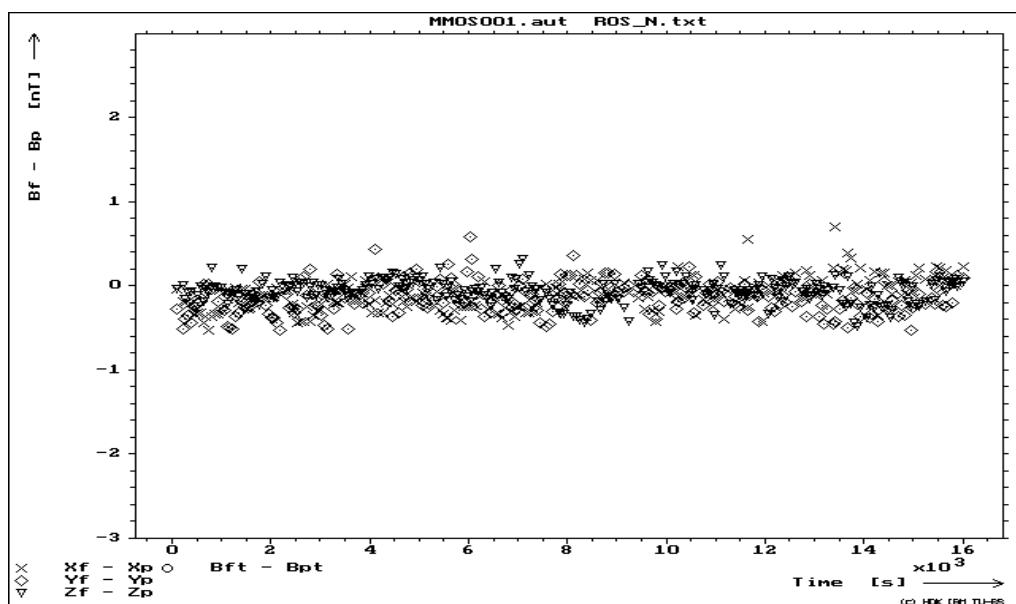
3.1.2.4.2 Second Measurement

```
Summary Sheet (Global Mode)



Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFM\OB\S\D03-22\MMOS002.aut
Comment     : ROS DPU-FM SEN-FM-OB SPHERE
Date        : 22/03
Time        : 06:43:31 - 11:13:48
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): +16.891 [deg C]
Mean stddev xp [nT]:+0.180   yp [nT]:+0.213    zp [nT]:+0.155    T [C]:+0.029


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter      ^1[1]       ^2[nT^-1]    ^3[nT^-2]    ^4[nT^-3]    ^5[nT^-4]
   m1,1          1.09046   --------     --------     --------     --------
   m1,2      3.10166e-003  --------     --------     --------     --------
   m1,3      6.02587e-003  --------     --------     --------     --------
   m2,1     -4.48232e-003  --------     --------     --------     --------
   m2,2          1.09302   --------     --------     --------     --------
   m2,3     -6.28378e-003  --------     --------     --------     --------
   m3,1     -6.50726e-003  --------     --------     --------     --------
   m3,2      5.12099e-003  --------     --------     --------     --------
   m3,3          1.09211   --------     --------     --------     --------
                 ^0[nT]    Tx[C^-1]     Ty[C^-1]     Tz[C^-1]
   xp         --------     --------     --------     --------
   yp         --------     --------     --------     --------
   zp         --------     --------     --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  4'25.7  x,z:   90  1'26.4   y,z:   90  3'33.5
Sensitivity [1]        x: 1.090481114   y: 1.093052011    z: 1.092145230

Static Setup              xf              yf              zf
   xp [deg,','']        0 21'20.3      90  9'39.9       90 19' 1.4
   yp [deg,','']       89 45'45.1       0 24'18.8       89 40'17.9
   zp [deg,','']       89 39'33.1      90 16' 9.8        0 26' 3.9
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):              Orthogonality (O^-1):
    1.09048     0.00000     0.00000      1.00000 -1.288e-003 -4.190e-004
    0.00000     1.09305     0.00000      0.00000  9.999e-001 -1.035e-003
    0.00000     0.00000     1.09215      0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001 -4.097e-003  5.940e-003  Rot. about X axis:-   0 16' 4.8
-4.110e-003  9.999e-001 -4.719e-003  Rot. about Y axis:    0 20'30.8
-5.967e-003 -4.701e-003  9.999e-001  Rot. about Z axis:    0 14' 7.8
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -6.044e-01  -1.060e+00  -5.875e-01
         Max  [nT]: +2.303e-01  +5.317e-01  +2.846e-01
         Mean [nT]: -1.298e-01  -1.204e-01  -4.615e-02
         Std  [nT]: +1.578e-01  +1.855e-01  +1.303e-01
```
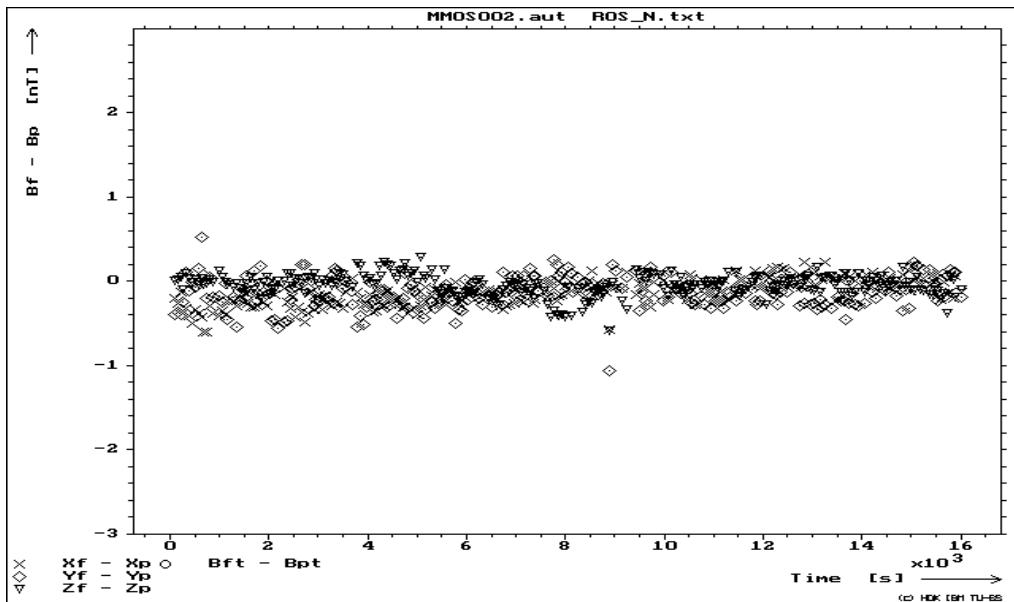
3.1.2.5   Temperature Calibration

```
Summary Sheet (Temperature)


Program      : merf.exe Version 4.0
Input files : o:\fgm\a\ROS\DPUFM\SFM\OB\T\SUM\MMOTS001.kas
Comment      :
Date         : 23/03    - 28/03
Time         : 16:21:47 - 08:12:16
Temperature  :   -51.75 -    69.89
Std temp. :       0.0 -       1.98
Std temp. mean :  4.41e-001
Std temp. std. :  4.54e-001


Results:

Measurements : 96 of 101

                   Offset [1]     Slope [1/K]     Correlation [1]
Sensitivity X [1]:      1.09046   -1.17204e-005   -9.98643e-001
Sensitivity Y [1]:      1.09223   -7.86612e-006   -9.98241e-001
Sensitivity Z [1]:      1.09153   -6.72493e-006   -9.94528e-001
                   Offset [']     Slope ['/K]     Correlation [1]
Alignment   XY [']:     3.84707   -3.76247e-003   -9.78160e-001
Alignment   XZ [']:     2.38991   -7.72549e-003   -9.88913e-001
Alignment   YZ [']:     2.17891   -5.39814e-003   -9.84597e-001


Statistical Parameter:

                  Min           Max           Mean       Std
```

```
Sensitivity X [1]:        1.08959      1.09108      1.09029    4.22689e-004
Sensitivity Y [1]:        1.09169      1.09265      1.09212    2.83800e-004
Sensitivity Z [1]:        1.091        1.09184      1.09144    2.43533e-004
Alignment   XY [']:       3.54021      4.05649      3.79391    1.38532e-001
Alignment   XZ [']:       1.89378      2.8588       2.28076    2.81355e-001
Alignment   YZ [']:       1.82718      2.46273      2.10263    1.97457e-001
```
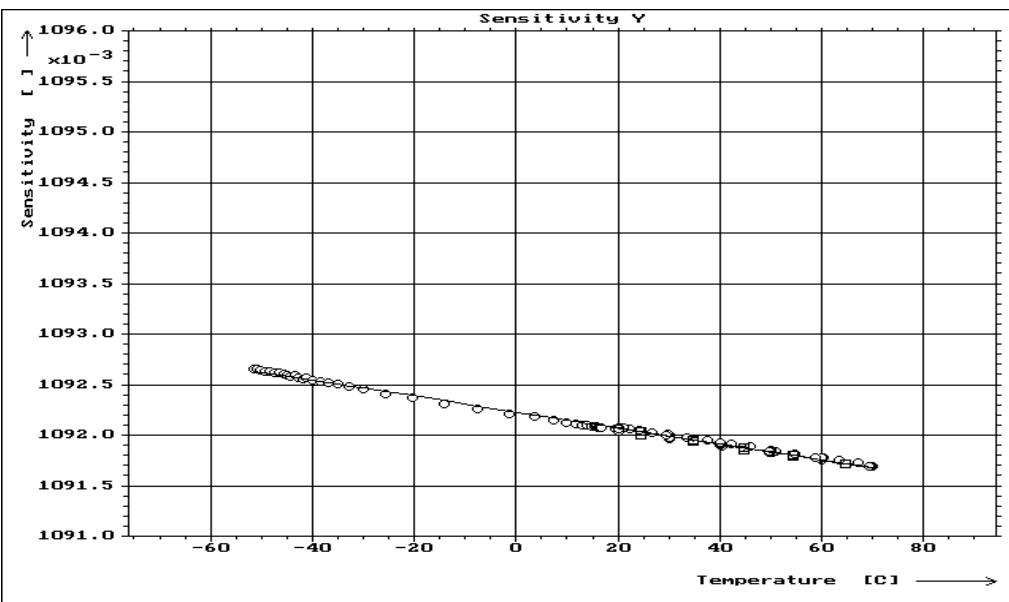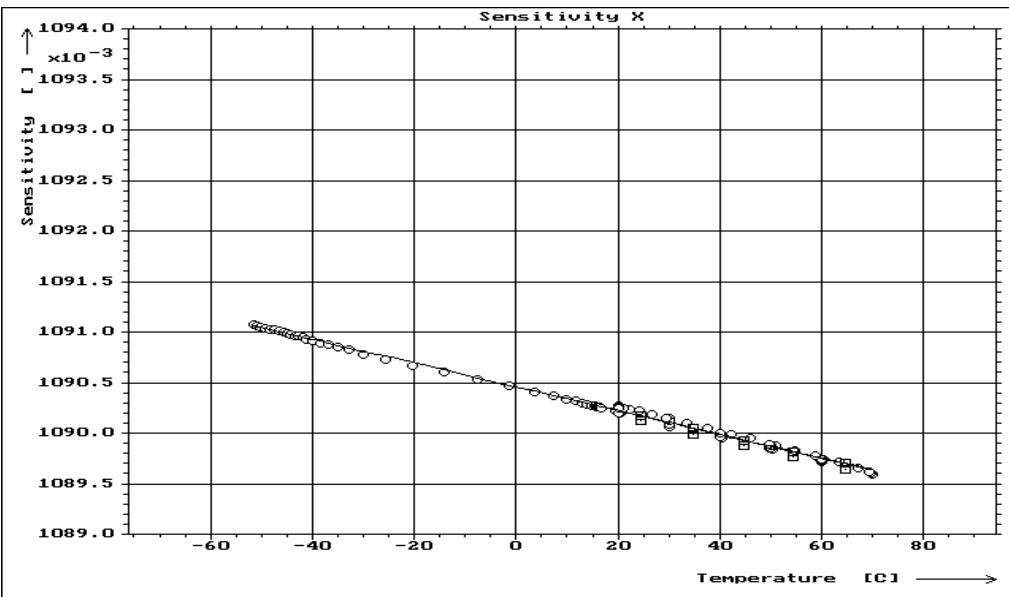
Sensitivity Z
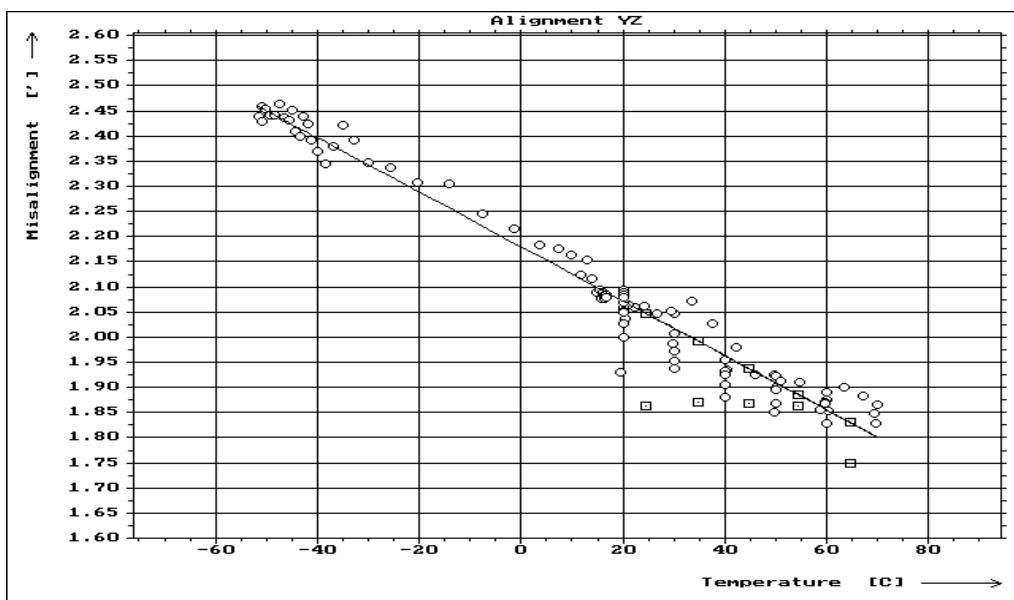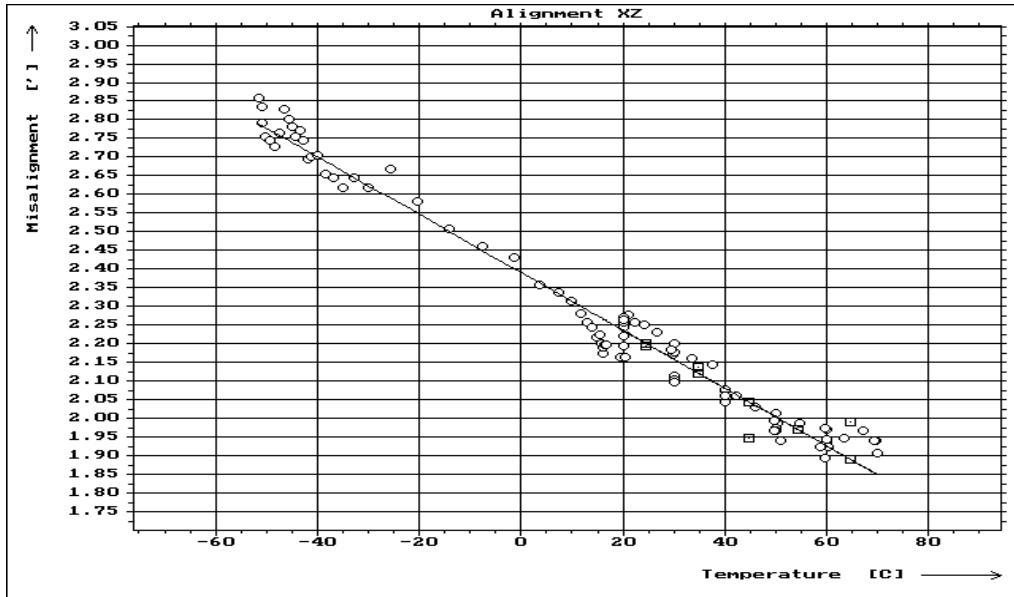
Alignment XY

3.2 SENSOR: FS

3.2.1 Inboard Sensor (IB)

3.2.1.1 Offset before T-cycle

```
Summary Sheet (Offset Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFS\IB\O\D04-23\MSIO001.aut
Comment     : ROS DPU-FM SEN-FS-IB OFF
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset      : +0.0000000 +0.0000000 +0.0000000

Date        : 23/04
Time        : 09:05:01 - 09:54:24
Quality of Input Data:
Mean Temperature: -99.990
              Xc       Yc       Zc       T
Mean stddev: +0.167    +0.176   +0.141    -99.990



Result:
        Offset        Residual field
   X    +3.35e+01        +1.40e-01
   Y    -9.21e+01        +2.29e-01
   Z    +5.20e+02        +1.26e+00
```

3.2.1.2 Calibration on Axes

3.2.1.2.1 First Measurement

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFS\IB\L\D04-20\MSIL001.aut
Comment     : ROS DPU-FM SEN-FS-IB LIN
Date        : 20/04
Time        : 14:09:57 - 15:41:46
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000
```

```
Quality of Input Data:
Mean Temperature (T): +17.260 [deg C]
Mean stddev xp [nT]:+0.179   yp [nT]:+0.215    zp [nT]:+0.141    T [C]:+0.075


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]         ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
  m1,1            1.09490     --------      --------      --------      --------
  m1,2         -1.36636e-003  --------      --------      --------      --------
  m1,3          1.04723e-002  --------      --------      --------      --------
  m2,1          1.05015e-003  --------      --------      --------      --------
  m2,2            1.09188     --------      --------      --------      --------
  m2,3         -1.14592e-003  --------      --------      --------      --------
  m3,1         -8.46257e-003  --------      --------      --------      --------
  m3,2          1.57300e-003  --------      --------      --------      --------
  m3,3            1.09154     --------      --------      --------      --------
                ^0[nT]       Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
  xp            --------      --------      --------      --------
  yp            --------      --------      --------      --------
  zp            --------      --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90 1' 1.0  x,z:   89 53'46.6   y,z:   89 58'40.7
Sensitivity [1]          x: 1.094950341   y: 1.091883361     z: 1.091577623


Static Setup             xf             yf             zf
  xp [deg,','']          0 33'15.7      89 55'39.0     90 32'58.5
  yp [deg,','']         90  3'16.1       0  4'53.5     89 56'21.5
  zp [deg,','']         89 33'25.5      90  4'55.1      0 27' 1.5
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):                  Orthogonality (O^-1):
    1.09495    0.00000    0.00000     1.00000 -2.961e-004  1.809e-003
    0.00000    1.09188    0.00000     0.00000  9.999e-001  3.846e-004
    0.00000    0.00000    1.09158     0.00000    0.00000   9.999e-001
Rotation (R^-1):
 9.999e-001  9.664e-004  7.784e-003  Rot. about X axis:-   0  4'56.6
 9.590e-004  9.999e-001 -1.436e-003  Rot. about Y axis:    0 26'34.1
-7.728e-003 -1.430e-003  9.999e-001  Rot. about Z axis:-   0  3'17.8
Determinant (R^-1):  9.999e-001


Quality of Fit:         Xp         Yp         Zp
Residual Min  [nT]: -2.707e-01  -2.708e-01  -5.333e-01
         Max  [nT]: +2.673e-01  +2.851e-01  +1.681e-01
         Mean [nT]: -1.520e-02  -3.740e-02  -2.690e-02
         Std  [nT]: +1.064e-01  +1.274e-01  +1.289e-01
```

3.2.1.2.2   Second Measurement

```
Summary Sheet (Global Mode)



Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFS\IB\L\D04-21\MSIL002.aut
Comment     : ROS DPU-FM SEN-FS-IB LIN
Date        : 21/04
Time        : 00:08:23 - 01:40:11
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
```
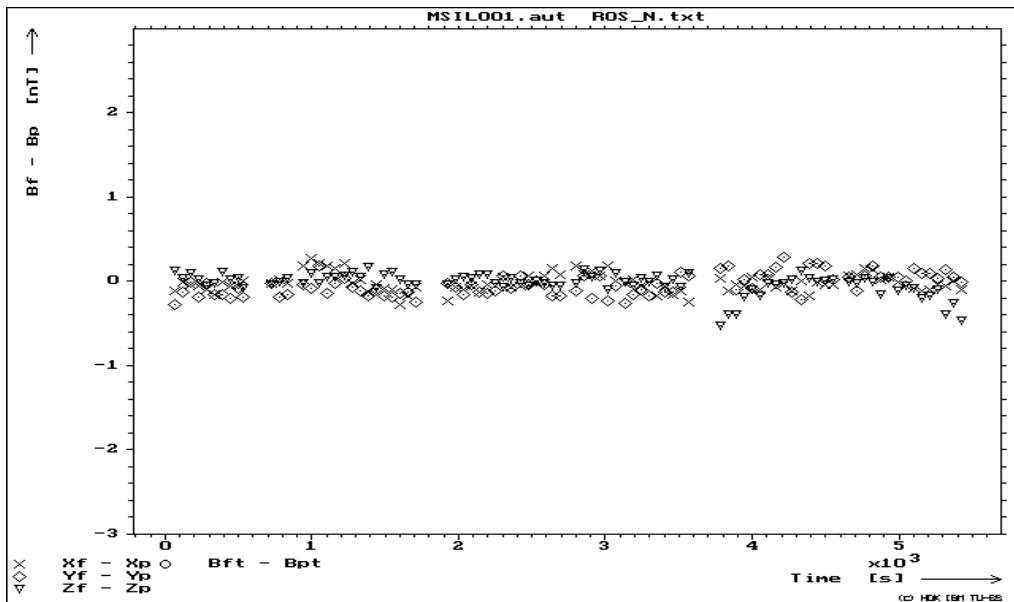
```
              -1.0000000 +0.0000000 +0.0000000
              +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): +17.169 [deg C]
Mean stddev xp [nT]:+0.174    yp [nT]:+0.210    zp [nT]:+0.136    T [C]:+0.046


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1          1.09491    --------      --------      --------      --------
   m1,2       -1.36005e-003 --------      --------      --------      --------
   m1,3        1.04660e-002 --------      --------      --------      --------
   m2,1        1.06198e-003 --------      --------      --------      --------
   m2,2          1.09188    --------      --------      --------      --------
   m2,3       -1.16037e-003 --------      --------      --------      --------
   m3,1       -8.45906e-003 --------      --------      --------      --------
   m3,2        1.58430e-003 --------      --------      --------      --------
   m3,3          1.09154    --------      --------      --------      --------
                ^0[nT]      Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp          --------     --------      --------      --------
   yp          --------     --------      --------      --------
   zp          --------     --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  0'57.6  x,z:   89 53'47.2   y,z:   89 58'41.3
Sensitivity [1]        x: 1.094958210   y: 1.091880039   z: 1.091576155


Static Setup            xf              yf              zf
   xp [deg,','']        0 33'14.3       89 55'40.2      90 32'57.4
   yp [deg,','']       90  3'18.3        0  4'57.0      89 56'18.8
   zp [deg,','']       89 33'26.1       90  4'57.2       0 27' 1.3
Separation of M^-1 = R^-10^-1S^-1
```

```
Sensitivity (S^-1):                 Orthogonality (O^-1):
     1.09496      0.00000      0.00000      1.00000 -2.796e-004  1.807e-003
     0.00000      1.09188      0.00000      0.00000  9.999e-001  3.816e-004
     0.00000      0.00000      1.09158      0.00000      0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  9.771e-004  7.781e-003  Rot. about X axis:-   0  4'58.8
 9.698e-004  9.999e-001 -1.446e-003  Rot. about Y axis:    0 26'33.5
-7.725e-003 -1.441e-003  9.999e-001  Rot. about Z axis:-   0  3'20.0
Determinant (R^-1):  9.999e-001

Quality of Fit:         Xp          Yp          Zp
Residual Min  [nT]: -2.635e-01  -5.128e-01  -4.576e-01
         Max  [nT]: +4.011e-01  +3.013e-01  +1.425e-01
         Mean [nT]: +5.453e-02  -4.173e-02  -4.497e-02
         Std  [nT]: +1.083e-01  +1.672e-01  +1.229e-01
```
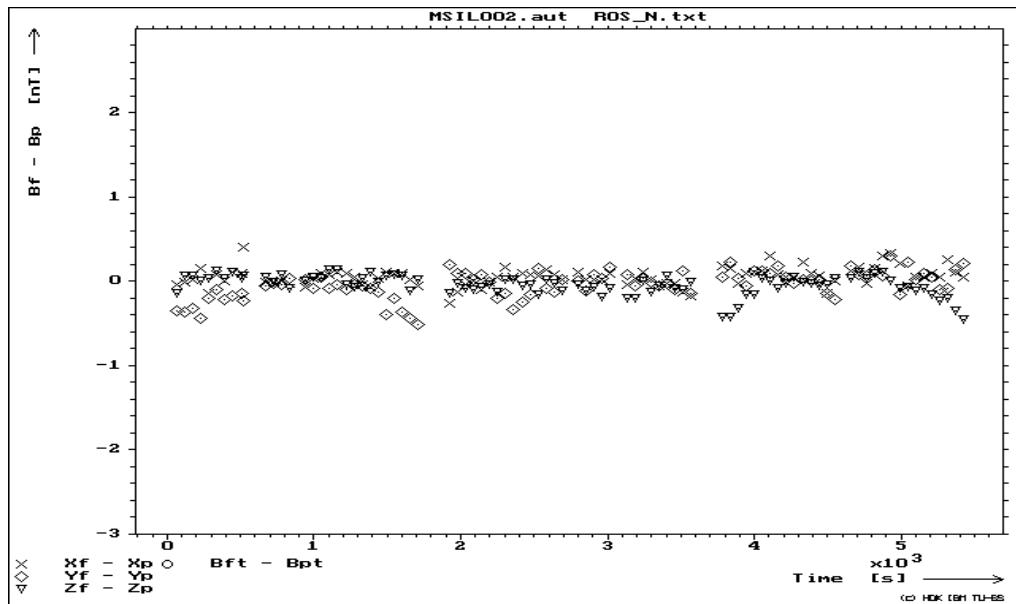

3.2.1.3   Calibration on a Spiral Sphere

3.2.1.3.1   First Measurement

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files  : o:\fgm\a\ROS\DPUFM\SFS\IB\S\D04-20\MSIS001.aut
Comment      : ROS DPU-FM SEN-FS-IB SPHERE
Date         : 20/04
Time         : 15:43:09 - 19:34:32
```

```
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): +17.304 [deg C]
Mean stddev xp [nT]:+0.177    yp [nT]:+0.215    zp [nT]:+0.134    T [C]:+0.054


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1           1.09491    --------      --------      --------      --------
   m1,2       -1.36999e-003  --------      --------      --------      --------
   m1,3        1.04712e-002  --------      --------      --------      --------
   m2,1        1.05283e-003  --------      --------      --------      --------
   m2,2           1.09188    --------      --------      --------      --------
   m2,3       -1.15422e-003  --------      --------      --------      --------
   m3,1       -8.46638e-003  --------      --------      --------      --------
   m3,2        1.57742e-003  --------      --------      --------      --------
   m3,3           1.09154    --------      --------      --------      --------
                  ^0[nT]     Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp          --------      --------      --------      --------
   yp          --------      --------      --------      --------
   zp          --------      --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:    90  1' 1.2  x,z:   89 53'47.6   y,z:   89 58'41.5
Sensitivity [1]          x: 1.094960015   y: 1.091877940    z: 1.091578417


Static Setup              xf              yf              zf
  xp [deg,','']         0 33'15.6       89 55'38.3      90 32'58.3
  yp [deg,','']        90  3'16.6        0  4'55.0      89 56'20.0
  zp [deg,','']        89 33'24.8       90  4'55.9       0 27' 2.4
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):               Orthogonality (O^-1):
     1.09496     0.00000     0.00000      1.00000 -2.971e-004  1.805e-003
     0.00000     1.09188     0.00000      0.00000  9.999e-001  3.810e-004
     0.00000     0.00000     1.09158      0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  9.688e-004  7.787e-003  Rot. about X axis:-   0  4'57.5
 9.615e-004  9.999e-001 -1.440e-003  Rot. about Y axis:    0 26'34.8
-7.732e-003 -1.434e-003  9.999e-001  Rot. about Z axis:-   0  3'18.3
Determinant (R^-1):  9.999e-001


Quality of Fit:         Xp          Yp          Zp
Residual Min  [nT]: -5.665e-01  -5.865e-01  -4.825e-01
         Max  [nT]: +3.037e-01  +3.292e-01  +3.927e-01
         Mean [nT]: -6.768e-02  -1.106e-01  -1.005e-01
         Std  [nT]: +1.314e-01  +1.596e-01  +1.334e-01
```


3.2.1.3.2   Second Measurement


```
Summary Sheet (Global Mode)



Program    : kalt.exe Version 4.00
```
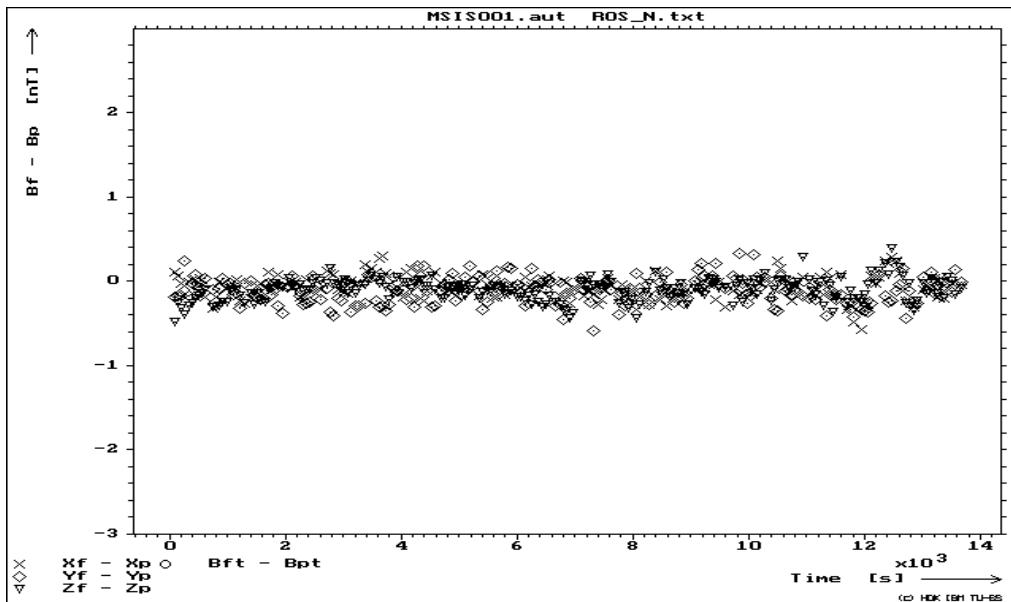
```
Input files : o:\fgm\a\ROS\DPUFM\SFS\IB\S\D04-21\MSIS003.aut
Comment     : ROS DPU-FM SEN-FS-IB SPHERE
Date        : 21/04
Time        : 01:41:51 - 05:33:16
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): +17.112 [deg C]
Mean stddev xp [nT]:+0.176    yp [nT]:+0.209    zp [nT]:+0.136    T [C]:+0.042


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter     ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1          1.09492   --------      --------      --------      --------
   m1,2     -1.36266e-003  --------      --------      --------      --------
   m1,3      1.04676e-002  --------      --------      --------      --------
   m2,1      1.04927e-003  --------      --------      --------      --------
   m2,2          1.09188   --------      --------      --------      --------
   m2,3     -1.17056e-003  --------      --------      --------      --------
   m3,1     -8.45355e-003  --------      --------      --------      --------
   m3,2      1.58417e-003  --------      --------      --------      --------
   m3,3          1.09155   --------      --------      --------      --------
                 ^0[nT]    Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp          --------    --------      --------      --------
   yp          --------    --------      --------      --------
   zp          --------    --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  1' 0.6  x,z:  89 53'45.9   y,z:  89 58'43.3
Sensitivity [1]      x: 1.094968191   y: 1.091877306   z: 1.091580961
```

```
Static Setup              xf              yf              zf
  xp [deg,','']        0 33'14.7      89 55'39.7      90 32'57.6
  yp [deg,','']       90  3'15.9       0  4'56.9      89 56'16.9
  zp [deg,','']       89 33'27.2      90  4'57.2       0 27' 0.2
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):                  Orthogonality (O^-1):
    1.09497      0.00000      0.00000      1.00000 -2.937e-004  1.813e-003
    0.00000      1.09188      0.00000      0.00000  9.999e-001  3.723e-004
    0.00000      0.00000      1.09158      0.00000      0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  9.654e-004  7.776e-003  Rot. about X axis:-   0  4'58.8
 9.582e-004  9.999e-001 -1.446e-003  Rot. about Y axis:    0 26'32.4
-7.720e-003 -1.441e-003  9.999e-001  Rot. about Z axis:-   0  3'17.6
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -4.278e-01  -6.881e-01  -5.770e-01
         Max  [nT]: +3.011e-01  +3.726e-01  +2.259e-01
         Mean [nT]: -2.373e-02  -1.570e-01  -9.674e-02
         Std  [nT]: +1.125e-01  +1.720e-01  +1.440e-01
```
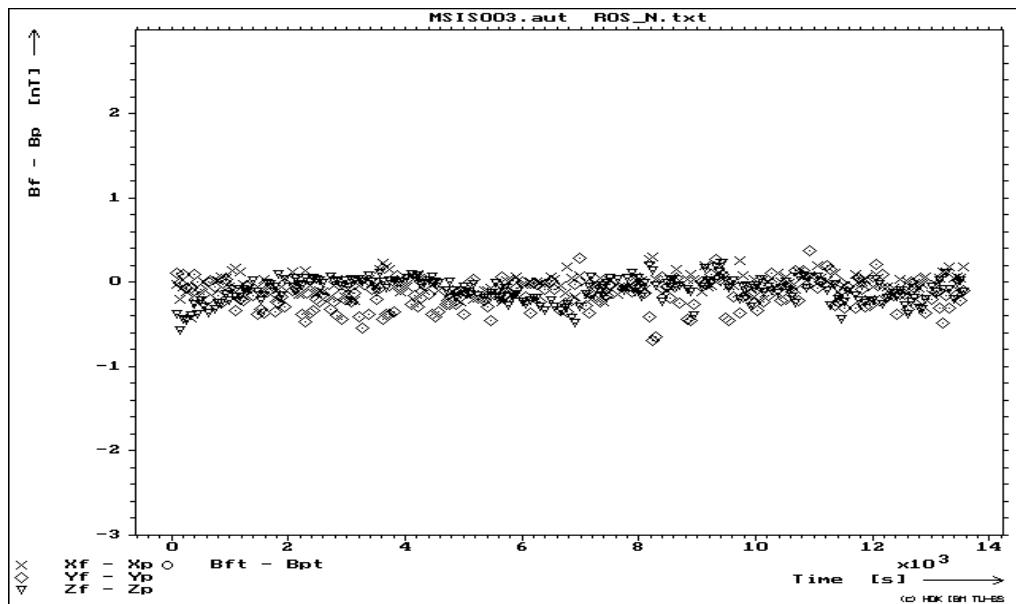

3.2.1.4   Calibration on a Sphere

3.2.1.4.1   First Measurement

```
Summary Sheet (Global Mode)
```

```
Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFS\IB\S\D04-20\MSIS002.aut
Comment     : ROS DPU-FM SEN-FS-IB SPHERE
Date        : 20/04
Time        : 19:36:47 - 00:07:10
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): +17.218 [deg C]
Mean stddev xp [nT]:+0.180    yp [nT]:+0.212    zp [nT]:+0.139    T [C]:+0.044


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]        ^2[nT^-1]      ^3[nT^-2]      ^4[nT^-3]      ^5[nT^-4]
  m1,1         1.09491      --------       --------       --------       --------
  m1,2        -1.36752e-003 --------       --------       --------       --------
  m1,3         1.04676e-002 --------       --------       --------       --------
  m2,1         1.05552e-003 --------       --------       --------       --------
  m2,2         1.09188      --------       --------       --------       --------
  m2,3        -1.16190e-003 --------       --------       --------       --------
  m3,1        -8.45885e-003 --------       --------       --------       --------
  m3,2         1.58406e-003 --------       --------       --------       --------
  m3,3         1.09154      --------       --------       --------       --------
               ^0[nT]       Tx[C^-1]       Ty[C^-1]       Tz[C^-1]
  xp           --------     --------       --------       --------
  yp           --------     --------       --------       --------
  zp           --------     --------       --------       --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  1' 0.3  x,z:   89 53'46.9   y,z:   89 58'41.7
Sensitivity [1]       x: 1.094961007    y: 1.091877854    z: 1.091573476


Static Setup             xf             yf             zf
  xp [deg,','']         0 33'14.8      89 55'38.8      90 32'57.6
  yp [deg,','']        90  3'17.1       0  4'56.4      89 56'18.5
  zp [deg,','']        89 33'26.2      90  4'57.2       0 27' 1.2
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):               Orthogonality (O^-1):
   1.09496    0.00000    0.00000    1.00000 -2.924e-004  1.808e-003
   0.00000    1.09188    0.00000    0.00000  9.999e-001  3.801e-004
   0.00000    0.00000    1.09157    0.00000    0.00000   9.999e-001
Rotation (R^-1):
 9.999e-001  9.712e-004  7.781e-003  Rot. about X axis:-   0  4'58.7
 9.639e-004  9.999e-001 -1.446e-003  Rot. about Y axis:   0 26'33.4
-7.725e-003 -1.441e-003  9.999e-001  Rot. about Z axis:-   0  3'18.8
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -7.250e-01  -5.489e-01  -7.049e-01
         Max  [nT]: +2.892e-01  +4.127e-01  +5.542e-01
         Mean [nT]: -9.540e-02  -9.515e-02  -9.981e-02
         Std  [nT]: +1.475e-01  +1.745e-01  +1.521e-01
```

3.2.1.4.2   Second Measurement

R O S E T T A	Document:	RO–IGM–TR–0003
	Issue:	1
	Revision:	1
IGM Institut für Geophysik und Meteorologie	Date:	October 12, 2001
Technische Universität Braunschweig	Page:	53
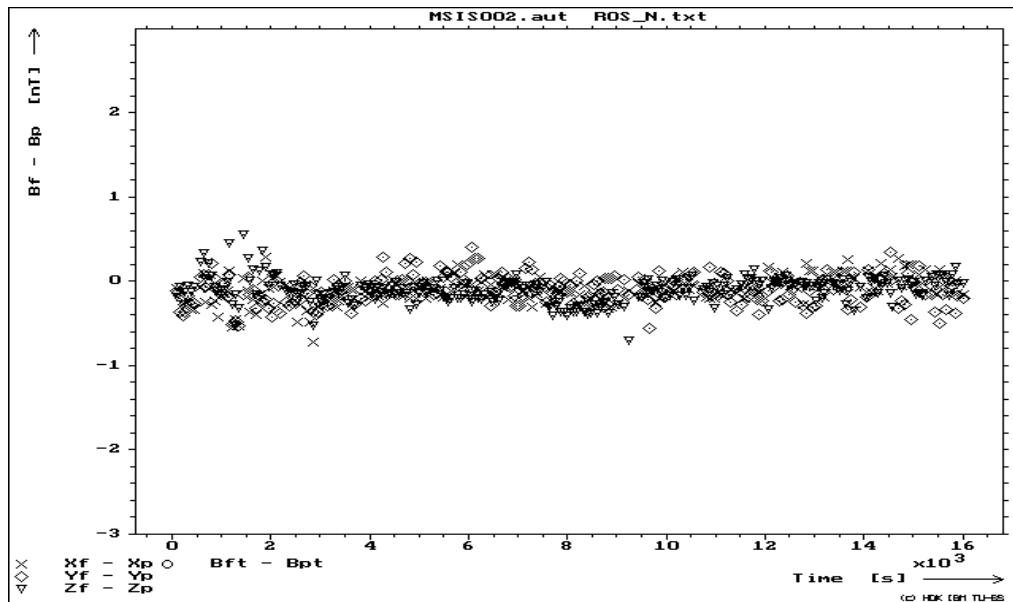

```
Summary Sheet (Global Mode)


Program       : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFS\IB\S\D04-21\MSIS004.aut
Comment       : ROS DPU-FM SEN-FS-IB SPHERE
Date          : 21/04
Time          : 05:35:31 - 10:05:58
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset [nT]  : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +17.106 [deg C]
Mean stddev xp [nT]:+0.177   yp [nT]:+0.191    zp [nT]:+0.135    T [C]:+0.056


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1          1.09492    --------      --------      --------      --------
   m1,2        -1.36533e-003 --------     --------      --------      --------
   m1,3         1.04645e-002 --------     --------      --------      --------
   m2,1         1.04532e-003 --------     --------      --------      --------
   m2,2          1.09188    --------      --------      --------      --------
   m2,3        -1.16844e-003 --------     --------      --------      --------
   m3,1        -8.45426e-003 --------     --------      --------      --------
   m3,2         1.58553e-003 --------     --------      --------      --------
   m3,3          1.09154    --------      --------      --------      --------
               ^0[nT]       Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp          --------     --------      --------      --------
   yp          --------     --------      --------      --------
   zp          --------     --------      --------      --------
```

```
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  1' 1.8  x,z:   89 53'46.6   y,z:   89 58'42.6
Sensitivity [1]        x: 1.094969617   y: 1.091882495     z: 1.091578856


Static Setup              xf              yf              zf
  xp [deg,','']         0 33'14.2       89 55'39.2       90 32'57.1
  yp [deg,','']        90  3'15.2        0  4'56.1       89 56'17.3
  zp [deg,','']        89 33'27.1       90  4'57.5        0 27' 0.4
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):               Orthogonality (O^-1):
    1.09497     0.00000     0.00000     1.00000 -2.998e-004  1.810e-003
    0.00000     1.09188     0.00000     0.00000  9.999e-001  3.755e-004
    0.00000     0.00000     1.09158     0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  9.618e-004  7.776e-003  Rot. about X axis:-   0  4'59.0
 9.546e-004  9.999e-001 -1.447e-003  Rot. about Y axis:    0 26'32.5
-7.721e-003 -1.442e-003  9.999e-001  Rot. about Z axis:-   0  3'16.9
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -3.544e-01  -6.643e-01  -4.503e-01
         Max  [nT]: +3.759e-01  +2.607e-01  +2.125e-01
         Mean [nT]: -5.715e-02  -1.325e-01  -9.252e-02
         Std  [nT]: +1.207e-01  +1.642e-01  +1.247e-01
```
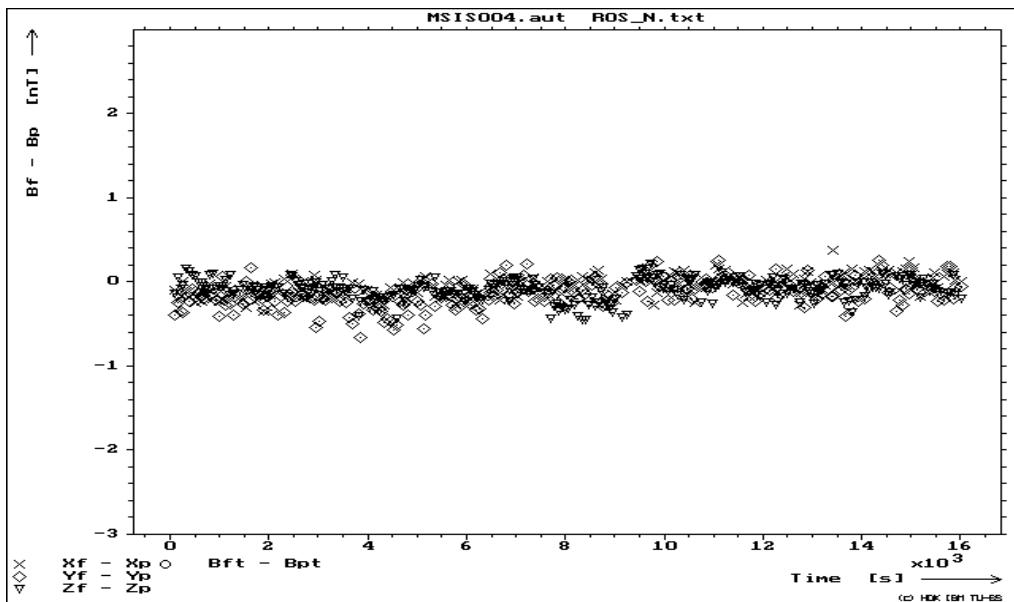

3.2.2   Outboard Sensor (OB)

3.2.2.1   Offset before T-cycle

```
Summary Sheet (Offset Mode)



Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFS\OB\O\D04-23\MSOO001.aut
Comment     : ROS DPU-FM SEN-FS-OB OFF
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset      : +0.0000000 +0.0000000 +0.0000000

Date        : 23/04
Time        : 09:01:11 - 09:46:56
Quality of Input Data:
Mean Temperature: -99.990
              Xc       Yc       Zc       T
Mean stddev: +0.196    +0.189   +0.145     -99.990



Result:
        Offset       Residual field
    X   +2.22e+02        -1.57e-01
    Y   -1.42e+01        -1.57e-01
    Z   +4.82e+02        -6.98e-01
```

3.2.2.2 Calibration on Axes

3.2.2.2.1 First Measurement

```
Summary Sheet (Global Mode)



Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFS\OB\L\D04-21\MSOL002.aut
Comment     : ROS DPU-FM SEN-FS-OB LIN
Date        : 21/04
Time        : 21:28:32 - 23:00:20
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +17.247 [deg C]
Mean stddev xp [nT]:+0.190   yp [nT]:+0.162    zp [nT]:+0.146    T [C]:+0.050

Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter    ^1[1]       ^2[nT^-1]    ^3[nT^-2]    ^4[nT^-3]    ^5[nT^-4]
   m1,1       1.08361    --------     --------     --------     --------
   m1,2     -2.74078e-003 --------    --------     --------     --------
   m1,3      1.16734e-002 --------    --------     --------     --------
   m2,1      1.68928e-003 --------    --------     --------     --------
```

```
    m2,2           1.09460    --------     --------     --------     --------
    m2,3        2.27075e-003  --------     --------     --------     --------
    m3,1       -9.34358e-003  --------     --------     --------     --------
    m3,2       -4.00808e-003  --------     --------     --------     --------
    m3,3           1.09199    --------     --------     --------     --------
                   ^0[nT]     Tx[C^-1]     Ty[C^-1]     Tz[C^-1]
    xp             --------   --------     --------     --------
    yp             --------   --------     --------     --------
    zp             --------   --------     --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,','']  x,y:  90  3'18.7   x,z:  89 52'20.9   y,z:  90  5'31.8
Sensitivity [1]       x: 1.083675254    y: 1.094600047     z: 1.092037850

Static Setup              xf              yf              zf
  xp [deg,','']       0 37'43.7      89 51'31.6      90 36'45.9
  yp [deg,','']      90  5'25.2       0  8'55.5      90  7' 5.4
  zp [deg,','']      89 30'22.6      89 47'20.3       0 32'12.8
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):            Orthogonality (O^-1):
    1.08368    0.00000    0.00000     1.00000 -9.636e-004  2.225e-003
    0.00000    1.09460    0.00000     0.00000  9.999e-001 -1.606e-003
    0.00000    0.00000    1.09204     0.00000   0.00000    9.999e-001
Rotation (R^-1):
 9.999e-001  1.509e-003  8.461e-003  Rot. about X axis:   0 12'37.0
 1.558e-003  9.999e-001  3.682e-003  Rot. about Y axis:   0 29'38.4
-8.622e-003  3.683e-003  9.999e-001  Rot. about Z axis:-  0  5'21.5
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp         Yp         Zp
Residual Min  [nT]: -3.419e-01  -2.503e-01  -4.309e-01
         Max  [nT]: +2.060e-01  +4.036e-01  +1.464e-01
         Mean [nT]: +2.231e-02  +7.198e-03  -3.546e-02
         Std  [nT]: +1.071e-01  +1.484e-01  +1.020e-01
```

3.2.2.2.2   Second Measurement

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files  : o:\fgm\a\ROS\DPUFM\SFS\OB\L\D04-22\MSOL003.aut
Comment      : ROS DPU-FM SEN-FS-OB LIN
Date         : 22/04
Time         : 20:36:06 - 22:07:54
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +17.286 [deg C]
Mean stddev xp [nT]:+0.188    yp [nT]:+0.160     zp [nT]:+0.147    T [C]:+0.035

Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter     ^1[1]         ^2[nT^-1]      ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
```
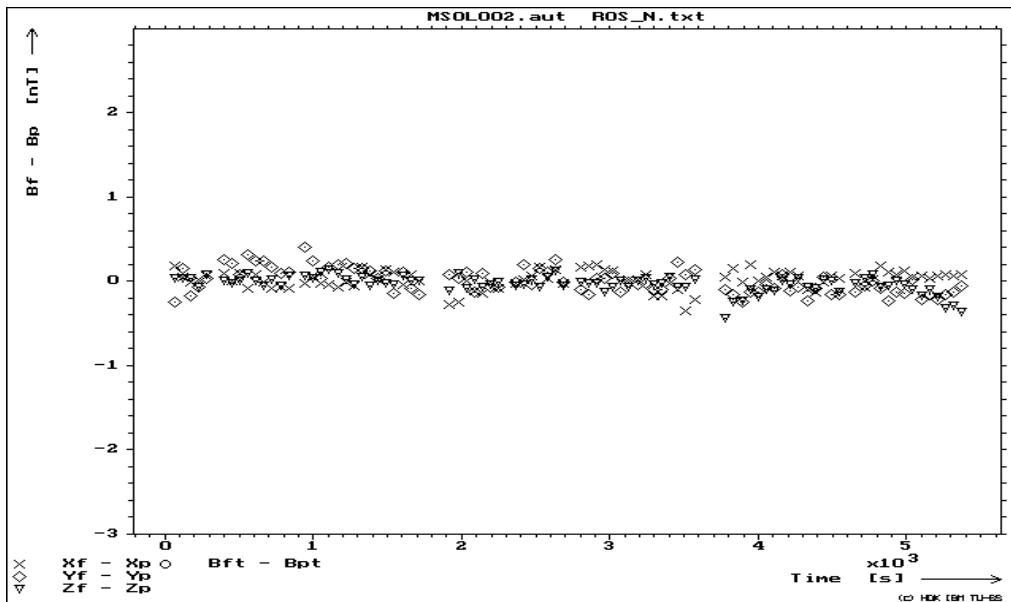
```
m1,1          1.08361      --------      --------      --------      --------
m1,2      -2.74258e-003    --------      --------      --------      --------
m1,3       1.16643e-002    --------      --------      --------      --------
m2,1       1.69780e-003    --------      --------      --------      --------
m2,2          1.09460      --------      --------      --------      --------
m2,3       2.26792e-003    --------      --------      --------      --------
m3,1      -9.33925e-003    --------      --------      --------      --------
m3,2      -4.00182e-003    --------      --------      --------      --------
m3,3          1.09198      --------      --------      --------      --------
              ^0[nT]      Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
xp          --------      --------      --------      --------
yp          --------      --------      --------      --------
zp          --------      --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''']  x,y:   90  3'17.5   x,z:   89 52'21.9   y,z:   90  5'31.2
Sensitivity [1]        x: 1.083672824    y: 1.094604803    z: 1.092024571

Static Setup               xf               yf               zf
 xp [deg,',''']          0 37'42.2       89 51'31.2       90 36'44.2
 yp [deg,',''']         90  5'26.8        0  8'56.0       90  7' 4.9
 zp [deg,',''']         89 30'23.5       89 47'21.4        0 32'11.6
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):               Orthogonality (O^-1):
    1.08367      0.00000      0.00000        1.00000  -9.575e-004   2.220e-003
    0.00000      1.09460      0.00000        0.00000   9.999e-001  -1.603e-003
    0.00000      0.00000      1.09202        0.00000      0.00000   9.999e-001
Rotation (R^-1):
 9.999e-001   1.517e-003   8.458e-003   Rot. about X axis:    0 12'35.8
 1.566e-003   9.999e-001   3.677e-003   Rot. about Y axis:    0 29'37.6
-8.618e-003   3.677e-003   9.999e-001   Rot. about Z axis:-   0  5'23.1
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp           Yp           Zp
```

```
Residual Min  [nT]: -3.124e-01  -5.647e-01  -4.338e-01
         Max  [nT]: +3.914e-01  +2.821e-01  +2.529e-01
         Mean [nT]: +3.211e-03  -8.258e-02  -3.292e-03
         Std  [nT]: +1.257e-01  +1.721e-01  +1.175e-01
```
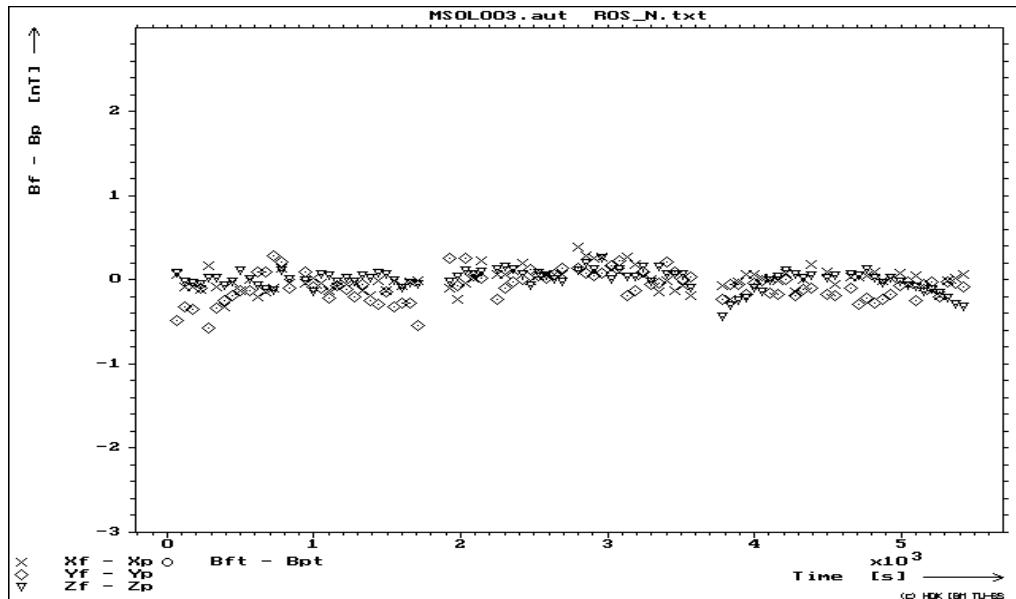

3.2.2.3   Calibration on a Spiral Sphere

3.2.2.3.1   First Measurement

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFS\OB\S\D04-21\MSOS001.aut
Comment     : ROS DPU-FM SEN-FS-OB SPHERE
Date        : 21/04
Time        : 13:03:18 - 16:54:40
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +17.280 [deg C]
Mean stddev xp [nT]:+0.194   yp [nT]:+0.196    zp [nT]:+0.147    T [C]:+0.046

Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)
```

```
Parameter      ^1[1]          ^2[nT^-1]   ^3[nT^-2]   ^4[nT^-3]   ^5[nT^-4]
   m1,1           1.08360      --------    --------    --------    --------
   m1,2        -2.74394e-003   --------    --------    --------    --------
   m1,3         1.16682e-002   --------    --------    --------    --------
   m2,1         1.69194e-003   --------    --------    --------    --------
   m2,2           1.09460      --------    --------    --------    --------
   m2,3         2.27508e-003   --------    --------    --------    --------
   m3,1        -9.35135e-003   --------    --------    --------    --------
   m3,2        -4.01027e-003   --------    --------    --------    --------
   m3,3           1.09199      --------    --------    --------    --------
                  ^0[nT]       Tx[C^-1]    Ty[C^-1]    Tz[C^-1]
   xp           --------       --------    --------    --------
   yp           --------       --------    --------    --------
   zp           --------       --------    --------    --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90 3'18.8   x,z:  89 52'23.4   y,z:  90 5'31.5
Sensitivity [1]        x: 1.083670928   y: 1.094604190   z: 1.092034773

Static Setup              xf             yf             zf
   xp [deg,','']       0 37'42.9      89 51'31.0     90 36'44.9
   yp [deg,','']      90 5'25.7        0 8'56.4      90 7' 6.2
   zp [deg,','']      89 30'21.2      89 47'19.8      0 32'14.4
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):            Orthogonality (O^-1):
    1.08367     0.00000    0.00000      1.00000  -9.640e-004  2.213e-003
    0.00000     1.09460    0.00000      0.00000   9.999e-001 -1.605e-003
    0.00000     0.00000    1.09203      0.00000   0.00000     9.999e-001
Rotation (R^-1):
 9.999e-001  1.511e-003  8.469e-003  Rot. about X axis:   0 12'37.4
 1.561e-003  9.999e-001  3.684e-003  Rot. about Y axis:   0 29'39.9
-8.629e-003  3.685e-003  9.999e-001  Rot. about Z axis:-  0 5'22.0
Determinant (R^-1): 9.999e-001

Quality of Fit:       Xp          Yp          Zp
Residual Min  [nT]: -3.117e-01  -8.310e-01  -4.193e-01
       Max   [nT]: +3.168e-01  +3.246e-01  +1.858e-01
       Mean  [nT]: -7.847e-03  -1.227e-01  -7.315e-02
       Std   [nT]: +1.238e-01  +1.817e-01  +1.256e-01
```

3.2.2.3.2   Second Measurement

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFS\OB\S\D04-21\MSOS003.aut
Comment     : ROS DPU-FM SEN-FS-OB SPHERE
Date        : 21/04
Time        : 23:01:43 - 02:53:12
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +1.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset [nT] : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
```
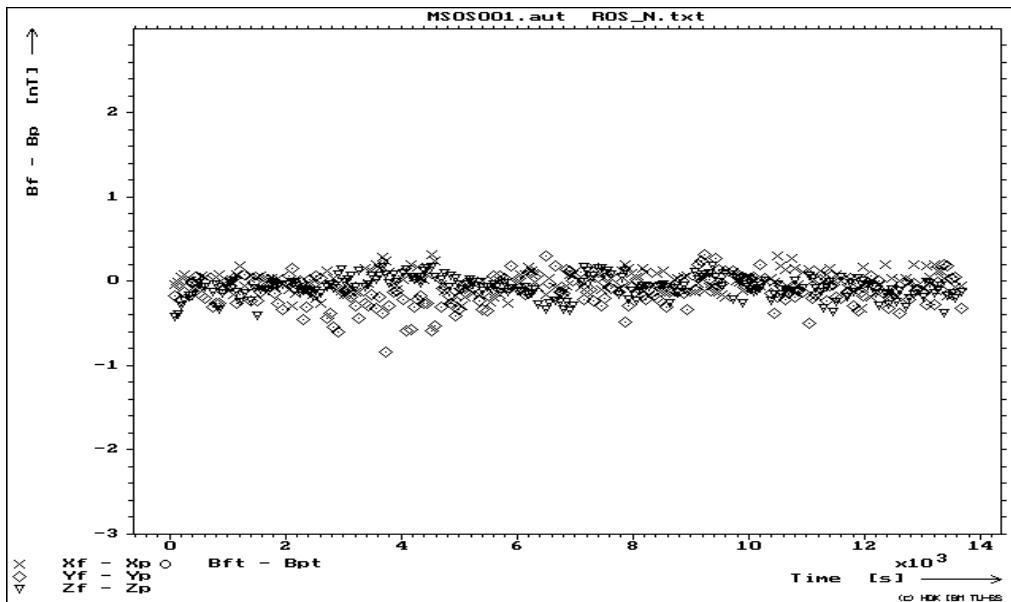
```
Mean Temperature (T): +17.182 [deg C]
Mean stddev xp [nT]:+0.191    yp [nT]:+0.169     zp [nT]:+0.147    T [C]:+0.041


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]          ^2[nT^-1]      ^3[nT^-2]      ^4[nT^-3]      ^5[nT^-4]
   m1,1           1.08361     --------       --------       --------       --------
   m1,2        -2.74333e-003  --------       --------       --------       --------
   m1,3         1.16605e-002  --------       --------       --------       --------
   m2,1         1.69279e-003  --------       --------       --------       --------
   m2,2           1.09460     --------       --------       --------       --------
   m2,3         2.27685e-003  --------       --------       --------       --------
   m3,1        -9.34348e-003  --------       --------       --------       --------
   m3,2        -4.01145e-003  --------       --------       --------       --------
   m3,3           1.09198     --------       --------       --------       --------
                  ^0[nT]      Tx[C^-1]       Ty[C^-1]       Tz[C^-1]
   xp             --------    --------       --------       --------
   yp             --------    --------       --------       --------
   zp             --------    --------       --------       --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  3'18.5   x,z:   89 52'23.4   y,z:   90  5'31.3
Sensitivity [1]        x: 1.083675164    y: 1.094601292     z: 1.092029778


Static Setup              xf             yf             zf
   xp [deg,','']          0 37'41.5      89 51'31.1     90 36'43.5
   yp [deg,','']         90  5'25.9       0  8'56.8     90  7' 6.5
   zp [deg,','']         89 30'22.7      89 47'19.6      0 32'13.1
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):                Orthogonality (O^-1):
    1.08368    0.00000    0.00000      1.00000 -9.627e-004  2.213e-003
    0.00000    1.09460    0.00000      0.00000  9.999e-001 -1.604e-003
    0.00000    0.00000    1.09203      0.00000  0.00000  9.999e-001
Rotation (R^-1):
```

```
 9.999e-001  1.512e-003  8.462e-003  Rot. about X axis:    0 12'37.6
 1.562e-003  9.999e-001  3.686e-003  Rot. about Y axis:    0 29'38.4
-8.622e-003  3.686e-003  9.999e-001  Rot. about Z axis:-   0  5'22.2
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp         Yp         Zp
Residual Min  [nT]: -4.130e-01  -6.825e-01  -3.921e-01
         Max  [nT]: +4.281e-01  +2.631e-01  +1.462e-01
         Mean [nT]: -1.812e-02  -1.155e-01  -4.857e-02
         Std  [nT]: +1.402e-01  +1.711e-01  +9.302e-02
```
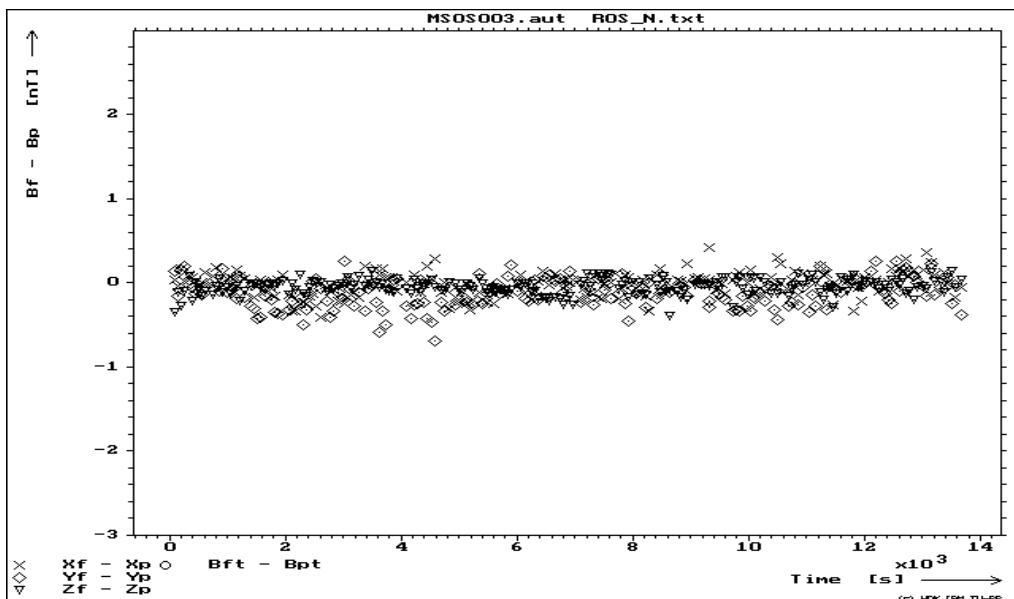

3.2.2.4   Calibration on a Sphere

3.2.2.4.1   First Measurement

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFS\OB\S\D04-21\MSOS002.aut
Comment      : ROS DPU-FM SEN-FS-OB SPHERE
Date         : 21/04
Time         : 16:55:11 - 21:27:24
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000
```

```
Quality of Input Data:
Mean Temperature (T): +17.286 [deg C]
Mean stddev xp [nT]:+0.188    yp [nT]:+0.172     zp [nT]:+0.140    T [C]:+0.035


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]        ^2[nT^-1]    ^3[nT^-2]    ^4[nT^-3]    ^5[nT^-4]
   m1,1         1.08360     --------     --------     --------     --------
   m1,2      -2.74690e-003  --------     --------     --------     --------
   m1,3       1.16698e-002  --------     --------     --------     --------
   m2,1       1.69391e-003  --------     --------     --------     --------
   m2,2         1.09460     --------     --------     --------     --------
   m2,3       2.27197e-003  --------     --------     --------     --------
   m3,1      -9.34612e-003  --------     --------     --------     --------
   m3,2      -4.00626e-003  --------     --------     --------     --------
   m3,3         1.09198     --------     --------     --------     --------
                ^0[nT]      Tx[C^-1]     Ty[C^-1]     Tz[C^-1]
   xp          --------     --------     --------     --------
   yp          --------     --------     --------     --------
   zp          --------     --------     --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  3'19.0   x,z:  89 52'22.1   y,z:  90  5'31.3
Sensitivity [1]        x: 1.083662030   y: 1.094605457    z: 1.092030481


Static Setup              xf              yf              zf
   xp [deg,','']        0 37'43.3       89 51'30.4      90 36'45.2
   yp [deg,','']       90  5'26.1        0  8'56.2      90  7' 5.6
   zp [deg,','']       89 30'22.1       89 47'20.6       0 32'13.2
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):                   Orthogonality (O^-1):
    1.08366    0.00000    0.00000        1.00000 -9.650e-004  2.219e-003
    0.00000    1.09461    0.00000        0.00000  9.999e-001 -1.604e-003
    0.00000    0.00000    1.09203        0.00000    0.00000   9.999e-001
Rotation (R^-1):
 9.999e-001  1.513e-003  8.464e-003  Rot. about X axis:    0 12'36.6
 1.563e-003  9.999e-001  3.681e-003  Rot. about Y axis:    0 29'38.9
-8.624e-003  3.681e-003  9.999e-001  Rot. about Z axis:-   0  5'22.4
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -6.133e-01  -5.919e-01  -4.197e-01
         Max  [nT]: +3.507e-01  +3.396e-01  +2.299e-01
         Mean [nT]: -1.594e-01  -1.175e-01  -1.032e-01
         Std  [nT]: +1.791e-01  +1.740e-01  +1.139e-01
```

3.2.2.4.2   Second Measurement

```
Summary Sheet (Global Mode)



Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFM\SFS\OB\S\D04-22\MSOS004.aut
Comment      : ROS DPU-FM SEN-FS-OB SPHERE
Date         : 22/04
Time         : 02:53:40 - 07:25:43
Facility Parameter:
```
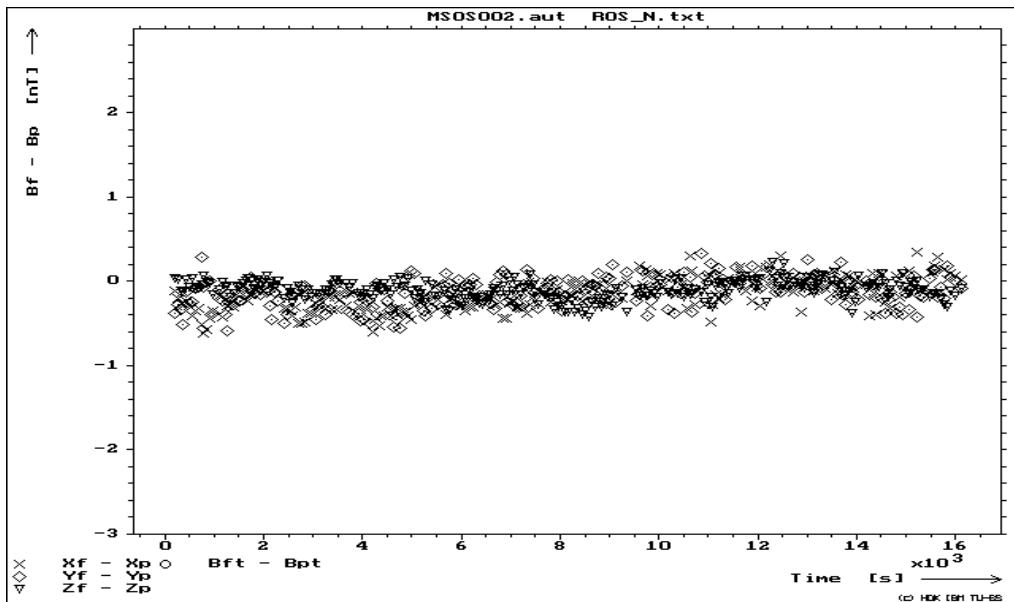
```
Alignment Mat.: +0.0000000  +1.0000000  +0.0000000
                -1.0000000  +0.0000000  +0.0000000
                +0.0000000  +0.0000000  +1.0000000
Offset  [nT]  : +0.0000000  +0.0000000  +0.0000000


Quality of Input Data:
Mean Temperature (T): +17.129 [deg C]
Mean stddev xp [nT]:+0.190    yp [nT]:+0.179    zp [nT]:+0.141    T [C]:+0.047


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter        ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1          1.08360      --------      --------      --------      --------
   m1,2         -2.74325e-003 --------      --------      --------      --------
   m1,3          1.16626e-002 --------      --------      --------      --------
   m2,1          1.69041e-003 --------      --------      --------      --------
   m2,2          1.09460      --------      --------      --------      --------
   m2,3          2.28433e-003 --------      --------      --------      --------
   m3,1         -9.34359e-003 --------      --------      --------      --------
   m3,2         -4.01459e-003 --------      --------      --------      --------
   m3,3          1.09198      --------      --------      --------      --------
                 ^0[nT]       Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp            --------     --------      --------      --------
   yp            --------     --------      --------      --------
   zp            --------     --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  3'19.0   x,z:   89 52'23.0   y,z:   90  5'30.5
Sensitivity [1]         x: 1.083670223   y: 1.094603255    z: 1.092026847


Static Setup            xf              yf              zf
   xp [deg,','']        0 37'41.9       89 51'31.1      90 36'43.9
   yp [deg,','']       90  5'25.4        0  8'57.7      90  7' 8.0
   zp [deg,','']       89 30'22.6       89 47'19.0       0 32'13.3
```

```
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):                    Orthogonality (O^-1):
    1.08367      0.00000      0.00000       1.00000 -9.647e-004  2.215e-003
    0.00000      1.09460      0.00000       0.00000  9.999e-001 -1.600e-003
    0.00000      0.00000      1.09203       0.00000      0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  1.510e-003  8.462e-003  Rot. about X axis:     0 12'38.2
 1.559e-003  9.999e-001  3.688e-003  Rot. about Y axis:     0 29'38.4
-8.622e-003  3.689e-003  9.999e-001  Rot. about Z axis:-    0  5'21.7
Determinant (R^-1):  9.999e-001


Quality of Fit:          Xp          Yp          Zp
Residual Min  [nT]: -5.141e-01  -7.615e-01  -4.749e-01
         Max  [nT]: +2.239e-01  +2.970e-01  +2.089e-01
         Mean [nT]: -1.222e-01  -1.516e-01  -5.996e-02
         Std  [nT]: +1.411e-01  +1.741e-01  +9.961e-02
```
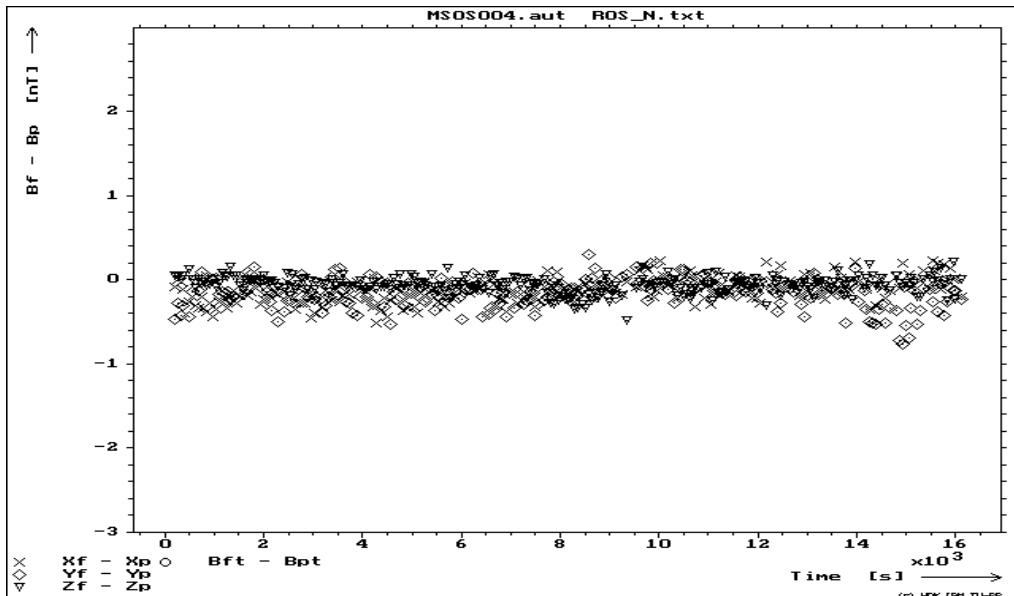

4 DPU: FS

4.1 SENSOR: FM

4.1.1 Inboard Sensor (IB)

4.1.1.1 Offset before T-cycle

```
Summary Sheet (Offset Mode)



Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFM\IB\O\D04-05\SMIO001.aut
Comment     : ROS DPU-FS SEN-FM-IB OFF
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset      : +0.0000000 +0.0000000 +0.0000000

Date        : 05/04
Time        : 09:47:22 - 10:34:04
Quality of Input Data:
Mean Temperature: -99.990
              Xc        Yc       Zc       T
Mean stddev: +0.196    +0.227   +0.168    -99.990



Result:
        Offset      Residual field
   X    +7.04e+01       +4.98e+00
   Y    -1.04e+02       +8.89e-01
   Z    +3.98e+02       +3.57e-01
```

4.1.1.2   Calibration on Axes

```
Summary Sheet (Global Mode)



Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFM\IB\L\D04-06\SMIL001.aut
Comment     : ROS DPU-FS SEN-FM-IB LIN
Date        : 06/04
Time        : 07:26:33 - 08:58:23
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset [nT] : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +17.345 [deg C]
Mean stddev xp [nT]:+0.155   yp [nT]:+0.238    zp [nT]:+0.119    T [C]:+0.064

Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter      ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
  m1,1          1.09035     --------      --------      --------      --------
  m1,2         -2.67235e-004 --------     --------      --------      --------
  m1,3          1.51611e-002 --------     --------      --------      --------
  m2,1         -5.52042e-004 --------     --------      --------      --------
  m2,2          1.09418     --------      --------      --------      --------
  m2,3         -4.30866e-003 --------     --------      --------      --------
  m3,1         -1.40937e-002 --------     --------      --------      --------
  m3,2          5.20141e-003 --------     --------      --------      --------
  m3,3          1.09387     --------      --------      --------      --------
```

```
                  ^0[nT]      Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
     xp          --------     --------      --------      --------
     yp          --------     --------      --------      --------
     zp          --------     --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,','']  x,y:   90  2'45.9   x,z:   89 56'29.7    y,z:   89 57'10.1
Sensitivity [1]        x: 1.090459352     y: 1.094187372     z: 1.093976900

Static Setup              xf               yf               zf
  xp [deg,','']        0 47'39.1        89 58'56.0        90 47'38.4
  yp [deg,','']       89 58' 5.0         0 13'38.9        89 46'29.1
  zp [deg,','']       89 15'34.5        90 16'19.7         0 47'19.8
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):                  Orthogonality (O^-1):
    1.09046     0.00000     0.00000       1.00000 -8.042e-004  1.019e-003
    0.00000     1.09419     0.00000       0.00000  9.999e-001  8.244e-004
    0.00000     0.00000     1.09398       0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001 -4.990e-004  1.283e-002  Rot. about X axis:-   0 16'18.4
-5.062e-004  9.999e-001 -4.762e-003  Rot. about Y axis:    0 44'25.9
-1.292e-002 -4.750e-003  9.999e-001  Rot. about Z axis:    0  1'44.4
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -1.194e-01  -3.433e-01  -2.664e-01
        Max   [nT]: +6.655e-01  +2.304e-01  +1.813e-01
        Mean  [nT]: +1.582e-01  -2.980e-02  +2.971e-03
        Std   [nT]: +1.345e-01  +1.196e-01  +8.529e-02
```


4.1.1.2.1 Measurement just before T–cycle

```
Summary Sheet (Global Mode)



Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFM\IB\L\D09-06\SMITL004.aut
Comment     : ROS DPU-FS SEN-FS-IB T-LIN
Date        : 06/09
Time        : 12:14:57 - 12:53:04
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): +17.977 [deg C]
Mean stddev xp [nT]:+1.066   yp [nT]:+0.729    zp [nT]:+0.841    T [C]:+0.042


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter    ^1[1]        ^2[nT^-1]    ^3[nT^-2]    ^4[nT^-3]    ^5[nT^-4]
  m1,1         1.08982     --------     --------     --------     --------
  m1,2        -9.58086e-003 --------    --------     --------     --------
  m1,3         1.71590e-002 --------    --------     --------     --------
  m2,1         8.95829e-003 --------    --------     --------     --------
  m2,2         1.09336     --------     --------     --------     --------
  m2,3        -2.49336e-004 --------    --------     --------     --------
  m3,1        -1.64147e-002 --------    --------     --------     --------
  m3,2         1.45115e-003 --------    --------     --------     --------
  m3,3         1.09311     --------     --------     --------     --------
               ^0[nT]      Tx[C^-1]     Ty[C^-1]     Tz[C^-1]
  xp           --------    --------     --------     --------
  yp           --------    --------     --------     --------
  zp           --------    --------     --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90 2' 4.0   x,z:  89 57'32.2   y,z:  89 56'38.6
Sensitivity [1]         x: 1.090001916  y: 1.093400089   z: 1.093236336


Static Setup            xf              yf              zf
  xp [deg,','']        1  1'49.4        89 29'48.5      90 53'57.0
  yp [deg,','']       90 28'14.3         0 28'15.9      89 58'46.3
  zp [deg,','']       89  8'11.4        90  4' 6.4       0 51'58.2
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):               Orthogonality (O^-1):
    1.09000     0.00000     0.00000     1.00000  -6.013e-004  7.163e-004
    0.00000     1.09340     0.00000     0.00000   9.999e-001  9.767e-004
    0.00000     0.00000     1.09324     0.00000   0.00000     9.999e-001
Rotation (R^-1):
 9.998e-001  8.180e-003  1.498e-002  Rot. about X axis:-  0  4'31.9
 8.218e-003  9.999e-001 -1.210e-003  Rot. about Y axis:   0 51'46.3
-1.505e-002 -1.195e-003  9.998e-001  Rot. about Z axis:-  0 28'15.4
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -2.558e-01  -3.681e-01  -2.712e-01
         Max  [nT]: +3.169e-01  +2.066e-01  +3.416e-01
         Mean [nT]: +8.503e-02  -5.939e-02  -3.076e-02
         Std  [nT]: +1.142e-01  +1.534e-01  +1.369e-01
```

This measurement has been executed with an increased supply voltage of ±5.1 V rather

than ±5.0 V, as the supply voltage during flight onboard the ROSETTA s/c is supposed
to be 10 % higher than the nominal voltage of ±5.0 V.
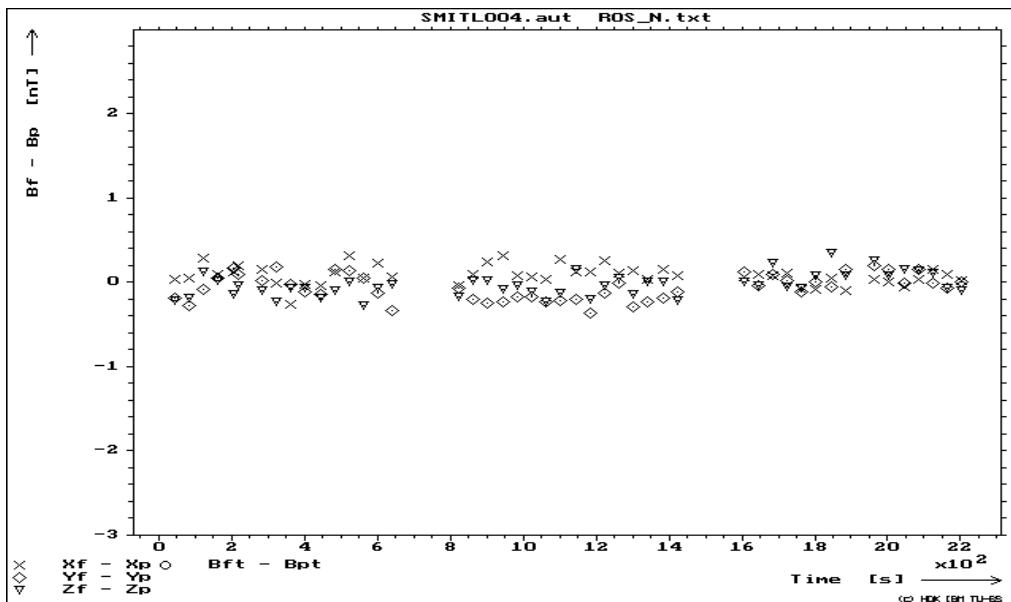
4.1.1.3 Calibration on a Spiral Sphere

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFM\IB\S\D04-06\SMIS001.aut
Comment      : ROS DPU-FS SEN-FM-IB SPHERE
Date         : 06/04
Time         : 08:59:44 - 12:51:03
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +17.394 [deg C]
Mean stddev xp [nT]:+0.154   yp [nT]:+0.233    zp [nT]:+0.123    T [C]:+0.061


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter     ^1[1]       ^2[nT^-1]    ^3[nT^-2]    ^4[nT^-3]    ^5[nT^-4]
  m1,1        1.09035     --------     --------     --------     --------
  m1,2       -2.71172e-004 --------    --------     --------     --------
  m1,3        1.51671e-002 --------    --------     --------     --------
  m2,1       -5.52614e-004 --------    --------     --------     --------
  m2,2        1.09417     --------     --------     --------     --------
```

```
m2,3      -4.31056e-003    --------    --------    --------    --------
m3,1      -1.41008e-002    --------    --------    --------    --------
m3,2       5.21004e-003    --------    --------    --------    --------
m3,3       1.09388         --------    --------    --------    --------
                ^0[nT]     Tx[C^-1]    Ty[C^-1]    Tz[C^-1]
xp             --------    --------    --------    --------
yp             --------    --------    --------    --------
zp             --------    --------    --------    --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  2'46.7  x,z:  89 56'29.9  y,z:  89 57' 8.8
Sensitivity [1]        x: 1.090454493  y: 1.094181736  z: 1.093982895

Static Setup              xf              yf              zf
 xp [deg,','']       0 47'40.2       89 58'55.2       90 47'39.5
 yp [deg,','']      89 58' 4.9        0 13'39.3       89 46'28.7
 zp [deg,','']      89 15'33.1       90 16'21.4        0 47'21.7
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):              Orthogonality (O^-1):
    1.09045     0.00000     0.00000     1.00000 -8.084e-004  1.018e-003
    0.00000     1.09418     0.00000     0.00000  9.999e-001  8.305e-004
    0.00000     0.00000     1.09398     0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001 -4.994e-004  1.284e-002  Rot. about X axis:-  0 16'20.0
-5.067e-004  9.999e-001 -4.770e-003  Rot. about Y axis:   0 44'27.3
-1.293e-002 -4.757e-003  9.999e-001  Rot. about Z axis:   0  1'44.5
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -1.334e-01  -4.407e-01  -1.875e-01
         Max  [nT]: +6.192e-01  +3.825e-01  +2.579e-01
         Mean [nT]: +2.542e-01  -6.337e-02  +4.662e-02
         Std  [nT]: +1.438e-01  +1.499e-01  +9.231e-02
```
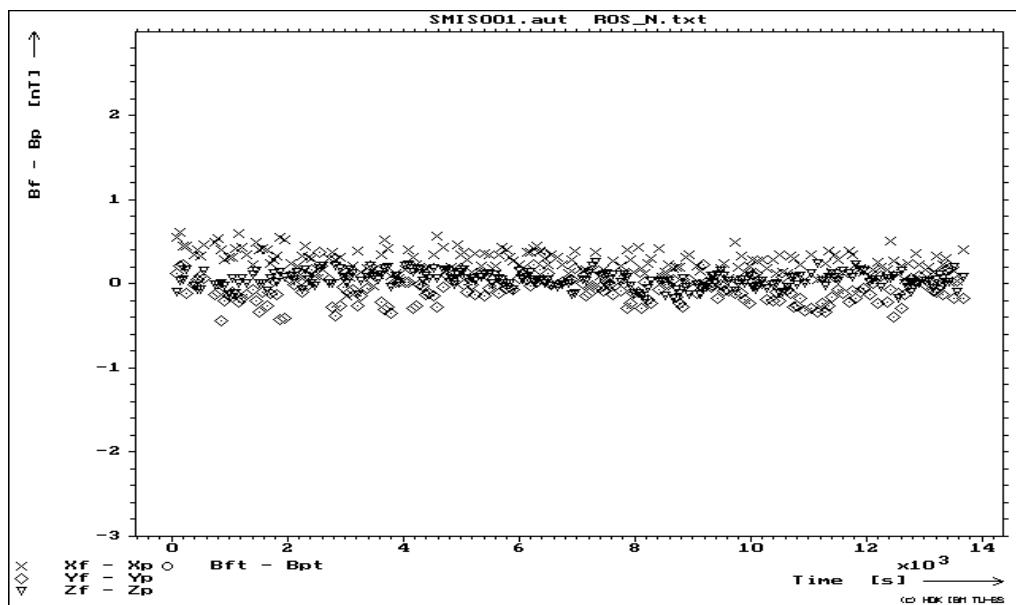
4.1.1.4 Temperature Calibration

```
Summary Sheet (Temperature)


Program     : merf.exe Version 4.0
Input files : o:\fgm\a\ROS\DPUFS\SFM\IB\T\SUM-T4\SMITS001.kas
Comment     :
Date        : 06/09    - 13/09
Time        : 18:38:31 - 06:23:55
Temperature :   -44.21 -    69.75
Std temp.   : 1.72e-002 -       1.48
Std temp. mean :  4.16e-001
Std temp. std. :  3.43e-001


Results:

Measurements : 127 of 132

                 Offset [1]      Slope [1/K]     Correlation [1]
Sensitivity X [1]:       1.09026  -1.42163e-005   -9.98081e-001
Sensitivity Y [1]:       1.09354  -9.29058e-006   -9.75921e-001
Sensitivity Z [1]:       1.09336  -8.54783e-006   -9.93069e-001
                 Offset [']      Slope ['/K]     Correlation [1]
Alignment  XY [']:       2.08742   5.12657e-003    9.59940e-001
Alignment  XZ [']:      -2.47684   2.22494e-003    6.14170e-001
Alignment  YZ [']:      -3.40131   7.18197e-003    9.51067e-001


Statistical Parameter:

                 Min             Max             Mean        Std
Sensitivity X [1]:       1.08923         1.09091         1.08998   3.67825e-004
Sensitivity Y [1]:       1.09278         1.09385         1.09336   2.45837e-004
Sensitivity Z [1]:       1.09269         1.09369         1.09319   2.22277e-004
Alignment  XY [']:       1.76262         2.45406         2.18868   1.37912e-001
Alignment  XZ [']:      -2.56762        -2.19159        -2.43289   9.35515e-002
Alignment  YZ [']:      -3.66721        -2.7767         -3.25945   1.95008e-001
```

This measurement has been executed with an increased supply voltage of ± 5.1 V rather than ± 5.0 V, as the supply voltage during flight onboard the ROSETTA s/c is supposed to be 10 % higher than the nominal voltage of ± 5.0 V.

Sensitivity X

Sensitivity Y
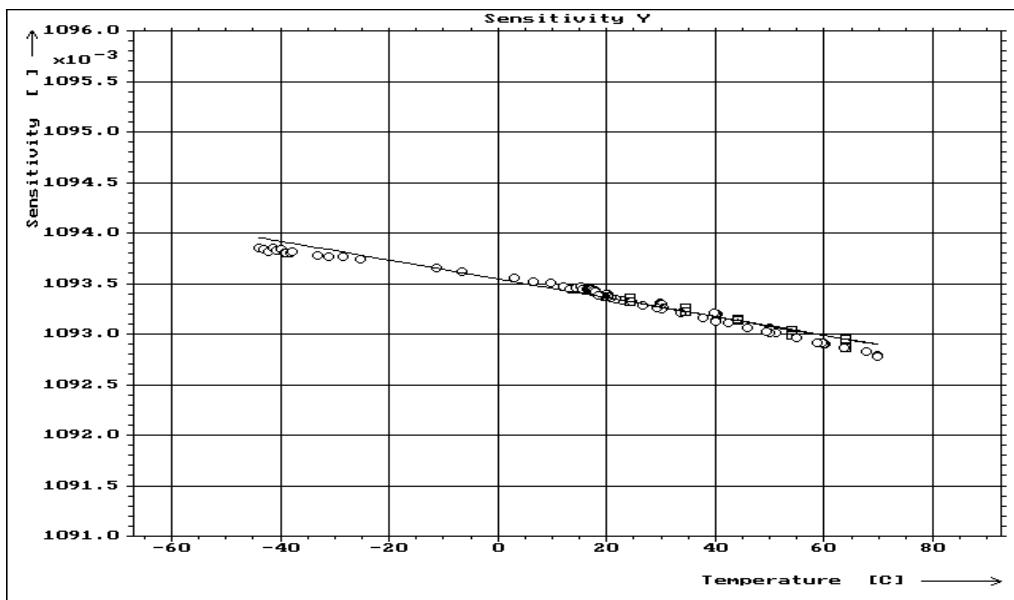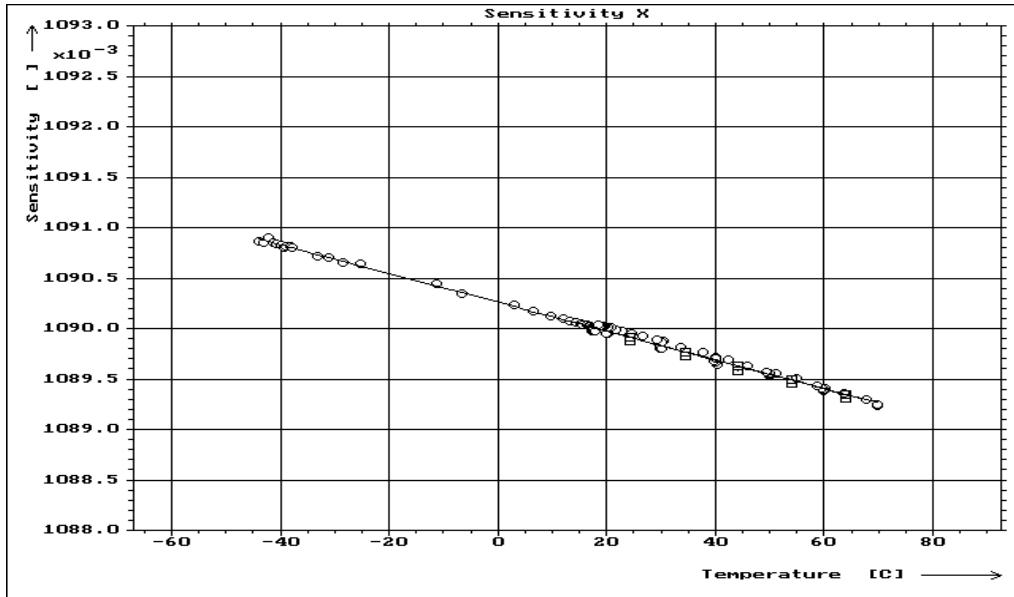
4.1.2   Outboard Sensor (OB)

4.1.2.1   Offset before T-cycle

```
Summary Sheet (Offset Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFM\OB\O\D04-05\SMOO001.aut
Comment     : ROS DPU-FS SEN-FM-OB OFF
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset        : +0.0000000 +0.0000000 +0.0000000

Date        : 05/04
Time        : 09:42:22 - 10:27:08
Quality of Input Data:
Mean Temperature: -99.990
               Xc        Yc        Zc        T
Mean stddev: +0.220    +0.246    +0.210     -99.990



Result:
        Offset        Residual field
   X    +1.61e+02         -1.49e-01
   Y    -9.48e+01         -1.22e-01
   Z    +3.50e+02         +3.73e+00
```

4.1.2.2   Calibration on Axes

4.1.2.2.1   First Measurement

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFM\OB\L\D04-05\SMOL001.aut
Comment     : ROS DPU-FS SEN-FM-OB LIN
Date        : 05/04
Time        : 13:08:58 - 14:40:46
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset [nT]  : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +17.524 [deg C]
Mean stddev xp [nT]:+0.176   yp [nT]:+0.237    zp [nT]:+0.152    T [C]:+0.097
```

```
Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]        ^2[nT^-1]    ^3[nT^-2]    ^4[nT^-3]    ^5[nT^-4]
   m1,1           1.09077    --------     --------     --------     --------
   m1,2        1.45466e-003  --------     --------     --------     --------
   m1,3        9.00148e-003  --------     --------     --------     --------
   m2,1       -2.72712e-003  --------     --------     --------     --------
   m2,2           1.09333    --------     --------     --------     --------
   m2,3       -9.17998e-003  --------     --------     --------     --------
   m3,1       -9.39349e-003  --------     --------     --------     --------
   m3,2        8.02982e-003  --------     --------     --------     --------
   m3,3           1.09270    --------     --------     --------     --------
                  ^0[nT]     Tx[C^-1]     Ty[C^-1]     Tz[C^-1]
   xp          --------      --------     --------     --------
   yp          --------      --------     --------     --------
   zp          --------      --------     --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''']  x,y:   90  4'13.6   x,z:   90  1' 8.9   y,z:   90  3'31.6
Sensitivity [1]         x: 1.090803800    y: 1.093372389     z: 1.092774093


Static Setup              xf              yf              zf
  xp [deg,',''']       0 28'41.3       90  4'21.9      90 28'21.3
  yp [deg,',''']      89 51' 9.4        0 30' 8.0      89 31'11.5
  zp [deg,',''']      89 30'27.5       90 25'17.1       0 38'53.1
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):            Orthogonality (O^-1):
    1.09080     0.00000     0.00000     1.00000 -1.229e-003 -3.342e-004
    0.00000     1.09337     0.00000     0.00000  9.999e-001 -1.026e-003
    0.00000     0.00000     1.09277     0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001 -2.497e-003  8.574e-003  Rot. about X axis:-   0 25'12.7
-2.500e-003  9.999e-001 -7.374e-003  Rot. about Y axis:    0 29'36.2
-8.611e-003 -7.355e-003  9.999e-001  Rot. about Z axis:    0  8'35.7
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -3.893e-01  -4.265e-01  -7.620e-01
         Max  [nT]: +9.419e-01  +3.970e-01  +3.680e-01
         Mean [nT]: +1.197e-01  -5.872e-02  +1.678e-02
         Std  [nT]: +2.941e-01  +1.528e-01  +2.032e-01
```

4.1.2.2.2   Second Measurement

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFM\OB\L\D04-05\SMOL002.aut
Comment     : ROS DPU-FS SEN-FM-OB LIN
Date        : 05/04
Time        : 23:07:22 - 00:39:09
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000
```
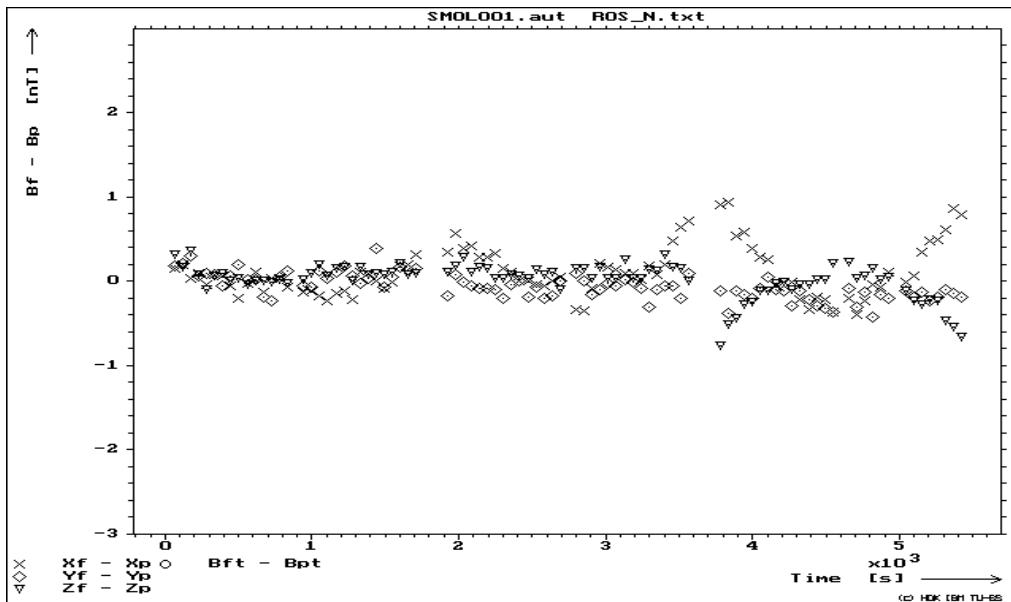
```
Quality of Input Data:
Mean Temperature (T): +17.354 [deg C]
Mean stddev xp [nT]:+0.172    yp [nT]:+0.197     zp [nT]:+0.143     T [C]:+0.050


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]         ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
  m1,1         1.09076       --------      --------      --------      --------
  m1,2         1.45138e-003  --------      --------      --------      --------
  m1,3         9.01155e-003  --------      --------      --------      --------
  m2,1        -2.73903e-003  --------      --------      --------      --------
  m2,2         1.09334       --------      --------      --------      --------
  m2,3        -9.19524e-003  --------      --------      --------      --------
  m3,1        -9.40883e-003  --------      --------      --------      --------
  m3,2         8.06970e-003  --------      --------      --------      --------
  m3,3         1.09270       --------      --------      --------      --------
               ^0[nT]        Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
  xp           --------      --------      --------      --------
  yp           --------      --------      --------      --------
  zp           --------      --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  4'16.5  x,z:   90  1' 9.9   y,z:  90  3'26.9
Sensitivity [1]        x: 1.090795937   y: 1.093385415    z: 1.092771262


Static Setup           xf             yf             zf
  xp [deg,','']        0 28'43.1      90  4'21.2     90 28'23.2
  yp [deg,','']       89 51' 7.1       0 30'11.4     89 31' 8.6
  zp [deg,','']       89 30'24.6      90 25'24.6      0 39' 0.1
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):               Orthogonality (O^-1):
   1.09080    0.00000    0.00000      1.00000  -1.243e-003 -3.390e-004
   0.00000    1.09339    0.00000      0.00000   9.999e-001 -1.003e-003
   0.00000    0.00000    1.09277      0.00000   0.00000     9.999e-001
```

```
Rotation (R^-1):
 9.999e-001 -2.507e-003  8.588e-003  Rot. about X axis:-   0 25'20.1
-2.511e-003  9.999e-001 -7.411e-003  Rot. about Y axis:    0 29'39.1
-8.625e-003 -7.391e-003  9.999e-001  Rot. about Z axis:    0  8'37.9
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -1.041e-01  -2.270e-01  -9.072e-01
         Max  [nT]: +6.847e-01  +2.765e-01  +2.386e-01
         Mean [nT]: +2.318e-01  +1.647e-04  -7.323e-02
         Std  [nT]: +1.807e-01  +1.148e-01  +2.065e-01
```
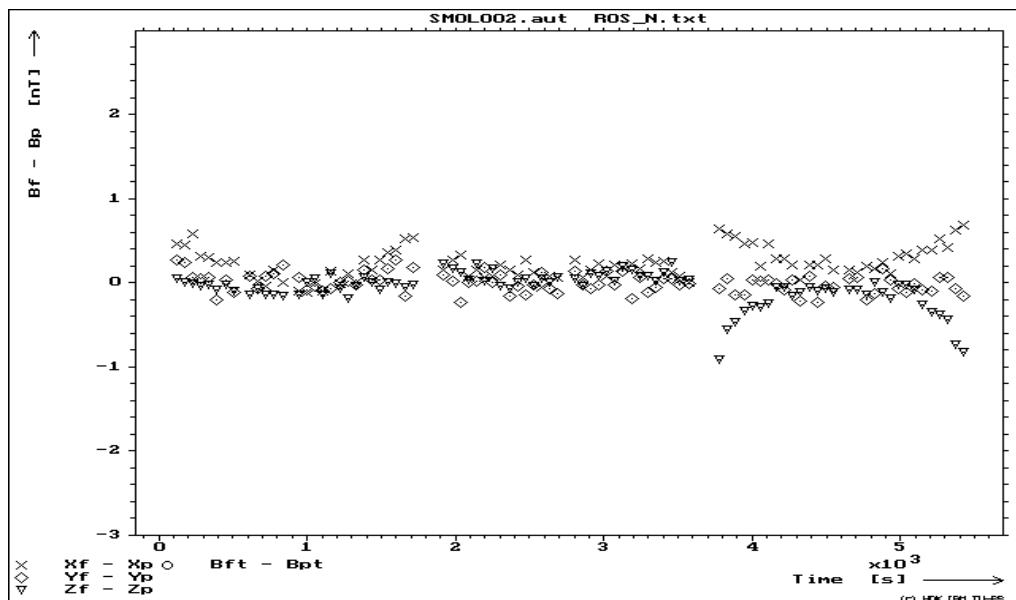

4.1.2.2.3   Measurement just before T–cycle

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFM\OB\L\D09-06\SMOTL004.aut
Comment     : ROS DPU-FS SEN-FS-IB T-LIN
Date        : 06/09
Time        : 12:14:57 - 12:53:04
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +17.977 [deg C]
Mean stddev xp [nT]:+1.295   yp [nT]:+0.934    zp [nT]:+1.175    T [C]:+0.042
```

```
Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter     ^1[1]        ^2[nT^-1]    ^3[nT^-2]    ^4[nT^-3]    ^5[nT^-4]
  m1,1          1.09024     --------     --------     --------     --------
  m1,2        -9.54307e-003 --------     --------     --------     --------
  m1,3         1.70322e-002 --------     --------     --------     --------
  m2,1         8.33511e-003 --------     --------     --------     --------
  m2,2          1.09235     --------     --------     --------     --------
  m2,3        -2.89870e-003 --------     --------     --------     --------
  m3,1        -1.77418e-002 --------     --------     --------     --------
  m3,2         2.34815e-003 --------     --------     --------     --------
  m3,3          1.09191     --------     --------     --------     --------
                ^0[nT]      Tx[C^-1]     Ty[C^-1]     Tz[C^-1]
  xp           --------     --------     --------     --------
  yp           --------     --------     --------     --------
  zp           --------     --------     --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,','']  x,y:   90  4' 0.0   x,z:   90  2'12.9   y,z:   90  2' 9.3
Sensitivity [1]        x: 1.090413508     y: 1.092384097     z: 1.092060185


Static Setup            xf              yf              zf
  xp [deg,','']          1  1'26.4      89 29'51.3      90 53'32.2
  yp [deg,','']         90 26' 7.6       0 27'48.7      89 50'27.9
  zp [deg,','']         89  4' 0.5      90  6'53.9       0 56'24.9
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):                  Orthogonality (O^-1):
    1.09041     0.00000     0.00000      1.00000 -1.163e-003 -6.445e-004
    0.00000     1.09238     0.00000      0.00000  9.999e-001 -6.277e-004
    0.00000     0.00000     1.09206      0.00000      0.00000  9.999e-001
Rotation (R^-1):
 9.998e-001  7.605e-003  1.623e-002  Rot. about X axis:-   0  7'19.5
 7.643e-003  9.999e-001 -2.021e-003  Rot. about Y axis:    0 55'56.2
-1.627e-002 -2.007e-003  9.998e-001  Rot. about Z axis:-   0 26'16.9
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -3.767e-01  -4.385e-01  -5.519e-01
        Max   [nT]: +5.296e-01  +2.669e-01  +3.355e-01
        Mean  [nT]: +9.278e-02  -3.526e-02  -8.582e-02
        Std   [nT]: +2.130e-01  +1.541e-01  +2.281e-01
```

This measurement has been executed with an increased supply voltage of ±5.1 V rather than ±5.0 V, as the supply voltage during flight onboard the ROSETTA s/c is supposed to be 10 % higher than the nominal voltage of ±5.0 V.

4.1.2.3   Calibration on a Spiral Sphere


```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files  : o:\fgm\a\ROS\DPUFS\SFM\OB\S\D04-05\SMOS001.aut
Comment      : ROS DPU-FS SEN-FM-OB SPHERE
Date         : 05/04
```
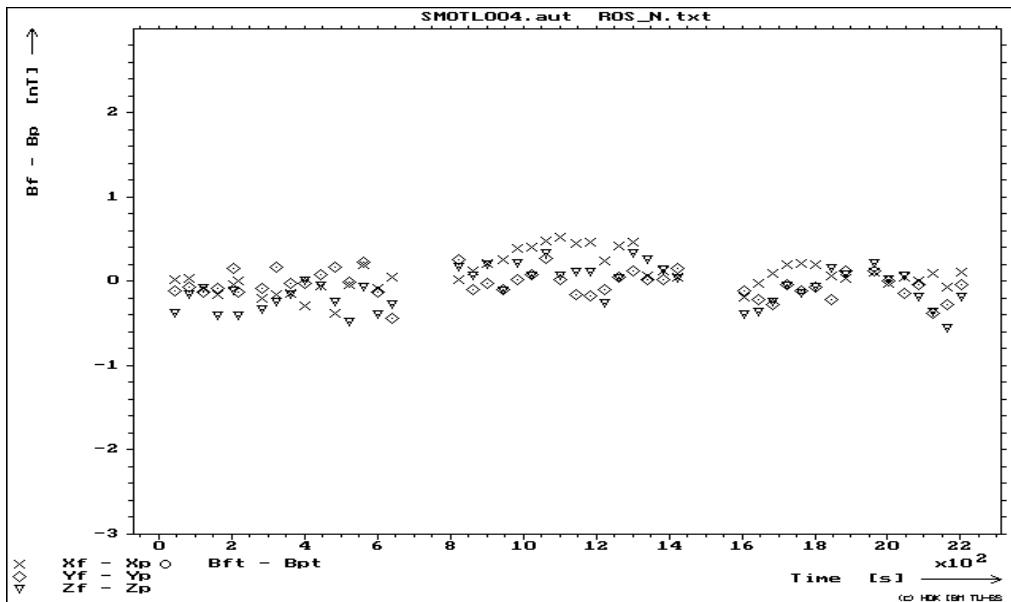
```
Time        : 14:42:07 - 18:33:24
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset [nT] : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +17.431 [deg C]
Mean stddev xp [nT]:+0.180    yp [nT]:+0.237    zp [nT]:+0.149    T [C]:+0.049

Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter     ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1          1.09075   --------      --------      --------      --------
   m1,2      1.45934e-003  --------      --------      --------      --------
   m1,3      9.01136e-003  --------      --------      --------      --------
   m2,1     -2.73630e-003  --------      --------      --------      --------
   m2,2          1.09334   --------      --------      --------      --------
   m2,3     -9.18423e-003  --------      --------      --------      --------
   m3,1     -9.40187e-003  --------      --------      --------      --------
   m3,2      8.06348e-003  --------      --------      --------      --------
   m3,3          1.09271   --------      --------      --------      --------
                ^0[nT]     Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp         --------     --------      --------      --------
   yp         --------     --------      --------      --------
   zp         --------     --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  4'14.5  x,z:  90  1' 8.6   y,z:  90  3'26.1
Sensitivity [1]        x: 1.090791485   y: 1.093378537   z: 1.092777128

Static Setup            xf              yf              zf
   xp [deg,','']        0 28'43.3       90  4'22.7       90 28'23.2
```

```
yp [deg,','']           89 51' 7.6         0 30' 9.3         89 31'10.7
zp [deg,','']           89 30'25.9        90 25'23.5          0 38'58.4
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):                     Orthogonality (O^-1):
    1.09079      0.00000      0.00000        1.00000  -1.234e-003 -3.327e-004
    0.00000      1.09338      0.00000        0.00000   9.999e-001 -9.996e-004
    0.00000      0.00000      1.09278        0.00000     0.00000   9.999e-001
Rotation (R^-1):
 9.999e-001 -2.505e-003  8.581e-003  Rot. about X axis:-  0 25'19.0
-2.508e-003  9.999e-001 -7.405e-003  Rot. about Y axis:   0 29'37.8
-8.619e-003 -7.386e-003  9.999e-001  Rot. about Z axis:   0  8'37.4
Determinant (R^-1):  9.999e-001


Quality of Fit:          Xp          Yp          Zp
Residual Min  [nT]: -8.963e-01  -3.294e-01  -7.037e-01
         Max  [nT]: +1.599e+00  +4.594e-01  +6.718e-01
         Mean [nT]: +3.584e-01  +4.929e-02  -2.176e-02
         Std  [nT]: +3.003e-01  +1.568e-01  +2.557e-01
```
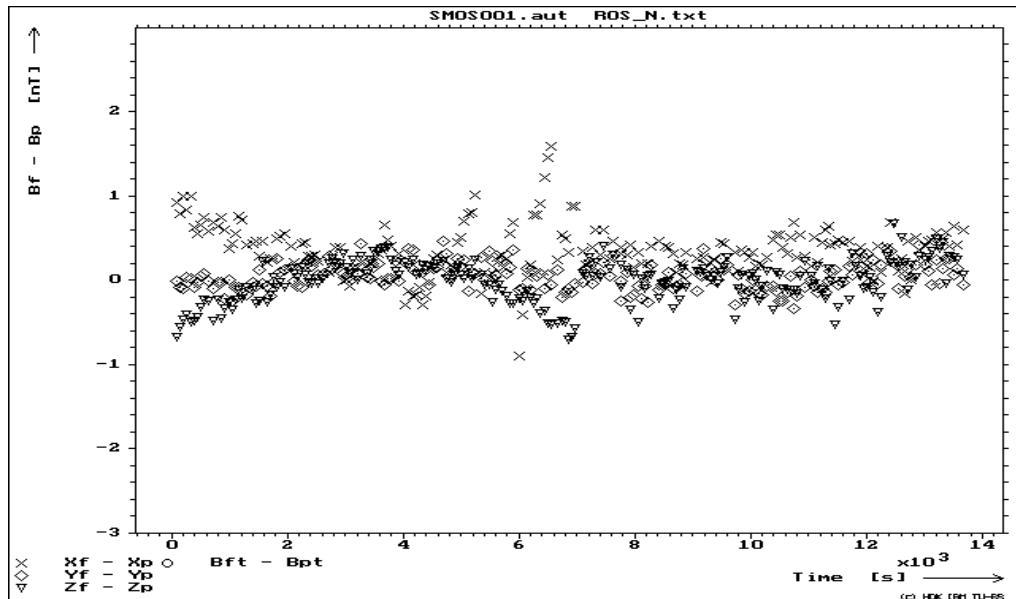
4.1.2.4   Calibration on a Sphere

4.1.2.4.1   First Measurement

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFM\OB\S\D04-05\SMOS002.aut
Comment      : ROS DPU-FS SEN-FM-OB SPHERE
Date         : 05/04
Time         : 18:34:00 - 23:06:10
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): +17.391 [deg C]
Mean stddev xp [nT]:+0.180   yp [nT]:+0.242    zp [nT]:+0.145    T [C]:+0.029


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter     ^1[1]        ^2[nT^-1]    ^3[nT^-2]    ^4[nT^-3]    ^5[nT^-4]
   m1,1          1.09076    --------     --------     --------     --------
   m1,2      1.45532e-003   --------     --------     --------     --------
   m1,3      9.02175e-003   --------     --------     --------     --------
   m2,1     -2.73970e-003   --------     --------     --------     --------
   m2,2          1.09334    --------     --------     --------     --------
   m2,3     -9.19668e-003   --------     --------     --------     --------
   m3,1     -9.40557e-003   --------     --------     --------     --------
   m3,2      8.06930e-003   --------     --------     --------     --------
   m3,3          1.09270    --------     --------     --------     --------
              ^0[nT]       Tx[C^-1]     Ty[C^-1]     Tz[C^-1]
   xp        --------     --------     --------     --------
   yp        --------     --------     --------     --------
   zp        --------     --------     --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  4'15.9  x,z:  90  1' 7.3  y,z:  90  3'27.3
Sensitivity [1]        x: 1.090793623   y: 1.093380004   z: 1.092773024


Static Setup              xf              yf              zf
   xp [deg,','']        0 28'45.1      90  4'21.9      90 28'25.1
   yp [deg,','']       89 51' 7.0       0 30'11.7      89 31' 8.4
   zp [deg,','']       89 30'25.3      90 25'24.6       0 38'59.6
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):              Orthogonality (O^-1):
    1.09079     0.00000     0.00000      1.00000 -1.241e-003 -3.266e-004
    0.00000     1.09338     0.00000      0.00000  9.999e-001 -1.005e-003
    0.00000     0.00000     1.09277      0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001 -2.508e-003  8.585e-003  Rot. about X axis:-  0 25'20.1
-2.511e-003  9.999e-001 -7.411e-003  Rot. about Y axis:   0 29'38.5
-8.622e-003 -7.391e-003  9.999e-001  Rot. about Z axis:   0  8'38.0
Determinant (R^-1):  9.999e-001


Quality of Fit:       Xp           Yp           Zp
```

```
Residual Min   [nT]: -7.007e-02  -2.960e-01  -7.002e-01
         Max   [nT]: +8.579e-01  +4.715e-01  +4.083e-01
         Mean  [nT]: +2.906e-01  +5.853e-02  -4.500e-02
         Std   [nT]: +1.676e-01  +1.555e-01  +2.128e-01
```
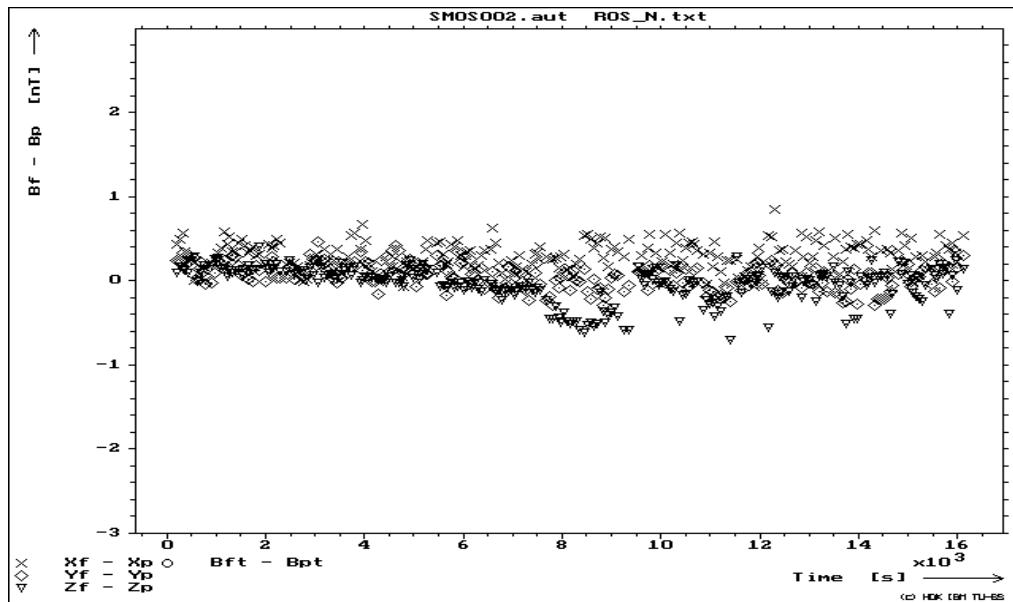

4.1.2.4.2   Second Measurement

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files  : o:\fgm\a\ROS\DPUFS\SFM\OB\S\D04-06\SMOS003.aut
Comment      : ROS DPU-FS SEN-FM-OB SPHERE
Date         : 06/04
Time         : 00:41:32 - 05:11:53
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +17.317 [deg C]
Mean stddev xp [nT]:+0.176    yp [nT]:+0.223    zp [nT]:+0.141    T [C]:+0.050


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]        ^2[nT^-1]      ^3[nT^-2]      ^4[nT^-3]      ^5[nT^-4]
   m1,1            1.09076   --------       --------       --------       --------
   m1,2        1.45941e-003  --------       --------       --------       --------
   m1,3        9.01883e-003  --------       --------       --------       --------
```

```
      m2,1      -2.74543e-003    --------    --------     --------     --------
      m2,2           1.09333     --------    --------     --------     --------
      m2,3      -9.20145e-003    --------    --------     --------     --------
      m3,1      -9.41221e-003    --------    --------     --------     --------
      m3,2       8.07383e-003    --------    --------     --------     --------
      m3,3           1.09270     --------    --------     --------     --------
                    ^0[nT]      Tx[C^-1]    Ty[C^-1]     Tz[C^-1]
      xp          --------     --------    --------     --------
      yp          --------     --------    --------     --------
      zp          --------     --------    --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  4'16.3   x,z:   90  1' 9.1   y,z:   90  3'27.3
Sensitivity [1]         x: 1.090794148    y: 1.093376095     z: 1.092774084

Static Setup                 xf              yf              zf
  xp [deg,','']          0 28'44.7       90  4'22.7      90 28'24.6
  yp [deg,','']         89 51' 5.9        0 30'12.9      89 31' 7.5
  zp [deg,','']         89 30'24.0       90 25'25.4       0 39' 1.1
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):                  Orthogonality (O^-1):
    1.09079     0.00000     0.00000     1.00000 -1.242e-003 -3.353e-004
    0.00000     1.09338     0.00000     0.00000  9.999e-001 -1.005e-003
    0.00000     0.00000     1.09277     0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001 -2.513e-003  8.591e-003  Rot. about X axis:-   0 25'20.9
-2.516e-003  9.999e-001 -7.415e-003  Rot. about Y axis:    0 29'39.8
-8.628e-003 -7.395e-003  9.999e-001  Rot. about Z axis:    0  8'39.1
Determinant (R^-1):  9.999e-001

Quality of Fit:         Xp          Yp          Zp
Residual Min  [nT]: -2.253e-01  -3.959e-01  -6.958e-01
         Max  [nT]: +8.423e-01  +5.114e-01  +3.364e-01
         Mean [nT]: +2.600e-01  -2.684e-02  -4.589e-02
         Std  [nT]: +1.767e-01  +1.589e-01  +2.165e-01
```

4.1.2.5   Temperature Calibration

```
Summary Sheet (Temperature)


Program      : merf.exe Version 4.0
Input files  : o:\fgm\a\ROS\DPUFS\SFM\OB\T\SUM-T4\SMOTS001.kas
Comment      :
Date         : 06/09    - 13/09
Time         : 18:41:11 - 06:23:55
Temperature  :  -44.24 -    69.75
Std temp.  :  2.21e-002 -      1.48
Std temp. mean :  4.31e-001
Std temp. std. :  3.72e-001


Results:

Measurements : 92 of 97


                Offset [1]      Slope [1/K]     Correlation [1]
Sensitivity X [1]:       1.09066 -1.18453e-005  -9.95439e-001
```
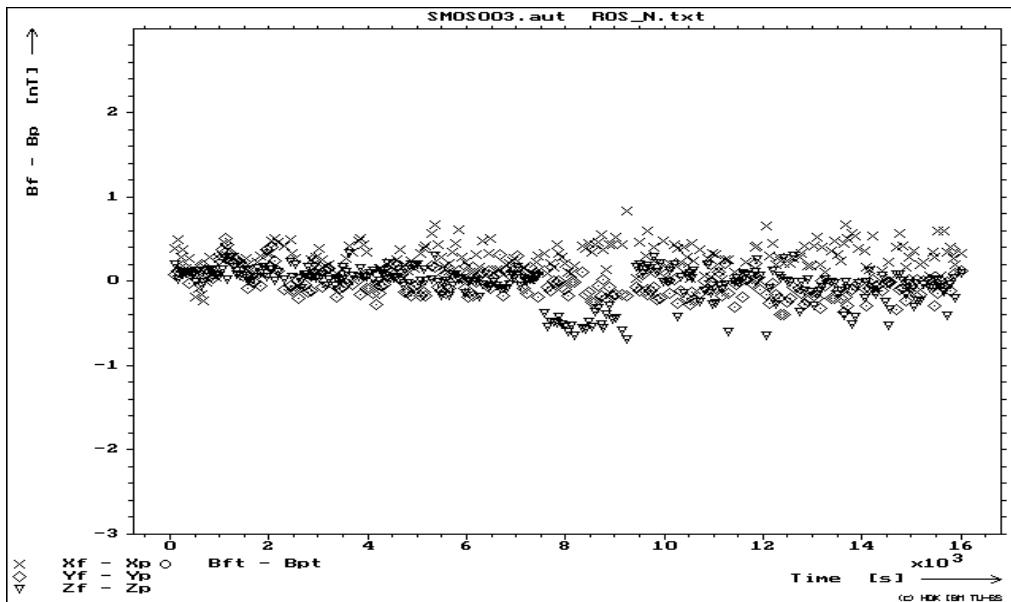
```
Sensitivity Y [1]:        1.09251   -8.19796e-006   -9.98733e-001
Sensitivity Z [1]:        1.09217   -6.96792e-006   -9.87794e-001
                 Offset [']     Slope ['/K]     Correlation [1]
Alignment  XY [']:        3.99875   -3.62638e-003   -9.30543e-001
Alignment  XZ [']:        2.19618   -6.68124e-003   -9.26096e-001
Alignment  YZ [']:        2.22072   -4.87483e-003   -9.21873e-001


Statistical Parameter:

                   Min          Max          Mean       Std
Sensitivity X [1]:      1.0898       1.09134      1.09037    3.12881e-004
Sensitivity Y [1]:      1.09195      1.09288      1.09231    2.15825e-004
Sensitivity Z [1]:      1.09162      1.09242      1.092      1.85474e-004
Alignment  XY [']:      3.73342      4.23194      3.91107    1.02466e-001
Alignment  XZ [']:      1.78994      2.73554      2.03463    1.89691e-001
Alignment  YZ [']:      1.91583      2.52072      2.10285    1.39038e-001
```

This measurement has been executed with an increased supply voltage of ± 5.1 V rather than ± 5.0 V, as the supply voltage during flight onboard the ROSETTA s/c is supposed to be 10 % higher than the nominal voltage of ± 5.0 V.

Sensitivity Z

Alignment XY
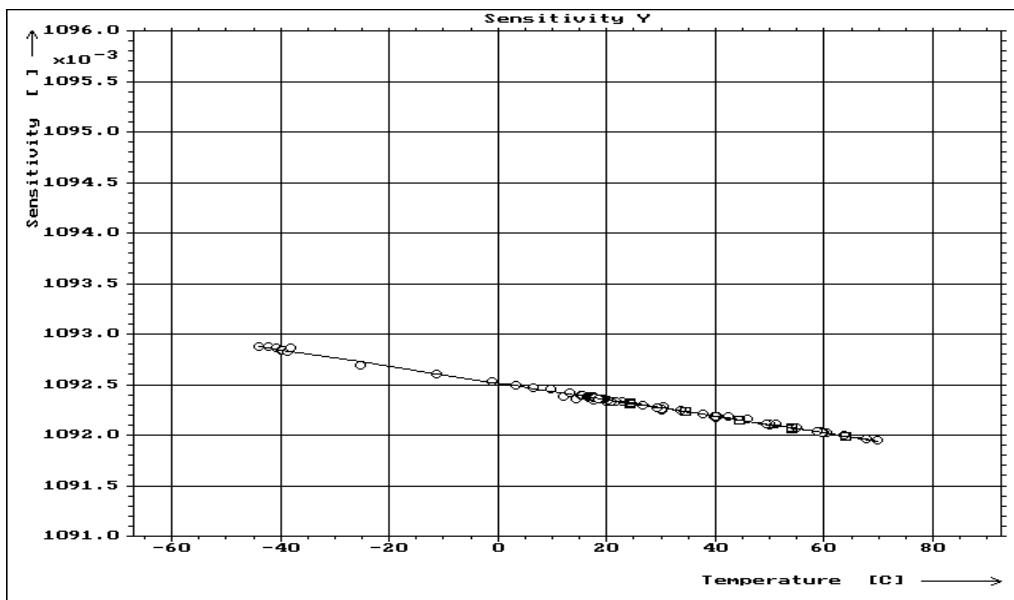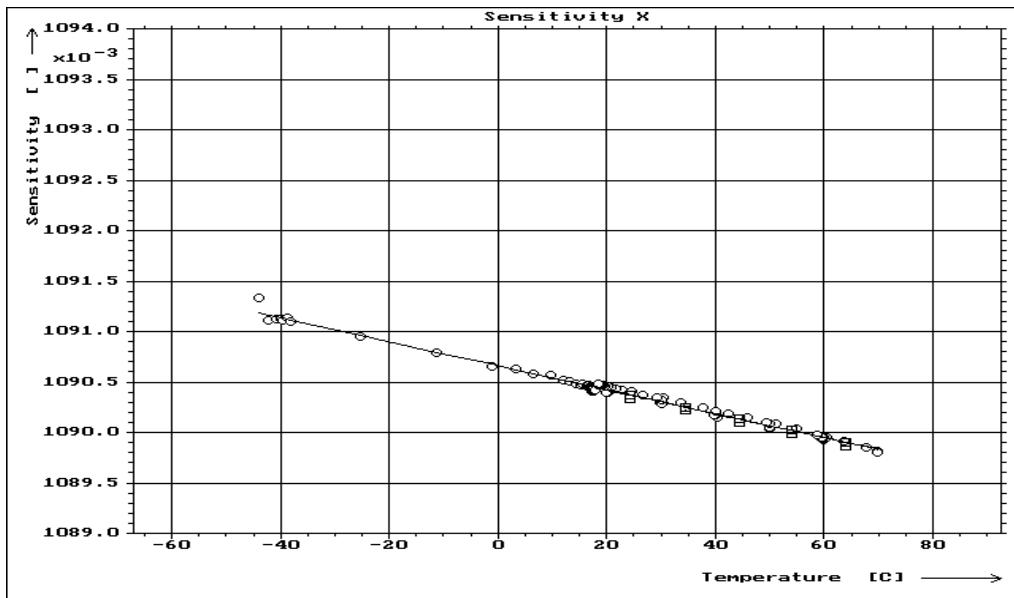
4.2 SENSOR: FS

4.2.1 Inboard Sensor (IB)

4.2.1.1 Offset before T-cycle

```
Summary Sheet (Offset Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\IB\O\D04-25\SSIO001.aut
Comment     : ROS DPU-FS SEN-FS-IB OFF
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset        : +0.0000000 +0.0000000 +0.0000000

Date        : 25/04
Time        : 13:32:05 - 14:20:27
Quality of Input Data:
Mean Temperature: -99.990
               Xc        Yc        Zc        T
Mean stddev: +0.181    +0.245    +0.174     -99.990



Result:
        Offset      Residual field
    X     +1.49e+01       -1.07e-01
    Y     -1.41e+02       +2.90e-02
    Z     +4.55e+02       +1.21e+00
```

4.2.1.2 Calibration on Axes

4.2.1.2.1 First Measurement

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\IB\L\D04-23\SSIL002.aut
Comment     : ROS DPU-FS SEN-FS-IB LIN
Date        : 23/04
Time        : 22:35:20 - 00:07:06
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000
```

```
Quality of Input Data:
Mean Temperature (T): -99.990 [deg C]
Mean stddev xp [nT]:+0.159   yp [nT]:+0.203    zp [nT]:+0.128    T [C]:-99.990


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]         ^2[nT^-1]     ^3[nT^-2]    ^4[nT^-3]     ^5[nT^-4]
  m1,1          1.09517       --------      --------     --------      --------
  m1,2         -1.84758e-003  --------      --------     --------      --------
  m1,3          1.14148e-002  --------      --------     --------      --------
  m2,1          1.60693e-003  --------      --------     --------      --------
  m2,2          1.09201       --------      --------     --------      --------
  m2,3         -3.54337e-003  --------      --------     --------      --------
  m3,1         -9.35583e-003  --------      --------     --------      --------
  m3,2          4.02847e-003  --------      --------     --------      --------
  m3,3          1.09197       --------      --------     --------      --------
                ^0[nT]        Tx[C^-1]      Ty[C^-1]     Tz[C^-1]
  xp            --------      --------      --------     --------
  yp            --------      --------      --------     --------
  zp            --------      --------      --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  0'51.4  x,z:  89 53'38.6   y,z:   89 58'30.9
Sensitivity [1]        x: 1.095229025   y: 1.092013790    z: 1.092014182


Static Setup            xf             yf            zf
  xp [deg,','']          0 36'24.3      89 54' 3.0    90 35'54.9
  yp [deg,','']         90  4'56.9       0 12'15.0    89 48'47.5
  zp [deg,','']         89 30'36.8      90 12'37.9     0 31'59.1
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):                  Orthogonality (O^-1):
    1.09523    0.00000    0.00000      1.00000 -2.492e-004  1.848e-003
    0.00000    1.09201    0.00000      0.00000  9.999e-001  4.321e-004
    0.00000    0.00000    1.09201      0.00000  0.00000     9.999e-001
Rotation (R^-1):
 9.999e-001  1.474e-003  8.605e-003  Rot. about X axis:-  0 12'40.5
 1.467e-003  9.999e-001 -3.679e-003  Rot. about Y axis:   0 29'22.0
-8.542e-003 -3.674e-003  9.999e-001  Rot. about Z axis:-  0  5' 2.6
Determinant (R^-1):  9.999e-001


Quality of Fit:         Xp         Yp         Zp
Residual Min  [nT]: -2.668e-01 -5.262e-01 -3.159e-01
         Max  [nT]: +3.873e-01 +5.378e-01 +5.173e-01
         Mean [nT]: +8.804e-02 +7.051e-05 +6.474e-02
         Std  [nT]: +1.232e-01 +1.869e-01 +1.139e-01
```

4.2.1.2.2 Second Measurement

```
Summary Sheet (Global Mode)



Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\IB\L\D04-23\SSIL002.aut
Comment      : ROS DPU-FS SEN-FS-IB LIN
Date         : 23/04
Time         : 22:35:20 - 00:07:06
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
```

```
            -1.0000000 +0.0000000 +0.0000000
            +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): -99.990 [deg C]
Mean stddev xp [nT]:+0.159   yp [nT]:+0.203    zp [nT]:+0.128    T [C]:-99.990


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1          1.09517    --------      --------      --------      --------
   m1,2       -1.84758e-003 --------      --------      --------      --------
   m1,3        1.14148e-002 --------      --------      --------      --------
   m2,1        1.60693e-003 --------      --------      --------      --------
   m2,2          1.09201    --------      --------      --------      --------
   m2,3       -3.54337e-003 --------      --------      --------      --------
   m3,1       -9.35583e-003 --------      --------      --------      --------
   m3,2        4.02847e-003 --------      --------      --------      --------
   m3,3          1.09197    --------      --------      --------      --------
                 ^0[nT]      Tx[C^-1]     Ty[C^-1]     Tz[C^-1]
   xp          --------     --------      --------      --------
   yp          --------     --------      --------      --------
   zp          --------     --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  0'51.4  x,z:  89 53'38.6   y,z:  89 58'30.9
Sensitivity [1]        x: 1.095229025  y: 1.092013790   z: 1.092014182


Static Setup            xf            yf            zf
   xp [deg,','']        0 36'24.3     89 54' 3.0    90 35'54.9
   yp [deg,','']       90  4'56.9      0 12'15.0    89 48'47.5
   zp [deg,','']       89 30'36.8     90 12'37.9     0 31'59.1
Separation of M^-1 = R^-10^-1S^-1
```

```
Sensitivity (S^-1):                  Orthogonality (O^-1):
     1.09523     0.00000     0.00000       1.00000 -2.492e-004  1.848e-003
     0.00000     1.09201     0.00000       0.00000  9.999e-001  4.321e-004
     0.00000     0.00000     1.09201       0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  1.474e-003  8.605e-003  Rot. about X axis:-   0 12'40.5
 1.467e-003  9.999e-001 -3.679e-003  Rot. about Y axis:    0 29'22.0
-8.542e-003 -3.674e-003  9.999e-001  Rot. about Z axis:-   0  5' 2.6
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -2.668e-01  -5.262e-01  -3.159e-01
         Max  [nT]: +3.873e-01  +5.378e-01  +5.173e-01
         Mean [nT]: +8.804e-02  +7.051e-05  +6.474e-02
         Std  [nT]: +1.232e-01  +1.869e-01  +1.139e-01
```


4.2.1.2.3   Measurement just before 1. T–cycle

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\IB\L\D04-26\SSITL001.aut
Comment      : ROS DPU-FS SEN-FS-IB T-LIN
Date         : 26/04
Time         : 10:05:38 - 10:43:45
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset [nT]  : +0.0000000 +0.0000000 +0.0000000
```

```
Quality of Input Data:
Mean Temperature (T): +17.854 [deg C]
Mean stddev xp [nT]:+0.145    yp [nT]:+0.198     zp [nT]:+0.129    T [C]:+0.109


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter       ^1[1]         ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1          1.09462      --------      --------      --------      --------
   m1,2        -3.85252e-003  --------      --------      --------      --------
   m1,3         1.73731e-002  --------      --------      --------      --------
   m2,1         4.00435e-003  --------      --------      --------      --------
   m2,2          1.09117      --------      --------      --------      --------
   m2,3        -2.55125e-003  --------      --------      --------      --------
   m3,1        -1.56686e-002  --------      --------      --------      --------
   m3,2         3.26288e-003  --------      --------      --------      --------
   m3,3          1.09132      --------      --------      --------      --------
                  ^0[nT]       Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp            --------      --------      --------      --------
   yp            --------      --------      --------      --------
   zp            --------      --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  89 59'36.6   x,z:  89 54'49.9   y,z:  89 57'56.4
Sensitivity [1]        x: 1.094768937   y: 1.091183099    z: 1.091436672


Static Setup            xf            yf            zf
   xp [deg,','']       0 56' 3.5     89 47'42.0    90 54'41.6
   yp [deg,','']      90 12'27.4      0 14'56.0    89 51'45.9
   zp [deg,','']      89 10'45.4     90 10' 6.2     0 50'16.0
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):                  Orthogonality (O^-1):
    1.09477    0.00000    0.00000       1.00000   1.131e-004  1.502e-003
    0.00000    1.09118    0.00000       0.00000   9.999e-001  5.988e-004
    0.00000    0.00000    1.09144       0.00000    0.00000    9.999e-001
Rotation (R^-1):
 9.998e-001  3.686e-003  1.441e-002  Rot. about X axis:-  0 10'17.1
 3.657e-003  9.999e-001 -2.941e-003  Rot. about Y axis:   0 49'12.2
-1.431e-002 -2.939e-003  9.999e-001  Rot. about Z axis:-  0 12'34.5
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min [nT]: -2.608e-01  -2.902e-01  -3.934e-01
        Max  [nT]: +2.954e-01  +4.676e-01  +3.171e-01
        Mean [nT]: +2.126e-02  +1.099e-01  -4.065e-02
        Std  [nT]: +1.538e-01  +1.395e-01  +1.094e-01
```

4.2.1.2.4   Measurement just after 1. T–cycle

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\IB\L\D05-02\SSITL002.aut
Comment      : ROS DPU-FS SEN-FS-IB T-LIN
Date         : 01/05
Time         : 23:45:52 - 01:42:02
Facility Parameter:
```
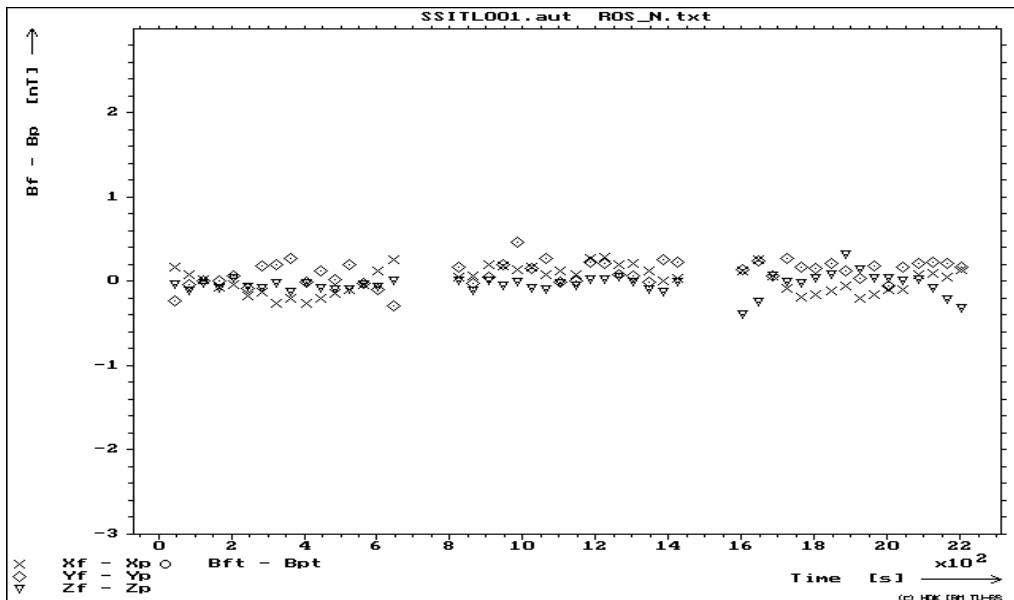
```
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): +17.873 [deg C]
Mean stddev xp [nT]:+0.186    yp [nT]:+0.192    zp [nT]:+0.195    T [C]:+0.045


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1         1.09468     --------      --------      --------      --------
   m1,2        -4.59144e-003 --------     --------      --------      --------
   m1,3         1.72841e-002 --------     --------      --------      --------
   m2,1         4.74550e-003 --------     --------      --------      --------
   m2,2         1.09117     --------      --------      --------      --------
   m2,3        -2.05371e-003 --------     --------      --------      --------
   m3,1        -1.55972e-002 --------     --------      --------      --------
   m3,2         2.74866e-003 --------     --------      --------      --------
   m3,3         1.09135     --------      --------      --------      --------
               ^0[nT]       Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp         --------      --------      --------      --------
   yp         --------      --------      --------      --------
   zp         --------      --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  89 59'34.2   x,z:  89 54'53.4   y,z:  89 58' 1.5
Sensitivity [1]        x: 1.094829489   y: 1.091182597   z: 1.091461105


Static Setup            xf             yf             zf
   xp [deg,','']        0 56'20.2      89 45'23.9     90 54'24.7
   yp [deg,','']       90 14'48.4       0 16'15.2     89 53'17.7
   zp [deg,','']       89 10'59.1      90  8'27.1      0 49'44.3
```

```
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):                     Orthogonality (O^-1):
     1.09483      0.00000     0.00000        1.00000  1.249e-004  1.486e-003
     0.00000      1.09118     0.00000        0.00000  9.999e-001  5.740e-004
     0.00000      0.00000     1.09146        0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.998e-001  4.368e-003  1.435e-002  Rot. about X axis:-   0  8'40.0
 4.334e-003  9.999e-001 -2.462e-003  Rot. about Y axis:    0 48'58.6
-1.424e-002 -2.458e-003  9.999e-001  Rot. about Z axis:-   0 14'54.1
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -1.755e-01  -6.994e-01  -4.368e-01
         Max  [nT]: +4.251e-01  +2.859e-01  +2.388e-01
        Mean  [nT]: +8.225e-02  -4.298e-02  +2.728e-02
         Std  [nT]: +1.146e-01  +1.753e-01  +1.013e-01
```
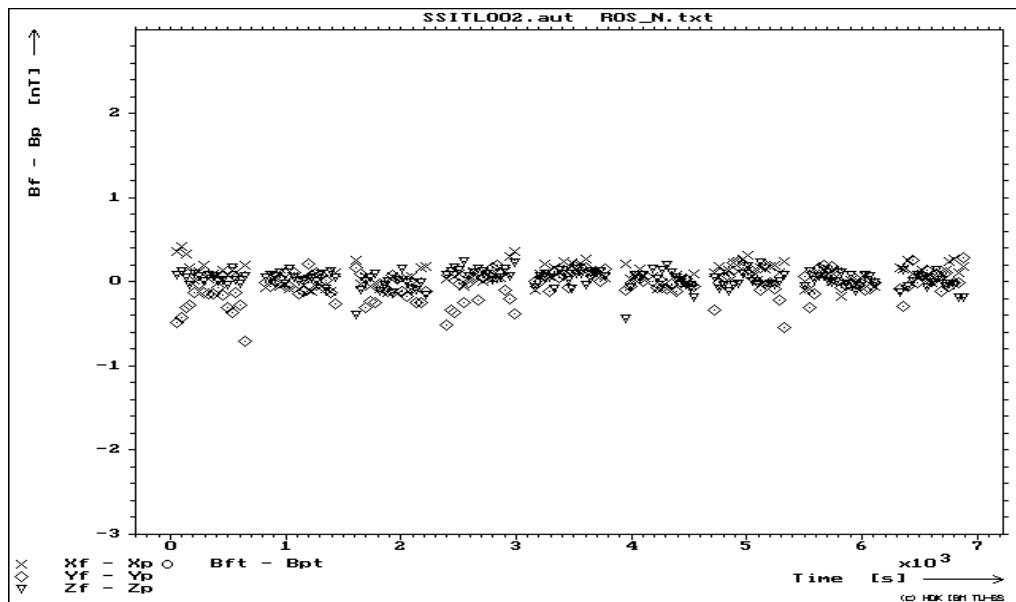
4.2.1.2.5   Measurement just before 2. T–cycle

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\IB\L\D08-28\SSITL003.aut
Comment     : ROS DPU-FS SEN-FS-IB T-LIN
Date        : 28/08
Time        : 11:33:01 - 12:11:08
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +19.242 [deg C]
Mean stddev xp [nT]:+0.406   yp [nT]:+0.375    zp [nT]:+0.378   T [C]:+0.136

Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter     ^1[1]        ^2[nT^-1]    ^3[nT^-2]    ^4[nT^-3]    ^5[nT^-4]
  m1,1         1.09450     --------     --------     --------     --------
  m1,2        -1.19854e-002 --------    --------     --------     --------
  m1,3         1.88525e-002 --------    --------     --------     --------
  m2,1         1.21681e-002 --------    --------     --------     --------
  m2,2         1.09114     --------     --------     --------     --------
  m2,3        -2.40892e-003 --------    --------     --------     --------
  m3,1        -1.71705e-002 --------    --------     --------     --------
  m3,2         3.25352e-003 --------    --------     --------     --------
  m3,3         1.09121     --------     --------     --------     --------
               ^0[nT]      Tx[C^-1]     Ty[C^-1]     Tz[C^-1]
  xp          --------     --------     --------     --------
  yp          --------     --------     --------     --------
  zp          --------     --------     --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  89 59'26.3  x,z:  89 54'59.5  y,z:  89 57'56.6
Sensitivity [1]        x: 1.094723817  y: 1.091214441  z: 1.091354609

Static Setup           xf           yf           zf
  xp [deg,','']        1 10'23.7     89 22' 4.1    90 59'17.9
  yp [deg,','']       90 38' 5.3      0 38'58.2    89 51'45.2
  zp [deg,','']       89  5'57.9     90  9'39.3     0 54'53.4
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):              Orthogonality (O^-1):
    1.09472    0.00000    0.00000     1.00000  1.629e-004  1.456e-003
    0.00000    1.09121    0.00000     0.00000  9.999e-001  5.980e-004
    0.00000    0.00000    1.09135     0.00000    0.00000   9.999e-001
Rotation (R^-1):
 9.997e-001  1.119e-002  1.582e-002  Rot. about X axis:-  0 10'15.6
 1.111e-002  9.999e-001 -2.821e-003  Rot. about Y axis:   0 53'55.3
-1.568e-002 -2.808e-003  9.998e-001  Rot. about Z axis:-  0 38'13.0
Determinant (R^-1):  9.999e-001

Quality of Fit:       Xp          Yp          Zp
Residual Min  [nT]: -2.936e-01  -4.123e-01  -2.850e-01
         Max  [nT]: +2.503e-01  +3.871e-01  +3.029e-01
         Mean [nT]: +3.647e-02  +3.190e-02  +1.009e-02
         Std  [nT]: +1.124e-01  +1.596e-01  +1.506e-01
```

This measurement has been executed with an increased supply voltage of ± 5.1 V rather than ± 5.0 V, as the supply voltage during flight onboard the ROSETTA s/c is supposed to be 10 % higher than the nominal voltage of ± 5.0 V.
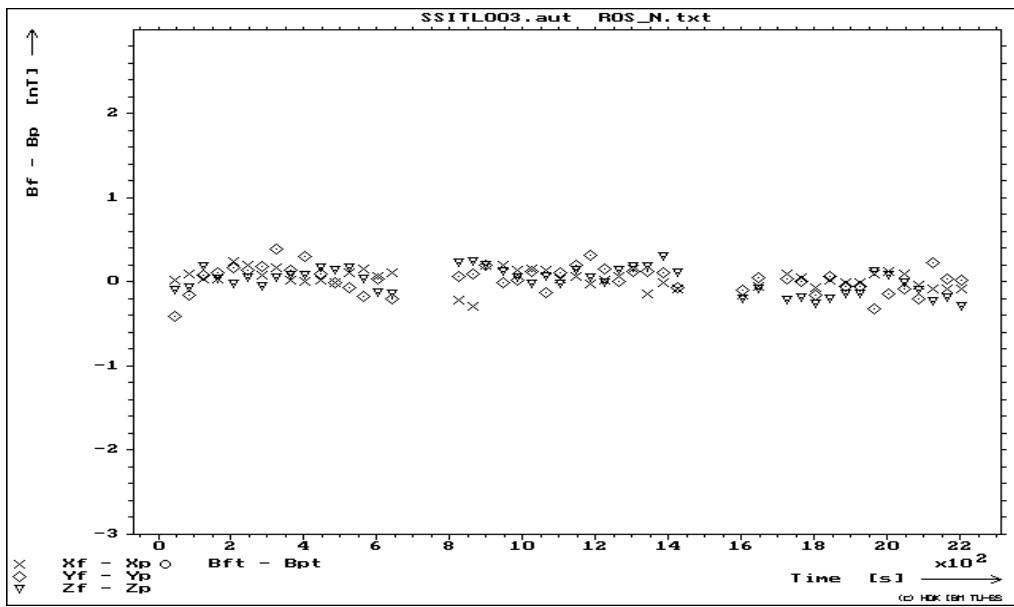

4.2.1.3 Calibration on a Spiral Sphere

4.2.1.3.1 First Measurement

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\IB\S\D04-23\SSIS001.aut
Comment      : ROS DPU-FS SEN-FS-IB SPHERE
Date         : 23/04
Time         : 14:10:03 - 18:01:22
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): -99.990 [deg C]
Mean stddev xp [nT]:+0.166    yp [nT]:+0.226    zp [nT]:+0.126    T [C]:-99.990


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)
```

```
Parameter     ^1[1]        ^2[nT^-1]    ^3[nT^-2]    ^4[nT^-3]    ^5[nT^-4]
   m1,1         1.09516     --------     --------     --------     --------
   m1,2        -1.85593e-003 --------    --------     --------     --------
   m1,3         1.14156e-002 --------    --------     --------     --------
   m2,1         1.59891e-003 --------    --------     --------     --------
   m2,2         1.09201     --------     --------     --------     --------
   m2,3        -3.53555e-003 --------    --------     --------     --------
   m3,1        -9.36185e-003 --------    --------     --------     --------
   m3,2         4.01936e-003 --------    --------     --------     --------
   m3,3         1.09197     --------     --------     --------     --------
                ^0[nT]       Tx[C^-1]     Ty[C^-1]     Tz[C^-1]
   xp          --------     --------     --------     --------
   yp          --------     --------     --------     --------
   zp          --------     --------     --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  0'54.5   x,z:   89 53'39.6   y,z:   89 58'31.1
Sensitivity [1]        x: 1.095223306   y: 1.092012625   z: 1.092015435

Static Setup            xf              yf              zf
  xp [deg,','']        0 36'24.7      89 54' 1.5      90 35'55.0
  yp [deg,','']       90  4'55.4       0 12'13.0      89 48'49.0
  zp [deg,','']       89 30'35.7      90 12'36.1       0 31'59.5
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):                 Orthogonality (O^-1):
    1.09522      0.00000      0.00000      1.00000 -2.641e-004  1.843e-003
    0.00000      1.09201      0.00000      0.00000  9.999e-001  4.310e-004
    0.00000      0.00000      1.09202      0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  1.467e-003  8.610e-003  Rot. about X axis:-   0 12'38.7
 1.459e-003  9.999e-001 -3.671e-003  Rot. about Y axis:    0 29'23.1
-8.547e-003 -3.665e-003  9.999e-001  Rot. about Z axis:-   0  5' 1.1
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -5.590e-01  -6.378e-01  -3.295e-01
         Max  [nT]: +9.369e-01  +4.108e-01  +5.127e-01
         Mean [nT]: +2.317e-01  -6.029e-02  +6.403e-02
         Std  [nT]: +2.353e-01  +1.928e-01  +1.413e-01
```

4.2.1.3.2   Second Measurement

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\IB\S\D04-24\SSIS003.aut
Comment     : ROS DPU-FS SEN-FS-IB SPHERE
Date        : 24/04
Time        : 00:08:30 - 03:59:53
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): -99.990 [deg C]
```
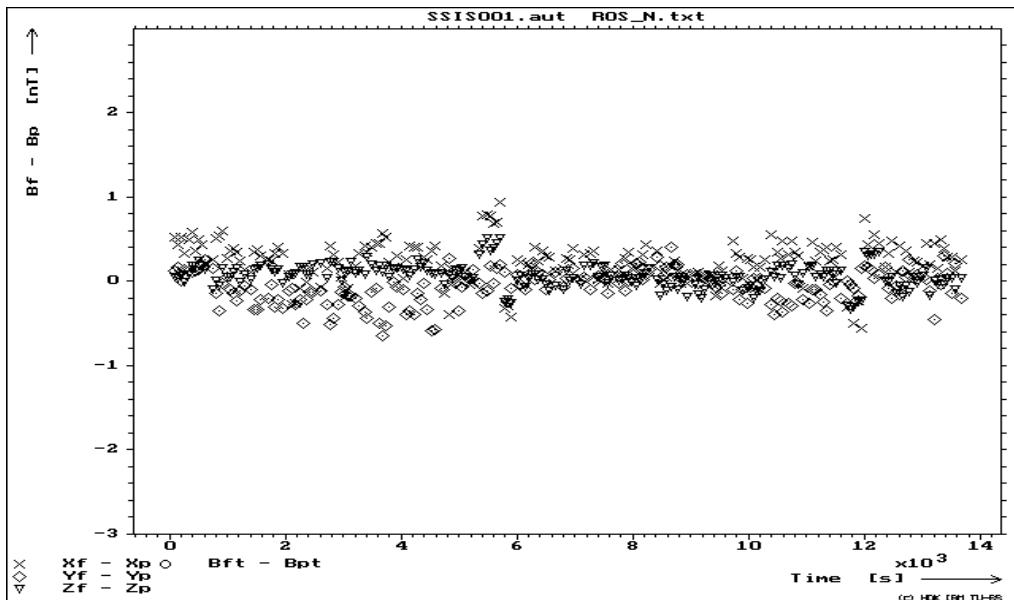
```
Mean stddev  xp [nT]:+0.172    yp [nT]:+0.199    zp [nT]:+0.130     T [C]:-99.990

Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter       ^1[1]         ^2[nT^-1]      ^3[nT^-2]      ^4[nT^-3]      ^5[nT^-4]
  m1,1           1.09517      --------       --------       --------       --------
  m1,2          -1.84968e-003 --------       --------       --------       --------
  m1,3           1.14142e-002 --------       --------       --------       --------
  m2,1           1.60151e-003 --------       --------       --------       --------
  m2,2           1.09201      --------       --------       --------       --------
  m2,3          -3.54430e-003 --------       --------       --------       --------
  m3,1          -9.35636e-003 --------       --------       --------       --------
  m3,2           4.02400e-003 --------       --------       --------       --------
  m3,3           1.09197      --------       --------       --------       --------
                 ^0[nT]       Tx[C^-1]       Ty[C^-1]       Tz[C^-1]
  xp             --------     --------       --------       --------
  yp             --------     --------       --------       --------
  zp             --------     --------       --------       --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,','']  x,y:   90  0'52.8  x,z:  89 53'38.9   y,z:   89 58'31.9
Sensitivity [1]       x: 1.095230415    y: 1.092016613    z: 1.092014184

Static Setup             xf             yf             zf
  xp [deg,','']          0 36'24.2      89 54' 2.7     90 35'54.8
  yp [deg,','']         90  4'55.8       0 12'14.7     89 48'47.4
  zp [deg,','']         89 30'36.7      90 12'37.0      0 31'58.9
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):              Orthogonality (O^-1):
    1.09523    0.00000    0.00000    1.00000 -2.561e-004  1.847e-003
    0.00000    1.09202    0.00000    0.00000  9.999e-001  4.273e-004
    0.00000    0.00000    1.09201    0.00000    0.00000   9.999e-001
Rotation (R^-1):
 9.999e-001  1.469e-003  8.605e-003  Rot. about X axis:-   0 12'39.6
```

```
 1.462e-003  9.999e-001 -3.675e-003  Rot. about Y axis:    0 29'22.1
-8.542e-003 -3.670e-003  9.999e-001  Rot. about Z axis:-   0  5' 1.6
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp         Yp         Zp
Residual Min  [nT]: -8.297e-01  -6.158e-01  -6.706e-01
         Max  [nT]: +1.141e+00  +4.831e-01  +5.280e-01
         Mean [nT]: +2.033e-01  -9.207e-02  +3.867e-02
         Std  [nT]: +2.929e-01  +1.830e-01  +1.765e-01
```
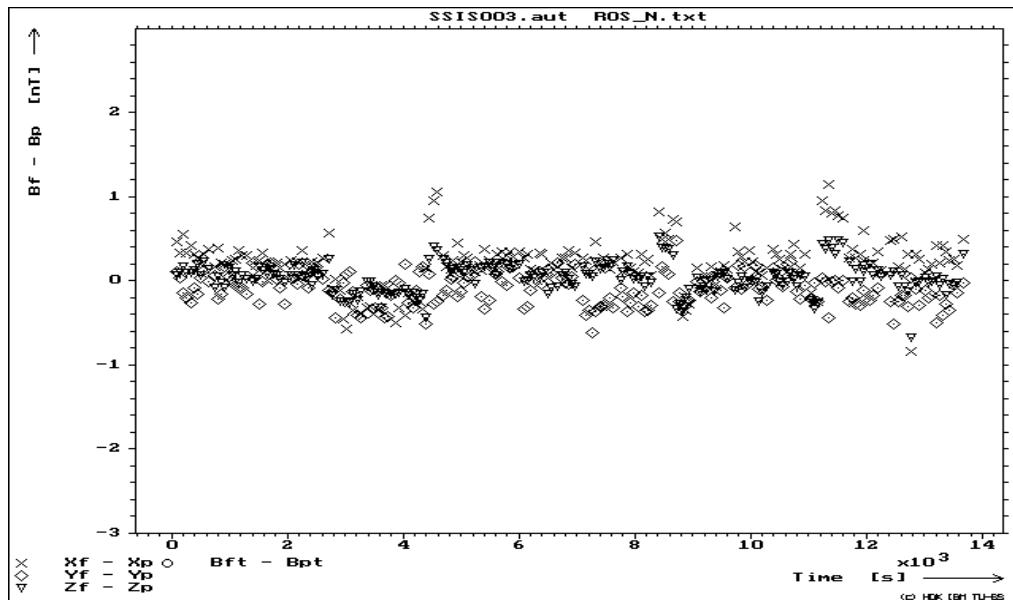

4.2.1.4 Calibration on a Sphere

4.2.1.4.1 First Measurement

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\IB\S\D04-23\SSIS002.aut
Comment      : ROS DPU-FS SEN-FS-IB SPHERE
Date         : 23/04
Time         : 18:01:59 - 22:34:10
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000
```

```
Quality of Input Data:
Mean Temperature (T): -99.990 [deg C]
Mean stddev xp [nT]:+0.161   yp [nT]:+0.216    zp [nT]:+0.122    T [C]:-99.990


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]          ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1           1.09517      --------      --------      --------      --------
   m1,2        -1.85095e-003   --------      --------      --------      --------
   m1,3         1.14153e-002   --------      --------      --------      --------
   m2,1         1.60215e-003   --------      --------      --------      --------
   m2,2           1.09200      --------      --------      --------      --------
   m2,3        -3.54675e-003   --------      --------      --------      --------
   m3,1        -9.35954e-003   --------      --------      --------      --------
   m3,2         4.02618e-003   --------      --------      --------      --------
   m3,3           1.09197      --------      --------      --------      --------
                  ^0[nT]       Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp             --------     --------      --------      --------
   yp             --------     --------      --------      --------
   zp             --------     --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  0'52.9  x,z:   89 53'39.2   y,z:   89 58'32.0
Sensitivity [1]        x: 1.095226562   y: 1.092011503    z: 1.092015115


Static Setup            xf              yf              zf
   xp [deg,','']        0 36'24.5      89 54' 2.4      90 35'55.0
   yp [deg,','']       90  4'56.0       0 12'15.2      89 48'46.9
   zp [deg,','']       89 30'36.1      90 12'37.4       0 31'59.6
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):                     Orthogonality (O^-1):
     1.09523     0.00000     0.00000     1.00000 -2.567e-004  1.845e-003
     0.00000     1.09201     0.00000     0.00000  9.999e-001  4.270e-004
     0.00000     0.00000     1.09202     0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  1.469e-003  8.608e-003  Rot. about X axis:-   0 12'40.0
 1.462e-003  9.999e-001 -3.677e-003  Rot. about Y axis:    0 29'22.7
-8.545e-003 -3.672e-003  9.999e-001  Rot. about Z axis:-   0  5' 1.7
Determinant (R^-1):  9.999e-001


Quality of Fit:         Xp          Yp          Zp
Residual Min  [nT]: -3.869e-01  -5.718e-01  -4.106e-01
         Max  [nT]: +8.095e-01  +4.208e-01  +4.068e-01
         Mean [nT]: +1.606e-01  -1.321e-01  +9.711e-02
         Std  [nT]: +1.678e-01  +1.683e-01  +1.259e-01
```

4.2.1.4.2   Second Measurement

```
Summary Sheet (Global Mode)



Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\IB\S\D04-24\SSIS004.aut
Comment      : ROS DPU-FS SEN-FS-IB SPHERE
Date         : 24/04
Time         : 04:00:24 - 08:32:27
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
```
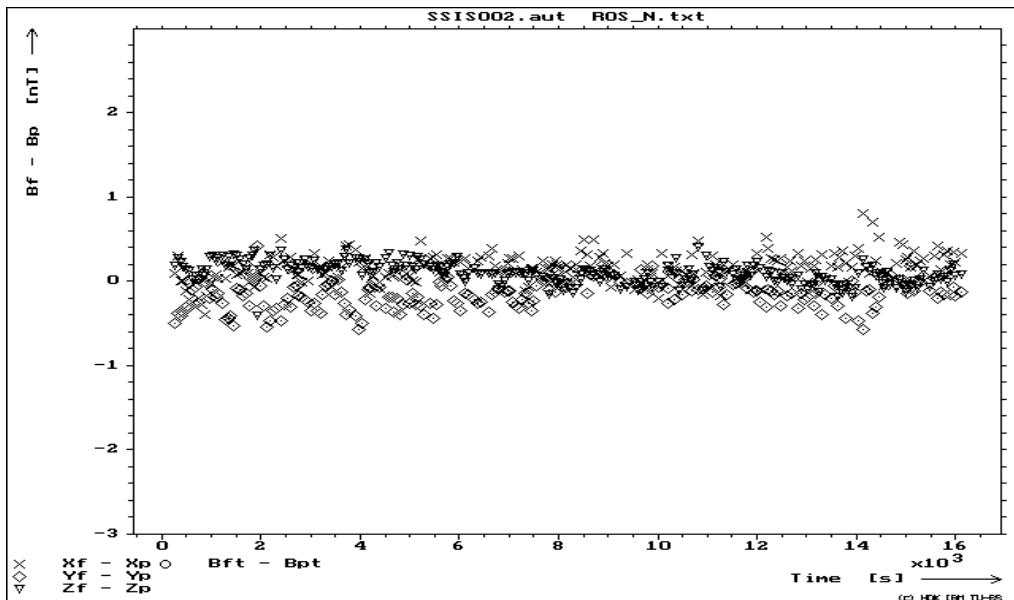
```
                   -1.0000000 +0.0000000 +0.0000000
                   +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  :  +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): -99.990 [deg C]
Mean stddev xp [nT]:+0.163   yp [nT]:+0.210     zp [nT]:+0.128    T [C]:-99.990


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]        ^2[nT^-1]    ^3[nT^-2]    ^4[nT^-3]    ^5[nT^-4]
   m1,1         1.09516     --------     --------     --------     --------
   m1,2        -1.84754e-003 --------    --------     --------     --------
   m1,3         1.14149e-002 --------    --------     --------     --------
   m2,1         1.59982e-003 --------    --------     --------     --------
   m2,2         1.09201     --------     --------     --------     --------
   m2,3        -3.54477e-003 --------    --------     --------     --------
   m3,1        -9.35570e-003 --------    --------     --------     --------
   m3,2         4.02216e-003 --------    --------     --------     --------
   m3,3         1.09196     --------     --------     --------     --------
               ^0[nT]       Tx[C^-1]     Ty[C^-1]     Tz[C^-1]
   xp          --------     --------     --------     --------
   yp          --------     --------     --------     --------
   zp          --------     --------     --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  0'52.7  x,z:   89 53'38.6   y,z:   89 58'32.3
Sensitivity [1]       x: 1.095223238   y: 1.092014143   z: 1.092012452


Static Setup            xf              yf              zf
   xp [deg,','']        0 36'24.3      89 54' 3.1      90 35'54.9
   yp [deg,','']       90  4'55.5       0 12'14.7      89 48'47.3
   zp [deg,','']       89 30'36.8      90 12'36.7       0 31'58.6
Separation of M^-1 = R^-10^-1S^-1
```

```
Sensitivity (S^-1):                  Orthogonality (O^-1):
     1.09522      0.00000      0.00000        1.00000  -2.557e-004  1.848e-003
     0.00000      1.09201      0.00000        0.00000   9.999e-001  4.252e-004
     0.00000      0.00000      1.09201        0.00000      0.00000  9.999e-001
Rotation (R^-1):
  9.999e-001  1.467e-003  8.604e-003  Rot. about X axis:-   0 12'39.3
  1.460e-003  9.999e-001 -3.674e-003  Rot. about Y axis:    0 29'21.9
 -8.542e-003 -3.668e-003  9.999e-001  Rot. about Z axis:-   0  5' 1.3
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp           Yp           Zp
Residual Min  [nT]: -3.845e-01   -5.675e-01   -2.891e-01
         Max  [nT]: +9.737e-01   +3.950e-01   +5.163e-01
         Mean [nT]: +1.880e-01   -1.045e-01   +8.761e-02
         Std  [nT]: +2.045e-01   +1.659e-01   +1.331e-01
```
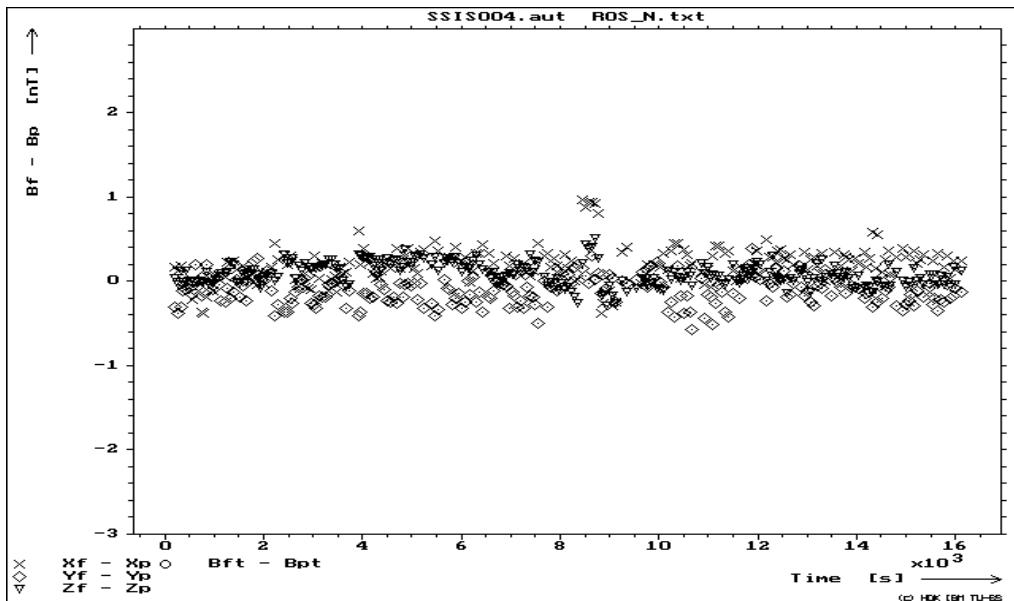

4.2.1.5   Temperature Calibration, 1. Run

```
Summary Sheet (Temperature)


Program     : merf.exe Version 4.0
Input files : o:\fgm\a\ROS\DPUFS\SFS\IB\T\SUM\SSITS001.kas
Comment     :
Date        : 27/04    - 01/05
Time        : 10:08:13 - 22:31:02
Temperature :    -20.25 -      69.92
Std temp.   : 2.57e-002 -       1.53
Std temp. mean :  3.42e-001
Std temp. std. :  4.11e-001
```

Results:

Measurements : 92 of 98

	Offset [1]	Slope [1/K]	Correlation [1]
Sensitivity X [1]:	1.09506	-1.39261e-005	-9.89667e-001
Sensitivity Y [1]:	1.09131	-7.92498e-006	-9.96669e-001
Sensitivity Z [1]:	1.09159	-8.07377e-006	-9.88883e-001
	Offset [']	Slope ['/K]	Correlation [1]
Alignment XY [']:	-4.13914e-001	-1.16585e-004	-5.79888e-002
Alignment XZ [']:	-5.12876	6.84065e-004	3.89534e-001
Alignment YZ [']:	-2.0933	5.93605e-003	9.54660e-001

Statistical Parameter:

	Min	Max	Mean	Std
Sensitivity X [1]:	1.09406	1.09531	1.09467	2.75386e-004
Sensitivity Y [1]:	1.09075	1.09144	1.09109	1.55613e-004
Sensitivity Z [1]:	1.09101	1.09171	1.09136	1.59783e-004
Alignment XY [']:	-5.88763e-001	-3.50827e-001	-4.17205e-001	3.93457e-002
Alignment XZ [']:	-5.30361	-5.01785	-5.10945	3.43677e-002
Alignment YZ [']:	-2.3148	-1.6935	-1.92573	1.21688e-001
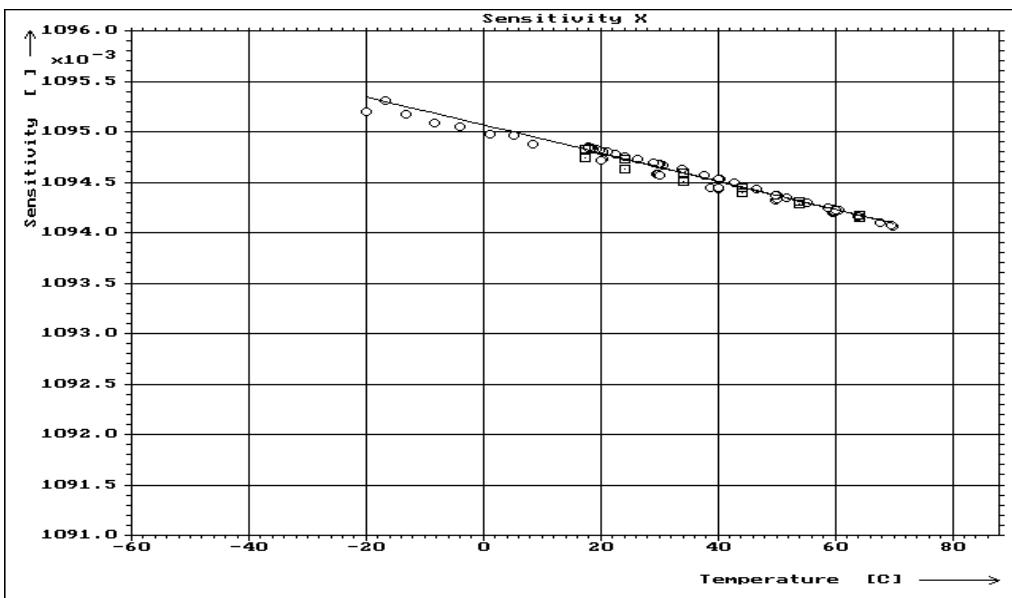
Alignment YZ
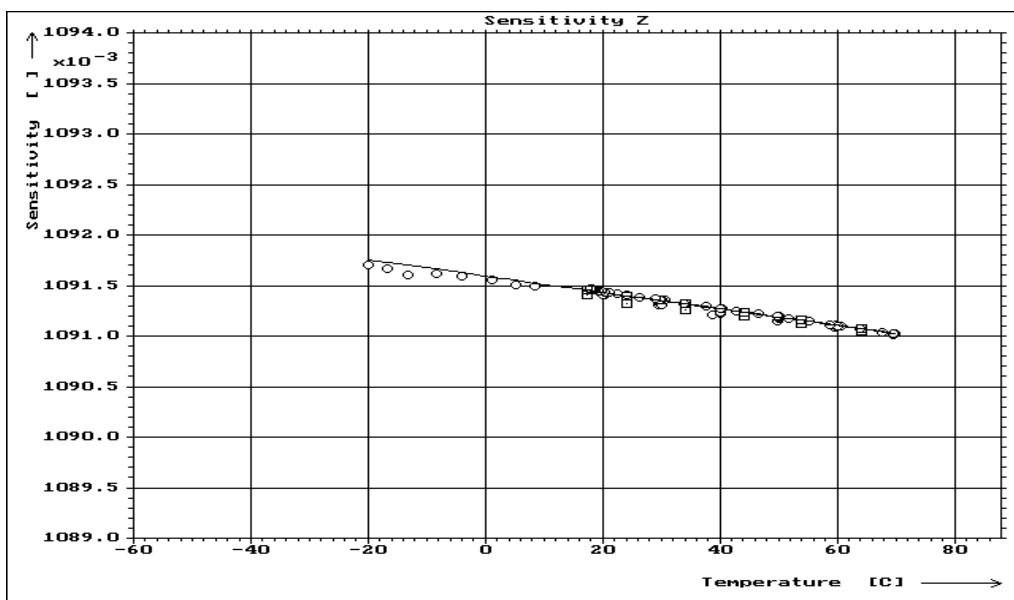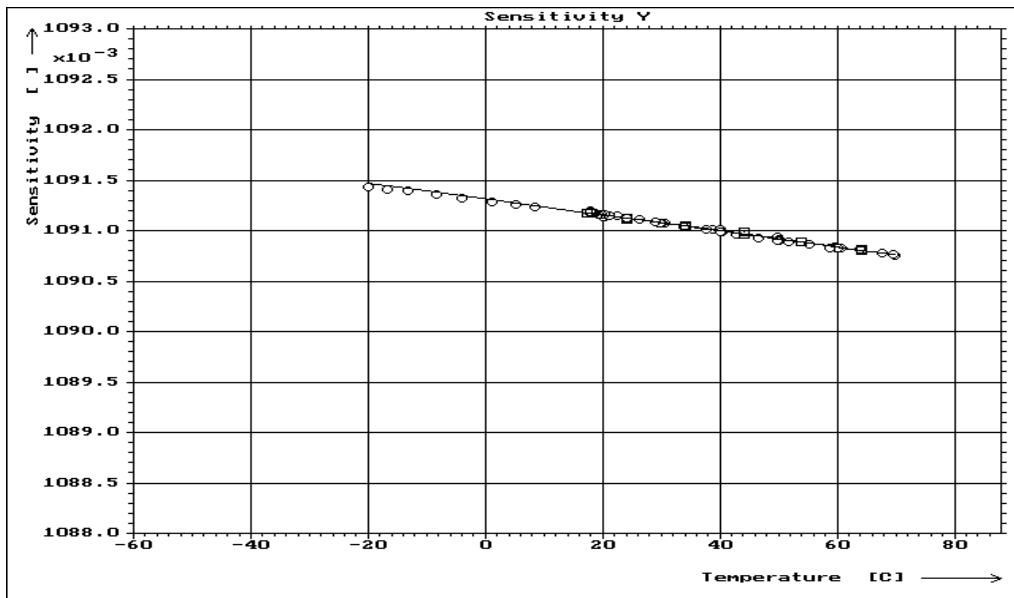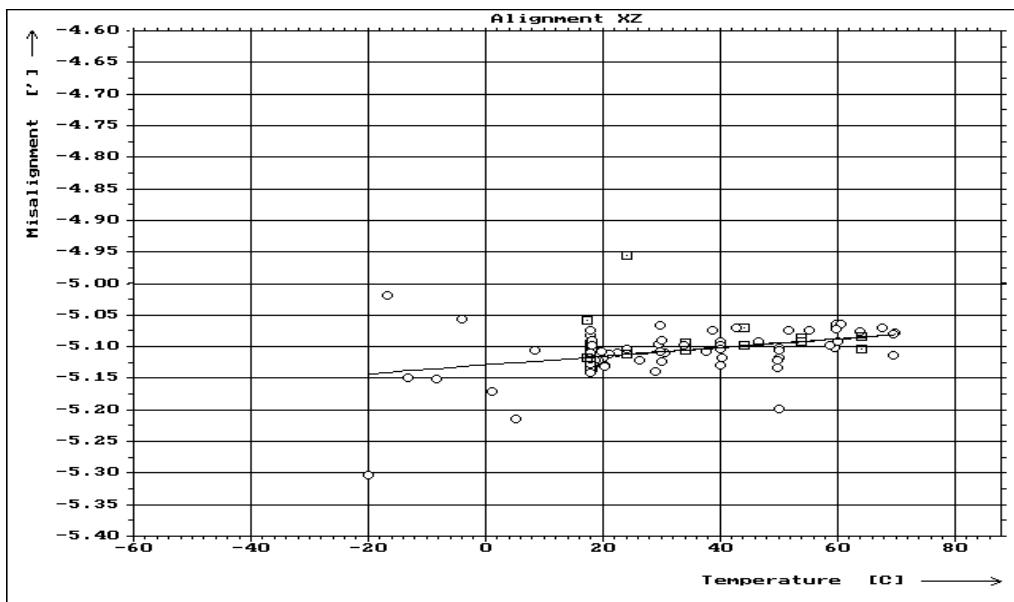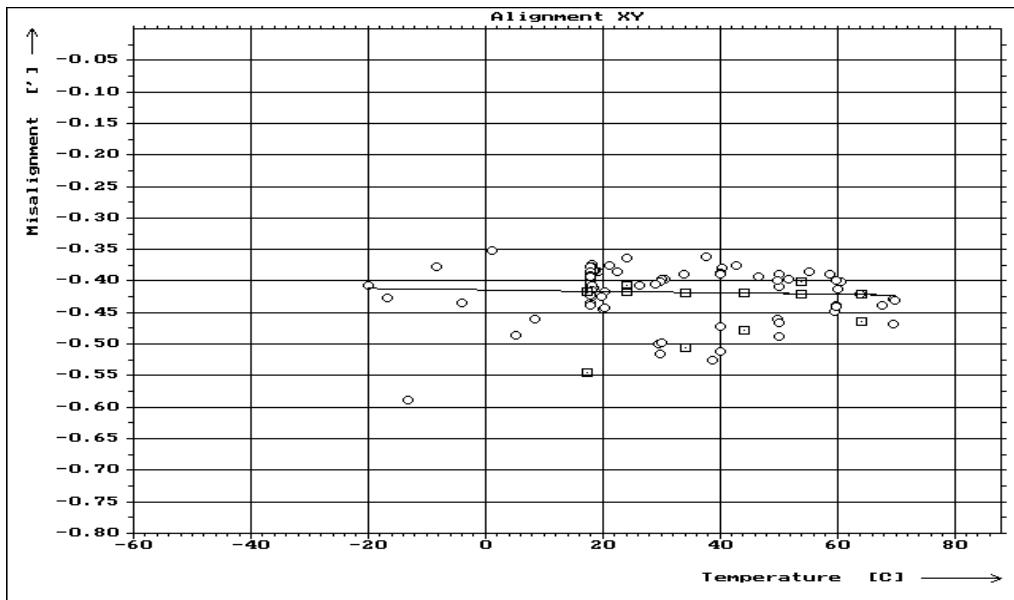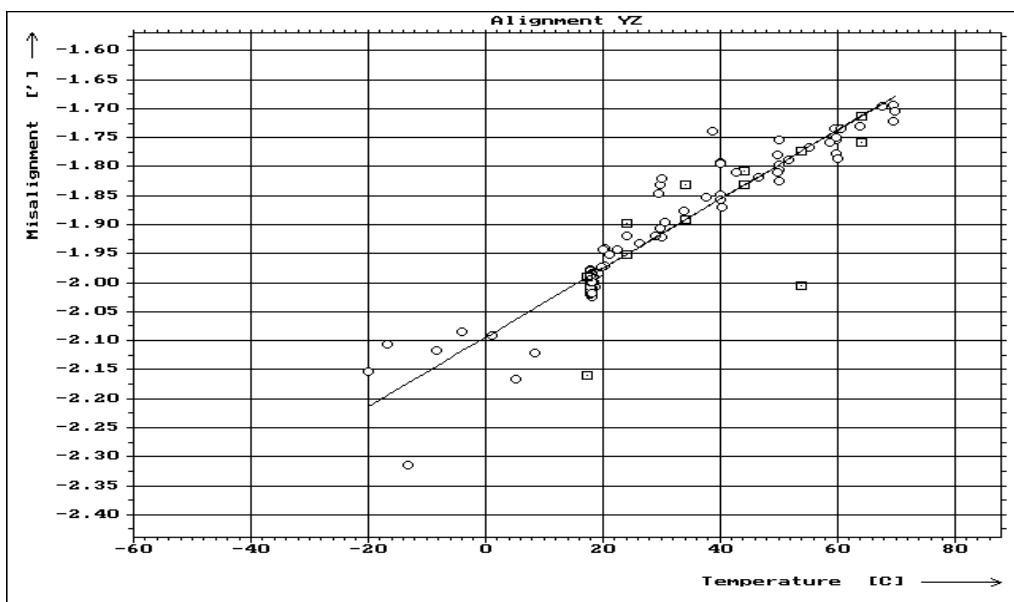
4.2.1.6   Temperature Calibration, 2. Run

```
Summary Sheet (Temperature)


Program     : merf.exe Version 4.0
Input files : o:\fgm\a\ROS\DPUFS\SFS\IB\T\SUM-T3\SSITS001.kas
Comment     :
Date        : 28/08    - 02/09
Time        : 12:14:35 - 23:24:42
Temperature :   -49.74 -     66.79
Std temp. : 3.54e-002 -        1.89
Std temp. mean :  4.93e-001
Std temp. std. :  4.93e-001


Results:

Measurements : 80 of 84

                  Offset [1]     Slope [1/C]     Correlation [1]
Sensitivity X [1]:       1.09497 -1.28000e-005  -9.97167e-001
Sensitivity Y [1]:       1.09133 -7.98119e-006  -9.95111e-001
Sensitivity Z [1]:       1.09148 -7.62899e-006  -9.93962e-001
                  Offset [']     Slope [1/']     Correlation [1]
Alignment  XY [']:  -4.52886e-001 -1.06211e-003  -4.83232e-001
Alignment  XZ [']:      -4.98434  4.56664e-004   1.33068e-001
Alignment  YZ [']:      -2.07092  3.81741e-003   9.05781e-001


Statistical Parameter:

                  Min            Max            Mean           Std
Sensitivity X [1]:       1.09408        1.09559        1.09458  3.28030e-004
Sensitivity Y [1]:       1.09076        1.09168        1.09108  2.04958e-004
Sensitivity Z [1]:       1.09093        1.09181        1.09125  1.96140e-004
Alignment  XY [']: -5.92802e-001  -2.78995e-001  -4.85358e-001  5.61672e-002
Alignment  XZ [']:      -5.1182        -4.26481        -4.97038  8.76982e-002
Alignment  YZ [']:      -2.25668        -1.75895        -1.95421  1.07699e-001
```

This measurement has been executed with an increased supply voltage of ± 5.1 V rather than ± 5.0 V, as the supply voltage during flight onboard the ROSETTA s/c is supposed to be 10 % higher than the nominal voltage of ± 5.0 V.

Sensitivity X

Sensitivity Y

Alignment XZ

Alignment YZ
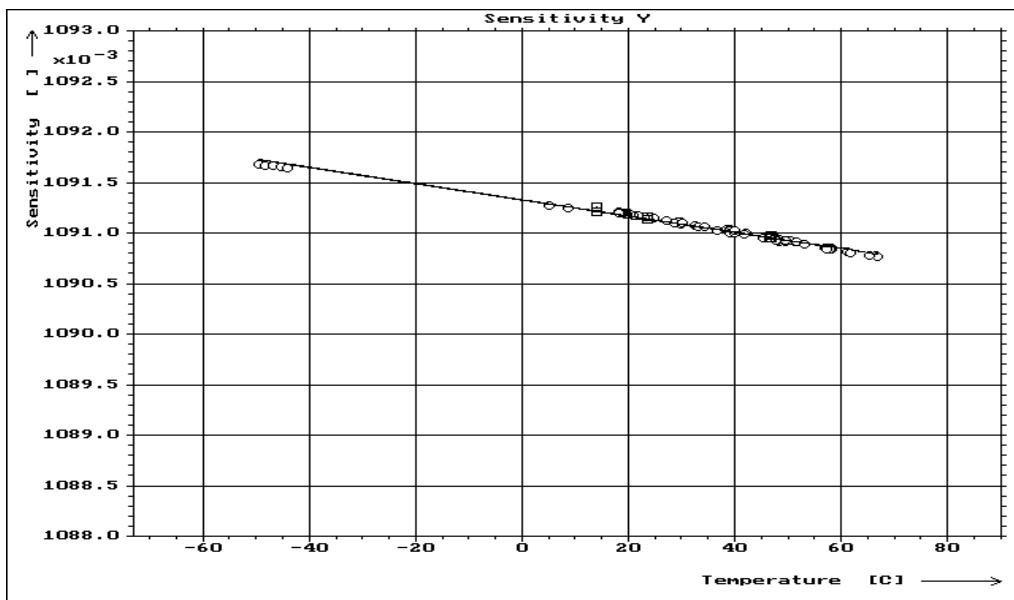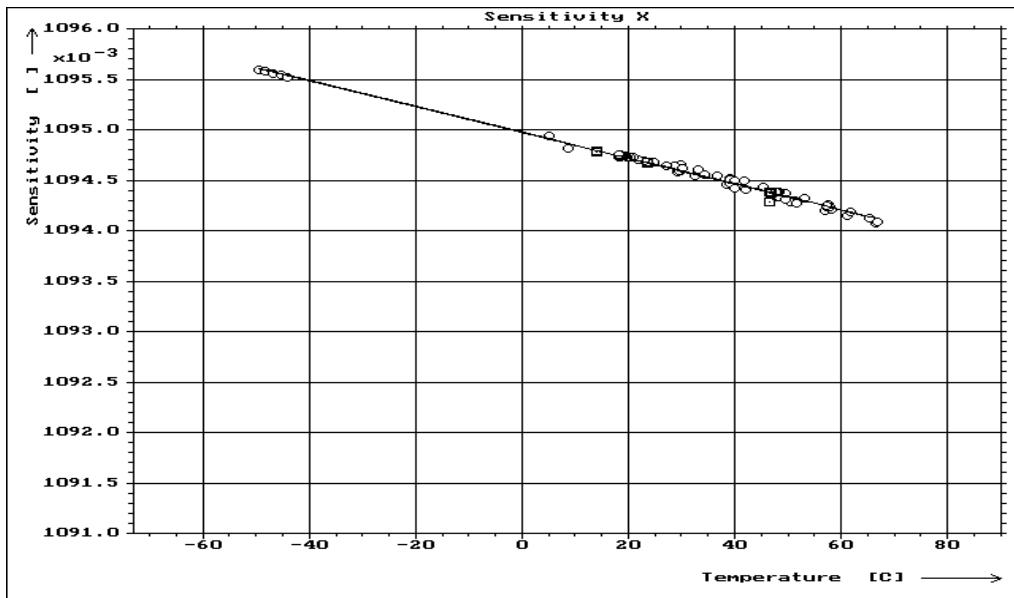
4.2.2 Outboard Sensor (OB)

4.2.2.1 Offset before T-cycle

```
Summary Sheet (Offset Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\OB\O\D04-25\SSO0001.aut
Comment     : ROS DPU-FS SEN-FS-OB OFF
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset       : +0.0000000 +0.0000000 +0.0000000

Date       : 25/04
Time       : 13:27:29 - 14:13:31
Quality of Input Data:
Mean Temperature: -99.990
               Xc        Yc        Zc        T
Mean stddev: +0.189    +0.302    +0.170    -99.990



Result:
        Offset        Residual field
    X   +1.70e+02         +5.21e-02
    Y   -3.78e+01         +1.74e-01
    Z   +4.09e+02         +4.28e-01
```

4.2.2.2 Calibration on Axes

4.2.2.2.1 First Measurement

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\OB\L\D04-24\SSOL001.aut
Comment     : ROS DPU-FS SEN-FS-OB LIN
Date       : 24/04
Time       : 13:31:42 - 15:03:33
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset [nT]  : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): -99.990 [deg C]
Mean stddev xp [nT]:+0.160   yp [nT]:+0.219    zp [nT]:+0.128   T [C]:-99.990
```

```
Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]          ^2[nT^-1]      ^3[nT^-2]      ^4[nT^-3]      ^5[nT^-4]
  m1,1             1.08382     --------       --------       --------       --------
  m1,2         -1.40164e-003   --------       --------       --------       --------
  m1,3          1.09257e-002   --------       --------       --------       --------
  m2,1          4.71726e-004   --------       --------       --------       --------
  m2,2             1.09489     --------       --------       --------       --------
  m2,3          1.60194e-003   --------       --------       --------       --------
  m3,1         -8.53403e-003   --------       --------       --------       --------
  m3,2         -3.33846e-003   --------       --------       --------       --------
  m3,3             1.09266     --------       --------       --------       --------
                 ^0[nT]        Tx[C^-1]       Ty[C^-1]       Tz[C^-1]
  xp             --------      --------       --------       --------
  yp             --------      --------       --------       --------
  zp             --------      --------       --------       --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,','']  x,y:   90  2'54.8   x,z:   89 52'10.9   y,z:   90  5'29.1
Sensitivity [1]        x: 1.083872387    y: 1.094892768    z: 1.092697996


Static Setup              xf               yf               zf
  xp [deg,','']         0 34'38.8        89 55'42.2        90 34'22.7
  yp [deg,','']        90  1'32.1         0  5'15.2        90  5' 1.4
  zp [deg,','']        89 32'56.1        89 49'29.0         0 29' 2.1
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):                 Orthogonality (O^-1):
    1.08387      0.00000      0.00000      1.00000 -8.476e-004  2.274e-003
    0.00000      1.09489      0.00000      0.00000  9.999e-001 -1.593e-003
    0.00000      0.00000      1.09270      0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  4.089e-004  7.724e-003  Rot. about X axis:    0 10'30.3
 4.352e-004  9.999e-001  3.058e-003  Rot. about Y axis:    0 27' 4.0
-7.873e-003  3.059e-003  9.999e-001  Rot. about Z axis:-   0  1'29.7
Determinant (R^-1):  9.999e-001


Quality of Fit:         Xp           Yp           Zp
Residual Min  [nT]: -2.612e-01   -3.620e-01   -3.475e-01
         Max  [nT]: +6.346e-01   +2.253e-01   +2.398e-01
         Mean [nT]: +1.548e-01   -9.487e-02   +2.452e-03
         Std  [nT]: +1.787e-01   +1.162e-01   +8.873e-02
```

4.2.2.2.2   Second Measurement

```
Summary Sheet (Global Mode)



Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\OB\L\D04-24\SSOL002.aut
Comment      : ROS DPU-FS SEN-FS-OB LIN
Date         : 24/04
Time         : 23:30:06 - 01:01:56
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000
```

SSOL001.aut   ROS_N.txt

Bf - Bp [nT] →

Time [s] →

×10³

× Xf - Xp   ○ Bft - Bpt
◇ Yf - Yp
▽ Zf - Zp

(c) HDK IBM TU-BS
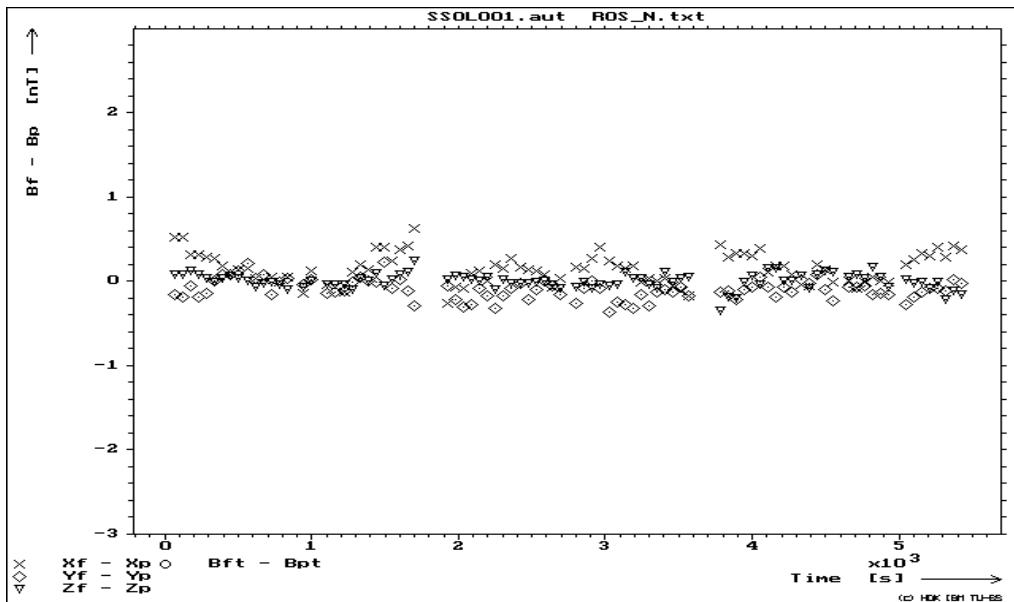
```
Quality of Input Data:
Mean Temperature (T): -99.990 [deg C]
Mean stddev xp [nT]:+0.155   yp [nT]:+0.195     zp [nT]:+0.127    T [C]:-99.990


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter      ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
  m1,1         1.08384      --------      --------      --------      --------
  m1,2        -1.39490e-003 --------      --------      --------      --------
  m1,3         1.09224e-002 --------      --------      --------      --------
  m2,1         4.62872e-004 --------      --------      --------      --------
  m2,2         1.09490      --------      --------      --------      --------
  m2,3         1.60663e-003 --------      --------      --------      --------
  m3,1        -8.53385e-003 --------      --------      --------      --------
  m3,2        -3.32113e-003 --------      --------      --------      --------
  m3,3         1.09267      --------      --------      --------      --------
                 ^0[nT]      Tx[C^-1]     Ty[C^-1]      Tz[C^-1]
  xp           --------     --------      --------      --------
  yp           --------     --------      --------      --------
  zp           --------     --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  2'55.2  x,z:   89 52'11.5   y,z:   90  5'24.9
Sensitivity [1]        x: 1.083896242   y: 1.094896950     z: 1.092708386


Static Setup            xf              yf              zf
  xp [deg,','']        0 34'38.0       89 55'43.4      90 34'22.1
  yp [deg,','']       90  1'30.4        0  5'15.6      90  5' 2.3
  zp [deg,','']       89 32'56.2       89 49'32.2       0 29' 0.8
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):             Orthogonality (O^-1):
    1.08390    0.00000    0.00000      1.00000 -8.494e-004  2.271e-003
    0.00000    1.09490    0.00000      0.00000  9.999e-001 -1.573e-003
    0.00000    0.00000    1.09271      0.00000  0.00000     9.999e-001
```

```
Rotation (R^-1):
 9.999e-001  4.011e-004  7.724e-003  Rot. about X axis:    0 10'27.0
 4.270e-004  9.999e-001  3.042e-003  Rot. about Y axis:    0 27' 4.0
-7.873e-003  3.043e-003  9.999e-001  Rot. about Z axis:-   0  1'28.0
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -1.821e-01  -3.622e-01  -3.118e-01
         Max  [nT]: +7.178e-01  +1.839e-01  +2.559e-01
         Mean [nT]: +2.244e-01  -8.135e-02  +3.157e-03
         Std  [nT]: +2.030e-01  +1.059e-01  +1.055e-01
```
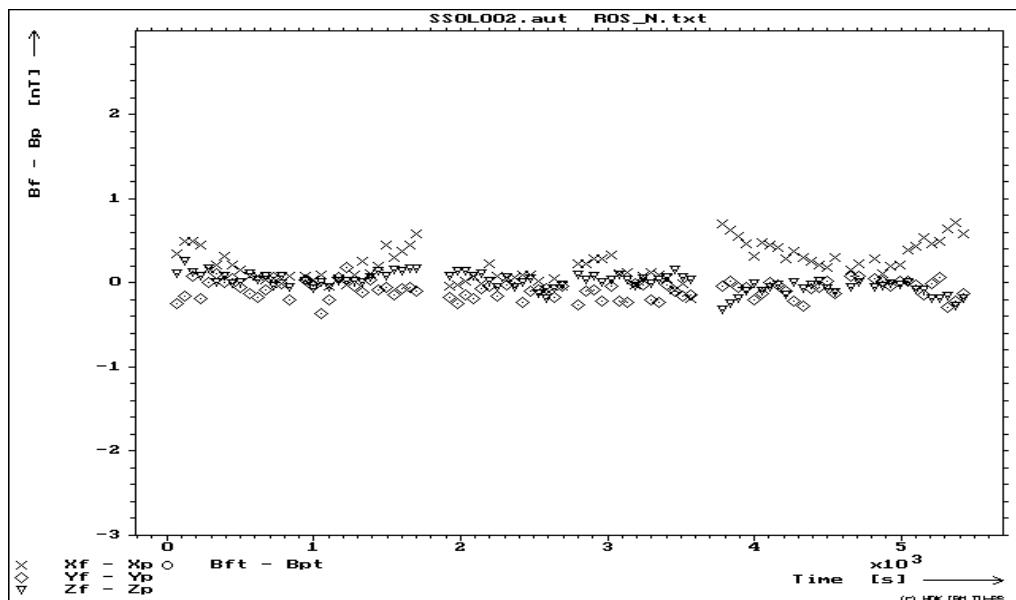

4.2.2.2.3   Measurement just before 1. T–cycle

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\OB\L\D04-26\SSOTL001.aut
Comment     : ROS DPU-FS SEN-FS-OB T-LIN
Date        : 26/04
Time        : 10:05:38 - 10:43:45
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +17.854 [deg C]
Mean stddev xp [nT]:+0.142   yp [nT]:+0.203    zp [nT]:+0.130    T [C]:+0.109
```

```
Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter     ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1         1.08340     --------      --------      --------      --------
   m1,2        -6.24449e-003 --------     --------      --------      --------
   m1,3         1.49258e-002 --------     --------      --------      --------
   m2,1         5.72479e-003 --------     --------      --------      --------
   m2,2         1.09394     --------      --------      --------      --------
   m2,3         1.18054e-003 --------     --------      --------      --------
   m3,1        -1.29852e-002 --------     --------      --------      --------
   m3,2        -2.37143e-003 --------     --------      --------      --------
   m3,3         1.09207     --------      --------      --------      --------
                ^0[nT]      Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp          --------     --------      --------      --------
   yp          --------     --------      --------      --------
   zp          --------     --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''']   x,y:    90  1'46.3   x,z:    89 53'28.4   y,z:    90  3'58.1
Sensitivity [1]         x: 1.083519787   y: 1.093956994    z: 1.092145983


Static Setup             xf              yf              zf
   xp [deg,',''']         0 50'53.7       89 40'28.8      90 47' 0.1
   yp [deg,',''']        90 18'12.4        0 18'32.0      90  3'28.0
   zp [deg,',''']        89 18'50.3       89 52'18.8       0 41'52.3
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):                  Orthogonality (O^-1):
     1.08352     0.00000     0.00000      1.00000 -5.156e-004  1.898e-003
     0.00000     1.09396     0.00000      0.00000  9.999e-001 -1.153e-003
     0.00000     0.00000     1.09215      0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.998e-001  5.166e-003  1.176e-002  Rot. about X axis:    0  7'28.4
 5.283e-003  9.999e-001  2.224e-003  Rot. about Y axis:    0 41'12.0
-1.198e-002  2.235e-003  9.999e-001  Rot. about Z axis:-   0 18' 9.8
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -1.770e-01  -6.057e-01  -2.567e-01
         Max  [nT]: +4.719e-01  +5.384e-01  +3.294e-01
         Mean [nT]: +1.190e-01  +1.287e-01  -2.831e-04
         Std  [nT]: +1.660e-01  +2.410e-01  +1.399e-01
```

4.2.2.2.4   Measurement just after 1. T−cycle

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\OB\L\D05-02\SSOTL002.aut
Comment     : ROS DPU-FS SEN-FS-OB T-LIN
Date        : 01/05
Time        : 23:45:52 - 01:42:02
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000
```
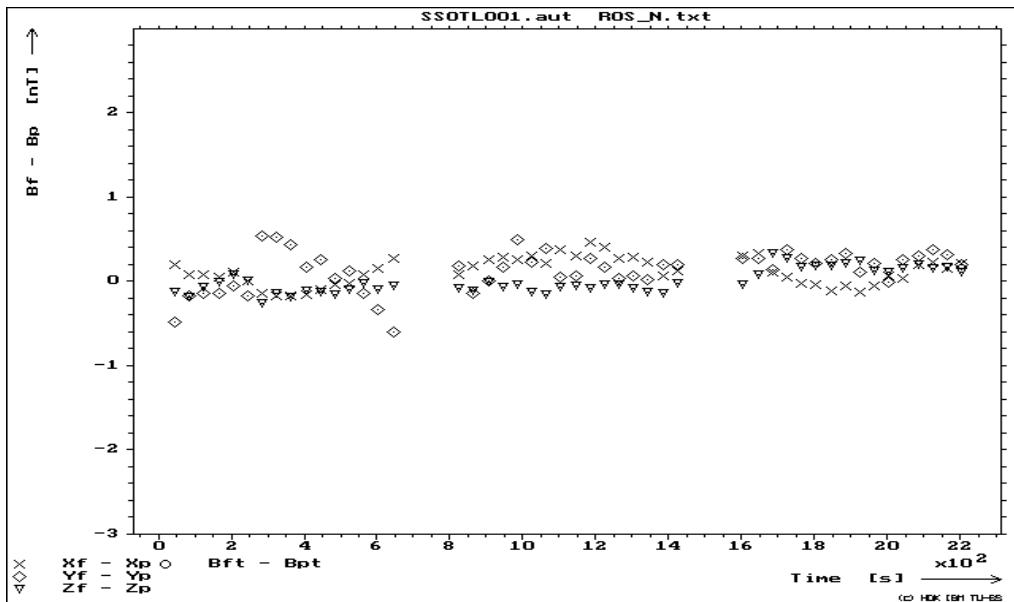
```
Quality of Input Data:
Mean Temperature (T): +17.873 [deg C]
Mean stddev xp [nT]:+0.209    yp [nT]:+0.214     zp [nT]:+0.197     T [C]:+0.045


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]           ^2[nT^-1]       ^3[nT^-2]       ^4[nT^-3]       ^5[nT^-4]
   m1,1         1.08349        --------        --------        --------        --------
   m1,2        -6.21615e-003   --------        --------        --------        --------
   m1,3         1.50356e-002   --------        --------        --------        --------
   m2,1         5.72085e-003   --------        --------        --------        --------
   m2,2         1.09394        --------        --------        --------        --------
   m2,3         2.11422e-003   --------        --------        --------        --------
   m3,1        -1.30985e-002   --------        --------        --------        --------
   m3,2        -3.32971e-003   --------        --------        --------        --------
   m3,3         1.09207        --------        --------        --------        --------
                ^0[nT]         Tx[C^-1]        Ty[C^-1]        Tz[C^-1]
   xp          --------        --------        --------        --------
   yp          --------        --------        --------        --------
   zp          --------        --------        --------        --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,','']  x,y:   90  1'39.1   x,z:   89 53'28.1   y,z:   90  4' 3.1
Sensitivity [1]        x: 1.083613477    y: 1.093958988     z: 1.092155065


Static Setup            xf             yf              zf
   xp [deg,','']         0 51'10.7      89 40'36.7      90 47'21.8
   yp [deg,','']        90 18'13.7       0 19'19.2      90  6'24.2
   zp [deg,','']        89 18'29.9      89 49'18.0       0 42'51.4
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):              Orthogonality (O^-1):
    1.08361    0.00000    0.00000     1.00000  -4.806e-004  1.899e-003
    0.00000    1.09396    0.00000     0.00000   9.999e-001 -1.178e-003
```

```
       0.00000      0.00000      1.09216         0.00000      0.00000  9.999e-001
Rotation (R^-1):
 9.998e-001  5.165e-003  1.186e-002  Rot. about X axis:    0 10'29.0
 5.279e-003  9.999e-001  3.103e-003  Rot. about Y axis:    0 41'33.3
-1.208e-002  3.112e-003  9.999e-001  Rot. about Z axis:-   0 18' 9.0
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -1.263e-01  -9.154e-01  -1.304e-01
         Max  [nT]: +5.321e-01  +3.526e-01  +3.064e-01
         Mean [nT]: +1.229e-01  -4.307e-02  +4.786e-02
         Std  [nT]: +1.144e-01  +2.242e-01  +8.626e-02
```
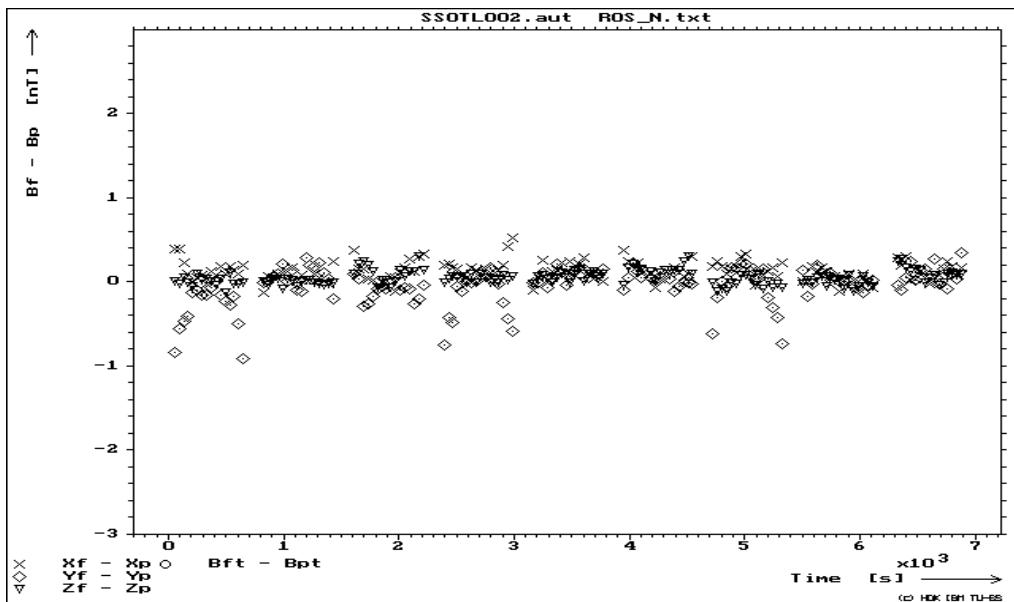
4.2.2.2.5   Measurement just before 2. T–cycle

Summary Sheet (Global Mode)


```
Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\OB\L\D08-28\SSOTL003.aut
Comment      : ROS DPU-FS SEN-FS-OB T-LIN
Date         : 28/08
Time         : 11:33:01 - 12:11:08
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): +19.242 [deg C]
Mean stddev xp [nT]:+0.489   yp [nT]:+0.435     zp [nT]:+0.468    T [C]:+0.136

Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)

Parameter      ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1           1.08325    --------      --------      --------      --------
   m1,2       -1.41919e-002  --------      --------      --------      --------
   m1,3        1.62092e-002  --------      --------      --------      --------
   m2,1        1.35754e-002  --------      --------      --------      --------
   m2,2           1.09390    --------      --------      --------      --------
   m2,3        1.46395e-003  --------      --------      --------      --------
   m3,1       -1.42942e-002  --------      --------      --------      --------
   m3,2       -2.57026e-003  --------      --------      --------      --------
   m3,3           1.09195    --------      --------      --------      --------
              ^0[nT]        Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp          --------      --------      --------      --------
   yp          --------      --------      --------      --------
   zp          --------      --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90  2'18.3  x,z:  89 53'27.4  y,z:  90  4' 2.9
Sensitivity [1]       x: 1.083468950   y: 1.093985009    z: 1.092044119

Static Setup          xf           yf           zf
   xp [deg,','']       1  7'43.9     89 15'31.6     90 51' 4.9
   yp [deg,','']      90 43' 7.9      0 43'18.8     90  3'58.1
   zp [deg,','']      89 14'44.8     89 51'20.1      0 46' 4.4
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):              Orthogonality (O^-1):
    1.08347   0.00000   0.00000     1.00000 -6.708e-004  1.903e-003
    0.00000   1.09399   0.00000     0.00000  9.999e-001 -1.176e-003
    0.00000   0.00000   1.09204     0.00000    0.00000  9.999e-001
Rotation (R^-1):
 9.998e-001  1.227e-002  1.292e-002  Rot. about X axis:   0  8' 6.4
 1.252e-002  9.999e-001  2.493e-003  Rot. about Y axis:   0 45'21.3
-1.319e-002  2.520e-003  9.999e-001  Rot. about Z axis:-  0 43' 4.7
Determinant (R^-1):  9.999e-001

Quality of Fit:         Xp           Yp           Zp
Residual Min  [nT]: -3.501e-01   -2.810e-01   -2.858e-01
         Max  [nT]: +2.284e-01   +2.475e-01   +1.935e-01
         Mean [nT]: +4.170e-02   -2.687e-03   -5.006e-02
         Std  [nT]: +1.249e-01   +1.231e-01   +1.232e-01
```

This measurement has been executed with an increased supply voltage of ± 5.1 V rather than ± 5.0 V, as the supply voltage during flight onboard the ROSETTA s/c is supposed to be 10 % higher than the nominal voltage of ± 5.0 V.
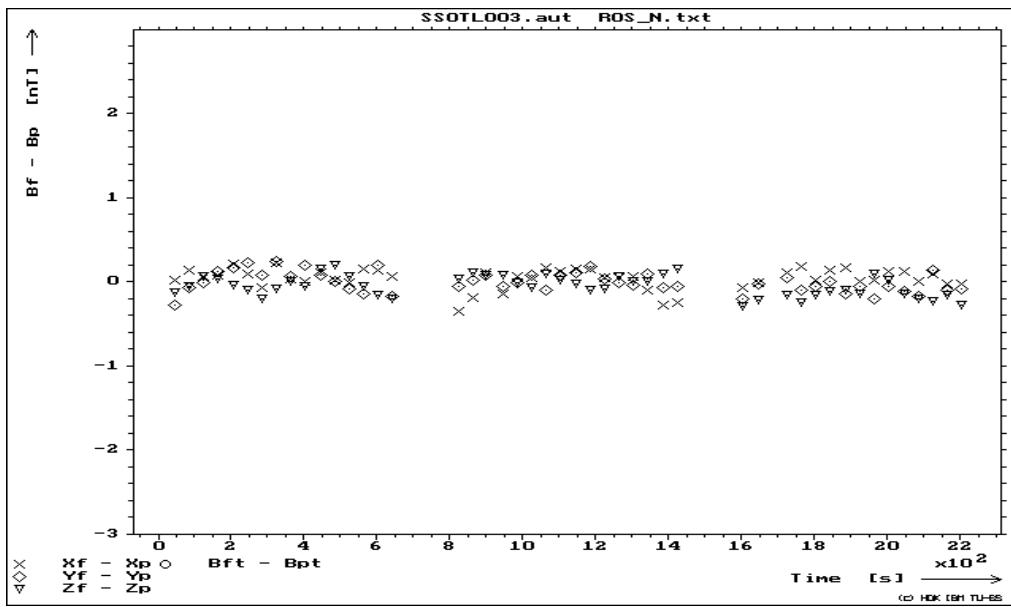
4.2.2.3 Calibration on a Spiral Sphere

4.2.2.3.1 First Measurement

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\OB\S\D04-24\SSOS001.aut
Comment     : ROS DPU-FS SEN-FS-OB SPHERE
Date        : 24/04
Time        : 15:04:53 - 18:56:15
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): -99.990 [deg C]
Mean stddev xp [nT]:+0.158   yp [nT]:+0.214    zp [nT]:+0.120    T [C]:-99.990

Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)
```

```
Parameter      ^1[1]        ^2[nT^-1]    ^3[nT^-2]     ^4[nT^-3]    ^5[nT^-4]
   m1,1          1.08382     --------     --------     --------     --------
   m1,2        -1.40569e-003 --------     --------     --------     --------
   m1,3         1.09279e-002 --------     --------     --------     --------
   m2,1         4.72464e-004 --------     --------     --------     --------
   m2,2          1.09489     --------     --------     --------     --------
   m2,3         1.60083e-003 --------     --------     --------     --------
   m3,1        -8.53576e-003 --------     --------     --------     --------
   m3,2        -3.32809e-003 --------     --------     --------     --------
   m3,3          1.09267     --------     --------     --------     --------
                 ^0[nT]      Tx[C^-1]     Ty[C^-1]     Tz[C^-1]
   xp          --------      --------     --------     --------
   yp          --------      --------     --------     --------
   zp          --------      --------     --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  2'55.4  x,z:   89 52'10.8   y,z:   90  5'27.3
Sensitivity [1]        x: 1.083880350   y: 1.094888345   z: 1.092708541

Static Setup              xf              yf              zf
  xp [deg,','']         0 34'39.3       89 55'41.4      90 34'23.1
  yp [deg,','']        90  1'32.2        0  5'15.0      90  5' 1.2
  zp [deg,','']        89 32'55.8       89 49'30.9       0 29' 1.7
Separation of M^-1 = R^-1O^-1S^-1
Sensitivity (S^-1):                   Orthogonality (O^-1):
    1.08388    0.00000    0.00000     1.00000 -8.506e-004  2.274e-003
    0.00000    1.09489    0.00000     0.00000  9.999e-001 -1.585e-003
    0.00000    0.00000    1.09271     0.00000     0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  4.097e-004  7.725e-003  Rot. about X axis:   0 10'28.3
 4.359e-004  9.999e-001  3.049e-003  Rot. about Y axis:   0 27' 4.3
-7.875e-003  3.049e-003  9.999e-001  Rot. about Z axis:-  0  1'29.9
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -3.943e-01  -4.925e-01  -2.327e-01
         Max  [nT]: +9.770e-01  +2.157e-01  +3.173e-01
         Mean [nT]: +2.860e-01  -9.583e-02  +3.739e-02
         Std  [nT]: +2.196e-01  +1.265e-01  +1.100e-01
```

4.2.2.3.2   Second Measurement

```
Summary Sheet (Global Mode)


Program      : kalt.exe Version 4.00
Input files  : o:\fgm\a\ROS\DPUFS\SFS\OB\S\D04-25\SSOS003.aut
Comment      : ROS DPU-FS SEN-FS-OB SPHERE
Date         : 25/04
Time         : 01:03:18 - 04:54:37
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
               -1.0000000 +0.0000000 +0.0000000
               +0.0000000 +0.0000000 +1.0000000
Offset  [nT] : +0.0000000 +0.0000000 +0.0000000

Quality of Input Data:
Mean Temperature (T): -99.990 [deg C]
```
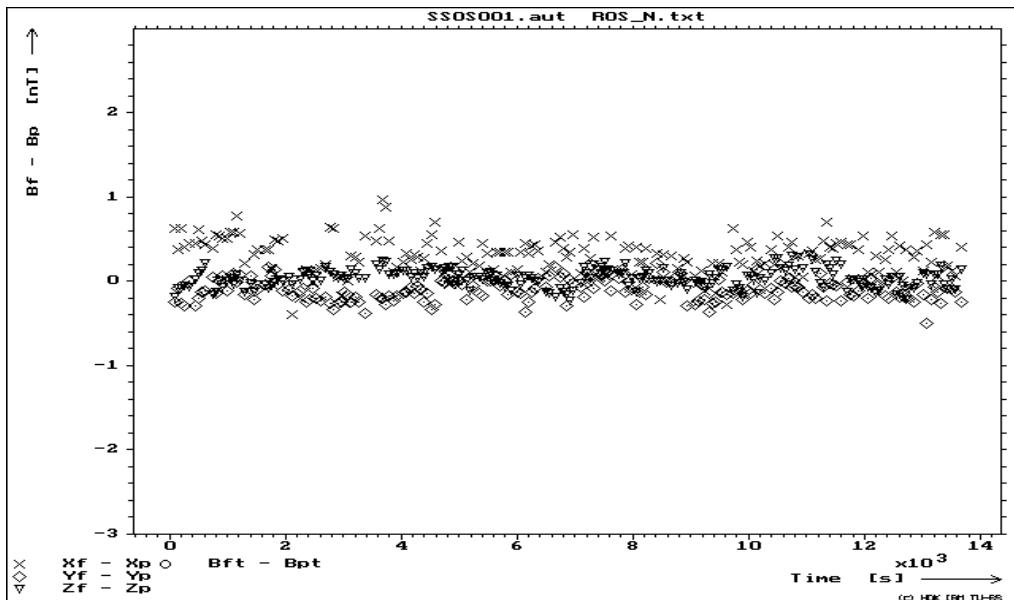
```
Mean stddev xp [nT]:+0.153    yp [nT]:+0.194    zp [nT]:+0.123    T [C]:-99.990


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter       ^1[1]         ^2[nT^-1]      ^3[nT^-2]      ^4[nT^-3]      ^5[nT^-4]
   m1,1          1.08384      --------       --------       --------       --------
   m1,2         -1.40083e-003 --------       --------       --------       --------
   m1,3          1.09290e-002 --------       --------       --------       --------
   m2,1          4.67440e-004 --------       --------       --------       --------
   m2,2          1.09489      --------       --------       --------       --------
   m2,3          1.59374e-003 --------       --------       --------       --------
   m3,1         -8.53472e-003 --------       --------       --------       --------
   m3,2         -3.32512e-003 --------       --------       --------       --------
   m3,3          1.09268      --------       --------       --------       --------
                 ^0[nT]       Tx[C^-1]       Ty[C^-1]       Tz[C^-1]
   xp           --------      --------       --------       --------
   yp           --------      --------       --------       --------
   zp           --------      --------       --------       --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:   90  2'55.4  x,z:   89 52'10.4  y,z:   90  5'28.1
Sensitivity [1]        x: 1.083898939     y: 1.094891656     z: 1.092714176


Static Setup             xf             yf             zf
   xp [deg,','']        0 34'39.4      89 55'42.3     90 34'23.3
   yp [deg,','']       90  1'31.3       0  5'13.5     90  4'59.9
   zp [deg,','']       89 32'56.0      89 49'31.5      0 29' 1.3
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):              Orthogonality (O^-1):
   1.08390   0.00000   0.00000     1.00000 -8.508e-004  2.276e-003
   0.00000   1.09489   0.00000     0.00000  9.999e-001 -1.588e-003
   0.00000   0.00000   1.09271     0.00000  0.00000     9.999e-001
Rotation (R^-1):
 9.999e-001  4.051e-004  7.724e-003  Rot. about X axis:    0 10'27.8
```

```
  4.312e-004  9.999e-001  3.046e-003  Rot. about Y axis:   0 27' 4.1
 -7.874e-003  3.046e-003  9.999e-001  Rot. about Z axis:-  0  1'28.9
 Determinant (R^-1):  9.999e-001


 Quality of Fit:        Xp          Yp          Zp
 Residual Min  [nT]: -1.997e-01  -4.373e-01  -3.032e-01
         Max   [nT]: +7.652e-01  +3.629e-01  +2.984e-01
         Mean  [nT]: +2.988e-01  -5.798e-02  +4.444e-02
         Std   [nT]: +2.124e-01  +1.334e-01  +1.165e-01
```
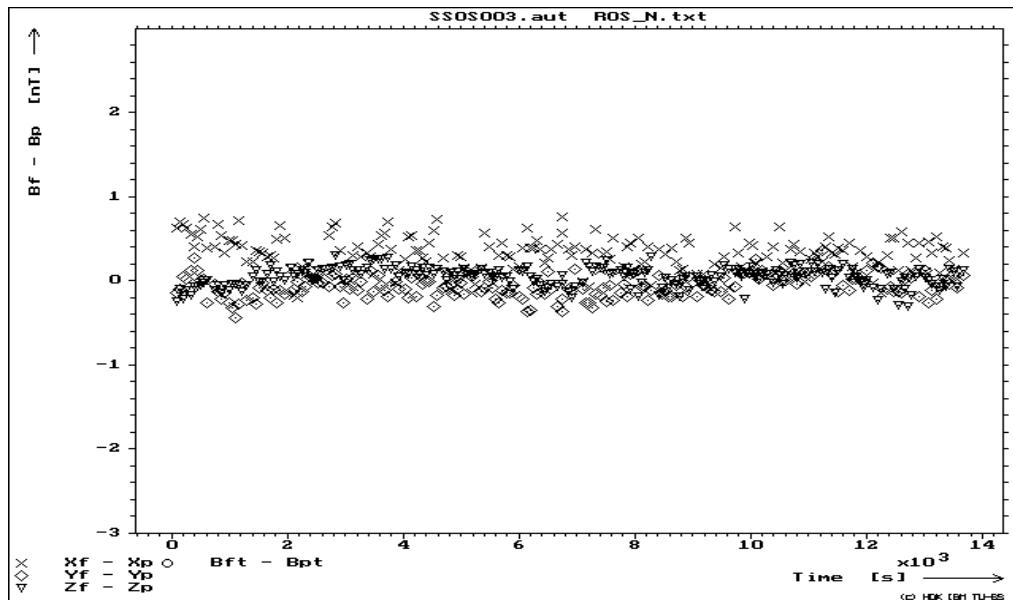

4.2.2.4   Calibration on a Sphere

4.2.2.4.1   First Measurement

```
Summary Sheet (Global Mode)


Program     : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\OB\S\D04-24\SSOS002.aut
Comment     : ROS DPU-FS SEN-FS-OB SPHERE
Date        : 24/04
Time        : 18:58:31 - 23:29:00
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
                -1.0000000 +0.0000000 +0.0000000
                +0.0000000 +0.0000000 +1.0000000
Offset [nT] : +0.0000000 +0.0000000 +0.0000000
```

```
Quality of Input Data:
Mean Temperature (T): -99.990 [deg C]
Mean stddev xp [nT]:+0.155   yp [nT]:+0.205    zp [nT]:+0.122    T [C]:-99.990


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter     ^1[1]        ^2[nT^-1]    ^3[nT^-2]    ^4[nT^-3]    ^5[nT^-4]
  m1,1           1.08382    --------     --------     --------     --------
  m1,2       -1.40919e-003  --------     --------     --------     --------
  m1,3        1.09273e-002  --------     --------     --------     --------
  m2,1        4.72216e-004  --------     --------     --------     --------
  m2,2           1.09489    --------     --------     --------     --------
  m2,3        1.59937e-003  --------     --------     --------     --------
  m3,1       -8.53670e-003  --------     --------     --------     --------
  m3,2       -3.32428e-003  --------     --------     --------     --------
  m3,3           1.09267    --------     --------     --------     --------
                ^0[nT]      Tx[C^-1]     Ty[C^-1]     Tz[C^-1]
  xp           --------     --------     --------     --------
  yp           --------     --------     --------     --------
  zp           --------     --------     --------     --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,',''] x,y:  90 2'56.1  x,z:  89 52'11.1  y,z:  90  5'26.9
Sensitivity [1]         x: 1.083873343  y: 1.094890203    z: 1.092708788


Static Setup             xf            yf            zf
  xp [deg,','']         0 34'39.2     89 55'40.8     90 34'23.0
  yp [deg,','']        90  1'32.2      0  5'14.8     90  5' 0.9
  zp [deg,','']        89 32'55.6     89 49'31.6      0 29' 1.6
Separation of M^-1 = R^-10^-1S^-1
Sensitivity (S^-1):                 Orthogonality (O^-1):
    1.08387    0.00000    0.00000       1.00000 -8.541e-004  2.273e-003
    0.00000    1.09489    0.00000       0.00000  9.999e-001 -1.582e-003
    0.00000    0.00000    1.09271       0.00000    0.00000   9.999e-001
Rotation (R^-1):
 9.999e-001  4.094e-004  7.726e-003  Rot. about X axis:   0 10'27.6
 4.356e-004  9.999e-001  3.045e-003  Rot. about Y axis:   0 27' 4.5
-7.876e-003  3.046e-003  9.999e-001  Rot. about Z axis:-  0  1'29.8
Determinant (R^-1):  9.999e-001


Quality of Fit:        Xp          Yp          Zp
Residual Min  [nT]: -5.929e-01  -3.983e-01  -4.307e-01
         Max  [nT]: +7.478e-01  +4.340e-01  +3.323e-01
         Mean [nT]: +1.666e-01  -2.874e-02  +3.370e-02
         Std  [nT]: +2.711e-01  +1.495e-01  +1.303e-01
```

4.2.2.4.2   Second Measurement

```
Summary Sheet (Global Mode)



Program      : kalt.exe Version 4.00
Input files : o:\fgm\a\ROS\DPUFS\SFS\OB\S\D04-25\SSOS004.aut
Comment      : ROS DPU-FS SEN-FS-OB SPHERE
Date         : 25/04
Time         : 04:55:11 - 09:27:18
Facility Parameter:
Alignment Mat.: +0.0000000 +1.0000000 +0.0000000
```
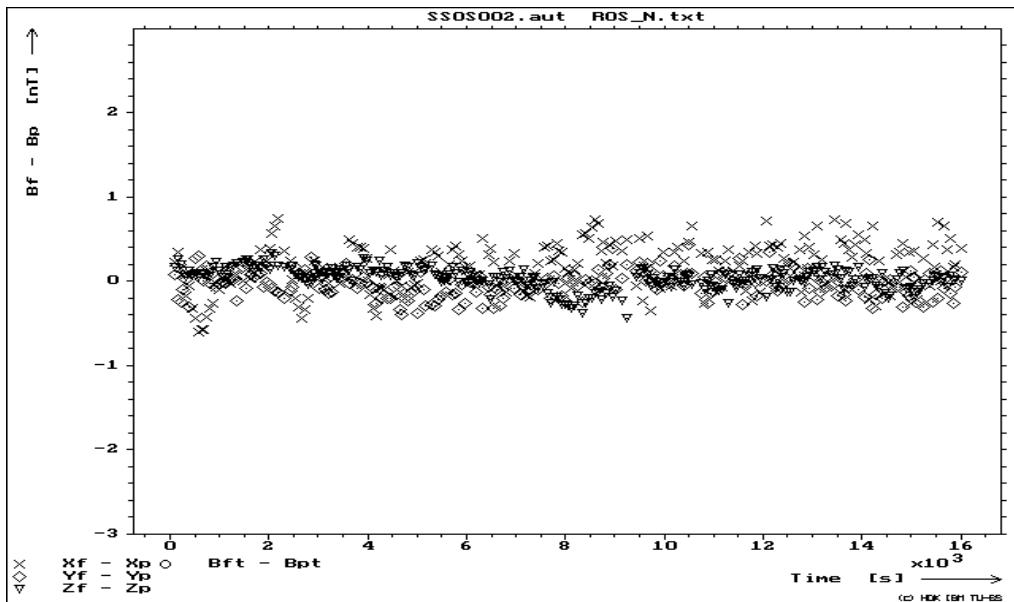
```
              -1.0000000 +0.0000000 +0.0000000
              +0.0000000 +0.0000000 +1.0000000
Offset  [nT]  : +0.0000000 +0.0000000 +0.0000000


Quality of Input Data:
Mean Temperature (T): -99.990 [deg C]
Mean stddev xp [nT]:+0.157    yp [nT]:+0.191    zp [nT]:+0.122    T [C]:-99.990


Transfer Function Matrix  (M^(-1)) Probe (p) -> Facility (f)


Parameter      ^1[1]        ^2[nT^-1]     ^3[nT^-2]     ^4[nT^-3]     ^5[nT^-4]
   m1,1           1.08384    --------      --------      --------      --------
   m1,2      -1.40310e-003   --------      --------      --------      --------
   m1,3       1.09285e-002   --------      --------      --------      --------
   m2,1       4.68700e-004   --------      --------      --------      --------
   m2,2           1.09489    --------      --------      --------      --------
   m2,3       1.59913e-003   --------      --------      --------      --------
   m3,1      -8.53441e-003   --------      --------      --------      --------
   m3,2      -3.32712e-003   --------      --------      --------      --------
   m3,3           1.09267    --------      --------      --------      --------
              ^0[nT]       Tx[C^-1]      Ty[C^-1]      Tz[C^-1]
   xp          --------     --------      --------      --------
   yp          --------     --------      --------      --------
   zp          --------     --------      --------      --------
Calculation based on linear parameters m^1 of M^-1:
Sensor parameter:
Alignment [deg,','']  x,y:  90  2'55.6  x,z:   89 52'10.4  y,z:   90  5'27.4
Sensitivity [1]       x: 1.083896240  y: 1.094891194  z: 1.092707111


Static Setup              xf              yf              zf
   xp [deg,','']          0 34'39.3      89 55'41.9      90 34'23.3
   yp [deg,','']         90  1'31.5       0  5'14.5      90  5' 0.9
   zp [deg,','']         89 32'56.1      89 49'31.1       0 29' 1.3
Separation of M^-1 = R^-10^-1S^-1
```

```
Sensitivity (S^-1):                 Orthogonality (O^-1):
    1.08390      0.00000     0.00000       1.00000 -8.517e-004  2.276e-003
    0.00000      1.09489     0.00000       0.00000  9.999e-001 -1.585e-003
    0.00000      0.00000     1.09271       0.00000      0.00000  9.999e-001
Rotation (R^-1):
 9.999e-001  4.062e-004  7.724e-003  Rot. about X axis:     0 10'28.2
 4.324e-004  9.999e-001  3.048e-003  Rot. about Y axis:     0 27' 4.1
-7.873e-003  3.048e-003  9.999e-001  Rot. about Z axis:-    0  1'29.2
Determinant (R^-1):  9.999e-001

Quality of Fit:        Xp         Yp         Zp
Residual Min [nT]: -3.822e-01  -4.846e-01  -3.063e-01
        Max  [nT]: +7.176e-01  +2.829e-01  +3.234e-01
        Mean [nT]: +1.797e-01  -4.887e-02  +4.237e-02
        Std  [nT]: +2.205e-01  +1.476e-01  +1.081e-01
```
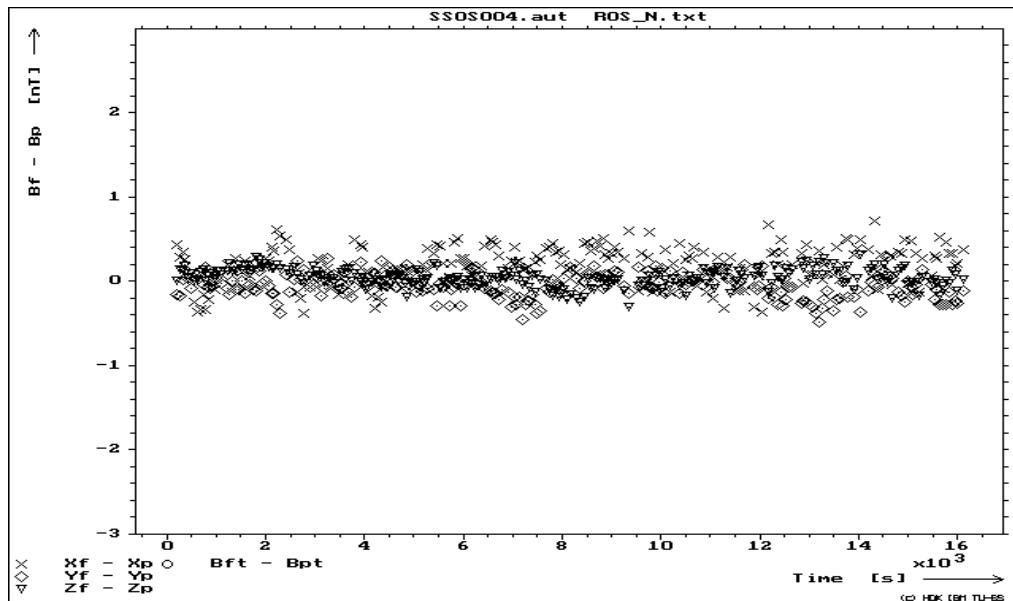

4.2.2.5   Temperature Calibration, 1. Run

```
Summary Sheet (Temperature)


Program     : merf.exe Version 4.0
Input files : o:\fgm\a\ROS\DPUFS\SFS\OB\T\SUM\SSOTS001.kas
Comment     :
Date        : 26/04    - 01/05
Time        : 11:34:19 - 22:31:02
Temperature :   -20.26 -     69.92
Std temp.   : 2.57e-002 -        1.53
Std temp. mean :  3.46e-001
Std temp. std. :  4.19e-001
```

```
Results:


Measurements : 92 of 99


                  Offset [1]      Slope [1/K]      Correlation [1]
Sensitivity X [1]:       1.08385  -1.45040e-005    -9.89500e-001
Sensitivity Y [1]:       1.09405  -4.98228e-006    -9.91468e-001
Sensitivity Z [1]:       1.09228  -7.43399e-006    -9.97547e-001
                  Offset [']      Slope ['/K]      Correlation [1]
Alignment   XY [']:      1.67473   2.74564e-004     8.50400e-002
Alignment   XZ [']:     -6.48649  -1.81780e-003    -5.30335e-001
Alignment   YZ [']:      4.0019    1.35697e-003     7.65671e-001


Statistical Parameter:


                  Min           Max              Mean        Std
Sensitivity X [1]:     1.0828        1.08404          1.08344     2.87007e-004
Sensitivity Y [1]:     1.09368       1.09417          1.09391     9.83938e-005
Sensitivity Z [1]:     1.09174       1.0924           1.09207     1.45917e-004
Alignment   XY [']:    1.27699       1.97352          1.68248     6.32179e-002
Alignment   XZ [']:   -6.63924      -6.14318         -6.5378      6.71140e-002
Alignment   YZ [']:    3.92822       4.13373          4.0402      3.47015e-002
```

Alignment XY

Alignment XZ

Alignment YZ
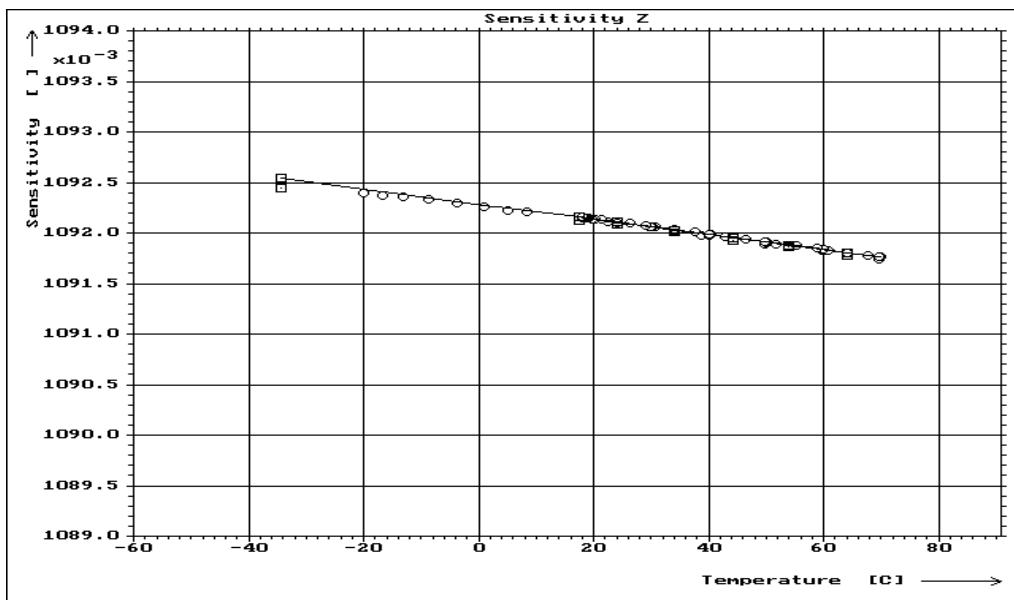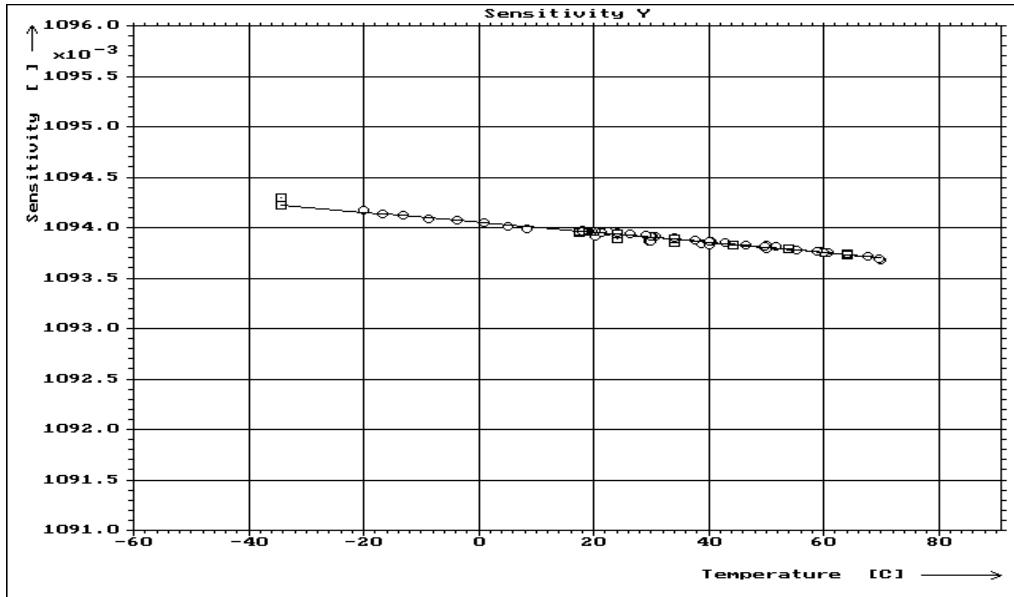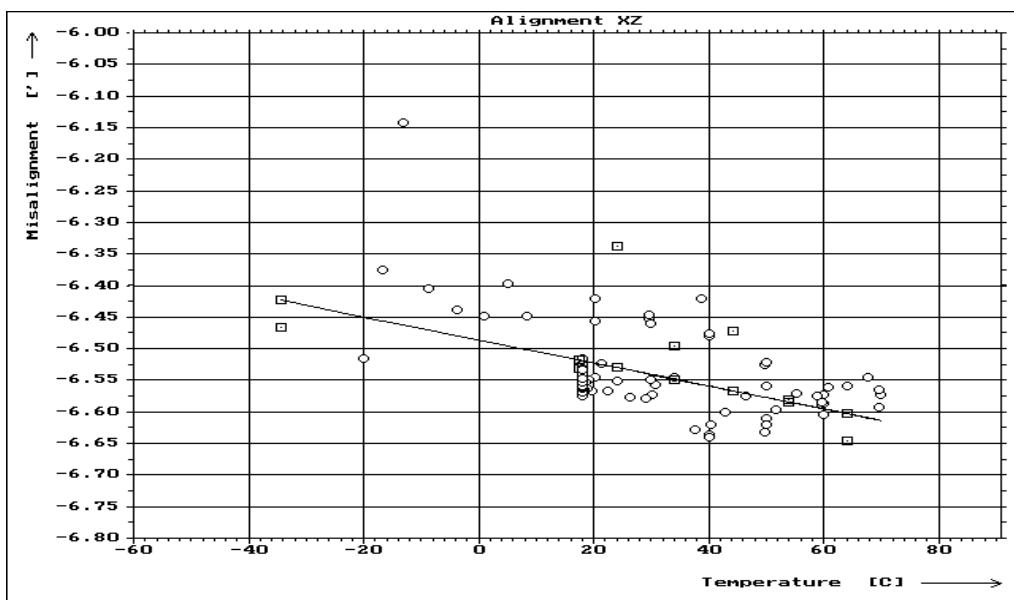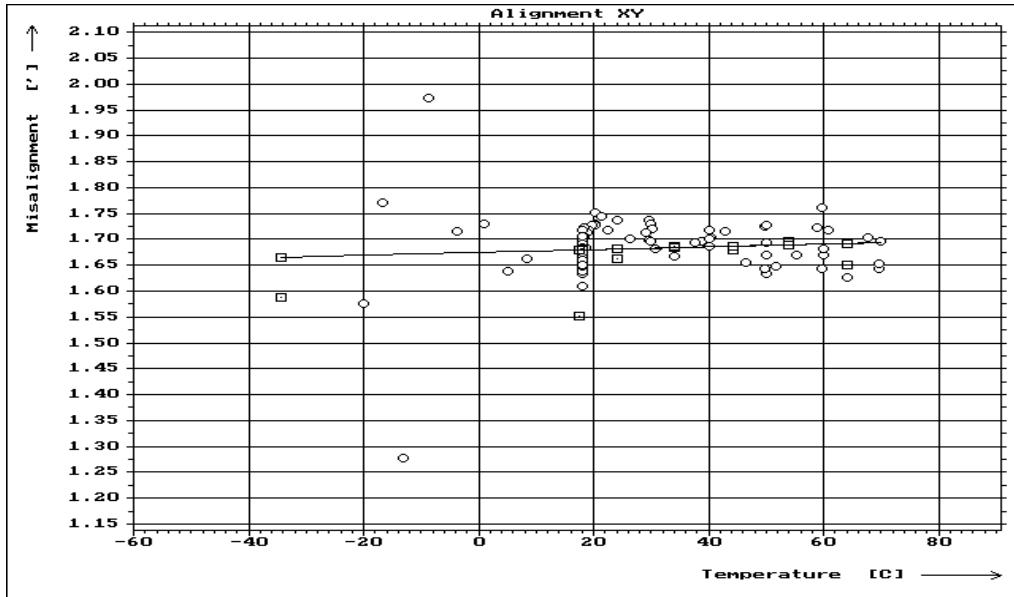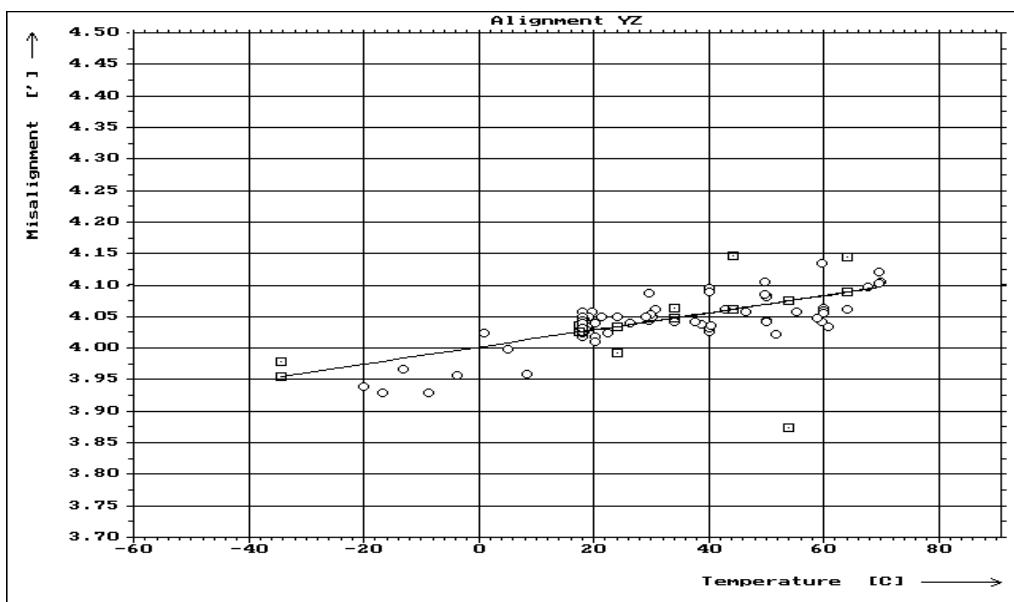
4.2.2.6 Temperature Calibration, 2. Run

```
Summary Sheet (Temperature)


Program      : merf.exe Version 4.0
Input files : o:\fgm\a\ROS\DPUFS\SFS\OB\T\SUM-T3\SSOTS001.kas
Comment      :
Date         : 28/08    - 02/09
Time         : 12:14:35 - 23:24:42
Temperature  :   -50.94 -    66.79
Std temp. :  3.53e-002 -       1.88
Std temp. mean :  5.26e-001
Std temp. std. :  4.94e-001


Results:

Measurements : 107 of 115

                  Offset [1]     Slope [1/K]     Correlation [1]
Sensitivity X [1]:      1.08384  -1.57264e-005   -9.91193e-001
Sensitivity Y [1]:      1.09381   5.75378e-007    8.79481e-002
Sensitivity Z [1]:      1.09232  -1.08472e-005   -9.44842e-001
                  Offset [']     Slope ['/K]     Correlation [1]
Alignment  XY [']:      2.23476   1.52996e-003    7.52106e-001
Alignment  XZ [']:     -6.4652   -1.09132e-003   -5.80925e-001
Alignment  YZ [']:      3.96353   1.95571e-003    8.61919e-001


Statistical Parameter:

                  Min          Max             Mean        Std
Sensitivity X [1]:    1.08279      1.0847         1.08359  5.58658e-004
Sensitivity Y [1]:    1.09327      1.09444        1.09382  2.30357e-004
Sensitivity Z [1]:    1.09166      1.09294        1.09215  4.04236e-004
Alignment  XY [']:    2.09044      2.49053        2.2595   7.16271e-002
Alignment  XZ [']:   -6.61906     -6.21202       -6.48284  6.61467e-002
Alignment  YZ [']:    3.73738      4.12944        3.99516  7.98940e-002
```

This measurement has been executed with an increased supply voltage of ± 5.1 V rather than ± 5.0 V, as the supply voltage during flight onboard the ROSETTA s/c is supposed to be 10 % higher than the nominal voltage of ± 5.0 V.
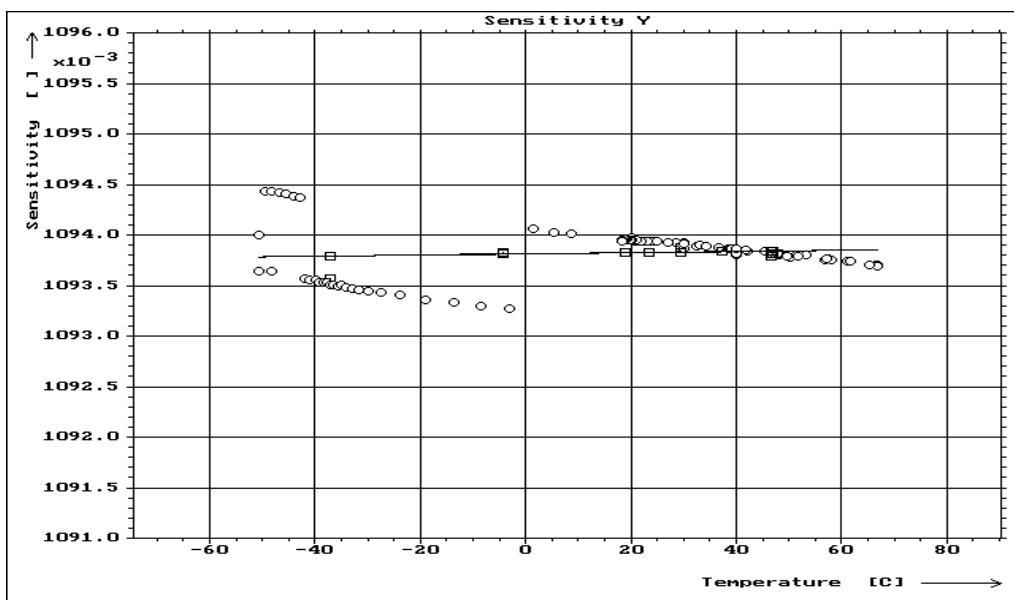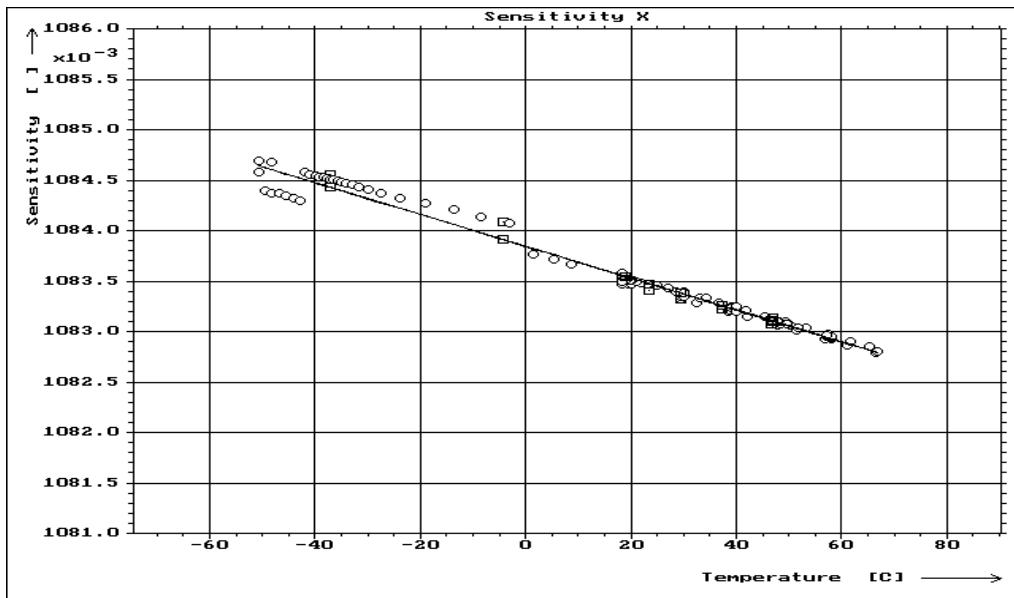
5 Special Tests

5.1 Supply Voltage Dependence — DPU: FM, Sensors FM–IB & FM–OB

With this check it should be tested whether the digital readings are influenced by the supply voltage. Therefore, the supply voltages generated by the instrument power supply are varied in discrete steps. The needed positive and negative supply voltages are changed in parallel at the same time.

The used voltages are:

Step	Voltage [V]	%-Variation
1	±5.00	abs(Nominal)
2	±4.90	abs(Nominal) −2%
3	±4.75	abs(Nominal) −5%
4	±4.50	abs(Nominal) −10%
5	±5.10	abs(Nominal) +2%
6	±5.25	abs(Nominal) +5%
7	±5.50	abs(Nominal) +10%

The test is done for both, FM–OB and FM–IB, sensors. The sensors are placed in diagonal in space position.

5.1.1 Results

The following plots show the results of the supply voltage variation check. As visible in the first diagram of figure 1 and 2 the applied field structure was 0 nT, +20000 nT, -20000 nT, 0 nT for every pair of supply voltages. For a better visibility the y–component has been plotted with an inverted sign. Additionally the single traces have been shifted by convenient offsets for a maximum of clarity.

The analysis of the plots reveals that the y– and the z–component are nearly constant, the x–component, however, shows significant changes in dependency of the supply voltage. Figure 3 shows the result in the most clear way, as the output signals of both, the FM–OB and the FM–IB sensors, are plotted versus the deviation of the supply voltage.

As the power supply onboard the ROSETTA s/c will keep the voltages constant in the order of 1 %, the performance of the instrument is acceptable.
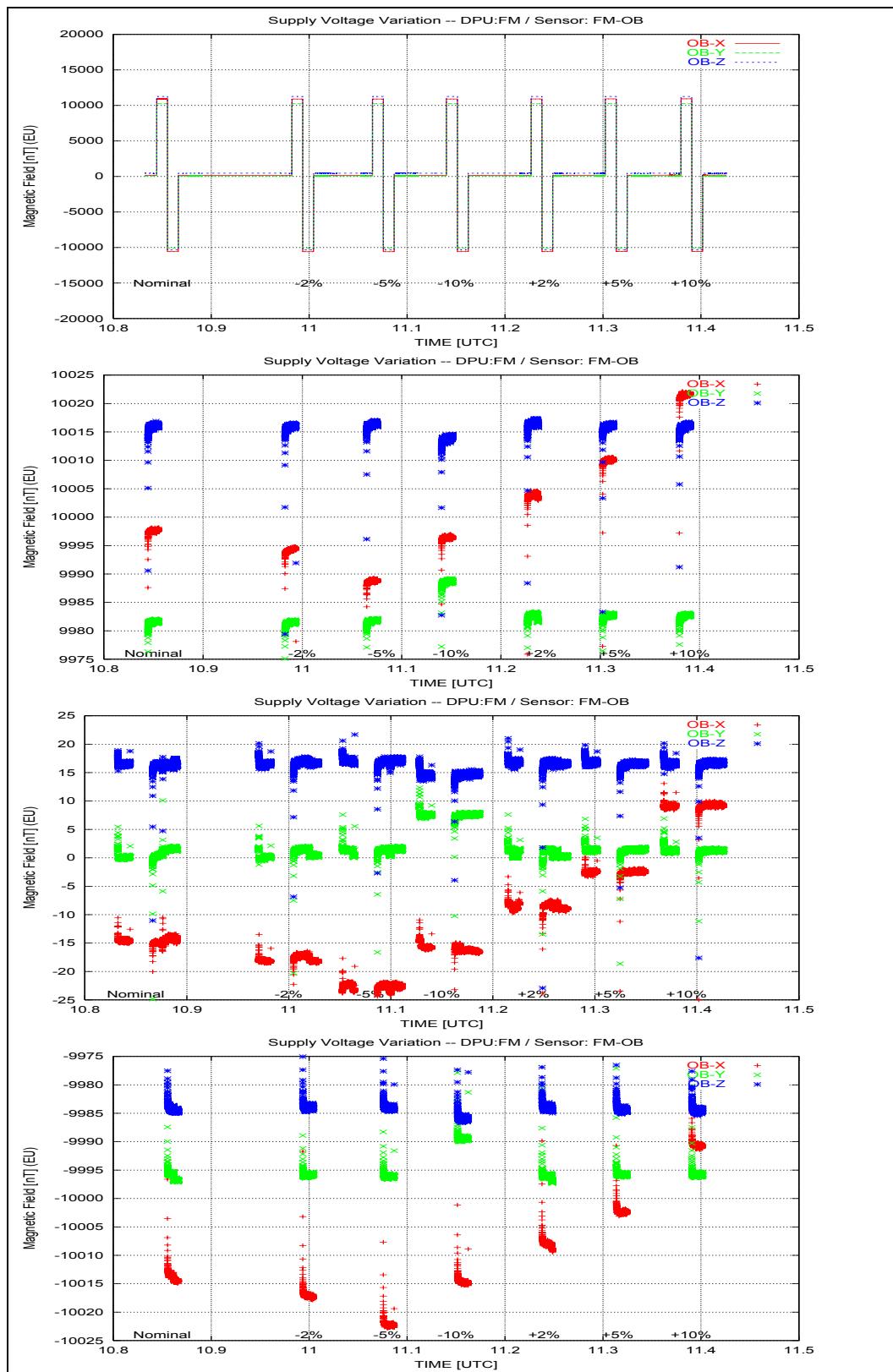
Figure 1: Supply voltage dependence results: FM – OB.
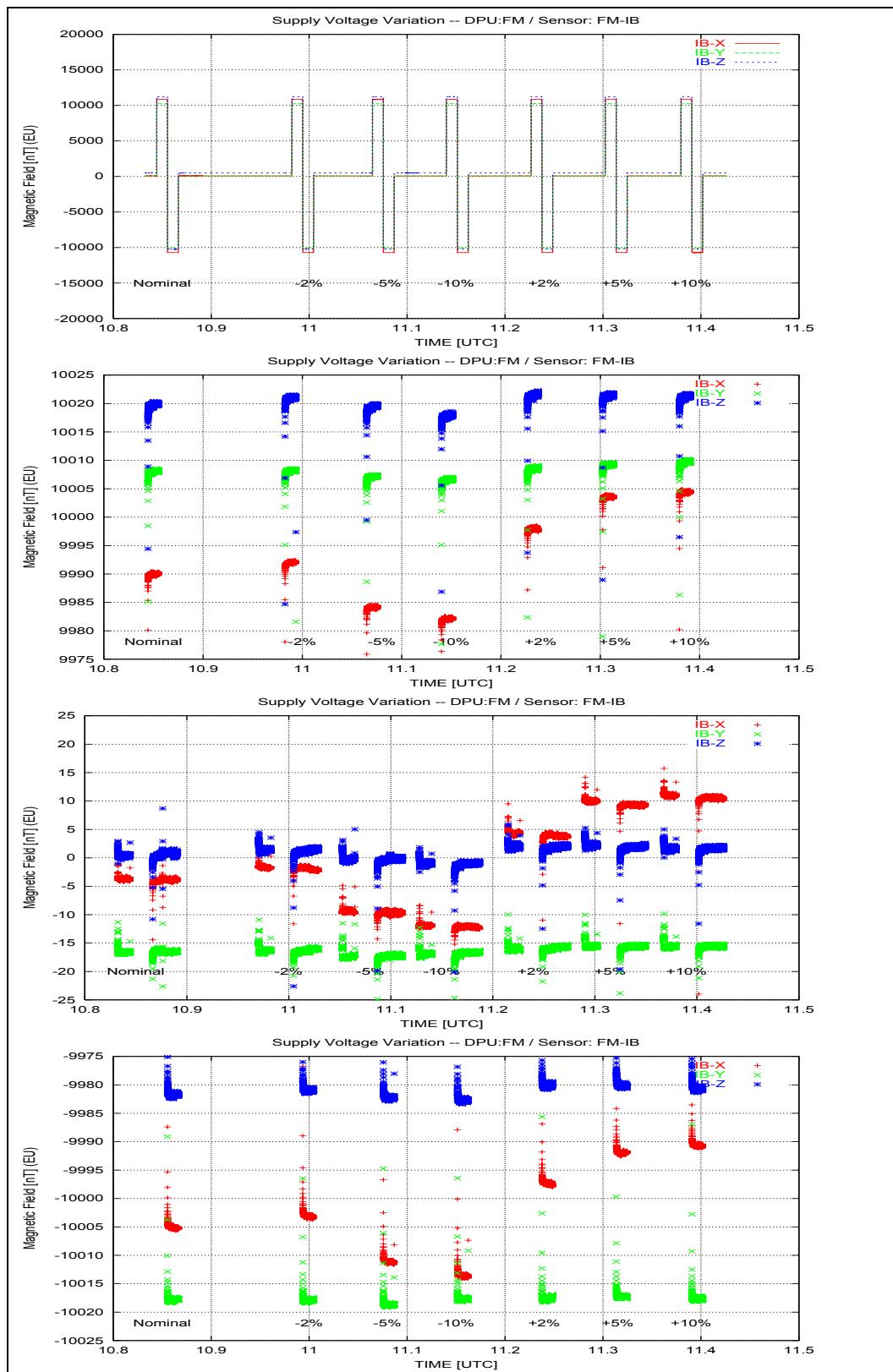
Figure 2: Supply voltage dependence results: FM – IB.

Power Variation Check   DPU: FM , Sensors: FM
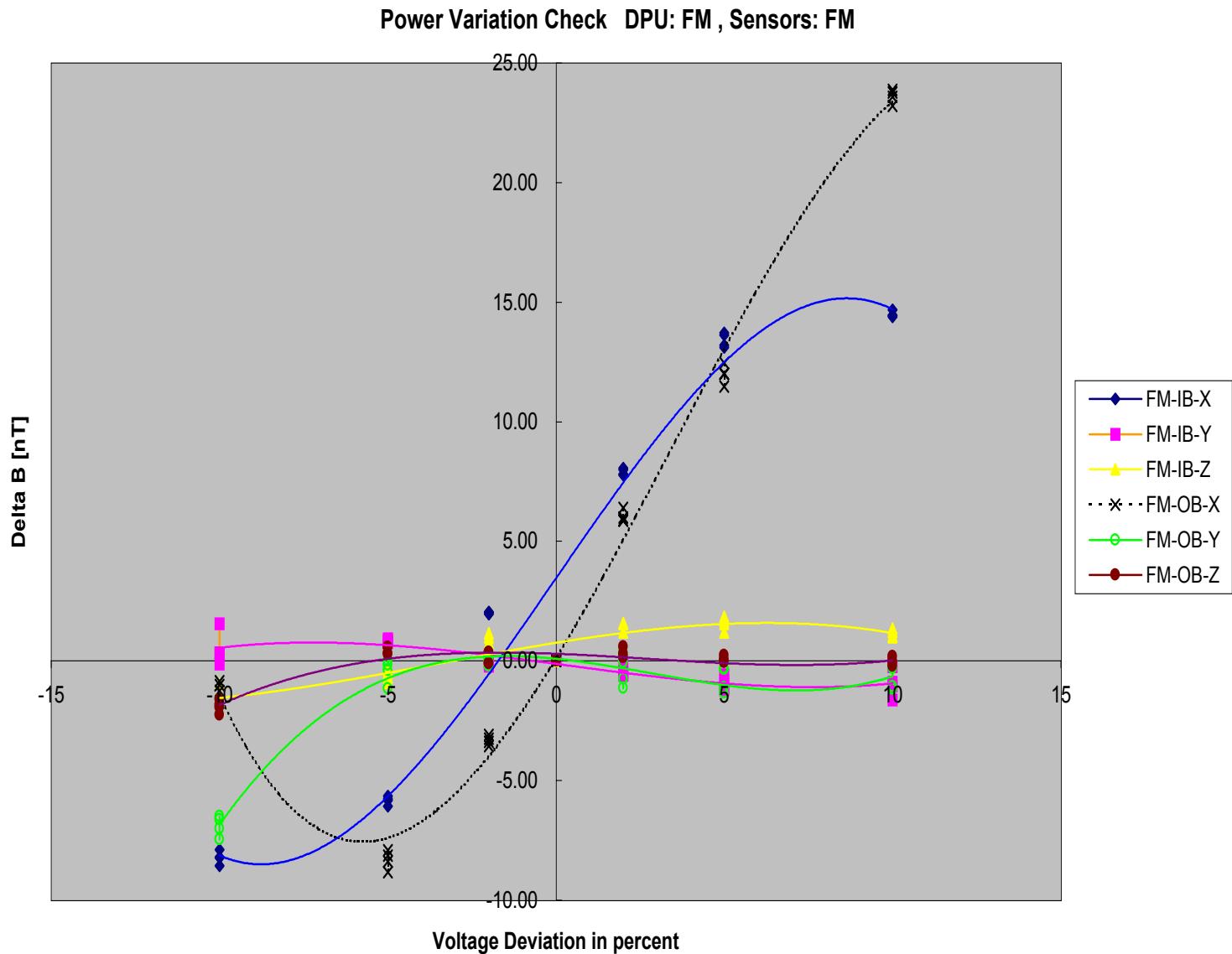
Figure 3: Supply voltage dependence results: DPU: FM, Sensors: FM.

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5.2 Supply Voltage Dependence — DPU: FS, Sensors FS–IB & FS–OB

With this check it should be tested whether the digital readings are influenced by the supply voltage. Therefore, the supply voltages generated by the instrument power supply are varied in discrete steps. The needed positive and negative supply voltages are changed in parallel at the same time.

The used voltages are:

Step	Voltage [V]	%-Variation
1	±5.00	abs(Nominal)
2	±4.90	abs(Nominal) −2%
3	±4.75	abs(Nominal) −5%
4	±4.50	abs(Nominal) −10%
5	±5.10	abs(Nominal) +2%
6	±5.25	abs(Nominal) +5%
7	±5.50	abs(Nominal) +10%

The test is done for both, FS–OB and FS–IB, sensors.

5.2.1 Results

The following plots show the results of the supply voltage variation check. As visible in the first diagram of figure 4 and 5 the applied field structure was 0 nT, +20000 nT, -20000 nT, 0 nT for every pair of supply voltages. For a better visibility the y–component has been plotted with an inverted sign. Additionally the single traces have been shifted by convenient offsets for a maximum of clarity.

The analysis of the plots reveals that the FS–OB–y and the FS–OB–z component are nearly constant. The other ones , however, show significant changes in dependency of the supply voltage in the region of positive deviation of the nominal supply voltage. Figure 6 shows the result in the most clear way, as the output signals of both, the FS–OB and the FS–IB sensors, are plotted versus the deviation of the supply voltage.

As the power supply onboard the ROSETTA s/c will keep the voltages constant in the order of 1 %, the performance of the instrument is acceptable.

After these special power supply variation check the setup was changed for the temperature measurements of the FS Sensors connected to the FS DPU.
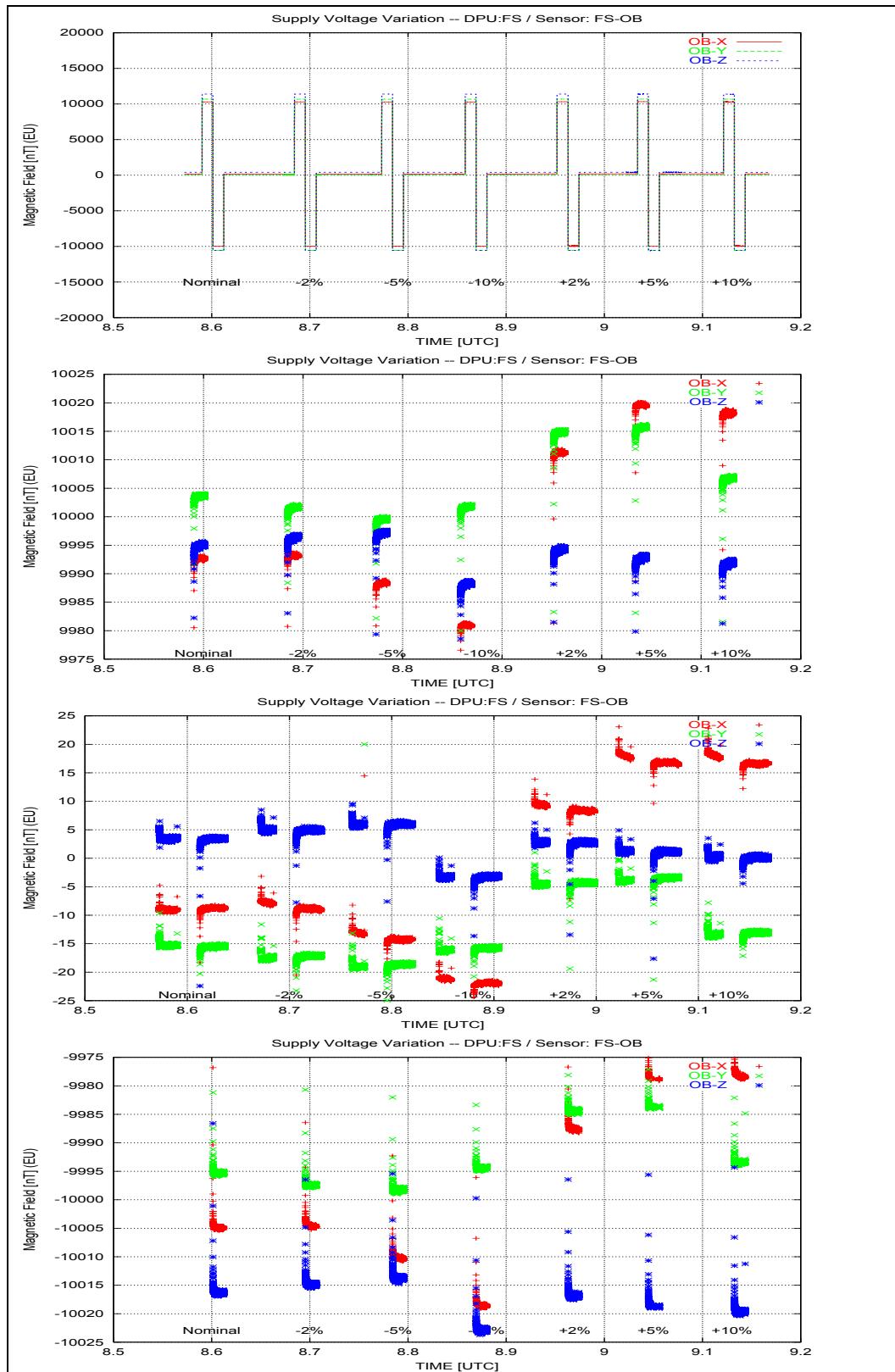
Figure 4: Supply voltage dependence results: FS – OB.
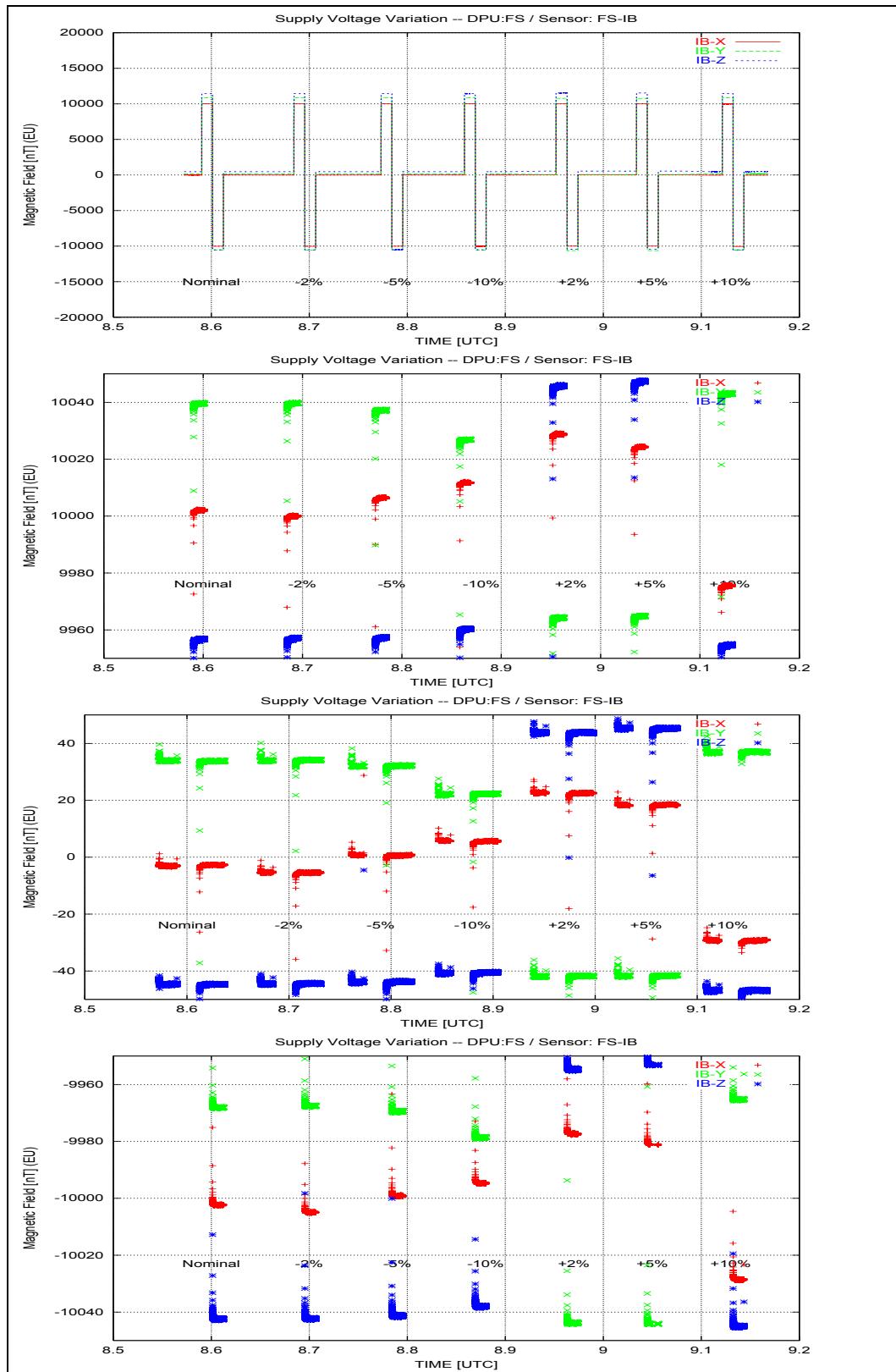
Figure 5: Supply voltage dependence results: FS – IB.

Power Variation Check   DPU: FS , Sensors: FS

Delta B [nT]

Voltage Deviation in percent

FS-IB-X
FS-IB-Y
FS-IB-Z
FS-OB-X
FS-OB-Y
FS-OB-Z
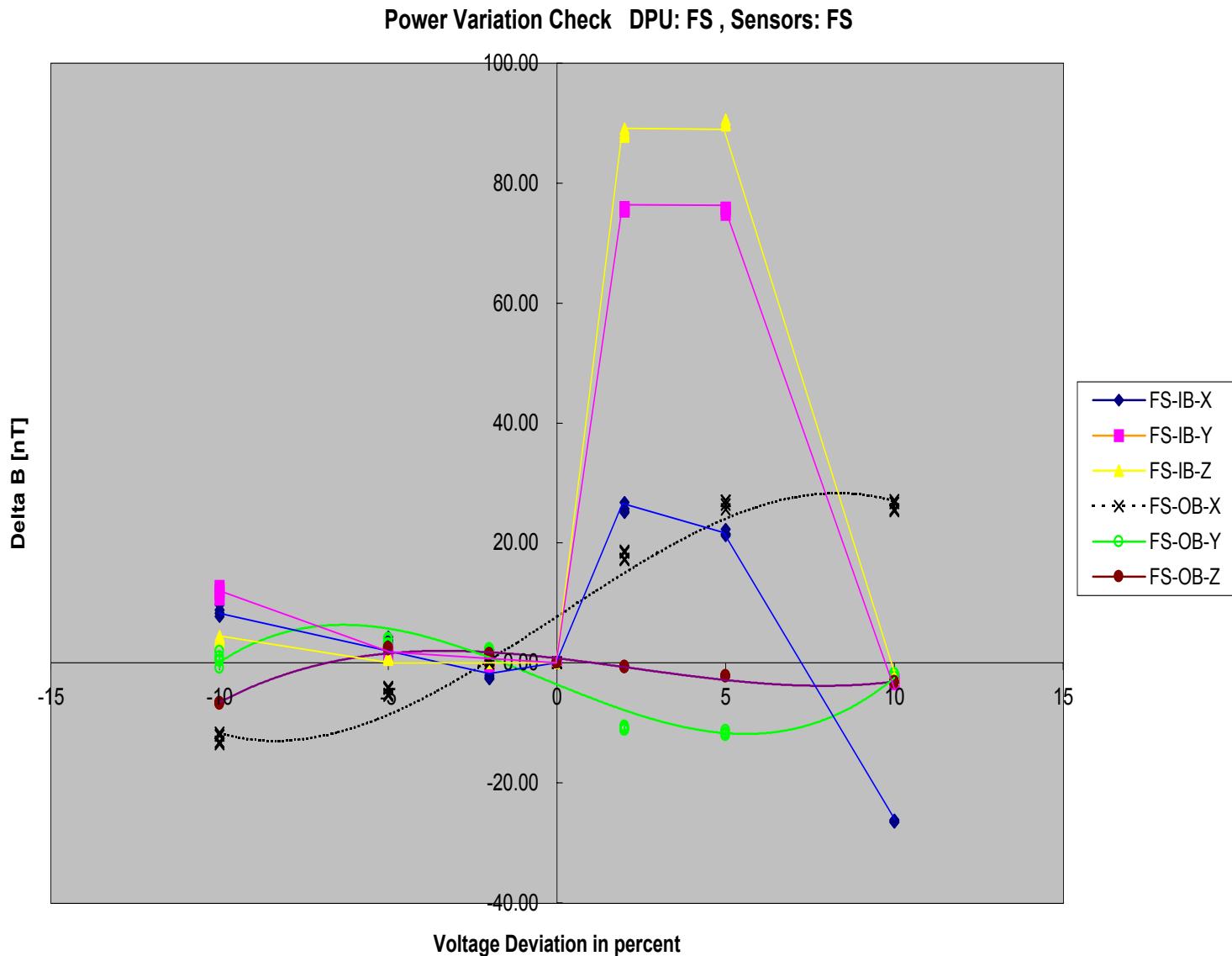
Figure 6: Supply voltage dependence results: DPU: FS, Sensors: FS.

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5.3   Earth Field Variation Check. DPU: FM, Sensors: FS–IB & FS–OB

The check is designed to investigate the regular registration of the two FGM sensors. The sensors are placed and fixed on the aluminium support on the open thermal test box plate. The distance between them is 15 cm. The test has been performed with a fixed suppressed earth field.
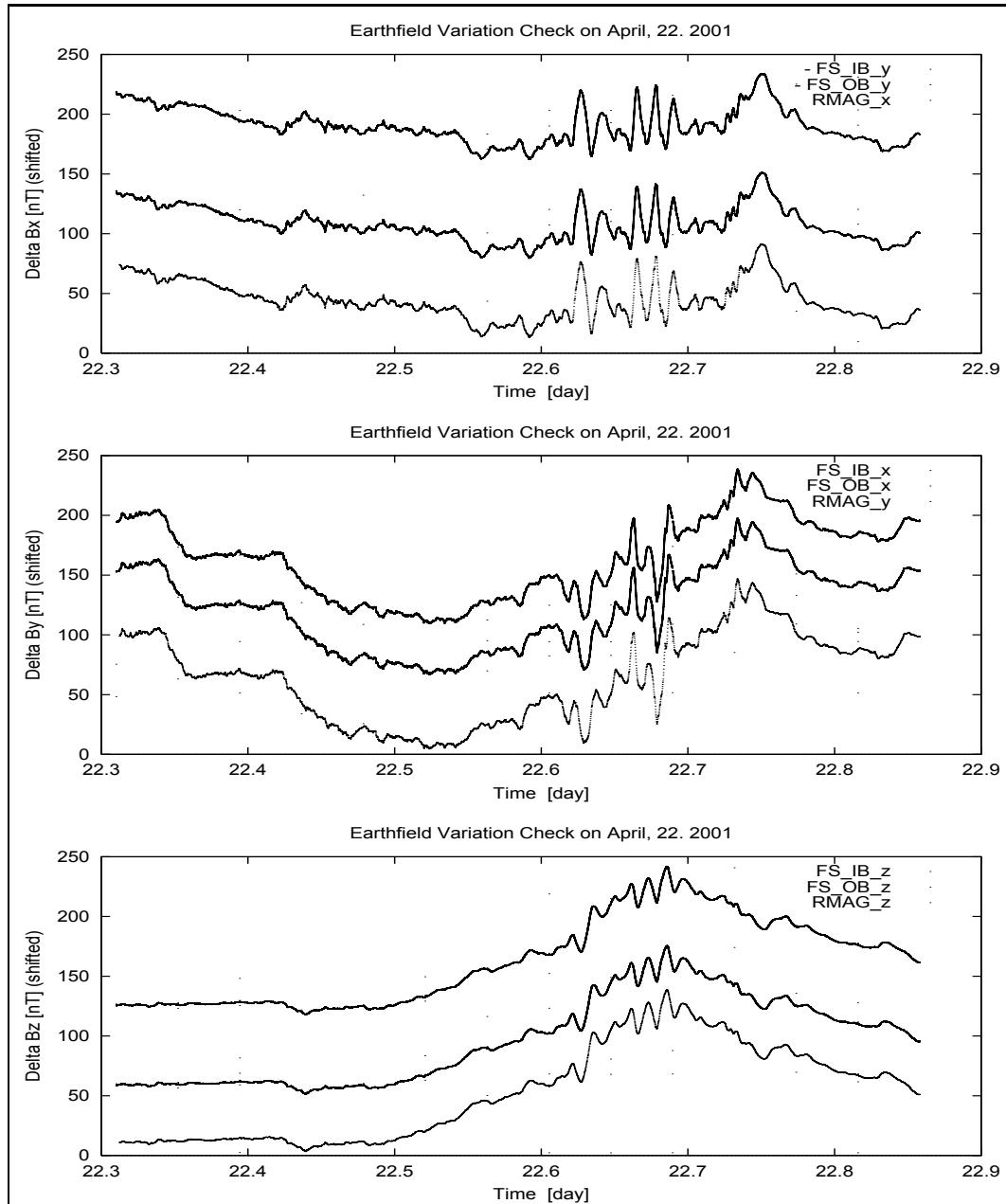
Figure 7: April, 22. 2001: Earth field variation Check

6 Excerpts from the AC-Calibration (IWF–Graz)

6.1 Analysis Results for the FM–DPU & FM–Sensors
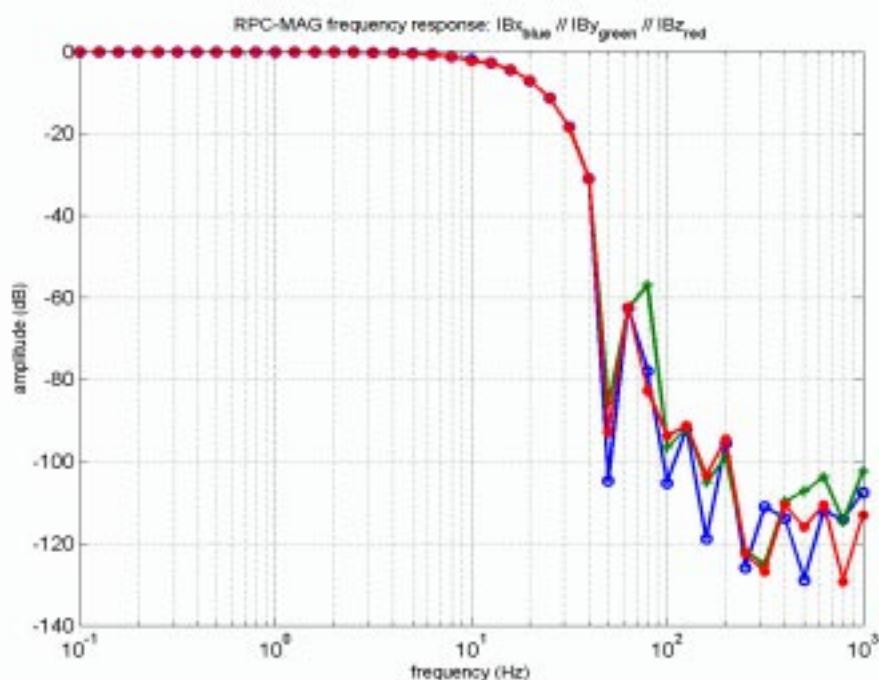
Figure 8: FS–IB Sensor with FM–DPU
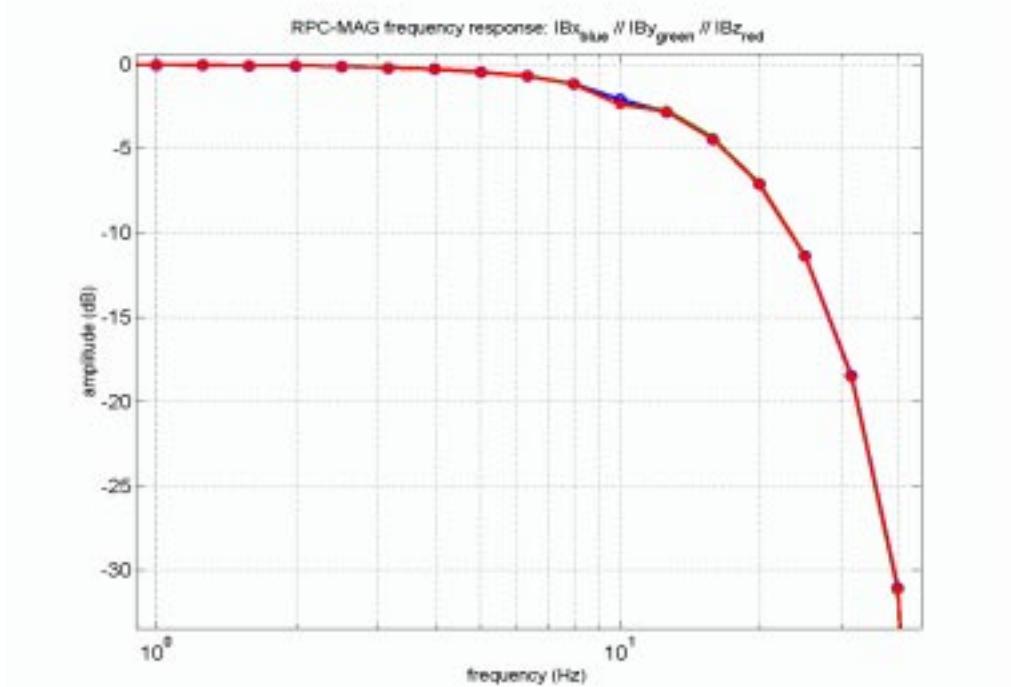
Figure 9: FS–IB Sensor with FM–DPU

6.2 Analysis Results for the FS–DPU & FM–Sensors
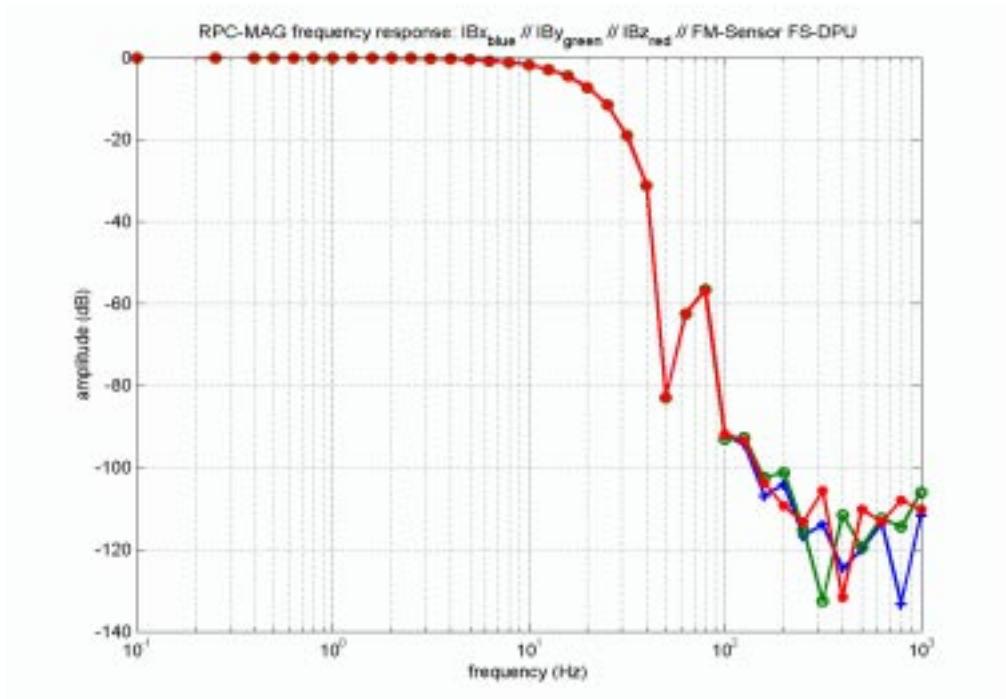
Figure 10: FM–IB Sensor with FS–DPU
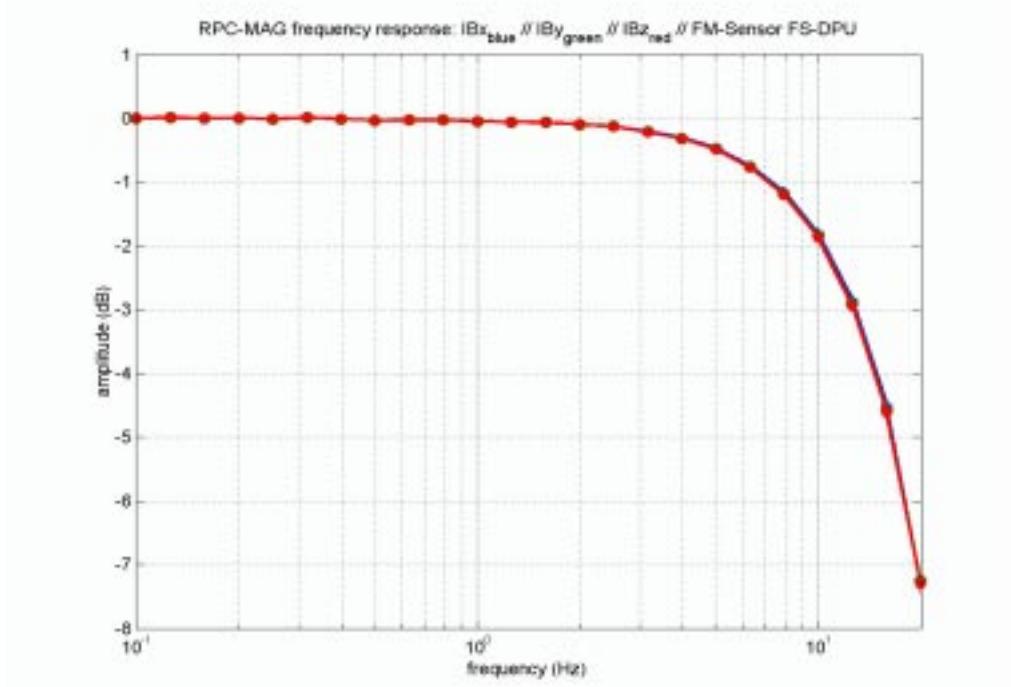
Figure 11: FM–IB Sensor with FS–DPU
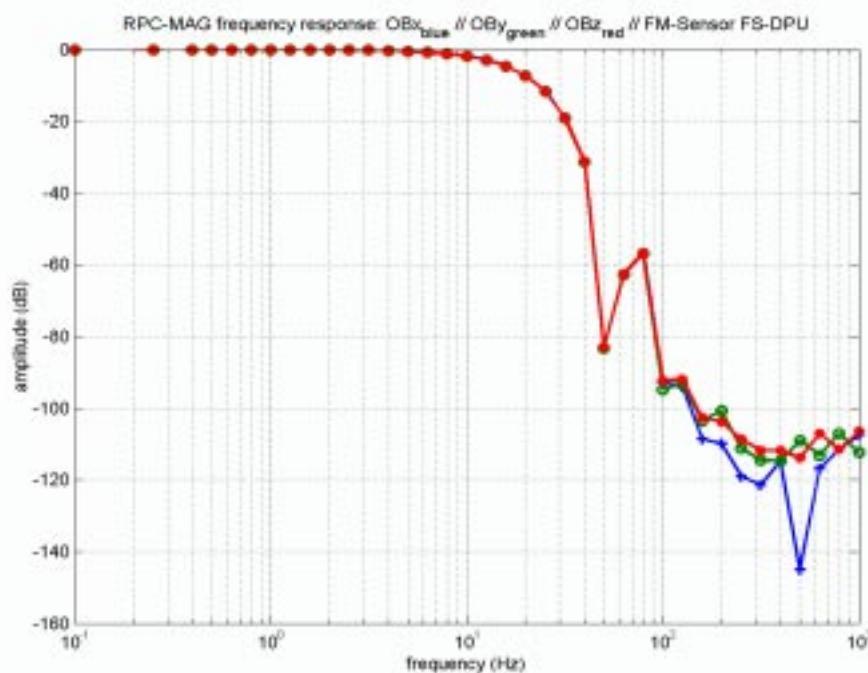
Figure 12: FM–OB Sensor with FS–DPU
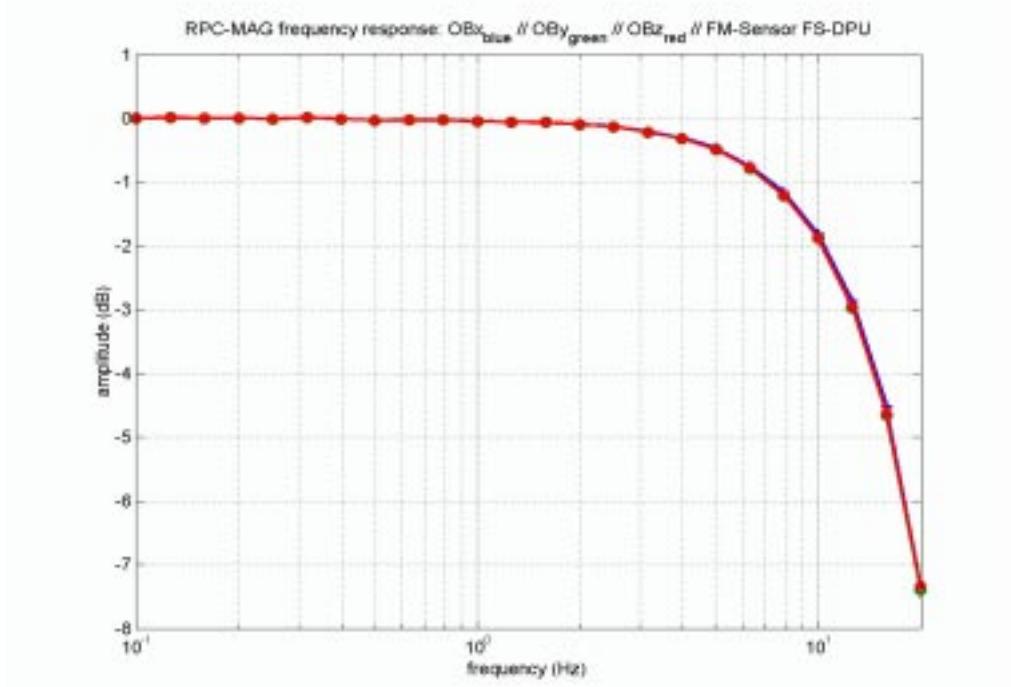
Figure 13: FM–OB Sensor with FS–DPU
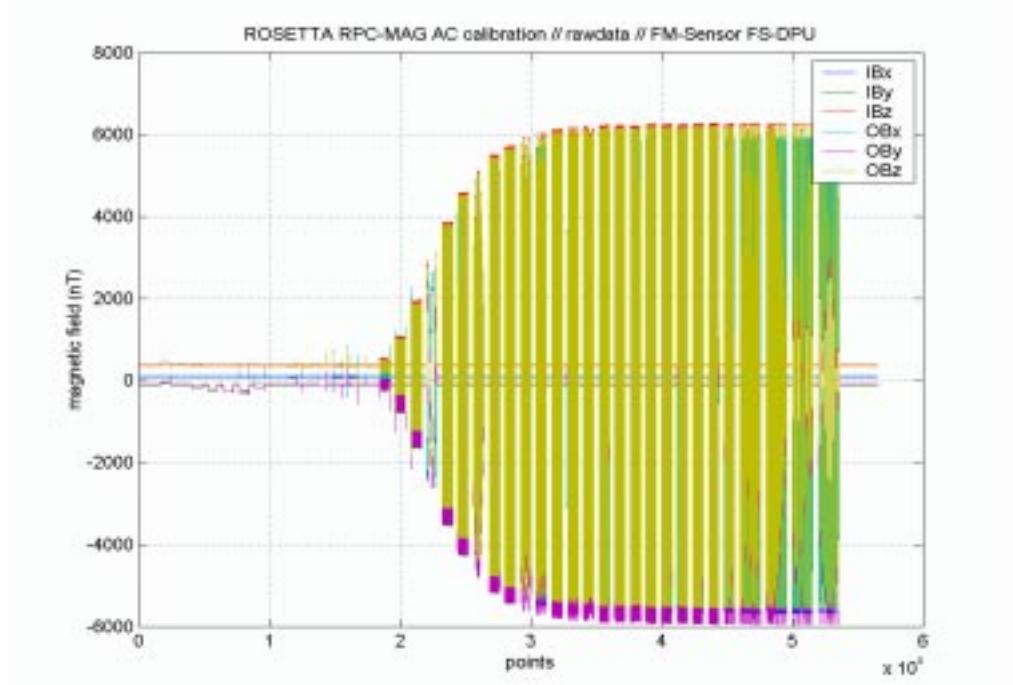
Figure 14: FM Sensors with FS–DPU

7 Mathematical Description of the Calibration

7.1 Basic Principle

The Magnetsrode Coil Facility (MCF) generates an artificial magnetic field $\underline{B}^c$ that can be considered as a calibrated, orthogonal magnetic reference field[1]. The magnetometer under test at the center of the coil system (CoC) generates magnetic raw data $\underline{B}^r$. These data include an eventually existing residual field of the coil system $\underline{B}^{res}$ and the magnetometer offset $\underline{B}^{off}$. Therefore, the first step of the calibration is the generation of offset and residual field corrected measured field data $\underline{B}^m$:

$$\underline{B}^m = \underline{B}^r - \underline{B}^{off} - \underline{B}^{res}$$

The relation between the calibration field and the magnetometer data is then defined by

$$\underline{B}^m = \underline{\underline{M}}\ \underline{B}^c$$

where $\underline{\underline{M}}$ is the complete calibration transfer matrix, defined by

$$\underline{\underline{M}} = \underline{\underline{S}}\ \underline{\underline{O}}\ \underline{\underline{R}}.$$

$\underline{\underline{S}}(T)$ represents the temperature dependent sensitivity.
$\underline{\underline{O}}(T)$ describes the temperature dependent internal sensor misalignment (orthogonalisation matrix).
$\underline{\underline{R}}$ describes the rotation of the sensor against the coil axes.

The calibration computes the inverse matrices:

$$
\begin{aligned}
\underline{\underline{\mu}} \quad =: \quad & \underline{\underline{M}}^{-1} \\
= \quad & \underline{\underline{R}}^{-1}\ \underline{\underline{O}}^{-1}\ \underline{\underline{S}}^{-1} \\
=: \quad & \underline{\underline{\rho}}\ \underline{\underline{\omega}}\ \underline{\underline{\sigma}}\ .
\end{aligned}
$$

These matrices have the subsequent shape:

---

[1]During the calibration the temperature dependent sensitivity of the coil system is calculated every 3 minutes and taken into account as well as the static misalignment of the coil system to produce orthogonal, known fields.

$$\underline{\underline{\sigma}} = \begin{pmatrix} \sigma_1 & 0 & 0 \\ 0 & \sigma_2 & 0 \\ 0 & 0 & \sigma_3 \end{pmatrix} \ ,$$

$$\underline{\underline{\omega}} = \begin{pmatrix} 1 & \cos\xi_{xy} & \cos\xi_{xz} \\ 0 & \sin\xi_{xy} & \dfrac{\cos\xi_{yz} - \cos\xi_{xy}\cos\xi_{xz}}{\sin\xi_{xy}} \\ 0 & 0 & \sqrt{\sin^2\xi_{xz} - \dfrac{(\cos\xi_{yz} - \cos\xi_{xy}\cos\xi_{xz})^2}{\sin^2\xi_{xy}}} \end{pmatrix} \ ,$$

$$\underline{\underline{\rho}} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\lambda & -\sin\lambda \\ 0 & \sin\lambda & \cos\lambda \end{pmatrix} \begin{pmatrix} \cos\mu & 0 & \sin\mu \\ 0 & 1 & 0 \\ -\sin\mu & 0 & \cos\mu \end{pmatrix} \begin{pmatrix} \cos\nu & -\sin\nu & 0 \\ \sin\nu & \cos\nu & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Remark: The automatically generated calibration files of the preceding chapters designate the matrix elements of $\underline{\underline{M}}^{-1}$ by $m_{i,j}$!

The rotation matrix $\underline{\underline{R}}$ is of interest just for the calibration to determine the right magnetometer parameters. The transfer function during flight, however, is just

$$\underline{\underline{\mu}} = \underline{\underline{\omega}}\,\underline{\underline{\sigma}}$$

7.2 Temperature Effects

In the last section the basic principle of calibrating a linear sensor has been described. Now the important question of temperature dependence shall be discussed.
Three aspects will be considered:

- Temperature influence on the OFFSET.

- Temperature influence on the SENSITIVITY.

- Temperature influence on the ALIGNMENT.

The temperature parameters are measured during the ground calibration at the Magnetsrode Coil Facility. To save some time the two sensors IB and OB, will be tested in parallel. For this purpose they are both placed in the temperature box. Thus, one sensor is fixed a few centimeters north and the other one is some centimeters south of CoC. Therefore,

the calibration field acting at these positions is not the same as the reference field at CoC used for the other calibration tasks.

For this reason some algorithms will be presented in the next sections to deduce the "true" temperature effects from the measurements with a slightly "wrong" field.

7.2.1 Temperature influence on the OFFSET

Offset measurements are executed under zero field condition. Therefore, no geometrical problem, mentioned above, arises.
The calibration reveals a linear temperature dependence:

$$\underline{B}^{off} = \underline{a}_0 + \underline{a}_1 \cdot T - \underline{B}^{res}$$

The coefficients are obtained using zero field measurements during the temperature cycle and fitting the sensor output versus the temperature.

As the sensor cannot be turned by $180°$ whilst inside the temperature box, actually the sum of offset and residual field is measured. Therefore, this constant residual field has to be subtracted to get the offset. It can be determined by comparing the normal offset measurements (sensor flipping at CoC) at the reference temperature T_1 with the "temperature offset measurement" (i.e. the offset as determined during the temperature cycle) at T_1.

7.2.2 Temperature influence on the SENSITIVITY

The standard temperature model for a FGM sensor assumes a linear temperature dependence of the sensitivity. Therefore, the sensitivity components can be described as follows:

$$\sigma_i(T) = \sigma_{0,i} + \sigma_{1,i} \cdot T$$

Here $\sigma_{0,i}$ assigns the offset and $\sigma_{1,i}$ the slope of the ith component of the sensitivity. Performing measurements at CoC one would get exactly this behavior. As, however, the measurements are taken at an off–CoC position one gets a slightly different law

$$\sigma_i^1(T) = \sigma_{0,i}^1 + \sigma_{1,i}^1 \cdot T$$

where the 1 in the exponent assigns the off–CoC position.

At CoC just the reference sensitivity $\sigma_i^0(T_1)$ measured at T_1 is known (upper index 0 denotes CoC position) from an independent measurement outside the T–cycle. Thus the problem is the calculation of the temperature dependent sensitivity at CoC

$$\sigma_i^0(T) = \sigma_{0,i}^0 + \sigma_{1,i}^0 \cdot T$$

from the known coefficients.

Solution:
For the temperature T_1 the sensitivities at different places inside the coil system should only differ by a constant geometry correction factor

$$k_i = \frac{\sigma_i^1(T_1)}{\sigma_i^0(T_1)}.$$

As this factor is a temperature independent coil system parameter, $\sigma_i^0(T)$ can be deduced by

$$\sigma_i^0(T) = \frac{1}{k_i}\ \sigma_i^1(T).$$

Hence

$$\sigma_i^0(T) = \frac{1}{k_i}\ \left(\sigma_{0,i}^1 + \sigma_{1,i}^1 \cdot T\right)$$

delivers the desired result.

7.2.3 Temperature Influence on the ALIGNMENT

For the alignment a linear temperature dependency of the misalignment angles ξ_{xy}, ξ_{xz}, ξ_{yz} is assumed.

$$\xi_{ij}(T) = \xi_{0,ij} + \xi_{1,ij} \cdot T$$

Here $\xi_{0,ij}$ assigns the offset and $\xi_{1,ij}$ the slope of the ij–angle of the misalignment. Performing measurements at CoC one would get exactly this behavior. As, however, the measurement are taken at an off–CoC position one gets a slightly different law

$$\xi_{ij}^1(T) = \xi_{0,ij}^1 + \xi_{1,ij}^1 \cdot T$$

where the 1 in the exponent assigns the off–CoC position.

At CoC just the reference angles $\sigma_{ij}^0(T_1)$ measured at T_1 are known (upper limit 0 denotes CoC position) from an independent measurement. Thus the problem is the calculation of the temperature dependent angles at CoC

$$\xi_{ij}^0(T) = \xi_{0,ij}^0 + \xi_{1,ij}^0 \cdot T$$

from the known coefficients, or more precisely, to get the temperature dependent orthogonalisation matrix

$$(\underline{\underline{\omega^0}})(T) = \begin{pmatrix} 1 & \cos(\xi_{xy}^0(T)) & \cos(\xi_{xz}^0(T)) \\ 0 & \sin(\xi_{xy}^0(T)) & \frac{\cos(\xi_{yz}^0(T)) - \cos(\xi_{xy}^0(T)) \cdot \cos(\xi_{xz}^0(T))}{\sin(\xi_{xy}^0(T))} \\ 0 & 0 & \sqrt{\sin^2(\xi_{xz}^0(T)) - (\omega^0(1,2))^2} \end{pmatrix}$$

at CoC.

Solution:
The consideration of the sensitivity revealed a geometrical correction factor k_i which defines the transfer from off–CoC position to the CoC.
In the case of the alignment angles, however, a constant scalar factor is not the right tool to transform the angles, as these angles appear in cosine-terms of the orthogonalisation matrix. Therefore, the transformation is made by a geometrical correction matrix $\underline{\underline{K}}$ which is defined by the orthogonalisation ratio of measurements at CoC and an off–CoC position at constant temperature T_1.

$$\underline{\underline{K}} = (\underline{\underline{\omega^0}})^{-1}(T_1) \cdot (\underline{\underline{\omega^1}})(T_1)$$

As this matrix is a temperature independent coil system parameter, the desired orthogonalisation matrix $\omega^0(T)$ can be deduced by

$$(\underline{\underline{\omega^0}})(T) = (\underline{\underline{\omega^1}})(T) \cdot \underline{\underline{K}}^{-1}$$

Hence

$$(\underline{\underline{\omega^0}})(T) = \begin{pmatrix} 1 & \cos(\xi_{xy}^1(T)) & \cos(\xi_{xz}^1(T)) \\ 0 & \sin(\xi_{xy}^1(T)) & \frac{\cos(\xi_{yz}^1(T)) - \cos(\xi_{xy}^1(T)) \cdot \cos(\xi_{xz}^1(T))}{\sin(\xi_{xy}^1(T))} \\ 0 & 0 & \sqrt{\sin^2(\xi_{xz}^1(T)) - (\omega^1(1,2))^2} \end{pmatrix} \cdot \underline{\underline{K}}^{-1}$$

delivers the desired result.

8 Application of Calibration Results

The calibration procedure has to be executed in the following steps:

1. Calibrate the sensor temperatures (ref. section 9.3):

$$T_{\text{IB}}^c(U_{\text{T,IB}}) \;=\; c_0 \;+\; c_1 U_{\text{T,IB}} \;+\; c_2 U_{\text{T,IB}}^2 \;+\; c_3 U_{\text{T,IB}}^3 - T_{\text{IB}}^O$$
$$T_{\text{OB}}^c(U_{\text{T,OB}}) \;=\; c_0 \;+\; c_1 U_{\text{T,OB}} \;+\; c_2 U_{\text{T,OB}}^2 \;+\; c_3 U_{\text{T,OB}}^3 - T_{\text{OB}}^O$$

2. Calculate the actual, temperature dependent sensor offset (ref. sections 9.1.1, 9.2.1):

$$B_{s,i}^{off} = a_{s,0} + a_{s,1} \cdot T_s^c$$

3. Generate the offset corrected magnetic field raw data:

$$B_{s,i}^m = 10000.0 \cdot B_{s,i}^r - B_{s,i}^{off}$$

The factor 10000.0 has been inserted into the raw data from the magnetometer during the calibration at Magnetsrode to generate sensitivities in the order of one. Therefore, it has to be taken into account here before applying the sensitivity matrix to the magnetic field data.

4. Calculate the actual, temperature dependent sensitivity (ref. sections 9.1.2, 9.2.2):

$$(S_{s,ii})^{-1}(T) =: \sigma_{s,i}^0(T) = \sigma_{0,s,i}^0 + \sigma_{1,s,i}^0 \cdot T_s^c$$

5. Evaluate the temperature dependent sensor misalignment (ref. sections 9.1.3, 9.2.3):

$$\underline{\underline{Q}}_s^{-1}(T) =: \underline{\underline{\omega}}_s^0(T) = \begin{pmatrix} 1 & \cos(\xi_{xy}^0(T)) & \cos(\xi_{xz}^0(T)) \\ 0 & \sin(\xi_{xy}^0(T)) & \frac{\cos(\xi_{yz}^0(T)) - \cos(\xi_{xy}^0(T)) \cdot \cos(\xi_{xz}^0(T))}{\sin(\xi_{xy}^0(T))} \\ 0 & 0 & \sqrt{\sin^2(\xi_{xz}^0(T)) - (\omega^0(1,2))^2} \end{pmatrix}$$

6. Apply calibration matrices to produce calibrated data:

$$\begin{aligned} \underline{B}_s^c &= \underline{\underline{Q}}_s^{-1}(T) \; \underline{\underline{S}}_s^{-1}(T) \; \underline{B}_s^m \\ &= \underline{\underline{\omega}}_s^{(}T) \; \underline{\underline{\sigma}}_s(T) \; \underline{B}_s^m \end{aligned}$$

9 Final Calibration Coefficients

For the ROSETTA mission it was decided to fly the magnetometer in the following configuration:

Unit	Selection
DPU	FS
IB–Sensor	FM–IB
OB–Sensor	FM–OB

9.1 Final Results for the Flight IB Sensor

9.1.1 Offset

The sensor offset obeys the equation

$$\underline{B}^{off} = \underline{a}_0 + \underline{a}_1 \cdot T - \underline{B}^{res}$$

The calibration revealed:

$\underline{a}_0$ [nT]	$\underline{a}_1$ [nT/K]	$\underline{B}^{res}$ [nT]
114.3	-0.565	-2.0
-119.8	0.731	2.0
494.0	-1.673	-15.0

9.1.2 Sensitivity

Reference Temperature for Linearity/Sphere–Measurement: $T_1 = 17.394000$ [°C]

Reference Sensitivities for Linearity/Sphere–Measurement at T_1 at CoC:

$\sigma_x^0(T_1)$ [1]	$\sigma_y^0(T_1)$ [1]	$\sigma_z^0(T_1)$ [1]
1.09045	1.09418	1.09398

The coefficients from the temperature calibration at the off-center position are

$\sigma_{0,x}^1$ [1]	$\sigma_{0,y}^1$ [1]	$\sigma_{0,z}^1$ [1]
1.09026	1.09354	1.09336

$\sigma_{1,x}^1$ [1/K]	$\sigma_{1,y}^1$ [1/K]	$\sigma_{1,z}^1$ [1/K]
-1.42E-005	-9.29E-006	-8.55E-006

The geometrical correction coefficient $\underline{k}$, caused by the 2 different positions during the linearity measurements and the temperature measurements is defined by

$$k_i = \frac{\sigma_i^1(T_1)}{\sigma_i^0(T_1)}$$

The evaluation reveals

k_x [1]	k_y [1]	k_z [1]
0.99959	0.99927	0.99929

Using this factor the desired temperature dependence of the sensitivity

$$\sigma_i^0(T) = \frac{1}{k_i}\left(\sigma_{0,i}^1 + \sigma_{1,i}^1 \cdot T\right)$$

can be evaluated. The needed coefficients

$$\sigma_{0,i}^0 \quad := \quad \frac{1}{k_i}\left(\sigma_{0,i}^1\right)$$
$$\sigma_{1,i}^0 \quad := \quad \frac{1}{k_i}\left(\sigma_{1,i}^1\right)$$

for the sensitivity

$$\boxed{(S_{ii})^{-1} =: \sigma_i^0 = \sigma_{0,i}^0 + \sigma_{1,i}^0 \cdot T}$$

are:

$\sigma_{0,x}^0$ [1]	$\sigma_{0,y}^0$ [1]	$\sigma_{0,z}^0$ [1]
1.09070	1.09434	1.09413

$\sigma_{1,x}^0$ [1/K]	$\sigma_{1,y}^0$ [1/K]	$\sigma_{1,z}^0$ [1/K]
-1.42E-005	-9.30E-006	-8.55E-006

9.1.3 Alignment

Reference Temperature for Linearity/Sphere–Measurement: $T_1 = 17.394000$ [°C]
Reference Misalignment for Linearity/Sphere–Measurement at T_1 at CoC:

$\xi^0_{xy}(T_1)$ [°]	$\xi^0_{xz}(T_1)$ [°]	$\xi^0_{yz}(T_1)$ [°]
90.0463	89.9416	89.9500

The alignment coefficients obtained from the temperature calibration at the off-center position are

$\xi^1_{0,xy}$ [°]	$\xi^1_{0,xz}$ [°]	$\xi^1_{0,yz}$ [°]
90.0348	89.9587	89.9433

$\xi^1_{1,xy}$ [°/K]	$\xi^1_{1,xz}$ [°/K]	$\xi^1_{1,yz}$ [°/K]
8.54E-005	3.71E-005	1.20E-004

The geometrical correction matrix $\underline{\underline{K}}$, caused by the 2 different positions during the linearity measurements and the temperature measurements is defined by

$$\underline{\underline{K}} = (\underline{\underline{\omega}}^0)^{-1}(T_1) \cdot (\underline{\underline{\omega}}^1)(T_1)$$

with the inverse misalignment matrix $\underline{\underline{\omega}} =: \underline{\underline{Q}}^{-1}$, consisting of the direction cosines $\cos(\xi_{ij})$. The evaluation reveals

$$(\underline{\underline{K}})^{-1} = \begin{pmatrix} 1.00000 & -0.00017 & 0.00031 \\ 0.00000 & 1.00000 & -0.00008 \\ 0.00000 & 0.00000 & 1.00000 \end{pmatrix}$$

Using this matrix the desired temperature dependence of the alignment

$$(\underline{\underline{\omega}}^0)(T) = (\underline{\underline{\omega}}^1)(T) \cdot \underline{\underline{K}}^{-1}$$

can be evaluated. $(\underline{\underline{\omega}}^0)(T)$ results as

$$(\underline{\underline{\omega}}^0)(T) = \begin{pmatrix} 1 & \cos(\xi^1_{xy}(T)) & \cos(\xi^1_{xz}(T)) \\ 0 & \sin(\xi^1_{xy}(T)) & \frac{\cos(\xi^1_{yz}(T)) - \cos(\xi^1_{xy}(T)) \cdot \cos(\xi^1_{xz}(T))}{\sin(\xi^1_{xy}(T))} \\ 0 & 0 & \sqrt{\sin^2(\xi^1_{xz}(T)) - (\omega^1(1,2))^2} \end{pmatrix} \begin{pmatrix} 1.00000 & -0.00017 & 0.00031 \\ 0.00000 & 1.00000 & -0.00008 \\ 0.00000 & 0.00000 & 1.00000 \end{pmatrix}$$

with

$$\xi^1_{ij}(T) = \xi^1_{0,ij} + \xi^1_{1,ij} \cdot T$$

9.2 Final Results for the Flight OB Sensor

9.2.1 Offset

The sensor offset obeys the equation

$$\underline{B}^{off} = \underline{a}_0 + \underline{a}_1 \cdot T - \underline{B}^{res}$$

The calibration revealed:

$\underline{a}_0$ [nT]	$\underline{a}_1$ [nT/K]	$\underline{B}^{res}$ [nT]
214.5	-1.053	0.0
-79.9	0.073	4.0
384.7	-1.657	-20.0

9.2.2 Sensitivity

Reference Temperature for Linearity/Sphere–Measurement: $T_1 = 17.391000$ [°C]

Reference Sensitivities for Linearity/Sphere–Measurement at T_1 at CoC:

$\sigma_x^0(T_1)$ [1]	$\sigma_y^0(T_1)$ [1]	$\sigma_z^0(T_1)$ [1]
1.09079	1.09338	1.09277

The coefficients from the temperature calibration at the off-center position are

$\sigma_{0,x}^1$ [1]	$\sigma_{0,y}^1$ [1]	$\sigma_{0,z}^1$ [1]
1.09066	1.09251	1.09217

$\sigma_{1,x}^1$ [1/K]	$\sigma_{1,y}^1$ [1/K]	$\sigma_{1,z}^1$ [1/K]
-1.18E-005	-8.20E-006	-6.97E-006

The geometrical correction coefficient $\underline{k}$, caused by the 2 different positions during the

linearity measurements and the temperature measurements is defined by

$$k_i = \frac{\sigma_i^1(T_1)}{\sigma_i^0(T_1)}$$

The evaluation reveals

k_x [1]	k_y [1]	k_z [1]
0.99969	0.99907	0.99934

Using this factor the desired temperature dependence of the sensitivity

$$\sigma_i^0(T) = \frac{1}{k_i}\left(\sigma_{0,i}^1 + \sigma_{1,i}^1 \cdot T\right)$$

can be evaluated. The needed coefficients

$$\sigma_{0,i}^0 \quad := \quad \frac{1}{k_i}\left(\sigma_{0,i}^1\right)$$

$$\sigma_{1,i}^0 \quad := \quad \frac{1}{k_i}\left(\sigma_{1,i}^1\right)$$

for the sensitivity

$$\boxed{(S_{ii})^{-1} =: \sigma_i^0 = \sigma_{0,i}^0 + \sigma_{1,i}^0 \cdot T}$$

are:

$\sigma_{0,x}^0$ [1]	$\sigma_{0,y}^0$ [1]	$\sigma_{0,z}^0$ [1]
1.09100	1.09352	1.09289

$\sigma_{1,x}^0$ [1/K]	$\sigma_{1,y}^0$ [1/K]	$\sigma_{1,z}^0$ [1/K]
-1.18E-005	-8.21E-006	-6.97E-006

9.2.3 Alignment

Reference Temperature for Linearity/Sphere–Measurement: $T_1 = 17.391000$ [$^{\circ}$C]
Reference Misalignment for Linearity/Sphere–Measurement at T_1 at CoC:

$\xi_{xy}^0(T_1)$ [$^{\circ}$]	$\xi_{xz}^0(T_1)$ [$^{\circ}$]	$\xi_{yz}^0(T_1)$ [$^{\circ}$]
90.0711	90.0187	90.0576

The alignment coefficients obtained from the temperature calibration at the off-center position are

$\xi_{0,xy}^1$ [$^{\circ}$]	$\xi_{0,xz}^1$ [$^{\circ}$]	$\xi_{0,yz}^1$ [$^{\circ}$]
90.0666	90.0366	90.0370

$\xi_{1,xy}^1$ [$^{\circ}$/K]	$\xi_{1,xz}^1$ [$^{\circ}$/K]	$\xi_{1,yz}^1$ [$^{\circ}$/K]
-6.04E-005	-1.11E-004	-8.12E-005

The geometrical correction matrix $\underline{K}$, caused by the 2 different positions during the linearity measurements and the temperature measurements is defined by

$$\underline{K} = (\underline{\omega}^0)^{-1}(T_1) \cdot (\underline{\omega}^1)(T_1)$$

with the inverse misalignment matrix $\underline{\omega} =: \underline{Q}^{-1}$, consisting of the direction cosines $\cos(\xi_{ij})$. The evaluation reveals

$$(\underline{K})^{-1} = \begin{pmatrix} 1.00000 & -0.00010 & 0.00028 \\ 0.00000 & 1.00000 & -0.00038 \\ 0.00000 & 0.00000 & 1.00000 \end{pmatrix}$$

Using this matrix the desired temperature dependence of the alignment

$$(\underline{\omega}^0)(T) = (\underline{\omega}^1)(T) \cdot \underline{K}^{-1}$$

can be evaluated. $(\underline{\omega}^0)(T)$ results as

$$(\underline{\omega}^0)(T) = \begin{pmatrix} 1 & \cos(\xi_{xy}^1(T)) & \cos(\xi_{xz}^1(T)) \\ 0 & \sin(\xi_{xy}^1(T)) & \frac{\cos(\xi_{yz}^1(T)) - \cos(\xi_{xy}^1(T)) \cdot \cos(\xi_{xz}^1(T))}{\sin(\xi_{xy}^1(T))} \\ 0 & 0 & \sqrt{\sin^2(\xi_{xz}^1(T)) - (\omega^1(1,2))^2} \end{pmatrix} \begin{pmatrix} 1.00000 & -0.00010 & 0.00028 \\ 0.00000 & 1.00000 & -0.00038 \\ 0.00000 & 0.00000 & 1.00000 \end{pmatrix}$$

with

$$\xi_{ij}^1(T) = \xi_{0,ij}^1 + \xi_{1,ij}^1 \cdot T$$

9.3   Calibration of the Sensor Thermistors

The sensor temperatures are measured using standard PT1000 elements inside the sensors. Table 9.3 gives a part of the manufacturer's provided nominal function derived from the following third order polynomial functions $T(U)$.

$$T(U) = c_0 \; + \; c_1 U \; + \; c_2 U^2 \; + \; c_3 U^3$$

with

$c_0 =$ -368.61072
$c_1 =$ 458.49304
$c_2 =$ -356.02890
$c_3 =$ 180.00644

T [$^\circ$C]	R(T) [Ω]	U(T) [V]	T [$^\circ$C]	R(T) [Ω]	U(T) [V]
-150.000	423.219	0.743420	10.0000	1039.14	1.27399
-140.000	461.402	0.789310	20.0000	1078.40	1.29715
-130.000	499.567	0.832850	30.0000	1117.77	1.31951
-120.000	537.730	0.874230	40.0000	1157.26	1.34112
-110.000	575.906	0.913610	50.0000	1196.86	1.36201
-100.000	614.108	0.951160	60.0000	1236.58	1.38222
-90.0000	652.351	0.987000	70.0000	1276.41	1.40178
-80.0000	690.646	1.02128	80.0000	1316.36	1.42072
-70.0000	729.005	1.05408	90.0000	1356.43	1.43907
-60.0000	767.436	1.08552	100.000	1396.60	1.45686
-50.0000	805.950	1.11569	110.000	1436.90	1.47411
-40.0000	844.555	1.14466	120.000	1477.31	1.49084
-30.0000	883.256	1.17251	130.000	1517.84	1.50708
-20.0000	922.061	1.19931	140.000	1558.48	1.52286
-10.0000	960.974	1.22512	150.000	1599.24	1.53818
0.000000	1000.00	1.25000			

Table 1: Calibration data for the sensor PT1000 elements, nominal data provided by the manufacturer.

Therefore, the raw temperature T_s^r of sensor s (s={IB | OB}), measured in [e°C], is obtained by applying the polynomial coefficients to the sensor output voltage.

$$
\begin{aligned}
T_{\text{IB}}^r(U_{\text{T,IB}}) &= c_0 + c_1 U_{\text{T,IB}} + c_2 U_{\text{T,IB}}^2 + c_3 U_{\text{T,IB}}^3 \\
T_{\text{OB}}^r(U_{\text{T,OB}}) &= c_0 + c_1 U_{\text{T,OB}} + c_2 U_{\text{T,OB}}^2 + c_3 U_{\text{T,OB}}^3
\end{aligned}
$$

The temperature calibration at Magnetsrode revealed that the subsequent temperature offsets have to be considered to get the calibrated temperature data T_s^c in °C.

$$
\begin{aligned}
T_{\text{IB}}^O &= -1.5 \text{ °C} \\
T_{\text{OB}}^O &= -2.7 \text{ °C}
\end{aligned}
$$

$$
\begin{aligned}
T_{\text{IB}}^c &= T_{\text{IB}}^r - T_{\text{IB}}^O \\
T_{\text{OB}}^c &= T_{\text{OB}}^r - T_{\text{OB}}^O
\end{aligned}
$$

10   Nomenclature

Abbreviations in the analysis summary tables:

Digit		
1	M	DPU–FM
	S	DPU–FS
2	M	FM Sensors
	S	FS Sensors
3,4	IB	Inboard Sensor
	OB	Outboard Sensor
5	–	
6	O	Offset measurement
	L	Linearity measurement
	S	Crosstalk measurements on a Sphere/Spiral Sphere
	T	Temperature measurements
7	A	Measurement **a**fter temperature cycle
	B,V	Measurement **b**efore temperature cycle
	1,2,3,...	Just a running number

Abbreviations in the plots:

Item	Meaning
Bf	Magnetic field of the facility
Bp	Calibrated probe field (sensor)
Xf	X-component of facility field
Yf	Y-component of facility field
Zf	Z-component of facility field
Bft	Modulus of facility field
Xp	X-component of calibrated probe field (sensor)
Yp	Y-component of calibrated probe field (sensor)
Zp	Z-component of calibrated probe field (sensor)
Bpt	Modulus of calibrated probe field

Abbreviations in theoretical sections:

Item	Meaning
$a_{s,0}, a_{s,1}$	Fit coefficients for the sensor offset of sensor s versus temperature
$\underline{B}^c$	Magnetic calibration field generated by coil system
$\underline{B}^{off}$	Offset of the magnetometer [enT]
$\underline{B}^m$	Measured magnetic field raw data, offset & residual field corrected [enT]
$B_{s,i}^m$	Component i of sensor s, measured magnetic raw data, offset & residual field corrected [enT]
$B_{s,i}^{off}$	Temperature dependent offset, component i of sensor s [enT]
$\underline{B}^r$	Magnetic field raw data
$B_{s,i}^r$	Component i of sensor s, magnetic raw data [V]
$\underline{B}^{res}$	Residual field of the coil system
e°C	Engineering degrees centigrade units
enT	Engineering NanoTesla units
c_0, c_1, c_2, c_3	Fit coefficients of the sensor thermistor
i	component x | y | z
CoC	Center of Coil system
$\underline{G}$	$= \underline{S}\ matO$, Geometry matrix
$\underline{\gamma}$	$= \underline{G}^{-1}$, Inverse geometry matrix
k_i	Geometrical correction coefficient (component i) for sensitivity determination between CoC and off-CoC position
$\underline{\underline{K}}$	Geometrical correction matrix for alignment determination between CoC and off-CoC position
$\underline{\underline{M}}$	Complete calibration transfer matrix
$\underline{\underline{\mu}}$	$= \underline{\underline{M}}^{-1}$, Inverse transfer matrix
$\underline{\underline{O}}$	Orthogonalisation matrix
$\underline{\underline{\omega}}$	$= \underline{\underline{O}}^{-1}$, Inverse orthogonalisation matrix
$\underline{\underline{R}}$	Rotation matrix of sensor vs. coil system
$\underline{\underline{\rho}}$	$= \underline{\underline{R}}^{-1}$, Inverse rotation matrix

Item	Meaning
$\underline{\underline{S}}$	Sensitivity matrix
$\underline{\underline{\sigma}}$	$= \underline{\underline{S}}^{-1}$, Inverse sensitivity matrix
σ_i^0	Temperature dependent sensitivity of component i, related to the CoC
$\sigma_{0,i}^0, \sigma_{1,i}^0$	Offset & slope (temperature) of component i, of CoC related sensitivity
σ_i^1	Temperature dependent sensitivity of i. component, related to the off-CoC position
$\sigma_{0,i}^1, \sigma_{1,i}^0$	Offset & slope (temperature) of the component i, of off-CoC position related sensitivity
T_s^c	Temperature of sensor s, calibrated data [°C]
T_s^r	Temperature of sensor s, raw data [e°C]
s	Sensor IB | OB
T_1	Reference temperature for sensitivity & alignment measurements at CoC
$U_{\text{T, IB}}$	IB–Temperature data [V], measured
$U_{\text{T,OB}}$	OB–Temperature data [V], measured
ξ_{ij}^0	Temperature dependent alignment angle (ij component), related to the CoC
$\xi_{0,ij}^0, \xi_{1,ij}^0$	Offset & slope (temperature) of the CoC related alignment angle (ij component)
ξ_{ij}^1	Temperature dependent alignment angle (ij component), related to the off-CoC position
$\xi_{0,ij}^1, \xi_{1,ij}^0$	Offset & slope (temperature) of the off-CoC position related alignment angle (ij component)