

**CALIBRATION PROCEDURE  
FOR THE  
ION AND ELECTRON SPECTROMETER (IES)  
PROTOFLIGHT MODEL (PFM) UNIT**

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Prepared by Raymond Goldstein



**SOUTHWEST RESEARCH  
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# CALIBRATION PROCEDURE FOR THE ION AND ELECTRON SPECTROMETER (IES) PROTOFLIGHT MODEL (PFM) UNIT

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## 1 Scope, Objectives, and Description

This document is the calibration procedure for the IES Proto-Flight Model (PFM) instrument being developed by Southwest Research Institute (SwRI) for the European Space Agency Rosetta Project under contract number JPL-960549. This procedure is used to obtain ion and electron calibration data for the instrument.

## 2 Applicable Documents and Standards

The following documents and standards shown form a part of the document to the extent specified. If a revision number is not shown, then it is the issue in effect on the date of this document. In the event of a conflict between this document and the contents of one of the documents and standards listed below, the order of precedence is the contract, this document, European Space Agency documents, then Military and SwRI documents.

### European Space Agency

RO-EST-RS-3001/EID-A	Experiment Interface Document Part A
RO-EST-RS-3001/EID-B	Experiment Interface Document Part B
RO-EST-RS-3001/EID-B	Experiment Interface Document Part C

### Military Documents

MIL-STD-810E Notice 2	Environmental Test Methods and Engineering Guidelines
MIL-STD-831	Preparation of Test Reports 28 Aug 1963
MIL-STD-45662A	Calibration System Requirements

### SwRI

OP-5-15-101	Document Control
OP-9-15-101	Calibration Control
OP-9-30-104	Calibration System
OP-16-15-301	ESD Control
QAP-12-1	Nonconformance Control
QAP-12-2	Failure Reporting, Analysis, and Corrective Action System
QAP-14-1	Corrective Action Control
PAIP-97-15-8182	Performance Assurance Implementation Plan
8182-ISIES-01	Instrument Specification for the Ion and Electron Spectrometer
8182-FTPFM-02	Functional Test Procedure for IES PFM Unit
8182-HVPFM-01	High-Voltage Checkout Procedure for IES PFM Unit
XXXX	Cleanliness Requirements for High Vacuum Applications
Software	IES PFM flight Software, Sci6 software

FRA-2X1-2/EGPS-2X1	Electron Beam Equipment Manual
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### 3 Abbreviations

DEF	Deflection
ESA	Electrostatic Analyzer
IES	Ion and Electron Spectrometer
MCP	Microchannel Plate
QA	Quality Assurance
SwRI	Southwest Research Institute
UUT	Unit Under Test

### 4 Test Documentation and Reporting

#### 4.1 Test Results

Test data will be logged on the GSE computer, and/or recorded directly on this procedure or on a test-computer printout attached to this procedure in Appendix A. Mark the front page of this procedure "As-Run Test Report" or similar. Submit "As-Run" procedure to Document Control for file. All log files are to be captured at the end of this test on 3 1/2" diskettes, properly labeled and submitted to document control.

During the course of running the calibration procedure, test data shall be kept under the following directory names on their respective machines:

D:\DATA\FM\090501FMCAL\GSEOSRaw – Raw Link Packet data recorded by GSEOS  
D:\DATA\FM\090501FMCAL\IESViewData – ASCII comma-delimited files generated by LabVIEW  
D:\DATA\FM\090501FMCAL\SCRIPTS – Command log script files used by this procedure

Whenever new record files are created by IESVIEW, they shall be logged in the table in Section 11. Execute each of the test cases contained in Section 10 of this document. Write test observations in the OBSERVED RESULTS column. Whenever possible, obtain a hardcopy printout of test results. Annotate those results with the procedure number, test case number, and date and time the test was executed. Mark in the PASS/FAIL column whether the observed result matches the expected result as a pass or fail.

#### 4.2 Nonconformances and Problem/Failure Reports

Nonconformances and problems/failures encountered during the execution of this test shall be dispositioned in the manner prescribed by QAP-12-1 and QAP-12-2.

#### 4.3 Changes to Test Procedures

Changes to this test procedure may be made in response to last minute changes in test requirements or to correct errors in the test procedure identified after the test has started. Changes are defined as minor or major changes dependent upon how much the procedure is changed. Changes should be made in red ink in the procedure with appropriate initials, dates and stamps annotated in the right hand margin.

##### 4.3.1 Minor Changes

Minor changes are defined as those changes that will not significantly change the actual test procedure or affect the results of the test. Such changes as equipment model number changes or corrections of procedural errors are minor changes. The test conductor may make minor changes with the concurrence of the project manager and the cognizant QA engineer. Changes must be initialed and dated by the test conductor, the project manager and receive a QA stamp or initial and date after approval.

**Calibration Procedure for the IES PFM Unit****4.3.2 Major Changes**

Major changes are defined as those changes that will significantly change the actual test procedure or affect the test results. Changes to procedure to reduce schedule impact, changes as the result of test failure closeouts, or changes in the scope of the test (temperature, dwell time, etc.) are defined as major changes. Major changes must be initiated by the project manager and receive a QA stamp or initial after approval.

**5 TEST PERSONNEL**

Test personnel will include a test conductor and technicians as needed to support the testing. The test engineer or project manager shall notify QA of the test schedule so that QA may monitor test activities and results.

**6 TEST TOLERANCES**

The following tolerances will be observed in making measurements for the test:

Voltage	1%
Current	3%

**7 CLEANLINESS AND CONTAMINATION CONTROL**

The UUT shall be handled in a class 10,000, or better, clean environment. For transportation and operation in a non-clean room environment, the unit will be wrapped in conductive wrap except for the mounting feet areas and connectors. The aperture cover will be in place to minimize contamination in the sensor assembly at all times unless otherwise directed by the governing procedure.

The areas in and around the calibration chamber are considered contamination sensitive and must be protected from incompatible materials such as hydrocarbons, hydroscopic materials, and body detritus. Procedures are established and shall be enforced to prevent contamination.

Refer to the document "DOP-8-15-405 Cleanliness Requirements for High Vacuum Applications" for cleanliness procedures.

The only gas allowed for use as backfill shall be nitrogen in purity levels of 99.995% (zero grade) or 99.999% (preferred). Any gas used as backfill must be certified for contamination levels of less than 0.5ppm hydrocarbons.

**8 TEST EQUIPMENT****8.1 CALIBRATION REQUIREMENTS**

All equipment used to make measurements during the execution of this procedure shall have current calibration certifications. The date of the last calibration and the due date for the next calibration shall be clearly marked on the test equipment. Requirements for calibration are specified in SwRI documents OP-9-30-104.

**8.2 Required Test Equipment**

1. Power Supplies to provide +5, -5, +12, -12 V
2. Digital multimeter (Calibration Required)
3. SwRI PIU Power Simulator (or equivalent)
4. SwRI PIU Interface Simulator



**Calibration Procedure for the IES PFM Unit**

5. Laptop PC running the Rosetta Spacecraft Simulator and the IES GSE
6. IES GSE/Thermal Vac Cable SwRI P/N: 81822600

Equipment Identification	Serial Number	Next Cal. Due Date

**9 Test Overview and Setup**

**9.1 Test Overview**

This test is designed to characterize the performance of the instrument. This is accomplished by using the SwRI calibration system and performing the following tests. (Note that the list is approximately in priority order, but regarding test of the flight software, it should be run prior to step 8 if at any time it is likely that no more than a few hours remain before IES must be removed from the chamber.)

1. Use SCI6 software
2. N<sup>+</sup> beam set to 2 keV
3. Full ESA sweep, no angle scans
4. Ion MCP gain test
5. Electron beam set at 1 keV
6. Full ESA sweep, no angle scans
7. Electron MCP gain test
8. Here or earlier if short of time load flight software, run full ESA sweep and limited DEF sweep
9. Return to Sci6 software
10. ESA and DEF sweep with inner angle scan
11. ESA and DEF sweep with inner and outer angle scan
12. Return to N<sup>+</sup> beam, at 2 keV
13. ESA and DEF sweep with inner angle scan
14. ESA and DEF sweep with inner and outer angle scan
15. Set N<sup>+</sup> beam to 21 keV
16. ESA and DEF sweep with inner and outer angle scan
17. Set N<sup>+</sup> beam to 500 eV
18. ESA and DEF sweep with inner and outer angle scan
19. Set both N<sup>+</sup> and e beams
20. Full ESA sweep at 3 fixed inner angles
21. ESA and DEF sweep for one position of step 18.

## Calibration Procedure for the IES PFM Unit

### 9.1.1 Environmental Conditions Monitoring

Pressure and temperature shall be recorded automatically by the calibration chamber system once every minute. A residual gas content measurement shall be taken once every 12 hrs.

### 9.2 Test Set up

- \_\_\_\_\_ a) Verify that the test area meets the cleanliness requirements for this instrument.
- \_\_\_\_\_ b) Verify that there is sufficient N<sub>2</sub> to complete this test.
- \_\_\_\_\_ c) Set the +5V power supply current limit to .25A
- \_\_\_\_\_ d) Set the -5, +12, and -12 V power supply limits to 0.150 A
- \_\_\_\_\_ e) Verify that the power supplies are off.
- \_\_\_\_\_ f) Connect the PIU power simulator to the 28V power supply.
- \_\_\_\_\_ g) Power up the PIU power simulator and verify the following voltages

+5V : V=\_\_\_\_\_ V<sub>dc</sub>

-5V : V=\_\_\_\_\_ V<sub>dc</sub>

+12V : V=\_\_\_\_\_ V<sub>dc</sub>

-12V : V=\_\_\_\_\_ V<sub>dc</sub>

- \_\_\_\_\_ h) Power off the PIU power simulator
- \_\_\_\_\_ i) Install the Unit Under Test (UUT) in the calibration chamber as shown in Figure 1.
- \_\_\_\_\_ j) Cable up the UUT.
- \_\_\_\_\_ k) QA Verify test setup per Figure 2.
- \_\_\_\_\_ l) Verify that the V/8 only plug is installed.
- \_\_\_\_\_ m) Verify that the freedom of motion with the test cables connected is sufficient to complete this test.
- \_\_\_\_\_ n) Perform IES PFM functional test procedure, 8182-FTPFM-02.

Pass : \_\_\_\_\_ Fail: \_\_\_\_\_

Time: \_\_\_\_:\_\_\_\_:\_\_\_\_ Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

## 10 Test Procedure

INNER rotation limits: -115° to +225°  
OUTER rotation limits: -55° to +55°

Calibration Procedure for the IES PFM Unit

10.1 Pumpdown

- \_\_\_\_\_ a) Close Chamber and begin pumping the chamber down to a pressure  $< 1 \times 10^{-7}$  Torr.
- \_\_\_\_\_ b) Record the time and date when the chamber has stabilized at a pressure  $< 1 \times 10^{-7}$  Torr.

Time : \_\_\_\_ : \_\_\_\_ : \_\_\_\_      Date : \_\_\_\_ / \_\_\_\_ / \_\_\_\_

- \_\_\_\_\_ c) Allow the unit to pump for at least 24 hrs from the time recorded in 10.1.b.

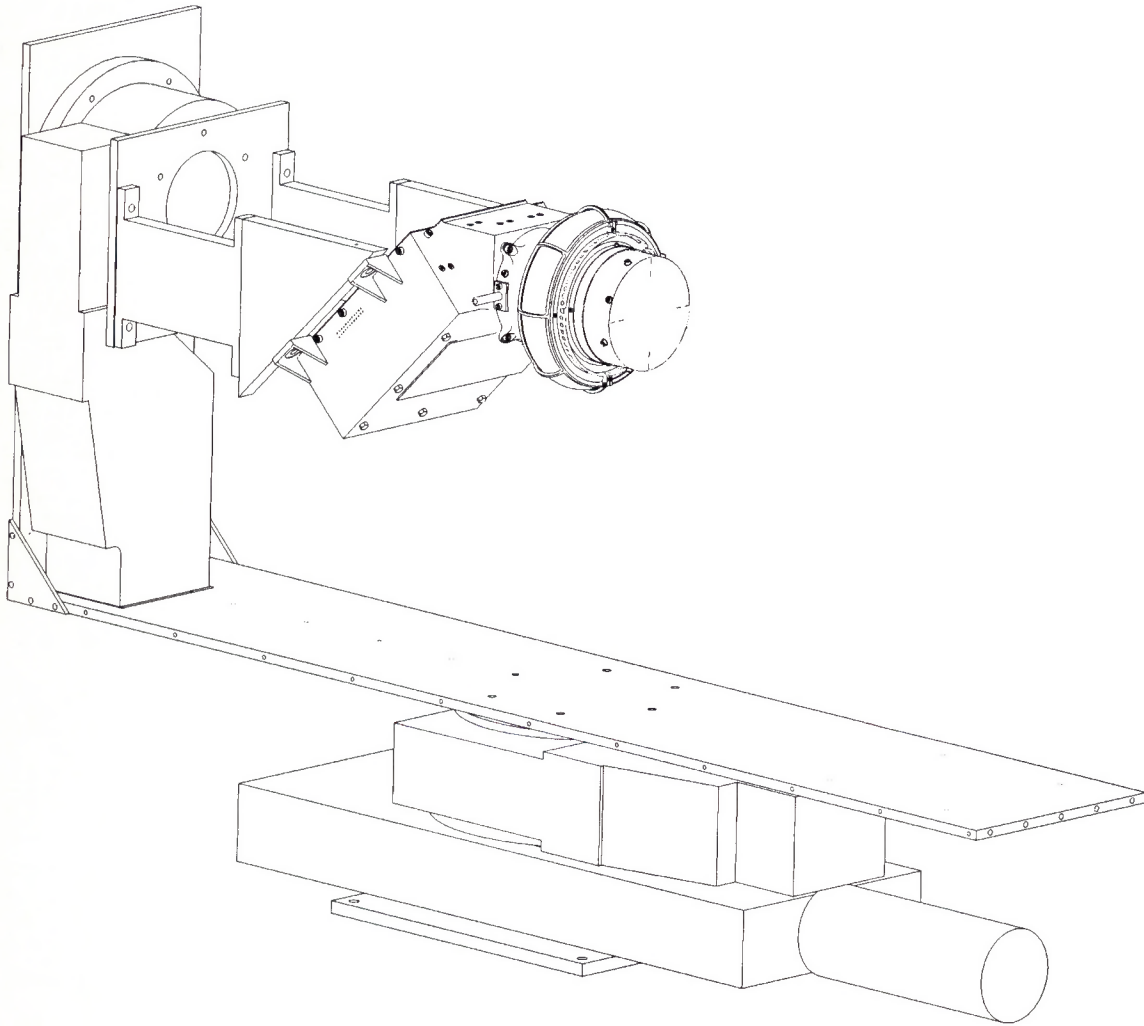


Figure 1. IES Installation in Calibration Chamber





**Calibration Procedure for the IES PFM Unit**

Pressure : \_\_\_\_\_

\_\_\_\_\_ b) Perform IES High-Voltage Checkout procedure, 8182-HVPFM-01.

Pass : \_\_\_\_\_ Fail: \_\_\_\_\_

Time: \_\_\_\_:\_\_\_\_:\_\_\_\_ Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

**10.4 Initialize Calibration**

It is assumed that as a result of running 8182-HVPFM-01, the voltages should be at the following settings so that the calibration procedure can proceed with Section 10.5: (The MCP operating voltages may need to be changed later as a result of the gain tests of Section 10.5.2)

ELC MCP: 2500 V  
ION MCP: -2500 V  
MCP ENABLED  
ESA: 0 V  
ESA ENABLED  
DEF: 0 V  
DEF ENABLED

If there are breaks in the calibration schedule and the instrument is turned off, the following steps shall be run from 8182-HVPFM-01 for subsequent high-voltage turn-on:

4.1, 4.2, 8.1.1-8.1.6, 8.2.1-8.2.3, 8.3.1, 8.4.1.

*Note that it is anticipated that the state of the calibration system will require each angular position move to be performed manually, one step at a time. Most of the data will be collected using the SCI6 instrument software, which means that any voltage sweep scripts must also be run manually at each position. As a result, It is recommended that a separate data file be written for each position after the system has settled to its new position. Observe the motion and be sure the system has settled before recording data. The following is a suggestion for a file naming convention:*

*TEEEOOOOIIIIISDHHmm.dat, where*

*T = I for ion, e for electron, or b if both are measured simultaneously*

*EEE = beam energy (in in hundreds of Volts)*

*OOOO = OUTER angle position (=instrument azimuth angle), with p for positive or n for negative angle as the first entry of the four places*

*IIII = INNER angle position (=instrument elevation angle), with p for positive or n for negative angle as the first entry of the four places*

*S = ESA sweep status, i.e. f=full sweep, p=partial sweep, n=no sweep*

*D DEF sweep status, i.e. f=full sweep, p=partial sweep, n=no sweep*



## Calibration Procedure for the IES PFM Unit

*HHmm = hour :minute time stamp imposed by the computer*

*A log shall be kept of all data files written. An example of a Table representing such a log is shown in Section 11.*

10.5 N<sup>+</sup> Beam at 2 keV

Purpose: Set up 2keV N<sup>+</sup> beam according to the following table:

Source	Type	Energy	Current
ELC	None	N/A	N/A
ION	N <sup>+</sup>	2 keV	0.8 pA

Procedure:

- \_\_\_\_\_ a) Make sure gate valve is closed
- \_\_\_\_\_ b) Deploy Faraday cup (FC)
- \_\_\_\_\_ c) Set up N<sup>+</sup> beam in DP source
- \_\_\_\_\_ d) Turn beam on at 1 kV U<sub>float</sub> + 1 kV U<sub>extraction</sub> = 2 keV beam and center the FC. Set x-raster to 15 V and y-raster to 30.2 V.
- \_\_\_\_\_ e) Total ion current should not exceed 0.8 pA
- \_\_\_\_\_ f) Go to beam stability mode
- \_\_\_\_\_ g) Verify that beam is steady for 10 minutes before proceeding
- \_\_\_\_\_ h) If beam current is below 0.5 pA, extend MCP sensor and record cts/sec reading  
\_\_\_\_\_ (efficiency measurement)
- \_\_\_\_\_ i) Retract FC
- \_\_\_\_\_ j) Turn off IES high voltages
- \_\_\_\_\_ k) Open gate valve to chamber
- \_\_\_\_\_ l) Observe pressure increase in chamber
- \_\_\_\_\_ m) Wait until chamber pressure returns at least to <math>5 \times 10^{-7}</math> Torr range.
- \_\_\_\_\_ n) Ramp up high voltages per Section 10.4

## 10.5.1 Full ESA Sweep

Purpose: Determine satisfactory operation of ESA and ion detector.

Expected Result: Should obtain an energy profile of the beam centered around 2 keV.

Procedure

- \_\_\_\_\_ a) Orient IES at instrument 0-degree OUTER and INNER at such angle such that the ion beam will be centered on ion channel 15.
- \_\_\_\_\_ b) Create SCI6 data File: **i0200000p022fnhmm.dat** to record IES output data.
- \_\_\_\_\_ c) Run full ESA sweep by executing script file: **i2alln.spt**.  
This script file uses the following parameters for ESA:

Calibration Procedure for the IES PFM Unit

Parameter	Description	Start	End	Step Size	No. Steps	Time per Step	
ESA	Full exponential sweep with 8 bkgd steps	0 V	1.667 kV	Exp	256	2 s	
DEF	Fixed at 0 V	0 V	0 V	N/A	N/A	N/A	
INNER	Fixed at 22.5°	22.5°	22.5°	N/A	N/A	N/A	
OUTER	0°	0°	0°	N/A	N/A	N/A	
<b>TOTAL TIME</b>						hh:mm	00:09

\_\_\_\_\_ a) Record the date and time sweep is completed.

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Time: \_\_\_\_:\_\_\_\_:\_\_\_\_

10.5.2 Ion MCP gain test.

Purpose: Determine proper operating voltage for the ion MCP.

Expected Result: Should obtain a gain curve of the ion MCP.

Procedure:

- \_\_\_\_\_ a) Maintain position of IES as in previous procedure.
- \_\_\_\_\_ b) Set ESA voltage to the center of the peak measured in the previous procedure.
- \_\_\_\_\_ c) Create SCI6 data Files: **i20ISM.dat** to record IES output data (where angle "I" is the inner angle, "S" is the fixed ESA voltage, and "M" is the MCP voltage.)
- \_\_\_\_\_ d) Beginning at -2500 V, step the MCP voltage not to exceed -2800 V in 20 V increments, pausing 2 minutes at each step.
- \_\_\_\_\_ e) Record information for each file in the Table illustrated in Section 12, MCP Test Table.
- \_\_\_\_\_ f) From the results of this test, determine the appropriate ion MCP operating voltage and perform all additional calibrations with this value.

Record the value of the new operating voltage: \_\_\_\_\_

End of ion test

- \_\_\_\_\_ a) Turn off ion beam.

10.6 Electron Beam at 1 keV

Purpose: Set up 1keV electron beam according to the following table:

Source	Type	Energy	Current
ELC	ELC	1 keV	0.8 pA
ION	None	N/A	N/A

Procedure:

- \_\_\_\_\_ a) develop electron beam at 1 keV using procedure in electron beam manual, FRA-2X1-2/EGPS-2X1

Calibration Procedure for the IES PFM Unit

Note that since there is no detector monitoring the electron beam intensity it is important to proceed slowly, starting with low intensity until there is assurance that the countrate in IES does not exceed 100 kHz in any channel.

10.6.1 Full ESA Sweep

Purpose: Determine satisfactory operation of ESA and electron detector.

Expected Result: Should obtain an energy profile of the beam centered around 1 keV.

Procedure:

- \_\_\_\_\_ a) Orient IES at instrument 0-degree OUTER and the INNER angle such that the electron beam is centered on sector 12.
- \_\_\_\_\_ b) Create SCI6 data File: **e010000p011fnhhmm.dat** to record IES output data.
- \_\_\_\_\_ c) Run full ESA sweep by executing script file: **e1alln.spt**.  
 This script file uses the following parameters for ESA:

Parameter	Description	Start	End	Step Size	No. Steps	Time per Step
ESA	Full exponential sweep with 8 bkgd steps	0 V	1.667 kV	Exp	256	5 s
DEF	Fixed at 0 V	0 V	0 V	N/A	N/A	N/A
INNER	11.25°	11.25°	11.25°	11.25°	N/A	N/A
OUTER	Fixed at 0°	0°	0°	N/A	N/A	N/A
<b>TOTAL TIME hh:mm</b>						<b>00:21</b>

- \_\_\_\_\_ d) Record the date and time sweep is completed.  
 Date: \_\_\_\_/\_\_\_\_/\_\_\_\_  
 Time: \_\_\_\_:\_\_\_\_:\_\_\_\_

10.6.2 Electron MCP test.

Purpose: Determine proper operating voltage for the electron MCP.

Expected Result: Should obtain a gain curve of the electron MCP.

Procedure:

- \_\_\_\_\_ a) Maintain orientation of IES as in the previous procedure.
- \_\_\_\_\_ b) Set ESA voltage to the center of the peak measured in the previous procedure.
- \_\_\_\_\_ c) Create SCI6 data Files: **e1225ISM.dat** to record IES output data (where angle "I" is the inner angle, "S" is the fixed ESA voltage, and "M" is the MCP voltage.)
- \_\_\_\_\_ d) Beginning at 2500 V, step the MCP not to exceed 2800 V in 20 V increments, pausing 2 minutes at each step.
- \_\_\_\_\_ e) Record information for each file in the Table illustrated in Section 12, MCP Test Table.
- \_\_\_\_\_ f) From the results of this test, determine the appropriate ion MCP operating voltage and perform all additional calibrations with this value.

10.7 Flight software test

Purpose: To verify proper functioning of the flight software during beam stimulation.

Expected result: Satisfactory operation of software.



Calibration Procedure for the IES PFM Unit

Procedure (Note: Either John Hanley or Charles Zinsmeyer must be present for this procedure)

- \_\_\_\_\_ a) Record data in file TBD
- \_\_\_\_\_ b) Start up flight software in IES.
- \_\_\_\_\_ c) Run as for section 10.8.1 but for a single INNER angle position.
- \_\_\_\_\_ d) Record the date and time run is completed.

Date: \_\_\_\_\_  
 Time: \_\_\_\_\_ Pass \_\_\_\_\_ Fail \_\_\_\_\_

**10.8 Return to SCI6 software**

10.8.1 ESA Sweep with INNER Scan

Purpose: Determine satisfactory operation of as many anode and electronics strings as possible.

Expected Result: Should result in INNER profile of the beam.

Procedure:

- \_\_\_\_\_ a) Orient IES at instrument 0-degree OUTER and 0-degree INNER.
- \_\_\_\_\_ b) Set up calibration system scanner using the parameters in the following table.
- \_\_\_\_\_ c) Create SCI6 data files: **e0100000IIIIpp.dat** to record IES output data.
- \_\_\_\_\_ d) Run ESA sweep with INNER scan by executing script file: **e1na.spt**.  
 This script file uses the following parameters:

Parameter	Description	Start	End	Step Size	No. Steps	Time per Step
ESA	Linear sweep centered around 1 keV	75 V	100 V	1.2 V	20	22s
DEF	Sweep	+/-25V	+/-25V	5V	11	2 s
INNER	Scan over allowable range	-115°	+221°	6°	57	7.7m
OUTER	Fixed at 0°	0°	0°	N/A	N/A	N/A
<b>TOTAL TIME</b>					<b>hh:mm</b>	<b>7:32</b>

- \_\_\_\_\_ a) Record the date and time sweep is completed.  
 Date: \_\_\_\_/\_\_\_\_/\_\_\_\_  
 Time: \_\_\_\_:\_\_\_\_:\_\_\_\_

10.8.2 ESA Sweep with OUTER Scan

Purpose: Determine satisfactory operation of ESA and OUTER scan.

Expected Result: Should result in OUTER profile of the beam.

Procedure:

- \_\_\_\_\_ a) Orient IES at instrument -50-degree OUTER and -115-degree INNER.
- \_\_\_\_\_ b) Set up calibration system scanner using the parameters in the following table.
- \_\_\_\_\_ c) Create SCI6 data file: **e0100000IIIIpphmm.dat** to record IES output data.
- \_\_\_\_\_ d) Run ESA and DEF sweeps with both angle scans by executing script file: **e1nl.spt**.

Calibration Procedure for the IES PFM Unit

This script file uses the following parameters:

Parameter	Description	Start	End	Step Size	No. Steps	Time per Step
ESA	Linear sweep centered around 1 keV	75 V	100 V	2.5 V	11	22 s
DEF	Sweep	+/- 25 V	+/- 25 V	5V	11	2s
INNER	Scan	-115°	+221°	24°	29	5m
OUTER	Scan	-50°	+50°	10°	11	3h
<b>TOTAL TIME</b> hh:mm						21:26

\_\_\_\_\_ e) Record the date and time sweep is completed.

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Time: \_\_\_\_:\_\_\_\_:\_\_\_\_

10.8.3 End of 1 keV electron beam

\_\_\_\_\_ e) Turn off 1 keV electron beam.

**Turn on 2 keV N<sup>+</sup> beam.**

10.8.4 ESA Sweep with Inner angle Scan

Purpose: Determine satisfactory operation of as many anode and electronics strings as possible.

Expected Result: Should result in INNER angle profile of the beam.

Procedure:

- \_\_\_\_\_ a) Orient IES at instrument 0-degree OUTER and -115-degree INNER.
- \_\_\_\_\_ b) Set up calibration system scanner using the parameters in the following table.
- \_\_\_\_\_ c) Create SCI6 data files: **i0200000llllpp.dat** for each position of the INNER angle "I" to record IES output data.
- \_\_\_\_\_ d) Run ESA sweep with INNER scan by executing script file: **i2na.spt**.  
(Note that 10° steps are used over the coarse sectors while 1° steps are used for the fine ones.)

This script file uses the following parameters:

Parameter	Description	Start	End	Step Size	No. Steps	Time per Step
ESA	Linear sweep centered around 2 keV	151V	199V	2.4 V	21	42s
DEF	Sweep	+/-50V	-/+50V	5 V	21	2s
INNER	Scan over allowable range	-115°	+221°	10°/1°	32/45	42m
OUTER	Fixed at 0	0°	0°	N/A	N/A	N/A
<b>TOTAL TIME</b> hh:mm						7:21/11:16



Calibration Procedure for the IES PFM Unit

\_\_\_\_\_ e) Record the date and time sweep is completed.

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Time: \_\_\_\_:\_\_\_\_:\_\_\_\_

10.8.5 ESA Sweep with INNER and OUTER Scans

Purpose: Determine satisfactory operation of ESA and both INNER and OUTER scan.

Expected Result: Should result in OUTER profile of the beam.

Procedure:

- \_\_\_\_\_ a) Orient IES at instrument 0-degree OUTER and 0-degree INNER.
- \_\_\_\_\_ b) Set up calibration system scanner using the parameters in the following table.
- \_\_\_\_\_ c) Create SCI6 data file: **i20lpp.dat** to record IES output data.
- \_\_\_\_\_ d) Run ESA and DEF sweeps with INNER and OUTER scans by executing script file: **i2nl.spt**. This script file uses the following parameters:

Parameter	Description	Start	End	Step Size	No. Steps	Time per Step
ESA	Linear sweep centered around 2 keV	151 V	199 V	4.8 V	11	42 s
DEF	Sweep	+/-50 V	+/-50 V	5 V	21	2s
INNER	Scan	-115°	+221°	24°	15	7.7m
OUTER	Scan	-50°	+50°	10°	11	4/2.4h
<b>TOTAL TIME</b>						21.2h

\_\_\_\_\_ e) Record the date and time sweep is completed.

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Time: \_\_\_\_:\_\_\_\_:\_\_\_\_

Turn off 2 keV N<sup>+</sup> beam

10.9 N<sup>+</sup> Beam at 21 keV

Purpose: Set up 21 keV N<sup>+</sup> beam according to the following table:

Source	Type	Energy	Current
ELC	N/A	N/A	N/A
ION	N <sup>+</sup>	21 keV	0.8 pA

Procedure:

- \_\_\_\_\_ a) Set IES DEF and ESA voltages to zero.
- \_\_\_\_\_ b) Deploy Faraday cup (FC)
- \_\_\_\_\_ c) Set up N<sup>+</sup> beam in DP source
- \_\_\_\_\_ d) Turn beam on at 20 kV U<sub>float</sub> + 1 kV U<sub>extraction</sub> = 21 keV beam and center the FC. Set x-raster to 15 V and y-raster to 30.2 V.
- \_\_\_\_\_ e) Total ion current should not exceed 0.8 pA
- \_\_\_\_\_ f) Go to beam stability mode
- \_\_\_\_\_ g) Verify that beam is steady for 10 minutes before proceeding

**Calibration Procedure for the IES PFM Unit**

- \_\_\_\_\_ h) If beam current is below 0.5 pA, extend MCP sensor and record cts/sec reading  
 \_\_\_\_\_ (efficiency measurement)
- \_\_\_\_\_ i) Retract FC

10.9.1 Full ESA Sweep

Purpose: Determine satisfactory operation of optics and ion detectors with a high energy beam.

Expected Result: Should obtain an energy profile of the beam centered around 21 keV.

Procedure:

- \_\_\_\_\_ a) Orient IES at instrument 0-degree OUTER and at an INNER angle such that the beam is centered on channel 15.
- \_\_\_\_\_ b) Create SCI6 data File: **i2100000p022fn.dat** to record IES output data.
- \_\_\_\_\_ c) Run full ESA sweep by executing script file: **i21alln.spt**.  
 This script file uses the following parameters for ESA:

Parameter	Description	Start	End	Step Size	No. Steps	Time per Step
ESA	Full exponential sweep with 8 bkgd steps	0 V	1.667 kV	Exp	256	2 s
DEF	Fixed at 0 V	0 V	0 V	N/A	N/A	N/A
INNER	Fixed at 22.5°	22.5°	22.5°	N/A	N/A	N/A
OUTER	Fixed at 0°	0°	0°	N/A	N/A	N/A
<b>TOTAL TIME</b> hh:mm						00:09

- \_\_\_\_\_ d) Record the date and time sweep is completed.  
 Date: \_\_\_\_/\_\_\_\_/\_\_\_\_  
 Time: \_\_\_\_:\_\_\_\_:\_\_\_\_

10.9.2 ESA Sweep and ELEVATION Scan

Purpose: Determine satisfactory operation of as many anode and electronics strings as possible.

Expected Result: Should result in ELEVATION profile of the beam.

Procedure:

- \_\_\_\_\_ a) Orient IES at INNER = -115°, OUTER = 0°.
- \_\_\_\_\_ b) Set up calibration system scanner using the parameters in the following table.
- \_\_\_\_\_ c) Create SCI6 data file: **i2100000000pnhhmm.dat** to record IES output data.
- \_\_\_\_\_ d) Run ESA sweep with ELEVATION scan by executing script file: **i21na.spt**.  
 This script file uses the following parameters:

Calibration Procedure for the IES PFM Unit

Parameter	Description	Start	End	Step Size	No. Steps	Time per Step	
ESA	Linear sweep centered around 21 keV	1367 V	1667 V	20 V	16	2 s	
DEF	Fixed at 0 V	0 V	0 V	N/A	N/A	N/A	
INNER	Scan over allowable range	-115°	+175°	10°	30	100 s	
INNER	Scan over allowable range	+175°	+221°	1°	46		
OUTER	Fixed at 0°	0°	0°	N/A	N/A	N/A	
<b>TOTAL TIME</b>						<b>hh:mm</b>	<b>01:00</b>

\_\_\_\_\_ e) Record the date and time sweep is completed.

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Time: \_\_\_\_:\_\_\_\_:\_\_\_\_

10.9.3 DEF scan for high energy beam

Procedure:

- \_\_\_\_\_ a) Orient IES at instrument to INNER angle +22.5°.
- \_\_\_\_\_ b) Set up calibration system scanner using the parameters in the following table.
- \_\_\_\_\_ c) Create SCI6 data file: **i2100000p025pn.dat** to record IES output data.
- \_\_\_\_\_ d) Run ESA and DEF sweeps by executing script file: **i21n.spt**.
- \_\_\_\_\_ e) This script file uses the following parameters:

Parameter	Description	Start	End	Step Size	No. Steps	Time per Step	
ESA	Linear sweep centered around 21 keV	1575 V	1667 V	20 V	16	200s s	
DEF	Sweep	+/-1kV	+/-1k V	50V	41	2s	
INNER	Fixed	22.5°	22.5°	N/A	N/A	N/A	
OUTER	Fixed at 0°	0°	0°	N/A	N/A	N/A	
<b>TOTAL TIME</b>						<b>hh:mm</b>	<b>00:40</b>

10.9.4 Perform the following DEF scans

OUTER angle	DEF scan range (V)	Step size (V)
-45°	+/-3280: 3330	5
+/-37.5°	+/-3280: 3330	5
+/-30°	+/-3280: 3330	5
+/-22.5°	+/-3280: 3330	5
+/-15°	+/-2175: 2225	5
+/-7.5°	+/-1075: 1125	5
0°	+/-25: -/+25	5



## Calibration Procedure for the IES PFM Unit

### 10.9.5 End 21 keV N<sup>+</sup> Beam

- \_\_\_\_\_ a) Turn off 21 keV N<sup>+</sup> beam.

### 10.10 N<sup>+</sup> Beam at 500 eV

Purpose: Set up 500 eV N<sup>+</sup> beam according to the following table:

Source	Type	Energy	Current
ELC	N/A	N/A	N/A
ION	N <sup>+</sup>	500 eV	0.8 pA

Procedure:

- \_\_\_\_\_ a) Set ESA and DEF voltages to zero.
- \_\_\_\_\_ b) Deploy Faraday cup (FC)
- \_\_\_\_\_ c) Set up 500<sup>+</sup> beam in DP source
- \_\_\_\_\_ d) Total ion current should not exceed 0.8 pA
- \_\_\_\_\_ e) Go to beam stability mode
- \_\_\_\_\_ f) Verify that beam is steady for 10 minutes before proceeding
- \_\_\_\_\_ g) If beam current is below 0.5 pA, extend MCP sensor and record cts/sec reading  
\_\_\_\_\_ (efficiency measurement)
- \_\_\_\_\_ h) Retract FC

#### 10.10.1 Full ESA Sweep

Purpose: Determine satisfactory operation of ESA and ion detector.

Expected Result: Should obtain an energy profile of the beam centered around 500 eV.

Procedure:

- \_\_\_\_\_ a) Orient IES at instrument 0-degree OUTER and 0-degree INNER.
- \_\_\_\_\_ b) Create SCI6 data File: **ip0050000000lf00fn.dat** to record IES output data.
- \_\_\_\_\_ c) Run full ESA sweep by executing script file: **i21alln.spt**.  
This script file uses the following parameters for ESA:

Parameter	Description	Start	End	Step Size	No. Steps	Time per Step	
ESA	Full exponential sweep with 8 bkgd steps	0 V	1.667 kV	Exp	256	2 s	
DEF	Fixed at 0 V	0 V	0 V	N/A	N/A	N/A	
INNER	Fixed at 0°	0°	0°	N/A	N/A	N/A	
OUTER	Fixed at 0°	0°	0°	N/A	N/A	N/A	
<b>TOTAL TIME</b>						<b>hh:mm</b>	<b>00:09</b>

Calibration Procedure for the IES PFM Unit

\_\_\_\_\_ d) Record the date and time sweep is completed.

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Time: \_\_\_\_:\_\_\_\_:\_\_\_\_

10.10.2 Linear ESA sweep and DEF sweep.

Purpose: Determine satisfactory operation of ESA and ion detector.

Expected Result: Should obtain a higher resolution energy profile of the beam centered around 500 eV and deflector profiles.

Procedure:

- \_\_\_\_\_ a) Create SCI6 data File: **i0050000IIIIIfOlpn.dat** to record IES output data.
- \_\_\_\_\_ b) Run ESA and DEF sweeps with limited INNER scan by executing script file: **1500na.spt**.
- \_\_\_\_\_ c) This script file uses the following parameters for ESA:

Parameter	Description	Start	End	Step Size	No. Steps	Time per Step
ESA	Linear sweep around 500 eV	38 V	46 V	1 V	9	100 s
DEF	Sweep	+/-100 V	+/-100 V	5 V	21	2 s
INNER	Scan over range	-115°	+175°	10°	18	13 m
INNER	Scan over range	+175°	+221°	1°	47	
OUTER	Fixed at 0°	0°	0°	N/A	N/A	N/A
<b>TOTAL TIME</b> hh:mm						08:00

10.10.3 Perform Sweeps and Scans as follows:

OUTER Angle	DEF range (V)	step size (V)
-45°	150-200	5
-30°	80-130	5
-15°	25 : 75	5
0°	-25 : +25	5

10.10.4 End 500 eV N<sup>+</sup> Beam

\_\_\_\_\_ e) Turn off 500 eV N<sup>+</sup> Beam.

10.11 Electron Beam at 1 keV and N<sup>+</sup> Beam at 2 keV

Purpose: Set up 1 keV electron beam and 2 keV N<sup>+</sup> beam according to the following table:



Calibration Procedure for the IES PFM Unit

Source	Type	Energy	Current
ELC	ELC	1 keV	0.8 pA
ION	N <sup>+</sup>	2 keV	0.8 pA

Procedure:

N<sup>+</sup> beam:

- \_\_\_\_\_ a) Set ESA voltage to zero
- \_\_\_\_\_ b) Deploy Faraday cup (FC)
- \_\_\_\_\_ c) Set up N<sup>+</sup> beam in DP source
- \_\_\_\_\_ d) Turn beam on at 1 kV U<sub>float</sub> + 1 kV U<sub>extraction</sub> = 2 keV beam and center the FC. Set x-raster to 15 V and y-raster to 30.2 V.
- \_\_\_\_\_ e) Total ion current should not exceed 0.8 pA
- \_\_\_\_\_ f) Go to beam stability mode
- \_\_\_\_\_ g) Verify that beam is steady for 10 minutes before proceeding
- \_\_\_\_\_ h) Retract FC

Electron beam:

- \_\_\_\_\_ a) Run electron beam up to 1 keV using procedure in electron beam manual, FRA-2X1-2/EGPS-2X1

10.11.1 Full ESA Sweep

Purpose: Determine satisfactory operation of ESA and ion and electron detectors stimulated simultaneously.

Expected Result: Should obtain an energy profile of the electron beam centered around 1 keV and of the ion beam around 2 keV.

Procedure:

- \_\_\_\_\_ a) Orient IES at instrument 0-degree OUTER and 0-degree INNER.
- \_\_\_\_\_ b) Create SCI6 data File: **e1i200fn.dat** to record IES output data.
- \_\_\_\_\_ c) Run full ESA sweep by executing script file: **e1i1alln.spt**.  
This script file uses the following parameters for ESA:

Parameter	Description	Start	End	Step Size	No. Steps	Time per Step
ESA	Full exponential scan with 8 bkwd steps	0 eV	1.667 kV	Exp	256	2 s
DEF	Fixed at 0°	0°	0°	N/A	N/A	N/A
INNER	Fixed at 0	0°	0°	N/A	N/A	N/A
OUTER	Fixed at 0°	0°	0°	N/A	N/A	N/A
<b>TOTAL TIME</b>						<b>hh:mm</b>
						00:21

- \_\_\_\_\_ d) Record the date and time sweep is completed.

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_  
Time: \_\_\_\_:\_\_\_\_:\_\_\_\_

### 10.11.2 ESA Sweep with INNER Scan

Purpose: Determine satisfactory operation of as many anode and electronics strings as possible.

Expected Result: Should result in INNER profile of the beam.

Procedure:

- \_\_\_\_\_ a) Orient IES at instrument 0-degree OUTER and 0-degree INNER.
- \_\_\_\_\_ b) Set up calibration system scanner using the parameters in the following table.
- \_\_\_\_\_ c) Create SCI6 data file: **b01200.dat** to record IES output data.
- \_\_\_\_\_ d) Run ESA sweep with INNER scan by executing script file: **e1i1na.spt**.  
This script file uses the following parameters:

Parameter	Description	Start	End	Step Size	No. Steps	Time per Step
ESA	Linear sweep covering 1 and 2 keV	50 V	202 V	4 V	8	2 s
DEF	0V	0V	0V	0V	N/A	N/A
INNER	Scan over range	-115°	+175°	5°	59	100 s
	Scan over range	+175°	+221°	2°	24	
OUTER	Fixed at 0°	0°	0°	N/A	N/A	N/A
				<b>TOTAL TIME</b>	<b>hh:mm</b>	<b>01:00</b>

\_\_\_\_\_ e) Record the date and time sweep is completed.

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Time: \_\_\_\_:\_\_\_\_:\_\_\_\_

10.11.3 End of calibration tests. Turn off electron and ion beams.

\_\_\_\_\_ a) Turn off 2 keV N<sup>+</sup> beam.

\_\_\_\_\_ b) Turn off 1 keV electron beam.

### 10.12 Archive Data

When calibration is complete, all the files in the D:\data\FM subdirectories from each of the machines shall be copied and written to a CD-ROM.

### 10.13 Comments:

### 10.14 Closure:

IES PI Signature \_\_\_\_\_

IES Project manager Signature \_\_\_\_\_

IES QA Signature \_\_\_\_\_





12 MCP Test Log

Date	Time	Filename	Ion MCP V	Electron MCP V	i sector/Counts	e Sector/Counts	Comments
			-2500				
			-2520				
			-2540				
			-2560				
			-2580				
			-2600				
			-2620				
			-2640				
			-2660				
			-2680				
			-2700				
				2500			
				2520			
				2540			
				2560			
				2580			
				2600			
				2620			
				2640			
				2660			
				2680			
				2700			