

# New Horizons Kuiper Belt Extended Mission 2 (KEM2) Overview

This material was originally adapted from the New Horizons web site. During the migration to Planetary Data System's (PDS) PDS4 data standards, this current description was adapted from the latest PDS3 New Horizons KEM2 mission catalog file, providing light edits to the text, format, and flow. This second extended mission's contracted stop date is 30 September 2024.

## Summary

Launch:	January 19, 2006
Launch Vehicle:	Atlas V 551 first stage; Centaur second stage; STAR 48B solid rocket third stage
Location:	Cape Canaveral Air Force Station, Florida
Trajectory:	To Pluto and the Kuiper Belt via Jupiter Gravity Assist
Mission Start Date:	October 1, 2022
Mission Stop Date:	September 30, 2024

## Mission Overview

The New Horizons Kuiper Belt Extended Mission (KEM) is a mission to a recently discovered, unexplored region of the solar system, the Kuiper Belt. The first part (KEM1) included a close flyby of Kuiper Belt Object (KBO) 2014 MU69 (Arrokoth). This second part (KEM2) continued to survey the Kuiper Belt using New Horizons as an observatory, examining many other Kuiper Belt Objects and Centaurs while studying the Kuiper Belt dust, gas, plasma, and energetic particle environments. These studies will place both the Pluto system and Arrokoth in better context among KBOs, increasing scientific understanding of both. New science goals for KEM2 include: new studies in Planetary Science (large-phase angle observations of gas giants), Heliophysics (Lyman-alpha all sky map), and Astrophysics (cosmic optical and ultraviolet background, and distant shock regions). KEM2 data deliveries also include data taken during KEM1 but not downlinked until KEM2.

## Mission Design

The New Horizons spacecraft trajectory was designed to optimize the earliest possible Pluto flyby. Post-Pluto modifications of the trajectory were limited by the need to conserve fuel. A campaign to discover suitable Kuiper Belt Objects within the cone of possible New Horizons trajectory changes revealed five candidates.

In June, 2016, based on the 2016 Planetary Mission Senior Review Panel report, NASA directed the New Horizons extended mission to plan for continued operations through fiscal year 2021. The New Horizons extended mission included a visit to a Kuiper Belt Object known as 2014 MU69. The spacecraft passed 2014 MU69 with the closest approach on Jan 1, 2019.

As an extended mission to a target of opportunity, design options for the New Horizons Kuiper Belt Extended Mission were limited. 2014 MU69 was observed using the same instruments and procedures as proved so effective for studying the Pluto system in 2015.

See the New Horizons Mission Overview document for more information on mission design and target opportunities within the primary mission phase.

## Mission Phases

### Summary of mission phases

Mission phases provide convenient handles and approximate time boundaries to

1. partition the data into very broad categories of mission activity
2. provide approximate time boundaries for Planetary Data System (PDS) archive data sets

The mission is continuous, so the boundaries are very soft, i.e. in an operational sense they do not exist in a noticeable way.

That being the case, the user should not expect the actual range of times covered by data in this data set to exactly agree with the boundaries of the corresponding mission phase described below; the data set time range may be far less or it may overlap the boundaries.

See the New Horizons Mission Overview document for an extended explanation of prime mission phases.

Short name	Start <sup>(1,3)</sup>	Stop <sup>(2,3)</sup>	Full MISSION_PHASE_NAME, plus optional Description
LAUNCH	2006-01-19	2006-12-31	POST-LAUNCH CHECKOUT
JUPITER	2007-01-01	2007-06-26	JUPITER ENCOUNTER
PLUTOCRUISE	2007-06-27	2015-01-15	PLUTO CRUISE, Jupiter-Pluto/Charon Interplanetary Cruise
PLUTO	2015-01-15	2016-10-26	PLUTO ENCOUNTER, Pluto mission phase, Pluto/Charon approach, flyby, post-encounter
KEMCRUISE1	2016-10-26	2018-08-14	CRUISE TO FIRST KBO ENCOUNTER, Kuiper belt Extended Mission (KEM) first cruise
KEM1	2018-08-14	2022-09-30	KEM1 ENCOUNTER, KBO1 ENCOUNTER, KBO1 approach, flyby, post-encounter
KEM2	2022-10-01	2024-09-30	KEM2 CRUISE

#### Notes:

1. Start at 00:00:00 UTC on the spacecraft that day
2. End before 00:00:00 UTC on the spacecraft next day
3. Start and end dates are not exact and identical for all instruments; some instruments take single observations over several days which span these mission phase boundaries. Late (re)playbacks can also require the inclusion of new or modified data files from an earlier mission phase.

## KEM Cruise1

Short phase name:	KEMCRUISE1
Formal mission phase name:	CRUISE TO FIRST KBO ENCOUNTER
Mission Phase Start Time:	2016-10-26
Mission Phase Stop Time:	2018-08-14

Activities during the KEMCRUISE1 mission phase to the first KBO encounter were similar to those for Pluto Cruise phase. They also included post-Pluto encounter calibrations in mid-2016, along with continuing download of data from the Pluto encounter.

## KEM 1 Encounter

Short phase name:	KEM1
Formal mission phase name:	KEM1 ENCOUNTER
Mission Phase Start Time:	2018-08-14
Mission Phase Stop Time:	2022-09-30

Activities during the extended mission included imaging of distant Kuiper belt objects throughout the extended mission, a close encounter with the cold classical Kuiper belt object (486958) Arrokoth on January 1, 2019, a post-Arrokoth encounter calibration campaign in mid-2019, continued particle, plasma, and dust observations, observations testing new flight software developments, along with download of data from all of these activities. There were also occasional additional observations as opportunities arise, such as color observations of Uranus and Neptune, observations of zodiacal dust, and observations of stars for an outreach-oriented stellar parallax campaign.

## KEM 2 Cruise

Short phase name:	KEM2
Formal mission phase name:	KUIPER BELT EXTENDED MISSION 2
Mission Phase Start Time:	2022-10-01
Mission Phase Stop Time:	2024-09-30

Activities during the KEM2 mission phase include continuing observations of distant KBOs, and dust and plasma measurements along the New Horizons flight path through the Kuiper belt and beyond. KEM2 also includes new studies in Planetary Science (large-phase angle observations of gas giants), Heliophysics (Lyman-alpha all sky map), and Astrophysics (cosmic optical and ultraviolet background, and distant shock regions).

## Mission phases and sub-phases in data products

Those general phase descriptions above were implemented slightly differently in mission data products. A table of data product mission phase and sub-phase designations follows. Again, primary mission phases are included for convenience and continuity.

Phase	Sub-phase	UTC	DOY	MET
CHECKOUT		2006-01-16	2006-016	-324483
	LAUNCH	2006-01-16	2006-016	-324483
JUPITER		2007-01-01	2007-001	29915517
	JUPITER	2007-01-01	2007-001	29915517
PLUTOCRUISE		2007-06-29	2007-180	45381117
	PLUTOCRUISE	2007-06-29	2007-180	45381117
	ACO1	2007-09-24	2007-267	52897917
	ACO2	2008-01-01	2008-001	61451517
	ACO3	2009-01-01	2009-001	93073917
	ACO4	2010-01-01	2010-001	124609917
	ACO5	2011-01-01	2011-001	156145917
	ACO6	2012-01-01	2012-001	187681917
	ACO7	2013-01-01	2013-001	219304317
	ACO8	2014-01-01	2014-001	250840317
PLUTO		2015-01-15	2015-015	283585917
	AP1	2015-01-15	2015-015	283585917
	AP2	2015-04-05	2015-095	290497917
	AP3	2015-06-23	2015-174	297323517
	CORE	2015-07-07	2015-188	298533117
	DP1	2015-07-16	2015-197	299310717
	DP2	2015-08-04	2015-216	300952317
	DP3	2015-10-22	2015-295	307777917
KEMCRUISE1		2016-10-26	2016-300	339745917
	KEMCRUISE1	2016-10-26	2016-300	339745917
KEM1		2018-08-14	2018-226	396489600
	KEM1	2018-08-14	2018-226	396489600
KEM2		2022-10-01	2022-274	526888318
	KEM2	2022-10-01	2022-274	526888318

## Mission Objectives Summary

### Planetary

Multiple, unique studies of distant KBO populations not yet well studied by New Horizons; unique, high-phase studies of several Kuiper belt dwarf planets; large-phase angle studies of the ice giants Uranus and Neptune with direct application to exo-ice giants as well as themselves; and otherwise unobtainable measurements of in situ Kuiper belt dust density as a function of heliocentric distance.

### Heliophysics

New outer heliosphere measurements not performed by Voyager or Pioneer of particle populations and processes that ultimately shape the various heliospheric boundaries; observations of dust and hydrogen gas in the outer solar system; and important collaborative synergies with other heliophysics missions ranging from the inner solar system to the ISM (interstellar medium) in the most widely spaced Heliophysics System Observatory to date.

## Astrophysics

Potentially paradigm-shifting astrophysical studies of the cosmic optical and ultraviolet backgrounds with unprecedented sensitivity owing to New Horizon's position beyond the zodiacal light; and unique UV (ultraviolet) observations of the local interstellar medium.

## References

None

## Further Reading

New Horizons Mission Overview, [urn:nasa:pds:nh\\_documents:mision:nh\\_mission\\_overview](#), NASA Planetary Data System.

New Horizons Kuiper Belt Extended Mission (KEM1) Overview, [urn:nasa:pds:nh\\_documents:mision:nhkem1\\_mission\\_overview](#), NASA Planetary Data System.