

New Horizons Encounter Rehearsal Planning and Execution

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ABSTRACT

First in NASA's New Frontiers series of missions, the New Horizons spacecraft was successfully launched on January 19, 2006 and is scheduled to fly past the Pluto-Charon system in 2015. The spacecraft will begin to conduct approach phase science in January 2015, culminating in closest approach on July 14, 2015. Seven days prior to closest approach the spacecraft will be commanded into "Encounter State". This operational state contains special autonomy rules and macros as well as guidance and control (G&C) parameters not used in other spacecraft operational states. The purpose of having a dedicated Encounter State is to allow the spacecraft to continue to collect science data in the event of a severe anomaly such as a G&C sensor failure or command and data handling (C&DH) computer reset. An anomaly of this type in any other operational state would cause autonomy to suspend the command sequence and transition the spacecraft into a spin-stabilized safe mode. New Horizons will remain in Encounter State for nine days, conducting hundreds of critical science observations before being commanded back to Normal State on July 16, 2015. Normally all spacecraft activities are tested on a high-fidelity hardware-in-the-loop simulator prior to being loaded and executed on the spacecraft. However, because of the complexity of the Encounter Command Sequence (CORE), the limited amount of time the real spacecraft has been in Encounter State, the importance of successfully executing planned flyby science at the first and only opportunity, and the stressful environment that will be placed on both the spacecraft and the operations team during closest approach it was important to rehearse portions of the CORE sequence at least twice on the spacecraft prior to the actual encounter.

The first spacecraft encounter rehearsal was conducted in 2012, and was designed as a stress test of the 22 hours around the closest approach of Pluto. The 22-hour closest approach period contains the most critical and time constrained observations of the CORE sequence, as well as the most ambitious observations of the entire mission. From a G&C standpoint, the observations within the 22-hour closest approach period are of significant difficulty since they involve rapidly slewing the spacecraft to point different body-fixed science instruments towards the multiple targets that compose the Pluto-Charon system with very little

time between observations. Following the 2012 rehearsal, telemetry was analyzed and any differences in performance between the high fidelity simulator and the spacecraft were noted and adjustments were made to the models and command sequence prior to the second rehearsal in 2013. The 2013 rehearsal contained all of the observations in the CORE sequence up through closest approach, and included optical navigation simulations and periodic updates to the spacecraft's onboard ephemerides. Pointed activities after simulated closest approach were not conducted on the spacecraft to protect science instruments from being pointed too close to the Sun.

Both rehearsals were extremely successful. The changes made from lessons learned in 2012 had the desired effects in 2013. This paper will discuss how the encounter rehearsals were planned and executed on the spacecraft in 2012 and 2013. We will present an overview of the New Horizons spacecraft, the concept of operations for the 2015 closest approach activities, how the rehearsals were conducted to emulate the flyby as closely as feasible while protecting spacecraft health and safety, and how these activities were analyzed after the rehearsal to make adjustments to the spacecraft simulator and the CORE sequence.