

Asteroid Redirect Mission (ARM) Update to the Small Bodies Assessment Group

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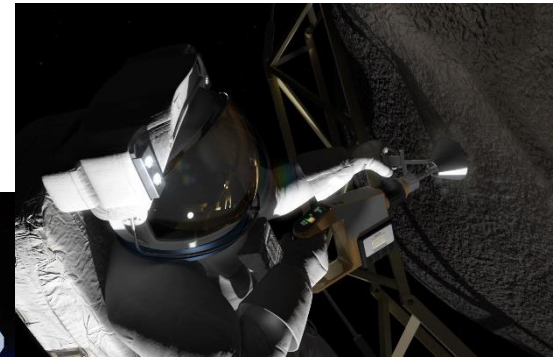


- **Based on the Fiscal Year 2018 budget blueprint and subsequent budget request, NASA will not pursue ARM, but will continue to develop key technologies such as solar electric propulsion.**
 - No partner provided systems/payloads or Investigation Team members will be selected.
 - The ARM team is documenting its activities and ensure that key knowledge from the mission concept is archived as part of an orderly closeout.
- **Asteroid encounter mission concepts remain of interest due to the broad array of benefits for the human and robotic exploration, science, planetary defense, and asteroidal resources communities.**

Overall Vision of ARM



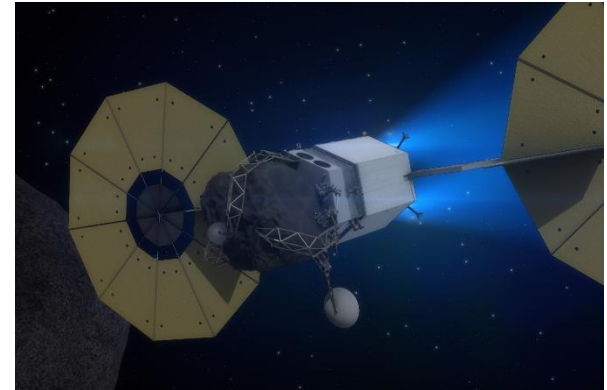
- **NASA's Asteroid Redirect Mission (ARM) was a capability demonstration mission that combined robotic and crewed segments to develop, test, and utilize a number of key capabilities needed for future exploration of Mars and other Solar System destinations, along with other benefits that leverage key ongoing activities in human exploration, space technology, and planetary defense.**
- **The combined objectives of human exploration and planetary defense, along with the knowledge gained and operational experience would have also benefited the scientific and asteroidal resources communities.**



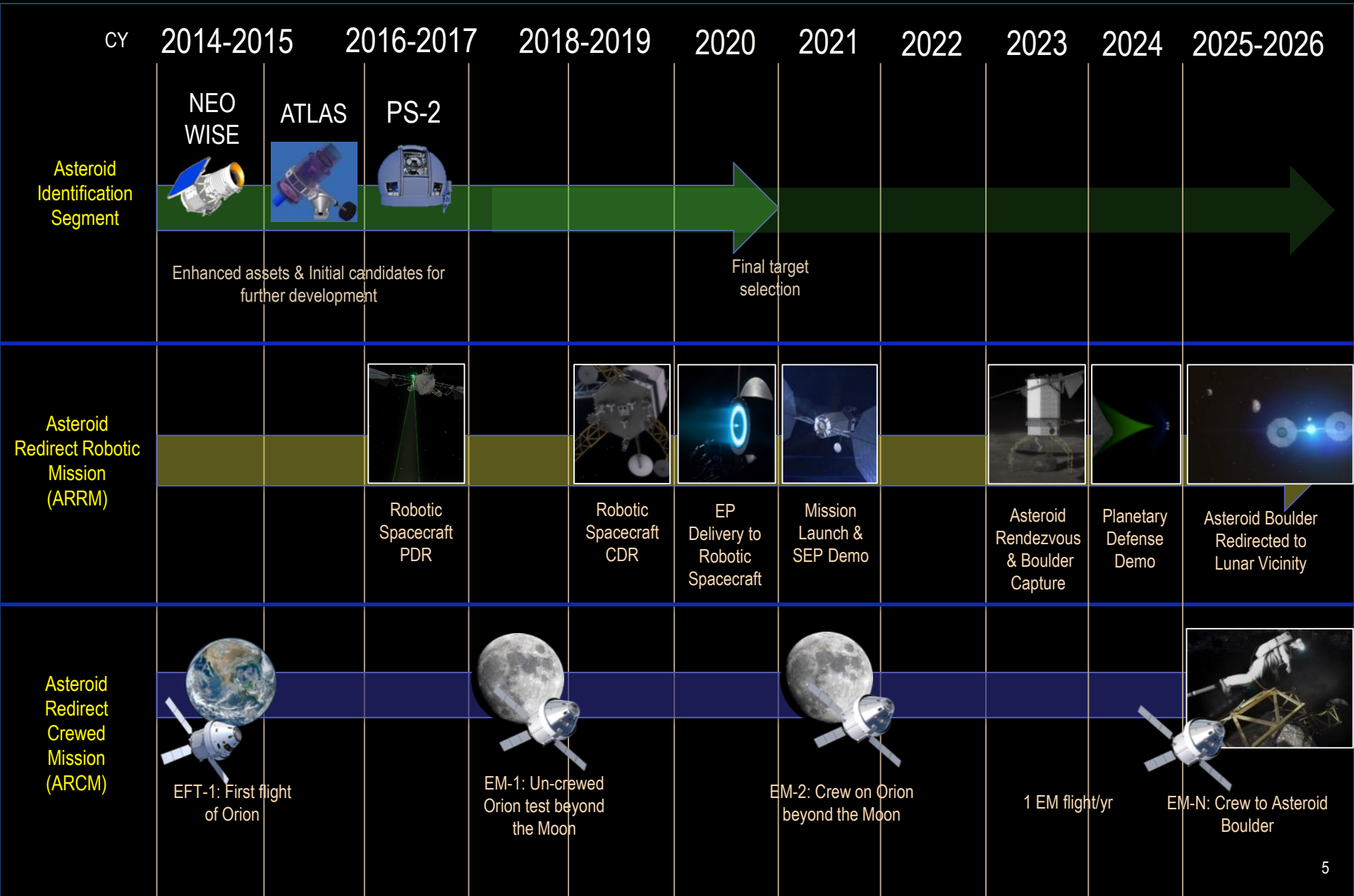
Overview and Benefits of ARM



- **ARM consisted of the first-ever robotic mission to visit a large near-Earth asteroid, collect a multi-ton boulder from its surface, demonstrate a planetary defense technique known as the Enhanced Gravity Tractor (EGT), and return the asteroidal material to a stable orbit around the Moon.**
- **Astronauts would have conducted multiple extravehicular activities to explore the boulder once it was in cis-lunar space, and returned to Earth with extraterrestrial samples for the first time since the final Apollo mission.**
- **Following completion of the crewed operations, the robotic spacecraft and asteroidal material could have served as an orbiting laboratory near Earth to facilitate additional small body exploration and research, including the testing of resource extraction and processing techniques.**



Asteroid Redirect Mission Alignment Strategy



Collaborative/Participatory Elements



- **Center-to-Center Collaboration and Partnership**
- **Cross-Directorate Collaboration**
- **Evolution of Small Bodies Assessment Group (SBAG) Interaction**
- **Participatory Formulation through the Formulation Assessment and Support Team**
- **Leveraging Commercially Available Spacecraft from US Industry**
- **Potential for “Commercial” (Entrepreneurial) Collaboration**
- **Continued Discussions with Potential International Partners**



ARM Key Milestones (2011-2014)

- **Keck Institute for Space Studies (KISS) workshops – September 2011 and February 2012; Final report – April 2, 2012**
- **ARM retrieval options briefed at NASA-sponsored Blue Sky workshop – June 19, 2012**
- **FY14 NASA Budget Release announces Asteroid Initiative and Retrieval Mission – April 2013**
- **ARM retrieval options presented at the 2013 Planetary Defense Conference in Flagstaff, AZ – April 2013**
- **ARM Feasibility Study Report – June 2013 (Option B focused)**
- **Asteroid Initiative Call for Ideas Event, RFI Released – June 2013**
- **ARM Mission Feasibility Review – July 30, 2013**
- **Asteroid Initiative Ideas Synthesis Workshop – September & November 2013**
- **ARM Status Review of Options A and B – December 17, 2013**
- **ARM Concepts Phase 2 Outbriefing at NASA HQ – February 19, 2014**
- **ARM Option A/B Down select Architecture Review – December 16-17, 2014**

ARM Key Milestones (2015-2017)



- **BAA released for concept studies for ARRM – February 2015**
- **ARRM Mission Concept Review (MCR) KDP-A (Option B decision) – March 24, 2015**
- **Acquisition Strategy Meeting (ASM) – July 23, 2015**
- **Requirements Closure TIM – December 15-16, 2015**
- **Aerojet Rocketdyne, Inc. selected to develop STMD-sponsored SEP system – April 19, 2016**
- **Mission Design Review (MDR-lite) – May 18-19, 2016**
- **ARRM Key Decision Point-B (KDP-B) ‘entry into Phase B’ – July 15, 2016**
- **ARRM spacecraft Phase 2 RFP release – October 2016 (selection rescheduled for April 2017 due to change in Continuing Resolution date)**
- **Investigation Team and hosted payload solicitations reviews – February/March 2017**
- **Formal ARM cancellation notification based on FY18 budget blueprint – April 4, 2017**



SBAG appreciates the continuing engagement of the Asteroid Redirect Mission (ARM) management with the planetary science community. The dialogue between the ARM project and the science community has been highly productive, and the mission has evolved considerably from the original concept, resulting in a marked increase in the mission's science potential. The possibility of additional science instruments (possibly provided as hosted payloads, as solicited in the ARM Broad Area Announcement (BAA)), could further enhance the science of the mission. In addition, many early technical concerns of the science community have been allayed. The small bodies community's interest in this mission as now formulated is demonstrated by the large number of proposals in response to the ARM BAA Investigation Team solicitation.

NASA Advisory Council Finding

Deliberations: March 30-31, 2017



The Asteroid Redirect Mission (ARM) team has worked diligently over the last several years to develop the systems and operations to retrieve a large sample from an asteroid and return it to the vicinity of the Earth. The mission analysis and system design work performed by the ARM team will have a tremendous influence on the way deep space exploration will be performed in the future. The NASA Advisory Council commends the members of the ARM team for their hard work and creativity.

External Engagement Highlights



- **SBAG Meetings – 2013-2017**
- **Target NEO Workshop 2 – July 9, 2013**
- **Asteroid Initiative Announcement of Opportunities BAA Release – March 21, 2014**
- **Asteroid Initiative Opportunity Forum at NASA HQ – March 26, 2014**
- **Asteroid Initiative Ideas Synthesis Workshop at the Lunar Planetary Institute (LPI) – Fall of 2014**
- **Asteroid Initiative Expert and Citizen Assessment of Science and Technology (ECAST) events in Phoenix and Boston – November 2014**
- **Formulation Assessment and Support Team (FAST) – Fall of 2015**
- **Asteroid Redirect Mission Community Update – October 23, 2015**
- **ARM Virtual Industry and Community Outreach Day – September 14, 2016**
- **Path to leverage commercial bus designs & support high power industry SEP – RFP released by JPL on September 20, 2016 & proposals due October 24, 2016**
- **NASA BAA for Investigation Team and hosted payloads – Fall of 2016**

Small Bodies Community Support



- **Multiple opportunities to brief and update the small bodies community, engage in a productive dialog, and receive valuable input and feedback – SBAG and other venues, including EPSC, DPS, LPSC, PDC, ACM, and ESF.**
- **Formulation Assessment and Support Team (FAST).**
 - Support from the community was outstanding (100 applicants).
 - Expertise assembled provided critical support for the ARRM Requirements Closure TIM in December of 2015 and subsequent development of the robotic mission.
- **SBAG SAT: ARM Connections to Priority Small Body Science and Exploration Goals.**
 - Report submitted on September 26, 2016.
 - Confirmed the scientific benefits of the mission.
- **Broad Agency Announcement (BAA) Investigation Team and hosted payload solicitations.**

On behalf of NASA and the entire ARM team – THANK YOU!

