Highlight

The paper presents current development and new highlights on the design of Asteroid Impact Mission. All results and analyses presented here are performed by the authors under ESA contract within the design phase of the mission.

Abstract

The Asteroid Impact Mission (AIM) [1] is an ESA mission whose goal is to explore and study the binary asteroid 65803 Didymos [2], which is expected to transit close to the Earth (less than 0.1 AU) in late 2022. AIM is part of a joint collaboration with NASA in the AIDA (Asteroid Impact & Deflection Assessment) [3, 4] mission. The primary goal of AIDA is to assess the feasibility of deflecting the heliocentric path of a Near Earth Asteroid (NEA) binary system, by impacting on the surface of the smaller (or secondary) asteroid of the couple. To this aim, AIDA includes the kinetic impactor, DART (Double Asteroid Redirection Test) [5] by NASA and the observer, AIM (Asteroid Impact Mission) by ESA. The work presented in this paper has been performed by the authors under ESA contract within the design phase of AIM mission.

The paper summarizes the consolidated mission analysis of AIM spacecraft during all mission phases and the scientific payload operations at Didymos. The selected interplanetary trajectory is presented, including the available launch window to reach Didymos on time. Suitable transfer solutions are selected based on $\Delta v$ constraints imposed by the launcher and requirement imposed by spacecraft design. More in detail, AIM is planned to be launched in late 2020 and to arrive at Didymos system in middle 2022.

As the spacecraft approaches the asteroid system, it will go through far- and close-approaching maneuvers. The far-approaching maneuver is presented in detail: the final $\Delta v$ to stop AIM at Didymos is split into five smaller maneuvers, performed at one week distance between each other, to decrease the overall maneuver cost and to allow for precise tracking and rendezvous with the binary system.

Close proximity operations at the asteroid are then extensively described. During this phase, AIM mission analysis is driven mainly by observational requirements coming from scientific payload on board, to study the asteroid system before and after DART impact (expected for late 2022), such to accomplish mission objectives. Observation stations are selected for AIM spacecraft to
study Didymos by operating scientific payloads. Figure 1 shows the AIM spacecraft at one of its observation stations, 10 km away from Didymos system barycenter. Close proximity operations include the release of a lander on the surface of the smaller asteroid of the couple (secondary) and the release of a network of cubesat opportunity payloads (COPINS). The deployment strategies are described from the operational and maneuvering point of view. In addition, payload operations include technological demonstration of deep space laser communications, low frequency radar tomography of the smaller asteroid of the couple (called Didymoon) and high frequency radar subsurface investigation.

![Image](image.png)

**Figure 1. AIM at 10 km observation station (VTS software [6] used for visualization).**

The Earth-Spacecraft-Sun-Asteroid geometry is presented into detail during all mission phases. The paper includes the analysis of coverage and illumination conditions during all phases of the missions, to provide inputs to the planning of scientific payload operations and ground segment operations. Both AIM ground and asteroid coverage is analyzed. Constraints imposed by natural illumination of the asteroids are highlighted, to identify poles visibility and to assess visible latitude bands, during the mission time line and payload operations at asteroid.

The results and analyses presented here are part of the phase A design of the AIM spacecraft. The project is currently ongoing and the mission analysis will be further iterated and refined through the design phase.

1. **References**


