Asteroid Impact Mission

High Frequency Radar

Concept Design Study Executive Summary

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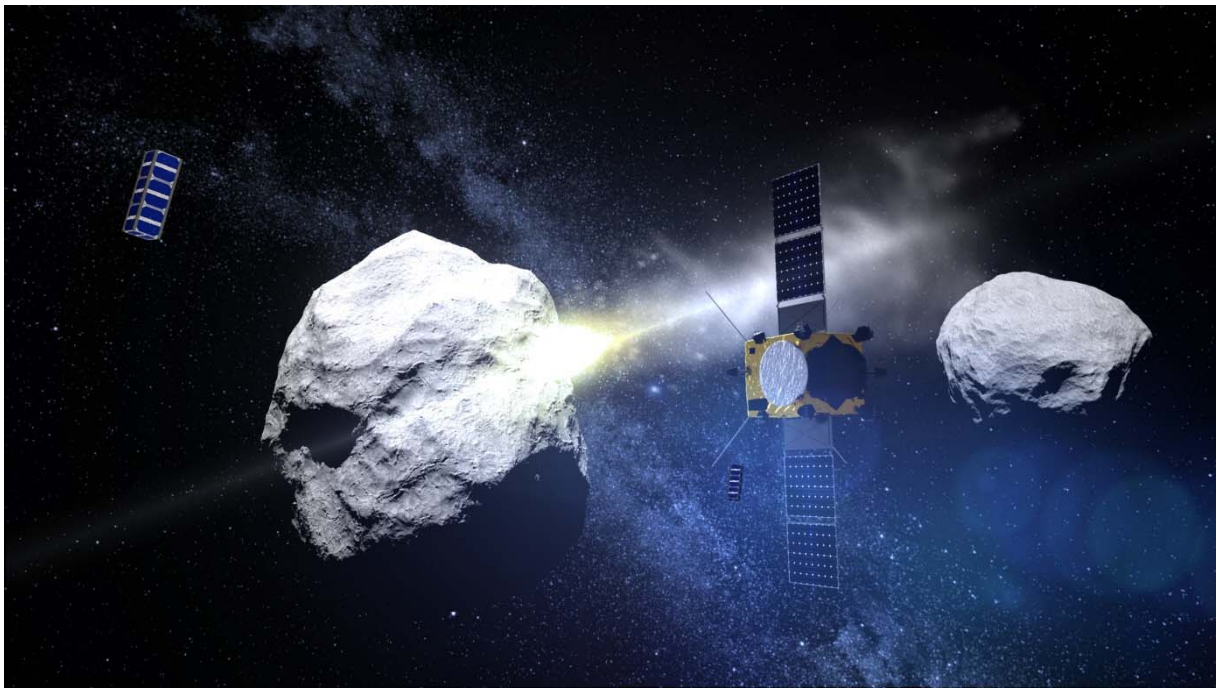
PICTURE



MOTIVATION

This purpose of the study was to develop a high frequency radar to sound the first tens of metres of asteroid regolith and to achieve 3D tomography with metric resolution in order to

- Determine its structure and layering
- Identify geomorphological elements (rocks, boulders, etc.) embedded in the sub-surface
- Map the spatial variation its texture
- Derive an estimate of dielectric permittivity of the sub-surface material

This purpose of the phase A study was to:

- Revisit the instrument system analysis
- Optimize instrument design inheriting from WISDOM ExoMars

Define interfaces and programmatics in the frame of the Asteroid Impact Mission

METHODOLOGY

The HFR concept design study has been performed according to the following logic:

- Review of the AIM Mission science objectives and scenario
- Review of radar instrument concepts and HFR instrument baseline specifications
- Preliminary payload sub-system specification: analogue radio-frequency s/s, onboard digital processing, radar control s/s and antenna s:s
- Preliminary design of sub-systems
- Review, trade-off and selection of architectural design

- Payload interface studies: mechanical, thermal, electrical & power preliminary studies, data handling and operational modes
- Development of performance and signal quality tools

- Review of on-ground radar processing methods.
- Review of preliminary regolith and dielectric models
- Radar performance analysis with baseline specification and operational concepts.

- Programmatic analysis

RESULTS

- Specification of the HFR instrument and its modes

- Preliminary architecture and detailed design

- Payload interface document (PID) including mass, volume, power and data budgets
- Instrument verification breadboard and software simulator toolbox

- Selection of possible on-ground processing methods and processing pipeline
- Synthetic Aperture Radar processing software for baseline processing method.
- Preliminary operational concept definition

- Preliminary development plan
- Cost estimation

HIGHLIGHTS

Demonstration of the instrument concepts has been made for the main objectives. A trade-off has to be made on secondary objectives during phase B, in particular those addressed by the Arecibo (Earth based observation cross-validation) and altimeter modes.

Hardware and software toolboxes have been developed to support the AIM phase B tasks for the consolidation and complete verification of the instrument design. The preliminary design study has shown the identification of specific open issues and, in particular, concerning the power amplifier solution. This will also be addressed in the next development phase B.

First inputs on AIM platform and HFR instrument interface iterations have been initiated.

A working and efficient prototype for synthetic aperture radar processing software is ready to use to continue the definition of operation concept and instrument performances.

PUBLICATIONS

A Hérique and the FANTINA Team, *A DIRECT OBSERVATION OF THE ASTEROID'S STRUCTURE FROM DEEP INTERIOR TO REGOLITH: WHY AND HOW?* , proceedings of 4th IAA Planetary Defence Conference – PDC 2015 - April 2015, Frascati, Roma, Italy.

A. Herique , V Ciarletti and the AIM Team, *A DIRECT OBSERVATION OF THE ASTEROID'S STRUCTURE FROM DEEP INTERIOR TO REGOLITH: TWO RADARS ON THE AIM MISSION*, Asteroid Impact Mission (AIM) Science Meeting, 1-2 March 2016, ESA/ESAC (Conference invitee)

Valerie Ciarletti and Alain Hérique, *RADAR OBSERVATIONS OF THE ASTEROID'S STRUCTURE FROM DEEP INTERIOR TO REGOLITH*, EGU 2016

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