ASTEROID IMPACT MONITORING MISSION: MISSION ANALYSIS AND INNOVATIVE STRATEGIES FOR CLOSE PROXIMITY MANEUVERING

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THE ASTEROID IMPACT MISSION

AIM arrival at Didymos

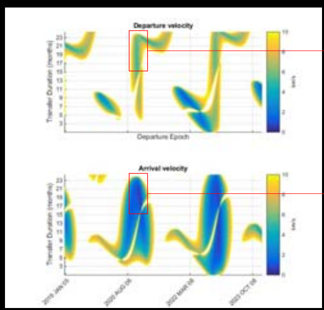
Binary NEA 65803 Didymos will have a close encounter (less than 0.1 AU) with Earth in late 2022

AIDA (Asteroid Impact & Deflection Assessment)

Asteroid Impact Mission (AIM) – ESA
- Study of binary system
- Deployment of a lander (MASCOT-2)
- Deployment of cubesats (COPINS)

Double Asteroid Redirection Test (DART) – NASA
- High velocity kinetic impactor

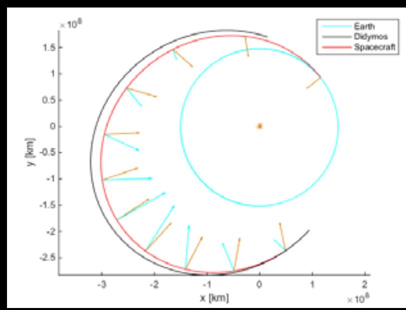
INTERPLANETARY TRANSFER



Pork-chop plot

Launch window	2020 October 23rd – November 6th
Asteroid arrival	2022 April 5th – June 16th
Transfer duration	17 – 20 months
Δv at arrival	0.9 – 1.1 km/s

- Δv to be injected into interplanetary trajectory is provided by the launcher
- Bi-impulsive maneuver transfer
- Arrival at binary system few months before DART to study the asteroids before impact



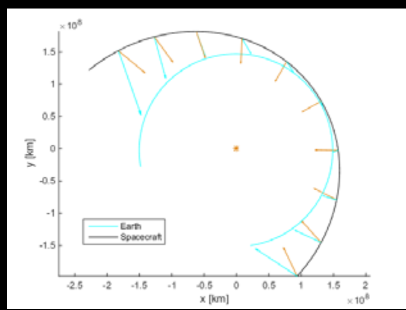
Heliocentric trajectory during transfer phase

OPERATIONS AT ASTEROID SYSTEM

Main issues with small bodies operations:

- Low escape velocity: rebounding after landing may put the lander in an escape trajectory
- Weak and irregular gravity field: highly perturbed environment
- In case of binary systems, the presence of two asteroids lead to excessively inaccurate results when designing trajectories using classical two-body model

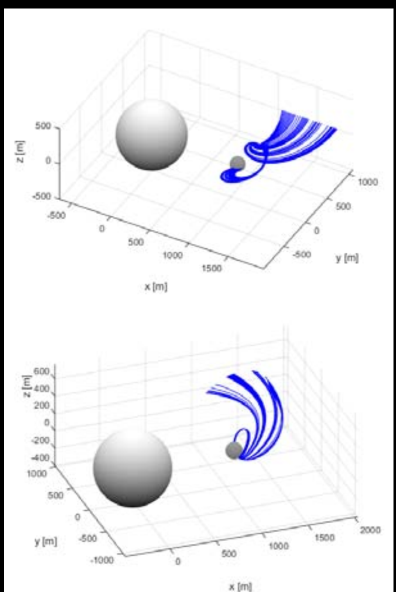
The dynamics of a small body in the proximity of the binary system are naturally modelled using the Three-Body Problem formulation



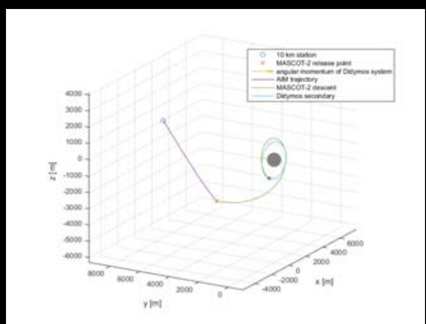
Heliocentric trajectory during operations at asteroid, close encounter is expected in October 2022

Alternative solutions exist to land MASCOT-2 on the surface of the smallest asteroid, comparing to classical two-body solutions:

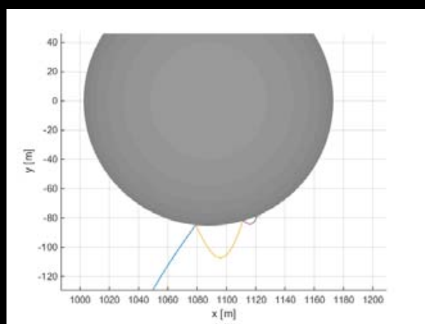
- Safer: no need of close fly-bys or hovering, AIM can release MASCOT-2 at a safe distance from the asteroid
- Simpler: from operational point of view, only one maneuver is needed for AIM to deploy MASCOT-2
- Lower risk of rebounding (lower touch-down velocity)



Families of stable manifolds in the Didymos CR3BP. Suitable in-plane and out-of-plane landing trajectories



MASCOT-2 landing maneuver on the secondary asteroid



MASCOT-2 landing maneuver: touch-down at secondary asteroid

FINAL HIGHLIGHTS

- Three-body formulation is best suited to design trajectories in the proximity of a binary asteroid system, leading to safer, simpler and more effective solutions with respect to the classical two-body approach