Payload options for the hypothetical asteroid impact threat scenario 2024 PDC25

Payload Definition for fast flyby mission
Launches in 2027, arrives in 2028 - 1 year phase A/B, 2 years phase C/D

Visible observation (shape, surface features):
WAC & NAC, cf. Line 18, MALIN's cameras from LRO is a typical potential solution. DRACO (DART), Polycam & MapCam (Osiris Rex) LORRI (New Horizon and Lucy), OSIRIS (Rosetta), Asteroid Framing Camera (DAWN, spares are available) are other options. Thus state of the art cameras exist and can be reproduced fairly quickly. Typical WAC is 1 kg, NAC is 10 kg, resolution can reach 50 cm @ 50 km

Discussion about deploying a complementary daughtership (a cubesat similar to Liciacube), to try to get the full imagery of the asteroid. Rotation axis and period need to be known in advance (supposably in 2 months from now, feasibility of can then be assessed). WAC & NAC cameras from JAXA developed for Comet Interceptor would be suitable for the cubesat.
Near IR spectro-imager is desirable to give a diagnostic of the composition of the asteroid (and possibly relate it to similar bodies which may have been characterized in terms of internal structure before). Birches from JPL (derived from Osiris Rex and New horizon) is a good candidate.

Mass estimation through orbit deviation by asteroid's gravity influence (depends of relative velocity and mass). Uses orbit determination and radioscience. The asteroid's mass cannot be measured by a single spacecraft with tracking to Earth. With cross-link radios, it is likely possible, but it will require one of the satellites to navigate within a few hundred meters to ~1 km of the asteroid.

Compared to a single spacecraft, a multiple spacecraft configuration, such as Comet Interceptor, would provide a more extensive surface imagery (of spin axis and period are known in advance), and enable a rough mass estimation.

Payload Definition for rendezvous mission
Arrives in dec 2031 at the earliest, deviation impact can take place in nov 2032.
Visible and near IR spectro-imagery - cf. flyby mission, to be complemented by:
- Thermal IR imager (such as TIRI on Hera)
- Lidar Altimeter (ex JAXA on Hayabusa 2 – 3.5 kg, or CSA's OLA on Osiris Rex)
- Dust measurement?

After a characterization phase of ~year, expectation to observe the impact(s). Can be done with visible camera identified for the fly by mission, but rises various mission design considerations:
- *Move the mothership away from the asteroid during the impact(s) period.*
- *Add cubesat that stay close (and take risks), but their life time in the asteroid vicinity has to be > 1 year*

Mass estimation (and mass distribution) can be much more accurate than with the flyby. The HERA (or RAMSES) mission concepts which can use Doppler shifts on the ISLs are quite powerful.

Radar tomography needed for internal structure. Monostatic (cf. JurA on HERA), or bistatic (such as studied for DROID).

If a lander can be delivered to the surface, a gravimeter (such as GRASS on Hera) can be deployed, together with **a geophone** for seismology that will provide complementary information on internal structure.

Multiple spacecraft architecture (such as Hera or DROID) enhances the robustness of the system during the impact phase, enhances the mass distribution estimation, and enables bi-static radar tomography.