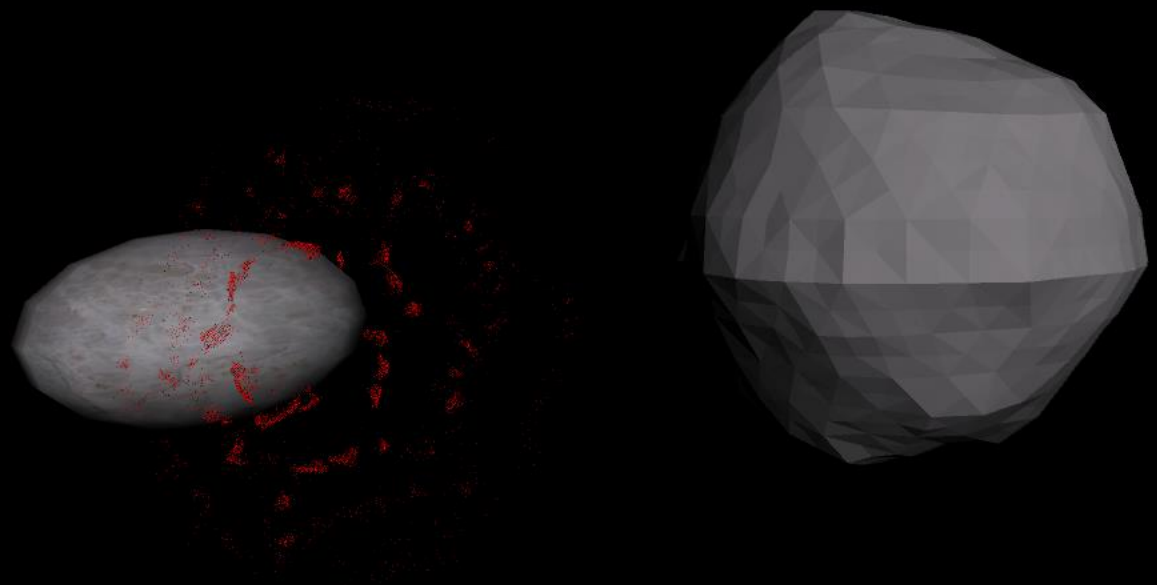
Dynamics of ejecta plume after the DART impact on Dimorphos



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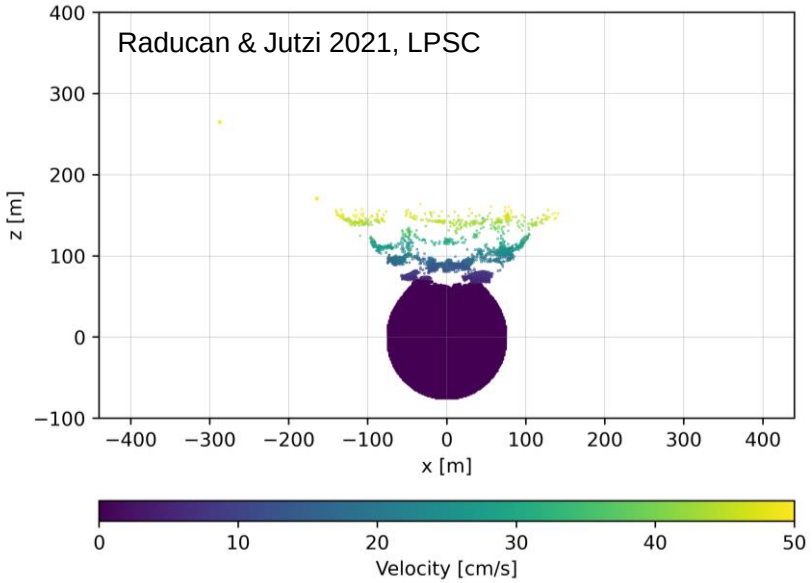
INTRODUCTION

Goal: study the short-medium term dynamical evolution of the ejecta fragments after the DART impact on Dimorphos
Methodology: hybrid approach using both SPH and N-body DEM simulations

Smoothed-Particle Hydrodynamics (Bern's SPH)
To model the hypervelocity impact and ejecta formation

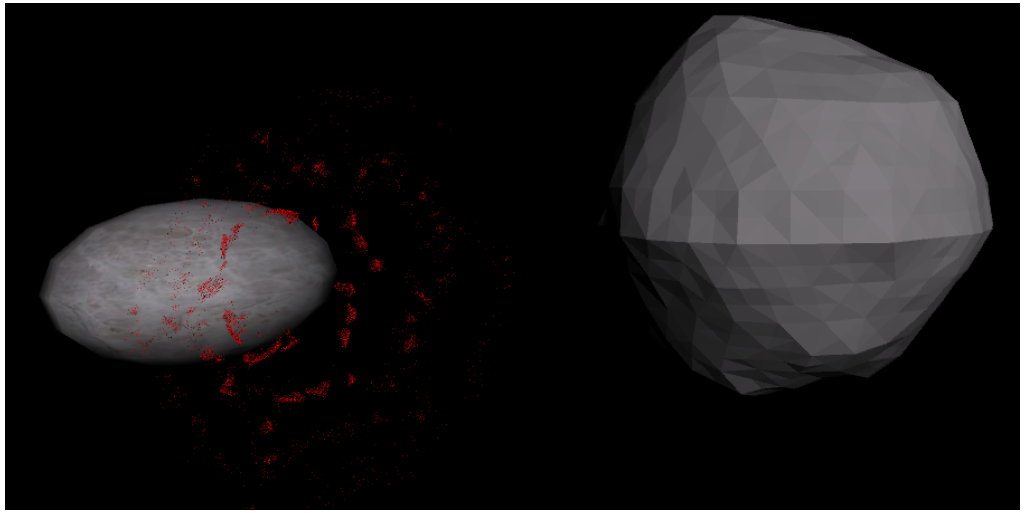


- Friction and cohesion
- Porosity / compaction model
- Self-gravity

(Jutzi et al 2008, Jutzi & Michel 2014, Jutzi 2015)

Interface between SPH and N-body when ejected particles are affected by gravity only

N-body DEM (GRAINS)
To model the ejecta evolution in the gravity regime



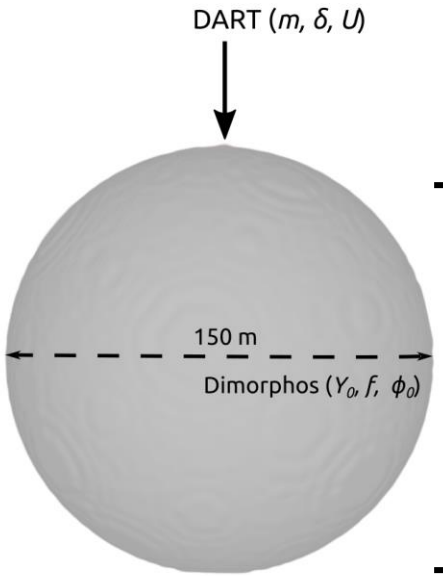
- Gravity of Didymos and Dimorphos
- Self-gravity between ejecta
- Contact/collisions between non-spherical fragments

(Ferrari et al 2017, Ferrari et al 2020, Ferrari & Tanga 2020)

IMPACT AND EJECTA FORMATION
Properties of target and projectile

We used Bern's SPH to model DART-like impacts on weak spherical targets

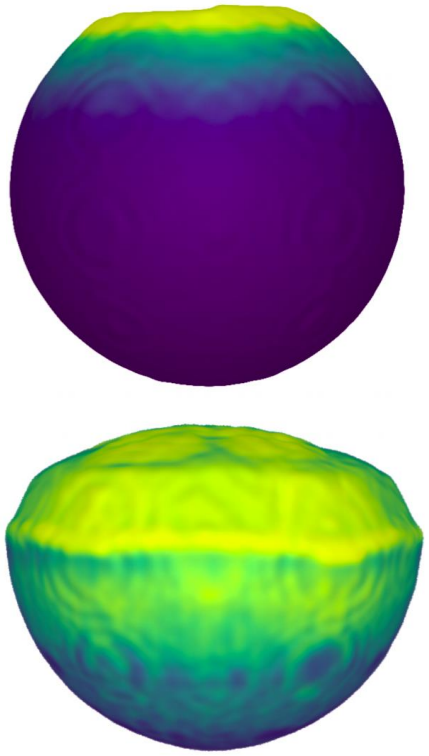
Projectile parameters			Target parameters		
Radius, a	Mass, m	Velocity, U	Cohesion, Y_0	Friction, f	Density, ρ
0.5 m	500 kg	6 km/s	0 Pa / 10 Pa	0.6	1.62 g/cm^3



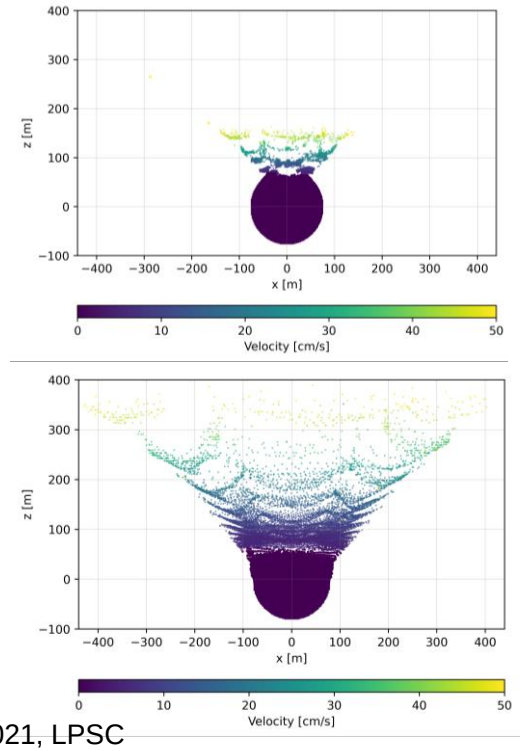
Scenario 1, Y_0 = 10 Pa

Scenario 2, Y_0 = 0 Pa

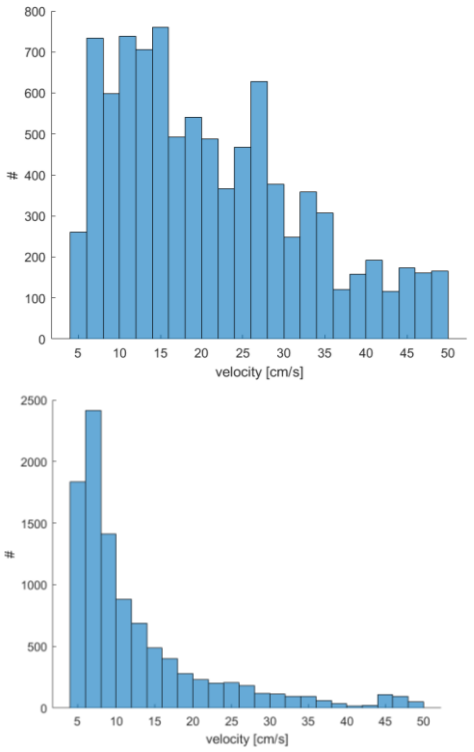
Post-impact target morphology



Ejecta at SPH/N-body interface



Ejecta velocity distribution



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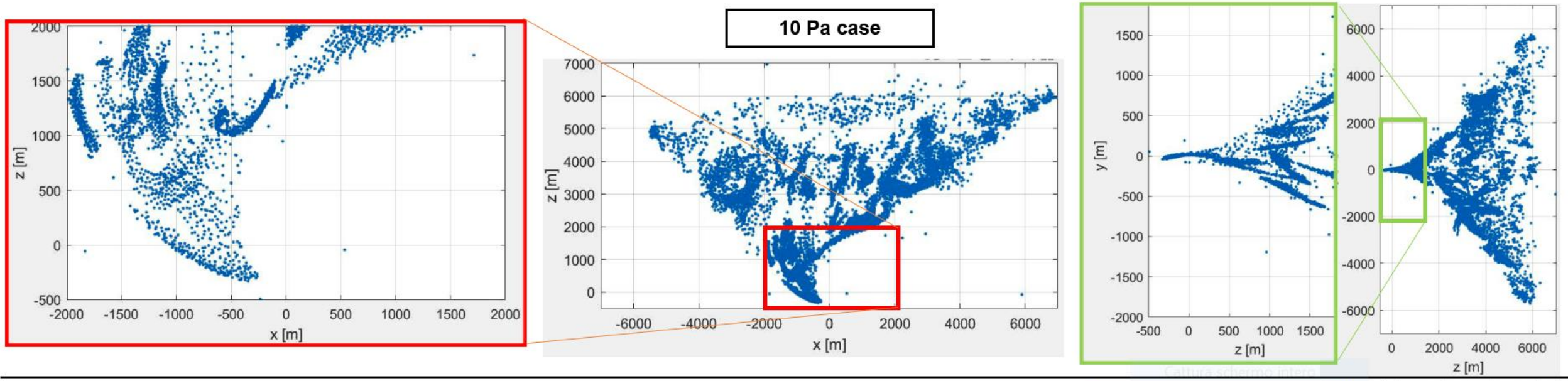
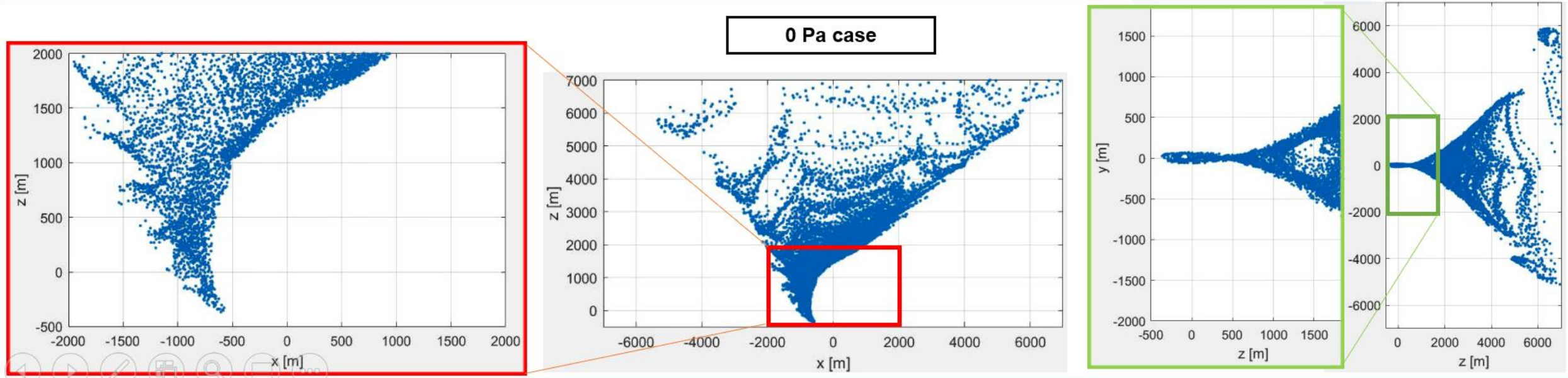
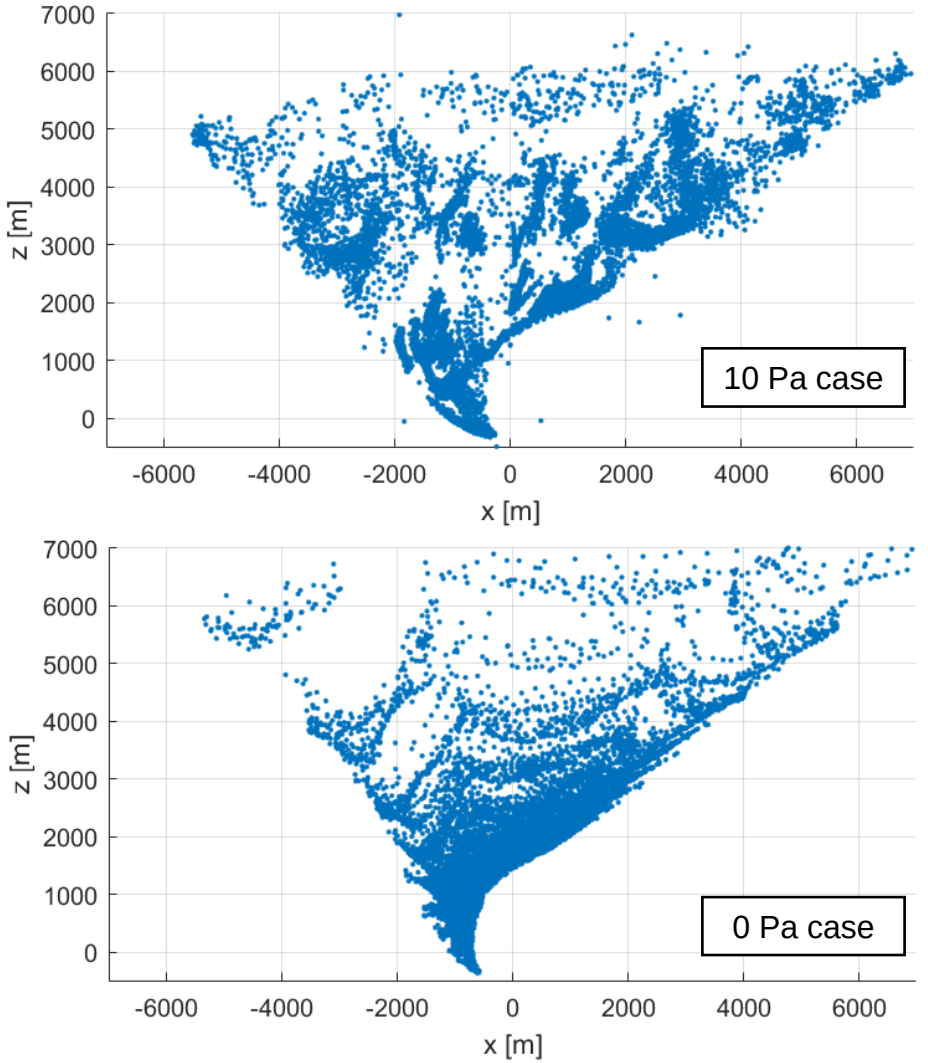
EVOLUTION OF EJECTA
10 Pa vs 0 Pa cases





CONCLUSION

- We set up the numerical problem to study short-medium term evolution of ejecta fragments, using a **hybrid SPH/N-body approach**
- We simulated a DART-like hypervelocity impact on a weak spherical target using **Bern's SPH** code
- We transition to a **N-body DEM code (GRAINS)** to simulate the evolution of ejecta in Didymos gravitational environment, considering self-gravity and contact/collisions between **non-spherical** ejecta fragments.
- Both **cohesive** (10 Pa) and **cohesionless** (0 Pa) target surface is considered
- Preliminary test cases (evolution up to several hours after impact) have shown **different behavior of fragments ejected** between cohesive and cohesionless cases



Ejecta evolution 4h after impact. Projection of the ejecta curtain on the x-z plane (Dimorphos orbital plane). The frame is centered at the barycenter of Didymos system. Asteroids are not shown: they are located approximately near the origin (Didymos) and at point [x=600m, z=1000] (Dimorphos).