

BIRDY-T: INTERPLANETARY CUBESAT TO PROBE SMALL SOLAR SYSTEM BODIES



Daniel HESTROFFER



Institut de Mécanique Céleste et de Calcul des Éphémérides

Laboratoire d'Études Spatiales et d'Instrumentation en Astrophysique

M. AGNAN, B. SEGRET, J.J. MIAU, P. ROSENBLATT, G. QUINSAC, J. VANNITSEN

IMCCE - CNRS - PSL - Paris observatory, France e-mail: hestro@imcce.fr

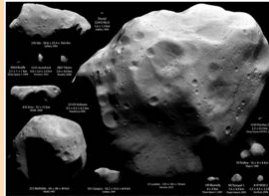


Interior of Small Solar System Bodies

Small bodies are of interest to science (formation of the Solar System, origin of life, tests of dynamics, planetary ephemerides), to Space Situational Awareness and threat to Earth, and for resources' exploitation. Asteroids, comets, irregular satellites show a large variety in sizes and morphology, and many are supposed to be gravitational aggregates. Fundamental parameters often unknown are:

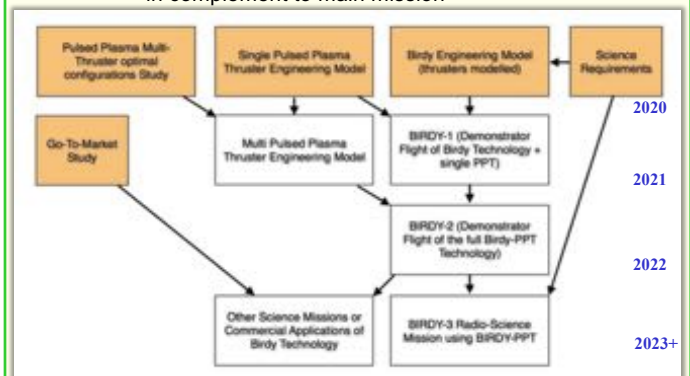
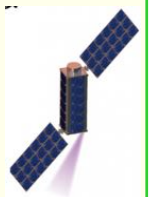
- mass and bulk density
- porosity and internal structure

About 20 targets visited so far by space probes, asteroids/comets Phobos/Deimos. In orbit or simple rendez-vous yielding sometimes the mass. No Trojan, no binary (exl.Dactyl)



BIRDY: a Deep-Space CubeSat Concept

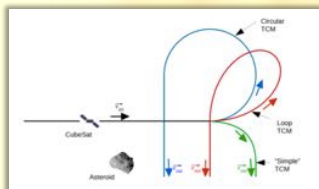
- **accompanying 3U CubeSat** – piggyback orbit insertion and data relay through mothercraft
- **proximity operations** – take more risks, unlock new applications
- **science** – dedicated instruments and operations, in complement to main mission



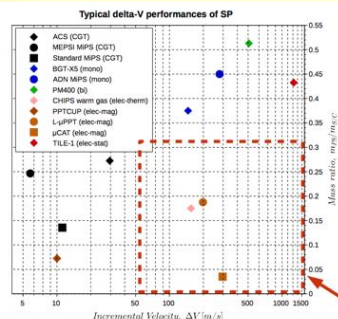
BIRDY-T roadmap

Autonomous Navigation NGC / IFOD

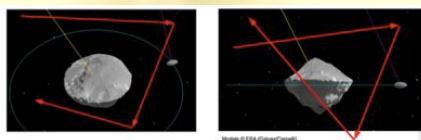
- Propulsion
Electric plasma PPT (solid or liquid)



Continuous thrust trajectory maneuvers (Delta V 1-5 m/s)

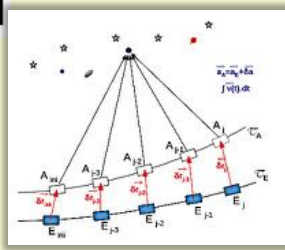


- Flying legs concept
orbital segments and multiple flybys, and Trajectory Correction Maneuvers



- In-flight orbit determination IFOD
« object tracker » stars and foreground SSOs astrometry package - aim 0th1 positioning asynchronous triangulation

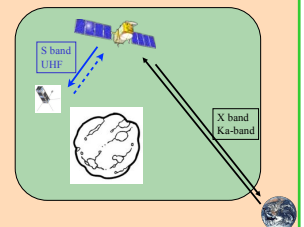
Astrometry - Asynchronous triangulation



Radio Science - Planetary geodesy

Echo + Doppler and imaging + stellar astrometry additional, accelerometer, radio link to surface (MASCOT), ...

- Intersatellite link
no USO on board SmallSat
2way, 4way link
- UHF, S-band, X-band
S-band link budget
0.9mm/s @60s integration time
- Precise orbit determination POD,
on ground and shape model
mass and J_i gravity field
- 2 CubeSats on same orbit (GRACE, GRAIL concept)
- End of (propulsion) life: land on surface, radio operations



Acknowledgements: ESEP, PSL/C²ERES, PNGRAM, CNES undergraduate students for their contribution

BIRDY at C²ERES space centre and campus <https://cceres.univ-psl.fr/>

