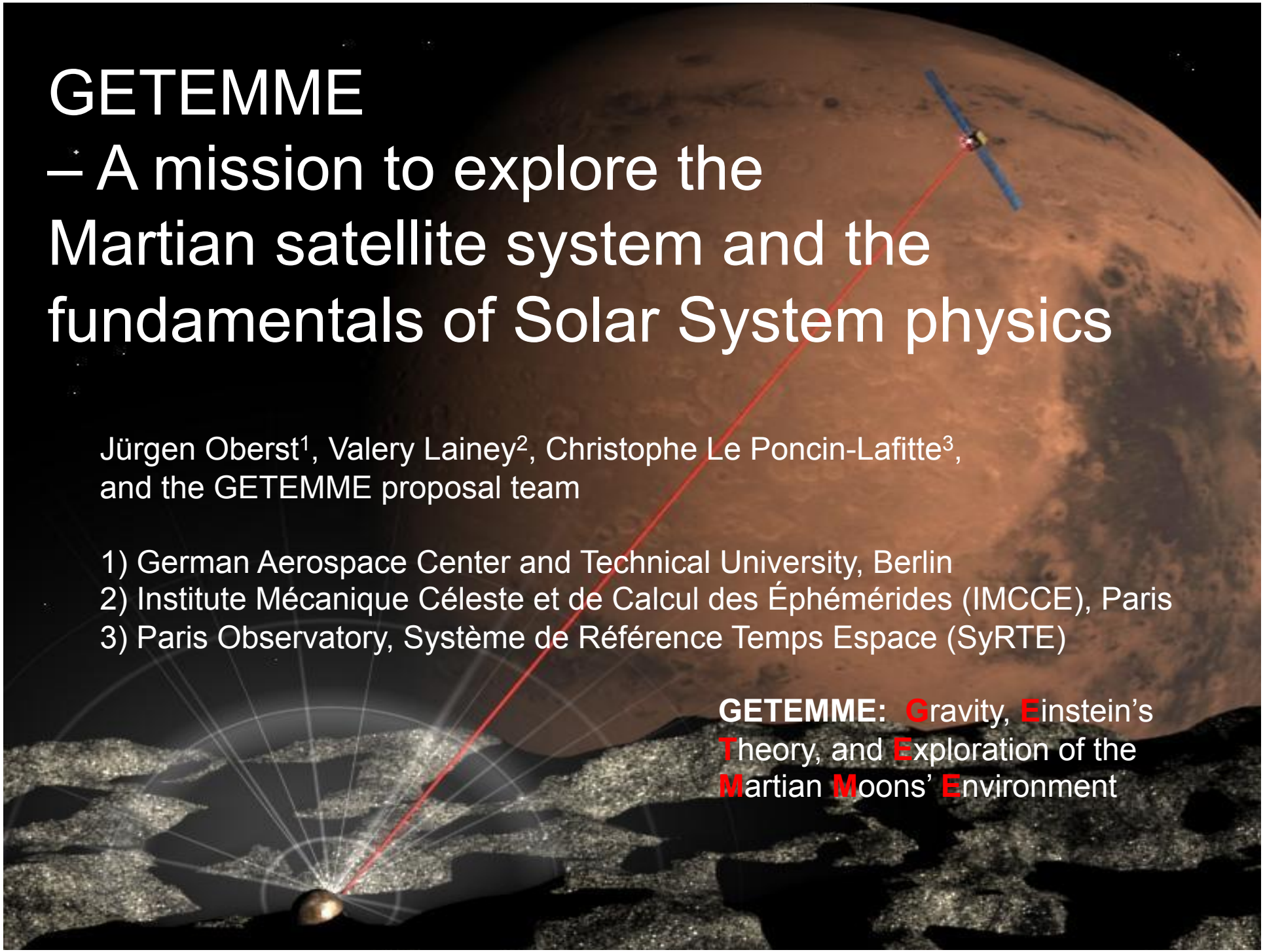


GETEMME – A mission to explore the Martian satellite system and the fundamentals of Solar System physics

Jürgen Oberst[1], Valery Lainey[2], Christophe Le Poncin-Lafitte[3], and the GETEMME proposal team

1) German Aerospace Center and Technical University, Berlin
2) Institute Mécanique Céleste et de Calcul des Éphémérides (IMCCE), Paris
3) Paris Observatory, Système de Référence Temps Espace (SyRTE)

GETEMME: **G**ravity, **E**instein's **T**heory, and **E**xploration of the **M**artian **M**oons' **E**nvironment

GETEMME Mission Scenario

- M-Class Mission proposal (ESA Cosmic Vision Program)
- Launch in 2020 on Soyus Fregat
- Transfer to Mars; arrival in 2022

Deimos

Mars

Phobos

GETEMME Mission Scenario

- Deimos rendezvous, comprehensive mapping, and deployment of two Laser reflector stations
- Transfer to Phobos, mapping and deployment likewise…
- Transfer to final orbit (1500 km above Mars) and begin scientific Laser ranging campaign

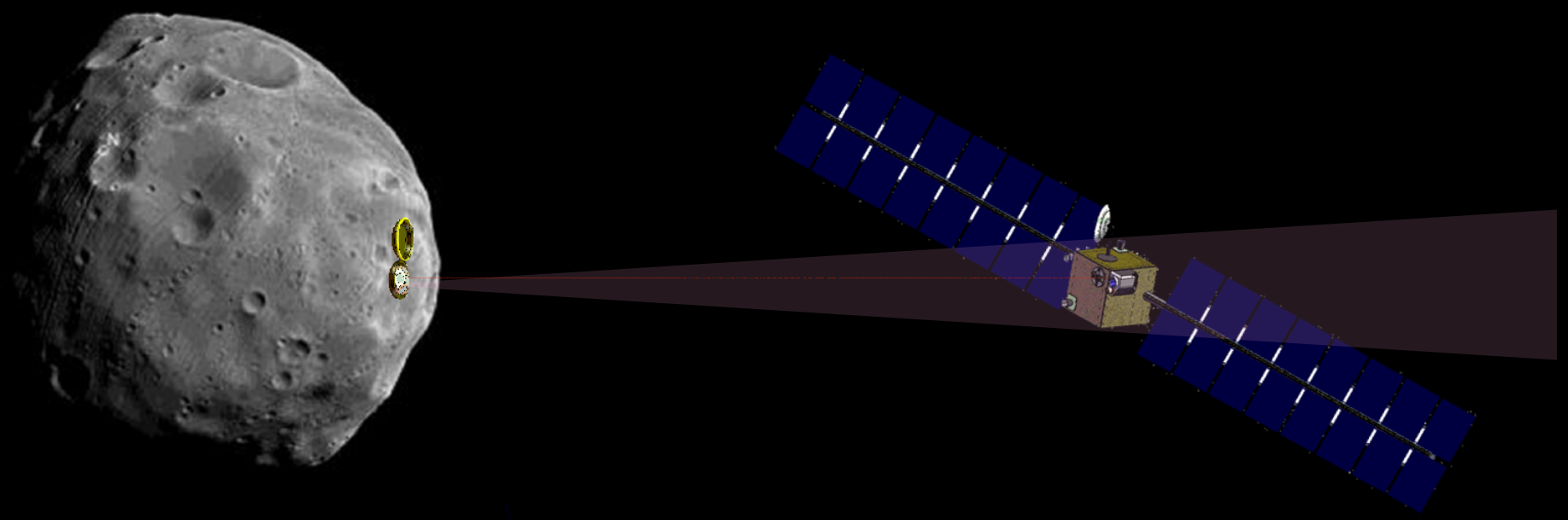
Deimos

Mars

Phobos

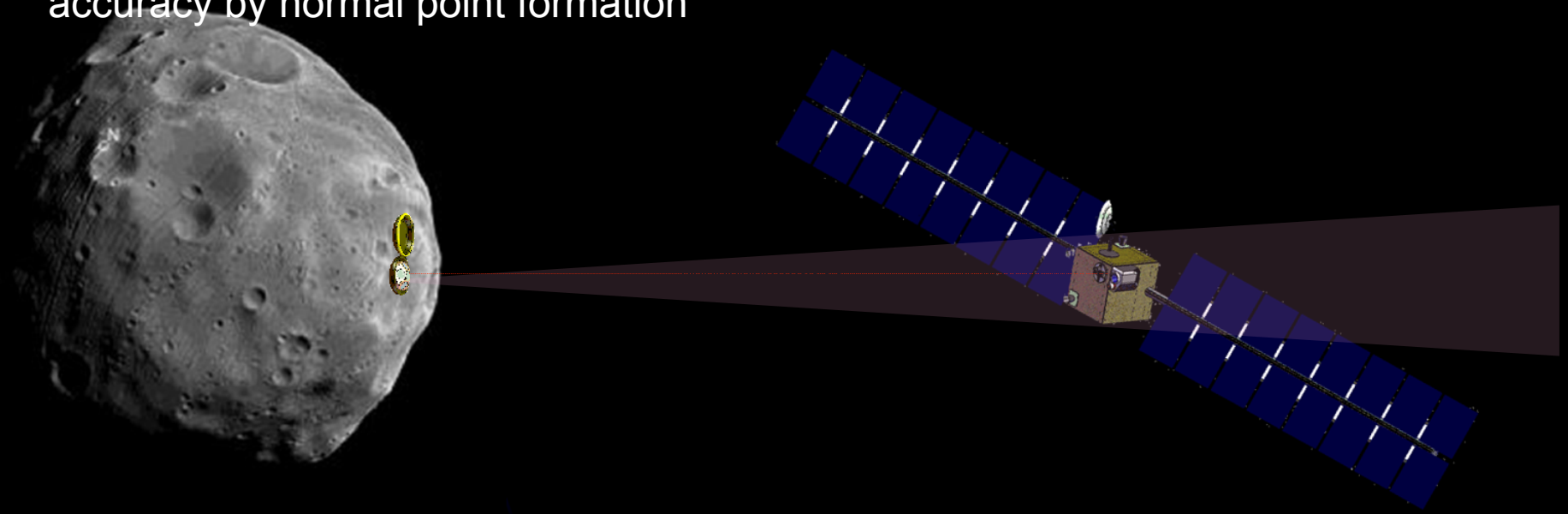
GETEMME Science Objectives

- Investigate origin, evolution, and dynamics of planetary satellite systems
- Carry out tests of theory of Einstein
- Improve realizations of Solar System reference frames

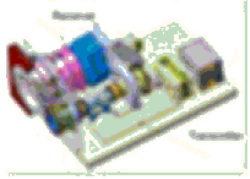
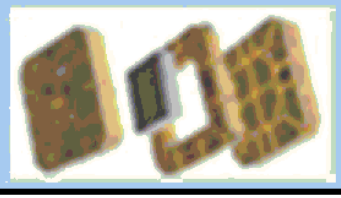
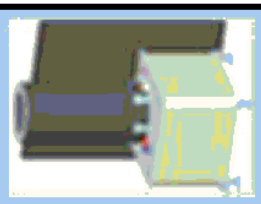


GETEMME Measurement Objectives

- Full characterization of Phobos and Deimos using imaging, altimetry, spectro-photometry, and radio science
- Range measurements between S/C and Phobos / Deimos for 1 Martian year, > 100,000 shots each
- Asynchronous two-way range measurement from S/C to Earth / from Earth to S/C for 1 Martian year, > 50,000 shots each
- Range measurement accuracy: meter- accuracy for single shots; centimeter-accuracy by normal point formation

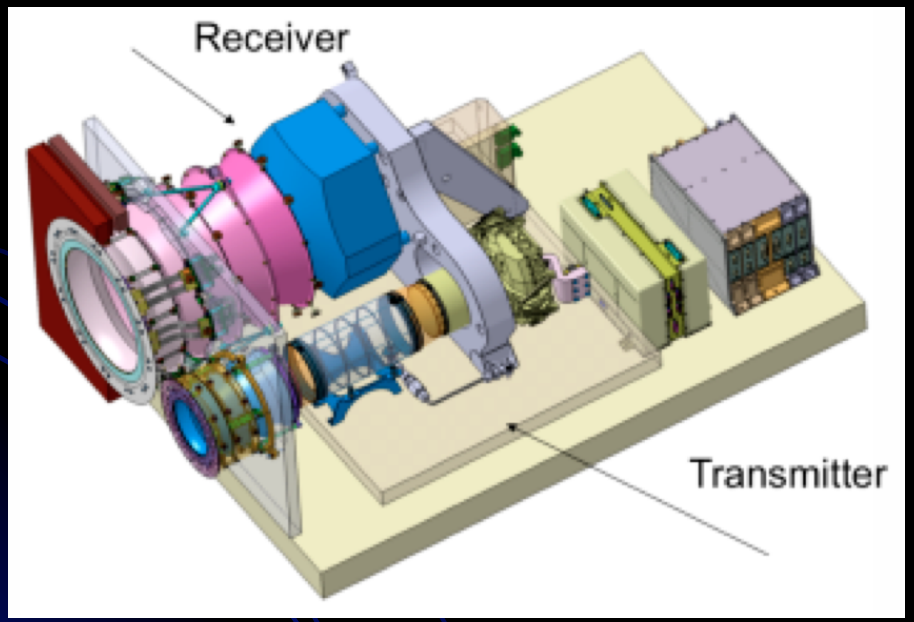


GETEMME Payload

Retroreflectors		4 passive landers with retroreflectors Heritage: CHAMP, GRACE, GOCE; 150 x 150 x 100 mm^3; Mass: 20 kg
Laser Ranging		Range measurements to Phobos, Deimos, Earth Heritage: Bepi Colombo Laser Altimeter; 1,000 x 550 x 450 mm^3; Mass: 15.5 kg
Accelerometer		Ultrasensitive accelerometers Heritage: CHAMP, GRACE, GOCE; 340 x 340 x 200 mm^3; Mass: 3.5 kg
Camera		Imaging Science Heritage: ROKVISS, SRC@MEX, DAWN camera; 700 x 420 x 450 mm^3; Mass: 5.6 kg
Spectrometer		Spectro-photometry: 400–2900 nm Heritage: CRISM Imaging Spectrometer; 310 x 430 x 510 mm^3; Mass: 14 kg

GETEMME Laser

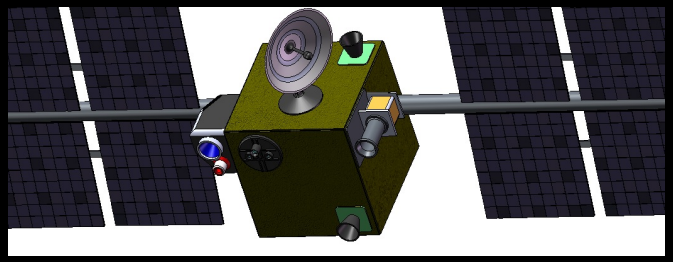
- Three applications
  - Range measurements to Phobos / Deimos reflectors,
  - asynchroneous Earth-ranging,
  - classic altimetry
- Heritage: BELA (Bepi Colombo Laser Altimeter)

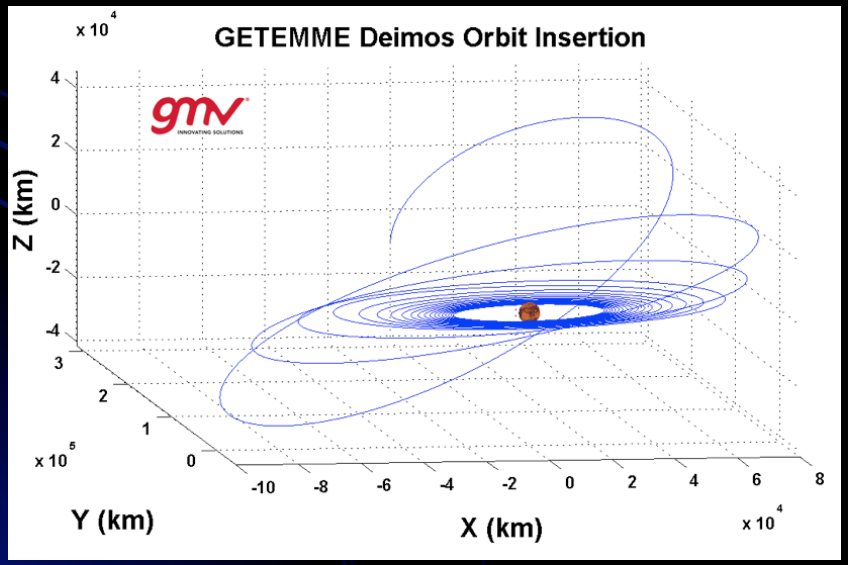


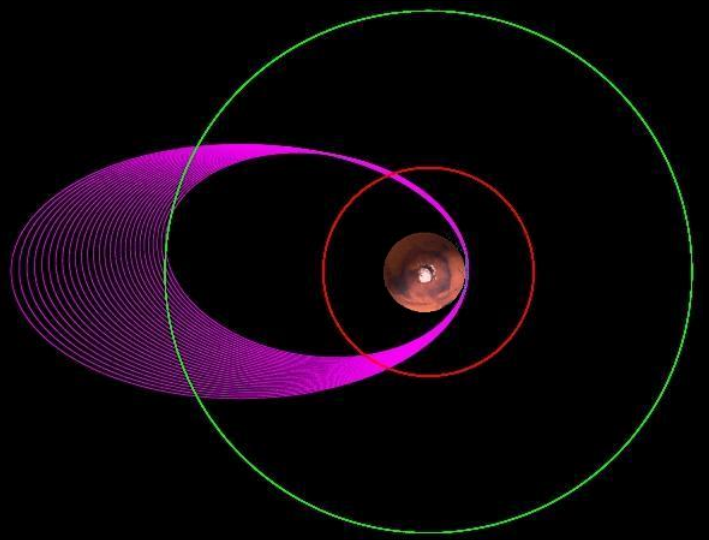
Laser type	Nd:YAG
Frequency	1064 nm
Energy	50 mJ (BOL), 40 mJ (EOL)
Repetition rate	10 Hz
Pulse duration	3-8 ns
Pulse width	5,5 ns +- 2,5 ns (50% of peak [FWHM])
Beam Diameter	74 mm (Aperture of BEX)
Beam Divergence	50 micro rad +- 10 micro rad
Receiver sensor	Silicon APD (Avalanche Photo Diode)
Telescope diameter	20 cm
Focal Length	1250 mm
Field of view telescope	450 micro rad

GETEMME Spacecraft

- Spacraft: 1m x 1m x 1m; launch mass: 1600 kg; payload mass: 120 kg
- Use Solar Electrical Propulsion System



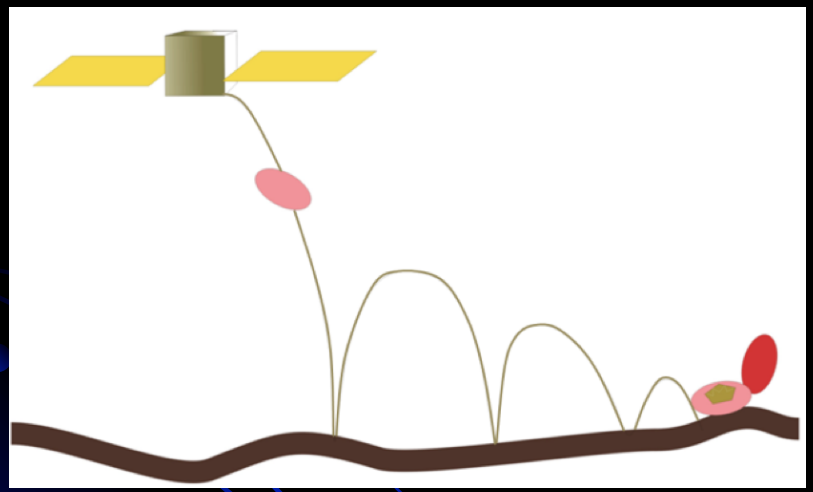


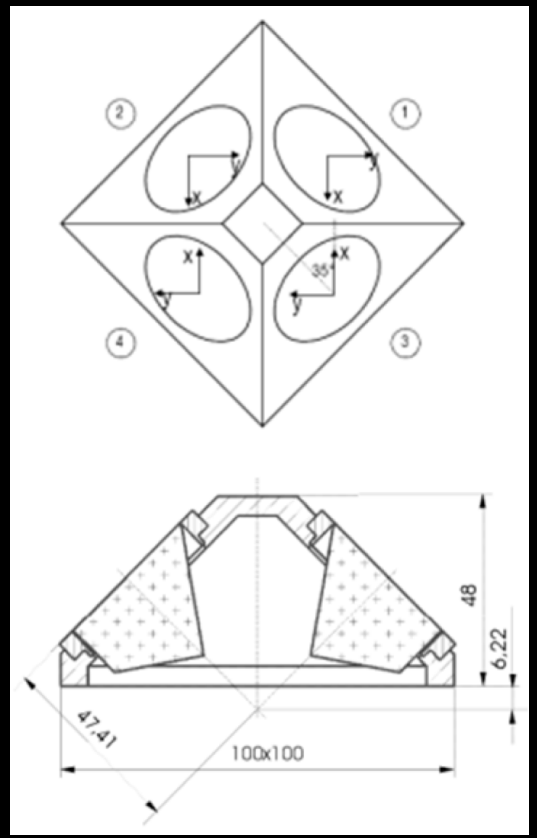


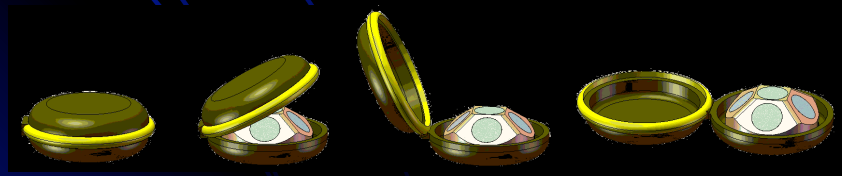
Aerobraking option

GETEMME Reflector Stations

- 4 landers, 2 on each satellite near side (to allow measurements of librations
  - low touch-down velocity: < 10 m/s
  - open cover after deployment
  - battery power for few hrs after landing
  - stay passively on the satellite surfaces for years …

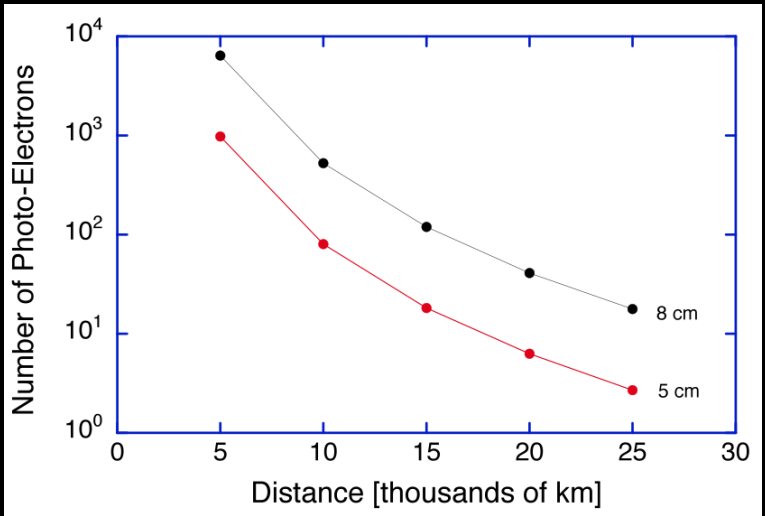




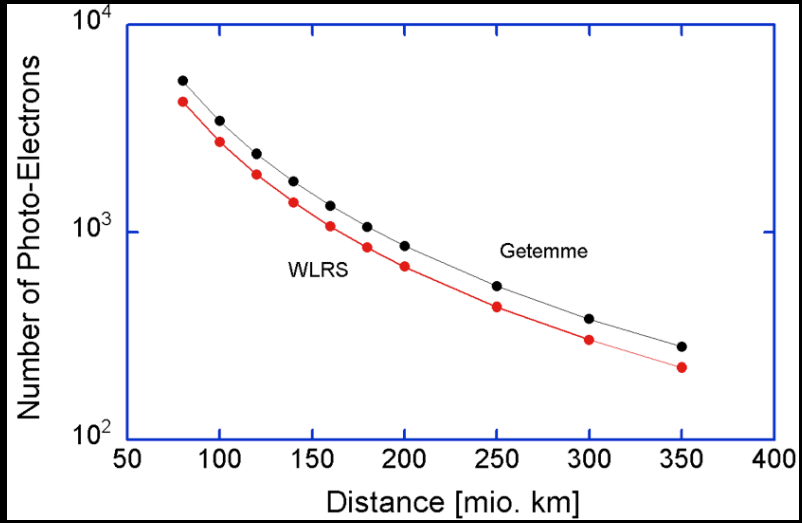


Retroreflectors /
Heritage: Champ

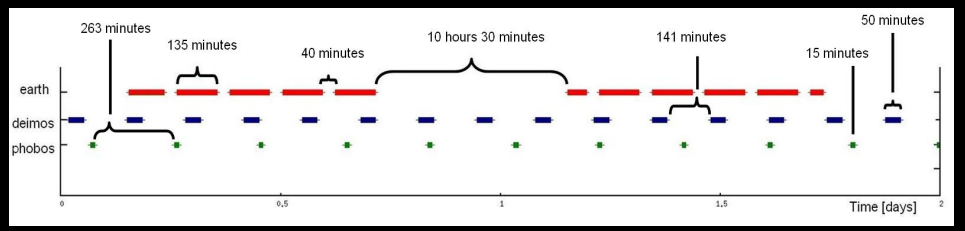
GETEMME Link Budgets



Photon link budget for different Phobos/ Deimos reflector sizes



Photon link budget for Earth ranging



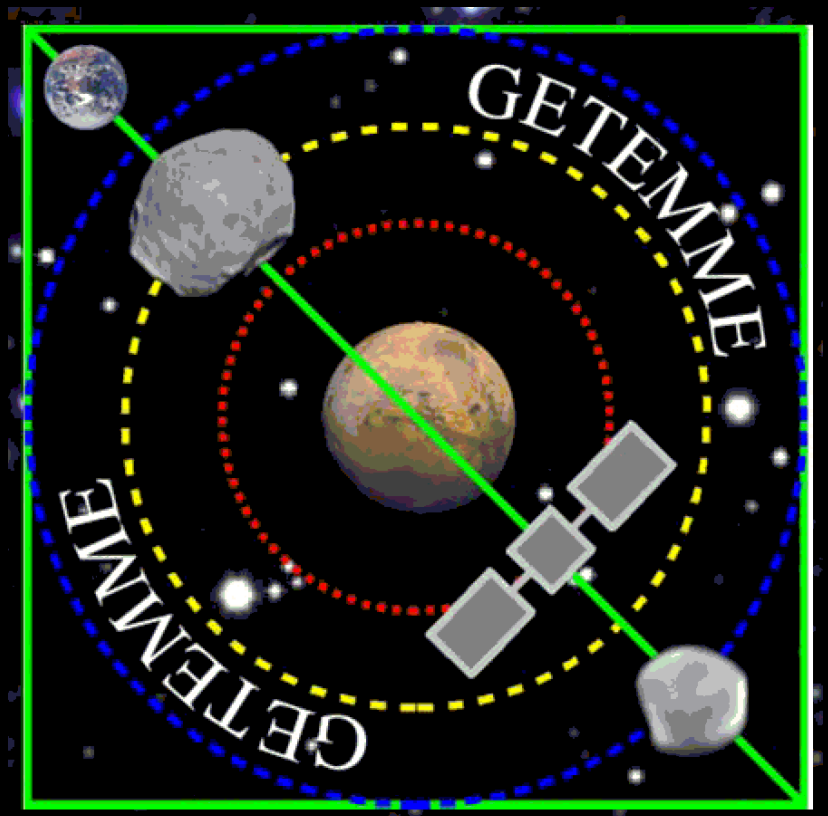
Phobos / Deimos ranging schedule

Challenge: delicate balance must be found between Laser power, reflector size, receiver size, Laser beam spreading, and Laser pointing accuracy

GETEMME Proposal Team:

Oberst, J. TU Berlin / DLR BA (D) – Lainey, V. IMCCE (F) – Le Poncin-Lafitte, C. SyRTE (F) – Dehant, V. ROB (B) – Rosenblatt, P. ROB (B) – Ulamec, S. DLR KP (D) – Biele, J. DLR KP (D) – Hoffmann, H. DLR BA (D) – Willner, K. TU Berlin (D) – Schreiber, U. Wettzell Obs. (D) – Rambaux, N. IMCCE (F) – Laurent, P. SyRTE (F) – Zakharov, A. IKI (R) – Foulon, B. ONERA (F) – Gurvits, L. JIVE (US) – Murchie, S. APL (US) – Reed C. APL (US) – Turyshev S. G. JPL (US), Noyelles, B. FUNDP (F) - Gil, J. GMV (E) - Graziano, M. GMV (E) - Kahle, R. DLR OP (D) - Klein, V. Kayser Threde (D) - Pasewaldt, A. DLR BA (D) - Schlicht, A. Wettzell Obs (D) - Spurmann, J. DLR OP (D) - Wählisch, M. DLR BA (D) - Wickhusen, K. DLR BA (D)

GETEMME



Thank you for your attention !