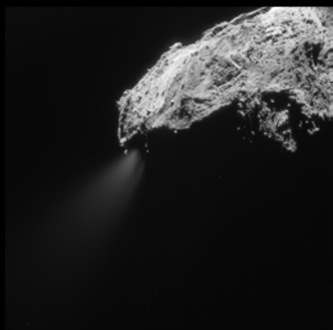
ESA Planetary Protection Update

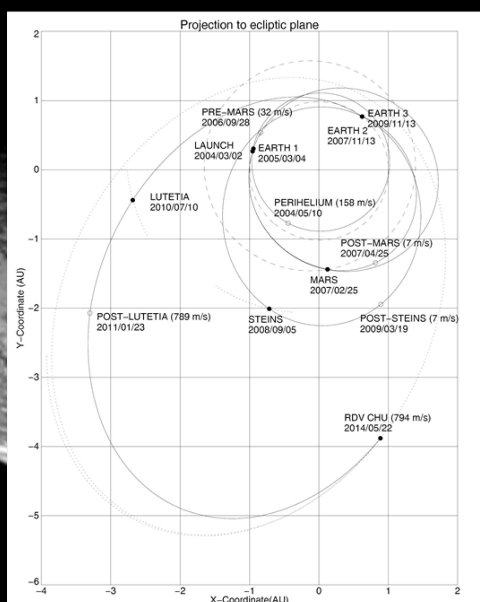
Dr. Gerhard Kminek
Planetary Protection Officer
European Space Agency

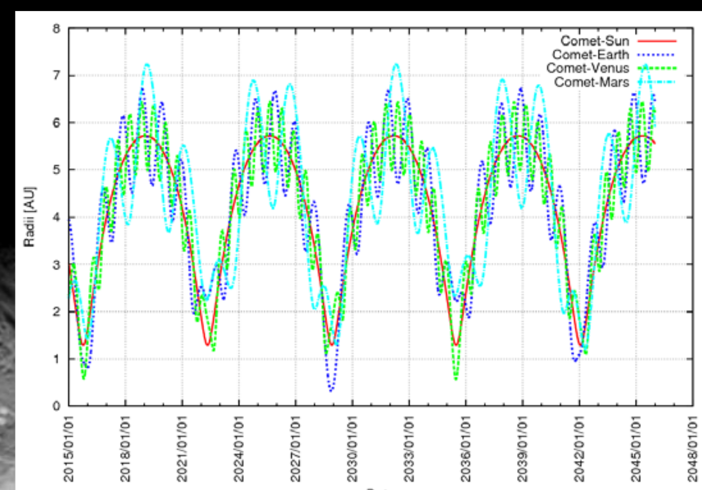
NASA Planetary Protection Subcommittee Meeting
1-2 June 2016, NASA-HQ

Rosetta



Launched: 2004
Gravity assists: 4 (1 Mars, 3 Earth)
Encounters: Stein 2008 (E-type), Lutetia 2010 (C/M type)
Final target: Comet 67/P 2014; reached in 2014
Final disposition: Landing on the comet in September 2016 time period; ecliptic inclination is 1.8° for Mars and 7.1° for the comet; minimum distance to Mars of nucleus is 1 AU until 2045





European Space Agency

Mars Express

<u>Launched:</u> 2 June 2003

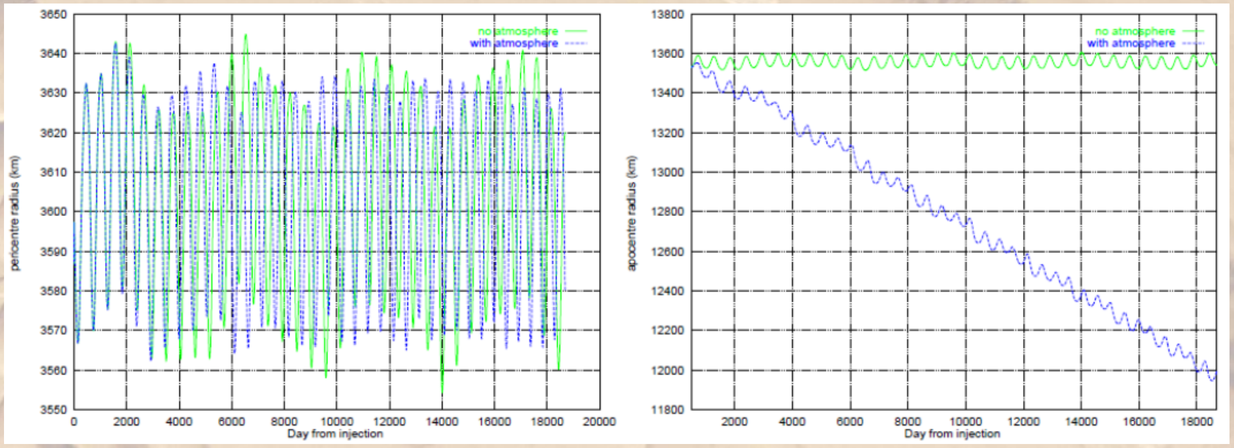
<u>Mission extension:</u> 5th mission extension

<u>Planetary protection approach:</u> orbital lifetime for a time period of 50 years after launch

<u>Current status:</u> elliptical 88:25 resonance orbit with a pericenter of ~300 km and an apocenter of ~10.000 km; **current orbit stable for > 50 years ⇒ mission remains compliant with orbital lifetime requirement** (independent of S/C health status)

<u>Siding Spring encounter:</u> time of periares changed to avoid maximum flux; maneuver completed

<u>End of mission:</u> S/C remains in stable orbit (confirmed 31 May 2016); limiting resource is battery lifetime; spacecraft passivation (Mars orbital debris) under discussion



European Space Agency

ExoMars 2016

<u>Mission elements:</u> Trace Gas Orbiter (TGO) and Schiaparelli lander
<u>Mission lead:</u> ESA, cooperation with Roscosmos; NASA provided Electra equipment
<u>Launch site:</u> Baikonur Space Centre, Proton-M/Breeze-M
<u>Landing site:</u> Meridiani Planum
<u>Planetary protection category:</u> SCC and TGO-Cat. III, Schiaparelli-Cat. IVa
<u>Planetary protection approach:</u>

- Orbital lifetime for TGO, including bottom-up hardware reliability assessment and micrometeoroid impact and effect assessment; trajectory part covered by Monte-Carlo analysis
- Bioburden controlled assembly for Schiaparelli lander, including use of new cleanroom for main assembly phase and clean tent for testing and launch operation; dry heat sterilisation for most of the flight hardware; >3000 assays, including use of rapid assay technique
- Planetary Protection Certification of Compliance issued on 8 March 2016

<u>Project status:</u> launched on 14 March 2016; DSM end of July 2016, Schiaparelli lander separation on 16 October 2016, and TGO MOI on 19 October 2016

Credit: ESA/ExoMars

Credit: ESA/ExoMars

ExoMars 2016

Credit: ESA/ExoMars

→ Excellent work of the industrial team under the leadership of Thales Alenia Space Italy

&

→ Excellent work of our Russian partners during the launch campaign

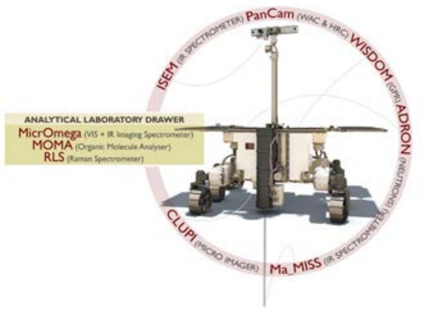
Thank you!

ExoMars 2020

Mission elements: Carrier Module (CM), Descent Module (DM), Rover Module (RM) with Pasteur Payload (PPL)
Mission lead: Cooperation ESA-Roscosmos; NASA provides major part of life-detection payload
Use of perennial heat sources: Yes
Launch Site: Baikonur Space Centre, Proton Launcher
Planetary protection category: IVb
Planetary protection approach: bioburden control for CM (credit for break-up/burn-up), bioburden controlled assembly for DM and RM, sub-system IVb implementation; NGS for biodiversity assessment

Project status:

- Completed mission SRR and PDR
- Landing site selection on-going
- New aseptic contamination controlled glove-boxes at Thales site in Turin are ready
- New bioburden controlled cleanroom for the rover assembly at Airbus site in Stevenage is ready

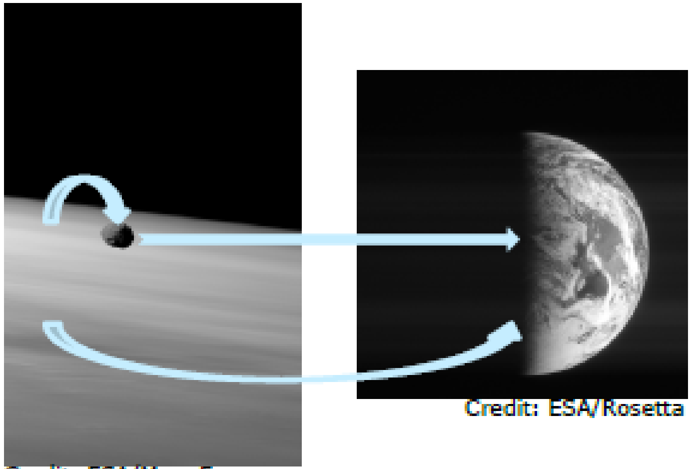


Credit: ESA/ExoMars

Phobos Sample Return

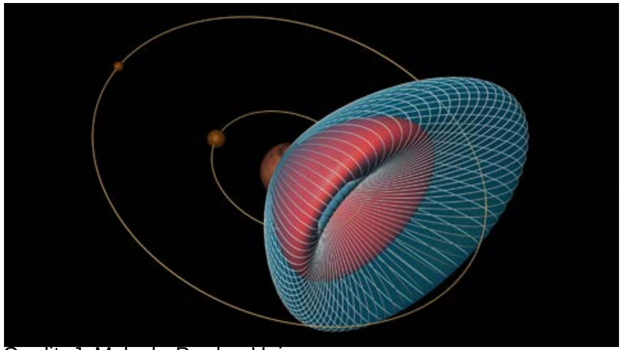
In support of mission studies, a re-assessment of planetary protection categorization for Phobos sample return missions has been initiated

- → Transfer of material from Mars to Phobos (Melosh *et al.*, 2011)
- → Different models predict an abundance of martian material on Phobos in the ppm range with uncertainties that span several orders of magnitude (Chappaz *et al.,* 2012; Ramsley and Head III, 2013) and major transfers as young as 3 million years (Werner *et al.*, 2014)
- → Level of biological inactivation of material transferred from Mars to Phobos due to hypervelocity impact on Phobos and exposure to the ionizing radiation and temperature environment on the surface and near sub-surface of Phobos is uncertain



Credit: ESA/Rosetta

Credit: ESA/Mars Express

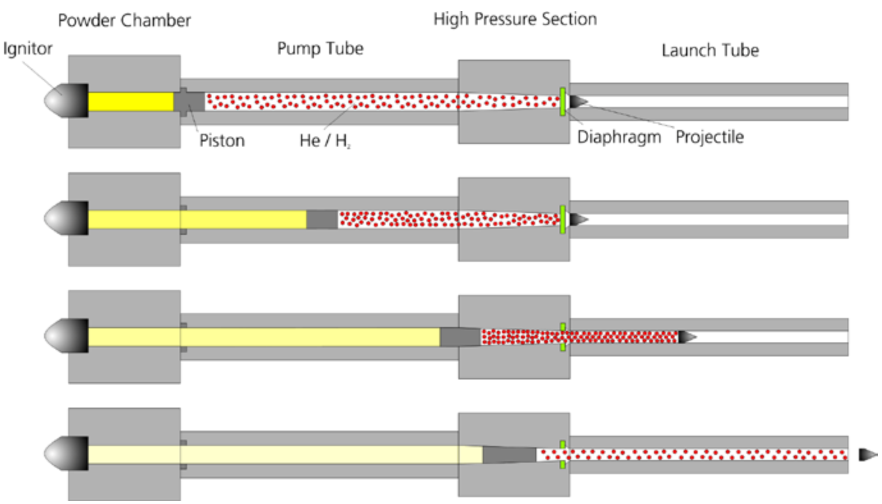


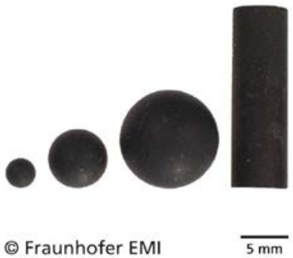
Credit: J. Melosh, Purdue Univ.

Credit: Werner *et al.*, 2014, NASA MRO CTX

Phobos Sample Return

- → Preliminary tests carried out by the Fraunhofer Institute, Ernst Mach Institute, Freiburg, Germany, demonstrate the feasibility to manufacture basaltic projectiles, accelerate them to 5 km/sec, and recover them from a low-density target
- → A subsequent workshop at the Fraunhofer Institute established the baseline for the type of tests that would be required to support an assessment of the sterilisation potential of martian material transferred to Phobos





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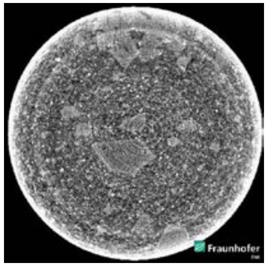
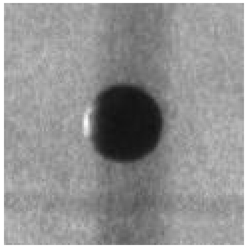


Glass spheres Quartz powder Basalt powder



Phobos Sample Return

- Consortium under the lead of the Open University is conducting the tests and modelling
- NASA funded a team at the Marshall Spaceflight Centre and the Purdue Univ. to support this activity
- Tests cover impact tests, ionizing radiation tests (gamma, proton and helium), and rapid heat inactivation tests
- Test campaigns is expected to finish after the summer 2016
- Results will feed in to an assessment of the planetary protection category for a Phobos sample return mission

Credit: Open University

The Open University | Public Health England | ThalesAlenia Space | Kallisto Consultancy | IWF

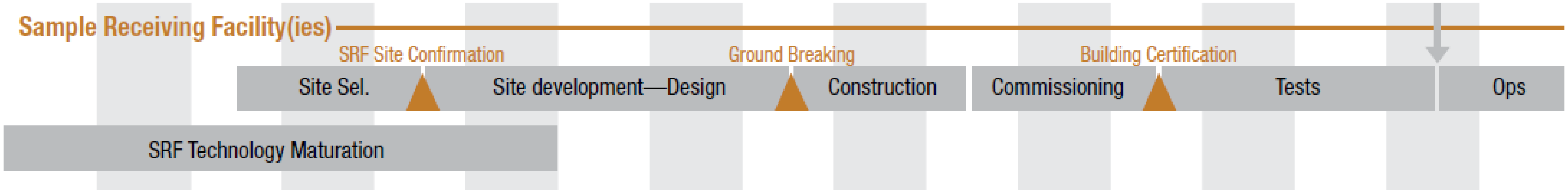
Mars Sample Return

Recent bi-lateral discussions between ESA and NASA about Mars sample return cooperation scenario

- → NASA Mars 2020 lander/rover selects and acquires samples
- → NASA Mars orbiter 2022 could include an ESA contribution to capture and prepare the samples for the flight to Earth (i.e. capture of samples in orbit and application of flight containment system)
- → Subsequent ESA Courier mission could bring an Earth Return Vehicle (ERV) to Mars to get the contained samples from the NASA Mars orbiter and returns to Earth

ESA responded to this new cooperation scenario

- → Placed a CCN to the existing flight containment system contract to evaluate an accelerated development for the capture mechanism (TRL-6) and the flight containment system (TRL-4) with a focus on test and verification of current design
- → Initiated a concurrent design activity for the MSR Courier mission
- → Prepared proposal (ExPeRT) for next ESA council meeting at ministerial level in December 2016 (mission implementation decision proposed for 2019)



Credit: iMars Phase 1, 2008

European Commission Funding

EuroCares

- European Curation of Astromaterials Returned from Exploration of Space
- Developing a roadmap for a European Sample Curation Facility (ESCF), designed to curate precious samples returned from Solar System exploration missions to asteroids, Mars, the Moon, and comets
- Three year, multinational project
- Members from academia and industry

PPOSS

- Planetary Protection of Outer Solar System Bodies
- Developing a planetary protection handbook (including relevant organic contamination aspects for *in-situ* life detection and sample return), training and seminar series, and roadmaps for research and development
- Three year multinational project, including partners from Russia, China, Japan, and an observer from the US (Academies)
- Members from academia and industry