



MARS EXPRESS

***supports the NASA
MSL mission and the
Curiosity Rover***

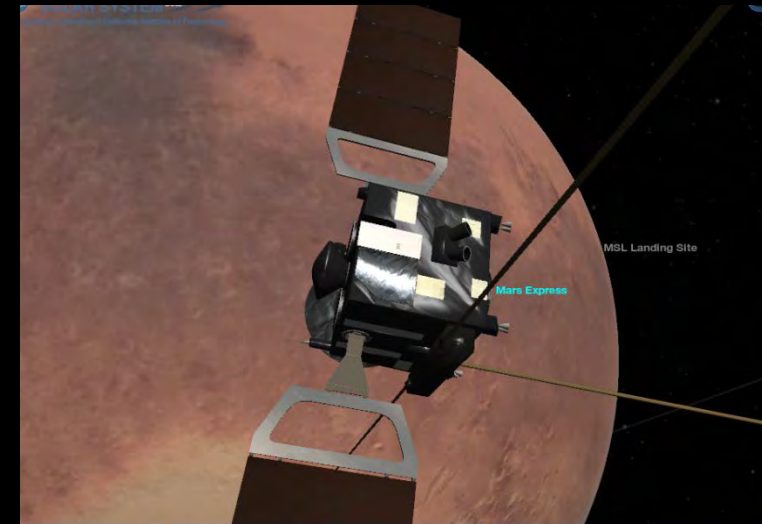
Entry Descent and Landing Event

ESOC 6 August 2012

Michel Denis, Mars Express Spacecraft Operations Manager

Overview

- The Mars Express (MEX) mission
- ESA-NASA cooperation - also at Mars
- How the MSL support is possible
- **Today: MEX and ESOC support during Entry, Descent and Landing (EDL)**
- „Tomorrow“ : MEX support to Curiosity on surface



Mars Express – Europe@Mars since 2003

- **11,000 orbits** „Each orbit is a mission“
- Science : 15,000 targets
- Surface/Atmosphere (50/50)
- 6 instruments: 40,000 observations
- Returned from Mars 700 Gigabytes raw data



Mars moon Phobos

2 flybys a year:

often science, always safe



With radio for lost Beagle-2,

MEX relayed 3 (now 4) NASA landers



ESA- NASA Cross support

7000 MEX Earth contacts:

- 4000 on ESA ground stations,
- **3000 on NASA Deep Space Network (DSN)**



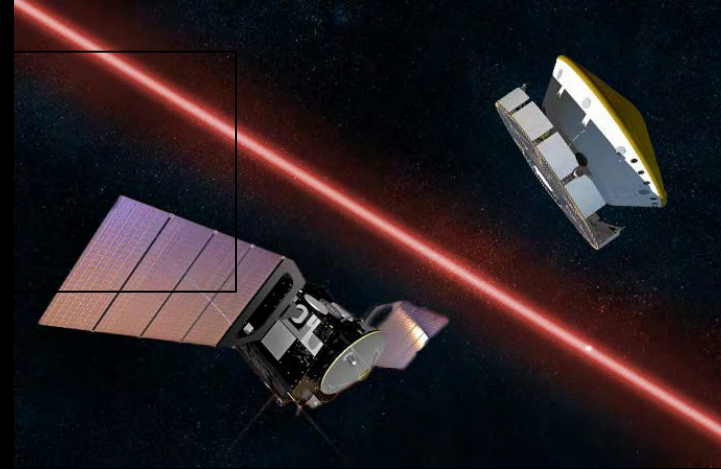
Returning Support :

- ESA ground stations support NASA launches & missions
- MEX: Phoenix arrival 2008, **MSL 2012 and beyond**
- **ESA New Norcia 35m** (Australia) special support for MSL

International co-“Operations“ means:

- Standard (Space Link Extension): Earth stations +network
- Idem at Mars: standards and compatible radio devices

MEX Support to MSL EDL



NASA called for ESA MEX support today – at 250 million km

- Similar to Phoenix Landing (May 2008)
- Following Entry / Descent / Landing from multiple platforms
- May be crucial to the design of future Mars missions

Joint Preparation

- Agreement with NASA Jet Propulsion Lab (JPL, California)
- ESOC changed MEX orbit (2 April 2012) for contact today
- Adapted MEX radio software for more efficiency
- Joint flight tests MEX - Mars Exploration Rover (Opportunity)

MSL Arrival Timeline (all times CEST)

Point the Mars Express UHF antenna towards MSL

Track Entry in atmosphere, Descent and Landing

Record at Mars the radio signal sent by MSL

Record it also on Earth (New Norcia)

Time	On Earth	On MEX	MSL	Time
06:07		Turn MEX towards MSL		06:07
06:25	New Norcia START recording			06:25
06:29	<div style="border: 2px solid black; border-radius: 15px; background-color: yellow; padding: 5px;"> <p>.../.../.../... .../.../.../... .../.../.../... .../.../.../... .../.../.../... .../.../.../... .../.../.../...</p> </div>	Switch UHF relay radio ON		06:29
06:37		Start Tracking MSL		06:37
07:09		<u>START Recording signal</u>		07:09
07:14			MSL-MEX Min Distance 2000 km	07:14
07:15			<u>Cruise Stage separation - MSL UHF starts</u>	07:15
07:25			<u>Atmosphere - Entry Interface Point</u>	07:25
07:28			Parachute Deploy	07:28
07:29			Heat Shield separation	07:29
07:29:37	<i>Occultation of MSL by Mars</i>			07:29:37
07:30:40			Backshell separation	07:30:40
07:31:17			Rover Separation	07:31:17
07:31:37			<u>MSL Landing</u>	07:31:37
07:37		Swith Relay radio + Recoding) OFF		07:37
07:39		End Tracking MSL		07:39
07:40	New Norcia STOP recording			07:40
08:10		MEX is turned back towards Earth		08:10
08:16	New Norcia Start Get Dataset			08:16
08:42	Dataset complete -> NASA			08:42
09:00	MSL Signal reconstituted (ESOC)			09:00

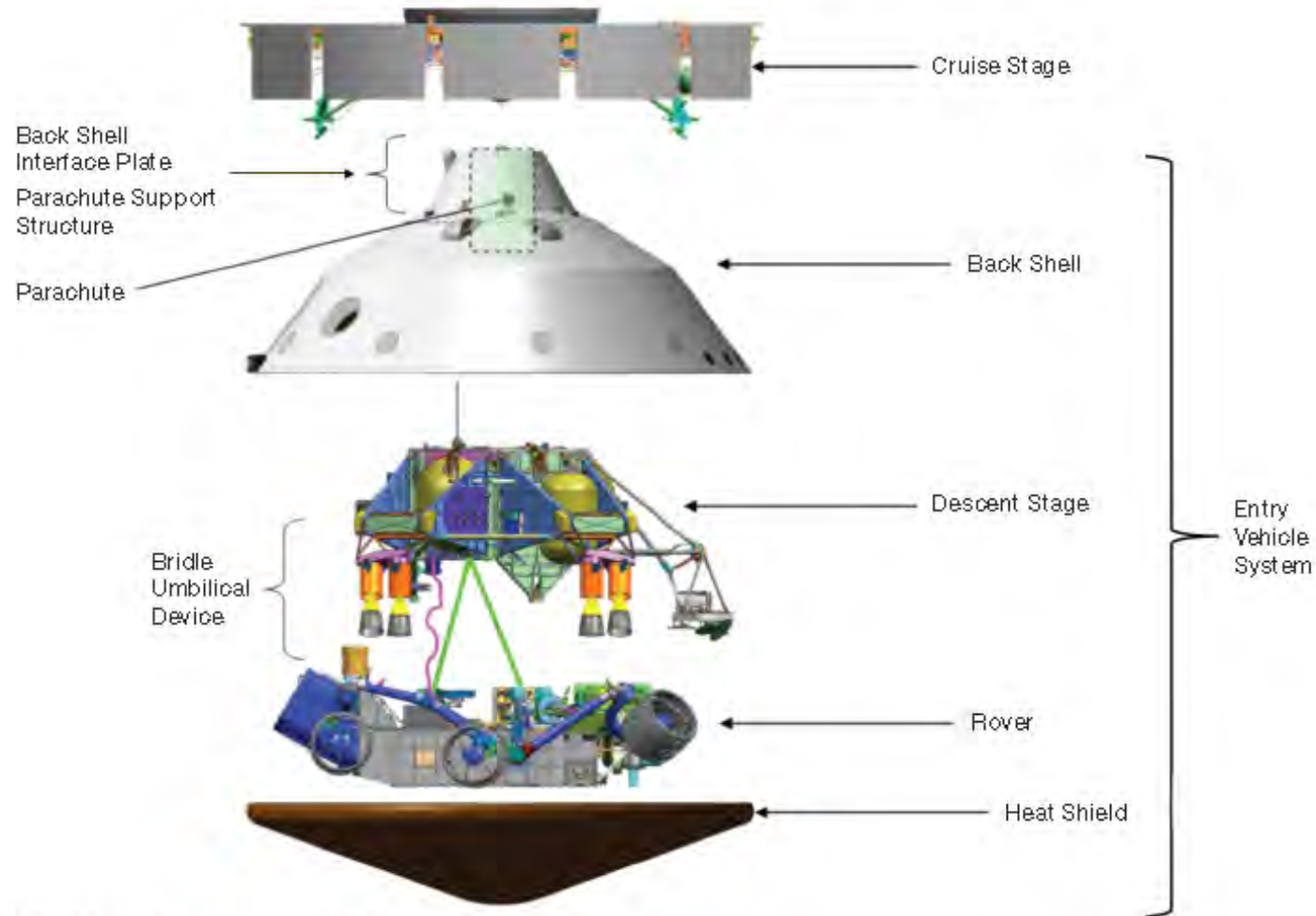
Decelerating from 20,000 to 3 km/hr

1

3

4

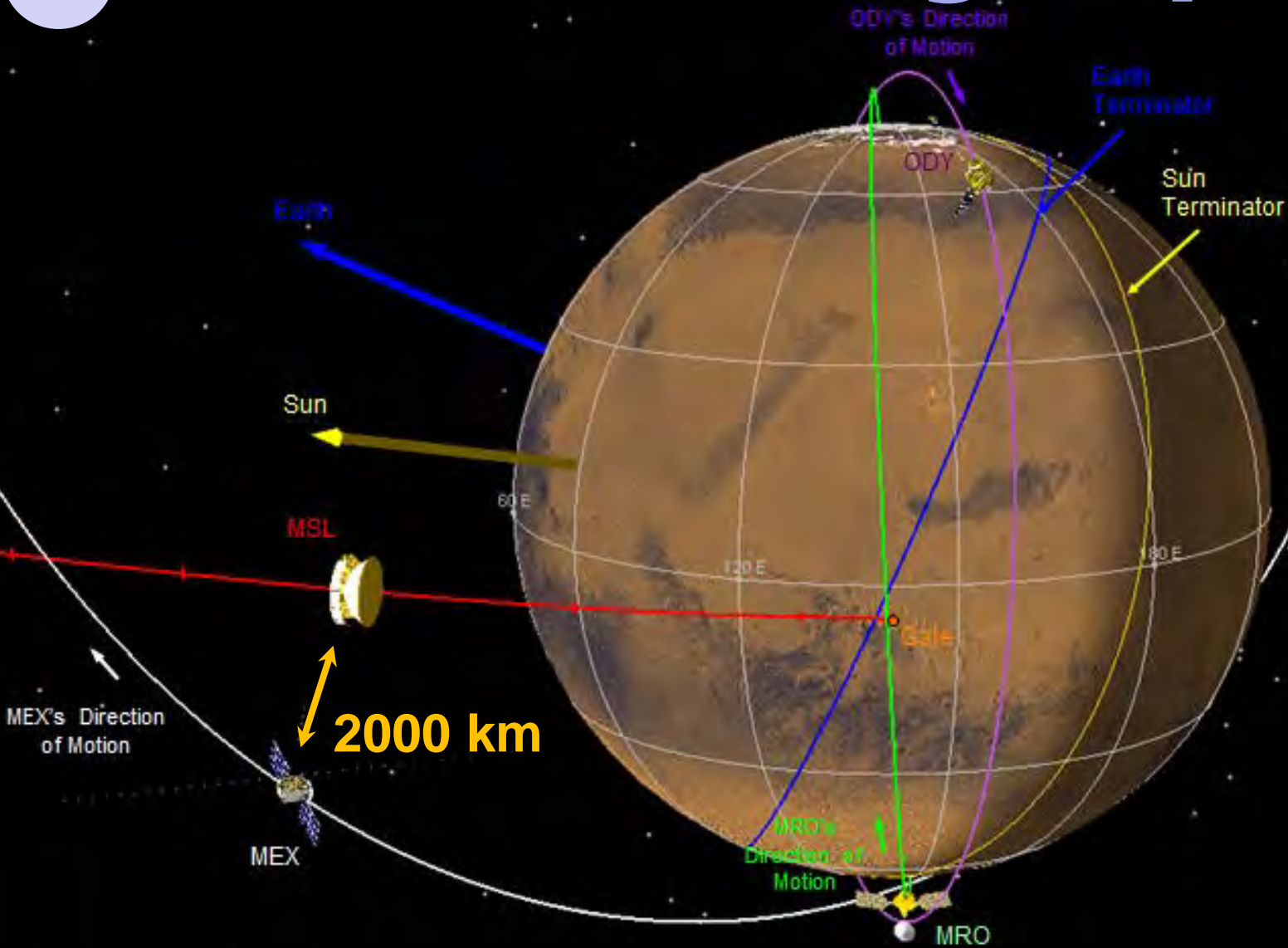
2

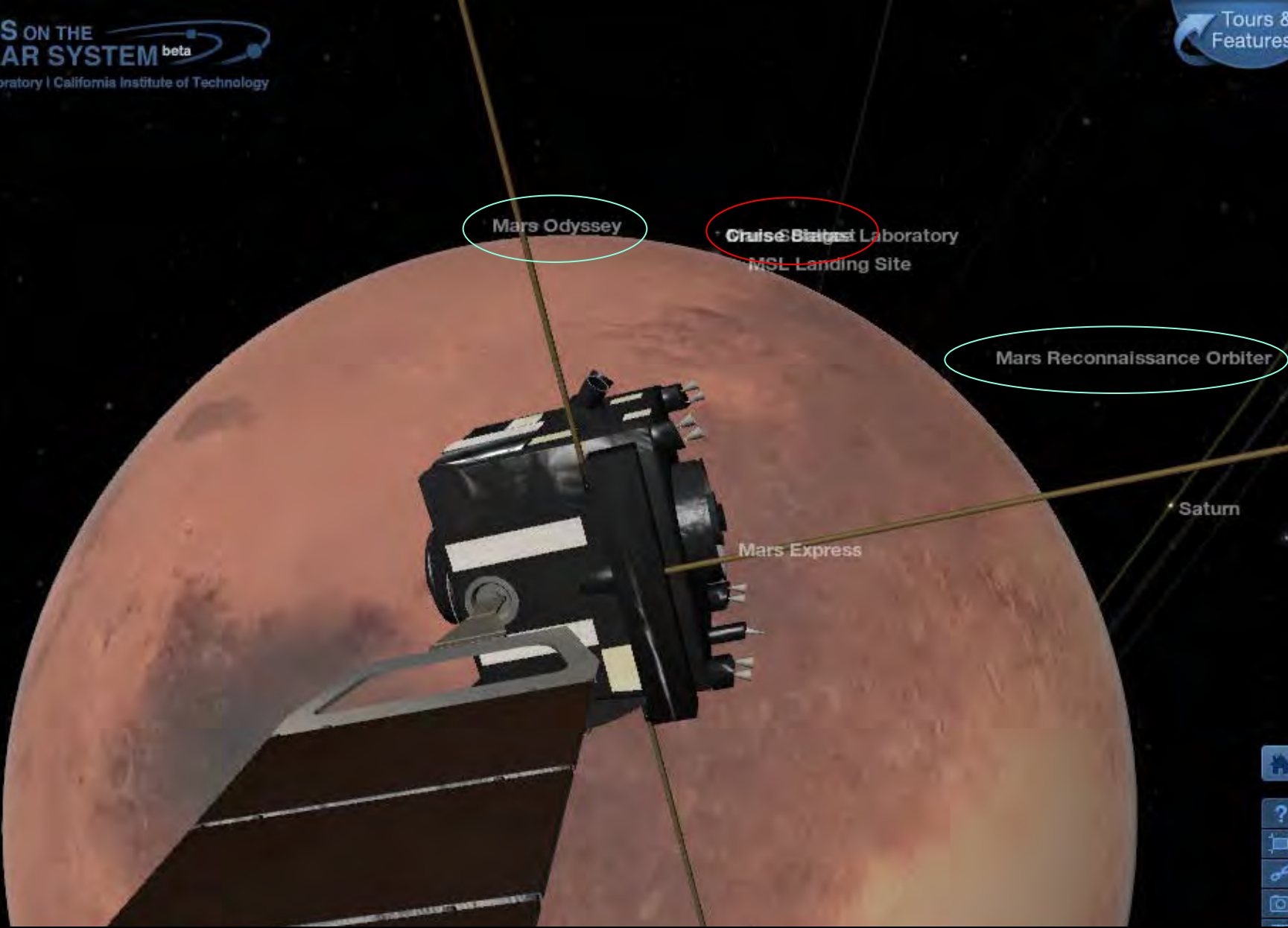


Mars Science Laboratory flight system, expanded view

1

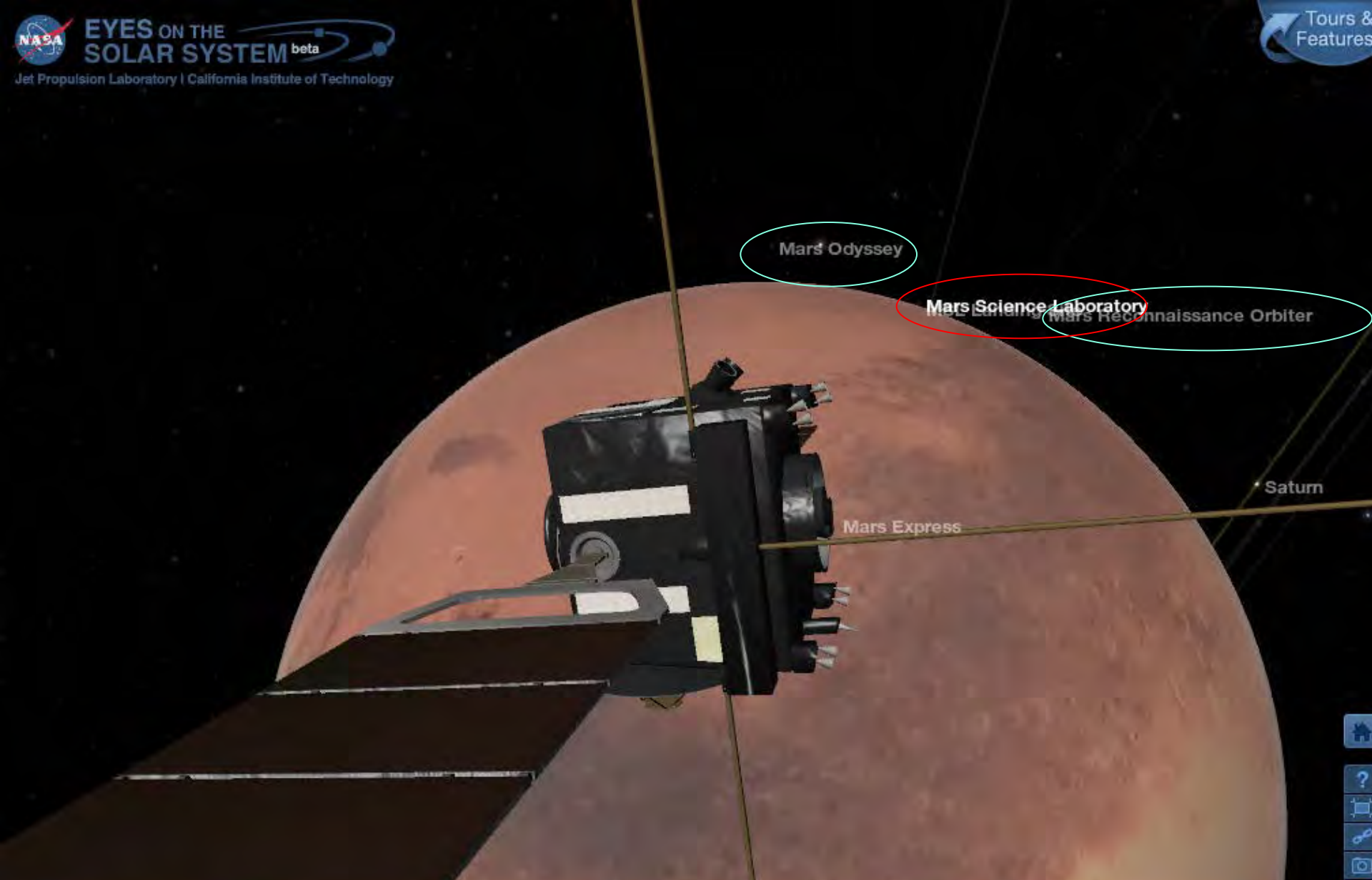
07:14: Cruise stage separates





2

07:24 Atmospheric Entry



3

07:28 Parachute Opens

Credit : NASA



4

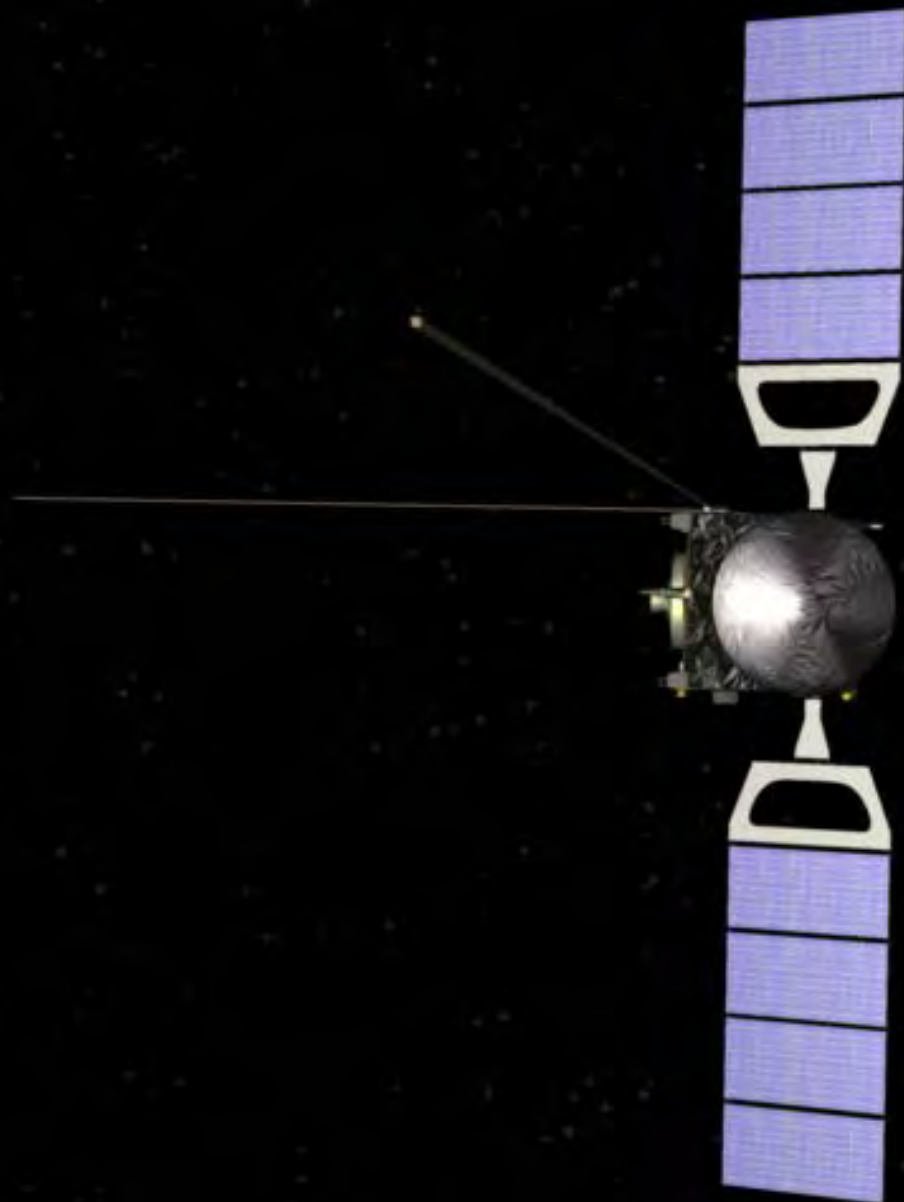
07:30 Powered Descent (retro-rocket, Sky Crane)



07:31 Curiosity has landed ! - NASA to confirm

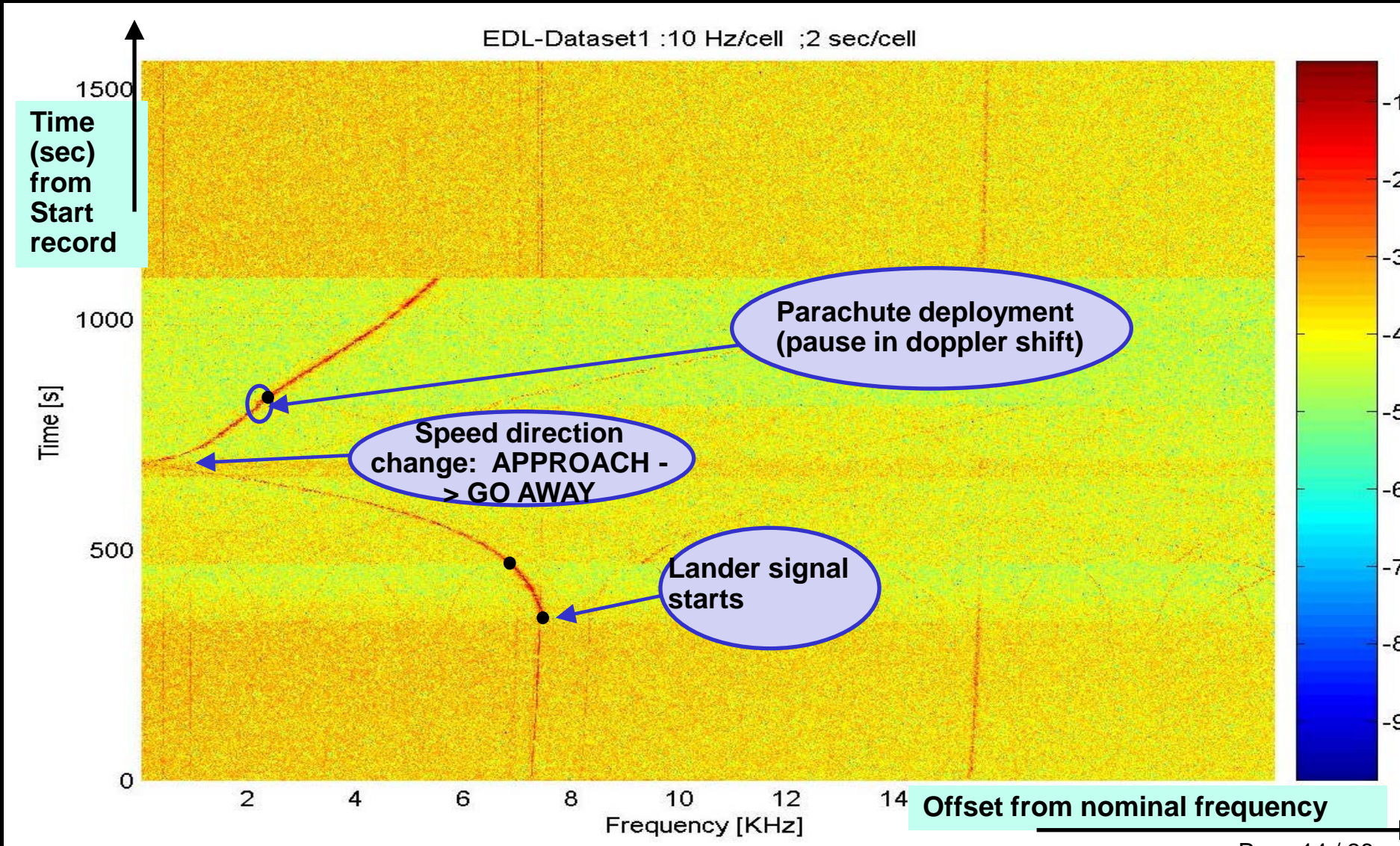
Credit : NASA

07:39 - 08:10 MEX turns back to Earth



Credit : NASA

09:00 MEX Results: a "spectrogram"



Conclusions and Perspectives



Mars Express

- Science spaceship + ESA and Europe base-camp at Mars
- European node of first inter-agency, interplanetary network

After Landing:

- Demonstrate MEX can relay Curiosity data and commands

First contact: 19 August, then, several times this year, then, regularly

- **“Europe-Assistance”** can intervene at Mars within 1 day

Upon NASA call, MEX can replace Science by 1-2 Relays / 24hr for some time

