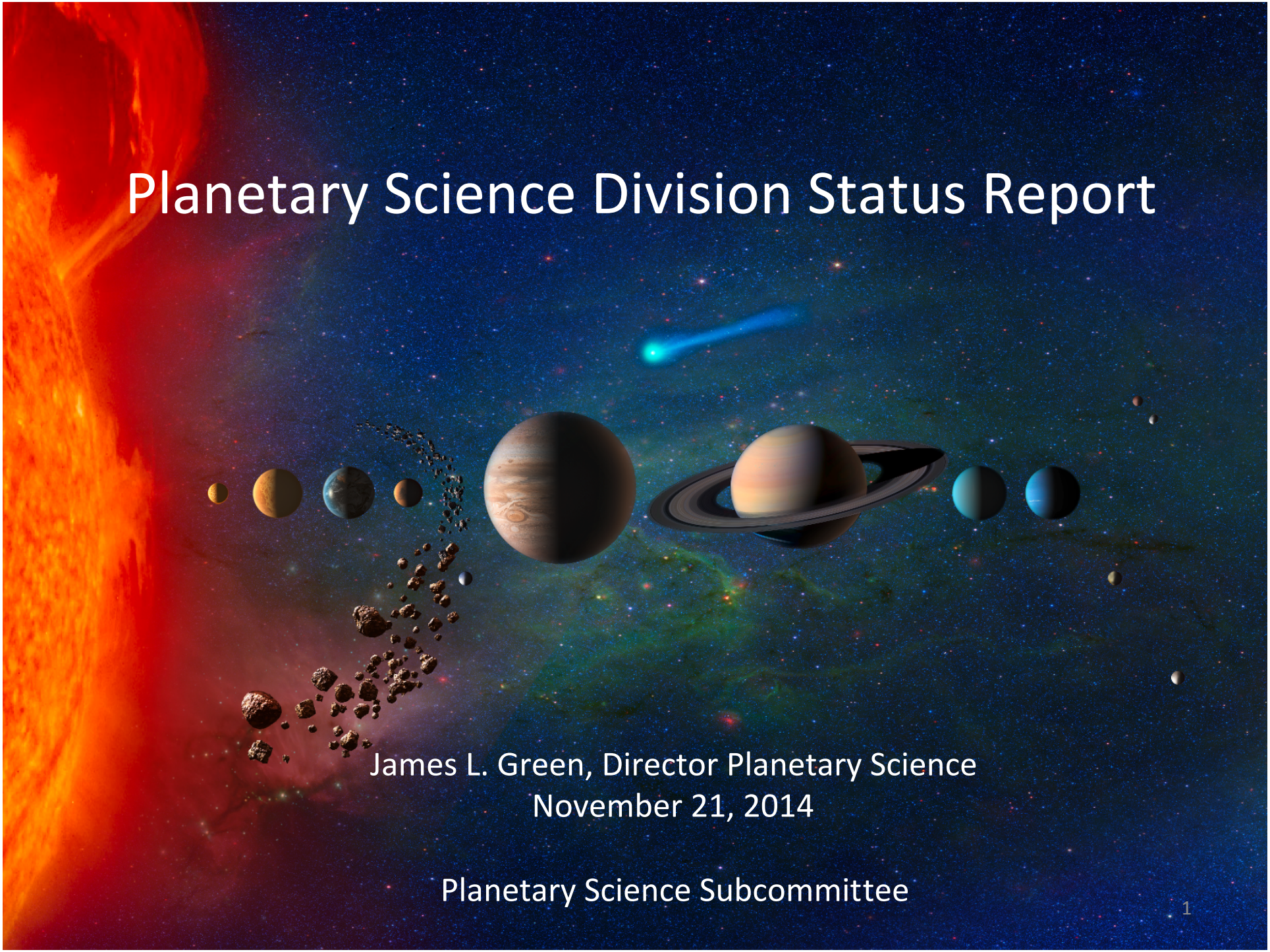
Planetary Science Division Status Report



James L. Green, Director Planetary Science

November 21, 2014

Planetary Science Subcommittee

Outline

- Planetary Upcoming Mission Events
- Recent Accomplishments
- Mars Program Update
- MAVEN Arrives at Mars
- Comet Siding Spring (CSS) Encounter with Mars
- Use of Astrophysics Telescopes
- SMD EPO CAN

Planetary Science Missions Events *as of July 24, 2014*

2014

July – *Mars2020* Rover instrument selection announcement

August 6 – 2nd Year Anniversary of *Curiosity* Landing on Mars

September 21 - *MAVEN* inserted in Mars orbit

October 19 – Comet Siding Spring encountered Mars

September - *Curiosity* arrives at Mt. Sharp

November 12 – ESA's *Rosetta* mission lands on Comet Churyumov–Gerasimenko

November 30 – Launch of *Hayabusa-2* to asteroid 1999 JU_3

2015

January – Discussions with Indian Space Research Organization (ISRO)

March - *MESSENGER* spacecraft impacts Mercury

Late March – *Dawn* inserted into orbit at dwarf planet Ceres

April - Europa instrument Step 1 selection

May - Discovery 2014 Step 1 selection

July 14 – *New Horizons* flies through the Pluto system

2016

March – Launch of Mars missions *InSight* and ESA's *ExoMars Trace Gas Orbiter*

March - Europa instrument step 2 selection

July - *Juno* inserted in Jupiter orbit

July – ESA's *Bepi Columbo* launch to Mercury

August - Discovery 2014 Step 2 selection

September - *InSight* Mars landing

September – Launch of Asteroid mission *OSIRIS – REx* to asteroid Bennu

September - *Cassini* begins to orbit between Saturn's rings & planet

* **Completed**

Recent Accomplishments

- Released Discovery AO - November 5, 2014
  - Step-1 proposals due in February 2015
- Europa Instrument AO - October 17, 2014
  - Currently under review
- R&A all but one core program has had review since restructuring (Rall presentation)
  - Community is actively involved and reviewers generally pleased with process

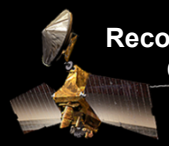
Mars Program

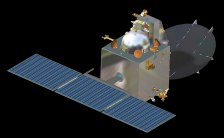
Mars Missions this Decade

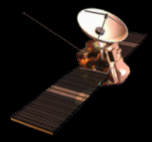
Operational
Launched 2001–2013

2016 | **2018** | **2020** | **2022**

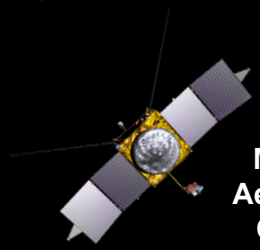

Odyssey


Mars Reconnaissance Orbiter


ISRO Mars Orbiter Mission


ESA Trace Gas Orbiter (Electra)

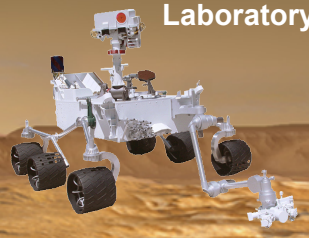

ESA Mars Express


MAVEN Aeronomy Orbiter

Follow the Water | *Habitable Environments* | *Seeking Signs of Life* | *Future*

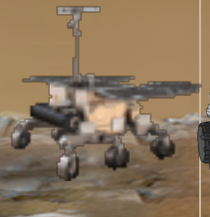
Opportunity

Curiosity – Mars Science Laboratory

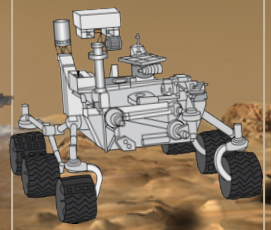


InSight

ESA ExoMars Rover (MOMA)

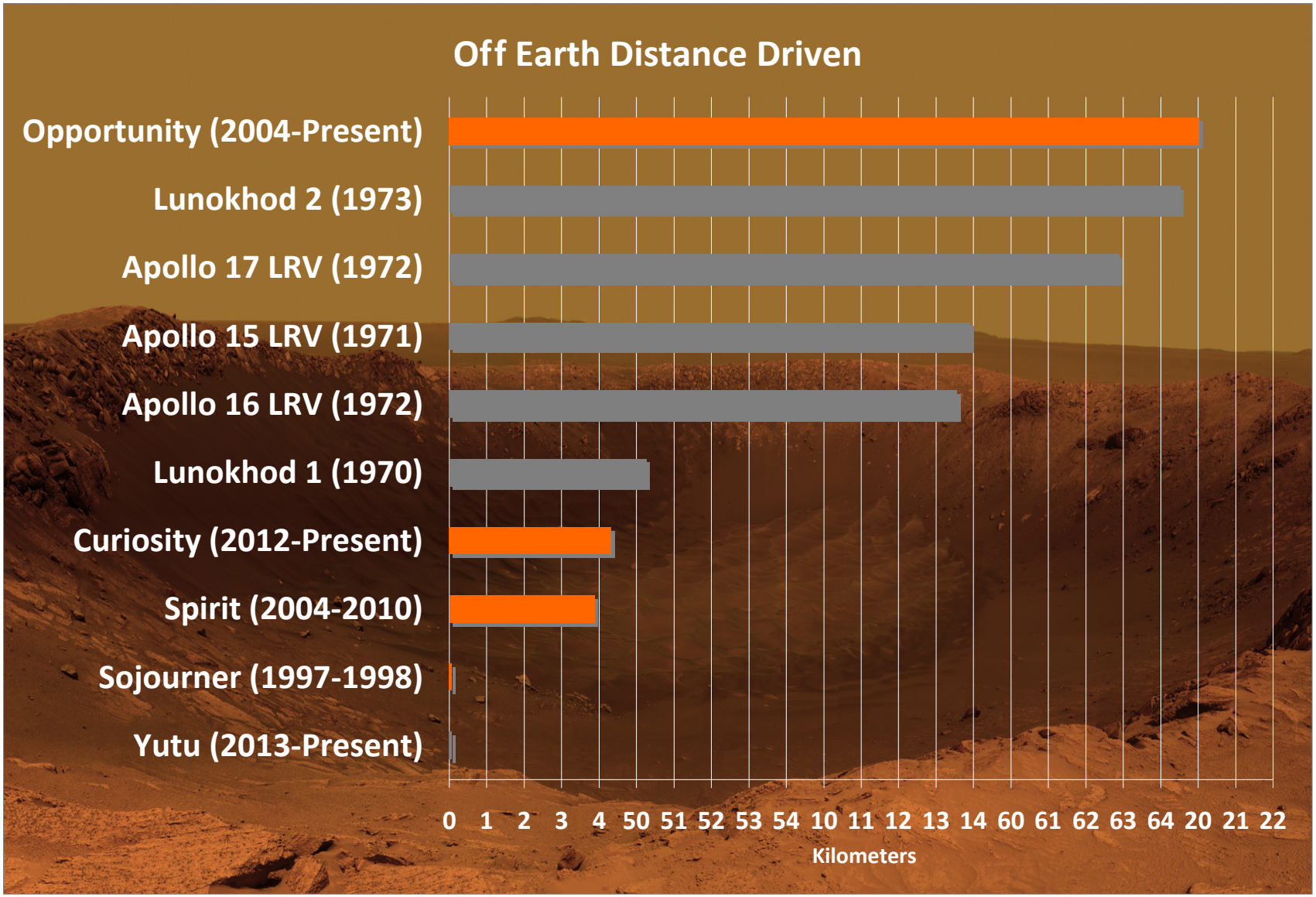


2020 Science Rover



6

Off-Earth Odometry Records



2014-07-20

MAVEN: Mars Orbit Insertion

Sept 12	13	14	15	16	17	18	19	20	21	22	23
MOI Rel	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1

TCM-4

CLT 27 Hrs
Battery 100%
Pre-MOI Uplinks

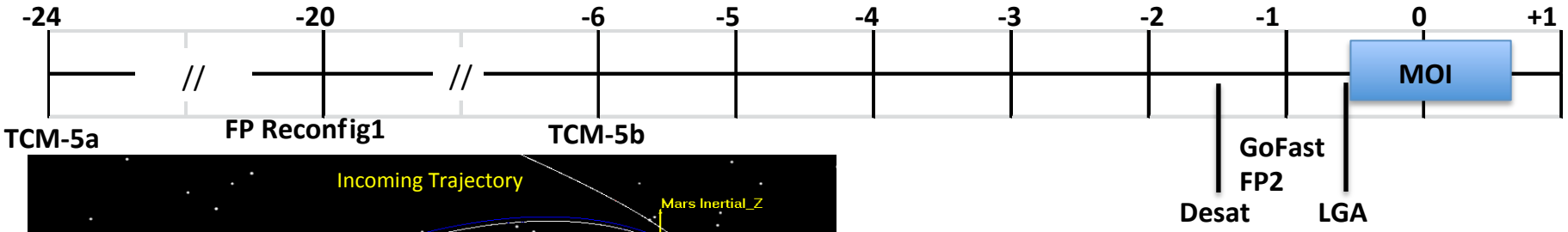
Prop Tank Preheat
CMIC Copies
LV30 Open
Phase = MOI
Start moi_nom

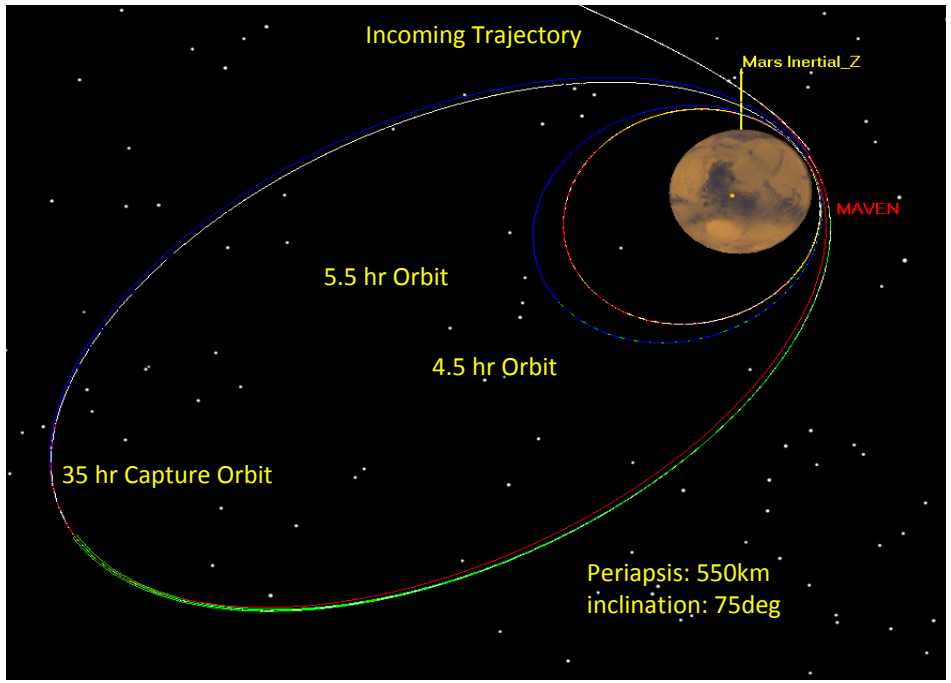
MOI

A1

End
MOI
Phase

MOI Countdown (Hrs)

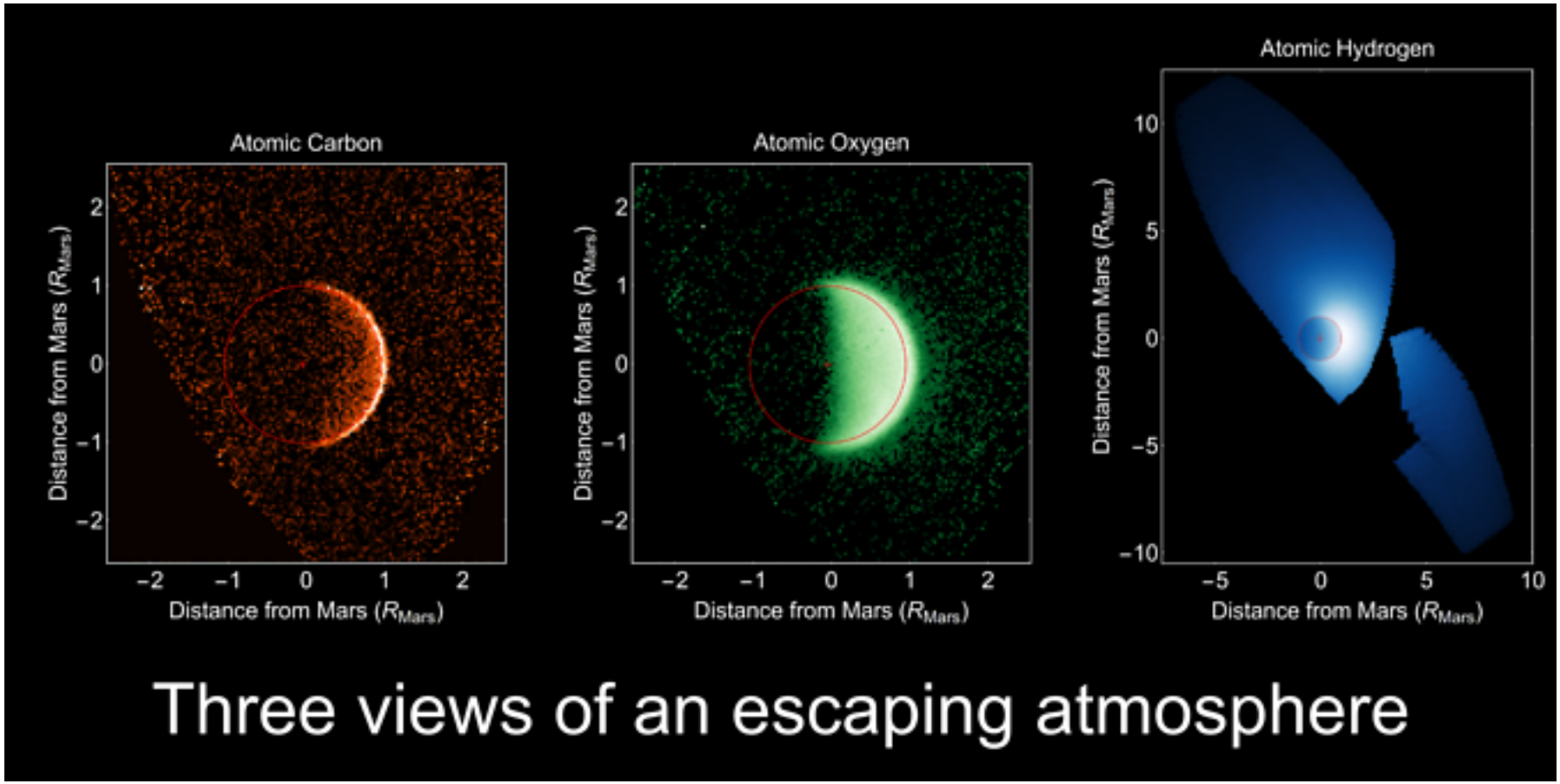




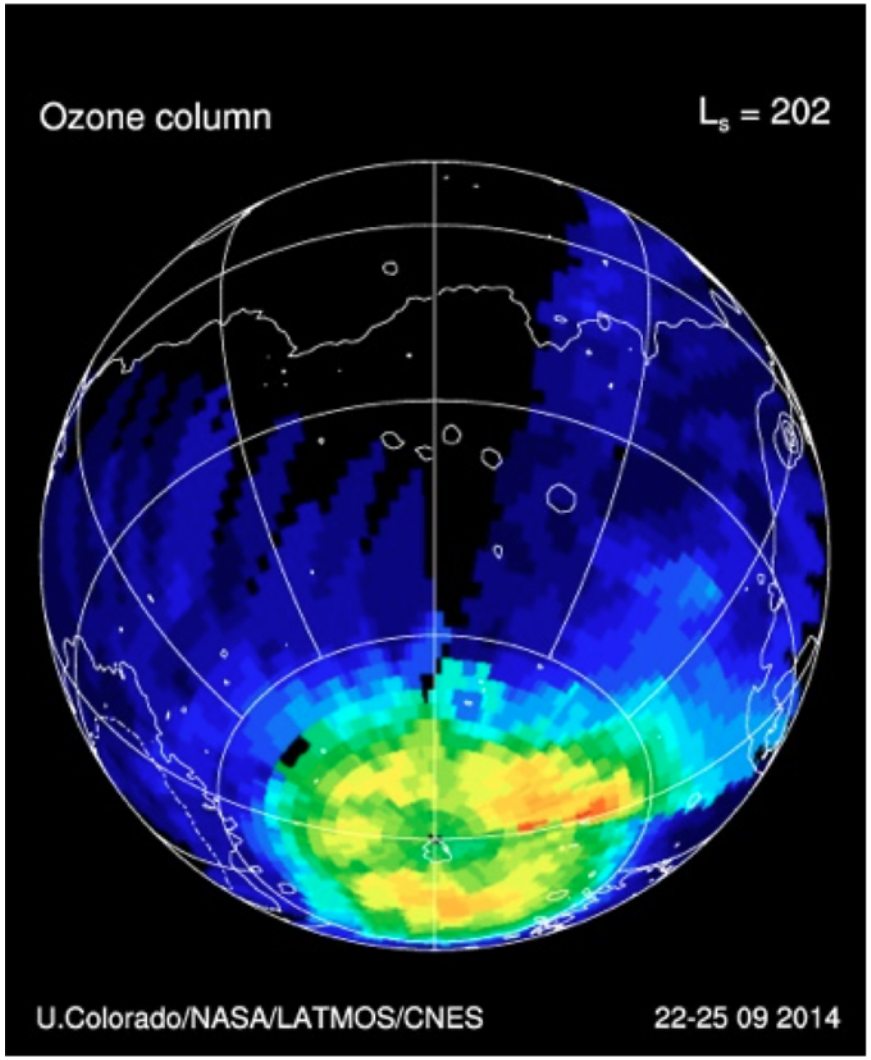
- MOI will occur on 9/21/14 (ET)
- Sequence activates 3 days out
- Emergency TCM 5a and 5b opportunities at MOI-24 hours and MOI-6 hours
- Configure for GoFast Recovery (MOI-1 hour)
- In contact with earth during the entire burn sequence
- Primary operations at LM-Denver, backup operations at Goddard

Escape of Climate Controlling Gases

- In 35 hour orbit obtained unique observations



Bruce Jakosky, UCB

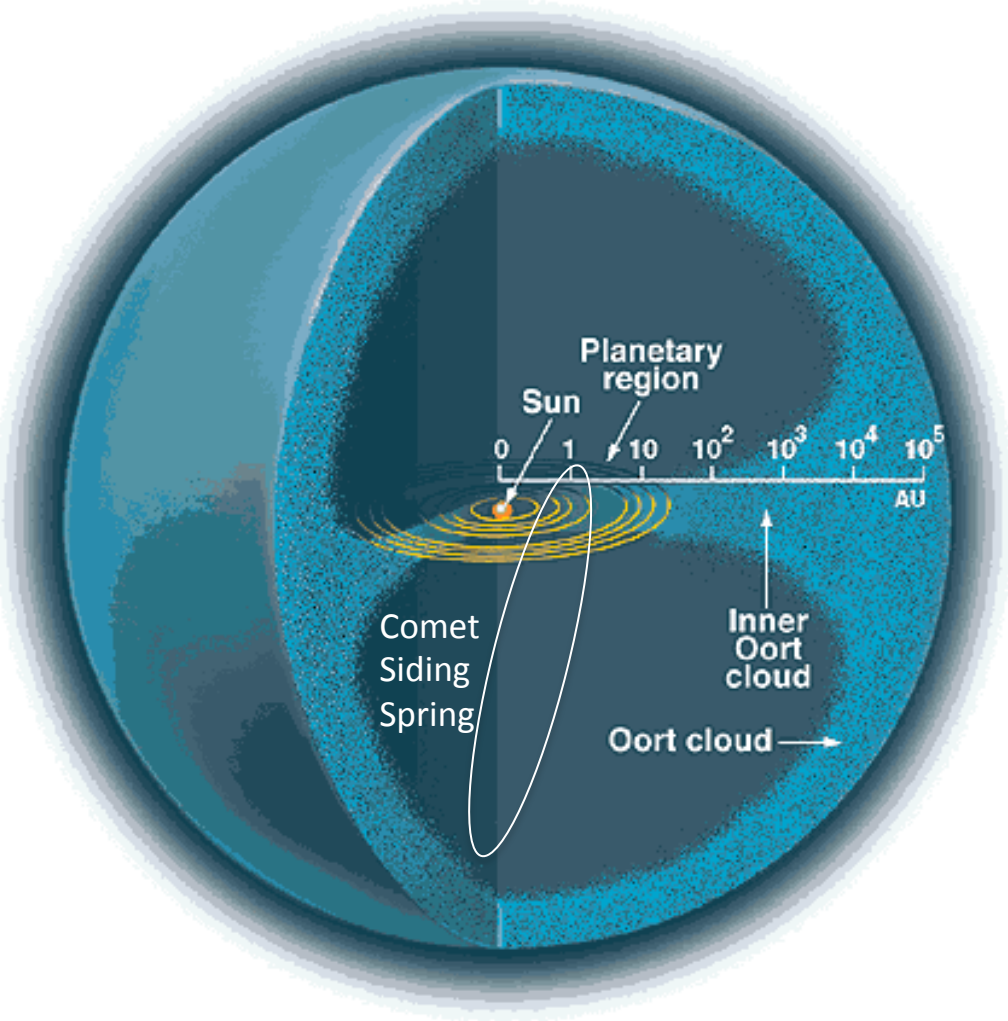


- On Mars, ozone is primarily destroyed by the combined action of water vapor and sunlight
- The cold, dark conditions near the pole allow ozone to accumulate

Bruce Jakosky, UCB

Overview of Siding Spring

- C/2013 A1 (Siding Spring) is an Oort cloud comet discovered on January 3, 2013, by Robert McNaught at Siding Spring Observatory at 7.2 AU
- Comet C/2013 A1 took millions of years to come from the Oort cloud
- It is believed that this is its first passage by the Sun
- On October 19, 2014, passed within ~130,000 km from Mars

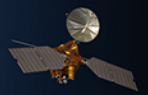


How NASA Assets Observed
COMET SIDING SPRING

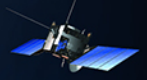
Closest Approach to Mars on October 19, 2014


BOPPS, a sub-orbital balloon, observed the comet in September 2014


NASA's Infrared Telescope Facility observed the comet in Jan., Sept. and observed Mars in Oct. 2014


Mars Reconnaissance Orbiter observed the comet in October 2014


Mars Odyssey observed the comet in October 2014


ESA's Mars Express observed the comet and Mars in October 2014


MAVEN observed the comet and Mars in October 2014**

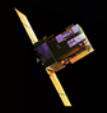

Opportunity Rover observed the comet in October 2014


Curiosity Rover made observations in October 2014


Hubble observed the comet in Oct. 2013 and Jan/Mar 2014,* and observed the comet and Mars in October 2014


Swift observed the comet multiple times since November 2013


STEREO detects the comet in its observations


SOHO detects the comet in its observations


NeoWISE observed the comet in January, July and September 2014


Spitzer observed the comet in March and October 2014


Kepler observed the comet in October 2014


Chandra observed the comet in October 2014

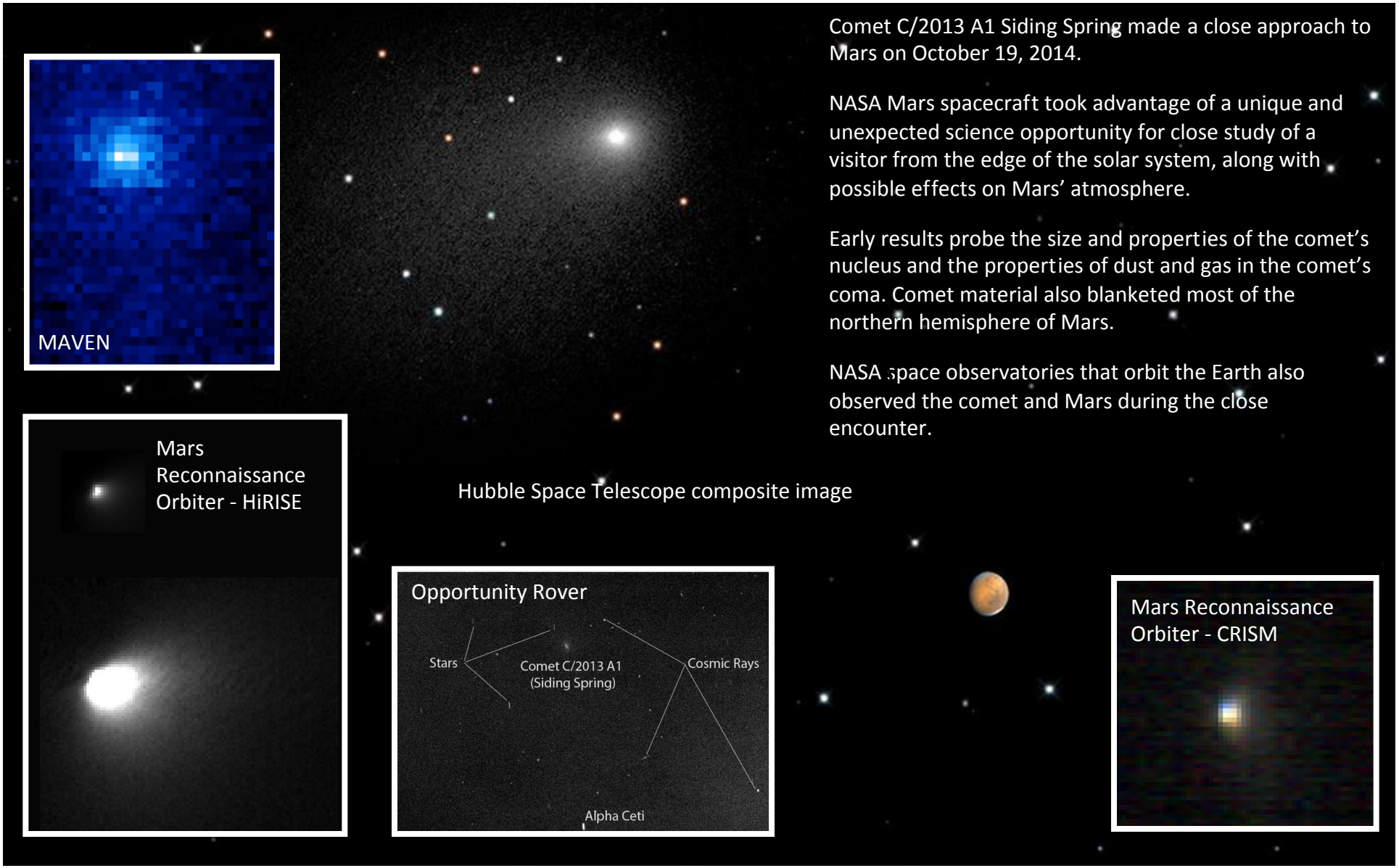
*Comet Image shown was processed by Hubble on March 11, 2014

**India's Mars Orbiter Mission obtained orbit 09/24/14

http://mars.nasa.gov/comets/sidingspring
http://cometcampaign.org

#JOURNEYTOMARS

First Released Images of Comet Siding Spring Encounter from NASA's Mars and Space Assets

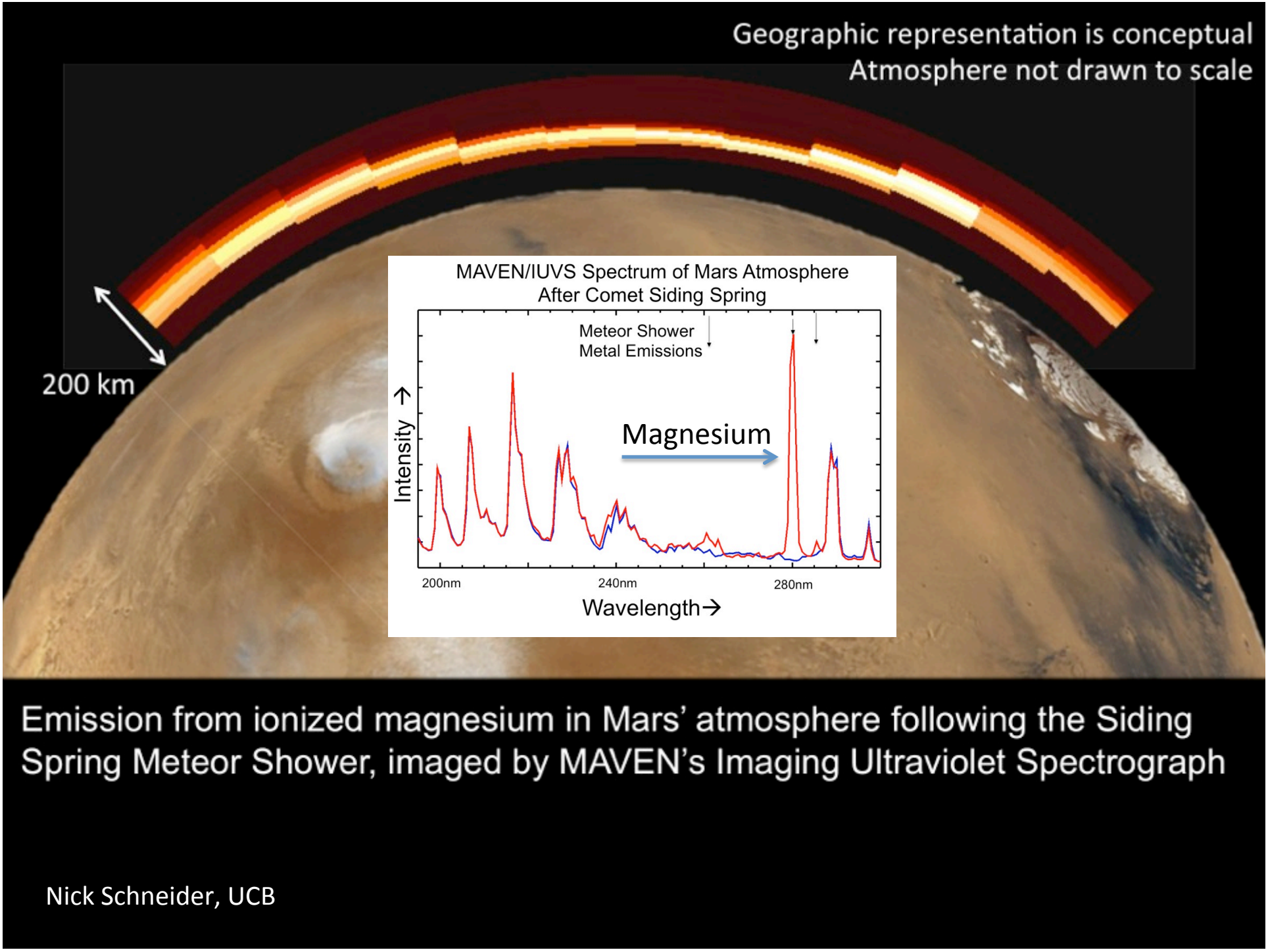


Comet C/2013 A1 Siding Spring made a close approach to Mars on October 19, 2014.

NASA Mars spacecraft took advantage of a unique and unexpected science opportunity for close study of a visitor from the edge of the solar system, along with possible effects on Mars' atmosphere.

Early results probe the size and properties of the comet's nucleus and the properties of dust and gas in the comet's coma. Comet material also blanketed most of the northern hemisphere of Mars.

NASA space observatories that orbit the Earth also observed the comet and Mars during the close encounter.



Emission from ionized magnesium in Mars' atmosphere following the Siding Spring Meteor Shower, imaged by MAVEN's Imaging Ultraviolet Spectrograph

Nick Schneider, UCB

Rosetta Mission New Results

NASA Contribution to ESA's Rosetta Mission

1. 3 instruments plus a significant portion of the electronics package for another (MIRO, ALICE, IES, and ROSINA DFMS Electronics)
2. 3 Principal Investigators, Interdisciplinary Scientist
3. 40 Co-Investigators and researchers
4. Deep Space Network 70 meter and 34 meter support
5. Scheduling software for science observations
6. Multi-mission Ephemeris Support tool
7. Comet modeling
8. Shadow navigation for flight dynamics verification
9. Outreach and media products
10. Support for ESA's Amateur Ground Observing Campaign

NASA Hardware Contribution

ALICE (an ultraviolet imaging spectrometer) will map the comet's nucleus for pockets of both dust and ice - Alan Stern, SWRI

MIRO (Microwave Instrument for the Rosetta Orbiter) will remotely examine the vicinity for signs of water coming off the nucleus and will construct temperature maps - Sam Gulkis, JPL

IES (Ion and Electron Sensor) will look for examples of direct interaction between the solar wind and the nucleus - James Burch, SWRI

ROSINA (Rosetta Orbiter Spectrometer for Ion and Neutral Analysis) will identify gases sublimating from the comet. NASA is providing ROSINA's DFMS (Double Focusing Mass Spectrometer) Electronics - Stephen Fuselier, SWRI

NASA Participation in the Rosetta Payload

Orbiter Teams

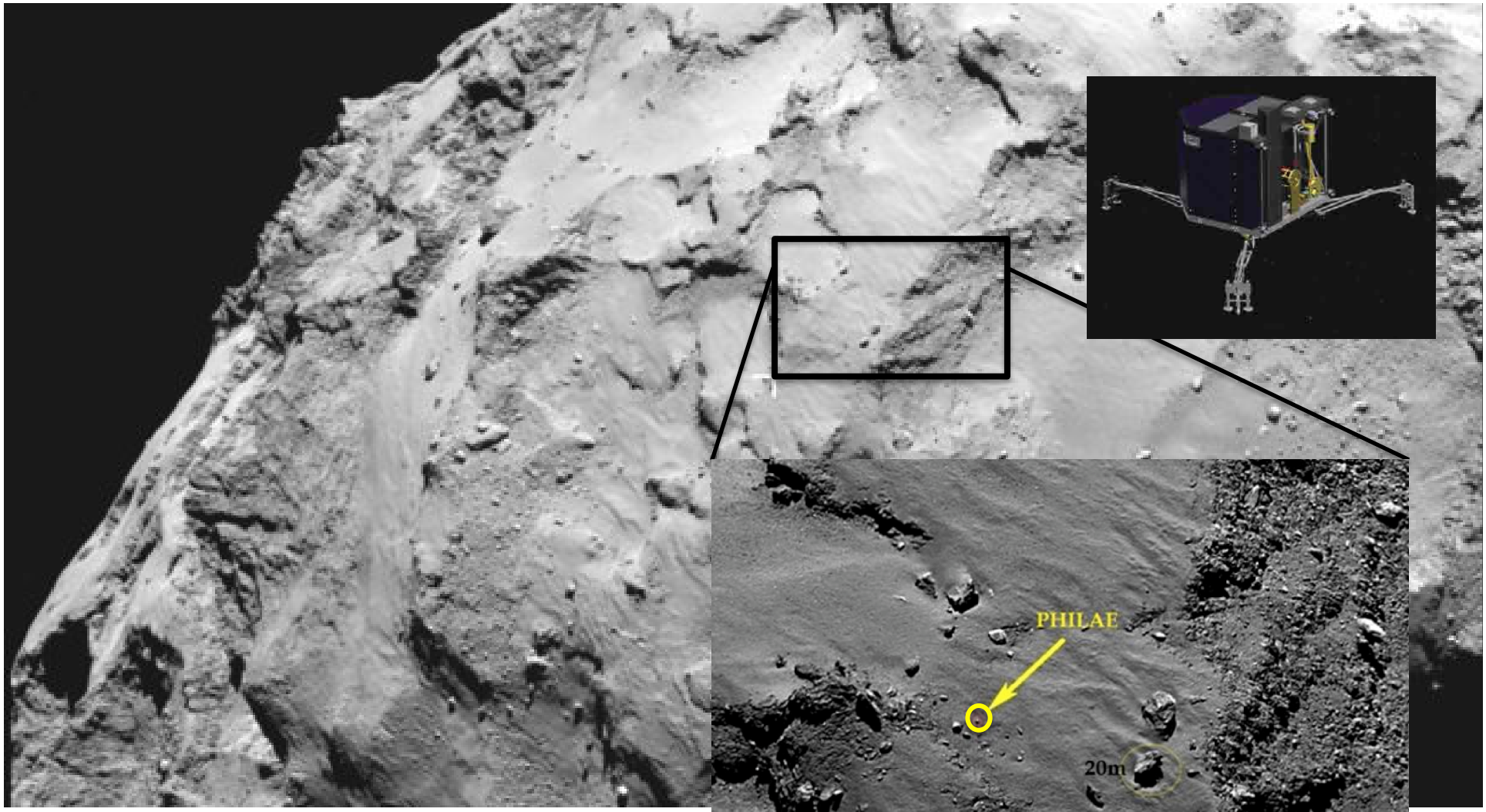
1. ALICE - UV spectrometer
2. CONSERT - tomography/radio sounding
3. COSIMA - chemistry
4. GIADA - dust analysis
5. IES - ion and electron sensor
6. ICA - plasma analyzer
7. MAG - magnetometer
8. MIDAS - atomic force microscope (dust particles)
9. MIP - magnetic impedance probe
10. MIRO - microwave spectrometer / radiometer
11. LAP - Langmuir probe
12. OSIRIS - camera
13. ROSINA - mass spectrometer
14. RSI - radio science
15. VIRTIS - IR spectrometer

Lander Terms

16. APXS - X-ray spectrometer
17. CIVA - lander mass spectrometer
18. COSAC - lander mass spectrometer
19. MODULUS - gas analyzer
20. MUPUS - probe
21. ROLIS - lander descent camera
22. ROMAP - lander magnetometer/material magnetism
23. SESAME - seismic data
24. CONSERT (2) - tomography/radio sounding
25. SD2 - drill
26. PTOLEMY - gas analyzer

Legend:
NASA hardware contribution
NASA Investigator Participation

Rosetta at Comet Churyumov-Gerasimenko



Square is the site for the Philae lander

Yellow circle shown to size of lander

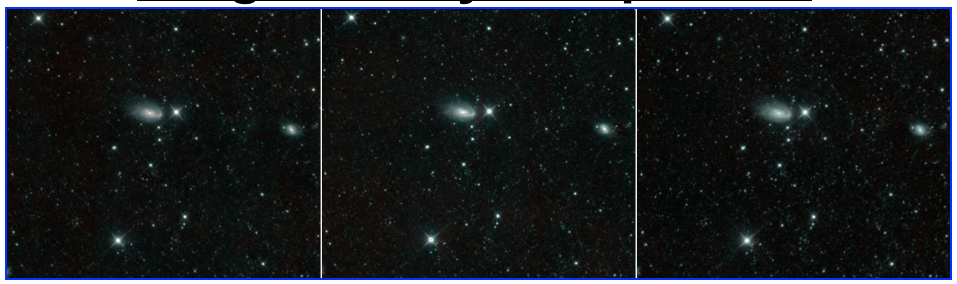
Philae will attempt landing on Nov. 12th

Credit: ESA/Rosetta/OSIRIS
Stuart Atkinson, Rosetta Ameteur Campaign Team

Use of Astrophysics Telescopes

Wide-field Infrared Survey Explorer (*WISE*)
NEOWISE Restart

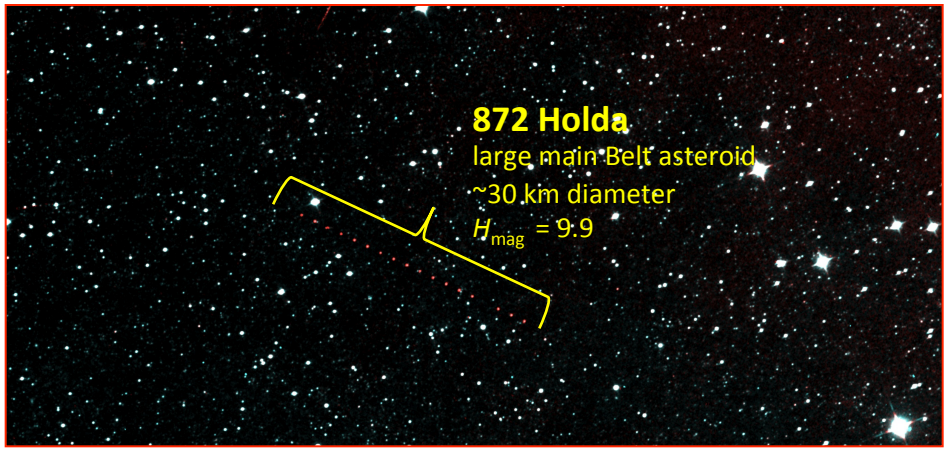
Image Quality Comparison

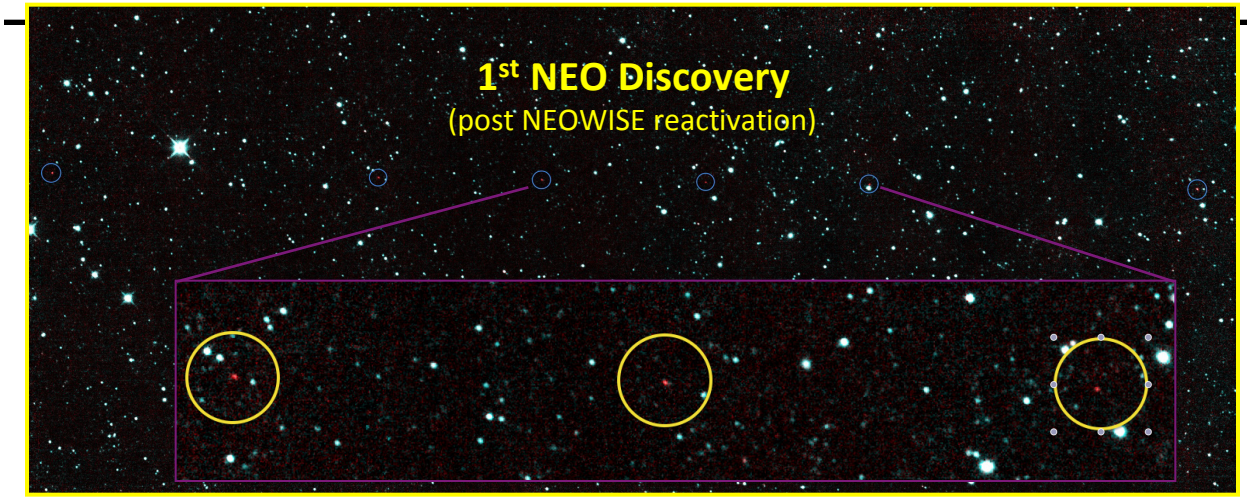


Cryogenic WISE mission | **Post-cryo prime NEOWISE mission** | **NEOWISE Restart mission**

An intermediate spiral galaxy, NGC 4654, in the constellation of Coma Berenices. This galaxy is ~55 million light years away (imaged in 3.4 μm [W1] and 4.6 μm [W2]). There is almost no degradation in image quality!

An Initial Reactivation Image





Detection of a potentially hazardous asteroid 2013 YP_{139}

- Minimum approach distance of only 1 lunar distance
- Preliminary estimate of characteristics: 650 (±230) meters, 1-3% albedo, H_{mag}=21.6
- Velocity 3.2° per day across the sky at time of discovery
- NEOWISE made 6 detections in 0.4 days

New NEO Discovery Talley

Designation	Size (m)	Albedo
2013 YP_{139}	660	0.01
2014 AQ_{46}	860	0.03
2014 AA_{53}	710	0.06
2014 BG_{60}	770	0.02
2014 BE_{63}	600	0.02
2014 CY_{4}	510	0.04
2014 CF_{14}	790	0.16

Plus, new comet (C/2014 C3, aka 'Comet NEOWISE')

03/07/14

Astrophysics Division Telescopes

- HST surveys approved:
  - NH KBO (3 found) & Europa plumes
  - Hubble DD program to execute every year until the end of mission.
    - A total of 29 orbits/yr for Cycles 22-24, 41 orbits per Cycle thereafter.
    - Two global maps each for Jupiter, Uranus, Neptune and Saturn (starting after end of Cassini).
  - More planetary proposals to HST are encouraged!
- Spitzer operations extended for the next two yrs
  - Astrophysics and the Planetary Science Divisions have requested observing time commitments for FY15
- Spitzer & Keck solicit high priority investigations of solar system objects:
  - Planetary science proposals reviewed, and selected in accordance with current Spitzer and Keck proposal practice
  - PSD strongly encourages you to submit Planetary proposals for time
- K2 Mission will make use of the Kepler spacecraft and its assets to expand its discoveries. K2 will provide opportunities for solar system observations.
  - Generally, slow moving sources and major planets between V=4 and 20 will be possible targets.
  - K2 has a funded GO program accepting proposals twice a year.

Spitzer Cycle-11 Overview

- 157 proposals received - 41,970 hours!
  - 137 proposals in Cycle-10 - 31,817 hours
- Oversubscription of ~5.4

- 15 proposals - twice as many as Cycle-10
- 5 times the hours requested in Cycle-10

SciCat	Number	Hours
SOLAR SYSTEM		
asteroids	5	142.3
comets	4	597.8
KBO	2	44.3
NEO	2	2710.1
satellites	2	19.7
Total	**15**	**3514.2**

Astrophysics Mission & Solar System Science

Planetary Science and Astrophysics divisions held joint workshops at the DPS:

A) SOLAR SYSTEM OBSERVATIONS WITH THE K2 MISSION

TUESDAY, NOVEMBER 11, 2014

Discuss the scientific capabilities of the K2 mission for Solar System science. This workshop consisted of:

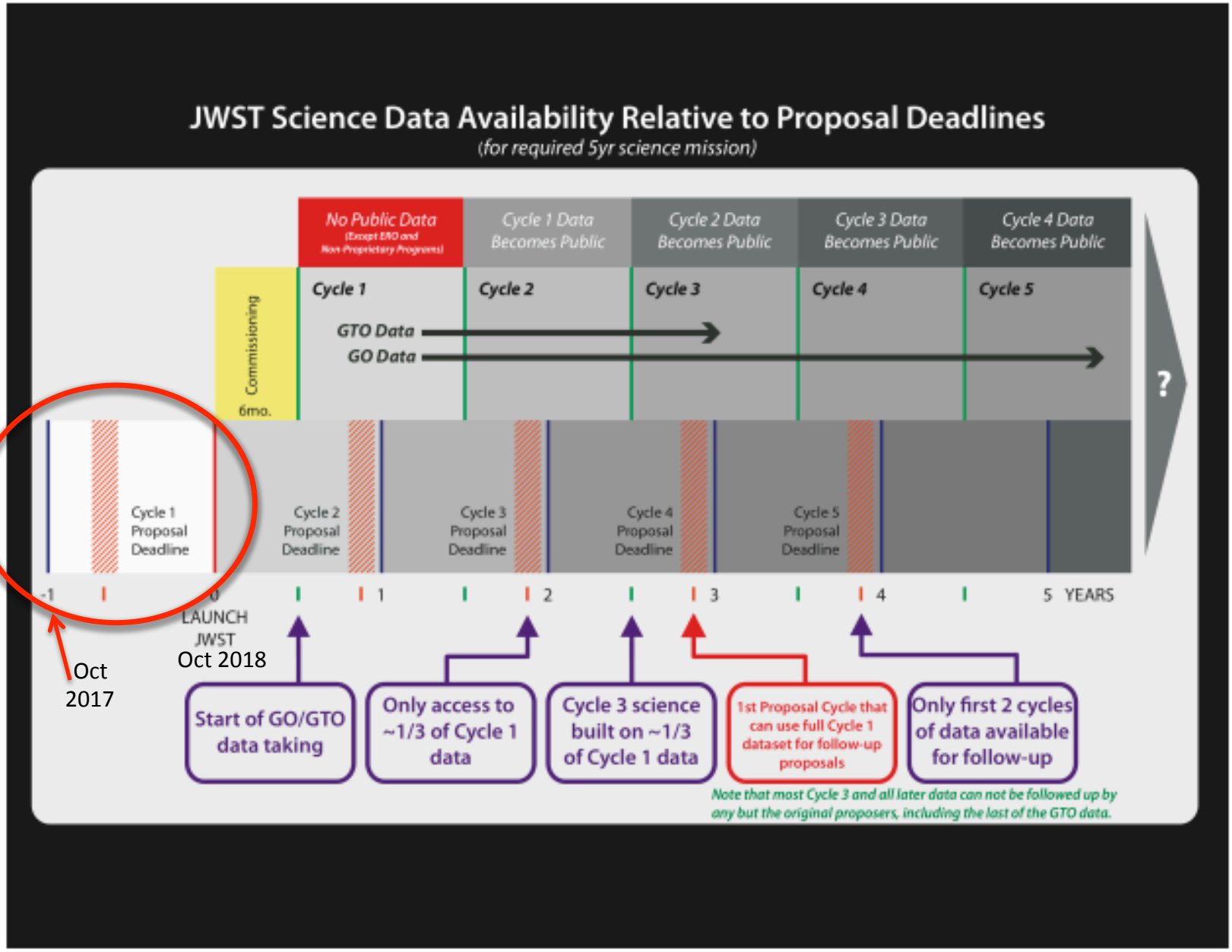
1. Presentations on the K2 mission
2. Solar System Observations with the mission, and
3. Discussion with the broader community to identify observatory capabilities and envision future opportunities.

B) JWST WORKSHOP ON POTENTIAL SCIENCE INVESTIGATIONS

SUNDAY, 9 NOVEMBER, 2014

Provide community input on potential solar system science with JWST. This workshop consisted of:

1. Presentations offindings from the focus groups,
2. Discussion with the broader community to identify gaps in the focus-group science use cases and in envisioned observatory capabilities. These outputs from the workshop will be used to inform ongoing development and pre-launch operational studies.



GDI – 11/04/09 JSTAC
(with 7-8 months between proposal deadline and start of science observations)

SMD EPO CAN

SMD EPO Draft CAN

- Draft Cooperative Agreement Notice (CAN) released for community comments Thursday November 6, 2014
- Draft text downloadable from the NSPIRES web page at: http://nspires.nasaprs.com/
- Objectives:
  - Enabling STEM education
  - Improving U.S. science literacy
  - Advancing National education goals and
  - Leveraging science education through partnerships
- Select one or more focused, science discipline-based team(s)
- While it is envisioned that multiple agreements may be awarded, selection of a single award to support all of SMD science education requirements is not precluded.
- Awards are anticipated NLT September 30, 2015

Anticipated SMD Science Education CAN schedule:

- Final CAN Release Date (target)..... NET December 2014
- Notice of Intent to Propose Deadline..... 30 days after final CAN release
- Proposal Deadline..... 90 days after final CAN release
- Selections Announced (target)..... Summer 2015
- Projects Begin (target)..... October 1, 2015

Contact:
Kristen Erickson
Science Mission Directorate
NASA Headquarters
Washington, DC 20546
E-mail: CANsci-ed@hq.nasa.gov

Questions?