PROGRAM CEZHRANIČNEJ SPOLUPRÁCE
2007 2013
SLOVENSKÁ REPUBLIKA
ČESKÁ REPUBLIKA

EURÓPSKA ÚNIA
EURÓPSKY FOND REGIONÁLNEHO ROZVOJA
SPOLOČNE BEZ HRANÍC

euroregion BÍLÉ - BIELE KARPATY

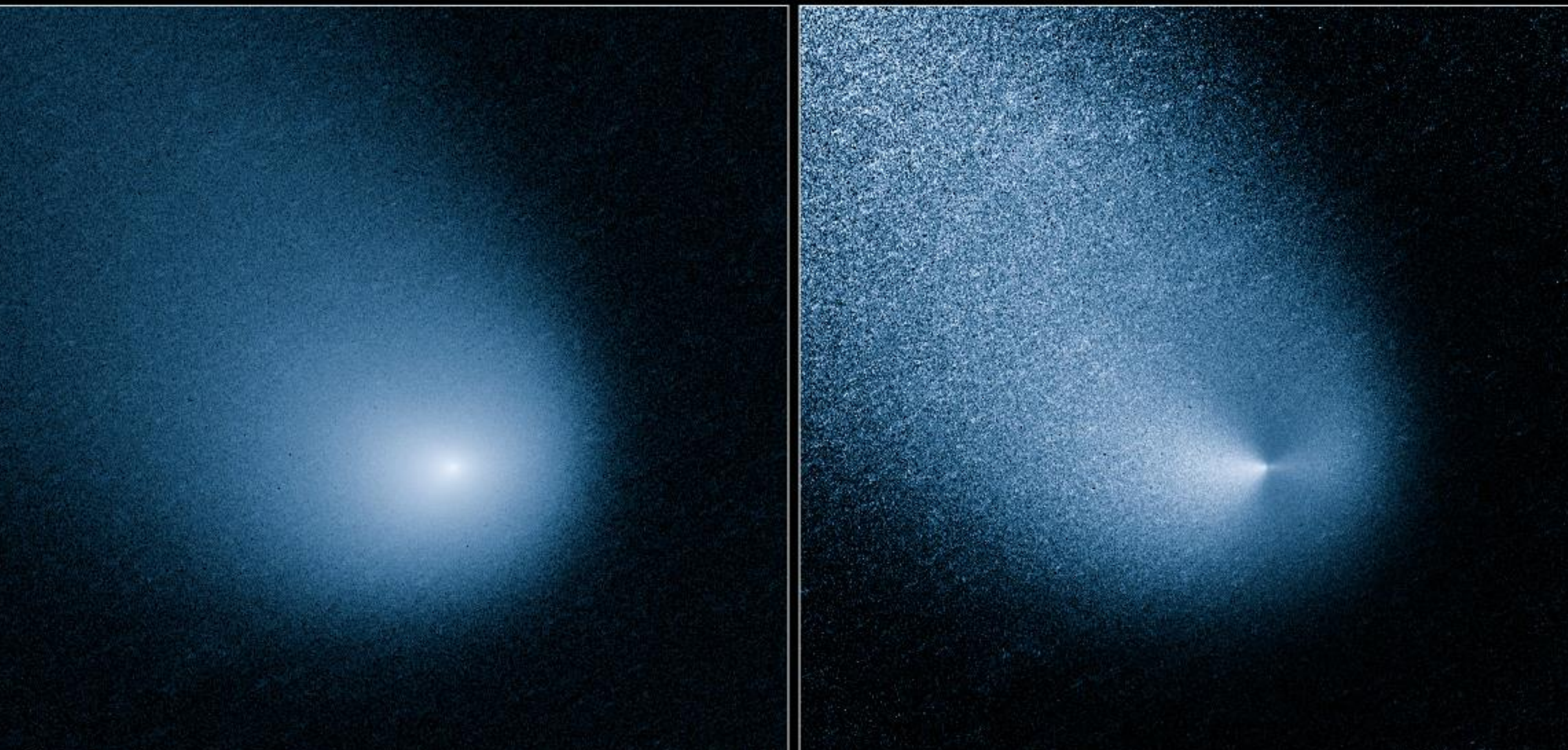
FOND MIKROPROJEKTŮ

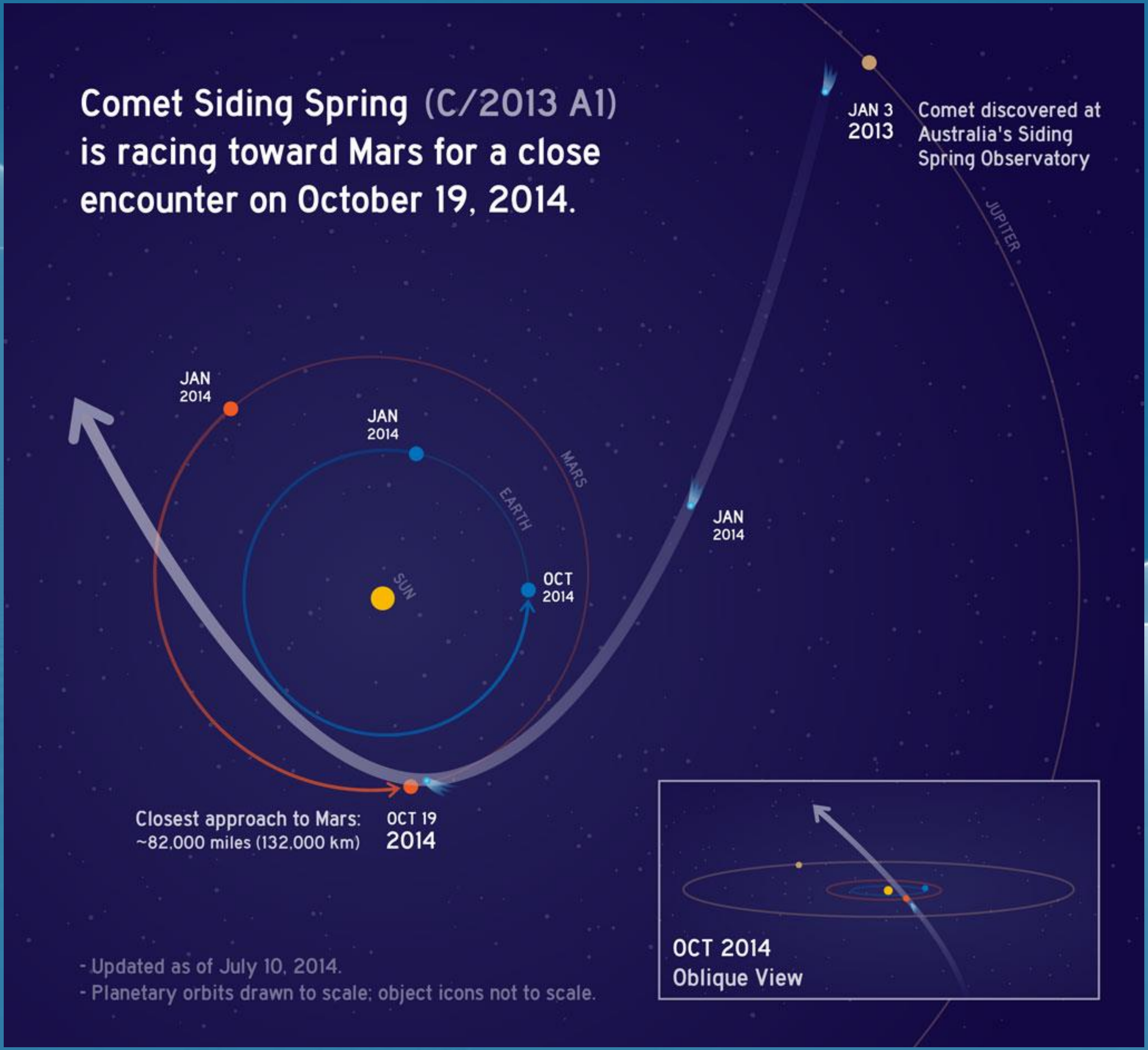
Projekt Společně pod tmavou oblohou

SPOLEČNĚ POD TMAVOU OBLOHOU


C/2013 A1
Rendezvous

C/2013 A1 (Siding Spring) - 3. 1. 2013, 7,2 AU
Robert H. McNaught, Siding Spring Observatory, 0,5 m dalekohled



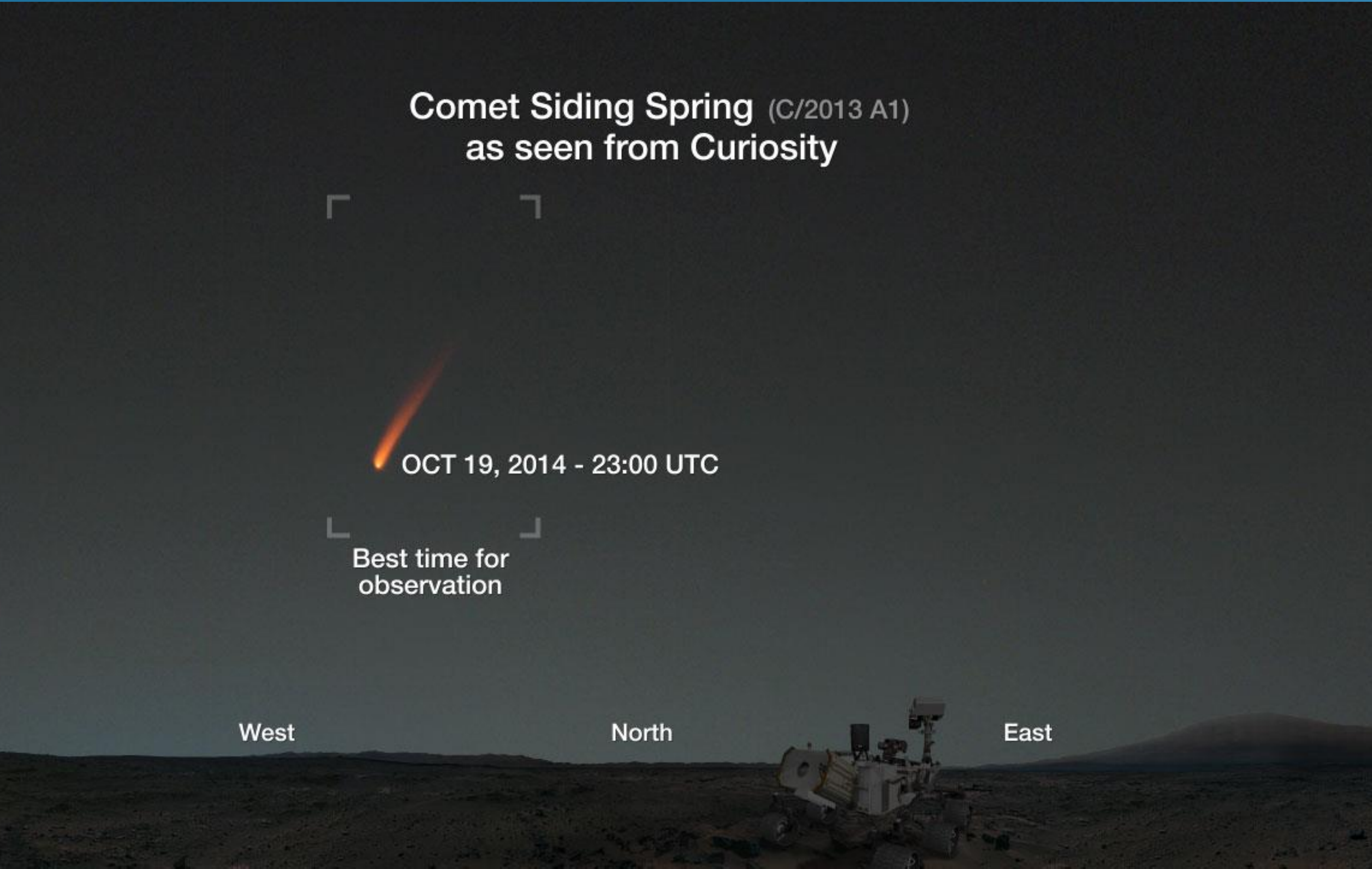


Průlet kolem Marsu:
19. 10. 2014
135,000±5000 km
18:29 UTC (±3 min)

Perihelium:
25. 10. 2014
1,4 AU

i=129°

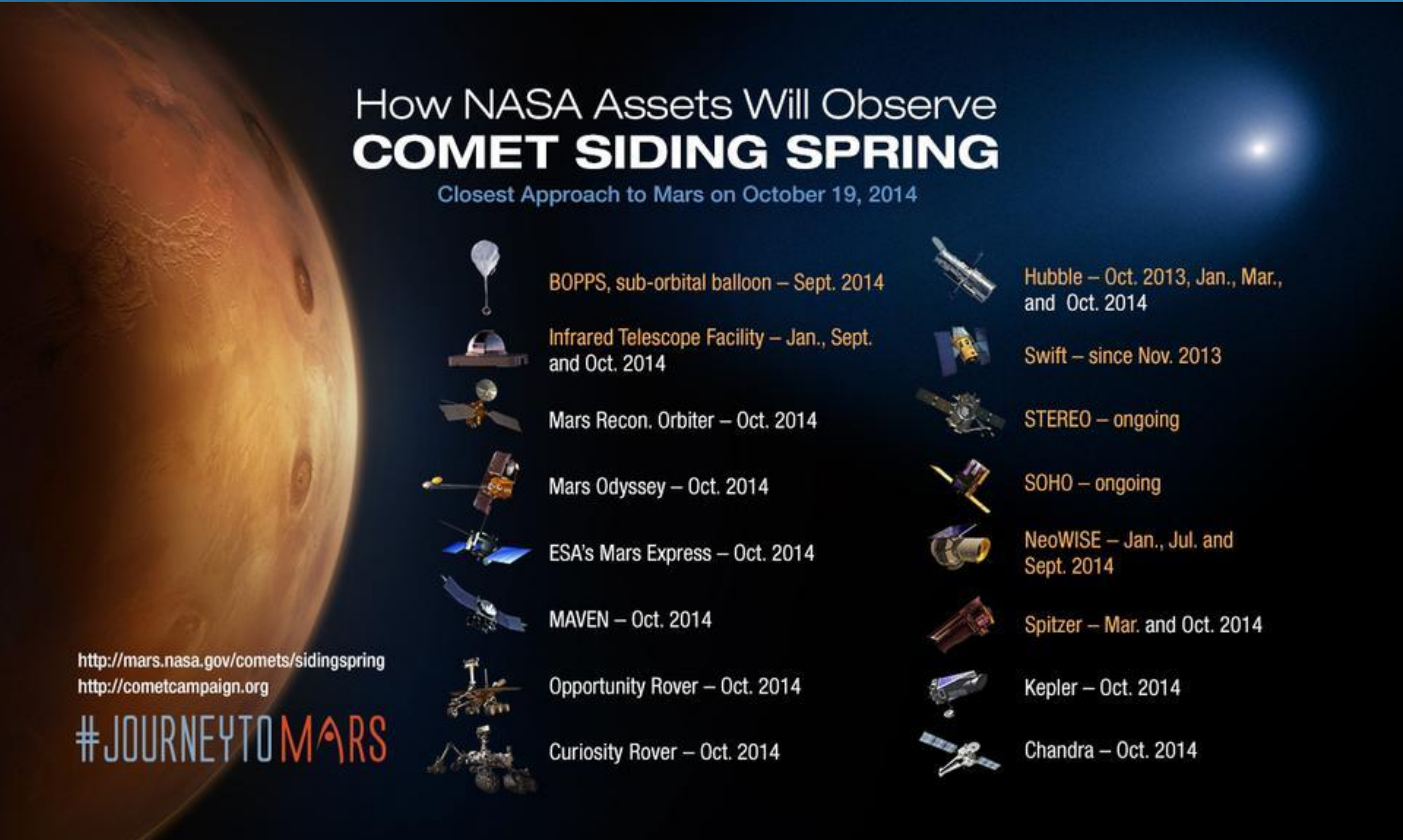
1,6 AU od Země (+10 mag)

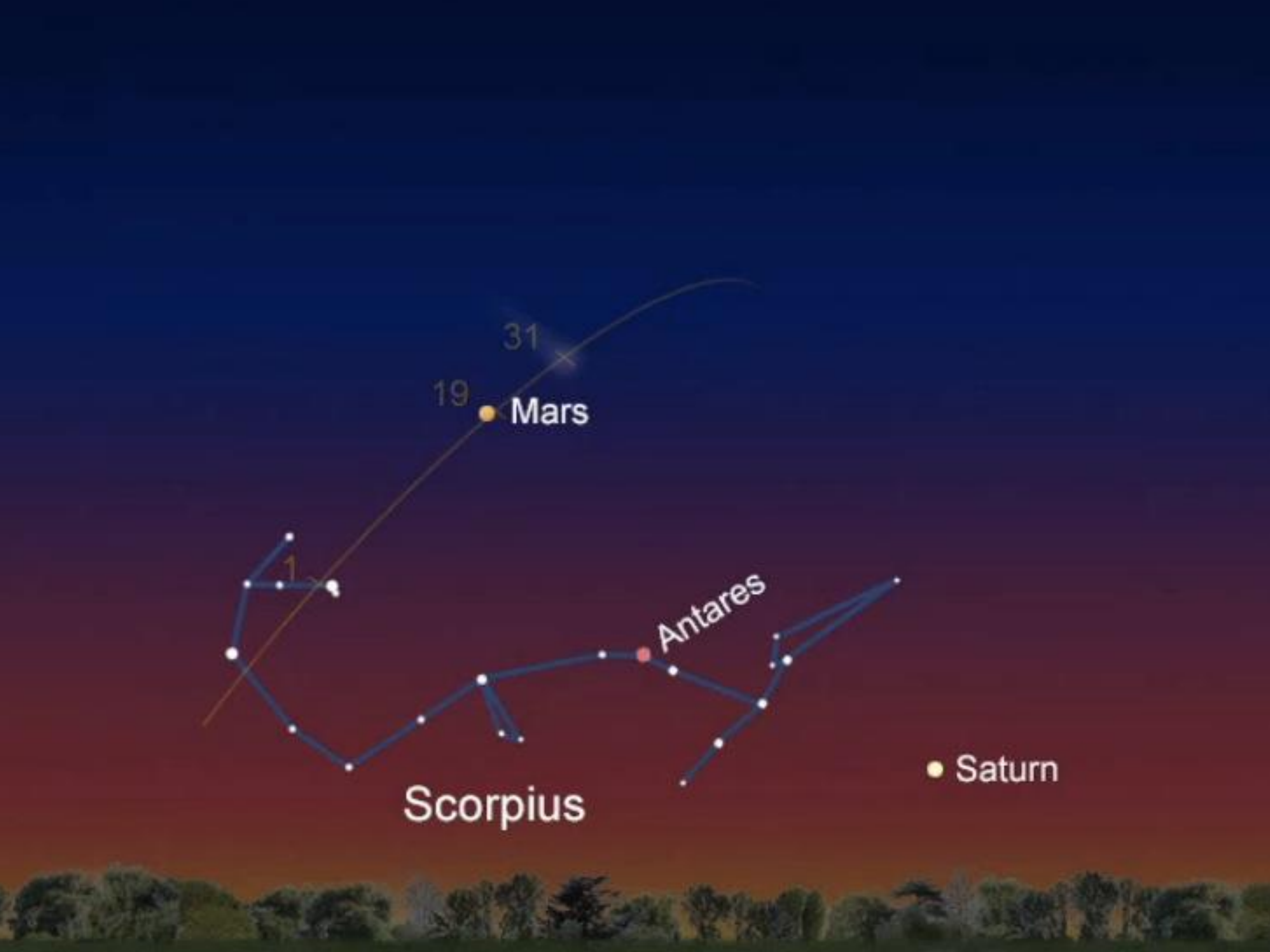

Comet Siding Spring (C/2013 A1)
as seen from Curiosity
OCT 19, 2014 - 23:00 UTC
Best time for observation
West
North
East

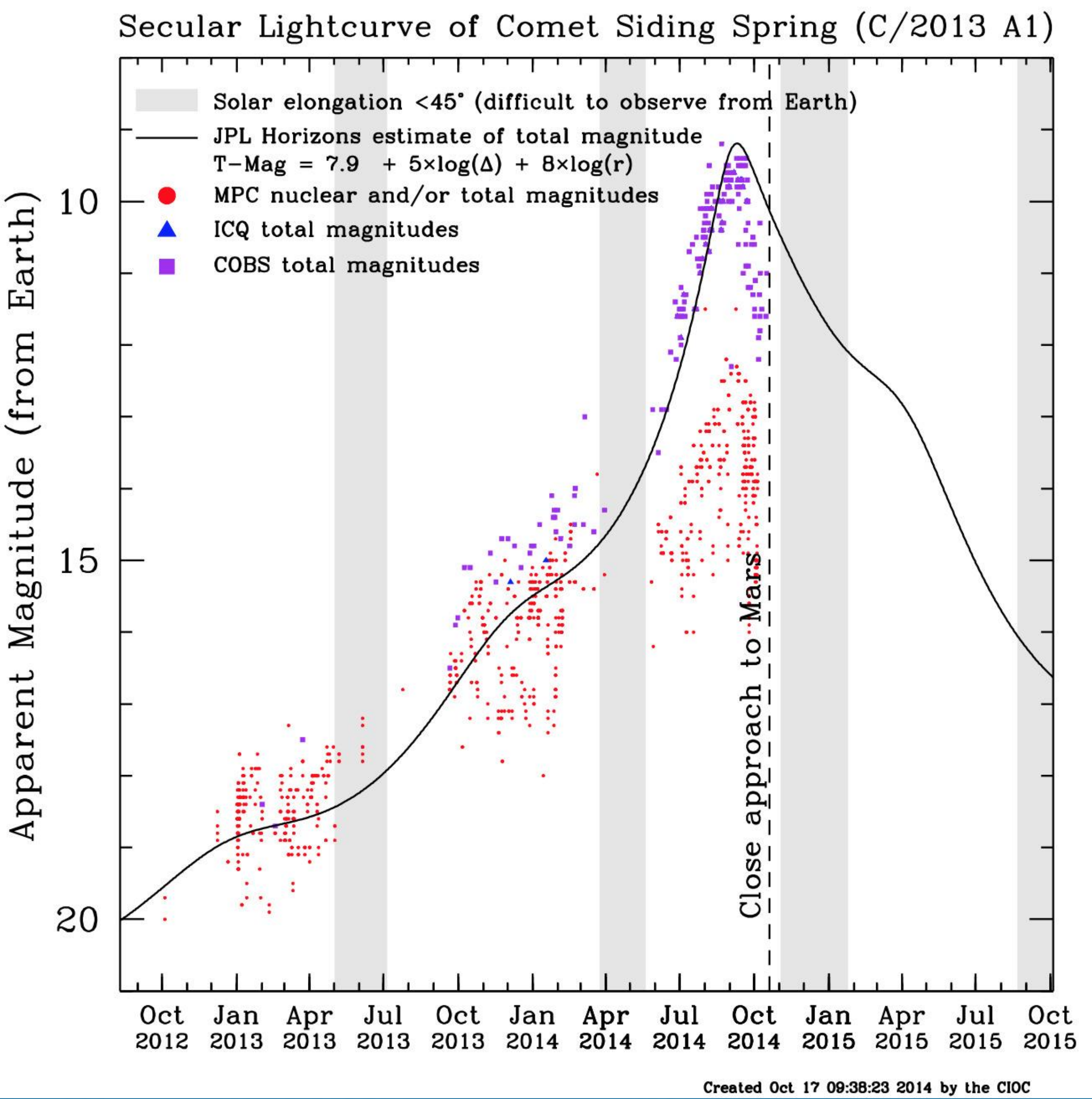
Comet Siding Spring
Planned Science Observations

TARGET	OBSERVATION OBJECTIVE	Mars Reconnaissance Orbiter: HiRISE	MRO: CTX	MRO: CRISM	MRO: MCS	MRO: MARCI	MRO: SHARAD	Mars Odyssey: THEMIS	Mars Odyssey: HEND/NS	MAVEN*: IUVS	MAVEN*: LPW, MAG, SEP	MAVEN*: NGIMS, STATIC SWEA, SWIA	Curiosity: MastCAM, CHEMCAM	Opportunity: PANCAM
COMET	**Comet General Features**					◇		◇		◆	◆		◆	◆
	Comet Nucleus (size, shape, variation)	◆												
	Comet Activity (jets, variable brightness)	◆	◆	◇				◇		◆				
	Comet Coma (variability, particle size, gas composition)	◆	◇	◆	◆	◆		◆		◆				
	Comet Tail (particle size)		◆	◇	◇	◇		◇		◆	◆			
MARS ATMOSPHERE RESPONSE	**Upper Atmosphere Composition** (neutrals, ions & electrons, meteor trails)						◇		◇	◆	◆	◆	◆	◆
	Lower Atmosphere (temperature, clouds)			◇		◇		◇		◇			◇	◇

◆ Major contribution ◇ Contribution * MAVEN observations conducted in the event of nominal transition to science orbit.


How NASA Assets Will Observe
COMET SIDING SPRING
Closest Approach to Mars on October 19, 2014
BOPPS, sub-orbital balloon – Sept. 2014
Infrared Telescope Facility – Jan., Sept. and Oct. 2014
Mars Recon. Orbiter – Oct. 2014
Mars Odyssey – Oct. 2014
ESA's Mars Express – Oct. 2014
MAVEN – Oct. 2014
Opportunity Rover – Oct. 2014
Curiosity Rover – Oct. 2014
Hubble – Oct. 2013, Jan., Mar., and Oct. 2014
Swift – since Nov. 2013
STEREO – ongoing
SOHO – ongoing
NeoWISE – Jan., Jul. and Sept. 2014
Spitzer – Mar. and Oct. 2014
Kepler – Oct. 2014
Chandra – Oct. 2014
http://mars.nasa.gov/comets/sidingspring
http://cometcampaign.org
#JOURNEYTOMARS


31
19
Mars
1
Antares
Saturn
Scorpius



Stav k 17.10.2014

CIOC

(Coordinated Investigations Of Comets)

Table I. Siding Spring Observational Data

Date	r_h [1] (AU)	Δ [2] (AU)	α [3] (deg)	A(0)fρ [4] (cm)	Comments [5]
PanSTARRS					
20 Nov 2011	10.3	9.6	4		Undetected
2 Dec 2011	10.2	9.5	4		Undetected
HST/WFC3					
29 Oct 2013	4.6	4.0	11	2705	
21 Jan 2014	3.8	3.7	15	2365	
11 Mar 2014	3.3	3.8	14	1920	
NEOWISE					
16 Jan 2014	3.8	3.7	15	280	$Q(CO_2) = 4\times10^{26}$
Swift/UVOT					
2 Nov 2013	4.5	4.0	11	1740	$Q(H_2O) < 6\times10^{27}$
28 Dec 2013	4.0	3.6	14	1495	$Q(H_2O) < 2\times10^{27}$
18 Feb 2014	3.5	3.8	15	1530	$Q(H_2O) < 3\times10^{27}$
15 Mar 2014	3.2	3.8	14	1100	$Q(H_2O) < 3\times10^{27}$
Spitzer					
26 Mar 2014	3.1	3.1	19	1460	$Q(CO_2) = 3.5\times10^{26}$

[1] Heliocentric distance
[2] Geocentric distance or Spacecraft range
[3] Solar phase angle
[4] A measure of dust in the coma
[5] Q = gas production (molecules/sec)

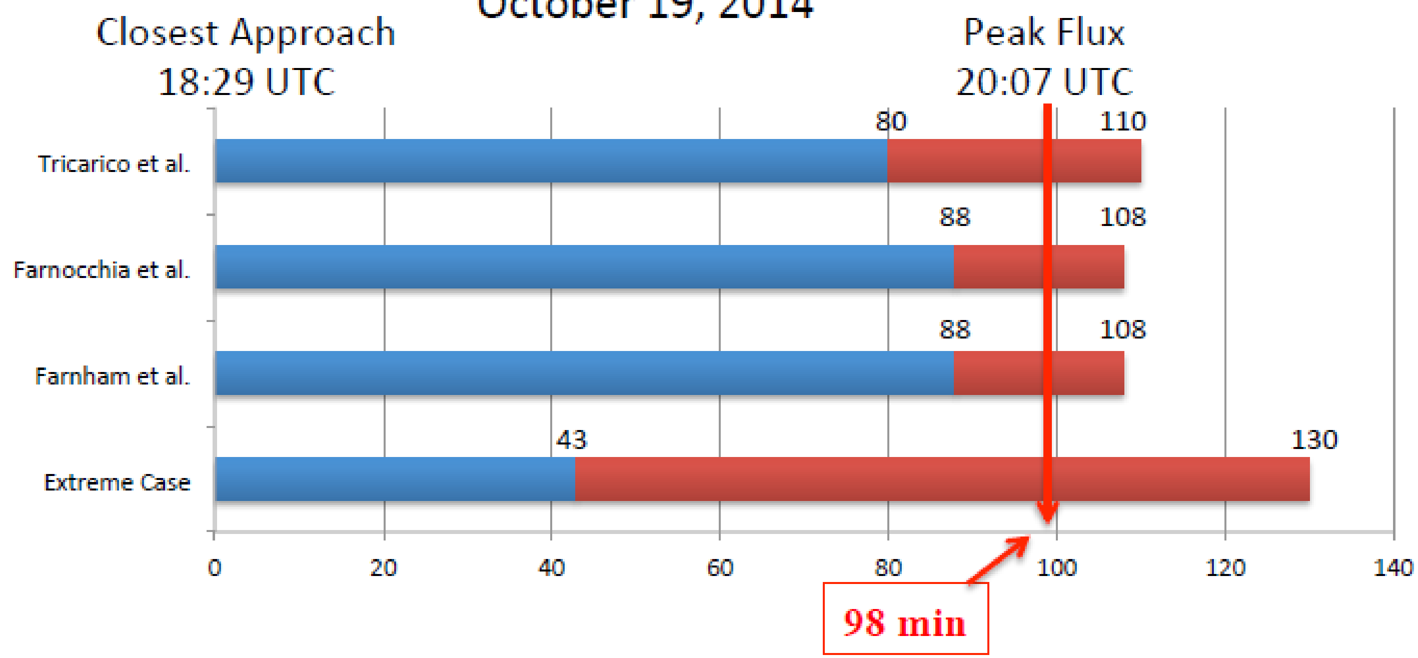
National Aeronautics and Space Administration

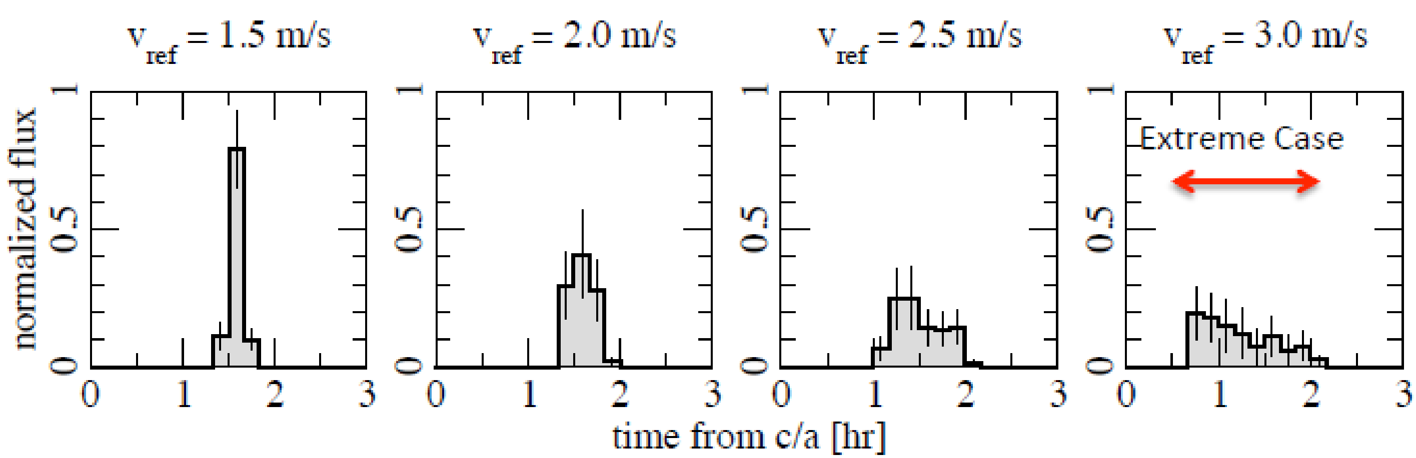
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Time of Maximum Flux

Mars Exploration Program

October 19, 2014

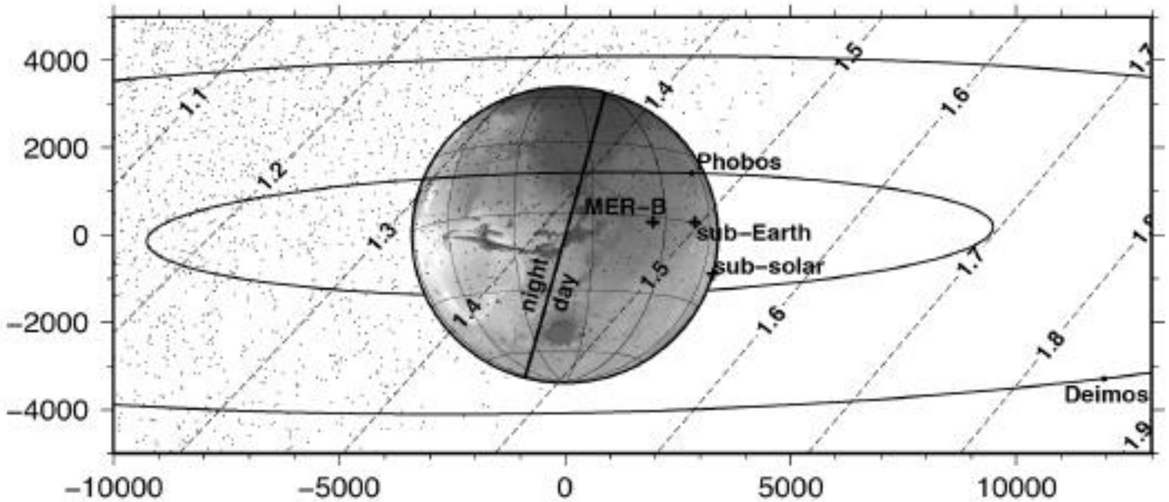


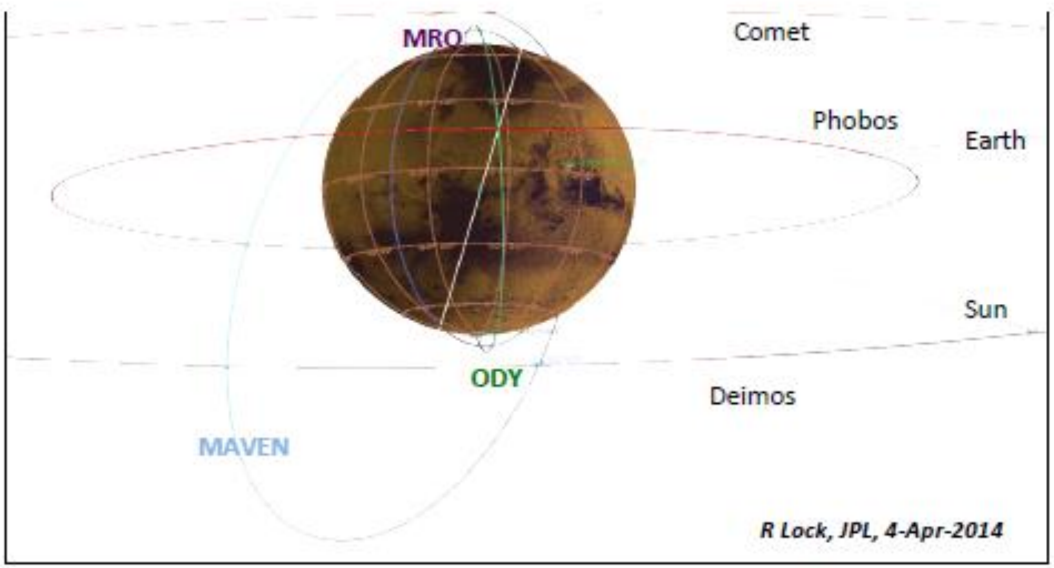


View from Approaching Particle Direction

At Comet Closest Approach plus 95 minutes (20:04 UTC)

P. Tricarico et al., ApJL, 787, L35, 2014





Same view as Tricarico, above, with Mars Odyssey, MRO and MAVEN orbits shown

Specific Modeling Results

- **Best estimate**:
  - Vref ~0.4 m/s
  - Mars will be just outside the debris trail, encountering no particles.

- **Conservative estimate:**
  - Case 1 (Farnham/Farnocchia): Vref ~ 0.7 m/s, particles encounter Mars in a 20 minute window centered at 98 minutes after closest approach of the nucleus;
    - Fluence[1] is: ~ 1-4 x 10^{-7} particles/m^2 ;
  - Case 2 (Tricarico): Assuming a high velocity tail (at a few %) with Vref ~ 1.5 m/s, particles encounter Mars in a 30 minute span centered at 95 minutes after closest approach;
    - Fluence[1] ~ 3% x 2×10^{-5} particles/m^2 = 6 x 10^{-7} particles/m^2 ;
  - Summary: Fluence[1] is: < 10^{-6} particles/m^2.

- **Extreme case:** Use unrealistically high velocity component (Vref = 3 m/s) assigned to jets/outbursts (a few %) and power law favoring large particles:
  - Fluence[1] ~ 2% x 1.3×10^{-2} particles/m^2 ~ 3 x 10^{-4} particles/m^2.

[1]*Fluence = total # of particles encountered per unit area during event*

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Science Observations - *Preliminary*

**Conducted only if safe, posing no spacecraft or instrument issues*

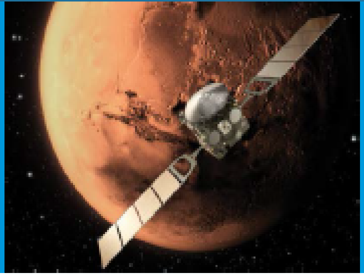
NASA Missions

Target	Observation Objective	MRO						ODY		ROVERS		MAVEN[1]		
		HiRISE	CTX	CRISM	MCS	MARCI	SHARAD	THEMIS VIS & IR	HEND/NS	PANCAM	MastCAM CHEMCAM?	IUVS	LPW,MAG, SEP	NGIMS,STATIC SWEA,SWIA
Comet	Comet General Features					✣		✣		◆	◆	◆	◆	
	Comet Nucleus: Size, Shape & Rotation	◆												
	Comet Activity: Jets & Variable Brightness	◆	◆	✣				✣				◆		
	Comet Coma: Variability, particle size, gas composition	◆	✣	◆	◆	◆		◆				◆		
	Comet Tail: Particle Size		◆	✣	✣	✣		✣				◆	◆	
Mars Response	Mars Upper Atmosphere Composition: Neutrals, ions & electrons; meteor trails						✣		✣	◆	◆	◆	◆	◆
	Mars Lower Atmosphere: Temperature and Clouds			✣		✣		✣		✣	✣	✣		

Key: major contribution ◆ contribution ✣

[1] *Conducted only if transition to science orbit is nominal*

S-S MEX potential observations



- Meteor Observation HRSC:
  - Meteoroid statistics (Magnitude / frequency relationships)
  - Temporal / spatial distribution
  - Meteor characteristics
  - Beginning- and end height *) **)
  - Break-up?
  - After-glow?
  - Do the small cometary meteoroids hit the surface?
  - Impact flash magnitudes?

*) Note: Terrestrial meteors occur in the upper atmosphere, ~ 80-120 km; atmospheric density in Earth`s upper atmosphere corresponds to Mars atmospheric density near surface (!)

**) As the orbits, radiants and speeds of the stream meteoroids are known, meteor trajectories can be fully reconstructed

COBS

Comet Observers Database

Jakub Černý, Jure Zakrajšek

„Comet Siding Spring Close Encounter with Mars Observers“ Workshop

August 11, 2014

Děkuji Vám za pozornost.