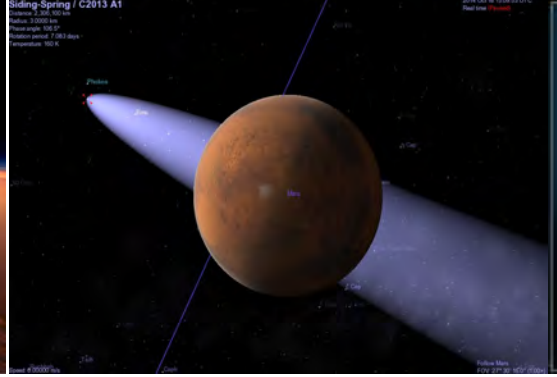



# Comet Investigative Observing Campaign (CIOC)
# C/Siding Spring Update for SBAG 11, 29 July 2014

**CIOC Team** established Jan 2013 at SBAG-8. Team has a mix of experiences, skillsets, and research specialties. Abundant contributions from early- and mid-SBAG scientists. Reported monthly to Lindley Johnson, Kelly Fast, & Jim Green.

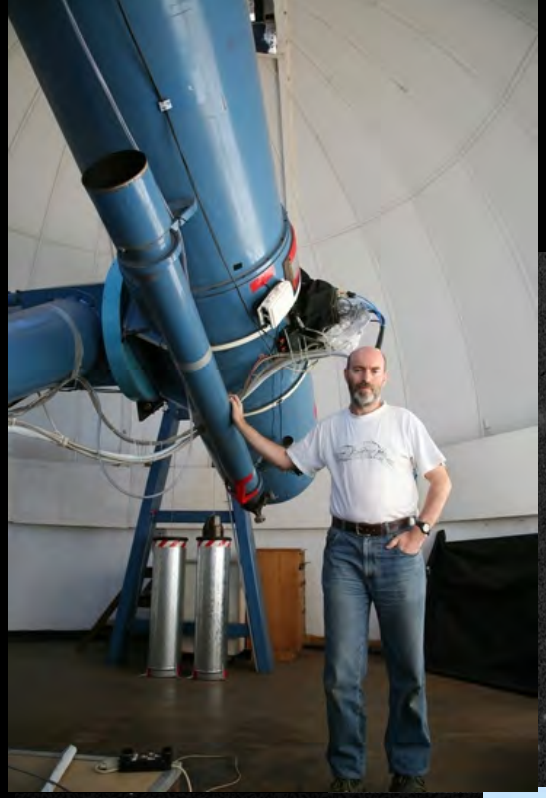
**Members chosen from SBAG, MEPAG***: Lisse, Battams, DiSanti, Farnham, Fernandez, Kelley, Knight, Lemmon, Li, Seelos, Vervack, Warner, Yanamandra-Fisher.

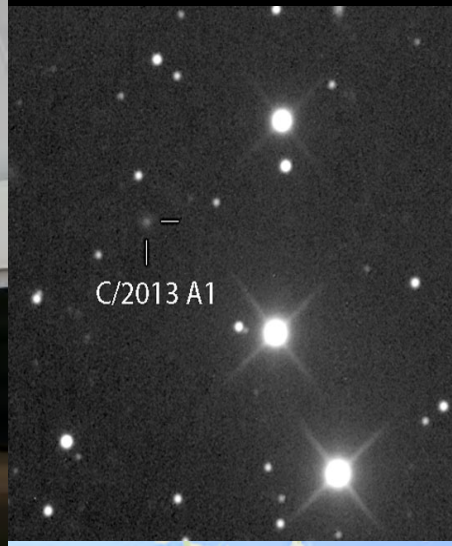
**Mantra**: Facilitate, facilitate, facilitate. 2014 Bottom line is to maximize the science returned from Comet Siding Spring by involving every telescope available (mainly Southern on Earth, high sensitivty remote, + Mars Fleet) forobservations.

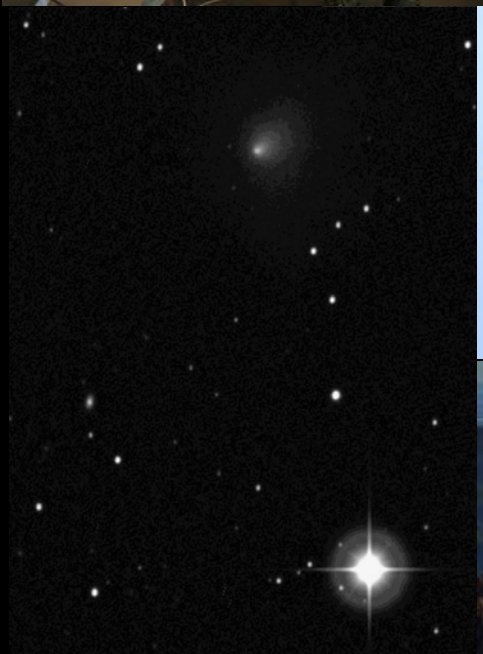
**CIOC Contact Info**: http://www.cometcampaign.org

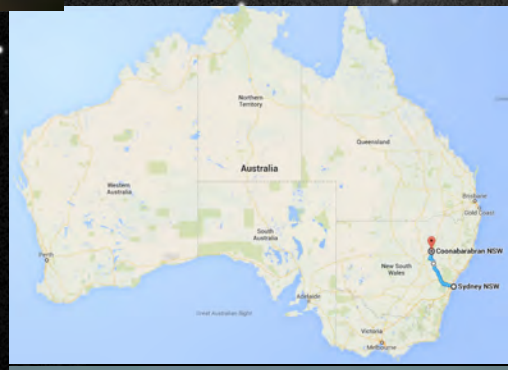
# Comet C/2013 A1 (Siding Spring)

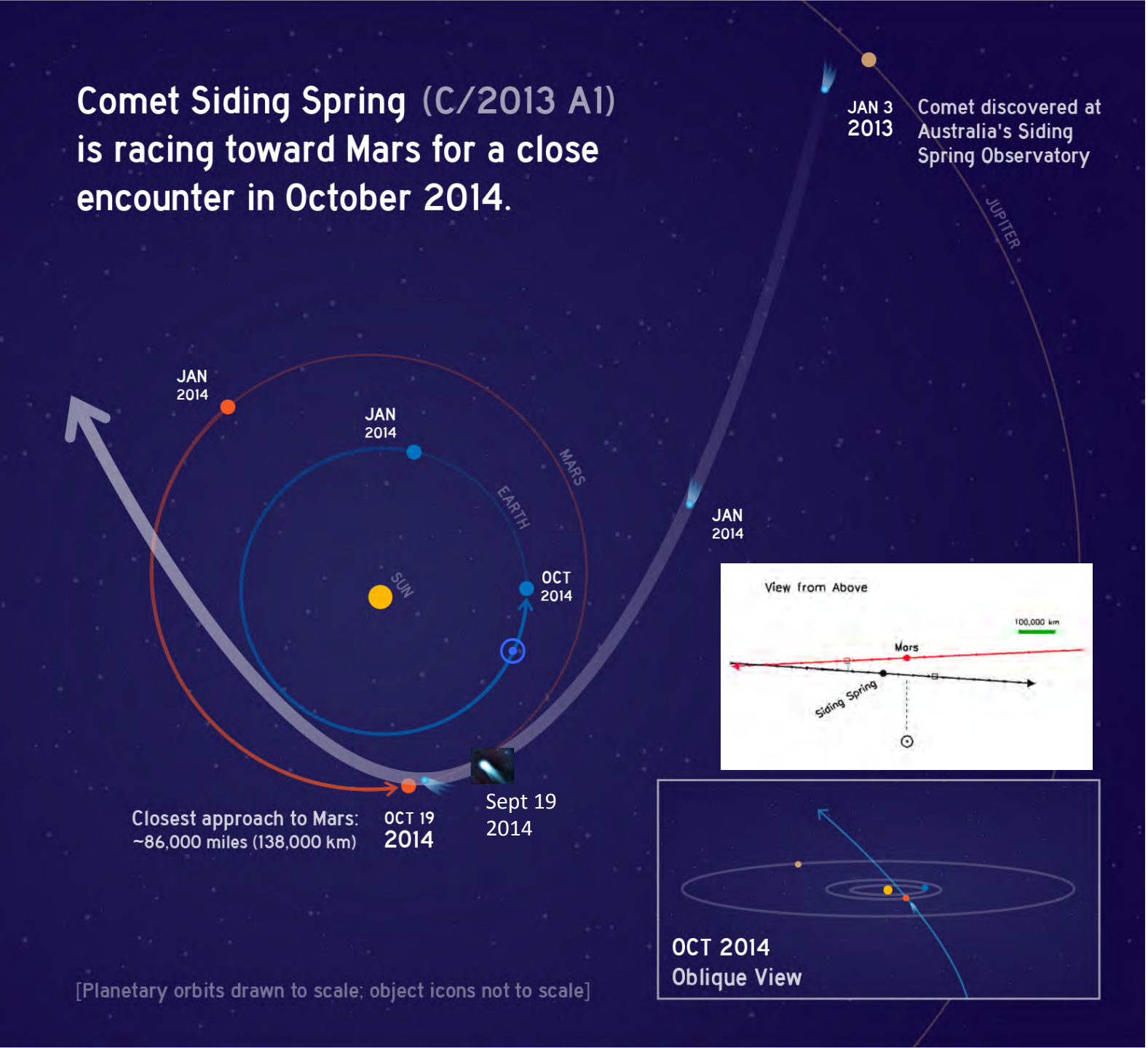
- Discovered on 3 January 2013 by Robert H. McNaught (also discoverer of >10 other comets) at V ~ 19.
- Used the 0.5-meter Uppsala Southern Schmidt Telescope at Siding Spring Observatory, Australia
- Orbit determined within a few days, first solutions implied a potential Mars collision. Refinements showed a very near-miss on Otc 19, 2014 5 days before perihelion. Comet will be coming “up” from the South, and will be passing “almost horizontally” between the Sun and Mars.
- Comet Siding Spring has grown and brightened considerably since its discovery. (COBS @ Crni Vrnh reports V~10.8 on 7/28/2014, 2.5’ width, $r_h$=1.9 AU)







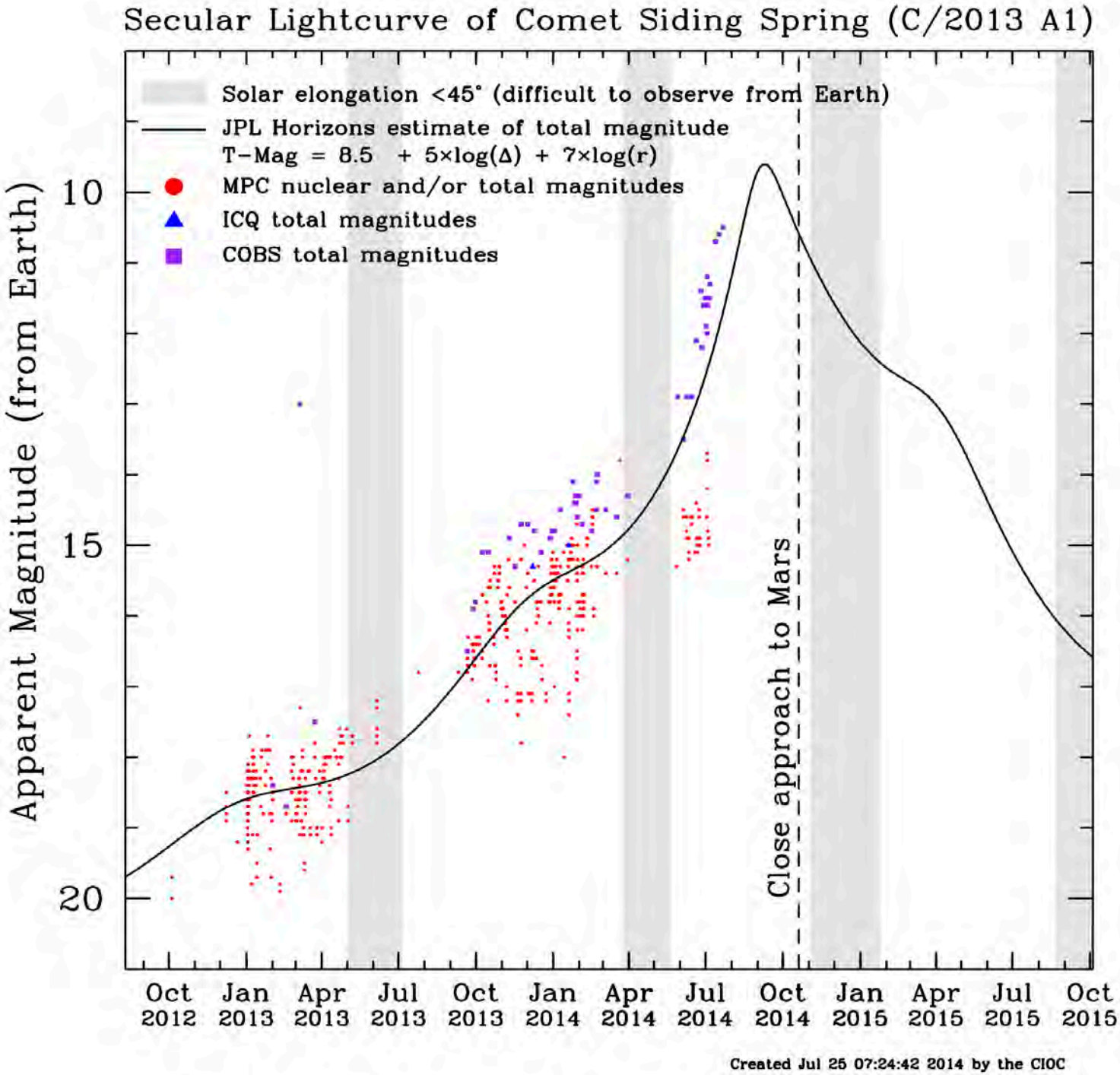




# CSS 2014 Timeline, Retrograde Orbital Trajectory:

Best Earth Observing Time in mid-September; Mars C.A. ~ 138,000 km, @ 16:38 UT, 56 km/sec relative (but max danger maybe 100 min later when Mars + s/c cross comet's orbit)

# How Close is 138,000 Km?

- 1/3 the average Earth-Moon distance.
- 1/16 the distance of the closest comet to flyby Earth in the last 500 years.
- The C.A. distance of a very good NEA apparition.
- 15x the mean distance of R = 11 km Phobos from Mars.
- 6x the mean distance of 6 km Deimos from Mars (note that at $R_{CSS,nuc}$=0.3 – 5 km, CSS is smaller than the moons by 1.2x to 35x).
- $R_{\text{Hill Sphere, Mars}}$ ~ 577, 000 km
- In the outer coma ($10^5$ – $10^6$ km) of an active comet.




**Good news!**

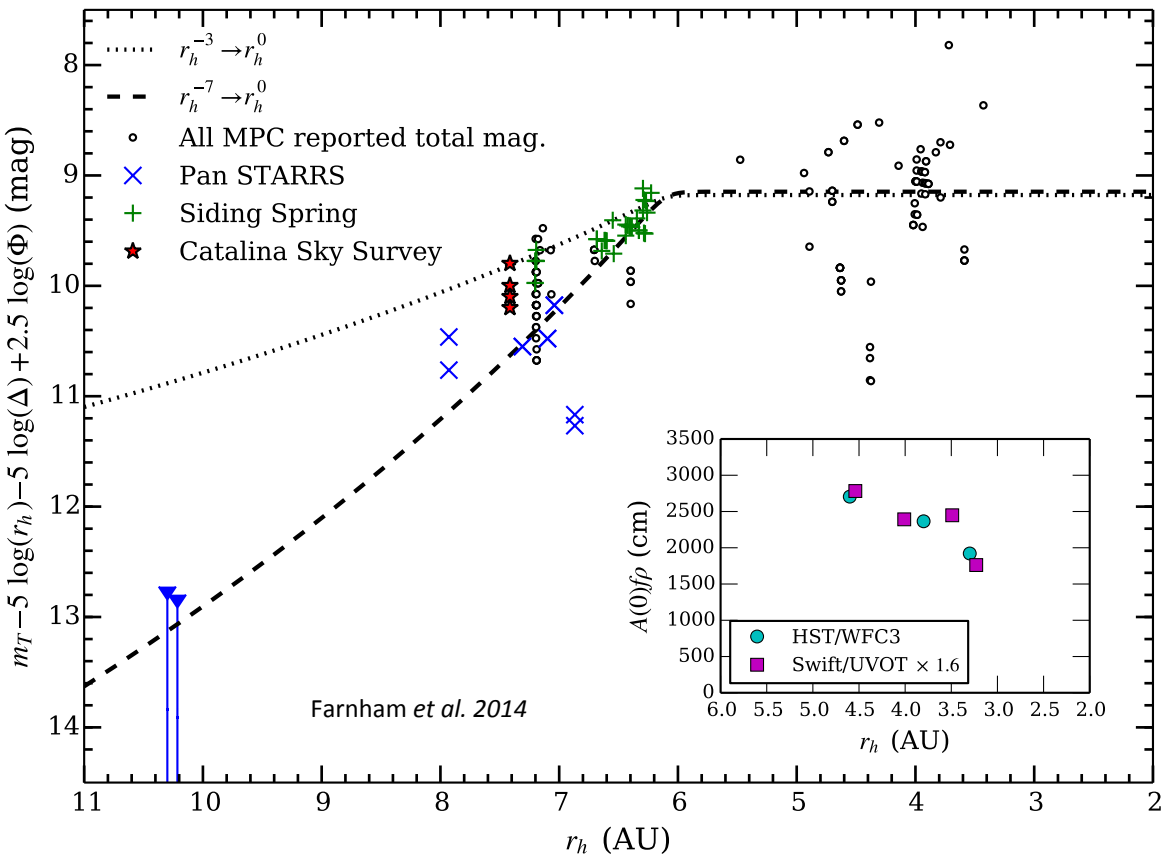
**Comet Siding Spring is running 0.5 – 0.75 mags brighter than the JPL Horizons Predictions.**

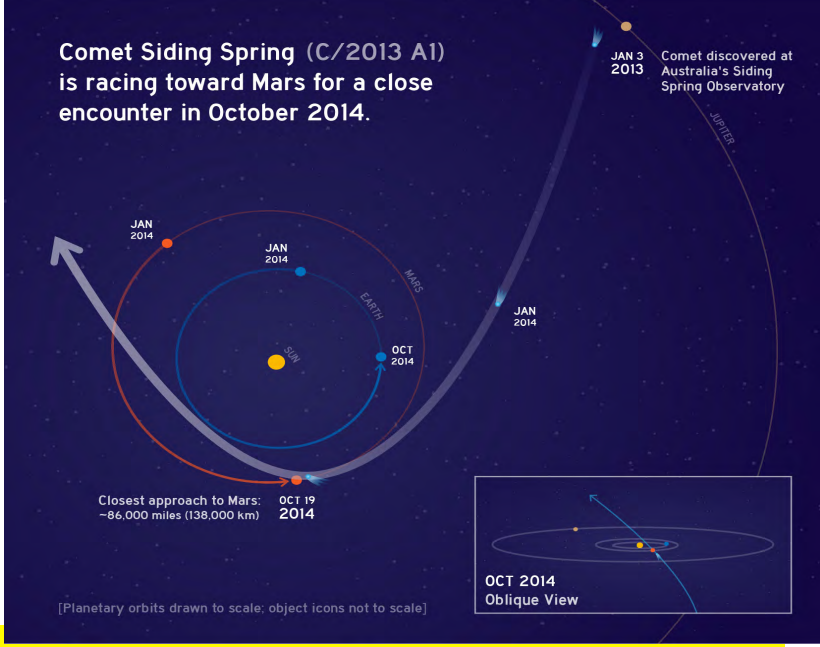
**Still TBD:**

**How easily a 10th magnitude object will be detectable near 0th mag Mars.**

# Onset of Activity

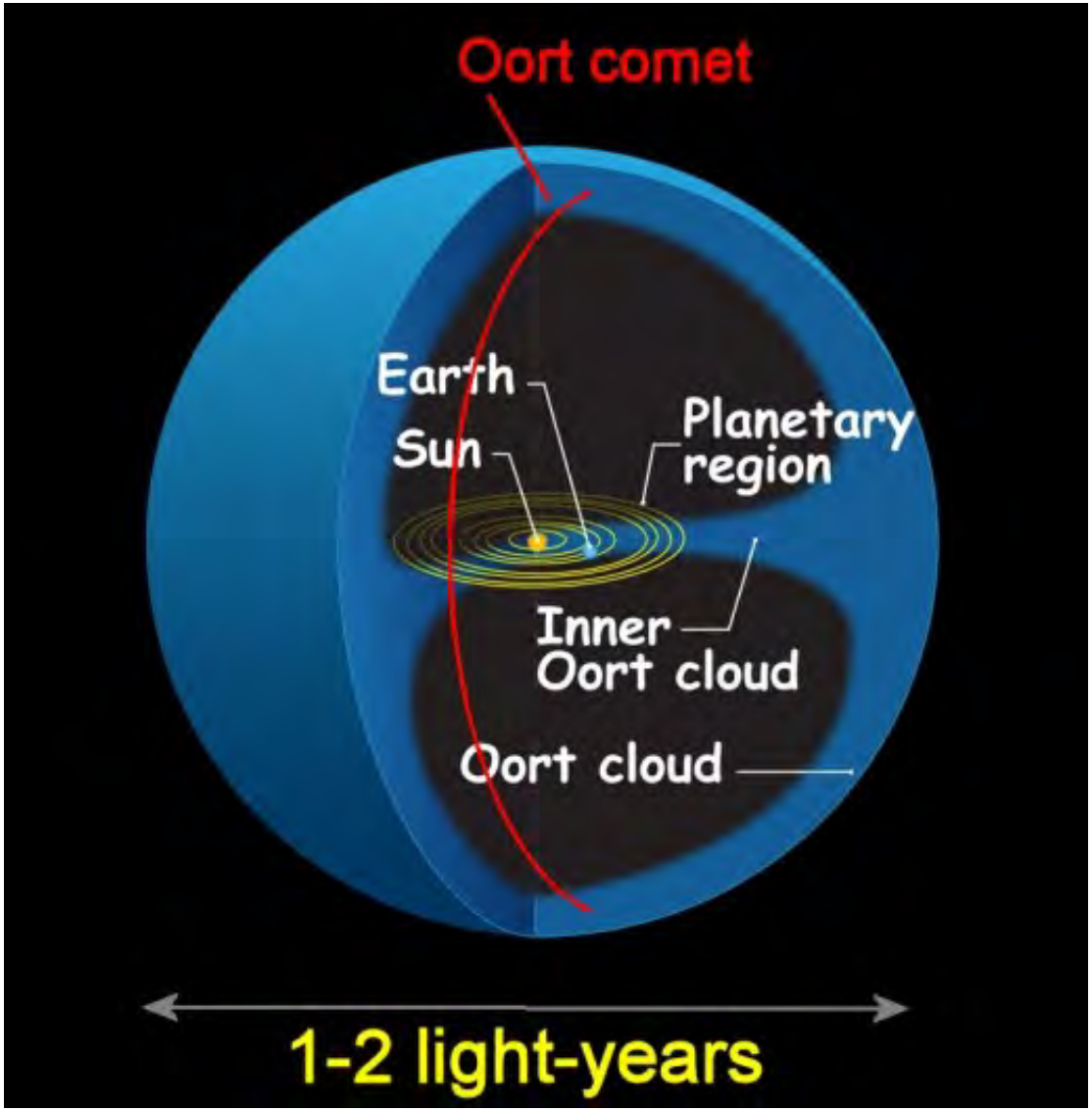
- Secular lightcurve data constrains brightness
- PanSTARRS data from 20 Nov and 2 Dec 2011 (~10 AU)
  - No detections to mag 23
- Suggests activity started ramping up between 10.5 and 8 AU




# Scientific Importance of Comet C/2013 A1 (Siding Spring):

- **Dynamically New** - First passage through inner system since formation & ejection
  - Icy planetisimal older than Earth likely containing leftover primordial SS material
  - Detailed orbital knowledge for Oort comet perturbed Mya to into inner system
- **On a Mars-grazing Orbit**, with > 1 yr lead time since discovery
  - Peri-Mars on Oct 19, 2014 at $r_{C.A.}$ = 132,000 km, 1/3 Earth-Moon distance and 16 closer than the closest comet has come to Earth in the last 500 yrs.
- **Unlike ISON in 2013, this is the only very close planetary encounter for CSS.**
- **CSS is coming so close to Mars that MRO should be able to resolve the nucleus, and Mars and the orbiters will be in the outer coma of the comet. => A free s/c flyby of the comet starring the Mars fleet of orbiters + rovers.**




**C/Siding Spring has likely spent the 4.5 Gyr since its formation far from the Sun and the planets in the deep freeze of the Oort Cloud.** For C/SS to come from the depths of the Cloud, with more than a year's notice, at ~129$^{o}$ inclination to the ecliptic and have an extremely close encounter with Mars at/near perihelion is very rare.

# CIOC Campaign

- **A Campaign Focused on Oct 18 – 20, 2014**

- **Observing Opportunities from Ground Limited: Southern Twilight** Comet, Brightest from Earth in mid- to late-September => Good Opportunities to characterize the comet pre-Mars, pre-perihelion.

- No NASA IRTF, **KECK Public Calls**

- **Mars Fleet**: MRO, Mars Odyssey, MEX, MSL, Opportunity, MOM, MAVEN. Practice for Comet C/2013 A1 (Siding Spring)'s ***VERY*** close Mars approach on 10/19/14

- ***Helio* Fleet**: SOHO, STEREO

- ***Astrophysics* Spacecraft** : SWIFT, *WISE*, HST, Spitzer, Chandra

- **CIOC Website** (FAQS, news, lightcurves, schedules/logs, **no archiving**) http://www.cometcampaign.org

- **PRO-AM COLLABORATIONS**: Facebook, Twitter, and Pinterest groups; COBSA & other "professional amateurs"; Jet Morphology campaign; Ion tail campaign

- **NASA HQ EPO**: Ask an Astronomer; FAQS; Media Point of Contact – PBS, NHK, Discovery, BBC, NYT, etc.

- **Siding Spring WORKSHOPS**: 2014 Aug 11 (Observer's Planning) & 2014 Sept 19 (Mars Hazard Tag-Up) at APL/JPL. Free, Livestreamed. SBAG invited to attend – send email to carey.lisse@jhuapl.edu for WebEx, meeting site details.

# Comet Siding Spring Observing Campaign Website

New CIOC Website Established:
**http://www.cometcampaign.org**
(site name purchased from GoDaddy)

- Latest news/updates about the comet
- Updated MPC lightcurve
- Workshop information
- Resources for amateur/pro-am/professional astronomers
- Blog posts from CIOC Team members
- Observer on-line schedule
- Observing logs
- List of papers/CBETS published
- Feedback form
- Associated: email exploder.


- > 1,500,000 pageviews since launch -

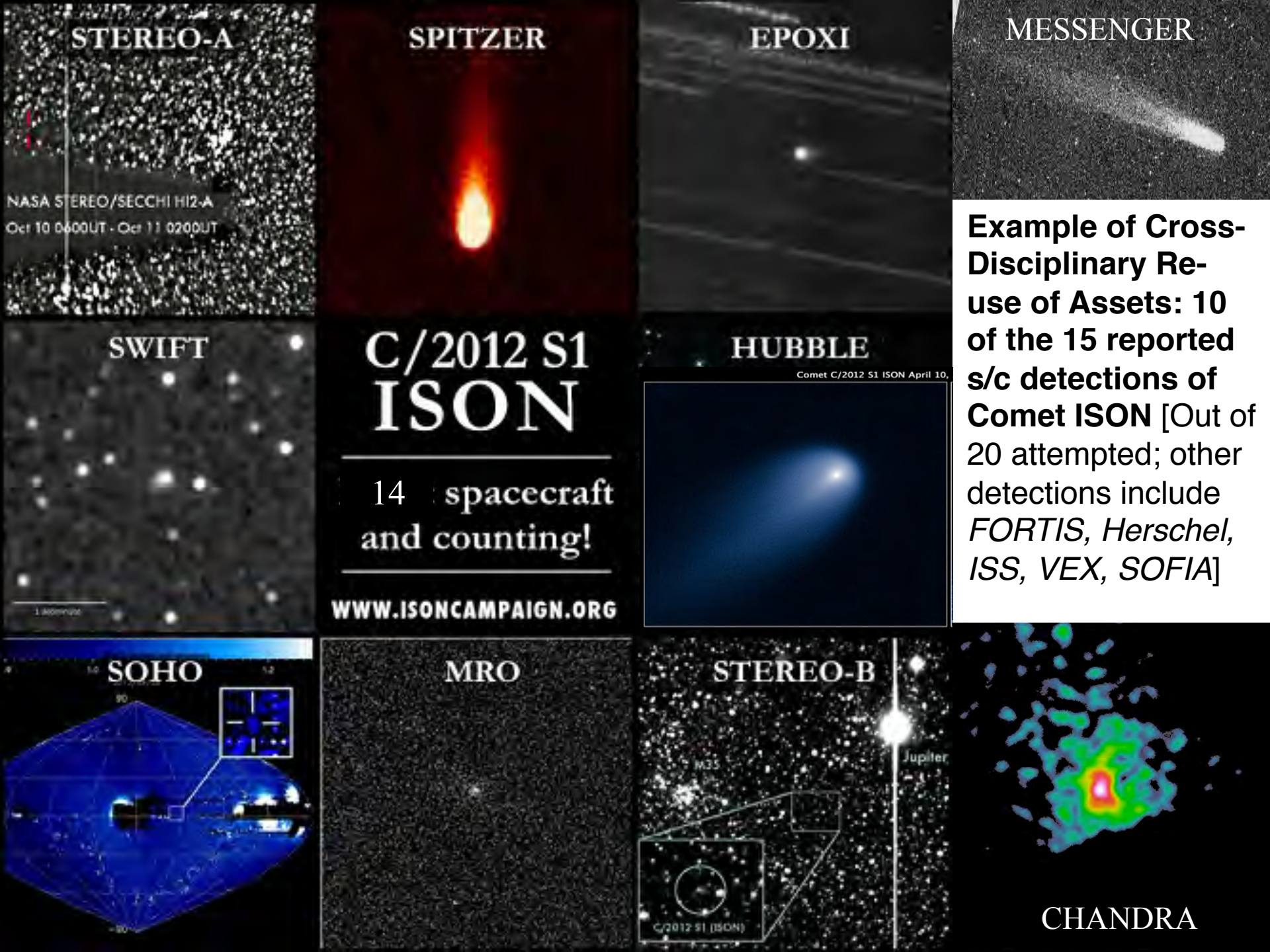
- **HQ Introduction (Green/Johnson/Fast) 8:30 – 8:45**
-
- **Comet Siding Spring Overview 8:45 – 9:30**
- CSS in context; the campaign; focus on C.A. day; issues with detecting 10th mag CSS at 0th mag Mars (Lisse)
- Hazard modeling results & what we can expect from the encounter (Farnham)

- **Spacecraft Based Observations 9:45 – 12:30**
- ***HST*** (J-Y Li/Lisse/Clarke) (30min+5min)
- ***SWIFT*** (Bodewits) (15min+5min)
- ***Spitzer*** (Kelley) (5min+5min)
- ***WISE*** (Bauer) (15min+5min)
- ***STEREO****/HI2,* ***SOHO****/SWAN* (Battams 10min + 5min)
- ***Chandra*** (Lisse) (10min+5min)
- ***Herschel*** (T. Mueller) (15min+5min)
- ***BOPPS*** (Cheng/Hibbitts) (10min + 5min)

- **Earth Based Observations of a Southern, twilight/daytime object 13:30-15:00**
- ***TRAPPIST*** (Jehin/Opitom) (15min + 5min)
- ***Crni Vrnh/COBS*** (Jure Zakrajšek/CIOC) (15min? + 5min)
- ***NASA/IRTF*** (Villanueva for Kelley/Lisse) (15min+5min)
- ***VLT*** (Kelley) (10min+5min)
- ***Subaru*** (Padma/Ootsubo); SOFIA (Wooden) (15min+5min)
- Radio – ***ALMA, APEX, Arecibo*** (Cordiner/Millam) (15min+5min)
- Pro-AM Summary of Observations to Date + Future Plans (Padma) (15min+5min)
-
- **Mars Based Observations 15:15 – 18:00**
- ***MRO*** (Tammppari/Delamere/Humm/Kass) (30min+5min)
- ***MAVEN*** (Yelle/Crismani) (20min+5min)
- ***Mars Oddessy*** (Christensen/Malin/McSween/Bell) (15min+5min)
- **MSL/Opportunity** (Bell/Lemmon/Lasue) (20min+5min)
- ***MEX*** (Bertaux/Bibring?) (15min+5min)
- ***MOM*** (Bhardwaj?) (10min +5min)

# Aug 11th Observer's Workshop Speakers:

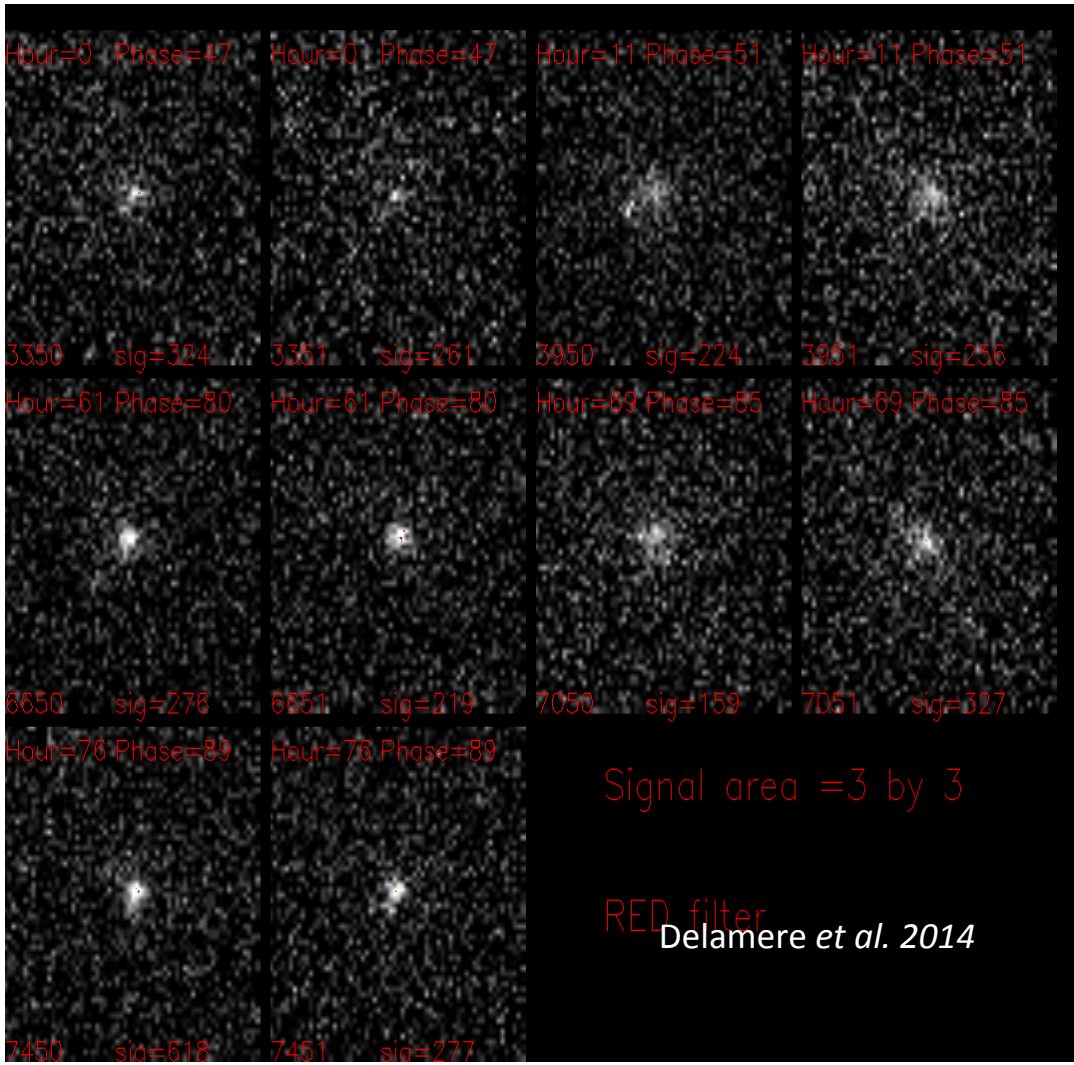
# Representing Multiple S/c + Ground Based Observing Platforms




**Example of Cross-Disciplinary Re-use of Assets: 10 of the 15 reported s/c detections of Comet ISON** [Out of 20 attempted; other detections include *FORTIS, Herschel, ISS, VEX, SOFIA*]

# ISON MRO/HiRISE Observations

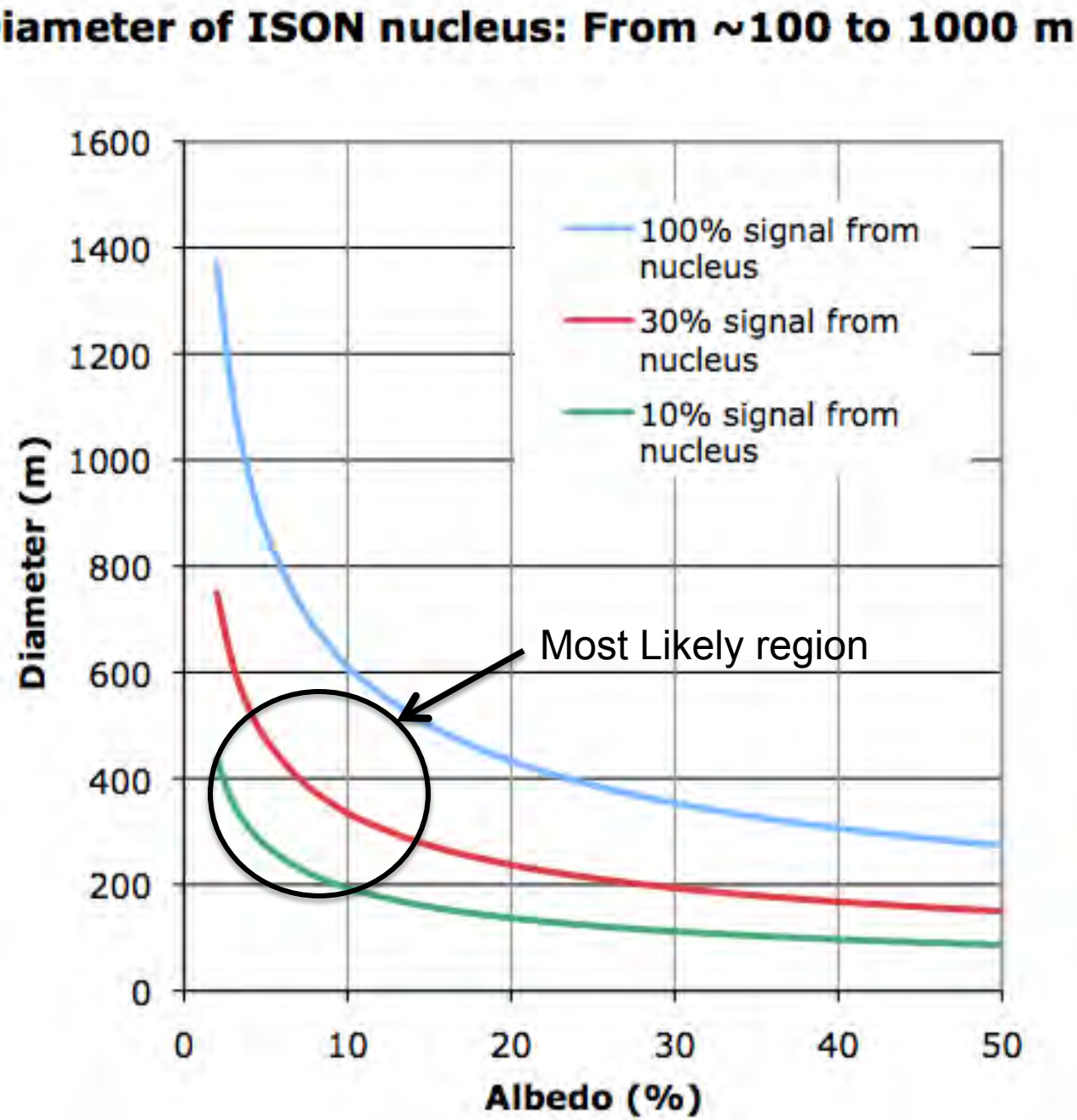
- Used Red CCDs 4, 5 and 6 centered on CCD 5 and Blue-Green CCDs 12 & 13
- Observation frame 6000 columns by 4000 lines (6 x 4 milliradian, 1240 x 825 arc-second)
- Six observations per orbit
  - 5 ISON images (2 - 2.5sec,2 - 1sec and 1 - 0.2sec)
  - 1 star cal at 0.12s to verify telescope PSF
- ISON detected in all five orbits Sept 29th –Oct 2nd



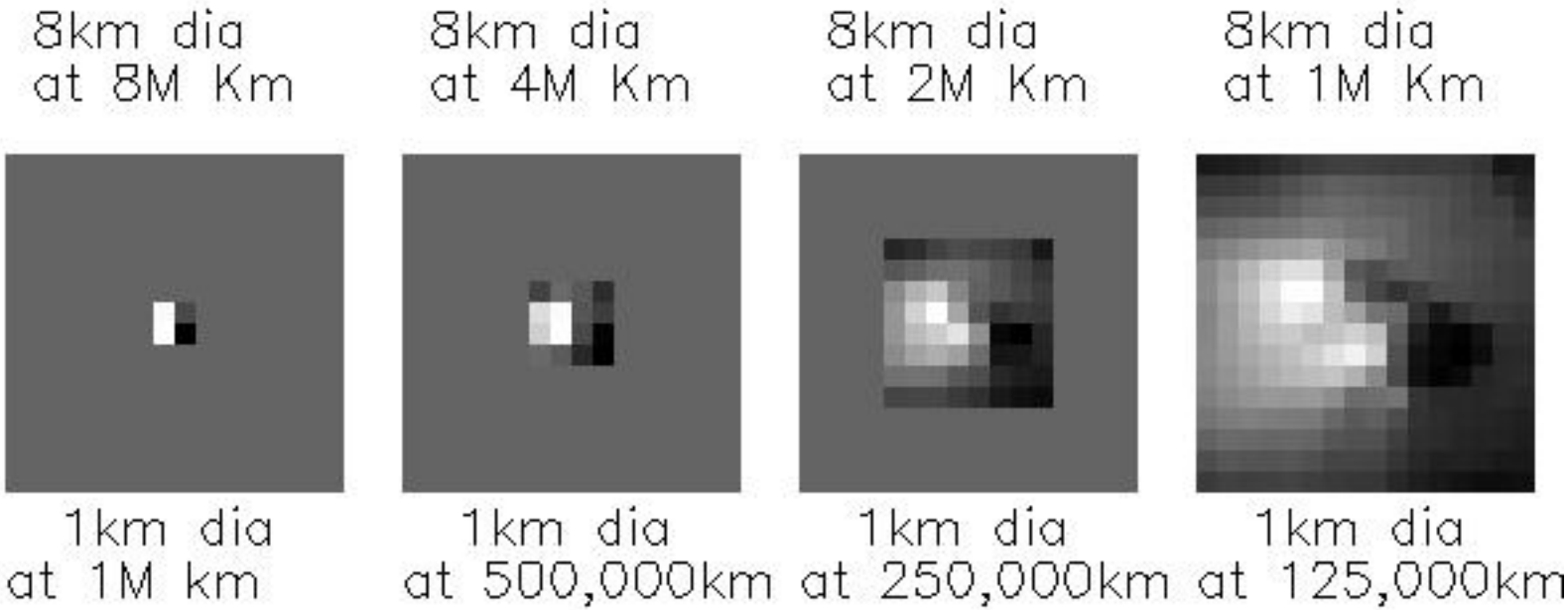

Delamere *et al. 2014*

A model size of the nucleus depends on the nucleus albedo, phase function, and how much of the signal comes from the nucleus rather than the coma.

This gives a family of reasonable solutions ranging from ~100 to 1000 m diameter.



# Simulation using Halley image
# 16 by 16 pixel box




Delamere *et al. 2014*

PSF not applied to simulated images

# Upcoming Venues Where Comet C/2013 A1 (Siding Spring) Will be Discussed

- Observer's Workshop, (11 Aug 2014) APL/WebEx
- Mars Fleet Tag-Up Workshop, (19 Sept 2014) APL/ WebEx
- Winter 2014 AGU (14-19 Dec) , San Francisco USA
- LPSC 2015 (15-20 Mar), Houston, TX USA
- AAS/DPS 09-14 Nov 2015, Washington, DC USA
- Special issue of Icarus for the Comet Siding Spring observing results? (Current volunteers for special editors: P. Yamaranda-FIsher, ground based observations; R Vervack., s/c observations; C. Lisse, big picture context papers.) Submission deadline Winter 2015, publication in late 2016 to mid 2017.

# Comet Siding Spring at Mars Observer's Workshop

August 11, 2014  APL/JPL/WebEx

# Some Siding Spring Science Questions to Answer

- How big is this DN Oort Cloud Comet? Is it sub-km like ISON?
- Is Comet Siding Spring like ISON and also a C/Kohoutek 1973 analogue?
- Did we detect Siding Spring early out past the orbit of Saturn because it was unusually volatile rich or DN? Or because it was surrounded by a cloud of active near-nucleus icy grains? Or was it in outburst from 10 – 5 AU?
- Why did CSS have evidence for jets far from the Sun, pre-perihelion, and ISON didn't until 0.3 – 0.4 AU?