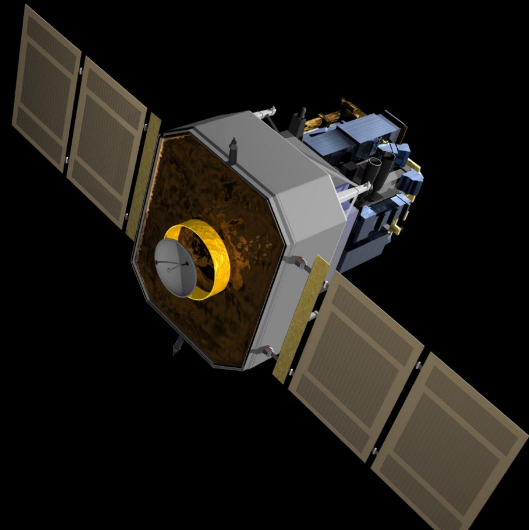




# Observations of Comet ISON from **SOHO**, **STEREO** and **SDO**

Just *sixty-eight days* from today, on Oct 10<sup>th</sup>, Comet ISON will enter the field of view of the NASA STEREO/SECCHI HI-2A instrument.

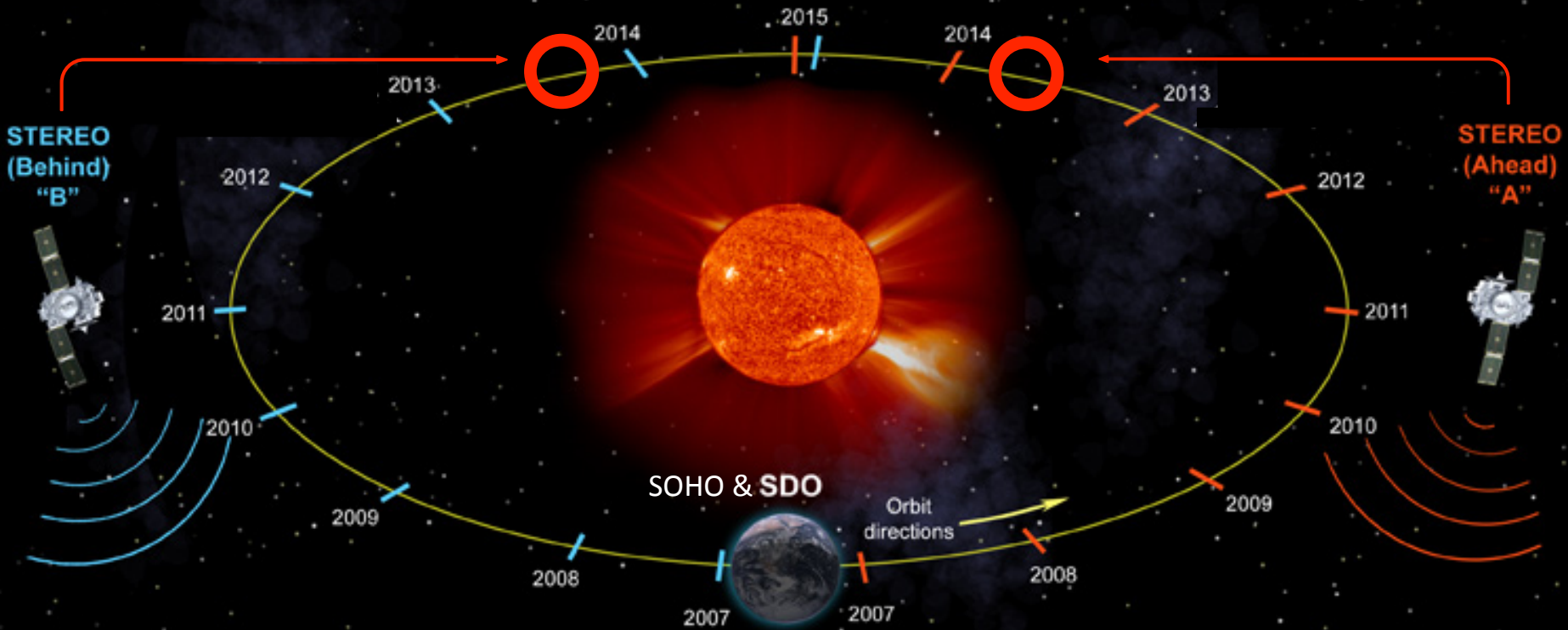
From that time, and until at least December 7, it will be imaged around the clock, at least every two hours, by around a *dozen imaging instruments* on **FOUR** solar physics research satellites, situated in three **very different locations** in the solar system.



**Karl Battams**

US Naval Research Laboratory

# WHERE will the spacecraft be?



1. The **SOHO** satellite is at the L1 Lagrange point, about 1-million miles from Earth in the Sun-Earth line.
2. The **SDO** satellite is in a geosynchronous orbit
3. The **STEREO** - satellites follow Earth's orbit but at relatively faster ("STEREO-Ahead") and slower ("STEREO-Behind") velocities than Earth. On November 28, 2013, the STEREO spacecraft will have a **64° separation angle on the far side of the Sun**

# Timeline of Observations

## Pre-Perihelion:

October 10:	Enters STEREO/SECCHI HI-2A (to Nov 22)
November 21:	Enters STEREO/SECCHI HI-1A (to Nov 28)
November 26, 0400UT:	Enters STEREO/SECCHI COR-2B
November 27, 0200UT:	Enters SOHO/LASCO C3
November 28, 0400UT:	Enters STEREO/SECCHI COR-2A
November 28, 1300UT:	Enters SOHO/LASCO C2

## PERIHELION observations, (*T = November 28 18:17UT*)

~1600 - 2300UT:	Transits STEREO/SECCHI COR-1B
~1700 - 2200UT:	Transits STEREO/SECCHI COR-1A
~1720 - 1920UT:	Transits SOHO/SUMER
~1810 - 2010UT:	Transits STEREO/SECCHI EUVI-B
~1820UT +/- ??hr:	Transits SDO/AIA → <b>TBD</b>

## Post-Perihelion:

November 28 2300UT:	Exits SOHO/LASCO C2
November 29 1400UT:	Exits STEREO/SECCHI COR-2A
November 29 2000UT:	Exits STEREO/SECCHI COR-2B
November 30 2300UT:	Exits SOHO/LASCO C3
November 31 0000UT:	Enters STEREO/SECCHI HI-1A (to Dec 7)

# Observations of Comet ISON from **SDO**

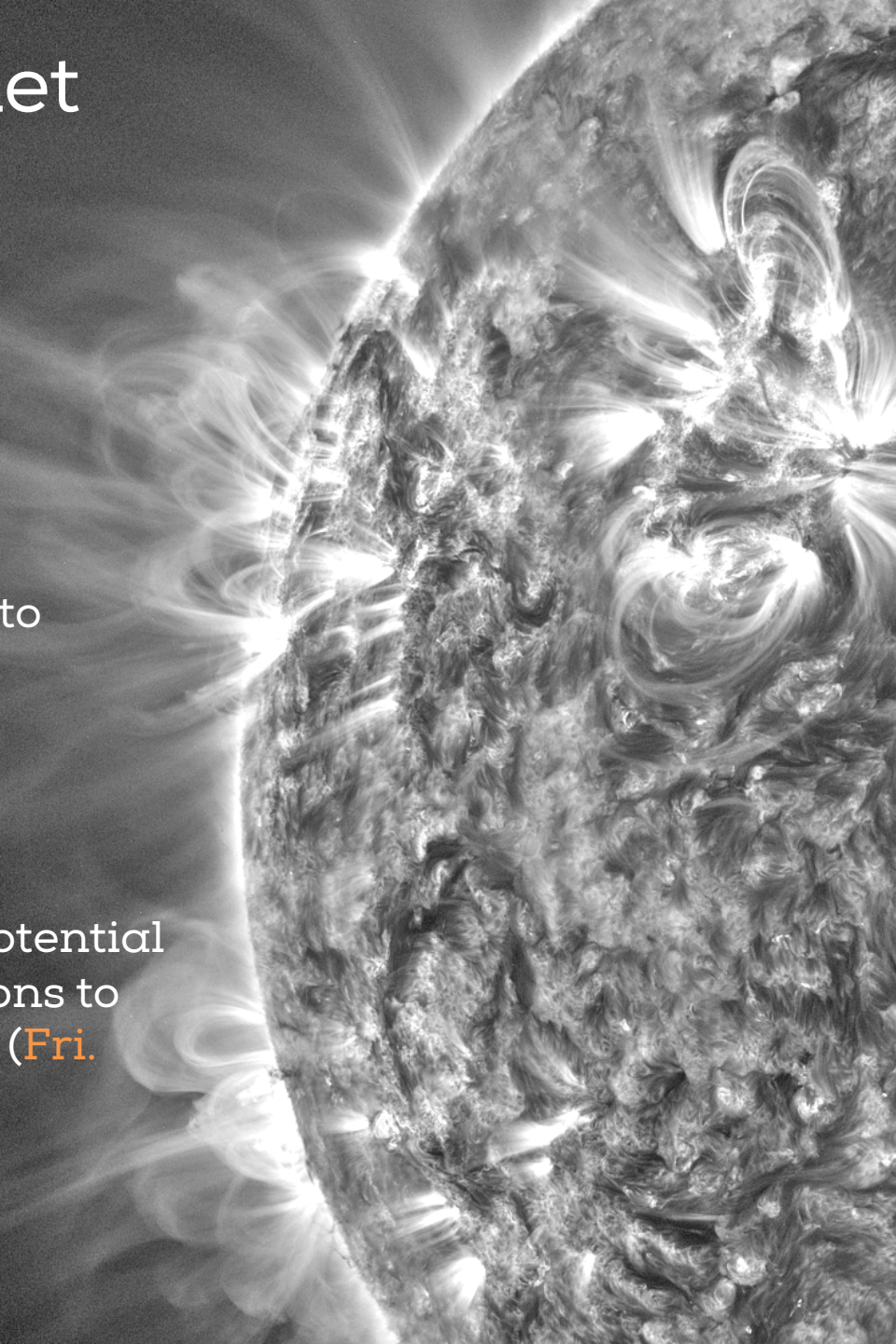
Comet Lovejoy reached perihelion at 0.0055AU, for which the SDO team off-pointed the spacecraft by ~800-arcsec.

In order to image Comet ISON, with perihelion at 0.012AU, SDO will need to off-point by up to ~1600-arcsec.

**Can they do it? Will they see ISON?**

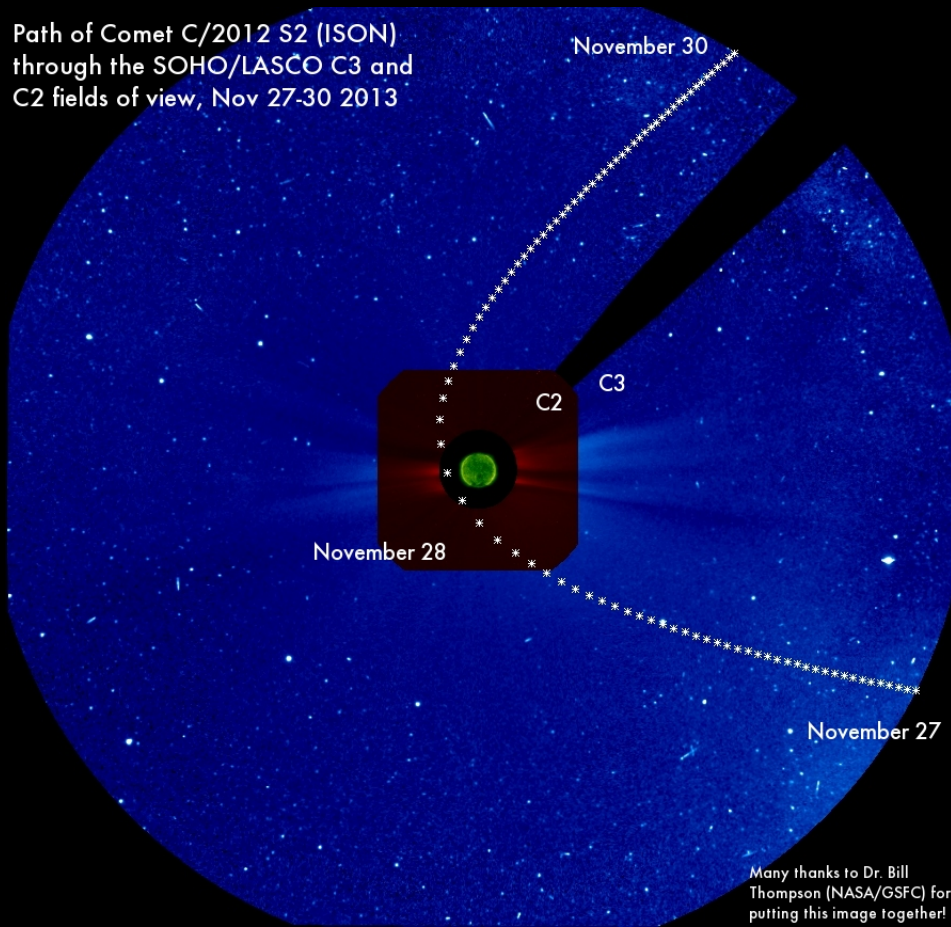
Comet Lovejoy! →

I defer further discussion of potential SDO observations to Karel Schrijver (**Fri. 9am session**)



# Observations of Comet ISON from **SOHO**

Path of Comet C/2012 S2 (ISON) through the SOHO/LASCO C3 and C2 fields of view, Nov 27-30 2013



Many thanks to Dr. Bill Thompson (NASA/GSFC) for putting this image together!

LASCOC3 and C2 will observe from **Nov 27 ~0200UT through Nov 30 ~2300UT** with only a ~2.5hr gap while the *nucleus* is behind the LASCOC2 occulting disk.

Image cadence will be **12-min**, with rotation through filters/polarizers, and both long and short exposures (times TBD) to view both the **tail** and **nucleus** without saturation.

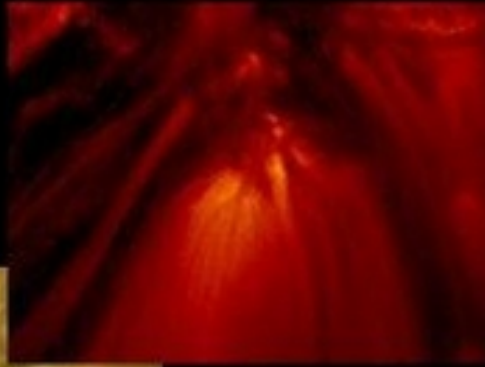
A request has been made for **real-time commanding** coverage:

1. At first appearance in C3
2. During entire C2 transit
3. No more than 8hr gaps for post-perihelion C3 transits

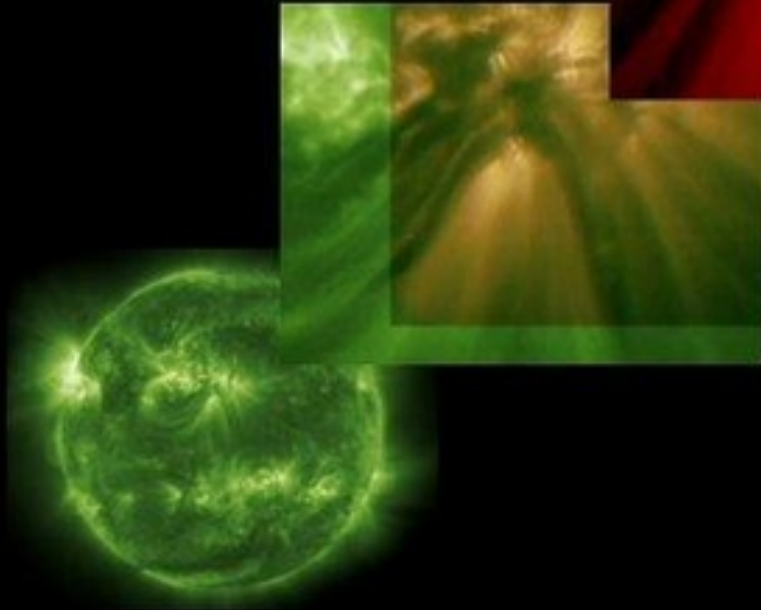
## LASCOC FILTERS:

Blue	- 420-520nm
Orange	- 540-640nm
Deep Red	- 730-835nm
Clear	- 400-850nm

# Observations of Comet ISON from **SOHO**



For approximately 1hr either side of perihelion, Comet ISON will transit part of the **SOHO/SUMER** slit.



The SUMER (**Solar Ultraviolet Measurements of Emitted Radiation**) instrument is a **UV telescope and spectrometer**. It has a spatial resolution of 1-arcsec across the slit and 2-arcsec along the slit, and a wavelength range of 50-161nm.

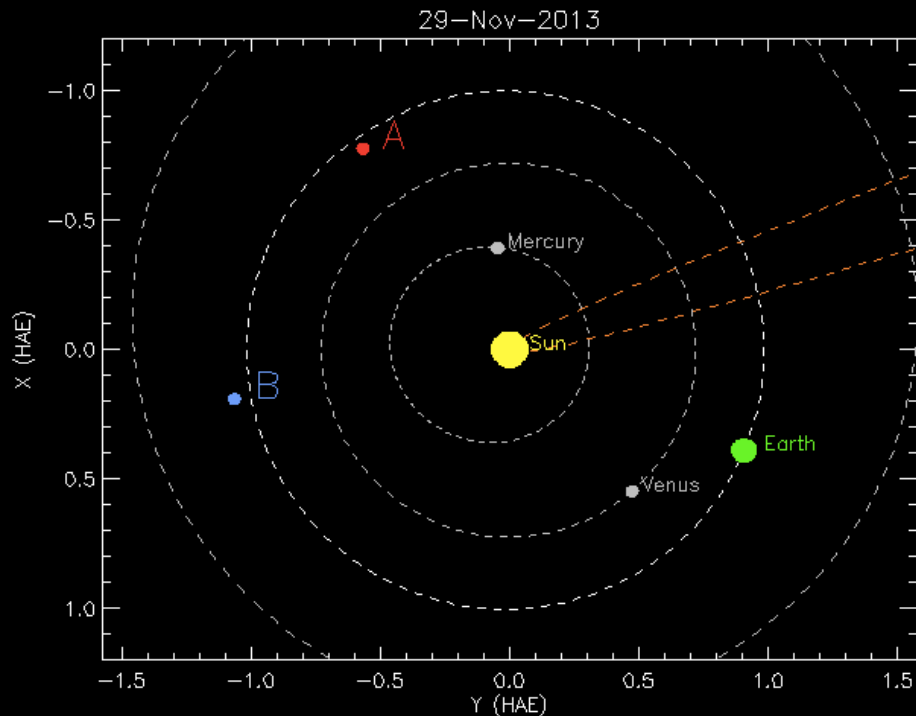
SUMER has not been operational since 2011 (?) but considerations are underway to turn the instrument back on for ISON's perihelion passage.

**SUMER has never been used to observe a comet.** The SOHO/UVCS instrument has, and returned valuable Comet Lovejoy results, for example, but that instrument is no longer functional.

# Observations of Comet ISON from **STEREO**

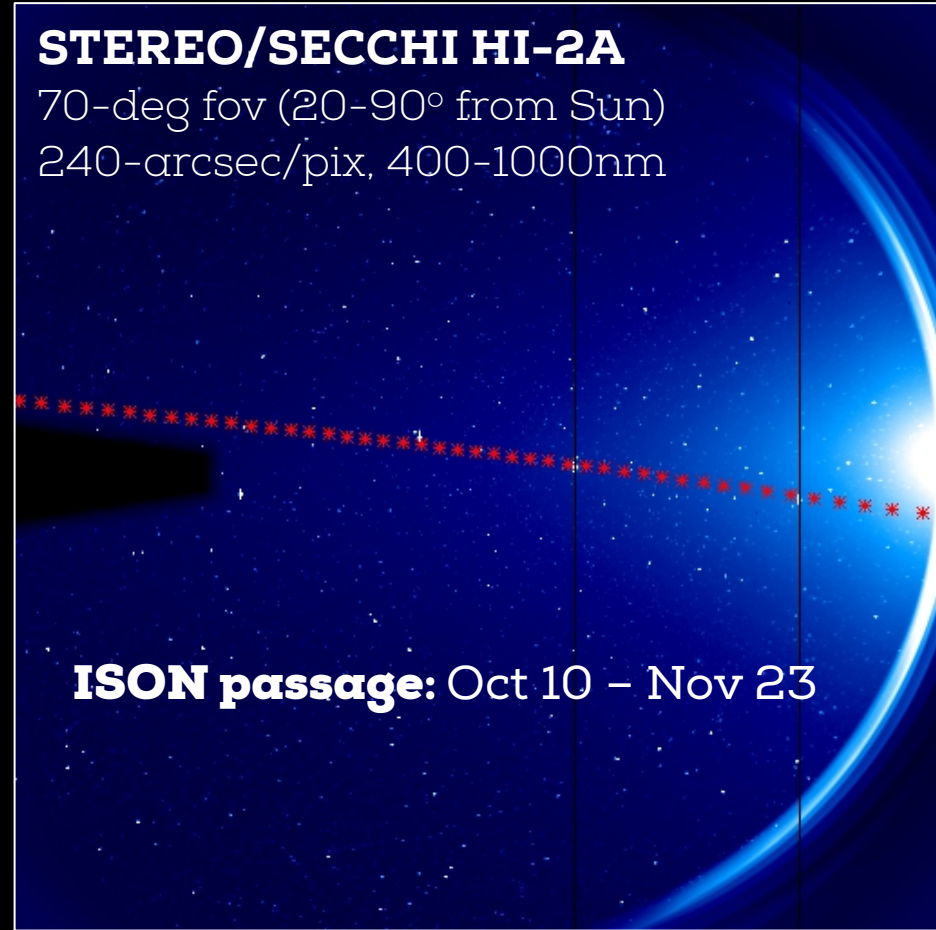
## Observing plan:

Nominal observations only (40-min exposure, 2hr cadence)



## STEREO/SECCHI HI-2A

70-deg fov (20-90° from Sun)  
240-arcsec/pix, 400-1000nm



**ISON passage:** Oct 10 – Nov 23

HI-2 will give us a nice early view of ISON, and maybe some **solar wind interactions**, but the very large pixels can prohibit detailed analyses. Thus we see no reason for extra telemetry here.

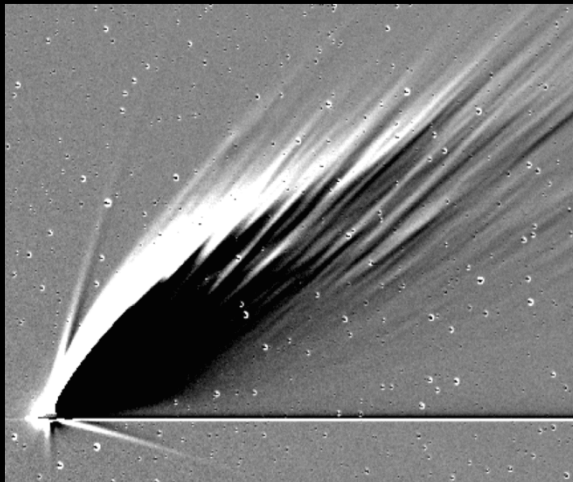
# Observations of Comet ISON from **STEREO**

## Observing plan:

Nominal: 35-min exposure, 40-min cadence

## Additional HI-1A Observations:

Depending on brightness and available telemetry, individual **short-exposures** and **sub-fields** may be taken at times.



## STEREO/SECCHI HI-1A

20-deg fov (3 - 23° from Sun)

35-arcsec/pix, 650 - 750nm



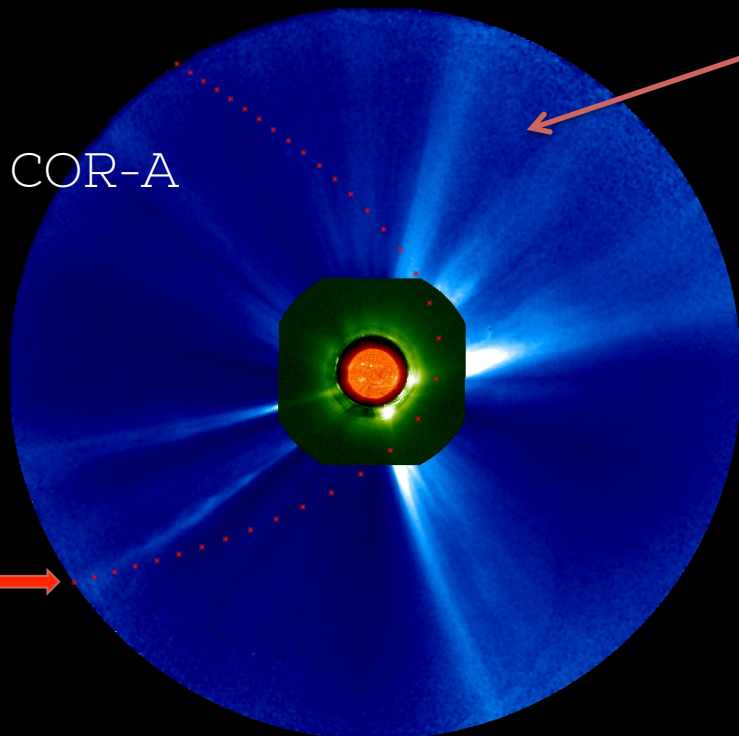
**ISON passage:** Nov 21 - 28

HI-1 images can reveal beautiful **comet tail structures** and **solar wind interactions**

[opposite: C/2012 L4 (PanSTARRS) in STEREO HI-1B]

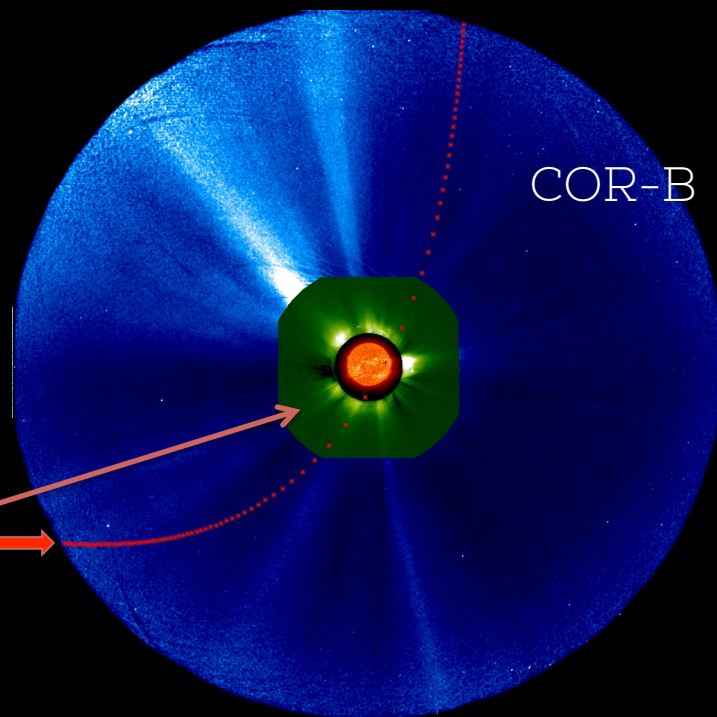


# Observations of Comet ISON from **STEREO**



**STEREO/SECCHI COR2 coronagraph**

2-15Rsun fov, sun-centered,  
15-arcsec/pix, 650 - 750nm, brightness and pB



**STEREO/SECCHI COR1 coronagraph**

1.3 - 4Rsun fov, sun-centered,  
7.5-arcsec/pix, 650 - 660nm, brightness and pB

## **ISON perihelion passage:**

COR2-A: Nov 28, 04UT - Nov 29, 13UT

COR1-A: Nov 28, 1700 - 2200UT

EUVI-A: No transit

## **ISON perihelion passage:**

COR2-B: Nov 26 04UT - Nov 29, 20UT

COR1-B: Nov 28, 1600 - 2300UT

EUVI-B: Nov 28, 1810 - 2010UT

# Observations of Comet ISON from **STEREO**

## **STEREO/SECCHI COR2 observing plans**

Additional telemetry requested during perihelion passage, but STEREO's distance from Earth (nearly 2AU) places constraints

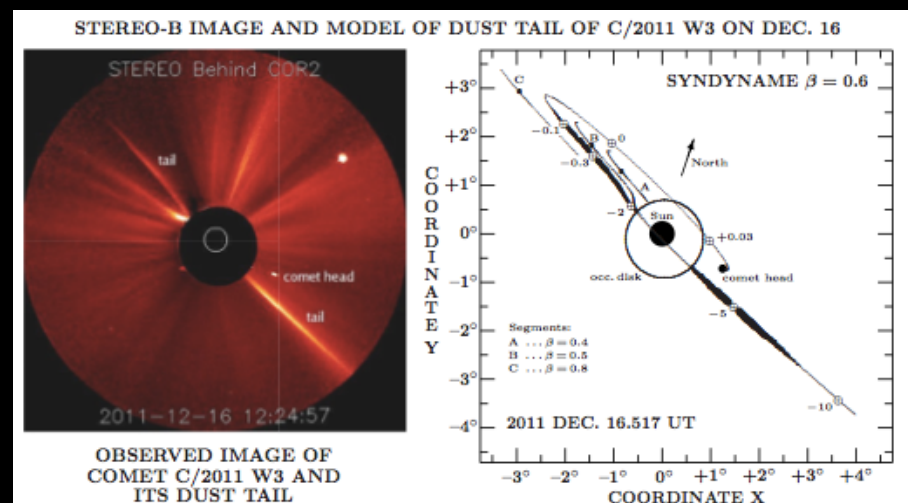
COR-2 nominal cadence: 15-min brightness, 60-min sequence, full-res  
Additional request: 15-min cadence (brightness) subfield with varied exposure times

COR-1 nominal: 10-min brightness and polarization seq., half-resolution  
Additional requested: 5-min brightness and seq subfield (effective cadence: 2.5min)

Specific exposure times and sub-fields TBD

## **STEREO/SECCHI COR-x Science**

Observations from STEREO's *two different viewpoints* in space yield important results about the **dust tails** of comets (e.g. Comet Lovejoy results)



*From Sekanina & Chodas, 2012*

# Observations of Comet ISON from **STEREO**

## **STEREO/SECCHI EUVI**

0.9° fov, 1.6-arcsec/pixel  
304A, 171A, 195A, 284A

## **STEREO/SECCHI EUVI-B observing plans**

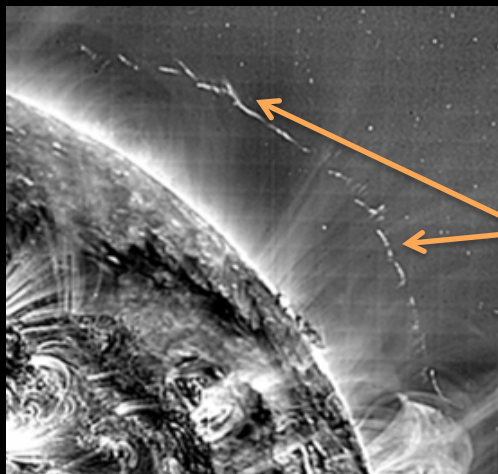
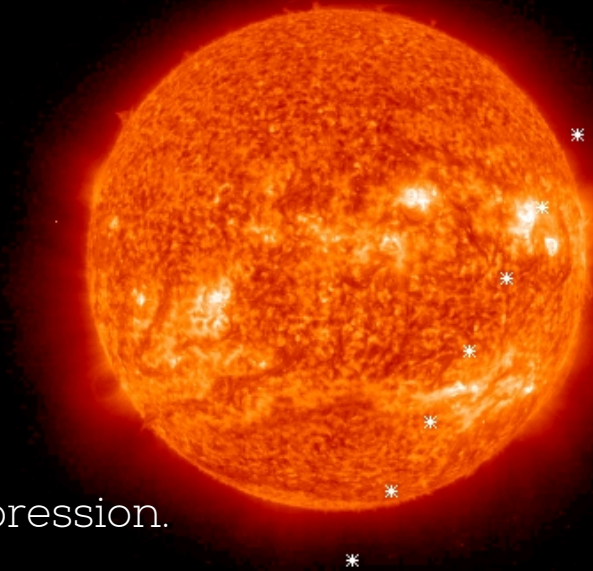
Additional telemetry requested during perihelion passage

Nominal Observations: 10-min cadence

Planned Observations:

- 171A only (Lovejoy showed strongest here)
- 10-min full field (low compression)
- 40s subfield (off-limb), long exp, lossless compression.

**ISON passage:**  
Nov 28, 1750 – 2000UT



## **STEREO/SECCHI EUVI Science**

Comet Lovejoy was seen clearly “wiggling” through the solar corona in 2011. Data such as these have opened **a new window in solar physics**, yielding valuable clues about both the coronal magnetic fields, and the comets themselves.

# Observations of Comet ISON from **STEREO**

## **Comet ISON: Outbound**

As Comet ISON heads away from perihelion (assuming survival!), it will pass once more through HI-1A before departing all of our fields of view...

...unless...

## **Additional observations of ISON**

We have the opportunity to **roll either one or both** of the STEREO spacecraft such that observations of ISON are increased and/or extended.

However, any spacecraft maneuver has **inherent risks**. The STEREO spacecraft are approaching 7yrs old and the IMUs are showing signs of **significant degradation**. While the IMU is not essential for a roll, there currently exists no CONOPS for operating STEREO without the IMUs, should they fail completely.

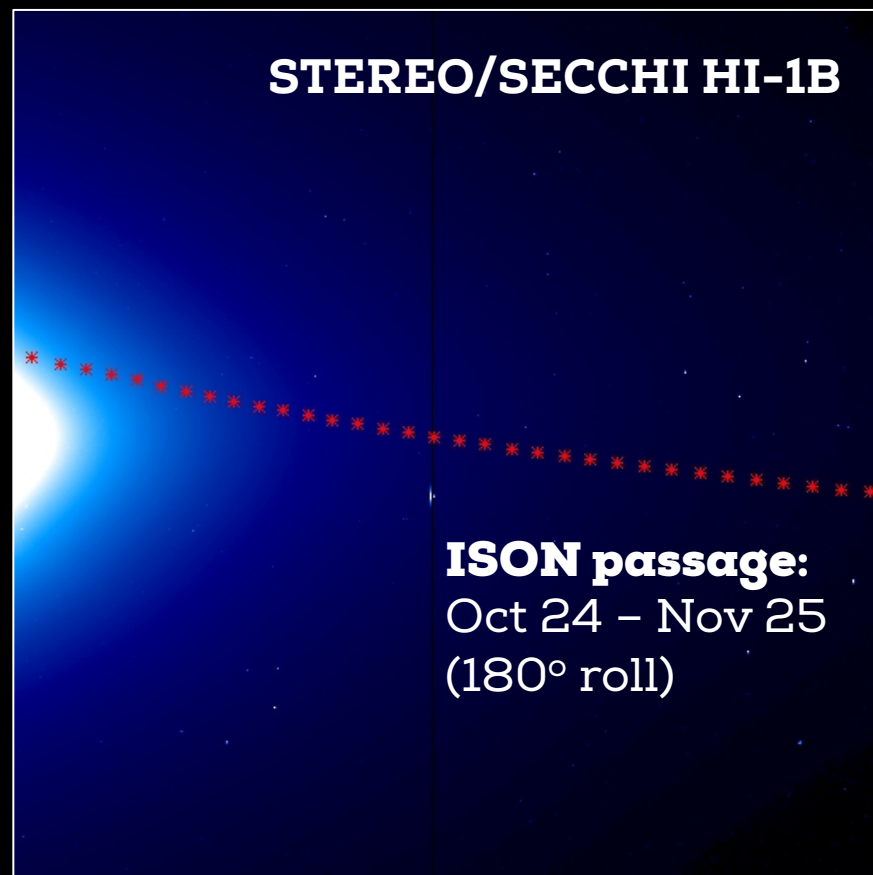
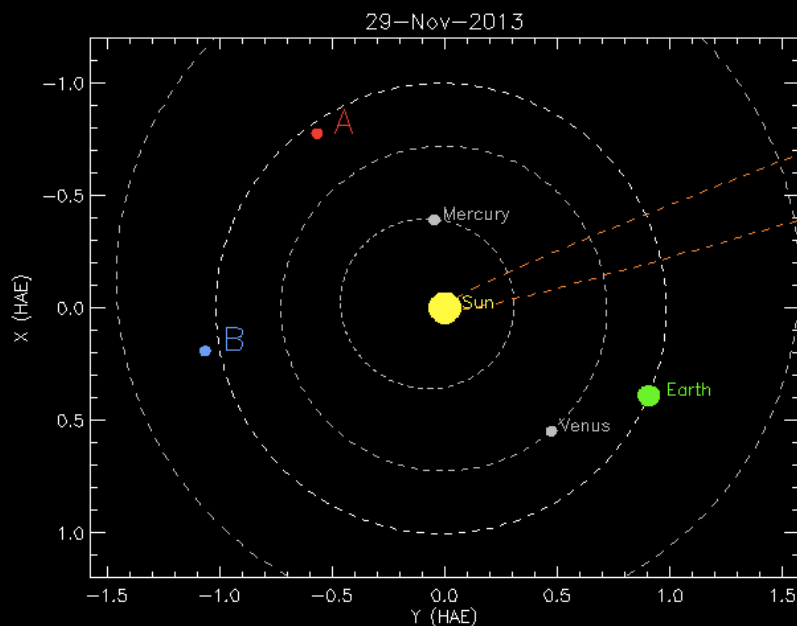


# Observations of Comet ISON from **STEREO**

## Comet ISON: Additional observations

Pre-perihelion, a **180-degree roll** of the STEREO-B spacecraft will yield the passage opposite.

These observations would coincide with those from HI-1A during Nov 21- 25  
→ "Stereoscopic" observations?



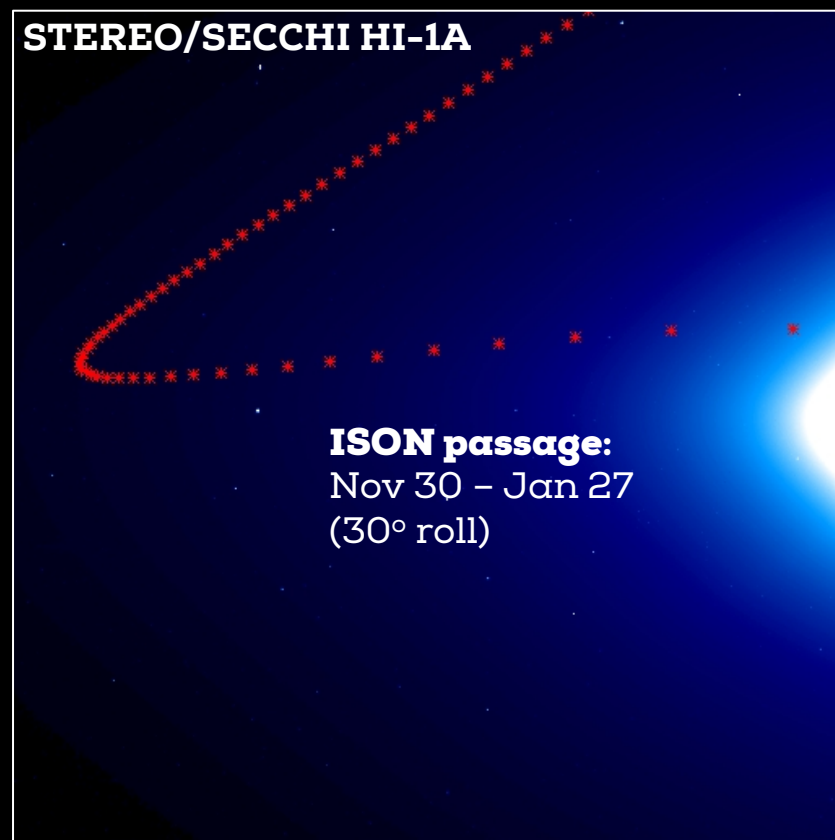
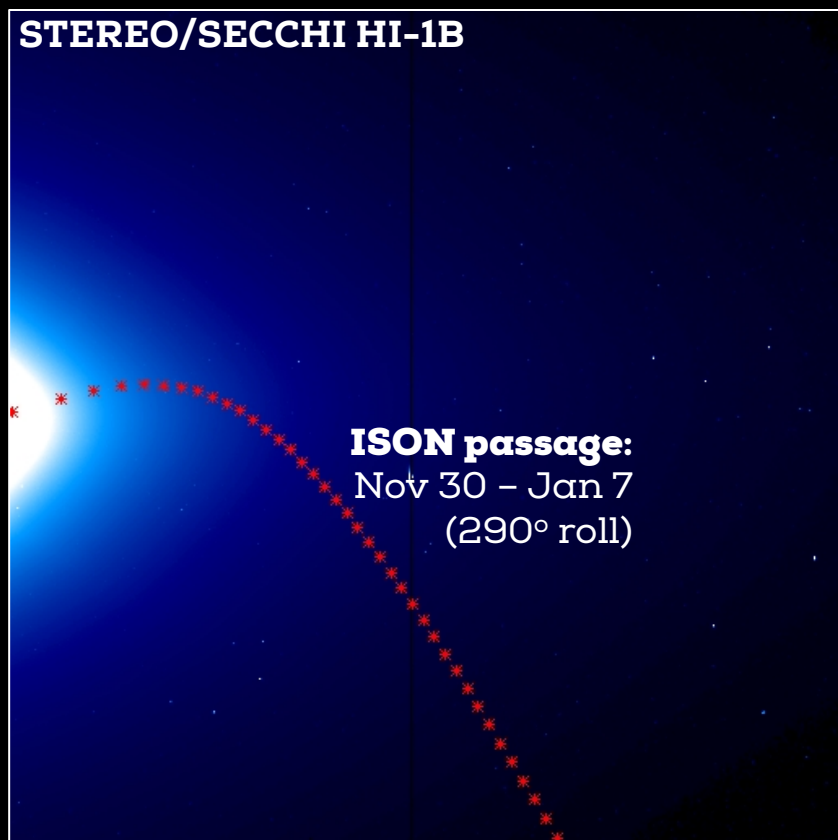
STEREO **can not dwell** at this roll angle for more than a couple of hours per day  
→ repeated roll maneuvers

# Observations of Comet ISON from **STEREO**

## Comet ISON: Additional observations

Post-perihelion, ISON will leave HI-1A on Dec 7.

We can **roll both spacecraft** and **extend observations through January 27**.



# Observations of Comet ISON from STEREO: Going beyond nominal

## Restrictions:

- Can only roll for a couple of hours per day
- On STEREO-A, the IMU is currently turned OFF and must be **turned on 4hrs prior to use, and functionally verified**, before a roll can occur.
- The STEREO-B IMU is functional but aging

## Possible options:

- Roll **daily for ~1 week** beyond perihelion, then **every 4-5 days after** that
- Roll **every few days only**
- **Only roll B**, per the above (lower the IMU risk, but only one viewpoint)
- No rolls.

## Possible negative Impacts:

- STEREO-A IMU may **fail completely** (not fatal to s/c, but certainly not good)
- STEREO-B IMU may **begin to degrade** similarly with excessive use
- STEREO Heliospheric Imager science mission interrupted
- In-situ instruments on STEREO affected (though they may not care)

# Observations of Comet ISON from STEREO: **Going beyond nominal**

## ***Our question to the community:***

What is the **SCIENTIFIC VALUE** of additional, rolled, HI-1 observations of Comet ISON both pre- and post-perihelion?

What **SCIENCE GOAL** can be achieved with this data that **can not** be achieved by other means?

- Solar wind interaction?
- CME/CIR interaction?
- Dust/ion tails?
- Stereoscopic views?
- Photometry?

*"More images = better"* is insufficient justification for the risk to the IMUs.

**Please come and find myself and Bill Thompson (GSFC, STEREO Scientist) during this Workshop and discuss this with us!**

**karl.battams@nrl.navy.mil**

**william.t.thompson@nasa.gov**