

Possibility of laser ranging support for the next-generation space VLBI mission, ASTRO-G (aka “VSOP-2”)

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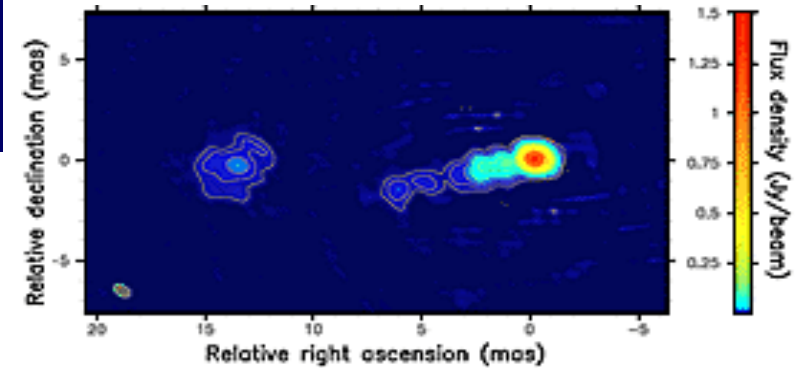
Hirobumi Saito, Hisashi Hirabayashi, Takaji Kato, Makoto Yoshikawa, Yasuhiro Murata, Yoshiharu Asaki and Shin-ichi Nakamura

Japan Aerospace Exploration Agency

Space VLBI

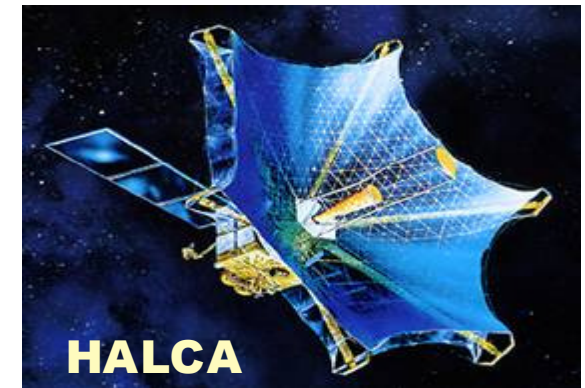
VSOP = VLBI Space Observatory Program

- High-resolution imaging of active galactic nuclei
- Motion in galactic star forming regions
- Observations of extragalactic water masers
- etc



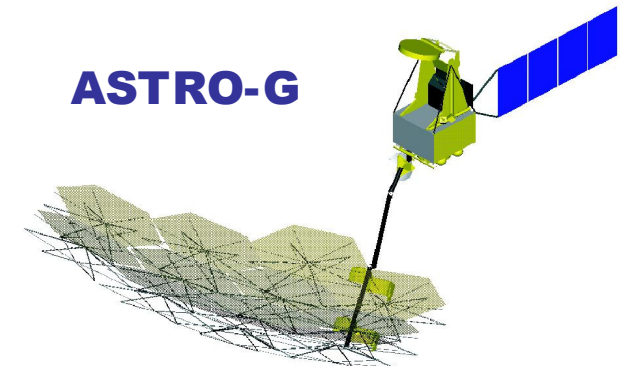
HALCA = MUSES-B (VSOP)

1997 to 2005; 1st Space VLBI satellite

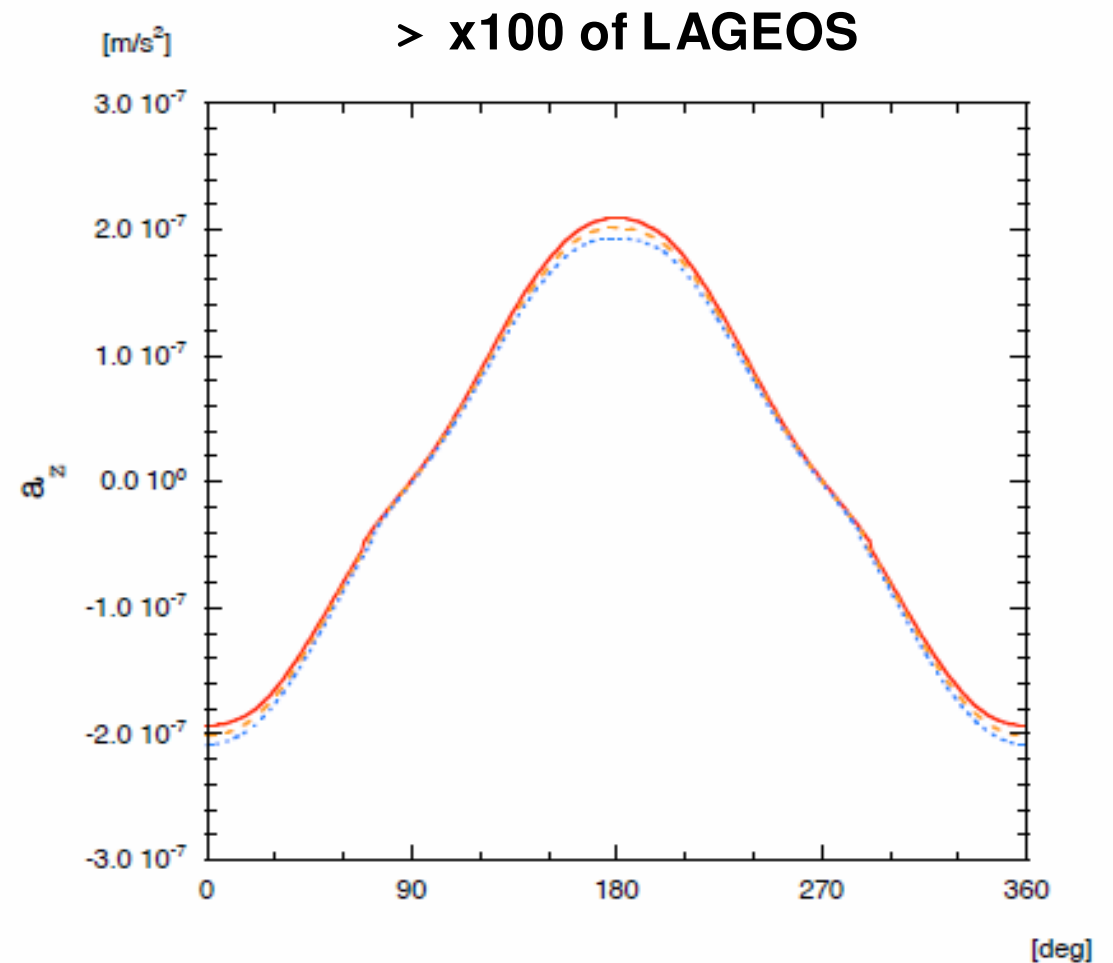
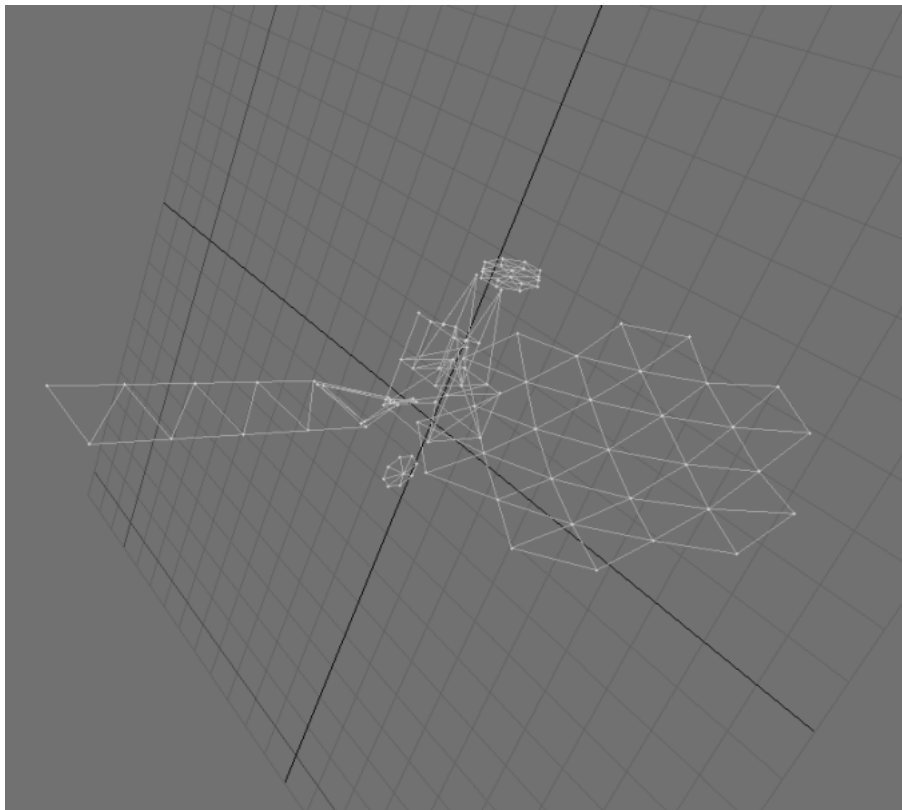


ASTRO-G (VSOP-2)

- Just approved!
- Launch: 2012 (5-year mission)
- 9.6-metre antenna
- Observation bands: 8.4, 22 and 43 GHz
- High frequency, High resolution and High sensitivity



Solar Radiation Pressure: Strong & Complicated



ASTRO-G: Orbit & Observation

Orbital element: HEO (highly elliptic orbit)

$$a = 19400 \text{ km}$$

$$e = 0.62$$

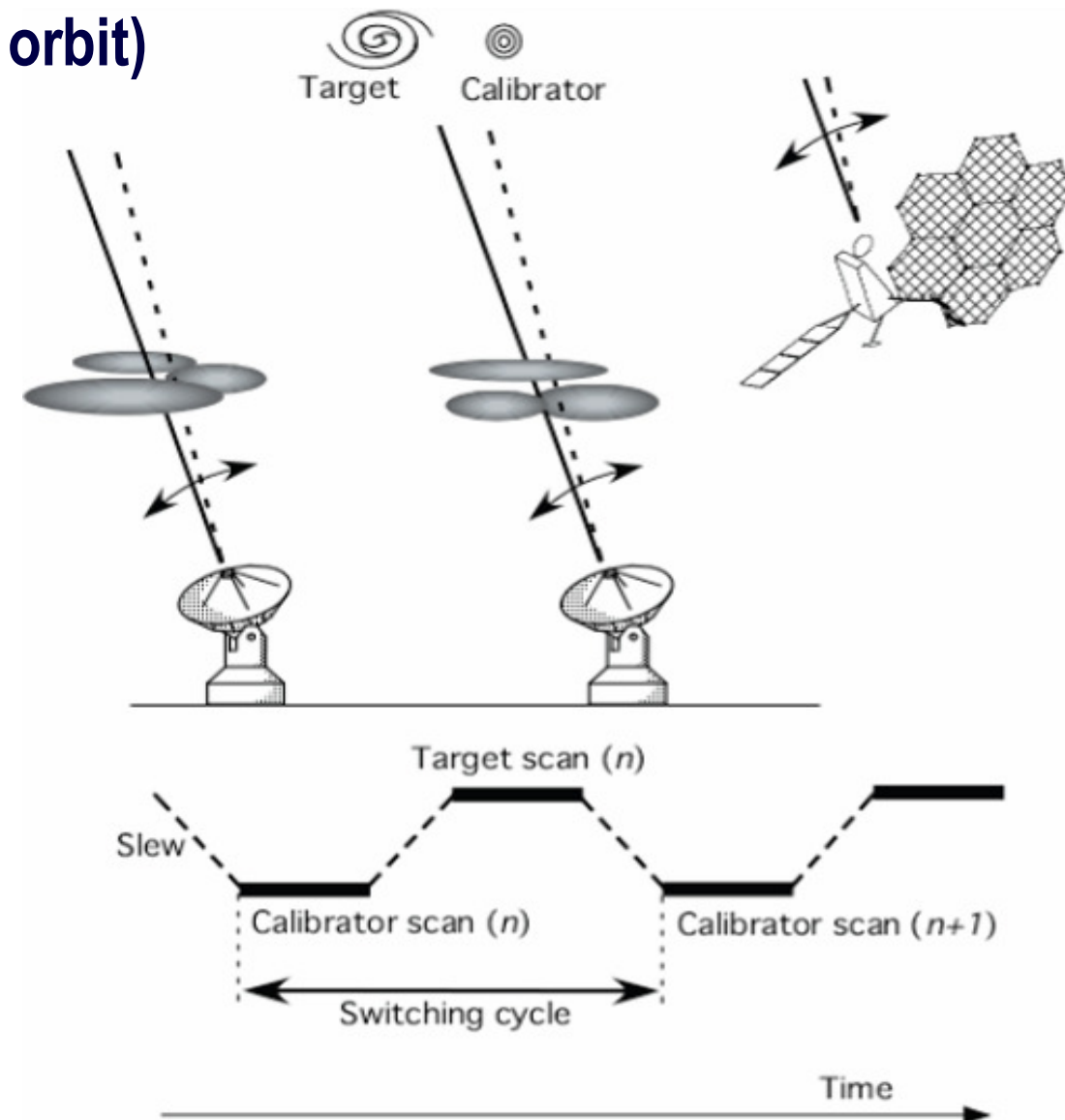
$$i = 31^\circ$$

(Altitude: 1000 km to 25000 km,
Orbital period: 7.5 hrs)

→ Long + various baseline

Orbit accuracy requirement

Phase compensation observation:
switch every minute by 2-3 deg
3 to 5 cm orbit accuracy
throughout the trajectory



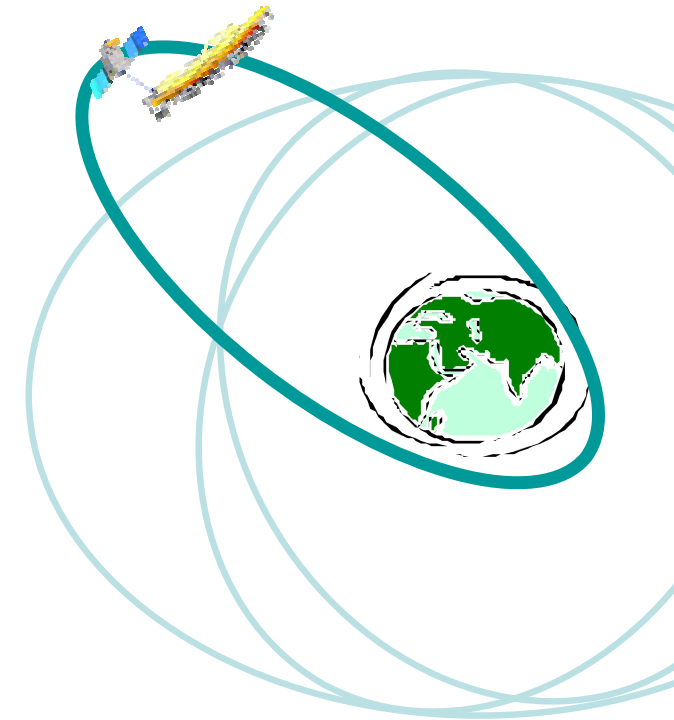
ASTRO-G: Possible instrument for POD

No decision has been made so far.

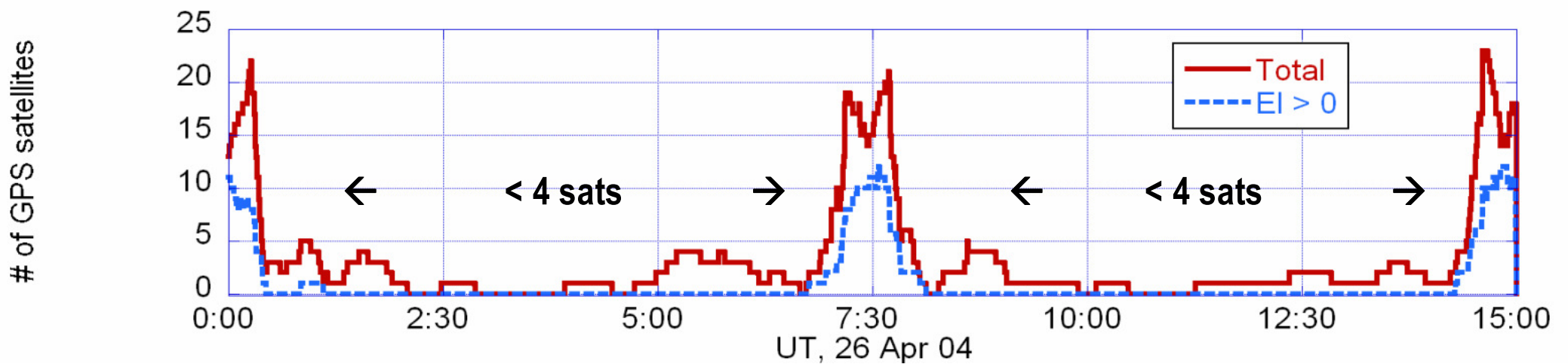
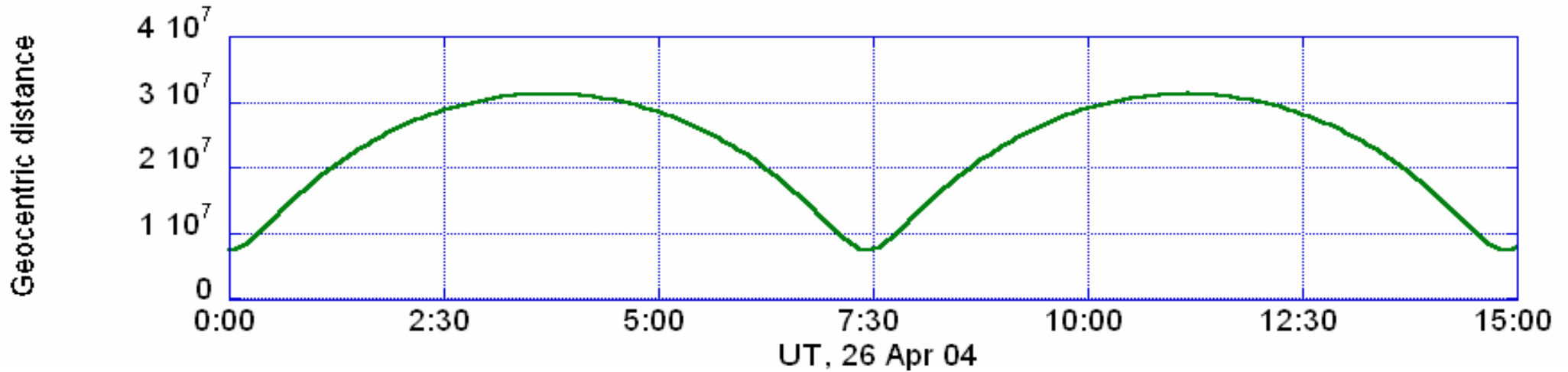
(Tell us if the ILRS network is happy to track it.)

Possibility

1. GPS (+Galileo?+Glonass?) receiver ...*very likely*
 Effective only below 3000-5000 km (1 hr per 7.5 hrs).
 Sidelobe? One-frequency use?
2. SLR retros ... *possibly*
 (discussed later)
3. Accelerometer ...?
 CoM out of satellite body.
4. Space VLBI observation ...?
 Always pointing toward one direction.

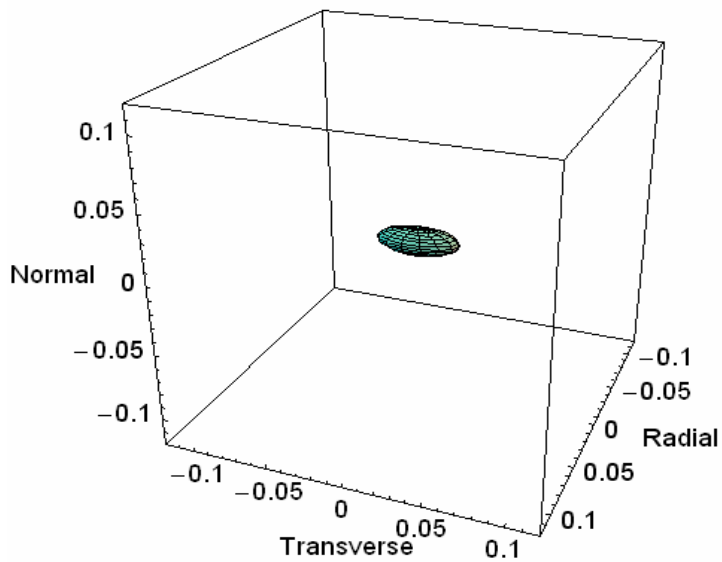


Number of visible GPS vehicles

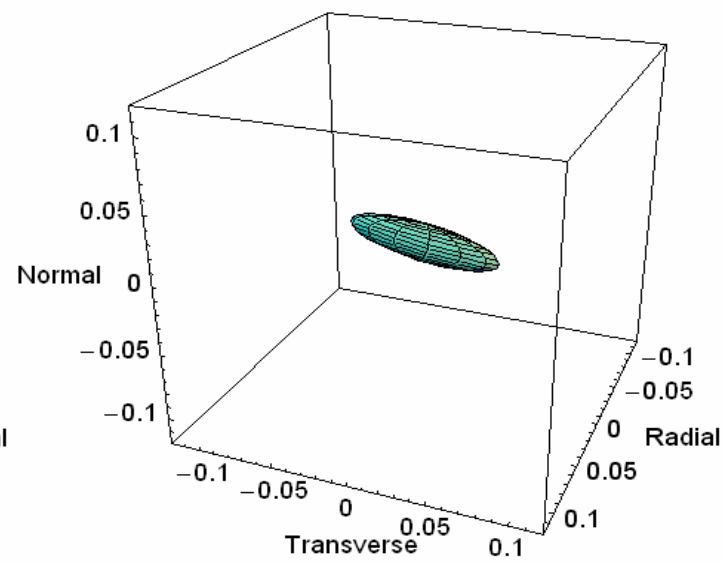


Error ellipsoid [1]: GPS only

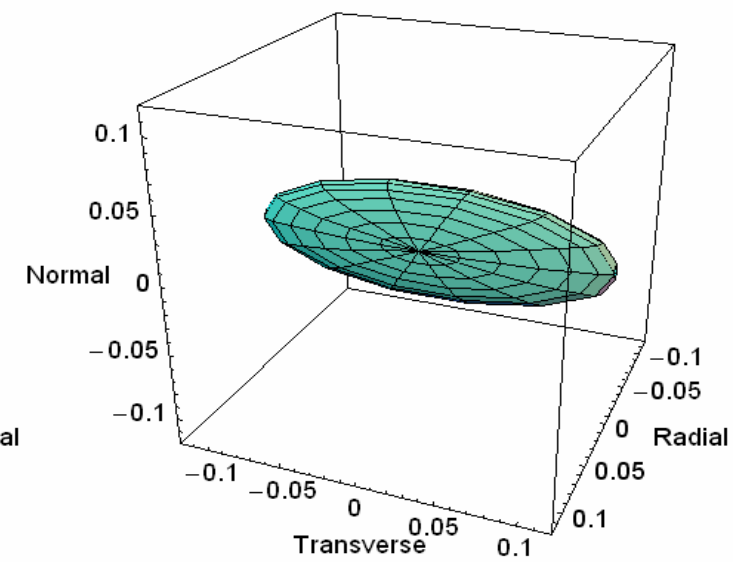
Covariance analysis



**7h 30m UT
 (~perigee)**



6h 30m UT



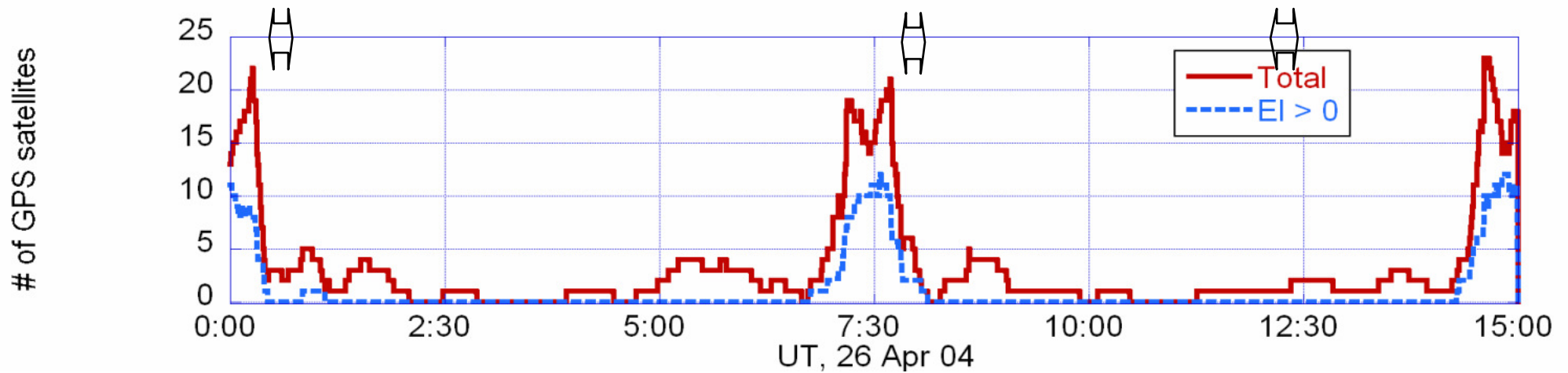
**4h 00m UT
 (~apogee)**

Adding some SLR data...

5 NPs (~20 min)
 from Monument Peak

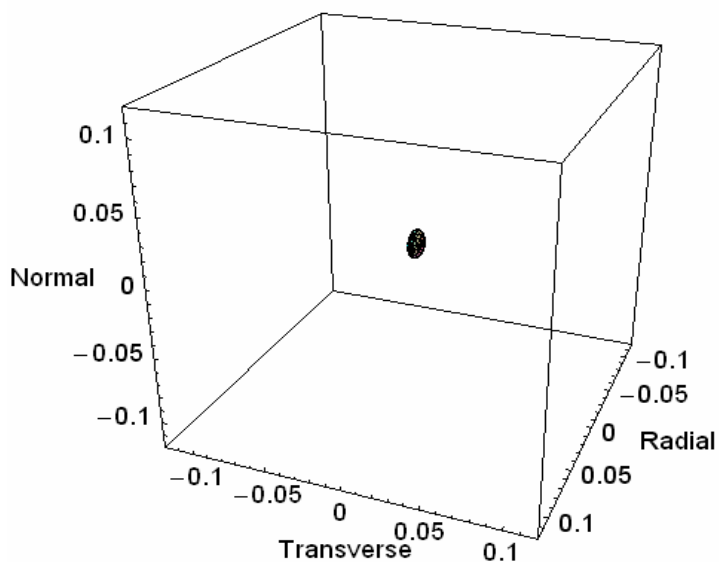
5 NPs (~20 min) from
 Tanegashima

5 NPs (~20 min) from
 Yarragadee

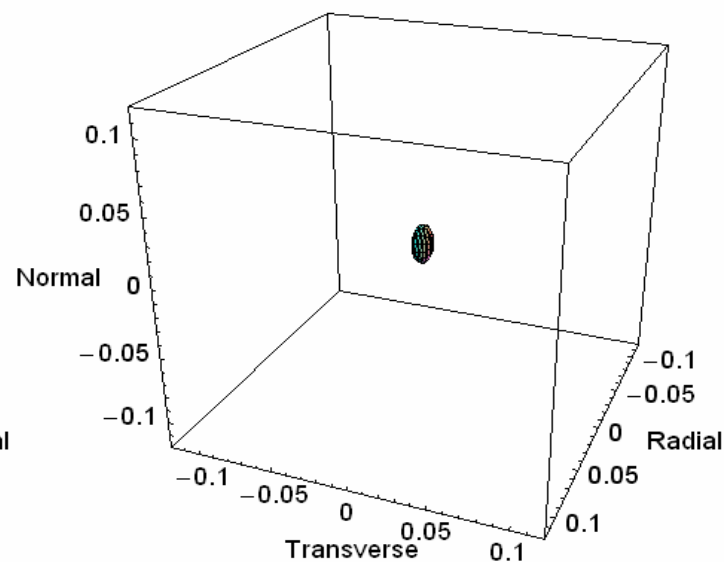


Error ellipsoid [2]: GPS + SLR

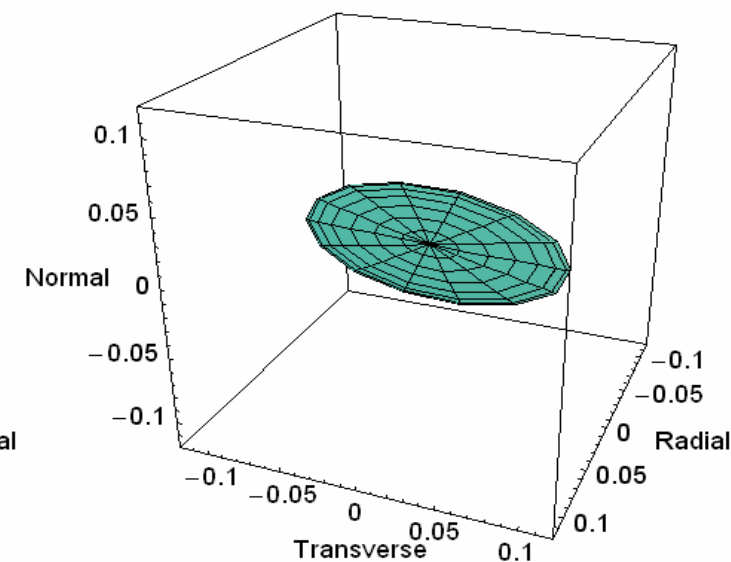
Covariance analysis



**7h 30m UT
 (~perigee)**



6h 30m UT



**4h 00m UT
 (~apogee)**

Laser Ranging Support for ASTRO-G?

Preliminary simulation study: SLR data seems promising

Will ILRS support this mission? Tell us what you think (hopefully sth positive).

TO DO 1: Retro Array Design

Similar to the GPS retro array? Velocity aberration?

TO DO 2: Observation Management Software

Operation software at each station: ready for HEO?

(Short pass around the perigee. Long pass around the apogee.)

TO DO 3: Normal-Point Generation Procedure

Discontinuity (switching observation mode)

→ New tasks in normal-point generation, such as data screening & NP bin setting

Laser Ranging for Black Hole Studies...

