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

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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

> x100 of LAGEOS
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
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

![Graph showing geocentric distance and number of GPS satellites over time.](image)

- **Geocentric distance**
- **# of GPS satellites**
- **UT, 26 Apr 04**
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 something 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...