

# Overview of VSOP-2 (ASTRO-G) Project

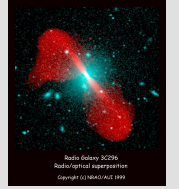
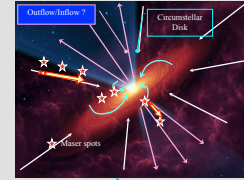
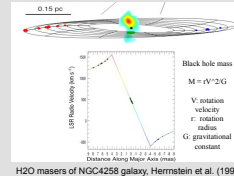
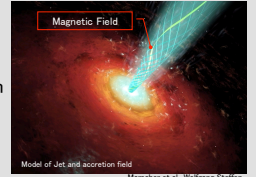
T. Umemoto, Y. Hagiwara, H. Kobayashi (NAOJ), Y. Murata, M. Tsuboi, H. Saito (JAXA),  
and VSOP-2/ASTRO-G Project Team

## ABSTRACT: VSOP-2/ASTRO-G Project

VSOP-2 (VLBI Space Observatory Programme 2) is a successor to VSOP/HALCA in which Japan plays a leading role. The space radio telescope (ASTRO-G) will be launched by Japan Aerospace Exploration Agency (JAXA) and will be operated as a single radio telescope with a 35,000km diameter, combined with ground radio telescopes. VSOP-2 will attain the angular resolution of about 40 micro-arcseconds at 43 GHz, 2,000 times better than the Hubble Space Telescope, and reveal the relativistic phenomena such as jets around super-massive black holes at the centers of galaxies, and the dynamics in galaxies and stars by observations of masers. VSOP-2 project is now proceeding through the cooperation of the National Astronomical Observatory of Japan (NAOJ) and universities and institutes in Japan and all over the world, e.g., Europe, USA, Korea, China, Taiwan. NAOJ is expected to play vital roles in organizing the ground VLBI arrays and upgrading the ground facilities in the east-Asian region, East-Asian VLBI Network (EAVN), and construction and operation of science operation center to maximize science output.

## VSOP-2 Science Goals

- Imaging of Accretion disks around super-massive black holes
- Imaging of Relativistic Jets from the accretion disks, with the polarization information
- Dynamics in galaxies and stars by observations of cosmic masers



## Information of VSOP-2 Project

- JAXA/ISAS Space VLBI WG
- NAOJ SpaceVLBI Project
- <http://www.vtop.isas.jaxa.jp/>
- <http://vsop.mtk.nao.ac.jp/vsop2/>

## Launch & Orbit

### Launch

H2A Rocket  
by JAXA

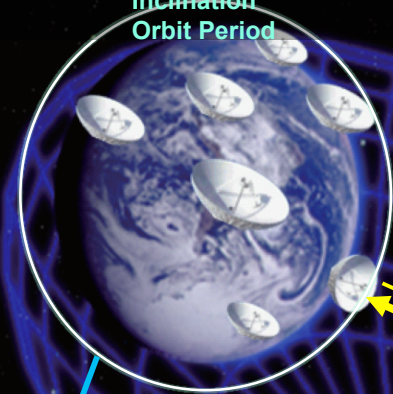
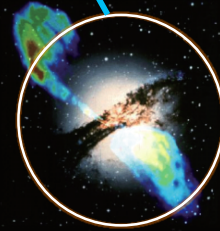
### Orbit

Apogee Height 25,000 km  
Perigee Height 1,000 km  
Inclination 31 deg  
Orbit Period 7.5 hour

## VSOP-2 (Astro-G) Mission

### Observing Bands

X band: 8.0–8.8 GHz  
K band: 20.6–22.6 GHz  
Q band: 41.0–45.0 GHz  
Dual Polarization @ all bands



### Phase Links & Data Transmission

Uplink H-maser signal @40GHz  
1 Gbps QPSK Data Downlink @37–38GHz

### BUS System

Weight 1300 kg (wet)  
Attitude Control  
Structure, Thermal Control  
Communications, Data Processing

### Phase-referencing capability

High speed Switching Maneuver  
10cm Orbit Determination (GPSR/ SLR)

### Large Deployable Antenna

9.3 m 7 Module Antenna with  
High Surface Accuracy, and  
Precision Pointing (0.005 deg)

### The Largest Telescope

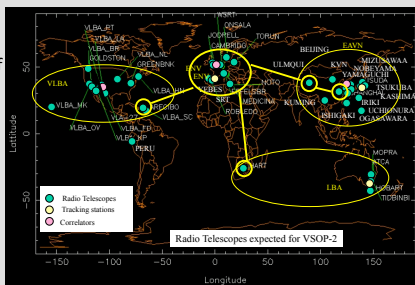
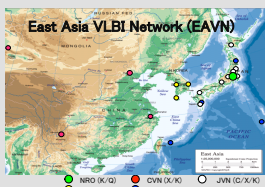
35,000 km Diameter with Ground Radio Telescopes  
40 micro-arcseconds Resolution @43GHz  
1,000 times better than the Hubble Space Telescope

### Mission Life Time

Normal Life Time is 3 years

## International Collaborations of Ground Facilities

- Ground VLBI Telescopes/Arrays (East Asia VLBI Network, European VLBI Network, etc)
- Tracking Stations (Japan: Usuda, Spain: Yeves, and other)
- Correlators (ex., Korea-Japan Joint VLBI Correlator [KJJC])
- Role of NAOJ – organization of ground VLBI arrays & upgrade of EAVN and the Correlator



## Science Operation Center (SOC) (tentative name)

Role of SOC @Mitaka NAOJ – Point of Contact for VSOP-2 Users

- Scheduling of Space & Ground Telescopes/Arrays
- Open use desk, Announce of Opportunity
- Management & Processing of science data to provide for users (pipeline processing, data archive and database)
- User Support for proposal & data analysis
- Correlator control & support
- Education & public outreach
- International cooperation

