Design of Near-term Next Generation Space-VLBI Mission VSOP-2

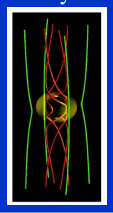
Hisashi Hirabayashi, Yasuhiro Murata, Philip Edwards, Yoshiharu Asaki, Nanako Mochizuki
(Institute of Space and Astronautical Science / JAXA),
Makoto Inoue, Tomofumi Umemoto, Seiji Kameno
(National Astronomical Observatory of Japan),
Leonid Gurvits (Joint Institute for VLBI in Europe),
Andrei Lobanov (Max-Planck Institute for Radioastronomy)

Abstract

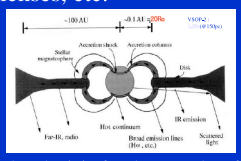
The successful launch of the HALCA satellite in 1997 made space-VLBI imaging a reality. VSOP (VLBI Space Observatory Programme) observations have been made at 1.6 and 5.0 GHz with HALCA and wide international collaborations. Sceintific results of the VSOP mission were reviewed in detail at a dedicated international symposium held in January 2000 [1]. A second generation space VLBI mission, VSOP-2, is being planned for a launch in 2010 or soon after. The scientific objectives are very high angular resolution imaging of astrophysically exotic regions, including the cores, jets, and accretion disks of active galactic nuclei (AGN), water maser emission, micro-quasars, coronae of young stellar objects, etc. The highest angular resolution of about 40 micro-arc-second is achieved in the 43 GHz band. Engineering developments are in progress for the deployable antenna, high data rate transmission, cryognic receivers, antenna pointing, accurate orbit determination, etc., to realize this mission. International collaboration is as important as it has been for VSOP, and both instrumental and scientific collaborations are under discussion.

Summary of VSOP-2 Science Goals

- Key science :
  - Jet structures, collimation and acceleration regions
  - Structure of accretion disks around AGN
  - Structure of magnetic fields in protostars
- Other science targets :
  - Galactic masers in star-forming region
  - Extragalactic Megamasers
  - Radio quiet quasars
  - X-ray binaries, SNR, gravitational lenses, etc.



Jet magnetic field structure and collimation allow models to be tested.
–Recent MHD models
–Radiation pressure acceleration models



Non-thermal emission from the magnetsphere of YSOs
•Correlation with X-ray flare
•Gyro synchrotron emission

VSOP-2 / VSOP Improvements

- Improvements over VSOP by factors of 10.
  - Higher frequencies (the highest observing frequency: 43GHz)
  - Higher resolution (38 micro arcsecond at 43 GHz)
  - Higher sensitivity

cooled receivers, wide band data downlink, phase-referencing, etc

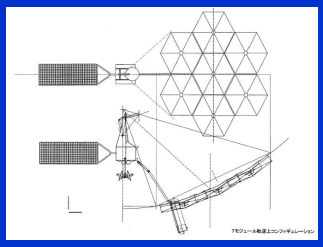
Comparison of VSOP-2, VSOP, and VLBA

	VSOP-2	VSOP	VLBA
Antenna diameter	9 m	8 m	25 m
Apogee height	25,000 km	21,500 km	0 km
Orbit period	7.5 hour	6.3 hour	1 day
Polarization	LCP/RCP	LCP	LCP/RCP
Data downlink	1 Gbps	128 Mbps	512 Mbps
Observing frequency (GHz)	8, 22, 43	1.6, 5, (22) <*>	1.6, 2, 5, 8, 15, 22, 43, 86
Highest resolution	38 micro as	360 micro as	96 micro as
Sensitivity 5/8 GHz)	22 mJy	158 mJy	7.9 mJy
(22 GHz)	39 mJy	--	23 mJy
(22 GHz with phase-ref.) (1.5-hour integration	9.1 mJy	--	5.3mJy
Launch	2010 FY(target)	Feb.1997	

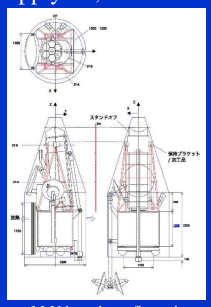
<*> Although the VSOP satellite has a 22-GHz receiver, the system noise temperature is very much higher than expected, possibly due to damage to the waveguide connection during the launch.

VSOP-2 Satellite

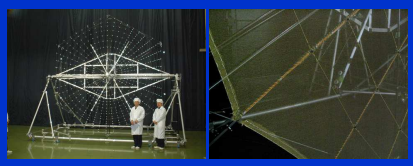
- Observing frequencies : 8 / 22 / 43 GHz
- Cooled receivers (22 / 43 GHz)
- Wide band data downlink (1 Gpbs)
- Dual polarization (LCP / RCP)
- Phase-referencing capability by fast switching
- Orbit apogee (perigee) : 25,000 (1,000) km, inclination : 31 deg
- Satellite mass (wet) : 910 kg, power supply : 1,800 W



9-m offset cassegrain antenna of seven hexagonal modules (Light weight, Easy adjustment)



M-V launch configuration



Real scale model of one module (2003 and 2004 FY)

VSOP-2 Proposal Status

The VSOP-2 proposal was submitted to ISAS' Science Steering Committee in October 2003, at the same time as the X-ray mission NeXT. Both missions were highly ranked, but ultimately, due to ISAS' near term budget profile for the next few years, neither was included in the budget request for the 2005 FY. ISAS is going to prepare a long-term plan to outline a coherent strategy for future missions connected with future budget request.

An improved and revised proposal will be submitted later this year in response to the next call for mission proposals. It is likely that some development funding will be available to continue the studies of the main antenna, rapid slewing with CMGs, etc, made to date.

The ongoing support and assistance from the domestic and international community will be required for the submission of an even more competitive proposal.

VSOP-2 Web Site: www.vsop.isas.jaxa.jp/vsop2/

Reference

[1] "Astrophysical Phenomena Revealed by Space VLBI", Proceedings of the VSOP Symposium held at the Institute of Space and Astronautical Science, Eds H. Hirabayashi P.G. Edwards, D.W. Murphy (ISAS: Sagamihara), 2000