Space VLBI History, JIVE and Leonid

Richard Schilizzi

ngSVLBI-3 Workshop, Dwingeloo, 18 October 2022

Some highlights in the history of VLBI

1965 – first mention of space VLBI
1967 – first fringes with independent tape recording & oscillators
1976 – US VLBI Network established
1977 – satellite-linked VLBI demonstration
1980 – European VLBI Network established
1983 – first contact EVN & European Commission → JIVE 10 years later
1986 – first Space-VLBI fringes with TDRSS
1993 – Global VLBI WG formed to coordinate SVLBI
– dedication of VLBA
– JIVE established
1994 – Leonid arrives in Dwingeloo
1997 – VSOP launched
1998 – inauguration of EVN Data Processor at JIVE
2011 – RadioAstron launched

Space VLBI history is a tale of two missions and four phases

Space VLBI history is a tale of two missions and four phases

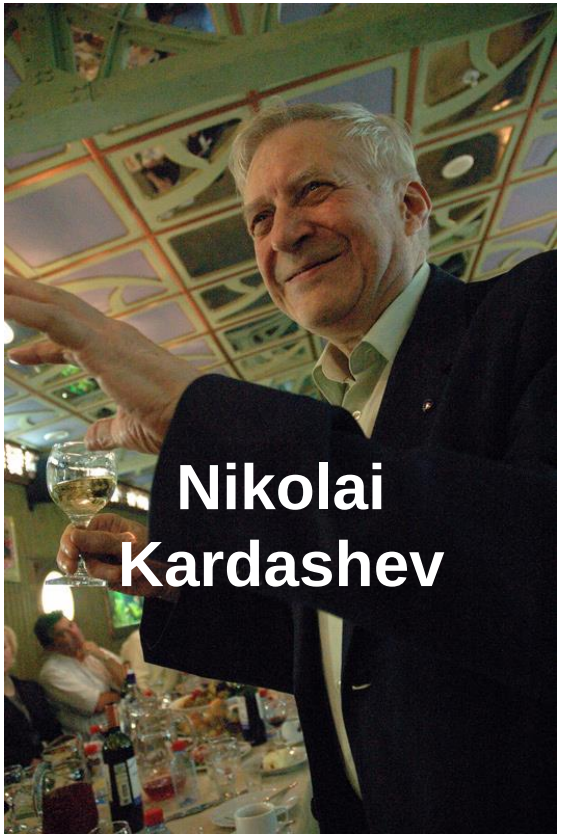
VSOP - HALCA

Space VLBI history is a tale of two missions and four phases

VSOP - HALCA

and

RadioAstron



MANCHESTER 1824

Phase 1:
The very early days of space VLBI, 1960s - 1982

First idea

1963 Nikolai Kardashev

Matveenko, L.I., Kardashev, N.S. & Sholomitsky, G.B. 1965, "On radio interferometer with a large base", Radiophysics, v. 8, No. 4, 651-654 (in Russian).

included a suggestion that a radio telescope on a spacecraft would enable baselines even longer than the diameter of the Earth.

Private communication from Leonid Gurvits

USSR

The space VLBI concept was pursued by Kardashev from the late 1960s.

It became a formal project in the Space Research Institute in Moscow in June 1978.

Concept was low-orbit space telescope (KRT-30) for very complete coverage of uv-plane and a high orbit space telescope (10m) for very good angular resolution. (Kardashev 1983, Paris, March 1983)

Leonid joined the space VLBI project in April 1979 after he finished his MSc in Aerospace Engineering (Moscow Aviation Institute) and Astrophysics (Moscow State University).

USA

Bob Preston, Feb 1977, VLBI with an Earth-Orbiting Antenna

JET PROPULSION LABORATORY

ENGINEERING MEMORANDUM

315-16

11 February 1977

TO: Distribution

FROM: R. A. Preston *RAP*

SUBJECT: VLBI with an Earth-Orbiting Antenna

Bernie Burke et al, Nov 1978 VLBI Station on 1981-1983 Space Lab Missions

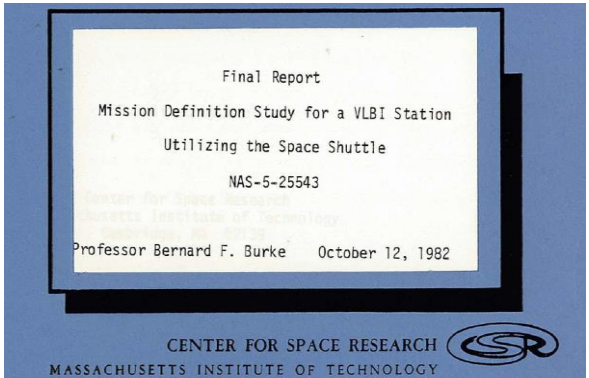
INVESTIGATION AND TECHNICAL PLAN

Volume 1

Of a Proposal to the

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Bernie Burke et al, Oct 1982 VLBI Station on Space Shuttle



An important side-show – satellite-linked VLBI

1977

Real-Time, Very-Long-Baseline Interferometry Based on the Use of a Communications Satellite

Abstract. *The Hermes satellite, a joint Canadian-American program, has been used to provide a communication channel between radio telescopes in West Virginia and Ontario, for very-long-baseline interferometry (VLBI). This system makes possible instantaneous correlation of the data as well as a sensitivity substantially better than that of earlier VLBI systems, by virtue of a broader observational bandwidth. With the use of a geostationary communications satellite it is possible to eliminate the tape recorders and the most troublesome part of the postobservational data processing. A further possibility is the development of a phase-coherent interferometer.*

1982: US-Europe discussions on how to proceed on space VLBI following local failures → QUASAT

An important side-show – satellite-linked VLBI ……

1977

Real-Time, Very-Long-Baseline Int

Based on the Use of a Communicati

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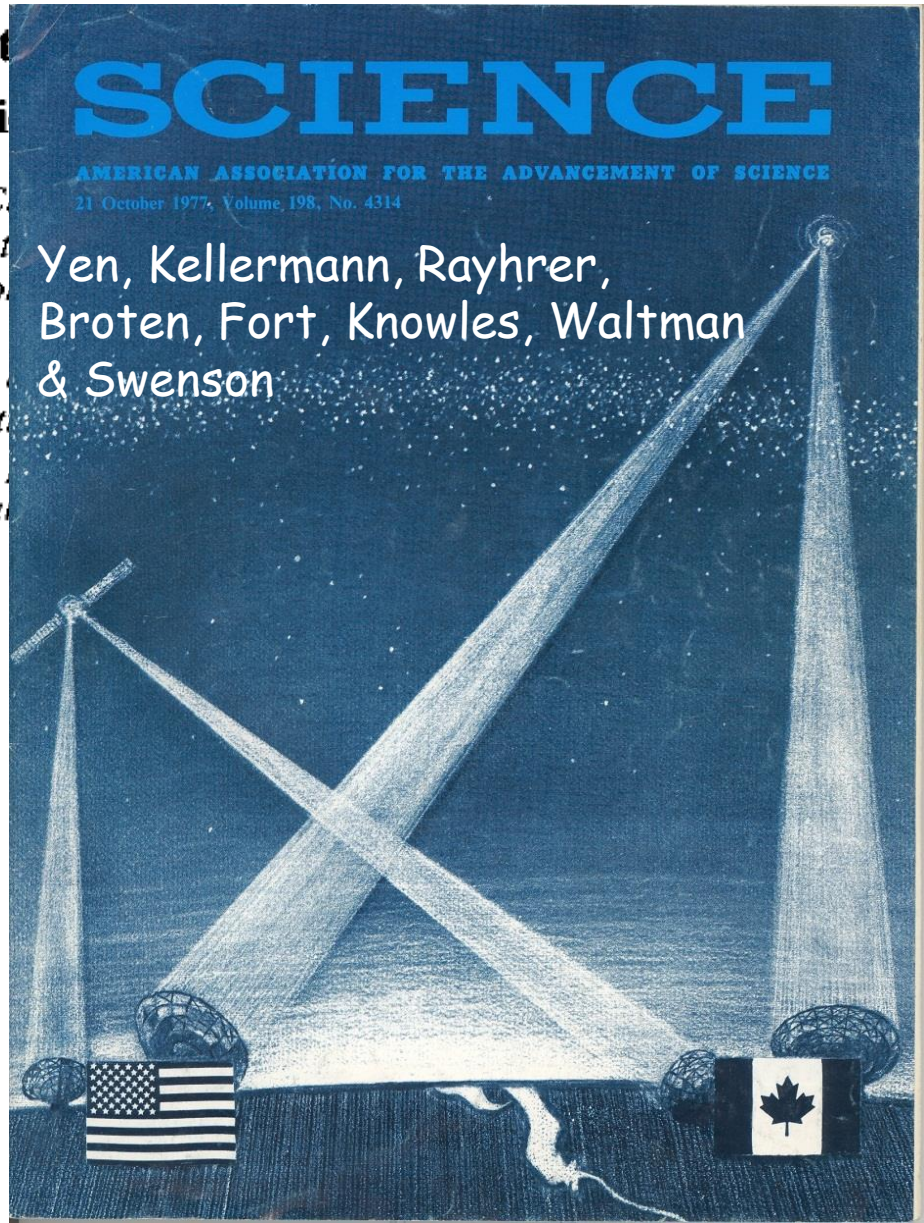

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An important side-show – satellite-linked VLBI

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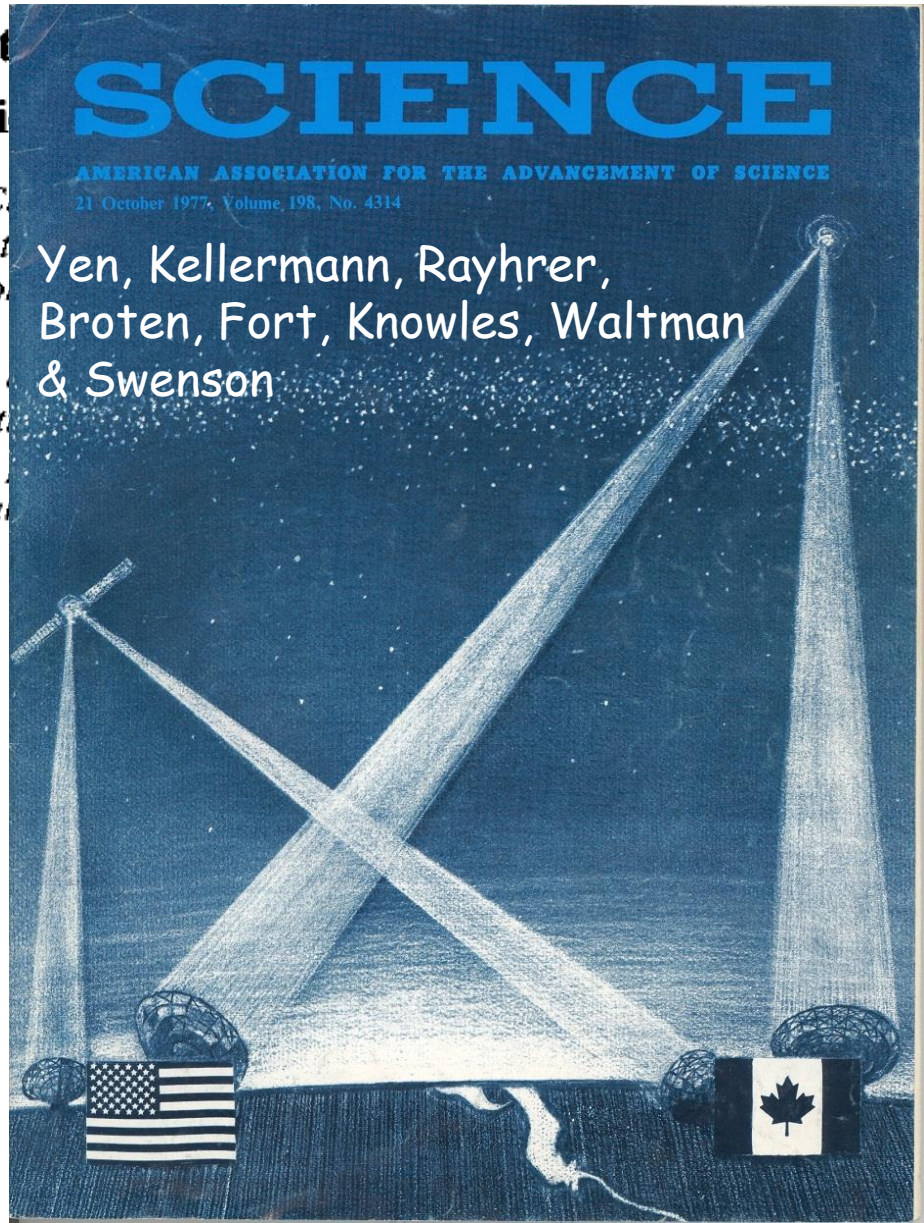


1978: ESA Feasibility Study of satellite-linked VLBI (Schilizzi et al)

1981: ESA Phase A study of satellite-linked VLBI using L-SAT (Schilizzi et al)

1981: Satellite-linked VLBI in Europe abandoned

1982: US-Europe discussions on how to proceed on space VLBI following local failures → QUASAT

Japan

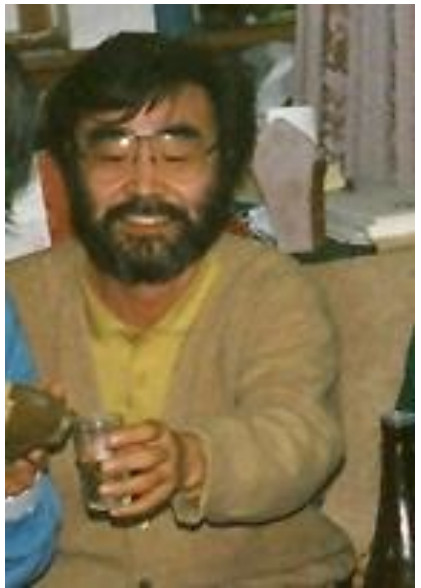
SPACE VLBI 1982

H. HIRABAYASHI, Y. CHIKADA, M. INOUE, M. MORIMOTO

Nobeyama Radio Observatory*, Tokyo Astronomical Observatory,
University of Tokyo, Nobeyama, Minamisaku-gun
Nagano-Ken 384-13, Japan

(Submitted to Space Station Symposium Tokyo)

Oct. 1982



e diameter
nna on US
e Station

Phase 2:
Mission Studies 1983-1988

Europe - USA

esa
european space agency

SCI(85)5
NOVEMBER 1985

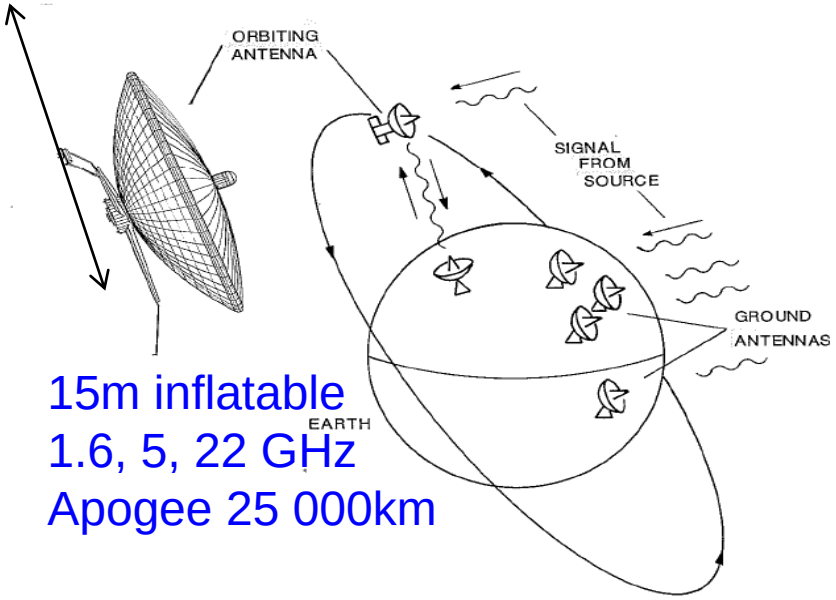
Joint ESA-NASA Study

QUASAT

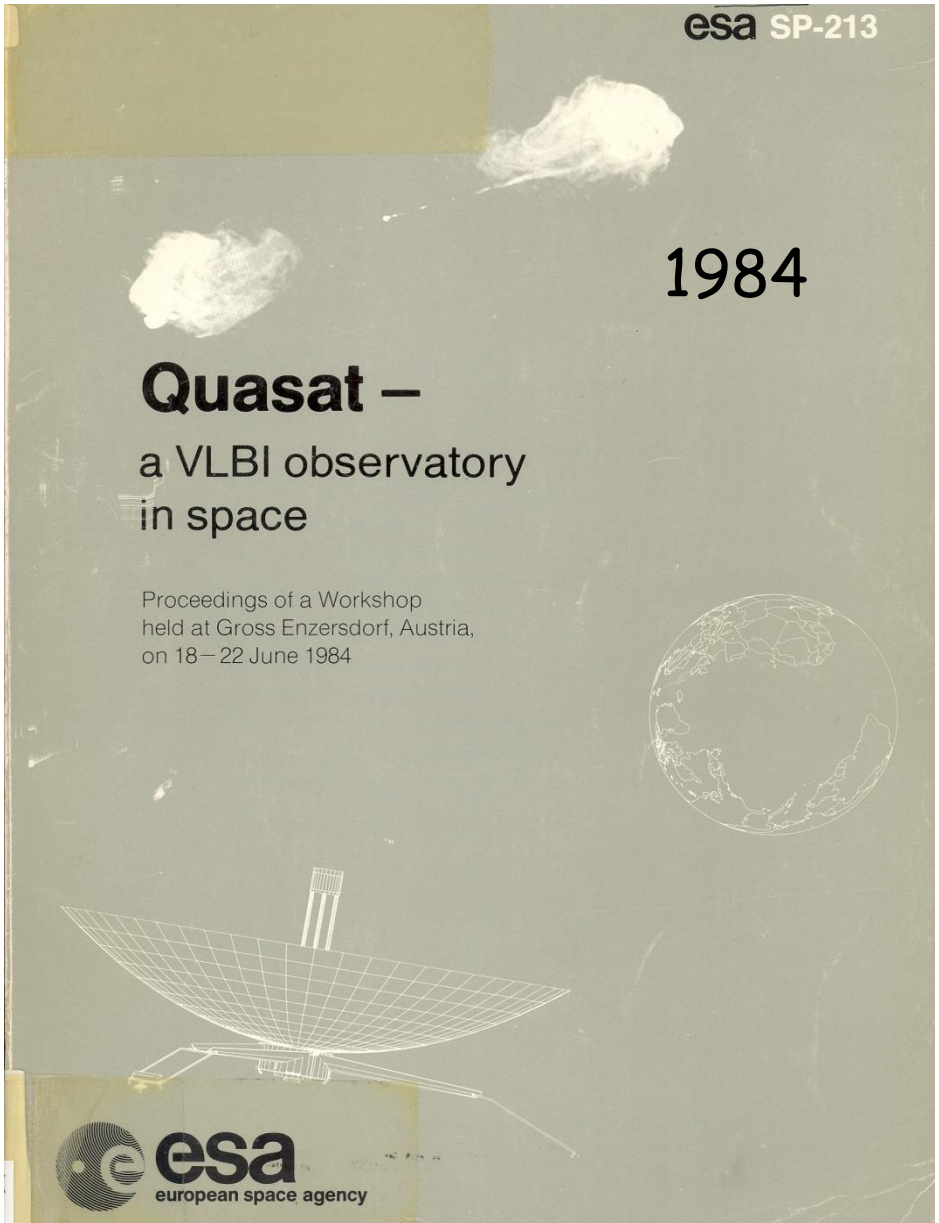
A SPACE VLBI SATELLITE

1983-1985

ASSESSMENT STUDY



15m inflatable
1.6, 5, 22 GHz
Apogee 25 000km



High-level coordination began to take place in 1984

- COSPAR Ad-hoc Committee on Space VLBI
  - served as a body to coordinate the efforts in the Soviet Union, Europe, USA, and Japan until mission-specific International Scientific Committees were formed
  - space-space VLBI baselines were a factor
- Inter-(Space) Agency Consultative Group
  - Panel 1 on Space VLBI

RadioAstron was “approved” in 1985 for launch in 1989

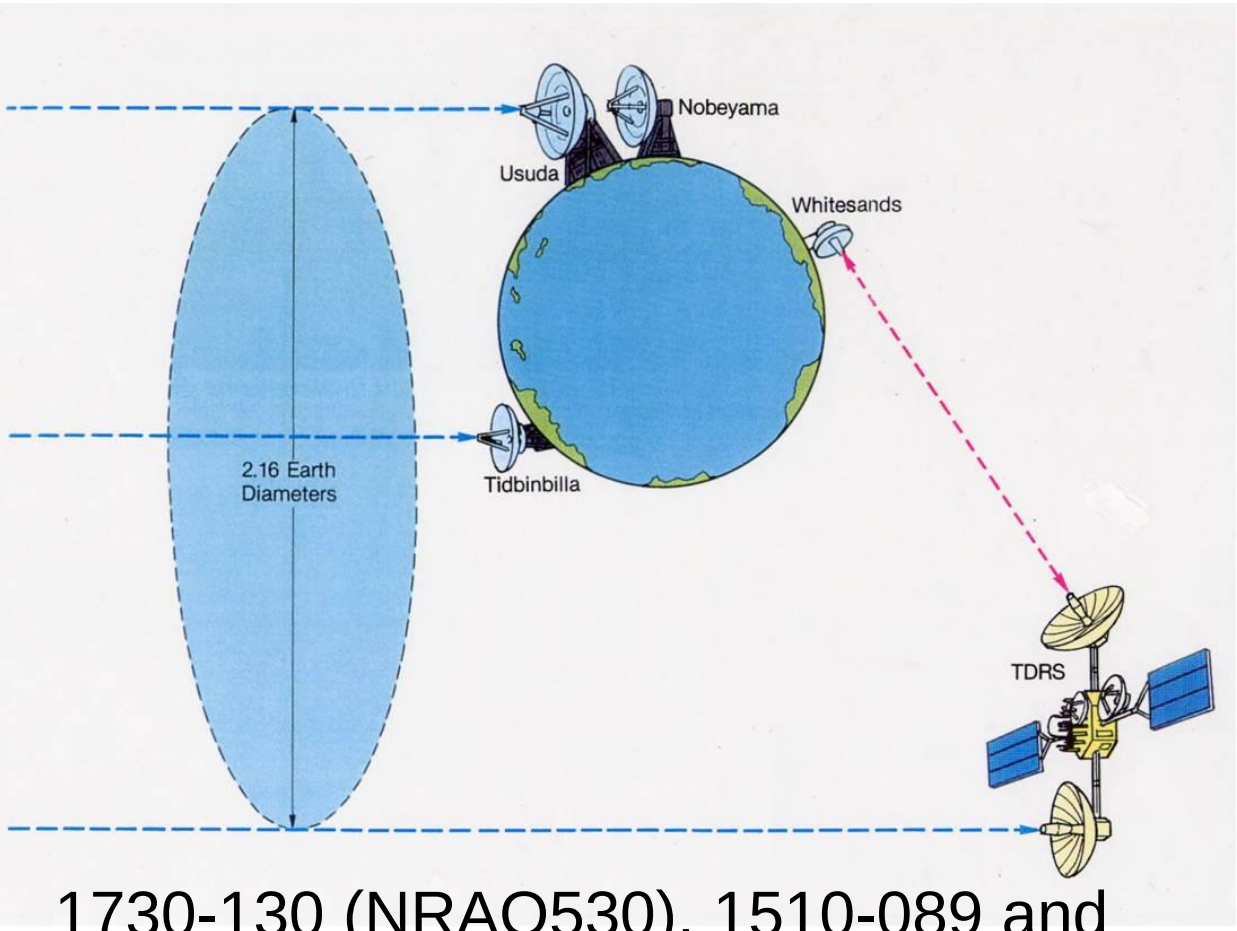
Announcement made at the first RadioAstron International Scientific Committee (RISC) in Moscow in June 1985

10m diameter, 0.3, 1.6, 5, 22 GHz, apogee 100000 km, later changed to 320 000 km

Led to celebrations!

First space VLBI fringes with TDRSS in1986

Gerry Levy et al
JPL



1730-130 (NRAO530), 1510-089 and 1741-038, detected at 2.3 GHz

Cultural exchanges took place

October Revolution Parade in Leningrad, November 1988

Cultural exchanges took place. II

End of Phase 2

QUASAT was not selected by ESA in October 1988 in a competition won by Cassini-Huygens

VSOP was approved by ISAS in December 1988

- 8m diameter 1.6, 5, 22 GHz; apogee 21 600 km

RadioAstron carried on

Phase 3:
VSOP and RadioAstron
in centre-stage

International Scientific Councils

RadioAstron (RISC) - April 1988 in Dwingeloo *(Leonid was a member from 1989)*

VSOP (VISC) - November 1992 in Sagamihara *(Leonid was a member from 1992)*

There were risks in being a RISC member

The famous bus crash on the Pushchino to Moscow Road, November 1991

The Ground Segment

Global VLBI Working Group (est. 1993)

To serve as a liaison between ground-based observatories and national or international space agencies, for coordination of participation by ground radio telescopes in Space VLBI missions.

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The Ground Segment

Global VLBI Working Group (est. 1993)

Onsala, October 1993

VSOP-HALCA space segment

Technical development advisors

the chief cook (Hirax),

9 assistant cooks, and

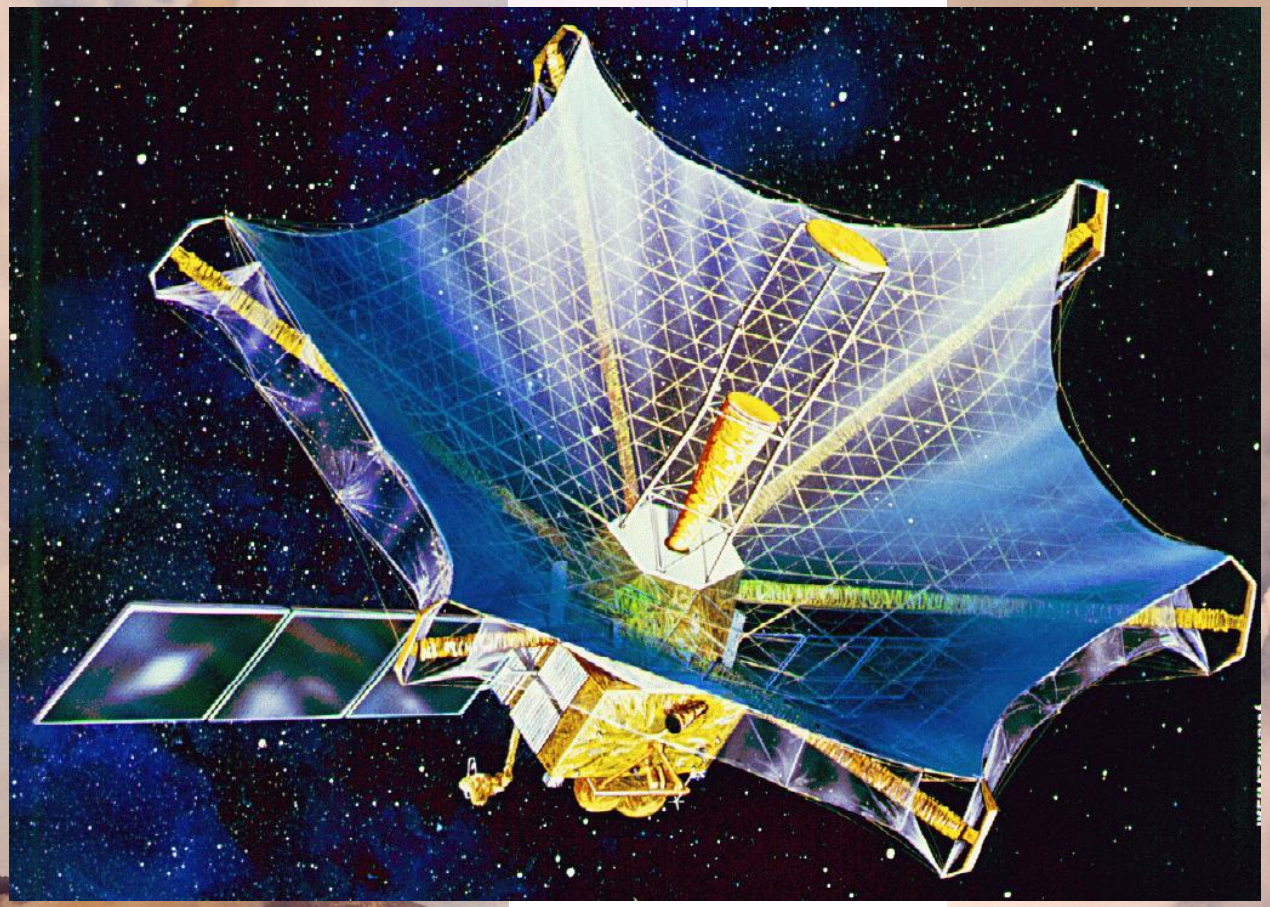
one bottle-washer

Launch in February 1997

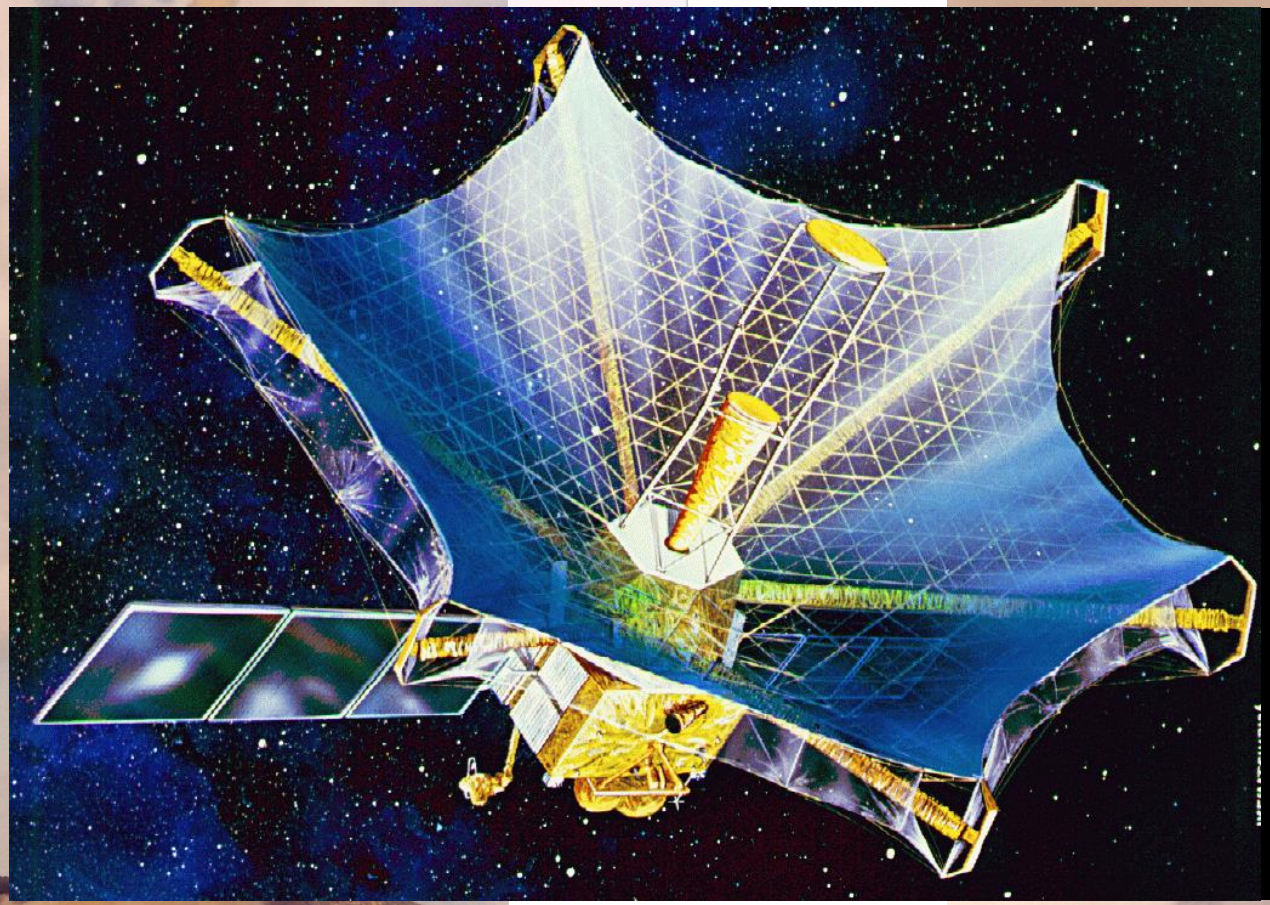
Launch in February 1997

Launch in February 1997

Launch in February 1997



Launch in February 1997



operational until Nov 2005


RadioAstron Flight Model
2008

And finally the launch in July 2011

And finally the launch in July 2011

Phase 4:
ngSVLBI mission studies

MANCHESTER 1824

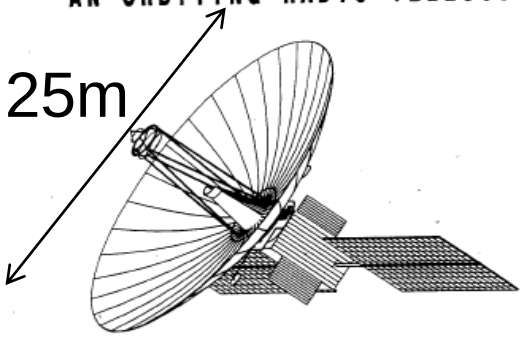
esa european space agency

ASC

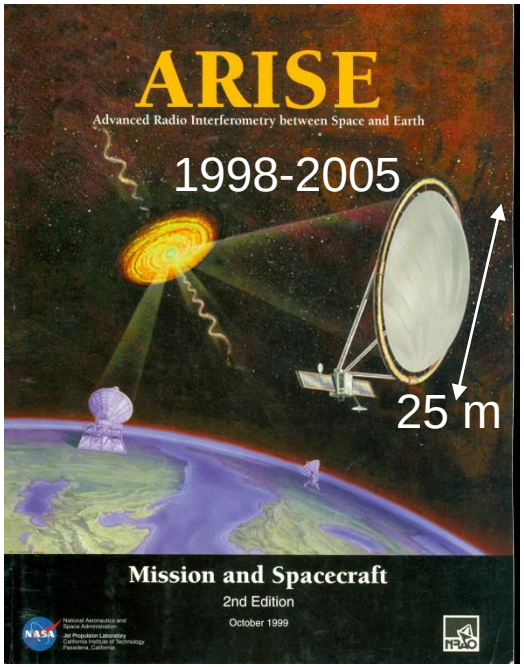
1989-1991

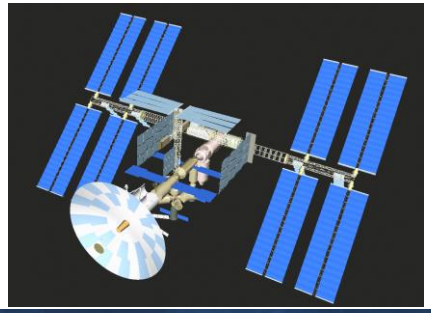
I V S

AN ORBITING RADIO TELESCOPE



REPORT ON THE ASSESSMENT STUDY



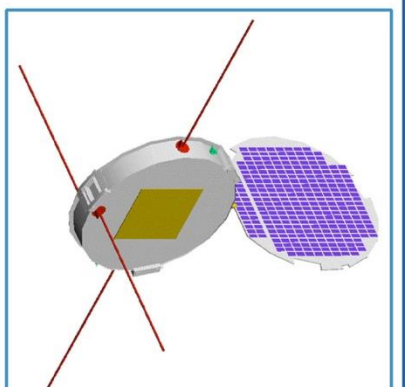


ISS-SVLBI,
Ø ≥30m
1998-2000

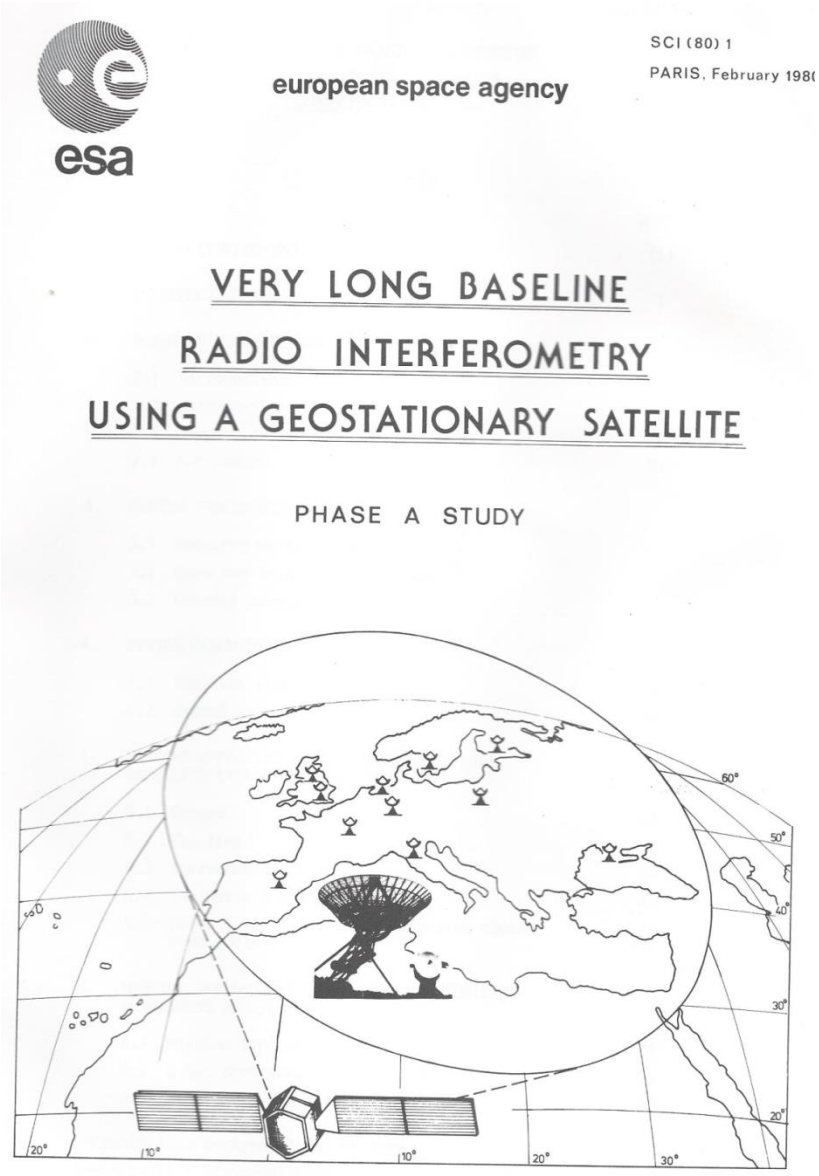
J

ALFA (~2002)

Antenna :	100 km array of 16 spacecraft
Frequency Bands (MHz):	0.03 - 30 (tunable)
Resolution (arcseconds):	10,000 - 10
Sensitivity:	several Jy



JIVE and Space VLBI



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European discussions on (large) correlators in the 1970s and 1980s

1980 First meeting of EVN Telescope Directors in Bonn discussed satellite-linked VLBI and data processing needs - **8-station real-time correlator**

1981 ESA required € 2.5-3.5 M from the EVN for modifications to L-SAT for VLBI + EVN to pay for ground stations at each telescope
→ Demise of satellite-linked VLBI

1983 Director's meeting in Garching
- upgrade Mk3 processor at MPIfR to 12 stations

- develop new generation (12 station) data processor in Dwingeloo for the longer-term future including QUASAT which had started in mid-1982

1983 Contact made with the European Commission

1992 Funding for a 16-station data processor came from the Netherlands, France and Sweden

The EVN data processor at JIVE

Dec 1993	JIVE established as a Dutch Scientific Foundation
1993 –1998	Design, prototyping, and construction of 16-station MkIV processor by international consortium Part of the EVN Upgrade
Total cost	8.7 M€
Oct 98	Inauguration of EVN Data Processor at JIVE

Inauguration of the EVN Data processor at JIVE, October 1998

Leonid at JIVE, 1994-2002

Science

Space VLBI management

- RISC member, RadioAstron Project Scientist, organisation of RISC meetings
- VISC member
- Space VLBI panel member, Inter-(Space) Agency Consultative Group
- GVWG member
- member of the ESA-Space Research Institute (Russia) Feasibility Study of the ngSpace VLBI mission *International VLBI Satellite*

Space VLBI at working level

- member GVWG Technical Working Group – global VLBI database, ground observatory support
- European Coordinator for the VSOP in-Orbit Checkout (IOC) phase
- Regional VSOP Expert for Europe and China, support for observing proposals
- European rep on VSOP Science Operations Group (VSOG)
- RadioAstron Newsletter (together with Denise Gabuzda and Slava Slysh)
- Space VLBI User Assistance software (FOMI Satellite Geodetic Observatory Hungary)
- assistance in testing RadioAstron antenna petals at ESTEC (1994, 1998)

Leonid at JIVE,1994-2002

Space VLBI Science Advisory Groups

ISS-VLBI, ARISE, VSOP-2

Other International Collaboration

- Coordinator INTAS grant for collaboration on radio astronomy
  (INTernational ASsociation for the Promotion of Cooperation with Scientists from the Independent States of the Former Soviet Union)
- Coordinator, NL-Hungary collaboration on radio astronomy
- Coordinator, NL-China collaboration on radio astronomy
- Manager, EC Infrastructure Cooperation Network, RadioNet
- Manager, EC Research & Technical Development in Radio Astronomy

Leonid's travels 1994-2001

Year	#meetings in NL and elsewhere	#presentations in NL and elsewhere	#trips outside NL	#countries visited
1994	14	14	8	7
1995	12	21	9	6
1996	15	11	14	11
1997	15	20	11	8
1998	20	22	12	8
1999	21	20	9	7
2000	15	20	5	5
2001	21	25	15	9

One word to describe Leonid

Indefatigable

(incapable of being fatigued)