VERA
VLBI Exploration for Radio Astrometry

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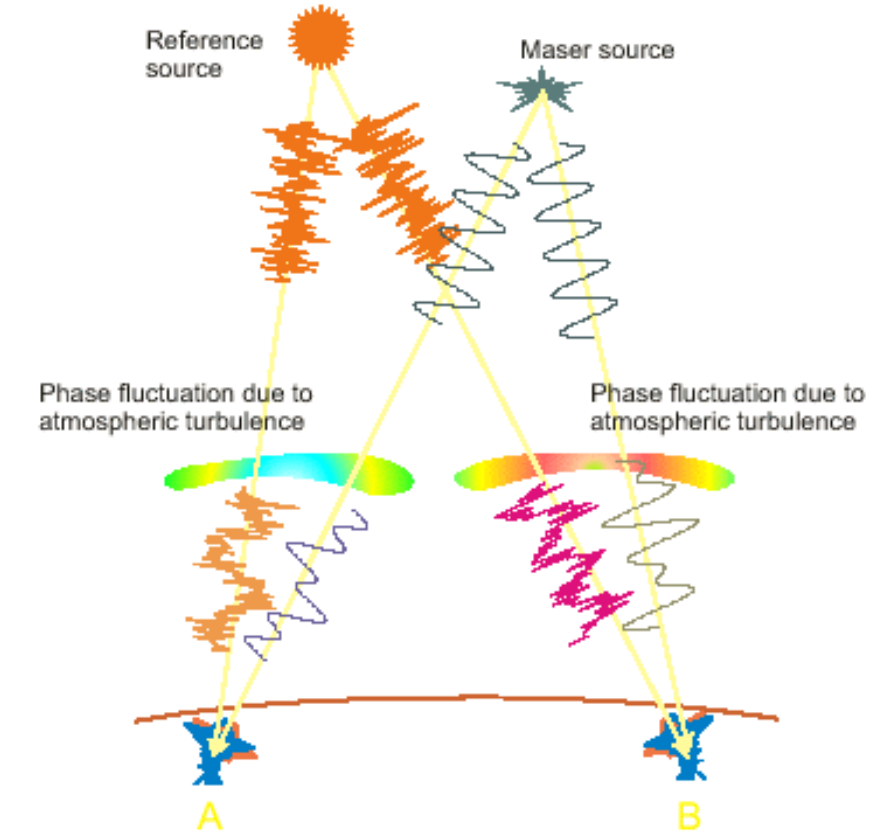
2004/Oct./15
EVN symposium@Toledo

Scientific goal

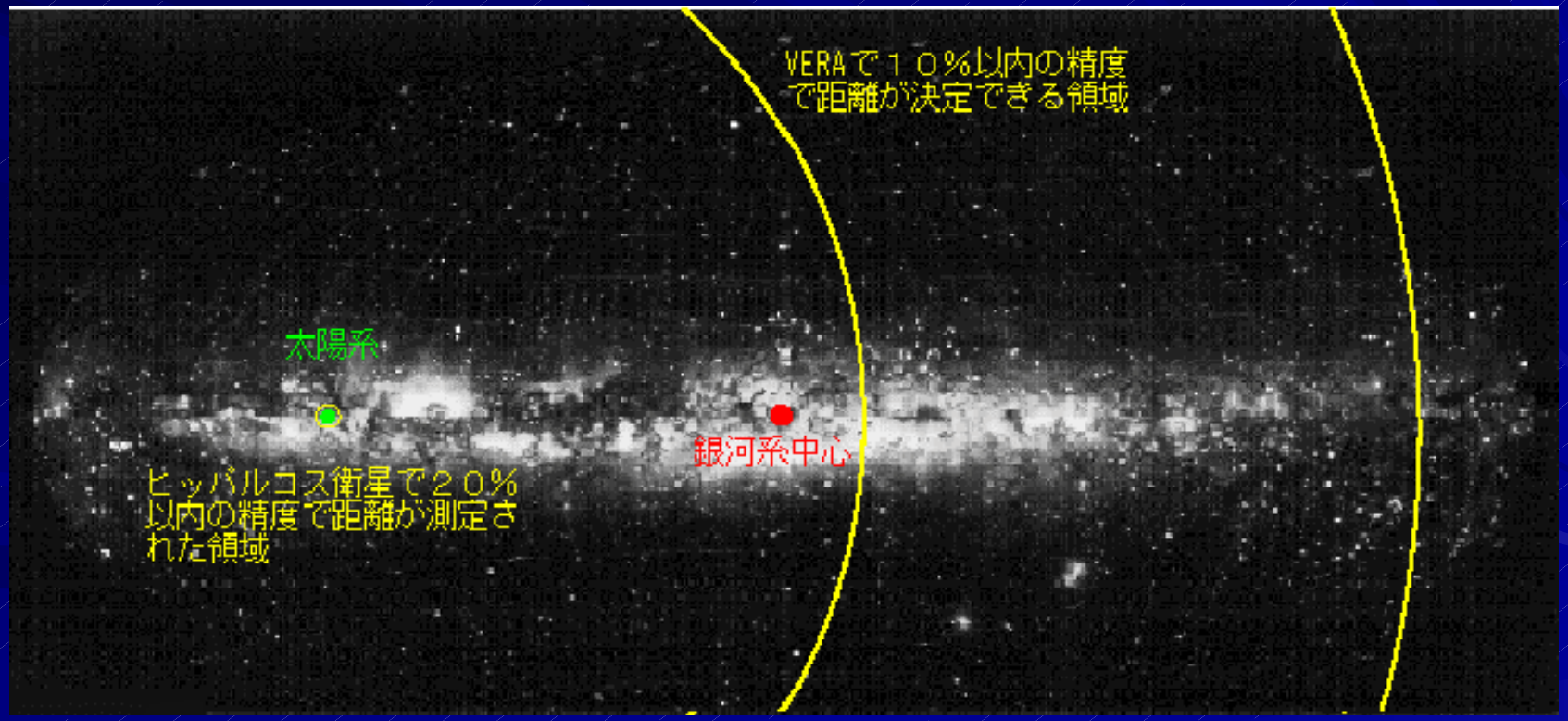
- Astrometry with 10μarcsec. accuracy between background object and galactic object within 2.2 degree separation
  - Proper motion and parallax measurements
    - 3D map and velocity field of the Galaxy
    - Detailed 3D velocity structure of molecular gas around evolved stars and star forming regions
- Phase referencing to improve sensitivity with long integration

Phase-referenced VLBI

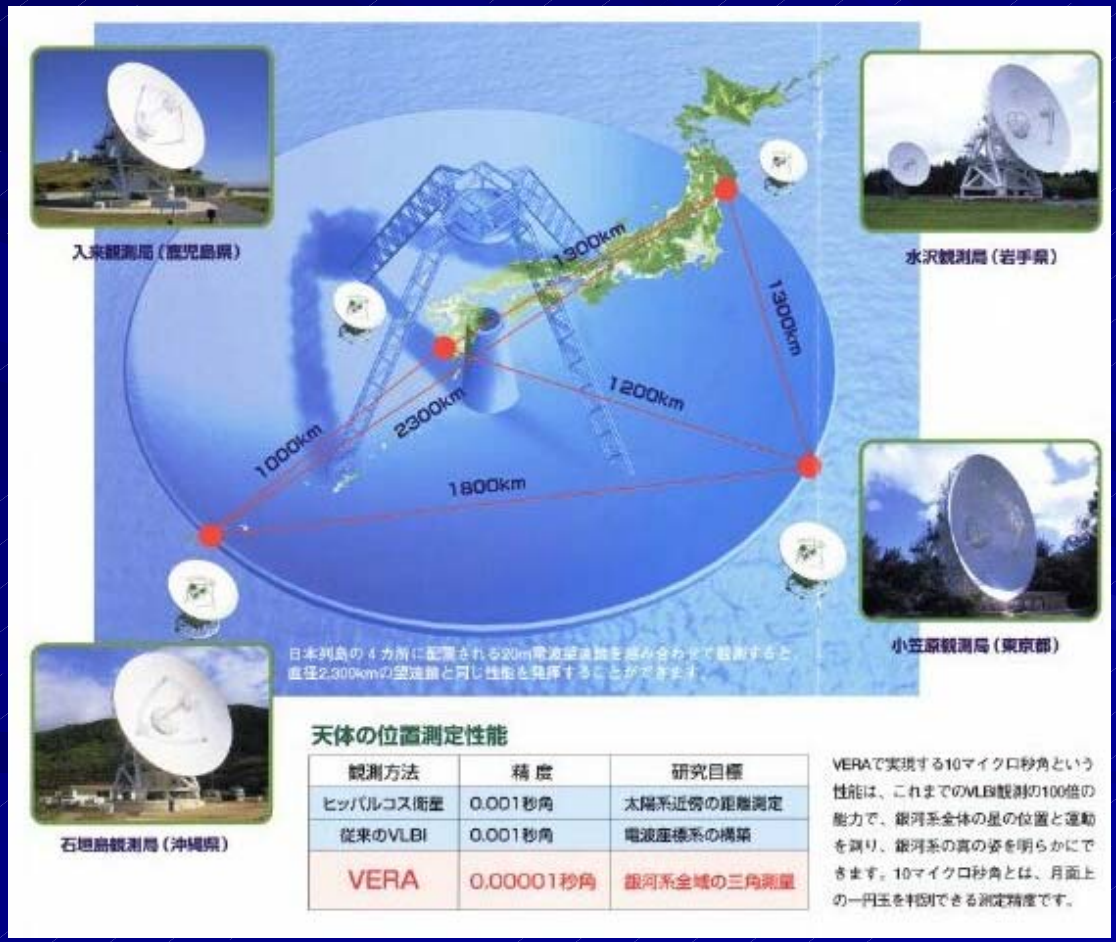


Expected distance accuracy of VERA

Sun **10% error at the G.C** **20% error at opposite side**



Array configuration



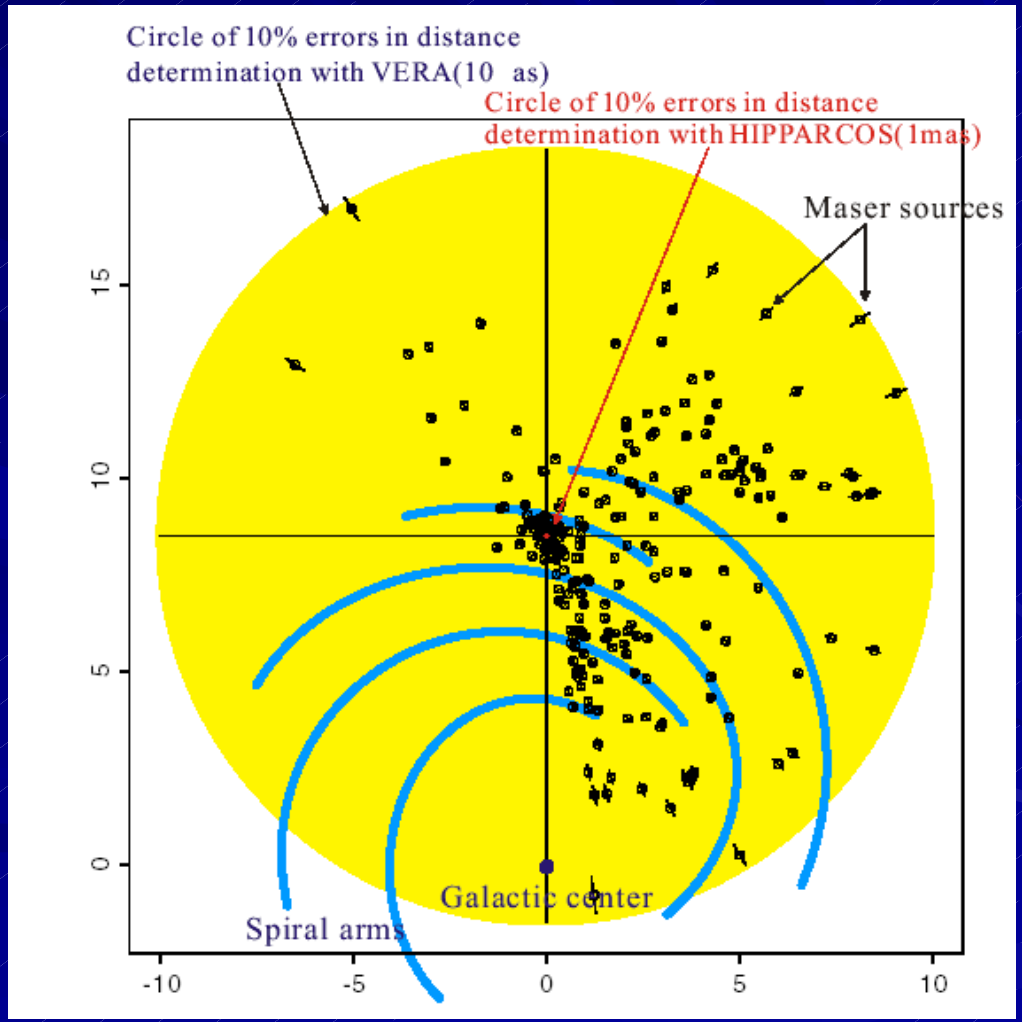
Specifications

- Antenna diameter ; 20m
  - surface accuracy ; 250 μm
- Observing bands ; 2GHz, 8GHz, 22GHz•43GHz
- Tape recording rate ; 1Gbps
- 2 beam system for phase referencing
- Path error between 2 beam; 100μm

VERA scientific goal

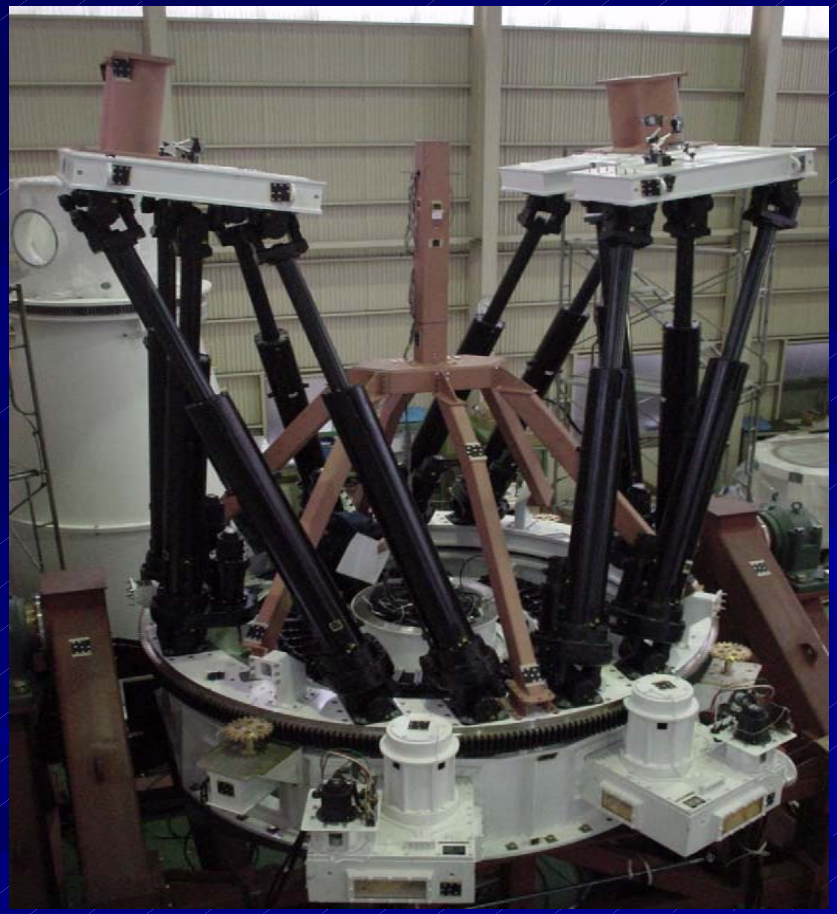
- Measurements of distance and proper motions of galactic maser objects
- Dynamics of the Galaxy Maser object:
- • luminous point-like objects

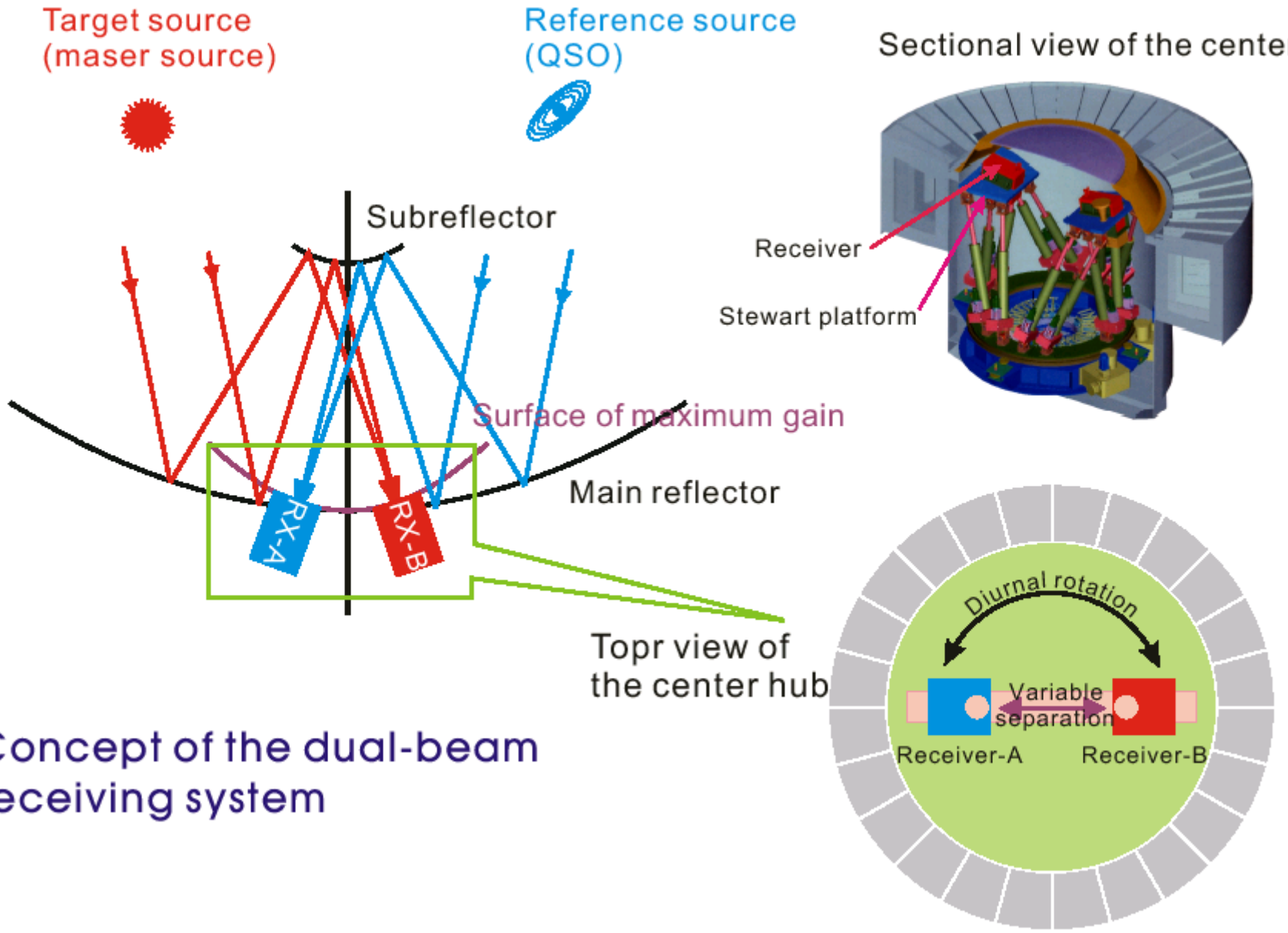
-> triangulation point of the Galaxy !



Antenna • Mizusawa station)

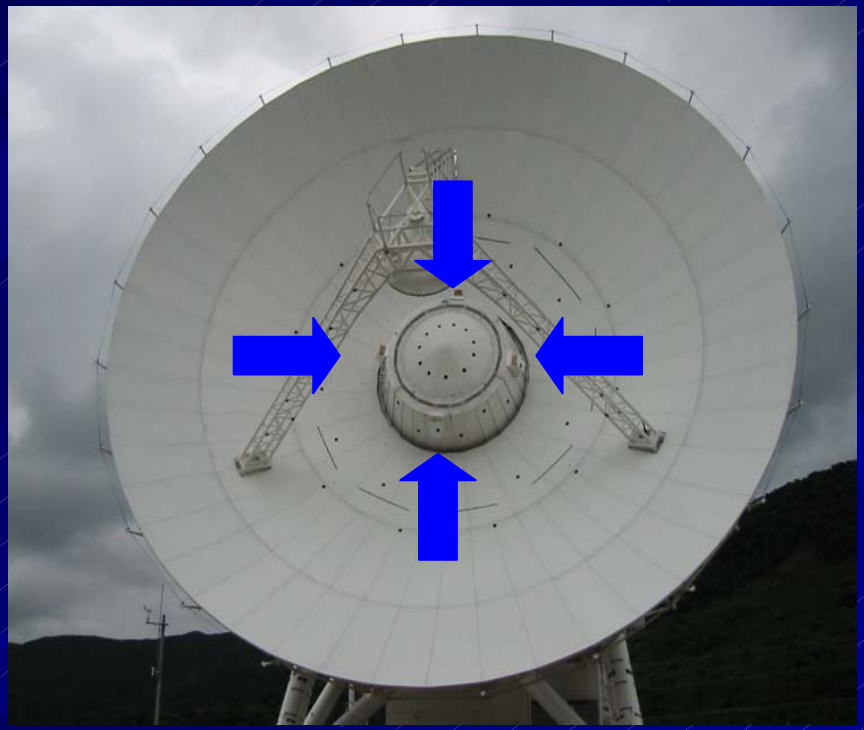
Receiver platform for 2 beam





Concept of the dual-beam receiving system

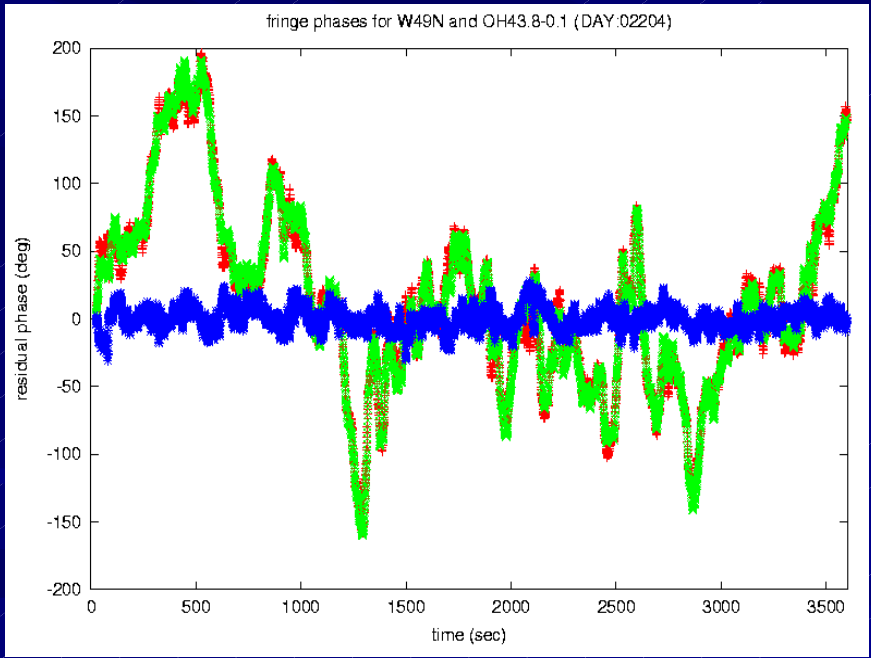
Radiator for 2 beam phase correction on the surface



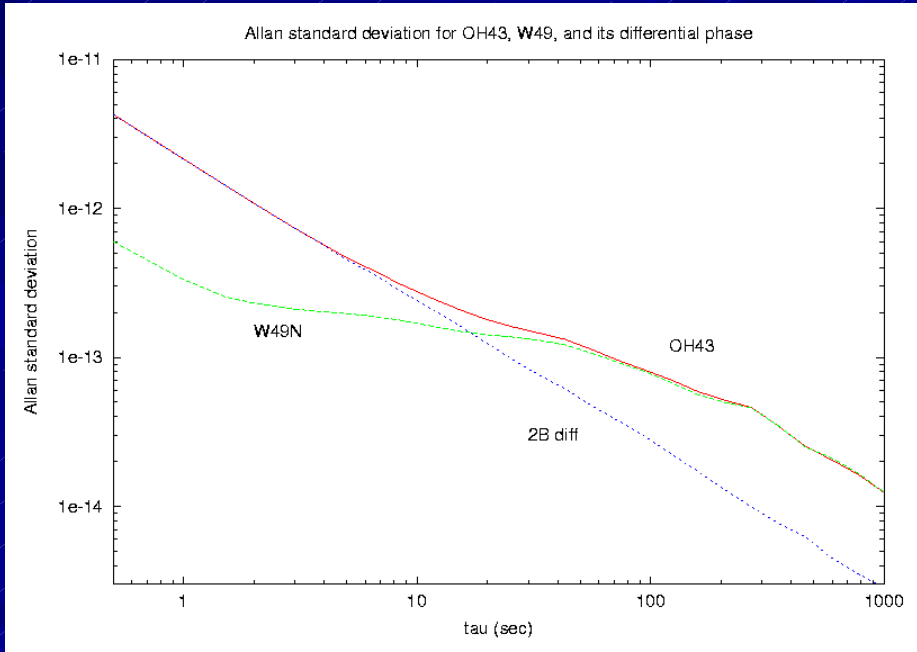
Measurement of positions
with 0.1 mm accuracy

First phase variations between 2 beams

Fringe phase of W49N,OH43 and difference



Allan variance of them



Results of test observations

- Phase referencing observation
  - 2beam observations
  - 3C345,NRAO512 pair
- Imaging feasibility check
  - VERA,NRO 45m, Kashima 34m

UV-coverage

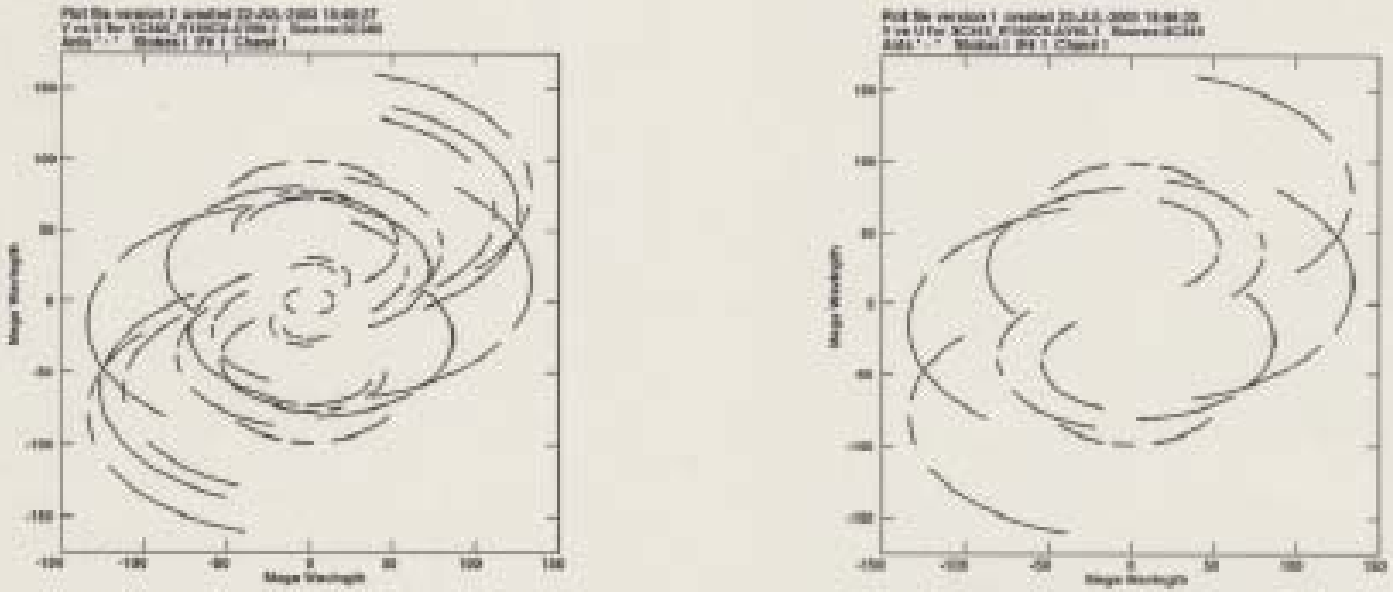


Fig. 2. *Left:* UV coverage for B03150 (synthesized beam 1.47x0.78mas, PA -42°). *Right:* For comparison, only VERA baselines.

VERA + NRO,CRL **VERA only**

2 beam observation result

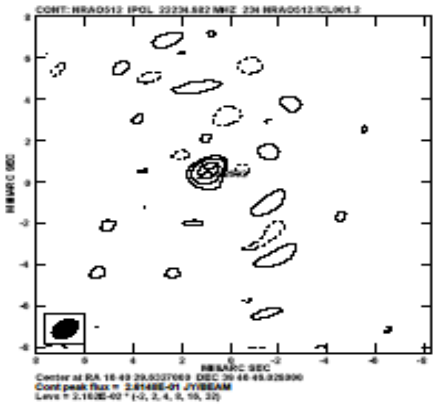


図 1: r03234a

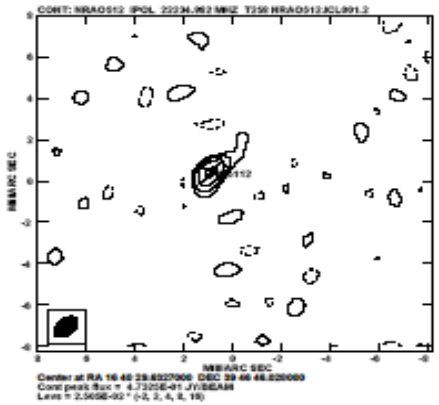


図 2: r03258a (A:3C345, B:NRAO512)

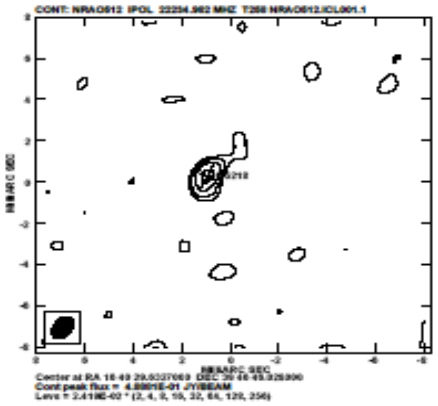


図 3: r03258a (A:NRAO512, B:3C345)

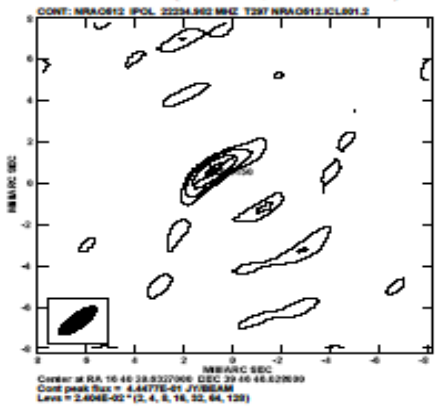


図 4: r03297a

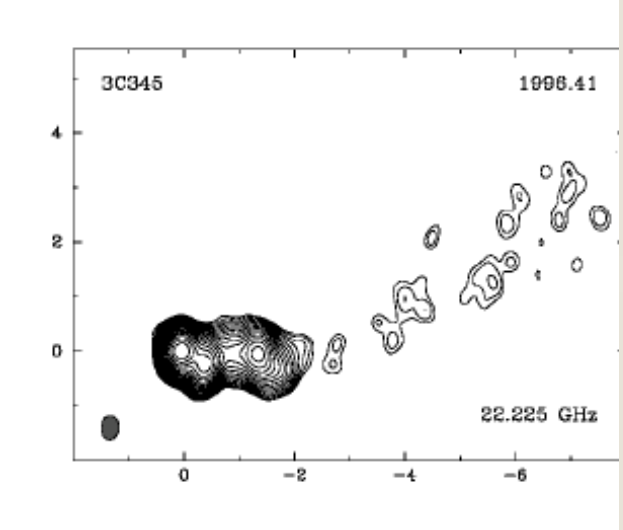
200 micro-arc-second　phase referencing repeatability,

500 micro-arc-second　displacement of R.A. direction from the ICRF position

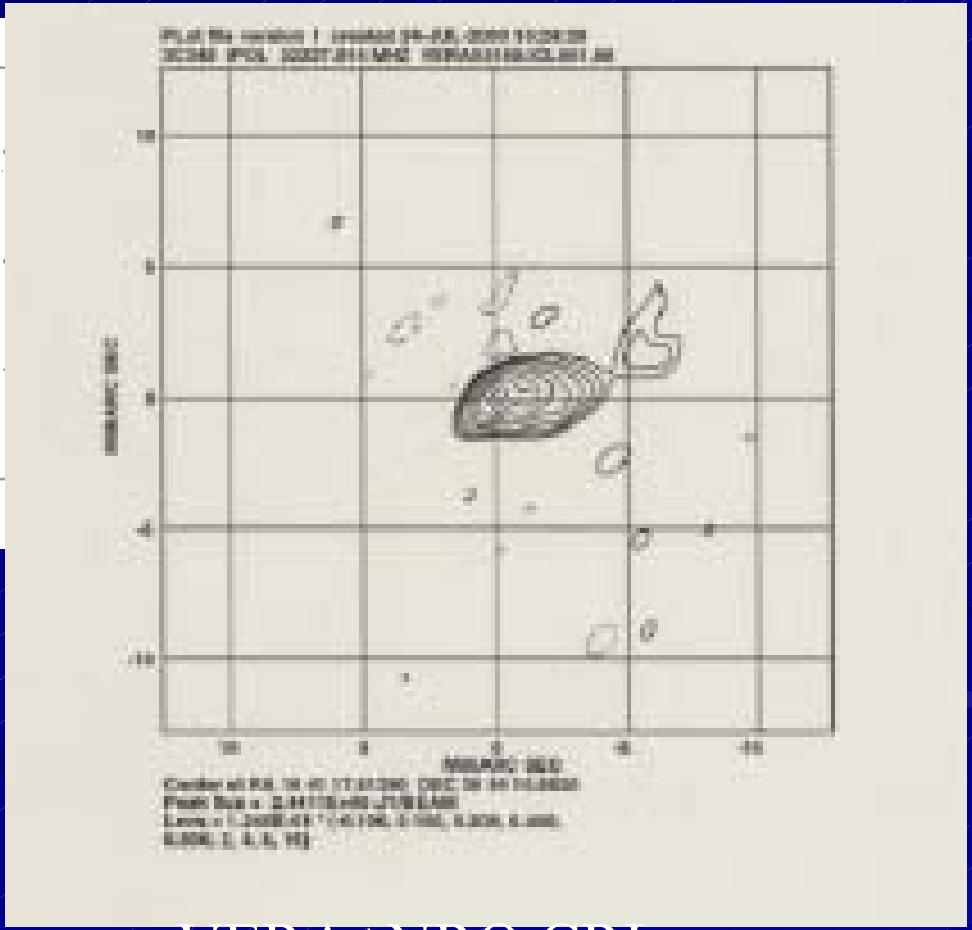
Reason of displacement

- Correlator model error
  - Correction based on CALC
  - Correction of atmospheric delay
- Station position
  - 3 cm error -> 0.1 mas for 1deg. separation pair

Comparison with VLBA



VLBA 22GHz



VERA+NRO,CRL

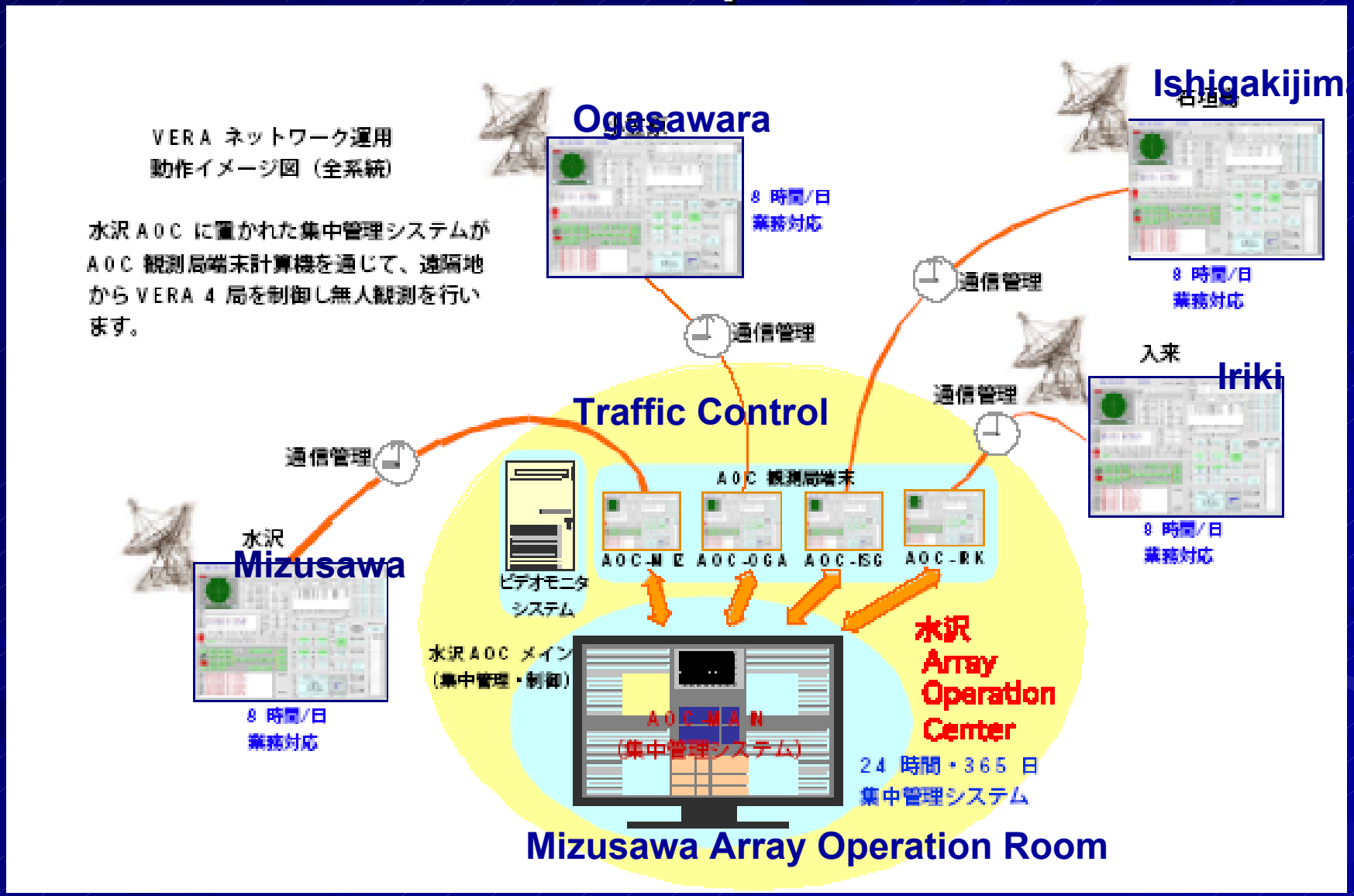
Current status

- Number of day of observation
  - 117 days from Nov. 2003 to Oct. 2004
  - maintenance for 2 months (June-July)
- Remote operation
  - 4 station operation from Mizusawa
    - Station status
    - Spectrometer data
    - Video monitor
    - Real time fringe check by software correlator (under developing)
- Improvement of sensitivity
  - Discrete HEMT LNA -> MMIC HEMT LNA
  - Low loss fee dome of Cassegrain cabin

• • • • • recorder & correlation

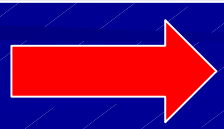
- •SONY • DIR2000 • 1024Mbps •
  - • 80 min/tape
  - • 24 tape auto-changer
- • Data quality monitor
  - • bit distribution for 2 or 1 bit sampling
  - • real-time fringe monitor for 1 sec. data by software correlator
  - • auto-correlation data
- •Mitaka FX correlator
  - •5 station correlation with 1Gbps

Remote Operations

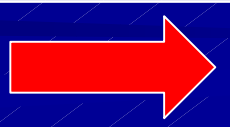


Improvement of sensitivity

• • • • •

	Before improvement		After improvement	
Atmospheric loss	τ=0.2	66K	τ=0.2	66K
Ground coupling		25K		25K
Fee dome loss	-0.6 dB	54K	-0. • dB	• • K
Receiver	80K	112K	40K	50K
System noise Tsys*		232K		164K 566Jy

Improvement of sensitivity
43• • •

	Before improvement		After improvement	
Atmospheric loss	τ=0.15	49K	τ=0.15	49K
Ground coupling		29K		29K
Fee dome loss	-1 dB	90K	-0.3dB	24K
Receiver	130K	190K	70K	84K
System noise Tsys*		358K		198K 683Jy

Geodesy observations

- Combine with the world coordinate by SX observations
  - Combined with Tsukuba 32m of Japanese GSI
- Baseline determination
  - Required accuracy 2mm
  - 22GHz wideband observations
  - SX conventional observations

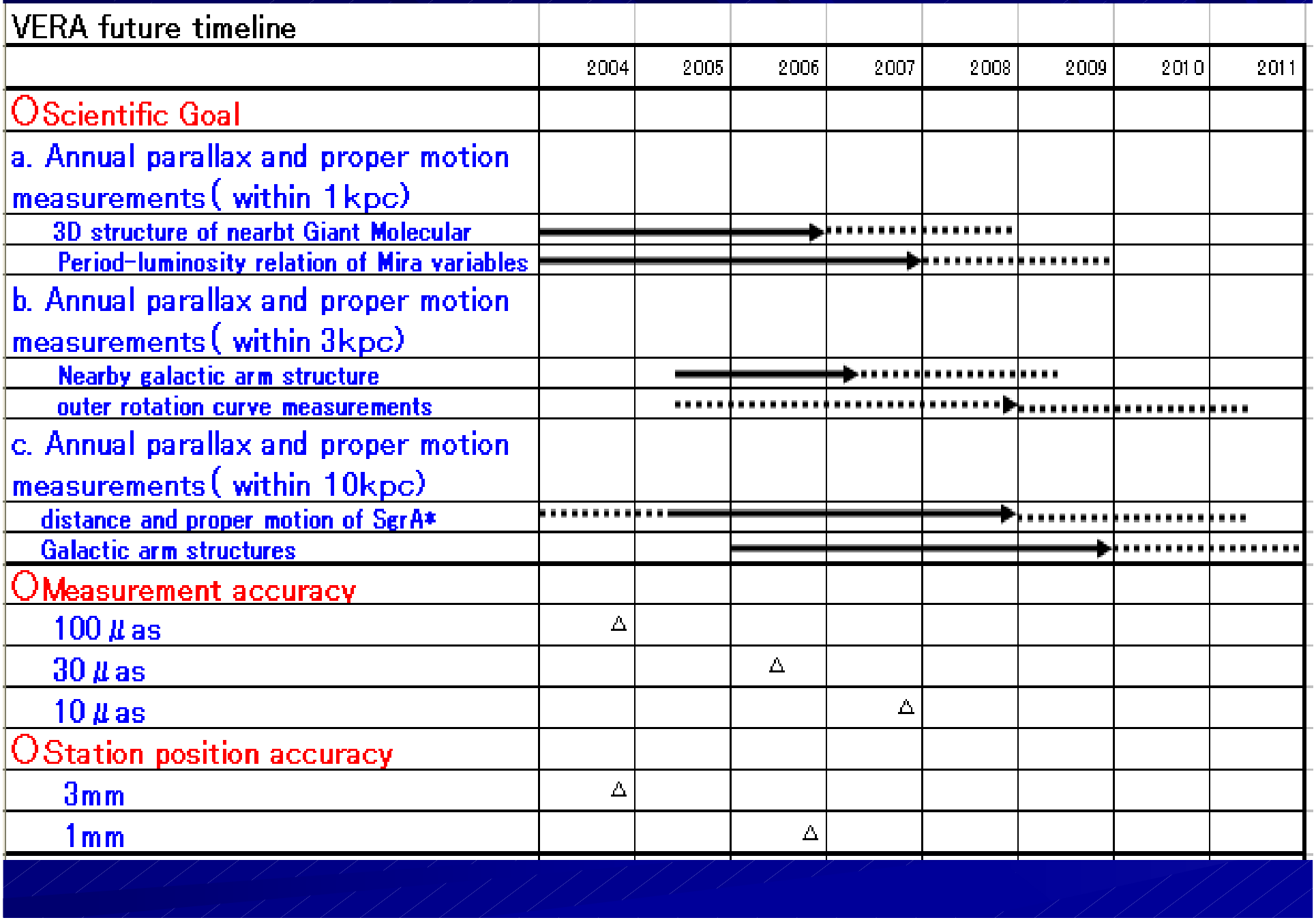
Damage by the Sanriku-minami earthquake

Vertical 0.2G, Horizontal 0.3G

Deformation of elevation gear and loose of some bolts

After repair, no significant change of antenna gain !!

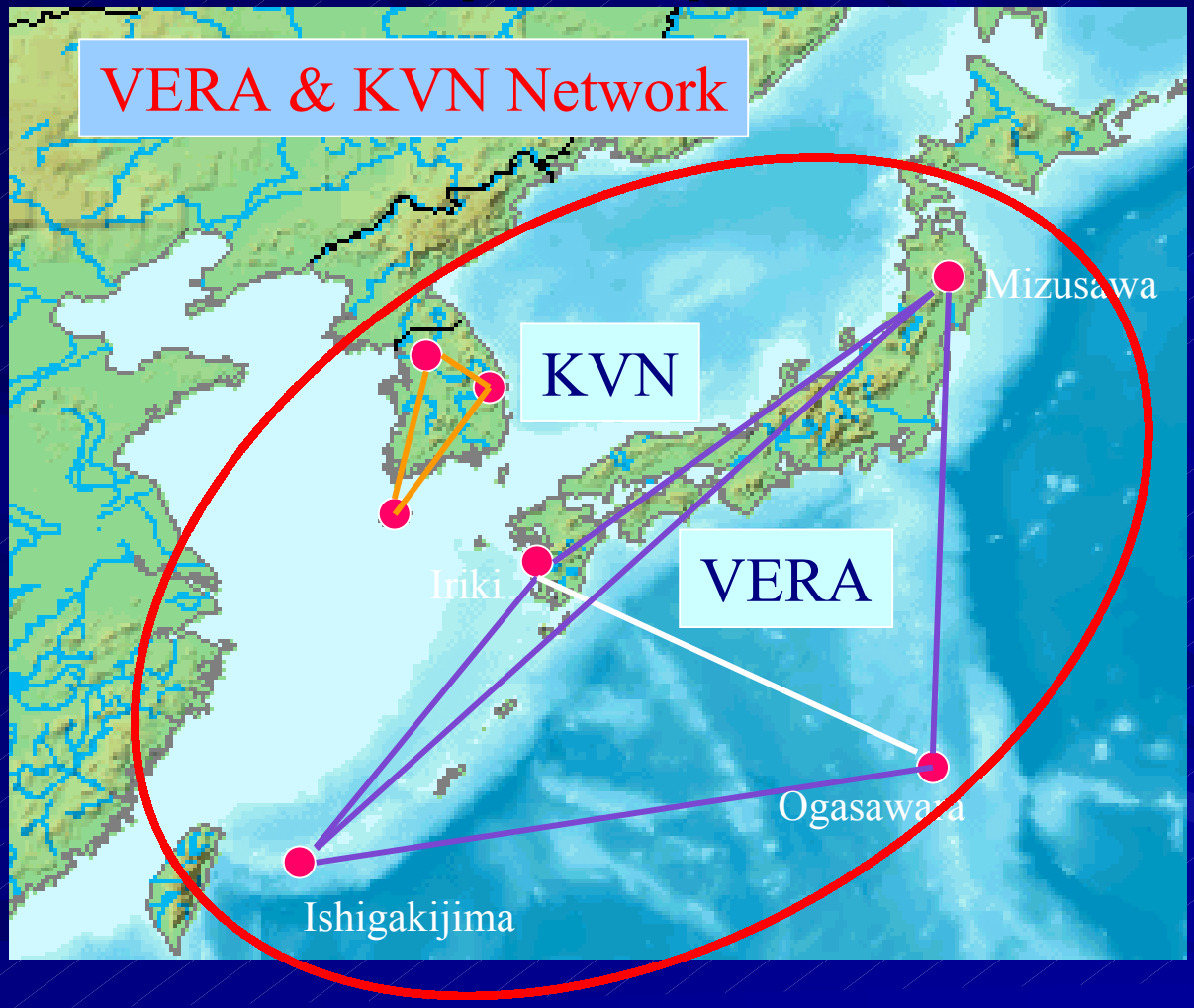
VERA future timeline



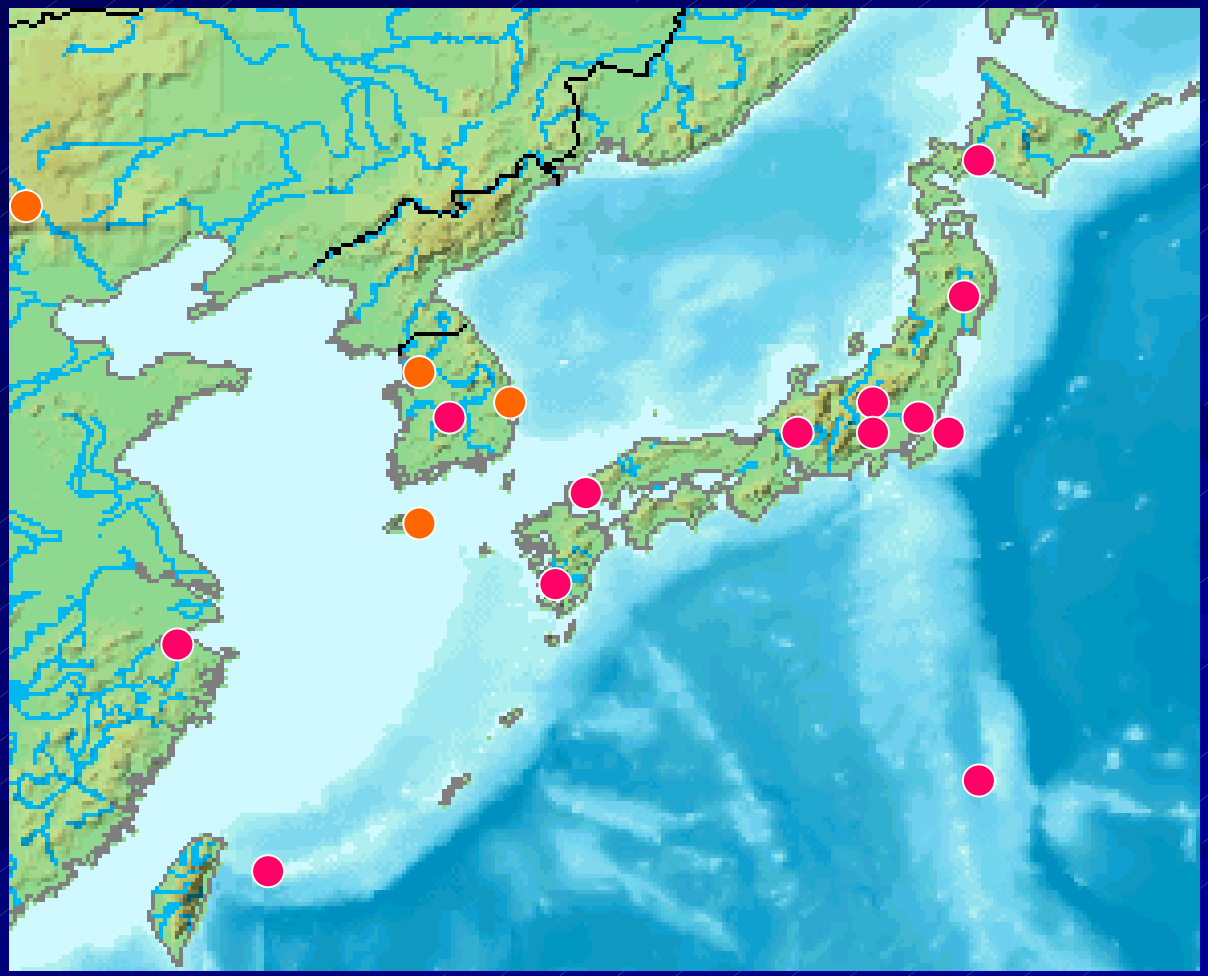
Plan of open use observations

- 15 % observation time
  - 45 days
  - With Nobeyama 45-m, Kashima 34-m
  - From 1st quarter of 2006
  - Test use for domestic users in 2003,2004
  - 22, 43GHz with 2-beam
- Archive data will be opened

Future perspective



East Asia VLBI stations• • 18 stations



Japan • 11

China • • 3

Korea• • • 4

VERA job advertisement

- senior researcher
- Duration : 5 years
- Evaluation of phase referencing and astrometry accuracy
- Write software to correct visibility data
- Progress the science of VERA
- Deadline of application: Dec. 24, 2004
- Details will be shown at AAS job register from November