

# VERAの現状と今後

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2006/2/20

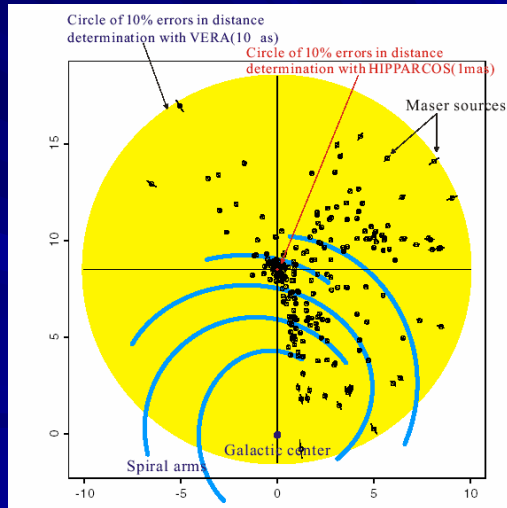
銀河系研究会@三鷹

## Scientific goal

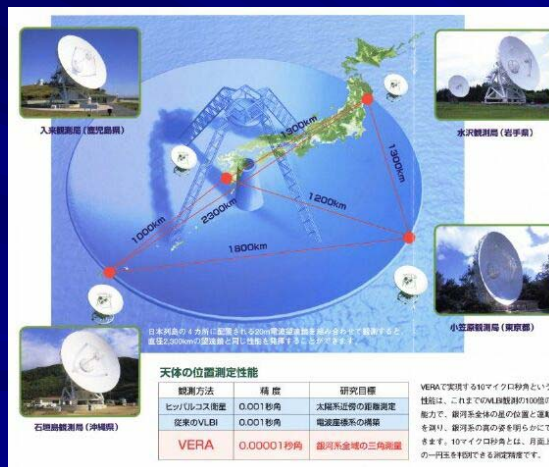
- Astrometry with  $10 \mu$  arcsec. accuracy between background object and galactic object within 2.2 degree separation
  - Proper motion and parallax measurements
    - 3D map and velocity field of the Galaxy
    - Detailed 3D velocity structure of molecular gas around evolved stars and star forming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

# 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 !**



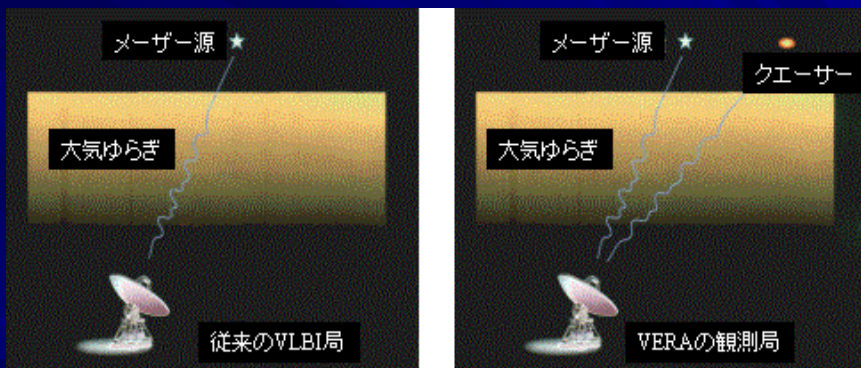
# Array configuration



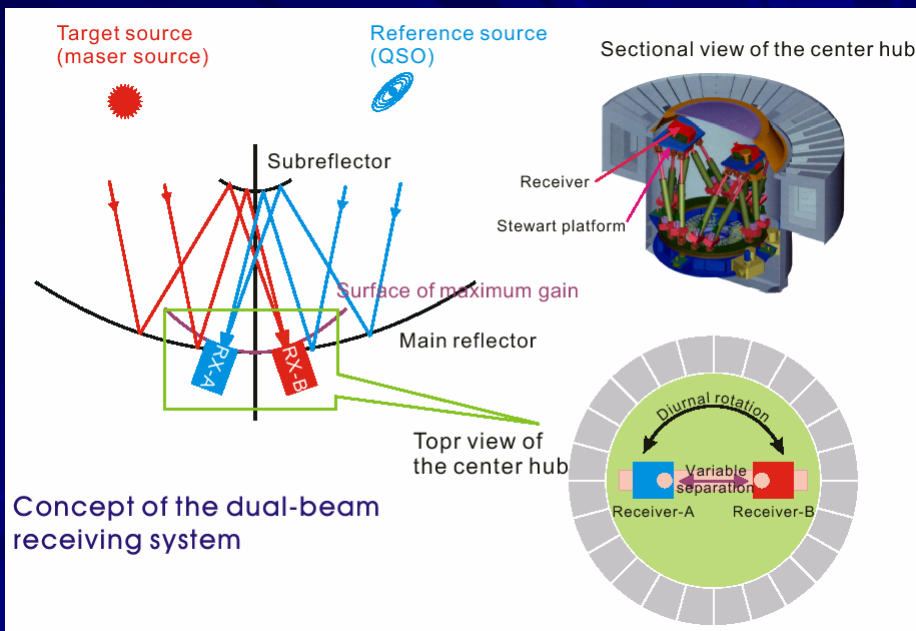
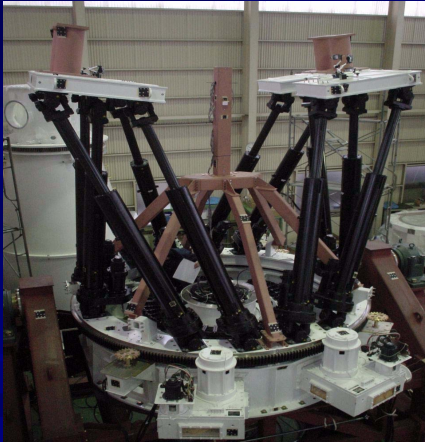
# Specifications

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

## 相対VLBI



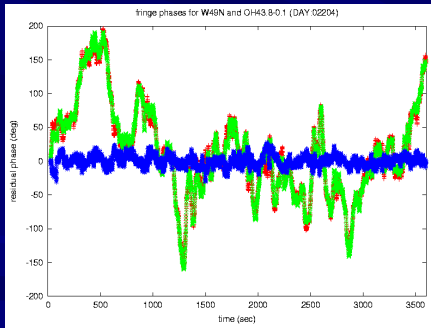
# Receiver platform for 2 beam



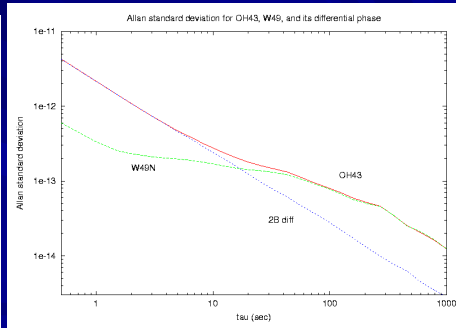


# First phase variations between 2 beams

Fringe phase of W49N, OH43 and difference

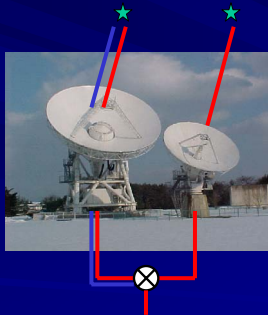


Allan variance of them

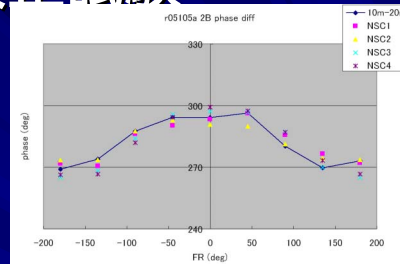


## 2B 位相校正試験

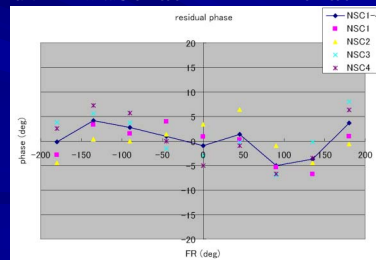
装置起因の位相誤差は、2B光路長差換算で0.1mm程度



2B間の同一天体のスイッチングによる検証、10mを参照アンテナ



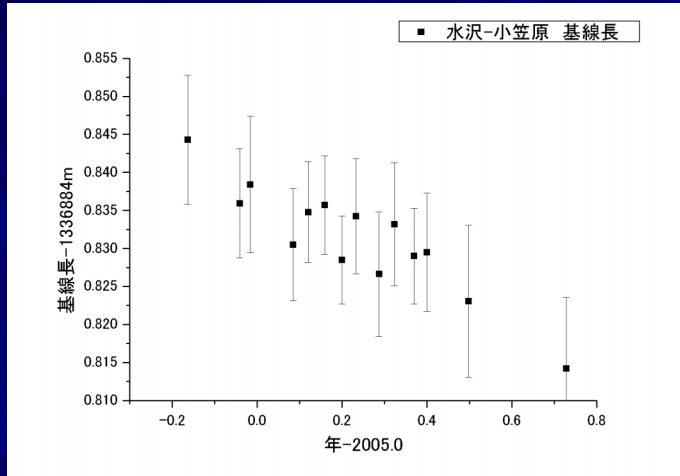
校正電波源位相差とフリッジ位相差



校正電波源位相差とフリッジ位相差の差



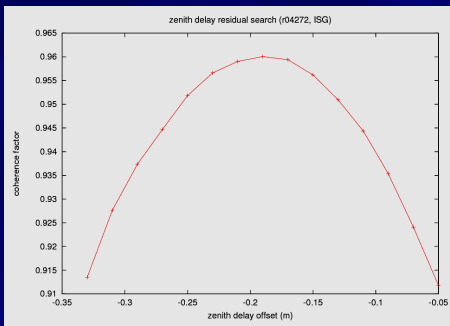
# 測地観測 (精度 5mm程度)



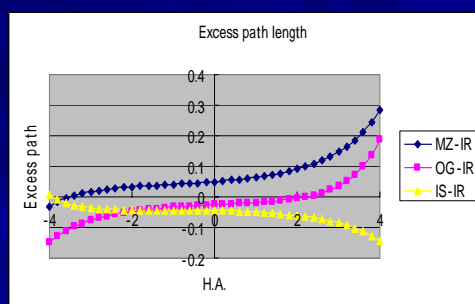
2004年10月より1Gbpsによる測地観測の定常化

# 天頂大気遅延の推定

天頂大気遅延の推定のための観測方法、解析ソフトの整備が必要



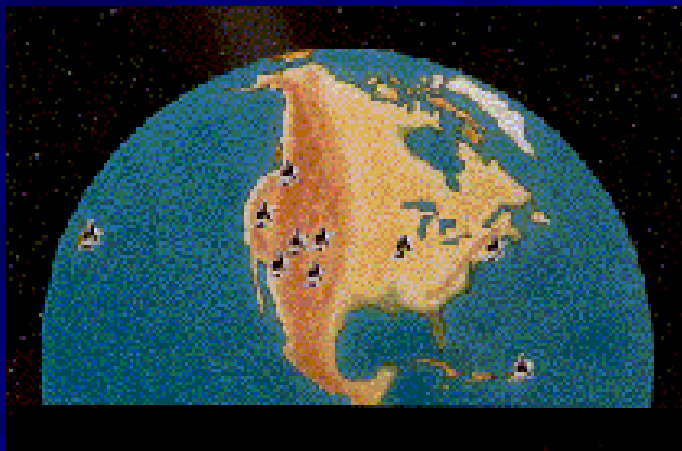
S269における天頂大気遅延の推定例



天頂大気遅延誤差10mmの時の2B光路長差の誤差

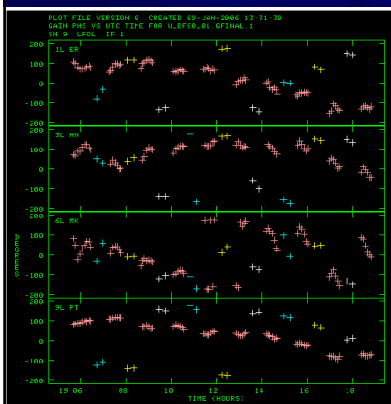
-> 位置誤差換算で 0.1mm程度

# VLBI(VLBA)



## VLBA PHASE FITTING AT 15 GHz by E.B.Fomalont(2006)

Observed phase



BR-OV  
1050 km

HN-OV  
4600 km

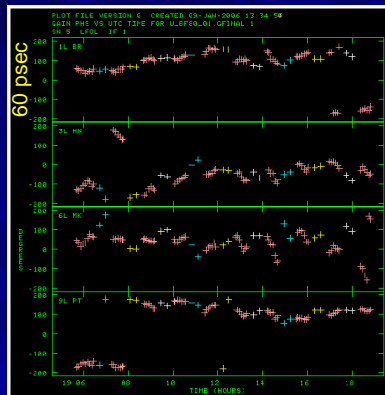
MK-OV  
3900 km

PT-OV  
700 km

+ 3C279; + J1304; + J1256; + J1258

Use a 'mini-solve to determine better source positions and linear phase gradient in sky. Phase gradient is caused by the sum of many effects but dominated by the error in the zenith path delay.

Residual phase after fit



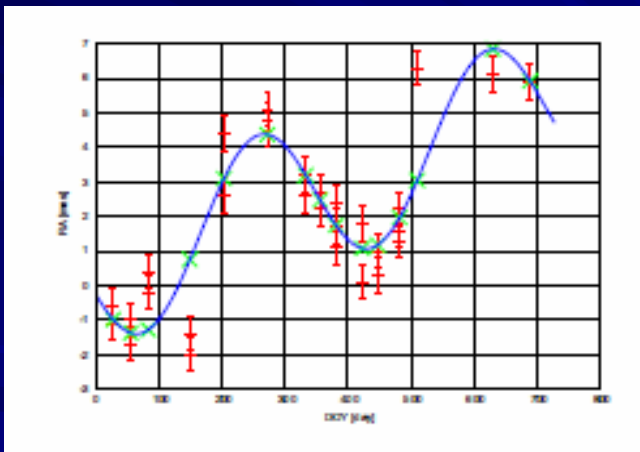
Result of best fit to source positions and phase gradient. What remains is the residual temporal clock error. Relative position error About **0.03 msec.** (Structure effect has been removed)



# VERAによる成果

- 固有運動の検出
  - OH 43.8, 須田、など
- 年周視差の検出
  - Orion - KL, S 269など
- 22GHz/43GHz マッピングの重ね合わせ
  - SiO( $v=1,2$ )/H<sub>2</sub>O NML-Tauなど
- フリンジ検出サーベイ
  - 22GHz H<sub>2</sub>O/Cont.
  - 43GHz SiO/Cont.
  - 22 GHz 銀河面Cont.

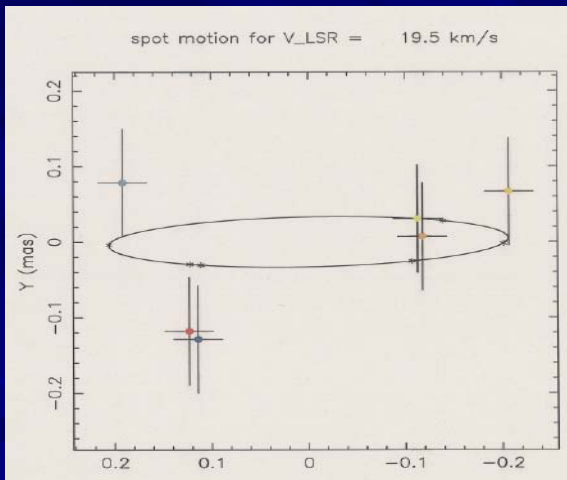
## 年周視差の検出 (Orion-KL)



450 pc  $\pm$  40pc

-> 廣田発表

# 年周視差の検出(S269)

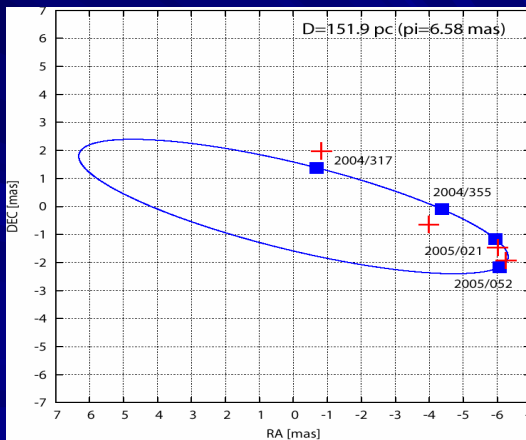


-> 本間発表

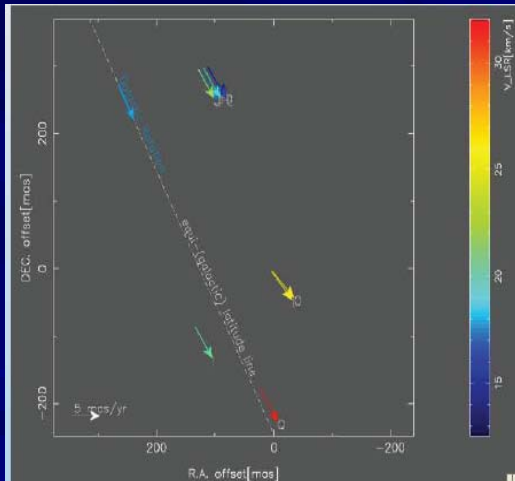
# HH7 - 11

Used distance :  
180 pc -250 pc

-> 廣田



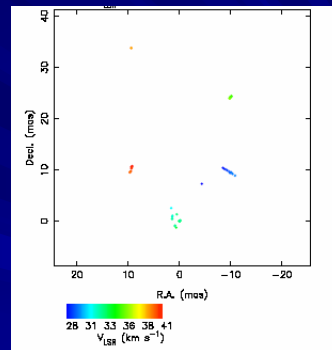
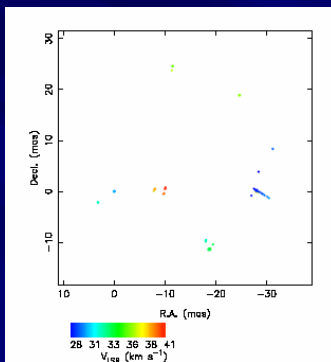
# 固有運動の検出(IRAS19181+1349)



$D = 9.4$  kpc

-> 須田学位論文

# Comparison of SiO $v = 1, 2$



NML Tau SiO J=1- $\rightarrow$ 0  $v=1$  and  $v=2$

D: 250 pc (鹿児島大、清水・松本)

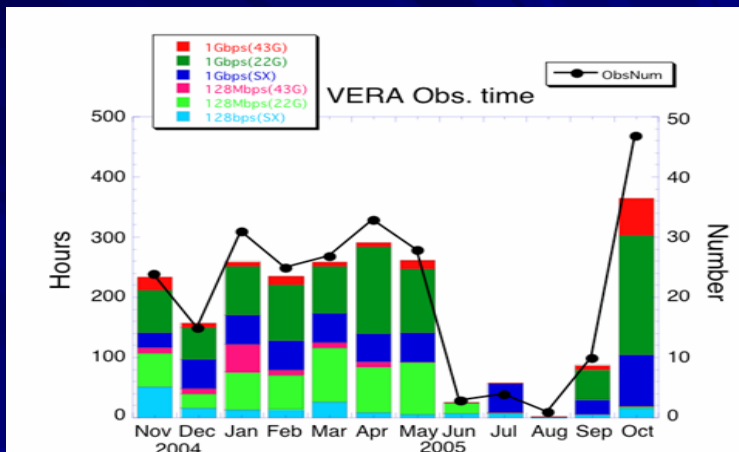
# VERA プロジェクトの当初予定

VERA future timeline	2004	2005	2006	2007	2008	2009	2010	2011
<b>○Scientific Goal</b>								
a. Annual parallax and proper motion measurements ( within 1kpc)								
3D structure of nearby Giant Molecular Clouds								
Period-luminosity relation of Mira variables								
b. Annual parallax and proper motion measurements ( within 3kpc)								
Nearby galactic arm structure								
outer rotation curve measurements								
c. Annual parallax and proper motion measurements ( within 10kpc)								
distance and proper motion of SerA*								
Galactic arm structures								
<b>○Measurement accuracy</b>								
100 $\mu$ as		△						
30 $\mu$ as			△					
10 $\mu$ as				△				
<b>○Station position accuracy</b>								
3mm		△						
1mm			△					

# Remote Operations



# 2005年 VERA運用実績



月間 350時間の観測 (50%)

→ 今後、天候・トラブルに対応したダイナミックスケジューリングの検討が必要

## East VLBI Network array configuration



## Feature of East Asia VLBI array

- Dense station distribution  
total effective aperture :
  - 5,600 m<sup>2</sup> @ 8GHz
  - 4,400 m<sup>2</sup> @ 22GHz
- Wide band observation
  - Wide band recording
  - Optical fiber link
- Phase referencing
  - VERA : 2 beam
  - KVN : multi-frequency
- VERA reference 天体の構造効果の補正 (VLBAも)

## 日韓共同開発による大規模VLBI相関器 July 7<sup>th</sup> @NAOJ



**2008年完成目標** Park(KASSI)、 Kaifu(NAOJ)

# Summary

- VERA is a unique VLBI array with 2-beam system
- System implementation was finished
- Usual operation (250 days, 4,200 hours per year) was started
- Annual parallax may be detected, but the accuracy still must be investigated more.
- East Asia VLBI network is organizing with Japanese, Korean and Chinese stations.