

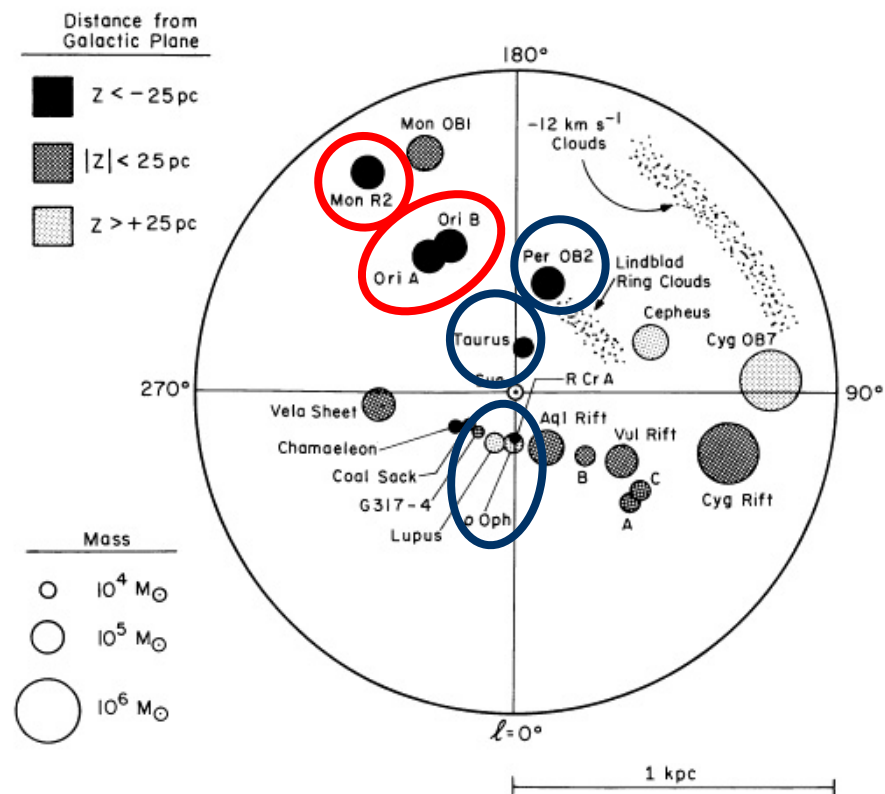
VERAユーザーズミーティング2006
プロジェクト観測結果報告
近距離分子雲の距離決定

Tomoya HIROTA (VERA, NAOJ)

Nearby SFR projects for VERA

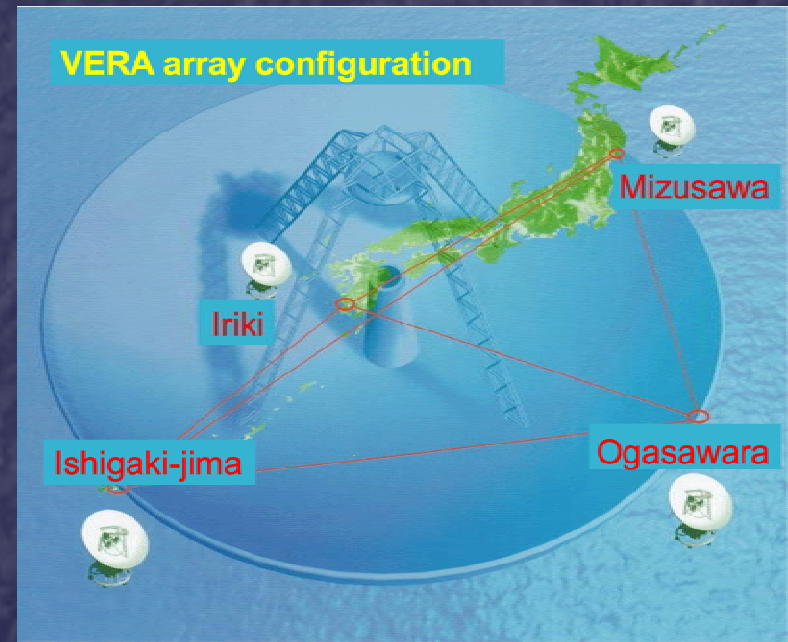
- Nearby molecular clouds (<1 kpc)
 - Orion-Monoceros (since 2004 Jan.)
 - Taurus (2005 sep.-2006 mar.)
 - Perseus (since 2004 Sep.)
 - Ophiuchus (Imai et al.)
- Distance measurements
- Refine the physics of star-formation

Distribution of molecular clouds (Dame et al. 1987)



Observations

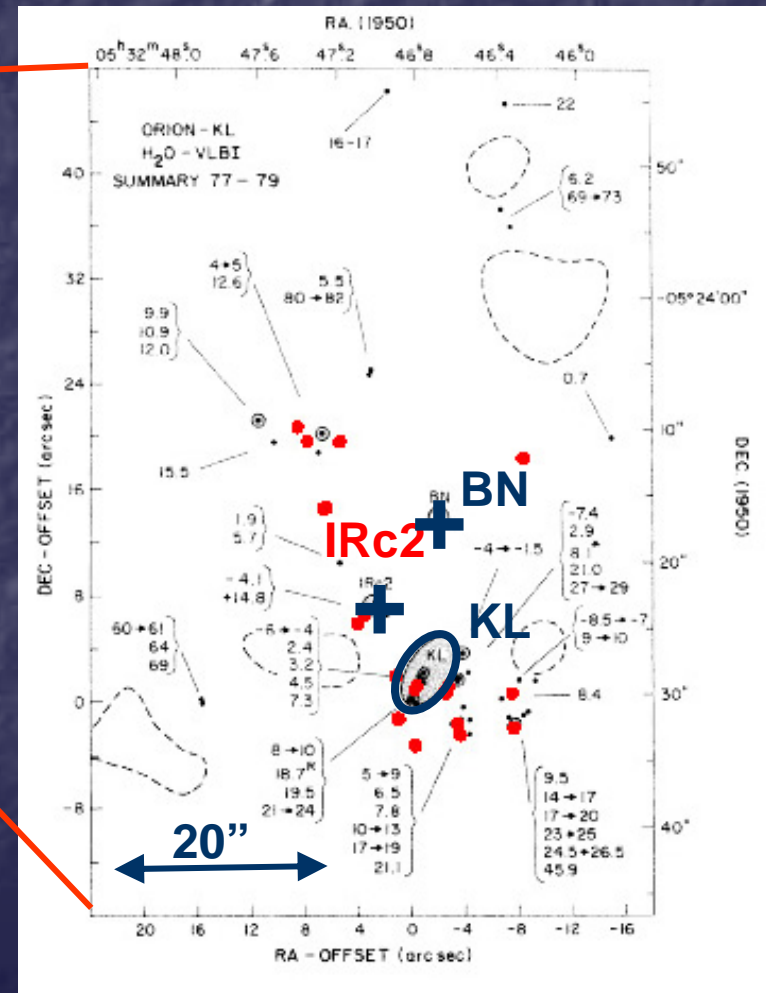
- 2004 Jan. - 2006 May., once per month
- Spectral resolution: 15.625 kHz (0.21 kms^{-1})
- Beam size: 1.5 X 0.9 mas
- $T_{\text{sys}} = 120\text{-}500$ K
- Observed sources
 - Orion KL, HH1, Mon R2
 - NGC1333 SVS13A
 - TMR-1 (IRAS04361+2547)
 - rho-Oph East (IRAS16293-2422) --- Imai et al.
- Monitoring with the VERA 20 m telescope: To^③



Orion KL region

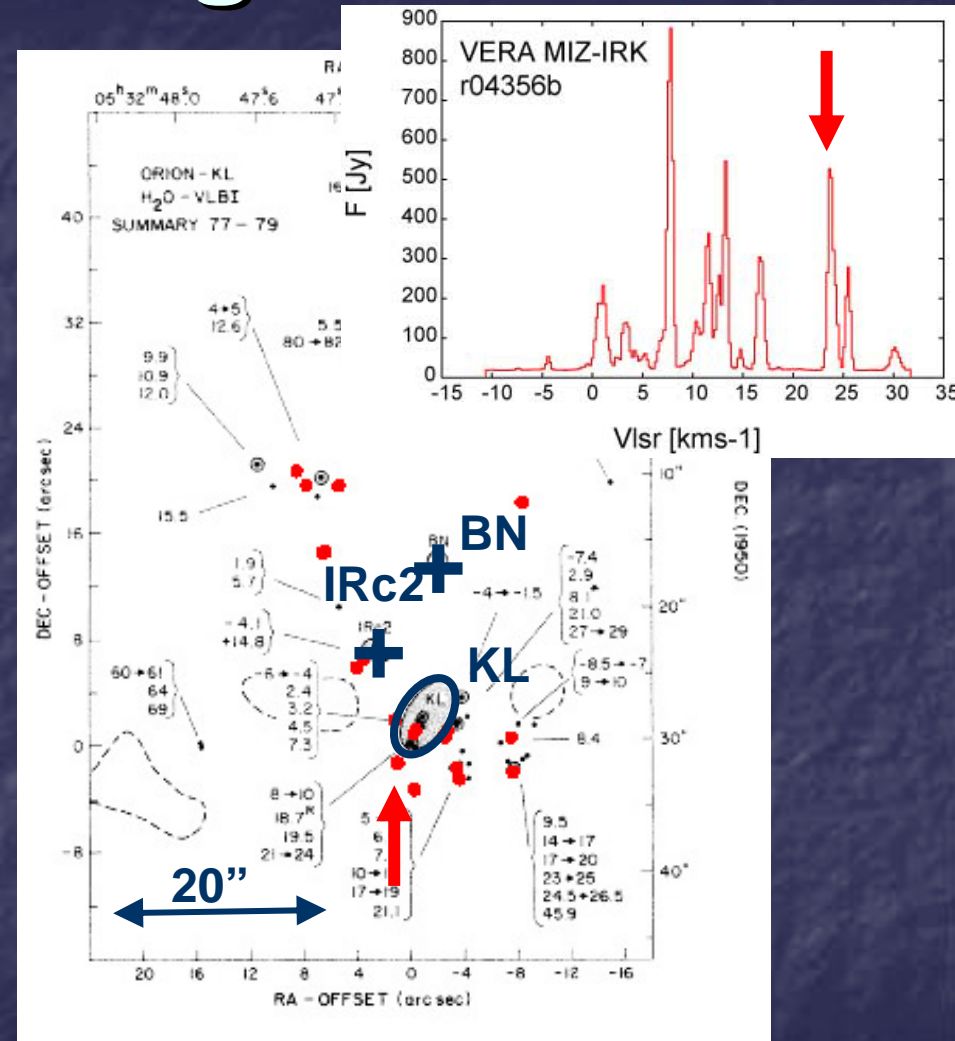
NIR image (Subaru)

H₂O masers (Genzel et al. 1981)



Orion KL region

- More than 100 maser features were found.
- Maser features around IRc2 were completely resolved out.
- About 10 maser features were alive during all the sessions.
- We analyzed one maser spot near the KL object.



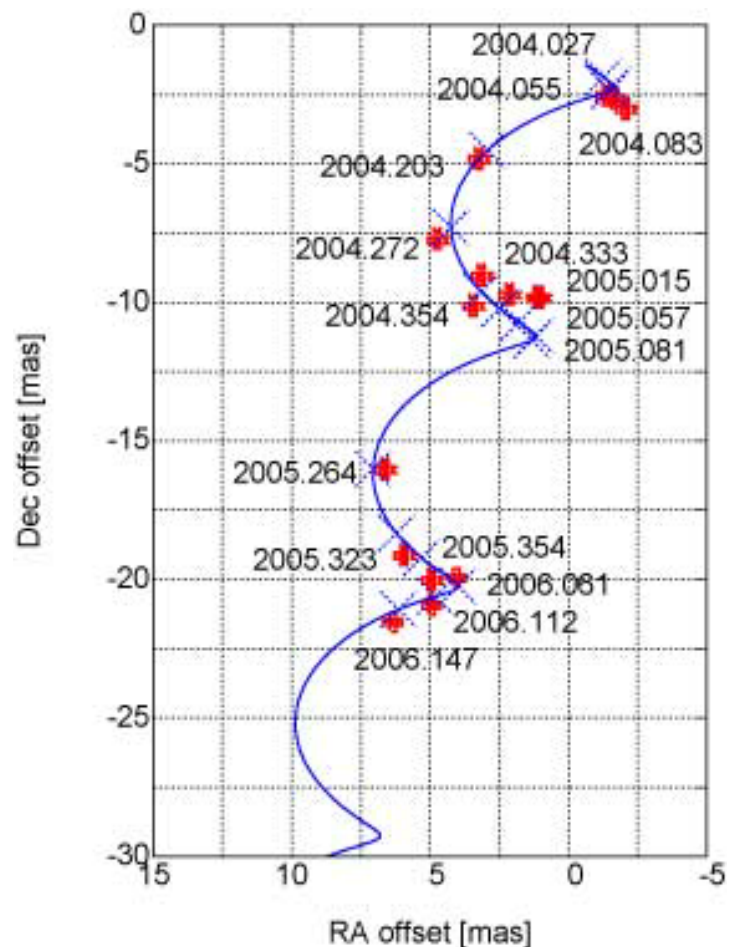
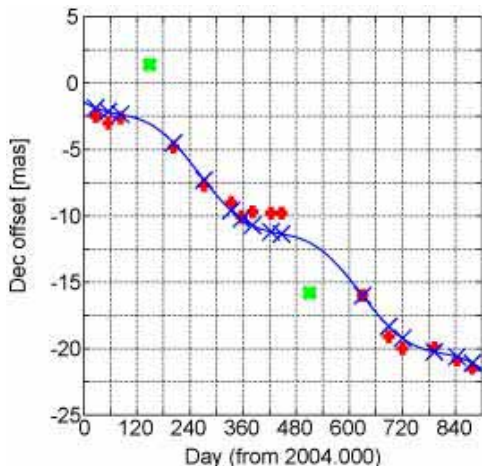
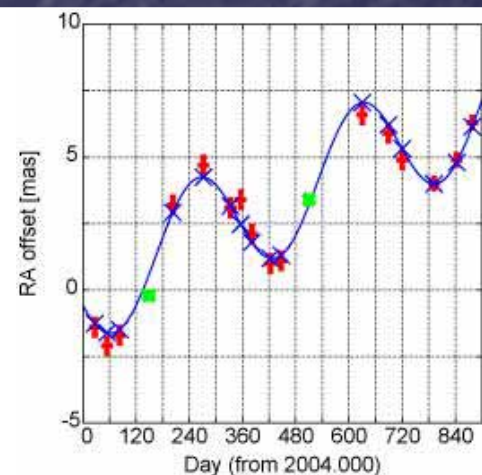
Genzel et al. (1981)
and results of VERA

Before and after UM2005...

- In the VERA users meeting 2005
 - Correction of correlator model:
Atmospheric zenith delay measured with GPS
(Honma >> Hirota)
 - Phase-referencing:
 - Annual parallax of NGC 1333 --- 6.6 ± 3.1 mas (150pc)?
 - Annual parallax of Orion KL --- not yet detected
 - Large uncertainty due to zenith delay residual?
- After VERA UM2005
 - Correction of zenith delay residual
 - Correction of several errors

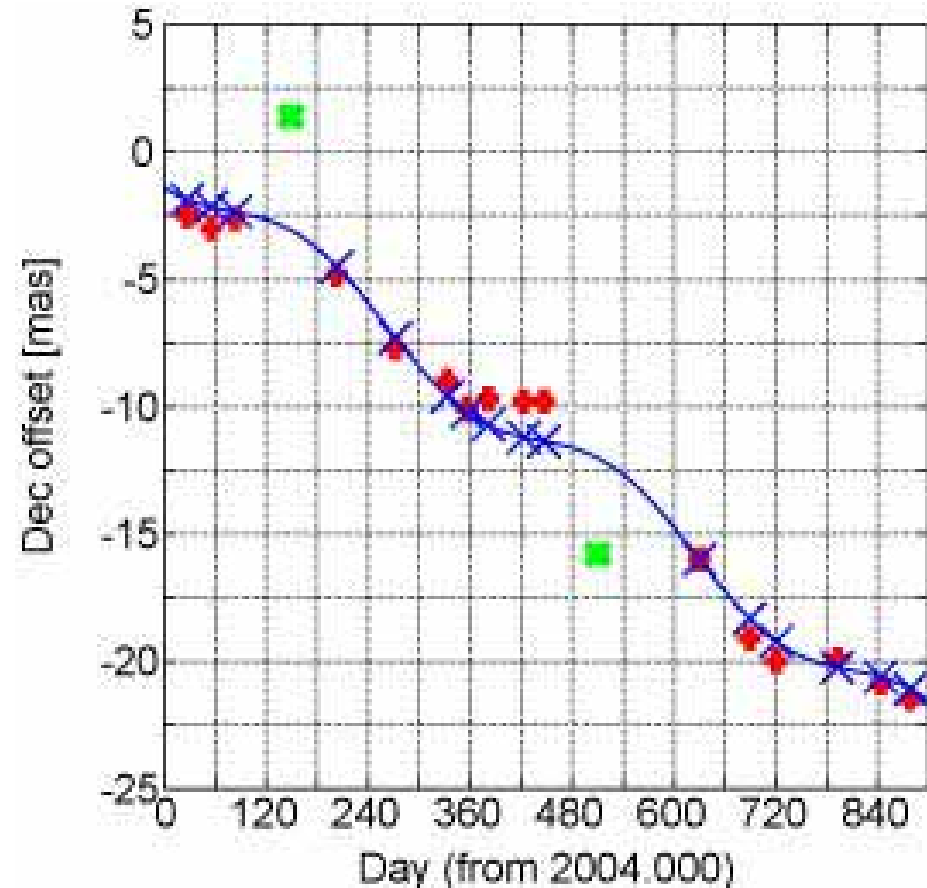
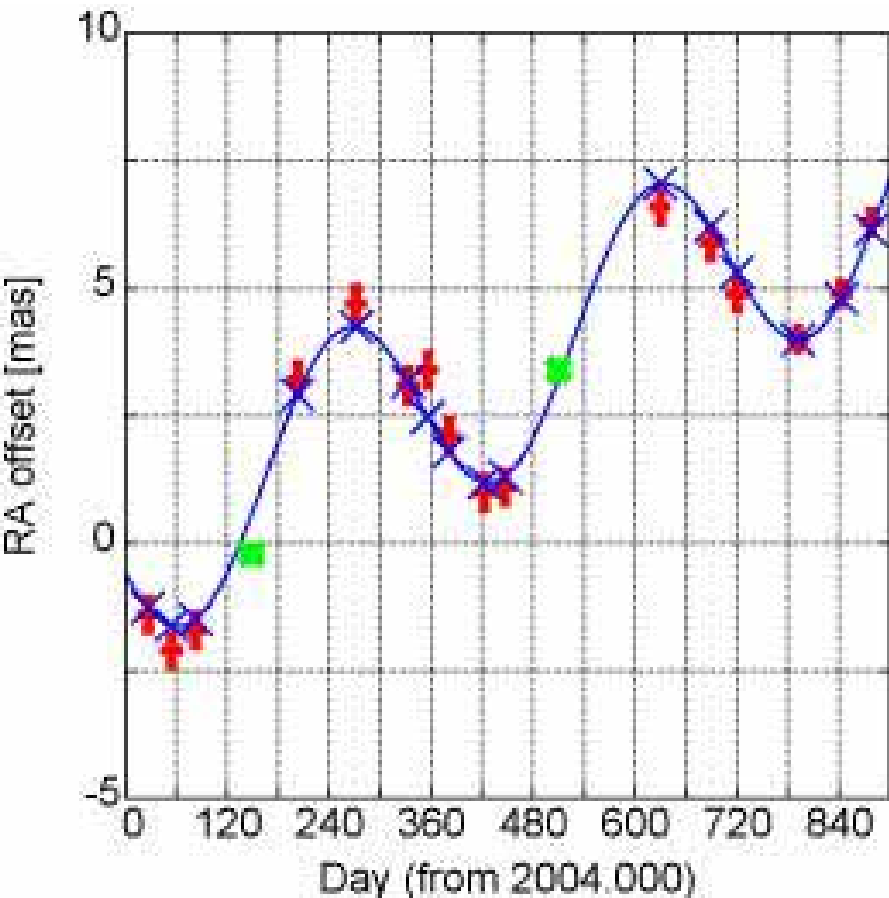
Annual parallax of Orion KL

- RA data only: $\pi = 2.3 \pm 0.1$ mas --- $D = 440 \pm 20$ pc
- Genzel et al. (1981): 480 ± 80 pc



Annual parallax of Orion KL

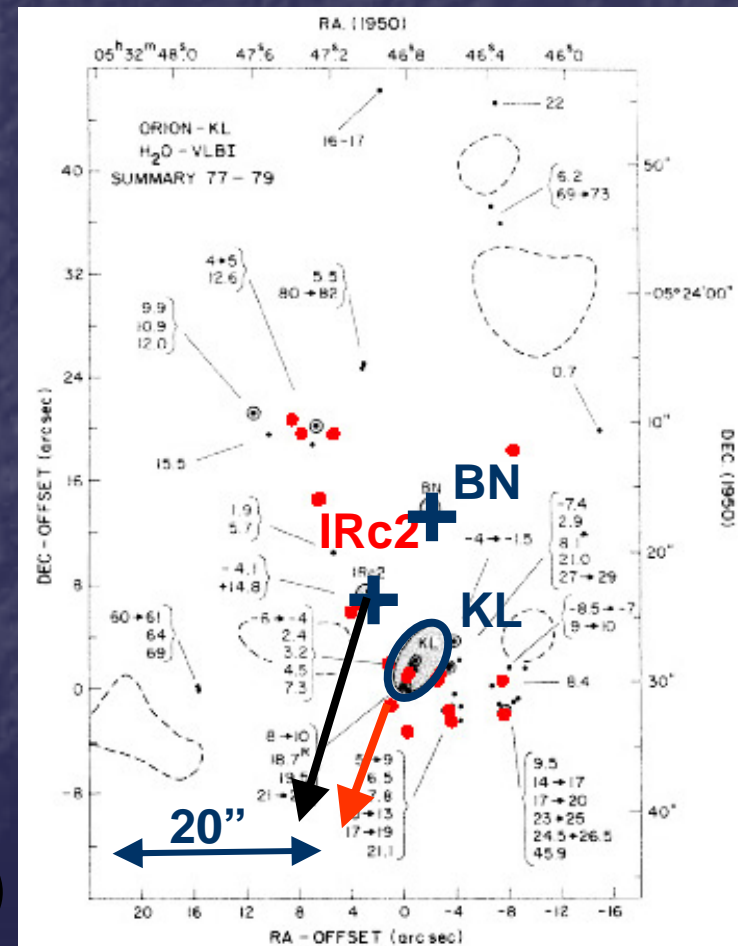
- RA data only: $\pi = 2.3 \pm 0.1 \text{ mas}$ --- $D = 440 \pm 20 \text{ pc}$
- Genzel et al. (1981): $480 \pm 80 \text{ pc}$



Proper motion of Orion KL

- Proper motion of the spot wrt rest frame of Orion
 - (1.5 mas, -4.1 mas) --- 9.0 kms⁻¹
- Proper motion of source I
 - (2.26 mas, 7.46 mas;
Gomez et al. 2005)
- Jet from IRc2/source I?
- Further analysis for other spots is necessary.

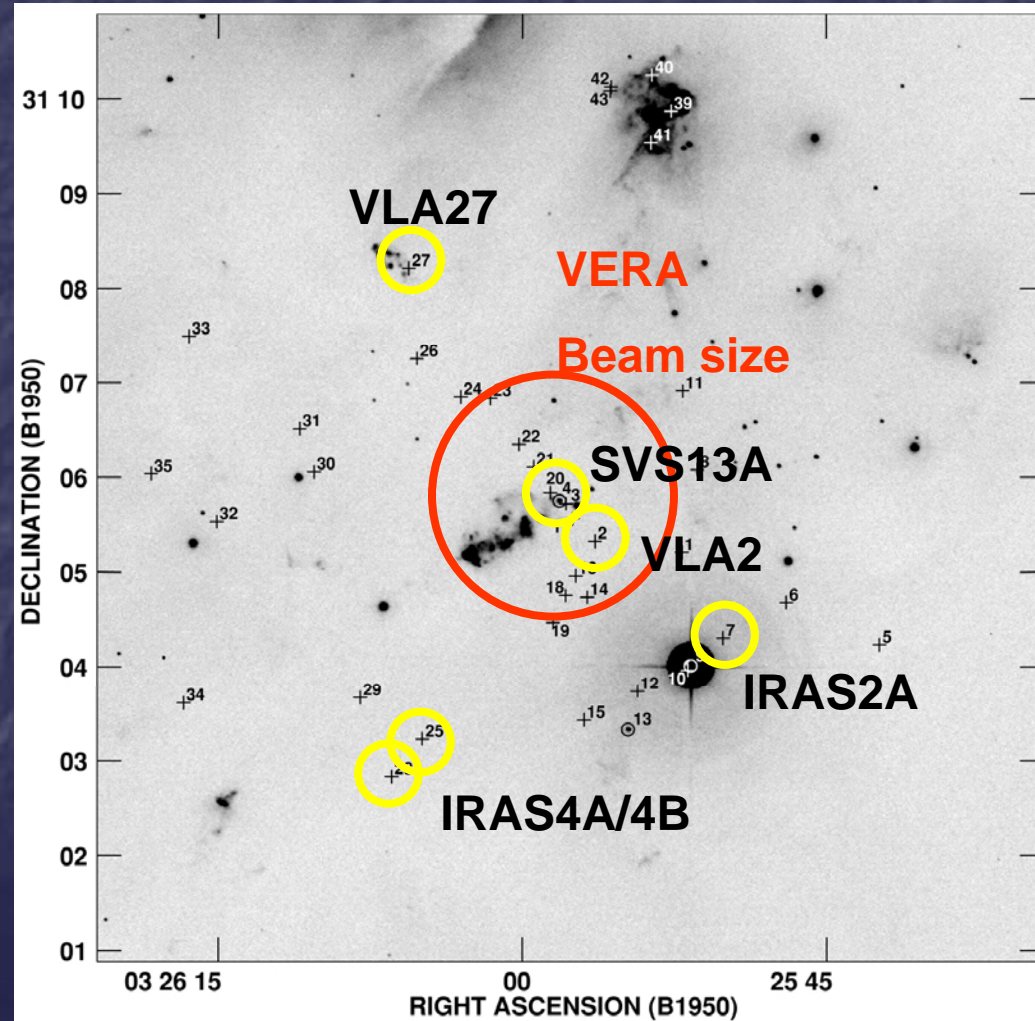
(Genzel et al. 1981)



NGC1333

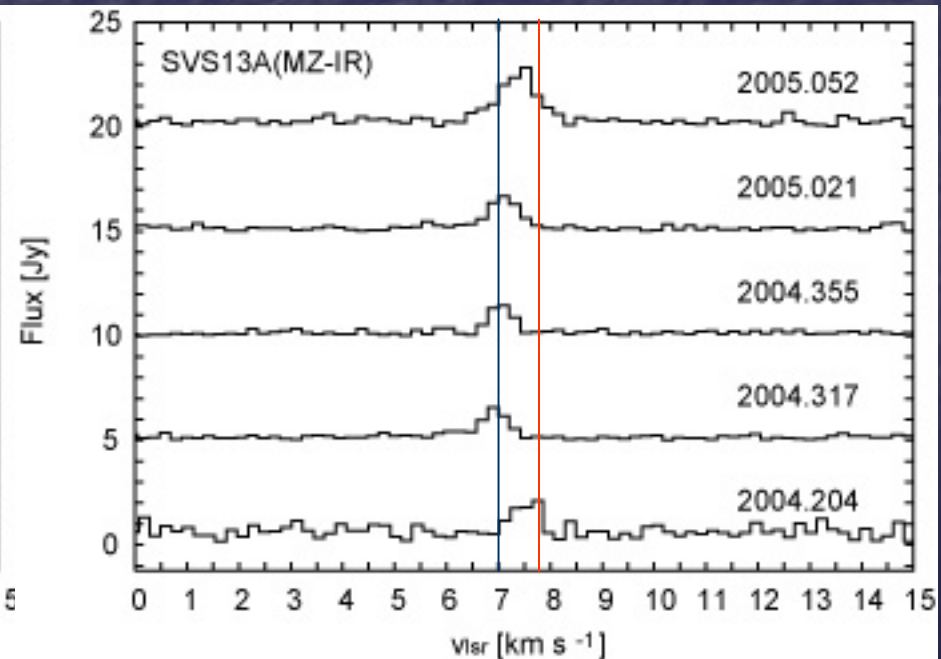
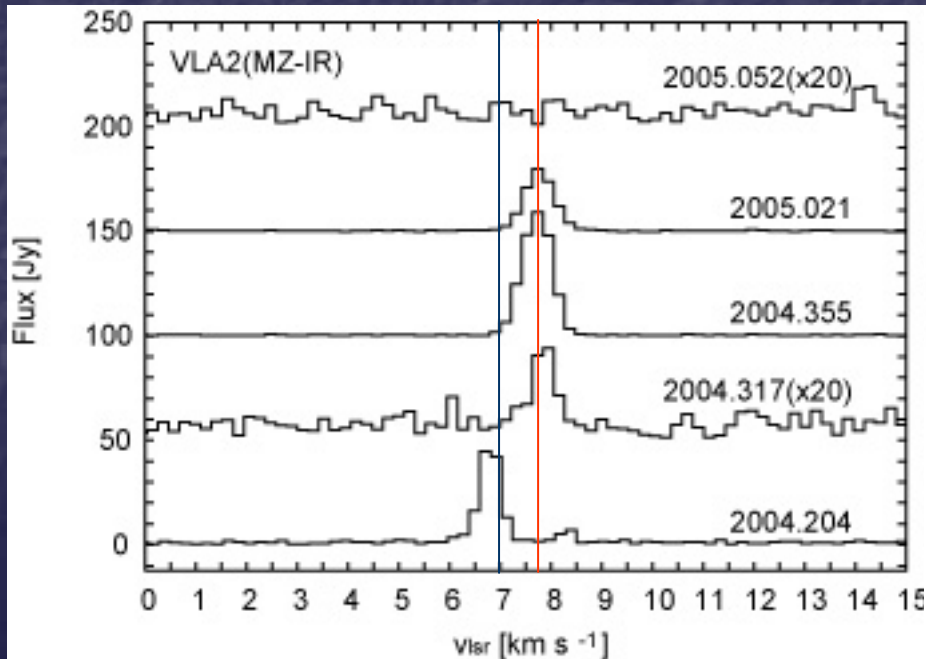
- Nearby low-mass SFR in Perseus
- Several young stellar objects (YSOs) with H₂O masers
 - SVS13A/VLA2(35")
 - J0336+3218(1.9deg)

VLA sources and SII image
(Rodriguez et al. 1999)



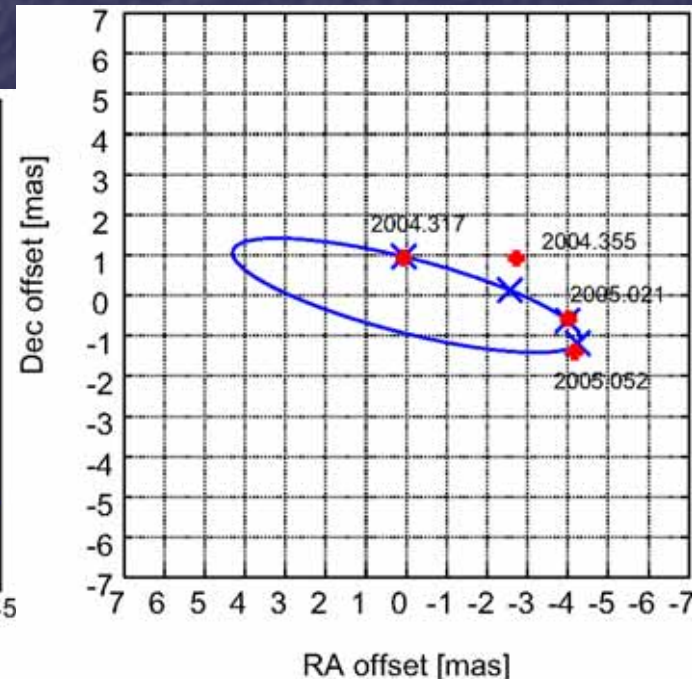
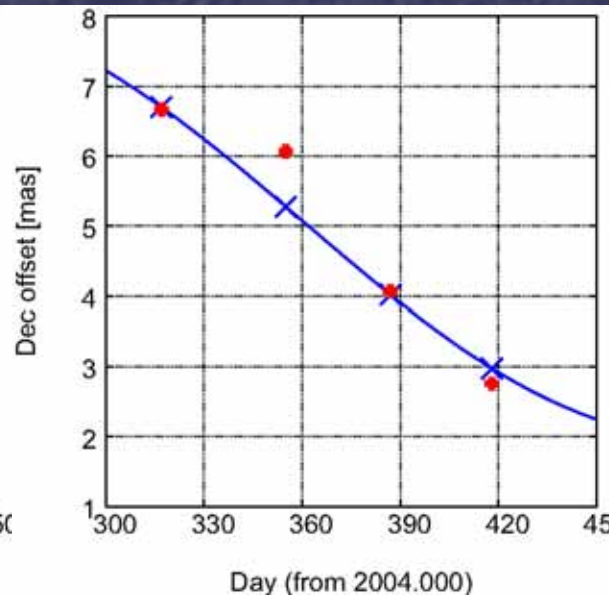
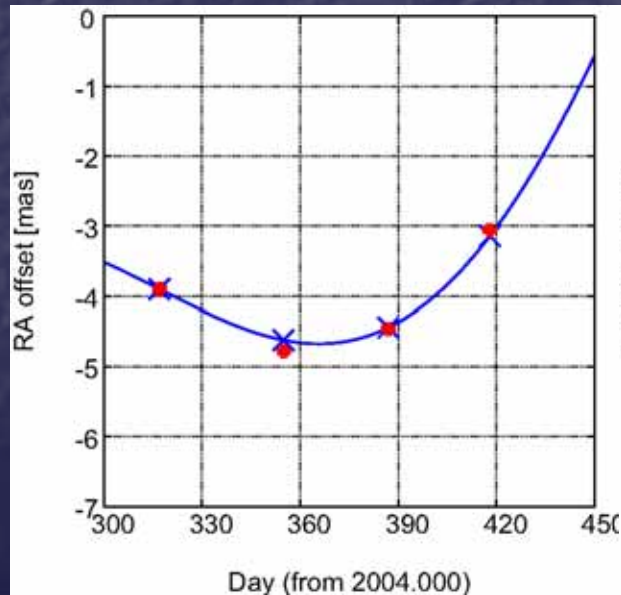
Spectra of NGC1333

- From 50 Jy to 0 Jy during 6 months
 - Highly valuable: sometimes life time < a few months
 - Known for low-mass YSOs (Claussen et al. 1996)
- Data for SVS13A were analyzed
 - VLA2 is 30" south from phase-tracking center!



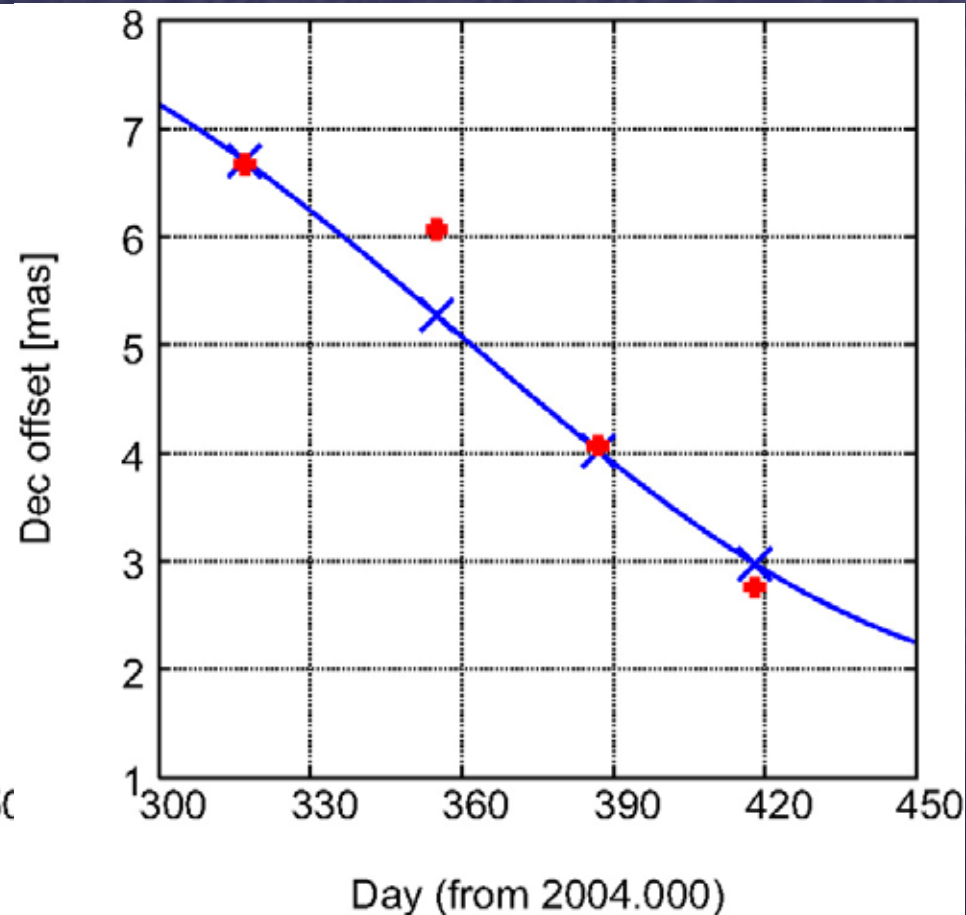
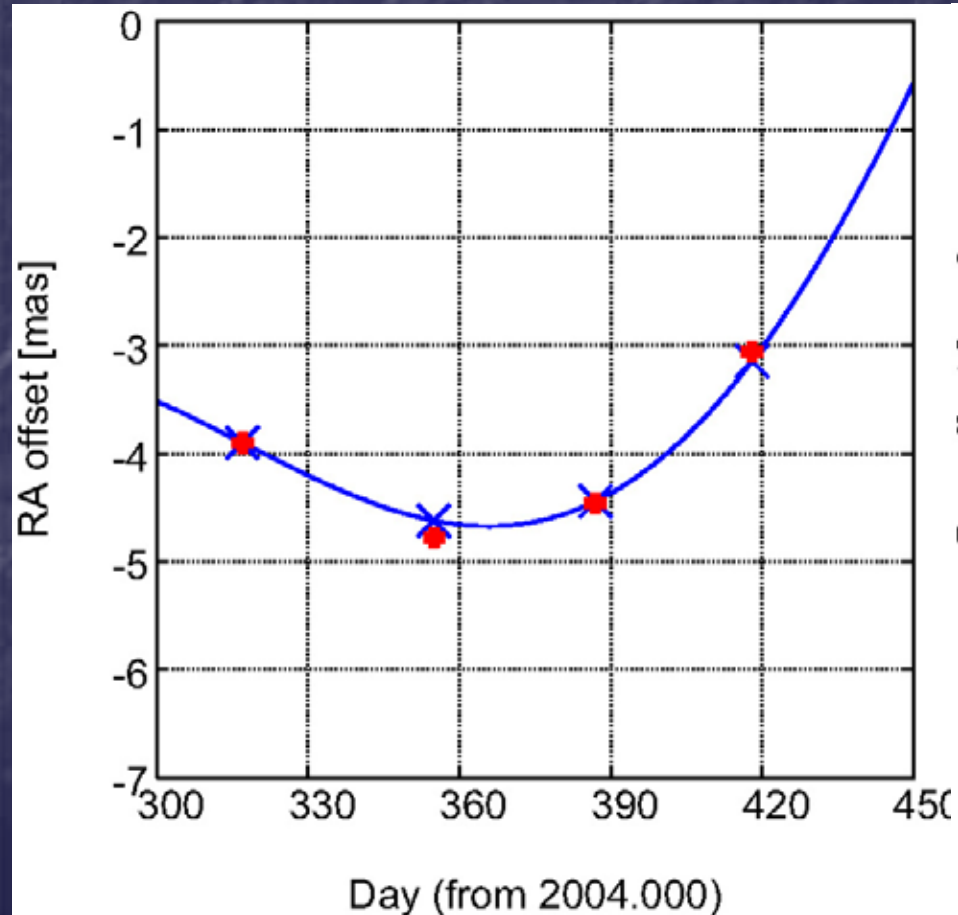
Annual parallax of NGC1333

- $\pi = 4.4 \pm 0.9$ mas --- $D = 230 \pm 50$ pc
 - Consistent with Cernis (1989): 220 pc
- Large scatter in 2004.355day: only in dec.
 - Atmospheric delay?
 - Structure of the spot?



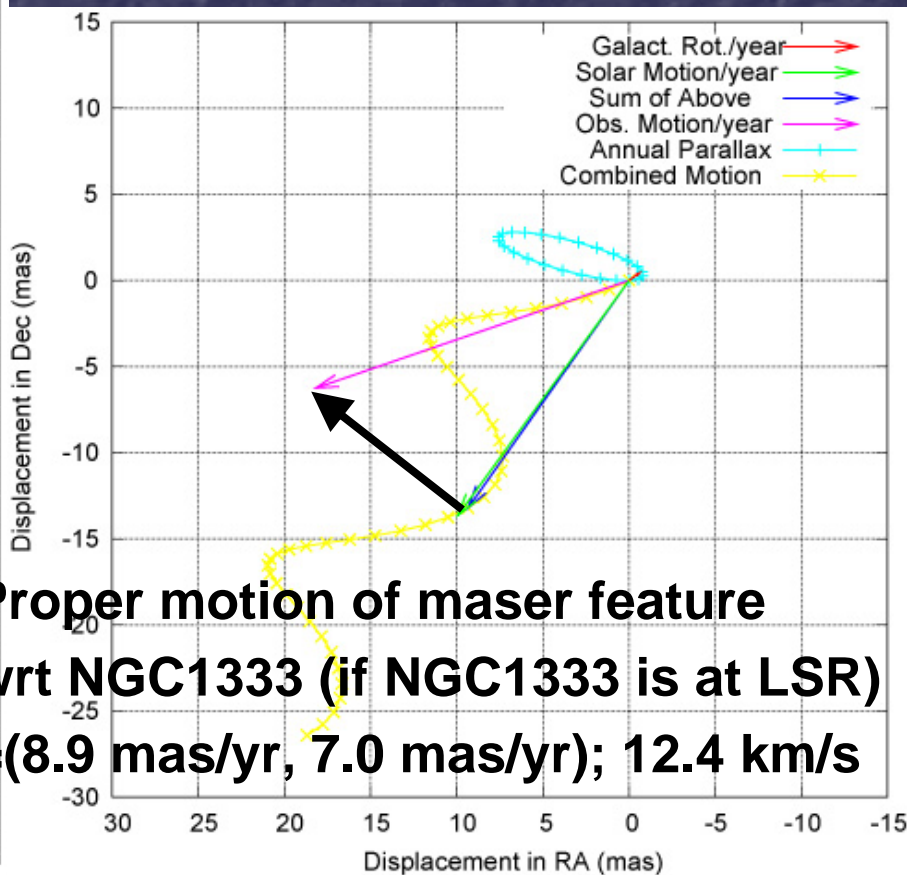
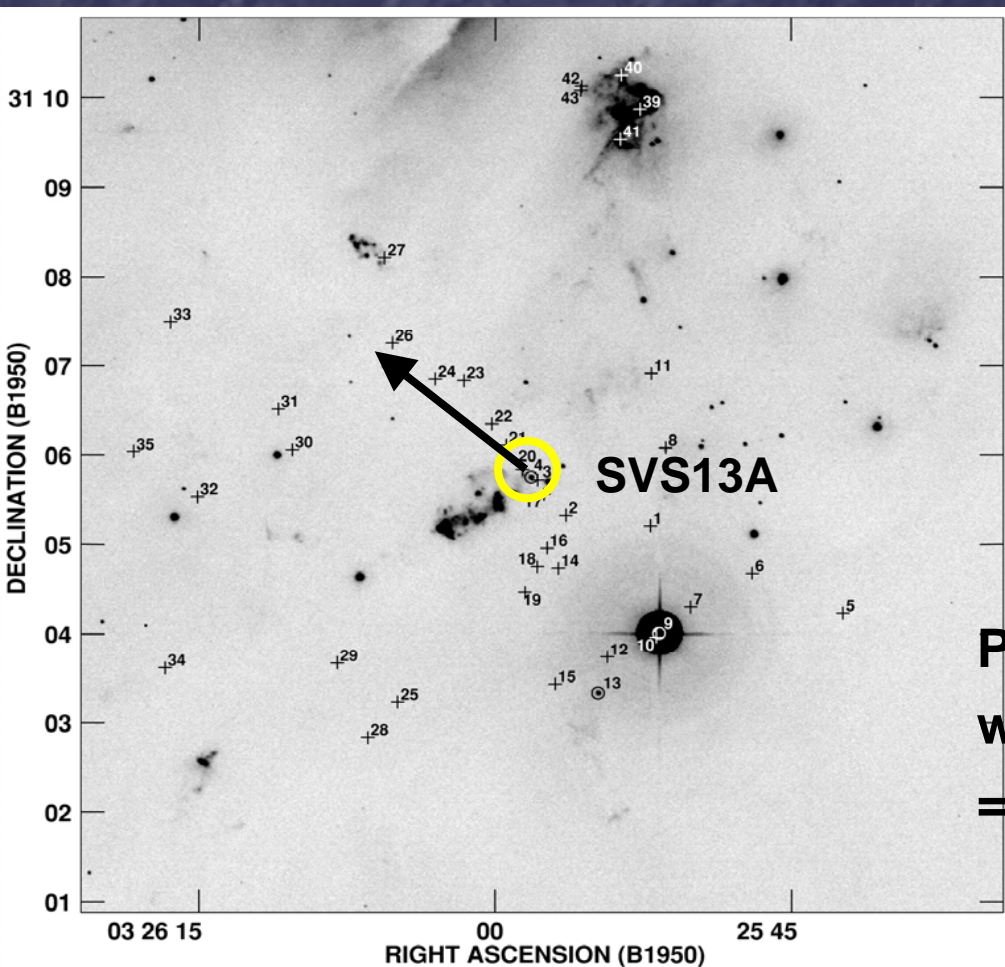
Annual parallax of NGC1333

- $\pi = 4.4 \pm 0.9 \text{ mas}$ --- $D = 230 \pm 50 \text{ pc}$
- Consistent with Cernis (1989): 220 pc



Proper motion of NGC1333

- Proper motion wrt the LSR
 - Perpendicular to the jet from SVS13A(HH7-11) ?



Summary

- Annual parallax and proper motion of Orion KL and NGC1333 were successfully measured.
- We have not yet analyzed the kinematics (jet/disk?) of Orion KL and NGC1333.
- We will analyze other maser spots/sources.
- We will monitor the masers in NGC1333 to complete our measurements.

Future plan

- We plan to observe H₂O maser sources in nearby molecular clouds ($D < 1$ kpc).
- We carried out survey of 72 H₂O masers and reference sources with VERA last week.
- Several source pairs will be monitored to measure annual parallax and proper motion.