Introduction of KVN Key Science & VLBI test observation between KVN & VERA

Oh, Chungsik (KVN/KASI)

한국우주전파관측망
KOREAN VLBI NETWORK · KASI

KVN Key Science Projects

- AGN & Galaxies
- Star Forming Regions
- Late-Type Stars
- Astrometry

AGN WITH KVN

KVN CP SURVEY
VECORSS(VLBI EXTRAGALACTIC COMPACT RADIO SOURCE SURVEY) PROJECT

EAVN HPF SURVEY
OPACITY IN AGN JETS

KVN AGN single dish research 2009/10

- KVN calibrator survey
  - > 500 mJy sample almost completed
- Primary calibrator flux measurement
  - 3C147, 3C286 using Mars emission model
- Joint IDV AGN monitoring
  - three opt-radio sessions, 1 SWIFT campaign, 1 KVN-Yamaguchi obs.
- F-GAMMA pilot observation
  - one test obs.
- Baby Radio Galaxies (HFP)
  - test obs. some looks like Blazars
- AGN-host evolution
  - several Elliptical, and a few Spiral detected

Flux estimation

❖ KVNCS1

	KVNCS1.0	KVNCS1.1	KVNCS1.2
Candidates	595		983
Observed	595		396
Estimated K flux (≥7σ) (cf. VERA)	**295 (132)**		자료처리중
Estimated Q flux (≥7σ)	**10**		자료처리중
Detected sources (≥5σ)	417 (K) **(155)**, 48 (Q)		자료처리중
Detected sources (≥3σ)	517 (K) **(171)**, 226 (Q)		자료처리중

Detection limit at K band (clear weather)
~ 200mJy

KVN Single-Dish Projects regarding Star Formation

KVN Key Project
Maser Studies of Massive YSOs

H_2O/CH_3OH

- H_2O masers appear to trace disks in some massive YSOs, while they appear to trace outflows in some others.

- Proper motion studies of H_2O masers would provide convincing evidence for accretion disks and jets around massive protostars, so allow us to distinguish bet. the two competing models: accretion vs. merging.

- CH_3OH masers appear to trace the interaction regions of outflows from massive YSOs with the ambient gases.

- Distribution, kinematics, and proper motion studies of H_2O/CH_3OH masers in a sample of Massive Protostars would provide valuable info of disks/outflows.

"Key science project for KVN & EAVN"

Observational Results

- H_2O & CH_3OH (44.0) maser surveyed towards ~1000 massive YSOs

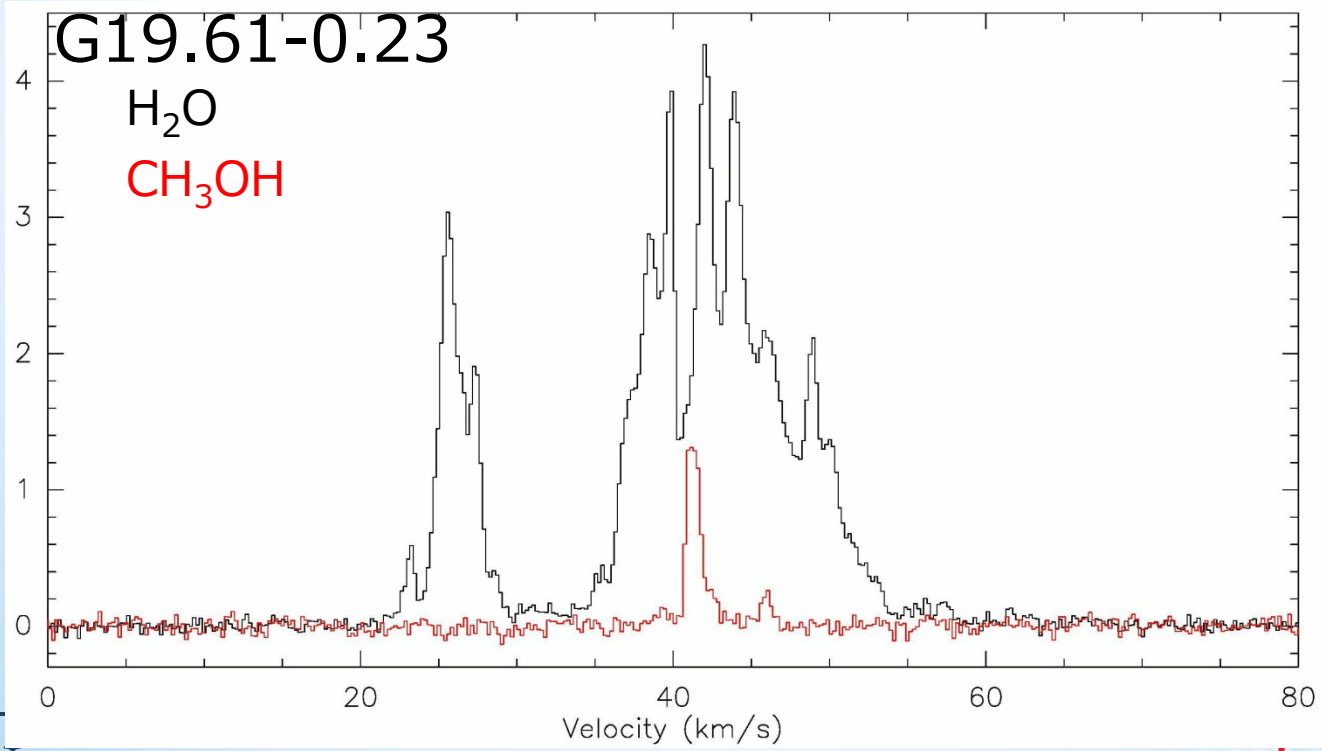
- IRDC's (Egan+ 98, Simon+ 05): lower detection rates, weaker
  190 Dense cores in 38 IRDCs (Chambers+ 09): 25%, 20%
  39 w/ SF indicators: extended 4.5μm emission, 24μm PS: 33%, 38%

- Protostars
  217 luminous IRAS PSs (Molinari+ 98, Sridharan+ 02): 32%, 38%
  284 6.7GHz ClassII CH_3OH Masers (Pestalozzi+ 05): 51%, 43%
  86 weak 6.7GHz Masers (AMGPS, Panadian+ 07): 38%, 19%
  90 Extended Green Objects (EGO, Cyganowski+ 08): 47%, 42%
  ~300 Red MSX Sources (RMS) (Urquhart+ 08): not yet observed

- UCHIIs: similar or higher detection rates, stronger 112
  UCHIIs (Wood & Churchwell 89, Kurtz+ 94): 61%, 40%

Observational Results

- Overall Detection Rates
  - H_2O: 372/979 (38%)
  - CH_3OH: 343/979 (35%)
    - 121 CH_3OH sources: 71 ($\delta > -30^o$) + 50 ($\delta < -30^o$)
  - ~300 New Detections



Study of Late-Type Stars using KVN

Simultaneous Multi-freq. & Multi-epoch Obs. of SiO & H_2O Masers : Key Issues

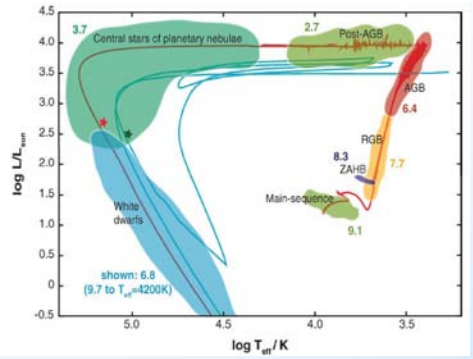
- **Dynamical effect on SiO and H_2O maser regions via dust formation layer due to stellar pulsation with relations of mass loss mechanism**
  - **Kinematics of SiO and H_2O maser spots ~ inward/outward motion, rotation, proper motion, bipolar outflow, jets**

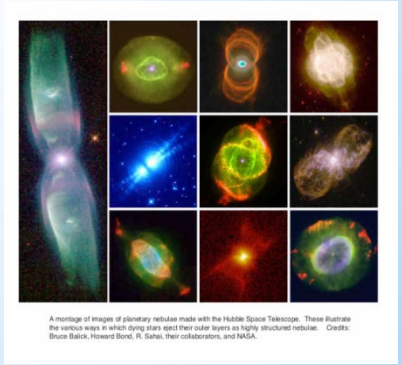
  → **Dynamical evolution from AGB star to post AGB star and PPN**

- **Spatial structure of each transition of SiO and H_2O maser emission (3 dimensional) : Masers trace the structure of atmosphere and envelope at various distances from star**

◈ **How appears an evolution process from AGB star and post-AGB to planetary nebula in both maser emission?**

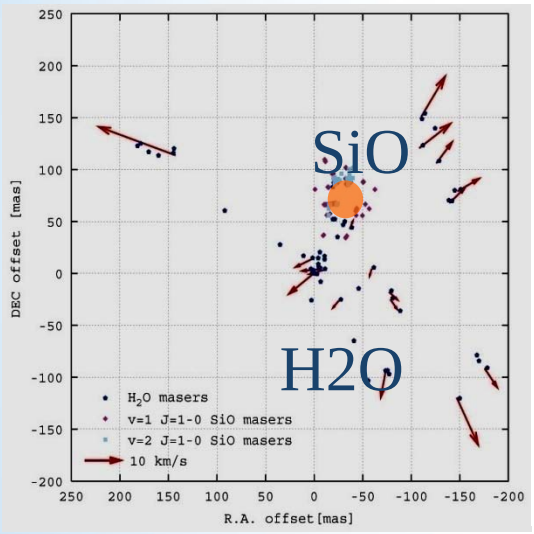
→ Isolated stars and binary stars ?

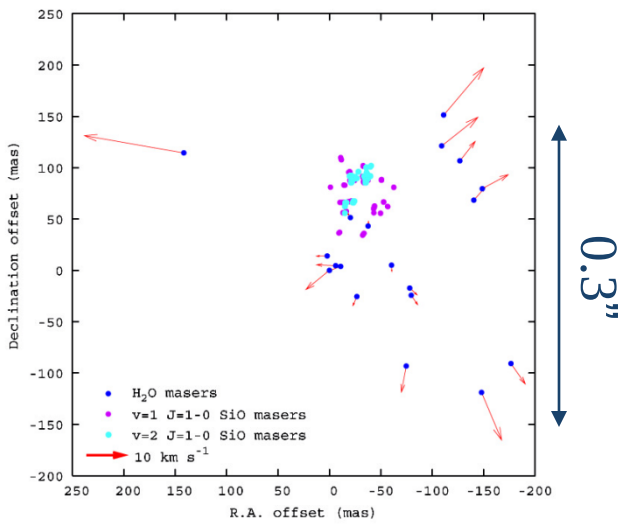


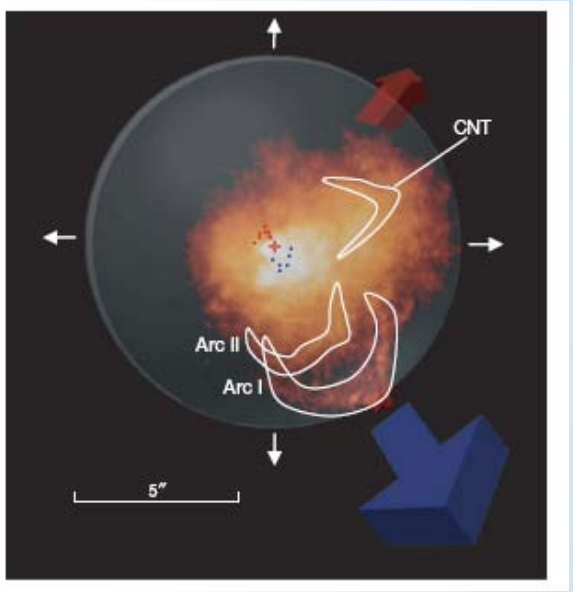


Simultaneous Multi-freq. & Multi-epoch Obs. of SiO & H_2O Masers

Ex.: Red Supergiant VY CMa with VERA (Choi et al. 2008, PhD thesis, PASJ)







■ Model of outflow superimposed on HST IR image (Ziurys et al. 2007, Nature)

■ Annual parallax → distance 1.15 kpc
►Proper motion
►Modeling for the kinematics of 3 dimensional circumstellar envelope

◈ We expect to trace the development of outward motion from SiO maser region to H_2O maser region using KVN/KVN+VERA

Selection of Objects : both SiO & H_2O Maser Emission Sources

Based on KVN single dish observations

■ **Survey : Simultaneous Observations of SiO/H2O Masers toward**
- ○ **Known Stellar SiO and H2O Maser Sources (166)**
- ○ **Known SiO-Only Detected Sources (83)**
- ○ **Known H2O-Only Detected Sources (156)**

■ **Time Monitoring Obs. : Simultaneous Observations of SiO/H2O Masers toward**
- ○ **62 Objects (AGB Stars, Post-AGB Stars)**
- ○ **9 (21) Symbiotic Stars**

→ At 1st stage (22/43 GHz) → KVN (+ VERA) Test Research Obs.
- ◈ RR Aql, W Hya, RT Vir, IK Tau, WX Psc, NV Aur, V4201 Sgr, V1111 Oph ?

→ At 2nd stage : Symbiotic Stars, Water-fountain Stars can be added

KVN Key Science Project 運用

◆ KVN側

● KVN 21m x 3 台 VLBI 観測：22/43 GHz 同時　研究観測 (2011.9 以降),
22/43/86/129 GHz 同時　研究観測 (2012.9 以降)

► 全観測可能時間の ~50 %

● KVN 21m x 3 台 + VERA 20m x 4 台 VLBI 観測：22 GHz, 43 GHz 観測

□ ► 全観測可能時間の ~50 %

◆ KVN+VERA KSP ► VERAとの打ち合わせ

►KVN, KVN+VERA テスト観測(サイエンス）必要

◆ 今後の予定

● 2010年8月：KVN　UM
● 2010年 9/10月： KVN 科学委員会 1段階選定
● 2010年10月から：テスト観測(サイエンス）開始
● 2011年7/8月： KSP 修正・補完
● 2011年 9月： 22/43 GHz サイエンス研究観測開始

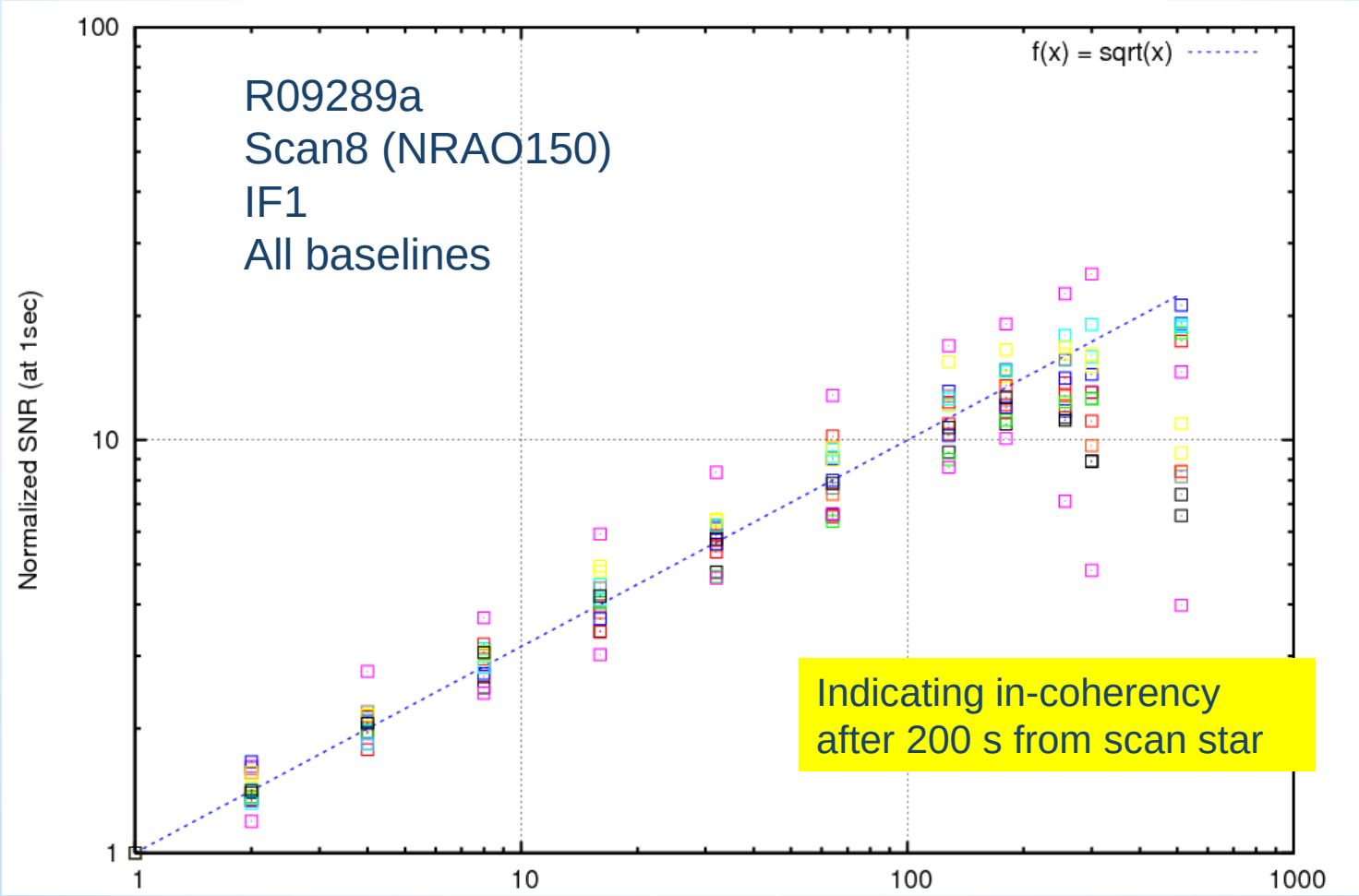
VLBI test observations of KVN (in collaboration with VERA)

Observational Status

Exp. Code	Obs. Date	UT	Freq.	Bitrate(Mbps)	Stations	Corr. Status	Reduced by
r10148a	2010-05-28	02-08	43	128,1024(Mk5B)	YsUsTn_VERA	being corr.	(cnt), (spc)
r10147a	2010-05-27	02-08	22	128,1024(Mk5B)	YsUsTn_VERA	being corr.	(cnt), (spc)
r10120a	2010-04-30	04-09	43	128,1024(Mk5B)	YsUsTn_VERA	being corr.	(cnt), (spc)
r10116a	2010-04-26	04-09	22	128	YsUsTn_VERA	being corr.	(cnt), (spc)
r10107b	2010-04-17	03-08	43	128,1024(Mk5B)	YsUsTn_VERA	being corr.	(cnt), (spc)
r10105a	2010-04-15	06-11	22	128,1024(Mk5B)	YsUsTn_VERA	being corr.	(cnt), (spc)
r10069b	2010-03-10	15-20	43	128,1024(Mk5B,D2K)	YsTn_VERA	arrived(in DVD)	LSS/CJS(cnt), OCS(spc)
r10068a	2010-03-09	06-14	43	128,1024(Mk5B,D2K)	YsTn_VERA	arrived(in DVD)	LSS/OJH(cnt), OCS(spc)
r10063b	2010-03-04	15-20	22	128,1024(Mk5B,D2K)	YsTn_VERA	arrived(in DVD)	SBW(cnt), OCS(spc)
r10062a	2010-03-03	06-14	22	128,1024(Mk5B,D2K)	YsTn_VERA	arrived(in DVD)	SBW(cnt), OCS(spc)
r09357c	2009-12-23	11-18	43	128,1024(Mk5B)	YsUs_VERA	arrived(in DVD)	LSS(cnt), OCS(spc)
r09356b	2009-12-22	11-22	43	128,1024(Mk5B)	YsUs_VERA	arrived(in DVD)	LSS(cnt), OCS(spc)
r09296a	2009-10-23	10-12	22	128,1024(Mk5B)	YsUsTn_VERA	arrived(in DVD)	SBW(cnt), OCS(spc)
r09295b	2009-10-22	20-22	43	128,1024(Mk5B)	YsUsTn_VERA	arrived(in DVD)	SBW(cnt), OCS(spc)
r09289a	2009-10-16	20-22	22	128,1024(Mk5B)	YsUsTn_VERA	arrived(in DVD)	SBW(cnt), OCS(spc)
r09268a	2009-09-25	12:30-14:30	22	128	Ys_Us_VERA	not fully correlated	data cable problem
r09142c	2009-05-22	03-13	22	128	Ys_VERA	arrived(in DVD)	correlation problem
r09140c	2009-05-20	19-1/01	22	128	Ys_VERA	arrived(in DVD)	correlation problem
r09108c	2009-04-18	00-15	22	128	Ys_VERA	arrived(in DVD)	correlation problem
r09072d	2009-03-12	12:40-14:00	43	128	Ys_VERA	arrived(in DVD)	SBW(cnt), Kurayama(spc)
r09072b	2009-03-12	10:00-11:30	22	128	Ys_VERA	arrived(in DVD)	SBW(cnt), Kurayama(spc)
r09071b	2009-03-11	4:30-6:30	43	128	Ys_VERA	arrived(in DVD)	SBW(cnt), Kurayama(spc)
r09071a	2009-03-11	1:30-3:30	22	128	Ys_VERA	arrived(in DVD)	SBW(cnt), Kurayama(spc)
r08308b	2008-11-03	16-18	22	128	Ys_VERA	arrived(in DVD)	SBW(cnt), Kurayama(spc)
r08306b	2008-11-01	05-07	22	128	Ys_VERA	arrived(in DVD)	SBW(cnt), Kurayama(spc)

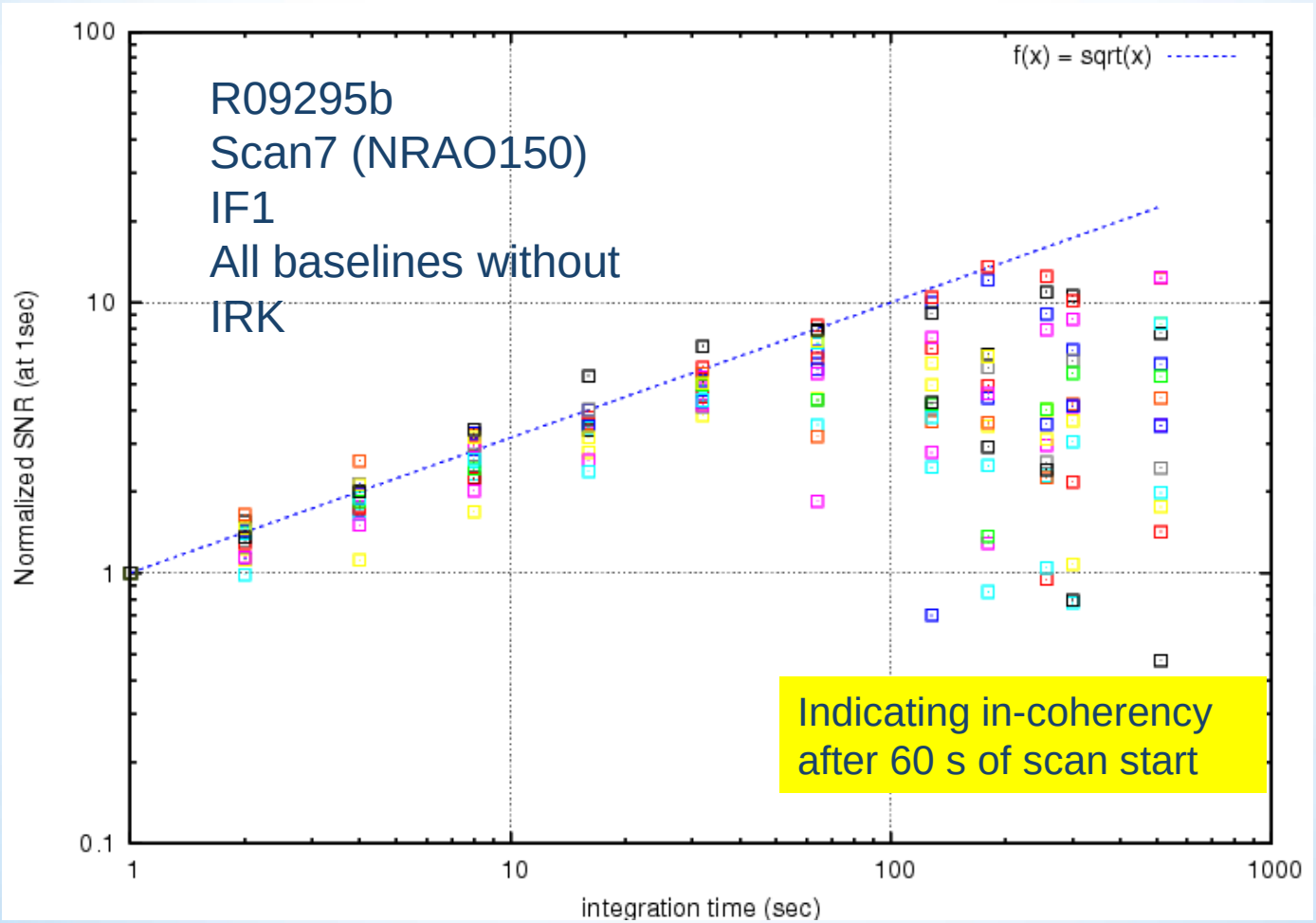
Characteristics of the in-coherency

Normalized SNR : 22GHz



Characteristics of the in-coherency

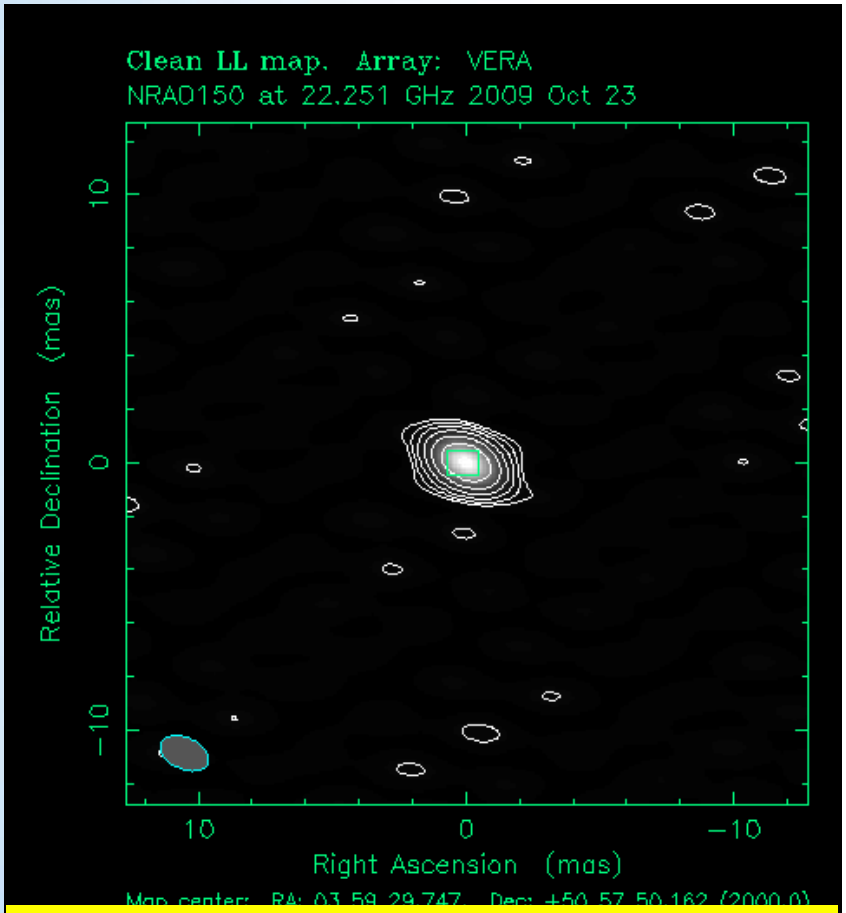
Normalized SNR : 43GHz



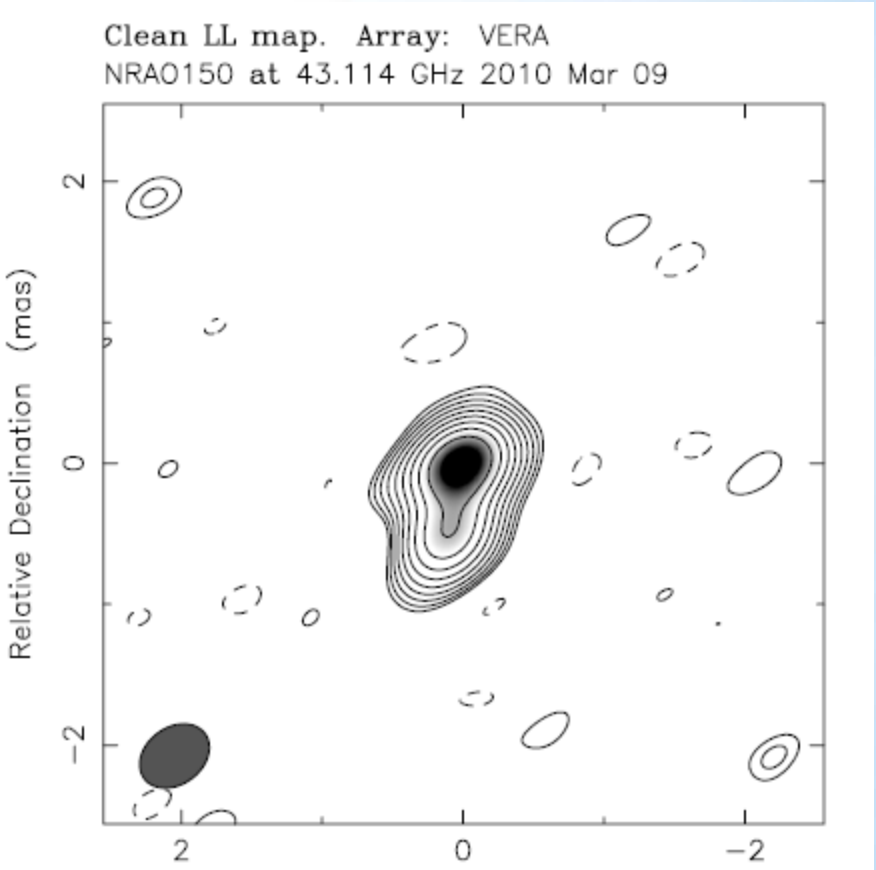
Characteristics of the in-coherency

- **Variation of phase difference**
  - Weather
  - Instrumental phase error (LO,H-maser)
  - Source/antenna position

Image Sensitivity



10min observations with
KVN + VERA at 22GHz
On October 2009
Beam size : 1.9 x 1.2 mas



1 hour observations with
KVN + VERA at 43GHz
On March 2009
Beam size : 0.5 x 0.4 mas

Image Sensitivity

❖ Image sensitivity

- Quantization loss: η_Q = 0.88 (2-bit), Bandwidth: B = 32 MHz (16MHz x 2ch), Integration time: τ = 10 min, Averaged SEFD : $SEFD_{ave}$ ~ 2591 Jy (SEFD = 3805 (MIZ), 4514 (IRK), 4387 (OGA), 5924 (ISH), 1442 (YS)), Number of antenna participated : N = 7

$$\Delta I = \frac{1}{\eta_Q} \frac{SEFD_{ave}}{\sqrt{N(N-1)B\tau}} = 0.003 Jy/beam$$

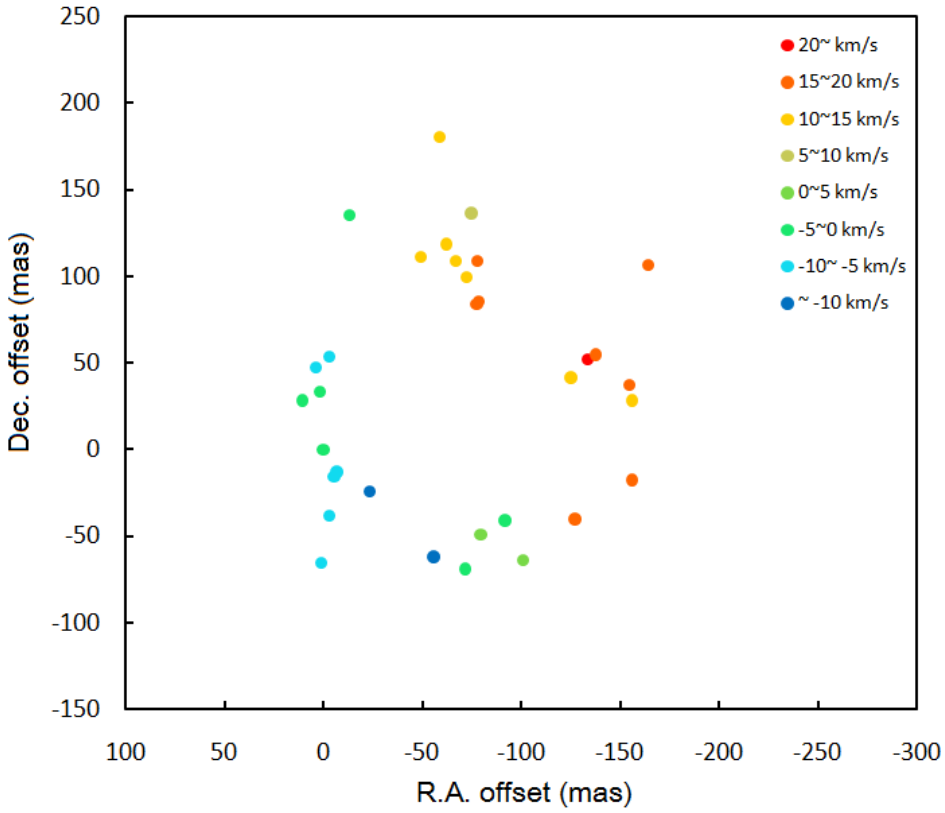
$$\Delta I_{meas} = 0.013 Jy/beam$$

$$\Delta I_{ideal} = 0.003 Jy/beam$$

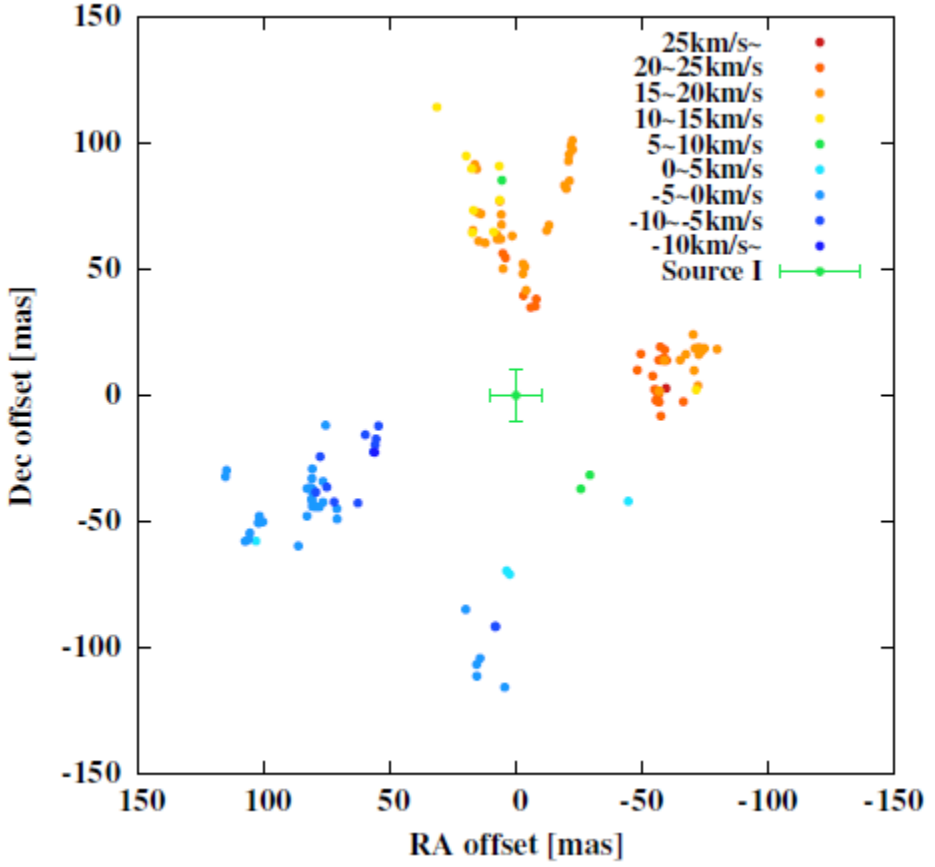
$$\Delta I_{meas} = 4 \times \Delta I_{ideal}$$

SiO observations towards Orion KL

1hour observation with KVN YS + VERA (KVN VLBI WG) On Dec. 2009



8hours observation with VERA (Kim et al. 2008)



今後のVLBIテスト観測

◆ サイエンス観測(テスト)

- AGN：銀河中心
- 星形成：４４GHｚメタノールメーザー
- 晩期形星：近傍の星
- etc…


2010 전파사용자회의 및 우주전파워크샵
▶일시 : 2010년 8월 16일(월) – 18일(수)
▶장소 : 연세대학교 제2공학관
▶주최 : 한국천문학회 우주전파분과, 한국천문연구원 전파천문연구본부, 서울대학교 전파천문대