

Upgraded TRAO and Its Performance

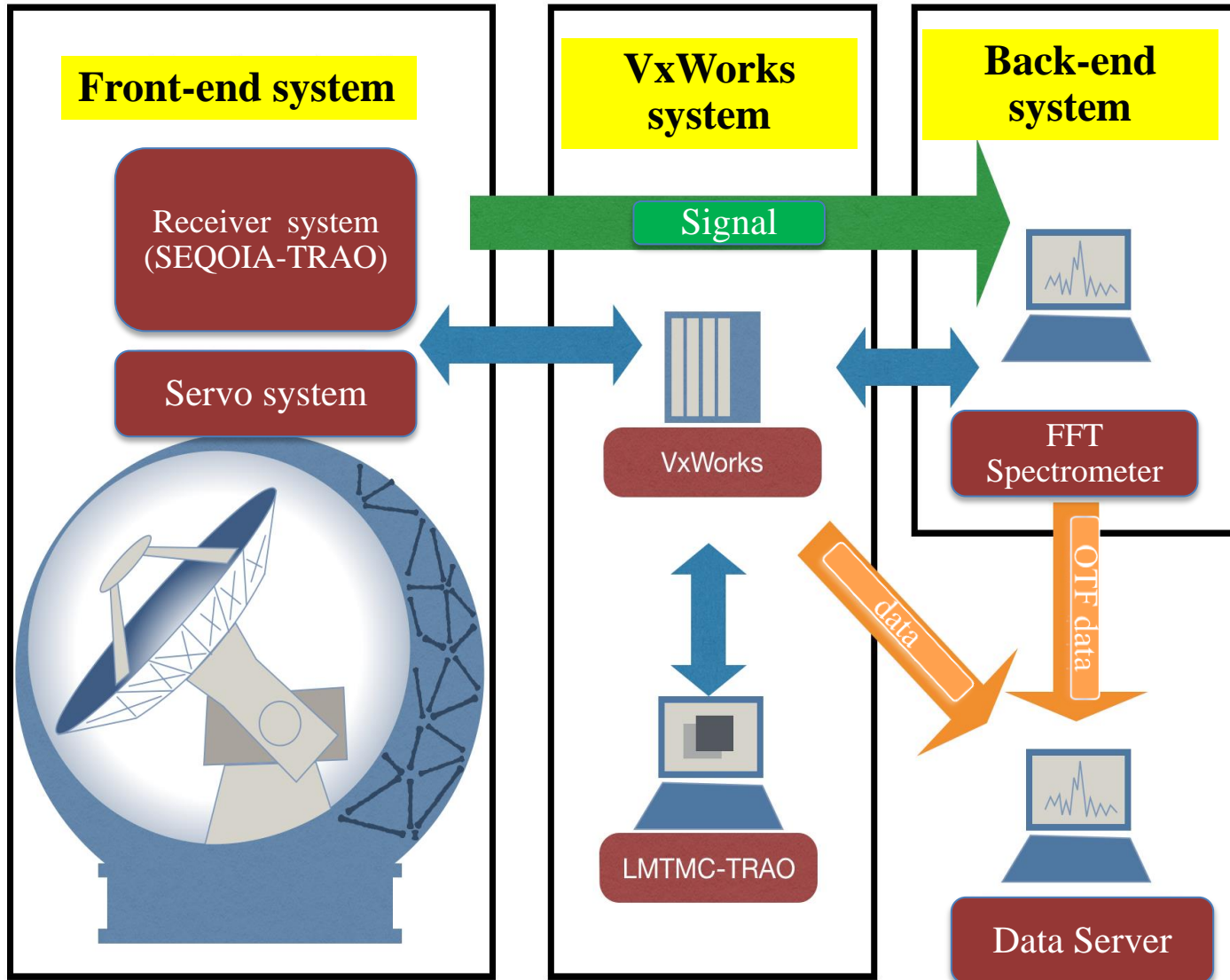
Chang Won Lee & TRAO team

Korea Astronomy & Space Science Institute



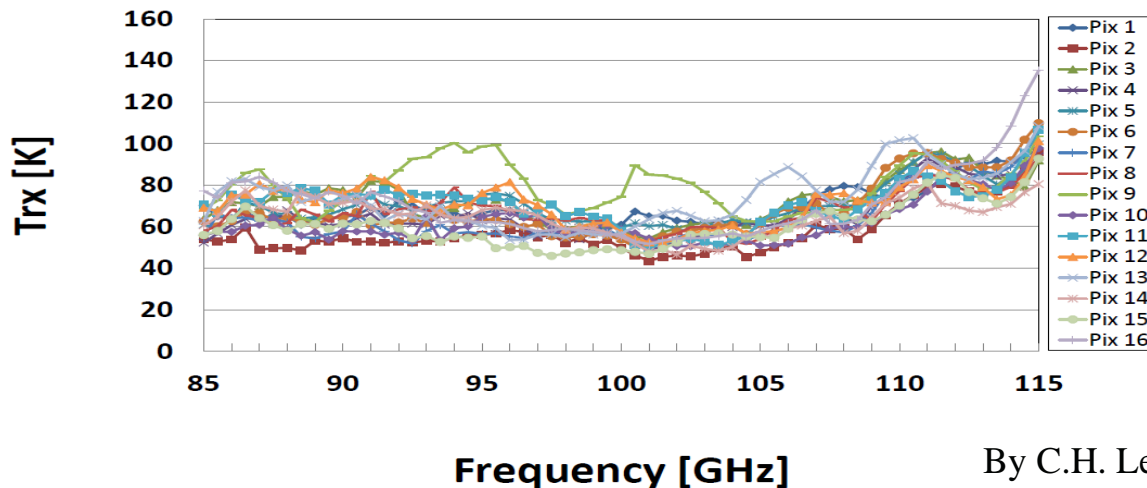
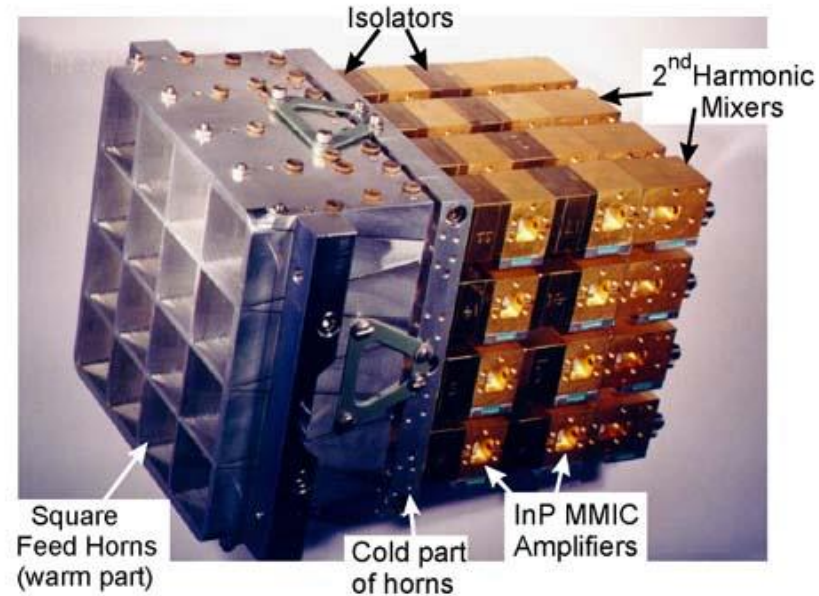
September 27, 2016. EAMA10, Seoul

TRAO Block Diagram



New receiver system

- New Multi-beam receiver system (SEQUOIA-TRAO) imported from U. Mass, 16 pixel MMIC preamplifiers in a 4x4 array
- Working frequency band : 85 – 115.6 GHz
- $T_{rx} = 60\text{-}80\text{ K}$ for 86 - 110 GHz,
80-110 K for 115GHz



New Back-end systems

- New FFT spectrometer

- Full spectra bandwidth: 125 MHz (~ 375 km/s at 100 GHz)
- Best spectral resolution: ~ 15.5 kHz with 8192 channels (~ 0.04 km/s at 100 GHz)



→ With two 2nd LOs in a parallel mode set-up, *two molecular lines (maximum 15GHz apart) can be simultaneously observable*. A single observation will enable us to get the data of 16 beams in 2 lines simultaneously, with the spectral bandwidth of ~ 60 MHz.

TRAO Observing mode : OTF

- On-the-Fly (OTF) mode (+ a simple position switching mode)
 - Useful for mapping large area $> 10' \times 10'$
e.g.) Mapping $15' \times 15'$ area which corresponds to a factor ~ 6 wider than $6' \times 6'$ mapping area only requires twice the time for mapping area of $6' \times 6'$, for the same sensitivity !

Mapping Area	Area Fraction (AF)	Time Fraction (TF)	Mapping Efficiency(AF/TF)
$15' \times 15'$	6.25	2	3.1
$12' \times 12'$	4	1.7	1.3
$10' \times 10'$	2.8	1.4	2
$6' \times 6'$	1	1	1

Performance

- (Best) System temperature

Mol. Line. (Freq. GHz)	HCO ⁺ 1-0 (89.189)	N ₂ H ⁺ 1-0 (93.176)	SO (99.2999)	NH ₂ D (110.154)	C ¹⁸ O 1-0 (109.782)	¹³ CO 1-0 (110.201)	¹² CO 1-0 (115.271)
T _{sys} (K)	160	160	240	230	190	210	400

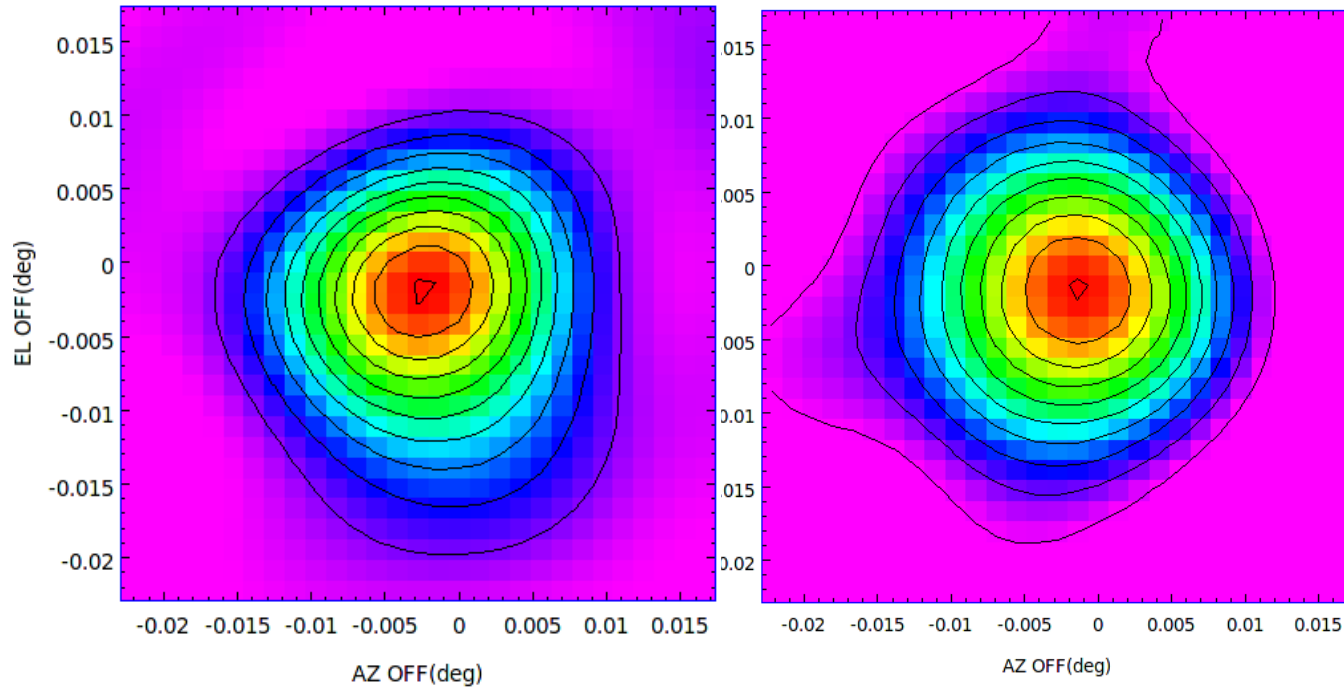
By Chung et al.
and A. Soam
et..al

- Pointing Accuracy ~10''

By Jung et al.

Beam Parameters

Orion



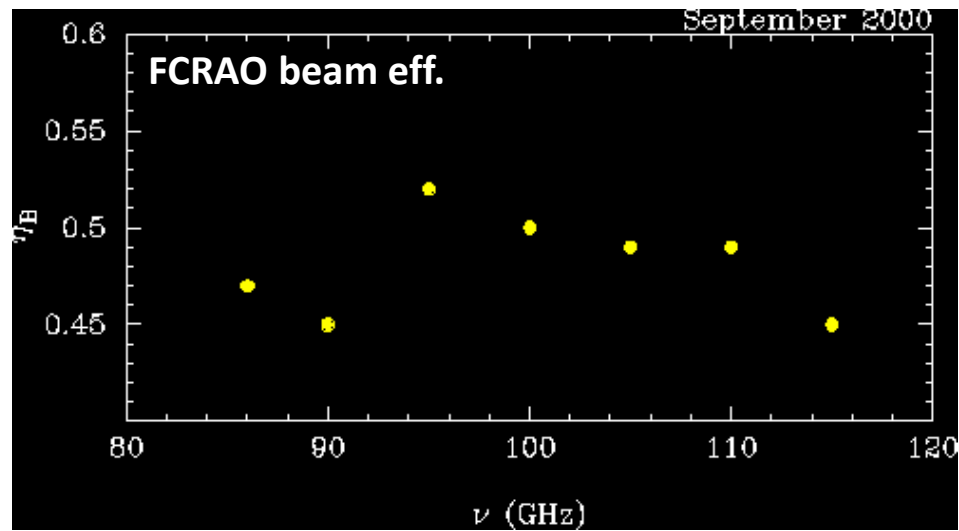
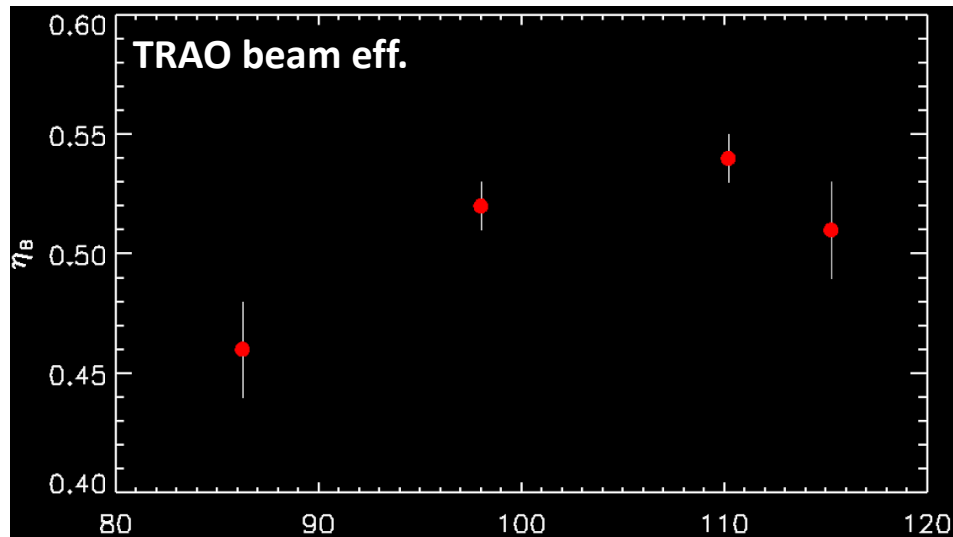
R Leo

By Jung et al.

Frequency (GHz)	86.243	98.000	110.201	115.271
ϑ_B (")	60	53	47	45
η_A (%)	39 ± 2	44 ± 1	46 ± 1	43 ± 2
η_B (%)	46 ± 2	52 ± 1	54 ± 1	51 ± 2

- Beam size from SiO Maser observations for Orion (left) and R Leo (Right) at 86.243 GHz.
- Beam efficiencies from Venus and Jupiter continuum observations

Beam Efficiency



By Jeongng et al.

TRAO Internal –Risk-Shared Observations (Jan. – April, 2016)

TRAO Key Science Programs

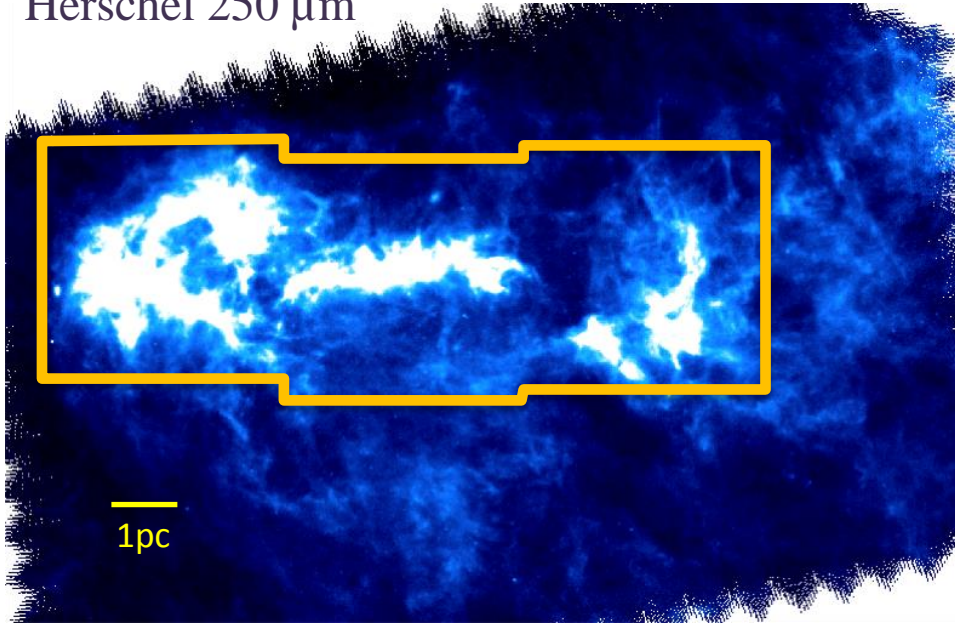
1. TRAO Multi-beam Legacy Survey of Nearby Filamentary Molecular Clouds (NFMC; CW Lee)
2. Mapping turbulent properties of star-forming molecular clouds down to the sonic scale (TPMC; JE Lee)
3. TRAO Observations of Planck cold clumps (TOP; T Liu)

General Programs

1. Molecular line diagnostics of the radiation-driven implosion mode of triggered star formation on bright-rimmed clouds (BRC; A Soam)
2. Molecular Line Observations of the Far-Infrared Bright Supernova Remnants (FIRSNR; I Jeong)
3. A Search for High-mass Star Forming Region Near Isolated Small H II Region (HMSFR; S Kang)
4. CO Survey of Inner Bar Region of the Milky Way (Inner Bar; Y Lee)
5. Methanol Outflow of the Extremely Young Protostar V380 Ori NE (Methanol Outflow; M Choi)
6. TRAO Outer Galactic Planer Survey (TOGS; Y Lee)

TRAO Results — Filamentary clouds

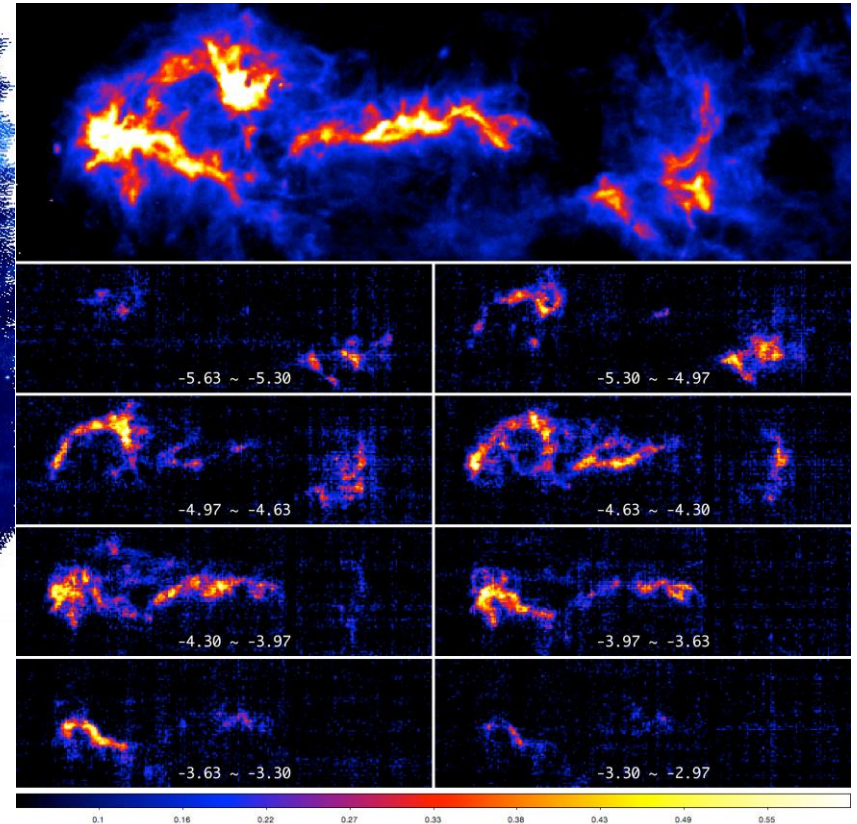
Herschel 250 μm



L1251 of Cepheus Molecular Cloud

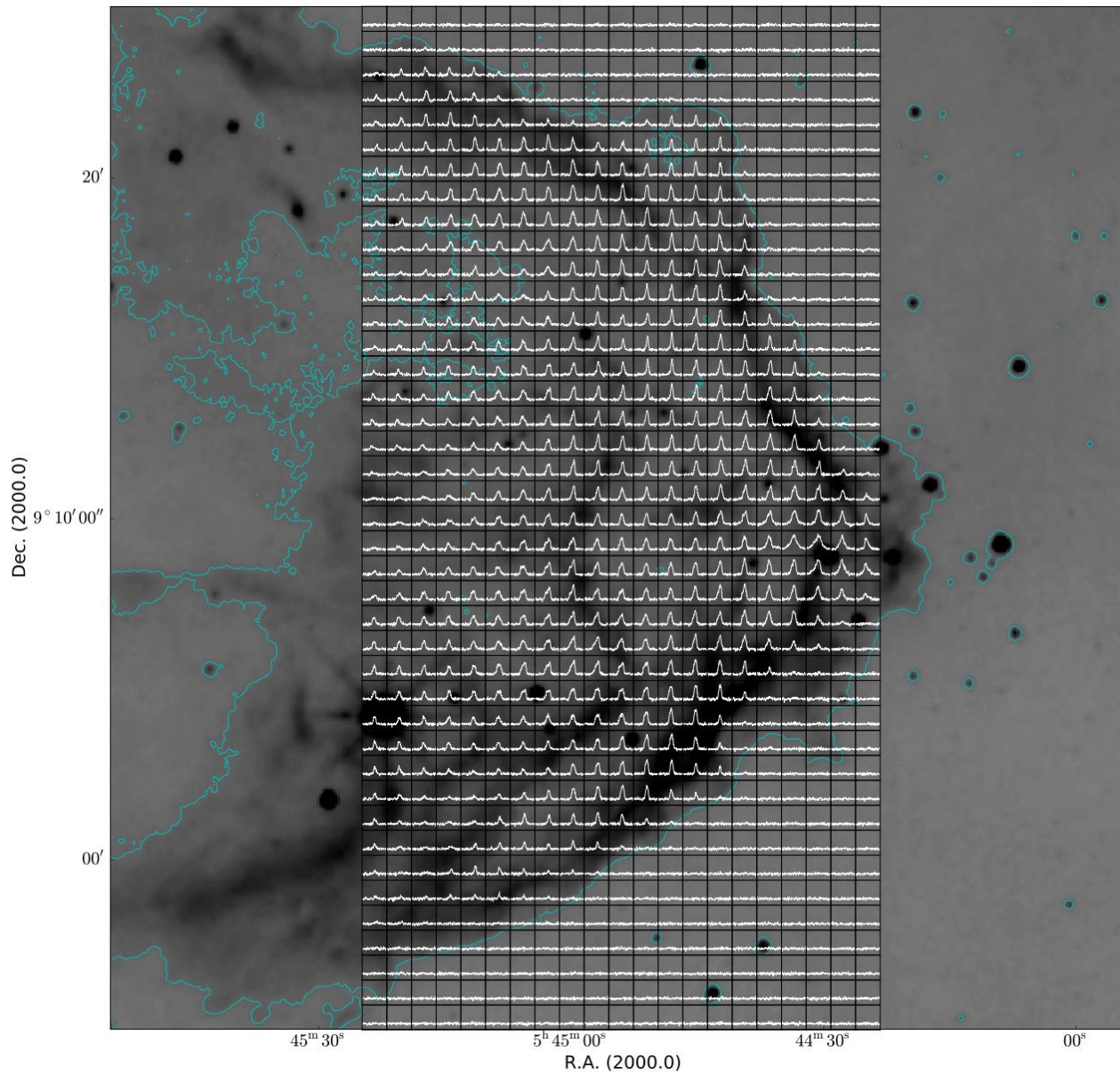
$\sim 96' \times 32'$ in 0.155K rms (in T_A^*), $t_{\text{int}} \sim 20$ hours,
with simultaneous ^{13}CO 1-0 observations

C^{18}O 1-0 integrated intensity map and
channel maps



S. Kim et al. 2016 in prep.

TRAO Results - BRCs



SFO 18 CO(1-0) (+WISE 12 μ m)

- Known to be in the no-triggered star formation category, but now believed to be “triggered” star-formation region from this observation.

A. Soam et al. 2016 in prep.

More for TRA0 upgrade

- Radome will be replaced this October.
- New Servo system is planned to be replaced next year. Pointing stability and accuracy will be improved.
- Development of wideband ($\sim 2\text{GHz}$) spectrometer is planned.

TRAO Open use

- TRAO Proposal call for general users for late Autumn 2016 and Spring of 2017 (till the end of April 2017)
 - Dead line : September 30st, 2016 (by midnight KST)
 - Maximum ~100 hours per proposal

Just visit TRAO web site and write your proposal for TRAO.

We welcome your proposal!