Upgraded TRAO and Its Performance

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TRAO Block Diagram

Front-end system
- Receiver system (SEQOIA-TRAO)
- Servo system

VxWorks system
- VxWorks
- LMTMC-TRAO

Back-end system
- FFT Spectrometer
- Data Server

By H. Kang et al.
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
- $\text{Trx} = 60-80$ K for 86 - 110 GHz, 80-110 K for 115GHz

By C.H. Lee et al.
**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 ~60MHz.
**TRAO Observing mode : OTF**

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

<table>
<thead>
<tr>
<th>Mapping Area</th>
<th>Area Fraction (AF)</th>
<th>Time Fraction (TF)</th>
<th>Mapping Efficiency(AF/TF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15’ x 15’</td>
<td>6.25</td>
<td>2</td>
<td>3.1</td>
</tr>
<tr>
<td>12’ x 12’</td>
<td>4</td>
<td>1.7</td>
<td>1.3</td>
</tr>
<tr>
<td>10’ x 10’</td>
<td>2.8</td>
<td>1.4</td>
<td>2</td>
</tr>
<tr>
<td>6’ x 6’</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Performance

• (Best) System temperature

<table>
<thead>
<tr>
<th>Mol. Line. (Freq. GHz)</th>
<th>HCO$^+$ 1-0 (89.189)</th>
<th>N$_2$H$^+$1-0 (93.176)</th>
<th>SO (99.2999)</th>
<th>NH$_2$D (110.154)</th>
<th>C$^{18}$O 1-0 (109.782)</th>
<th>$^{13}$CO 1-0 (110.201)</th>
<th>$^{12}$CO 1-0 (115.271)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{sys}$ (K)</td>
<td>160</td>
<td>160</td>
<td>240</td>
<td>230</td>
<td>190</td>
<td>210</td>
<td>400</td>
</tr>
</tbody>
</table>

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

• Pointing Accuracy ~10”

By Jung et al.
**Beam Parameters**

- **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.

<table>
<thead>
<tr>
<th>Frequency (GHz)</th>
<th>86.243</th>
<th>98.000</th>
<th>110.201</th>
<th>115.271</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_B$ (&quot;)</td>
<td>60</td>
<td>53</td>
<td>47</td>
<td>45</td>
</tr>
<tr>
<td>$\eta_A$ (%)</td>
<td>39±2</td>
<td>44±1</td>
<td>46±1</td>
<td>43±2</td>
</tr>
<tr>
<td>$\eta_B$ (%)</td>
<td>46±2</td>
<td>52±1</td>
<td>54±1</td>
<td>51±2</td>
</tr>
</tbody>
</table>

- 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 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

L1251 of Cepheus Molecular Cloud
~96′x32′ in 0.155K rms (in $T_A^*$), $t_{\text{int}}$ ~20 hours, with simultaneous $^{13}$CO 1-0 observations

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 TRAO 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 (~2GHz) 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 30\textsuperscript{st}, 2016 (by midnight KST)
  - Maximum ~100 hours per proposal

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

We welcome your proposal!