Feedhorn-coupled TiN Kinetic Inductance Detectors for the BLAST–TNG Submillimeter Polarimeter

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BLAST–TNG Science Overview

- Balloon-borne Submillimeter Polarimeter
- Successor to BLAST / BLAST–Pol

- Map Polarized Dust Emission
- Role Magnetic Fields Play in Star Formation
BLAST–TNG Instrument Design

<table>
<thead>
<tr>
<th>Band</th>
<th>250 μm</th>
<th>350 μm</th>
<th>500 μm</th>
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</thead>
<tbody>
<tr>
<td>Pixel Count</td>
<td>955</td>
<td>475</td>
<td>215</td>
</tr>
<tr>
<td>NEPy (W/√Hz)</td>
<td>16.8 E-17</td>
<td>11.0 E-17</td>
<td>7.4 E-17</td>
</tr>
<tr>
<td>Resolution</td>
<td>22”</td>
<td>30”</td>
<td>42”</td>
</tr>
</tbody>
</table>

- 30% fractional bandwidth
- 2.5 meter primary
- 340 arcmin² FOV
- 28 day cryogenic hold time
- 270mK cold stage
- 4 Readout Chs.

BLAST–TNG Gondola (sunshields not shown)
**BLAST-TNG Detector Design**

- Multilayer TiN/Ti/TiN MKIDs
  - Tuned Tc = 1.4 K
  - High Responsivity
  - Extremely Uniform
  - One Layer Fab
- Lumped element design
- Drilled Feedhorn-coupled
- Two orthogonal polarization-sensitive detectors in each pixel

b) 5 single pol. test pixel array. c) Close up shows absorbing inductor. d) Pixel cross-section.
Blackbody Load Testing

a) 10 mm

Diagram:
- LOW-PASS FILTER
- FEEDHORN ARRAY
- DETECTOR WAFER
- 100mK ADR stage

Legend:
- coax in
- coax out
Blackbody Load Testing

Photon Noise (load 0–20K)

Dark Noise (load at 3.5K)

in-flight photon noise level
Beam Profile and Polarization Efficiency

Horn-Coupled Continuous Single-Pol Antenna

Agrees with Predicted 10° FWHM

65% Pol. Efficiency agrees with HFSS
- Push to improve polarization efficiency
- Bring Y traces as close to X as possible (1 um)
- Required switch to multilayer Ti/TiN/Ti

Narrower inductor traces require thicker multilayer film to conserve sheet impedance (20 ohm/sq)
Dual Polarization Results

Responsivity

Photon Noise (0–20K)

Suggests optical efficiency ~85%
Conclusion

- Polarization efficiency measurements on deck
  - See the results in the conference proceedings
- Progressing rapidly towards full 250 µm array fabrication
- Pivot towards 350 µm and 500 µm pixel optical coupling optimization

Expected Pol. Eff. 98.2% & 97.6% For Y and X respectively