The QUIET polarization module

D1, D2: $|L \pm R|^2 = |(E_x+iE_y) \pm (E_x-iE_y)|^2 = 4E_x^2,4E_y^2 \quad \{Q\}

D3, D4: $|(L \pm R)+i(L \mp R)|^2 = |(L \pm iR)|^2 = |L|^2 + |R|^2 \mp 2\text{Im}(RL^*)$

$\text{Im}(RL^*) = \text{Im}(E_x+iE_y)^2 = 2E_xE_y \quad \{U\}$

Fast phase-switching

Simultaneous measurement of $Q$, $U$ every $250\mu s$
Drawing: Laura Newburgh
Q-band Cryostat, Platelet Array
(During Columbia Integration of Q-band Receiver)
Q-band OMTs, modules, electronics
(During Columbia Integration of Q-band Receiver)
W-band Receiver Integration at Chicago

W-band should ship in January

Slide: Bruce Weinstein
QUIET Calibration/Optimization

Q-band - modules optimized on gain and isolation. Biases adjusted automatically using downhill simplex (fast) and simulated annealing (slower, but examines broader parameter space).

W-band - modules optimized on polarization sensitivity. Biases adjusted automatically using a downhill simplex algorithm, 10 bias voltages are so adjusted; optimization procedure takes about 3 hours and 7 modules are so optimized simultaneously.

This is done at 77K; the results are then extrapolated to the Chilean sky (6-8K Q-band, 10 K W-band)

\[ Q = Q_{\text{reflected}} + Q_{\text{emitted}} \]

\[ = \sqrt{4\pi \nu \rho \varepsilon_0} (\cos \beta - \sec \beta) (T_{\text{plate}} - T_{\text{load}}) \sin(2\alpha) \]

\[ \cong 50 \text{ mK (Al) } \text{ Q-band (max)} \]
\[ \cong 250 \text{ mK (SS) } \text{ Q-band (max)} \]
### Instrument Fundamentals (QUIET Phase I)

<table>
<thead>
<tr>
<th></th>
<th>Q-band</th>
<th>W-band</th>
</tr>
</thead>
<tbody>
<tr>
<td># array elements</td>
<td>19</td>
<td>91†</td>
</tr>
<tr>
<td>Angular resolution (')</td>
<td>28</td>
<td>12</td>
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<tr>
<td>Multipole coverage (l)</td>
<td>60-450</td>
<td>60-1000</td>
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<tr>
<td>Measured $T_{\text{rec}}$ (K)</td>
<td>20-30</td>
<td>70-130</td>
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<tr>
<td>Measured BW (GHz)</td>
<td>7.5-8</td>
<td>11-16</td>
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<tr>
<td>Instrument NEQ ($\mu K s^{1/2}$)</td>
<td>65 (deployed)</td>
<td>60†</td>
</tr>
<tr>
<td>1/f knee (mHz)</td>
<td>10-100</td>
<td>50-200</td>
</tr>
</tbody>
</table>

† 19 modules currently in array with ~60 modules currently on hand. Expectation is that new modules will perform better than existing ones but below numbers assume same performance as existing 19.

‡ Projected value for 91 elements. Current value is 149 ($\mu K s^{1/2}$) with 19 elements in array. Could deploy with ~80 elements and achieve 75 ($\mu K s^{1/2}$)

Sky coverage: 4x400 square degrees

Field of View ~8 degrees

Polarization Modulation: fast phase switching, rapid scanning, sky rotation
Q-band completed receiver integrated with telescope at Caltech
Q-band completed camera, telescope, ground screen, electronics, etc. installed on the CBI mount in Atacama desert (last weekend)

- ~5000 meter (~17,000 ft.) elevation
- atmospheric transmission 0.988
- At the current CBI site, near ACT, ALMA
- Logistical support available from San Pedro de
QUIET Science Expectations (Phase I)

**E-mode power**

10 months, 50% duty

**B-mode power**

$r=0.3$

A. Kusaka