Summary

We discuss the current capabilities and instrumentation under development covering the 3mm atmospheric window from 67-115.3 GHz for the Robert C. Byrd Green Bank Telescope (GBT). The current GBT 4mm receiver operates from 67 GHz to 93 GHz and has comparable sensitivity to ALMA Cycle-1 at 84-90 GHz. Within the 3mm window below 84 GHz (ALMA has no frequency coverage below 84 GHz), no facility in the world comes close to matching the GBT sensitivity.

The development of 3mm multi-pixel cameras such as Argus and Mustang will greatly improve the spectral-line and continuum mapping capabilities of the GBT. Although ALMA will provide excellent sensitivity at sub-arcsec resolution over small areas, multi-pixel cameras on the GBT will greatly improve the available mapping speeds for large areas at 3mm. The GBT surveys will provide targets for detailed follow-up ALMA studies, and the GBT could provide sensitive short-spacing data for GBT+ALMA imaging.

Based on the 2012 portfolio review which was misguided and flawed in its understanding of radio facilities and techniques, the NSF is threatening to close the GBT. If you are interested in keeping the GBT open for astronomical research, voice your concerns to NSF and on the AUI web forum. The GBT is operated by the National Radio Astronomy Observatory and is currently a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc.

4mm Receiver

The GBT 4mm receiver is a dual feed, dual linear polarization receiver which operates from 67 – 93 GHz. The science drivers are primarily based on spectroscopic studies, but the receiver also includes a ¼ wave-plate to provide circular polarization for VLB observations.

Mustang

Mustang is a 3mm bolometer camera for the GBT. The detectors for Mustang-1.5 are 3-8x more sensitive than the current Mustang. Mustang-1.5 (available 2013) will provide similar mapping speeds to ALMA, while Mustang-2 with 332 detectors will map more than 10x faster than ALMA.

ARGUS

16 element scalable W-band FPA for the GBT

The GBT has the largest effective collecting area of any telescope on earth and a 40x wider field of view than any other facility in the world comes close to matching the GBT sensitivity. The current Mustang. Mustang-1.5 (available 2013) will provide similar mapping speeds to ALMA, while Mustang-2 with 332 detectors will map more than 10x faster than ALMA.

CASA Simulations

The panels below show CASA simulations comparing GBT, ALMA, ACA, and ALMA+ALMA+TP data sets. Ideally for good image reconstruction, one should use short-space data from a single dish that is at least 2 times the size of the shortest interferometric baselines. This points to the usefulness of the GBT for many ALMA 3mm and VLA programs.

GBT vs ALMA Sensitivity: Estimated Observing Times

<table>
<thead>
<tr>
<th></th>
<th>GBT (1 pixel)</th>
<th>GBT/ARGUS (16 pixel)</th>
<th>GBT (100 pixel)</th>
<th>ALMA (1&quot;)</th>
<th>ALMA (5&quot;)</th>
<th>ACA (62&quot;)</th>
<th>ALMA-TP (3&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rms=1mJy</td>
<td>2.5min</td>
<td>2.5min</td>
<td>2.5min</td>
<td>12min</td>
<td>12min</td>
<td>5hr</td>
<td>3hr</td>
</tr>
<tr>
<td>Rms=2mJy</td>
<td>2.5min</td>
<td>2.5min</td>
<td>2.5min</td>
<td>12hr</td>
<td>12min</td>
<td>6min</td>
<td>3min</td>
</tr>
<tr>
<td>Map 3&quot;x3&quot; with 1mJy/beam</td>
<td>18hr</td>
<td>69min</td>
<td>12min</td>
<td>59min</td>
<td>59min</td>
<td>80hr</td>
<td>27hr</td>
</tr>
<tr>
<td>Map 3&quot;x3&quot; with 5mJy/beam</td>
<td>18hr</td>
<td>69min</td>
<td>11min</td>
<td>6000hr</td>
<td>9hr</td>
<td>96min</td>
<td>27hr</td>
</tr>
</tbody>
</table>

The table above shows the observation time needed to reach 1mJy/beam (point-source sensitivity) and 2mJy (extended-source sensitivity) for a 100km/s spectral line at 89 GHz using the GBT (9") resolution with a different number of W-FPA "pixels" compared with ALMA, ACA, and ALMA-total-power mode. The GBT+ARGUS provides similar mapping speeds as ALMA, and an 100 pixel W-FPA could map 3mm spectral-lines much faster than ALMA.