Specifications for the W′-band Focal Plane Array

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1. Introduction

The W'-band Focal Plane Array (W′-FPA) is a proposed large-element spectroscopic focal-plane array at 3mm (W-band) for the Robert C. Byrd Green Bank Telescope (GBT). The scope of this memo is to layout the basic requirements of the instrument.

2. Specifications

1. Frequency range: 84–115.3 GHz. This frequency range matches ALMA Band-3 and reaches the ^{12}CO$(1-0)$ transition at the high-frequency end of the band. Coverage at lower frequencies would be highly beneficial, if possible (e.g., 67—115.3 GHz). The system should be optimized at around 90 GHz, corresponding to the transitions of the important dense gas tracers.

2. Receiver temperature: $\lesssim 60$ K from 86 – 94 GHz and $\lesssim 80$ K outside the central band.

3. Array footprint: 2–5′. A size scale of a few arcminutes efficiently maps the typical science targets, such as nearby galaxies and cloud cores.

4. Feed separation: $\lesssim 30''$. This is approximately $\sim 3\times$ the HPBW at lowest frequency of the band.

5. Number of feeds: ≥ 8, but the system should be scalable up to of order 100 elements.

6. Single linear polarization per feed. Most science applications would benefit from more feeds rather than from fewer feeds with dual polarization. The theoretical sensitivity gain associated with dual polarization is typically not fully achieved in practice. The feeds could be alternated with opposite linear polarizations to enable polarization mapping.

7. Instantaneous Bandwidth: ≥ 1 GHz per feed. Additional bandwidth would be highly beneficial. The minimum 1 GHz bandwidth is needed for observations of broad extragalactic lines. If the system is limited by the accumulative amount of the IF bandwidth from all feeds, a system that could configure some feeds with more bandwidth than others would be beneficial for some experiments.

8. Optical Isolation (between beams): $\gtrsim 15$ dB
9. Electronic Isolation: > 25 dB
10. Relative calibration between elements reproducible to better than 5%.
11. Supported observing modes:
    - Spectroscopy with the standard spectrometer setups
      - Position switching
      - Frequency switching
      - SubBeamNod
      - On-the-fly mapping
    - Total power detection with the DCR