

Filters for the GBT Array

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1. Optical Design

The cold optics for the GBT uses 2 planar/convex silicon lenses to refocus the $f/1.94$ beam onto the 8×8 array of TES detectors with an $f\#$ of 1.62. The first lens is cooled to 40 K, the second to 3 K. The detectors must be cooled to <0.3 K. No feed horns are used so the bandpass of the receiver is defined by filters. A schematic of the optical design is shown in Figure 1.

In the current design there are 3 locations for filters; one at 40K entrance to the cold optics box (partly to reduce loading on the 40K cryogenics), one at the Lyot stop, and a band defining filter at 0.3 K above the array. The clear and edge apertures needed/possible are given in table 1. Because of the unknown atmosphere at Green Bank the ability to add a neutral density filter at 40 or 3 K may be needed.

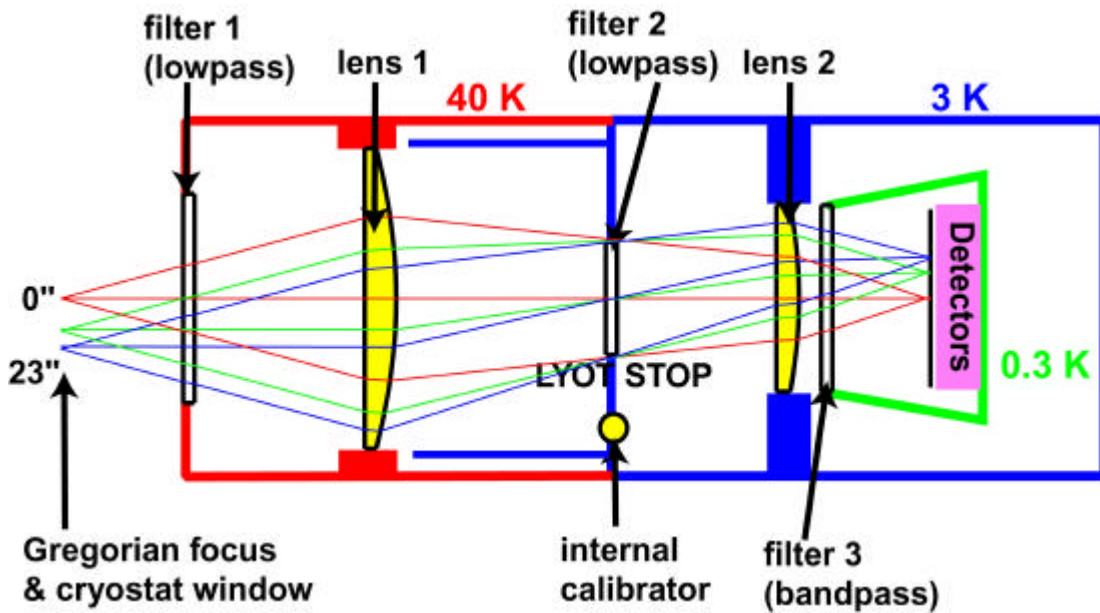


Figure 1: The cold optics & filter locations. All the optics are enclosed in a light-tight tube (represented by the red, blue, and green lines) painted black on the inside. The optics is drawn to scale.

Filter location	Minimum clear aperture	Suggested edge aperture
40 K	90 mm	100 mm
3 K (Lyot stop)	47.6 mm (exact)	100 mm
0.3 K	80 mm	90 mm

Table 1: The clear apertures needed. These are set to 130% of the clear aperture needed to admit all rays that can hit the detectors.

2. Specifications

A filter system needs to be designed with the following properties:

- Commissioning Bandpass : 86 to 94GHz
- Out-of-band transmission
 - Less than 1% of total power.
 - Less than -30dB averaged over 10GHz intervals
 - No leaks above -15dB
- In-band transmission should be as high as possible.
- Keep optical loading on the cryogenics to less than 100 mW @ 40 K, 10 mW @ 3K, and 5 μ W @ 0.3 K.
- Keep optical loading from the telescope on the detectors (3.3 \times 3.3 mm squares) below 1 pW.

The location of the bandpass filter in the design in figure 1 is important. Without this filter at .3K loading from within the 0.3K Lyot stop cavity would saturate the bolometers. In order to keep the load on the detectors down it is important that this filter is effective at angles over 45° off-axis.

The silicon lenses can also act as filters, cutting all radiation off in the IR & optical regions.