



# A 90 GHz array

For the

# Green Bank Telescope

(GBT)

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**NRAO (Green Bank)**  
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**NIST**

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# Our receiver will have:

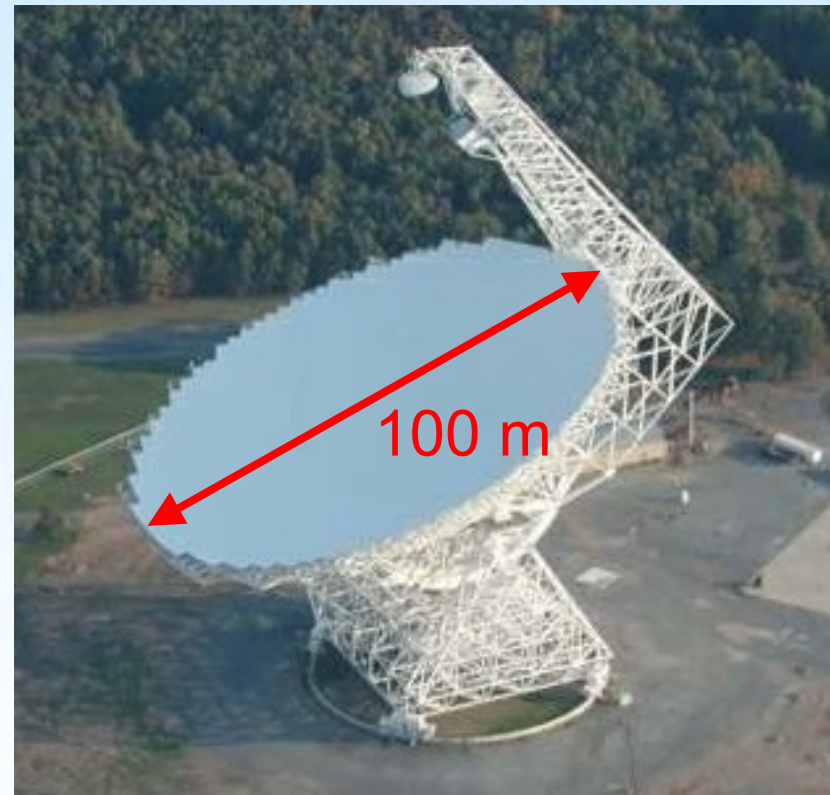
- An 8×8 array of TES bolometers (I01 D.Benford)
- Time-division SQUID multiplex readout (E01 K.Irwin, E05 W.Doriese)
- An 8 arcsecond beam size
- Sensitivities of :  $970 \mu\text{Jy}/\sqrt{\text{Hz}}/\text{detector}$  (with a 86-94 GHz bandpass.)

It will be a facility instrument on the Green bank Telescope.



# The Green Bank Telescope

- Off-axis Gregorian design
- 290 MHz to 100 GHz
- Active surface
  - 0.24 mm surface RMS
  - (36% surface efficiency)
- 90 GHz effective area :  
2500m<sup>2</sup>



First light August 22<sup>nd</sup> 2000



# The Green Bank Telescope

- Multi frequency capability : 8 + 1 receivers



# The Cryogenics.

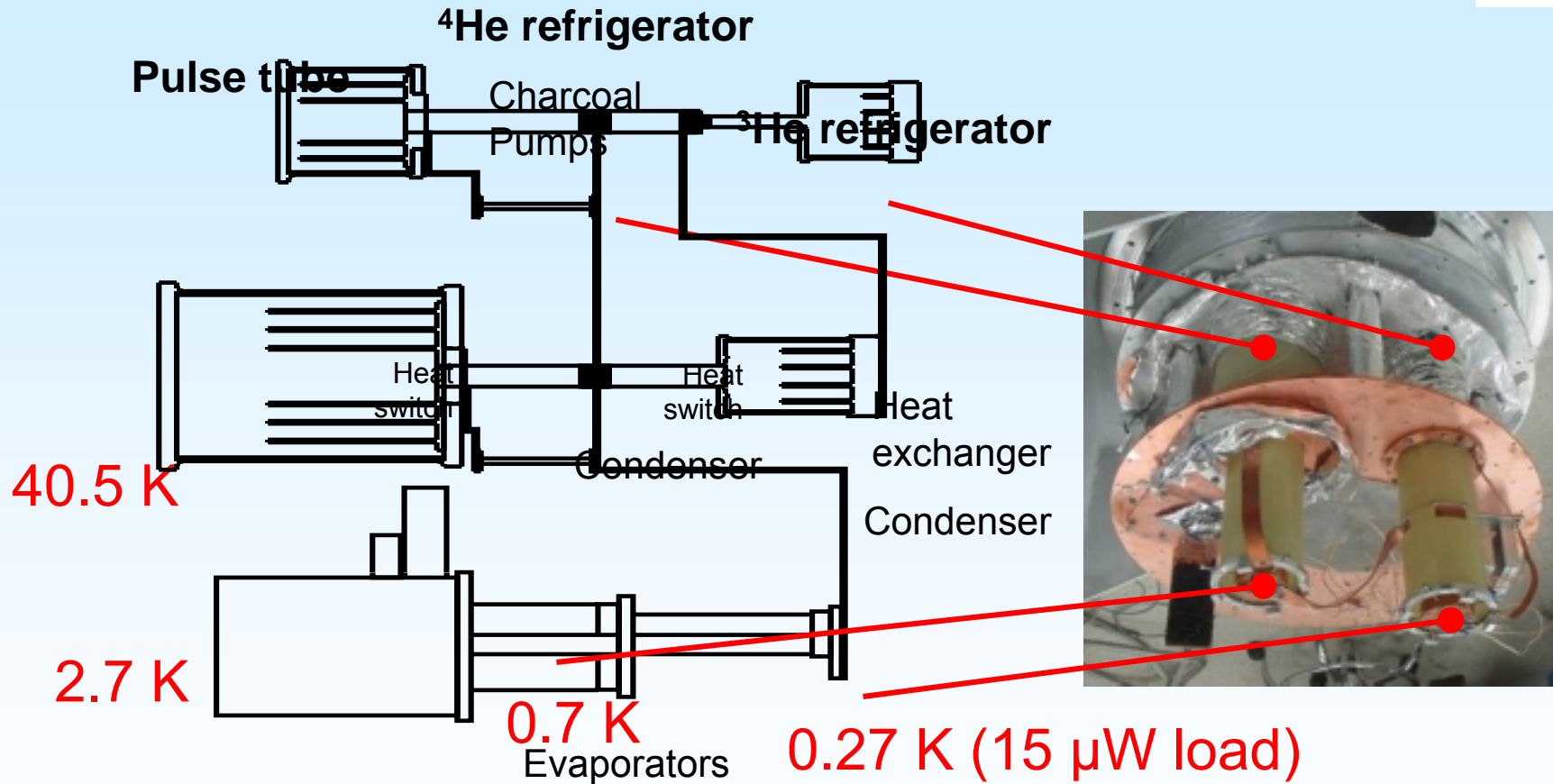


## Requirements :

- Closed cycle cooling to  $< 290$  mK with loads up to  $15 \mu\text{W}$
- Hold times  $> 24$  hours;  $> 90\%$  duty cycle
- Operational up to  $57^\circ$  from the vertical
- Can recover from  $72^\circ$  tilts within 1 hour



# The Cryogenics.

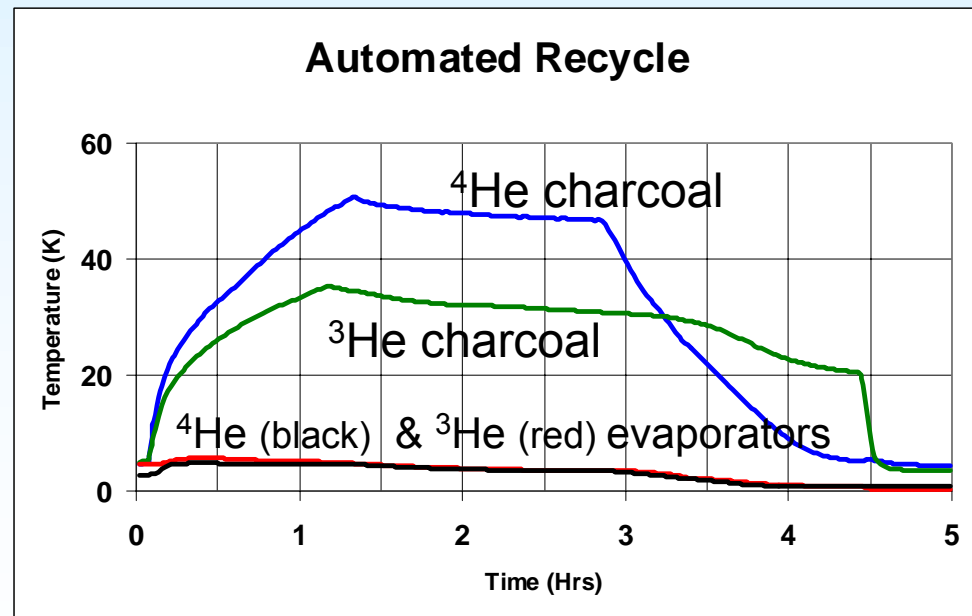


A helium-7 system cycles off a PT405 pulse tube.



# The Cryogenics.

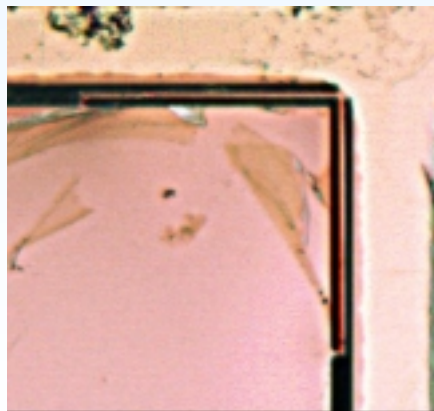
- Base Temperature 250 mK
- $^3\text{He}$  hold time 72.7 hours (15  $\mu\text{W}$  load)
- $^3\text{He}$  stage stable down to 57°
- Computer controlled cycling in 4.5 hours:  
(Limited by the capacity of the pulse tube)





## Our TES bolometers:

- Power per detector 1.2—2.6 pW (telescope & sky)
- Saturation power of detectors : 8 pW
- Photon NEP  $1.8—2.7 \times 10^{-17}$  W/ $\sqrt{\text{Hz}}$
- Total NEP  $2.3—3.0 \times 10^{-17}$  W/ $\sqrt{\text{Hz}}$  (for 86-94 GHz band)
- Mechanical models have been made:

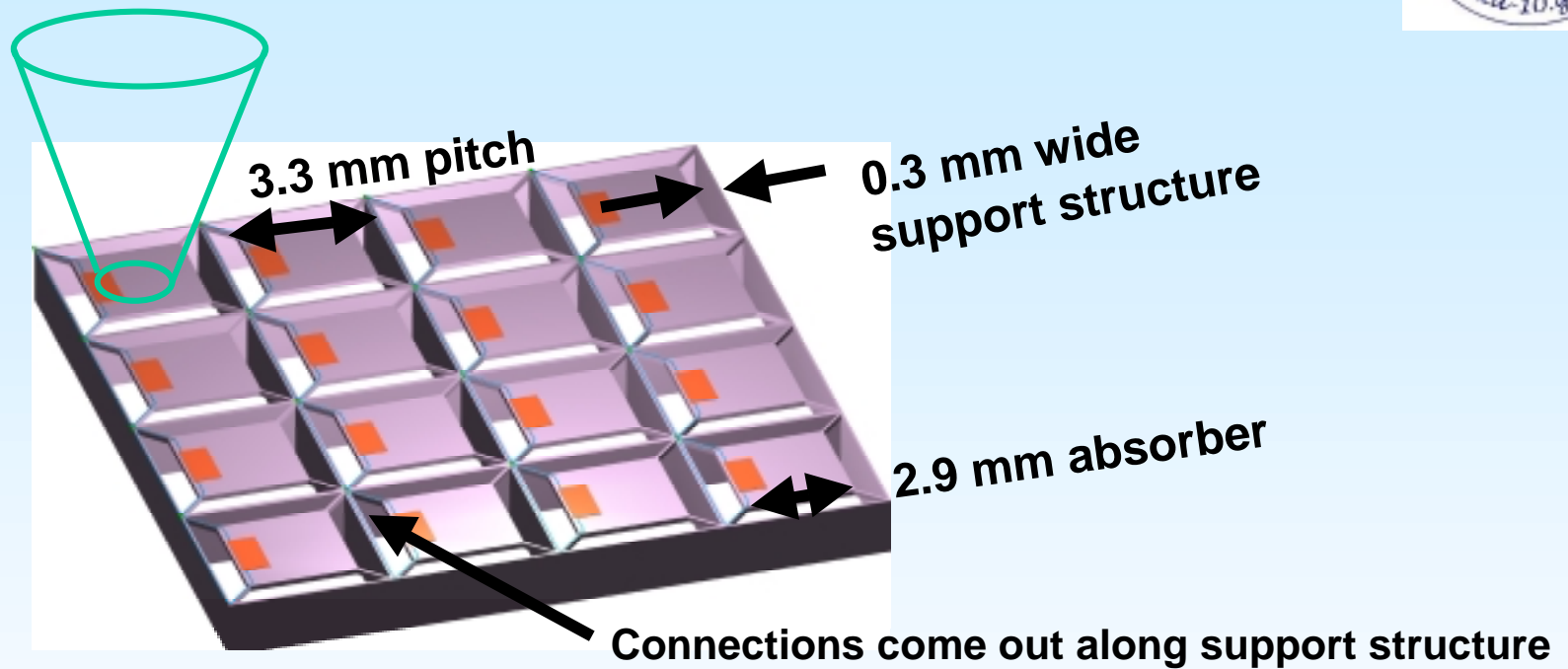


Close-up of corner



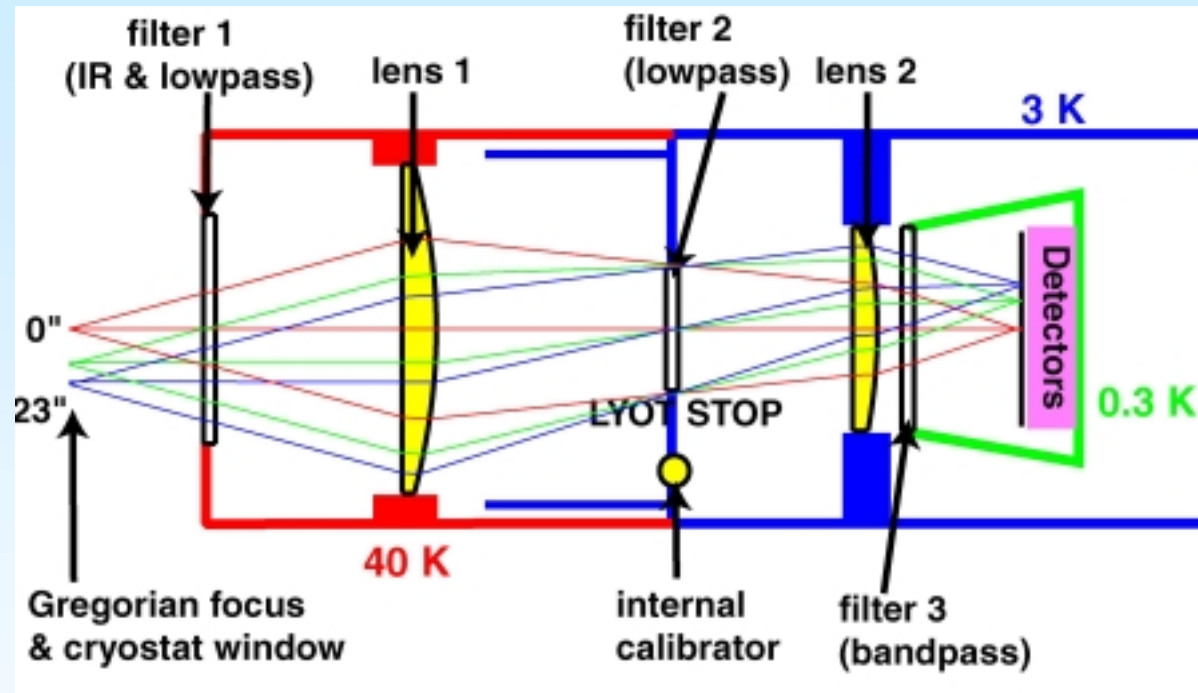


# We will have bare planar arrays:



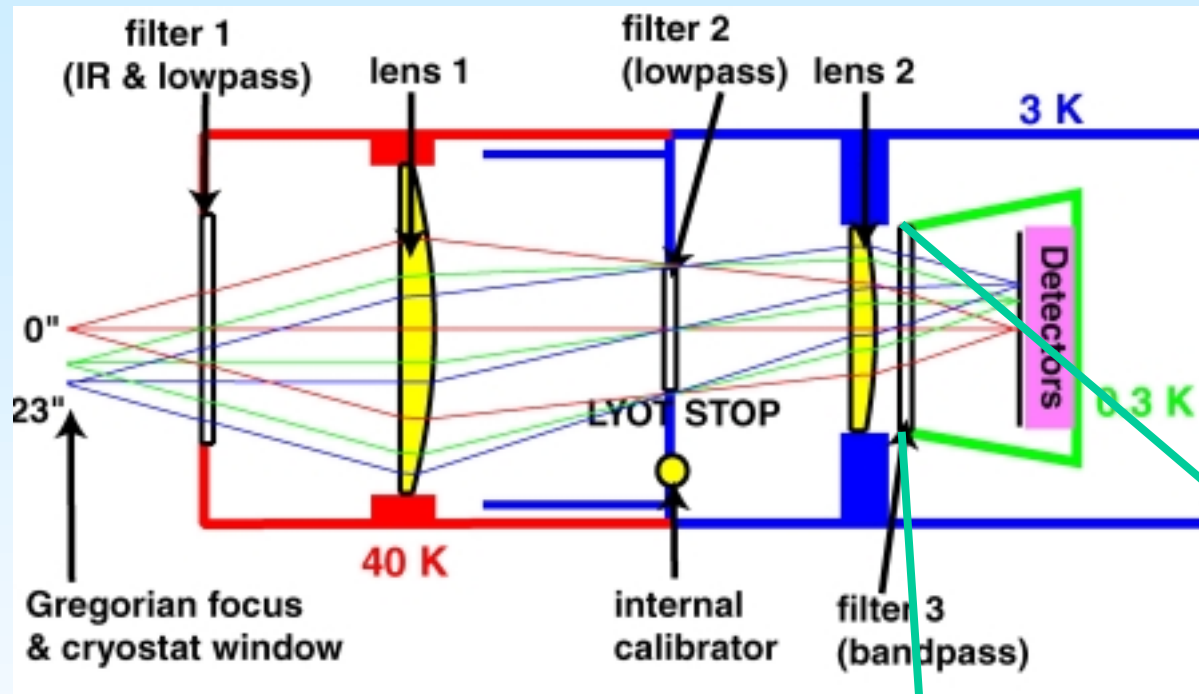
- We require a fully sampled focal plane
- Feed horns can not be used.
- Care must be taken to control loading.

# Optics

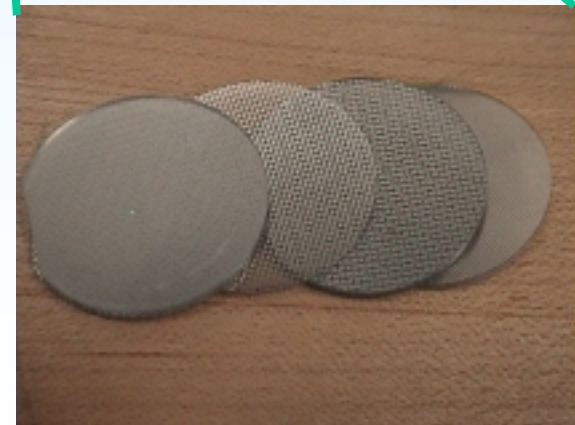


- For  $0.5f\lambda$  spacing  $f/1.62$  beams are needed
- Aspheric silicon lenses give good off-axis image quality
- Anti-reflective coatings & careful design keep down ghosting

# Optics



- Filters define a 86—94 GHz bandpass



# Conclusions



## Done so far:

- Developed & tested a dry cryogenics system
- Designed cryostat & optics
- Decided on detector parameters

## To do

- Build the final cryostat
- Build & test the detectors
- Write user software (operational & analysis)
- Map 15'×15' areas of the sky to 0.25 mJy in 1 hour  
(winter 2004)