Noise Comparison, Open vs Crossed Dragone

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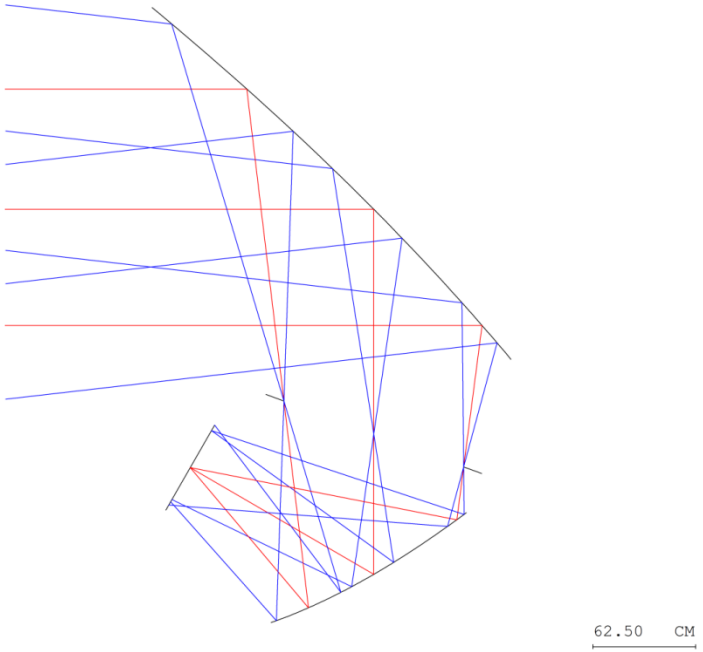
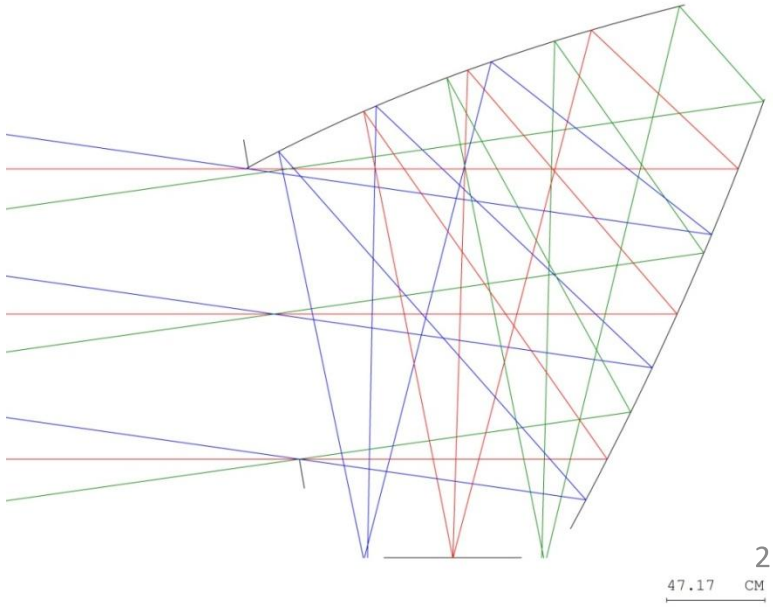
Noise Comparison

- Goal: compare loading and white noise levels between Open Dragone and Crossed Dragone with full focal plane.

- Open Dragone
  - 30 K primary, 4 K stop, 4 K secondary
  - 10 dB edge taper



- Crossed Dragone
  - 30 K primary, 30 K stop, 30 K secondary
  - 25 dB edge taper



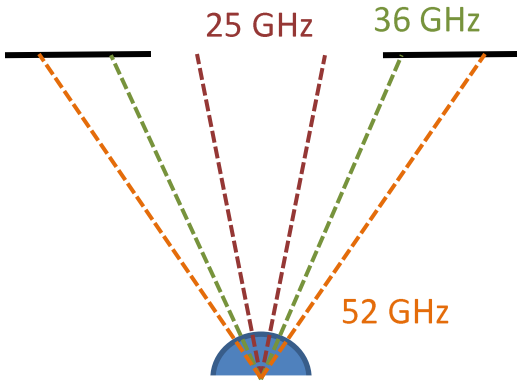
Status

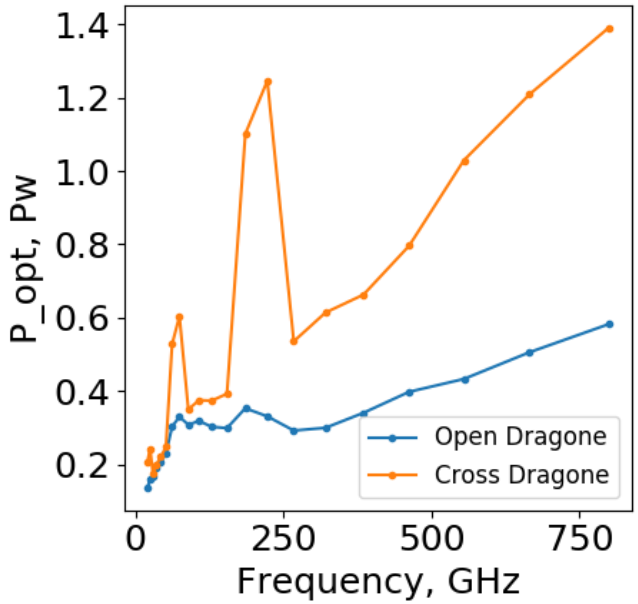
- Multichroic pixels added, beam $1/e^2$ angle is: $\theta = \frac{2.95\lambda}{\pi D}$
- Comparison between bath temperatures, 250 vs 100 mK.
- Diffraction limited field of view and number of pixels calculated.
- Polarization weight estimated from white noise level

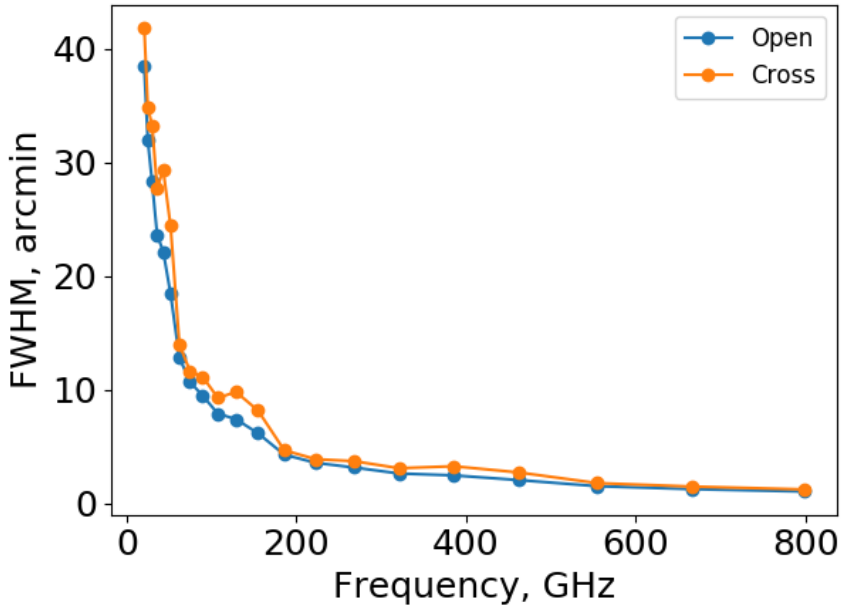
- Next steps:
  - Update readout noise to reflect new ICE boards
  - Investigate effect of stop temperature
  - Optimize pixel size
  - Add thermal filters to light path
  - Compare with O'Brient's TDM model

Multichroic pixels

- Multichroic pixels have been added to the model.
- Three bands per pixel so illumination of the stop changes and edge taper varies with band.
- Optical load no longer increases smoothly with frequency.
- FWHM does not decrease smoothly with frequency.

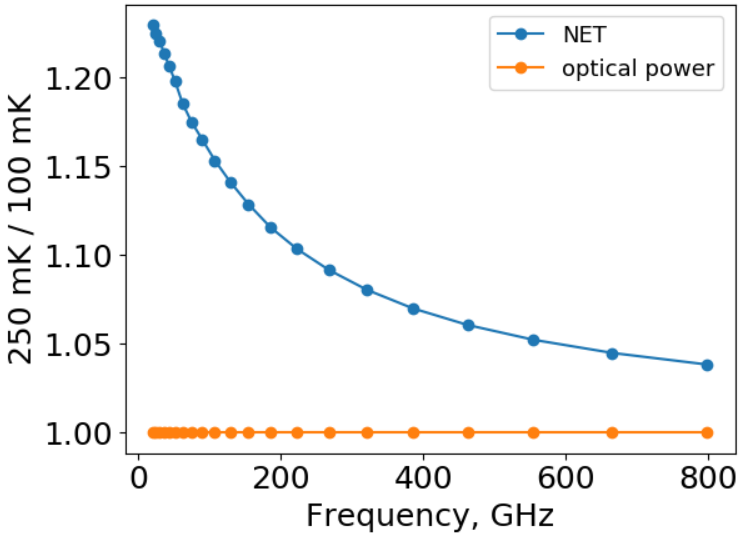


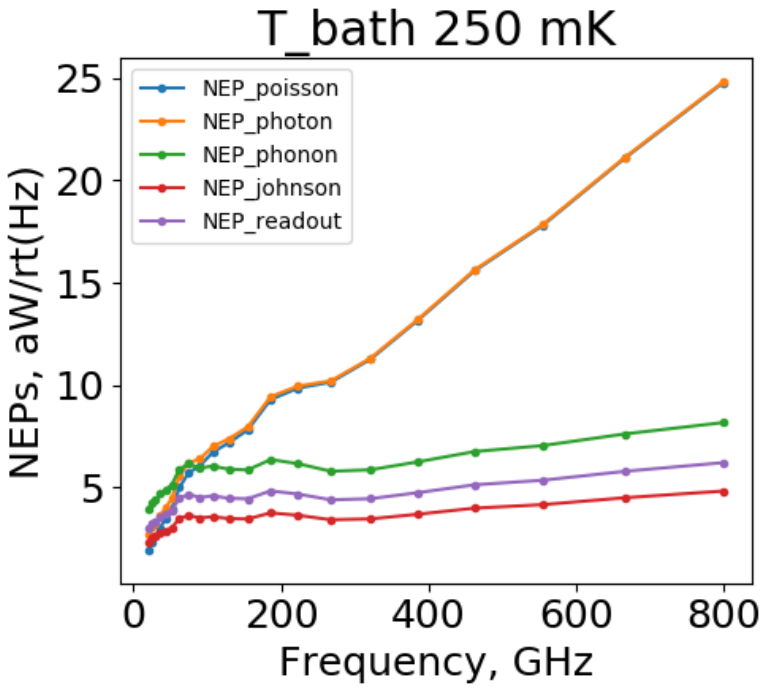


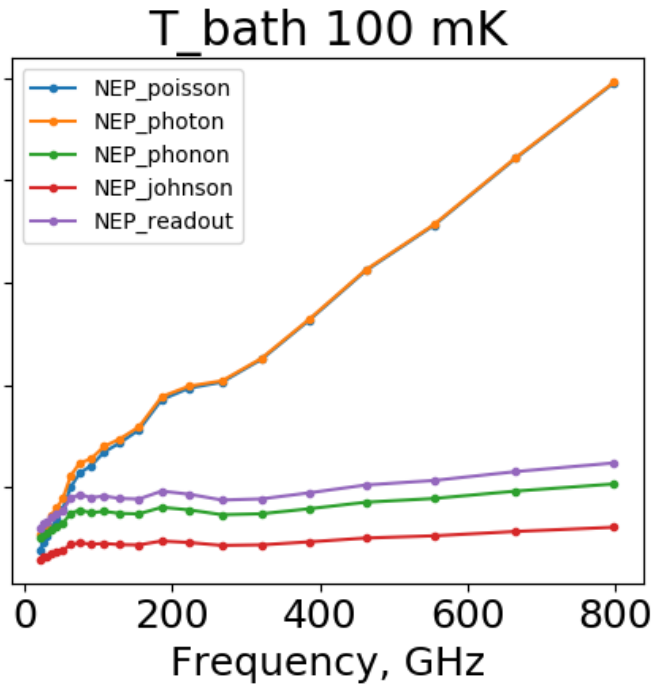


Changing T bath to 100 mK

- Reduced T bath, reduces phonon and Johnson noise by sqrt(250/100).
- Effect on NET is largest at the lowest frequency.







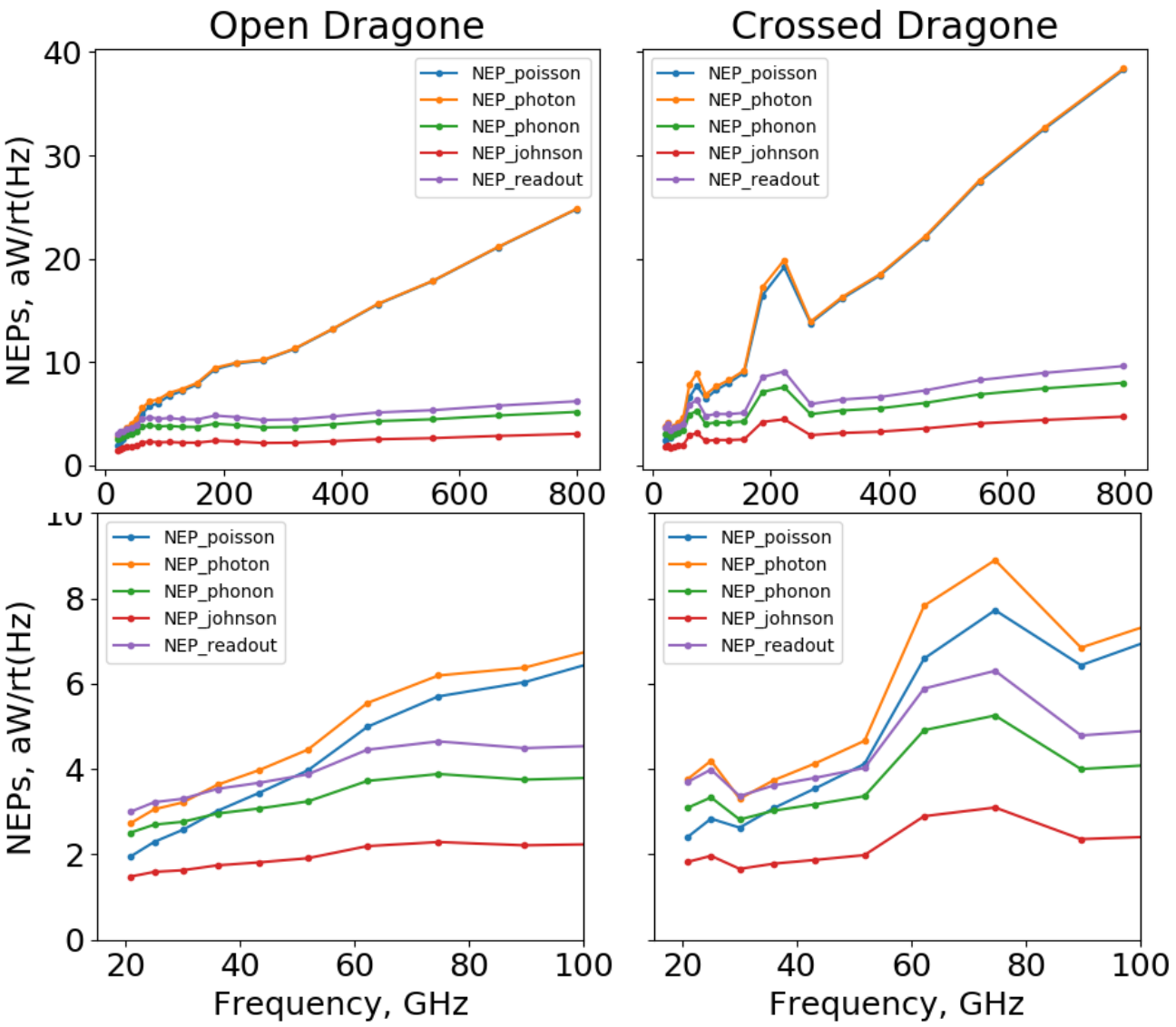
Noise Comparison, NEPs

T bath = 100 mK

Open edge taper = 10 dB

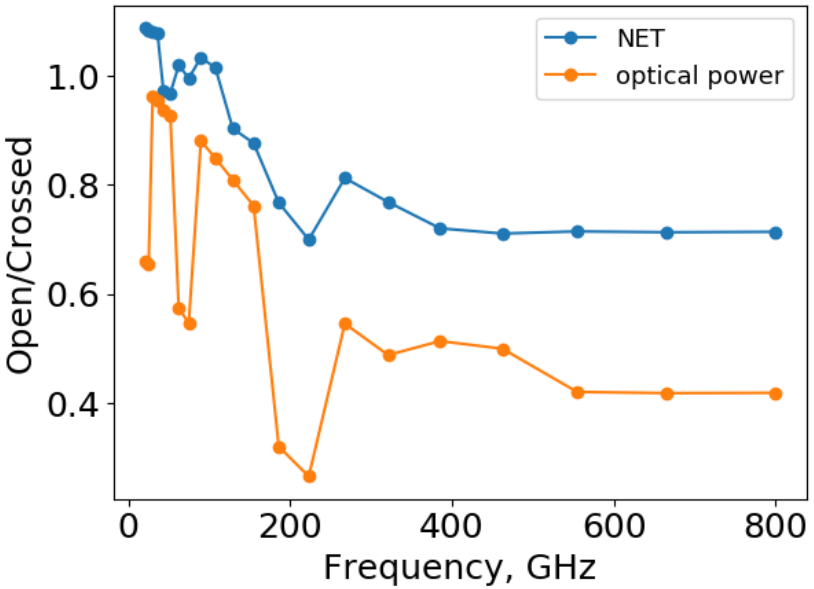
Cross edge taper = 25 dB

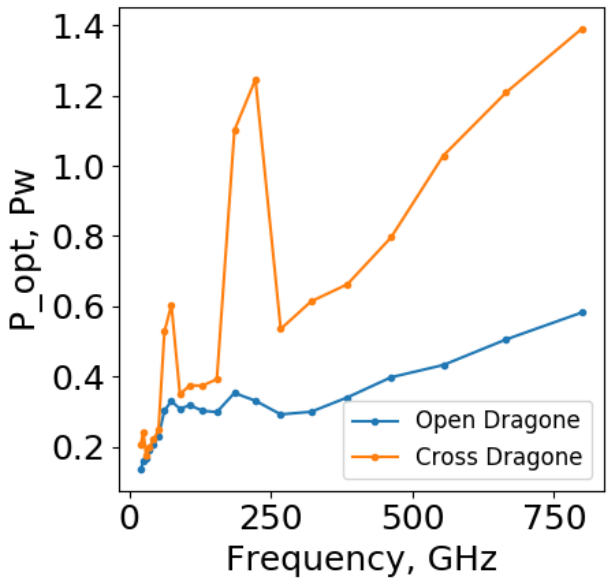
Multichroic pixels

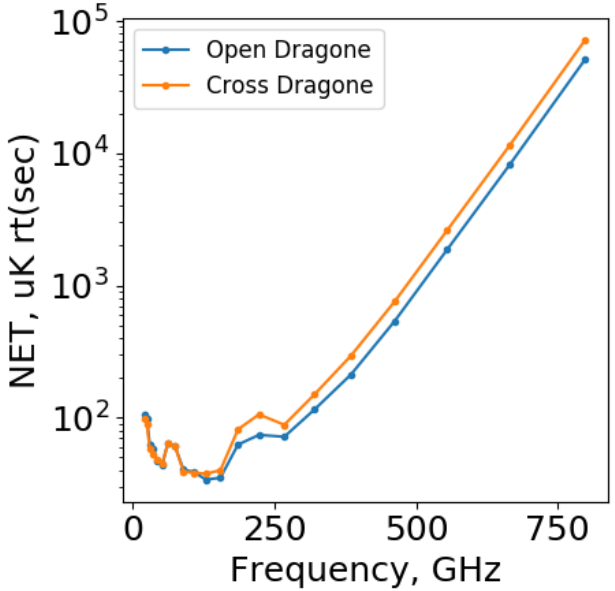


Noise Comparison, NETs

- Open has lower loading and therefore lower NEPs with the largest difference at high frequencies.
- Crossed is more efficient (0.5% spillover vs 10%) which improves NET.
- The sharp jumps are due to illumination changing with frequency due to multichroic pixels.



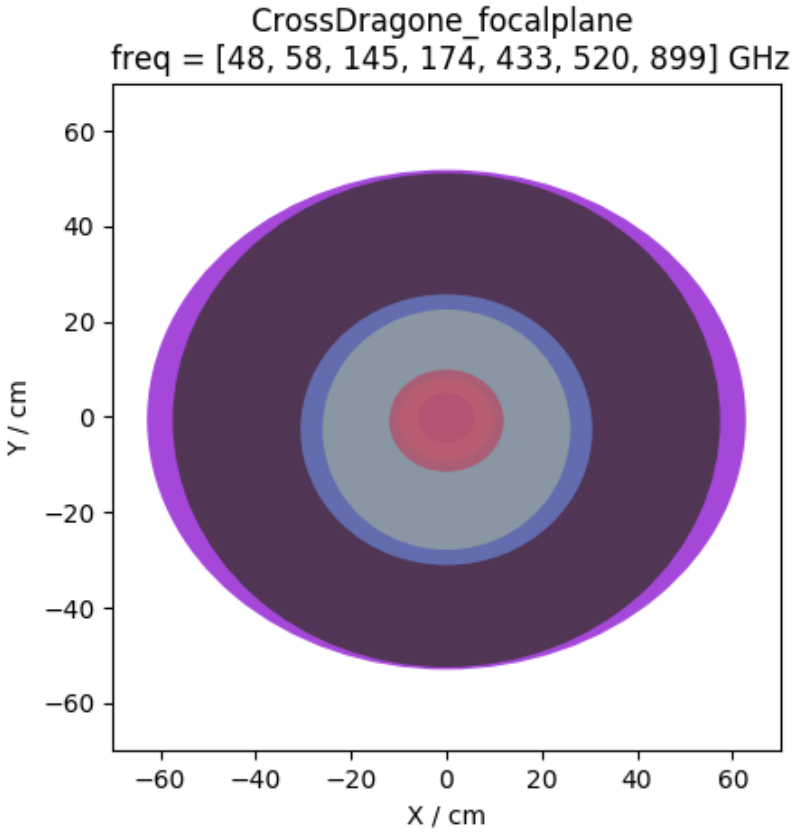


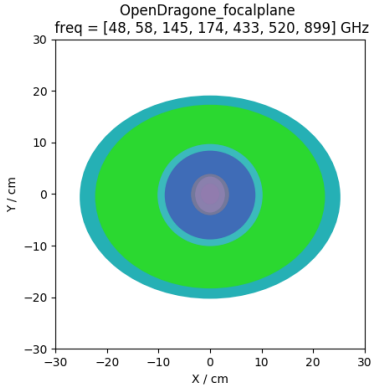


DLFOV for Crossed and Open

- Diffraction limited field of view (DLFOV) is defined as where Strehl > 0.8 at a given frequency.

- Crossed has larger DLFOV, but also larger pixels.
  - F-number 2.14 vs 1.5
  - edge taper 25 dB vs 10 dB





Scale roughly equal between plots!

DLFOV for Crossed and Open

- Comparison in terms of Fλ
  - Open has 50% the diameter of crossed
    - Due to open vs crossed (ratio of 75%)
    - Stop placed between primary and secondary (further 20% reduction)
      - Details in Qi Wen's presentation on today's wiki page.

Frequency (GHz)	Average Diameter (Fλ)		Ratio Open/Crossed
	Open	Crossed	
48	48.0	86.7	0.56
58	51.7	98.7	0.52
145	64.8	133	0.49
174	667.3	139	0.48
433	74.1	153	0.48
520	74.0	153	0.48
899	75.9	154	0.49

Populating a focal plane

- Number of pixels calculated from:
  - Available DLFOV area
  - Pixel size
  - Hex packing factor of 0.9069
- Physical focal plane NOT laid out.
- Full sky and 4 yr mission at 100% observing.
- Crossed does better at most frequencies.
- Crossed: 21k detectors
- Open: 13k detectors

Pixel type	Bands (GHz)	Px diameter (mm)		Px count	
		Open	Crossed	Open	Crossed
A	20.8, 30, 43.2	31.3	69.4	120	148
B	25, 36, 51.8	26.1	57.8	250	340
C	62.2, 89.6, 129	10.5	23.2	280	400
D	74.6, 108,155	8.7	19.3	420	600
E	186, 268, 385	3.5	7.8	460	800
F	223, 321, 462	2.9	6.5	440	780
G	555	1.7	3.8	180	380
H	666	1.4	3.1	160	380
I	799	1.2	2.6	140	380