

Baseline and 50 cm systems

October 10, 2017

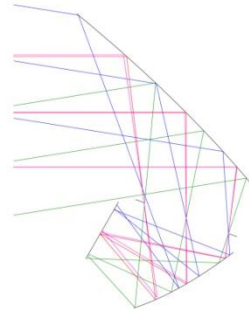
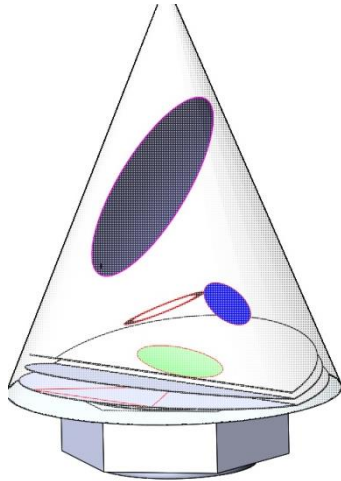
Karl Young, Shaul Hanany, Qi Wen, Xin Zhi
Tan

Status of Optical Systems

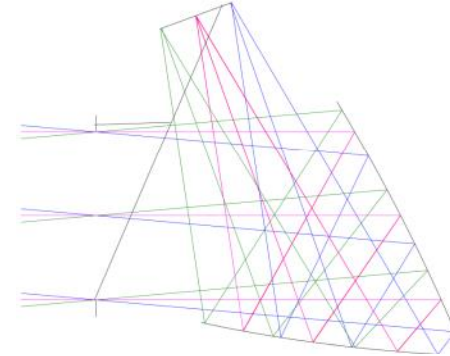
Open

Crossed

Large

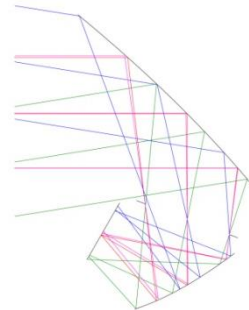
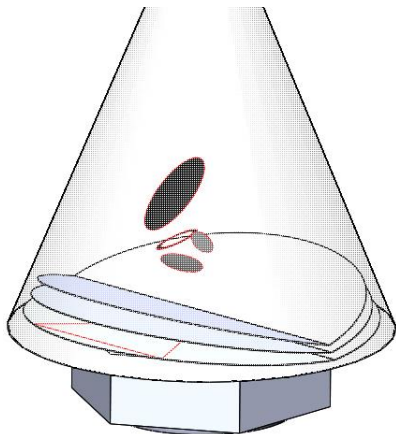


Baseline, Version 2.5
1.4 m
Baffling works
Packs in envelope
Noise, weights calculated

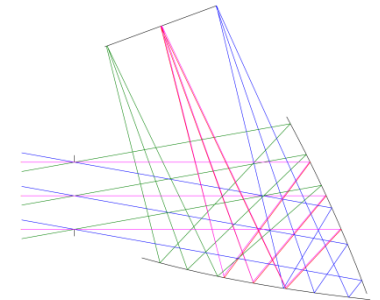
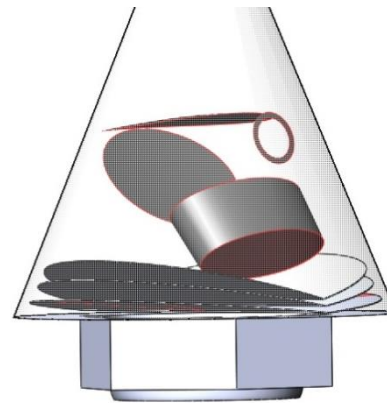


1.2 m
Focal plane views sky
Under investigation

Small,
50 cm



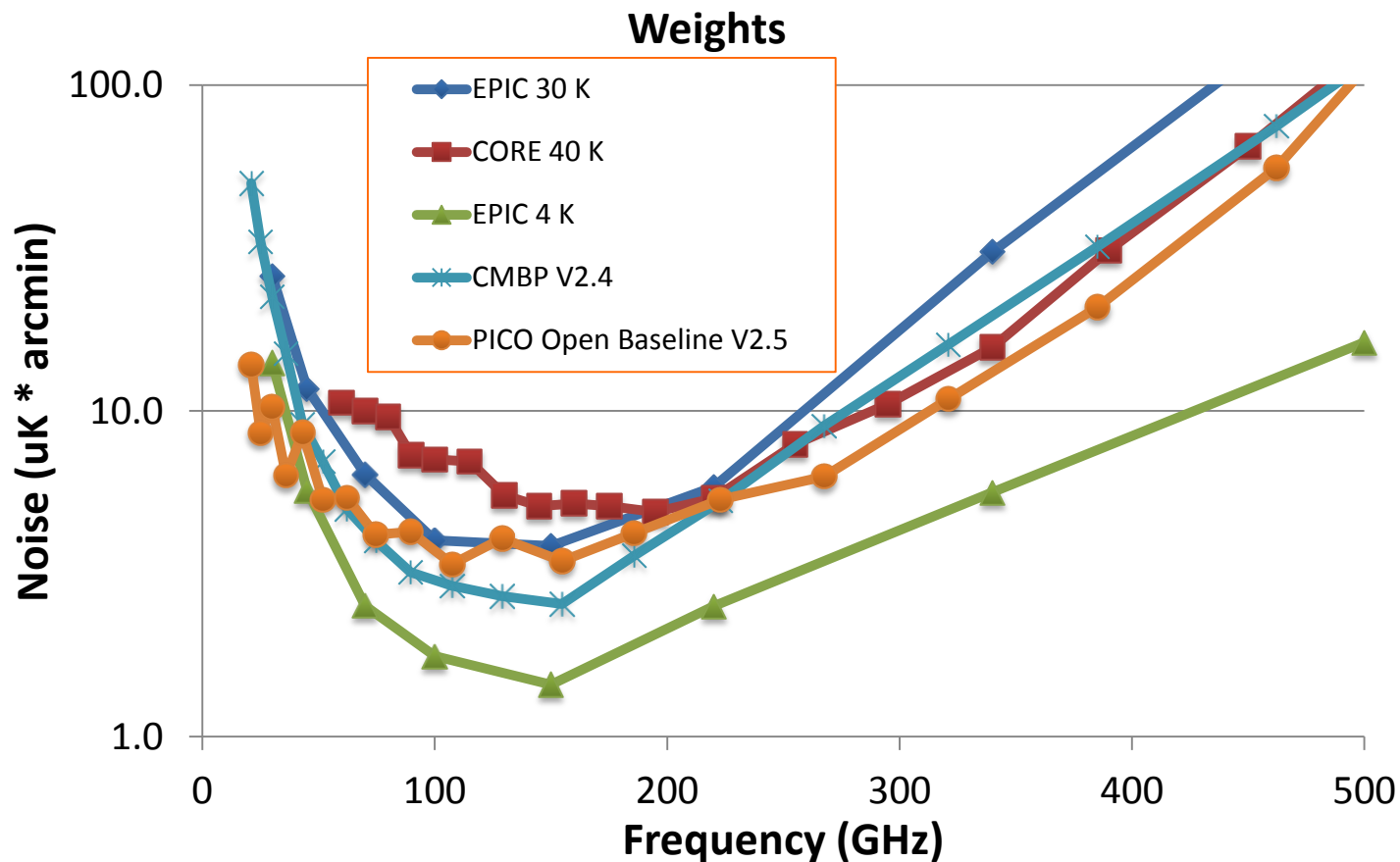
Baffling works
Packs in envelope
Noise, weights calculated
Completely 4K version
30 K primary version



Baffling works
Packs in envelope
Noise, weights calculated
Completely 4K version
Completely 30K version

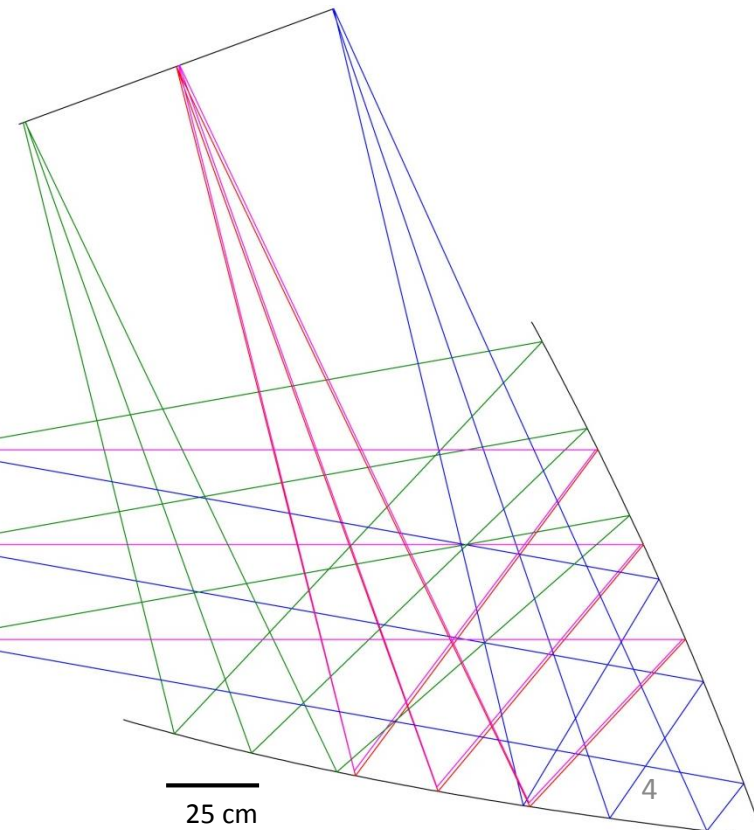
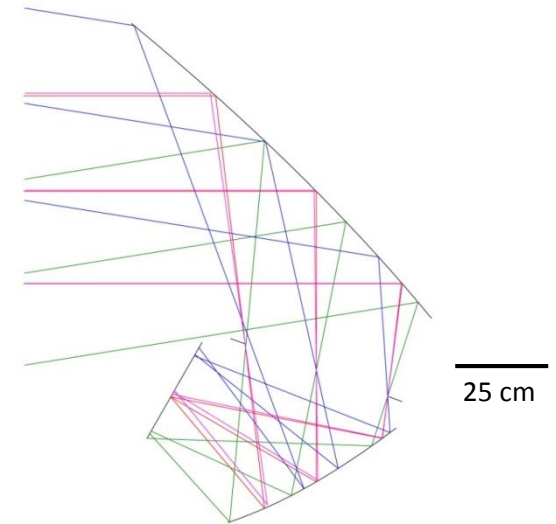
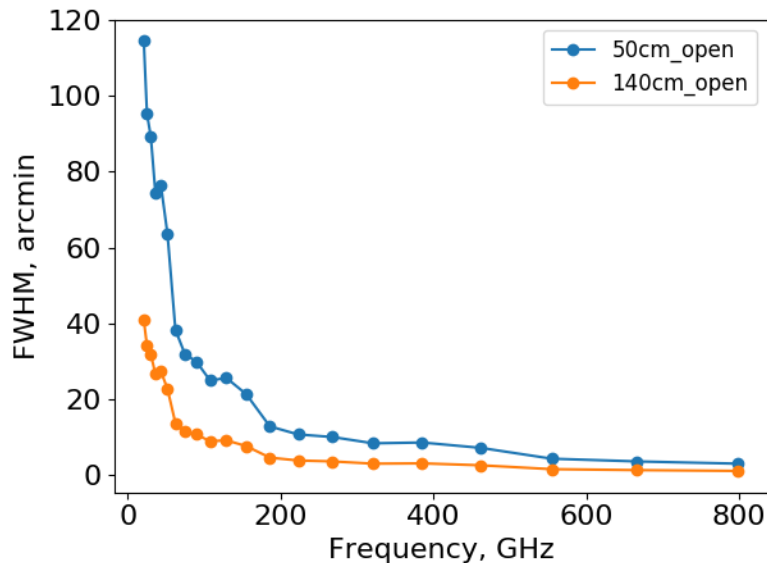
Baseline, Open Dragone

- We've set a baseline version as the 140 cm Open Dragone.
 - Pixels and bands are chosen, 21 - 800 GHz in 21 bands
 - NET and polarization weights are calculated
 - Numbers are posted to wiki in [BandDefinition Large V2.5](#)
 - Scan angles of $\alpha = 22$, $\beta = 73$ degrees



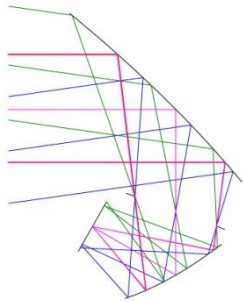
50 cm Dragones

- Reducing both systems to 50 cm aperture
 - Open, 50 cm aperture, F/1.5, FOV = ± 13 , ± 8 deg.
 - Corss, 50 cm aperture, F/5, FOV = ± 20 , ± 10 deg.
- Compared to 140 cm Open Dragone
- If all mirrors are cooled to 4 K
 - Per pixel NET is better, offsetting the smaller number of pixels
 - Polarization weight is similar at CMB bands, better at high frequency, worse at low frequency
- If primary is kept at 30 K
 - Per pixel NET is unchanged
 - Fewer pixels mean worse sensitivity
- Biggest difference is resolution, FWHM 3x lower



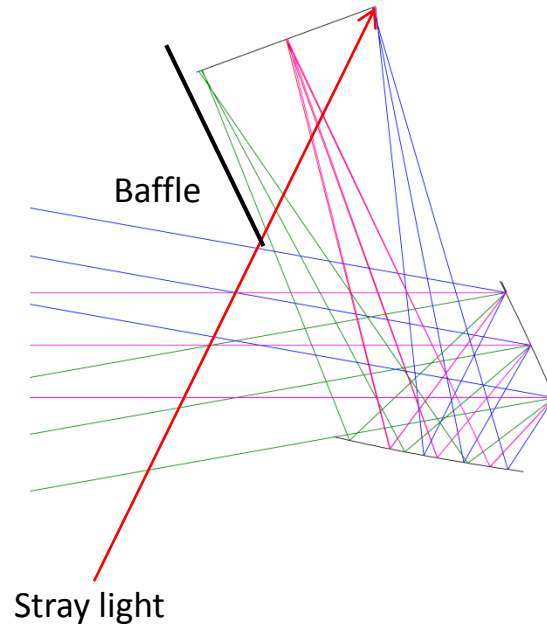
50 cm Dragonos

Open, $F\# = 1.5$



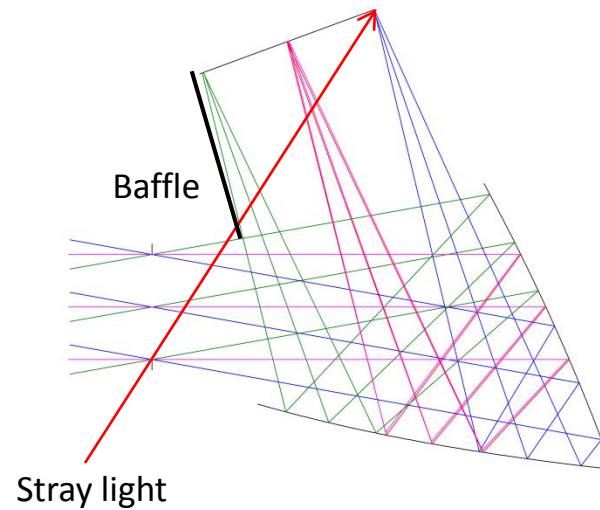
50.00 CM

50 cm Cross, $F\# = 5$
Stop at primary



50.00 CM

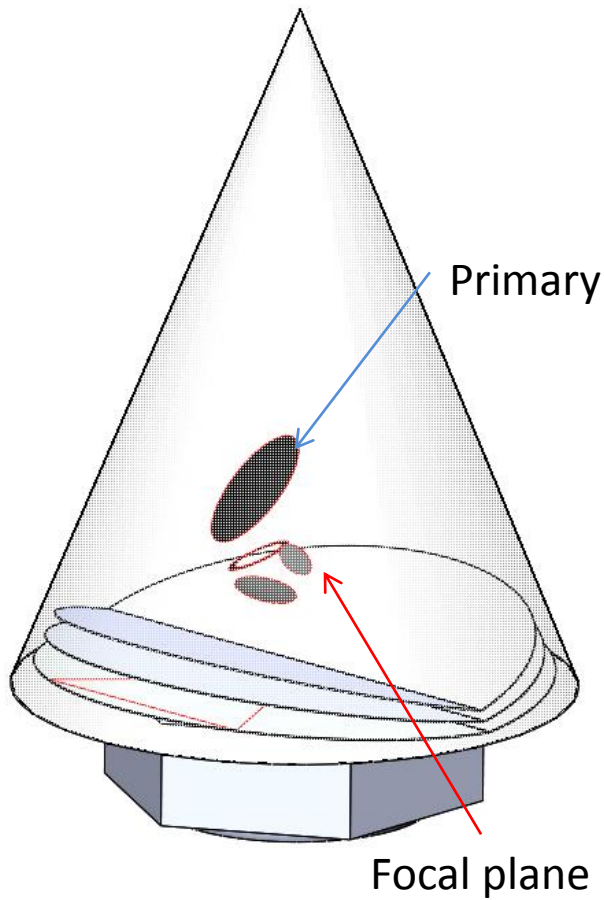
50 cm Cross, $F\# = 5$
Stop in front



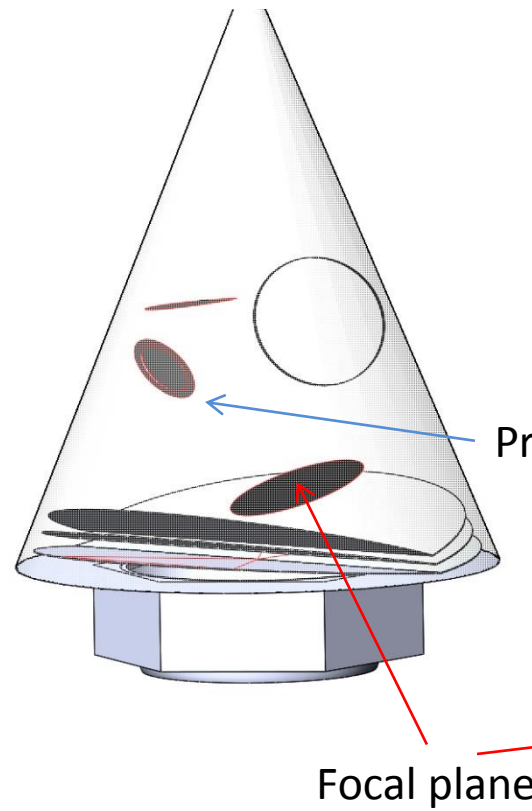
50.00 CM

50 cm Dragonos

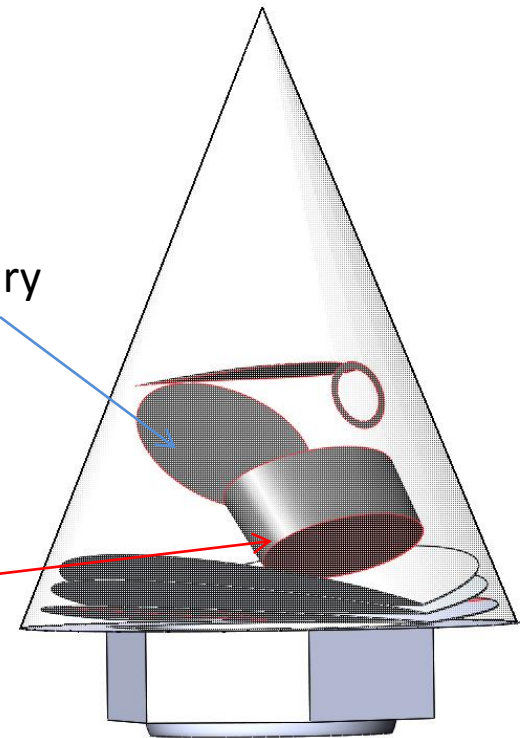
Open, $F\# = 1.5$



50 cm Cross, $F\# = 5$
Stop at primary

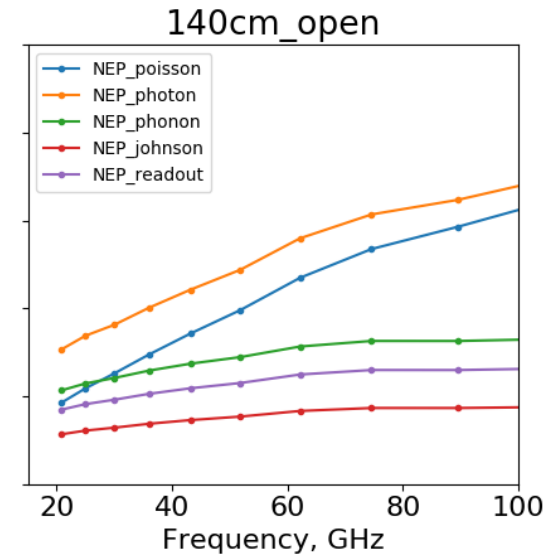
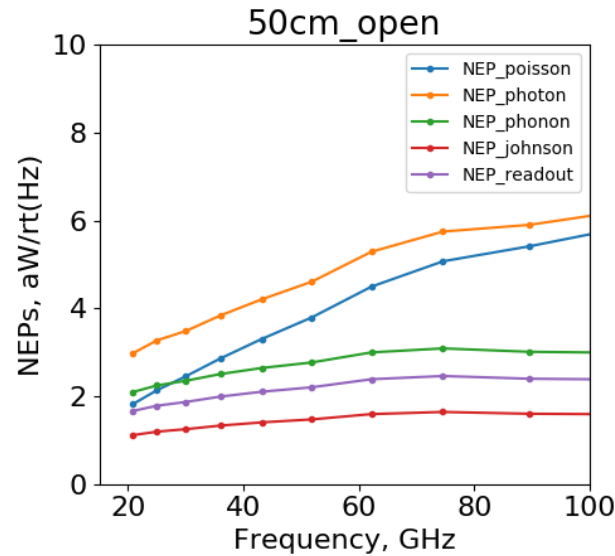
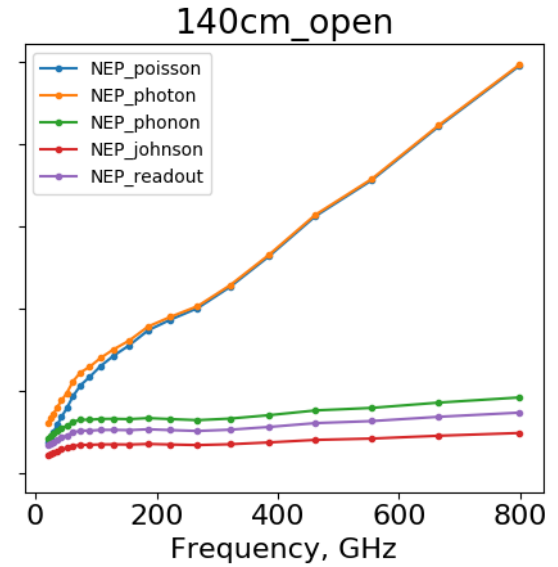
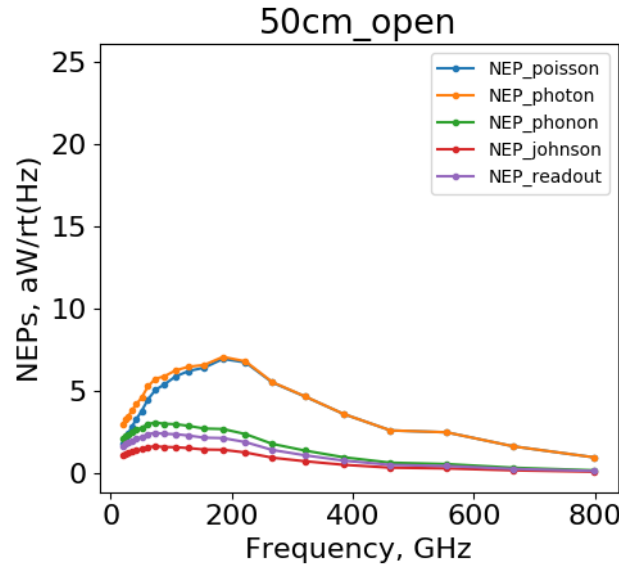


50 cm Cross, $F\# = 5$
Stop in front



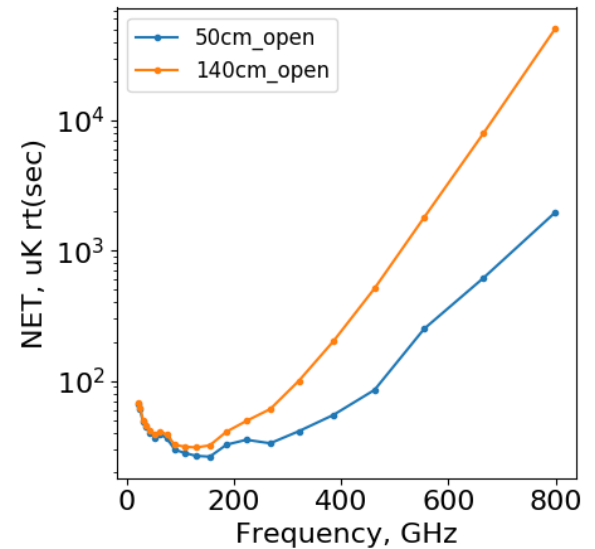
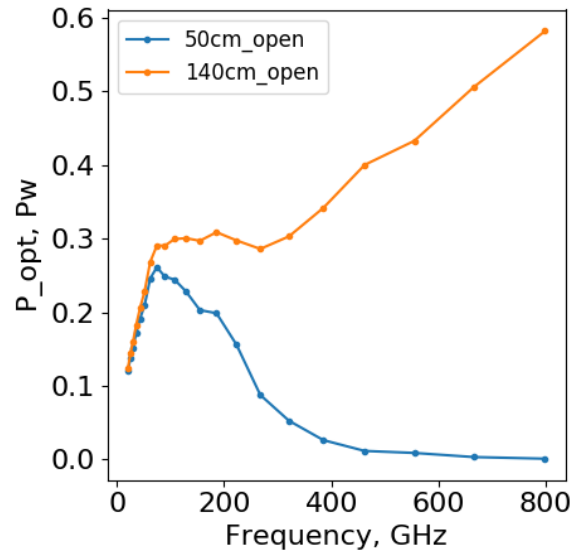
50 cm Open Dragone, 4 K

- NEPs per pixel
- All 4 K mirrors lower loading and lower noise.
- Largest effect at high frequencies

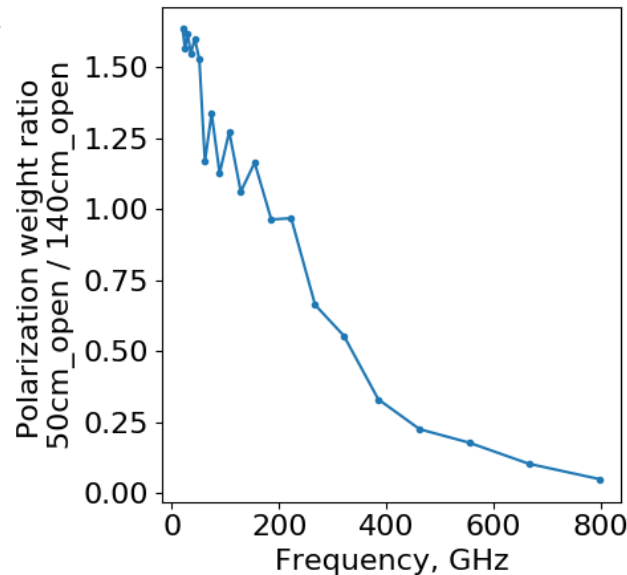


50 cm Open Dragone, 4 K

- NET per pixel (upper plots)
 - 4 K system means low noise at high frequencies

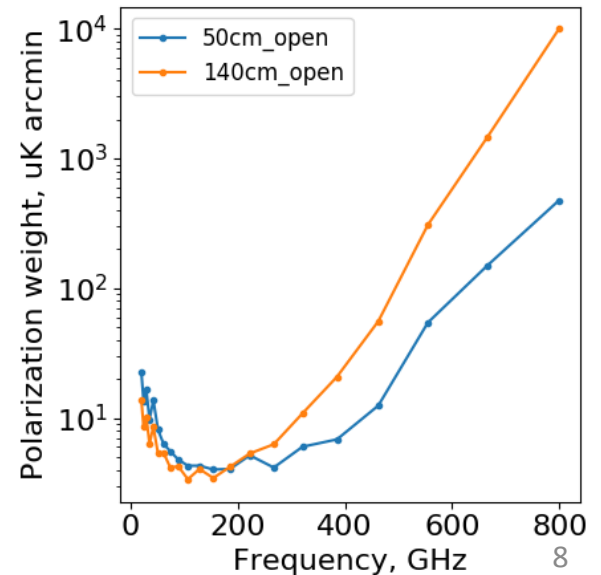


- Total polarization weight given available focal plane area. (lower plots)



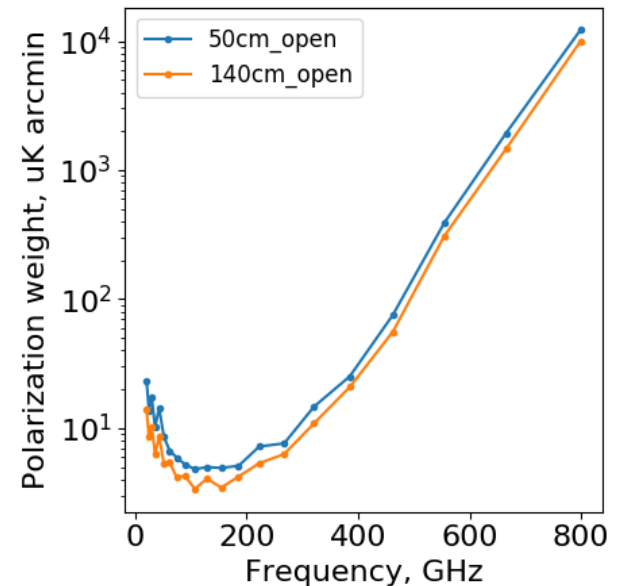
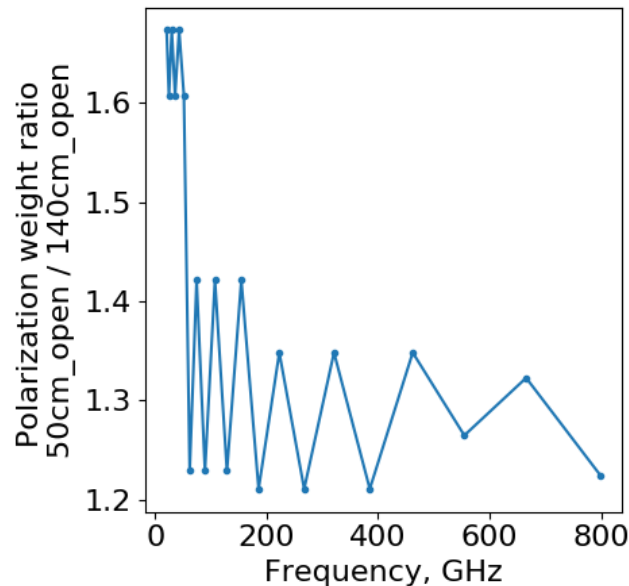
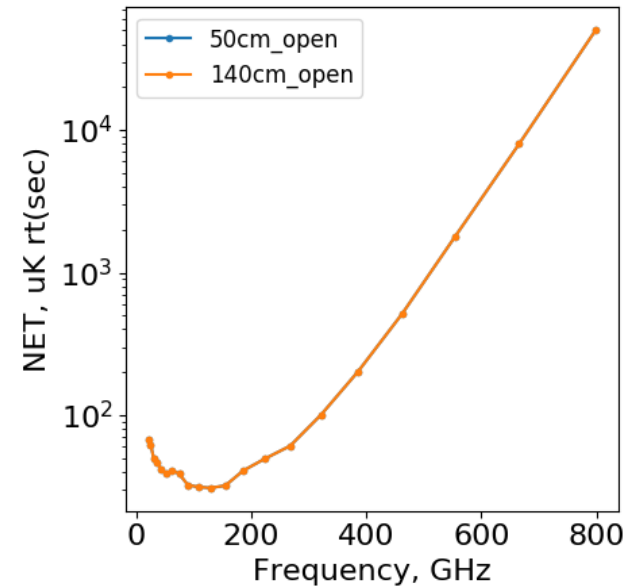
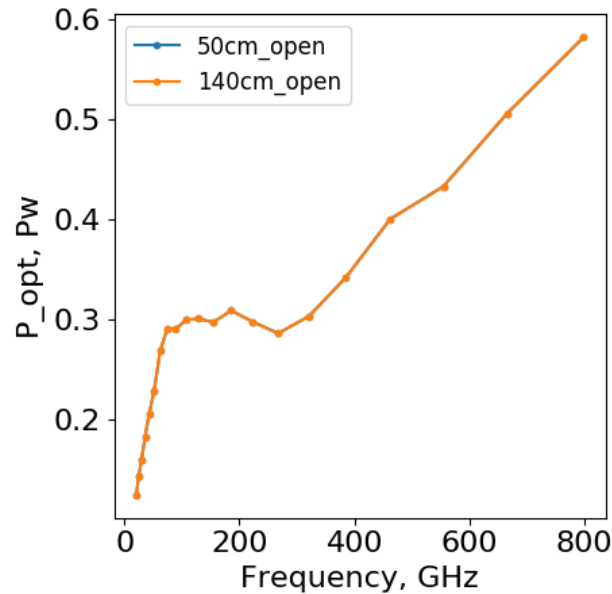
- Number of low frequency detectors is limited, lowering sensitivity.

- 1,684 bolometers



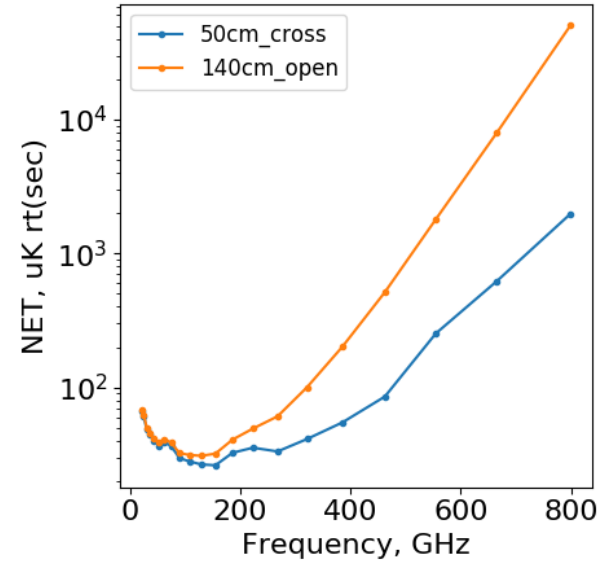
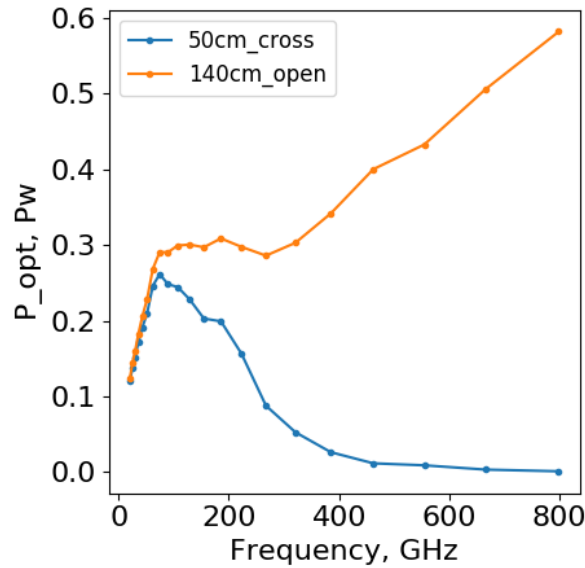
50 cm Open Dragone, 30 K primary

- Primary is 30 K, so per pixel noise is the same for both systems.
- Total polarization weight is worse because 50 cm has a smaller focal plane.
- 1,684 bolometers vs 3k bolometers in baseline

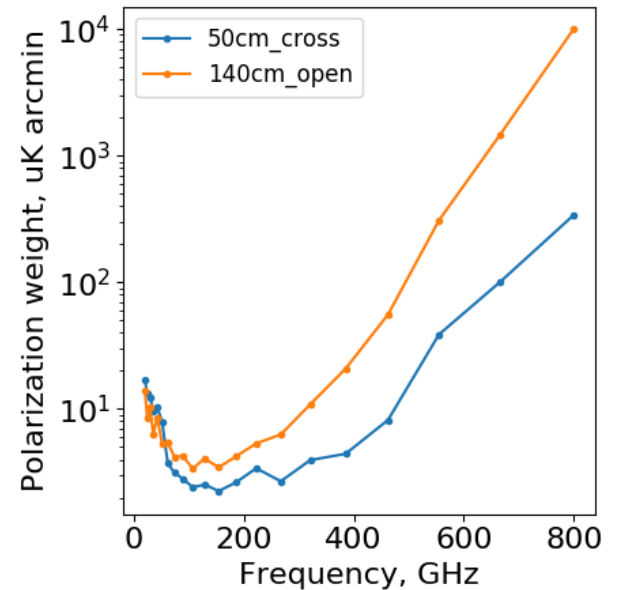
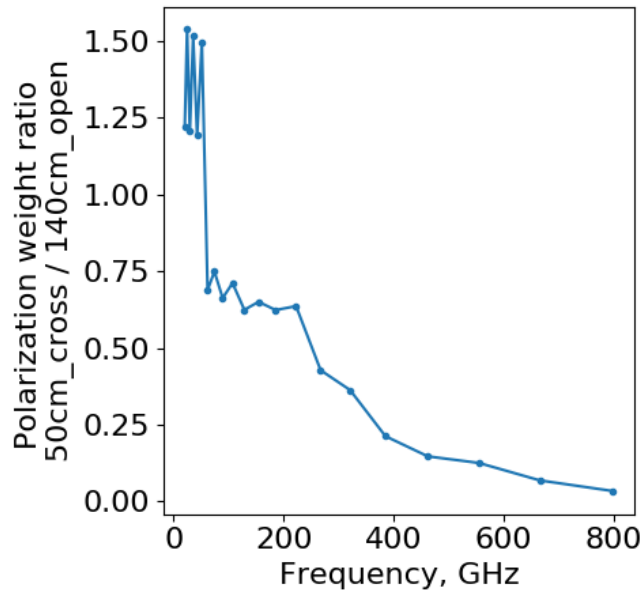


50 cm Cross Dragone, 4 K

- Primary is 4 K, improving per pixel noise.

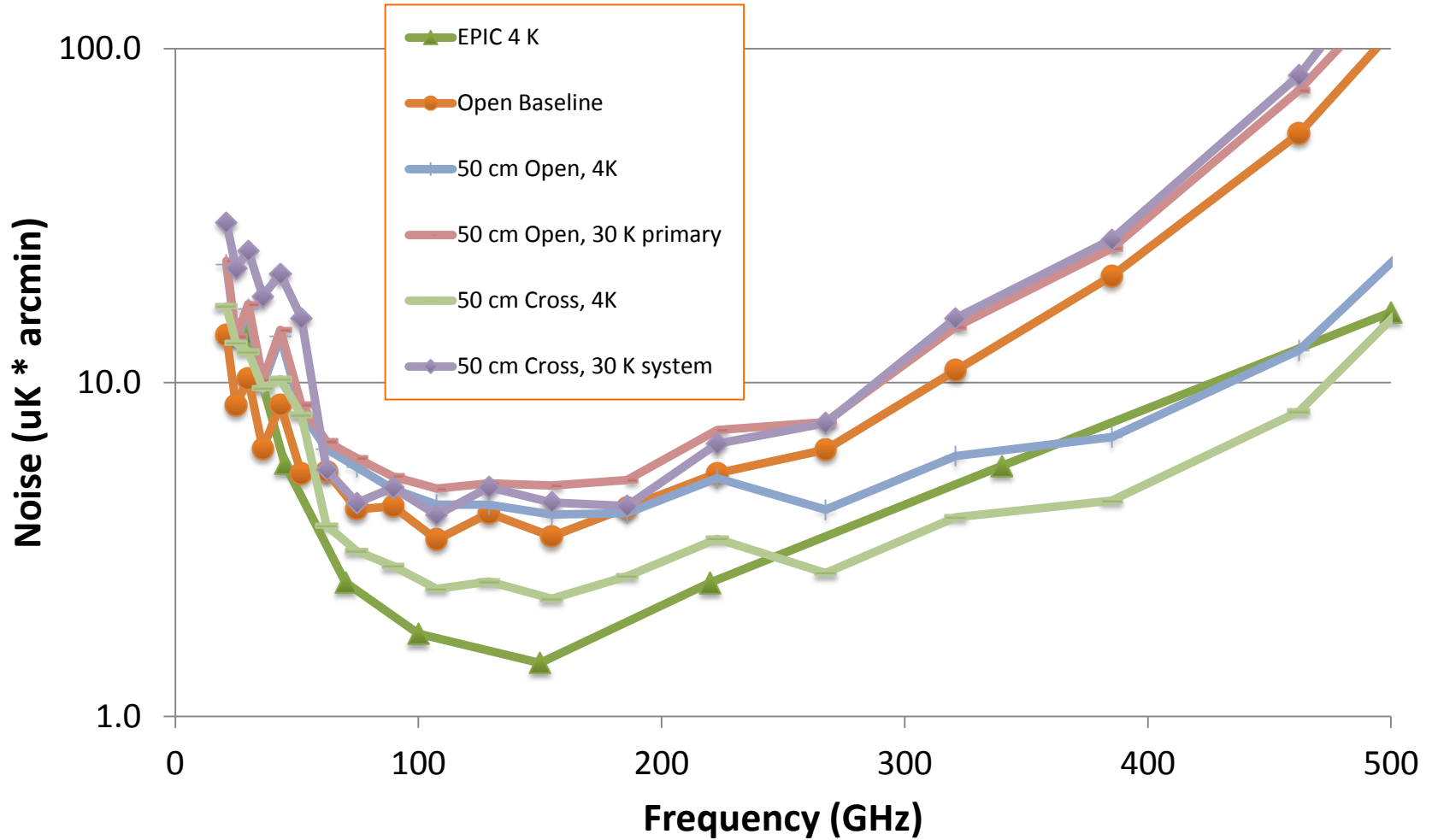


- 4k bolometers

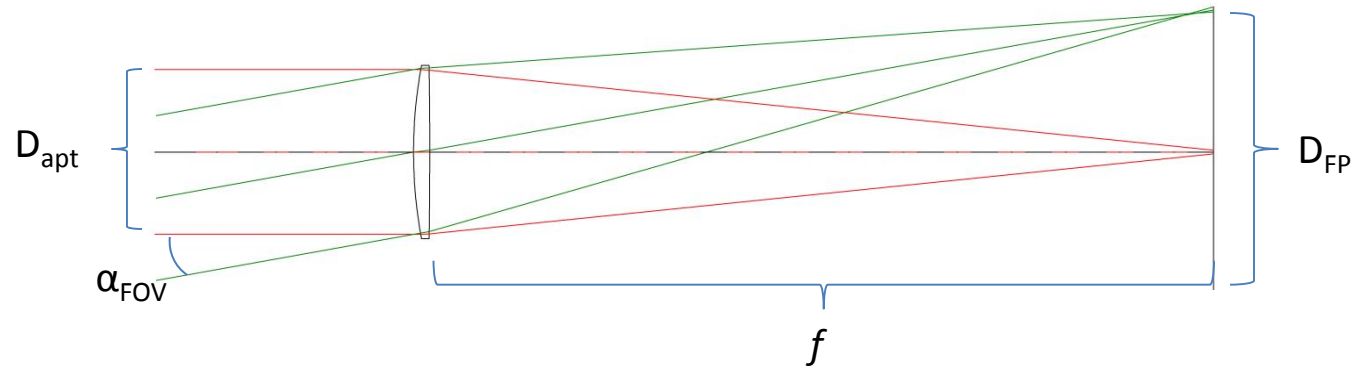


Comparing all cases

Weights



Focal Plane Scaling



Pixel diameter (cm) depends on f-number, F , and λ : $D_{px}(cm) \propto F \lambda$

Focal plane diameter (cm) depends on chosen α_{FOV} and effective focal length, f :

$$D_{FP}(cm) = 2 f \alpha_{FOV} = 2 F D_{apt} \alpha_{FOV}$$

Focal plane in units of $F \lambda$: $D_{FP}(F \lambda) = 2 D_{apt} \alpha_{FOV} / \lambda$

Number of pixels:
$$N_{px} \propto \left(\frac{D_{FP}}{D_{px}} \right)^2 = \left(\frac{2 F D_{apt} \alpha_{FOV}}{F \lambda} \right)^2 = \left(\frac{2 D_{apt} \alpha_{FOV}}{\lambda} \right)^2$$

So there is no dependence on F , but there is on α_{FOV} and D_{apt} . Last week's confusion arose because Qi changed F , α_{FOV} , and D_{apt} between the designs.

In the CORE study we fixed α_{FOV} and D_{apt} so there was no dependence on F .