Imager Update

Oct. 25, 2017

Imager - Approach

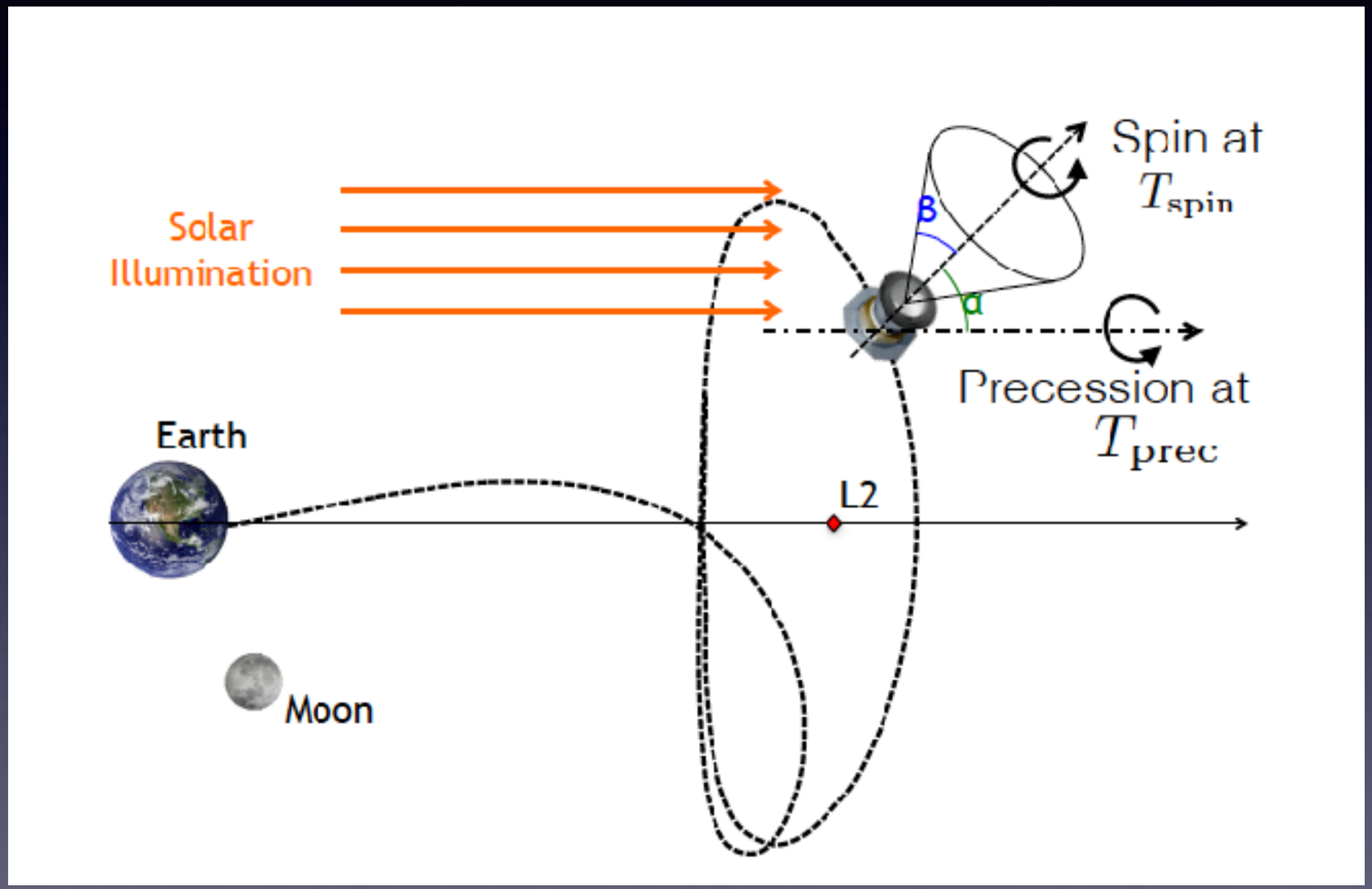
- Starting point: the largest aperture that can fit within the cost cap
  - 1.0 - 1.4 m (=> no HWP)
- No compelling driver to come below the cost cap
- No resources to separately cost both a large and a small (LiteBIRD type) missions
- Arrays of multi-chroic bolometers
- multiplexed readout

Imager - Major Focus

- Majority of work concentrated on optics design; scan angles; focal plane model
- Goal: be ready for instrument session at JPL in December

Scan Angle Reminder

- Spacecraft at L2
- Spinning and precessing
- Choice of angles affects sky and pixel scan pattern

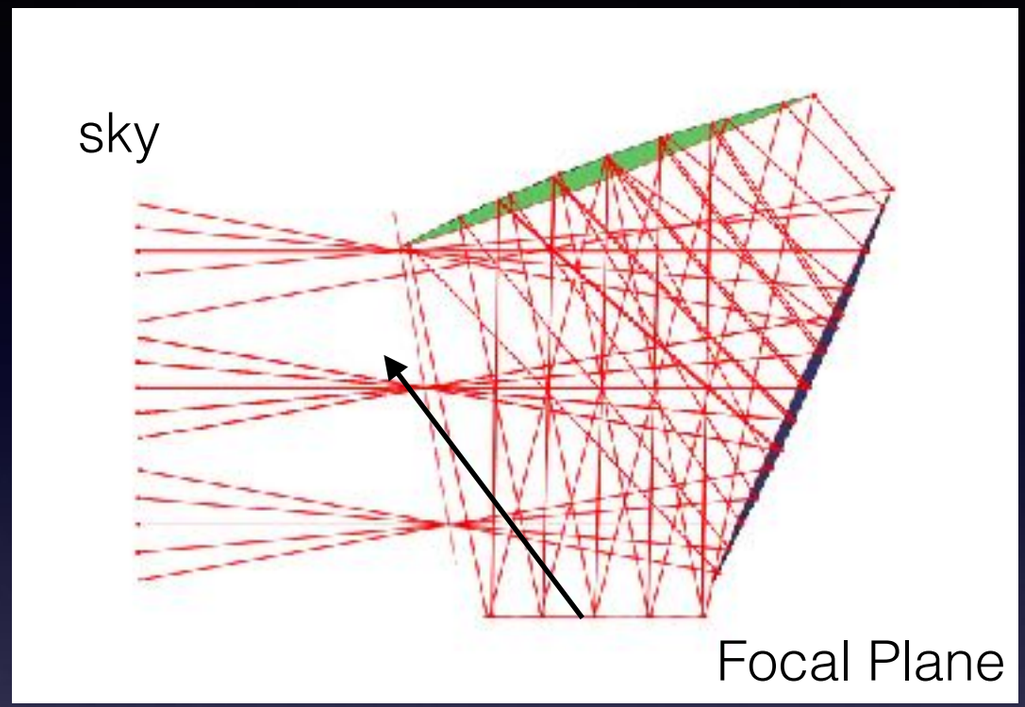


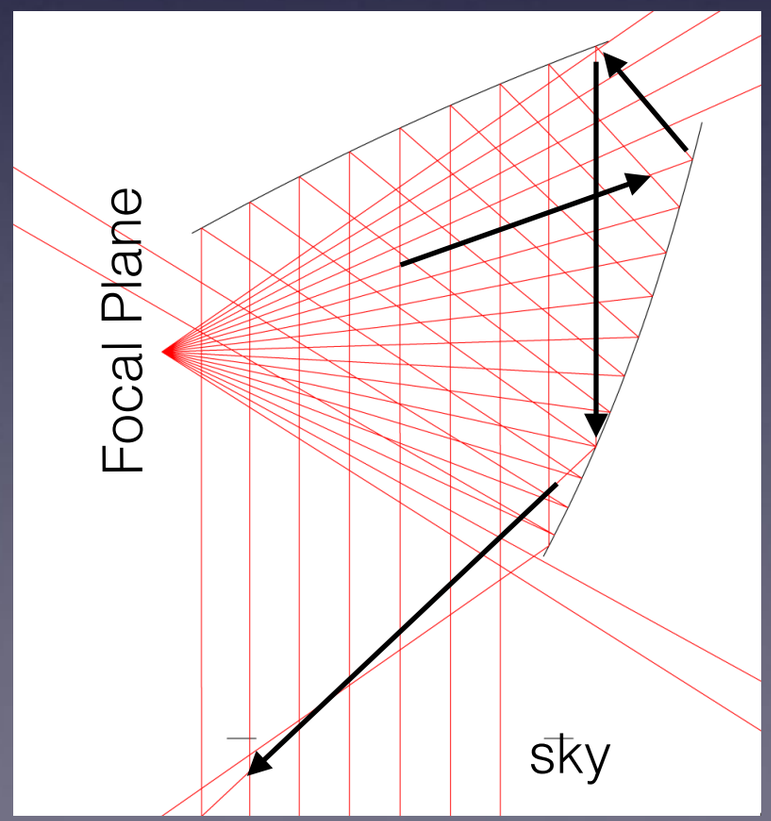
4 Imager Options

- Imager group developed 4 options
  - two with larger aperture (1.4 and 1.2 m), stand alone instruments
  - two with small aperture (0.5 m), intended for combined spectrometer/imager
  - all with 21 bands between 21 and 799 GHz

Optics Reminder

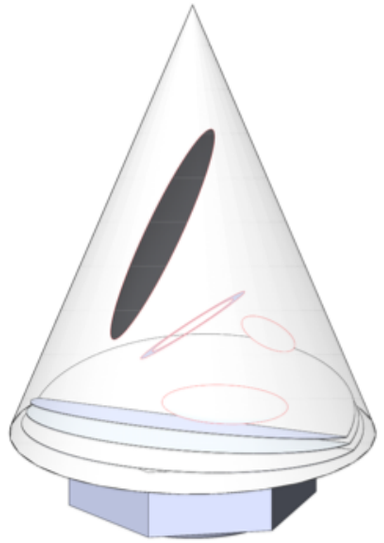
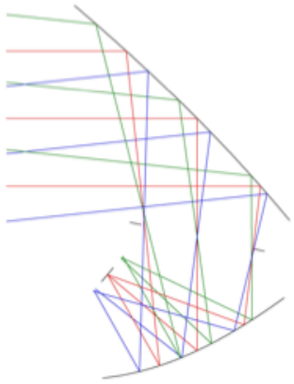
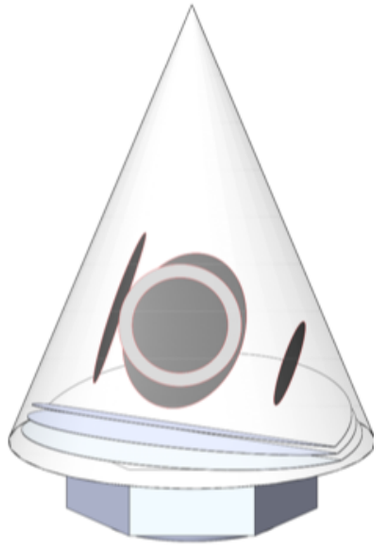
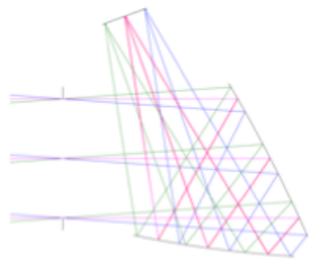
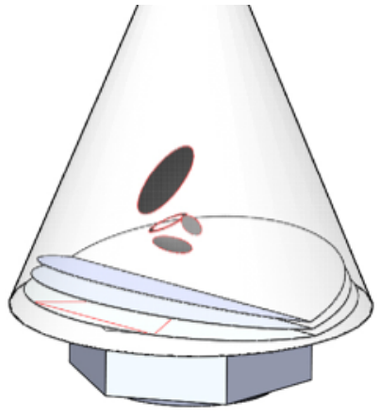
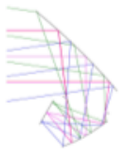
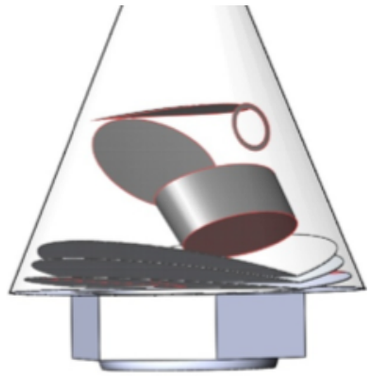
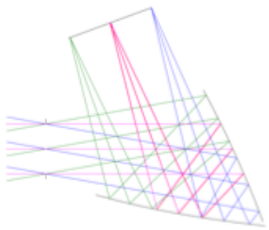
- Crossed Dragone Systems (EPIC, QUIET, ABS, CORE, LiteBIRD, CCAT-prime)
  - Give large diffraction limited field of view
  - Compact
  - More challenging to baffle





4 Options are Ready (all alpha=22, beta = 73)

Status of Optical Systems

	Open	Crossed
Large	✓  4.6 m  1 m Baseline V2.5, D = 1.4 m Baffling works Packs in envelope Noise, weights calculated Primary @ 30K, others @ 4K	✓  4.6 m  1 m D = 1.2 m Baffling works Packs in envelope Noise, weights calculated All @ 30K
Small	✓  4.6 m  1 m D = 0.5 m Baffling works Packs in envelope Noise, weights calculated Completely 4K version (30 K primary version)	✓  4.6 m  1 m D = 0.5 m Baffling works Packs in envelope Noise, weights calculated Completely 30K verison (Completely 4K version)

4 Options are Ready (same, but no scale bars)

Status of Optical Systems

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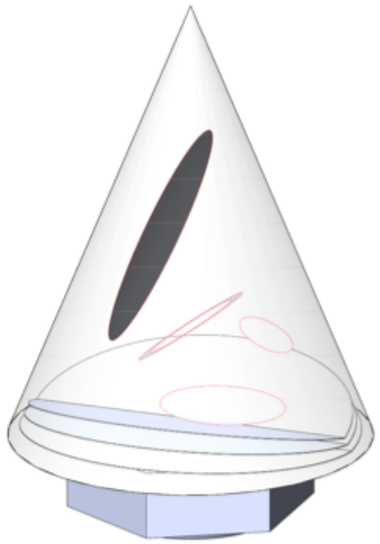
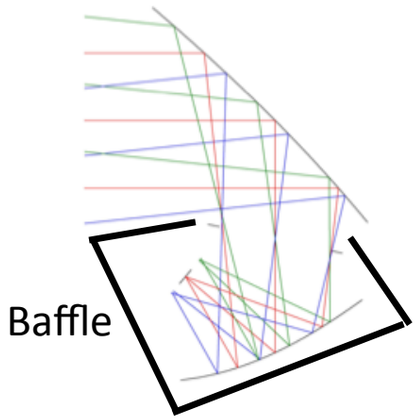
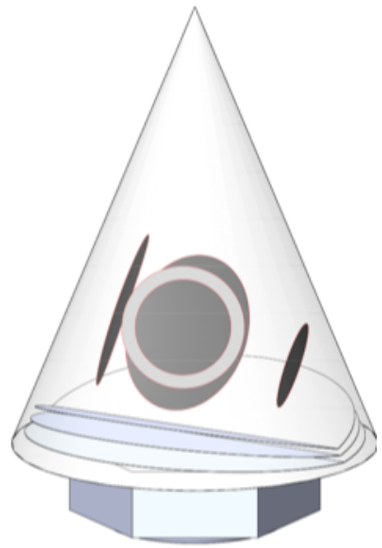
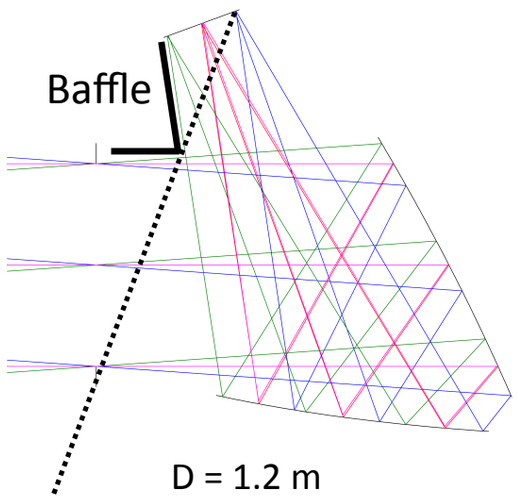
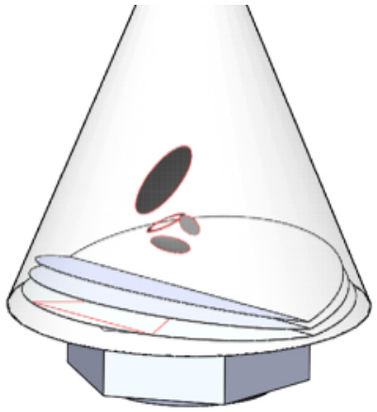
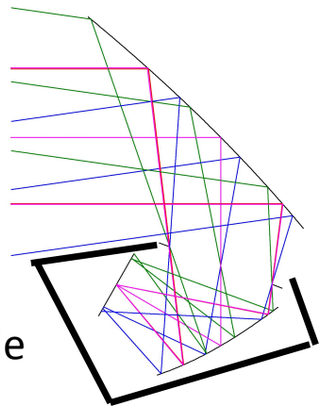
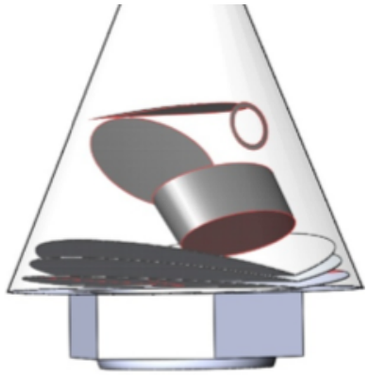
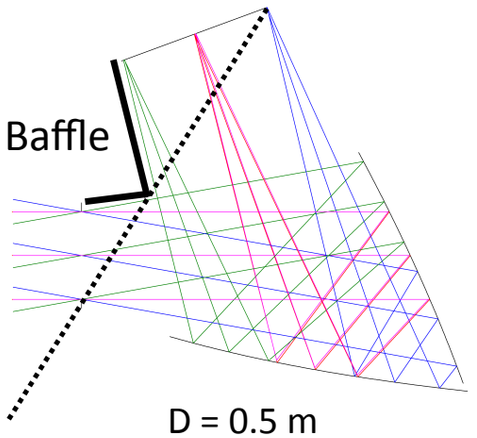
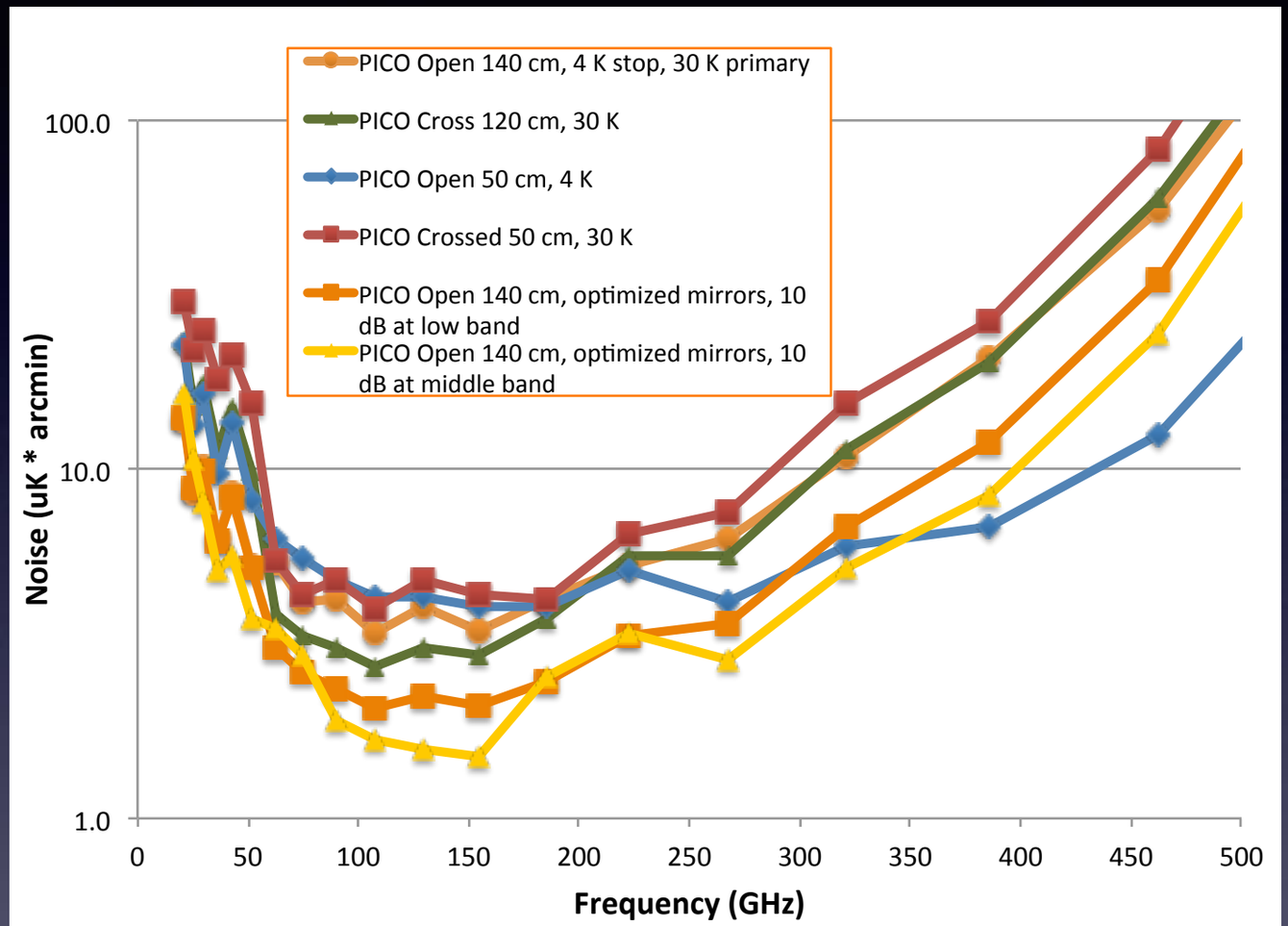
Large	✓   Baseline V2.5, D = 1.4 m Baffling works Packs in envelope Noise, weights calculated Primary @ 30K, others @ 4K	✓   D = 1.2 m Baffling works Packs in envelope Noise, weights calculated All @ 30K
Small	✓   D = 0.5 m Baffling works Packs in envelope Noise, weights calculated Completely 4K version (30 K primary version)	✓   D = 0.5 m Baffling works Packs in envelope Noise, weights calculated Completely 30K verison (Completely 4K version)

Imager Options - White Noise Levels

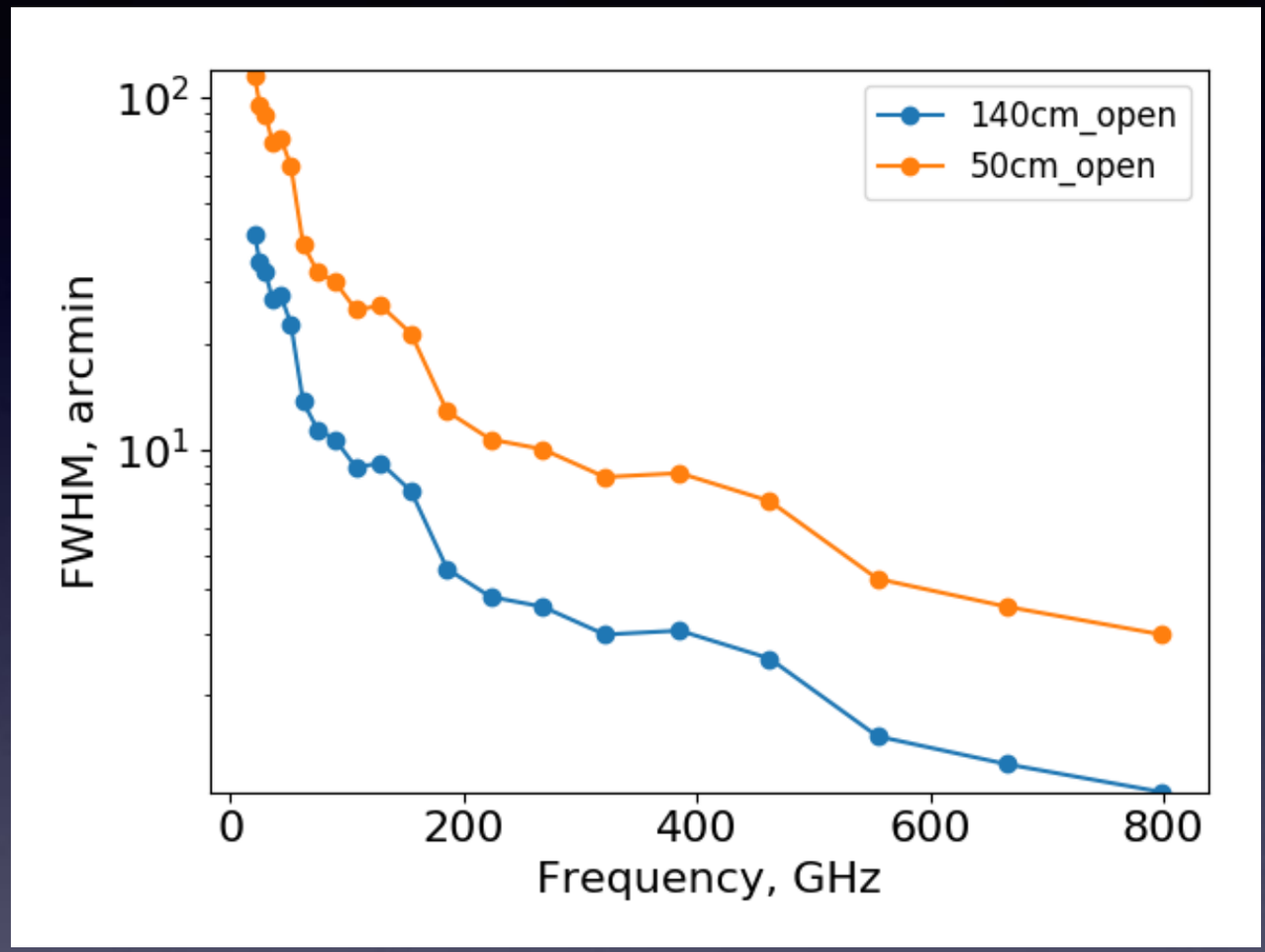
- 1.4 m open (orange)
  - 30 K primary, 4 K cold stop+secondary; 3024 bolometers
- *1.4 m open optimized (low orange/yellow)*
  - *30 K primary, 4 K cold stop+secondary;*
  - *7350, 15030 bolometers*
- 1.2 m crossed (green)
  - 30 K telescope; 5010 bolometers
- 0.5 m open (blue)
  - 4 K telescope; 1684 bolometers
- 0.5 m crossed (red)
  - 30 K telescope; 2358 bolometers



1.4 m Open (orange) gives combined 0.8 uK*arcmin for a 4 year full sky survey

Imager Options - Resolution

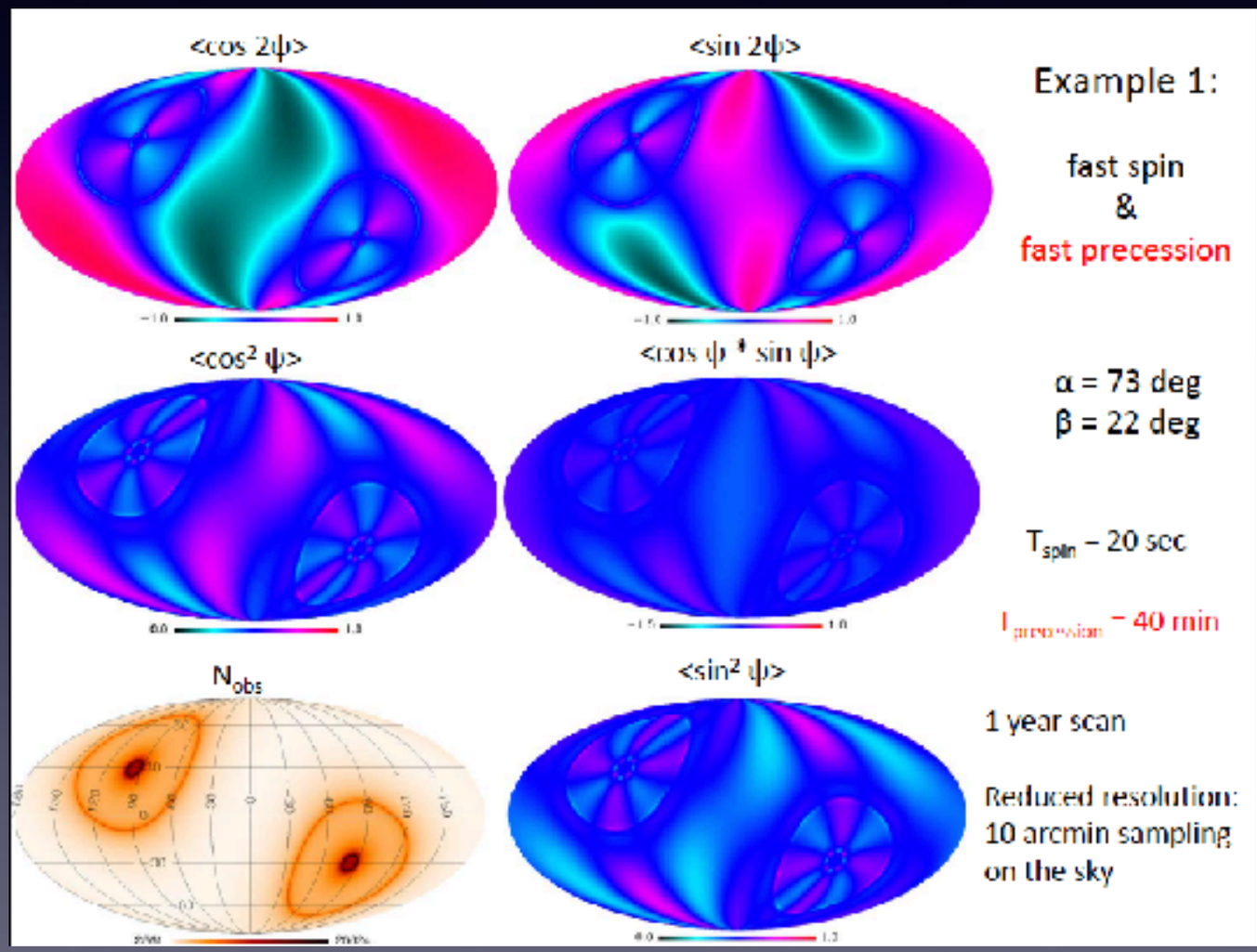
- 1.4 m open (blue)
  - Single mode optics
  - 40’ @ 20 GHz
  - 1’ @ 800 GHz



Simulations of Sky Scan

- Initial survey (Gorski)
  - builds upon LiteBIRD, CORE
  - single detector, with PICO's angles

1. Gather the physical/engineering constraints on the 7 parameters of the scanning strategy (Shaul)
   - L2 orbit radius
   - Precession angle (alpha)
   - Spin angle (beta)
   - Precession rate
   - Spin rate
   - HWP rate (maybe constrained to zero if we know we won't have one)
   - Detector sampling rate
2. Gather the various metrics by which we want to evaluate each scanning strategy (Jacques)
   - Time to cover the full sky
   - Conditioning of individual detector maps
   - Planet crossing time
   - Daily peak-to-peak dipole
   - etc
3. Construct a cost function from some weighted combination of the metrics
4. Optimize the cost function over the allowed parameter ranges.



Imager - In the Future

- JPL working on
  - telescope quotes
  - Focal plane cost model
  - Cooling architecture
- Milestone: TeamX in December
- Future:
  - Readout power (cold stage, warm)
  - Consequences of scan angles, beam sizes (data rates)
  - Optimizing distribution of detectors/band
  - Mitigating systematic uncertainties (simulations)
  - More detailed optics simulations (for beam systematics)

Backup Slides

Imager Options - noise levels

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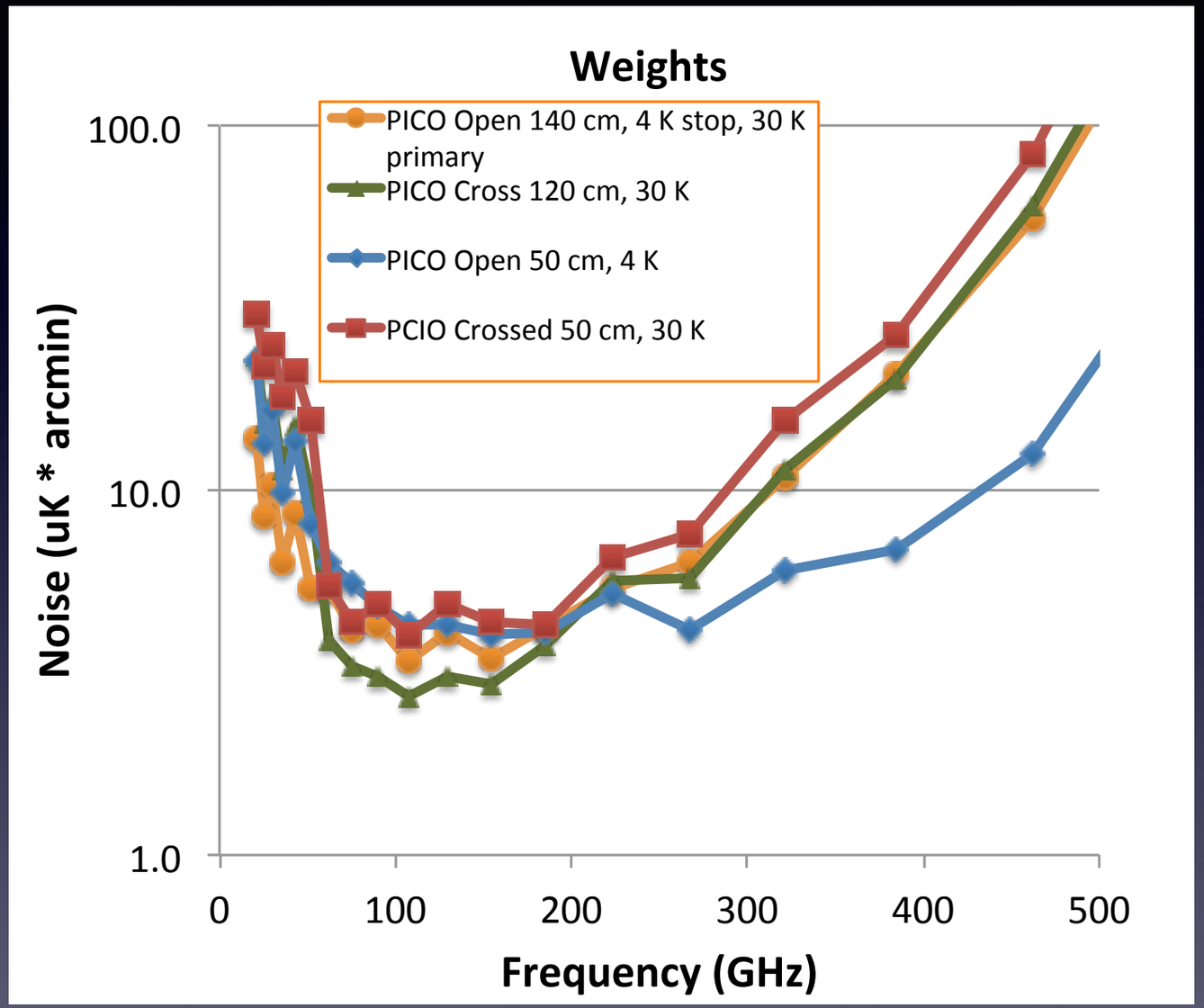

1.4 m Open gives combined 0.8 uK*arcmin for a 4 year full sky survey (somewhat deeper than S4)