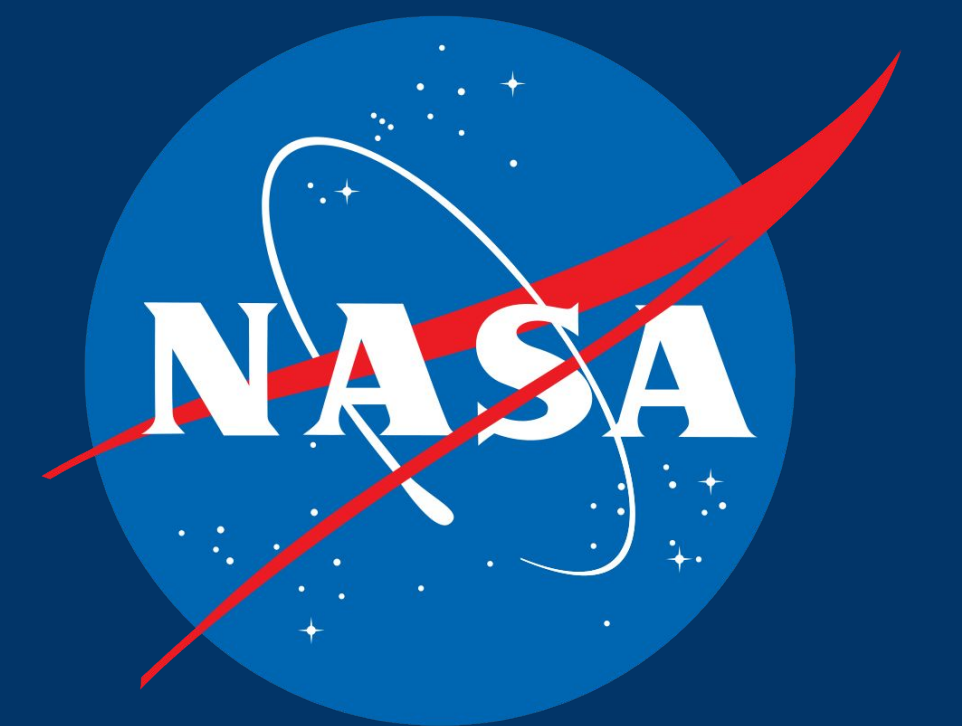


Parallel plate capacitor TiN KID array development for the Balloon Experiment for Galactic Infrared Science

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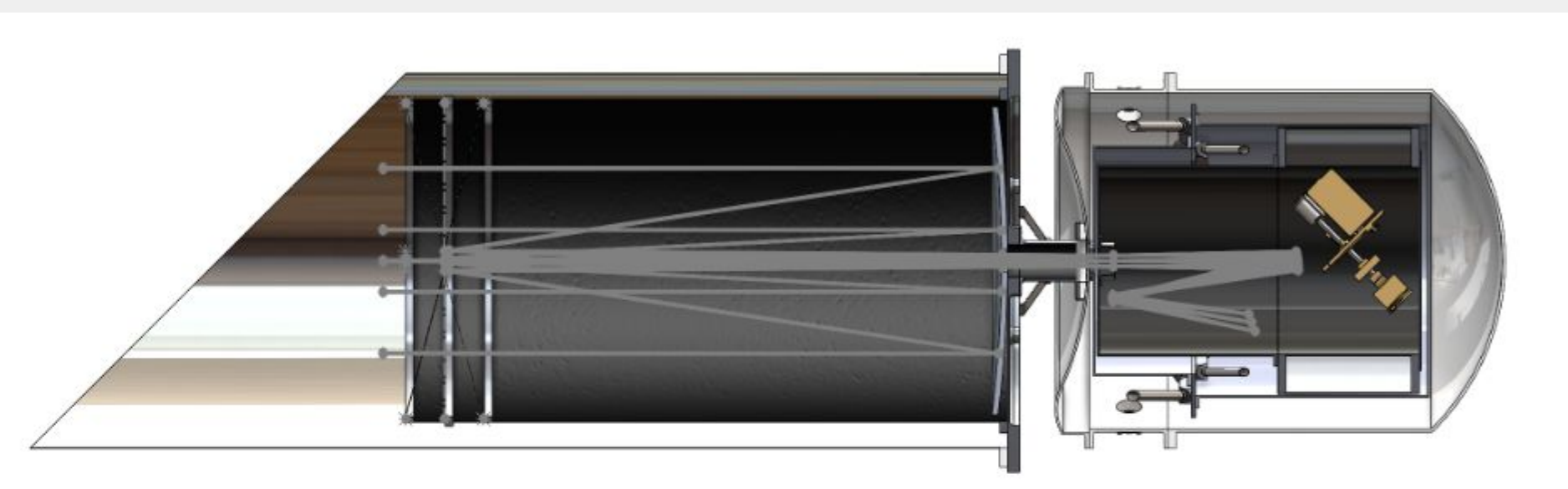
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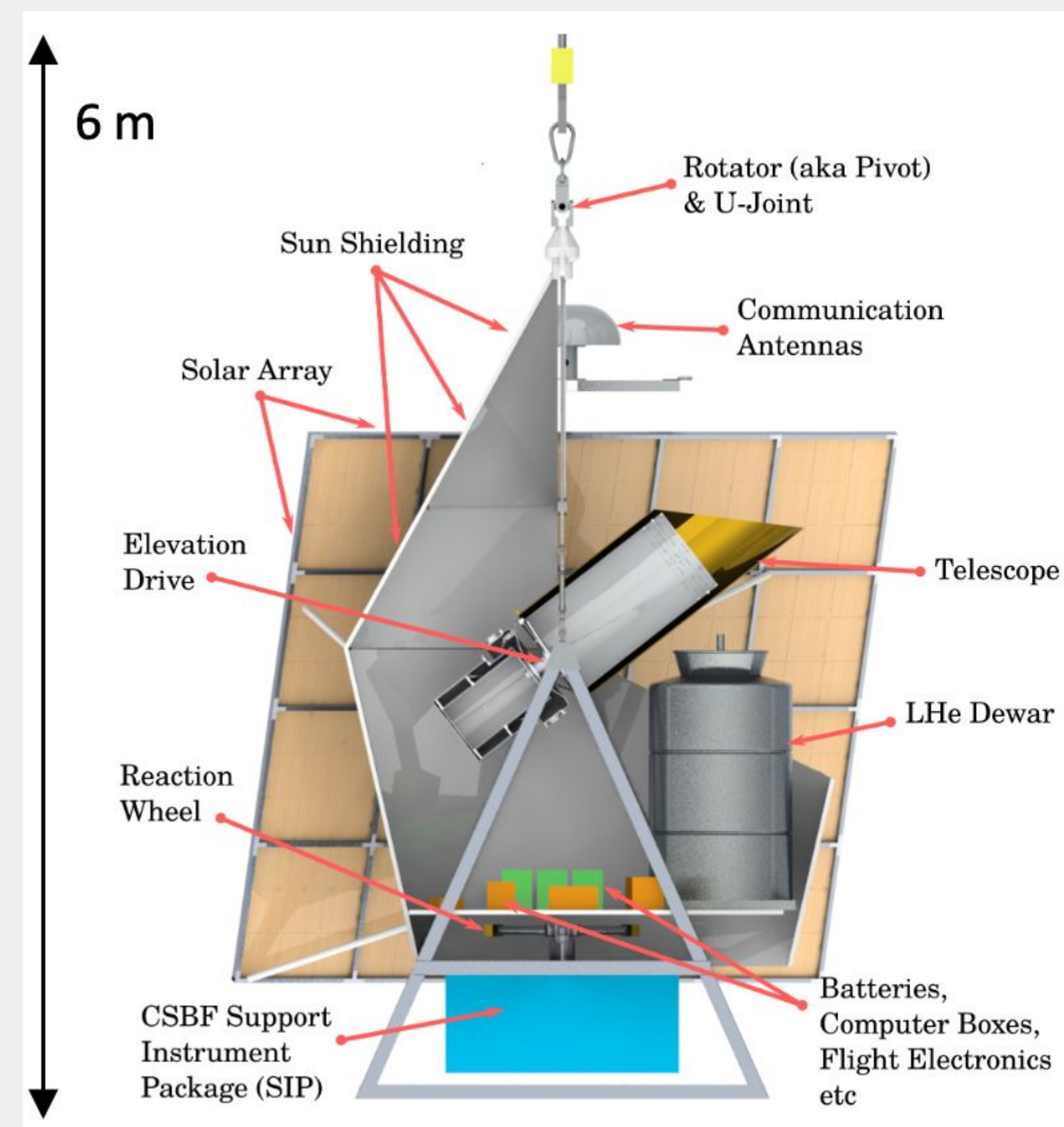


Notional design of the Balloon Experiment for Galactic Infrared Science

- Balloon Experiment for Galactic Infrared Science (BEGINS)
 - Radiation field and dust properties in harsh star-formation environments
- Telescope
 - 0.5 m Cassegrain, aluminum mirrors
 - 12 arcmin angular resolution at 25 μm
 - 0.2° x 0.1° diffraction limited field of view
- Cryostat
 - Liquid He backed 300 mK ⁴He/³He cooler
 - 2,000 kinetic inductance detectors (KIDs)
 - $R \sim 10$ for $\lambda = 25 - 65 \mu\text{m}$
 - $R \sim 3 - 6$ for $\lambda = 70, 100, 160, 250 \mu\text{m}$
- Targeted Flights
 - Test flight: Fort Sumner, NM
 - Science flight: Esrange, Sweden



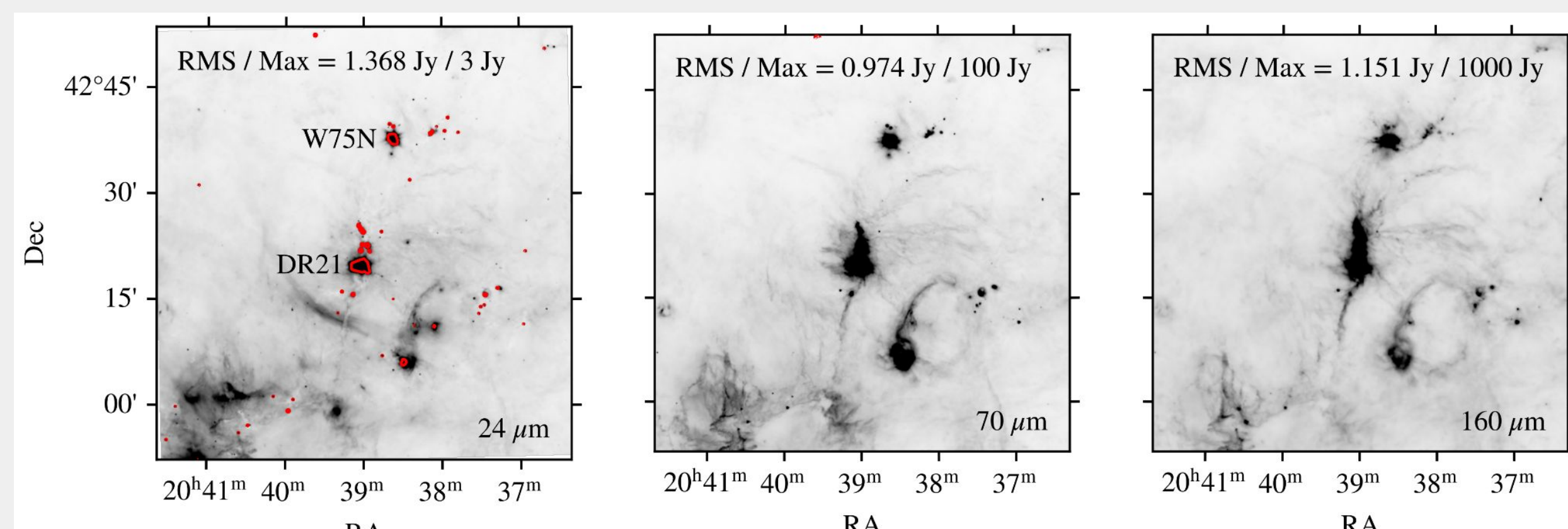
Conceptual 50-cm Cassegrain telescope with baffle tube and instrument cryostat.



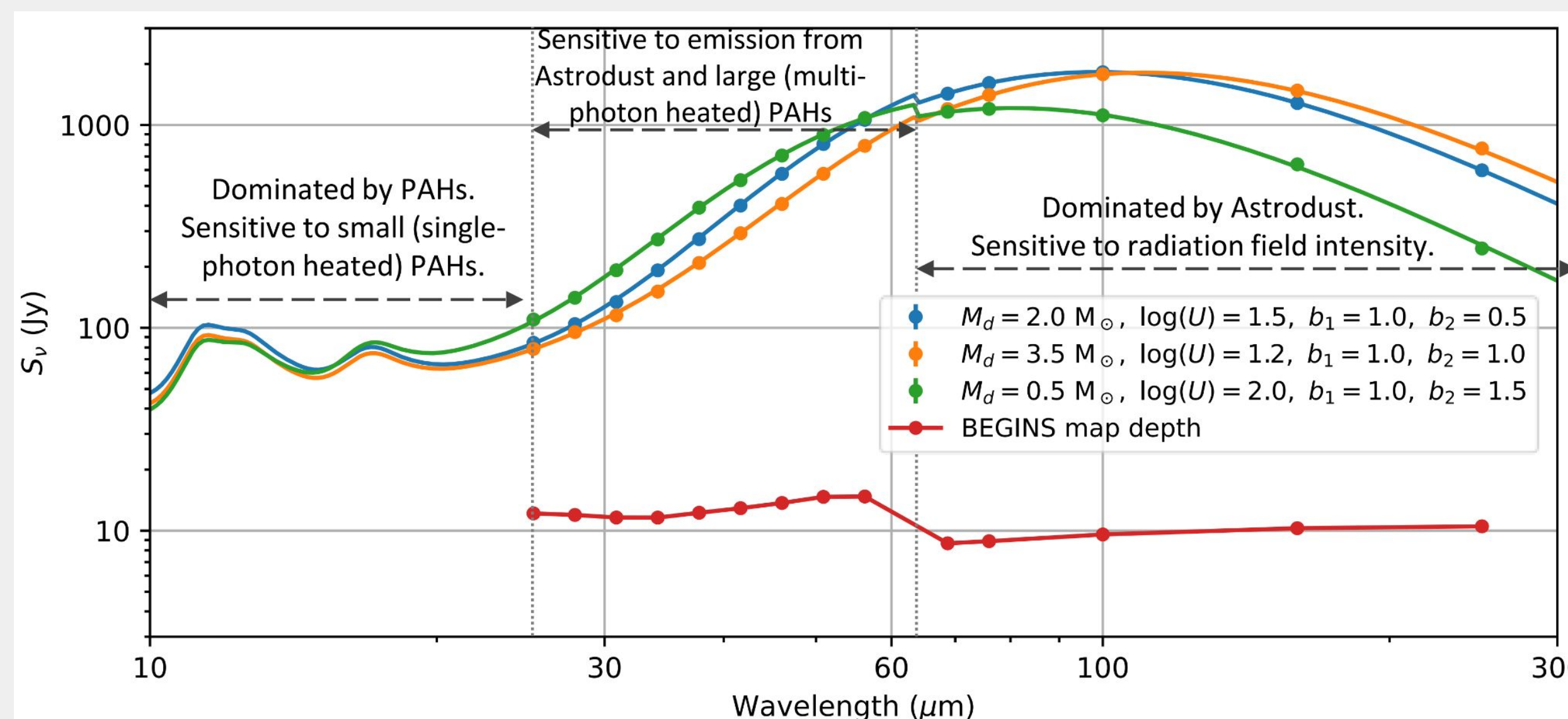
Conceptual BEGINS gondola with major components labeled.

Measuring dust + polycyclic aromatic hydrocarbons (PAHs) with BEGINS

- Spectral energy distributions (SEDs)
 - Cygnus complex
 - One square degree
 - Centered on DR21
- Measure
 - Radiation field intensity
 - Dust column density
 - Relative abundance of single- vs multi- photon heated PAHs
- Constrain interstellar dust evolution
- Test current dust emission models
- Probe grain distribution in a rich variety of star-formation environments



Broadband archival *Spitzer* and *Herschel* data of Cygnus, centered on DR21. BEGINS will map SEDs in this region with high SNR.



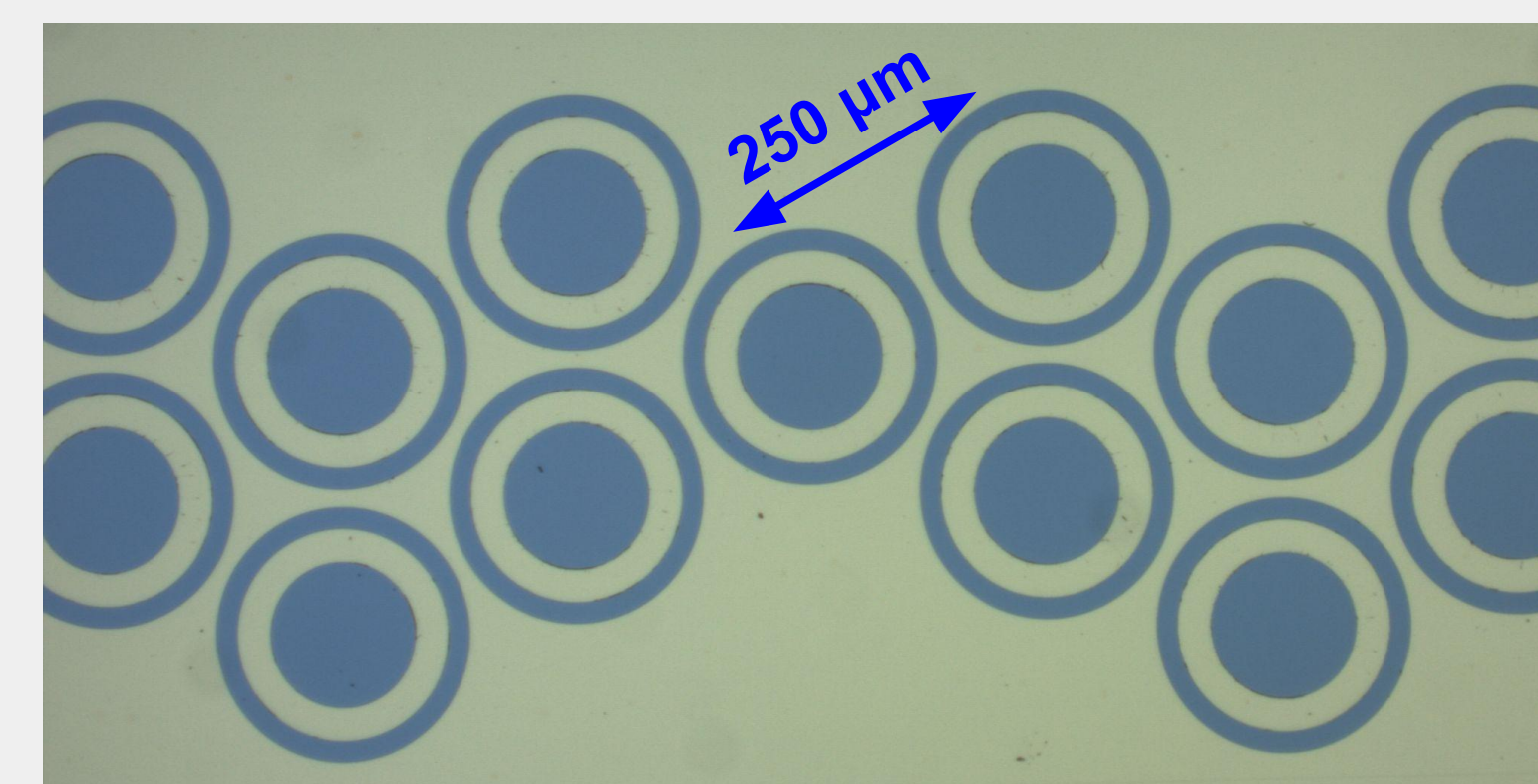
Three model dust spectra [1] with differing radiation field intensities, total dust masses, and relative PAH abundances. Expected BEGINS measurements will distinguish these spectra.

Conclusions and Next Steps

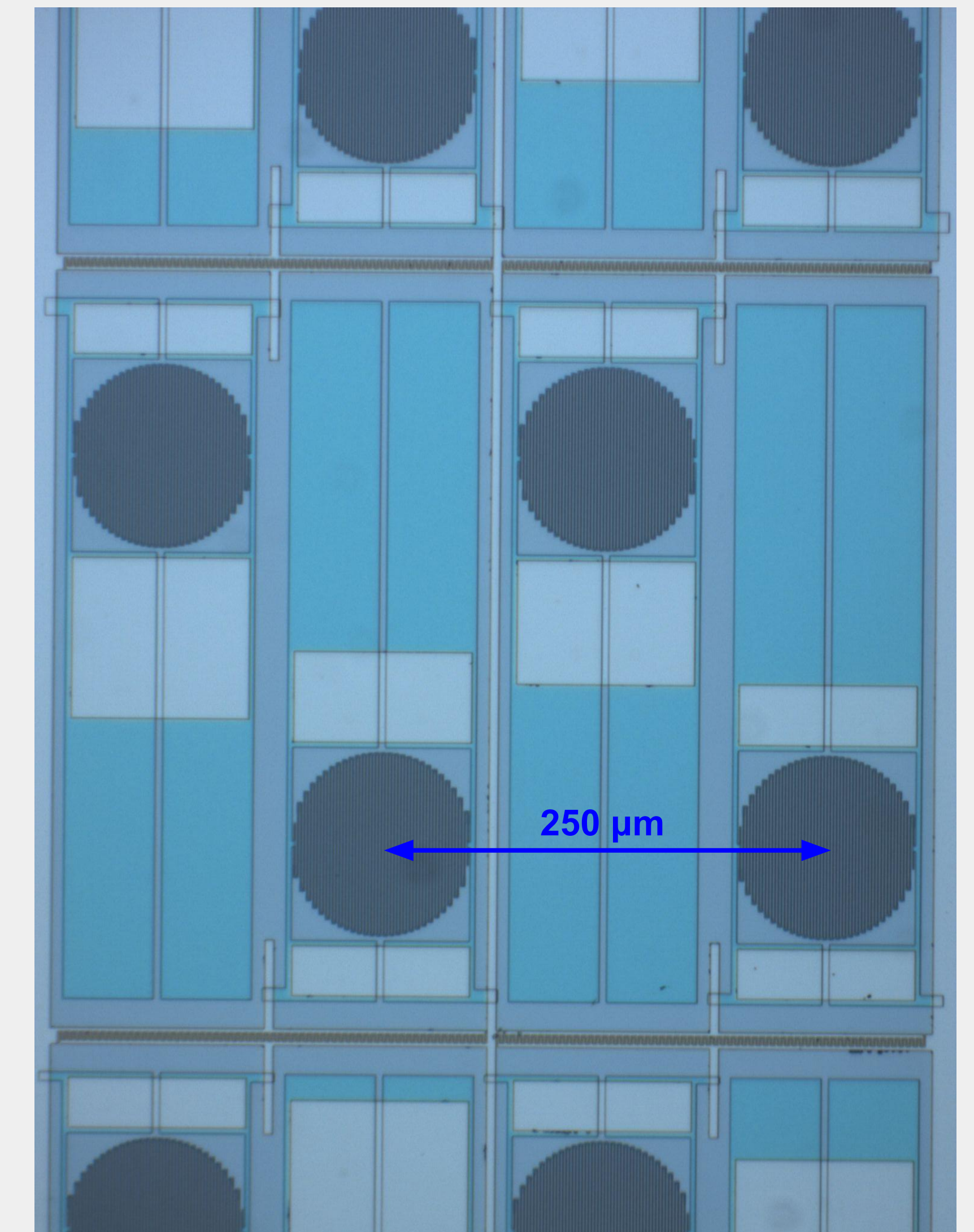
- Instrumentation development for BEGINS
 - TiN parallel plate capacitor KIDs
 - Calibrated blackbody measurements and NEP calculations coming soon
 - PPC TLS and crosstalk characterization coming soon
 - Optical coupling
 - Fresnel zone plate lenses work prototype KID measurements
 - 3D silicon micromachined microlens array development underway
 - Silicon-based continuously linear variable filters
 - Fixed bandpass filters working well (see poster [4])
 - Linear variable development in progress

Parallel Plate Capacitor Kinetic Inductance Detectors

- Titanium Nitride KIDs [2]
 - Meandered TiN inductor/absorber
- Parallel Plate Capacitor (PPC) [3]
 - Reduce two-level system noise
 - Reduce pixel footprint
 - Reduce EM field crosstalk
- Fresnel zone plate (FZP) lenses
 - For test chips
- Micromachined silicon microlens
 - For flight arrays
- Continuously linear variable filters [4]
 - Enables 25 – 65 μm SED mapping



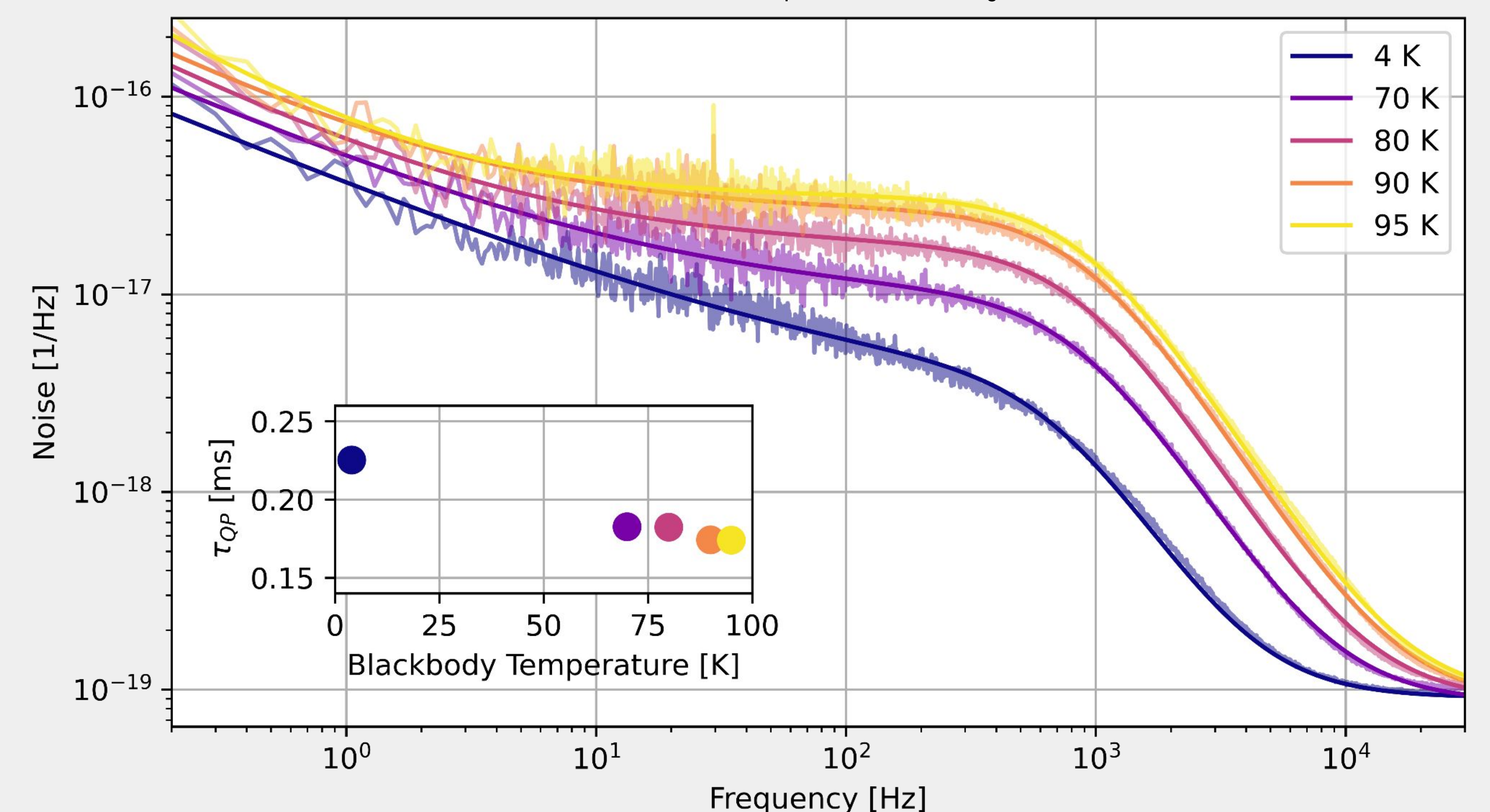
Lithographically patterned aluminum FZP lenses. Each set of rings comprises a FPZ lens and is aligned to a KID absorber on the chip's backside.



PPC KIDs. A meandered TiN inductor comprises the absorber. Unique capacitors define the unique resonant frequency of each detector.

PPC TiN KID Noise Performance

- Array yield 180/192 ~ 94%
- Noise at target optical loadings
 - Cryogenic Blackbody
 - 30 μm bandpass filter
- Typical resonator freqs: 180 – 560 MHz
- NEP ~ $2 \times 10^{-16} \text{ W}/\sqrt{\text{Hz}}$
 - Blackbody at 95 K (~2 pW loading)
- $Q_i \sim 65,000$, $Q_c \sim 34,000$



Noise measurements of a prototype TiN PPC KID at various blackbody temperatures.

Acknowledgements

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