



Effects of Stray Light on SOFIA Science Data

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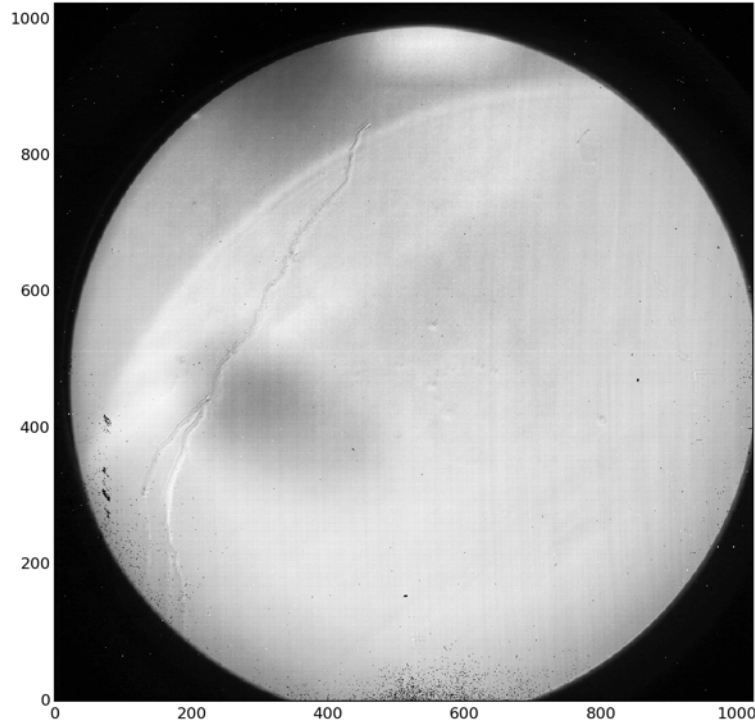


Extra Background seen with FLITECAM

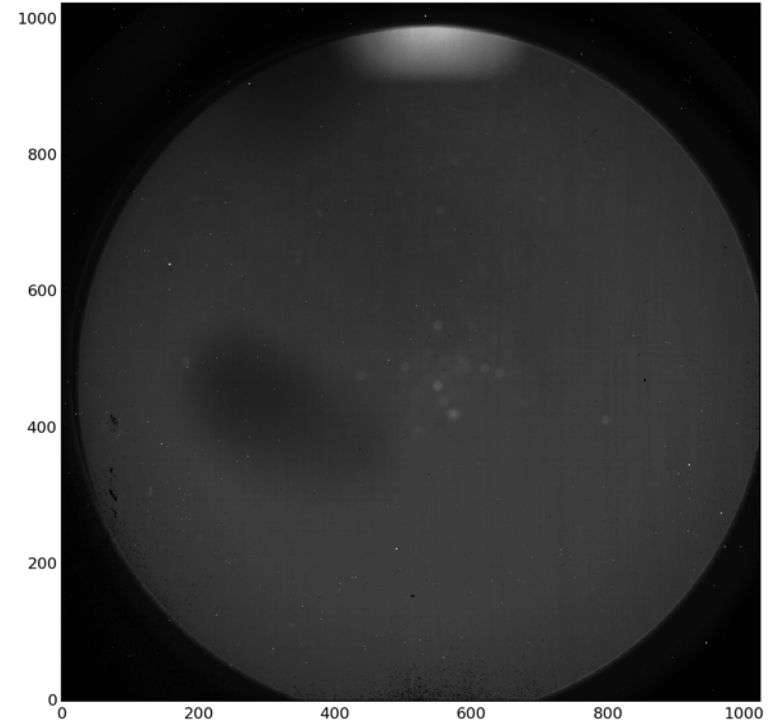


- During the Pluto Occultation Practice Flight, an extra background at $2.2 \mu\text{m}$ was noted; strongly dependent on telescope elevation (stronger at lower tel els)
 - Extra background had been seen in earlier FLITECAM commissioning observations, but not fully characterized.
 - Extra background could be easily seen at 35 degrees and varied as the plane tipped slightly ~ 1 deg; disappeared by ~ 45 deg
 - Pupil images reveal two bright regions
 - Blackbody fits to the excess emission give $T \sim 500\text{-}700$ K
 - Most likely explanation: emission from engine cone (dominant source) and plume directly striking/scattering off upper edge of primary and reflecting off spiders
 - Reflection off aft spider is brightest region in pupil images above ~ 20 deg elevations





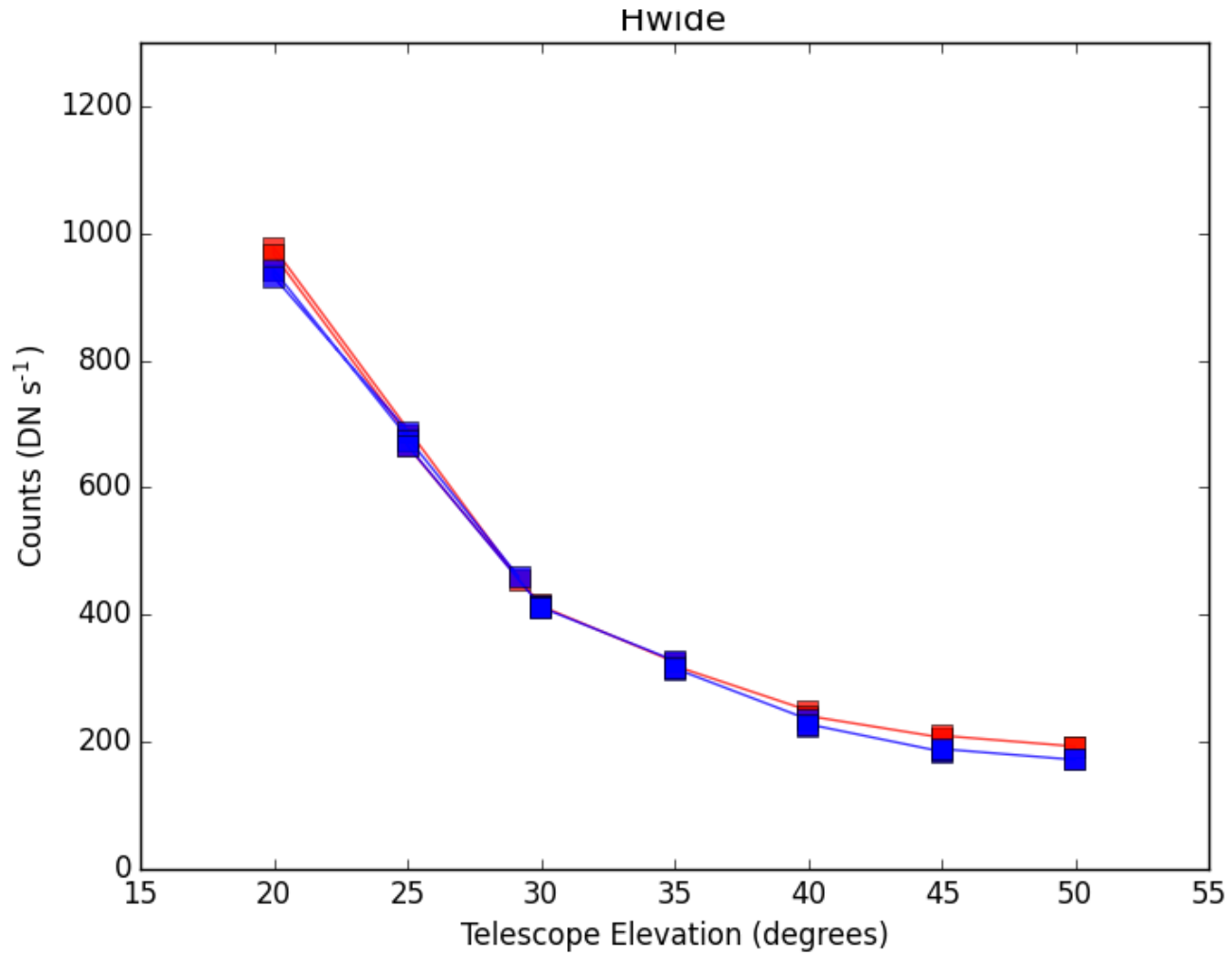
20 deg. elev.

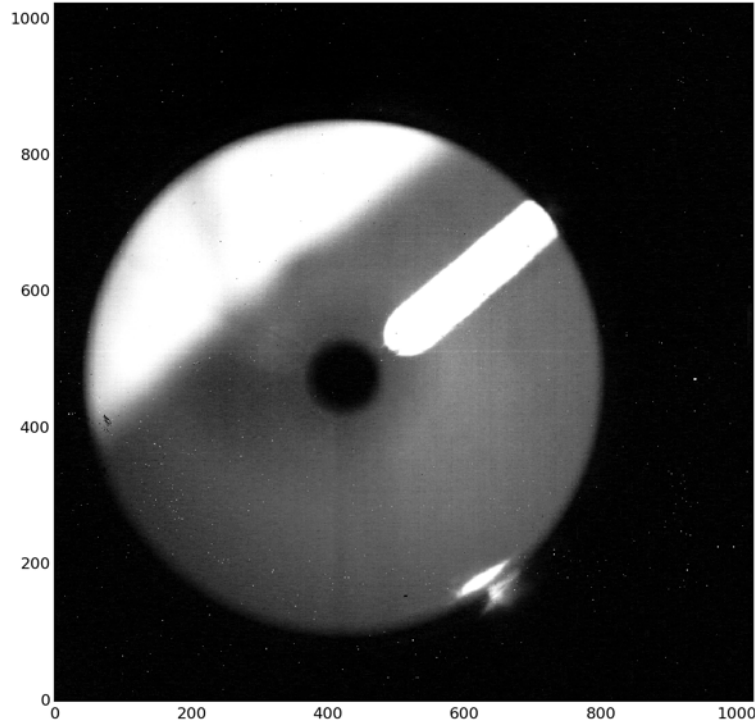


50 deg. elev.

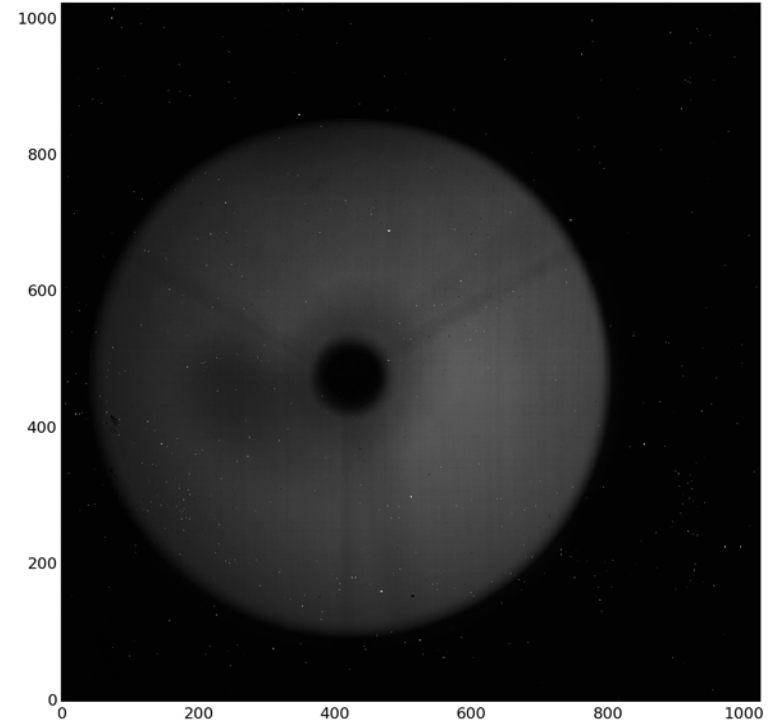


1.8 micron Background vs Elevation





25 deg. elev.



50 deg. elev.

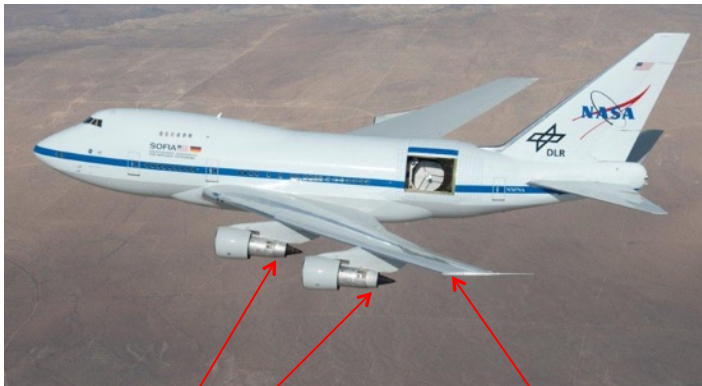
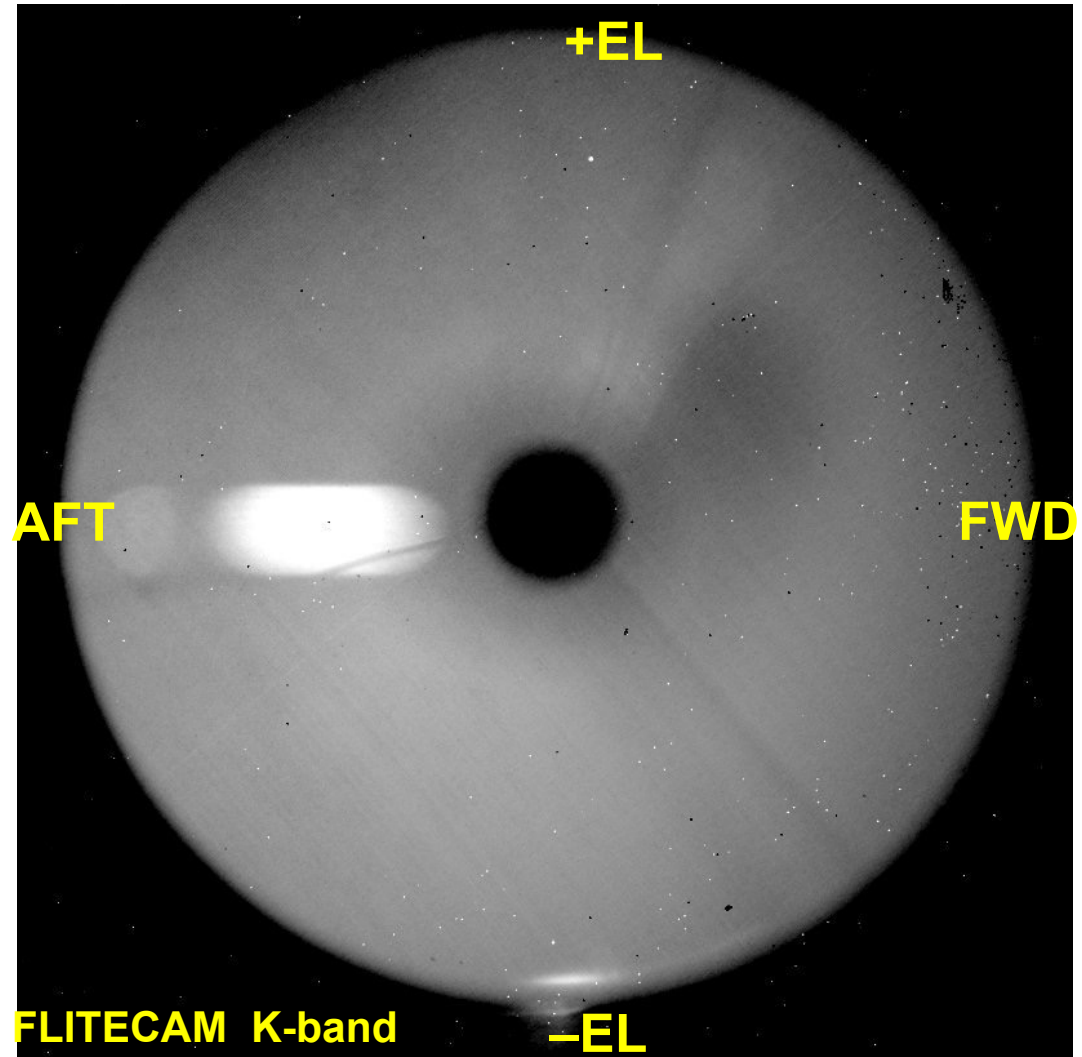


Current Spiders as "shiny" poles in IR



View from outside looking in

View from inside looking out

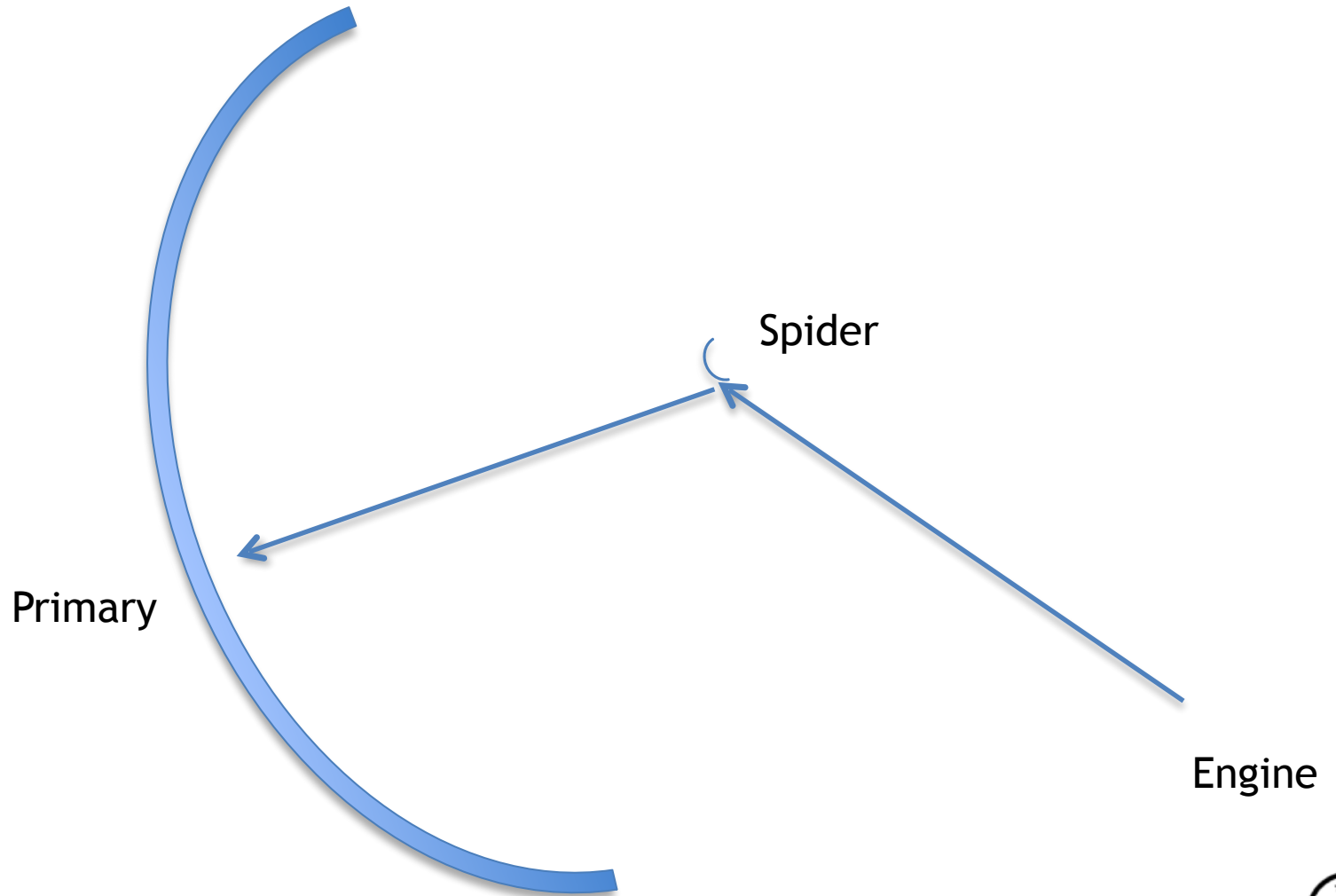


USRA Tail Cones + Plume(s)





Geometry



Engine 1 Outboard cone on door side

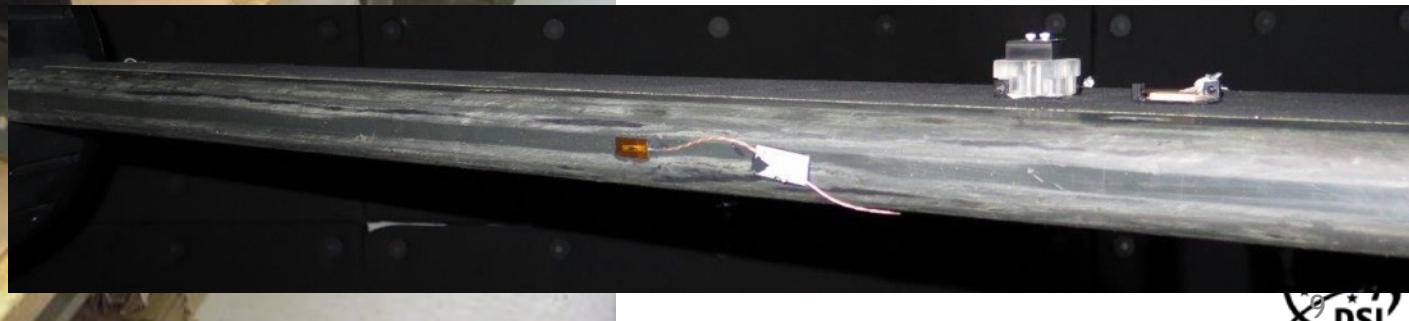
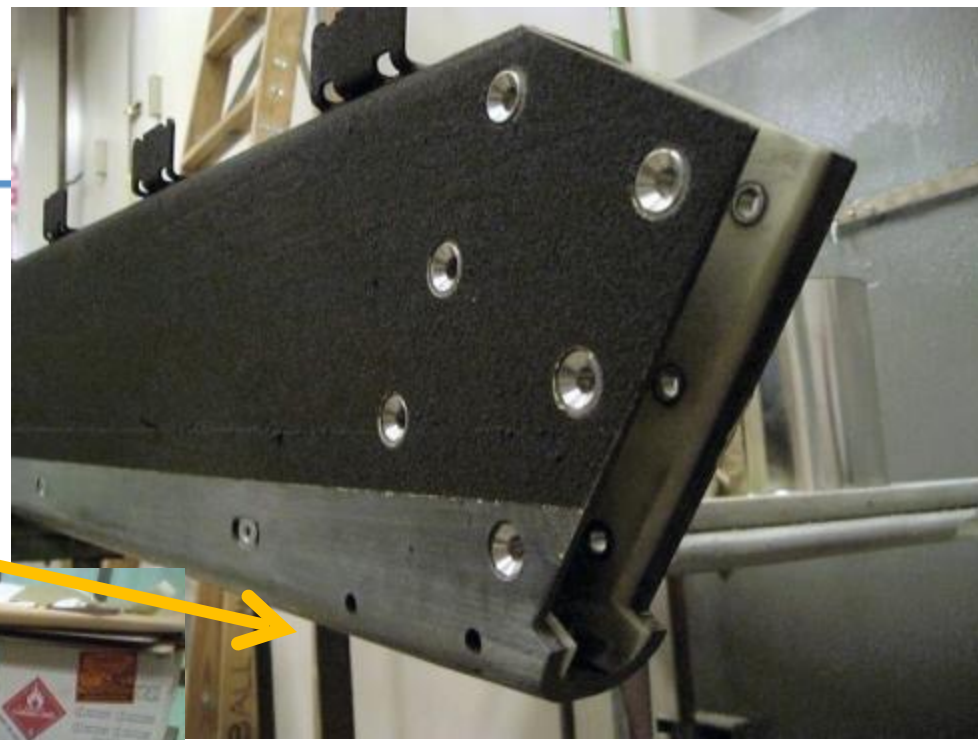




Current unfinished state of Spiders:

Quasi-rounded surfaces with attach points

- Lower edge & surfaces uncoated
- Broadband; “IR mirrors”
- Interface design: to accept Spider Covers
- Uneven → has “facets”



Night view of PM and Spiders with bright illumination and camera located at engine #1 tail cone, TA at roughly 20 degrees.

In-flight wing flex (est. 0.6 m) not simulated – more of PM would be illuminated





- TA a two elevations



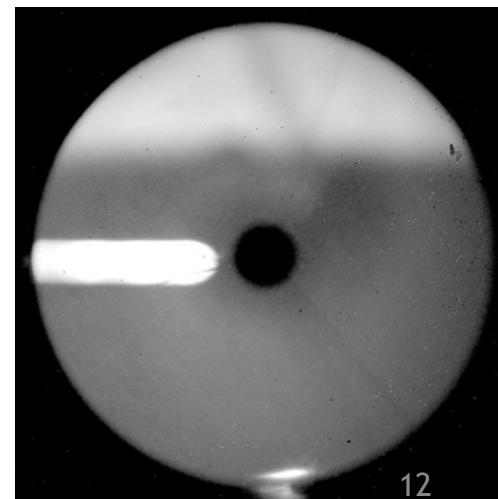
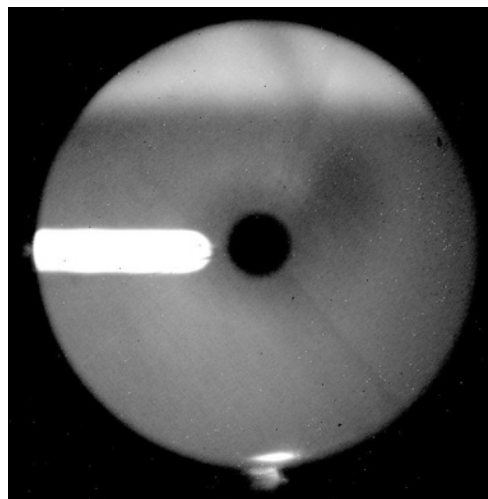
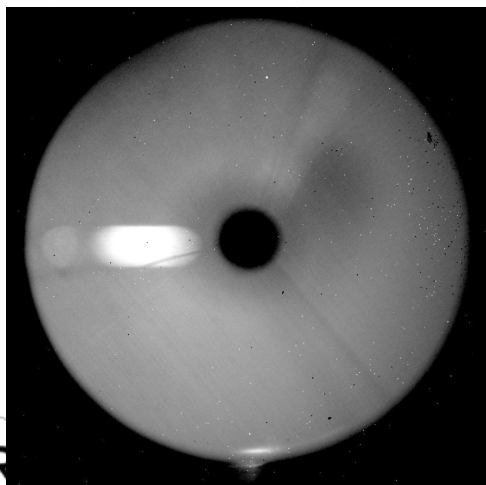
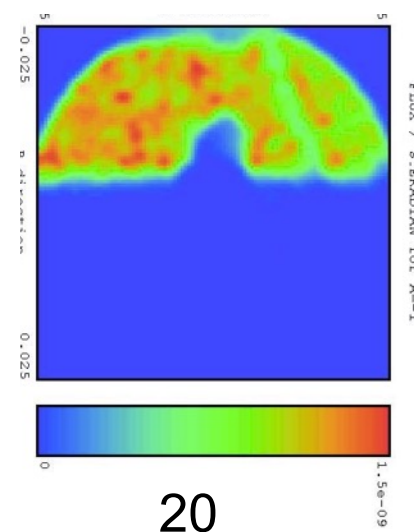
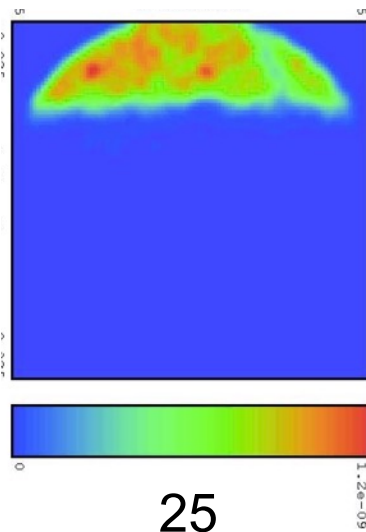
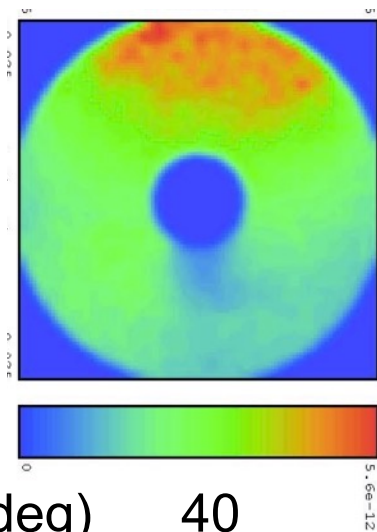
Stray Light Images

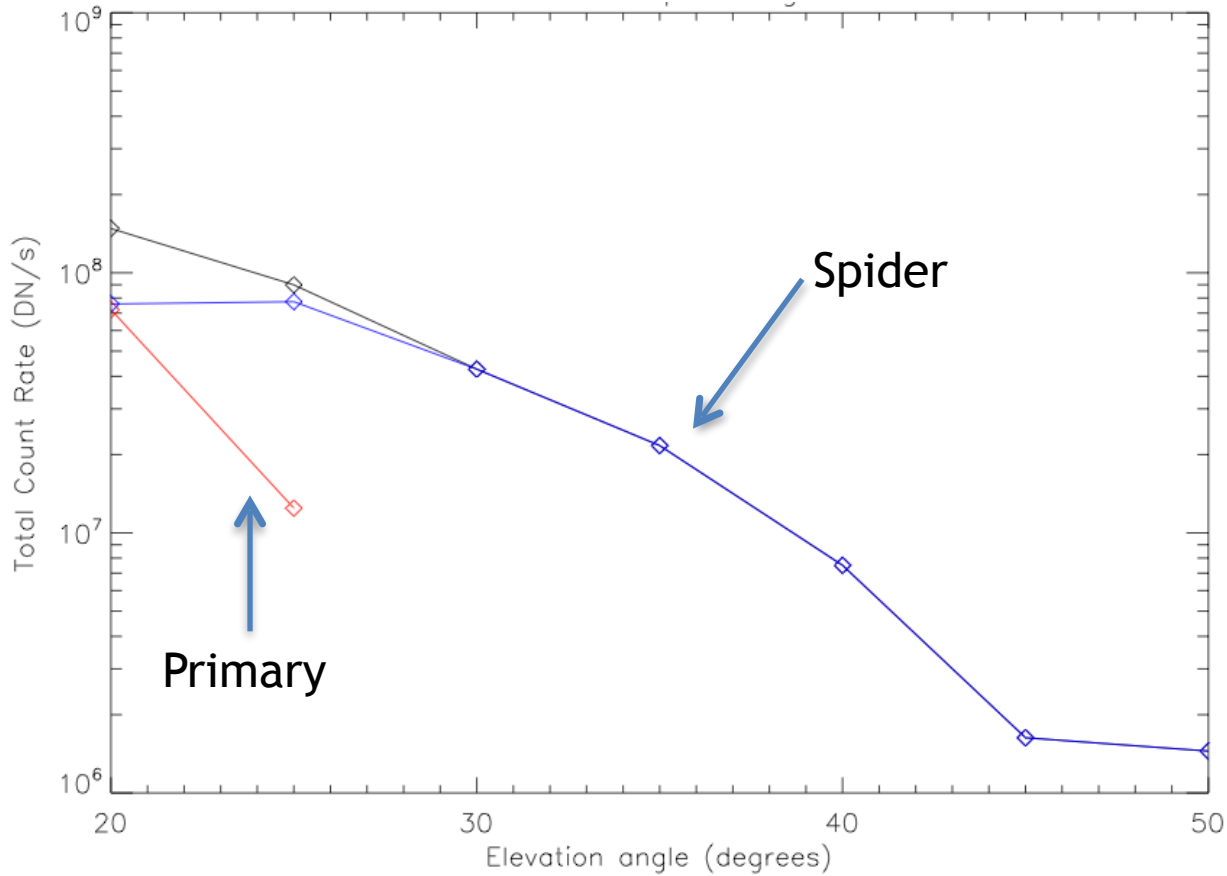


Comparing images with Breault Research Org. stray light studies (5-7 μ m), 1998

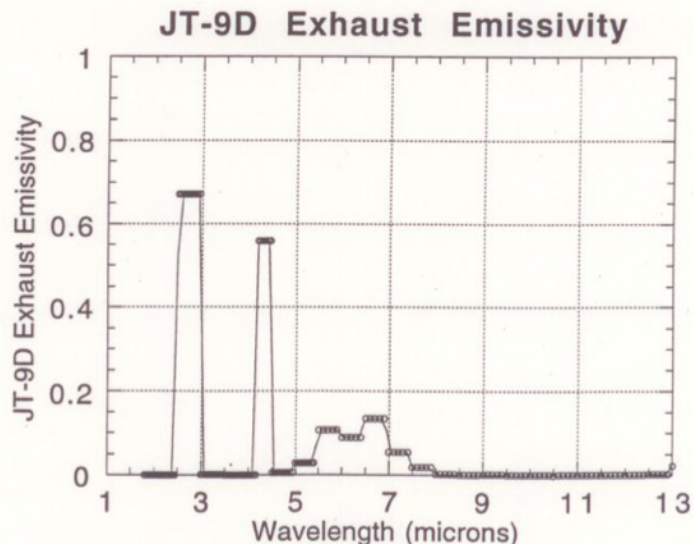
Note: intensity scale change \rightarrow
1/214 for this diagram

Model assumes Level 500 contamination \rightarrow
12,000 x 50 micron particle, sq. ft. = 0.1m²
Not sure how much wing flex is in BRO model

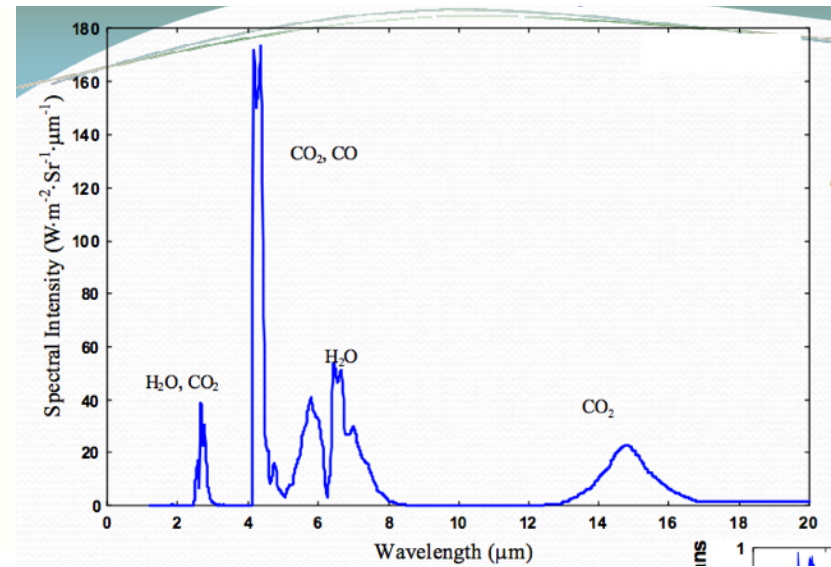




Variable on time scales of few minutes, due to aircraft motions

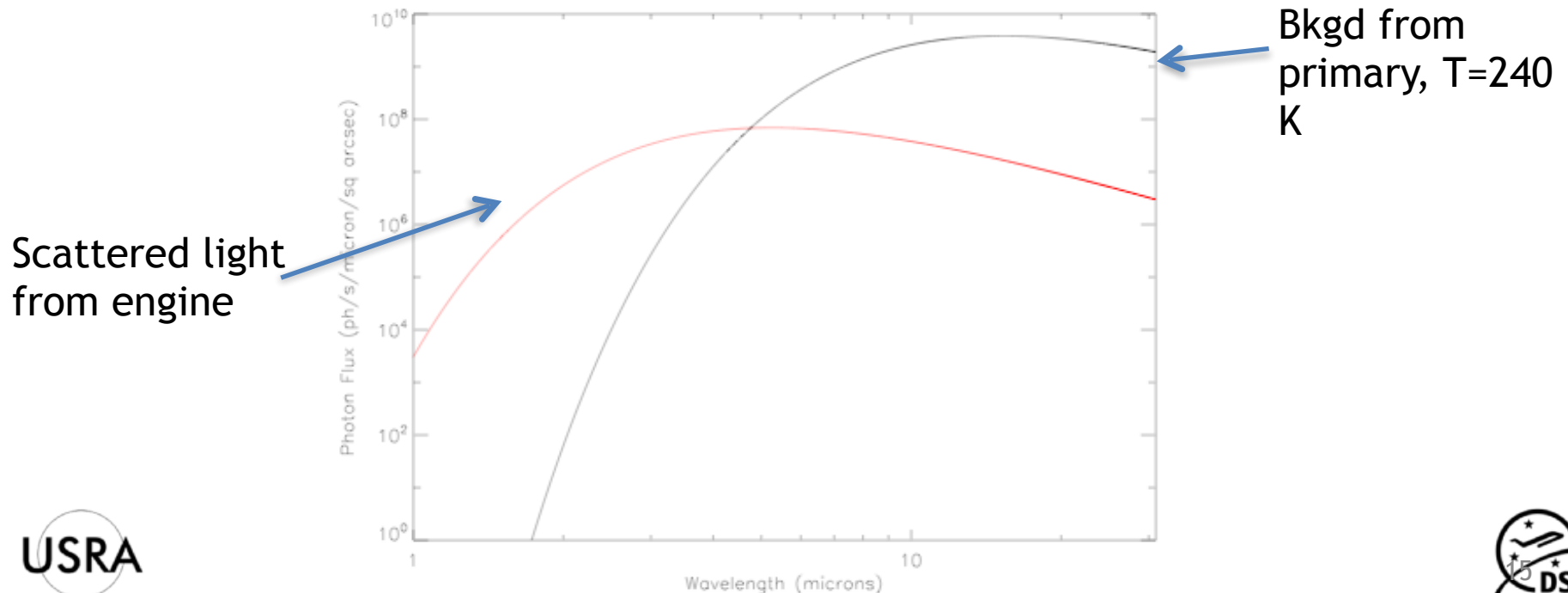


Shuttle Carrier Aircraft (Dinger et. al.)



Simulation (Bao & Buijtenen; TUDelft)

- Some line emission from plume might be detected by spectroscopic instruments working in the 2 to 15 micron region (FLITECAM, FORCAST and EXES). No known measurements.
- Continuum emission from engine cone dominates thermal background only at $\lambda \leq 5-8 \mu\text{m}$
- Nod subtraction should remove both to a large degree (for small nods), since emission is additive; however, extra background will increase the noise, and background is variable due to changes in aircraft roll
- Black baffles on spiders should decrease stray light flux by orders of magnitude.





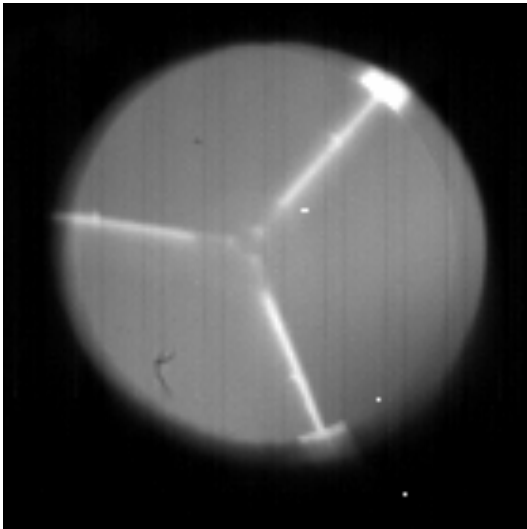
FORCAST Pupil images at 6.4



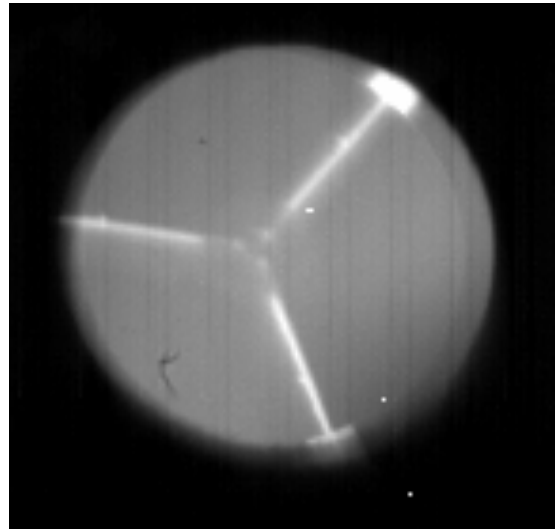
μm

No extra background seen;
No change with tel elevation

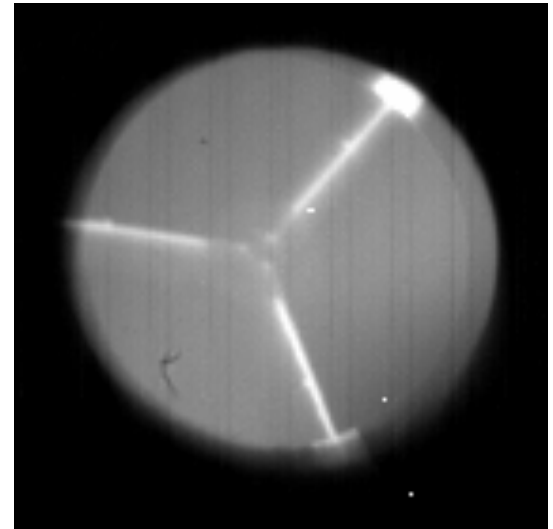
Raw 21 γ elev



Raw 40 γ elev



Raw 57 γ elev

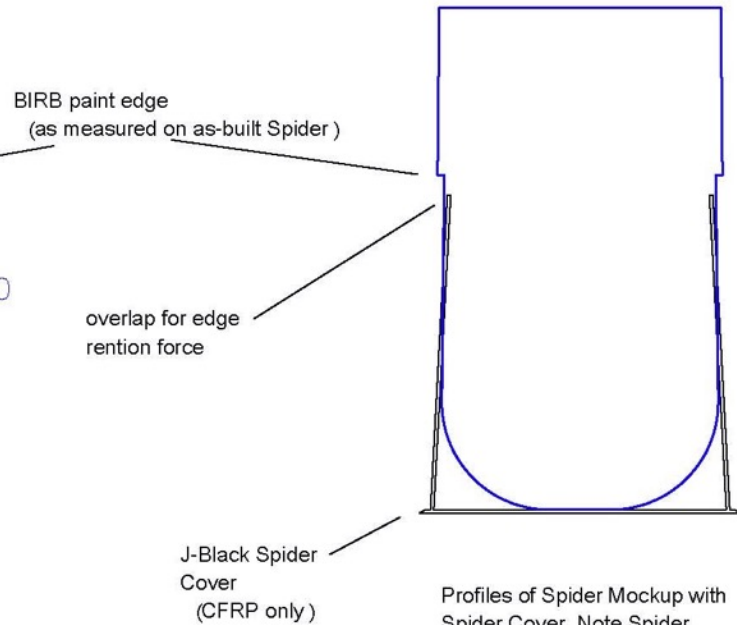




Spider Covers to Reduce Stray Light

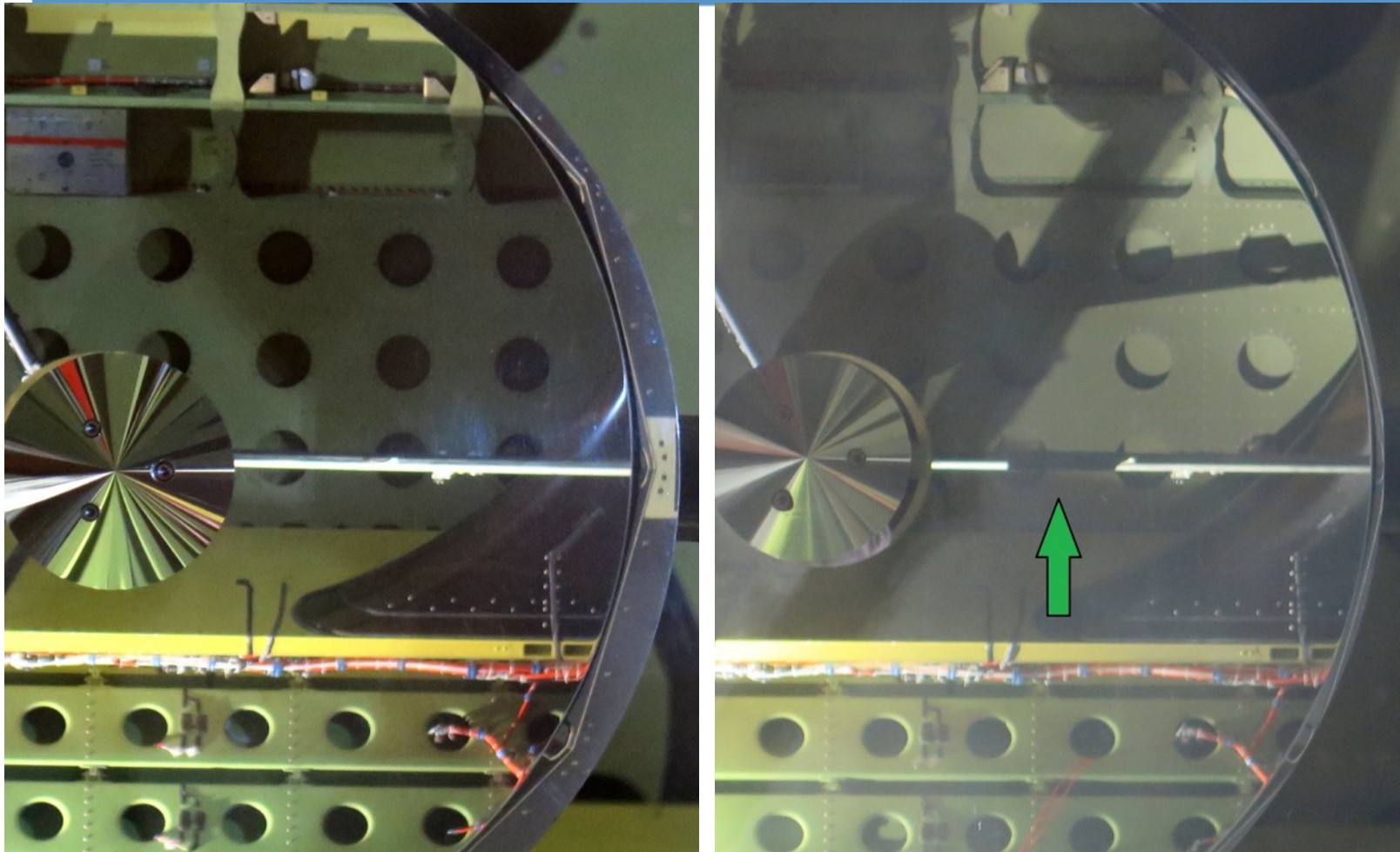


J-Black Spider profile



Profiles of Spider Mockup with Spider Cover. Note Spider Covers are designed to flex outward when mounted.





Spider Covers as baffles



Spider Covers as baffles – fabrication schedule (2016)

- Jan – Measure as-built Spiders and compare with dwgs.
- Feb – Fabricate Spider Cover fabrication jig and Spider Cover Mock-up (300 mm section)
- Apr – Test fit Mock-up
- May – Acquire all materials & parts
- Jun/Jul – Fabricate CFRP components, load test, assemble & distribute reports
- Jul/Aug – Apply J-Black, further testing
- Aug – Parts & paperwork delivered for test fit and integration



Backup



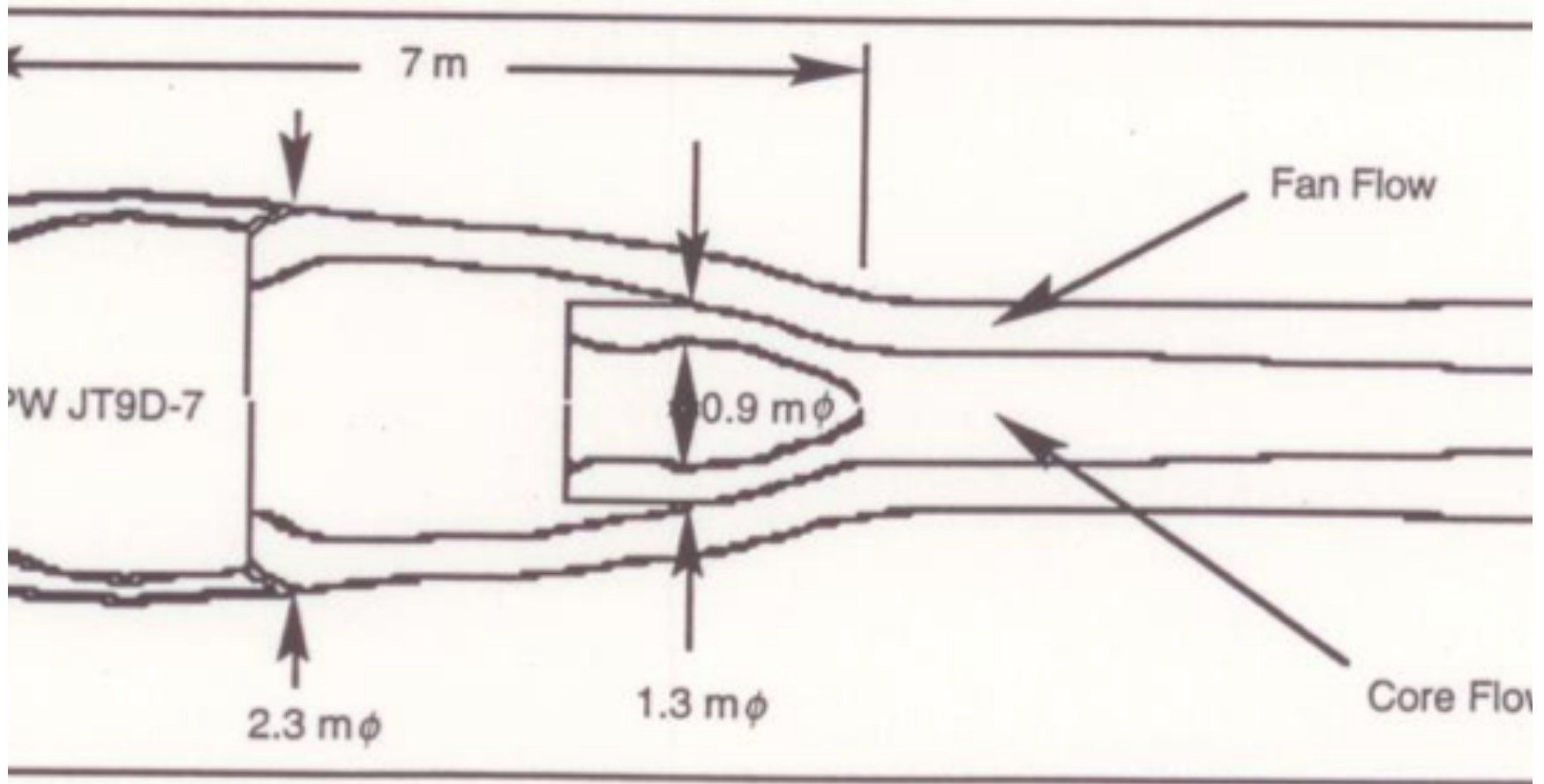
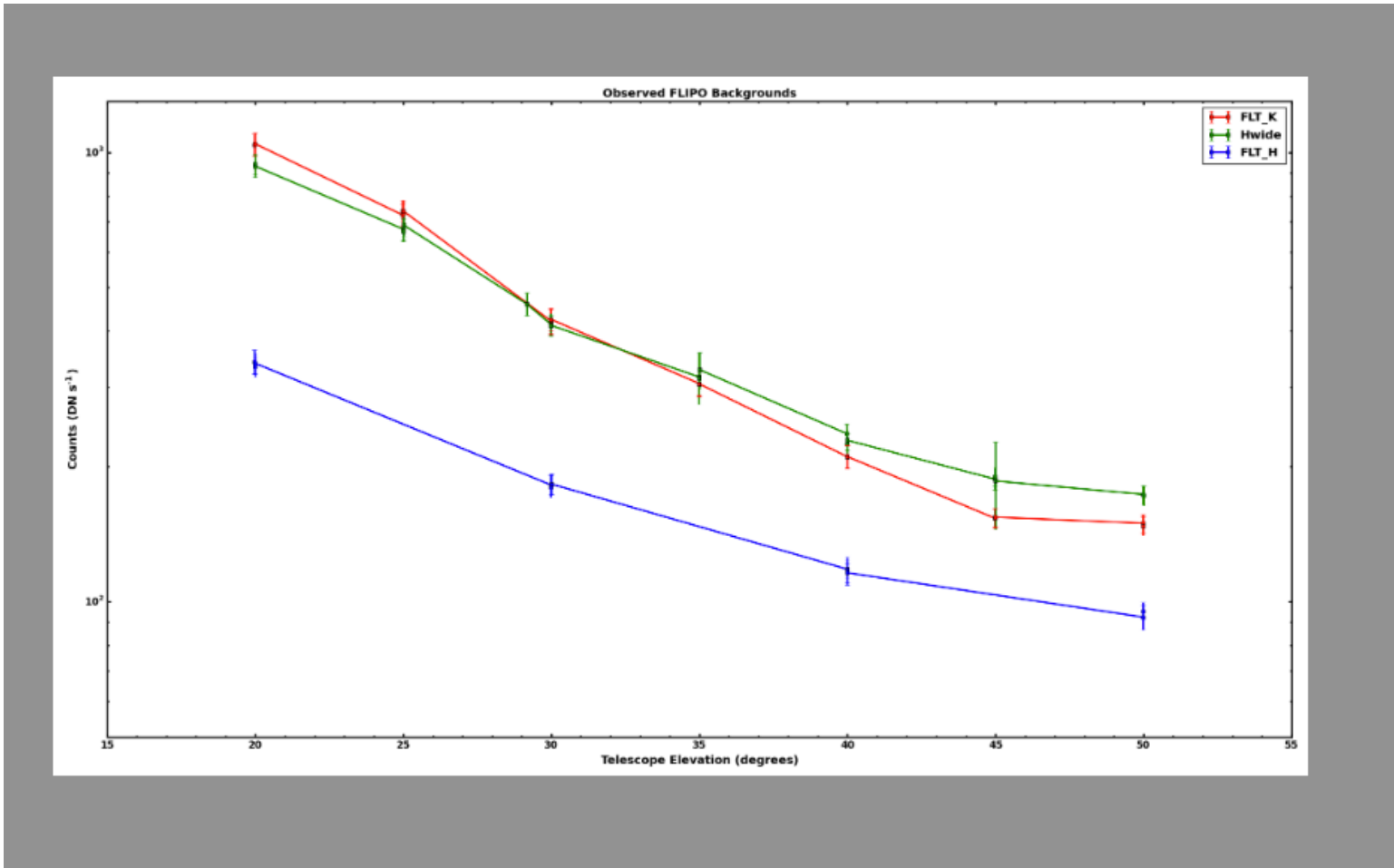


Figure II-1. Sketch of P&W JT9D-7 Jet Engine and Exhaust

Engine 1 Cone and Cavity Door



Measured Background Vs Lambda



SOFIA Exhaust Plume Emissivity

