This is a first-draft response to the question:
Roughly what aperture can we expect to propose as a NASA Probe class concept?

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Cost of constructing mirrors and structure

Actual cost: For optical telescopes this is an important driver. For mm-wave telescopes the tolerances on the surface of the mirrors are relatively easier to meet. Herschel, for example, had a 3.5m diameter primary mirror. So, the actual production cost of the mirrors is not a big driver.

Modeled cost: NASA cost models very frequently take instrument mass as an important input. The bigger our mirrors, the bigger our structures and sun shades, and therefore more massive. So, cost models will produce higher cost estimates. We will need a well-told cost story and comparables to explain our cost estimates. So, there is some cost evaluation risk in being large/heavy, even if the actual hardware is not too challenging and expensive. However, this is probably not our driver in selecting our telescope design. Fairing size is…

Physical Limit - Fairing Size

We will almost certainly want to propose a Falcon 9 launch vehicle (no other cost effective options).
Falcon 9 fairing has 4.6m usable diameter.
From Falcon 9 Users Guide →

Context:

- EPIC-IM concept was in Atlas V 401 (3.75m diameter usable).
- Both CORE and the ESA Apr-2016 CDF report assumed the Arianne 6, which is 4.6m diameter like the Falcon 9

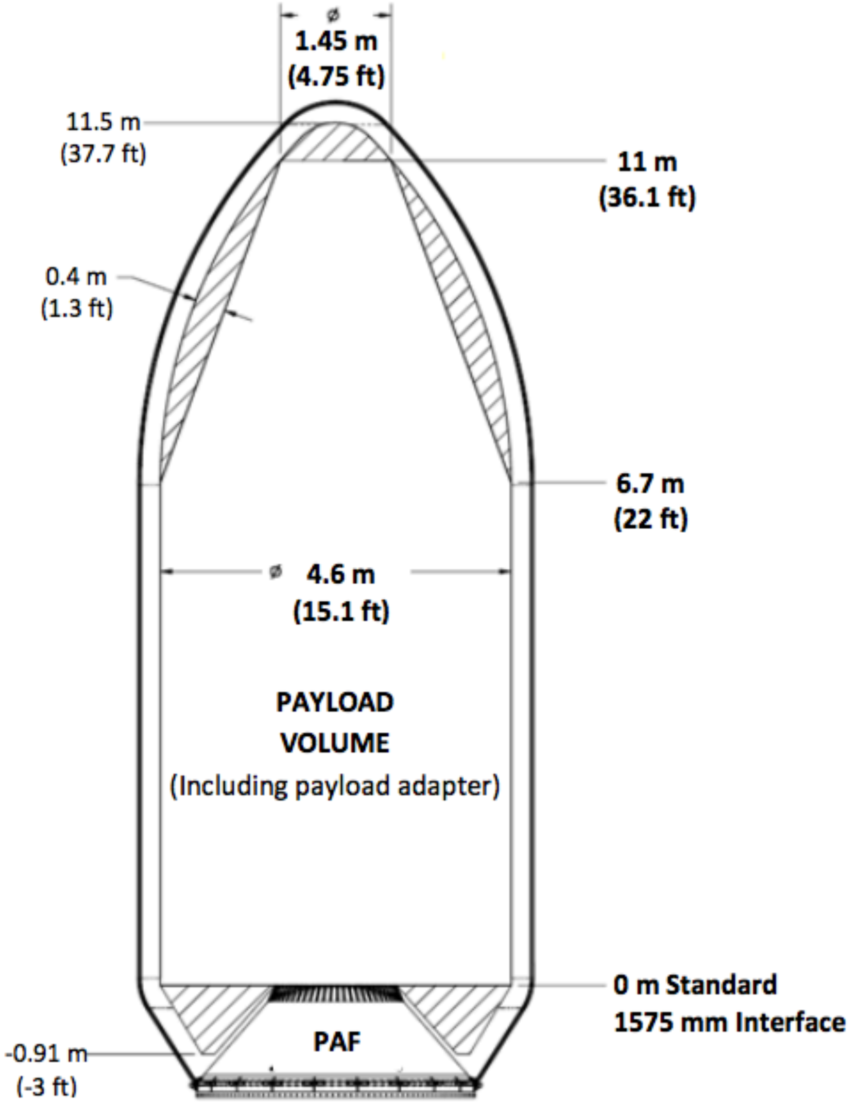


Figure 5-2: Falcon 9 fairing and payload dynamic envelope[3], meters (feet)

[3] Payload dynamic envelope (shown as "payload volume") indicates the volume that the spacecraft is allowed to move within, without intrusion by the fairing due to its dynamic motions.

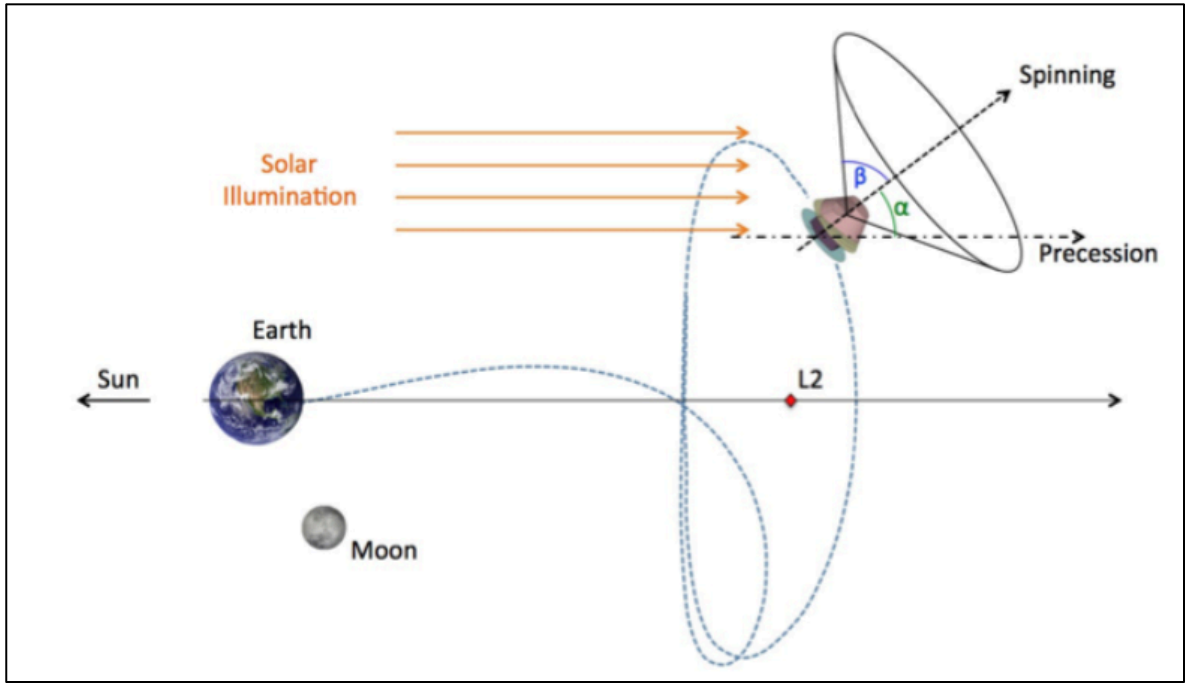
Geometrical considerations

- Must fit in fairing
- No Sun or Earthshine on telescope (optical, thermal problem)
- Focal plane should be down close to spacecraft body (not floating up high), so that it can be appropriately mechanically supported and kept cold (don’t want long thermal paths)
- Need multiple thermal stages protecting the cold instrument
- Do not want deployables (too expensive and risky − unless you want to make this your risky thing and go with old detectors, etc. − which I don’t think you do)
- To reduce systematics, desire to spin and to precess the spin-axis

Lots of people have thought about this − lets leverage that..

Summary of Findings

When studying science capabilities to set science requirements, assume we won't have an effective aperture larger than 1.2m (like CORE), unless you want to fly something more like Planck, with a very limited scanning strategy (spin axis not more than ~10° off Sun-Spacecraft axis).
At this point, I recommend assuming CORE-like optics as the working (changeable) baseline.

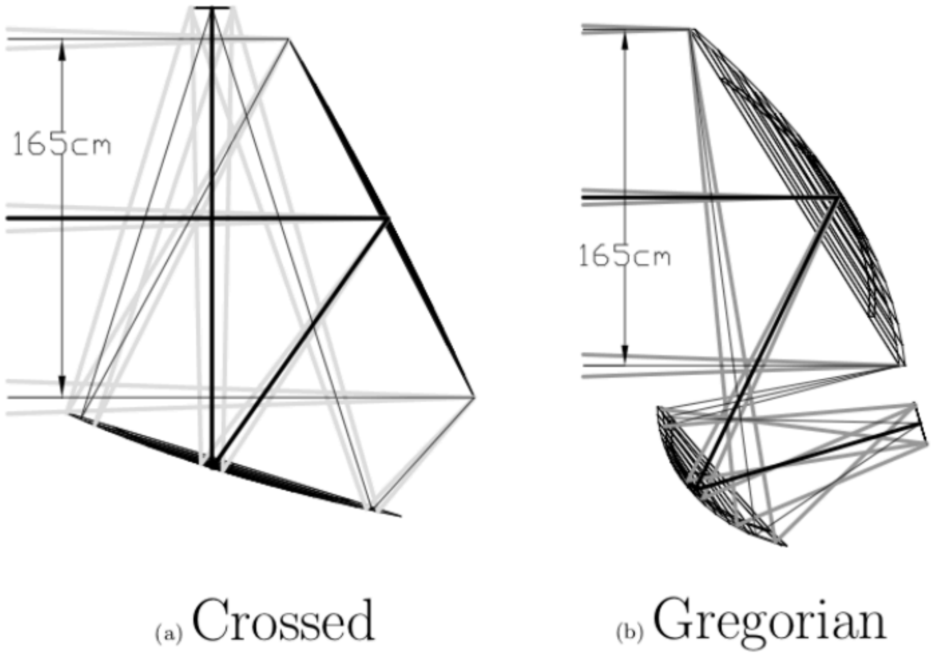


	α	β	Telescope	Effective aperture
CORE (same fairing diameter)	30°	65°	Crossed-Dragone	1.2m
ESA-CDF (same fairing diameter)	55°	45°	Gregorian	1.2m
Planck (slightly smaller fairing)	7.5°	85°	Gregorian	1.5m
LiteBIRD LFT	65°	30°	Crossed-Dragone	0.4m
EPIC-IM (high cost, risk)	45°	55°	Crossed-Dragone	1.4m

More detail on following slides…

Crossed-Dragone vs. Gregorian Mizuguchi–Dragone

Tran et al. 2008



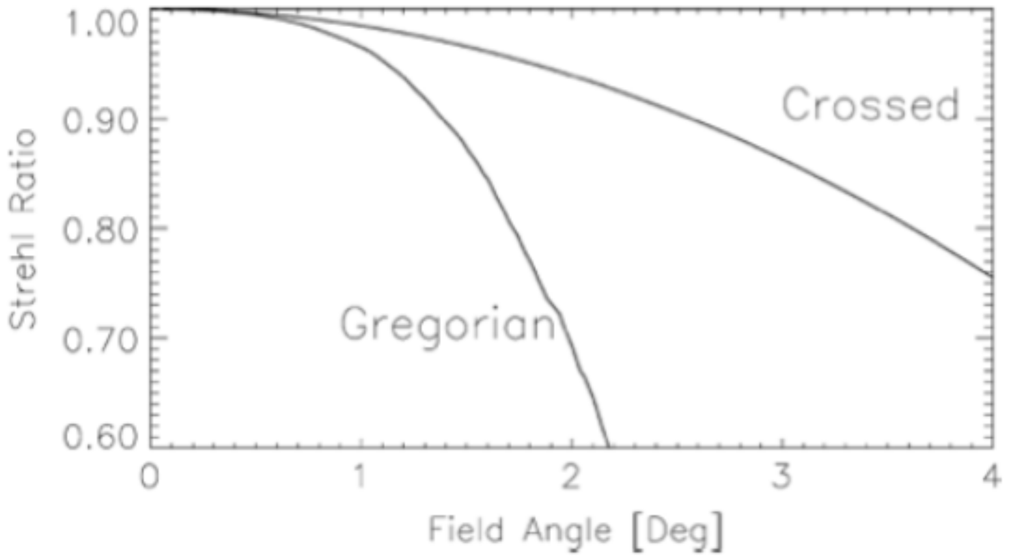
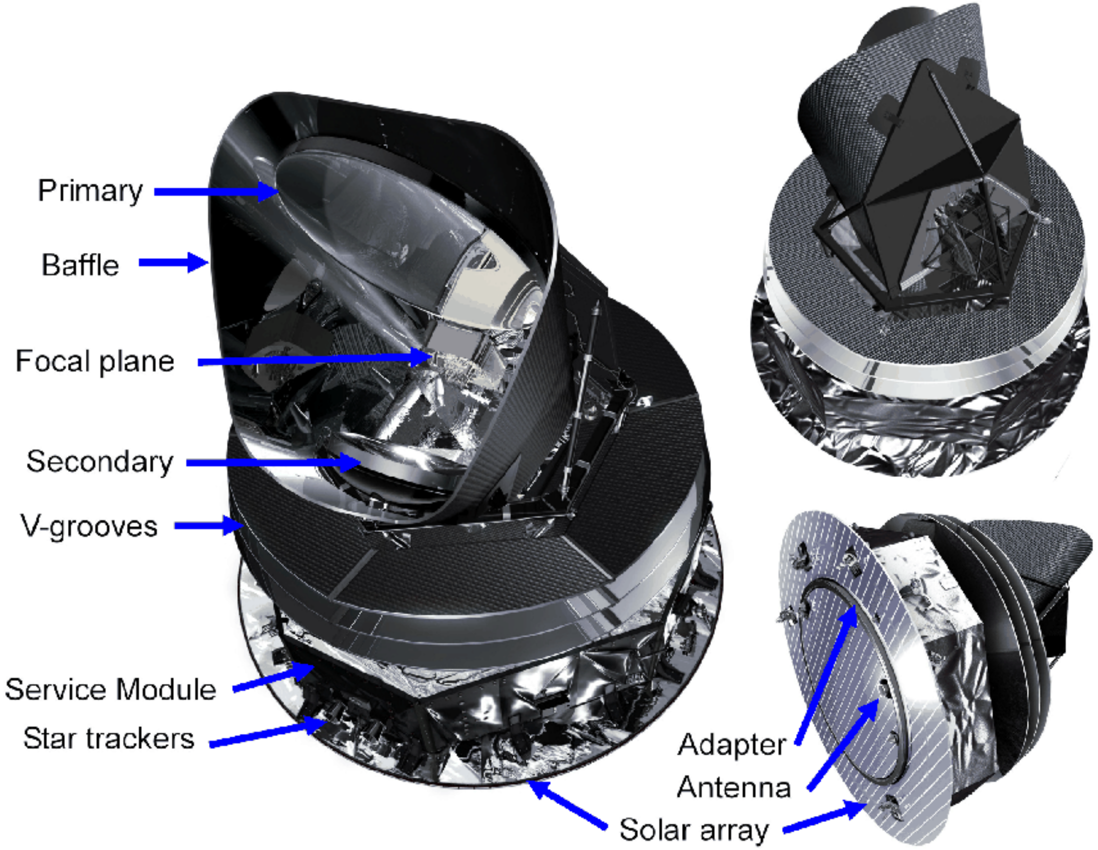


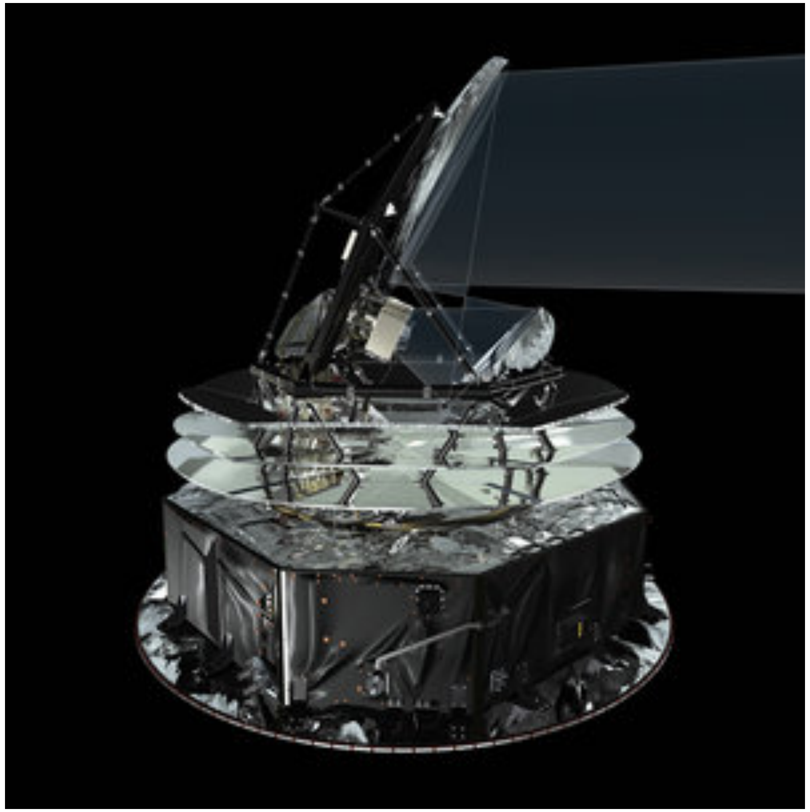
Fig. 2. Strehl ratios across the focal plane, calculated at 150 GHz. Crossed shows a clear advantage in terms of DLFOV. A design is considered diffraction-limited if the Strehl ratio is above 0.8.

Crossed-Dragone has 2x larger diffraction-limited FOV
Crossed-Dragone has ~10dB better cross-polarization performance

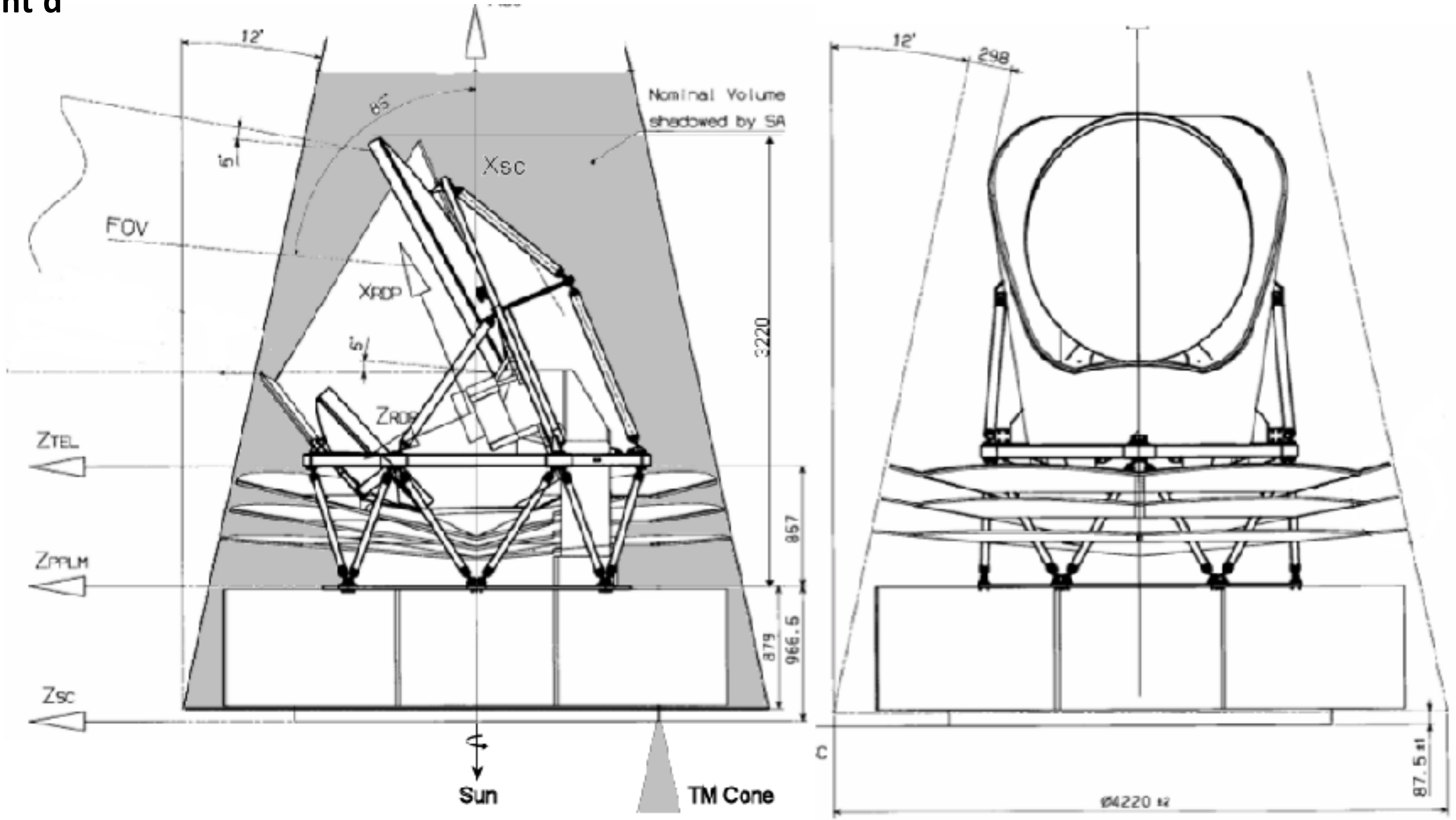
Planck

- V-shaped (shallow angle) Vgroove radiators + Shield
- Gregorian telescope / effective aperture 1.5m / primary mirror 1.9m x 1.5m
- Boresight 85deg off spin axis, Spin axis 7.5deg off Sun-Spacecraft axis





Planck cont'd



4.2m

Proposal Sensitive – Do Not Disseminate

EPIC-IM Concept

- 3 V-groove radiators + 4 very large (>15m) deployable sunshade layers + Optics tent to shield telescope
- Crossed Dragone telescope / effective aperture 1.4m / primary mirror 2.2m x 2.2m
- Boresight 55deg off spin axis, Spin axis 45deg off Sun-Spacecraft axis

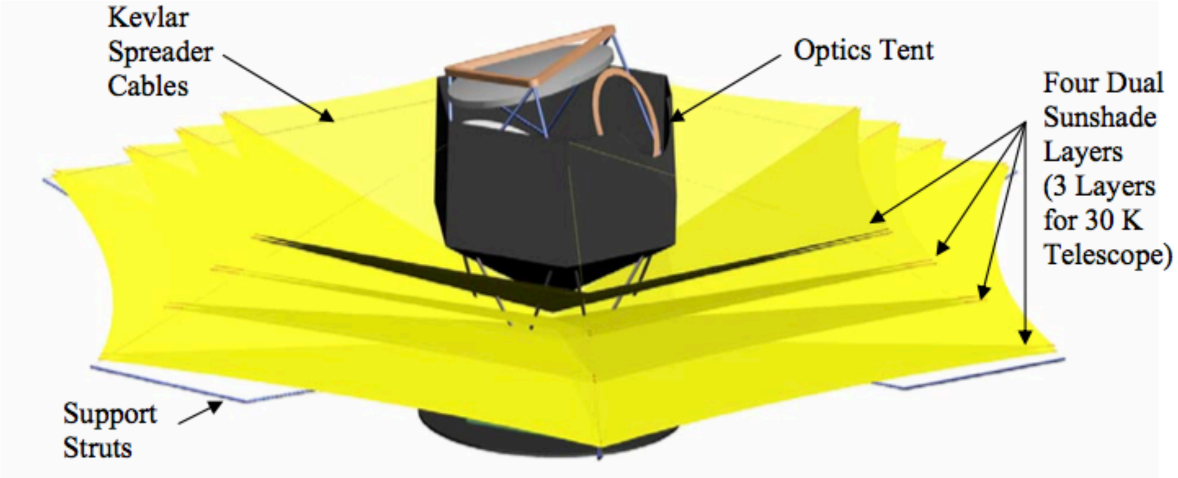


Fig. 9.1. Deployed 4 K telescope sunshade with optics tent (central V-groove radiators not visible).

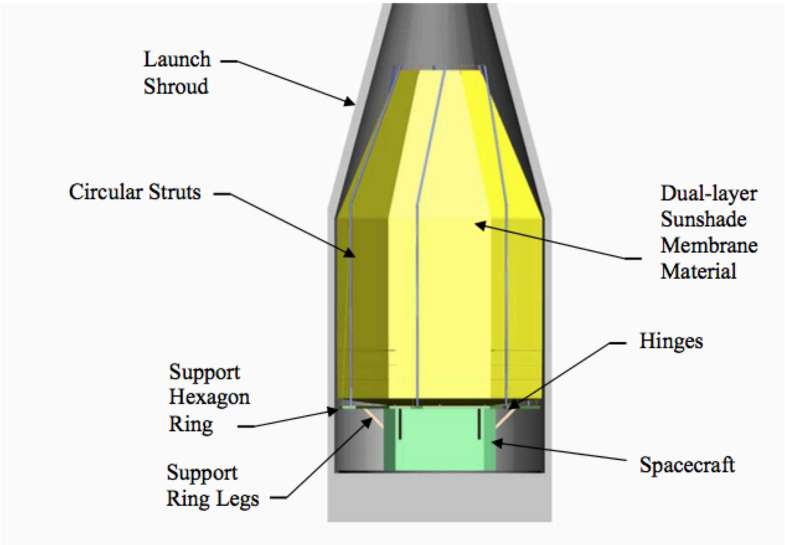


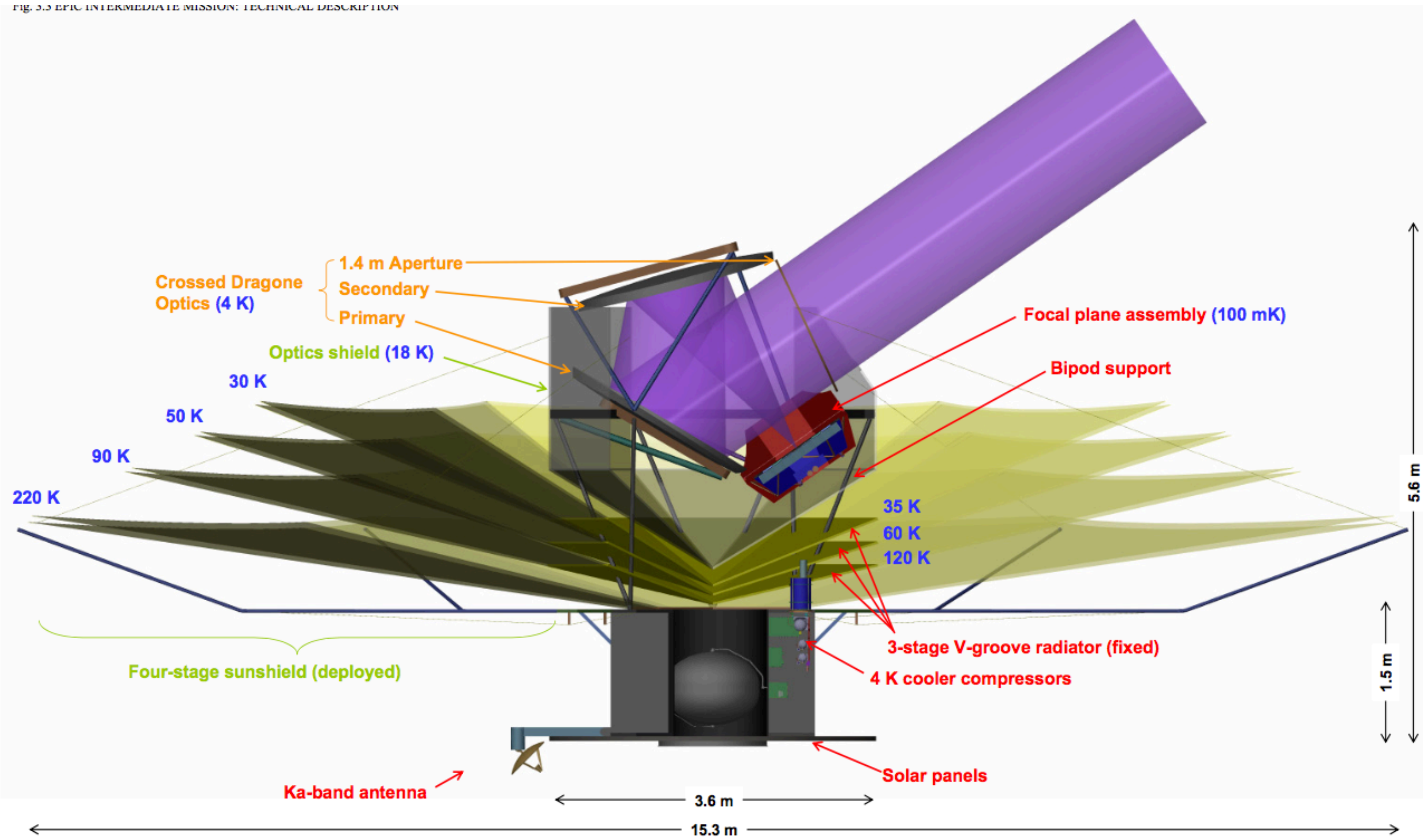
Fig. 9.3. Stowed configuration of the sunshade inside the Atlas V 401 launch shroud.

I strongly recommend against this approach (large deployable). It would be expensive in design, build, and test, and would be viewed as risky (and therefore expensive/unselectable) by a proposal review board.

Also, even the Team X EPIC-IM cost estimate exceeds $1B when you inflate it to today's dollars − not a good cost posture.

The Atlas V 401 has a smaller fairing than Falcon, so maybe they felt they were stuck with this approach at the time, or maybe a solution looking for a problem.

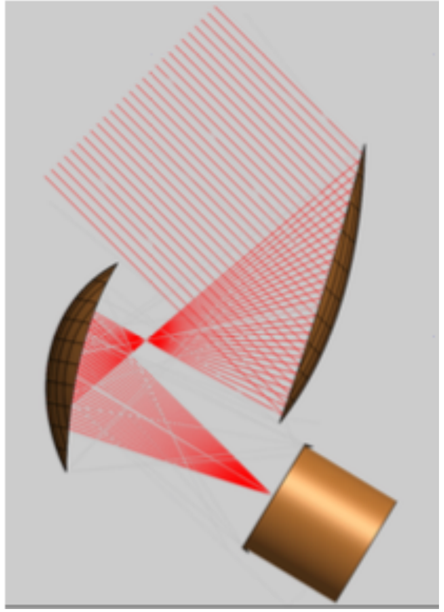
EPIC-IM Concept cont'd

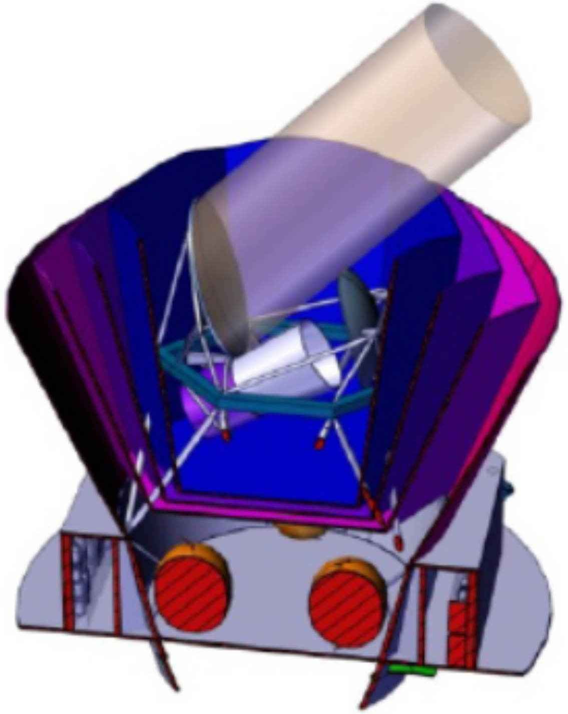


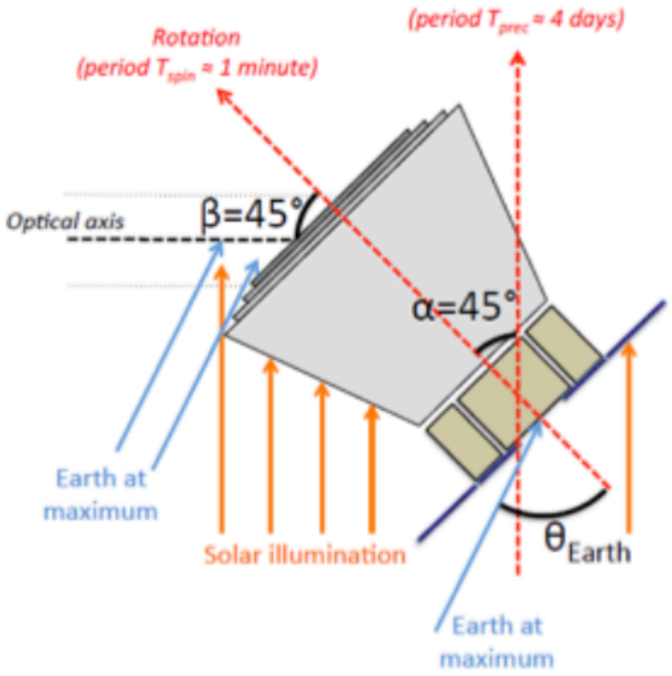
Proposal Sensitive – Do Not Disseminate

ESA Apr-2016 CDF report Concept (~same fairing diameter as Falcon 9)

- 3 Tulip-shaped (steep angle) V-groove radiators + sunshield
- Gregorian telescope / effective aperture 1.2m / primary mirror 1.5m x 1.2m
- Boresight 45deg off spin axis, Spin axis 50deg off Sun-Spacecraft axis



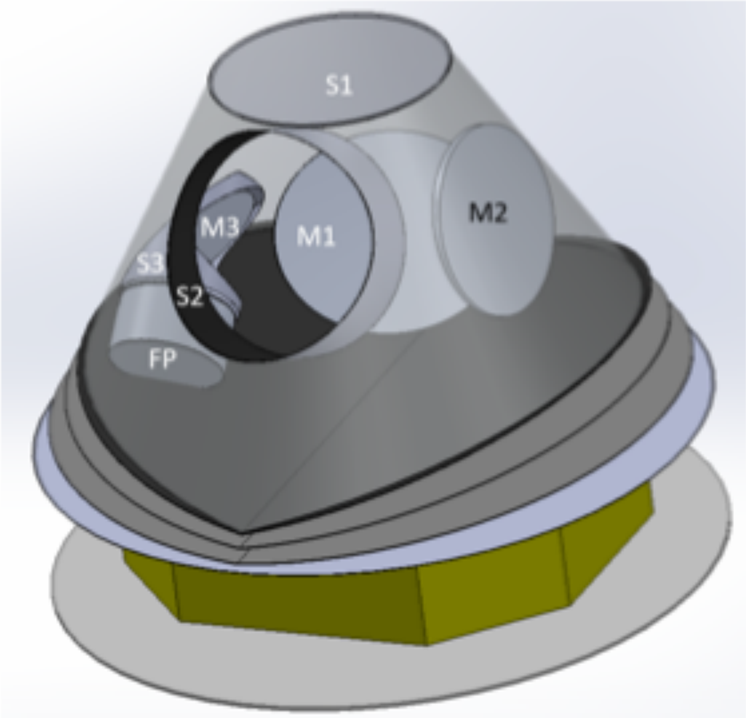


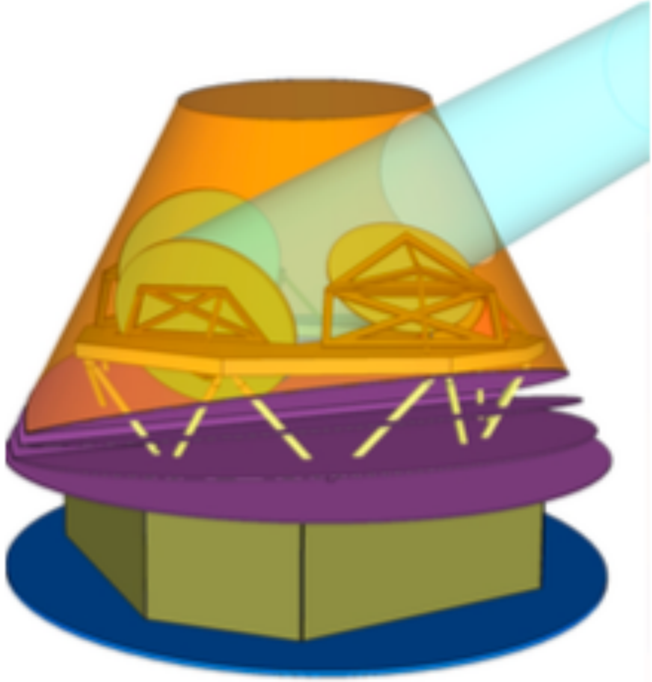


Snug fit in 4.6m fairing − no room to grow

CORE Concept (~same fairing diameter as Falcon 9)

- V-shaped (shallow angle) Vgroove radiators + Shell
- Crossed Dragone telescope / effective aperture 1.2m / primary mirror 1.5m x 1.3m
- Boresight 65deg off spin axis, Spin axis 30deg off Sun-Spacecraft axis





Snug fit in 4.6m fairing
– no room to grow