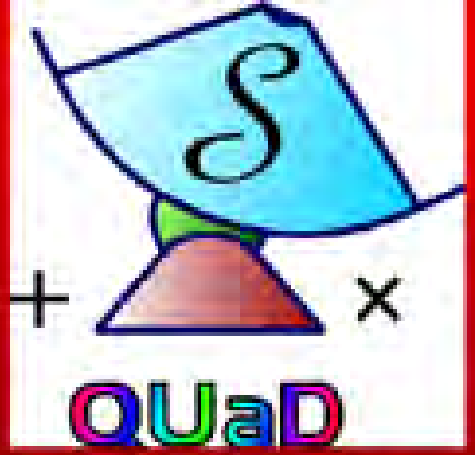


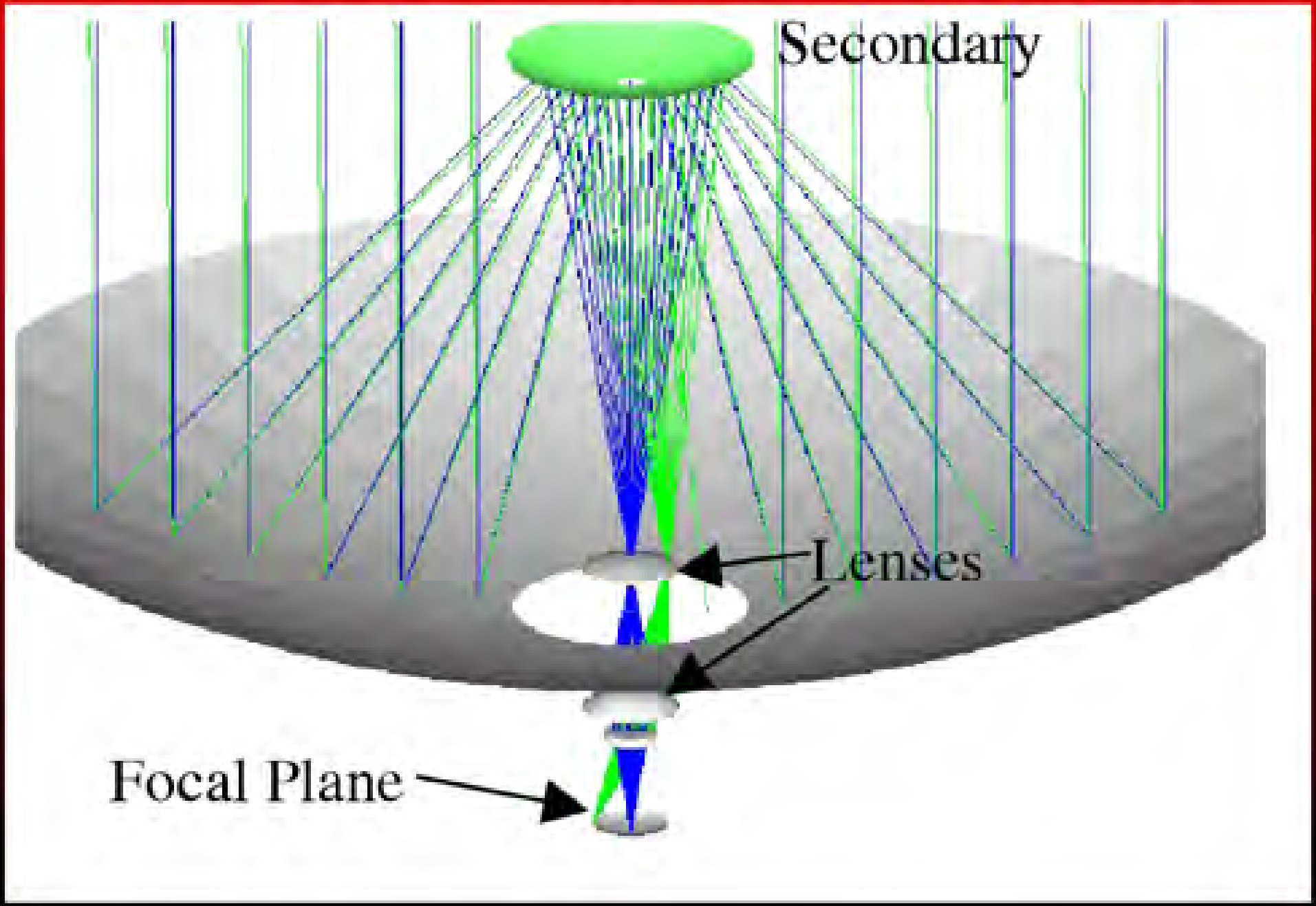
Suitability of On Axis Reflector Designs for Space

Clem Pryke

CMBpol Technology Workshop

28 August 2008

On Axis Reflector System (QUaD)



Disadvantages

- Blockage of primary aperture by secondary
  - Produces near sidelobes and loss of efficiency
  - Large field of view requires large secondary making efficiency loss worse
- Secondary support structure scatters light
  - Far sidelobes
  - Further loss of efficiency
- Secondary illuminates annulus between receiver entrance aperture and edge of primary hole
  - More far sidelobes (although can baffle)
- Diffraction from edge of secondary
  - More far sidelobes

Advantages

- None(?)
  - Well actually can have low (zero) instrumental cross polarization
    - But IP is degenerate with rel gain for pair difference systems...
  - And for terrestrial applications cheaper, and easier to rotate around line-of-sight

- Community consensus is that off axis is better:
  - EBEX, CLOVER, POLARBEAR, QUIET, ABS, SPTpol

QUaD Secondary Support Foam Cone

- For on axis polarimeter conventional feedlegs cause problems
- In addition wish to keep mirrors warm to prevent snow accumulation

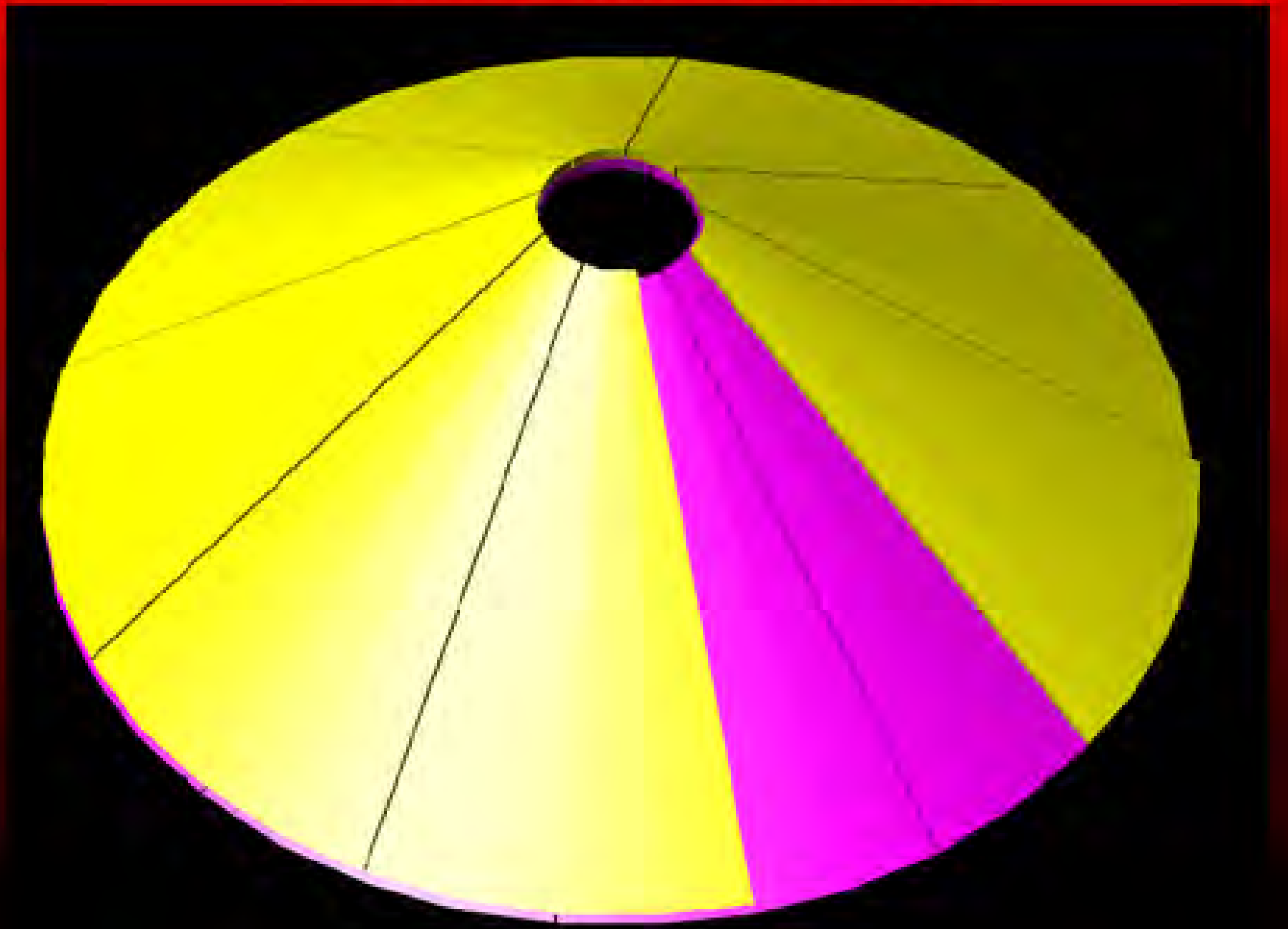
- Material Zotefoam PPA30 is legendary in the field for its transparency at these wavelengths
  - Polypropylene copolymer expanded using dry nitrogen
  - Used for cryostat windows...

- But manufactured only in 6x3' flat sheets
  - How to make a 9' base diameter cone?

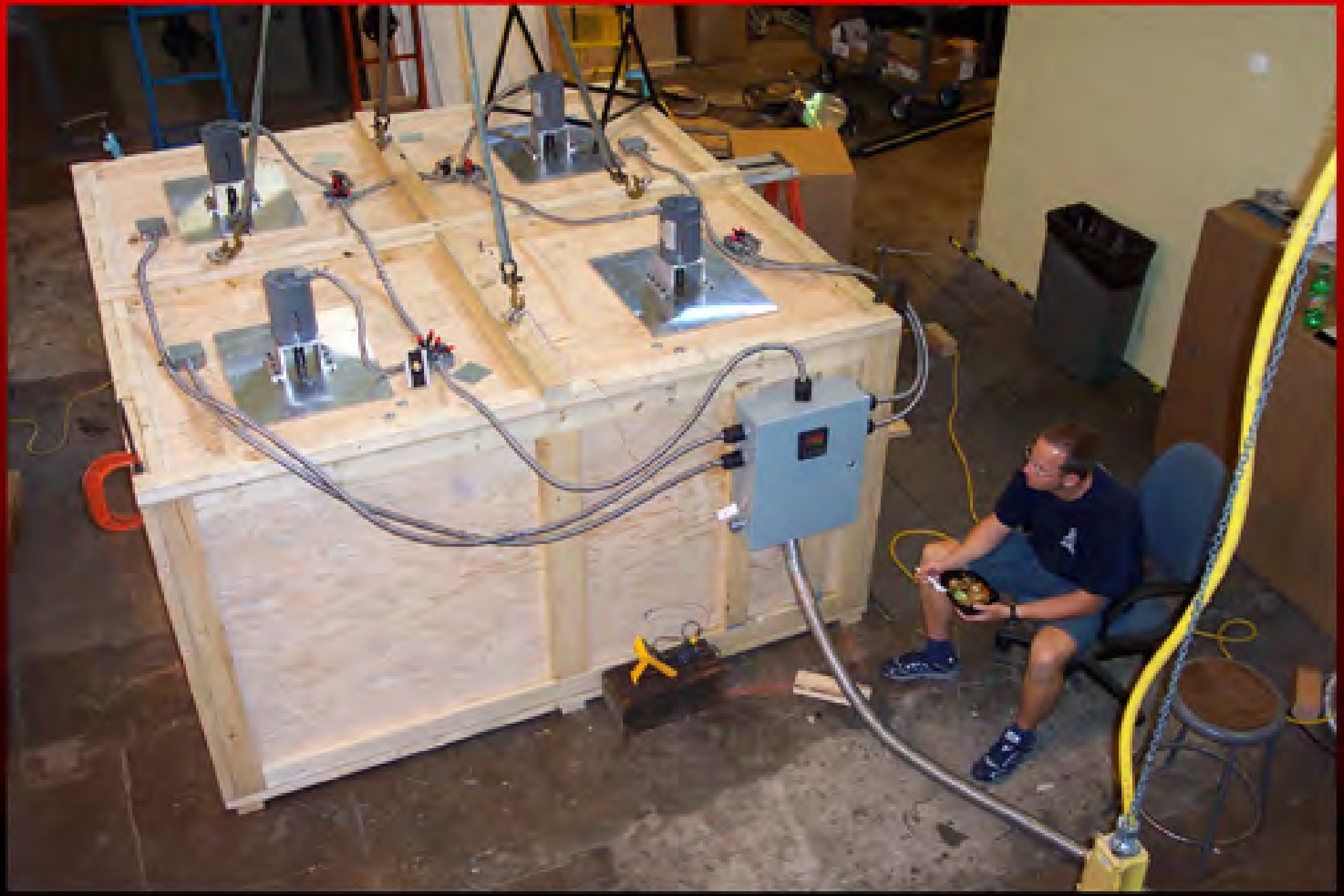
Foam Cone II

- Material can be thermoformed
  - Force into desired shape, heat to 150C, cool, holds shape
- Make 40deg sections of conical surface and trim to fit together
- Glue 2 layers of 9 sections each with joints offset by half a section
  - Make a 1 piece continuous cone
- Need an RF transparent adhesive…
  - Used a 2mil acrylic transfer tape product from 3M

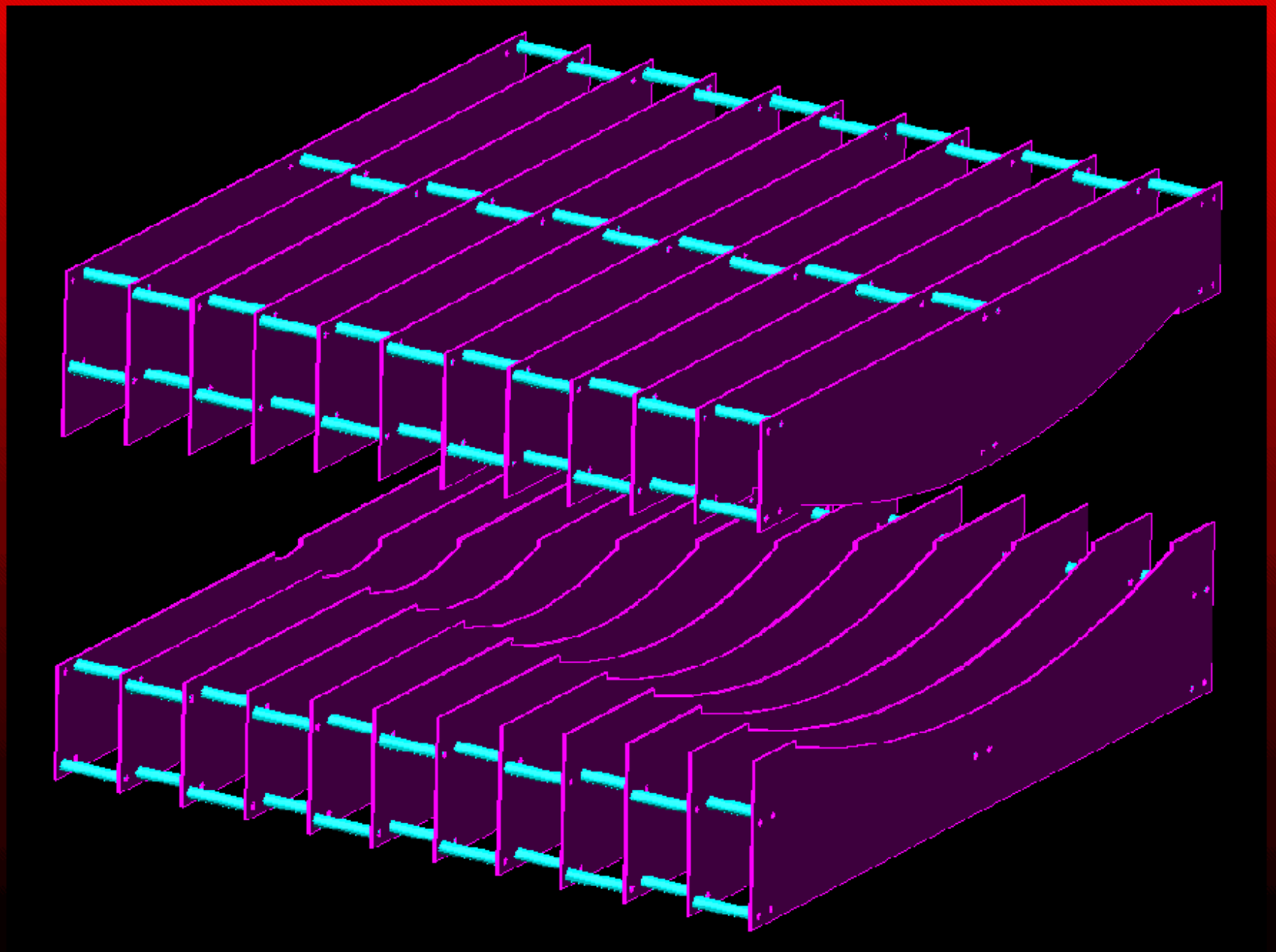
Foam Cone Concept



Thermoforming Oven



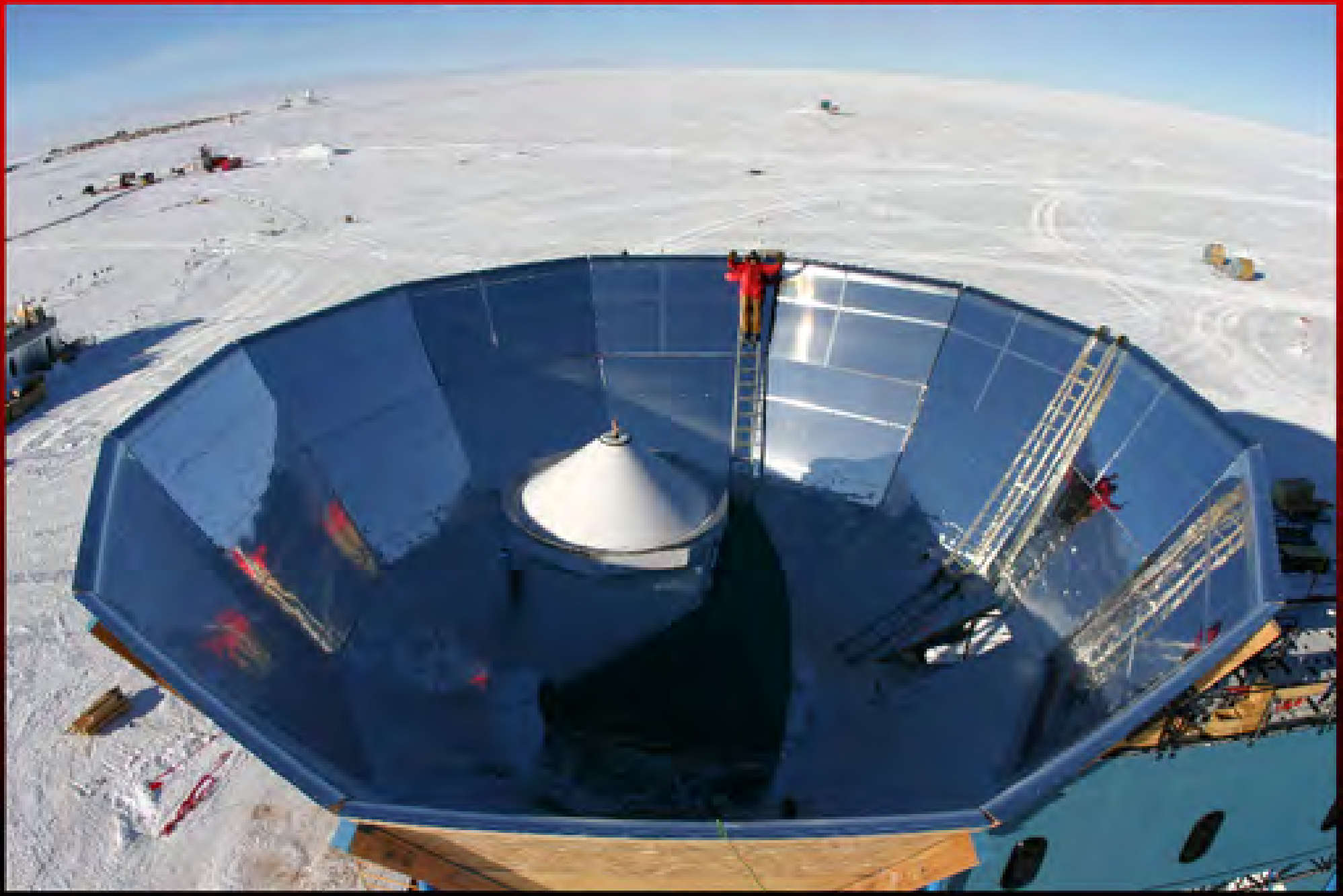
Per Section Oven Form



Ahh - The Smell of Fresh Cooked Foam!

Full Size Form and Vacuum Bagging

QUaD at South Pole Feb 2005



Far Sidelobes

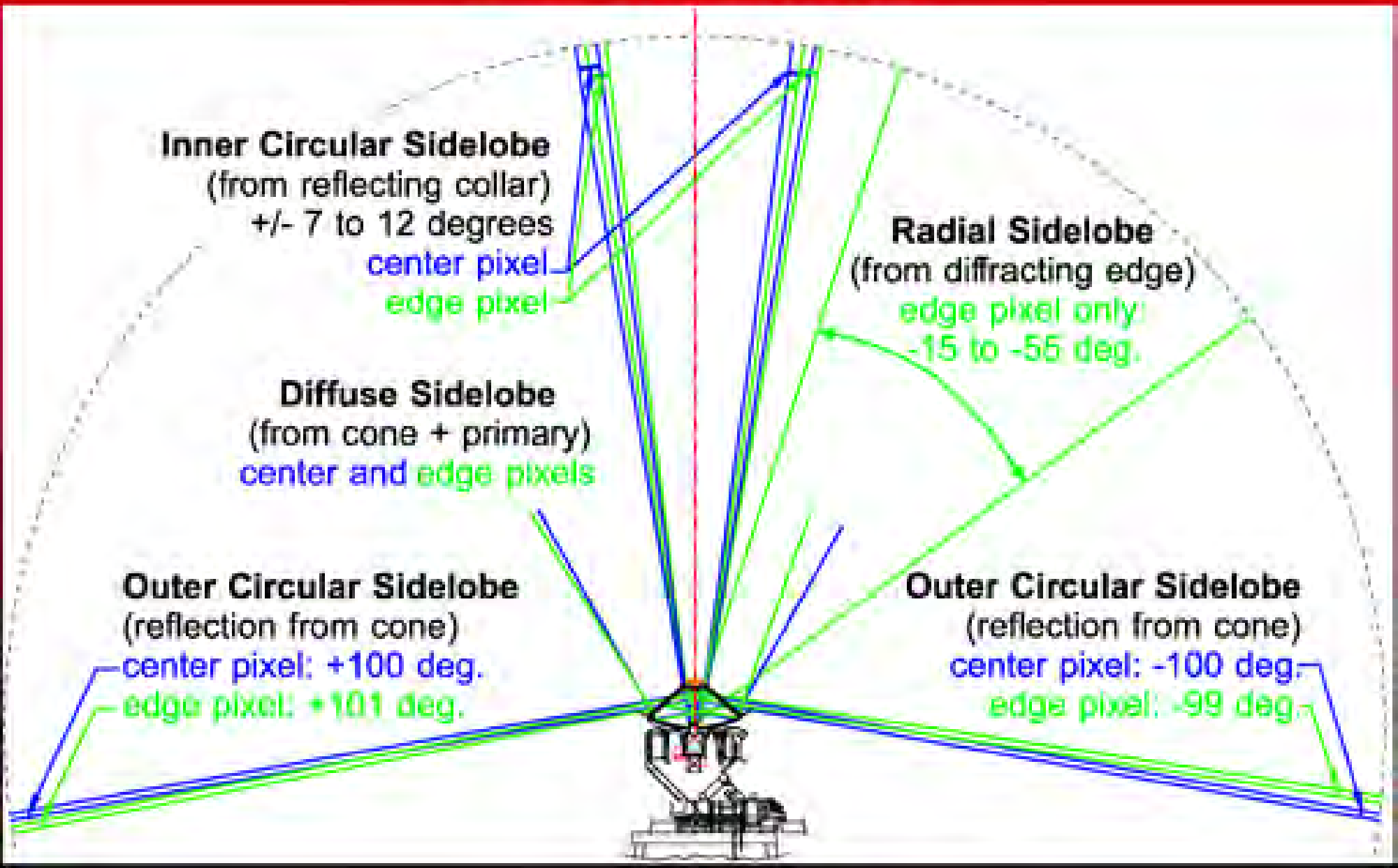
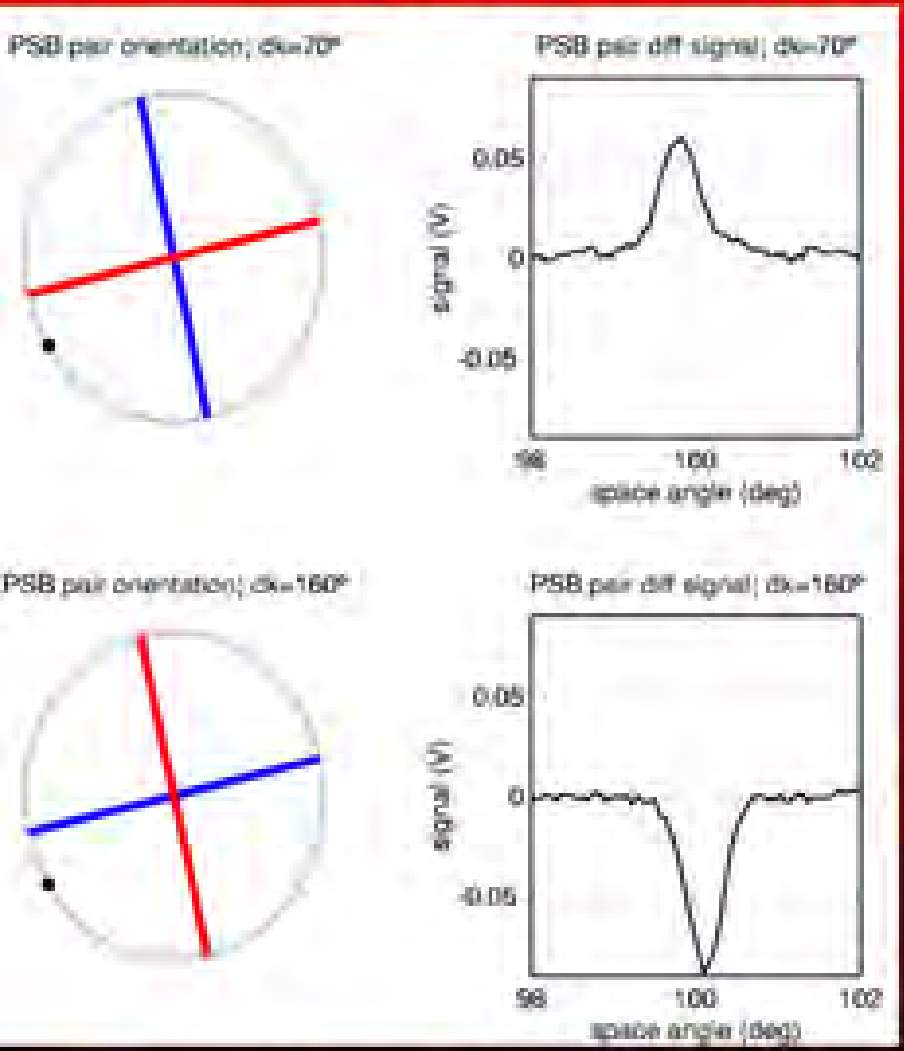
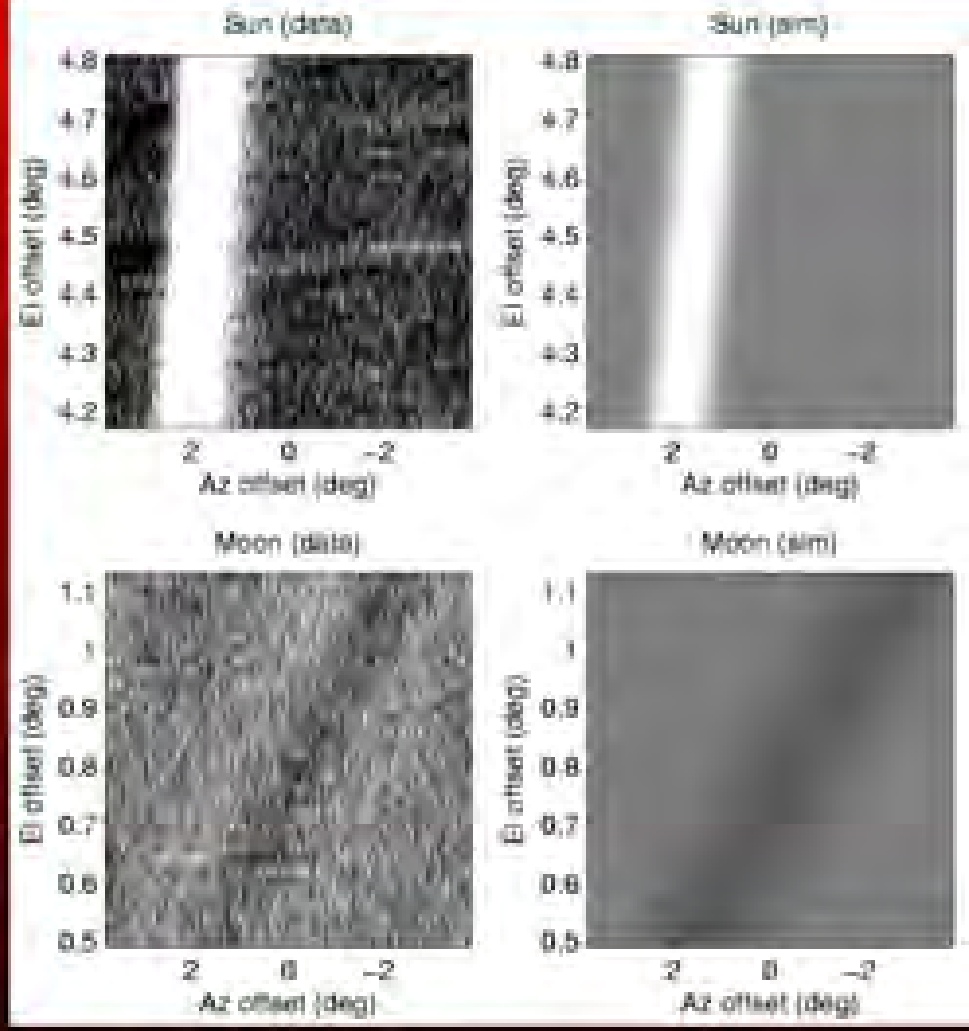


Figure from Hinderks et al. astro-ph/0805.1999

100 degree Ringlobe Due to Foam Cone





- Caused by reflection from adhesive in cone
  - Probed in detail using Sun as source
  - Detailed model reproduces contamination in CMB data

Modelling by Tom Culverhouse

Conclusions

- QUaD has made the deepest observations of CMB polarization to date
  - But it did this in spite of, rather than because of, it's on-axis design
- Likely NASA could make a secondary support structure with far better performance than the one used for QUaD...
  - But there is no reason to do so
- It is recommended that on-axis reflector designs not be considered any further for CMBpol