Shaped Optics and Phased-Array Feeds

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Study Outline

• TDP shaping study shows 10–15% increase in $A_{eff}$ (0.4 to 0.6 dB)

• Shaping changes prime focus from point to caustic

• Question: how does this affect the performance of a finite-sized array?

• Use GRASP9 to calculate fields in a measurement plane
  – TDP 55° feed half-angle shaped design
  – 1m \times 1m measurement plane (41 \times 41 points)
  – Integrate transverse fields
  – Compare shaped to parabolic (reference)
Physical Geometry
Optical Geometry
Focus Curve
Focal Spot for Parabolic Reflector
Focal Spot for Shaped Primary
Focal Spot $-1.5^\circ$ (x-z plane)
Focal Spot $+1.5^\circ$ (x-z plane)
Focal Spot $+2^\circ (y-z \text{ plane})$
Comments

• Ray tracing plots are a poor indicator of focal fields
  – no amplitude/phase information

• For central beam, measurement plane area has to be expanded by
  $\sim 10\%$ to equal captured power of parabolic case

• Off-axis focal spots are severely distorted
  – in principle can be corrected with PAF if most of the beam is
    intercepted by array
  – need to determine size increase necessary to match performance
    of parabolic case
FoV x-z Plane
FoV y-z Plane

![Graph showing fractional captured power vs. offset in degrees, comparing parabola and best focus models.](image-url)
Array Size

- Want “shaped, best focus” curves to match parabola at the 95% level
- Measurement plane needs to be expanded by 10% in each dimension or 20% in area
- This increase also applies to the number of receivers, data transmission links, and beamformer inputs
Concerns

- This work needs to be verified
- Starting to work on physically combining PAFs with WBSPFs
- Current optical designs do not leave much room for PAFs
- Examination of secondary focus is next