Naysmith Optics of the Solar-C Telescope

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Introduction

• Solar-C Telescope
• Naysmith Optics
• Simulation Tools
• Final Design
Solar-C Telescope

0.50 m Primary Mirror
Objective

• Design the Naysmith Optics for the Solar-C Telescope

  – Geometric Ray Tracing
    • Optical Light Path in Solar-C
    • Relative Positioning of the Imaging and Optics

  – Zemax
    • Optical Design Simulator
    • Simulates Response of Lenses
    • Graphs and Diagrams for Aberration Correction
Solar-C Naysmith Optics

- Secondary Mirror
- Gregorian Focus
- Final Image Plane
- Image Plane
- Lens 1
- Naysmith Lens 2
- Optical Axis
- Fold Mirror
- Primary Mirror Image
- Primary Mirror
Solar-C Naysmith Optics

- Two Lens and Mirror Combination to Extract Image
  - First lens – Collimate the Light
  - Mirror – 45° Tilt
  - Second lens – Focus the Light
- Magnification
  - Second Lens Focal Length : First Lens Focal Length
- Length of Collimated Light
  - Optical Invariant and Footprint of Light on First Lens

![Diagram of Solar-C Naysmith Optics]

**Diagram Notes:**
- Focal Plane
- Footprint
- Mirror
- Optical Axis
- Length of Collimated Light
- Lens 1
- Lens 2
Zemax Simulations

• Analyzing Design
  – Geometric Ray Tracing
  – Calculates Aberrations
    • Ray Fan Diagrams
    • Spot Diagrams
    • Encircled Energy Diagrams
Aberrations

• Something that Blurs Out an Image
• Types of Aberrations
  – Spherical, Focal, and Chromatic

-focused Image of Sun\hspace{1cm}\text{Out of Focused Image of the Sun}\

• Minimize the Aberrations
Ray Fan Diagrams

- Transverse Error Diagram
  - Lens
  - Ray Location at Lens
  - Transverse Error
  - Optical Axis
  - Ideal Ray Location at Focus

- Ideal Lens

- Singlet Lens

- Doublet Lens
Spot Diagrams

Ideal Lens

Singlet Lens

Doublet Lens
Encircled Energy Diagrams

Encircled Energy Radius Diagram

- <2 * Encircled Energy Radius
  - Indistinguishable

- 2 * Encircled Energy Radius
  - Distinguishable

Singlet Lens

Doublet Lens

Ideal Lens
Naysmith Optics Zemax Simulations

• Lenses and Mirror Combinations
  – Diffraction Limited Spot Sizes, Minimal Aberrations, Small Radius of Encircled Energy
  – Bandwidth of a System
  – Optics Selection

Zemax Simulations for the Solar-C Telescope with Naysmith Optics

Center Frequency of 1000 nm
Final Design
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Questions

Sunrise on top Haleakala