



The WALOPNorth Instrument

JOHN A. KYPRIOTAKIS

The PASIPHAE Survey - Background

- Problem: B-modes in the CMB
 - Distorted by dust and magnetic field
 - Depends on the number and characteristics of dust clouds in the line-of-sight
- Solution: Similar distortions in the polarization of optical sources (stars)
- Stars:
 1. (usually) intrinsically unpolarized
 2. known distances (Gaia)
- 1,2 → 3D structure of dust clouds →
A way to clear our picture of the CMB polarization

The PASIPHAE Survey - Numbers

- 2 Wide-Area Linear Optical Polarimeters (WALOPs)
 - Skinakas 1.3m telescope
 - SAAO 1m Elizabeth telescope
- 10000 $^{\circ}2$ at the galactic poles
- 360 stars per $^{\circ}2$ \rightarrow 3.5*MStars* \rightarrow 1000 times the state of the art

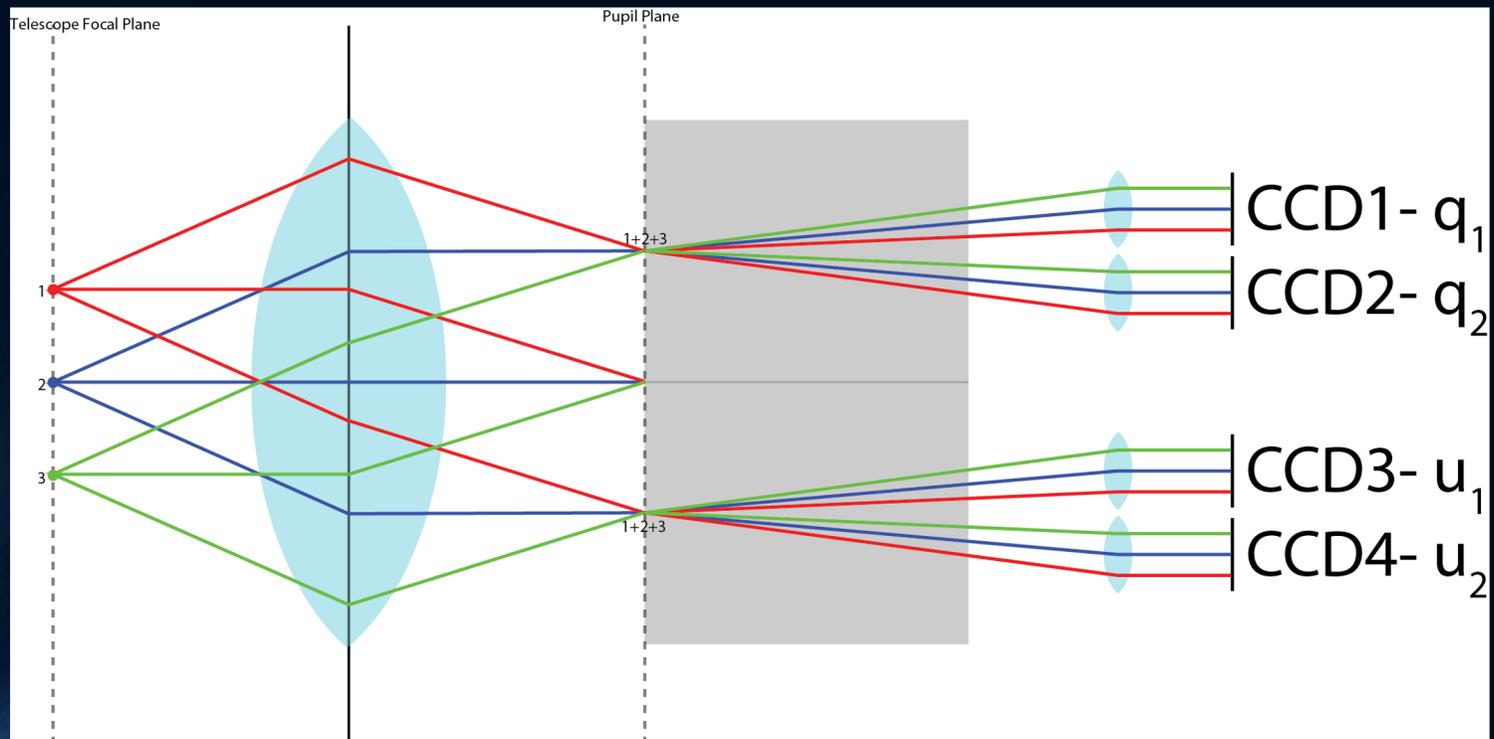
The PASIPHAE Survey - Deliverables

- High Galactic Latitude Survey
 - polarization measurements (p, EVPA)
 - 0.2% accuracy in p
 - over 360 stars per $^{\circ}2$
 - over 1500 $^{\circ}2$ per year
- Tomographic map and CMB foreground subtraction
 - Sky mask
 - Foreground removal
- Astrophysical Applications
 - structure and magnetic field properties of translucent molecular clouds
 - stellar astrophysics of intrinsically polarized stars
 - high-energy astrophysical sources of cyclotron and/or synchrotron emission

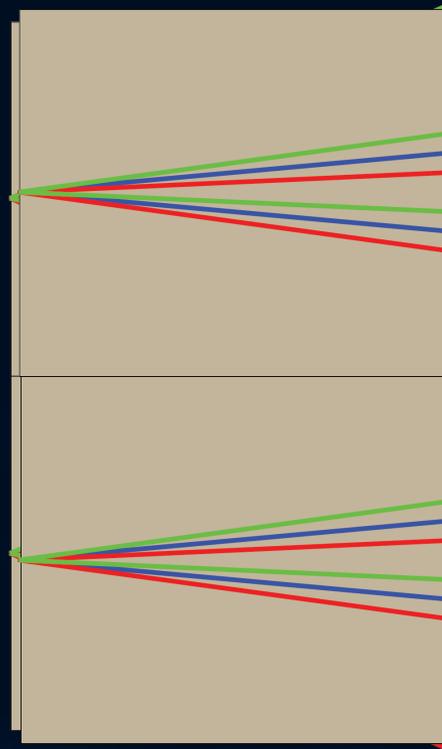
WALOP - Requirements

- One shot
- No moving parts
- 30'x30' field-of-view
- Every polarization state in proprietary detector
- $\sigma_p \leq 0.1\%$

Base Design



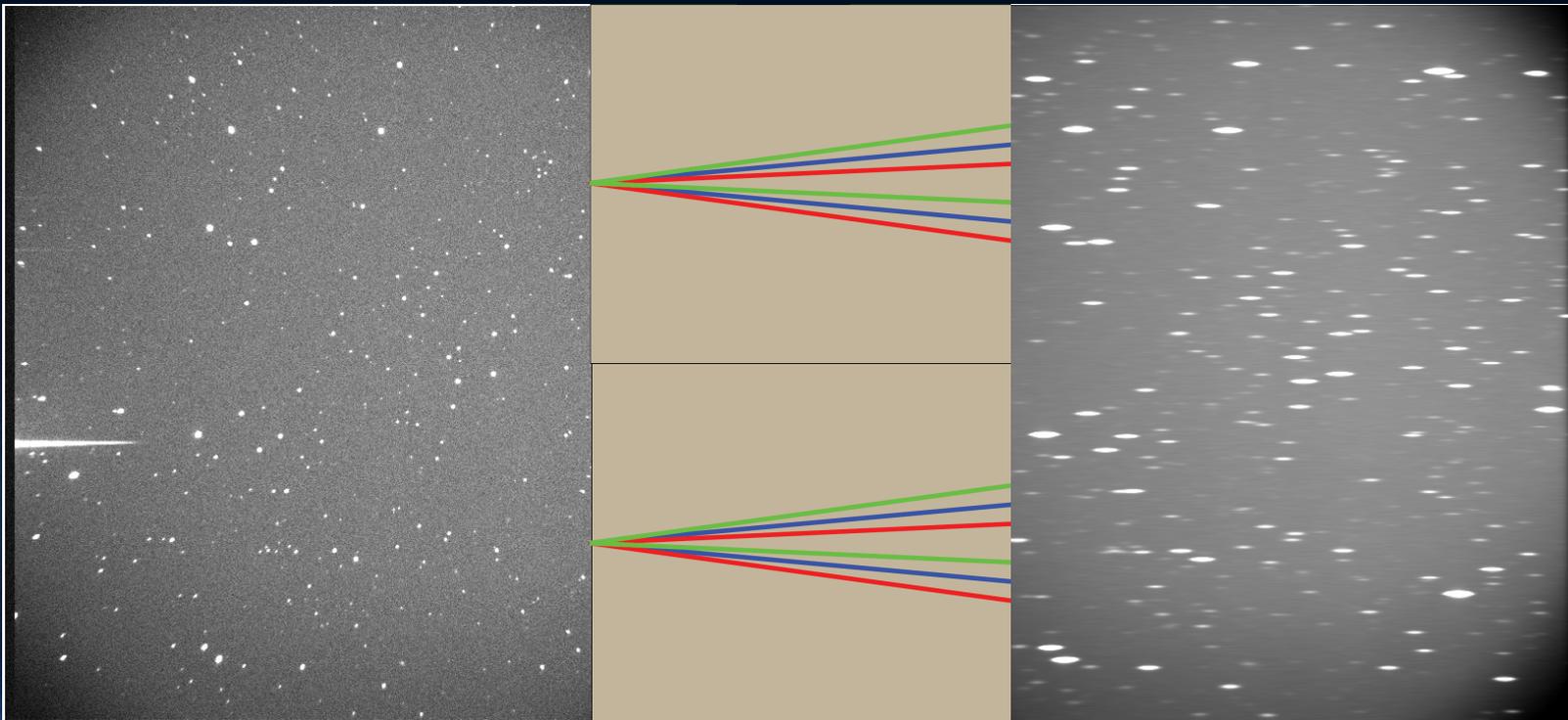
Problem – Prism Interface



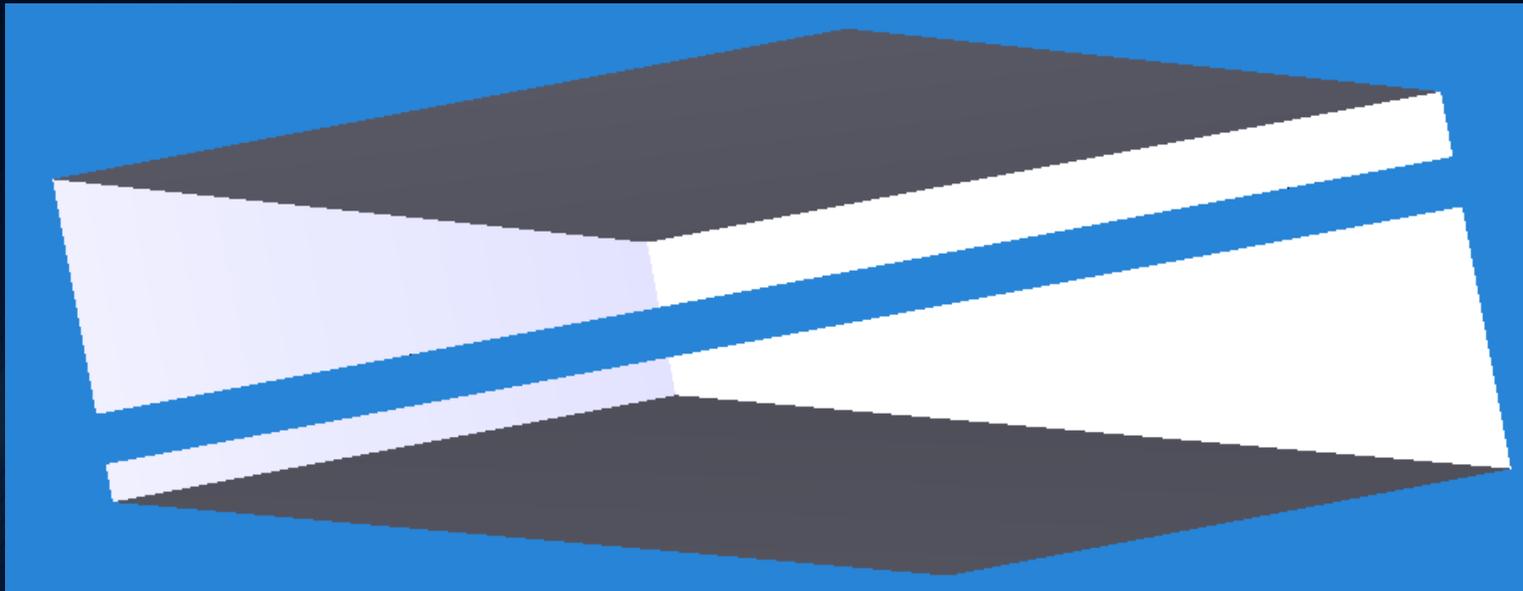
Solution – Prism Interface



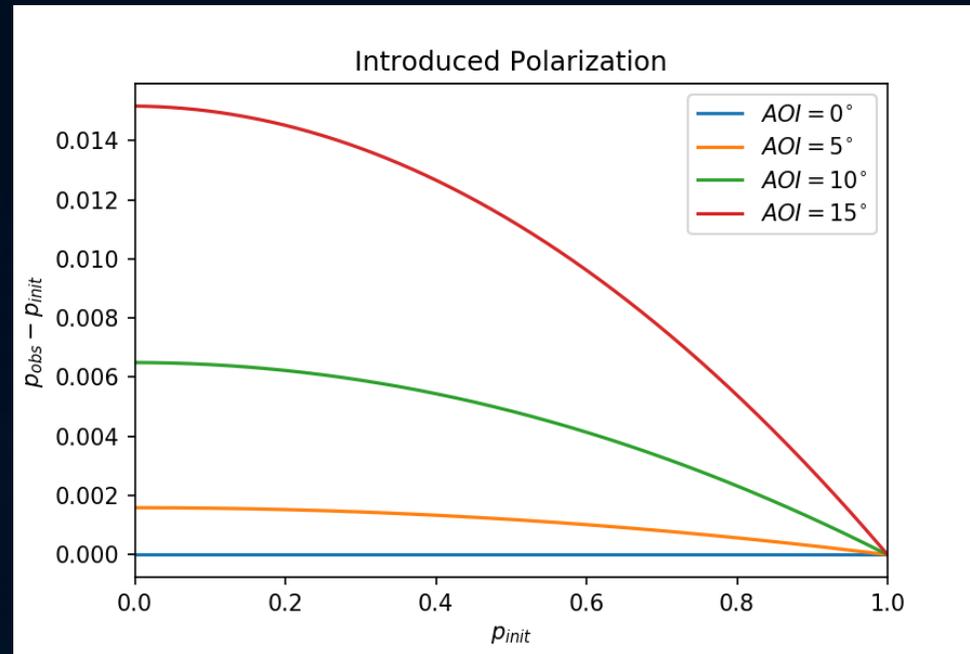
Problem – Wavelength Dependent Split



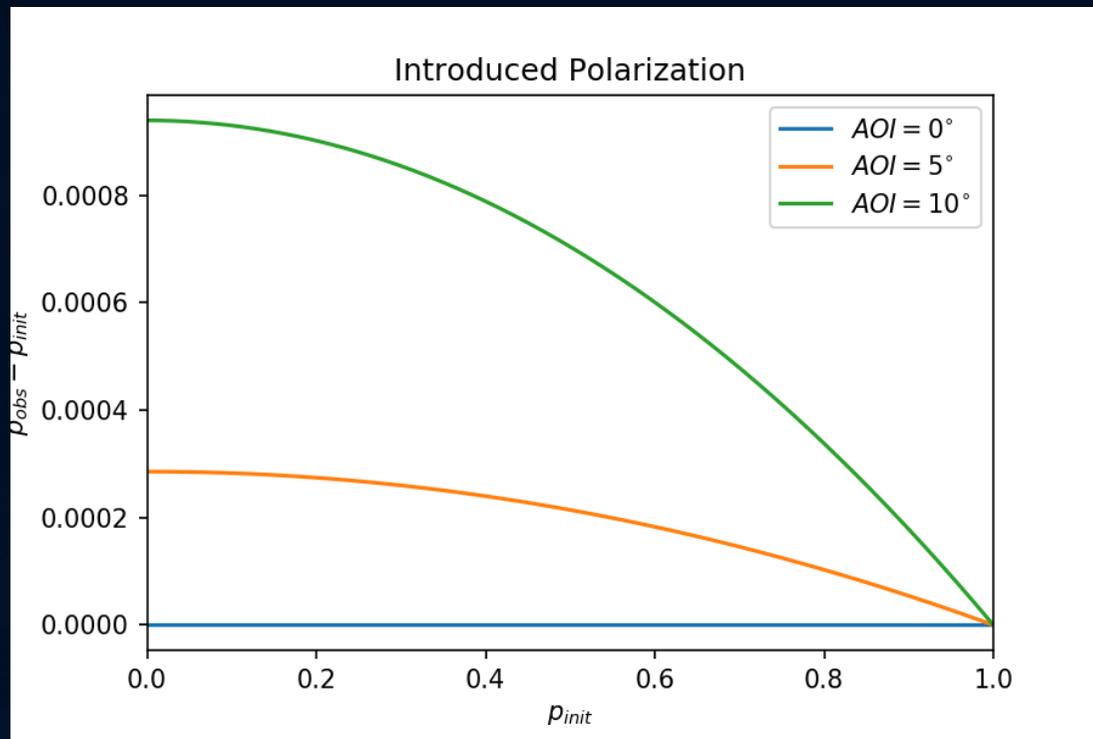
Solution – Wavelength Dependent Split



Problem – Filter Polarization

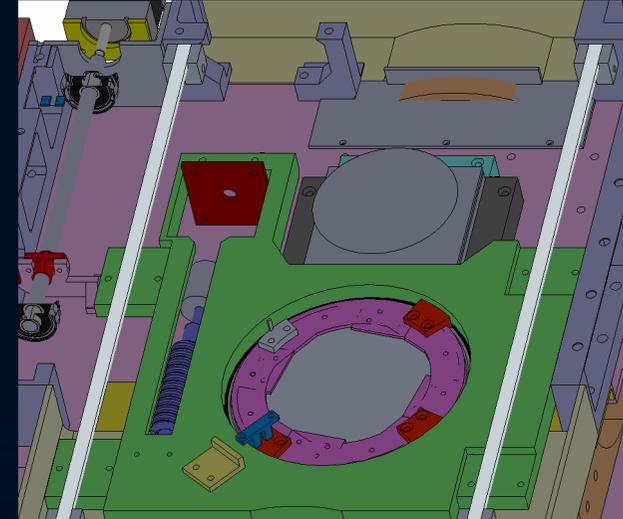
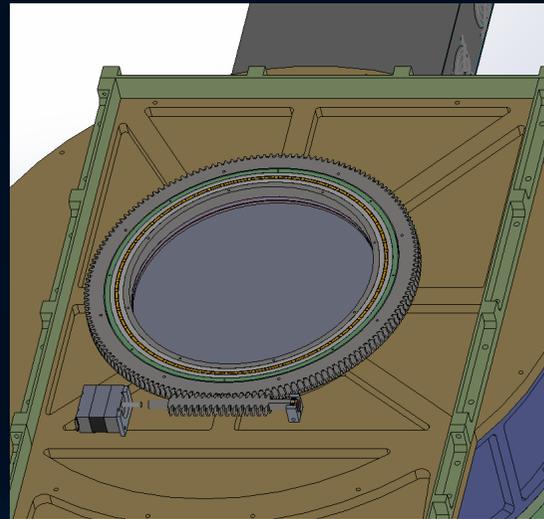
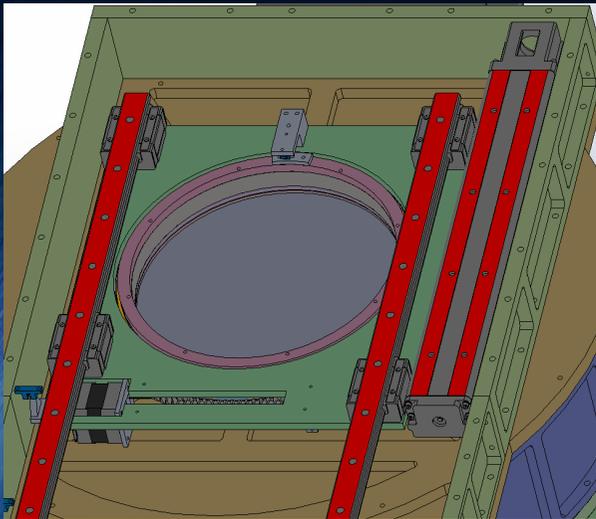


Solution – Filter Polarization

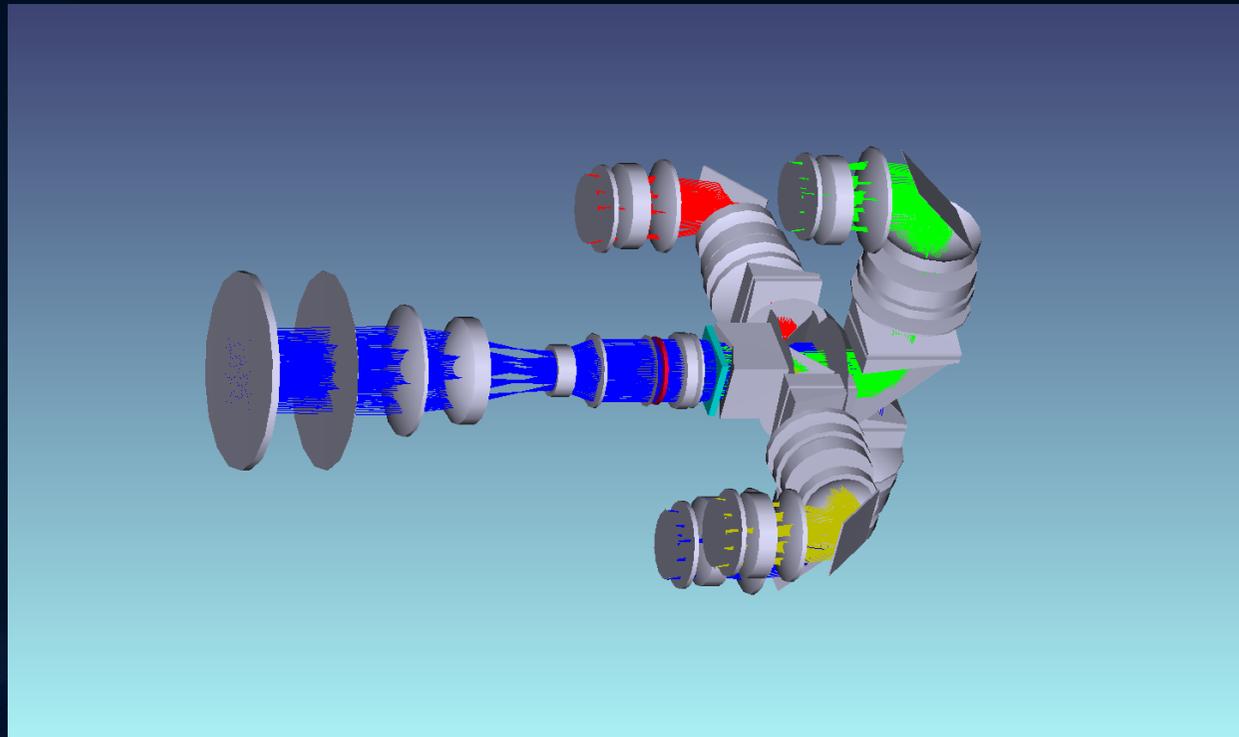


Problem/Solution – Calibration

- Polarizer (rotatable in steps/continuously) at the instrument entry
- HWP (rotatable in steps/continuously) before the prism



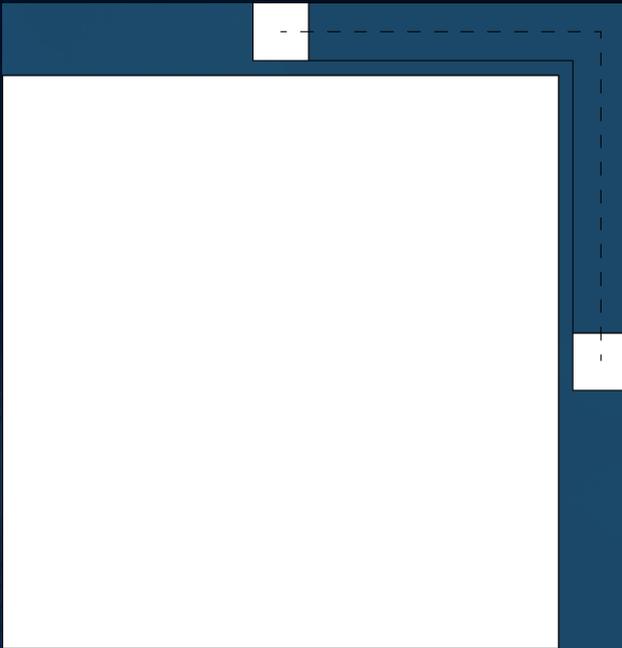
Optics



Problem – Guider Field

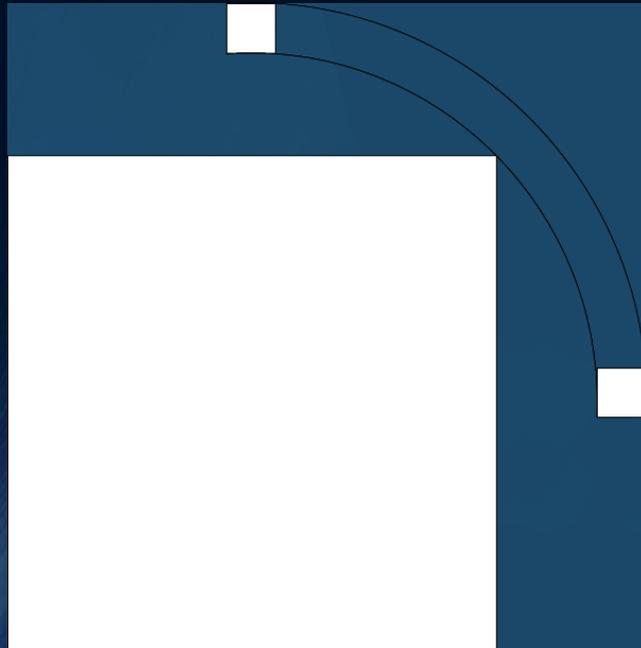
- Limiting Magnitude: 17 (without filter)
- Guiding Time: 9s
- Guiding Accuracy: $\frac{1}{3}''$
- Limiting Field (min. 3 stars brighter than limit): 10'x10'

Solution I – Guider Field



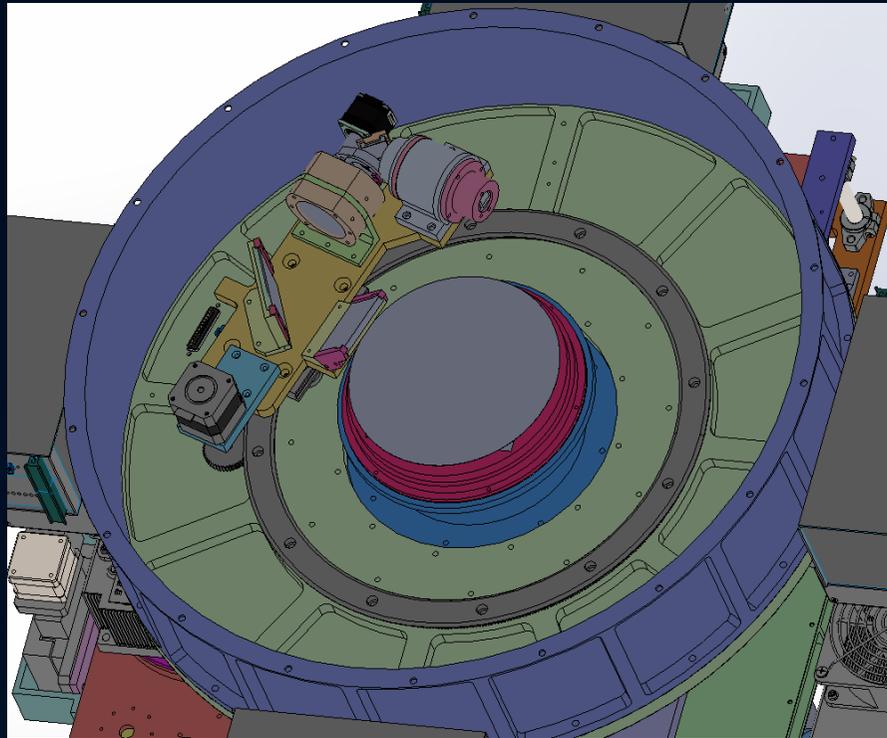
- 2'x2'
- Requires 2 linear motors
- Simple optics
- Simple Mechanics
- More space

Solution II – Guider Field

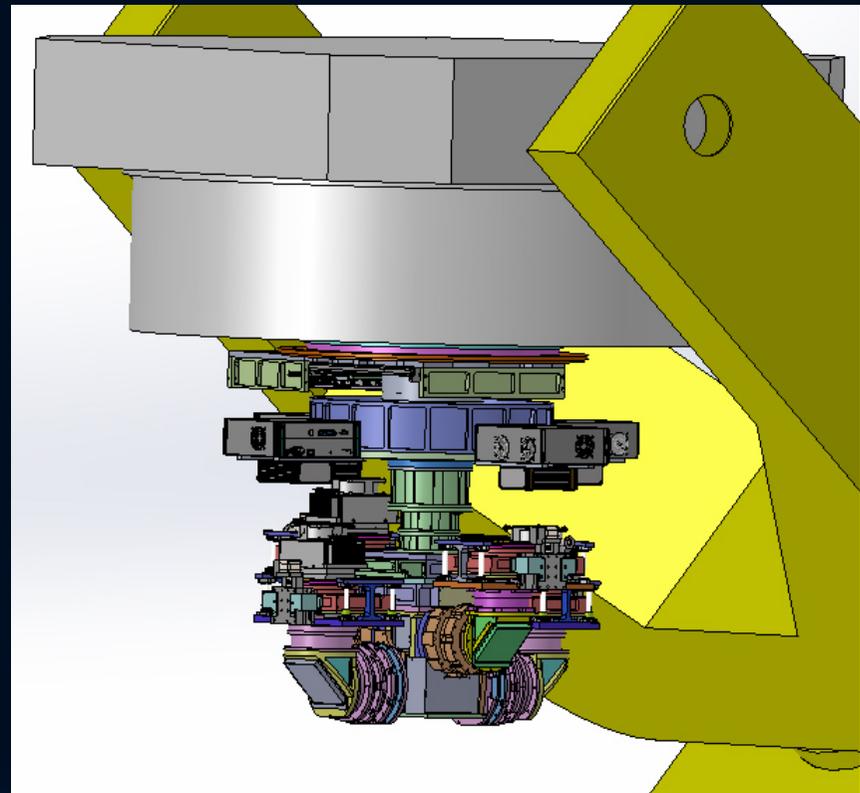
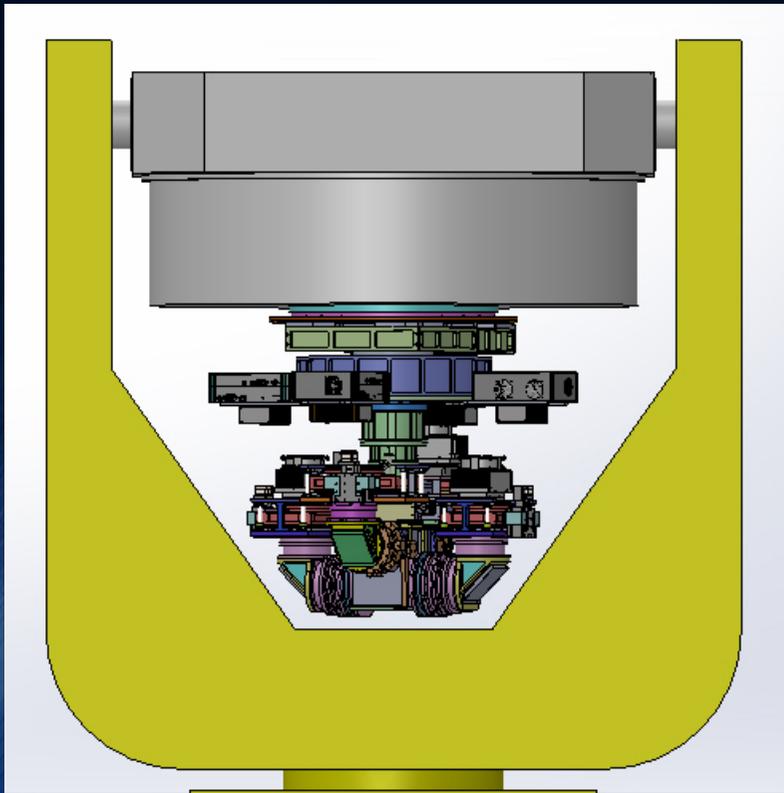


- 1'x1'
- Requires 1 rotary motor
- Simple optics
- Tougher Mechanics
- Less space

Solution II – Guider Field



Looks



Software Snap (no time for the flowchart, this is the control interface)

The screenshot displays the WALOPNorth Control Panel software interface, which is a comprehensive control system for astronomical equipment. The interface is organized into several functional panels:

- Filter Wheel:** Includes fields for Server (127.0.0.1), Port (26600), Name, and File. A 'Connect' button is present, and the status is 'DISCONNECTED'.
- Camera Connect:** Features fields for Command Server (127.0.0.1), Command Port (50510), Image Server (127.0.0.1), and Image Port (50520). It also includes Gain, Frequency, Channels, and Sampling settings. The status is 'DISCONNECTED'.
- Temperature Control:** Shows Gain, Frequency, CCD Temperatures, Set Temperature (0 °C), and Regulating status (ON). The status is 'DISABLED'.
- Telescope Connect:** Includes fields for R.A., Dec., Amass, Tracking, Dome, COM Port, Baud Rate (9600), and Timeout (1000). The status is 'DISCONNECTED'.
- Control:** A central hub with 'Weather Server' (COM Port, Baud Rate), 'Mode Control' (Manual, START, STOP, Auto Port), and 'Pointing Control' (Input Type, R.A., Dec., GO!, STOP!, Enable Slew).
- Exposure Control:** Features 'Save To', 'Mode' (Bias, EXPOSE, ABORT), and 'Exp. Time' settings.
- Guiding:** Includes 'Guider Camera' (ASCOM Simulator: Camera), 'Set Up', 'Connect' (DISCONNECTED), 'Reset View', 'Disconnect', 'Expose', 'Calibrate', 'Guide', 'Record Subframe', and 'Clear' buttons.
- Calibration Mechanism:** Includes fields for Server (127.0.0.1), Port (26601), and HWP/Polarizer settings (Position, Angle, Rotating, Speed). The status is 'DISCONNECTED'.

At the bottom of the interface, a status bar provides real-time data: Temperature: -99.9°C, Wind: 999.9km/h, Direction: 359°, Dust: 9999.9pt/ft³, Moon Illumination: 99%, Moon Angle: 179.9°, UTC: 6/8/2020 9:28:52 AM, LT: 6/8/2020 12:28:52 PM, Copyright: John A. Kyriotakis 2019, Version: 0.1.3.