1 Scope of Project

This document describes the specifications for the fabrication of two waveplates to be used in the Prime Focus Imaging Spectrograph on the 11m Southern African Large Telescope (SALT). The PFIS optical system (Fig 1) consists of a collimator which collimates the F/4.2 beam over the wavelength range 320 nm - 1.7 microns. The collimated space contains either Fabry-Perot etalons, or a Volume Phase Holographic (transmission) grating. The visible wavelength camera focuses the wavelength range 320 - 900 nm at F/2.2 onto a focal plane array of three 4096 x 2048 CCD's. The polarimetric module consists of two superachromatic waveplates, ½ and 1/4 wave, inserted in the diverging beam within the collimator, and an array of calcite Wollaston beamsplitters inserted in the visible wavelength collimated beam.

2 Waveplate design

The waveplates shall be 6 element superachromatic Pancharatnam ½ and 1/4 wave linear retardation plates, optimized for the wavelength range 320 nm - 1.7 μ and an F/4.2 beam. The fast beam and the large wavelength coverage extending into the near UV requires an optimization rather different from the conventional collimated beam Pancharatnam waveplates. Appropriate ZEMAX optimization macros are available from the customer (these require ZEMAX-EE, version 10, 15 Aug 01 update). The halfwave plate is optimized for maximum efficiency. The quarterwave plate has an additional constraint on the maximum axis angle variation and a minimum element thickness of 250 μ. The performance specifications for the full wavelength range 320 nm - 1.7 μ are:

Item	Retardation τ	Minimum Efficiency	Maximum Axis variation
half wave	0.5 ± 0.05	> 0.975	
quarter wave	0.25 ± 0.06	> 0.94	±2.5°

(Efficiency for the halfwave plate is defined as (1 - cos τ)/2, and for the quarterwave, sin τ.) Acceptable designs that meet these polarimetric specifications are shown and figures 2 and 3, and the corresponding element thicknesses and angles are given below.

3 Physical Specifications

Meets Spec Y N

Internal transmission: > 95% ___ ___

Coverplates: fused quartz, OH < 50 ppm (eg Heraeus Infrasil or Tosoh ED-H) ___ ___
stress birefringence < 2 nm/cm ___ ___
thickness 7 mm ___ ___
surfaces 1/2 λ at 630 nm ___ ___
scratch/ dig: 60/40 ___ ___
wedge < 30 arcsec, ___ ___
bevel: < 1 mm at 45 deg ___ ___
coating: MgF_2 broad band, 320 - 900 nm ___ ___

Total thickness: 16 mm (-0.1, +0) ___ ___

Element thickness tolerance: ±1 μm, except ratios of thicknesses better than ±0.1% ___ ___

Element axis alignment ±0.1 deg ___ ___

3.1 Halfwave Plate

Shape: Octagonal (Figure 4)

Physical size: Minimum 101 mm ___ ___

Maximum < 110 mm ___ ___

Clear aperture: 100 mm (circular). (scratch/dig 60/40 over 90 mm aperture on elements) ___ ___

Total wavefront distortion: < 5 lambda (628 nm) ___ ___

Angle between inner and outer pairs: 52.78 ± 0.1 ___ ___

Element *	Thickness (μ)
#1, MgF2	284.194
#2, Quartz	331.947
#3, MgF2	277.089
#4, Quartz	323.648
#5, MgF2	284.194
#6, Quartz	331.947
Total	1833.020

3.2 Quarterwave Plate

Shape: Octagonal, with chamfers (Figure 4)

Physical size: Minimum > 61 mm ___ ___

Maximum < 65 mm ___ ___

Clear Aperture: > 60 mm (circular) ___ ___

Total wavefront distortion: < 5 lambda (628 nm) ___ ___

Angle between inner and outer pairs: 68.05 ± 0.1 ___ ___

Element *	Thickness(μ)
#1, MgF2	250.000
#2, Quartz	299.911
#3, MgF2	400.000
#4, Quartz	479.858
#5, MgF2	250.000
#6, Quartz	299.911
Total	1979.680

* The order within the pairs (1-2, 3-4, 5-6) may be inverted as desired

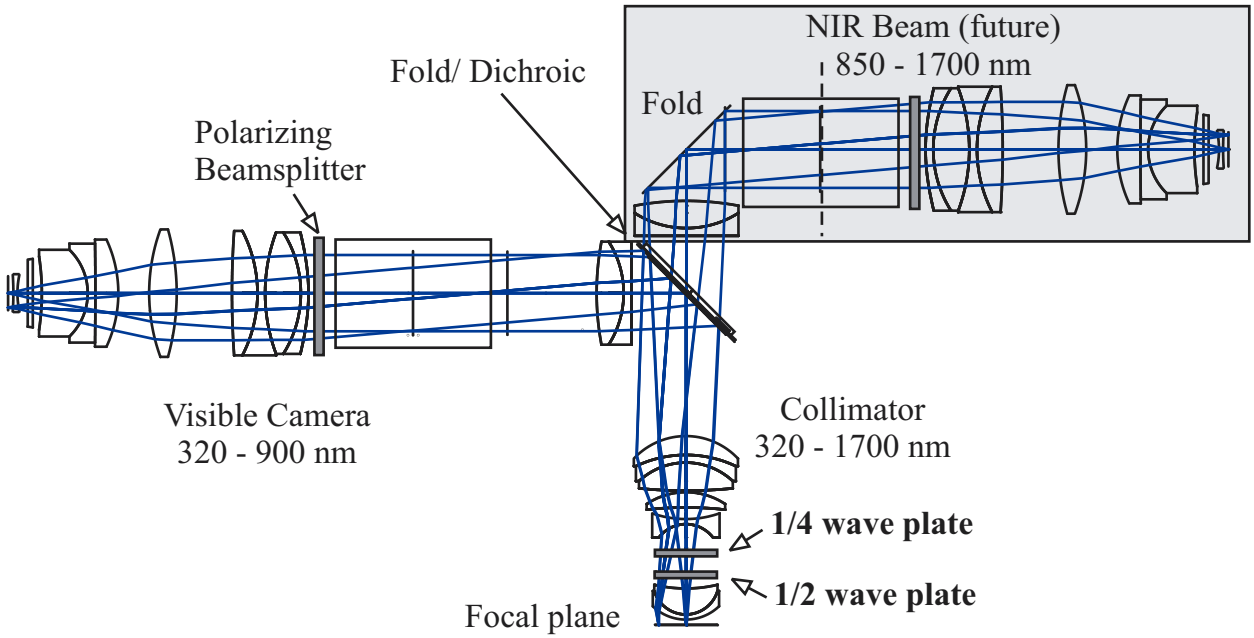

Figure 1. PFIS Optics

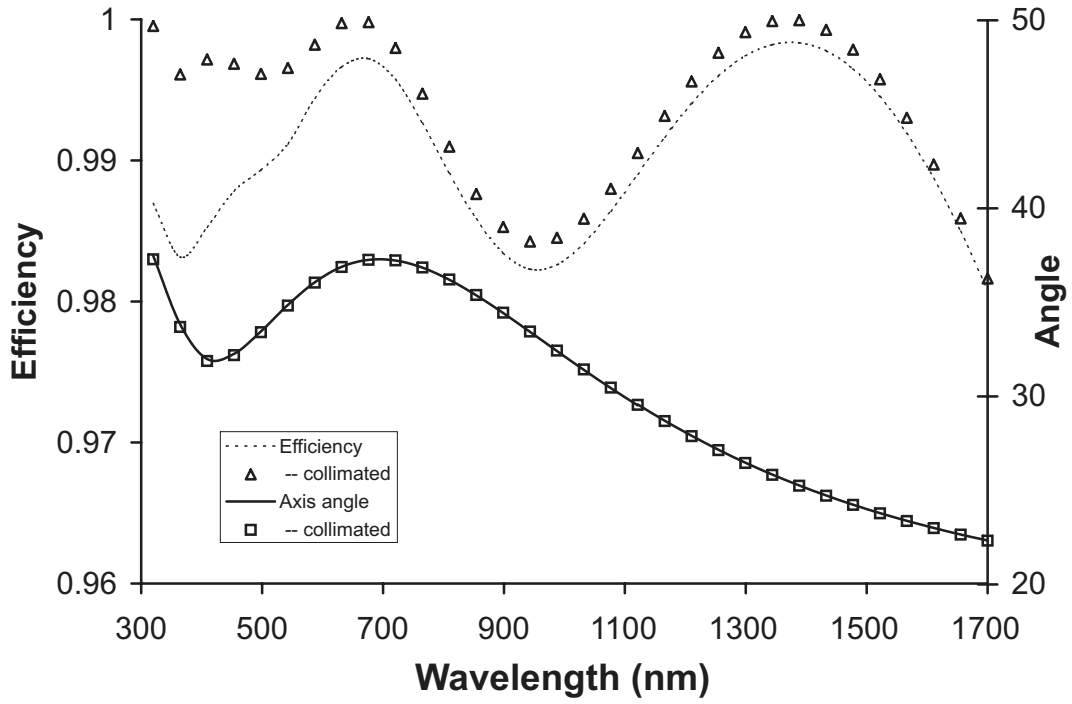

Figure 2. Halfwave plate Performance

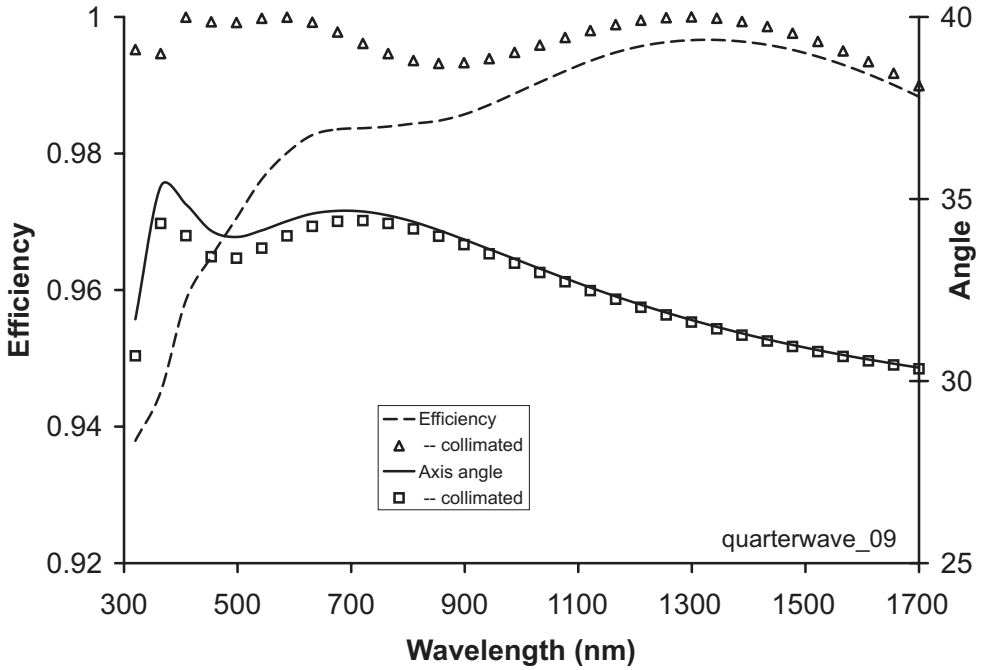

Figure 3. Quarterwave plate Performance

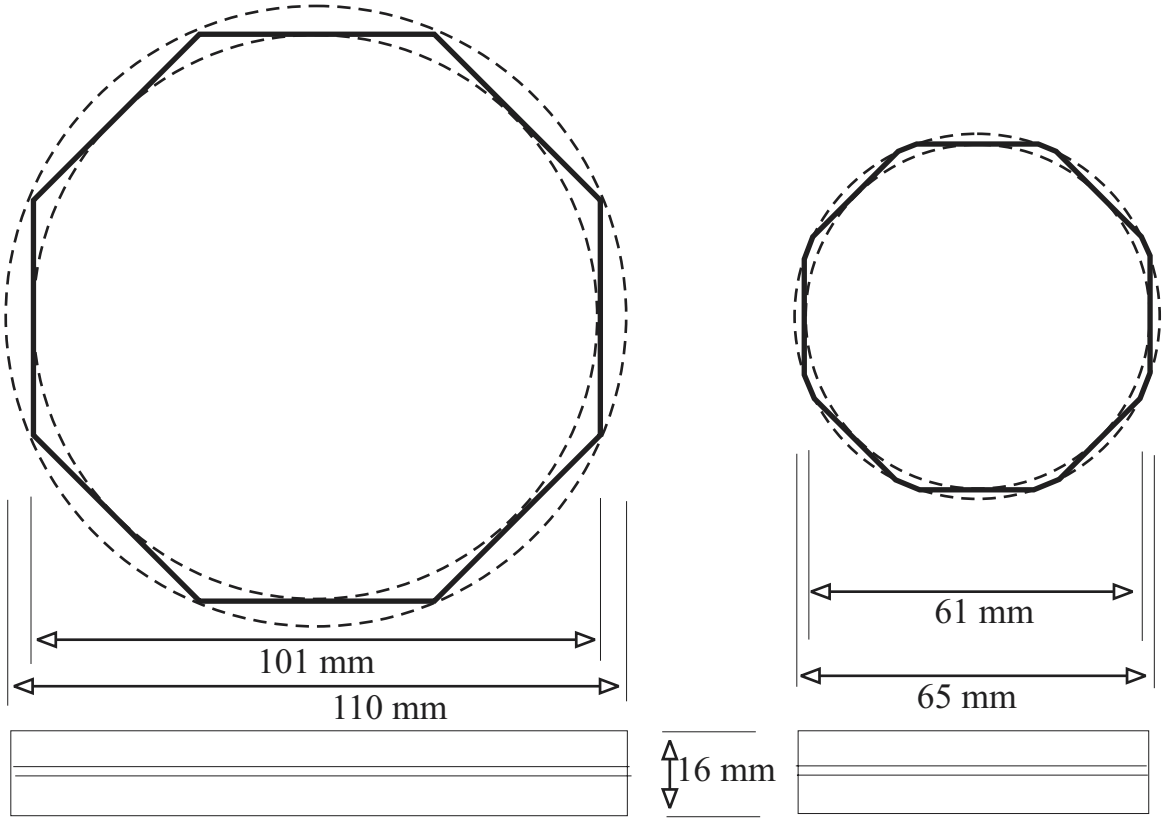

Figure 4. Waveplate Dimensions