

REQUIREMENTS FOR FILTERS

Spartan IR Camera for the SOAR Telescope

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22 April 2004 Add parallelism & drawing

The filters are placed in a cell (see attached drawing). The cell is inserted in the large filter wheel, which is very close to the Lyot stop.

Table 1 Requirements

P-V surface irregularity	158 nm
Surface parallelism	20 arcsec
Aperture diameter	46.6 mm
Maximum diameter	51.2 mm
Nominal thickness	3 mm
Maximum thickness	9 mm
Max angle from surface normal f/12	7.2 deg
Max angle from surface normal f/21	4.3 deg

Surface accuracy

Since the beam from a point source illuminates the filter (placed near the Lyot stop) completely, surface irregularities cause degradation in the amount of light in the diffraction spike. An RMS irregularity σ on each surface causes a loss in Strehl of

$$d\text{Strehl} = 2 (2 \pi \sigma (n-1)/\lambda)^2,$$

which is Marachal's formula. For P-V irregularity of $632\text{nm}/4$, $\text{RMS}=\text{PV}/4$, and a substrate index of 1.5, the loss of Strehl is 0.021, 0.011, and 0.006 for the J, H, and K band, respectively. The point-spread function of the tip-tilt corrected image does have significant power in the diffraction spike in the H and K bands, but not the J band.

Surface Parallelism

A wedge in the filter causes the image to shift. If the front and back surfaces of the filter are tilted by angle θ , then the beam deflects by $(n-1)\theta$. Angles in the sky are magnified in the instrument by

$f_{\text{tele}}/f_{\text{inst}}$, the ratio between the focal lengths of the telescope and the collimator in the instrument, which is 109 for the f/21 channel and 98 for f/12. Therefore the requirement on surface parallelism is

$$\theta_{\text{at filter}} = \theta_{\text{sky}} f_{\text{tele}}/f_{\text{inst}} / (n-1)$$

We require the deflection to be less than 0.08 arcsec in the sky so that the shift in boresight with changes in filters is less than the diffraction width. Then the two surfaces of the filter must be parallel to 17 arcsec.

Aperture Diameter

The aperture is the region through which the light reaches the detector.

Maximum Diameter

is the size of the cell that holds the filter.

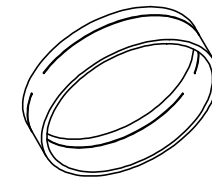
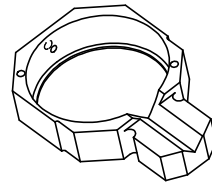
Nominal Thickness and Maximum Thickness

A spring holds the filter in its cell. The nominal thickness is the thickness for which the spring is made. For this particular design of the spring, the filter cannot be thicker than the maximum.

Maximum Angle from Surface Normal

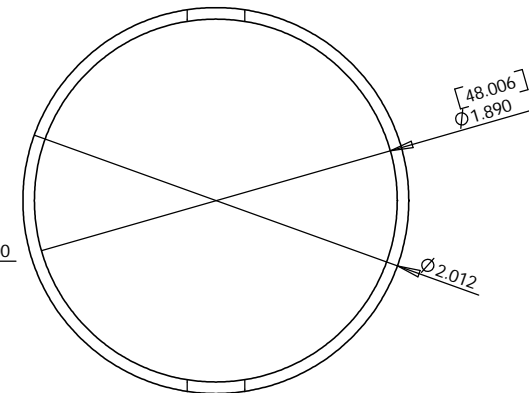
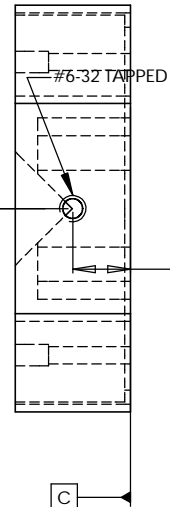
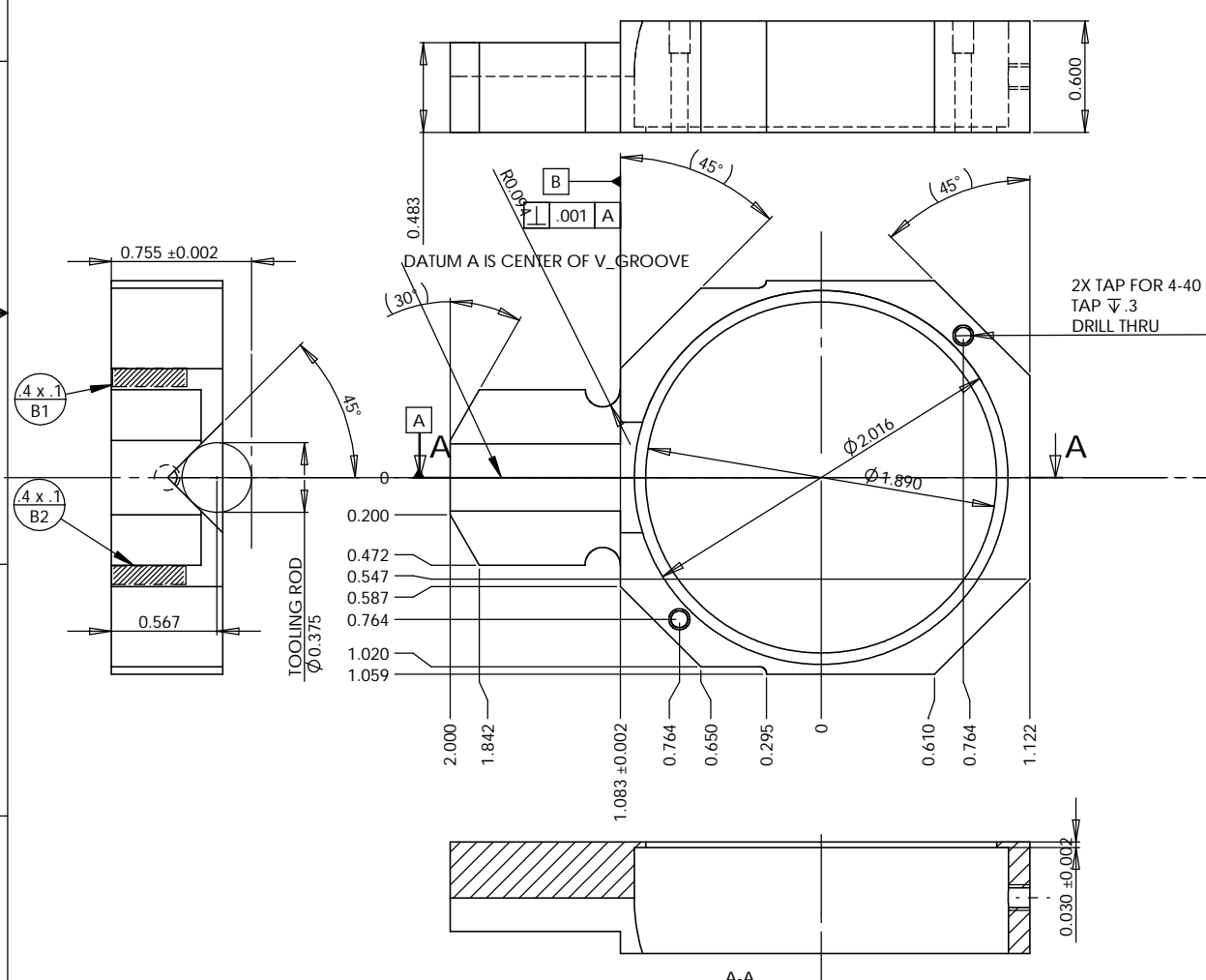
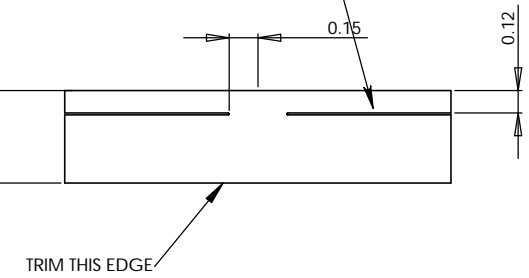
The beam is collimated at the filter, and the angle of the beam depends on the field position.

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	DESIGNER
		Removed teflon lateral springs. Removed steel axial springs & replaced with cuts in ring. Changed minor dimensions.	5/20/03	O Loh



0.482 max.
CUT TO FIT FILTER TO ALLOW
0.007 > SPRING COMPRESSION > .001

CUT WITH $\phi .010$ WIRE



UNLESS OTHERWISE SPECIFIED		DATE	NAME
DESIGNED	03 May 02	R Laporte	
DETAILS	21 Jun 03	O Loh	
ENG APPR.			
MFG APPR.			
C.A.			
INTERPRET GEOMETRIC TOLERANCING PER:			
MATERIAL:	AL 6061-T6		
FINISH	--		
NEXT ASSY	USED ON		

Physics-Astronomy Department Michigan State University	
TITLE: FILTER CELL	
SIZE C	DWG. NO. 7-2
SCALE: 2:1	WEIGHT:
SHEET 1 OF 2	

6 REQUIRED

SPARTAN R CAMERA

LCHHMSJLEJN