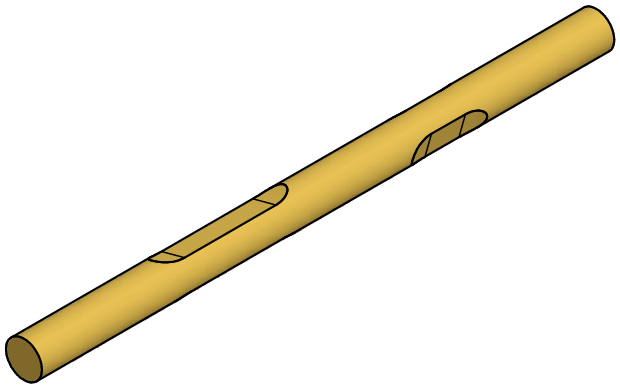

Fig. 14.— 3-D rendering of the final polarizer design. This can be thought of as an image of the aluminum mandrel that will be used for electroforming.

9. Leakage contributions from other optical elements

The polarization leakages computed thus far do not include the effects of optical elements between the feedhorn and the sky. There are at least 2 such elements that can degrade the polarization purity – the antireflection grooves on IR filters in the 6-m dewars, and the Mylar beamsplitters used on both the 6-m and 10-m receivers to inject the local oscillator into the beam.

Grooved IR filters. The 6-m dewars use $0.3''$ thick Teflon windows in the 50K radiation shields as infrared filters. Both the front and back surfaces of the windows are grooved to reduce reflections; the groove depth is $0.010''$ for the 1mm windows. The refractive index of the matching layers differ for signals polarized parallel and perpendicular to the grooves:

$$n_{\parallel} = \sqrt{\frac{\epsilon+1}{2}}, \qquad n_{\perp} = \sqrt{\frac{2\epsilon}{\epsilon+1}}.$$

For Teflon ($\epsilon = 2.08$) the matching layer has refractive index 1.24 for the electric field component $E_{\parallel}$ aligned with the grooves, and 1.16 for $E_{\perp}$. Unfortunately the grooves are oriented in the same direction on the front and back surfaces of the window, leading to a phase difference at 230 GHz of

$$\Delta\phi \;=\; \frac{2\pi}{\lambda}\,(2d)\,(n_{\parallel} - n_{\perp}) \;\sim\; 11^{\circ},$$

which causes a leakage of ~ 0.1, a very serious degradation in performance. Fortunately this can be avoided by regrooving one side of the Teflon filters in the perpendicular direction, or by replacing the Teflon windows with foam IR filters.

The lenses that serve as windows on the 6-m dewars also are antireflection coated with a series of concentric grooves. These grooves are expected to have much less effect on the leakage because the path delays are equal for the 2 polarizations when averaged over the lens. Another set of lenses at the feedhorn apertures – at an image of the primary mirror – were antireflection-coated by drilling a grid of holes into the surfaces (Plambeck 2000) to avoid polarization-sensitive delays.

Beamsplitters. The polarization purity also will be degraded by the beamsplitters that couple local oscillator power to the SIS mixers. The beamsplitter transmission differs for electric fields parallel