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Memorandum

Date: 14 July 2005

To: APF Project File

Subject: Lead Shielding for the APF Detector

The most protection of the detector from background radiation is accomplished by Chris Lockwood's tantalum enclosure that surrounds the CCD within the dewar. Additional shielding to increase protection provided elsewhere and external to the dewar is the subject of this report.

The shielding considered in this study was lead with a thickness 3/8 inches.

The table lists all the components with weights and area percentages. The first three items mentioned above were not calculated individually for coverage. They're grouped together as the first attempt to block everything except the light path coming out the camera.

Table

item	component	Wt (lbs)	% of 4π	comments
1	box	14.2	--	sheet metal around dewar window
2	baffle	14.4	--	within camera baffle system
3	hoop	6.3	--	around outside camera barrel
4	plate	643	7.8	about 7½" below grating
5	lining	800	7.8	"bucket" lining bottom of enclosure
6	horseshoe	103	6.09	bottom of camera
7	disc	31	1.18	top of grating, around prism
8	floor	67	.54	on enclosure floor

Solid angles are approximate using best fit spheres and no attempt to project surface areas of shield components

Figure 1 shows three components that, together, will cover a major portion of the external (outside the dewar) protection, leaving only about 7.8% of the 4π solid angle. The box component is just conceptual but shows most of the protection can be accomplished with several panels close to the dewar. The size of the box (Item 1) shown here actually have to grow in size realistically to clear the structure that will hold the folding flat and the optical elements above that. It can probably be done with a final weight of around 20 pounds or so.

The baffle (Item 2) is contained within the camera. It can probably be part of the baffle system and can even replace one of the thin sheet metal optical baffles if desired. This disc is actually modeled as a thick baffle. The tab features around the OD would not necessarily be incorporated into this part. The hoop (Item 3) would wrap partially around the outside of the camera barrel. A full hoop is not necessary since only hemispherical protection for the CCD is needed. The baffle part could be clocked just like the optical baffles, so it would not need to be full disk either.

These three parts would add about 20-25 pounds to the breadboard and about the same to the camera.

The first three items, therefore, afford about 92% (together with the interior tantalum) of the protection. Figure 2 shows what would be necessary to address the remaining 5. This area is approximately 7½ inches below the grating. A lead plate of 3/8" thickness would weigh 643 pounds. Mapping this area all the way down to the main floor would require covering virtually the entire area plus the entire circumference and top of the telescope pedestal. In this case we'd be look at considerably more lead weight.

Lining the bottom of the enclosure (Figure 3) to take up the 7.8% doesn't help. This lining (Item 5) ends up weighing almost 800 pounds. Although it is closer the problem and in a smaller contained area, more surface area is required due the projection angles.

The only other solution is to get up closer to the light path and more perpendicular to the viewing angle. Figures 4 thru 6 show three additional areas (Items 6-8) that do that. Together they would add about 203 pounds. 136 would be on the truss, the other 67 would be on the floor of the enclosure, and slightly up the slanted front side.

Please keep in mind that the shielding areas are approximate and they may not be conservative in all cases. But they are probably within ±5%. The solid angles are rough too since most were not projected and all were not mapped to an appropriate sphere.

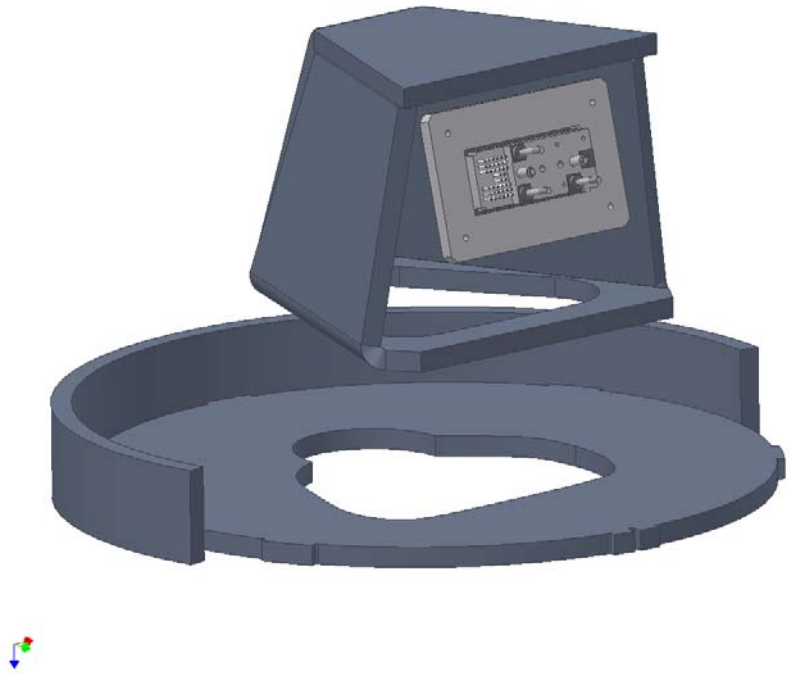

FIGURE 1

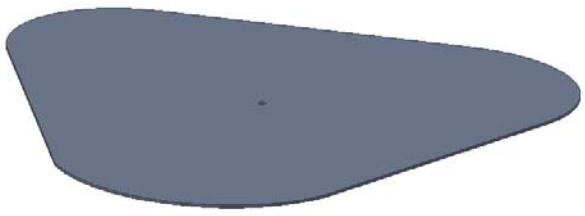

FIGURE 2

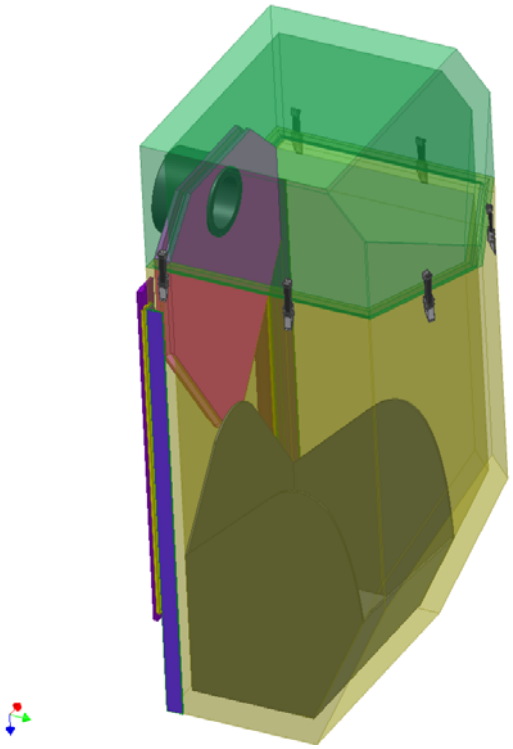

FIGURE 3

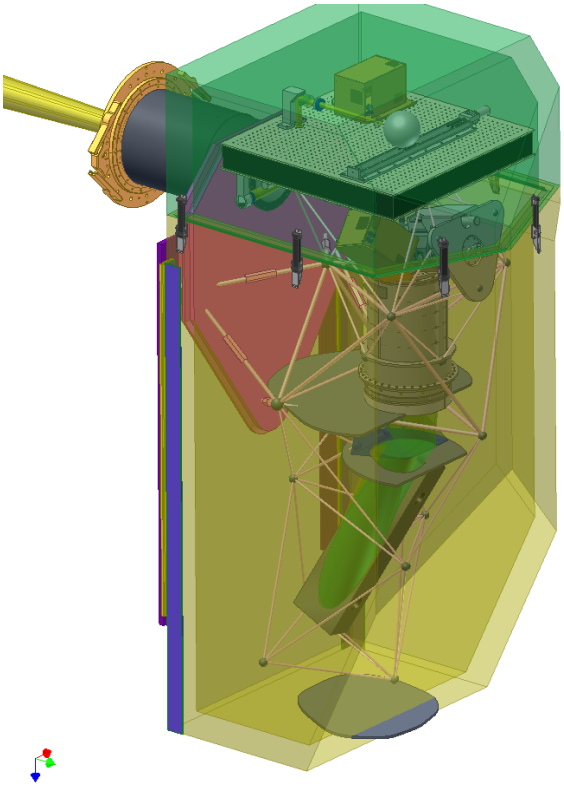

FIGURE 4

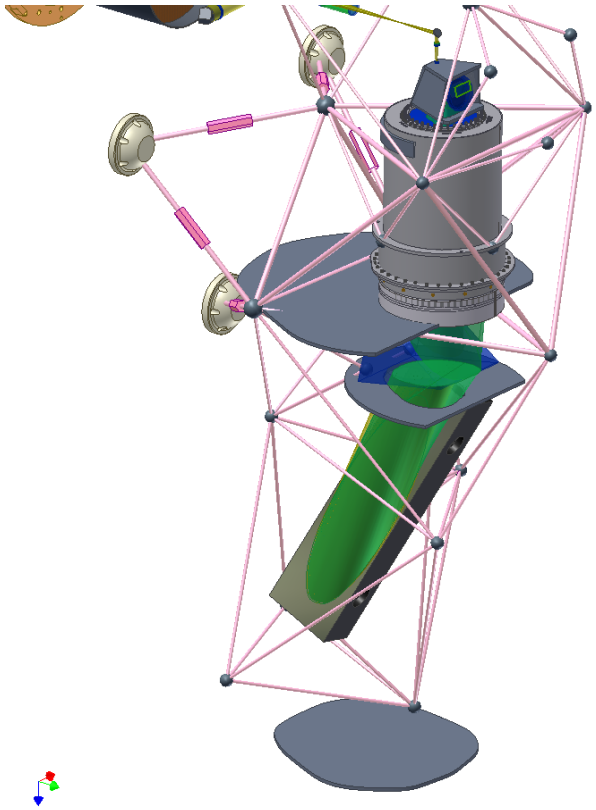

FIGURE 5

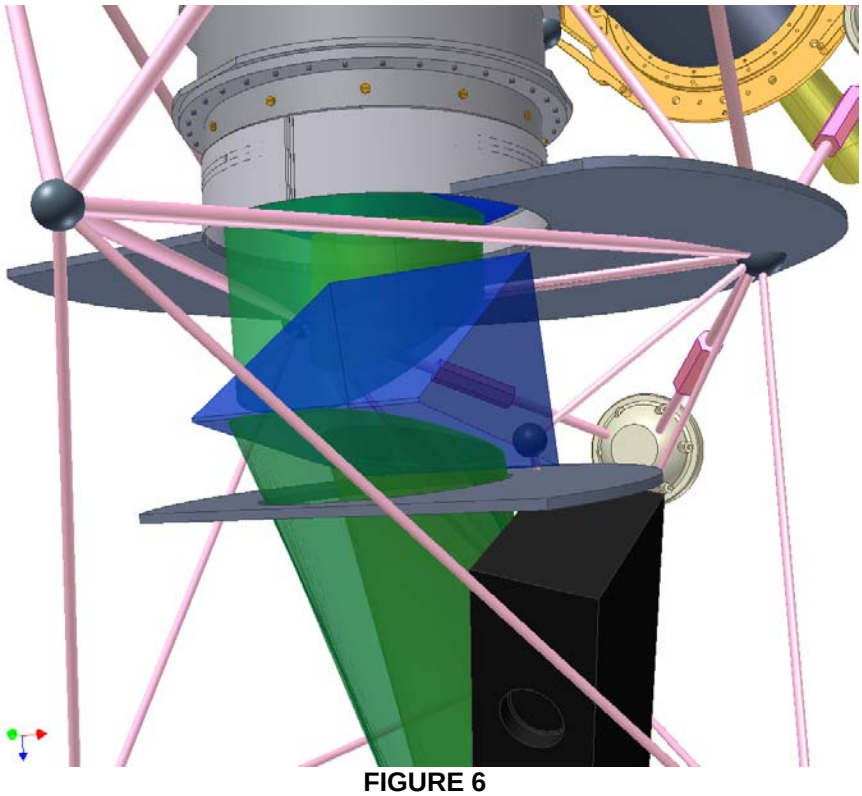

FIGURE 6