

# Dilution Factor for E161 Target Refrigerator.

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The dilution factor for the refrigerator that will be used in the E161 experiment was estimated from the materials that will be in the beam in addition to the target. There are two important points to consider throughout this note.

- The amount of material represents a worst case scenario. The amounts used when chosen because it is known that they can fulfill the requirements for refrigerator operation. While the dilution factor may be better than what is listed, it will not be worse.
- Many parts of the refrigerator have not yet been constructed. This means that for most of the materials listed, there is no problem replacing with another suitable material that would result in a lower dilution factor. The primary purpose for this note is to start conversation about different materials and different amounts which will still allow the refrigerator to operate with a lower dilution factor.

## Upstream

The upstream portion of the refrigerator (figure 1) has (starting from the entrance and moving toward the target) a small entry window, four radiation shields, a window which leads into the mixing chamber, and a thin window that leads into the target cell. Both the mixing chamber window and the entry window must be able to withstand an atmosphere of differential pressure. For the entry window, 5 mil Al will suffice, while the mixing chamber window will be made of 1.5 mil Ti. These thicknesses of these materials will be able to withstand the pressure difference. For the radiation shields, the material is 1 mil Al. There is, however, no requirement for the radiation shields to withstand any differential pressure. Therefore, any conductive material may work, aluminized Mylar for example. The target cell window only needs to be strong enough to hold the target material. 0.5 mil Al is typical of cell windows used in other experiments.

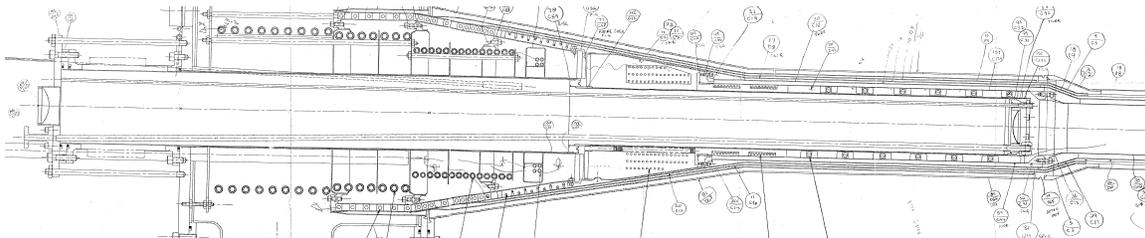


Figure 1.

## Downstream

Downstream from the target, there is the exit window to the target cell, followed by five shells (figure 2). All but the fourth shell must be able to withstand a high differential pressure. For these shells it is assumed that they will be made from 20 mil Al. This is a significantly higher number than the windows in the upstream portion of the refrigerator. This is due to the fact that the end of the shells will have a significantly greater area. The fourth shell is a radiation shield only, and therefore is given the same value as before of 1 mil Al. The statements made in regards to the upstream radiation shields will still apply, but the materials used may need to be different depending on engineering difficulties. The exit window to the target cell will be made of the same material as the entry window to the target cell was.

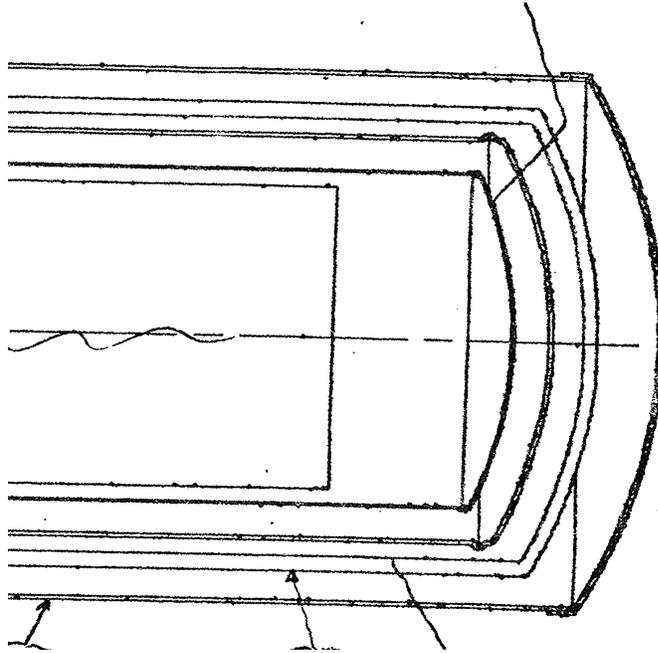


Figure 2.

### Dilution Factor

The amount of target material depends on the configuration used. It may be possible to use a solid rod as our target. This means that there would be 6.56 g/cm<sup>2</sup> of LiD as the target. We may find that the solid rod cannot be polarized effectively. If this is the case, we will have to use crushed LiD. With the crushed LiD, there is a packing fraction of 60%. This means that there is only 3.936 g/cm<sup>2</sup> LiD in the target. A mixture of 4He and 3He liquid and gas would occupy the remaining space in the target. The exact density of this mixture is unknown, but it is certainly less than the density of liquid 4He. The density of this mixture is therefore assumed to be 0.464 g/cm<sup>2</sup>.

### Refrigerator Materials

	Material	thickness (mil)	thickness (mm)	g/cm <sup>2</sup>
<b>UP STREAM</b>				
cell window	Al	0.5	0.013	0.003
mixing chamber	Ti	1.5	0.038	0.017
radiation shield	Al	1	0.025	0.007
radiation shield	Al	1	0.025	0.007
radiation shield	Al	1	0.025	0.007
radiation shield	Al	1	0.025	0.007
outer window	Al	5	0.127	0.034
<b>DOWN STREAM</b>				
cell window	Al	0.5	0.013	0.003
nose cap	Al	20	0.509	0.137
shell 2	Al	20	0.509	0.137
shell 3	Al	20	0.509	0.137
shell 4	Al	1	0.025	0.007
outer cap	Al	20	0.509	0.137

**TOTAL** 0.643

### TARGET

ROD	LiD	800	6.56
CRUSHED (0.60)	LiD	800	3.936
	4He		0.464