SLAC E160 Target Foils

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- Procuring Solid Target Foils
  - Goodfellow Inc. can provide all foils
  - Brush Wellman specializes in Be material
- Thickness Measurements
  - No problem to achieve sub-1% measurements on hard material.
  - Problems with soft metal foils
    - Non-uniform from vendor
    - Difficult to measure thickness

Target Materials

- Suggested Targets from Proposal:
  - 5 % r.l. Be; 14 % r.l. Al, 20 % r.l. Cu and Pb
  - TN-12 proposed modifications to the thicknesses and targets
    - E139 maximum thickness – 12% r.l.
    - Sn, Au target additions

Reproduction of Table 1 from TN-12:

Element	Z	A	ρ (g/cm^3)	g/cm^2	cm	Rad. Lengths	Int. Lengths	b^{-1}
No Targ	-	-	-	-	-	-	-	-
LiD	2	4	0.82	3.28	4.0	0.036	0.04	1.97
Be	4	9.012	1.848	3.26	1.764	0.050	0.043	1.96
Al	13	26.980	2.700	1.52	0.533	0.060	0.013	0.92
Al	13	26.980	2.700	3.05	1.067	0.120	0.027	1.84
Al w/ hole	13	26.980	2.700	3.05	1.067	0.120	0.027	1.84
Cu	29	63.546	8.960	1.54	0.172	0.120	0.011	0.93
Sn	50	118.710	7.310	1.05	0.144	0.120	0.009	0.63
Au	79	196.966	19.38	0.78	0.040	0.120	0.004	0.47
Pb	82	207.200	11.350	0.76	0.067	0.120	0.004	0.46

Procurement of Target Foils

Quotes from Goodfellow Inc.

Target	Part Number	Quantity	Thickness	Size	Purity	Cost
Be						
	Need special size		17.6 mm	15 mm x 15 mm	99.00%	$850.00
Al:						
	AL000760	2	2.0 mm	50 mm x 50 mm	99.999%	$185.00
	AL000690	1	1.0 mm	50 mm x 50 mm	99.999%	$105.00
	AL000637	2	0.32 mm	50 mm x 50 mm	99.999%	$160.00
	AL000375	2	0.01 mm	50 mm x 50 mm	99.999%	$223.00
Cu:						
	Cu000743	2	0.5 mm	50 mm x 50 mm	99.99%	$134.00
	Cu000600	1	0.125 mm	50 mm x 50 mm	99.99%	$109.00
	Cu000570	1	0.10 mm	50 mm x 50 mm	99.99%	$159.00
Sn:						
	Sn000440	1	1.0 mm	50 mm x 50 mm	99.99%	$207.00
	Sn000420	1	0.5	50 mm x 50 mm	99.99%	$175.00
Au:						
	Au000349	1	0.10 mm	50 mm x 50 mm	99.95%	$415.00
or						
	Au000350	1	0.125 mm	50 mm x 50 mm	99.99%	$731.00
or						
	Au000350	1	0.5 mm	50 mm x 50 mm	99.99%	
Pb:						
	Pb000401	1	0.5 mm	50 mm x 50 mm	99.95%	$62.50
	Pb000350	1	0.15 mm	50 mm x 50 mm	99.95%	$60.00
or						
	Pb000411	1	1.0 mm	50 mm x 50 mm	99.95%	$87.50

Approximate Cost (w/ 99.95% Gold): $2,845

The cost is subject to how one wants to produce the actual targets (i.e. stacks of thinner foils or one thick foil) and how closely one wants the thickness to match the proposal/tech. note numbers. It is quite likely that Brush Wellman can provide the Be target for less money.

Thickness Measurements

(areal density or ρt)

- The average areal density (ρt g/cm^2) can be determined precisely by measuring the target mass, the projected area in the beam direction, and calculating ρt = mass/area.
  - The foils must be machined to ensuring that the edges are straight and sharp.
  - Uniformity must be measured (i.e. micrometer)
  - $\delta\rho t/\rho t < 1$ % (exceptions: see next item)
- Problems for soft metal foils (Pb, Au, and Sn)
  - Typically thinnest targets used.
  - Less uniform from vendor.
  - More difficult to directly measure thickness.
    - SLAC E139 12% r.l. gold target error 1.3%.
    - Lead will be more difficult than gold.
      - Use attenuation measurement (x-ray or beta).
      - Use Tantalum instead.

Conclusion

The target foils can be procured from reliable vendors for a cost of a few thousand dollars. 1 % ρt determinations will be challenging for the softer materials.