In[431]:=

```
<< PhysicalConstants`
<< Units`
```

Foil properties
(Z, A, ρ, X_0(grams),X_0(cms),nuclear charge radius parameter)

In[438]:=

```
Beryllium = {4, 9, 1.85, 65.19, 35.28, .64};
Poly = {6, 12, 1, 43.8, 41.3, .69};
Al = {13, 27, 2.7, 24, 8.9, 1.04};
Au = {79, 197, 19.3, 6.46, .334, 2.3};
Foils = {Beryllium, Poly, Al, Au};
```

Size parameters used by Hofstadter
in exponential form : rms charge radius =
$2 * a\sqrt{3}$ but diverges from $A^{1/3}$ for light nuclei

Out[443]//TableForm=

	Slope parameter	$r_0 * A^{1/3}/(2\sqrt{3})$
Beryllium	0.64	0.780609
Carbon	0.69	0.859171
Gold	2.3	2.18361

Approximations to Hofstadter' s form:

In[444]:= $$\text{Rutherford}[\theta\_, Z\_, \text{EeMeV}\_] := 1/4\,(Z * \alpha_{EM})^2 \frac{\hbar c1^2}{\text{EeMeV}^2} \text{Csc}[\theta/2]^4$$

$$\text{Mott}[\theta\_, Z\_, \text{EeMeV}\_] := \text{Rutherford}[\theta, Z, \text{EeMeV}] * \text{Cos}[\theta/2]^2 \left(1 + \frac{\pi * Z * \alpha_{EM} * \text{Sin}[\theta/2] * (1 - \text{Sin}[\theta/2])}{\text{Cos}[\theta/2]^2}\right)$$

$$Q[\theta\_, \text{EeMeV}\_] := \frac{2 * \text{EeMeV}}{\hbar c} \text{Sin}[\theta/2]$$

In[447]:= $$\rho[r\_, a\_] := \frac{1}{8\pi\,(a)^3} \text{Exp}[-r/a]$$

In[448]:= $$\text{FormFactor}(\theta\_, a\_, \text{EeMeV}\_) := \frac{4\pi \int_0^\infty r\,\rho(r, a) \sin(r\,Q(\theta, \text{EeMeV}))\,dr}{Q(\theta, \text{EeMeV})}$$

$$\text{Hofstadter}[\theta\_, Z\_, \text{EeMeV}\_, a\_] := \text{Mott}[\theta, Z, \text{EeMeV}] * \text{FormFactor}[\theta, a, \text{EeMeV}]^2$$

Calculate the MCS scattering** angle, θ_0, **with the constraint that target produces 1** electron/cm^2 **at 90 or** 45^0 **1m from the target. Since the elastic scattering rate is:

$Rate = \frac{d\sigma}{d\Omega} d\Omega * Flux * \frac{\rho}{A * m_p}\, t$

and we require Rate=1 we invert this to find t.dΩ goes from $10^{-3} \to 10^{-4}$ ***ie 1/2 to 1 degree aperture.***

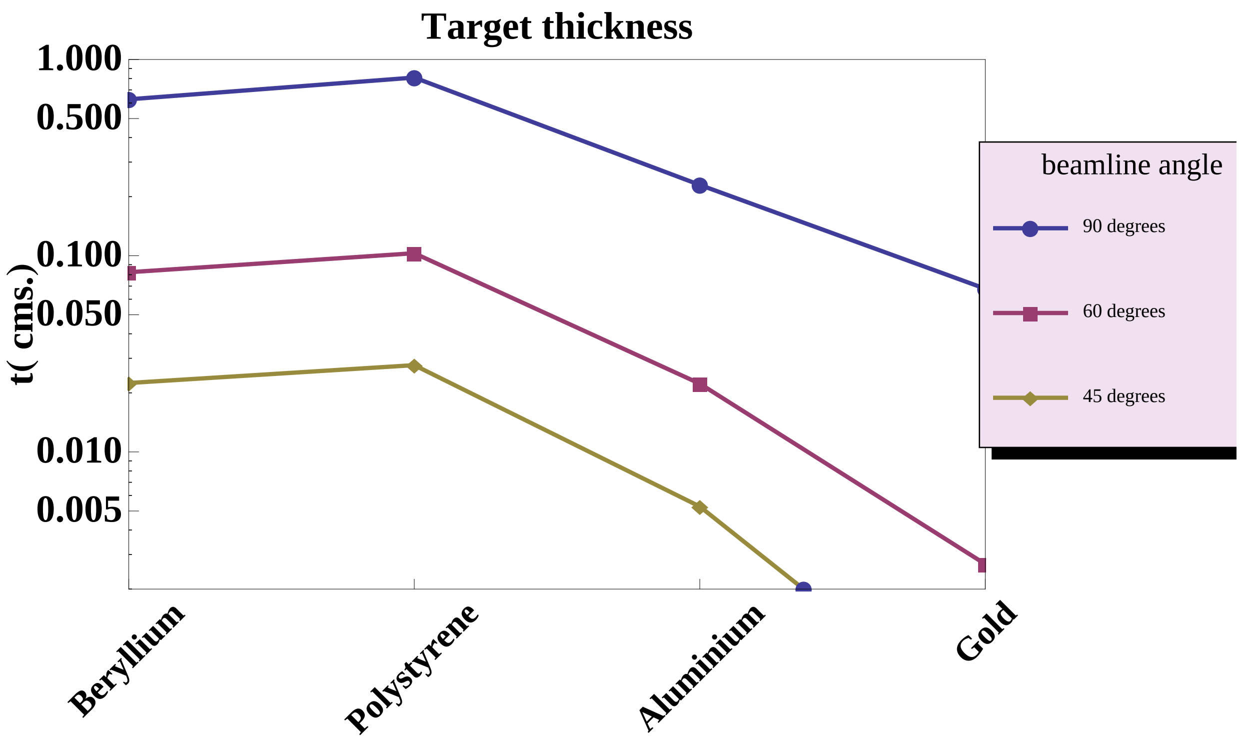
In[450]:= $d\Omega = 4 * 10^{-4}$; $Flux = 10^9$;

There are small corrections for the plastic - ie :

```
N_C = ChemicalData["Polystyrene", "ElementTally"][[1, 2]];
N_H = ChemicalData["Polystyrene", "ElementTally"][[2, 2]];
ρ_PS = ChemicalData["Polystyrene", "Density"] / 1000;
Molecules = ρ_PS / (N_C * 12 * M_p + N_H * M_p);
Atoms_H = N_H * Molecules;
Atoms_C = N_C * Molecules;
Correction = {1, 1, 1, 1};
Correction[[2]] = Atoms_C / (ρ_PS / (12 * M_p));
t45 =
  Table[.5 * (Foils[[i, 3]] / (M_p * Foils[[i, 2]]) * Correction[[i]] * Flux * dΩ *
       Hofstadter[45 * Degree, Foils[[i, 1]],
        80, Foils[[i, 6]]])^-1, {i, 4}];
t60 = Table[.5 * (Foils[[i, 3]] / (M_p * Foils[[i, 2]]) * Correction[[i]] *
       Flux * dΩ * Hofstadter[60 * Degree,
        Foils[[i, 1]], 80, Foils[[i, 6]]])^-1, {i, 4}];
t90 = Table[.5 * (Foils[[i, 3]] / (M_p * Foils[[i, 2]]) * Correction[[i]] *
       Flux * dΩ * Hofstadter[90 * Degree,
        Foils[[i, 1]], 80, Foils[[i, 6]]])^-1, {i, 4}];
```

Out[462]//TableForm=

	Beryllium	Polystyrene	Aluminum	Gold
45^0	0.0224508	0.0276849	0.00526937	0.000366703
60^0	0.0823612	0.102971	0.022279	0.00267969
90^0	0.62664	0.809059	0.229531	0.0678794



In[470]:=

```
MCS[rl_, t_] := 13.6/80 Sqrt[t/rl] * (1 + .038 * Log[t / rl])
mcs45 = Table[MCS[Foils[[i, 5]], t45[[i]]] / Degree, {i, 4}];
mcs60 = Table[MCS[Foils[[i, 5]], t60[[i]]] / Degree, {i, 4}];
mcs90 = Table[MCS[Foils[[i, 5]], t90[[i]]] / Degree, {i, 4}];
```

$$MCS[rl\_, t\_] := \frac{13.6}{80}\sqrt{\frac{t}{rl}} * (1 + .038 * Log[t/rl])$$

Out[474]//TableForm=

	Beryllium	Polystyrene	Aluminum	Gold
45^0	0.176992	0.182154	0.170071	0.239169
60^0	0.362245	0.375574	0.376402	0.712472
90^0	1.0993	1.15955	1.3468	4.12516