Scattering foil thickness for secondary beam

We calculate elastic scattering of 80 MeV electrons from a foil and find approximately the same
intensity for:

1) 1 micron Au
2) 30 micron Al
3) 120 micron LEXAN

which give ~ 1 scattered electron/pulse out of 10^7 incident beam into a 1 cm^2 counter 5m
from the target at 45^0. At 90^0 the rate is 16 times lower and at 20^0 it is 25 times higher.

Rutherford/Mott scattering of electrons:
Everything is in cgs, esu units. We calculate for A gold foil (1 micron thick) an
Aluminum foil (30 micron thick) and LEXAN (120 micron thick). 80 MeV electron beam.

In[233]:=
```
ZLexan = 6; ZAu = 79; ZAl = 13; qe = 4.8 * 10^-10; v = 3 * 10^10; me = 9 * 10^-28;
```

$$\frac{d\sigma}{d\Omega} \to R[\theta]$$

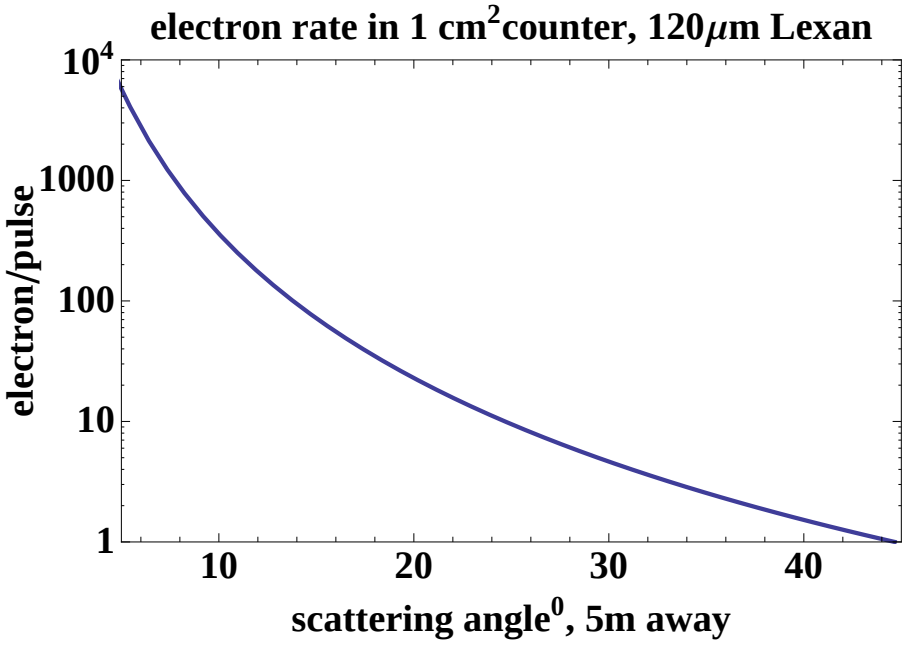
In[234]:=
```
R[θ_] := Z_Lexan^2 qe^4 Csc[θ / 2]^4 / (4 (me)^2 v^4)
```

1 cm^2 area 5 m away. at 45 degrees -> $d\Omega = 1\ cm^2 / (.25 * 10^6) = 4*10^{-6}$
distance of detector from beam center is d=5*10^2 cm*tan[θ]
So rate = flux * atoms / cm^3*t*sigma. atoms(Au)= $19.3 / (197 * 1.7 * 10^{-24})$,
Atoms(Al)= $2.7/(27 * 1.7 * 10^{-24})$,
Atoms (Lexan) = $1.2 * .76 / (12 * 1.7 * 10\text{^}-24) + .19 * 1.2 / (16 * 1.7 * 10\text{^}-24) * (8/6)^2$,
t = 1, 30, $120 * 10^{-4}$ cm foil.

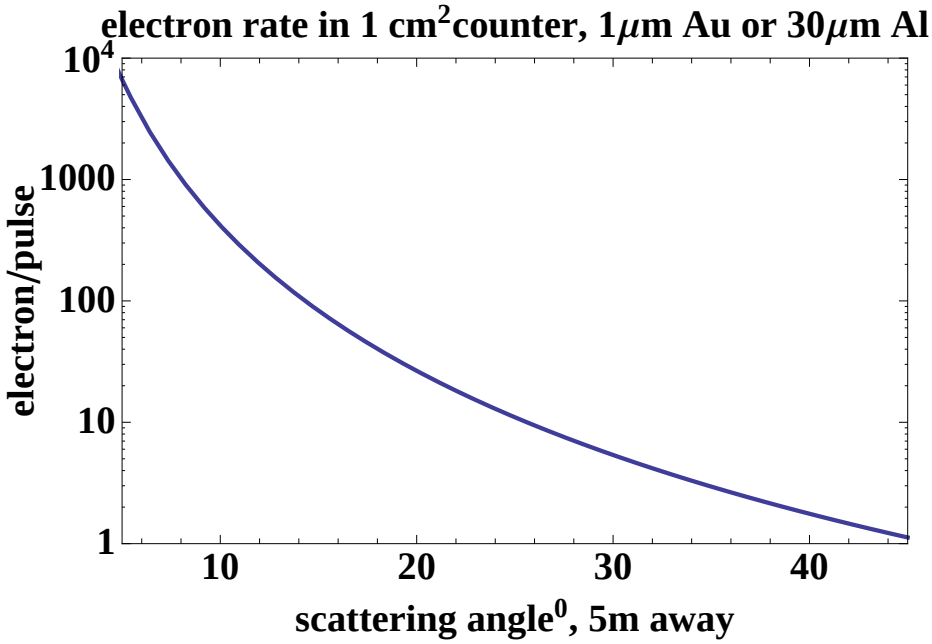
In[236]:=
```
atoms = 1.2 * .76 / (12 * 1.7 * 10^-24) + .19 * 1.2 / (16 * 1.7 * 10^-24) * (8 / 6)^2;
```

In[237]:=
```
d = N[5 * 10^2 * Tan[45 Degree]];
t = 120 * 10^-4;
domega = 4 * 10^-6;
Rate[θ_] := 10^7 atoms * domega * t * R[θ]
```

Out[241]=



Out[242]= 0.971457



So if we have a beam flux of 10^7electron/pulse and measure scattered electrons at 45^0 in 1 cm^2 area the rate is
1.4 e/pulse.

Bremsstrahlung radiation from the target:

The angular distribution of photons has an rms of θrms=me/Ebeam= 0.5/80= .36 degrees. In lexan X0 is
35 cms. so with a 30micron foil an electron loses ~ 7 keV

In[243]:=
```
Ebeam = 80
R[k_] := 1 - k / Ebeam
F[k_] := 1 - 2 / 3 R[k] + R[k]^2
Flux[k_] := .85 * 10^-4 * F[k] / k
LogPlot[Flux[k], {k, 0, Ebeam}, PlotRange → {{0, 80}, {10^(-6), 10^(-4)}}]
```

Out[243]= 80

Out[247]=