RUTHERFORD SCATTERING

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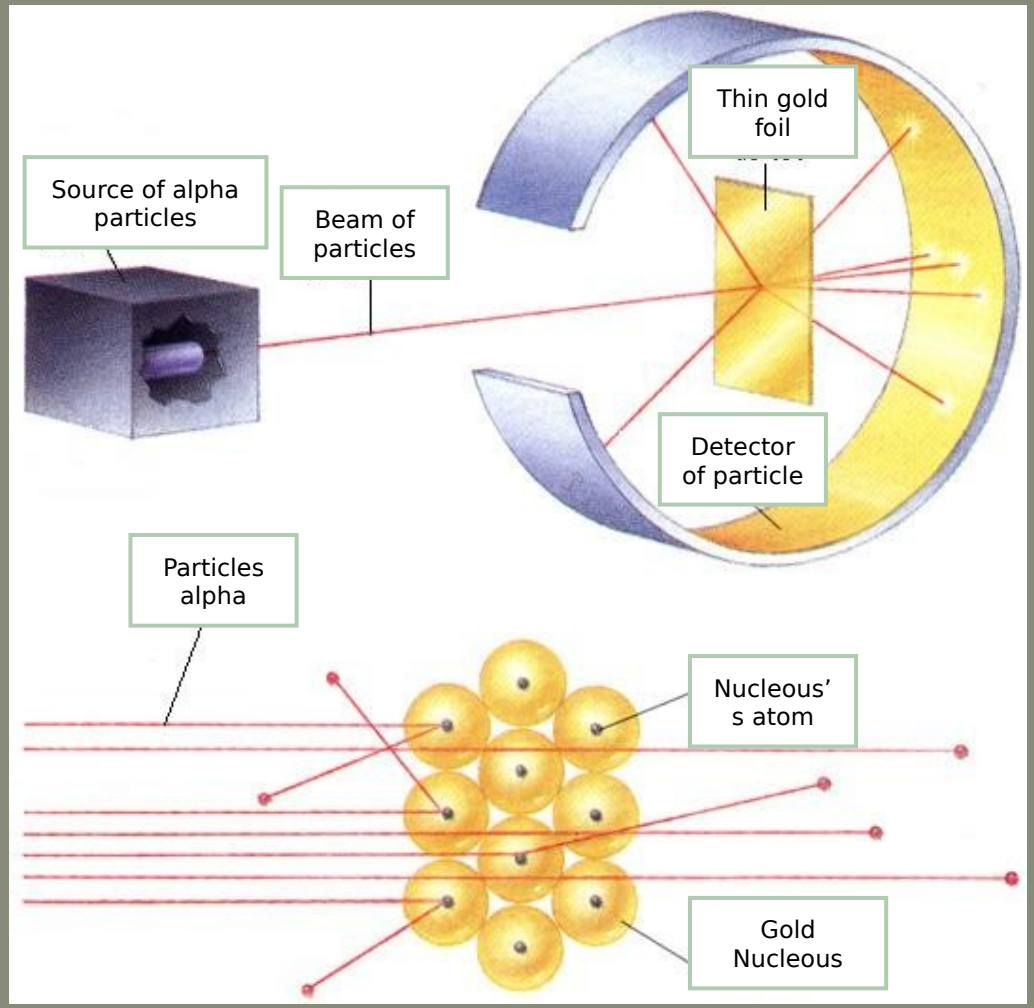
Rutherford Scattering

1º Bombarding a thin gold foil with alpha particles

2º Observed a number of particles was significantly deviated

3º Discovered the nucleus

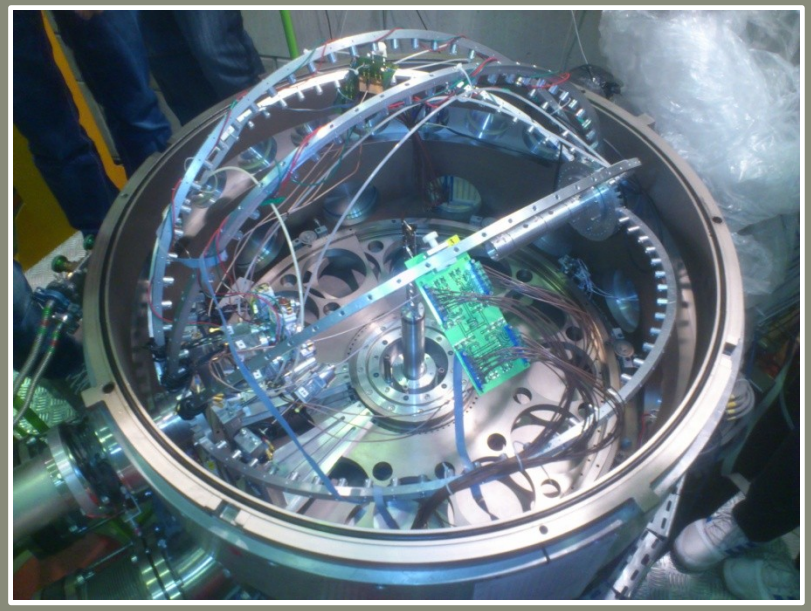


Dispersion of particles alpha

ICARE Set-up

ICARE is the charged particles detector system used for their identification and energy measurements.

The detectors can be mounted in any configuration preferred by users, using internal mounts



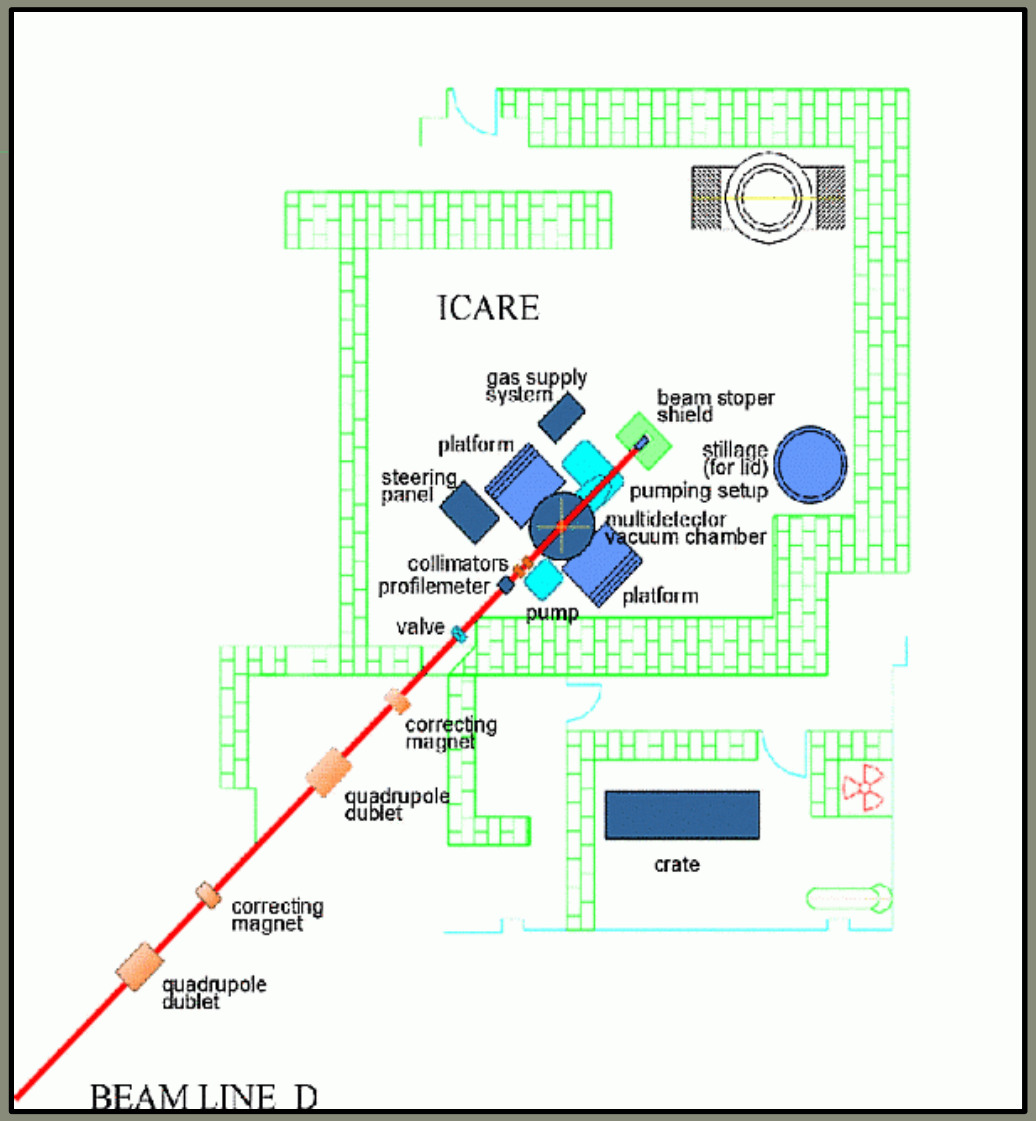
Accelerator

Beam energy

Througth the target

Monitor/ Detector

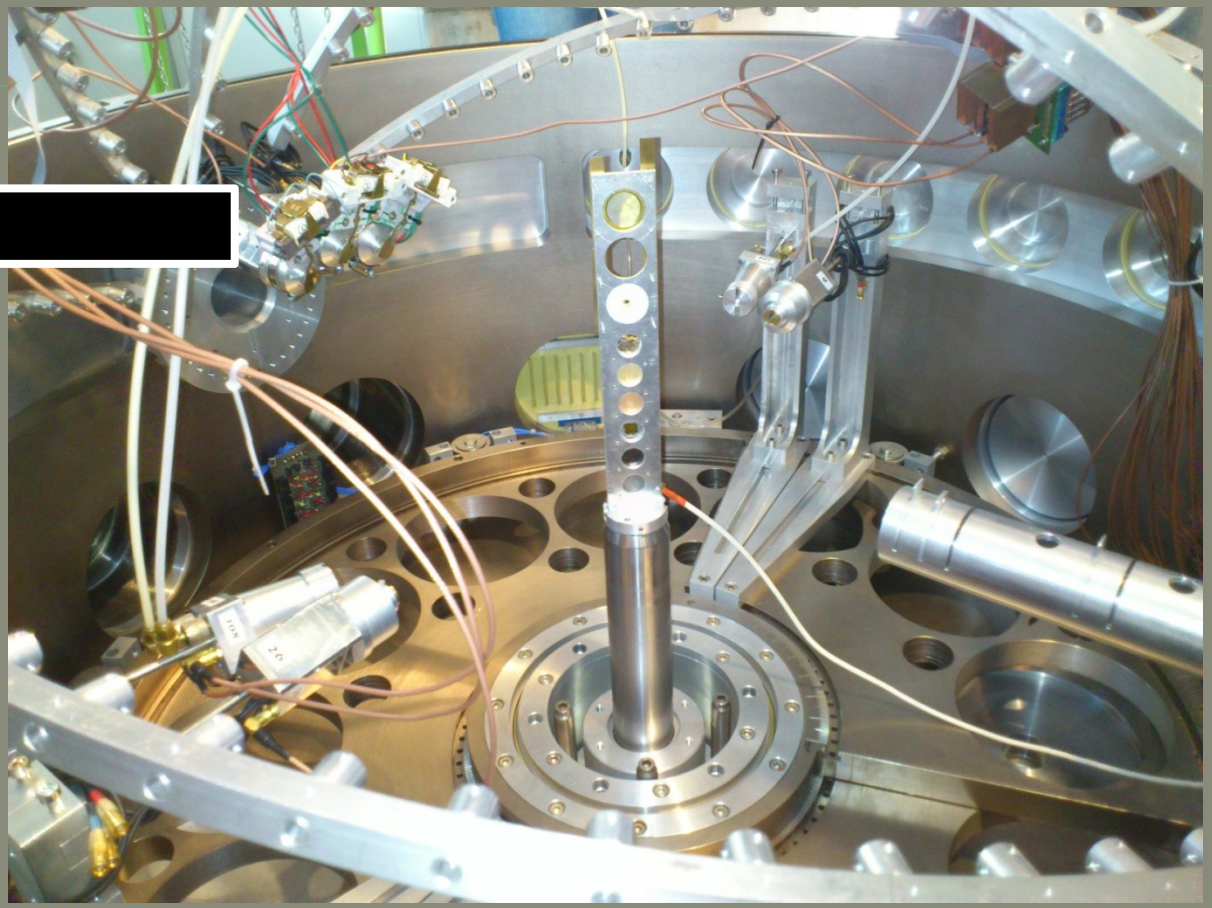
Measurements: Chosen angles to observe the particle energy spectra



Localization of the ICARE setup in the HIL experimental hall

Configuration chosen

3 Monitors



4 Detectors:

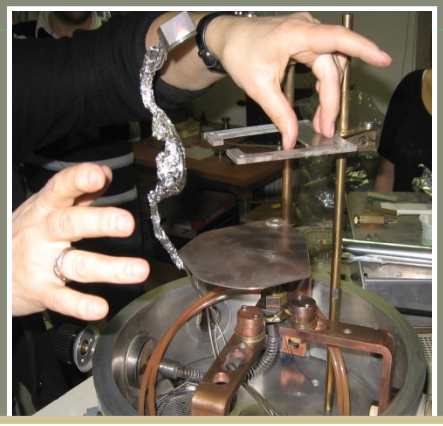
1 silicone and 1 telescope

each side

Procedure to follow

- Target prepared

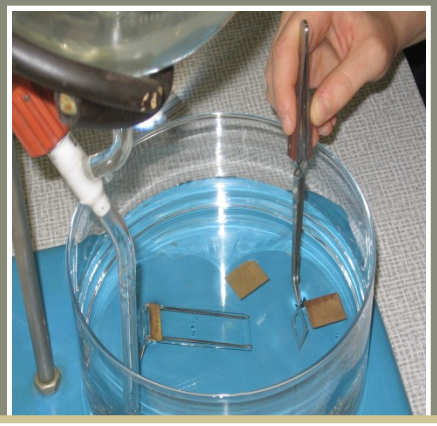
1º Application sugar on glass



2º Placement glasses

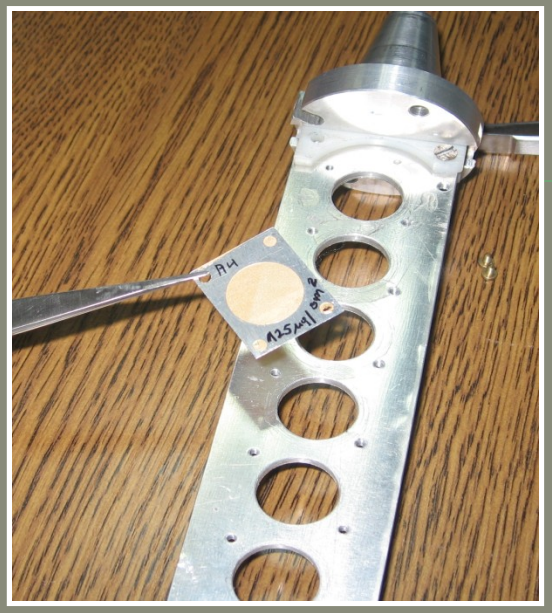
3º Evaporation procces

4º Gold foil on glass

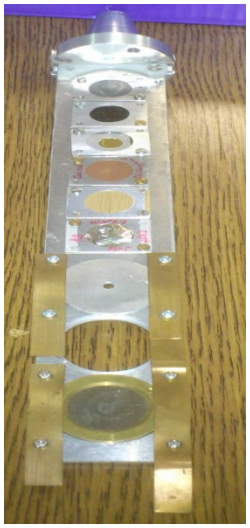


5º Preparation of gold foil

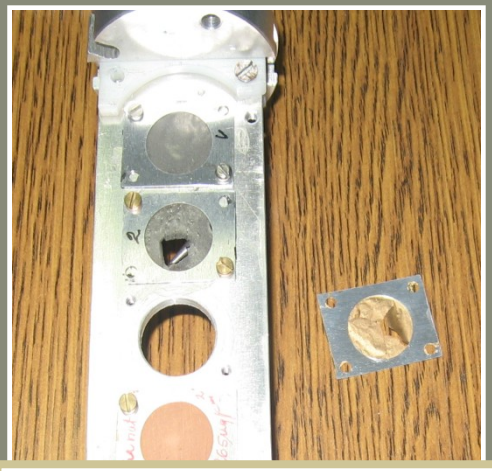
6º Mounting on the frame



9º Target holder completed

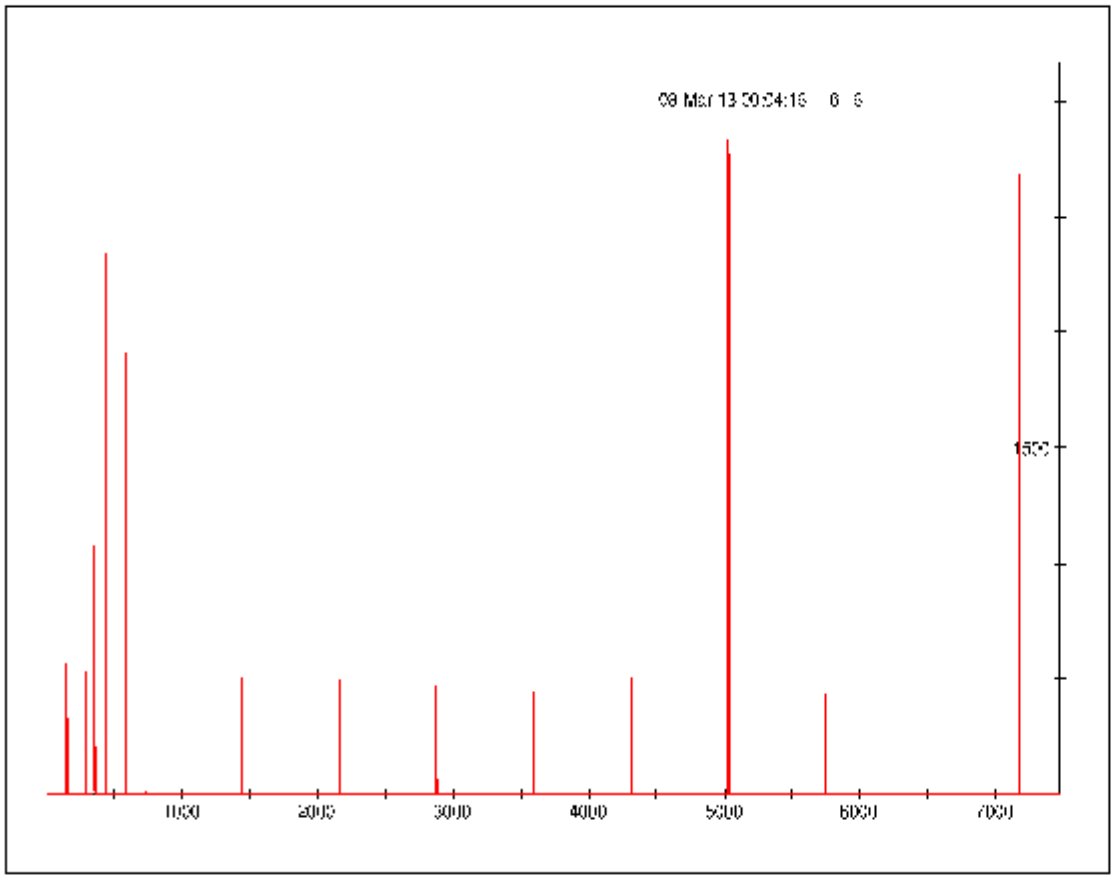


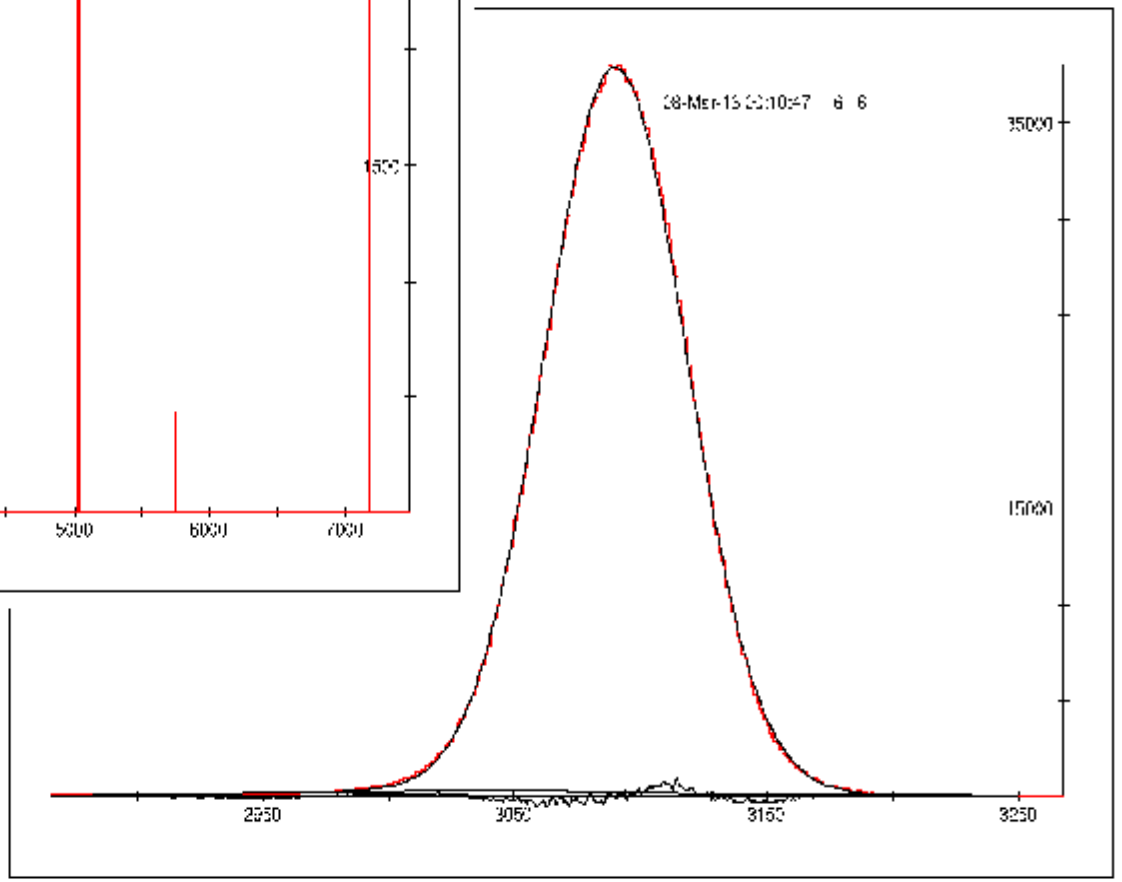
7º Mounting the target on holder



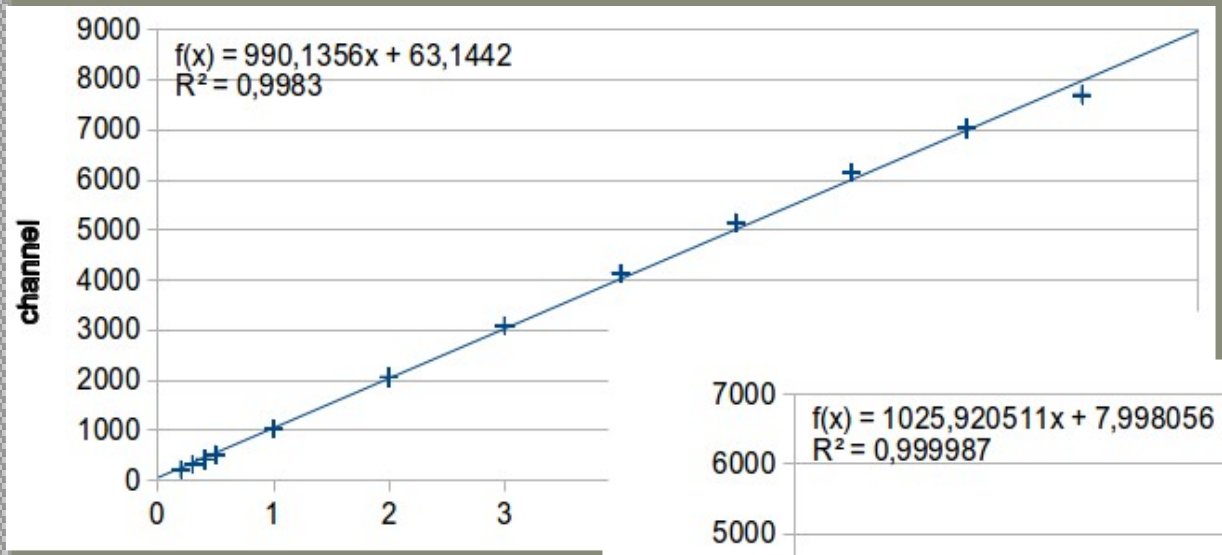
8º Disaster !!!

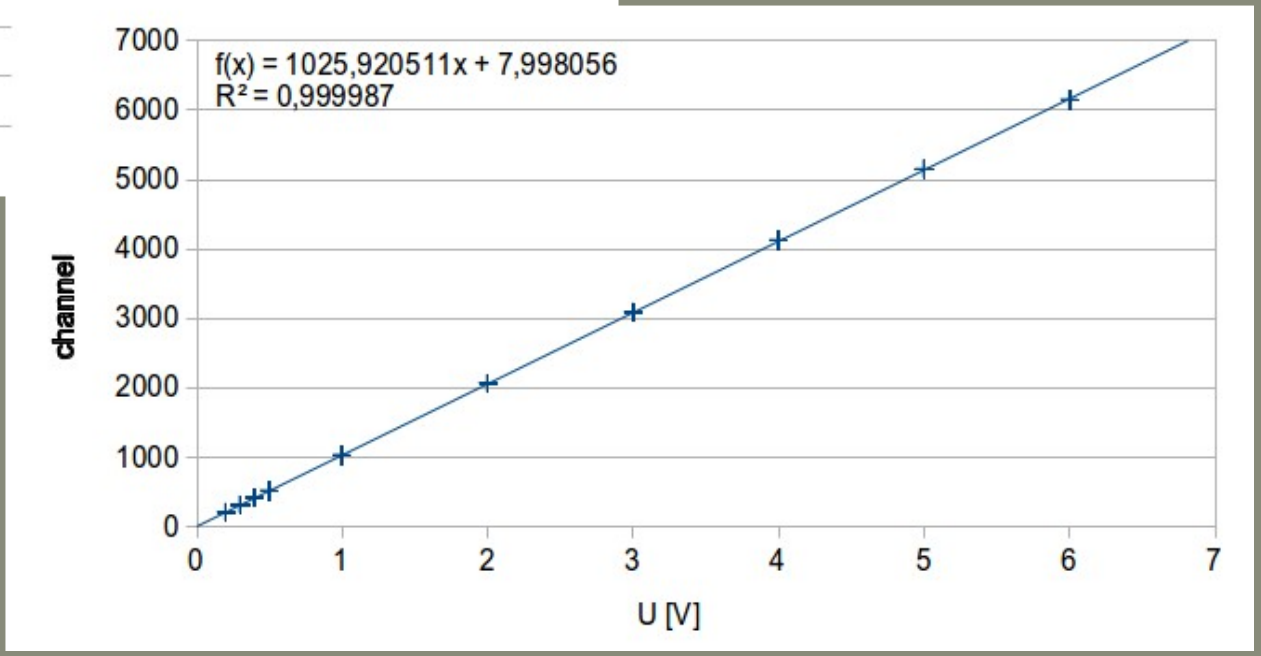
Calibration



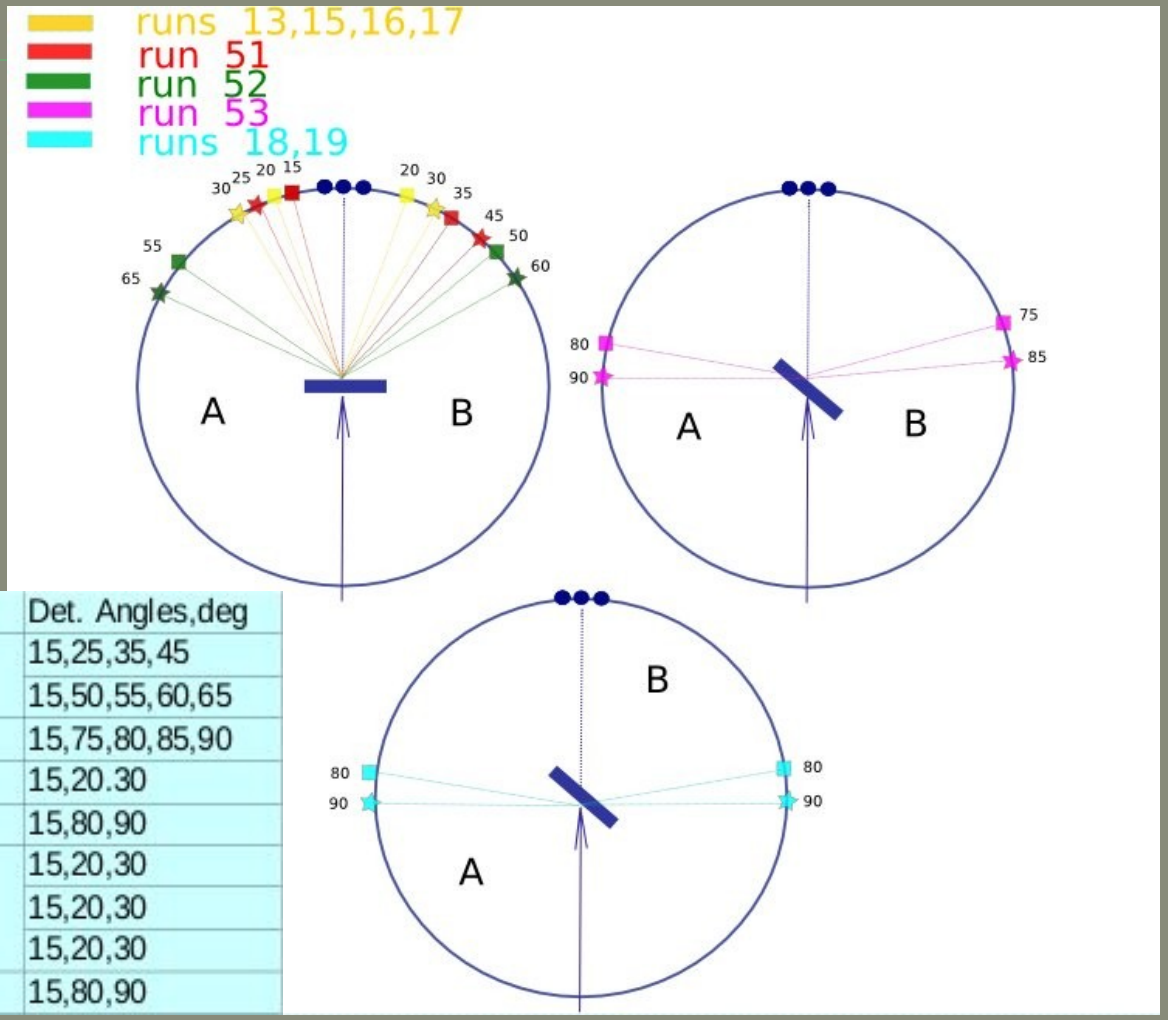


Calibration





Experimental run



Run	Target	target angle,deg	Det. Angles,deg
51	Thick Gold	0	15,25,35,45
52			15,50,55,60,65
53		45	15,75,80,85,90
16		0	15,20.30
19		45	15,80,90
13	Thin Gold	0	15,20,30
15	Silver		15,20,30
17	Copper		15,20,30
18		45	15,80,90

Objectives

Calculate the energy of the beam

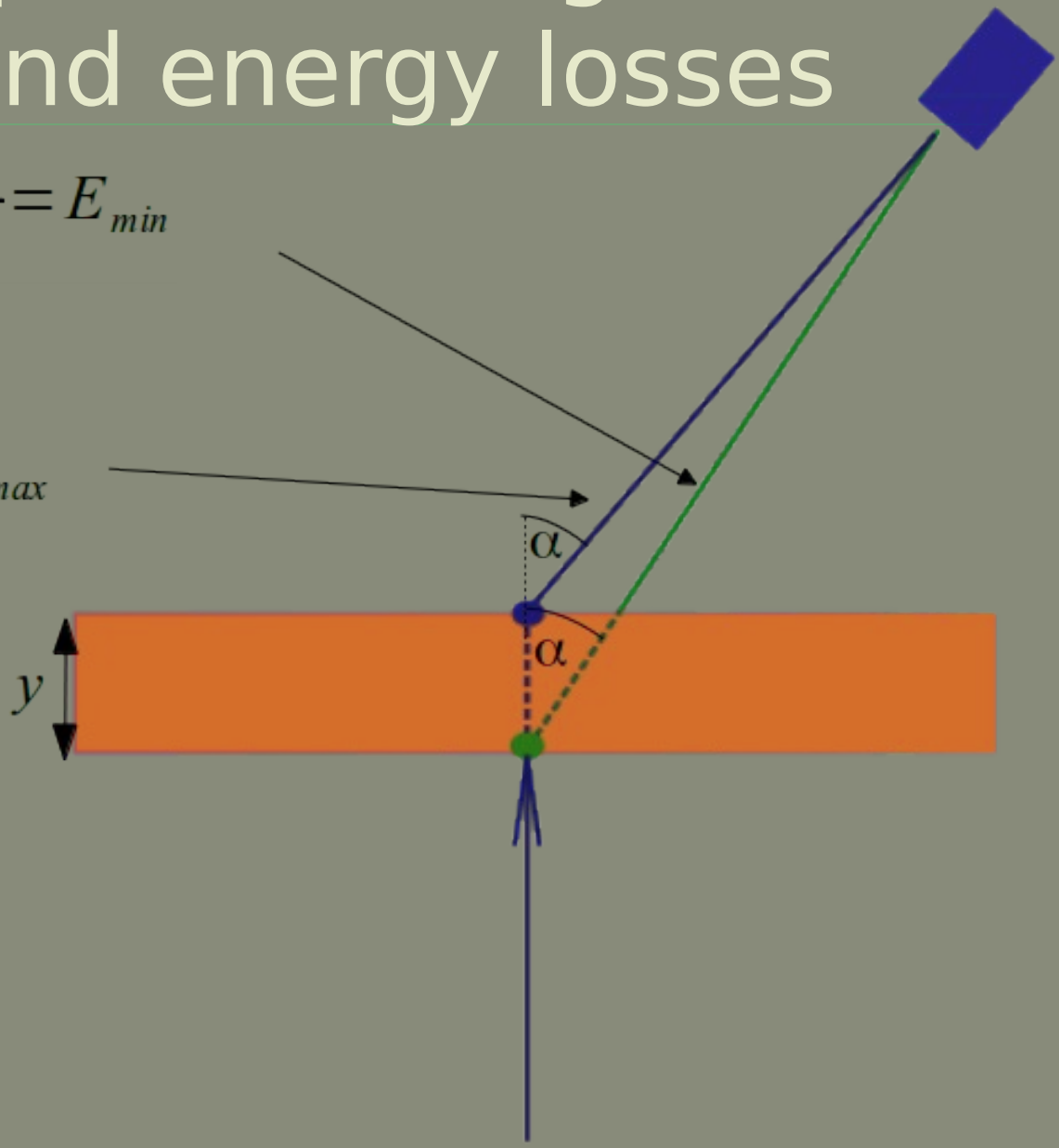
Determine target thickness

Differential cross section formula

Particles paths through the matter and energy losses

$$E_0 - \Delta E_{scat} - \frac{y}{\cos(\alpha)} \frac{dE}{dx} = E_{min}$$

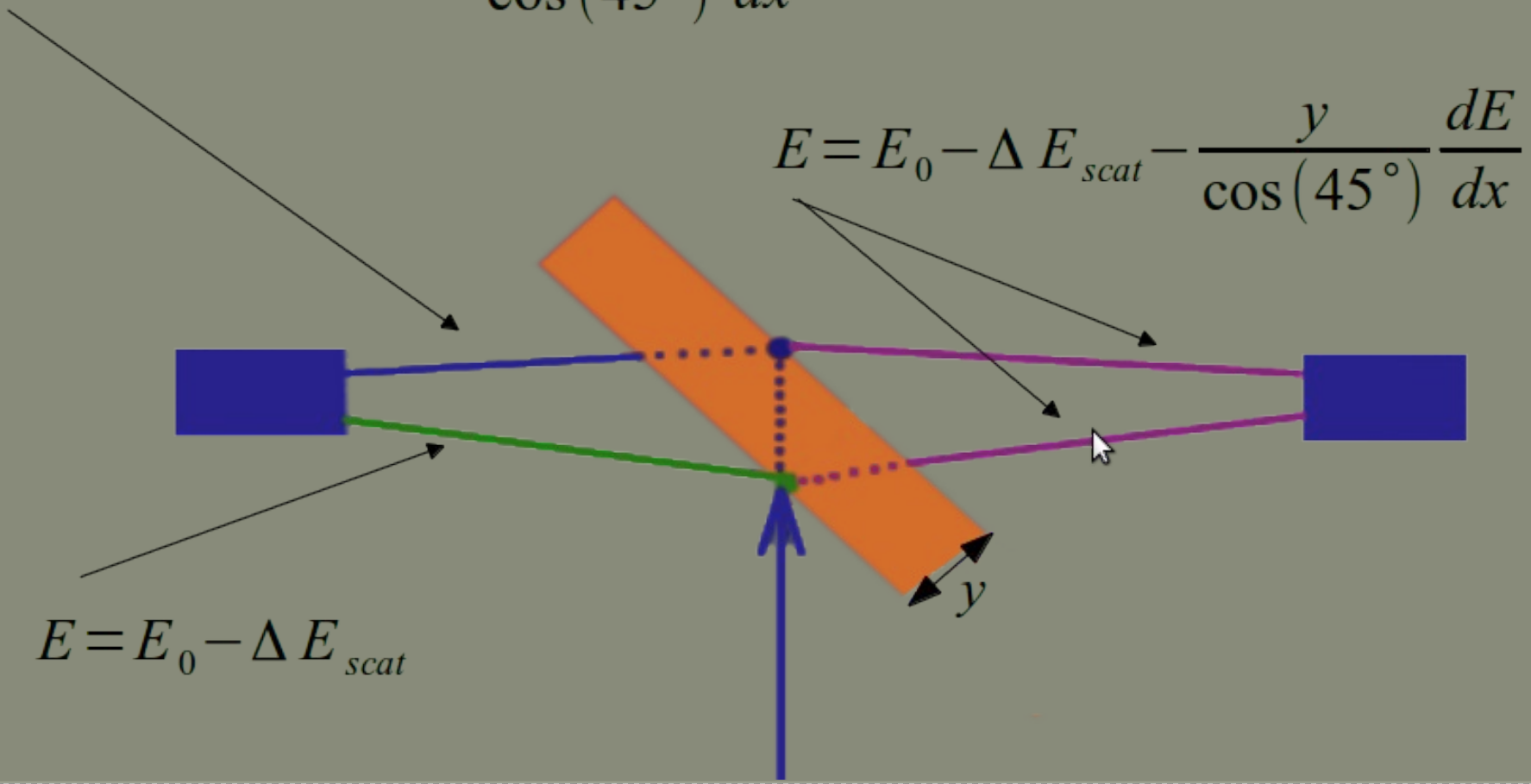
$$E_0 - \Delta E_{scat} - y \frac{dE}{dx} = E_{max}$$



Particles paths through the matter and energy losses

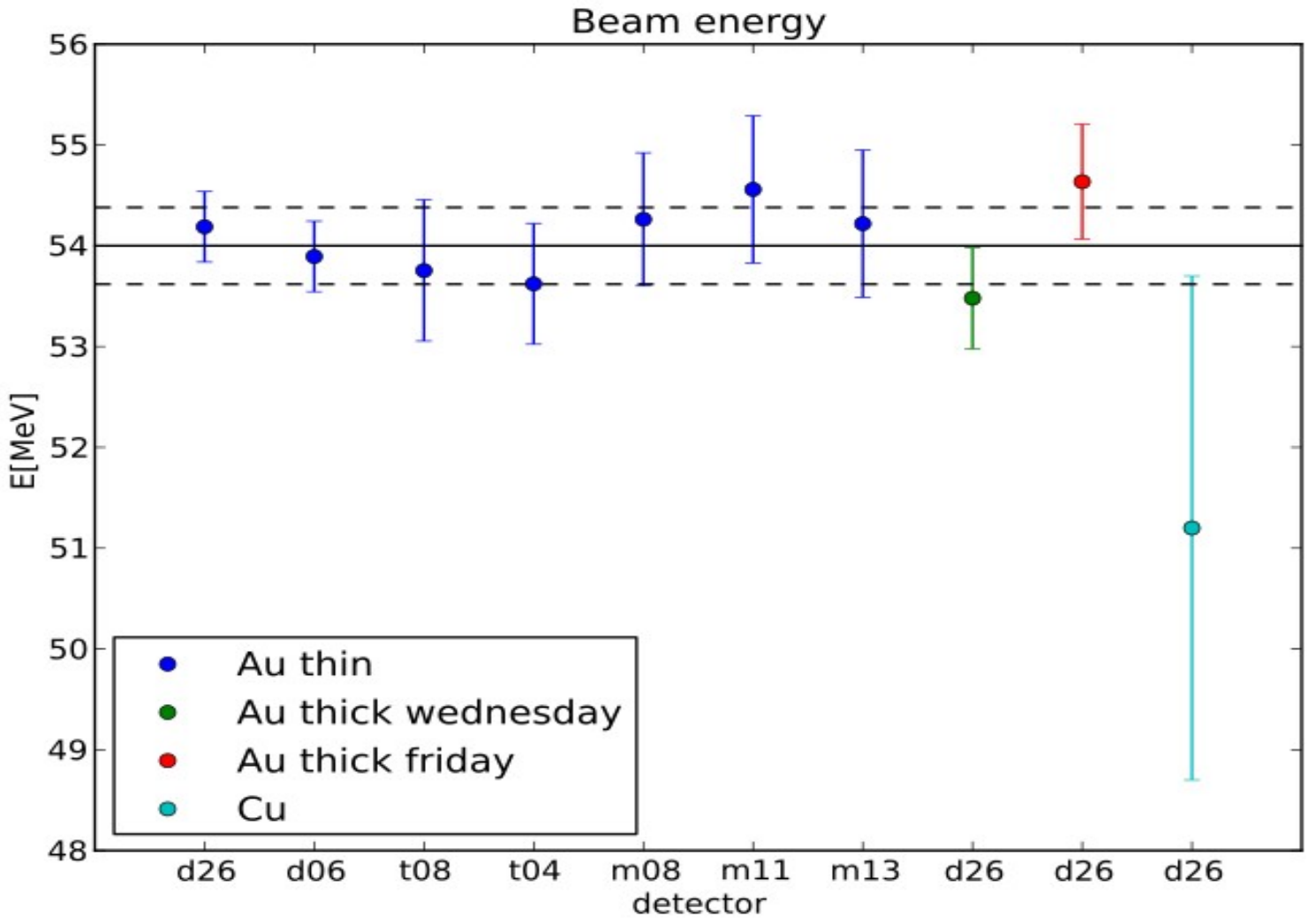
$$E_{max} = E_0 - \Delta E_{scat} - \frac{2y}{\cos(45^\circ)} \frac{dE}{dx}$$

$$E = E_0 - \Delta E_{scat} - \frac{y}{\cos(45^\circ)} \frac{dE}{dx}$$

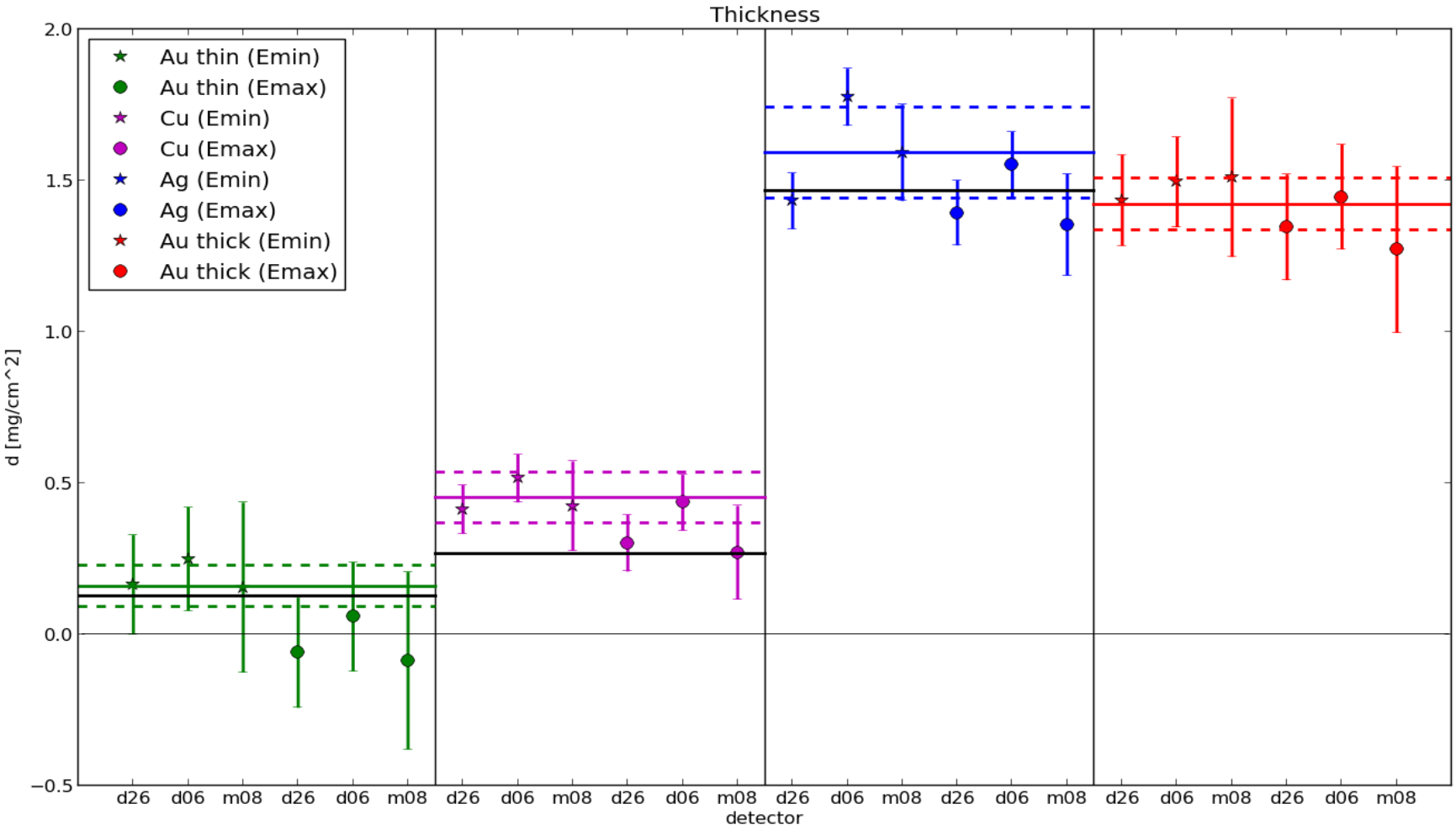


$$E = E_0 - \Delta E_{scat}$$

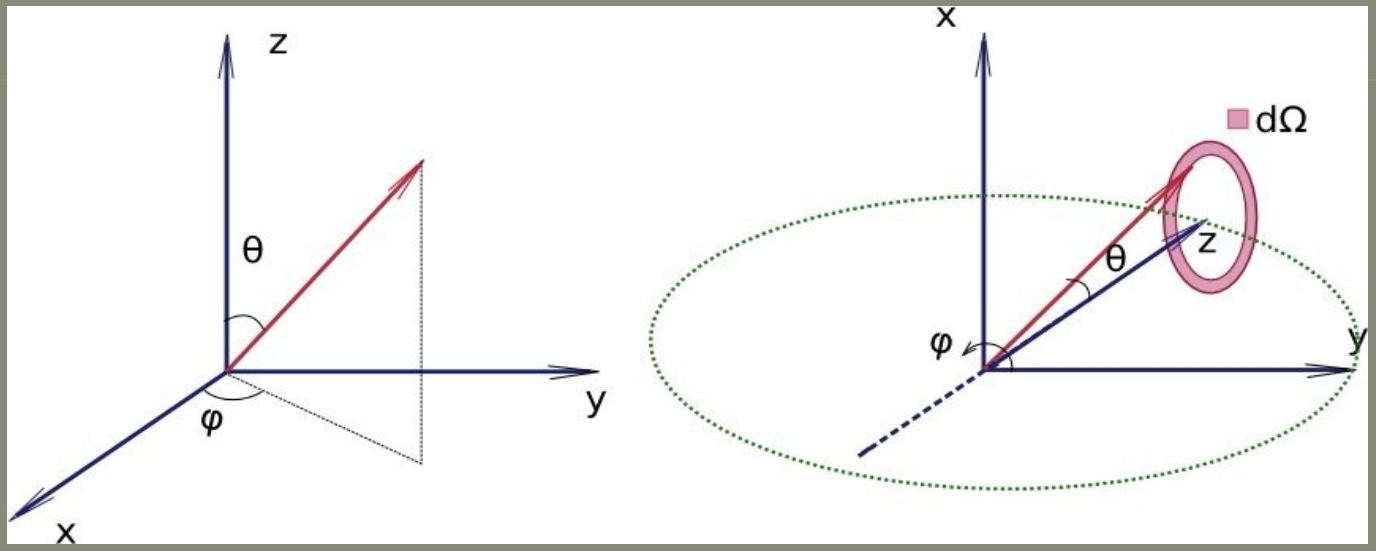
Energy of the beam



Targets thicknesses



Differential cross section



$$\frac{d\sigma}{d\Omega} = \frac{Z_1 Z_2 e^2}{16 \Pi \varepsilon_0 E_{kin}} \frac{1}{\sin^4(\theta_{CM}/2)}$$

$$P_{norm} = \frac{(d\sigma/d\Omega)}{(d\sigma/d\Omega)_m} = \frac{\sin^4(\theta_{m,CM}/2)}{\sin^4(\theta_{CM}/2)} = \frac{N}{\Omega} \frac{\Omega_m}{N_m}$$

$$d\Omega = \sin(\theta)\, d\theta\, d\varphi$$

Run	Target	target angle,deg	Det. Angles,deg
51	Thick Gold	0	15,25,35,45
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53		45	15,75,80,85,90
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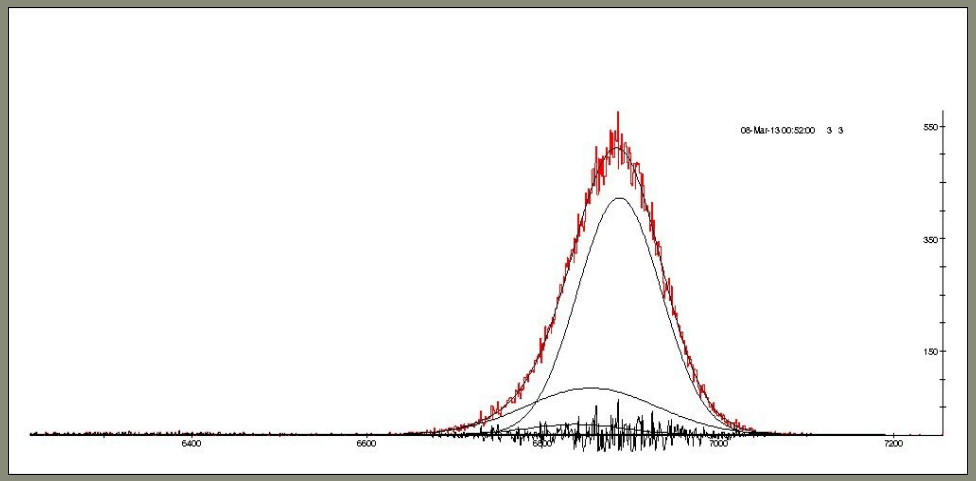
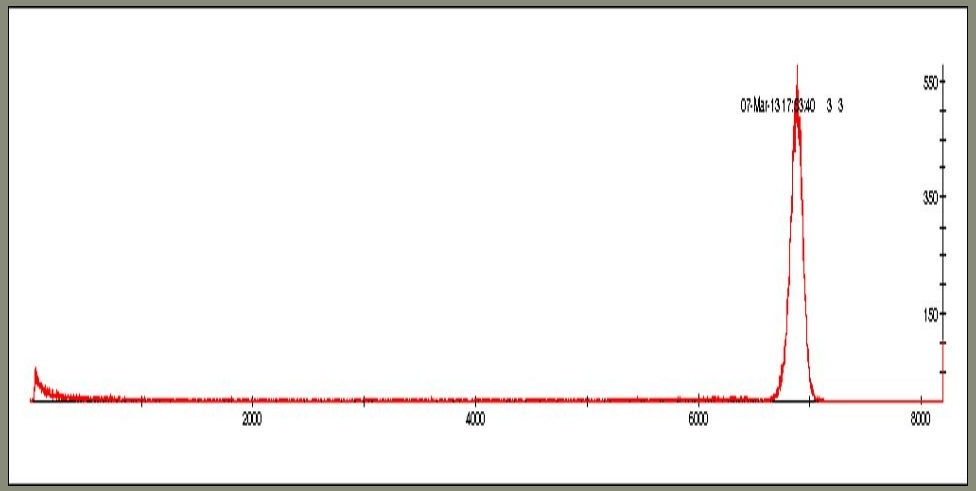
19		45	15,80,90





Differential cross section

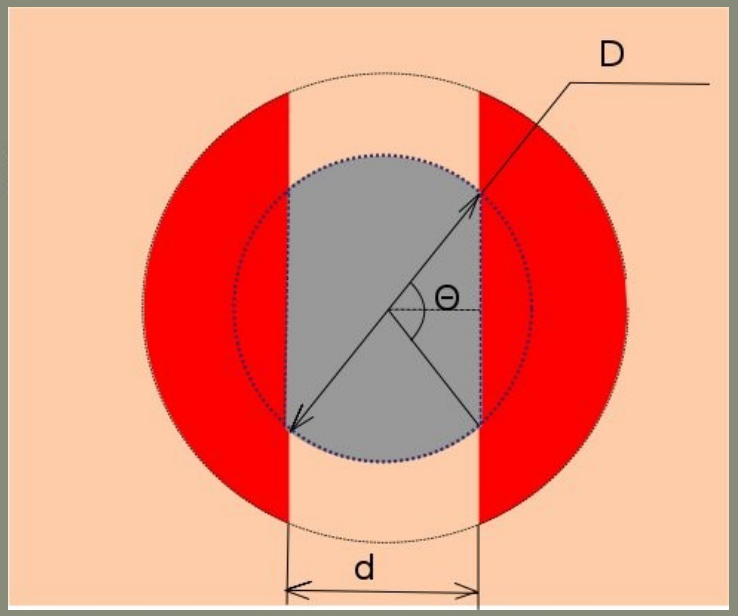
$$\Omega = \frac{S'}{TC^2}$$

Detectors	TC,cm	s', cm^2	Δs'/s',%	Ω=s/r^2,sr	ΔΩ/Ω,%
d26	21.2	0.225	3.23	0.000500	3.26
t8	22.7	0.361	3.59	0.000701	3.62
d6	21	0.225	3.23	0.000510	3.26
t4	22.9	0.361	3.59	0.000688	3.62
m8	27.9	0.225	3.23	0.000289	3.25

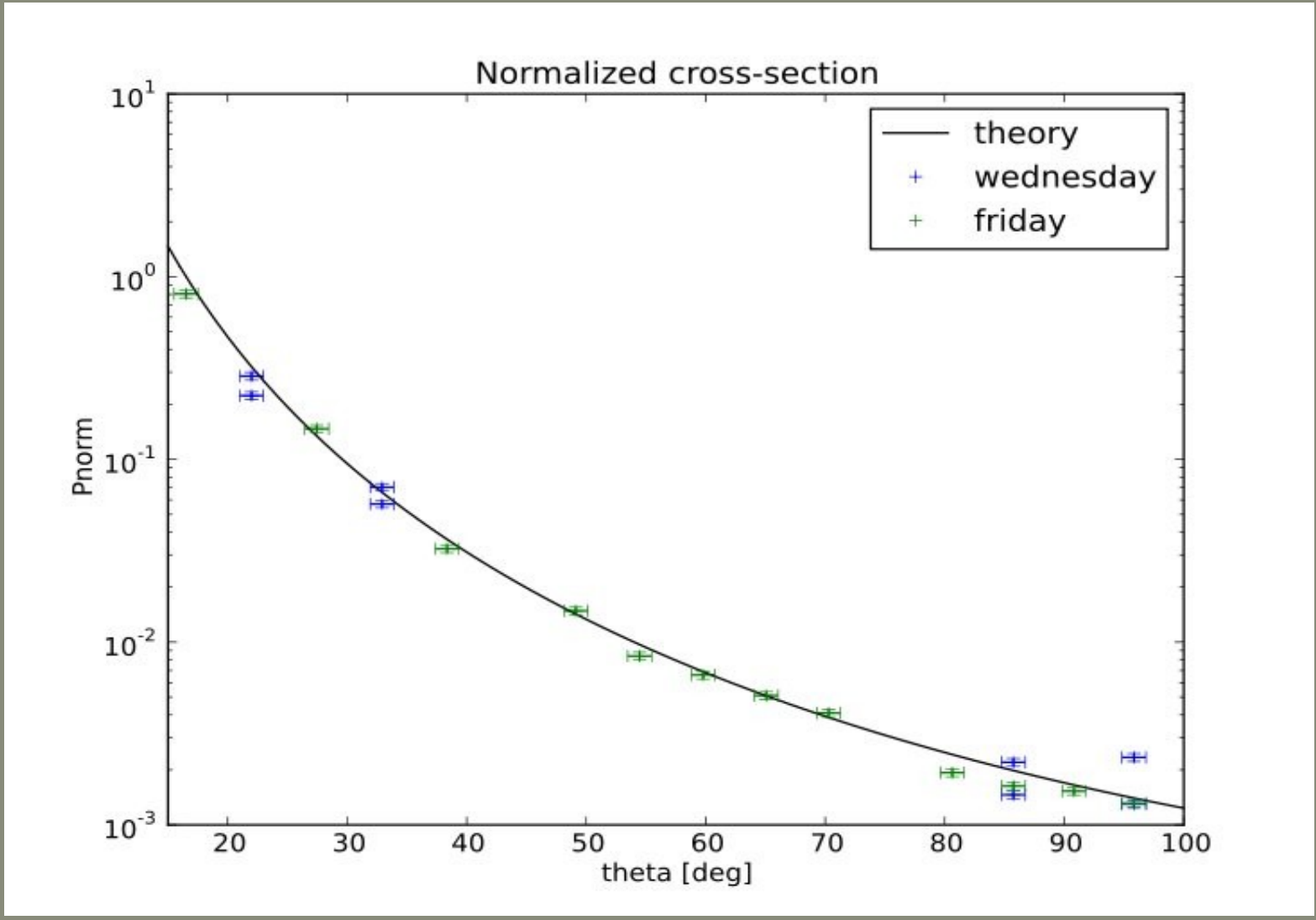
$$S' = S - 2s = \Pi \left| \frac{D}{2} \right|^2 - \left| \frac{D}{2} \right|^2 (\theta + \cos(\theta))$$

$$\theta = 2 \arccos \left| \frac{d}{D} \right|$$

$$\frac{d}{D} = \cos(\theta/2)$$



Differential cross section



Conclusions

1. We succesfully calculated energy of the beam
2. Our experimental data is well described by Rutherford scattering theory
3. We were able to determine the composition and thickness of unknown target
4. That was a great time spent together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