LIP: NUC-RIA PRODUCTION AND CHARACTERIZATION OF THIN SILVER FILMS

Andriy Myakush
Supervisors: Daniel Galaviz, Pamela Teubig

Objectives

- Produce thin silver films by thermal evaporation
- Thickness of the order of μm (from 0.32 μm to 1.05 μm)
- Measure the thickness with an α source
- Study the variation of the characteristics of the films with different parameters

Thin films: applications

- Photovoltaic cells
- Superconductors
- Nuclear targets

Important properties

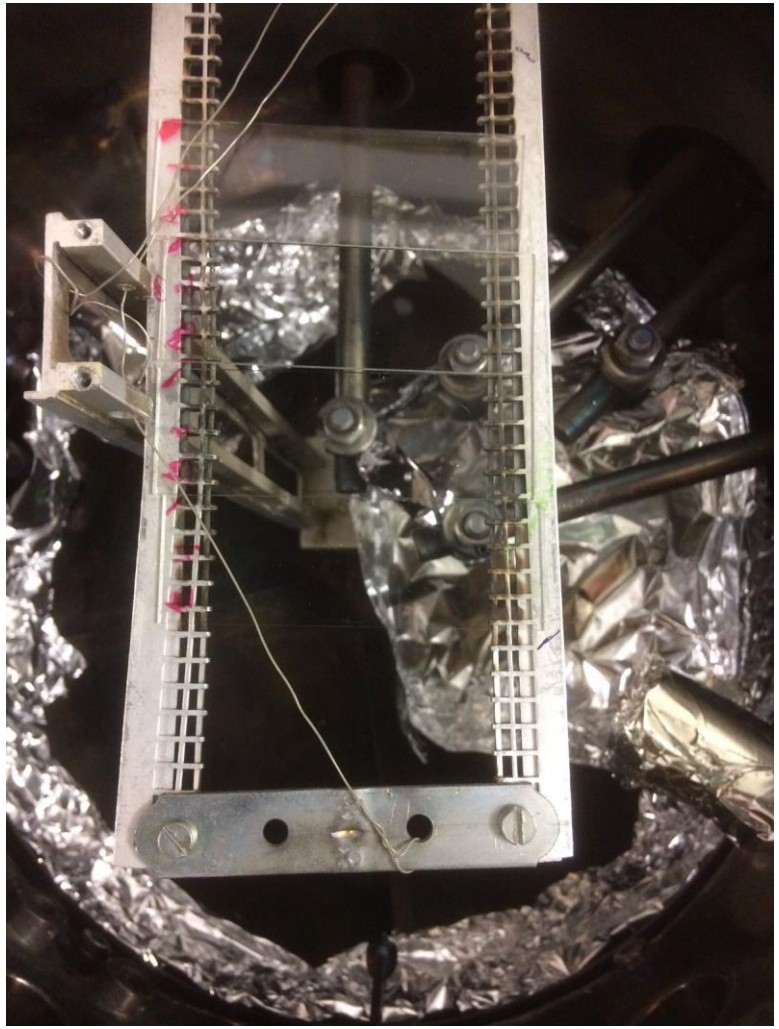
- Thickness
- Uniformity
- Chemical Purity
- Physical stability and resilience

Vacuum evaporation

- The material is heated in vacuum. It evaporates and then is deposited on a substrate by condensation
- The material is put in a metallic (Tantalum) “boat”
- The heating is achieved by a current

Treatment of substrates

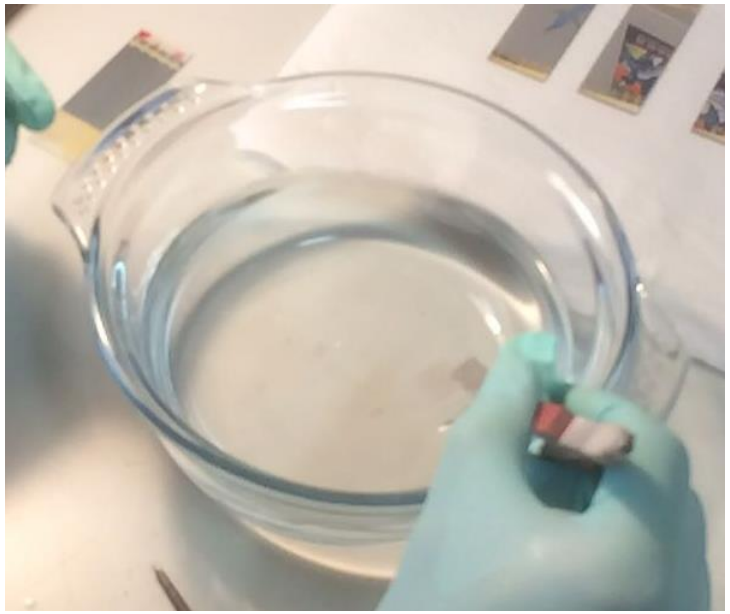
- Cleaning with alcohol
- Clear Identification of each glass
- Applying a thin layer of soap so that silver can be separated from the glass



Evaporation

“Fishing”

- The films are divided in segments, each segment is numbered.
- The silver is carefully separated from the glass by submerging it in a bowl of distilled water. The film is “fished” with a metallic target holder.

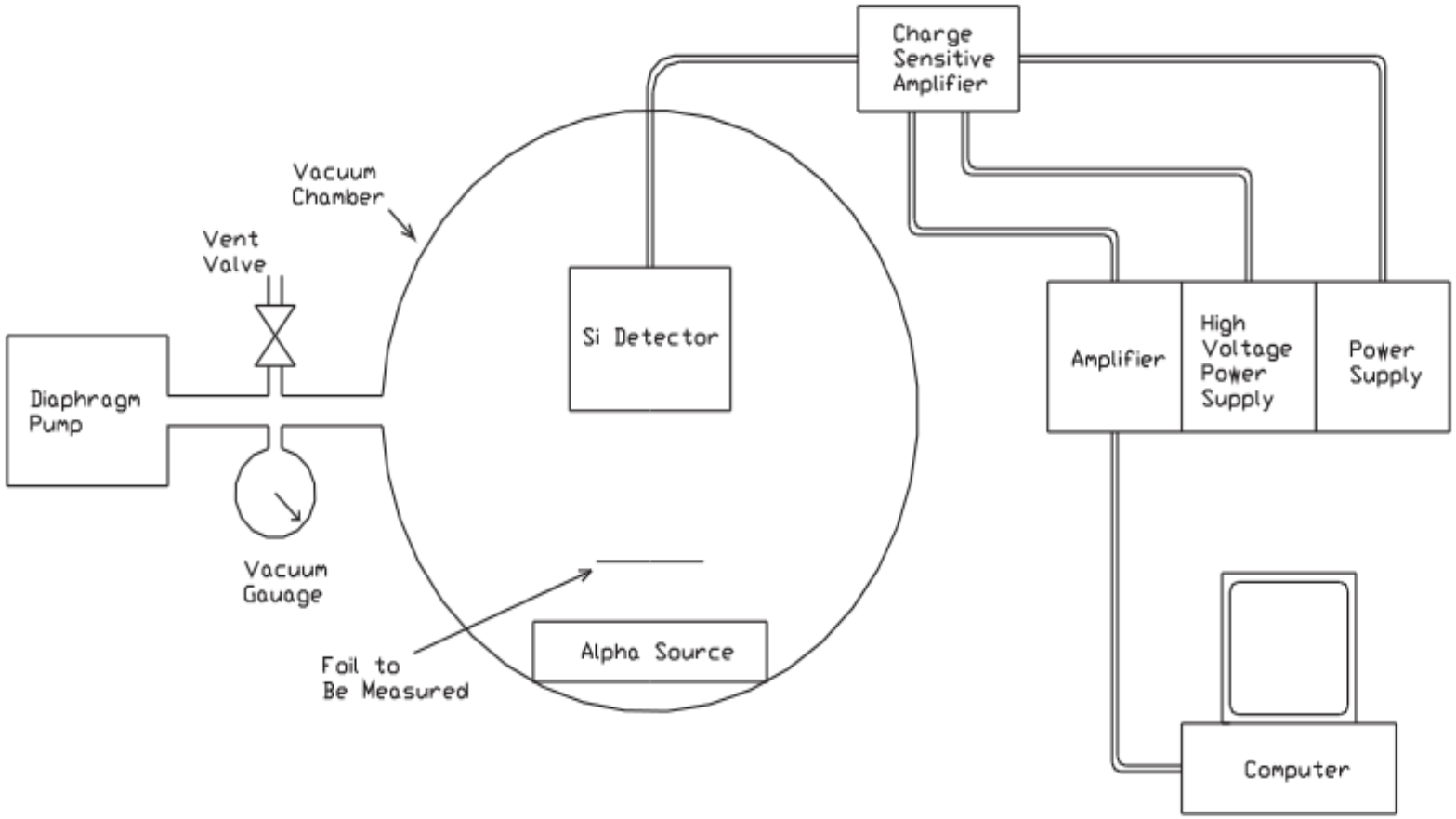


Thickness measurement: U-232 α source

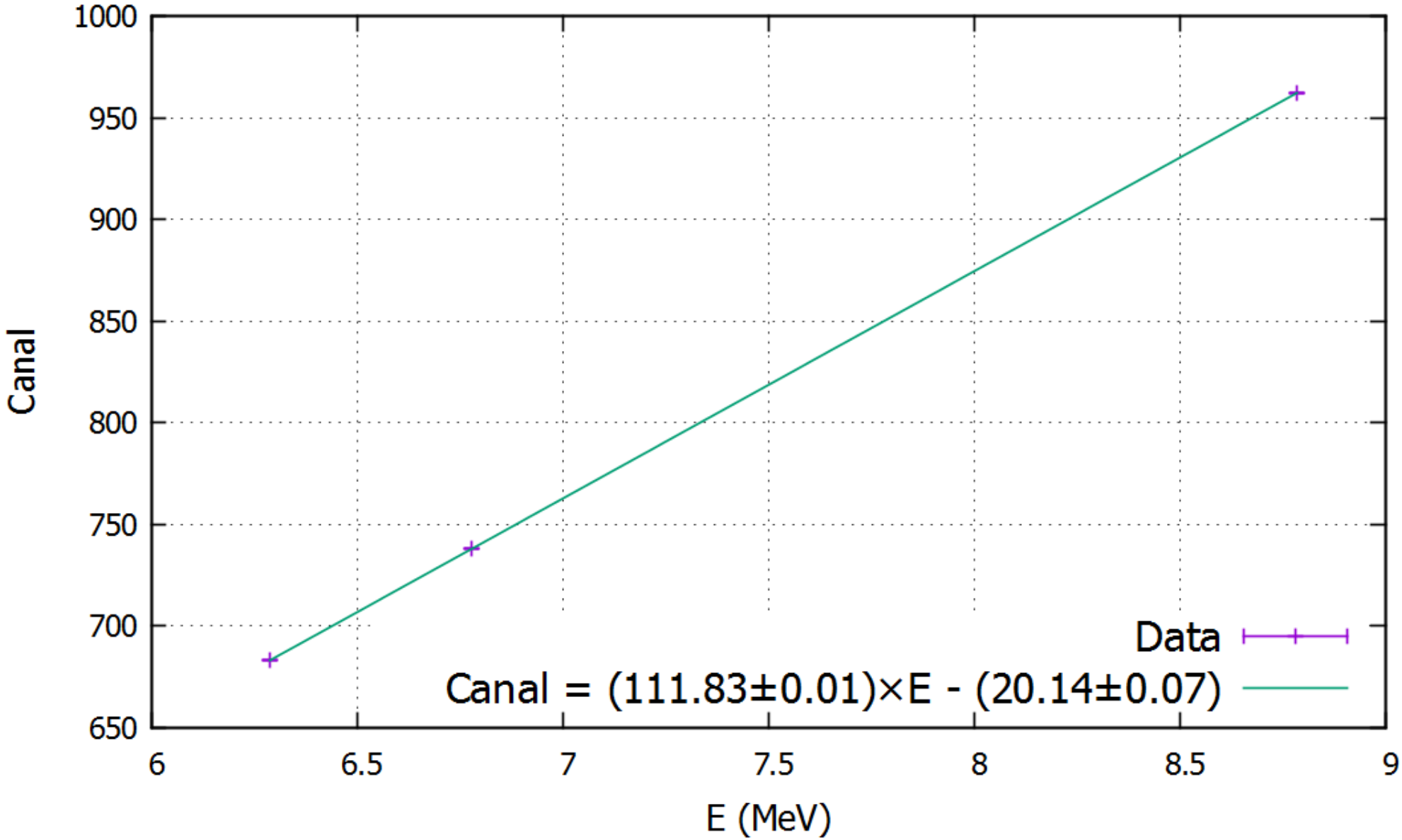
- The energy of alpha particles is measured before and after it passes through the film
- The thickness is given by the energy difference:

$$\Delta x = \frac{\Delta E}{S(E)}$$

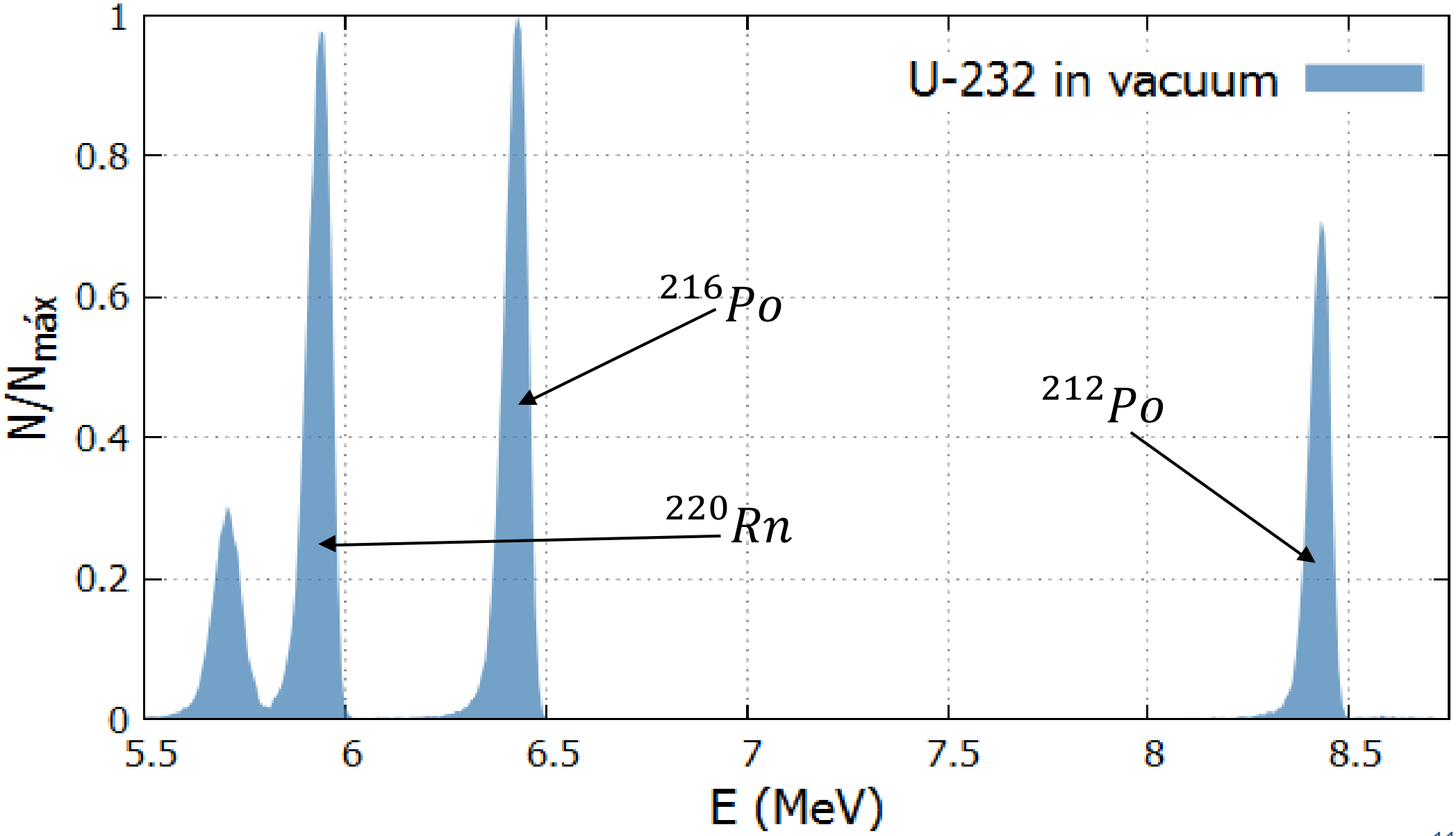
Stopping power, $-\frac{dE}{dx}$



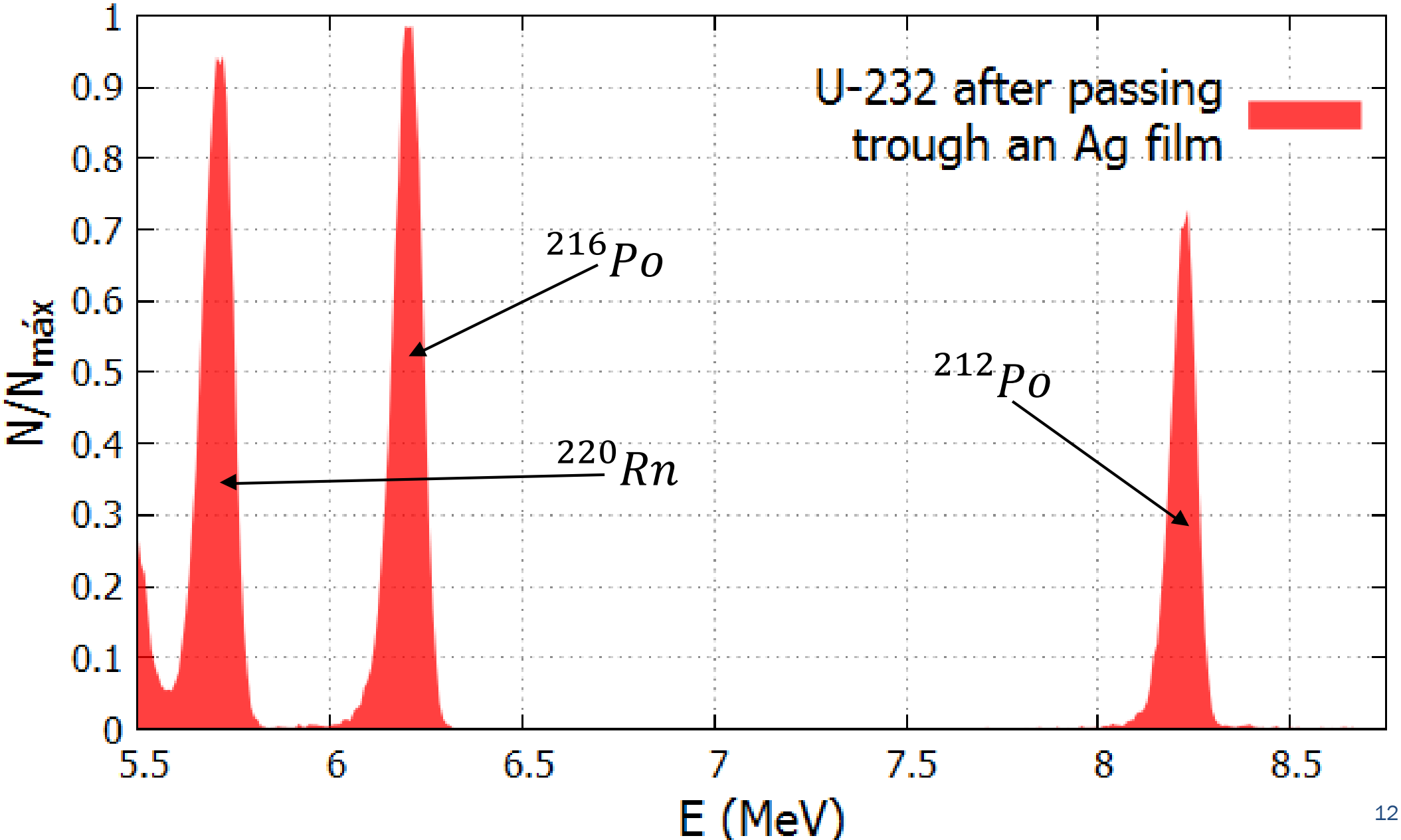
Calibration (χ^2/gl=2.48)



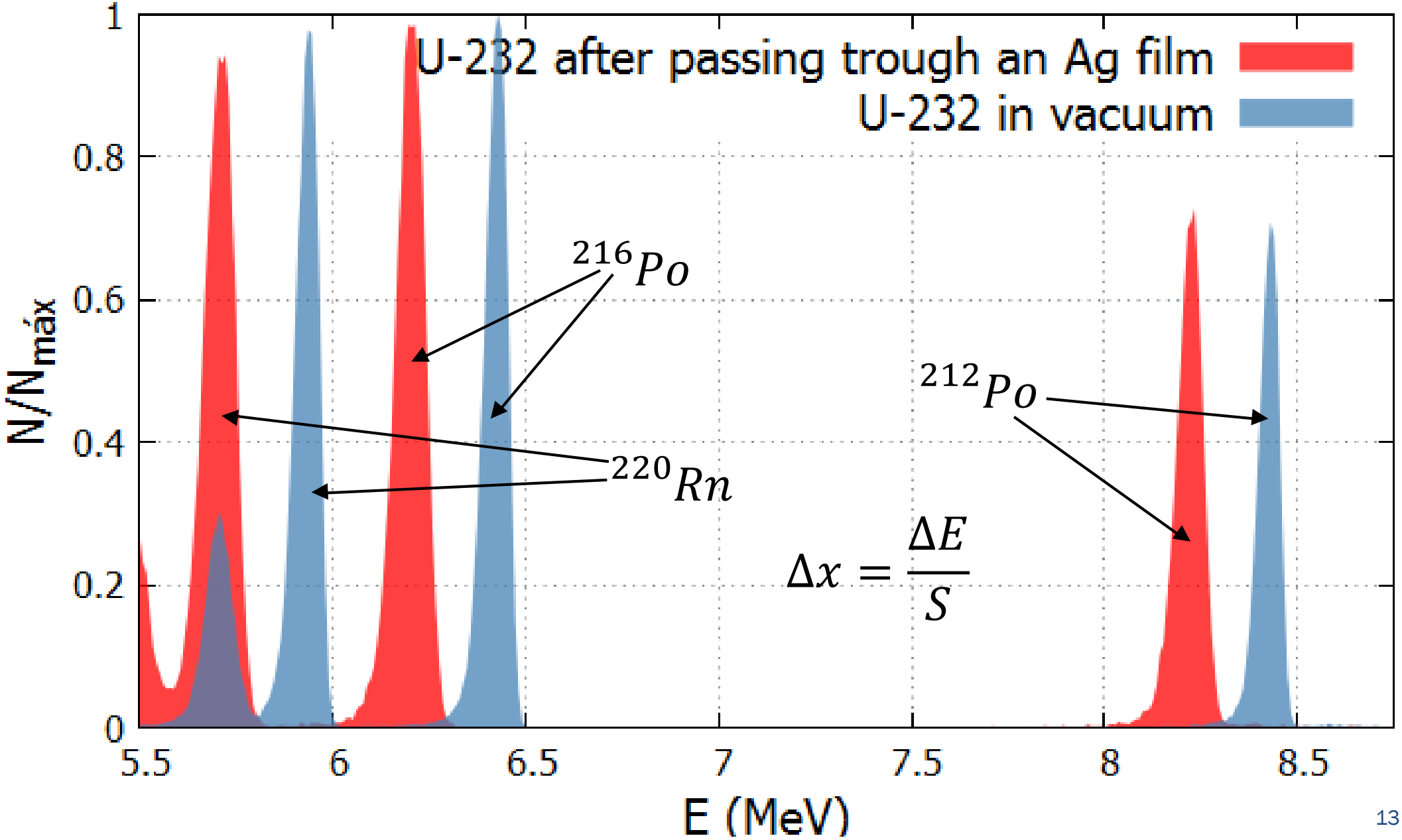
Initial U-232 α spectrum



Final α spectrum



α spectrum shift



Stopping power

- $\Delta x = \frac{\Delta E}{S(\beta)}$
- Bethe-Bloch formula (without corrections):

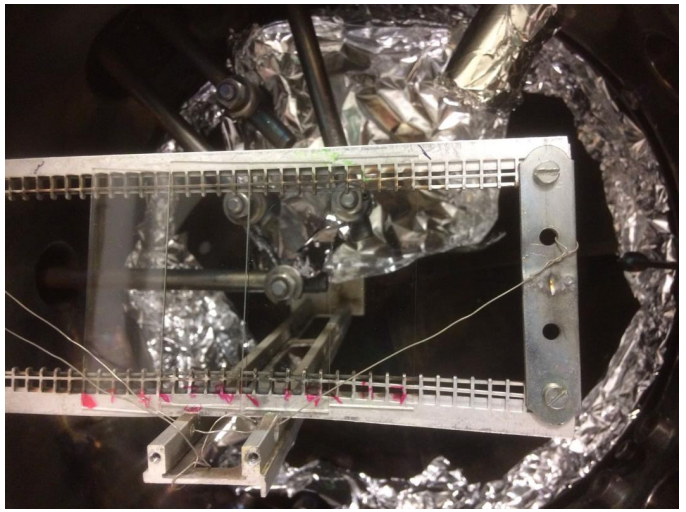
$$S(\beta) = -\frac{dE}{dx} = \frac{4\pi k_e^2 z_\alpha^2 e^4 n_{el,Ag}}{m_\alpha c^2 \beta^2}\left[\ln\left(\frac{2\, m_e c^2 \beta^2}{I\,(1-\beta^2)}\right) - \beta^2\right]$$

- S is assumed constant with β equal to that of the incident particle.
- A classical approximation is assumed to calculate relativistic velocity $\beta = \frac{v}{c}$:
  $E_\alpha = \frac{1}{2} m v^2$

Results

(0.74±0.06) µm	(0.63±0.06) µm	(0.99±0.05) µm	(0.99±0.06) µm	(0.71±0.02) µm

Evaporated mass: *(0.2904 ± 0.0001)* g



Conclusions

- 3 evaporations with the following masses:
  - *2.904 mg*
  - *1.893 mg*
  - *1.001 mg*
- Thicknesses between 1.05 µm and 0.32 µm
- Future work: a more rigorous study of the evaporation process influence parameters.

Bibliography

- Target preparation method and characterization, P.S. Morall
- Preparation of thin nuclear targets, A.H.F Muggleton
- Characterization of thin films produced by the thermal evaporation of silver oxide, M. F. Al-Kuhaili
- Atoms, Radiation, and Radiation Protection, J.E. Turner