

On the validation of electromagnetic models in Geant4 8.1

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Research topics:

GEANT4 in:

- * gamma irradiation processing (^{60}Co facility)
- * electron beam accelerator processing($\sim 10\text{MeV}$)
- * X-Ray Fluorescence spectrometry
- * Nuclear medicine (diagnostic & therapy)

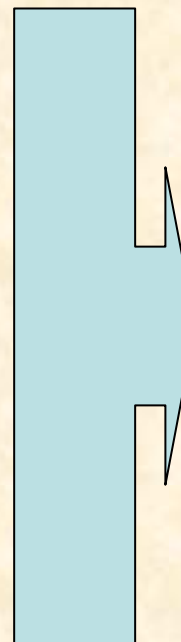
Future topic: GEANT4 development.

- ❖ Introduction
- ❖ Setup
- ❖ Deposit energy of 0.521 MeV e- in Al
 - # Electromagnetic packages comparison vs. cut range
 - # Step Limitation (facrange) effect
 - # Layers number effect
 - # Optimized result
- ❖ Deposit energy of 0.5 MeV e- in Ta (same study)
- ❖ Optimized conditions in Mo case
- ❖ Optimized conditions in Ta/Al case
- ❖ Optimized conditions in Al/Au/Al case
- ❖ Conclusions

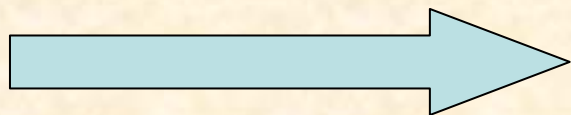
❖ The validation of Geant4 physics models with respect to **reference data** is a **critical issue, fundamental** to establish the **reliability** of Geant4-based simulations.

❖ Actual situation:

- ✓ Particle CSDA range
- ✓ Particle Stopping Power
- ✓ Cross sections
- ✓ Transmission coefficient
- ✓ Backscattering coefficient
- ✓ Photon Attenuation coefficient
- ✓ Particle range
- ✓ Bremsstrahlung energy spectrum
- ✓ Multiple scattering distributions
- ✓ Bragg peak (including hadronic interactions)



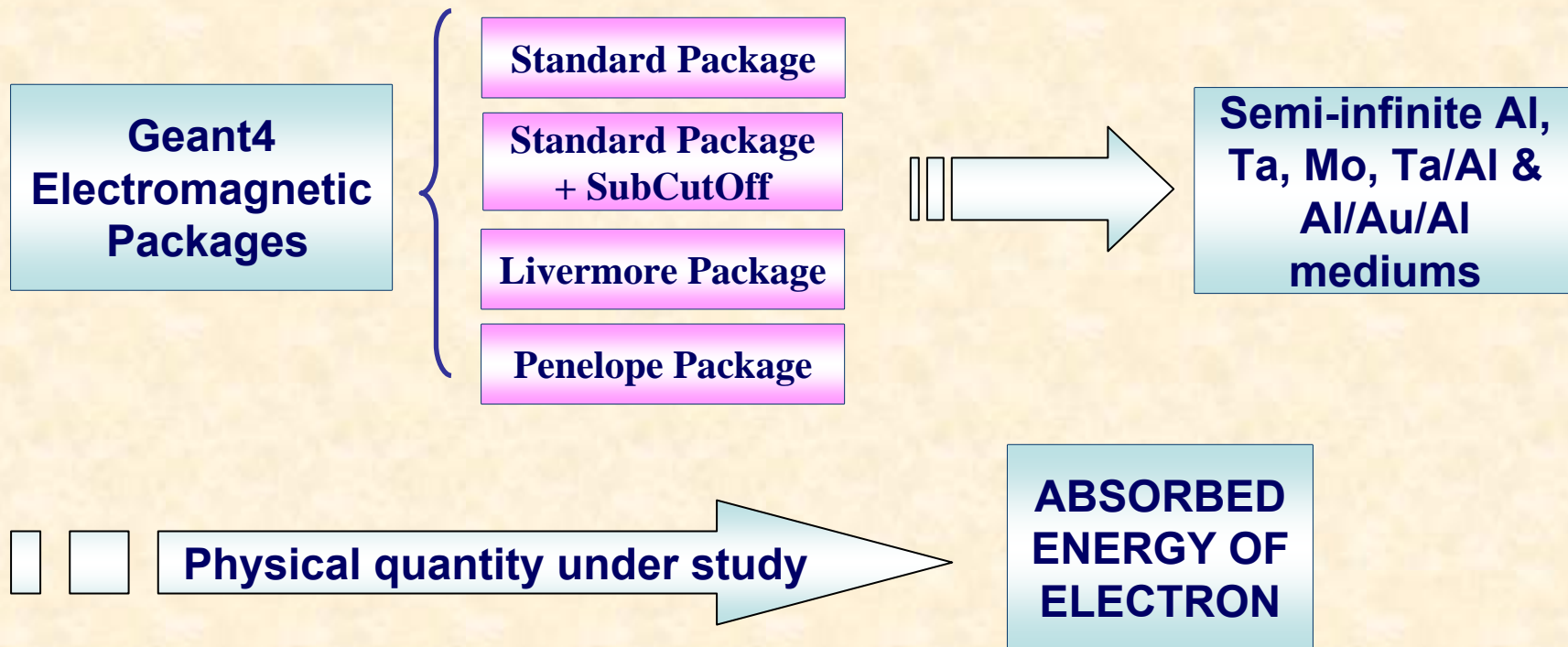
Validated
previously



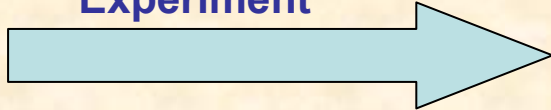
This work

Energy deposit in absorber

❖ Based on SANDIA data



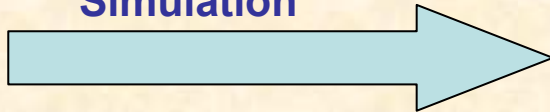
Experiment



Sandia report : SAND79-0414

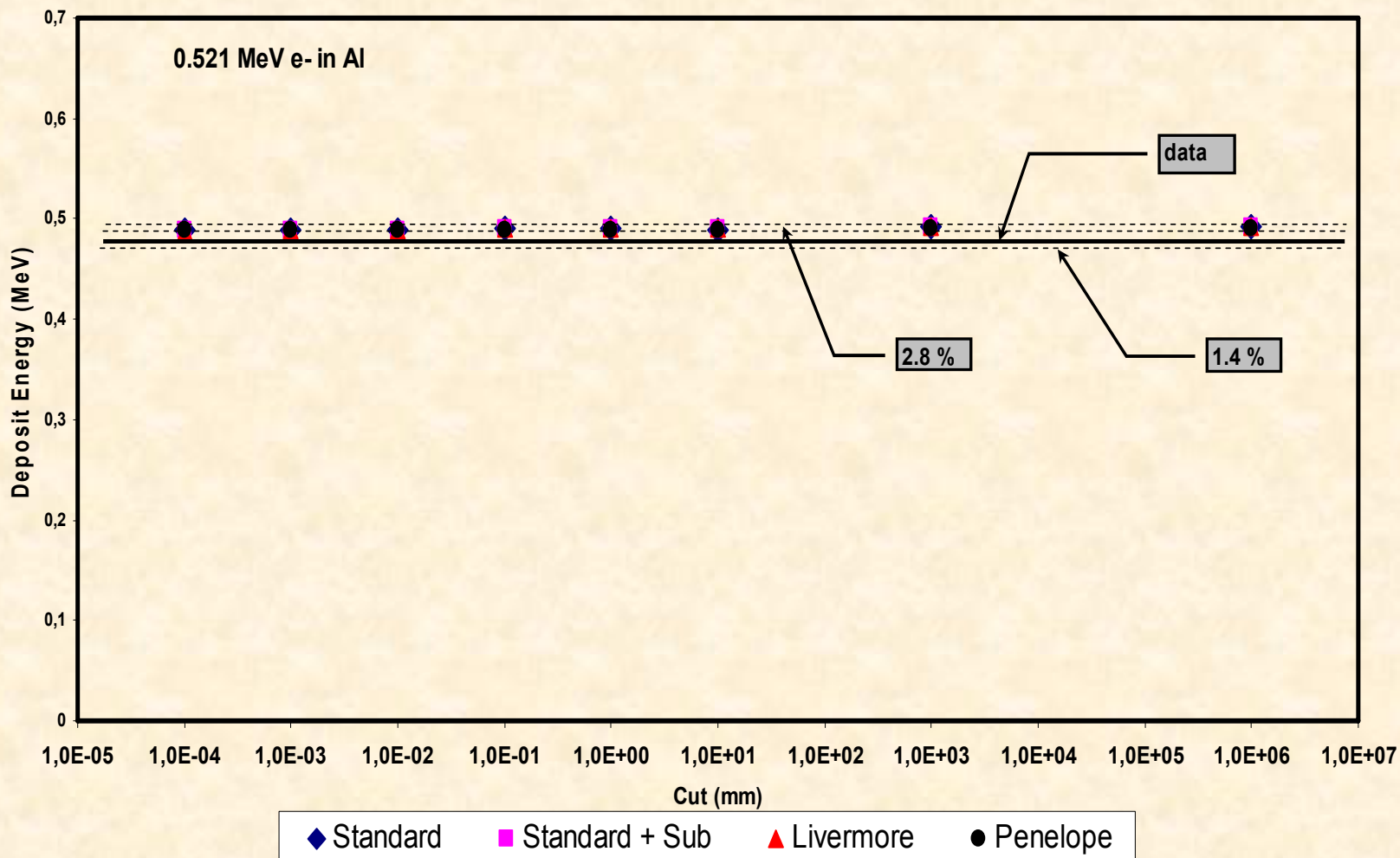
“Calorimetric Measurement of Electron Energy Deposition in Extended Media-Theory vs Experiment”

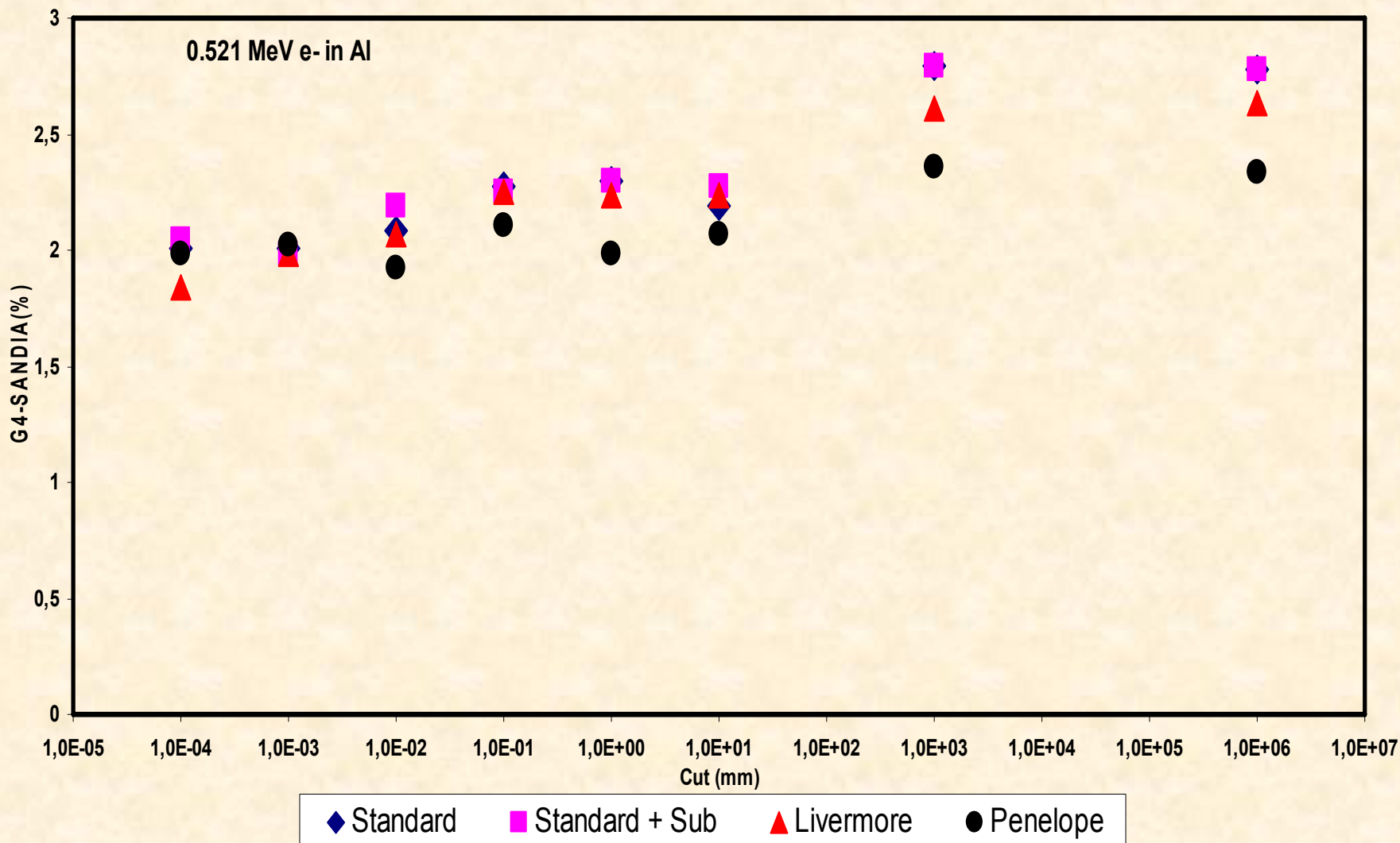
Simulation

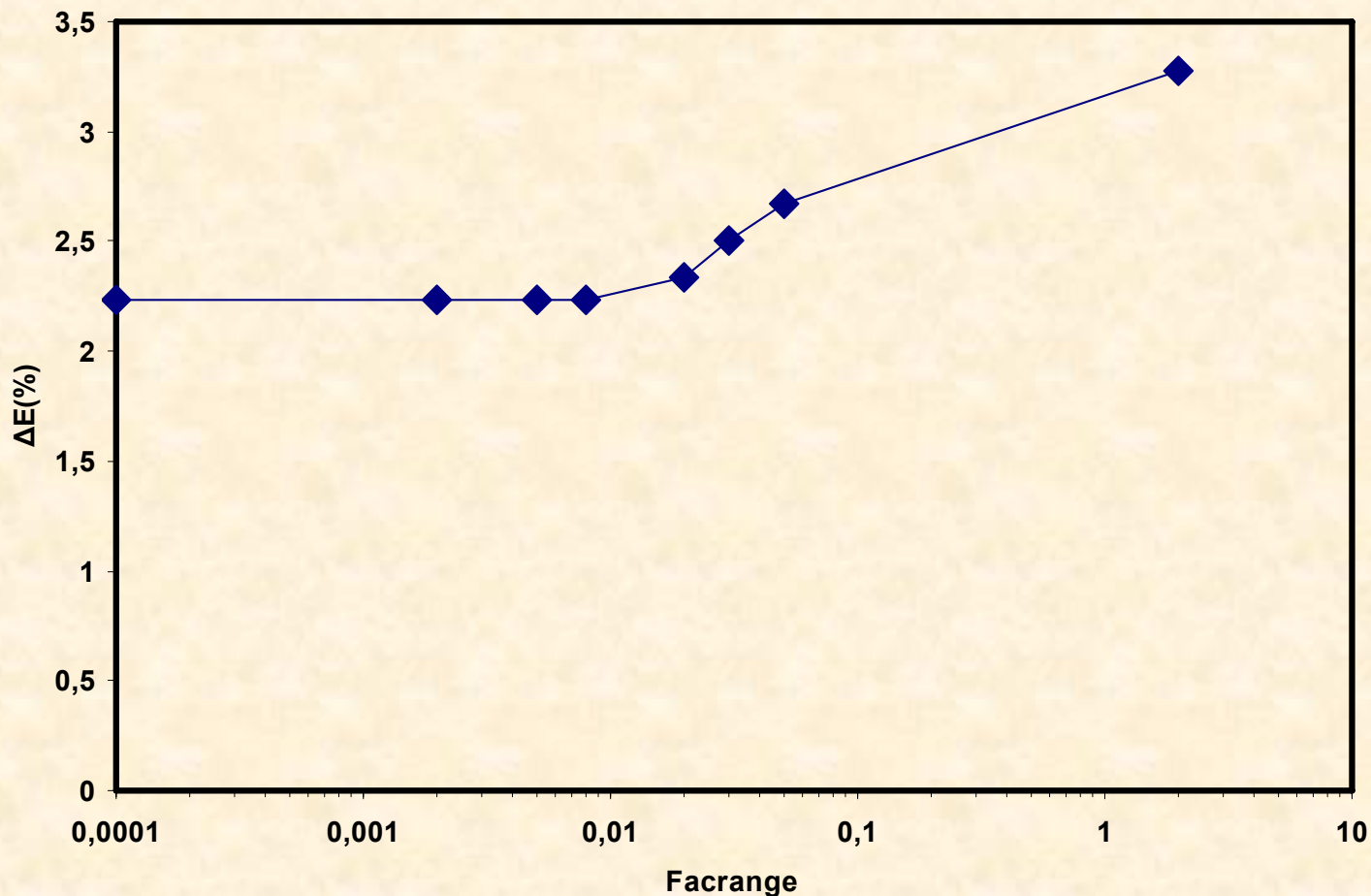


- ❖ **GEANT4.v8.0.ref 5 (equal to 8.1 for EM)**
- ❖ **1.79 GHz Laptop**
- ❖ **Program description :**
 - * **Layer of semi-infinite medium irradiated by electron beam**
 - * **Electromagnetic processes**
 - * **Collection of deposit energy vs penetration**

Deposit energy of
0.521 MeV e^- in Al ($Z=13$)



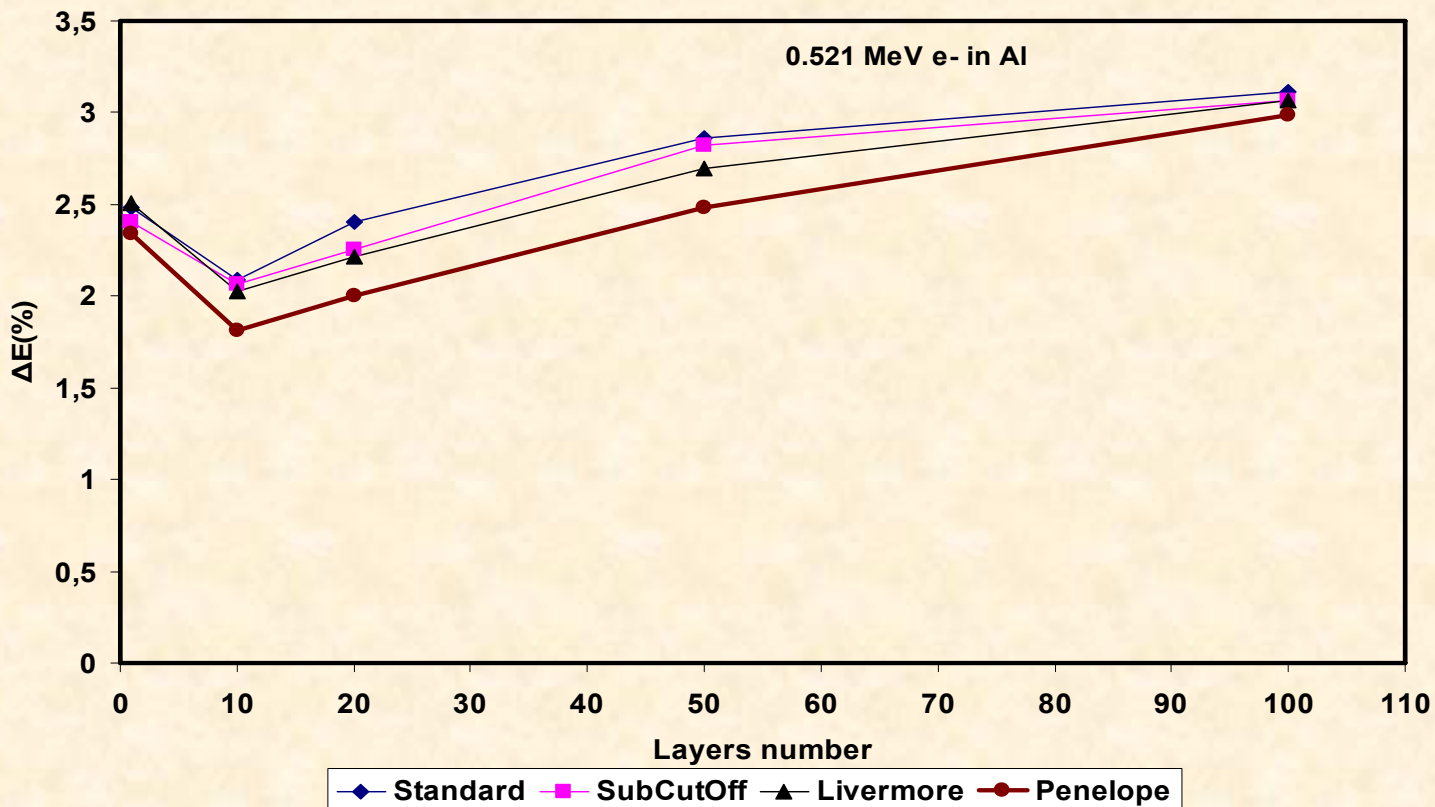
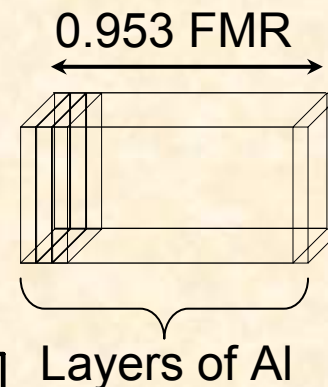
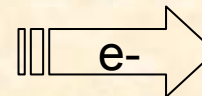


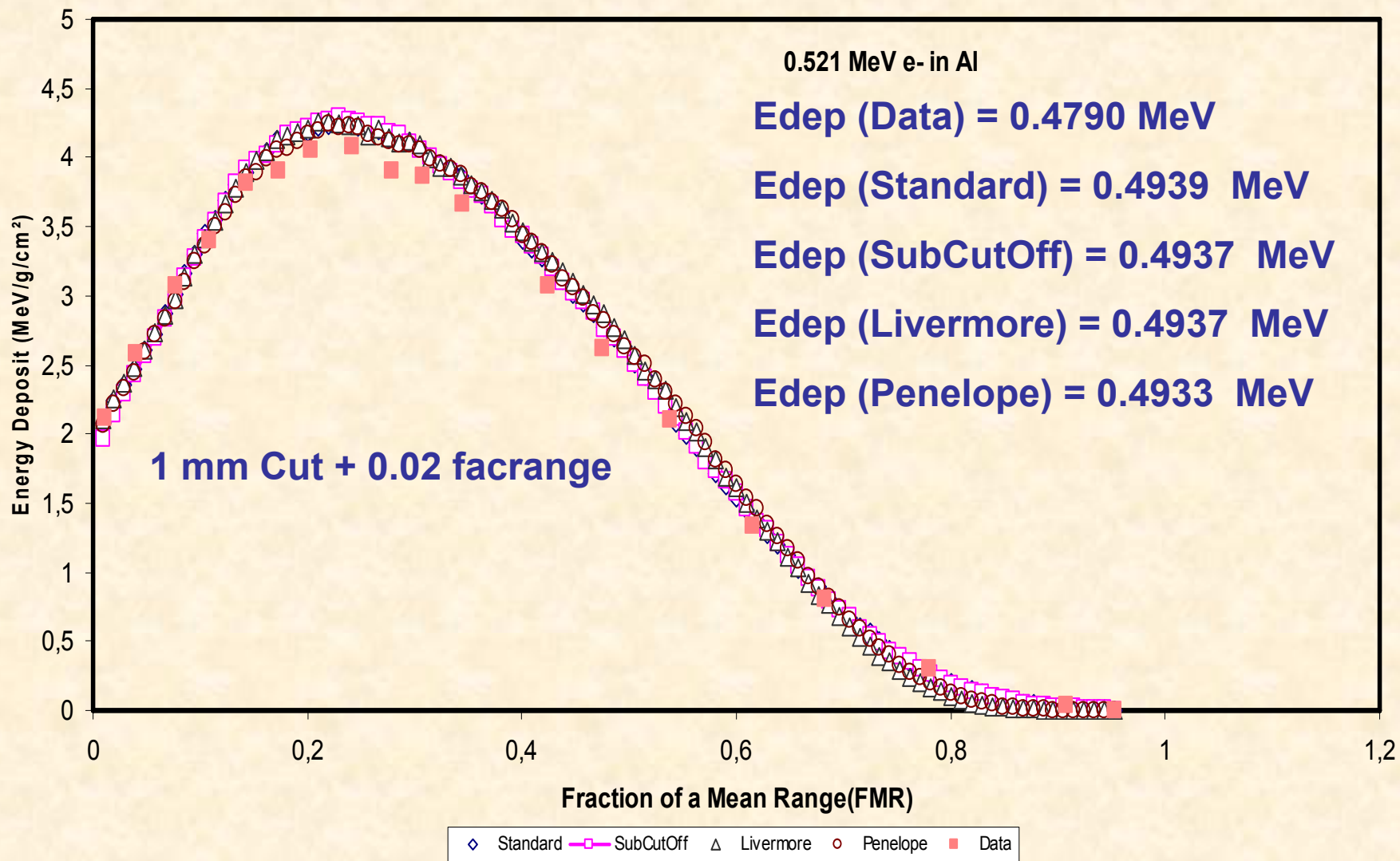


The best choice of facrange = 0.02

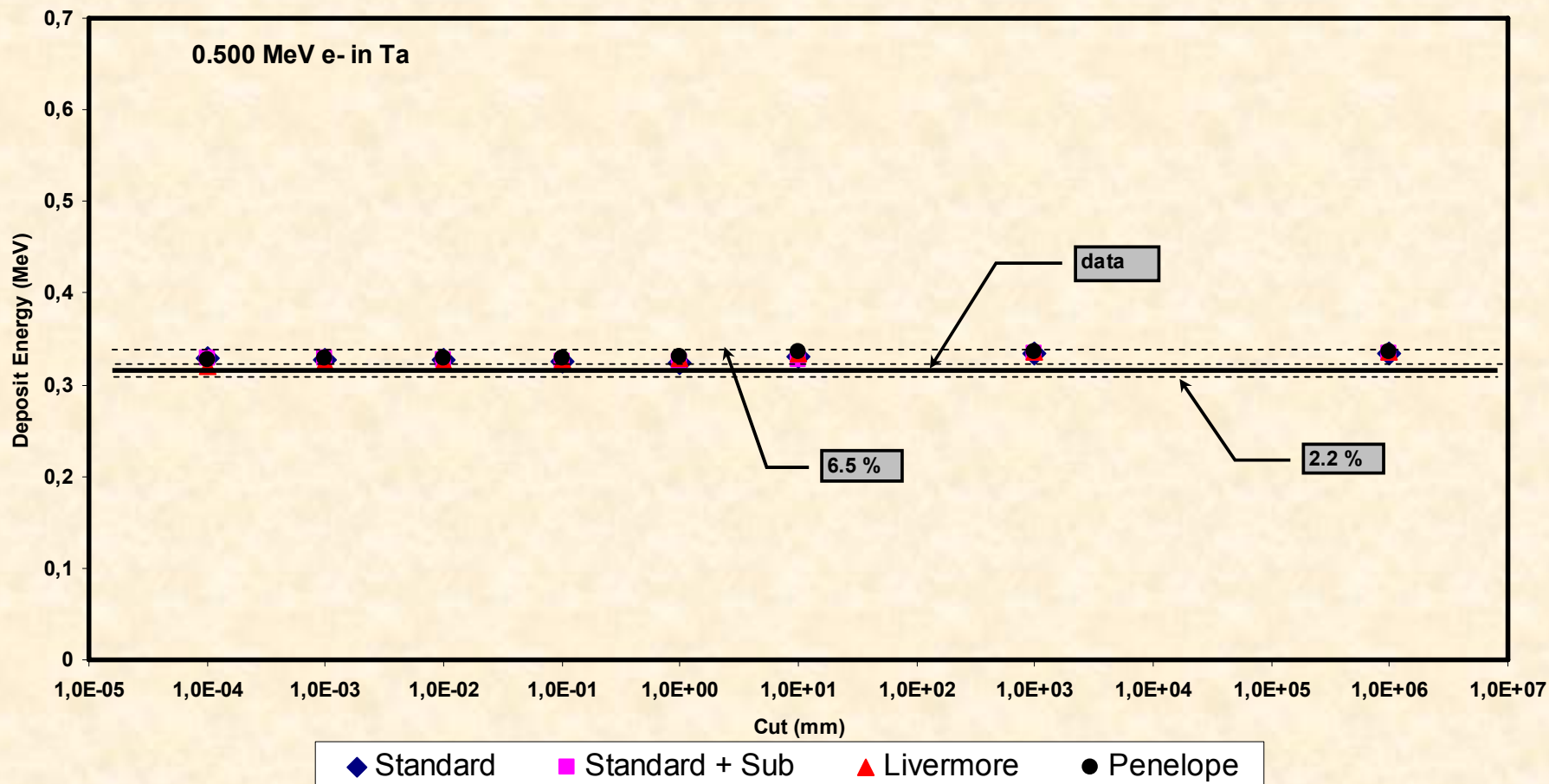
Cut : 1 mm ; facrange : 0.02

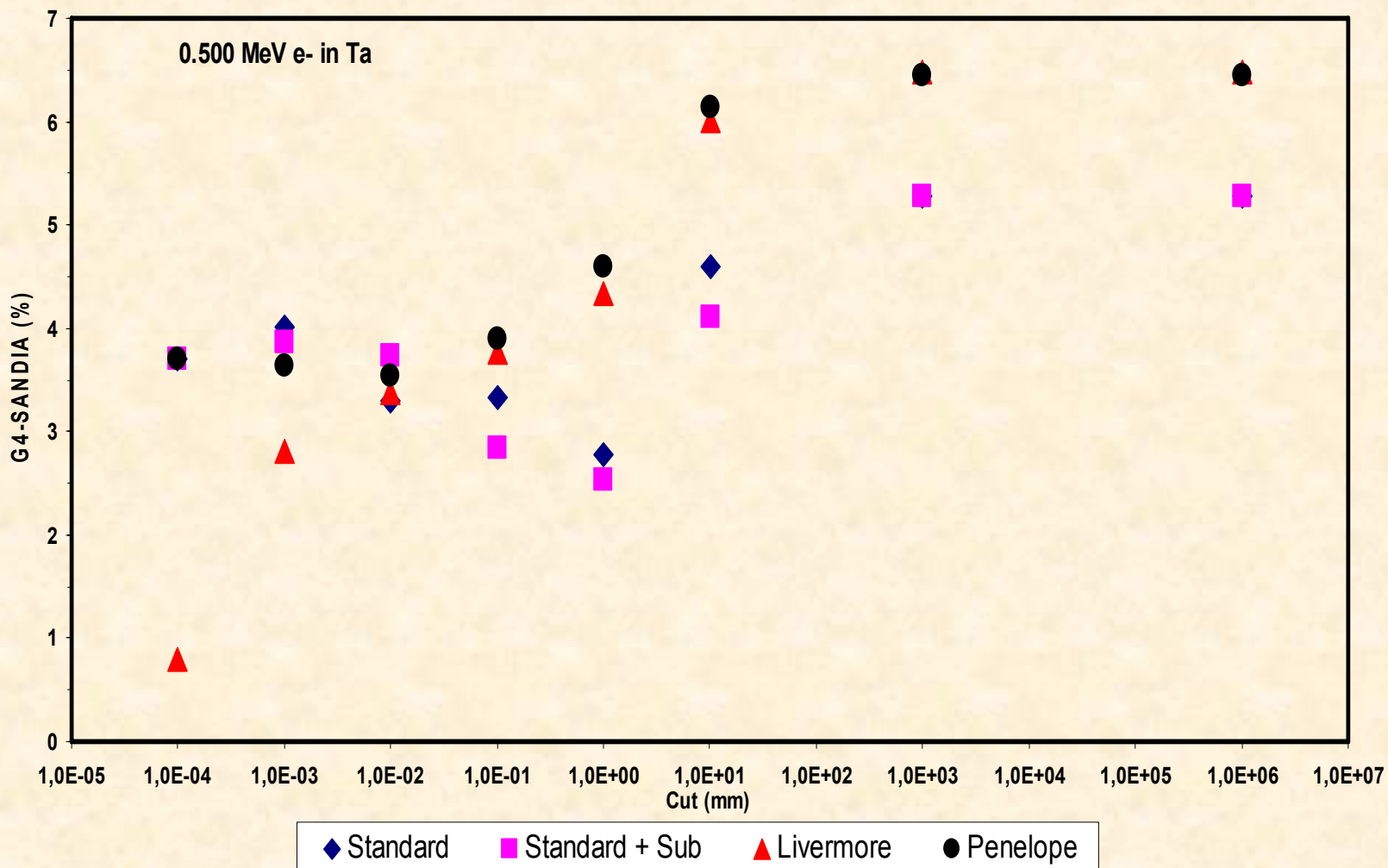
Studied cases: 1 – 10 – 20 – 50 – 100 layers

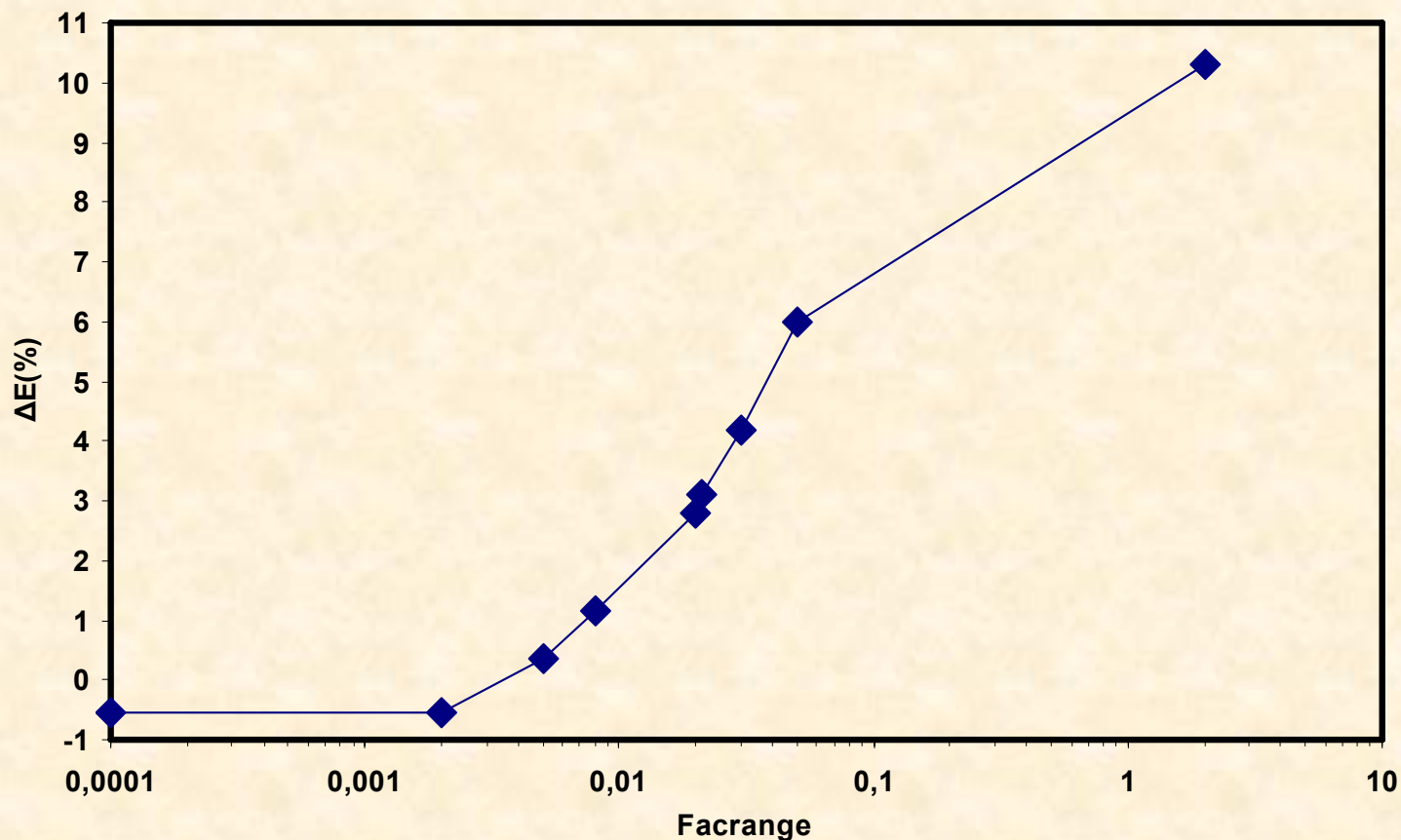




Deposit energy of
0.500 MeV e⁻ in Ta (Z=73)



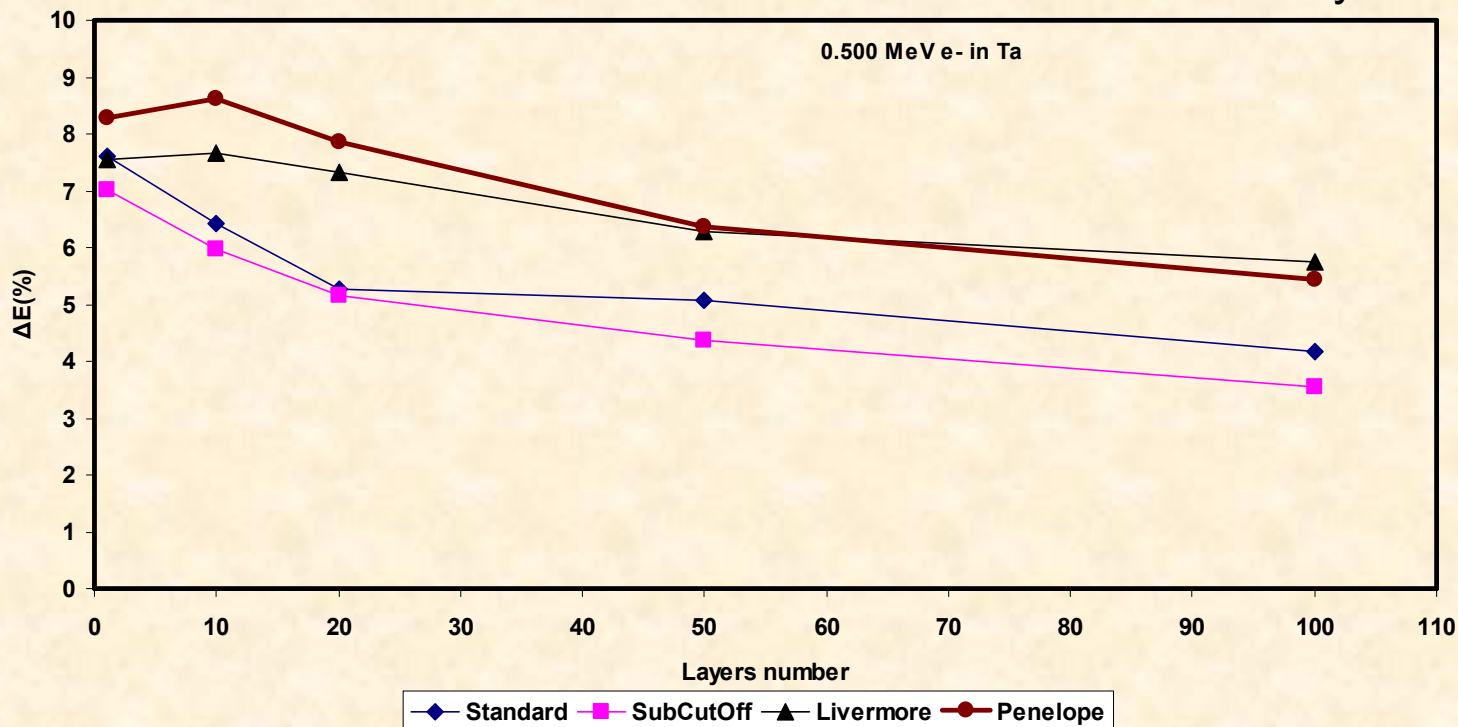
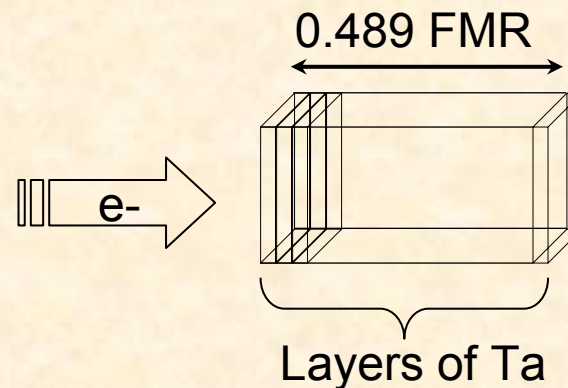


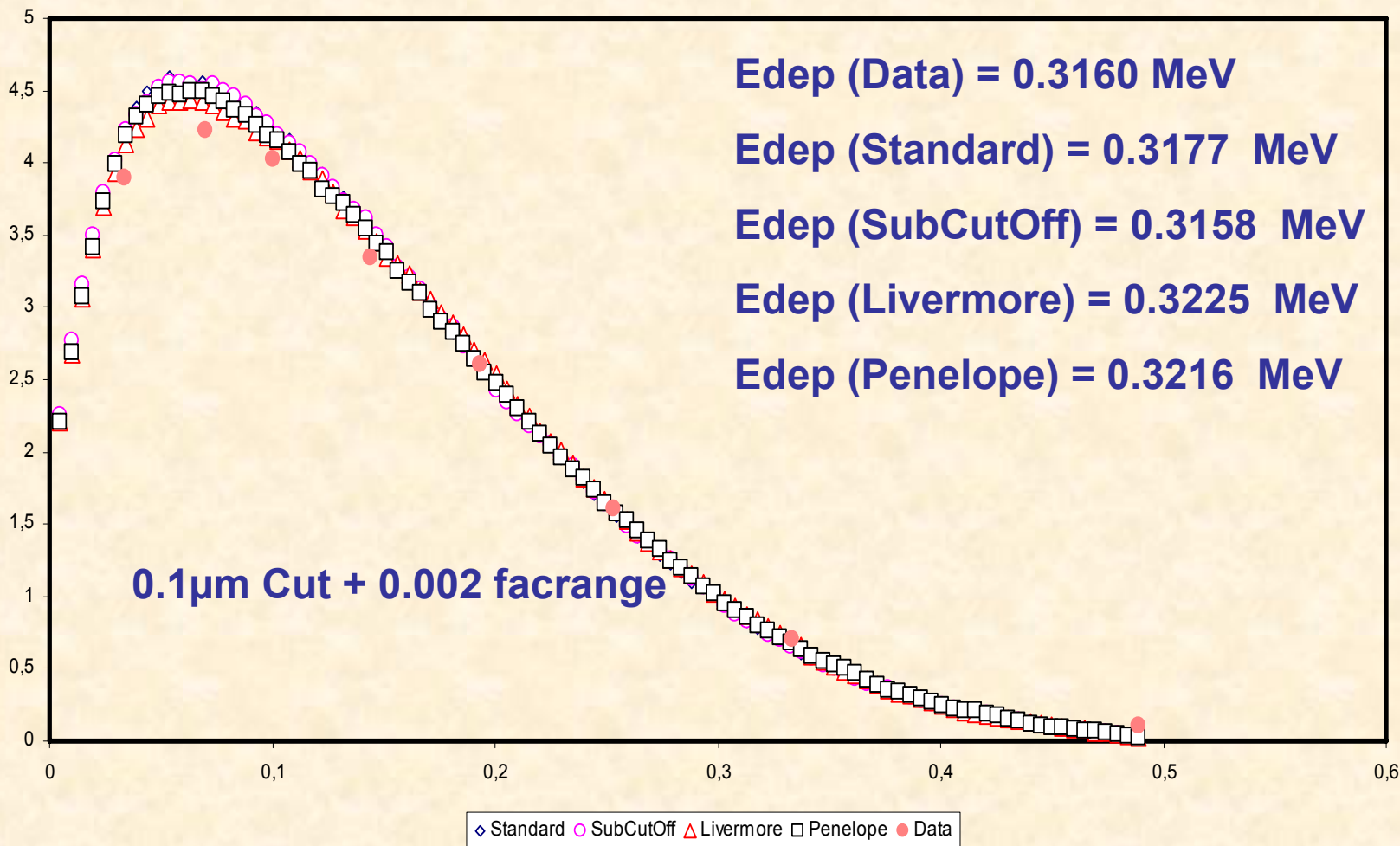


The best choice of facrange = 0.002

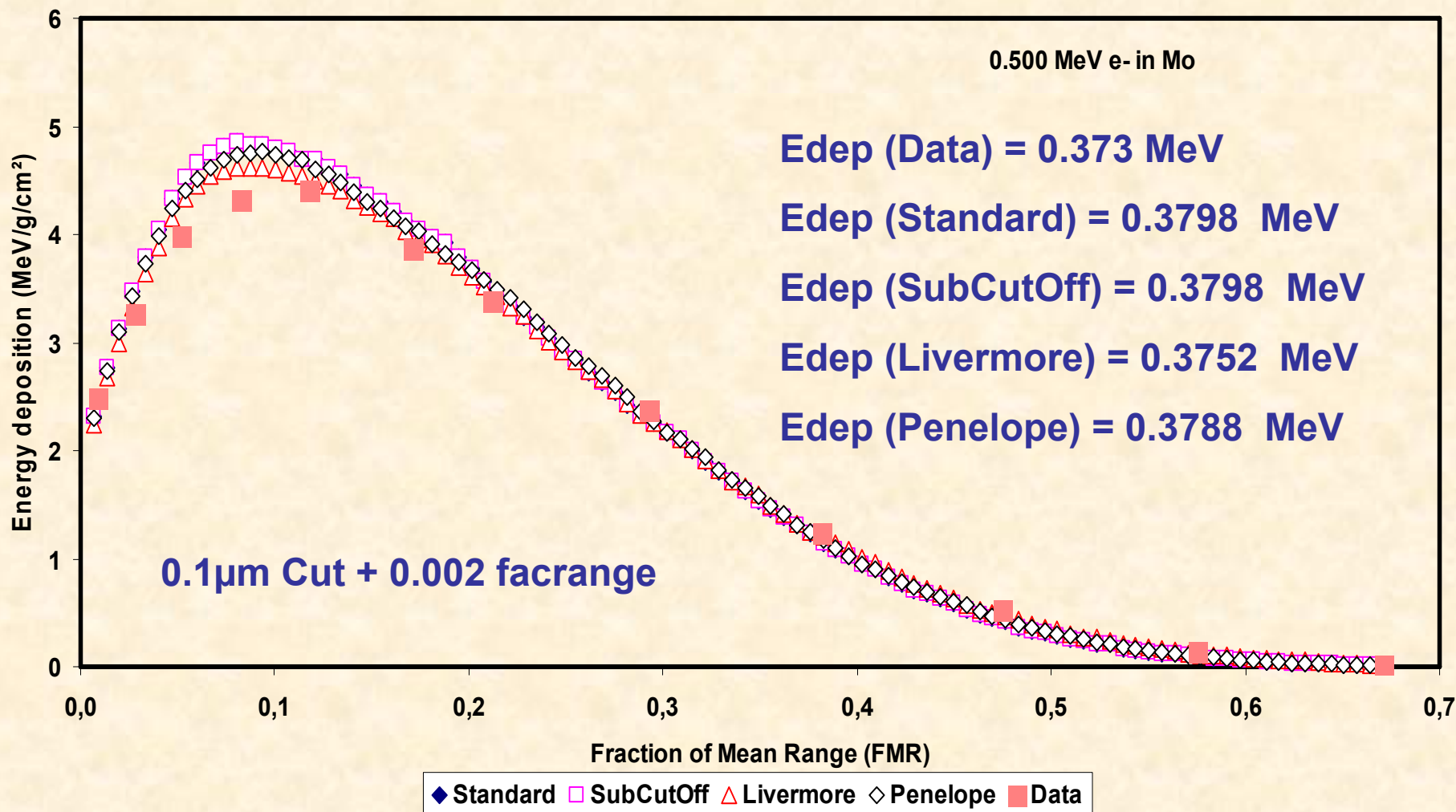
Cut : 1 mm ; facrange : 0.02

Studied cases: 1 – 10 – 20 – 50 – 100 layers

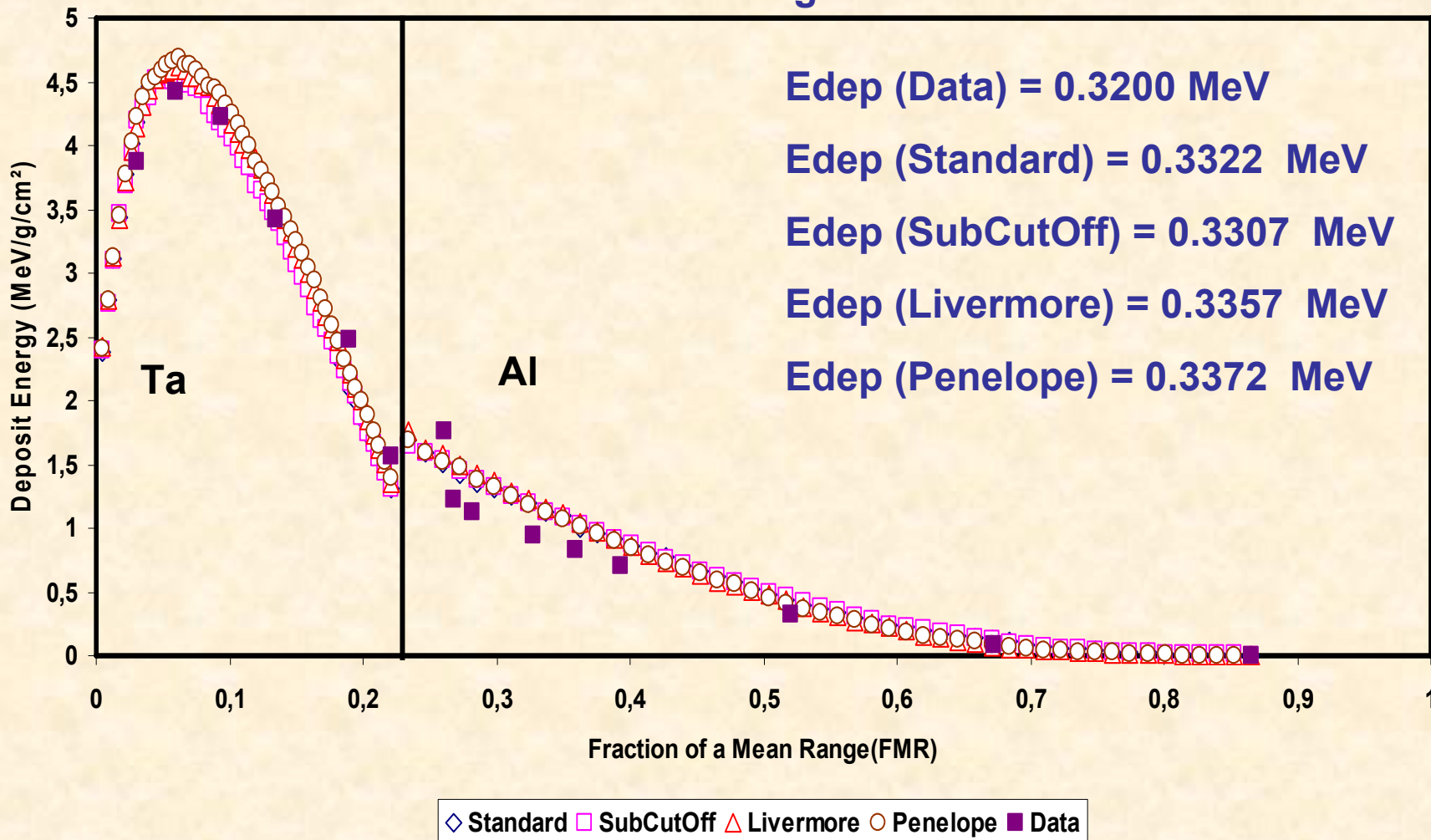




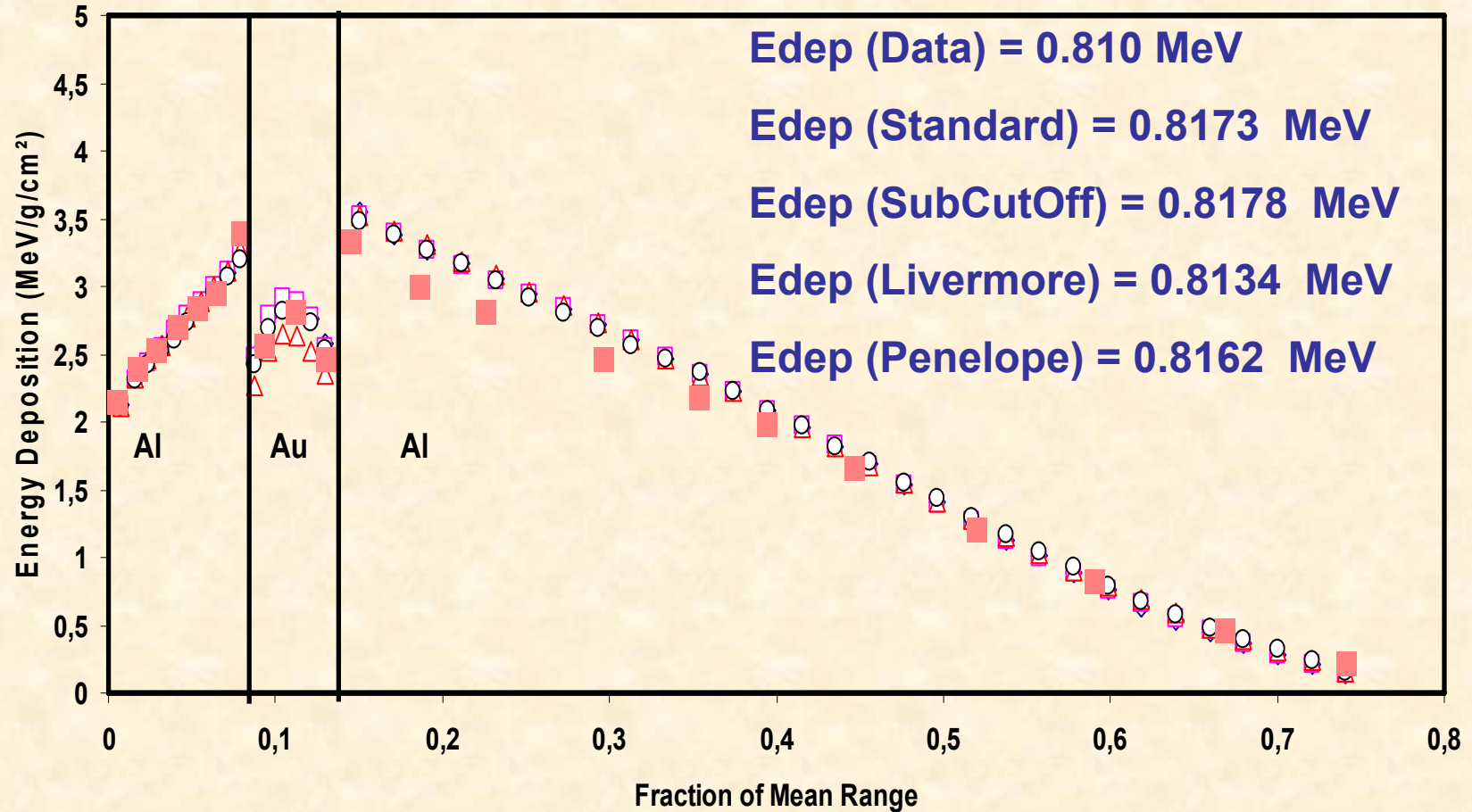
Deposit energy of 0.500 MeV e⁻ in other cases



1 mm Cut + 0.02 facrange



0.1 μ m Cut + 0.002 facrange



◇ Standard □ SubCutOff △ Livermore ○ Penelope ■ Data

- GEANT4 is able to predict absorbed energy in different mediums with a high accuracy.
- In standard conditions(1mm cut, 0.02 facrange) systematic uncertainty of simulation is about 3% for all models.
- As predicted the best arrangement to reach up to 1% of accuracy in term of absorbed dose : Livermore + Cut("0").
- Absorbed energy in semi-infinite medium, mainly depends on the **Cut range & Step limitation**.

THANK YOU FOR ATTENTION