# Exercise 10: Cutoffs

FLUKA Beginner's Course

# Exercise: Cutoffs

**Aim of the exercise:**

1- See the effect of different thresholds (easier with thin layers)

2- Discover DPA-SCO and NIEL-DEP

3- Improve plotting skills

4- Reminder on backscattering

# Exercise: Cutoffs - I

- Start from the solution of ex4 (Copy both .inp and .flair files).:

  mkdir ex10 ; cp ex4/ex.* ex10 ; cd ex10

**Instructions: changes to beam and geometry**

- 10 MeV electron beam
  - We will use a proton beam again in part II of the exercise: include #if/#elif/#endif statements to easily select between a proton and an electron beam, e.g. by setting #define PROTON)
- Beam size: circular with 2 mm radius
- Change target radius to 5 mm, thickness of each layer to 50 μm
- Change surrounding CO2 into VACUUM
- Swap material of TARGS2 and TARGS3
  - i.e.: target should be made of $H_2O$ – Pb – Al

**Instructions: general settings**

- Reminder: thin layers require high tracking precision, therefore DEFAULT PRECISIO is needed (is already there)

# Exercise: Cutoffs - I

**Instructions: general settings (continued)**

- Turn on single scattering at boundaries (find out how) and set the number of single scatterings when crossing a boundary to 2

**Instructions: set thresholds**

- Define 3 preprocessor variables: HI-THR, LOW-THR, VLOW-THR
- Use EMFCUT and DELTARAY cards to set both production and transport thresholds in all materials (hint: when specifying the range of materials/regions, use @LASTMAT/@LASTREG to refer to the last)

```
#if HI-THR
        photons: 5 keV , electrons: 1 MeV kinetic energy
#elif LOW-THR
        photons: 5 keV , electrons: 100 keV kinetic energy
#elif VLOW-THR
        photons: 5 keV , electrons: 10 keV kinetic energy
#endif
```

Reminder: stopping powers and ranges for electrons, protons, and He ions are available on the NIST webpage: www.nist.gov/pml/data/star/index.cfm

# Exercise: Cutoffs - I

## Instructions: scoring

- 1 USRBIN scoring DOSE over the target
  - Use 1 μm bins in z, 5 μm bins in R, unformatted unit 55
- 1 USRBDX scoring backscattered electron & positron fluence
  - Score from TARGS1 to INAIR
  - Use 1 linear bin in angle (you can leave the minimum and maximum solid angles blank such that default values are used), 100 linear bins in energy (between 0 and beam energy), unformatted unit 56

## Instructions: running

- For each threshold setting run 5 cycles x 100000 primaries
- Remember not to overwrite results

## Plot the results

- Plot the three backscattered electron cases on the same plot
- Dose: 1D-proj in z
  (fix y-scale: gnuplot option using: `set yrange[xx:yy]`)

# Exercise: Cutoffs - II

**Instructions: again proton beam**

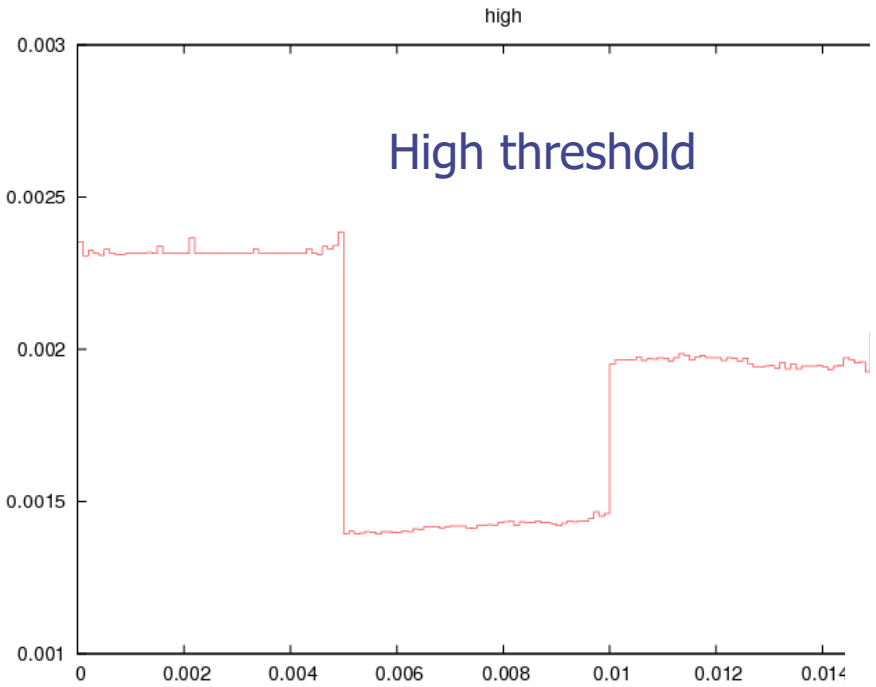
- 4 MeV proton beam (use #define PROTON) using the same beam size as for the previously defined electron beam (circular with 2 mm radius) and no momentum spread and divergence
- For HI-THR, LOW-THR, and VLOW-THR set proton threshold at 10 MeV, 100 keV, and 10 keV respectively
- Add MAT-PROP card specifying a DPA-ENERgy threshold of 25 eV for lead and 27 eV for aluminum (only for the VLOW-THR case)
- Add R-$\Phi$-Z USRBIN to score Displacement Per Atom and Non Ionizing Energy Loss deposition over aluminum and lead (50 bins in R, 1 bin in $\Phi$, 100 bins in Z) Unformatted unit 57

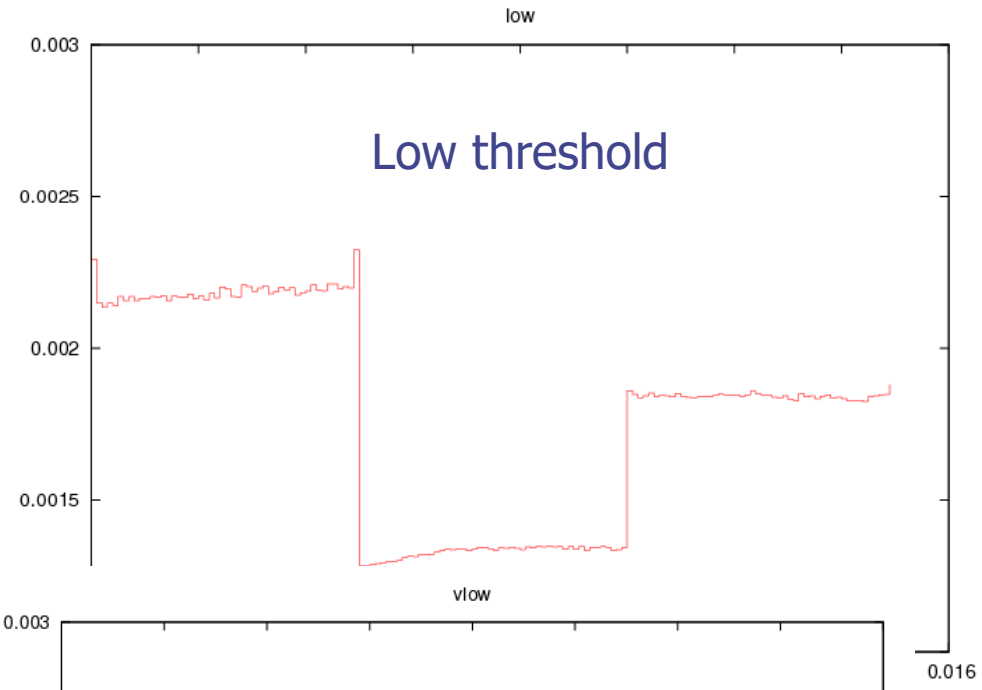
# Exercise: Cutoffs - II

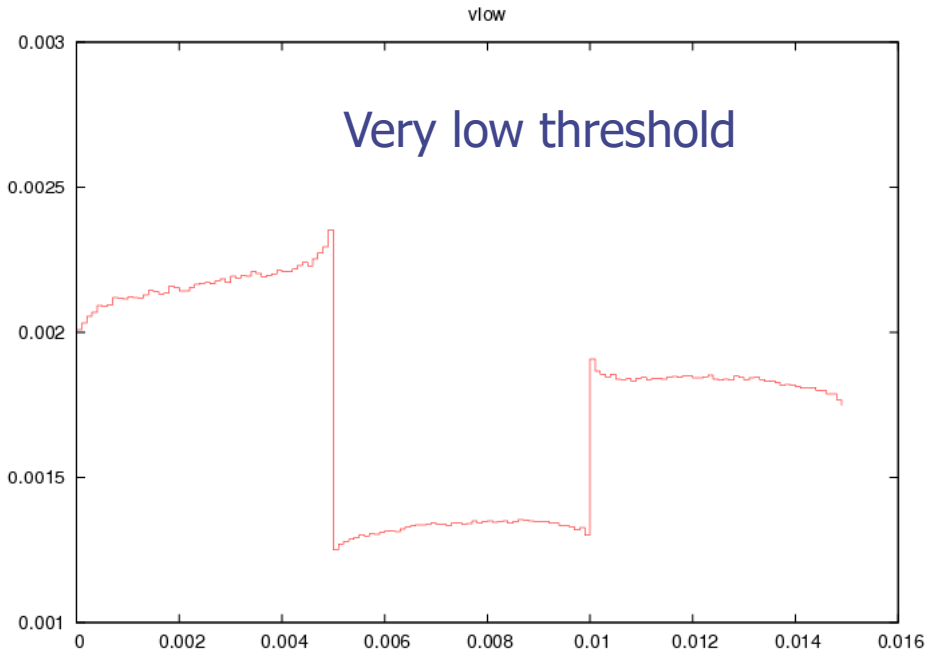
**Questions**

- Why not scoring on water?
- Evaluate the average number of DPA for
  a 100 day long beam time and 1 μA proton current
- For HI-THR and LOW-THR case, plot the dose and see the difference
  Can you explain the effect of the different thresholds?

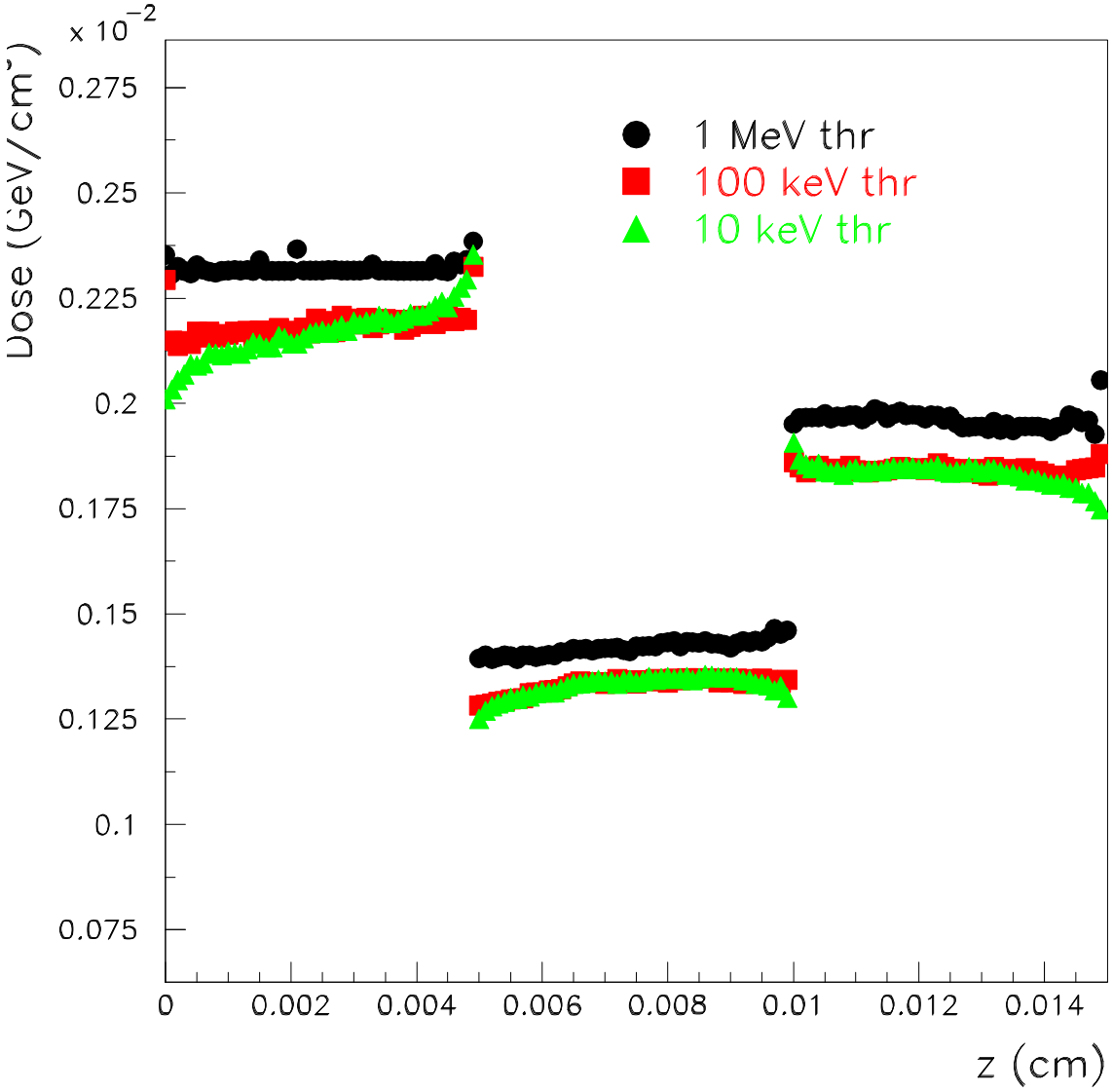
# Exercise: Cutoffs – I solution



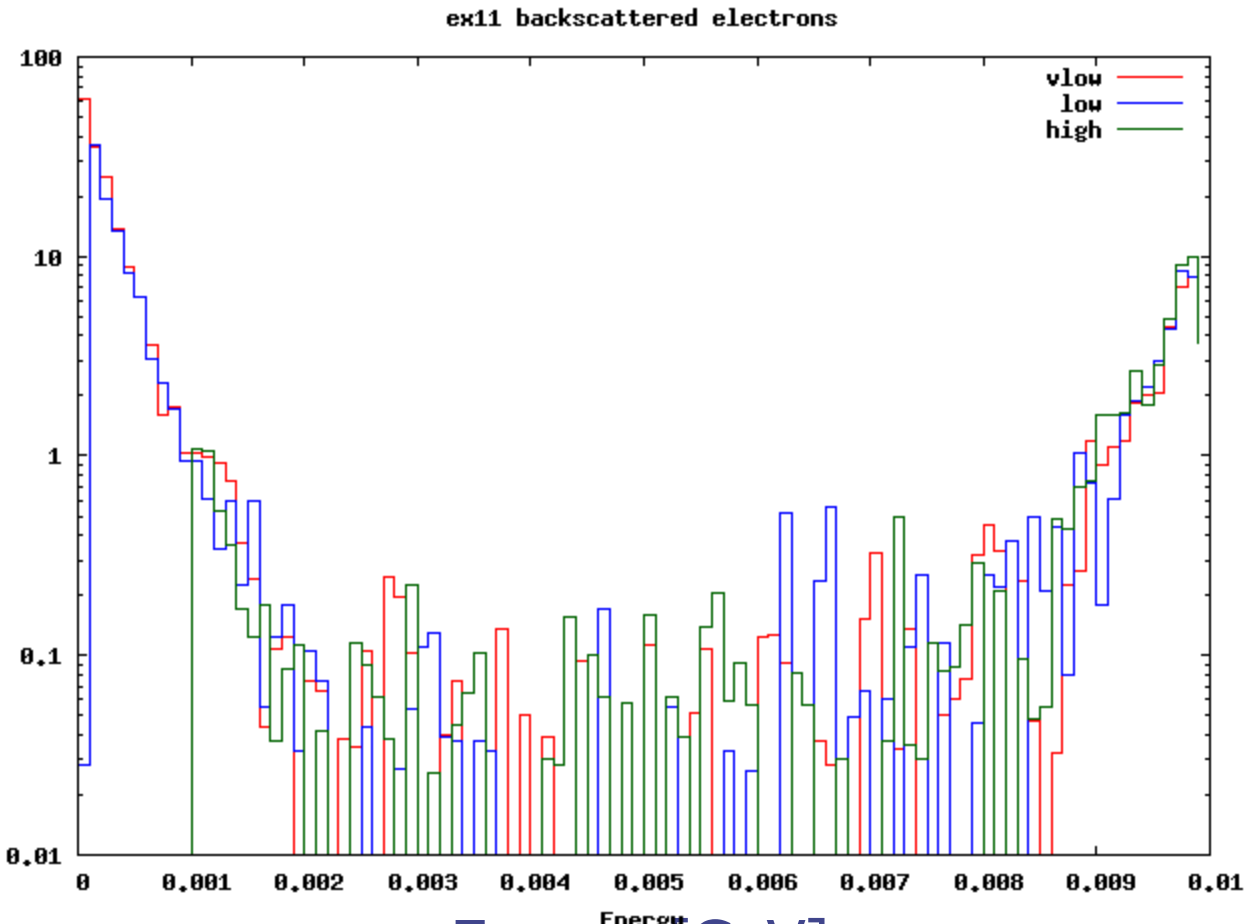



# Exercise: Cutoffs – I solution



# Exercise: Cutoffs – I solution




Energy [GeV]

# Exercise: Cutoffs – II solution