Exercise 11: Cutoffs

FLUKA Beginner's Course

Exercise 11: 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 11: Cutoffs - I

- Start from the solution of ex5 (copy both inp and flair files):

  mkdir ex11 ; cp ex5/ex5.* ex11/. ; cd ex11

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 11: 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 11: 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 `set yscale[xx:yy]`)

Exercise 11: 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-Φ-Z USRBIN to score Displacement Per Atom and Non Ionizing Energy Loss deposition over aluminum and lead (50 bins in R, 1 bin in Φ, 100 bins in Z) Unformatted unit 57

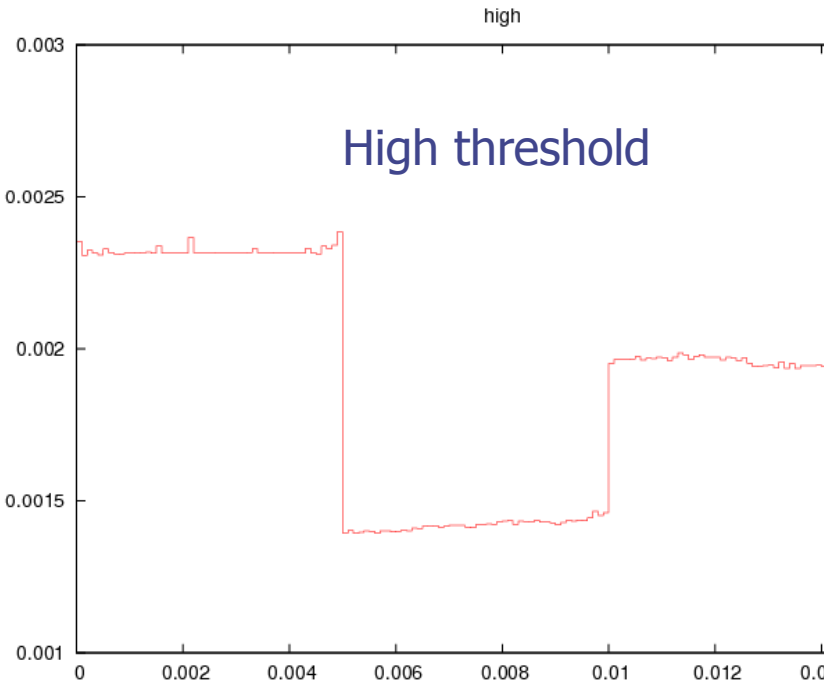
Exercise 11: Cutoffs - II

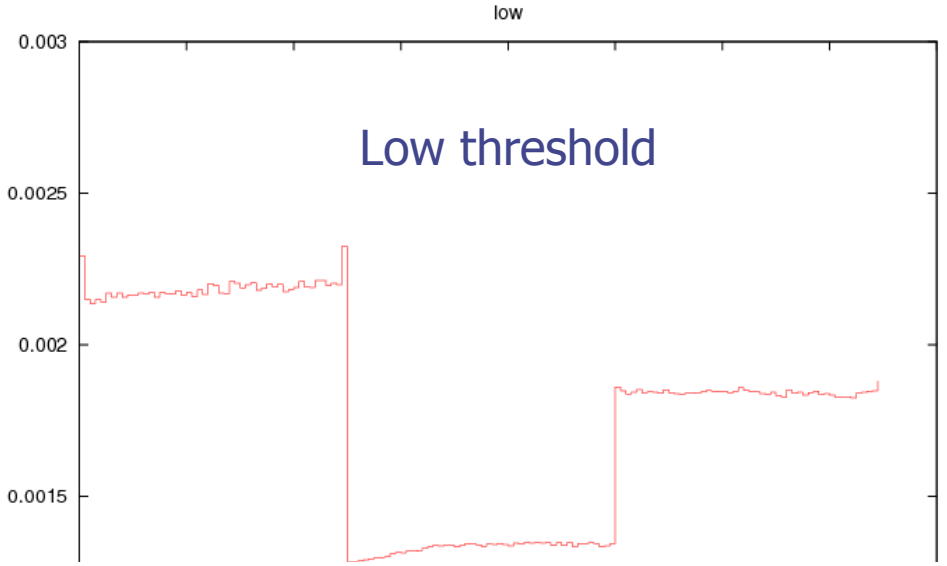
Questions

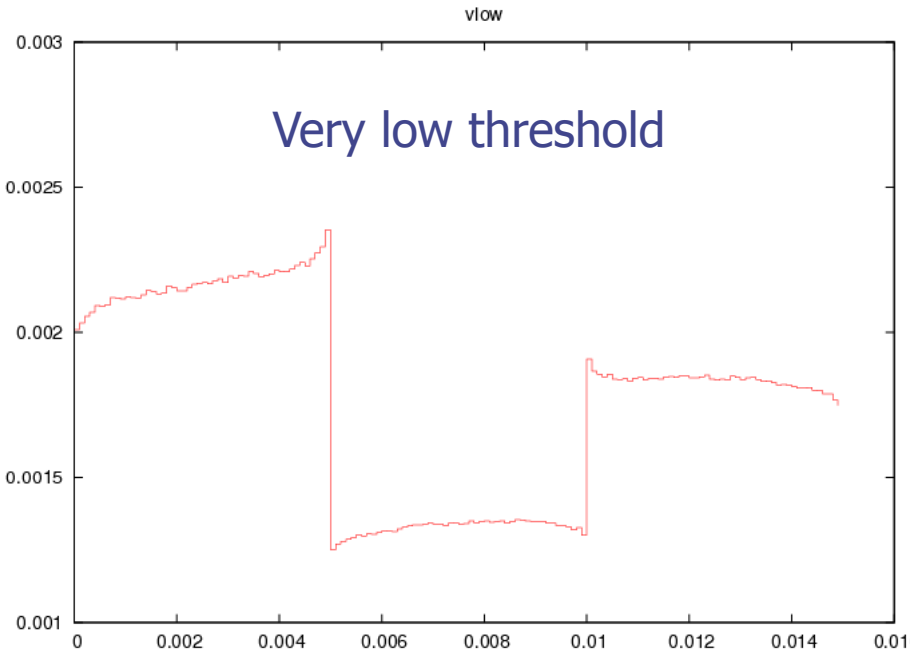
- Why not scoring on water?
- Evaluate the average number of DPA for
  a 100 day long beam time and 1 μA proton current
- For HI-THR and LOW-THR case, plot the dose and see the difference
  Can you explain the effect of the different thresholds?

Exercise 11: Cutoffs – solutions

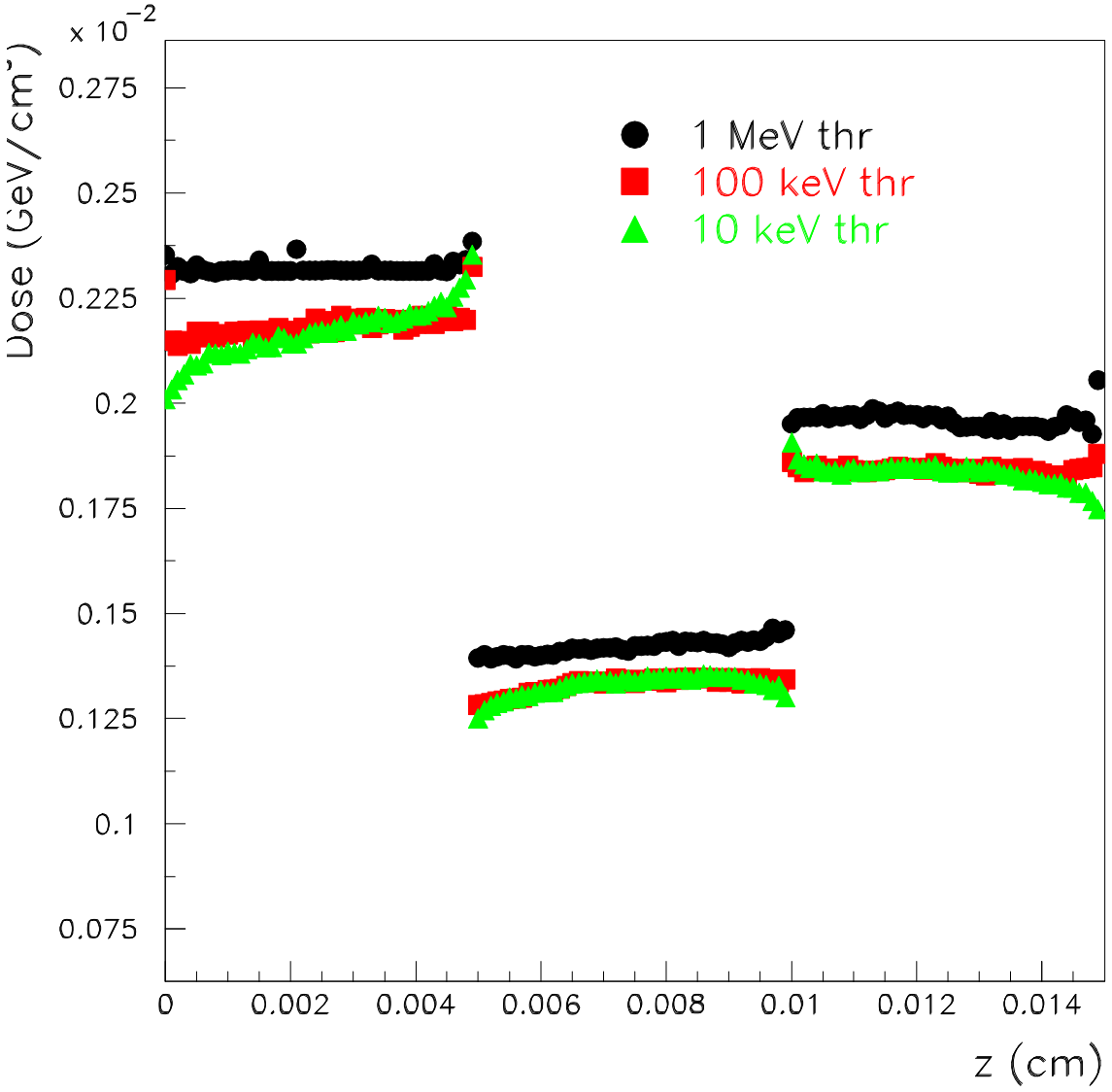
Exercise 11: Cutoffs – I solution



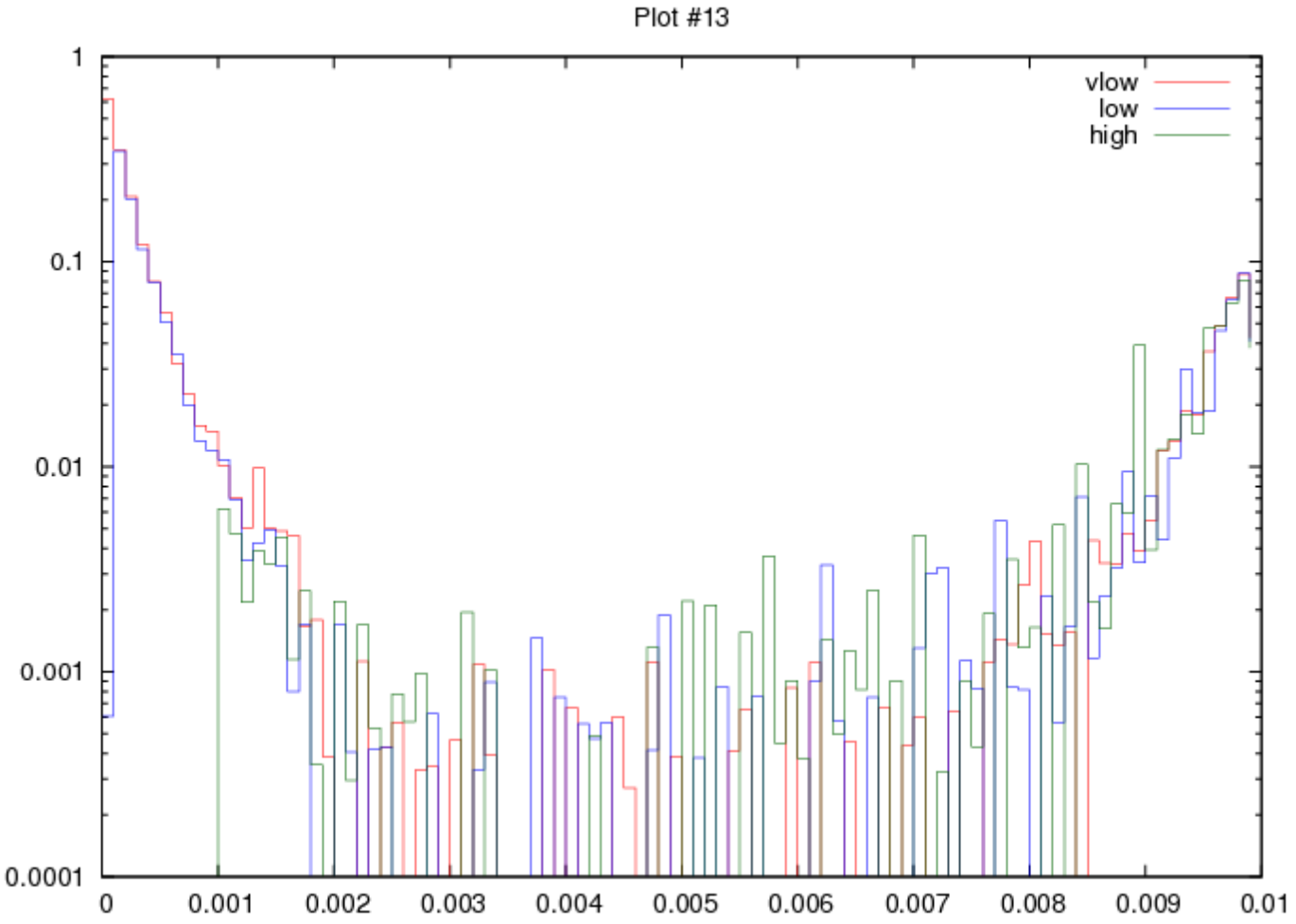
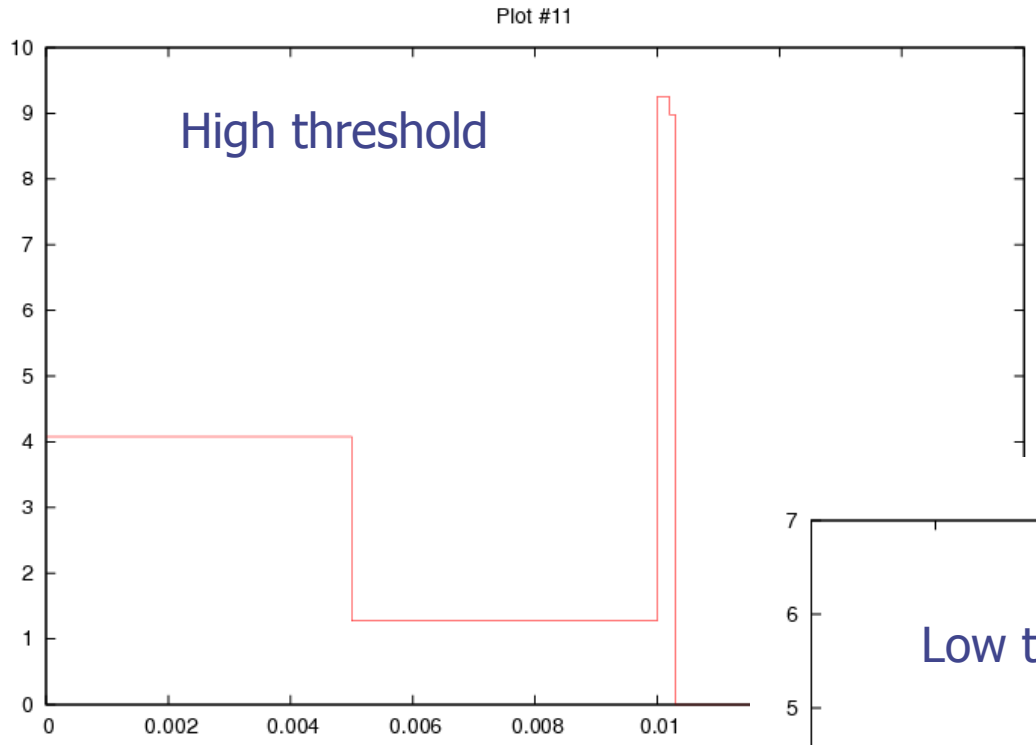
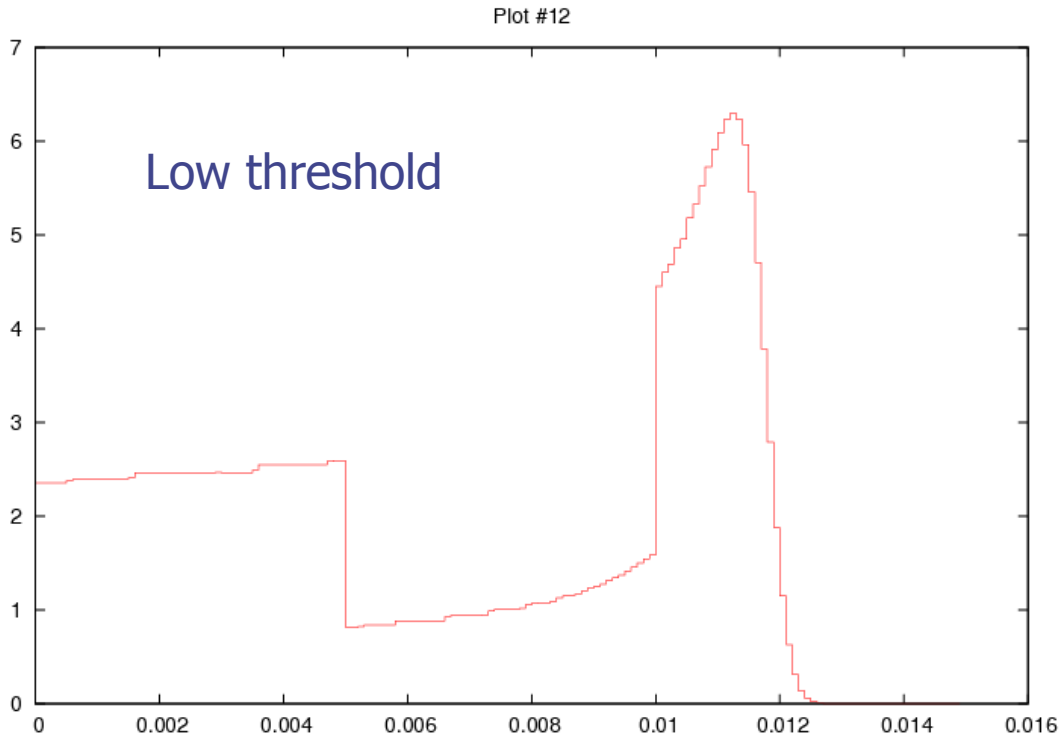




Exercise 11: Cutoffs – I solution



Exercise 11: Cutoffs – I solution



Exercise 11: Cutoffs – II solution