



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.inp ex11/ ; cp ex5/ex5.flair ex11/ex11.flair ; 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 H₂O – 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 using: `set yrange [xx:yy]`)

Exercise 11: Cutoffs - II

Instructions: again proton beam

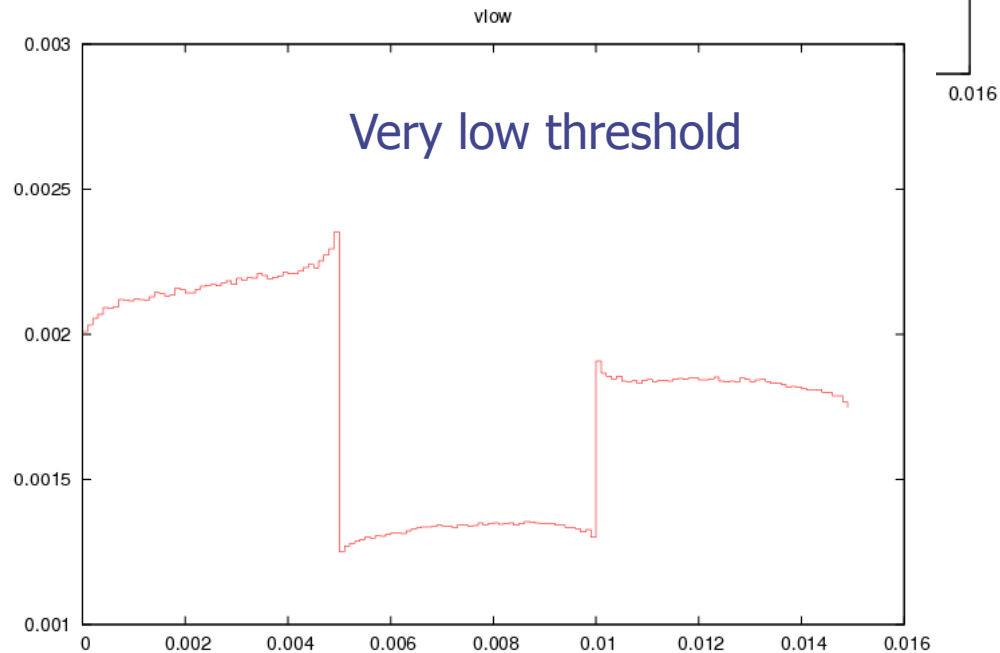
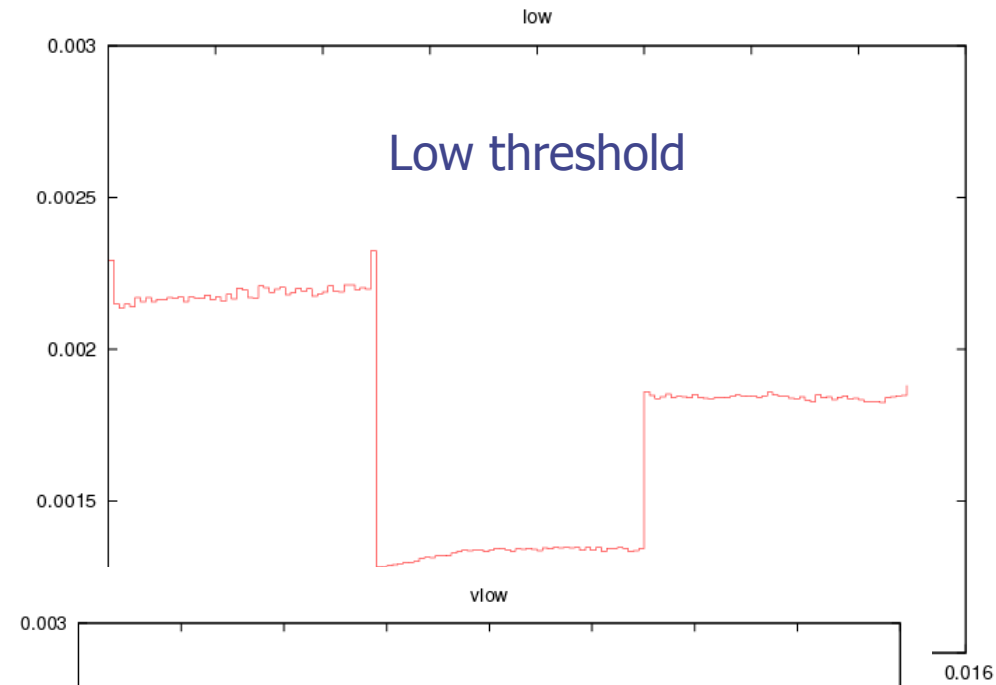
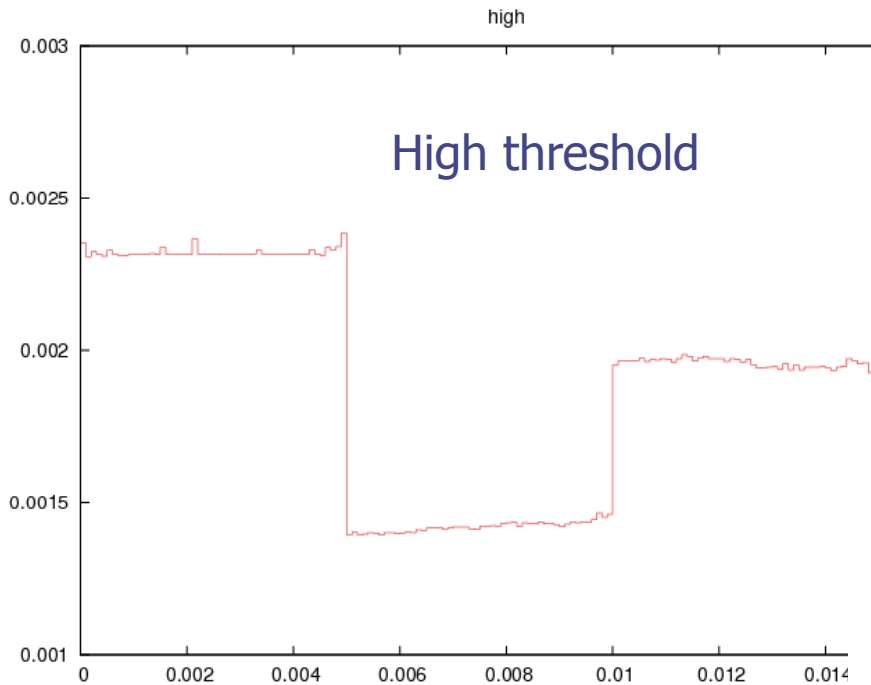
- ❑ 4 MeV proton beam (use #define PROTON) using the same beam size as for the previously defined electron beam (circular with 2 mm radius) and no momentum spread and divergence
- ❑ For HI-THR, LOW-THR, and VLOW-THR set proton threshold at 10 MeV, 100 keV, and 10 keV respectively
- ❑ Add MAT-PROP card 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)
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Exercise 11: Cutoffs - II

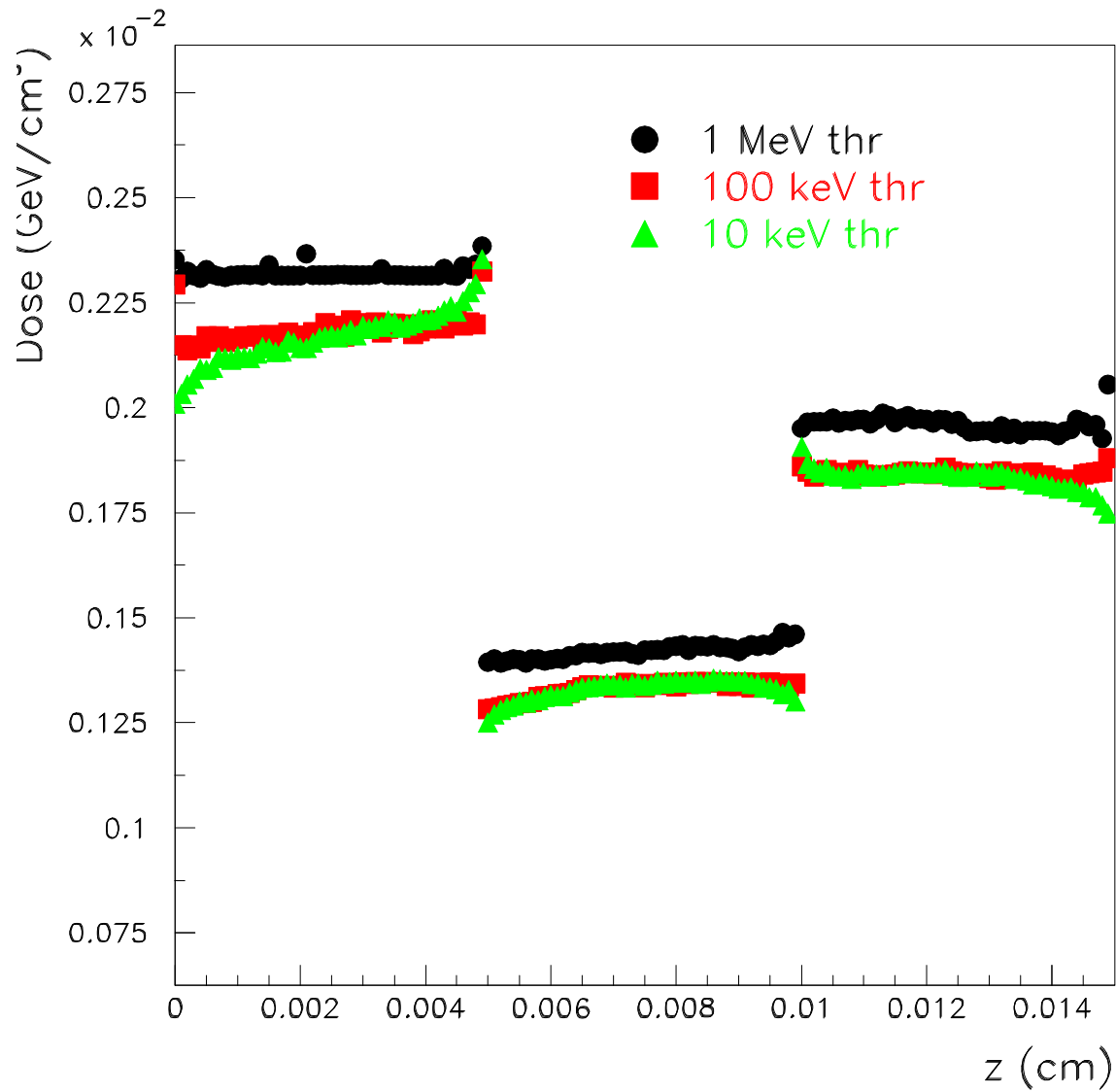
Questions

- ❑ 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?

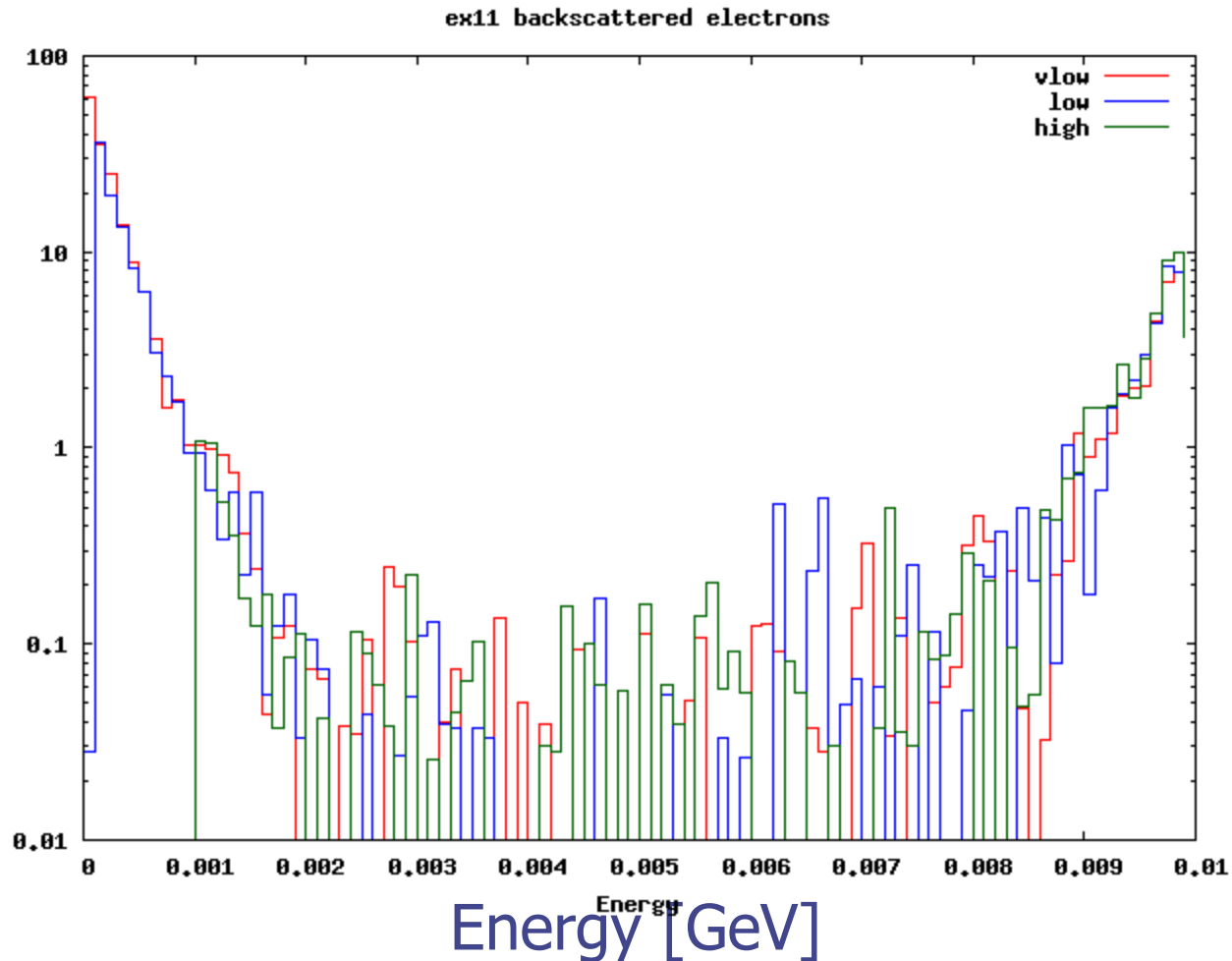
Exercise 11: Cutoffs – I solution



Exercise 11: Cutoffs – I solution



Exercise 11: Cutoffs – I solution



Exercise 11: Cutoffs – II solution

