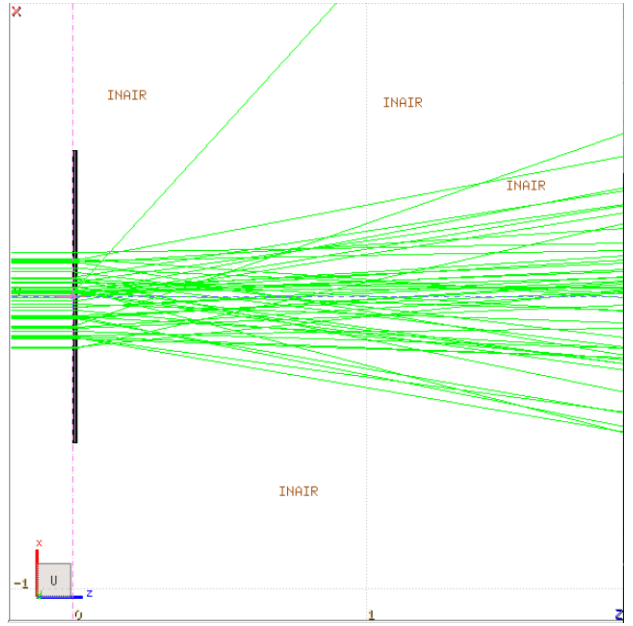
Exercise : Thresholds

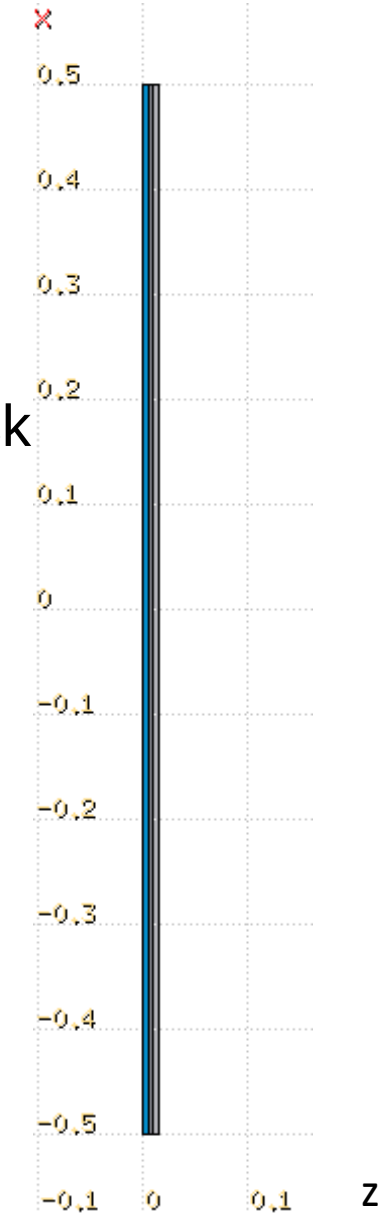
Aim of the exercise:

- Examine the effect of setting different threshold values
- Further interaction with the FLUKA manual
- Practice the use of preprocessor directives
- Strengthen plotting skills



Input file

- 10 MeV electron beam
  - Circular beam with 2 mm radius
  - Starting at x=0 cm, y=0 cm, z=-1 cm
- Cylindrical target along z, 5-mm radius, split in three layers, each 50 μm thick
  - Set to H_2O – Pb – Al
- Thin layers require high tracking precision. Thus, we set
  - **`DEFAULT PRECISIOn`**
- Notice that three preprocessor variables are defined
  - HI-THR, LOW-THR, VLOW-THR
- **`USRBIN`** scoring DOSE over the entire target
  - 1 μm bins in z, 1 bin in R, unformatted unit 55



Add EMFCUT cards

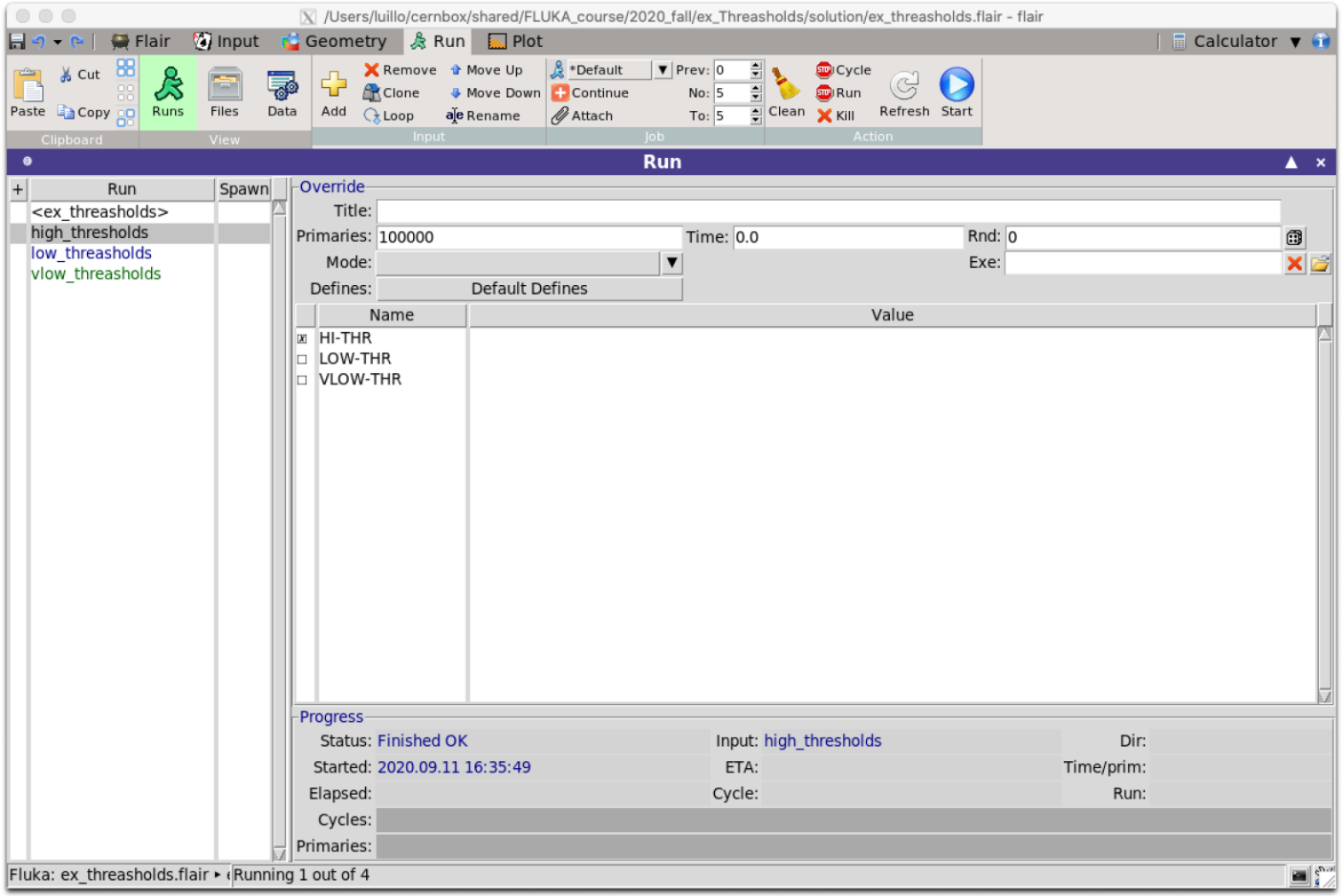
- Set both production and transport thresholds in all materials
  - Hint: when specifying the range of materials/regions, use @LASTMAT/@LASTREG as needed to refer to the last material or region, respectively

- Use preprocessor instructions to prepare three runs, one for each threshold case, exploiting the already defined preprocessor variables:

```
#if HI-THR
      photons: 1 keV ,      electrons: 1 MeV kinetic energy,      FUDGEM=1
#elif LOW-THR
      photons: 1 keV ,      electrons: 100 keV kinetic energy,    FUDGEM=1
#elif VLOW-THR
      photons: 1 keV ,      electrons: 10 keV kinetic energy,     FUDGEM=0.5
#endif
```

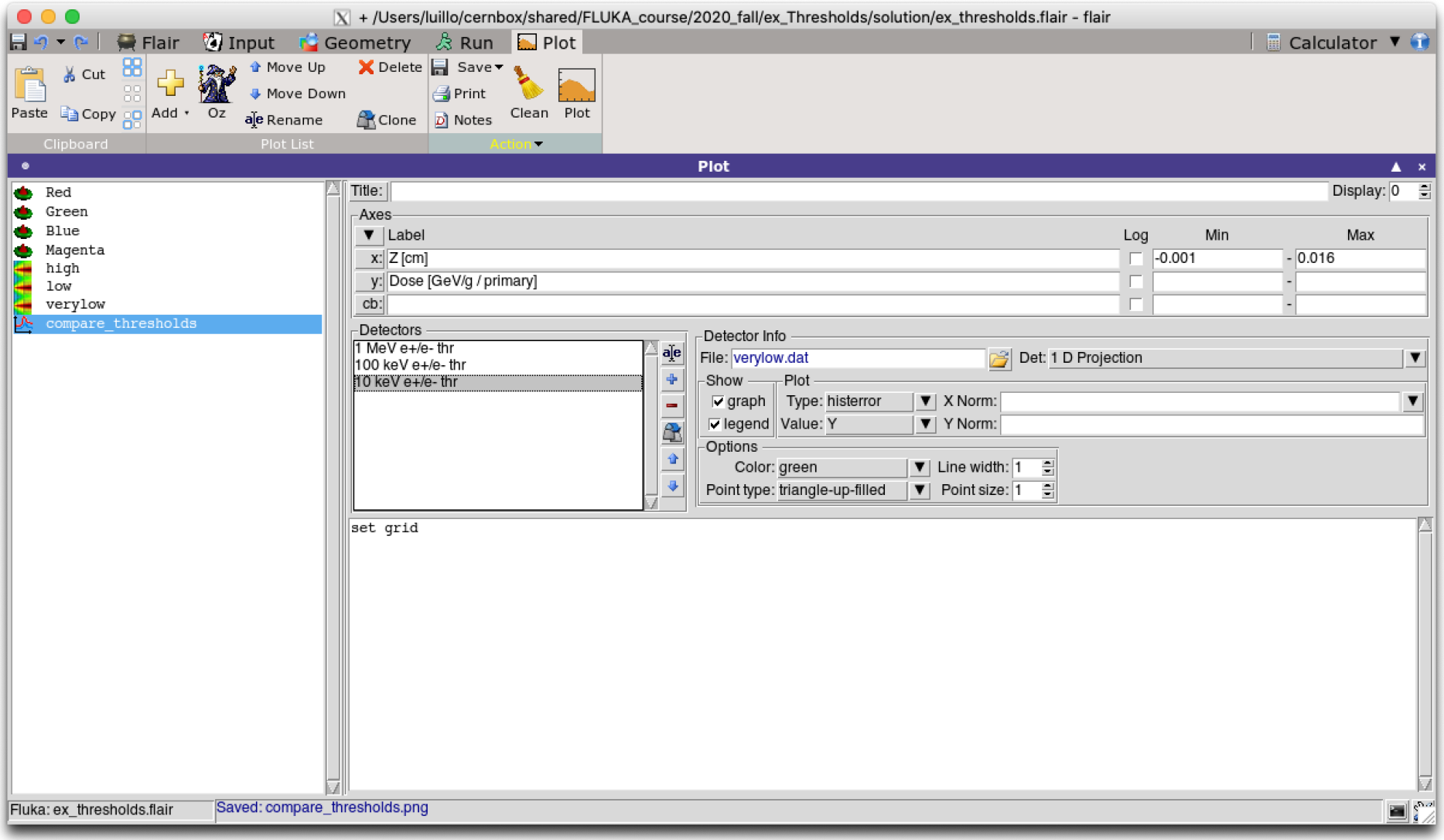
- Note that the electron threshold is 100 keV in case of **PRECISIOn,** corresponding to our LOW-THR case
- Reminder: stopping powers and ranges for electrons, protons, and He ions are available on the NIST webpage: https://physics.nist.gov/PhysRefData/Star/Text/intro.html

Run



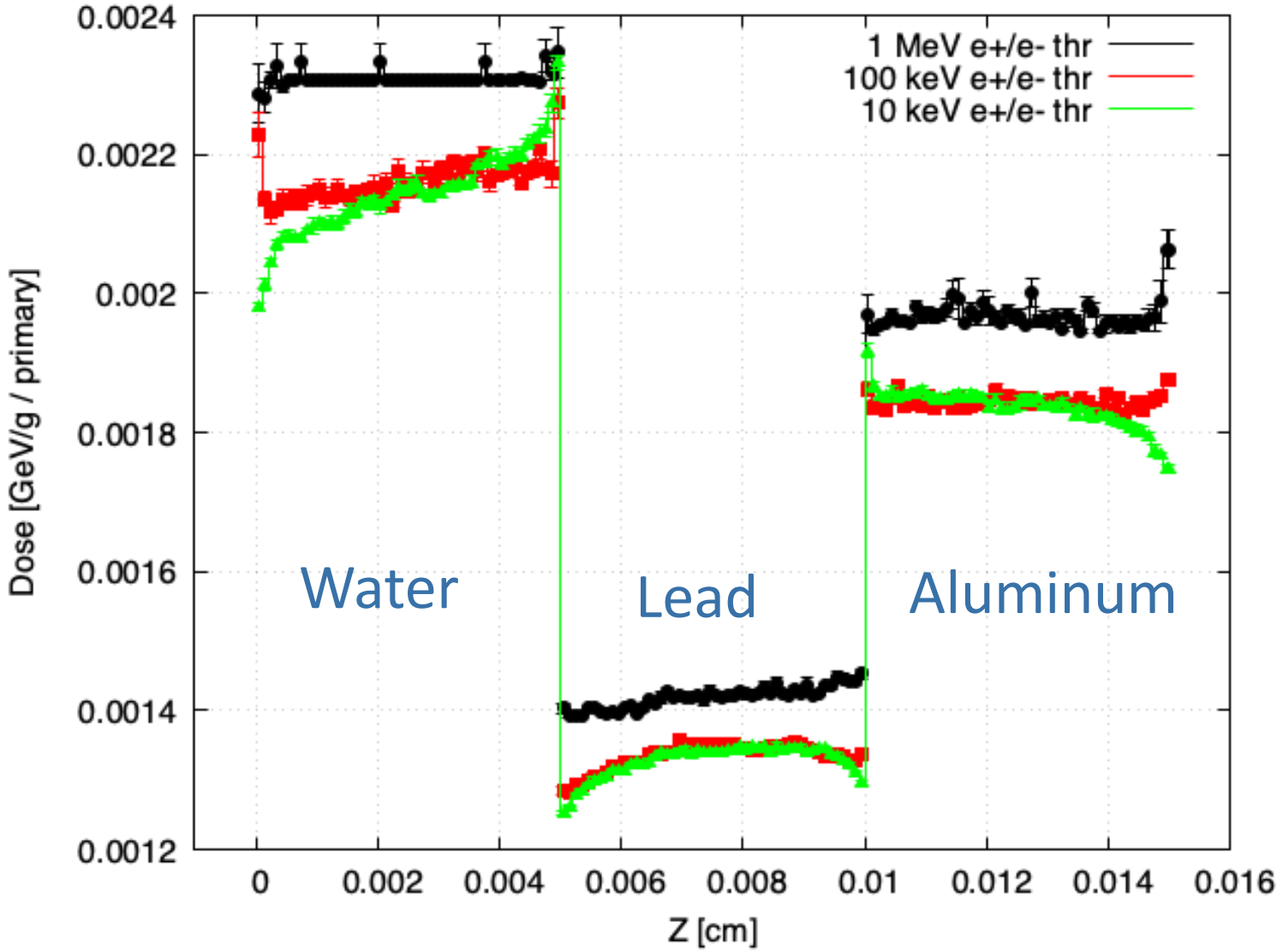
Run three simulations corresponding to high, low, or very low threshold values, with 5 cycles × 100000 primaries for each case
The three runs are already set up in the Flair project
Should take less than ~5 minutes on a reasonable machine.

Plot and compare the results



The plots are already set up in the Flair project

Compare depth-dose curve for various thresholds



- Premature dose deposition for 1-MeV threshold
- Correct deposition on average for 100-keV threshold (the value with DEFAULTS->PRECISION), but lacking details
- More refined result for 10-keV threshold
- Net flow of low energy electrons across boundary from high Z to low Z materials
- Physical effect!

Note

- Correct threshold values depend on the granularity of your geometry/scorings
- Do not blindly rely on default values
- Carefully set threshold values accordingly (range tables are helpful!)
- Do not forget to set the FUDGEM parameter


FLUKA

One final detail

```
EMFFIX    Mat1: WATER ▼ Max Frac.1: .01 Print:  ▼
          Mat2: LEAD ▼ Max Frac.2: .01
          Mat3: ALUMINUM ▼ Max Frac.3: .01
```