Interlude

- RADDECAY: “my simulation is taking a lot of time”
- LAM-BIAS: very helpful e.g. in e- machine shielding applications

RADDECAY detail

Input card: **RADDECAY**

From activation exercise instructions:

Preparation of the input file

- Add a **RADDECAY** card that:
  - Use defaults for residual transport (PRECISION: 100 keV for photons and electrons)
  - Switch off EMF for the prompt transport
- Define the irradiation profile:
  - 180 days of irradiation, with 10^{10} primaries per second
- Define a cooling time:
  - 12 hour after the end of irradiation

CPU time with/without killing prompt shower

- Killing the prompt shower as advertised:

```
RADDECAY   Decays: Active ▼ Patch Isom:  ▼ Replicas: 3.0
h/μ Int: ignore ▼ h/μ LPB: ignore ▼ h/μ WW: ignore ▼ e-e+ Int: ignore ▼
e-e+ LPB: ignore ▼ e-e+ WW: ignore ▼ Low-n Bias: ignore ▼ Low-n WW: ignore ▼
    decay cut: 10.0 prompt cut: 99999.0 Coulomb corr:  ▼
```

Average CPU time/primary: **10^{-2} s**

- Forgetting to kill the prompt shower:

```
RADDECAY   Decays: Active ▼ Patch Isom:  ▼ Replicas: 3.0
h/μ Int: ignore ▼ h/μ LPB: ignore ▼ h/μ WW: ignore ▼ e-e+ Int: ignore ▼
e-e+ LPB: ignore ▼ e-e+ WW: ignore ▼ Low-n Bias: ignore ▼ Low-n WW: ignore ▼
    decay cut: 10.0 prompt cut: 0.0 Coulomb corr:  ▼
```

Average CPU time/primary: **6×10^{-2} s**

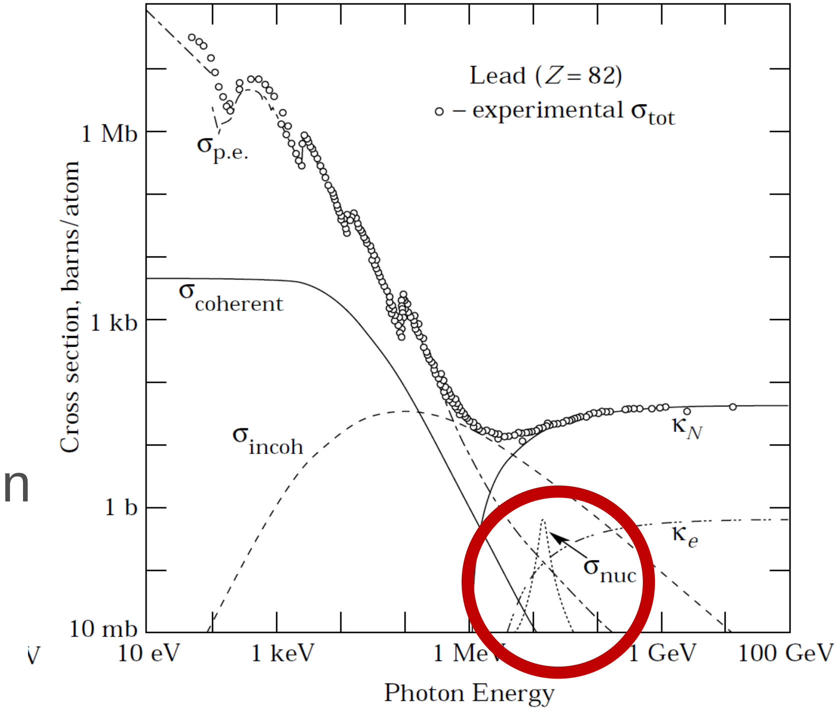
Mean Free Path Biasing

Input card: **`LAM-BIAS`**

Where is mean-free-path biasing needed?

- **Reaction yields from thin targets:**
  - E.g. you want to get the neutron spectrum from a thin (~1 mm) ^{7}Li slab under p irradiation
  - Nuclear inelastic scattering lengths are O(10 cm) -> less than 1% probability of sampling the (p,xn) events that are relevant for the above geometry
  - You would have to sample **a lot** of events for a small fraction of relevant events

- **e- machine shielding:**
  - The scenario:
    e- undergo Bremsstrahlung
    → Generated photons can undergo (γ,xn)
    → Radiation protection issue
  - Photonuclear interactions have comparatively low cross section
  - You'd have to sample **a lot** of events for a small fraction of relevant events



The mean-free-path biasing solution

- Artificially shorten the nuclear inelastic scattering length Λ_i, e.g. $\Lambda_i' = \Lambda_i / 100$

  → Nuclear interactions will be more frequently sampled

- This obviously distorts the physics

  → The particle's (statistical) weight is lowered accordingly

Mean Free Path Biasing

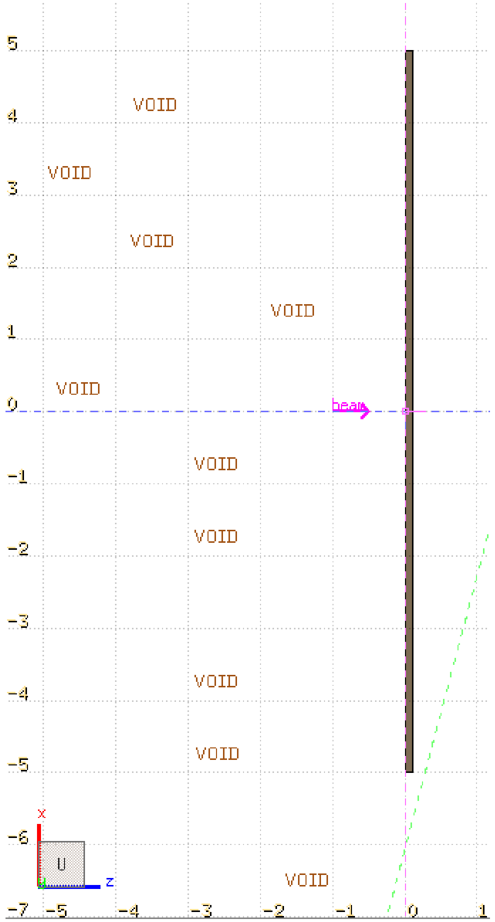
Input card: **LAM-BIAS** **(see manual for more details)**

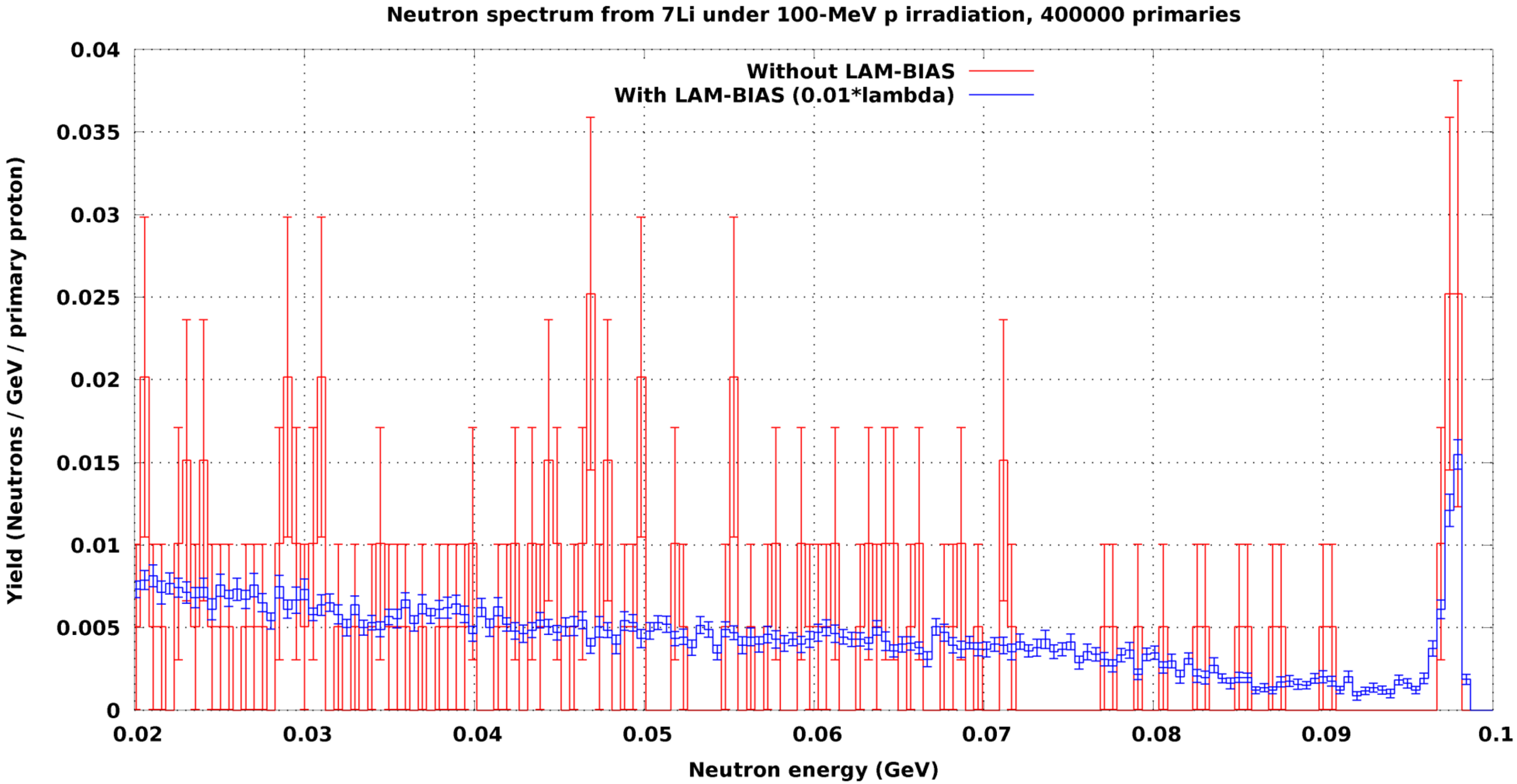
- *Type*
  - <empty>
- × *mean life*
  - Doesn't apply
- × *λ inelastic*
  - Interaction length correction factor
- *Mat*
  - Material where the correction factor applies
- *Part - to Part - Step*
  - Standard FLUKA particle selection

Example explanation:
Proton interaction length in *beryllium* is multiplied by a factor *correction factor=0.02* (reduced by a factor 50)

LAM-BIAS	Type: ▾	× mean life:	× λ inelastic: 0.02
Mat: BERYLLIU ▾	Part: PROTON ▾	to Part: ▾	Step:

Example: n yield from 1mm 7Li under 100-MeV p





Photonuclear interactions

- Are **not on by default** (!). You request them via the PHOTONUC card:

PHOTONUC Type: ▾ All E: On ▾
E>0.7GeV: off ▾ Δ resonance: off ▾ Quasi D: off ▾ Giant Dipole: off ▾
Mat: BLCKHOLE ▾ to Mat: @LASTMAT ▾ Step: 1

- Since photonuclear cross sections are somewhat suppressed compared to other processes, you need to shorten the mean free path for this process (e.g. factor 50-100) with the LAM-BIAS card:

LAM-BIAS Type: ▾ × mean life: 0 × λ inelastic: 0.01
Mat: LEAD ▾ Part: PHOTON ▾ to Part: ▾ Step: