Proton emission from deformed rare earth nuclei: A possible AIDA physics campaign

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AIDA for β, βp and p decays

- Fusion evaporation reactions?

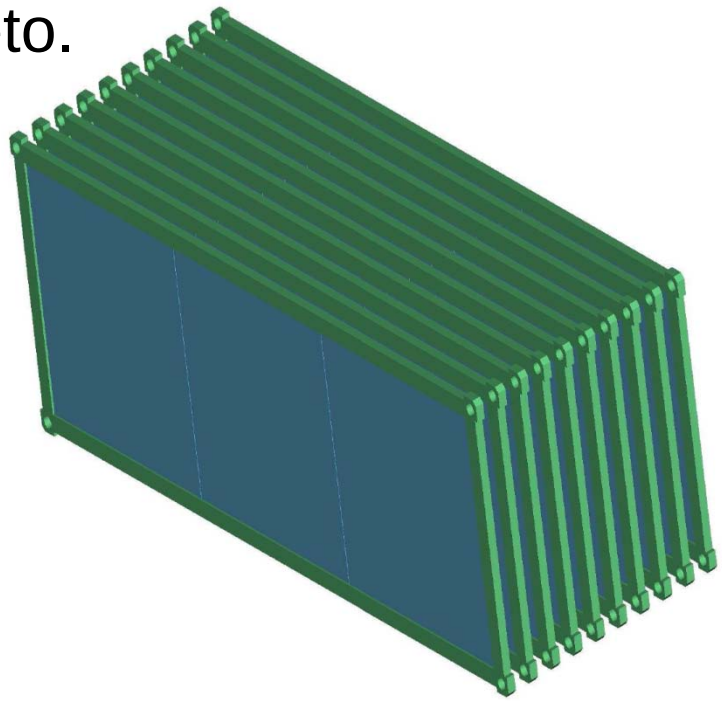
⇒ Gap in reactions that populate the deformed rare earth region.

- Exotic beams?

⇒ ^{238}U primary beam at GSI could populate a significant Number of nuclei in the region, with feasible yields.

*A*dvanced *I*mplantation *D*etector *A*rray

- Variable number of Si planes (1 mm thickness).
- Area 24 cm x 8 cm, or 8 cm x 8 cm.
- Strip pitch 625 μm.
- Front face for ΔE, back face for veto.



*A*dvanced *I*mplantation *D*etector *A*rray

- AIDA will be positioned at “low-energy” section of super FRS

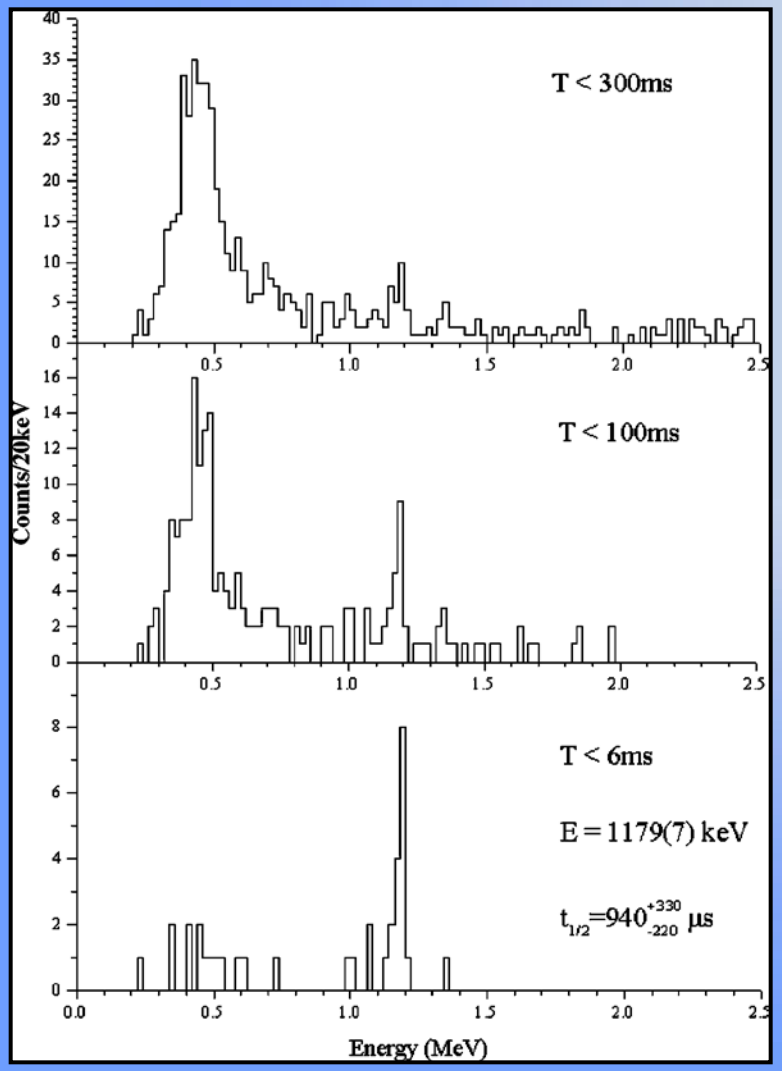
⇒ Exotic nuclei with energy ~ 50 – 150 MeV / u.

- Digital ASIC electronics

⇒ Dynamic range.

⇒ Fast overload recovery.

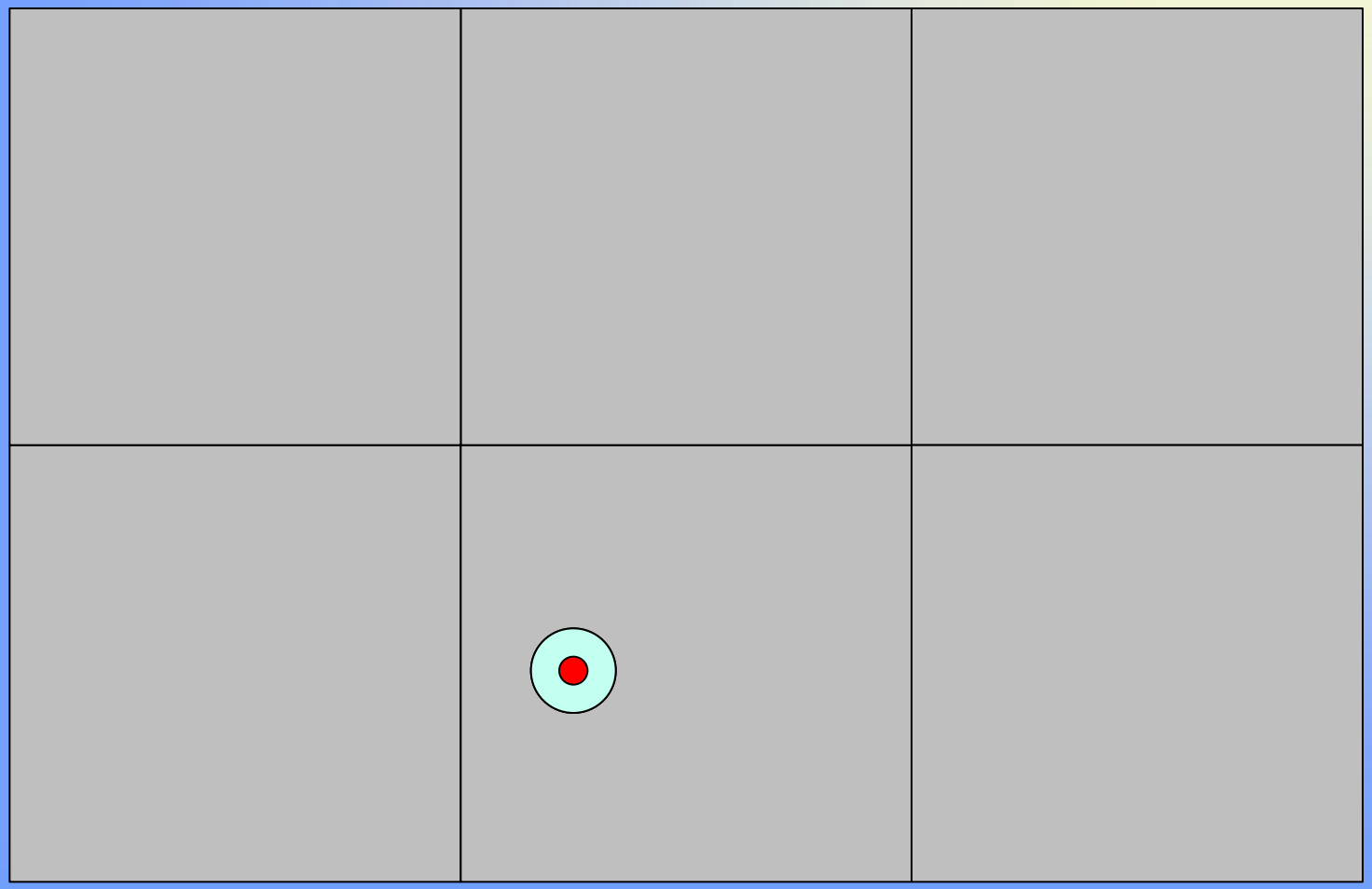
Background due to β decays



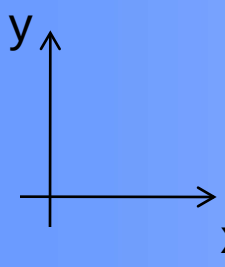
- Proton decaying state in ^{135}Tb populated by ^{92}Mo(p6n)^{135}Tb reaction.
- Background due to β decays.
- AIDA Si 1 mm thick, cf. 60 μm

P.J.Woods *et al*, Physical Review **C69** (2004) 051302.

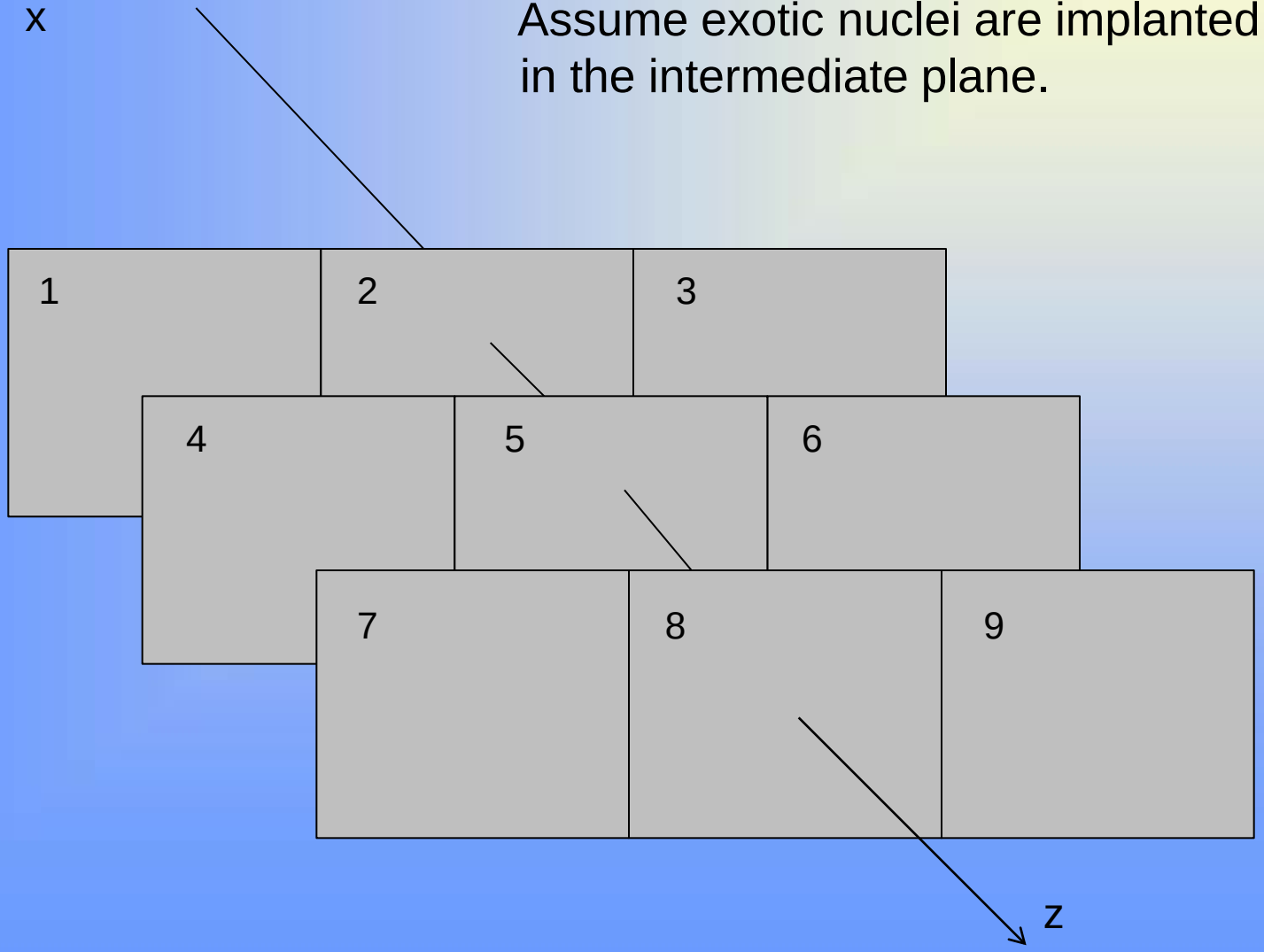
Beta-delayed proton decay



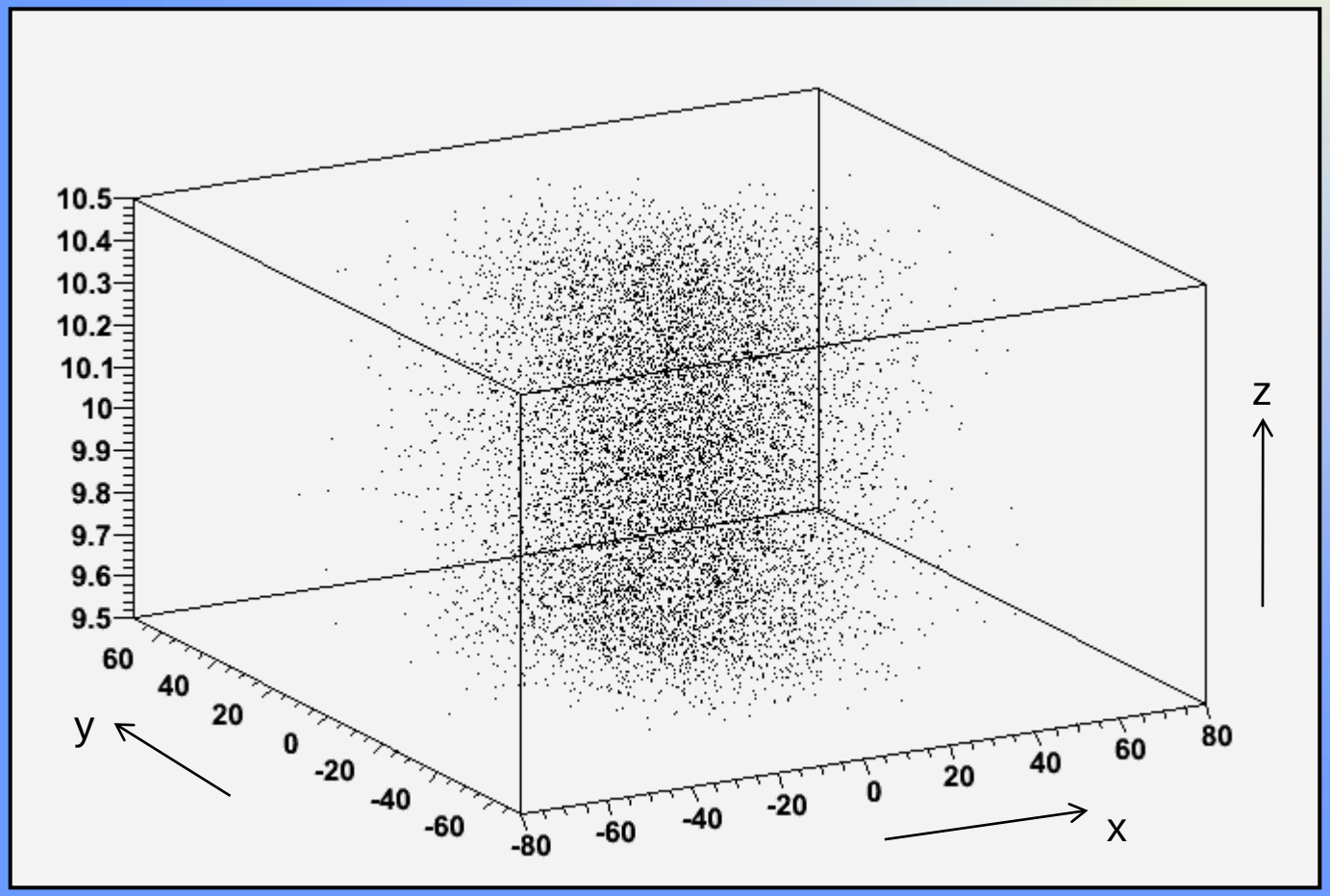
Simplest AIDA setup



Assume exotic nuclei are implanted in the intermediate plane.

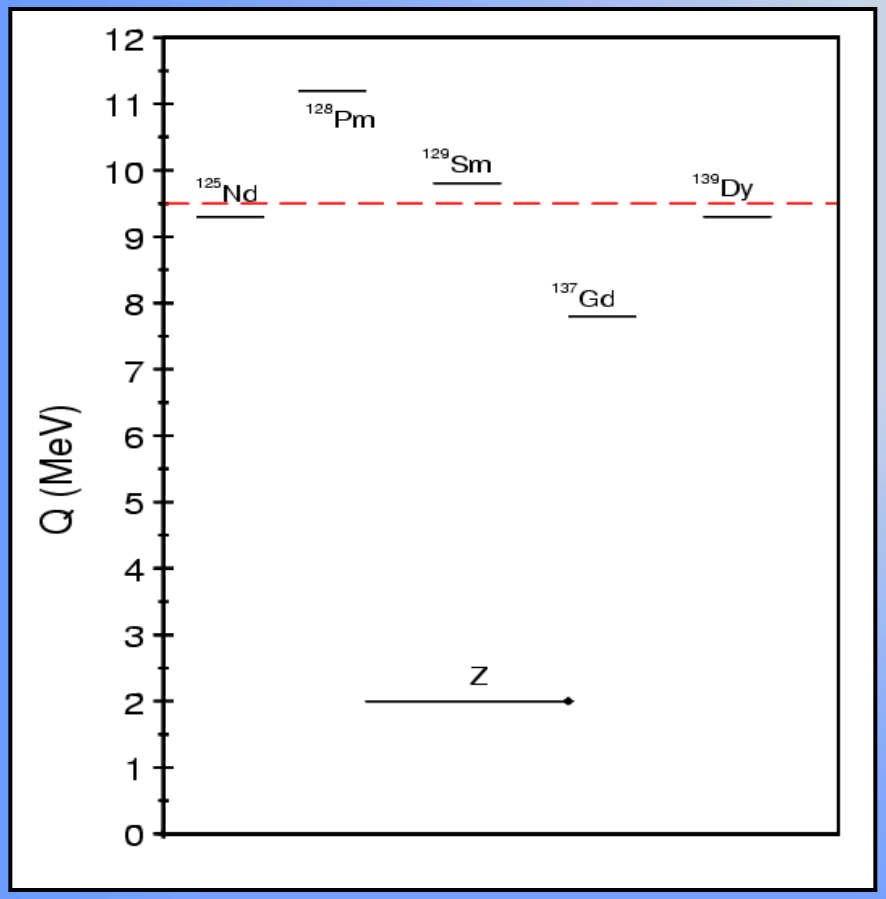


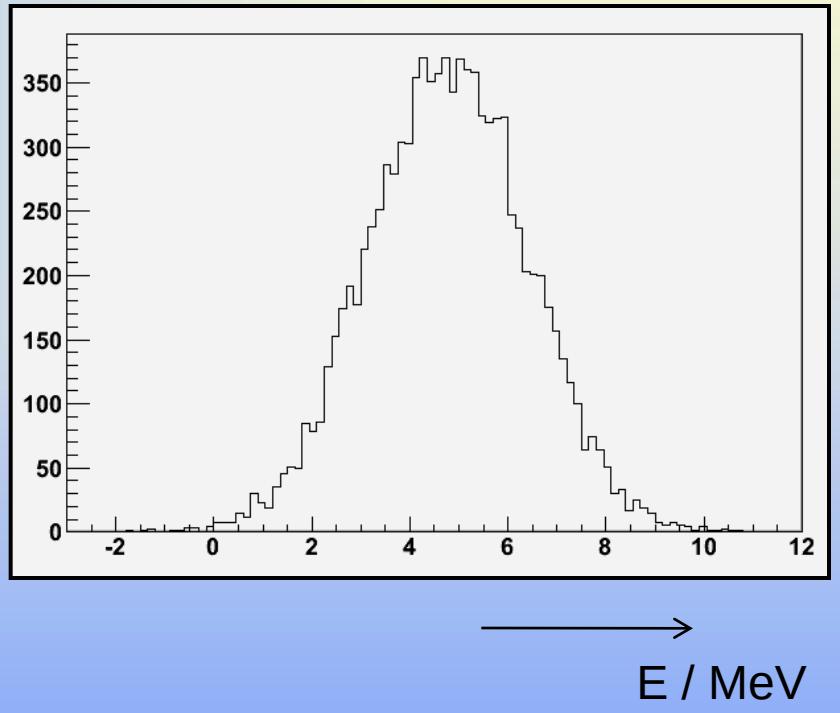
- Uniform distribution along z (beam) –axis.
- Distributed in (x, y) plane with $\sigma_x = \sigma_y = 2$ cm.
- 10, 000 initial events displayed.



• Typical Q_β in the deformed rare-earth region: $Q_\beta \sim 9.5$ MeV.

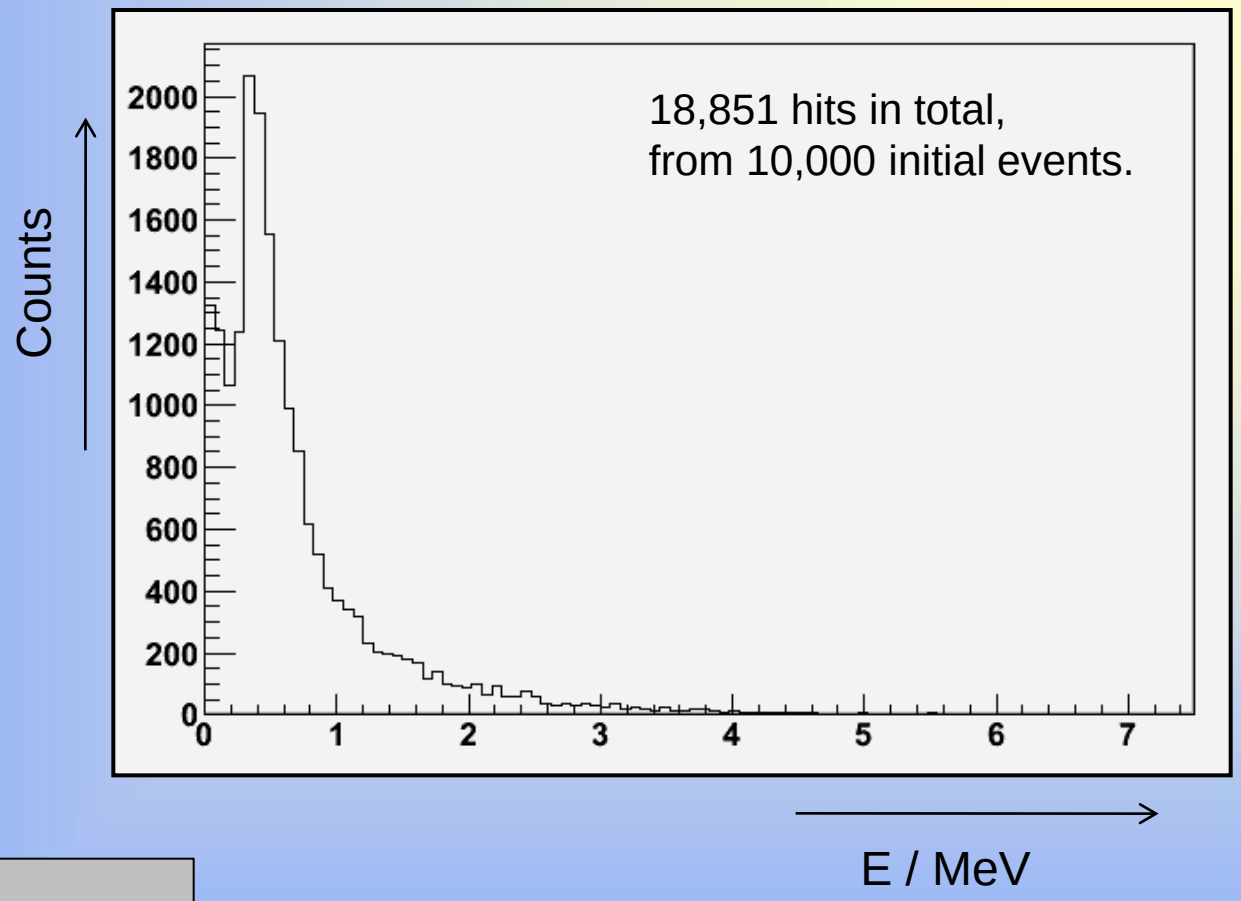
• To first approximation, assume peak of E_β spectrum at $\sim Q_\beta/2$, with $\sigma \sim Q_\beta/4$.

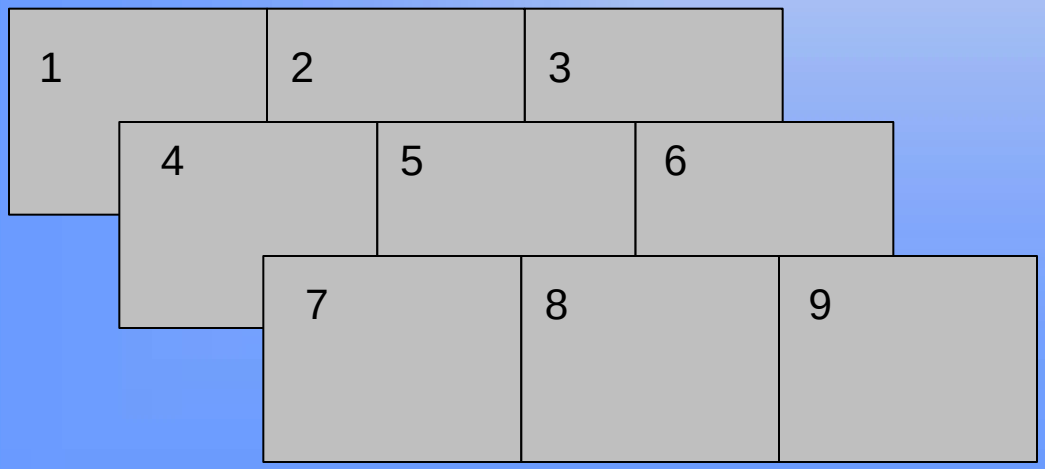




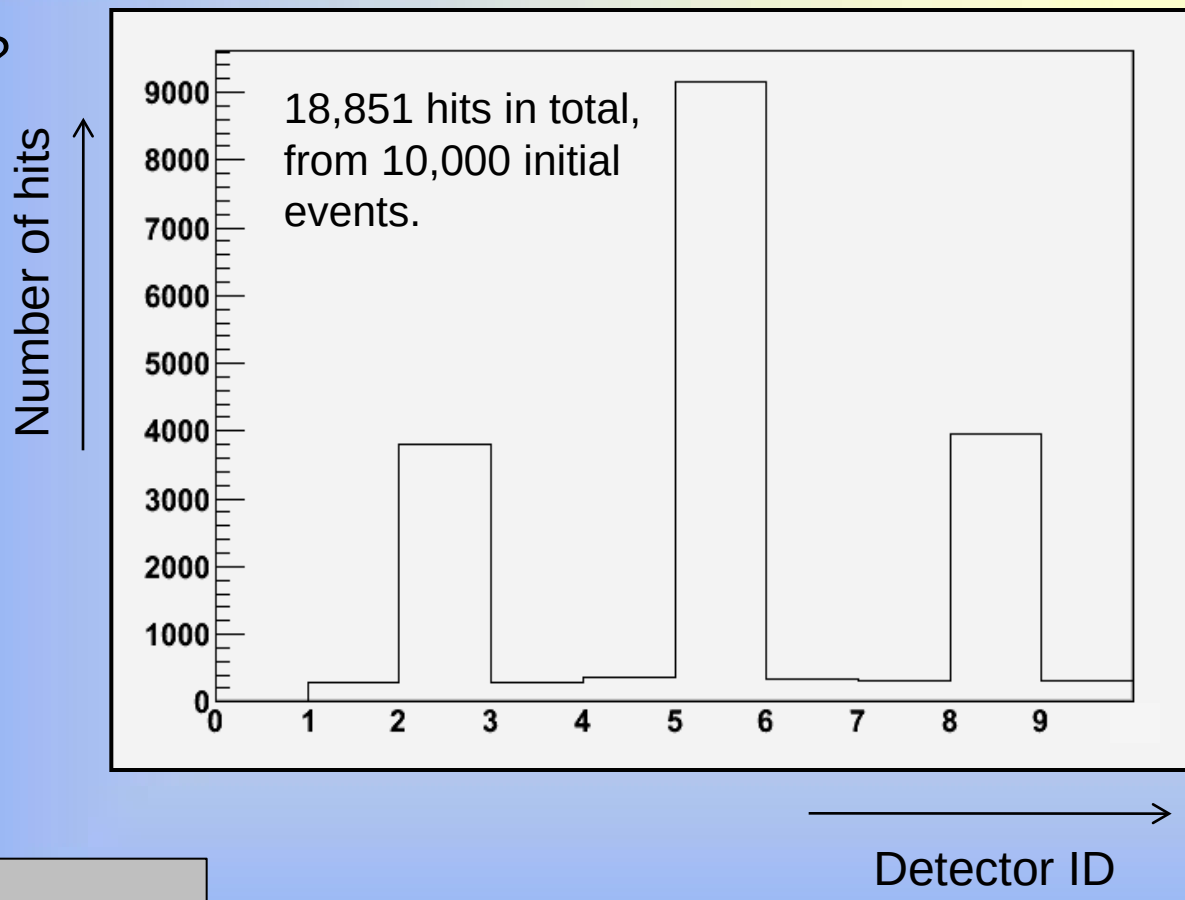
P.Moller, J.R.Nix, and K.-L.Kratz, At. Data. Nucl. Data Tables **66**, 131 (1997).
S.-W.Xu *et al*, Physical Review **C60** (1999) 061302.

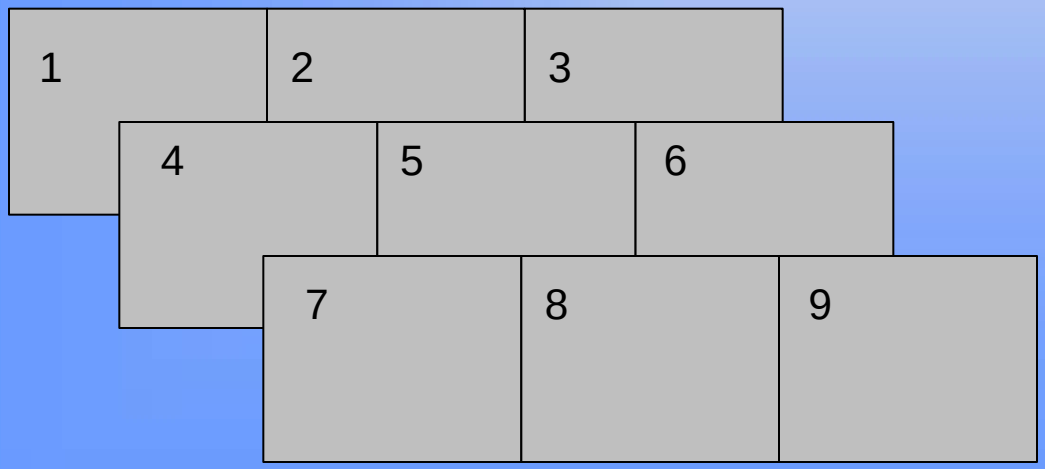
Energy distribution.



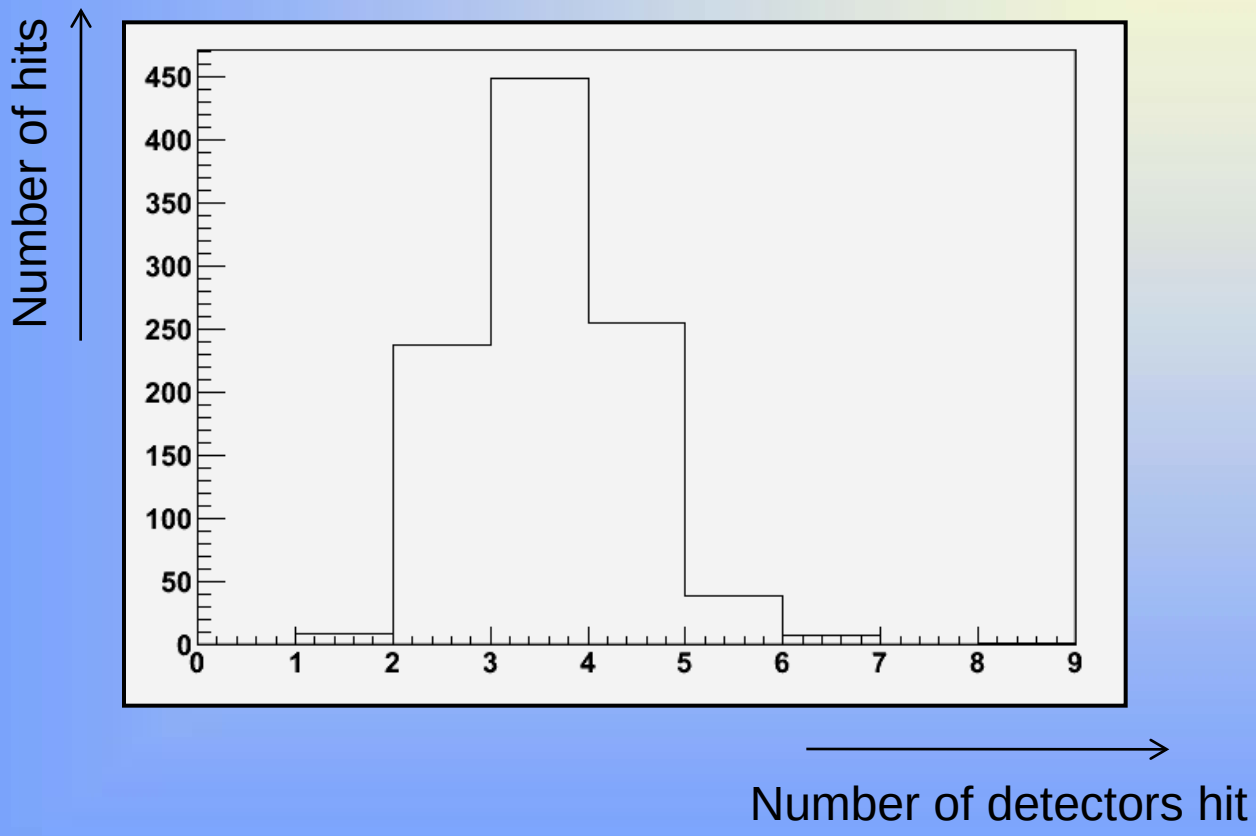


Which detectors are hit?



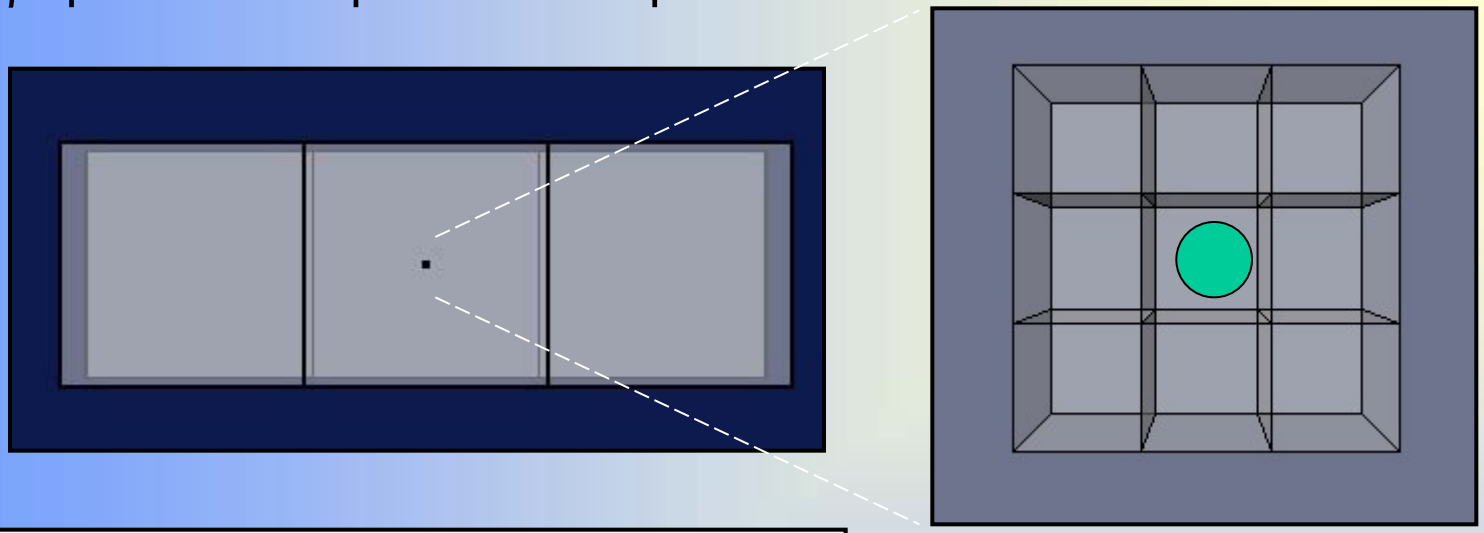


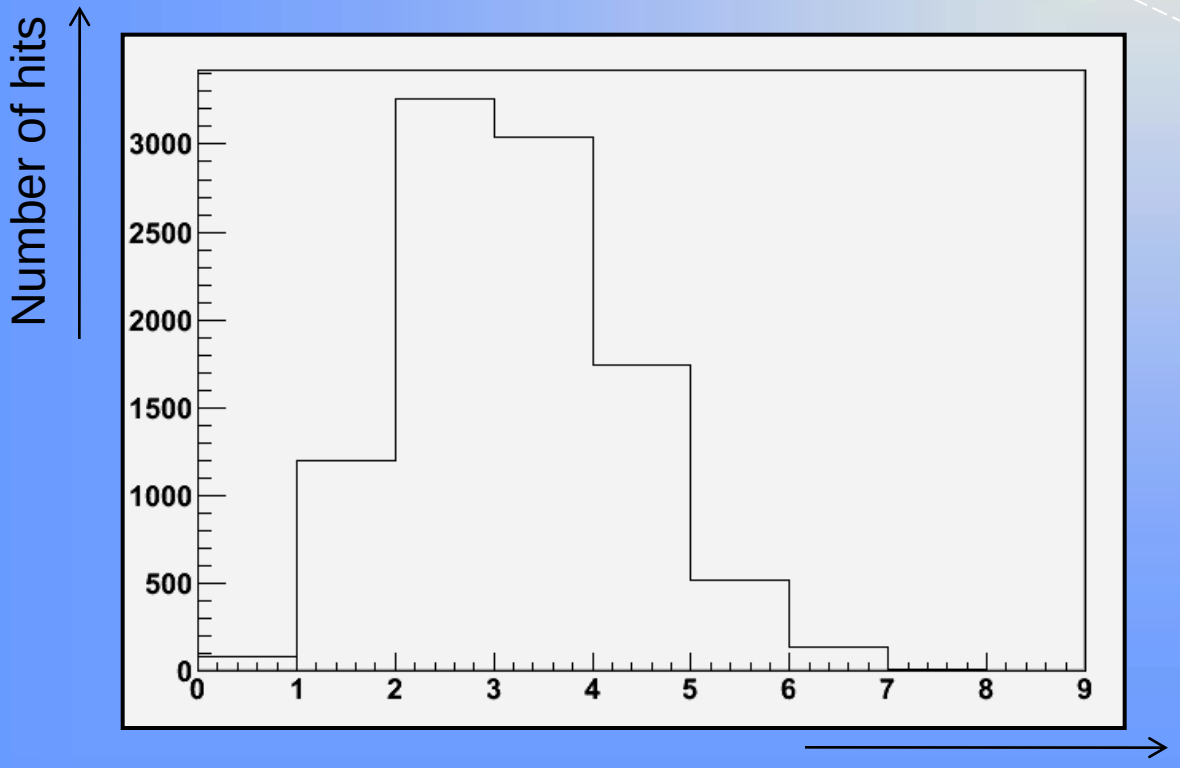
- Track individual primary β^+ particles through AIDA.
- How many only interact in the detector of origin?



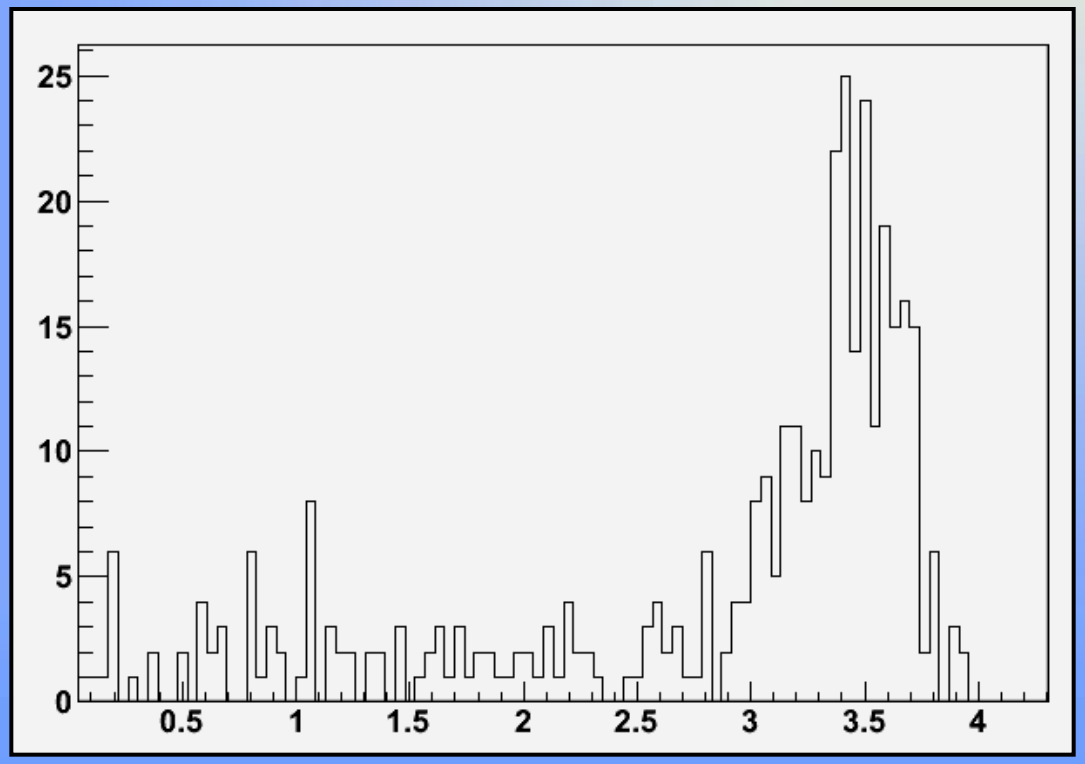
- The simulation suggests that ~ 1% of primary events lead to multiplicity 1.

- How many β^+ particles stop within one pixel?





- Proton measurements should be easier!
- Replace electron simulations with protons.
- Assume E_p = 3.5 MeV, with FWHM set to 0.5 MeV.
- In this case, ~ 60% of protons are stopped within one pixel.



Discussion / Questions