



Neutron



# Neutron Hunt

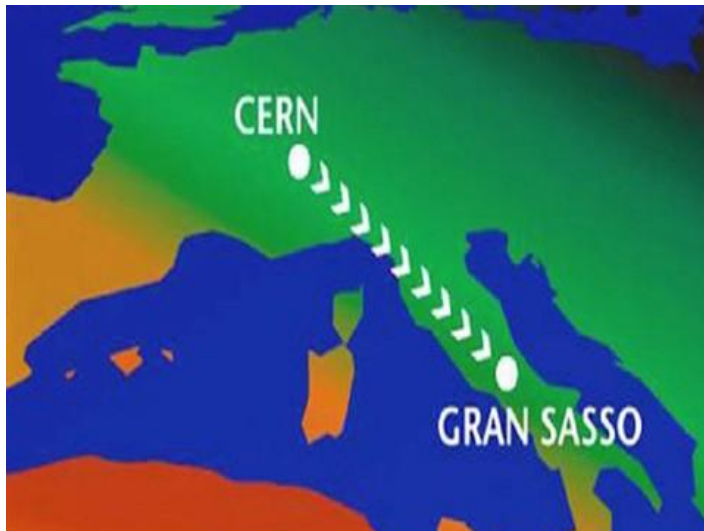
Project presentation  
by Andreas Nørgård Larsen,  
Copenhagen University

# Intro

- Where: CMS
- What: Medipix detectors.
- Why : Online neutron detection gives better knowledge of neutron flux. So we can:
  - Adjust simulations of the radiation in the CMS cavern.
  - Provide knowledge about the risk of Single Event Upset (SEU).

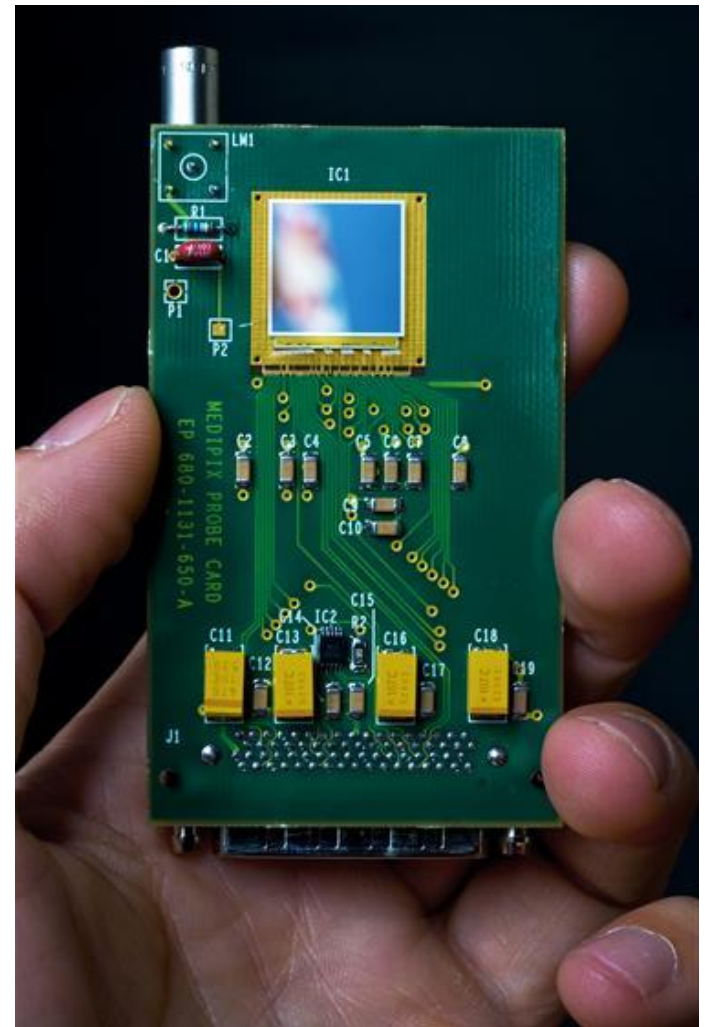
# Single Event Upset

- Change bit in electrical device: **1**  $\leftrightarrow$  **0**
- Example: Failure in electronics in CNGS (CERN Neutrinos to Gran Sasso) in 2007



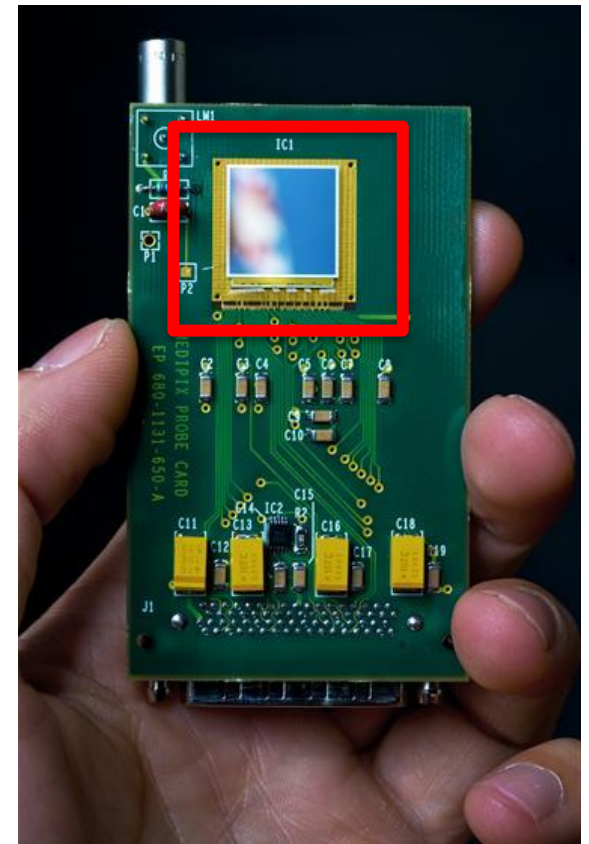
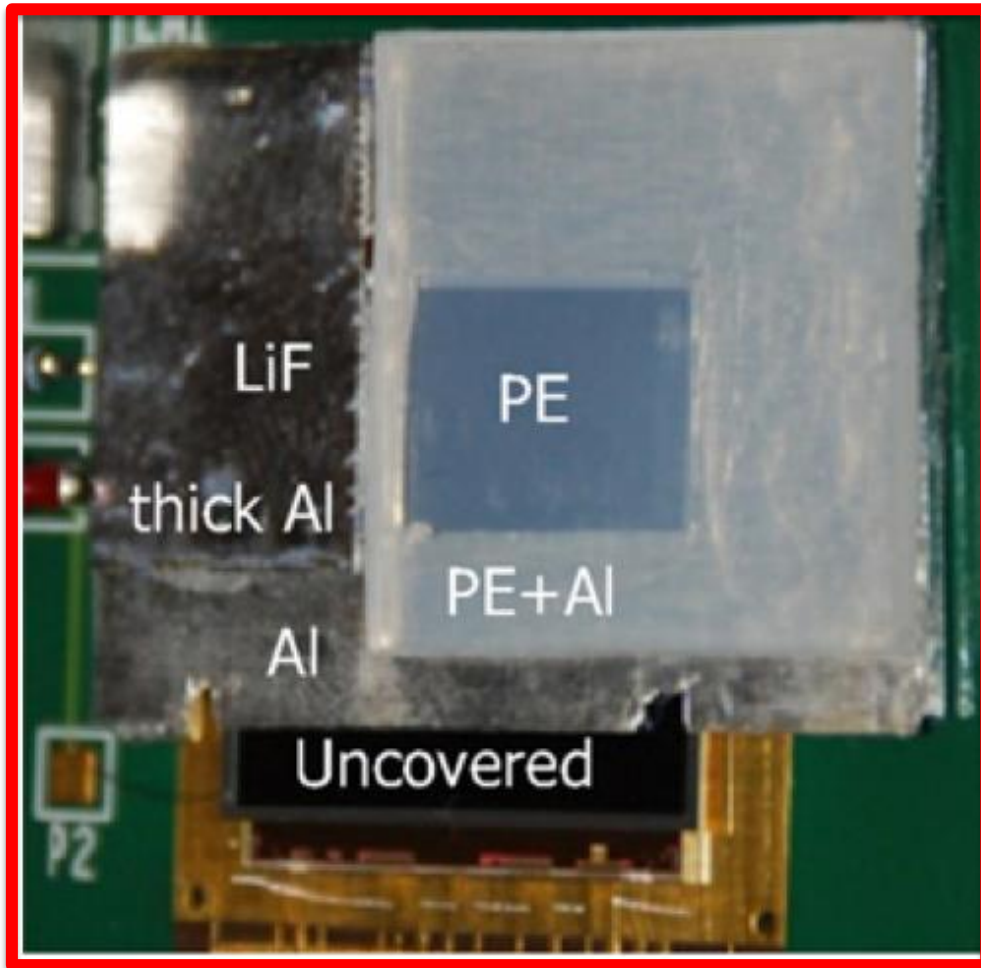
# Medipix

- Silicon: measure charged particles
- Low cross section for direct neutron-Si interaction generating charged particles, therefore: Conversion layers!



*Picture from: [www.scienceinschool.org](http://www.scienceinschool.org)*

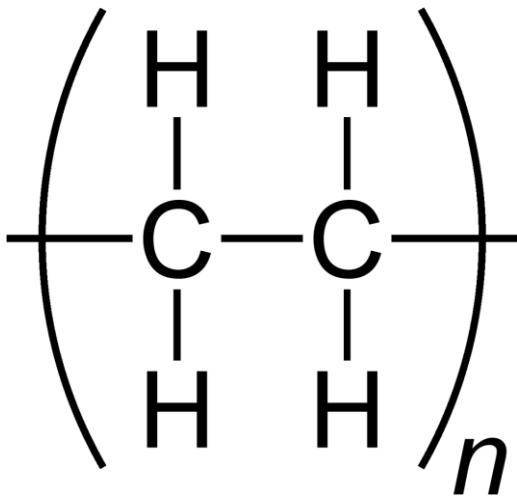
# Conversion layers



Picture from: D. Turecek, T. Holy, S. Pospicil, Z. Vykydal, Elsevier ;  
*Nuclear Instruments and Methods in Physics Research A 633 (2011) S45–S47*

# Conversion layers

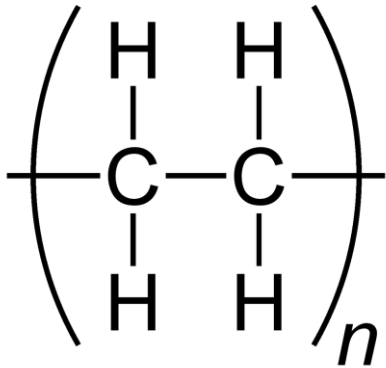
- Today's focus: Polyethylene, PE
  - Effective for fast neutrons, i.e. from 2 to 50 MeV.



# Polyethylene

- Elastic scattering

$$M_{neu} \approx M_{pro}$$

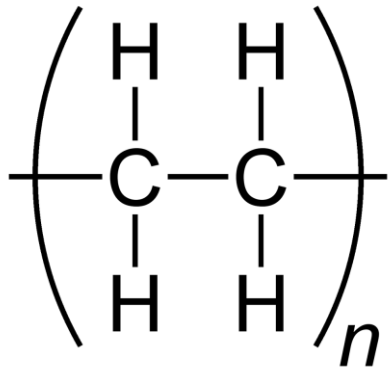


- The process of kicking out protons has a high cross section for fast neutrons
- Protons are charged!

# Polyethylene

- Elastic scattering

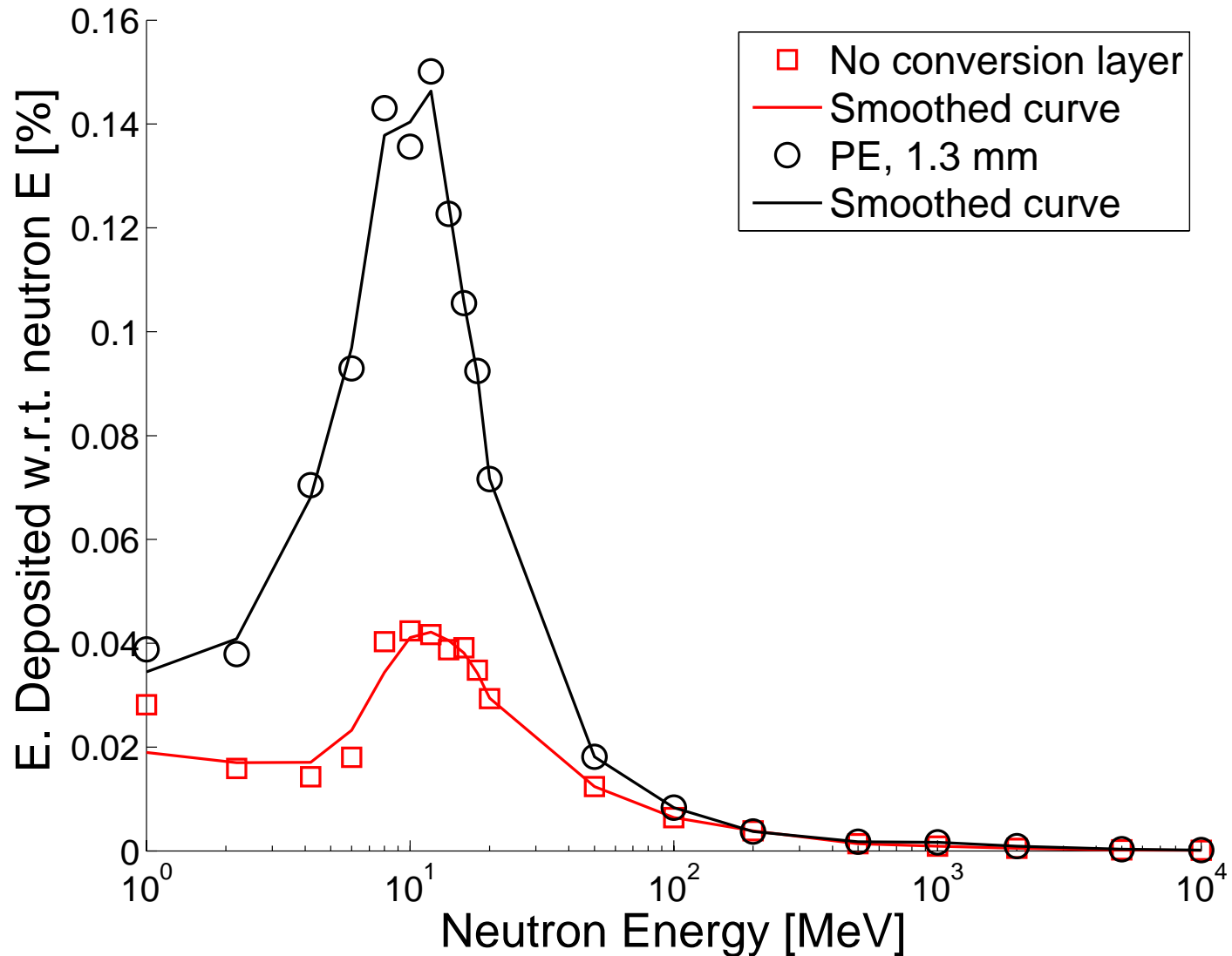
$$M_{neu} \approx M_{pro}$$



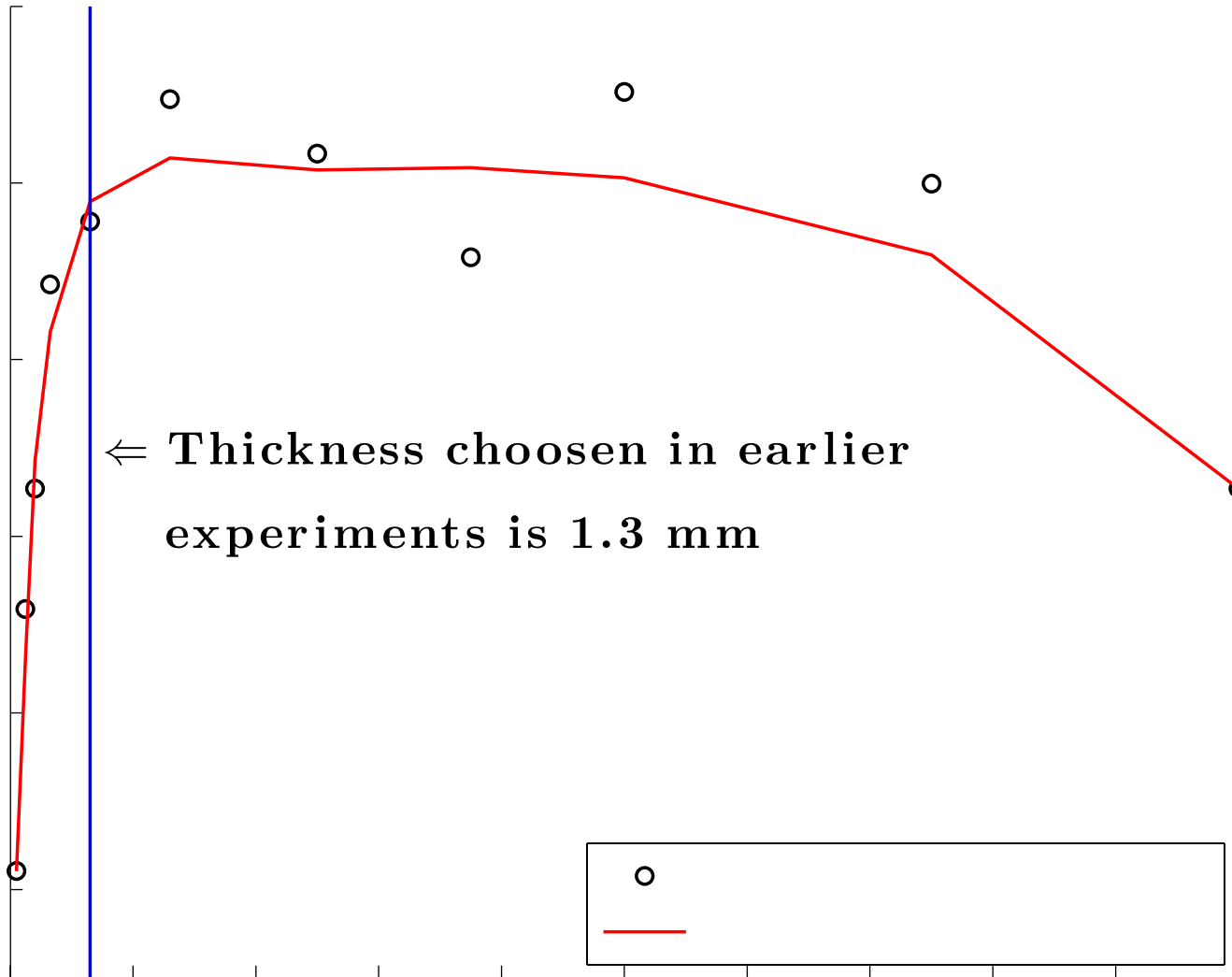
- The process of kicking out protons has a high cross section for fast neutrons
- Protons are charged!



# Effect of Conversion layers - simulation with FLUKA

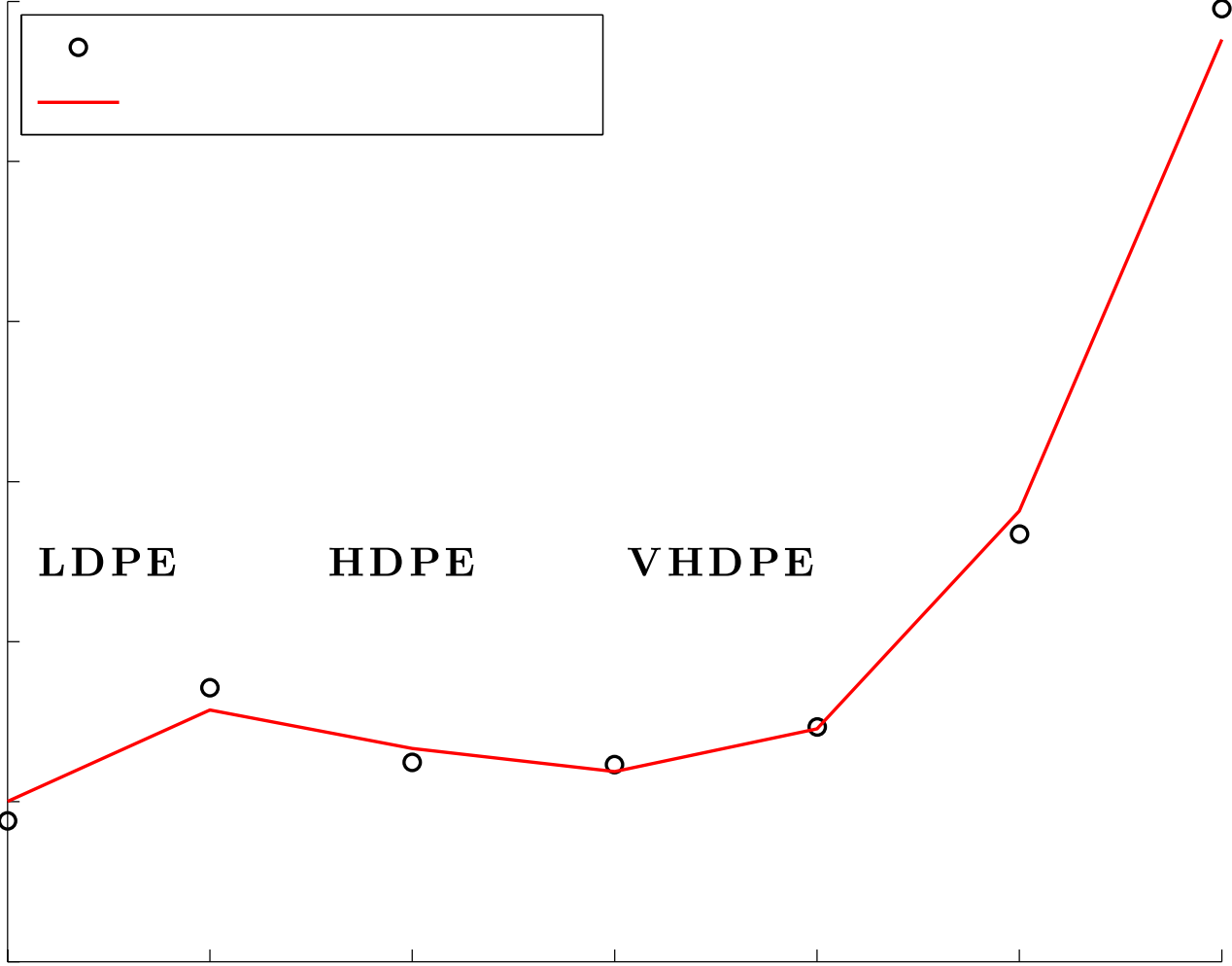


# Thickness of PE conversion layer

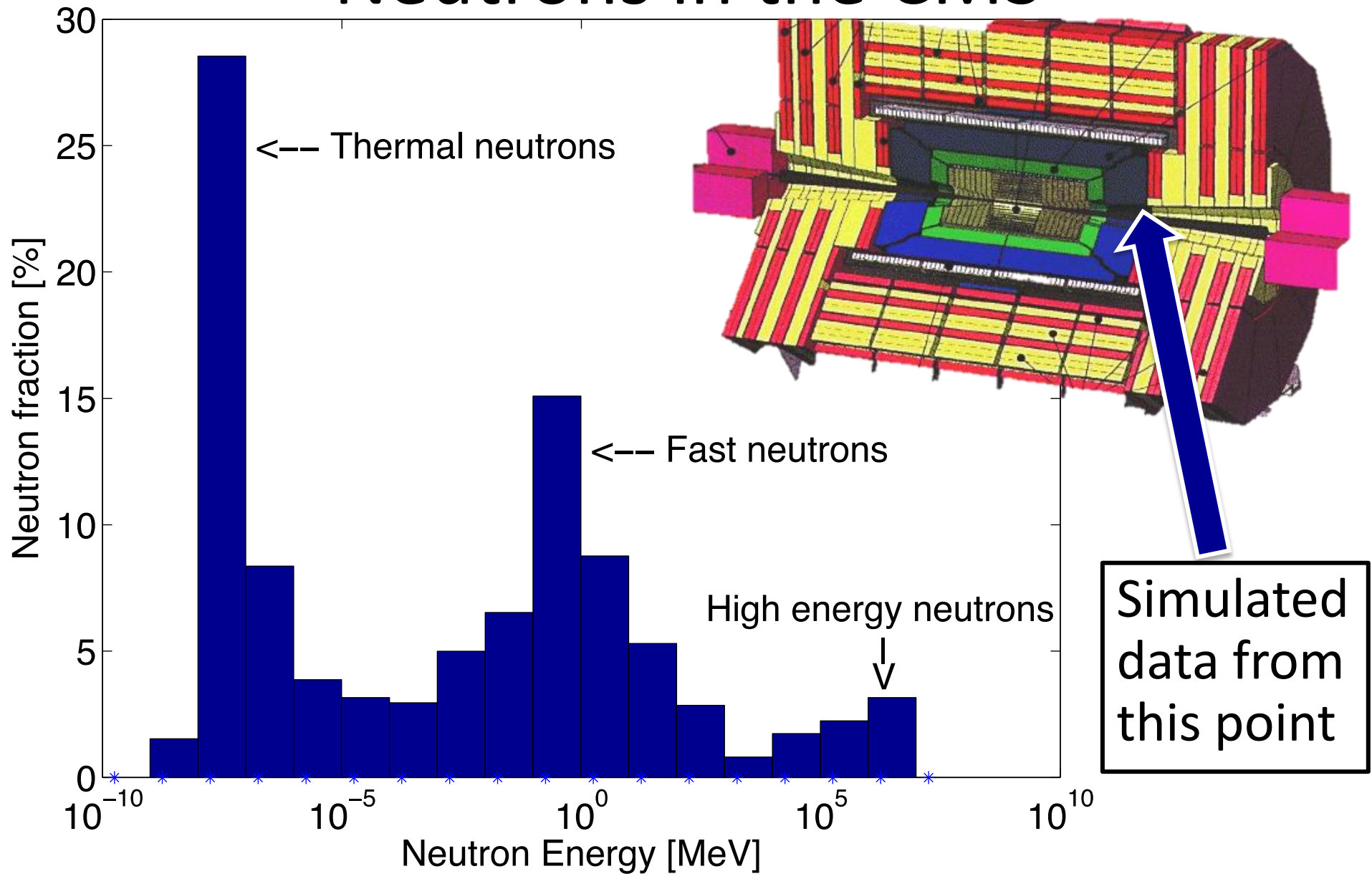


# Density of PE conversion layer

Thickness is 1.3 mm



# Neutrons in the CMS



# I hope you know

- Why neutrons are still interesting.
- How to hunt them.

# Thank you for your attention!

## Special thanks to:

- Dieter Loterman (focus data)
- Sophie Mallows (FLUKA expert 1)
- Mouritz Guthoff (FLUKA expert 2)
- Slawomir Konrad Tadeja (Computer expert)
  - Arkady Lokhovitskiy (supervisor)
  - Alan James Bell (supervisor)