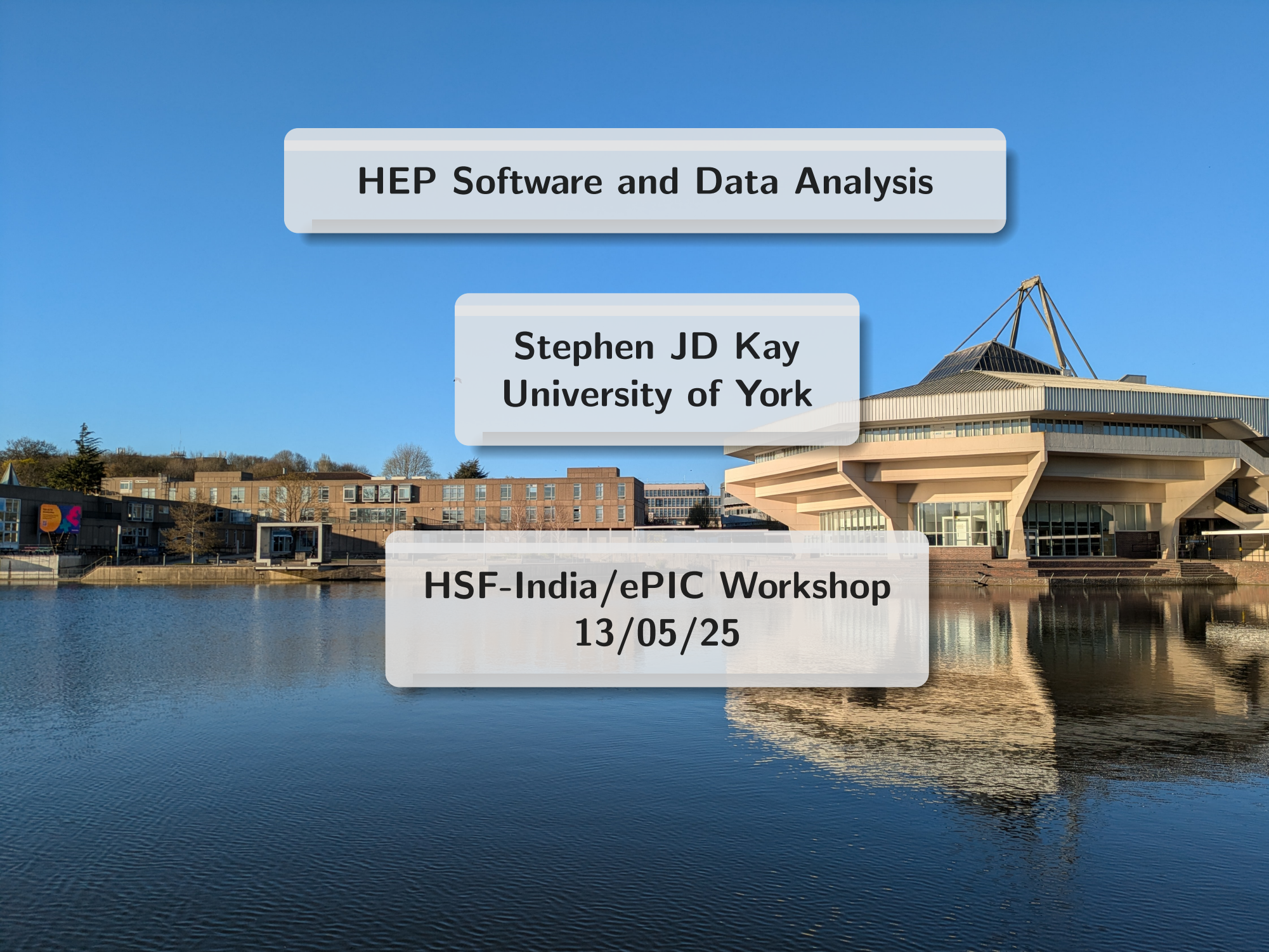

HEP Software and Data Analysis

Stephen JD Kay
University of York

HSF-India/ePIC Workshop
13/05/25

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- So what is High Energy Physics about?
- What information will our software be used on, **what hardware does it come from?**

Disclaimer

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Follow the references/links in many slides if you want to know more

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... or, just ask!

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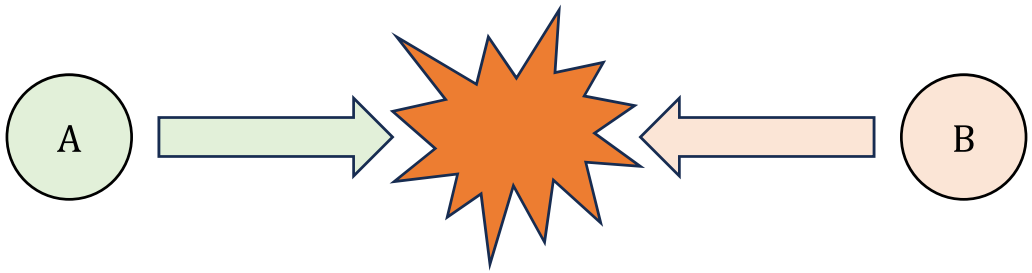

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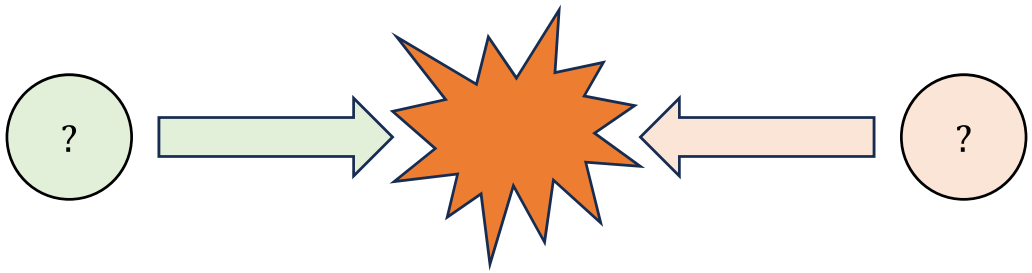

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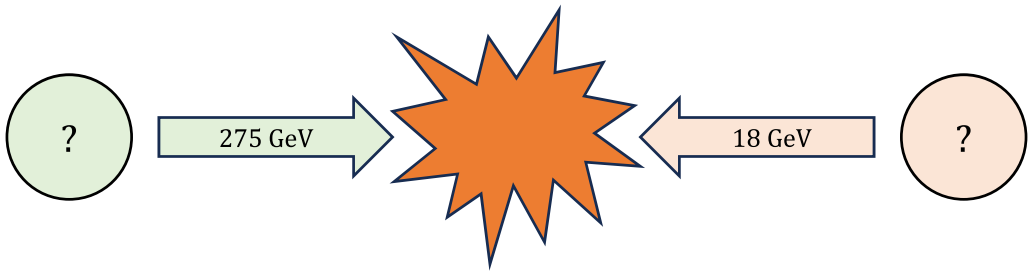

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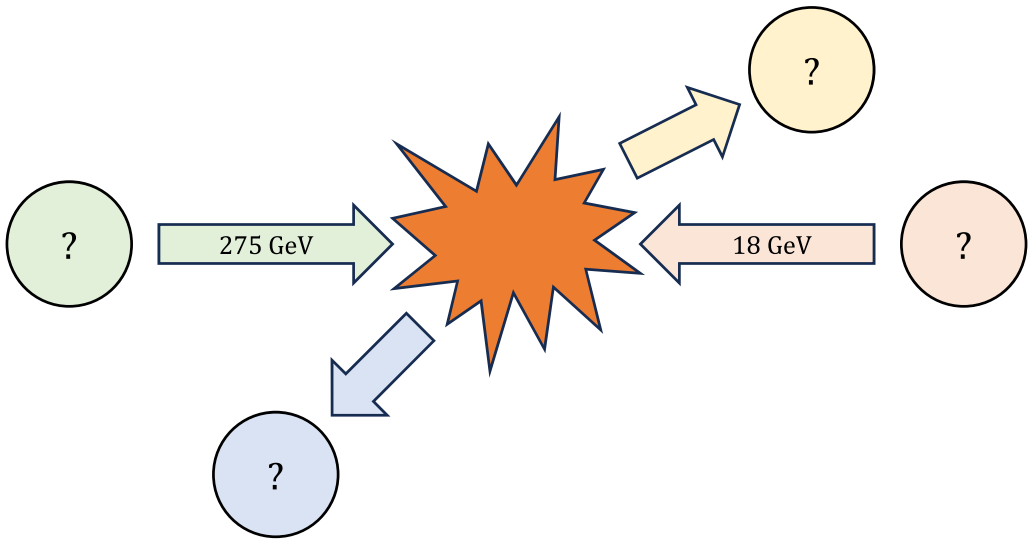

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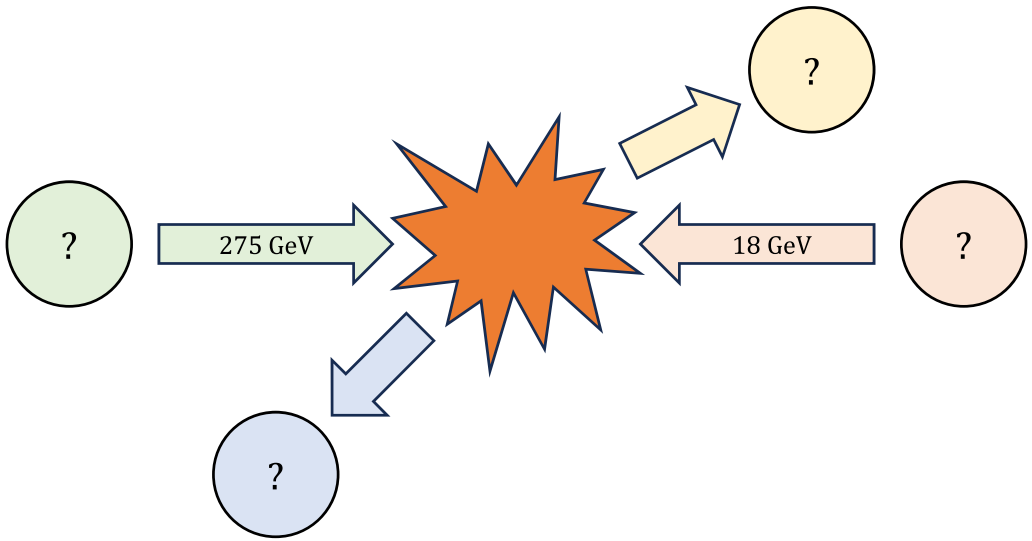

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- Typically, we can group events into categories **based upon the types of particles we detect in them**
- At the **E**lectron-**I**on **C**ollider, EIC, there are a few broad categories of events we wish to observe

Example Events: DIS

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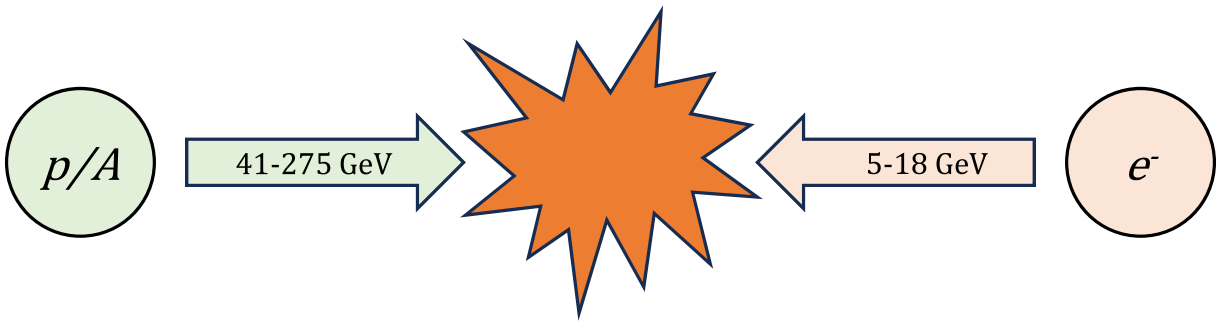

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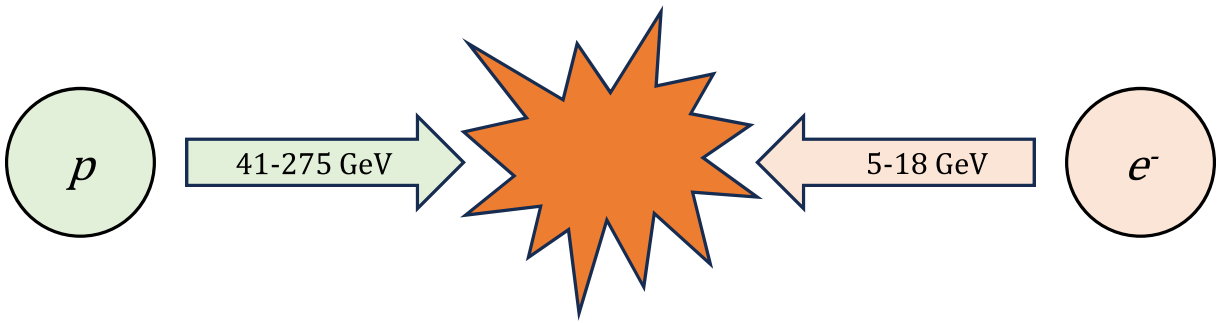

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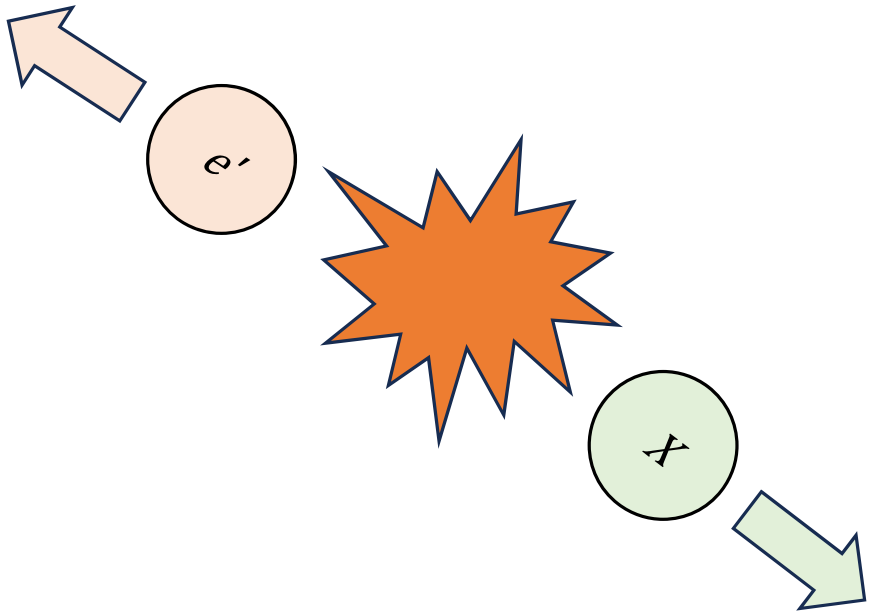
- In DIS, we have a scattered electron, e'
- ... and a shower of hadronic "stuff", X



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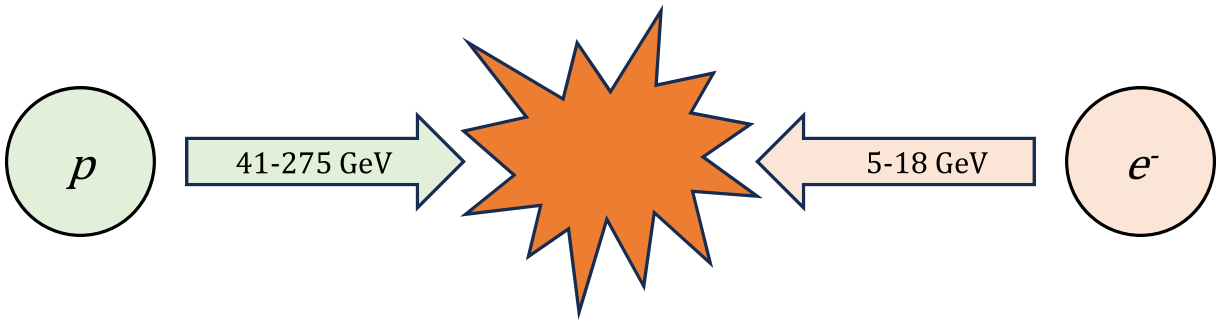

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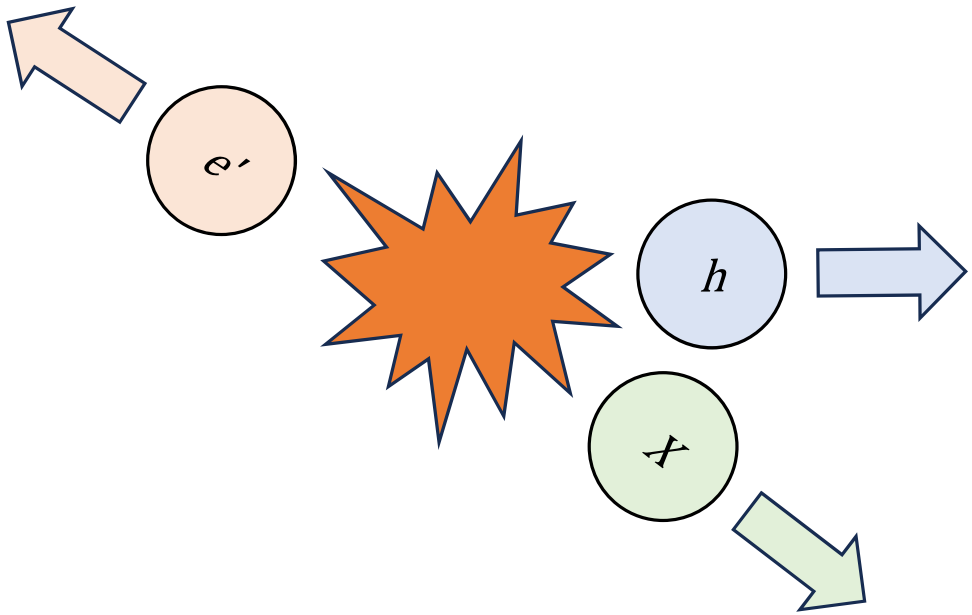

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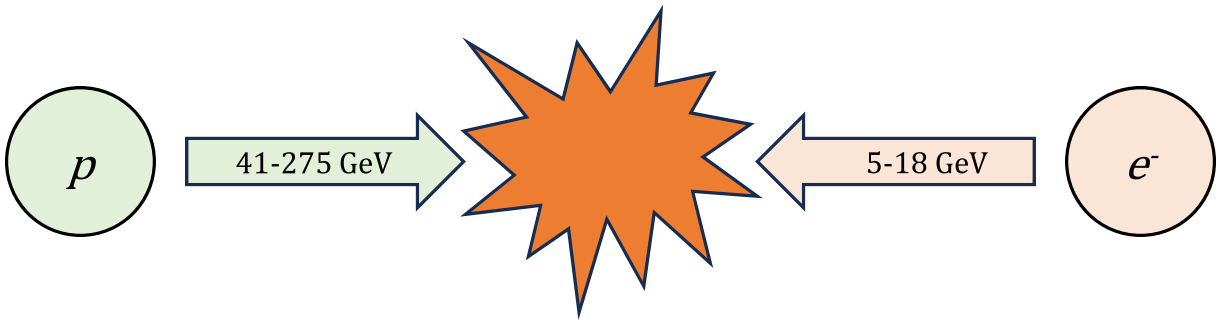

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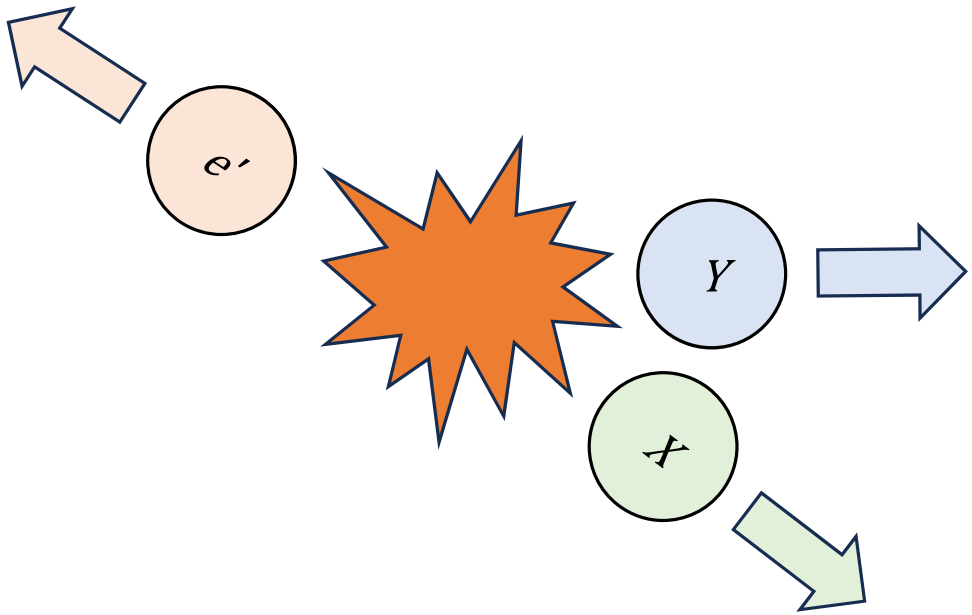

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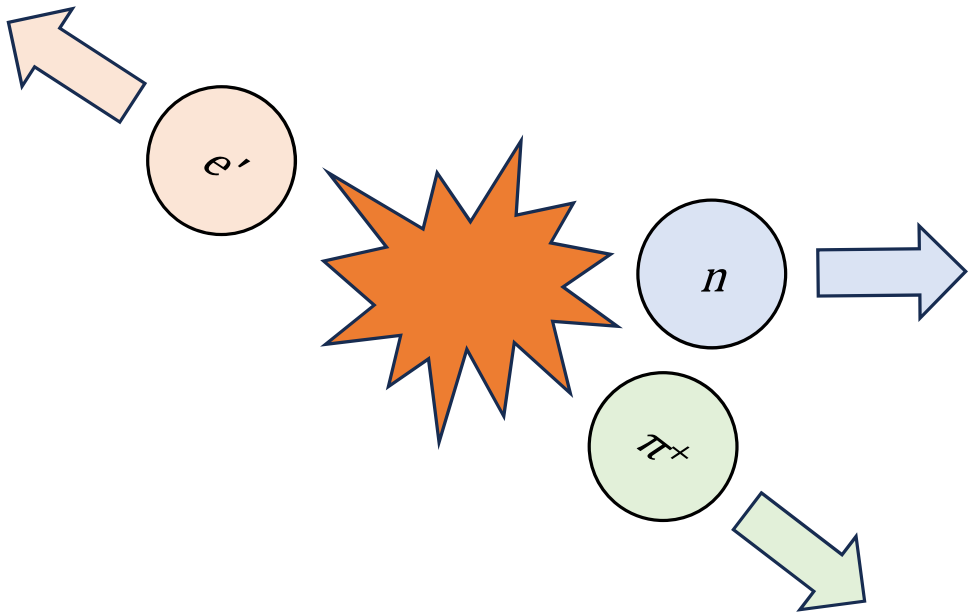

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- Analysis - We need to process readout from our detectors and use it to interpret the event
  - What particles were produced?
  - How much energy does each particle have?
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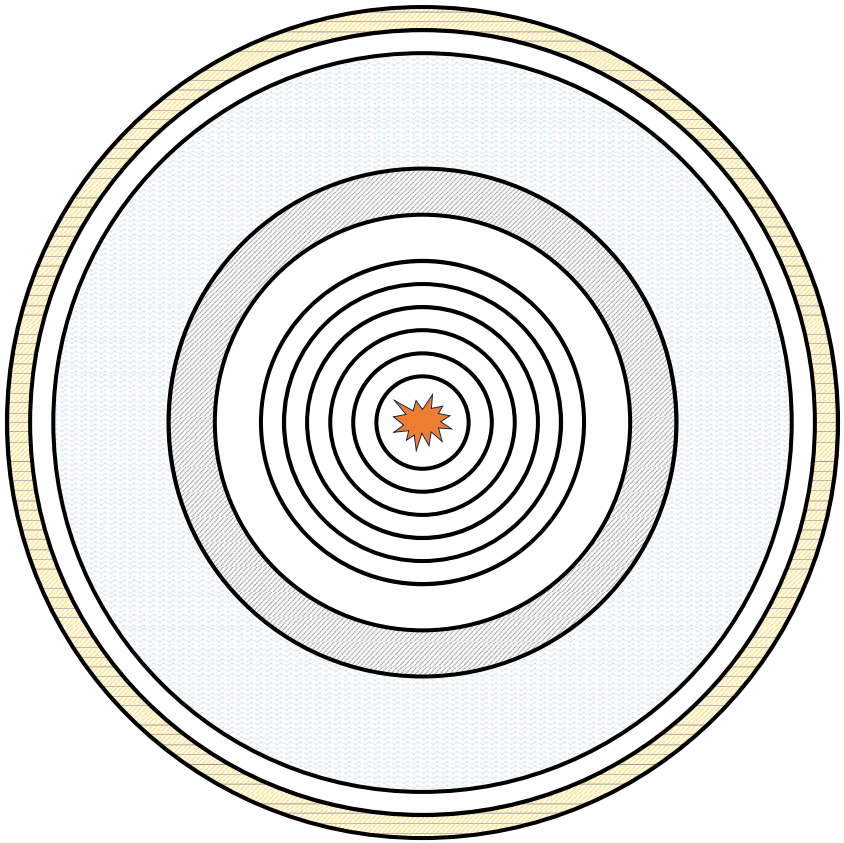
- Systems for other purposes too, polarimetry, timing etc

Detectors: Simplistic Model



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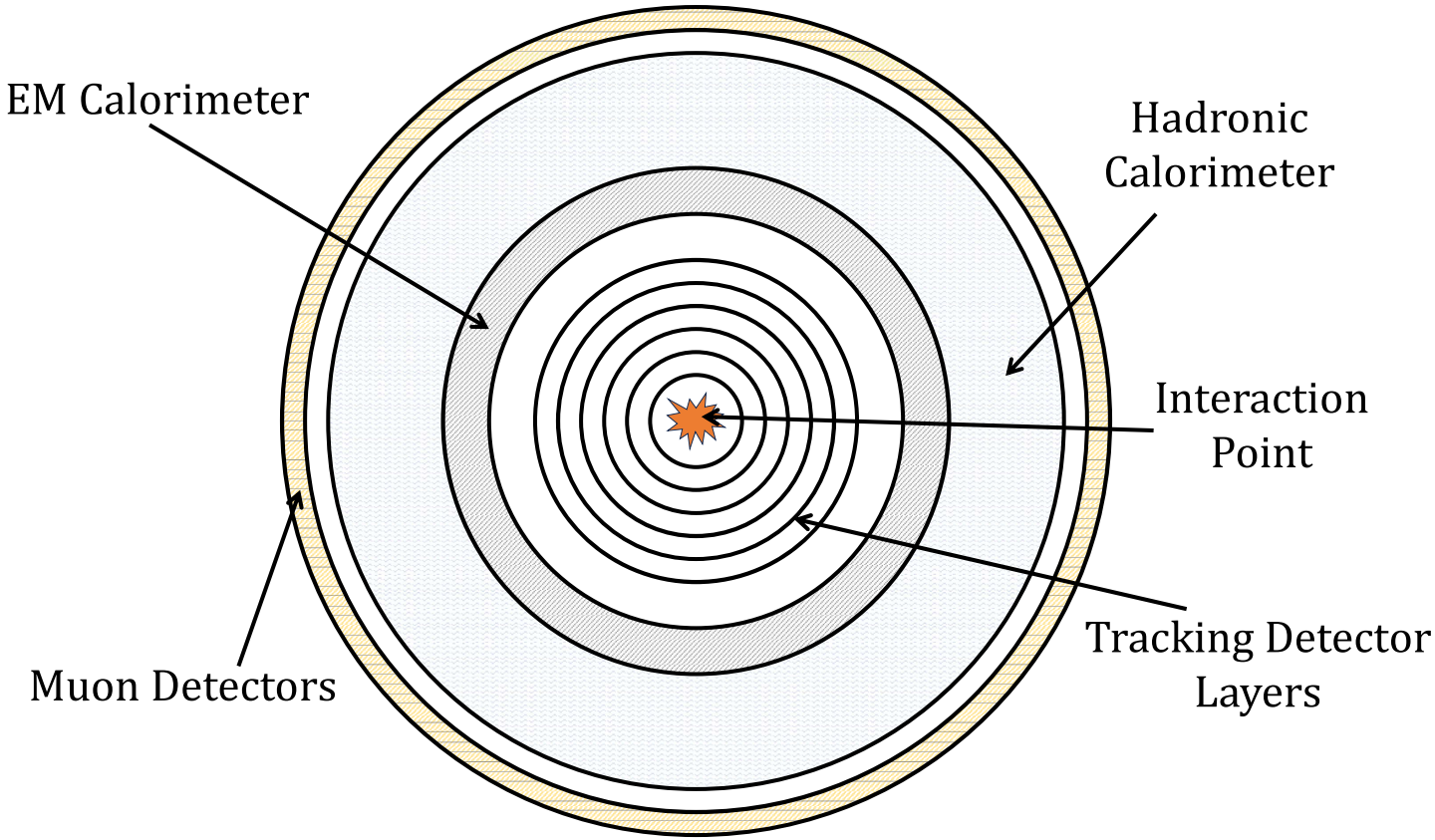
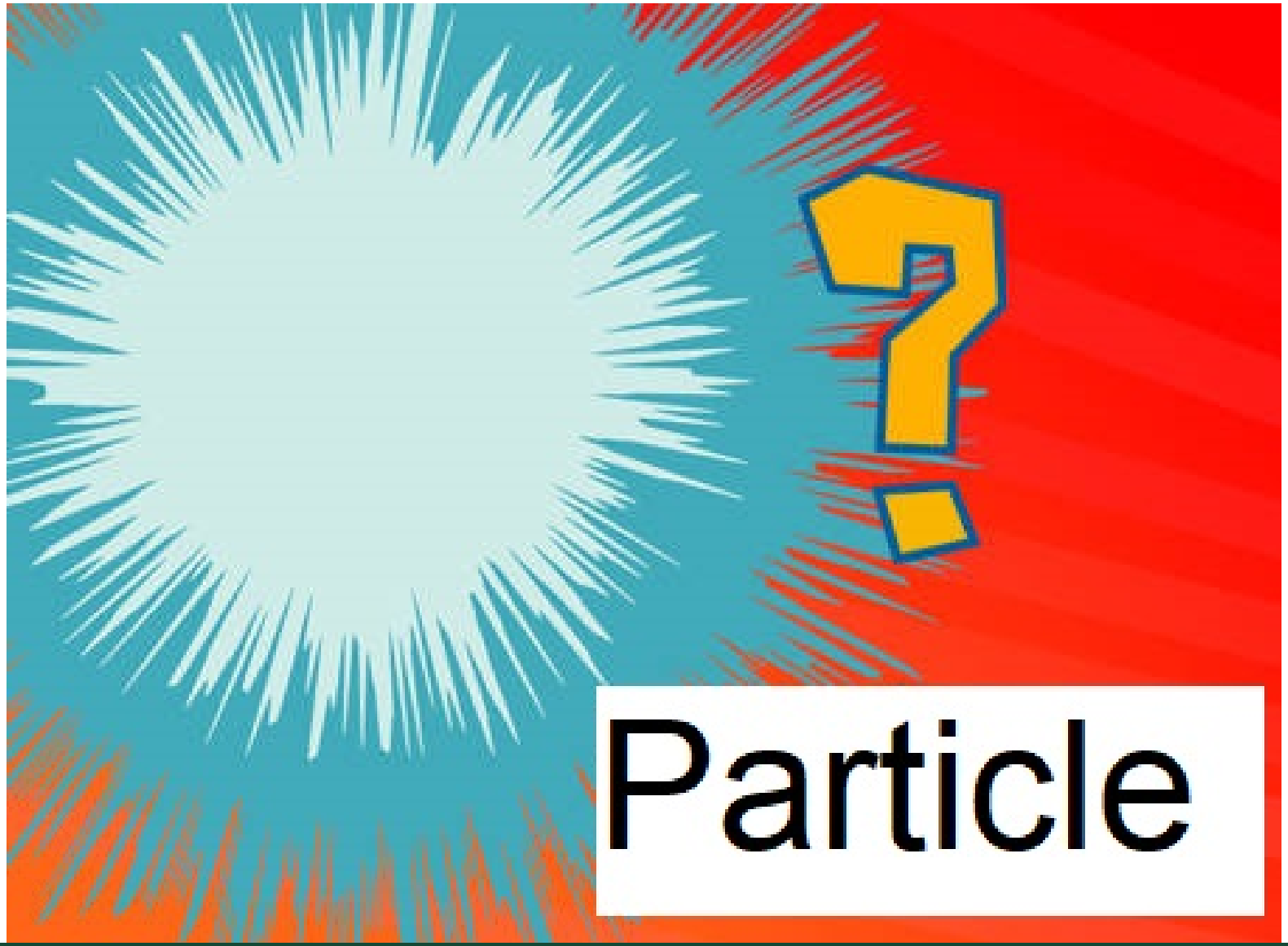


Who's that ~~Pokemon~~ Particle?



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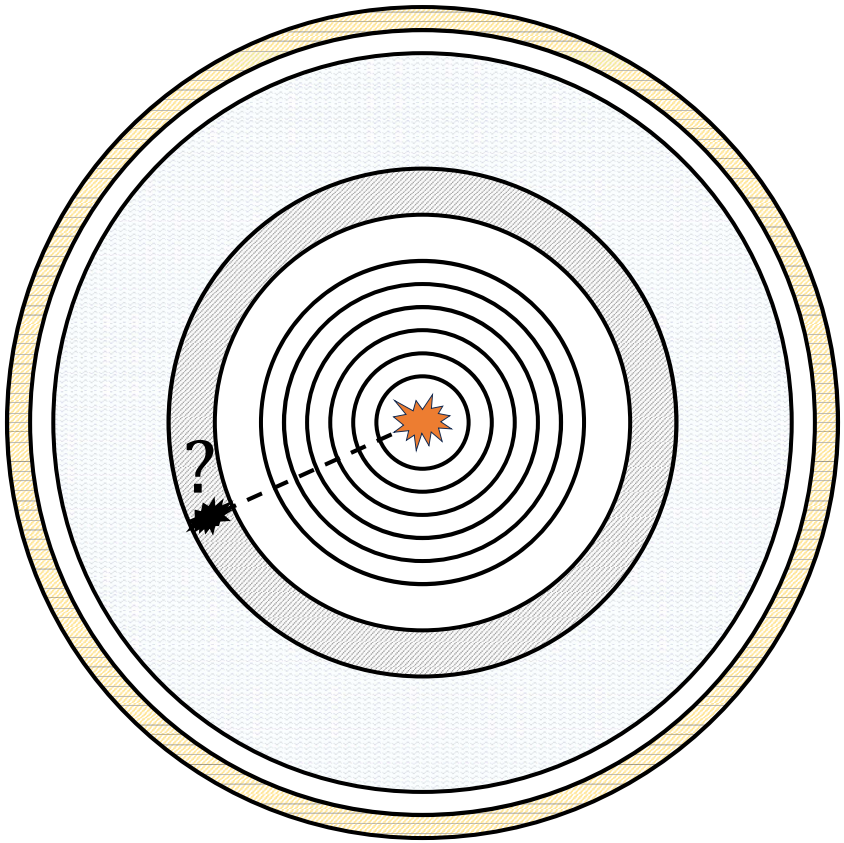

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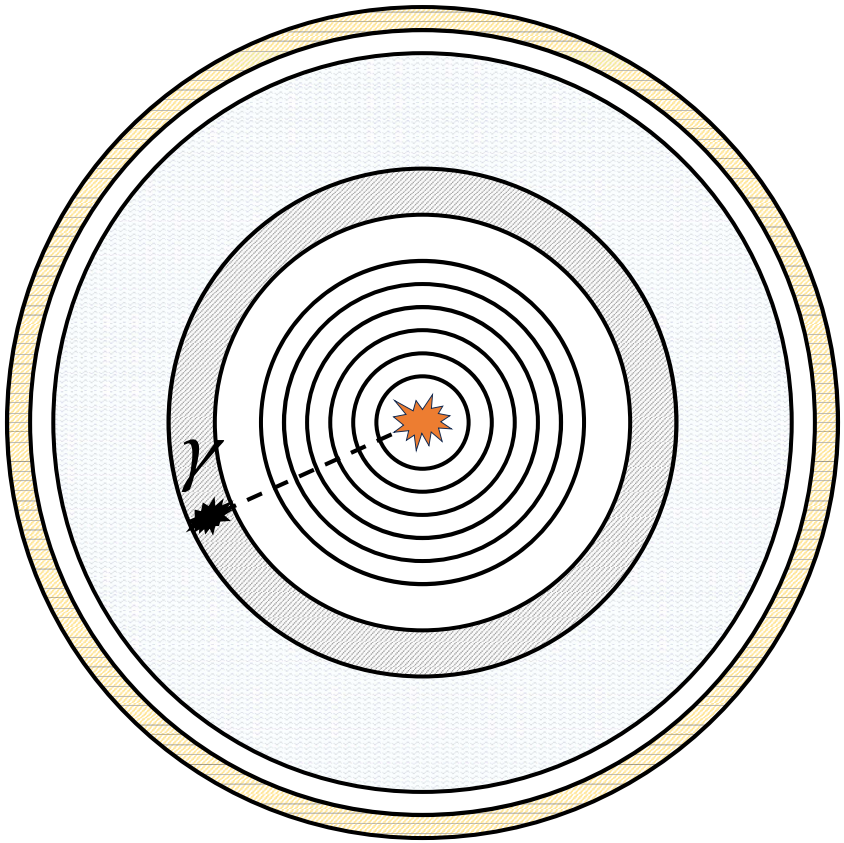

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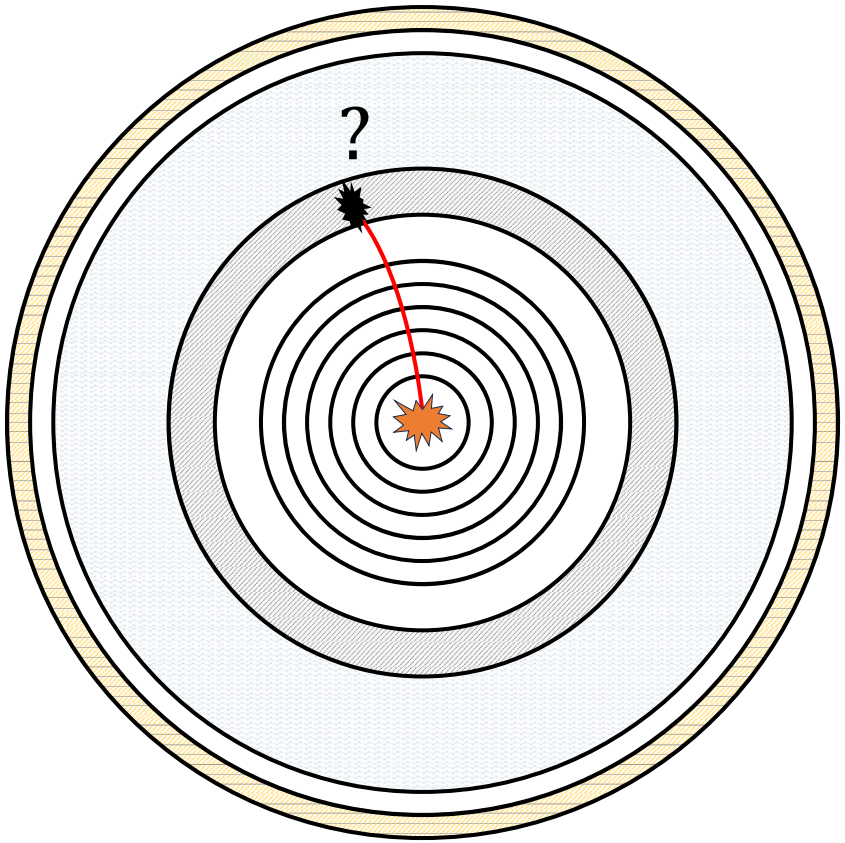

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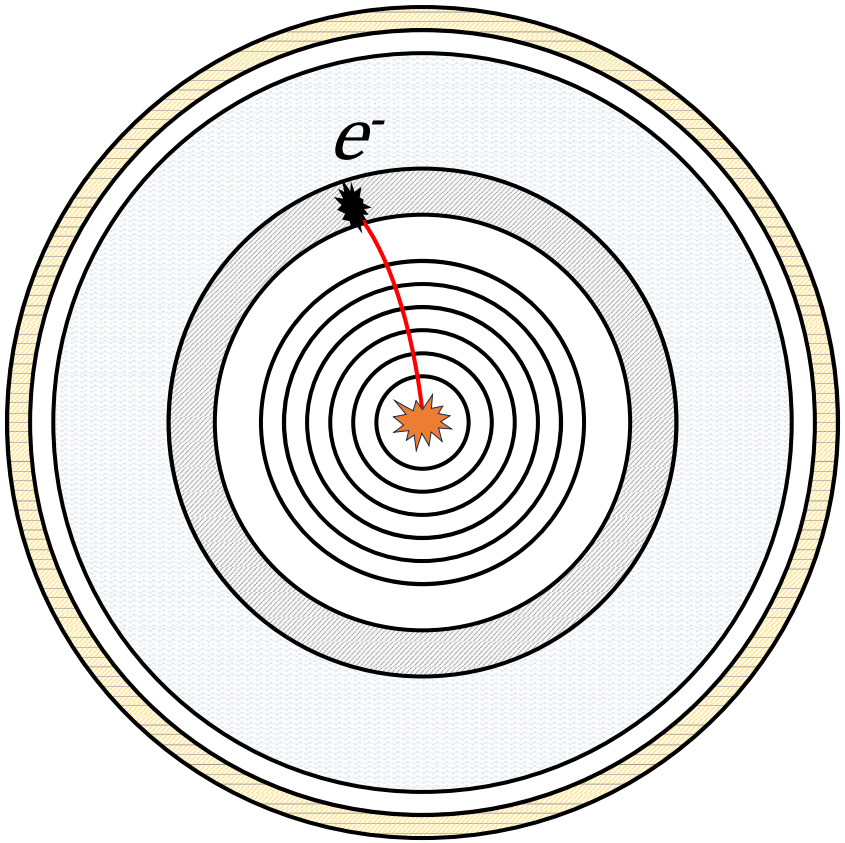

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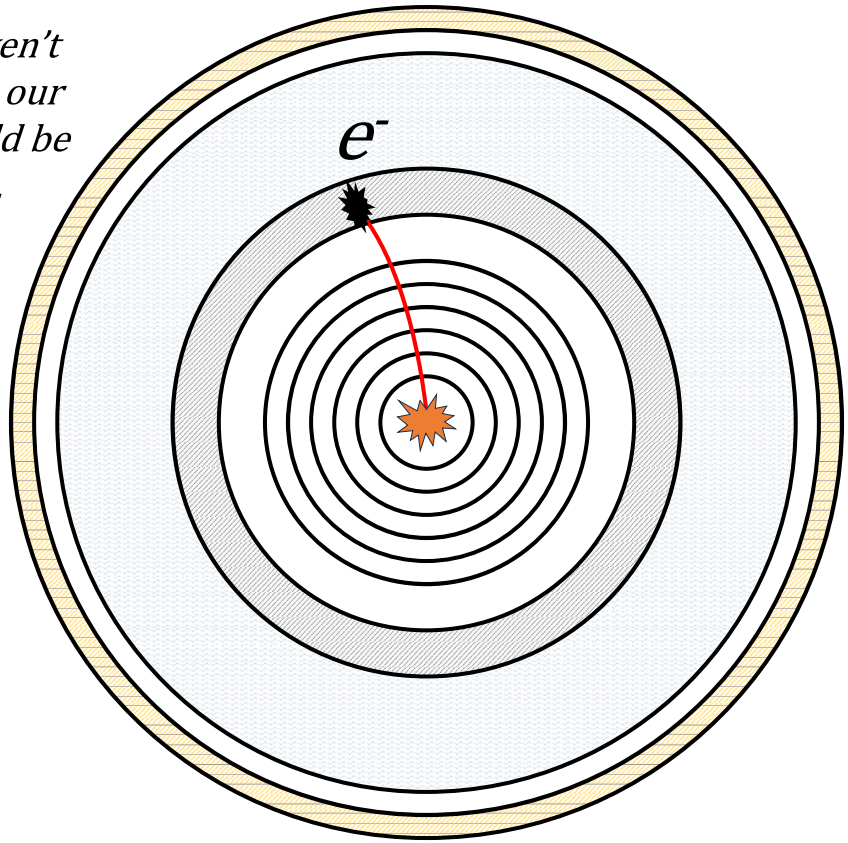
OR e^+, *we haven't really defined our field, so it could be a positron.*



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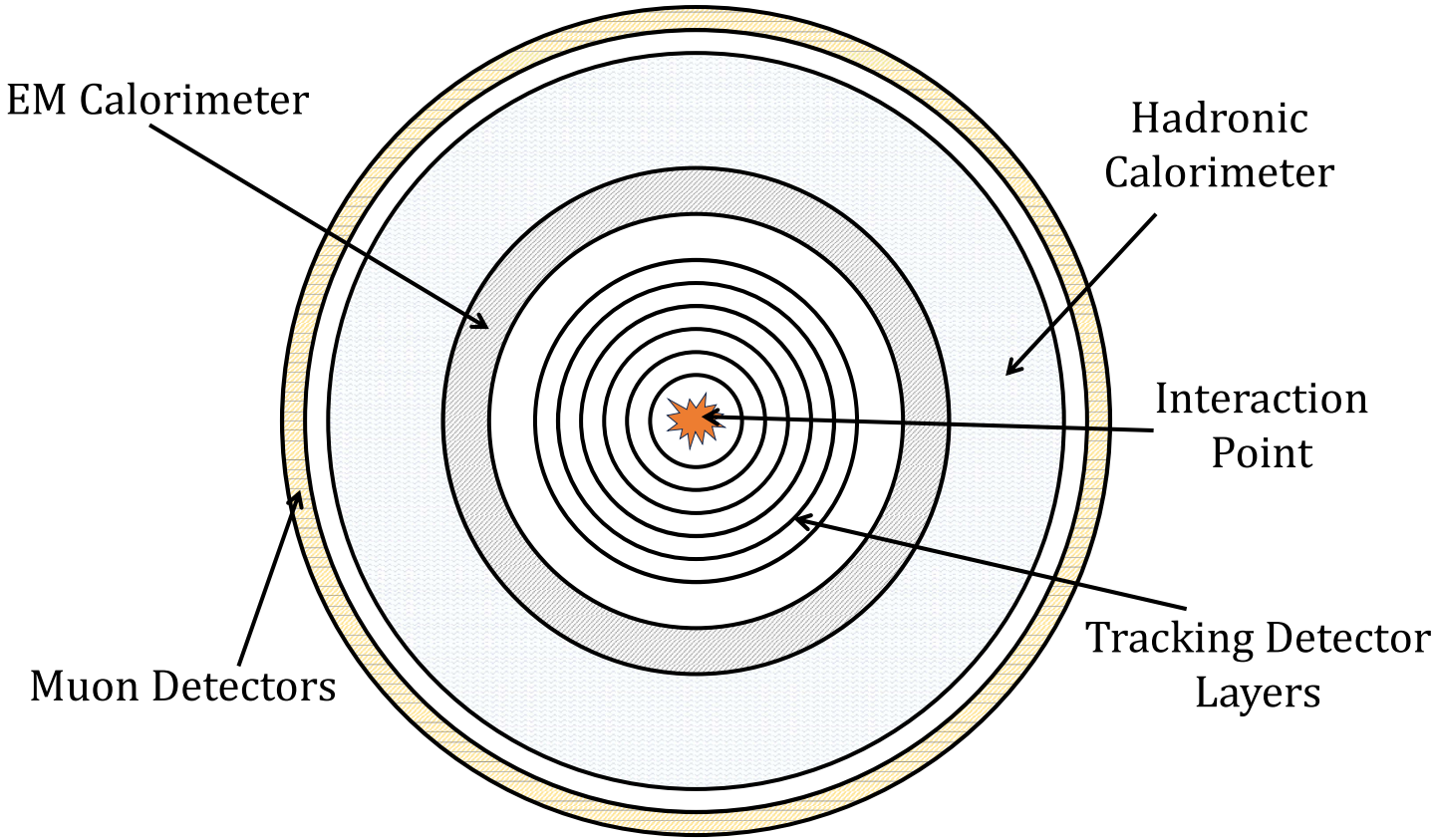

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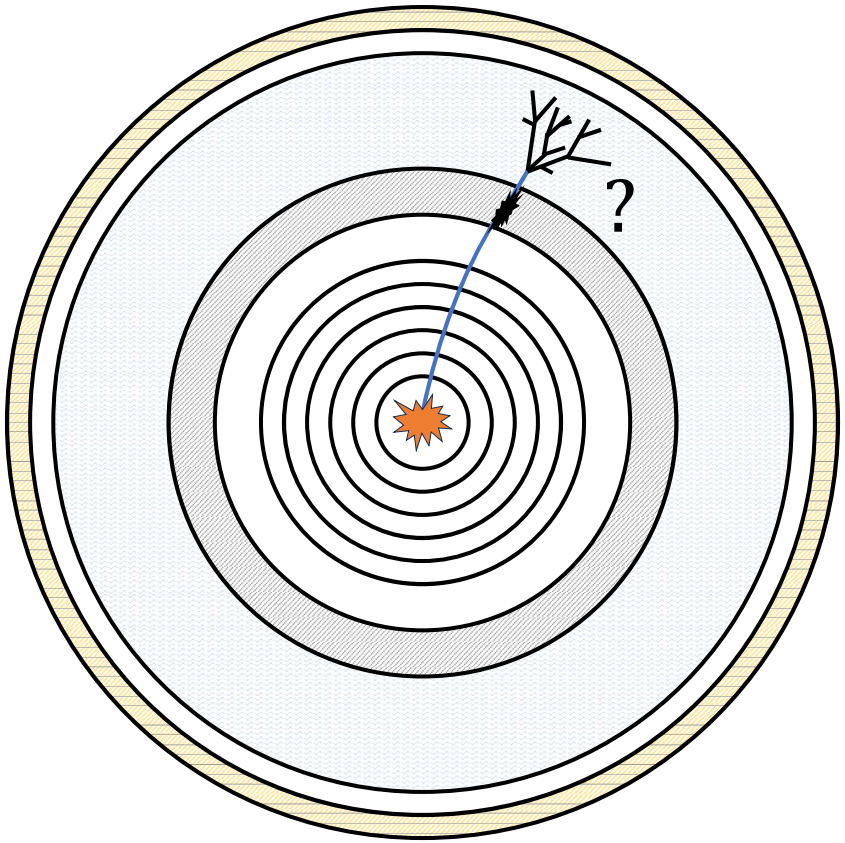

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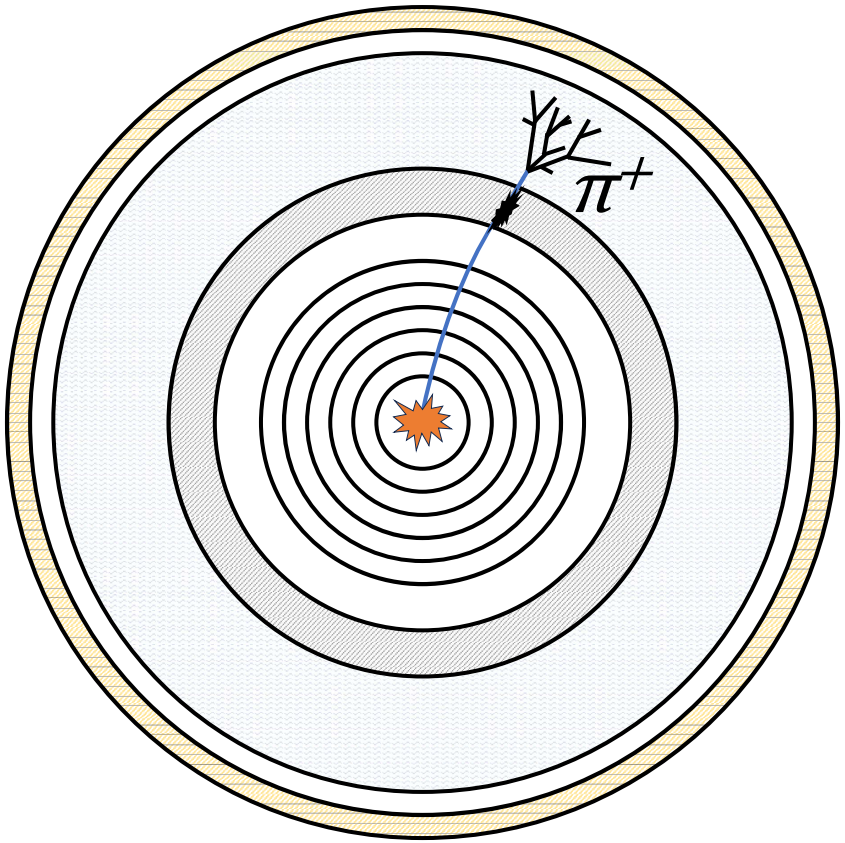

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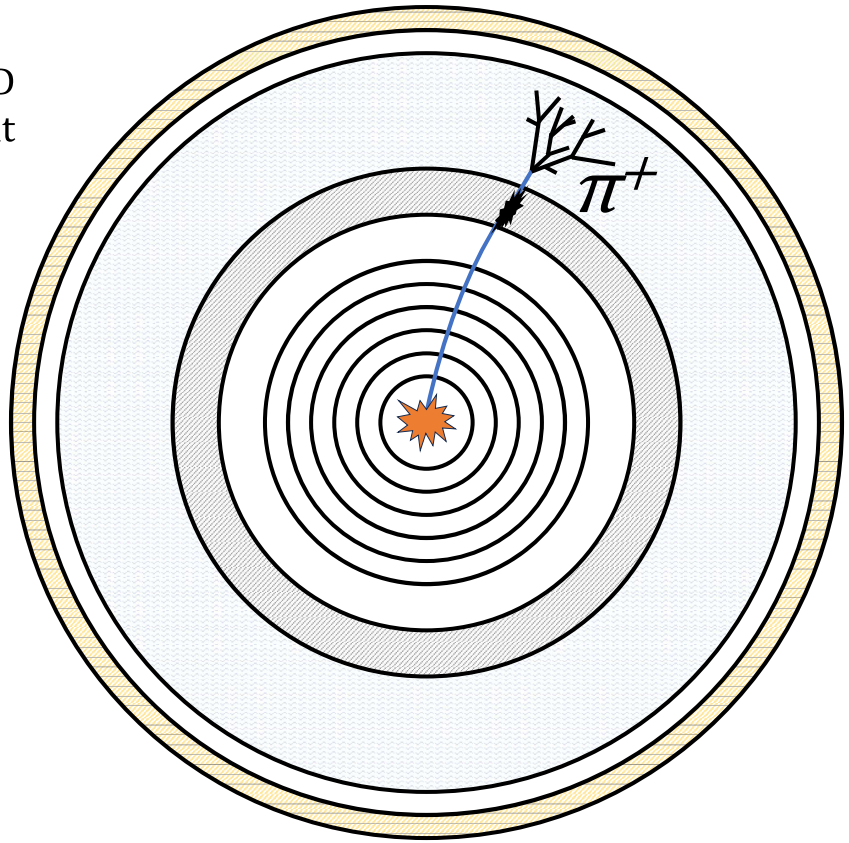
Or some other +ve hadron. Without PID info, we can't be that definitive here.



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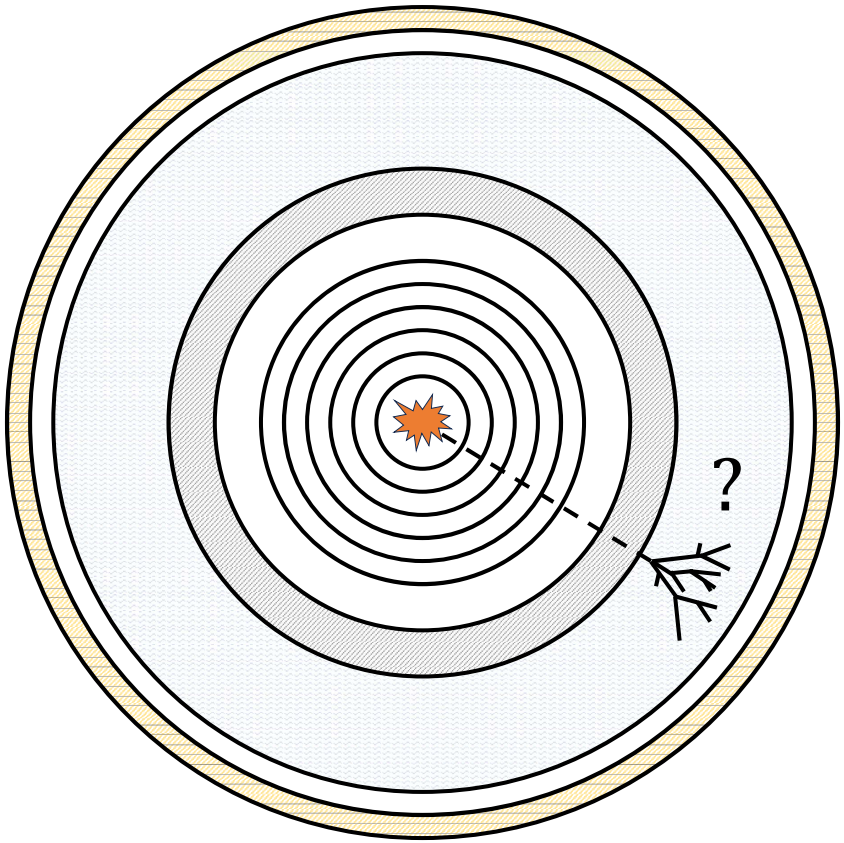

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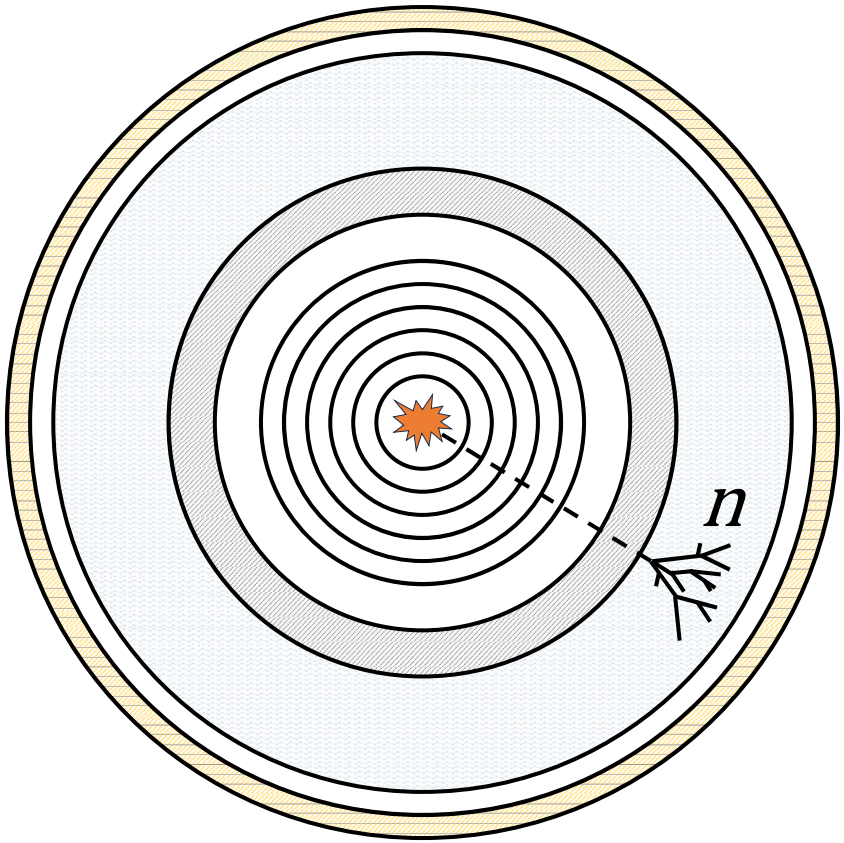

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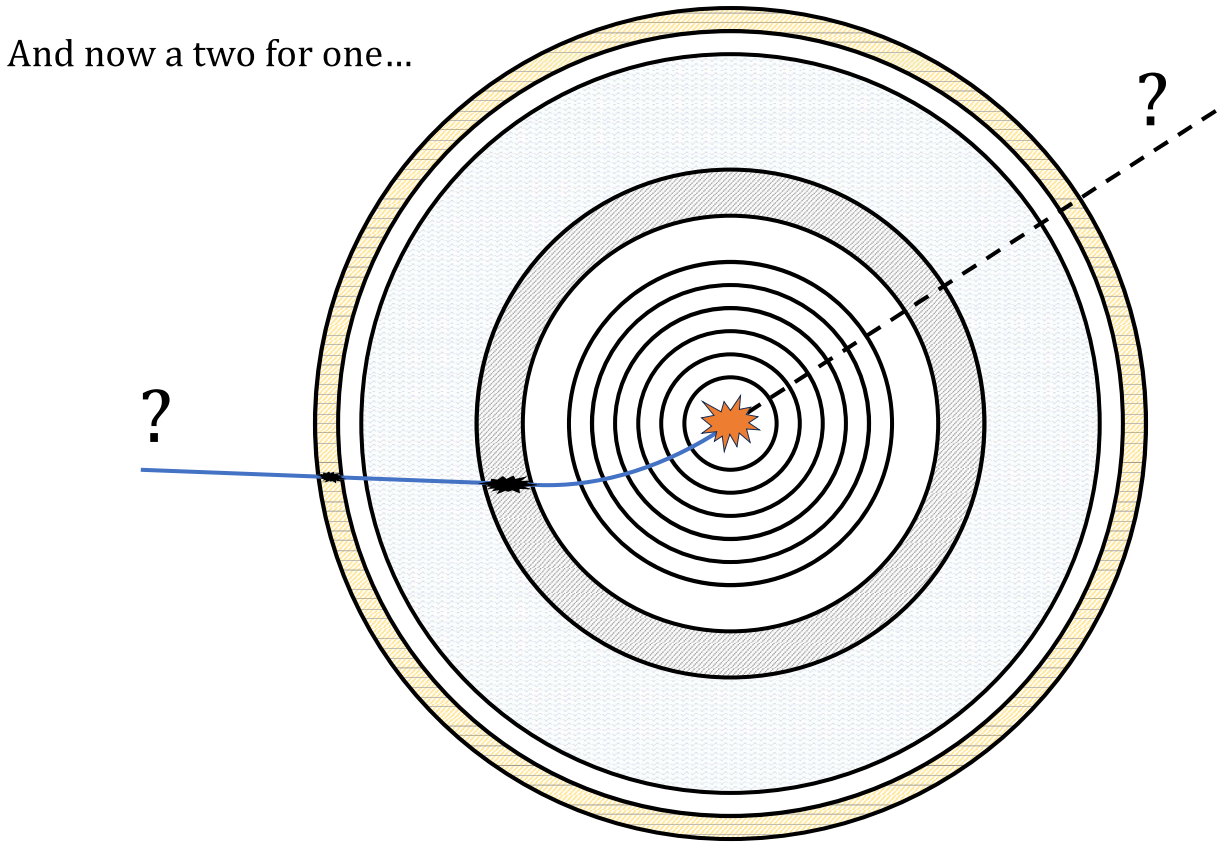

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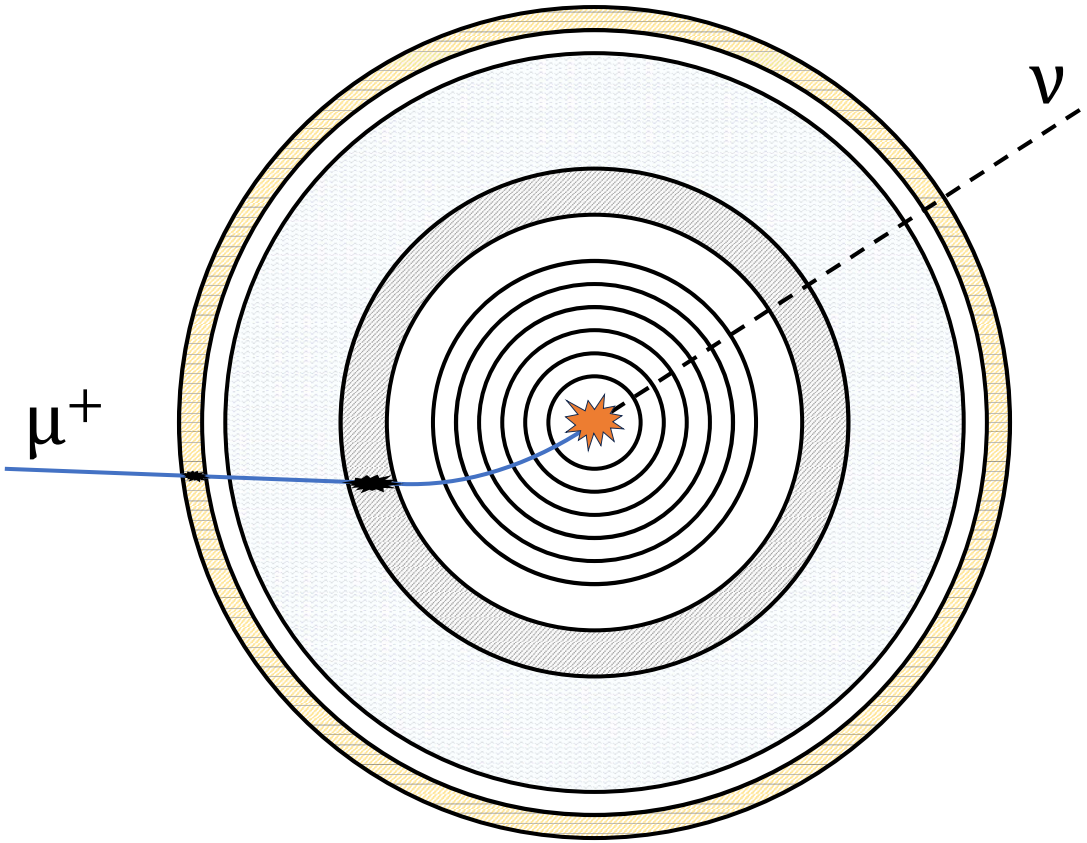

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- Many parameters to consider -
  - Energy resolution
  - Timing Resolution
  - Radiation length/nuclear interaction length
  - Sampling fraction
  - Position resolution
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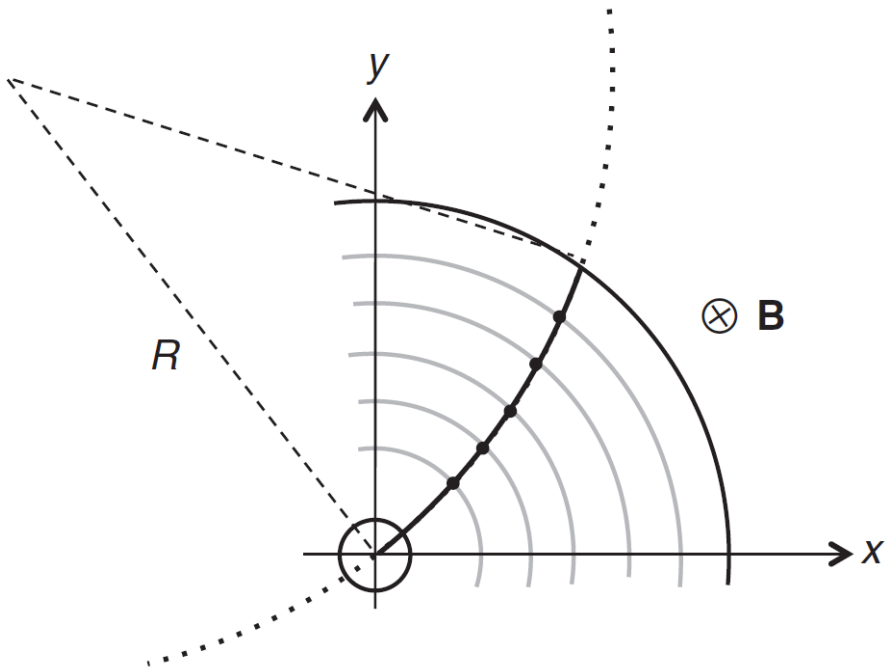

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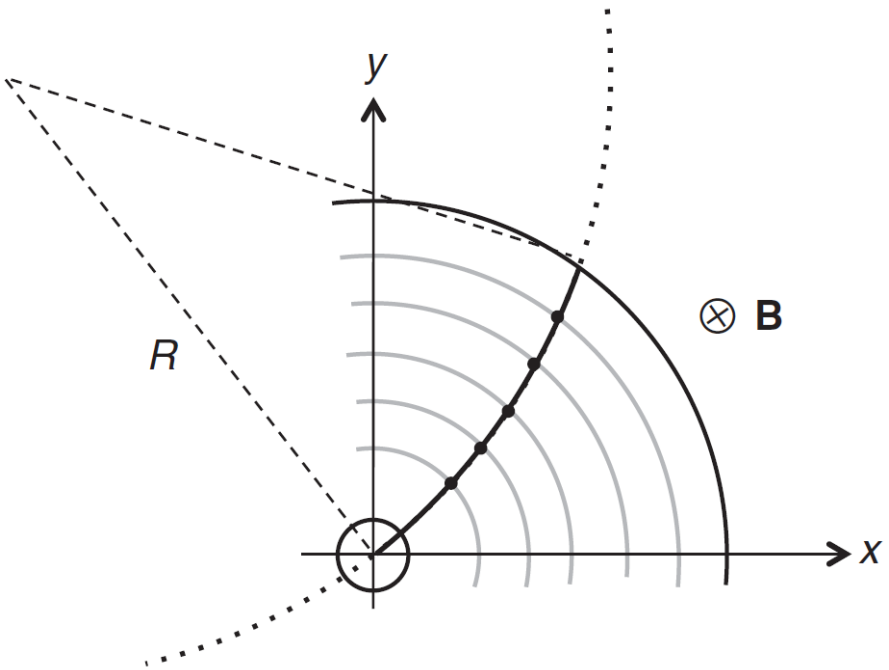

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- Utilise Cherenkov radiation
  - "Sonic boom" of light

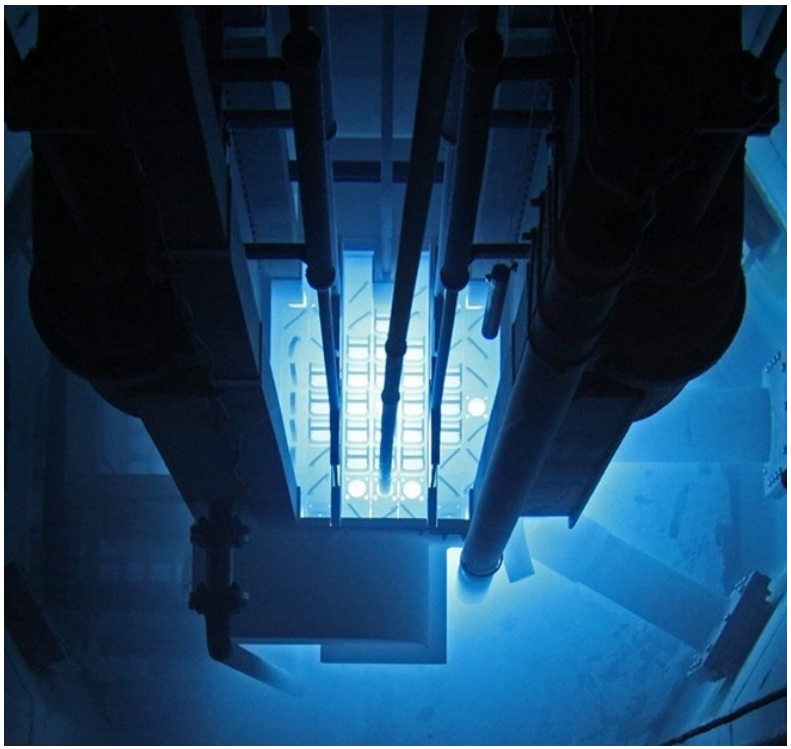

Image - University of Massachusetts, Lowell, public domain

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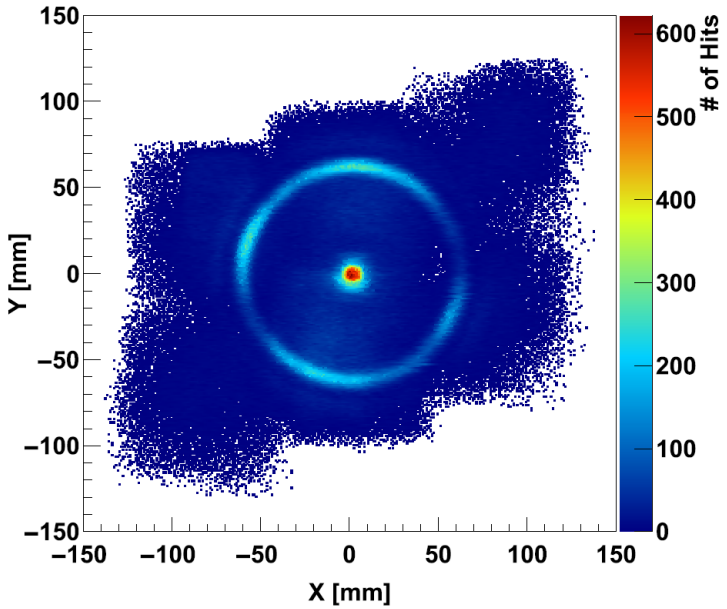

Image - S. Iwata et. al.

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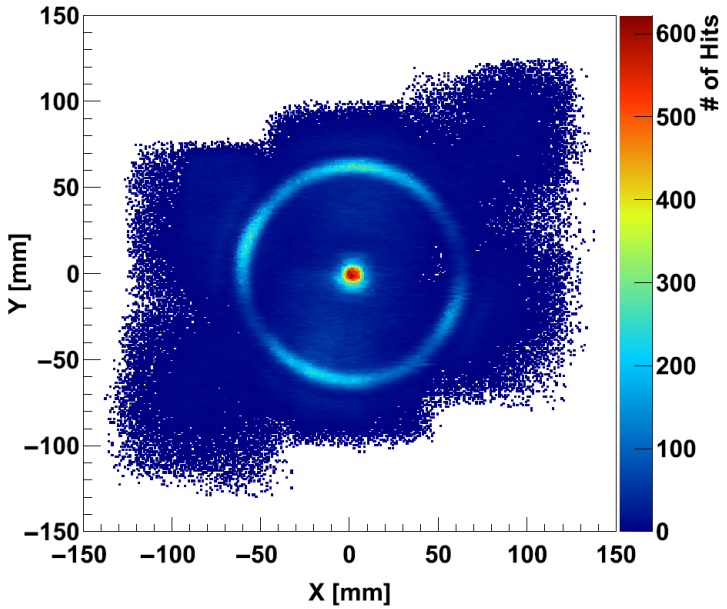

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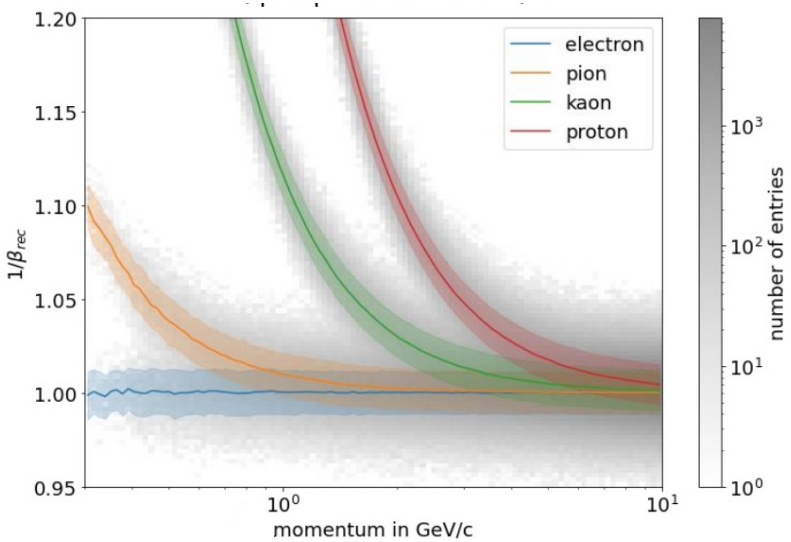

Image - Chandradoy Chatterjee, Hadron 2023

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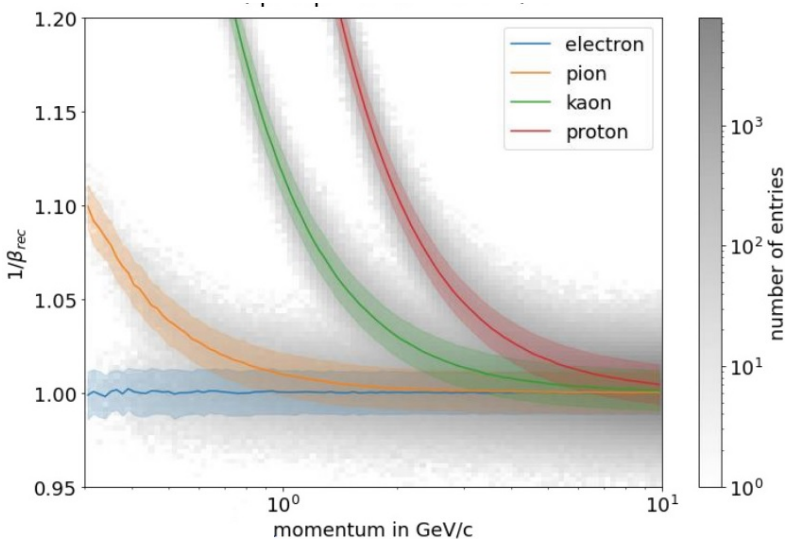

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- Software to digitise our processed signal
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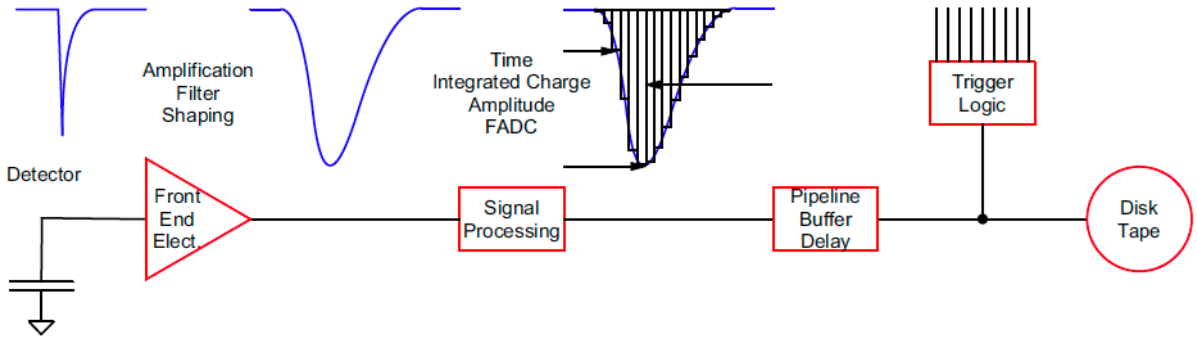

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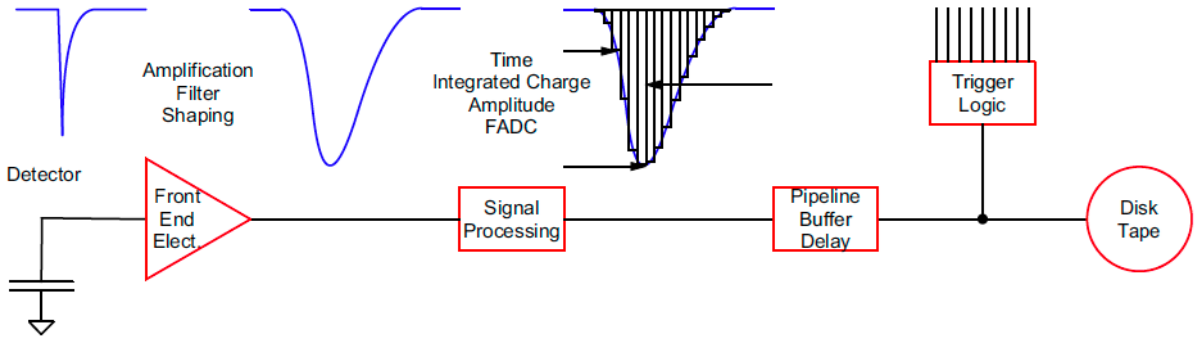

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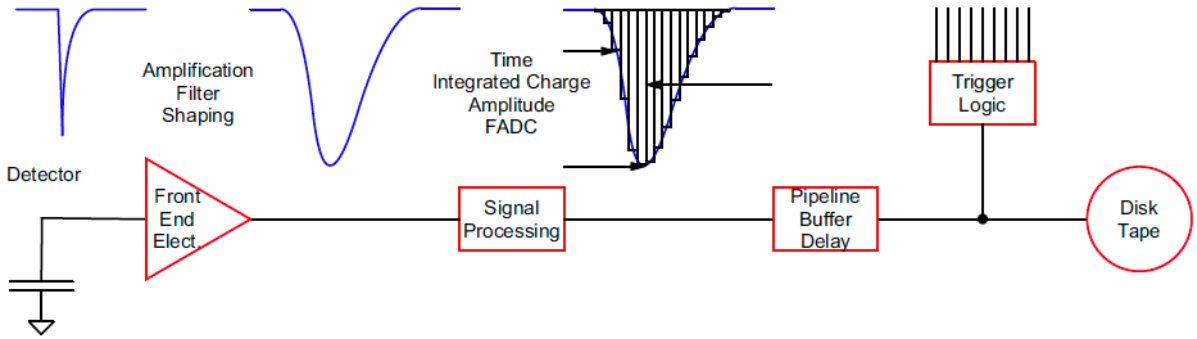

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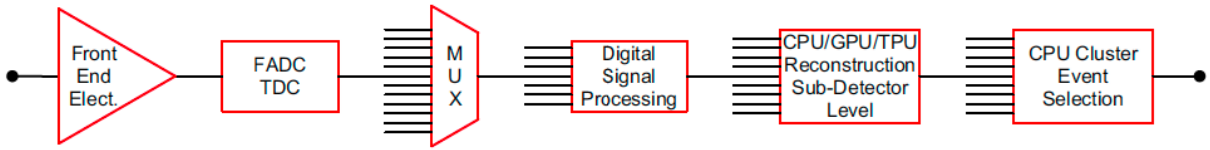

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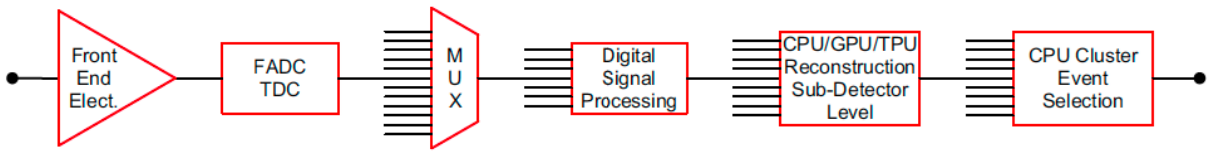

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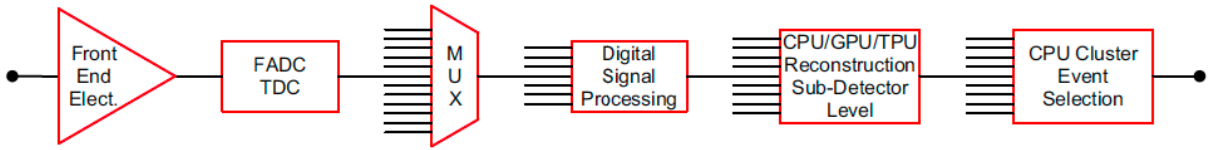

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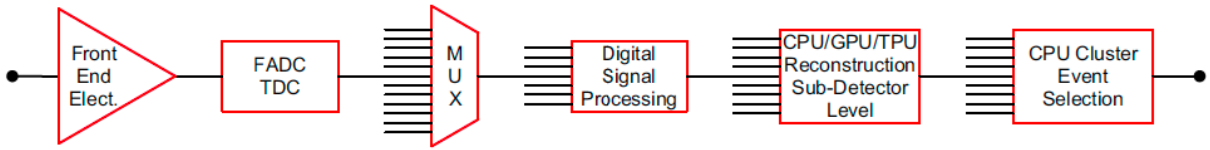

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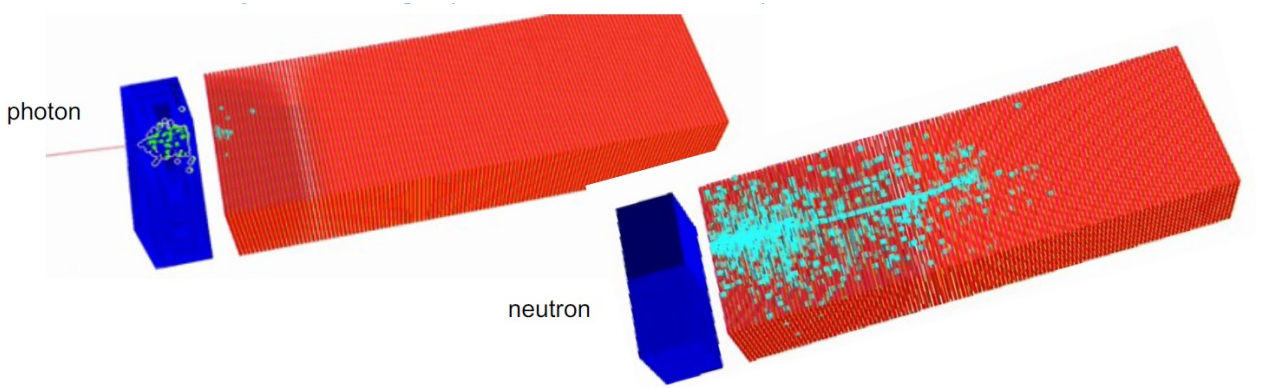

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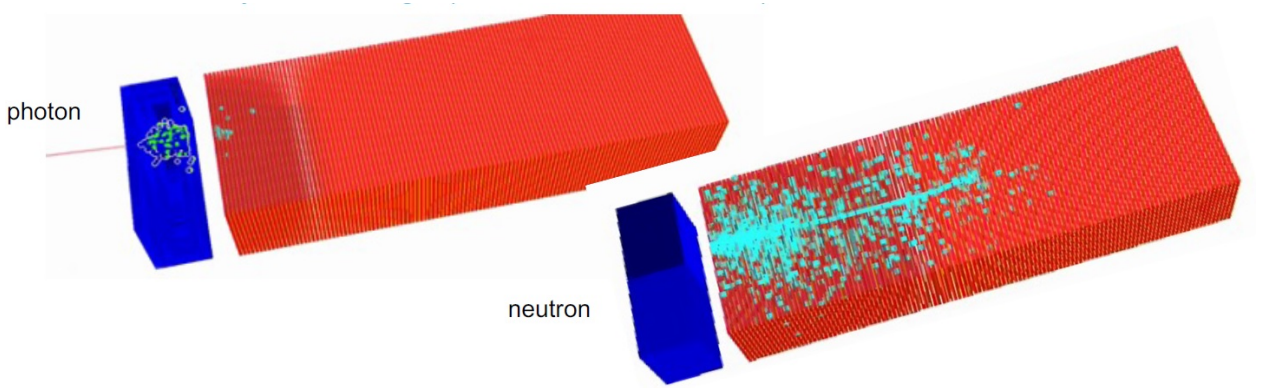

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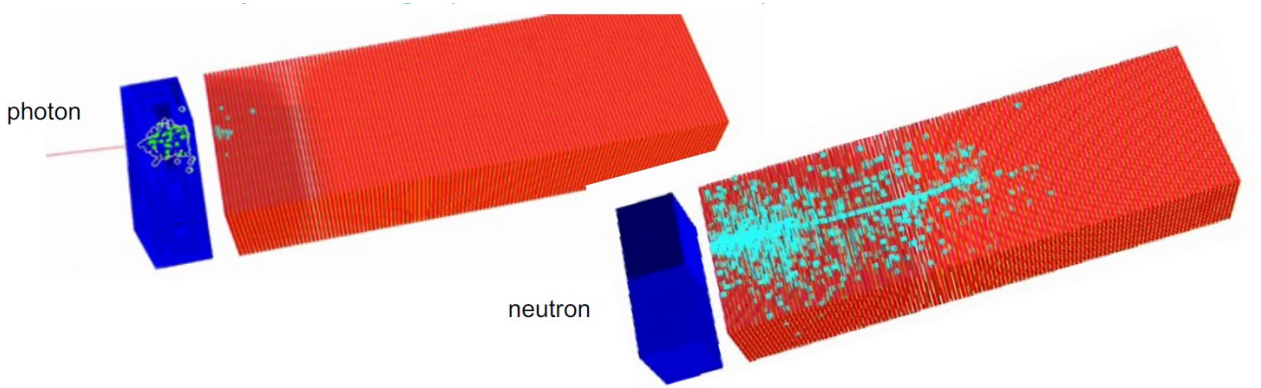

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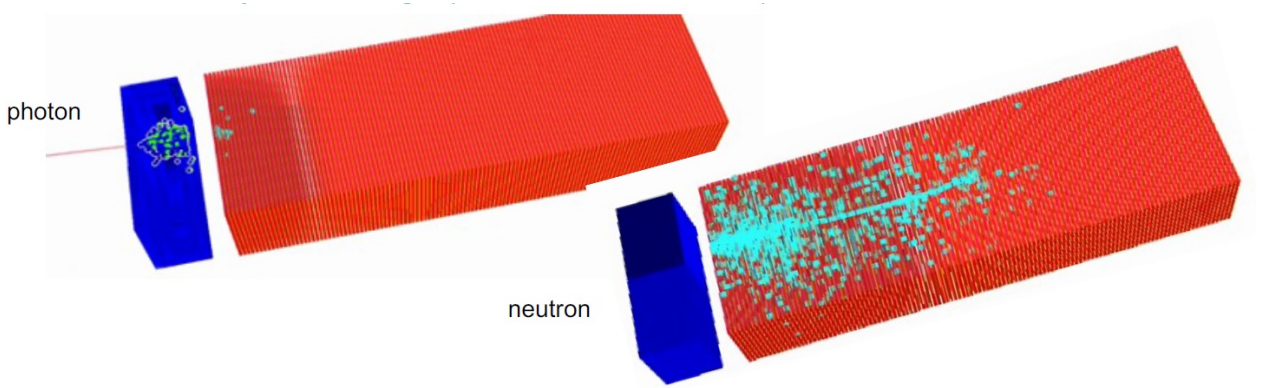

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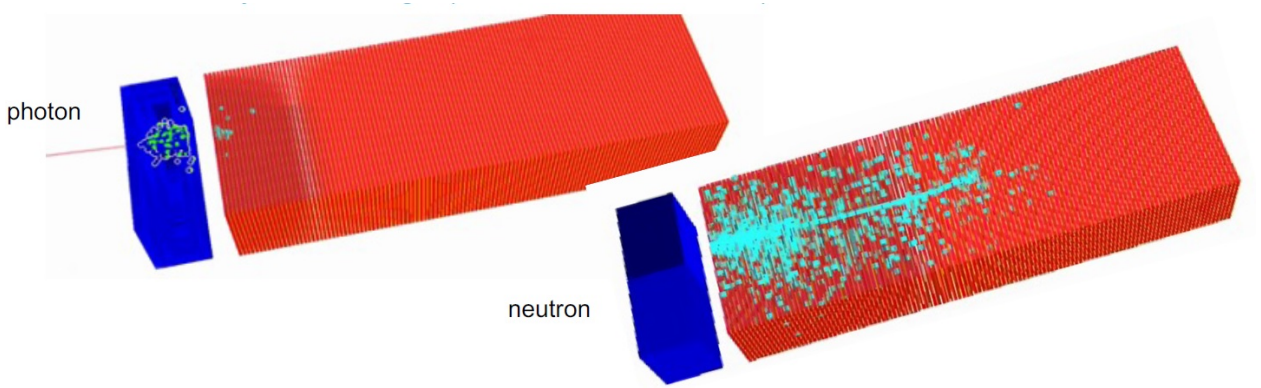

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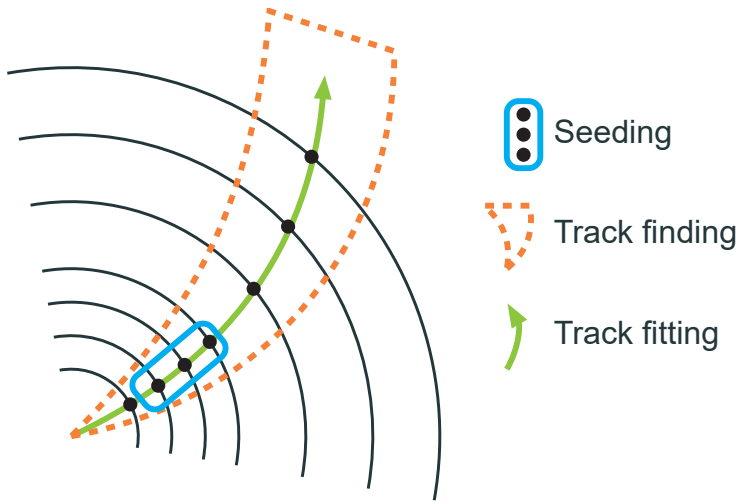

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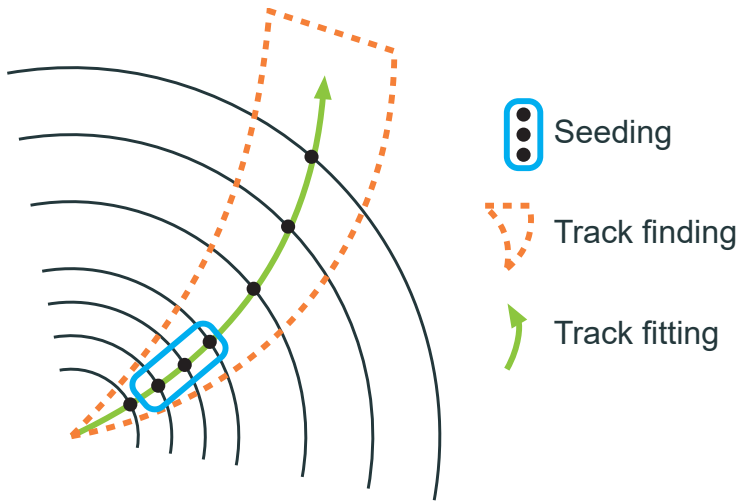

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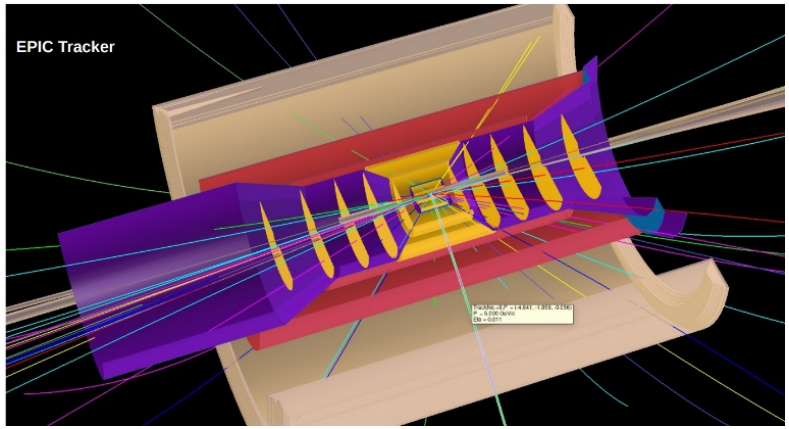

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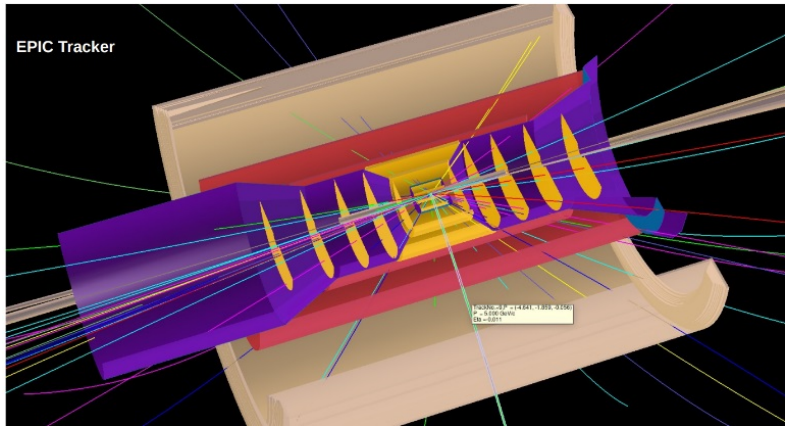

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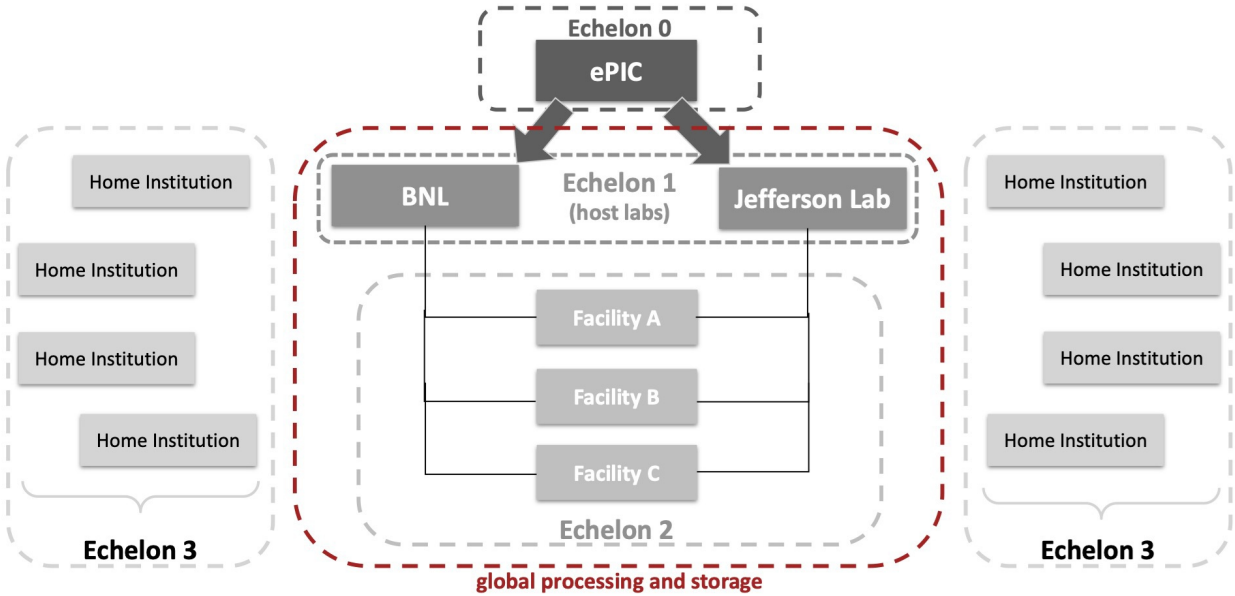

Image - The ePIC Streaming Computing Model v2

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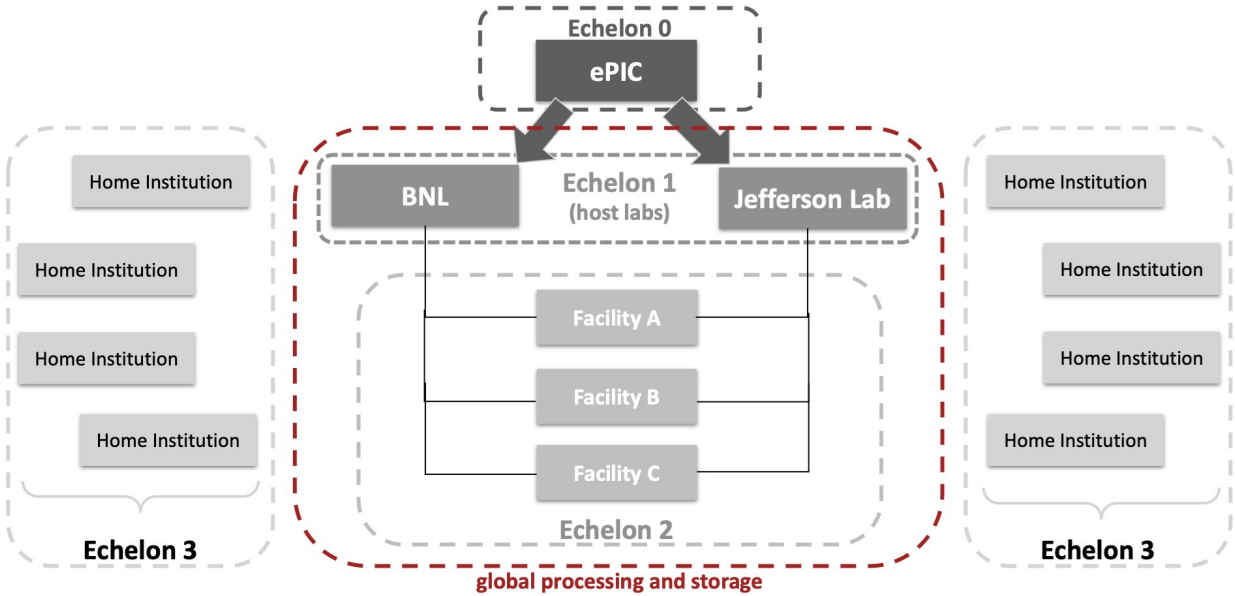

- Once we eventually get to our reconstructed data, need tools to analyse our output

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  - PyRoot,
  - Python/Uproot
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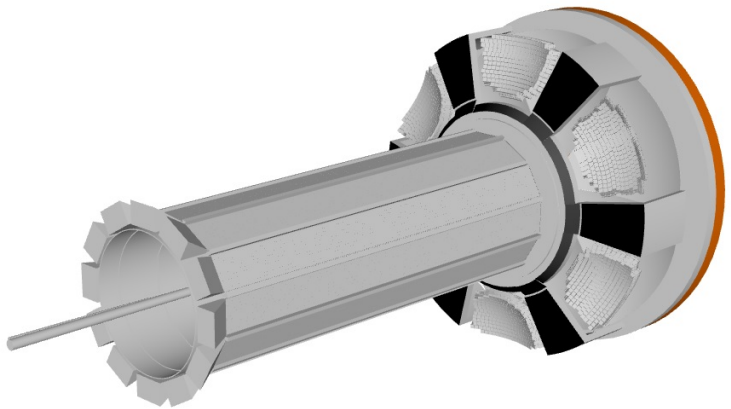

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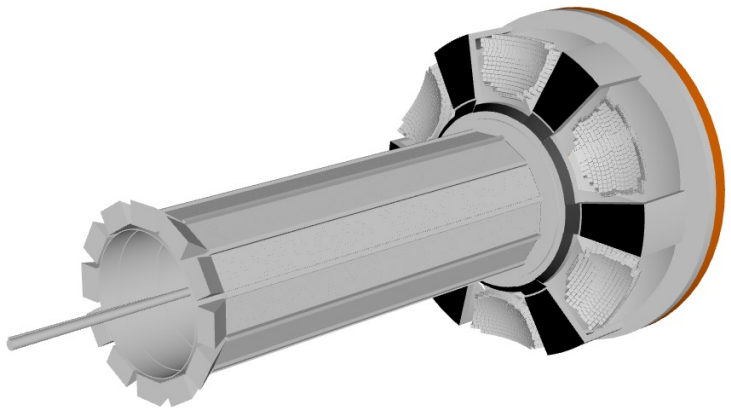

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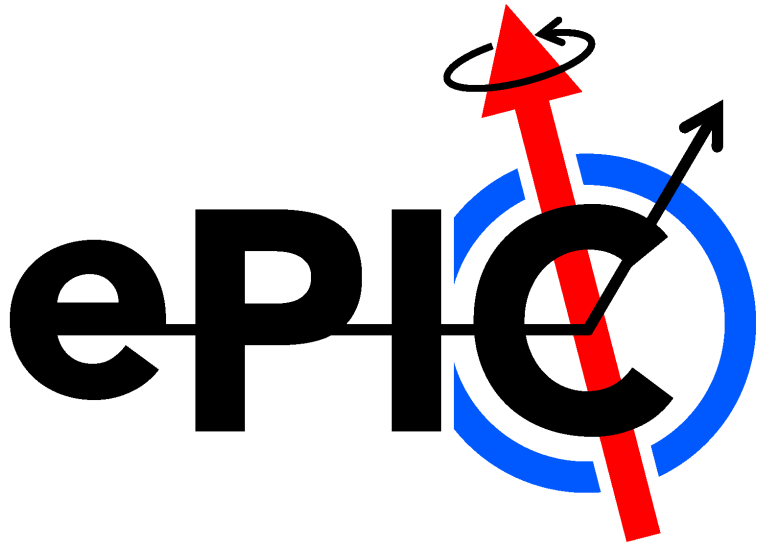
- We will cover:
  - Wednesday: The **output of our simulation** and how we can **analyse** it
  - Thursday: A closer look at the **ePIC detector** and how we reconstruct events, **focus on PID**
  - Friday: **Physics analysis**, what we do need to consider for in a physics analysis? How can we structure and write an analysis code?
  - Saturday: Working time on an analysis task
- Give you the tools and the techniques to analyse ePIC data

Thanks for listening, any questions before we move on?



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Ok then, time to try setting up our environment for the tutorials!