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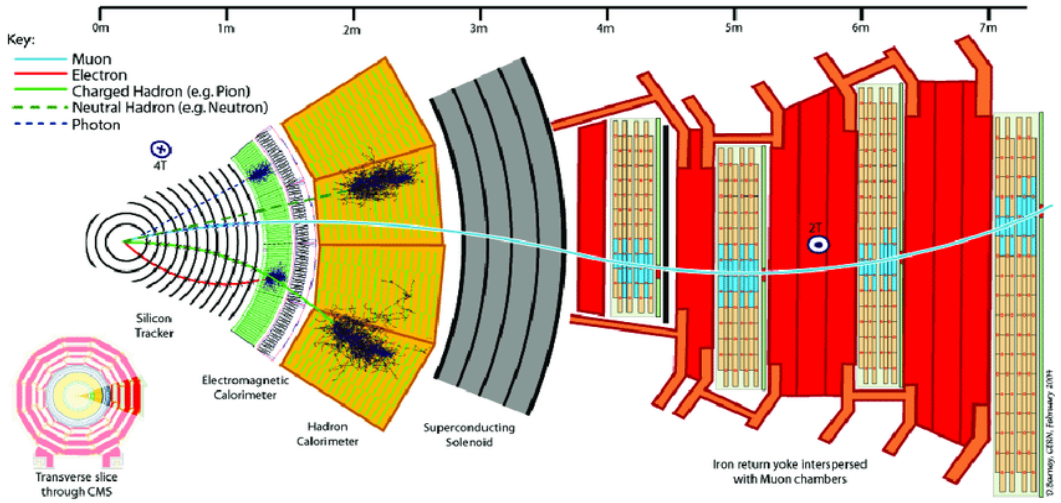
TITLE:

A new technique for the reconstruction of the interaction vertices inside the CMS detector at HL-LHC.

For the High-Luminosity LHC expected in 2027 the CMS detector will be modified. The Luminosity will be increased by a factor of 10 (up to 10^{35} $cm^{-2}s^{-1}$)

The upgrade of the ***tracker*** will enable tracks to be reconstructed in time for their use in the Level 1 trigger.

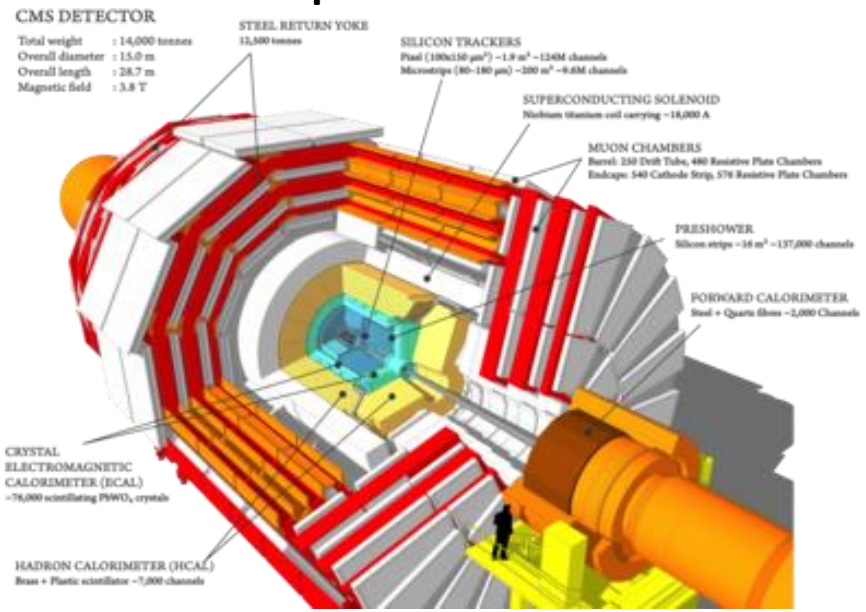
Transverse section of the Detector



CMS trigger is composed by 2 levels:

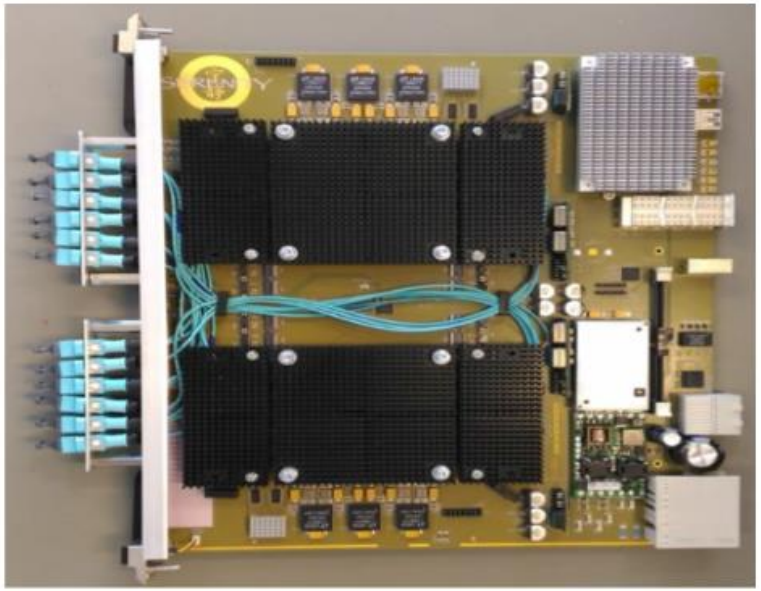
- hardware based one called *Level 1 (L1)*
- software based one called *High Level Trigger (HLT)*

Different parts of the Detector

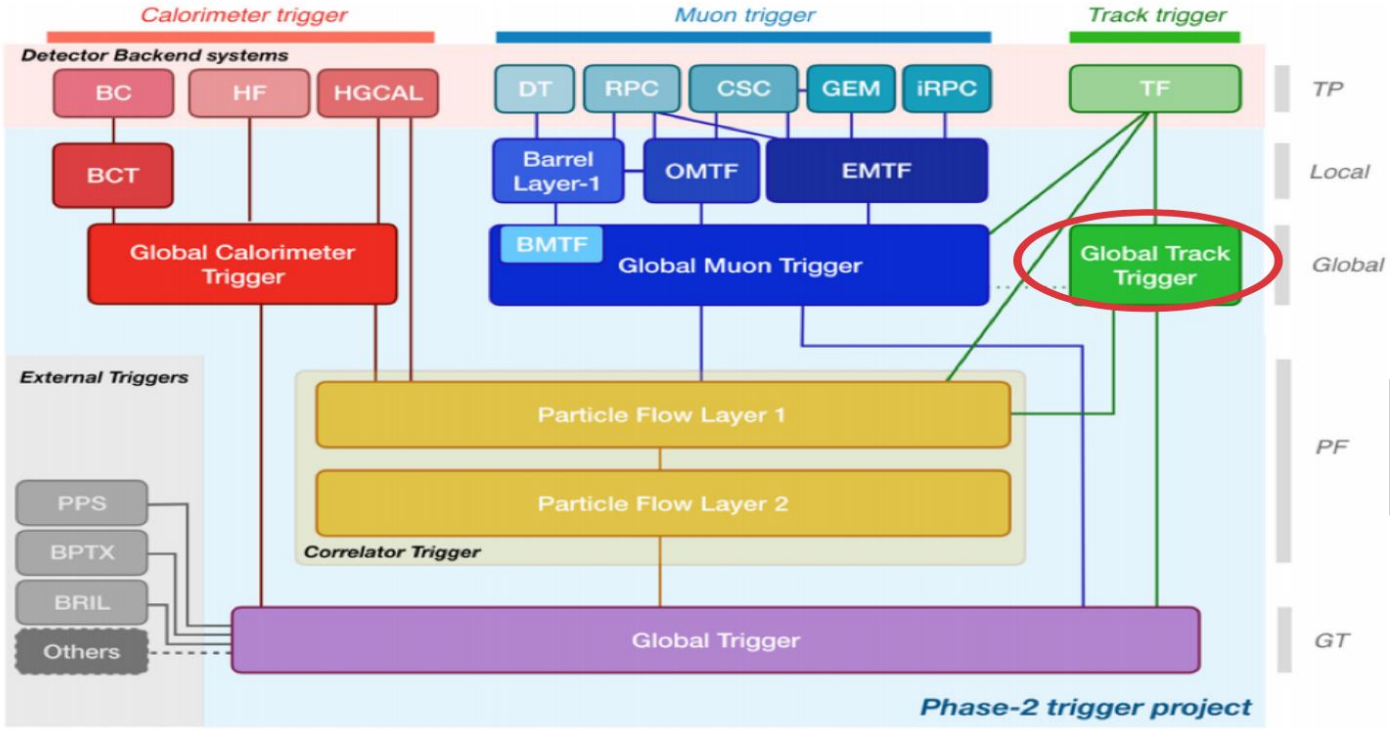


- Tracks will be used in Field Programmable Gate Array (FPGAs) to find Z positions of hard interaction vertices.

- Recognizing Z vertices will enable L1 trigger to reduce the event rates to a level suitable for the High Level Trigger HLT.

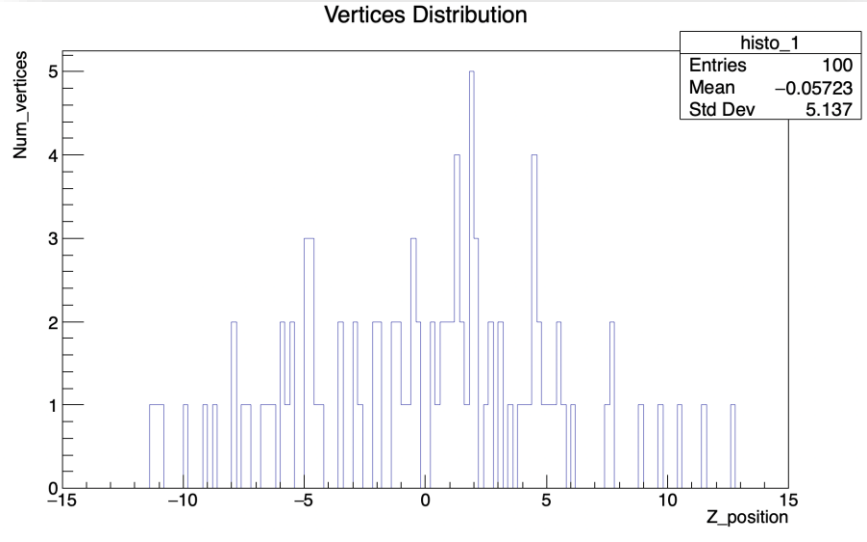


ATCA board with 2 FPGAs

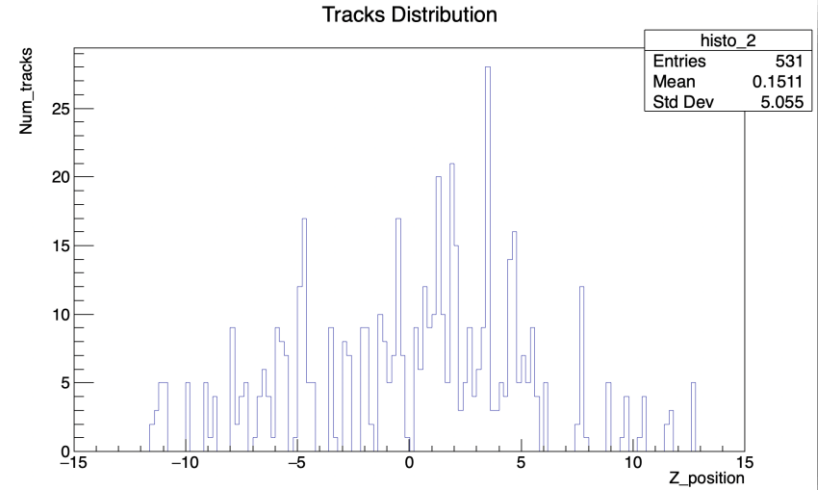


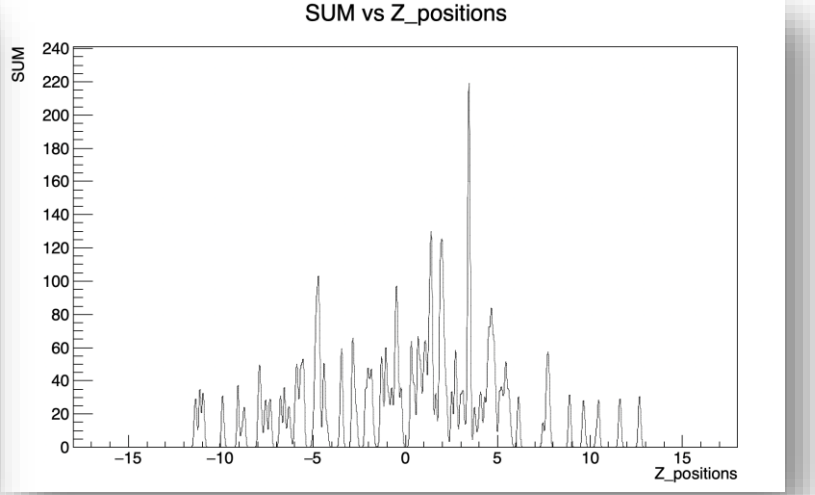
The vertex finding process will be done in the Global Track Trigger

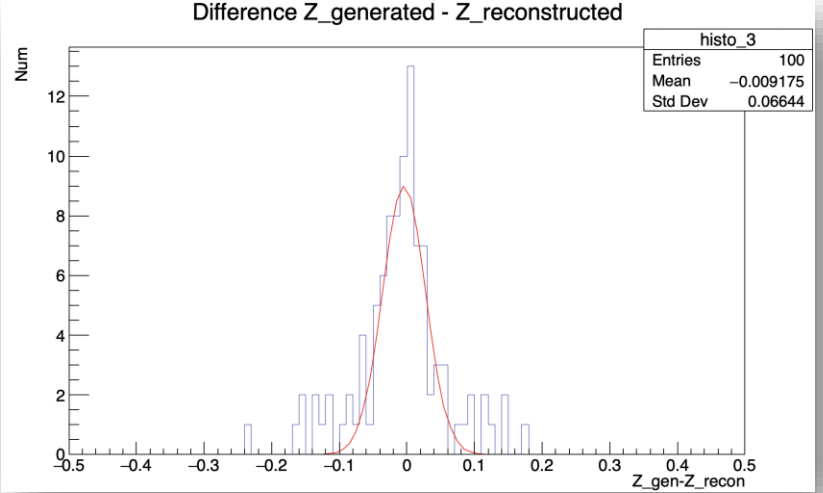
This is a toy MC to explore the method.



- I am exploring the functionality of a simple algorithm where I am generating a distribution of a number of vertices and I have the ability to set the track multiplicity.
- I can set the resolution of the Z & track parameters and with all the flexibility that it gives me I am able to explore the reconstruction technique.







Outlook and Future Plans

- This project will involve the development of algorithms for making trigger decisions in hardware (Level 1 trigger) and their implementation in FPGAs
- I will go from using this standalone simple approach to full simulations. I will study different types of event
- From final states with high multiplicity like t-tbar events or final states with low multiplicity & high pT like Z'-> e+ e- or Z'-> μ+μ - (the challenge will be different)
- I will explore the performance of a variety of algorithms from simple to complex NN ones

Thank you for your attention!

Backup Slides

I am exploring the functionality of a simple algorithm where I am generating a distribution of a number vertices and I have the ability to set the track multiplicity and set the resolution of the Z parameter of t track reconstruction and with all the flexibility that it gives me I am able to explore the reconstruction technique:

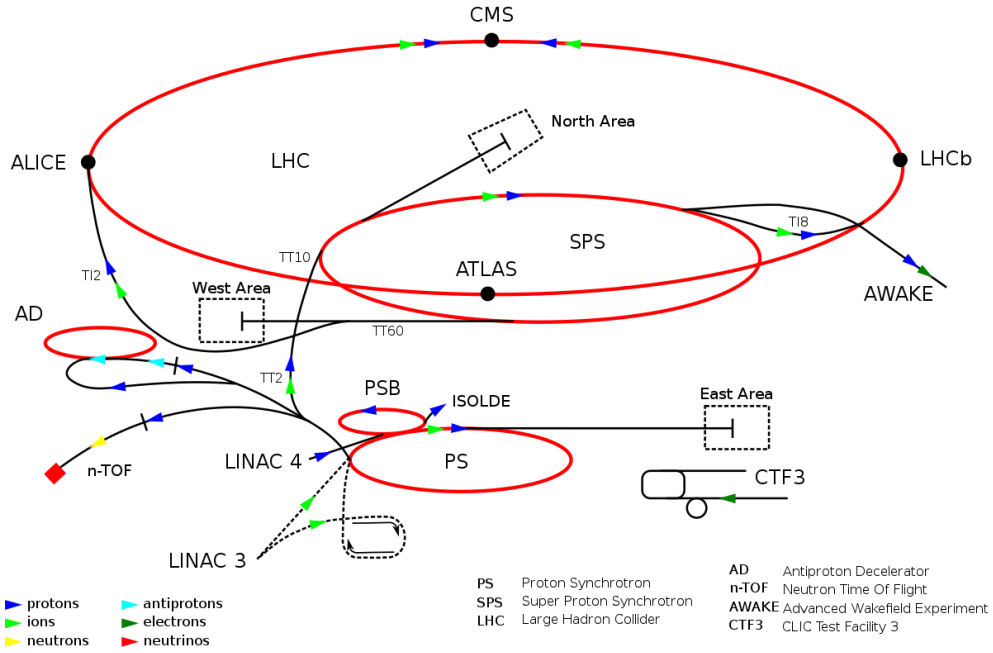
Describe what my reconstruction technique is and show some plots to say that it works and I am able t identify the separate picks.
For that you can problably just show a distribution.

-Different multiplicity speech
-I will introduce the pT

In future we will apply this technique:

Following this simple study I will look at full simulations of different types of event and the variation fro final states with high multiplicity like t-tbar and low multiplicity but high pt like Z'-> electrons or muons challenge is different. In high multiplicity is relative easy to have a good reconstruction in low multiplici haven't got so many tracks and I have we have to make use of the momentum of the tracks we recons to pick up the particle we are interested in.

What is HL-LHC?



CMS trigger system:

- Level-1 Trigger
- High Level Trigger
- LHC will reach a luminosity of 7.5 × 1034 cm^(−2) s^(−1) with a pileup of 200 collisions

- To exploit the higher luminosity, the CMS experiment will introduce a more advanced Level-1 Trigger and increase the full readout rate from 100 kHz to 750 kHz.

- CMS is designing an efficient data-processing hardware trigger that will include tracking information and high-granularity calorimeter information.
  The current Level-1 conceptual design is expected to take full advantage of advances in FPGA and link technologies over the coming years.

The nominal (ultimate) configuration of the accelerator will lead to pp collisions at the design energy of √ s = 14 TeV, and an instantaneous luminosity of up to 5.0 (7.5) ×1034 (see Tab. 1). At nominal (ultimate) luminosity, the pileup (occurrence of multiple pp interactions in the same or neighbouring bunch crossings) will reach an average of hPUi = 140 (200).