Characterisation of TimePix/MediPix3 assemblies for LHCb VELO upgrade

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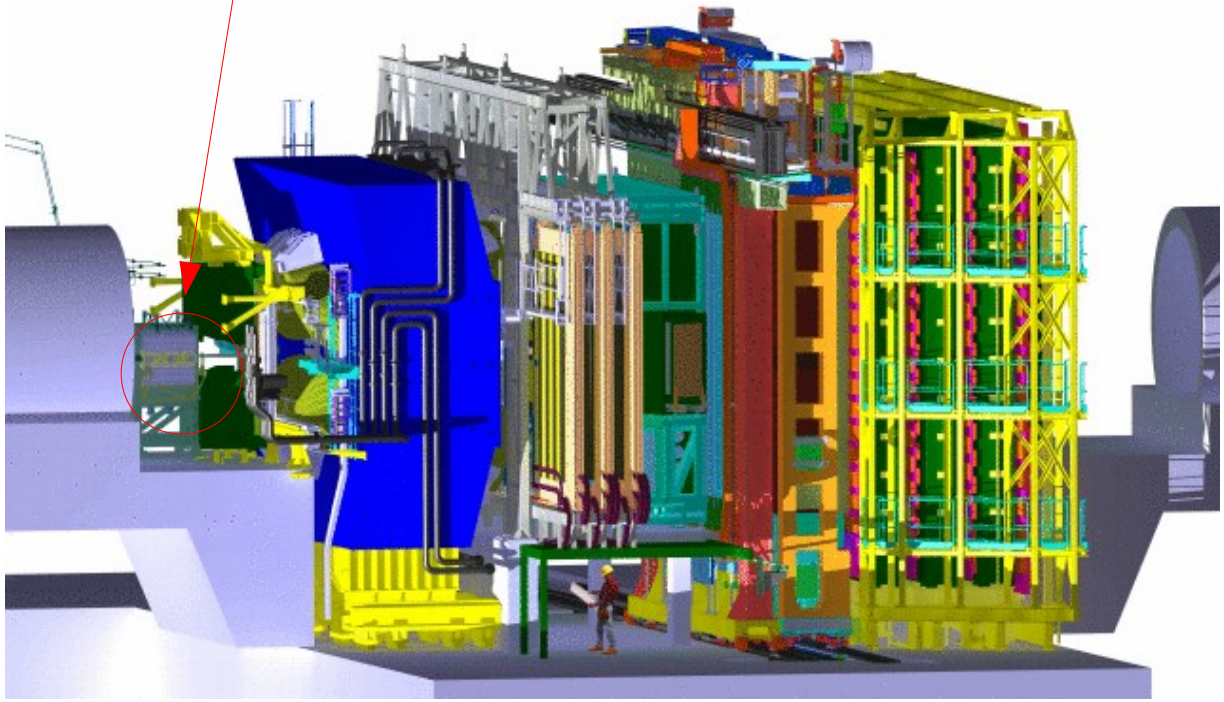
August 16th 2012

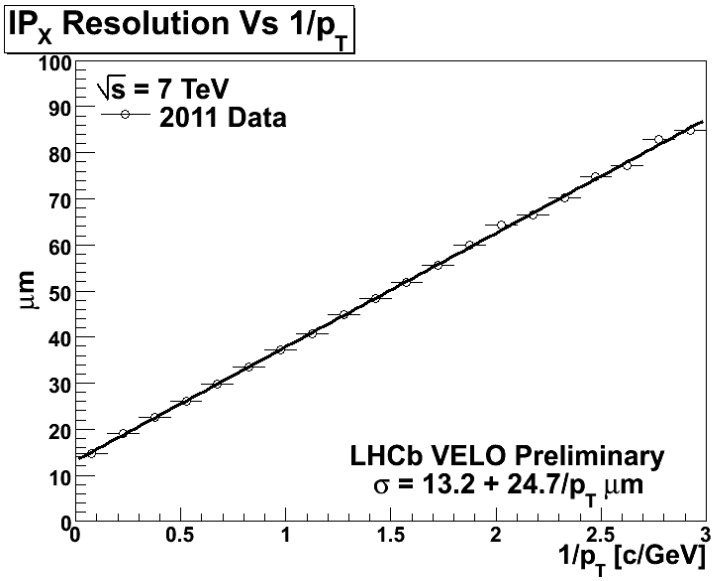
What is LOVE VELO ?

VErtex LOcator (VELO): silicon strip sensors in vacuum used to measure trajectories close to collision point, in order to separate primary and secondary vertices.



3D schematic of LHCb experiment

- Best resolution of all vertex detectors in LHC!
- About 13 μm IP (Impact Parameter) resolution at high momentum!



2018 LHCb upgrade

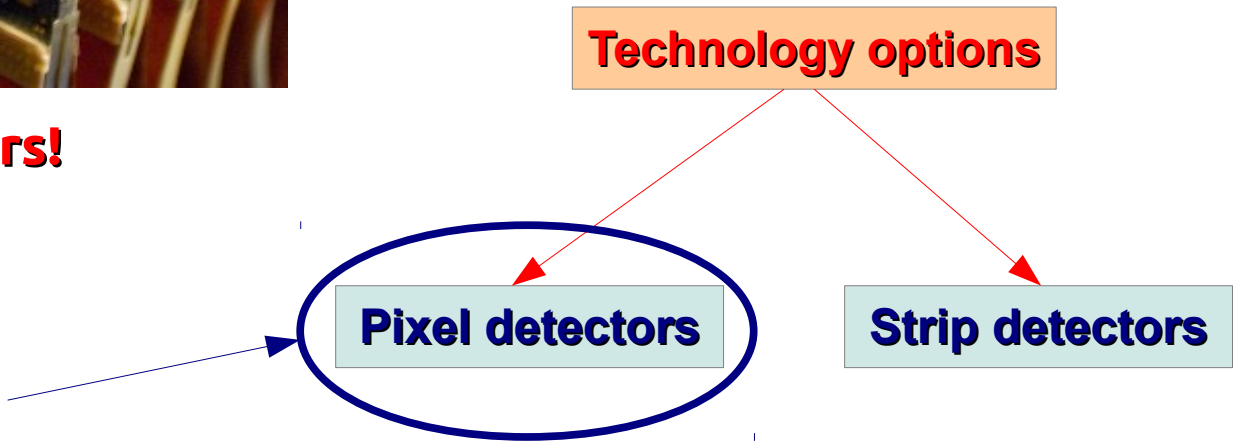
Current VELO assembly:

> Composed by strip detectors!

Main aims of VELO upgrade:

> Readout of every bunch crossing (~ 40 MHz)

> Being able to work with higher luminosity!



And here is where I'm working.

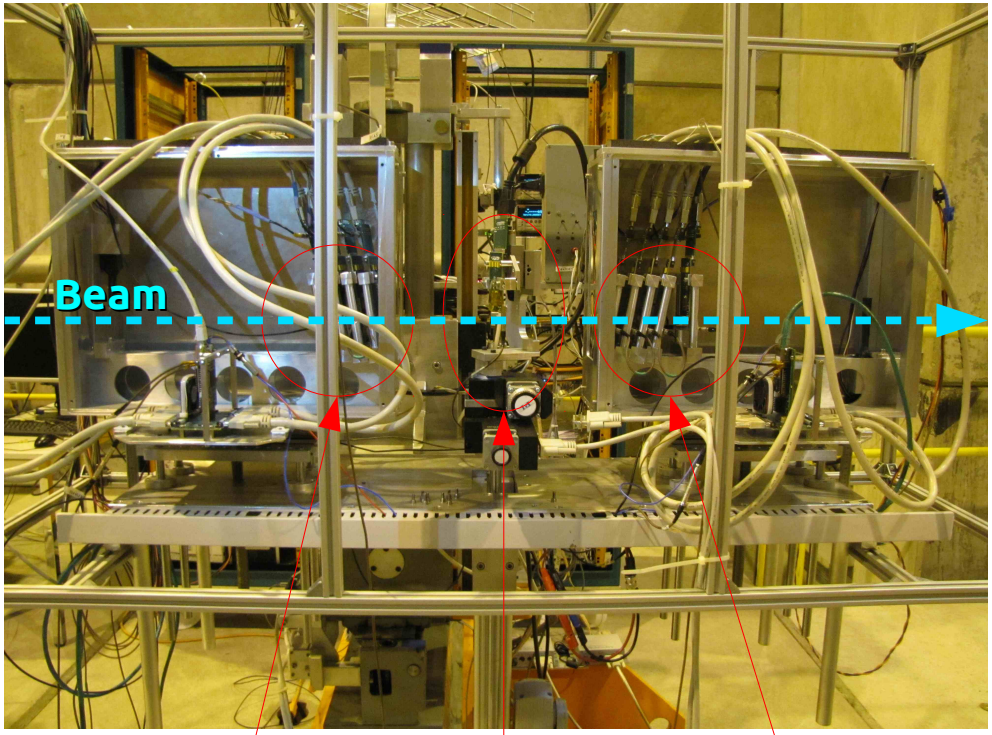
The road to VeloPix

- **TimePix:**
  - ToT or ToA information for each pixel
  - Works by frames
  - Radiation hardness is not too high
- **MediPix3:**
  - Only counting mode for each pixel
  - Works by frames
  - Radiation hard to the fluence expected in the upgrade
- **TimePix3:**
  - Has both ToT and ToA
  - High hit rate (~ 40 MHz)
  - Data-driven readout
  - Radiation hard to the fluence expected in the upgrade
- **VeloPix:**
  - Derived from TimePix3, specifically adapted for VELO
  - Higher hit rate (~ 400 MHz)

All of them:

- 55 µm
- 256x256 pixels

TimePix Telescope



Telescope is used for:

- Test different devices for LHCb upgrade
- Gather experience with pixel detectors

Telescope composition:

- Telescope planes: TimePix
- DUT: MediPix3, TimePix, Strip sensors ...

Data analysis from the last testbeam (May 2012)

(Finally, time to show some results...)

Telescope performance

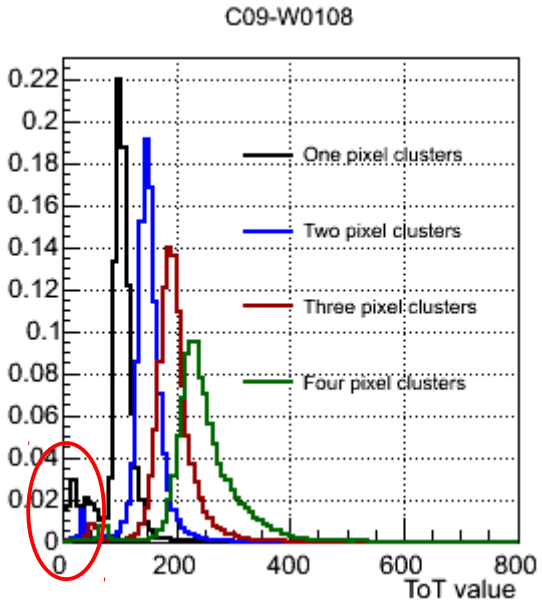
(Bias scan: data acquisition for different bias)

Objective:

> Study the performance of the telescope (only TimePix planes):

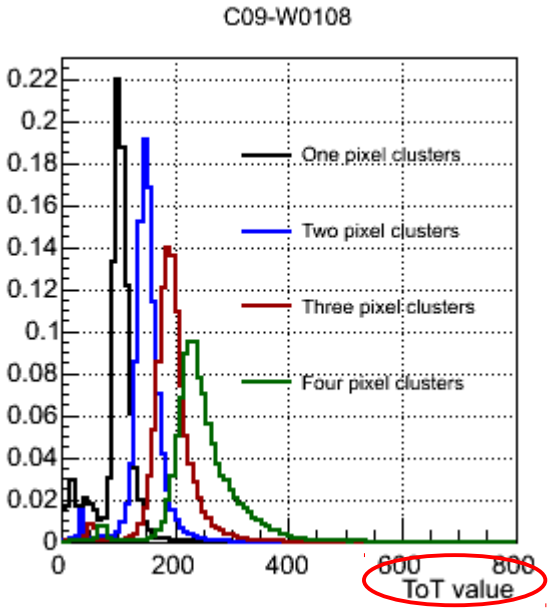
> Try to improve the resolution. How?

> ADC cuts:



Applying lower cuts in ToT (Time over Threshold) spectra, we exclude noise from track reconstruction!

> ToT calibration:



Knowing the relation between charge and ToT values (due to a previous calibration with test pulses), we can speak in terms of charge, instead of ToT values.

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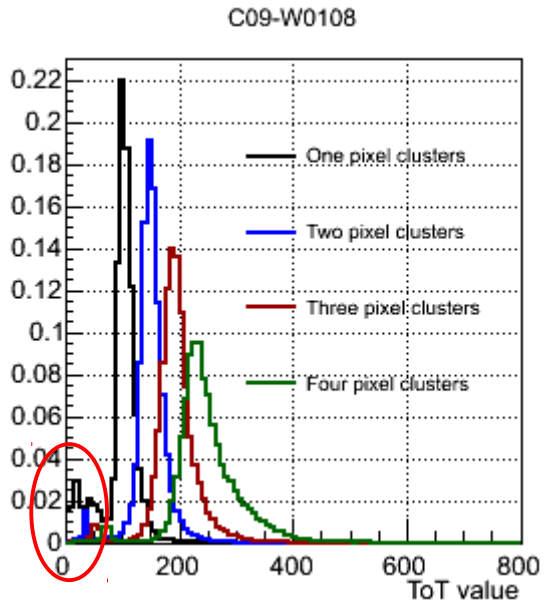

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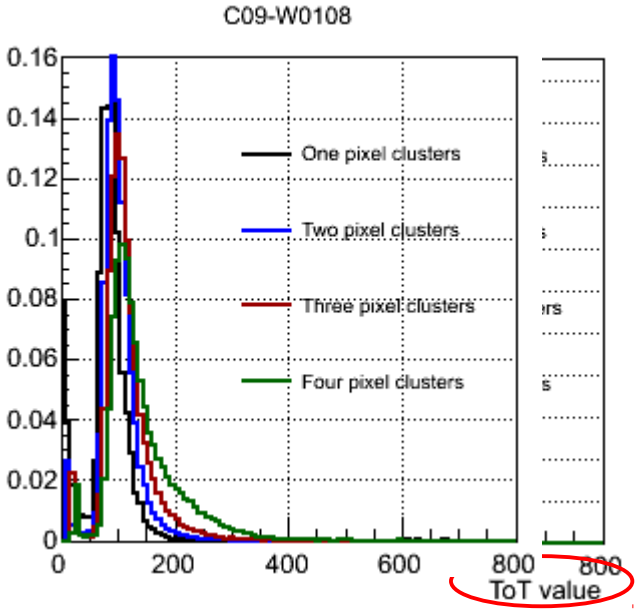

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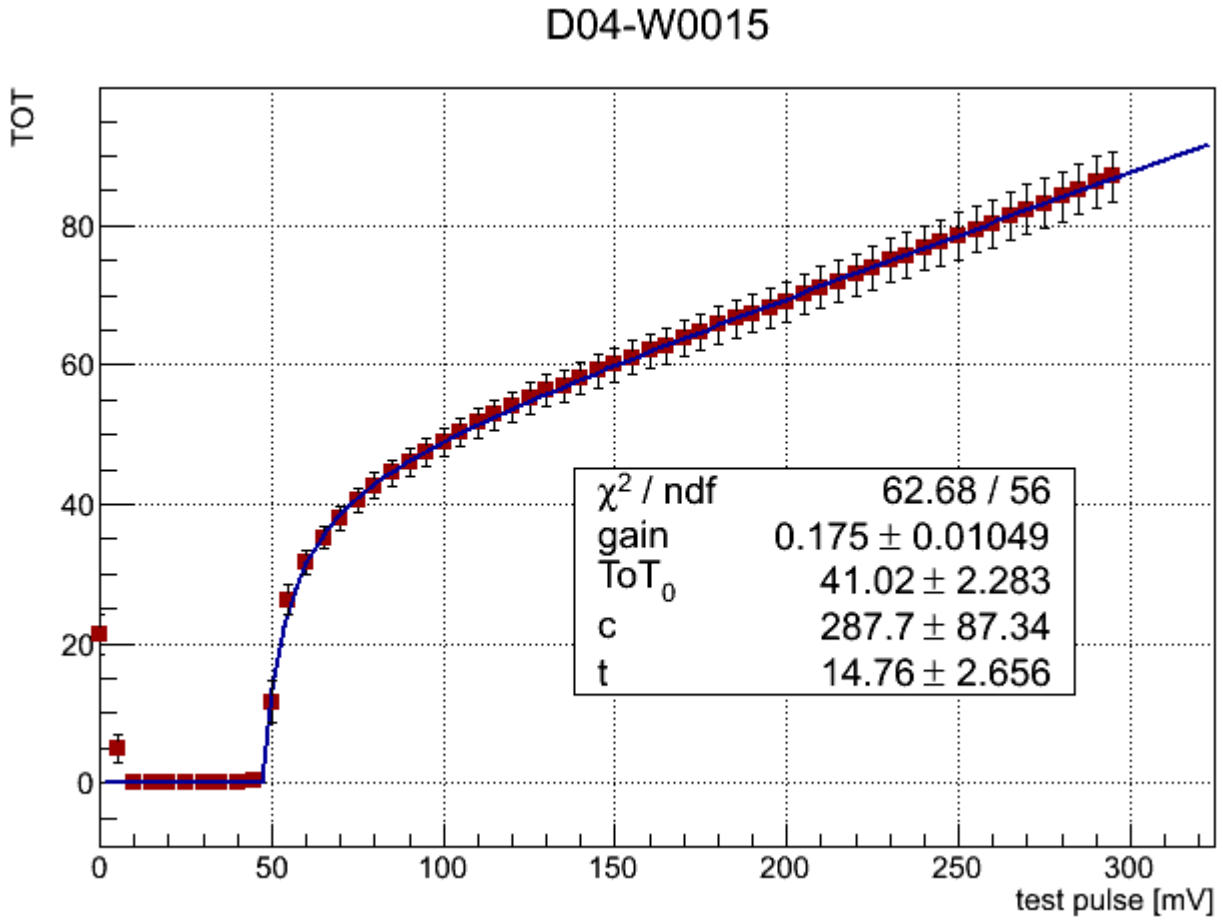

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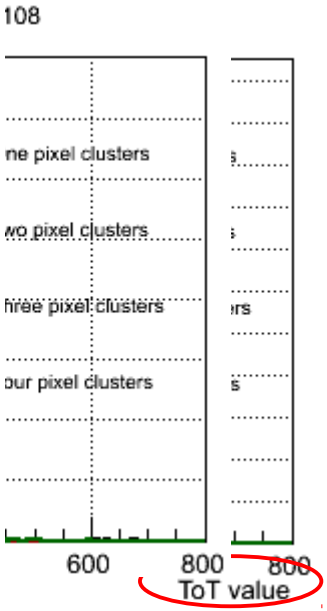

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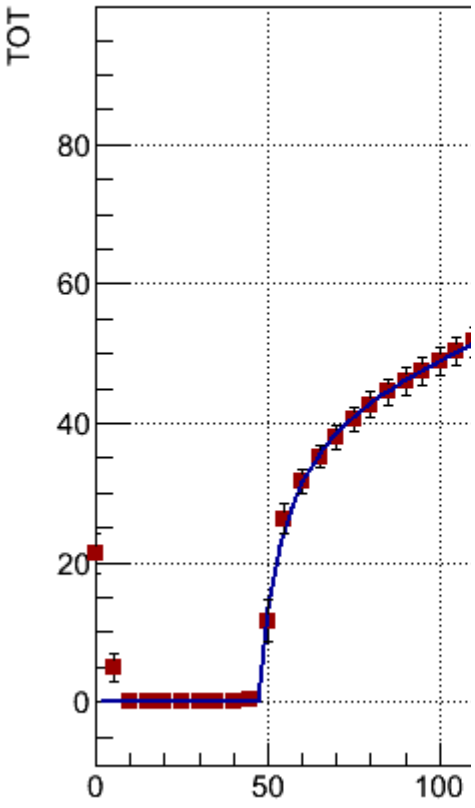

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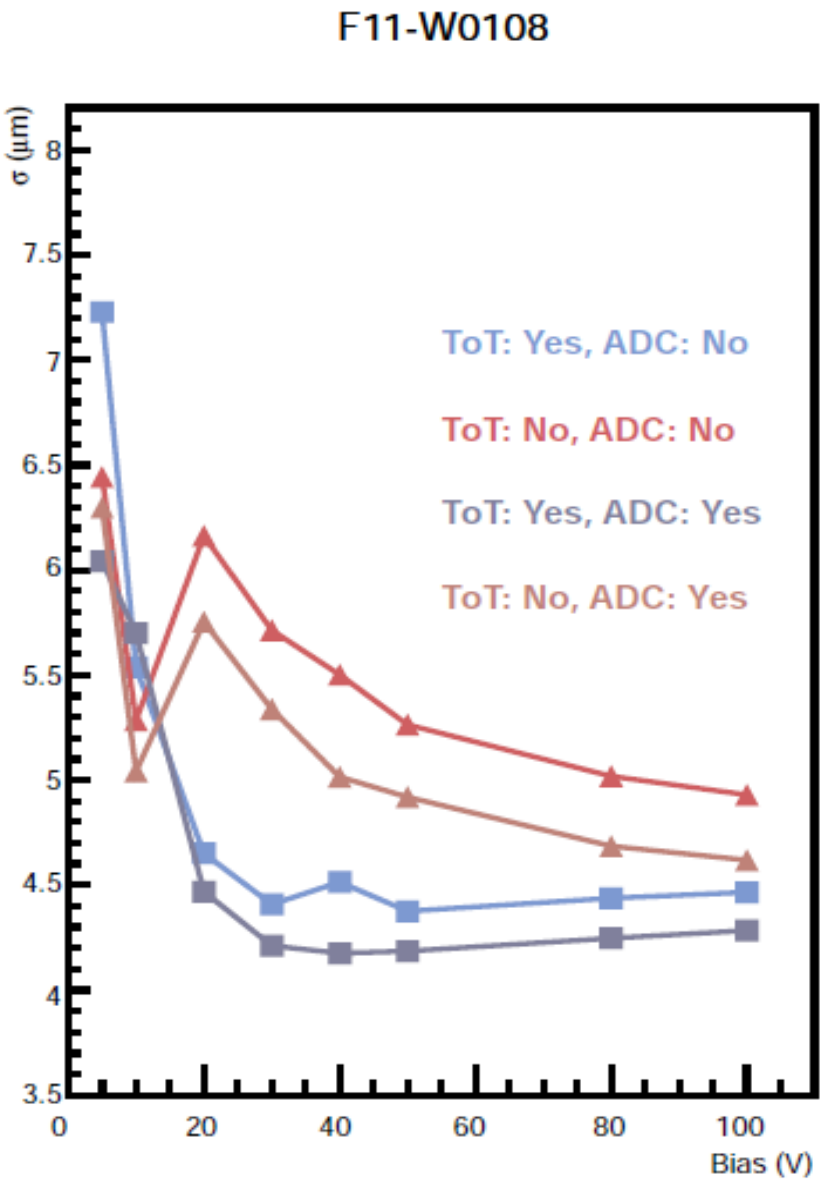

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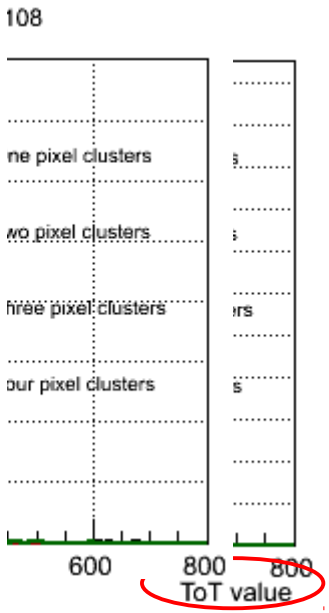

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stead of ToT values.

So, what's next?

> Compare the charge loss before and after irradiating the sensors! Why?
  > It's a way to test the radiation hardness of the sensors...

But, as a main objective:

> VELO needs devices which can cover all the active area with minimum losses. So,

> We want to study the behaviour of the sensors after and before being irradiated, in order to improve them and achieve the main objective!

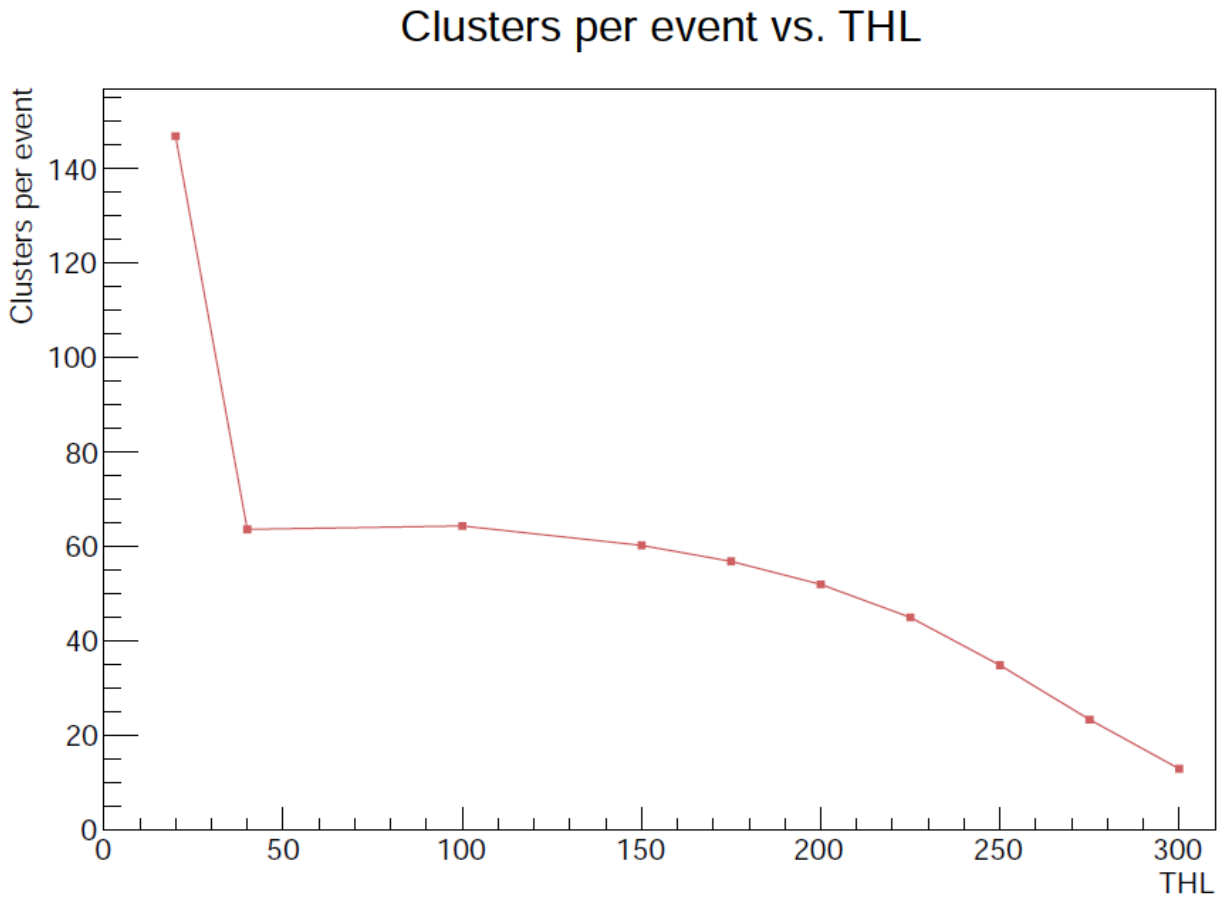
> We only have one pixel detector which stands the irradiation process: MediPix3.
  > Last testbeam (May): data from non-irradiated samples
  > Next testbeam (Now!): data from irradiated samples

MediPix3 efficiency study

(Threshold scan: data acquisition for different threshold)

Objective:

- **Study the efficiency of the MediPix3 (DUT):**
  - **Study the number of reconstructed tracks with and without DUT:**



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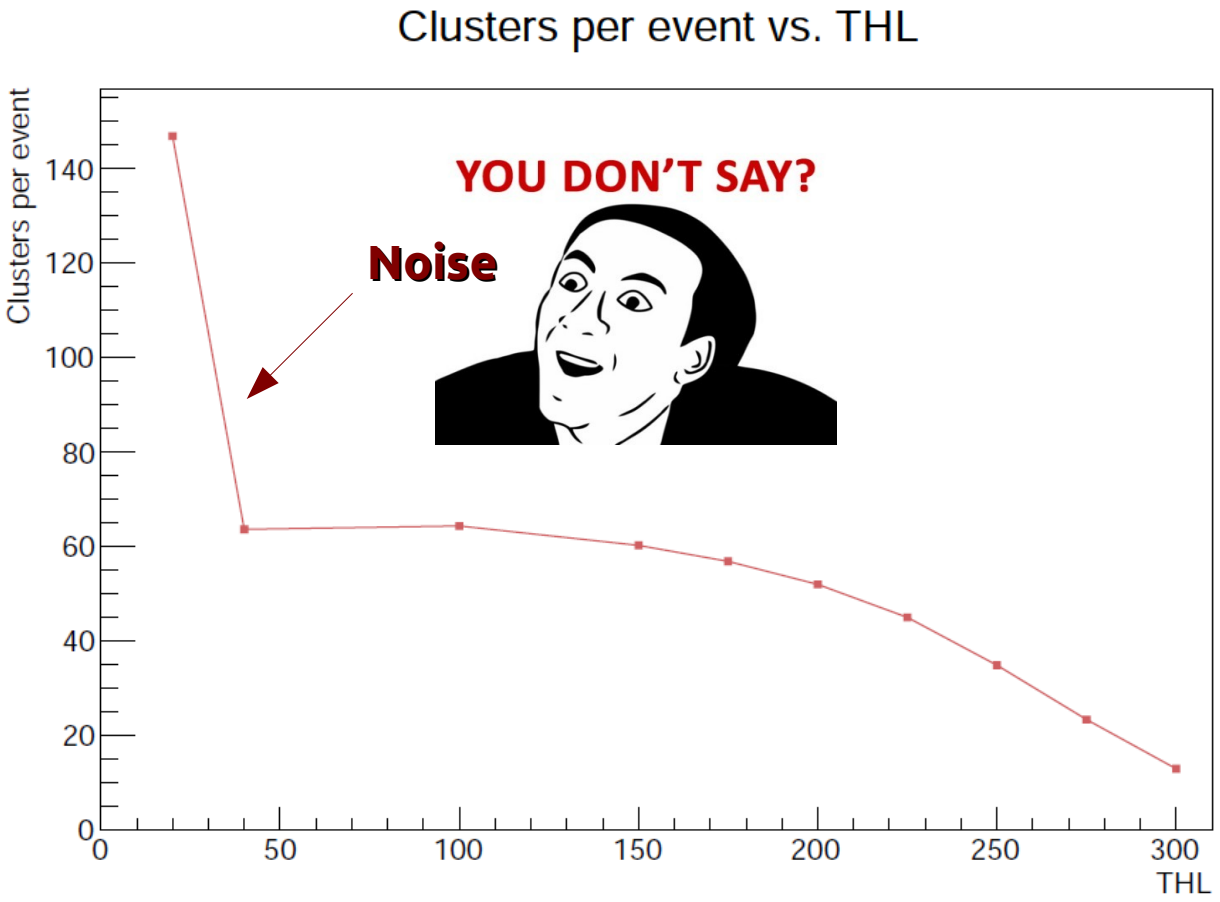

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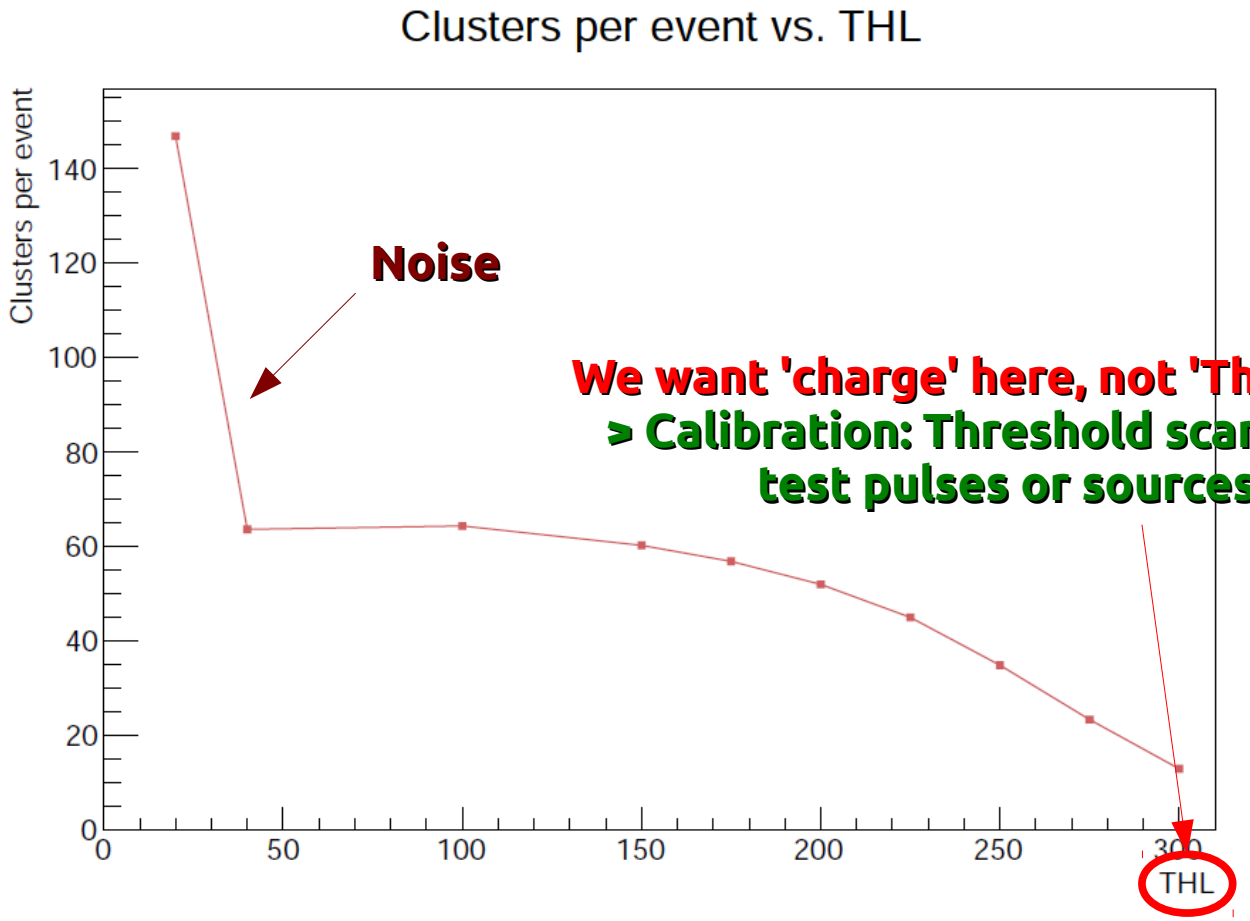


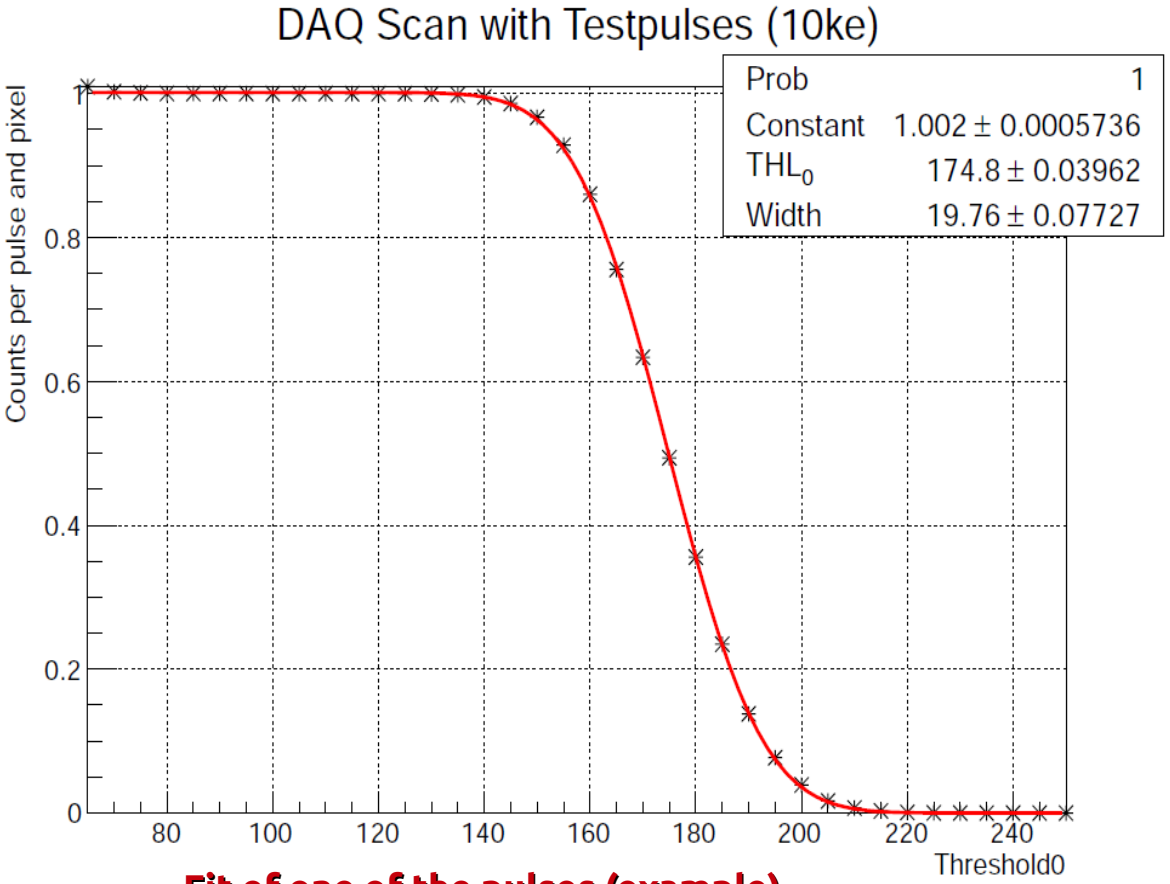
We want 'charge' here, not 'Threshold'!
> Calibration: Threshold scan using test pulses or sources!

MediPix3 calibration

(Threshold scan with test pulses (TP))

Objective:

- **Obtain a relation (should be linear) between charge (injected with TP) and threshold:**



Fit of one of the pulses (example)

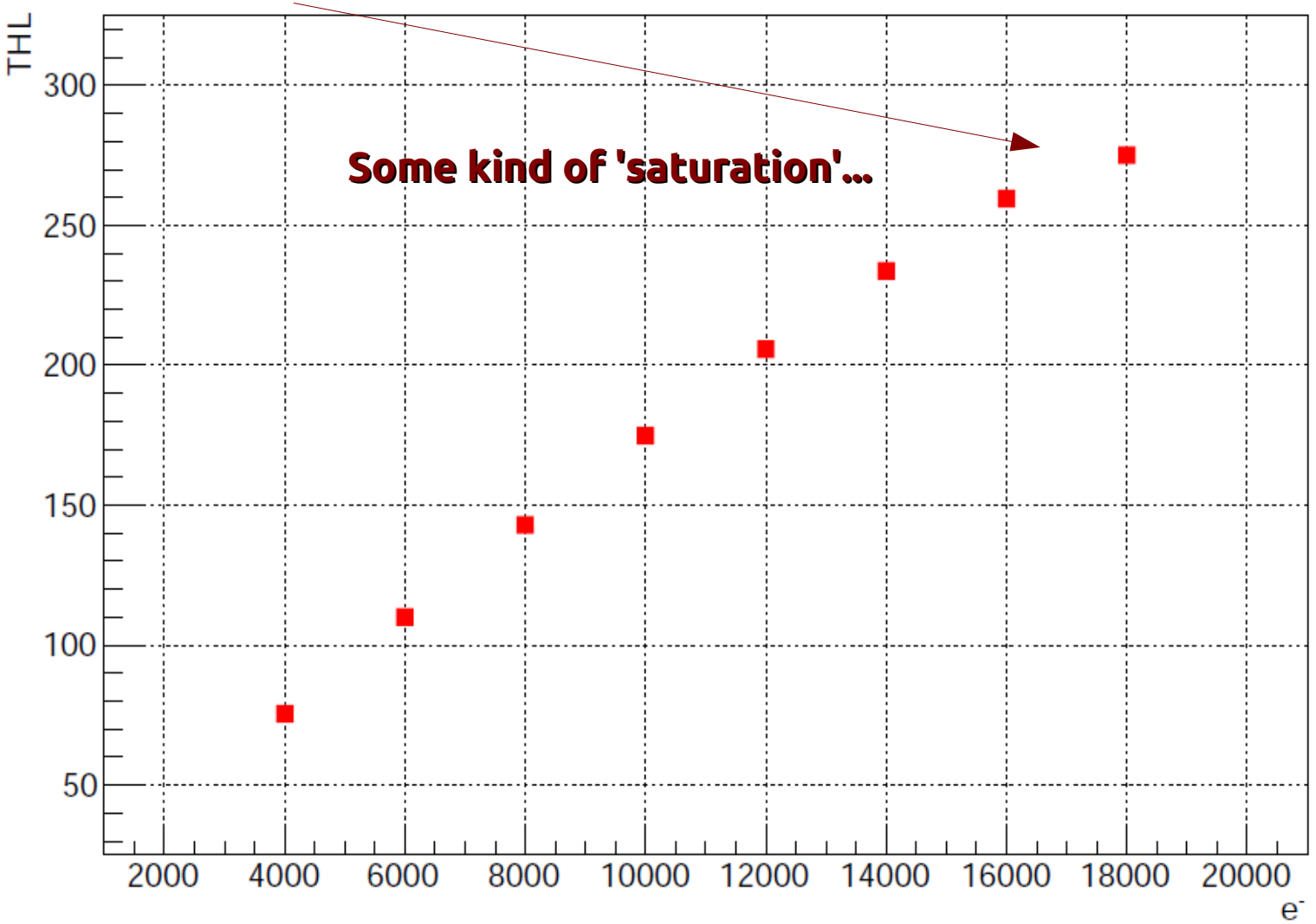
MediPix3 calibration

(Threshold scan with test pulses (TP))

Objective:

> Obtain
> and th

It's almost linear! Let's see what happens for higher charge..



MediPix3 calibration

(Threshold scan with test pulses (TP))

Object

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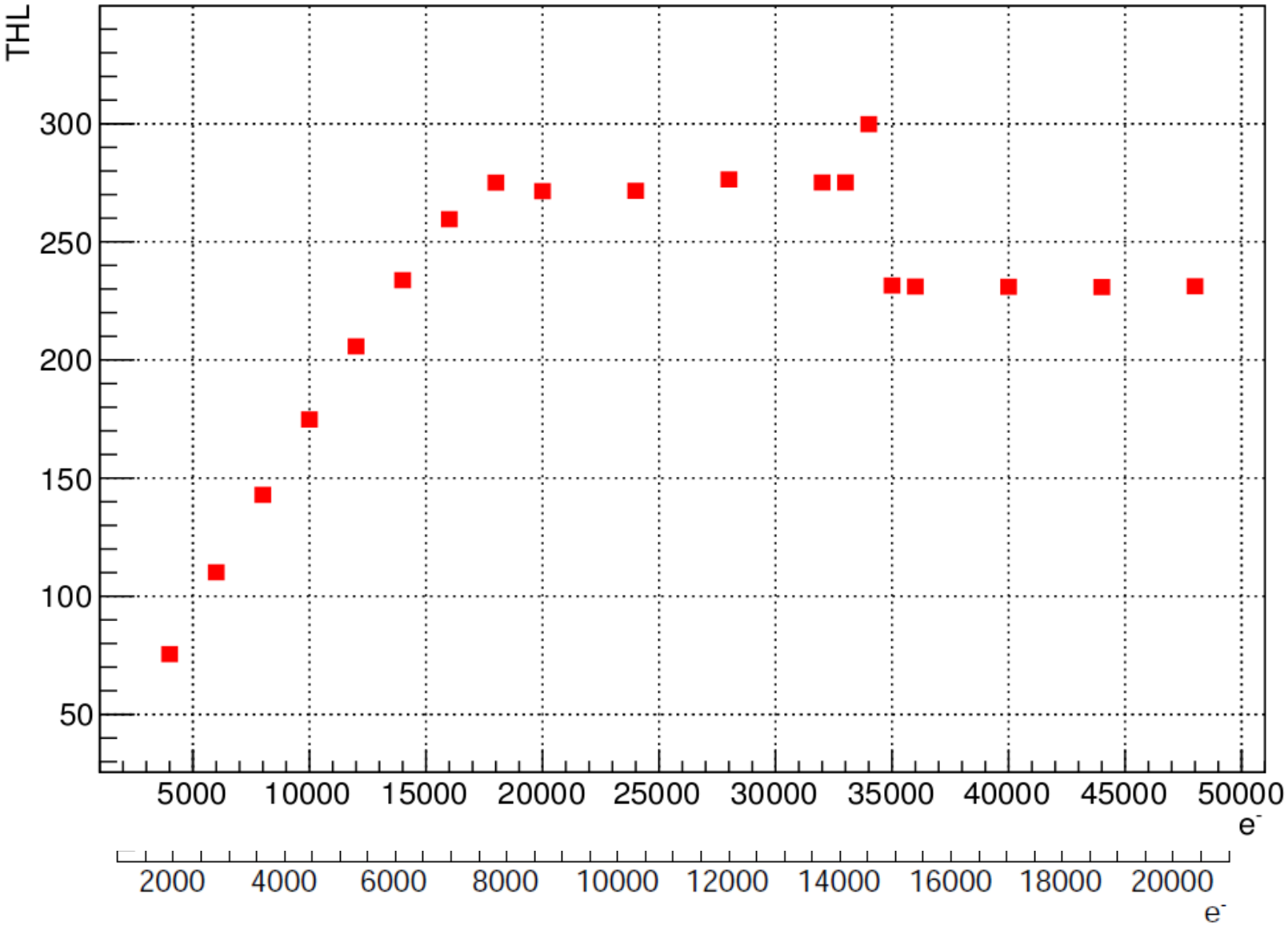

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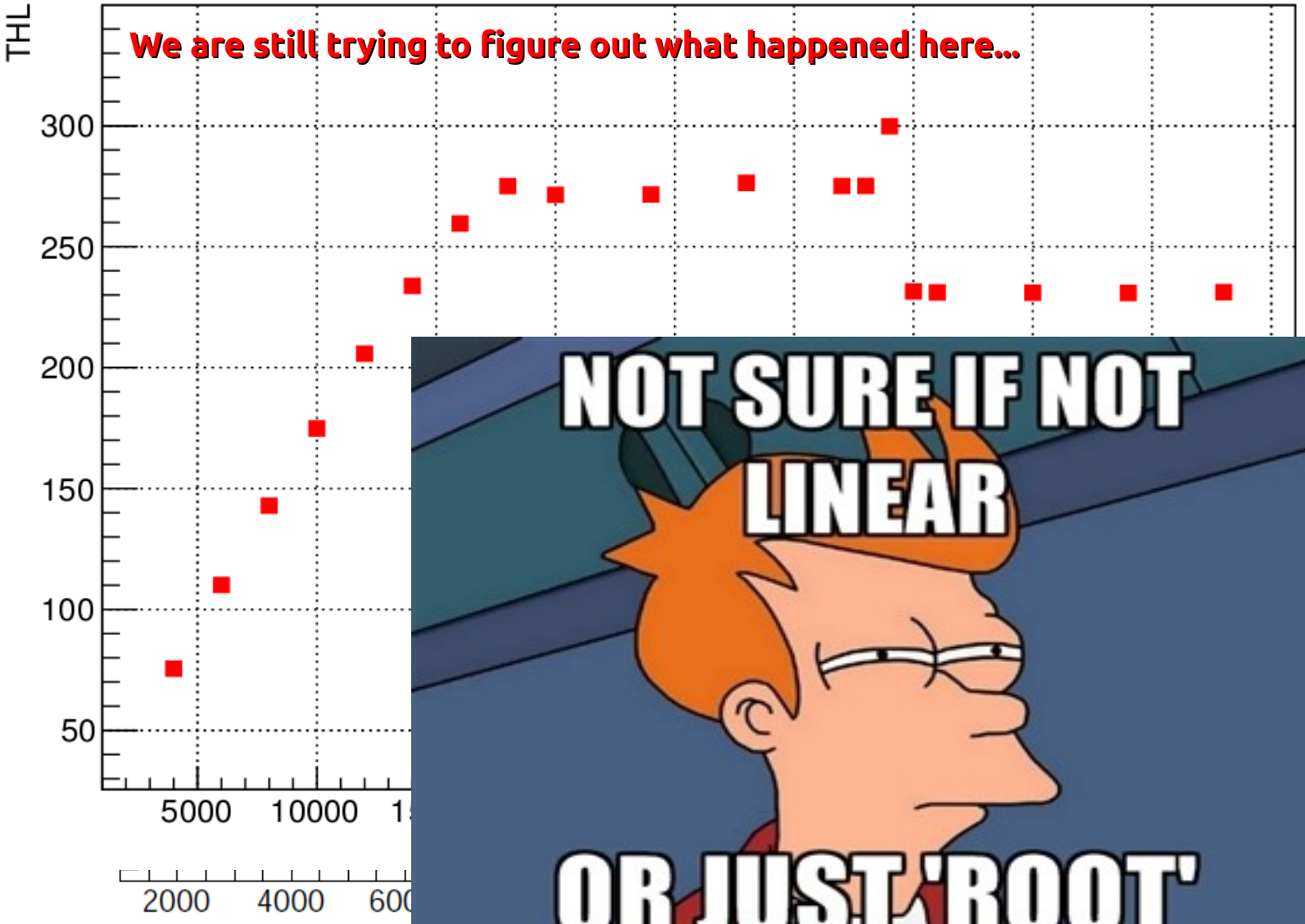

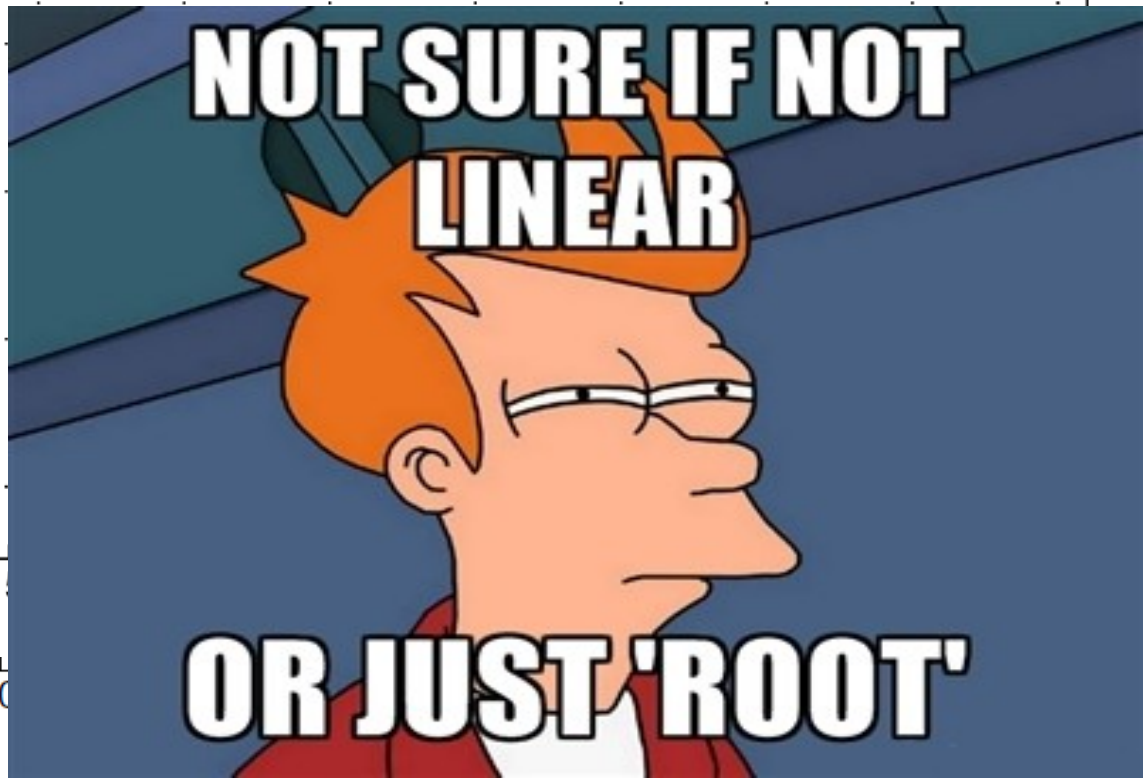

MediPix3 calibration

(Threshold scan with source)

Objective:

> Cross check the results obtained with the threshold scan done with TP!

Results:

MediPix3 calibration

(Threshold scan with source)

Objective:

> Cross check the results obtained with the threshold scan done with TP!

Results:

Nothing.

MediPix3 calibration

(Threshold scan with source)

Objective:

> Cross check the results obtained with the threshold scan done with TP!

Results:

Nothing.

Still working...

Thank you for your attendance!