SiW-ECAL TB updates (Short summary)

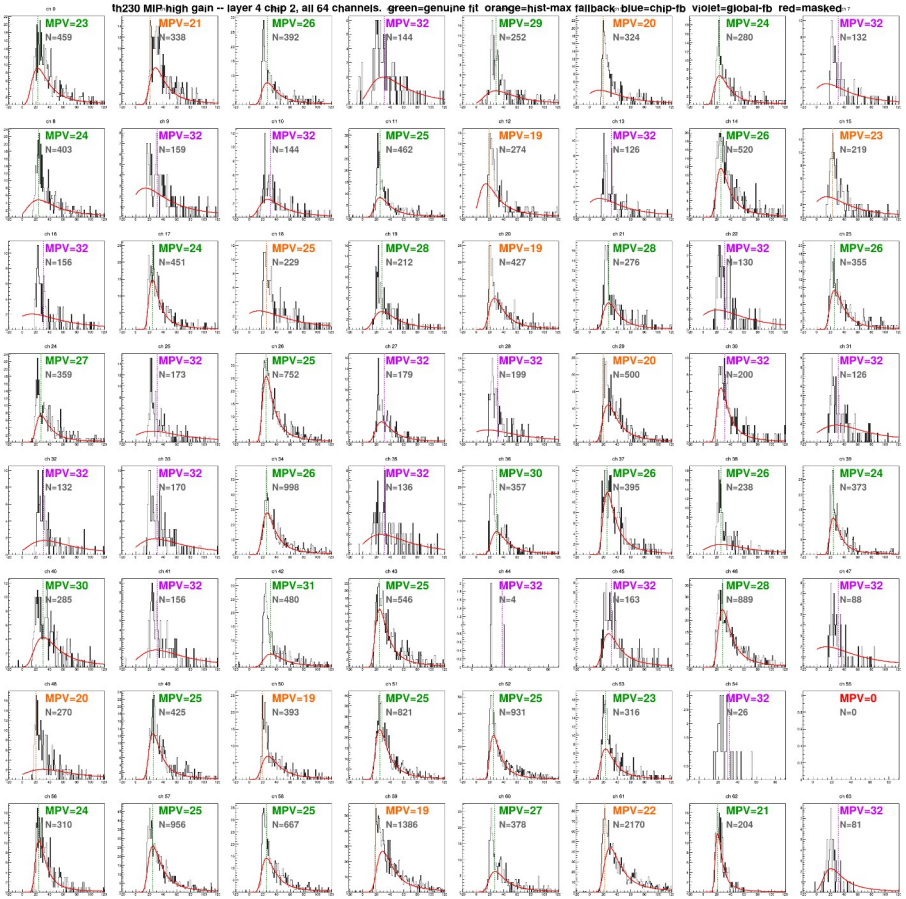
Jesús P. Márquez Hernández

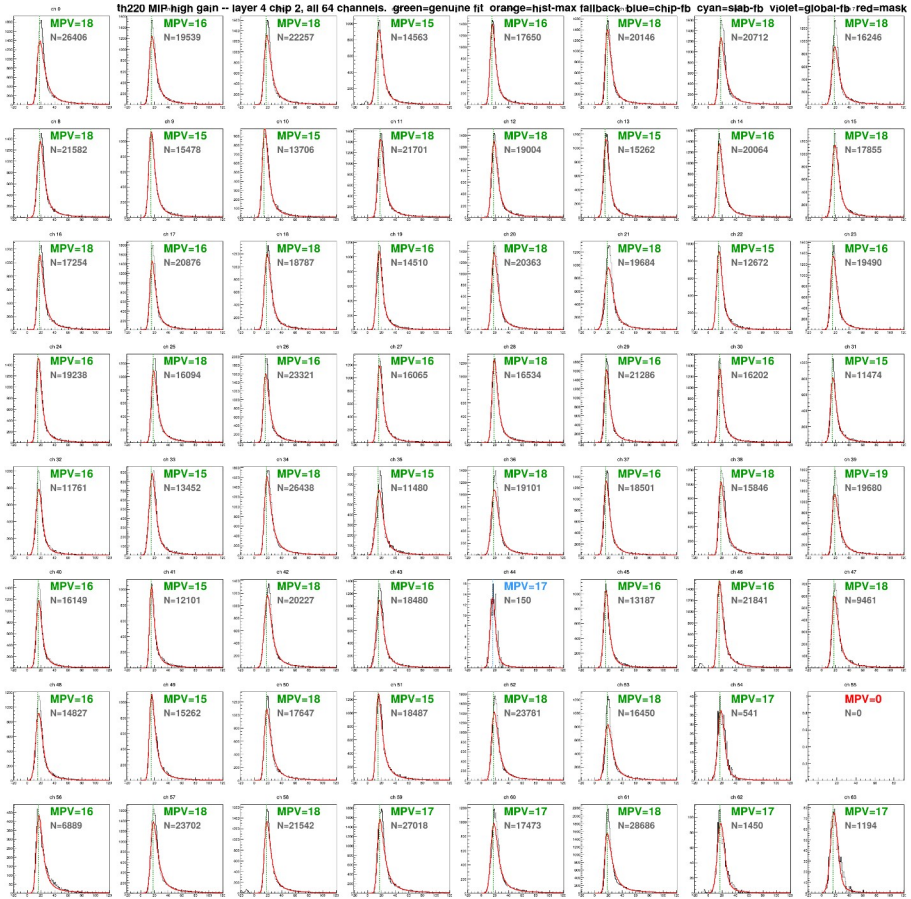
Current state of our software

- TB analysis: https://github.com/Olmichu22/siwecal-tb2026/tree/main
  - Data conversion
  - MIP & pedestal calibration, LG to HG intercalibration
  - Event building
  - Validation variables (shower study)
  - Event_display (key4hep native)
  - Event_viewer (Python, real-time tools) - Olmo
- Simulation: https://github.com/marherje/siwecal_k4sim
  - (WIP) Realistic digitization - Yukun
  - Mip Calibration
  - Validation variables (shower study)
  - Event_display (key4hep native)
  - Event_viewer (Python, multiple tools!)

Th230 vs th220

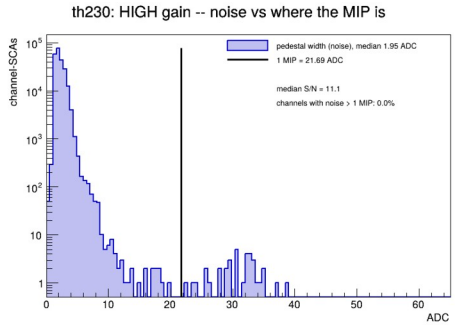
- First lesson: th230 is too high, we can't have a good HG MIP fit

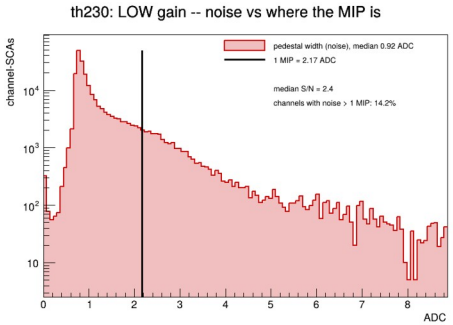


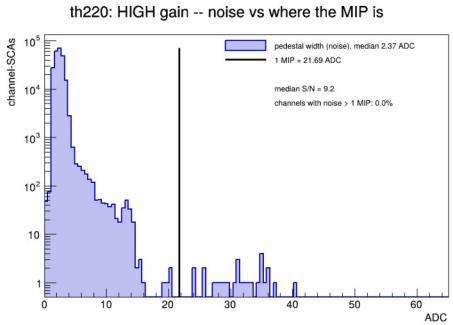


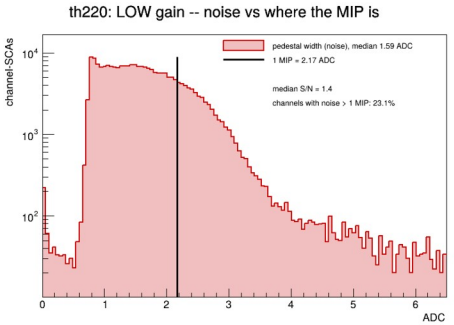
Pedestals and MIP values (th230 vs th220)

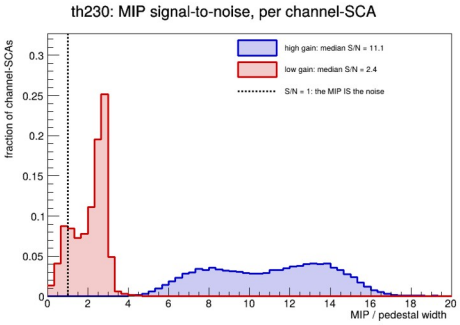
- Second lesson: LG MIP is hard to fit, specially as we go down in th
  - We need to anchor its value to HG
  - Using a higher capacitance in the future might help us to improve his S/N ratio

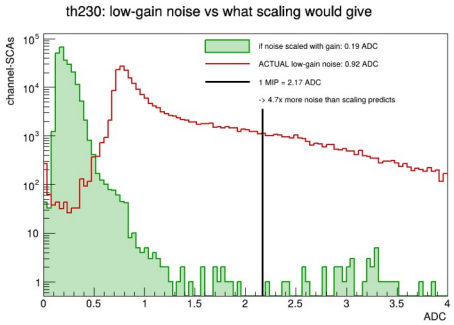


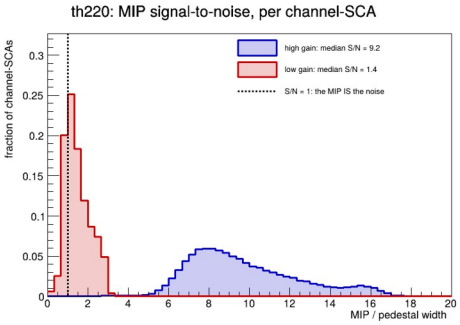


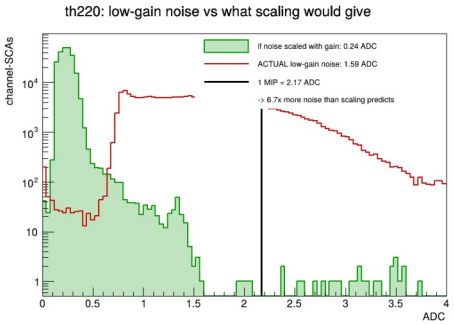




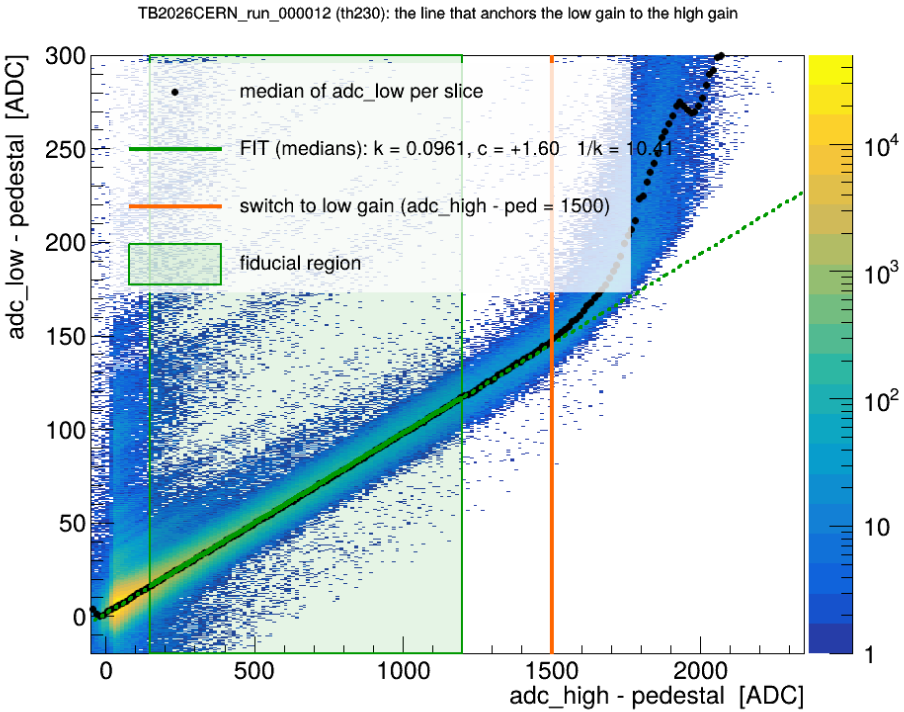


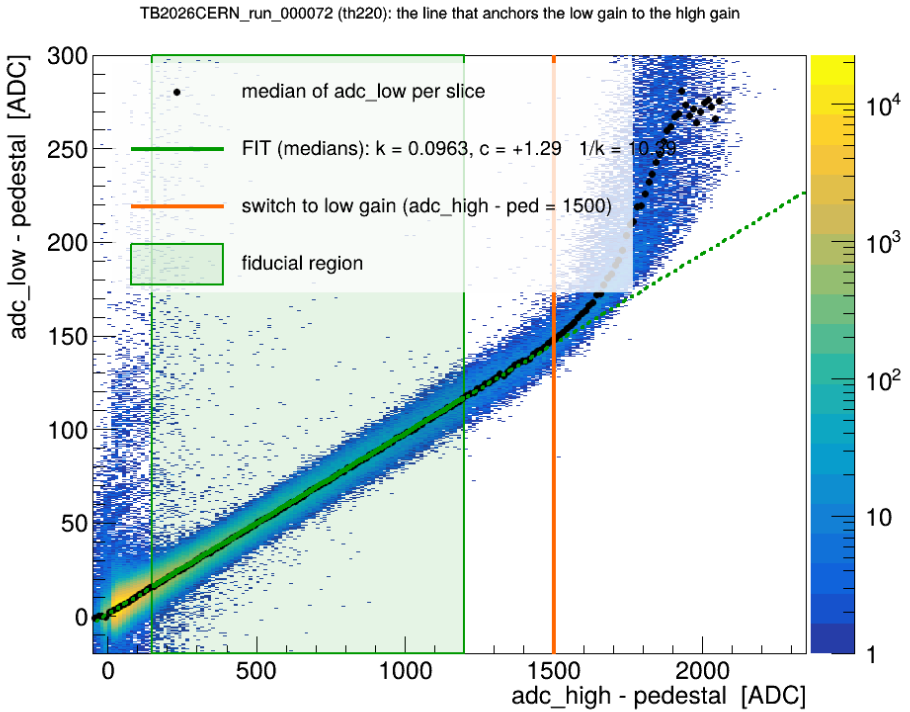






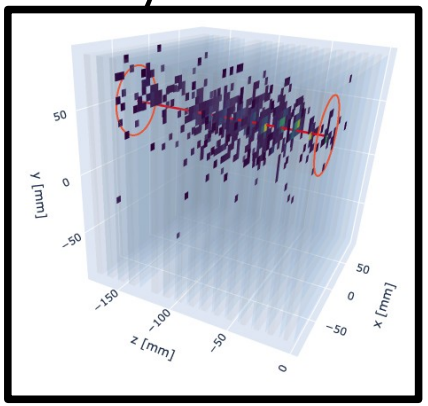
Anchoring the LG (th230 vs th220)

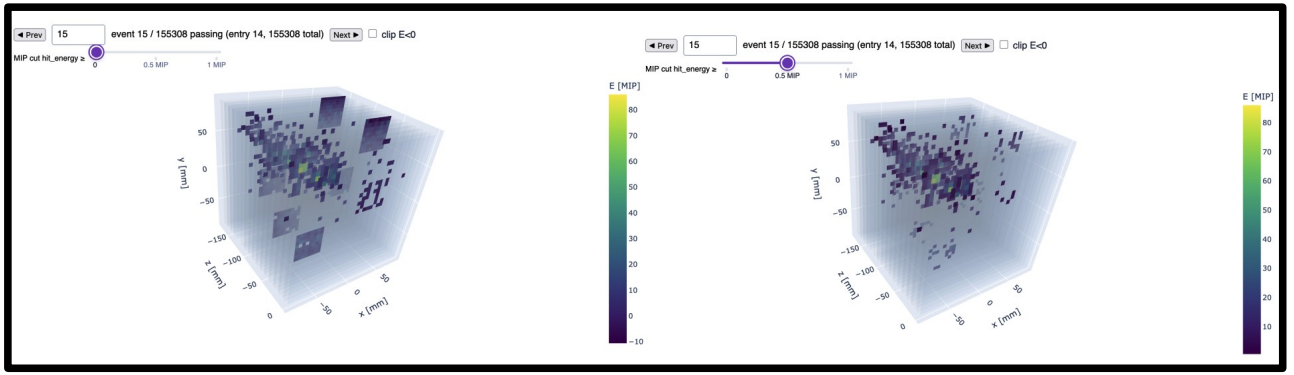


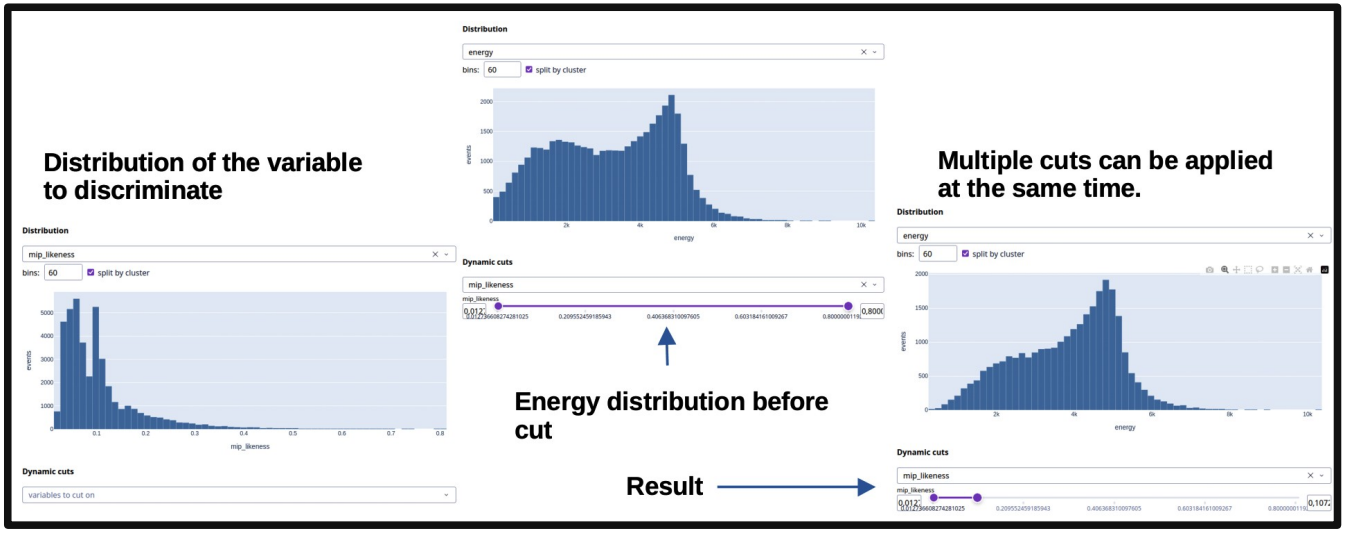


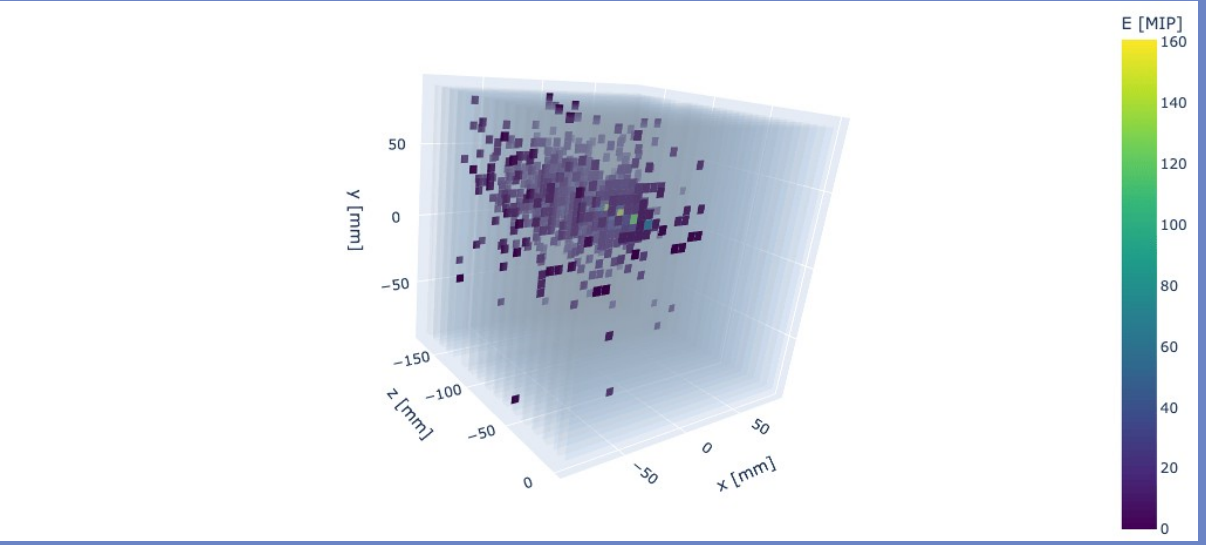
Examples of other tools in the stack

- Many of them in an interactive UI!

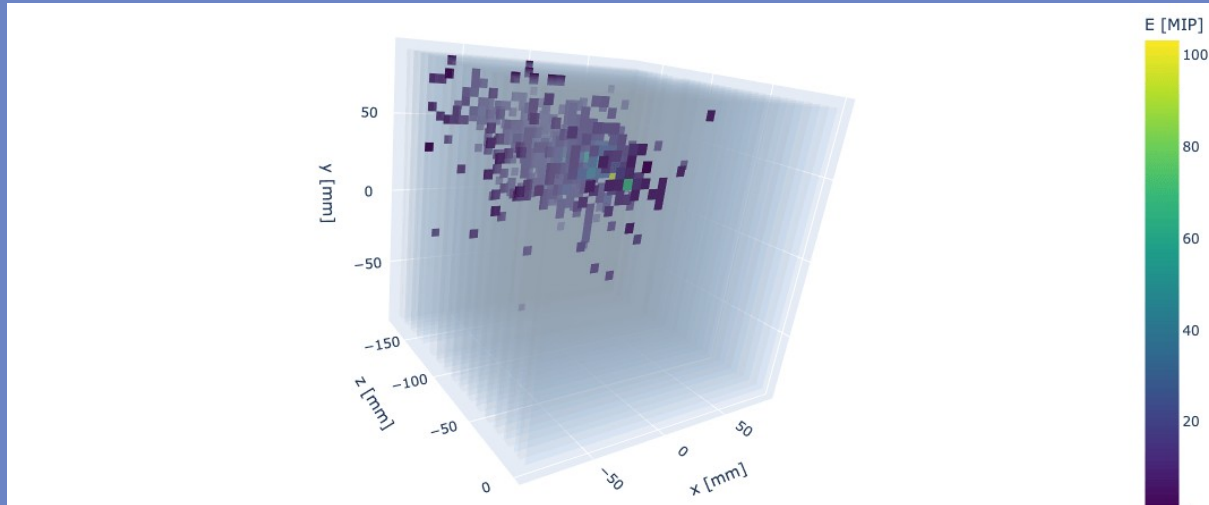








Simulation is also in good shape, can guess which one is it?



SHiP
Search for Hidden Particles

Key4ship updates

Jesús P. Márquez Hernández

CALO5
A new dimension in shower reconstruction

IJCLab
Irène Joliot-Curie
Laboratoire de Physique des 2 Infinis

cnrs

Updates overview (I)

- Track fitting improved
  - Cleaning shower region from ACTS measurements
    - Simple selection looking at neighbors
  - 4 iterations method
    - 1. Full system CKF, SiPad weights 16x
    - 2. Full system CKF, SiPad weights to 4x
    - 3. Full system CKF, all weights to 1
    - 4. KF with the remaining set of hits (Final track parameters and covariances)

- New pipelines to test the tracking with physic-based events
  - Case 1: μ^- & π^+
  - Case 2: e^- & π^+

Shot from the same vertex, right before the SiTarget and with customizable angle

Updates overview (II)

- Parametrization of the system ready to go
  - It was extremely easy to implement in dd4hep
    - One file config.py writes the steering file
    - One file parameters_geoX.yaml contains the N layers and position of each subsystem
      - TBD: Absorbers if we want to place the SiPad with Fe inside the magnet)
    - TBD: One bash script can launch grids of configurations (very easy to do)

- (parametrization→geometry→ddsim→hits→tracks) worked without any issue
  - I tested both physics channels:
    - μ^-/e^- 10 GeV, π^+ 5 GeV
    - With different incident angles (0.5°, 1°, 5°, 10°)
    - Vertex placed right before the SiTarget
    - Two different systems (SiTarget, SiPad, MTC)
      - GeoA (30,20,20+20+20)
      - GeoB (20,20,20+20+20)

Summary of new tracking tests

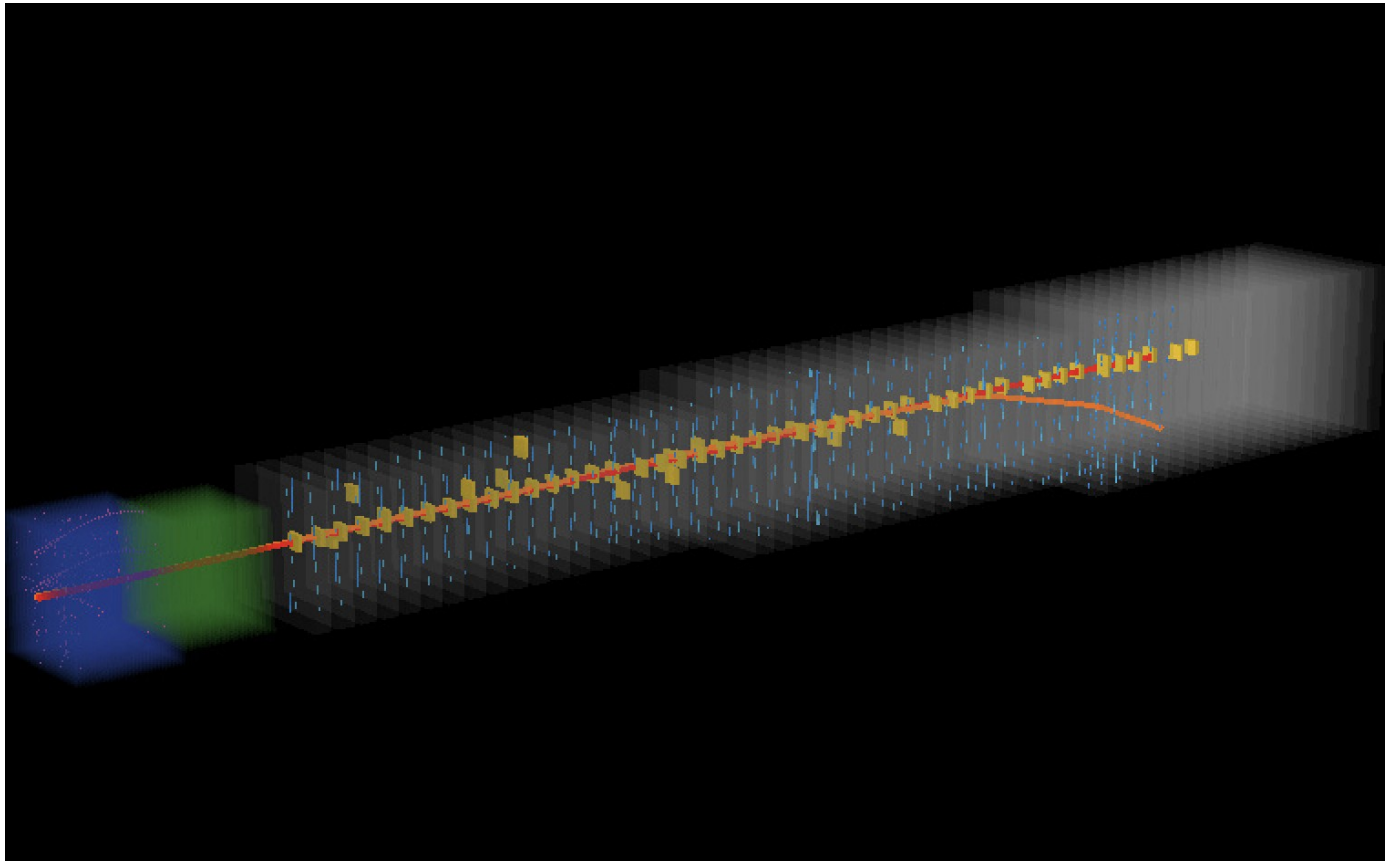
- These are % of events with 2 tracks (μπ) or 1 shower+1 track (eπ)
  - Which also reflects Physics: You won't always find π tracks

Ángulo	μπ geoA (30 capas)	μπ geoB (20 capas)	eπ geoA	eπ geoB
0.5°	44%	46%	32%	36%
1°	48%	49%	31%	25%
5°	30%	42%	19%	27%
10°	32%	29%	15%	18%
chi2/ndf med (μπ)	1.75–2.79	1.43–1.95	~7.4	~7.4

- Turns out most of these cases are duplicates of muon tracks so I have to reinforce the duplicate-filter!
- Anyways, we can see changes in the reconstruction performances between topologies and the natural progression of losing tracks as the angle increase
  - And the average chi2/ndf of tracks are really good!

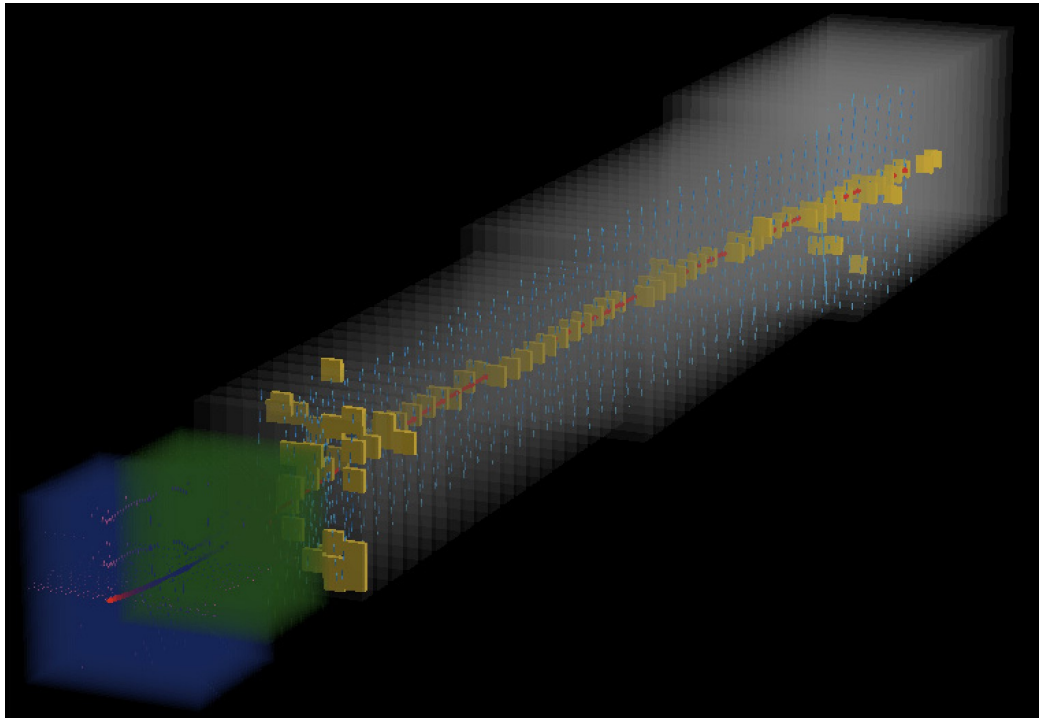
Examples (μ^- & π^+) - Duplicate

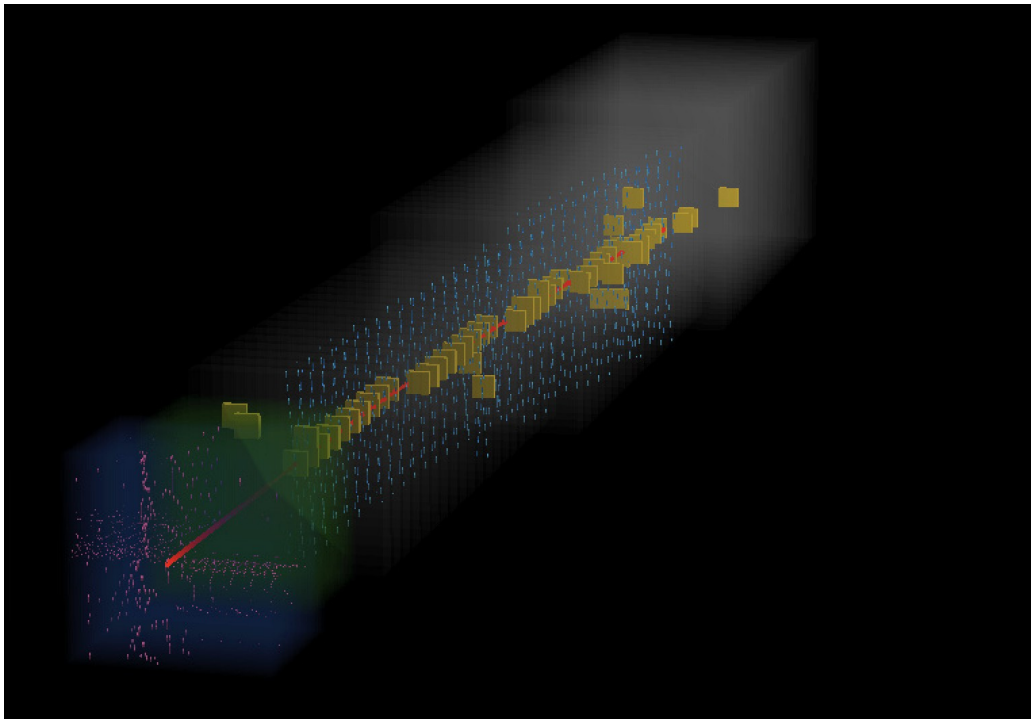
- Should be easy to clean with and additional filter



Examples (μ^- & π^+) - GeoA

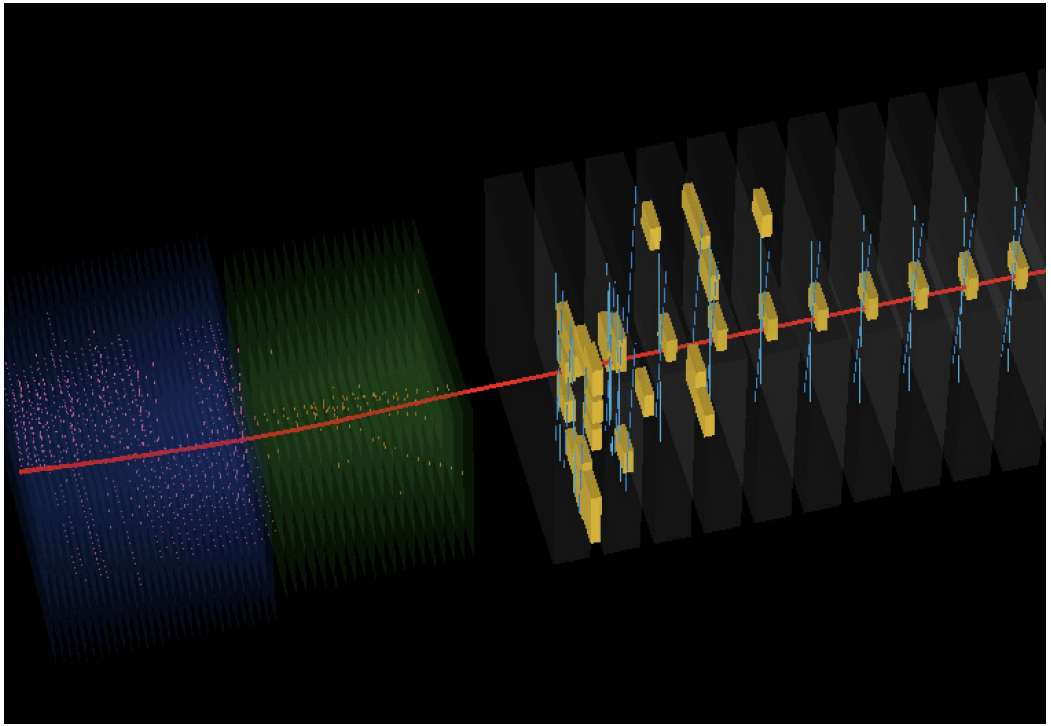
- 1° (left) vs 5° (right)

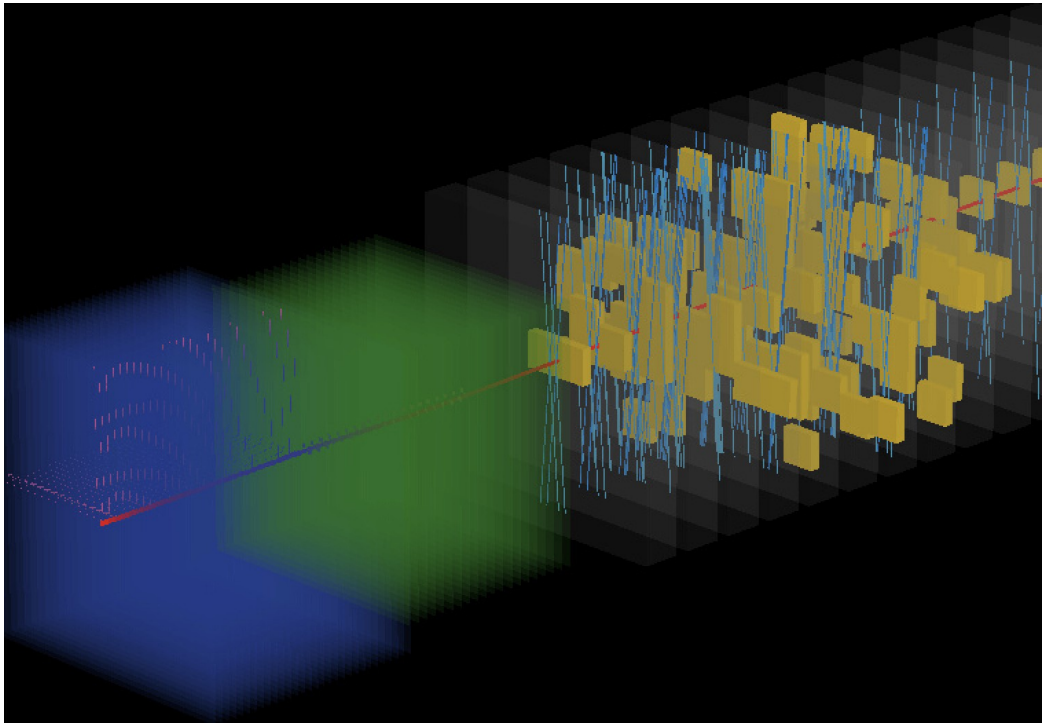




Examples (μ^- & π^+) - GeoA

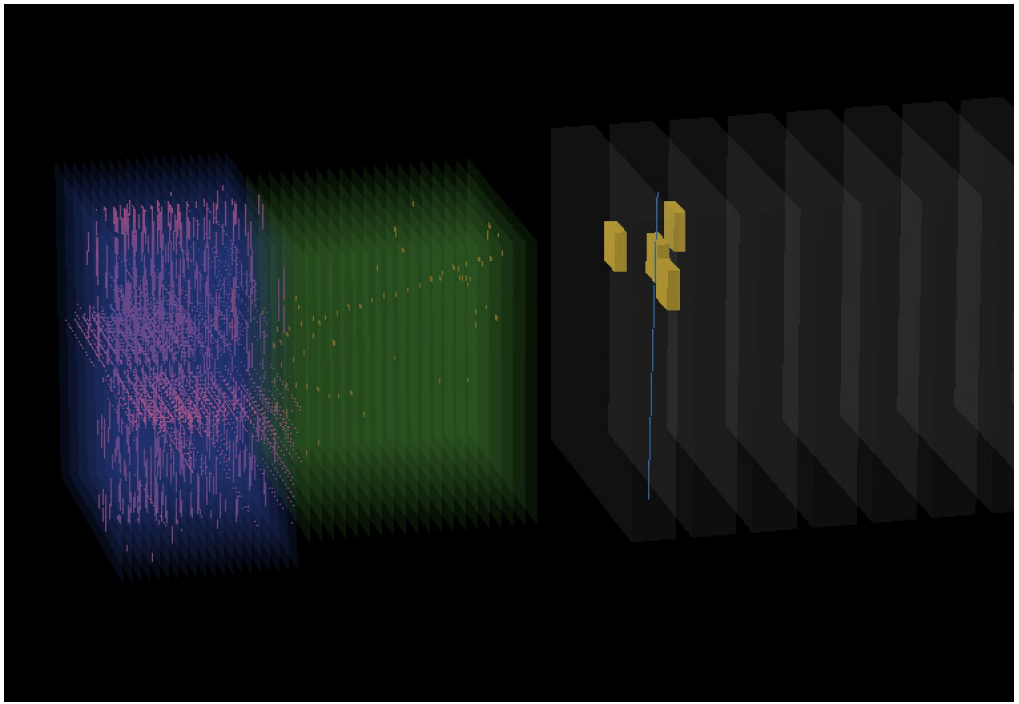
- ZOOM in some 1° events
  - Left: Early π^+ shower, tracks are lost first, muon track is recover by the MTC
  - Right: Late π^+ shower, muon track is reconstructed since the beginning

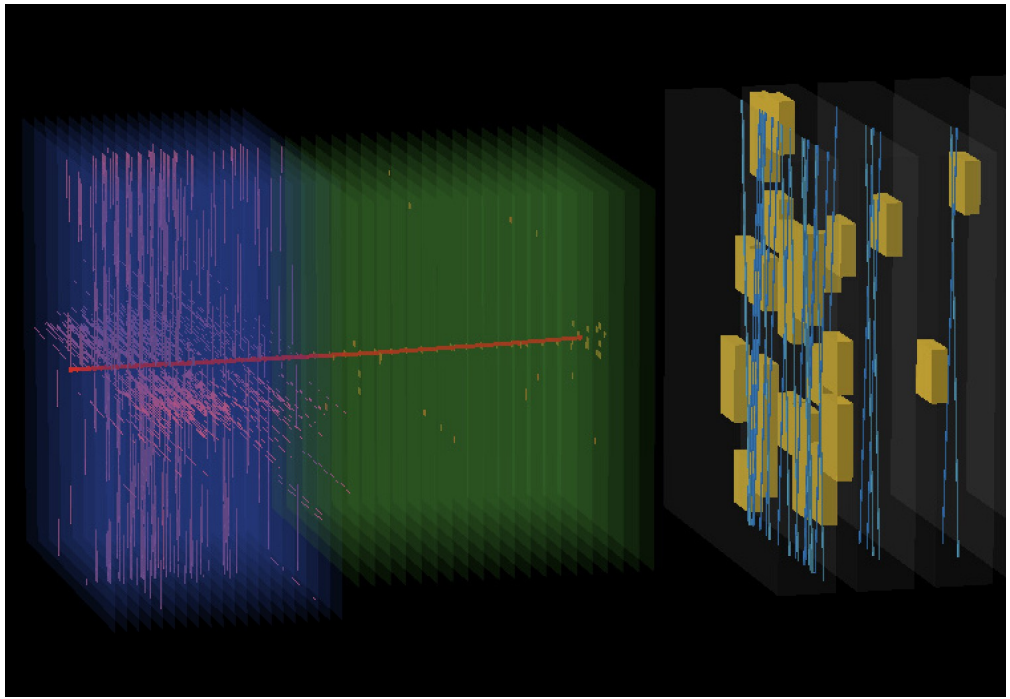




Examples (e^- & π^+) - GeoB

- Event w/o track (left) vs event with track (right)





Next steps

- I still have some work in the software, but not so much, mostly the parametrization:
  - Boundary conditions and automatic building of each block
  - Physical limits of parameter space
    - Finite multiples of W thicknesses to play with
    - Minimum separation between layers, etc.
  - Customization of absorber's thicknesses (almost finished)
  - Bash macros to launch a grid of different configurations (almost finished)
  - Add the emulsion target (TBD)
  - Improved segmentation

- I want to do some reading into optimization methods to decide what to implement
  - MOBO is my fav choice atm

- I need to finish implementing the new baseline design so I can ask for the Genie neutrino events!

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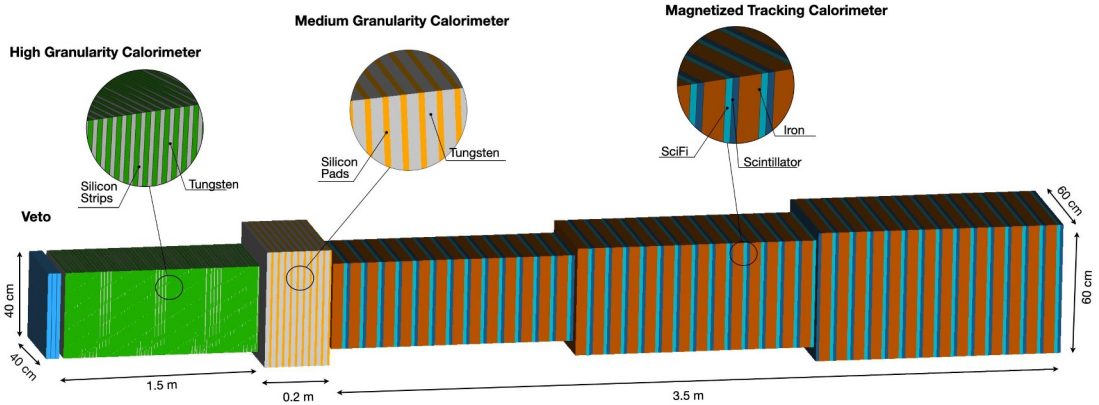
Newer baseline geometry (Being implemented)

- Fix tracking
  - Iteration system-by-system
  - Cleaning of duplicates
- 54x54
  - Some standard W thickness
- Full layout 120 + 10 +60
- New MTC layout, 60x60cm^2
  - Iron goes to 60 cm in Y everywhere
  - Steel to complete in X direction up yo 60 cm



HIGH GRANULARITY CAL	
Tungsten	120
Silicon Strips	120
Weight	1.3 tonnes

MEDIUM GRANULARITY CAL	
Tungsten	10
Silicon Pads	10
Weight	1.1 tonnes

MAGNETIZED TRACKING CAL	
Iron	42
Scintillator	42
SciFi	42
Weight	2.5 tonnes

Thanks for your attention!