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mCBM High Intensity Features

A study of various yields

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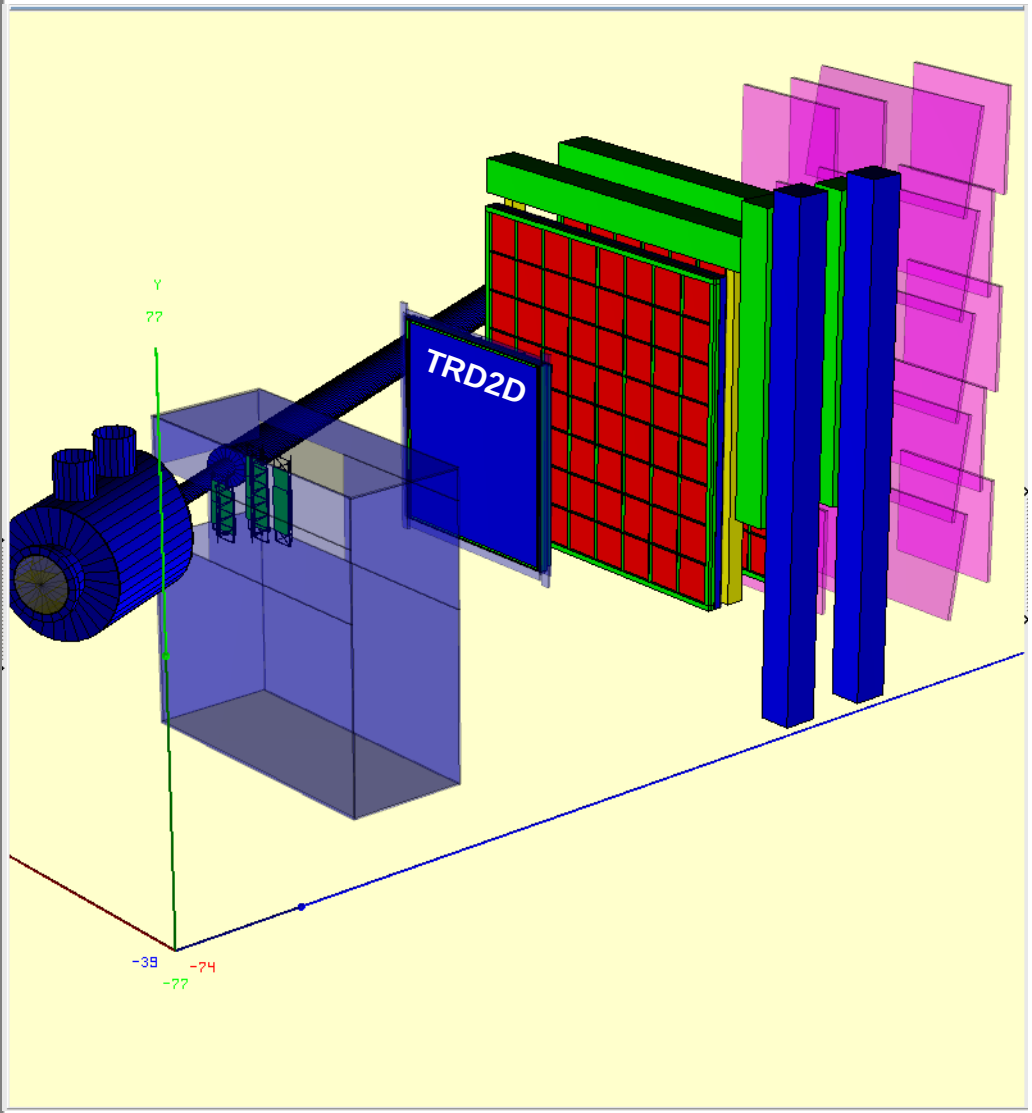
mCBM Data Analysis Meeting

27th June 2023

TRD2D @ mCBM



Milestones of the TRD2D @ mCBM

→ May 2021 : Installed with 4% of read-out demonstrated a good S/N and reliable time correlation with ToF. Fully available during run 1588 !

→ May 2022 : FEE upgrade to approx 50%. Took data in the common read-out partition for all runs of the campaign. Instrumental in alignment, HI runs, tracking, etc.

→ Feb 2024 : Full upgrade of the system including 2 new chambers (CBM type - PRR), New FEE (CBM type -higher integration)

TRD2D issues

TRD2D @ mCBM

→ data analysis
→ simulation tuning
→ support for all reconstruction scenarios (EbyE, TS)
→ Tracking, PID

Code wise

→ MR 1179
https://git.cbm.gsi.de/computing/cbmroot/-/merge_requests/1179

ToDos

MRs

- STS geo v22f ready to be merged
- TOF geo v22j, technical issue with material map (Pierre will try to find out)
- 1119 (event display, Pierre)
- 1123 (alignment matrices, Alex) – to be merged
- 1179 (channel masks, reco of full TS)
- Macro for EB with fixed time window (draft MR by Pierre) – to be tested

Cluster / hit reconstruction

- improve errors of TRD2D hits (Alex)
- check TRD eloss

CA track reconstruction

- Efficiency investigations – comparison reconstructed vs. MC points
- single protons: efficiency still low, partially no TOF match
- 3 hits in consecutive stations requested – necessary ? => skip station for triplets
- generating material maps on-the-fly – to be tested for mCBM

Simulations

- channel masks for TRD2D in preparation – others exist (see redmine issue 2708)
- determine acceptance by requesting (at least) a MC point in stations: STS0, STS1, TRD2D, TRD1D, TOF
- target position in sim like in experiment (to be set in macro, rerun transport)

Λ Reconstruction (Norbert's hadron analysis)

- Comparison sim – exp. data: 1) channel masks, 2) TOF calibration
- TOF calibration, Au data, run 2488: velocity edges show partially arc-like shapes, differs from strip to strip; in Ni data less pronounced. Origin ? MC ?

Λ Reconstruction with CA & KFParticle

- MC: fluctuating number of reconstructed Lambdas caused in particle finder (external package) due to lost tracks by calling "get DCA fast" at B=0 but DCA is nan => introduce a real option for B=0, straight extrapolation.
- KFsimple (dedicated for Lambda reco) usable and suited ?

Analysis of rate scans

- Local hit reco algos are not yet optimized to handle full TSs (performance); event building (eb) with seed detector generates a potential bias by the seed detector (e.g. saturates at high rates)
- Presently two options:

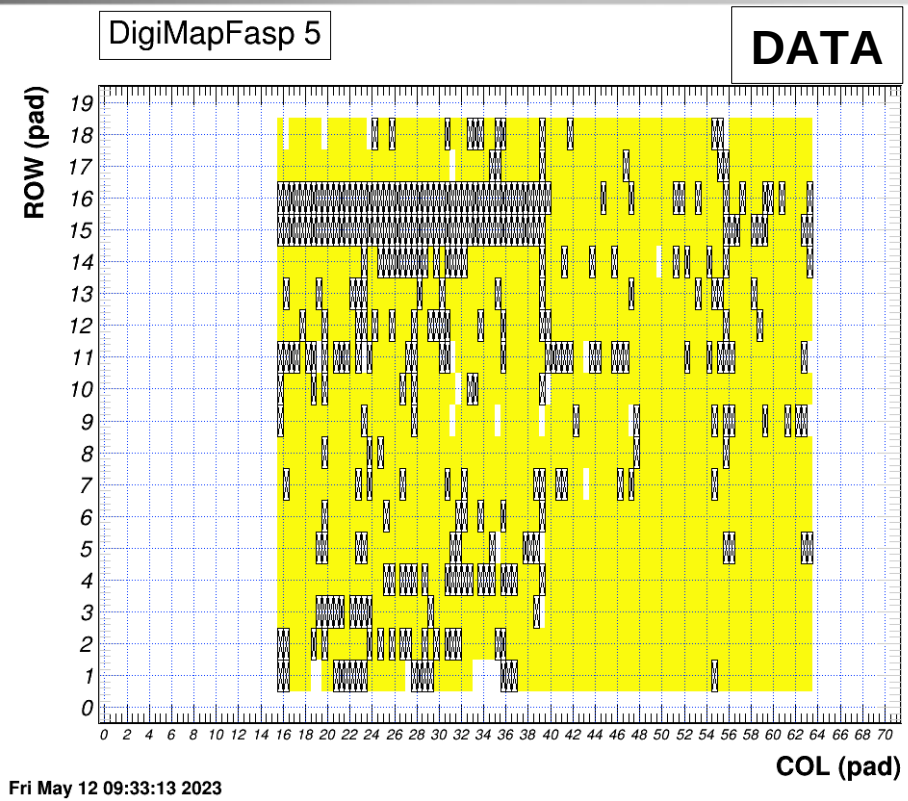
1. at given TS: eb with seed detector 1 => hits1, eb with seed detector 2 => hits2, hits1 vs. hits2 (at same TS!) , use eb option "no overlap".
2. apply eb with a fixed time window (w/o seed detector), Pierre will commit a dedicated macro.

- Ref runs: High intensity: 2570 / low intensity: 2545
- Incl. MUCH into CA track reco, start with sim. first
- Correlate MUCH hits vs. TRD hits after tuning of TRD hit finder

Alignment (mid/long term)

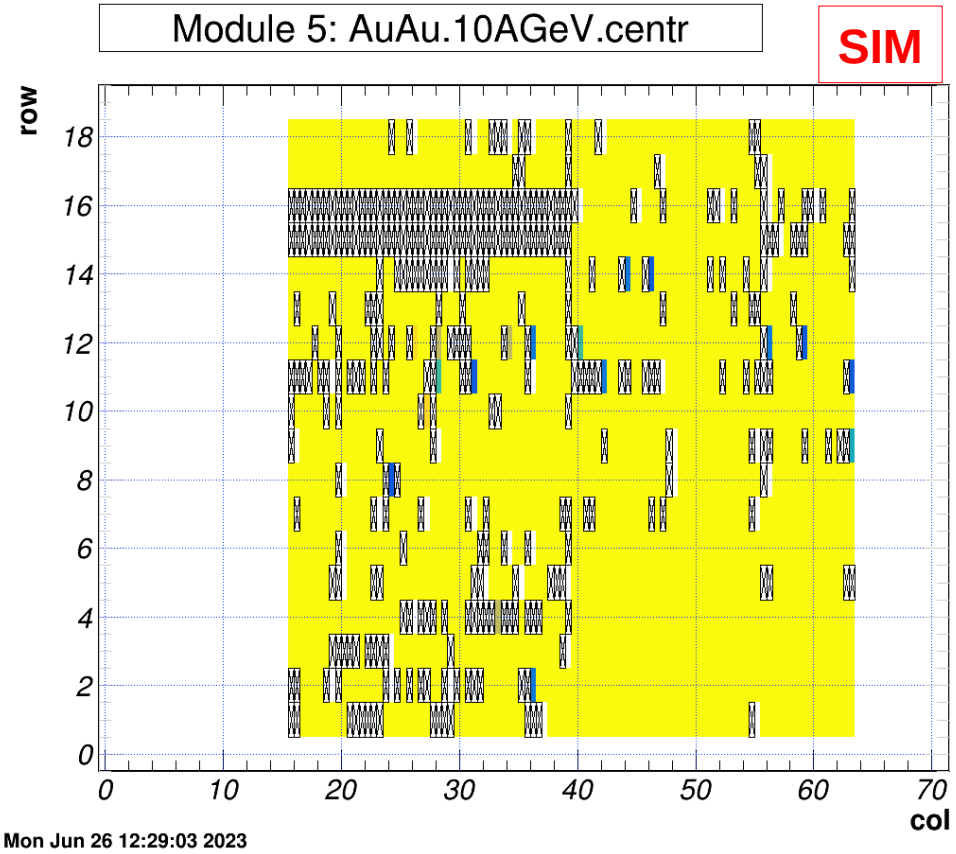
- Minimization procedure, aligning STS-TRD-TOF at once
- black-box approach ? => contact Nora

Channel masks



Comparing DATA - SIMULATION

→ Modeling the TRD2D system seems flexible enough to accommodate a hectic distribution of working FEE.



Masking of TRD2D channels

→ implemented at the level of setup parameters
→ does affect both simulation generation and reconstruction (incomplete cluster)
→ using one unique source to account for the running FEE at all data processing levels (FW, SW, RECO) – reduce copy/paste errors

Tuning TRD2D models to various reconstruction scenarios

Data → TS → Digi Event → low digi/hit multiplicity (easiest and most complete case)
→ *may be biased*
→ Full-TS → high multiplicity, no tracking
→ technical issues due to memory exhaustion solved

→ EbyE → [~~Digi Event~~] → Special care to avoid collision with Full-TS scenario
Sim → TS → Digi Event → checked the event time resolution against data
→ GetOutFile deprecated with TrdDigitize and the output file is not saved successfully.
https://redmine.cbm.gsi.de/issues/2598
→ Full-TS → Tests are on-going (problems with CA)

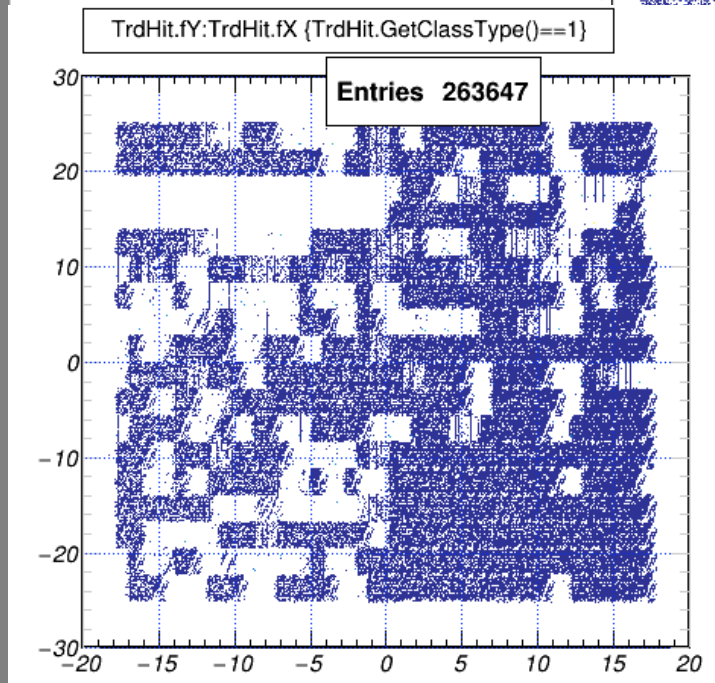
Hit reconstruction

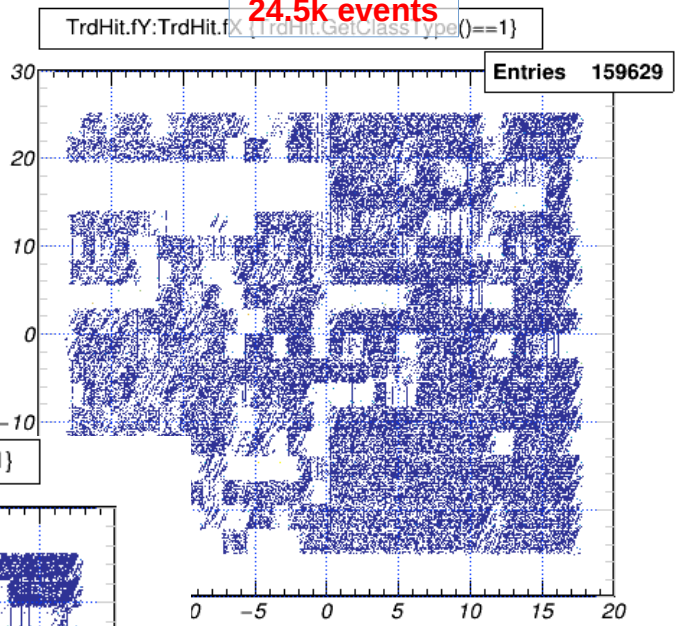
2391 TS0

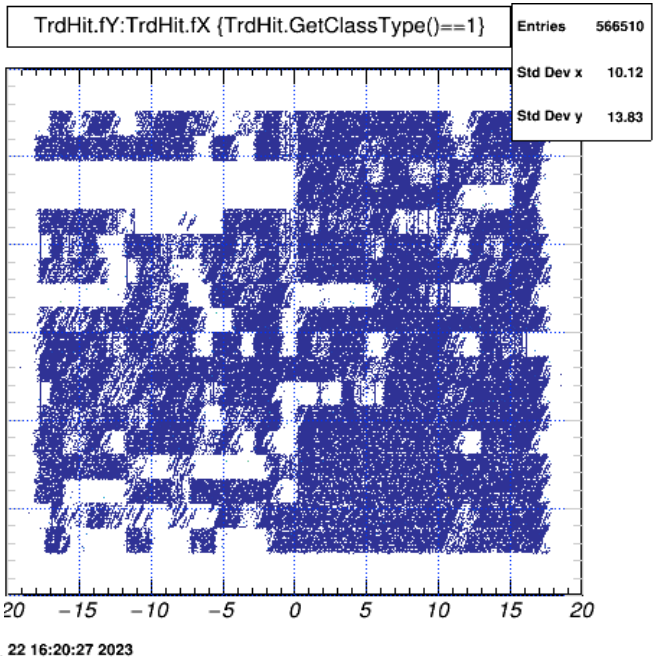
Digi Event
24.5k events

Full-TS

PHQMD
NiNi 1.93 AGeV mbias
97k events



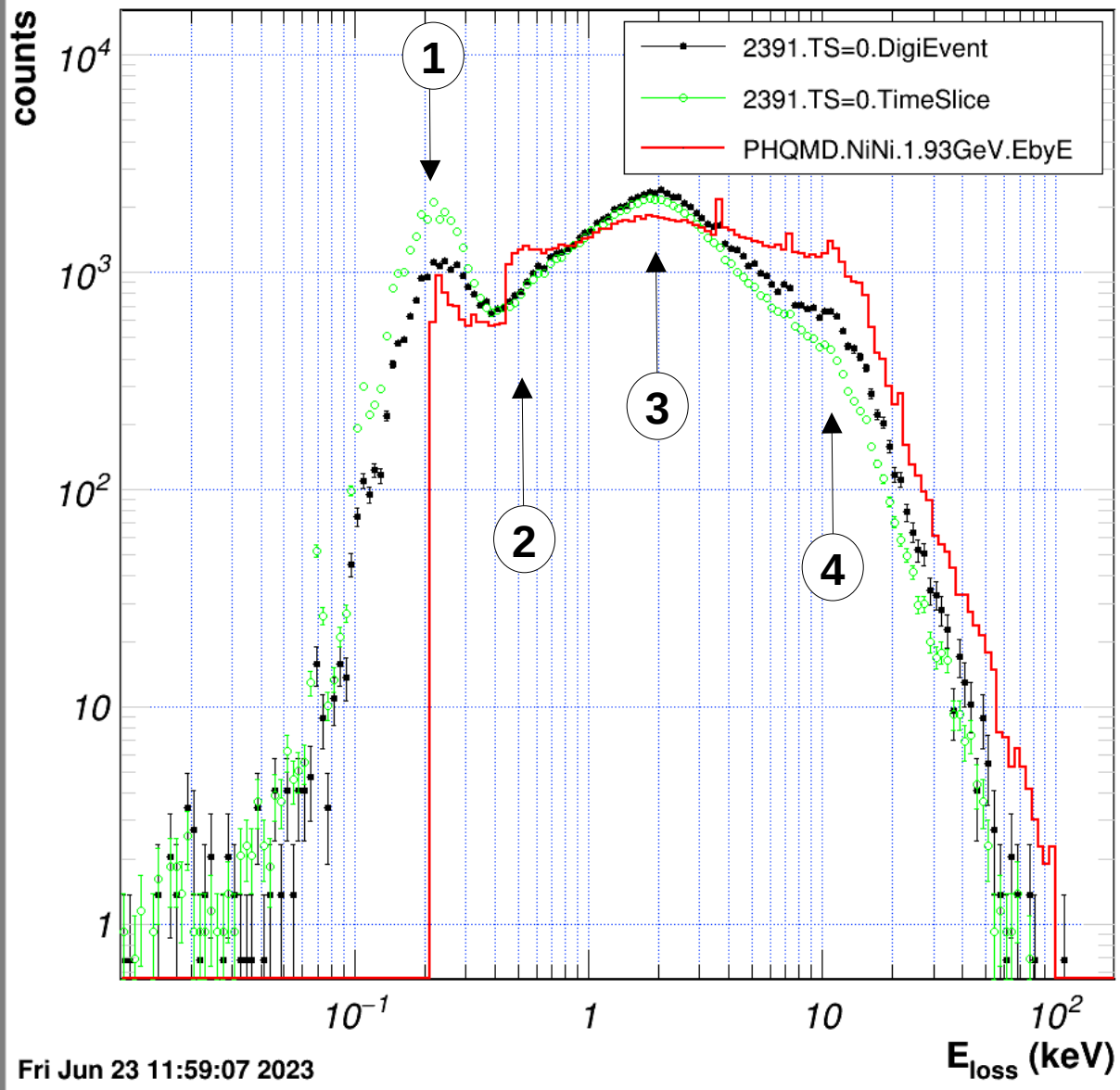




Position reconstruction - *observable sensitive to the* differential *description of CHMB+FEE modeling.*

→ Very similar patterns of acceptance across all biasing scenarios
→ For the TRD2D the patterns of hit distribution DO NOT CHANGE when event constrain is Imposed ! (low noisy hits yields !)
→ Event biased data (not necessarily related to vertex interactions) **6.5 hits/event**
→ THIS Event biasing **looses 72 % of the reconstructable TRD2D hits**.
→ Ideal E-by-E reconstruction gives **2.7 hits/event** (less than half as in data) !

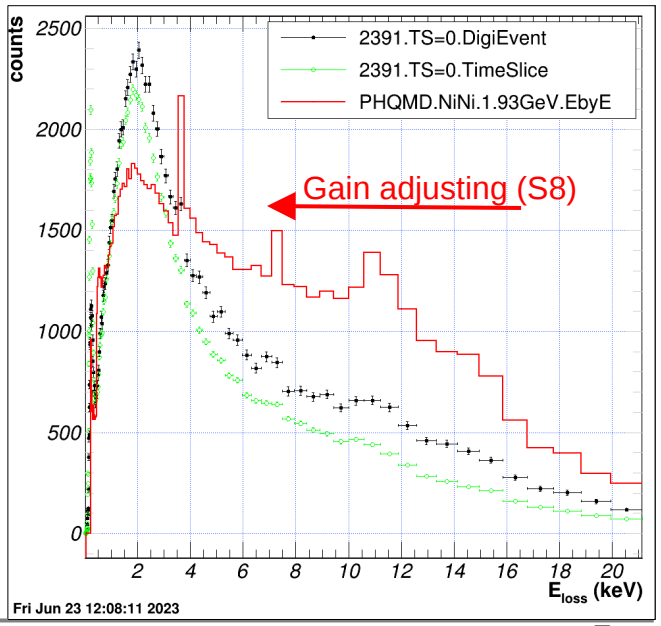
E_{LOSS} distribution



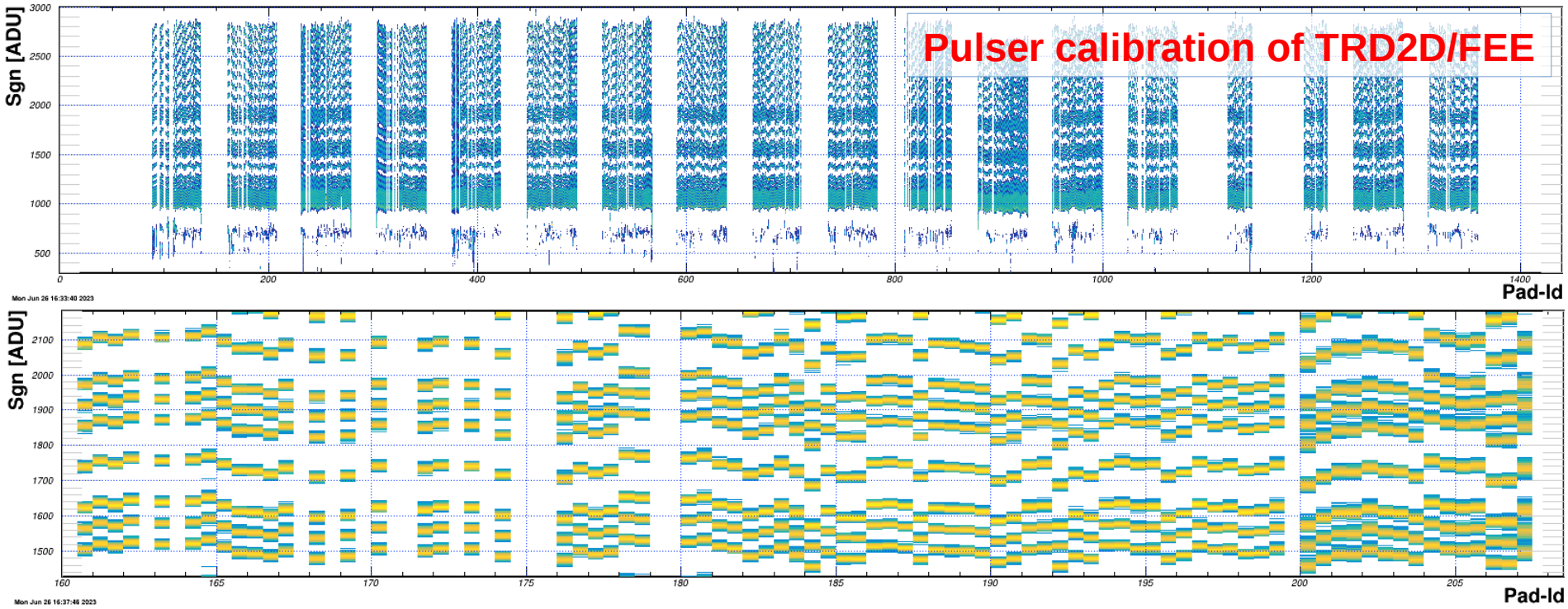
Energy reconstruction – *observable sensitive to the integral description of CHMB+FEE modeling.*

→ Energy reconstruction span 4 decades of energy loss.
→ All spectra show the same profile
→ The digi-event reconstruction is mid-way between the ideal simulated EbyE and un-biased full-TS reco.
→ Differences between data and simulations include :

- MC yield is shifted towards higher E_{LOSS}
- DATA yields arenot matched at low E_{LOSS}



Calibrating data and tuning simulations

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# Context: TestDefaultContext
##############################################################################
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RepoPid:  Text_t \
  parameters/trd/Likelihood_Xenon_85_GSI_12.root
Gas:  Text_t \
  Xe_80
NrOfModules:  Int_t  3
ModuleIdArray:  Int_t \
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5:  Int_t \
  1900 500 1 1
21:  Int_t \
  1600 500 0 0
37:  Int_t \
  1600 500 0 0
##############################################################################
```

Gas gain *in simulation has to be matched with the one used in data acquisition.*

→ *gas Xe, U_A[kV] = 1.90, U_D[kV] = 0.5*

While in mCBM'22 the setting was
→ *gas Ar, U_A[kV] = 1.85, U_D[kV] = 0.7*

SIM

DATA

Channel to channel variations in real detector (due to production variation of CHIPs and FEBs) is calibrated out by registering single pitched signals simultaneously in all channels.

This variation softens the E_{LOSS} spectrum from S7

Tracking
Private display of events

Disclaimer : I intended to use/test Pierre development MR 1119.
Afraid the collision with my MR 1179 already in conflict with Dominick MR ...