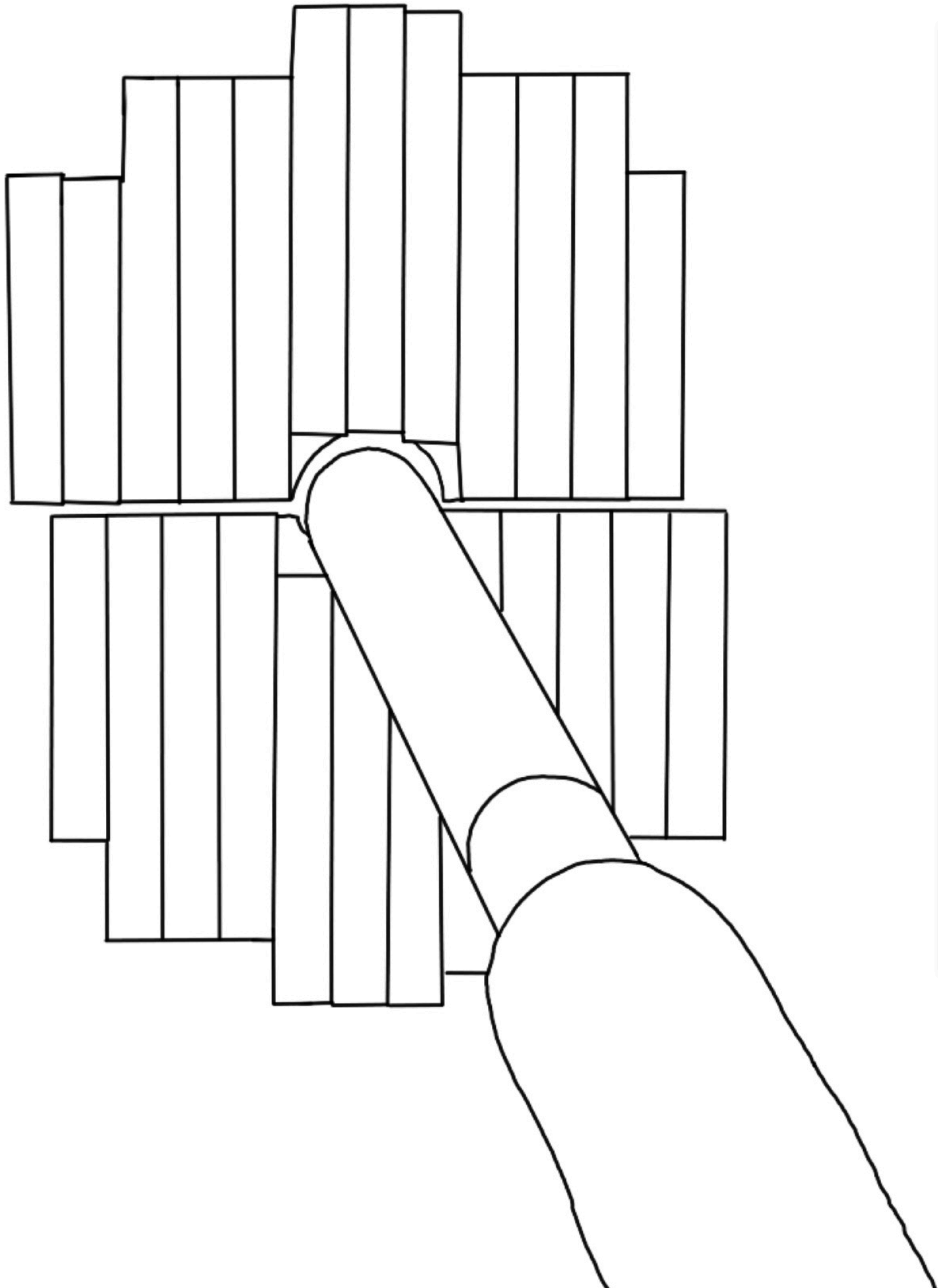


Status of the MFT

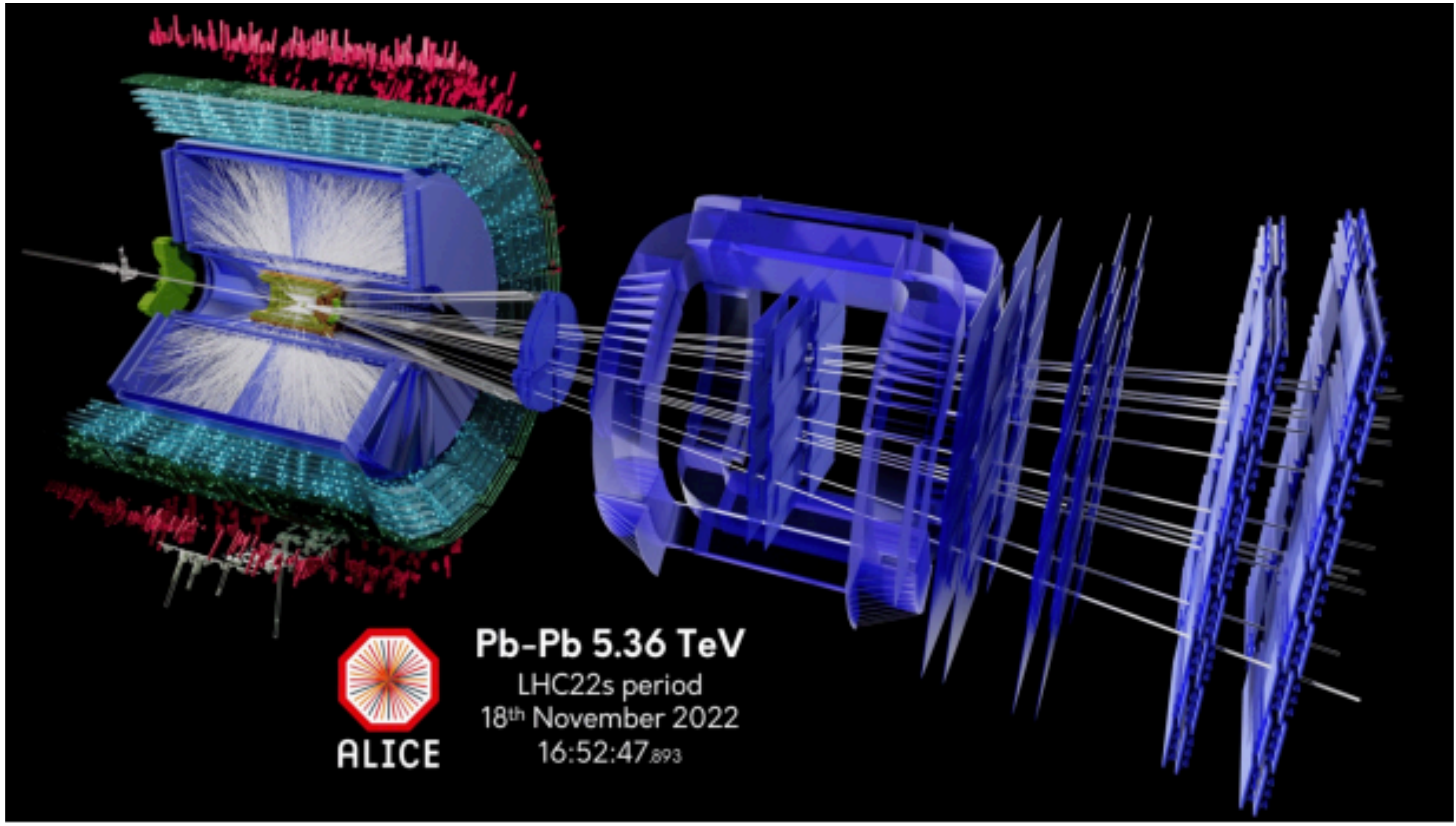
6. miniworkshop difrakce a ultraperiferních srážek, Děčín

14 September 2023

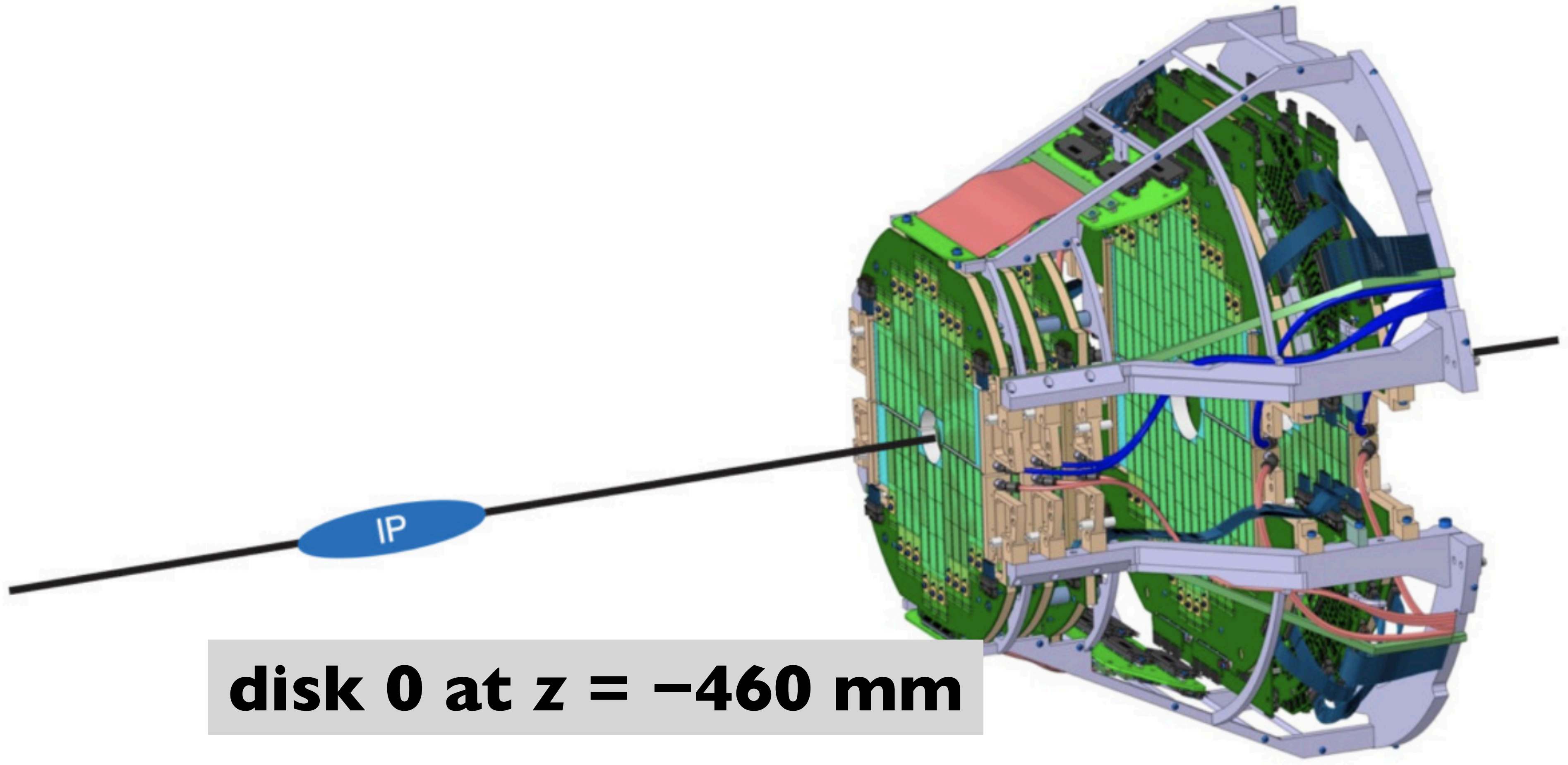
Diana Krupova

Outline

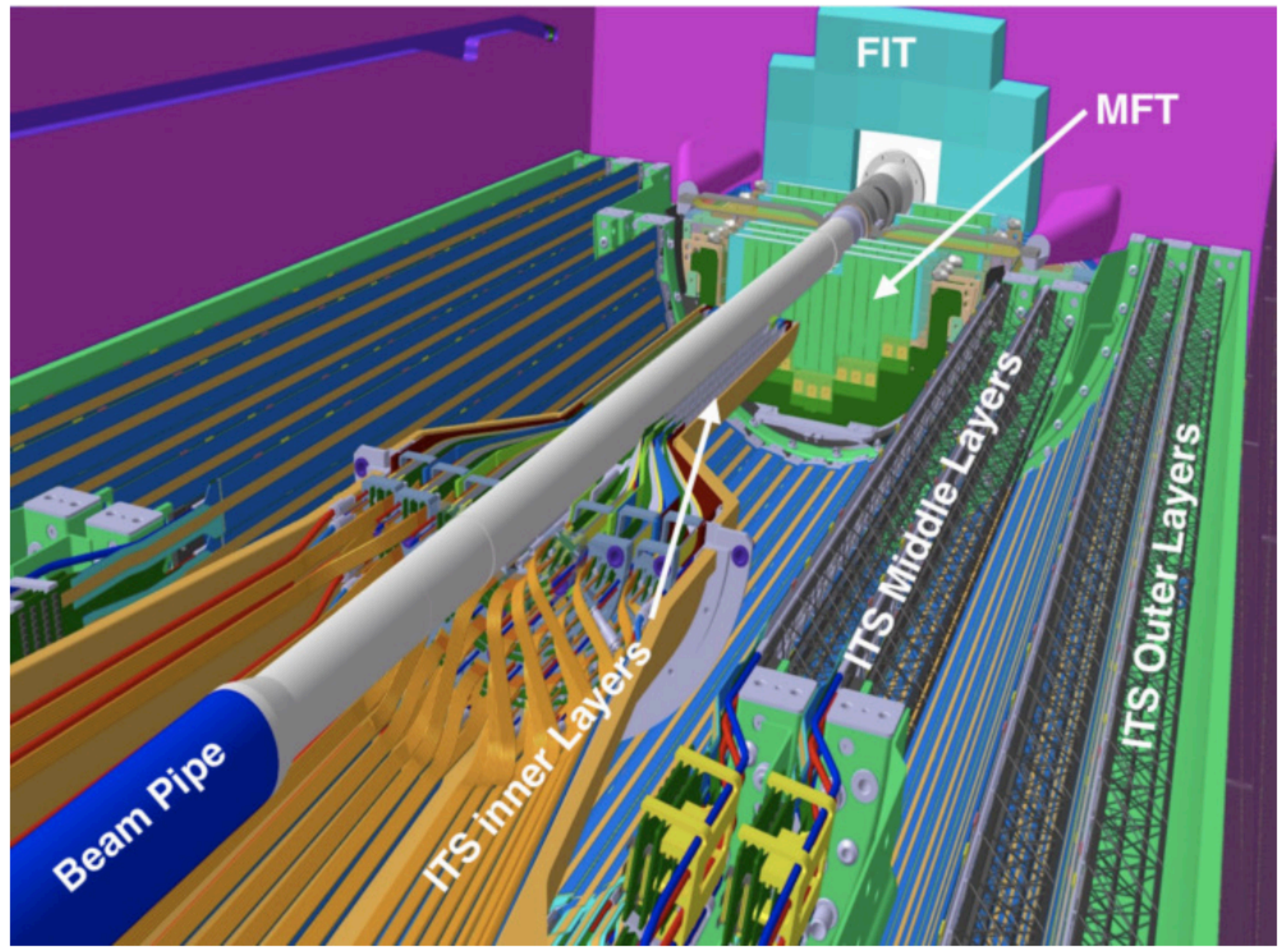
- MFT data taking in 2022 and 2023
- calibrations and readout
- improvements in MFT QC
- improvements in MFT tracking, alignment, timing
- MFT status for upcoming Pb-Pb data taking

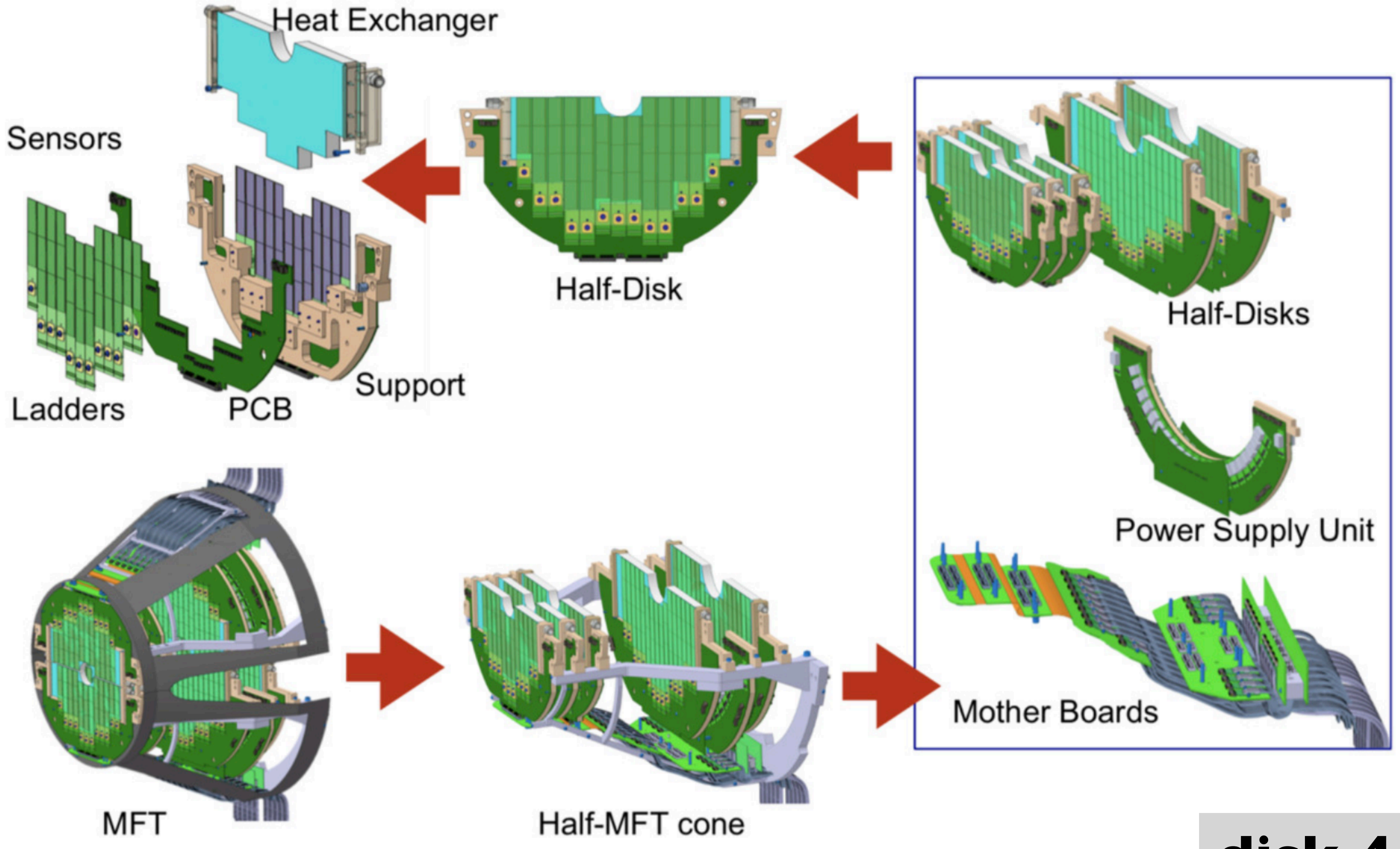


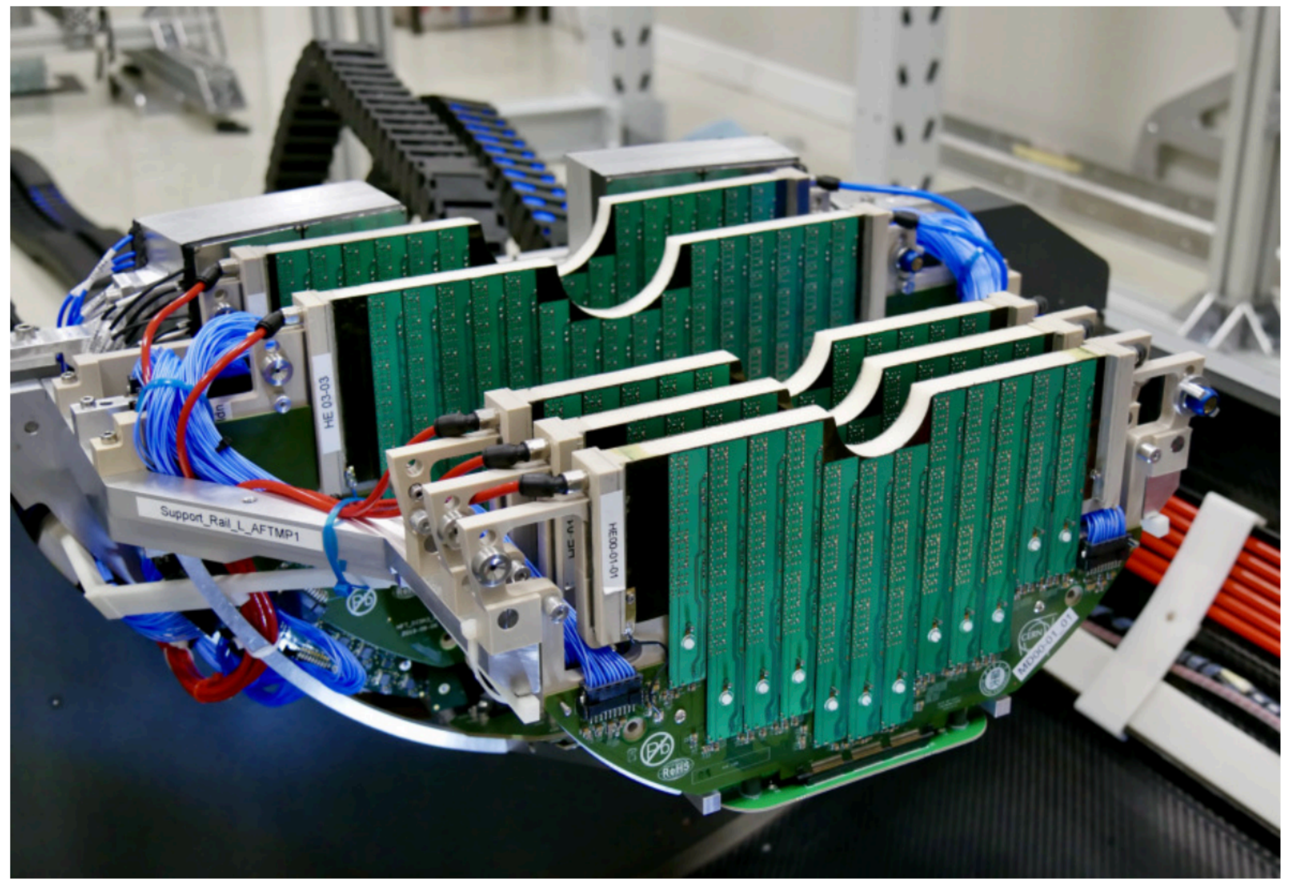
MFT layout

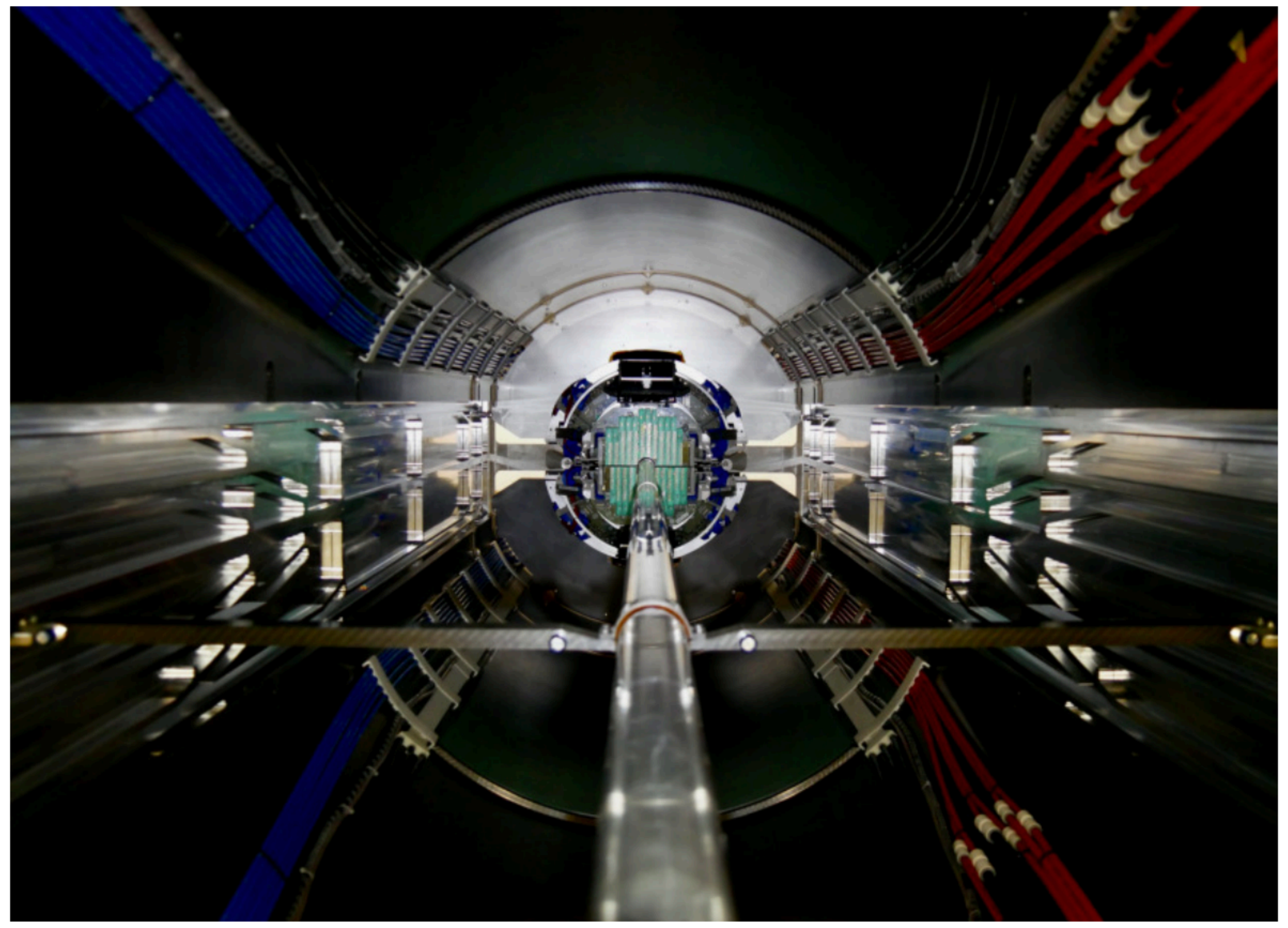


disk 0 at z = −460 mm





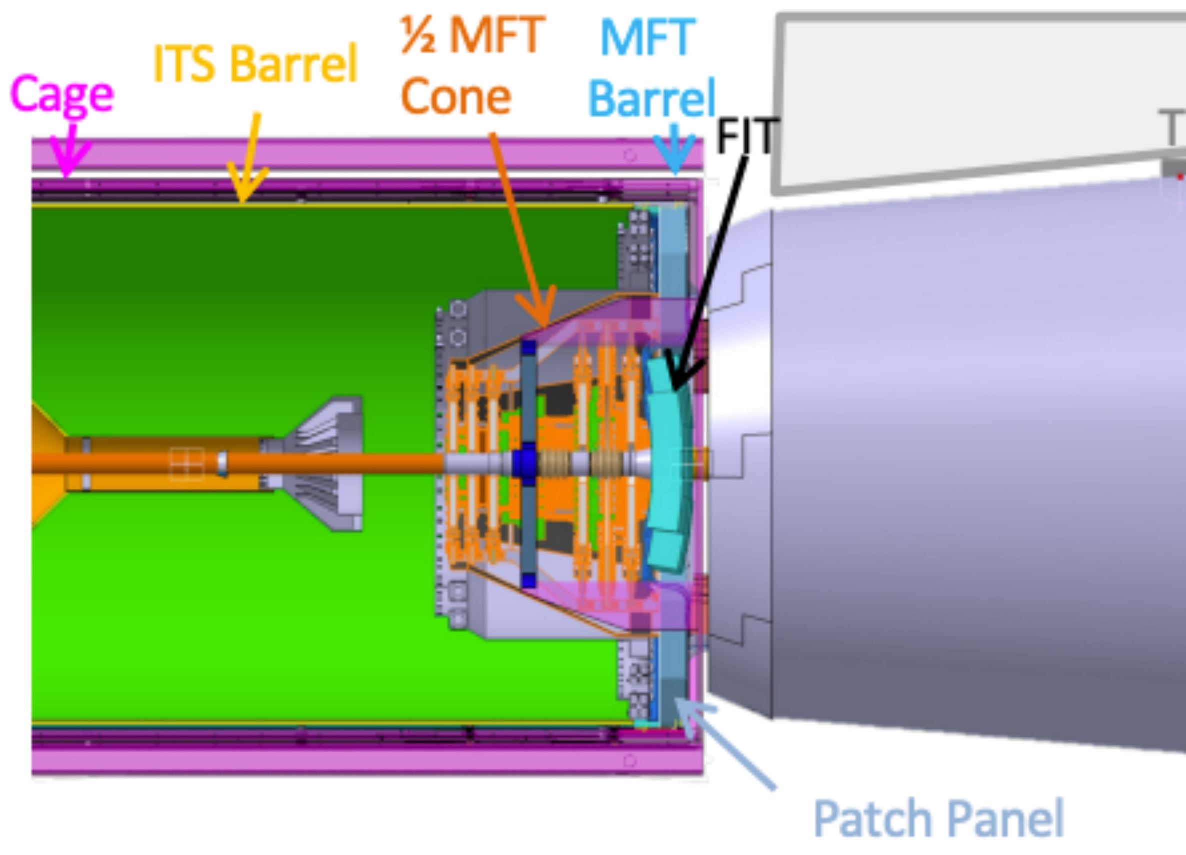


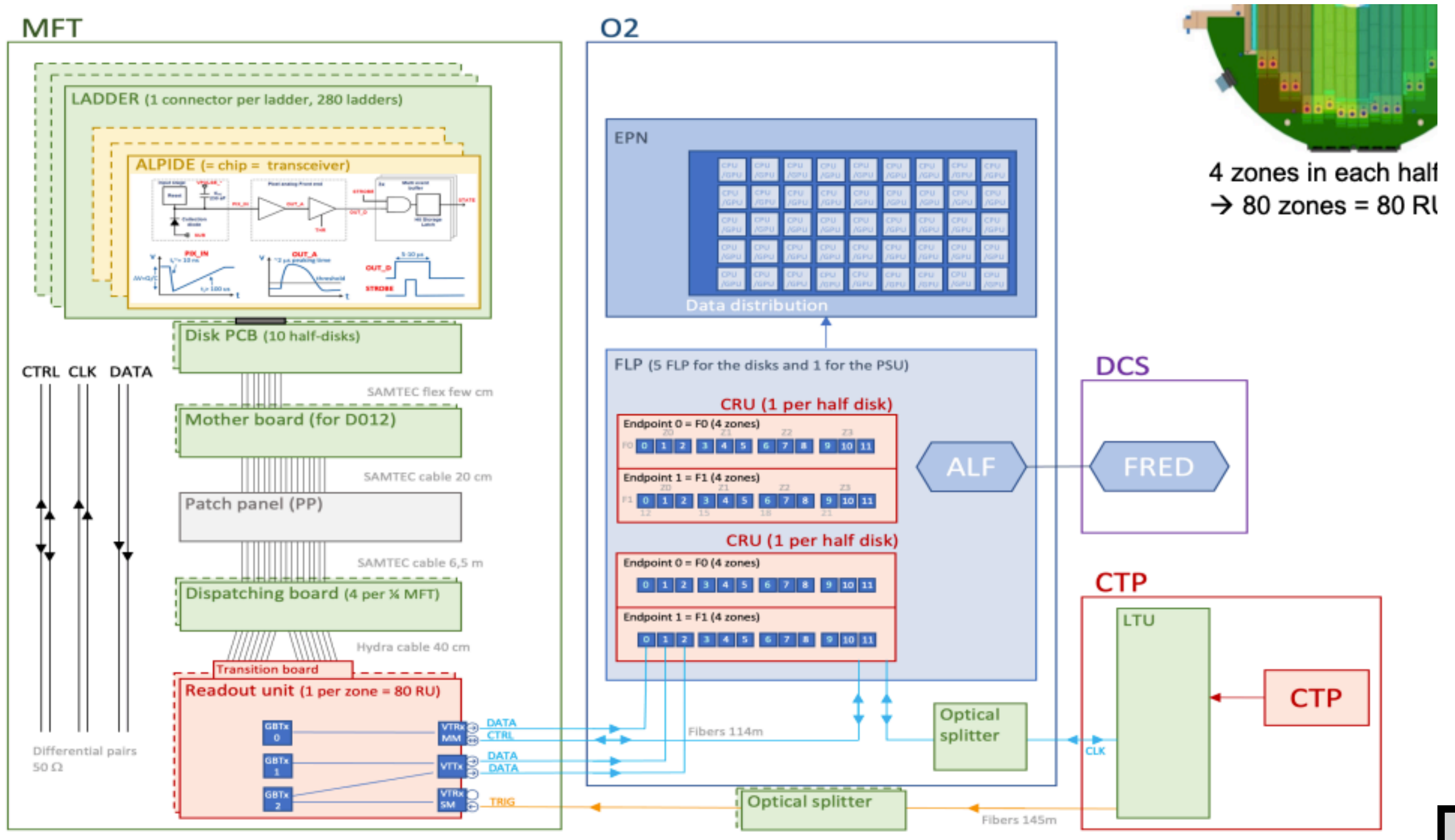


disk 4 at z = −768 mm

From installation to data taking

- MFT installed in December 2022, commissioning during 2021 and 2022
- 3% of MFT chips not active:
  - 14 dead chips
  - 14 masked chips due to configuration and tests errors
- located on disks 0 and 1 (redundant for reconstruction)
- functional tests regularly carried out to monitor situation





Data taking in 2022 and 2023

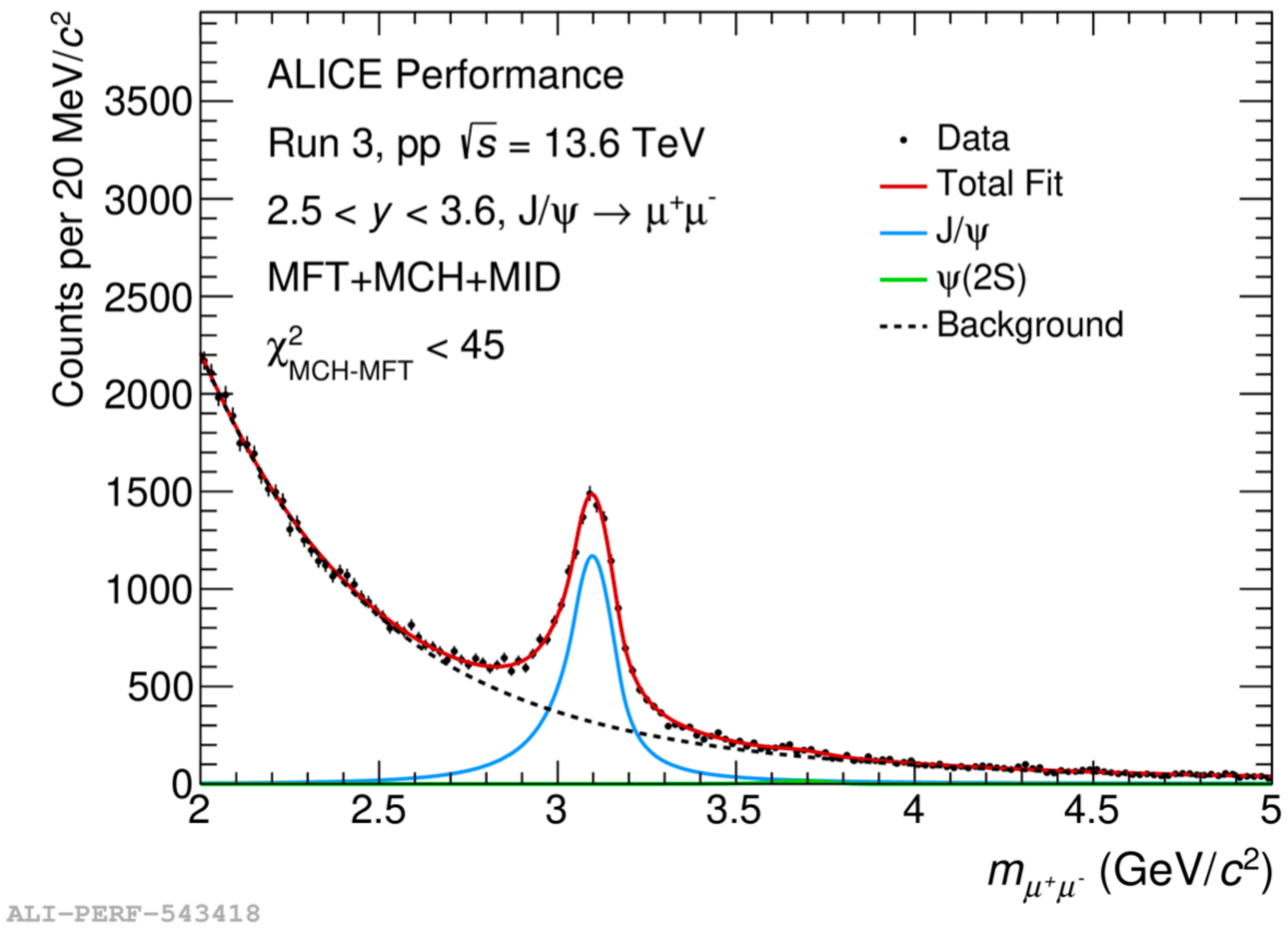
- 2022: MFT participated in 91.1% of global good PHYSICS runs (=910h, 558 runs)

- 2023: MFT included in more than 97% of global runs

    - pp physics production at 500 kHz

    - pp IR scans from few Hz to 4 MHz for Pb-Pb preparation

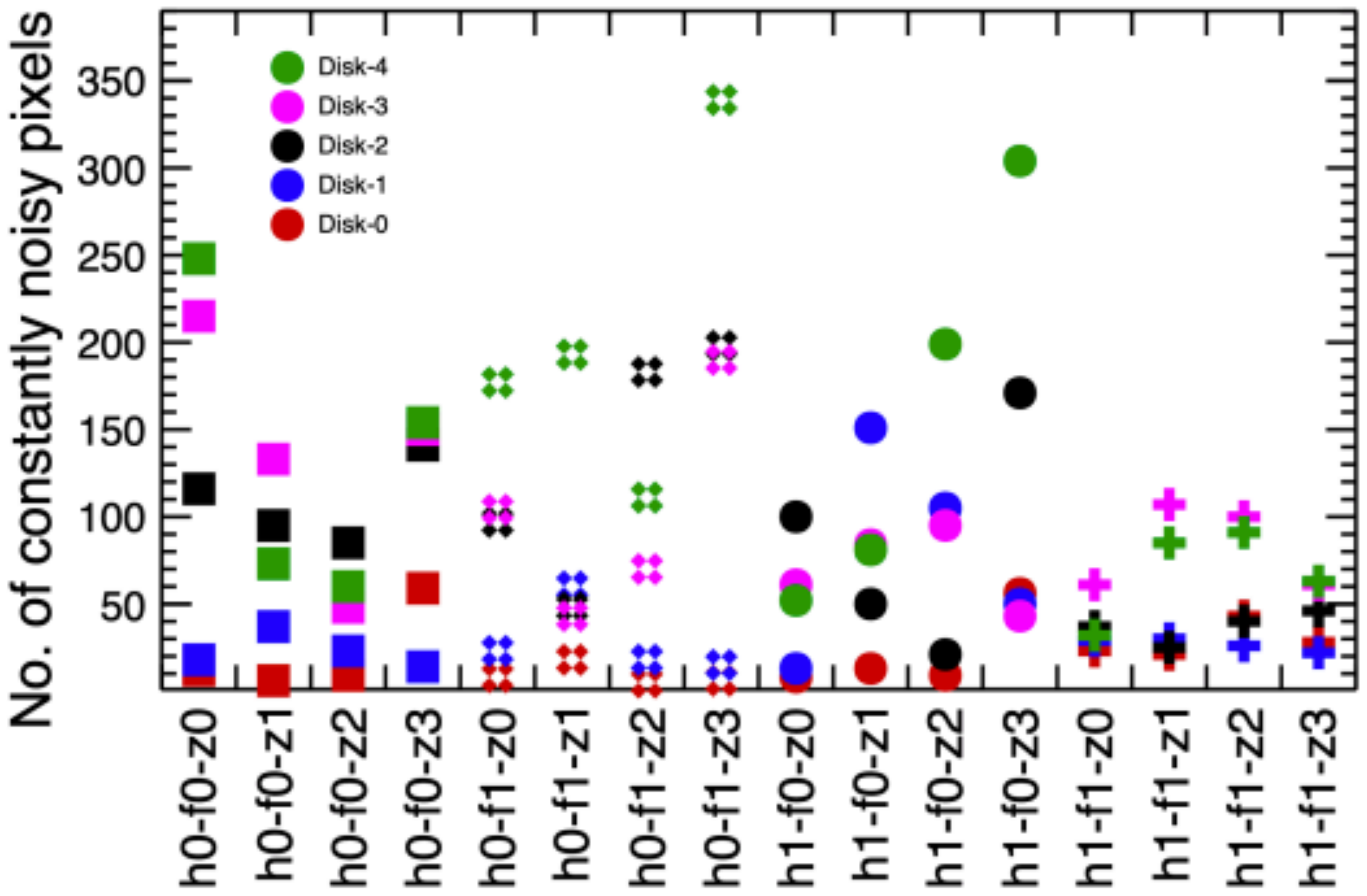
    - Pb-Pb with IR 30 Hz (pilot beam)



an example of invariant mass of J/ψ and ψ(2S) in Run 3 in pp collisions at $\sqrt{s} = 13.6$ TeV produced using the DQ framework

MFT calibration

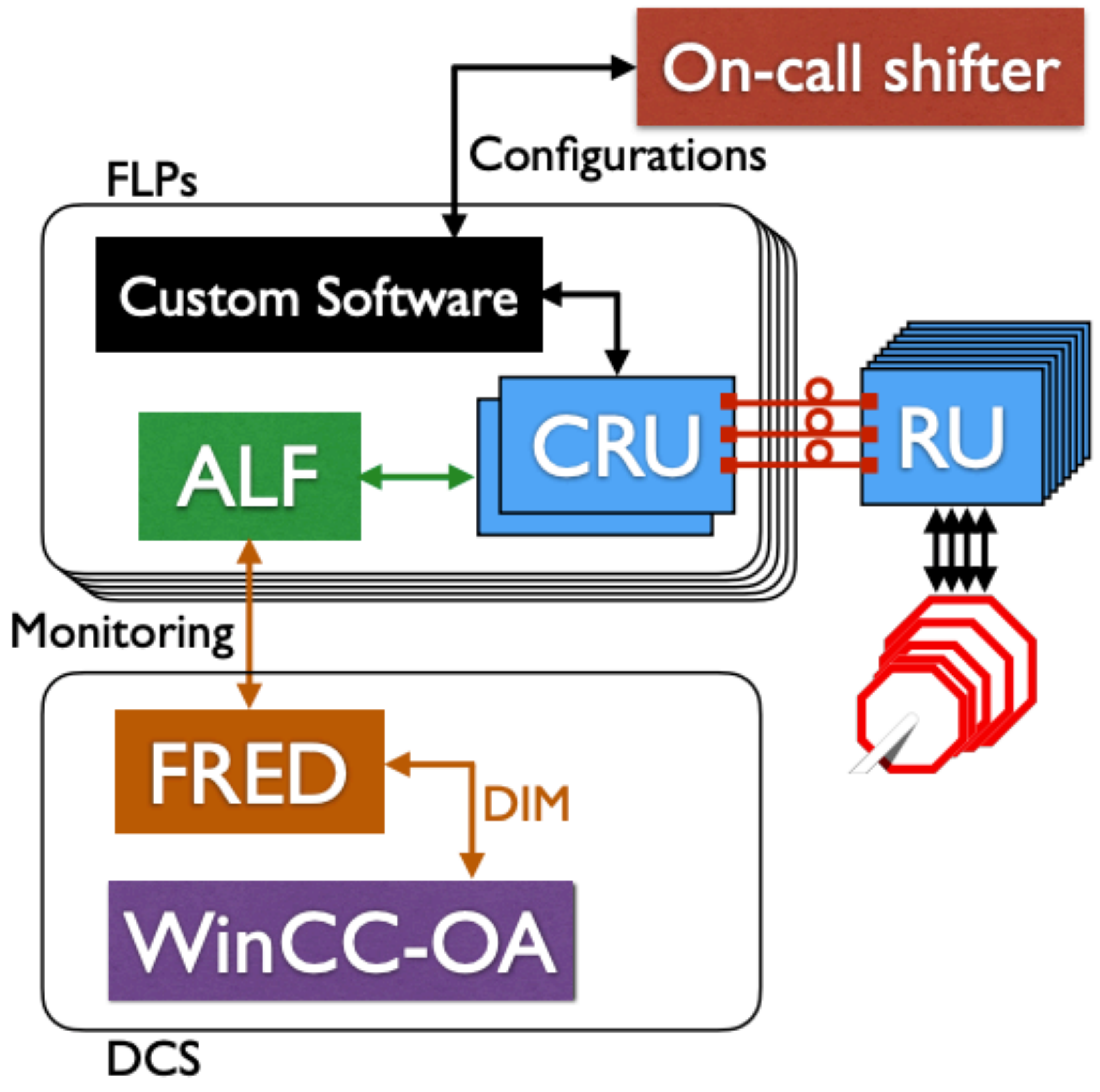
- noise scan:
  - regularly taken by central shift crew at each beam dump
  - allows to measure the noisy pixels and mask them
  - noise level stable over time
  - latest noise map sent to CCDB and automatically loaded in DCS confDB



Number of constantly noisy pixels in the whole MFT

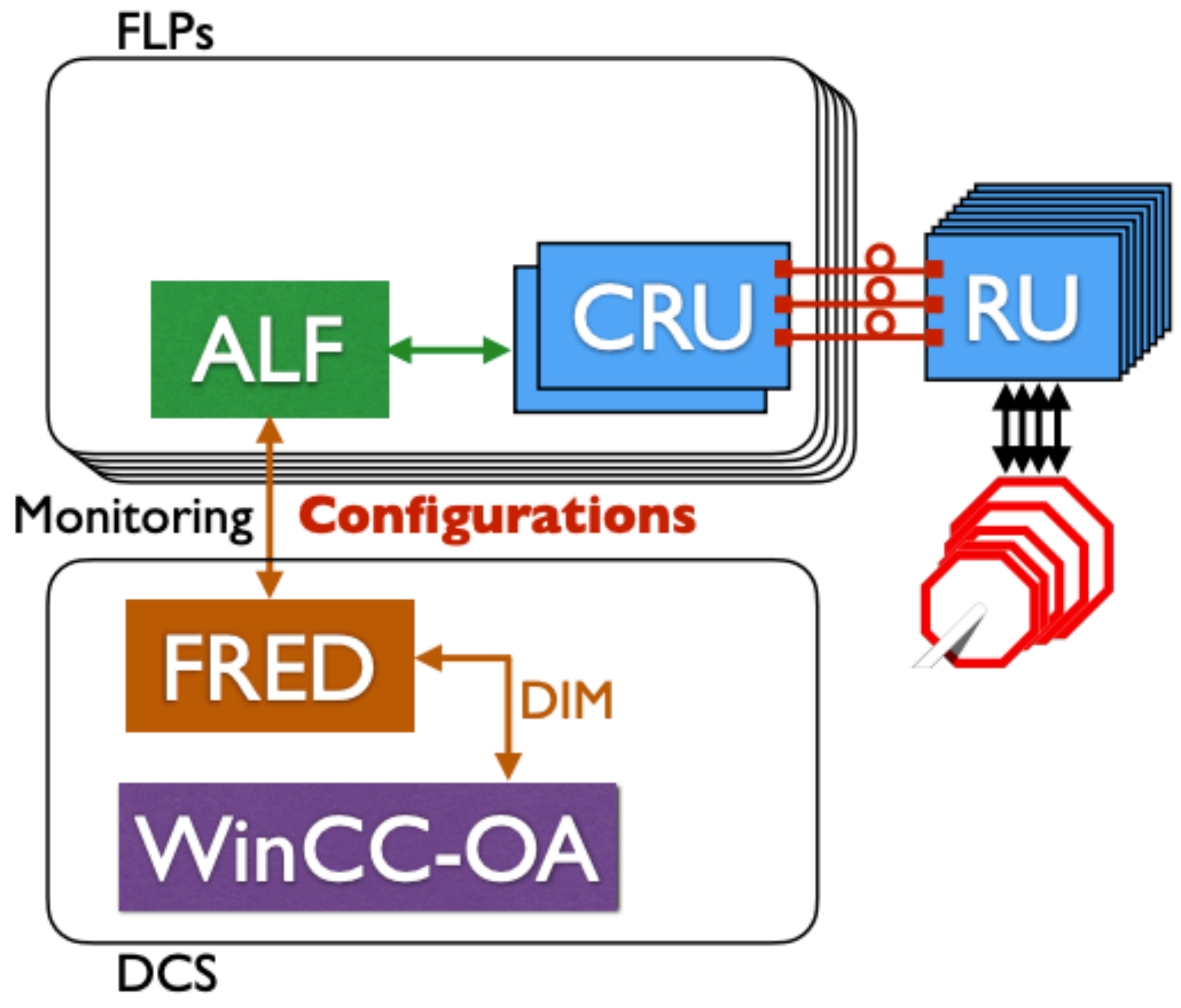
MFT readout

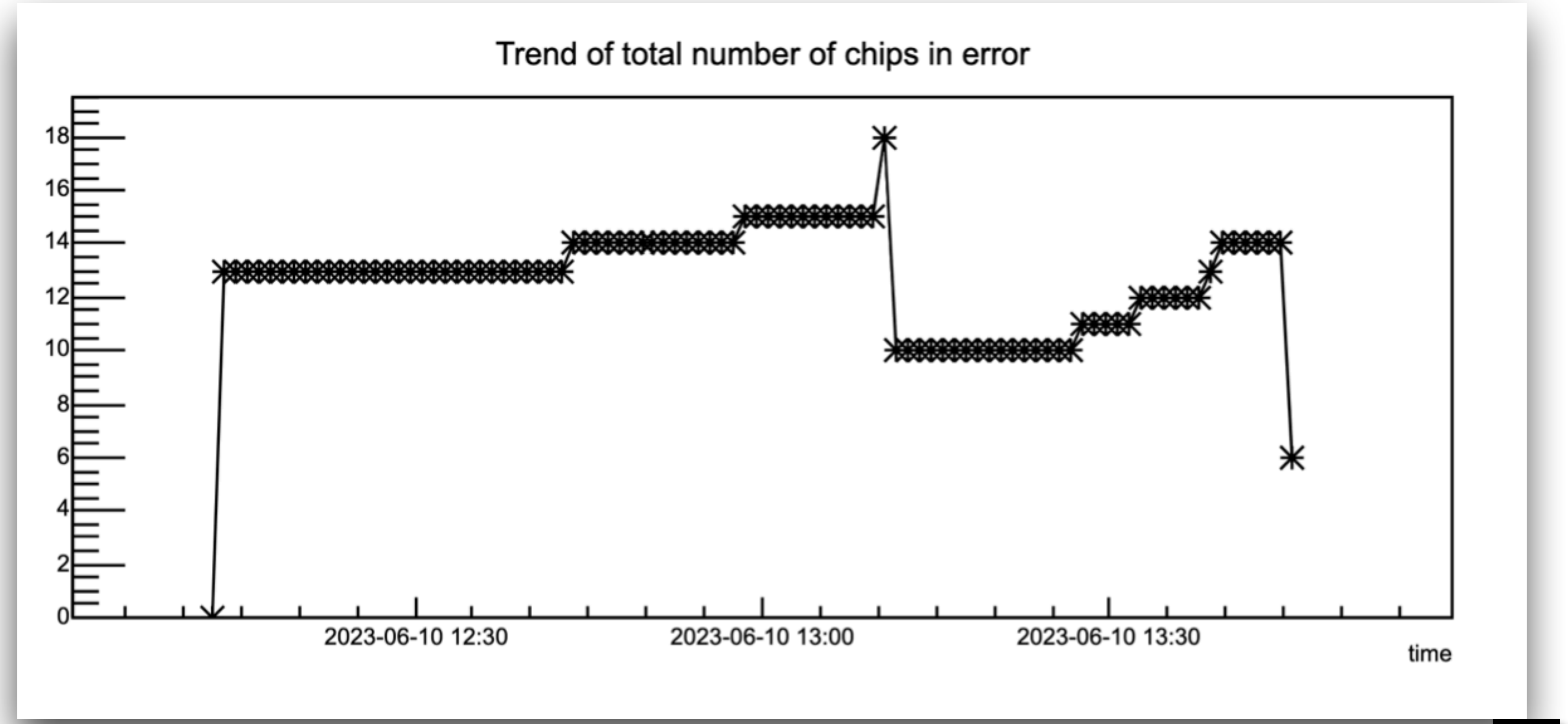
- in 2022:
  - on-call shifter had to configure RU+chips manually
  - using python script running on each FLP
- in 2023:
  - configuration triggered by DCS (FRED)
  - automatic selection of configuration based on run type (physics, cosmics, technical, synthetic, noise)
  - ALPIDE chips automatically recovered! 🎉



MFT sensor recovery

- automatically recovered during run if:
    - error: error in reception of data
    - fault: violation of protocol
- if a chip is still in error/fault after 3 recoveries, it will be excluded from recovery procedure during the current run
- **visible in trending plots of the readout task**:

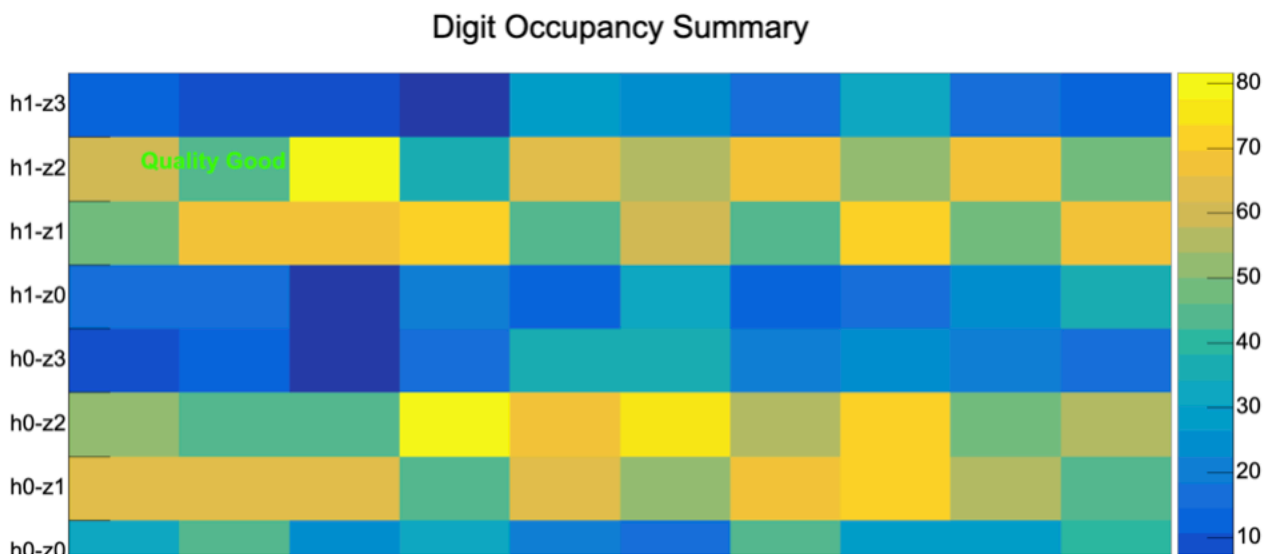




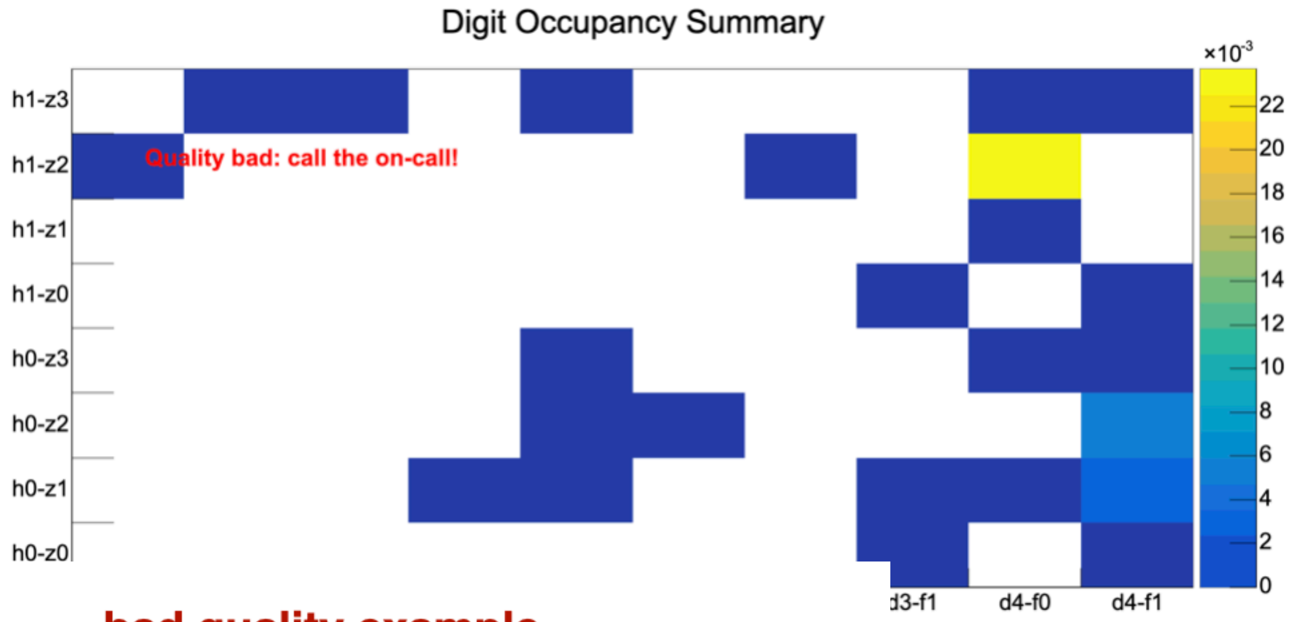
Improvements in MFT QC

- instructions for QC shifters
- references (good and bad example) included

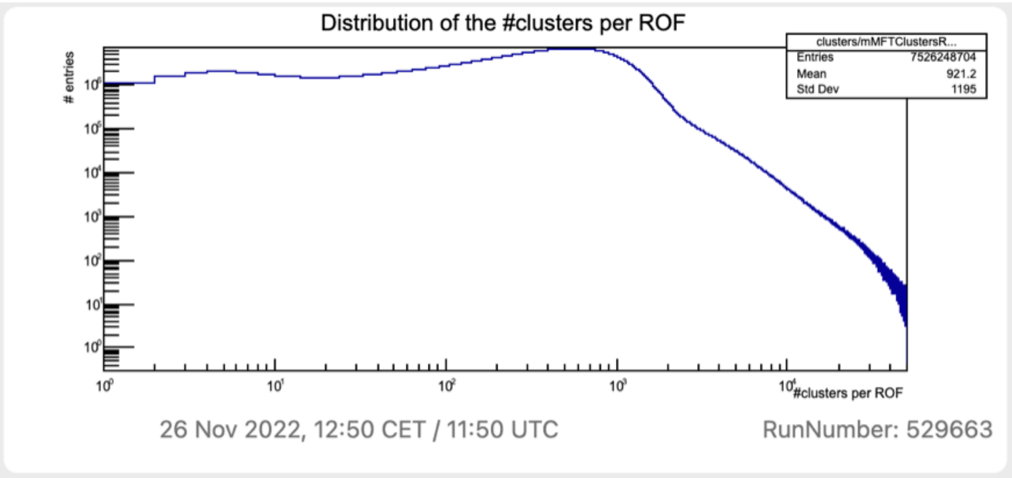
green message: good quality



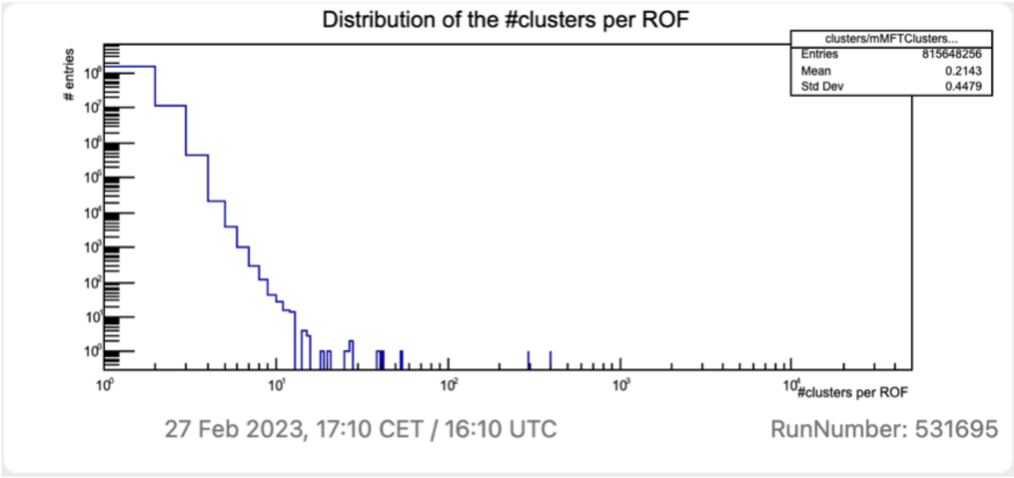
red message: bad quality



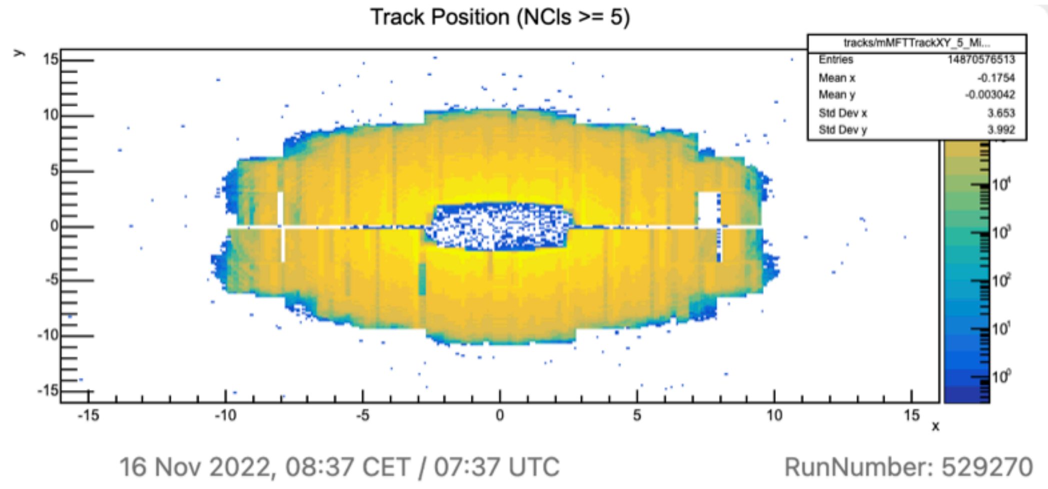
good quality example



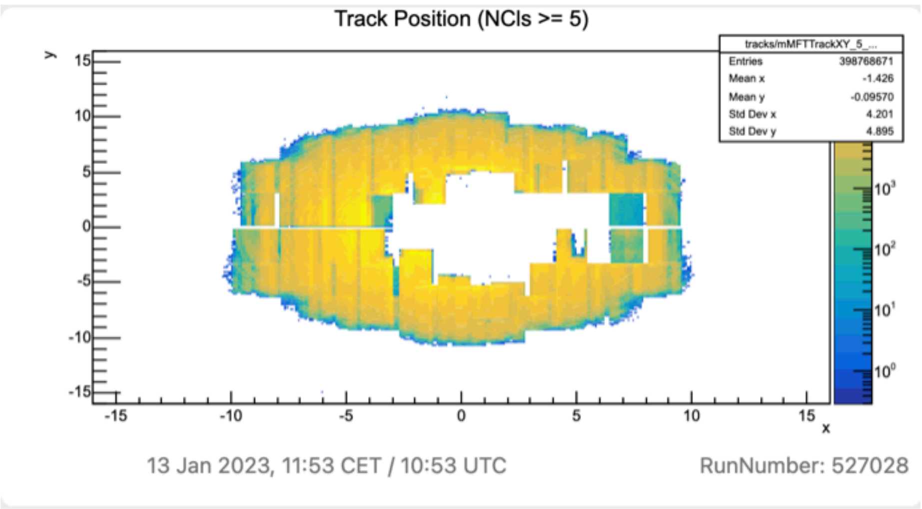
bad quality example



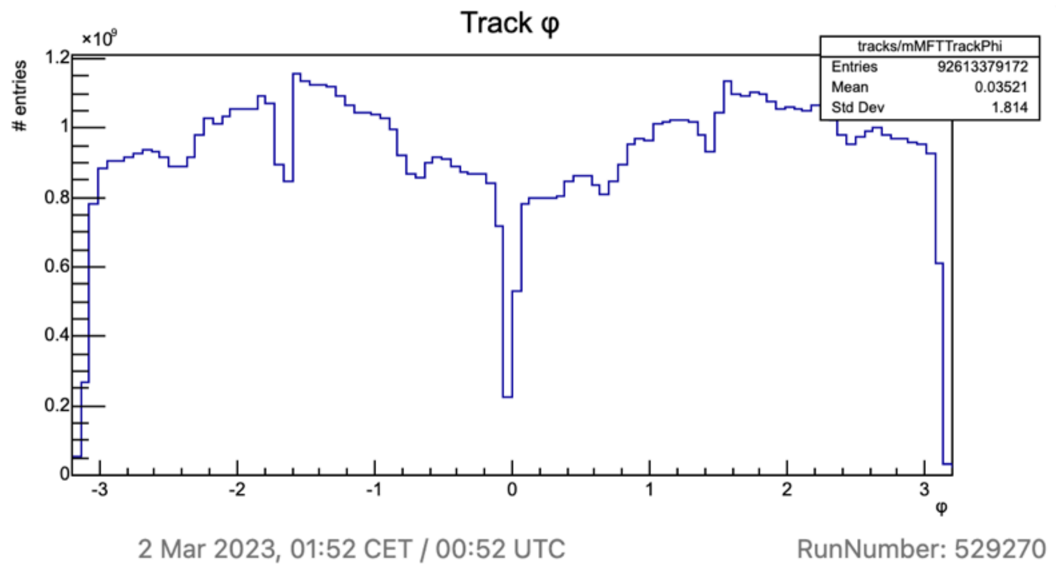
good quality example



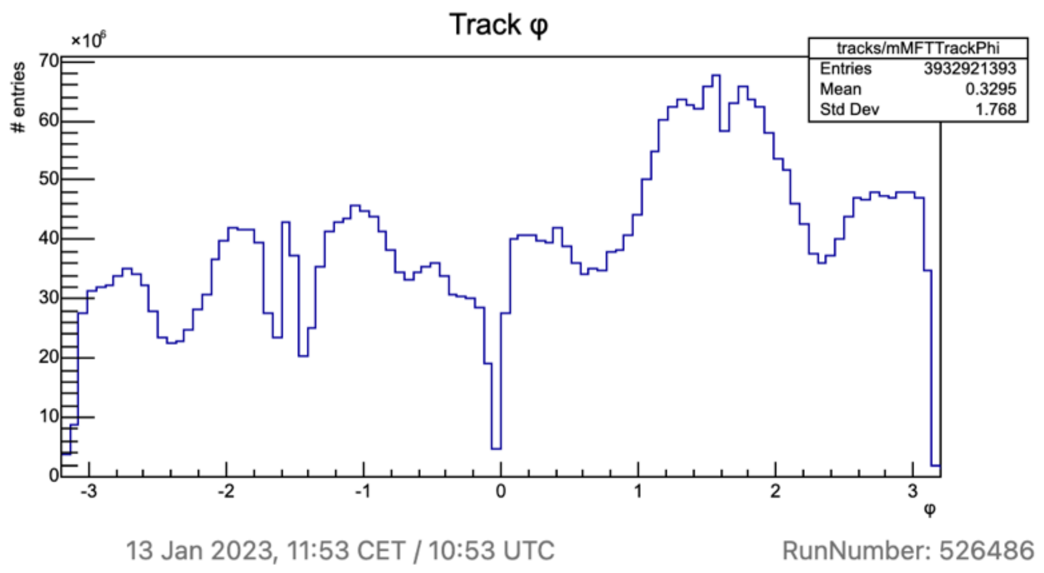
bad quality example



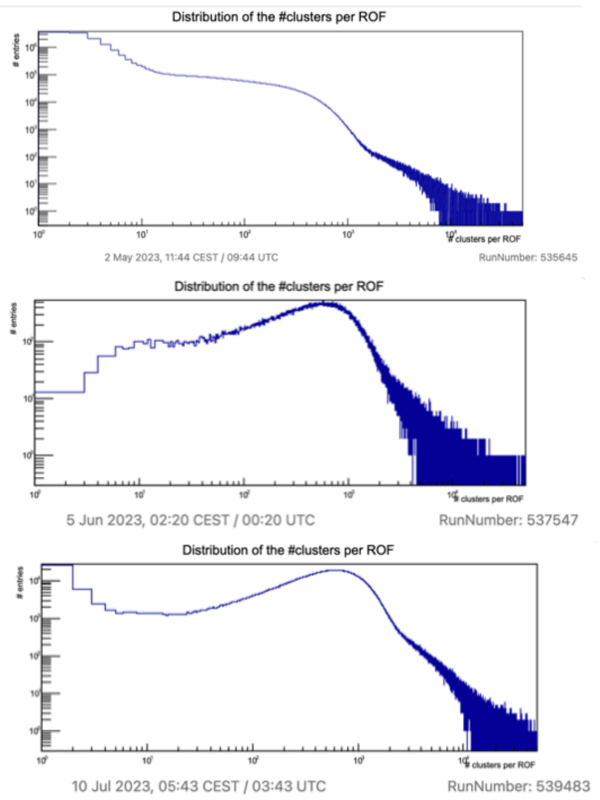
good quality example



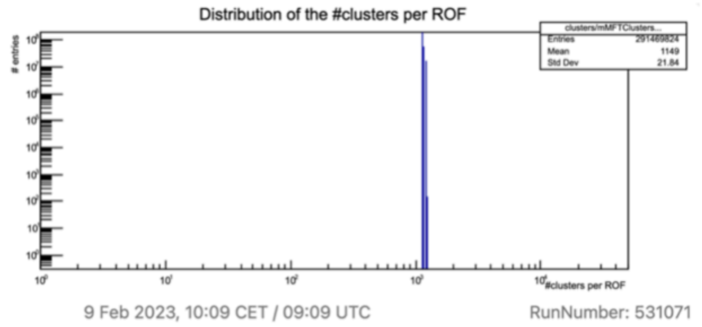
bad quality examp..



good quality examples

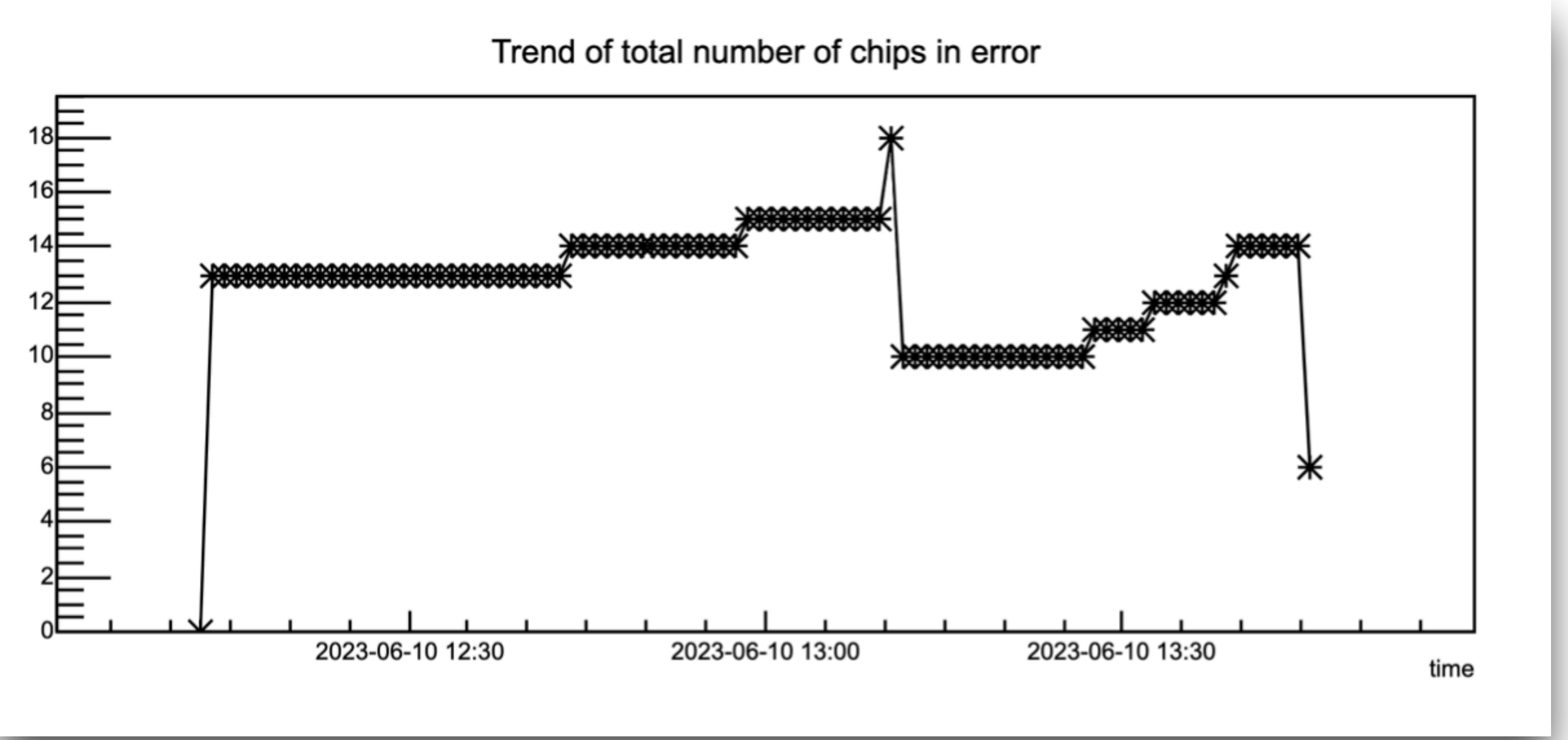


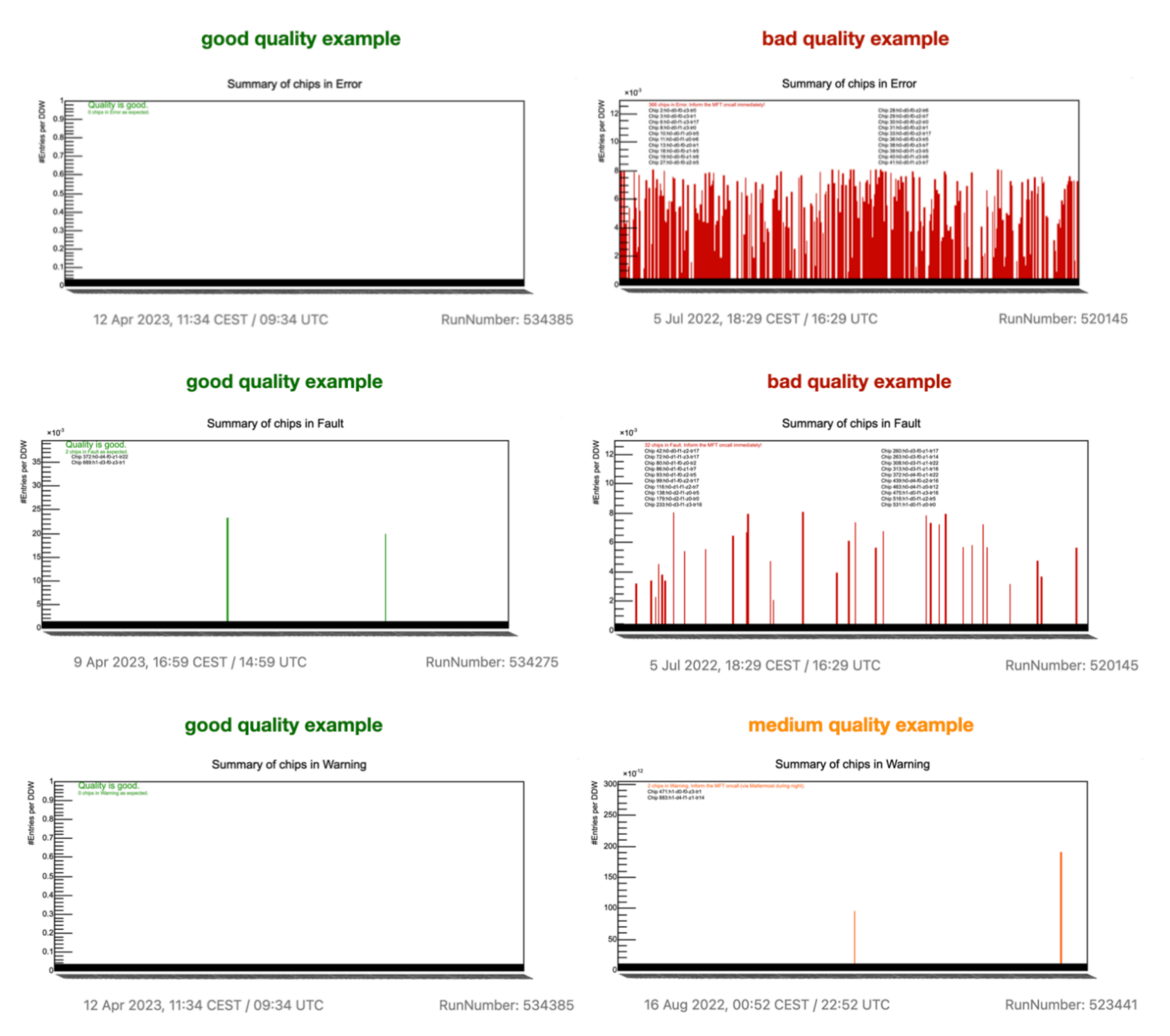
bad quality example



Improvements in MFT QC

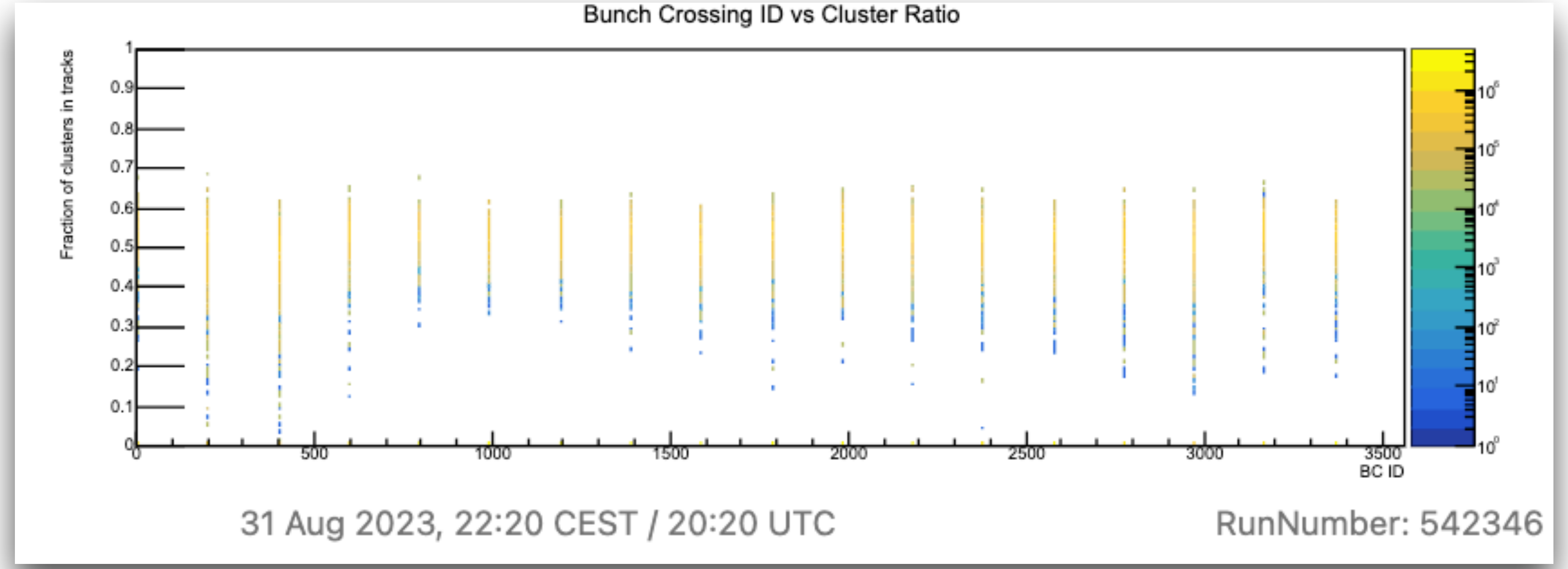
- QC readout histograms reset at each cycle (60s)
- in case of beam splash, the quality is not deteriorated

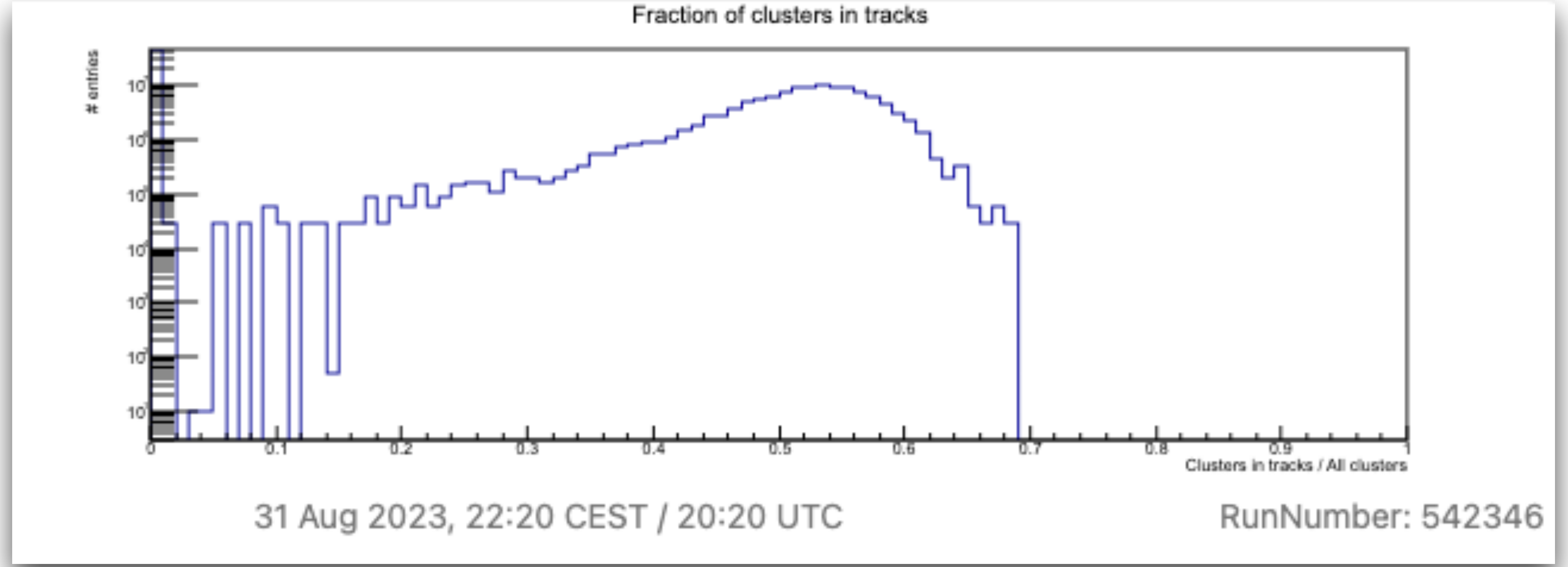




Improvements in MFT QC

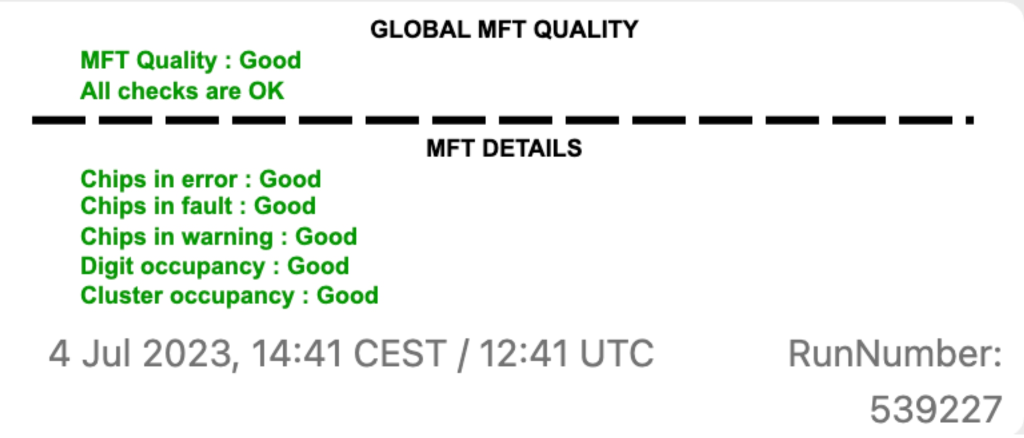
- displaying information about BC IDs and fraction of clusters in tracks

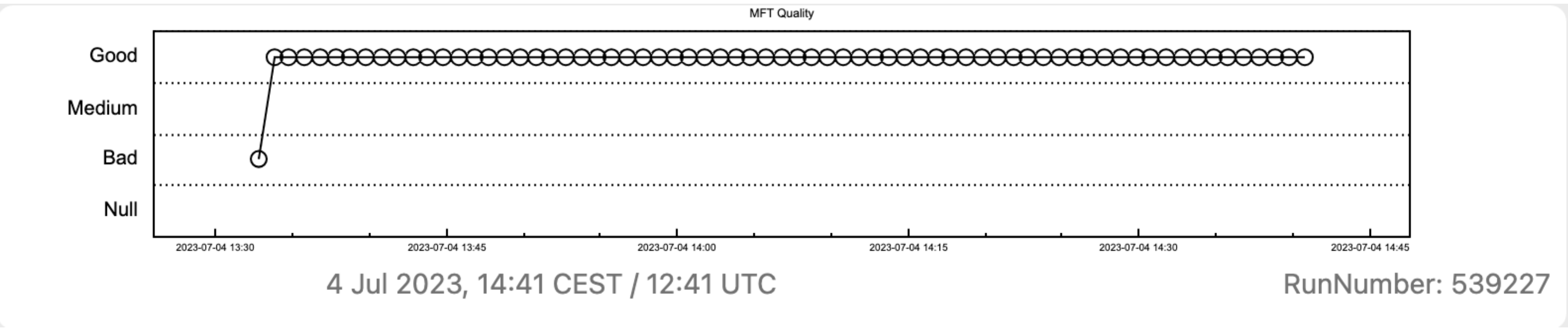


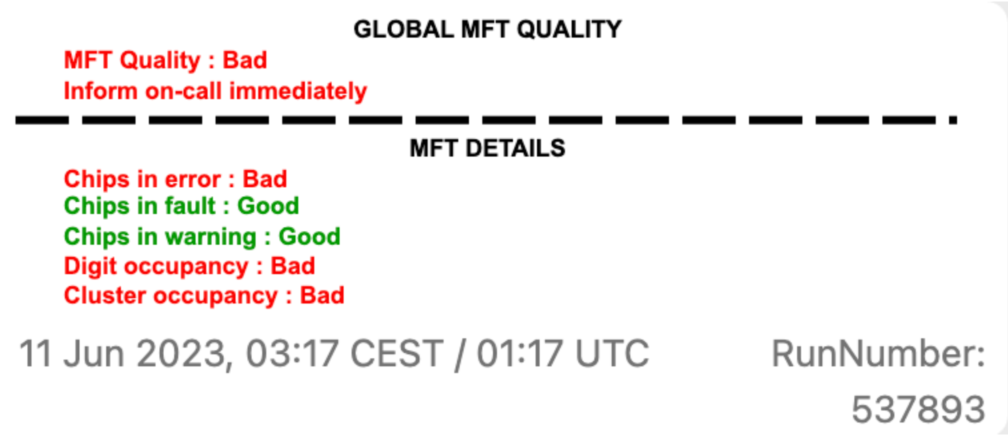


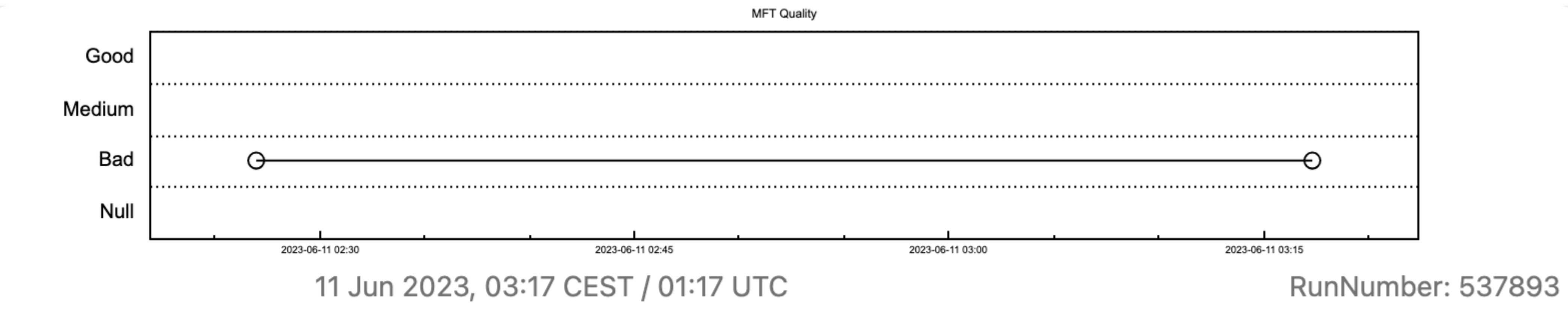
Improvements in MFT QC

- quality aggregator implemented
- to easily monitor the overall quality of a run by the central QC shifter



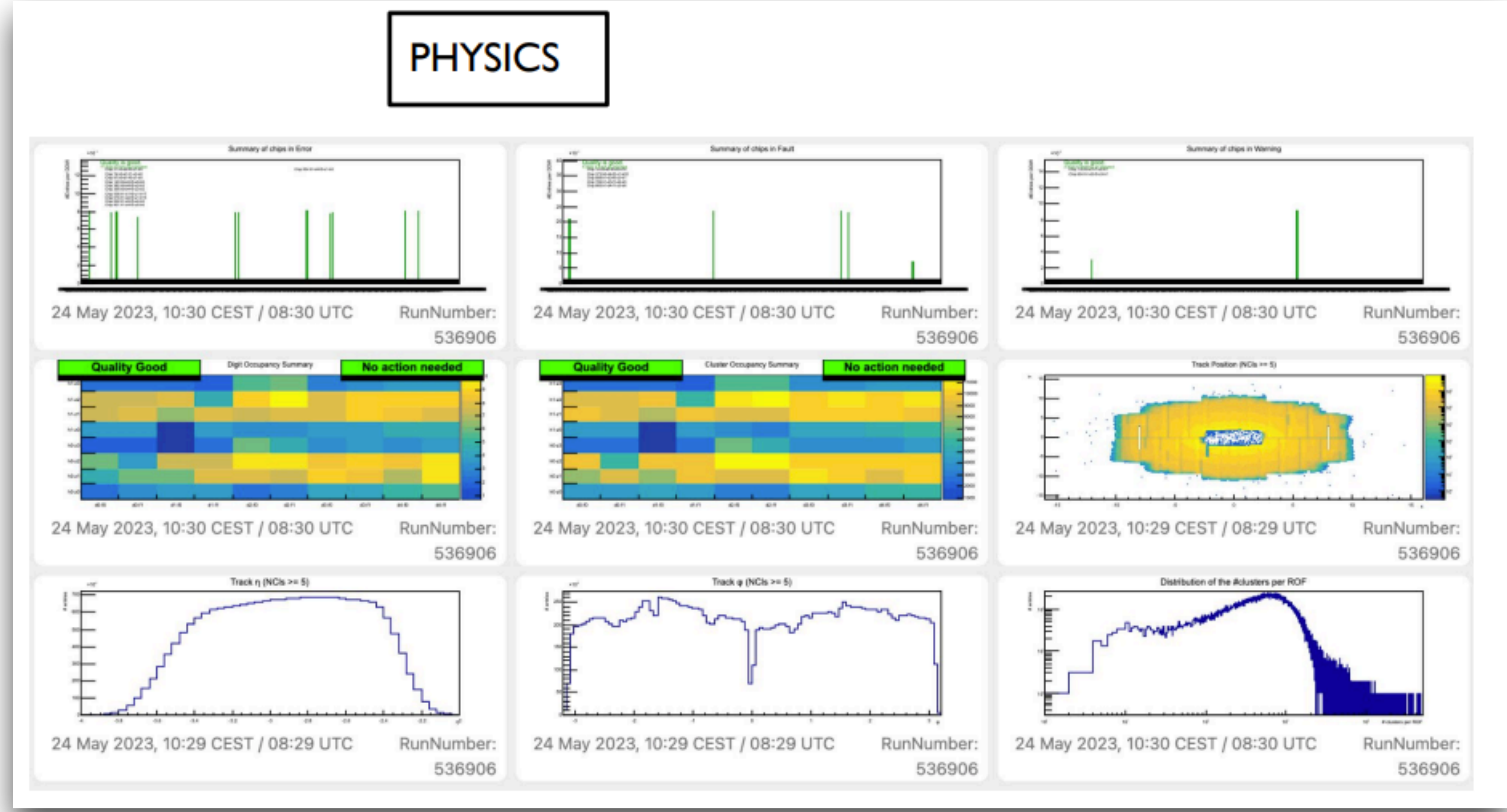


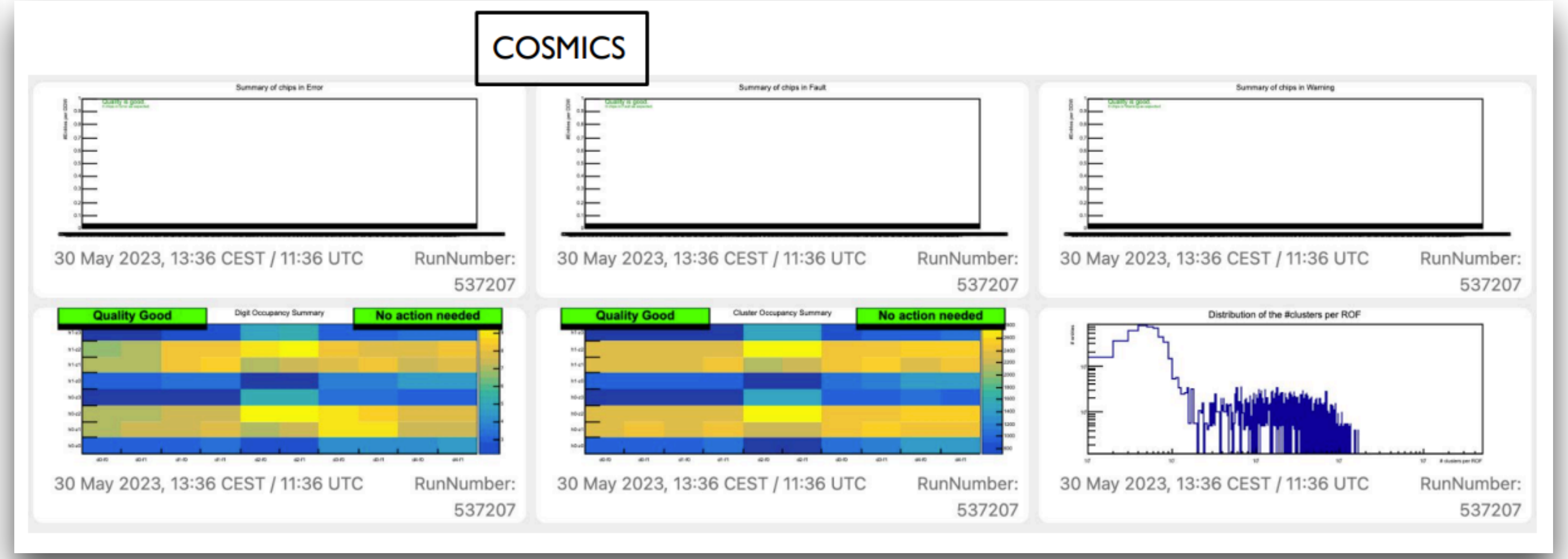




Improvements in MFT QC

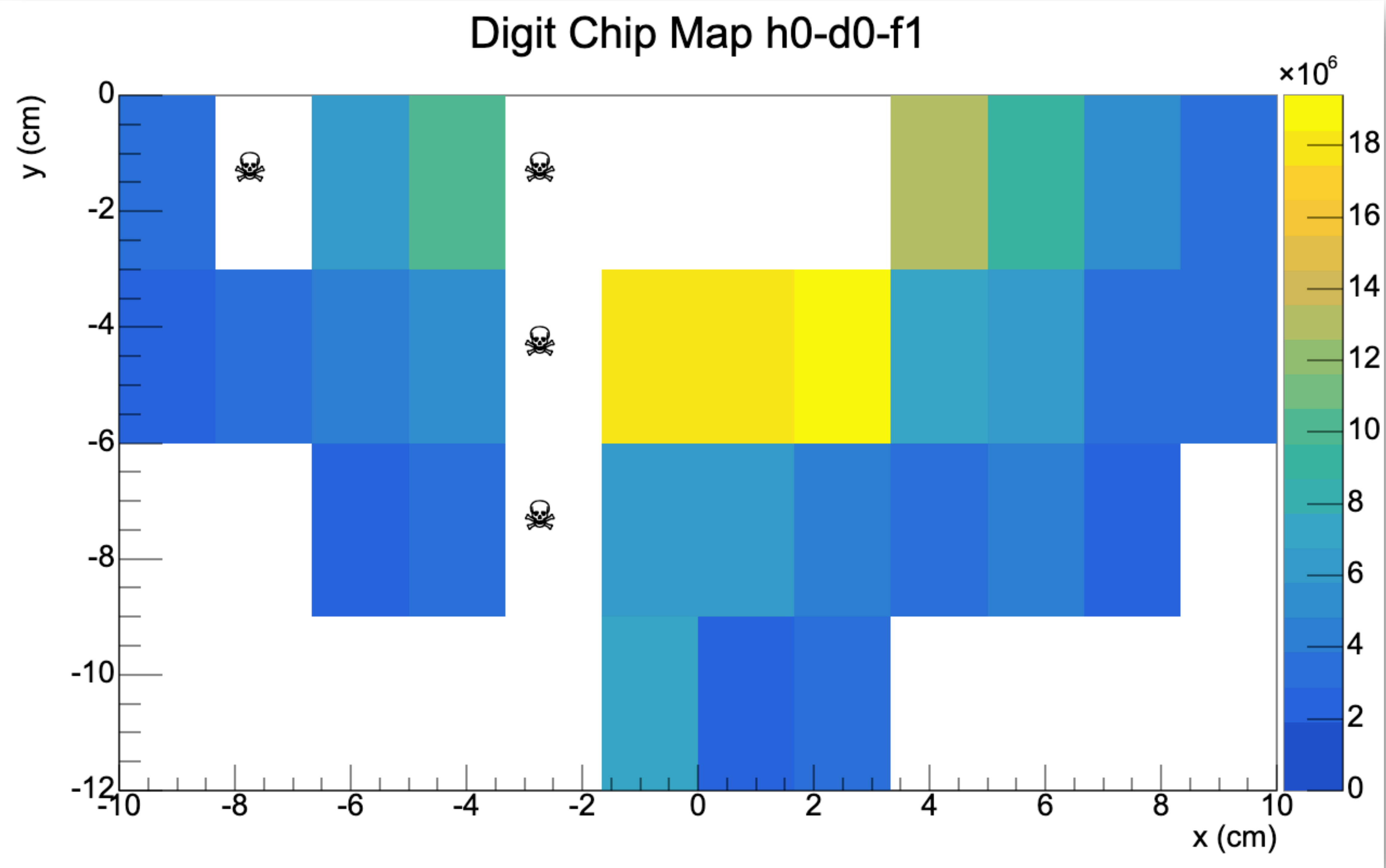
- QC objects stored in the QC repository
- layouts regularly updated

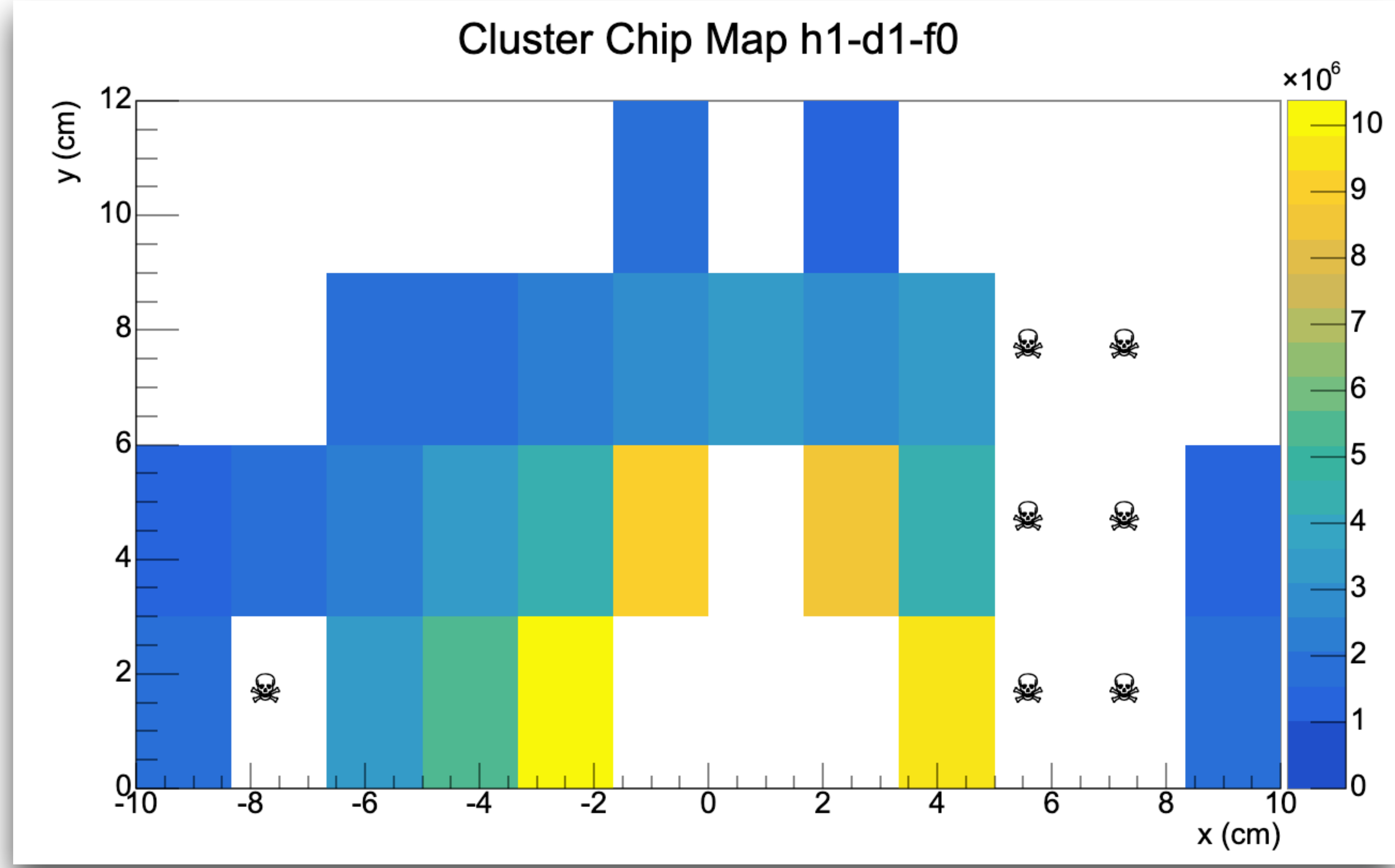




Improvements in MFT QC

- excluded (dead and masked) chips now displayed in chip maps 🎉
- using CCDB information



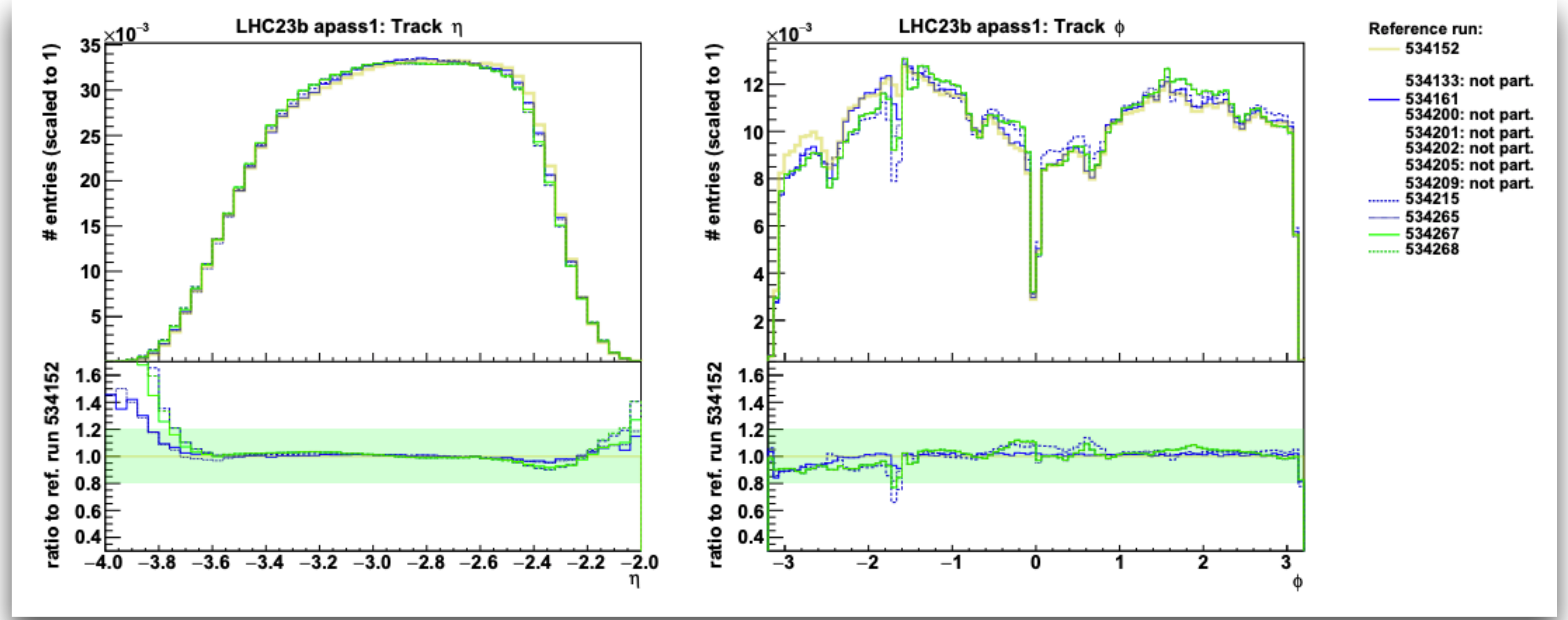


Improvements in aQC (David)

- a systematic and consistent assessment of run qualities in the aQC
- reference runs defined taking specific run conditions into account
  - energy, magnetic field, interaction rate, filling scheme
- comparisons not made run-by-run, but automatised

Improvements in aQC (David)

- comparisons not made run-by-run, but automatised
- a webpage created with all the information for each period in one place: https://alice-mft-aqc.web.cern.ch/



ALICE MFT Asynchronous QC

MFT A-QC Google Sheet

2023 reports

period	cpass0 JIRA	cpass0 report	apass1 JIRA	apass1 report
LHC23b	-		O2-3765	LHC23b_apass1.pdf
LHC23c	-		-	
LHC23d	-		-	
LHC23e	-		-	
LHC23f	O2-3831	LHC23f_cpass0.pdf	O2-4012	LHC23f_apass1.pdf
LHC23g	O2-3919	LHC23g_cpass0.pdf	O2-4018	LHC23g_apass1.pdf
LHC23h	O2-3918	LHC23h_cpass0.pdf		
LHC23i	O2-3924	LHC23i_cpass0.pdf	O2-4019	LHC23i_apass1.pdf
LHC23j	O2-3924	LHC23j_cpass0.pdf	O2-4019	LHC23j_apass1.pdf
LHC23k	O2-3924	LHC23k_cpass0.pdf	O2-4019	LHC23k_apass1.pdf
LHC23l	O2-3880	LHC23l_cpass0.pdf	O2-4017	LHC23l_apass1.pdf
LHC23m	O2-3880	LHC23m_cpass0.pdf	O2-4017	LHC23m_apass1.pdf
LHC23n	O2-3913	LHC23n_cpass0.pdf	O2-4023	LHC23n_apass1.pdf
LHC23o	O2-3925	LHC23o_cpass0.pdf	O2-4020	LHC23o_apass1.pdf
LHC23p	O2-3925	LHC23p_cpass0.pdf	O2-4020	
LHC23q	O2-3925	LHC23q_cpass0.pdf	O2-4020	LHC23q_apass1.pdf
LHC23r	O2-3925	LHC23r_cpass0.pdf	O2-4020	LHC23r_apass1.pdf
LHC23s	O2-3884	LHC23s_cpass0.pdf	O2-4036	
LHC23t	O2-3957	LHC23t_cpass0.pdf	O2-4042	LHC23t_apass1.pdf
LHC23u	O2-3885	LHC23u_cpass0.pdf	O2-4026	LHC23u_apass1.pdf
LHC23v	O2-3885	LHC23v_cpass0.pdf	O2-4026	LHC23v_apass1.pdf
LHC23w	O2-3957	LHC23w_cpass0.pdf	O2-4042	LHC23w_apass1.pdf
LHC23y	O2-3886	LHC23y_cpass0.pdf	O2-4027	LHC23y_apass1.pdf

Improvements in aQC (David)

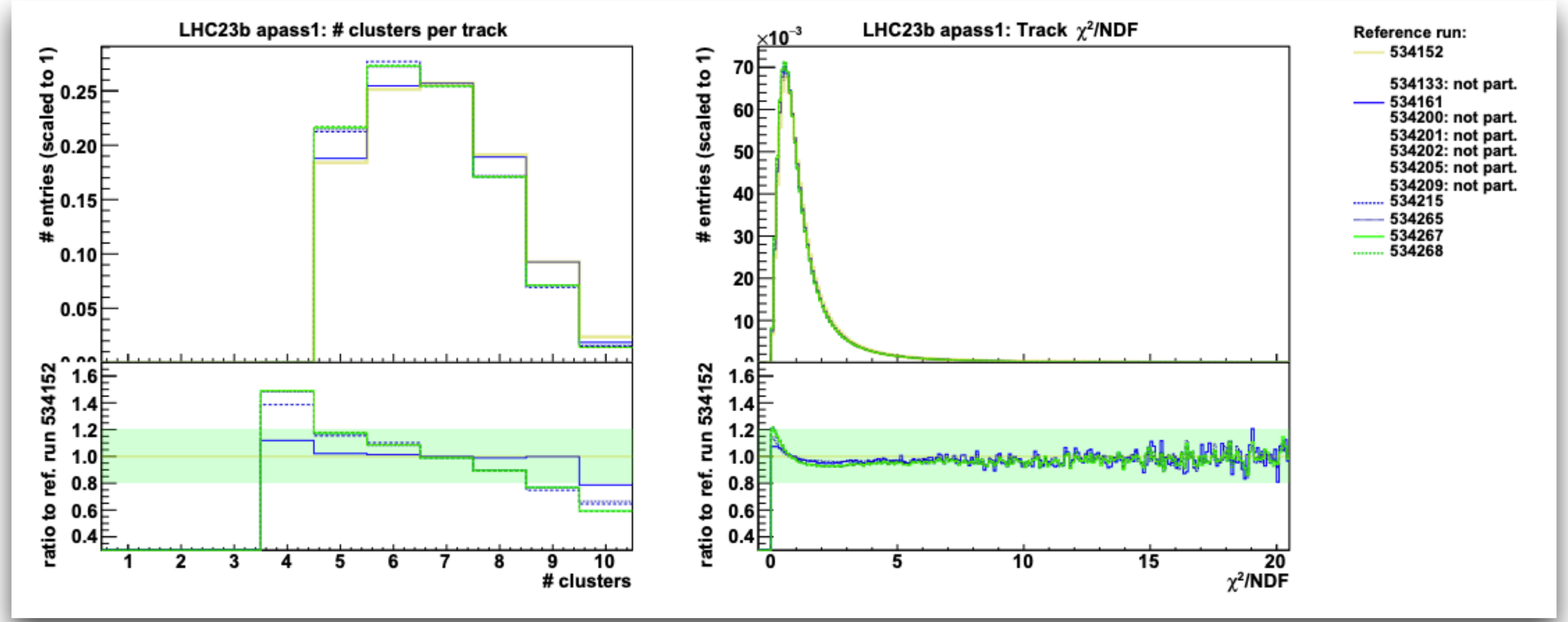
- link to JIRA tickets with reports of other detectors included
- issues reported to experts; issues usually related to problems during data taking

ALICE MFT Asynchronous QC

MFT A-QC Google Sheet

2023 reports

period	cpass0 JIRA	cpass0 report	apass1 JIRA	apass1 report
LHC23b	-		O2-3765	LHC23b_apass1.pdf
LHC23c	-		-	
LHC23d	-		-	
LHC23e	-		-	
LHC23f	O2-3831	LHC23f_cpass0.pdf	O2-4012	LHC23f_apass1.pdf
LHC23g	O2-3919	LHC23g_cpass0.pdf	O2-4018	LHC23g_apass1.pdf
LHC23h	O2-3918	LHC23h_cpass0.pdf		
LHC23i	O2-3924	LHC23i_cpass0.pdf	O2-4019	LHC23i_apass1.pdf
LHC23j	O2-3924	LHC23j_cpass0.pdf	O2-4019	LHC23j_apass1.pdf
LHC23k	O2-3924	LHC23k_cpass0.pdf	O2-4019	LHC23k_apass1.pdf
LHC23l	O2-3880	LHC23l_cpass0.pdf	O2-4017	LHC23l_apass1.pdf
LHC23m	O2-3880	LHC23m_cpass0.pdf	O2-4017	LHC23m_apass1.pdf
LHC23n	O2-3913	LHC23n_cpass0.pdf	O2-4023	LHC23n_apass1.pdf
LHC23o	O2-3925	LHC23o_cpass0.pdf	O2-4020	LHC23o_apass1.pdf
LHC23p	O2-3925	LHC23p_cpass0.pdf	O2-4020	
LHC23q	O2-3925	LHC23q_cpass0.pdf	O2-4020	LHC23q_apass1.pdf
LHC23r	O2-3925	LHC23r_cpass0.pdf	O2-4020	LHC23r_apass1.pdf
LHC23s	O2-3884	LHC23s_cpass0.pdf	O2-4036	
LHC23t	O2-3957	LHC23t_cpass0.pdf	O2-4042	LHC23t_apass1.pdf
LHC23u	O2-3885	LHC23u_cpass0.pdf	O2-4026	LHC23u_apass1.pdf
LHC23v	O2-3885	LHC23v_cpass0.pdf	O2-4026	LHC23v_apass1.pdf
LHC23w	O2-3957	LHC23w_cpass0.pdf	O2-4042	LHC23w_apass1.pdf
LHC23y	O2-3886	LHC23y_cpass0.pdf	O2-4027	LHC23y_apass1.pdf
LHC23z	O2-3881	LHC23z_cpass0.pdf	O2-4037	LHC23z_apass1.pdf



…in view of 2024 data taking:

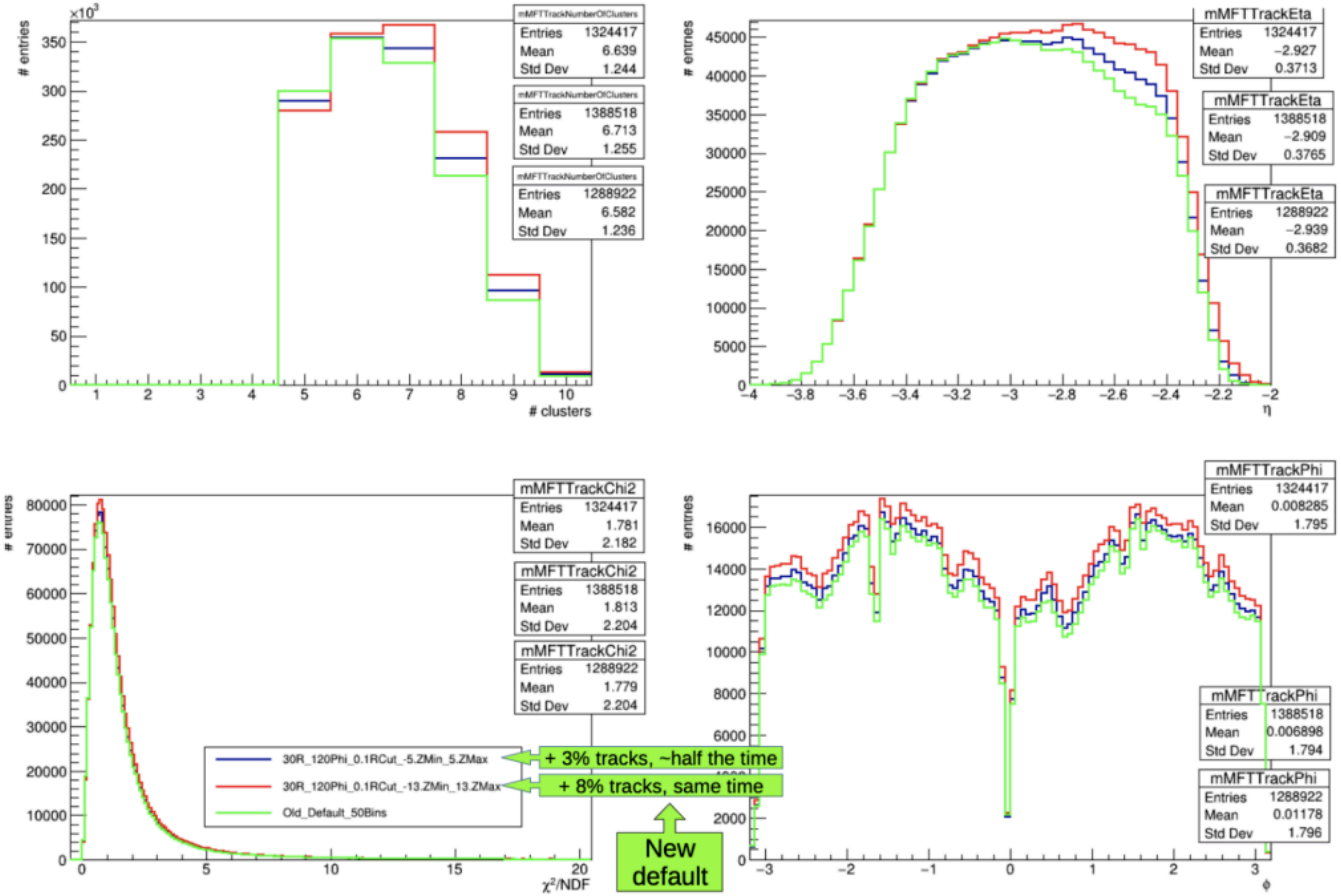
- QC plans:
  - adding reference plots to synchronous operation
  - adding a dedicated noise task
  - several minor updates

Improvements in MFT tracking

- variable radial bin size for each layer: cluster bins computed from PV geometry using cylindrical volume around z axis

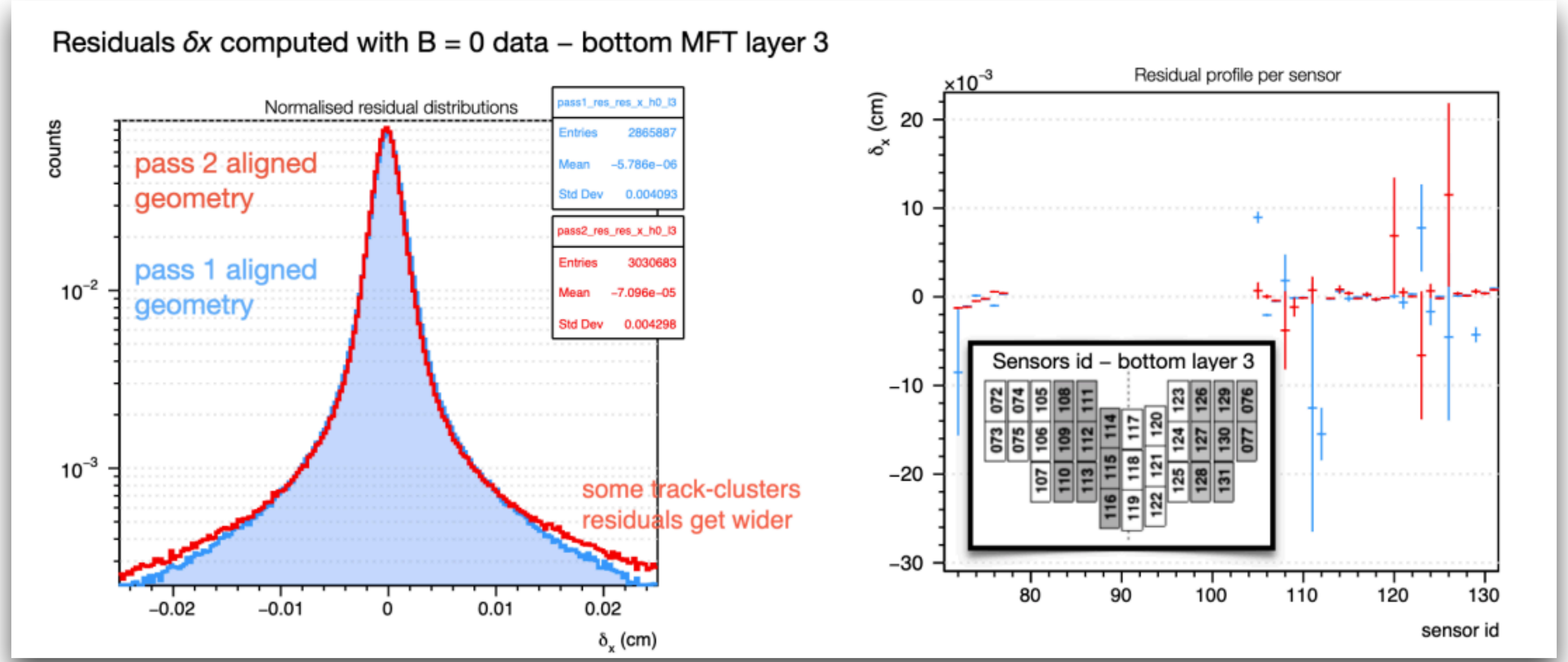
- improved control of optimisation parameters

- reducing CPU cost & recovering larger acceptance with better η uniformity



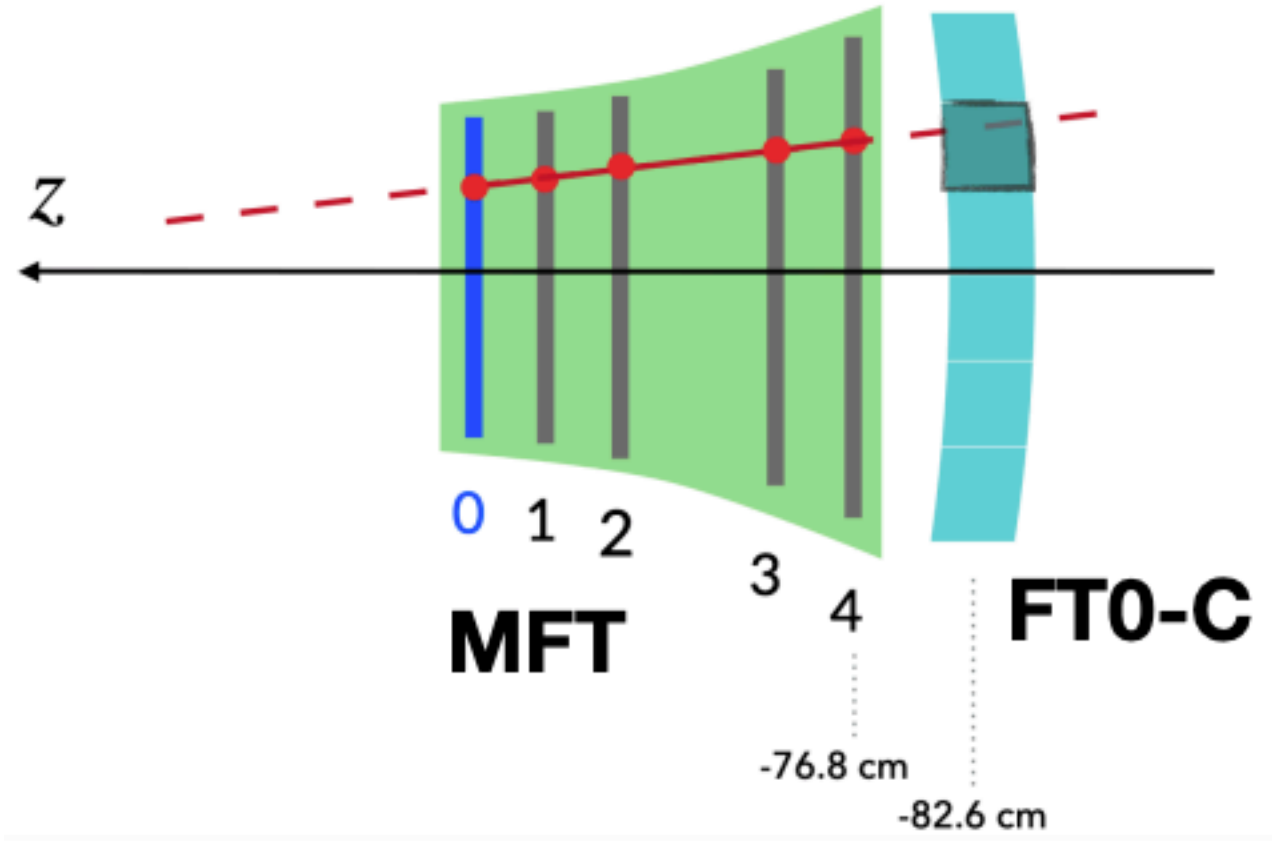
Improvements in MFT alignment

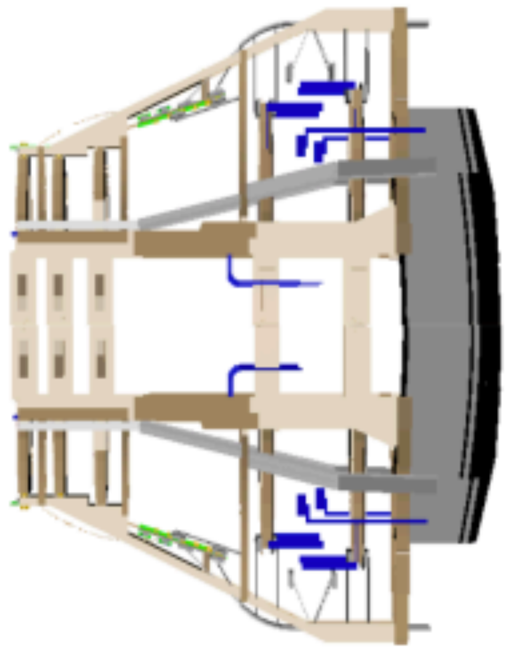
- pre-aligned geometry reco tracks → MillePede 4 DoF → pass1 alignment
  - MillePede corrections lead to significant improvements in track reconstruction
- ideal geometry reco tracks → MillePede 4 DoF → pass2 alignment
  - further improvements: increased # tracks, # clusters/track, track χ^2/NDF

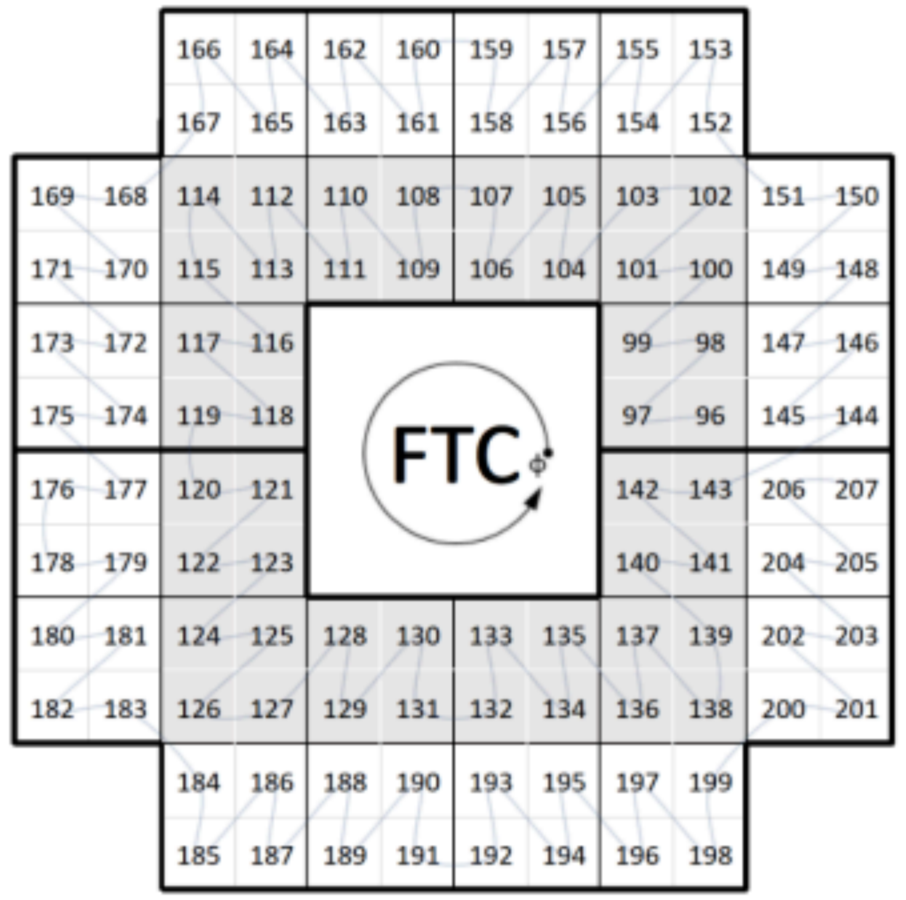


Ambiguous MFT tracks: time alignment with FT0-C

- ambiguous track: a track compatible with multiple collisions
- MFT track time window = 198 BC = 4.95 μs
- at IR=500kHz, ~2.475 collisions in 198 BC: higher number of ambiguous MFT tracks
- for a better time resolution, we can use FIT with precision of FT0-C of 20ps << 1 BC

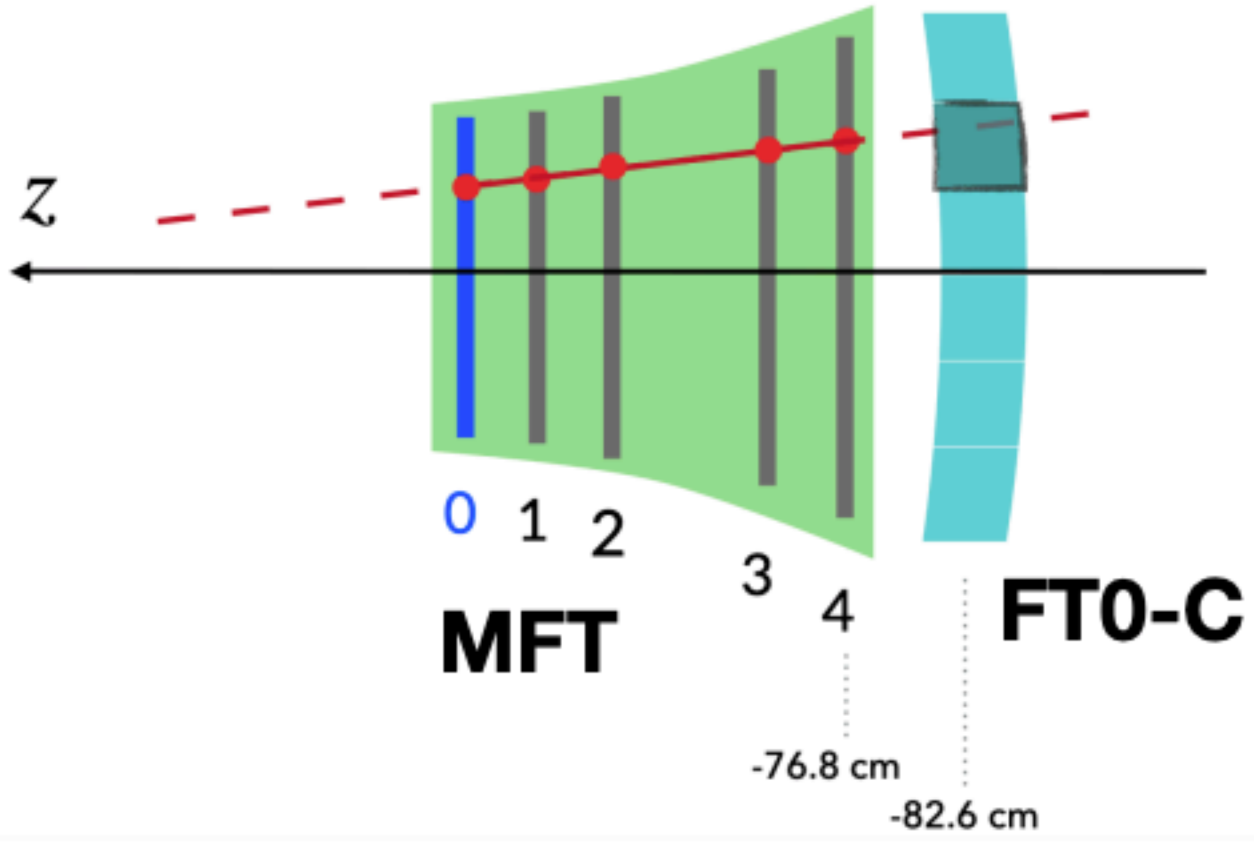


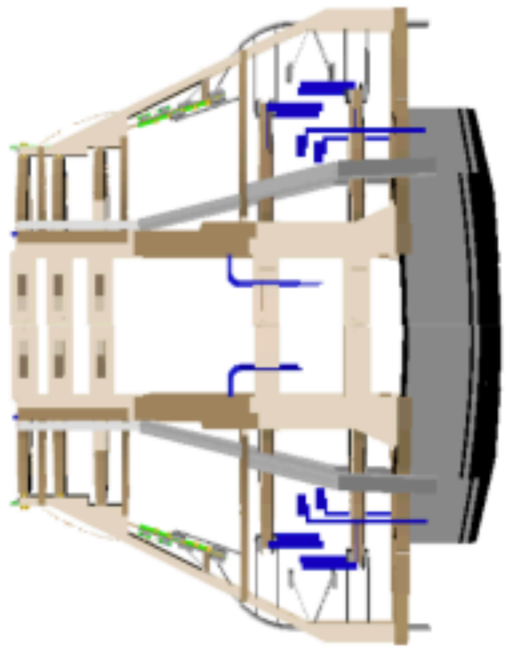


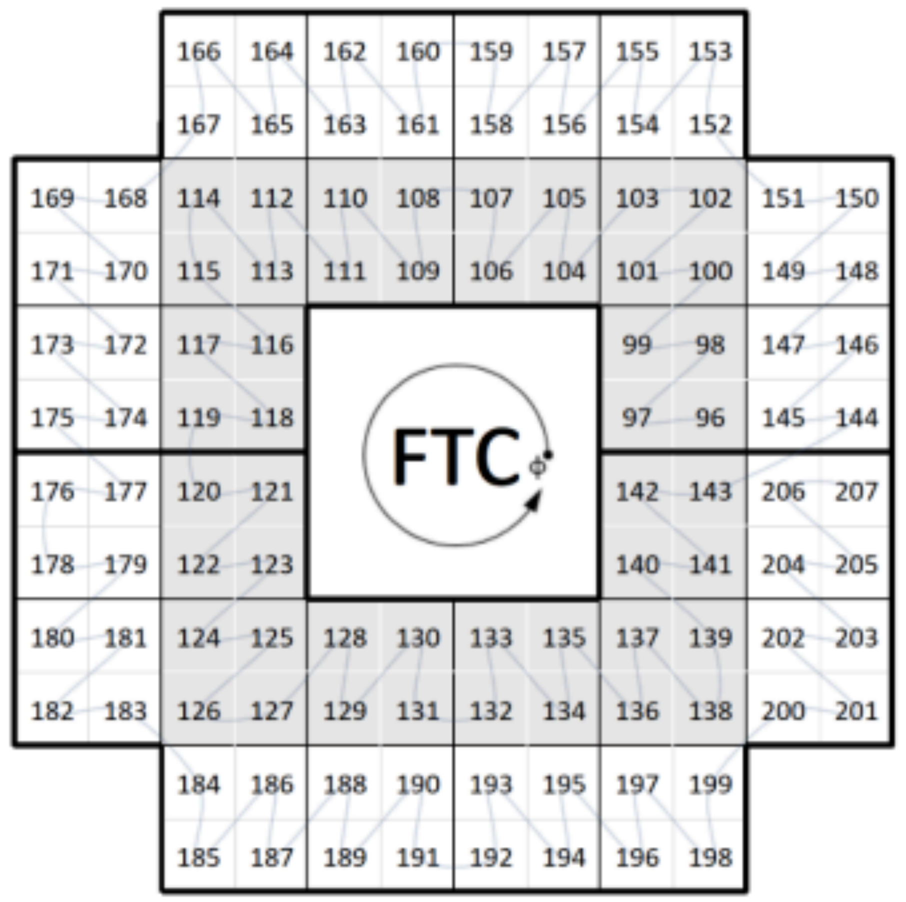


Ambiguous MFT tracks: time alignment with FT0-C

- ambiguous track: a track compatible with multiple collisions
- MFT track time window = 198 BC = 4.95 μs
- at IR=500kHz, ~2.475 collisions in 198 BC: higher number of ambiguous MFT tracks
- for a better time resolution, we can use FIT with precision of FT0-C of 20ps << 1 BC

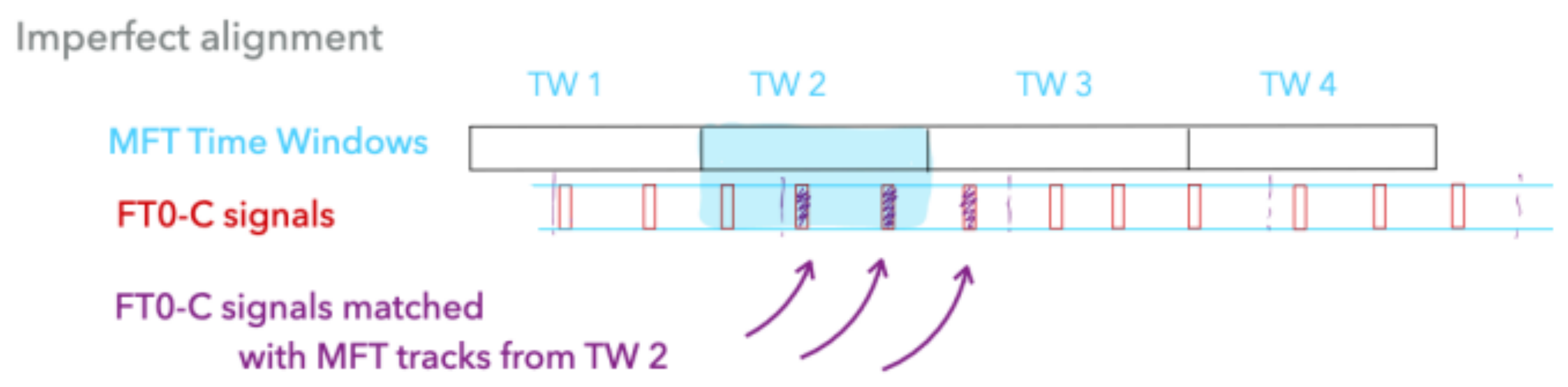


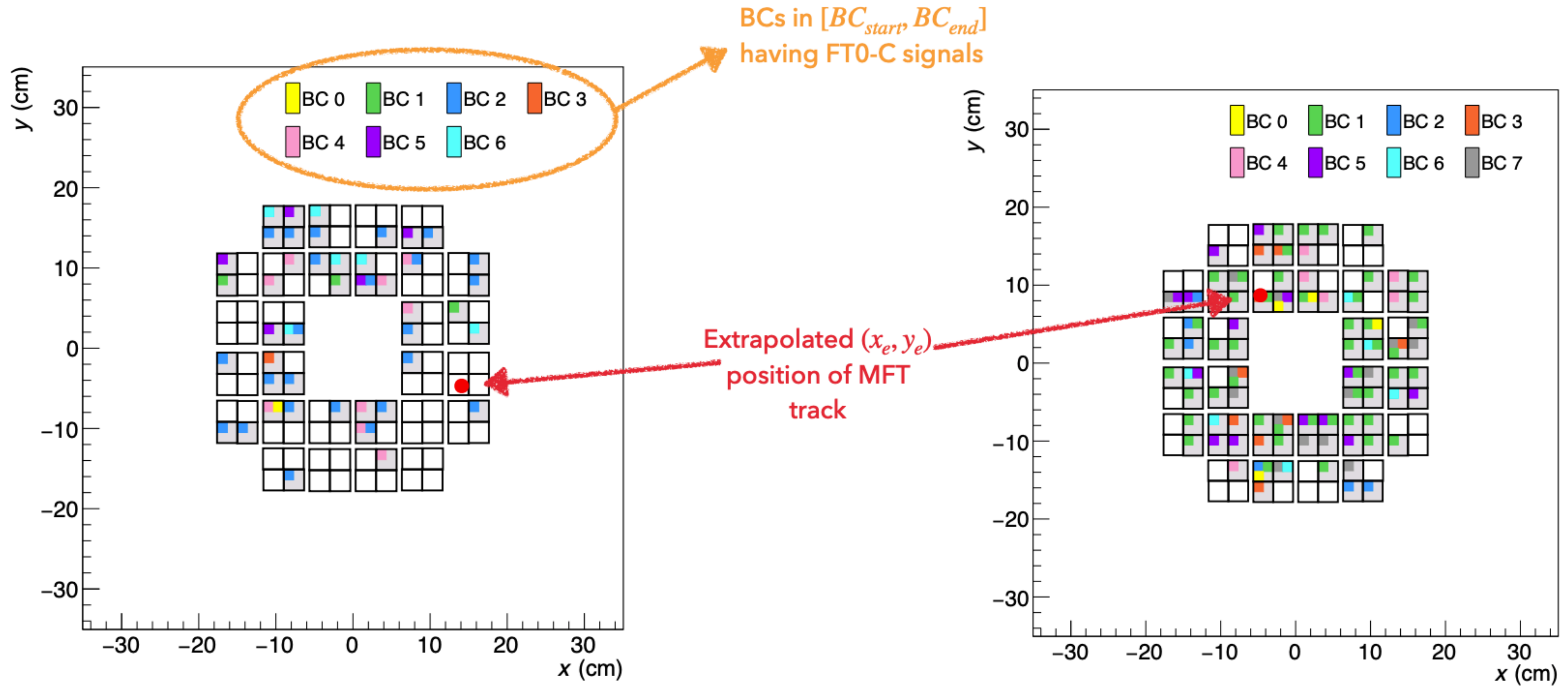




Ambiguous MFT tracks: time alignment with FT0-C

- for an MFT time window, check all BCs with FT0-C signal:
  - if the MFT has a position match in FT0-C: matched
  - if not: unmatched
- count the number of matched and unmatched tracks
- slightly shift the ROF by a few BCs and count again



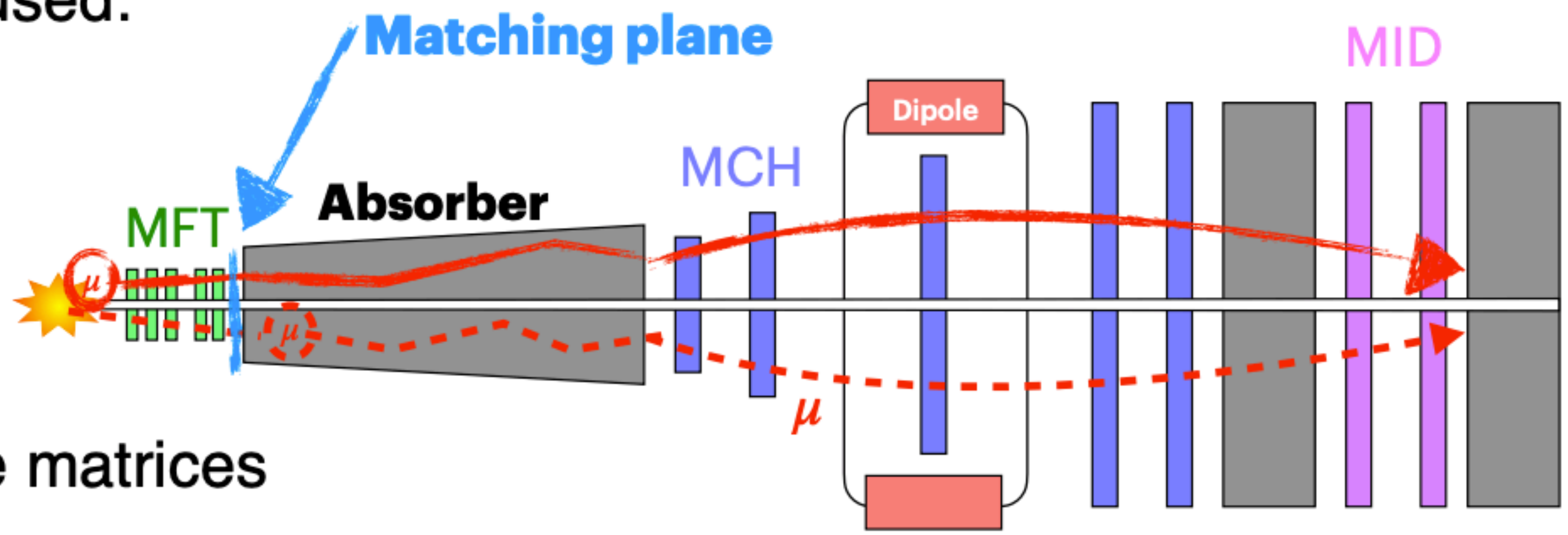


MFT-MCH matching

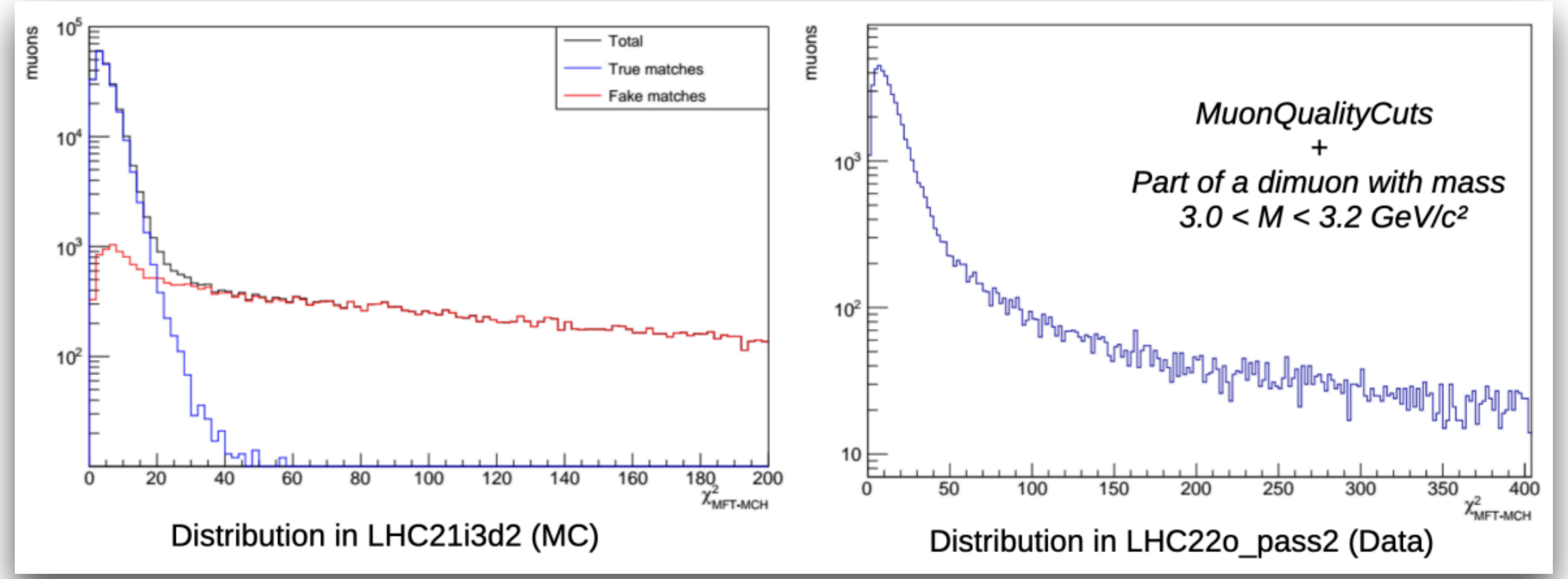
- χ^2 is calculated during the reconstruction for each MCH track with all the MFT candidates at matching plane at the end of the MFT

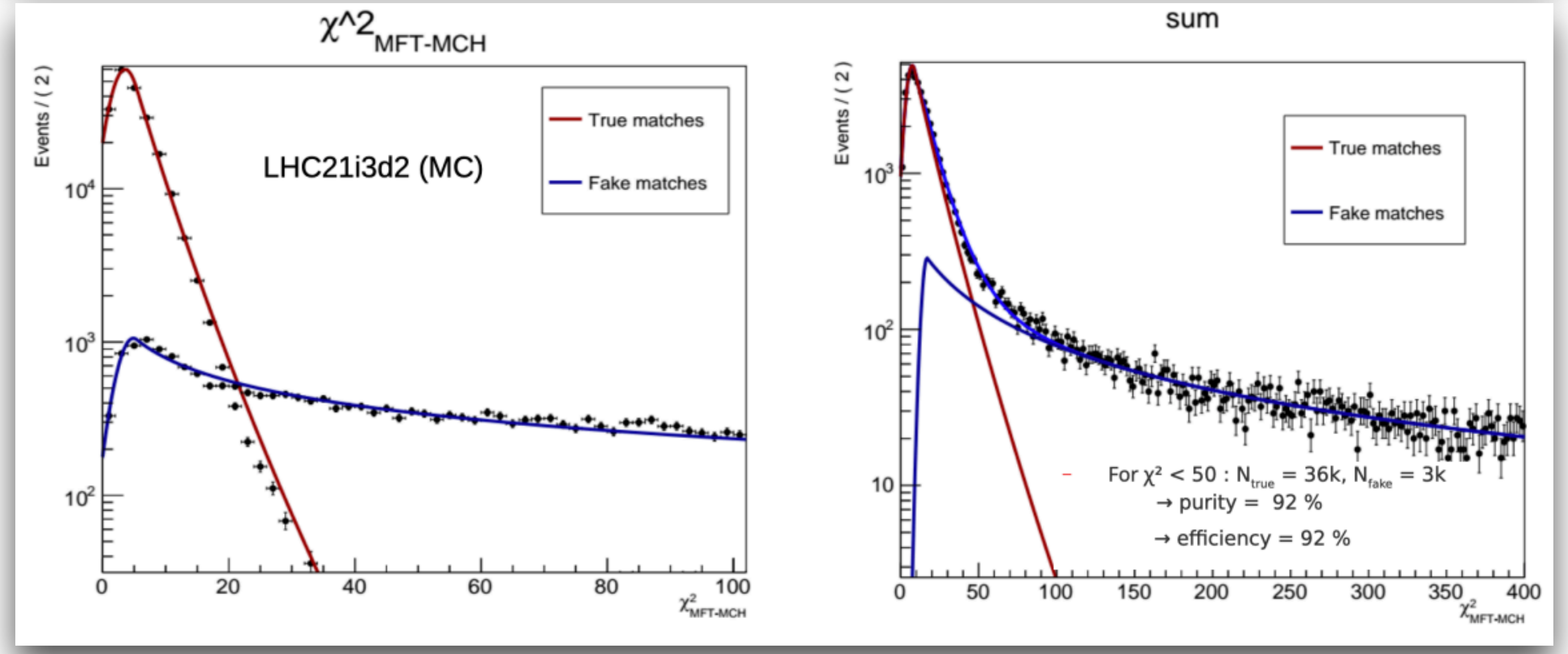
- the lowest χ^2 is taken as the best match

- Parameters used:
  - X
  - Y
  - ϕ
  - $\tan(\lambda)$
  - q/p_{T}
  - Covariance matrices



MFT-MCH matching

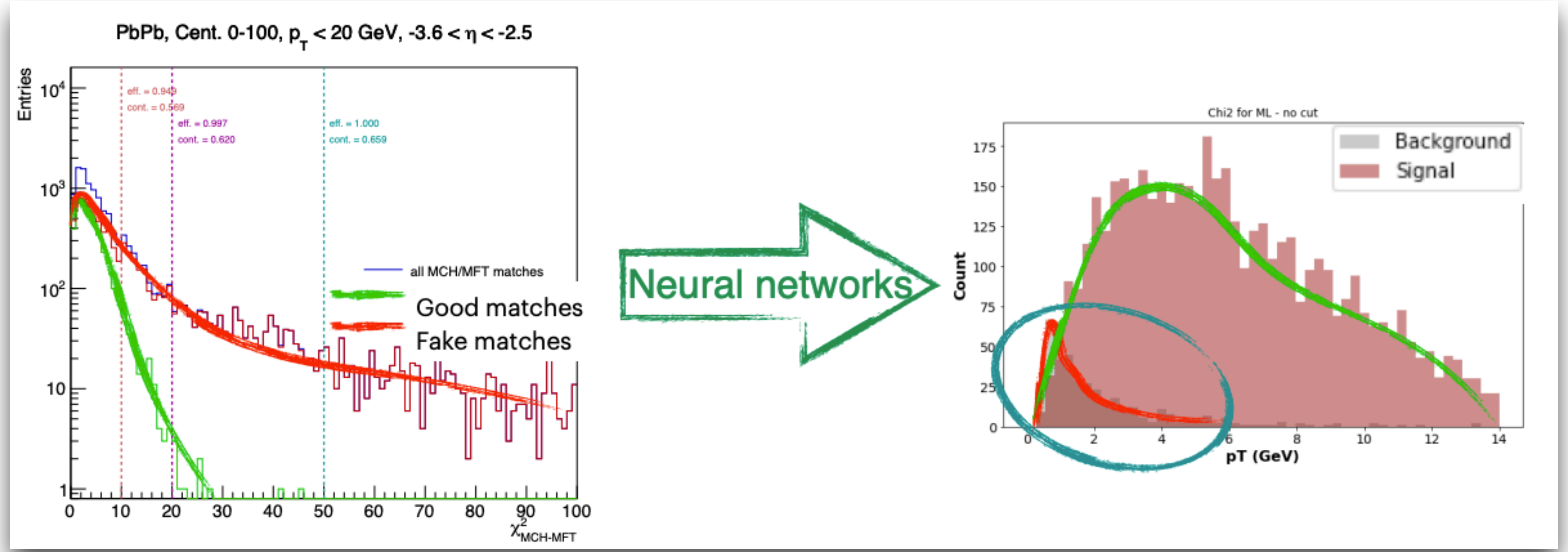




- better performance for matching in pp:
  - MFT has lower occupancy than for Pb-Pb
  - χ^2 matching is enough
- for J/ψ analyses: different widths of the distributions
- background estimation:
  - many studies ongoing to estimate the leftover efficiency and contamination from data

MFT-MCH matching in Pb-Pb

- due to higher occupancy in MFT for Pb-Pb: χ^2 matching is not enough
- χ^2 gives more fake matches than correct ones
- plan to use neutral networks to improve the matching performance



Summary

- MFT is a new detector for Run 3, successfully built, installed, commissioned and participating in global data taking
- QC histograms monitoring MFT performance online and also asynchronously
- many improvements in readout, DCS, QC to prepare MFT for data taking during heavy-ion period
- preparing to achieve GOOD data quality for the full Pb-Pb data taking period to make UPC studies feasible