# Overview of the eTOF reconstruction software in the STAR framework

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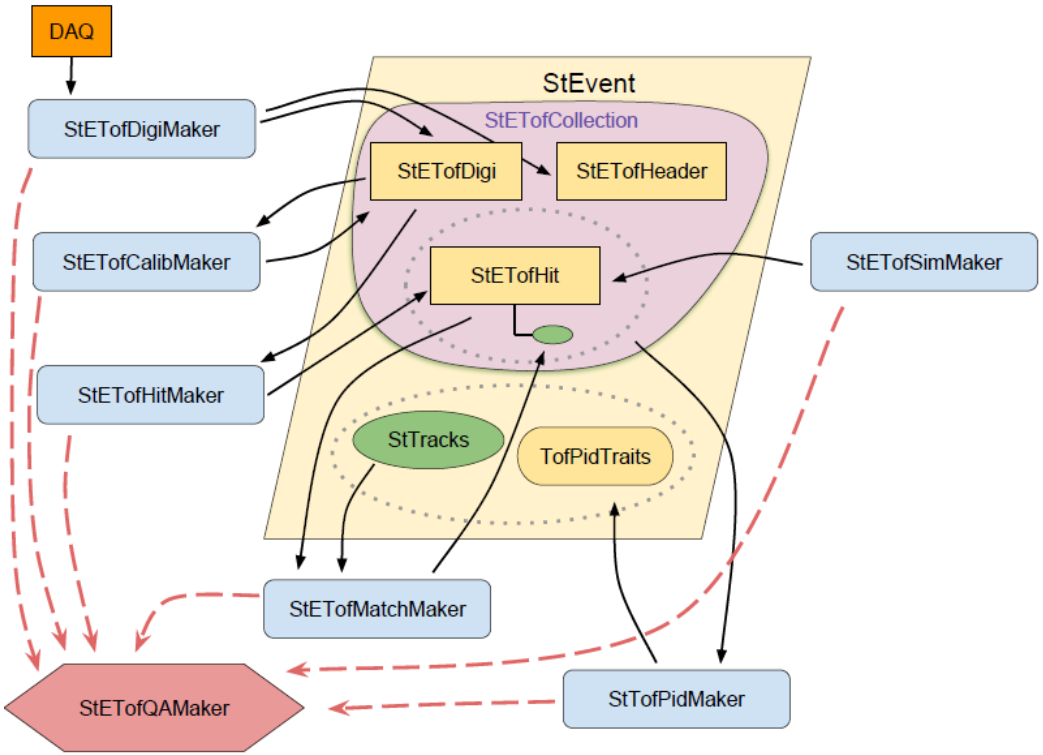


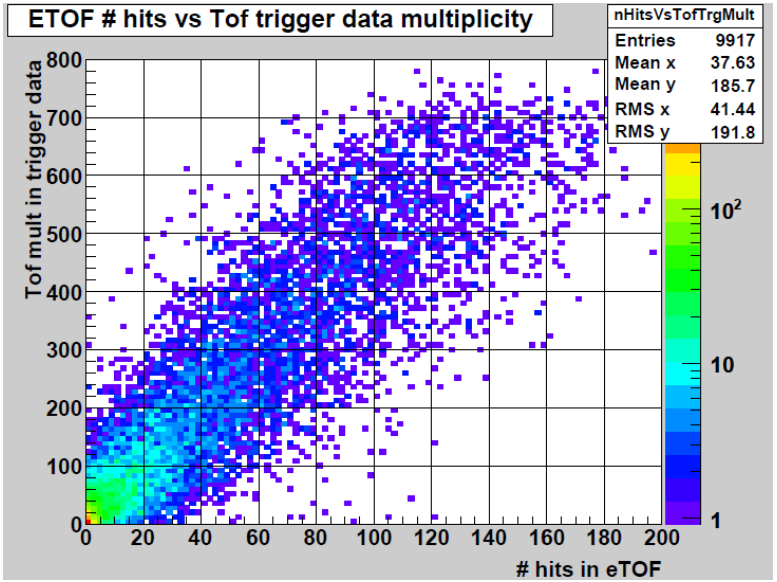
# eTOF software

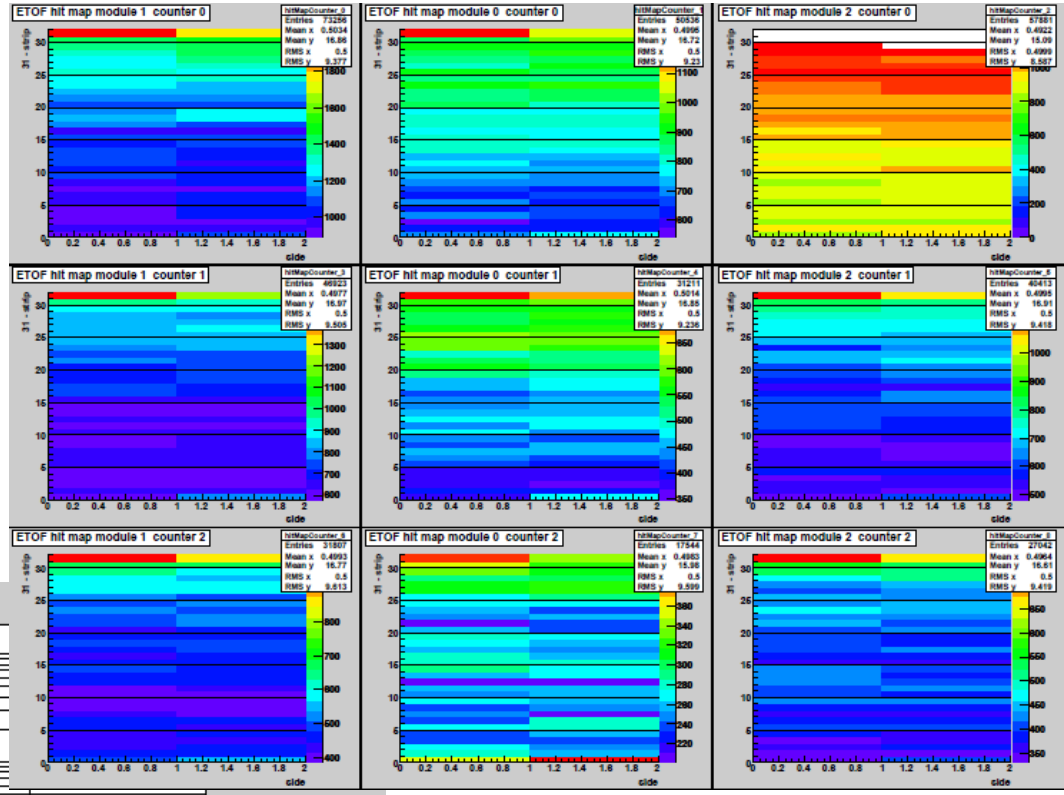
- action items beginning of this year
  - online monitoring plots
  - noise rate calculations from dedicated noise runs
  - offline reconstruction chain

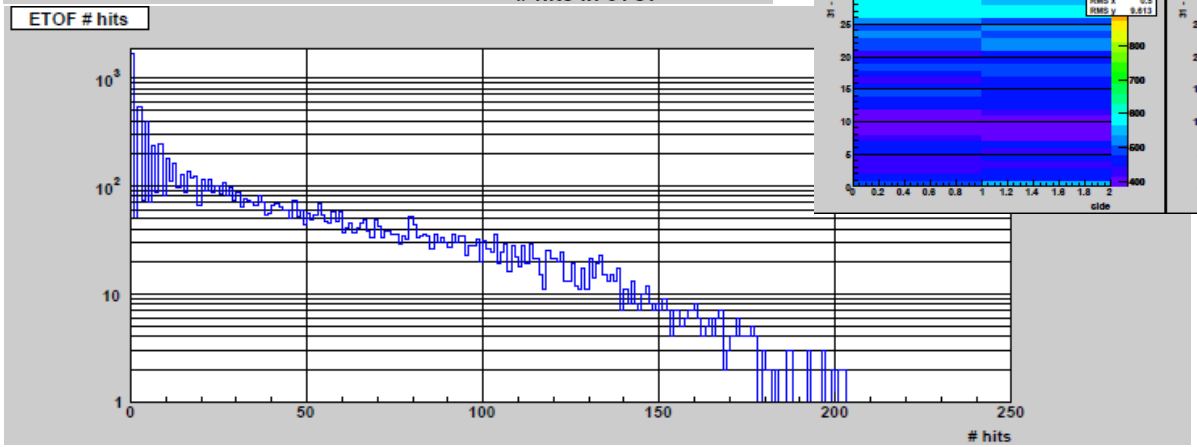
- issues
  - all events from last year (run 17) recorded with the eTOF were empty (only event header was there on the STAR DAQ side)
  - data unpacking / basic processing needed to be debugged beginning of this run (not so easy due to data blinding for isobar analyses)

# Online software

## JevpPlotBuilder – online QA



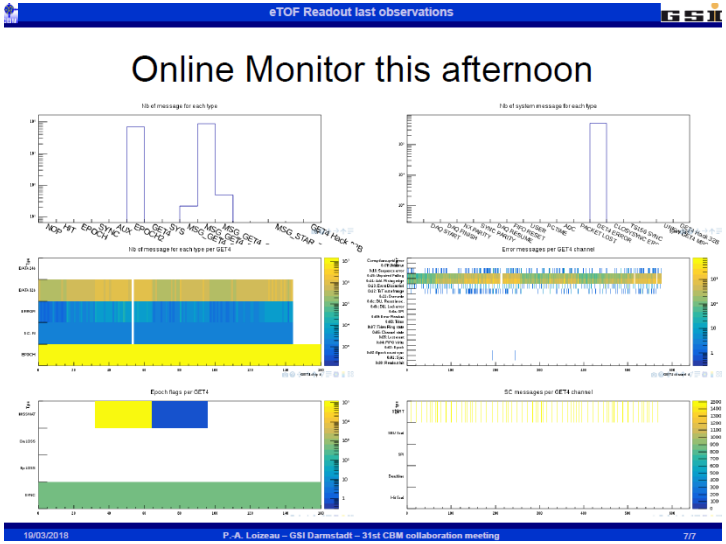



# Online software

## JevpPlotBuilder – online QA

- move (almost ?) all monitoring to the STAR side for next year to reduce DAQ dead time

- Pengfei already implemented some of these histograms
- needs to be updated to new data format for 2019

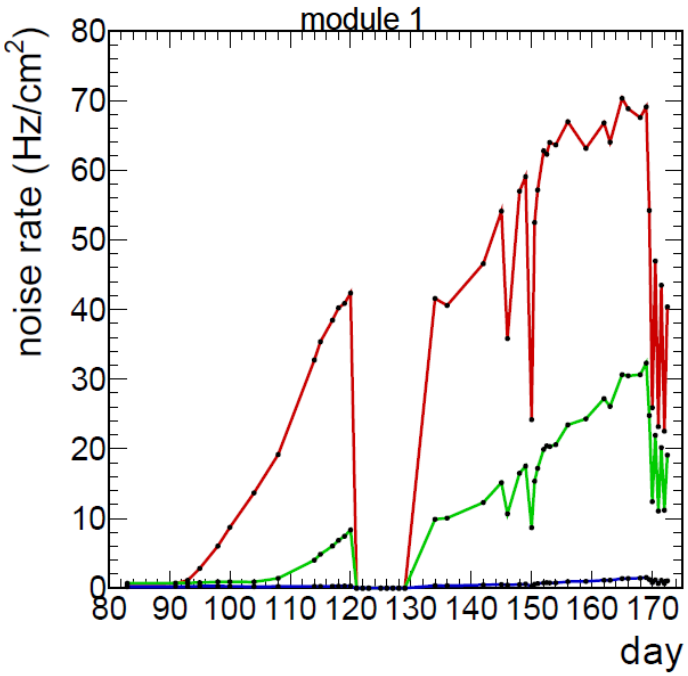


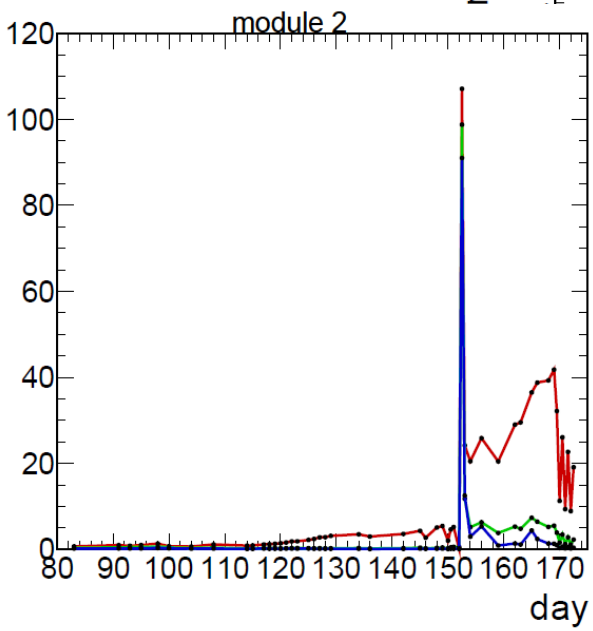

- add CAUTION / CRITICAL messages to the STAR DAQ monitor (?)

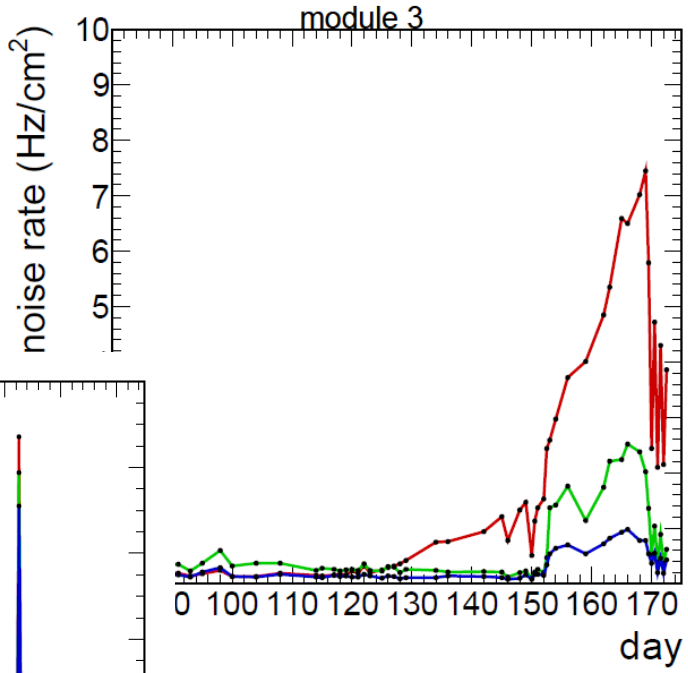
| Time | # | Node | Severity | Task | Source#line | |
|---|---|---|---|---|---|---|
| 13:28:42 | 1 | daqman | CRITICAL | scDeamon | scDeamon.C:#1321 | STGC[1] [0x4801] died/rebooted -- try restarting the Run |
| 13:28:42 | 1 | evb10 | CRITICAL | detEmulator | EthernetServer.C:#380 | Got too many connections (1) |
| 13:27:58 | 1 | daqman | CAUTION | scDeamon | scDeamon.C:#1532 | TCIM: connection failed (just a warning) |
| 13:27:55 | 1 | daqman | CRITICAL | scDeamon | rtsCfgLib.C:#689 | Error reading configuration file (/RTS/conf/handler/cfg_04000) -1 |
| 13:27:40 | 1 | rts02 | OPERATOR | rc | RcActions.java:#718 | Starting run #**19249016**. Config file is jmlPedAsPhys field=0.0 |
| 13:20:11 | 1 | daqman | CAUTION | scDeamon | scDeamon.C:#1532 | TCIM: connection failed (just a warning) |
| 13:20:08 | 1 | daqman | CRITICAL | scDeamon | rtsCfgLib.C:#689 | Error reading configuration file (/RTS/conf/handler/cfg_04000) -1 |

- automate full eTOF reboot to minimize interaction needed by shift crew (?)

# Noise rate monitoring

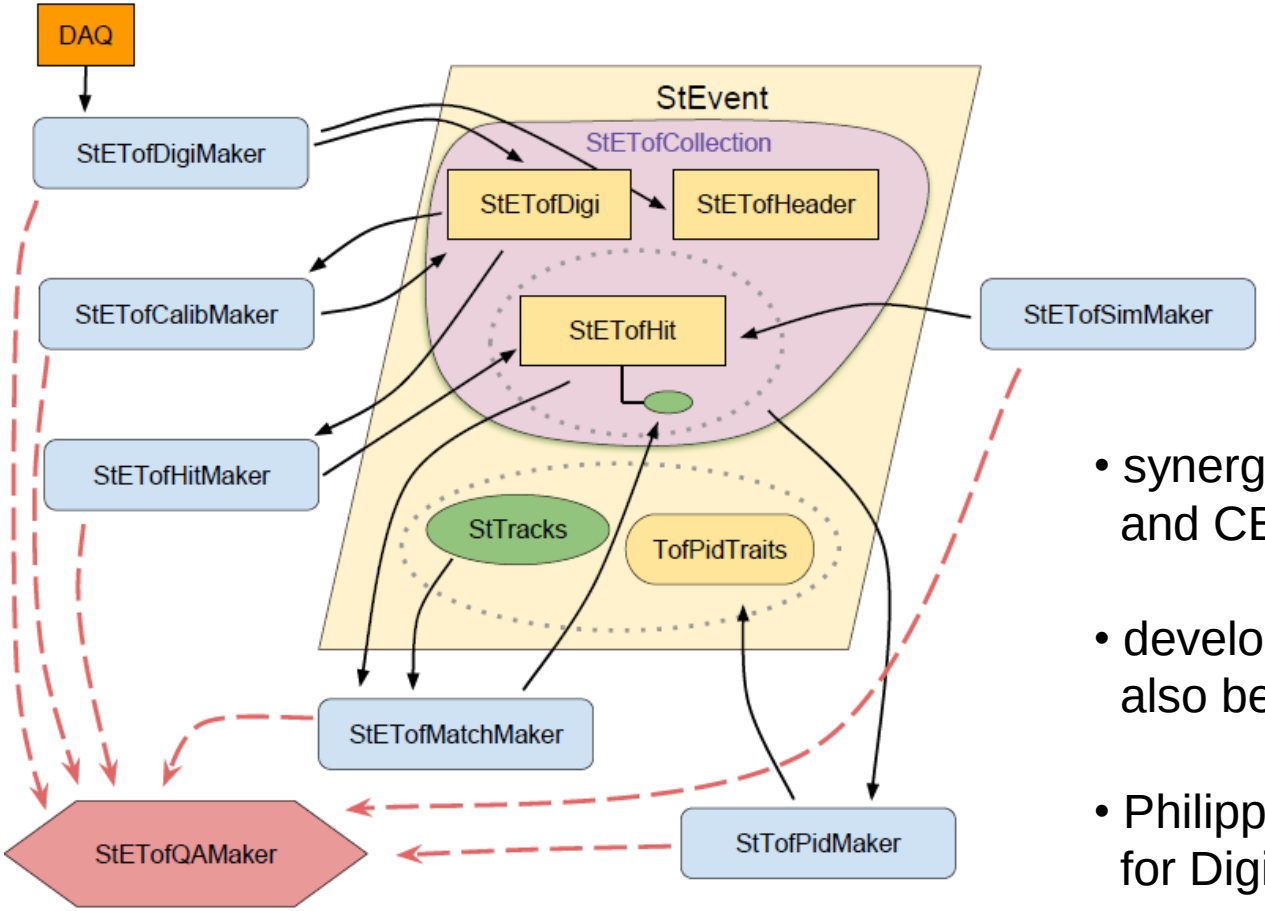


# Offline software

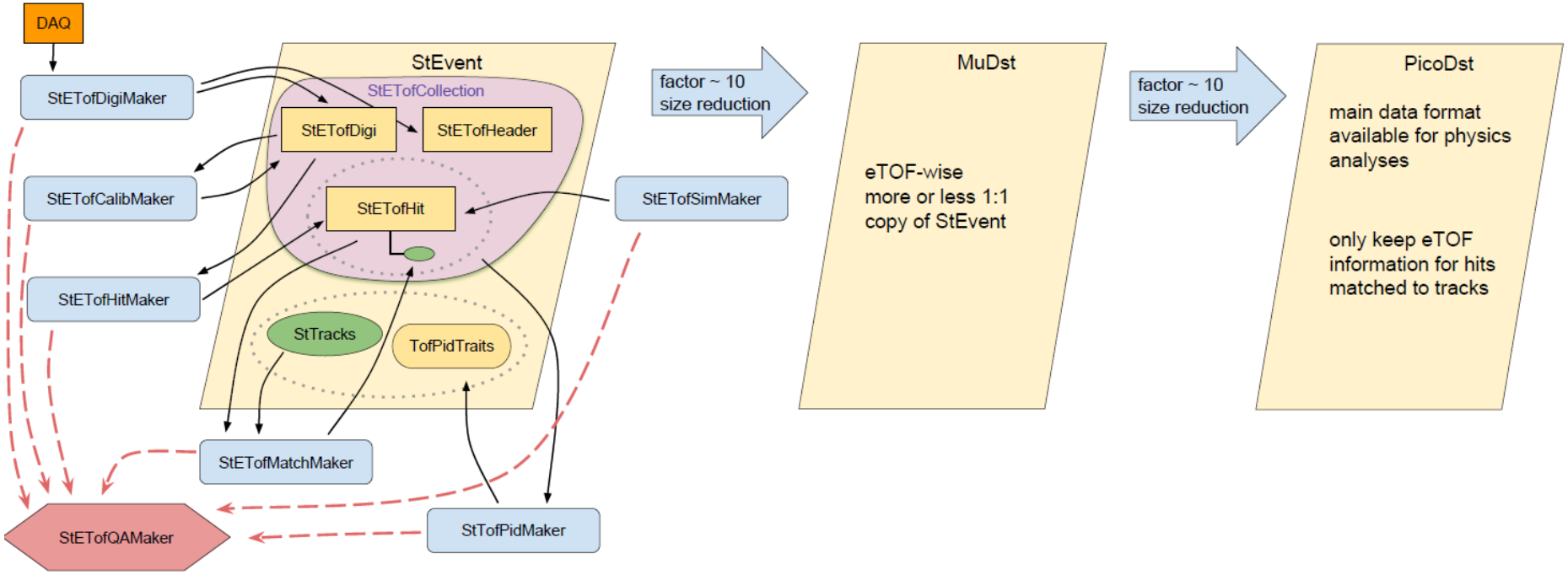
## general layout




- synergies with bTOF, MTD and CBM TOF software
- developments for eTOF might also be useful in those detectors
- Philipp will discuss more details for Digi-, Calib- and HitMaker

# Offline software

## general layout



# Offline software

**status**

- eTOF data classes in StEvent have been reviewed by STAR S&C team

- StETofDigiMaker and related utility classes have been reviewed

  → basic eTOF software included in production of calibration sample

- StETofCalibMaker, StETofQAMaker, StETofHitMaker and StETofMatchMaker are can be run as afterburner
  - iterative calibrations can be applied
  - basic functionality of track matching is working

# Offline software

**ongoing developments**

- iterative calibration procedure following CBM strategy – position, gain, slewing

- analysis of hit on the overlapping strips for many different days
  - check counter time resolution
  - proof that offsets between different AFCK cards remain constant following the full DAQ restart each day

- track matching & PID assignment
  - test with simulation
  - apply to data

# Offline software

## simulation

- stragegy in StETofSimMaker:
  - combine GEANT hits in different gas layers of the same strip into "combinedHits"
  - fast detector response (smear time & position)

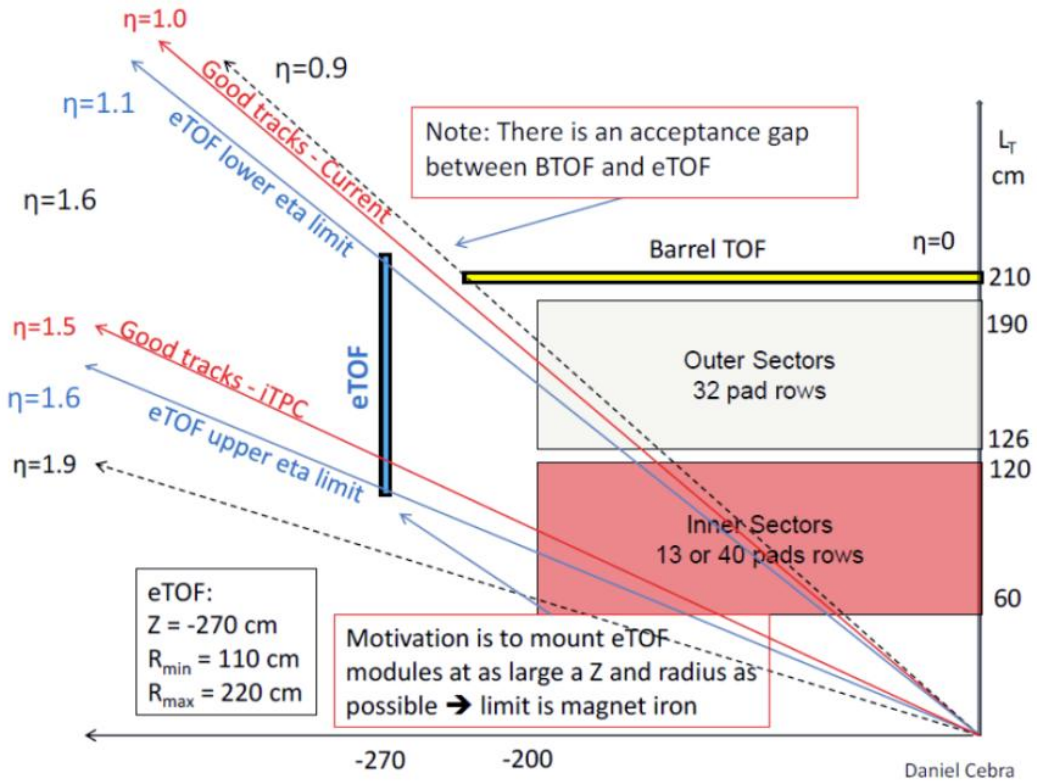
  → can be refined more in the future … main purpose for the moment was to get simulated StETofHits to feed them into the MatchMaker

- goal: simulate full heavy-ion collisions with e.g. UrQMD
  - estimate double hit probability etc.
  - further physics feasibility studies

- looking forward to iTPC code in simulation

# Offline software

- w/o iTPC upgrade tracks have barely enough fit points to form a good track in the TPC that reaches the eTOF



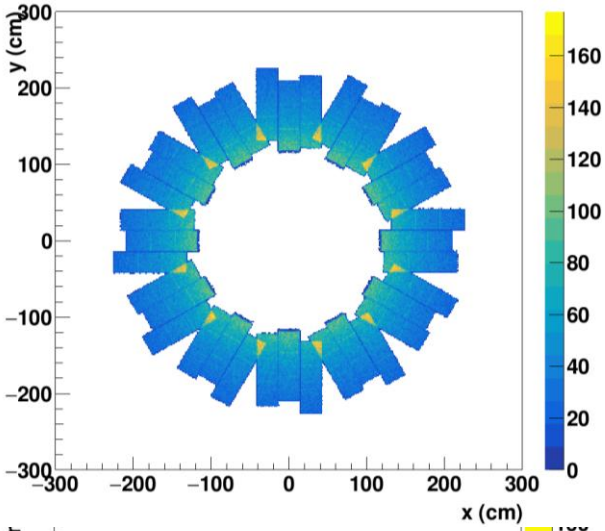
# Offline software

## MatchMaker

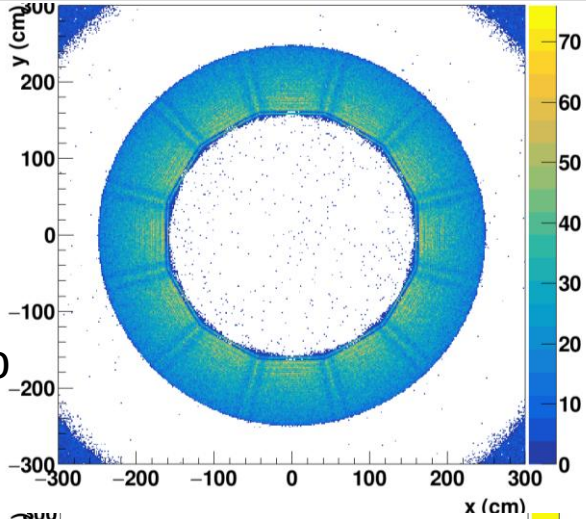
- similar steps as in bTOF and MTD code
  - get a list of detector hits
  - loop over tracks and get a list of track intersections with active eTOF volumes (at the moment there is an additional safety margin of 2cm around the counters)
  - compare the two lists and build match candidates if
    - intersection and detector hit are on the same detector
    - local distance in X and Y ($\Delta X$, $\Delta Y$) direction are small enough (at the moment rather loose cuts $\Delta X<5$cm, $\Delta Y<10$cm)
  - deal with cases where one track matches to several detector hits or serveral tracks point to one detector hit
  - fill StETofPidTraits with PID information (ToF, beta, $m^2$, …)

# MatchMaker

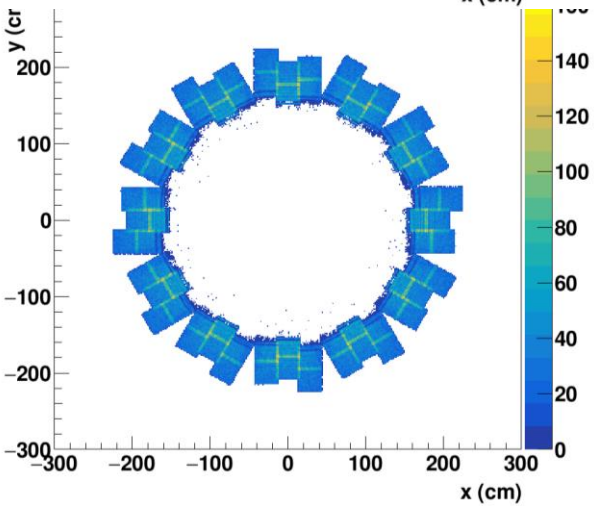
## simulation



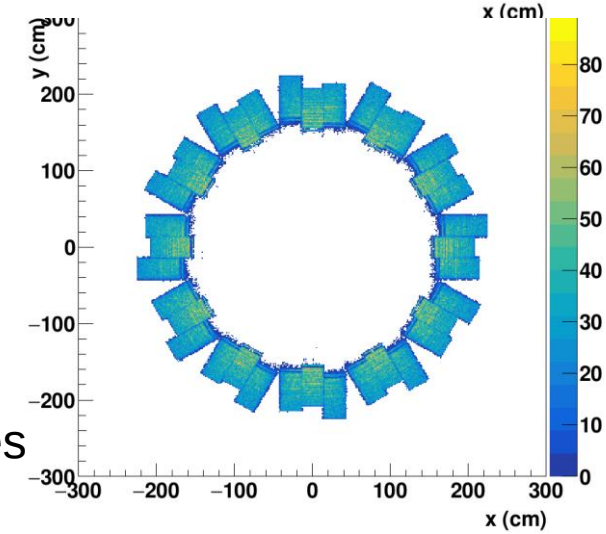

eTOF hits




track projection to eTOF plane



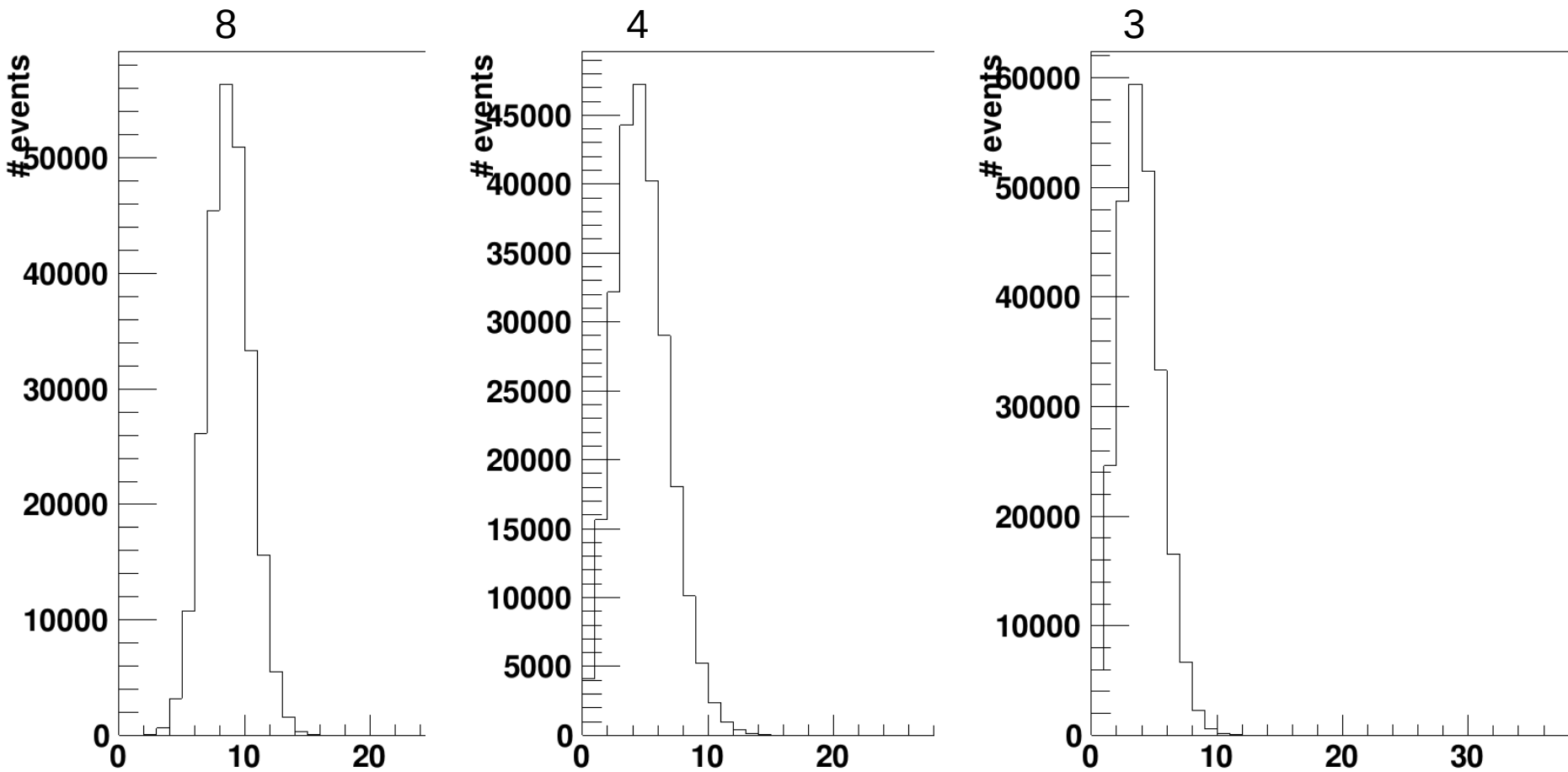

track intersections with active volumes




match candidates

# MatchMaker

**simulation with 10 particles in eTOF region**

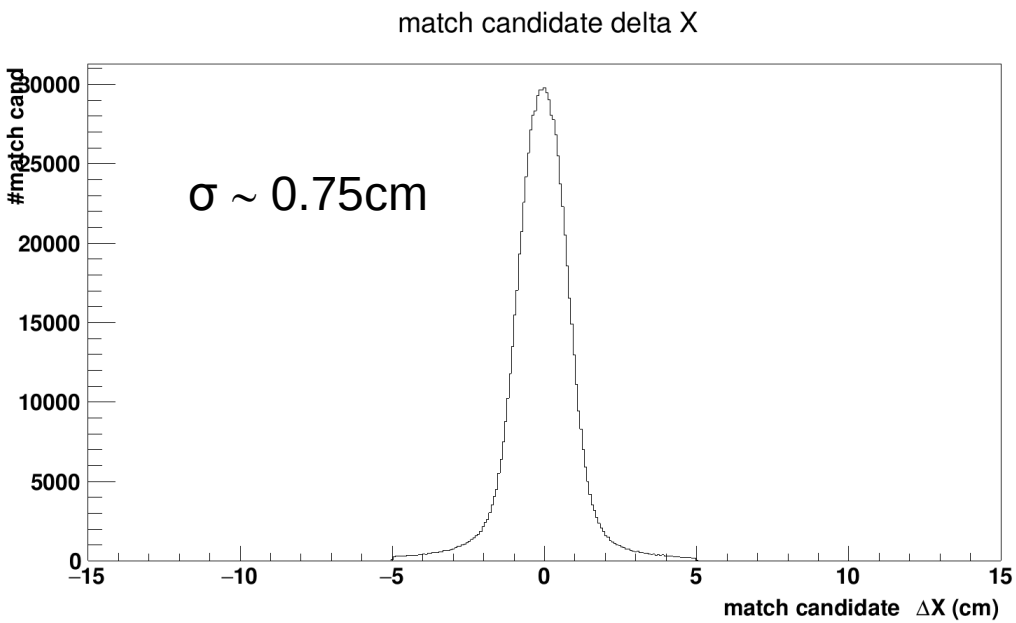


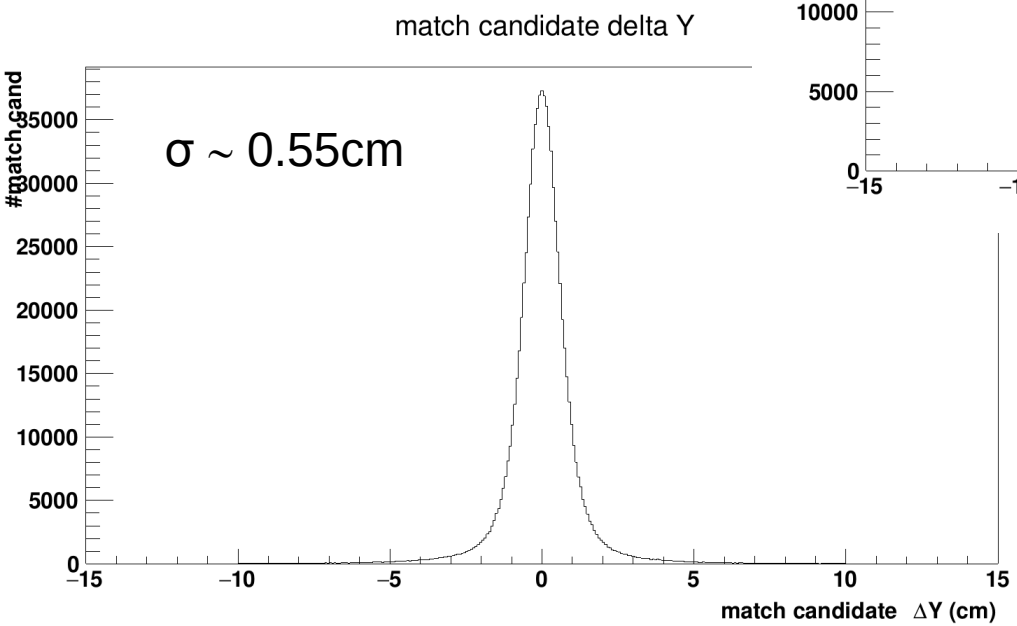

eTOF hits | track intersections | match candidates

# MatchMaker

## simulation

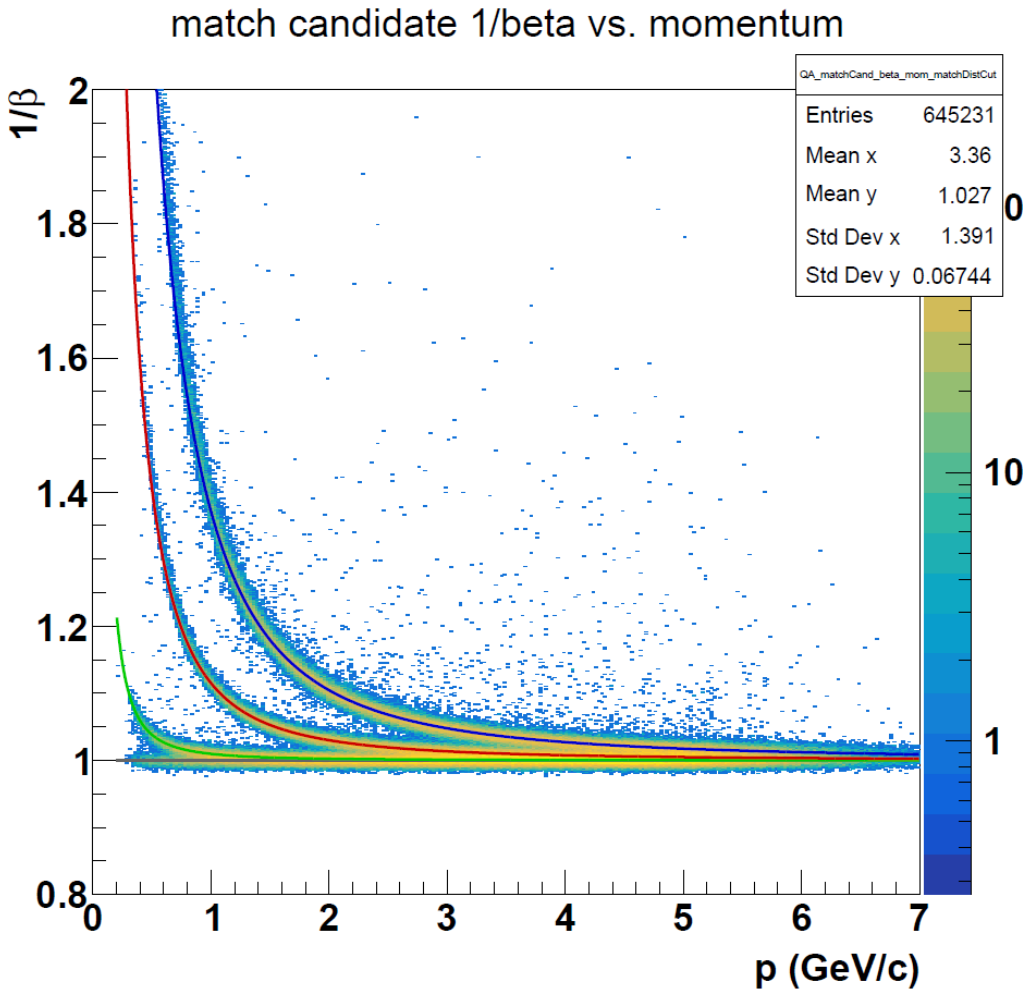
width of ΔX (across strips) slightly larger than ΔY (along strips)



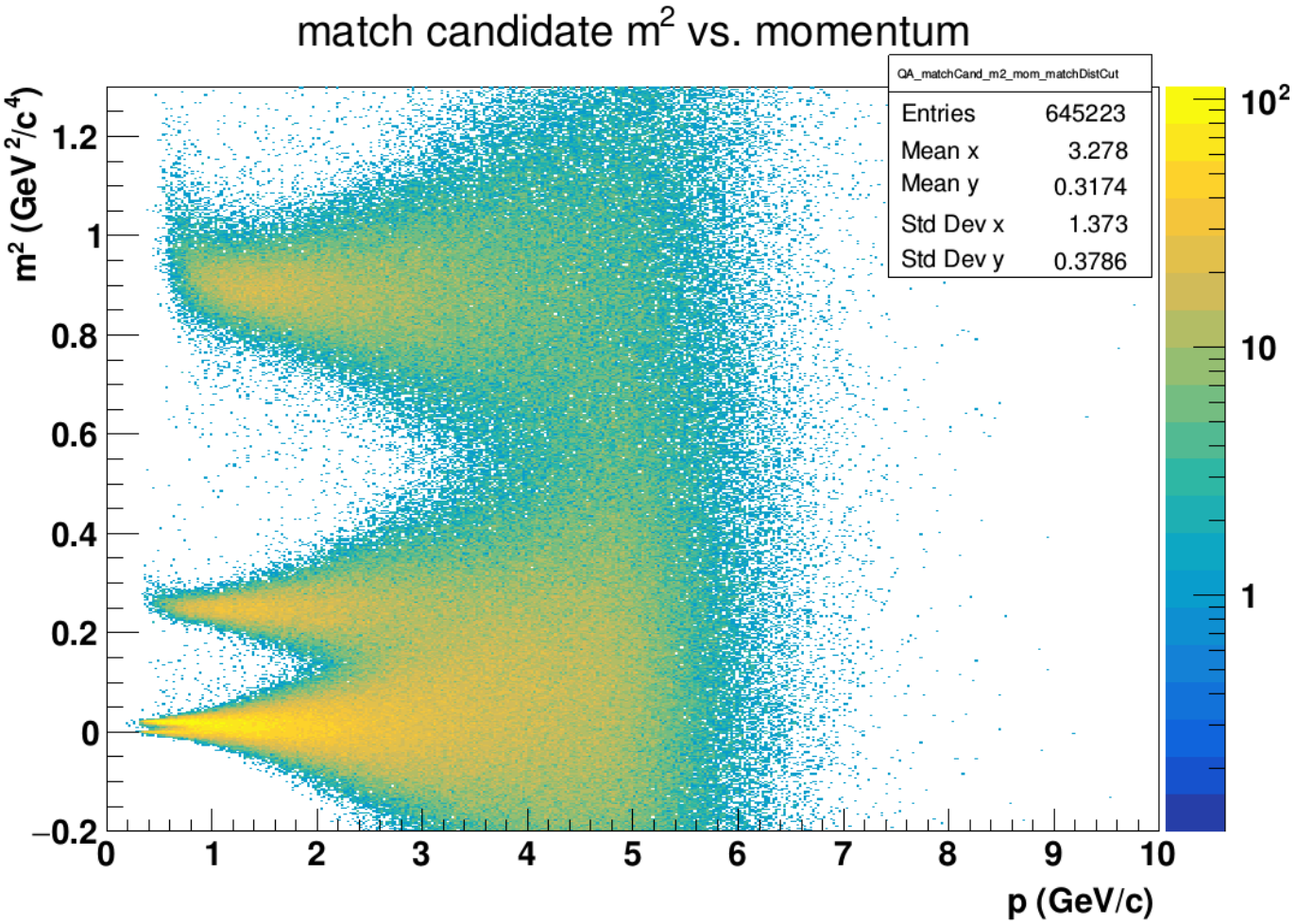
# MatchMaker

## simulation



# MatchMaker

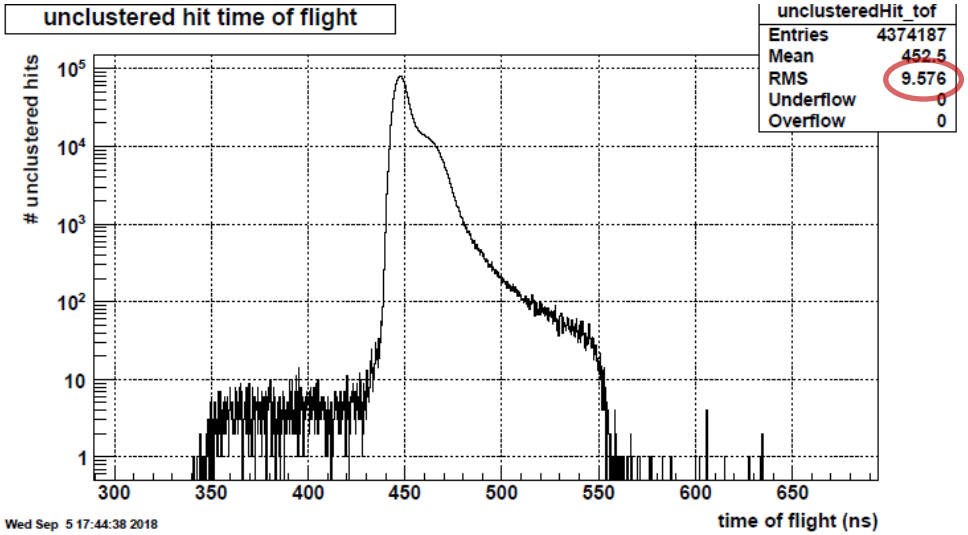
## simulation



# Offline software

## data - issues

- before day156 the AFCKs of the eTOF did not provide a useful reset time
- eTOF was included in the calibration production for Au+Au at 27GeV
  - ~ 2M events available in total
  - ~ 600k events with good timing eTOF information after firmware fix



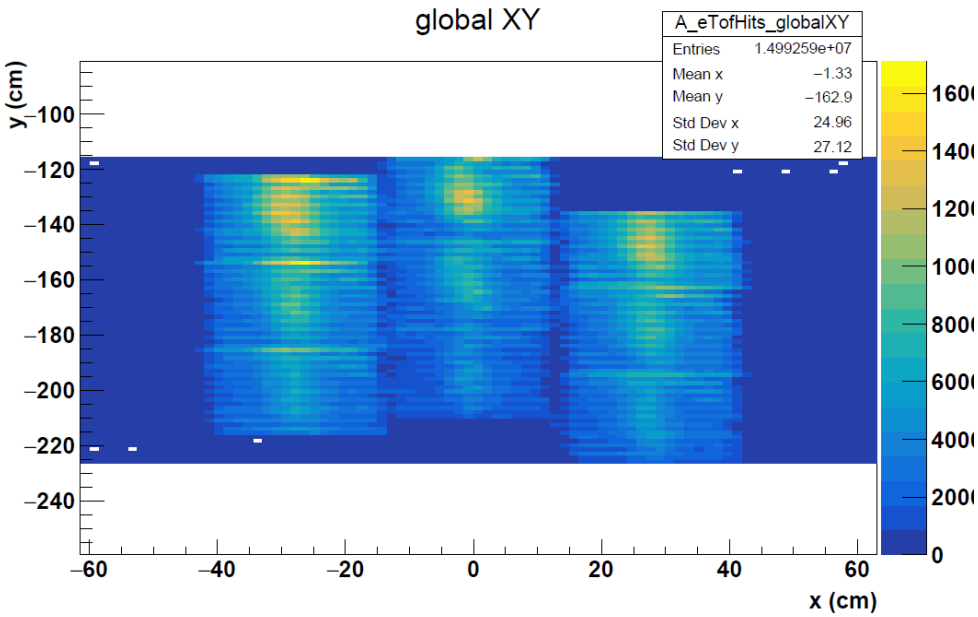

all eTOF hit times fall into peak around 450ns (T0 offset)
no outliers

( hit time – bTOF clock reset time ) “modulo” 51200 ns - VPD start time

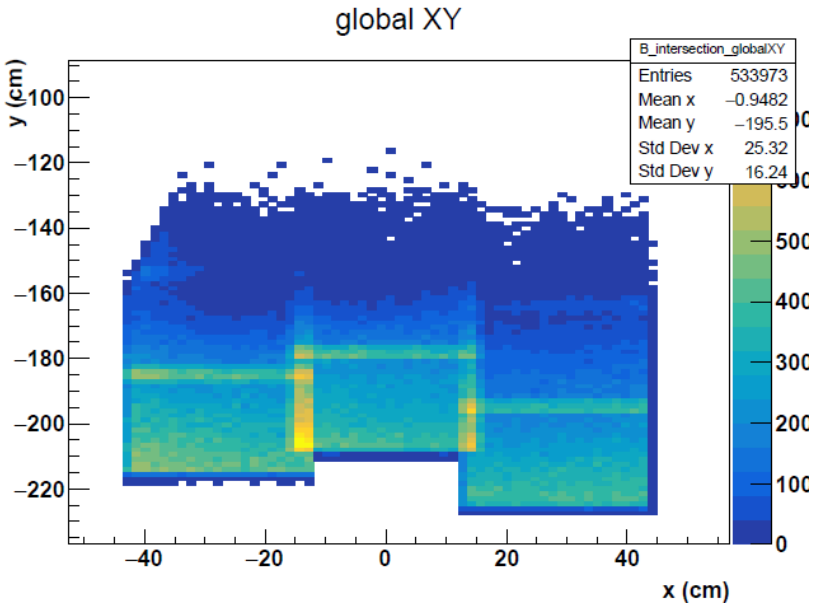
# MatchMaker

## data - global XY position of hits & track intersections

eTOF hits

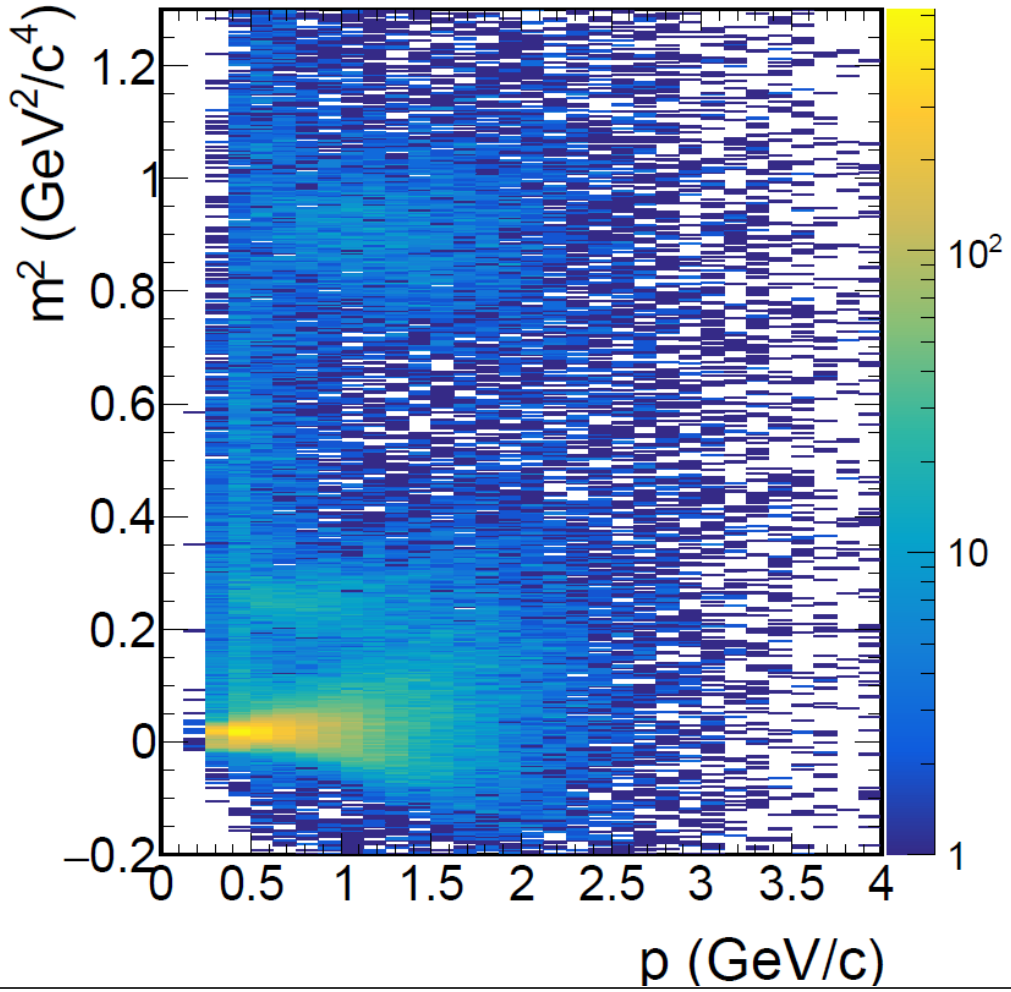



track intersections



# MatchMaker

**data - PID information for matched tracks**



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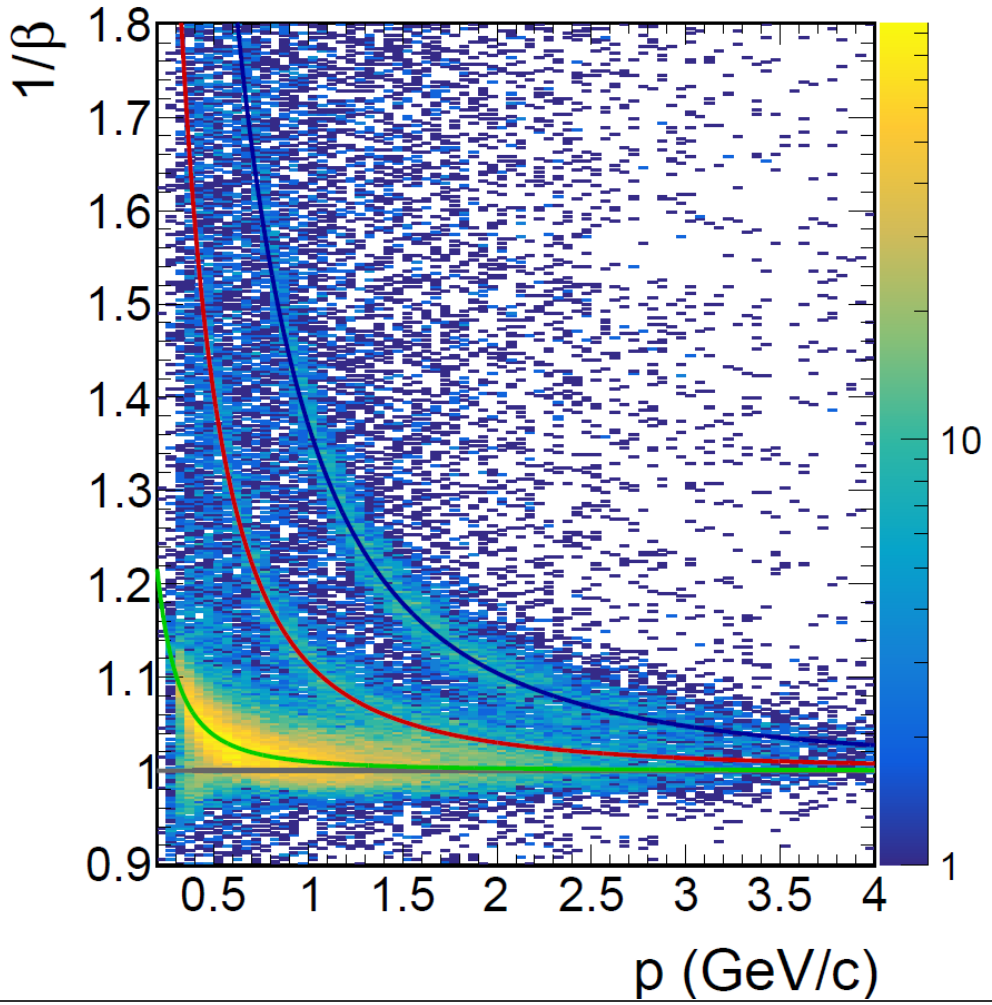

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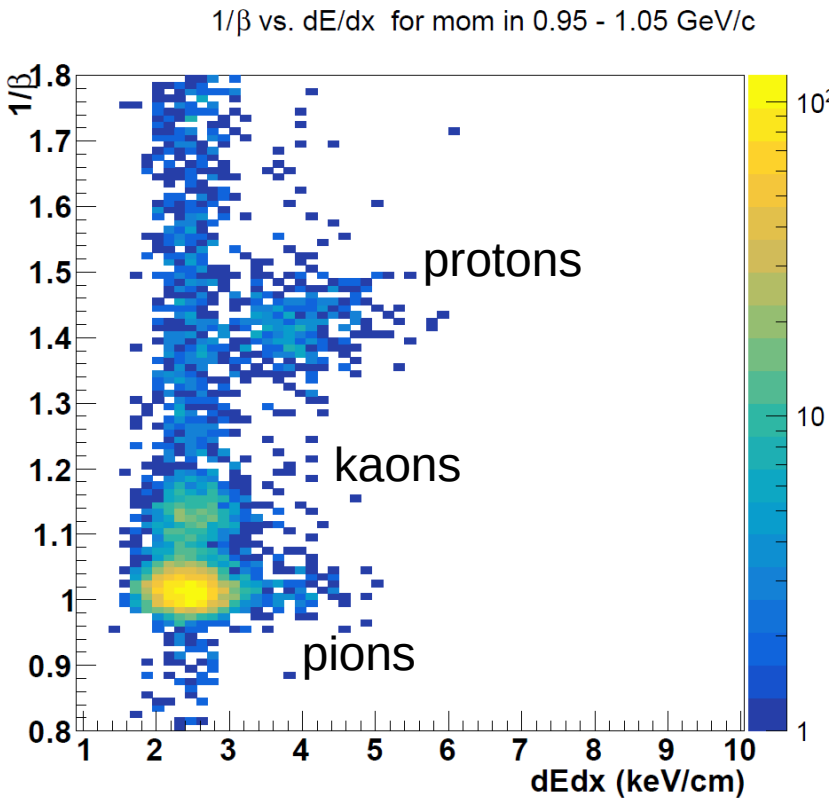


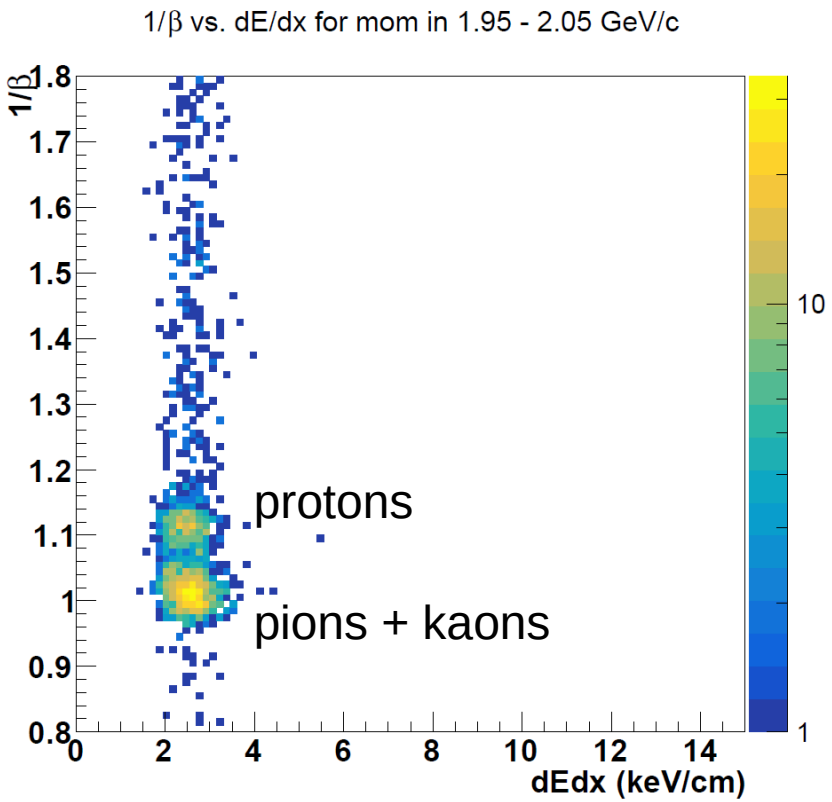


eTOF provides additional information to separate pions from kaons and protons where energy loss along can no longed differentiate

# Offline software

**summary & next steps**

- development of reconstruction software is making good progress
  - further room for improvements
    - calibrations not yet finished
    - rejection of bad match candidates / low quality tracks
  - there is a good chance to get also some useful eTOF information out of the 3GeV FXT data (taken before firmware fix) with bTOF start time & run-by-run T0 offsets (a typically fixed target run has 2-4M events)
- integration into MuDsts and PicoDsts
- full eTOF reconstruction chain will be ready for the start of the run 2019

# Offline software

**points for discussion**

- event builder & data format 2019/2020
- online monitoring
- matching criteria → match flags
- misalignments
- database tables