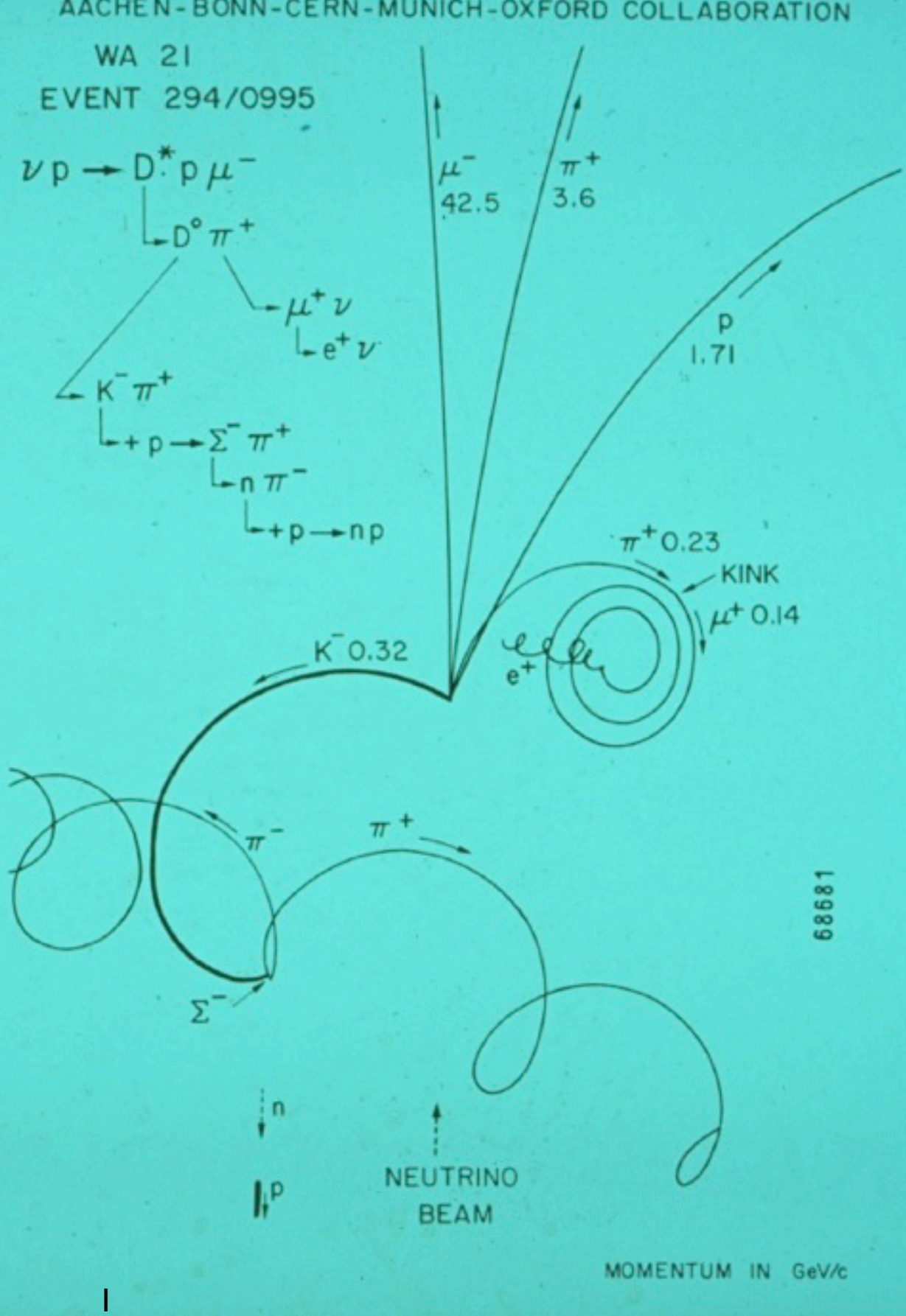
Tracking

Eugenio Paoloni

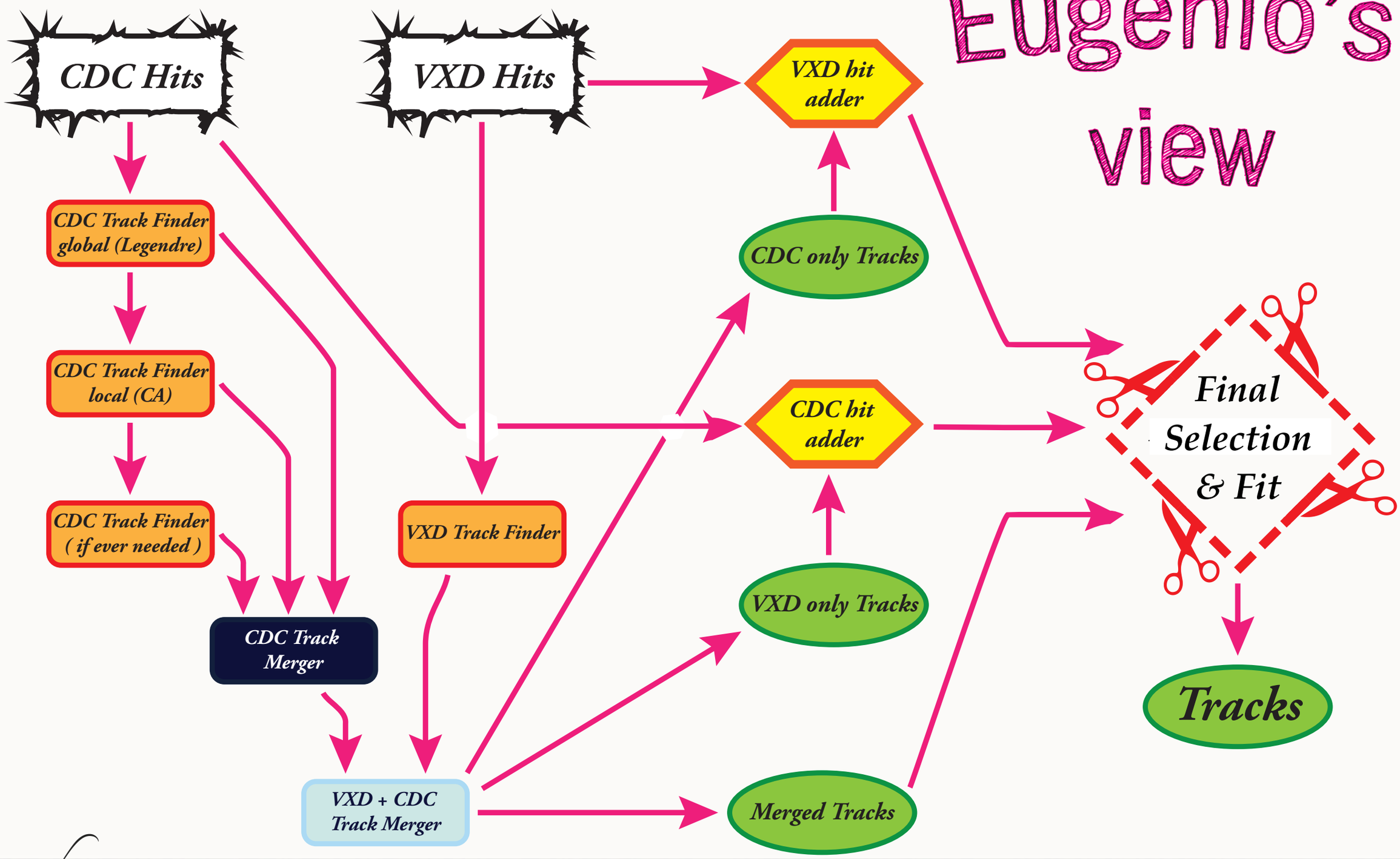


Talk Outline

- Report of the main results achieved since the last Belle2 Italian meeting.
- Critical Issues.

Trak Data Flow: Reminder

Eugenio's view



Tracking Group

- Group conveners:
  - Martin Heck, E.P.
- VXD & PXD:
  - Peter Kvasnicka, Peter Kodys, Rudi Früwirth, Jakob Lettenbichler, Eugenio Paoloni, Manfred Valentan, Martin Ritter, ***Thomas Madlener, Ian Watson***
- CDC:
  - Viktor Trusov, Oliver Frost, ***Niels Braun***
- Cross-detector:
  - Giulia Casarosa, ~~Benjamin Oberhof~~, Myroslav Stefaniuk, Ian
- Kalman Fit:
  - Tobias Schlüter, Johannes Rauch
- Analysis Data Model:
  - Markus Prim
- Data reduction
  - Giulia Casarosa
- QA:
  - ***Giulia Casarosa***, Micheal Ziegler, Simon Wehle, Thomas Hauth

Leaving Belle2

Unpaid

Now working on the ECL

Now working on his Belle1 PhD thesis

Leaving Belle2

Ongoing Activities Overview

- CDC pattern recognition:
  - Viktor Trusov + Niels Braun + Oliver Frost are working on the segment reconstruction using stereo hits. (Global finder of tracks from the IP using conformal + legendre transforms).
  - Oliver Frost is working on the local track finder (cellular automata): the plan is to have a first working release ready for the CDC cosmic test in Spring 2015.
- VXD pattern recognition
  - Jakob, Rudi, Thomas and Eugenio are working on the design and migration of the present VXD track finder.
- QA
  - Giulia (and Thomas from 2015) are working on an extensive set of reference plots and tests of the track reconstruction software (see next talk)
- V0 reconstruction
  - Tobias(vertexing) + Markus (persistency): **Done**
- Long standing issue: hit pattern in the mini-MDST
  - Giulia will take care of filling the information (finally!): **Done**
- Trak merging
  - Benjamin (low priority w.r.t. ECL code development)

Napoli Dec 2014

- ~March: CDC Track extrapolation to VXD Delayed
  → **MC campaign in April 14**
- ~September: CDC Finder functionality Delayed
  → **Physics Trigger development**

Now

- ~Spring 15: Low-Level Speed optimization for all track finders; Delayed
  Full VXD TF functionality, including making use of hits due to curling tracks (currently ignored); Delayed
  Cross detector searches; Delayed
  Killer module to remove likely fake or double-found tracks; Delayed
  → **cosmics with CDC, TOP, ECL,... in May 15**
- ~Spring 16: Studies of methods to determine systematics on trackfinding effieciency, fake rates, etc. (**should be done before Data Taking**)
- After data-taking begins:
  Validation MC ←→ Data
  Final Pattern Reco including hits from Cluster Rescue (tuning depends on background)
  Material budget determination
  → **High Quality Analysis**

Frascati May 2015

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VXD Track Finder Issues

- Very Inefficient PXD hit pattern recognition:
  - Only 18% of the PXD clusters are added to the SVD track
  - Poor resolution on the transverse and longitudinal impact parameter.
- Very irregular track reconstruction efficiency over the detector acceptance:
  - Polar angle: dip at lambda ~ 0 (theta ~ pi/2)
  - Azimuthal angle: modulation following the pin wheel geometry of the SVD layer 3
- Code almost impossible to debug: we (Martin, Jakob and I) decided to concentrate our efforts on the redesign.

VXD Track Finder Issues

SOLVED

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Solved

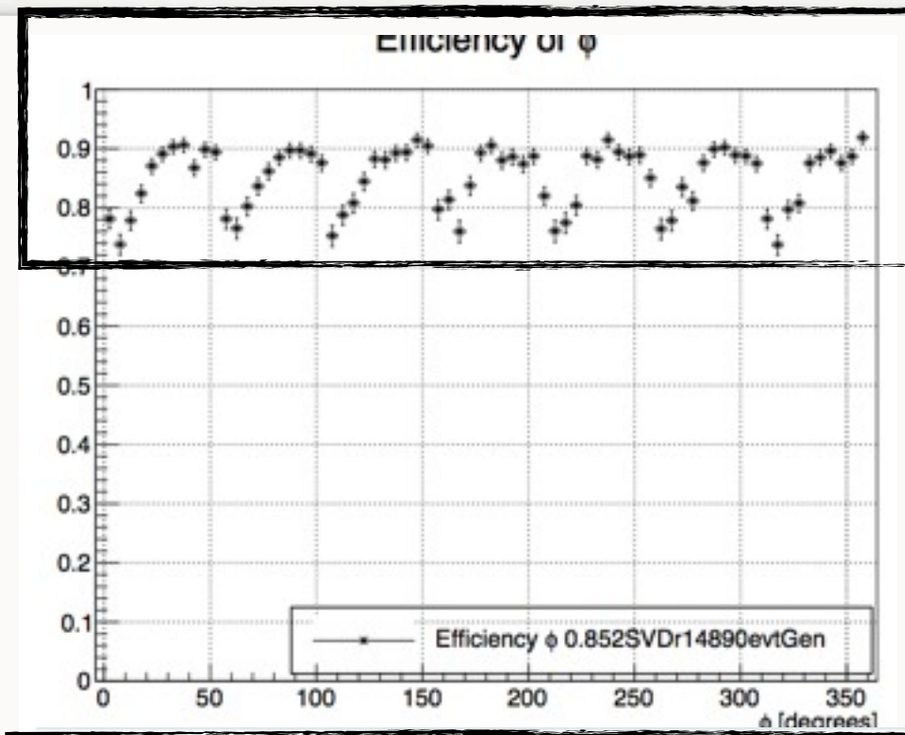
Solved

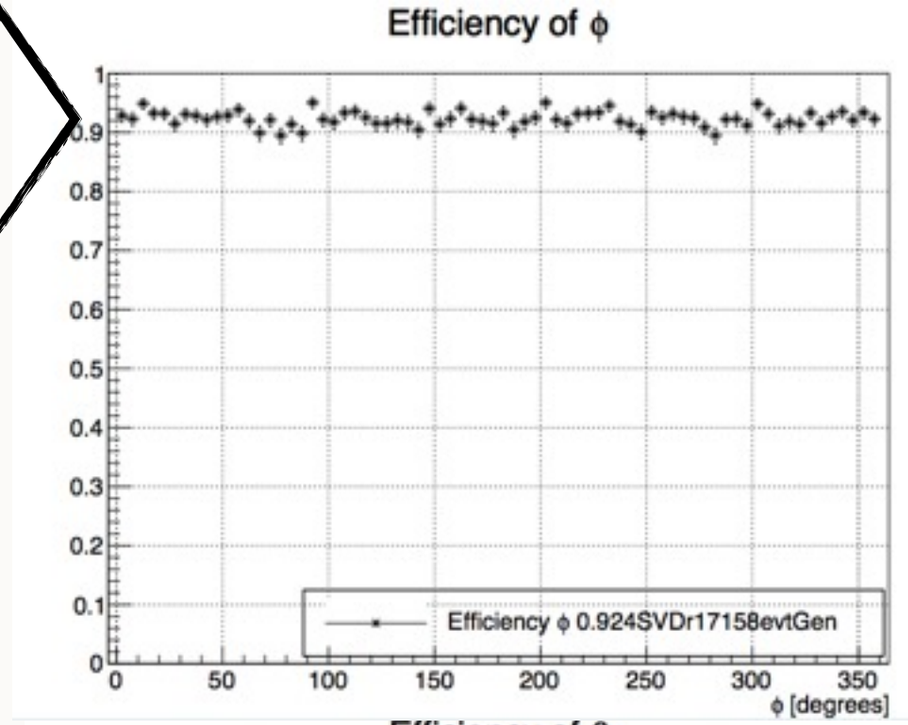
UnSolved

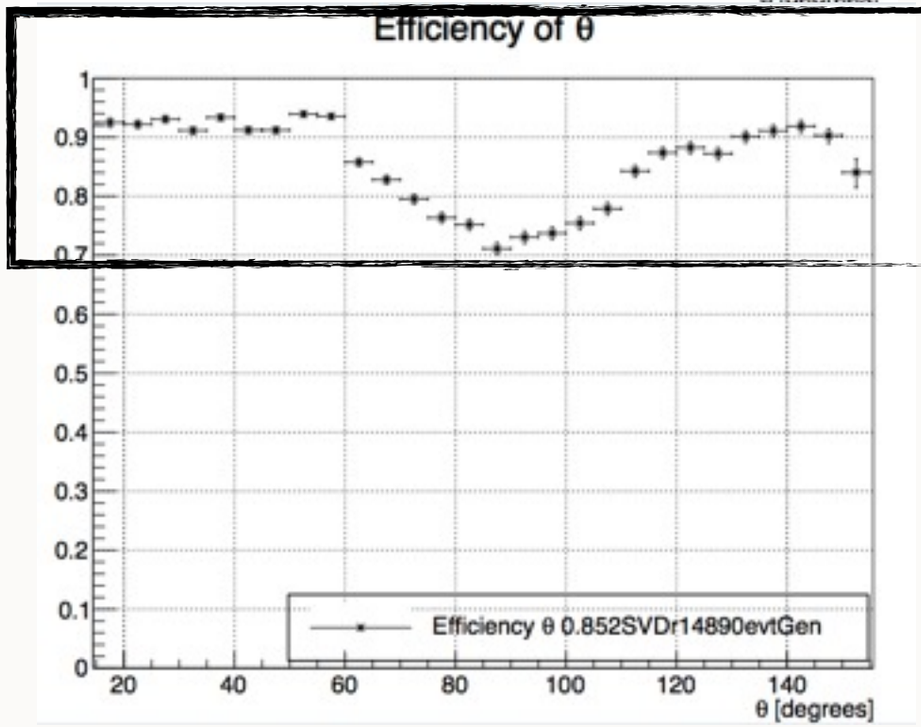
The Good News From The VXDTF Are

- First bug: transformation from local coordinates to local normalized coordinates was messing up the PXD cluster position
- Second bug: clustering algorithm in the VXD tuning was suboptimal
  - Clusters from MIPs at normal incidence were rejected
  - The associated space point went missing
  - hence no track

Performances Comparison



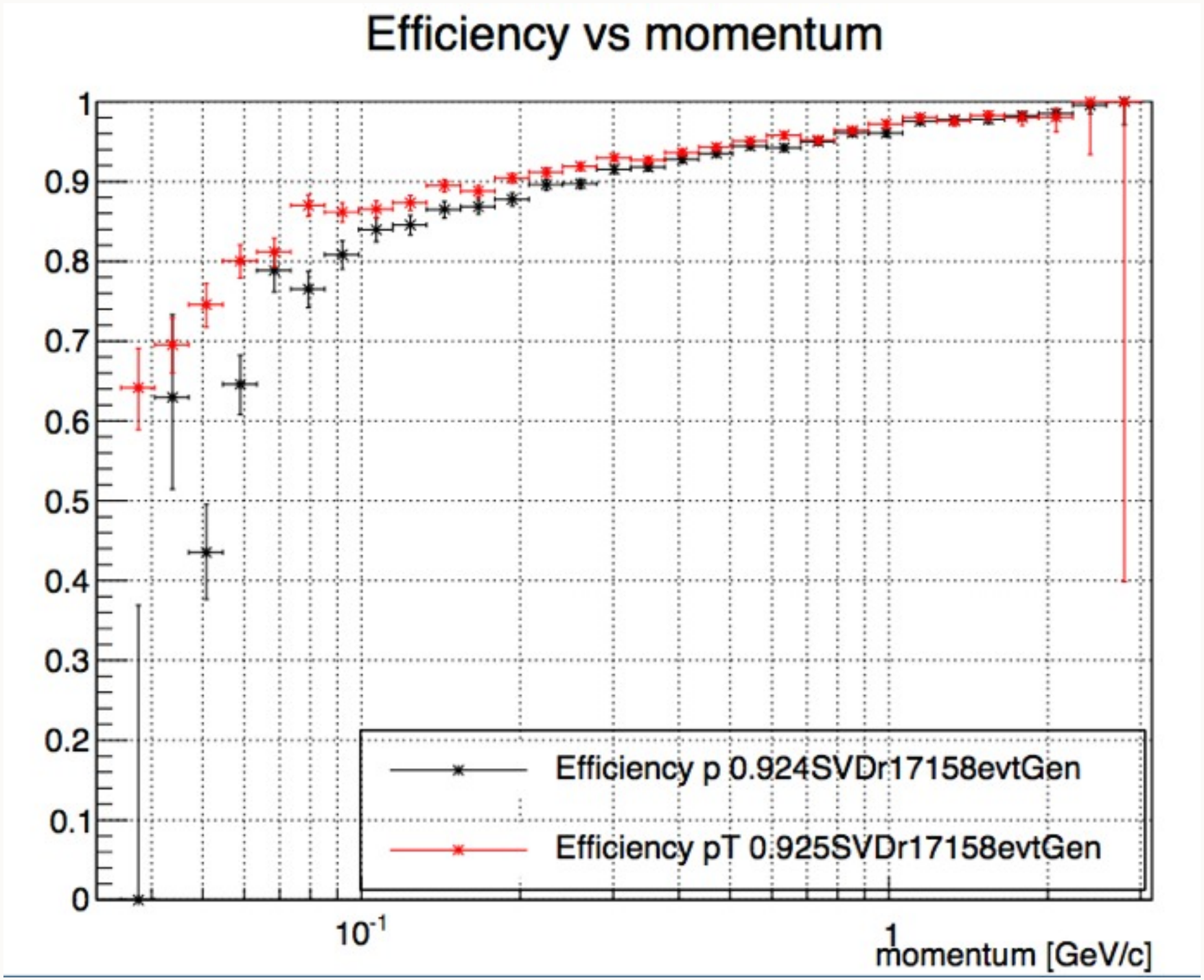




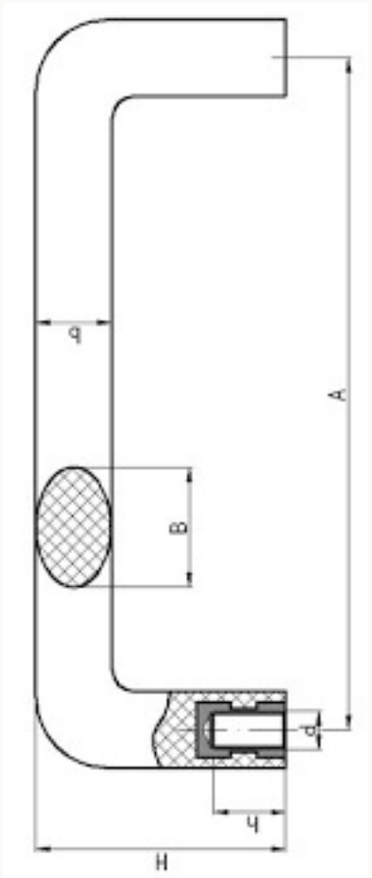
Performances Comparison

Revision	hitRatioPXD	hitRatioSVD	Efficiency	Ghost
r14890SVD	x	84.9%	85.18%	6.47%
r14890VXD	19.7%	81.5%	79.62%	5.4%
r14930SVD	x	83.5%	83.89%	5.84%
r14930VXD	78.9%	81.9%	85.52%	6.32%
r17158SVD	x	91.6%	92.4%	6.26%
r17158VXD	85.4%	87.8%	91.75%	6.12%

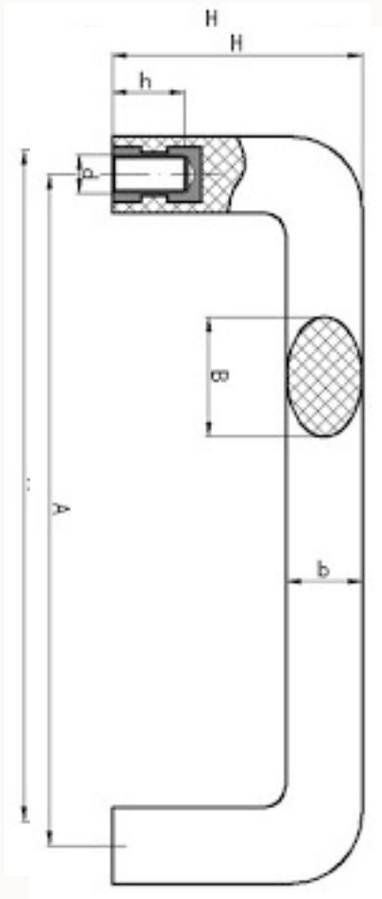
VXDTF Performances



VXDTF Redesign Issues

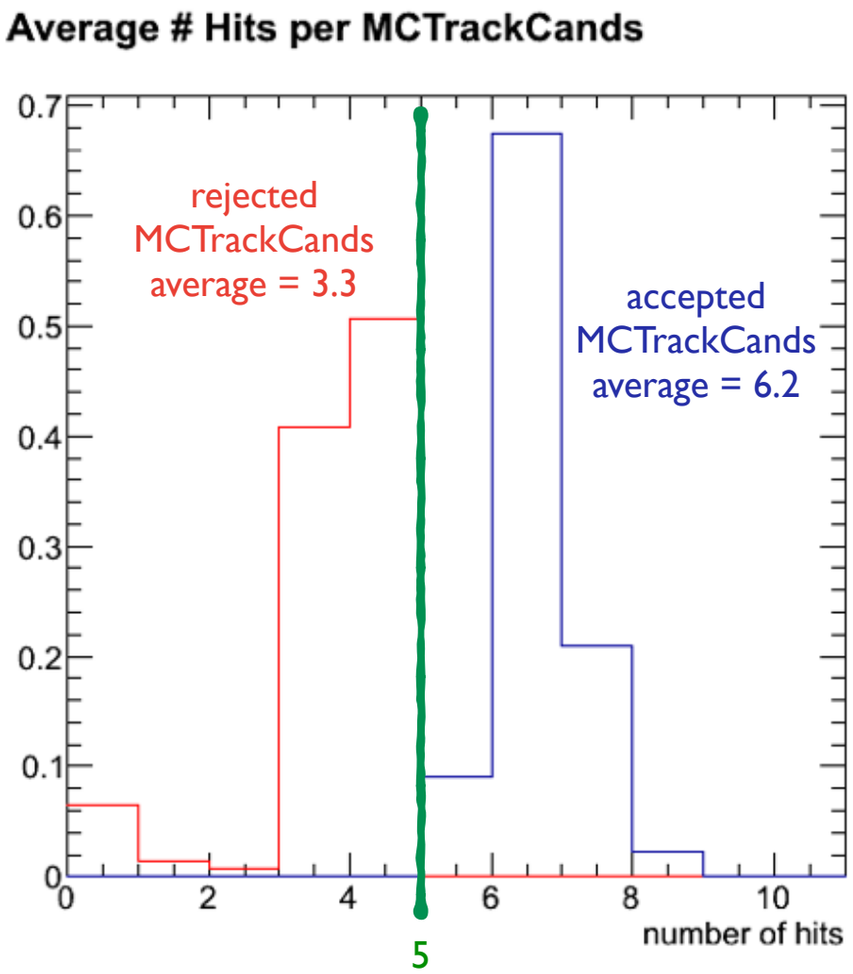


- How to put the handles on the problem?

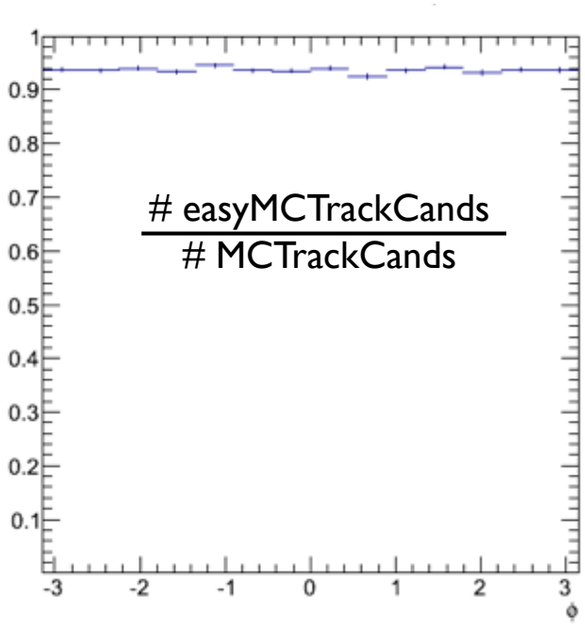


Definition Of Efficiency

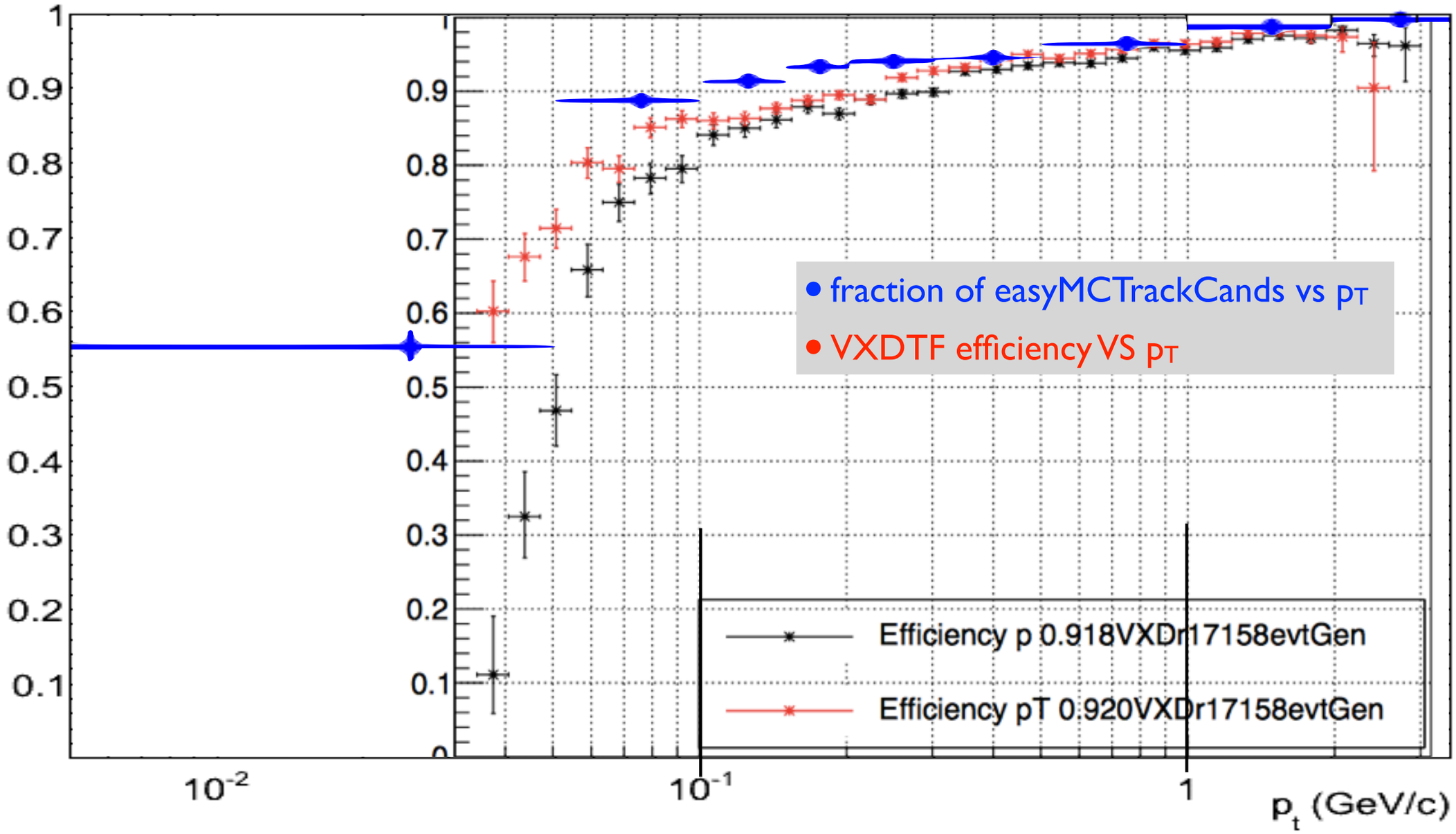
Fraction of easyMCTrackCands/MCTrackCands



- 5k Υ(4S) generic decays, *Belle II* geometry
- 50k MCTrackCands (PXD&SVD TrueHits, no use of clusters, # of 1-D hits > 5)
- fraction of MCTrackCands classified as *easy to find* = **(93.7±0.1)%**, homogeneously distributed in ϕ:



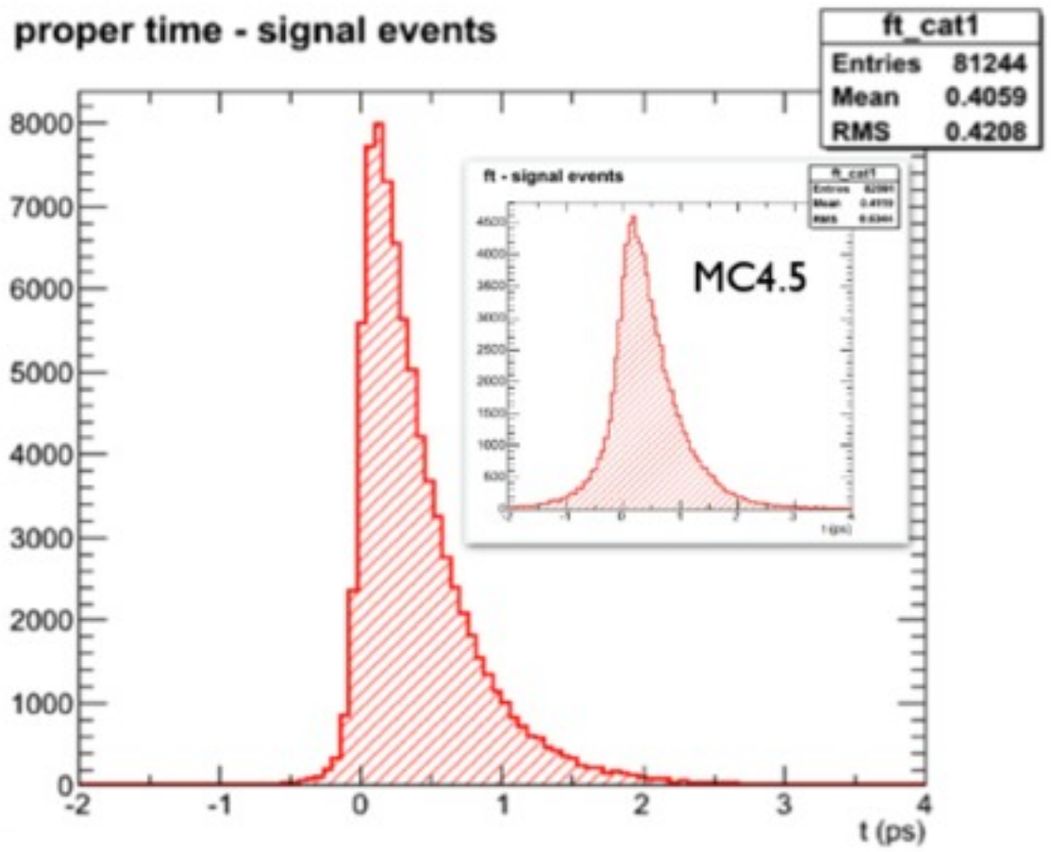
VXDTF Performances

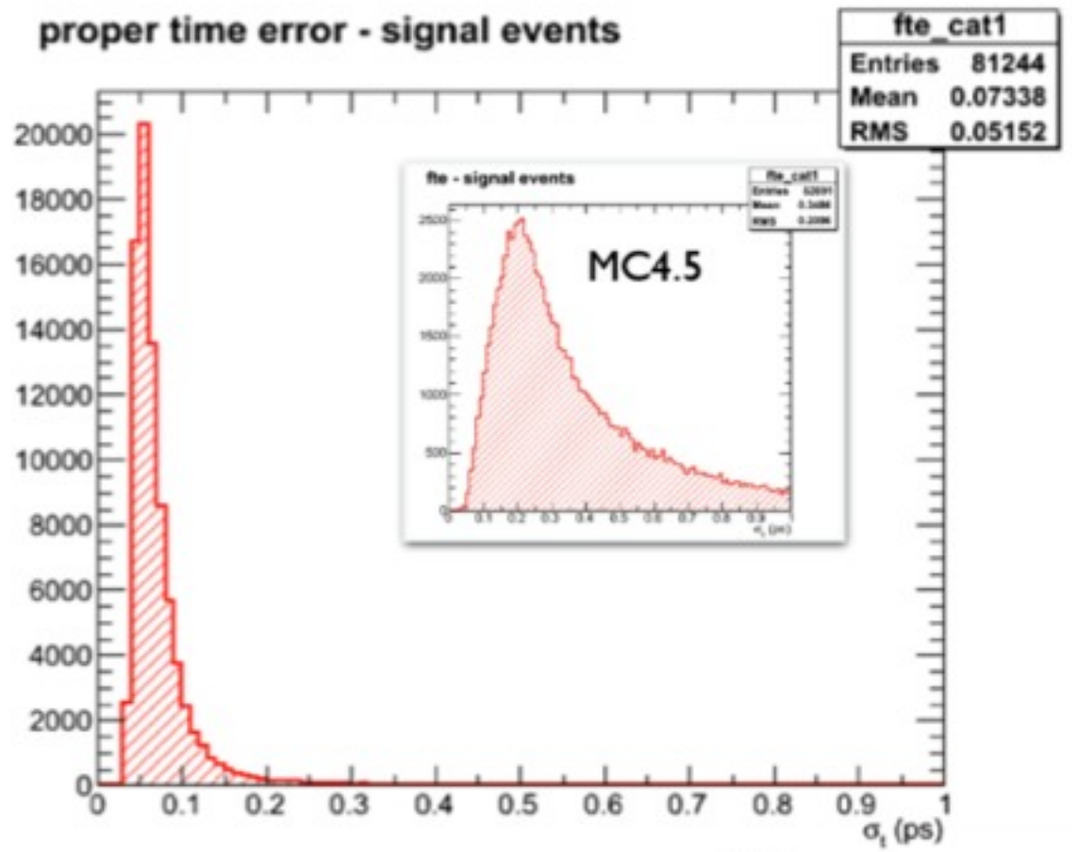


Is This Improvement Worthwhile To Mention ?

Proper time & proper time error

Courtesy by G. Casarosa

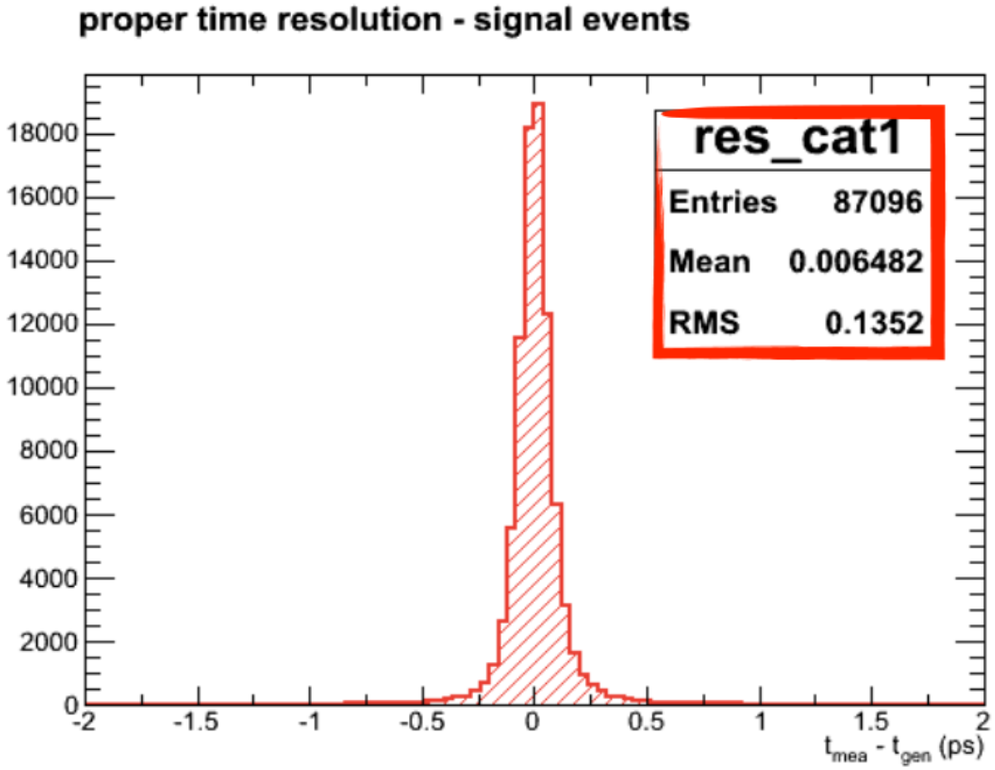


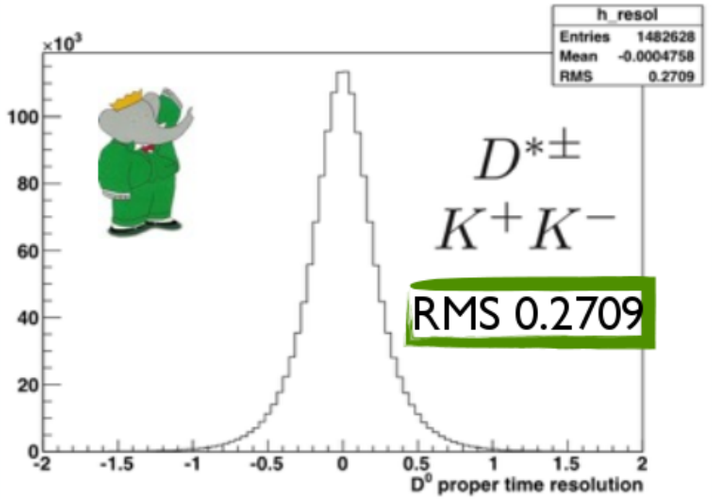


- tremendous improvement in the computation of σ_t w.r.t. MC4.5 (plot in the box)
  - average σ_t = 0.07 ps VS 0.35 ps in MC4.5
- tremendous improvement in the computation of *t* w.r.t. MC4.5 (plot in the box)
  - RMS t = 0.421 ps VS 0.634 ps in MC4.5

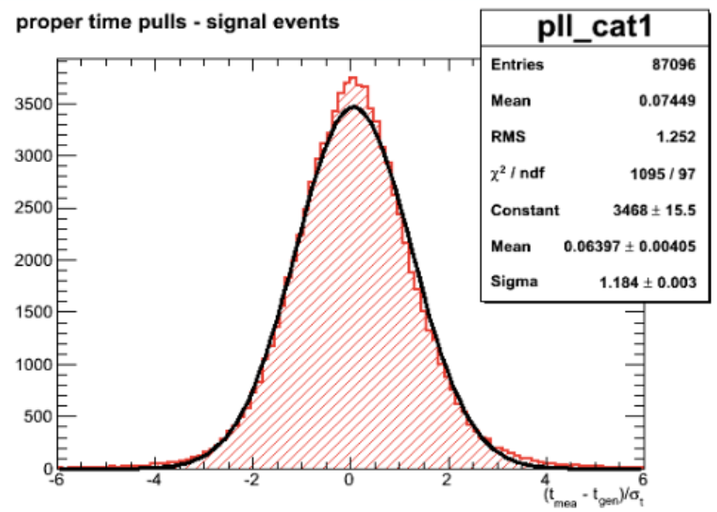
Proper time resolution

Courtesy by G. Casarosa



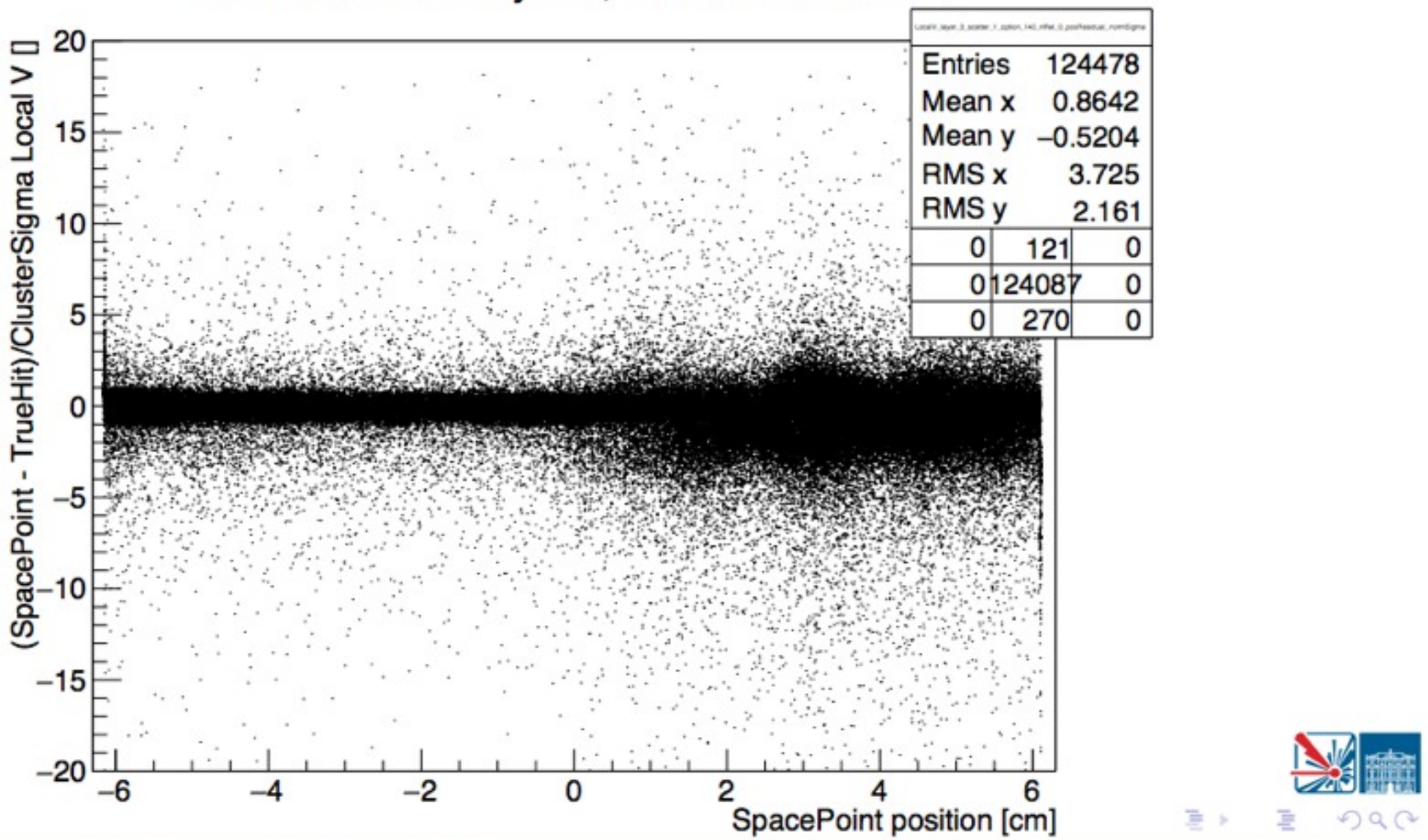


- **D^0 proper time resolution = 0.135 ps**
- factor 2 improvement w.r.t *BABAR* and Belle (0.28 ps)
- pulls distribution is OK:
  - error correctly estimated within 18%
  - bias of 6% of the error



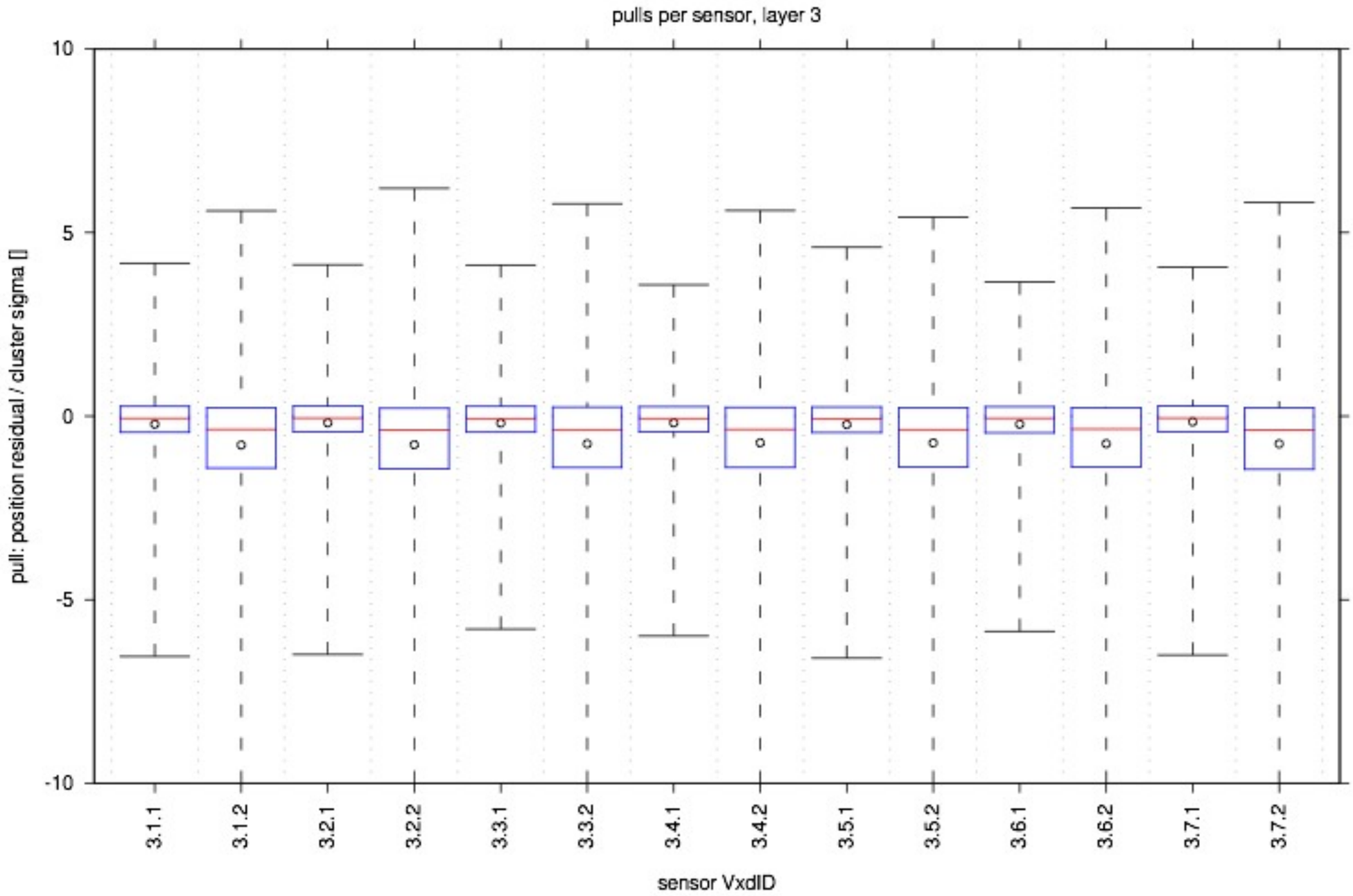
SVD Cluster Position & Errors

Pulls vs. Position layer 3 V new Digitizer



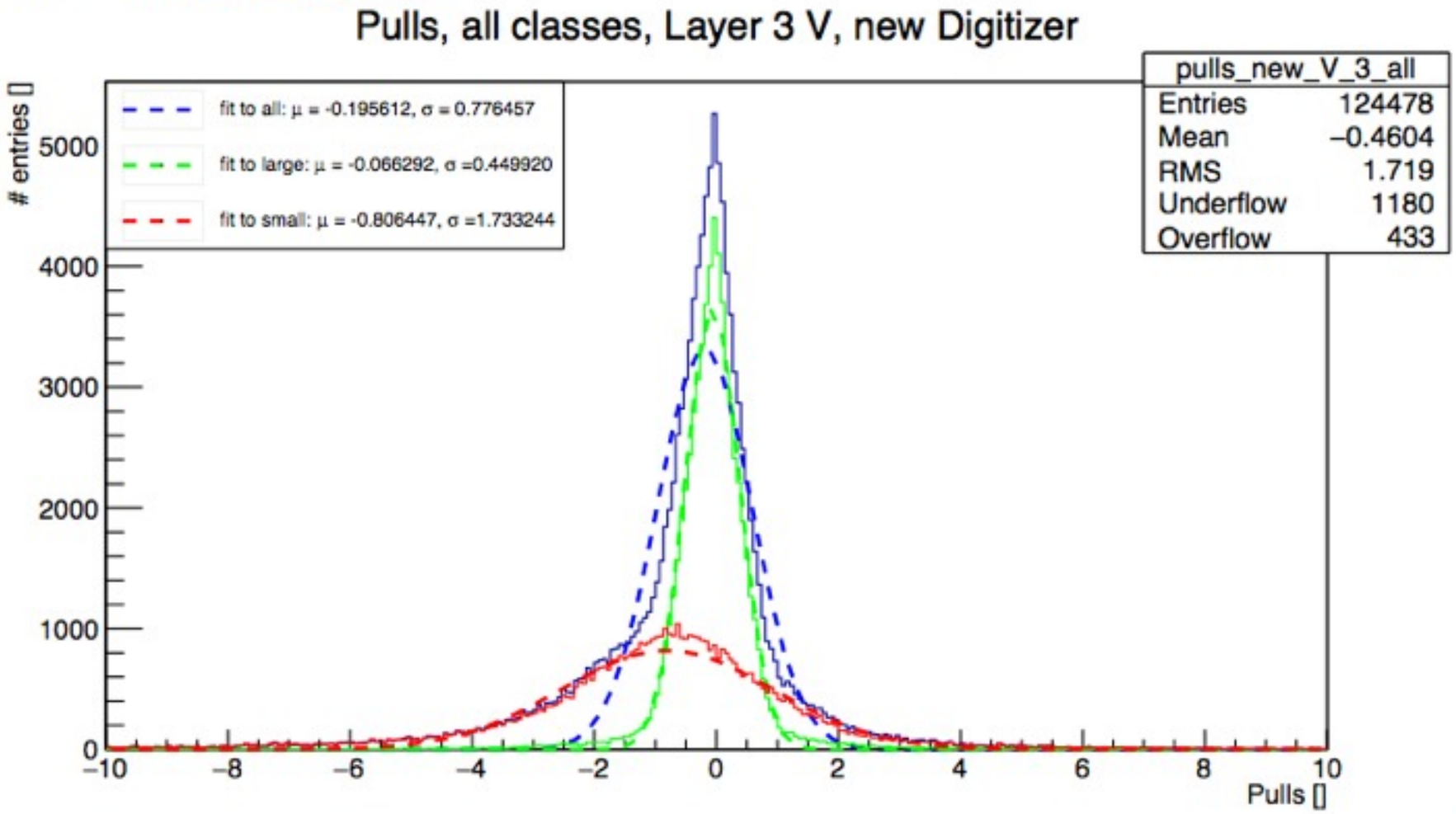
Layer 3 Pulls

distribution per sensor, layer 3 V new Digitizer



Layer3 Pulls

Pulls new Digitizer



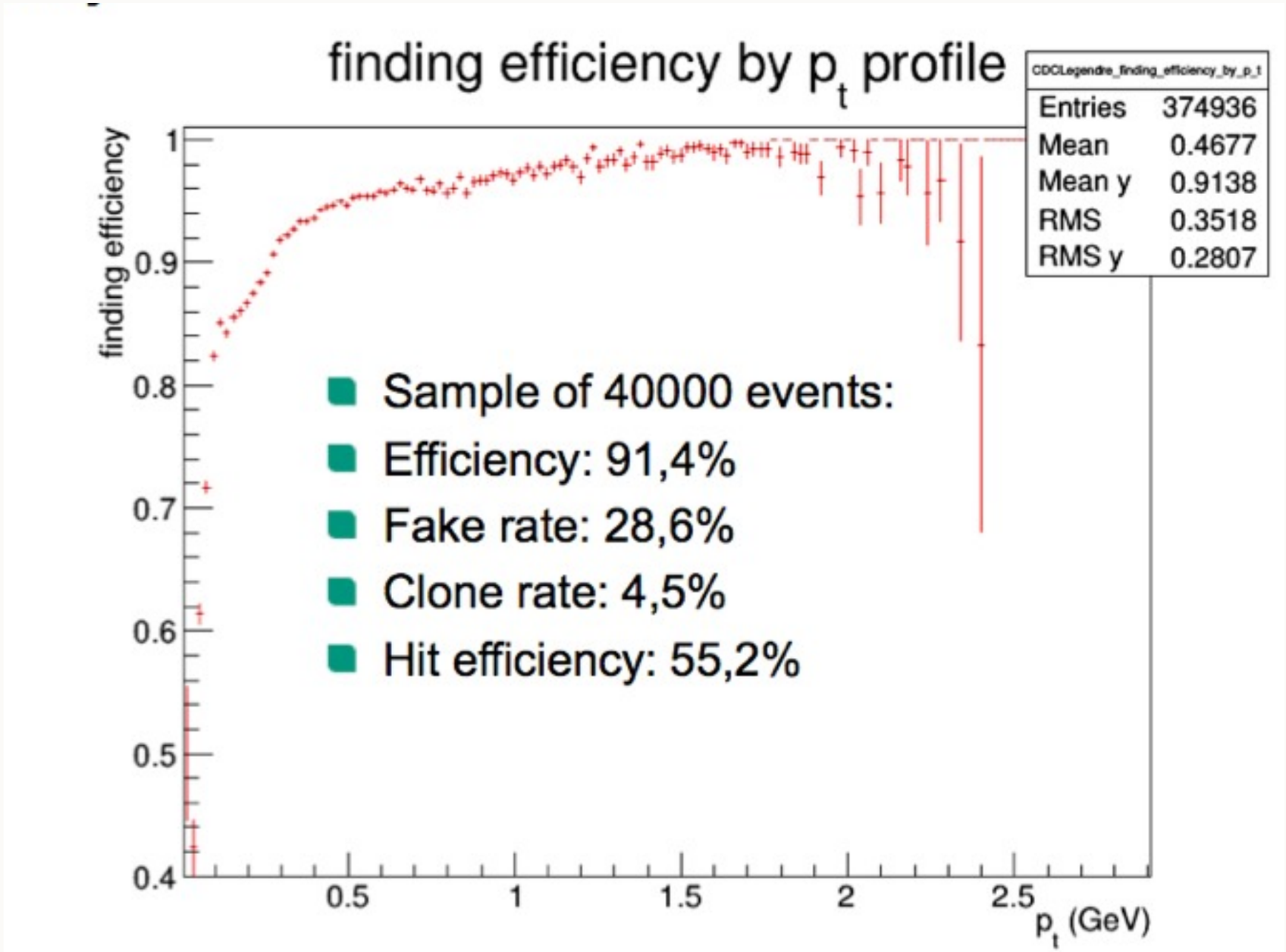
CDC Cosmic Run

- The local track finder is deployed and working (on MC)
  - We should be ready to reconstruct the first cosmic events
    - We should try to interact more closely with the CDC Hardware group (Thomas Hauth designated as contact person and Oliver Frost as main responsible for the reconstruction).
    - Apparently the CDC Hardware group is not eager and greedy of having Oliver in situ. (and this is BAD in my opinion).

CDC & TOP Cosmic Test?

- CDC + TOP can be tested with the Belle2 DAQ system and BASF2 reconstruction software
  - Is the joined test approved? I had just informal requests during coffee breaks at the last B2GM.
  - If it is approved what are the requirements? At the same coffee break I heard the requirement of a coarse evaluation of the momentum of the particle. How coarse?
  - I tried to switch the Tracking group from the “stand-by” state into the “active & propositive” state without success.

Global Track Finder



TrackFinderCDCLegendre: current status and new features — **by Viktor Trusov**

Issues:

- Event reconstruction data model (book-keeping of the hits, track history)
- Event t_0 determination
- B-field measurement in the tracking volume
- Get rid of Trasan

Conclusions

- The center of gravity of the tracking group is very close to Karlsruhe
- The italian contribution is quite limited in percentual (i.e. % of lines of C++/Python code, % of human time)
- The quality of our contribution is well appreciated by the rest of the collaboration:
  - Hit pattern long standing issue solved by Giulia
  - VXDTF problem solved by a trigger from Giulia's plots

F2F Tracking Meeting

Karlsruhe

1 - 2 Sept. 2015

Fit

MAKE A GIFT TO YOURSELF

JOIN THE TRACKING GROUP

GRAZIE

PER LA CORTESE

ATTENZIONE!