Release 7 Tracking Performances

outline

- ★ data flow
- ★ performance with no background
- ★ performance with background
- ★ Conclusions

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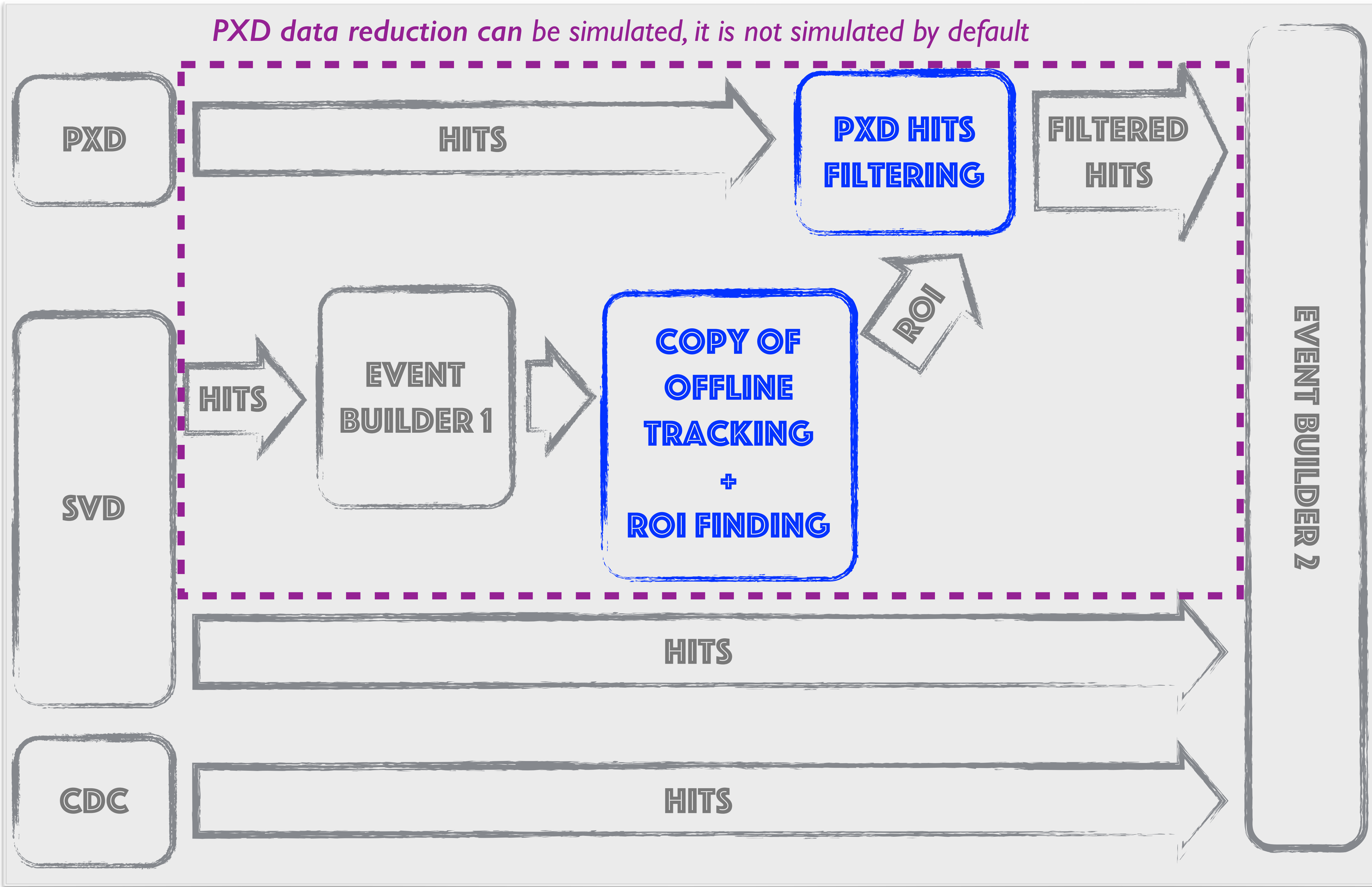
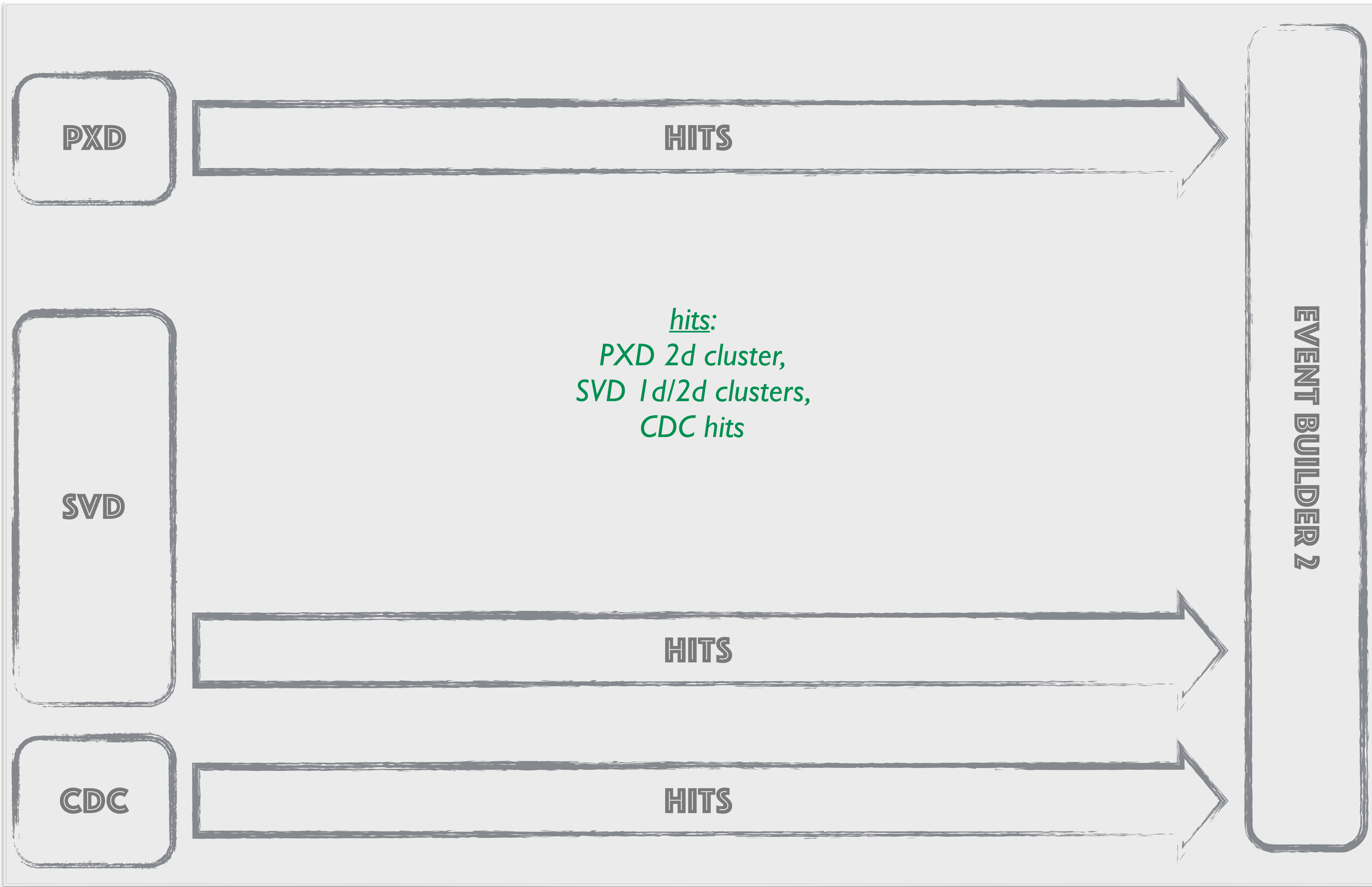
Introduction

- ➡ Tracking is part of the reconstruction software
- ➡ The tracking software is also used *online* for the PXD data reduction, especially when QED background is simulated
  - PXD data reduction idea: use SVD information to fit tracks, extrapolate them back to the PXD sensor and define the Regions of Interest (ROI). Only hits belonging to the ROIs are used for the offline reconstruction.
- ➡ It is therefore necessary to include tracking also in the simulation
- ➡ Release 7 is the first release in which it is possible to simulate the PXD data reduction
  - PXD data reduction is NOT simulated by default

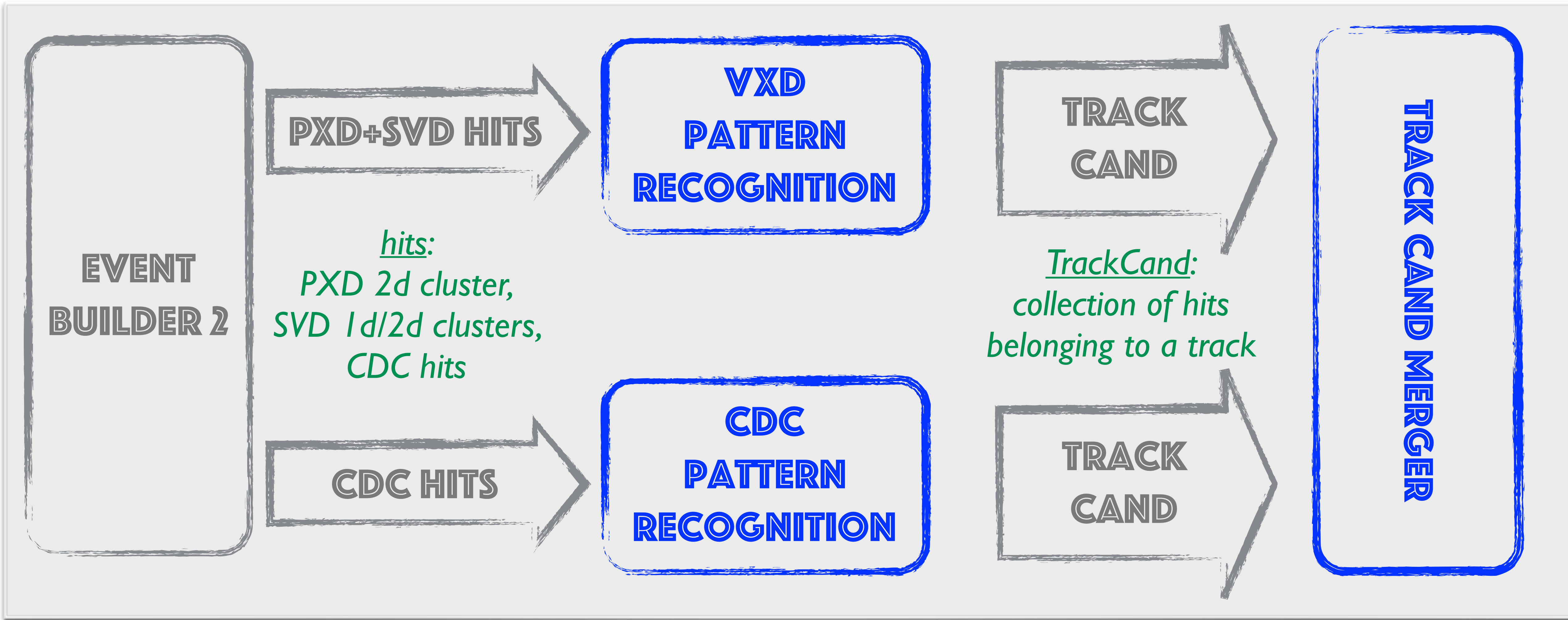
Online Tracking: PXD Data Reduction Simulation



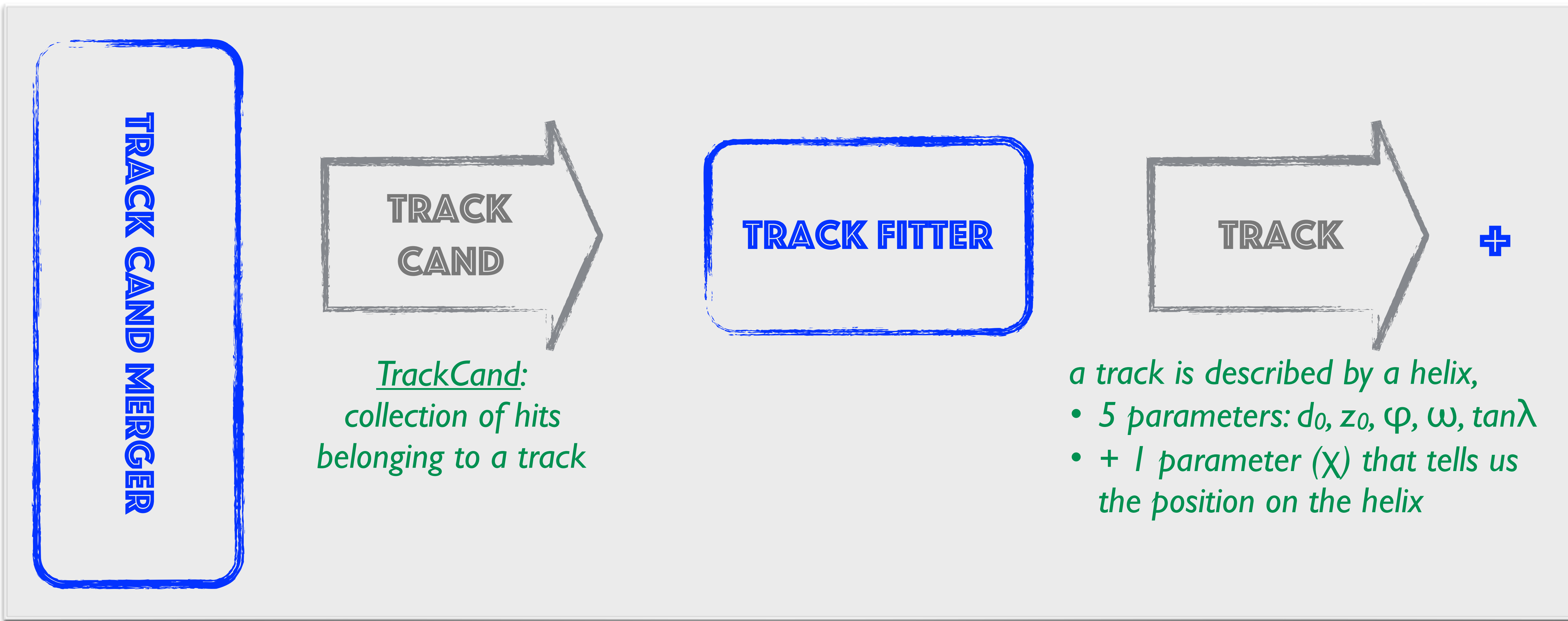
Standard Simulation in Release 7



Offline Reconstruction (1)

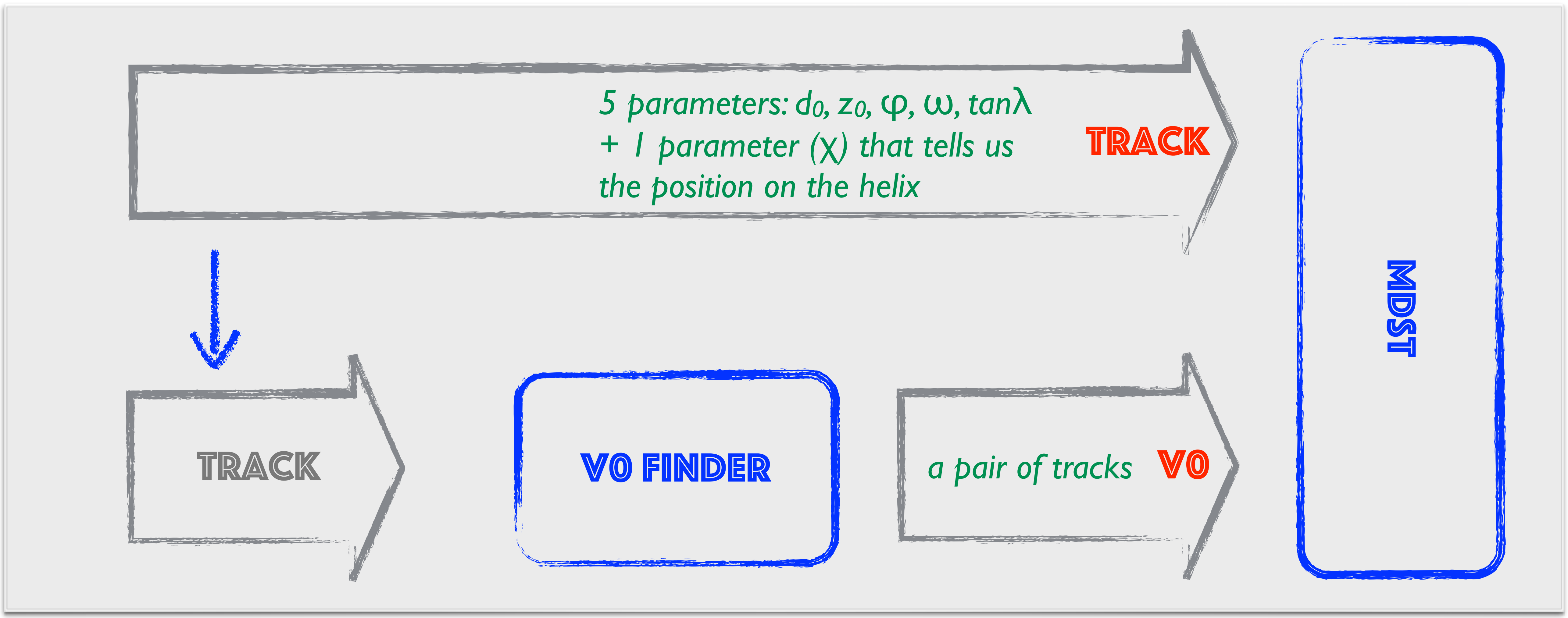


Offline Reconstruction (2)



DAF -- a Kalman fit that weights hits and rejects outliers with pion mass hypothesis

Tracking Objects: Tracks & V0s



Vertex Fitter with
mass hypothesis of K_S, γ, Λ

release-00-07-00 performances

tracks + *V0s*

Integrated Efficiency

➡ this study is based on a sample of 10k Υ(4S) generic decays reconstructed with the official standard reconstruction, no PXD Data Reduction & no background

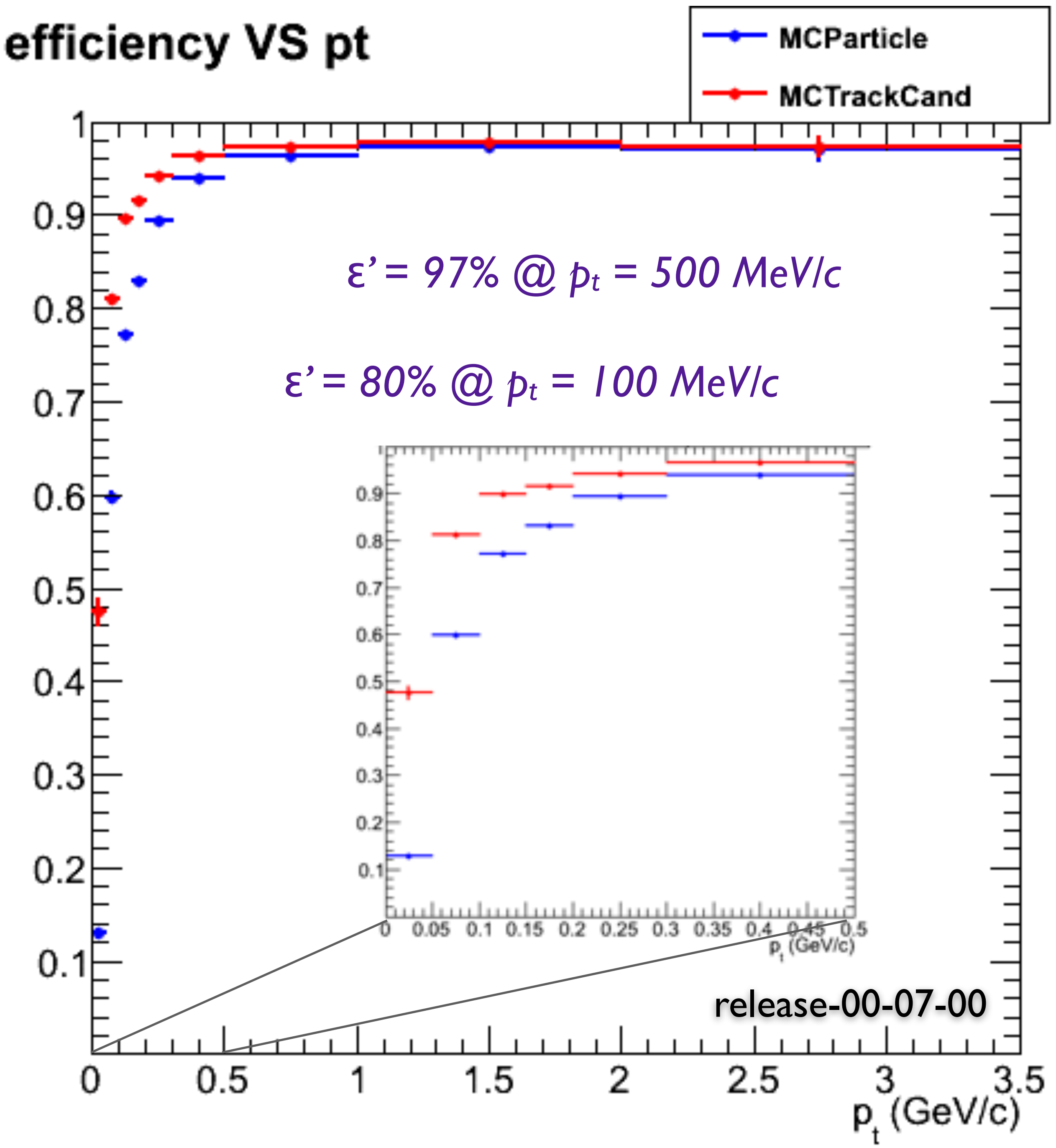
definition	*efficiency (%)*	release-00-05-03	release-00-07-00
$\frac{\text{\#MCParticles with at least one associated Track}}{\text{\# MCParticles}}$	**physical**	85.6±0.1	85.2±0.1
$\frac{\text{\#MCTrackCands with at least one associated Track}}{\text{\#MCTrackCands}}$	**geom. accept. & det. ineff. factored out**	94.0±0.1	93.7±0.1
$\frac{\text{\#MCTrackCand with at least one associated TrackCand}}{\text{\#MCTrackCands}}$	**pattern recognition**	96.6±0.1	94.5±0.1

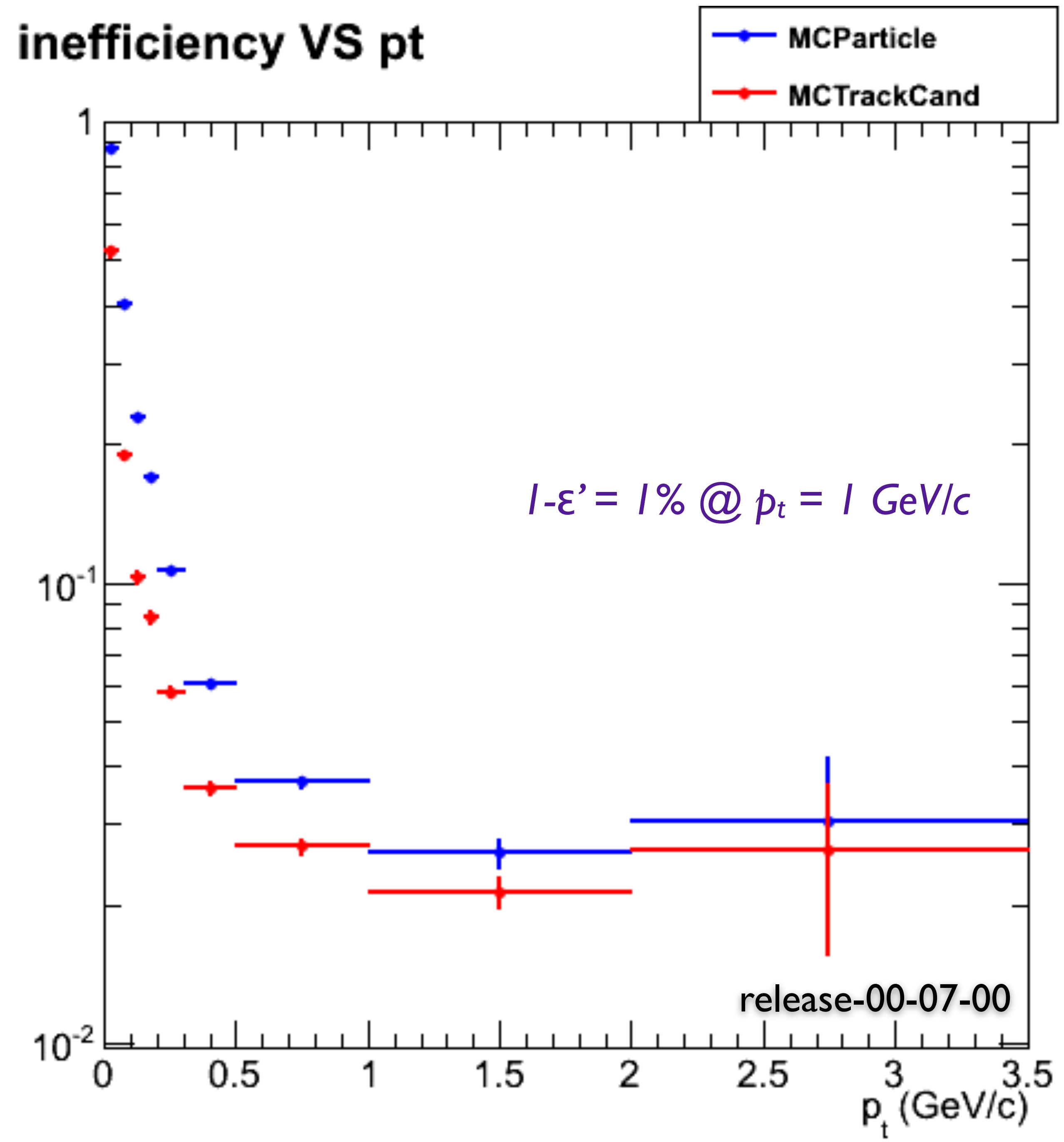
NOTE: MCTrackCand from ideal pattern recognition

➡ no significant changes in the standard tracking reconstruction in the last release w.r.t to the previous releases → no changes expected in the performances

- pattern recognition efficiency is slightly worse than last release
- physical efficiency is compatible with last release

Efficiency VS Transverse Momentum

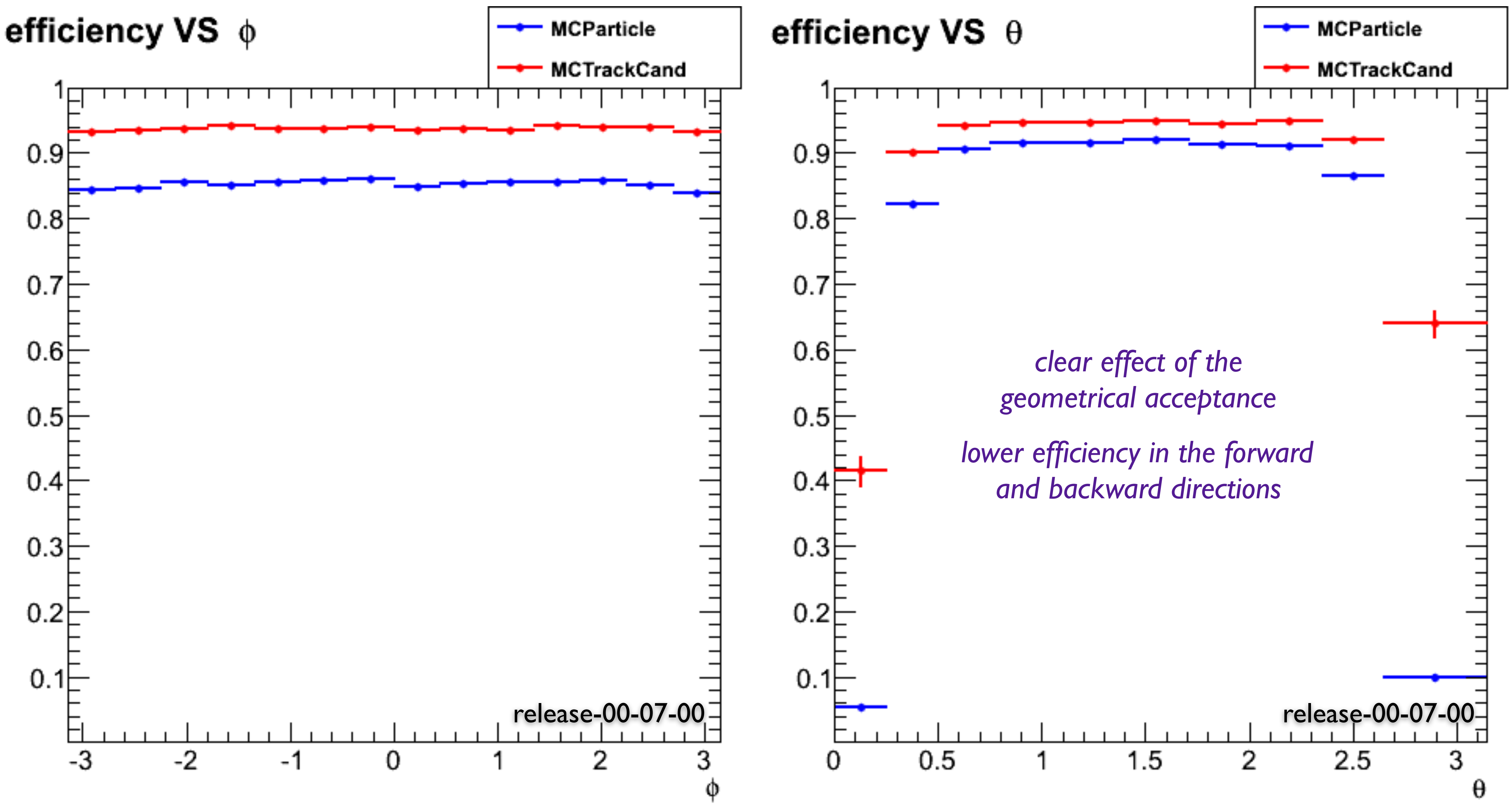




legend:

- physical efficiency
- geometrical acceptance and detector efficiency factored out

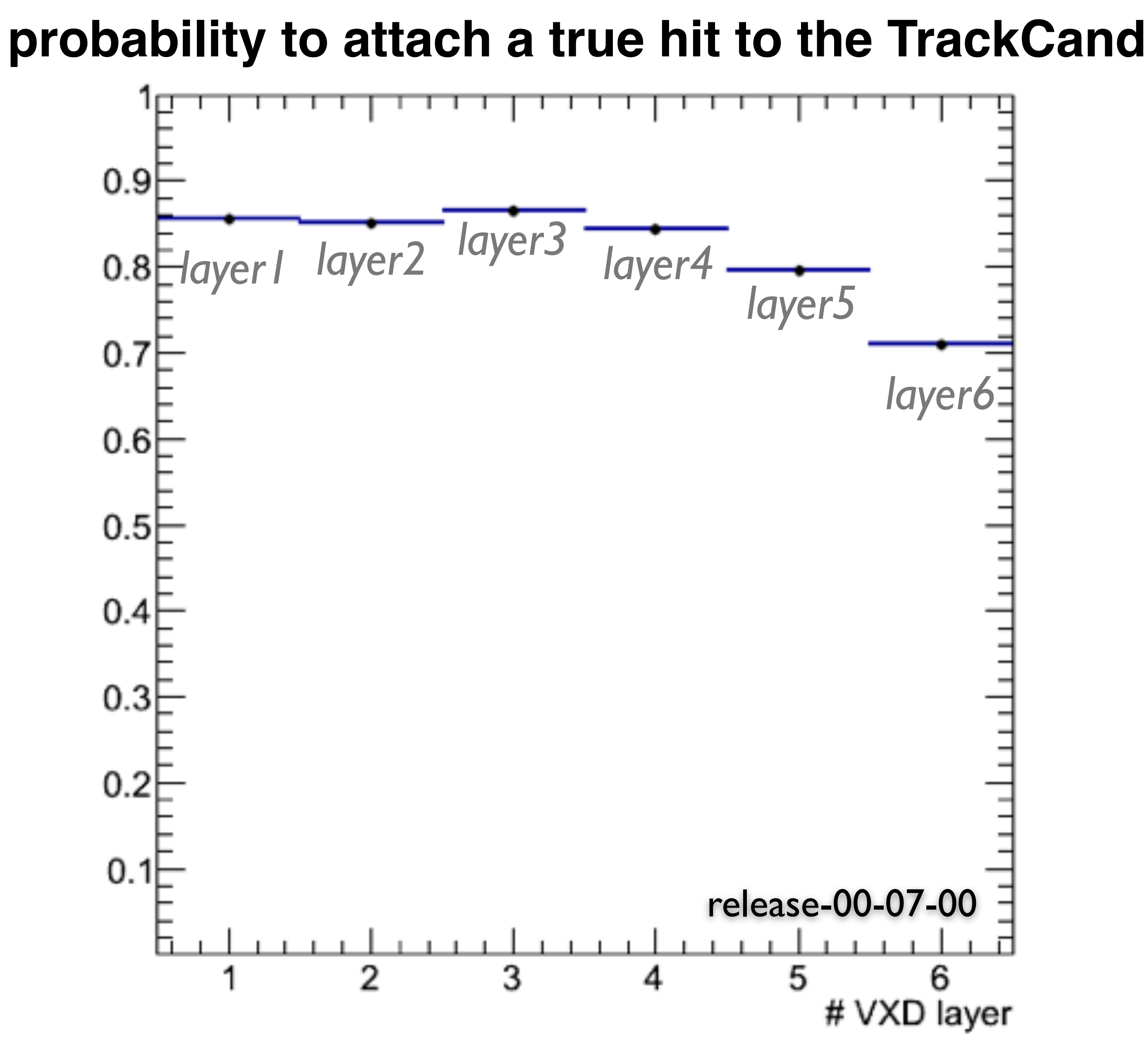
Efficiency VS Polar and Azimuthal Angles



legend:

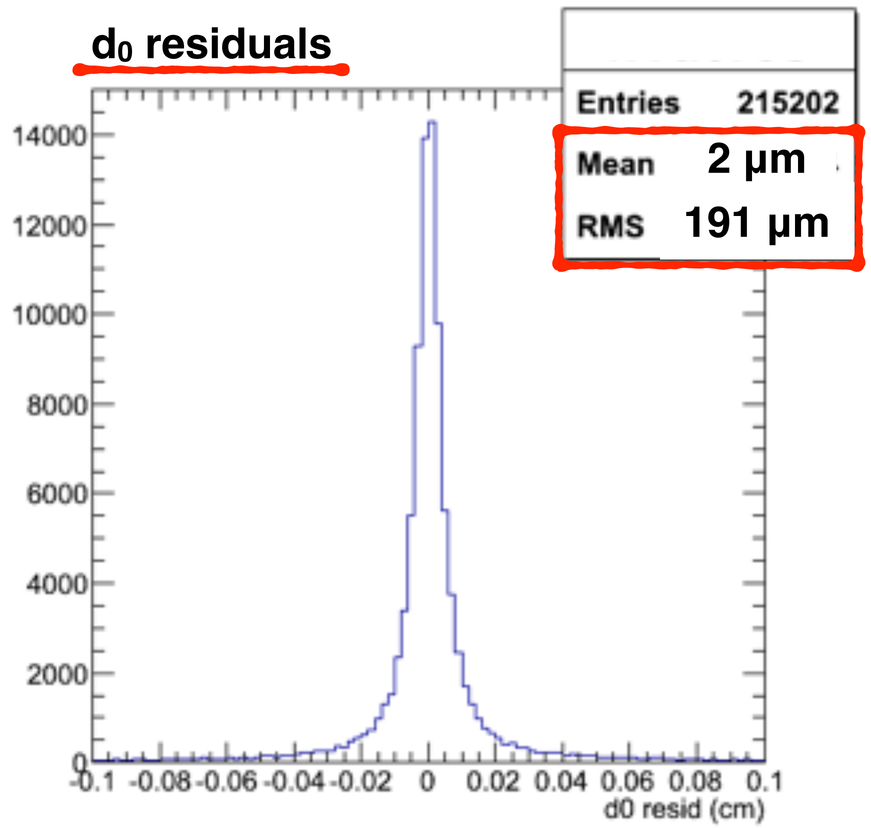
- physical efficiency
- geometrical acceptance and detector efficiency factored out

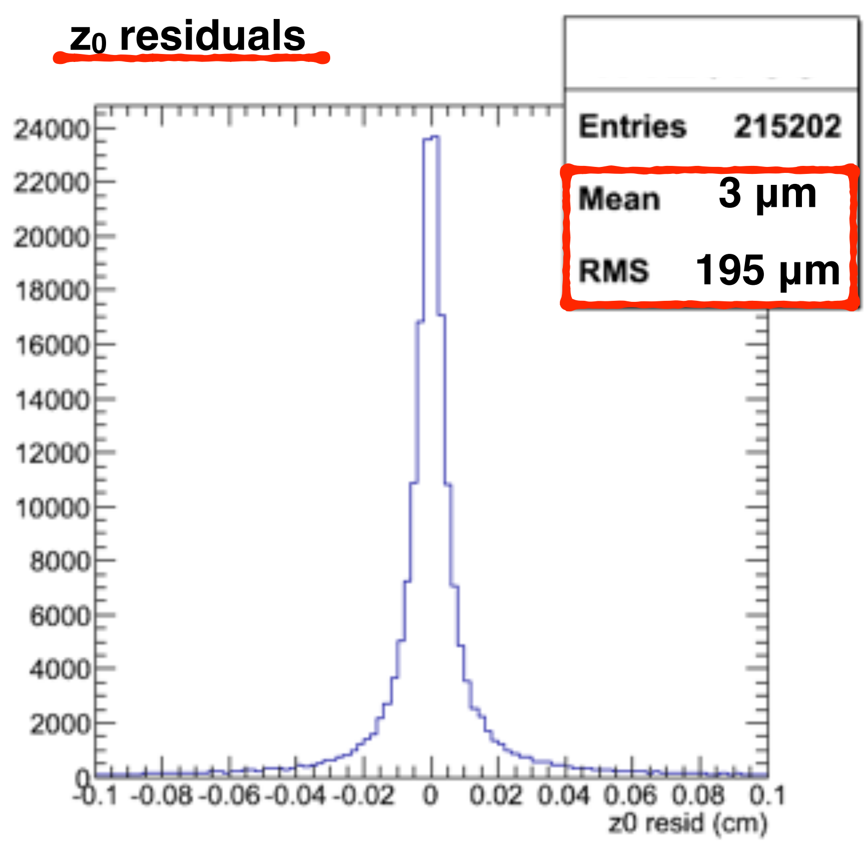
VXD Detector Information Usage

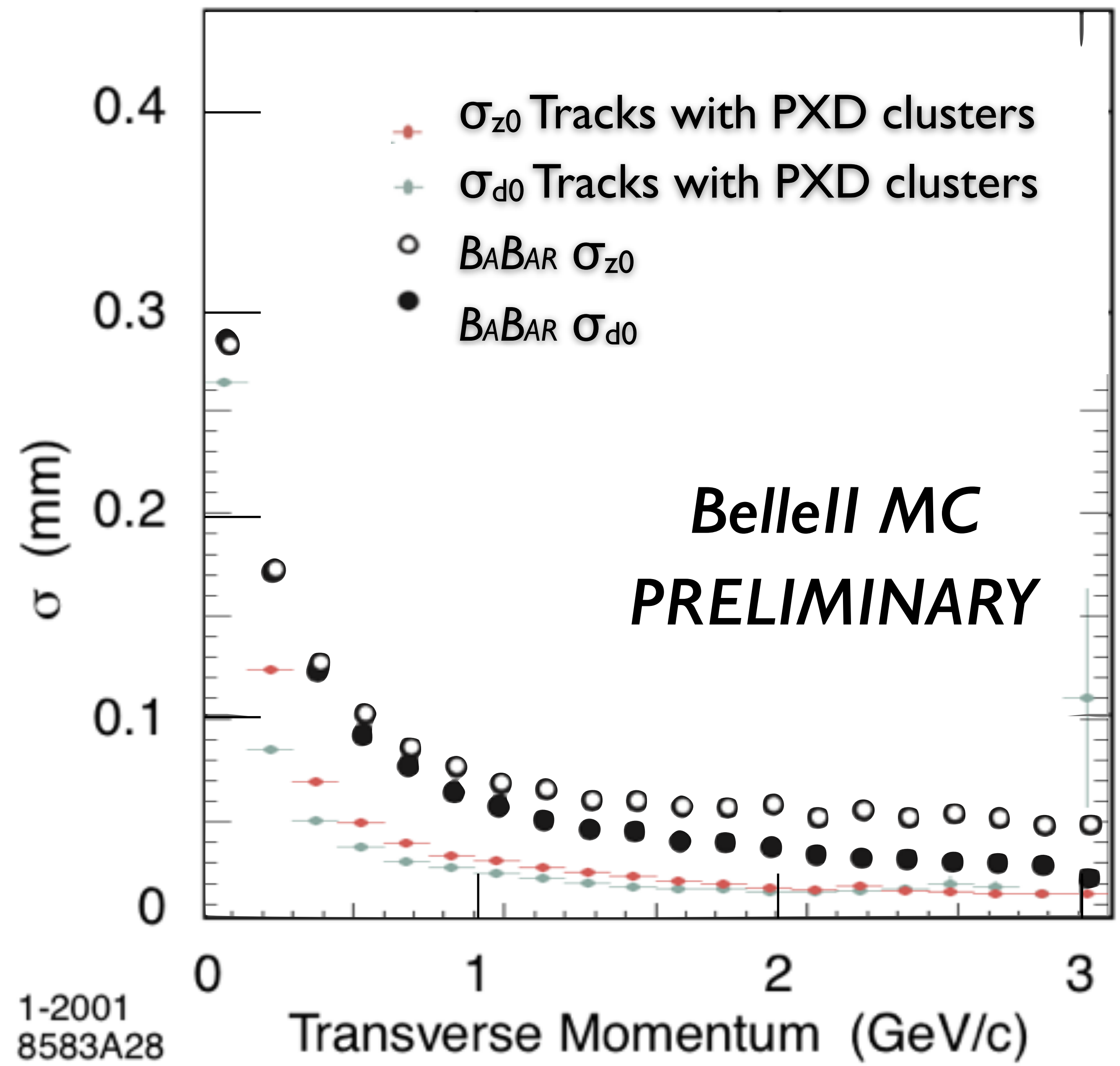


- The pattern recognition attaches a true hit to a TrackCand with a probability that:
  - is > 85% in the innermost 4 layers, and it's maximal on layer3
  - decreases from in the outer layers (80% on layer5, 70% on layer6)

Impact Parameters

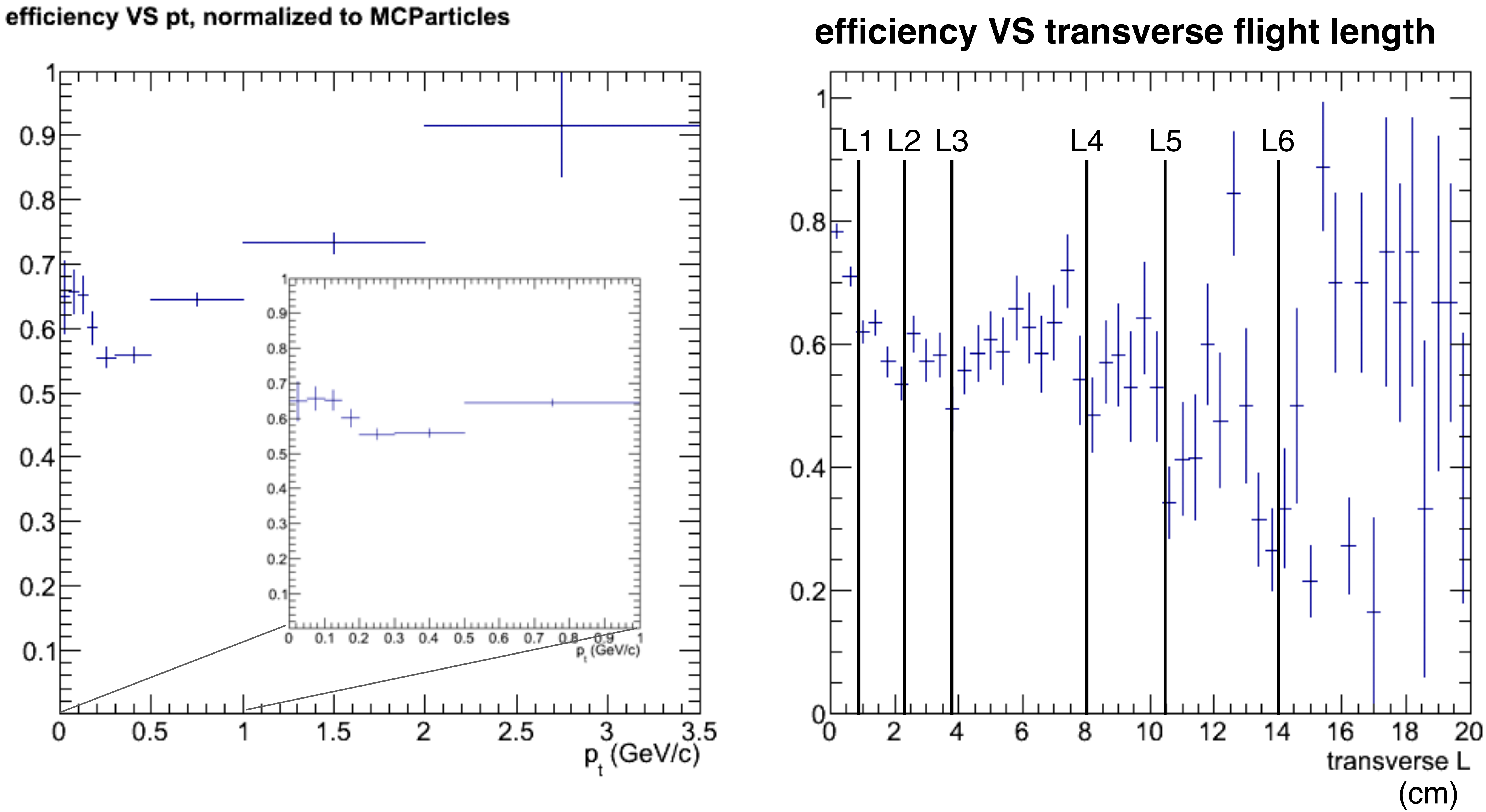






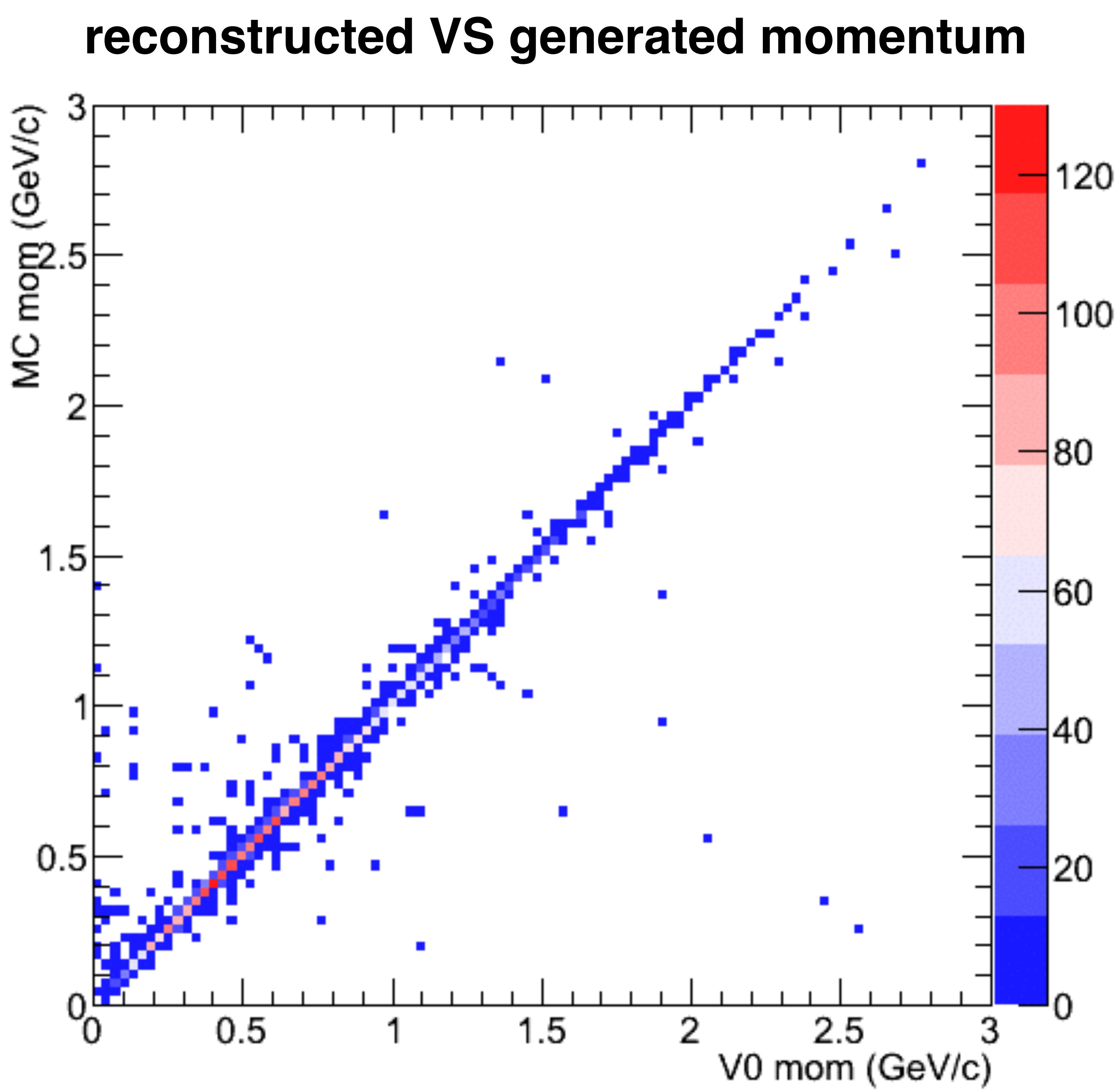
- ➡ *Belle II* VXD Tracking performs twice better than *BABAR*, when PXD clusters are attached to the track (75% of tracks have PXD cluster attached)

V0s Reconstruction



- ➡ Integrated efficiency = (60.8 ± 0.8)%
- ➡ quasi-constant efficiency for V0s decaying between two layers

V0s Momentum Reconstruction



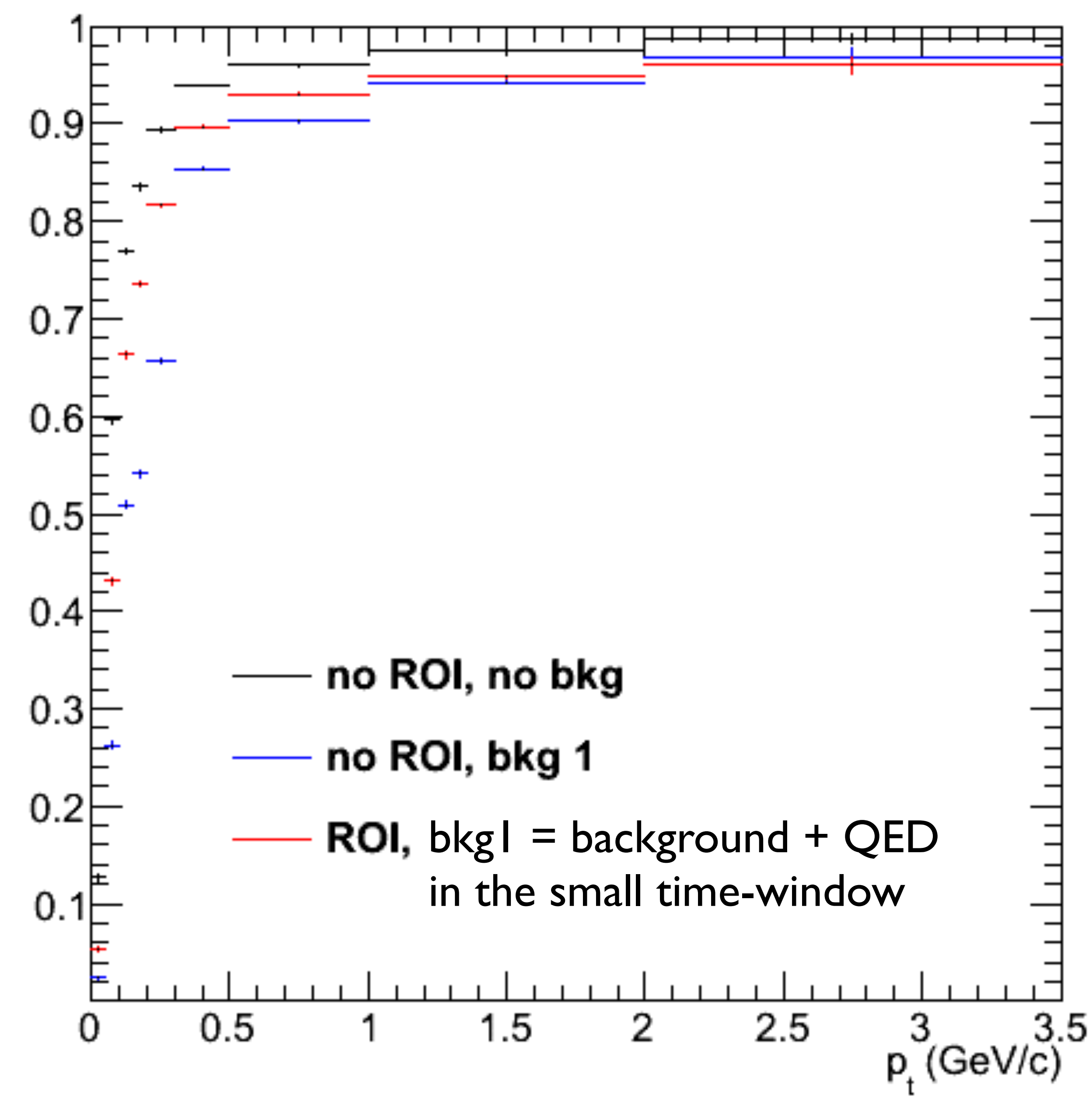
➡ Fitted momentum (x-axis) is correlated to the generated one (y-axis)

Background

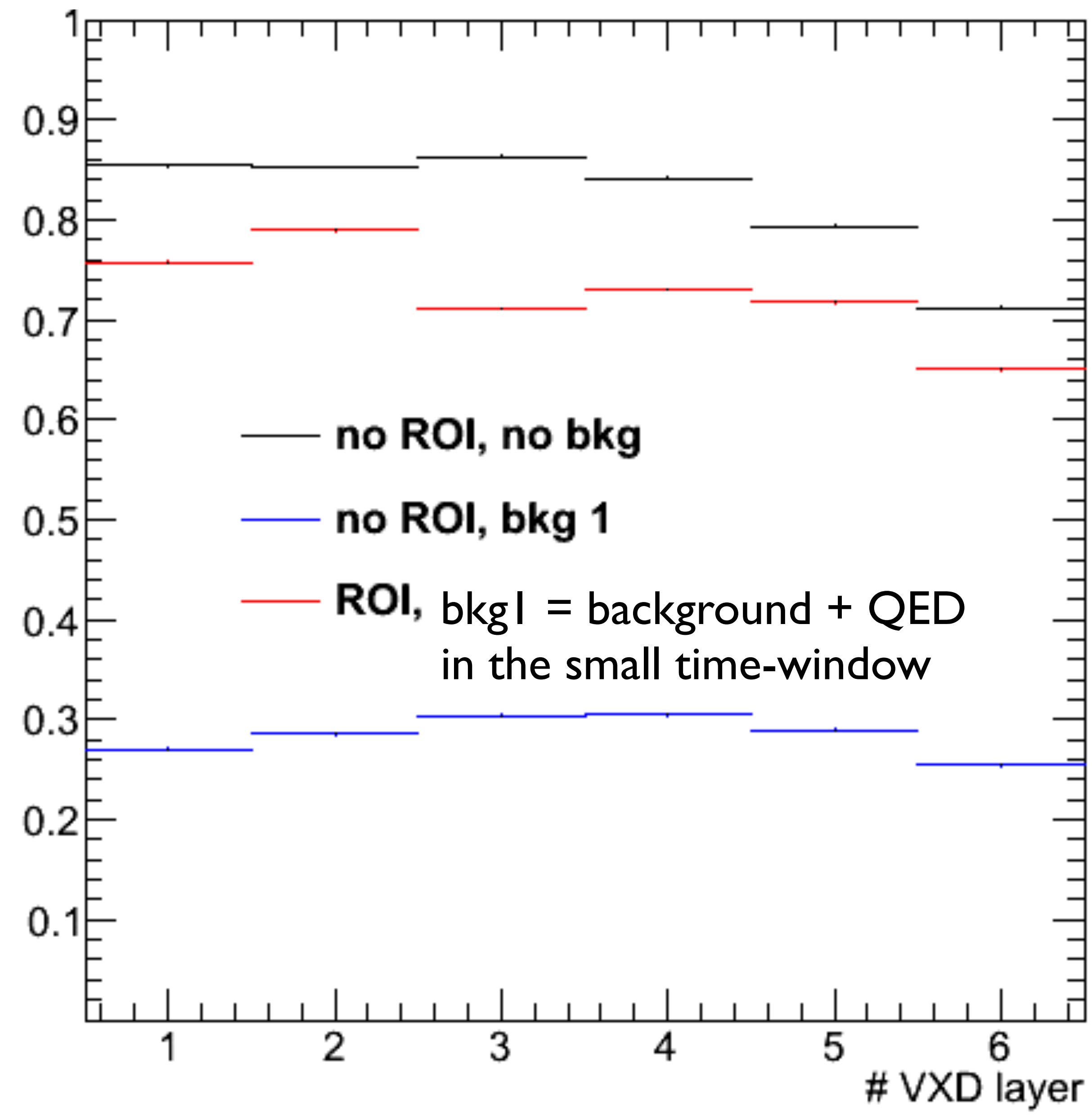
- ➡ Let's add background in the simulation
- ➡ Standard background: BHWide + Coulomb + RBB + Touschek
- ➡ QED background:
  - in the small time window (PXD) = bkg1
  - in the large time window (PXD) = bkg2
- ➡ PXD data reduction is also simulated, referred to as "ROI" in the next slides

Tracking Efficiency with Background

efficiency VS pt, normalized to MCParticles

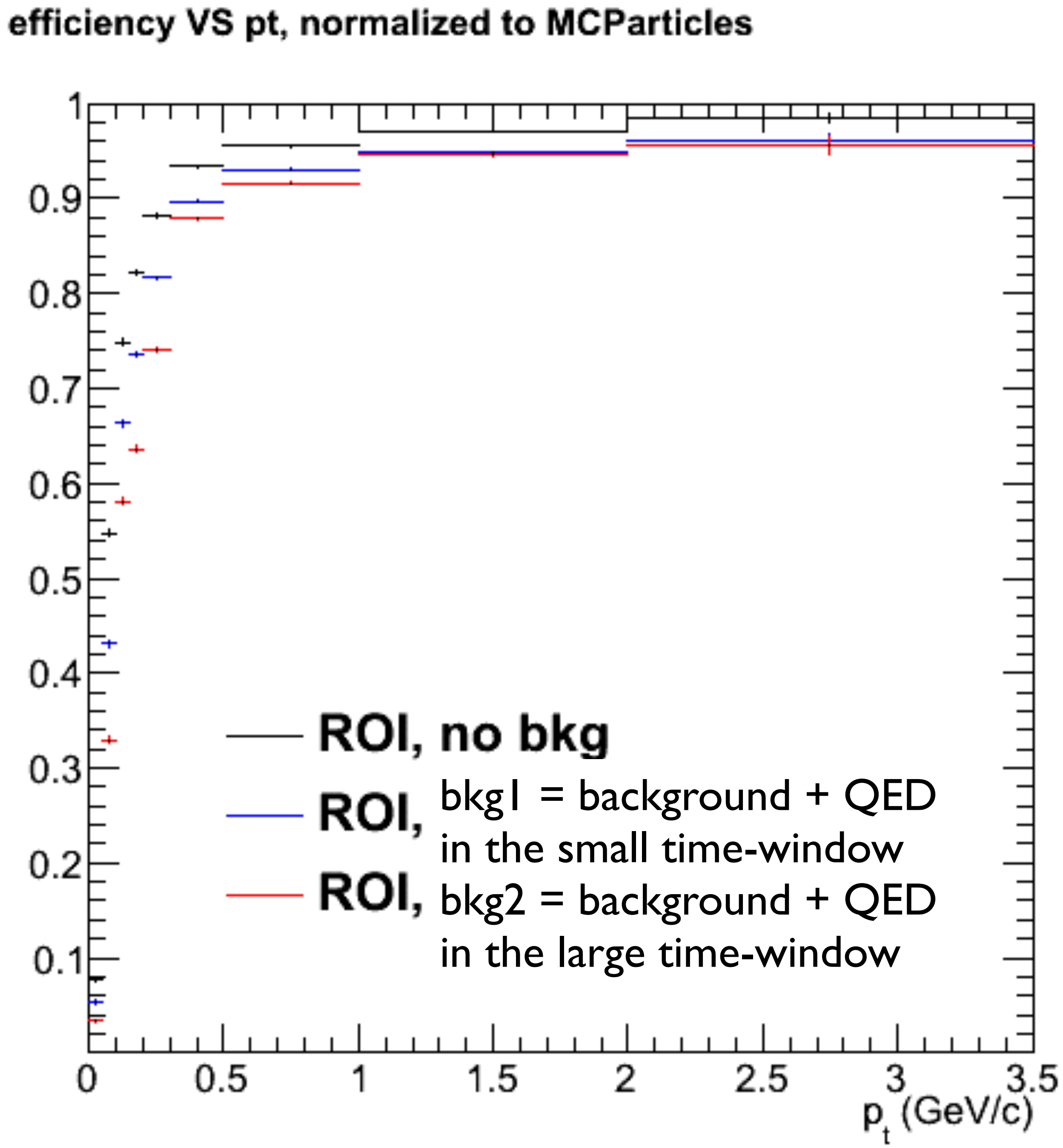


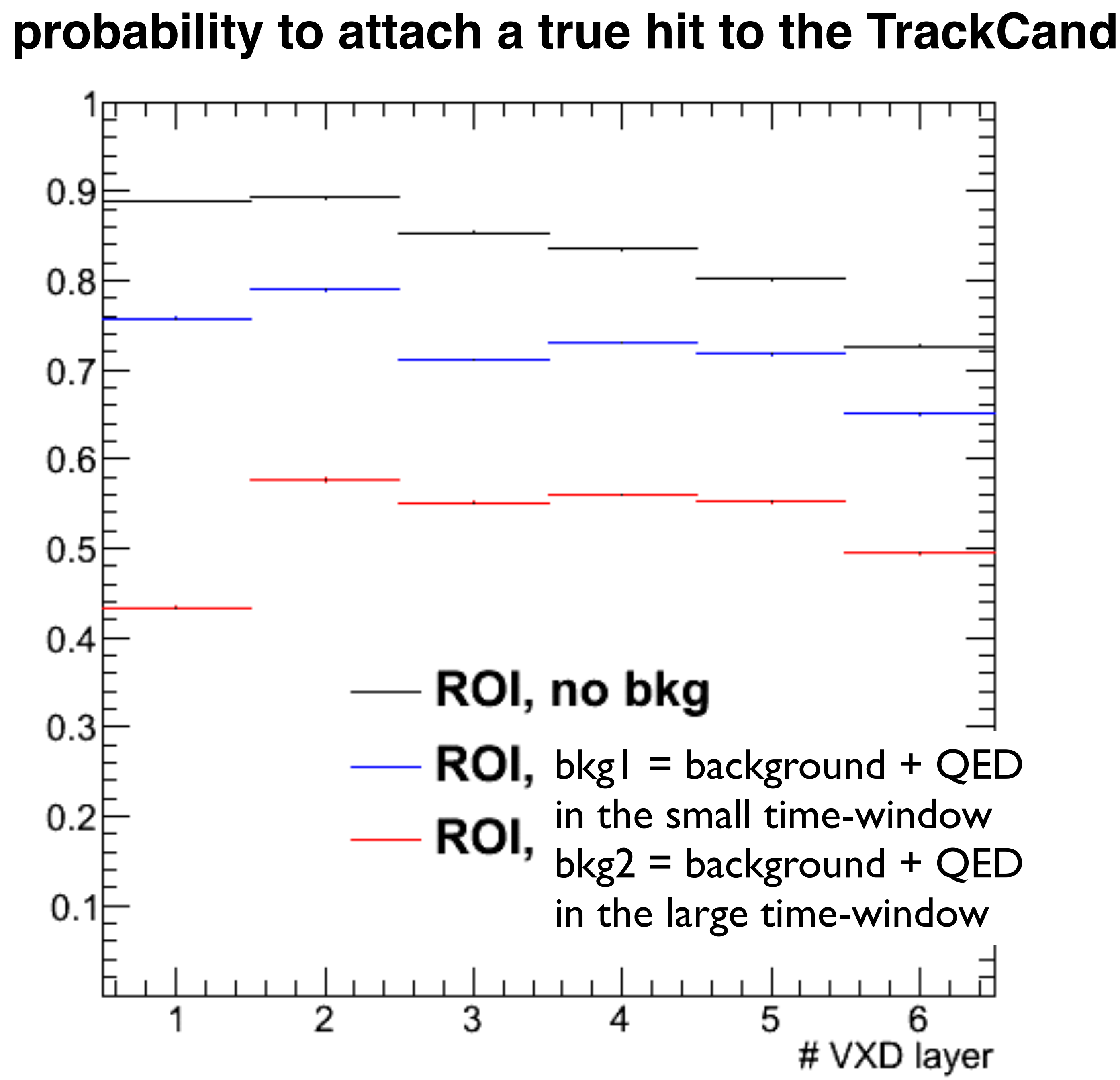
probability to attach a true hit to the TrackCand



- includes everything: geometrical acceptance, pattern recognition, fit
- significant degradation of efficiency with the background, simulating PXD data reduction partially recovers it

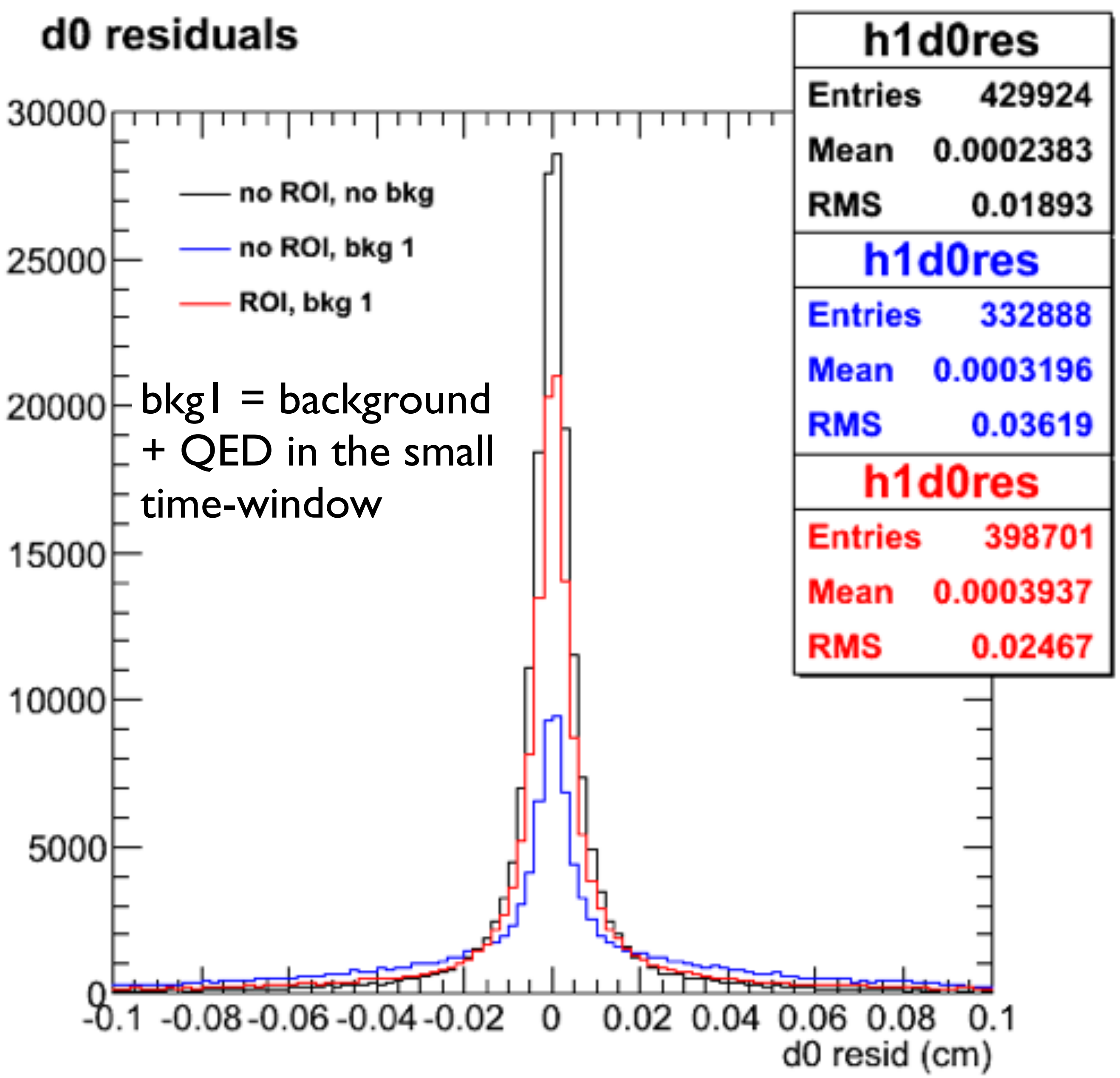
QED Background Effect

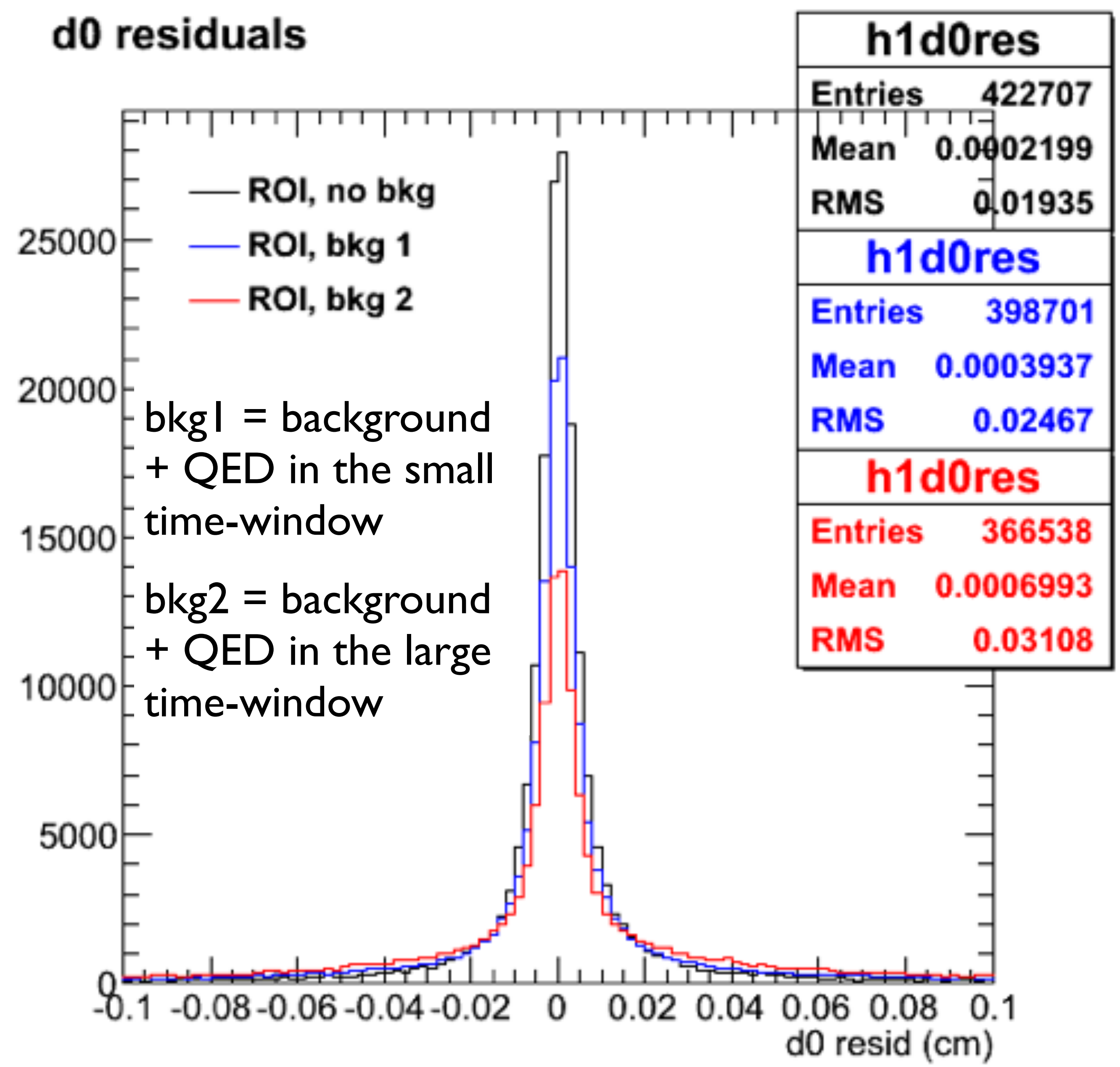




- ➡ includes everything: geometrical acceptance, pattern recognition, fit
- ➡ partial degradation of the efficiency when QED is simulated in the large time-window thanks to PXD data reduction

Background and Track Quality





- ➡ significant degradation of track quality with the background 1, simulating PXD data reduction partially recovers it, 30% increase in the RMS.
- ➡ QED background further reduces the quality of the tracks, +25% in the RMS

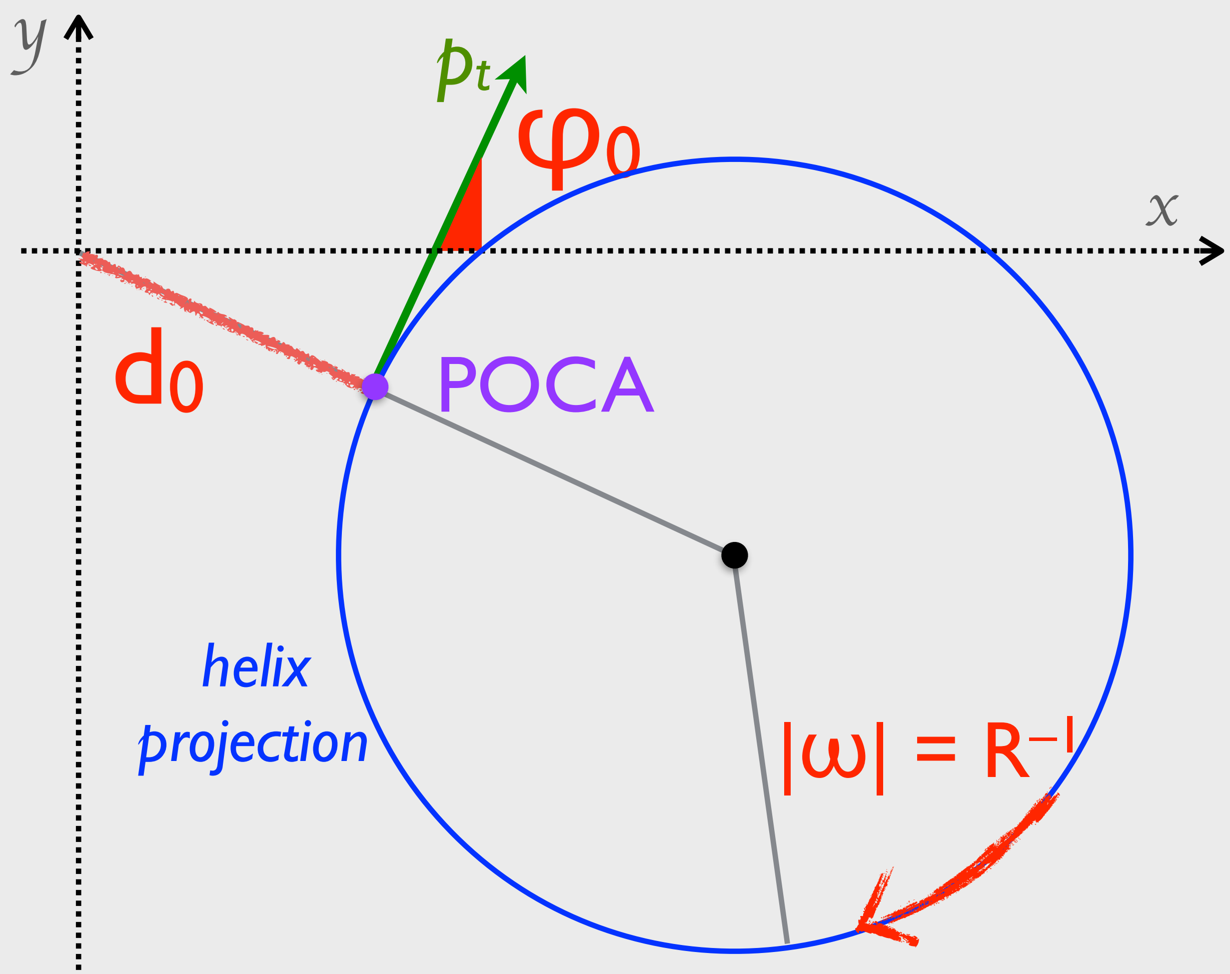
Conclusions

- Performances of Tracking in release-00-07-00 are perfectly compatible with previous release in case of no background
- An important step in the simulation was made: PXD data reduction simulation is now available
  - partially recovers the degradation of efficiency and track quality due to machine background
- Still a lot to improve (efficiency of using the PXD clusters, bias in the impact parameters, underestimation of the track parameters errors, …)
- write to tracking@belle2.kek.jp for feedbacks and questions

Thank You!

Track Parameterisation

TRANSVERSE PLANE



- POCA = Point Of Closest Approach
- d_0 is the 2d signed distance of the POCA from the z axis, the sign depends on the angular momentum of the track (>0 in the fig.)
- φ_0 is the angle between p_t and the x axis at the POCA, $\varphi_0 \in [-\pi,\pi]$
- the sign of ω, the curvature, is the same as the charge of the track (>0 in the fig.)

LONGITUDINAL VIEW

- $\tan\lambda$ is the ratio of p_z and p_t, $\lambda \in [-\pi,\pi]$
- z_0 is the signed distance of the POCA from the transverse plane