Tracking Performance

for Release-00-08-00

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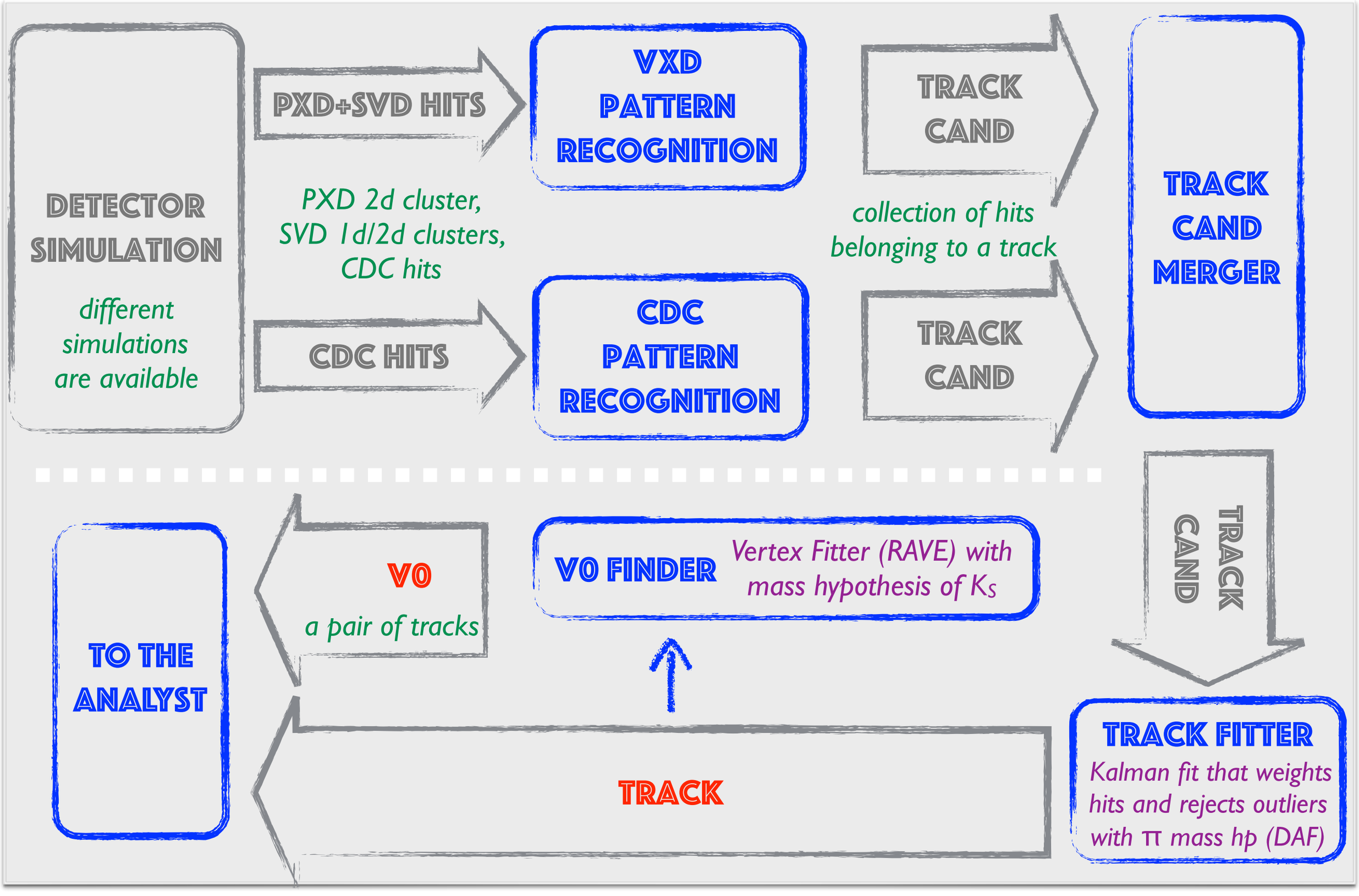
Outline

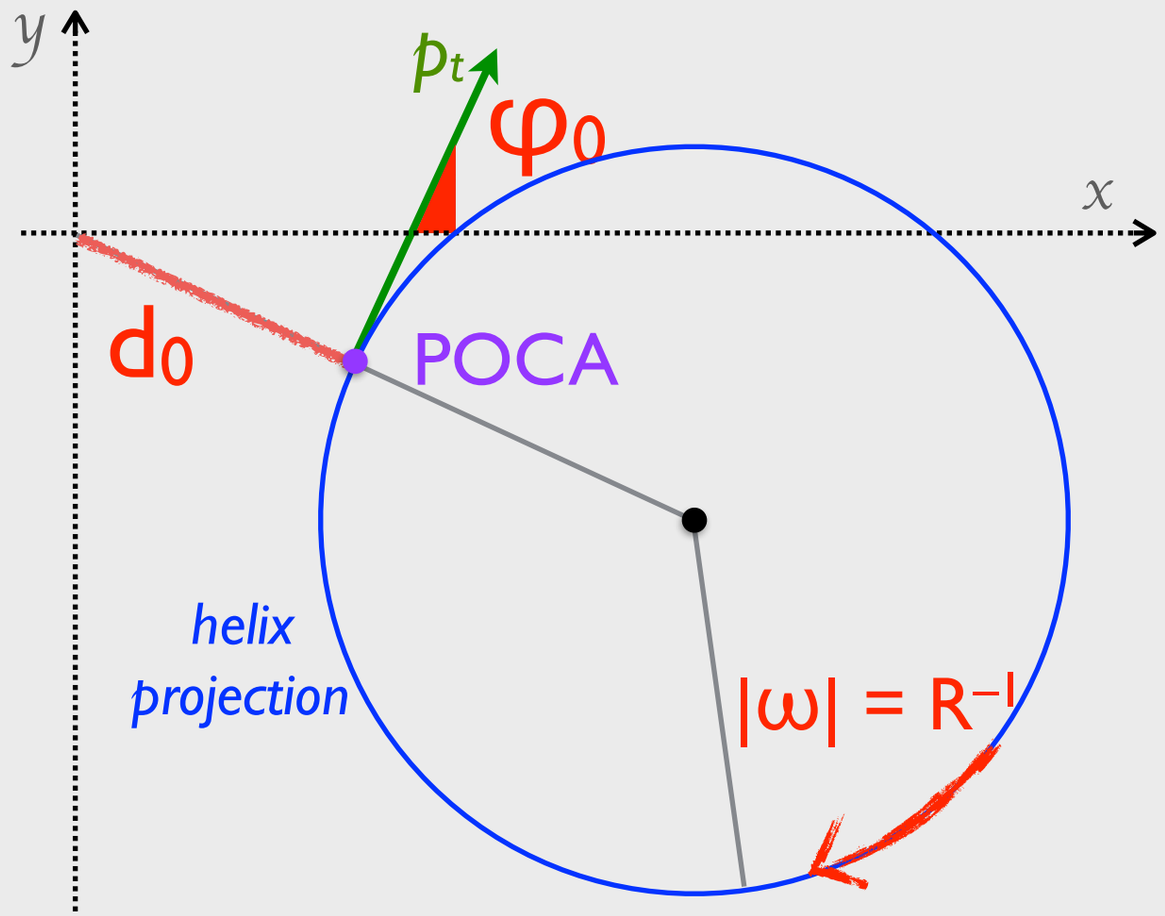
- ☑ *Integrated Efficiencies*
- ☑ *Efficiency vs p_T and polar angle*
- ☑ *Impact Parameters Resolution & Pulls*
- ☑ *Performance Monitoring in the Analysis Package*

Offline Tracking Reconstruction



Track Parameterisation

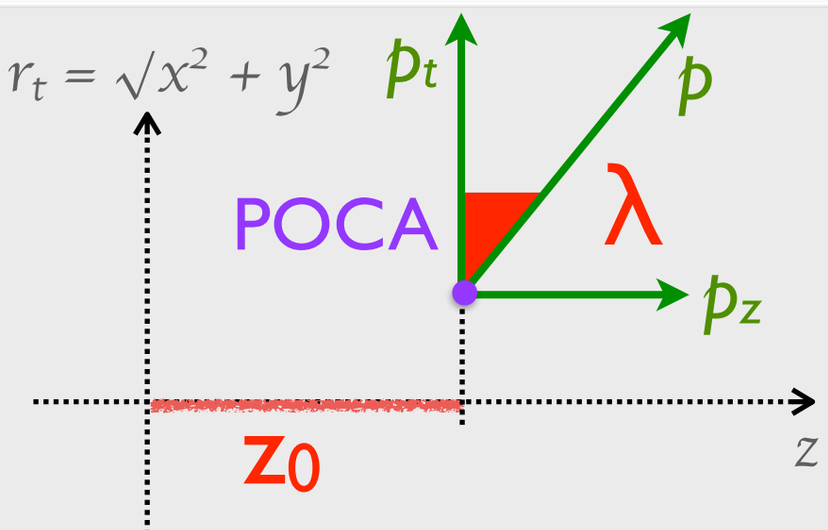
TRANSVERSE PLANE



- 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



Detector Simulations

- Multiple detector simulations can be used:
  - different background conditions
  - with/without PXD data reduction simulation
- Backgrounds:
  - std bkg = BHWide + Coulomb + RBB + Touscheck
  - two photons = QED background
  - two photons *reduced* = QED background simulated in a reduced time-window for the PXD

tracking tested against these simulations	no bkg	std bkg	std bkg + two photons reduced	std bkg + two photons
without PXDDataReduction	✓	✓	✗	✗
with PXDDataReduction	✓	✓	✓	✓

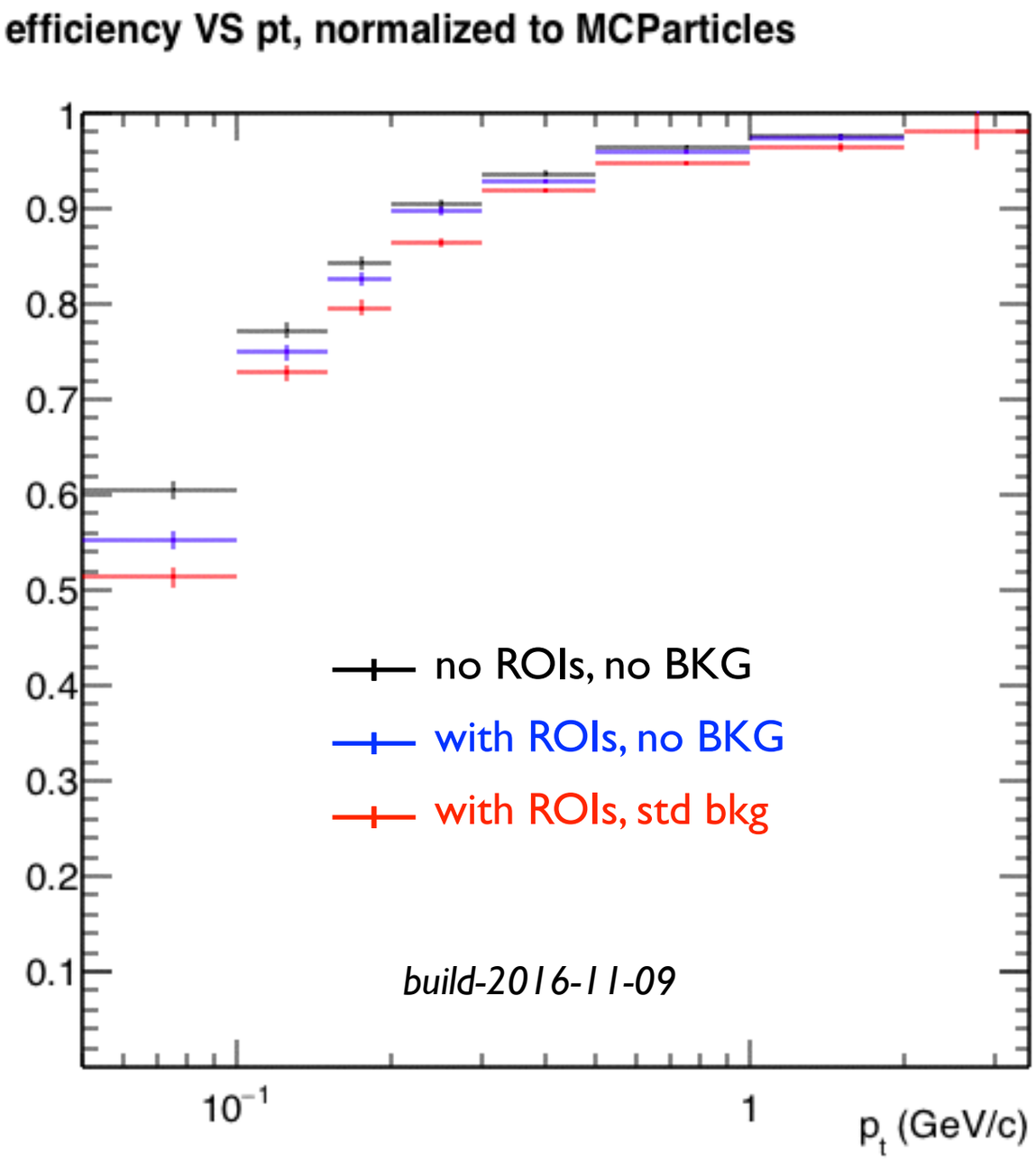
Integrated Efficiencies

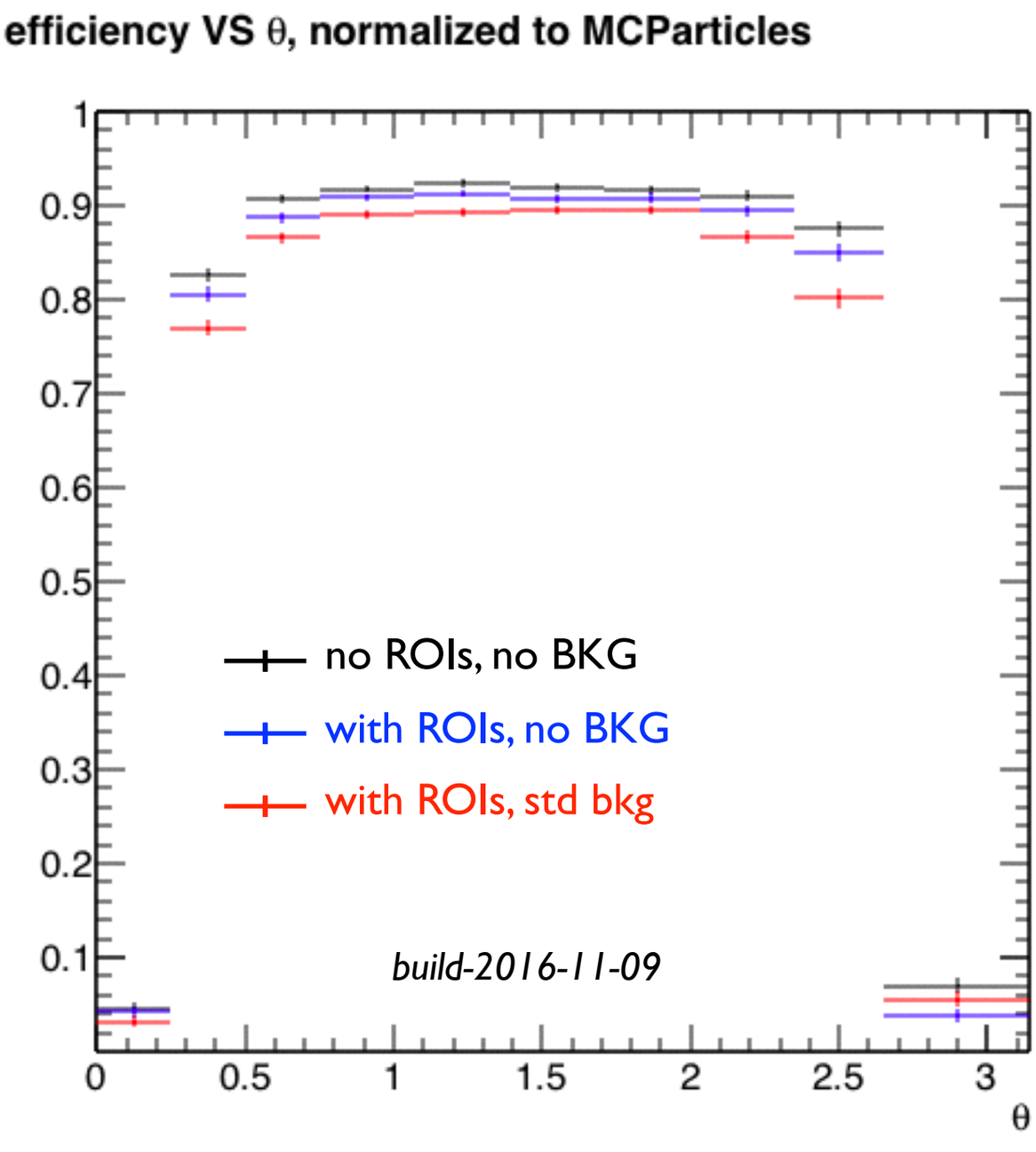
➡ The tracking performance is completely compatible with the one of release-00-07-01

- only the pion mass hypothesis has been used here

	with ROIs	*tracking efficiency*	*efficiency factoring out geom. accept.*	*V0 efficiency*
no bkg	no	**85.5 ± 0.2**	**94.0 ± 0.1**	**62 ± 1**
	yes	**84.1 ± 0.2**	**94.1 ± 0.1**	**61 ± 2**
std bkg	no	**81.7 ± 0.2**	**90.0 ± 0.2**	**52 ± 1**
	yes	**82.1 ± 0.2**	**91.9 ± 0.2**	**55 ± 1**
std bkg + two photons reduced	no	✘	✘	✘
	yes	**80.3 ± 0.2**	**90.1 ± 0.2**	**52 ± 2**
std bkg + two photons	no	✘	✘	✘
	yes	**78.1 ± 0.2**	**87.3 ± 0.2**	**47 ± 2**

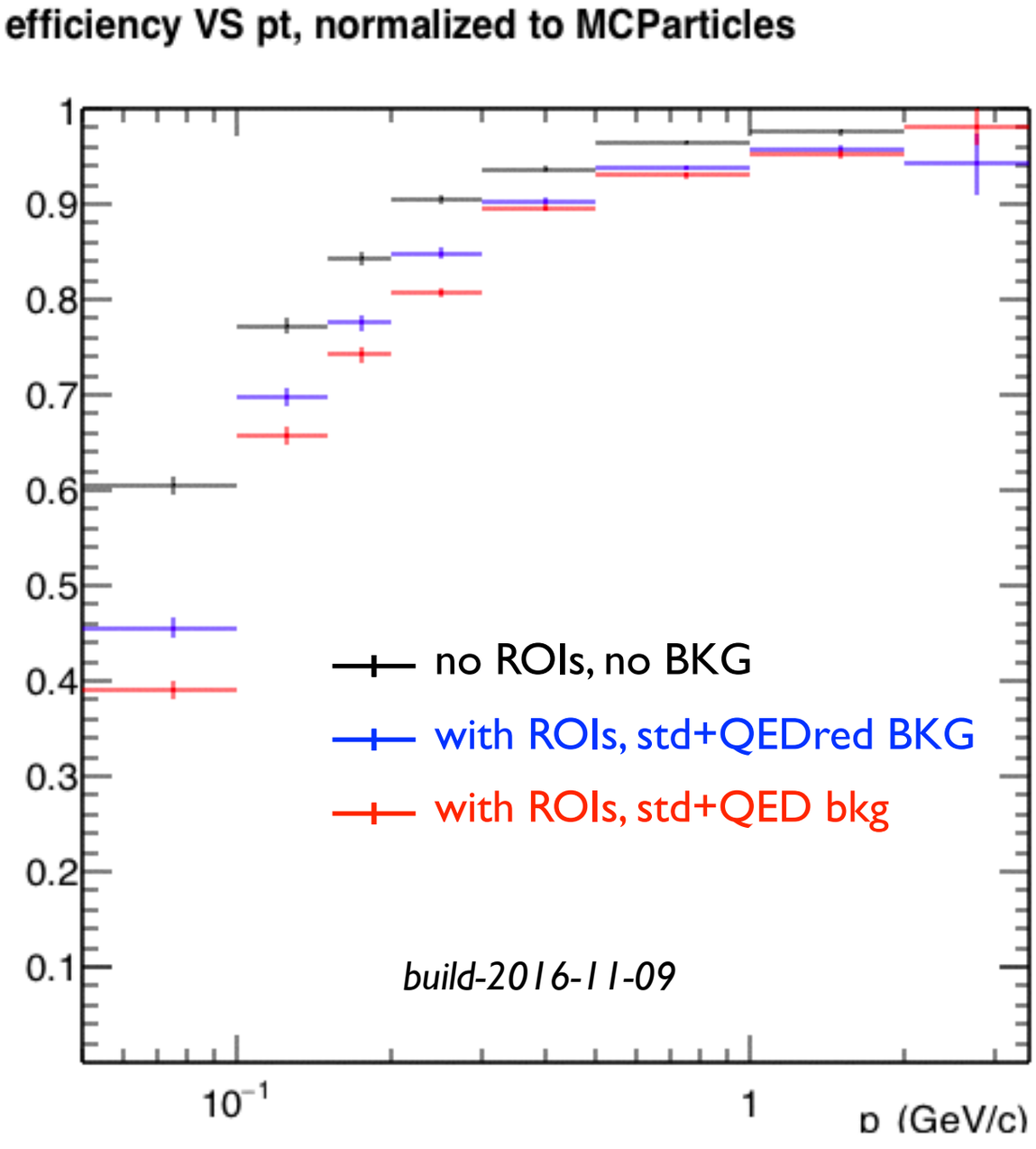
Efficiency vs p_T, and polar angle (1)

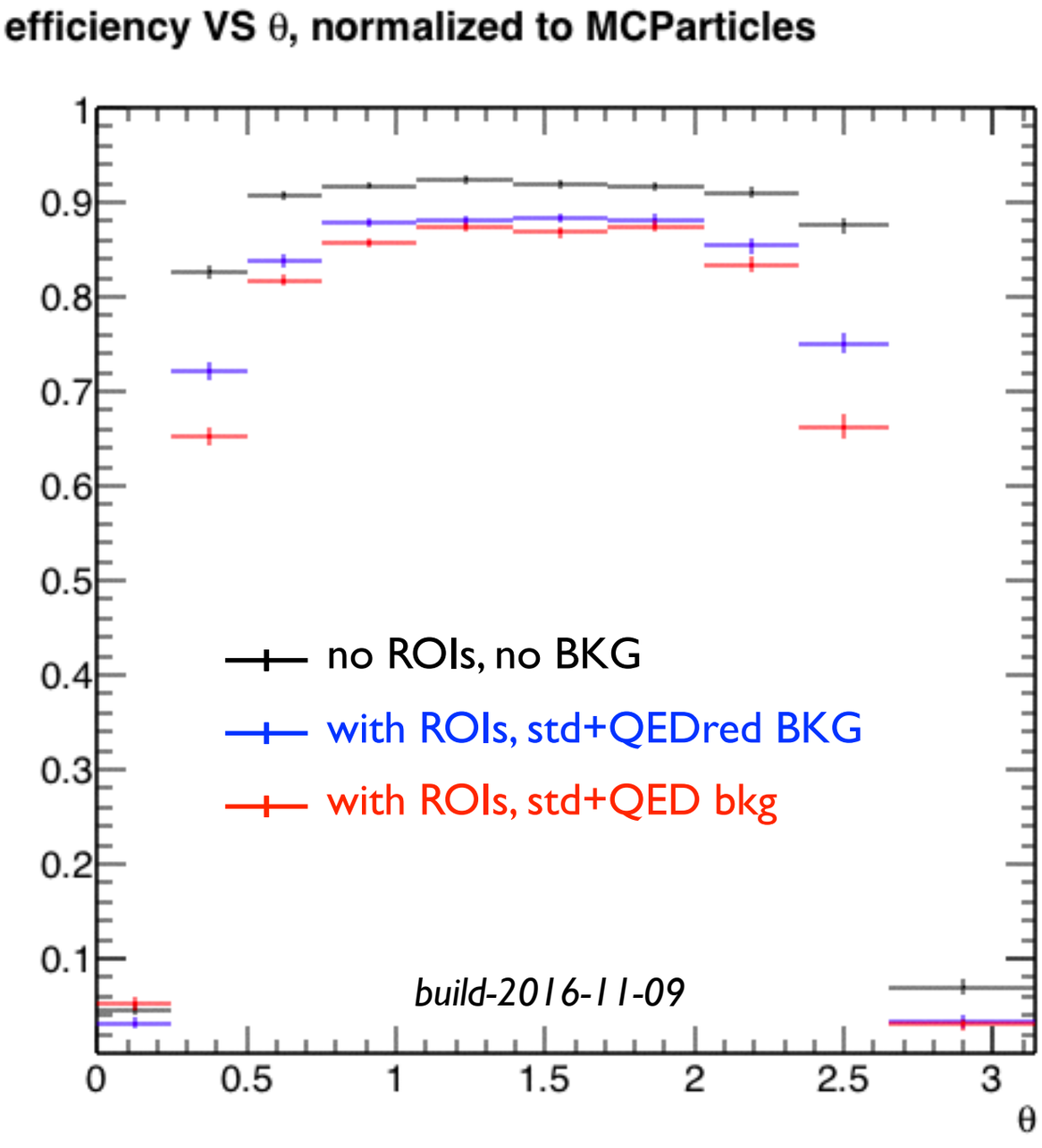




➡ Background and PXD data reduction effects slightly depend on the transverse momentum and the polar angle of the track

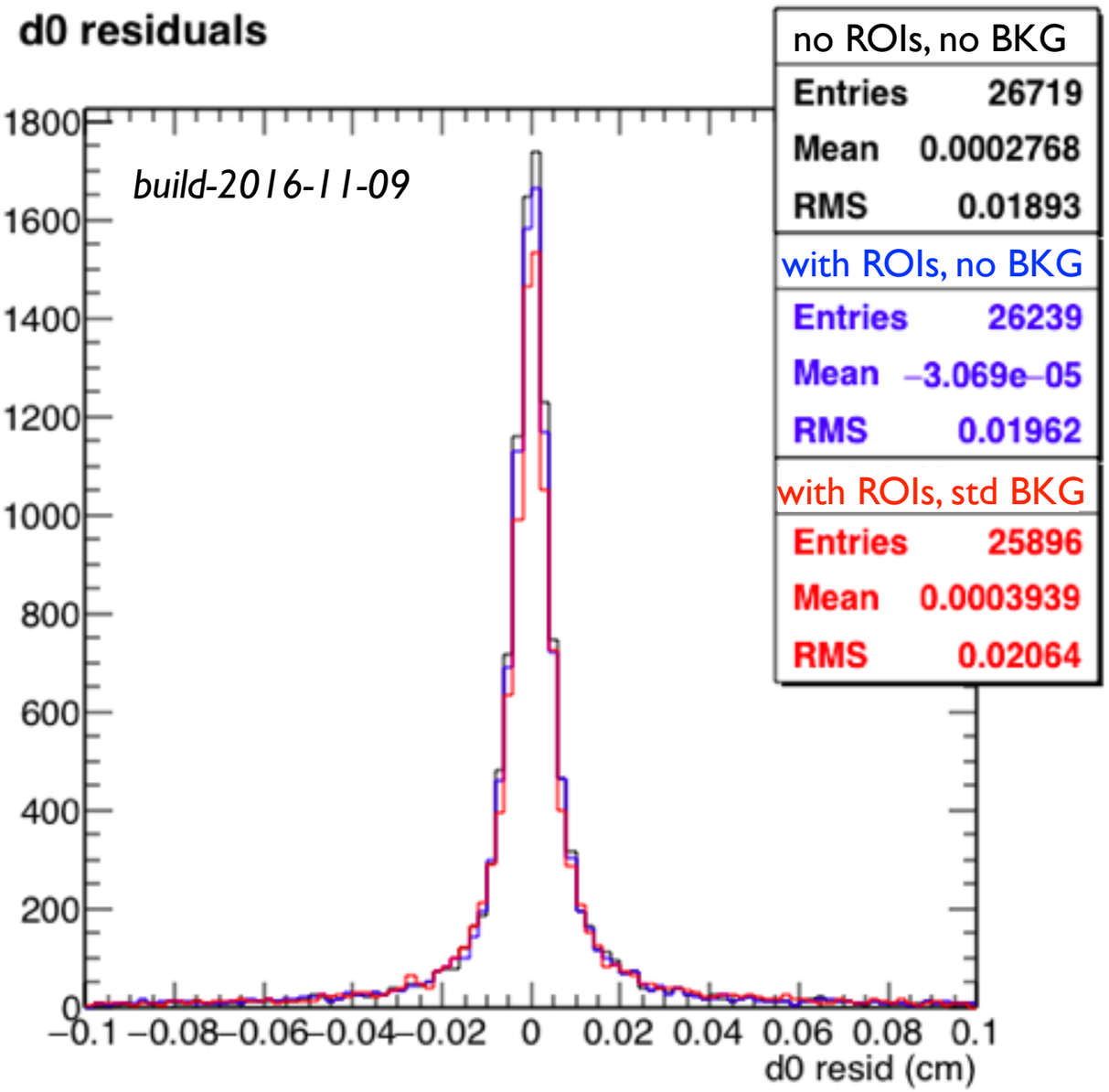
Efficiency vs p_T, and polar angle (2)

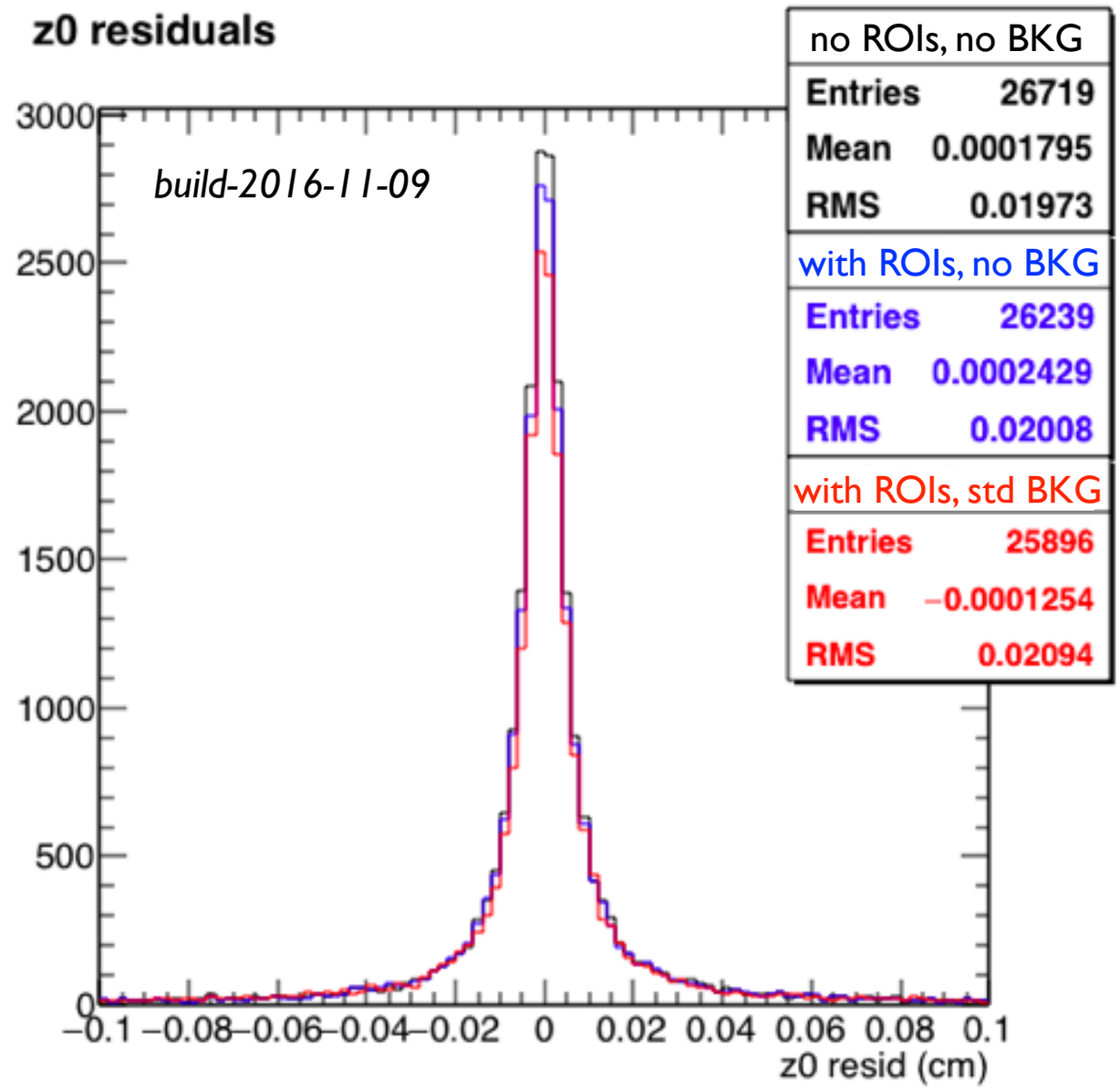




➡ Adding the QED background, the deterioration of the performance is more accentuated

Impact Parameters Residuals (1)





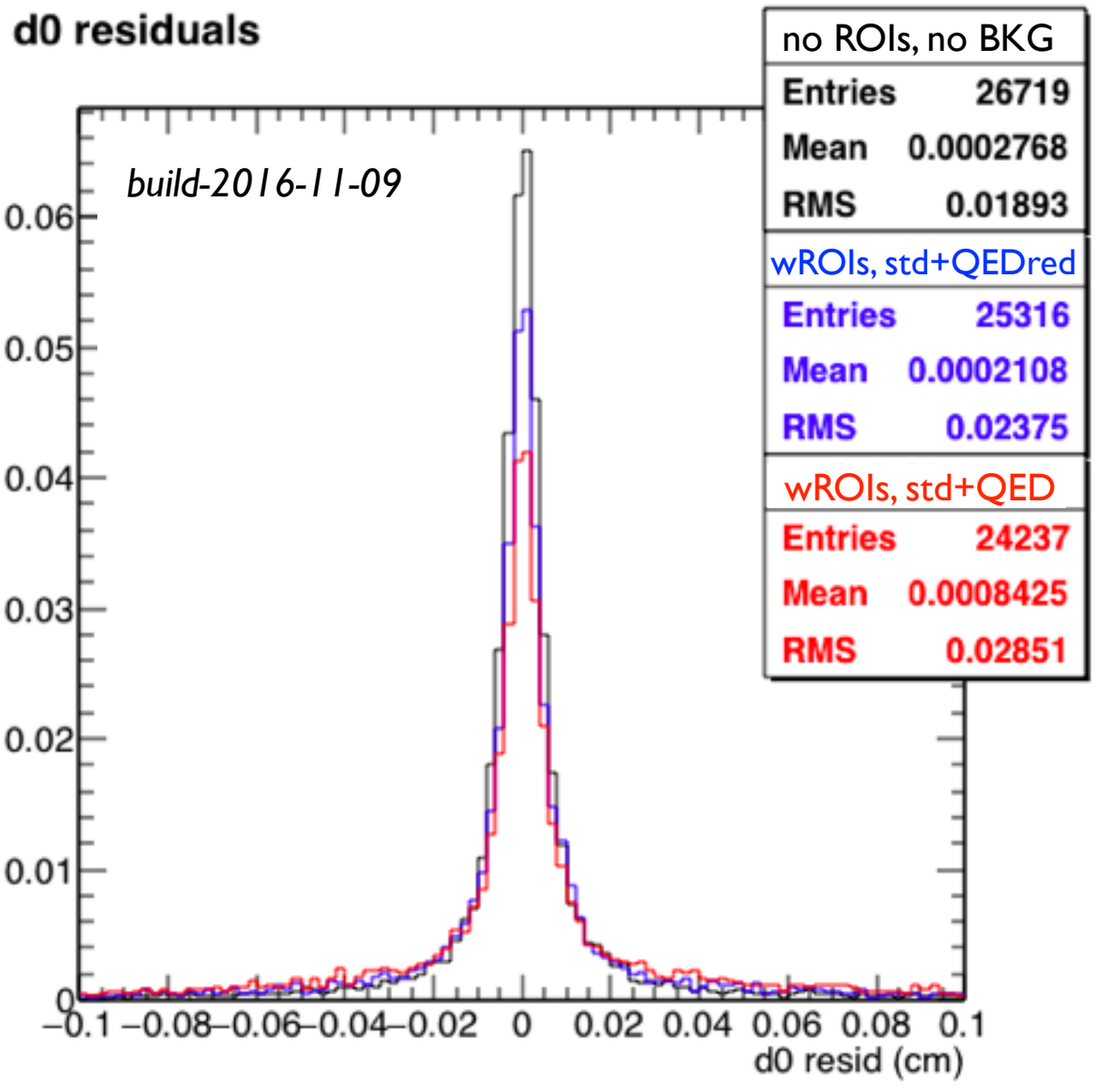
no ROIs, no BKG

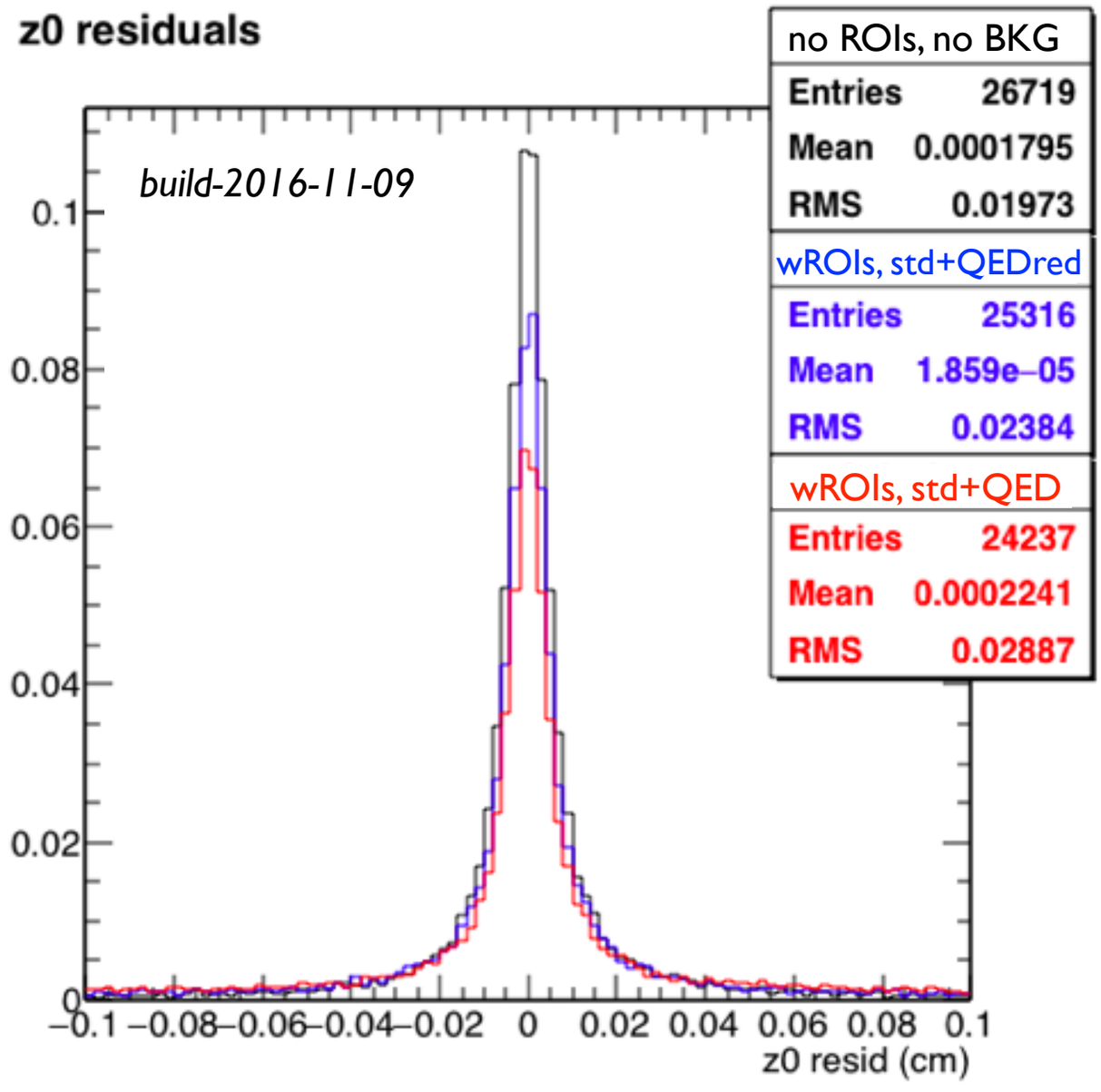
with ROIs, no BKG

with ROIs, std bkg

- resolution is deteriorated with bkg and PXD data reduction
- background and PXD data reduction effect on the bias is less straightforward

Impact Parameters Residuals (2)





- no ROIs, no BKG
- with ROIs, std+QEDred BKG
- with ROIs, std+QED bkg

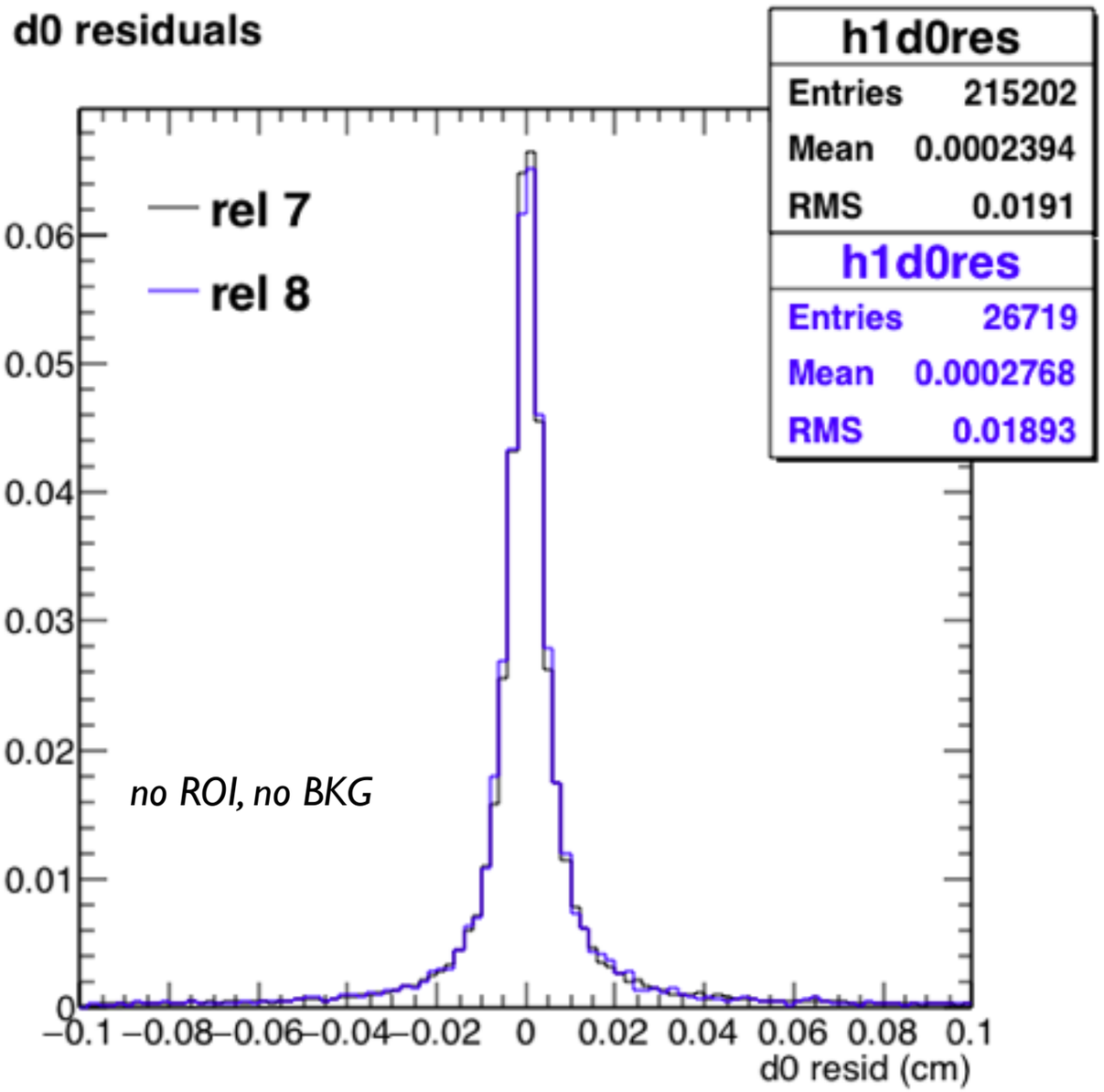
- ➡ resolution is deteriorated with bkg and PXD data reduction
- ➡ background and PXD data reduction effect on the bias is less straightforward

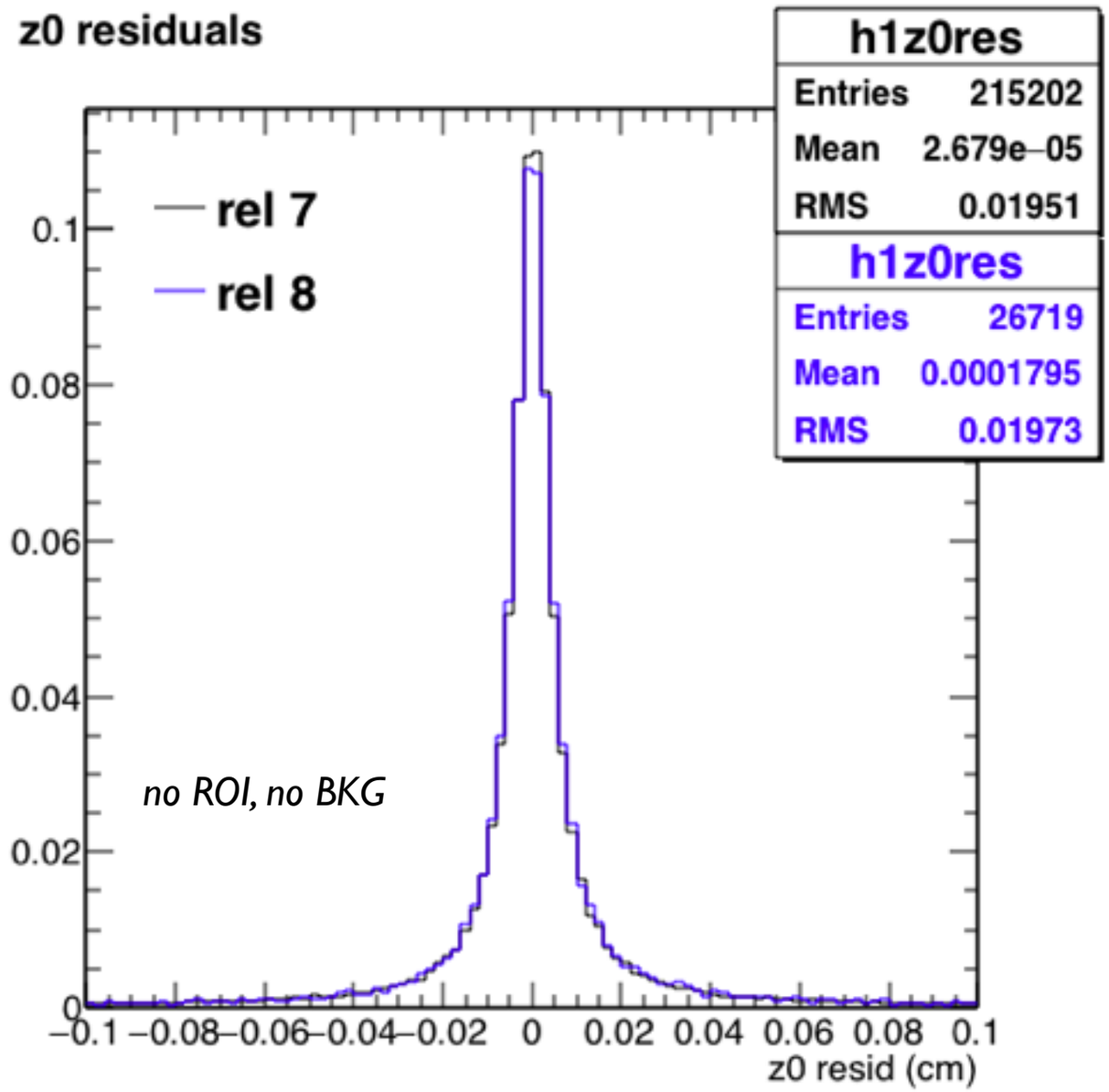
Impact Parameters Table

➡ It's maybe worth studying the resolution and the bias on the impact parameter as a function of the transverse momentum

	with ROIs	*d0*		*z0*	
		bias (μm)	*resolution (μm)*	*bias (μm)*	*resolution (μm)*
no bkg	no	**2.77**	**189**	**1.80**	**197**
	yes	**–0.31**	**194**	**2.43**	**201**
std bkg	no	–	–	–	–
	yes	**3.94**	**206**	**–1.25**	**209**
std bkg + two photons reduced	no	✘	✘	✘	✘
	yes	**2.11**	**238**	**0.19**	**238**
std bkg + two photons	no	✘	✘	✘	✘
	yes	**8.43**	**285**	**2.24**	**289**

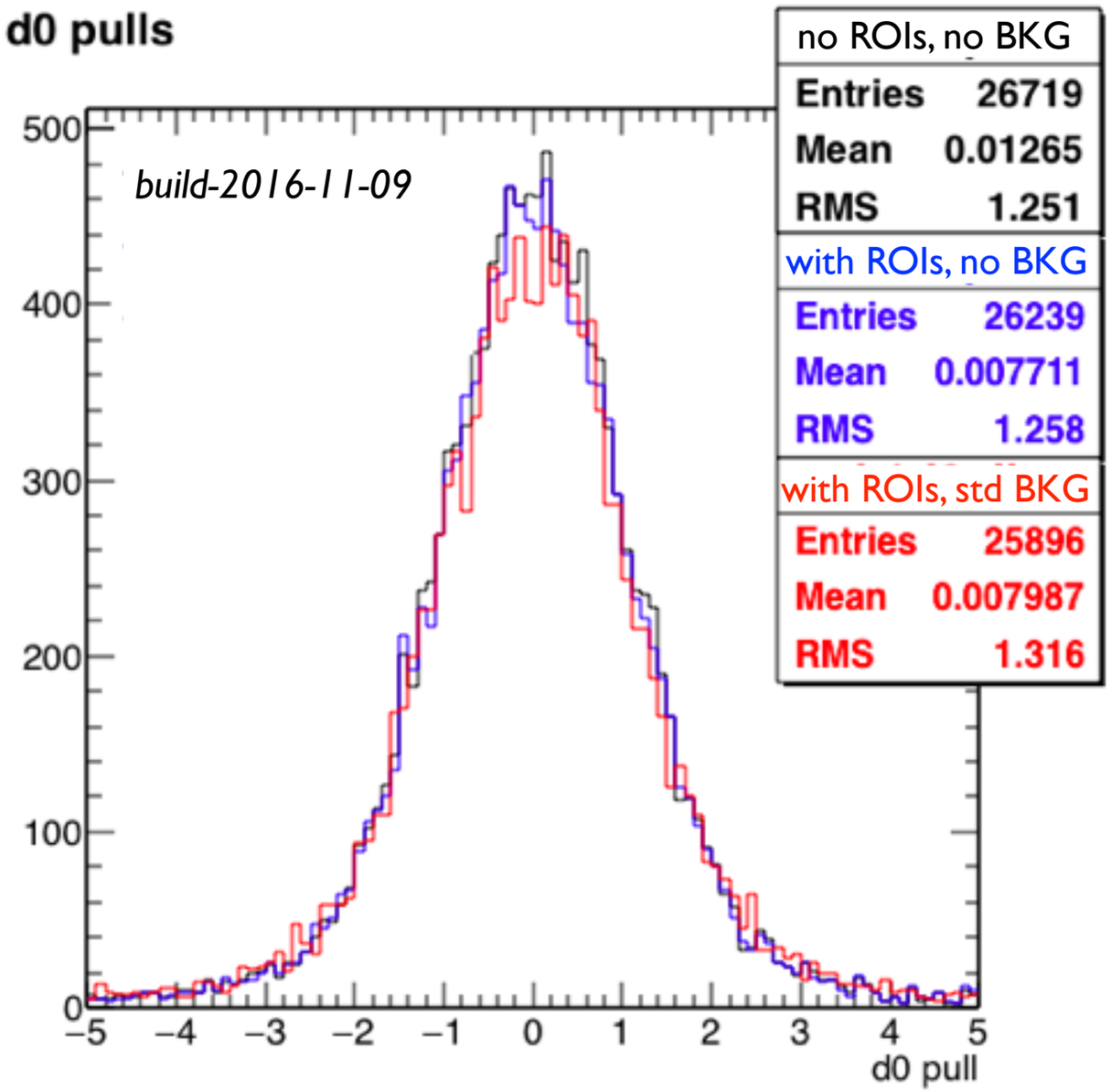
Impact Parameter rel7 vs rel8

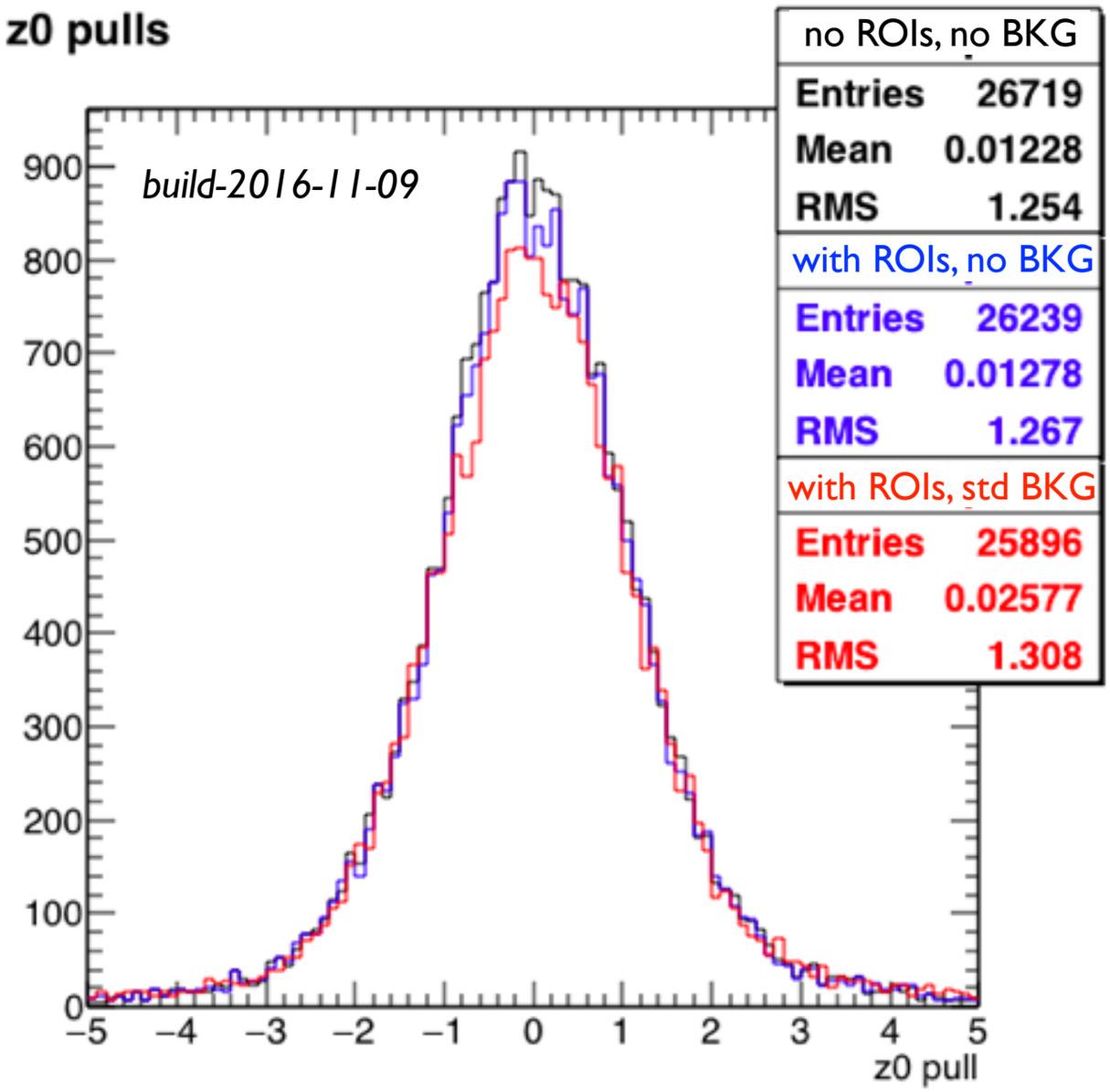




➡ Impact parameter resolutions for release-00-07-00 and build-2016-11-09 are very much compatible, as expected.

Impact Parameters Pulls (1)

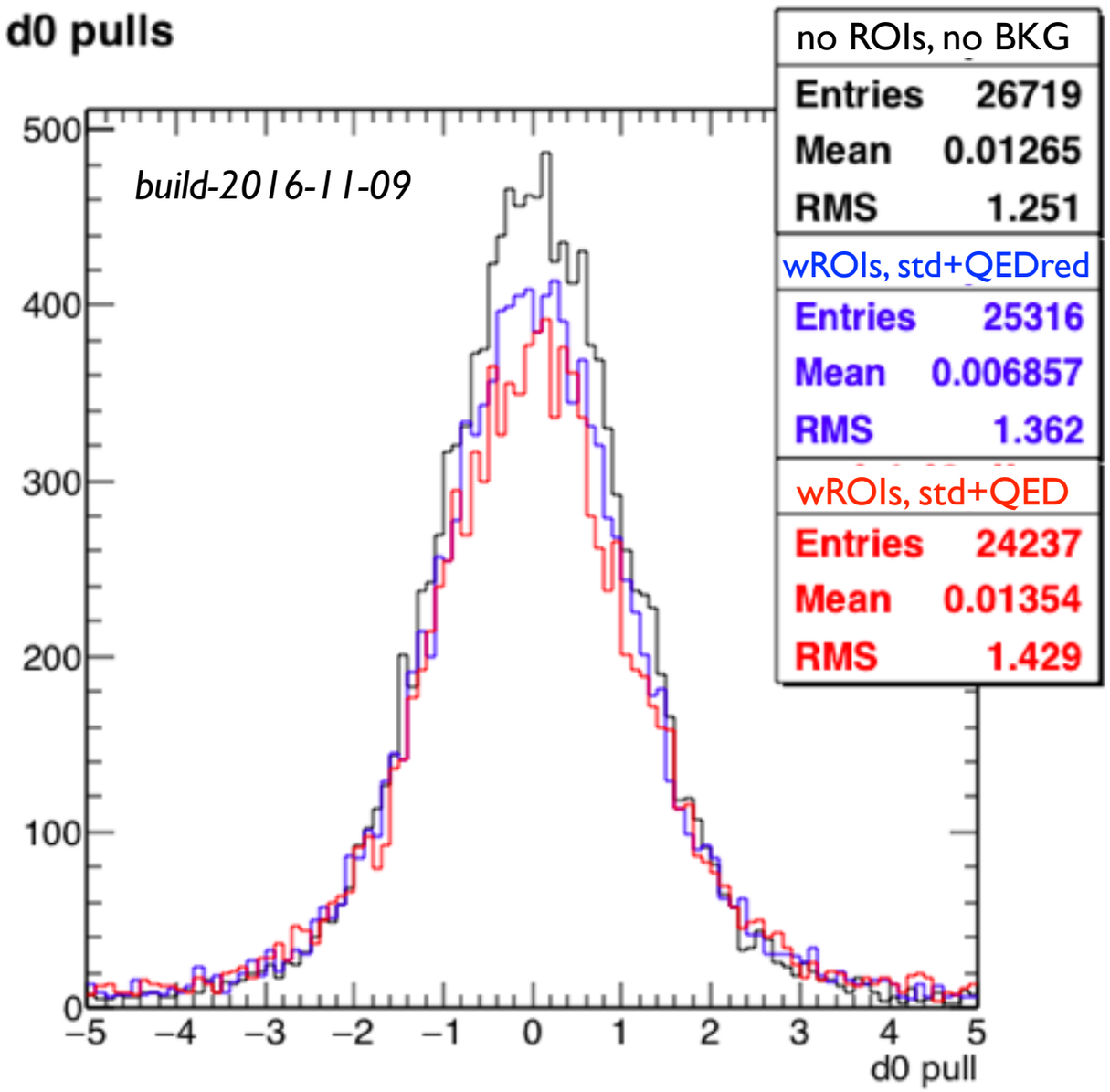


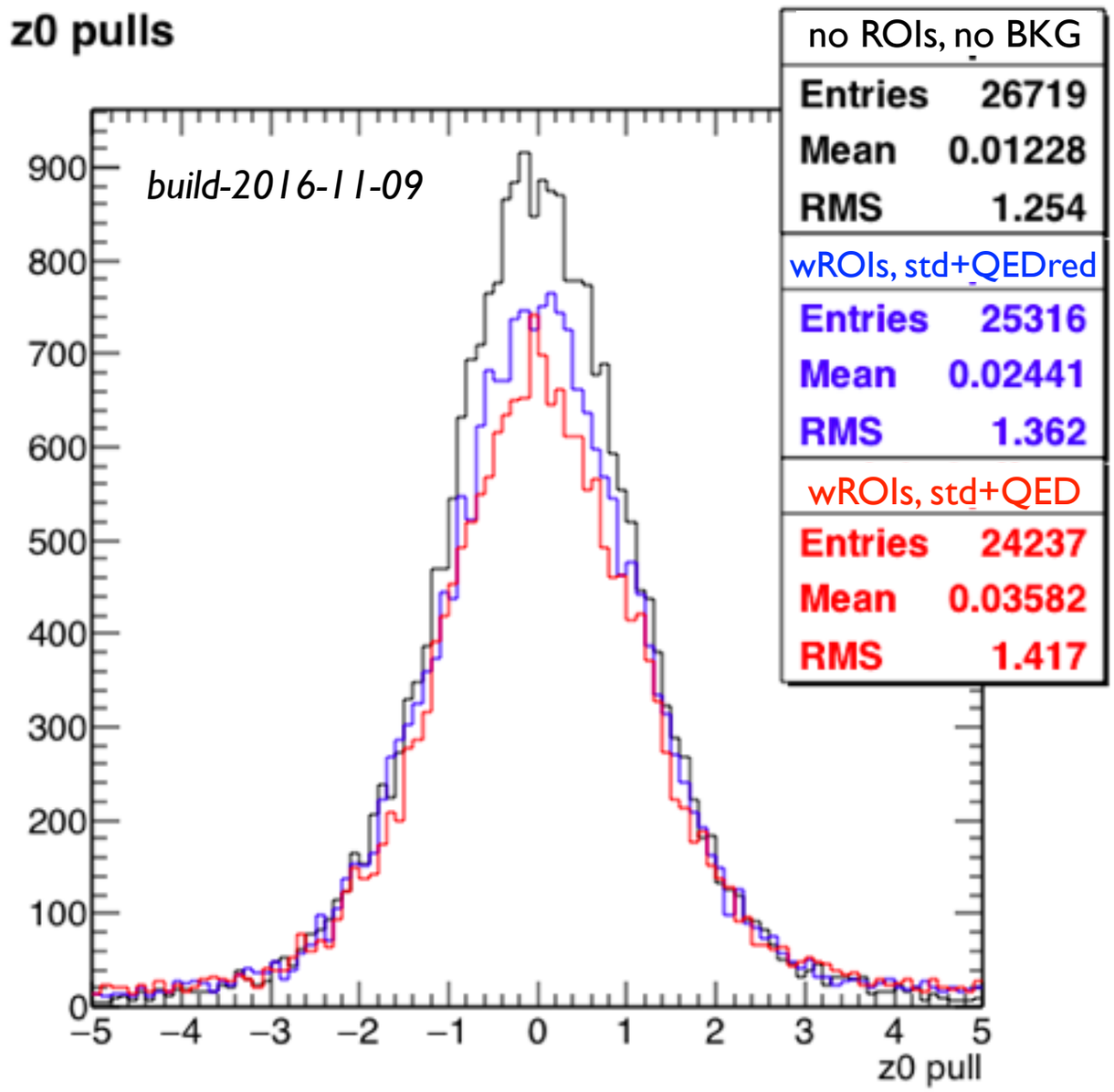


- no ROIs, no BKG
- with ROIs, no BKG
- with ROIs, std bkg

➡ underestimation of the impact parameter error is worse with background

Impact Parameters Pulls (2)





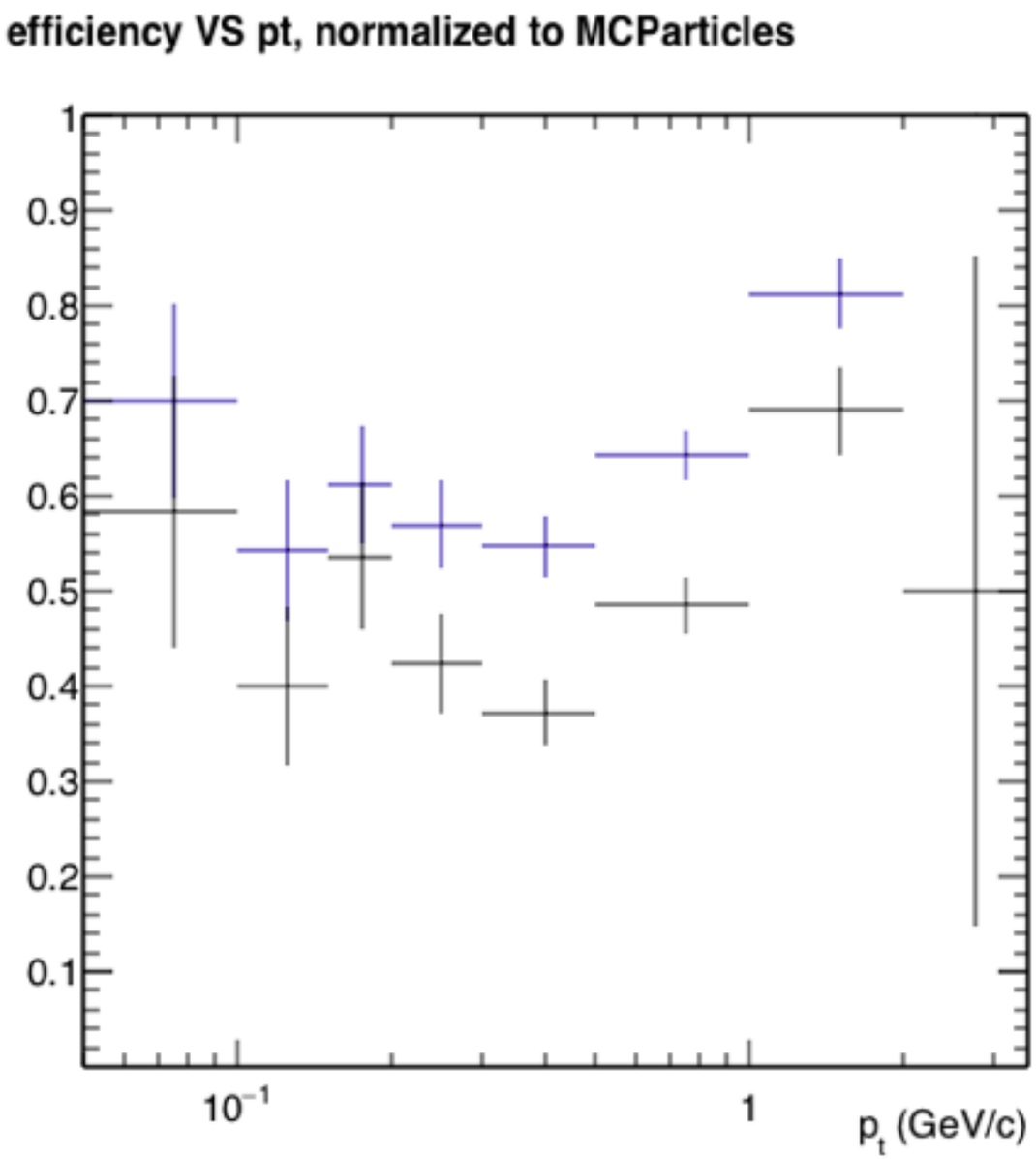
no ROIs, no BKG

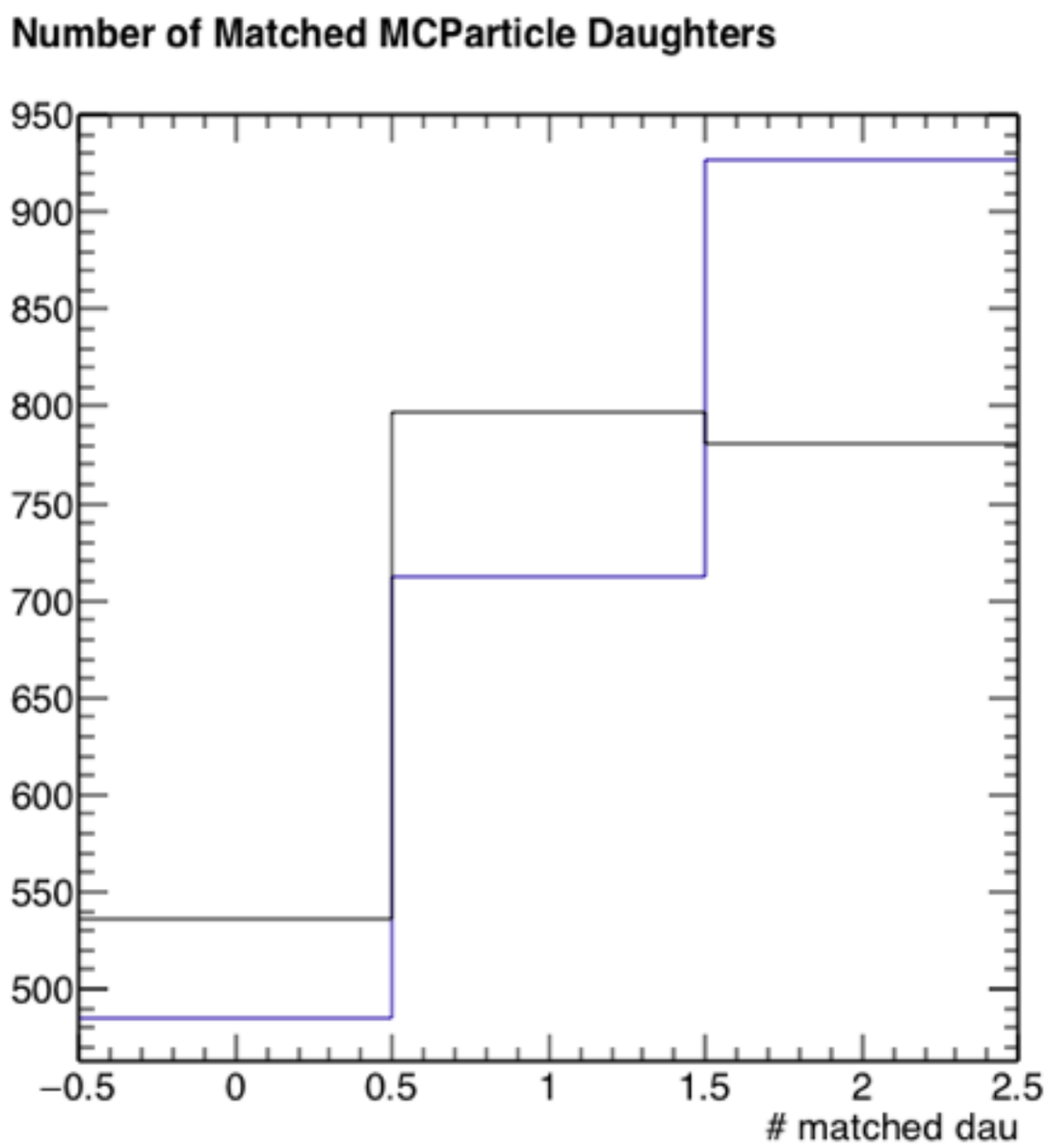
with ROIs, std+QEDred BKG

with ROIs, std+QED bkg

➡ underestimation of the impact parameter error is worse with background

V0 Finding Efficiency



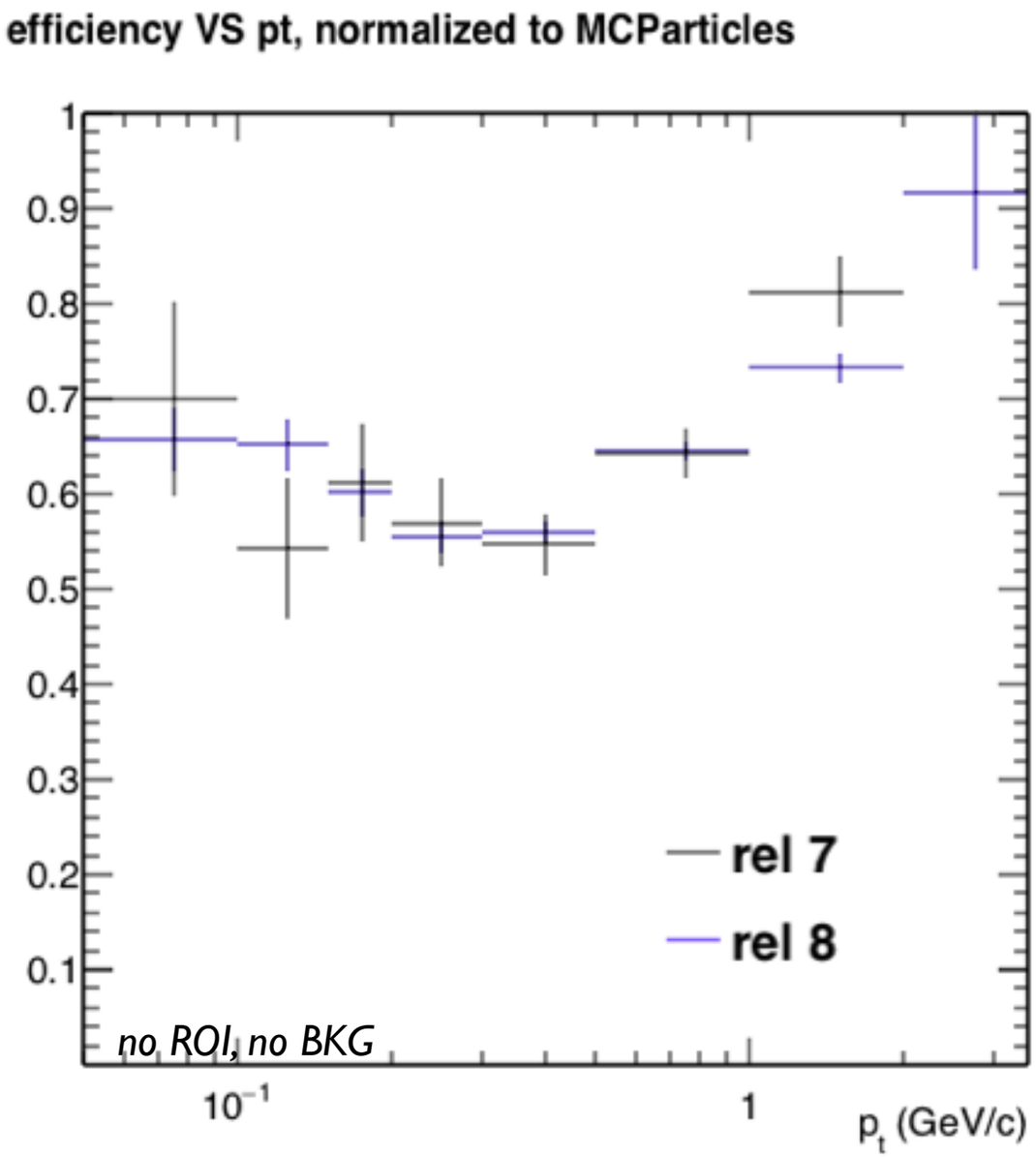


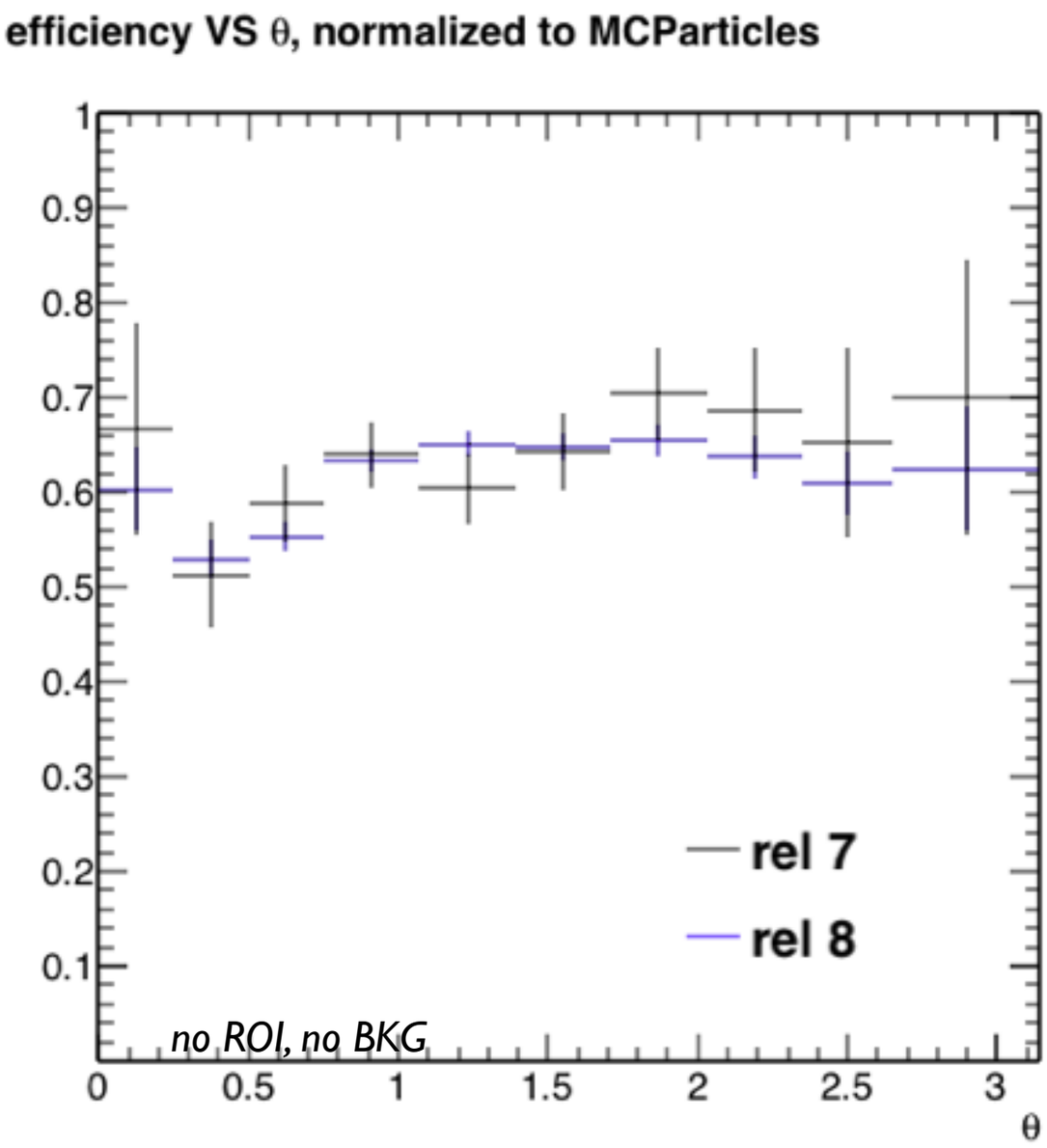
with ROIs, std+QED BKG

no ROIs, no BKG

➡ showing plots for **best** and **worst** scenario

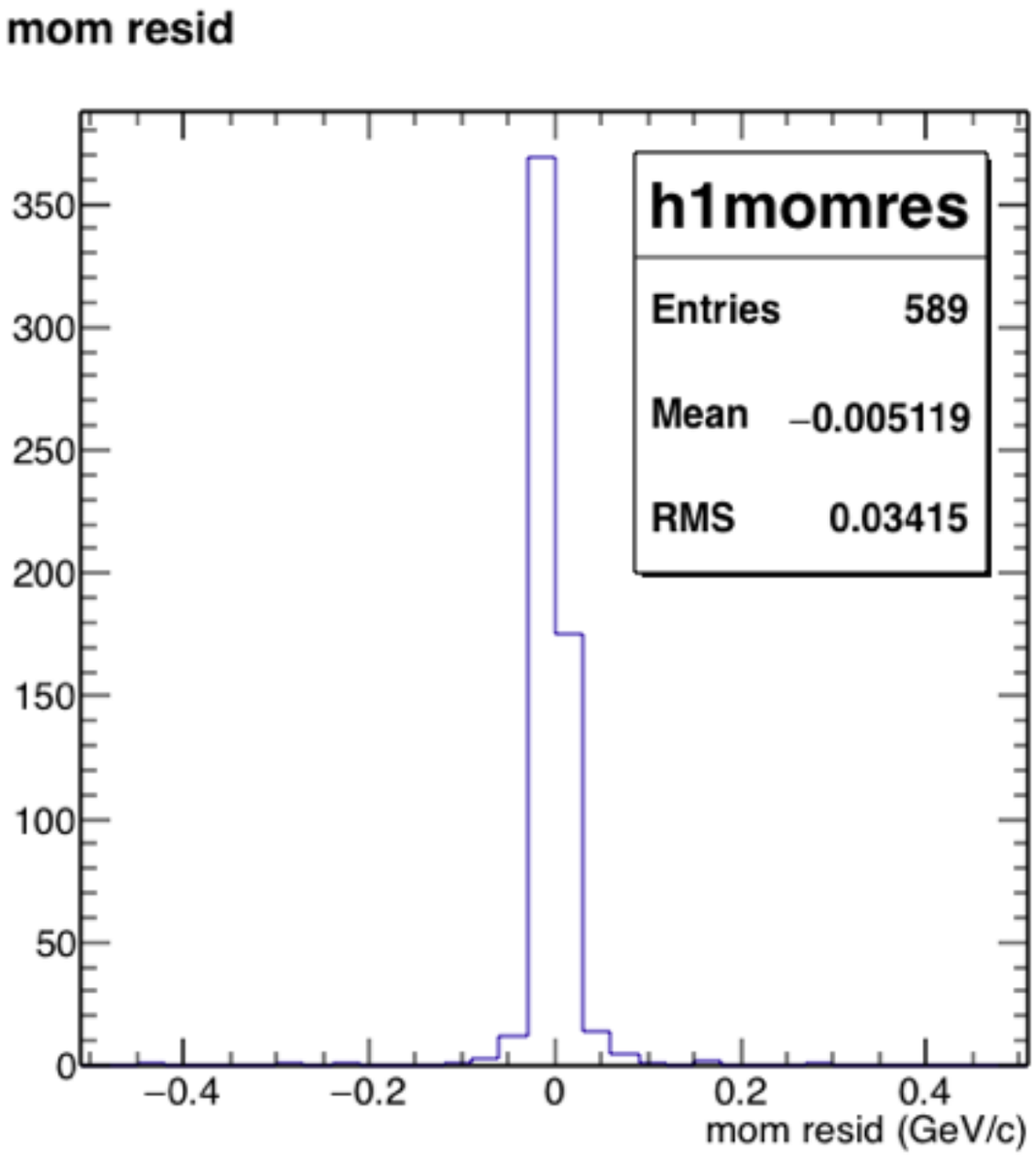
V0 Finding Efficiency rely vs rel8

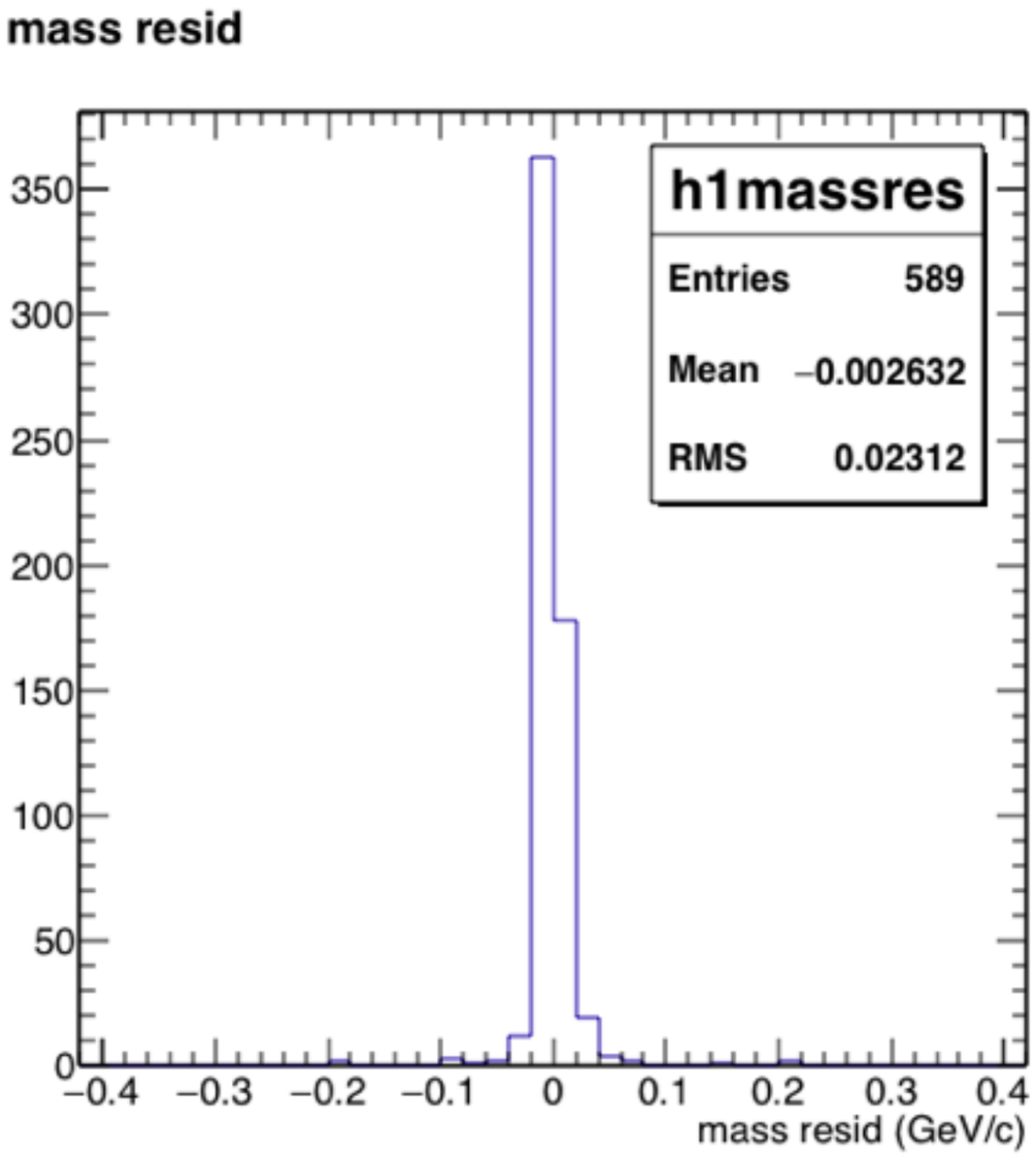




➡ V0 finding efficiency for release-00-07-00 and build-2016-11-09 are very much compatible, as expected.

V0 Resolutions





➡ Mass and Momentum resolutions need a different binning…

Summary on Tracking Performance

- Performance of release-00-07-00 are perfectly compatible with the ones in build-2016-11-09 that will be used for release-00-8-00

- Selected issues that most affect physics:
  - overall tracking efficiency & fraction of tracks with PXD hits attached
  - V0 finding efficiency: a lot of analysis with K_S, but also Λ and converted-γ
  - impact parameter bias

Performance Monitoring in the Analysis Package

- ➡ Analysts want to have a snapshot of the tracking performance of the release that they are using → include tracking performance plots in the analysis validation
- ➡ Tracking provides:
  - tracks with multiple mass hypothesis
  - V0 = pair of tracks with different invariant masses
- ➡ Analysts are interested in:
  - charged particle reconstruction efficiencies
  - reconstructed charged particle quality: impact parameter resolution, PXD hits
  - converted-γ, Λ and K_S reconstruction efficiency
  - converted-γ, Λ and K_S direction resolution
- ➡ Tracking performance depends on the channel they are reconstructing
  - momentum spectrum
  - angular distribution

Proposal for Charged Tracks Plots

➡ Proposed plots:

- efficiency VS p_T , polar and azimuthal angle
- fraction of tracks with (truth matched) PXD hits
- impact parameter resolution and bias vs p_T
- momentum resolution and bias vs p_T

➡ should tracks with electron mass hypothesis have their own set of plots?

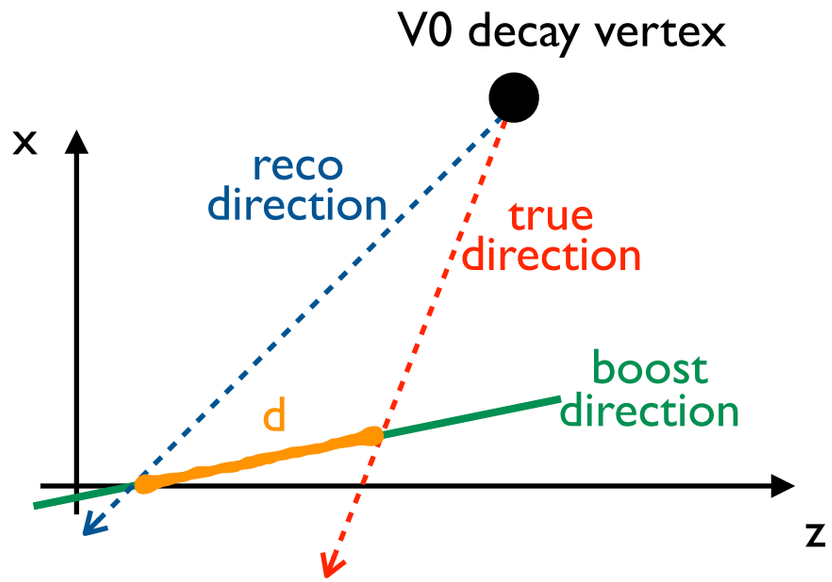
Proposal for V0s Plots

➡ Proposed V0 daughters plots:

- efficiency VS p_T , polar and azimuthal angle
- number of PXD, SVD and CDC hits
- momentum resolution and bias vs p_T

➡ Proposed V0 plots:

- efficiency VS p_T, polar angle and 2D flight length
- flight length resolution and bias vs polar angle
- mass and momentum resolution and bias vs p_T
- d distribution:



Benchmark Samples

➡ Run the validation on benchmark channels, not just on generic Y(4S) events, e.g.:

- $B \to J/\Psi\, K_S$
- $B \to D^{*+}\, \mu^-\, \nu$, $D^{*+} \to D^0\, \pi^+$; $D^0 \to K_S\, \pi^+\pi^-$
- channels used for B flavour tagging
- $D^0 \to K^+\, K^-\pi^+\pi^-$
- $D^{*+} \to D^0\, \pi^+$; $D^0 \to K^+\, K^-\pi^+\pi^-$
- a tau event?

The Plan

- ➡ Adapt the TrackingPerformanceEvaluation and the V0findingPerformanceEvaluation modules to produce the required additional plots
- ➡ time plan:
  - a deadline does not exist, as far as I know
  - since it's not a priority I can start working on this probably next year