Status of genfit2 implementation in PandaRoot

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PANDA Coll. Meeting, 16th March 2015
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Introduction

- Tracking is the core of physics analysis
- PandaRoot is the official framework of $\overline{\mathrm{P}}$ANDA @ FAIR
- PandaRoot has made use of the Kalman Filter for track finding/ fitting procedures
- Kalman equations in PandaRoot have been provided by an external package: *genfit*
- Update of *genfit* rev-400 in PandaRoot: *genfit2* rev-1765
- Several bug-fixes
- Improved tools
- Only <u>one track representation</u>: Runge-Kutta
- Track representation is part of *genfit2* external package
- Track follower is part of *genfit2* external package

Genfit2 in PandaRoot

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- *genfit2* is announced to be a general tool, for every B field

- In PANDA: different field maps
  solenoid (2T) →Kalman filter would work good!
  dipole (2Tm) →different representation is needed!
  ↓
  Runge-Kutta

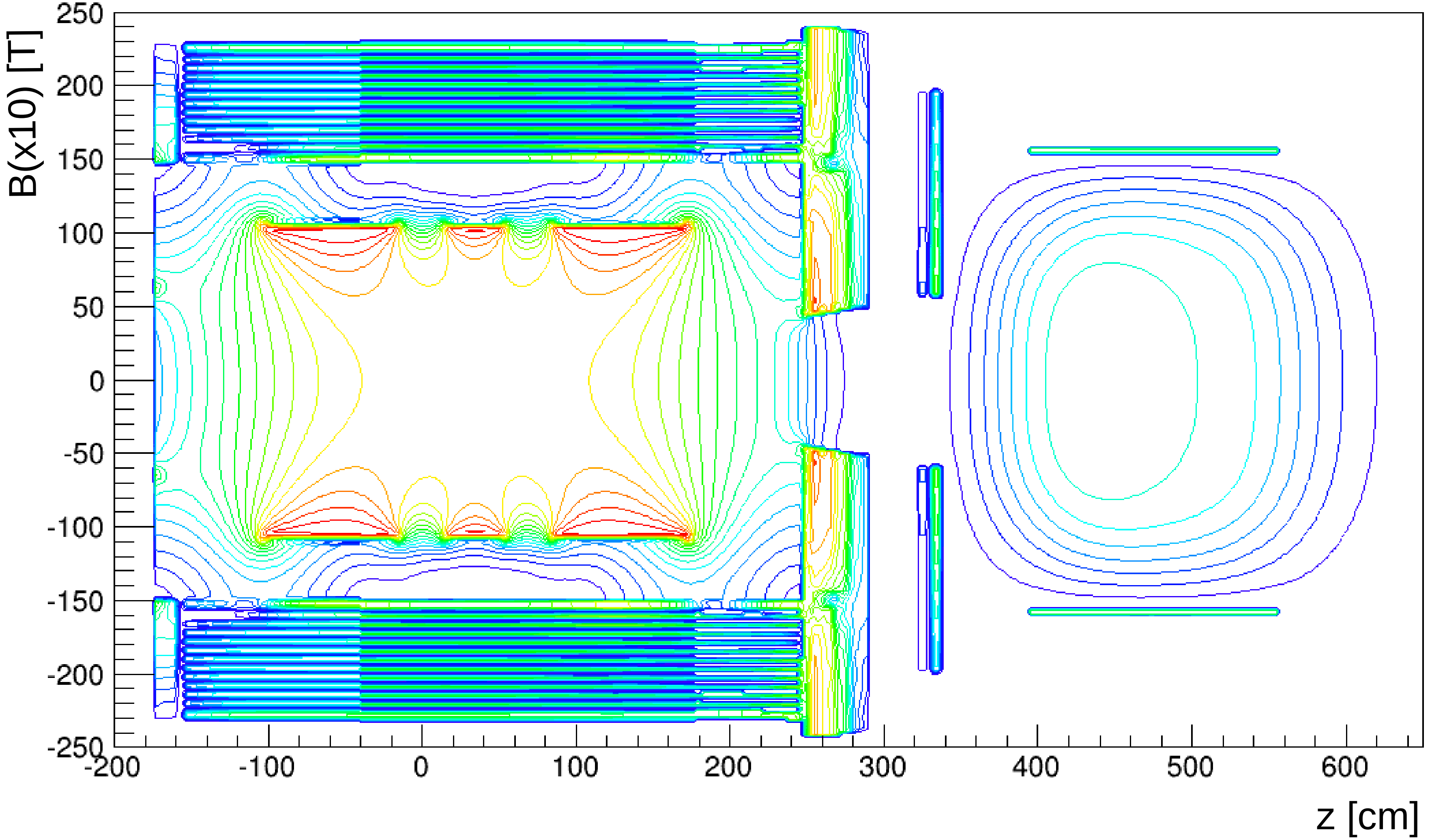
- *genfit* (rev 400) and *genfit2* (rev 1765) are not compatible in PandaRoot

- The current developed branch does not provide a switch to run both genfit revisions

- Interface built in PandaRoot to transform genfit-tracks to PndTracks: *GenfitTools*

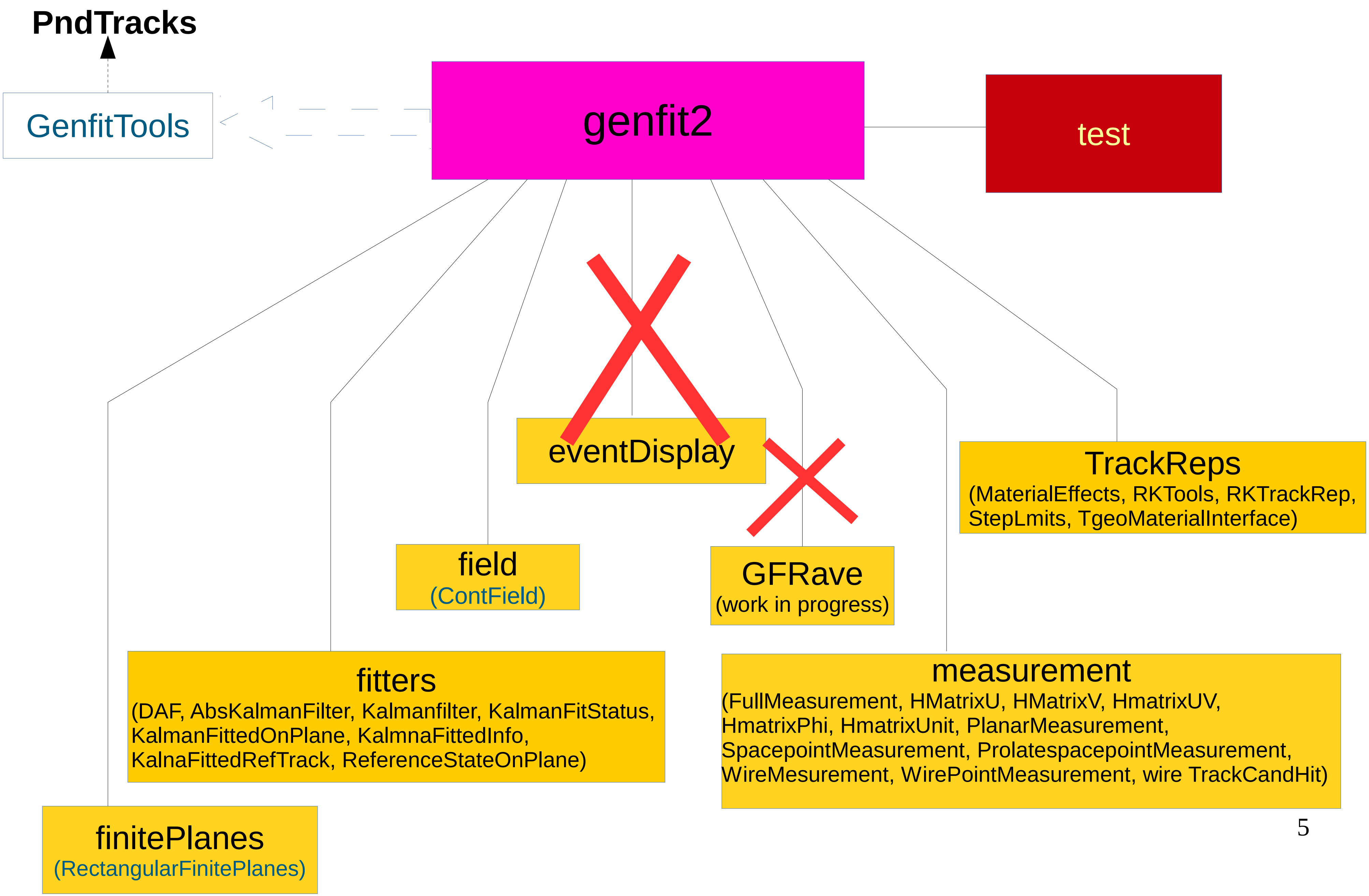
- *genfit2* is ported into /pandaroot/development as external package.

Magnetic field in $\bar{P}$ANDA



Map = “FULL”

Structure of the tool in PandaRoot



Testing PandaRoot trunk-revision with genfit2

- PandaRoot trunk-rev: 26185; genfit2-rev: 1765
- Basic variables to check: px, py, pz, e, x, y, z
- Need to test:
  - reconstructed variables
  - true values
  - error distributions
  - reconstruction efficiency vs p_T
  - pull of the variable distributions

- The equation of the motion of a charged particle (track) in a magnetic field is linear in 5 parameters:

z0, d0 = $\mathrm{Sqrt}(x^2 + y^2)$, curvature ($\propto Q/p_t$), $\tan\lambda$ ($p \cdot \cos\lambda = pt$), ϕ

$$\text{Resolution} = \text{var}_{reco} - \text{var}_{gen}$$

$$\text{Pull} = \text{var}_{reco} - \text{var}_{gen} / \text{err}_{reco}$$

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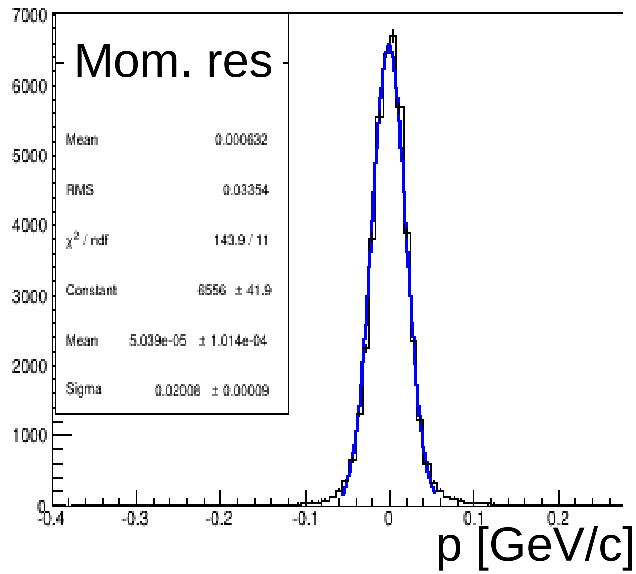
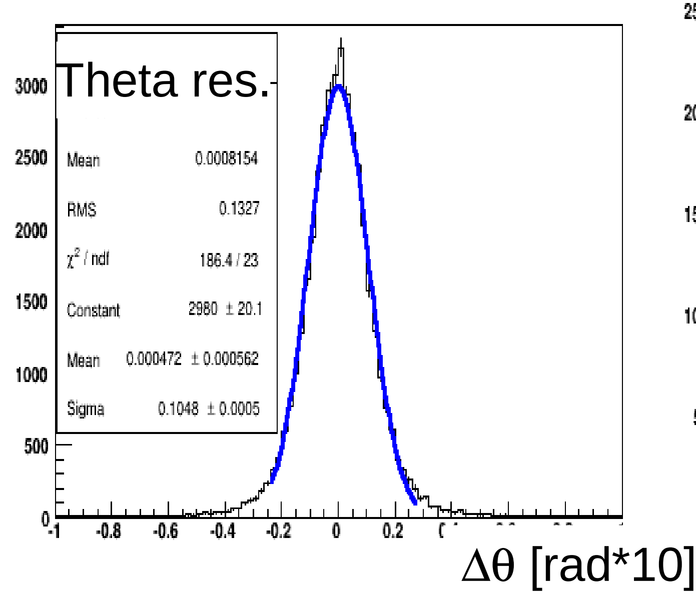
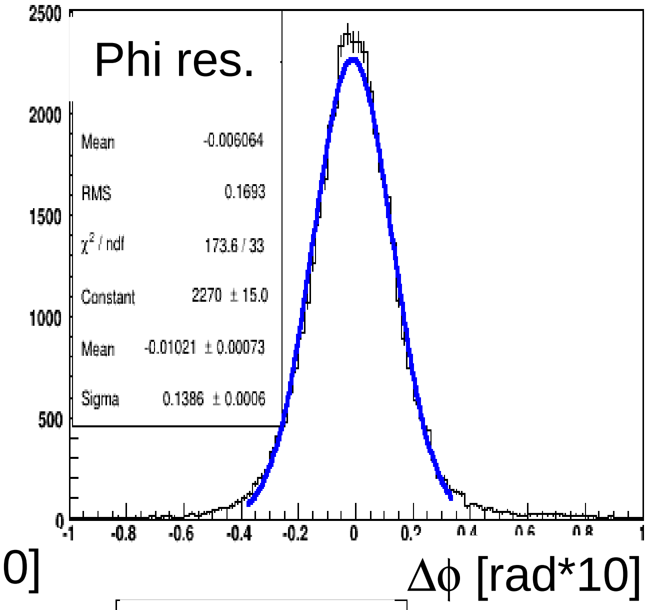
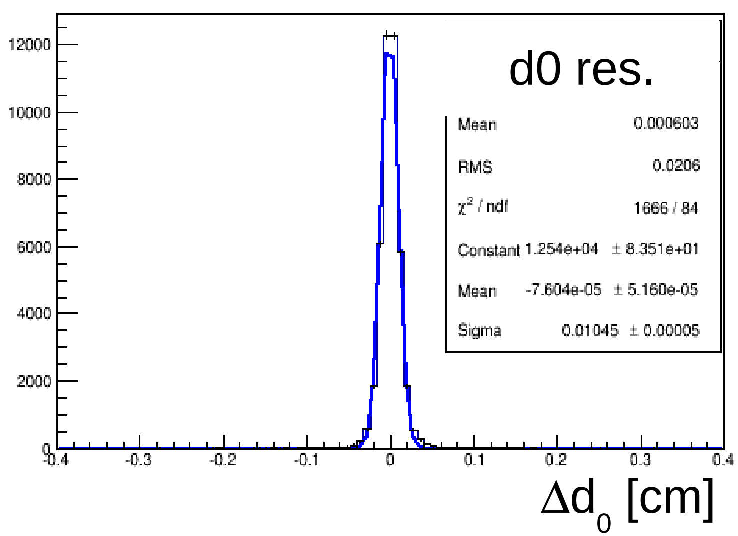
Testing Genfit2: Resolution

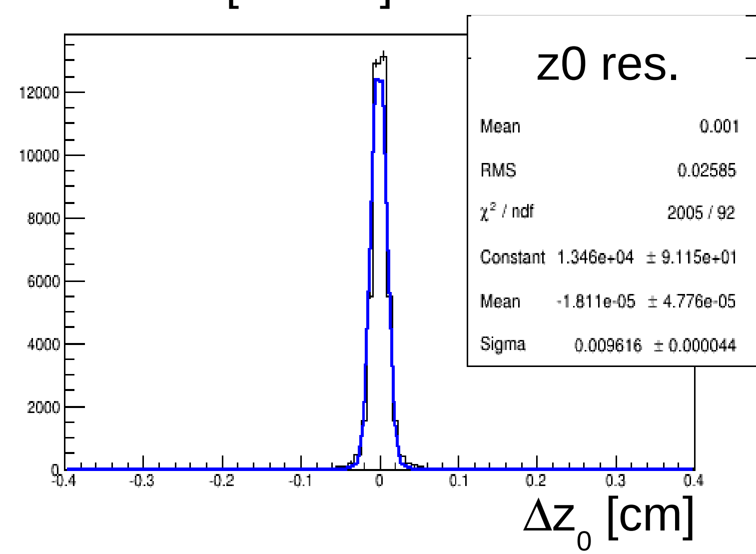
P_{beam} = 15 GeV/c; N = 50 000 π^+, **p = 1 GeV/c**; reconstruction efficiency = (86.18 ±0.15)%











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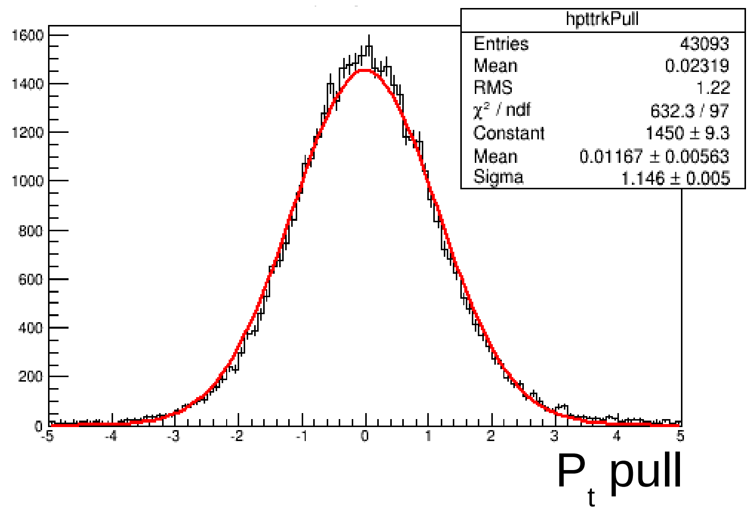
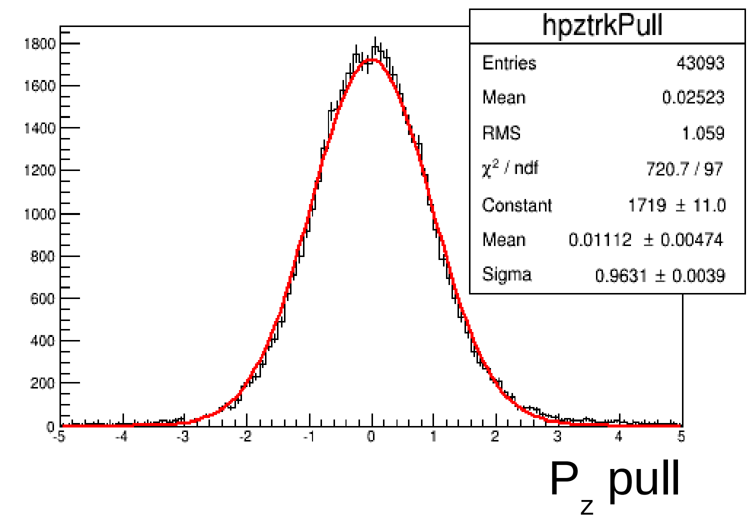
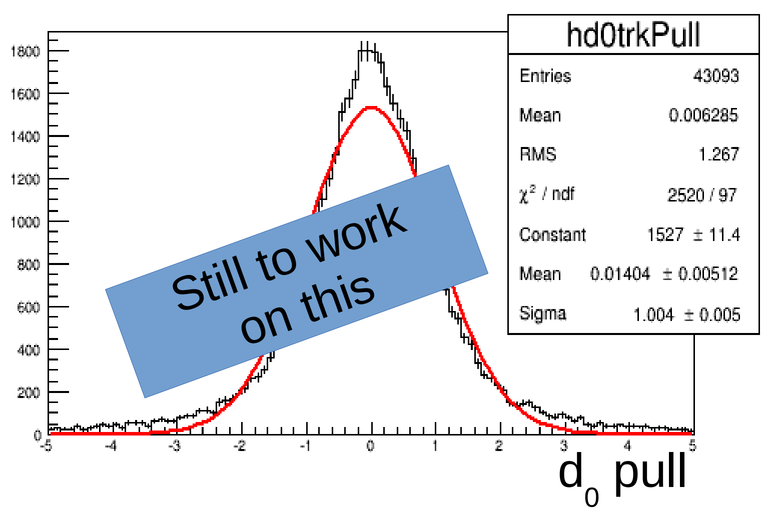
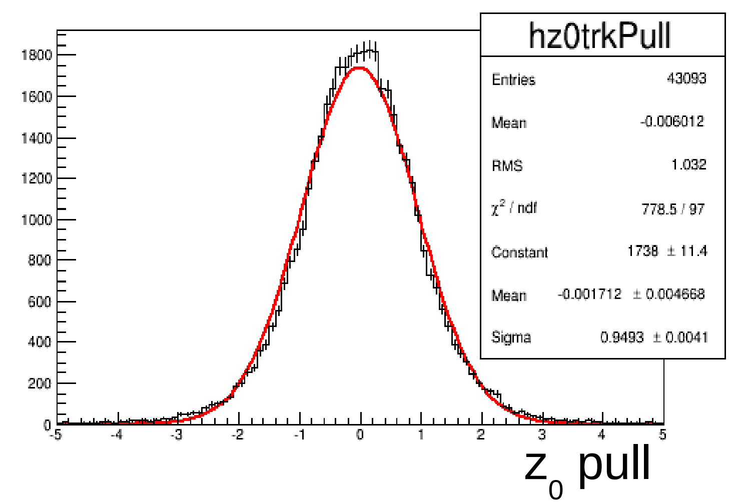




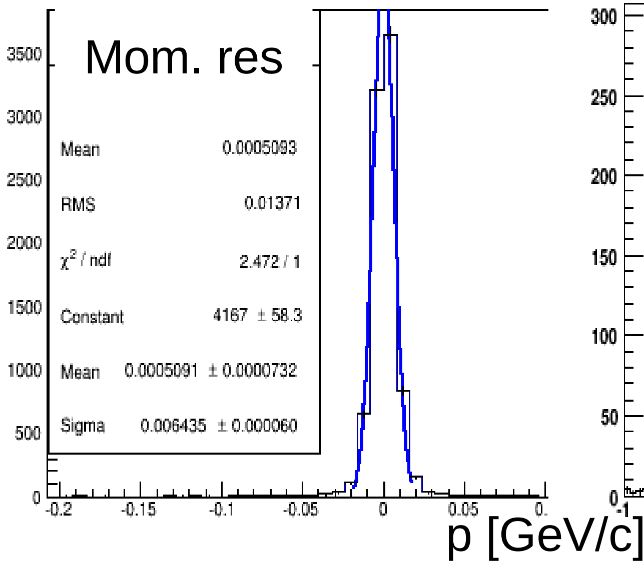


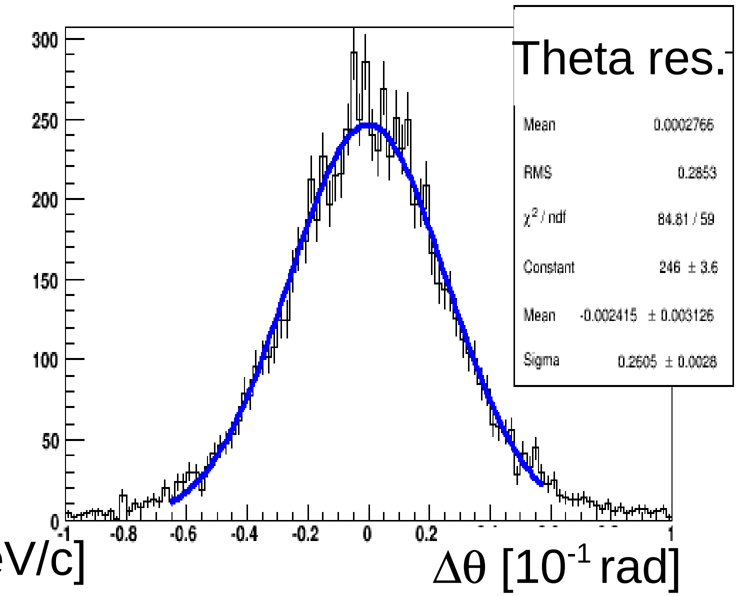


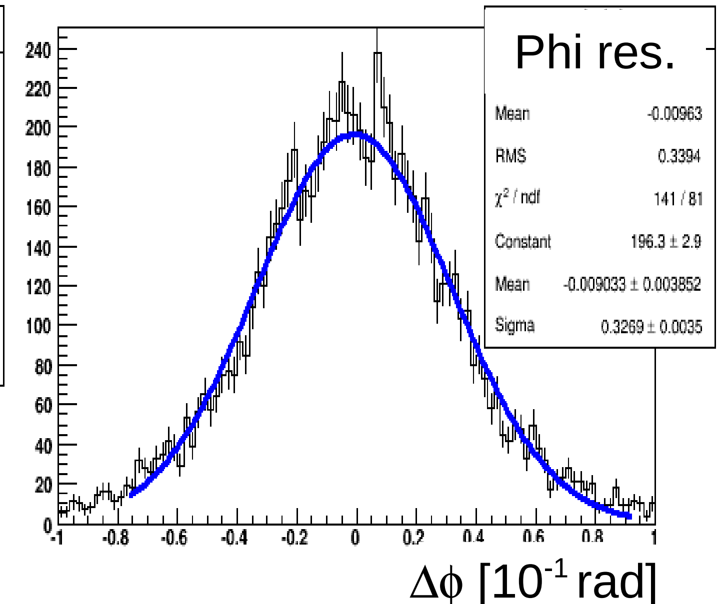
- Pull of tracking parameters is supposed to be have gaussian distribution, with σ = 1

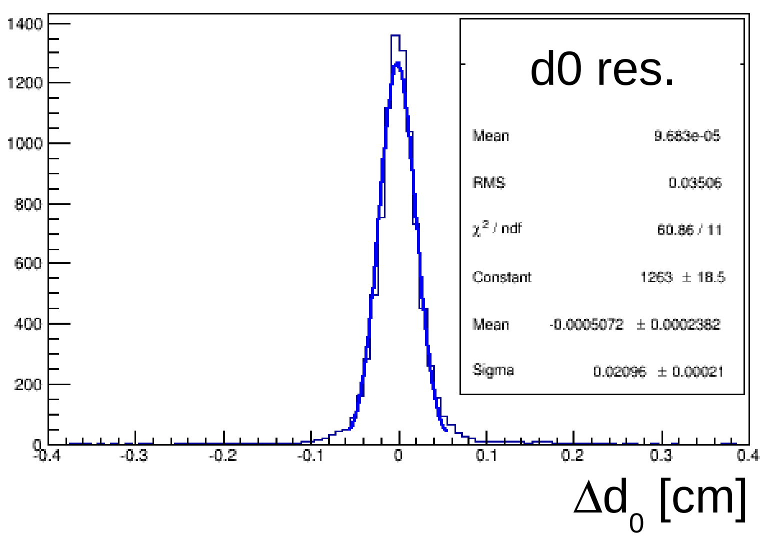
Testing Genfit2: Resolution

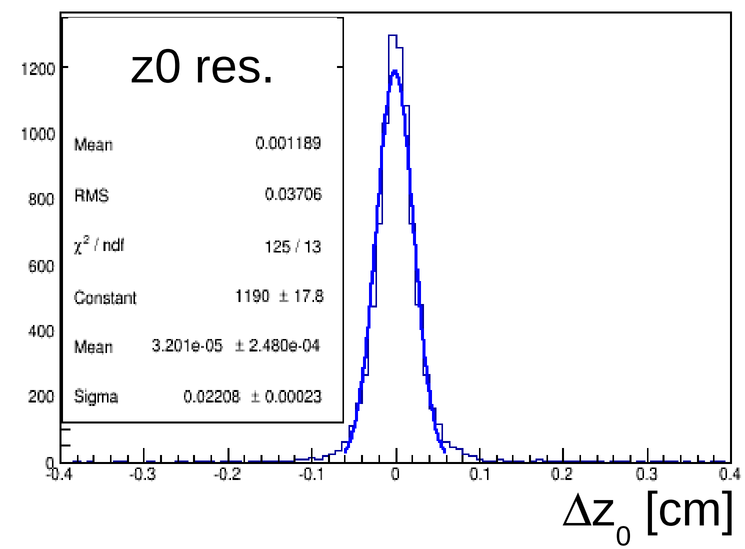
P_{beam} = 15 GeV/c; N = 10 000 π^+, **p = 0.4 GeV/c**; reconstruction efficiency = (85.54 ±0.92)%











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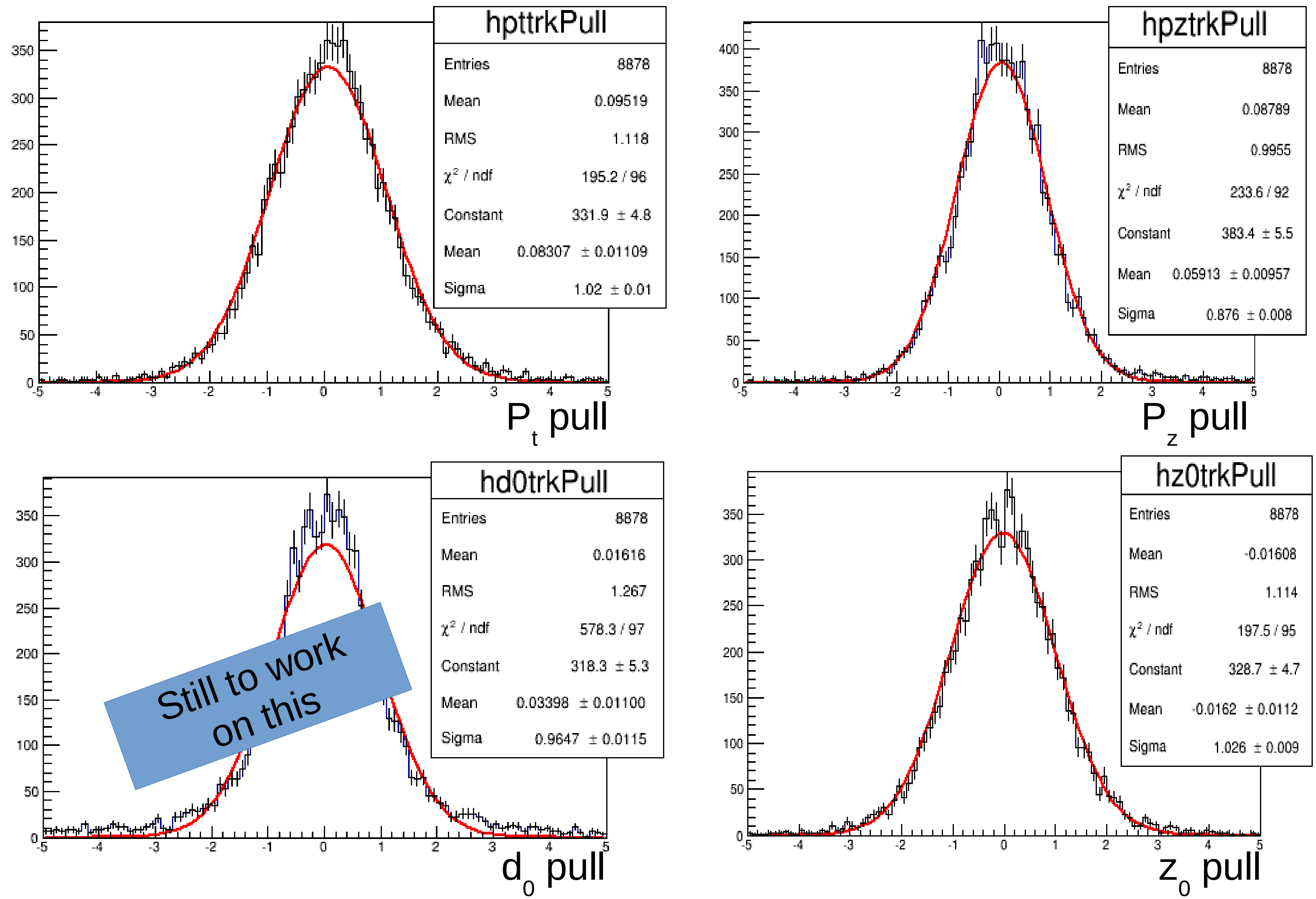
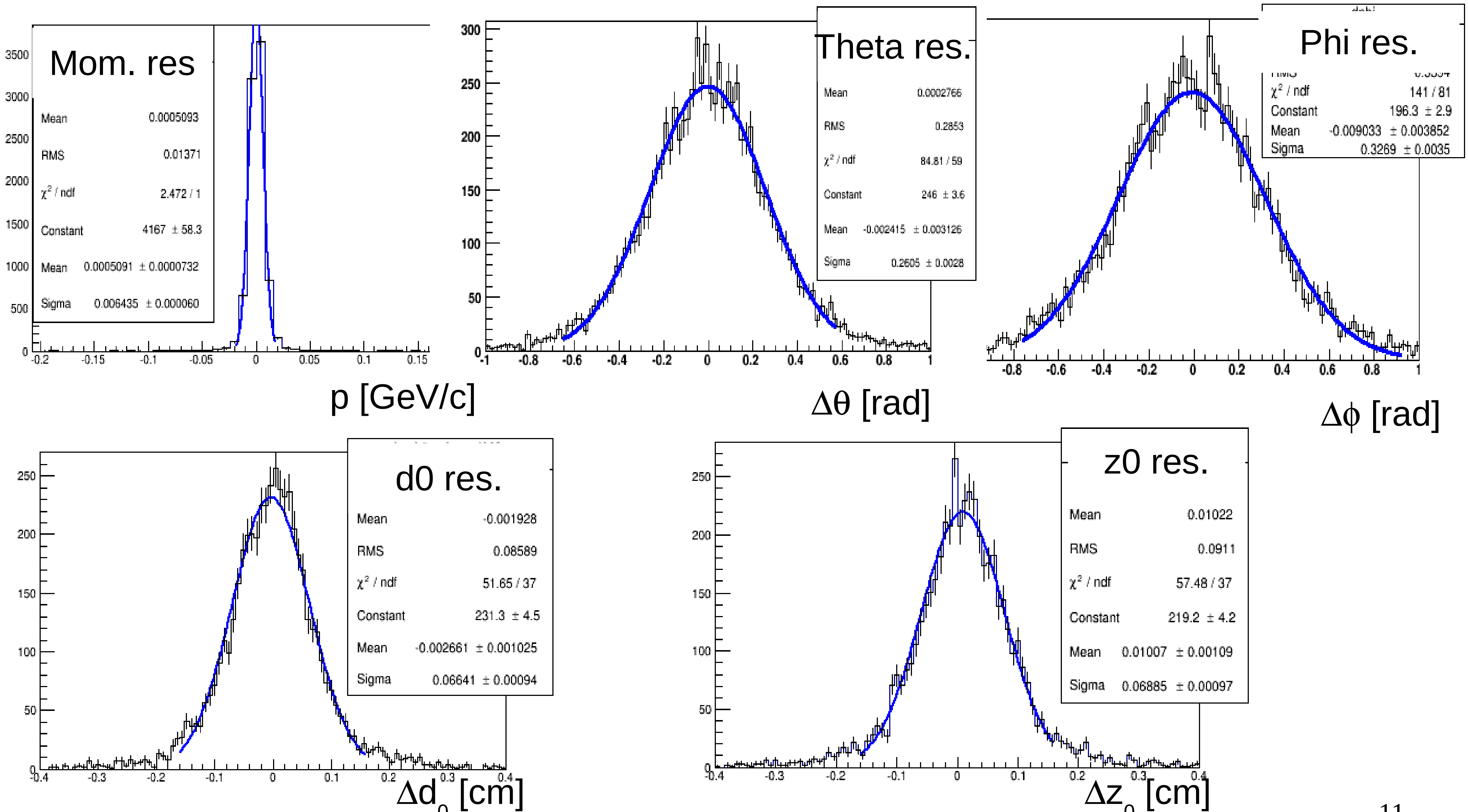
P_{beam} = 15 GeV/c; N = 10 000 π^+, **p = 0.4 GeV/c**; reconstruction efficiency = (85.54 ±0.92)%



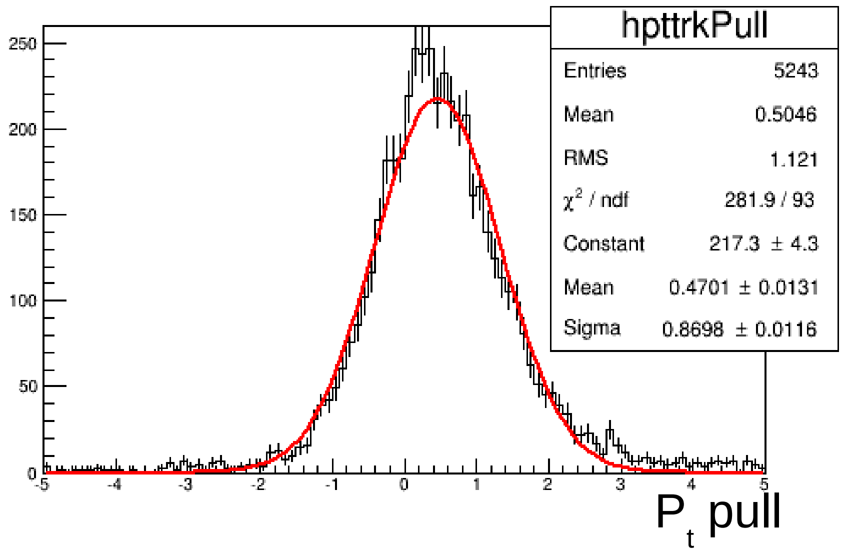
Testing Genfit2: Resolution

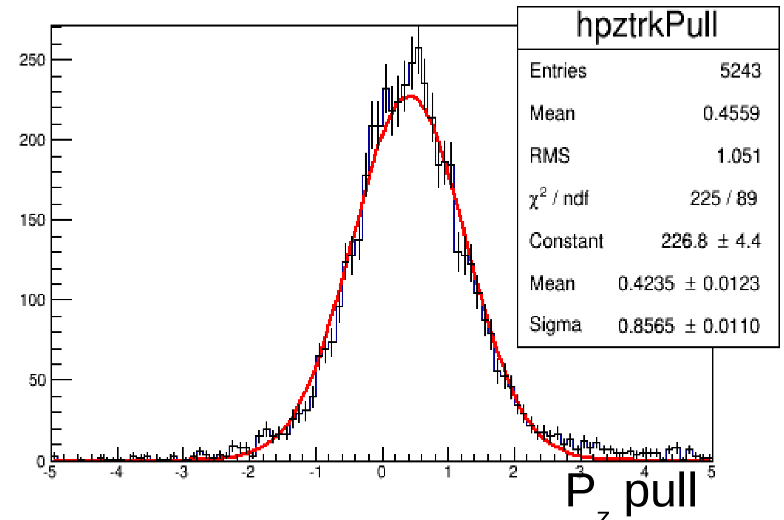
P_{beam} = 15 GeV/c; N = 10 000 π^+, **p = 0.15 GeV/c**; reconstruction efficiency = (50.26 ±0.71)%

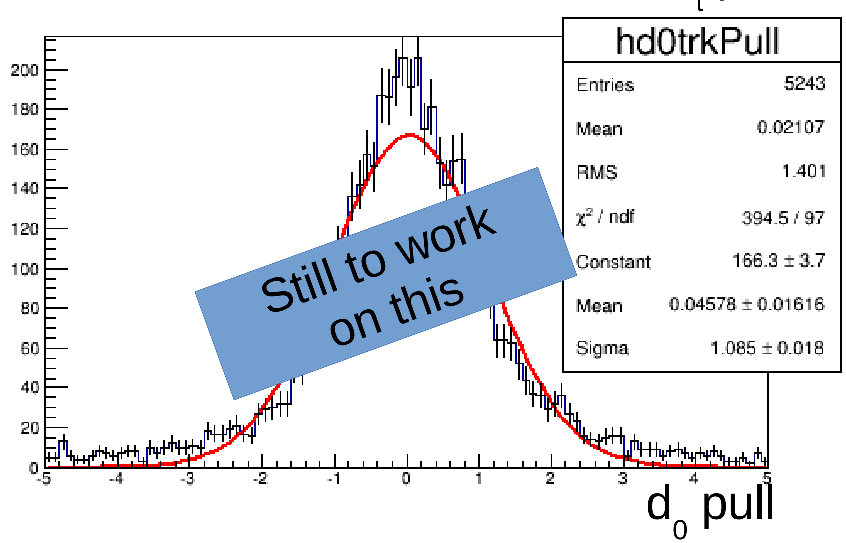


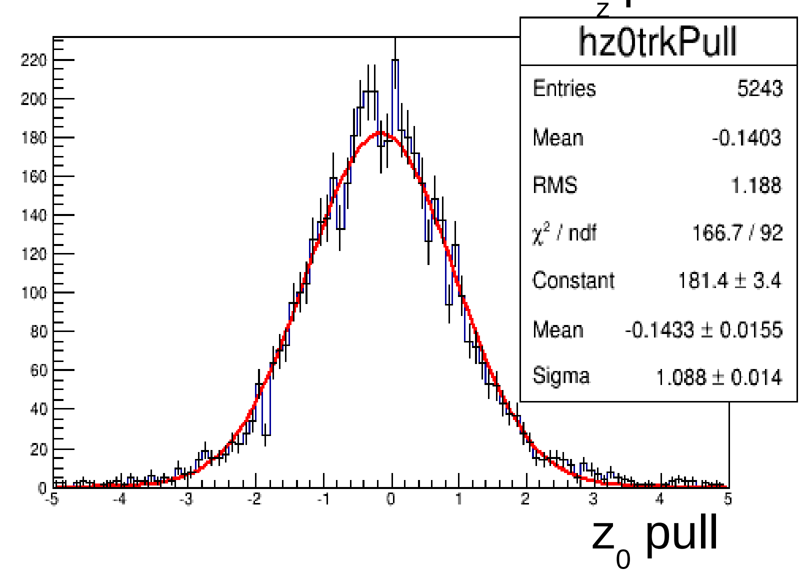
Testing Genfit2: Pull

P_{bea} = 15 GeV/c: N = 10 000 π^+. **p = 0.15 GeV/c**; reconstruction efficiency = (50.26 ±0.71)%

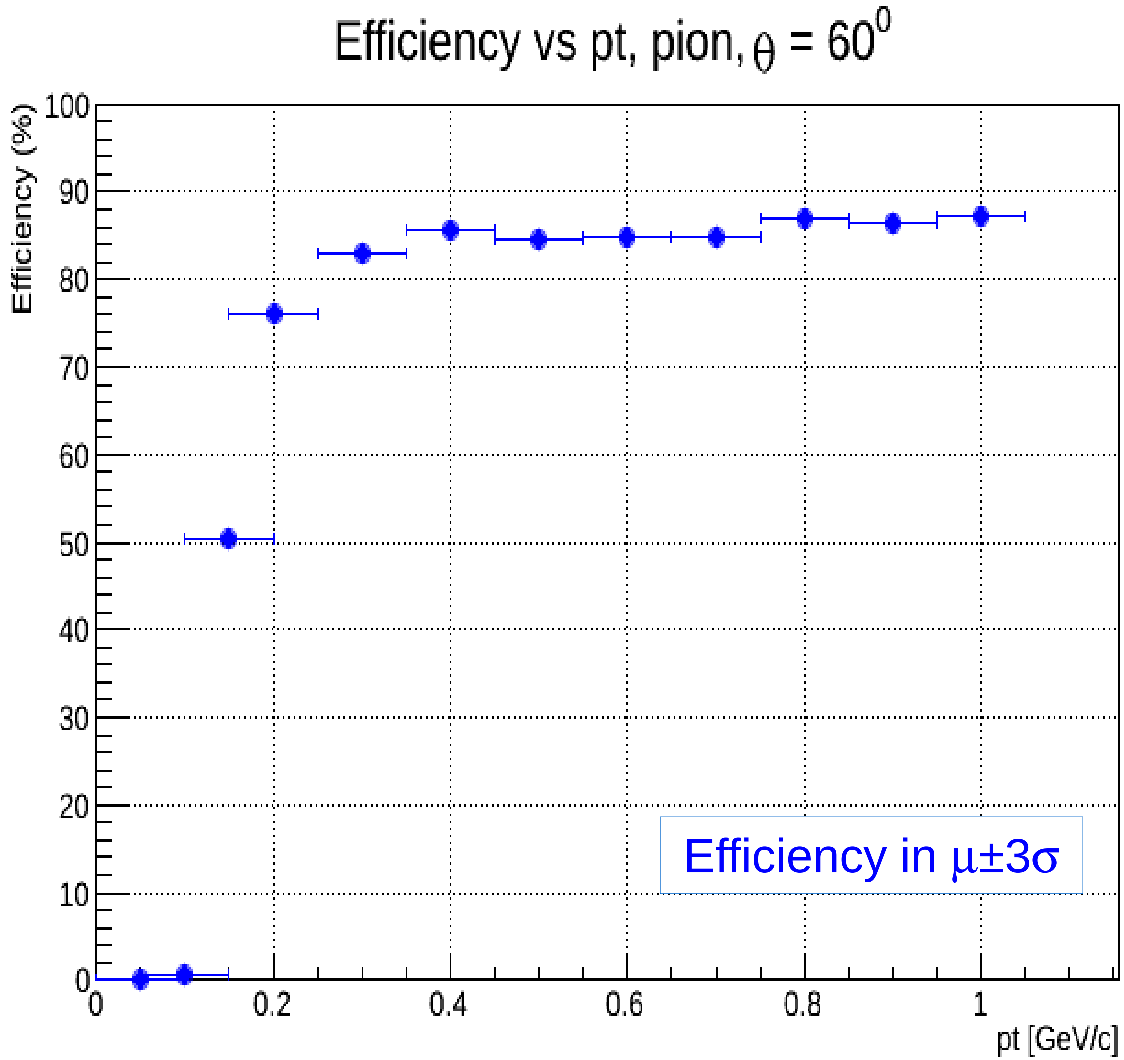








Testing Genfit2: Efficiency vs pt



Great improvement for low momentum tracks!

Efficiency vs Pt:
comparison with the previous tool

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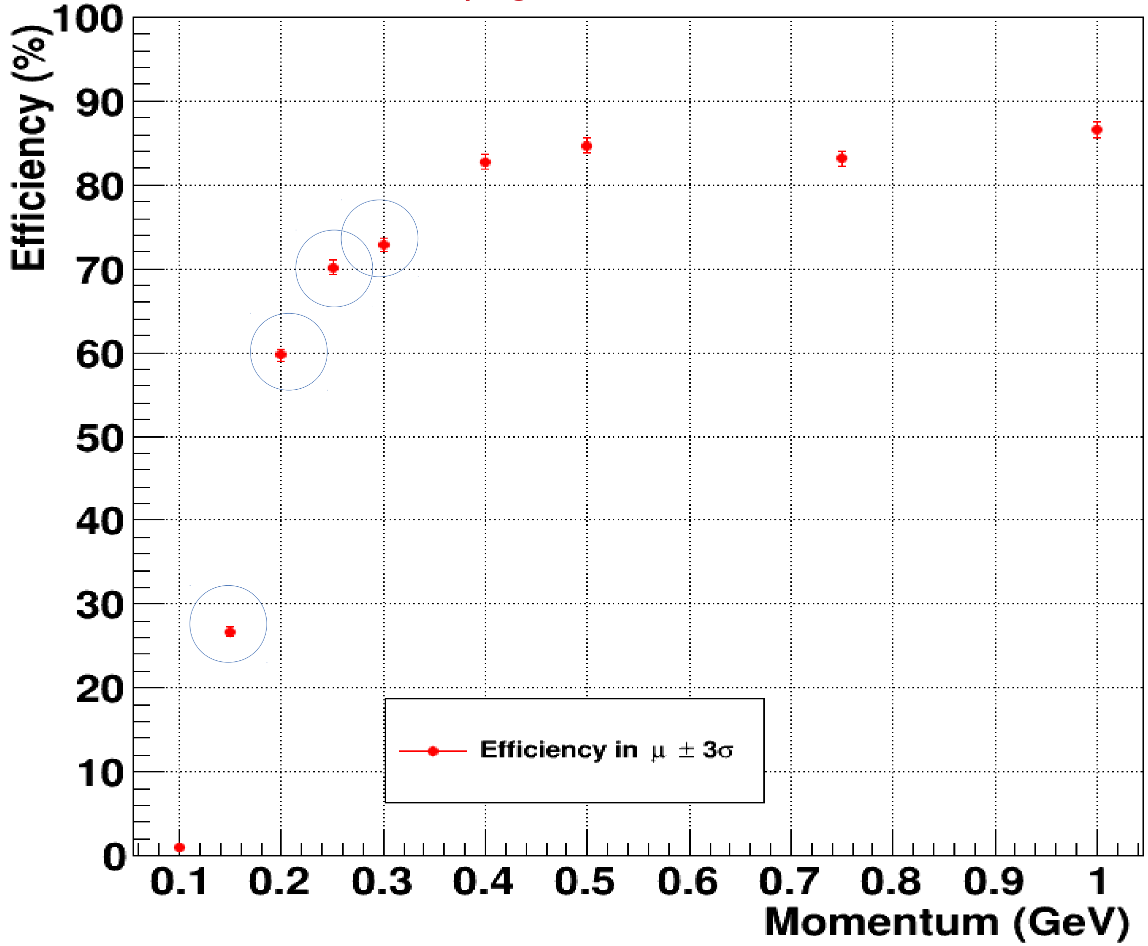


Comparison: resolution and pull fits

Pion mom. (MeV/c)	P resolution (*) (%)	ϕ resolution (mrad)	θ resolution (mrad)	z_0 resolution (μm)	Efficiency in $\mu\pm3\sigma$ (%)
1000	1.81±0.66	2.419±0.034	1.829±0.031	96.16±0.44	86.18±0.15
400	2.26±0.24	5.706±0.049	4.546±0.061	220.80±0.23	85.54±0.92
150	7.73±0.11	16.42±0.52	13.51±0.95	688.90±0.97	50.26±0.71

(*) p resolution (σ gaussian fit) is normalized to the mean value extracted from fit: $\Delta p/p$

p resolution: $\sigma \sim 16$ MeV/c

Pion mom. (MeV/c)	P_t pull	P_z pull	d_0 pull	z_0 pull	Efficiency in $\mu\pm3\sigma$ (%)
1000	1.146±0.005	0.96±0.04	1.004±0.005	0.949±0.01	86.18±0.15
400	1.02±0.01	0.88±0.08	0.965±0.012	1.026±0.009	85.54±0.92
150	0.87±0.01	0.86±0.01	1.085±0.018	1.088±0.014	50.26±0.71

Comparison: GF1 vs GF2

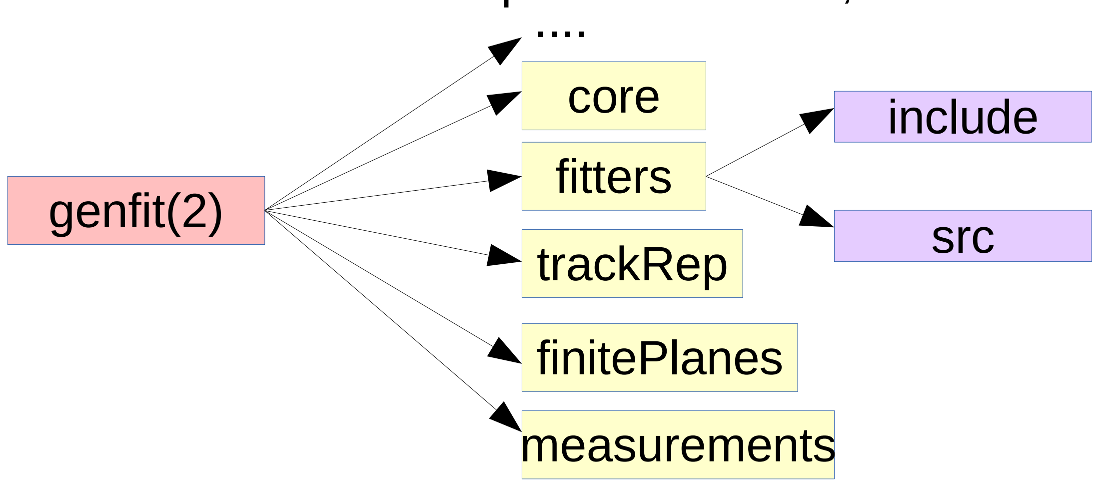
- Only 1 track representation in GF2: **RKTrackRep**.
GF2 makes use of the same track representation in the homogeneous and non-homogeneous B field (no helix, no parabola): adaptive step-method is used.

- GF2 makes a check on the fit convergence, while it was not done in GF1.

- Reference plane:
  in GF1 there was one reference plane; in GF2 each StateOnPlane gets a plane via the constructPlane() method of the class AbsMeasurement().
  In GF2 planes are automatically constructed by the fitter.

- LheTrack, LheGenTrack: not used any further in GF2

- Vertex finder: RAVE is part of GF2 now, but it still needs some tuning in PandaRoot.



Summary

- *genfit2* has been ported successfully in PandaRoot

- Pull distributions: $\sigma \cong 1$ for different particle momenta. Good!
- Different pion momenta tested: improvement at p = 0.15 GeV/c, but still...
- Different mass hypotheses tested, at different momentum values: consistency

- Improvements expected in physics analysis

THANK YOU for your attention!