JÜLICH
FORSCHUNGSZENTRUM

Update on Genfit2 in PandaRoot: gf-rev 1765

51st $\bar{P}$ANDA Collaboration Meeting, Jülich

Elisabetta Prencipe | 10th December 2014 | Forschungszentrum Jülich

JÜLICH
FORSCHUNGSZENTRUM

Status and perspectives

Overview

- Trunk rev-26559 was tested (standard revision)
- *genfit2* has been tested now also in the **rev 26559** (branch development).
- **Last fixes** are in the branch development:
  https://subversion.gsi.de/trac/fairroot/browser/pandaroot/development/genfit2
  where Johannes Rauch (TUM) and me have committed recently the code.
- Main changes compared to the past coll. meeting:

  /GenfitTool/recotaks/PndRecoKalmanfit.cxx fixes:
  ❶ideal track finder can run
  ❷number of iteration to run the Kalman Fit ≥2
- **Track follower** is part of the genfit2 tool
  geane track representation is not used: only Runge Kutta
- In /development/genfit2: different genfit tool structure.
  It required changes in several pandaroot packages:
  /lmd/, /hyp/, /hypGe/, /stt/, /mvd/, /GenfitTools/, and few other small changes...

Tracking classes are changed in these packages: new version already provided. You can find modifications in: **/development/genfit2/**

Overview

- /gentif2/ provides the Kalman equations and the Runge-Kutta track representation
- /genfit2/ is announced to be a general tool, for every B field
- /genfit/ (rev 400) and /genfit2/ (rev 1765) are NOT compatible;
  the current developed branch does not provide a switch to run both versions.
  /genfit2/ is ported into /pandaroot/development as external package.
- **First tests in trunk rev 20185 w/o *genfit2* were presented in March 2014**
  - tools running, and *mainly* working: improvement shown in resolution of ***p***, ***r***
  - problems with the detID were found (fixed in **gf-rev: 1731**)
  - problem to access the McTruth from GetMcTruth() in standard pandaroot macros.
- **2 fixes in trunk rev 25545 presented at the last collaboration meeting**
  - no problems to get the correct detID
  - no problems to access true values through GetMcTruth()
  - pull distribution have been shown.
- **Today: rev 26559 shows the recent tests, with recent fixes in a new gf-rev: 1765**

Motivation

- Several bugs found in the old version of *genfit* (the one we actually use)
- *genfit* is an external package providing the Kalman filter equations
- a new version of genfit is available: it includes a track representation
- good tracking tools, for low momentum tracks, are especially needed for hyperon/charm physics

- *genfit2* (GF2) offers a window of improvement: it is worth to try
- *genfit2* is an external package
- Maintenance: TUM/LMU
- *genfit2* has been ported in the Belle II code, successfully
- *genfit2* is still in development, but at very advanced stage

- in PandaRoot: PndTracks
- /GenfitTools/ is the interface between GF-Tracks and PndTracks.

Testing the standard trunk rev-26559....

- 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

- Kalman filter applies to reconstruction (central tracker)
- The equation of the motion of a charged particle (track) in a magnetic field is linear in 5 parameters:

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

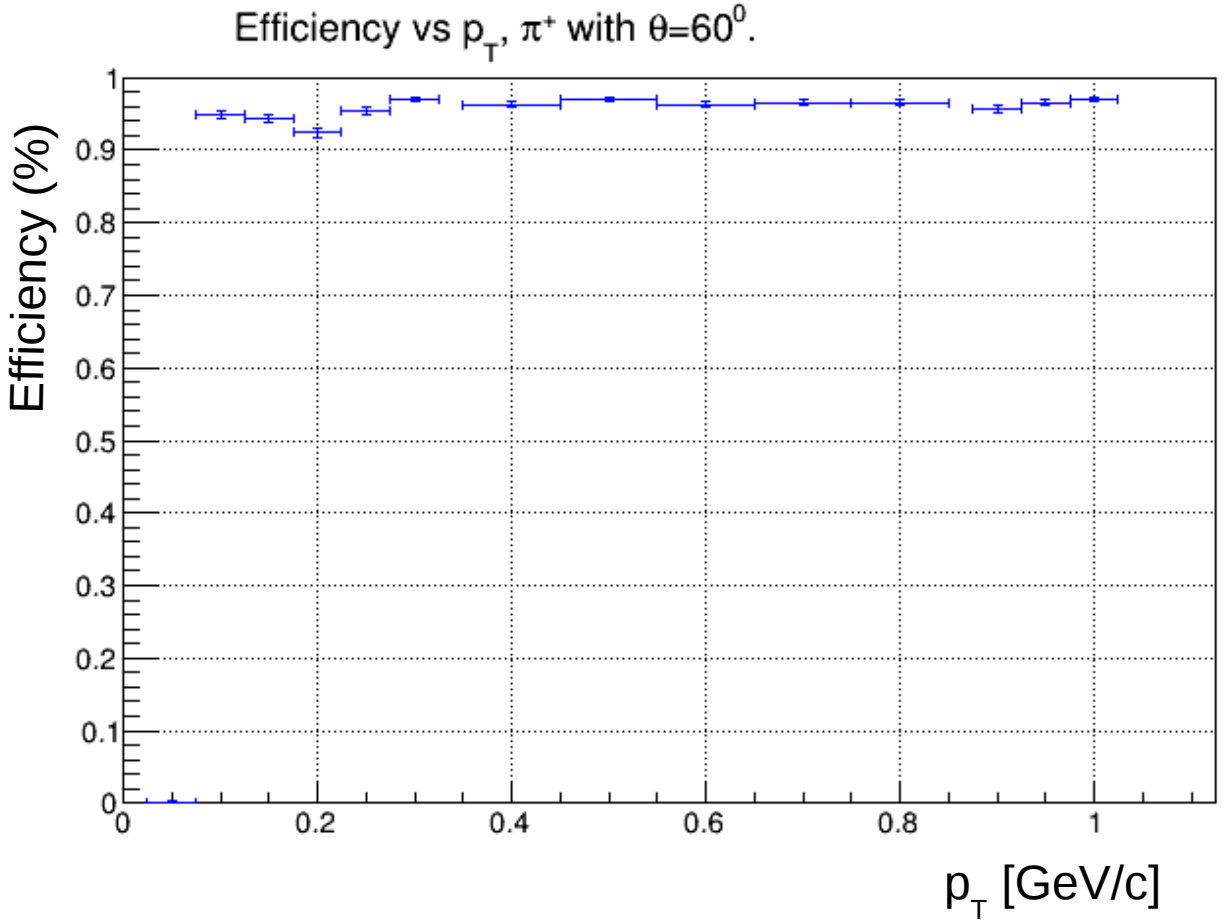
$$\text{Resolution} = var_{reco} - var_{gen}$$

$$\text{Pull} = var_{reco} - var_{gen} / err_{reco}$$

NB> In this talk efficiency – n /N, where N = generated events (2000); n = output of the PID macro

Testing the standard rel-oct14

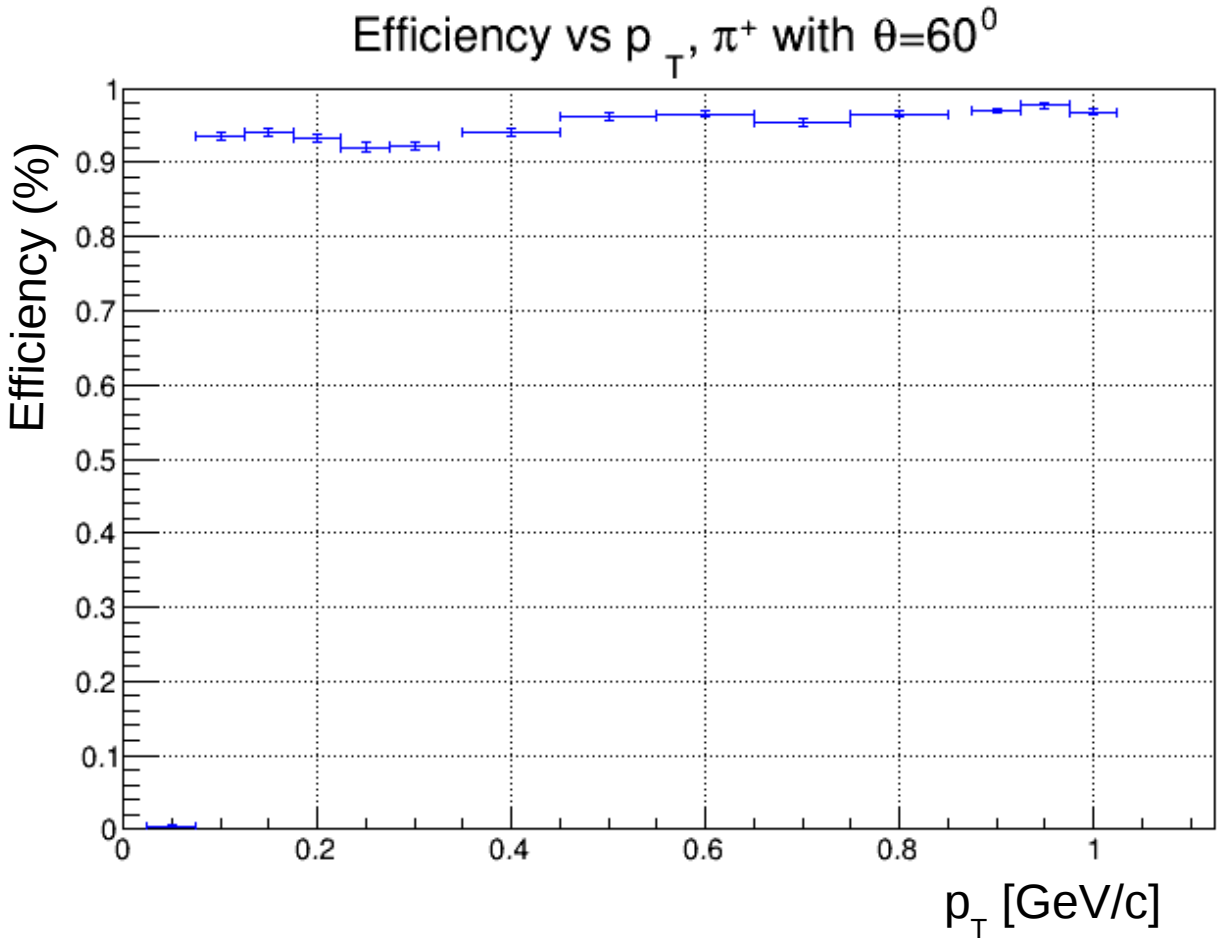
- Hypothesis = pion π^+
- Multiplicity = 1
- P_{beam} = 1.5 GeV/c
- Polar angle: 60^0
- **Ideal track finder**
- **GENFIT (1)**
- Geane trackRep
- Geant4
- Simulated:
  2000 events/point



Half magnetic field due to p<3 GeV/c ⇨ higher efficiency at the threshold. This is expected.

Testing the standard rel-oct14

- Hypothesis = pion π^+
- Multiplicity = 1
- P_{beam} = 15 GeV/c
- Polar angle: 60^0
- **Ideal track finder**
- **GENFIT (1)**
- Geane trackRep
- Geant4
- Simulated:
  2000 events/point



Ideal vs real track finder in PandaRoot

- Interest in running the ideal track finder.

With GF1:

- problems of backward propagation with the real track finder;
- problems of fit convergence with FST;
- problems of geometry overlapping;
- problems in converting GF track to PndTrack;
- problems in finding POCA;
- problems of tracks with p(last hit)>p(first hit).

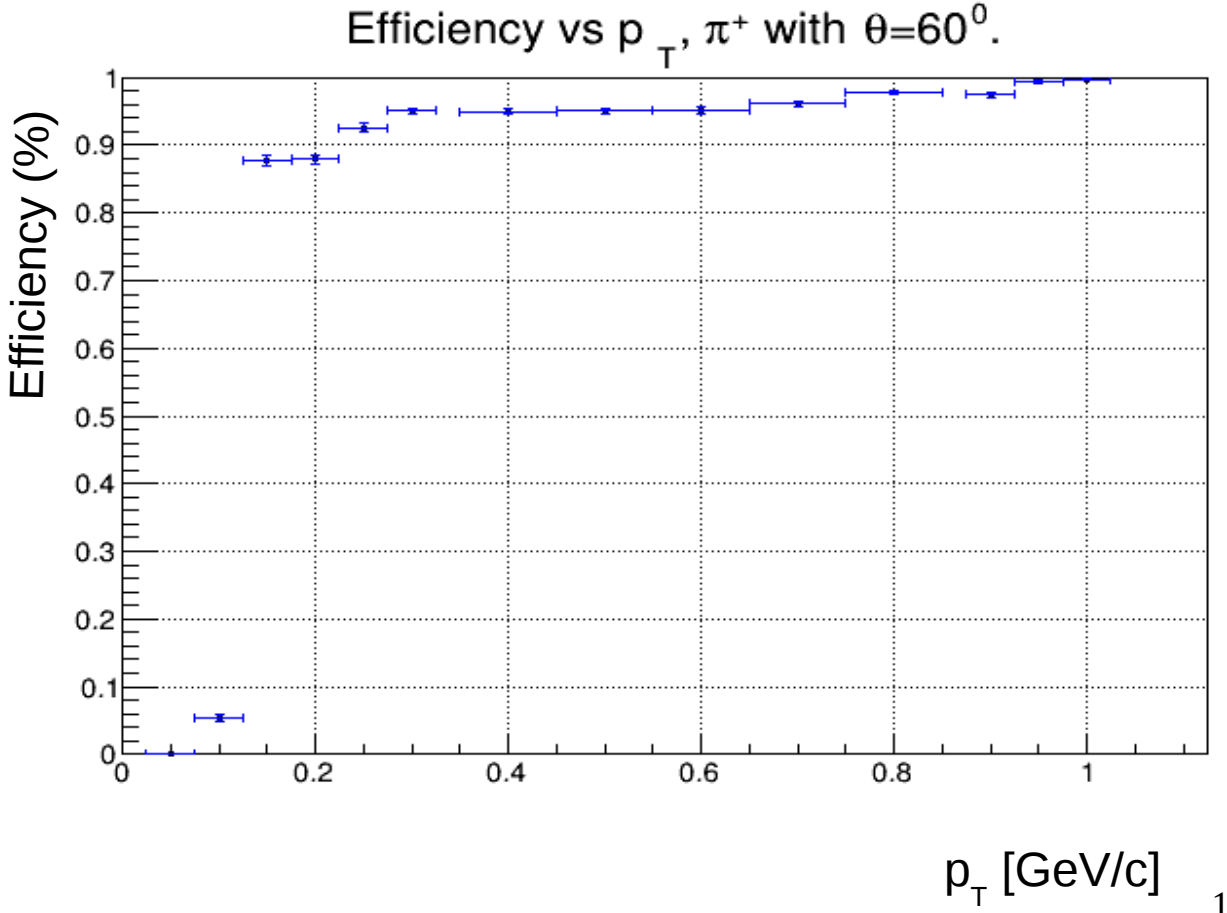
-W- PndPidCorrelator::GetTrackInfo :: Failed backward propagation

This message is observed 1% of times when running the ideal track finder

Testing the trunk rev-26559

- Hypothesis = pion π^+
- Multiplicity = 1
- P_{beam} = 1.5 GeV/c
- Polar angle: 60^0
- **Ideal track finder**
- **GENFIT (1)**
- Geane trackRep
- Geant4
- Simulated:
  2000 events/point

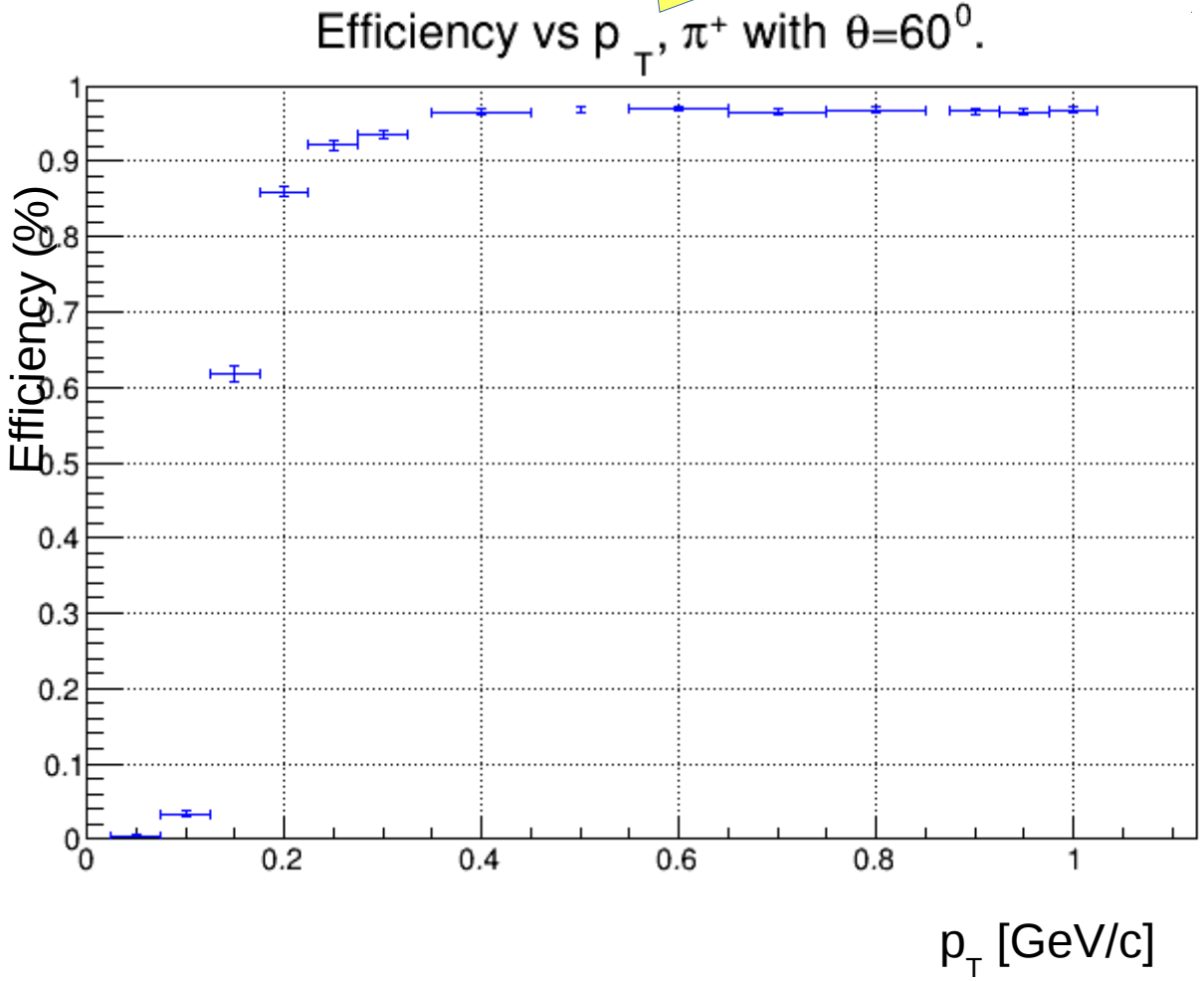
Update: new trunk



Testing the trunk rev-26559

- Hypothesis = pion π^+
- Multiplicity = 1
- P_{beam} = 1.5 GeV/c
- Polar angle: 60^0
- **Real track finder**
- **GENFIT (1)**
- Geane trackRep
- Geant4
- Simulated:
  2000 events/point

Update: new trunk



With ideal track finder I got more yield at threshold

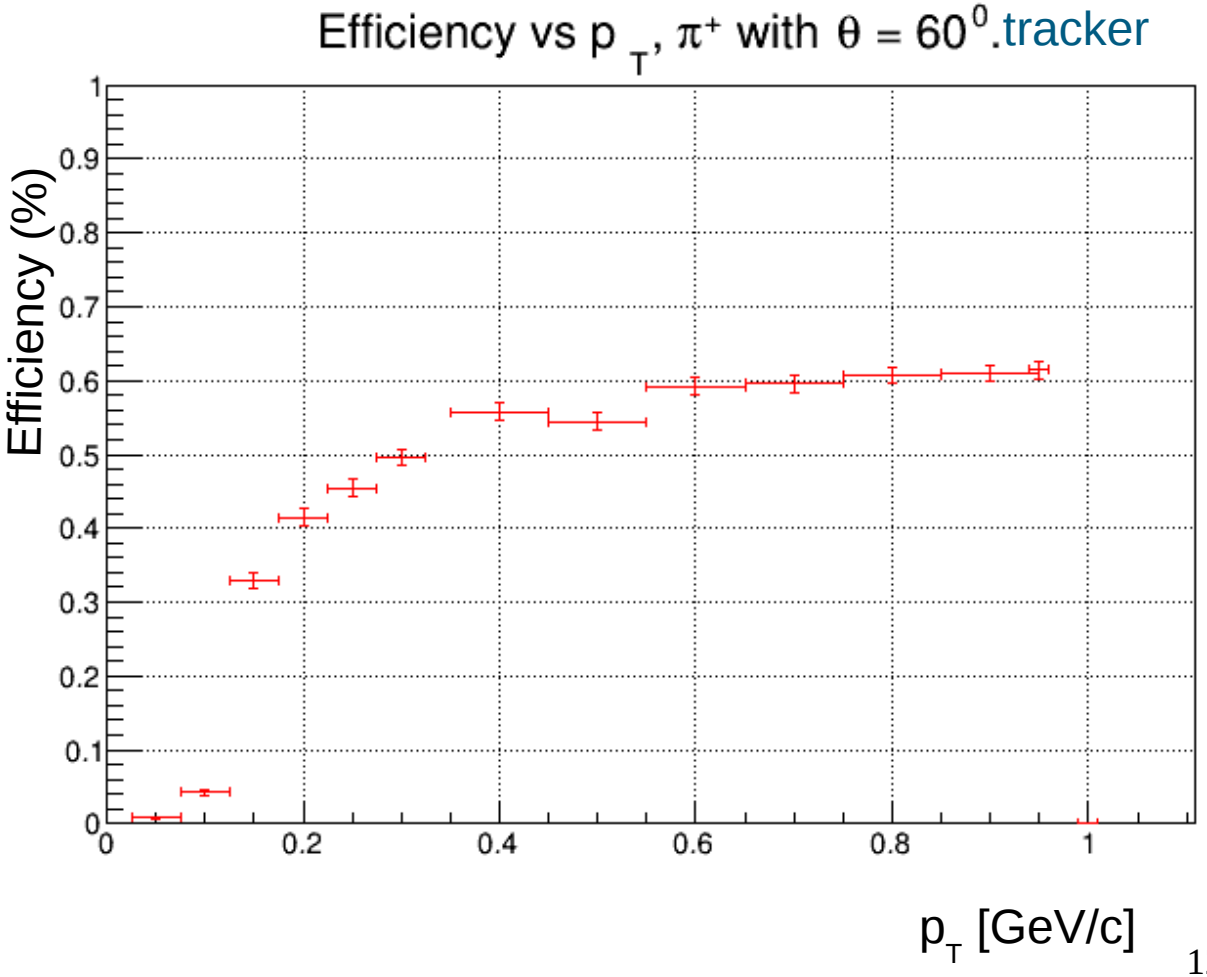
Testing the GF2 rev-26599

- Hypothesis = pion π^+
- Multiplicity = 1
- P_{beam} = 1.5 GeV/c
- Polar angle: 60^0
- **Ideal track finder**
- **GENFIT (2)**
- RK trackRep
- Geant4
- Simulated:
  2000 events/point

When a GF exception occurs, the track is not added

Problem of efficiency lost is observed <u>with the ideal track finder</u>, but....

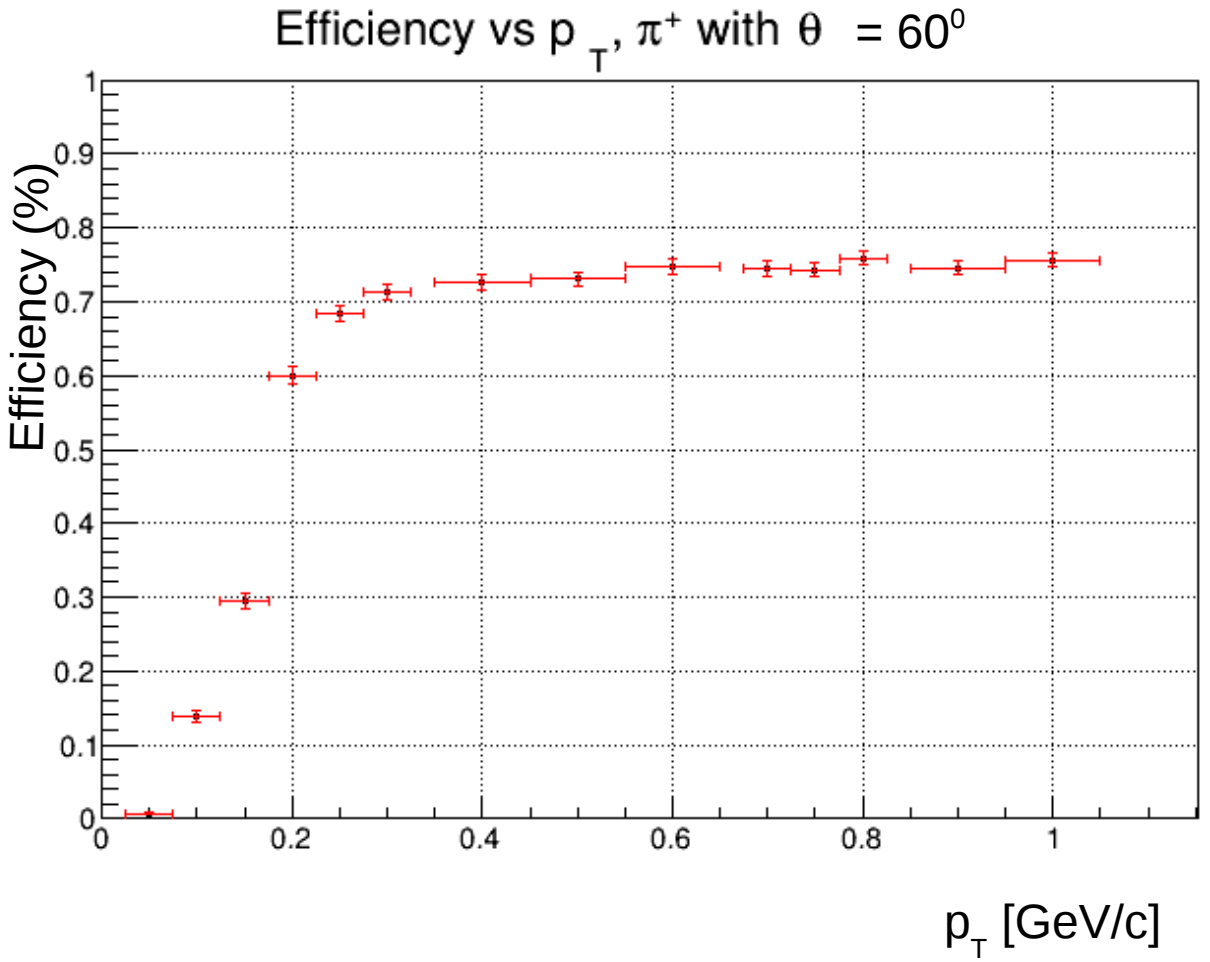
Only Central tracker



Testing the GF2 rev-26559

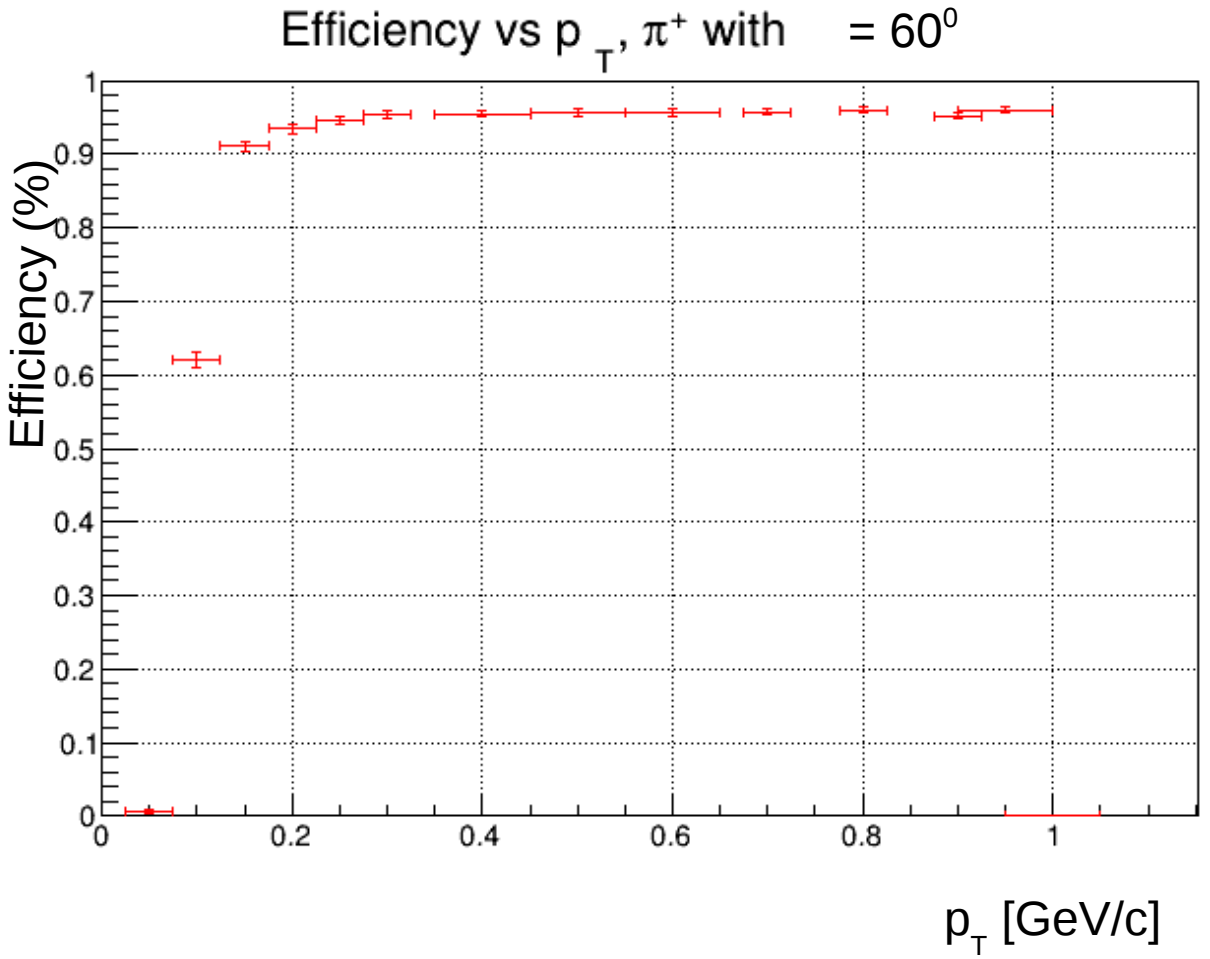
- Hypothesis = pion π^+
- Multiplicity = 1
- P_{beam} = 1.5 GeV/c
- Polar angle: 60^0
- **Ideal track finder**
- **GENFIT (2)**
- RK trackRep
- Geant4
- Simulated:
  2000 events/point

All detectors are included



Testing the GF2 rev-26559

- Hypothesis = pion π^+
- Multiplicity = 1
- P_{beam} = 1.5 GeV/c
- Polar angle: 60^0
- **Real track finder**
- **GENFIT (2)**
- RK trackRep
- Geant4
- Simulated:
  2000 events/point

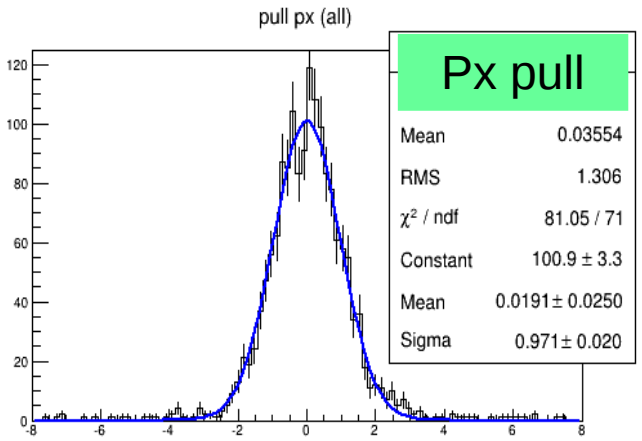


...with the real track finder results look as expected

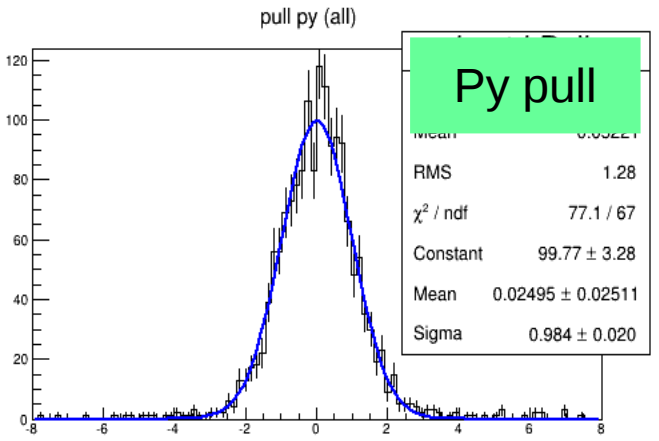
Testing the modified trunk (GF2)

with genfit2

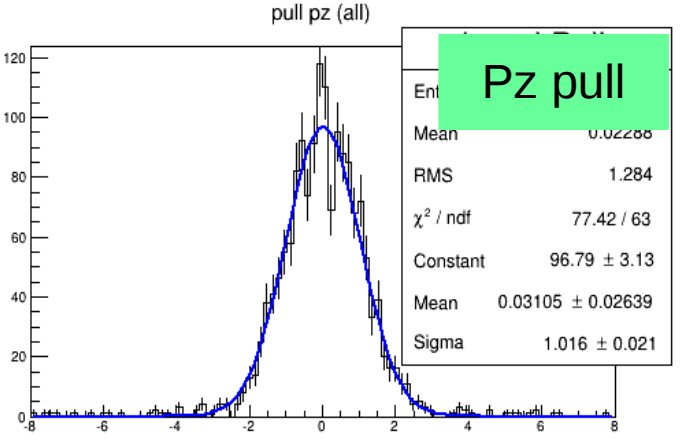
Hypothesis = K^-, p = 1 GeV/c; p_{beam} = 15 GeV/c; PID = "best"; sample: 2500 evt



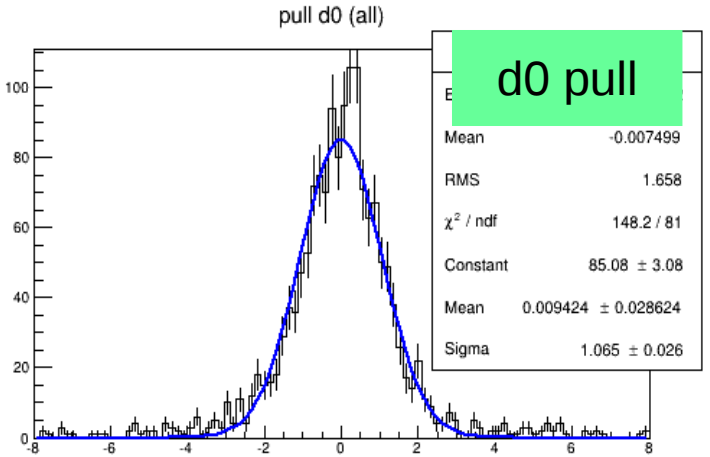
Px pull [GeV/c]



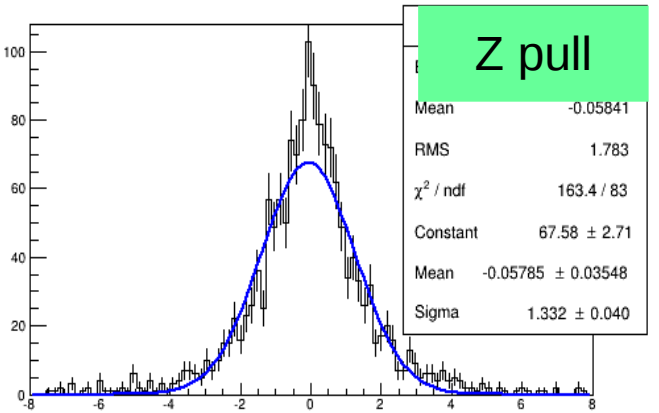
Py pull [GeV/c]



Pz pull [GeV/c]



d0 pull [cm]



z pull [cm]

Comparison on a small sample: 2500 generated events

Pull fit, p = 1 GeV/c	d0	z0	Px	Py	Pz
genfit	0.969±0.025	1.03±0.03	0.969±0.025	1.013±0.031	1.01±0.03
genfit2	1.065±0.026	1.332±0.040	0.971±0.020	0.984±0.020	1.016±0.021

- Real track finder was used for these tests.
- Better precision is shown, better efficiency with real track finder

What has been changed?

For users, nothing: you just continue to use PndTracks
For the computing coordinators, substantial changes.

Comparison: GF1 vs GF2

- Only 1 track representation in GF2: **RKTrackRep**.

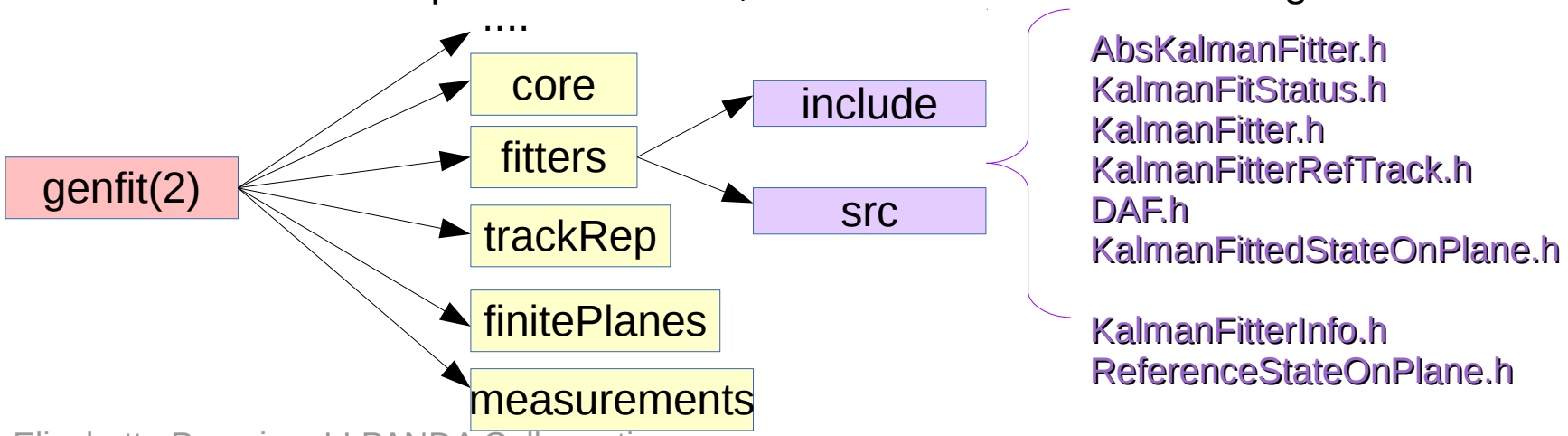
GF2 makes use of the same track representation in the homogeneous and non-homogeneous B field (no helix, no parabola): adaptive step-method is used.

- 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: eliminated in GF2!

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



GF1

GFWirepointHitPolicy.h

GFWireHitPolicy.h

GFPlanarHitPolicy.h

GFSpacepointHitPolicy.h

GFTrackCand.h

GFRecoHitIfc.h

GFAbsRecoHit.h

GFRecoHitProducer.h

GF2

MeasurementFactory.h

MeasurementProducer.h

FullMeasurement.h
PlanarMeasurement.h
SpacepointMeasurement.h
WirePointMeasurement.h
ProlateSpacepointMeasurement.h
WireMeasurement.h
WireTrackCandHit.h

Track.h
TrackCand.h
TrackCandHit.h

TrackPoint.h

Summary

- /genfit2/ has been ported in PandaRoot
- Additional comparison tests with old genfit version have been provided:
  tests on 2500 (single track) events show improvement
- Different mass hypothesis are tested in rev-25545, at different mom. values
- Last point to define: run correctly with the ideal track finder
- Please, help to check your analysis with genfit2 and report troubles
- A document with all tests performed on 100 000 events will be provided
  (give me time to do this....)
- Do we like to introduce genfit2 in pandaroot?

THANK YOU for your attention!

"The greatest danger for most of us lies not in setting our aim too high and falling short; but in setting our aim too low, and achieve our mark." (Michelangelo, 1475 - 1564)