Implementation of Genfit 2 in PandaRoot

XLVIII $\bar{\text{P}}$ANDA Collaboration Meeting

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Generalities

- What is Gentfit?

“General tool for track fitting, usable in a wide range of experiments, independent on the specific event topology, detector setup, magnetic field arrangement”

- Where do we find the documentation? (old version, genfit-1)

NIM A, Vol 620, 518-525 (2010)
Authors: C. Hoppner, . Neubert, B. Ketzer, S. Paul

Online site: genfit.sourceforge.net/Main.html

- Announced update of genfit available
  How/where to download the standalone version of genfit-**2**?
  svn checkout svn://svn.code.sf.net/p/genfit/code/branches/genfit2

Version checked here: rev-1582
Standalone genfit2 rev-1582 tested on **Fedora19**

It works!

Genfit1 vs Genfit2

- Genfit provides Kalman equations, Runge-Kutta equations

- A particle is described by a set of track parameters + cov. matrices
  They give a position along the track
  Track parameters are defined in reference planes (physical or virtual)
  Extrapolation of the track parameters
  Track representation + track extrapolation functionality = track representation
  Different track representations can be used in parallel in *genfit*

- Main difference with genfit1: no more *reco-hits*. We have *track-points*

In Genfit1: the object which represents a position measurement from a detector used in the track fit was called ***reconstruction hit*** (*GFRecoHitIfc; GFRecoHitFactory*)

In GenFit 2: hit reconstruction is not used; we have ***track points***, instead, defined by the information of x, y, z, px, py, pz, θ, ϕ (*SpacePointMeasurement; MeasurementFactory*)

Problems found in Genfit1

- Example from the analysis $p\bar{p} \rightarrow D_s^- D_s(2536)^+$

1. A % of tracks with low *p* in the MVD are found with p ~20 GeV/c in the STT

~4% of tracks in this analysis have p =0 in the MVD, and few GeV/c in the STT
It is a bug, of course!
This produce troubles when calculating the curvature of the track $\omega = q/p_t$
This problem has been found in a GEANE routine, but it is a bug in Genfit
In the old version of Linux-Fedora: a crash.
In Linux-Fedora19: an warning message is seen, but the job is successful:

*** ERTRGO *** Boundary loop: track 1 stack 0 NTMULT 0 PION -
Precision now set to 0.250E-04

2. GenFit1 does not provide a track representation
Genfit2 intends to propose a RK track representation, replacing the one in GEANE

Kalman gain: basic idea

Without magnetic field *B*, the vector state representing the track is: $(u,v,du/dw,dv/dw)^T$

vector u and v span the detector plane
$\bar{w} = \bar{u} x \bar{v}$

With the uniform magnetic field, the vector state representing a track is:
$(q/p,u,v,du/dw, dv/dw)^T$

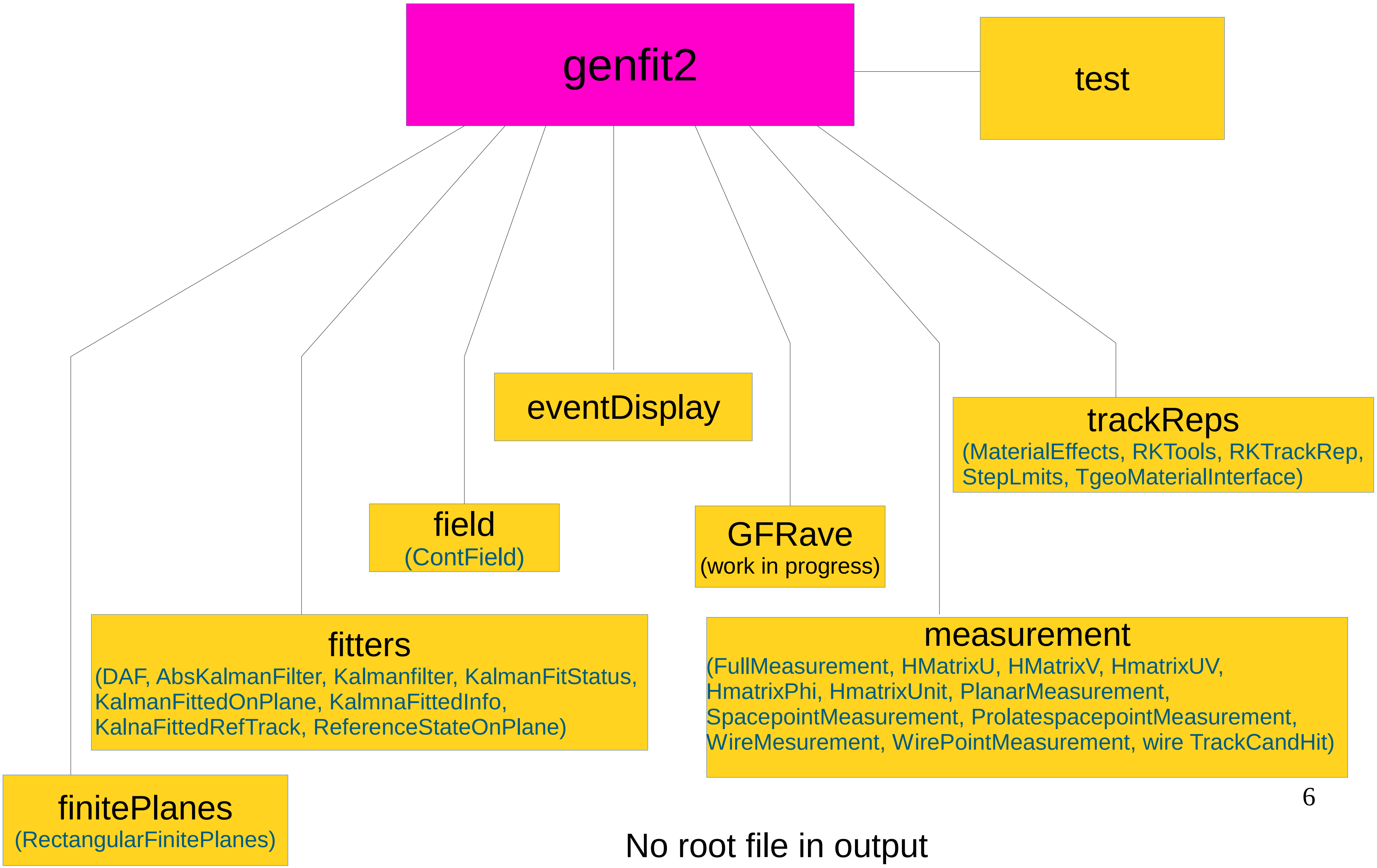
5 parameters
Matrix: 5x1

The ***track point*** contains the vector of the raw measurement coordinates and its corresponding covariance matrix ***C***.
A track point provides its detector plane, the measurement coordinates $\bar{\boldsymbol{m}}$ in the detector plane coordinate system, the covariance matrix ***V*** in the detector plane coordinate system, the projection matrix ***H*** to the fitting algorithm

$\bar{x}_k = \bar{x}'_k + K_k \bar{r}'_k$ $\quad$ $\bar{r}'_k = \bar{m}_k - H_k \bar{x}'_k$ $\quad$ r is the residual, updated

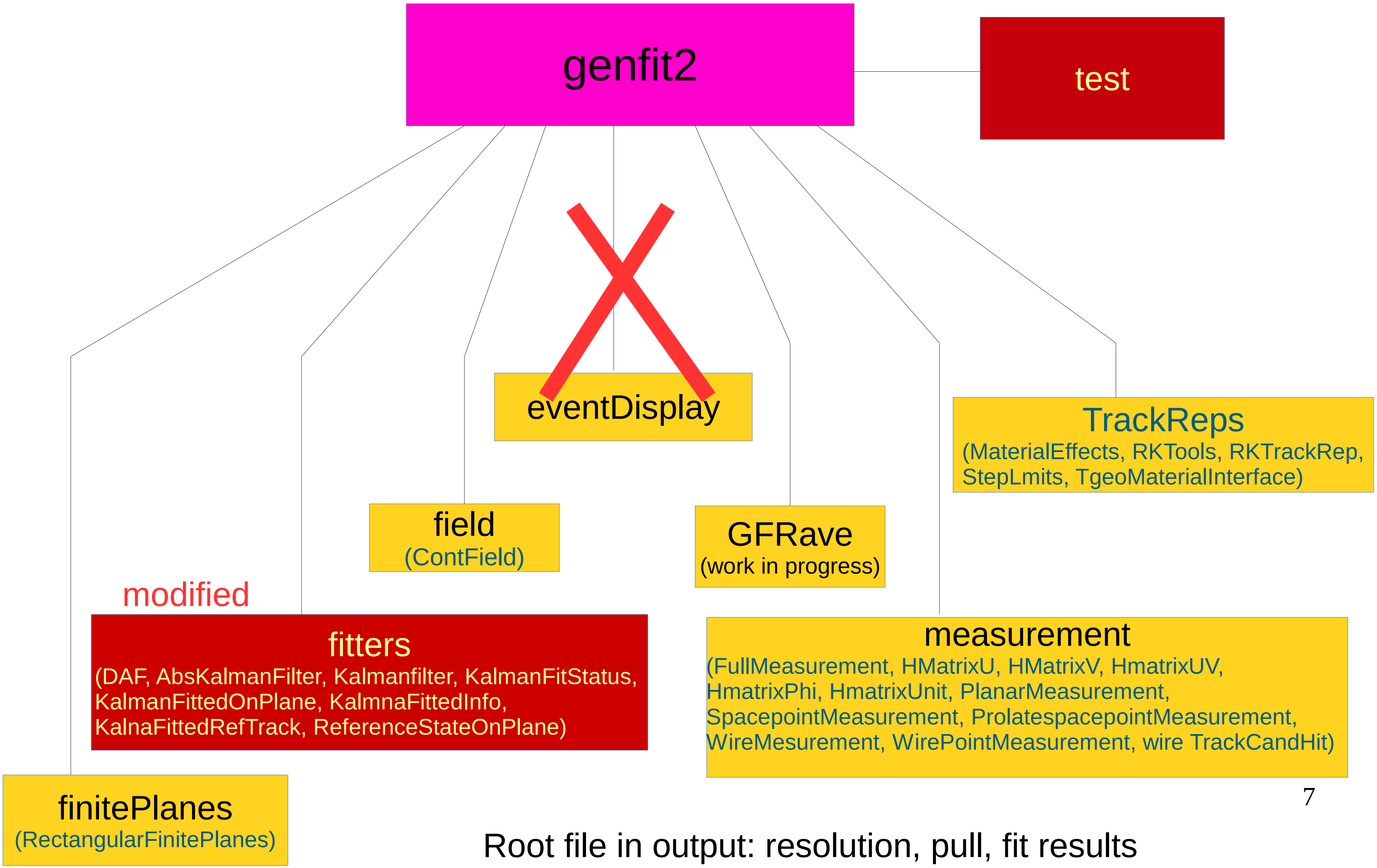
$C_k = (1-K_k H_k) C'_k$ $\quad$ $K_k = C'_k H^T_k (H_k C'_k H^T_k + V_k)^{-1}$ $\quad$ K is the Kalman gain

Structure of the tool



No root file in output

Structure of the tool - modification



Root file in output: resolution, pull, fit results

How to run this tool

1. Set up ROOTSYS to your <SIMPATH>
   Set up VMC to your <SIMPATH>

2. Open the file /genfit2/CmakeLists.txt and comment out "GBL".
   It is not used for the time being, and the path of this math library is different from what is proposed, in ROOT >v.5.30
   Remember to comment out the GBL* libraries in /genfit2/test/fitterTests/main.cpp

3. Create a folder "build" from where to compile genfit2:
   cmake ../genfit2
   make
   make tests (*)

(*) First: you open folder /genfit2/test/ and run the geometry macro: makeGeom.C
This will create the output file **genfitGeom.root**
Move the new root file in /build/bin/
Now you are ready to run your example macros from /genfit2/build/bin/

4. From the folder /build/bin/ you can run your executable files:

fitterTests measurementFactoryExamples minimalFittingExample streamerTest unitTest
(minimal configuration for a demonstration)

NOTE:

Genfit2 does not give root files as output if you run *fitterTests*
It works with an interactive graphic interface, with many options to set up
Events are flagged, so easy to identified
The Kalman fit is applied in both directions, one time inward, one time outward

A modification was done by myself: graphic mode is commented out, and a root file is saved
With the information of the Gaussian fit of the pull distribution of the 5 tracking parameters

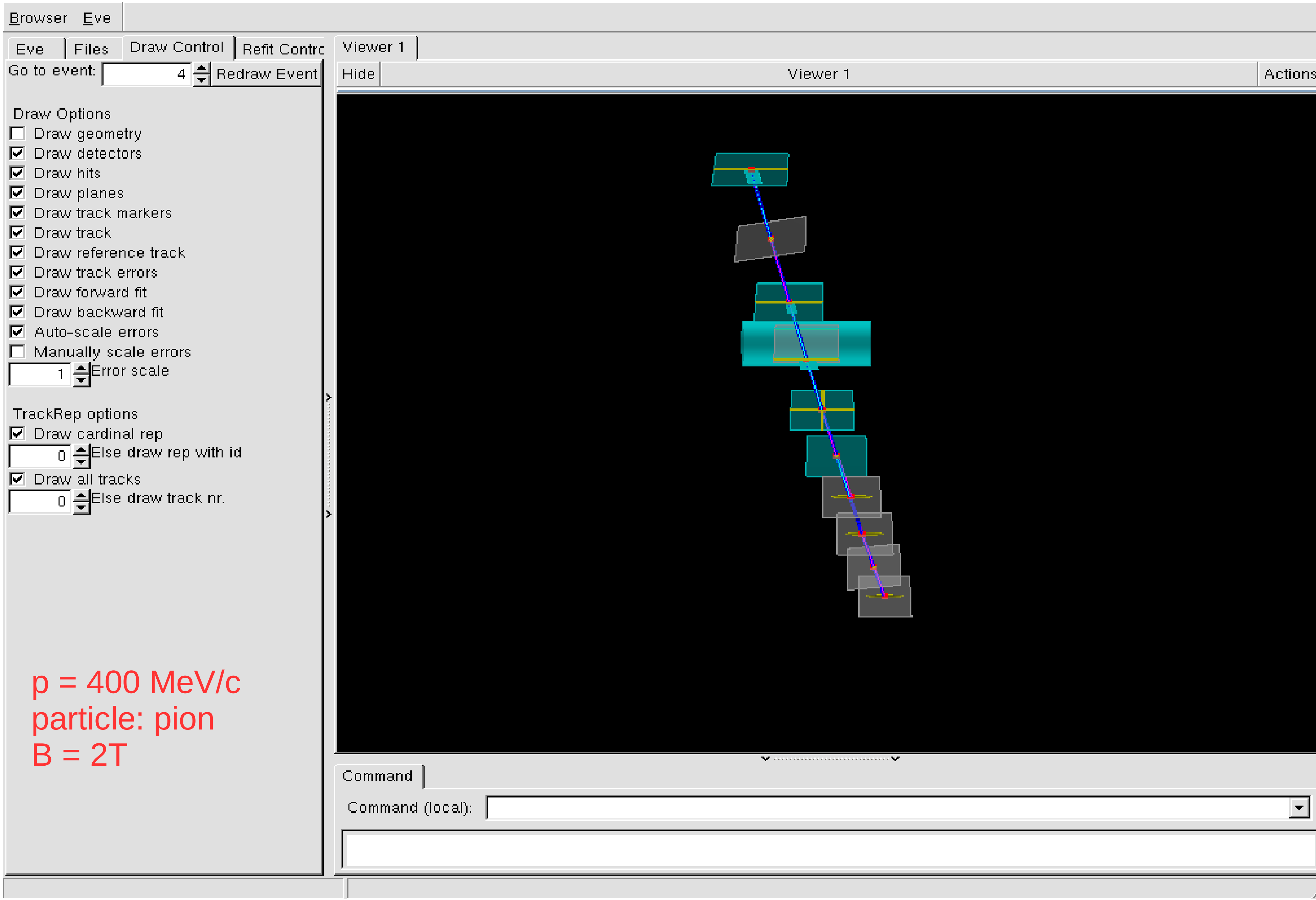
A problem of memory leak was found last week in rev. 1578. Now it is fixed, and 1M events can run ~2h (rev: 1582)

Still no documentation available

Examples

- In the folder **test**, a README file is available, and several examples

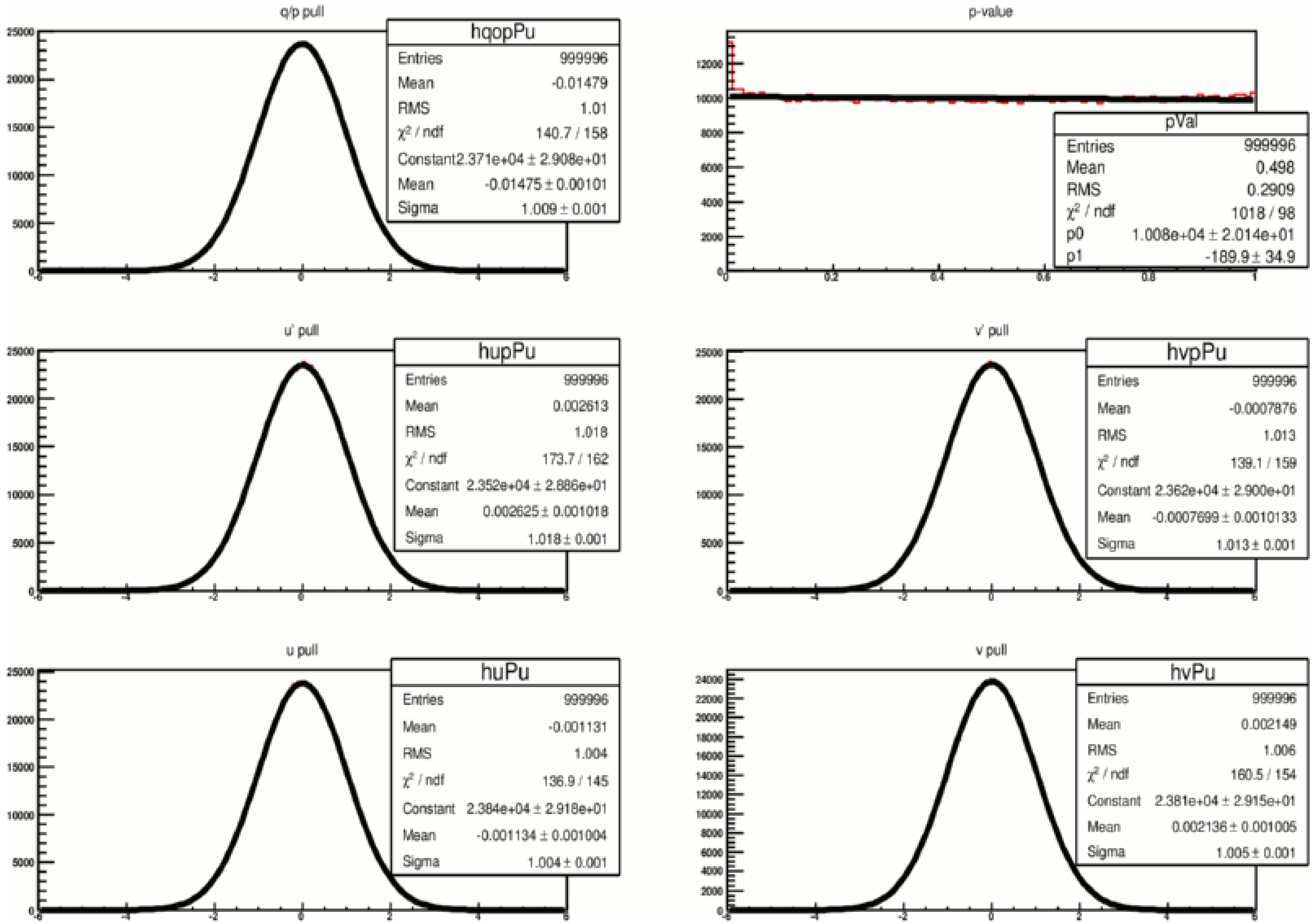
- fitterTests
- measurementFactoryExample
- minimalFittingExample
- streamerTest
- unitTests
- vertexingTest



p = 400 MeV/c
particle: pion
B = 2T

- FitterTest, run on 1M events: pull
- It is possible to set up:
  Particle mass hypotesis
  Momentum of the beam
  Magnetic field

PANDA detector conditions are in



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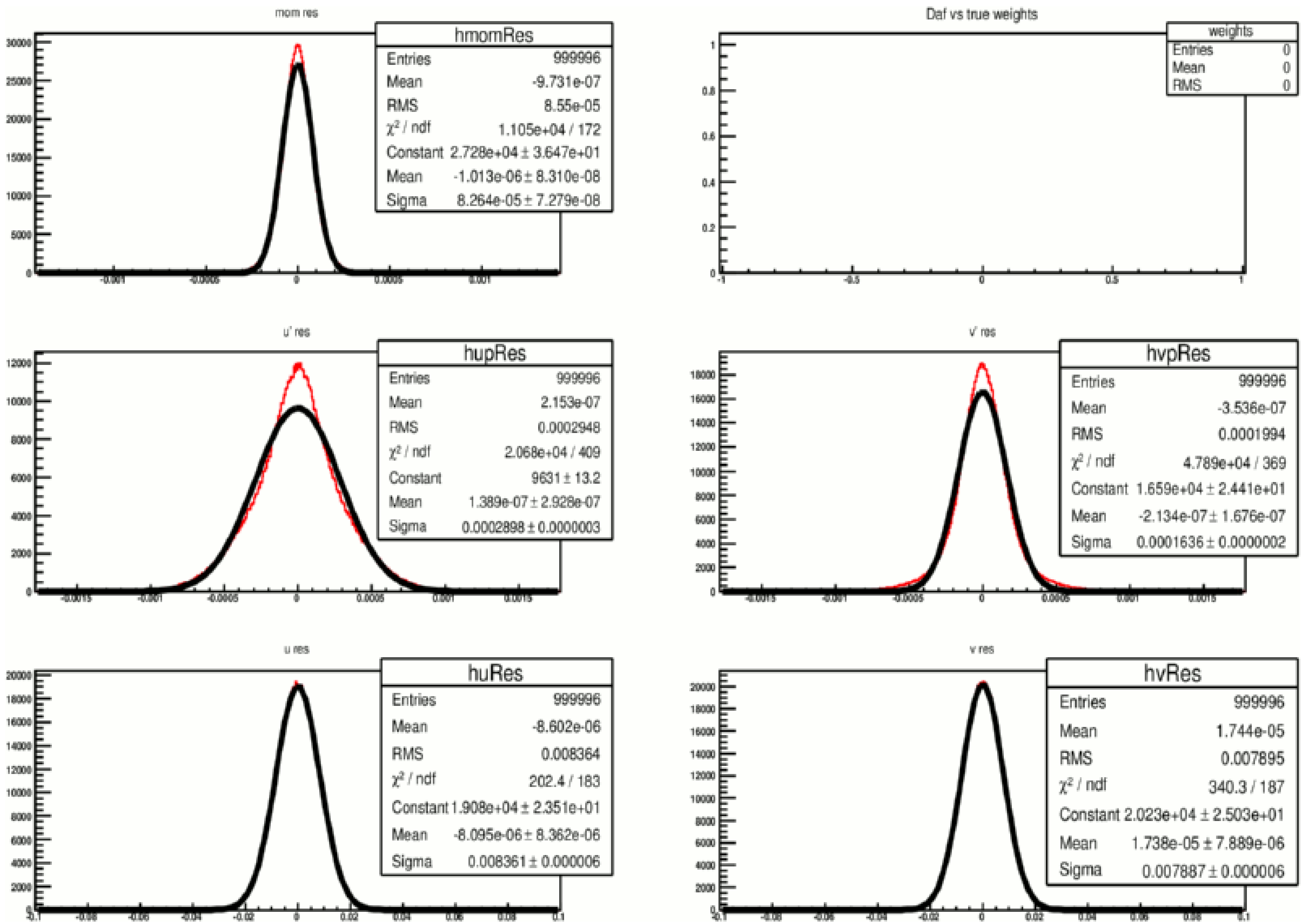
- FitterTest, run on 1M events: resolution
- In this particular example p =100 MeV/c, particle = pion



Genfit2 in pandaroot

- PandaRoot version: release jan14
  - Some troubles found in the covariance matrix calculation

/home/prencipe/panda/pandaroot3/genfit2/

```
[prencipe@pool-254-22-zam037 genfit2]$ ls
cmake                        CMakeLists.txt   extern          GBL                SConstruct    utilities
CMakeLists_panda.txt         core             fields          genfitLinkDef.h    makeEnv.sh    test
CMakeLists_standalone.txt    doc              finitePlanes    measurements       trackReps
                             eventDisplay     fitters         GFRave             README.build  UML
```

2 CmakeList files are built to interface Genfit2 to PandaRoot: still something to fix

- Goal that I want to reach: to track particles with p<400 MeV/c
- Cooperation with Johannes Rauch and Tobias Schülter (TUM)

Plans

- For June 2014 GenFit2 will be working in PandaRoot
- I will provide test examples and a comparison with Genfit1

This is the beginning....

"Genius is 1% talent and 99% hard work" (A.E.)

THANKS!