Refitting Tracks from DST

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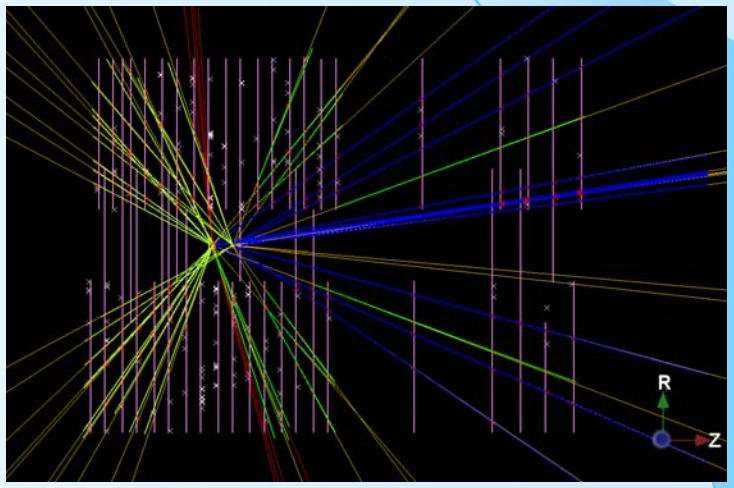
- ***Motivations***
- ***Step-by-step …***
- ***Current Performance***
  - ***Tests with Brunel v30r12***
- ***Outlook***



Motivations

Reconstruction and Physics

- **Refitting tracks is a necessity in real world analyses**
  - e.g.: needed after improvement in knowledge of alignment

Event Model

- **One of the reasons for the track event model review in 2004-5**
  - Nobody knew how to refit tracks from DST with the old event model

- **Ability to refit was a request to us**

… WAS STILL AN UNTACKLED ISSUE …

Setting the Scene (1/3)

In Brunel …

- **Whole of the tracking sequence:**
  - ***Pattern recognition***
  - ***Track fitting***
  - ***Clone killing***
  - ***tracks stripped of non-persistent information***
    - left basically with LHCbIDs and flags

  → job done with the "*TrackToDST*" algorithm

… saved on the DST

- **Container of "BEST" tracks**

Setting the Scene (2/3)

Two "kinds" of refitting

I. **Refit a single track**

- *probably mostly useful for tests, special studies, etc.*
- *Note: can also be done in Python … can show interesting things …*

II. **Refit all tracks in a container**

- *the common situation, I guess*

- **Solving situation II implies solving I**
  - *options to refit a track simply applied on the set of container tracks*

Setting the Scene (3/3)

Refitting tracks from DST

- **Read the cocktail of tracks in the "best" container**
- **Separate them back accordingly, in their original containers**
  - ***Rec/Track/Forward, Rec/Track/Match, etc.***
- **Refit per container with appropriate options**
  - ***options depend on the track type!***

→ **Need for a new algorithm …**

✓ ***New TrackFromDST algorithm in Tr/TrackUtils***

- classifies the tracks given as input according to their History / pattern recognition algorithms, i.e. remakes the PR algorithms produced in Brunel
- BUT: all clones are gone! Not quite the same containers …

First Blind Tests (1/2)

Home-made DST

- **Minimalistic Brunel job – only tracking**
  - ***still done in Brunel v30r10***

Refit tracks from DST

- **Can do study in (at least) 2 ways:**
  - **in DaVinci**
  - **with a standalone / simple Gaudi job**
  - **opted for a standalone Python script**
- **New *DaVinciRefitting.opts:***
  options file with "refit" process phase ***(details given later)***
- ***own code to match "Brunel original's" to refitted tracks***
- ***and then compare the outcome …***

First Blind Tests (2/2)

Looking first at Long tracks from PatForward

- **Same fitting options as in Brunel!**
- **Got many messages of the kind:**

FitForward.Fitter.RefInfoTool WARNING LongTrackReferenceCreator:: No Velo State StatusCode=FAILURE

Tool to set reference info. on « Long » tracks

- ***At the end of the job:***

```
FitForward     INFO ====================== TrackEventFitter Summary ======================
FitForward     INFO   Fitting performance   :    99.60 %
FitForward     INFO                              (   9604 /   9643 tracks )
FitForward     INFO ============================================================================
```

Conclusions:

- ***All these tracks had been successfully fitted in Brunel***
  - ***by construction, since they were taken from the "best" container***
- ***This first result is encouraging, but not good enough …***
- ***Let's have a look at the reference information tools …***

First Improvements (1/2)

- ✓ **Tr/TrackTools**
  - ➢ **LongTrackReferenceCreator:**
    - *Adapted so that it can be used for tracks from DST, i.e. without "EndVelo" and AtT" states – these are only available in Brunel*
    - *… now it takes closest states*
      - *improvements do not influence behaviour in Brunel*

Reference information tools for refitting:

- ❖ *In Brunel we have for now tools for only Long and seed (Tsa) tracks*
- ❖ *Tool for Long tracks successfully adapted/generalised*
  - *LongTrackReferenceCreator*
- ❖ *Tool for Tsa seed tracks cannot be used for now outside Brunel*
  - *Accesses pattern recognition intermediate information*
  - *We could/should make the tool flexible for refitting applications*
  - *Or make a new dedicated tool*
- ❖ *Tools for VeloTT and KShort fitting would be desirable …*

First Improvements (2/2)

The special case of Velo tracks:

- ***In Brunel they are "prepared for fitting"***
  - ***Get a P_T of 400 MeV***
  - ***P set accordingly, depending also on slope***
- ***Are prepared only those Velo tracks that are not ancestors of tracks in the "best" container***
- ***For other purposes/tests it can be handy not to take into account the "best" container …***

✓ **Tr/TrackUtils**

- **TrackPrepareVelo:**
  - ***modified so that Velo tracks ancestors of tracks in the "best" container can also be "prepared"***

Refitting Options

- **For now all in a file: *DaVinciRefitting.opts***
  - **“Refit” process phase**
  - ***Loading of all necessary libraries***
    - *tracking-related libraries*
    - *libraries for general needed tools (e.g.: cluster position tools)*
  - ***Remake all original containers from the “best” container***
  - ***Decoding of all tracking detectors – needed for track fit***
  - ***Refitting of all containers***
    - *with dedicated options according to track type*
    - *same options as in Brunel (except for ref. tools – see comments before)*

Second Round of Tests (1/2)

Some words on technical details

- **Reference information set only for Long tracks**
  - *tracks from PatForward and TrackMatching*

```
FitForward     INFO ====================== TrackEventFitter Summary ======================
FitForward     INFO   Fitting performance   :   100.00 %
FitForward     INFO                         (   9643 /   9643 tracks )
FitForward     INFO ================================================================

FitMatch       INFO ====================== TrackEventFitter Summary ======================
FitMatch       INFO   Fitting performance   :   100.00 %
FitMatch       INFO                         (   6461 /   6461 tracks )
FitMatch       INFO ================================================================
```

Much better !

- **Testing on other track types as well …**

Second Round of Tests (2/2)

```
FitVeloTT     INFO ====================== TrackEventFitter Summary ======================
FitVeloTT     INFO   Fitting performance   :    99.86 %
FitVeloTT     INFO                              (   2138 /   2141 tracks )
FitVeloTT     INFO ========================================================================
FitTsaSeed    INFO
FitTsaSeed    INFO ====================== TrackEventFitter Summary ======================
FitTsaSeed    INFO   Fitting performance   :   100.00 %
FitTsaSeed    INFO                              (  11000 /  11000 tracks )
FitTsaSeed    INFO ========================================================================
FitKShort     INFO
FitKShort     INFO ====================== TrackEventFitter Summary ======================
FitKShort     INFO   Fitting performance   :    99.91 %
FitKShort     INFO                              (   6483 /   6489 tracks )
FitKShort     INFO ========================================================================
```

- **Also encouraging**
  - **some fit failures left to be investigated later …**

Comparisons - Setup

Home-made DST

- **Minimalistic Brunel job – only tracking**
- **Now done in Brunel v30r12**
- **Extended DST:**
  has linker tables to be able to re-associate tracks

Refit tracks from DST

- **Extended standalone Python script**
- **same *DaVinciRefitting.opts***
- ***own code to match "Brunel original's" to refitted tracks***
- ***Tracks re-associated to MC truth***
- ***comparisons to same Brunel original track and MC truth***

Comparisons - Explanations

Brunel

- **Track's original value in Brunel**

DV

- **"DaVinci" value, i.e. value after track refitting**

X (DV – Brunel)

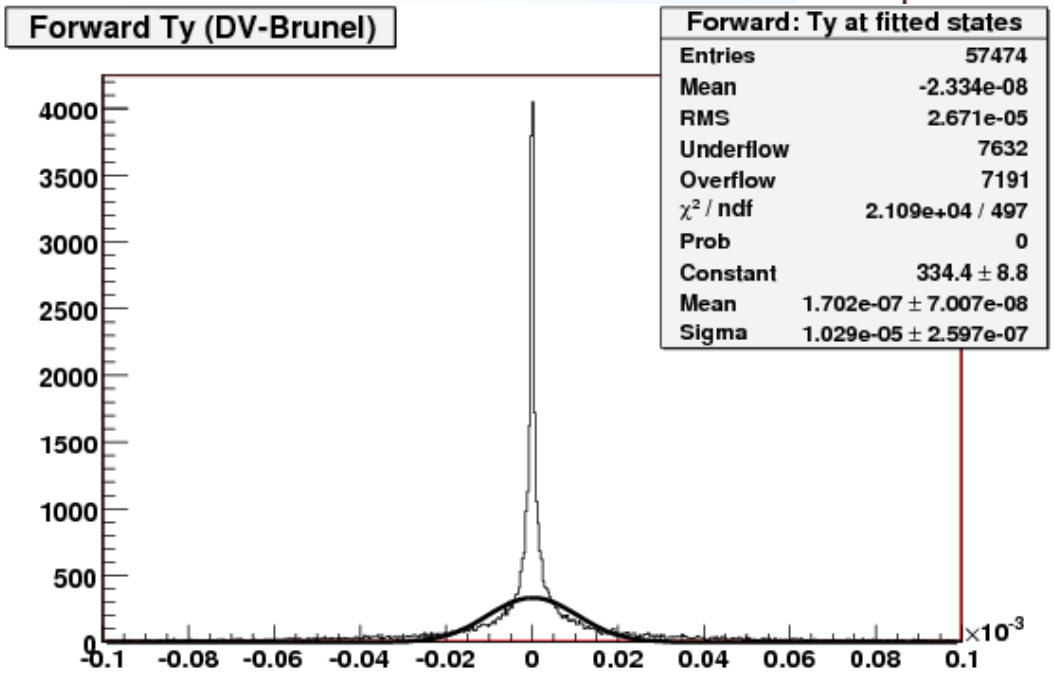
- **Resolution in variable "X" – comparison refitting/fitting**

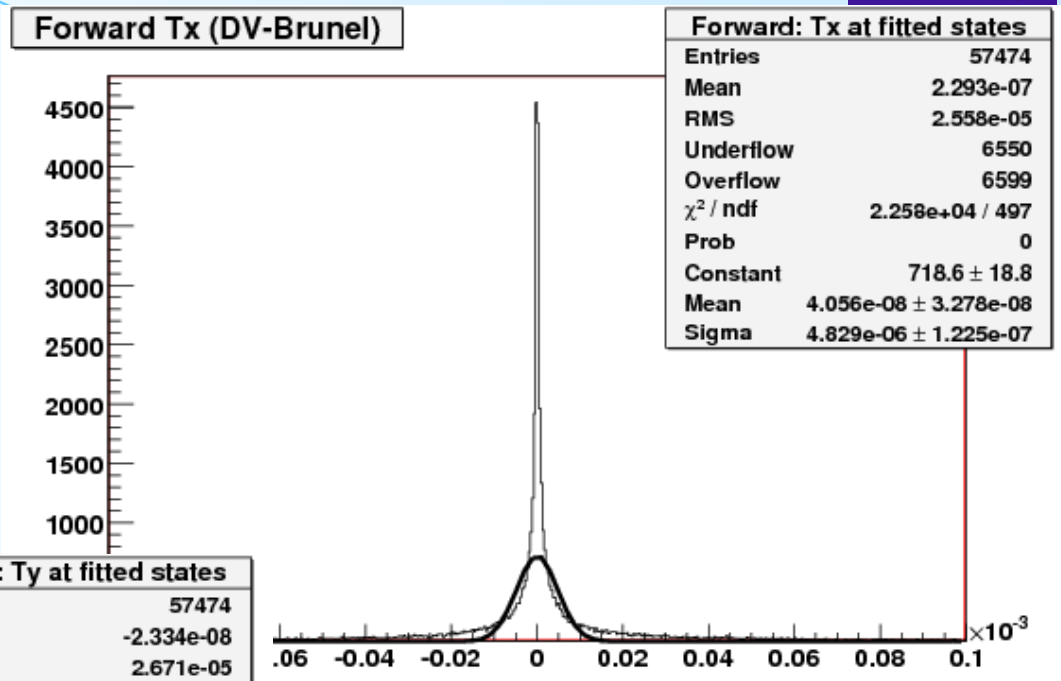
Plots for x, y, t_x, t_y:

- **Variable comparison looping over all states on the track**

Comparisons - Long Tracks (1/6)

Very good agreement in slopes



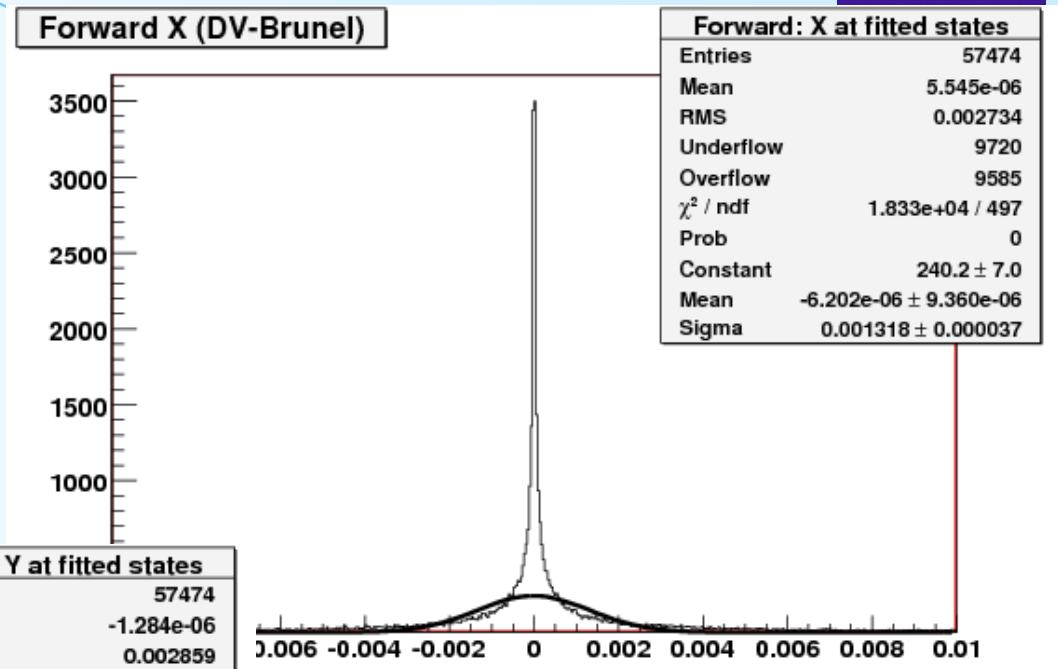


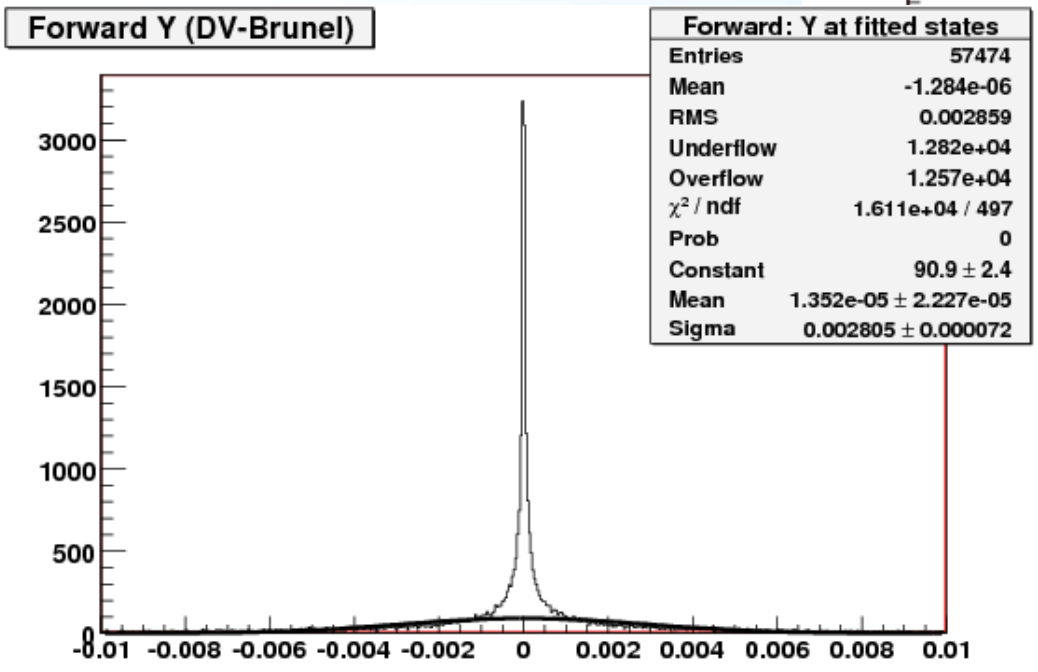
Tails to be understood

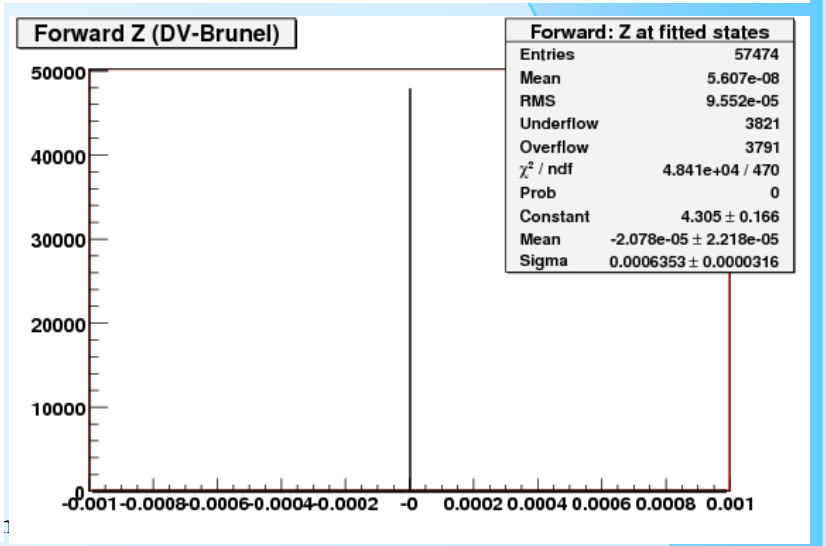
Comparisons - Long Tracks (2/6)

Very good Agreement in positions ~1-2 μm

... looping over Velo/TT/OT/... hits!

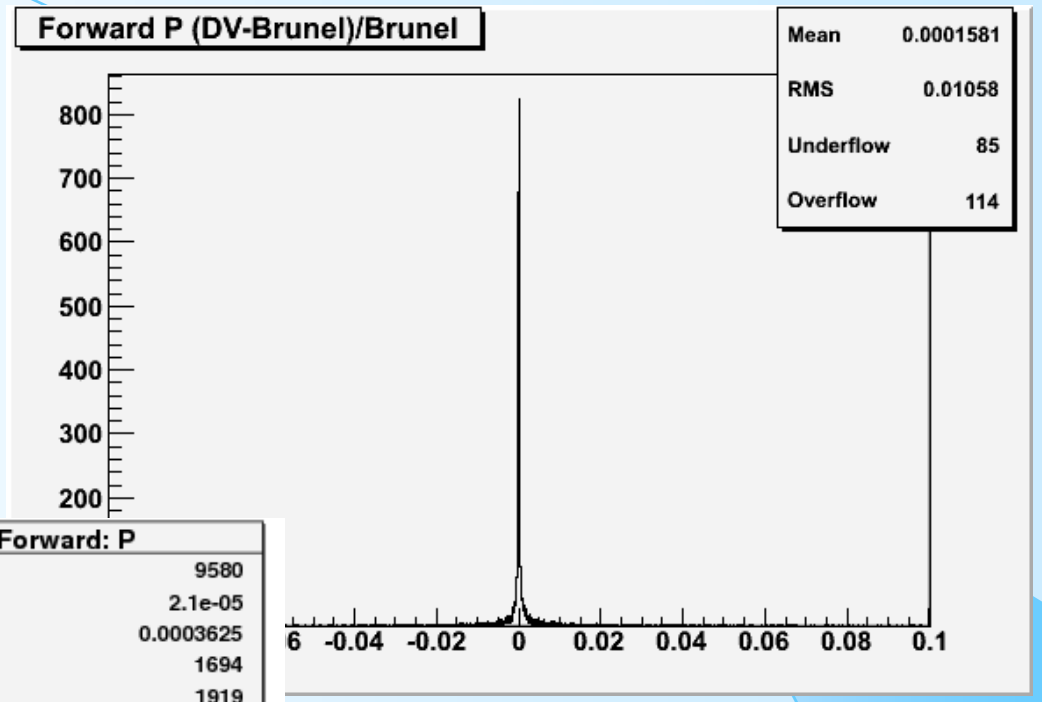


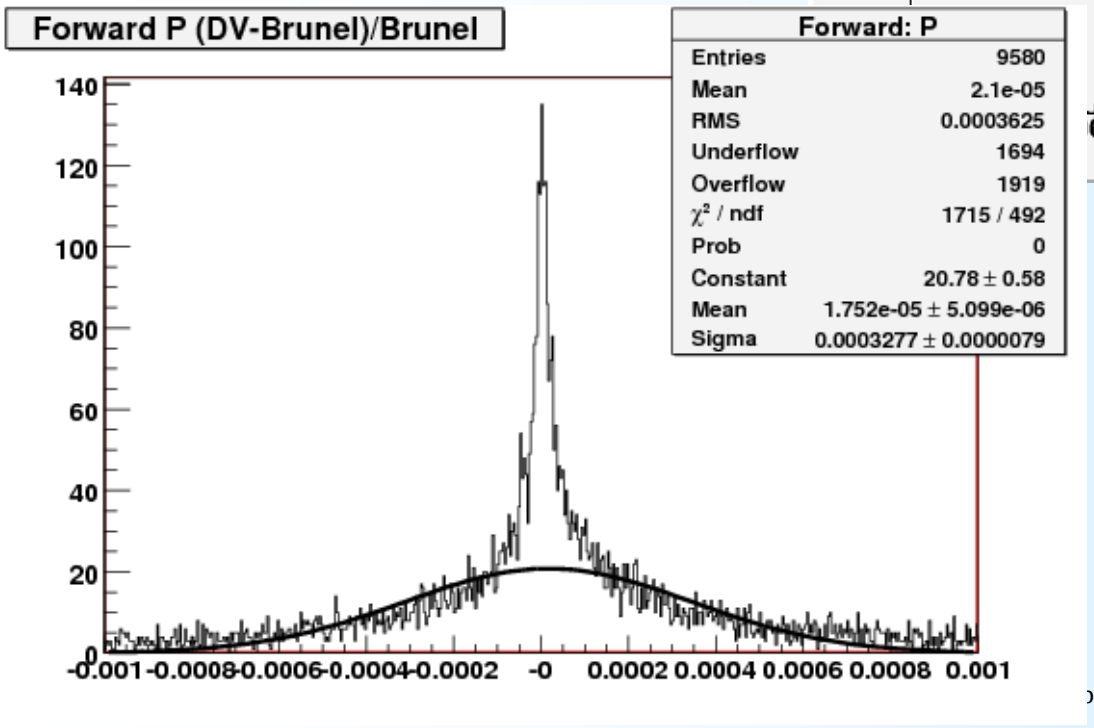




Comparisons - Long Tracks (3/6)

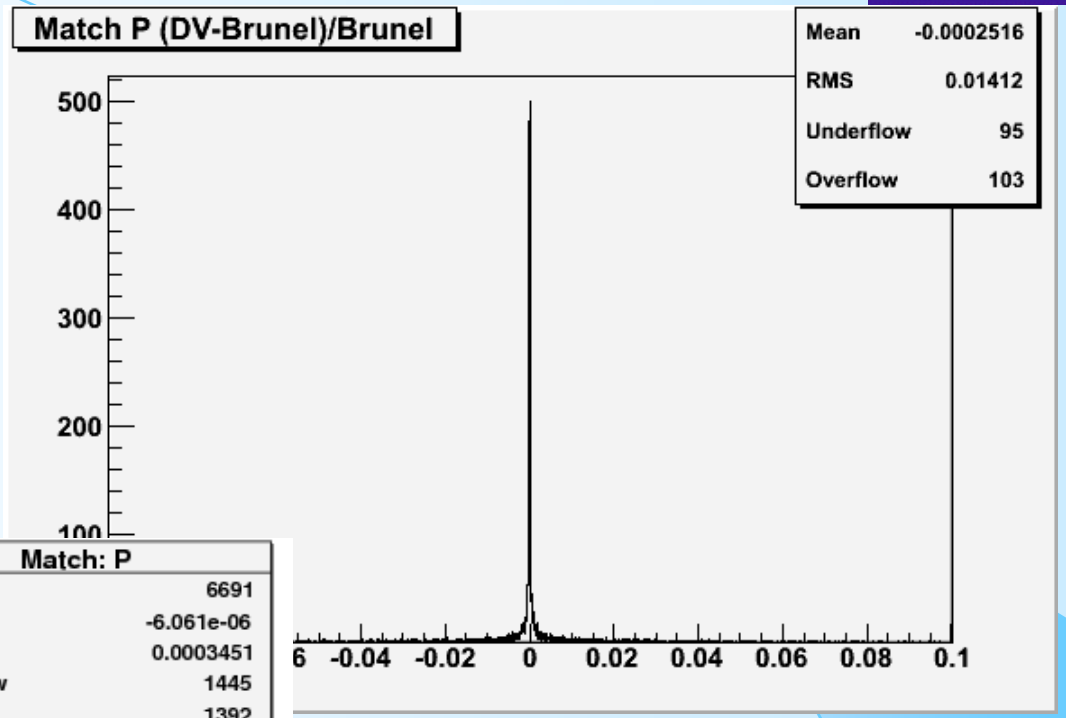
Very good agreement in momentum

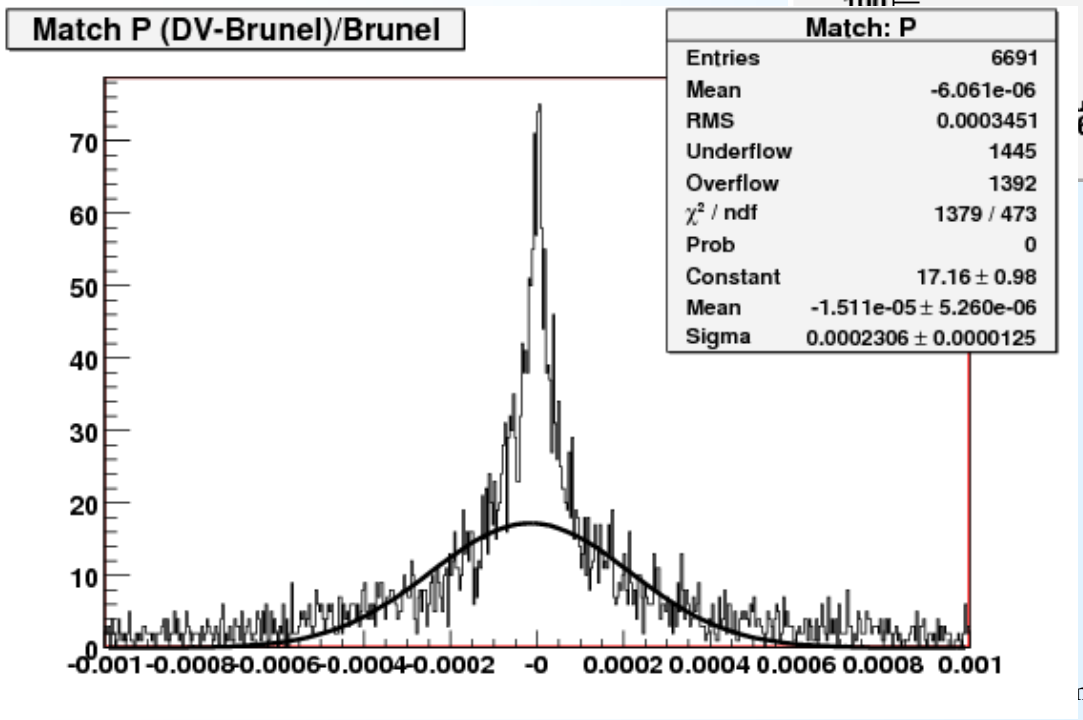




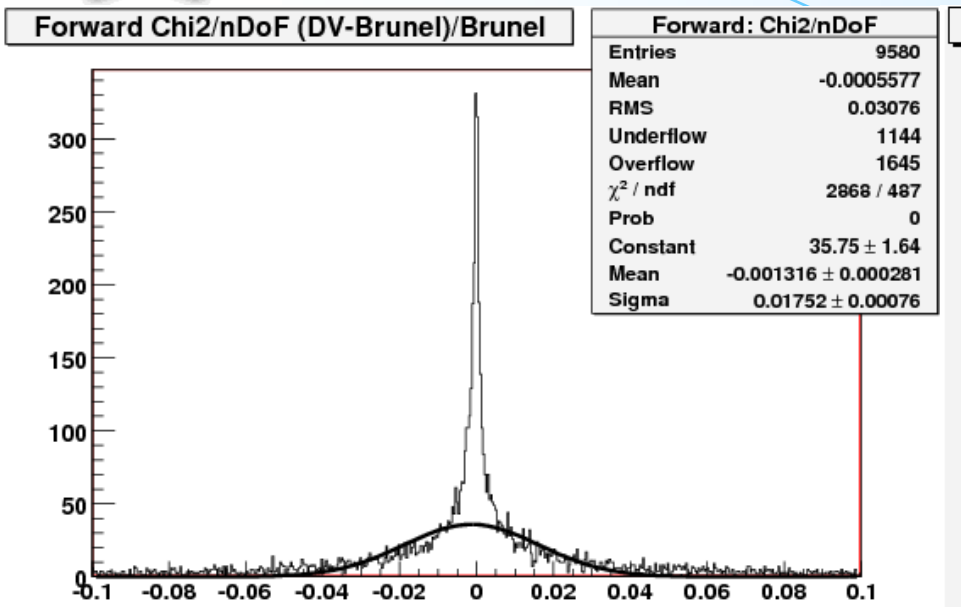
Comparisons - Long Tracks (4/6)

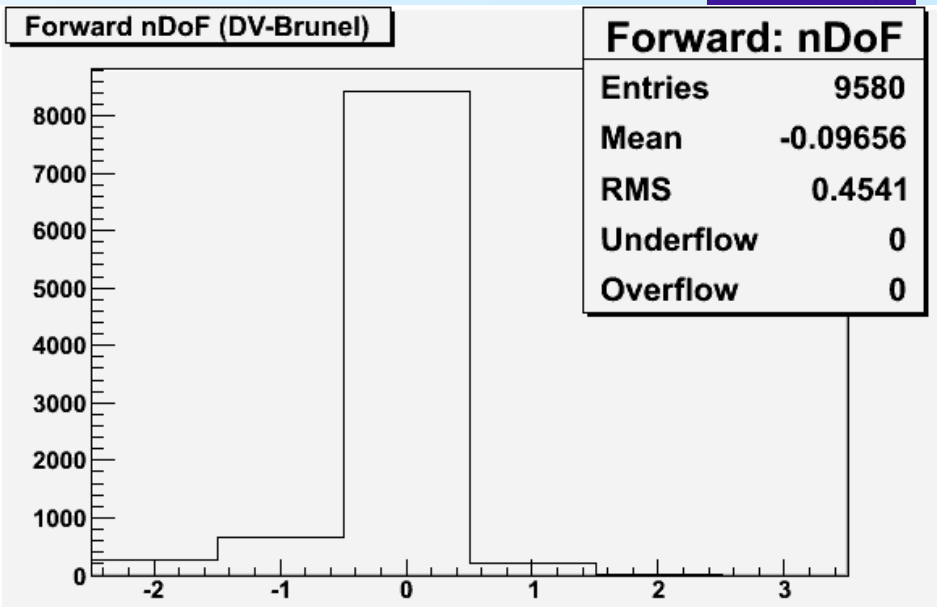
Very good agreement in momentum

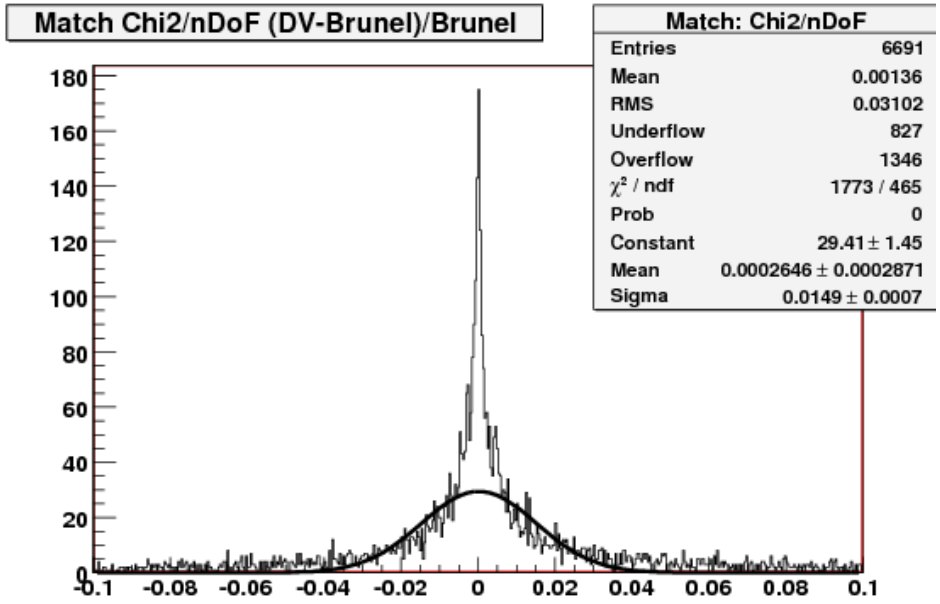


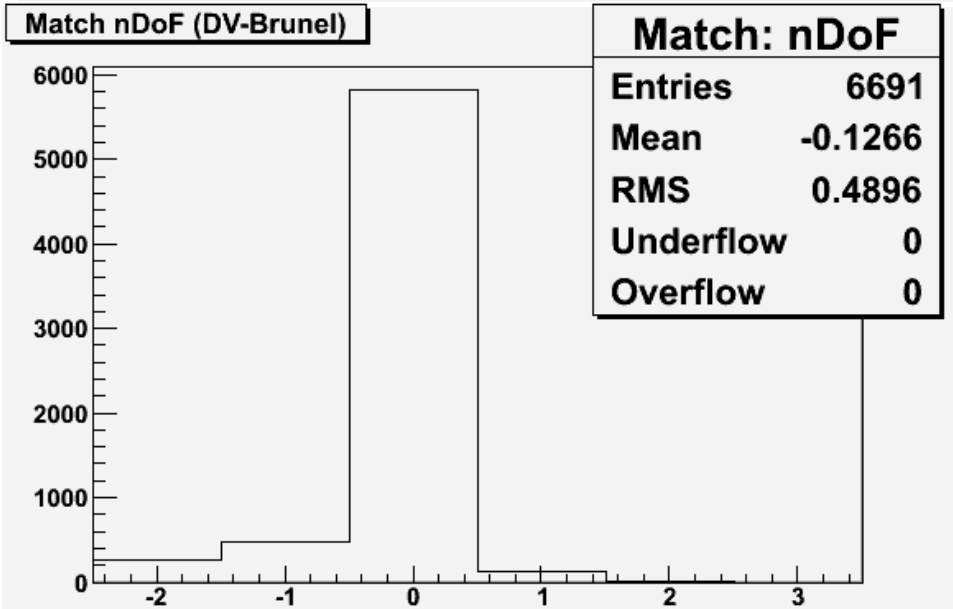


Comparisons - Long Tracks (5/6)



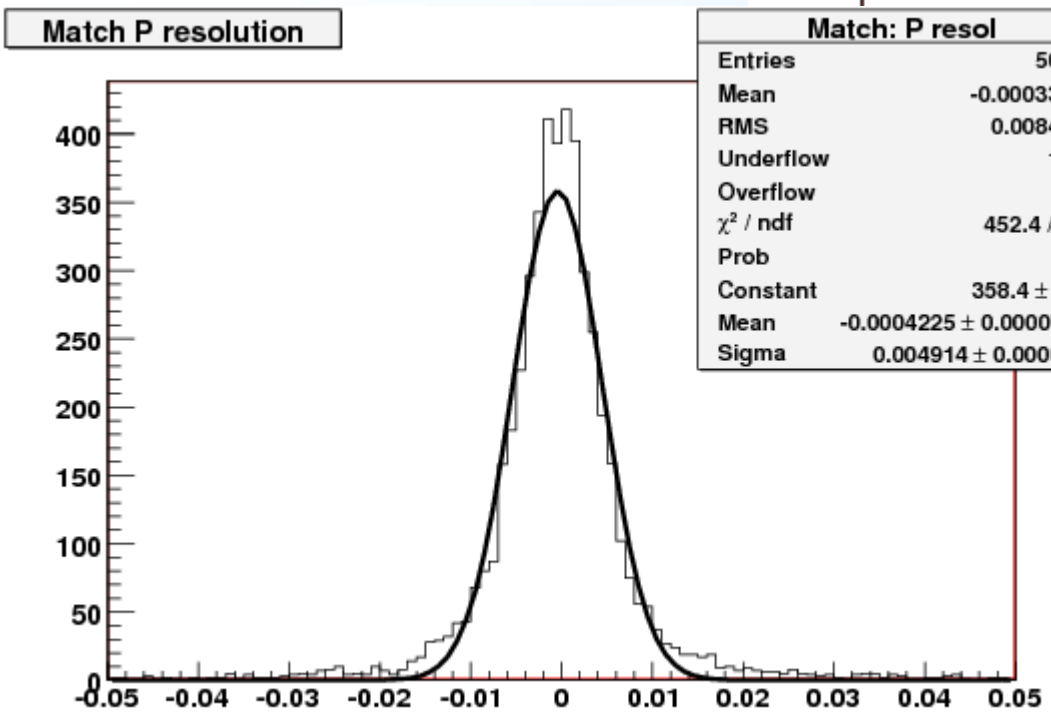


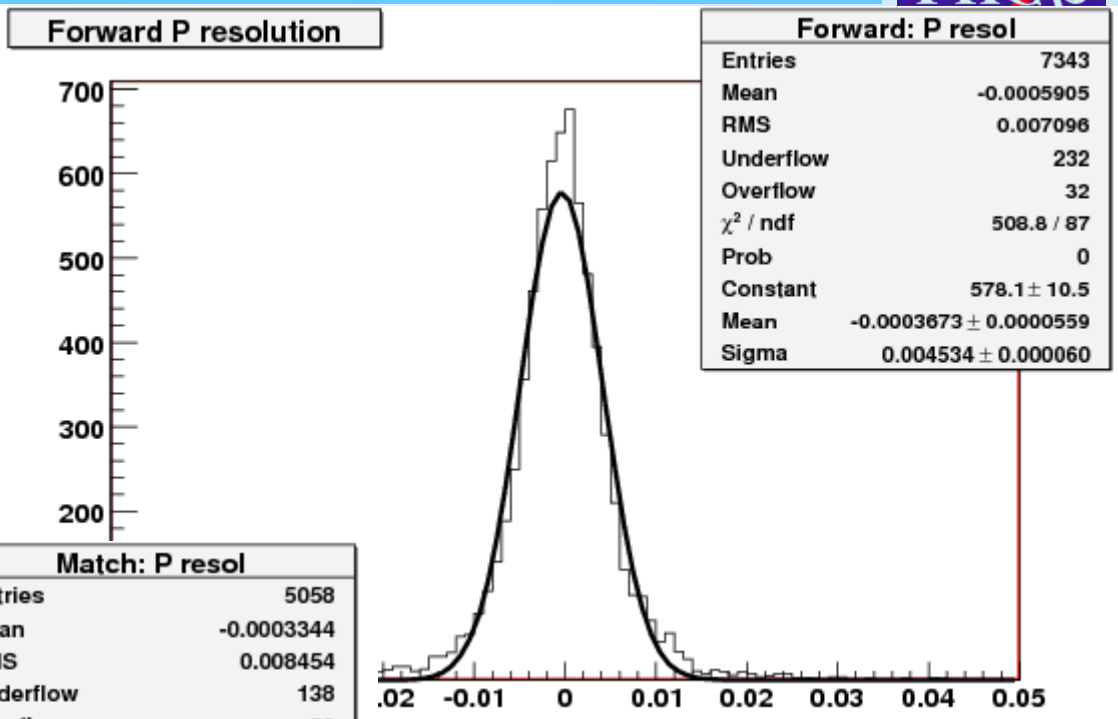




Comparisons - Long Tracks (6/6)

Momentum resolutions as in Brunel!





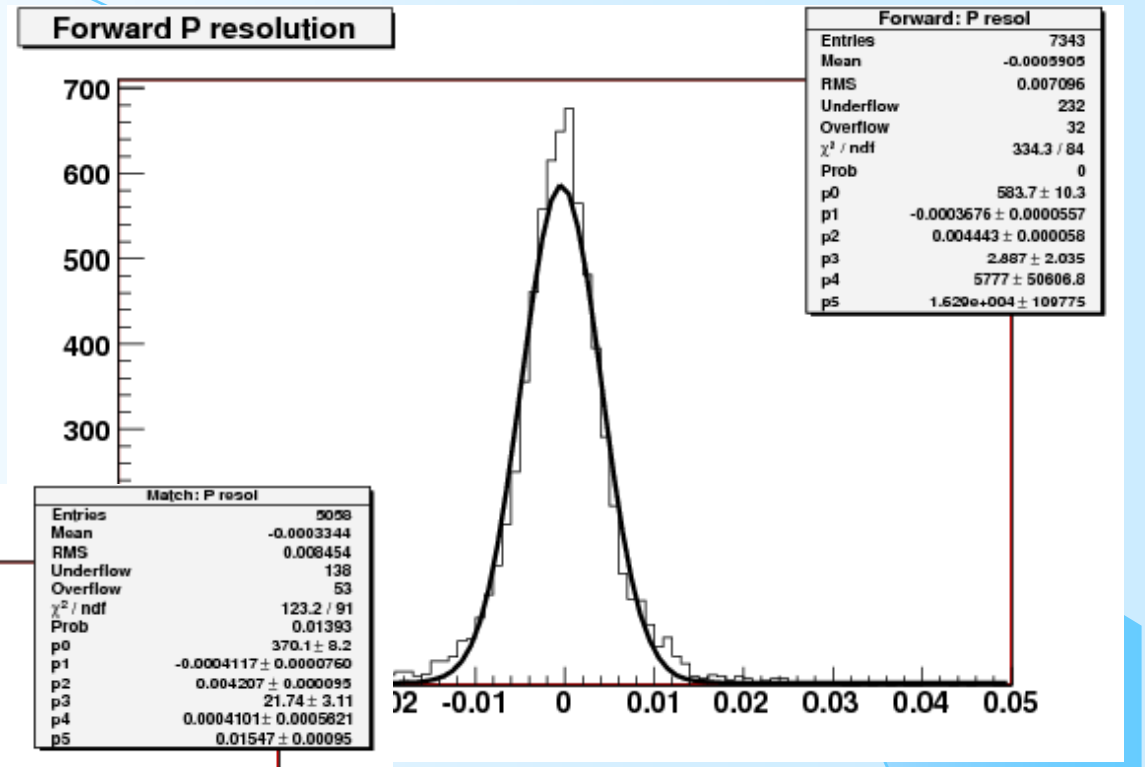
δp / p ~ 4.5 per mille

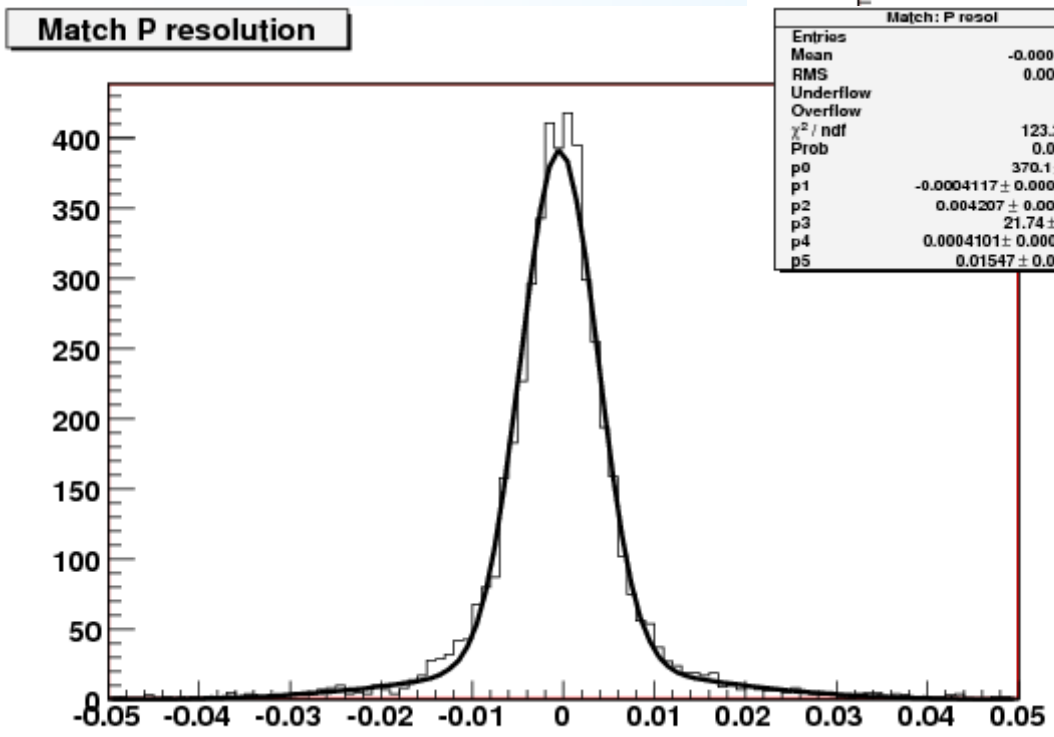
Comparisons - Long Tracks (6/6) -bis

Double Gaussian

Core resolutions

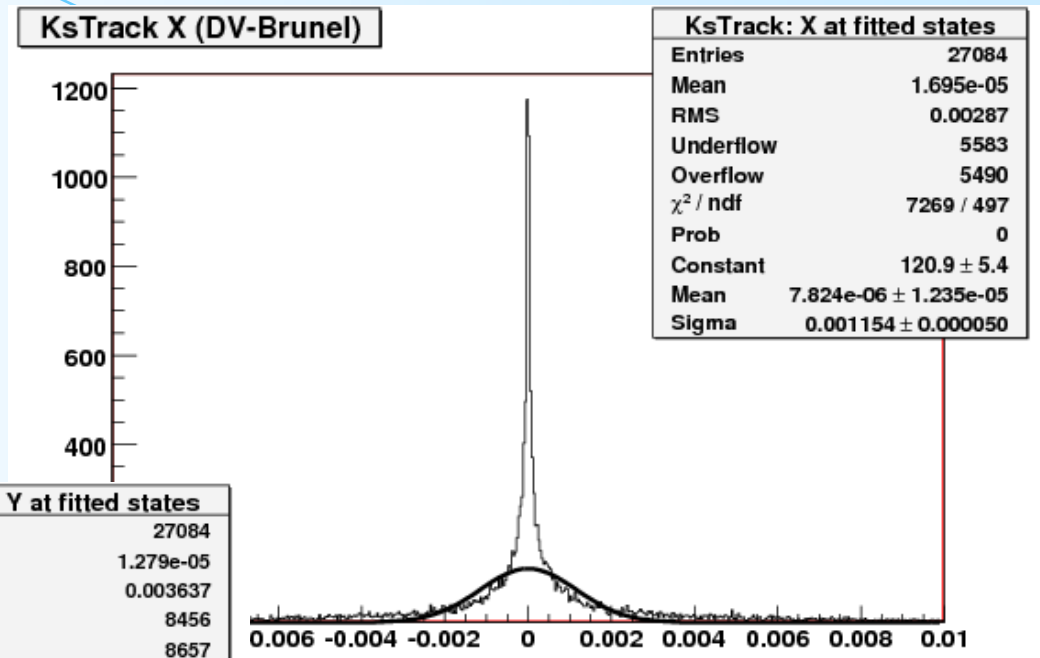
$\delta p / p \sim 4.2$ per mille

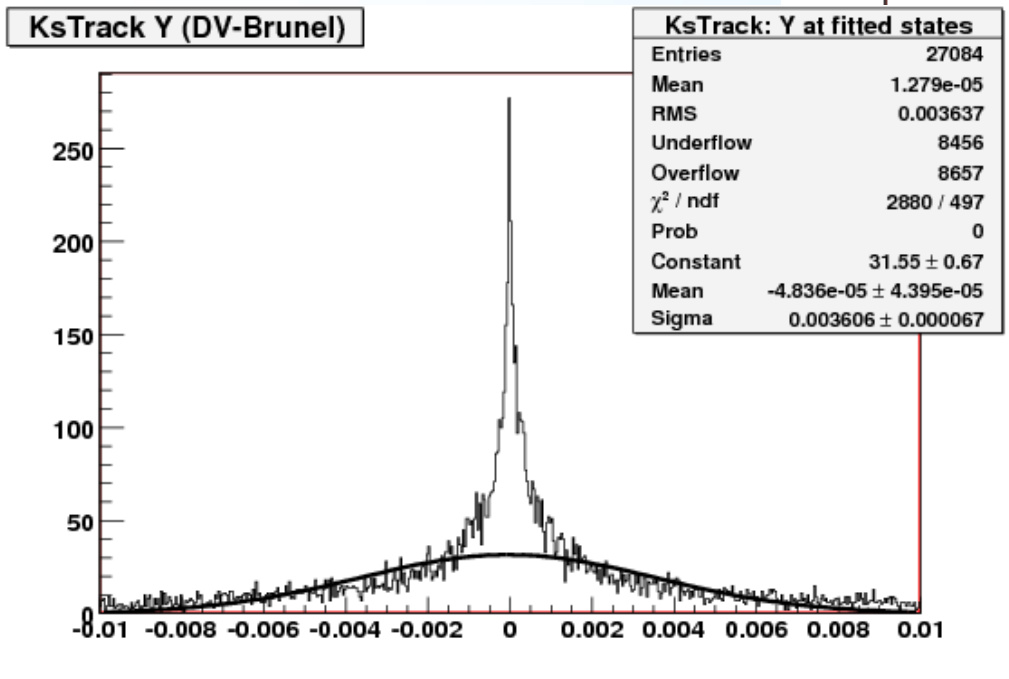


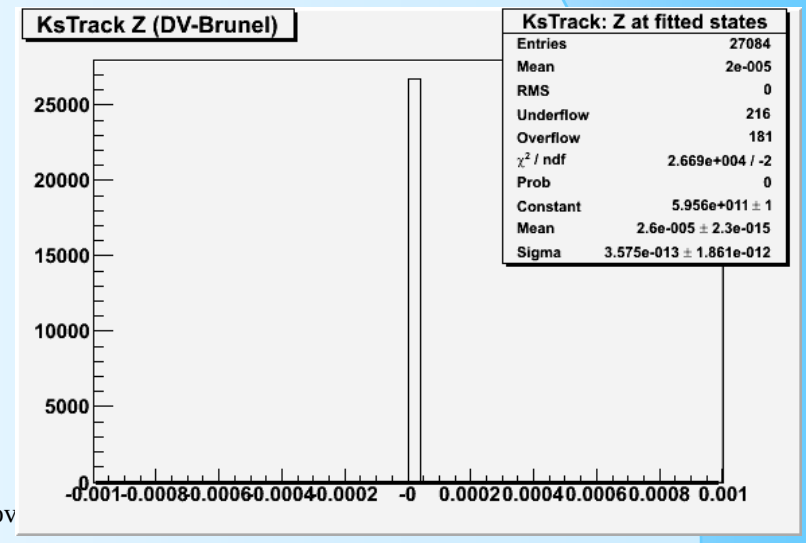


Comparisons - KShort Tracks (1/3)

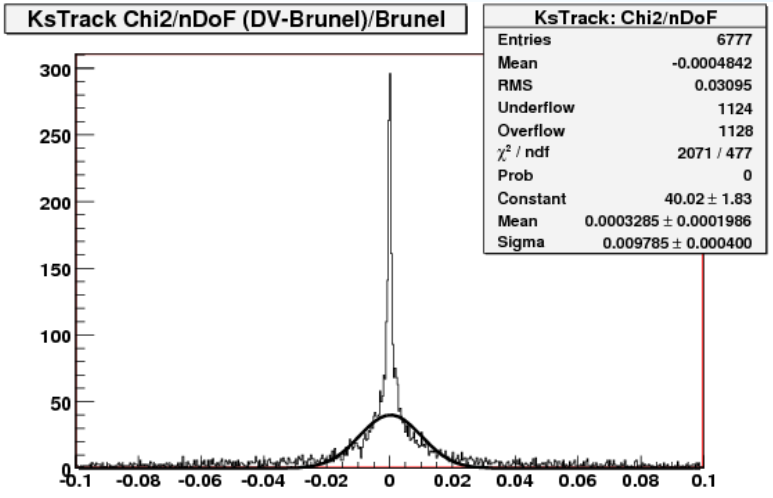
Very good agreement in positions

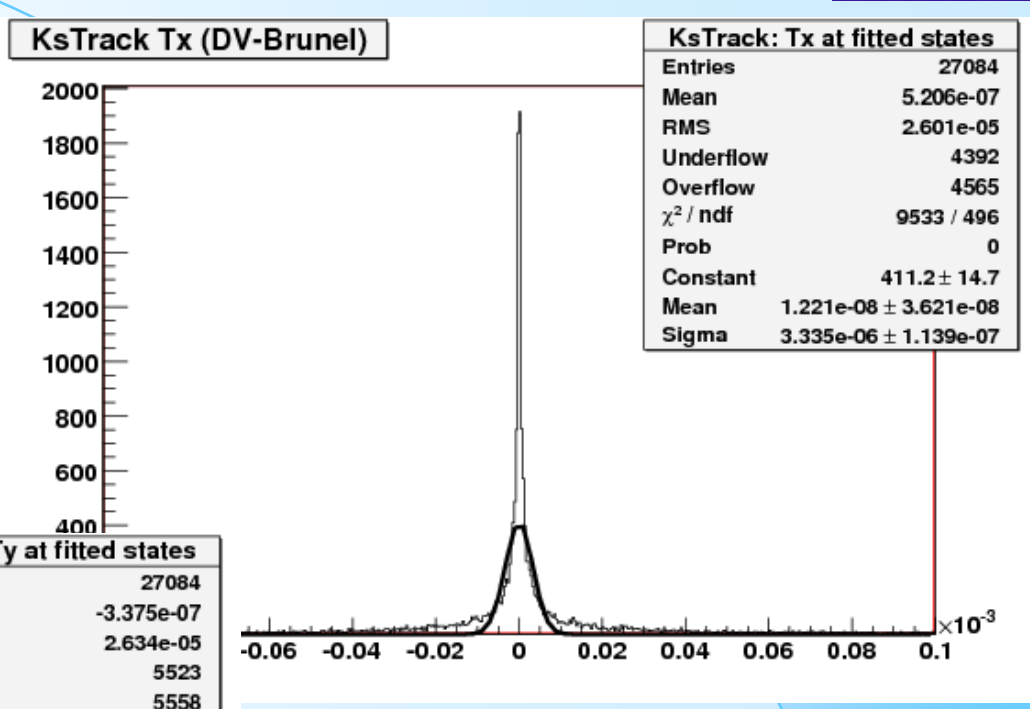


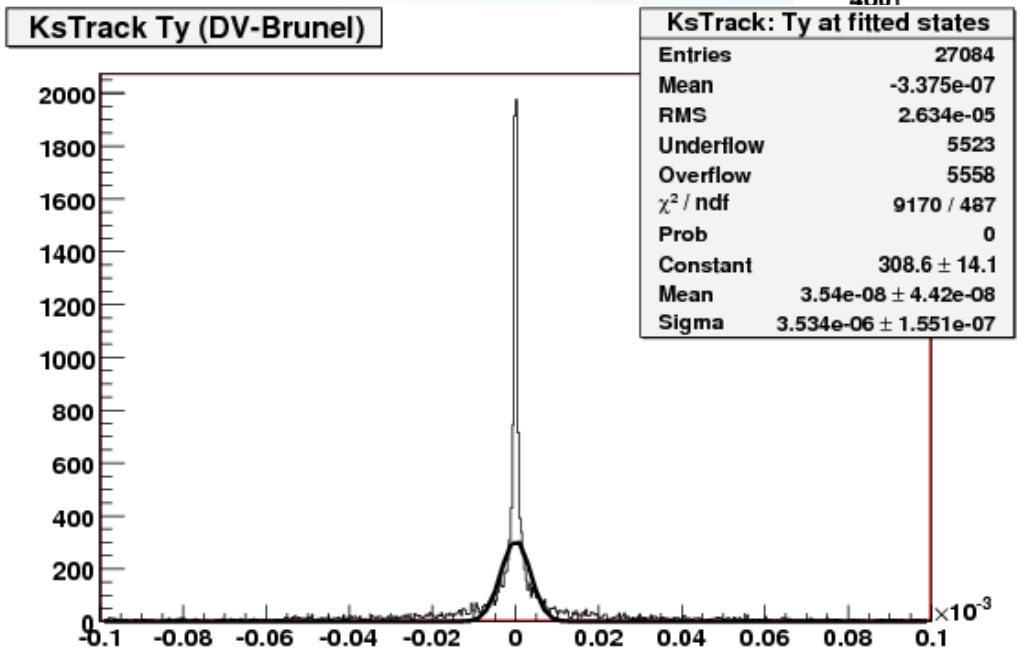


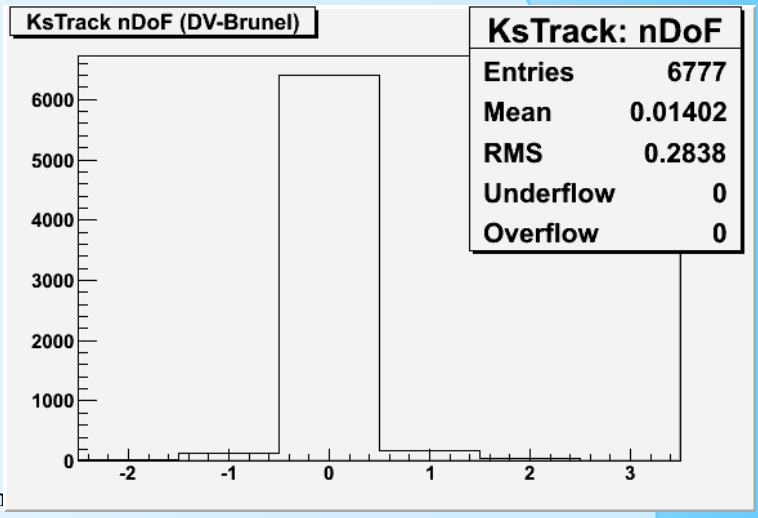


Comparisons - KShort Tracks (2/3)



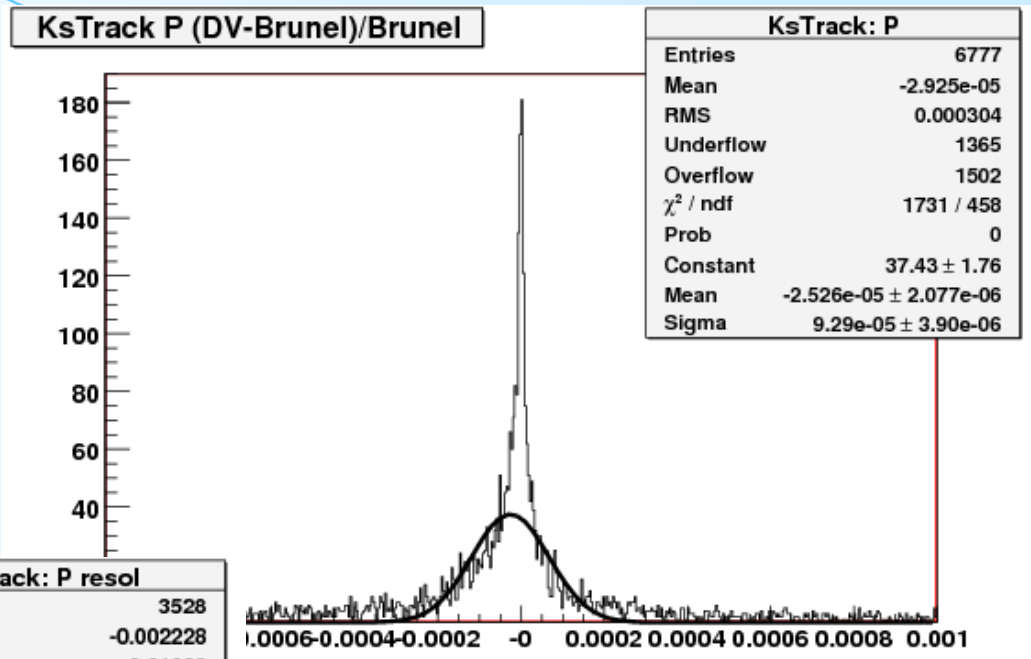


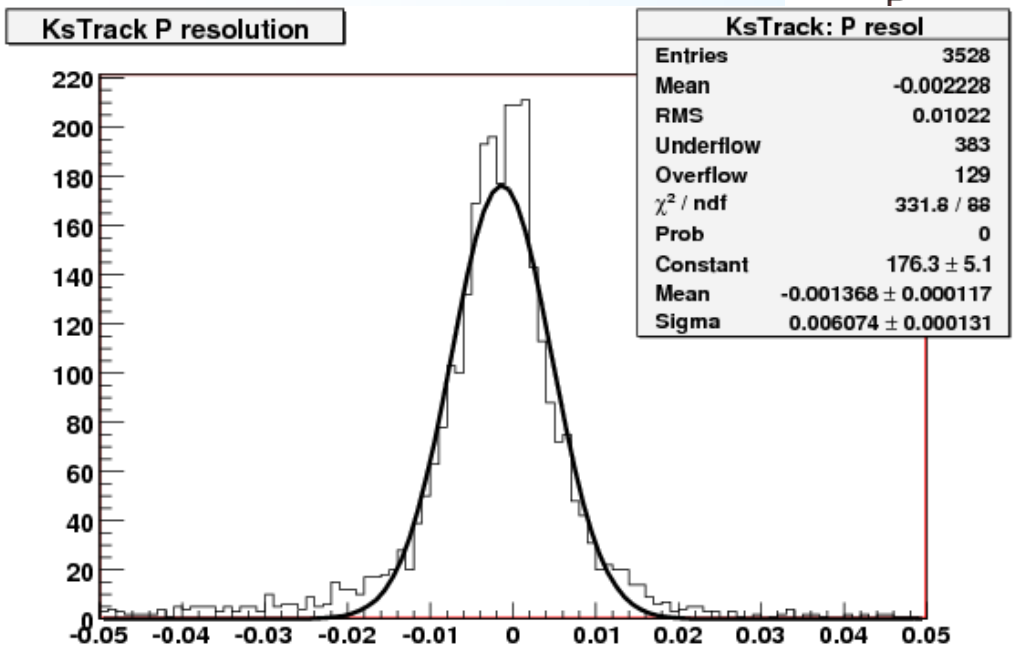




Comparisons - KShort Tracks (3/3)

Fair agreement in momentum

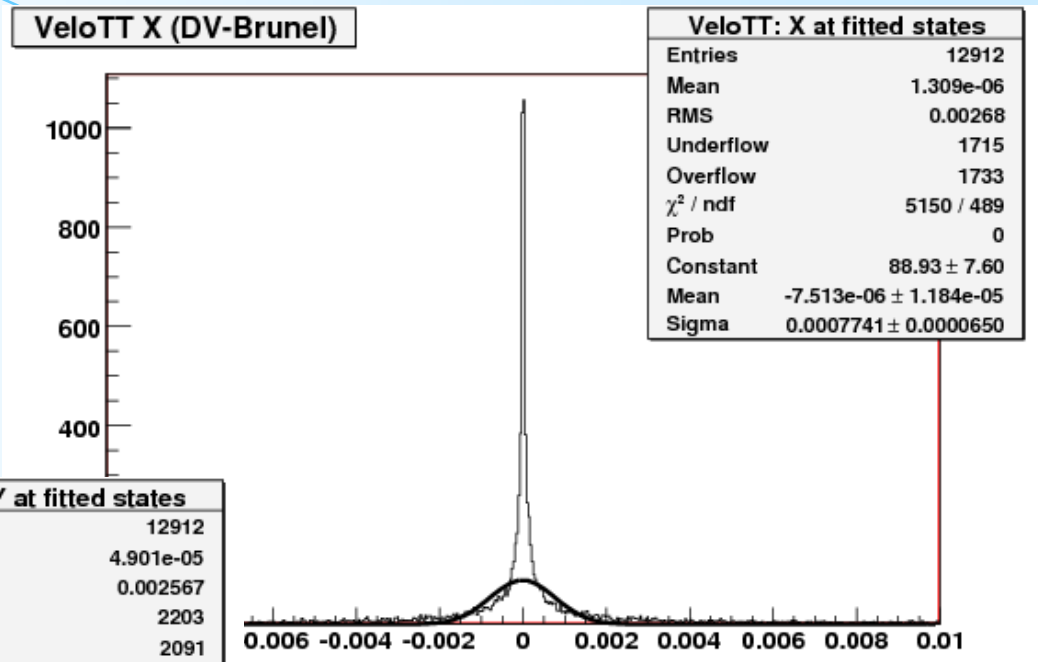


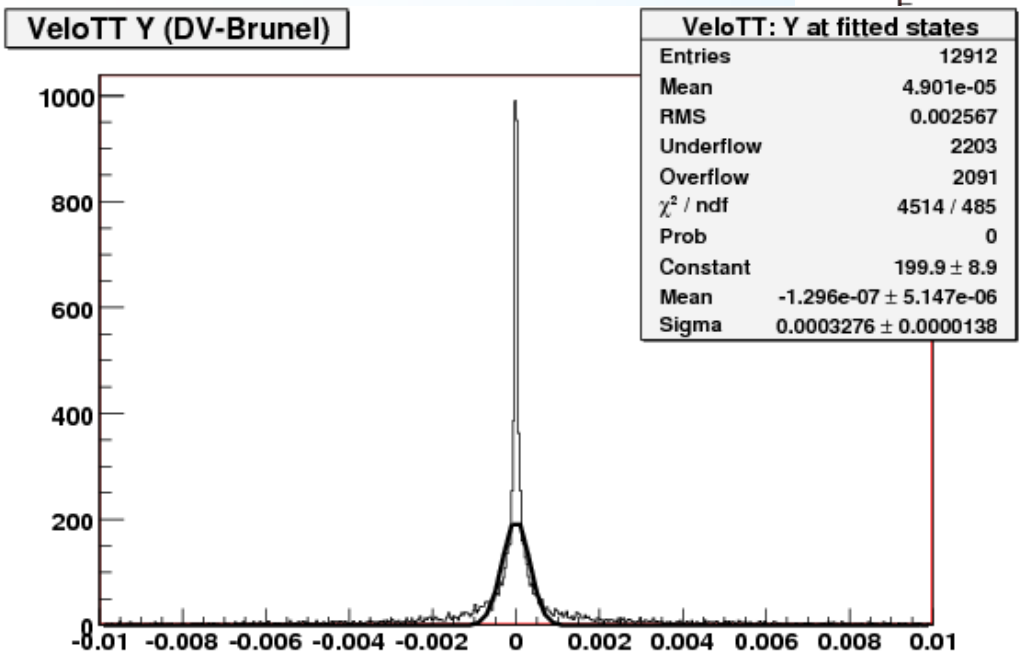


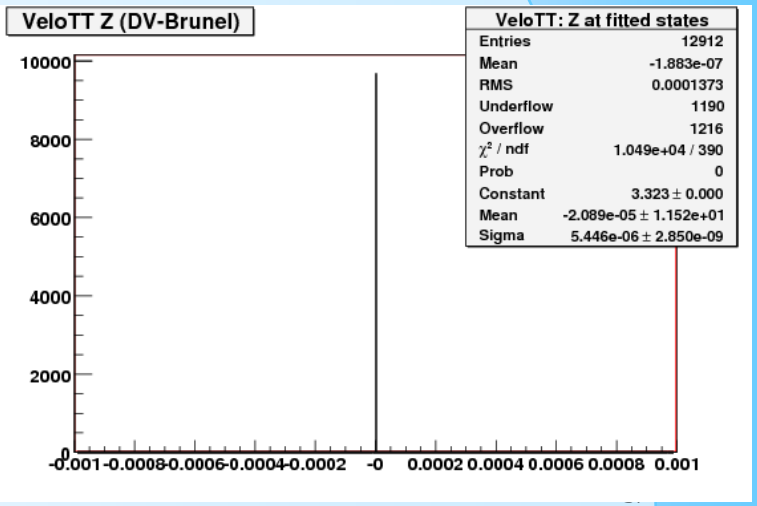
More fit iterations needed?

Too many outilers?

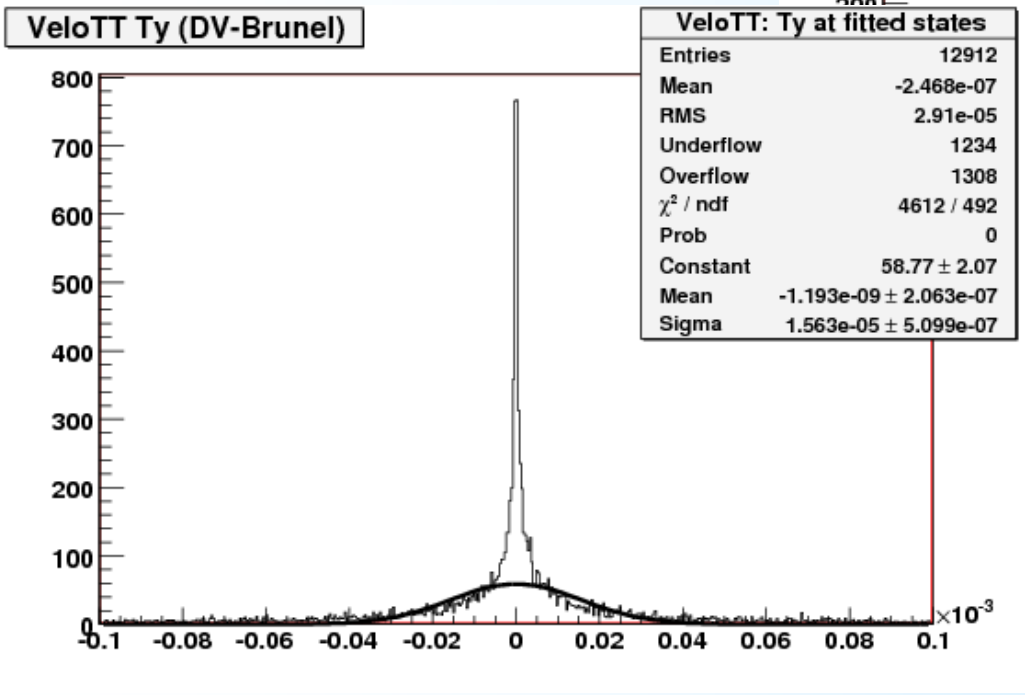
Comparisons - VeloTT Tracks (1/2)

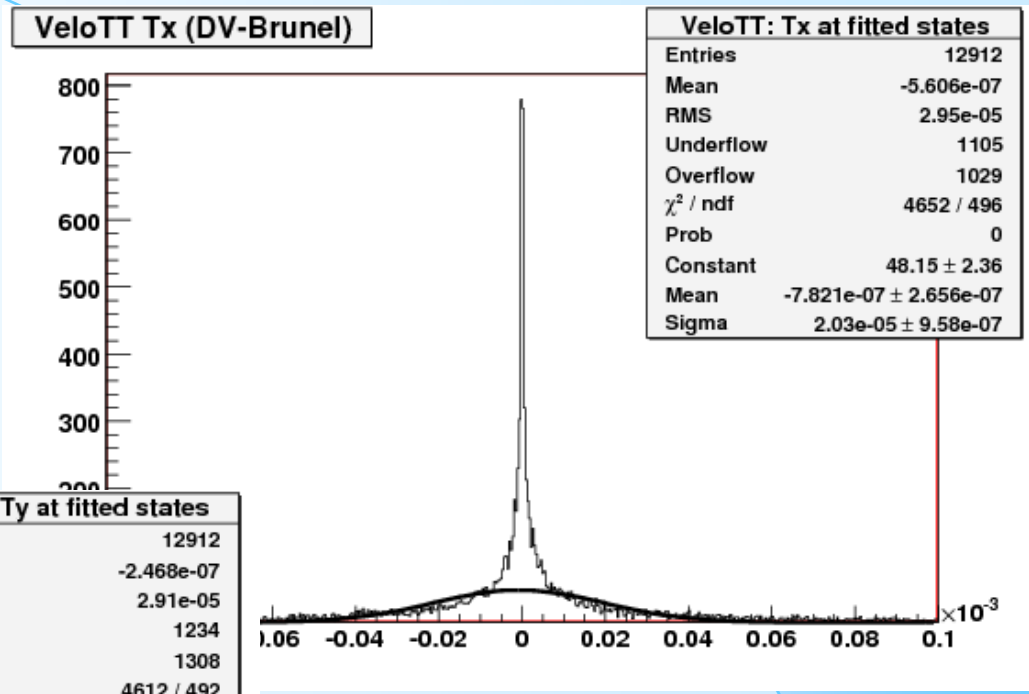


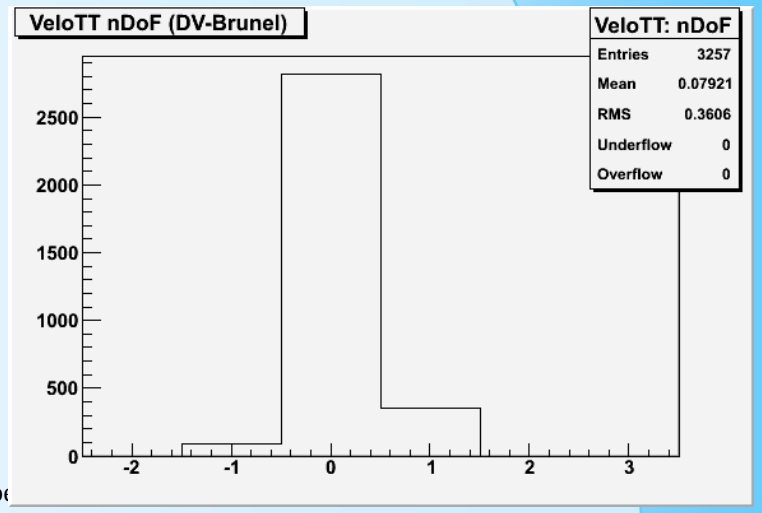




Comparisons - VeloTT Tracks (2/2)







Outlook

- ✓ ***First proof that we can refit tracks from DST***

  → **Refitting is now a reality!**

- ✓ ***First tests are rather encouraging***

  → **Differences between "Brunel-fitted" and "DST-refitted" tracks are in general well withing errors**

  → **momentum resolutions of refitted tracks very much the same as in Brunel**

- ➢ ***BUT one needs to understand:***

  - **Tails in the various distributions**
  - **Fit failures for tracks that had been successfully fitted in Brunel**
  - **Refitting of all track types in detail**