Status of the Track Event Model Classes and Tools

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- ***Status of the Track Event Model***
  - *- event classes*
  - *- tools and “helping” algorithms*
- ***Status of the Track Fitting***
  - *- the TrackFitter package*
  - *- ongoing tests*
- ***How to use the new TEM best***
  - *- using the event classes*
  - *- using the “core” tools*
  - *- extending the functionality*
- ***In preparation for DC’06***
  - *- what is still needed*
- ***Outlook***

Status of the Track Event Model

Event classes

Event/

- **TrackEvent : Track, State, Measurement, Node, TrackFunctor**

Tr/

- **TrackFitEvent : XxxMeasurement, FitNode**

Kernel/

- **LHCbKernel : LHCbID**

Status

- ***Rather stable & tested* since a while now**
- **Your comments / questions / feedback are welcome**
  - ***First (positive!) feedback from RICH & Calo given @ T-Rec meeting on 24th Oct.***
- **Extra functionality can be incorporated if needed**
  - ***Useful / necessary functionality will be considered …***

Status of the Track Event Model

Tools and “helping” Algorithms

Tr/

- TrackInterfaces
- TrackExtrapolators
- TrackProjectors
- TrackTools
- TrackMCTools
- TrConverters

Trg/

- TrgConverter

- Too many tools and algorithms to list here

- Full list given many times in the past

- Documentation is there for you … ;-)

Status

- **Full list** (adapted from “old” TEM) ***rather stable & tested*** **since a while now**
- **Little direct interaction with user – mainly e.g. TrackMasterExtrapolator**

Status of the Track Fitting

The TrackFitter package

Package Tr/TrackFitter/

- **TrackEventFitter algo**
- **TrackKalmanFilter tool**

Status :

- **All functionality adapted to the “new” TEM, e.g**
  - ***iteration of filtering-smoothing sequence***
  - ***outliers removal & update of “reference trajectories” available***
  - ***Upstream/downstream fitting…***
- **First public version of TrackFitter available in CVS**

- **Results of ongoing tests follow …**

Status of the Track Fitting

Ongoing Tests: set-up

In what follows:

- All initial tracks produced with the ideal pattern recognition of the old TEM
- Tracks selection - loose quality cuts:
  - *Only long tracks*
  - *Momentum > 1 GeV*
  - *# of hits on track > 20*

OLD

- TrFitTracks fitted *upstream* with old KF code

- states predicted at each meas. position

- TrFitTracks converted to Tracks

NEW

- non-fitted TrFitTracks converted to Tracks

- Tracks fitted *upstream* with new TEM KF package

- States predicted at each meas. position

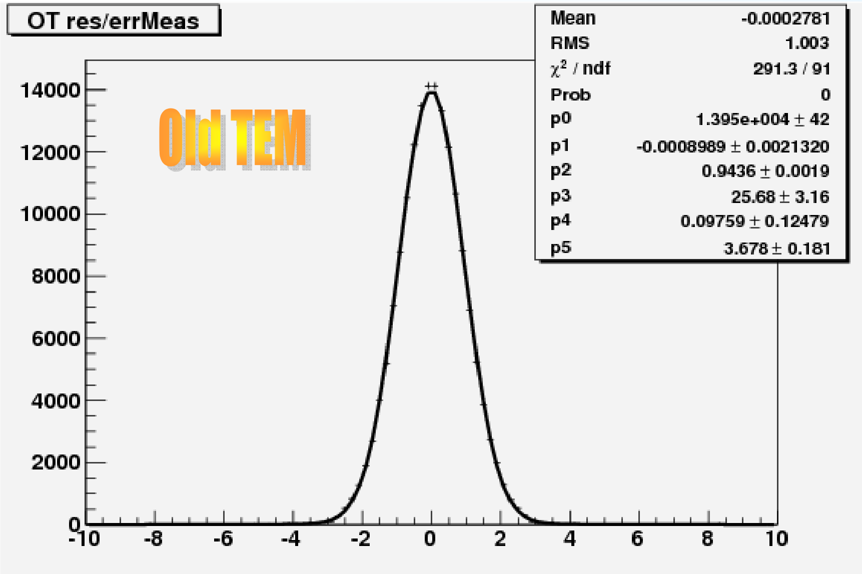
Plots:

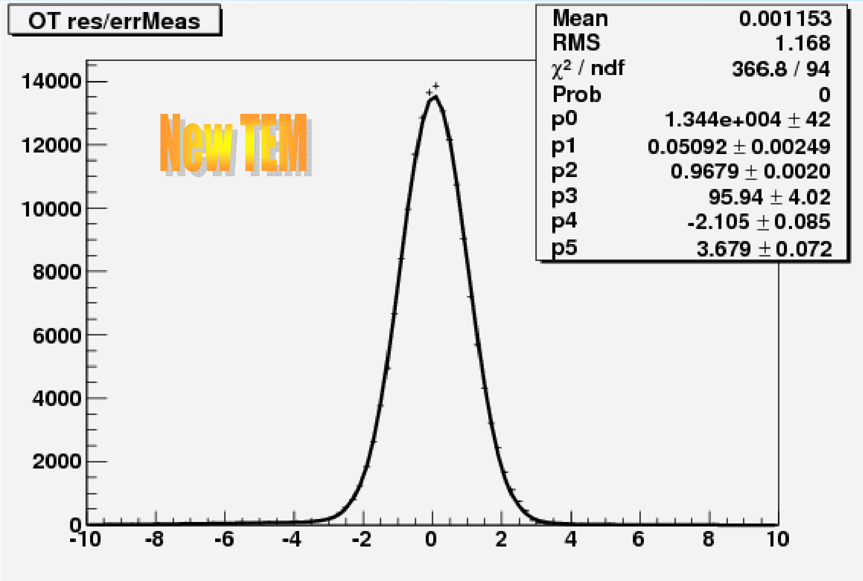
- Separate for OT, IT, Velo-R and Velo-Φ measurements

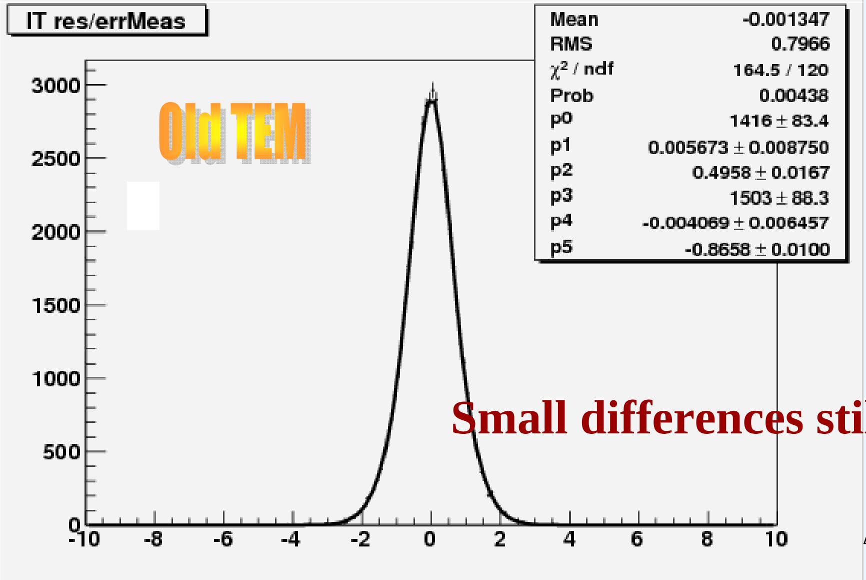
⇒ plots produced looping over all pairs of (state,measurement), all at same z-positions, by construction

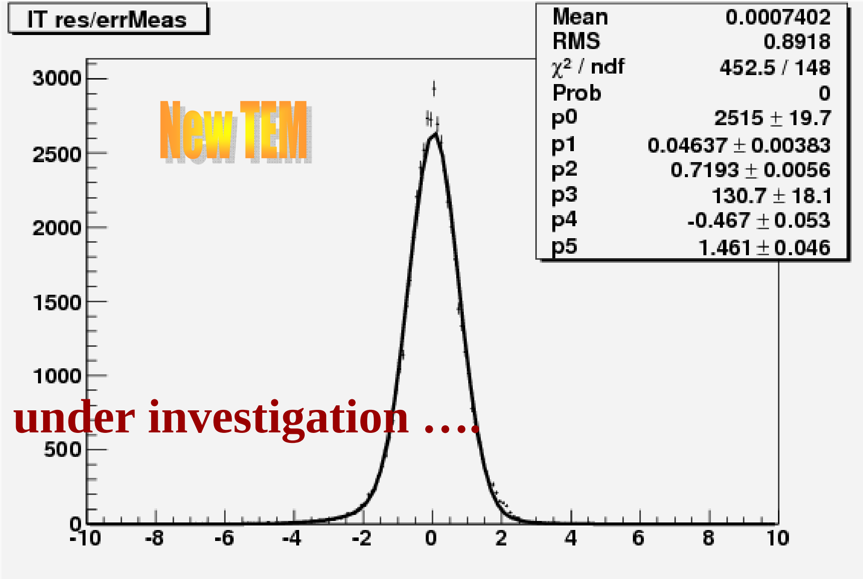
Status of the Track Fitting

Ongoing Tests





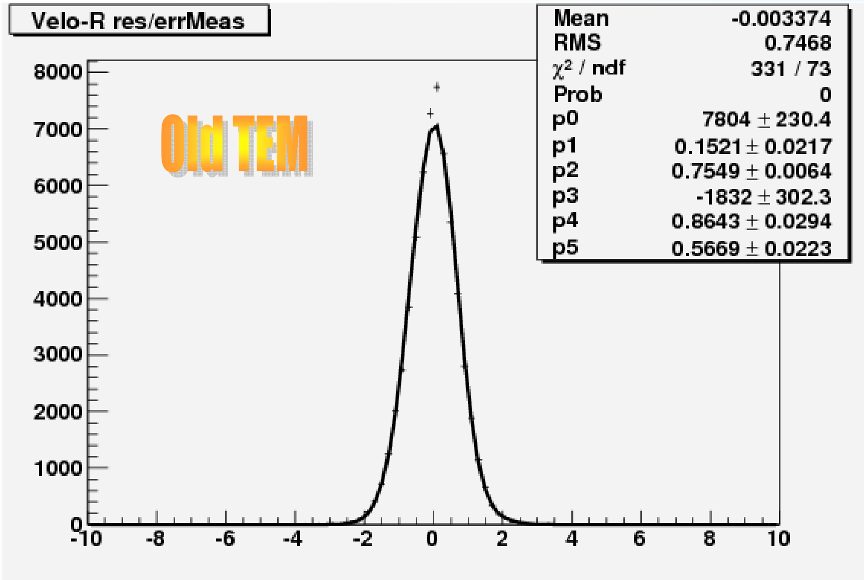


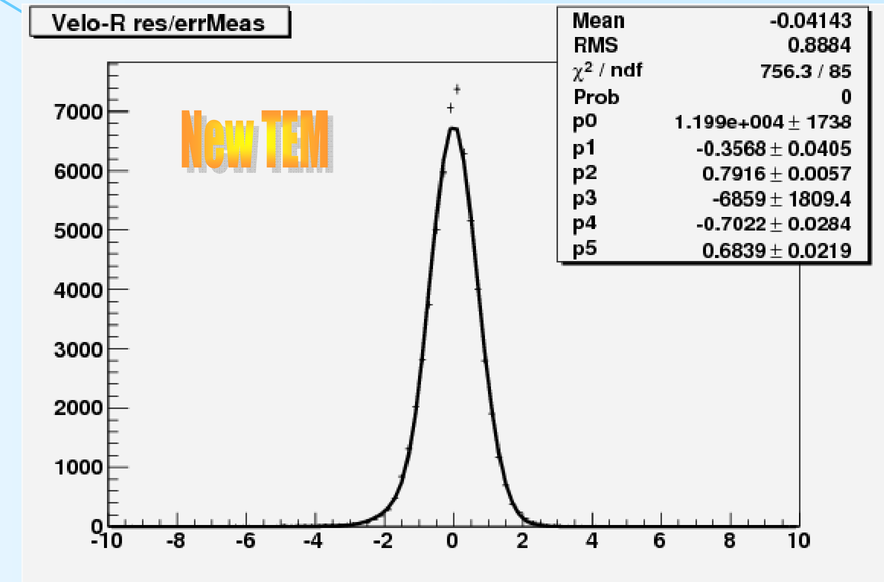


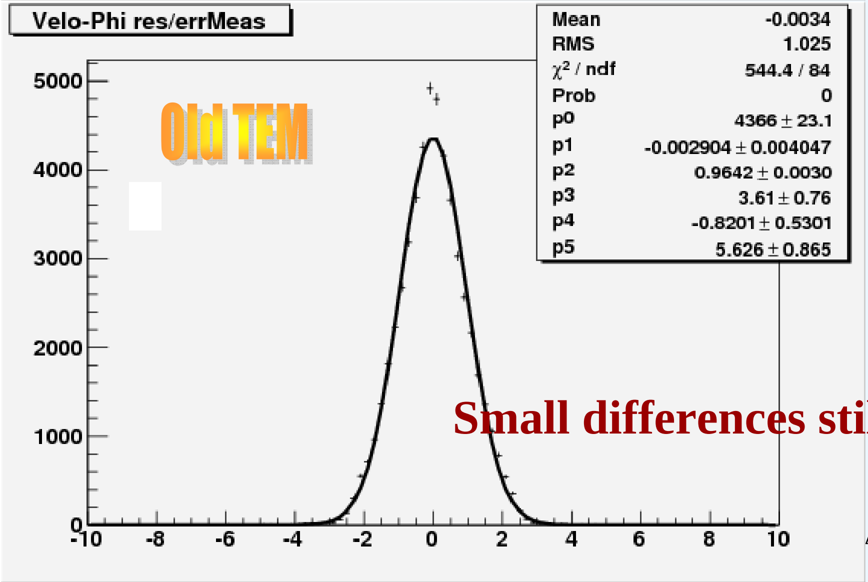
Small differences still exist … under investigation ….

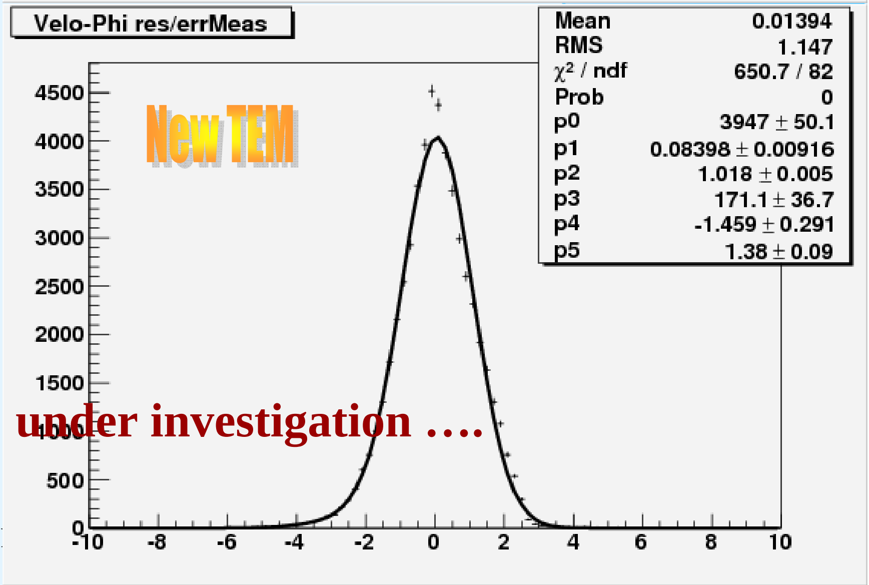
Status of the Track Fitting

Ongoing Tests









Small differences still exist … under investigation ….

Status of the Track Fitting

Ongoing Tests

Some side remarks :

- All TEM was performed in "blind development"
  - *New code timed for the first time only ~2 weeks ago!*
- Speed of "new" fitting code same as in "old" TEM
  - *Fair speed comparison*
  - *Fitting with the new TEM seems ~2-3% faster than with old TEM*
- This does not mean we will not try and improve further …!
- We keep testing and trying to understand possible features

How to use the new TEM best

Using the Event Classes

Preliminary remarks:

- **Design choices have been discussed at length elsewhere**
- **Best usage of current event model reflects those choices AND conventions**

Some basic guidelines :

- **Tools that provide info typically have references as arguments**
  - ***Means these tools do not get ownership of objects passed to them***
  - ***E.g. extrapolators, projectors***
- **Some methods return pointers**
  - ***In this case the user gets the ownership – is responsible for deletion***
  - ***E.g. clone methods***

How to use the new TEM best

Using the Event Classes

```
// .h file
// from TrackEvent
#include "Event/Track.h"
```

Basic Track information

```
// .cpp file

 Tracks* tracksCont = get<Tracks>( TrackLocation::Default );


  debug() << "Tracks container contains " << tracksCont -> size() << " tracks" << endreq;


  for (Tracks::const_iterator iTrk = tracksCont->begin(); tracksCont->end() != iTrk; ++iTrk ) {
    Track& track = *(*iTrk);
    debug() << "-> Track  # " << track.key() << endreq
                << "  * charge               = " << track.charge() << endreq
                << "  * is of type           = " << track.type() << endreq
                << "  * # states             = " << track.nStates() << endreq
                << "  * # measurements = " << track.nMeasurements() << endreq;
  }
```

How to use the new TEM best

Using the Event Classes

Basic Track information

```
// .cpp file

// …
Track& track = *(*iTrk);
   debug()
     << "-> Track  # " << track.key() << endreq
     << "  * is valid                 = " << !track.checkFlag( Track::Invalid ) << endreq
     << "  * is unique                = " << track.checkFlag( Track::Unique ) << endreq
     << "  * is a long track          = " << track.checkType( Track::Long ) << endreq
     << "  * is Backward              = " << track.checkFlag( Track::Backward ) << endreq
     << "  * has been fitted OK  = " << track.checkStatus( Track:: Fitted ) << endreq
     << "  * χ^2 from fit  = " << track.chi2() << endreq;


 // …
}
```

How to use the new TEM best

Using the Event Classes

```
// .cpp file

// …
Track& track = *(*iTrk);
 // position and momentum of the “first state” (i.e. the one stored by default on the DST)
HepPoint3D pos;
HepVector3D mom;
HepSymMatrix cov6D;
track.positionAndMomentum( pos, mom, cov );
// …
HepVector3D slp;
HepSymMatrix errSlp;
track.slopes( slp, errSlp );
HepVector3D slp2 = track.slopes();
// …
   debug()
     << "-> track momentum           = " << track.p() << endreq
     << "  * transverse momentum  = " << track.pt() << endreq;
// …
 }
```

Momentum information

How to use the new TEM best

Using the “core” Tools

```
// .h file
// from TrackEvent
#include "Event/Track.h“
// from TrackInterfaces
#include “TrackInterfaces/ITrackExtrapolator.h”
// …
ITrackExtrapolator* m_extrapolator;
```

Extrapolating …

```
// .cpp file

// … ( e.g. m_particleID = 211 for a pion )
Track& track = *(*iTrk);
double z = 1000.;
State state;
StatusCode sc = m_extrapolator -> propagate( track, z, state, m_particleID );
// after extrapolation the state will have its state vector and covariance matrix updated …


// …
}
```

How to use the new TEM best

Extending the Functionality

```
// .cpp file
// from TrackEvent
#include "Event/TrackFunctor.h“
#include "Event/Measurement.h“

// …
Track& track = *(*iTrk);

// counting the number of VELO measurements!
TrackFunctor::HasKey<Measurement> isVeloR ( &Measurement::checkType, Measurement::VeloR );
TrackFunctor::HasKey<Measurement> isVeloPhi ( &Measurement::checkType, Measurement::VeloPhi );
unsigned int nVeloMeas =    TrackFunctor::nMeasurements( track, isVeloR )
                          + TrackFunctor::nMeasurements( track, isVeloPhi );

// can be exploited to fabricate functions:
TrackFunctor::HasKey<Track> isBackward ( &Track::checkFlag, Track::Backward );
if ( isBackward(track) ) { // … }
 // …
}
```

Sophisticated manipulations

How to use the new TEM best

Extending the Functionality

Extra Flags for private usage:

- **Flags enum in Track.h has some dedicated “specific bits” for this**

Use cases not yet considered:

- **Your comments / questions / feedback are welcome**
- **Useful / necessary functionality will be considered for implementation …**

In preparation for DC'06

THE goal:

- **Fully operational tracking working with a realistic geometry!**

What is still needed, "mainly":

- **Event classes and tools:**
  - ***Extend / adapt code for realistic geometries – see Edwin's talk***
  - ***Improvements/bugs are not impossible/unrealistic …***
- **Pattern recognition:**
  - ***All PR packages in accordance with new TEM – see Matt's talks***
- **Setting-up of a tracking reconstruction sequence for Brunel**
  - ***Visit the Brunel's tracking sequence and in particular the "clone killer"***
- **Integration of B-field map in the software**

Outlook

- We are commissioning the new Track Event Model !
- The Track Event Model is in good shape !
- Most of the classes & tools have been tested
- Adapted code with new TEM seems to be as fast as old code
- Time to start profiling the classes / tools / algorithms in more detail
- A lot still ahead of us to cope with real geometries
- Time is tight but progress is steady …