Status of the implementation of the Track Event Model

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1. *The plan, and the classes (again)*
2. *The packages modified or to be modified*
3. *Interactive reconstruction*
4. *Some ideas*
5. *Conclusion and plans*

Plan

- **Motivation:**
  - Revisit the tracking code to try to improve the design
  - Unify code on/off line and define an interface for the clients
    - Define a Track! (for **on/off line**)
  - Define **data** and **tools** base classes for and tracking developers and clients
- **Method:**
  - Modify the current code adiabatically
  - Reusing almost all the code: “adapting” and not “writing new code”
- **Organization:**
  - Task Force (G. Raven) to:
    - ‘define the classes, requirements and implementation constrains’
- **Plan:**
  - Step I: Interfaces for clients
    - Track, State, ITrackExtrapolator
  - Step II: Tracking interfaces
    - Measurement, Node, ITrackProjector, ITrackKalmanFilter
- **Scale:**
  - 6 months

Step I: Track, State, (the most regarded classes…)

Track

A TRACK:

bitfield-flag: type, history, historyfit, status and flags

chi2/ndof, ndof: quality of the fit

<State*> :“transient” states and physic state

<Measurement*> :

<Node*> : (aggregate state-measurement => residual)

<LHCbID>: link MC, Clusters (measurements)

Methods:

Access to physic state: *p,pt, slopes, position*

Access states: *at z, plane, LOCATION*

Persistency:

bitfield-flag, quality, physic state and LHCbIDs

the rest on demand!

State

A STATE:

bitfield-flag: type, location

state-vector, covariance, z

Methods:

Access to physics contents: pt(),p()

ITrackExtrapolator

A Extrapolator: extrapolate a Track/State

Main method: propagate(state, z)

Methods:

propagate track, state to z

in the way: propagate to plane, line, point

physics access: p,pt…

Step II: Measurement, Node, Projector (the poor brothers…)

Measurement

A Measurement:

- **bitfield-flag: type (ie RVelo)**
- **measure, error (double)**
- **“z” and LHCbID**

Node

A Node:

- **type (I.e RVelo)**
- **Measurement* (“refined”)**
- **State***
- **residual, error**

Internal?…

Methods:

- **chi2(), …**

ITrackProjector

A Projector: Project a state into a measurement

Main method: project(State, Measurement)

Internally deals with the Alignment/Calibration

(I think) it accept the two approaches:

I) global-local-global; II) global

Methods:

residual, chi2, node, ProjectionMatrix (H)

IKalmanFilter

A KalmanFilter (interface)

methods:

- **fit(Track,State seed);**
- **filter(Track,State seed);**
- **filter(State, Measurement)**

Play and we will see…

The packages (quick look)…

- **Event/**
  - TrackEvent — CPT
- **Trg/**
  - TrgConverters — CT
  - TriggerVelo — W…
  - TriggerVeloTT — …
  - TriggerForward — …
- **Vis/**
  - SoEvent — CW
- **Tr/**
  - TrConverters — CT
  - TrackIdealPR — CT
  - TrackExtrapolators — CPT
  - TrackFitEvent — CP
  - TrackProjectors — C
  - TrackTools — W
  - TrackFitter — CW
  - TrackPython — CPT
  - TrackSimulator — …

C: compiles (Track version 13/5/5)

T: preliminary tested,

P: exposed to Python

W: work on progress

…: next…

The packages…

- **Event/**
  - TrackEvent:
    - Track, State, Measurement, Node
    - TrackKeys, StateKeys
      - enums for the flags…
- **Tr/**
  - TrConverters
    - TrFitTrack2TrackConv, Track2TrFitTrackConv
      - Algorithms to convert: TrFitTrack <-> Track
  - TrackExtrapolators
    - Track<T>Extrapolator:
      - T: Linear, Parabolic, FastParabolic, Herab, (FirstClever-> Master)
  - TrackFitEvent
    - <T>Measurement, FitNode, MeasurementProvider
      - T: OT,VeloPhi,VeloR,IT
        - the
      - FitNode: Node for the Kalman Filter
      - MeasurementProvider:
        - returns a Measurement from a LHCbID
        - to be move to Tr/TrackTools

The packages II

- **Tr/**
  - TrackIdealPR:
    - TrueTrackCreators
      - Algorithm: From MCParticles to Clusters to LHCbID to Measurements
  - TrackProjectors
    - <T>Projector
      - VeloR,VeloPhi,IT,OT and **Master**
        - Reusing the code from MeasurmentOnTrack
      - The master projector projects any measurement
        - it dispacthes the projection to the specific projector, project(State,Measurement)
  - TrackTools
    - Interfaces:
      - ITrackExtrapolator,ITrackProjector, ITrackKalmanFilter
        - (before in Kernel/LHCbInterfaces)
    - Tools:
      - Bintegrator, TrackPtKick,TrackReconstructible,TrackAcceptance, TrackSelector
  - TrackFitter
    - **KalmanFilter Tool** (A tool to fit/filter a Track or a State)
      - **Two external tools set by options: ITrackExtrapolator, ITrackProjector**
      - **Fit(Track,State seed):**
        - **fitTrack using a seed state (filter only, filter+smoother)**
      - **Filter(State,Measurement)**
        - **update the state, using the measurement**

The packages III

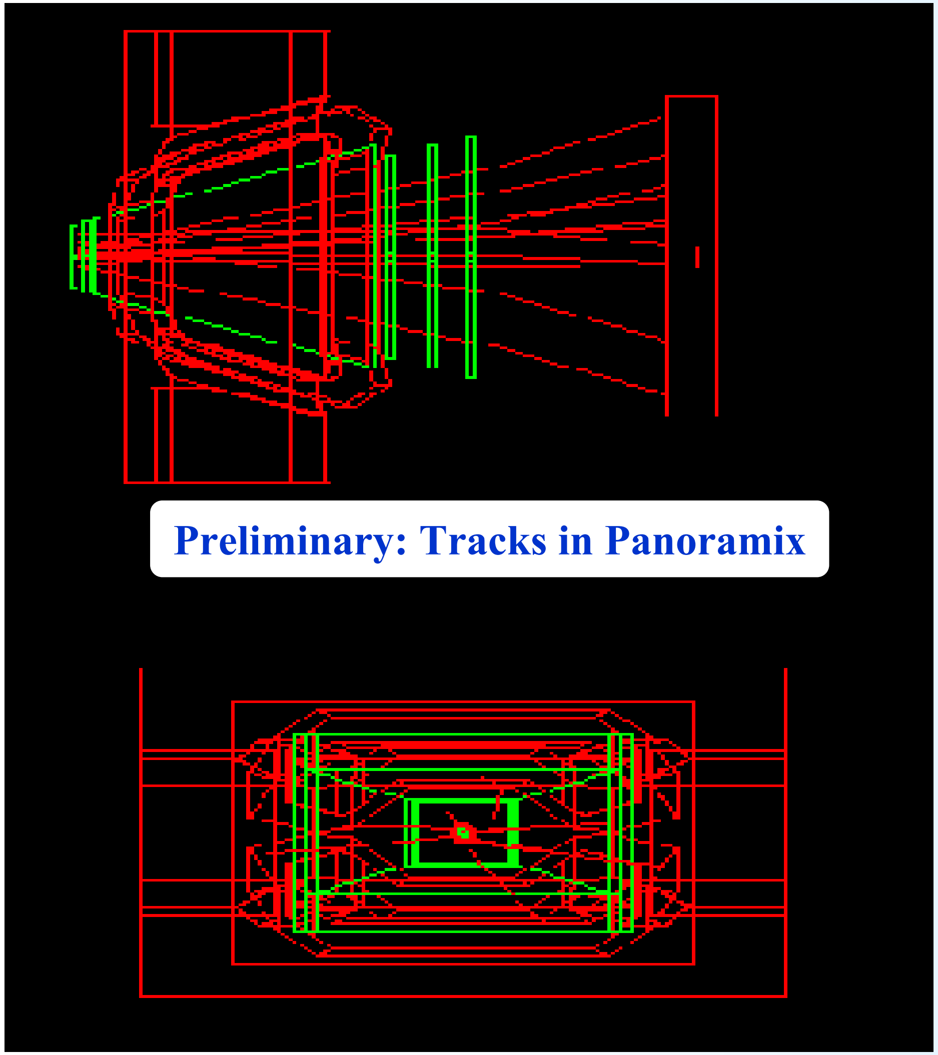
- **Tr/**
  - TrackPython:
    - Expose to Python the Tools Interfaces
      - ITrackExtrapolator (soon: ITrackProjector, ITrackKalmanFilter)
      - In future (ITrackSimulator, IMeasurementProvider) TrackProjectors
    - Python scripts:
      - translate_tracking.py
        - automatic translation of code to the ´new´tracking event model
- **Trg/**
  - TrgConverters:
    - TrgTrackToTrack, TrackToTrgTrack
      - Conversion: TrgTrack <-> Track
  - *TriggerVelo,TriggerVeloTT, TriggerForward*
    - TriggerVelo Private version to re-adapt to the last vertion of Track
      - Re-adapt the Trg reconstruction packages of DC04 (DV12 series) for the new Track
      - Compare the Trg (DC04) tracking with the new patter recognition tracking code.
      - Backwards compatibility:
        - with minor modifications (TrackEvent, TrackFitEvent?) we can run in DC04 data.
- **Vis/**
  - SoEvent
    - SoTrackCnv.cpp
      - Drawing the tracks in **Panoramix**
        - Improvements to draw: Measurements, States and maybe Nodes

Interactive reconstruction

- **Interactive reconstruction?: Via Python**
  - Already there:
    - GaudiPython and 'Bender'
      - Expose the Gaudi framework to Python: >> gaudi.run(1)
      - Expose most of DaVinci tools and LoKi 'metalenguage': 'Bender'
    - Interaction with Panoramix and the event display (T.Ruf)
  - In: Tr/TrackPython package
  - Benefits:
    - Interactive:
      - Debuging and testing the reconstruction
        - Event by event, track by track
    - Developing:
      - Simple for newcomers to start
        - A toolkit
      - Fast developing: 4 times faster than in C++
      - Easy prototyping: later you code in C++ with clear ideas
      - In fact, it run fast as it uses underneath the C++ code

Interactive and with display

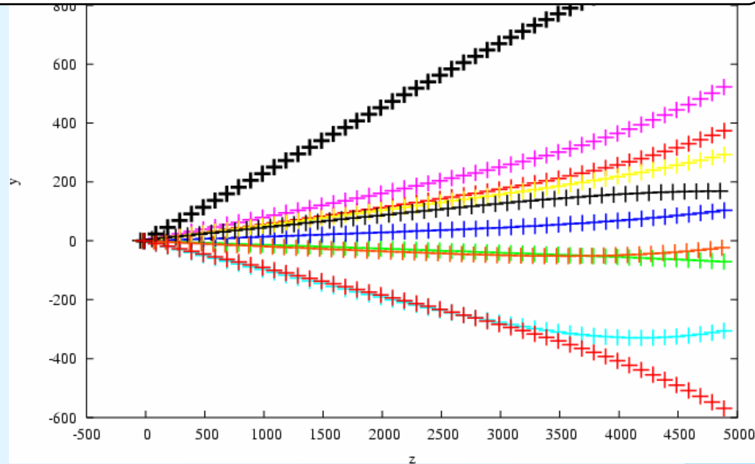
- **Python:**
  - Just import modules



Preliminary: Tracks in Panoramix

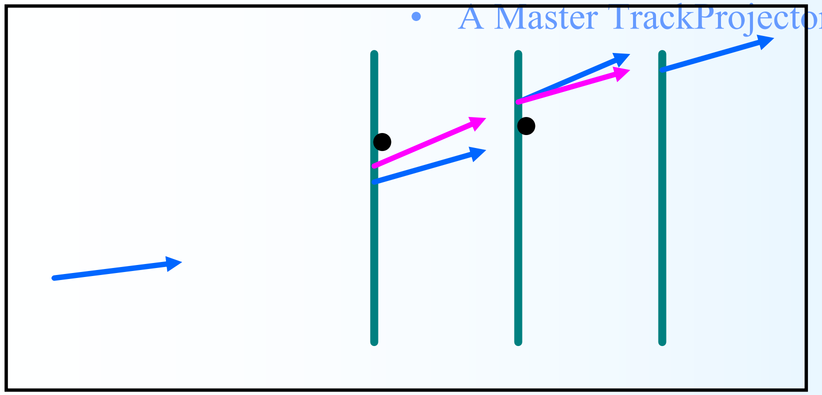
```
pol = extrapolator("TrackParabolicExtrapolator")

state = track.physicsState().clone()

z = 3000.

pol.propagate(state,z)

print state.y()
```

A scatter plot from a Python prompt



Some ideas: TrackSimulator

- **Tr/**
  - TrackSimulator
    - Simulator Tool: TrackSimulator
      - Main method: Simulate(Track&, const State& seed)
        - It will fill the Track with a collection of simulated measurements
      - Idea: simulate a Track with Measurement starting from a seed-State
        - Straight forward reuse of the Tracking Tools
      - To de:
        - Check that the KalmanFilter is correctely implemented
        - To check if the Extrapolator follows realistically the MCParticles
        - To do alignment studies
      - Setup of the Tool
        - A list of planes, or labels locations, or 'z' positions with the type of Measurements
        - A Master TrackProjector and an TrackExtrapolator.

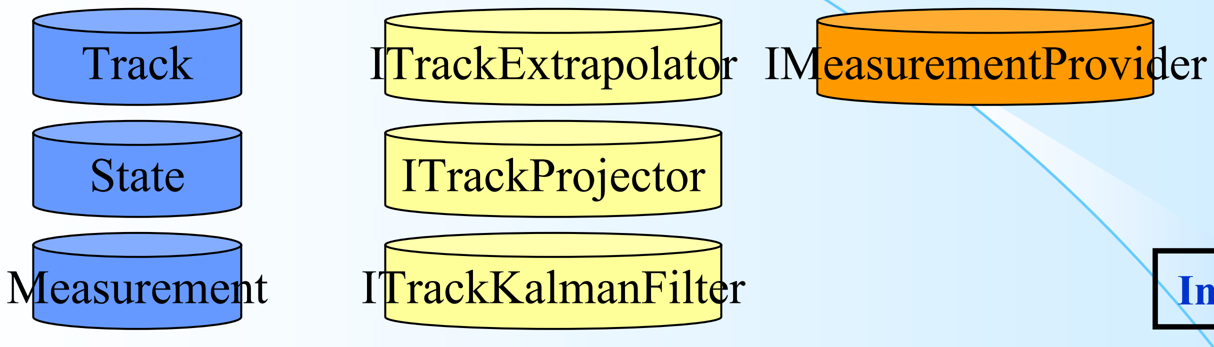


Do we want?:

Measurement->Cluster->Digit->buffer bank

Some ideas: toolkit reconstruction

- **The toolkit elements:**
  - Can you do the PR and fitting with this elements?



In Python or C++

  - A missing piece: MeasurementProvider (Tool):
    - A *smart* storage and *fast* provider of Measurements
      - Methods (design ideas…) , return a ordered list of measurements
        - orderByResidual(x,tolerance),
        - orderBySigma(x,sigmas), where x: 3D point
    - Using internal holders of Measurements (in tree hierarchy)
      - A holder class that could (design ideas…)
        - Methods: plane(), isInside(x) -a box-, id(),etc..
  - An aprox.. Example
    - From a state-seed extrapolate 'TT' planes
    - Get the measurements in order of sigmas around the extrapolated points
    - Make segments with them and fit them, select them according with a chi2 criteria
      - We have a collection of possible pt values associated to the seed,

Status and plans

- **Step I:**
  - Task Force has defined: Track and State
    - They are usable Track and States for:
      - Pattern Recognition, Fitting, Trigger and Offline
  - Implementation revisited 13/05/05
    - To be ready with the current status of packages: 27/05/05
- **Step II**
  - Task Force has defined preliminary versions: Measurement, Node, Projector
    - To use and see how they work
- **Plans:**
  - Pattern Recognitions packages:
    - Should fill the list of LHCbID of the Track
  - Fitting
    - Some recoding of the fitting, most already done.
    - Testing of the Extrapolators, Projectors and KalmanFilter
      - Delicate work…
    - An eye in the alignment…
  - Visualization and Interactivity
  - MC link
    - General use of LHCbIDs, link with the MC via LHCbIDs
- **Many front, small forces**