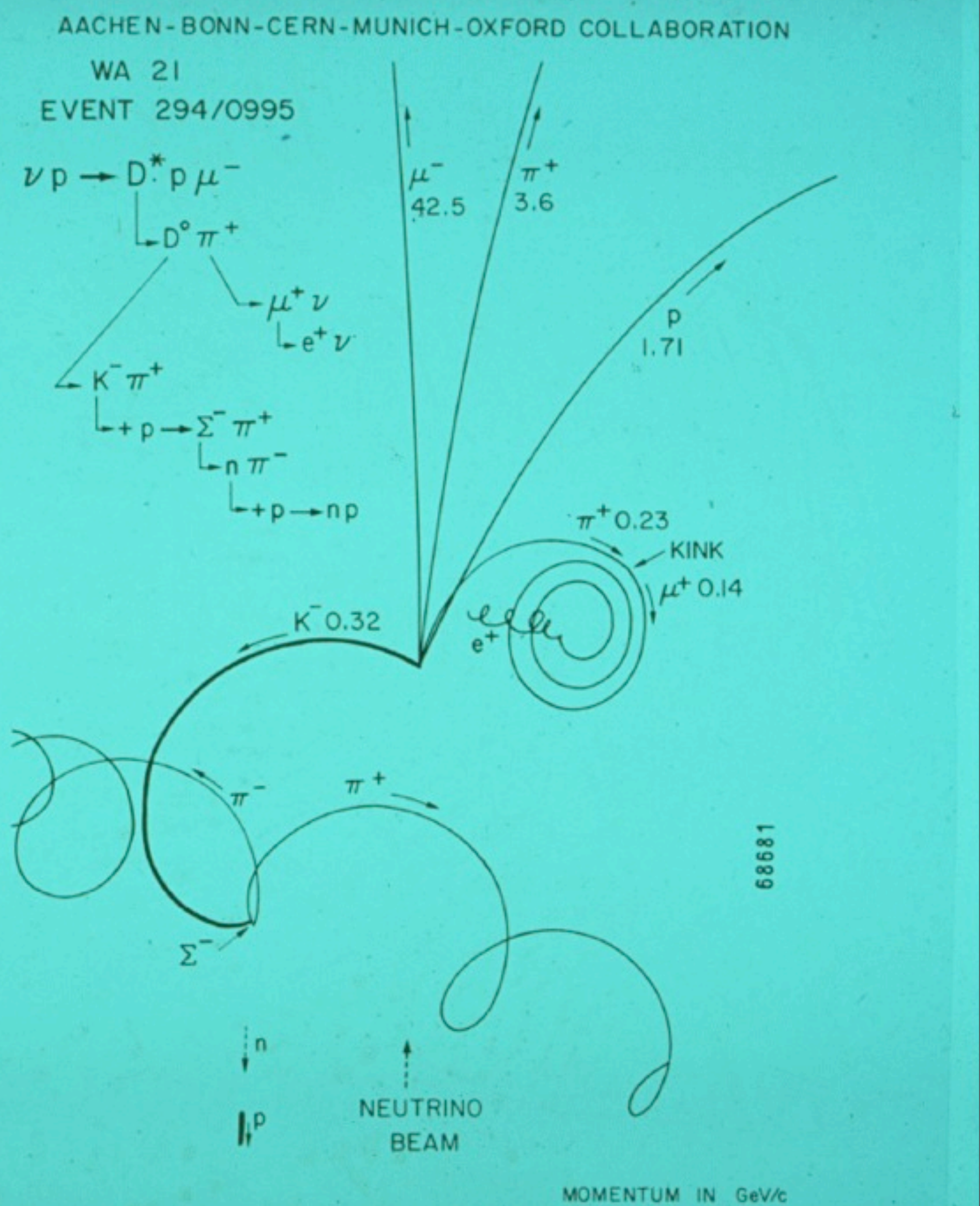
Tracking

Eugenio Paoloni



Talk Outline

- Tracking group in & out.
- Report of the activities since the last Belle2 Italian meeting.
- BaBar (1998) vs Belle2 (2014) track reconstruction code.
- Plan for the next months.

Tracking Group

- Group conveners:
  - Martin Heck, E.P.
- VXD & PXD:
  - Peter Kvasnicka, Peter Kodys, Rudi Früwirth, Jakob Lettenbichler, ***Eugenio Paoloni***, Manfred Valentan, Martin Ritter, ~~Isabelle Ripp-Baudot~~

Leaving Belle2

Now working on the "Beast"

- CDC:
  - Viktor Trusov, Oliver Frost
- Cross-detector:
  - Giulia Casarosa, ~~Benjamin Oberhof~~, Myroslav Stefaniuk

Now working on the ECL

- Kalman Fit:
  - Tobias Schlüter, Johannes Rauch

Now working on his Belle1 PhD thesis

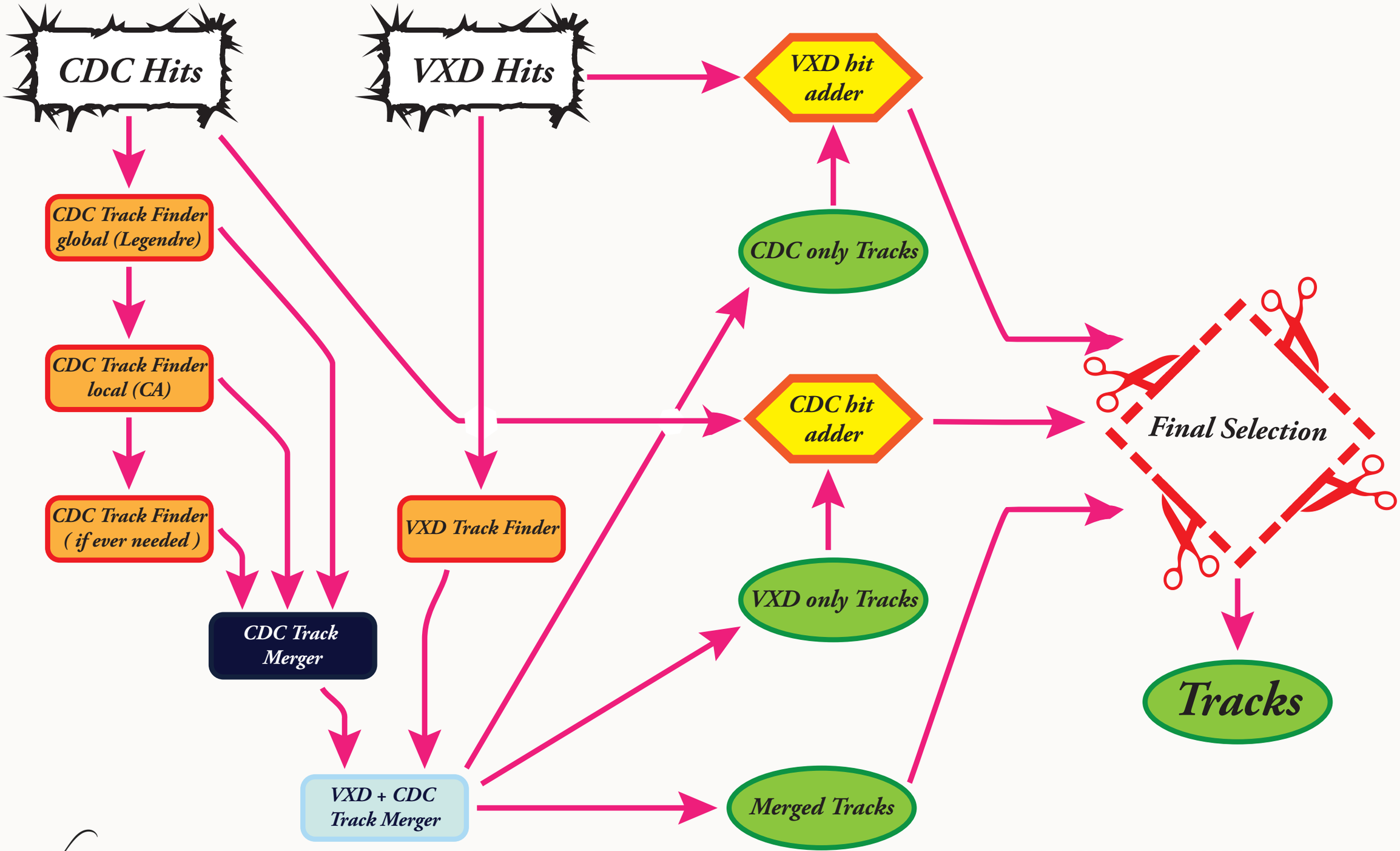
- Analysis Data Model:
  - Markus Prim
- Data reduction
  - Giulia Casarosa
- QA:
  - ***Giulia Casarosa***, Micheal Ziegler, Simon Wehle, Thomas Hauth

Leaving Belle2

Permanent Staff

- Rudi Früwirth (Vienna): pattern recognition, Kalman fit, vertexing etc. A cornerstone of the whole HEP track community (now retired).
- Eugenio Paoloni (Pisa): convener, SVD pattern recognition software consultant and developer.
- Peter Kvasnicka, Peter Kodys (Prague): geant4 simulation and digitization of the silicon hits.
  - ~ 0.5 (a fraction of my time) out of the 10 software developers.

Trak Data Flow: Reminder



Ongoing Activities Overview

- CDC pattern recognition:
  - Viktor Trusov is working on the segment reconstruction using stereo hits. (Global finder of tracks from the IP using conformal + legendre transforms).
  - Oliver Frost is working on the local track finder (cellular automata): the plan is to have a first working release ready for the CDC cosmic test in Spring 2015.
- VXD pattern recognition
  - Jakob and Eugenio are working on the design and migration of the present VXD track finder.
- QA
  - Giulia (and Thomas from 2015) are working on an extensive set of reference plots and tests of the track reconstruction software (see next talk)
- V0 reconstruction
  - Tobias(vertexing) + Markus (persistency)
- Long standing issue: hit pattern in the mini-MDST
  - Giulia will take care of filling the information (finally!)
- Trak merging
  - Benjamin (low priority w.r.t. ECL code development)

Road Map Presented At The 7th BPAC

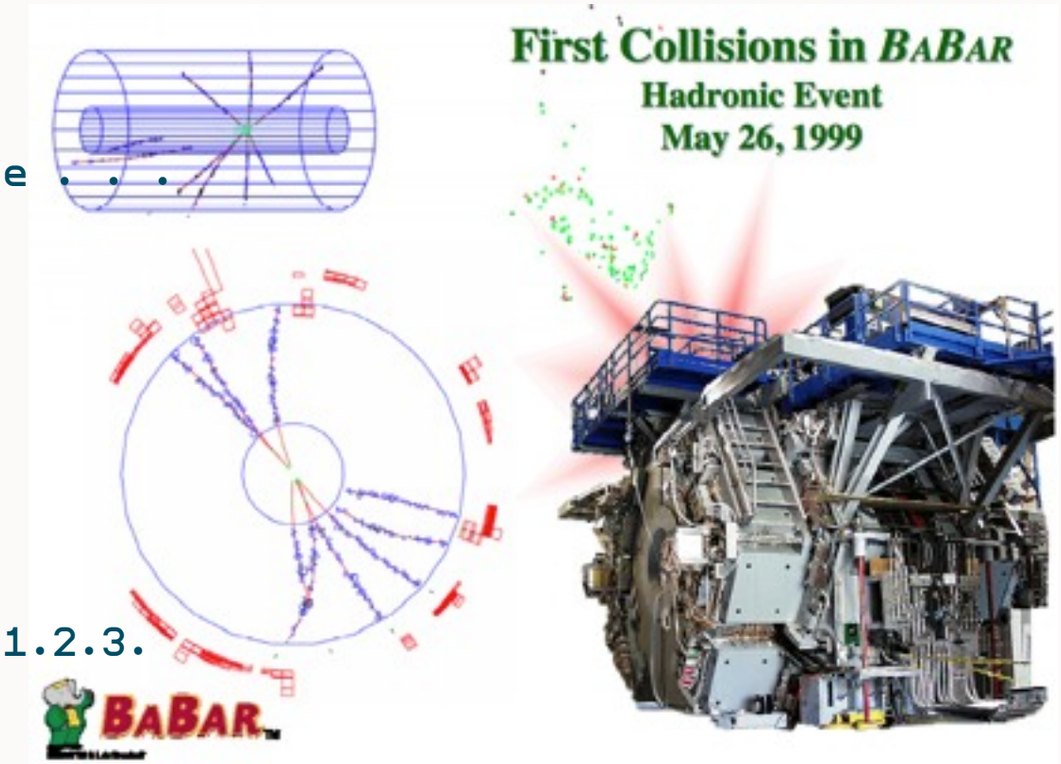
- ~March: CDC Track extrapolation to VXD Delayed
  → **MC campaign in April 14**
- ~September: CDC Finder functionality Delayed
  → **Physics Trigger development**

Now

- ~Spring 15: Low-Level Speed optimization for all track finders; Delayed
  Full VXD TF functionality, including making use of hits due to curling tracks (currently ignored); Delayed
  Cross detector searches; Delayed
  Killer module to remove likely fake or double-found tracks; Delayed
  → **cosmics with CDC, TOP, ECL,... in May 15**
- ~Spring 16: Studies of methods to determine systematics on trackfinding effieciency, fake rates, etc. (**should be done before Data Taking**)
- After data-taking begins:
  Validation MC ←→ Data
  Final Pattern Reco including hits from Cluster Rescue (tuning depends on background)
  Material budget determination
  → **High Quality Analysis**

BaBar TrkRecoTrk CVS Log

- 1.1 (Aug 30, 1996) [Steve Schaffner]
  - A few scattered pieces of newly designed tracking code.Nothing worth looking at yet.
- 1.2 (Oct 10, 1996)
  - More bits and pieces. Someday it will compile . . .
- 1.3 (Oct 24, 1996)
  - A couple of files compile now. Whoopee.
- 1.4 (Oct 30, 1996)
  - First set of files that will compile.
- 1.5 (Oct 30, 1996)
  - Untimely commit so I can move development to 1.2.3.
- 1.6 (Nov 5, 1996)
  - Added a version of the helix fitter (currently implemented with unmodernized HOTs). Compiles.



- April 1998: I joined the experiment. The track reconstruction was (painfully) working. There were no vertexing tools nor BetaMicros neither the map from reco objects to true MC particles on official MC production (because we were short on disk space).
- May 26, 1999: first hadronic event. [Steve Schaffner left the HEP]
- Aug 9, 1999: Lepton Photon talk: 2 (slowly spell it out: two) B to J/ψ K_s events (~150 pb^{-1})

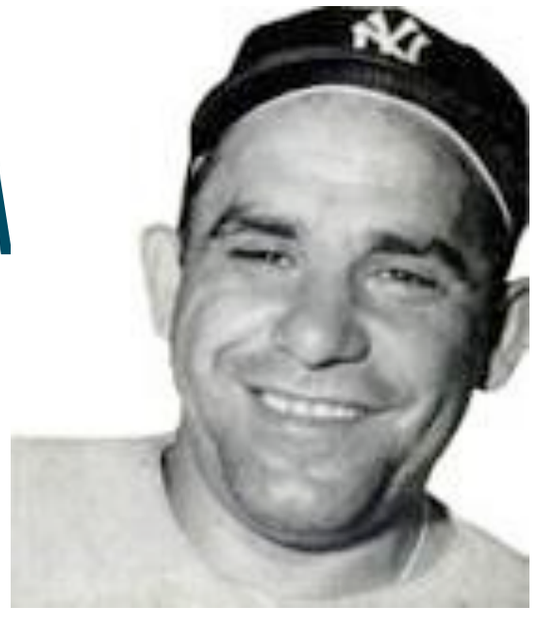
Where Do We Stand W.r.t. BaBar

- We are ***now*** in a better position w.r.t. BaBar ***one year before*** data taking on:
  - mini-MDST (BetaMicro equivalent): defined and almost correctly and completely filled.
  - Map from reco to MC true on official MC productions: it is available for all of us.
  - Framework, analysis data model, vertexing and composition tools, alignment tools.
  - Automatic validation and test.
  - Overall robustness of the code: painless, "Objectivity© hassle" free installation and joyful running experience. Marvelous event display.
- We are now in a worst position w.r.t. BaBar one year before data taking on:
  - Silicon pattern recognition (performances and reliability see next talk).
  - CDC pattern recognition (we do still rely on Trasan, the Belle1 track finder).
  - CDC VXD track merging and final track selection (we do still rely on MC truth).
  - Event reconstruction data model (we do still have to finalize its design).

Caveat Emptor!

"The Future Ain't What It Used To Be"

-Yogi Berra



VXD Track Finder Issues

- Very Inefficient PXD hit pattern recognition:
  - Only 18% of the PXD clusters are added to the SVD track
  - Poor resolution on the transverse and longitudinal impact parameter.
- Very irregular track reconstruction efficiency over the detector acceptance:
  - Polar angle: dip at lambda ~ 0 (theta ~ pi/2)
  - Azimuthal angle: modulation following the pin wheel geometry of the SVD layer 3
- Code almost impossible to debug: we (Martin, Jakob and I) decided to concentrate our efforts on the redesign.

VXDTF Code Redesign Goals

- Keep the good:
  - Algorithm principles (from Rudy + Jakob), speed, efficiency (as a starting point).
- Throw away the bad:
  - Code bloat (cut, copy and paste development style).
  - Hidden dependencies, hidden assumptions.
- Add some more good:
  - flexibility to implement smarter algorithms,
  - robustness enforced by design,
  - improvements on the efficiencies from bug fixes, parameters tuning.

Conclusions

- The tracking code is evolving at peace slower than planned (unexpected bugs, lack of well defined goals and milestones)
- We are trying to define clear goals by defining a set of key quantities and their final value defined by detector performances
- Experienced people are welcome for reviewing our results
- Young people are welcome for providing things to be reviewed by experienced people

Grazie

Per la cortese

Attenzione!