AIDA

Advanced European Infrastructures for Detectors at Accelerators

Presentation

Progress in Track Reconstruction

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05 September 2014

The research leading to these results has received funding from the European Commission under the FP7 Research Infrastructures project AIDA, grant agreement no. 262025.

This work is part of AIDA Work Package **2: Common software tools**.

Progress in Track Reconstruction

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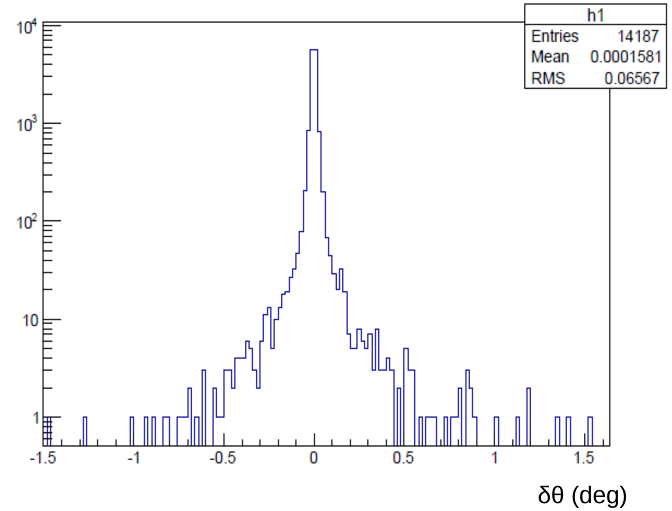
Outline

- Pattern recognition
  - Silicon tracking
    - FPCCD Tracking (Tatsuya Mori, Tohoku Univ.)
    - Cellular automaton for VXD tracking based on mini – vectors (DESY)
- Track fitting
  - aidaTT package (DESY)

Mini – Vector CA VXD Tracking

- Exploits the double sided ladder structure of VXD
- Up to now, has been applied in various CMOS VXD configurations (see table)
- Mini – vector formation
  1) Hits in adjacent layers (dist 2mm) with max distance 5mm
  2) Or δθ between hits in adjacent layers (cut can go up to 0.1^0)
- Divide VXD into θ, φ sectors
  - Try to connect mini – vectors in neighbouring sectors using a cellular automaton algorithm (next slide)



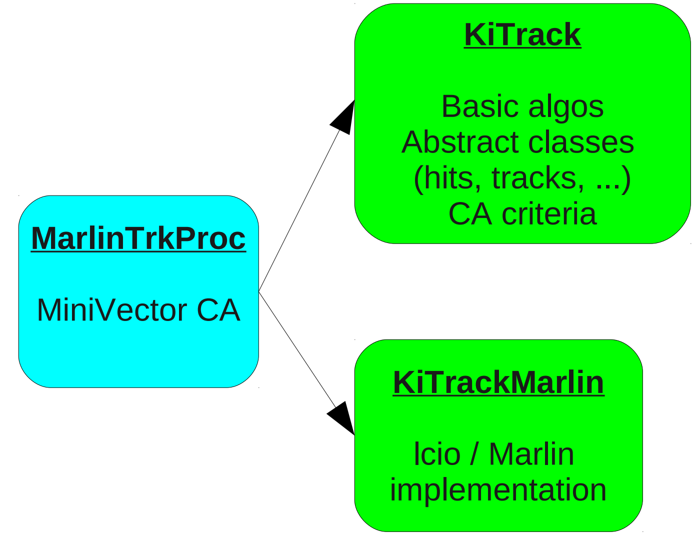
ttbar, δθ of hits belonging to a MV based on MC info

	CMOS 1		CMOS 2		CMOS 3	
layer	σ_{sp} (μm)	σ_{time} (μs)	σ_{sp} (μm)	σ_{time} (μs)	σ_{sp} (μm)	σ_{time} (μs)
L1 / L2	3 / 6	50 / 2	5 / 5	8 / 8	3 / 5	50 / 8
L3 / L4	4 / 10	100 / 7	5 / 5	16 / 16	5 / 5	16 / 16
L5 / L6	4 / 10	100 / 7	5 / 5	16 / 16	5 / 5	16 / 16

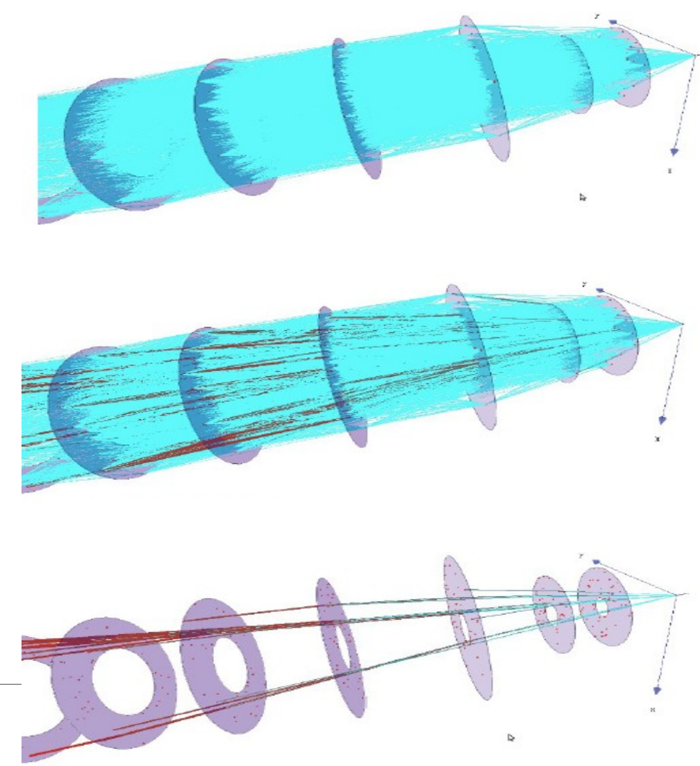
Cellular Automaton Tools

- <u>Core tools are already there for the FTD tracking</u>
- Very flexible
  - Appealing to be used for pattern recognition in other detectors
  - See R. Glattauer Diploma thesis

http://www.hephy.at/fileadmin/user_upload/Publikationen/DiplomaThesis.pdf



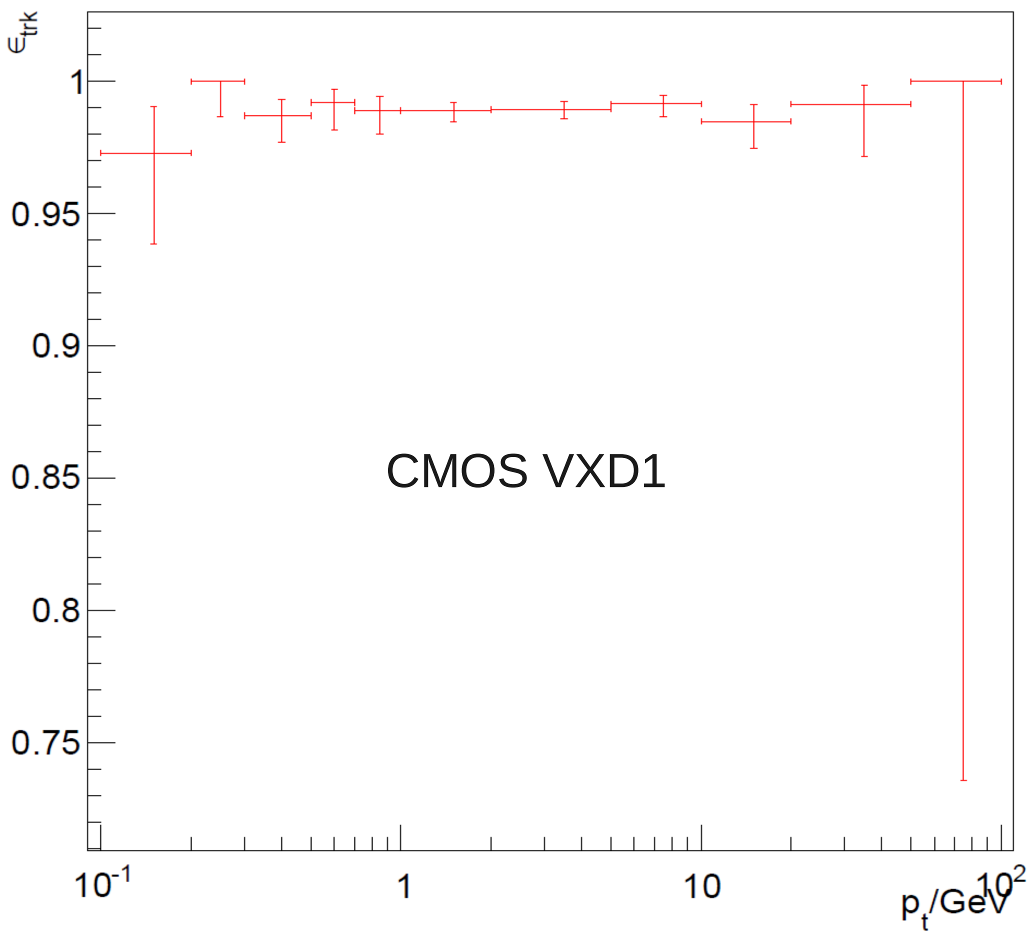
- ✓ VXD & mini – vectors related definitions of KiTrack abstract classes have been created in KiTrackMarlin
- ✓ Set of criteria for mini – vector connections have been defined in KiTrack
- ✗ Minor modifications in core tools
  - Pattern recognition is quite detector - specific...

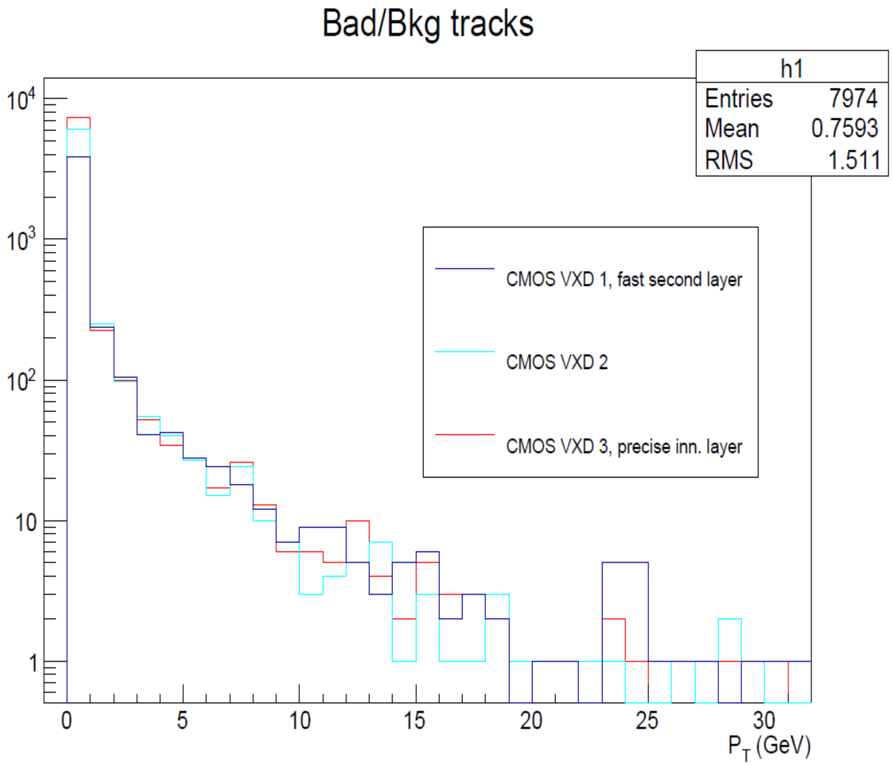


Performance

Sample: ttbar, √s = 500 GeV, pair bkg overlayed

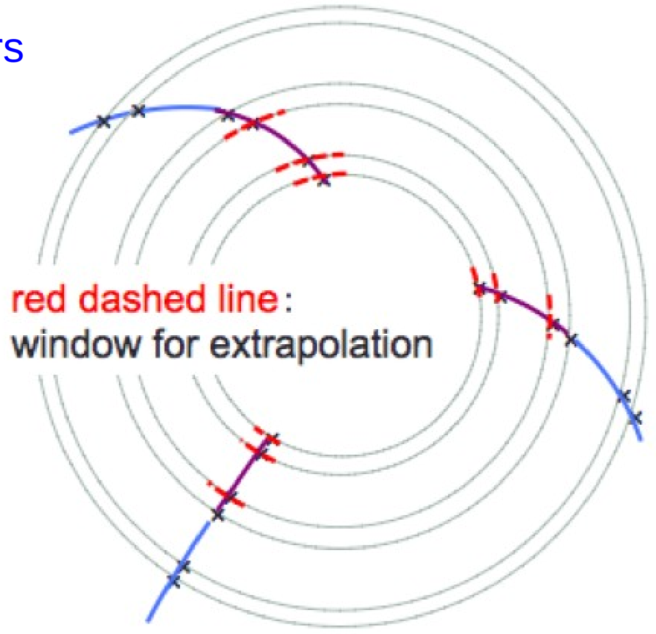
	CMOS 1	CMOS 2	CMOS 3
Hits ($x10^3$)	~120	~30	~100
Bad trks / evt	~56	~84	~100
Time / evt (s)	~15	~10	~100





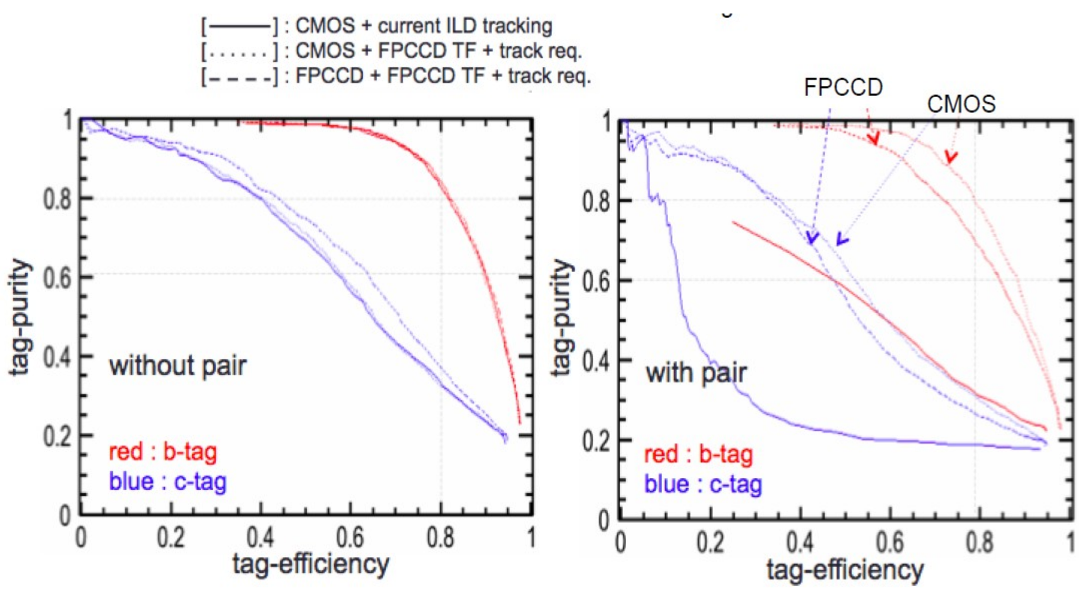
FPCCD Tracking

- Following the std silicon tracking philosophy
- Has improved the following crucial steps:
- Seed formation:
  - Angular sectors: φ width enough to generate seeds with minimum P_T 180 MeV
- Track extrapolation
  - Extrapolate seeds using Kalman filter instead of simple helix fit
    - More efficient for low P_T tracks, takes into account MSC
  - φ width for extrapolation flexible, defined by track parameters
    - It catches true hits and avoids most of bkg hits



Striking improvement in Silicon tracking performance in terms of efficiency, ghost rate, time in the presence of pair bkg compared to std algorithm

FPCCD Tracking Flavour Tagging Performance



- We examine 2k evts of Z→bb, cc, uds
  - One bunch train of pair bkg overlayed
- LCFIPlus trained with 14k evts
  - No pair bkg

Detector	Algorithm	Pairs	b – tag purity (%) (efficiency 80%)	c – tag purity (%) (efficiency 60%)
DBD	STD	No	82.8	56.4
DBD	STD	Yes	30.4	20.0
DBD	FPCCD	Yes	77.6	49.4
FPCCD	FPCCD	Yes	67.8	41.6

- Pair bkg degrades significantly the flavour tagging performance
- FPCCD track finder substantially improves the flavour tagging performance, compared to std silicon tracking algorithm

Results from J. Strube talk at AWLC14

aidaTT – a generic tracking toolkit

- Developed in the context of AIDA (EU FP7), with focus on ILD application
- Completely modular: data, algorithms, fields and geometry are independent entities
- Working track fitting implementation exists
  - GBL as fitting algorithm ("alignment enabled")
  - Field and data as in Marlin
  - Geometry in DD4hep - defined as surfaces
- Bundles with DD4hep: create a detector description, run a simulation, fit tracks - "works out of the box"
- Ongoing steps:
  - Implement/extend/connect to IMarlinTrk (enables full ILD usage, including existing track finding algorithms)
  - Incorporate/validate track finding algorithms for generic use (Conformal mapping and Riemann fitting)
  - Add KalmanFilter as alternative fit method
- Additional info:
  - Has to be finished by end of the year
  - Includes several examples
  - Extensively documented in code (doxygen) and manual
  - Complete build and (unit) test system

Conclusion

- Standalone Silicon tracking: significant progress since last ILD meeting
- 2 algorithms that can cope with beam bkg, FPCCD – mini – vector tracking
  - Cellular automaton mini – vector tracking
    - ✓ Excellent efficiency up to 100 MeV tracks && satisfactory time performance for fast CMOS detectors
    - ✗ Contamination from bkg – ghost tracks
    - ✗ Compromised performance for slower detectors (e.g. slower CMOS – FPCCD VXD)
  - FPCCD tracking
    - ✓ Satisfactory performance for FPCCD detector
    - ✗ Time – "bad" tracks rate
- Still quite some work ahead – degraded flavour tagging performance
- But now we have the tools to work on VXD optimisation
- Physics studies planned
  - Heavy flavour tagging, h→cc, bb
  - Light Higgsinos – ideal to study low P_T tracks reconstruction
- AidaTT outlook
  - Generic pattern recognition
  - Implementation of Kalman filter