HLR week, DESY, Hamburg

Silicon Tracking Options

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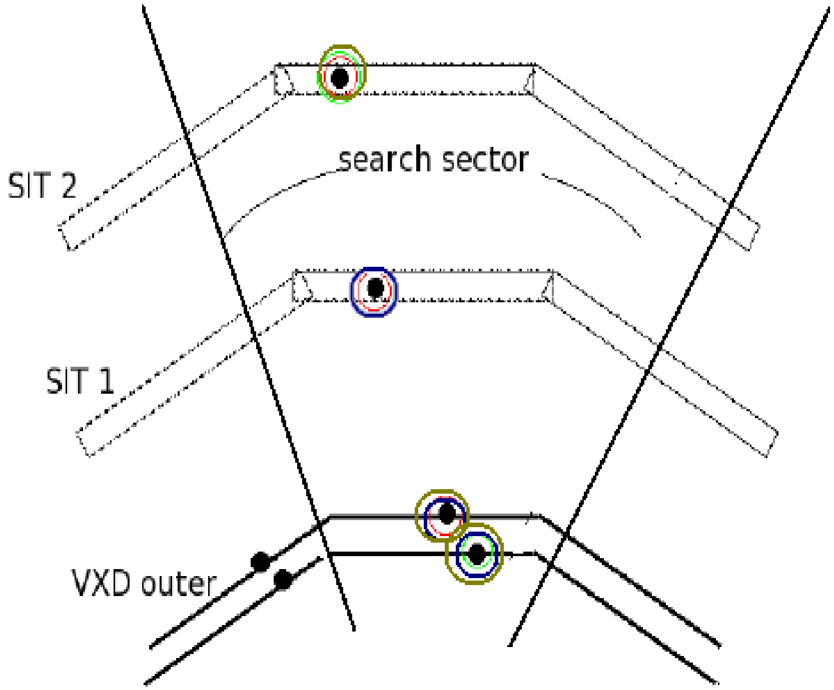
Outline

- Silicon tracking algorithms
  - DBD tracking
  - FPCCD tracking (Tatsuya Mori, Tohoku)
  - Mini-vector tracking based on a cellular automaton (DESY)
- Performance – pros & cons of each algorithm
- How to

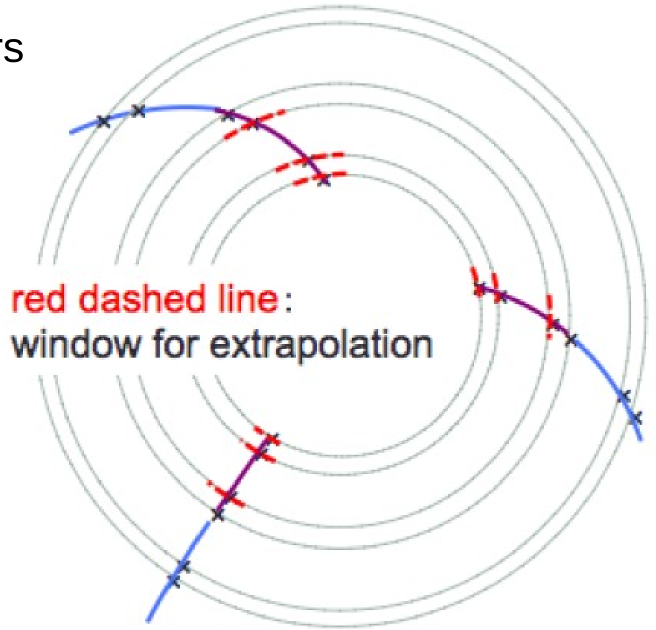
DBD silicon tracking

- Divide VXD – SIT into angular sectors
- brute force triplet search in stereo angle sectors based on a set of seed-layer-triplets
- Fit a helix to the seed triplets
- Follow the seed helix inwards – attach hits according to the distance from the helix
- Sorting – selection of track candidates
- Attach remaining hits in the intermediate layers
- Refit with Kalman fitting



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

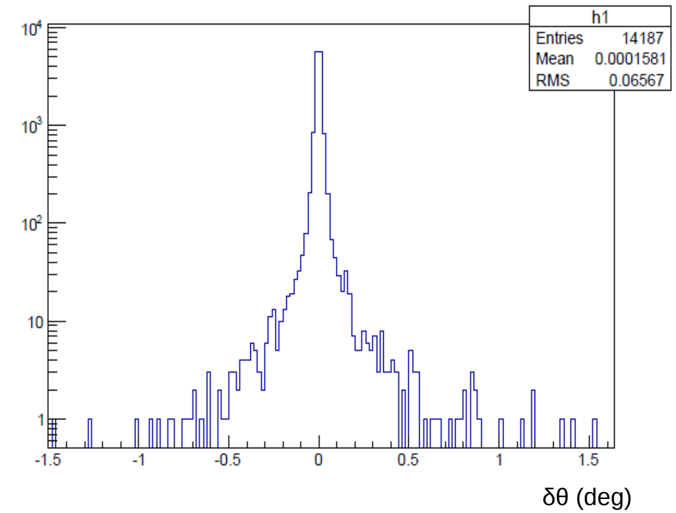


Striking improvement in Silicon tracking performance
in terms of efficiency, ghost rate, time
in the presence of pair bkg compared to std algorithm

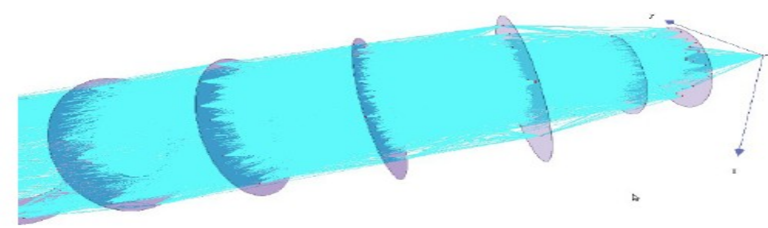
Mini-vector tracking

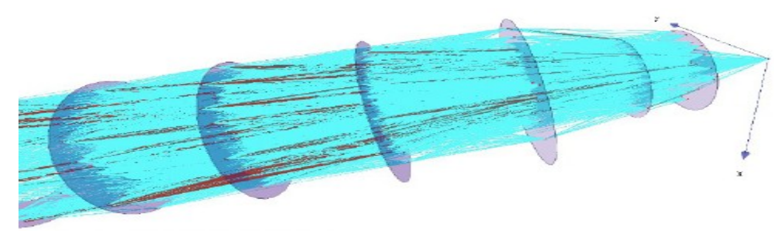
- Exploits the double sided ladder structure of VXD
- Up to now, has been applied in various CMOS VXD configurations
- Mini – vector formation
  1) Hits in adjacent layers (dist 2mm) with max distance 5mm
  2) Or δθ between hits in adjacent layers (cut can go up to 0.1^0)
- Divide VXD into θ, φ sectors
  - Try to connect mini – vectors in neighbouring sectors using a cellular automaton algorithm
- <u>Profit from cellular automaton tools for the FTD tracking</u>
- Very flexible
  - Appealing to be used for pattern recognition in other detectors
  - See R. Glattauer Diploma thesis

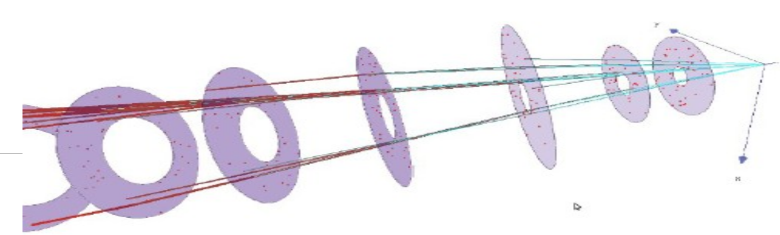
http://www.hephy.at/fileadmin/user_upload/Publikationen/DiplomaThesis.pdf



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

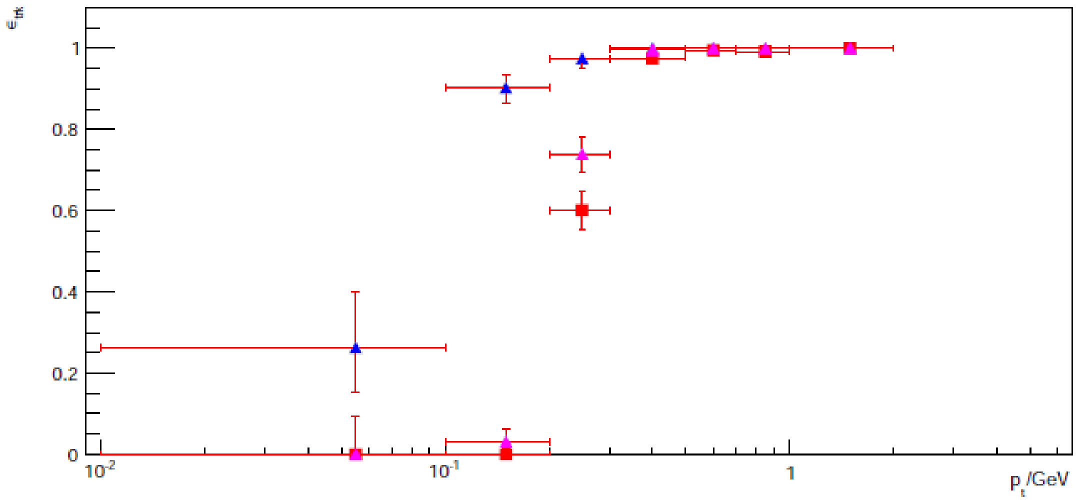


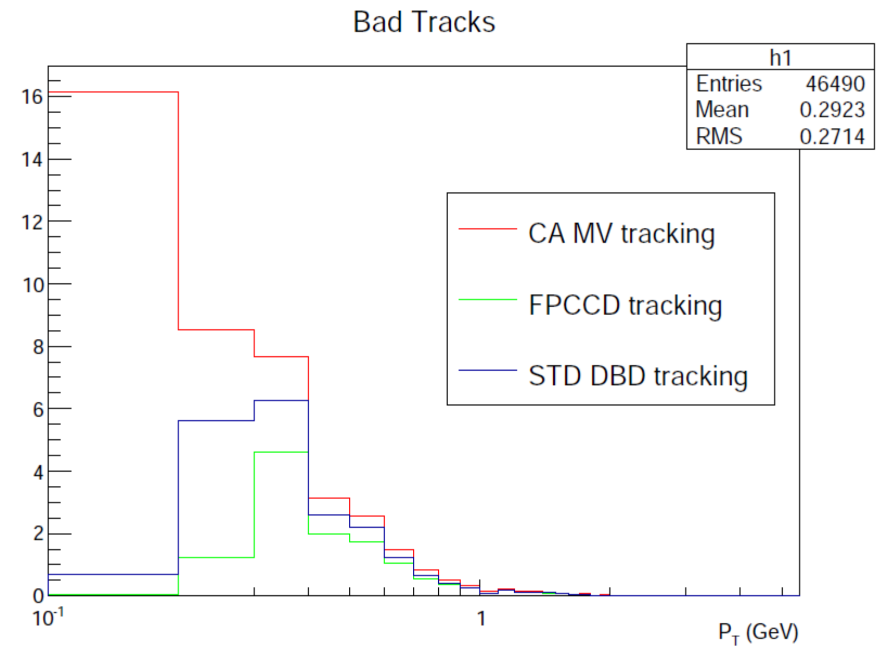


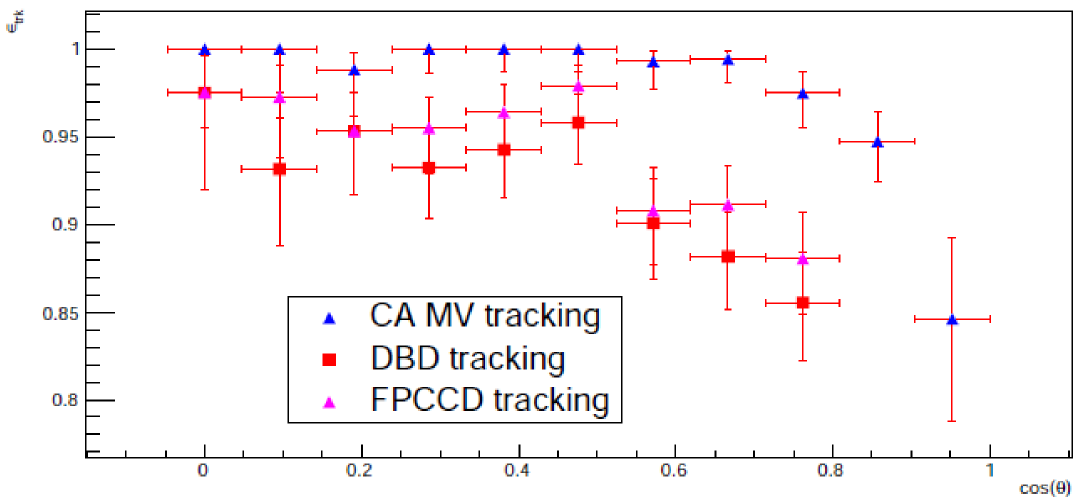


Performance of new VXD tracking tools

Sample: higgsino, √s = 500 GeV, fast CMOS VXD, pair bkg overlayed



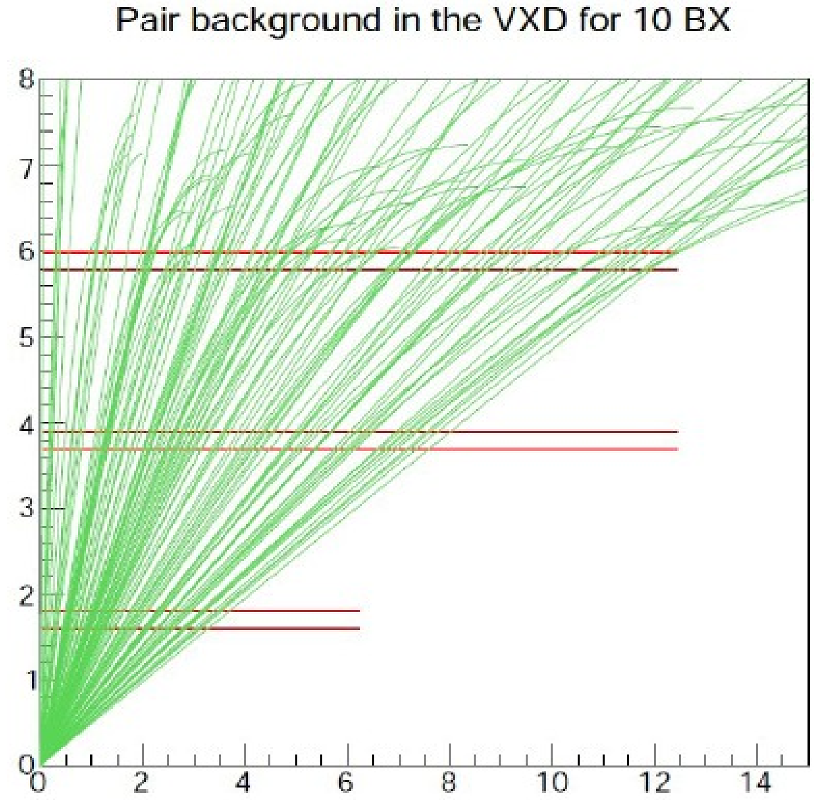




	Fast CMOS VXD	
layer	$\sigma_{spatial}$(μm)	σ_{time}(μs)
L1	3 / 6	50 / 2
L2	4 / 10	100 / 7
L3	4 / 10	100 / 7

When to use the mini-vector tracking

- Offers standalone VXD tracking
- Strongly detector-dependent
  - Double layers detector
  - Combination of fast & precise layers (CMOS VXD - like)
- High bad track rate due to the pair bkg in VXD
  - Dealing with bad tracks in analysis level
- ~15 s/evt (6 fermions + pair bkg according to CMOS VXD specifications)
- Used in higgsino study
  - Various VXD concepts are considered



From Armin Taenzer

Use of FPCCD tracking

- Not detector design dependent
- Deals with bad track rate – time performance issues by requiring ≥ 1 SIT hits during seeding
- ~ 1min/evt (6 fermions + pair bkg according to CMOS VXD specifications)
- Has been studied in the framework of heavy flavour tagging

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

Results from J. Strube talk at AWLC14

How to use the new tools

- Steering files minivector_reco.xml & FPCCDTracker_stdreco.xml have been added to ILDConfig
- minivector_reco.xml
  - SiliconTracking_MarlinTrk has been replaced by CellsAutomatonMV processor, which runs the minivector tracking
  - Output track collection (CATracks) been fed to TrackSubsetProcessor where are merged with forward tracks
- FPCCDTracker_stdreco.xml
  - SiliconTracking_MarlinTrk has been replaced by FPCCDSiliconTracking_MarlinTrk processor
  - FullLDCTracking_MarlinTrk has been replaced by FPCCDFullLDCTracking_MarlinTrk processor
    - Main difference an added strategy for bad track suppression (turned off by default)
- One should also edit the VXDPlanarDigiProcessor when using non-DBD VXD concepts (std case for mini-vector tracking)

Summary

- Do we need VXD standalone tracking (efficiency down to 100 MeV)
  - Mini-vector tracking
  - Detector dependent
  - Deal with “bad” tracks in analysis
    - Faster detectors?
- If we require high efficiency for $P_T > 300$ MeV
  - Requirement for SIT hit will substantially decrease “bad” rate
  - FPCCD appears to have better performance than DBD silicon tracking
- Validation of new pattern recognition algorithms
  - FPCCD has been studied in heavy flavour tagging
  - Mini-vector & FPCCD are under study in a higgsino scenario