# ILD Silicon Tracking

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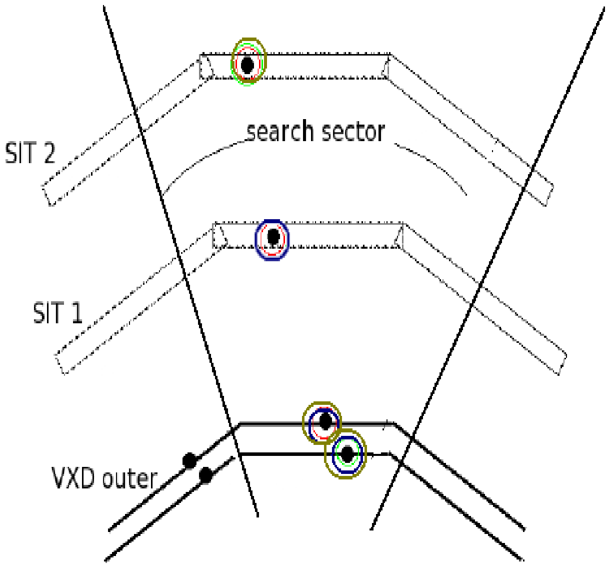
# Outline

- Motivation
  - Find low $P_T$ tracks
- Approaches
  - Cellular automaton (standalone Si tracking)
  - Track extrapolation from TPC (not standalone)
  - Combination of CA and Kalman filter based track following
- Main issue
  - Time per evt in presence of beamstrahlung hits
  - Minimisation of ghost / bkg tracks
- Sample
  - Muons at fixed $P_T$ + 500 GeV beam bkg hits overlayed

# Standalone Cellular Automaton




**Based on the CA algorithm for the FTD**

DBD VXD “slow”

| layer | $\sigma_{spatial}$ (μm) | $\sigma_{time}$ (μs) |
|---|---|---|
| L1 | 3 / 6 | 50 / 10 |
| L2 | 4 | 100 |
| L3 | 4 | 100 |

- Make hit combinations in all layers, inside a predefined range (2D angular sectors)
  - Huge number of hit combinations
- Test the combinations vs various connection criteria
  - Huge number of “raw” tracks
- Prefit the ones who survive
- If $\chi^2$ prob > 0.005, keep them as candidate tracks

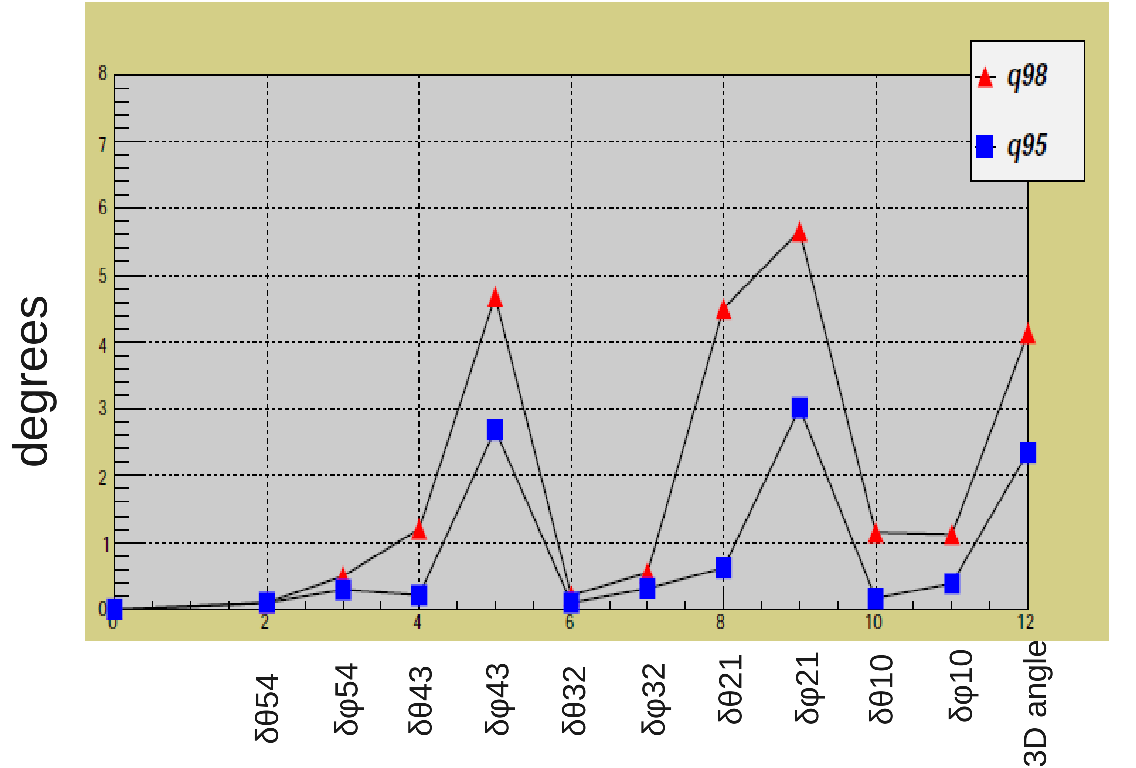
Proposed VXD design for √s = 1 TeV “fast”

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

# Criteria Optimisation

- Combinatorics reduction
- We first examine a favourable case
  - Standalone VXD
  - Hits combined only with hits from the next layer
  - Meticulously optimise the criteria for each layer to layer transition

- Criteria optimised for transition from each layer to the next one
- 2 rounds, with 98% and 95% acceptance on all momentum range
- Sample
  - ttbar



# Standalone CA – some results

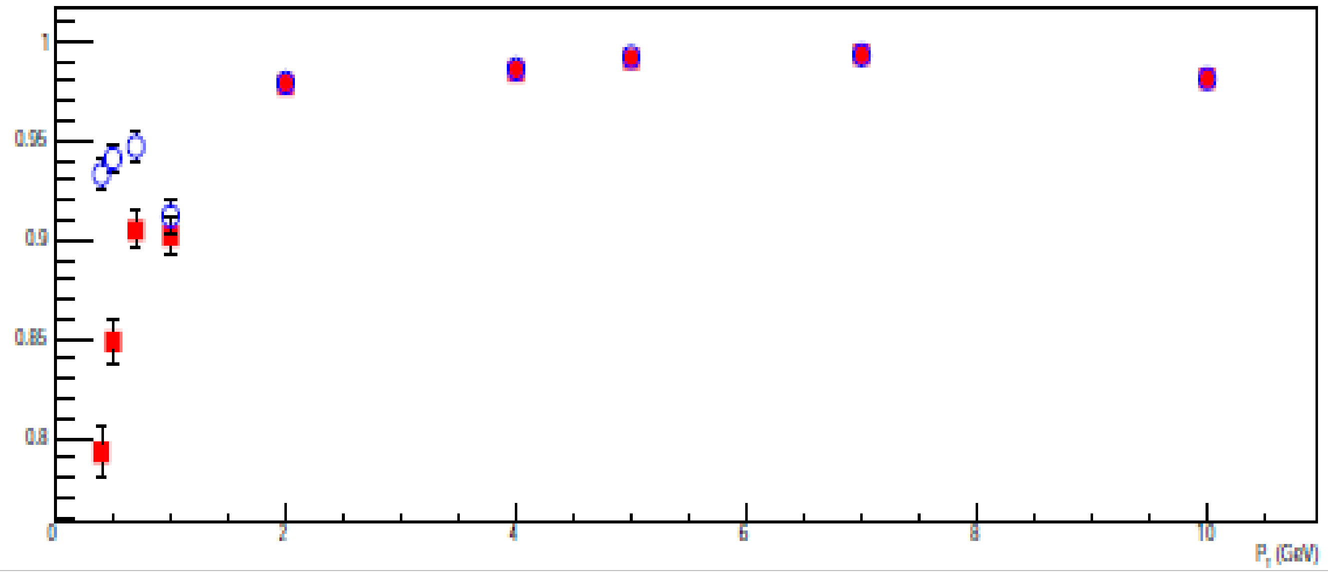
| | eff | Ghost - bkg | Time (s/evt) |
|---|---|---|---|
| Slow | 98 % | 5.7 | 325 |
| Fast | 98 % | 0.4 | 378 |

- 10 GeV muons, + beam bkg
  - Time consuming
  - 3D angular sectors, optimised for low Pt track reconstruction
  - Is there a faster/more efficient way to organise our data than 2D angular sectors?

# TPC to Outer VXD – not Standalone

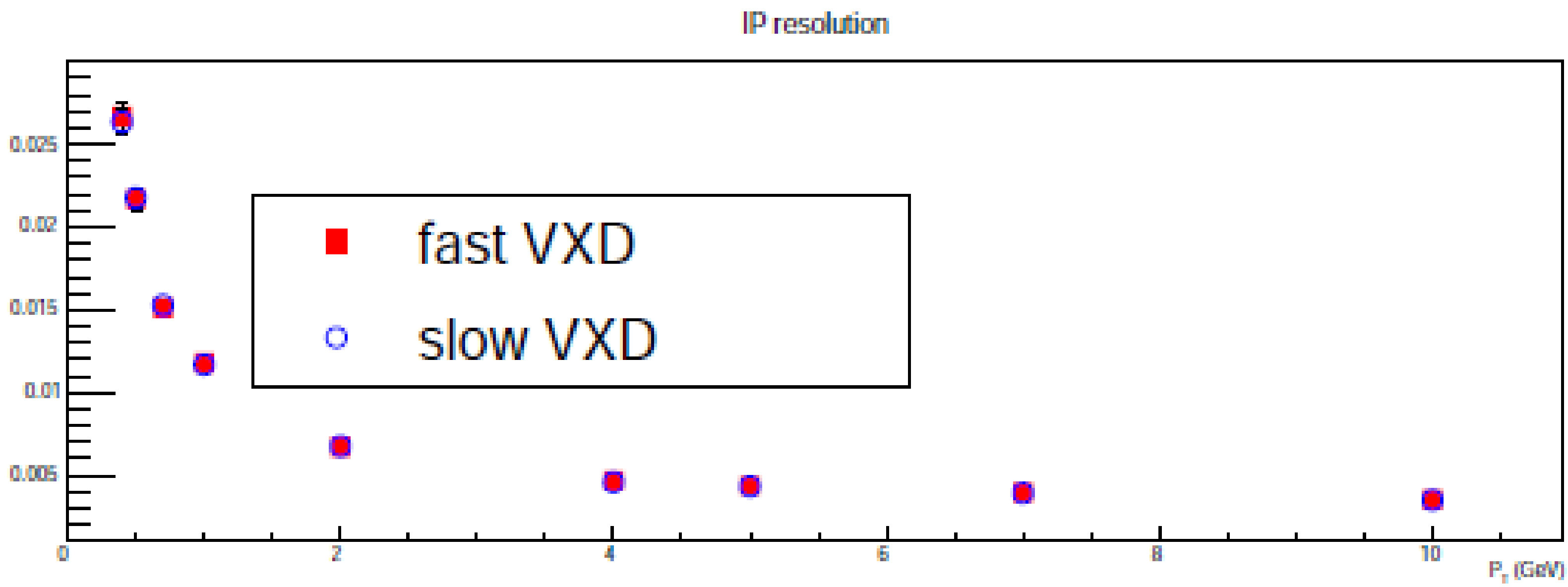
Prob. to associate bkg hit at outermost VXD


Efficiency



# What about Spatial resolution

- Fast VXD
- Slightly degraded s.p. resolution at sensors on middle & outer superlayer
- Could that effect the IP resolution?

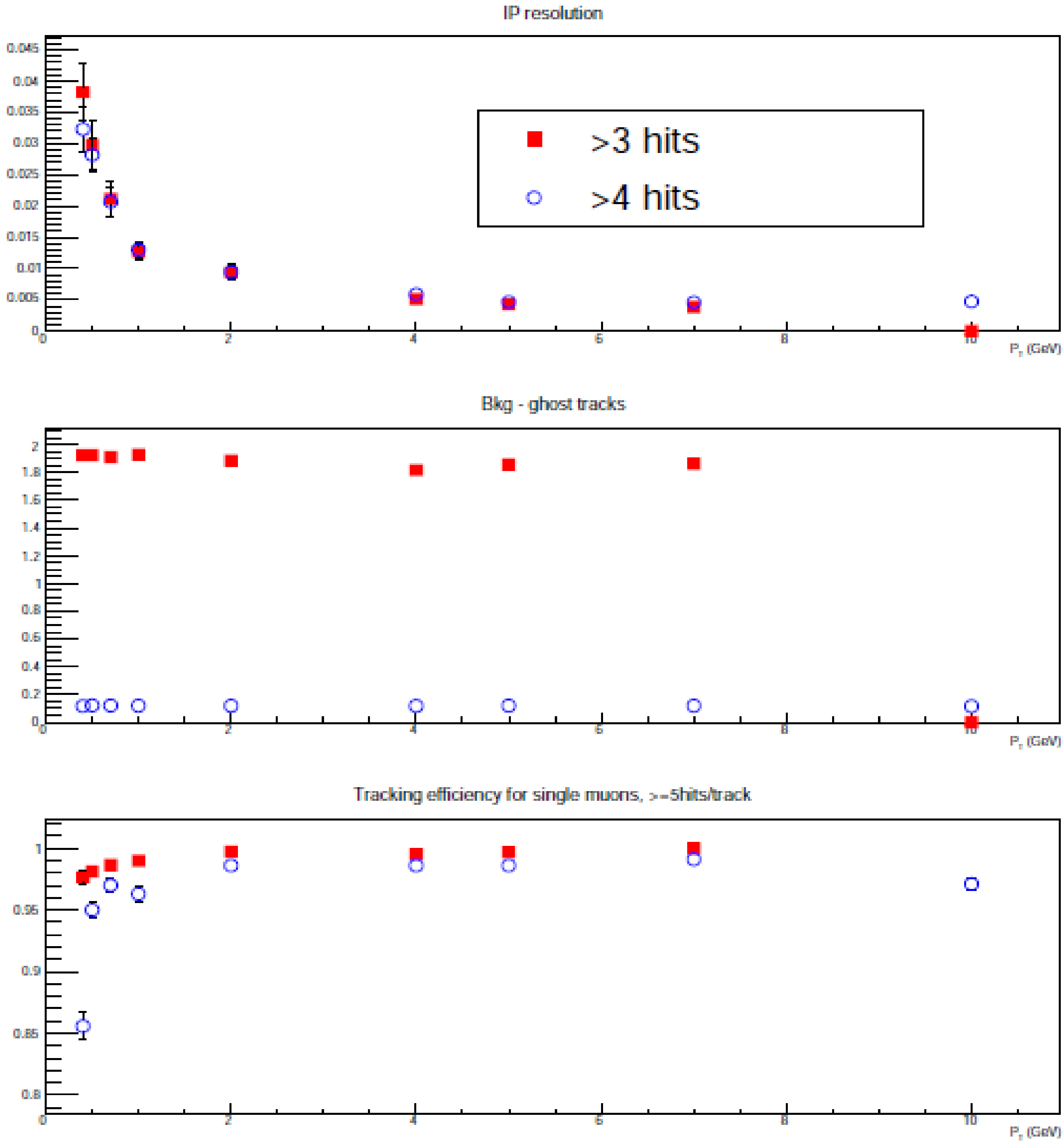



*We didn't observe any such effect*

# Cell. Automaton for seeding - Standalone

- In Cellular automaton we try to connect every hit with all hits inside a certain φ-θ range on subsequent sectors
- Very time consuming
  - Try to organise our data in a smarter way
  - **Exclude inner layer from cellular automaton**
- The idea is to find a seed using CA at the SIT, outer & intermediate VXD
- Then propagate to inner layer
- Seed hits ≥ 5 or ≥ 4

# Results




Time: 20 – 50 s / event

# Outlook

- **Standalone approach**
  - Explore more the low $P_T$ range, try to find a minimum $P_T$
  - Seeding only at SIT + outer VXD layers
  - Validate the results with physics sample
  - Further optimisation of time performance
    - Data structures
      - Is the 2D angular sectors the best option?
    - Software wise
      - Are there libraries which can perform e.g. matrix algebra faster?
- **Propagation from TPC**
  - VXD – SIT optimisation studies
  - S.p. resolution of VXD outer – intermediate layers
    - Negligible effect observed on IP resolution