HRS Analysis Code

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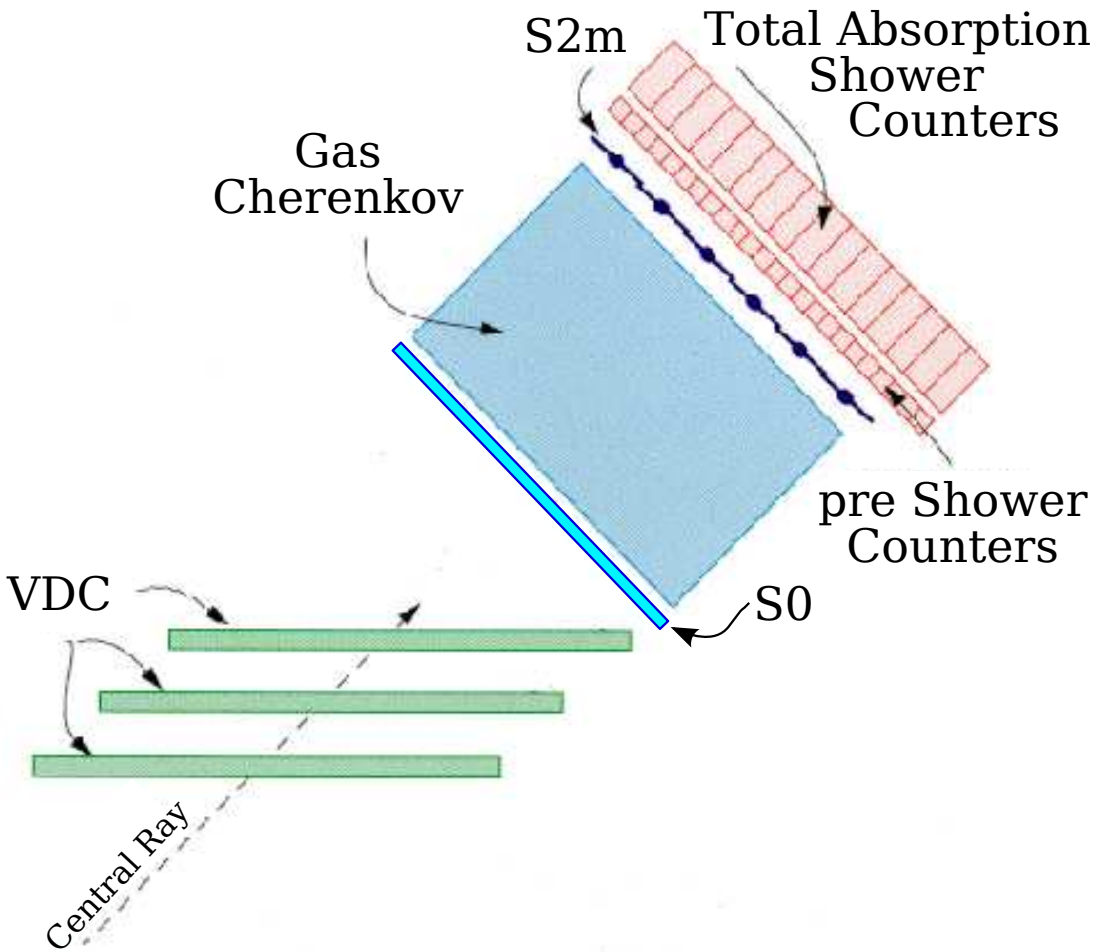
Jefferson Lab

G_M^p (E12-07-108) Collaboration Meeting
September 24, 2012

Proposed HRS Detectors for G_M^p



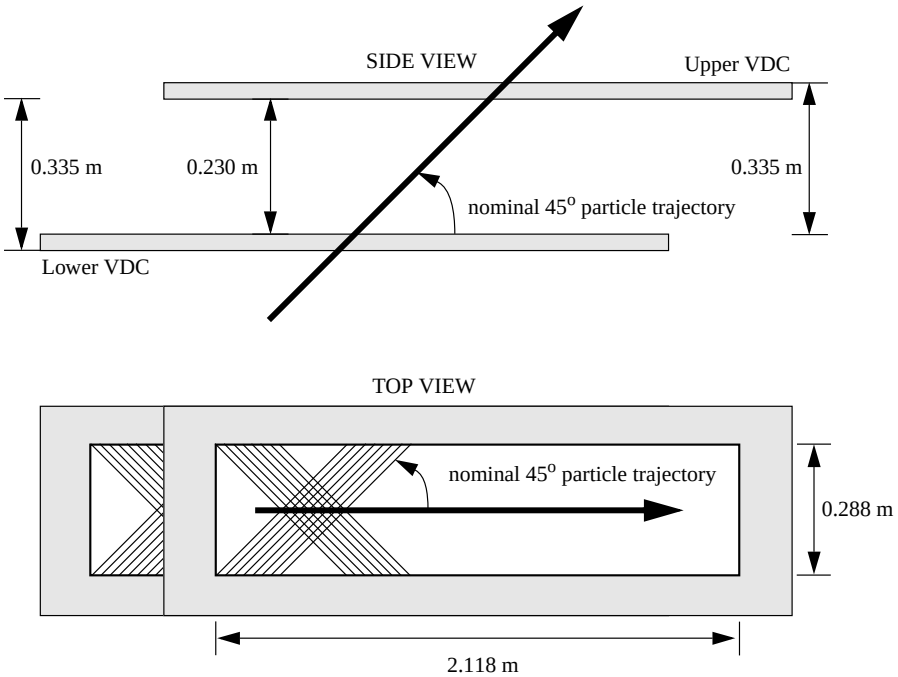
NB: Proposal calls for 3rd VDC chamber

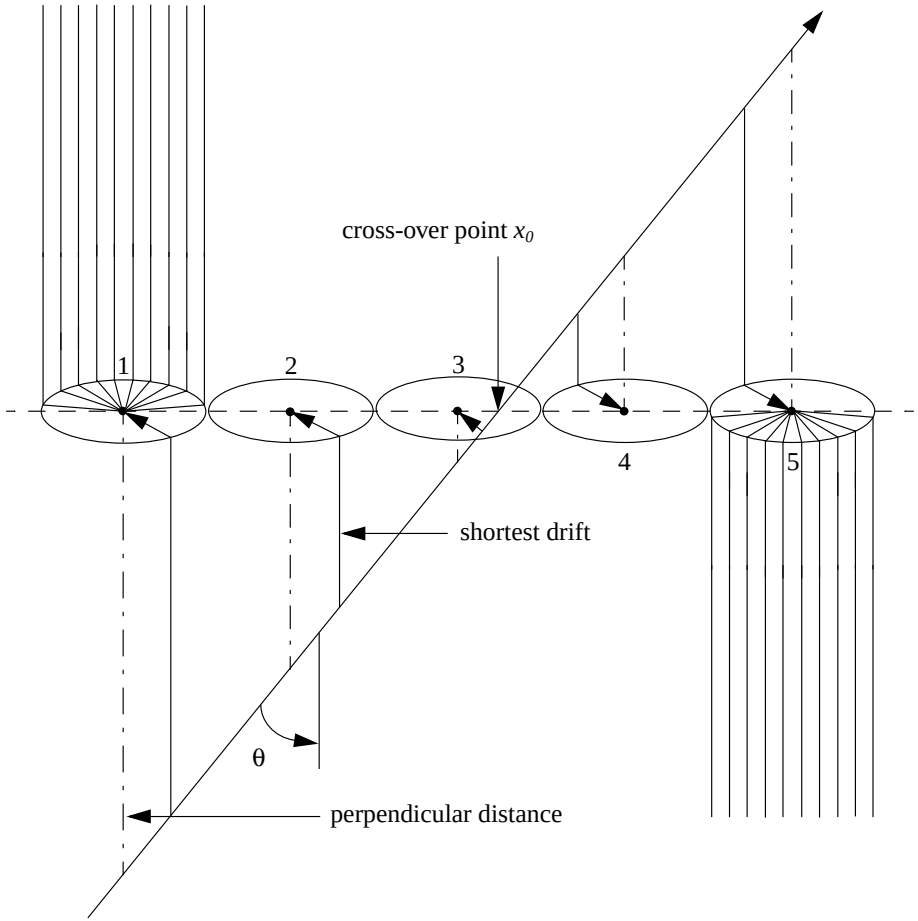
Status of HRS Analysis Software Modules

- VDCs: `THaVDC`
  - Standard code works well, but cannot handle tracking ambiguities
  - Improved code written for APEX largely solves ambiguity problem, but is not well tested yet
  - No support for a possible 3rd chamber. Not trivial to add
- Scintillator: `THaScintillator`
  - Handles arbitrary number of 2-PMT paddles w/ADCs and TDCs
  - Does basic gain, time offset & pedestal corrections
  - Some advanced corrections (timewalk etc.) — possibly buggy
- Cherenkov: `THaCherenkov`
  - Handles arbitrary number of PMTs w/ADCs and TDCs
  - Basic gain, time offset & pedestal corrections
  - Calculates ADC sum
  - No advanced computations (*e.g.* # p.e., time correlation, pileup removal)
- Calorimeter: `THaTotalShower`
  - Handles both shower and preshower w/configurable layouts
  - Pedestal & gain corrections
  - Finds the one cluster with the most deposited energy in each layer
  - Matches clusters in preshower and shower within configurable tolerances

VDC Characteristics

- Vertical Drift Chambers, optimized for precision measurement of single tracks
- Standard tracking systems for both HRSs
- Two wire directions (u/v @ $\pm 45°$), 368 wires per plane, 4.24 mm wire spacing

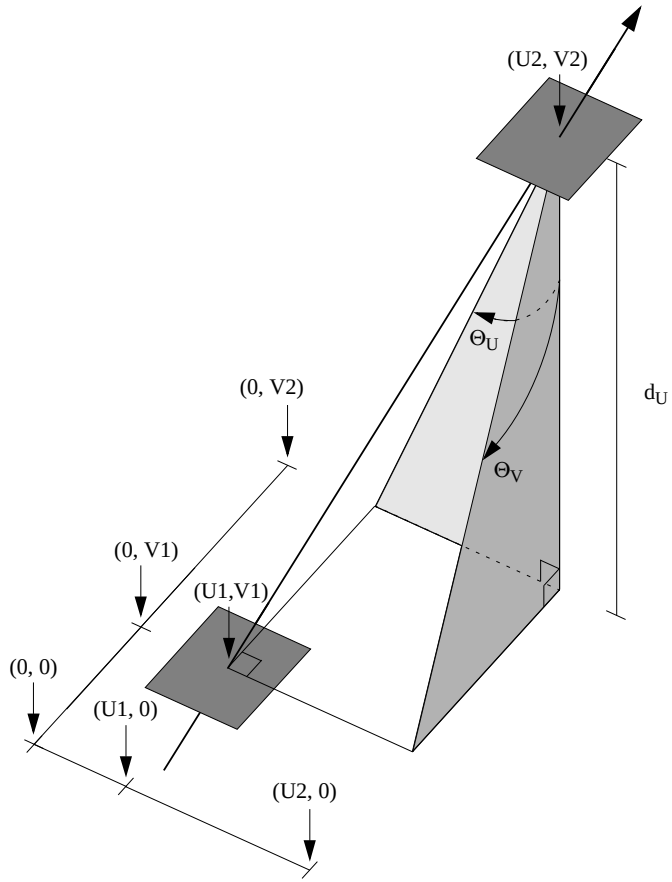




Fit to $n_{avg} \approx 5$ independent time measurements per plane yields a position resolution of ≈ 225 μm FWHM

VDC Tracking: Algorithm

- Find clusters in each plane, fit to drift distances & obtain crossover points
- Match *u* and *v* clusters in each chamber
- Connect matched points in top and bottom, requiring consistent track angles
- Reconstruct target quantities using reverse transport matrix



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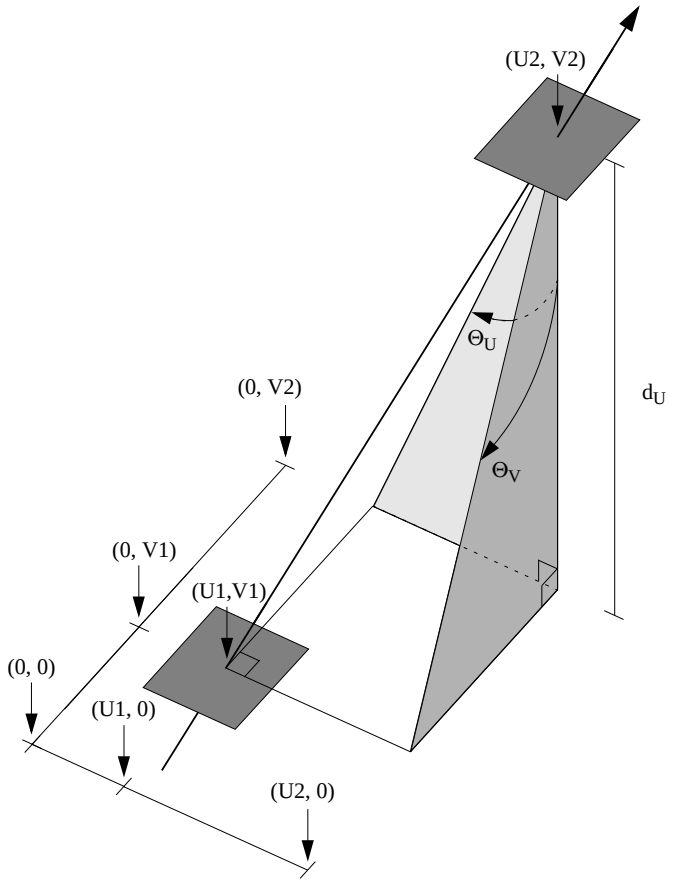

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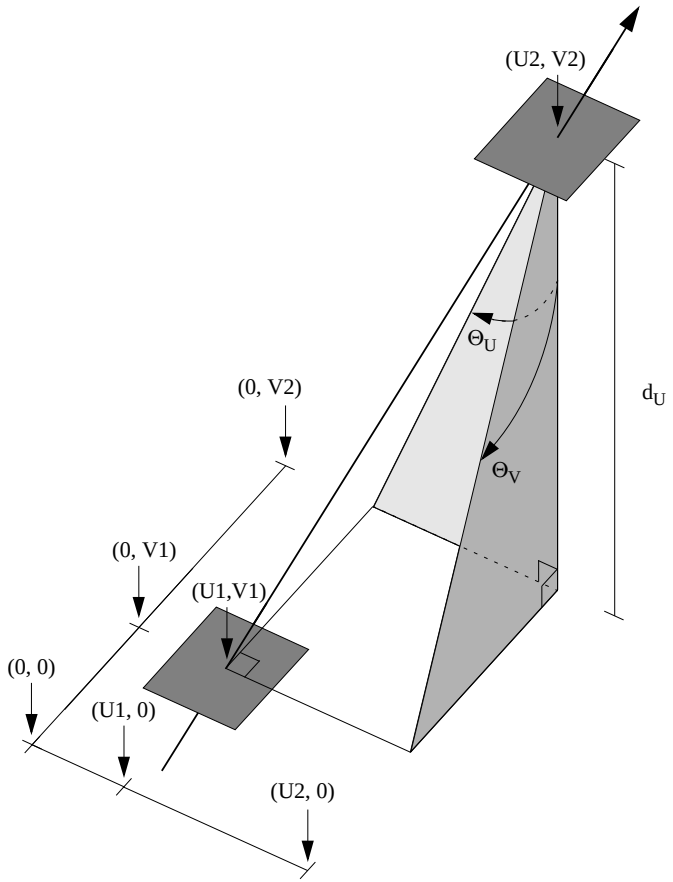
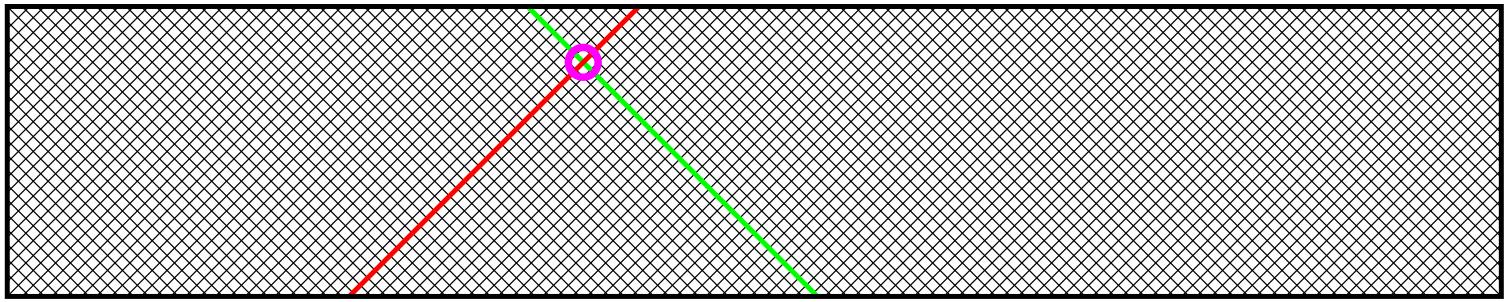


VDC Tracking: Matching u and v Clusters



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- Obvious if only one cluster per plane

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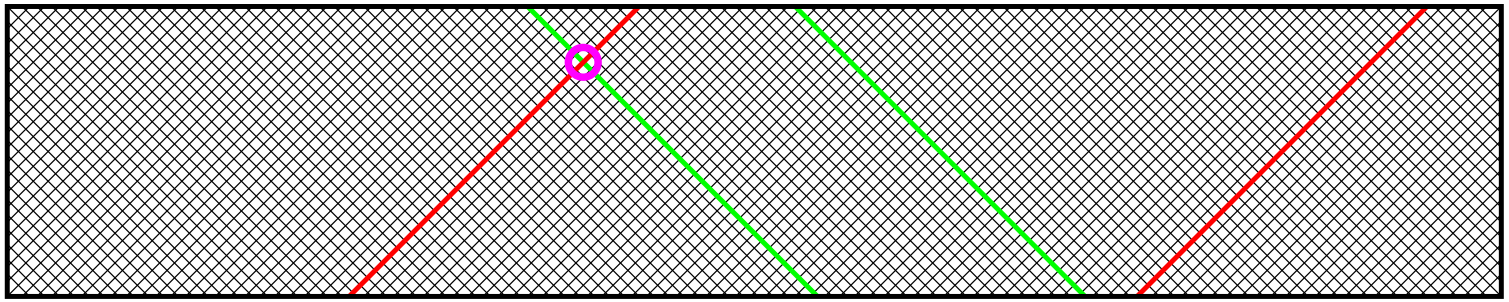

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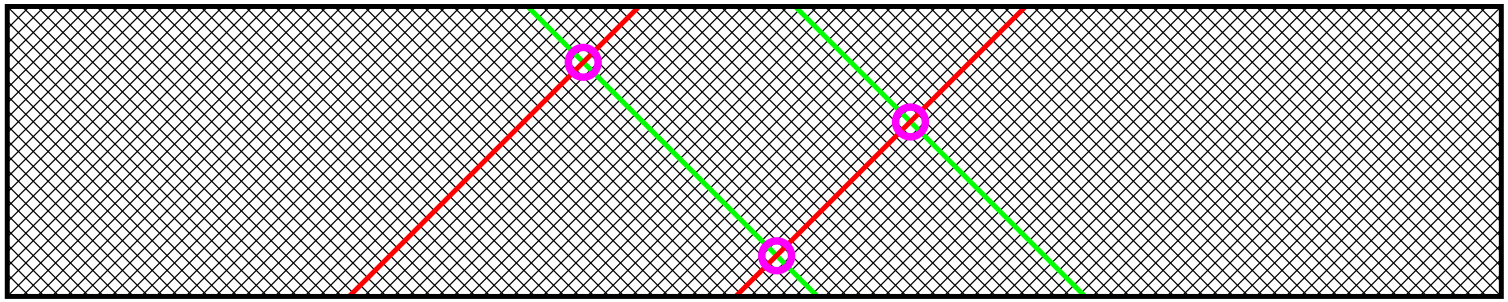

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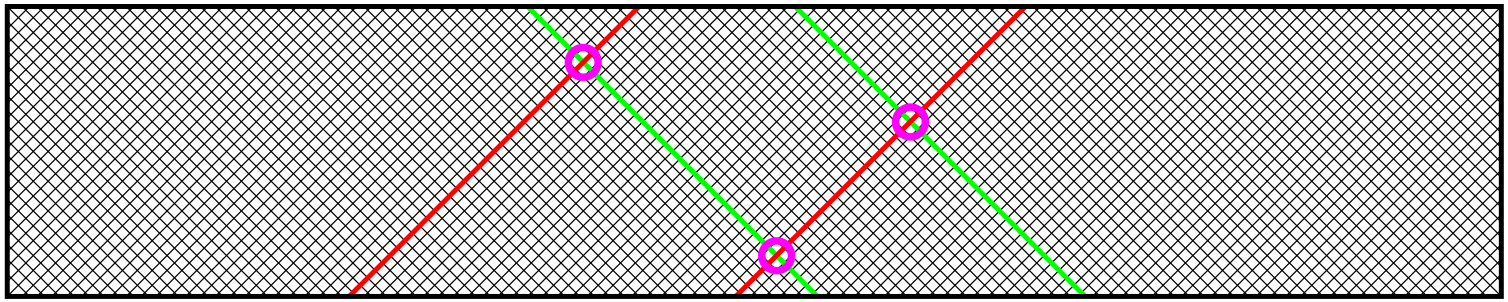

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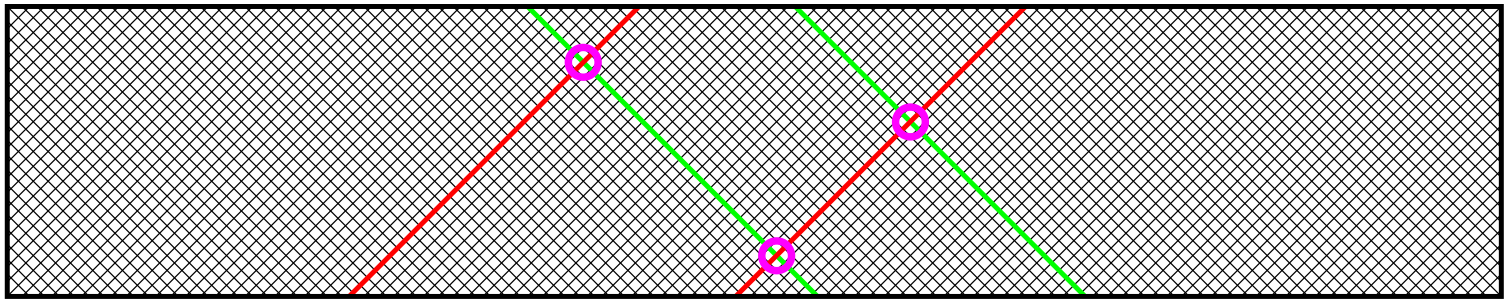

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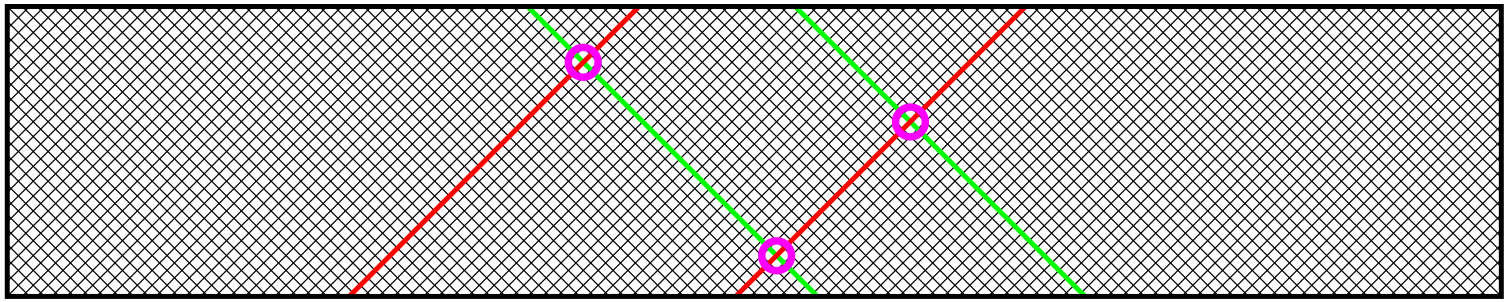

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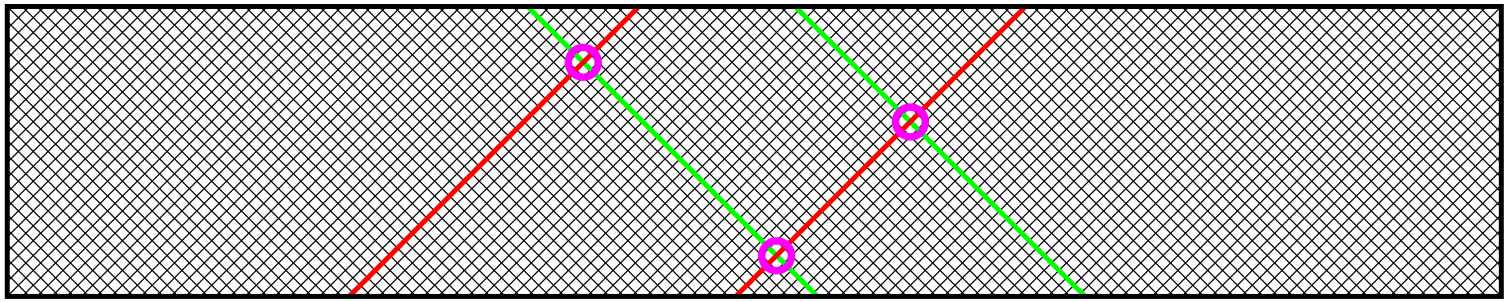

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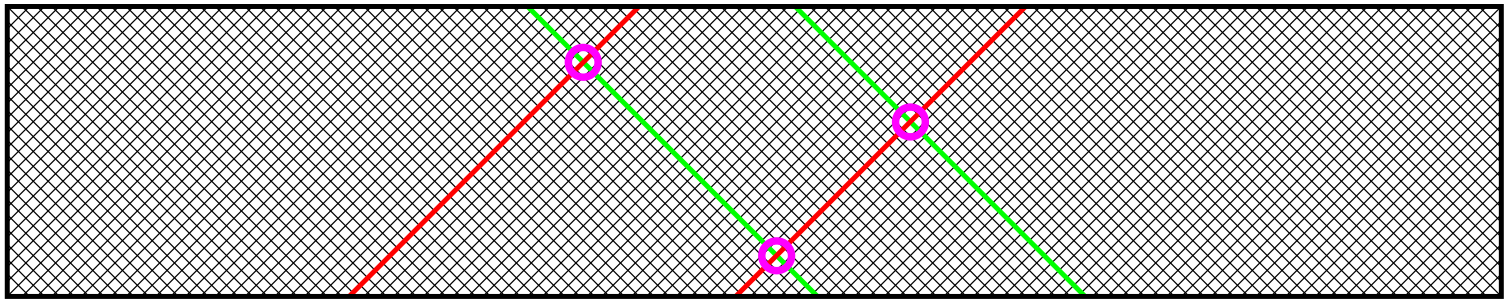

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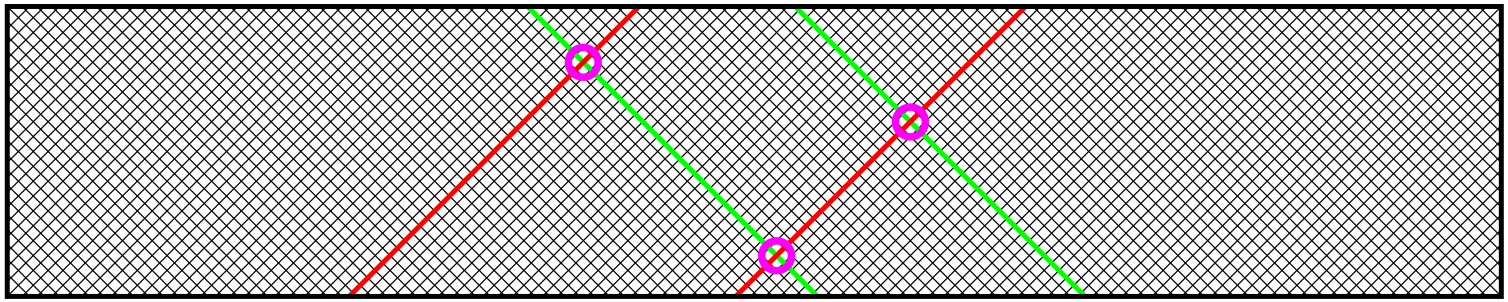

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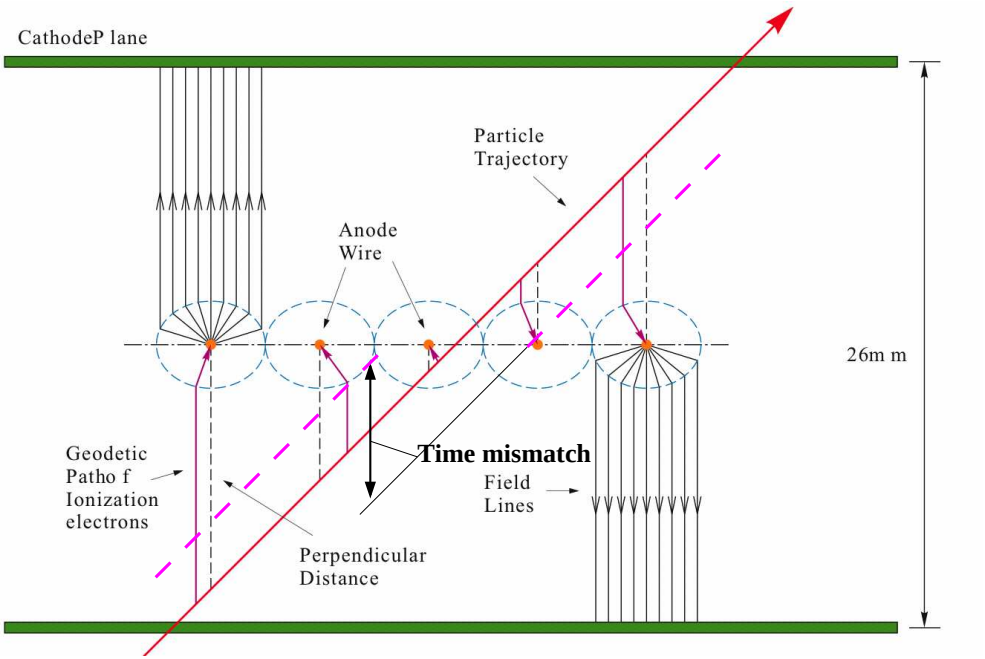
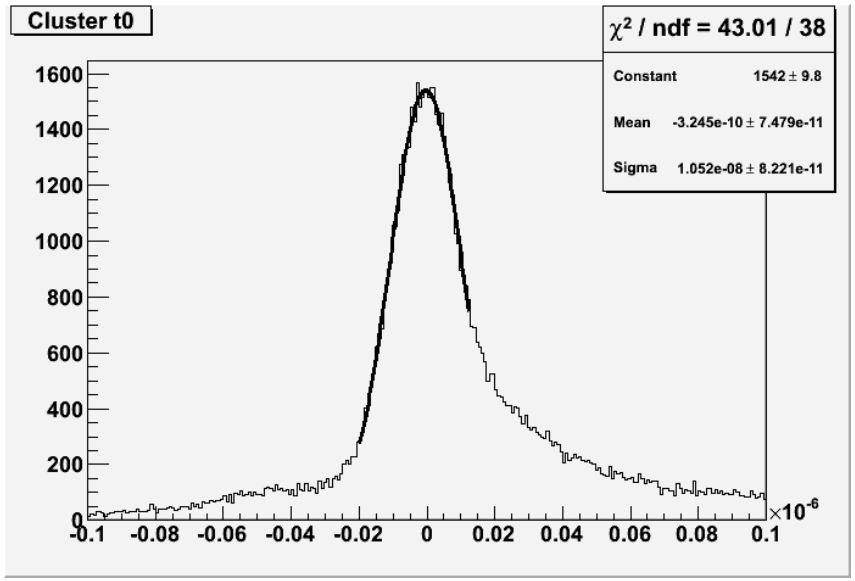
- How would a 3rd VDC chamber with u/v planes help here?

VDC Tracking: 3-Parameter Cluster Fit

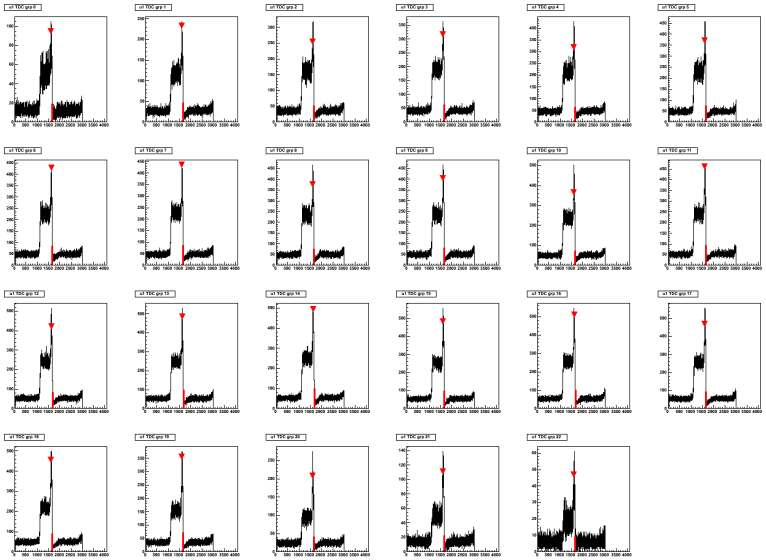


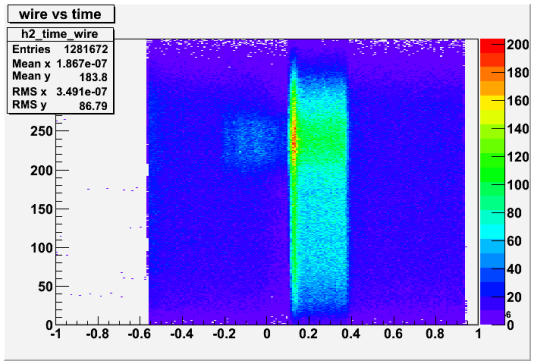


- Non-linear 3-parameter fit to extract track time offset t_0
- Computationally expensive: $\approx \times 20$ slower than 2-parameter fit
- $\approx$ 20 ns FWHM time resolution $\rightarrow$ background rejection factor ≈ 10
- Code written, still needs thorough testing and integration
- Used for APEX test run analysis ($\approx$ 2 accidental tracks per trigger)
- Alternative fast fitting code exists (summer student project), similar results, but at prototype stage

VDC Calibration Tools

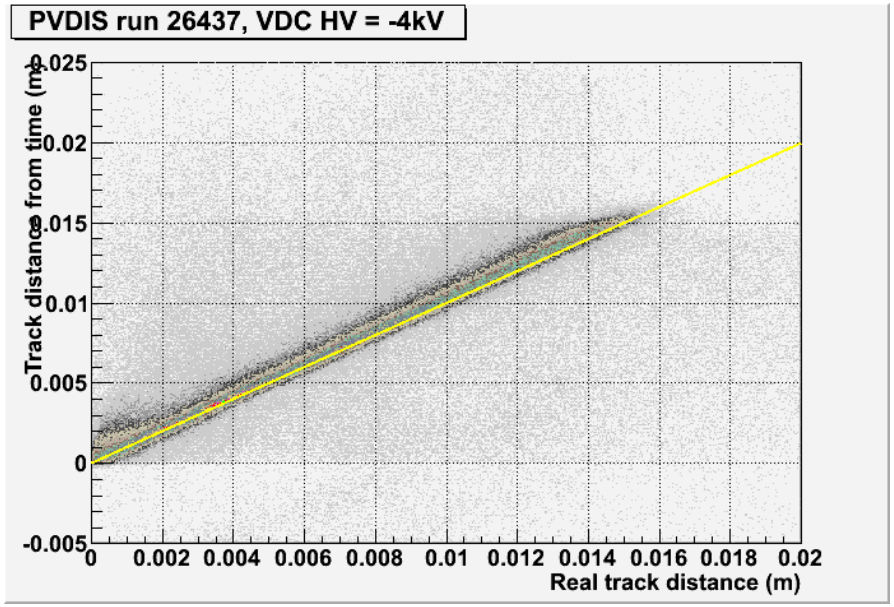
VDC time offsets





- Automated script (edge search) operating on special calibration runs (white spectrum)

VDC time-to-distance conversion



- Automated fit to analytic expression approximating time-to-distance relation
- Two linear sections with dependence on 1/tan(track angle)
- Attempts to obtain flat drift distance distribution
- Can operate on same calibration runs as time offset calibration

Conclusions

- HRS analysis software modules and calibration tools exist, are ready and very well tested for standard, low-rate experiments
- Recent improvements in VDC code address mainly the needs of very high rate data taking, but could be useful to improve tracking efficiency at low rates
- Analysis of tracking system with three VDC chambers would require new software development ($\approx$ 1–2 man-months)