


# Status of the Displaced Vertex Trigger

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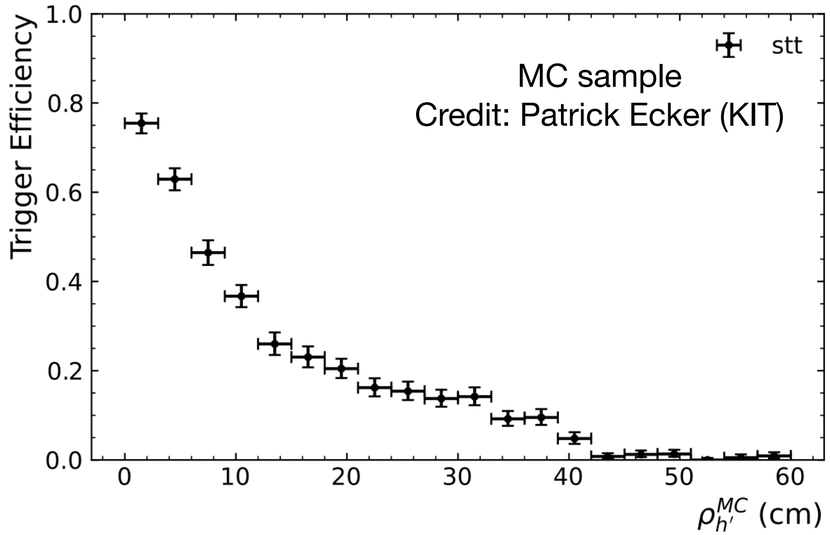
# I: Motivation

Well-motivated U(1) DM Signatures

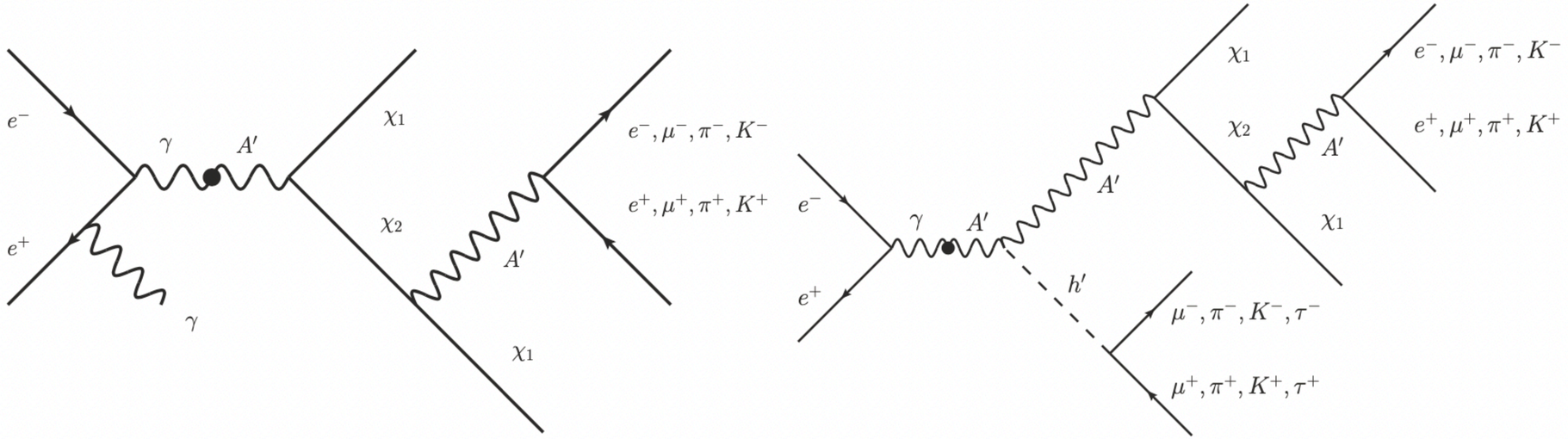
$e^+e^- \to \gamma_{\mathrm{ISR}} + \mathrm{invisible}$ Mono-γ

$e^+e^- \to A' \to l^+l^-$ resonance searches

- Third Signature:
  - $e^+e^- \to l^+l^- + \mathrm{invisible}$
- STT has a bad efficiency for large displacements
- Single photon triggers have high backgrounds
- Solution: **Displaced Vertex Trigger (DVT)**

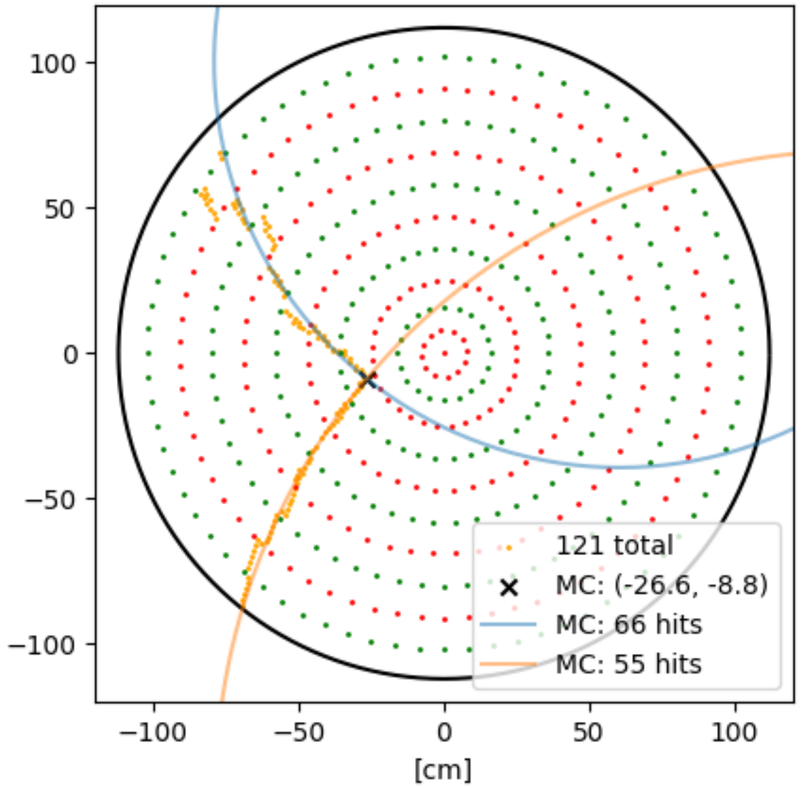


# Inelastic Dark Matter (iDM)




- Two natural scenarios:
- iDM, iDM + dark Higgs (iDMDH)
- Signature (same for many more dark sector models):
  - Two leptons from displaced vertex + missing energy
  - Displacement strongly model-dependent

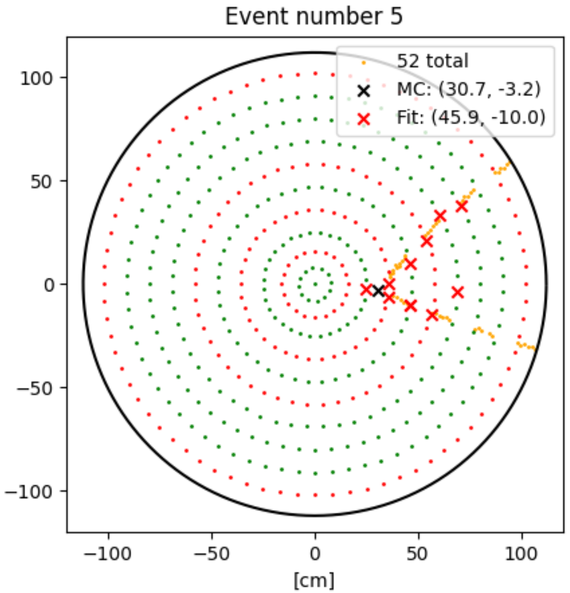
# II: Basic Strategy




- All hits in the transversal plane (2D)
- Probe ~400 reference vertices (=Macrocells) using Hough transform
- Demand that **two tracks** be consistent with a common vertex

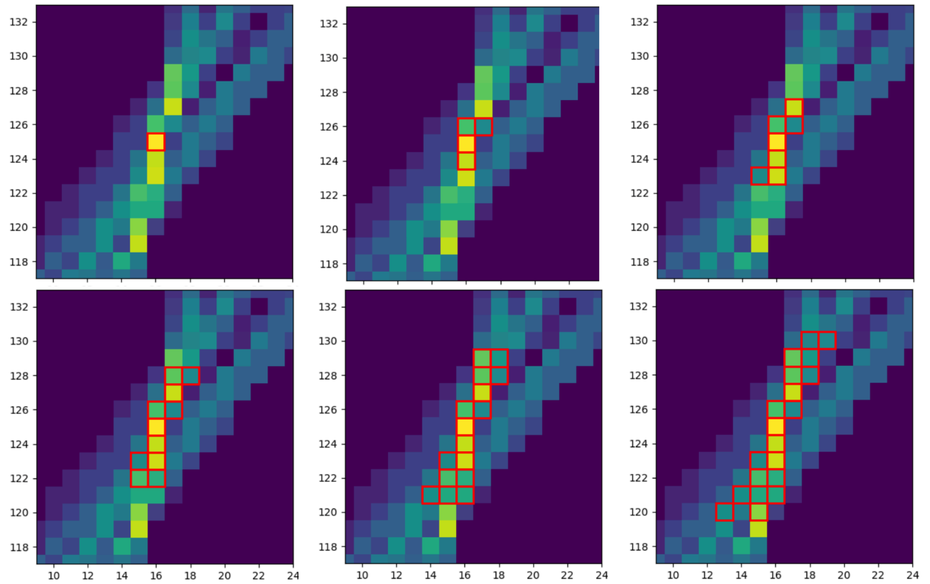
# II: Basic Strategy

## 1: Weighted Hough Transform



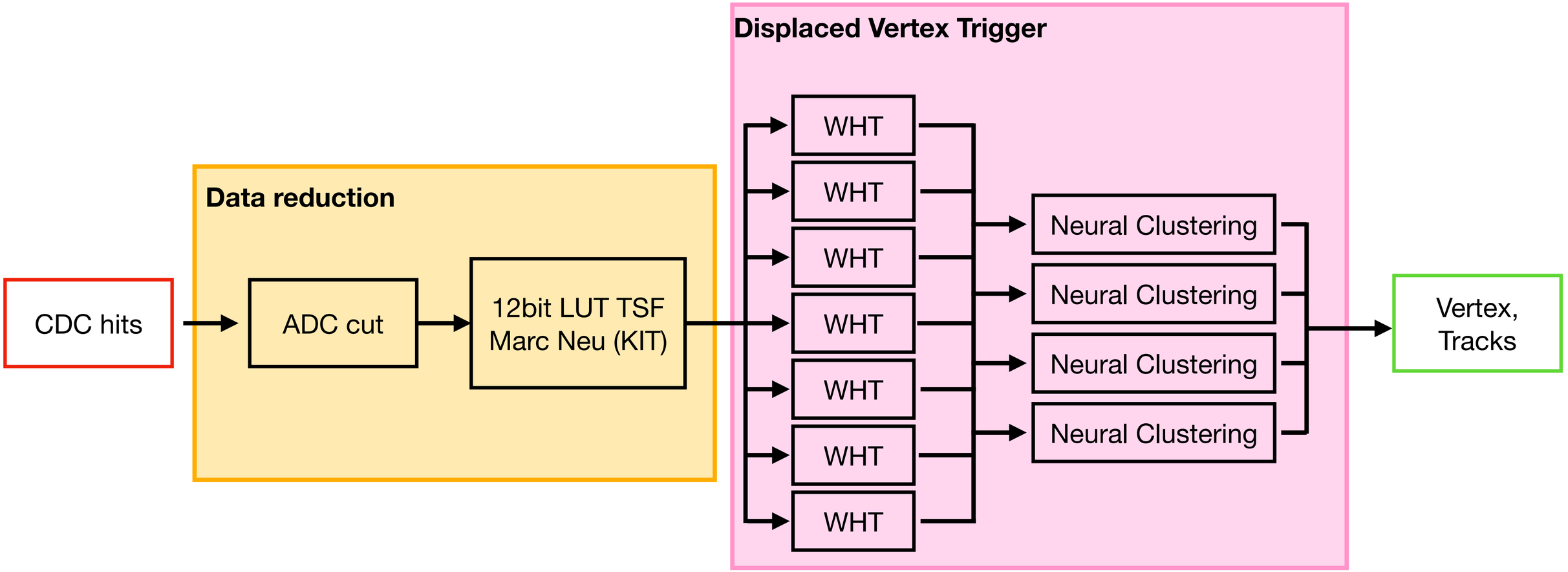

- Simple Thresholding too imprecise
- Select 10 promising candidates from peak heights in Hough Matrix

## 2: Neural Clustering in Hough Plane



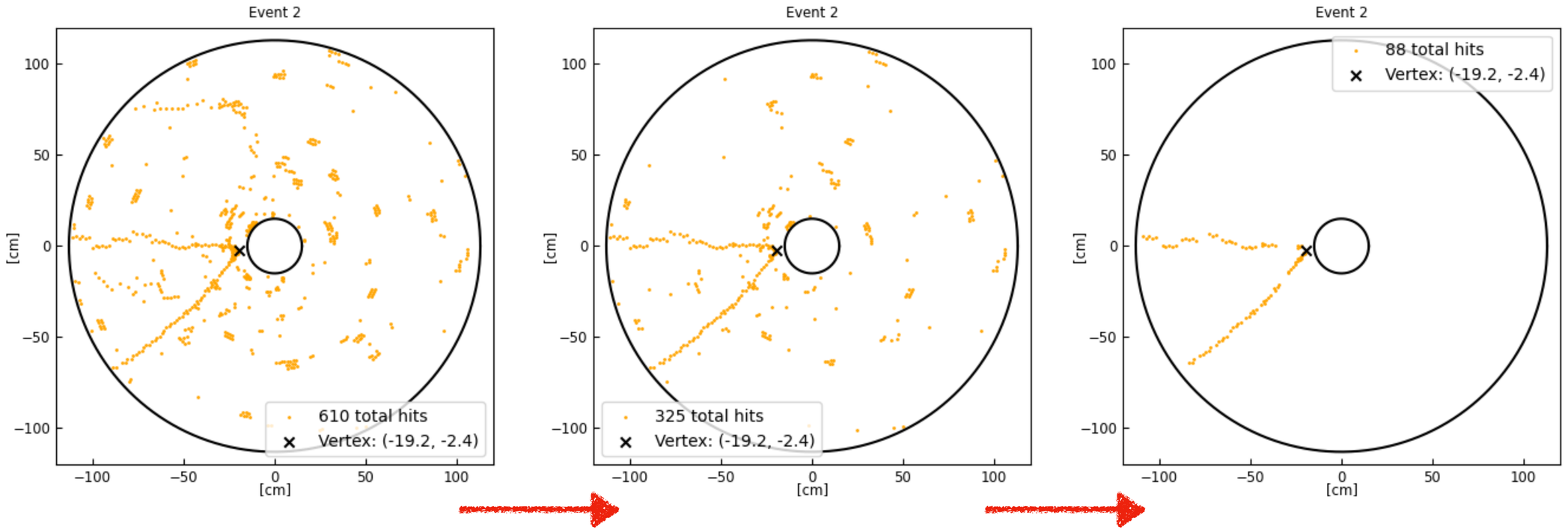
- Iterative Clustering (5 iterations)
- Cluster parameters —> Neural Net

# II: Basic Strategy



# Example event

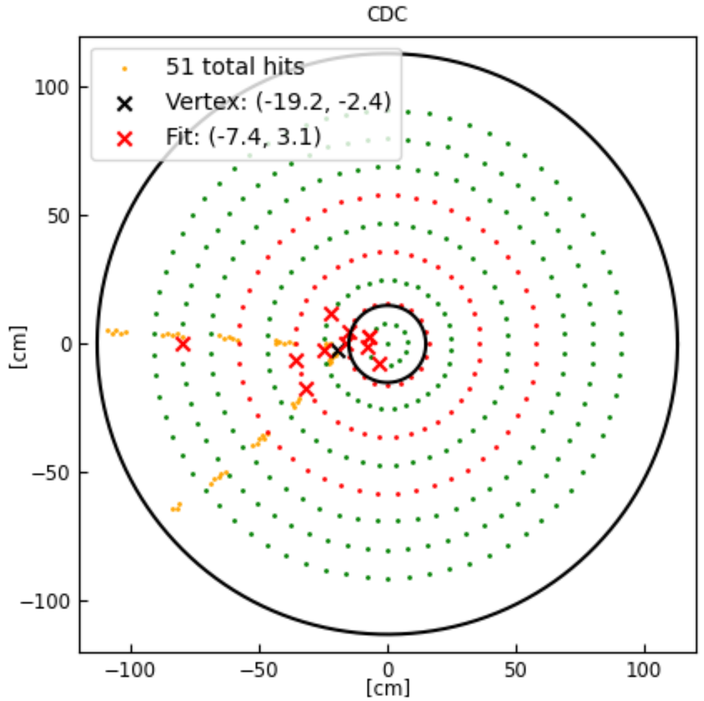
**Early Phase 3 background conditions**



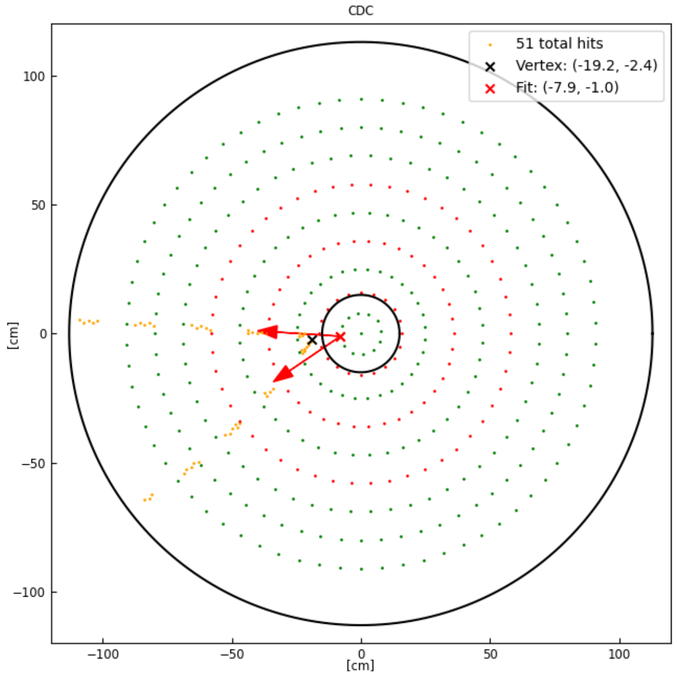

ADC cut [20, 200]

New Track Segment Finder
(Marc Neu's talk)

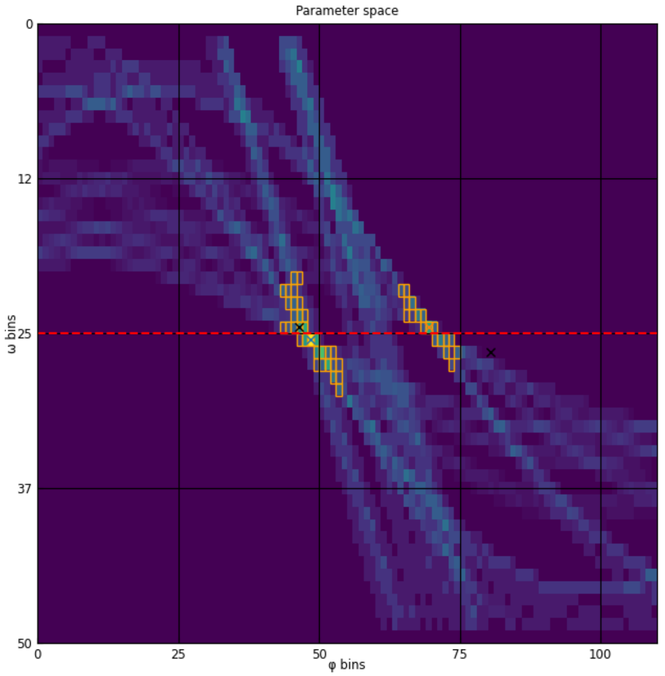
# Example event




Rough Hough Transformations
Give 10 vertex candidates



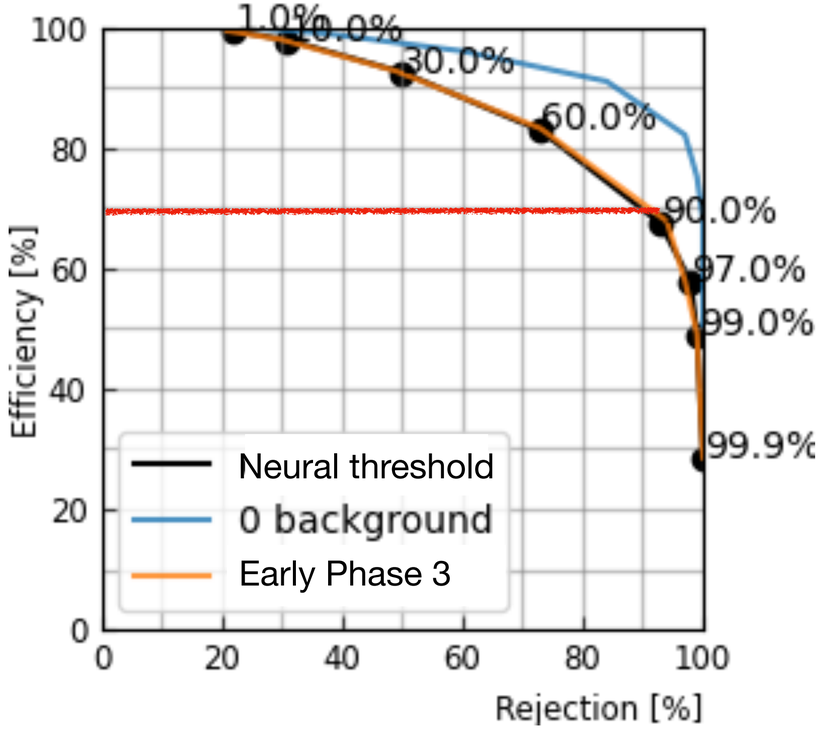

Neural clustering decides on
One vertex

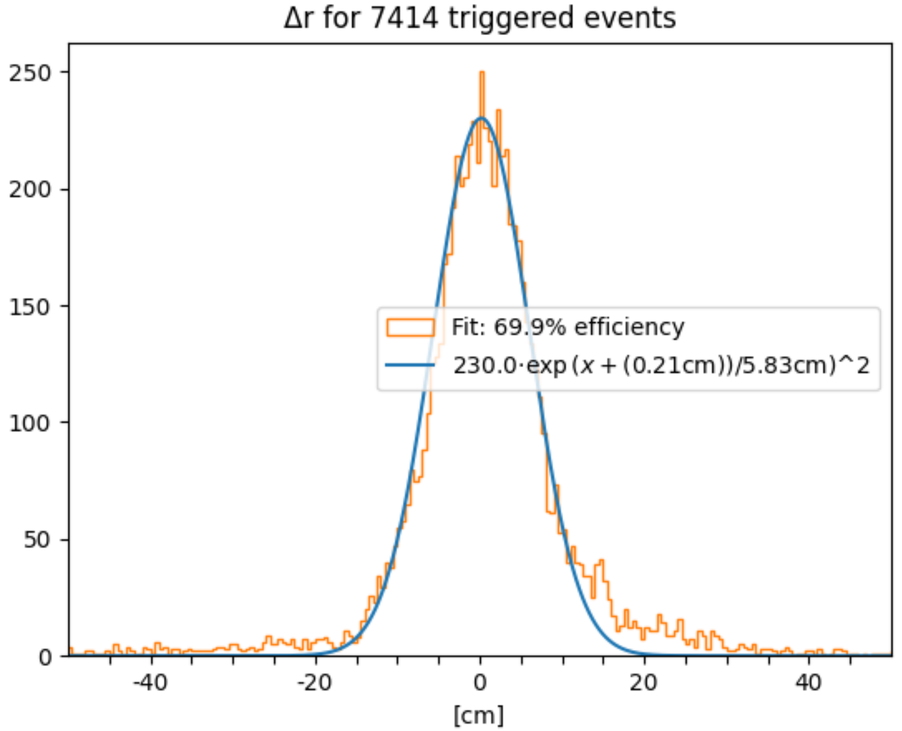


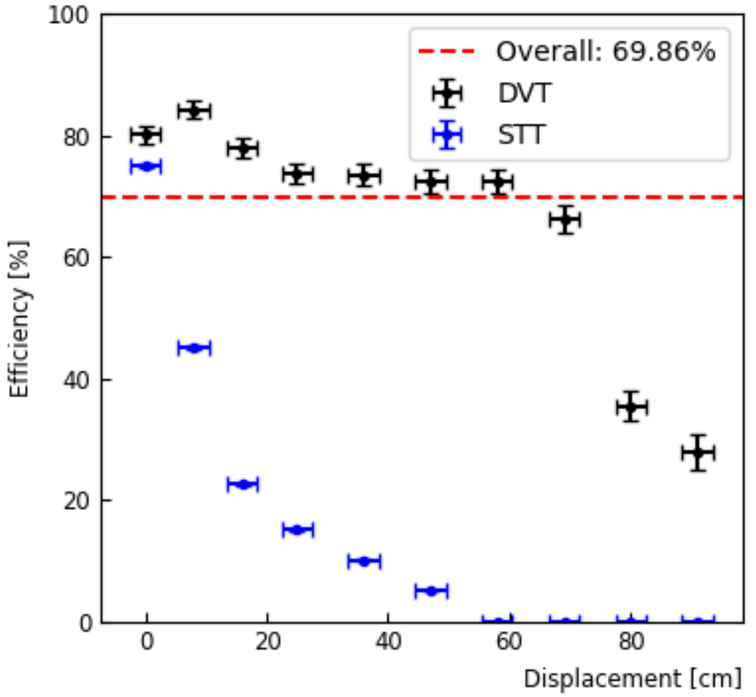

Entire Hough plane

Example: Neural score: 99.99%

# IV: Results



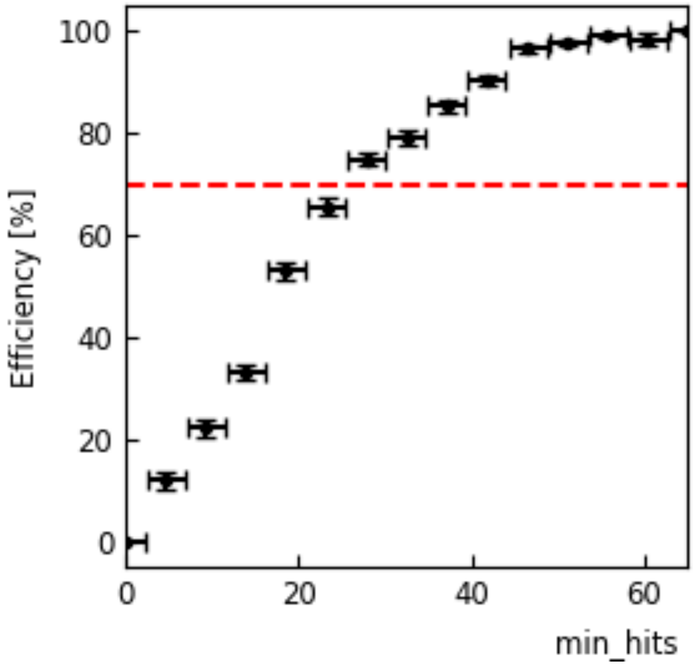

- Network training on Monte Carlo data
- Target value 1: Truth-matched clusters
- Target value 0: Fake Tracks (from Single Tracks)

- Efficiency can be varied with neural threshold

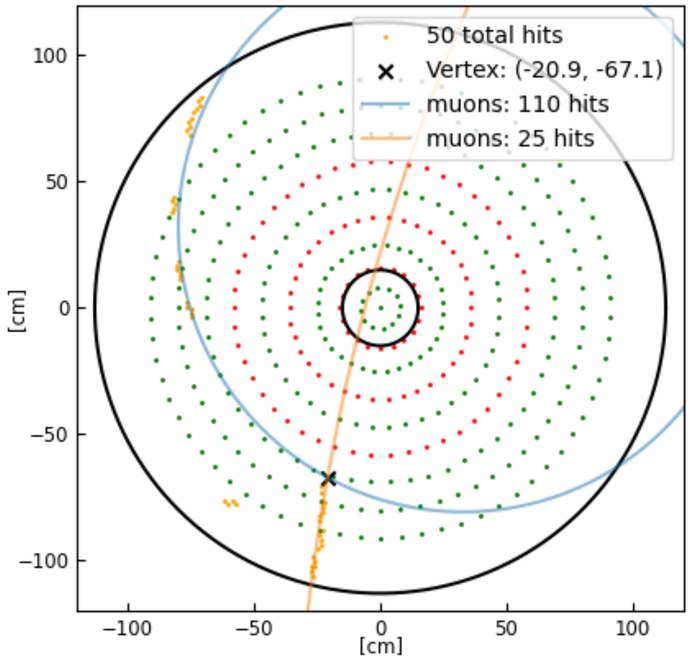
- Choosing efficiency of 70% yields
  - Fake-rejection rate of 91.3%
  - Vertex resolution of 5.83cm

- Outperforms STT for large displacement, sudden drop-off around 80cm

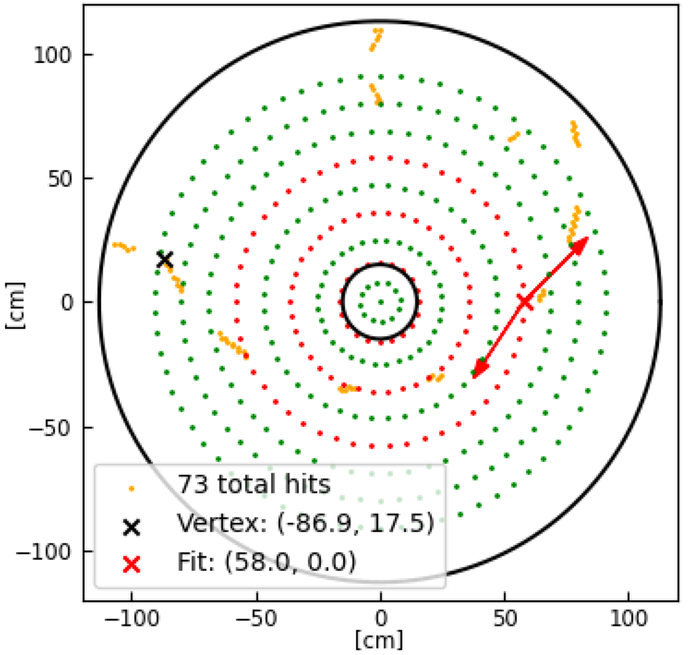
# IV: What is still going wrong?




Example 1

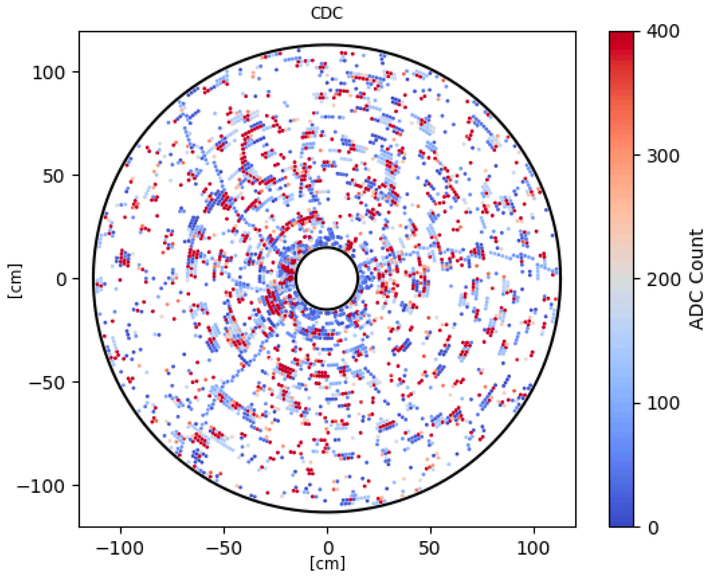


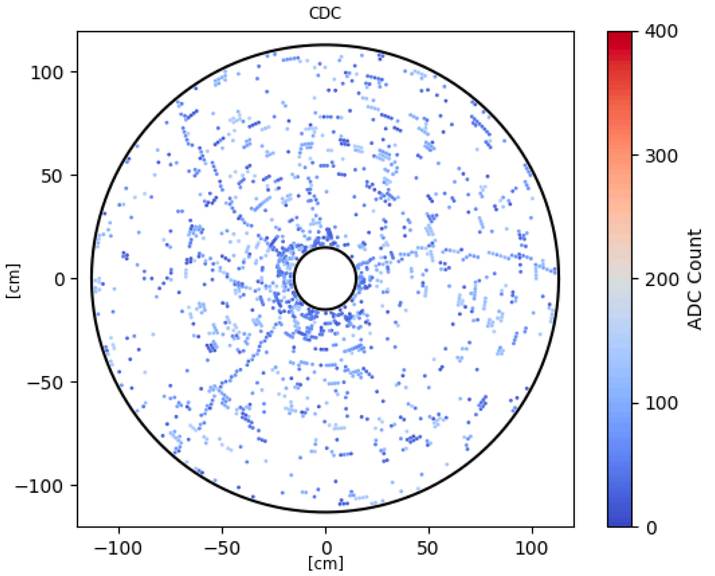

Example 2

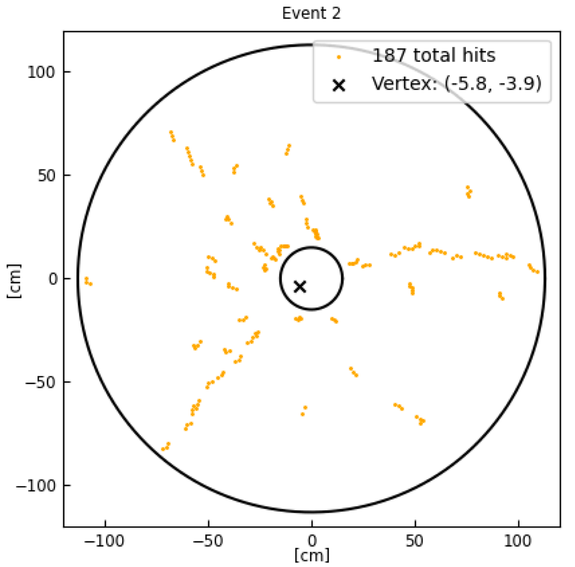



- Number of hits closely correlated to efficiency
- Badly reconstructed events include:
  - Very shallow tracks with hits not being captured by TSF (Example 1)
  - Background tracks in combination with weak signal tracks (Example 2)
- Better training needed
- DVT still requires clean CDC

# IV: What is still going wrong?




- TSF was not yet trained on nominal background
- ADC cut indispensable
- Algorithm not ready for nominal phase 3 background yet

- Problems:
- Only two tracks are searched for per event —> Background tracks difficult to deal with

# Conclusion and outlook

- Summary & conclusion:
  - Fully working DVT algorithm
  - Roughly within UT4 capabilities (further tests needed)
  - Good efficiency and fake-rejection

- Outlook:
  - Next goal: Nominal phase 3 background conditions -> ADC cut and new TSF
  - Define priority wires for new TSF
  - Tests on real data ( $K_0 \rightarrow \pi^+\pi^-$)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