Tracking in Calorimeters Reloaded

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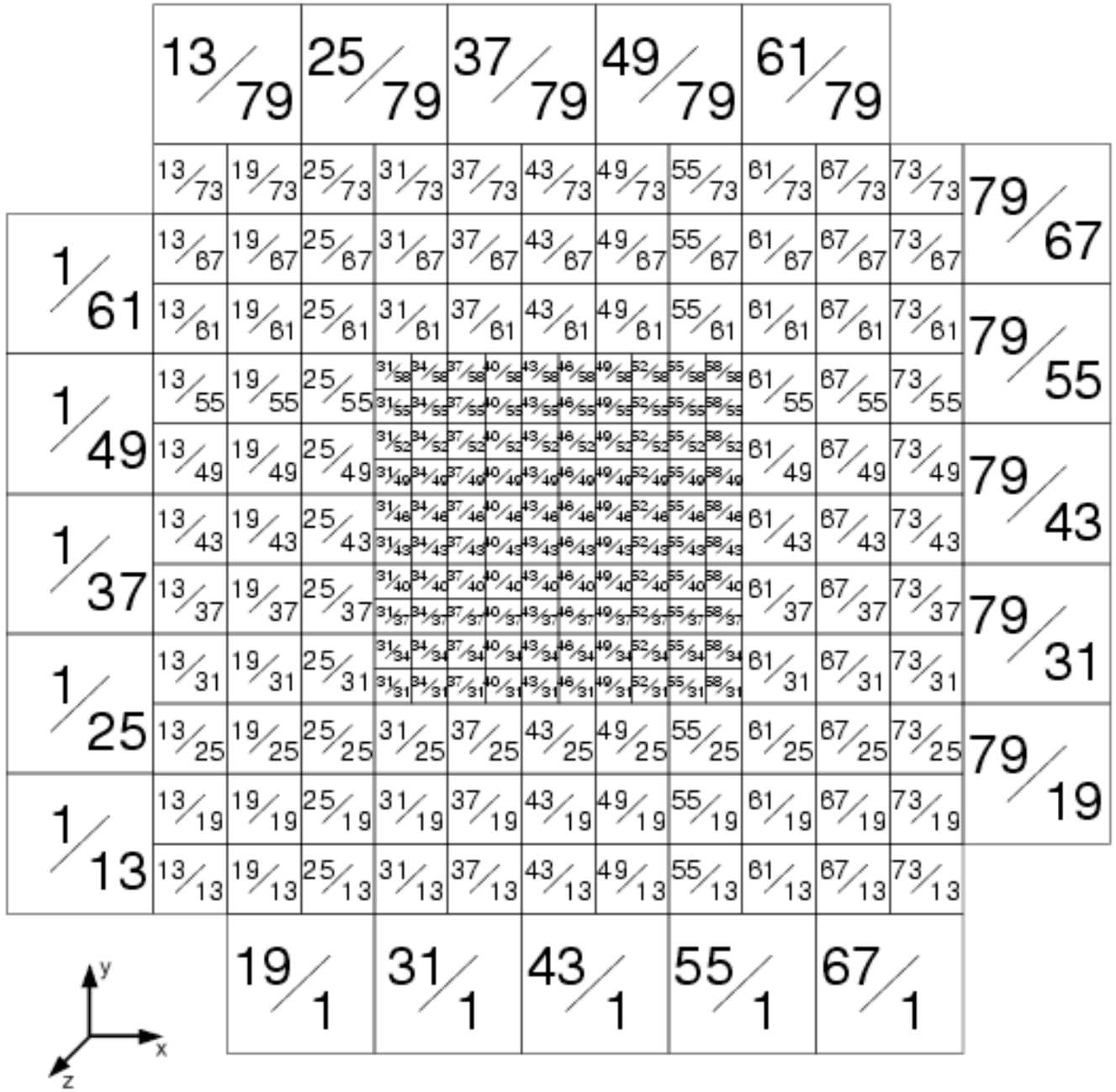
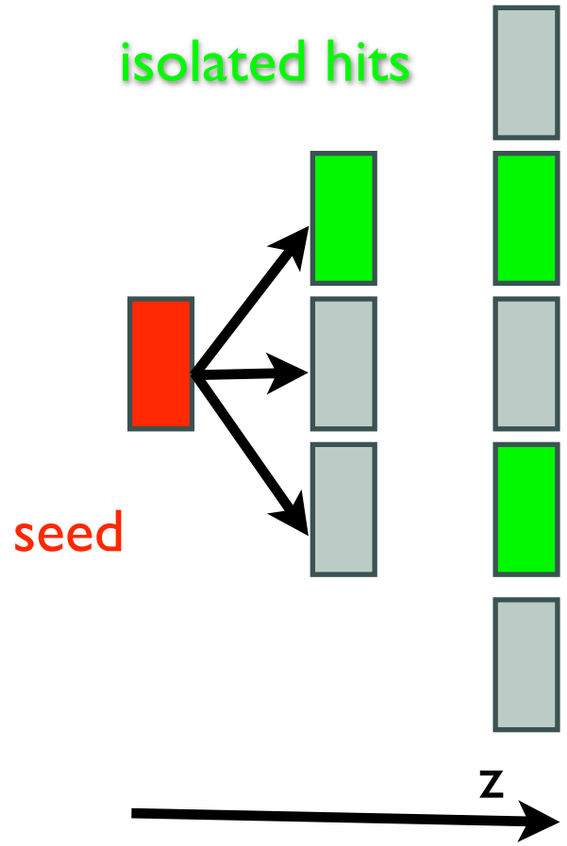
Highly Granular Calorimetry

- CALICE Calorimeter prototypes
  - highly granular structure (here: Analog HCal)
- New possibilities of looking into physics
  - e.g. tracks of MIPs in hadronic showers



Tracking in the AHCal

- Already presented in CAN-022
  - Nearest Neighbour algorithm
  - Needs 1 hit per layer
  - Based on layer isolated hits,
    i.e. hits with no adjacent hits in the same layer
- Plan: Publication (JINST?)
- Rewrite of code
  - No fundamental changes
  - Usage of official geometry classes
  - Made algorithm more general
    - Completely recursive implementation
    - With simplification: No need for special treatment of certain geometric cases
    - Improving identification of inclined tracks with gaps



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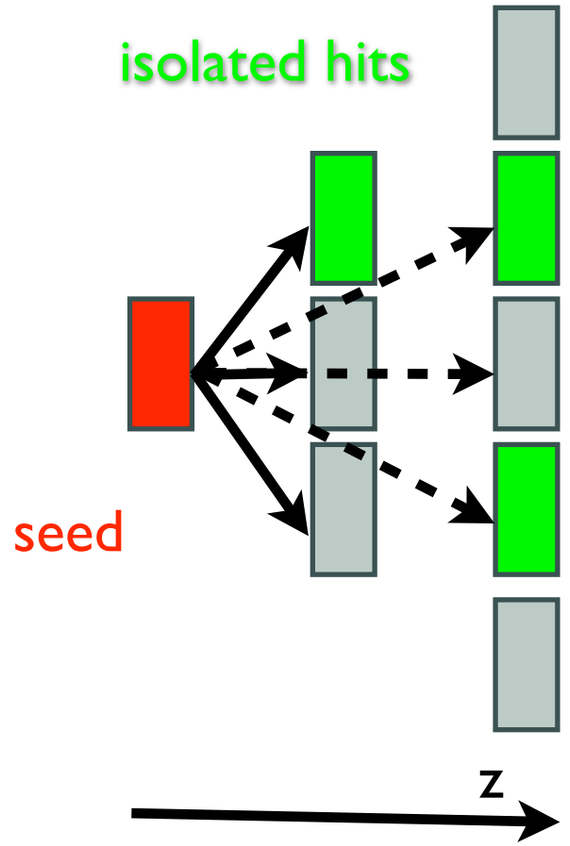

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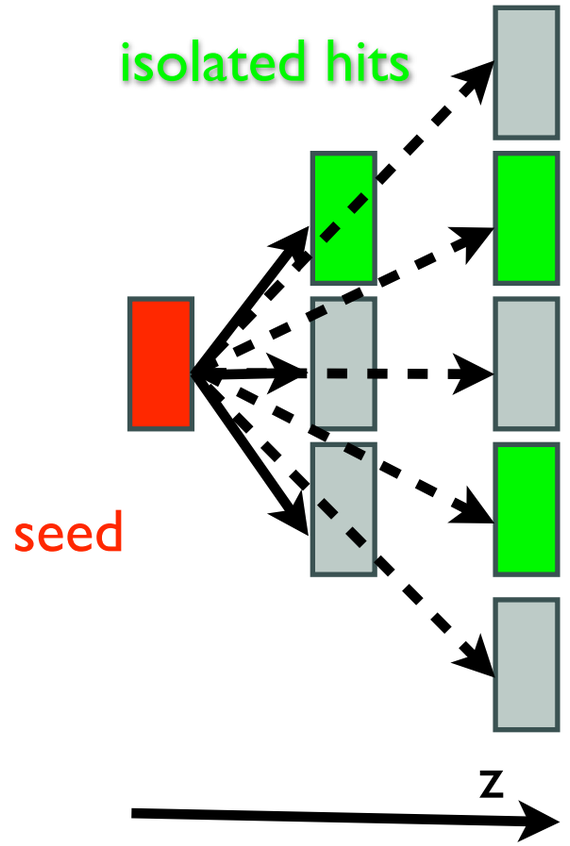
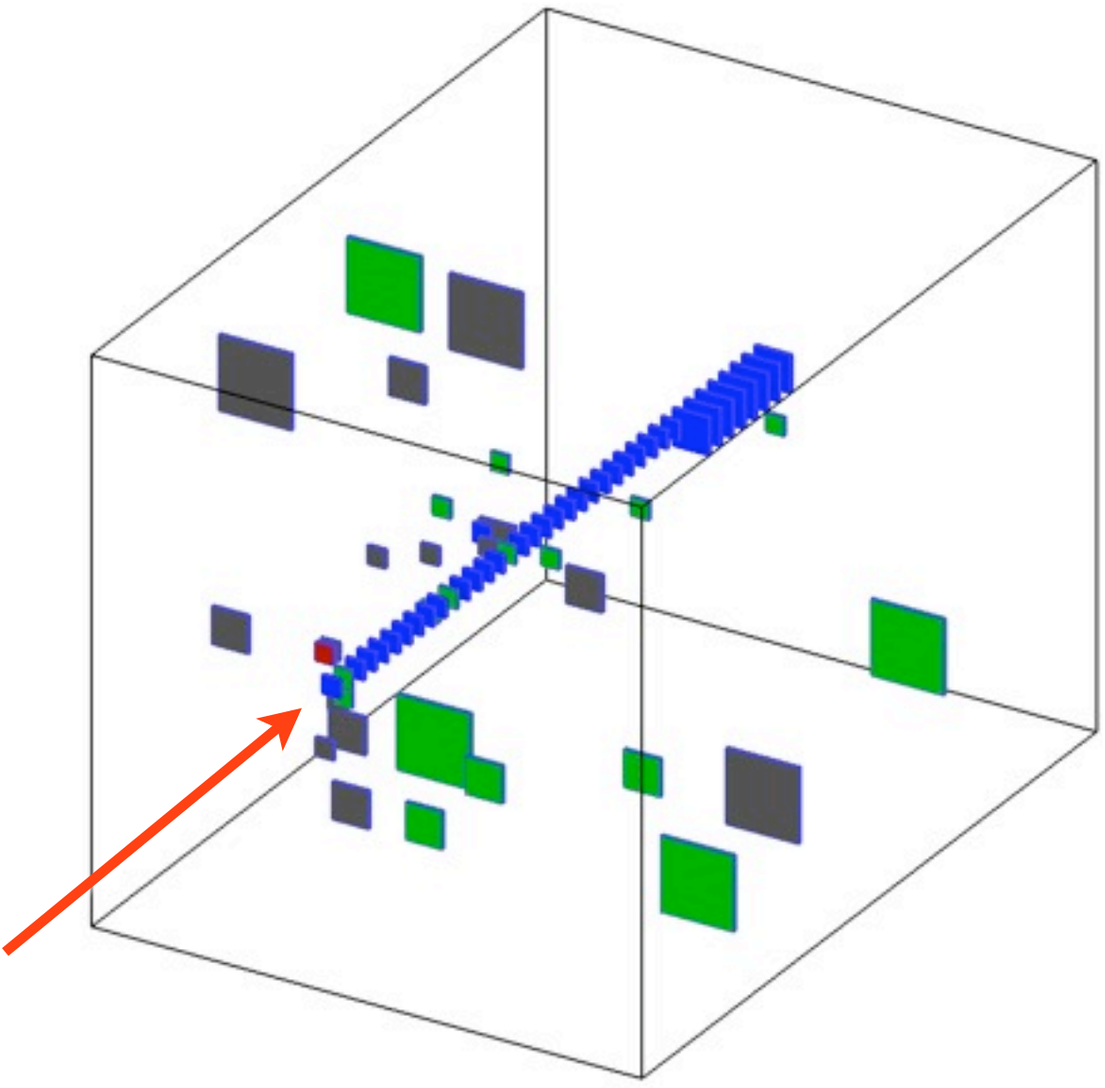
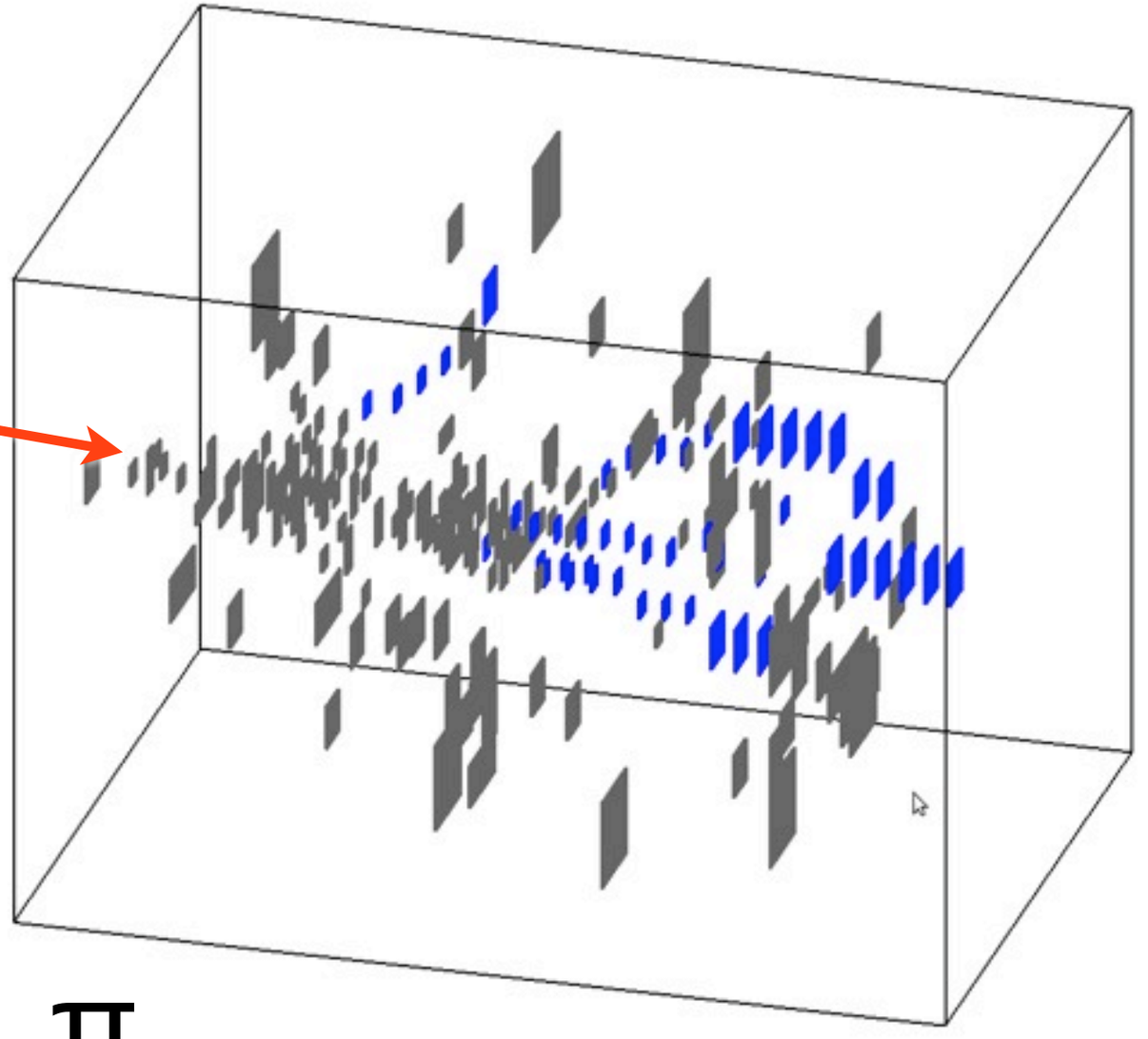


Example events



μ



π

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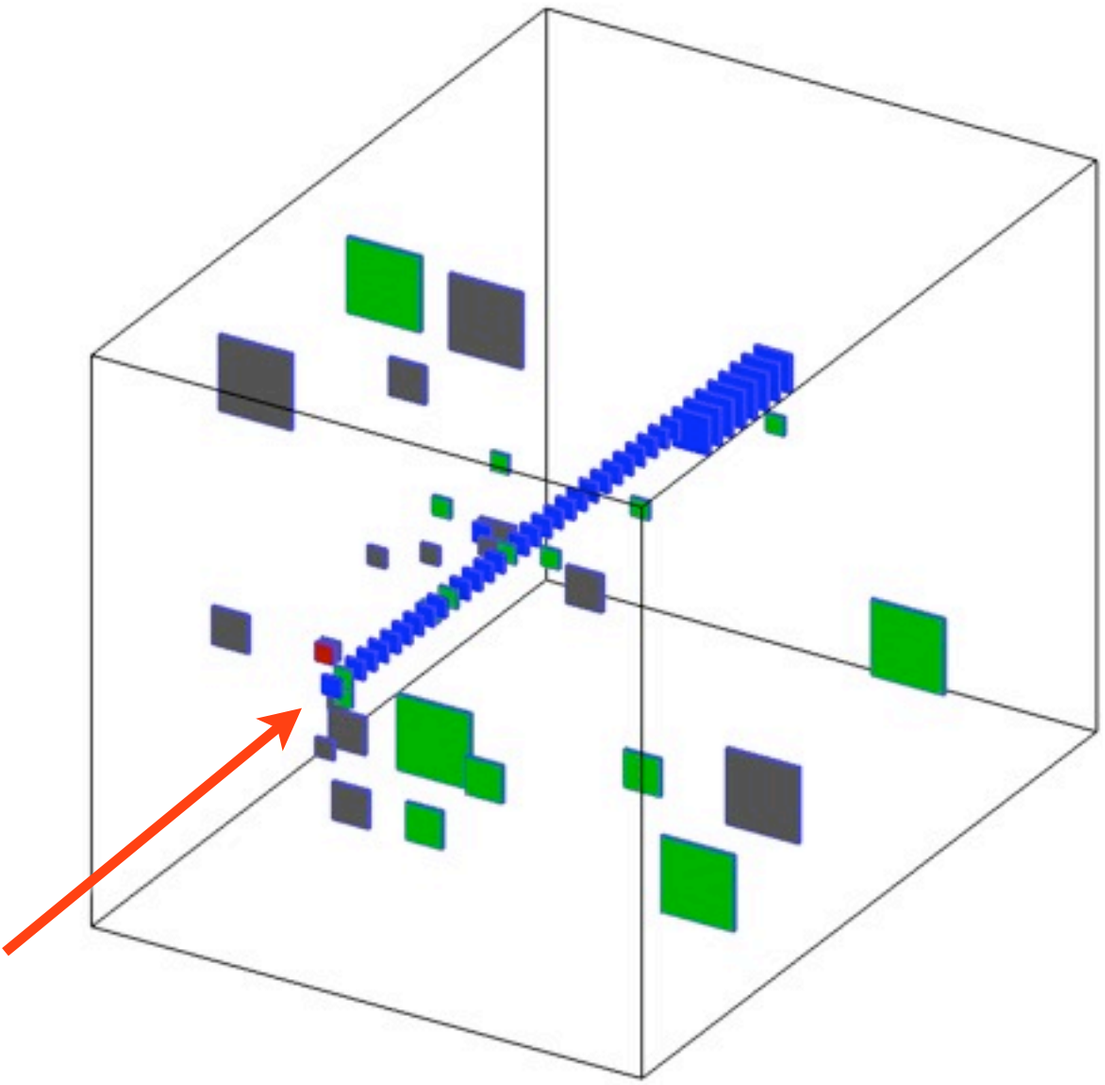

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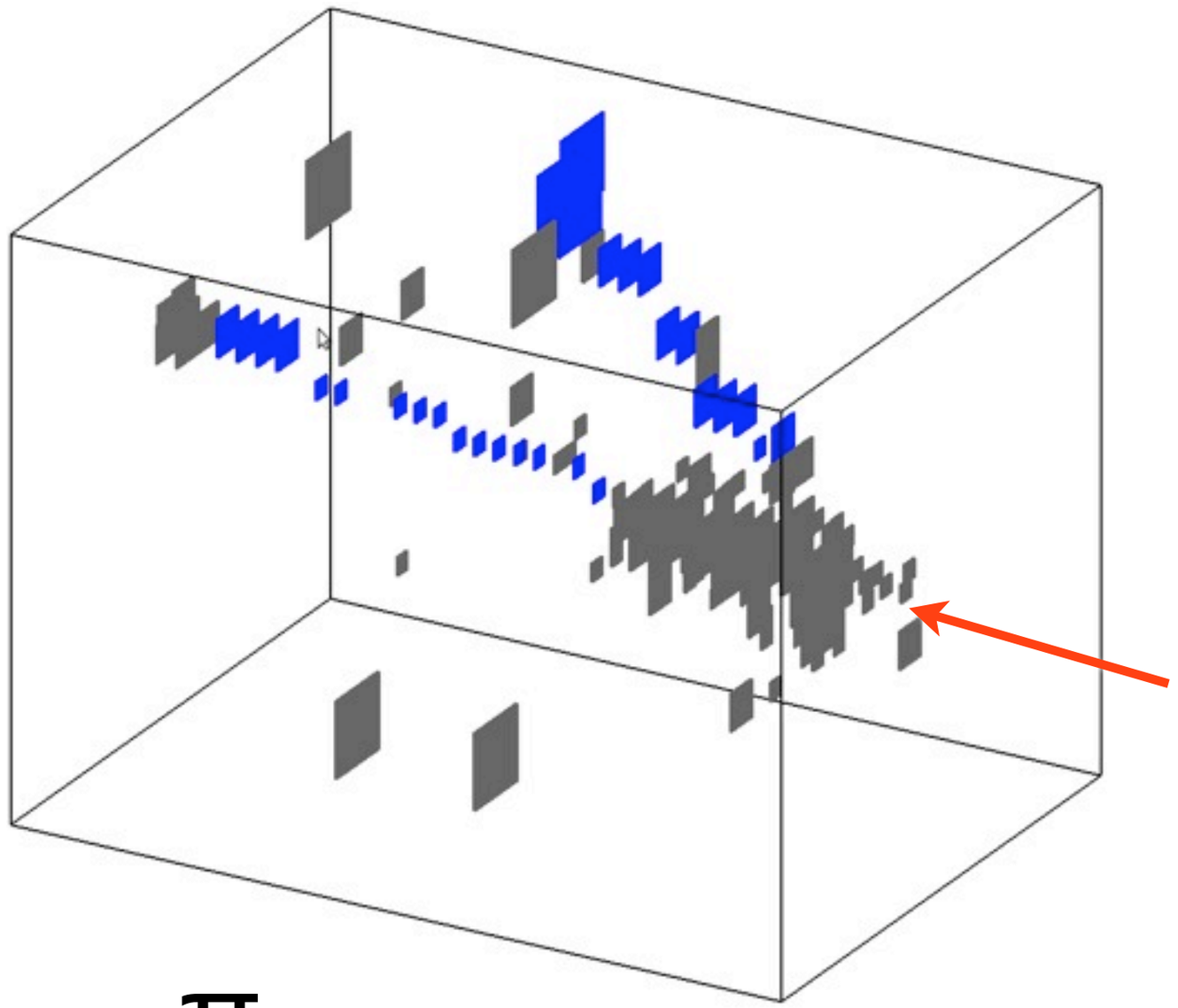
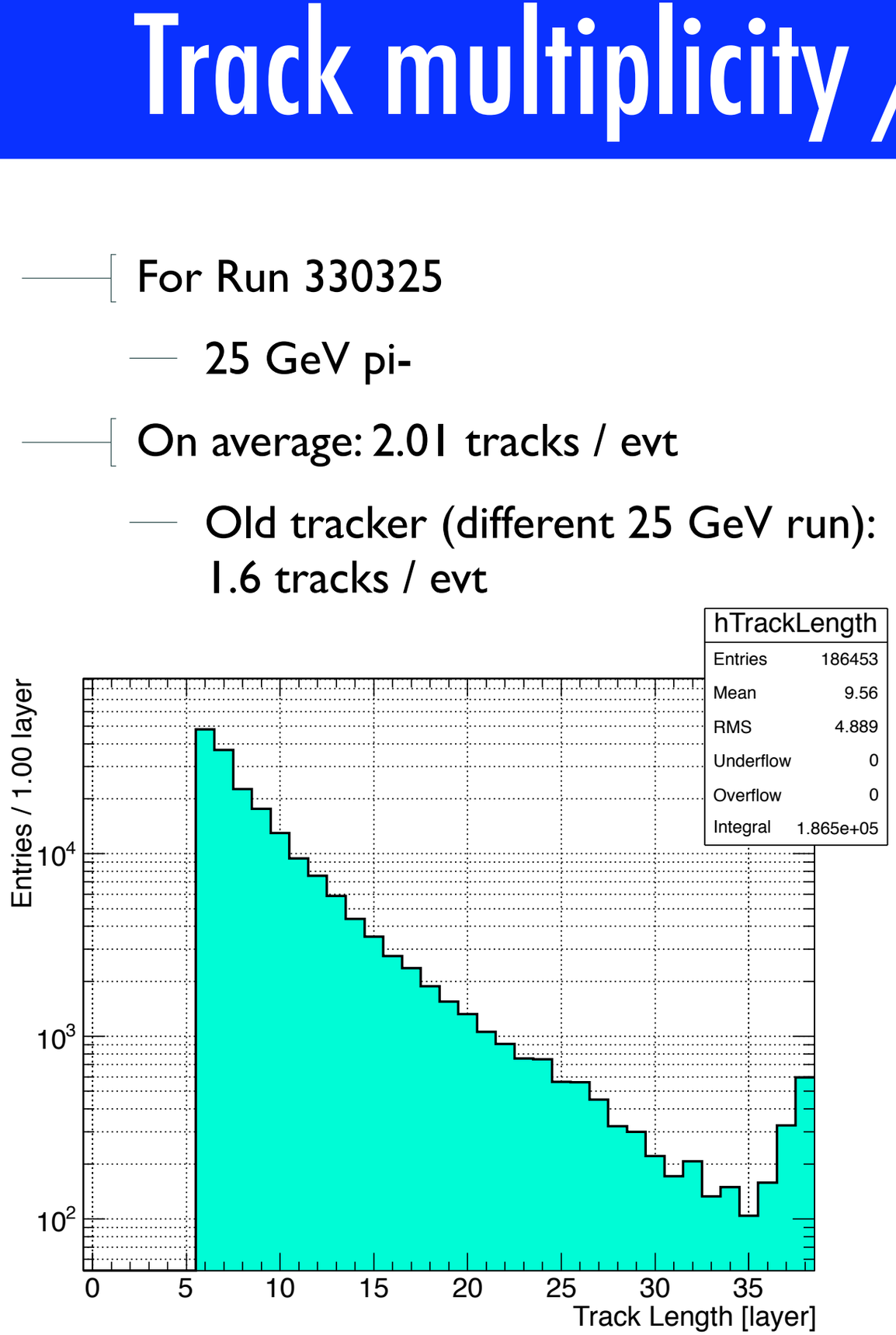
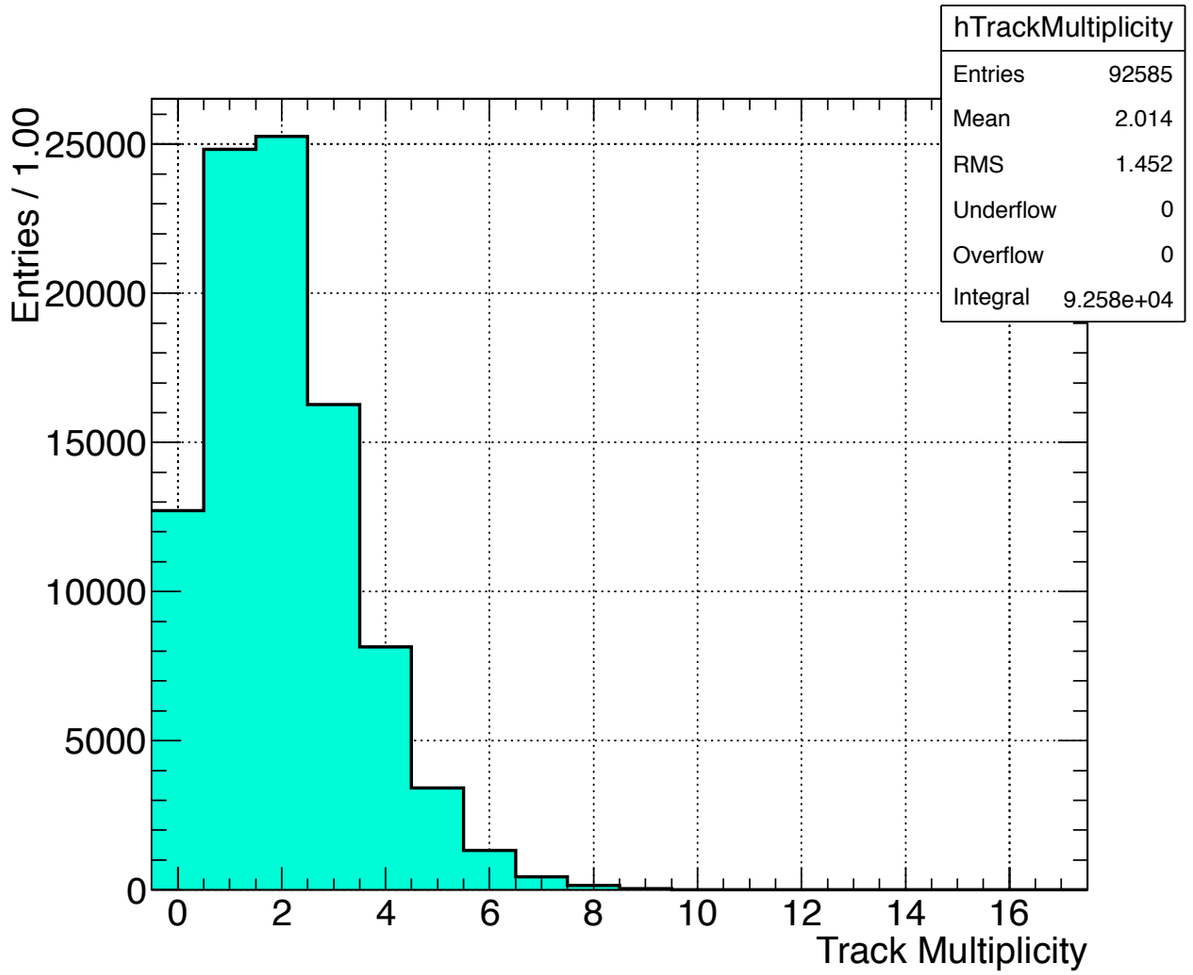


π

Track multiplicity / Track length

- For Run 330325
  - 25 GeV pi-
- On average: 2.01 tracks / evt
  - Old tracker (different 25 GeV run): 1.6 tracks / evt





- Exponentially decreasing tracklength

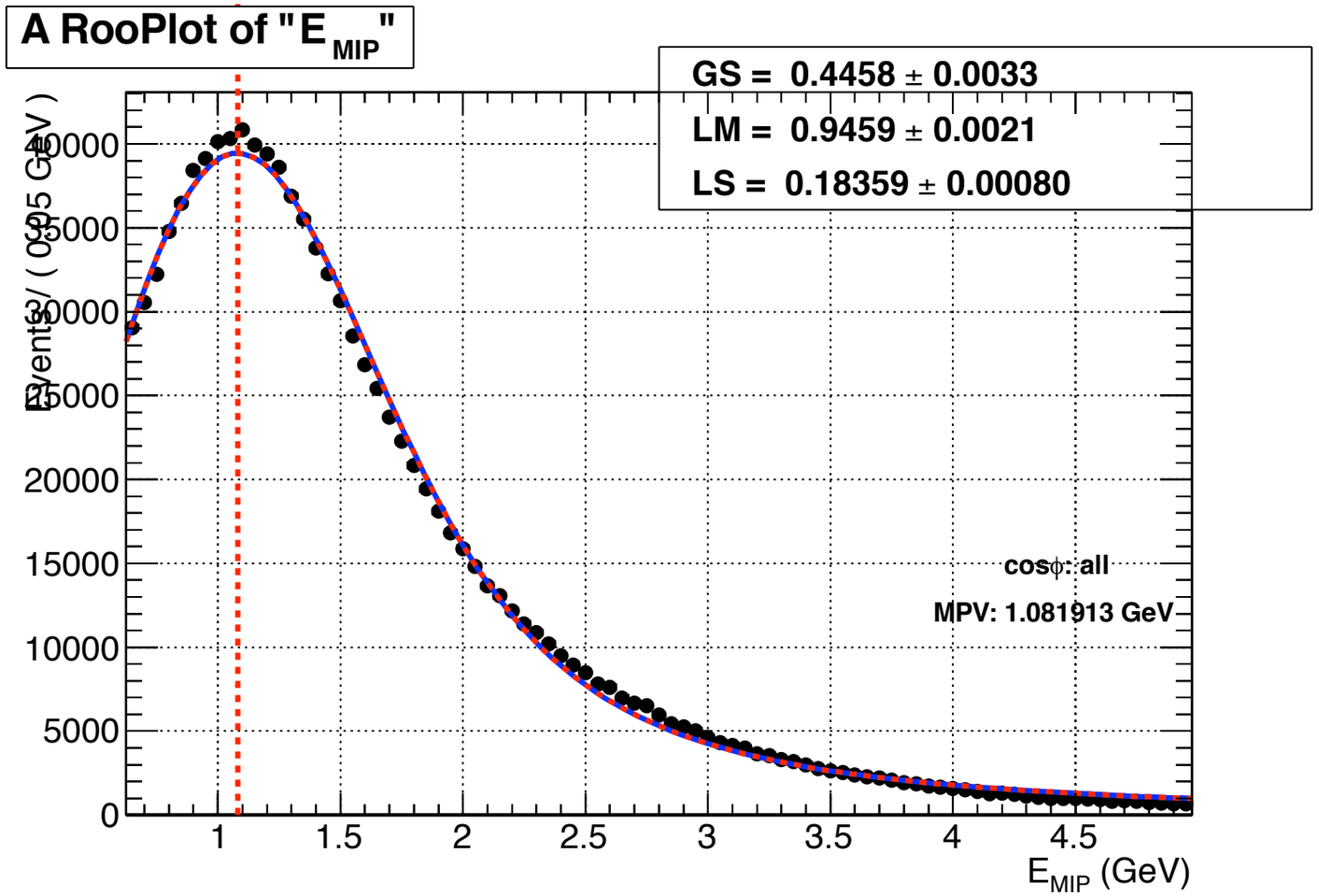
→ hadronic interaction length λ_0

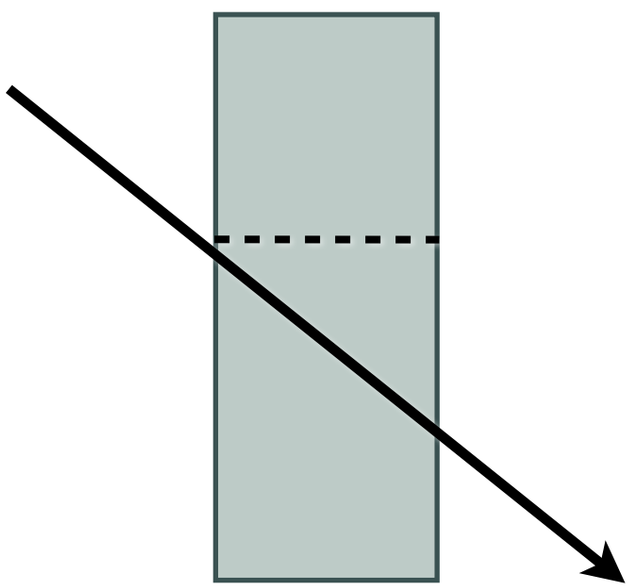
- Quick estimation of λ_0 (straight, primary tracks):

$$\lambda_0 = 8.1 \text{ layers}$$
$$\lambda_{0,PDG} = 8.88 \text{ layers}$$

Track segments by MIPs: Langau

- Energy deposition of MIPs:
  - Landau ⊗ Gauss: „Langau“
- Similar Fit like in FitMip package:
  - MPV = 1.08 GeV (all tracks)
- Energy deposition higher for inclined tracks
  - MPV = 0.99 GeV (straight tracks)





Run 331333: 60 GeV Pion

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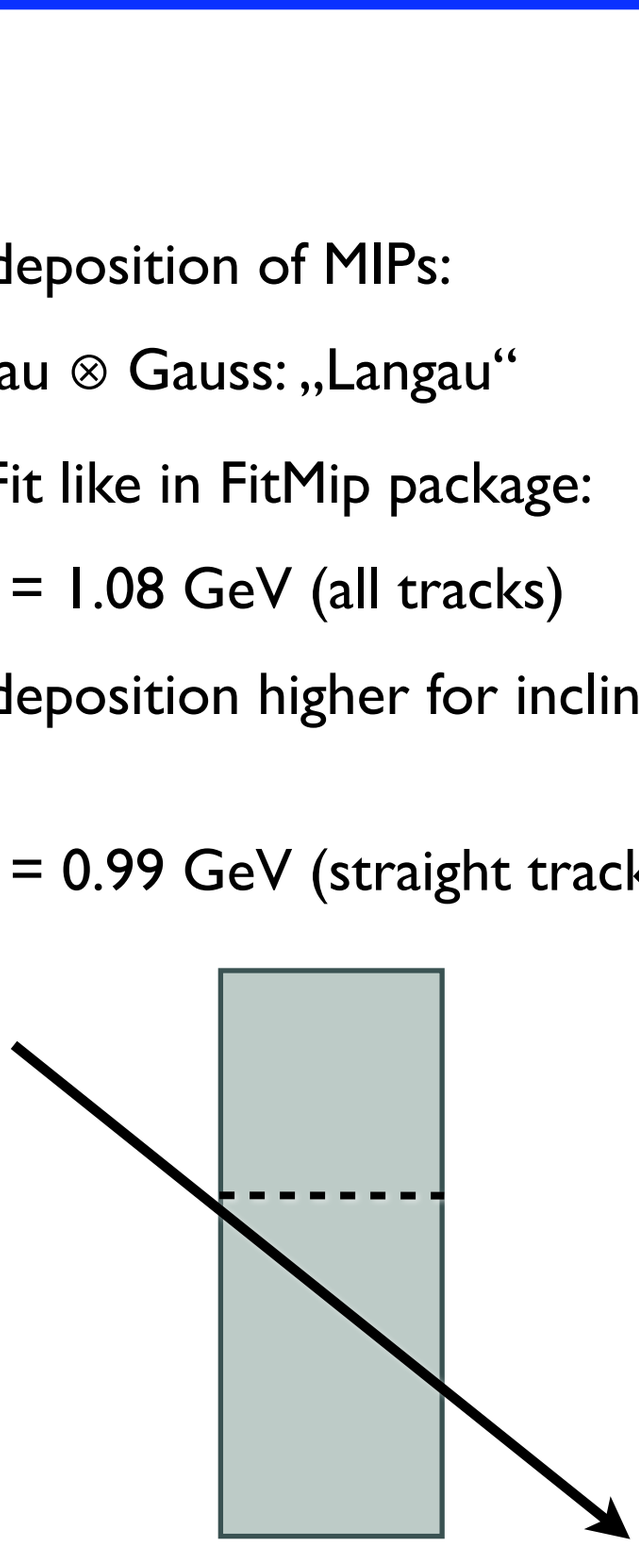

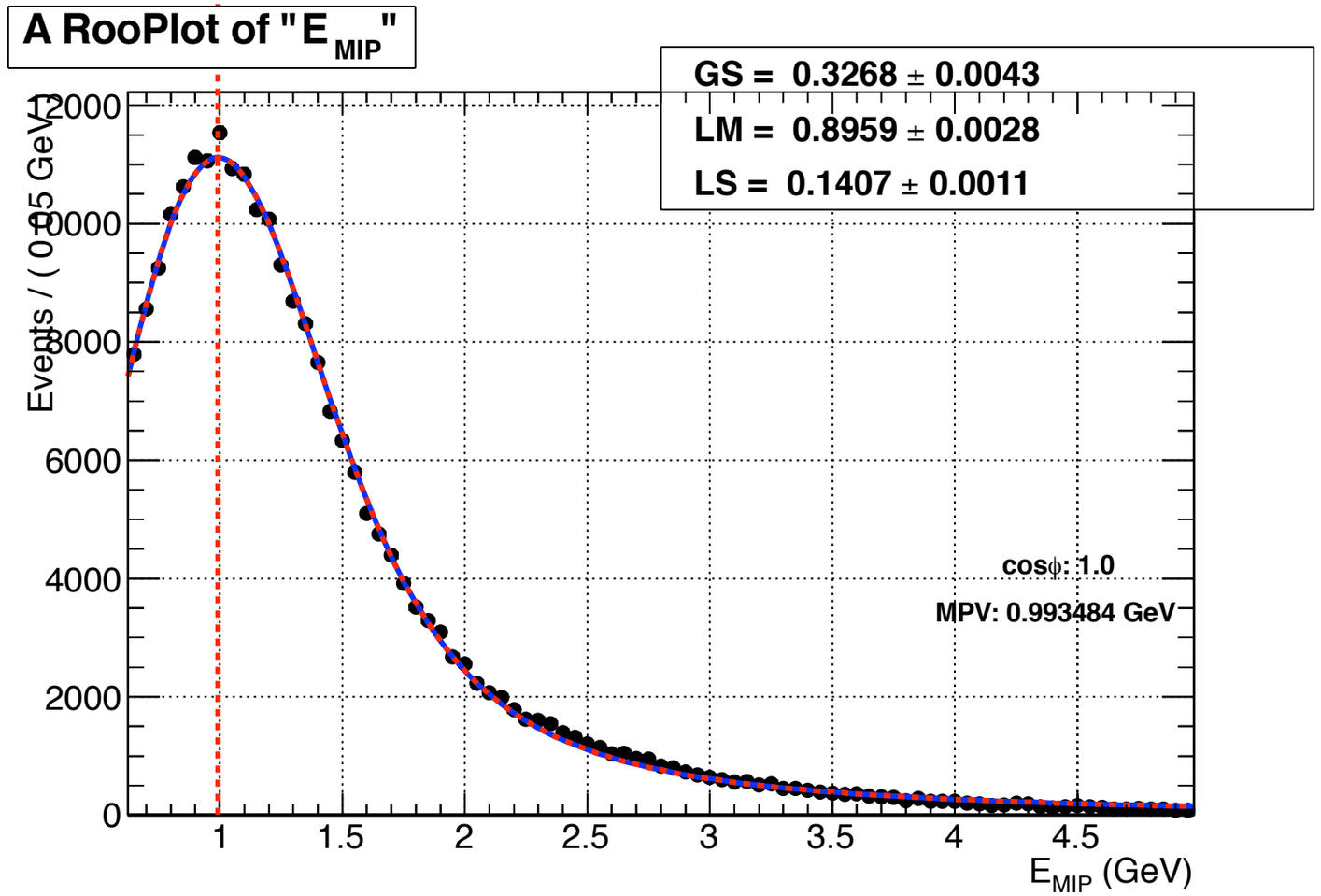

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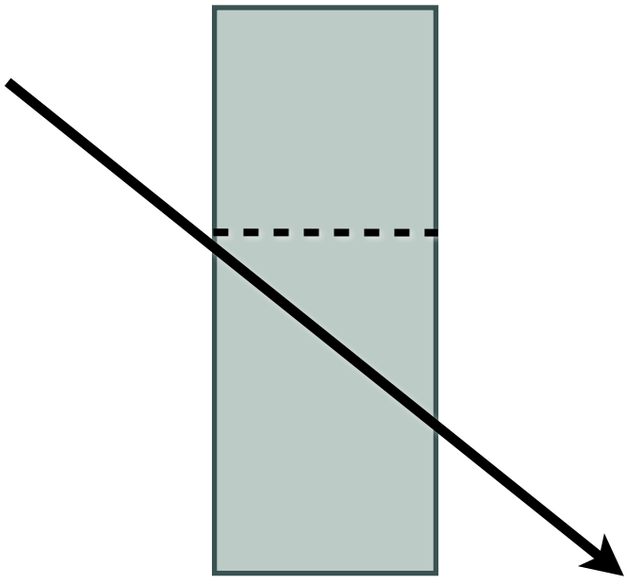
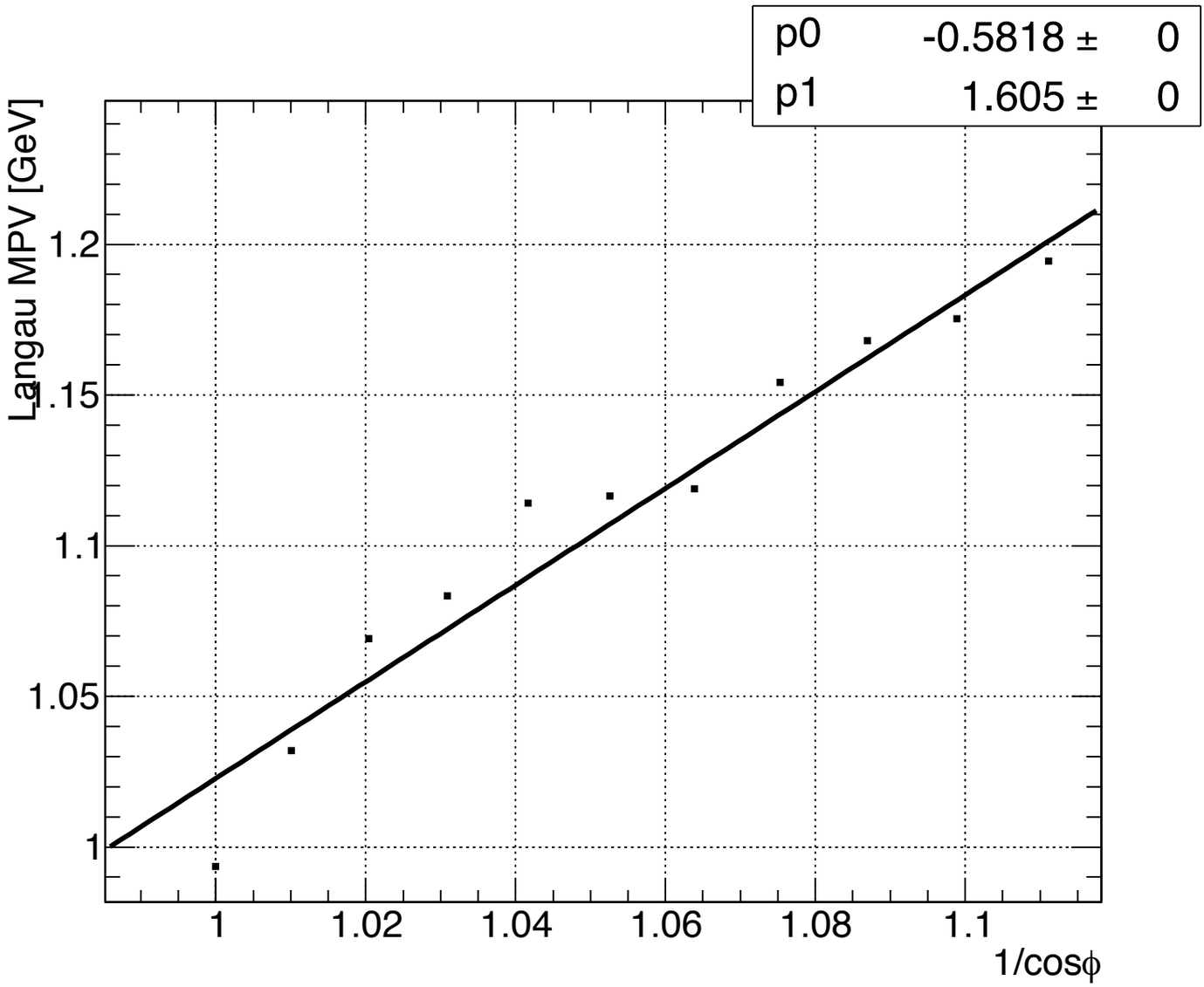
Langau MPV: Track angle dependence

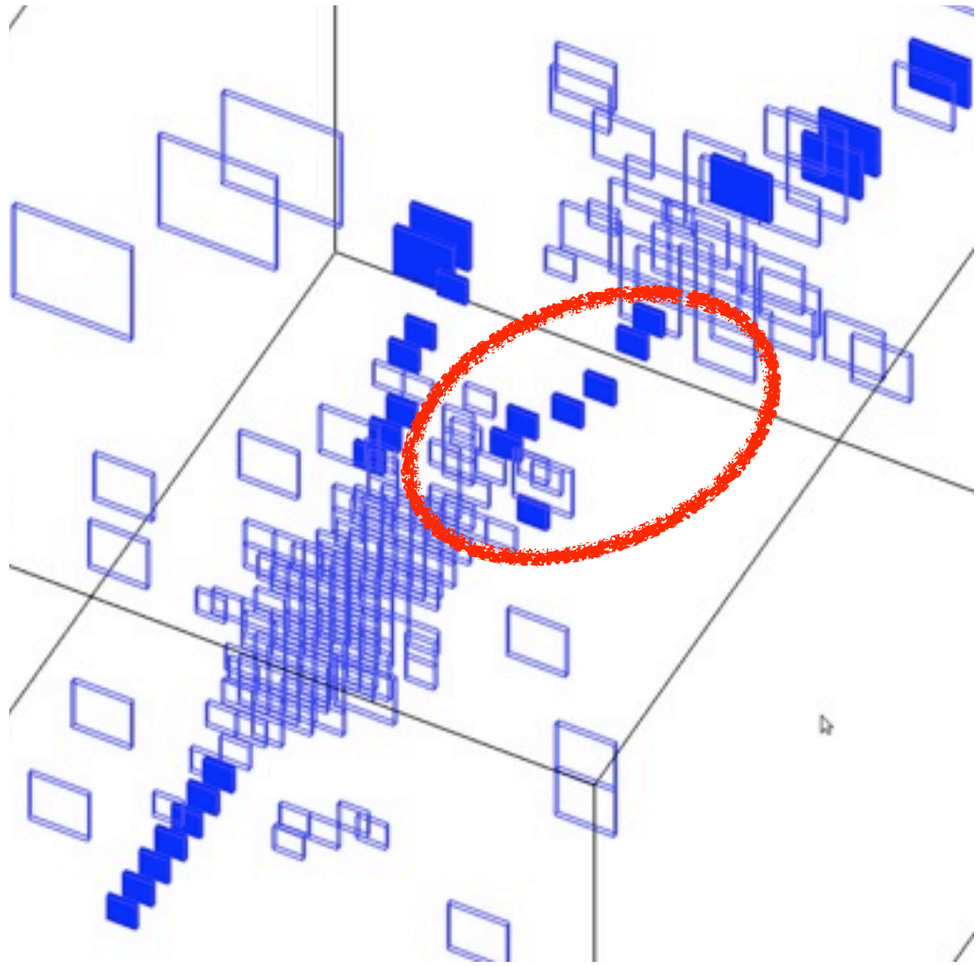


- Longer distance @ inclined tracks
  - higher E_{dep}
- expected: $E_{dep} \propto 1/\cos\varphi$



Track finding: Imperfections

- Nearest Neigbour Algorithm
  - No usage of physical flight trajectory
  - Noise hits influence track direction
- Solution:
  - Track Fitting
  - More advanced algorithms
- However: No/Small influence for
  - Straight/primary tracks
  - MC ⇔ Data comparison



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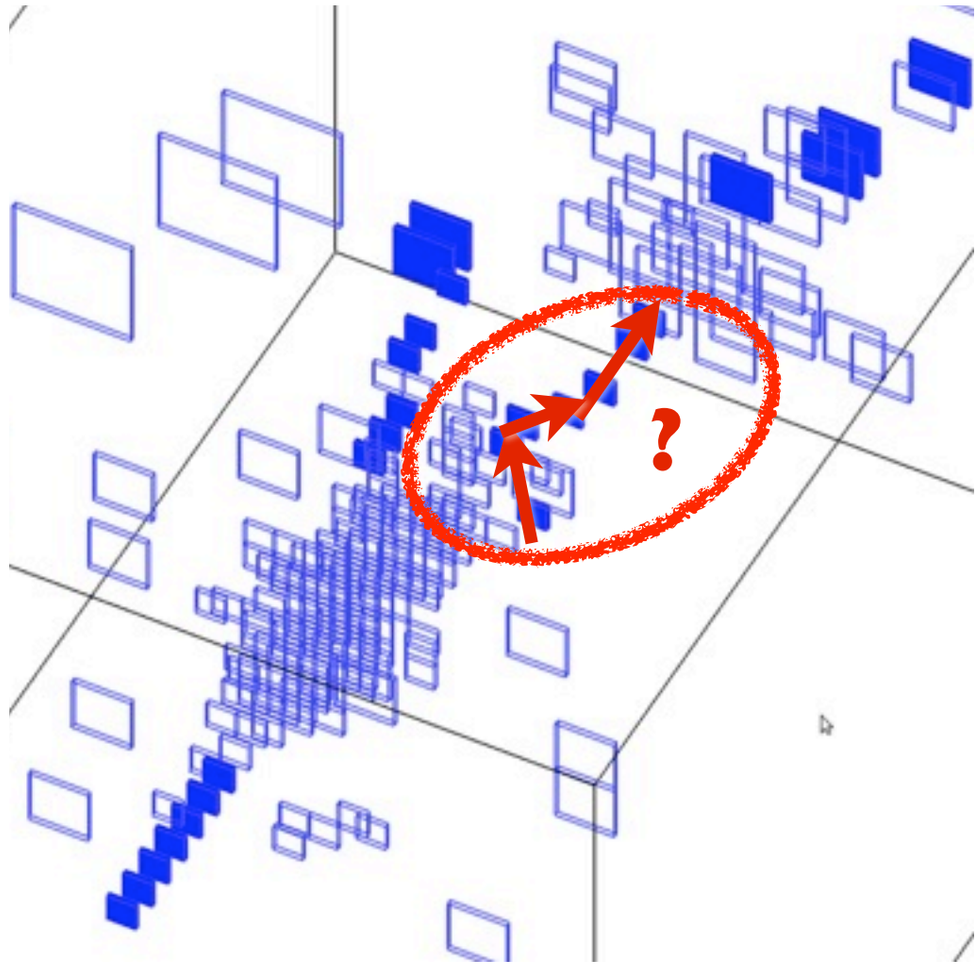
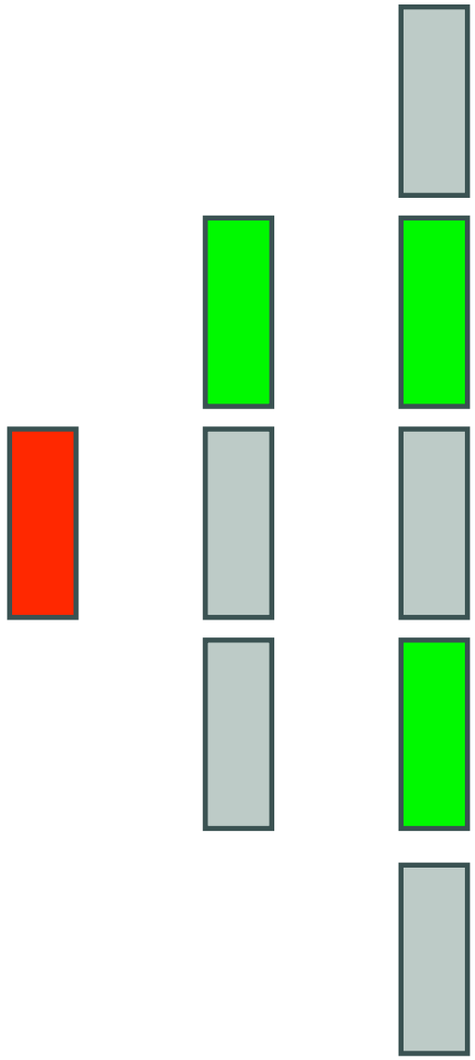


Publication Plan

- Description of algorithm
- Monte Carlo ↔ Data comparison
  - observables
    - track multiplicity / event
    - track length
    - track angle
  - physics lists
    - `LHEP, CHIPS`
    - `FTF_BIC, FTFP_BERT`
    - `QGSP_BERT(_TRV), QGSP_BERT_CHIPS, QGSP_FTFP_BERT, QGS_BIC`
    - `...` (suggestions)?
  - energy range: 10 to 80 GeV (same run list as software compensation paper)
- maybe: track length of primary, non inclined tracks → nuclear interaction length?

Run	energy [GeV]	particle
330777	10	π^-
330328	15	π^-
330327	18	π^-
330649	20	π^-
331340	30	π^+
330551	35	π^-
330412	40	π^-
330559	45	π^-
330391	50	π^-
331655	60	π^-
331567	80	π^+

Backup: Tracking Algorithm



- For each isolated hit as track start:
  - Collect isolated hits in the consecutive 2 layers
  - Sort them by distance to track start
  - Search for tracks with each of these as new track start point
    - Avoid double counting of hits
    - (Here: Hit 1 will use Hit 2a in its track, hence there is no possibility to start an independent track from Hit 2a)
  - Merge with longest track

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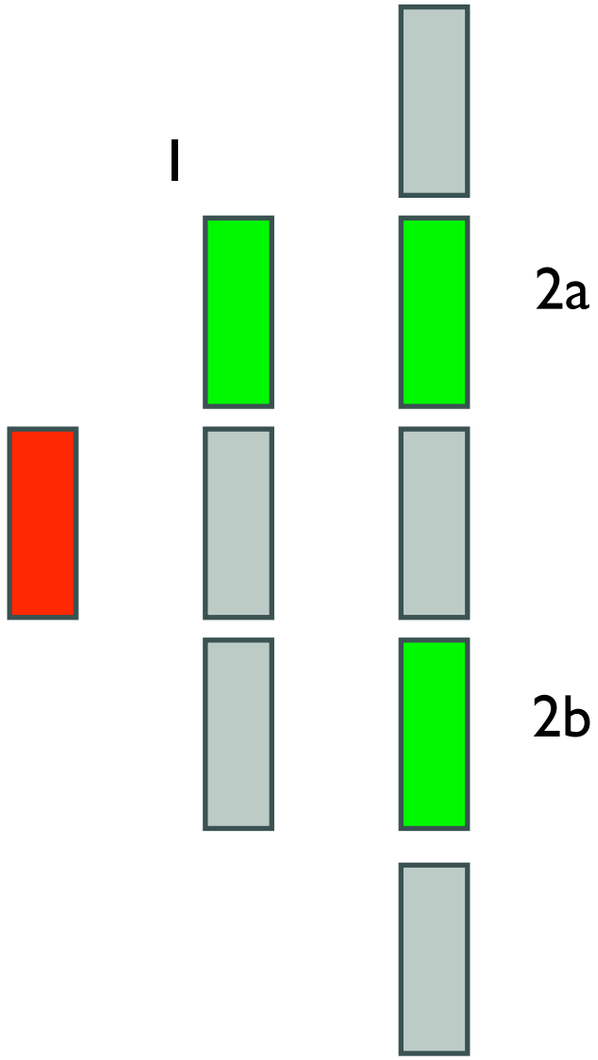

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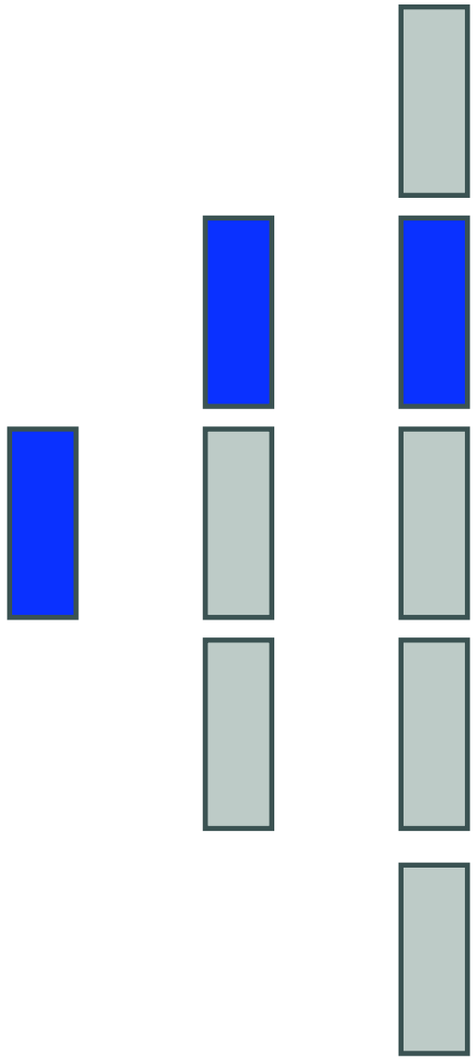

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