Monopole tracking

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Tracking meeting
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Introduction

- Magnetic monopole - a stable particle carrying magnetic charge
- Proposed by Dirac in 1931 as a way to quantize electric charge
  - $e_0 g_0 = n\hbar c/2$
  - Minimal magnetic charge $g_D \approx 68.5e$
- Various theories predict monopole existence with different charge constraints
- Searches are ongoing in cosmic rays and collision experiments
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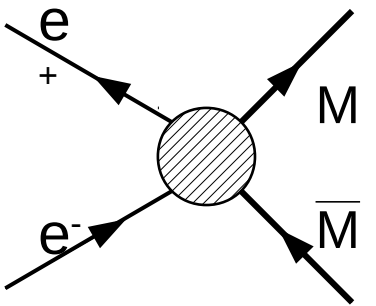
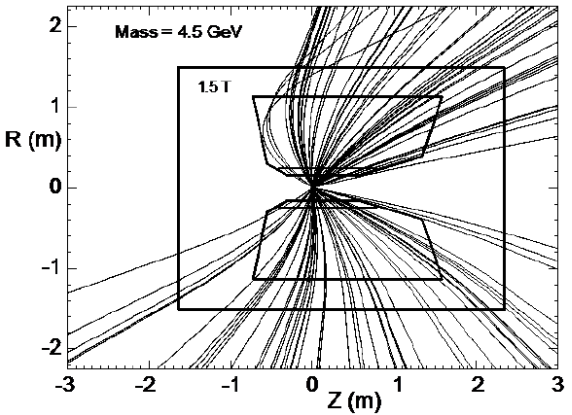
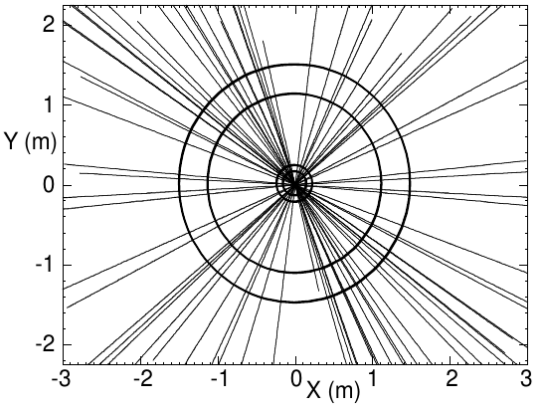
  Most recent searches
  - High magnetic charge
  - 2017 MoEDAL – 68.5e < g
  - 2016 ATLAS – 34e < g < 137e
  - Low magnetic charge
    1988 TASSO – $10e < g < 70e$
    1987 CLEO – $\boldsymbol{2e} < g < 10e$

Monopole parameters:
- Mass m
- Magnetic charge g
- Electric charge q



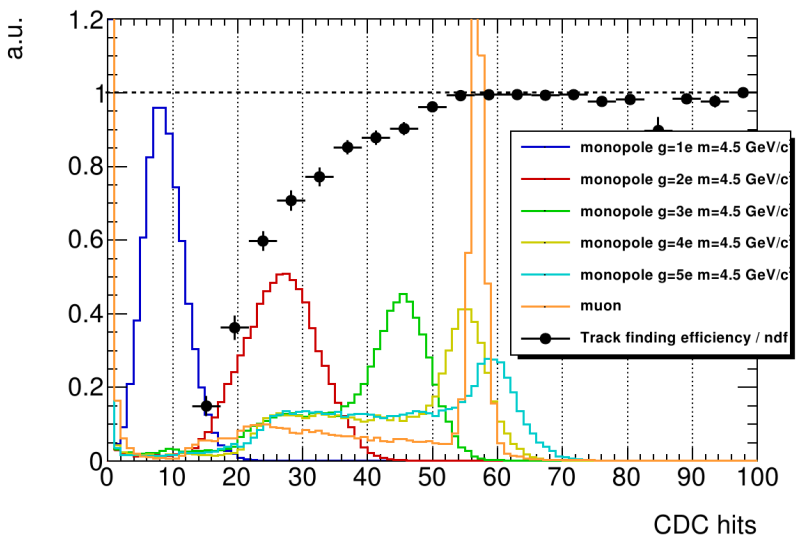


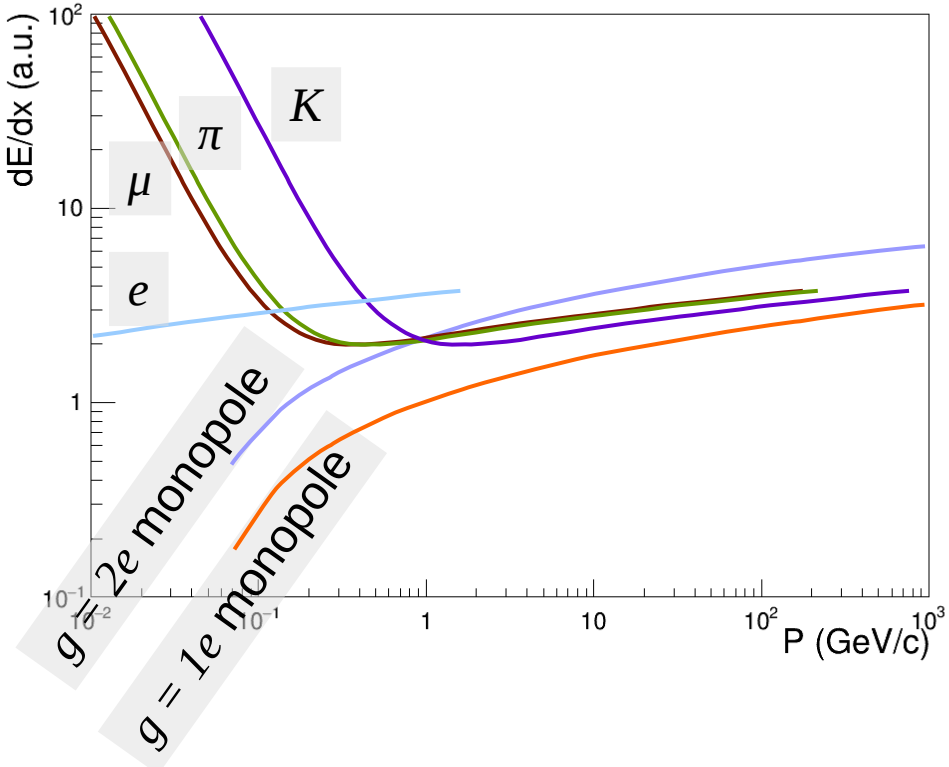


@M. Sullivan

Introduction

- Electric charges “see” magnetic one as a charge with a magnitude $g\beta$, which removes $1/\beta^2$ dependence from ionisation
- Monopoles produce less hits in the drift chamber, but are reconstructed in the ECL
- Curvature in RZ plane makes it even less possible to use conventional tracking

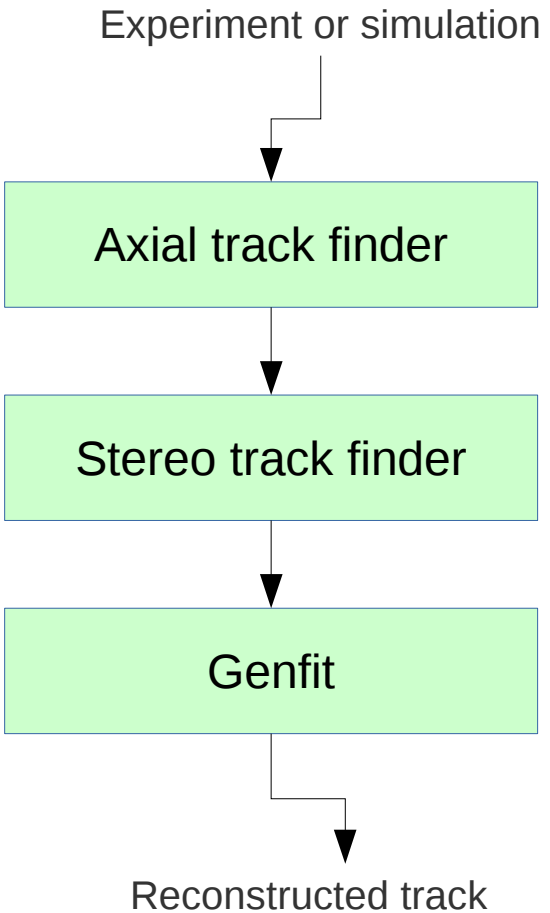




Tracking routine

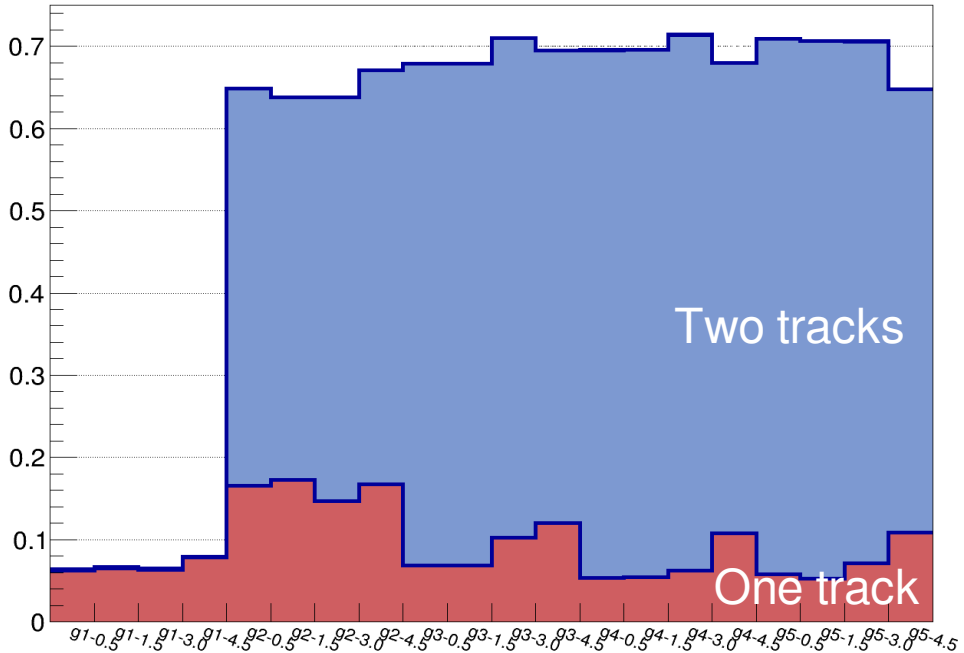
- A track is a std::vector of hits
  - Axial hits provide (R, φ) information
  - Stereo hits provide (z) information based on axial track
- Axial track finder types:
  - Conventional Legendre
  - Relaxed Legendre
  - Straight to ECL cluster
- Concerns for dedicated tracking
  - No change in conventional tracking
  - No change in mdst size
  - Low CPU cost
- Stereo track finder types:
  - Conventional (linear) hough
  - Quadratic hough

$$z(s) = z_0 + \frac{p_z}{p_T} s + \frac{gBm}{2p_T^2} s^2$$

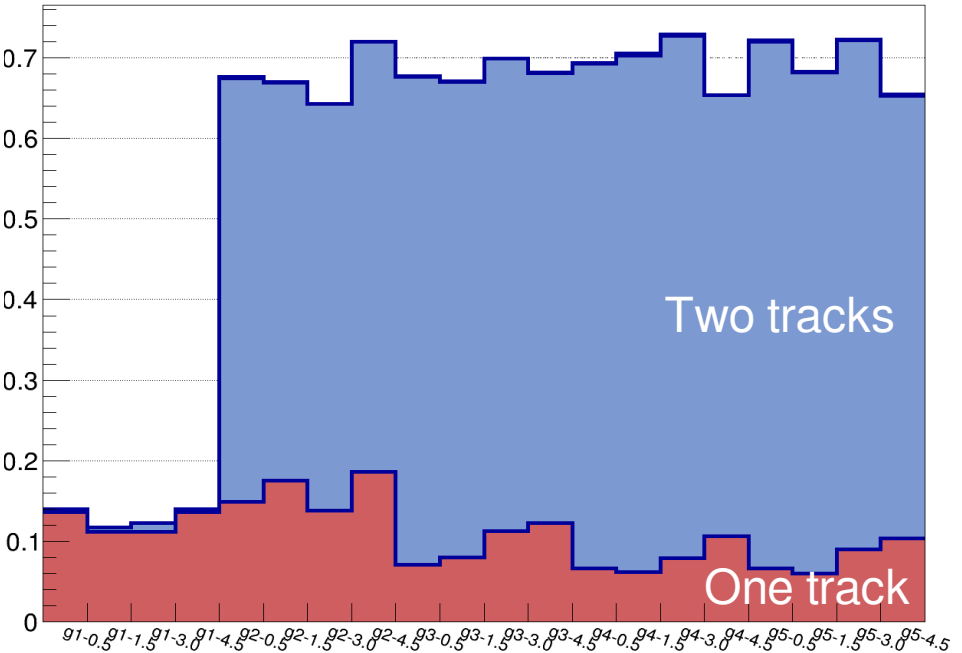


Standalone efficiency

Monopole tracking efficiency BGx00



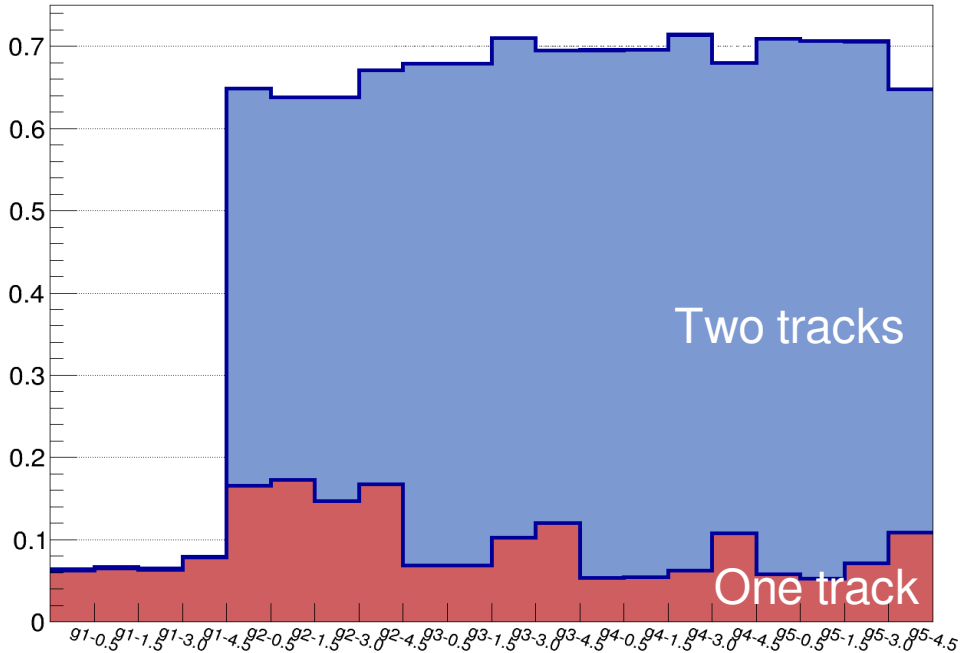
Monopole tracking efficiency BGx01



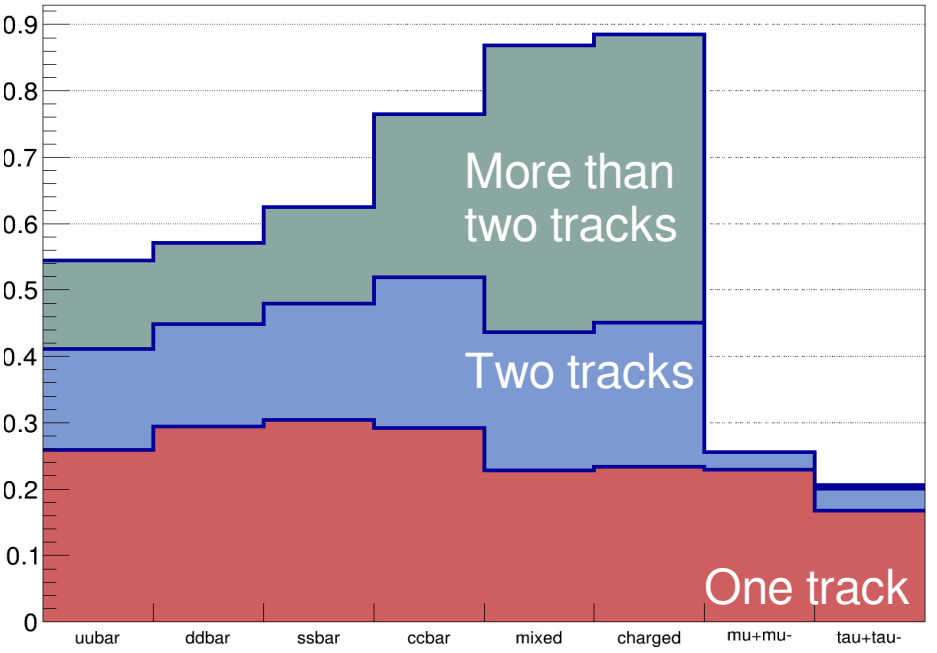
- No preselection ↔ max efficiency ~70%
- Straight axial track finder (min 5 hits)
- Quadratic hough stereo track finder (min 5 hits)

Standalone efficiency and fake rate

Monopole tracking efficiency BGx00



Monopole tracking fake rate BGx00



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Knobs and handles

In monopole tracking modules:

- Straight axial track finder
  - Number of hits
  - ECL energy
  - Distance from IP – ECL line
- Relaxed axial Legendre
  - Number of hits
  - R-φ curvature
  - Precision
- Quadratic stereo hough
  - Number of hits
  - z-s curvature?

Outside monopole tracking:

- Cluster matching
- ECL energy
- CDC hits taken/masked
- Helix tracks
- PID
- . . .

Discussion

- Monopole tracking pull request is open
- “number_of_mpl_candidates” HLT flag implemented in the calibration trigger
  - Need to run in parallel to normal tracking during reprocessing to get skimmed sample with CDCwirehits
  - Potentially would like to run in parallel on HLT during phase 3
- Questions
  - How to treat CDChits flags from normal tracking?
  - Where to put modules relatively to others in reconstruction.py?
  - Which figures to provide to software / tracking / HLT people in order to approve PR?