EIC Tracking Simulations:
μRWell Material Budget Benchmarks

22-06-2022 Update

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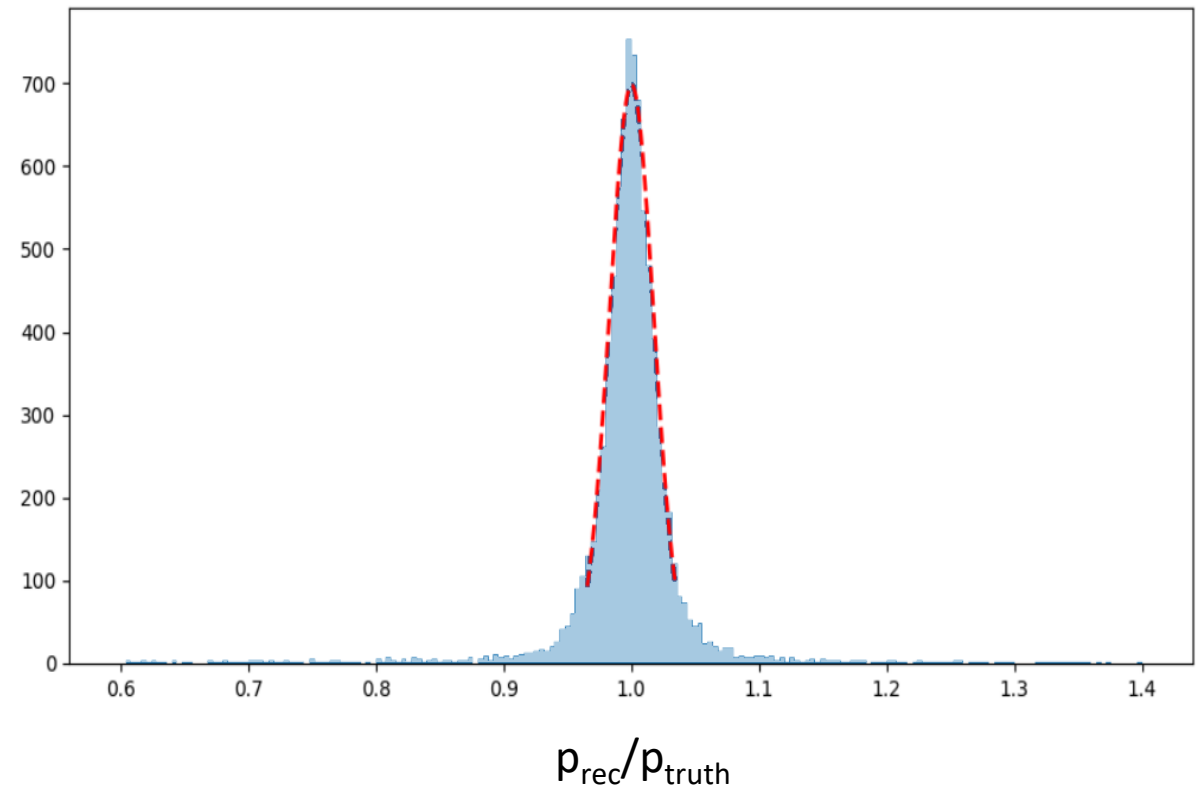
Setup

- Using Fun4All software stack to run simulations

- Began with "default" ECCE geometry (https://github.com/ECCE-EIC/macros)
  - Disabled all components except tracking detectors and materials within tracking volume
  - Everything else left the same
  - Note: default setup still fails to meet PWG tracking requirements in most areas

- Reproduced results from S. Maple et al. silicon tracking study (PDF)

- Next, replaced barrel μRWell geometry with a simplified version (single cylinder) for each detector
  - Parameterized thickness of this cylinder to easily change X_0 of detector
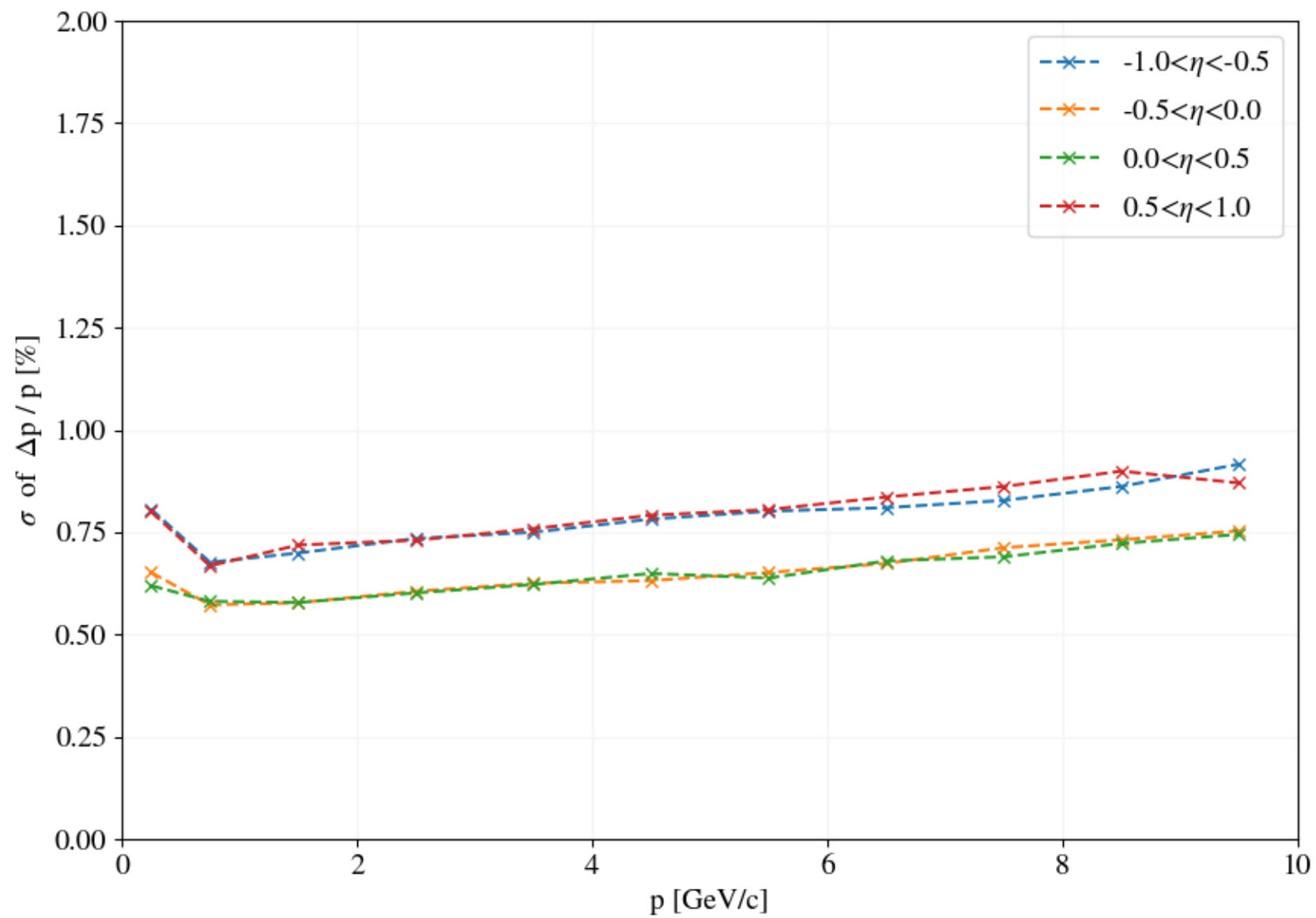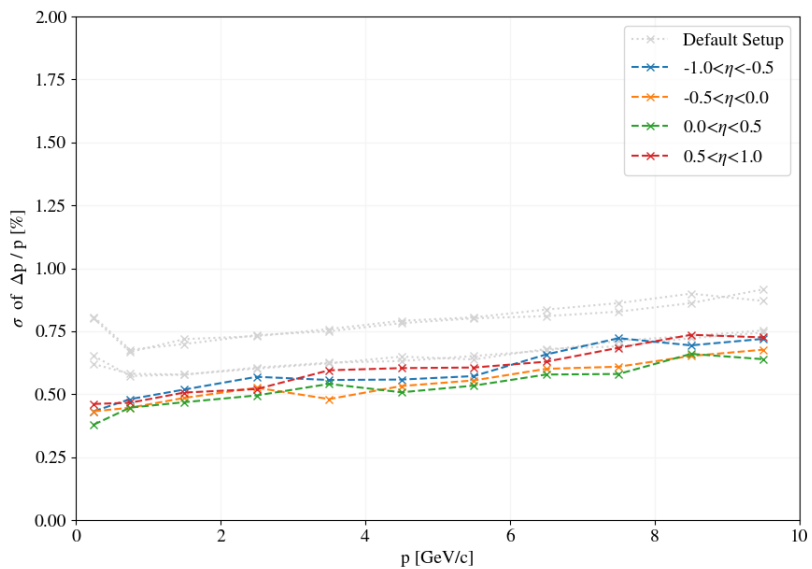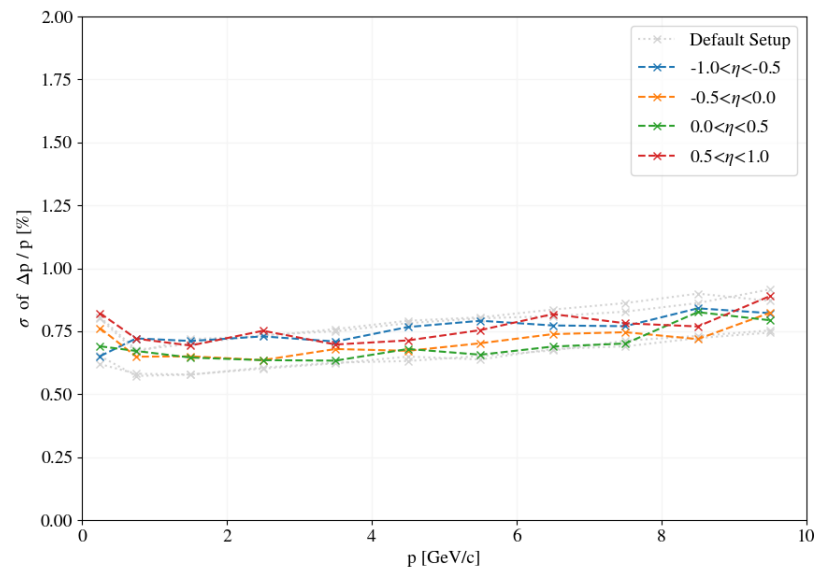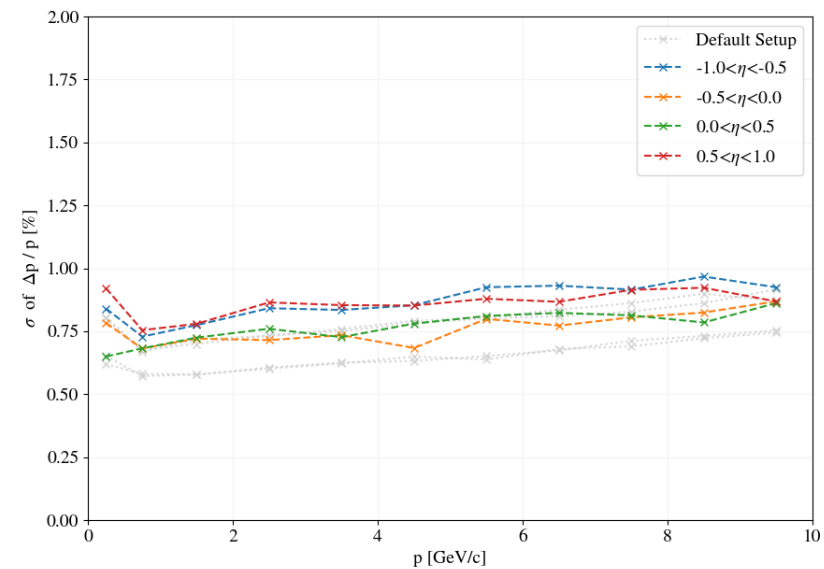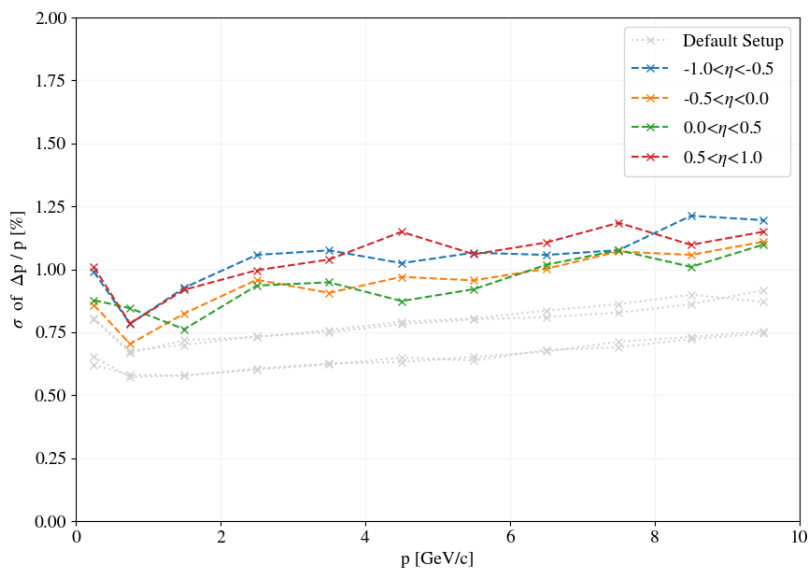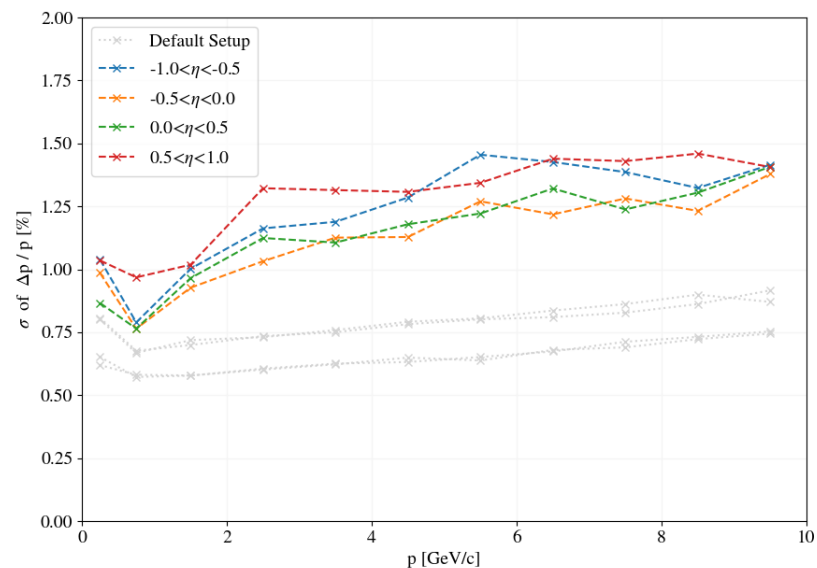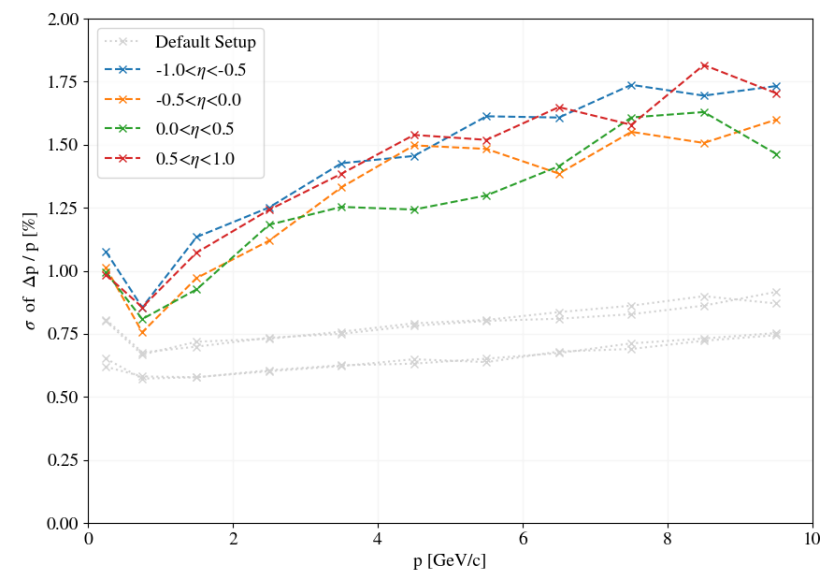 - Swept across X_0 and compared to default configuration

Details

- Generated π^- particles uniformly in η, p_t with ranges $-1.5 < \eta < 1.5$ and 0 GeV/c $< p_t < 10.0$ GeV/c
  - 500,000 particles to get stats for default configuration, 50,000 for each X_0

- Rescaled sPHENIX field map from 1.5T to 1.4T

- Create histogram of p_{rec}/p_{truth}, fit gaussian to distribution and record σ
  - Perform this process over bins in η and p

- (exact process S. Maple et al. used)

- Si sagitta layer material changed from 0.05% X_0 to 0.55% X_0
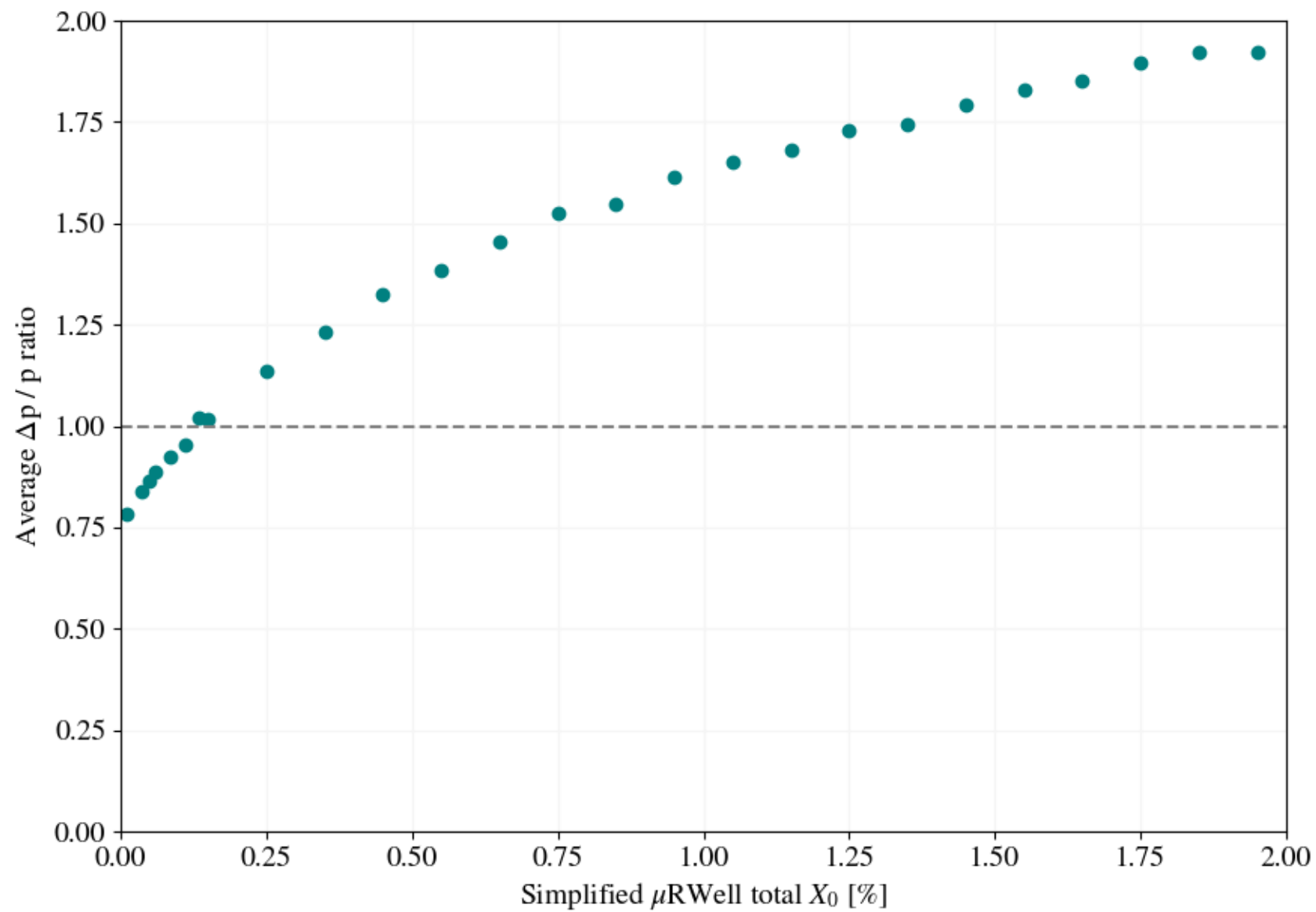
Relative Momentum Distribution Fit (example)

p_{rec}/p_{truth}

Δp / p Benchmark: Default μRWell Setup

Δp / p Benchmark: 0.010%X_0 μRWell
Δp / p Benchmark: 0.135%X_0 μRWell
Δp / p Benchmark: 0.250%X_0 μRWell
Δp / p Benchmark: 0.550%X_0 μRWell
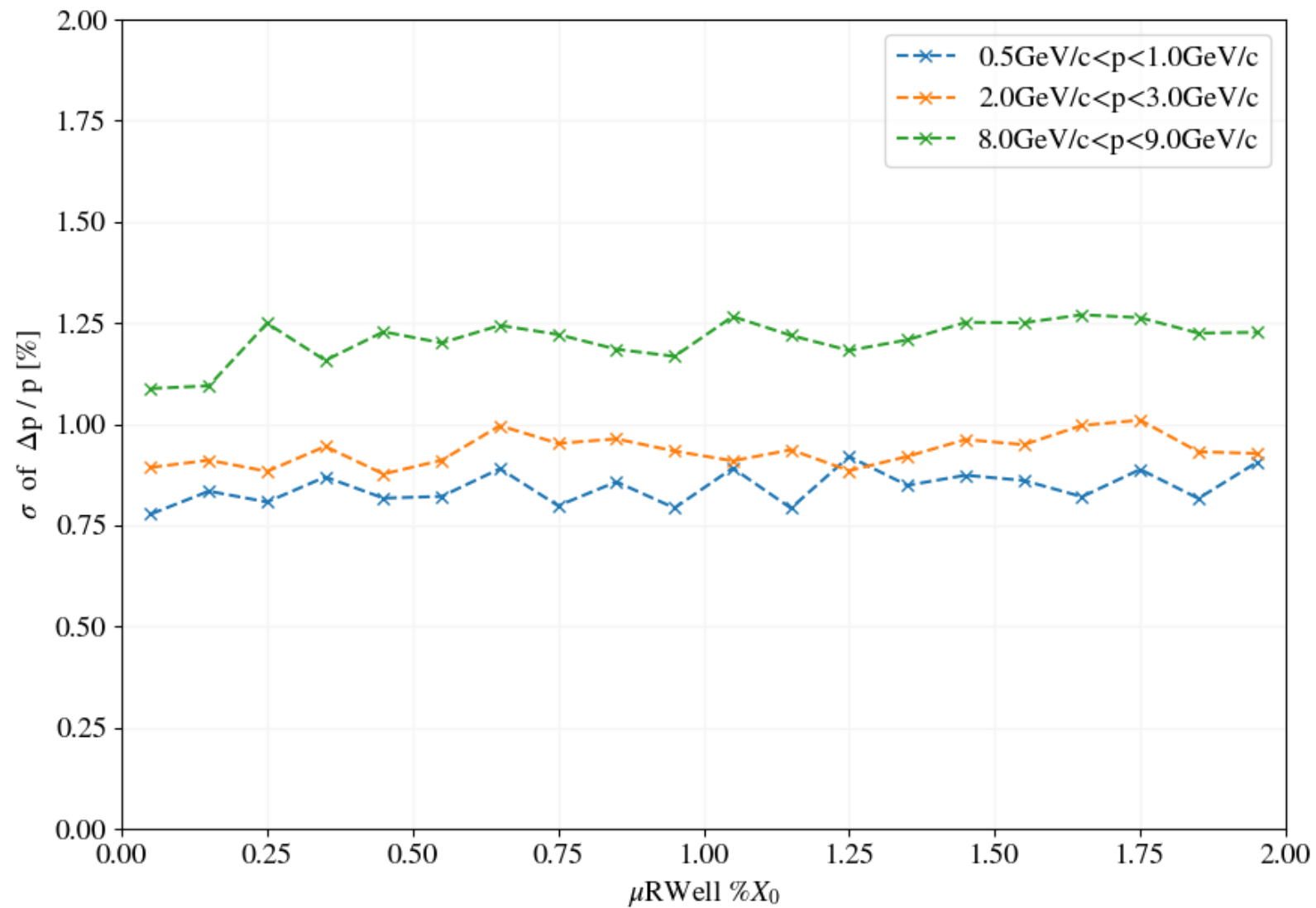Δp / p Benchmark: 1.050%X_0 μRWell
Δp / p Benchmark: 1.650%X_0 μRWell

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Resolution ratio between simplified μRWell and default μRWell

Average $\Delta p / p$ Benchmark for $-1.0 < \eta < 1.0$

Legend:
- 0.5GeV/c<p<1.0GeV/c
- 2.0GeV/c<p<3.0GeV/c
- 8.0GeV/c<p<9.0GeV/c

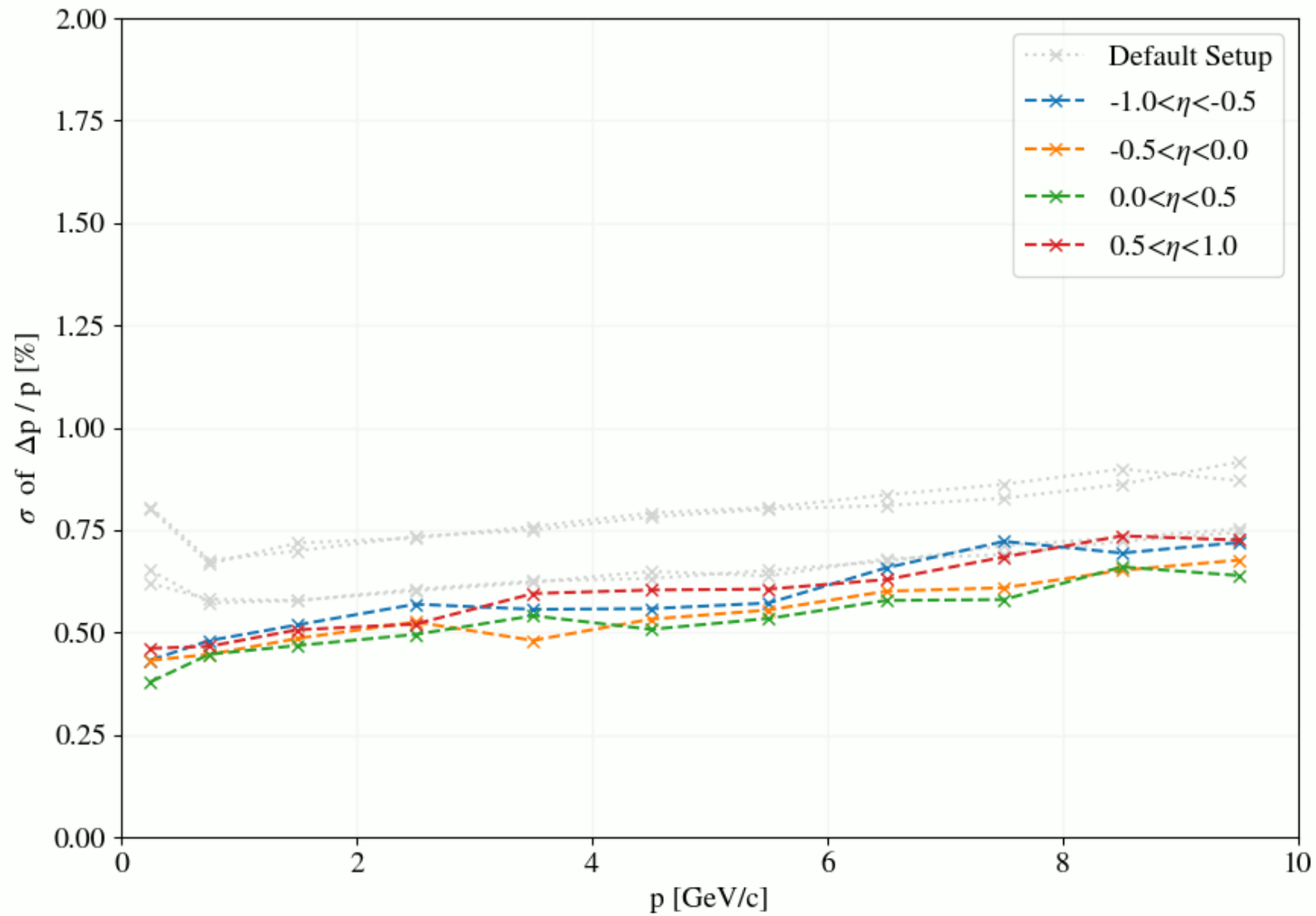Y-axis: σ of $\Delta p / p$ [%]

X-axis: μRWell $\%X_0$
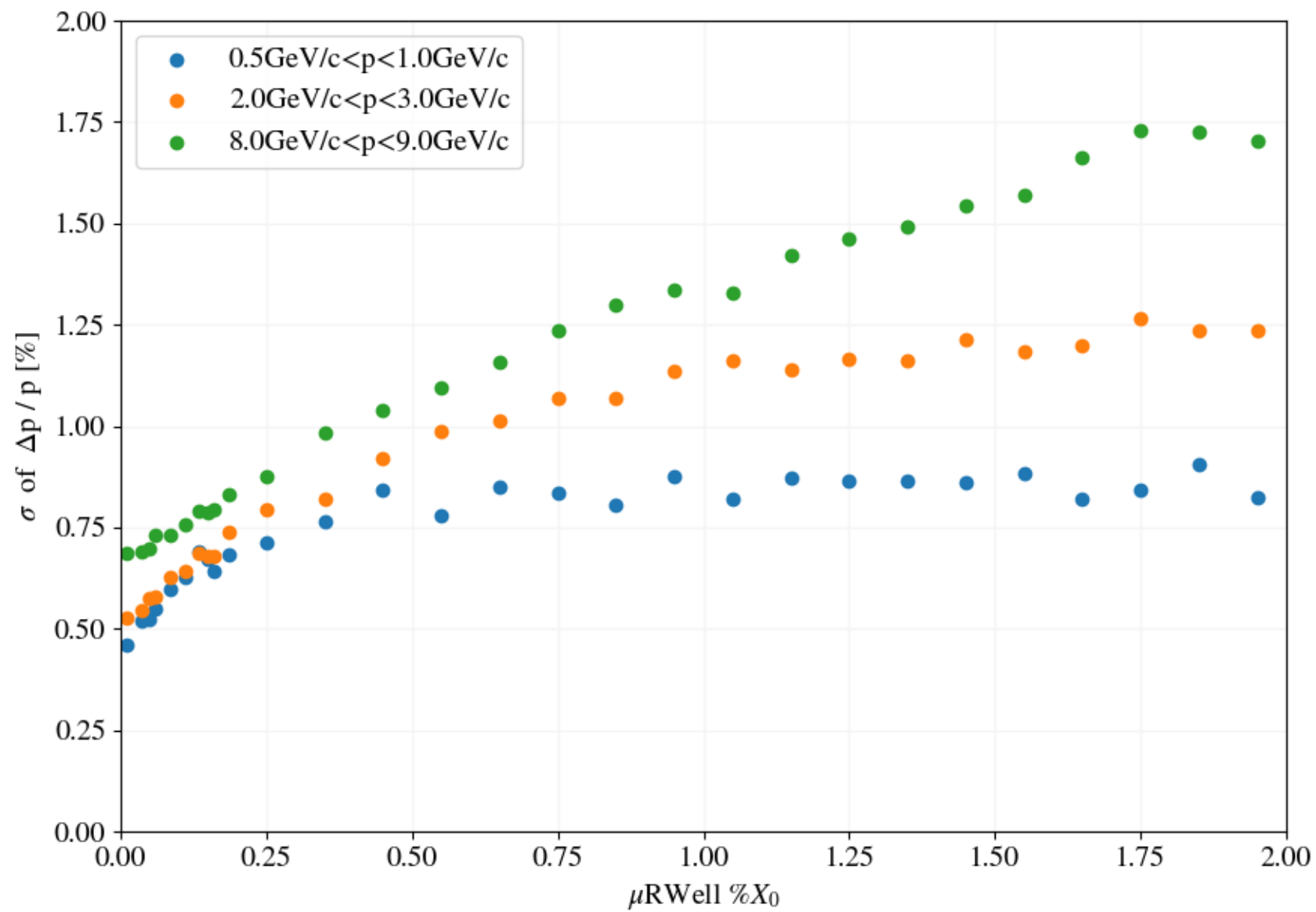
Average $\Delta p / p$ Benchmark for $-1.5 < \eta < -1.0$ and $1.0 < \eta < 1.5$

η=+/-1.0 is near the edge of the barrel, so very little
changes with X_0 after that

$\Delta p / p$ Benchmark: $0.010\% X_0\ \mu$RWell

Animation!