Update on u-channel $\rho \to \pi^+\pi^-$ Benchmark

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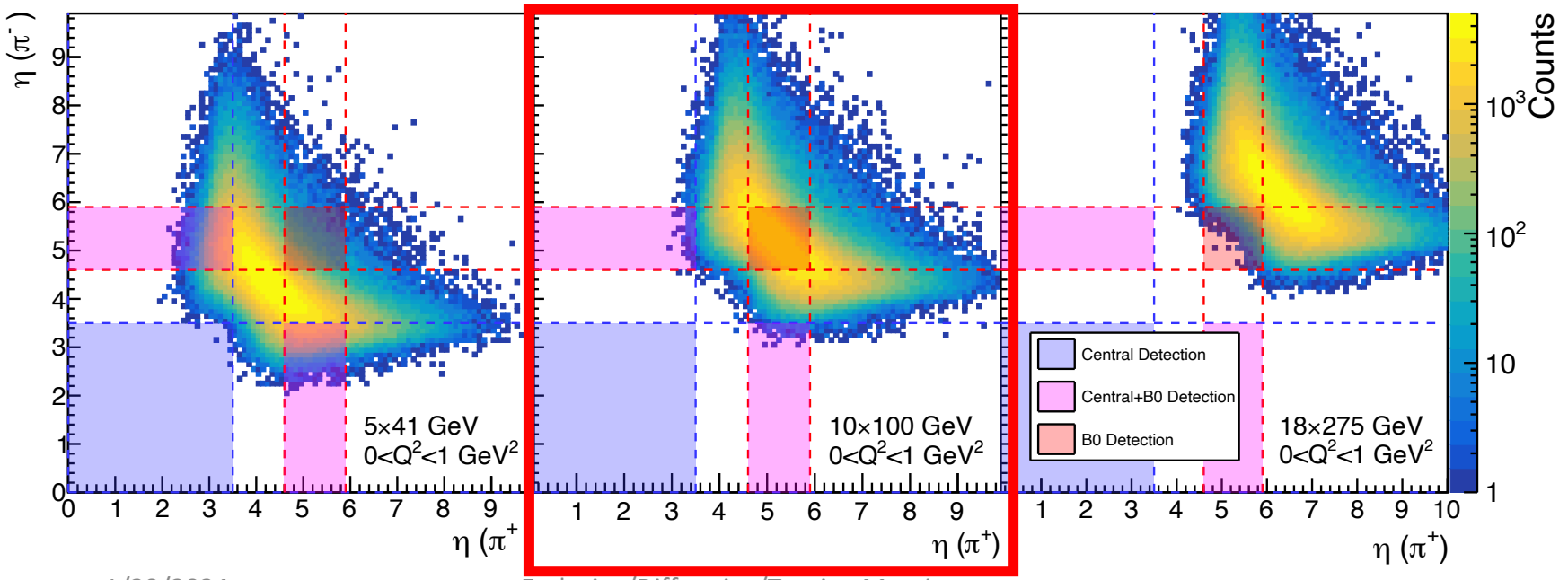
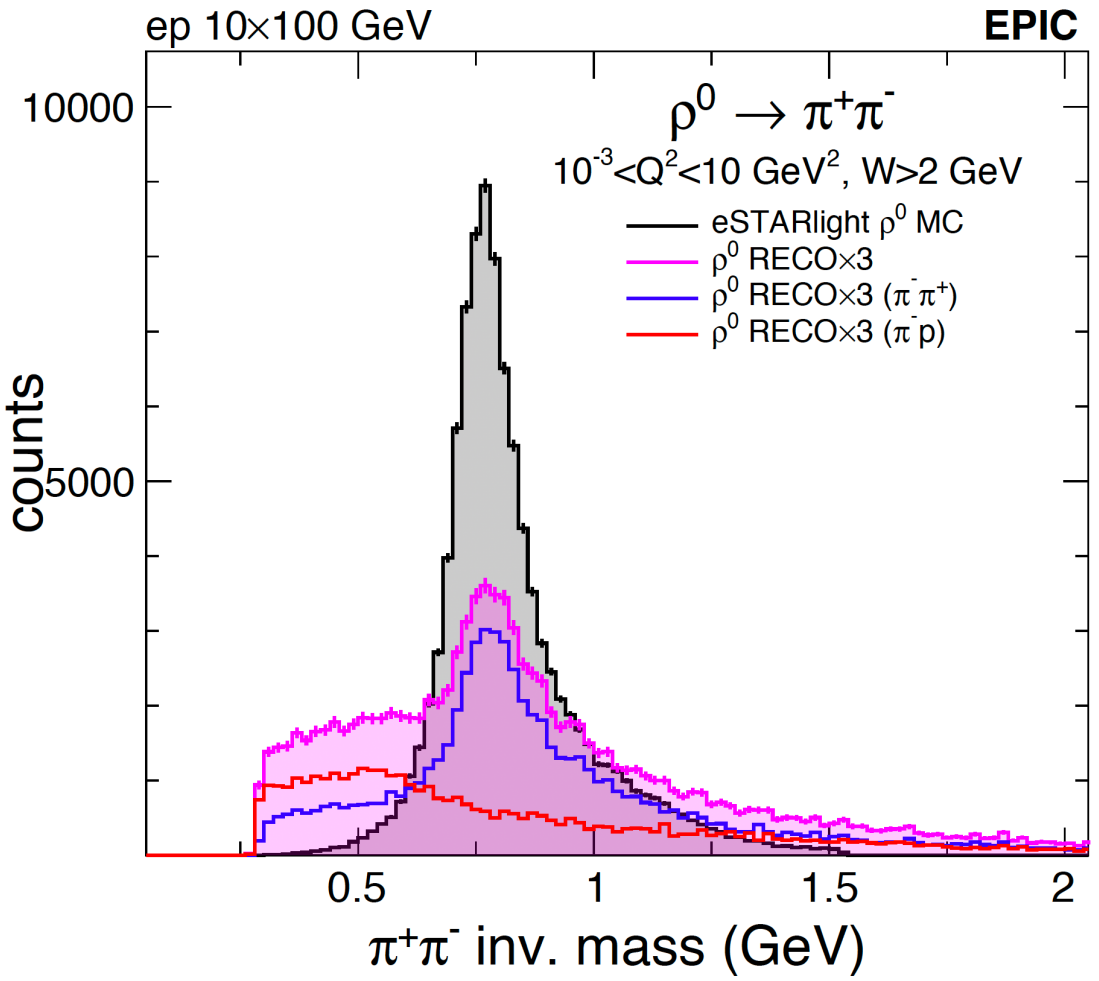
(RECAP) Far-Forward Benchmarks: Backward ρ^0

- Backward ρ production is an excellent benchmark for B0 tracking
- With $\rho \rightarrow \pi^+\pi^-$ we can test two things in the benchmark:
  1. Missing mass $e\,p \rightarrow e\,p\,\rho$
     - ❑ Tests backward (electron) detectors
     - ❑ Tests forward (hadronic) calorimeter and PID
     - ❑ Tests B0 reconstruction capability
  2. ρ mass reconstruction peak
     - ❑ If this changes, something may have changed with beam pipe, or B0 tracking resolution



Backward $\rho^0 \rightarrow \pi^+\pi^-$ Benchmark

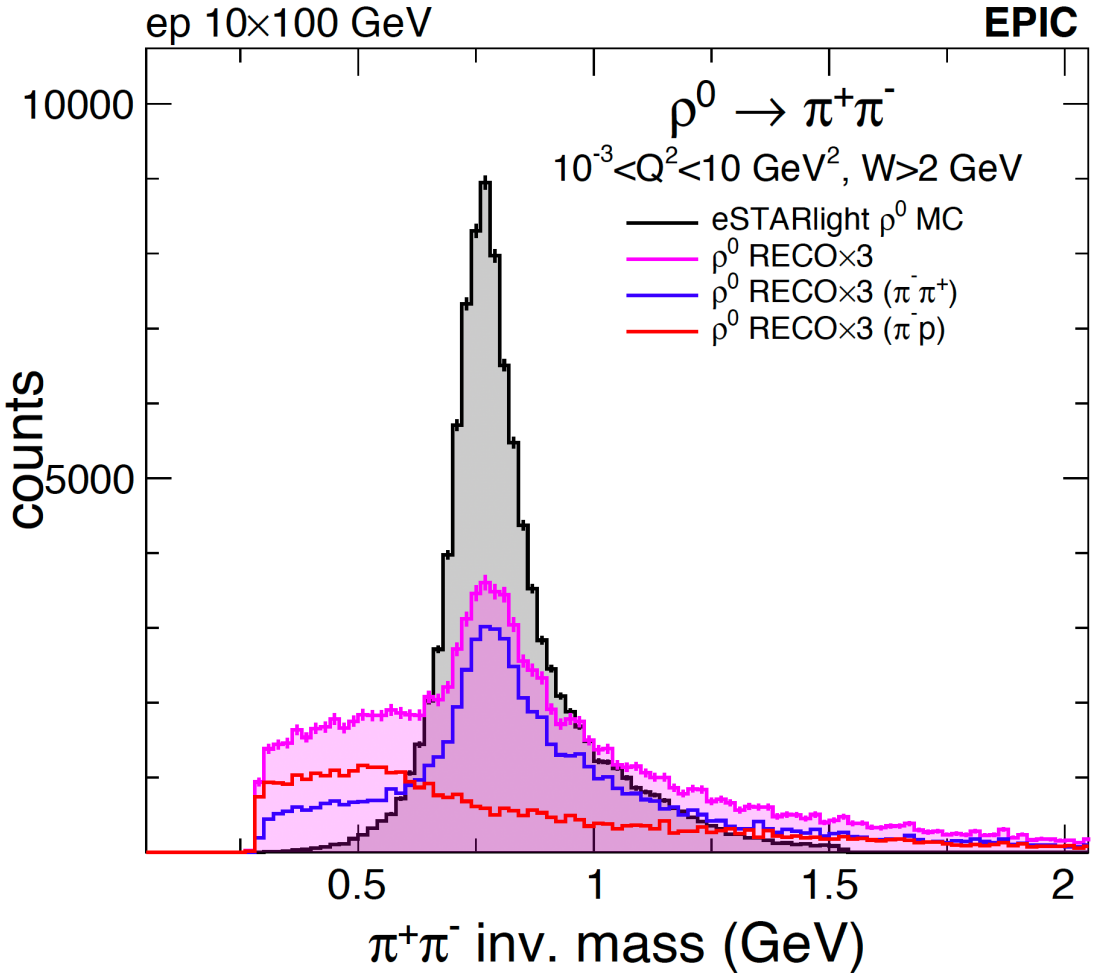
- Simulated 10×100 GeV samples included in December simulations
- With Kong's help, I was able to write some code to analyze the samples
- To construct the magenta histogram at right, I took the invariant mass of each reconstructed negative track with each reconstructed positive track
- At generator level these events only include
  $e+p \rightarrow e'p'\rho^0 \rightarrow e'p'\pi^+\pi^-$
- Background from taking invariant mass of $p+\pi^-$
- I then used the PDG ID of these tracks to identify true $\pi^+ + \pi^-$ and background $p+\pi^-$



Backward $\rho^0 \rightarrow \pi^+\pi^-$ Benchmark

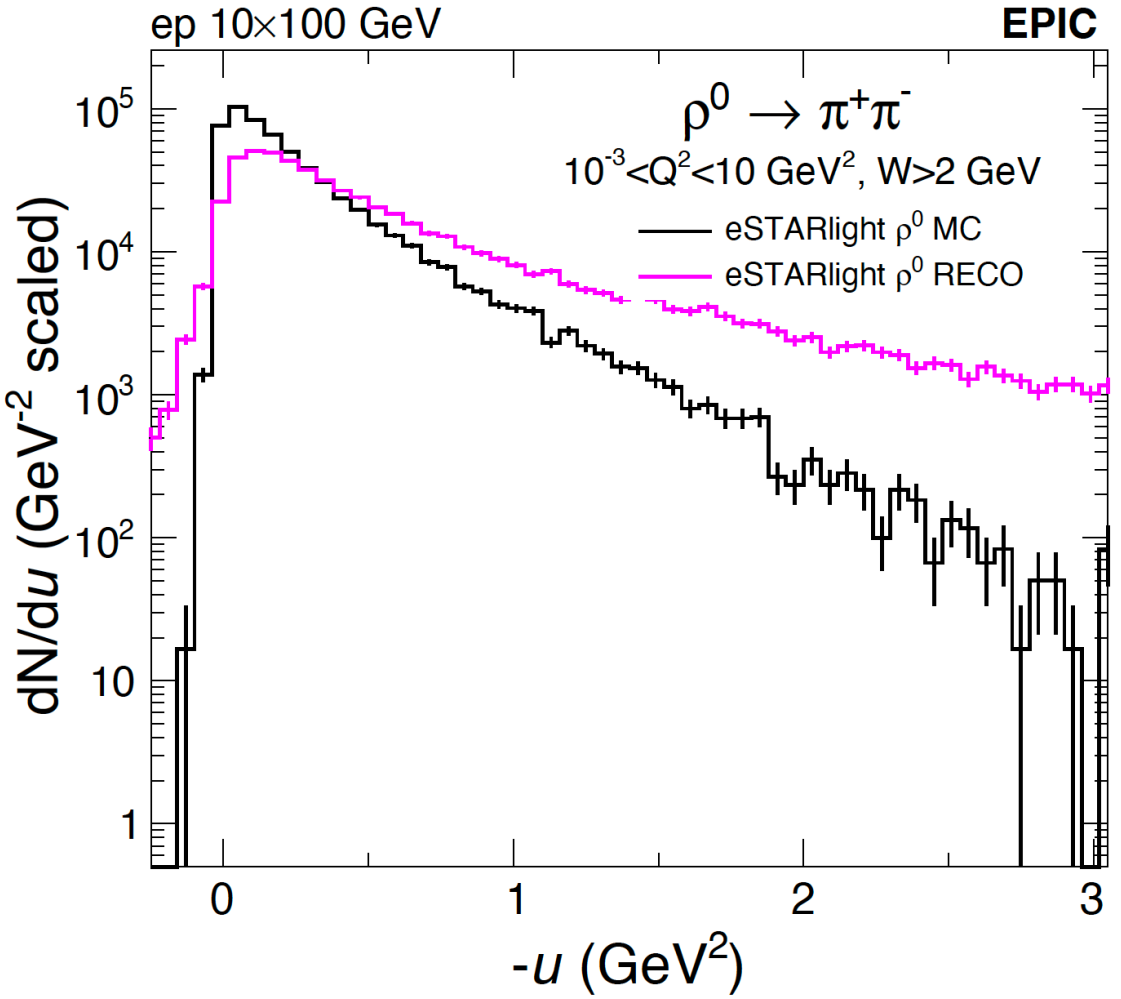
To do:

- check reco for both particles in B0
- check whether reco particles are primaries
- Investigate efficiency for both particles within acceptance
- Investigate whether exclusivity cuts help



Backward $\rho^0 \rightarrow \pi^+\pi^-$ Benchmark

- From the oppositely-charged reconstructed particle pairs, I calculate the total 4-momentum as if both particles were pions
- $u = (p_{\rho 0} - p_{p\ beam})^2$
- Again, contamination from $p+\pi^-$ pairing

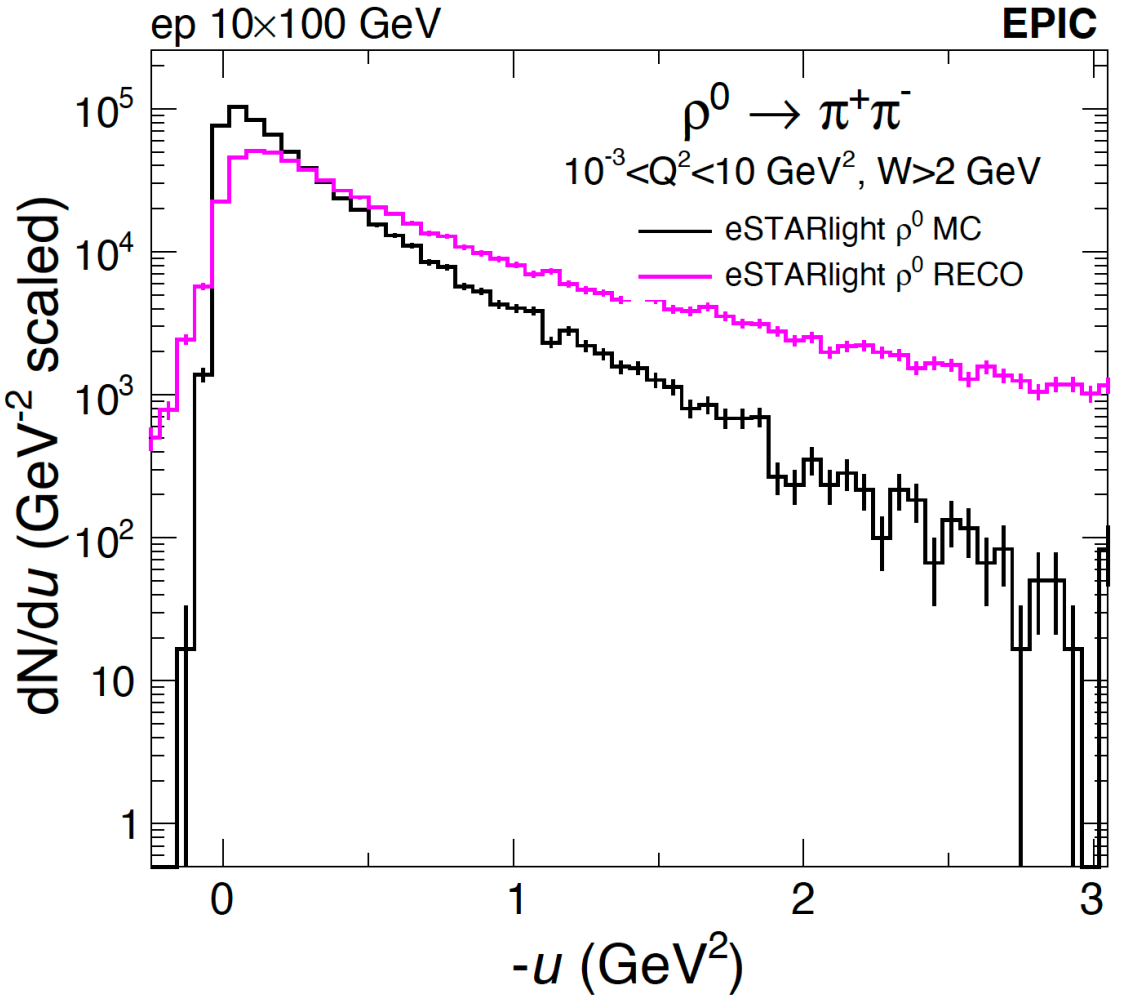


Backward $\rho^0 \rightarrow \pi^+\pi^-$ Benchmark

- From the oppositely-charged reconstructed particle pairs, I calculate the total 4-momentum as if both particles were pions
- $u = (p_{\rho 0} - p_{p\ beam})^2$
- Again, contamination from $p+\pi^-$ pairing

To do:

- Evaluate contamination from proton, and non-primaries
- Evaluate resolution for both particles in B0
- Investigate exclusivity cuts
- Think about how to quantify quality of reconstruction



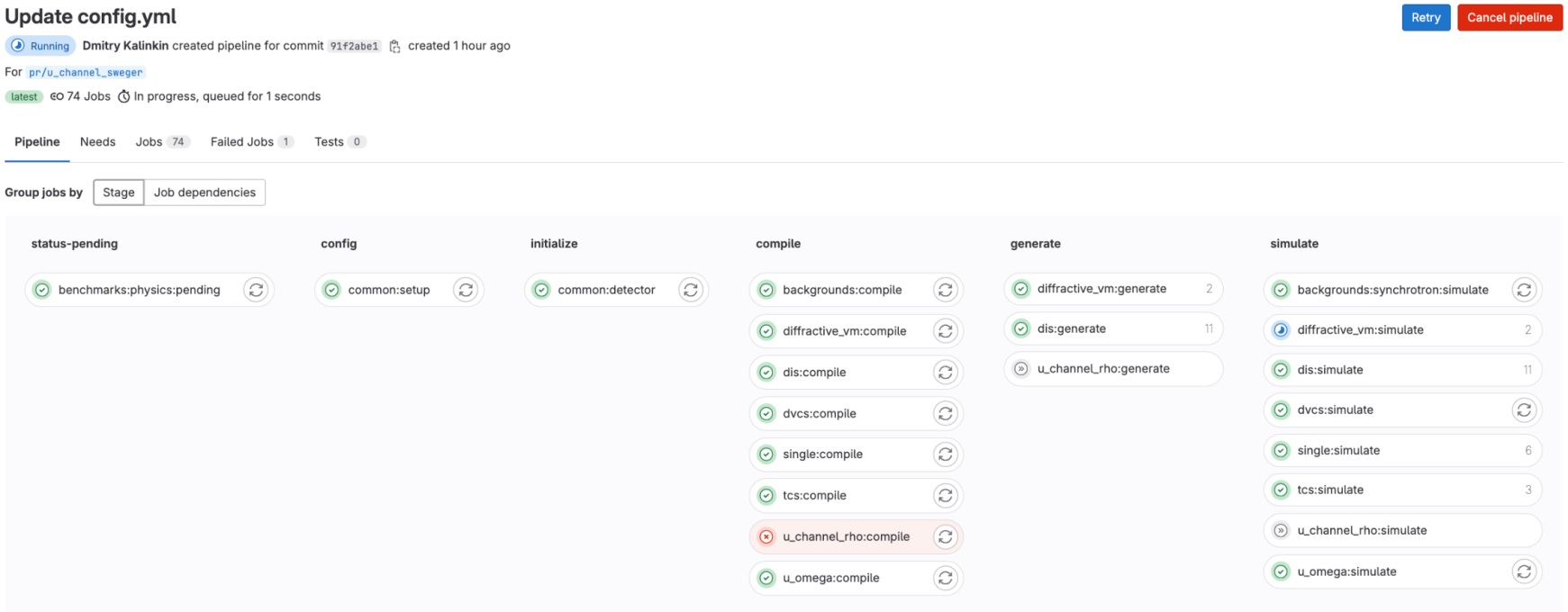
Integrating Benchmarks

Snakemake and snakefiles

- Snakefiles were discussed at the collaboration meeting (https://indico.bnl.gov/event/20473/contributions/84130/attachments/51840/88716/benchmark_tutorial_2024.pdf)
- Used to run benchmark scripts
- I've started to gather why these are useful:
  - ❑ You run snakemake with a command like: snakemake --cores 2 myplots.pdf
  - ❑ The Snakefile contains several sets of instructions to
    - ➢ Get reco files from S3
    - ➢ Run the benchmark script over the files
    - ➢ hadd the output root files
    - ➢ Run a macro over the combined root files
  - ❑ When you run "snakemake --cores 2 myplots.pdf", snakemake runs only those steps required to make myplots.pdf.
  - ❑ You can alternatively call "snakemake --cores 2 summed_output_files.root" which will only run those steps required to make the summed output file

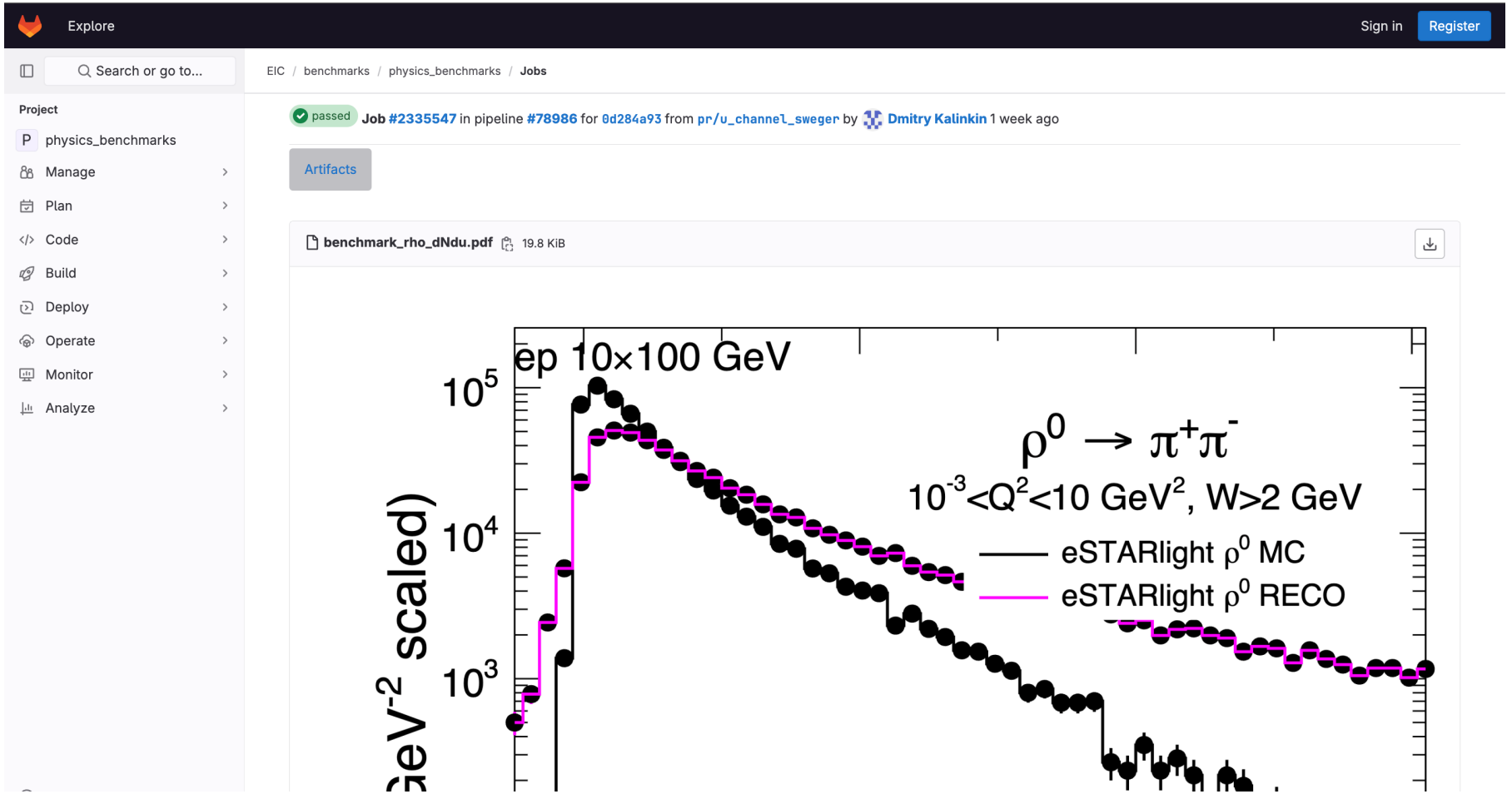
Integrating Benchmarks

- If you're curious about how to get a benchmark running in CI, so that the plots are remade whenever detector or software changes are pushed, you can check out my pull request which is not done yet: https://github.com/eic/physics_benchmarks/pull/3
- Right now this benchmark takes existing reco files from the December simulation campaign, runs an analysis script, combines the output analysis files, and creates plots.
- It does this automatically using GitLab's pipelines. You can monitor those here: https://eicweb.phy.anl.gov/EIC/benchmarks/physics_benchmarks/-/pipelines



Artifacts

- If everything goes well, the benchmark plots should be visible as artifacts: https://eicweb.phy.anl.gov/EIC/benchmarks/physics_benchmarks/-/artifacts



To Do

- Continue to investigate rho reconstruction quality
- In addition to finalizing the analysis plots, this benchmark is not complete until
  - ❑ It re-runs Geant simulations when detectors are updated
  - ❑ It re-runs reconstruction when algorithms are updated
  - ❑ Gives a failure or success statement based on output plots

Thank you for your attention!

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