Some troubleshooting of FF reconstruction and the afterburner

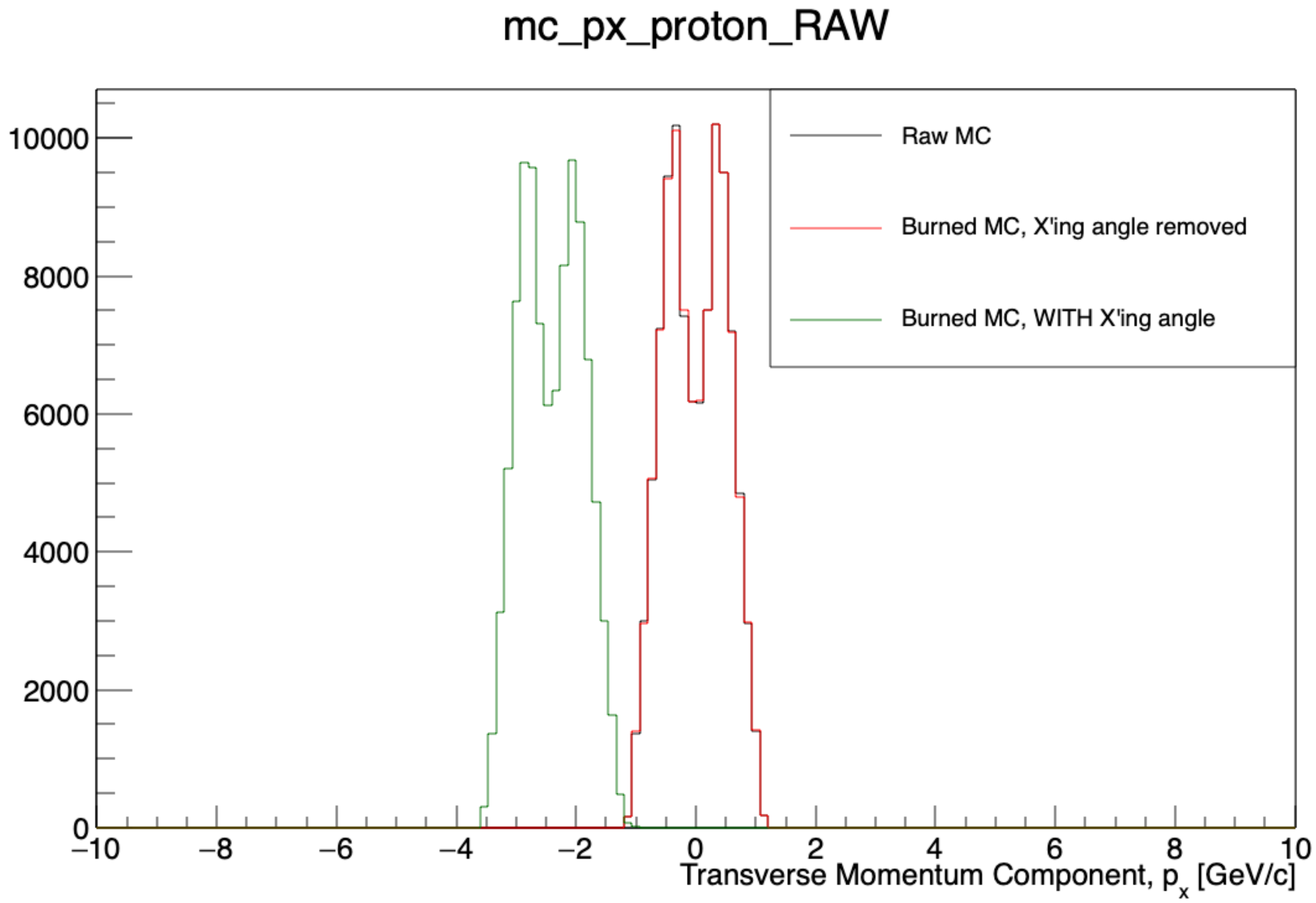
Alex Jentsch

2/26/2024

Preliminaries

- Some confusion generated by Hao's analysis (https://indico.bnl.gov/event/22009/contributions/87685/attachments/52784/90284/pp2.pdf) due to use of non-afterburned input files.
  - In general, one should see an "ab" or "abconv" in the filename to know it passed through the afterburner.
- How can a user quickly identify an issue like this (e.g. missing crossing angle)?
- What are some of the artifacts which arise from the beam smearing effects?
- **For this study:**
  - Using DVMP 10x100 events from the EpIC generator (cannot speak to details of MC events themselves).
  - Comparing raw and afterburned events (no detector effects AT ALL).
  - Looking at reconstruction and path forward.

What does the afterburner actually *do?*



- **Most importantly, it applies the crossing angle!**
  - This is done by applying proper boosts and rotation to ensure particles go *where they should* in the detector acceptance.
- In the far-forward case (e.g. protons with ~ beam energy), this amounts to a simple rotation by the full crossing angle amount.
  - Not true for particles not at far-forward rapidities or non-relativistic energies!

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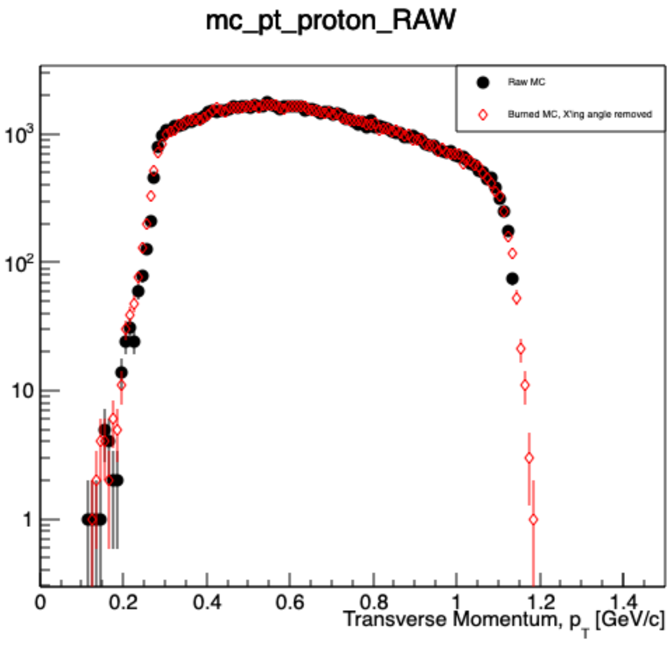
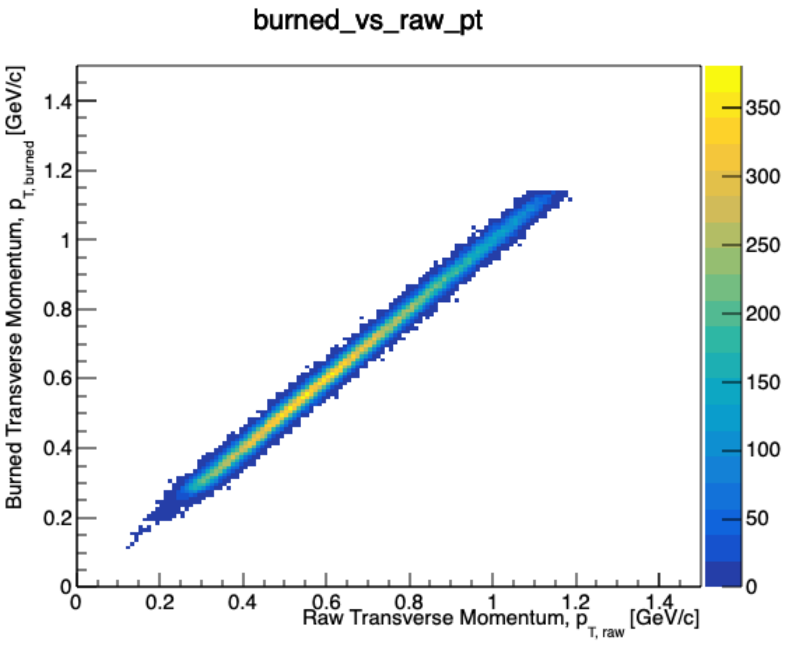
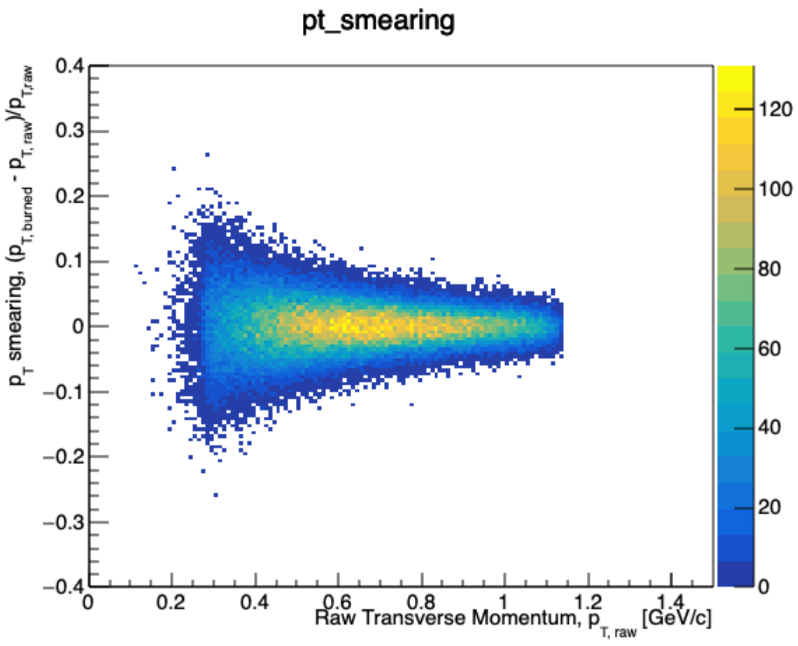




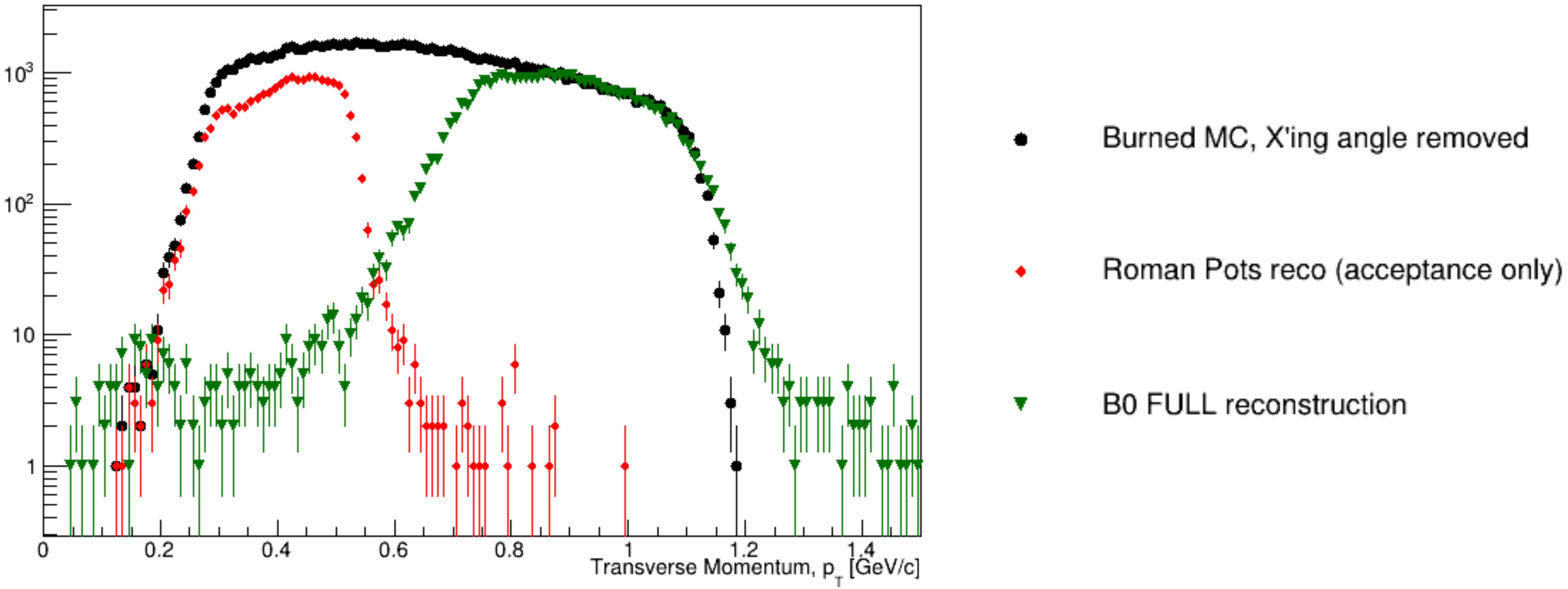


- It also applies the “beam effects”, which include beam momentum spread, angular divergence (purely transverse momentum component smearing, different in x/y), and vertex smearing to account for the length of the bunches.

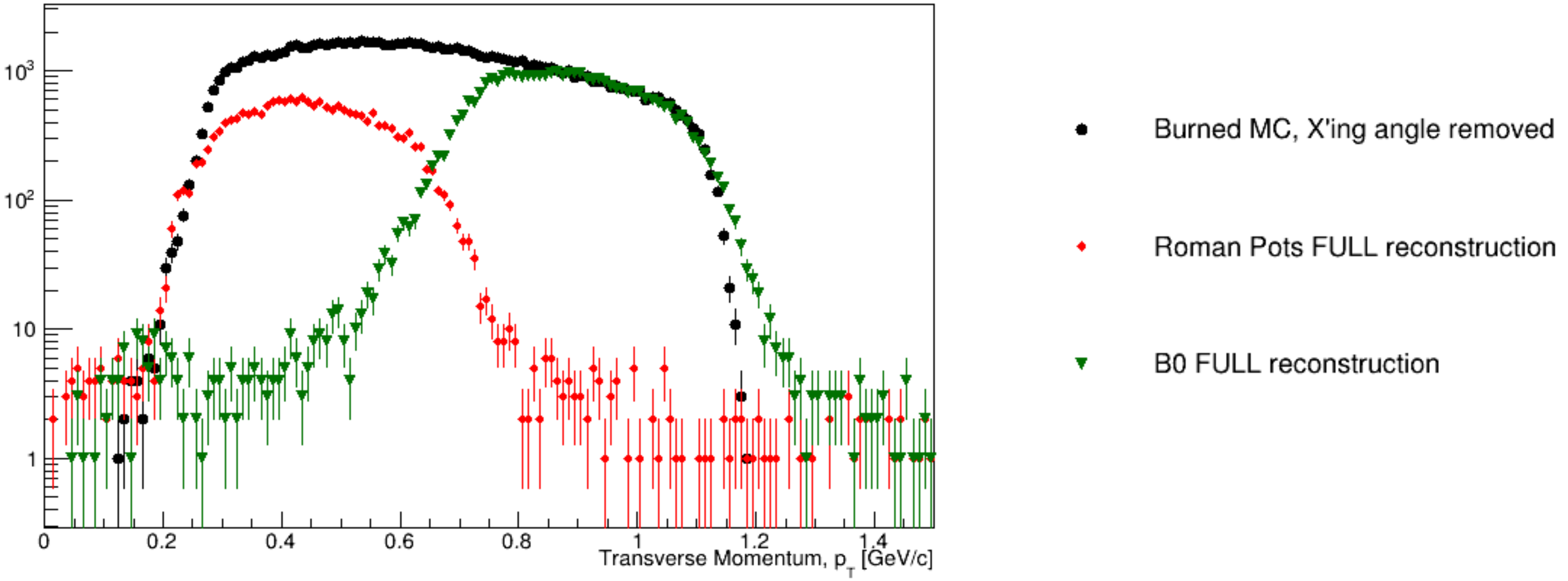
The difference between B0 and RP reco

- B0 is using only the hits in the tracking layers + the knowledge of the magnetic field. ACTS will then reconstruct the momentum of the track, where things like the material budget and pixel size will reduce the efficacy of accurate momentum extraction.
  - In a sense, the B0 is a fully-independent spectrometer, but in practice, other information can be used (e.g. constraint from primary vertex).
- Roman pots use a matrix approach, which relies on precise knowledge of the magnets, and derivation of a matrix which describes how particles with momentum at the IP are transported to the Roman pots and produce “hits”.
  - Momentum is reconstructed using a combination of the hit locations and slopes at the detector, **knowledge of the nominal beam momentum for that set of events**, and the correct **matrices**.

DVMP results, with afterburned input file (default)



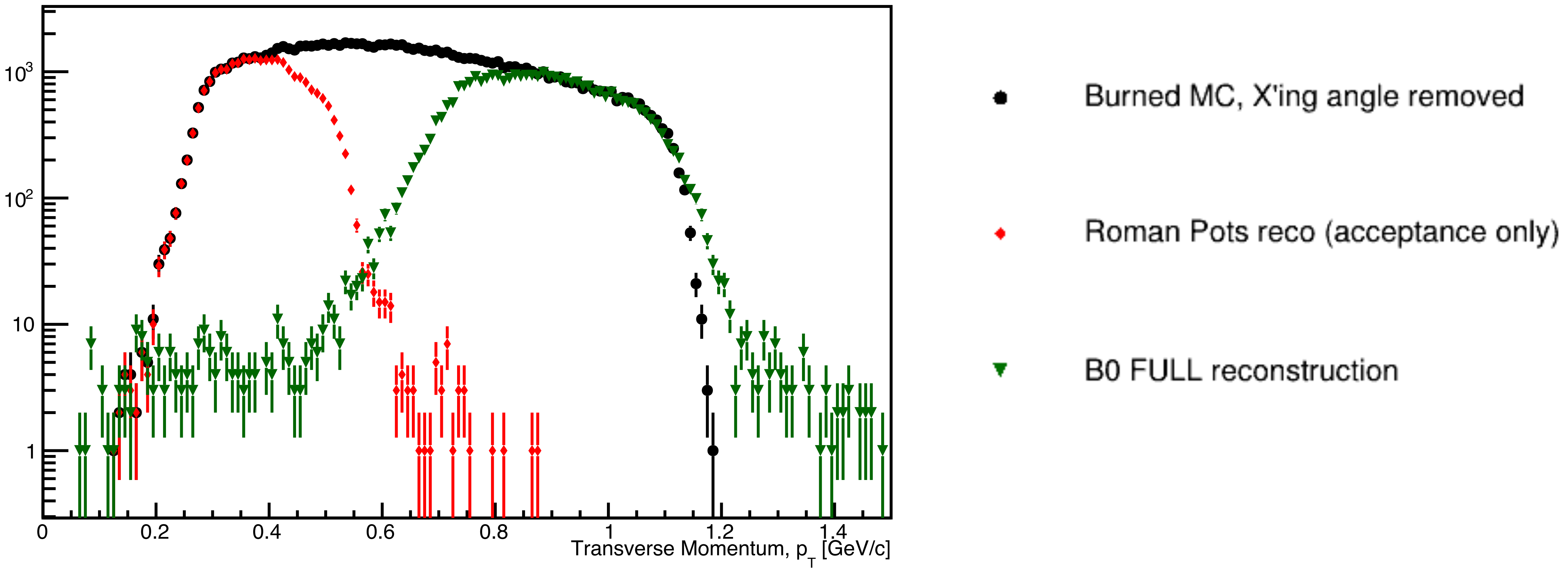
DVMP results, with afterburned input file (default)



A Few Issues

- For 100 GeV beam, a dipole was set with the wrong sign (https://github.com/eic/epic/pull/646) → now fixed.
- Also put together short-term solution to obtain beam information at run-time using MCParticles → only works *well* for e + p, but I have a case in there for deuterons (https://github.com/eic/EICrecon/pull/1315).
- Will also figure out a solution for the 10 sigma cut to make it applied properly at runtime, likely requires a geometry update.
  - Plots shown below have the 10sigma completely removed.
  - Stand by for an update on this in the near future, as the beam pipe geometry also needs to updated.
- **Remaining "large" smearing effects (for Roman Pots) from 3 sources**:
  - Beam effects.
  - Simplistic matrix approach (better for high-x_L).
  - Matrix tuning done originally with the MARCO field not present.

DVMP results, with afterburned input file, NO 10σ cut, and a few fixes applied (PRs pending)



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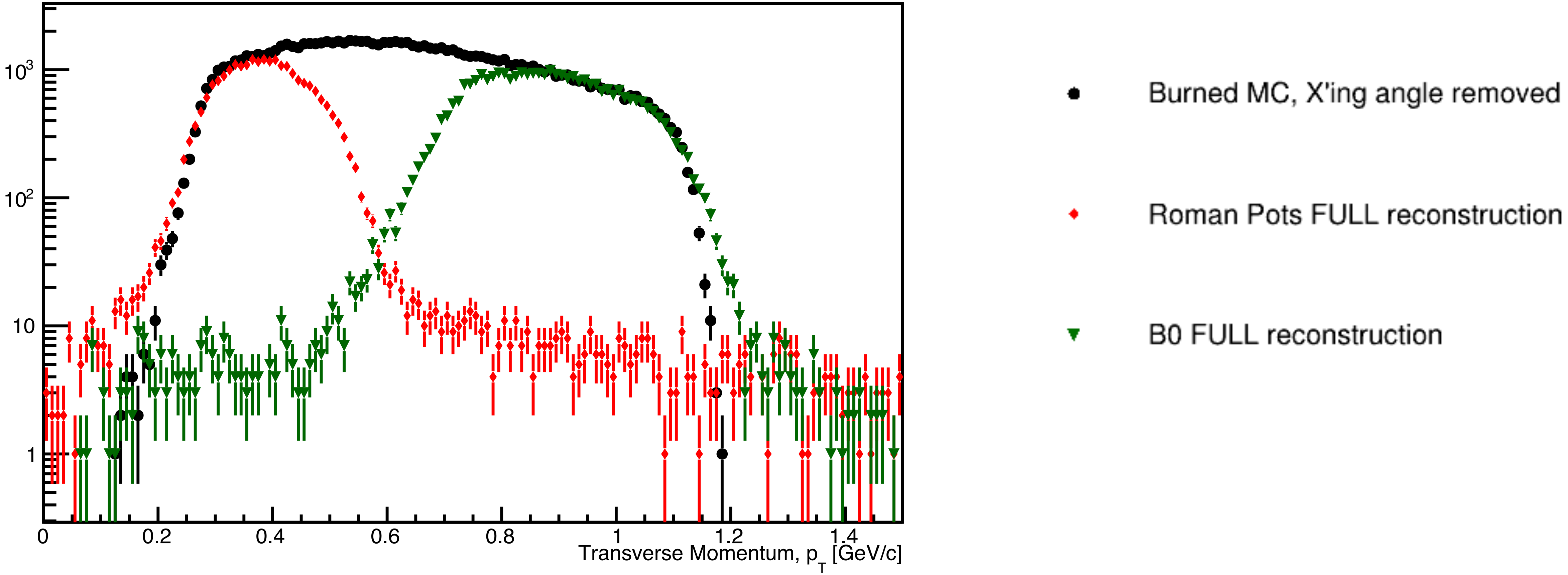

Some Takeaways and Next Steps

- Just like a real analysis from RHIC/JLAB/LHC, analyzers will need to think of quality cuts on reconstructed tracks.
  - Right now we are taking everything.
  - ReconstructedChargedParticle is "truth seeded" tracks, real seeding is progressing, and will need to be used soon.
- Still some issue with Roman pots that I am troubleshooting now.
  - acceptance issue is related to geometry → simpler to fix, but need a few days.
  - Reconstruction issue is related to wrong information being passed to EICrecon.
    - **Band-aid now applied to make simulation campaign output actually usable.**
- In the short term, it's best to ask if you need help to do a stand-alone production.
  - It's rather straightforward, and many of us can already do this and provide help.
  - Especially true for many light nuclei, for the moment.
- Stand-alone sample from this talk can be found here:
  - https://www.dropbox.com/scl/fo/0455opf99yhn7spiw89mf/h?rlkey=m2187odu3b6w0qnqjj2nrmr37&dl=0