Muon Cooling Project Updates

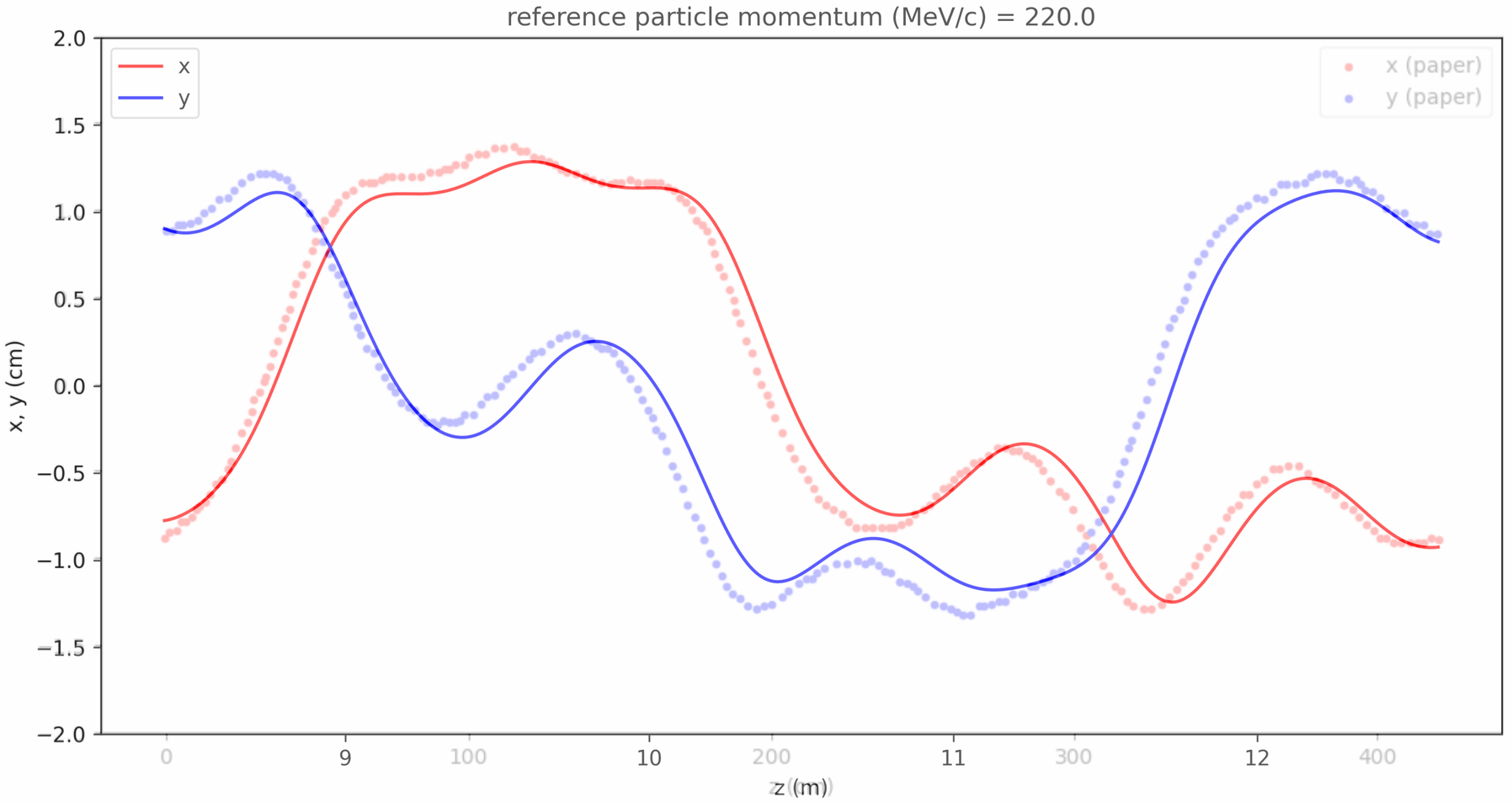
March 7, 2025

https://github.com/criggall/muon-cooling

Recent Progress

- Cleaned up GitHub repository
- Scanned reference particle momenta slightly below 225 MeV/c
  - Found best agreement with 223.2 MeV/c
  - Though I think this is not needed since we are rebuilding the channel and should select the reference momentum based on the set solenoid current?
- Started building the constant-current channel in G4beamline
  - I have some questions on this!

Reference Particle Momentum Scan

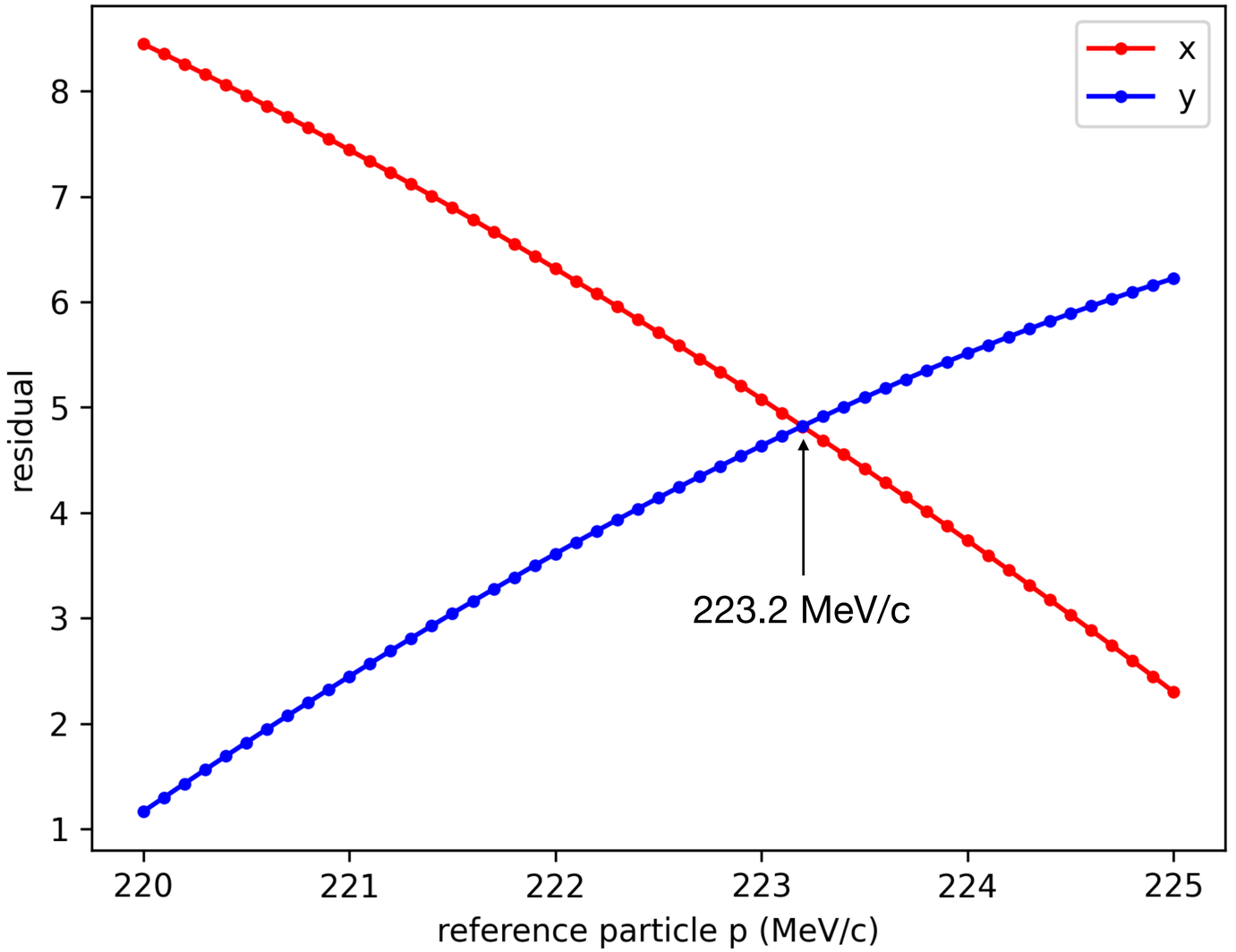


Reference Particle Momentum Scan

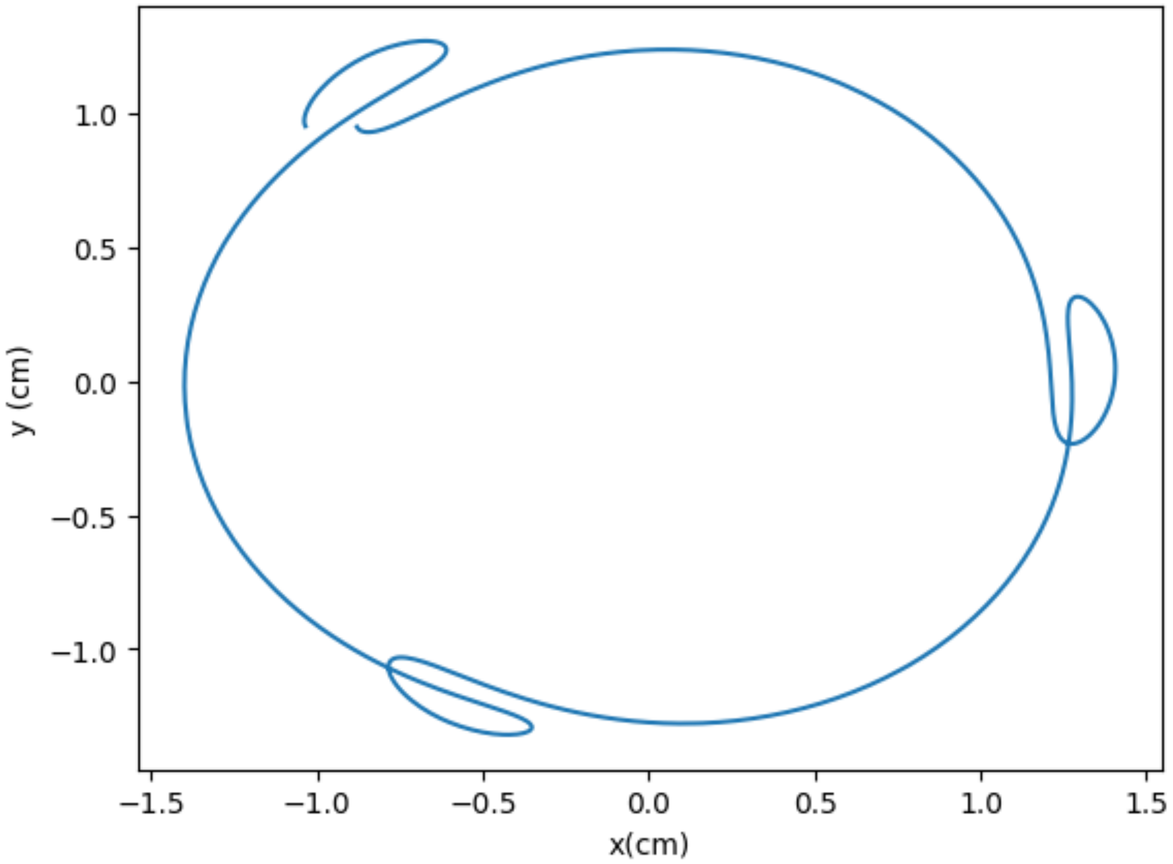
Residual =

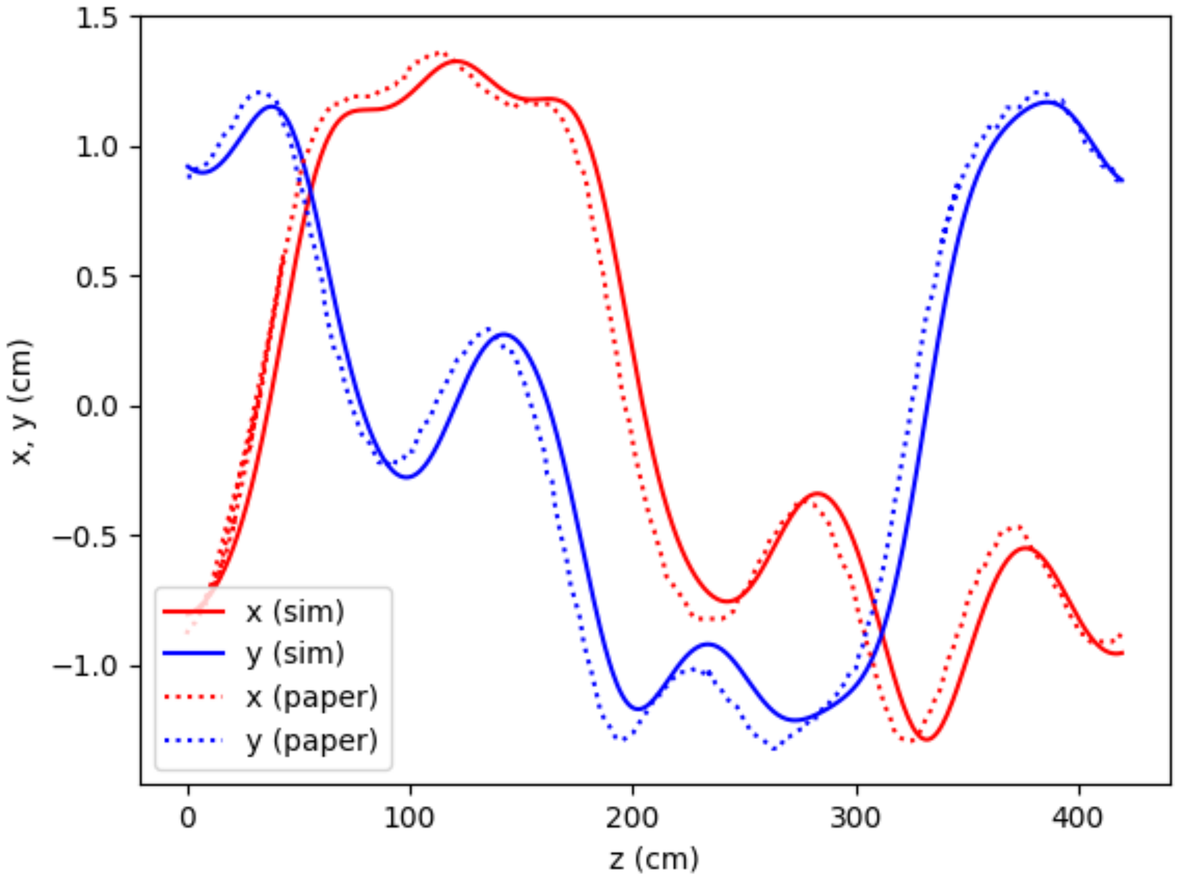
$$\sum_i \left(x_{i,sim} - x_{i,exp} \right)$$

$$\sum_i \left(y_{i,sim} - y_{i,exp} \right)$$



With 223.2 MeV/c Reference Particle





Building the Simplified Channel

4 periods (just the periodic section)

- GH2
- Solenoids (trying constant 90 amps)
- Wedge absorbers
- 5 detectors (at start and end of each period)
- Reference particle (set p based on constant current value)
- **RF cavities** <— adding this next!

Link to relevant directory in GitHub repo

Some G4beamline Questions

- How to set phase offset?

6.58 pillbox Defines a pillbox RF cavity

A Pillbox RF cavity is the basic RF element used to construct a linac. The phaseAcc parameter sets the phase of the tune particle at the center of the cavity, and the timing offset of the cavity is determined from that the first time that the Tune particle is tracked through the cavity. Zero degrees is the rising zero-crossing of the Ez field. If timeOffset is specified, it is used rather than setting it from the Tune particle.

- What is the distinction between the tune and reference particles?

The Tune particle can be used to:

1. Automatically set the timing of RF cavities so the Reference particle arrives at the desired RF phase.
2. Automatically set the gradient of RF cavities so the desired acceleration of the reference particle is achieved.
3. Automatically set the field of bending magnets so the Reference particle is parallel to the centerline downstream of the magnet.
4. Automatically determine the initial momentum of the Reference particle so that it has a specified momentum at some later point in the beamline.