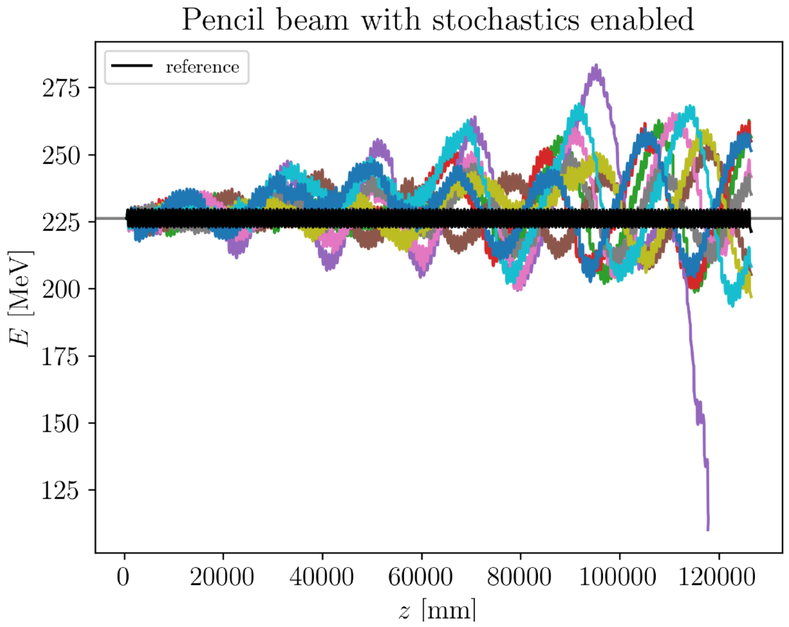
# HFOFO Project Updates

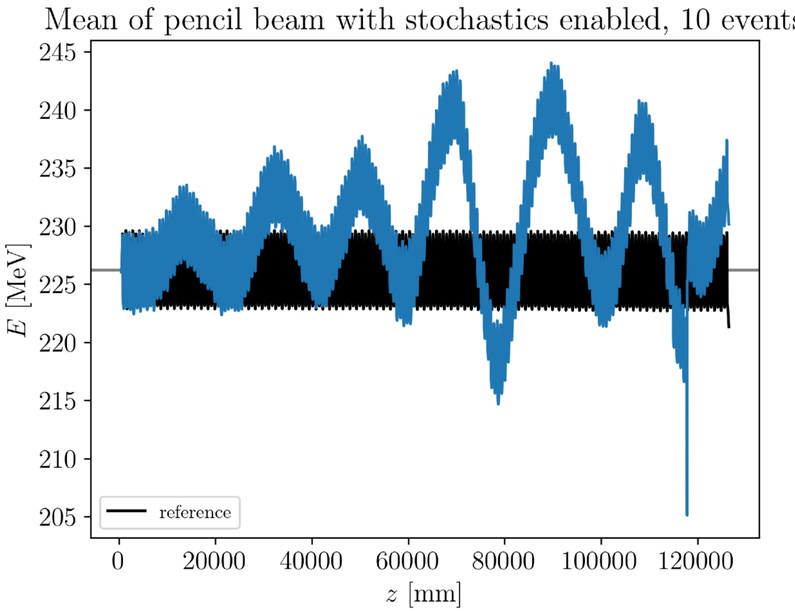
September 18, 2026

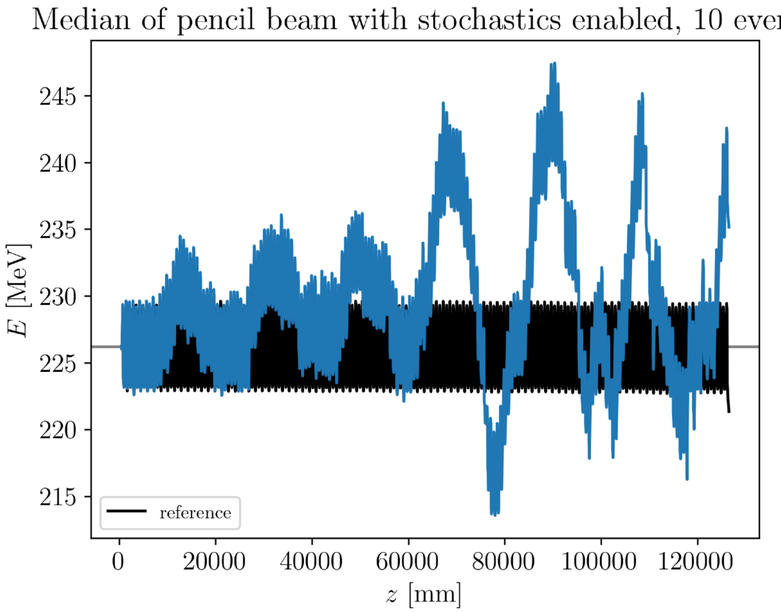
*https://github.com/criggall/muon-cooling/tree/main*

# Recap from last week






Sending in a pencil beam of 10 events with stochastics enabled told us that stochastic differences in energy loss contributed to significant fluctuations in energy vs. z

...too significant! Let us try studying more events

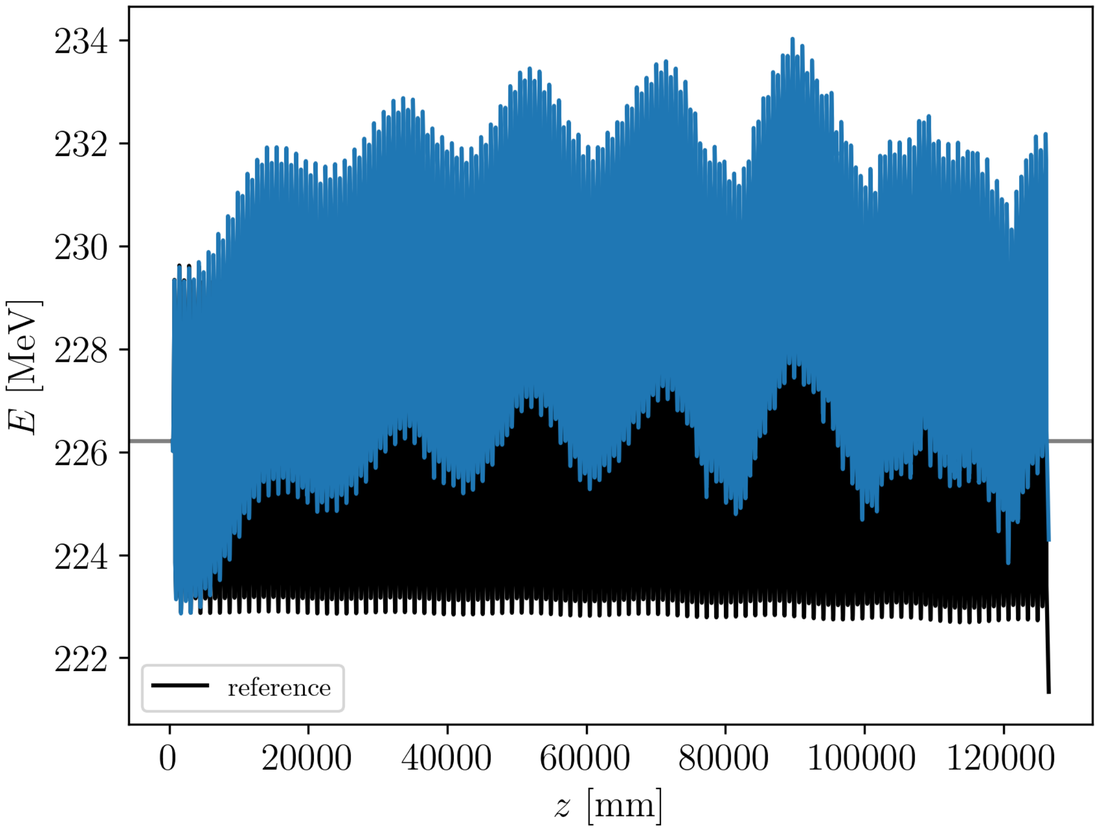
# A continued investigation of stochastic effects on periodic beam dynamics

*Issue #37*

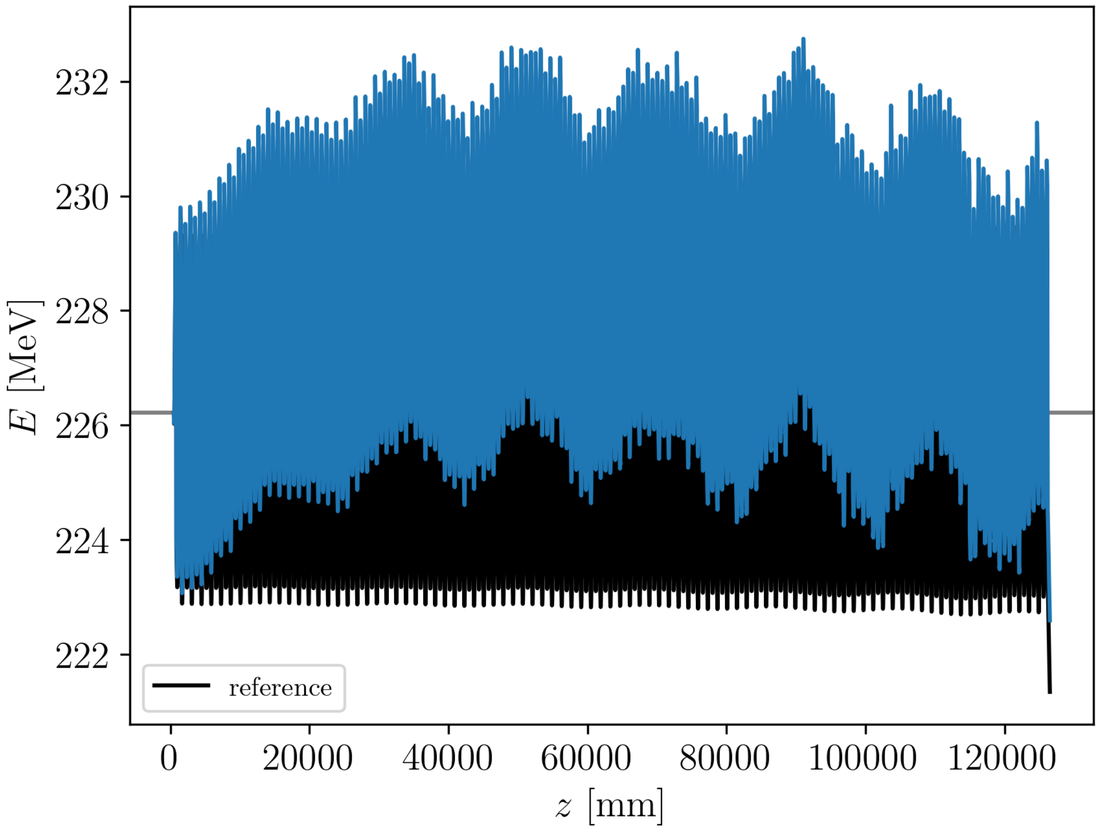
# Considering more events



Mean of pencil beam with stochastics enabled, 1000 events



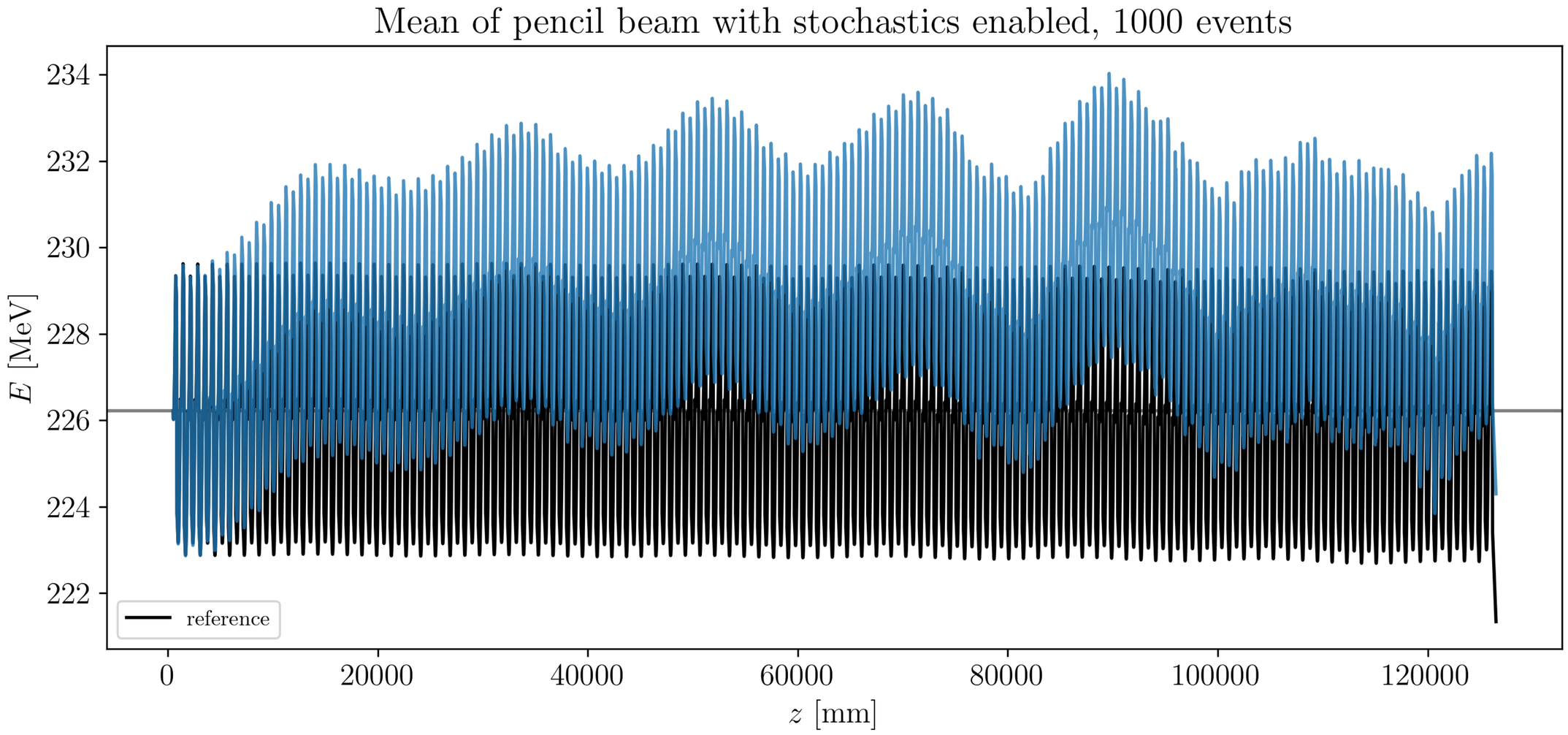

Median of pencil beam with stochastics enabled, 1000 events




O(1 MeV) ΔE makes much more sense!

# Considering more events





# Outstanding questions

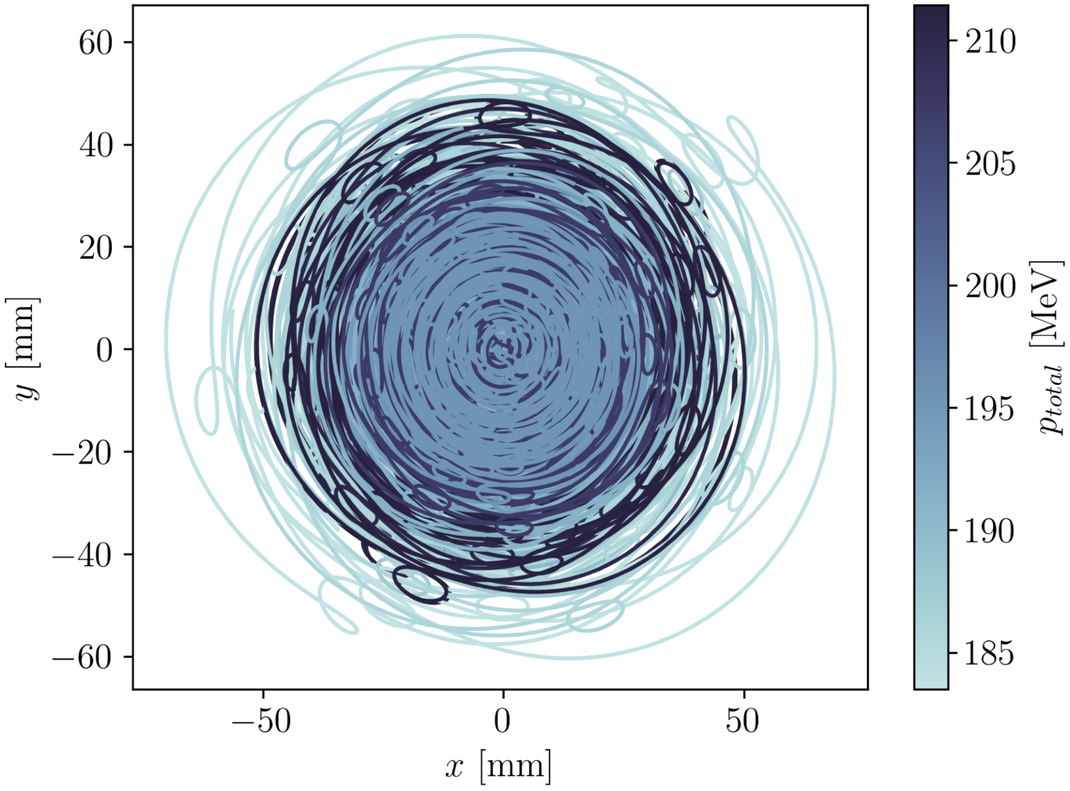


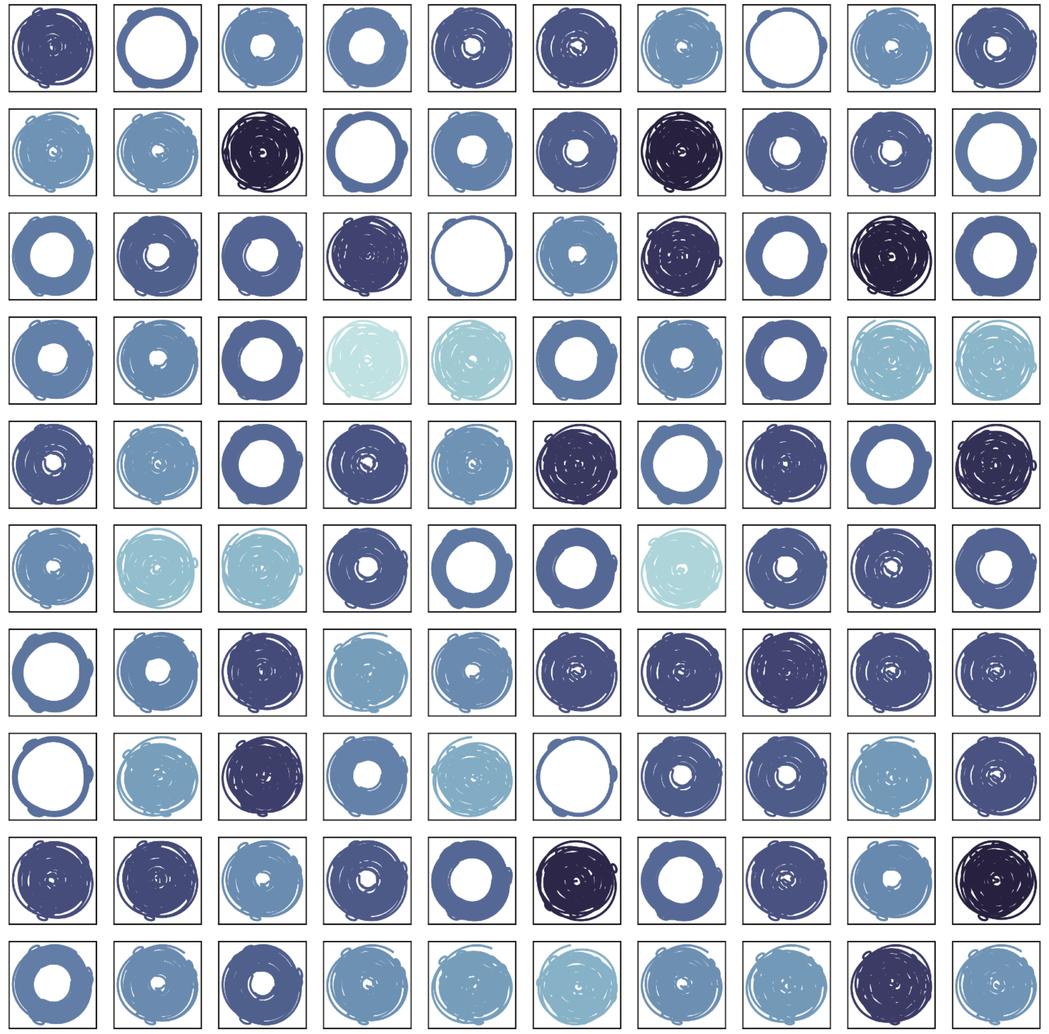
- How sensitive is the reference orbit to energy?
    - Or, how stable is the periodic solution?
- How large is the bucket?
    - Or, what is the longitudinal acceptance?

# How sensitive is the reference orbit to energy?



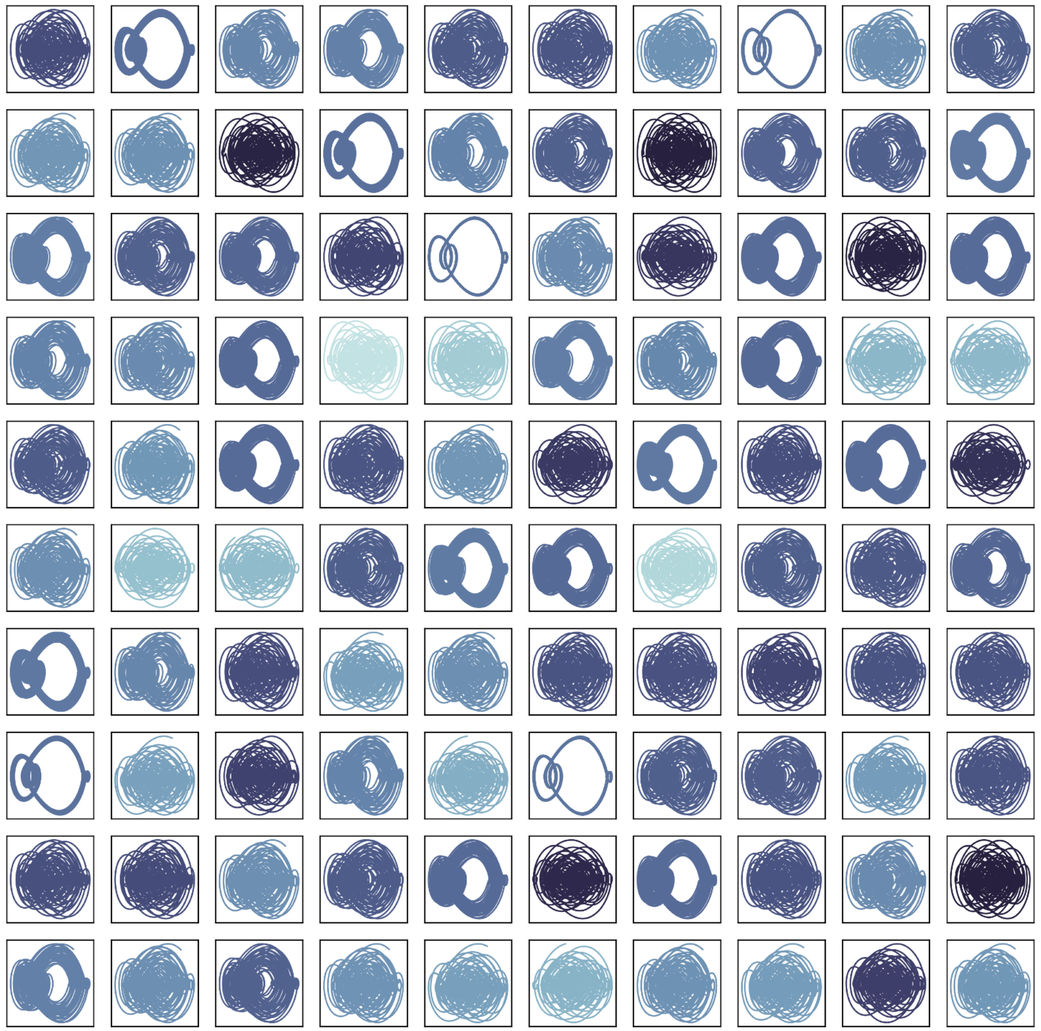
Let us try adding `sigmaP=5` to our pencil beam and observe how the orbit is deformed:



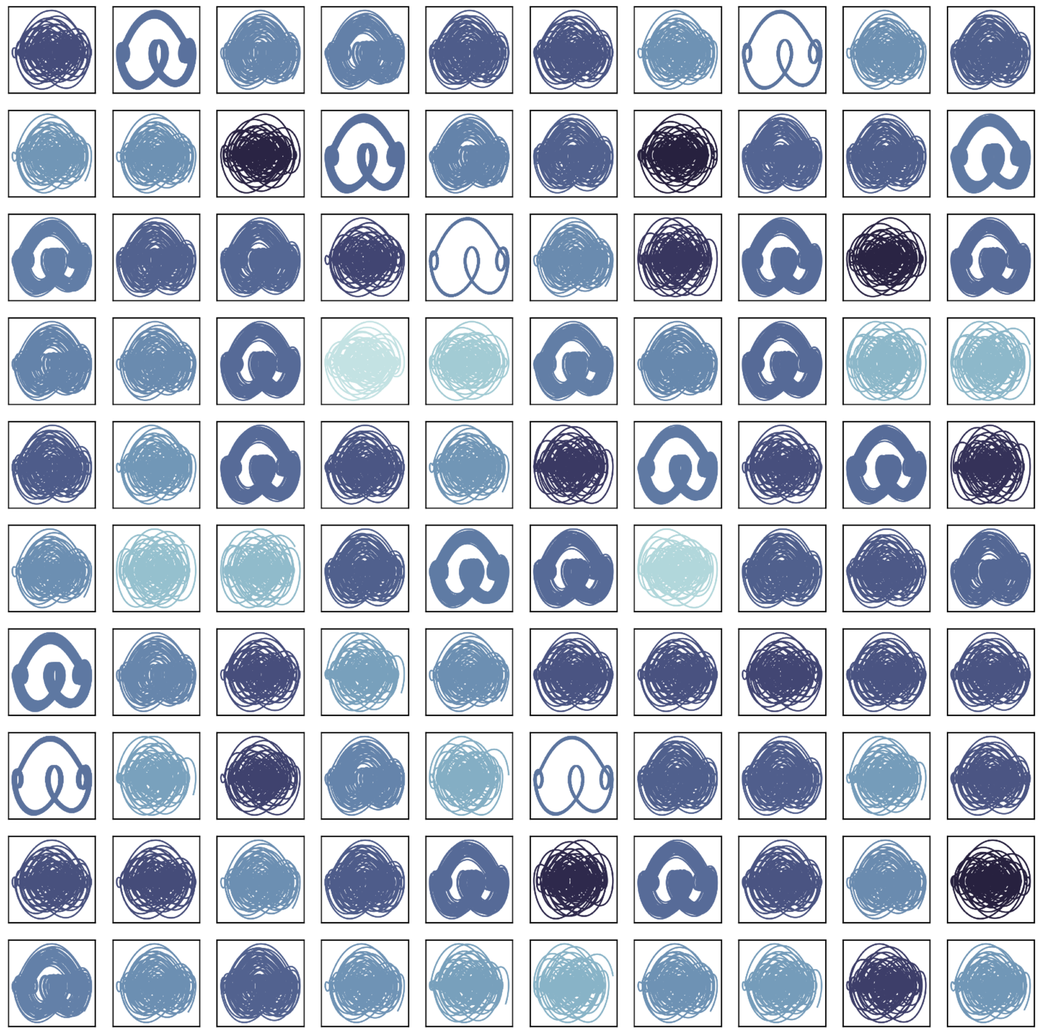



# How sensitive is the reference orbit to energy?





x' vs. x

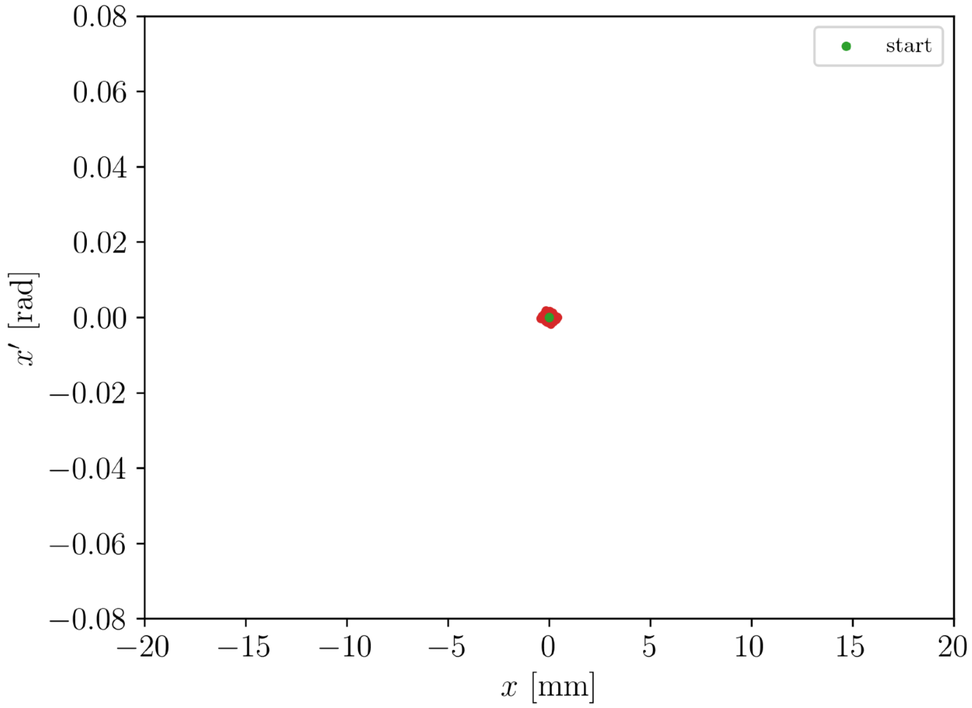


y' vs. y

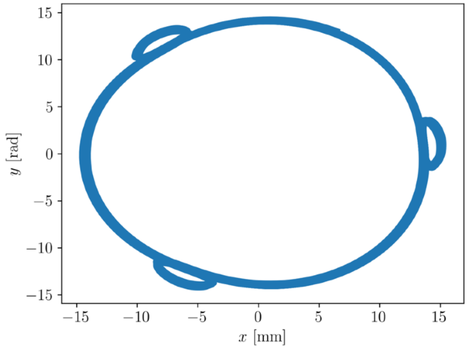
# How sensitive is the reference orbit to energy?



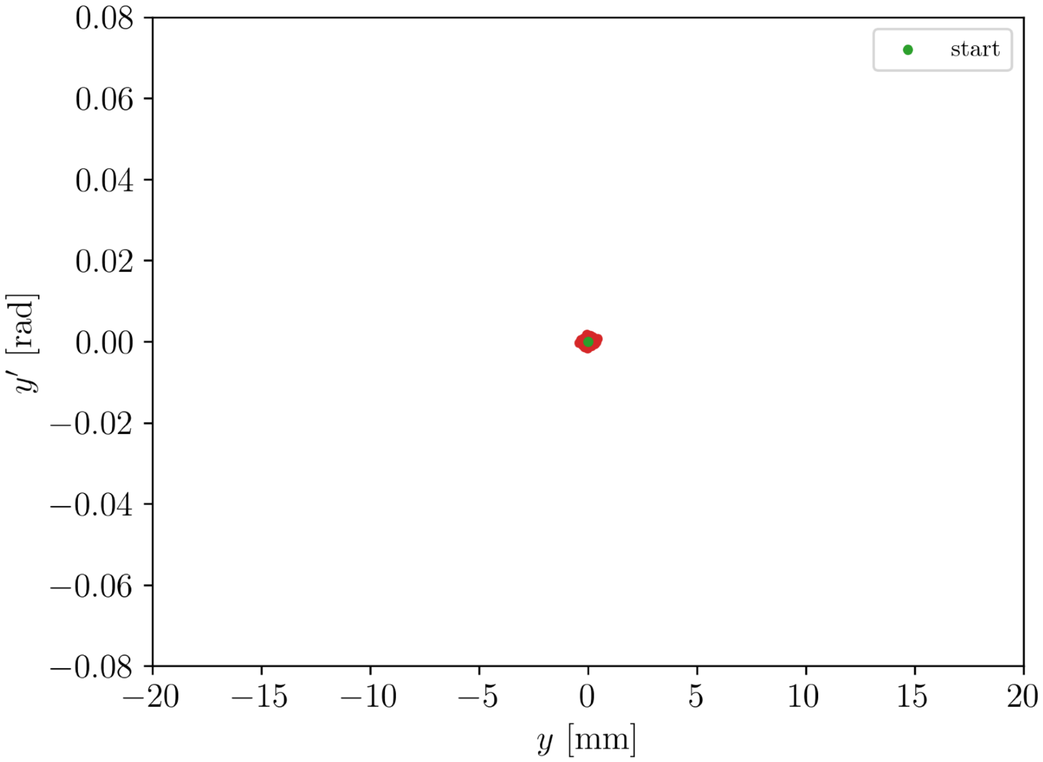
Now let us pick a few cases to study and make some Poincaré maps:




*(w.r.t reference)*



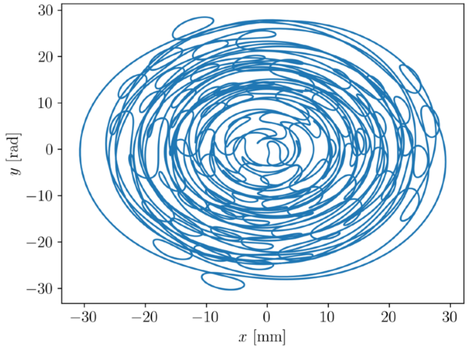

EventID=8



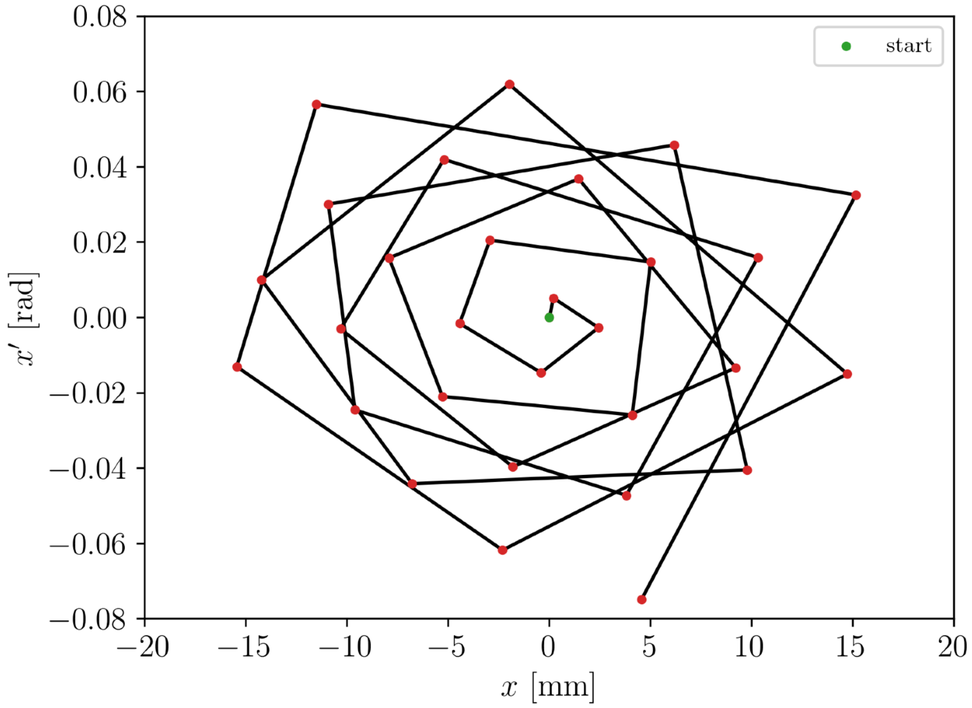
# How sensitive is the reference orbit to energy?



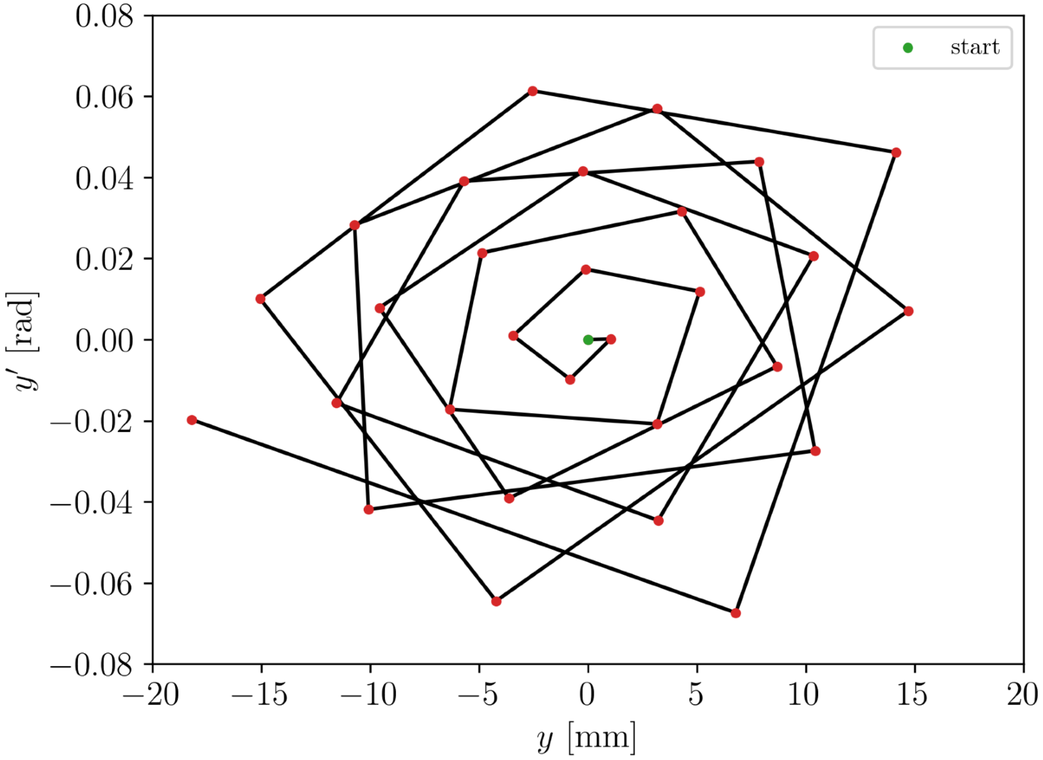
Now let us pick a few cases to study and make some Poincaré maps:




EventID=1




*n.b. does not converge as I would have expected*



# How sensitive is the reference orbit to energy?



But to answer the outstanding question, I think we need to be more quantitative.

==> Proposed next steps:

1. [some metric encoding deviation from closed orbit] vs. $\Delta E$

2. Find eigenvalues, one-turn transfer matrix, ...?
—> analytic description of stability of closed orbit

# Other next steps



Toward the second question of the longitudinal acceptance:

3. Analytically calculate bucket height

4. Make some plots of longitudinal phase space, timing vs. z, etc.

Other things:

5. Send through large distribution and iterate
—> find “matched” phase space distribution / energy for the channel