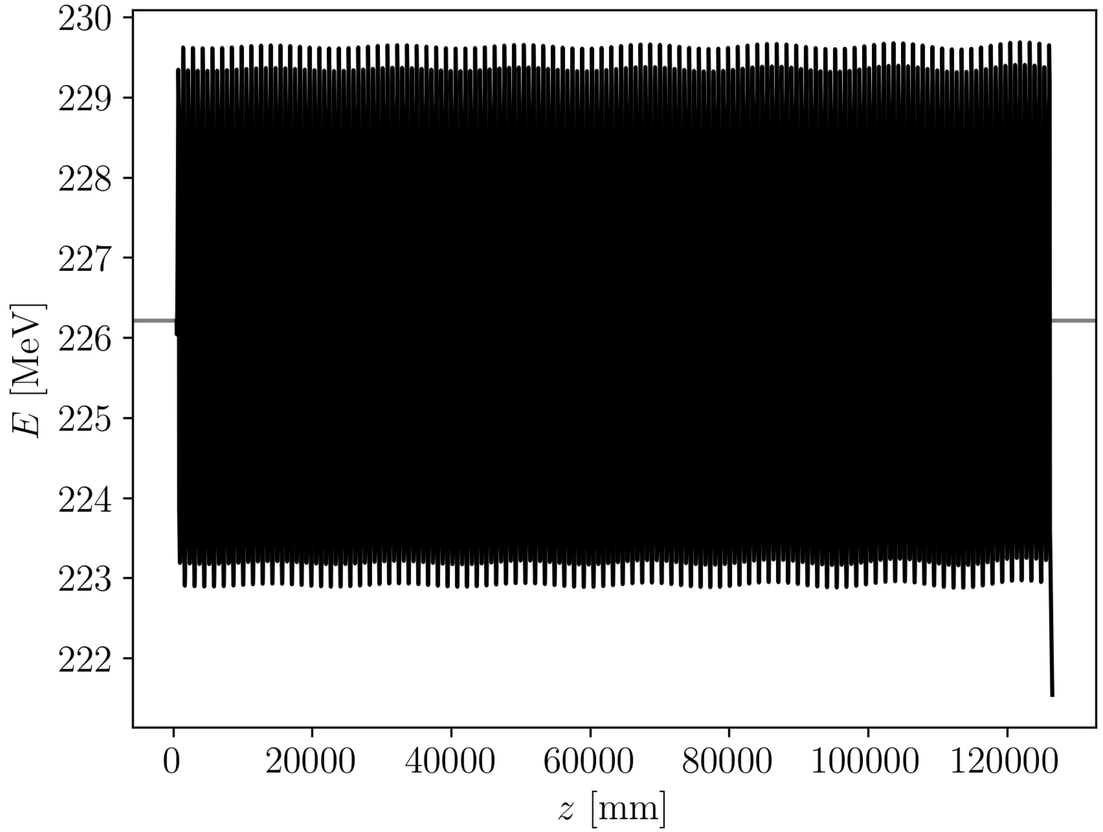
HFOFO Project Updates

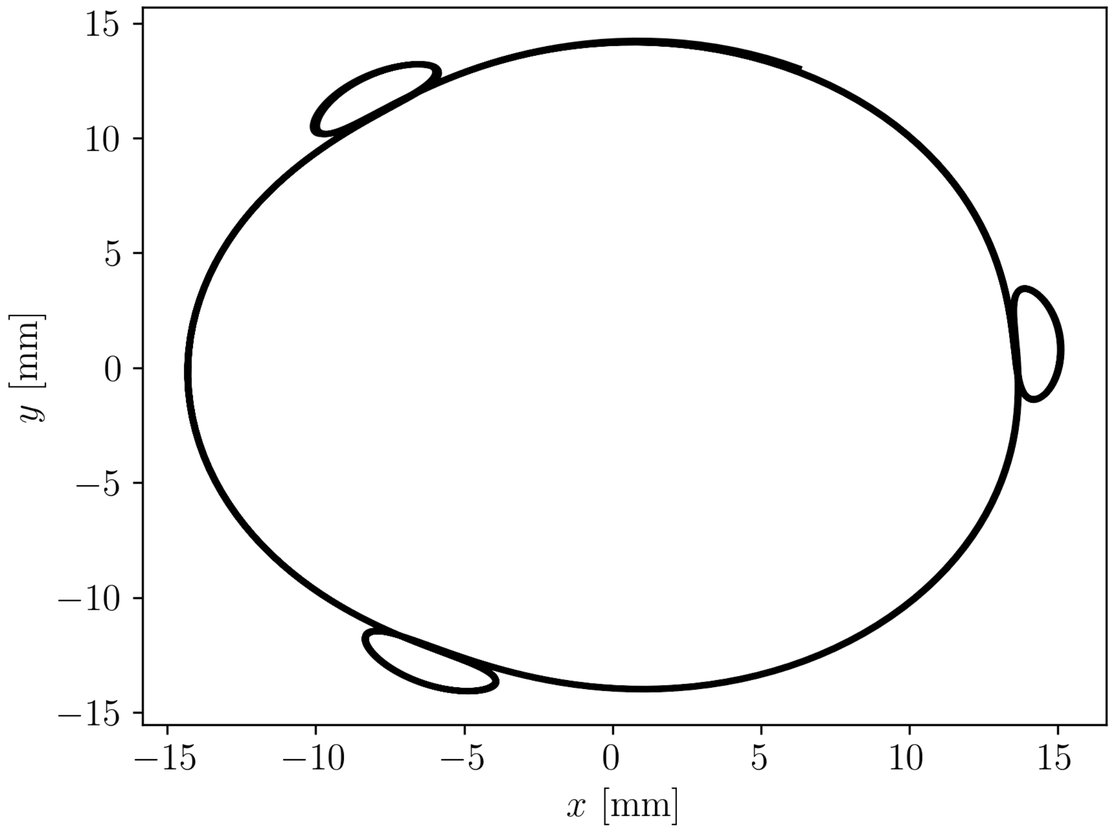
September 11, 2026

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

Recap from last week

We now have a periodic design which operates at (or rather oscillates about)
a constant momentum of 200 MeV/c





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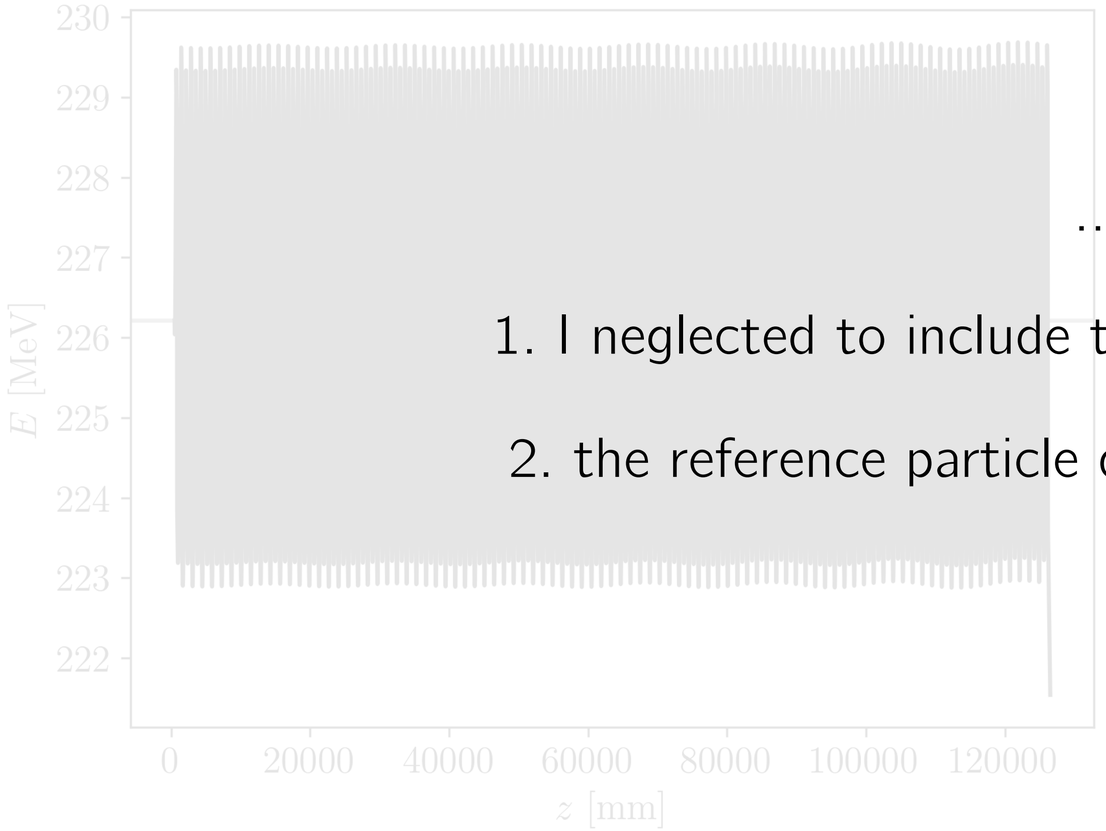
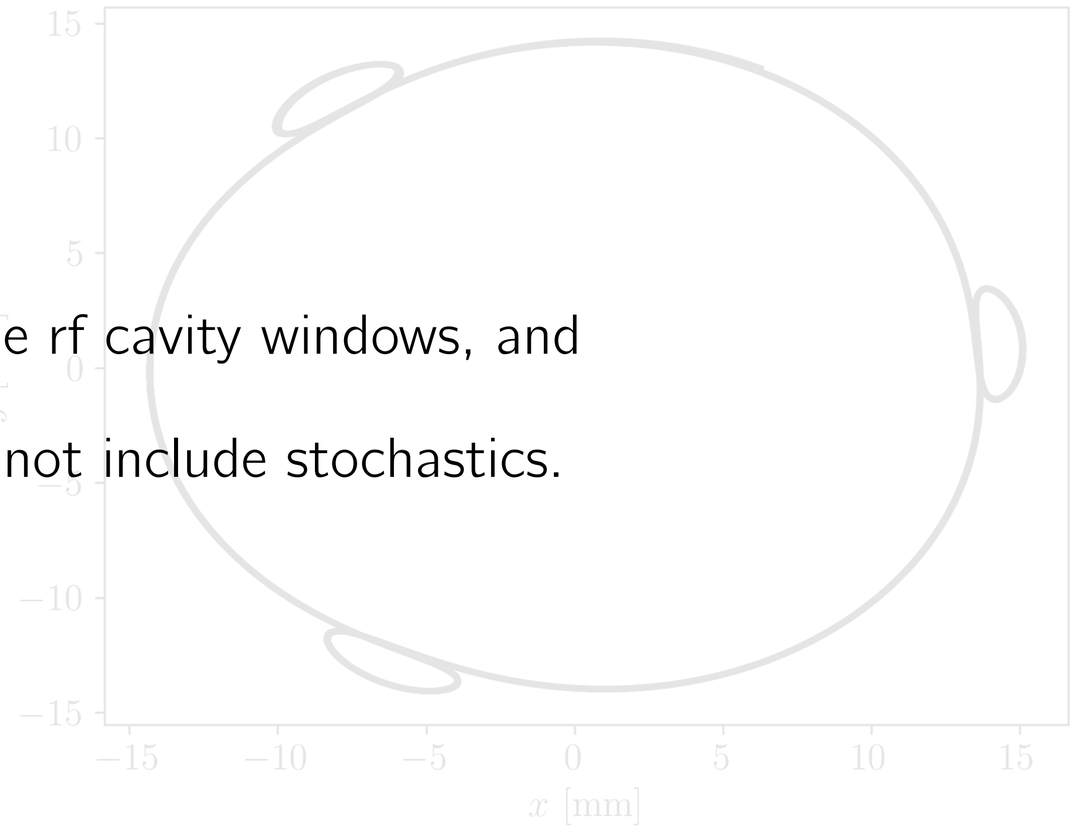




...but!

1. I neglected to include the Be rf cavity windows, and

2. the reference particle does not include stochastics.

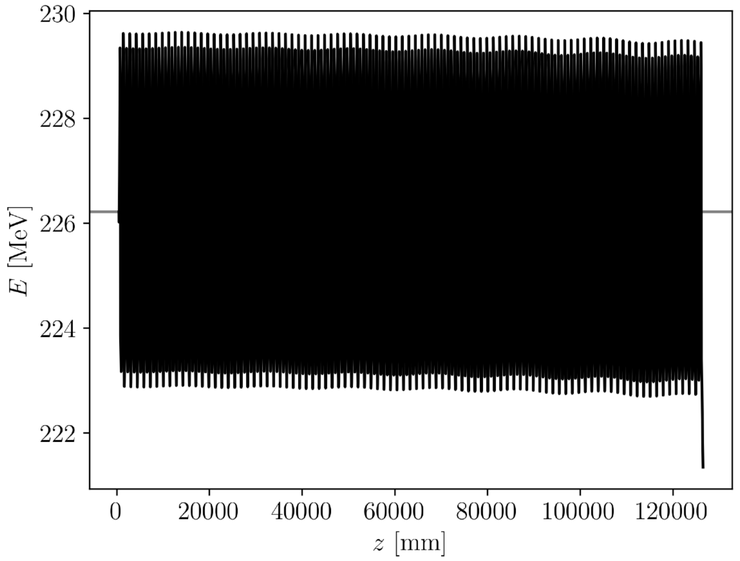
Fixing the first issue

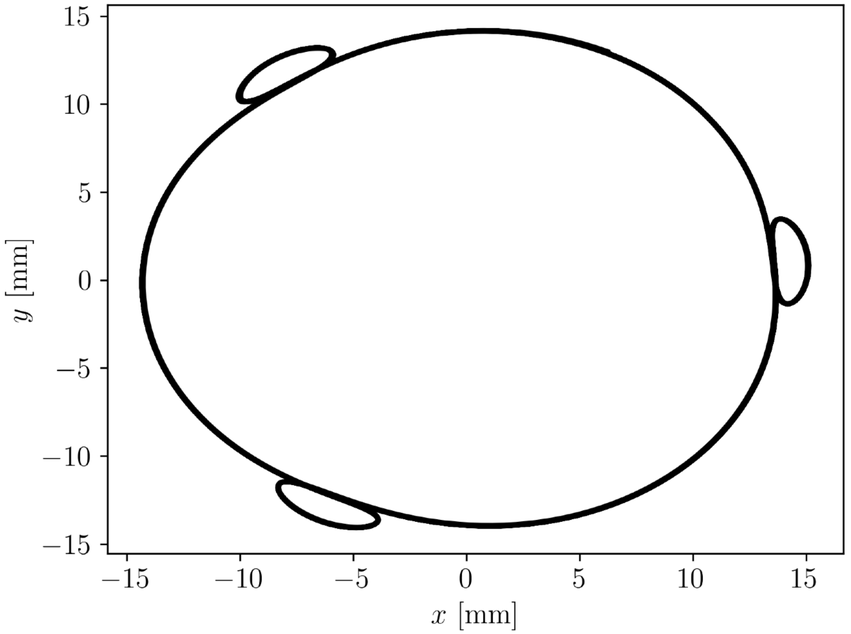

```
# for wedges+gas:
#param inc=26.958
#param phase1=9.3+$inc
#param phase2=9.278+$inc
# for wedges+gas+windows:
param inc=28
param phase1=9.3+$inc
param phase2=9.278+$inc
```

```
pillbox RFC innerLength=$rf_len-1 frequency=0.325 maxGradient=$rf_grad \
    win1Thick=0 win1OuterRadius=0 collarThick=0 collarRadialThick=0 \
    winMat=Be irisRadius=300 win2Thick=0.12 wallThick=0.4 pipeThick=0.4 cavityMaterial=Vacuum kill=1
```

Windows are quite thin ==> only small amount of tuning required

```
# for full gradient w/ wedges + gas
#param X=6.278180000000001
#param Y=12.8675
#param Xp=0.05199069571633454
#param Yp=-0.025585264541166733
# for full gradient w/ wedges + gas + windows
param X=6.2800650000000005
param Y=12.902899999999999
param Xp=0.05213936776327295
param Yp=-0.025578377354559985
```





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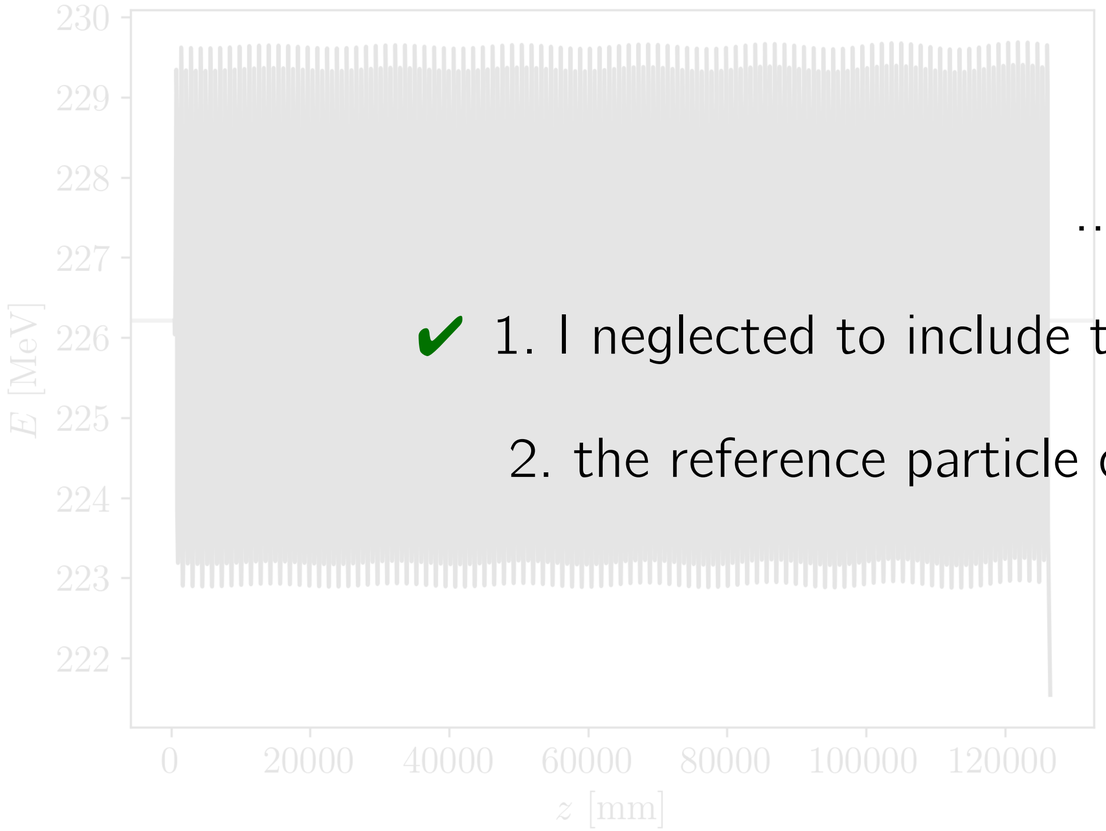
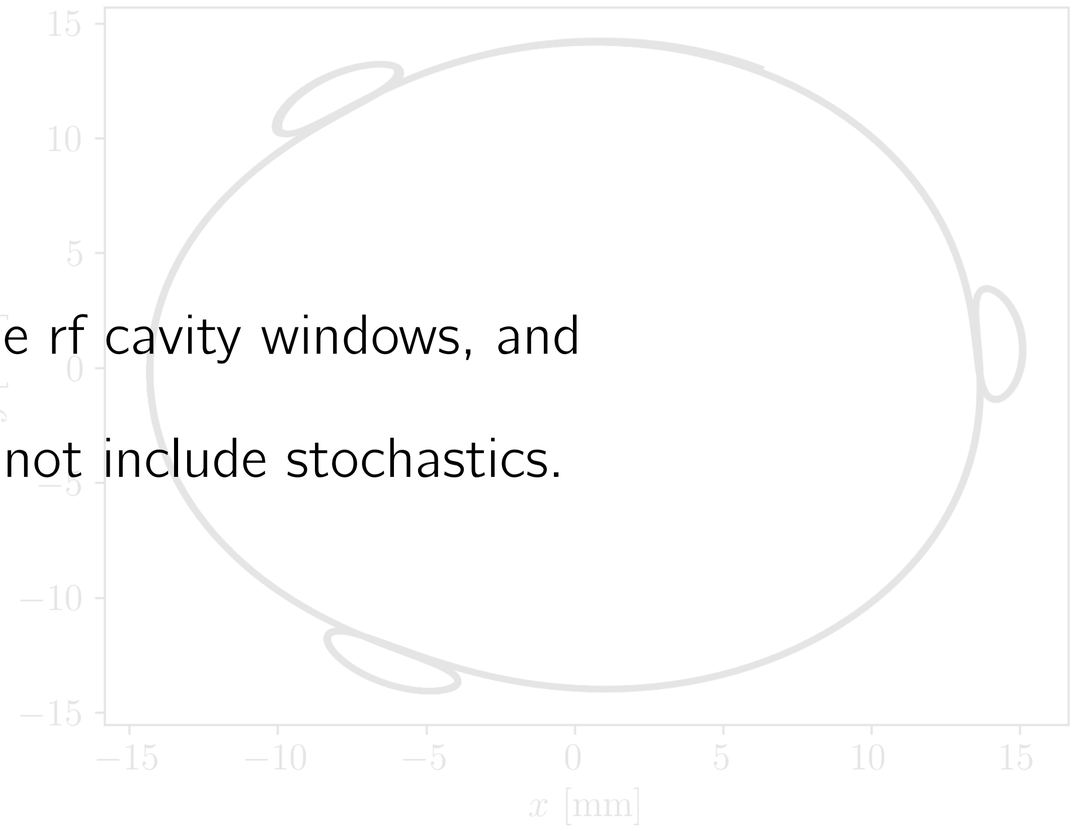




...but!

✔ 1. I neglected to include the Be rf cavity windows, and

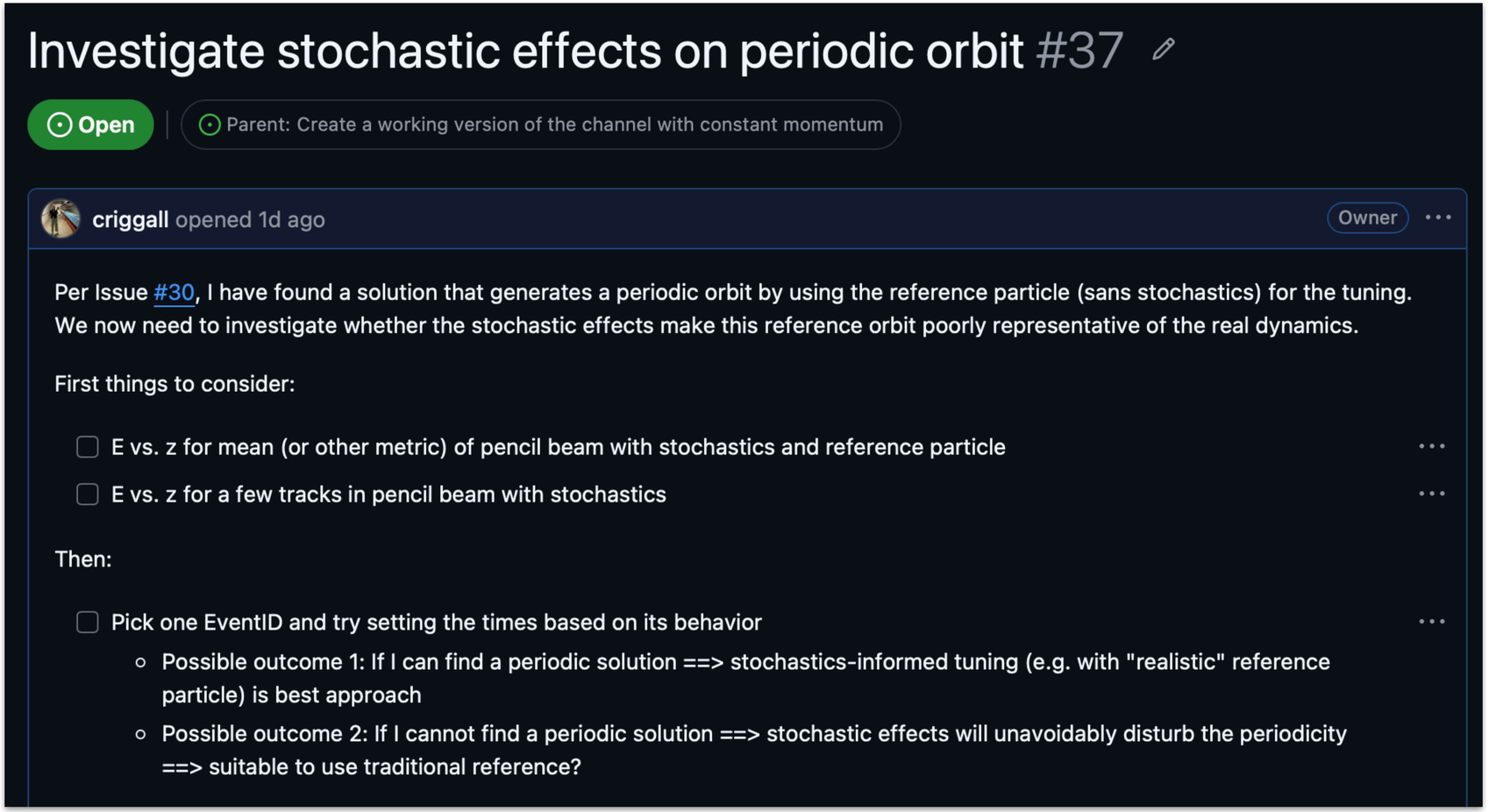
2. the reference particle does not include stochastics.

Investigating stochastic effects

Issue #37

Investigating stochastics effects

Q: is the reference particle representative of the actual dynamics when stochastics are enabled?



Investigate stochastic effects on periodic orbit #37

Open | Parent: Create a working version of the channel with constant momentum

criggall opened 1d ago — Owner

Per Issue #30, I have found a solution that generates a periodic orbit by using the reference particle (sans stochastics) for the tuning. We now need to investigate whether the stochastic effects make this reference orbit poorly representative of the real dynamics.

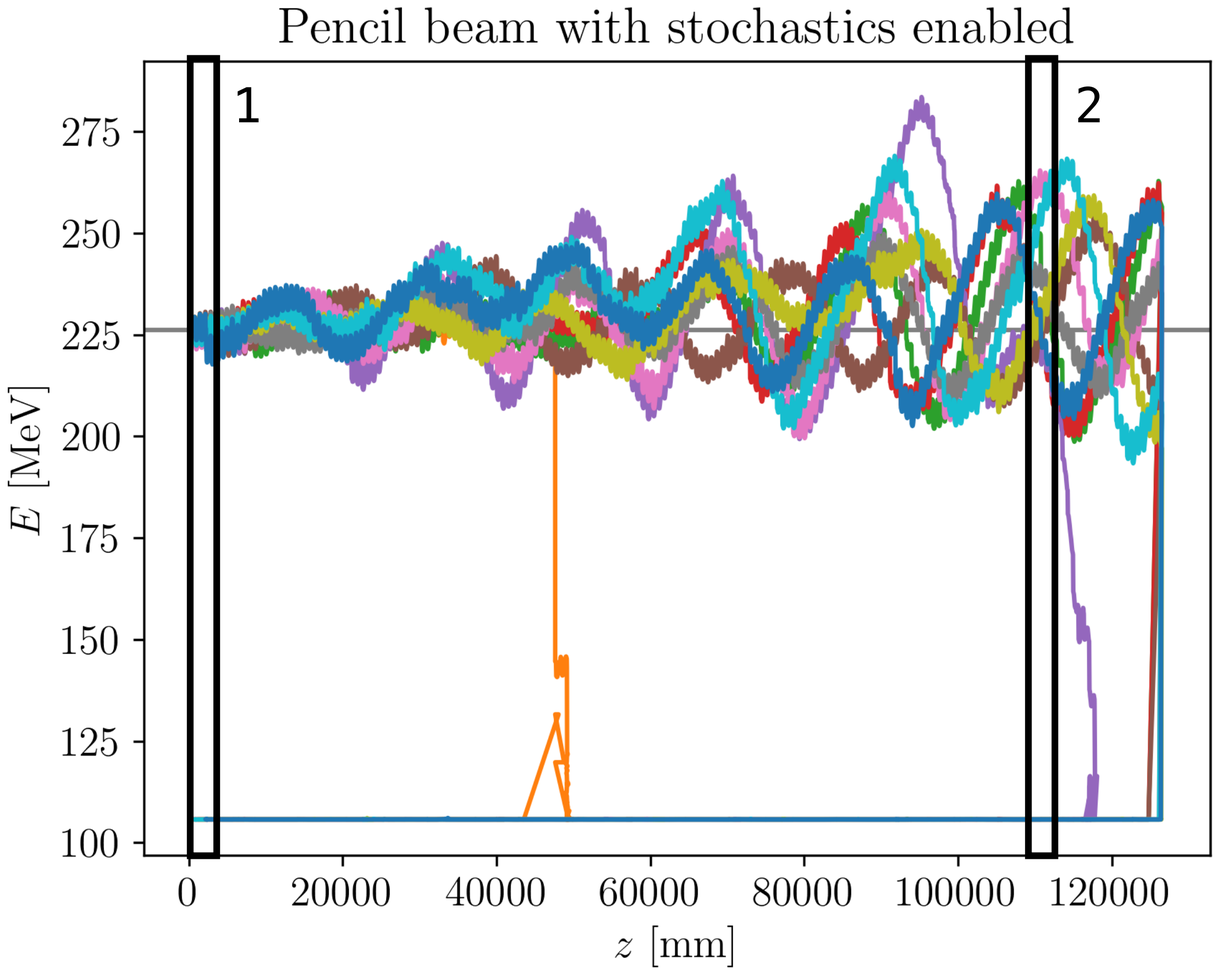
First things to consider:

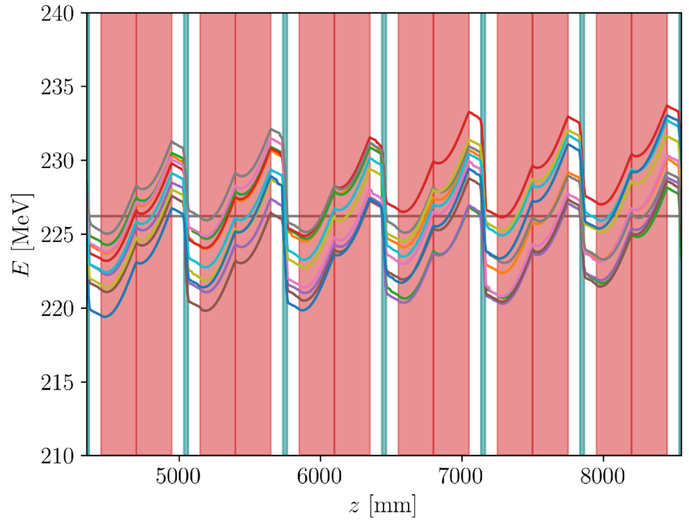
- [ ] E vs. z for mean (or other metric) of pencil beam with stochastics and reference particle
- [ ] E vs. z for a few tracks in pencil beam with stochastics

Then:

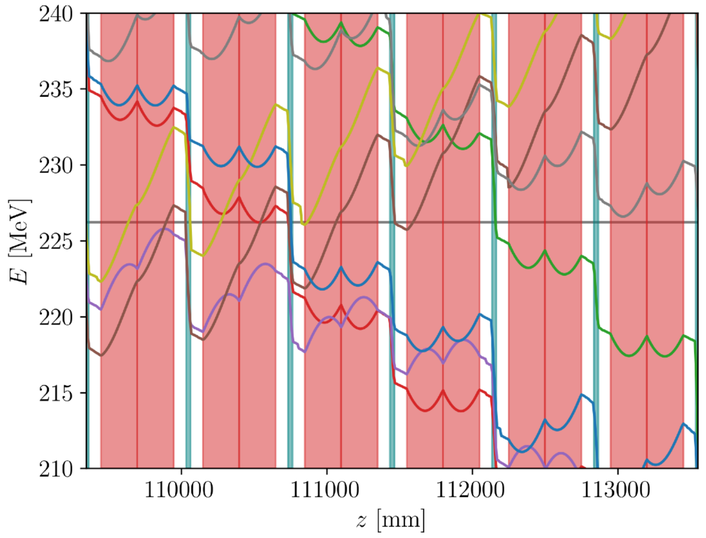
- [ ] Pick one EventID and try setting the times based on its behavior
  - Possible outcome 1: If I can find a periodic solution ==> stochastics-informed tuning (e.g. with "realistic" reference particle) is best approach
  - Possible outcome 2: If I cannot find a periodic solution ==> stochastic effects will unavoidably disturb the periodicity ==> suitable to use traditional reference?

Testing w/ pencil beam



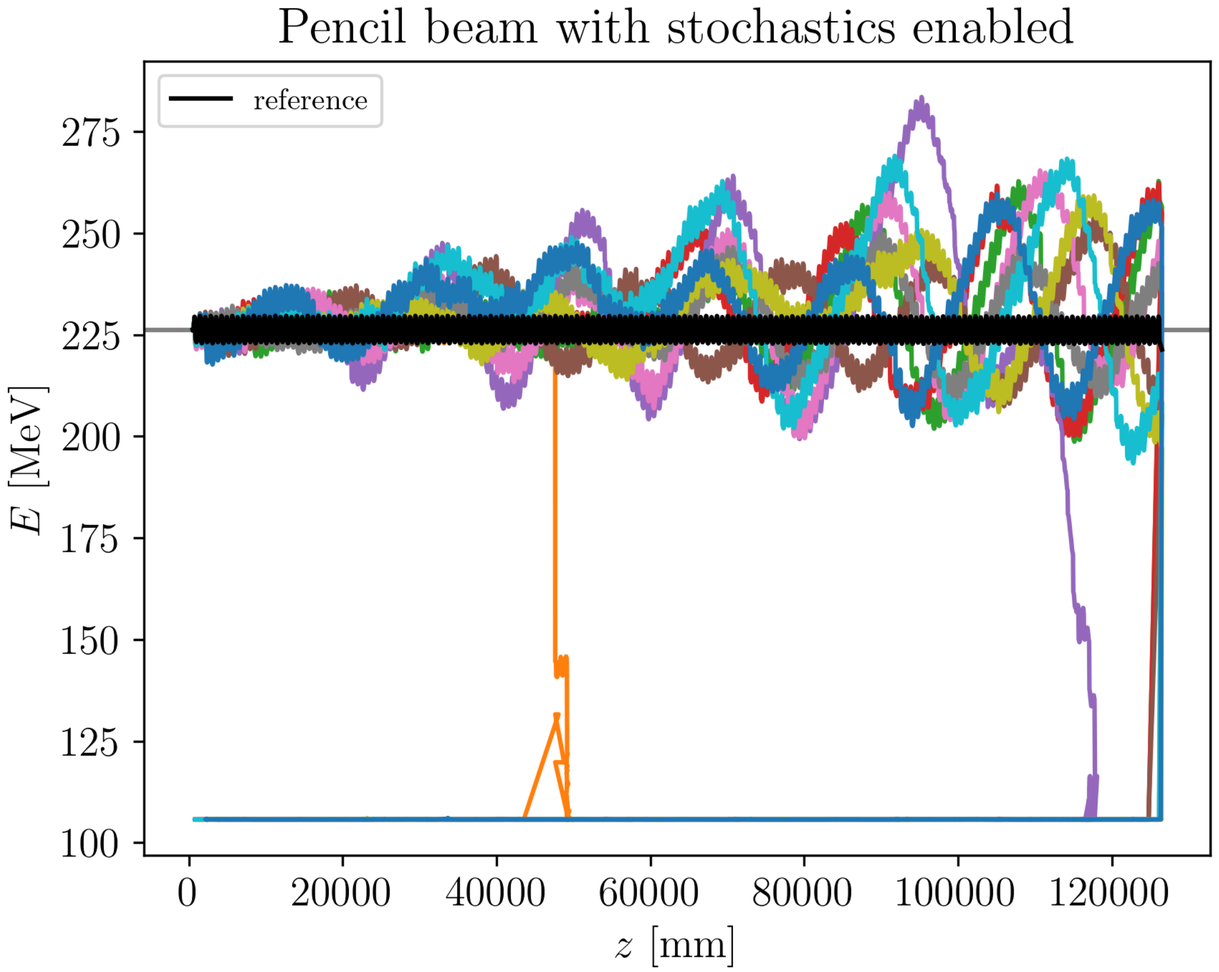


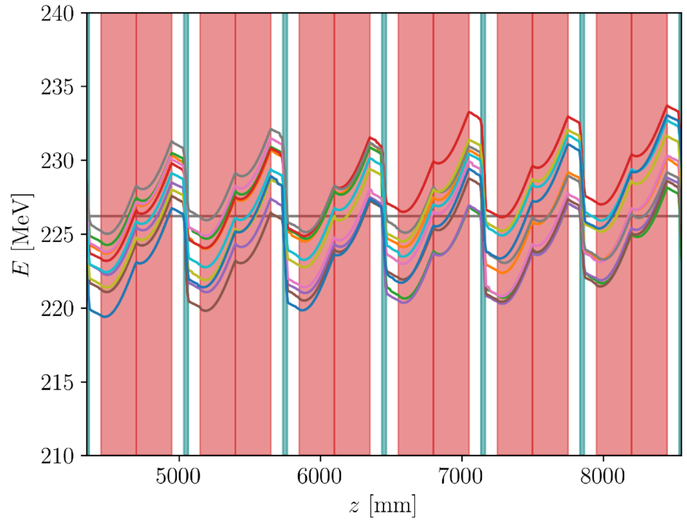
1

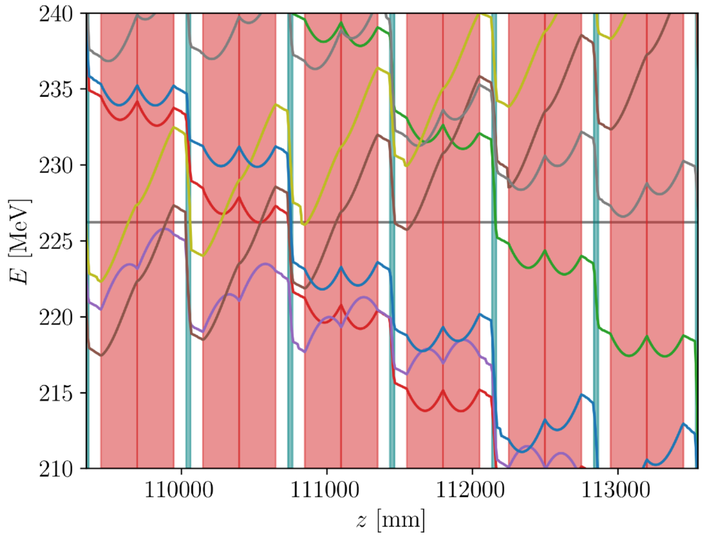


2

Testing w/ pencil beam







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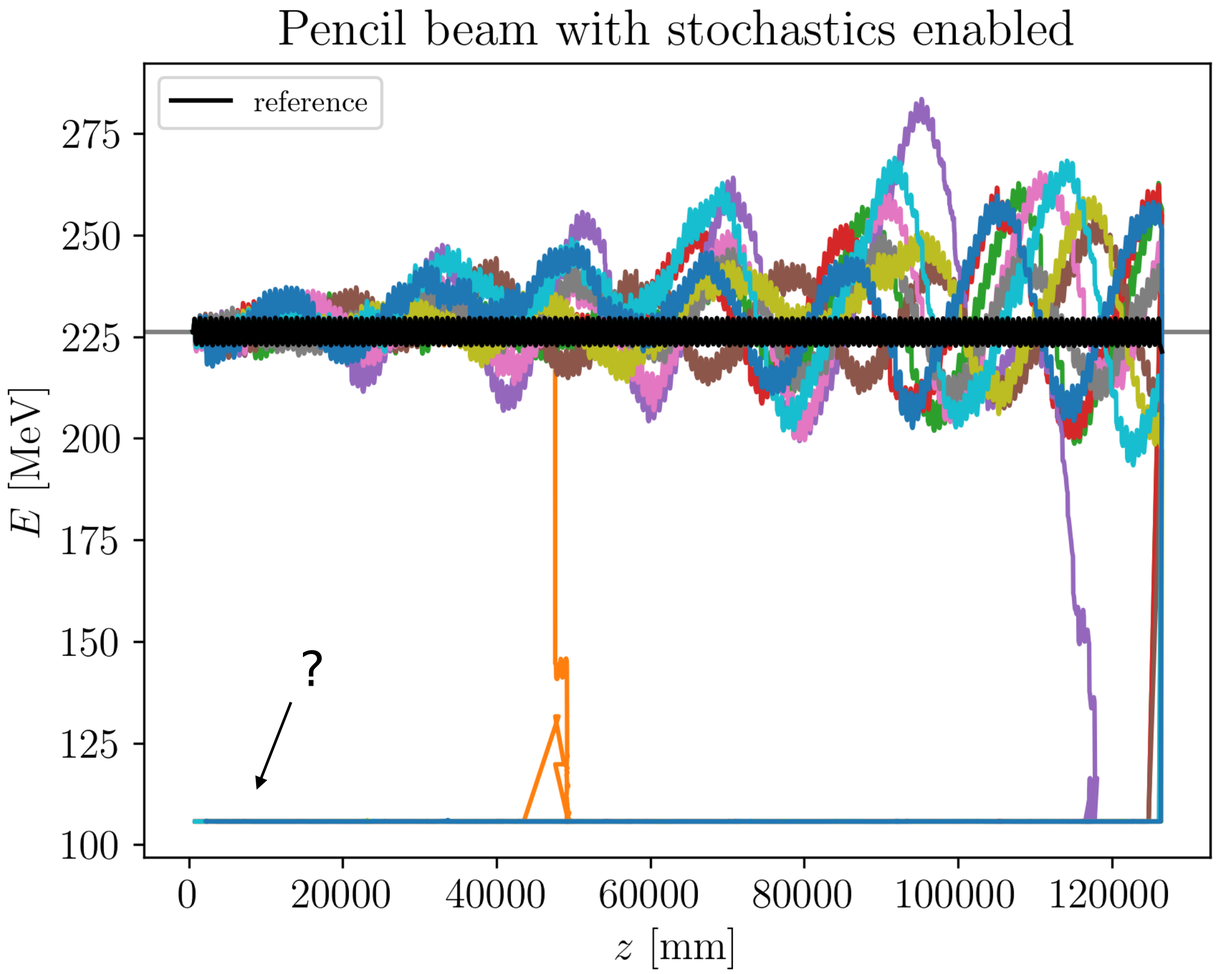

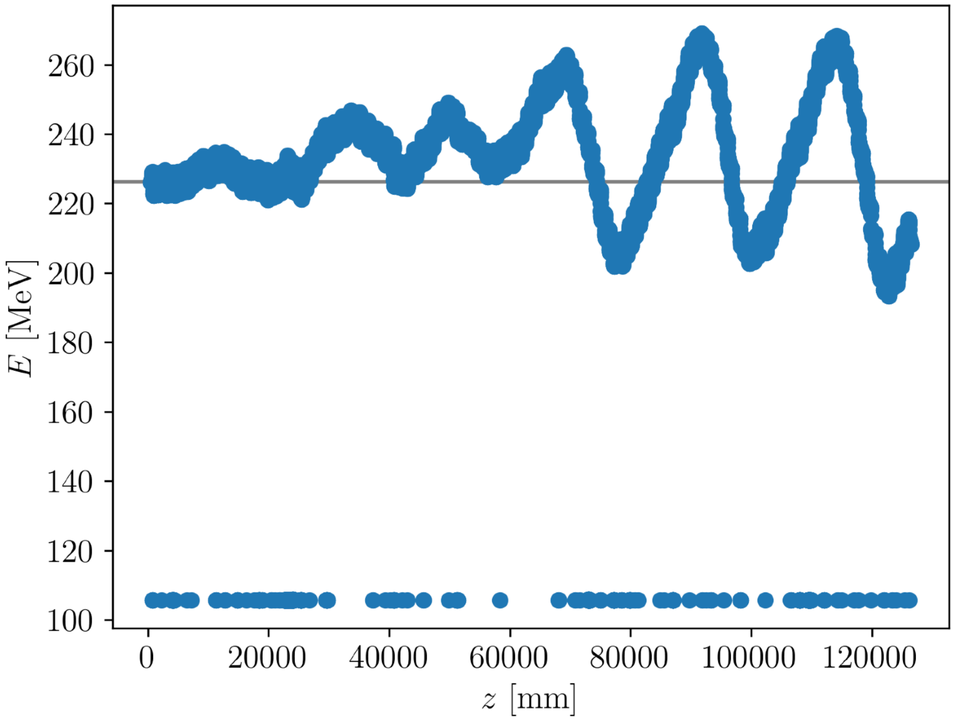

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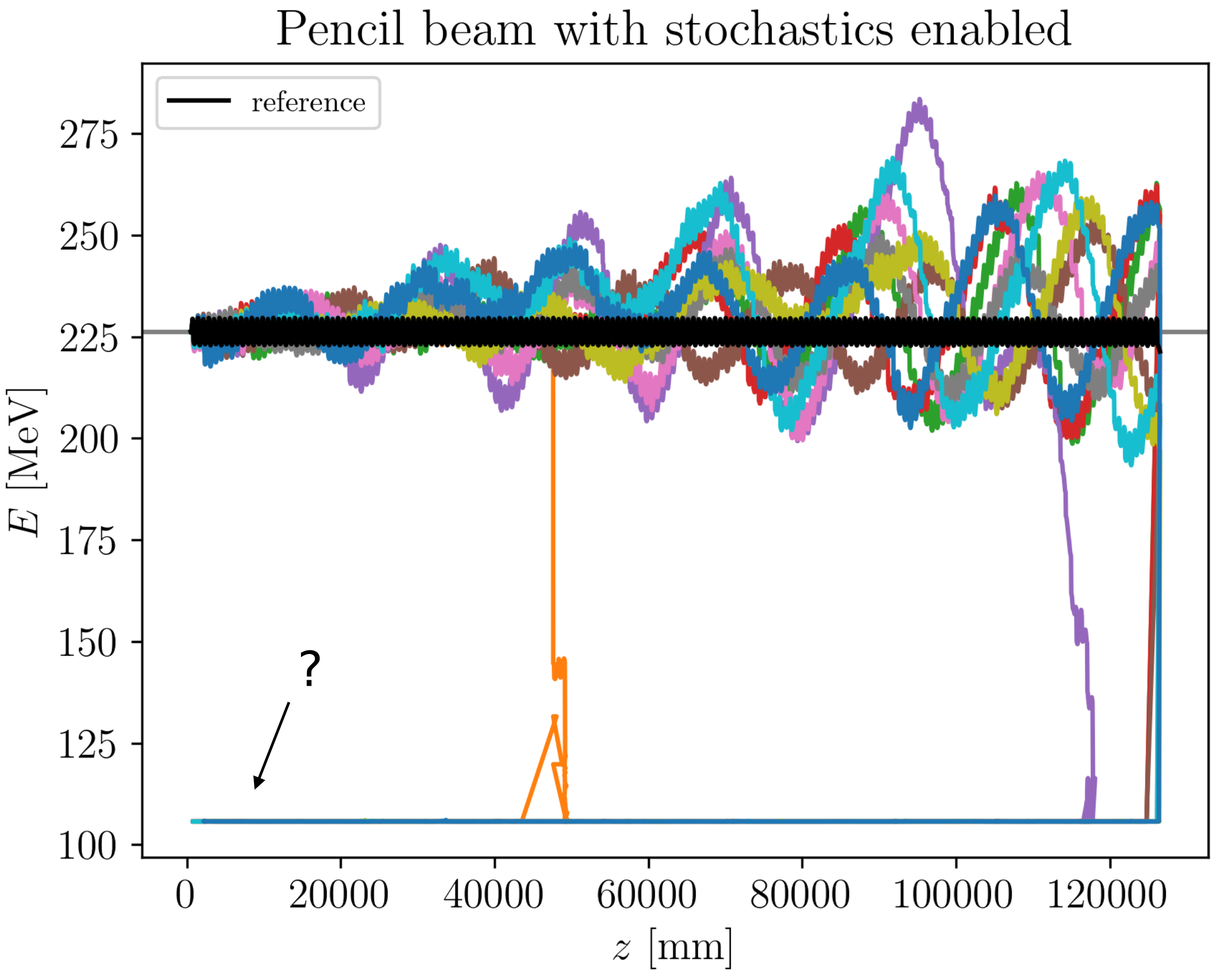

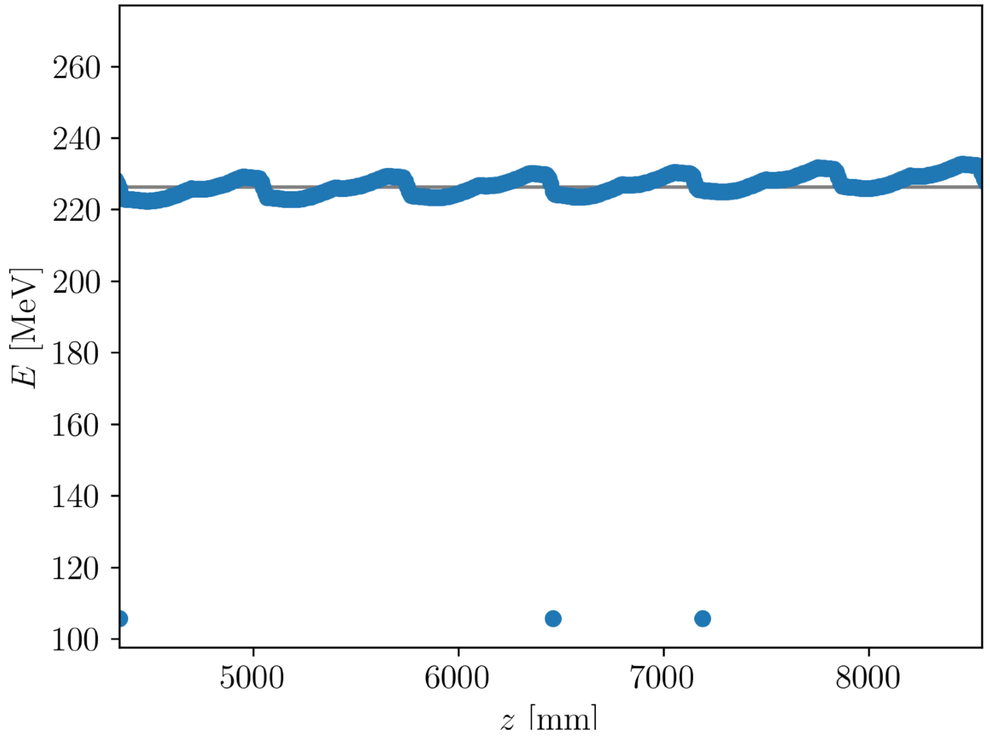

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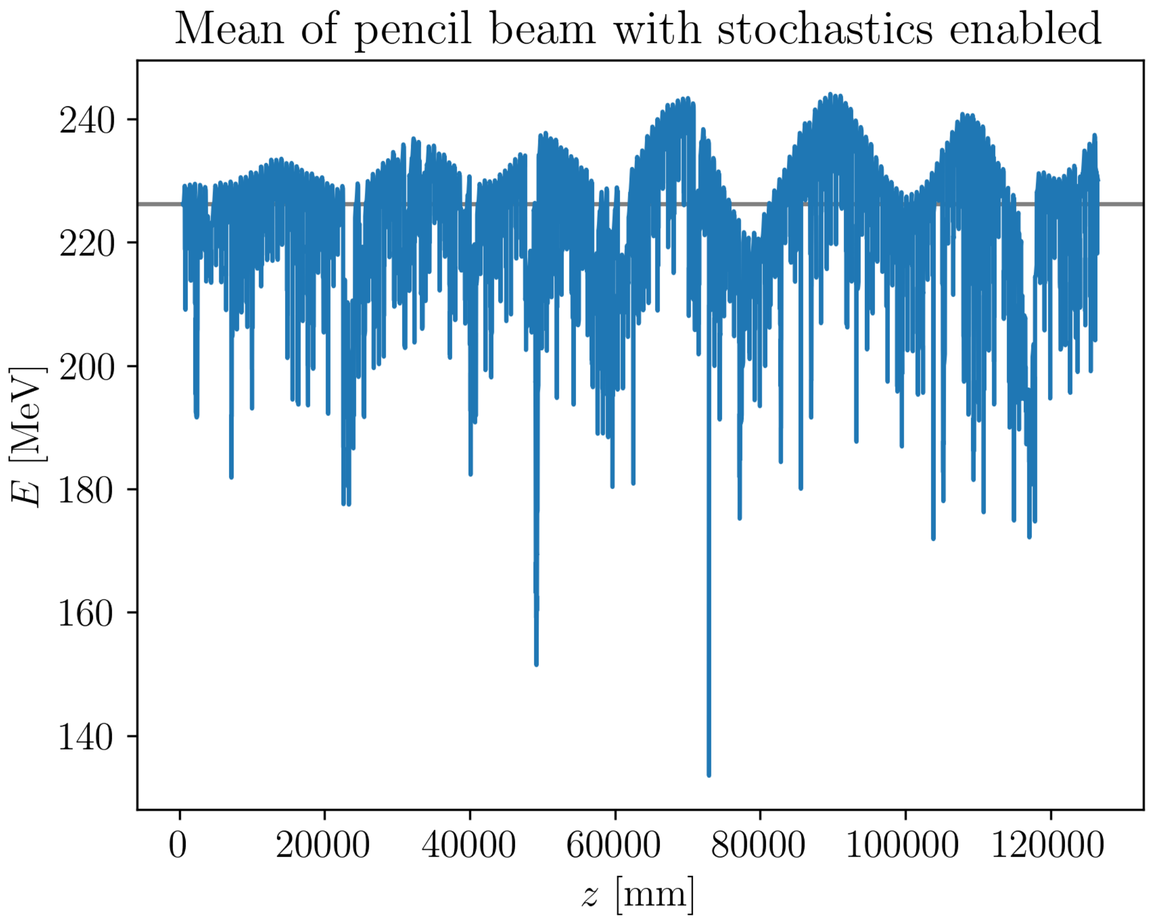
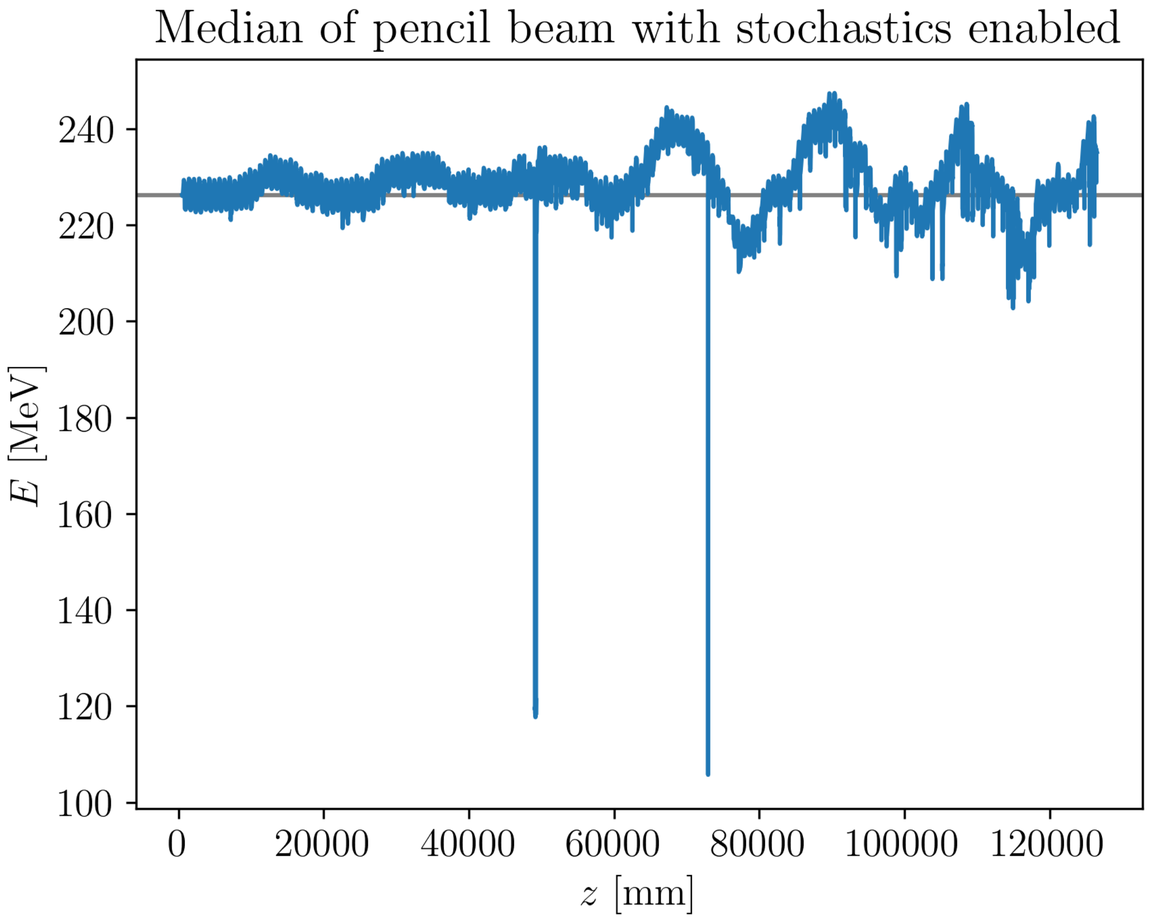




Experimenting w/ a single track

Methodology: pick one EventID and try setting the rf cavity phases based on its behavior

Possible outcome 1:

I find a periodic solution

==> stochastics-informed tuning (e.g. with "realistic" reference particle) is best approach

Possible outcome 2:

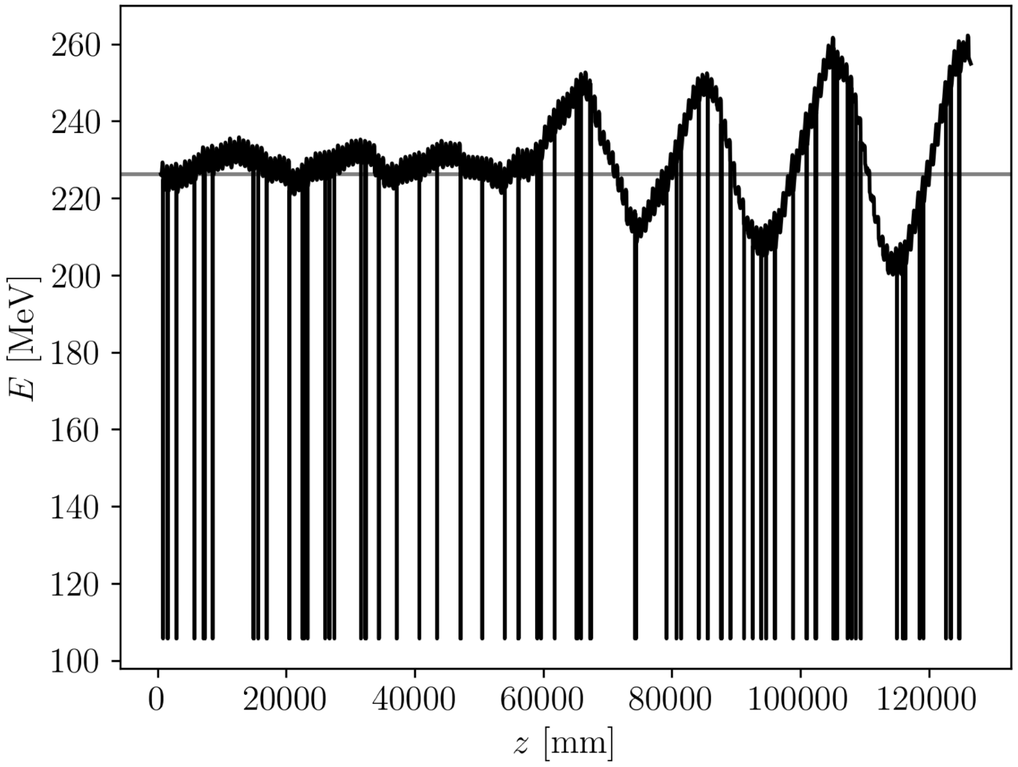
I cannot find a periodic solution

==> stochastic effects will unavoidably disturb the periodicity

==> suitable to use traditional reference?

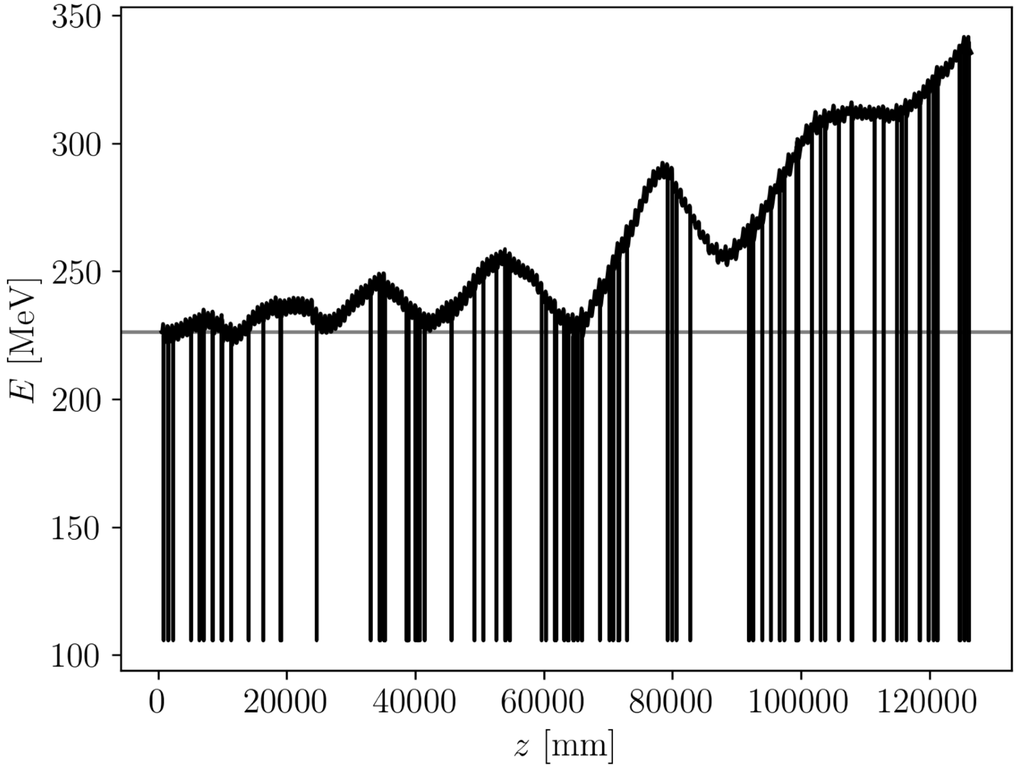
Experimenting w/ a single track

phaseAcc=37.3



(solution for reference)

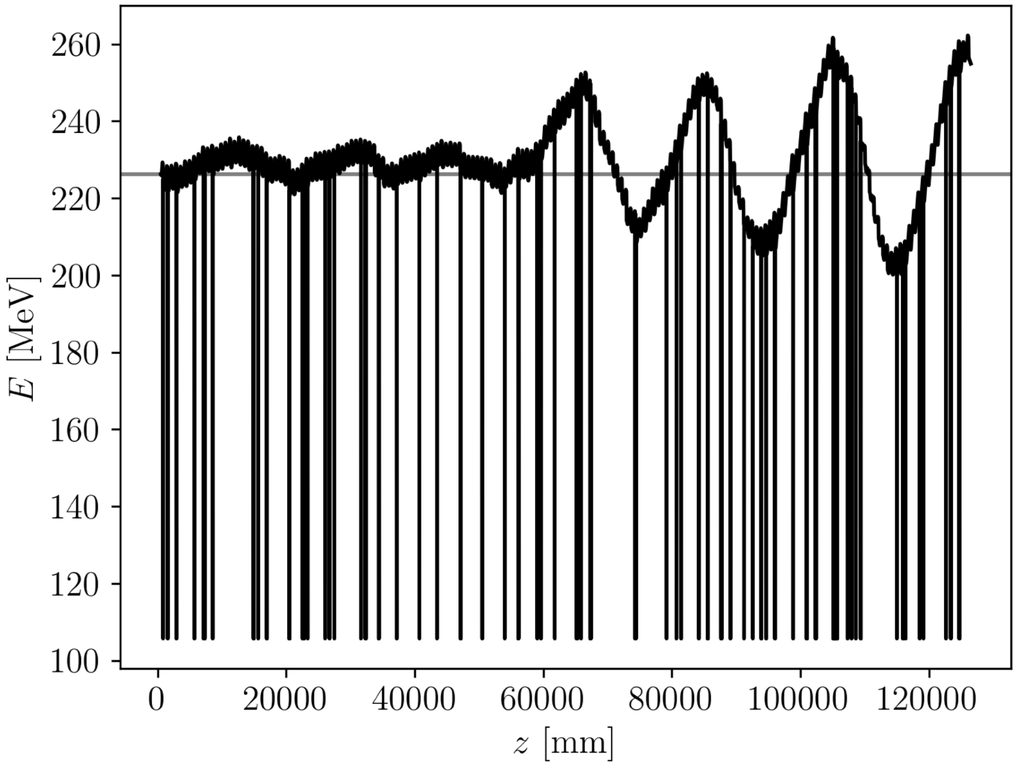
phaseAcc=38.3



EventID=3

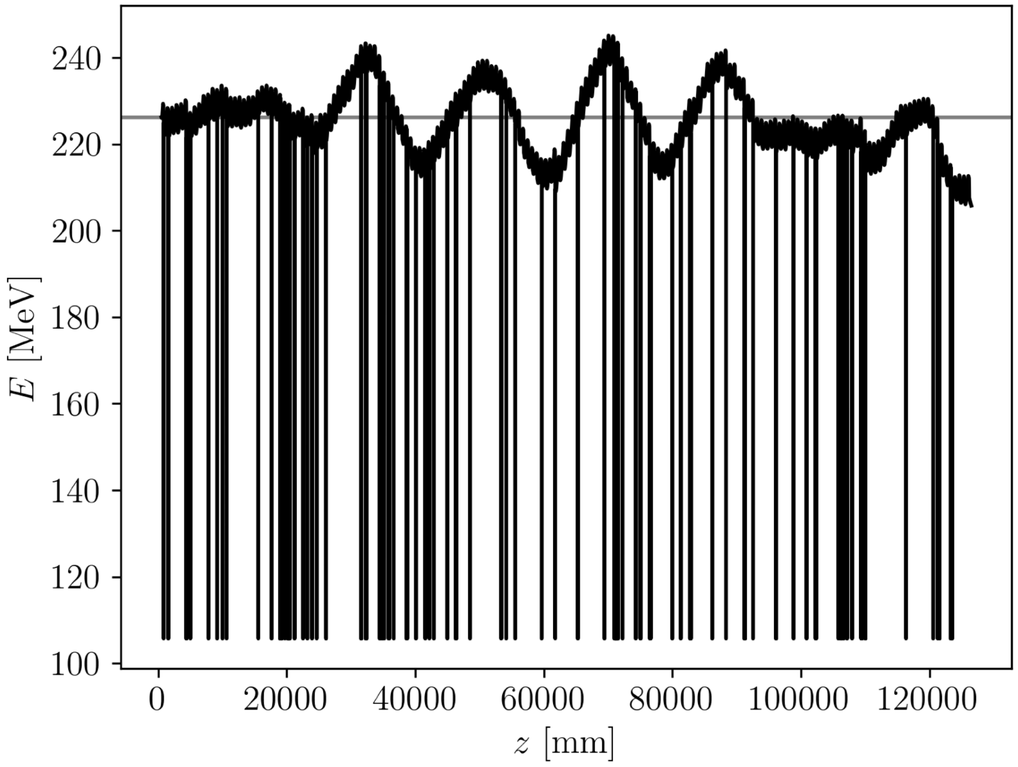
Experimenting w/ a single track

phaseAcc=37.3



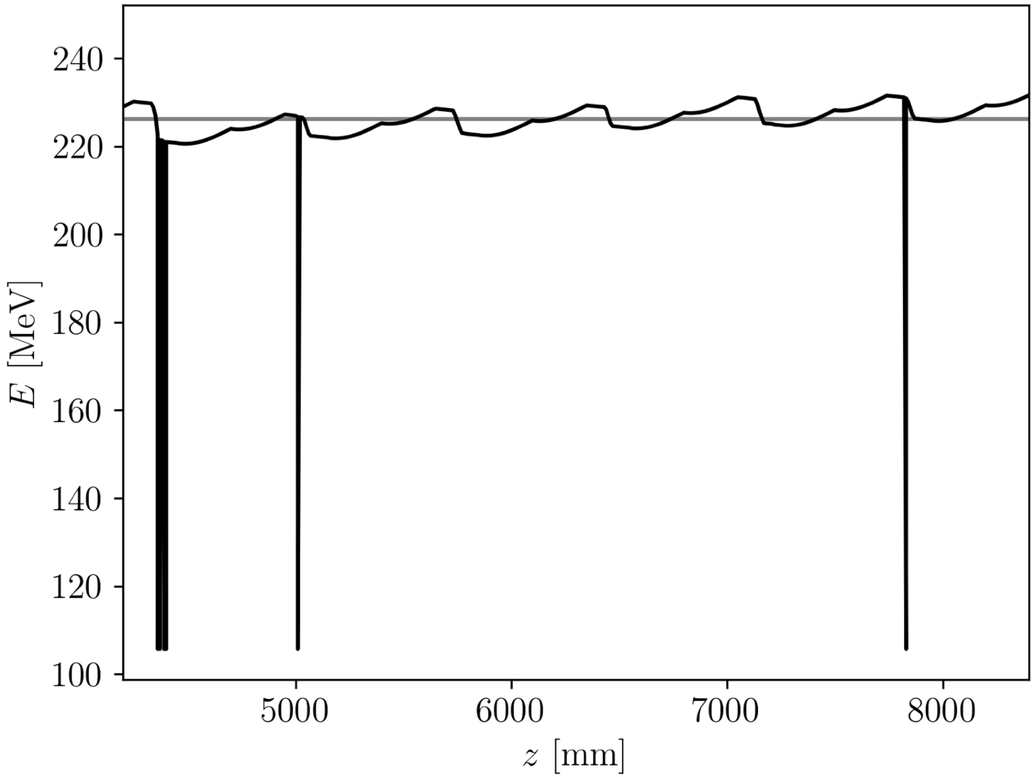
(solution for reference)

phaseAcc=38.2

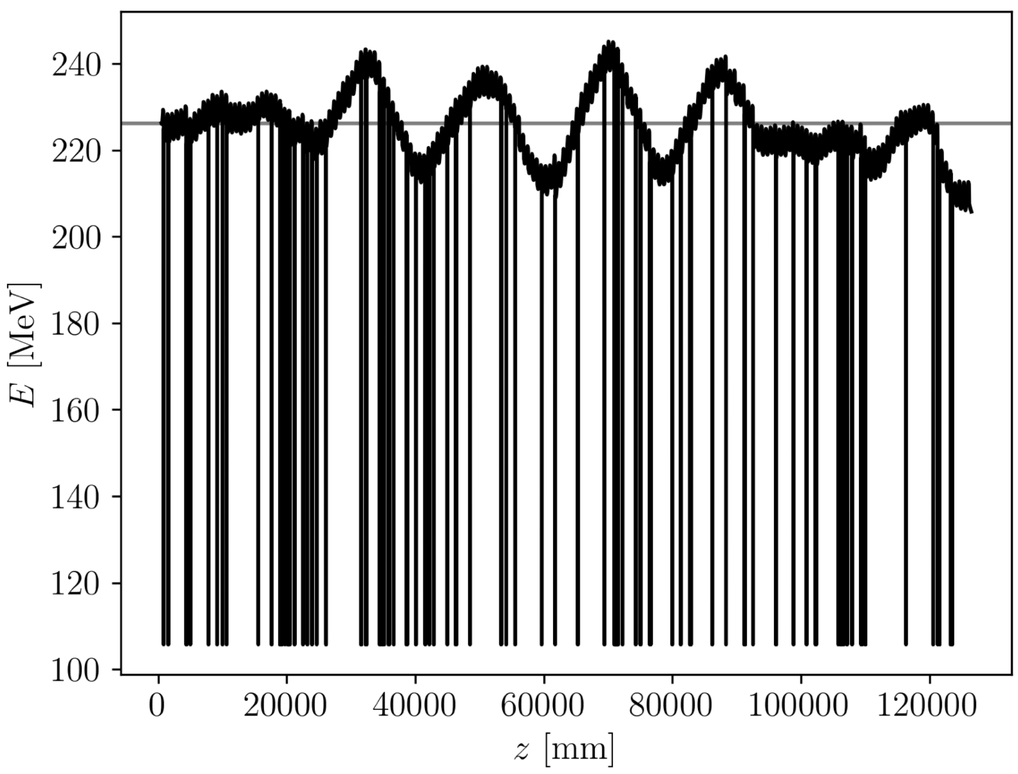


EventID=3

Experimenting w/ a single track

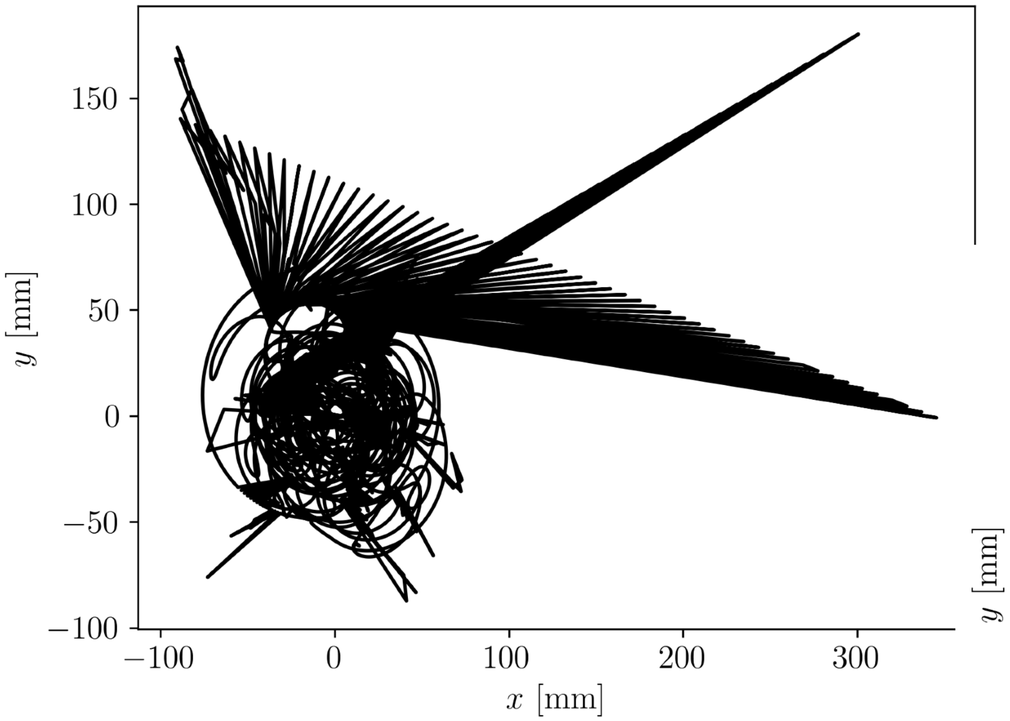


phaseAcc=38.2

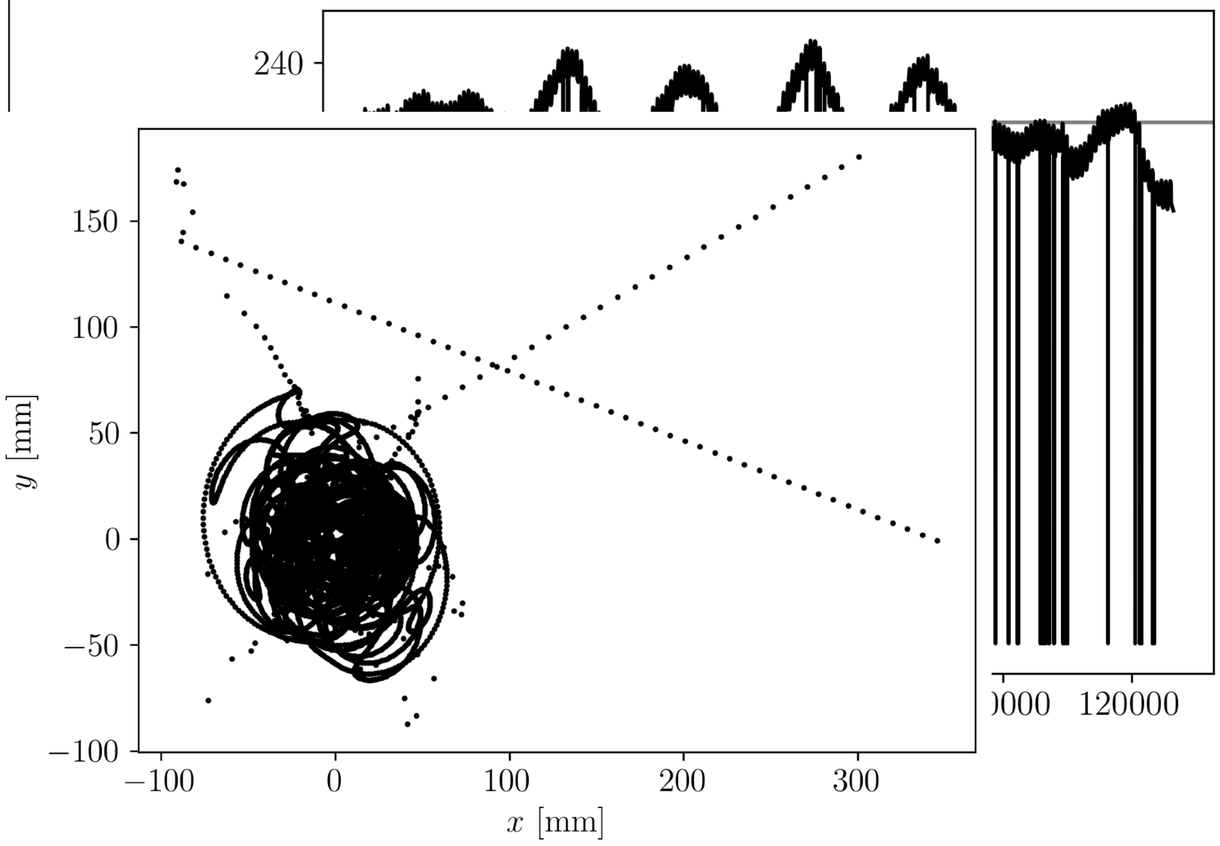


EventID=3

Experimenting w/ a single track



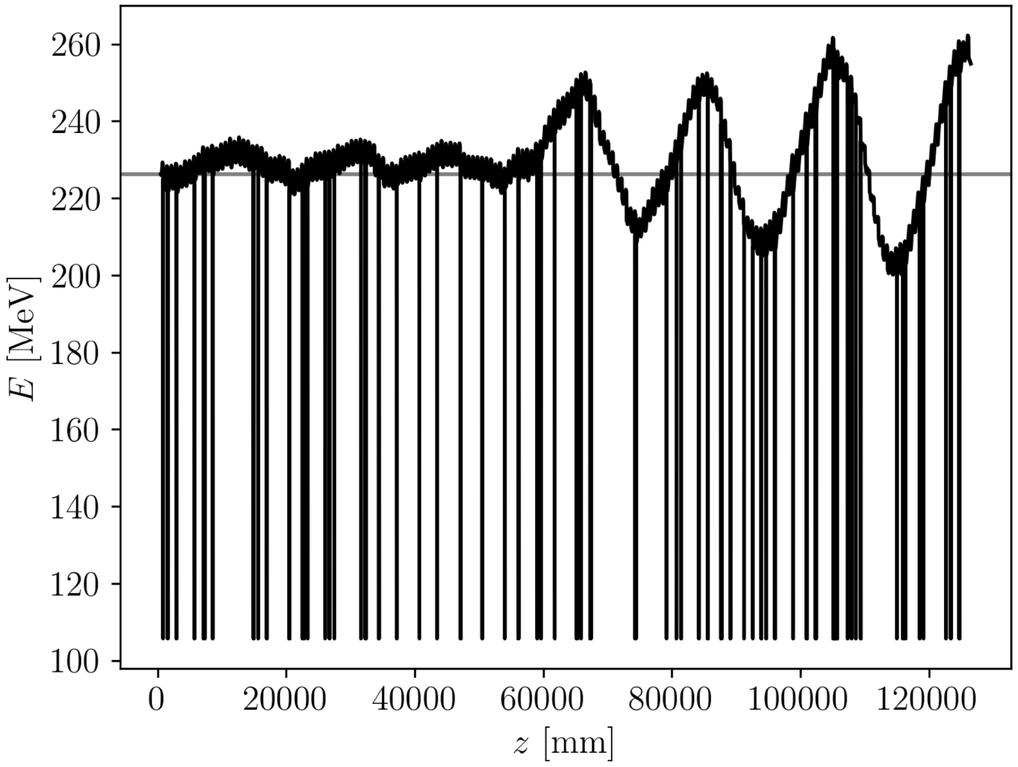
phaseAcc=38.2



EventID=3

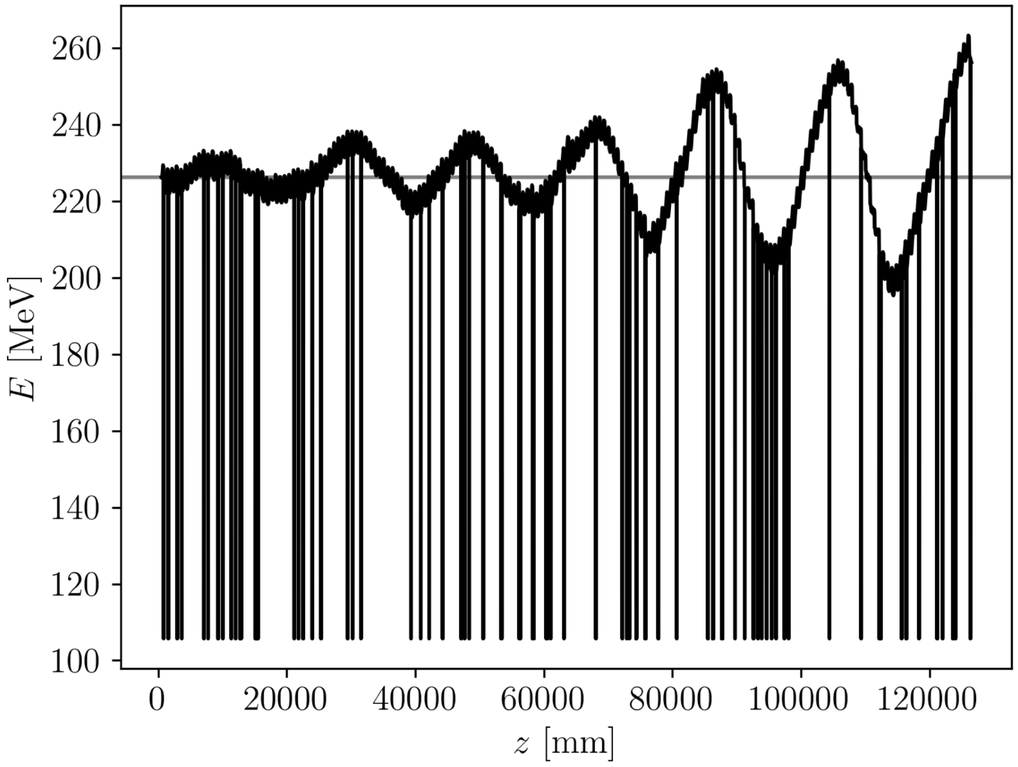
Experimenting w/ a single track

phaseAcc=37.3



(solution for reference)

phaseAcc=38.25



EventID=3

Mid meeting update!

The strange zero-momentum points vanished when `killSecondaries=1` was added