# Muon Beam Dynamics in HFOFO Cooling Channel

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# Recap

- Investigating differences in average dE/dx between beam with stochastics and realisticreference (withstochastics)

| | Reference particle | Beam, no stochastics | Beam, with stochastics | Reference, with stochastic | Bethe-bloch |
|---|---|---|---|---|---|
| 2.5 mm carbon absorber "tube" 200 MeV muon | 3.24 | 3.24 | 3.26 | 3.33 | 3.29 |
| LiH wedge absorber HFOFO 200 MeV muon | 1.72 | 1.72 | 1.73 | 1.43 | 1.73 |

Today's slides

# Validation test

- To rule out the possibility of an issue with realisticReference particle implementation, I tested modifying Stochastics settings for reference particle in G4beamline

```
// Tune and Reference particles cannot use collective mode
bool collectiveMode = runManager->getCollectiveMode();
runManager->setCollectiveMode(false);

printf("================= Prepare Tune Particle(s) ===========\n");
physics->setDoStochastics(FORCE_OFF,0);
runManager->Initialize();

printf("================= Begin Tune Particle(s) =============\n");
state = TUNE;
```

```
// Tune and Reference particles cannot use collective mode
bool collectiveMode = runManager->getCollectiveMode();
runManager->setCollectiveMode(false);

printf("================= Prepare Tune Particle(s) ===========\n");
physics->setDoStochastics(NORMAL,0);
runManager->Initialize();

printf("================= Begin Tune Particle(s) =============\n");
state = TUNE;
```

Enable stochastics in G4beamline input card

```
physics QGSP_BIC doStochastics=1
```

# Validation test

- To rule out the possibility of an issue with realisticReference particle implementation, I tested modifying Stochastics settings for reference particle in G4beamline

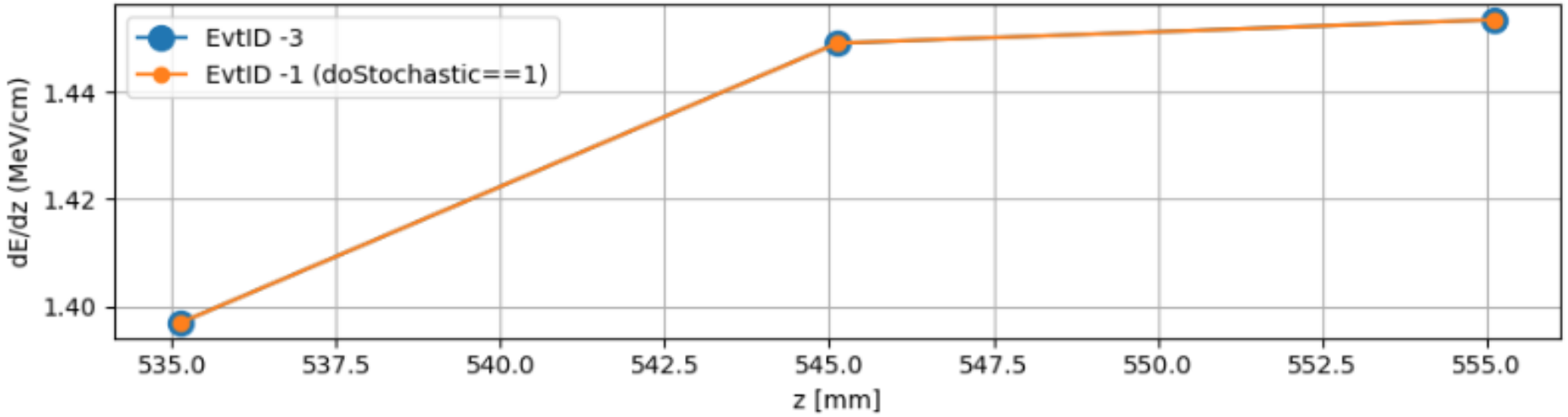
**Same results!**

RealisticReference Stochastic (-3)

| | z1 | z2 | E1 | E2 | dz | dE | dEdz |
|---|---|---|---|---|---|---|---|
| 55 | 535.124 | 545.124 | 226.193751 | 224.796820 | 10.000 | 1.396931 | 1.396931 |
| 56 | 545.124 | 555.123 | 224.796820 | 223.347809 | 9.999 | 1.449011 | 1.449156 |
| 57 | 555.123 | 564.879 | 223.347809 | 221.929746 | 9.756 | 1.418062 | 1.453529 |

Reference (-1) (doStochastics==1)

| | z1 | z2 | E1 | E2 | dz | dE | dEdz |
|---|---|---|---|---|---|---|---|
| 55 | 535.124 | 545.124 | 226.193751 | 224.796820 | 10.000 | 1.396931 | 1.396931 |
| 56 | 545.124 | 555.123 | 224.796820 | 223.347809 | 9.999 | 1.449011 | 1.449156 |
| 57 | 555.123 | 564.879 | 223.347809 | 221.929746 | 9.756 | 1.418062 | 1.453529 |



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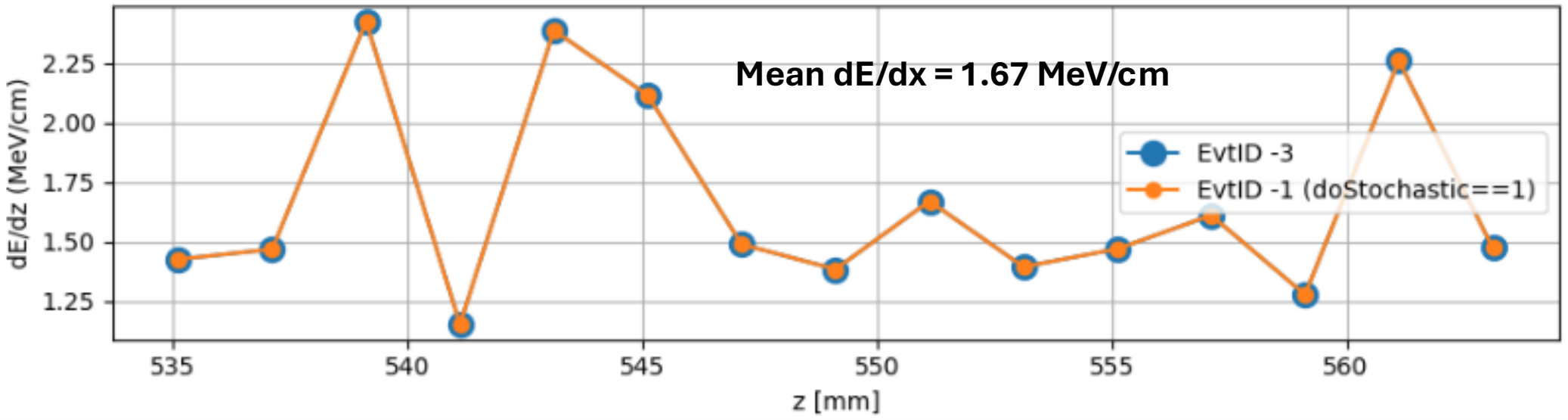

# Validation test

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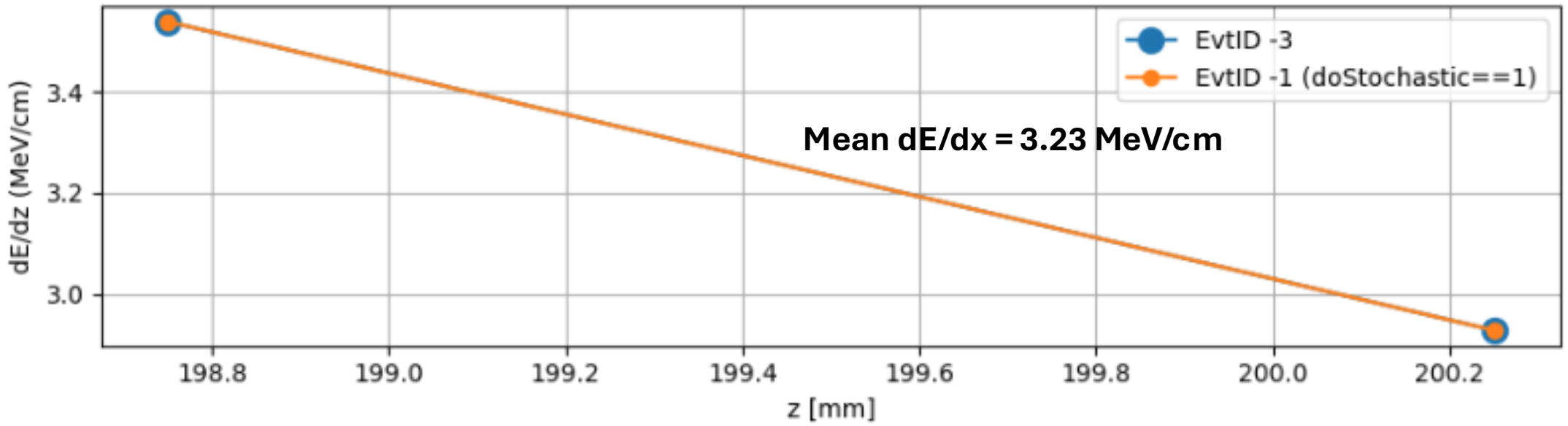
Carbon absorber 2.5 mm



# Updated comparison table

| | Reference particle | Beam, no stochastics | Beam, with stochastics | Reference, with stochastic | Bethe-bloch |
|---|---|---|---|---|---|
| 2.5 mm carbon absorber "tube" 200 MeV muon | 3.24 | 3.24 | 3.26 | 3.23 | 3.29 |
| LiH wedge absorber HFOFO 200 MeV muon | 1.72 | 1.72 | 1.73 | 1.67 | 1.73 |

# Conclusion

- Realistic reference average energy loss closely match to beam with stochastics enabled.
- Do we expect the numbers to match exactly?
  - May be not
  - Tried running nmultiple simulations but it didn't change the result
  - Next, I would like to try using `fluct` option and see if it changes anything.