Update on Rectilinear Cooling Channel Work at IMP

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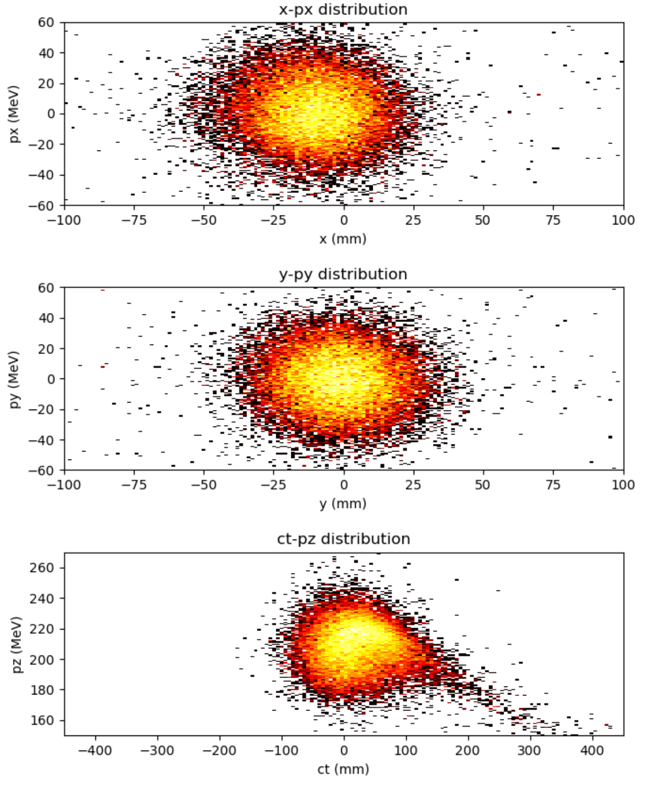
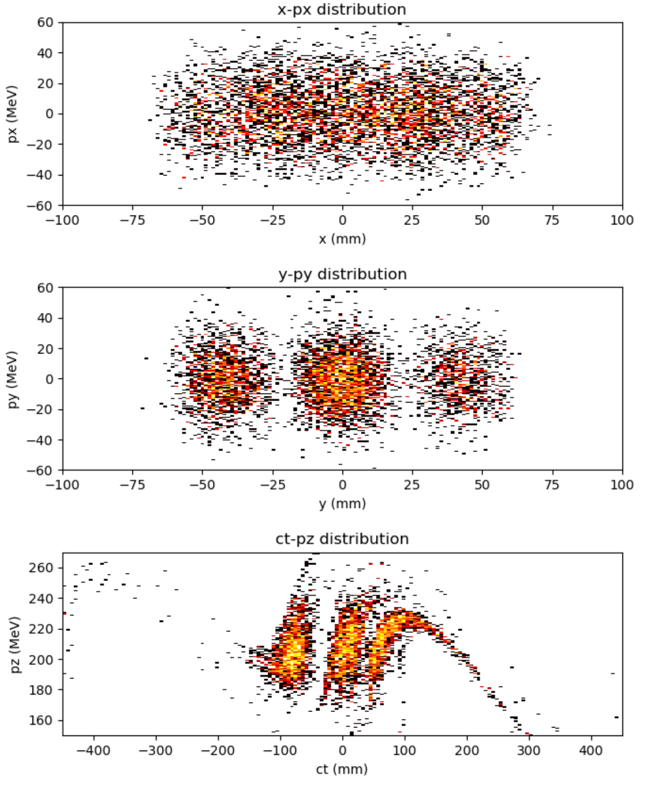
Part 1: Comparison with former paper

distribution used in my former simulation



distribution used in Diktys's simulation(after merging)



D. Stratakis and R. B. Palmer, Rectilinear six-dimensional ionization cooling channel for a muon collider: A theoretical and numerical study, Phys. Rev. ST Accel. Beams 18 (2015)

Problem: Lattice A can't cool the input beam.

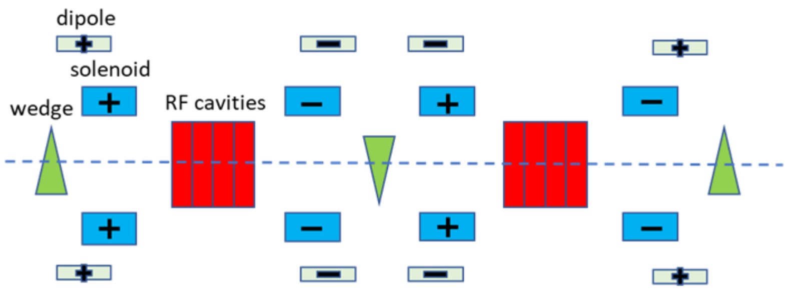
What is the reason?

Hint: Dispersion on the wedge calculated from realistic simulation has a reversed sign compared with dispersion calculated from the closed orbit.

$$D_x = \frac{(\langle x p_z\rangle - \langle x\rangle\langle p_z\rangle) \times \langle p_z\rangle}{\sigma_{p_z}}$$

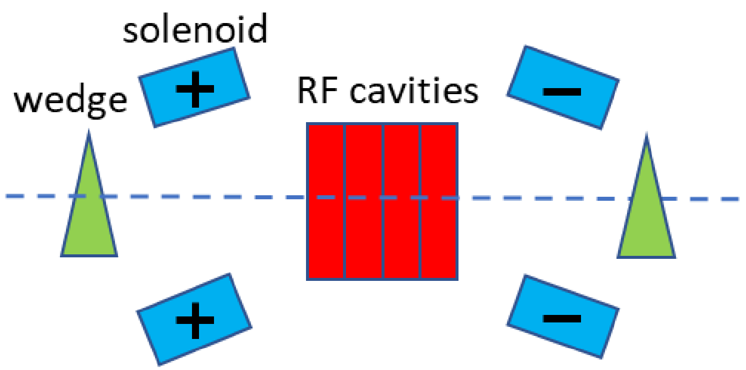
$$D_y = \frac{(\langle y p_z\rangle - \langle y\rangle\langle p_z\rangle) \times \langle p_z\rangle}{\sigma_{p_z}}$$

Cooling lattice A

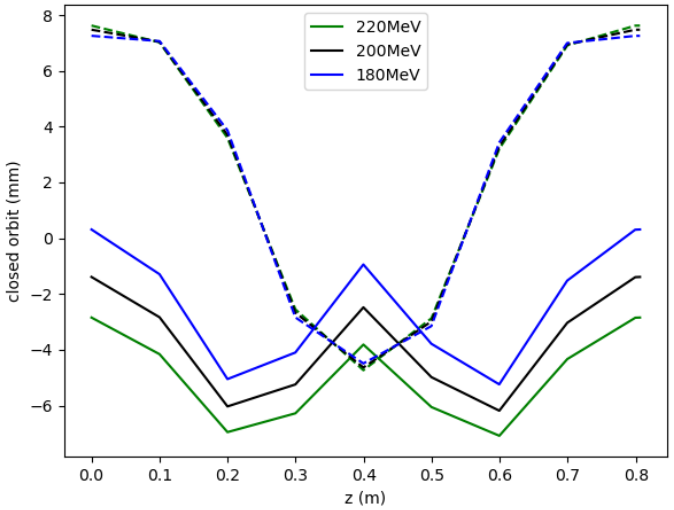


Part 1: Comparison with former paper

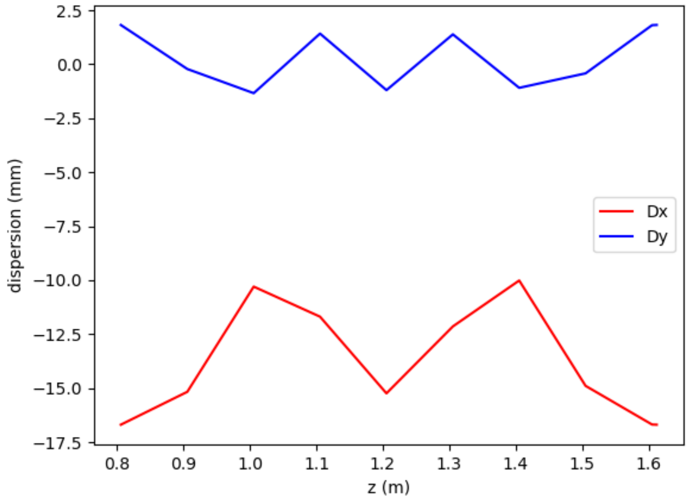
Cooling lattice from former paper



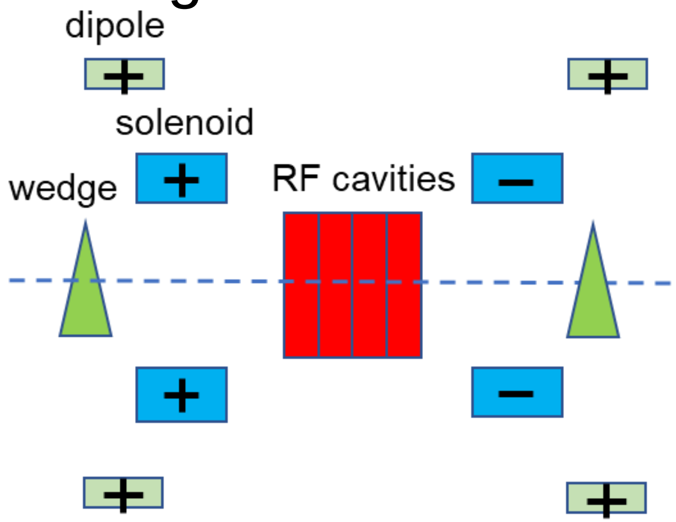
closed orbit



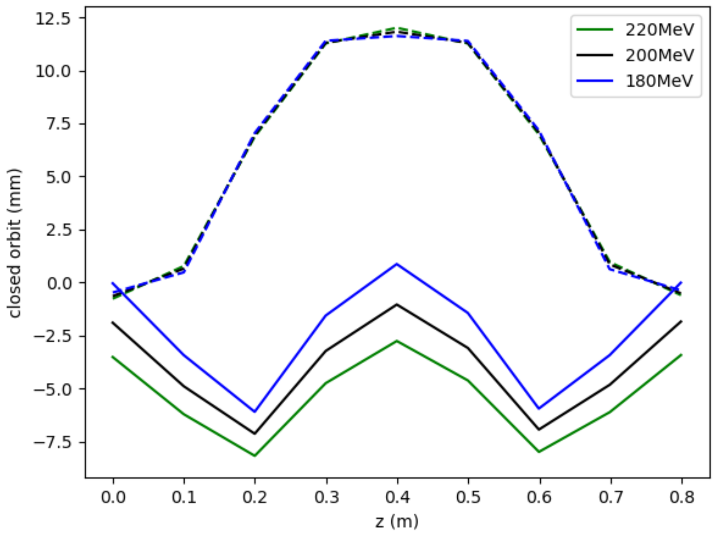
dispersion



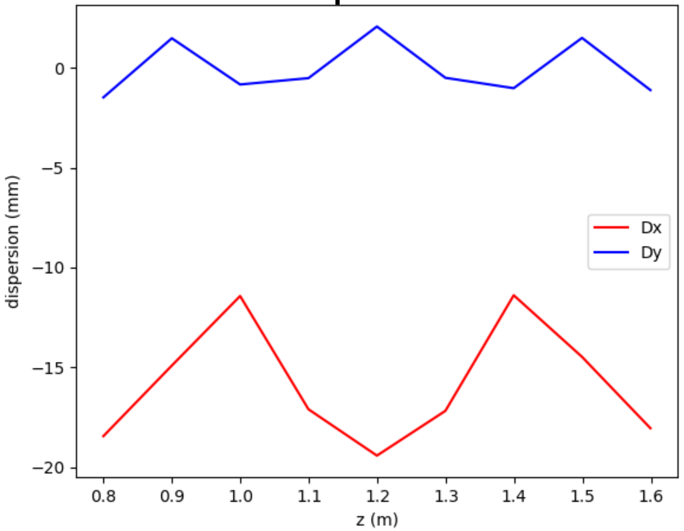
Cooling lattice B



closed orbit

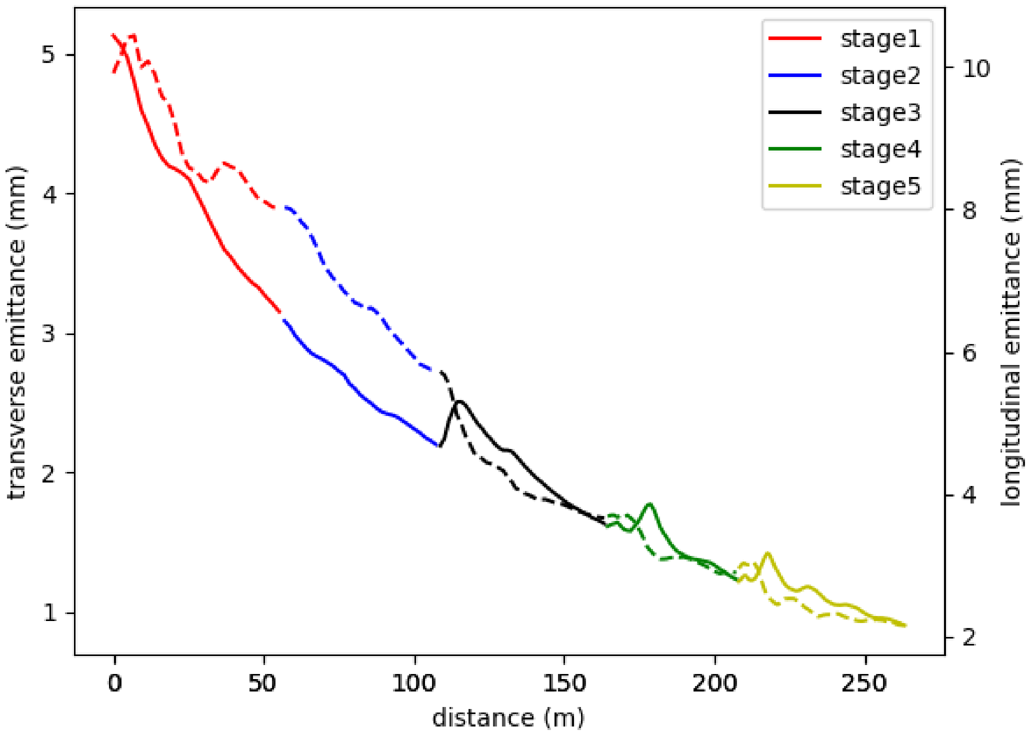


dispersion



Part 1: Comparison with former paper

Performance of cooling lattice B



	$\varepsilon_{\perp}$(mm)	$\varepsilon_{\parallel}$(mm)	ε_{6D}(mm^3)	T(%)
initial	5.13	9.91	260	
Stage 1	3.15	8	82.3	87.3
Stage 2	2.2	5.74	28.8	91
Stage 3	1.63	3.67	10.2	90
Stage 4	1.23	2.9	4.64	90
Stage 5	0.903	2.16	1.85	85.1

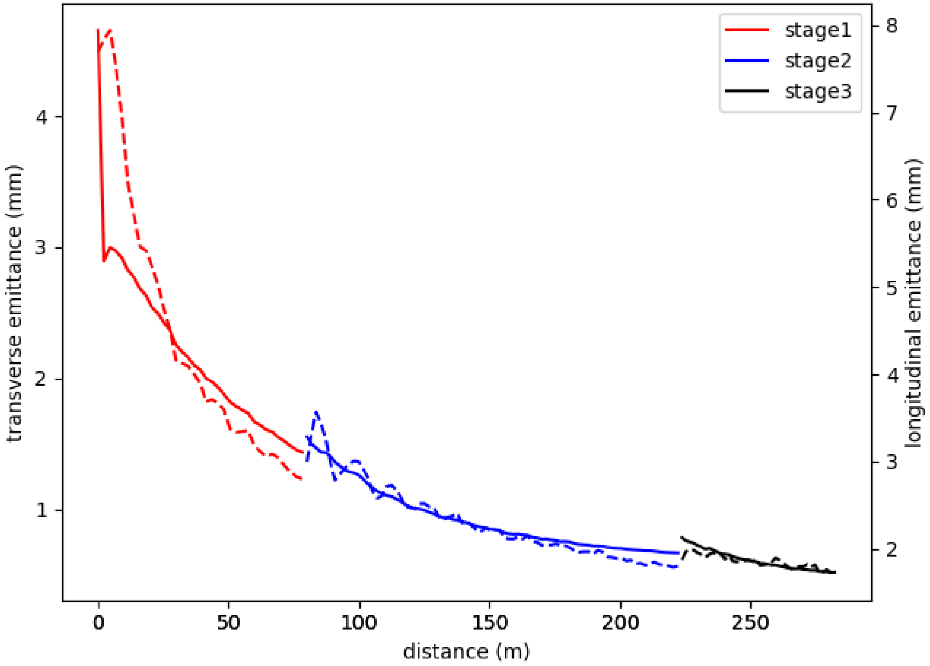
To reach the same 6D emittance(1.85 mm^3), distance is reduced by ~50 m compared with the result of Diktys.

Stage	ε_T^{sim} [mm]	ε_L^{sim} [mm]	P_z^{sim} [MeV/c]	T [%]
Begin	17.00	46.00	255	
A1	6.28	14.48	238	70.6
A2	3.40	4.64	229	87.5
A3	2.07	2.60	220	88.8
A4	1.48	2.35	215	94.6
Begin	5.10	10.04	209	
B1	3.76	7.76	210	89.7
B2	2.40	6.10	208	90.6
B3	1.55	4.28	207	89.2
B4	1.10	3.40	207	89.7
B5	0.68	2.97	204	87.5
B6	0.50	2.16	202	88.0
B7	0.38	1.93	200	89.6
B8	0.28	1.57	200	89.0

Part 2: High-pressure H_2 filled channel

➢ Cooling performance

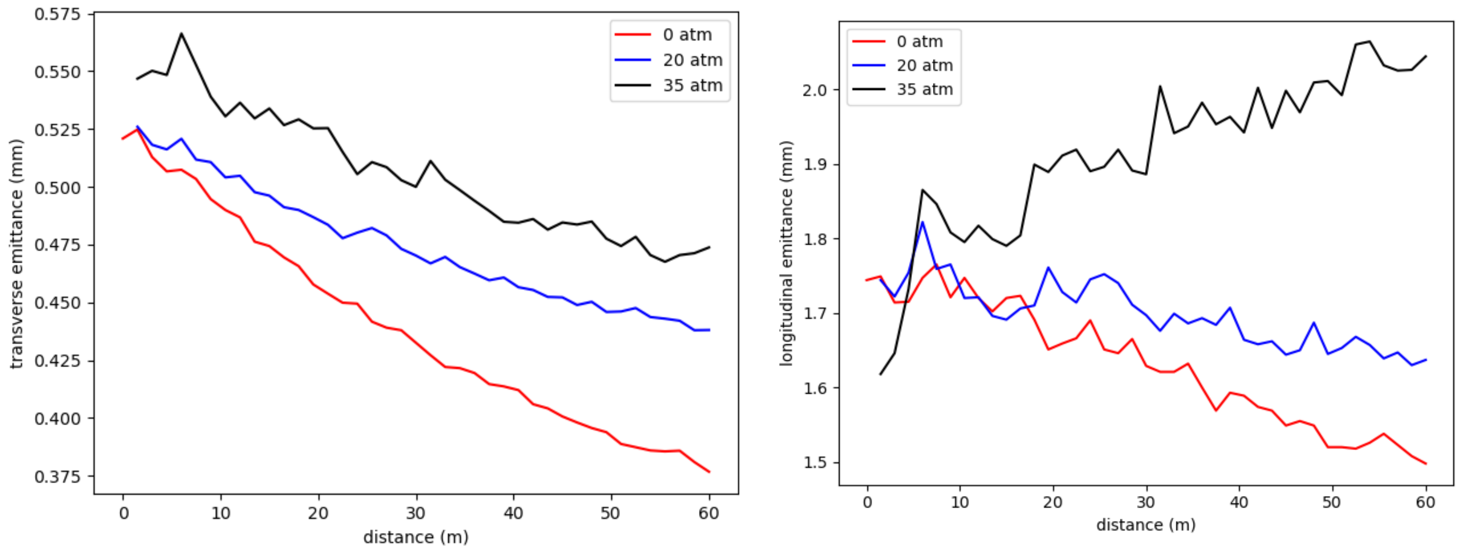
Stage 1 to Stage 3 (35 atm)



Transverse emittance: 4.65 to 0.52 mm
Longitudinal emittance: 7.7 to 1.74 mm

No significant difference from vacuum case.

Stage 4



- 0 atm : Transverse emittance: 0.52 to 0.37 mm
  Longitudinal emittance: 1.74 to 1.5 mm
- 20 atm : Transverse emittance: 0.52 to 0.44 mm
  Longitudinal emittance: 1.74 to 1.6 mm
- 35 atm : Transverse emittance: 0.52 to 0.47 mm
  Longitudinal emittance: 1.74 to 2 mm

Significant difference from vacuum case.

Conclusions and plans

- Distance is reduced by ~50 m compared with former study. Continue to do the cooling to more stages.(stage 6,7,8)

- Try to design matching section for the input beam to the cooling lattice A.(But how to do this?)

- Select the proper density of wedge to do the simulation for high-pressure H_2 filled channel.(probably use particle distribution from Diktys and cooling lattice B)