Possible 200 MHz Cooling Experiment

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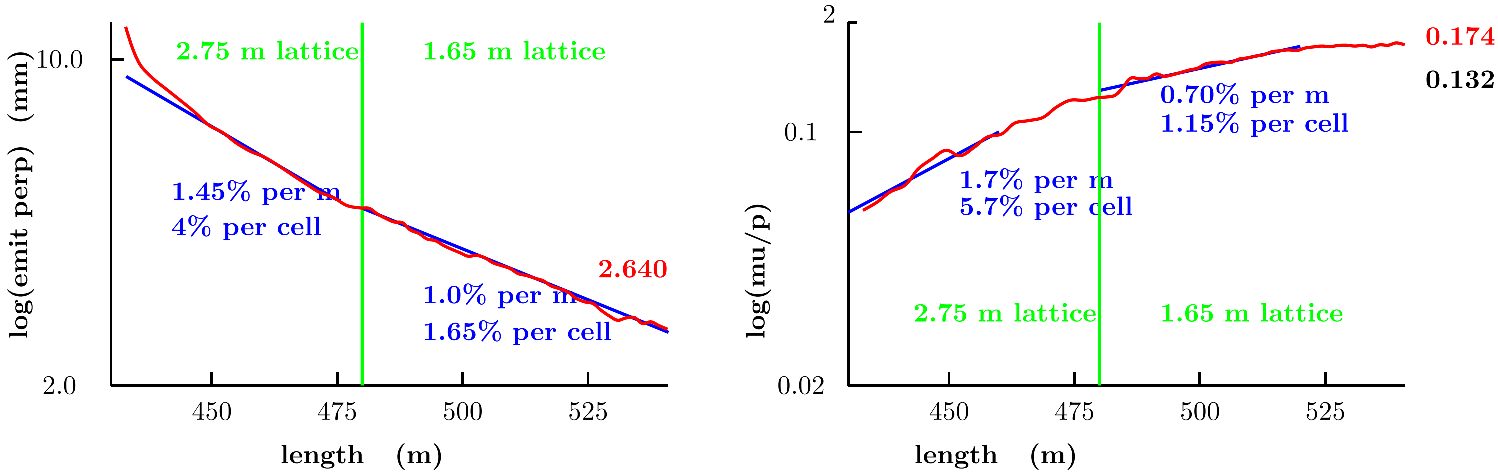
1 2.75 m vs. 1.65 m cell ?



The above figures show the rates of cooling, and rates of increase in accepted mu/p, in a simulation of the Study 2 system. We see that at the start, in the 2.75 m lattice, with an initial emittance of 10 mm rad, the transverse cooling is 4.0 % per cell (1.45 %/m). The accepted mu/p, proportional to the central beam density, is increasing by 4.7 % (1.7%/m). If we can measure to 0.5 % then one cell should be enough for an initial experimental demonstration of cooling.

The numbers for the 1.65 m cells are lower, partly because of the condition of the beam where it is used, partly because the lattice has a 20% poorer acceleration packing factor, and, per cell, because it is shorter. I estimate that with an initial transverse emittance of 5 π mm radians, the cooling would be 1.2% per m (2.0% per cell). Thus we would need 2 1.65 m cells for the same experimental significance as with the one 2.75 m cell. Note that the number of rf cavities would be the same: 4 in each case. But the magnet costs would be much higher: 5 M$ (for 2 1.65 m cells) compared with 2 M$ (for one 2.75 m cell). Both nubers taken from Study 2, excluding power supplies and cryo.

I also note that the required initial emittance in the 1.65 m case is 1/2 that in the 2.75 m case (this has to be so because the beta functions differ by this factor and the beam angles are constrained by the angular acceptsances that are similar). I think this means that it will be harder to measure even the same emittance change in the 1.65 m case.

All of these arguments suggest that the 2.75 m cell is the better one to use. Other arguments are:

- the fields are lower.
- there would be fewer absorbers
- the absorbers are larger and have more space.
- the whole design is less tight.

The only arguments that had seemed to go the other way are:

- The apertures are smaller.
- we only have rf for 2 cells.

But if that same rf was put into 4 cells we get $\sqrt{2}$ more acceleration, and thus $\sqrt{2}$ more cooling. And if it was fed to 8 cavities we would get 1/2 gradient in each: and cooling equivalent to one full 2.75 m cell. So my proposal is:

2 proposed experimental scheme

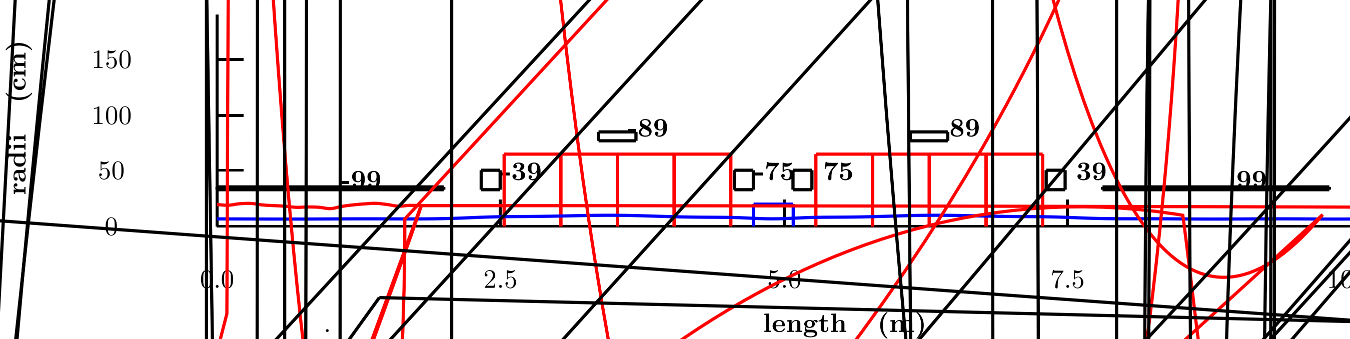
Use 8 rf cells in 2 groups. Use one absorber placed inside a single focus coil pair, and two coupling coils outside each of the two groups of rf. The rf is run at 1/2 gradient and uses the same power as 2 cells at full gradient. Coupling coils are designed to match into long solenoids where the measurements are made.

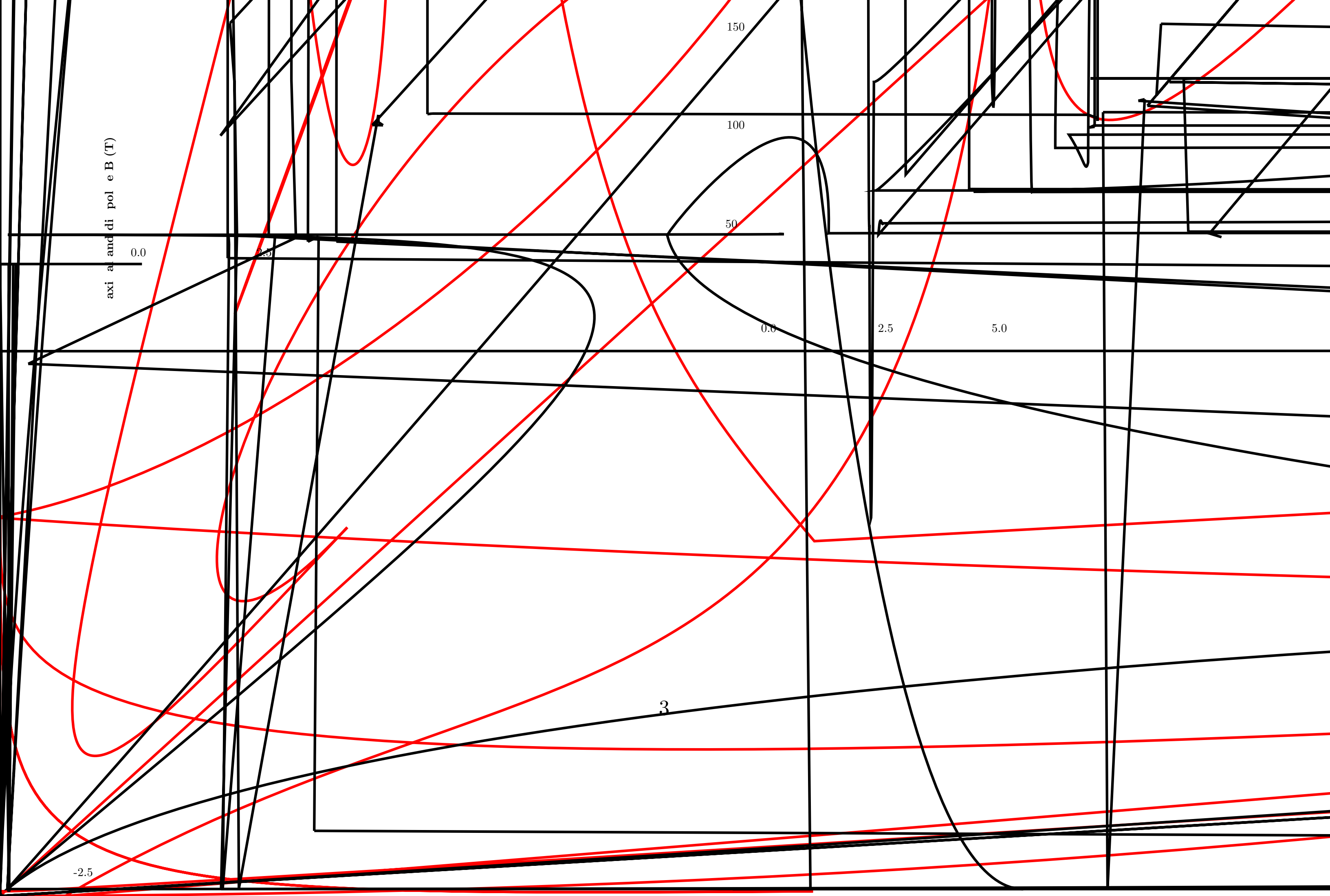
The coil Parameters are:

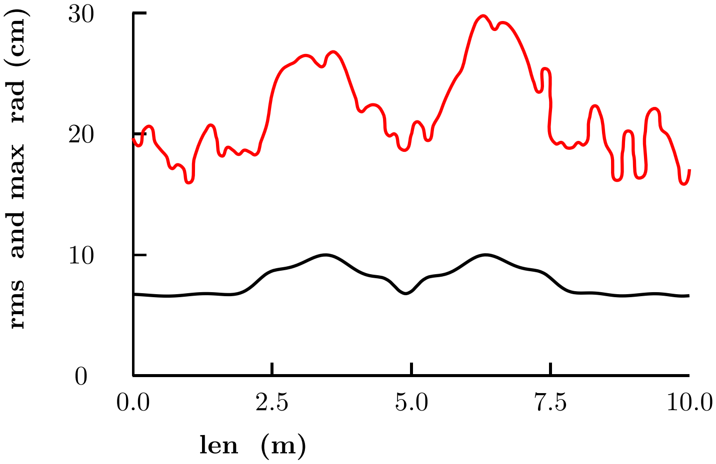
len1 m	gap m	dl m	rad m	dr m	I/A A/mm^2	n I A	n I l A m
0.000	0.000	2.000	0.330	0.025	-100.00	5.00	10.76
2.000	0.000	2.000	0.330	0.025	-100.00	5.00	10.76
4.000	0.000	2.000	0.330	0.025	-100.00	5.00	10.76
6.330	0.330	0.167	0.330	0.175	-39.11	1.14	3.00
7.365	0.868	0.330	0.770	0.080	-89.39	2.36	12.01
8.563	0.868	0.167	0.330	0.175	-75.96	2.22	5.82
9.080	0.175	0.167	0.330	0.175	75.96	2.22	5.82
10.115	0.868	0.330	0.770	0.080	89.39	2.36	12.01
11.313	0.868	0.167	0.330	0.175	39.11	1.14	3.00
11.810	0.330	2.000	0.330	0.025	100.00	5.00	10.76
13.810	0.000	2.000	0.330	0.025	100.00	5.00	10.76
15.810	0.000	2.000	0.330	0.025	100.00	5.00	10.76

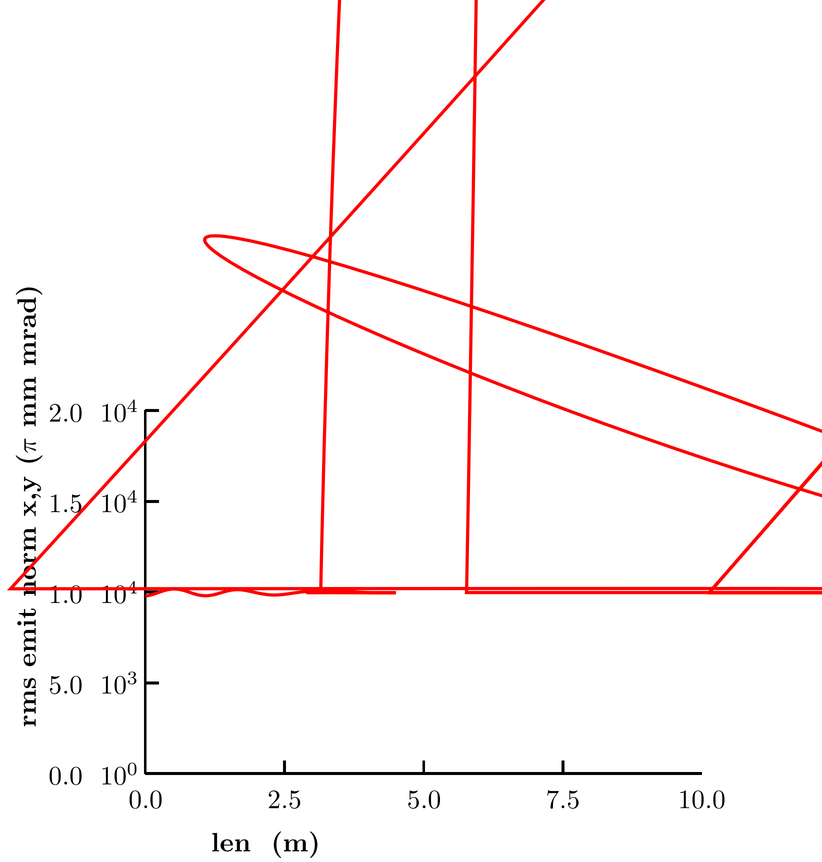
The geometry, and ICOOL tracking with no absorbers, rf, or collimation are shown below for parameters:

mu momentum	MeV	200
rms dp/p	%	9
normalized emittance	π mm	10






rms and max rad (cm)
30
20
10
0
0.0
2.5
5.0
7.5
10.0
len (m)


rms emit norm x,y (π mm mrad)
2.0 10^4
1.5 10^4
1.0 10^4
5.0 10^3
0.0 10^0
0.0
2.5
5.0
7.5
10.0
len (m)