Match: cooling to acceleration

DRAFT 2

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Method:

The match is achieved by adiabatically changing the lattice parameters from the short (1.65m) low beta (0.18 m)Super FOFO lattice at the end of the cooling to a longer (2.75 m) and higher beta (.6 m) FOFO lattice. The transition is made in 10 steps.

Initially there are seven 1.65 m cells, all identical in dimensions, but currents modified to gradually to raise the central betas, and change the form of beta vs momentum from a hump between two minima, to a monotonic slope.

This is followed by 3 cells with all longitudinal dimensions raised to further increase the beta.

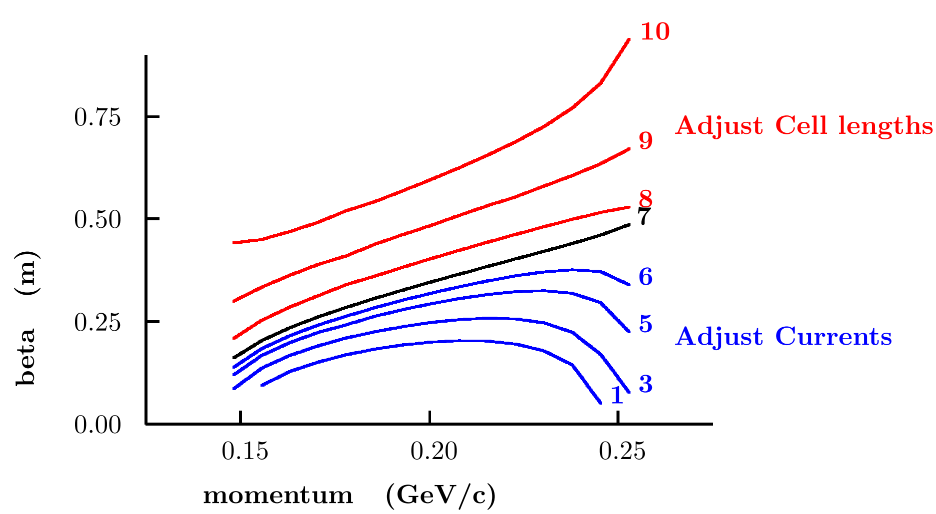
Finally, after a lone center (coupling) coil, followed by a reverse coil to bring the axial field down to zero, the beta is allowed to rise towards the quad system of the superconducting linac.

RF Cavities

RF is introduced to keep the bunch together and raise the average momenta. All currents are scaled with the rising momenta.

The RF fields (for phase= 90 deg.) average 8 MV/m over 19 m. Average energy gain is 3 MV/m. 2 RF cavities are in each cell, except that there are 3 cavities in cell 10 and 1 cavity beyond the final focus coils; for a total of 22 cavities. Each cavity is identical to those in the 1.65 m cooling cells. The total acceleration required (for phase=90 deg.) is 152 MeV, giving a requirement of 6.9 MV per cavity. The phase is set to give an actual mean acceleration of 2.6 MV per cavity.

Betas at cell ends



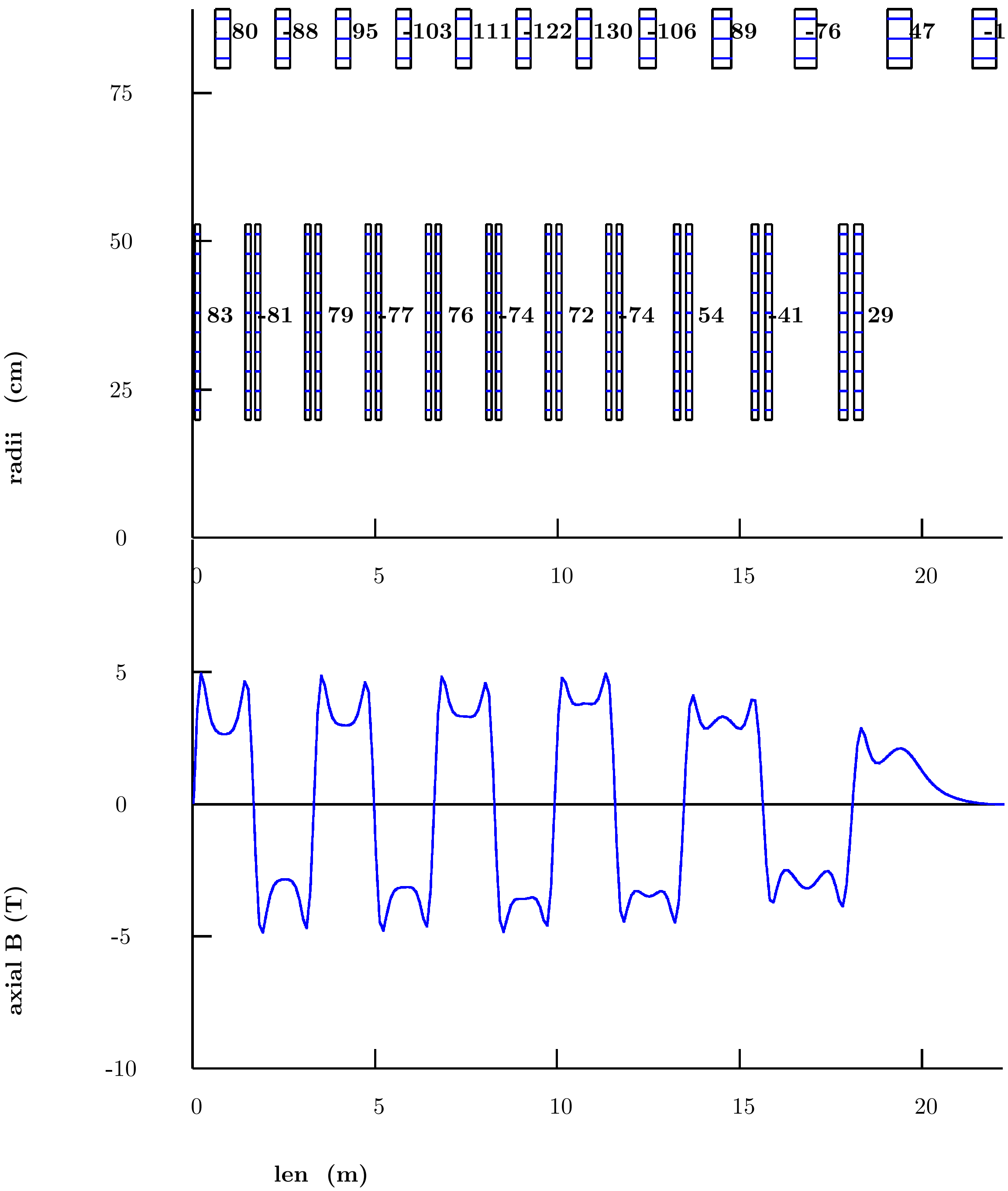
SC Coils:

The coils have the same radial dimensions as those in the final cooling lattices, but differing currents and, in the final cells, different lengths.

start m	dl m	rad m	dr m		I/A A/mm^2
0.066	0.145	0.198	0.330	10	83.76
0.627	0.396	0.792	0.099	3	80.10
1.439	0.145	0.198	0.330	10	81.31
1.716	0.145	0.198	0.330	10	-81.66
2.277	0.396	0.792	0.099	3	-88.55
3.089	0.145	0.198	0.330	10	-78.99
3.366	0.145	0.198	0.330	10	79.32
3.927	0.396	0.792	0.099	3	95.67
4.739	0.145	0.198	0.330	10	77.58
5.016	0.145	0.198	0.330	10	-77.89
5.577	0.396	0.792	0.099	3	-103.02
6.389	0.145	0.198	0.330	10	-75.99
6.666	0.145	0.198	0.330	10	76.29
7.227	0.396	0.792	0.099	3	111.46
8.039	0.145	0.198	0.330	10	74.23
8.316	0.145	0.198	0.330	10	-74.52
8.877	0.396	0.792	0.099	3	-122.79
9.689	0.145	0.198	0.330	10	-72.31
9.966	0.145	0.198	0.330	10	72.58
10.527	0.396	0.792	0.099	3	130.03
11.339	0.145	0.198	0.330	10	73.92
11.616	0.145	0.198	0.330	10	-74.18
12.246	0.462	0.792	0.099	3	-106.28
13.193	0.169	0.198	0.330	10	-54.23
13.517	0.169	0.198	0.330	10	54.42
14.240	0.528	0.792	0.099	3	89.45
15.322	0.194	0.198	0.330	10	41.57
15.692	0.194	0.198	0.330	10	-41.71
16.509	0.594	0.792	0.099	3	-76.98
17.726	0.218	0.198	0.330	10	-32.94
18.142	0.218	0.198	0.330	10	29.74
19.052	0.660	0.792	0.099	3	47.20
21.378	0.660	0.792	0.099	3	-1.42

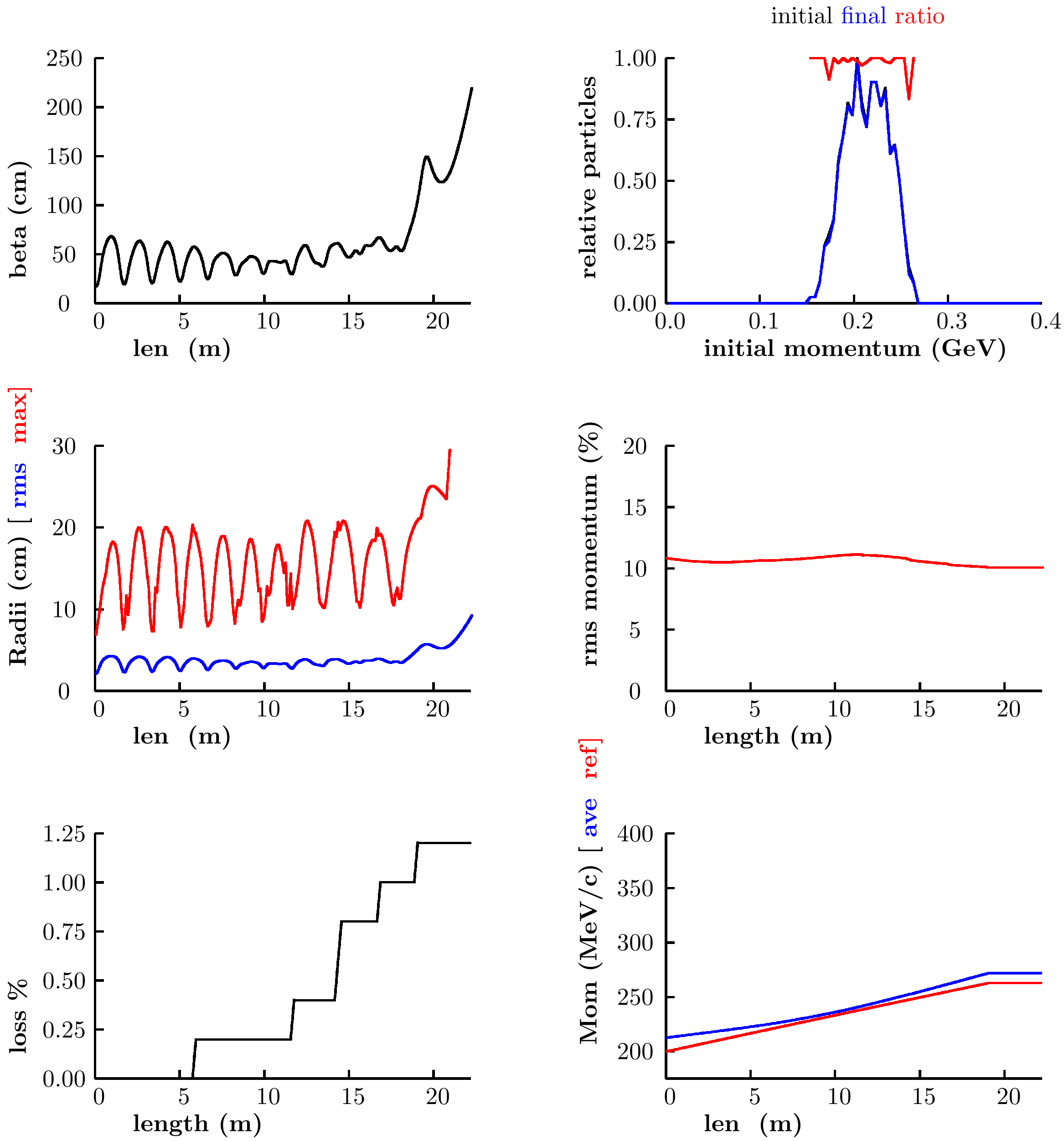
The current densities in some coils are very low and the dimensions of the coils could be reduced, if the total currents and current centers are maintained.

Coil dimensions and axial Fields

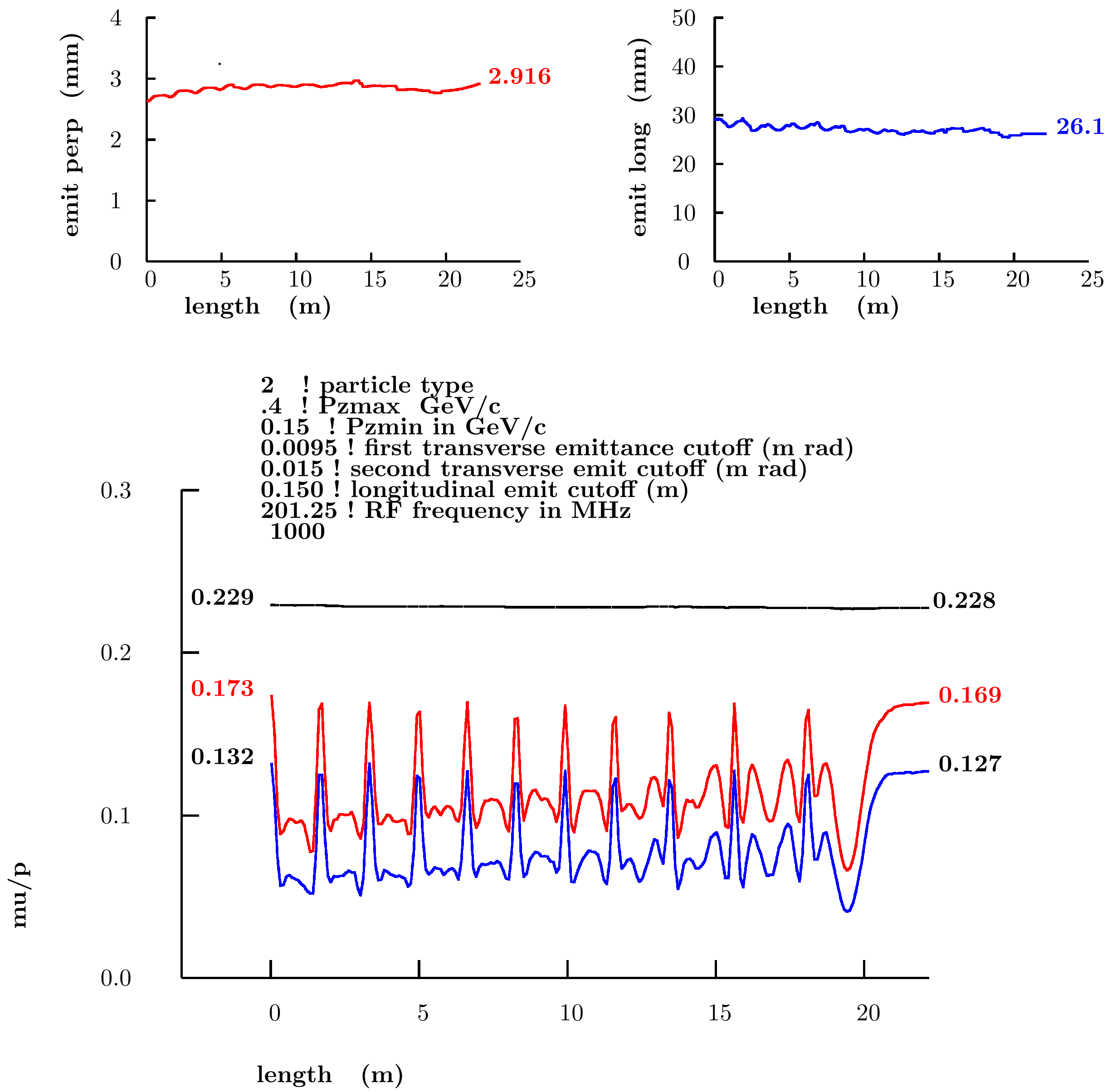


ICOOL Simulation

Simulation of this matching uses a file of tracks from the baseline cooling simulation.



Plots from ECALC9



Note: In the above plot, the selected mu/p ratios fluctuate. This is because ECALC9 does not correct for angular momentum when it applies the transverse acceptance cuts. The values are correct only at locations where the Bz's are zero. These are seen to be at the maxima.

Note

- No RF windows yet
- window apertures at 21 cm
- not computer optimized

Costing

The cost of this system can be taken, to first approximation, to be equal to that for 11 1.65 m cooling cells, without their hydrogen absorbers. Note that the length and cost of the SC linac can be reduced by the reduction of acceleration of 59 MeV.

Conclusion

- A 21 m long match has been designed
- The total losses are only 1.25%
- Loss of mu/p with cuts is only 2.4 %
- the initial beta is .18 m; the final is $\approx$ 1 m.
- The beam is accelerated from 212 MeV/c to 271 MeV/c
- The rms mom drops from 11% to 10%