Cooling lattice comparisons using G4MICE

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Outline

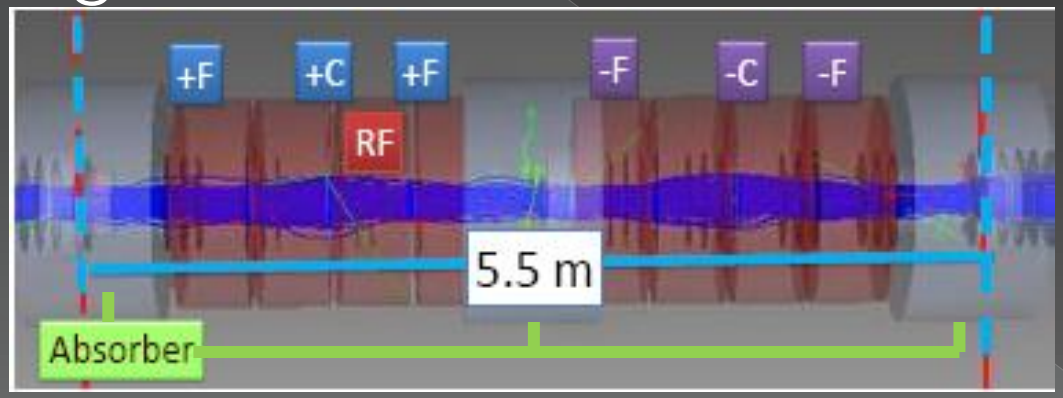
- Aim
- MICE-like cell
- FS2A cell
- Singlet cell
- Doublet cell
- Cuts
- Results
- Conclusion
- Future Plans

Aim

- 4 different lattices are compared on their cooling dynamics → *Find which of these 4 lattices gives the optimum cooling for the future Neutrino Factory*
- For all lattices initial beam had:
  - 10 mm Transverse Emittance and
  - 0.63 ns Longitudinal Emittance
- All cells had P mean 232 MeV/c except for the MICE-like cell that had 200 MeV/c

MICE-like cell

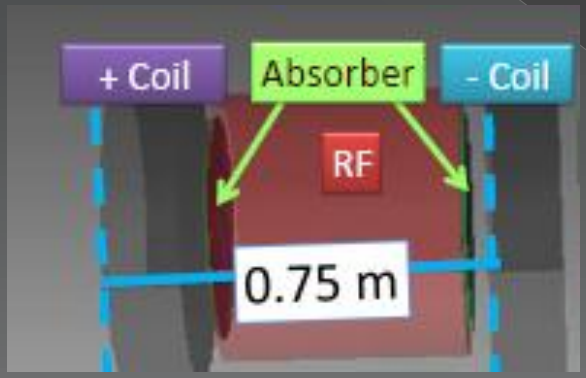
- Each cell consists of:
  - 2 liquid Hydrogen absorbers alternating with 2 sets of 4 RF cavities (201.25 MHz)
- Peak Electric Field*: 12.46 MV/m, phase: 40°
- Cell's length: 5.5 m



- ***The Peak Electric Field was chosen such as to keep the energy of the reference particle constant, i.e. energy lost in absorbers=energy gained by RFs***

FS2A cell

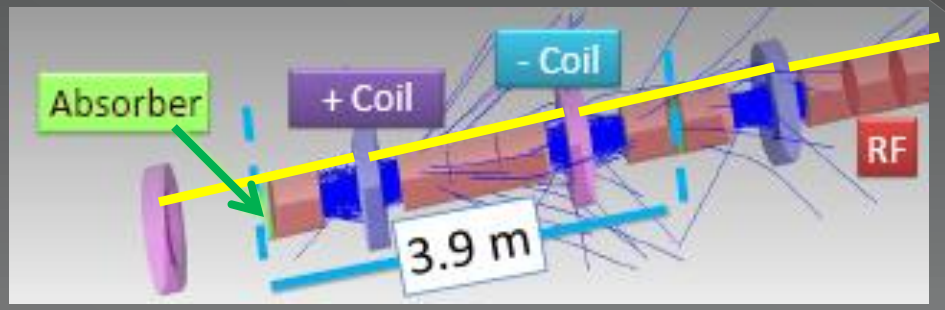
- Each cell consists of:
  - Coil-LiH absorber-200 MHz RF-absorber
- Peak Electric Field: 13.026 MV/m, phase: 40°
- Cell's length: 0.75 m



- *Polarity of coils alternates with every repeat*

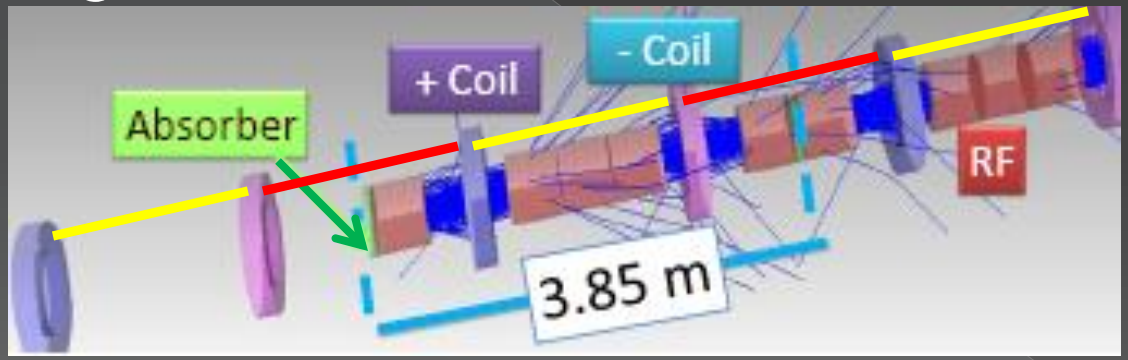
Singlet cell

- Each cell consists of:
  - LiH absorber-200 MHz RF-Positive Coil-3 RFs-Negative Coil-RF
- Peak Electric Field: 8.62 MV/m, phase: 45°
- Cell's length: 3.9 m



Doublet cell

- Each cell consists of:
  - LiH absorber-200 MHz RF-Positive Coil-3 RFs-Negative Coil-RF
- Peak Electric Field: 16 MV/m, phase: 45°
- Cell's length: 3.85 m

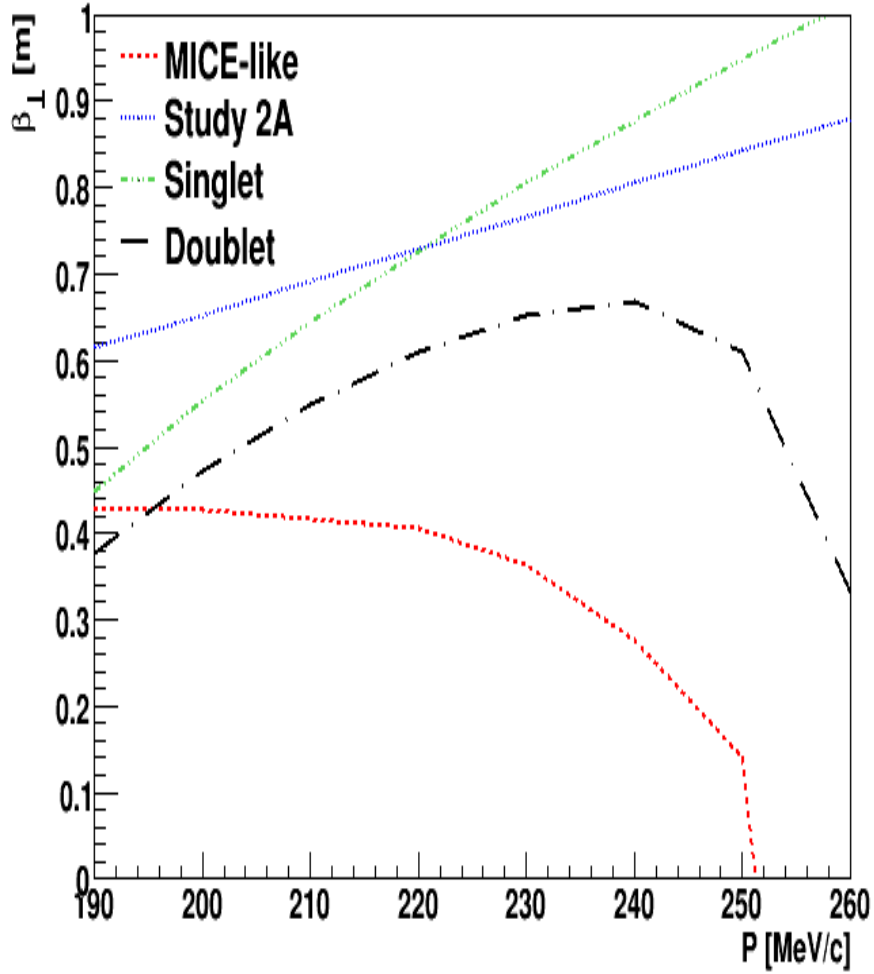


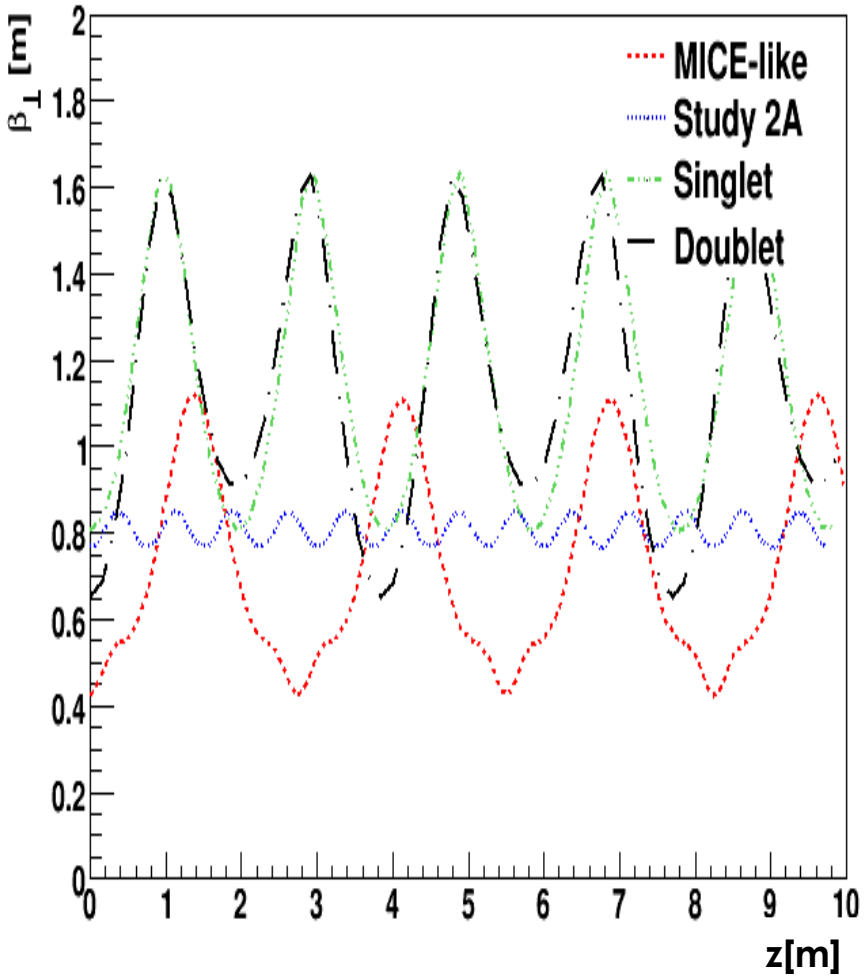
- *i.e. Doublet cell has the same components as the Singlet cell but the distance between coils of opposite polarity **is not** the same as the distance of same-polarity coils*

Cuts

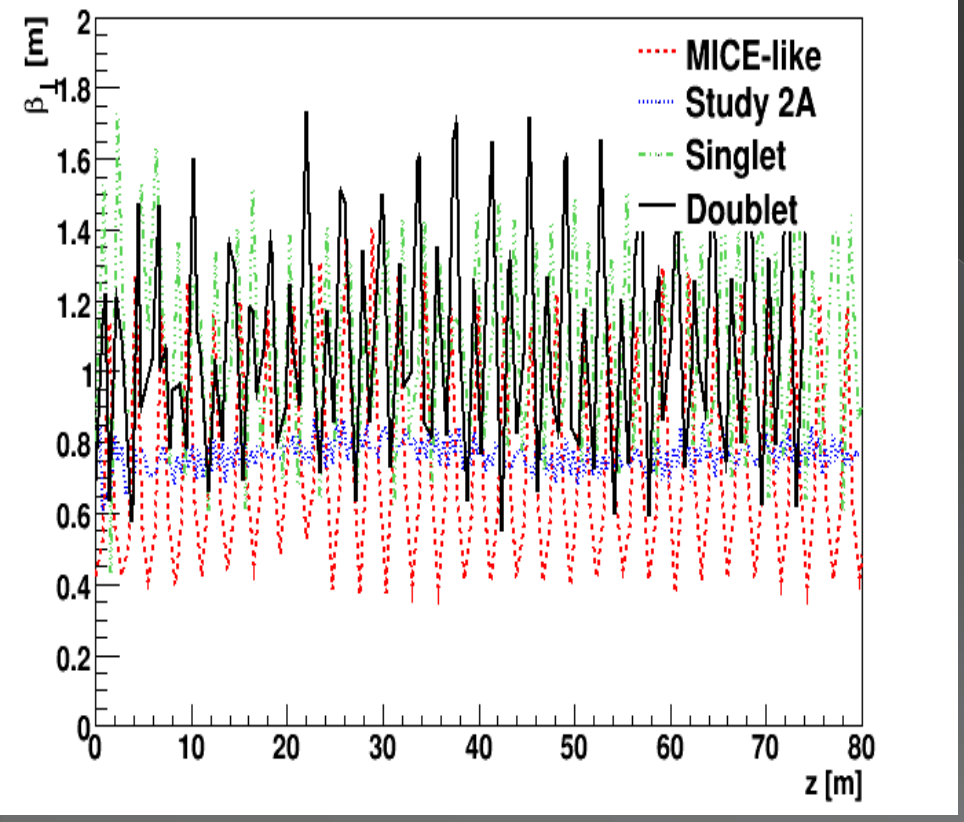
- R<30 cm
- P: ±100 MeV/c
- For the tracking results, only particles that made it to the end of the lattice were taken into account.

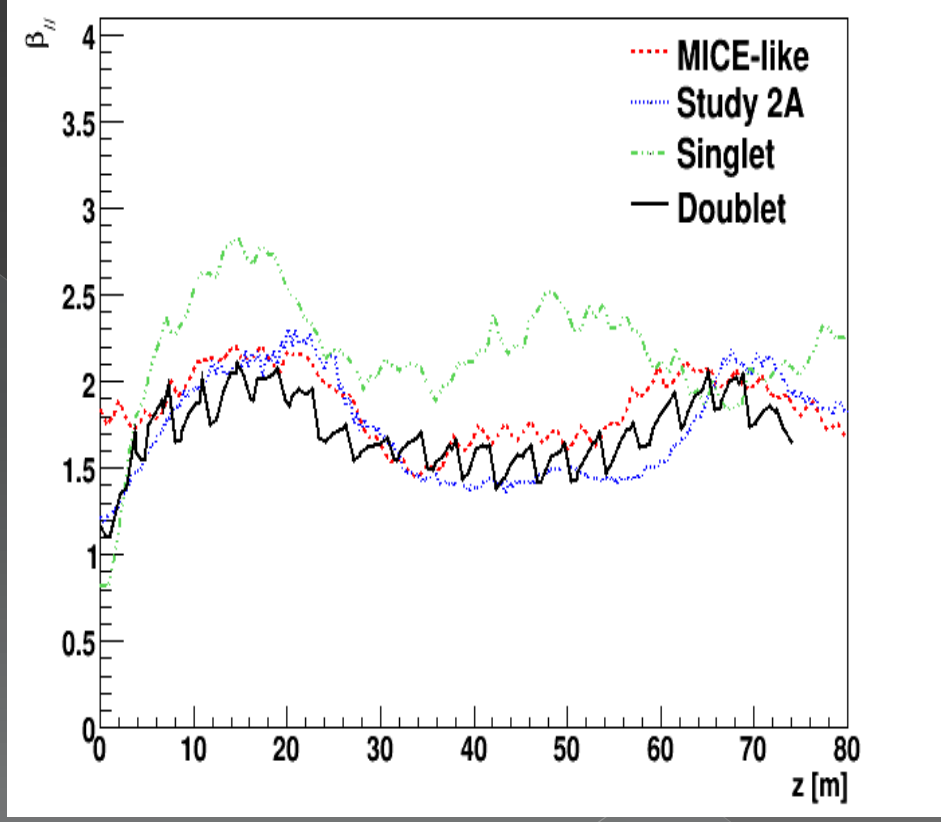
Results-Optics



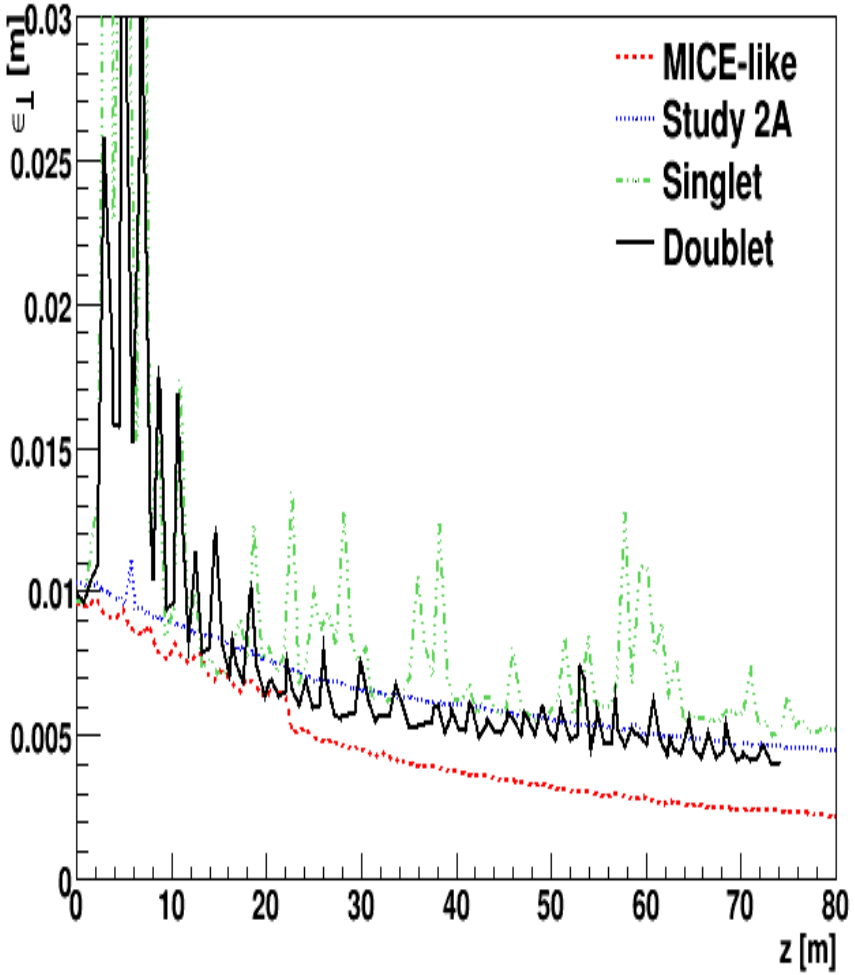


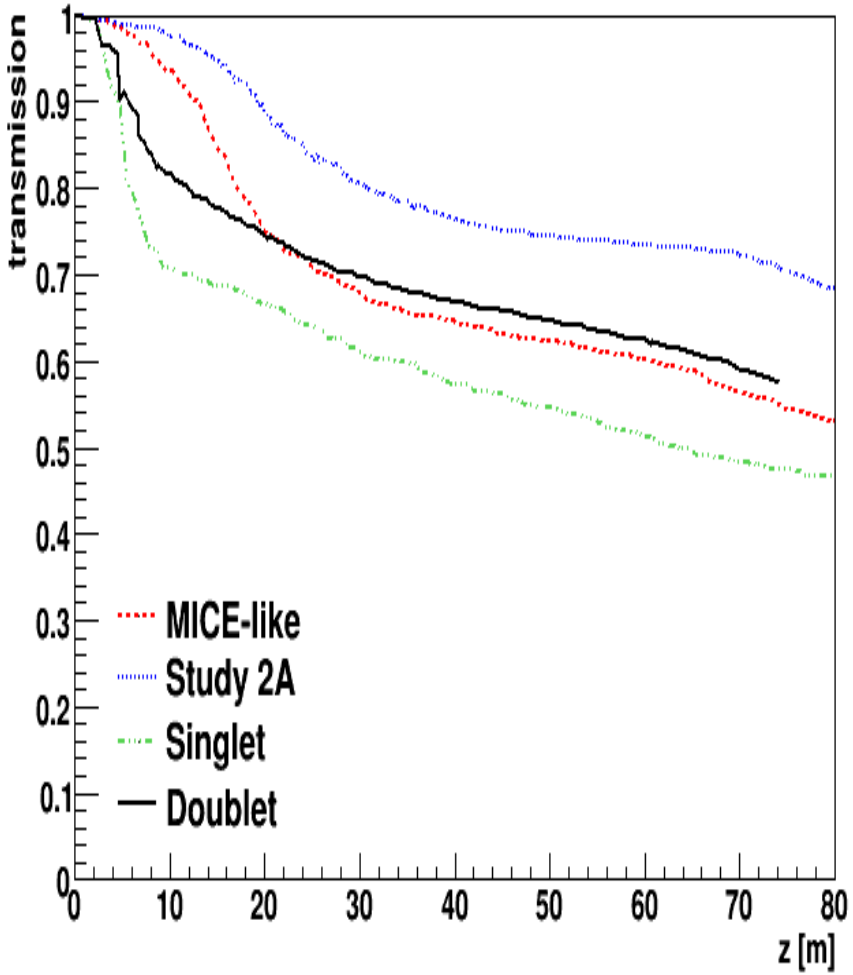
Results-Tracking





Results-Tracking





Conclusion

- MICE-like, FS2A, Singlet and Doublet cells: compared with respect to the cooling dynamics each provides, in order to find the optimum cooling lattice for the Neutrino Factory.
- Siglet and Doublet: designed to obtain low magnetic field in the RF cavities so the distance between the coils was larger than in the other lattices → increase of betatron function at the position of the coils→**higher beam size modulation with respect to FS2A lattice**.
- MICE-like cell→Lowest beta BUT low momentum acceptance.
- FS2A beta function: higher than the other lattices BUT **transmission is better** and acceptable emittance reduction.
- **Out of these four lattices, the most suitable lattice for the needs of the Neutrino Factory is the FS2A lattice.**

Future Plans

❖Focus on new configurations: study lattices in which the focusing at the position of the absorbers is very good, while keeping at the same time the magnetic field as low as possible within the RF cavities.

1

❖ Introduce longitudinal cooling

2

- reduce the muon losses
- stabilise the dynamics in the longitudinal plane
- facilitate the matching with the downstream accelerators

Introduce the dispersion function into the lattice (can be achieved by tilting the solenoidal coils).

Thank you!

Type of cell	MICE	FS2A	Singlet	Doublet
Cell Length [m]	5.50	0.75	3.90	3.85
RFs per cell	8	1	5	5
Absorbers per cell	2	2	1	1
Coils per cell	6	1	2	2
RFs				
P.E.F. [MV/m]	12.46	13.026	8.620	16.500
Phase [degrees]	40	40	45	45
Length[cm]	46	50	46	50
Radius [cm]	64.5	30.0	25.0	70.0
Absorbers				
Length [cm]	37.5	1.0	7.0	14.0
Radius [cm]	64.5	25.0	25.0	70.0
Coils				
Length [cm]	21	15	20	20
Radial Thickness [cm]	8.4	15.0	20.0	20.0
Inner Radius [cm]	26.3	35.0	30.0	30.0
Current Density [A/mm2]	113.9 96.2	106.7	47.5	47.5