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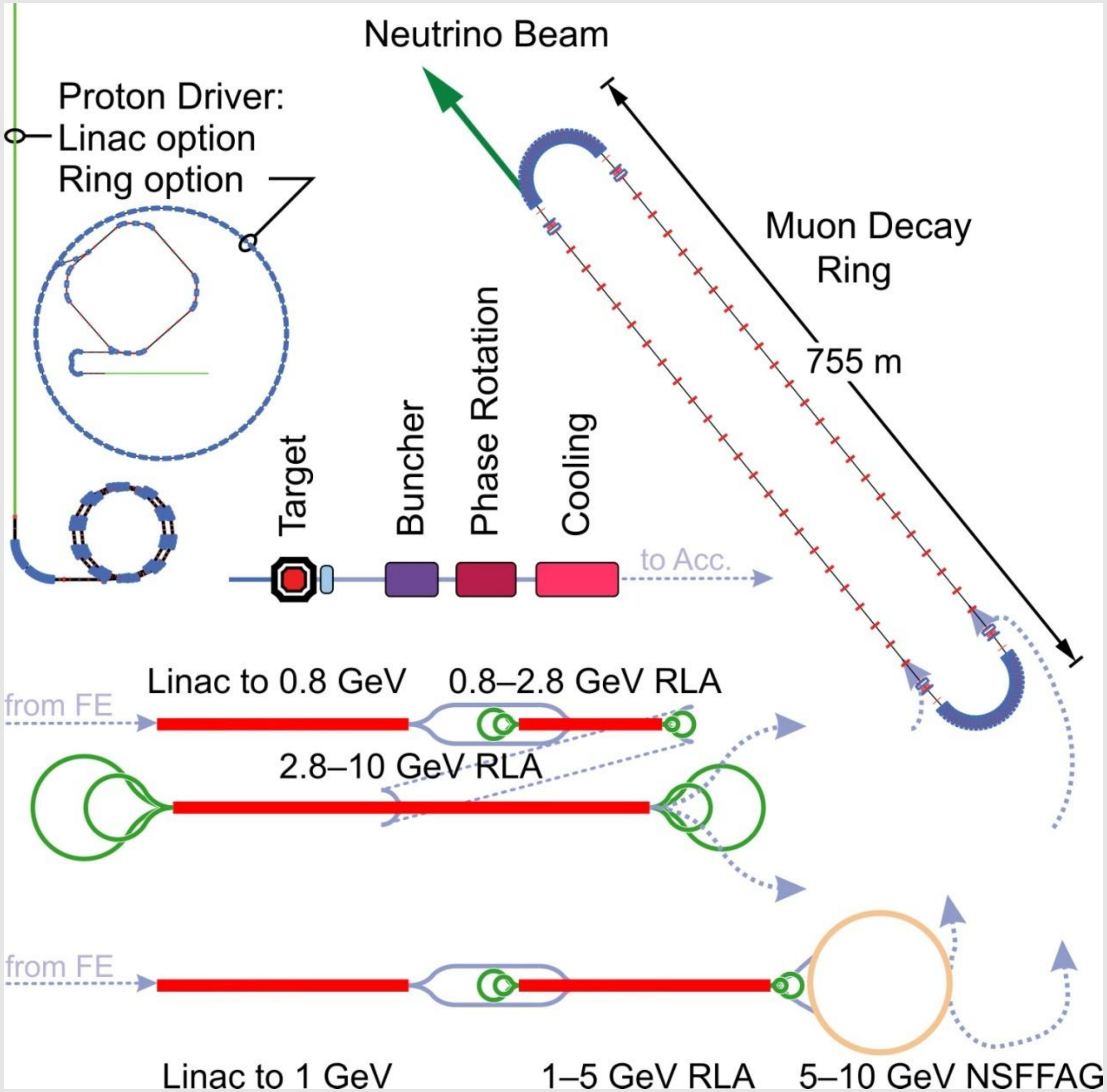
Muon Front End

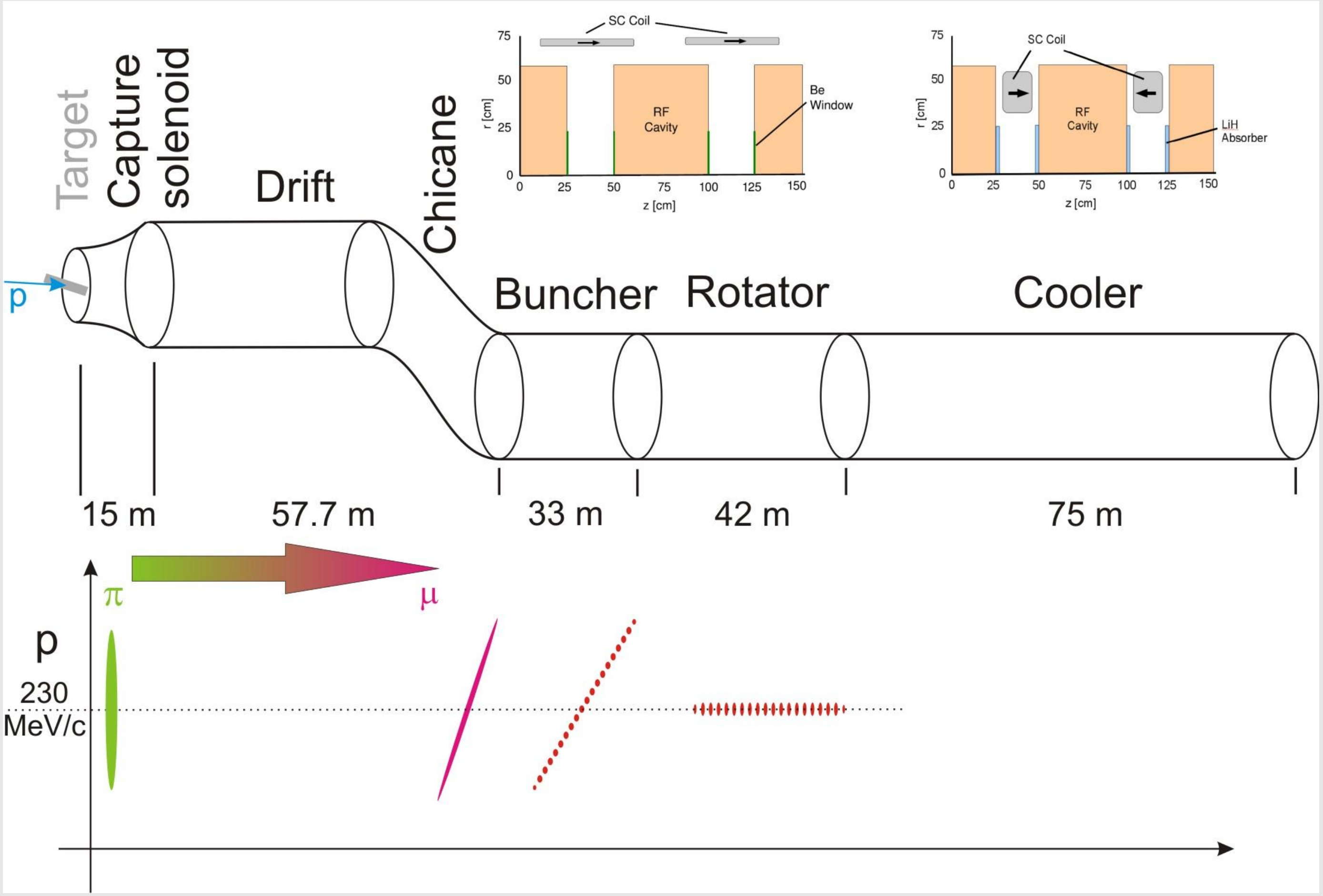


Due to the recent measurement results at Daya Bay the NF layout has to be adopted to accommodate the new requirements.

While the final muon energy is reduced to 10 GeV (Euroν 12.6 GeV) and only one decay ring aiming for a distance of ~2500 km, is required, the muon Front end essentially stays unchanged.

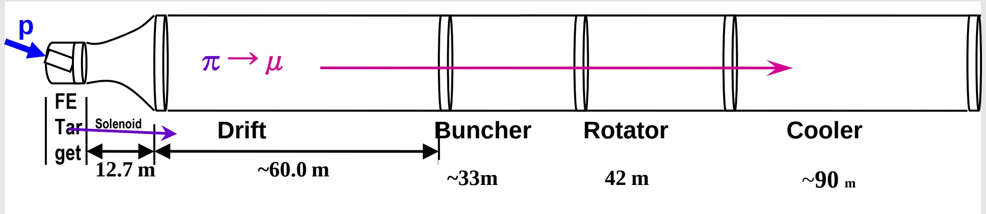
Muon Front End overview

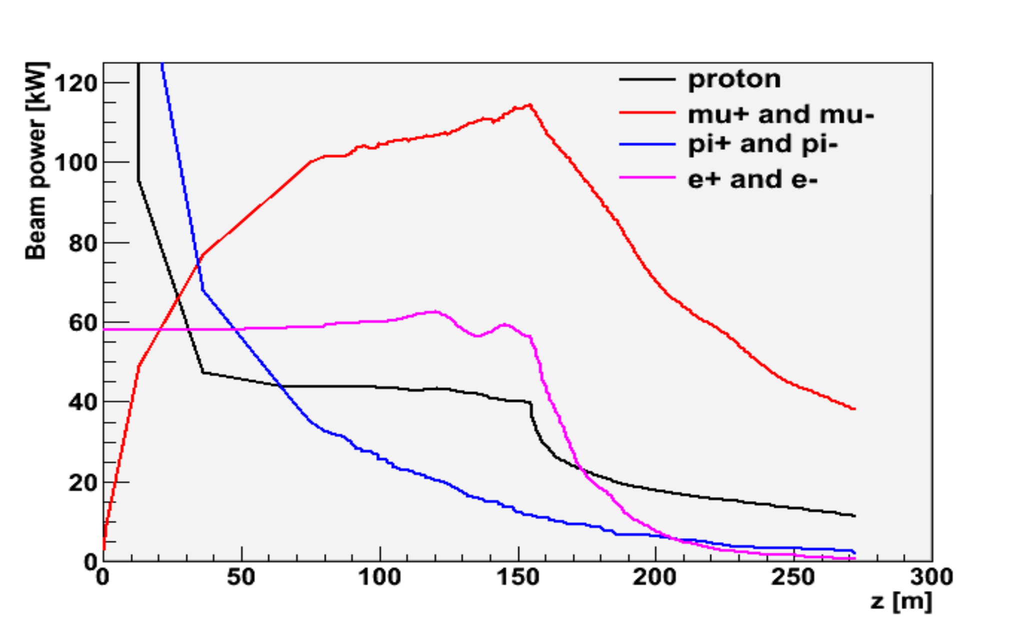
The muon front end is required to produce a phase space distribution suitable for the following accelerator section from the “spray” of particles produced by the target. While Buncher and Rotator influence the longitudinal phase space (always required), the cooler reduces the transversal phase space.



Problem: Beam losses along Front End

- Start with 4MW protons
  - **End with ~50kW $\mu^+ + \mu^-$**
    - *plus p, e, π, …*
    - *~20W/m μ-decay*
  - **~0.5MW losses along transport**
    - *>0.1MW at z>50m*

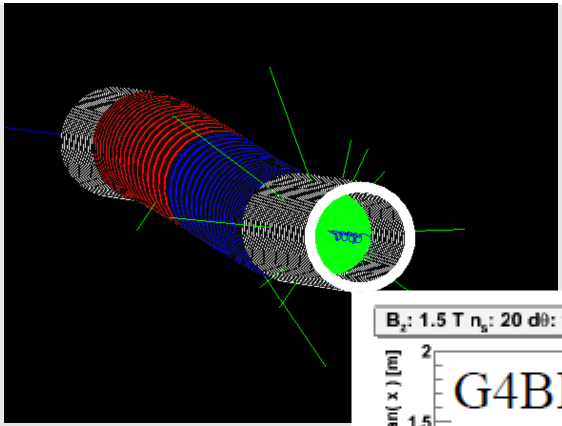


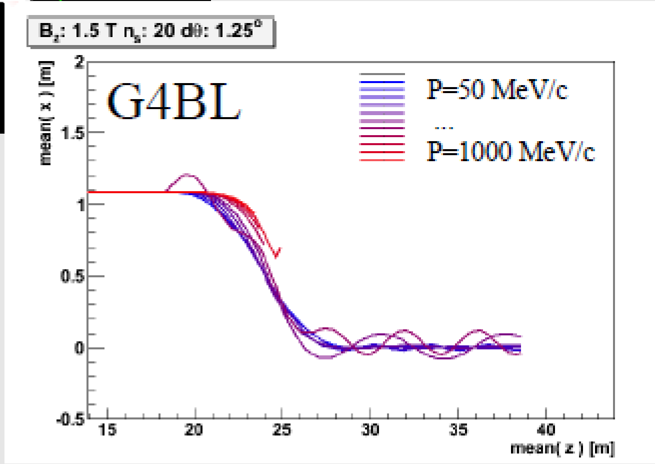


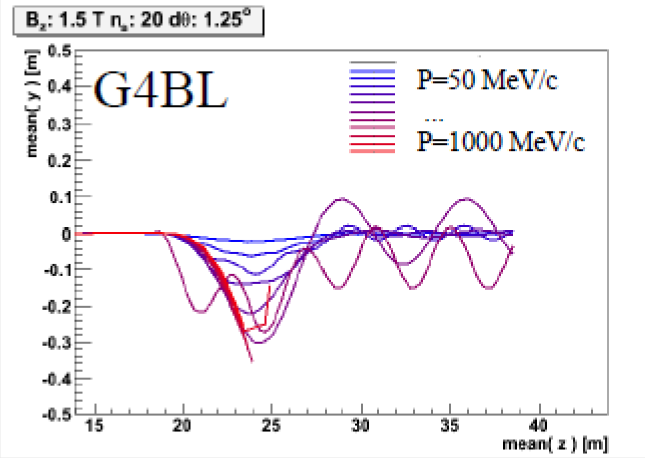
- Want "Hands-on" maintenance
  - **hadronic losses < 1W/m**
    - *Booster, PSR criteria*
  - **Simulation has >~100W/m**
    - *With no collimation, shielding, absorber strategy*

Chicane and Absorber

- Chicane effect:
  - **P > ~500MeV/c are lost**
  - **P < ~500MeV pass through**
    - *displaced by ~1.1m*
  - **Nominal Path length increased by only 8cm**
    - *orbits perturbed*
- absorber effect
  - **removes low energy particles**
    - *designed to remove protons*
  - **distorts energy distribution**
    - *energy phase-rotation distorted; must be rematched*



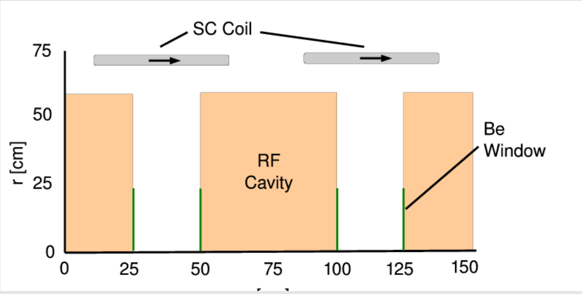


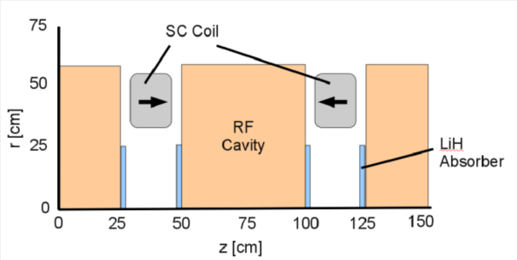


Baseline change !

Rf Buncher/Rotator/Cooler requirements

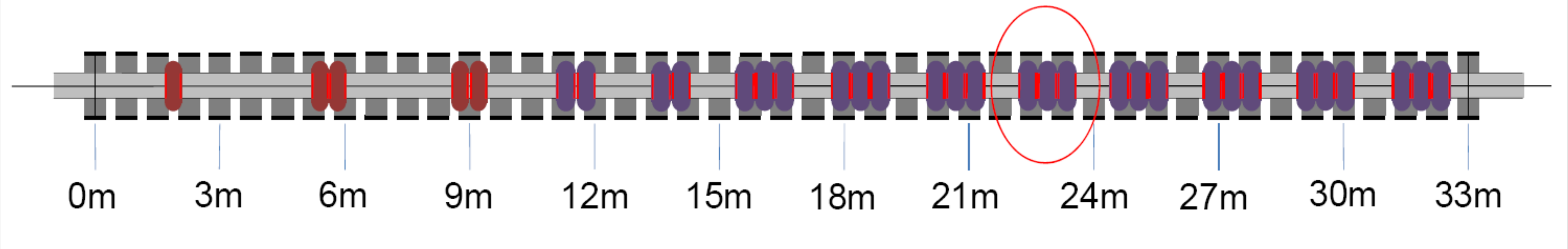
- Buncher
  - **37 cavities (13 frequencies)**
  - **13 power supplies (~1—3MW)**
- RF Rotator
  - **56 cavities (15 frequencies)**
  - **12 MV/m, 0.5m**
  - **~2.5MW (peak power) per cavity**
- Cooling System – 201.25 MHz
  - **100 0.5m cavities (75m cooler), 15MV/m**
  - **~4MW /cavity – most expensive item**





Front End section	Length	#rf cavities	frequencies	# of freq.	rf gradient	rf peak power requirements
Buncher	33m	37	319.6 to 233.6	13	4 to 7.5	~1 to 3.5 MW/freq.
Rotator	42m	56	230.2 to 202.3	15	12	~2.5MW/cavity
Cooler	75m	100	201.25MHz	1	15 MV/m	~4MW/cavity
Total	~240m	193		29	~1000MV	~550MW 400MW from cooling

Buncher: Toward Engineering & Cost Model

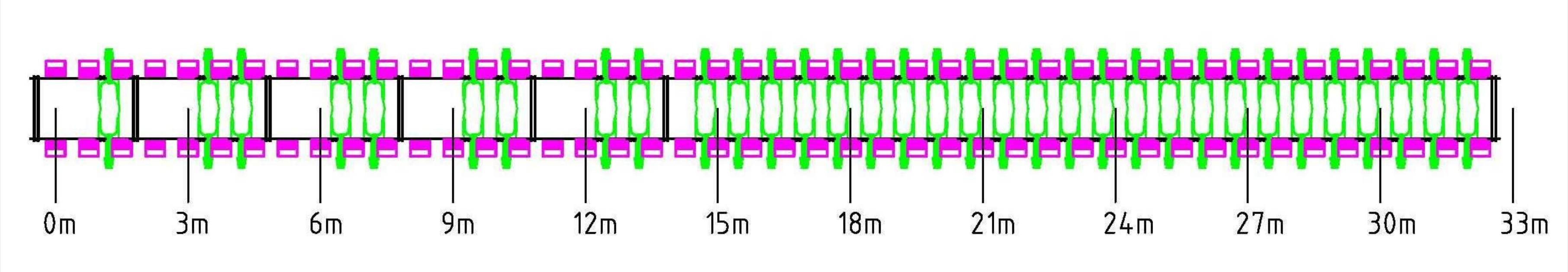


Schematic Layout

Initial approach: Bunch magnets in frequencies;
run off single power supply/frequency

More recent: shift to single cavity/cell
rf feeds similar/cell
Similar geometry used for Rotator section

Baseline change !



CAD Layout based on MICE cavities

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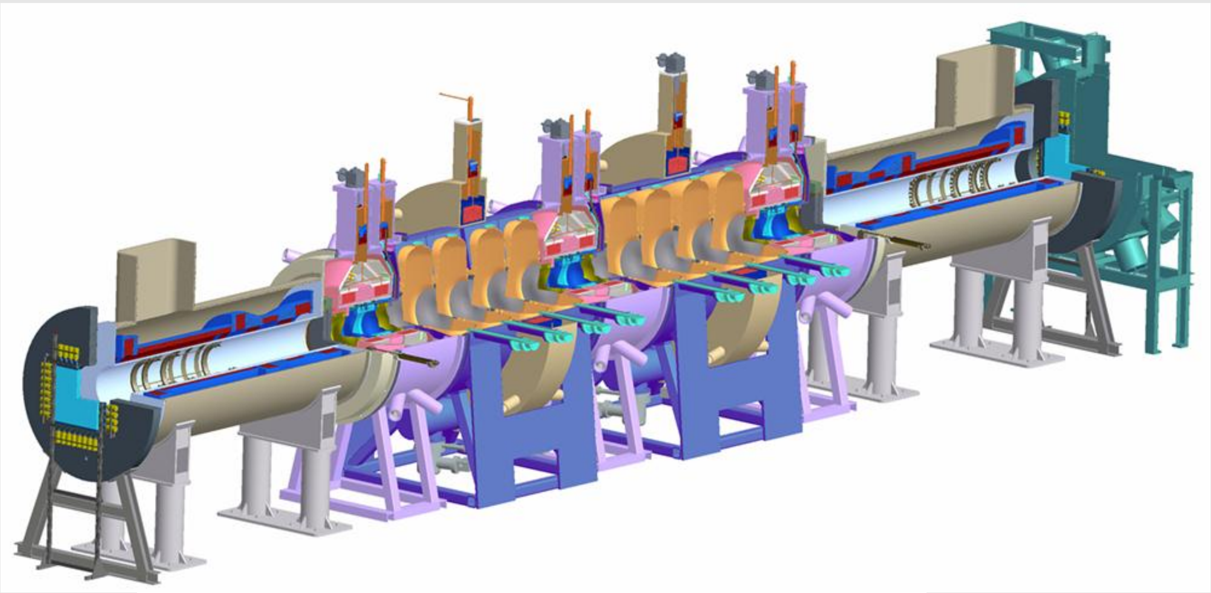
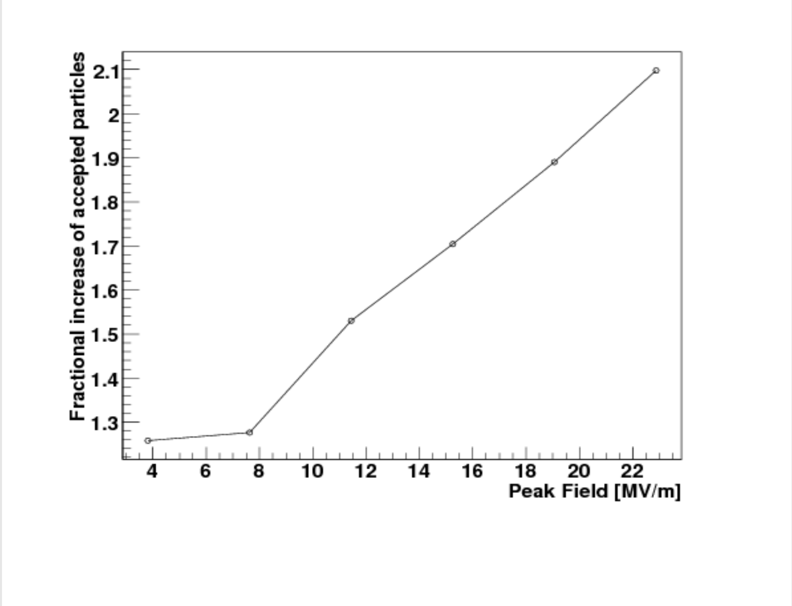
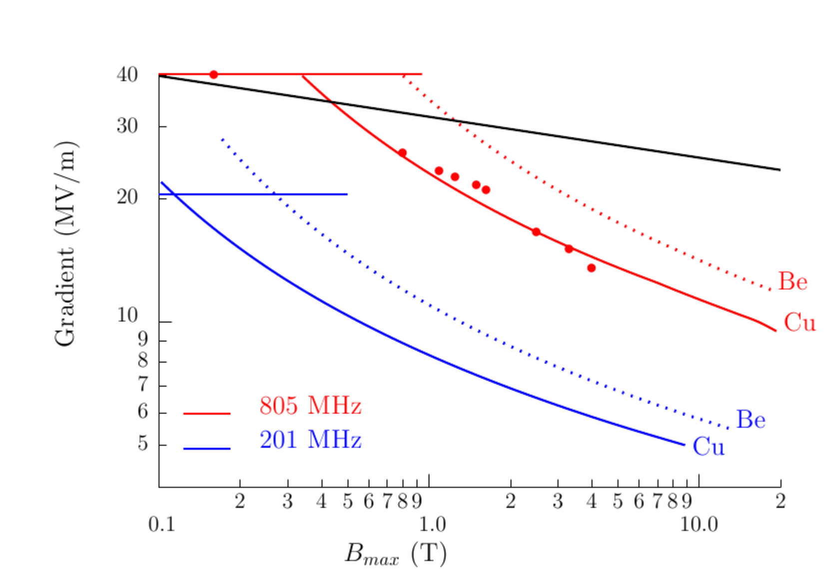
Muon ionisation cooling



The baseline cooling lattice (FSIIa) uses a significantly higher RF compared with the MICE experiment. A problem with achieving those gradients within the high magnetic field has been identified. Various alternatives have been investigated most of which are reducing the muon yield.





Alternative Cooling lattice (BC)

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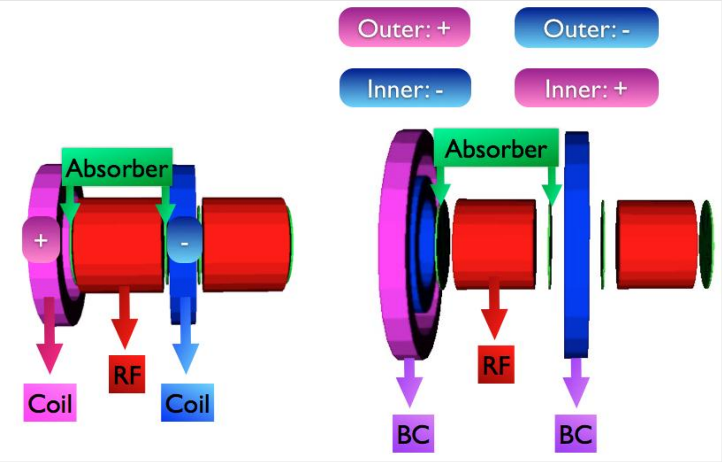
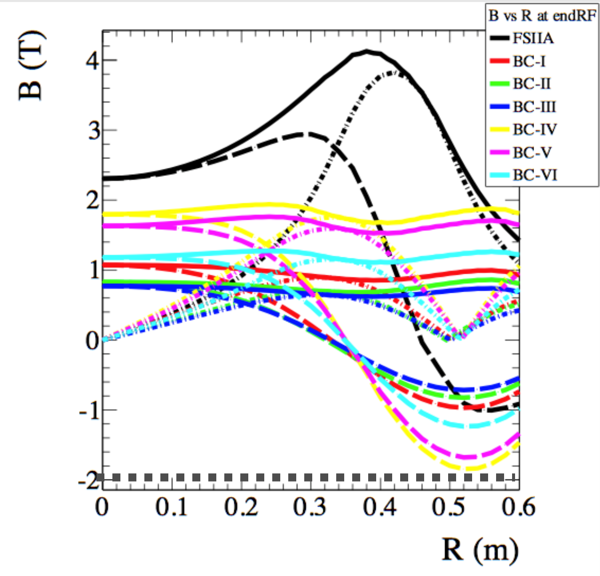
FSIIA BC



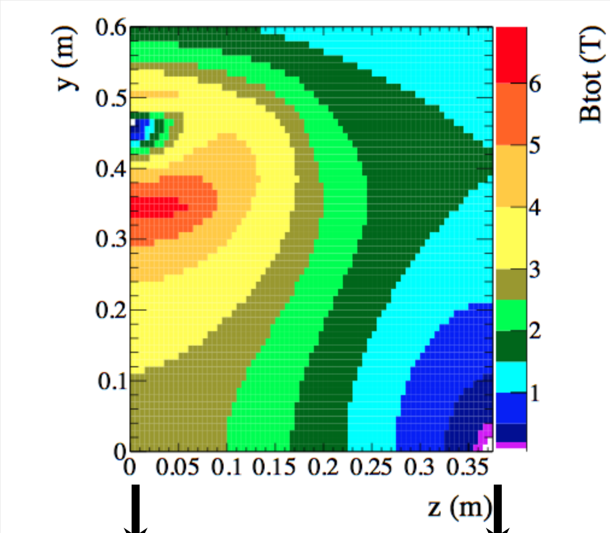
To mitigate the RF in high magnetic field problem and alternative cooling lattice has been developed.

white: 0<B<0.1 T
violet: 0.1<B<0.2 T
dark blue: 0.2<B<0.5 T
light blue: 0.5<B<1 T

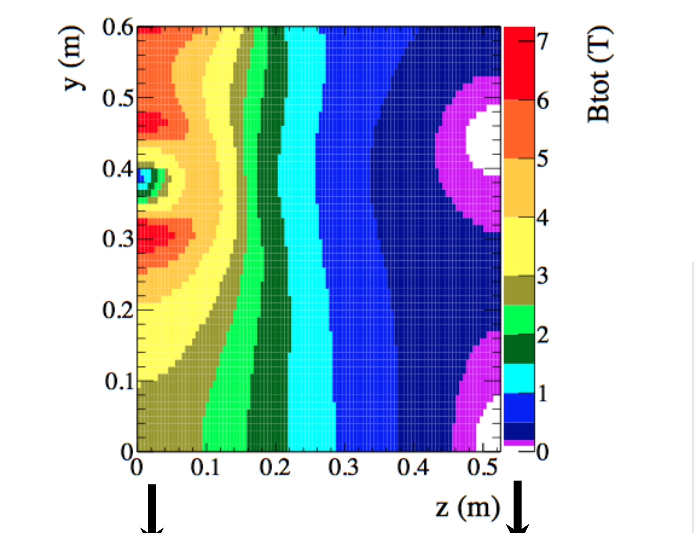


Continuous line: B_{tot}
Dashed line: B_z
Dashed/dotted line: B_r

FSIIA



BC-I



Coil centre RF centre Coil centre RF centre

Alternative Cooling lattice performance

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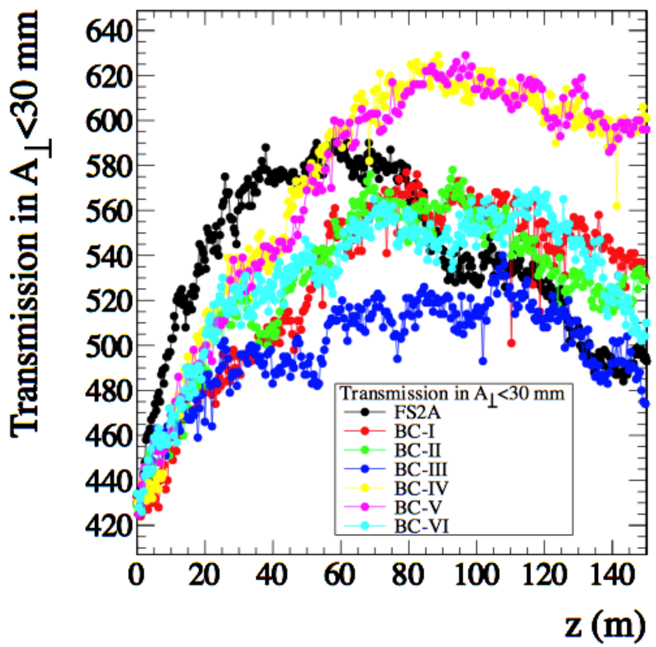
Black: FSIIA
Red: BC-I
Green: BC-II
Blue: BC-III
Yellow: BC-IV
Purple: BC-V
Cyan: BC-VI

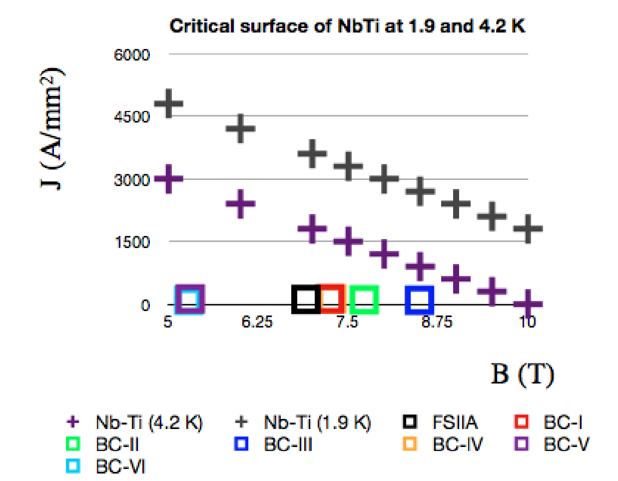


All BC-lattices have better, comparable, or insignificantly lower transmission within 30 mm of A_T at 70 m (where FSIIA has its maximum)

Lattice	35 cm
FSIIA	238.9

Only BC-III and BC-VI do not exceed the conservative 200 MPa hoop stress limit

Lattice	60 cm
BC-I	345.3
BC-II	249.9
BC-III	188.2
BC-IV	416.9
BC-V	304.0
BC-VI	187.4



No Baseline change for IDS so far !

All lattices are within the limits for superconducting design

Summary

- Particle tracking design for chicane to mitigate particle loss/radiation problem available, high momentum absorber will not be ready for EUROν final report.
- Buncher & Phase rotator engineering design available and costed
- Cooling latice available as well as alternative (BC) lattice for risk (high RF in magnetic field) mitigation
- Increased engineering effort made significant progress