Muon Based Neutrino Source
Neutrino Factory

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January 29, 2001

Muon Collaboration

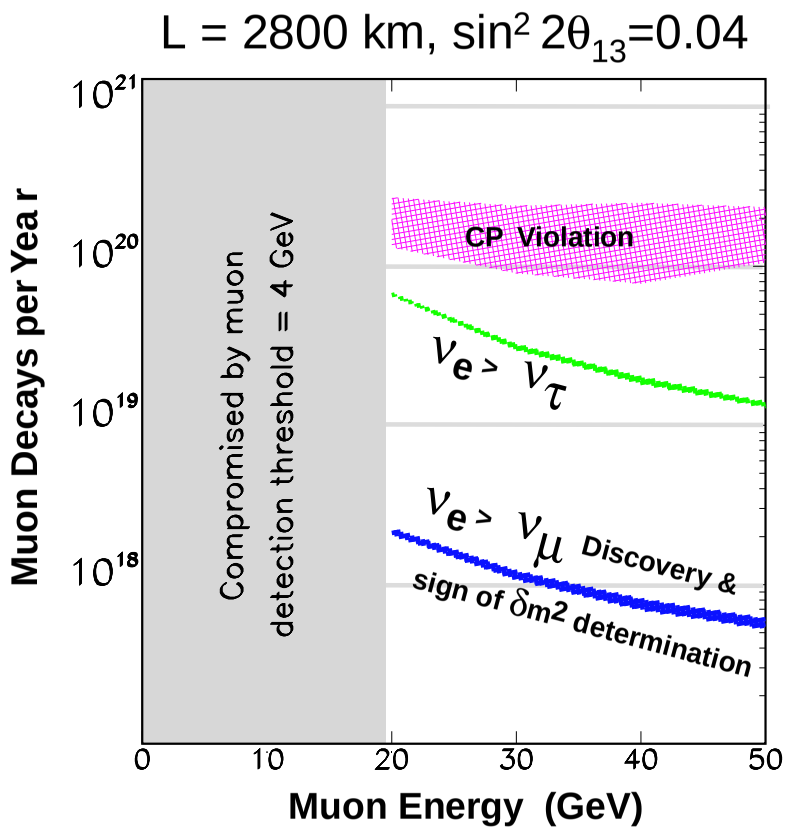
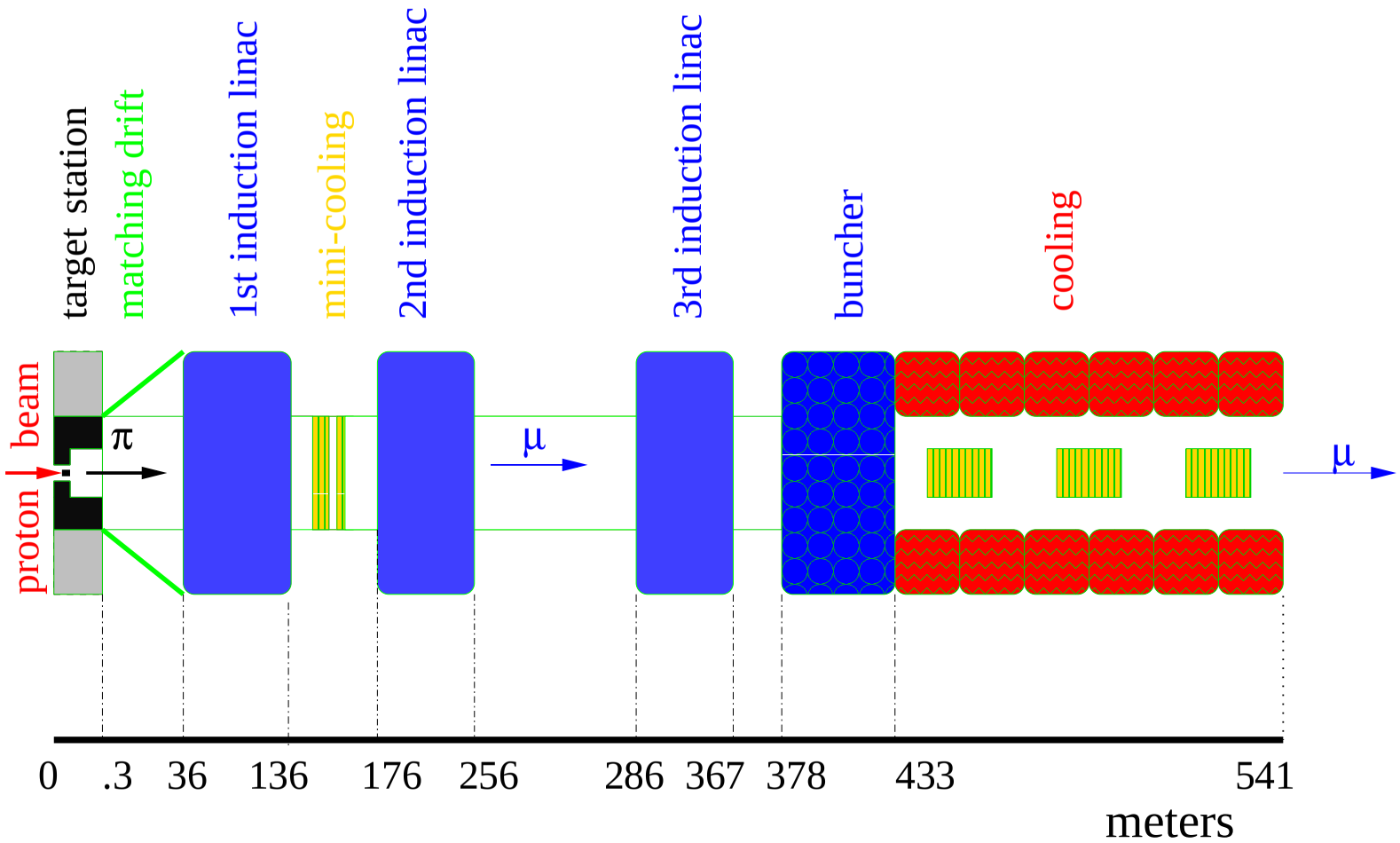


Figure II: The required number of muon decays needed in a neutrino factory to observe $\nu_e \to \nu_\mu$ oscillations in a 50 kt detector and determine the sign of δm^2, and the number of decays needed to observe $\nu_e \to \nu_\tau$ oscillations in a few kt detector, and ultimately put stringent limits on (or observe) CP violation in the lepton sector with a 50 kt detector. Results are from Ref. 51.



Schematic Layout of the Front-End

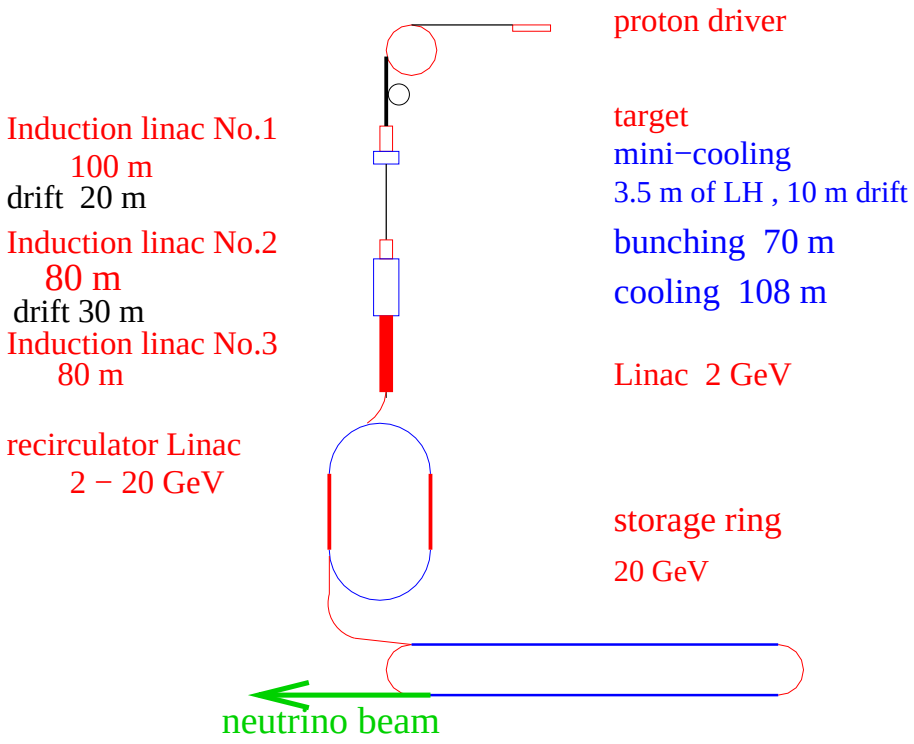
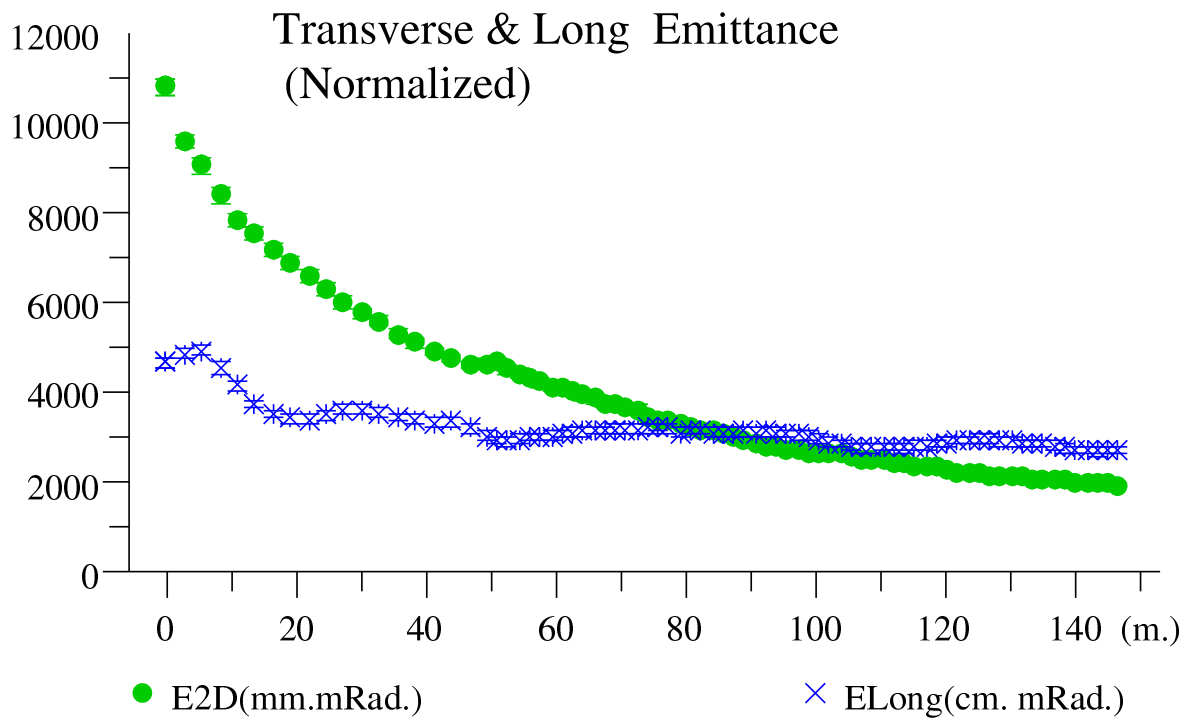

proton driver
target
mini−cooling
3.5 m of LH , 10 m drift
bunching 70 m
cooling 108 m
Linac 2 GeV
storage ring
20 GeV
Induction linac No.1
100 m
drift 20 m
Induction linac No.2
80 m
drift 30 m
Induction linac No.3
80 m
recirculator Linac
2 − 20 GeV
neutrino beam

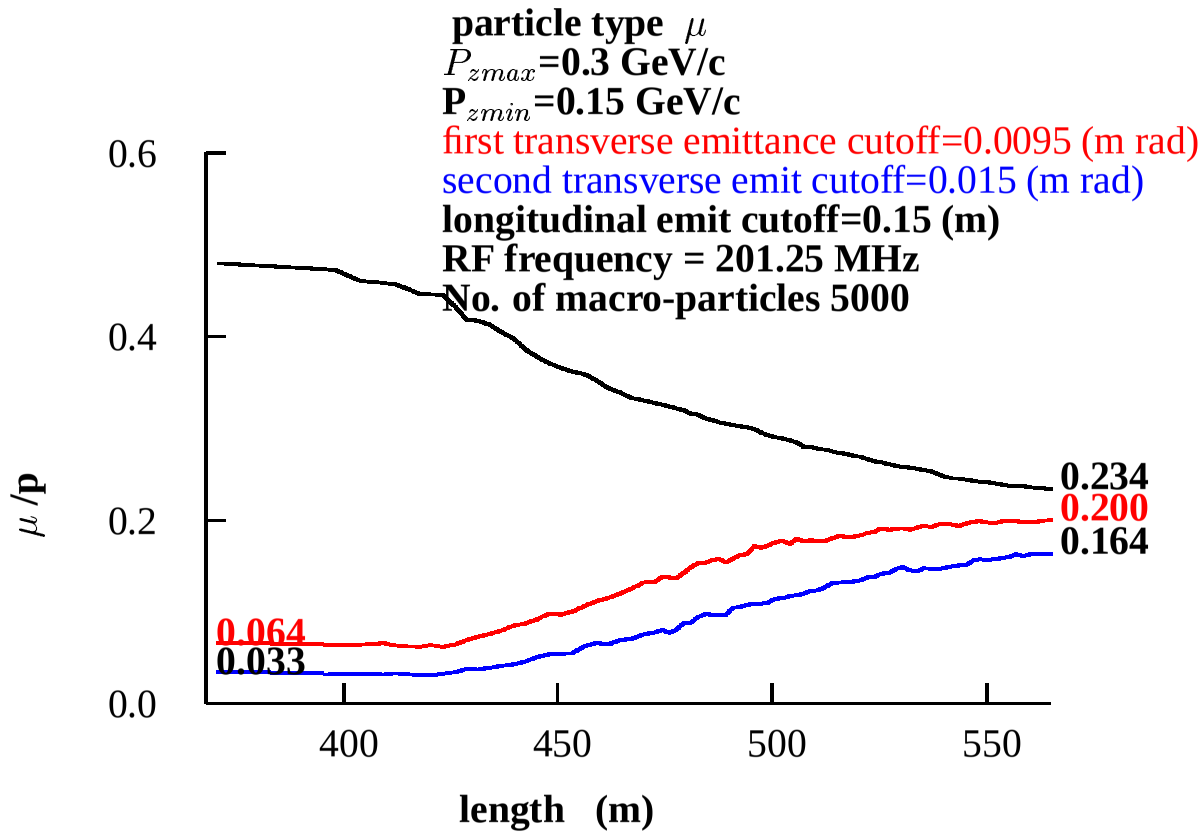
Table 1: Parameters of the proton driver

Energy	24	GeV
protons per bunch	$\approx 1.7\ 10^{13}$	
bunches per fill	6	
time between extracted bunches	≈ 20	ms
repetition rate	2.5	Hz
rms bunch length	≤ 3	ns
beam power	≥ 1	MW
normalized emittance (95%)	mm mrad	100
normalized emittance (rms)	mm mrad	17

Finite time between bunches is required for a number of reasons:

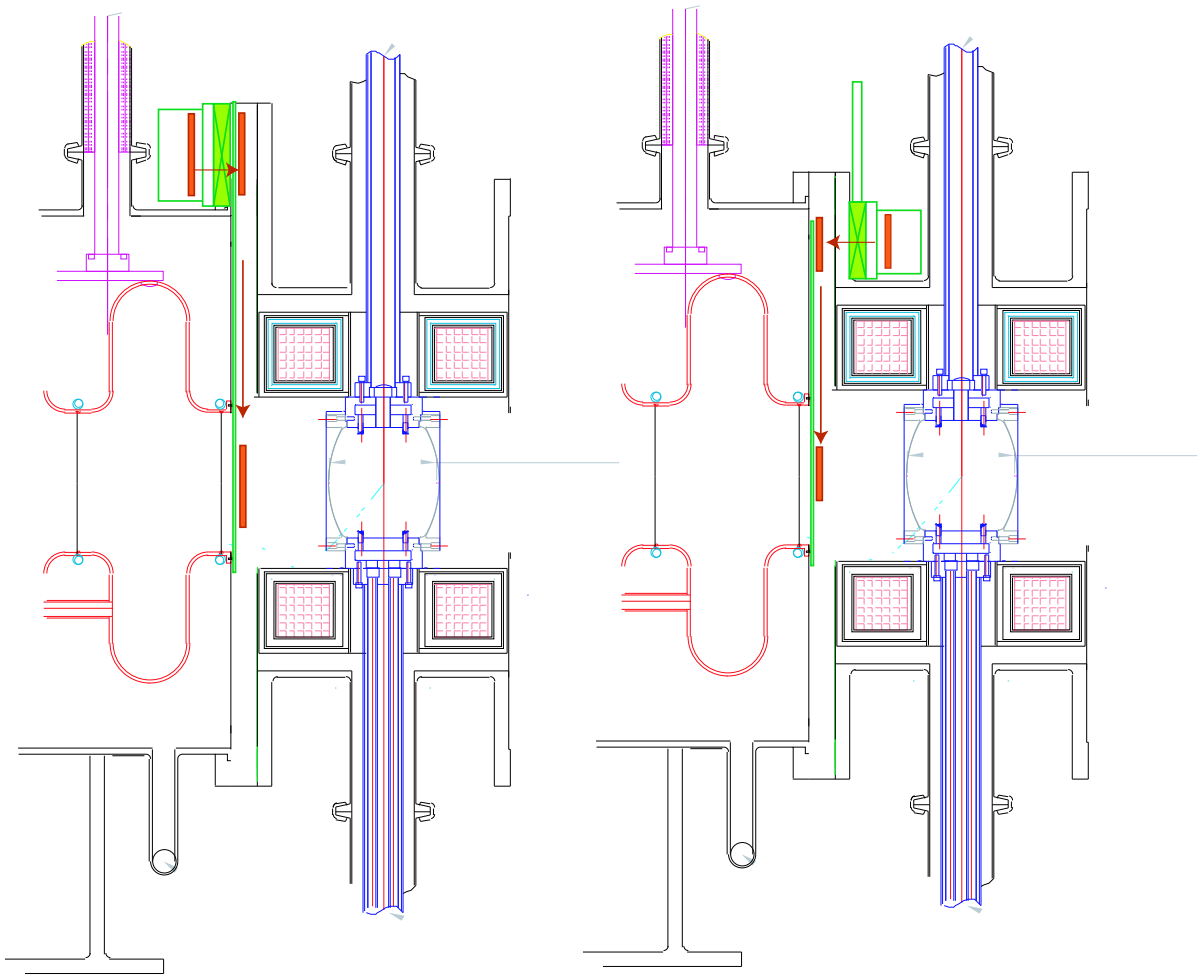
- To allow time to refill the RF cavities in the accelerating systems and avoid excessive beam loading;
- To avoid the need for multi pulsing of the induction linacs; and
- to allow the liquid target to be re-established after its assumed dispersal by the previous bunch. It is this requirement that sets the minimum spacing: The time required depends on the jet velocity and other parameters, and is not yet known. The number of 20 ms is a reasonable starting assumption. An even separation of bunches at 15 Hz would also be even better, but would require an accumulator ring.


Transverse & Long Emittance
(Normalized)
12000
10000
8000
6000
4000
2000
0
0
20
40
60
80
100
120
140
(m.)
E2D(mm.mRad.)
ELong(cm. mRad.)



Ratio of μ's over protons along the cooling channel.

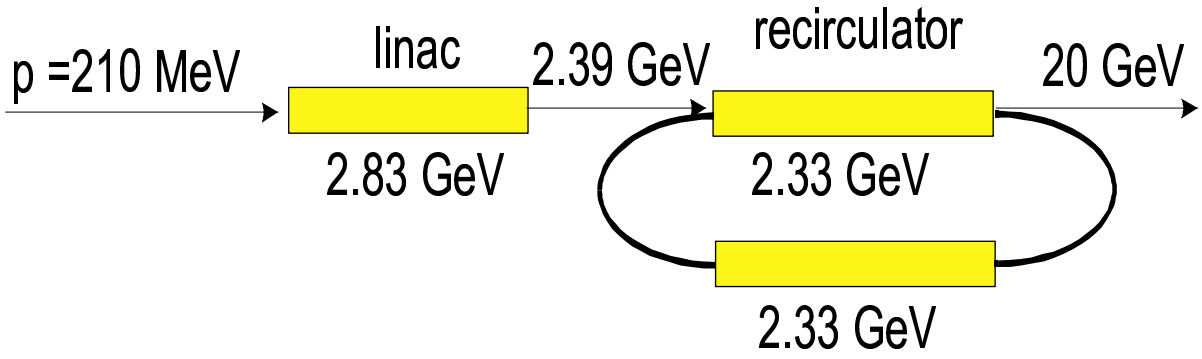
Total; first ϵ_T cut and second ϵ_T cut.



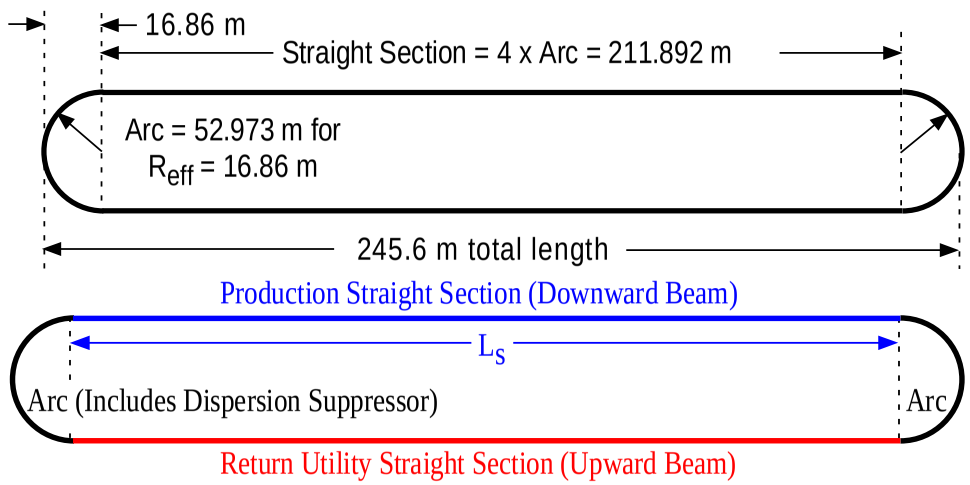
Cooling cell

Main parameters relevant to acceleration.

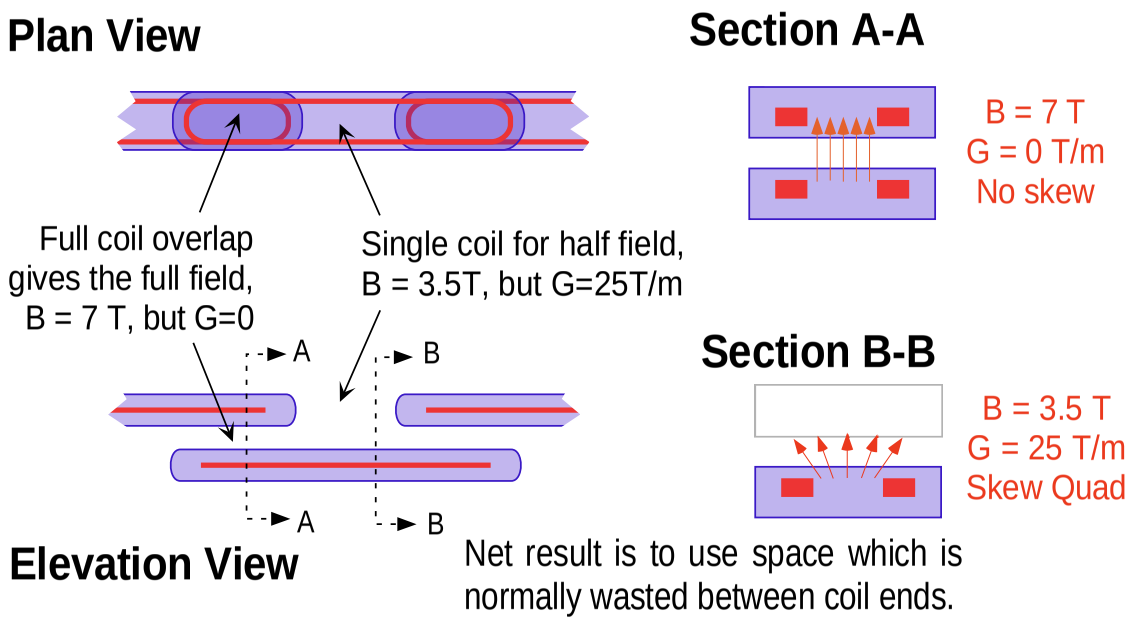
Initial momentum	210 MeV/c
Initial kinetic energy	129.4 MeV
Initial acceptance$_{norm}$	15π mm
Initial acceptance$_{long}$, $\Delta p L_b/m_\mu$	203π mm
Initial momentum spread$_{full}$, $\Delta p/p$	± 0.275
Initial full bunch length, L_b	± 372 mm
Bunches per pulse	67
Particles per pulse	3×10^{12}
Bunch frequency	201.25 MHz
Acceleration RF frequency	201.25 MHz
Time structure of beam	6 pulses separated by 20 ms repeating every 400 ms
Average beam power	150 kW



Layout of the acceleration systems.



Schematic of the Storage Ring



View of a proposed new magnet for the Storage Ring