

Comparison of an Alternate Solenoid and Long Solenoid Cooling Channels

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- (A) FOFO channel
- (B) Alternate solenoid channel with field ~~collecting~~ coils of small radius
- (C) Single or double field flip long solenoid channel

Input = Output of precooling channel:

- Protons 16 GeV
- Carbon target
- Decay 50 m
- Induction linac 200 MeV
- Minicooling 2.6 m of liquid H₂
- Buncher 201 MHz

IMPORTANT

Large momentum spread:

$$p_{\min} = 120 \text{ MeV}/c, \quad p_{\text{ave}} = 180 \text{ MeV}/c, \quad p_{\max} = 240 \text{ MeV}/c$$

Large solenoid radius: $R \approx 70 \text{ cm}$

MORE CONSERVATIVE DESIGN:

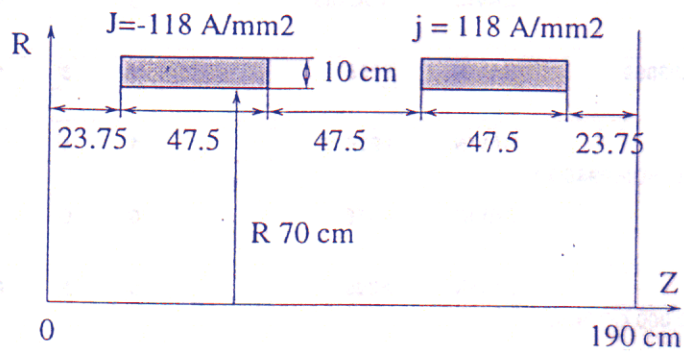
$$L = 0.95 \text{ m,}$$

$$B_0 = 2.67 \text{ T,}$$

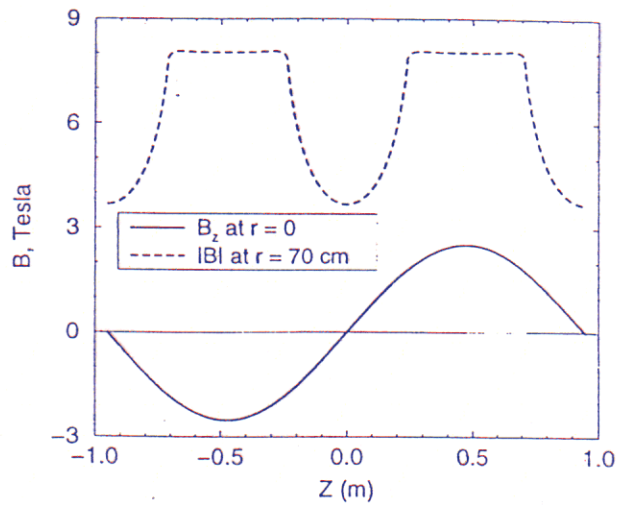
$$B_{\text{coil}} = 8 \text{ T,}$$

$$\beta_{\text{min}} = 54 \text{ cm}$$

Schematic



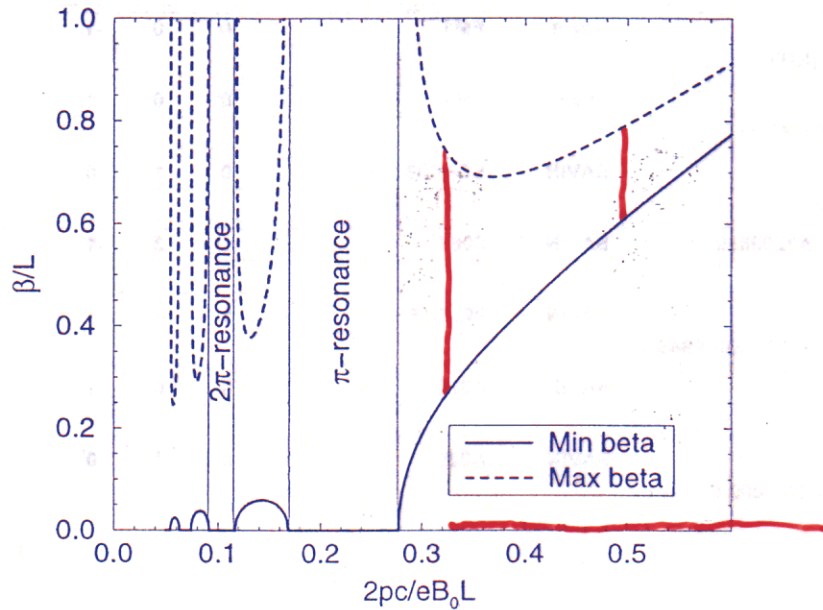
Field map



FOFO Channel

Almost sinusoidal axial field: $B(z) = B_0 \sin(\pi z/L)$

$$B_n \propto I_0 \left(\frac{\pi n r}{L} \right) \sim e^{\pi n r/L}$$



$$\rho_{\max} / \rho_{\min} \approx 2 \Rightarrow pc > 0.14 eLB_0 \Rightarrow LB_0 \approx 6(pc/e)_{\min}$$

$$\text{At } (pc)_{\min} = 120 \text{ MeV} \quad LB_0 = 2.4 \text{ T-m}$$

$$\text{At } (pc)_{\text{ave}} = 180 \text{ MeV} \quad 0.6 L < \beta < 0.8 L$$

$$\beta_{\min} = 35 \text{ cm} \Rightarrow L = 0.6 \text{ m}, \quad B_0 = 4 \text{ T}$$

$$B_{\text{coil}} > 30 \text{ T} \quad \text{at } R = 0.7 \text{ m} !$$

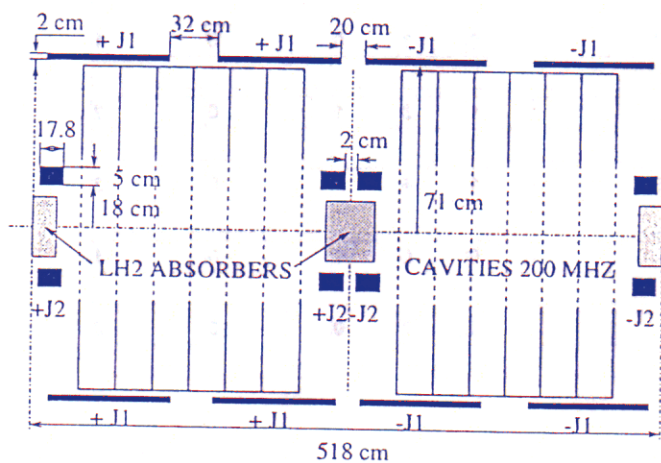
Alternative solenoid with correcting coils

An alternative solenoid with $|B| = \text{const}$ (instantaneous field flips) is resonance free:

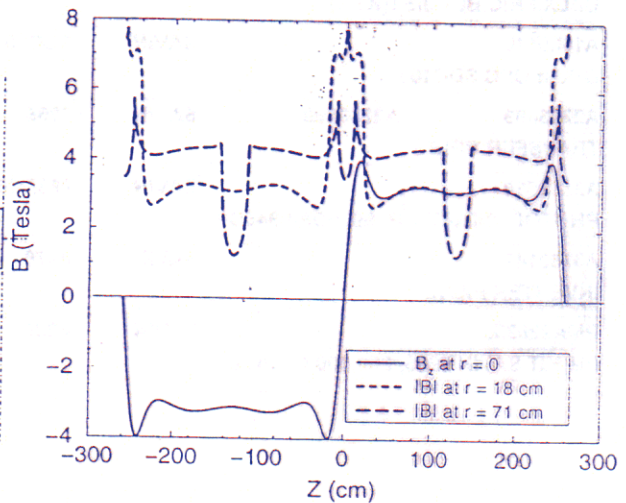
$$\beta = 2pc/e|B|$$

Fast field flip is possible only by small radius solenoids.

Schematic of the cell



Field map of the cell



Max and min β -functions of the lattice vs a particle energy

