



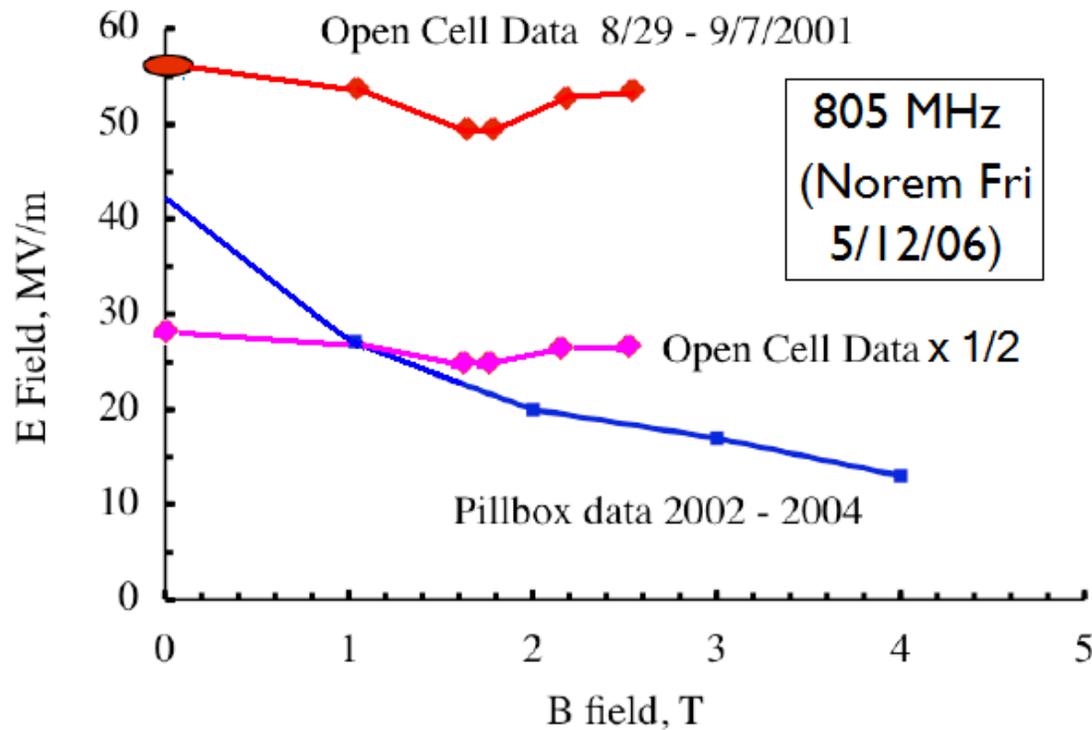
Open cell lattices

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1. Introduction
2. 1 coil/cell FOFO
3. 2 coil/cell FOFO
4. 4 coil/cell RFOFO
5. Other Symmetries
6. Conclusion

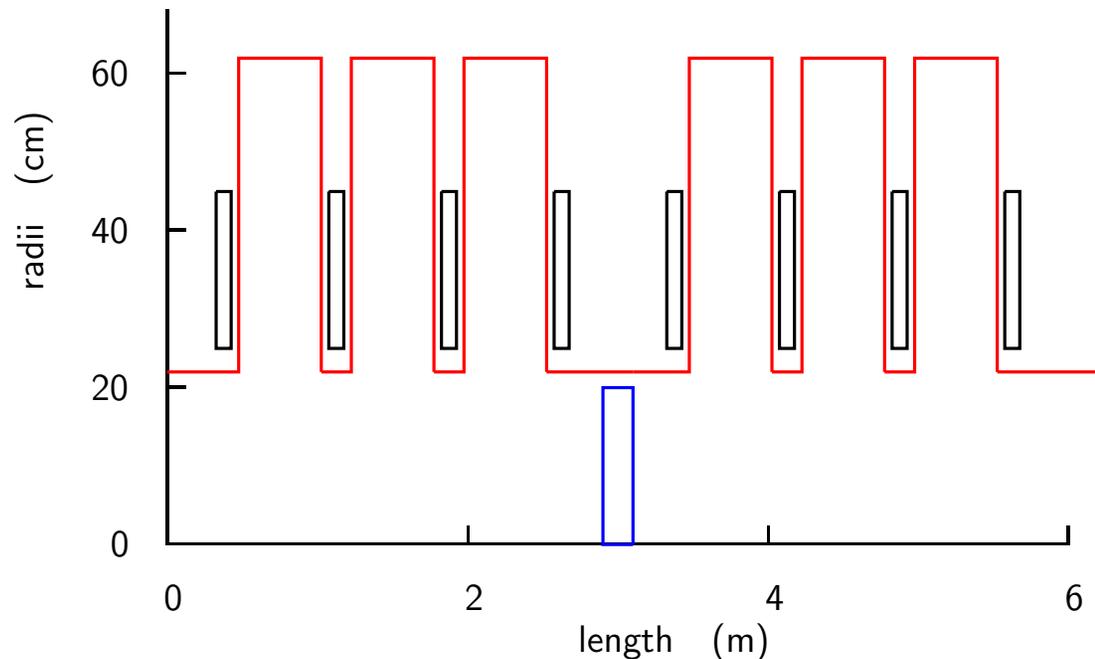
1) Introduction



- Surface breakdown fields in open cavity did not fall with magnetic field
Peak surface field ≈ 49 MV/m at 805 MHz
- But average/peak acceleration $\approx 1/2$ for open cavity
Ave acceleration $\approx 49/2 \approx 24$ MV/m at 805 MHz
- If breakdown $\propto \sqrt{f}$ then
average acceleration $\approx 24/2 \approx 12$ MV/m at 201 MHz
- This is still better than pillbox at 3 T

Proposal

- Pick iris rad approximately as Study 2 Be Windows (22 cm)
- Put coils in every iris at as small a radius as practicable (25 cm) to minimize stored energy
- Coil width (15 cm) and thickness (22 cm) to keep current densities low
- Pick different sequences of currents to obtain desired fields
- Skip 1 cavity in ≈ 10 and put absorber at center
- Allow energy to saw tooth



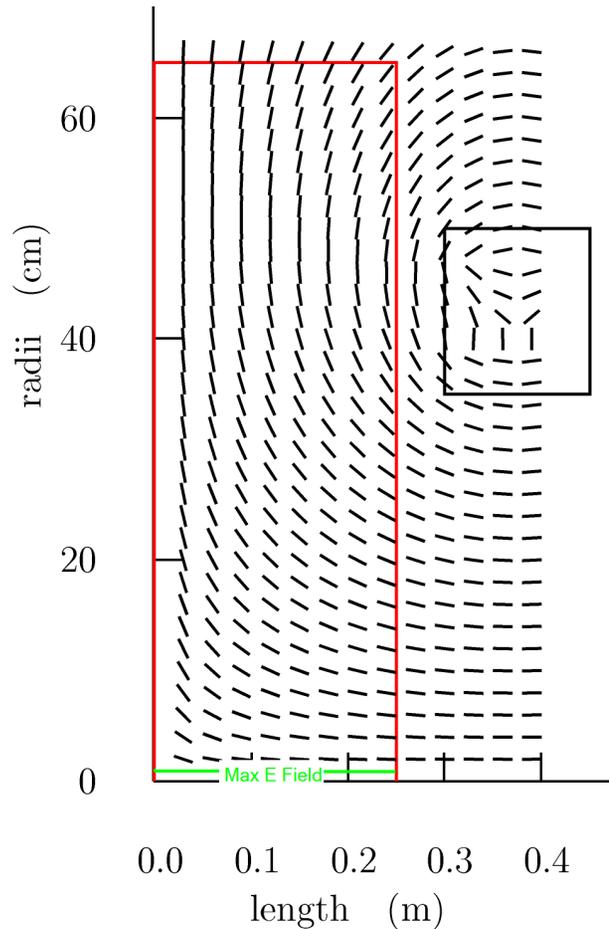
Remember CERN 44/88 MHz Proposal

- Coils in irises
- Absorber only after ≈ 10 cavities

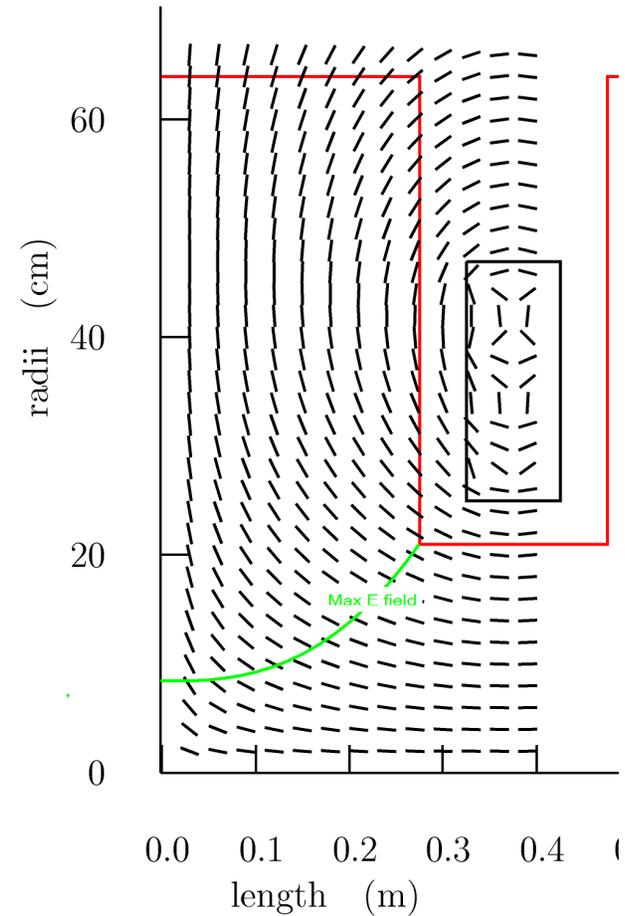
2) 1 coil/cell FOFO Lattice < + | - >

Compare with Study 2 and ISS lattice

Pillbox



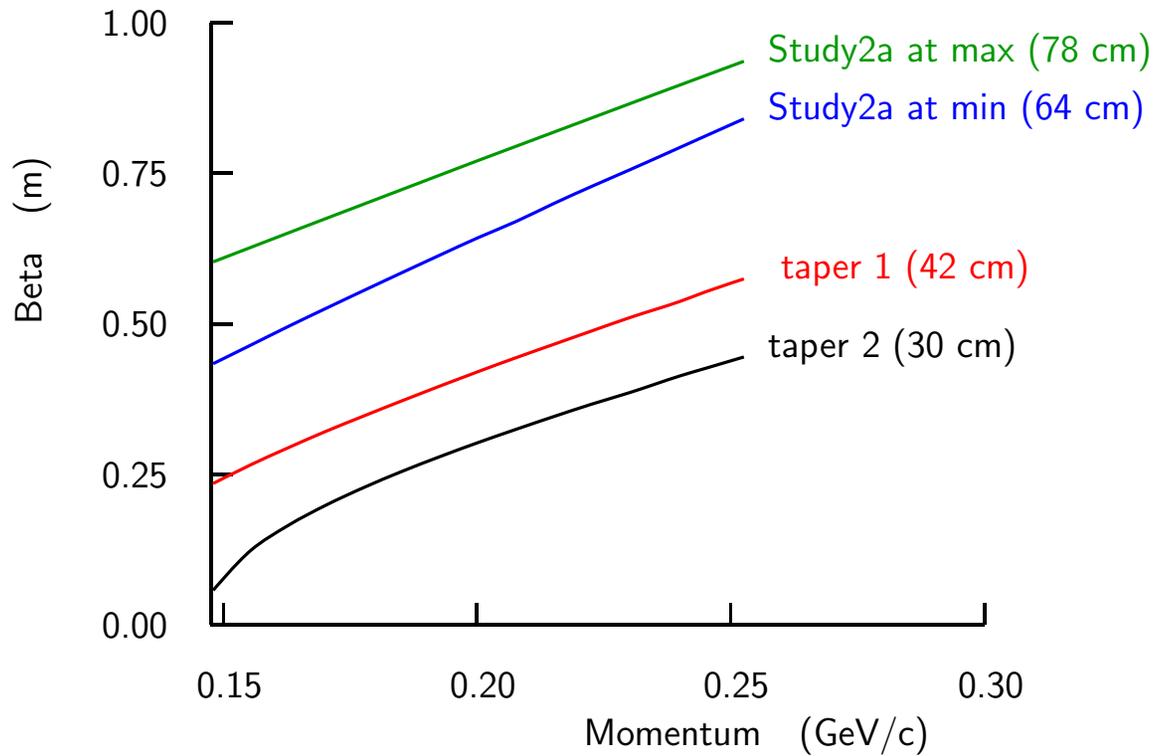
Open cell



- In open cell magnetic fields approximately perpendicular to electric fields
- Peak fields 6.6 T in pillbox, 5.5 T in open design

Tunability

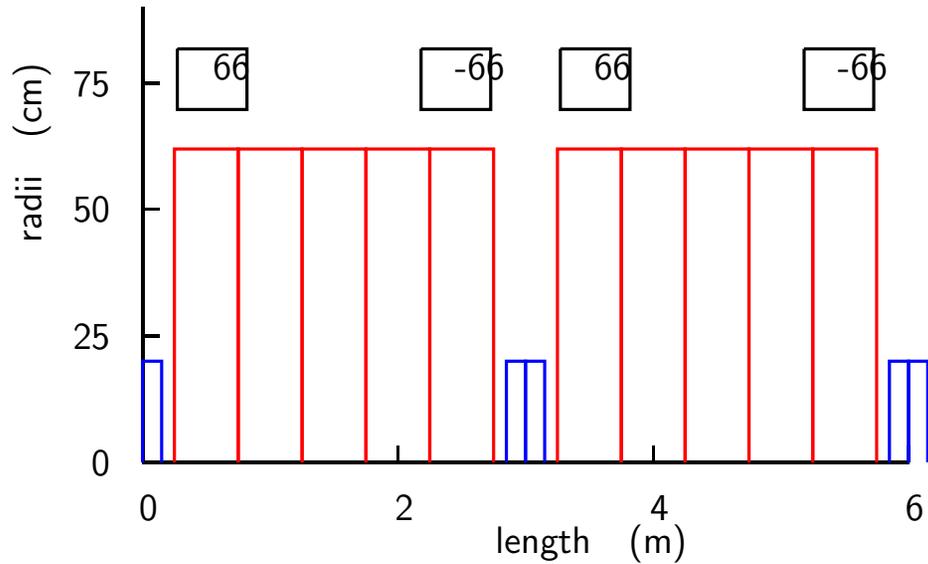
- Absorbers are now at beta minima
- Allows tapering to lower betas



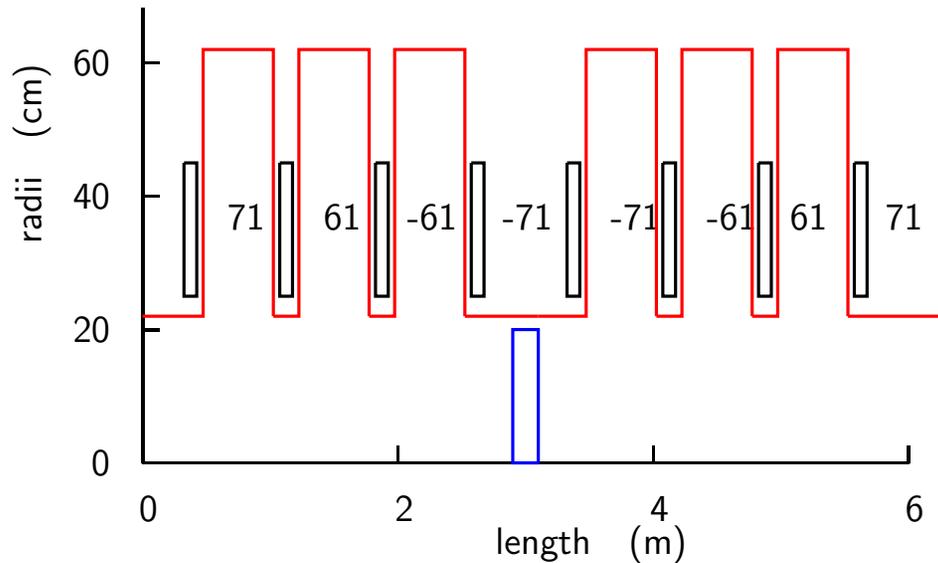
3) 2 coil/cell FOFO $\langle ++ | -- \rangle$

4) RFOFO lattices

Compare with RFOFO Guggenheim lattice

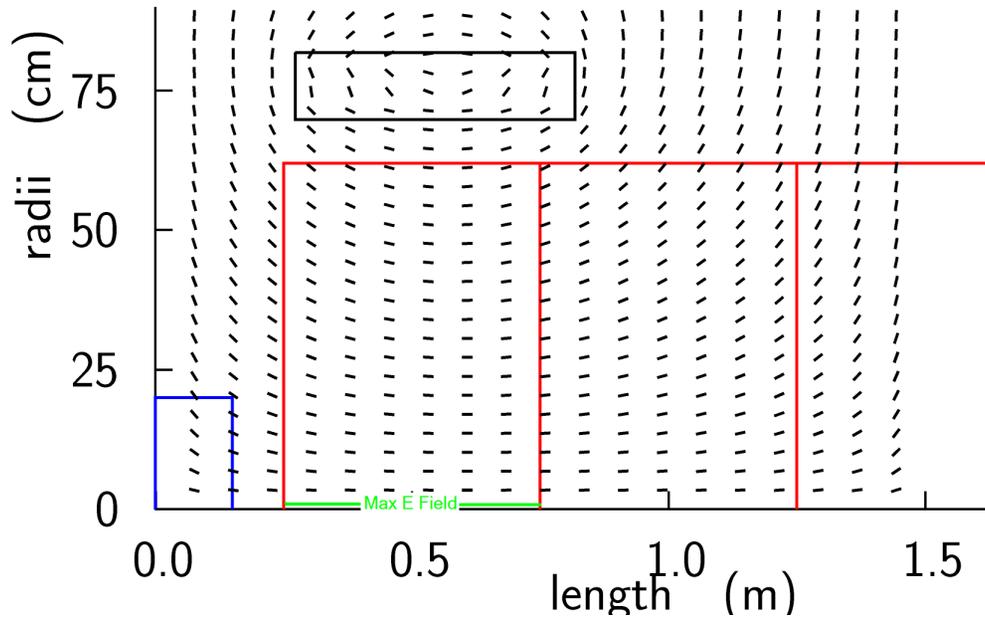


- Closed pill box $< + - | + - >$
- Coils outside rf
- Peak fields approx 5.5 T

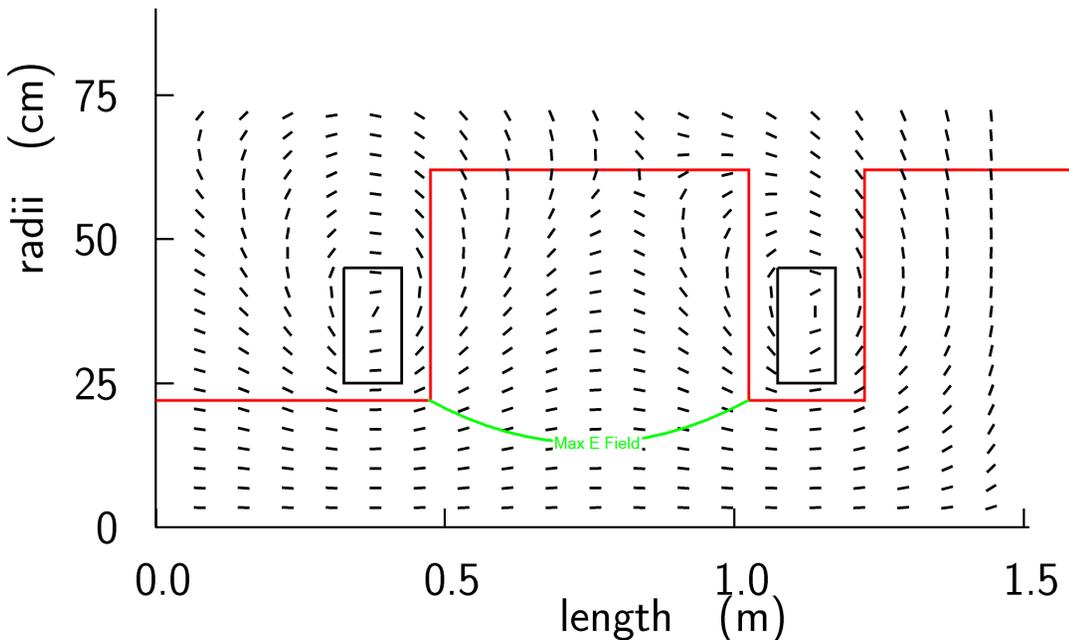


- Open cell proposal $< ++ -- | ++ -- >$
- Peak fields approx 4.9 T

Field directions



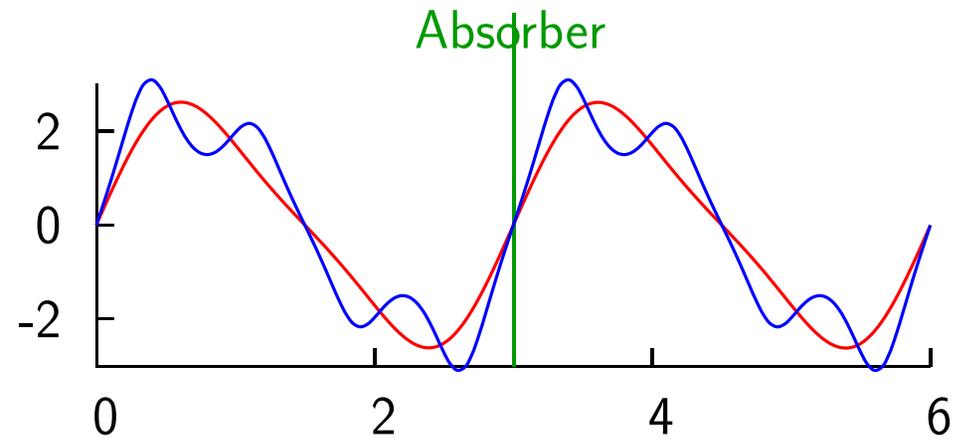
- Closed pill box as in Study 2
- B fields parallel to highest E fields



- Open cell proposal
- B fields approximately perpendicular to highest E fields
But not quite as good as in $\langle + | - \rangle$

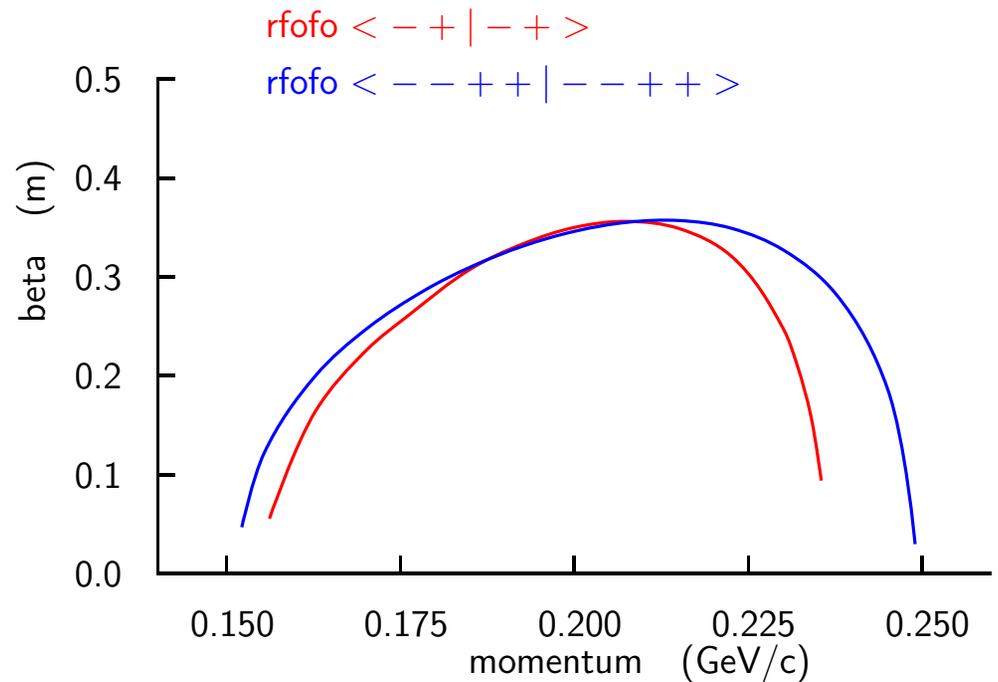
Fields vs. z

Red is for coils outside
Blue is for coils in irises



Betas vs. Momentum

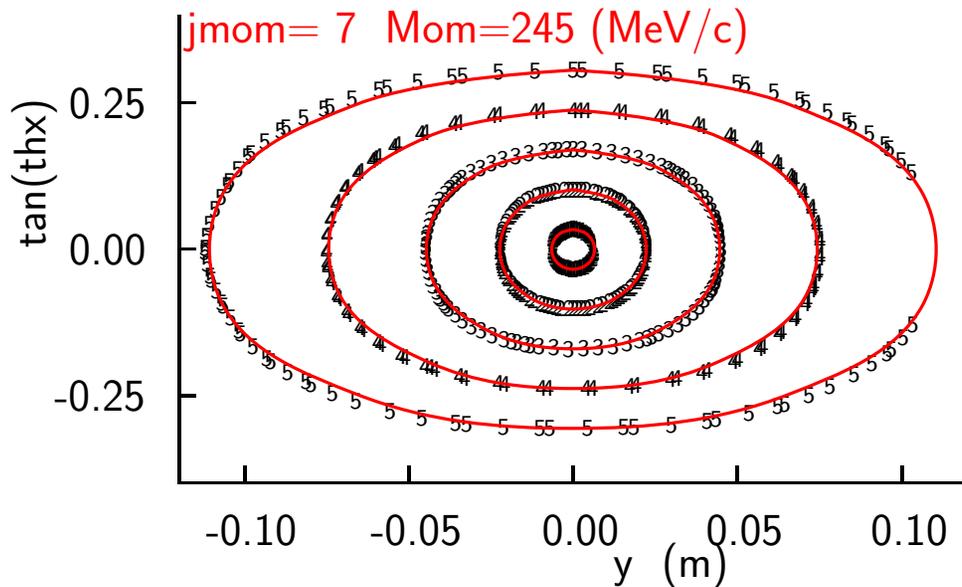
Red is for coils outside
Blue is for coils in irises



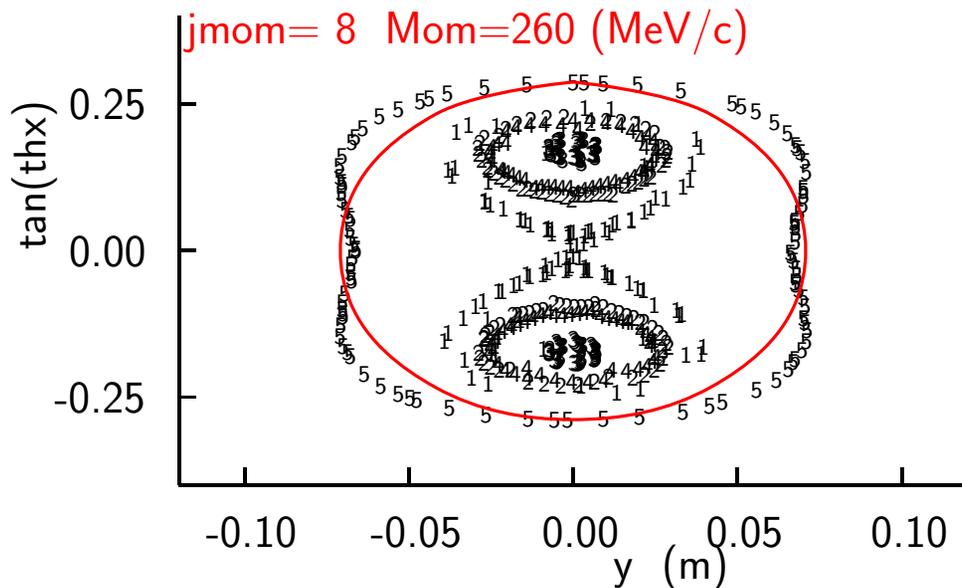
- Open cell RFOFO has significantly more momentum acceptance than old version
- Probably because it is a better approximation to constant $|B|$

Examples of Phase Plots

From ICOOL tracking of 50 cells (5 amplitudes at 9 momenta)

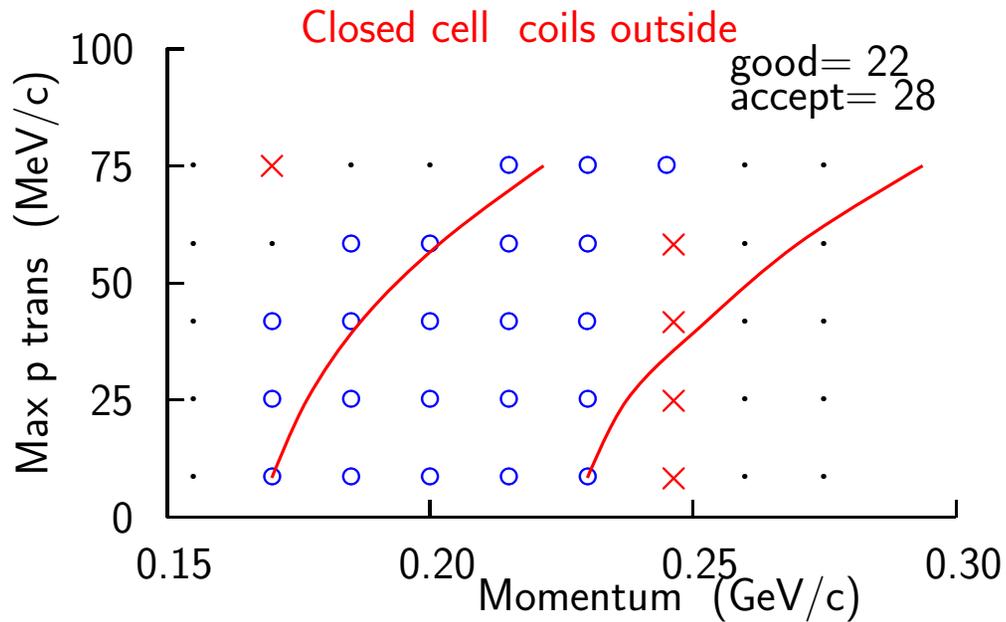


- 5 "Good" tracks that fit ellipses

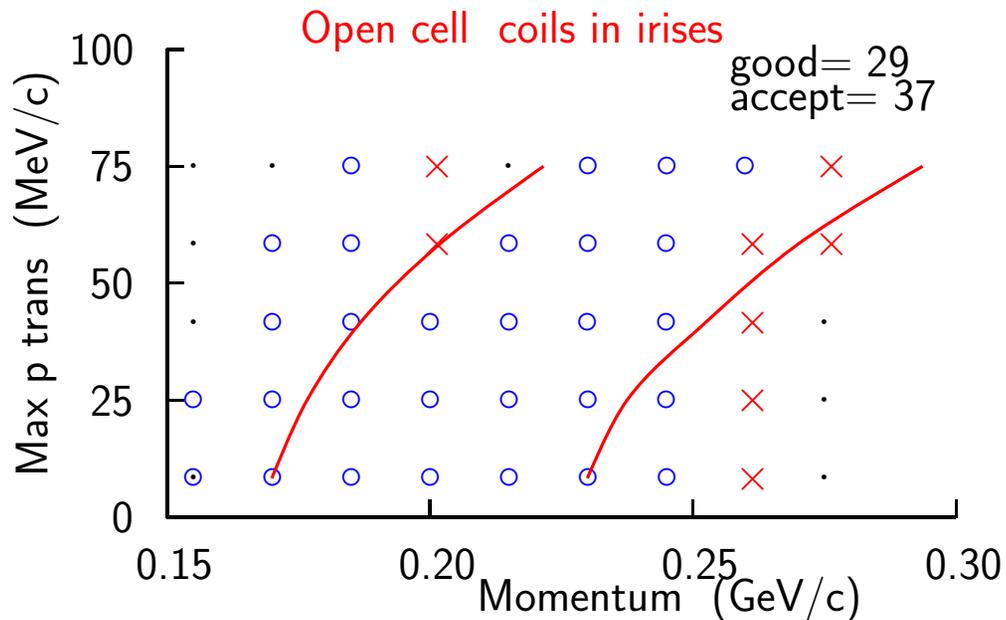


- 1 "Good" track and 4 "bad" tracks
Note loose definition of fit

Compare Acceptances in mom and amplitude



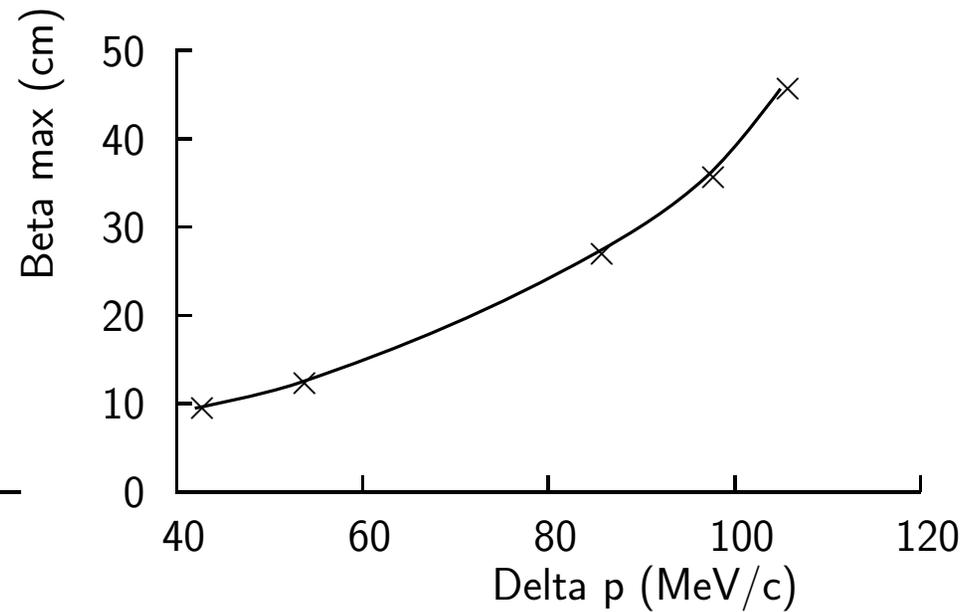
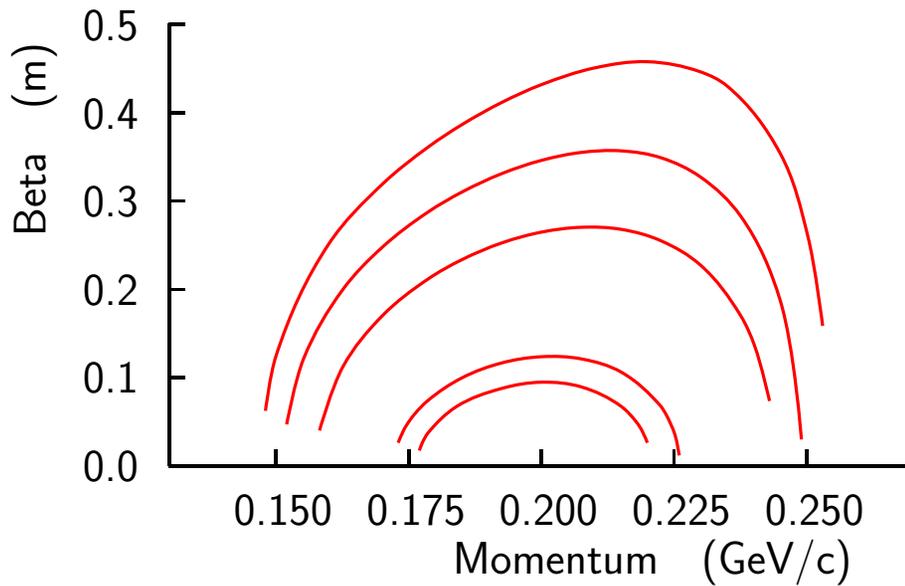
- ○ = fitted ellipse
- × = transmitted but not fitted
- · = Not transmitted
- Red lines indicate momenta with same velocities



- Open cell lattice with coils in irises
 - Has more high harmonics
 - But still better acceptance
- 37 vs 28 Tracks transmitted
29 vs 22 good tracks

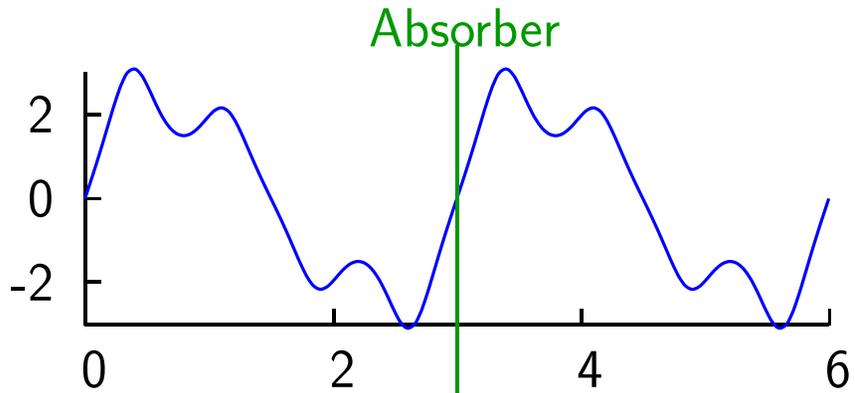
Tunability

Beta Max cm	j1 A/mm ²	j2 a/mm ²
45.7	54	42
35.7	59	39
27.0	64	34
12.3	78	24
9.5	83	0

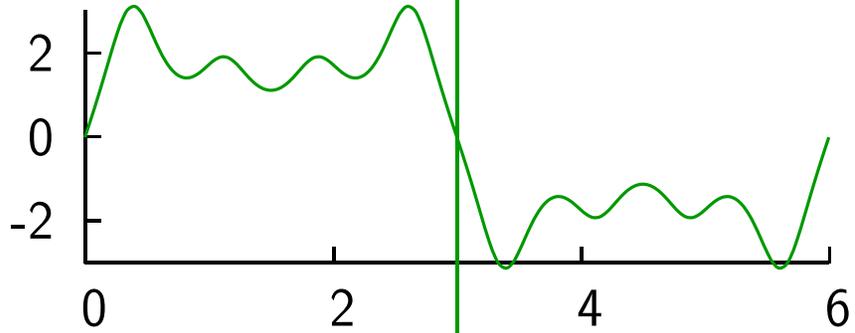


- Beta adjustable from 10 to 46 cm by currents alone

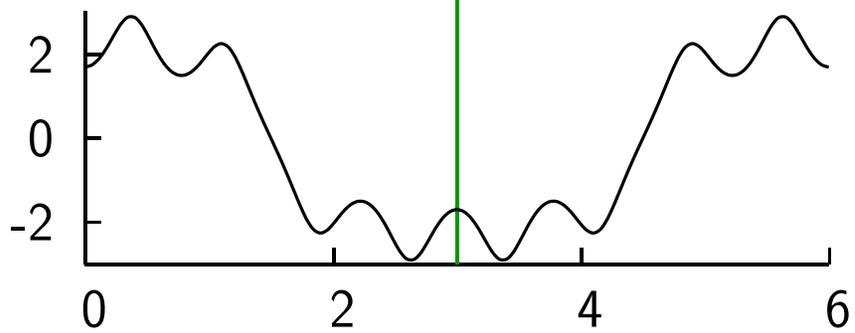
5) Other 4 coil/cell Symmetries



- Open Cell RFOFO
 $\langle ++-- | ++-- \rangle$
 37 transmitted 29 good



- Open Cell SFOFO
 $\langle ++++ | ---- \rangle$
 32 transmitted 26 good



- Open Cell Fernow FOFO
 $\langle ++-- | --++ \rangle$
 36 transmitted 23 good

- RFOFO is significantly better than other symmetries

Conclusions

- Open Cell lattices have small magnetic field dependence on breakdown
But reduced accelerating/maximum gradient
Accelerating gradient still better for open cavities at $B \geq 1$ T
- If coils placed inside irises
 - Open cells have magnetic and electric fields approximately perpendicular
 - Expected to further suppress breakdown
- For FOFO
 - Absorbers can be placed at beta minima, in occasional missing cavities
Being at minimum betas allows reducing betas along lattice (tapering)
- For RFOFO
 - Coils in irises have lower peak fields and much less stored energy
 - Momentum acceptance for the same betas are greater
 - Transmission and transmission with elliptical phase plots is improved
 - Betas (and momentum acceptances) can be tuned by currents alone
- Other Symmetries
 - SFOFO and Fernow FOFO have worse acceptances than RFOFO

Next Steps

- Look at acceptance with added bending
- Simulate liea cooling including saw tooth energy
- Simulate Guggenheim