Open Midplane Magnets: Part 1

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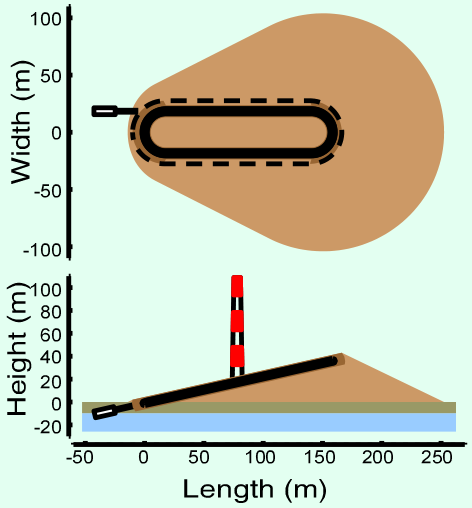
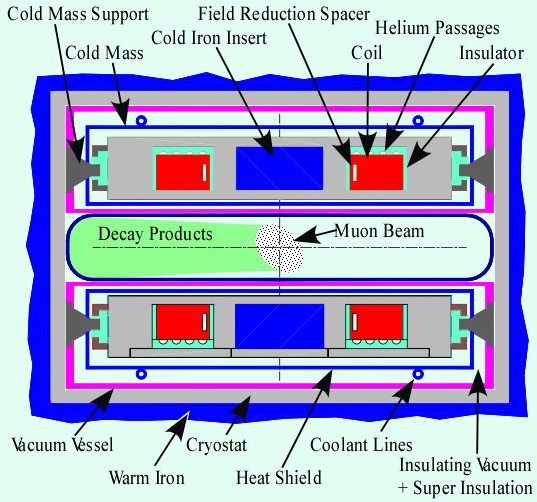
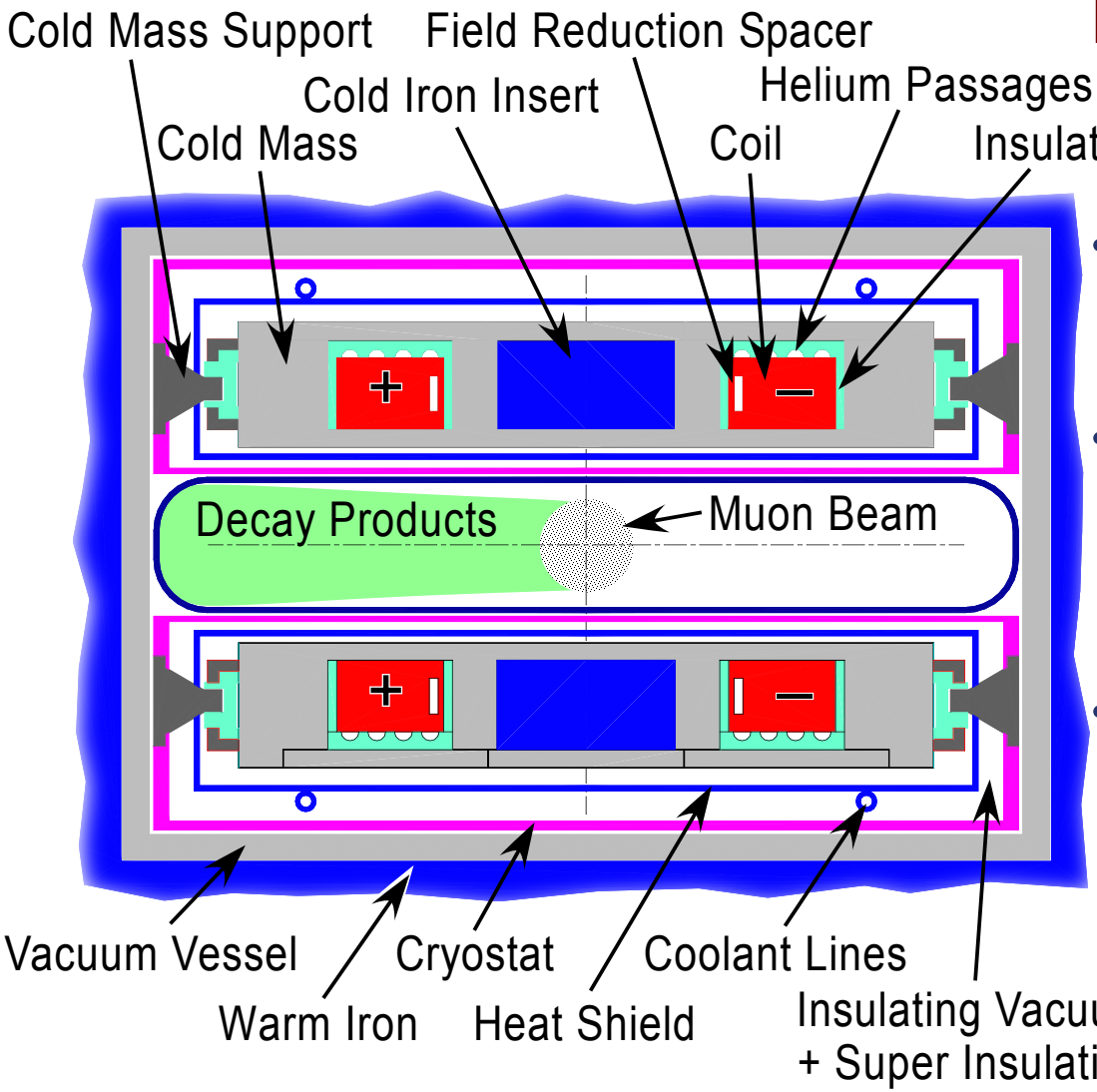




Introduction: Review Dipole Design

Muon Storage Ring Dipole Design

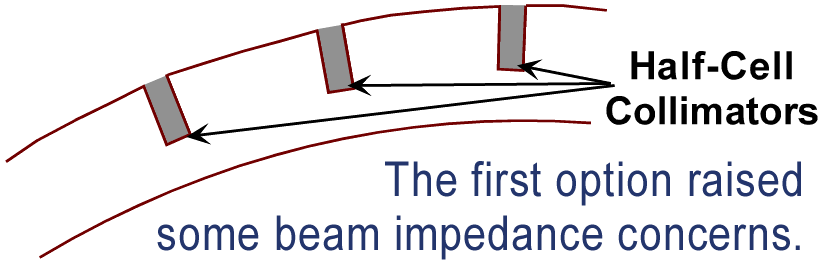


- Open midplane allows decay products to miss superconducting coils.
- Warm iron yoke minimizes cold mass and facilitates extracting energy deposition at room temperature.
- Racetrack coils enable simplified construction with large conductor bend radius (can use react & wind).

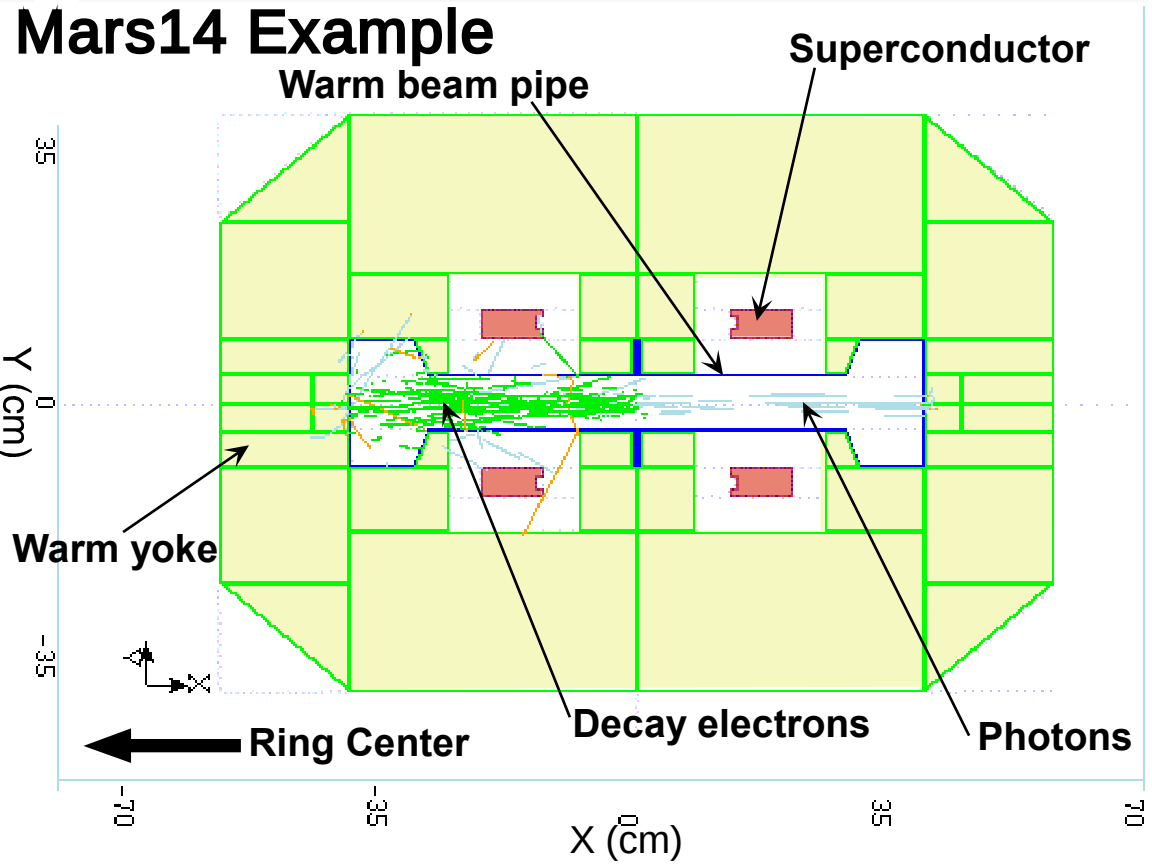
But what about the focusing structure?

During the course of Study-II we considered two quadrupole options

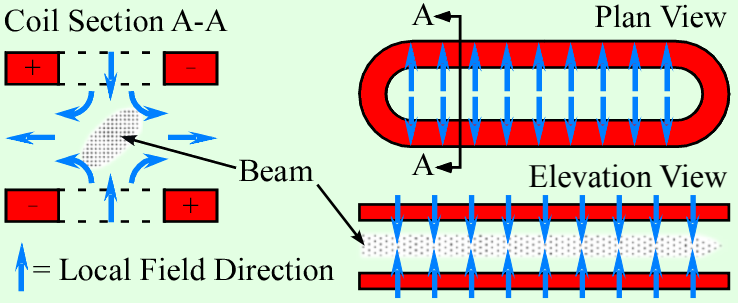
- Normal quadrupoles with dedicated collimators after the dipoles in each half-cell. Take energy deposition at room temperature at few fixed points.
- Use open midplane magnets, skew-quadrupoles, for the ring focusing and maintain same open aperture of the arc dipoles.



The first option raised some beam impedance concerns.

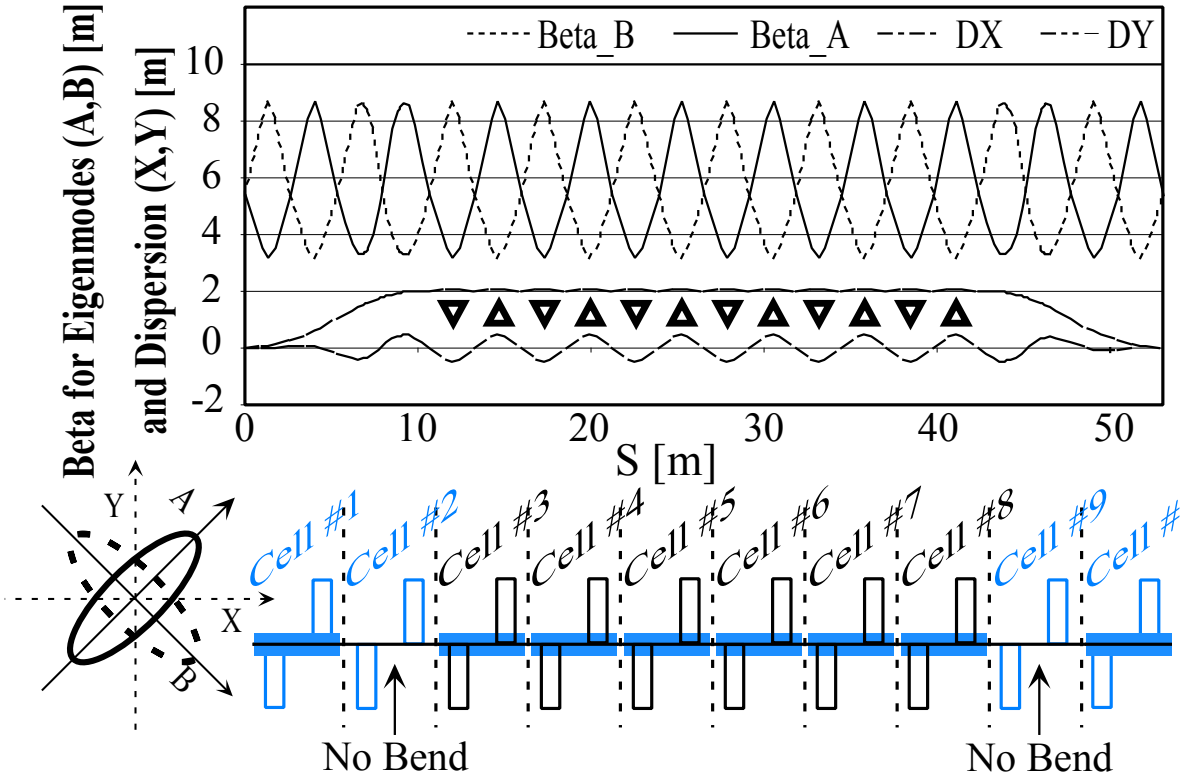


Make ring using skew-quadrupole magnets. They have the desired symmetry & can create fully decoupled lattice.

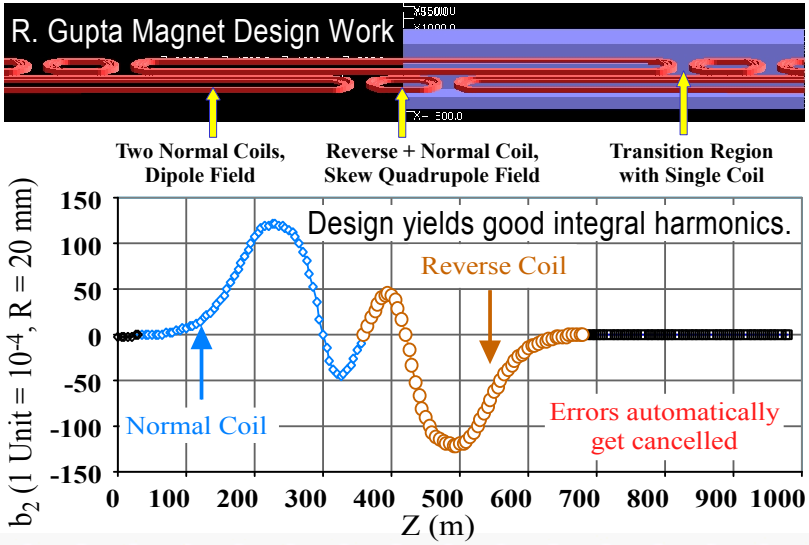


Example: The Sudy-II Storage Ring Optics

Muon Storage Ring Arc Lattice with 60° Cells



(I) Chose to use an almost continuous set of combined function magnets in order to keep arc compact (no waste space at magnet ends) with weaker focusing to minimize the required integrated gradient. The 60° phase advance gave a simple missing bend dispersion suppression scheme and flexible, distributed chromaticity adjustment via arc skew-sextupoles.

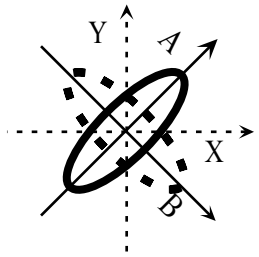


Other options, i.e. separated function & 90° phase advance are also possible.

Summary - *Open Midplane Magnets: Part 1*

Open midplane magnet designs enable us to handle significant energy deposition at room temperature, rather than inside the cryogenic structures, either with normal quadrupoles and dedicated warm protection collimators ...

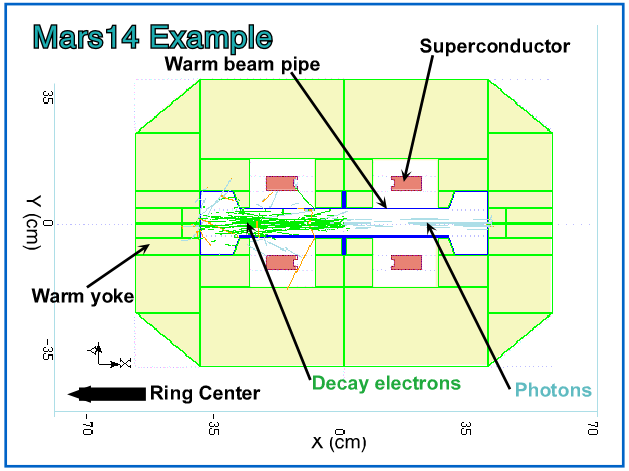
With pure skew focusing there can be completely independent betatron motion in each of two eigenplanes, denoted (*A*,*B*), but these eigenplanes are oriented at ±45° with respect to a conventional (*X*,*Y*) coordinate system. Betatron motion in such a lattice is most simply described via the (*A*,*B*) coordinates and results can be linearly transformed between (*A*,*B*) and (*X*,*Y*) according to the following relations:



$$X = (A+B)/\sqrt{2} \qquad Y = (A-B)/\sqrt{2}$$

or

$$A = (X+Y)/\sqrt{2} \qquad B = (X-Y)/\sqrt{2}$$



...or by using skew-focusing magnet lattices that naturally keep the superconducting coils out of harms way. The muon storage ring from Study-II is one such example.

Subsequently a lot of work was done on open midplane dipoles for the LHC IR and quads for large energy deposition at RIA that Ramesh will report on in Part 2.