SUPERFERRIC ARC DIPOLES FOR THE ION RING AND BOOSTER OF JLEIC

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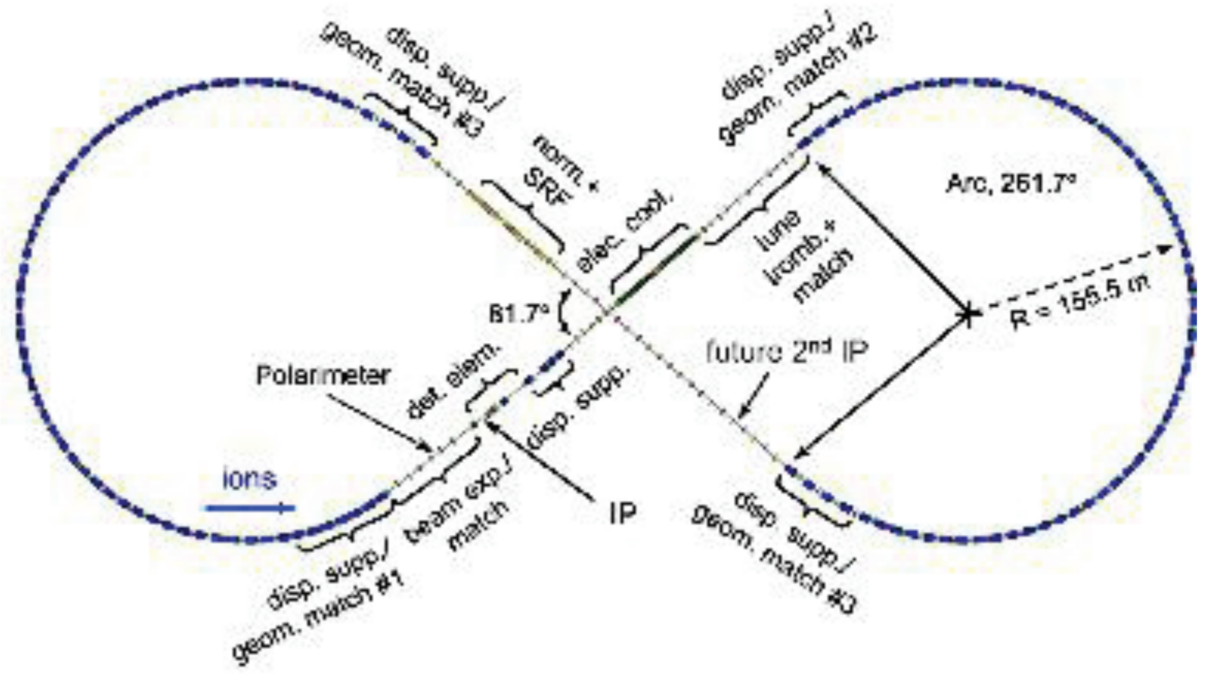
Abstract

The Jefferson Laboratory Electron Ion Collider (JLE-IC) project requires 3 Tesla superferric dipoles for the half-cells in the arcs of its Ion Ring and Booster. A super-ferric design using NbTi conductor in a cable-in-conduit package has been developed. A mockup winding has been constructed to develop and evaluate the coil structure, manufacture winding tooling and evaluate winding methods, and measure errors in the position of each cable placement in the dipole body.

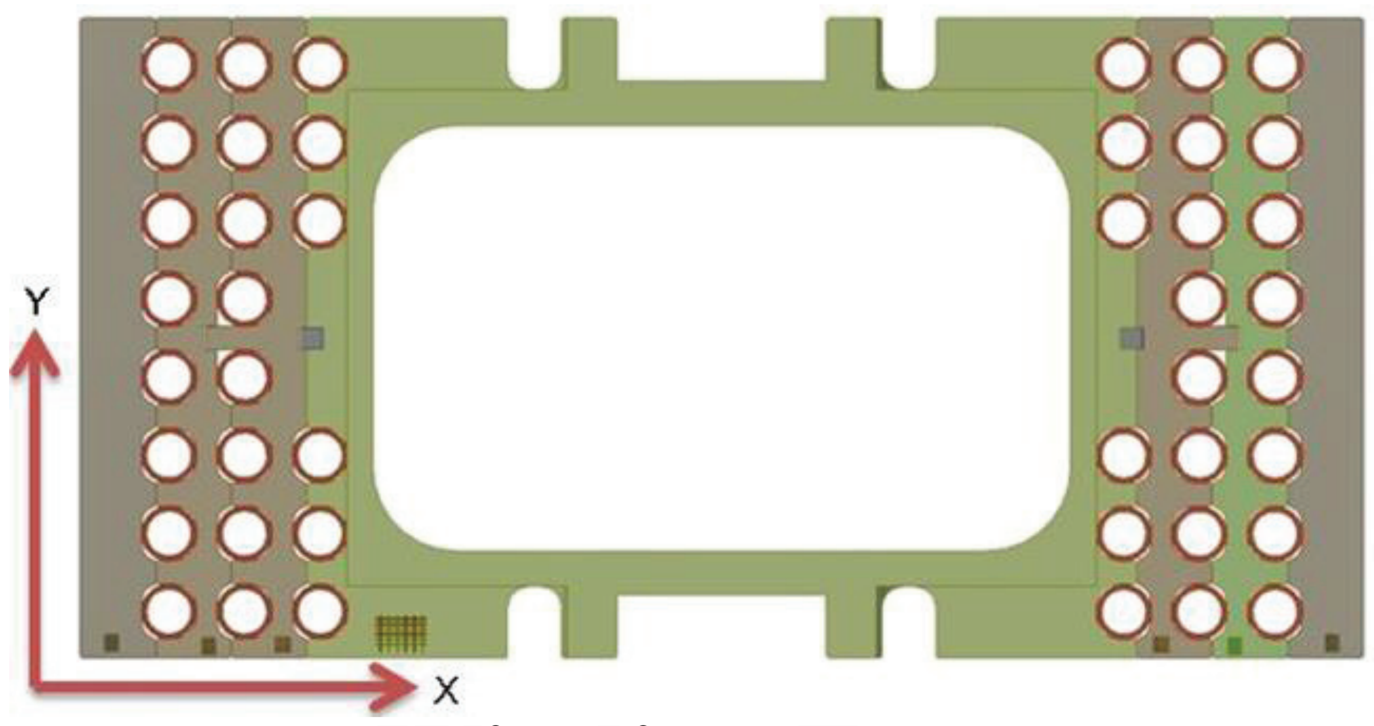


JLEIC Ring

64 half-cells that contain two 4m long dipoles each

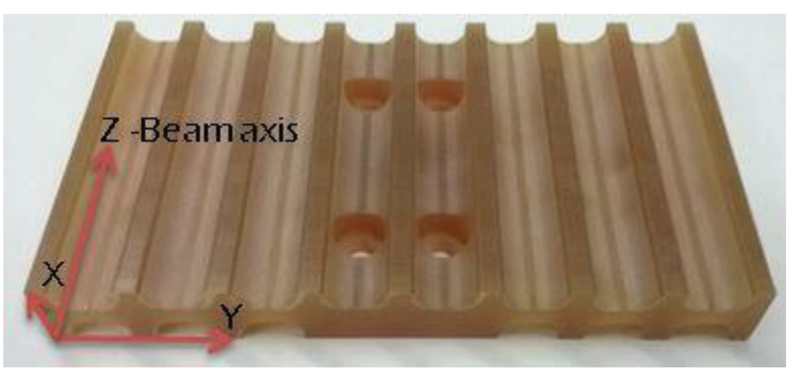
Cable-In-Conduit

15 strands of 1.2 mm Cu-NbTi Superconductor.



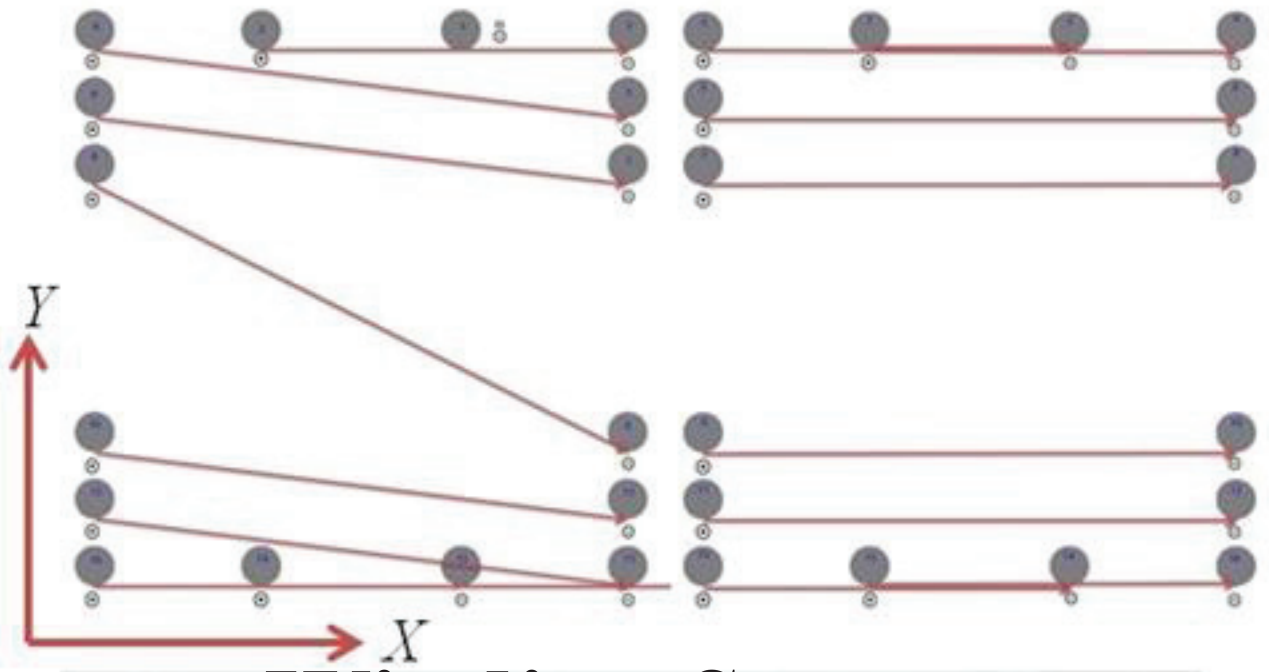
Winding Form

Block coil configuration.



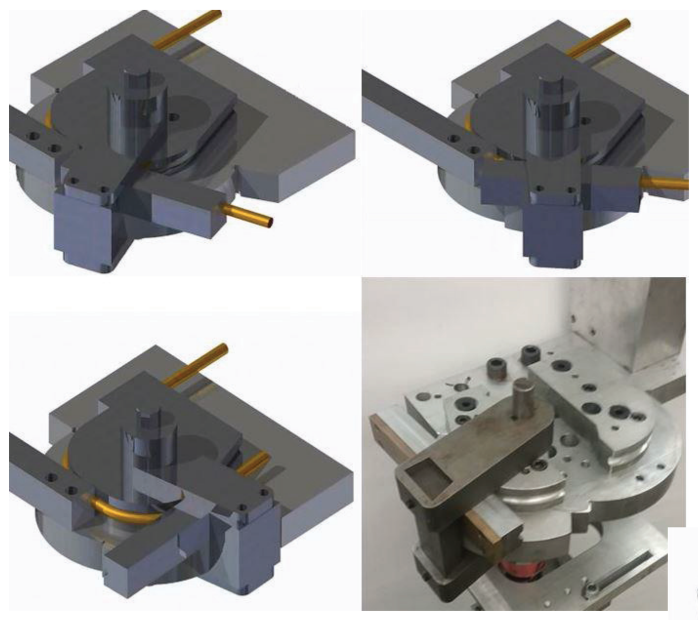
Orientation of G-11

Fibers of G-11 parallel to X-Y plane and normal to Z axis



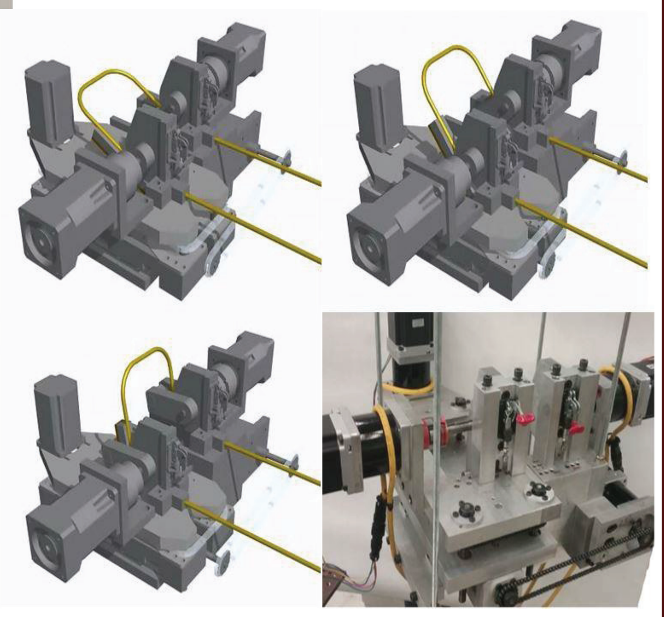
Winding Strategy

Continuous wind for first layer



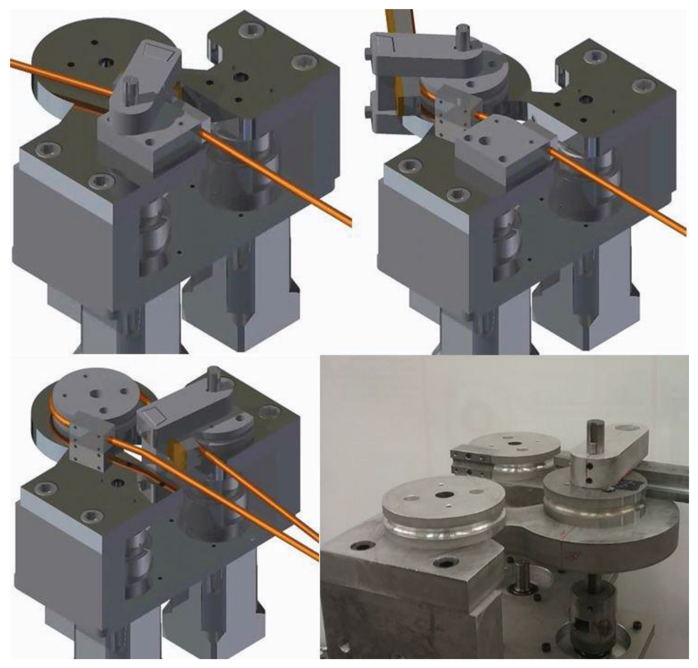
180 Degree Bender

Two setups with two forming dies determine X for cable



90 Degree Bender

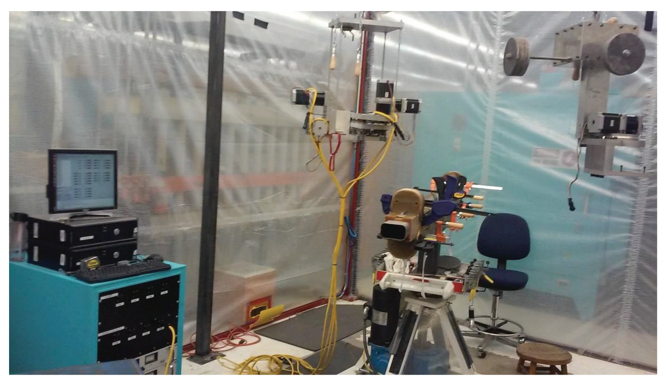
One setup but compound movement due to Y transition of cable

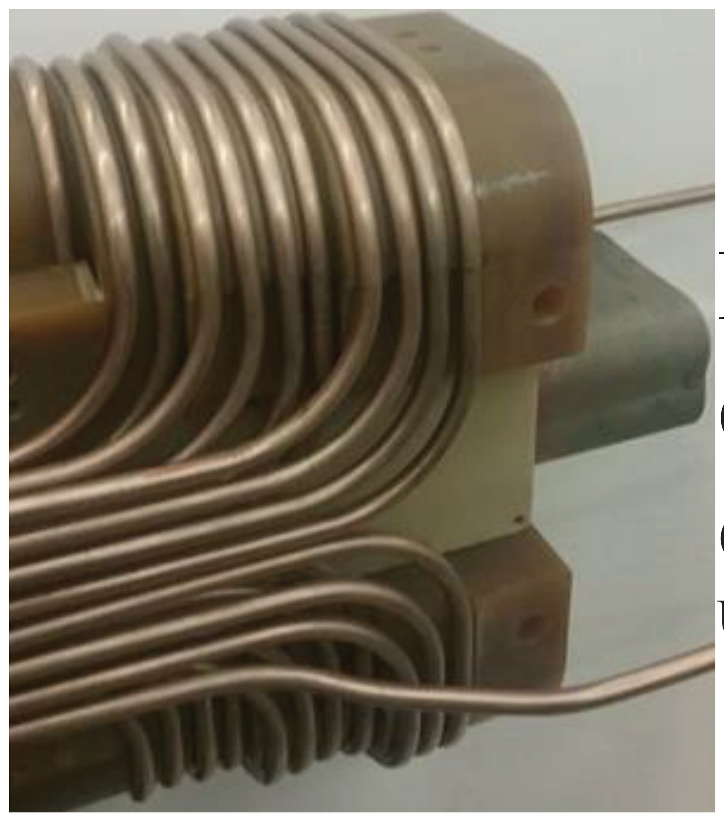


"Dog Bone" Bender

Bends the cable 180 degrees maintaining 2" minimum radius.

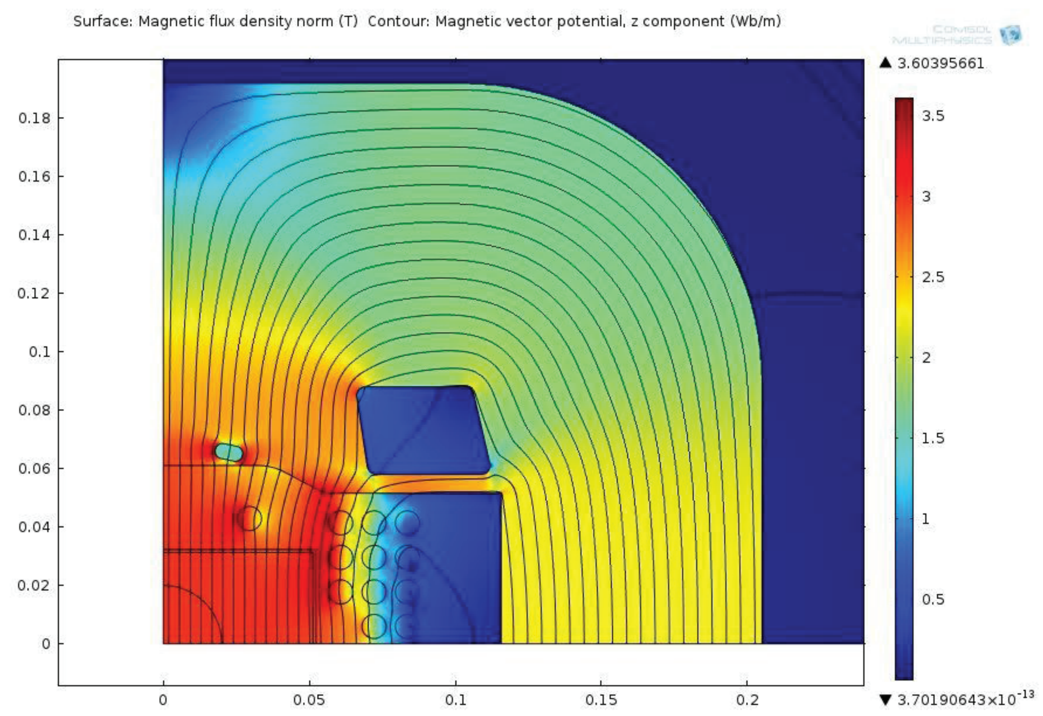
Winding Room



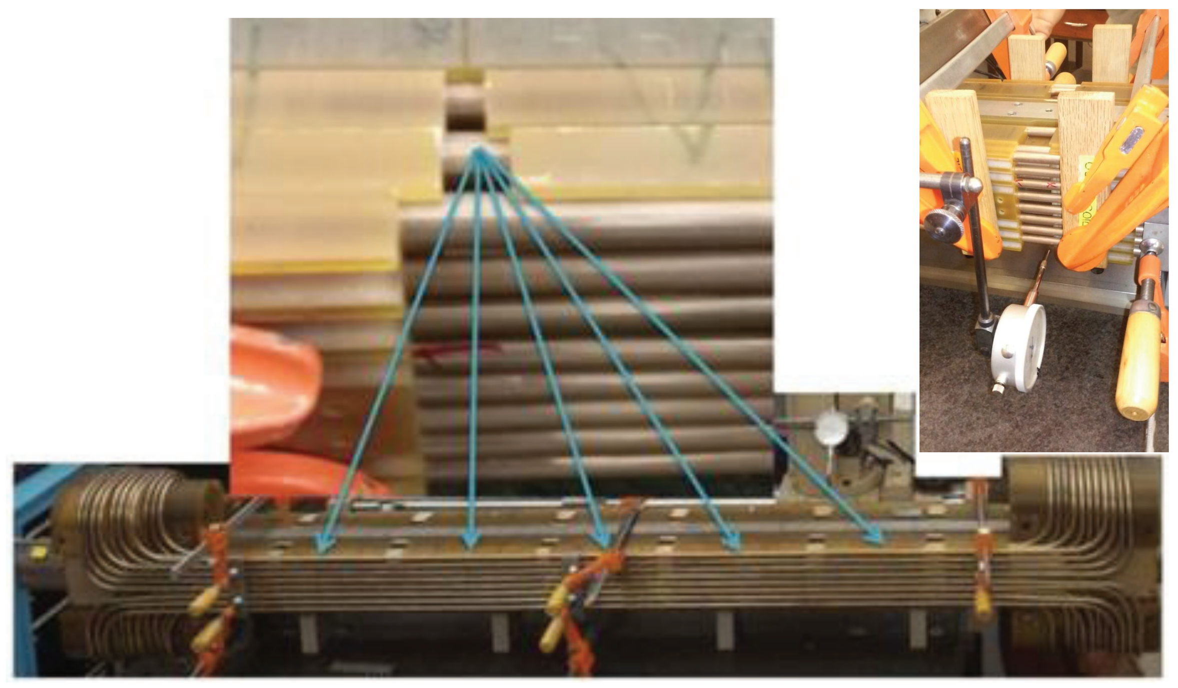


Beam entrance/exit of Dipole

Using the three benders shown.



One Quadrant of Dipole



Locations for Field Quality Check

For the prototype dipole empty cable was used. Therefore field error was determined by misplacement of cables. Design multipole errors are all less than one unit and the numbers presented are the errors from those values.

$$B_r(r,\theta) = \sum_{n=1}^{\infty}\left(\frac{r}{R_{ref}}\right)^{n-1}(B_n\sin(n\theta) + A_n\cos(n\theta))$$

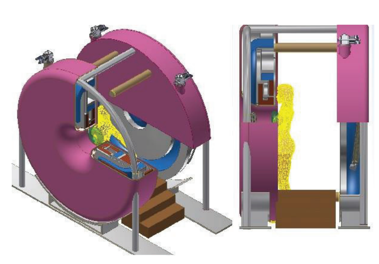
$$B_\theta(r,\theta) = \sum_{n=1}^{\infty}\left(\frac{r}{R_{ref}}\right)^{n-1}(B_n\cos(n\theta) + A_n\sin(n\theta))$$

Multipole	Error in Units
Dipole	1.5E-05
Quadrupole	0.00045
Sextipole	0.096
Octipole	0.00084
Skew Quadrupole	-1.1
Skew Sextipole	-0.26
Skew Octipole	-0.078

Skew quadrupole can be fix by new design for G-11 in winding form, proper sized cable and shimming the innermost cables.

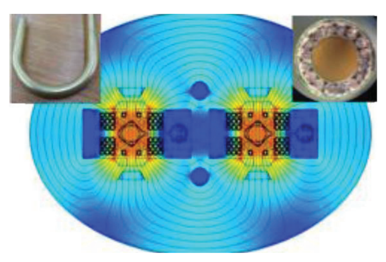
Now the 3T dipole can be developed.

Other Uses of CIC



Can be used in an MRI

Transmission lines



Or for dipoles in a 100Tev collider

Almost anywhere conducting/superconducting cables are used today

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