LERF C20 Cryomodule Demagnetization Magnetic Field Analysis

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Introduction

Three rounds of demagnetizations (demag) are planned to be performed on the C20 full cryomodule currently resides in LERF. The goal is to find out the effect of demag on cavity quality factor Q0. Refer to “C50/C75 Cavity & Cryomodule Magnetic Hygiene Control Plan” for details.

The demag power distribution system can supply up to 65A DC current to a solenoid type demag coil system. Three demag schemes will be carried out ：

- Apply 60 A peak current in a nominal 400-turn demag coil wound on all 4 cryounits and 5 bridging rings.
- Apply 65 A peak current in a nominal 300-turn demag coil wound on 3 cryounits and 4 bridging rings.
- Apply 65 A peak current in a 300-turn demag coil wound on one cryounit.

This report summarizes the magnetic field analyses conducted corresponding to the above three demag schemes.

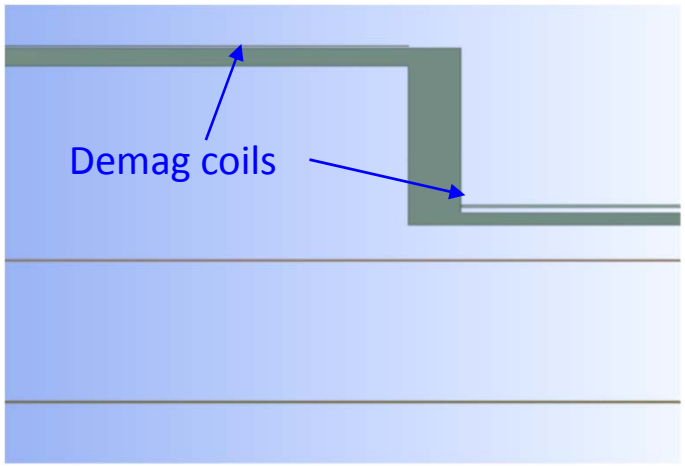
Analysis Model

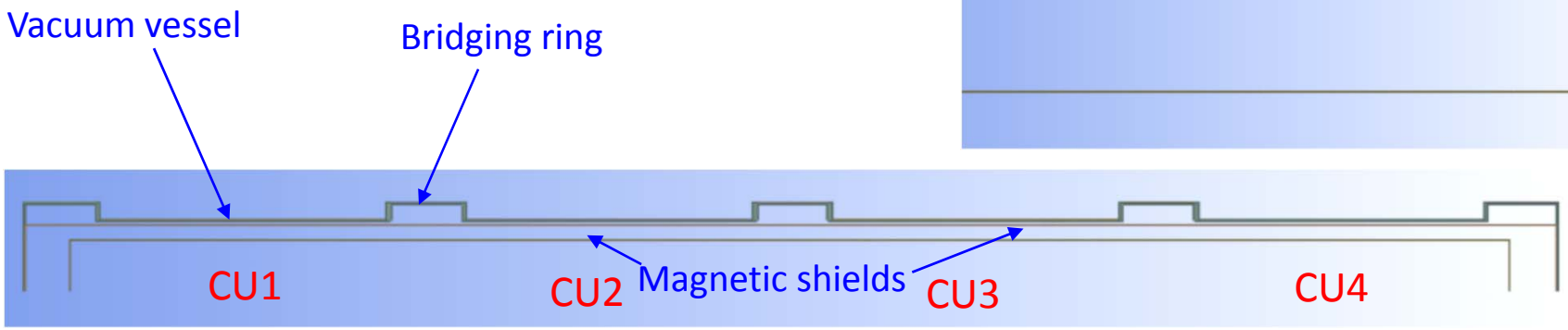
Field analysis is performed in ANSYS Workbench 19.2 via Electronic Desktop 2018.2. The vacuum vessel, bridging ring and magnetic shields are included in the 2D axisymmetric model. Demag coils are also in the model.

The C20 cryomodule contains 4 cryocuits: cryounit 1 (CU1), CU2, CU3 and CU4.

Coil cross sections are equivalent to that of the summed cross section of the strands of AWG 4 wires.

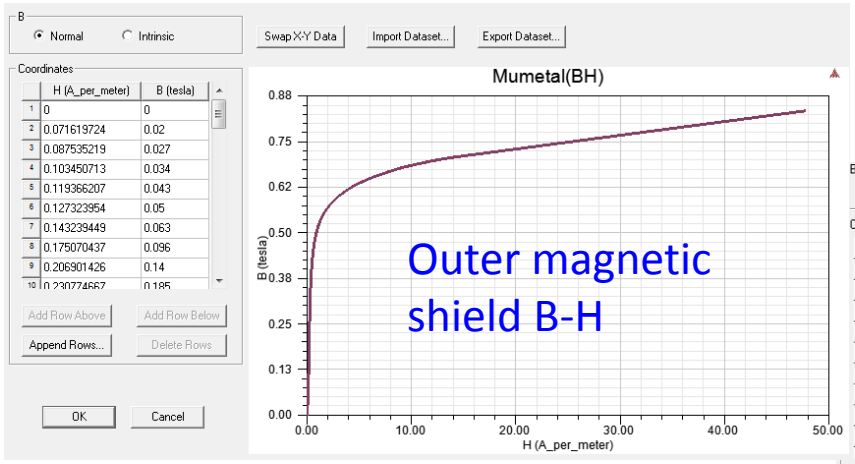
There is a vacuum region, not shown in pictures, that has an envelop approx. 20 feet away from the vacuum vessel and bridging rings along both longitudinal and radial directions.

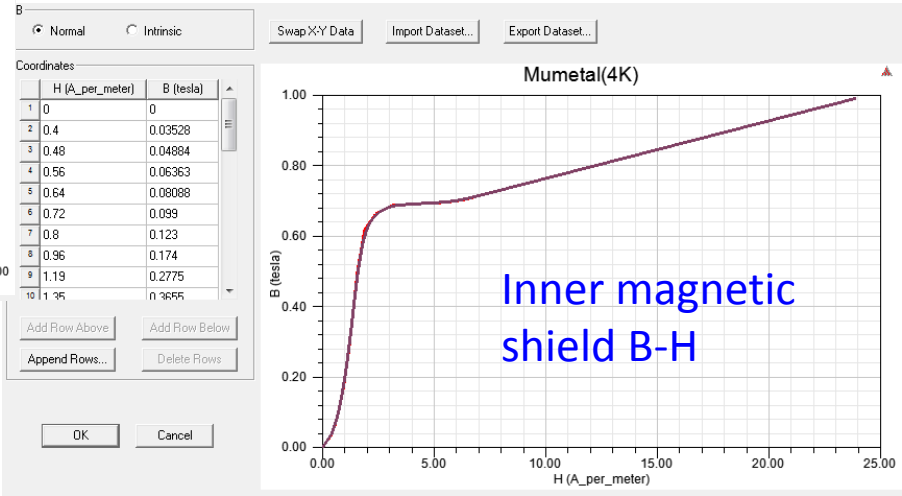




Material Properties

- Demag wire is made of copper
- Vacuum vessels and bridging rings are stainless steel that has unity permeability
- Magnetic shields B-H curves



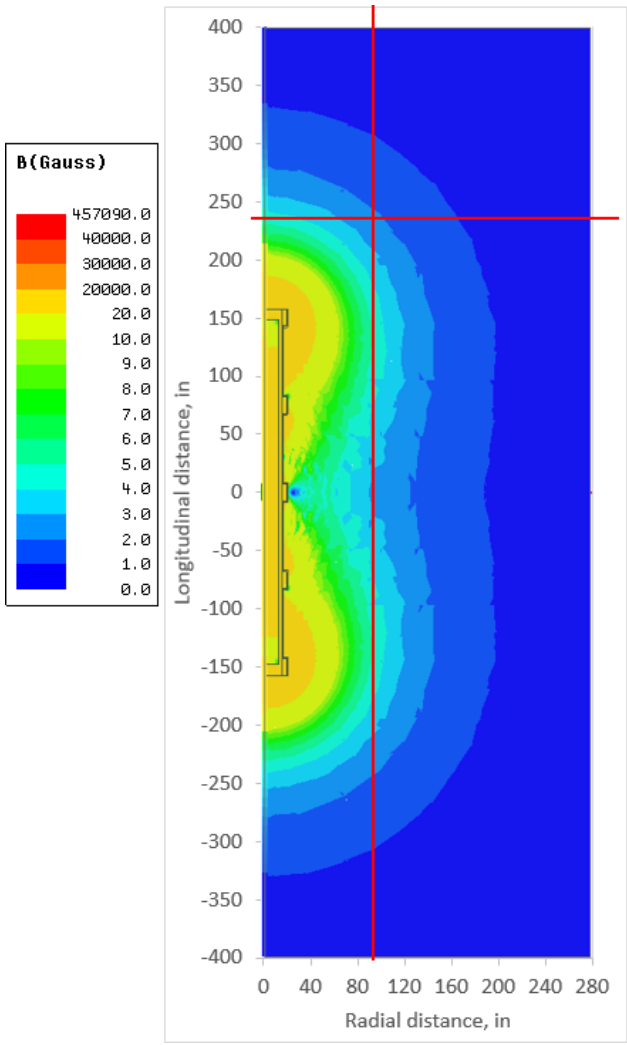


Demag Scheme 1: 400-turn, 60A, 4 Cryounits

The Bridging ring's outer radius is about 20 inches. And the distance from first to the fifth bridging ring is approximately 316 inches.

The magnetic field plot shows that the 5 Gauss safety field boundary is radially 70 inches/ 5.8 feet away from the exterior of bridging rings and 82 inches/6.8 feet longitudinally away from the end of the first and last bridging rings.

It is also seen that field > 20,000 Gauss is contained inside the cryomodule. In fact, the high field is mainly inside the high permeability magnetic shields.



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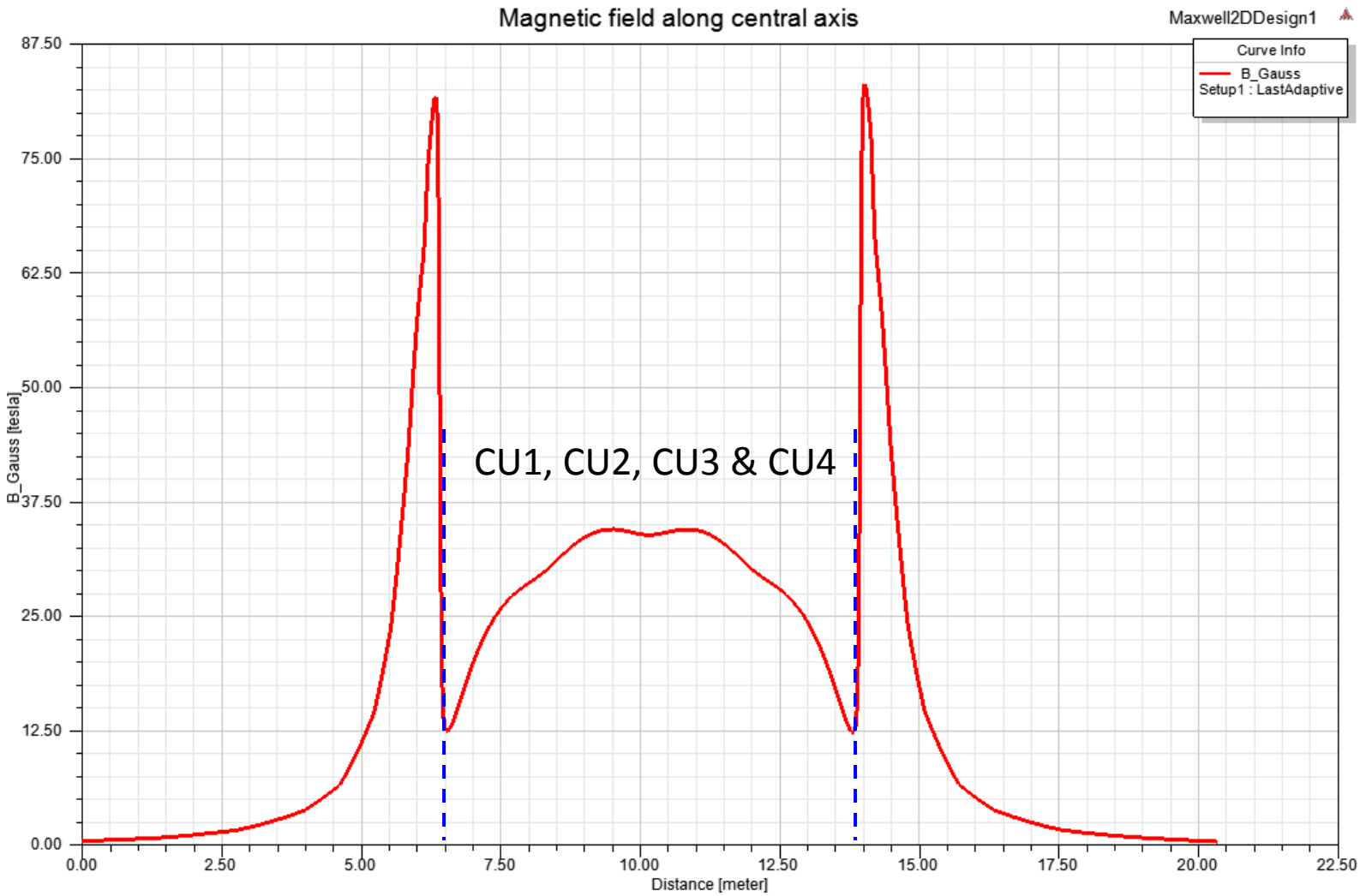
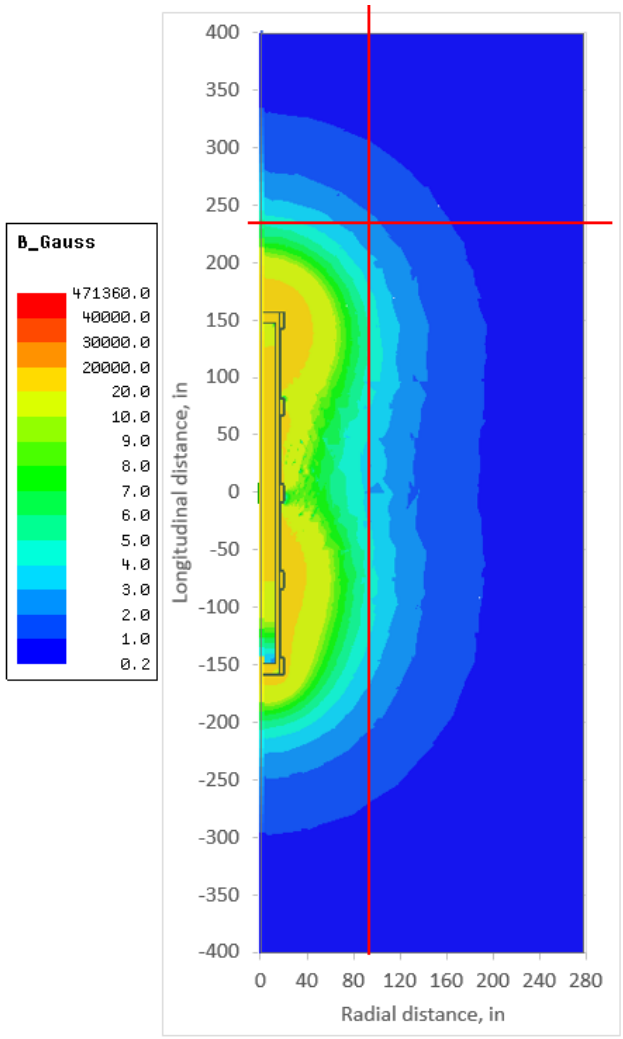


Demag Scheme 2: 300-turn, 65A, 3 Cryounits

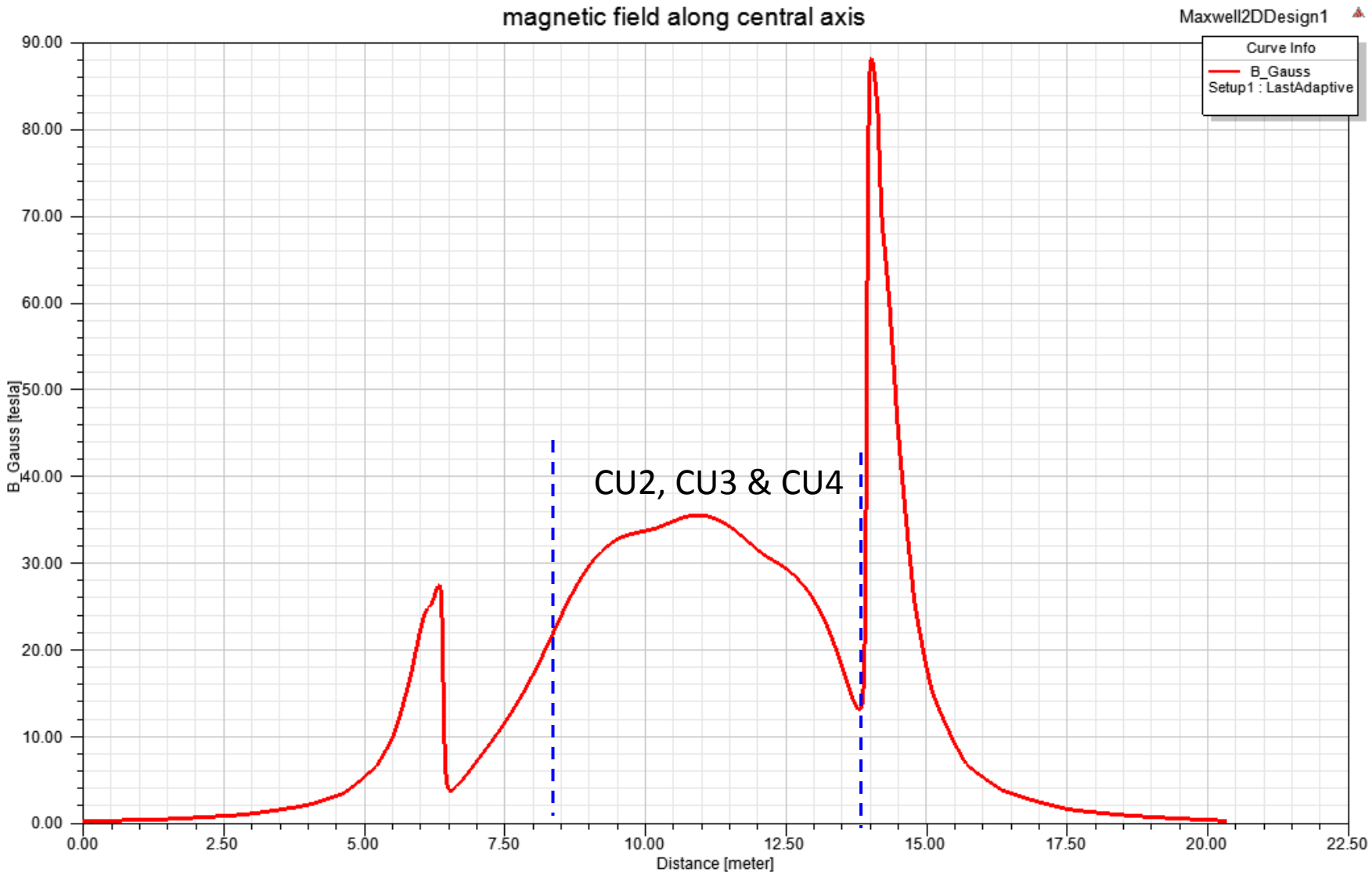
The Bridging ring's outer radius is about 20 inches. And the distance from first to the fifth bridging ring is approximately 316 inches.

The magnetic field plot shows that the 5 Gauss safety field boundary is radially 75 inches/ 6.3 feet away from the exterior of bridging rings and 85 inches/7.1 feet longitudinally away from the end of the last bridging rings.

Again, field > 20,000 Gauss is contained inside the cryomodule. The high field is mainly inside the high permeability magnetic shields.



Demag Scheme 2: 300-turn, 65A, 3 Cryounits

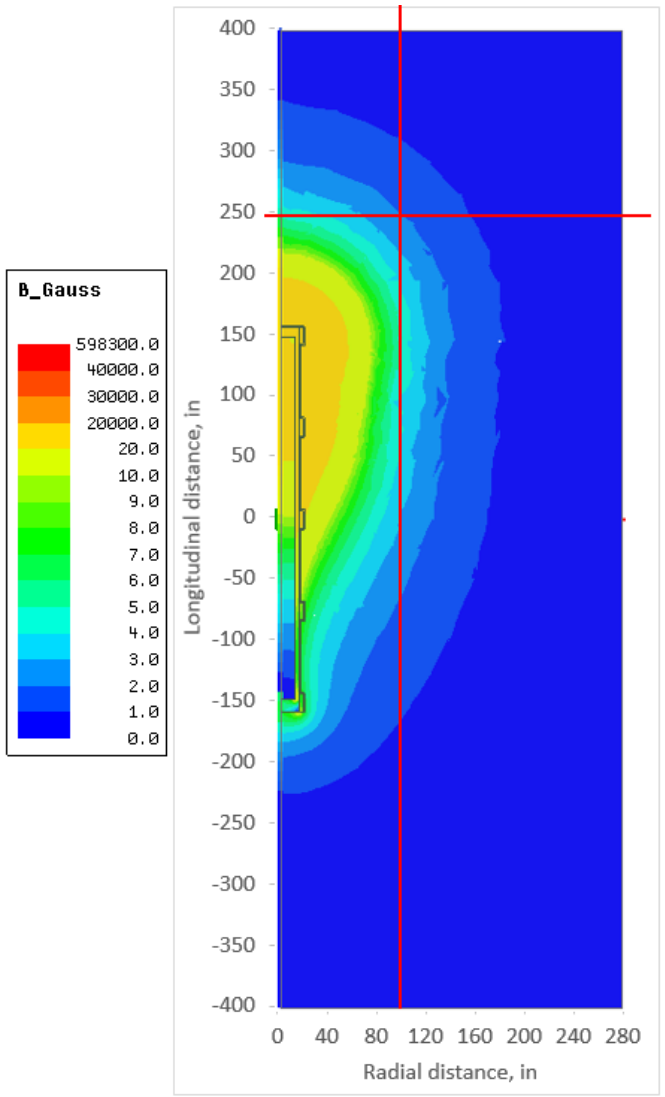


Demag Scheme 3: 300-turn, 65A, 1 Cryounit

The Bridging ring's outer radius is about 20 inches. And the distance from first to the fifth bridging ring is approximately 316 inches.

The magnetic field plot shows that the 5 Gauss safety field boundary is radially 80 inches/ 6.67 feet away from the exterior of bridging rings and 90 inches/7.5 feet longitudinally away from the end of the last bridging rings.

Field > 20,000 Gauss is contained inside the cryomodule. The high field is mainly inside the high permeability magnetic shields.



Demag Scheme 3: 300-turn, 65A, 1 Cryounit