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Magnetized Dusty Plasma Experiment (MDPX) Facility
Plasma Sciences Laboratory
Physics Department
Auburn University
Auburn, AL

Technical Summary Document

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Contact:

Prof. Edward Thomas, Jr., Physics Department, Auburn University
334-844-4126 (office) – 334-844-8508 (magnet lab)
etjr@auburn.edu

Prof. Uwe Konopka, Physics Department, Auburn University
334-844-4248 (office)
uzk0003@auburn.edu

Summary:

The purpose of this document is to provide a technical description of the Magnetized Dusty Plasma Experiment (MDPX) device for potential users and collaborators. While we have attempted to provide an overview of technical capabilities of the MDPX device, this document will likely never contain every detail of the experimental facility. Therefore, we strongly encourage any persons seeking to develop an experiment for MDPX to contact us to get the most up-to-date information.

The MDPX device consists of two integrated components: a superconducting magnet system and a plasma chamber.

Magnet:

The MDPX magnet is a “split-bore” superconducting magnet assembled from 4 electromagnet coils and a surrounding cryostat. The coils are cooled within the cryostat to a nominal temperature of 4.5 to 5 K to maintain a superconducting state. The magnet has a 50 cm diameter, 157 cm long (19.68” dia. x 62.0” long) cylindrical “warm bore” where the strongest magnetic field is generated. The open, split-bore design of the magnet (to be shown in the upcoming pages) means that items placed in the magnet can be accessed both from the ends of the magnet as well as radially – allowing substantially greater diagnostic access to the regions with high magnetic field.

The MDPX device is designed to achieve a central, uniform magnetic field of up to 4 T. However, unlike MRI magnets, the magnetic field of the MDPX device is designed to be reconfigurable from uniform to gradient conditions over a range of magnetic field settings. The capability to produce a variety of magnetic geometries “on demand” is a unique feature of the facility.

Vacuum chamber:

The primary vacuum chamber used on the MDPX device for dusty plasma experiments is an octagonal chamber with height of 17.78 cm and an inner diameter of 35.56 cm (7” tall x 14” inner dia.). The eight chamber sides have large 5” tall x 4” thru ports that accommodate windows or adapt to ISO-vacuum standard KF63, KF40, and KF25 vacuum ports. The top and bottom covers of the vacuum chamber have a large, 6” diameter port that can accommodate 36” long extensions tubes that expand the overall length of the plasma chamber to over 6 feet long. The top and bottom covers also have several KF25 ports for diagnostics.

Integration:

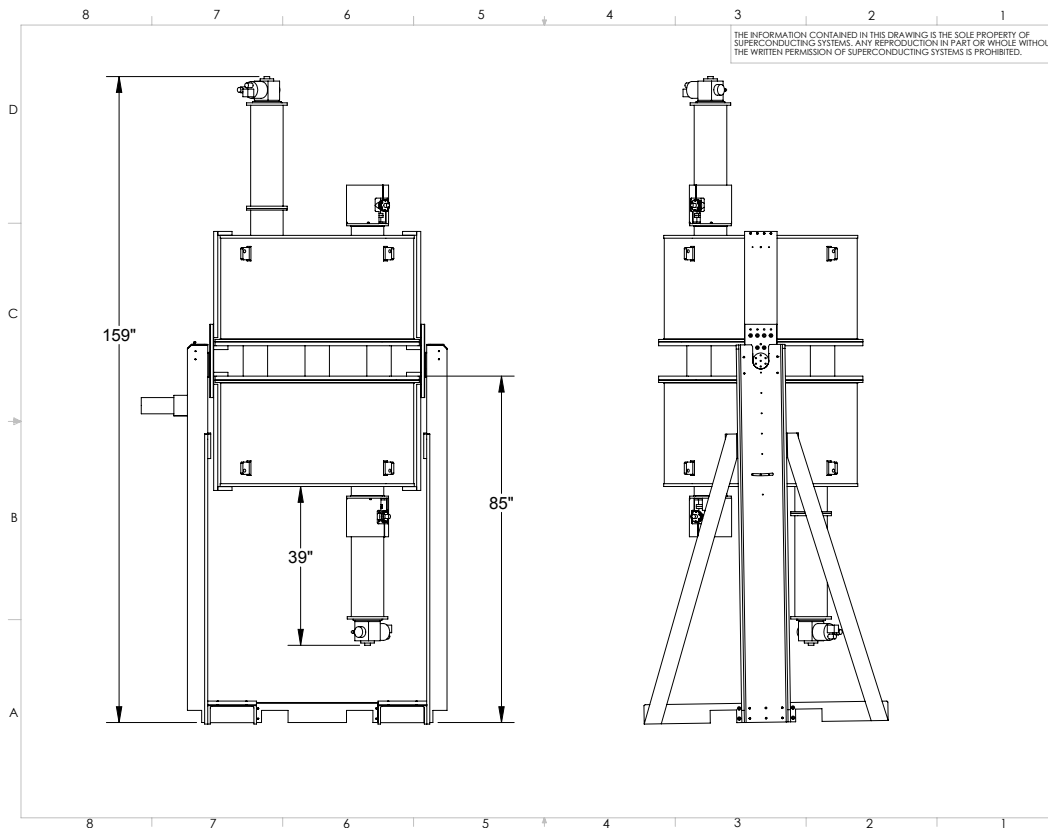
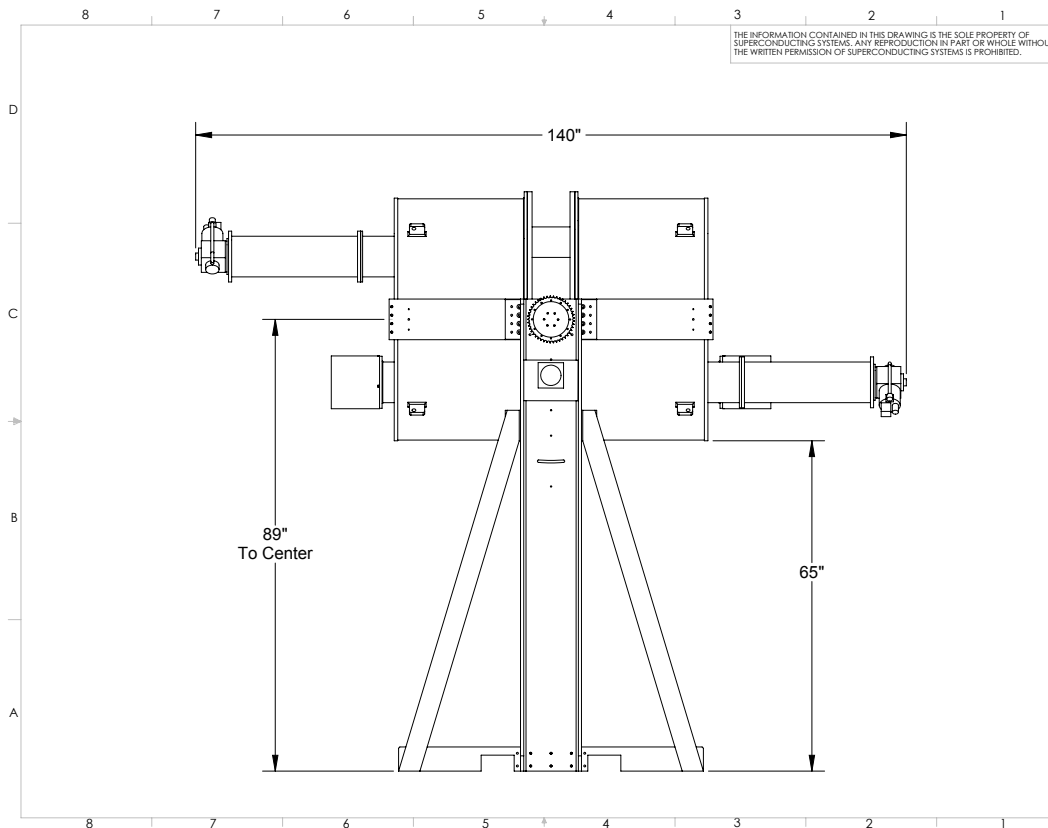
The two components are connected to each other using four aluminum brackets. There four mounting points are easily accessible through the split-bore and can rapidly be disconnected. This means that it is relatively easy (say within 1 to 3 days – depending upon the number of additional diagnostic system that have to be moved) to remove the vacuum chamber from the bore of the magnet and “swap” it with an alternate vacuum chamber or other structure that is to be placed in the bore – provided that the new device uses the same mounting points.

We believe that this flexibility of design will enable the MDPX device to serve as a research instrument for a variety of plasma physics and dusty plasma physics experiments (which is its primary mission). Moreover, this flexibility means that the device can be easily reconfigured to perform a variety of different scientific studies beyond plasma science.

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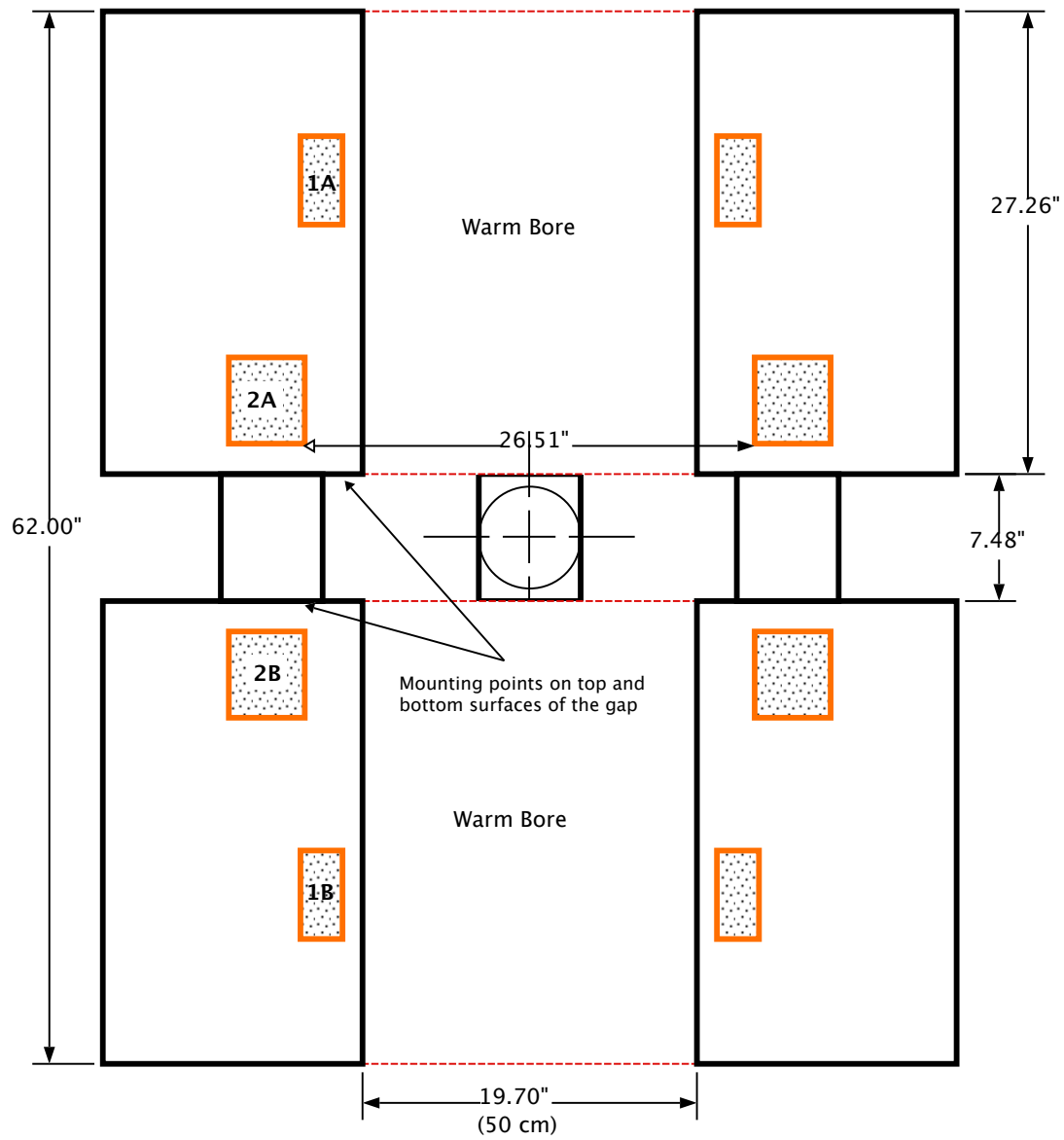
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Figure 1: Overall dimensions - courtesy Superconducting Systems, Inc. [SSI]



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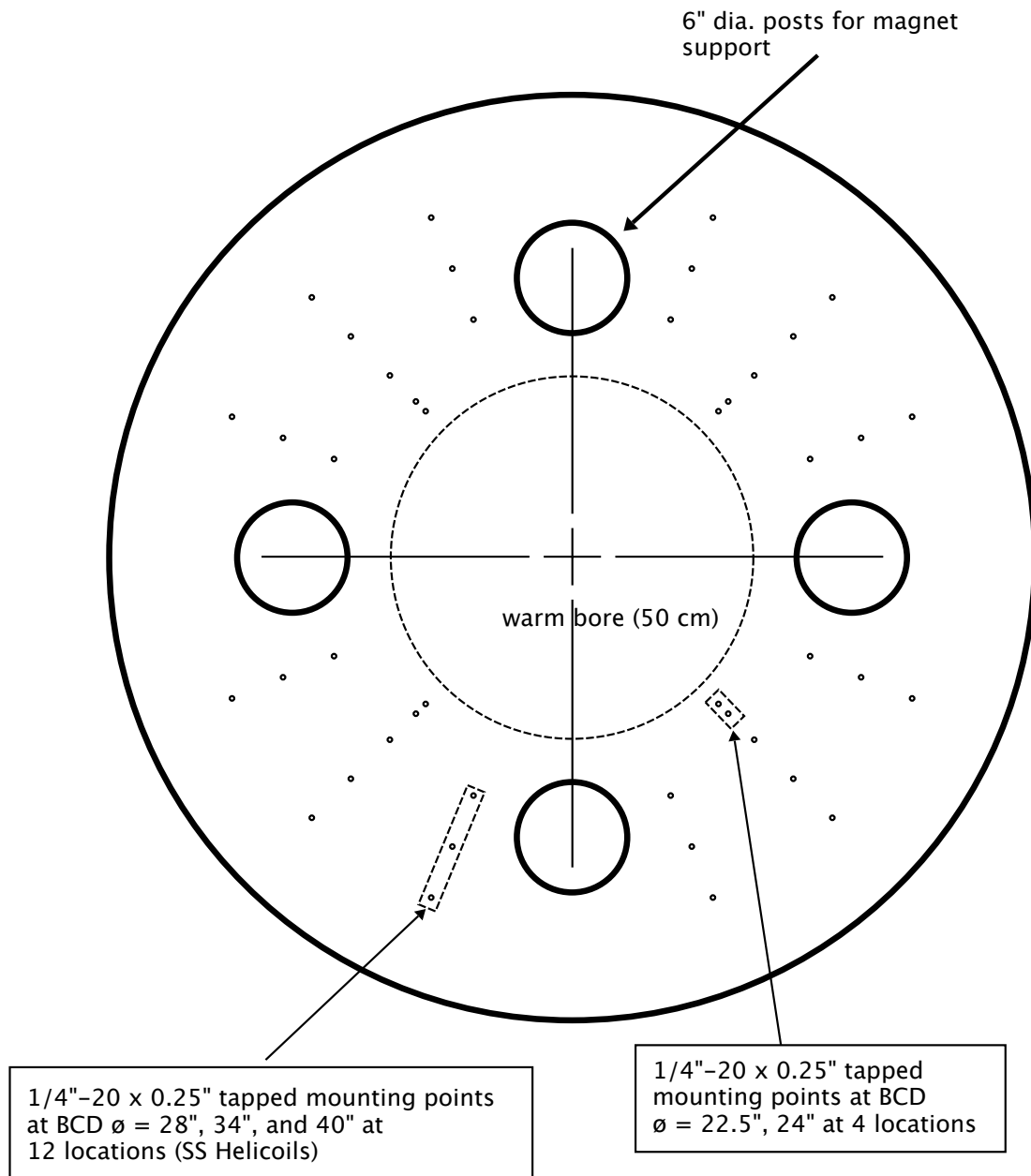
Figure 2: Schematic drawing of the magnet cryostat



Drawing: MDPX – Magnet Cryostat
By: E. Thomas, Jr.
Plasma Sciences Laboratory
Auburn University, Auburn, AL

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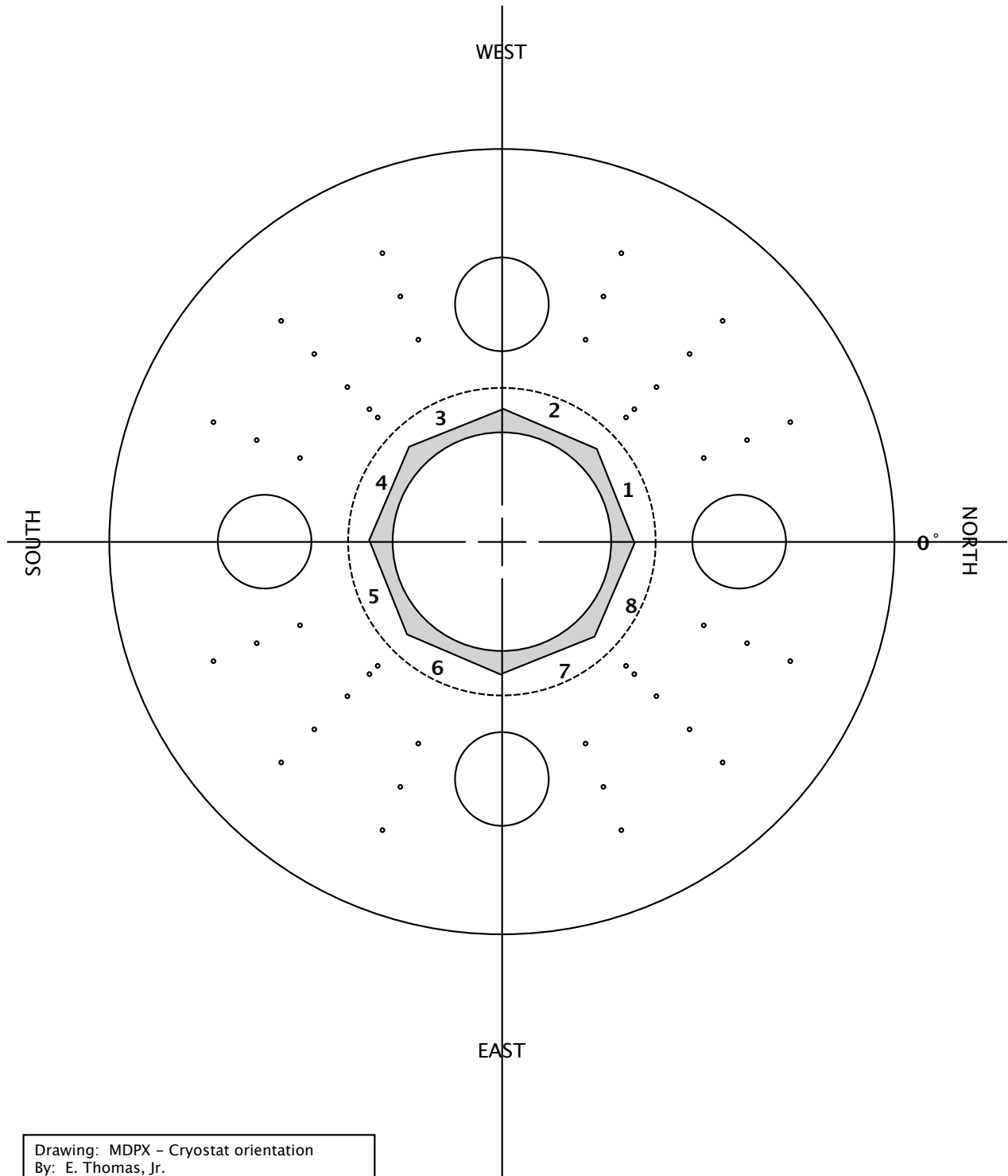
Figure 3: Cryostat mounting points



Drawing: MDPX – Cryostat mounting points
By: E. Thomas, Jr.
Plasma Sciences Laboratory
Auburn University, Auburn, AL

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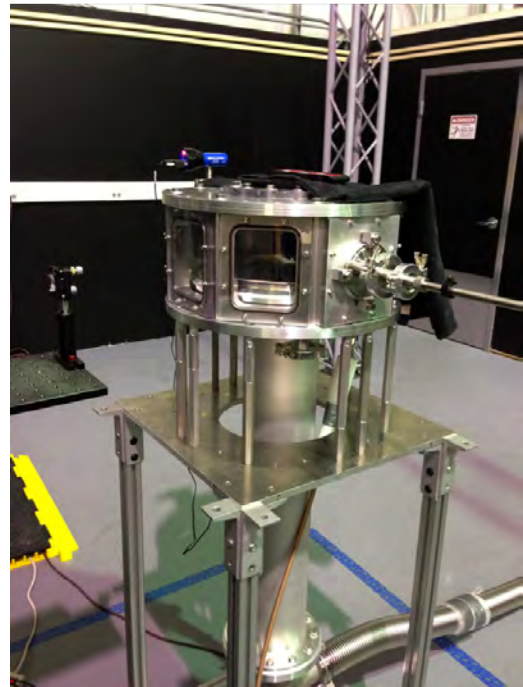
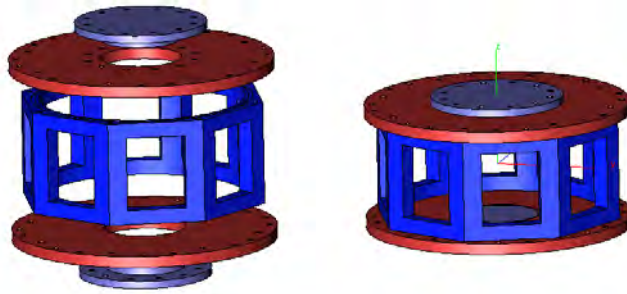
Figure 4: Cryostat and vacuum chamber orientation (number indicate port designation)



Drawing: MDPX – Cryostat orientation
By: E. Thomas, Jr.
Plasma Sciences Laboratory
Auburn University, Auburn, AL

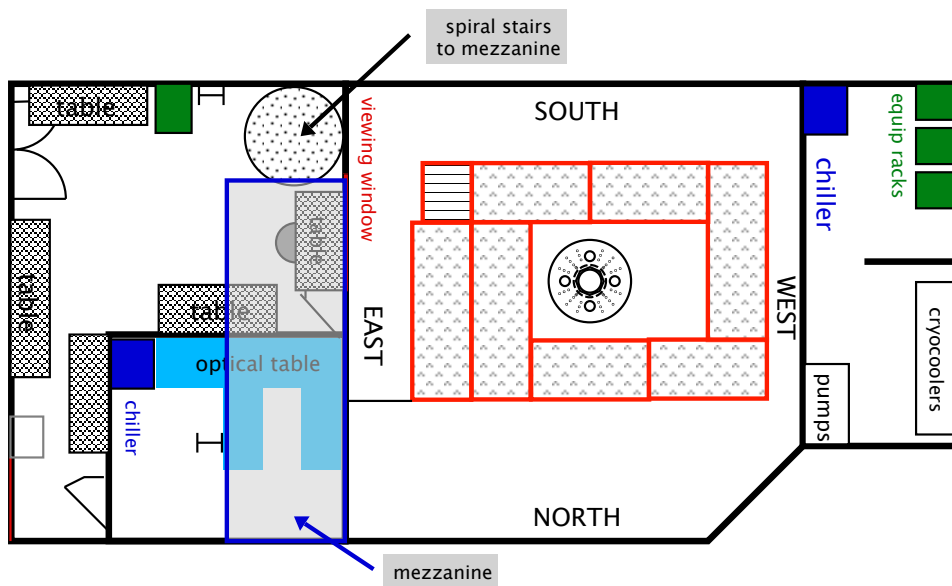
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Figure 5: MDPX vacuum chamber – design and photographs (before integration into magnet)



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Figure 6: Overview photograph and design of the Magnet Lab

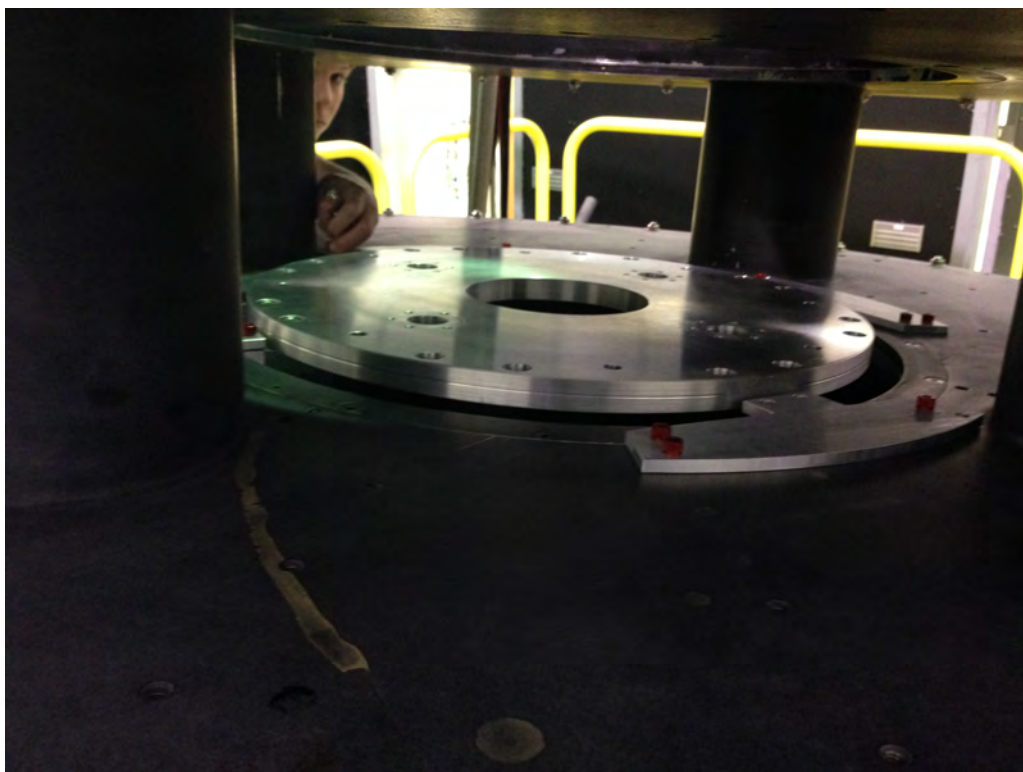


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Figure 7: Photograph of magnet cryostat showing split bore design



Figure 8: Photograph of mounting bracket



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Figure 9: Photograph of plasma glow in MDPX plasma chamber



Figure 10: Preliminary diagnostics for dusty plasmas experiments (July, 2014)

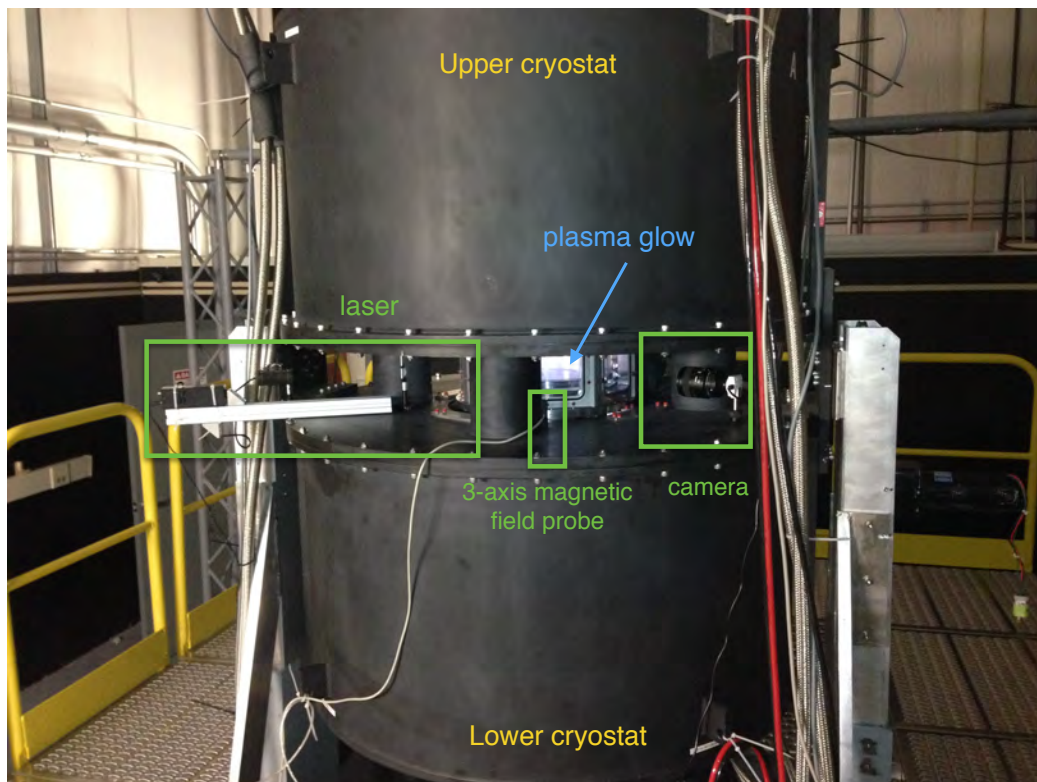
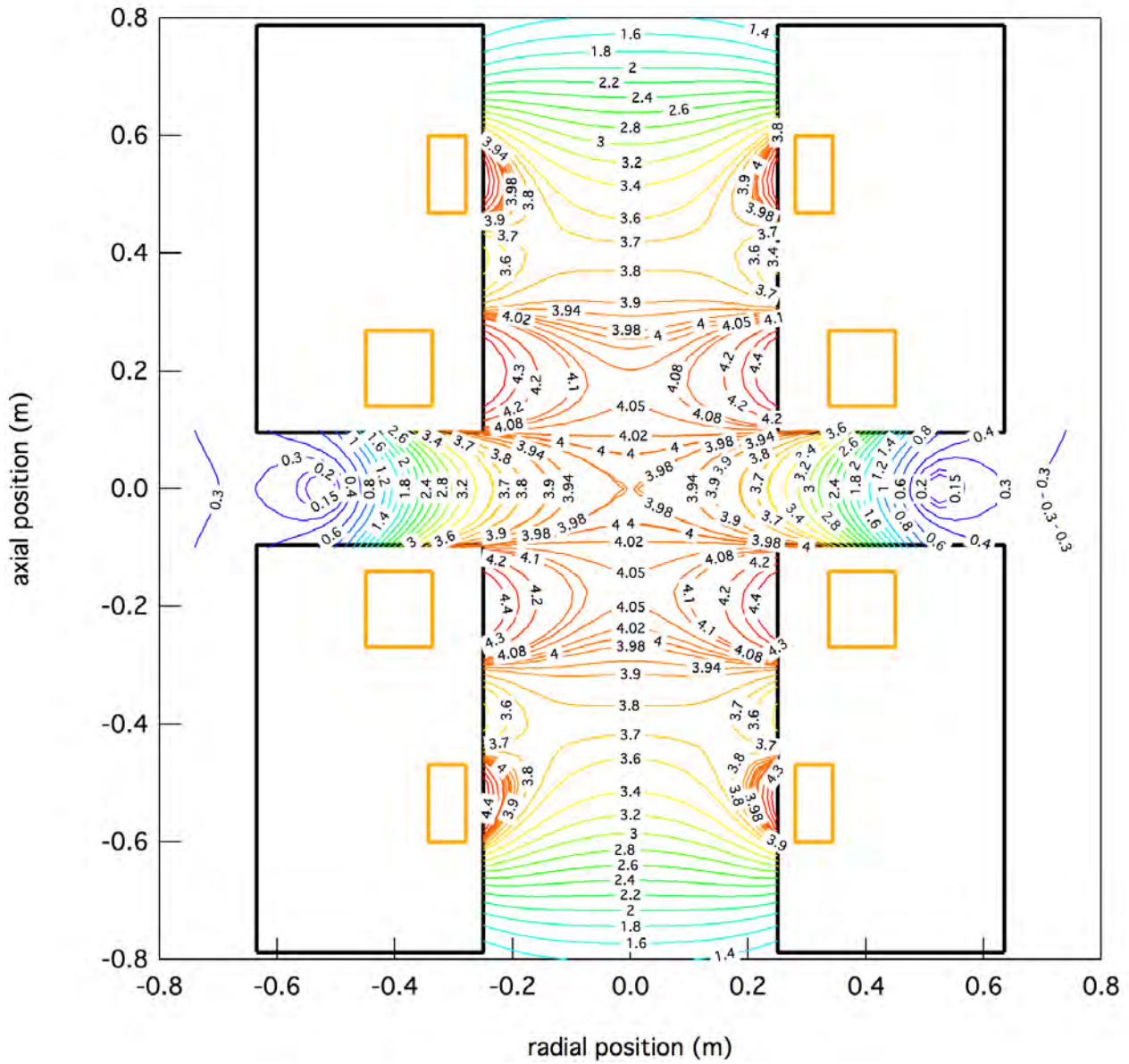


Figure 11: Magnetic field contour calculations – uniform field
[Based upon calibrated field model 7-31-14 for a central field of $B = 4$ T]

(a) Whole device magnetic field contour



(b) Central bore magnetic field contour

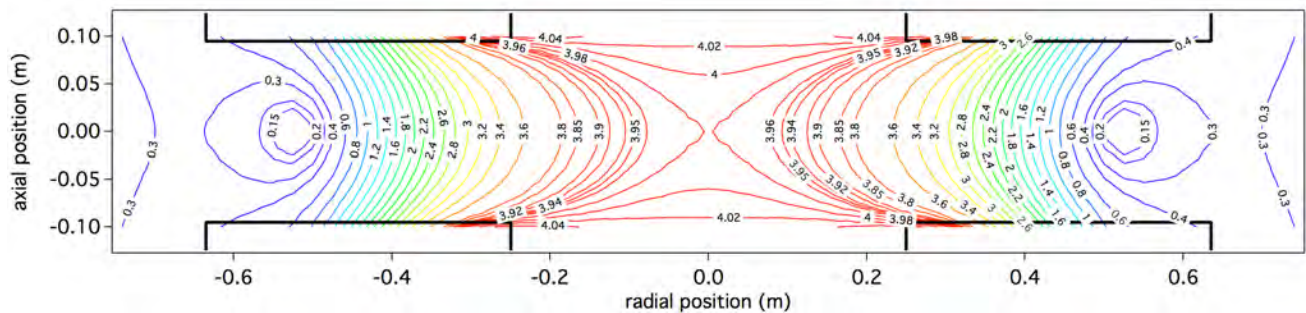
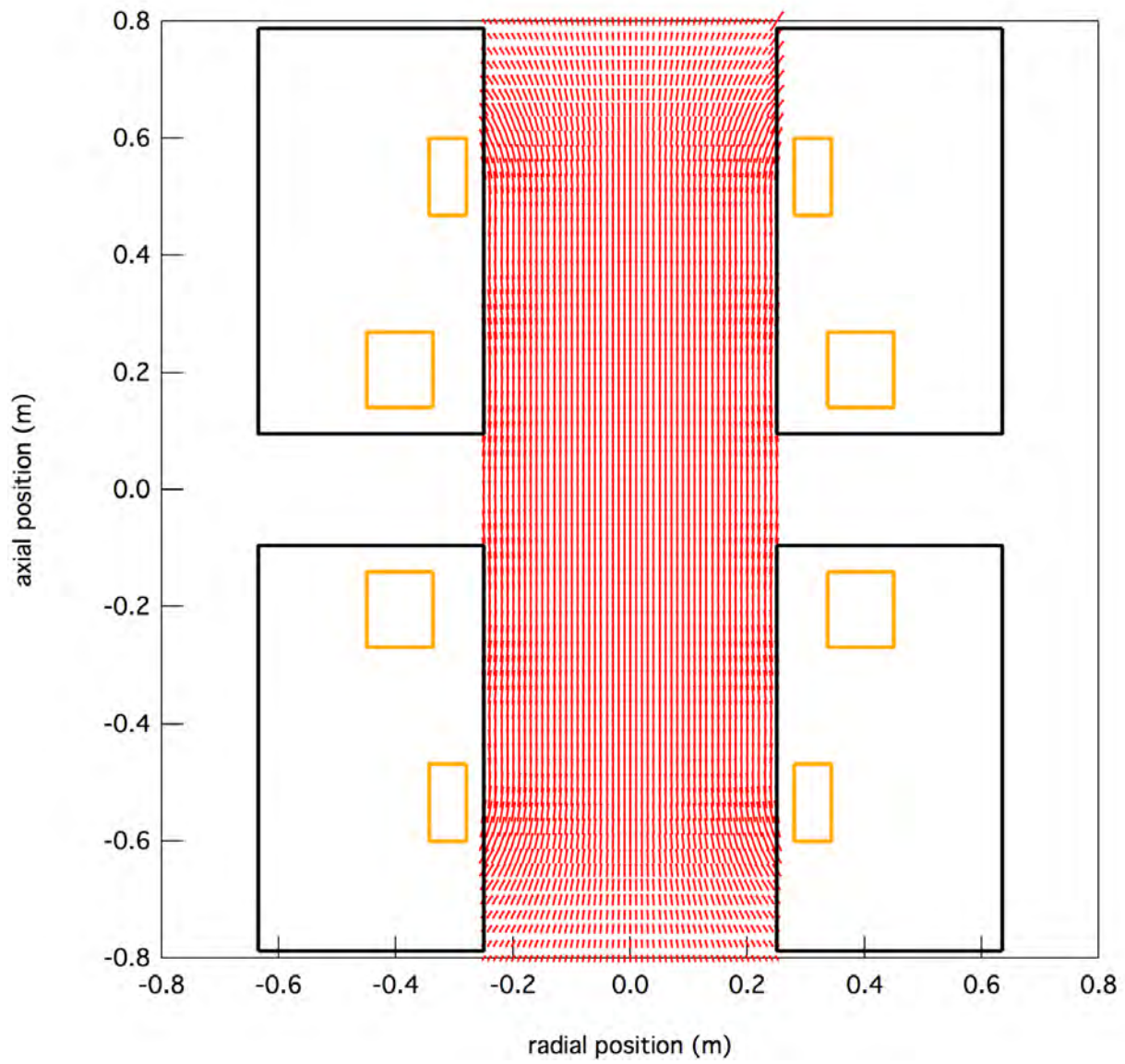


Figure 12: Magnetic field vector calculations – uniform field

(a) Whole device magnetic field vectors



(b) Central bore magnetic field vectors

