The Magnetized Dusty Plasma Experiment (MDPX) device: first observations

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A dusty (or complex) plasma is a four-component plasma system consisting of electrons, ions, neutral atoms, and charged, nanometer to micrometer-sized particles (i.e., the "dust"). Because these dust grains are charged, they fully participate in the plasma dynamics and can be used to reveal details about transport, instabilities, and charging properties of plasmas. However, one important area that has not been studied extensively is the area of magnetized dusty plasmas. Even though the charged dust grains in a typical laboratory experiment can acquire several thousand elementary charges, the large mass of the grains ensures that the charge-to-mass ratio is quite low. As a result, it is technically challenging to design an experiment that can achieve full magnetization of ions, electrons, and the charged dust grains.

The Magnetized Dusty Plasma Experiment (MDPX) device is a flexible, multi-user research instrument that is being used to study the physics of highly magnetized plasmas and magnetized dusty plasmas. The MDPX device uses four independent superconducting coils to produce a variety of magnetic field configurations: from a uniform field mode at greater than 4 Tesla to a linear gradient mode at up to 2 T/m. Plasmas are produced in a large octagonal chamber that has a 35 cm inner diameter and an axial length of 19 cm. With the addition of two, 15 cm diameter, 76 cm long cylindrical extensions, the vacuum vessel can have a length of over 170 cm. A broad range of probe and optical diagnostics (e.g., particle image velocimetry, high speed imaging, laser induced fluorescence, etc.) are used for plasma measurements. Initial operation of the MDPX device will begin in late Fall, 2013. This presentation will report on the construction, assembly, and initial plasma operations of the MDPX device.