Prototype at U4A

The first prototype VPPEM microscope was built at the National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory (BNL) on beamline U4A. Figure is a simplified rendering showing the main features of the equipment. The superconducting magnet has a 7 Tesla maximum field with 90mm clear air bore through which the UHV vacuum system is fitted.

The superconducting solenoid sits at the center of a mild steel enclosure approximately a meter on the side horizontally. A low carbon steel cylinder extends the field away from one side of the enclosure. Because of uncertainty about the strength of the mounting structure of the magnet within its cryostat we have only taken the magnet to 2.5 Tesla at present.

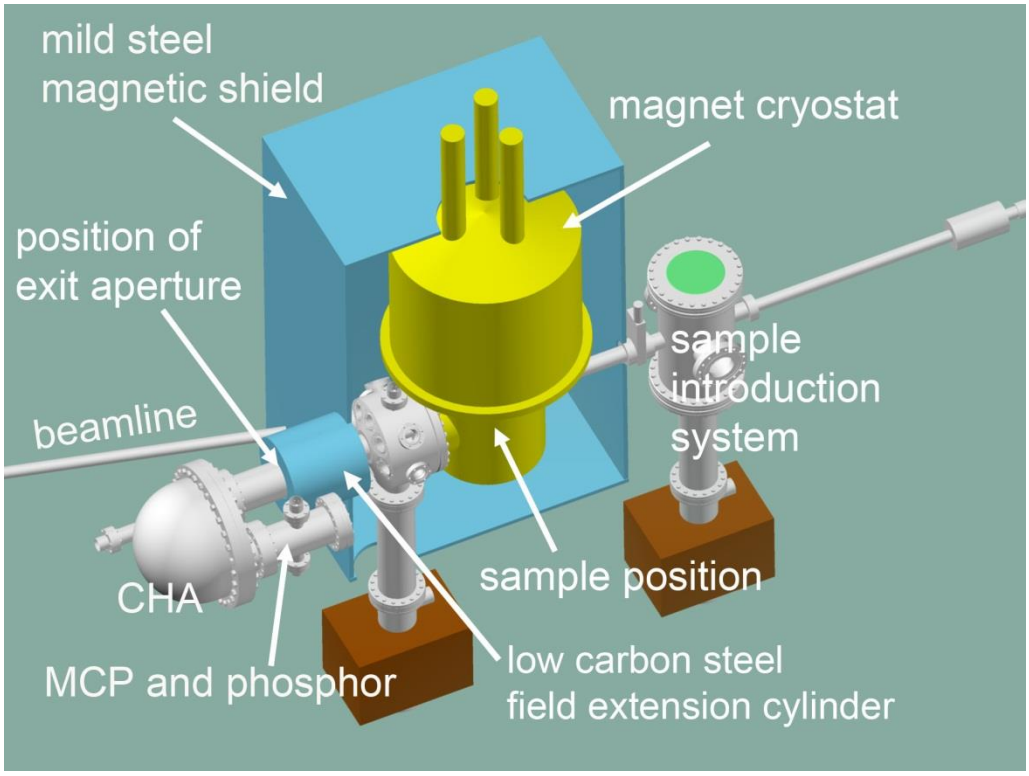

Figure 1 Rendering of the prototype VPPEM at U4A

There are image steering coils within the steel cylinder, and an external coil around the cylinder to reduce stray fields that otherwise penetrate the CHA shielding. The field exit aperture which sits at the end of the cylinder is made from an annealed soft iron ring with a 40 mm internal diameter. The magnetic field at the sample is typically 1.8 Tesla, and the photoelectrons exit the field at 0.0015 Tesla.

The center of the soft iron ring defines the microscope axis. The alignment of the solenoid and the ring is not critical.

The aluminum UHV sample chamber and port chambers, Figure, fit though the air bore. The sample is supported by a three axis stage at the center of the vector potential field. The port chamber has a variety of ports to allow a beam line to illuminate the sample, and to view the sample position optically. The connections between the port chamber and the CHA are all aluminum vacuum fittings. All aluminum was

found to be a critical part of the design. Earlier stainless steel parts became magnetized and distorted the image.

There is ample volume to add evaporators, and other instruments around the sample. Sample preparation, and cleaning are in process of implementation.

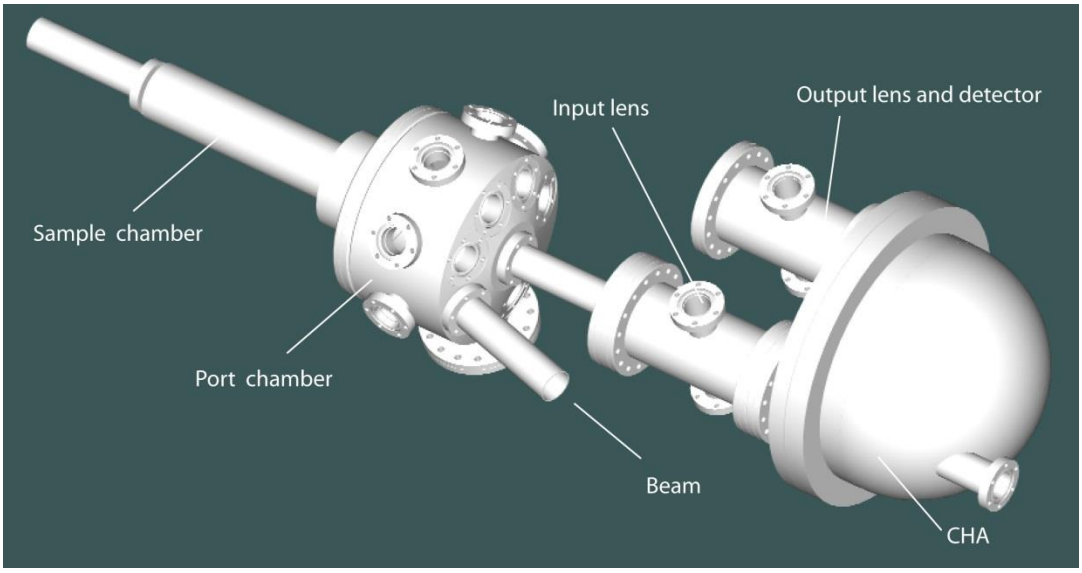

Figure 2 Rendering of VPPEM vacuum system, version 1

The following images show the various parts at different stages of development.

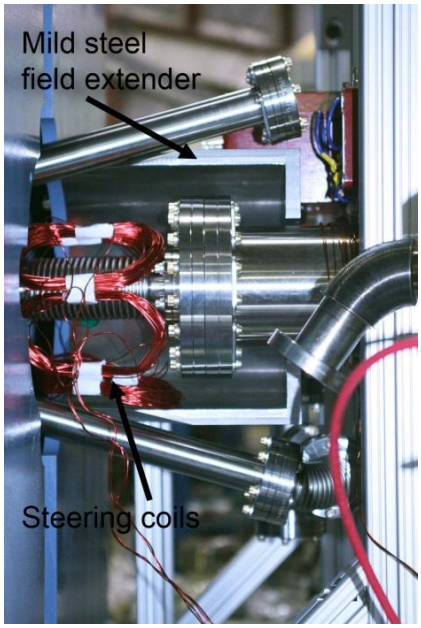

Figure 3 Steering coils in mild steel field extender

The steering coils with stainless steel fittings are shown in Figure . This implementation has the Fe ring inside the 6" vacuum fitting at the end of the mild steel field extender. Later implementations had the Fe ring outside the vacuum, see Figure . The current implementation with a custom Al fitting has the Fe ring again within the vacuum.

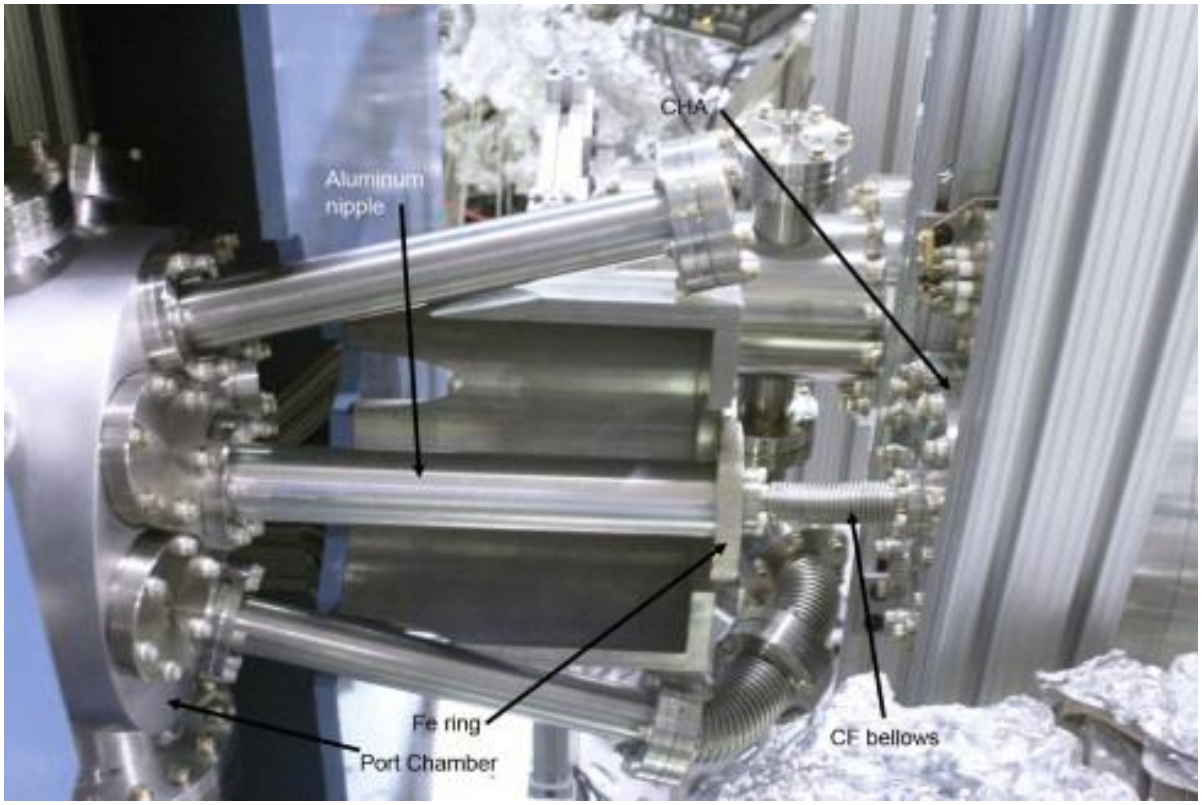

Figure 4 Al vacuum fitting showing pure Fe ring field termination

Sample introduction and manipulator

The sample introduction and preparation system has been recently upgraded to include a vacuum air lock, ion cleaning, and a three axis manipulator. The sample manipulator is rather complicated mechanically. A

counter weight is used to balance the weight of the manipulator and sample introduction bellows so that the micrometers can operate smoothly. This system is shown in Figure and Figure .

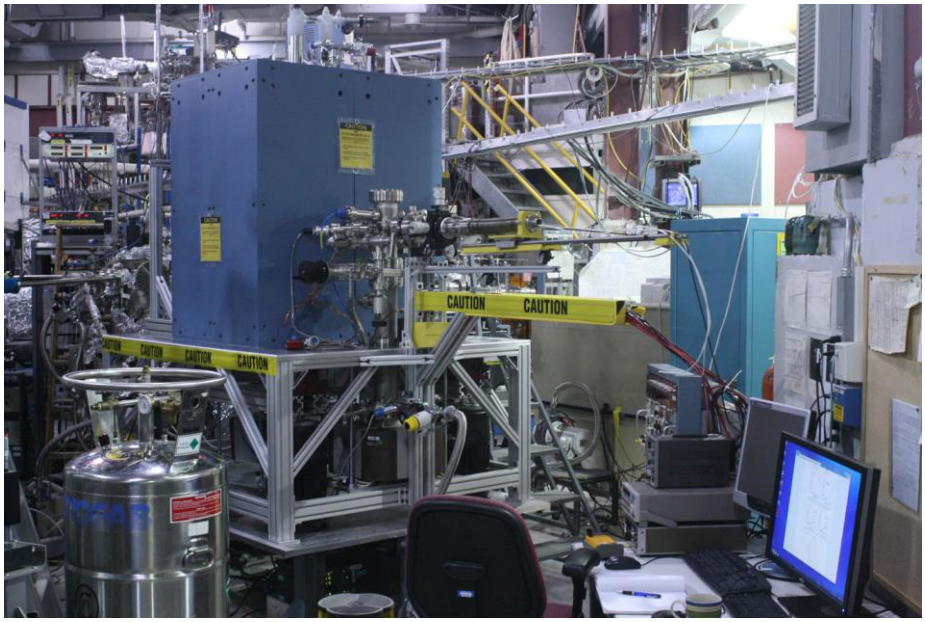

Figure 5 General view of VPPEM and sample introduction system with a long throw bellows, ion gun, and vacuum lock.

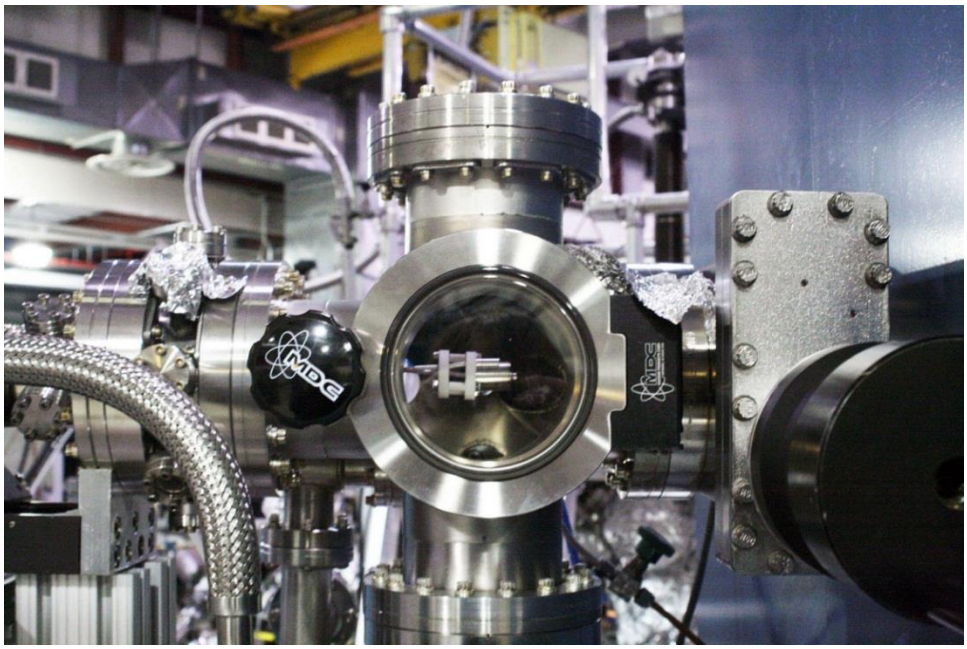

Figure 6 Sample mount in exchange chamber. The sample is mounted on a SEM like Al stub that fits into the sample mount.

The sample is mounted on an SEM type aluminum stub which fits into a support assembly that also acts as a ground electrode symmetrically around the stub. The sample stub is isolated and is connected to a HV power supply. In Figure a gold grid can be seen covering the Figure

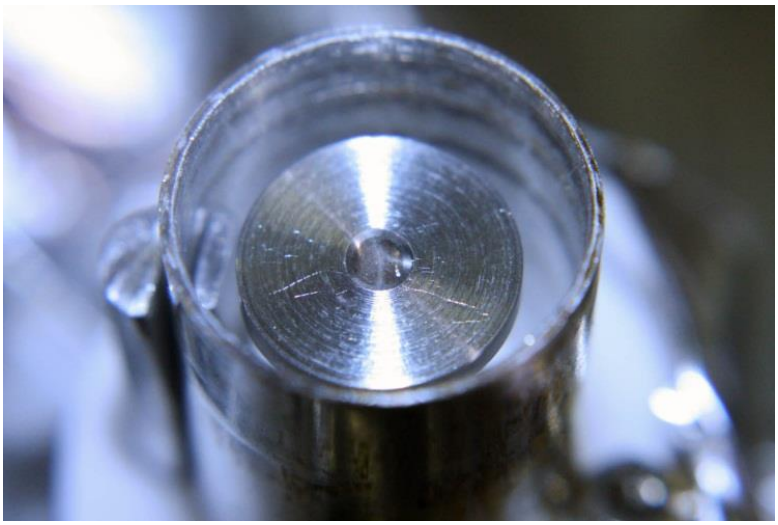

Figure 7 Au grid on sample stub