This is the basic outline of the prototype system. Other implementations may look different, but will have similar elements. A VPPEM as an electron optical system has several basic parts: a magnet, a field termination, and an imaging analyzer. However, each of these parts is complex in theory and practice. Also, the operation of the microscope depends in a rather complex way on the interaction of the parts, and on the beamline. So while we will break the instrument down into its parts to describe it, in practice we have found that to make it work we need to look at it as a complete system.

The VPPEM will be composed of the following subsystems:

1. Electron Optics
    a. Magnetic electron optical system including: magnet, field termination, alignment, scanning, and shielding system
    b. Electrostatic electron optical system including: energy scanning, imaging energy analyzer (CHA), analyzer input and output optics, image detector
2. Superconducting magnet support with cryogen and power supplies
3. Sample handling, microscope stage, sample introduction, and preparation
4. Vacuum system including: main chamber, pumping stacks
5. Support system including: antivibration table, equipment alignment, and access
6. Beamline

It is useful to think of the microscope split into two, first a magnetic part with the sample sitting in the vector potential, and second the electrostatic energy analysis with image formation.

Figure 1 Magnetic electron optics shows the main elements of the magnetic electron optical system.

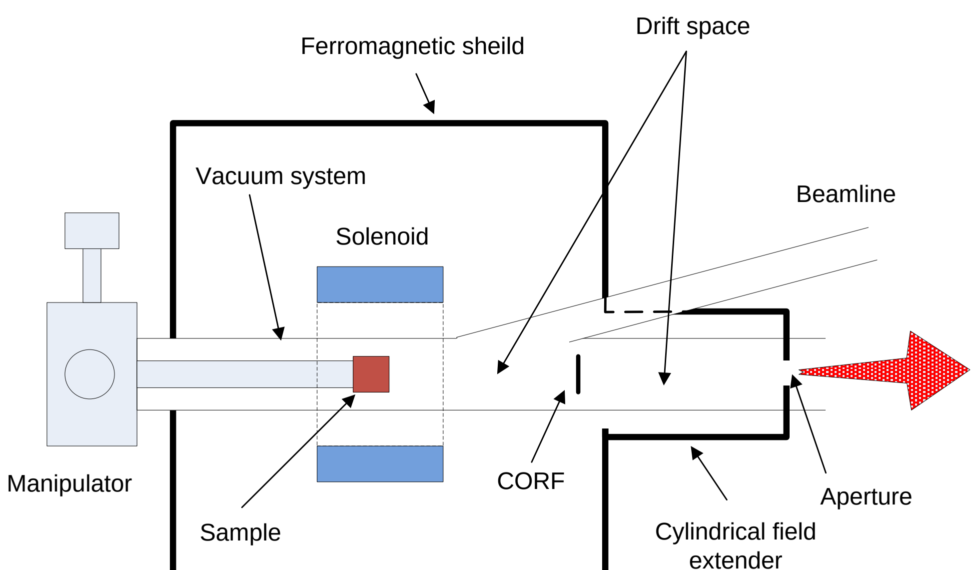

Figure 1 Magnetic electron optics

A high current solenoid, a superconducting magnet, sits within a ferromagnetic shield which also acts as a loosely connected yoke for the magnet. The solenoid provides the vector potential spatial reference.

There is a drift space over which the field decays by several orders of magnitude. There is a vector field termination aperture which is a magnetically soft annealed pure iron ring that sits at the end of the field extender. The sample sits just forward of the center of the vector potential field.

Not shown in

Figure 1 are some additional elements. There is an alignment optics which for the prototype is provided by x,y pancake coils that sit inside the cylindrical field extender. There are also field bucking coils around the field extender that reduce the stray field cast towards the CHA. There is also a field coil around the CHA to further buck this stray field to a value below the saturation limit of the CHA mu-metal shielding. The vacuum system inside the ferromagnetic shield is aluminum with Ti conflats.

Electron energy selection depends on the potential set on the stage and the subsequent acceleration/deceleration of electrons from the sample. The exit energy from the magnetic optics that is accepted by the CHA is currently 75eV.

Figure 2 shows the VPPEM electrostatic optics.

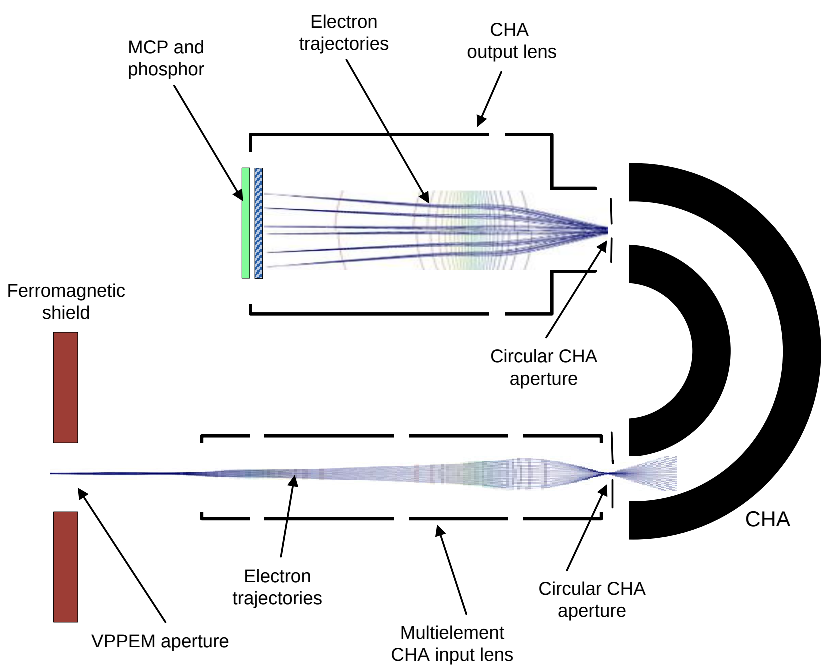

Figure 2 Electrostatic electron optics

The electrostatic system consists of a CHA input lens which acts as a condenser of the angular image from the VPPEM aperture in the ferromagnetic shield. The CHA has circular entrance and exit apertures which are currently both 2mm. The output lens is a three element lens, but currently is used as a two element lens. The output lens projects the monochromatic angular image out of the CHA as a real image onto a microchannel plate and a phosphor coated fiber optic window.