Magnetic Field

IPM are non destructive devices to measure the beam profile in accelerator rings. The beam ionizes the residual gas, mainly hydrogen. The residual gas ions are accelerated transversal to the beam by an electrical field toward a particle detector that is spatial resolving. Depending of the electrical field one can detect the residual gas ions or residual gas electrons. The electrical field box used in the heavy ion synchrotron (SIS) at GSI provides an aperture of about 180mm x 180mm. The residuals gas ions need about 350 ns to travel from the ionization area to the particle detector. The residual gas electrons just need about 7ns. To measure fast changes of the beam profile it is desirable to operate the IPM in a turn by turn mode. This fast measurement requires the detection of residual gas electrons. The space charge effect leads to large dispersion of the residual gas electrons. To overcome this problem it is needed to apply additional to the electrical field a parallel oriented magnetic field, see figure 1.

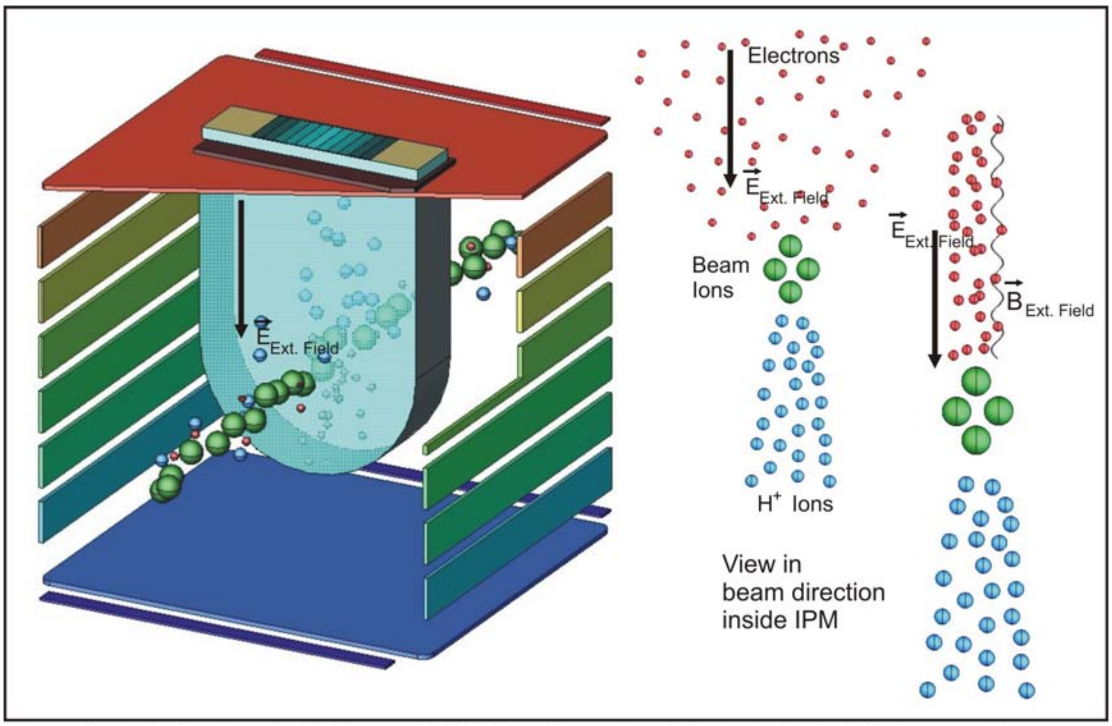

Figure XX: Ionization Area inside the electric Field box. Expansion of the ionized cloud due to space charge effects, with and without magnetic field due to space charge effects.

Figure 1: Ionization area, ion detection w/o magnet and electron detection with magnet.

The beam profile measured with an IPM is based on a projection of the beam. So the beam profile delivers information about one transversal direction. To measure the horizontal and the vertical beam profile it is meaningful to place two IPM after another, see figure 2. The second IPM is turned by 90° around the beam axis with respect to the first IPM. Each IPM is equipped with its own magnetic field. The magnetic fields affect not just the residual gas electrons but also the beam. To minimize the beam shift by the magnetic field two corrector fields are installed per main dipole.
An electrical window frame magnet seems to be the best solution. The difficulty is the need of two holes per dipole in the yoke to view the phosphor screen and to calibrate the

MCPs, see figure 2. The calibration is done by UV light with a wavelength of 120nm. The MCP illuminated by this light produces secondary electrons that can be seen with a phosphor screen and camera as so called dark counts.

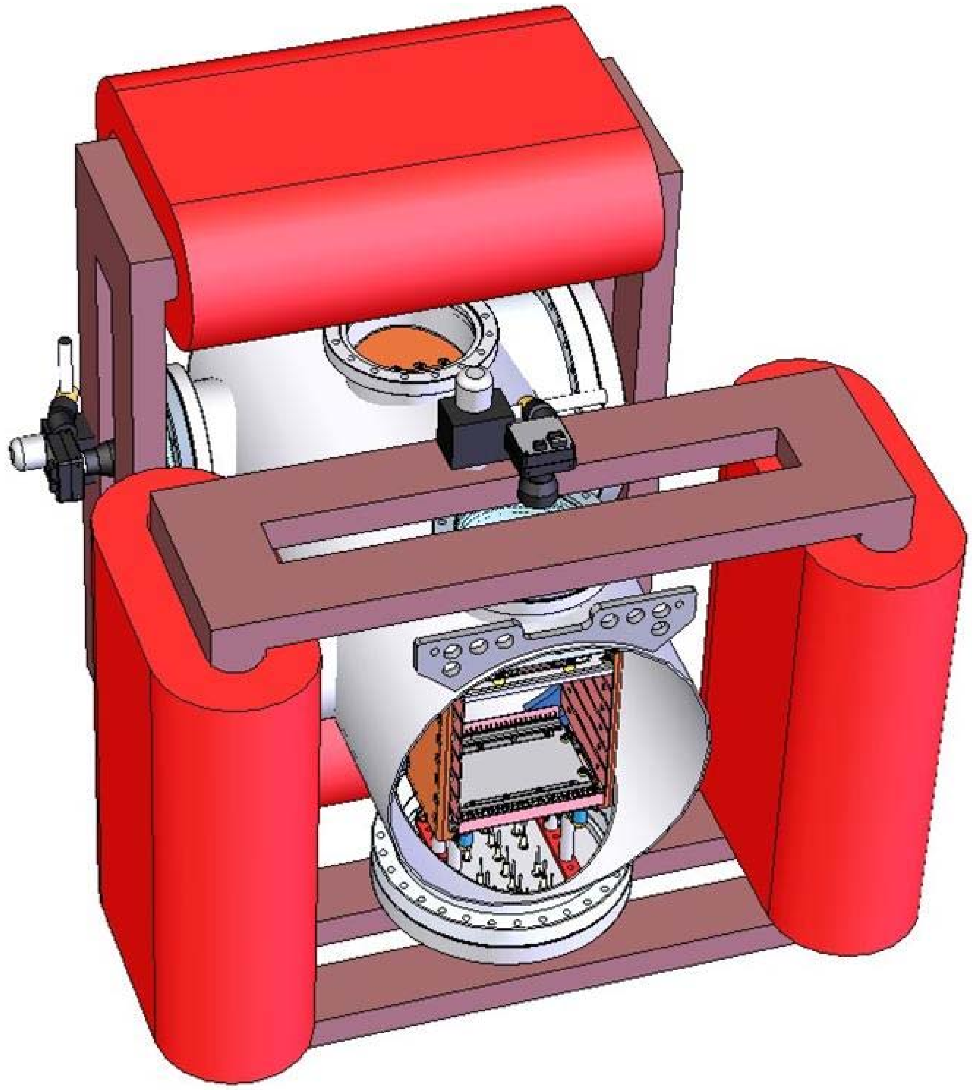

Figure 2: Two main dipoles attached to the vacuum tank. Corrector magnets are not shown.

Conclusion / Tasks:

The main task is to design a magnet that provides a uniform magnetic field. The magnet has two slits / holes to watch the phosphor screen inside the vacuum and to illuminate the MCPs inside the vacuum by a UV lamp that is located outside the vacuum. Camera and lamp are arranged opposite of each other. The next step is to design two corrector magnets that minimize the beam shift effect of the main magnet.

The final step is to design a full magnetic channel with 2 main magnets and 4 corrector magnets, whereby the magnetic field directions of the main magnets are turn by 90° around the beam axis.