IPM
Ionization Profile Monitor

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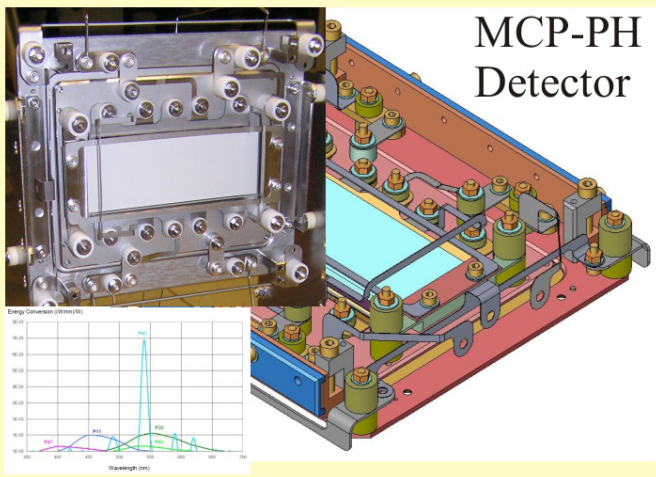
DITANET 2009 LONDON

Abstract

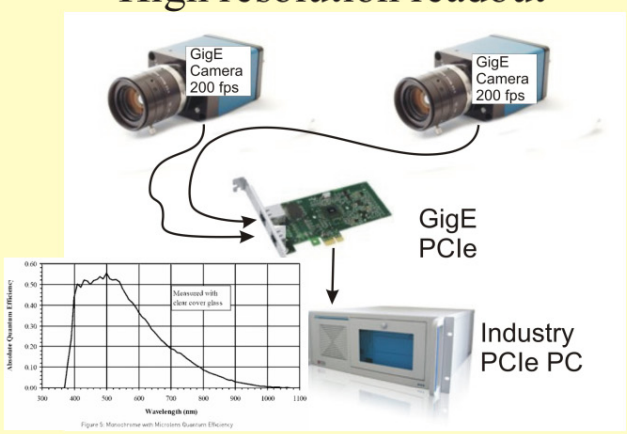
IPMs measure the beam profile in a non-destructive way. Our application is the heavy ion synchrotron SIS @ GSI in Germany. The SIS can accelerate ions with a large variety of different masses and charges. The IPM delivers beam profiles of a full accelerator cycle, from beam injection to extraction. It is used to obtain informations about the beam matching, the electron cooling and to support for any kind of machine experiments. The system consists of an electrical field box with an upstream MCP-Phosphor detector. The beam profiles are read out with GigE CCD cameras. The MCP calibration is done via an UV lamp. To realize a turn by turn readout mode a magnetic field of 30mT is applied outside the vacuum in parallel to the electrical field. To enlarge the MCP livetime a fast switch is integrated in the high voltage system. The whole device was planned with respect of high field uniformity and small mechanical dimensions at a large aperture of 180mm x 180mm.

MCP-PH Detector



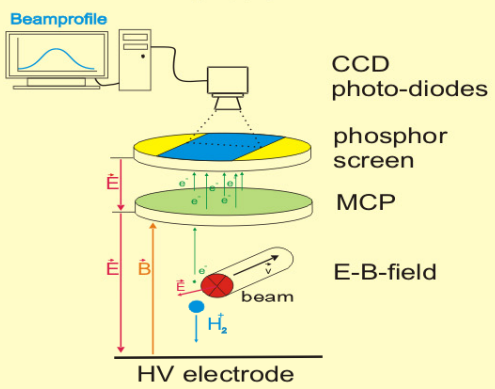
Rectangular MCP-Phosphor module, active area 96 mm x 38mm.
MCPs in Chevron configuration, gap = 100µm. Module size 180 mm by 170mm. Insulators are made of glass ceramic.

High resolution readout

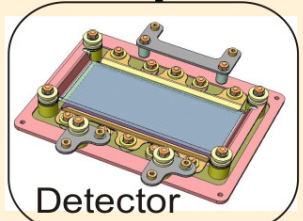


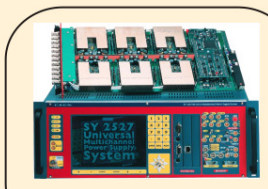
Data are readout by digital GigE CCD cameras connected to a PC via ethernet cables. A PCIe x4 GigE Vision card process the large amount of data. In the turn by turn mode the CCD cameras are replaced by a 32x photomultiplier array with downstream DSP electronics.

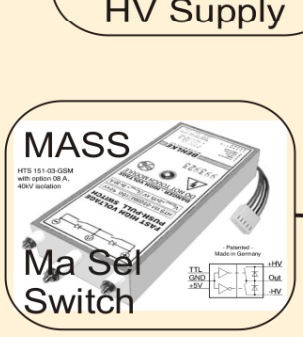
IPM function

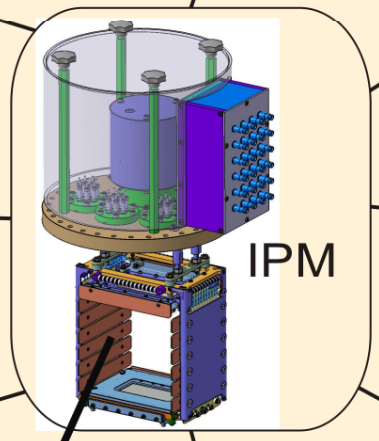


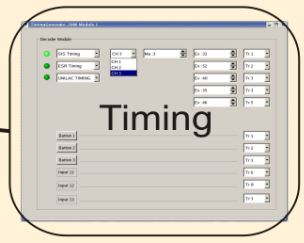
The beam ionizes the residual gas inside the accelerator. The ionization products are accelerated toward the MCP-Phosphor detector also inside the accelerator. The light of the phosphor screen can be detected from outside the accelerator through a viewport.

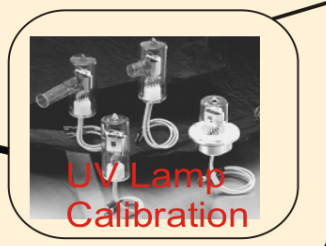


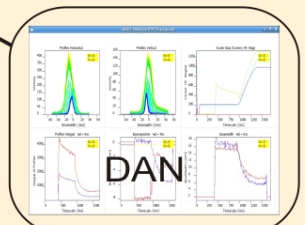


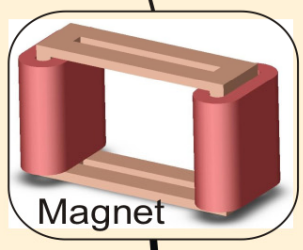


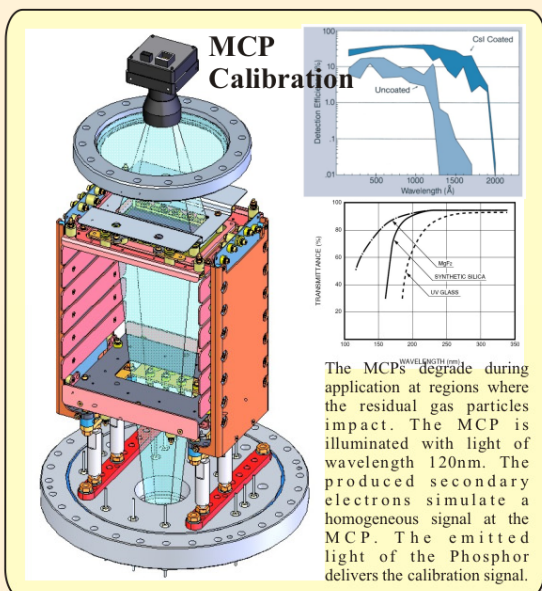




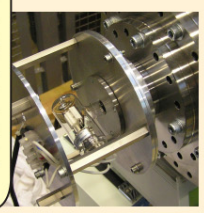


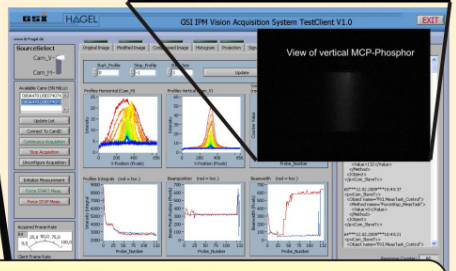


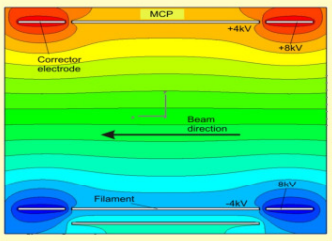




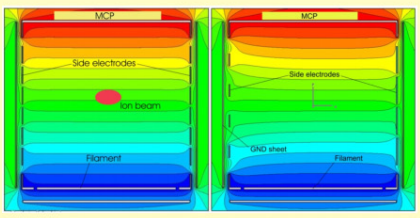
The MCPs degrade during application at regions where the residual gas particles impact. The MCP is illuminated with light of wavelength 120nm. The produced secondary electrons simulate a homogeneous signal at the MCP. The emitted light of the Phosphor delivers the calibration signal.





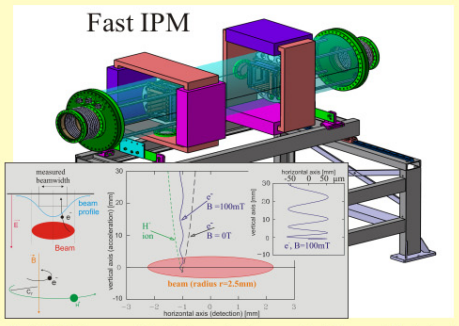


Longitudinal E-field uniformity is increased by correctors at high potential.



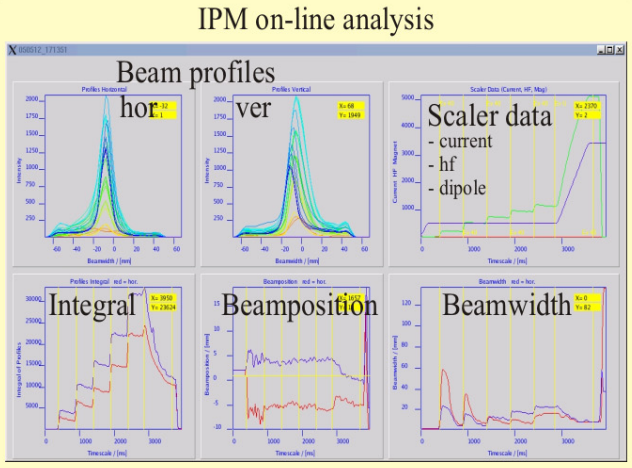
E-field design with discrete side electrodes.
Small dimensions = large clearance.
Field uniformity rises when the gaps are small.

Fast IPM



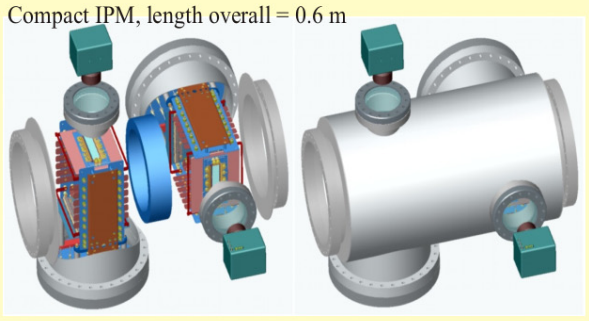
Fast IPM: to provide the turn by turnmode this model detects residual gas electrons. To overcome the space charge effect a magnetic field in parallel to the electric field guides the electrons toward the MCP. The CCD watches the Phosphor through a slit in the yoke.

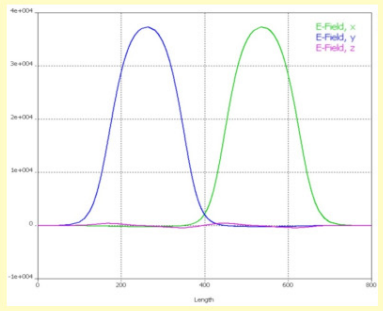
IPM on-line analysis



Beam profiles of a full cycle are plotted, 1st profile = red; last profile = blue; Secondary data like profile integral, beam position and beam width are shown. For convenience the DC current is plotted (green @ Scaler data).

Compact IPM, length overall = 0.6 m





Compact IPM design for horizontal & vertical beam profile measurement. This model is designed to detect residual gas ions. It provides a large aperture for wide beams at a short overall length. The electrical field is shielded between both monitors.