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MULTI-CHANNELTRON BASED PROFILE MONITOR AT THE ISIS PROTON SYNCHROTRON

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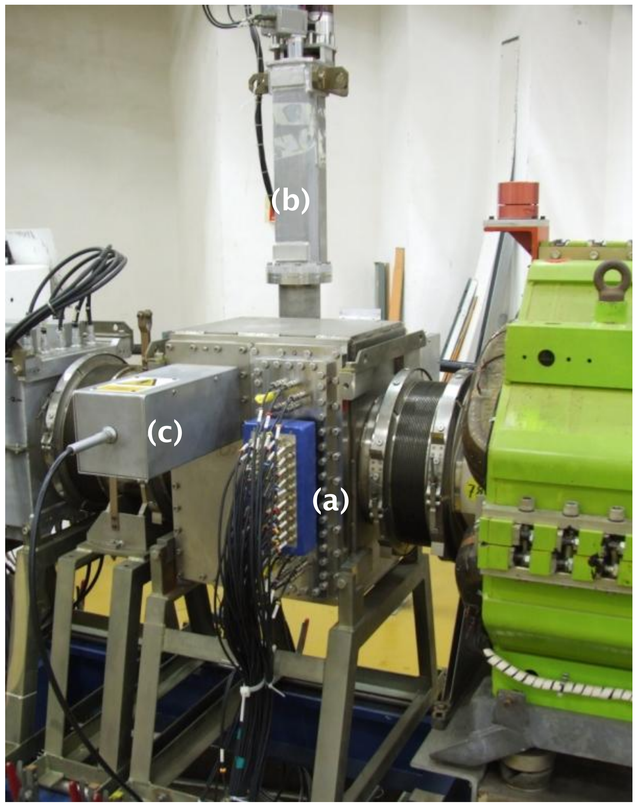
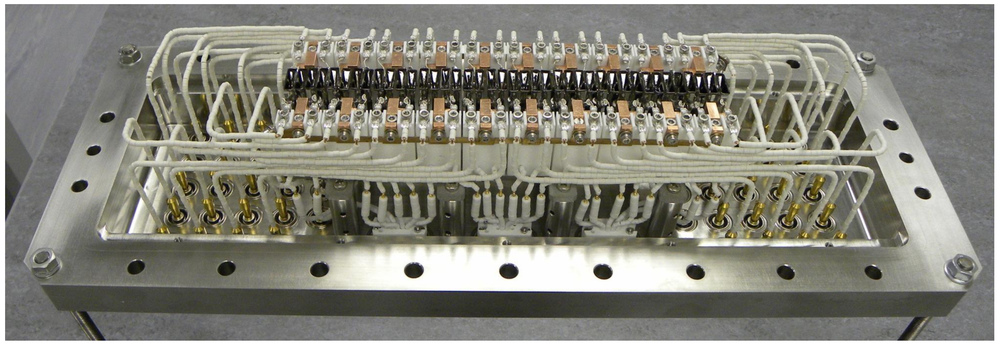
Abstract

The gas ionisation beam profile monitor is a well established piece of diagnostic hardware. At the Rutherford Appleton Laboratory we have produced a beam profile monitor that uses an array of 40 individually powered Channeltrons; these devices were chosen over the Micro Channel Plate for their robustness and longer lifetimes. We have successfully shown that an additional in-built calibration system using a single, motorised, Channeltron can overcome issues with gain variation. We report on the work to build the calibration system, and the 40 Channeltron array. Ongoing work on understanding how the drift field as well the beam field affects the measured profile is also discussed.

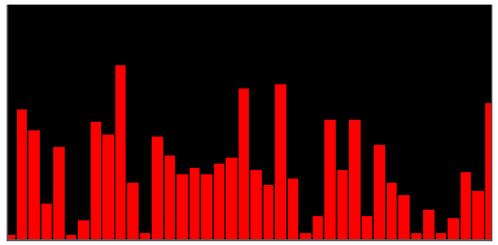


Left: A multi-Channeltron diagnostic mounted in the ISIS accelerator ring. The profile monitor (a) measures the beam profile in the vertical plane. Diagonally opposite is the motorised single Channeltron system (b) that provides calibration for the Channeltron array. One of two drift field assemblies is also shown (c).

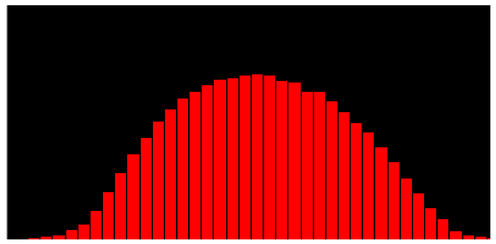


The Multi-Channeltron Profile Monitor

- 10 Macor blocks, each housing 4 Channeltrons [1] to form a 40 detector array [2, 3]
- 6mm spacing between Channeltrons giving 240mm active detector length
- Each Channeltron powered from its own 0-2.5kV power supply
- Calibration achieved using motorised (single Channeltron) profile monitor located in the same stainless steel vacuum vessel

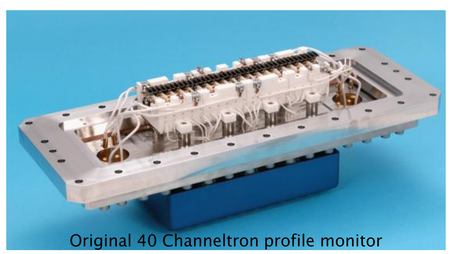


Uncalibrated output data

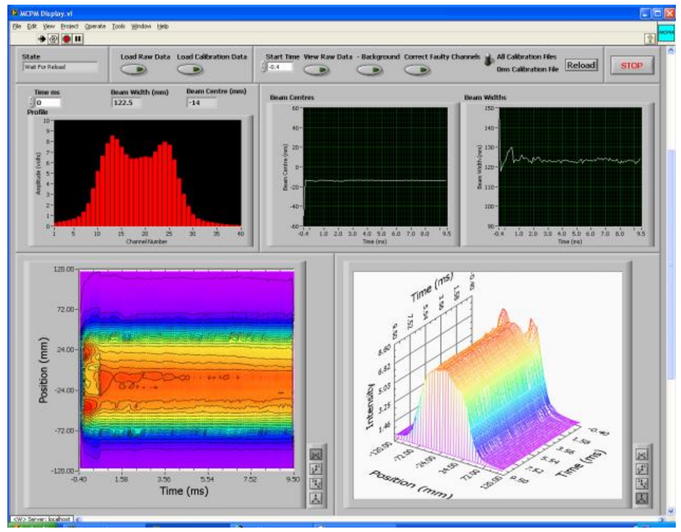


Calibrated output data

The first generation profile monitor used a single power supply for all 40 Channeltrons. Large gain variations between the Channeltrons were present (above). Use of single motorized Channeltron was required for calibration (corrected profile shown above right). Original detector is shown right.

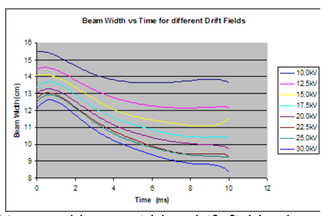


Original 40 Channeltron profile monitor

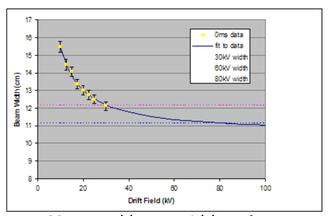


DAQ and Calibration

The data acquisition system consists of a National Instruments PXI system [4] with five 8-channel analogue input cards which are sampled simultaneously. On every 50Hz pulse of ISIS each of the 40 channels are read at a user selected interval between 10 - 100us. Single profiles and 3-D plots of the data, plus beam widths and centres are displayed.



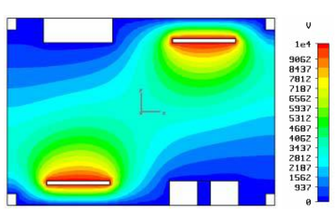
Measured beam width v drift field voltage



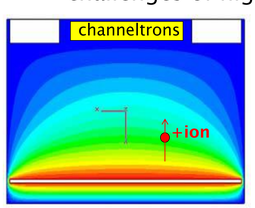
Measured beam width at 0ms

Further work

The measured width of the profile is a function of the drift field voltage and space charge forces. Increasing the drift field reduces the influence of the beams own electric field [5, 6]. Upgrade work on the drift field will increase the voltage to 60kV - a compromise between the technical challenges of higher voltages and cost.



Longitudinal field distribution[7]



Transverse field distribution[7]

The current drift field design does not use shaping field electrodes. CST simulation work is being carried out to look at the effect of the electric field on the measured profile [7]. Shaping fields may be included in the next upgrade.

References

[1] See 'Channeltron Electron Multiplier handbook', BURLE industries, www.burle.com . [2] S.J.Payne et.al 'A self calibrating real time multi-channel profile monitor for the ISIS proton synchrotron., DIPAC'07, Venice, Italy, 2007, p364. [3] S.J.Payne et.al 'Beam Diagnostics at ISIS' HB2008 conference, Nashville, TN, 2008. [4] For examples of PXI DAQ systems see National Instruments, http://www.ni.com. [5] B. G. Pine et al, 'Modelling of Diagnostics for Space Charge Studies on the ISIS Synchrotron', EPAC '06, Edinburgh, August 2006, p. 1082 (2006). [6] S J Payne et al, 'Investigation into the relationship between the drift field voltage and measured beam width on the ISIS ring profile monitor system', Rutherford Appleton Laboratory ISIS Machine Physics Report, IADM/MPS/2.1/03 (2003). [7] R. E. Williamson et al, 'Analysis of measurement errors in residual gas ionisation profile monitors in a high intensity proton beam', EPAC '08, Genoa, June 2008, p.1317 (2008)