Low Energy Beam Diagnostics Developments within

A Marie Curie Initial Training Network on Novel Diagnostic Techniques for Particle Accelerators

Carsten P. Welsch
University of Liverpool and Cockcroft Institute, UK
on behalf of the DITANET Consortium

Abstract

Low energetic ion beam are very attractive for a large number of fundamental physics experiments. The development of beam instrumentation for such beams poses many challenges due to the very low currents down to only a few thousands of particles per second and the resulting very low signal levels. Within DITANET, several institutions aim at pushing low energy, low intensity diagnostics beyond the present state-of-the-art. This contribution gives examples from the progress across the DITANET network in this research area..

Introduction

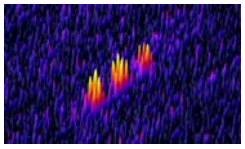
The DITANET project started on 1.6.2008. It is a Marie Curie Initial Training Network that brings together ten network beneficiary partners and presently 18 associated and adjunct partners. The main aim of the network is to provide research training to its internationally recruited early stage (ESR) and experienced researchers (ER). Participation of industry partners is an integral part of this training with smooth integration of industry not only in the individual research projects, but also in the overall training of the DITANET trainees. The network thereby strives to improving the career perspectives of the next generation of researchers in this field.

Electrostatic Storage Rings

At very low beam energies of only a few tens of keV, electrostatic storage rings offer significant advantages over their magnetic counterparts because of the mass independence of the electrostatic rigidity.
Within DITANET the University of Liverpool, the Manne Siegbahn Laboratory/Stockholm University and the Max Planck Institute for Nuclear Physics in Heidelberg carry out R&D into this rather new type of storage ring.

Scintillating Screens for x·10 keV Ion Beams

J. Harasimowicz, U Liverpool



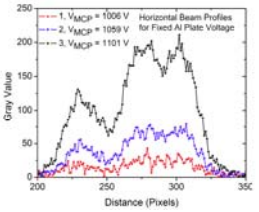
Example profile measured at INFN-LNS in Catania. A resolution of 0.3 mm was achieved in this measurement.

In view of the necessary beam instrumentation for an ultra-low energy antiproton storage ring (USR) at the future facility for low energy antiproton and ion research (FLAIR), measurements were realized in close collaboration with INFN-LNS, Italy. CsI:Tl, YAG:Ce, and a Tb glass-based scintillating fiber optic plate (SFOP) were tested. The screens' response to 200 and 50 keV proton beams with intensities ranging from a few picoampere down to subfemtoamperes was studied. It was found that CsI:Tl can be used to monitor beam intensities of down to only about $5 \cdot 10^3$ pps at 200 keV.

Secondary Emission Monitor

S. Das, MSL

A secondary emission monitor was developed at MSL. It consists of an Aluminium plate, a grid placed in front of this screen, a microchannel plate (MCP), a fluorescent screen and a CCD camera. Different collimators were used to study the spatial resolution of the system. Three holes of 1 mm diameter each, separated by 3 and 2 mm were used for measurements with a 10 keV proton beam. The monitor was tested succesfully downto 0.5 keV without any degradation in performance. It will be used for the DESIREE project and is under consideration for the USR. A spatial resolution of better than 2 mm was recently demonstrated.



Measured beam profiles with different MCP voltages, but fixed Al plate voltage of 6.4 kV

2-Dimensional Beam Profile Measurements with a Curtain Gas Jet

M. Putignano, U Liverpool

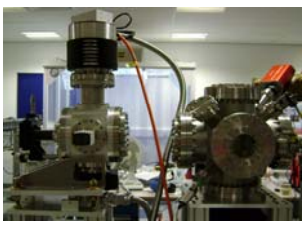


Photo of the experimental setup. The jet is expanded in the left chamber, skimmed and finally collimated at a variable distance in the right chamber.

A beam profile monitor based on a curtain gas jet has been designed and assembled. It relies on the ionization of atoms in the jet by the crossing ion or electron beam to be analyzed. In a dedicated detection chamber, shown on the right hand side of the image, an ion extraction system is included to attract the positive gas ions via an MCP detector imaged on an ITO coated phosphor screen that also acts as collecting electrode.

Jet density profiles will be taken shortly and a full experimental analysis will be done in 2011.

Medical Applications

From Particle Detection to Medical Applications

A. Bocci, Z. Abou-Haidar, U Seville/CNA

Recently many efforts have been done to develop silicon detectors for medical physics application. Following the group's experience in nuclear instrumentation and particle detection, a research program in radiotherapy with 6 MV photon beams was established between the Department of Physics of U Seville, the National Accelerators Center (CNA), the Virgen Macarena University Hospital, the Engineering School of U Seville and the private company Inabensa S.A.

The aim of this project is to benchmark a novel method to obtain a map of doses in the pre-treatment of patients with Intensity Modulated Radiation Therapy (IMRT). A commercial single sided silicon strip detector (SSSSD) (Micron Semiconductor Ltd.), with a 50x50 mm² active area, coupled to in-house developed electronics was used for dosimetric measurements. It is segmented into 16 strips on one side with a pitch of 3.1 mm. Two prototypes of phantoms have been designed and built in order to characterize and calibrate the detector. The material of the phantoms is tissue-equivalent and suitable for dosimetry measurements. A Siemens Primus Linac accelerator and an experimental set-up mounted during a measurement are shown to the right.

Monte Carlo simulations of the experimental set-up with Geant4 were carried out to modellize the detector, phantoms and accelerator characteristics. A final characterization of the detector, including a comparison between Geant4 simulations and the Treatment Planning System (TPS) calculations has been performed. A dedicated treatment plan verification will be realized within short.

Topical Workshop

As part of its training events, DITANET organized a Topical Workshop on Low Energy and Low Intensity Beam Diagnostics. During two days, 40 scientists and engineers discussed the state-of-the-art and open challenges in present and future accelerator projects.

Full details, including all talks and workshop proceedings, can be found at the CERN Indico under ConfID: 93294.

URL: http://www.liv.ac.uk/ditanet
Mail: carsten.welsch@quasar-group.org