OPAC

Accelerator Optimization Through Beam Diagnostics

C.P. Welsch, Cockcroft Institute and The University of Liverpool, UK
on behalf of the oPAC Consortium

Abstract

A comprehensive set of beam diagnostics is key to the successful operation and optimization of essentially any accelerator. The oPAC project received 6 M€ of funding within the EU's 7th Framework Programme. This has allowed to successfully train 23 Fellows since 2011. The network joins more than 40 institutions from all around the world, including research centers, universities and private companies. One of the project's largest work packages covers research in beam diagnostics. This includes advanced instrumentation for synchrotron light sources and medical accelerators, enhanced beam loss monitoring technologies, ultra-low emittance beam size diagnostics, diagnostics for high intensity beams, as well as the development of electronics for beam position monitors.
This poster presents an overview of the research outcomes from the diagnostics work package and the demonstrated performance of each monitor. It also shows how collaborative research helps achieving beyond state-of-the-art solutions and acts as an ideal basis for researcher training. Finally, an overview of the scientific events the network has been organizing for the wider accelerator community is given.
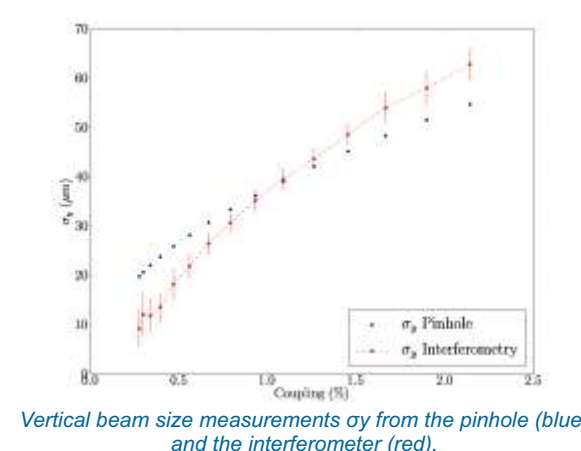
Research

oPAC is structured into 4 R&D work packages: beam physics, beam diagnostics, simulation tools and accelerator control systems. Here, the research results from projects on beam diagnostics R&D are summarized.

Beam Size Measurements at ALBA using Interferometry
L. Torino, ALBA, Spain

Project Aims: Design, optimize and install a high resolution interferometer for beam size measurements at the synchrotron ALBA.

Vertical beam size measurements σy from the pinhole (blue) and the interferometer (red).
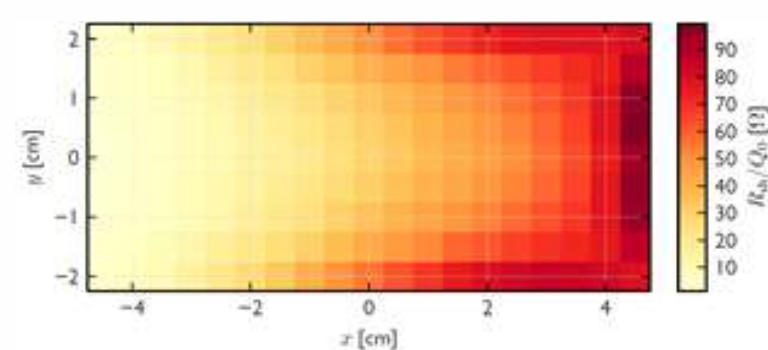
Studies carried out:
- Optimization of the light transport system for signal enhancement;
- Development of signal processing algorithm to increase the dynamic range of the measurement.

Results: Measurements with the interferometer were compared against pinhole measurement (at slightly different position). A good overall agreement between methods was found.

Position Detection for Ultra-Low Intensity Heavy-Ion Beams
X. Chen - GSI, Germany

Project Aims: Develop a sensitive Schottky detector for position detection of low intensity exotic ion beams.

Measured shunt impedance of the rectangular Schottky monitor prototype.

Studies carried out:
- Numerical investigations into optimum cavity shape;
- Analysis of impact of geometry changes on resonance frequency and shunt impedance;
- Design and construction of scaled prototypes;
- Bead-pull measurements.

Results: Automated measurements with a ceramic bead have been carried out at a purpose-built benchtop setup. As an example the measured shunt impedance for the rectangular prototype is shown above. An excellent agreement between simulation models and experiment was found.
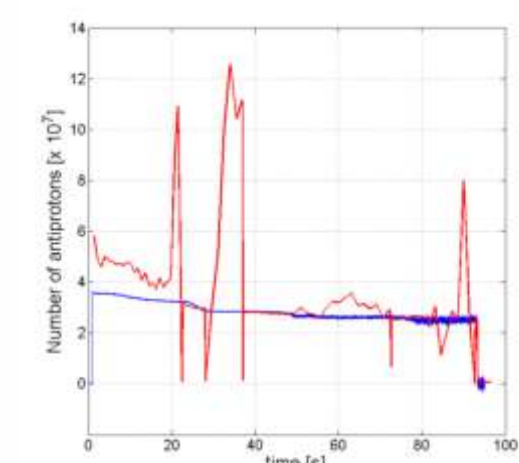
Cryogenic Current Comparator (CCC) for Low Energy Ion Beams
M. Fernandes, CERN, Switzerland

Project Aims: Develop a device for non-invasive absolute intensity measurements of nA pulsed and continuous beams in low energy synchrotrons (see MOPG48).

Studies carried out:
- Prototype designed, built up and tested at the Antiproton Decelerator at CERN;
- Current intensity resolution of 30 nA has been successfully demonstrated after low-pass filtering with a cut-off frequency at 10 Hz;
- The system was able to cope with a beam current signal slew-rate exceeding 8 kA/s.

Comparison between measurement with Schottky noise based monitor (in red) and CCC (blue).

Results: These are the first-ever CCC beam current measurements performed in a synchrotron using both, coasting and short-bunched beams. The CCC is currently the only device able to measure non-perturbatively very low-beam intensities.

Training

It is recognized that best practice researcher training involves cohorts of candidates rather than individuals. The ITN structure is ideal for this and to achieve the aspirations of the EU Principles for Innovative Doctoral Training oPAC takes best advantage of industry participation and by providing regular network training to bring the Fellows together.

International School on Accelerator Optimization
Royal Holloway University of London, UK

At the start of their training all oPAC Fellows participated in either the CERN Accelerator School or the Joint Universities Accelerator School. An **oPAC School on Accelerator Optimization** was organized by the consortium between **7th-11th July 2014** at Royal Holloway University of London, UK. It covered advanced techniques for the optimization of particle accelerators. **All lectures are available via the project home page.**

All Fellows followed a **Skills School** in Liverpool, UK in **June 2013**. This provided them with subject-specific training in addition to generic topics, including project management, scientific writing, problem solving techniques and building bridges between academia and industry. A second advanced school covering CV writing, interview skills, IPR, science communication and entrepreneurship was organized in June 2015.

Topical Workshops
Venues across the network

A workshop on the **Grand Challenges of Accelerator Optimization** was held in **June 2013** at CERN and gathered more than 120 participants to review the state-of-the-art in accelerator R&D. CERN IndicoID: 243336. Expert **training days** on 'Simulation Tools' and 'Beam Diagnostics' were held for all Fellows, hosted by CST AG and Bergoz, respectively.

In **April 2014 a Workshop on Libera** was offered by Instrumentation Technologies and one on **Beam Instrumentation** by CIVIDEC in Vienna, in **May 2014** (293158). **Computer-Aided Optimisation of Accelerators** was the focus at GSI in **March 2015**; this was a special event for the network as the event was organized by the Fellows (333414).
A workshop on **Beam Loss Monitors** will be held in Barcelona this year just after IBIC16 (527597).

International Conference on Accelerator Optimization and Symposium
Cockcroft Institute/University of Liverpool, UK

In **October 2015** a **Conference on Accelerator Optimization** was organized at CNA in Seville, Spain. It covered beam physics, diagnostics, computer simulations and control systems (380975). A large **Outreach Symposium** was held in Liverpool in June 2015, attracting hundreds (368273).