Optimization of Accelerators and Light Sources within oPAC

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on behalf of the oPAC Consortium

Abstract

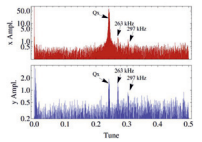
The optimization of particle accelerators and light sources by combining studies into beam physics, instrumentation, numerical simulations and accelerator control systems is the aim of the EU-funded oPAC project. With a budget of more than 6 M€, oPAC is one of the largest training networks ever funded by the EU and currently trains more than 20 Marie Curie Fellows.
This poster presents selected research highlights, including optimization studies into the CERN Proton Synchrotron (PS), measurement and correction of linear and nonlinear optics distortions in the ALBA synchrotron (Spain), perturbation measurements of a cavity Schottky noise detector at GSI (Germany) and R&D into device control data base tool at COSYLAB (Slovenia). Moreover, a summary of past and future oPAC events is also given.

Research

oPAC is structured into four R&D work packages: beam physics, beam diagnostics, simulation tools and accelerator control and data acquisition systems. Fellow R&S stretches across these work packages and targets the optimization of existing and future accelerator-based infrastructures. Here, recent results from a few selected projects are presented.

Optimization Studies into the CERN PS *(M. McAteer, et al.-CERN)*

Beam dynamics studies into the effect of space charge and instabilities that are being observed experimentally in the PS Booster have been carried out. For this purpose tracking simulations with space charge effects and an AC dipole, and comparisons of simulated results with trial measurements were realized (TUPRI029).

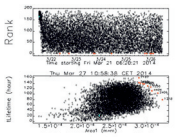


Spectrum of horizontal and vertical beam trajectories during turns 85,000-90,000

The spectrum of turn-by-turn trajectory shows two prominent peaks in each plane, in addition to the tunes, see figure above. These peaks always occur at a fixed frequency throughout the entire acceleration cycle (*THPRO082*). The exact origins of this perturbation is not currently understood and subject to beam dynamics studies. It is hoped that the cause of this perturbation can be located more precisely in the future when more BPM data will be available.

Performance improvements using Genetic Algorithms *(X. Gavalda, et al.-SOLEIL)*

Multi-Objective Genetic Algorithm (MOGA) and the tracking code ELEGANT have been used to optimize the linear and non-linear beam dynamics of the SOLEIL synchrotron light source in France.



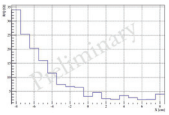
Optimization results of MOGA using 2 quadrupoles, 11 families of sextupoles without magnetic errors or vacuum chambers at SOLEIL during 5 days

First, the effects of the sextupoles on the beam dynamics of the machine were optimized. In a second step, MOGA-based optimization are used as a basis to study different upgrade scenarios of the storage ring with on example shown in the figure to the right. These upgrades will target a reduction of the effective horizontal emittance, thereby helping to increase the overall brightness of the facility (MOPMR007).

Perturbation Measurements of a Model Cavity *(X. Chen, et al.- GSI)*

A diagnostics cavity was manufactured and delivered to GSI at the end of last year. It has been used as a prototype to prove the design concept of a cavity-based, transversely sensitive, heavy-ion detector by means of Schottky noises. Tests were carried out on a dedicated platform for shunt impedance measurements of the cavity (THPM101).

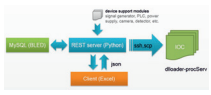
In the setup the circular cavity stands on a 2-D high-precision movement unit, consisting of two active tracks and two passive tracks. A 3 mm thick ceramic rod goes through the beam pipe and is fastened to a pair of height gauges at both sides.



Distribution of the shunt impedance .

Device Control Database Tool (DCDB) *(P. Maslov, et al. - COSYLAB)*

A new control system which provides an easy-to-use interface for quick configuration of an entire facility is being developed at COSYLAB. It uses Microsoft Excel as front-end application and allows the user to quickly generate and deploy IOC configuration, such as EPICS start-up scripts, alarms and archive configuration, onto IOCs.



Overview of DCDB architecture.

The DCDB tool utilizes a relational database which stores information about all elements of the accelerator. The communication between the client, database and IOCs is realized by a REST server written in Python. The key feature is that the user does not need to recompile the source code. It is achieved by using a dynamic library loader, which automatically loads and links device support libraries, see the illustration on the left.

Training

Training within the network is provided locally at the respective host institute, primarily through research, local lecture and seminar series, as well as oPAC-wide training offered by the whole consortium. In addition, the network also organizes a series of Topical Workshops and International Schools for its Fellows which are also open to the wider accelerator community.

International School on Accelerator Optimization

London, UK

At the start of their training all oPAC fellows participated in either the CERN Accelerator School or the Joint Universities Accelerator School. This provided them a sound training basis as they take on their projects within the Network. An **oPAC School on Accelerator Optimization** will be organized by the consortium between **7th-11th July 2014** at Royal Holloway University of London, UK. It will cover advanced techniques for the optimization of particle accelerator performance. We have made extra places available for IPAC participants only and re-opened registration - **register now !**

All Fellows met for a dedicated **Researcher Skills School** in Liverpool, UK in June 2013. During the week-long school they were provided with subject-specific training in addition to generic topics, including project management, scientific writing, problem solving techniques and building bridges between academia and industry.

The concept for this school had initially been developed by DITANET, but has since been refined. It is now offered to all PGR students in the School of Physical Sciences at University of Liverpool. Discussions with other HEIs are ongoing with the aim to let more researchers benefit from this successful scheme which was recently commended as a **success story** by the EU.

Topical Workshops

Venues across the network

As part of the network's long term strategy to create lasting structures for the wider scientific community, oPAC will organize a series of Topical Workshops. A first workshop on the **Grand Challenges of Accelerator Optimization** was held on 26/27 June 2013 at CERN and covered all work packages of the project. More than 120 registered participants reviewed the state-of-the-art in accelerator R&D during the two days. CERN IndicoID: 243336.

Expert **training days** on 'Simulation Tools' and 'Beam Diagnostics' were held for all Fellows, hosted by CST AG and Bergoz, respectively. A **Workshop on Libera** was held at Instrumentation Technologies in April 2014 and one on **Beam Instrumentation** focussing on beam profile, loss and position monitoring was hosted by CIVIDEC in Vienna, in May 2014. More are in the planning.

Full details and information about how to register can be found in the network's quarterly **newsletter** and its Facebook page. In order to subscribe, please send an email to the coordinator or ‚like' the project.

International Conference on Accelerator Optimization

Cockcroft Institute/*University of Liverpool, UK*

In October 2015 a 3-day international conference on the optimization of particle accelerators will be organized at CNA in Seville, with a focus on the methods developed within the network. It will be organized for the international accelerator community with a focus on contributions from early stage researchers.

Whilst the beneficiary and associated partners were defined at proposal stage, the projects encourages additional partner institutions to join this initiative. So-called **adjunct partners** can participate in the network's research activities and benefit from the wide ranging training program. Information on how to join can be obtained from the coordinator.

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http://www.opac-project.eu