

oPAC Advanced School on Accelerator Optimization

7TH – 11TH July 2014

Royal Holloway University of London, London, UK

Rita Galan



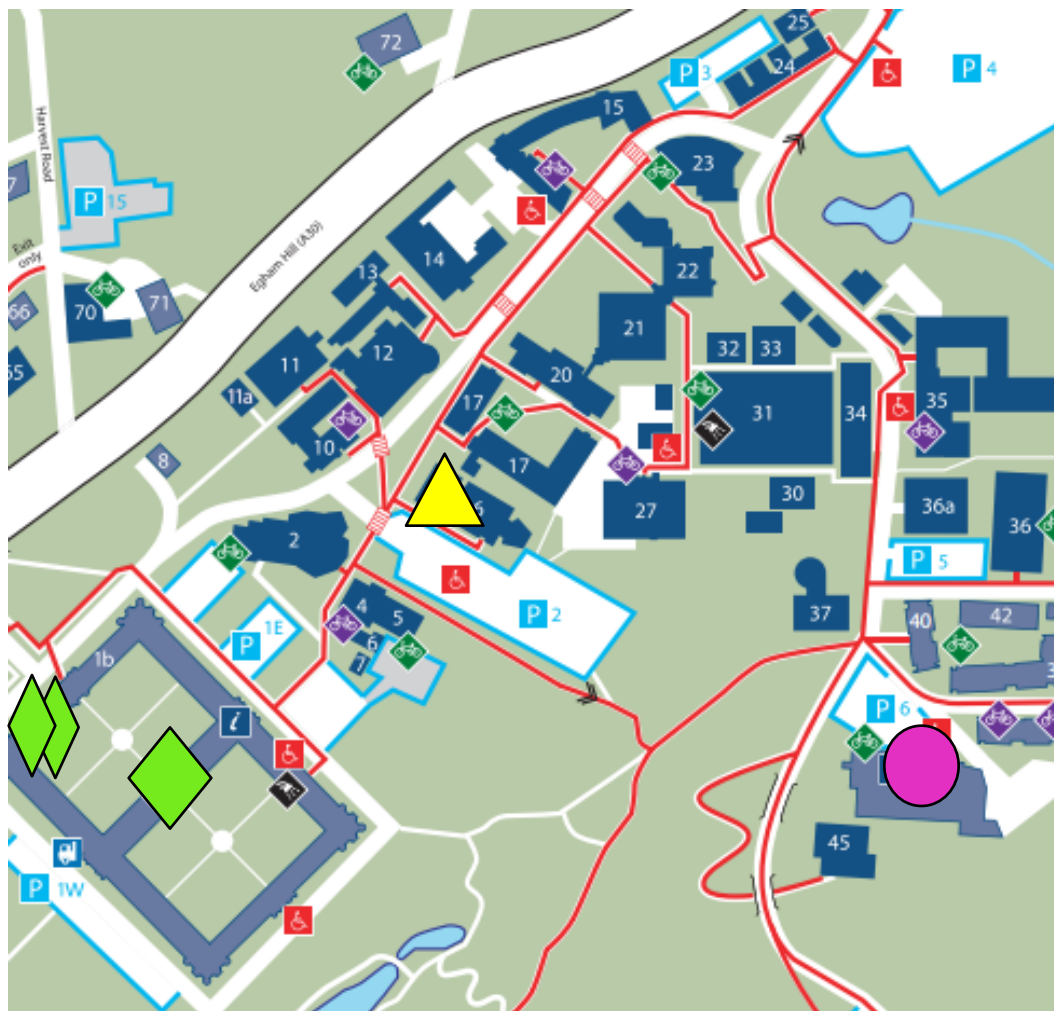
OPAC







Admin / Logistics: RHUL



Admin / Logistics: RHUL



-  Arts Bldg
-  Founder's Bldg
-  Picture Gallery
-  The Hub



Schedule

Advanced oPAC School on Accelerator Optimization: RHUL, UK					Monday 7 July to Friday 11 July 2014	
	Monday 7th	Tuesday 8th	Wednesday 9th	Thursday 10th	Friday 11th	
8:30 9:30	Admin/logistics oPAC Rita Galan, ULIV Welcome / Introduction Paul Hogg, RHUL Pavel Karataev, RHUL	Lattice Design: Bernhard Holzer, CERN	Beam Cooling Techniques Igor Meshkov, JINR	LHC Optimization Rogelio Tomas, CERN	09:00 start for SB and Fellows. 09:30 start for other delegates	
					9:00 Supervisory Board (SB) Annual Meeting: Fellows overview of progress Room AG24	
9:30 10:30	History of Particle Accelerators: Philip Bryant, CERN	Beam Profile Measurements (basics, high intensity beams, cryo, high energy) Enrico Bravin, CERN	Beam Loss Monitoring - detectors: Sergey Vinogradov, ULIV	Numerical Optimization of Particle Accelerators Oliver Boine-Frankenheim, GSI	Compact AMS Systems Jose Maria Lopez, U. Seville	SB Annual Meeting continued
				Accelerator Control Systems Mark Plesko, Cosylab		
11:00 12:00	Beam Dynamics, recap: Carsten Welsch, ULIV	Beam Position Measurements (also industry aspects) Stewart Boogert, RHUL	Particle Tracking Codes: David Newton, ULIV	Tutorial session split in 4 groups	SC meet Room AF28	The European Spallation Source – The first 'green' accelerator Andreas Jansson, ESS
	12:00 13:00	Particle beam characterization Pavel Karataev, RHUL	High(er) accelerating gradients: Alan Wheelhouse, STFC			3rd generation Light source Francis Perez, ALBA
LUNCH						
14:30 15:30	Sourcery: Jürgen Pozimski, IC	Tutorial session split in 4 groups	Next generation Light Sources Jim Clarke, STFC	Poster session	DEPARTURE	
	15:30 16:30		Accelerator Magnets: Neil Marks, STFC			
17:00 18:00	Q&A: Philip Bryant, CERN	Beam Loss Monitoring Eduardo Nebot, CERN	Tour of London 16:50: Train to London, 2½ h walking tour, Dinner at rainforest café 20:00 Back at 22.45	Seminar: roads into the anti-world Michael Doser, CERN		
Eve	Sunday 18:30: Reception at Foyer of the Arts building Finger food & drinks	18:30: Outreach seminar for general public and local media. Higgs – Phil Burrows		19:00 – 24:00 Formal Dinner at RHUL picture gallery		

Meals: Founders Dining Hall. Dinner: 18:00 on Monday, 20:00 Tuesday and Wednesday, 19:00 Welcome drinks & dinner on Thursday

Lectures: Art Lecture Theatre 1 (ALT1)

Tutorial Sessions: ALT1, AG24, AG3, AF1

Where and When?

- Meals:

- Breakfast: 07:30 - 08:59 Founders Dining Hall (FdH)

- Lunch: 13:00 – 14:00 FdH

- Dinner:

- Monday at 18:00 FdH

- Tuesday 20:00 FdH

- Wednesday: 20:00 Rainforest Cafe

- Thursday 19:00 Picture Gallery

- Lectures: Art Lecture Theatre 1 (ALT1)

- Tutorial Sessions: ALT1, AG24, AG3, AF1



OPAC[★] Delegate package

- Schedule
- Feedback forms: important to improve
- Future events!: oPAC, LA³NET
- Delegate's list
- Tutorial sessions
- oPAC Brochure





Emergency Contact Numbers



- Rita Galan +44 (0)7926682352
- Carsten Welsch +44 (0)7973 247982



What is oPAC?



- Optimization of Particle Accelerators
 - 23 ESRs
 - 35 Partner Institutions (*and growing...*)
 - 6 M€



www.opac-project.eu

- Beneficiary partners



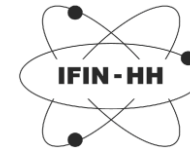
- Associated partners





Adjunct Partners

- Part of the long term strategy – oPAC is growing



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA



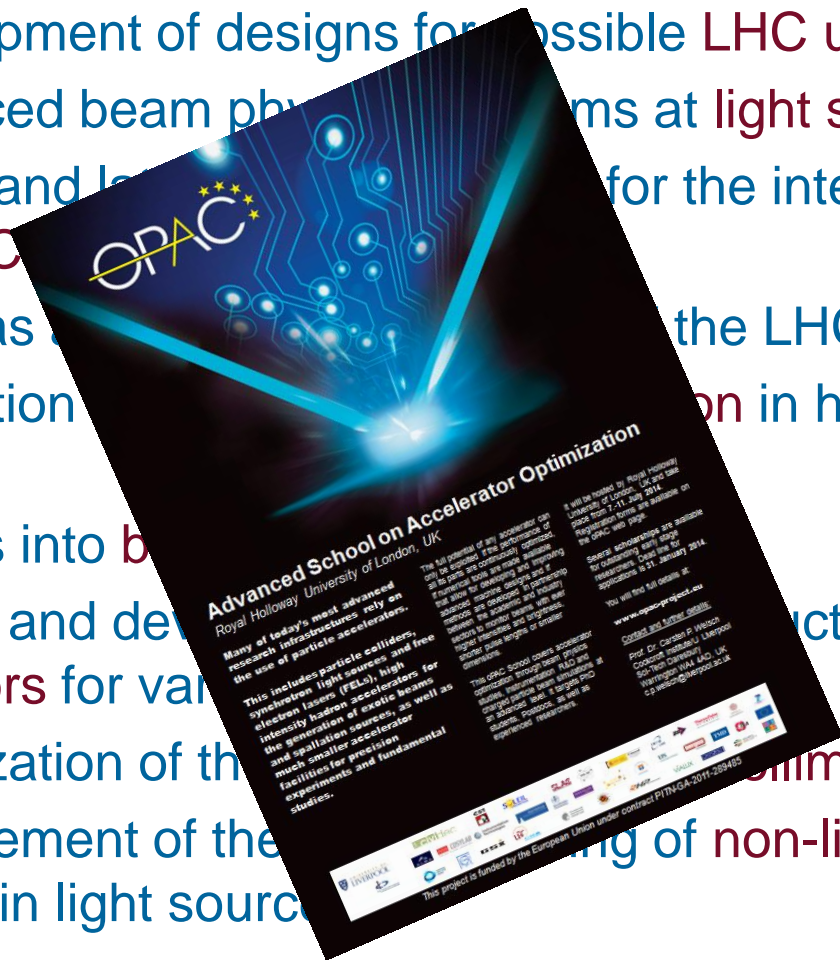
UPPSALA
UNIVERSITET



The University of Manchester



- Development of designs for possible LHC upgrade options
- Advanced beam physics experiments at light sources
- Optics and layout studies for the interaction region design of the LHC
- LHeC as an upgrade of the LHC
- Simulation of electron beams in high brightness electron beams
- Studies into beam dynamics
- Design and development of structures as components
- Optimization of the simulation of non-linear beam dynamics
- Improvement of the simulation of non-linear beam dynamics



Topical Workshop on Beam Diagnostics

Vienna, Austria: 8th/9th May 2014

To fully understand and optimize the properties of a beam in an accelerator, storage ring or light source, powerful beam diagnostics are essential. Beam diagnostics is a very broad research field which typically combines cutting edge technology from many different scientific areas to obtain a maximum of information on the particle beam that needs to be characterised. Of particular interest is R&D into least intrusive techniques that allow continuous operation of an accelerator whilst providing comprehensive information about the particle beam. This workshop covers the latest developments in beam profile and beam loss monitoring techniques and technologies.

This two-day international workshop will provide an overview of the current state of the art in beam instrumentation. It will discuss research and development being undertaken and ambitions to further improve the performance of existing and future facilities.

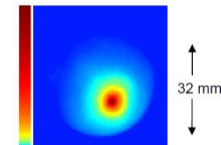
In addition to invited talks, there will be industry displays and all participants will have an opportunity to contribute a poster.

This event is open to all and free of charge. Advance registration is required; places are strictly limited. Full details and registration: www.opac-project.eu

Co-located:
 Prof. Dr. Carsten P. Welsch
 Associate Director
 Cockcroft Institute / University of Liverpool
 c.p.welsch@liverpool.ac.uk

This project is funded by the European Union under contract PITN-GA-2011-230465.

Development
 Instrumentation for light sources
 Beam current monitor
 for use in Cryogenic Environment
 the beam profile in high
 monitor for measuring
 beam
 detection
 system for verifying a 3D
 University Modulated Radiot



Training Workshop Beam Diagnostics 25th June 2013

The training will provide insight into the various methods within the field of beam diagnostics and will include:

- Assembly of a large dynamic range (SDR) beam current monitor with an opportunity to build your own set of components
- Optical inspection and beam tuning of a monitor using a laser
- Installation and assembly of a beam current monitor
- Review of design and simulation tools for beam diagnostics
- Development of a 3D CAD model for a beam current monitor
- Design and simulation of a beam current monitor
- Measurement of the beam current monitor
- Measurement of the beam current monitor
- Measurement of the beam current monitor

For further details on the oPAC project see the project web site: www.opac-project.eu

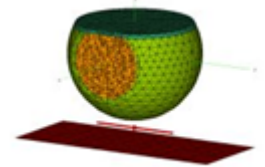
Co-located and hosted by:
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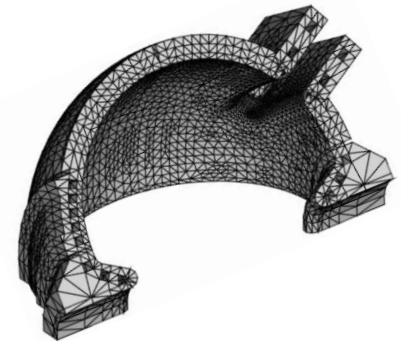


WP4 – Simulation Tools

- Included in most R&D project, plus:
- Development of a simulation suite based on the multilevel fast multipole method



Development of a GPU-based PIC solver



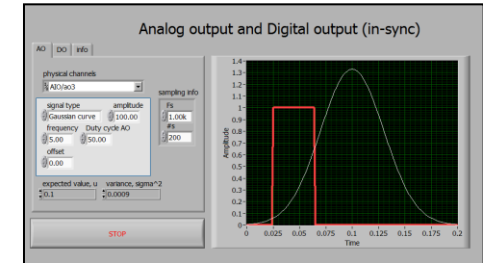
OPAC[★] WP5 – Control Systems

- Links all R&D projects, plus:
- Adaptation of existing open-source control systems from compact accelerators to large scale facilities
- Improvement of the process to identify the needs for accelerator instrumentation



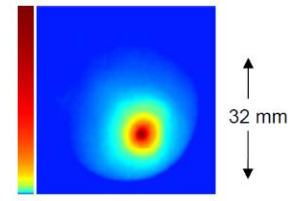
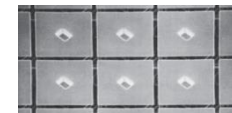
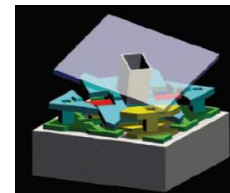
- Adaptation of existing open-source control systems from compact accelerators to large scale facilities

P. Maslov, Cosylab



- Beam Halo R&D

B. Lomborg, University of Liverpool



C.P. Welsch, et al., Meas. Sci. Technol. **17** (2006)
Phys. Rev. ST-AB (2012).

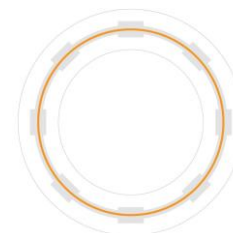
OPAC Accelerator Optimization: Examples

- Design and development of common applications for different particle accelerators

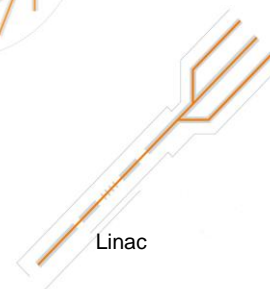
Manuel Cargnelutti, Instrumentation Technologies



Synchrotron Light Source



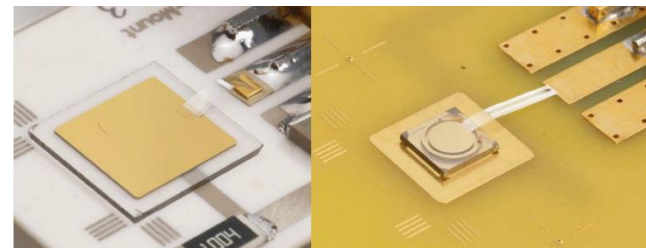
Hadron Collider



Linac

- Development of a versatile beam loss monitor

Pavel Kavargin, CIVIDEC





Publications and Talks

Publications

- M. Bartosik, et al., 'Characterisation of Si Detectors for use at 2 Kelvin', Proc. IPAC, Shanghai, China 2013.
- M. Bartosik, et al., 'Radiation Tolerance of Cryogenic Beam Loss Monitor Detectors', Proceedings IPAC, Shanghai, China 2013.
- E. Cruz, et al., 'LHeC IR Optics Design Integrated Into the HL-LHC Lattice', Proceedings IPAC, Shanghai, China 2013.
- P. Kavargin, et al., 'Diamond Detectors for LHC', Proceedings of the International Conference on Beam Instrumentation, IBIC 2012 Conference, Tsukuba, Japan, 2012.
- P. Kavargin, et al., 'Recent Results of the Diamond Beam Loss Monitors at LHC', Conference Proceedings of the International Conference on Beam Instrumentation, IBIC 2013 Conference, Oxford, Great Britain, 2012.
- K. Kruchinin, et al., 'Backward X-ray Transition Radiation from Multi-layered Target for Submicron Beam Diagnostics', Proceedings IPAC13, Shanghai, China 2013.
- K. Kruchinin, et al., 'Sub-micrometre resolution laser wire transverse beam size measurement system', Proceedings IPAC13, Shanghai, China, 2013.
- B. Lomberg, et al., 'Beam Halo Monitor Based on an HD Digital Micro Mirror Array', Proceedings, IBIC, Oxford, UK, 19.09.2013.
- M. McAteer et al., 'Preliminary Results of Linear Optics from Orbit Response in the CERN PSB', Proceedings IPAC'13, Shanghai, China 2013.
- M. McAteer et al., 'Determination of Octupole and Sextupole Polarities in the LHC', Proceedings IPAC'13, Shanghai, China 2013.
- S. Naveed, et al., 'Beam Position Monitor R&D for keV ion beams', Proceedings IBIC, Oxford University, Oxford, UK 19.09.2013.
- X. Nuel Gavalda, et al., 'Modelling resulting from magnetic and beam based measurements of the ALBA gradient dipoles', Proceedings IPAC13, Shanghai, China, 2013.
- L. Torino and U. Iriso, 'Charge Distribution Measurements at ALBA', Proceedings IBIC, Oxford, UK, 2013.
- L. Torino, et al., 'Transverse beam size measurements using interferometry at Alba', Proceedings IBIC, Oxford, UK, 2013.
- L. Torino 'Charge Distribution Measurements at ALBA', IBIC, 16-19.09.2013.
- Valloni, 'Strawman optics design for the LHeC ERL Test facility', Proceedings IPAC, Shanghai, China 2013.
- G.P. Wall, C.P. Welsch, 'Employability in Europe: Enhancing Post Graduate Complementary Skills Training', Proc. HEA STEM: Annual Learning and Teaching Conference, Birmingham, UK (2013)
- C.P. Welsch, 'Accelerator Optimization within the oPAC Project', Proc. IPAC13, Shanghai, China (2013)
- C.P. Welsch, 'Optimal Acceleration', PanEuropean Networks: Science & Technology 6 (2013)
- C.P. Welsch, 'Beam Instrumentation R&D within oPAC', Proc. IBIC, Oxford, UK (2013)
- C.P. Welsch, 'oPAC - optimizing accelerators through international collaboration', Proc. IPAC, New Orleans, USA (2012)
- C.P. Welsch, 'Beam diagnostics research within OPAC', Proc. BIW, Virginia, USA (2012)

Talks

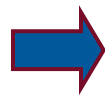
- M. McAteer 'Optics Measurements in the FNAL Booster and the CERN PSB', 2nd Joint HiLumi LHC-LARP Annual Meeting, INFN, Frascati, Italy, 14-16.11.2012.
- M. McAteer 'Polarity checks of non-linear circuits', LHC Optics Measurement and Corrections Review, CERN, Geneva, Switzerland, 17-18.06.2013.
- A. Valloni 'Beam Physics in Future Electron Hadron Colliders', 25th North American Particle Accelerator Conference, NA-PAC'13, Pasadena, USA, 30.09-04.10.2013.**
- Valloni 'Beam Physics in Future Electron Hadron Colliders', Physics Opportunities at an Electron-Ion Collider workshop, Jyväskylä, Finland, 2-5.09.2013.
- M. Sofranac 'Development of a Multi GPU based PIC', KWT 2013 Workshop on Advances in Electromagnetic Research, Riezlern, Austria, 17-23.08.2013.
- L. Torino, 'Charge Distribution Measurements at ALBA', IBIC, Oxford, 19.9.2013**
- M. C. Battaglia 'Design of a detection system to verify 2D dose maps for Intensity Modulated Radiation Therapy (IMRT) treatment', talk CNA, Seville, Spain, 09.2013.
- K. Kruchinin, 'Extremely Low Emittance Beam Size Diagnostics with Sub-Micrometer Resolution Using Optical Transition Radiation', IBIC, Oxford, 17. 9.2013**
- S. Naveed, 'Multi-level fast multipole method for accelerator optimization', University of Ankara, 20.8.2013
- C.P. Welsch, 'Cross-sector collaboration in Accelerator R&D', Thorlabs, Munich, Germany, 20.9.2013
- C.P. Welsch, 'Industry-Academia Collaboration', CST AG, Darmstadt, Germany, 15.8.2013
- C.P. Welsch, 'Roles & Goals of EC projects: A Vision for Europe - View of a University', EUCard2 kickoff meeting/Visions for the future of Particle Accelerators, Cern, Switzerland, 11.06.2013
- C.P. Welsch, 'Re-Structuring Post Graduate Researcher Training', HEA STEM: Annual Learning and Teaching Conference, Birmingham, UK 11.06.2013
- C.P. Welsch, 'Employability in Europe: Enhancing Post Graduate Complementary Skills Training', HEA STEM: Annual Learning and Teaching Conference, Birmingham, UK, 17.4.2013
- S. Davies, 'Industry-Academia Collaboration', Soltan, Slovenia, 10.10.2012
- C.P. Welsch, 'Research & Training Initiative in Accelerator Sciences – the oPAC Project', University of Mainz, Germany, 2.8.2012
- C.P. Welsch, 'Accelerator and Beam Instrumentation R&D', Karlsruhe Institute of Technology, Germany, 30.7.2012
- ...

Journal Papers

- 'Sub-micrometer transverse beam size diagnostics using optical transition radiation', K. Kruchinin, et al., Journal of Physics: Conference Series 517 (2014)
- 'Laserwire: A high resolution non-invasive beam profiling diagnostic', L. Corner, A. Aryshev, ..., K. Kruchinin, et al., Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, Volume: 740, Pages: 226 - 228, (2014)

OPAC WP6 - Training

- Objective: Train the next generation of accelerator experts in **best possible way**
- Provide them with **ideal skills basis** for their future careers
- Promote **collaboration** and cross sector exchange
- **Secondments R&D** at different places



Motivation: *Ideal* Training.



OPAC Training

- Local training by host;
- Network-wide schools on accelerator techniques;
- Intra-network exchange of researchers;
- Secondments to other network partners (cross sector);
- Training in complementary skills.

➡ Motivation: *Ideal* Training.

Skills training for first year PGRs

Course Structure

- PhD project-specific part
 - Presentation skills
 - Scientific writing
 - Project management
- Generic skills through outreach project
 - Team working
 - Proposal writing
 - Peer review
 - Working under (time) pressure



„Best practice“

“I hadn’t really thought of myself as a project manager until today!”

OPAC[★]★

Secondments

- Part of every R&D projects;
- Duration: 2 weeks – several months;
- Ensures cross-sector experience;
- Helps understanding different needs and success criteria;
- Gives access to important infrastructures/tools;

Adds value to training !



OPAC Future Events

- ***Accelerator School with RHUL, July 2014***
- ***CAoPAC: Computer Aided optimization of Particle Accelerators Workshop, March 11th-13th 2015, GSI***
- ***Technology transfer with UoL/CI, June 2015***
- ***Advanced Researcher Skills with UoL/CI, June 2015***
- ***Symposium with UoL/CI, June 2015***
- ***Conference with US/CNA, October 2015***

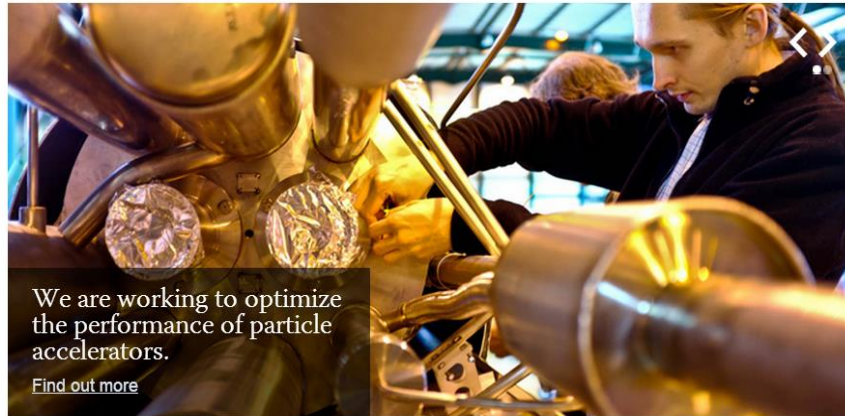




Dissemination: oPAC Website



- oPAC
- About us
- Network Structure
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- Vacancies
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- Events
- Dissemination
- Press
- Downloads
- Links
- EU Project T.E.A.M.
- Contact



Welcome to oPAC

The optimization of the performance of any Particle ACcelerator (oPAC) is the goal of this new network within the FP7 Marie Curie Initial Training Network (ITN) scheme.



Our Network

We work with the leading research centres, universities and industry partners.

[Find out more](#)

News

oPAC Fellows at EIC14

The Big Bang National Event - It all started with the Big Bang!!

www.liv.ac.uk/opac

OPAC Dissemination: Quarterly Newsletter

- Part of the dissemination strategy
- Contribution from all network partners
- Announcement and review of activities
- > 500 recipients, growing
 - All available via home page.



Follow us on Facebook

■ Conferences 2012

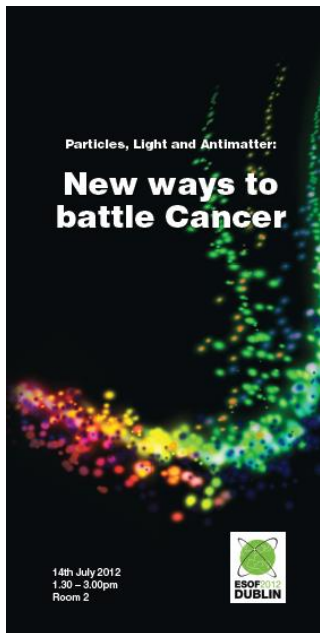
- IPAC stand and contribution
- BIW contribution
- ESOF session

■ Conferences 2013

- IPAC contributions
- IBIC stand in Oxford, UK
- Many seminars, conferences, etc.

■ Conferences 2014

- IPAC stand in Dresden, Germany
- HEA Workshop
- ESOF
- Contributions to BIW
- Learning & Teaching Conference ULIV



IBIC 2013 **OPAC** **IBIC 2013**

Beam Diagnostics R&D within oPAC

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

Abstracts
Optimization of particle accelerators by optimising research into beam physics, beam instrumentation, accelerator control systems and numerical simulation studies is the goal of the oPAC project. Supported with 6 million Euro by the European Union, the network is one of the largest ever Marie Curie Networks. During its four year duration 20 Fellows will be trained and a very broad international training program, consisting of Schools, topical Workshops and conferences will be organised by a consortium of currently more than 30 partner institutions.

Here we give an overview of the oPAC beam diagnosis R&D program, comprising instrumentation for synchrotron light sources, compact beam line monitors, ultra-low emittance beam size diagnostics and development of compact electronics for beam position monitors. An overview of oPAC events is also given.

Research
A versatile beam diagnostics system is crucial for the successful operation and continuous optimisation of any particle accelerator or light source. A few years ago, the oPAC consortium set out to define improved baseline standards in this research area and the development of cutting edge beam diagnosis is also being pursued in the oPAC network. Here we give a summary of the research results from Fellows across the network.

Beam Instrumentation for Light Sources (a. Thomas at the School)
To monitor the longitudinal charge distribution of the accelerated electron bunches, off-line techniques were used at ALBA using scintillators and electronic detection. Direct beam profile measurements were performed using a Fast Current Transformer (FCT) on a well-shielded part of the first harmonic of a Beam Position Monitor (BPM), both located in the ring.

In parallel of the visible part of the synchrotron radiation was detected at the X-ray beamline using a PMT and an oscilloscope based measurement and for the Synchrotron Storage Ring (SSR) at DESY. Good results were obtained for both horizontal and vertical beam-size measurements, but systematic errors are already present (PWA 3).

Oxygraphic Beam Line Monitors for the LHC at CERN and CERN
The production ability of the current OLM system around the 100k magnets at the LHC injection region is not maintained for the new generation of higher beam energies and intensities. Detectors shall be installed as close as possible to the superconducting coil for improved active pointing.

Injection measurements at cryogenic temperatures were performed with different candidate technologies. The measured position indicated signal degradation over 20 years of MoQ of LHC operation in the factor 25 x 5 for silicon detectors, while it is a factor of 10 x 3 for diamond detectors.

Compact Electronics for BPMs
In a compact and cost-effective form factor a BPM electronics typically focuses on storage rings where beam stability needs to be as good as can be. Precise measurements of position and fast data delivery make a high performance. For horizons such performance is not realistic when position resolution ranges from micrometres to millimetres, and the operator needs to access such information on demand.

To overcome both issues, a new platform is being developed. Great effort is spent in reducing the distance between front-end and high performance signal processing (HEPC 16).

Ultra-low Emittance Beam Size Measurement
The ultra-low emittance (ULE) beam is a key parameter for high resolution measurements. The latter is defined by the rms-measures of the P1st Synchronisation Function (SF) which can be the response of an optical system to a source distribution generated by a single charge. The beam resolution achieved so far by conventional OTR monitors is around a few micrometres.

Transverse beam size measurements were recently carried out at the ATF facility in Japan showing that it is possible to achieve a sub- μm resolution. The minimum measured vertical beam size was 0.25 \pm 0.05 μm , \sim 5 times better than the resolution of conventional OTR monitors. To further improve the resolution, effects significantly influencing on the P1st SF will need to be reduced (OVALC).

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

International School on Accelerator Optimization
School on Accelerator Optimization (SAO) will be held at the CERN Accelerator School or the Joint Universities Accelerator School. This provides then a good training basis as they take on their projects within the Network. An oPAC School on Accelerator Optimization will be organized by the consortium between 17th - 21st July 2014 at Royal Holloway University of London, UK. It will cover advanced techniques for the optimisation of particle accelerator performance - in particular the combination of different fundamental techniques to push the limits of acceleration over future.

All Fellows met for a dedicated Research at 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 the school had already been developed by oPAC/IBIC but has since been refined. It is now offered to all oPAC students in the School of Physical Sciences at University of Liverpool. Discussions with other UKLEs are ongoing with the aim to let more research centres benefit from this advanced school which was recently completed as a successful story by the CERN.

Topical Workshops
www.oac-project.eu

As part of the network's long term strategy to create lasting structures for the wider scientific community, oPAC will organise a series of Topical Workshops. A first workshop on the Grand Challenges of Accelerator Optimization was held on 20-27 June 2013 at CERN and covered all work packages of the project. More than 150 registered participants received the state-of-the-art in accelerator R&D during the two days. CERN Indico ID 24330.

Expert training days on 'Simulation Tools' and 'Beam Diagnostics' were held for all Fellows, hosted by CERN and DESY, respectively.

A Workshop on Beam Instrumentation focusing on beam profile and post injection monitoring will be hosted by DESY in Muenche, Austria on 01/09, May 2014 and many more are in the planning.

Full details and information about how to register can be found in the research council's newsletter and in the school pages. In order to subscribe, please send an email to the coordinator or like the project.

International Conference on Accelerator Optimization
Current newsletter: www.oac-project.eu

In the last year of oPAC, a 3-day international conference on the optimization of particle accelerators will be organized, 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 every stage. While the beneficiary and associated parties were defined a proposal stage, the project encourages additional parties to submit to join the initiative. Qualified and interested 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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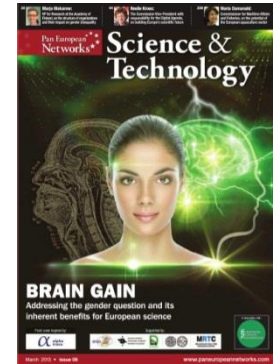
This project is funded by the European Union under contract FP7-24-307-630165 <http://www.oac-project.eu>



Outreach

- Leaflet for all events and personal contacts
- ESOF contributions – Session coordination
- Media interaction
- Fellows:
 - Webcasts about projects
 - Engagement with local schools
 - Specific opportunities (e.g. CERN guide, STEM ambassadors, etc.)
- Conference – Symposium

- IPAC 13: Fellows publications
- Pan European Networks, Science and Technology 6 (2013)
- STFC's UK news from CERN 2013: Issue 17 on oPAC
- Higher Education Academy's Annual Learning and Teaching Conference in Birmingham, UK



OPAC Partnership

JOINT UNIVERSITIES ACCELERATOR SCHOOL  

UNB              

Intensive program for Master & Doctoral students
Modular Courses for Professionals
Accredited by partner Universities (ECTS)

TWO COURSES ON PARTICLE ACCELERATORS
JUAS 2014
 6 January to 14 March

Course 1. SCIENCES & PHYSICS (January 6th to February 7th)
Course 2. TECHNOLOGY & APPLICATIONS (February 10th to March 14th)



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 F-74166 Saint-Julien-en-Genevois Cedex

Image credits: ESI - CERN - La August 2013

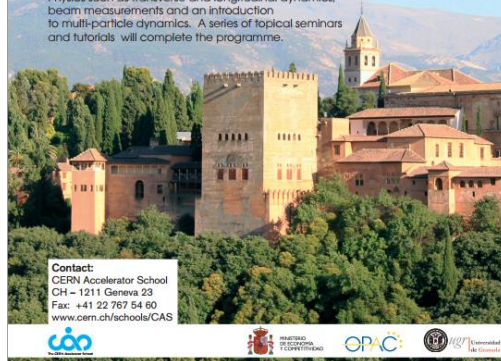


CERN Accelerator School & the University of Granada will organise a course on


Introduction to Accelerator Physics

28 October - 9 November 2012
 Granada, Spain

This basic Introductory course will be of interest to young staff from laboratories, universities and companies manufacturing accelerator equipment. The course will focus on the basics of Accelerator Physics such as transverse and longitudinal dynamics, beam measurements and an introduction to multi-particle dynamics. A series of topical seminars and tutorials will complete the programme.



Contact:
 CERN Accelerator School
 CH - 1211 Geneva 23
 Fax: +41 22 767 54 80
www.cern.ch/schools/CAS



JOINT UNIVERSITIES ACCELERATOR SCHOOL

TWO COURSES ON PARTICLE ACCELERATORS

Course 1. Sciences & Physics of Particle Accelerators - 5 weeks
Course 2. Technology & Applications of Particle Accelerators - 5 weeks

A flexible approach
 Intensive programme for Masters & Doctoral students
 Modular courses for professionals

Organised by
 the European Scientific Institute (ESI)

with the support of
 14 major European Universities

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 CERN, CEA, CNRS-IN2P3, CPAN, DESY, ESRF, ESS, GSI, Helmholtz Zentrum Berlin, HIC For FAIR, INFN, KIT, OPAC, PSI, SOLEIL, Bergo Instrumentation, Conseil Général de la Haute-Savoie.

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 Archamps Technopôle
 F-74166 Saint-Julien-en-Genevois Cedex

Phone: +33 (0)4 50 31 50 10
 juas@esi-archamps.eu

www.cern.ch/juas

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Assistant: Mrs Filiz DEMOLIS



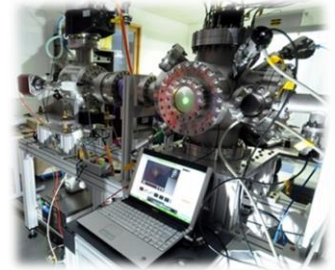
- 1st August 2013 -



oPAC has already become an important part of the accelerator community !!

OPAC Accelerator R&D

- Cross-sector collaboration key to research
- Large-scale experiments require international cooperation



- Research area needs significantly more trained accelerator experts
- Few universities in EU provide structured training – oPAC is unique initiative.

- Very good **research** results beyond expectations!
- **Training** program helped to create links between Fellows; recognized as success (UKRO, HEA, etc.);
- Excellent contributions from **industry**;
- **Events** as drivers for knowledge exchange.



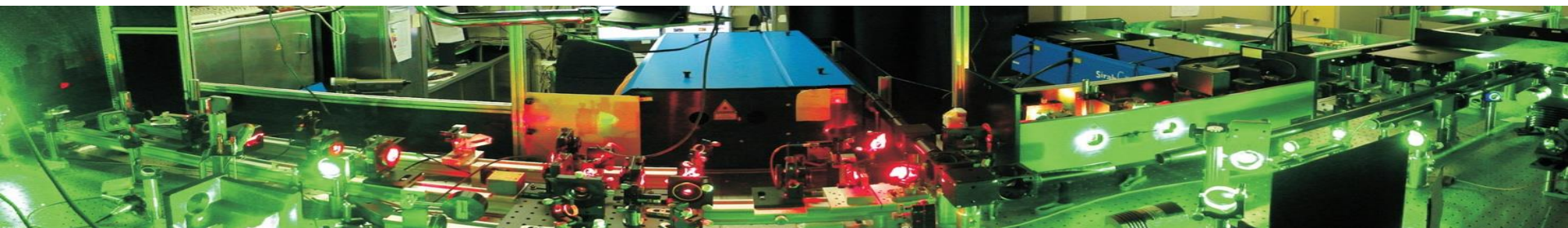


Further information

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Panorama photograph of the RILIS setup at CERN (image courtesy V. Fedosseev).