LOW-ε-RING network: Common challenges and common solutions

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WP6 - Low Emittance Rings: scope and background

- Bring together scientific communities of **synchrotron light sources' storage rings, damping rings** and **e+/e- ring colliders** in order to communicate, identify and promote common work on topics affecting the design of **low emittance electron and positron rings**

- Initiated by the CLIC-ILC collaboration working group on damping rings, chaired by YP and Mark Palmer (now at FNAL)

- State of the art in design of accelerator systems especially in **X-ray storage rings** approaches the **goals of damping rings** for linear colliders and **future e+/e- ring collider** projects

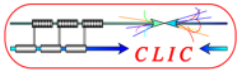
First Low Emittance Rings' workshop

- Organization of the 1st Low Emittance Rings' workshop in January 2010, at CERN (~70 participants)
- Common tasks identified including beam dynamics but also technology

Workshop on

Low Emittance Rings 2010

CERN, 12-15 January 2010



- *Home*
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The goal of this workshop is to bring together experts from the scientific communities working on low emittance lepton rings (including damping rings, test facilities for linear colliders, B-factories and electron storage rings) in order to discuss common beam dynamics and technical issues. It is organized by the joint ILC/CLIC working group on damping rings and specifically targets strengthening the collaboration within the two damping ring design teams and with the rest of the community. The workshop will profit from the experience of colleagues who have designed, commissioned and operated lepton ring colliders and synchrotron light sources.

Workshop sessions will include:

- **Low Emittance Design and Tuning**
- **Collective Effects (electron cloud, fast ion, IBS, impedances)**
- **Low Emittance Ring Technology (wigglers, kickers, instrumentation, etc.)**

Second Low Emittance Rings' workshop

- Second workshop on October 2011 in Creta acted as a catalyzer
- Proposal of a collaboration network enabling scientific interaction and coordination for common design work including measurements and tests in existing facilities for achieving ultra-low emittance, high intensity beams with remarkable stability

WP6: Objectives

- Task 6.1: Coordination and Communication
- Task 6.2: Low Emittance Ring Design (LERD)
- Task 6.3: Instabilities, Impedances and Collective Effects (IICE)
- Task 6.4: Low Emittance Rings Technology (LERT)

Task 6.1: Coordination and Communication

- Coordinators:
  - R. Bartolini (UOXF)
  - S. Guiducci (INFN-LNF)
  - Y. Papaphilippou (CERN)

  } Each one representing community of X-ray storage rings of e+/e- colliders and damping rings

- Form a **coordination board**, representing the Low Emittance Rings community (including non-EU members)
  - B. Hettel (SLAC)
  - Q. Qin (IHEP)
  - D. Rubin (Cornell)
  - J. Urakawa (KEK)

  } Representing "Ultimate-storage ring" community and damping ring test facilities

  - Task coordinators: M. Böge (PSI), R. Nagaoka (Soleil), H. Schmickler (CERN)
- Organize Low Emittance Rings' general and topical workshops

Third Low Emittance Rings' workshop

- Third workshop to be held on July 2013 in Oxford

http://www.physics.ox.ac.uk/lowemittance13/index.asp

- Already ~70 registered delegates
- Agenda to be finalized by the end of this week

Task 6.2: Low Emittance Ring Design

- Coordinator: M. Böge (PSI)
- Sub-Task 6.2.1. Optics Design of Low Emittance Rings
  - Optics design of multi-bend achromats in conjunction with damping wigglers
  - Potential benefit of dipole magnets with longitudinally variable bending field or Robinson wigglers
  - Numerical tools (GLASS, multi-objective algorithms) for linear and non-linear dynamics optimization
  - Reduction of collective effects through optics design
  - Design of low momentum compaction factor optics for bunch length reduction and production of coherent synchrotron radiation
  - Experimental tests for understanding limitations of existing theories and benchmarking of numerical codes
- Sub-Task 6.2.2. Minimization of Vertical Emittance
  - Methods for obtaining sub-picometer vertical emittance in high intensity beam conditions (betatron coupling and vertical dispersion)
  - Evaluation of magnetic error tolerances and control of geometric alignment (see task 6.4.1)
  - Diagnostics' requirements for precise beam size, position and emittance measurement as well as on-line correction techniques (see task 6.4.2)

Task 6.3: Instabilities, Impedances and Collective Effects

- Coordinator: R. Nagaoka (Soleil)
- Sub-Task 6.3.1: Impedances and Instabilities
  - Single and multi-bunch instability evaluation for ultra-high brightness, short bunches
  - Estimation and optimization of accelerator components' impedance in the presence of coating
  - Experience in existing machines on impedance reduction campaigns and impedance degradation due to new equipment installation
- Sub-Task 6.3.2: Two-Stream Instabilities
  - Numerical and experimental methods to estimate impact of two-stream instabilities, including code-benchmarking
  - Choice of most appropriate cures, including vacuum (coating for low pressure and/or secondary electron yield) and feedback systems and their impact to impedance budget
  - Vacuum methods including laboratory tests and impedance degradation leading to heating, pressure rise and ion instabilities
- Sub-Task 6.3.3: Particle Scattering
  - Scattering theory extension for non-Gaussian beams and benchmarking with simulations and experiments
- Sub-Task 6.3.4: Coherent Synchrotron Radiation Instabilities
  - Theory and simulation comparison of micro-bunching instability thresholds with experiments

Task 6.4: Low Emittance Ring Technology

- Coordinator: H. Schmickler (CERN)
- Sub-Task 6.4.1: Insertion Device, Magnet Design and Alignment
  - Manufacturing and operation of insertion devices with new super-conducting materials
  - Cryogenic and vacuum technology in the presence of synchrotron radiation heat loads
  - Novel measurement techniques for estimating magnetic errors
  - Beam based alignment techniques and real time alignment technologies for very low emittance and long-term stability
- Sub-Task 6.4.2: Instrumentation for Low Emittance
  - BPM systems for submicron orbit feedback and vertical dispersion control of a few mm, including turn-by-turn capabilities with micrometer resolution
  - Synchrotron radiation monitors for measuring ultra-low beam sizes and bunch lengths
  - Wideband feedback systems in the range of GHz able to measure, control and damp multi-bunch instabilities with fast rise times
- Sub-Task 6.4.3: Design of Fast Kicker Systems
  - Low impedance fast strip-line kickers with tight field tolerances
  - Fast rise- and fall-time high voltage pulsers with good amplitude stability and high reliability.
  - Experimental methods for minimizing kicker-induced orbit errors
- Sub-Task 6.4.4: RF Design
  - RF powering, super-conducting RF technology, and low level RF system design
  - RF systems contribution in total machine impedance and parameter optimization to reduce it

Deliverables

- One interim and one final report per task
- Help provided by sub-task coordinators (already identified)

Delive-rable Number [61]	Deliverable Title	Lead benefi-ciary number	Estimated indicative person-months	Nature [62]	Dissemi-nation level [63]	Delivery date [64]
D6.1	Low Emittance Ring Design interim report	19	2.00	R	PU	18
D6.2	Instabilities, Impedances and Collective Effects interim report	9	2.00	R	PU	18
D6.3	Low Emittance Ring Technology interim report	1	2.00	R	PU	18
D6.4	Low Emittance Ring Design final report	30	3.00	R	PU	46
D6.5	Instabilities, Impedances and Collective Effects final report	9	3.00	R	PU	46
D6.6	Low Emittance Ring Technology final report	1	3.00	R	PU	46

Milestones

- 3 topical and 3 general workshops (dates may be slightly adapted)
- Organize common events with other WPs (X-BEAM, Future magnets, Innovative RF technologies)

Milestone number [59]	Milestone name	Lead benefi-ciary number	Delivery date from Annex I [60]	Comments
MS41	First workshop of Collective effects in Low Emittance Rings	9	6	Activity report
MS42	First workshop of Low Emittance Rings Technology	1	9	Activity report
MS43	Annual LOW-e-RING workshop, first year	40	12	Activity report
MS44	First workshop of Low Emittance lattice design	30	18	Activity report
MS45	Annual LOW-e-RING workshop, second year.	40	24	Activity report
MS46	Second workshop of Collective effects in Low Emittance Rings	9	30	Activity report
MS47	Second workshop of Low Emittance Rings Technology	1	33	Activity report
MS48	Annual LOW-e-RING workshop, third year.	40	36	Activity report
MS49	Second workshop of Low Emittance lattice design	30	36	Activity report

Resources

- Total of 15.75 person months and 330KEuros

Participant short name [11]	Person-months per participant
CERN	5.25
SOLEIL	3.50
INFN	1.75
PSI	3.50
UOXF	1.75
Total	15.75

Next steps

- 1st coordination meeting, room 304-1-007, Friday 14 June, 9:00-12:00
- Draft Agenda:
  - Organisation of general workshop (program finalisation)
  - Future topical workshops: time, place and budget allocation
  - Collaboration board: membership and next meetings
  - Synergy with other EUCARD2 WPs
  - Low Emittance Ring's student prize

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THANK YOU!!!