## WG1: Storage Ring Radiation Sources

**Conveners:** K. Harkay (APS) and A. Ropert (ESRF)

**25 participants**

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tues 16 May</td>
<td>11:00-11:15</td>
<td>Introduction</td>
</tr>
<tr>
<td>11:15-11:35</td>
<td>S. Krinsky - Discussion of the Design of the NSLS-II Storage Ring</td>
<td></td>
</tr>
<tr>
<td>11:35-11:55</td>
<td>G. Geloni - Statistical Optics and Partially Coherent X-ray Beams in 3rd Gen Light Sources</td>
<td></td>
</tr>
<tr>
<td>11:15-12:30</td>
<td>Discussion: What ring parameters may lead to new science ?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lunch</td>
<td></td>
</tr>
<tr>
<td>14:00-14:20</td>
<td>Y. Li - Study of Dynamic Aperture for PETRA III Ring</td>
<td></td>
</tr>
<tr>
<td>14:20-14:40</td>
<td>V. Tsakanov - Beam Physics Issues in CANDLE Synchrotron Light Source Project</td>
<td></td>
</tr>
<tr>
<td>14:40-16:00</td>
<td>Discussion: Can we go beyond the present state of the art sources ?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coffee break</td>
<td></td>
</tr>
<tr>
<td>16:30-16:40</td>
<td>A. Streun - Compact low emittance lattices with longitudinal gradient bends</td>
<td></td>
</tr>
<tr>
<td>16:40-16:50</td>
<td>D. Robin - Bunch fill patterns and purification</td>
<td></td>
</tr>
<tr>
<td>16:50-17:10</td>
<td>B. Podobedov - High Current Effects in the NSLS-II Storage Ring</td>
<td></td>
</tr>
<tr>
<td>17:10-18:00</td>
<td>Discussion: Can we go beyond the present state of the art sources ?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Thurs 18 May</th>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00-9:20</td>
<td>J. Byrd - Observation of CSR from bunches following slicing at ALS</td>
<td></td>
</tr>
<tr>
<td>9:20-9:30</td>
<td>K. Harkay - Status of APS short pulse project</td>
<td></td>
</tr>
<tr>
<td>9:30-10:30</td>
<td>Discussion: Can we go beyond the present state of the art sources ?</td>
<td></td>
</tr>
<tr>
<td>11:00-11:10</td>
<td>G. Luo, P. Chou - Operation experience with SRF at NSRRC</td>
<td></td>
</tr>
<tr>
<td>11:10-11:20</td>
<td>E. Weihreter - HOM-free NC rf cavities</td>
<td></td>
</tr>
<tr>
<td>11:20-11:30</td>
<td>T. Weiss - HOM damped RF cavities</td>
<td></td>
</tr>
<tr>
<td>11:30-11:40</td>
<td>E. Gluskin - Insertion device R&amp;D</td>
<td></td>
</tr>
<tr>
<td>11:40-12:30</td>
<td>Discussion: What critical accelerator technologies require development ?</td>
<td></td>
</tr>
<tr>
<td>Lunch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14:00-14:10</td>
<td>A. Ropert - Future possibilities at the ESRF</td>
<td></td>
</tr>
<tr>
<td>14:10-14:20</td>
<td>Y. Wu - Hollow beam instability in the Duke storage ring</td>
<td></td>
</tr>
<tr>
<td>14:20-16:00</td>
<td>Discussion: Upgrade of existing sources: what is feasible ?</td>
<td></td>
</tr>
<tr>
<td>Coffee break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16:30-16:50</td>
<td>H. Hama - Featuring the Characteristics of the Super Coherent THz Photon Ring</td>
<td></td>
</tr>
<tr>
<td>16:50-17:10</td>
<td>Y. Kawashima - Proposal of a Synch Rad Facility to Supply UV, X-ray, MeV photon, GeV photon, and Neutron</td>
<td></td>
</tr>
<tr>
<td>17:10-18:00</td>
<td>Discussion: Is it worth building cost-effective but lower performing rings ? Should we build multipurpose or specialised sources ?</td>
<td></td>
</tr>
</tbody>
</table>
Present and future third generation light sources

1-2.4 GeV
22%

2.5-4 GeV
61%

6-8 GeV
17%

Hard X-rays thanks to the development of Insertion Device technology

UV and soft X-rays
What ring parameters may lead to new science? (1)

Figures of merit are strongly facility dependent

- Providing filling pattern options and short pulses with excellent bunch purity for those having a strong time-structure user community (5 to 33 %), has a strong priority.

Challenge is to satisfy them and flux users simultaneously.

D. Robin’s idea of kicking single bunch.

- For a large number of beamlines, flux is the important figure of merit.
  - Not a strong demand for beam current increase.
  - Some obstacles on the machine side.
What ring parameters may lead to new science? (2)

- There is a demand for low emittance, depending on the facility (1 nm at NSLS II and PETRA 3 for nanoscience)

- High stability of the photon beam has the highest priority for users

Good synergy between machine physicists and users
Can we go beyond state of the art sources? (1)

Overall challenges to answer:
How small an emittance is achievable practically in rings?
How short a pulse length and high a photon flux?
What is compromised?

- Lower emittance: Ways of achieving 1 nm
  - Longitudinal gradient in dipoles (feasible magnets could provide a significant reduction) but the dynamic aperture is an issue
  - Damping wigglers proposed for NSLS II (S. Krinsky talk) and PETRA 3 (up to 4 times reduction)
  - MAX-IV approach (1.4 nm at 3 GeV)

- Flexibility
  Some flexibility in the lattice and operating modes is required
Can we go beyond state of the art sources? (2)

- Dynamic aperture
  Serious issue for lattices with reduced emittance
  Less challenging when using damping wigglers (Y. Li)

Ideas for coping with small dynamic aperture at injection:
on-axis injection with very fast kicker, quadrupole kicker

- Maximum beam current
  ✓ Single bunch instabilities are the hardest to overcome
  ID chamber impedance is the major contributor to TMCI
  ✓ Microwave instability is also an issue
Discrepancy between experimental results and simulations
needs to be understood (B. Podobedov talk)
Can we go beyond state of the art sources? (3)

- Short pulses
  - Low $\alpha$ operation
    Sub-ps bunches expected with increasing the RF gradient by a factor of 20 (G. Wüstefeld talk)
  - Crab cavity scheme
    1 ps pulses achievable at APS (K. Harkay talk)
    issues on the SC cavity design and vertical emittance blow-up (tolerances on rf errors)
  - Seeded CSR at ALS (J. Byrd)
    Bursting mode CSR possible source of THz radiation with seeding
  - Isochronous beam transport (H. Hama)
    Preserves linac pulse length (~100 fs)
What are the critical accelerator technologies that require R&D? (1)

- RF systems: SC versus room temperature
  - SRF developed for SOLEIL, CESRB (selected for several new rings)
  - Operational experience with SC cavities (G. Luo talk)
    - 1 trip / week, 30 minutes to recover
  - Pro and cons of SC and NC (E. Weihreter talk)
    - SC: more gradient and better HOM damping
      operational experience more limited
    - NC: simple technology
      cost effective

Room temperature HOM damped cavity (EU design, T. Weis talk) meets CBI thresholds requirements for our rings
What are the critical accelerator technologies that require R&D? (2)

- What are the trends in ID development? (E. Gluskin)
  - Technology is mature
  - Facility related approach (APS industrial-type experience of standard IDs versus a series of unique IDs at ESRF)
  - Dramatic improvement of magnet quality over years
  - Challenging developments of short period SC undulators (shimming and field measurements)
  - Strong concern for intermediate and high energy machines about radiation damage likely due to bad injection. Installation of scrapers strongly advised

- Statistical optics method for ID radiation calculation in VUV-soft x-ray wavelength regime (G. Geloni talk)
Upgrades of existing sources, what is feasible?

- Boundary conditions: cost, infrastructure, interferences with users....
- Most often considered: low emittance, top-up, canted undulators, leave enough room for future enhancements

Examples:
- ESRF (A. Ropert talk)
- SLS (canted undulators with extra quadrupoles)
- Proposed new 3 GeV ring at Taiwan
- NSLS II: keep enough room for an ERL
Is it worth building cost-effective, lower performing rings?

- Low-cost, medium performance 3rd generation sources
- What is affordable at small institutions and countries (CANDLE, V. Tsakanov talk), availability of UV research facility for local emphasis, training ground for large x-ray facilities?
- “Turn-key” linac, Booster (CLS, ASP examples) in case of staffing issues
- Multipurpose vs. special purpose rings
  - Generating multiple wavelength photons, neutrons from 1-10 GeV ring (Y. Kawashima talk)
  - MAX-IV (UV and VUV production in 2 superimposed rings)
  - Compact inverse compton scattering sources
Conclusions

- Active and fruitful participation in WG1
- Ring technology is mature
- The experience gained from existing facilities benefits new sources
- Innovations are continuing: emittance, RF, magnets, IDs.....
- Upgrades at each facility are driven by the local user community
- No end in sight for new ring installation around the world