# High Current Operations and Collective Effects

*High-Brightness Synchrotron Light Source Workshop*

**NSLS-II**

**April 26-28, 2017**

# Session Summary

- Ryutaro Nagaoka - **Collective Beam Instabilities and Methods of their Suppression**
- Taekyun Ha - **Vacuum Systems for Storage Rings with High Current**

# Session Summary

- Collective Effects
  - Impedance model, longitudinal and transverse, needs to be calculated for a bunch length much shorter than the length of the circulated bunch. There is no EM field solver yet allowing to calculate the point particle wake.
  - Several 2D & 3D numerical codes available for time domain and frequency domain simulations, GdfidL, CST, HFSS, ECHO, URMEL, Vorpal, ACE3P, ABCI, Poisson/Superfish.
  - Do we understand contribution of the NEG coating of the Al chambers and Ti-coating of the ceramics chambers to the total impedance of the ring?

# Session Summary

- For future low emittance light sources, with small horizontal dispersion, low alpha (mom. compaction) collective effects can be an issue, microwave inst., resistive wall inst. , coupled bunch inst. etc.. Bunch lengthening, however, can have a positive effect: by increasing Touschek beam life time, decreasing loss factor (reducing heating issues).

- Contributions to impedance: Tapered transitions, RF cavities, BPMs, Flange gap, stripline etc can be well estimated numerically or analytically.
- Importance of dependence on chamber cross section: can lead to low frequency quadrupole impedance and induced betatron tune shift

- Importance of the impedance of NEG coated chambers (NEG coating of one micron successful in many machines)
- NEG coating may increase reactive part of the impedance (leading to bunch lengthening, coher./incoherent tune shift)
- NEG coating effect on resistive part needs to be studied
- NEG coating and impedance budget in Sirius
- Importance of impedance budget and comparison with measurements
- Comparison often underestimates the impedance (both reactive and resistive part (by a factor of ~2)
- General overview on instabilities and collective effects
  - IBS
  - Bunch lengthening
  - MWI and CSR
  - TMCI (discussed new developments, such VFP approach of R. Lindberg at APS, measurements at MAX-IV)
  - RWI (studies at SOLEIL as a function of chromaticity)
  - HOMs induced instability
  - Ion induced instability (discussed the effect that combining ion effects, RWI and feedback can lead to instability)

- Stabilizing Technics:
  - Bunch lengthening (more than factor of 5 at MAX-IV)
  - BxB feedback
  - Positive Chromaticity
  - Different beam filling – pattern

# Session Summary

- High Current Operation
  - The electron beam does not forgive even slight **errors** in vacuum component design, clearance, position, protection, … . Bellows, BPM, IVU foil, RF Spring, Ceramics chambers, …

# Session Summary

- Vacuum systems discussed for the Next Generation of Light Sources (NGLSs) with high current and low emittance.
- Vacuum pumping system methods:
  - Conventional pumping with ante-chamber, used at PLS-II, NSLS-II, ESRF EBS, Spring 8-II
  - NEG coated chamber: SOLEIL (activation with a stored beam), MAX-IV (state-of-art NEG coating)
  - Conventional pumping + NEG coating chamber
  - New technique for NEG coated chamber: ALS-U (in very narrow chambers, with magnetic sputtering), CERN (successful in very small NEG coated chambers)
  - Pill type NEG (low cost option): PLS-II
- Photon absorbers
  - Materials for high heath load photon absorbers
  - OFHC copper, glid copper, cold forged OFHC copper (excellent thermal conductivity), CuCrZr (good thermal conductivity)
- Damage protection
  - Cu/Ni foil damage in IVUs at PLS-II. Improvements: hardware, orbit control
  - RF shielding failure: PLS-II, PEP-II, NSLS-II
  - Design for robust RF shielding: super-KeK, NSLS-II, ESRF EBS (developed new technique, sliding fingers)
- Analysis of the heat location in NSLS-II based on the vacuum pressure profile vs. average current
  - Possible causes: thermal desorption, photon stimulated desorption.
  - Transition behavior of temperature
- BPM support
  - Discussed improvements in BPM position stability in PLS-II. Water cooling.