

Summary on the Session on Collective Effects

by Boris Podobedov and R. Nagaoka

Talks given on topics related to collective effects:

- Review of collective effects for low emittance rings (K. Bane)
- Impedance calculation and minimisation for low emittance rings (T. Günzel)
- Harmonic cavity and multi-bunch simulations for MAXIV (M. Klein)
- CSR-driven longitudinal instability - comparison of experimental and theoretical results (P. Kuske)
- Wakefield measurement with EOS (A.-S. Müller)
- OASIS: Self-consistent simulations for collective effects (G. Bassi)
- Review of beam ions instabilities (L. Wang)
- Measurement of transverse single bunch instability thresholds at APS (V. Sajaev)
- Effect of impedance of kicker and coatings in damping rings (E. Koukovini Platia)
- Report on the mini-workshop on heating from short bunches (G. Rehm)
- Measurements of the evolution of electron cloud with time-resolving electron detectors (J. Sikora)

--- Questions for collective effects session

- What are the limits on stored current in ultra-low emittance lattice?
 - Low horizontal dispersion → low momentum compaction → short (zero current) bunch length → Lower instability thresholds, Interaction of the beam with high frequency wakes
 - Smaller physical aperture → Larger machine impedance
 - Spoiling of the emittance (H and V) due to IBS

- What are the main collective effects? Is IBS the limiting factor?
 - Single bunch instabilities (microwave strong and weak, TMCI, headtail, bunch lengthening), and resistive-wall and beam-ion instabilities in multibunch
 - Some LSs (such as APS and SOLEIL) must deliver high current/bunch mode for users
 - Single bunch thresholds may not be far above the bunch current in multibunch operation (MAX IV ...)
 - Yes, IBS would generally be a limiting factor for any low emittance ring
 - We should explore whether going to negative momentum compaction could be beneficial for USRs having intrinsically large natural chromaticities, but it may not be compatible with the low emittance optics
 - Transverse feedback successfully mitigates RW instability in many 3rd generation LSs (such as SOLEIL), but its limit must nevertheless be quantitatively evaluated carefully for USRs (higher growth rates)
- Are round beams necessary to counteract IBS?
 - Since for USRs, the vertical emittance would be diffraction limited over most photon energies of interest, a round beam should be beneficial in suppressing the horizontal emittance blow up

- Discussions on IBS:

- We could still have a factor of 2 of discrepancies in the IBS calculations depending upon different treatments.
- In this respect, further studies must be made to better master IBS especially in ***extremely low emittance (violent) regime***;
 - * Consistency among different approaches (theory, tracking, Fokker-Planck, ...)
 - * Treatment of non-Gaussian distributions
 - * Modeling of tails (are tails important? ... Heated discussions)
 - * 6D simulation would be necessary
 - * Further experimental bench-markings are very welcome (e.g. studies made at SLS)
- Active bunch lengthening is beneficial to fight against IBS

- Is IBS emittance growth an issue for Touschek lifetime as well in ultra low emittance rings?

- For rings that have Touschek lifetime increase with decreasing emittance, IBS emittance growth is an issue.

- What is the optimal RF frequency? Is it a possible parameter for optimisation?

- A lower frequency RF would have a beneficial effect of lengthening a bunch, but has the disadvantage of increasing the bunch current due to a reduced number of buckets (i.e. self compensating effects).

- Is heat load on the pipe components (and on the beamlines) a problem?
 - Yes, it represents a critically important issue for any low emittance ring operating at high current (BPM accuracy, ion desorption, ID tapers, ...)
 - Again, active bunch lengthening should be an efficient way to mitigate the issue
- Is CSR a problem, in what conditions and how can it be mitigated, is shielding a viable option?
 - For ultra-low emittance LSs, it does not seem to be a problem
 - It could be a problem if operated in a low alpha mode
 - For low emittance damping rings, it is a potential danger of blowing up the energy spread (especially without shielding)
 - Efforts must be continued to better understand (qualitatively & quantitatively) the instabilities driven by CSR (impedance-wise and beam dynamics-wise ((short and long range)))
- Are ions (ion trapping and fast-ions) an issue, in what conditions and how can it be mitigated?
 - There are several ways of mitigation (transverse feedback, multi-trains, chromaticity, coupling, ...) which may be applicable.
 - Transverse feedback would not be efficient against emittance blow-ups
 - Combined effects such as observed at SOLEIL (RW, beam-induced heating, FBII, transverse feedback, ...) require further studies and attentions

There are still many points not fully addressed in the discussions ...

- What are the main sources of impedance (narrow and broad band)?
 - What are the guidelines for the design of a low impedance machine?
 - Are the estimates (analytical and numerical) of the impedance budget in agreement with measurements?
 - How to model heating of a pipe?
 - Pros and cons of circular versus flat chambers
 - Could taper impedance be further optimised?
 - How capable are the Geometric wake field solvers today?
 - Short bunch wake ... how to get them
 - Layers/RW analytical versus numerical
 - Roughness
 - Loss factor extensions (coupled bunch)
 - Heat propagations and cures
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- What are the effective existing means to mitigate/cure instabilities?
 - What are the main tracking codes for collective effects? Do they need further developments?
 - Do they agree with measurements?
 - What studies can be performed on existing rings to gain confidence towards building a low-emittance ring?
 - Efficiency chromaticity shifting
 - Pros and cons of Tracking / Linearised Vlasov / VFP methods
 - VFP / Vlasov any extensions
 - CSR instability studies extensions (impact transverse/coupled bunch/combined impedance, ...)
 - Microwave ... a performance limiting instability
 - Instability diagnostics (wake field measurement and comparison)
 - Bunch by bunch profile
 - Is transverse feedback reliable enough today?
 - Digital or analogue?
 - Technology limit

ANNOUNCEMENT OF A TOPICAL WORKSHOP ON INSTABILITIES, IMPEDANCES AND COLLECTIVE EFFECTS



Hosting Lab: **Synchrotron SOLEIL**

Date (Tentative): **16-17 January 2014**



Treated Subjects

- Impedances and Instabilities
- Two-Stream Instabilities
- Particle Scattering
- Coherent Synchrotron Radiation Instabilities
- + Other related topics

→ More information to be diffused later on

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