Session 10: Impedance of collimators and kickers

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LHC injection kickers (H. Day)

- Tight design requirements to meet specs
- Important beam induced heating was observed in 2011-12, especially at one of the modules (exchanged during a TS with an improved version)
- Coaxial cable measurements done on old modules and new modules before installation → in general resonances + broad-band, but the new improved model mainly has resonant structure
- Simulations demanding and done on scaled structures →resonant structure reproduced, but more resonances found in simulations than measurements (due to limited frequency resolution of measurements)
- Main solutions to reduce heating under investigation (to be able to run with HL-LHC parameters)
  - Impedance reduction (reduction of peak height and move resonances to higher frequency)
  - Improve magnet cooling
- No study yet done on transverse impedance to check possible impact on instabilities

LHC collimator geometric impedance (M. Zobov)

- Collimator high contributors to LHC impedance
  - Better modeling could explain at least a part of the existing discrepancy (factor 2) between expected and measured betatron tune shifts

- Extensive simulations using GdfidL:
  - Fine meshing needed in simulations due to the complicated structure (springs, RF contacts) and long tapers
  - Even for easy structures (flat tapered structure), there can be a factor 2 difference between simulation and analytical estimation
  - Geometric impedance is found to dominate for gaps larger than few mm for W collimators (in the evaluation of the transverse kick factor)
  - Higher order modes also exist and were evaluated in previous work. They are recovered in current simulations

- New collimator design (with BPM integrated for alignment + vertical RF contacts removed + ferrite for HOM damping) → transverse impedance 20% larger from BPM cavity + more resonances (e.g. high resonance peak at 70 MHz) because of removal of contacts + damped HOMs above 1 GHz, but little change below this value. Questions:
  - Simulation of dispersive materials in GdfidL correct? Benchmark with analytical cases?
  - Longitudinal impedance growing function of frequency, does this pose problems for the corresponding wake (for beam dynamics simulations)?
  - Damping with dielectrics instead of ferric lossy materials could be applicable (though they must be placed differently)? What would be the real advantages?

Ferrite kicker modeling + impedance mitigation techniques (C. Zannini)

- Simplified analytical model is fully recovered with CST simulations
  - Dispersive materials are correctly treated in CST

- Realistic modeling:
  - C-shape magnet, two conductors
  - Connection to external cables can be included in the modeling using the proper cable properties and terminations.
  - Longitudinal segmentation (especially important for SPS injection kickers, for instance)

- Mitigation strategies:
  - Metallic coated ceramic plates (e.g. PSB ejection kickers)
  - Beam outside of kicker except when the kicker needs to be used (injection, extraction; studied as an option for the SPS extraction kickers)
  - Serigraphy (e.g. SPS extraction kickers, which exhibited strongly reduced heating), which introduce also a low frequency peak (wavelength related to the serigrqphy finger length) → structure of serigraphy could be optimized to smear out the peak and new design could be implemented in future

SNS extraction kicker: modeling and effects on beam (J. Holmes)

- Extraction kickers are the main impedance source and therefore have been object of detailed study
  - However, main limitation is electron cloud instability …
  - 14 ferrite window-frame magnets

- Interaction with beam:
  - Only dipolar transverse impedance interaction modeled
  - Analytical model based on dispersion equation giving transverse stability boundary → measured energy distribution fitted analytically for model
    - Coasting beam model (no effects of bunched beam or space charge), but benchmarks for coasting beam case showed excellent agreement
  - ORBIT agrees well with analytical model for coasting beams, bunched beam significantly more stable → prediction is that instability is the strongest with coasting beams and corrected chromaticity

- Experimental verification under the most critical conditions:
  - Factor two slower instability because Landau damping not included in analytical modeling
  - Instability reproduced by ORBIT code (n=12 most critical + growth time) using an impedance model having only the dipolar impedance from the kicker (other contributions and quadrupolar are deemed negligible)

PEP II emittance spoiler impedance (A. Novokhatski)

- Emittance spoiler: can we learn a lesson for the BSRT in LHC?
  - To increase the emittance and decrease brightness
  - Equipped with ceramic tiles and Cu support with water cooling to absorb some of the radiated power
- MAFIA simulations:
  - Show the existence of an important trapped mode
  - Trapped mode cannot be damped, solution was to place the mode in between beam spectrum lines (for nominal operation) to avoid excitation
  - When bunch spacing was changed by putting a bunch every fourth bucket, the power loss in the spoiler destroyed the spoiler (=Ti foil)
  - New spoiler was installed