Impedance Issues in SuperKEKB
- With updated results

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With contributions from
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1. Impedance calculations: Results: LER

- Pseudo-Green wake function
  - $\sigma_z = 0.5\text{mm}$
  - Pumping ports and SR masks are negligible sources because of antechamber
  - CSR and CWR (Wiggler radiation): CSRZ code with rectangular chamber
  - Not considered yet: Grooves surface, Clearing electrodes
1. Impedance calculations: Results: LER

- Wake potential with nominal bunch length
  - $\sigma_z=5\text{mm}$
  - Main sources: Collimators, Resistive wall, ARES cavity, Bellows, MO flanges
  - CSR and CWR are not strong if no microbunching happens
1. Impedance calculations: Results: HER

- **Pseudo-Green wake function**
  - $\sigma_z = 0.5\text{mm}$
  - **CSR**: CSRZ code with rectangular chamber
  - **CWR** (Wiggler radiation) not considered yet
  - Not considered yet: Tapers (should be negligible)
1. Impedance calculations: Results: HER

➤ Wake potential with nominal bunch length
  - $\sigma_z = 5 \text{mm}$
  - Main sources: Movable masks, Resistive wall, Flange gaps, Bellows, SCC cavities, ARES cavities, Pumping port
  - CSR is weak if no microbunching happens

Flange and bellows: Strange?
2. Single-bunch effects: Longitudinal: LER

Simulations with input of Pseudo-Green wake:

- Use Cai-Warnock’s VFP solver
- Collimators are important sources in bunch lengthening
- Simulated $\sigma_z \approx 5.8\text{mm} @$Design bunch current
- Simulated MWI threshold is around $NP_{th} = 15.\text{E10}$
- CSR and CWR are likely to be not important. BUT ...
2. Single-bunch effects: Longitudinal: LER

- Simulations with input of Pseudo-Green wake:
  - BUT, pseudo-Green wakes for CSR, CWR and RW are not good choices. => To be improved.
  - Potential-well distortion => Longitudinal beam tilt => Impact on luminosity to be evaluated

NP=9.04E10
2. Single-bunch effects: Longitudinal: HER

- Simulations with input of Pseudo-Green wake:
  - Use Cai-Warnock’s VFP solver
  - Movable mask: KEKB-type model used => To be improved
  - Simulated $\sigma_z \approx 5.8\text{mm}$ @Design bunch current
  - Simulated MWI threshold is around $NP_{th} = 17 \times 10^{10}$
  - CSR and CWR are likely to be not important.
2. Single-bunch effects: Longitudinal: HER

➢ Simulations with input of Pseudo-Green wake:
  ● **BUT**, pseudo-Green wakes for CSR, CWR and RW are not good choices. => To be improved.
  ● Potential-well distortion => Longitudinal beam tilt => Impact on luminosity to be evaluated

![Graphs showing density/np vs z/sigma20 for different np values and options]
3. Summary

➤ Impedance calculations
  ● Longitudinal impedance calculations with $\sigma_z=0.5\text{mm}$ => Pseudo-Green wake => Simulations of MWI

➤ Longitudinal single-bunch effects
  ● $\sigma_z\approx5.8\text{mm}$ @Design bunch current for both LER and HER [Optimistic estimation. Measured bunch should be longer due to unknown impedance sources]
  ● LER design: $\sigma_{zp}=6\text{mm}$; HER design: $\sigma_{ze}=5\text{mm}$ (Challenging?).

➤ Simple estimate of lum. loss $\approx8\%$, if $\sigma_{ze}=5\text{mm} \rightarrow \sigma_{ze}=6\text{mm}$

$$L = L_0 R_{H\theta}$$

$$L_0 = \frac{N_e N_p f_0 N_b}{2\pi \sqrt{\sigma_{xe}^*^2 + \sigma_{xp}^*^2 \sqrt{\sigma_{ye}^*^2 + \sigma_{yp}^*^2}}}$$

$$R_{H\theta} \approx \frac{1}{\sqrt{1 + \frac{\sigma_{ze}^2 + \sigma_{zp}^2}{\sigma_{xe}^2 + \sigma_{xp}^2} \tan^2 \theta \frac{\theta}{2}}}$$