

CSR in the RTL of SuperKEKB

D. Zhou and Y. Seimiya

Acknowledgements:

N. Iida

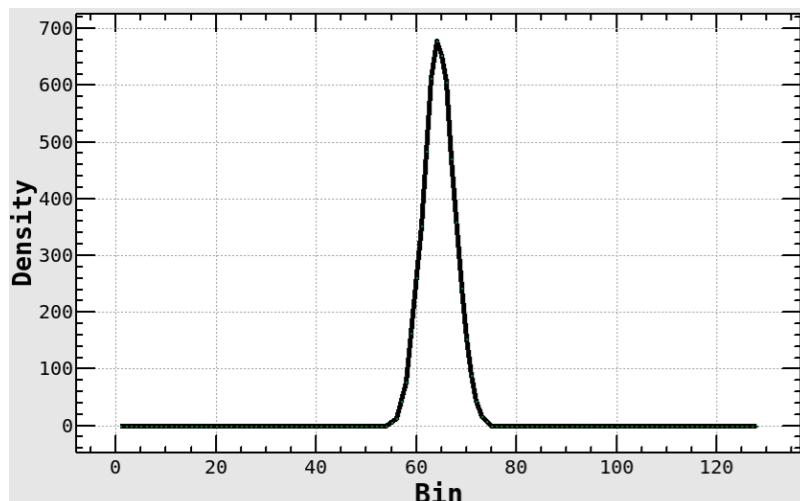
Emittance preservation task force meeting, Sep. 19, 2018

1. Benchmark study

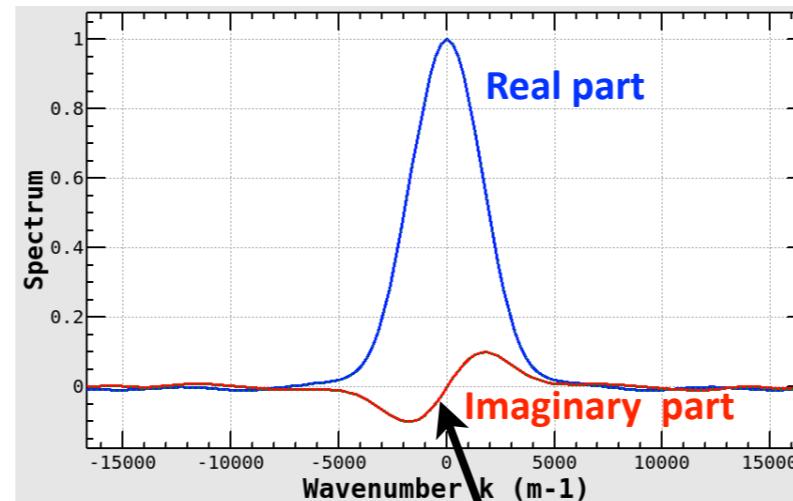
► Good resolution of beam spectrum depends on

- GCUT (in SAD used by GaussRandom[])
- Number of bins: Nbin
- Number of macro-particles: Np
- Example BL1S: $\sigma_z=0.6$ mm, GCUT=3, Nbin=128, Np=1e4, Q=0.7 nC

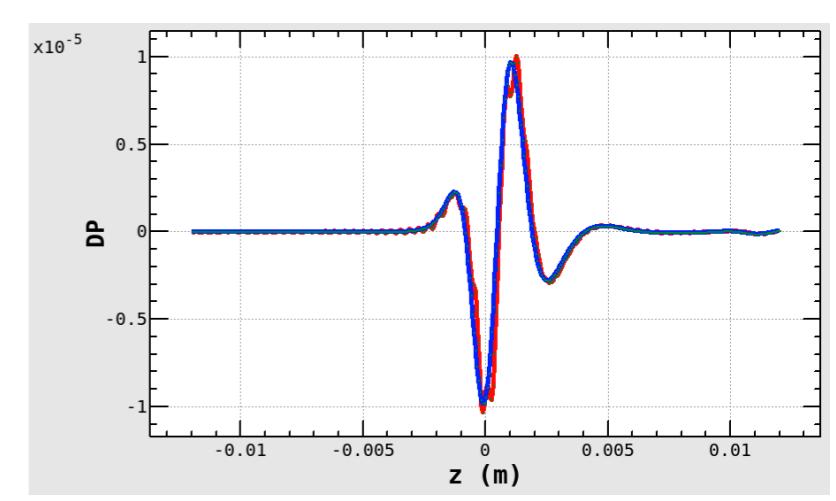
Bunch profile



Beam spectrum



CSR wake potential



Blue: Gaussian bunch
Red: Macro-particles

Numerical noise

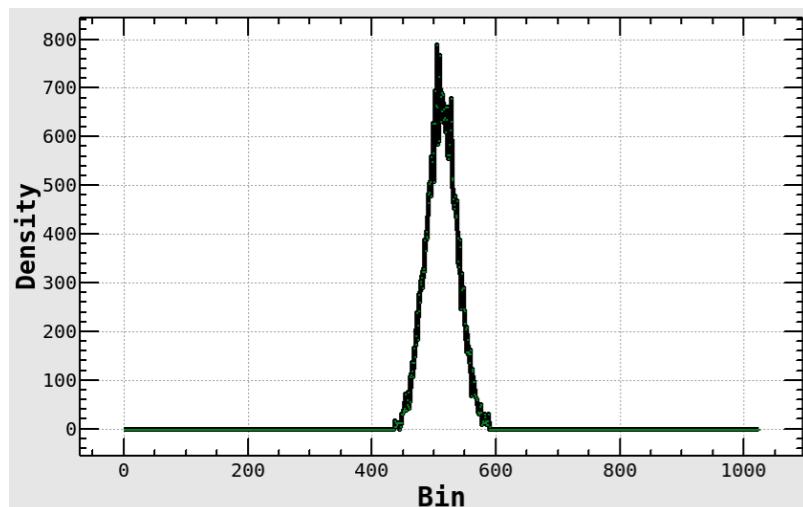
1. Benchmark study

► Good resolution of beam spectrum depends on

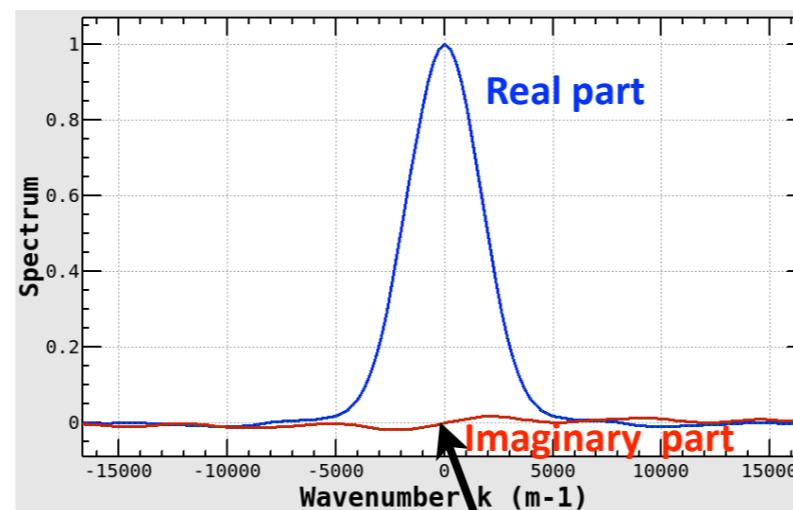
- GCUT (in SAD used by GaussRandom[])
- Number of bins: Nbin
- Number of macro-particles: Np
- Example BL1S: $\sigma_z=0.6$ mm, GCUT=3, Nbin=1024, Np=1e4, Q=0.7

nC

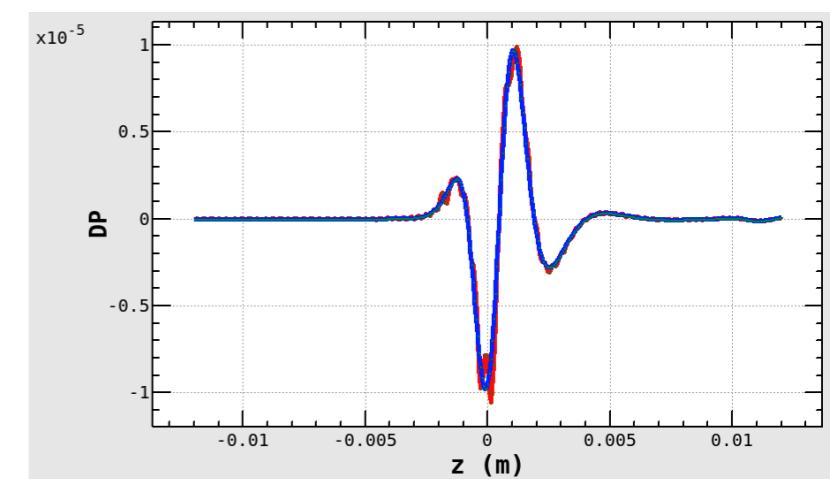
Bunch profile



Beam spectrum



CSR wake potential



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Red: Macro-particles

Numerical noise

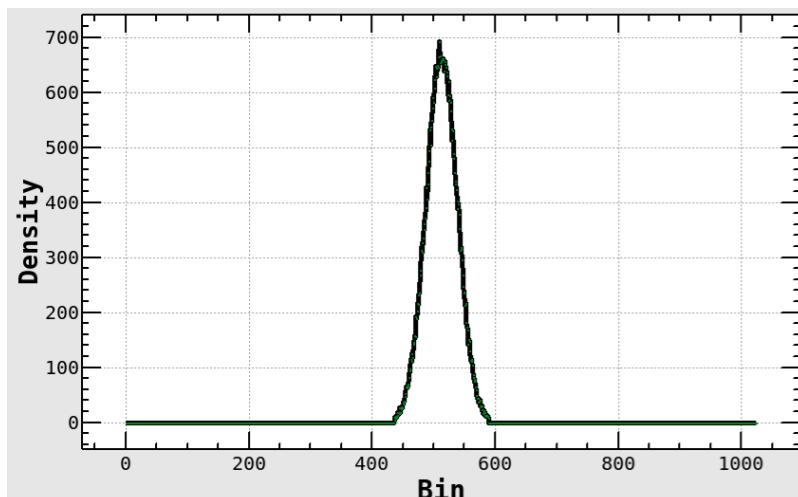
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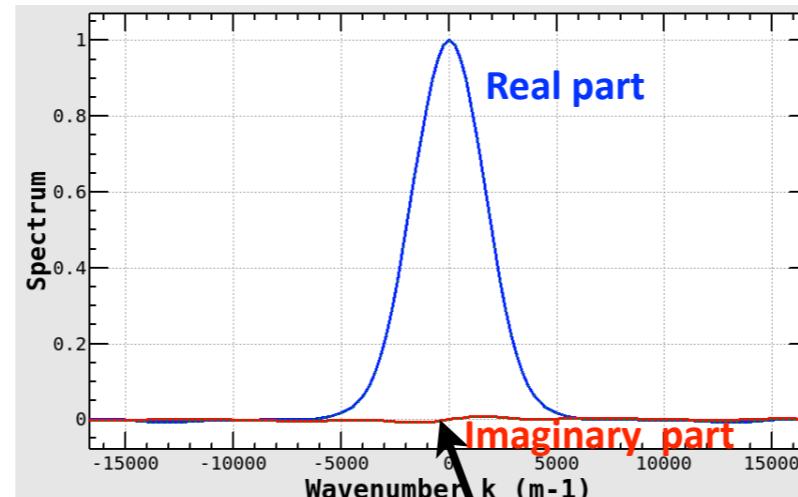
- GCUT (in SAD used by GaussRandom[])
- Number of bins: Nbin
- Number of macro-particles: Np
- Example BL1S: $\sigma_z=0.6$ mm, GCUT=3, Nbin=1024, Np=1e5, Q=0.7

nC

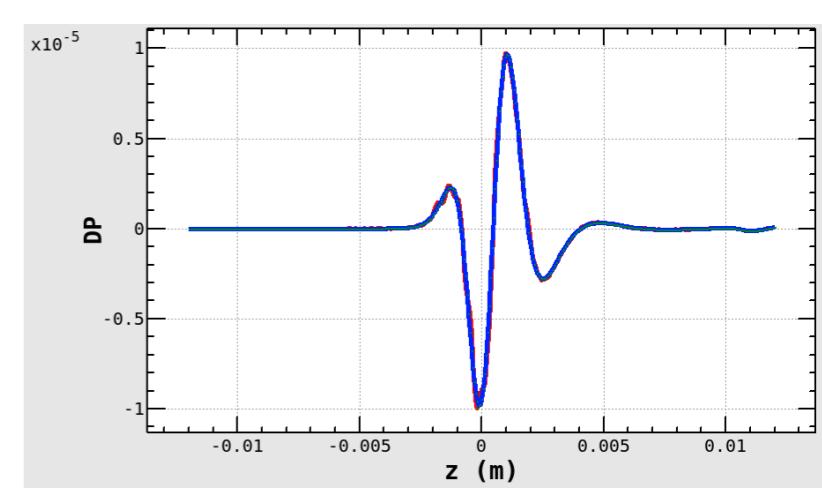
Bunch profile



Beam spectrum



CSR wake potential



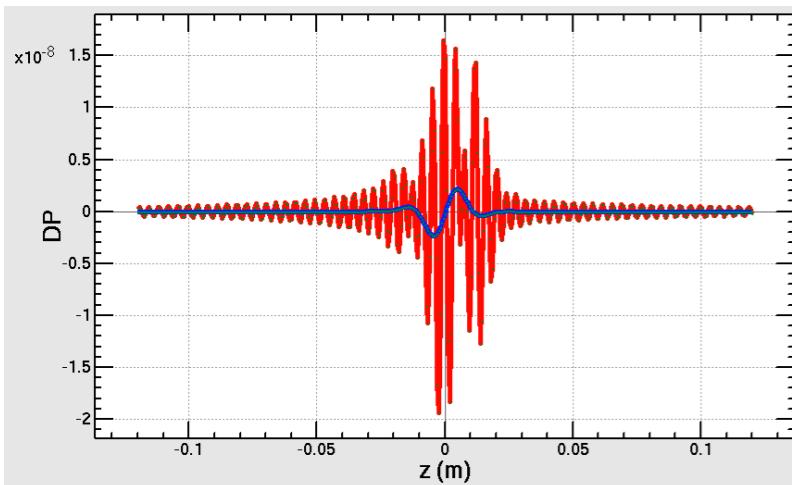
Blue: Gaussian bunch
Red: Macro-particles

Numerical noise

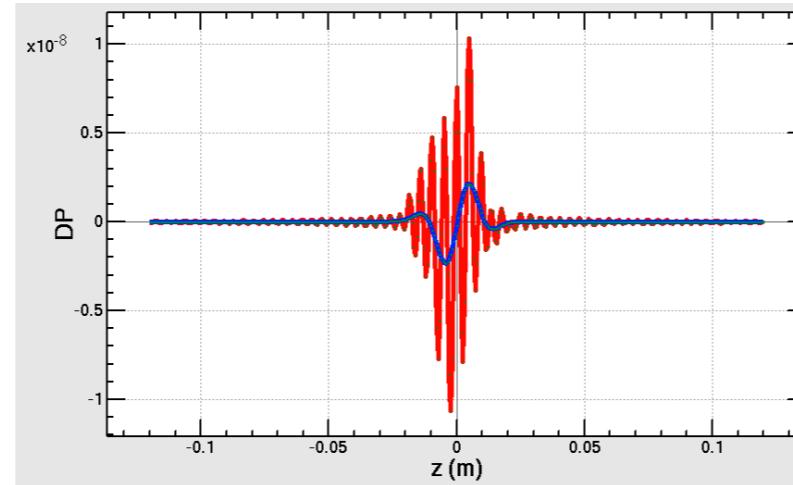
1. Benchmark study

- Good resolution of beam spectrum depends on
- GCUT (in SAD used by GaussRandom[])
 - Number of bins: Nbin
 - Number of macro-particles: Np
 - Example BL1S: $\sigma_z=6$ mm, GCUT=3, Nbin=128, Q=0.7 nC
 - Good choice: Large Nbin, Large density Np/Nbin

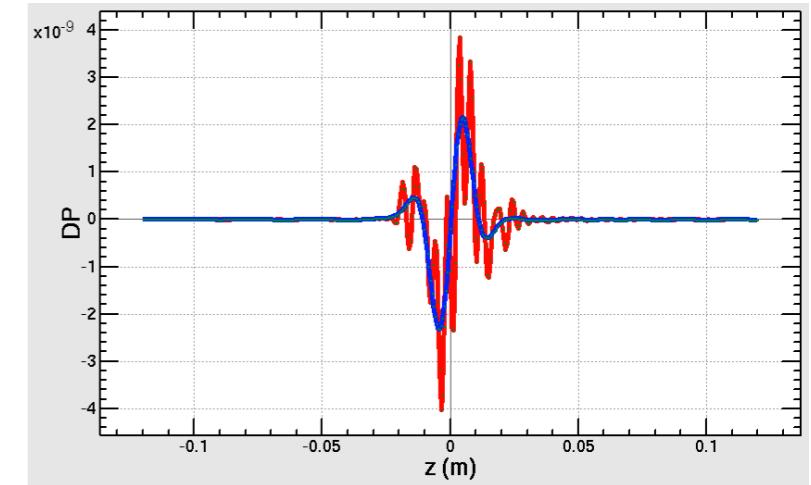
Np=1e4



Np=1e5



Np=1e6

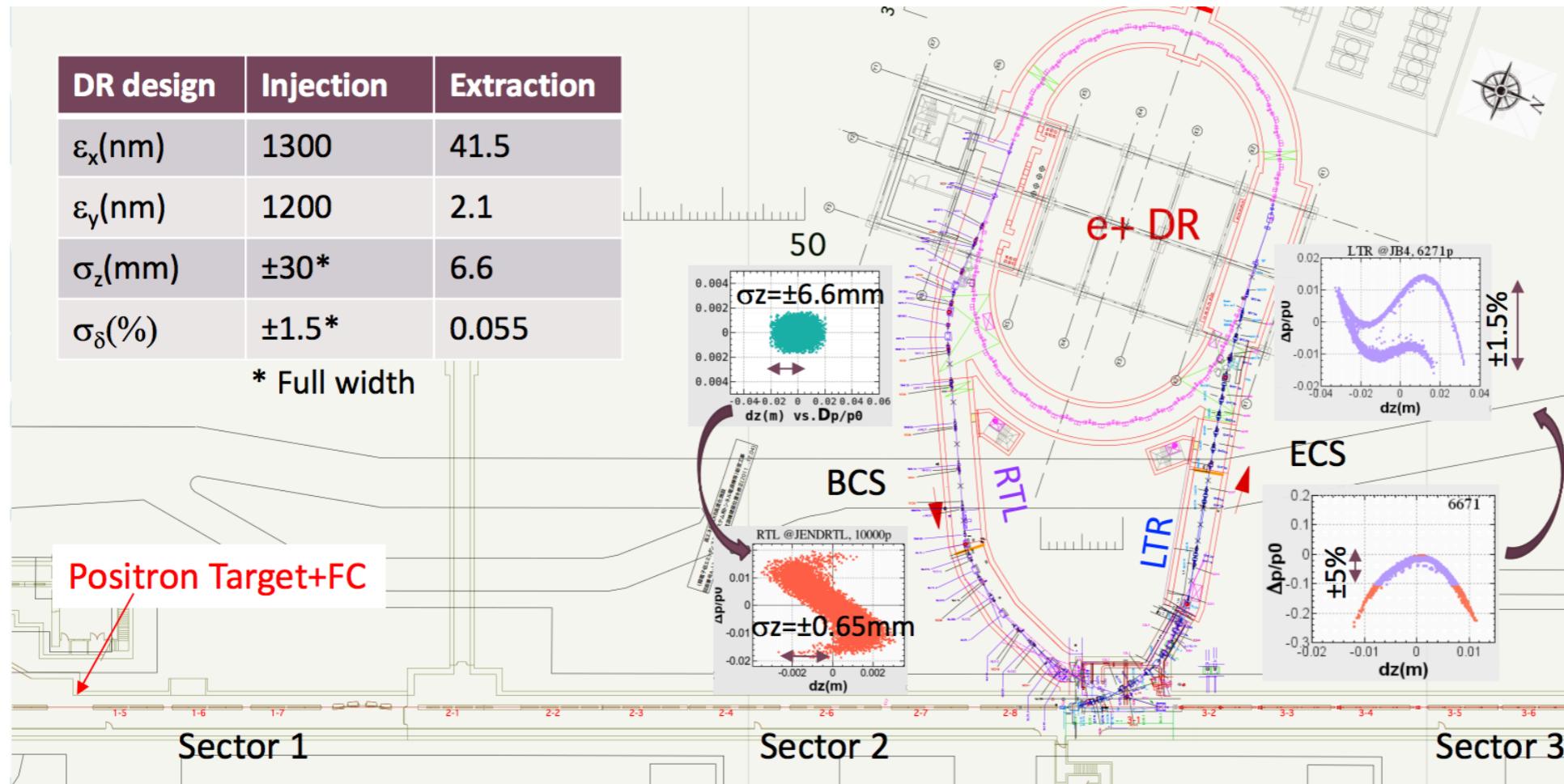


Blue: Gaussian bunch
Red: Macro-particles

2. Single-bunch effects: Longitudinal: CSR

► CSR at RTL of SuperKEKB

- Check N_p, N_{bin}
- Check V_rf
- Check bunch charge

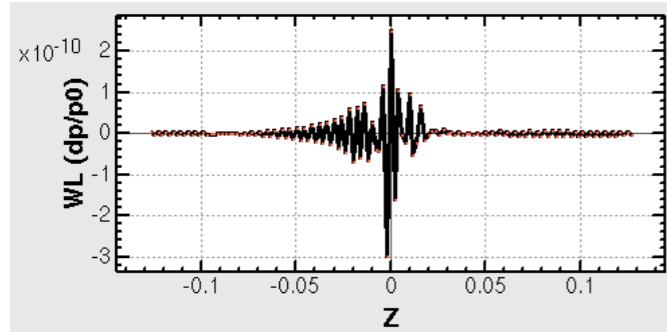


2. Single-bunch effects: Longitudinal: CSR

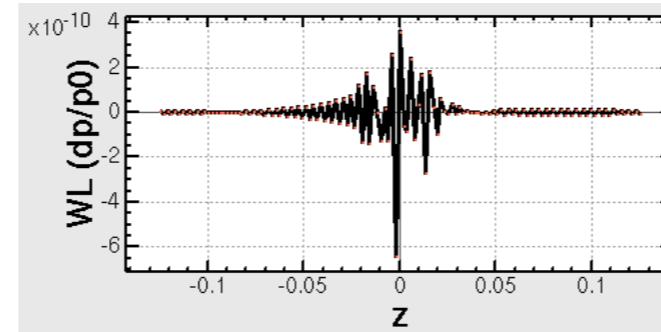
► Tracking with CSR:

- **Vrf=21.5 MV, Q=0.7 nC, Nbin=128, Np=1e4, GCUT=3**

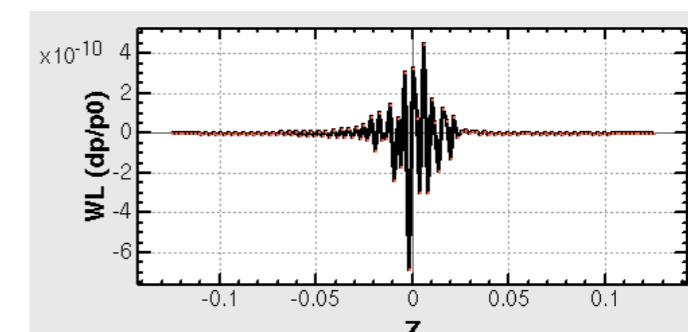
BSE1



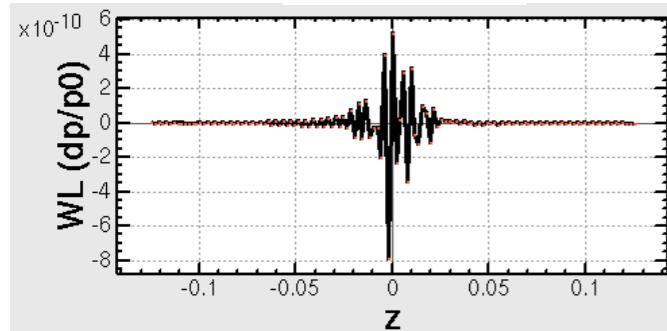
BRS.1



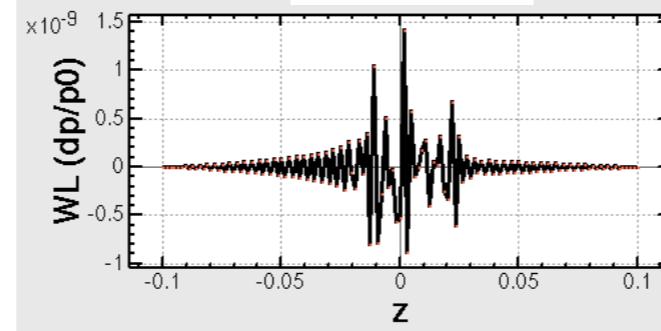
BRS.2



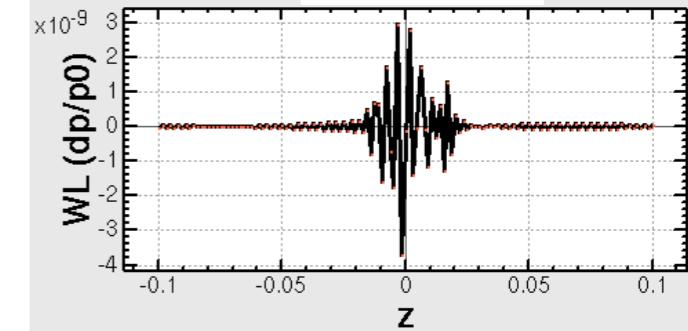
BRS.3



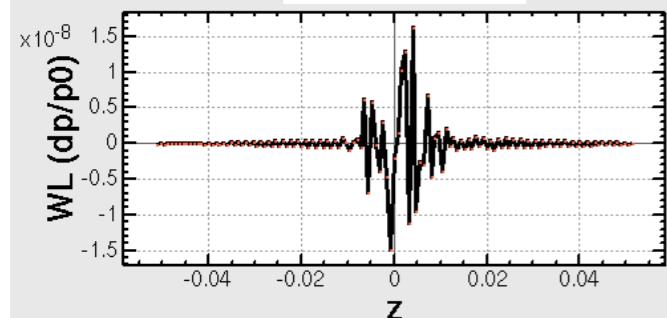
BL1S.1



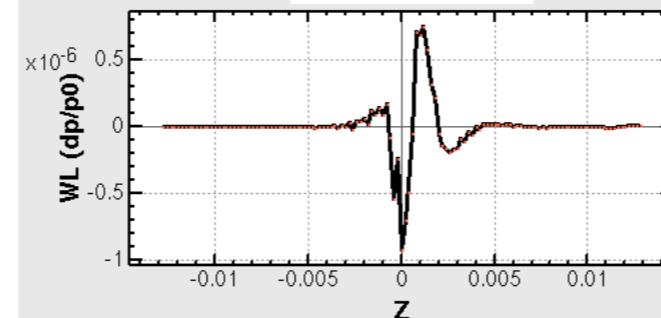
BL1S.2



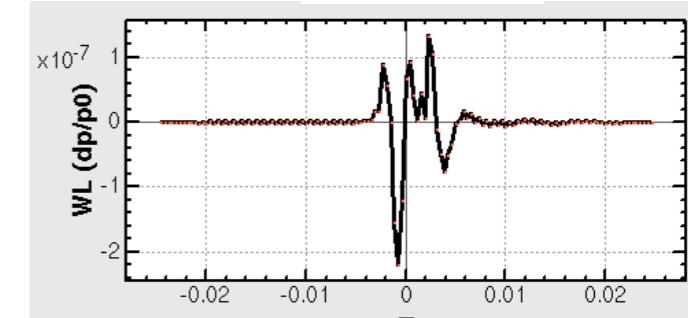
BL2S.1



BL2S.2



BL2S.3

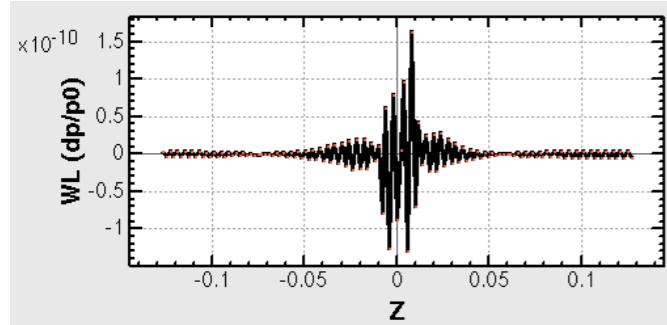


2. Single-bunch effects: Longitudinal: CSR

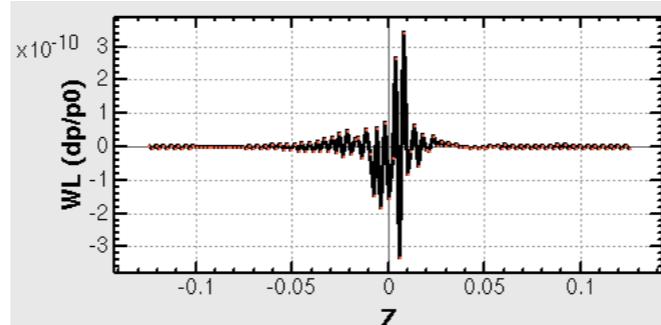
► Tracking with CSR:

- **Vrf=21.5 MV, Q=0.7 nC, Nbin=128, Np=1e5, GCUT=5**

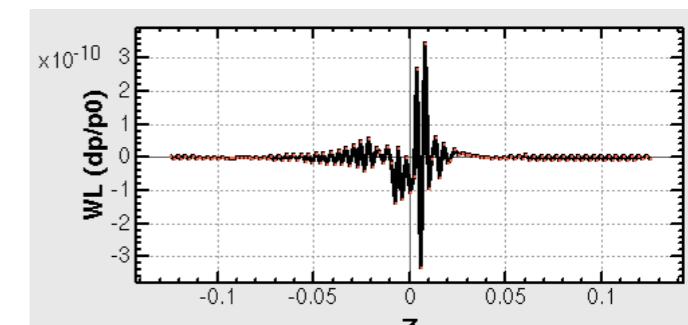
BSE1



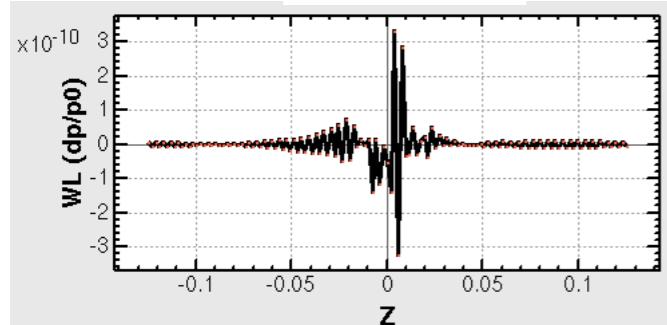
BRS.1



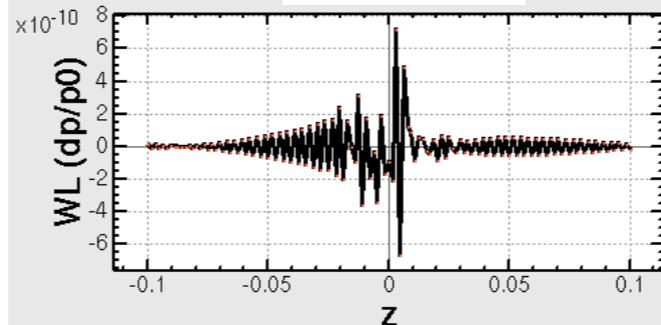
BRS.2



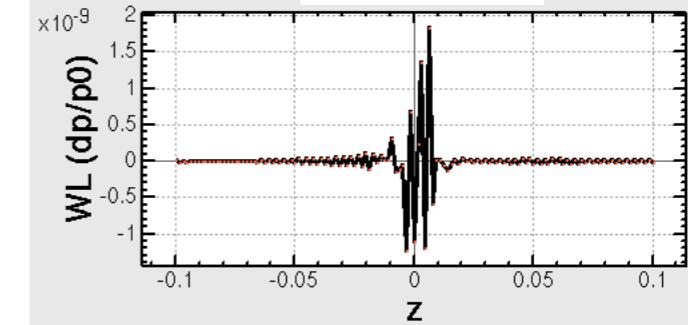
BRS.3



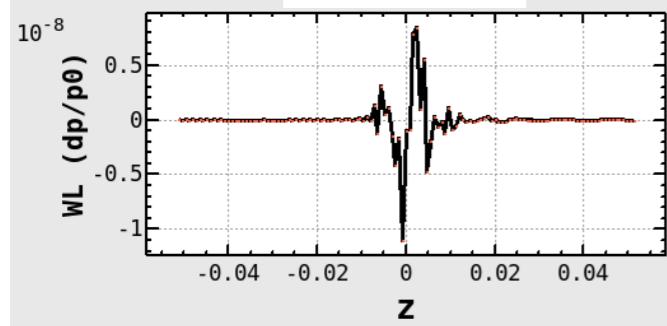
BL1S.1



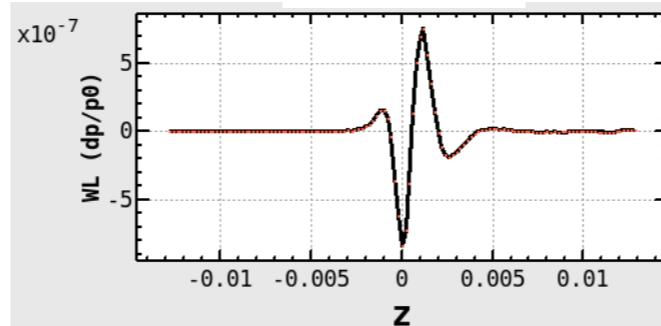
BL1S.2



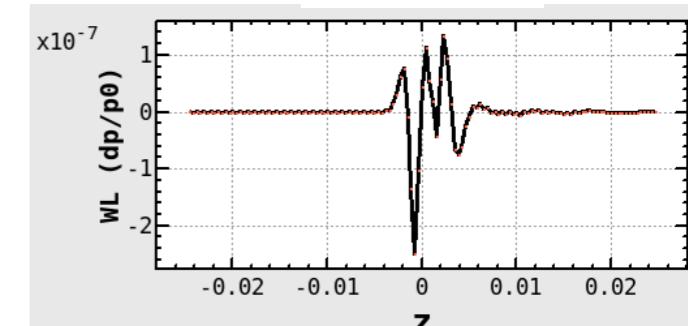
BL2S.1



BL2S.2



BL2S.3

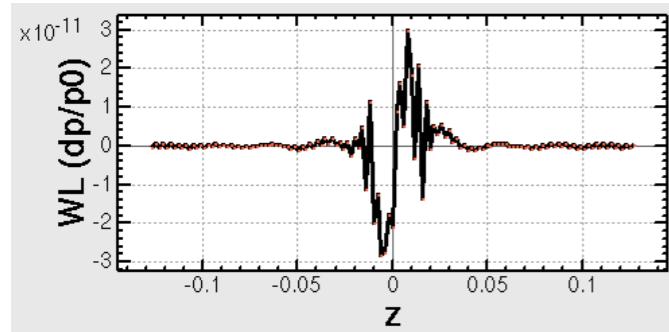


2. Single-bunch effects: Longitudinal: CSR

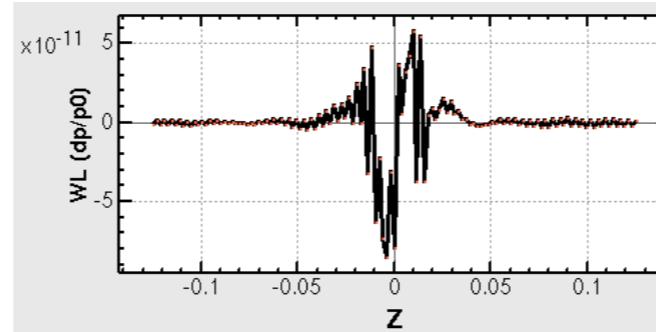
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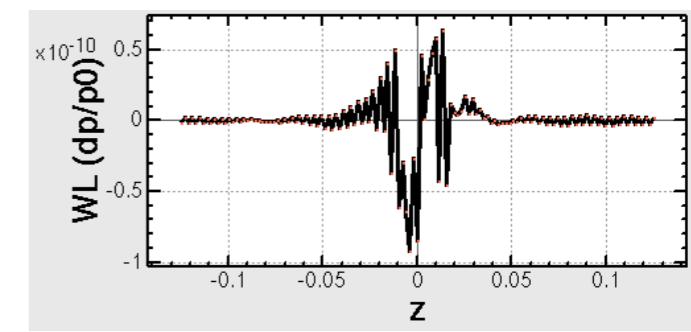
BSE1



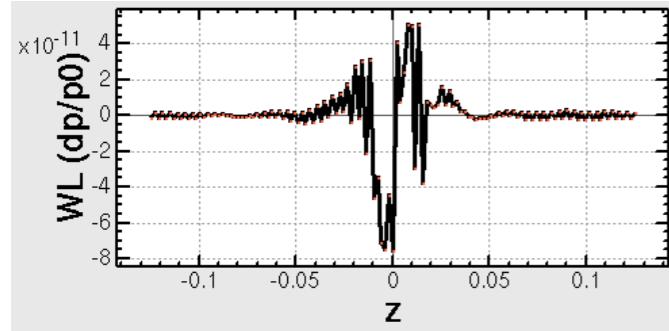
BRS.1



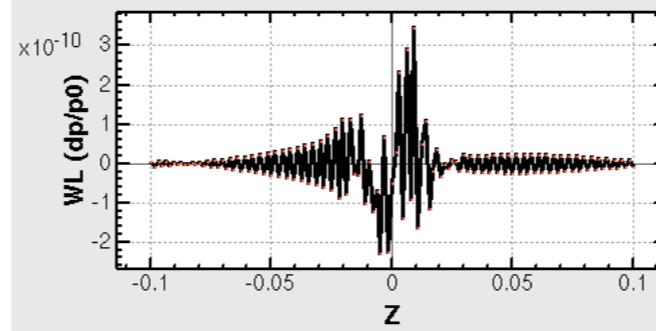
BRS.2



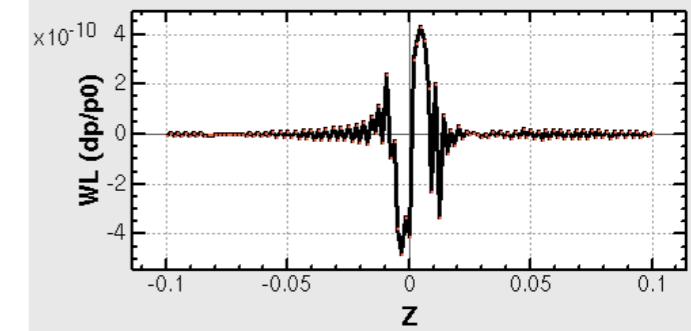
BRS.3



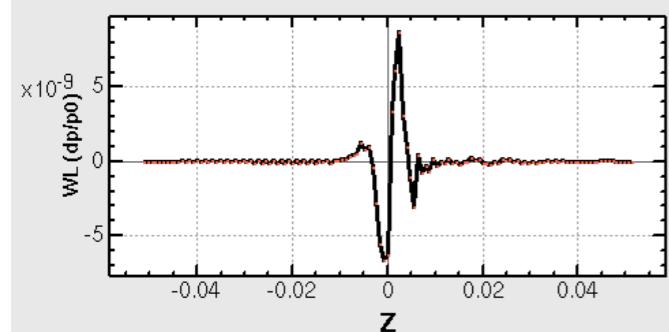
BL1S.1



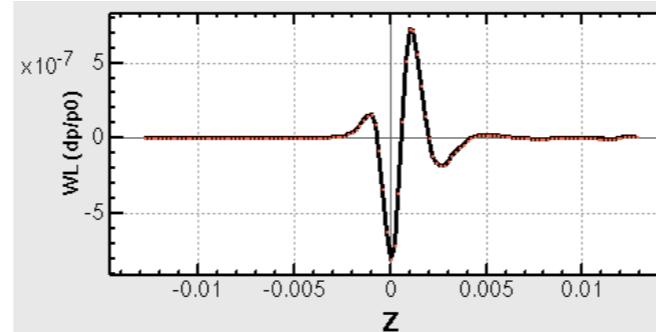
BL1S.2



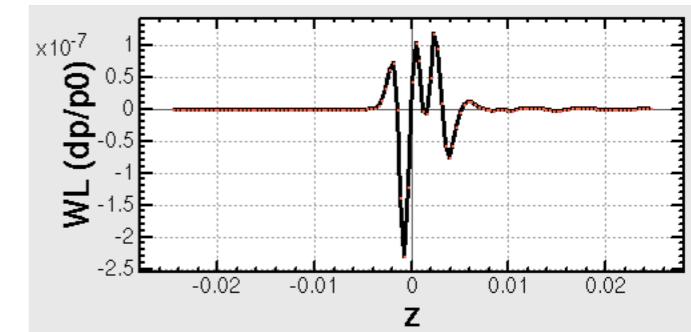
BL2S.1



BL2S.2



BL2S.3



2. Single-bunch effects: Longitudinal: CSR

➤ Check bunch charge ($N_p=1e6$, $V_{rf}=21.5$ MV):

- $Q=0.7$ nC, without CSR, $\gamma\varepsilon_x@ENDRTL = 91.563502$ nm
- $Q=0.7$ nC, with CSR, $\gamma\varepsilon_x@ENDRTL = 91.563793$ nm
- $Q=1.5$ nC, with CSR, $\gamma\varepsilon_x@ENDRTL = 91.564230$ nm
- $Q=2.0$ nC, with CSR, $\gamma\varepsilon_x@ENDRTL = 91.564561$ nm
- $Q=3.0$ nC, with CSR, $\gamma\varepsilon_x@ENDRTL = 91.565352$ nm
- $Q=4.0$ nC, with CSR, $\gamma\varepsilon_x@ENDRTL = 91.566320$ nm

➤ Check bunch charge ($N_p=1e6$, $V_{rf}=0.$ MV):

- $Q=4.0$ nC, without CSR, $\gamma\varepsilon_x@ENDRTL = 91.484075$ nm
- $Q=4.0$ nC, with CSR, $\gamma\varepsilon_x@ENDRTL = 91.484076$ nm

➤ Check bunch charge ($N_p=1e6$, $V_{rf}=23.$ MV):

- $Q=4.0$ nC, without CSR, $\gamma\varepsilon_x@ENDRTL = 91.577166$ nm
- $Q=4.0$ nC, with CSR, $\gamma\varepsilon_x@ENDRTL = 91.582571$ nm

3. Summary

- Impedance calculation checked => NO significant changes
- Bug in the code (Improper beam spectrum) => Found and removed
- CSR effects in RTL => Negligible?
- Code is ready for simulating CSR effects in J-ARC
- RF wakefield not loaded?

```
!-----  
! Wake L  
wake L CAV*;  
???General::fileopen: Open error for file /ldata/KEKB/KCG/developer/oldsad/Packages/WAKECOMMAND.in  
Get["/ldata/KEKB/KCG/developer/oldsad/Packages/WAKECOMMAND.n"]
```