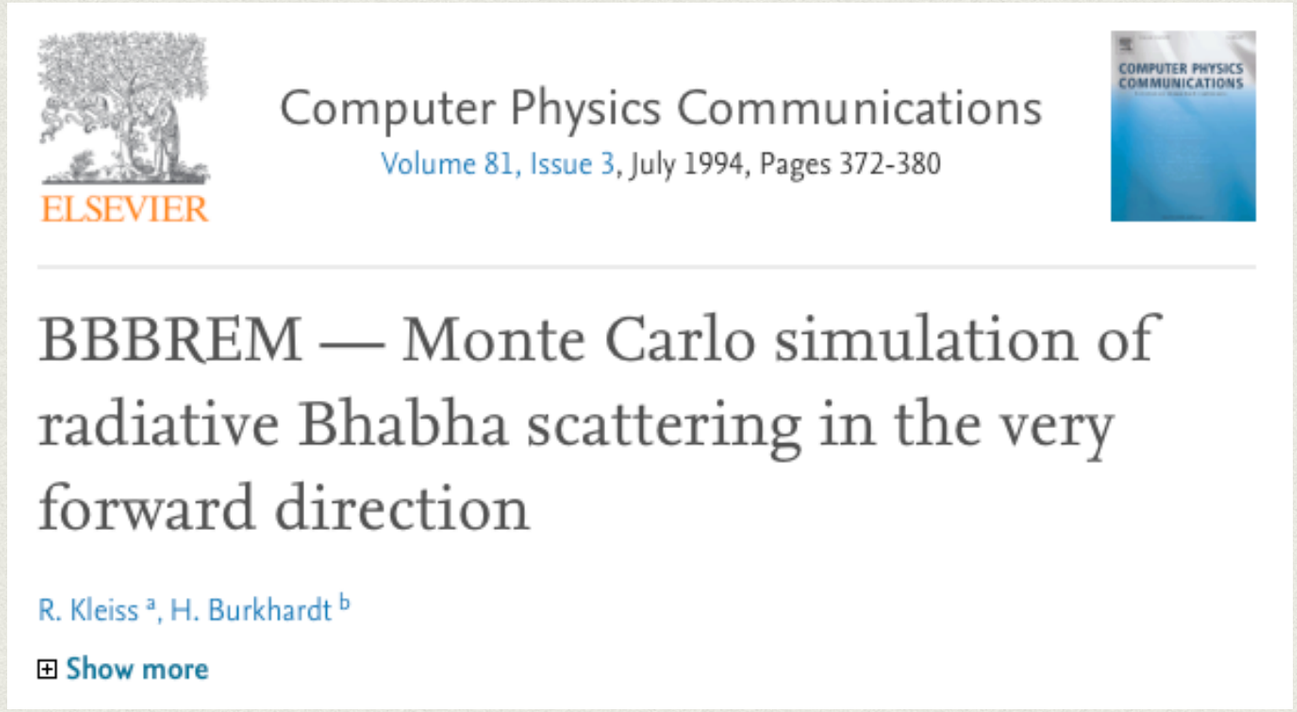
# Estimation of beam loss due to radiative Bhabha using BBBrem in SAD




K. Oide

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Many thanks to H. Burkhardt for providing the source of BBBrem.

# BBBrem in SAD

- A SAD function `BBBrem1` has been implemented in SAD as:

  `BBBrem1`[*sqrts, dsmin*]

returns one event as:

  {*p4, sigma*} ,

where

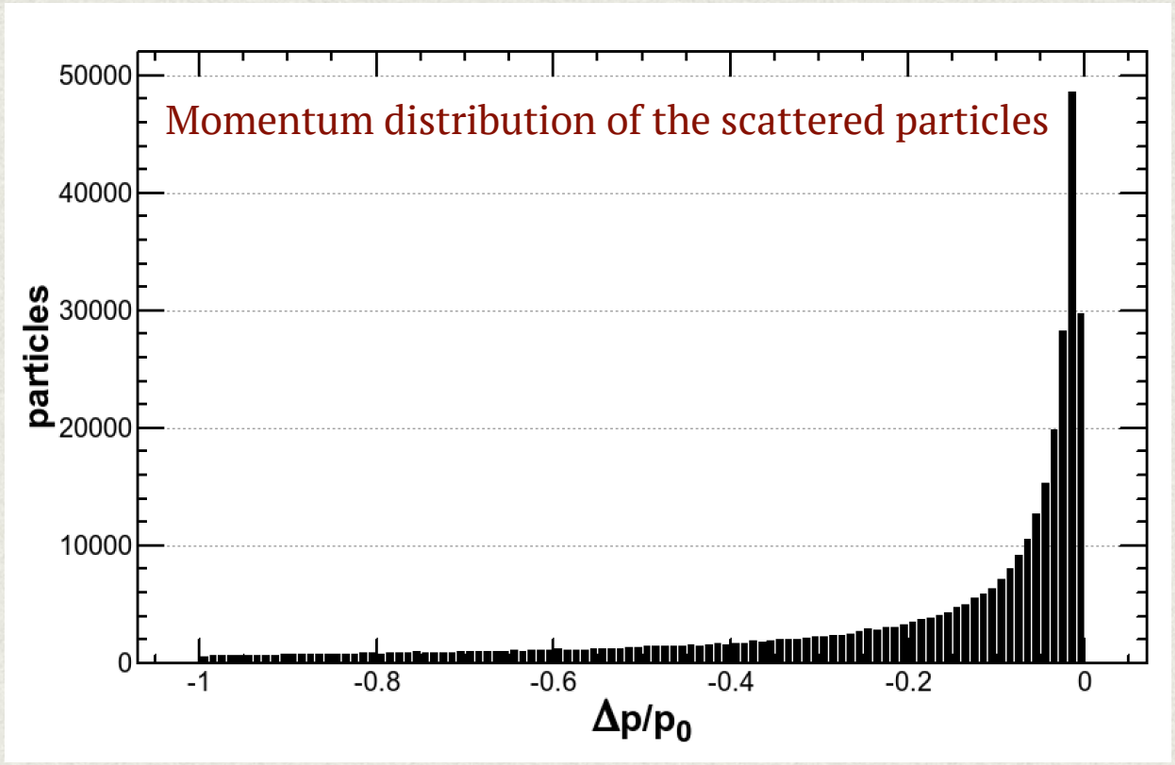
| | |
|---|---|
| *sqrts*: | $\sqrt{s}$ in eV |
| *dsmin*: | minimum $\Delta s/s$ |
| *p4*: | the 4-momentum vector of the scattered particle after rad. Bhabha in the CM frame in eV |
| *sigma*: | the estimated cross section in $m^2$. |

- Transformation from/to accelerator coordinate including the crossing angle is done in SAD side.

- Currently SAD uses the fortran version of BBBrem provided by H. Burkhardt.

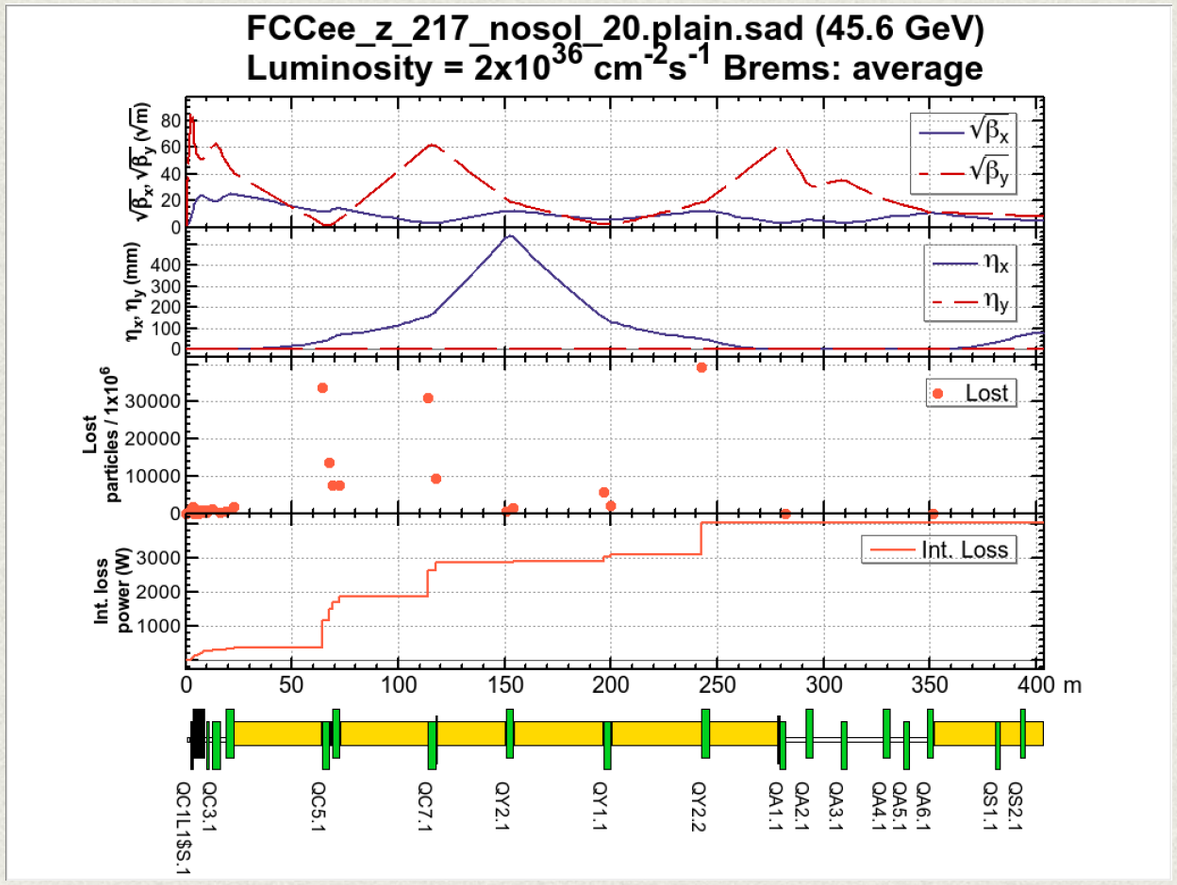
# Application to FCC-ee (Z)

- 1M BBBrem events are generated at the IP, either all before/after the beam-beam. (SAD's beam-beam does not call BBBrem during the collision yet.)
- Lattice: `FCCee_z_217_nosol_20.plain.sad` (45.6 GeV, 2 IP)
- Luminosity / IP: $2 \times 10^{36}$ $cm^{-2}s^{-1}$.
- Scattered particles are tracked starting from the IP.
- We assume a sufficient collimation between the IPs. Thus all scattered particles from one IP never reach the next IP.



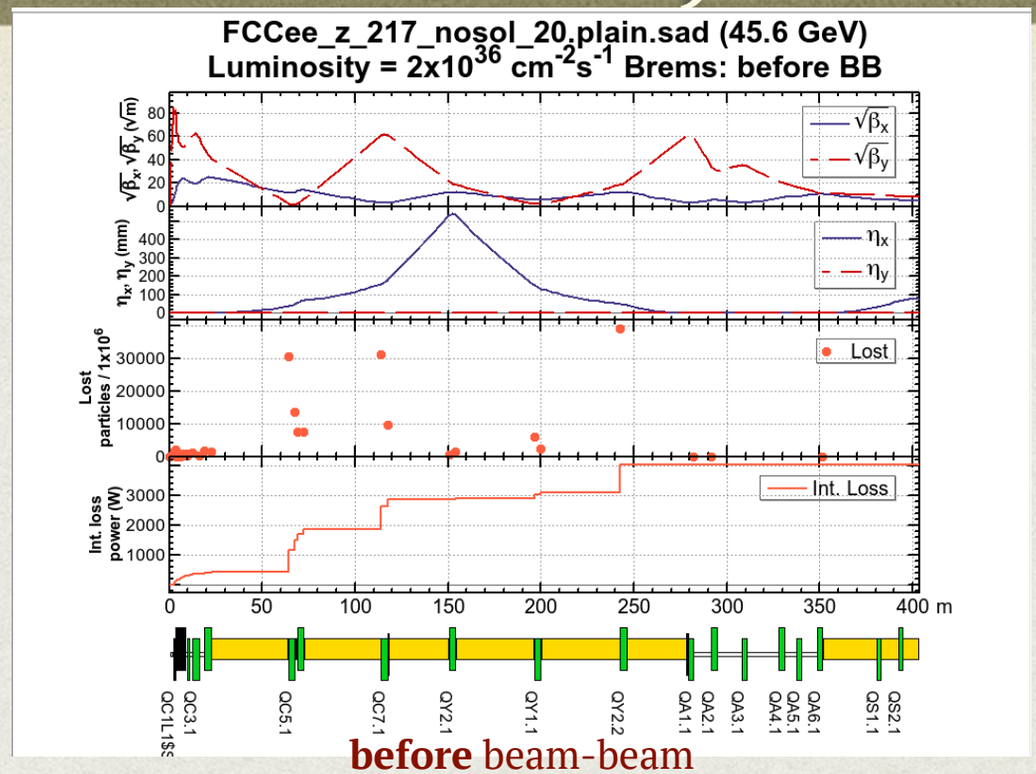

* small angle and small energy loss events are ignored.

# Downstream beam losses (down to 400 m from the IP)

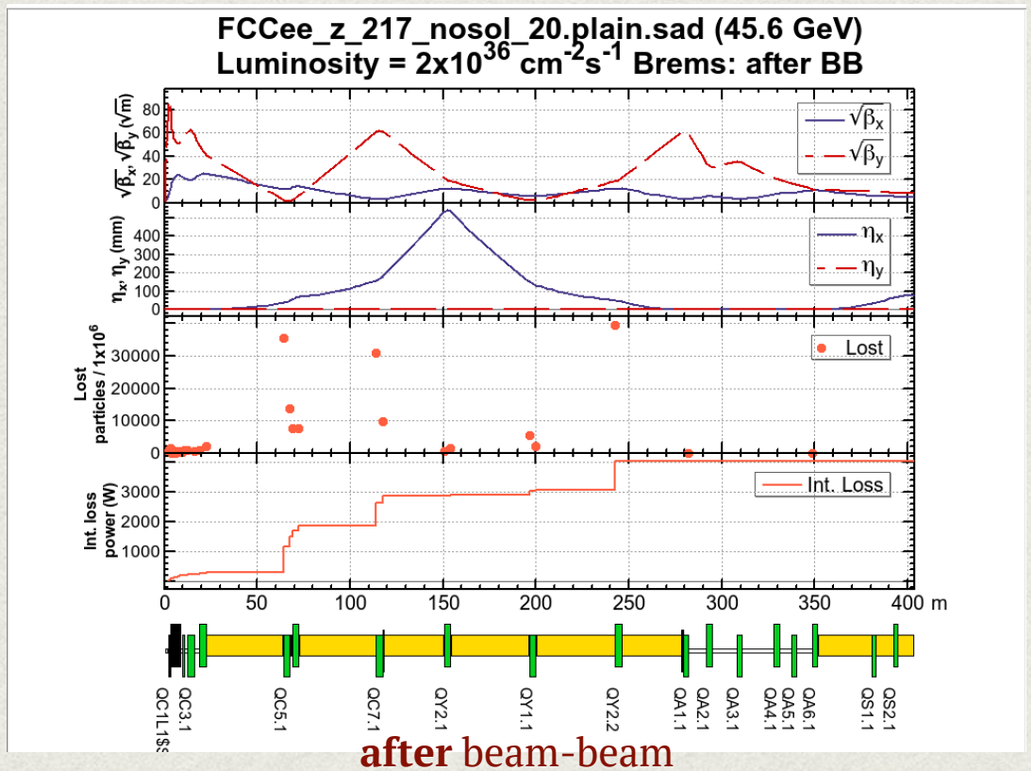



“average” of before and after beam-beam

- The difference between before and after beam-beam is not significant.
- Aperture radii: 15 mm at QC1, 20 mm at QC2, 35 mm other quads.

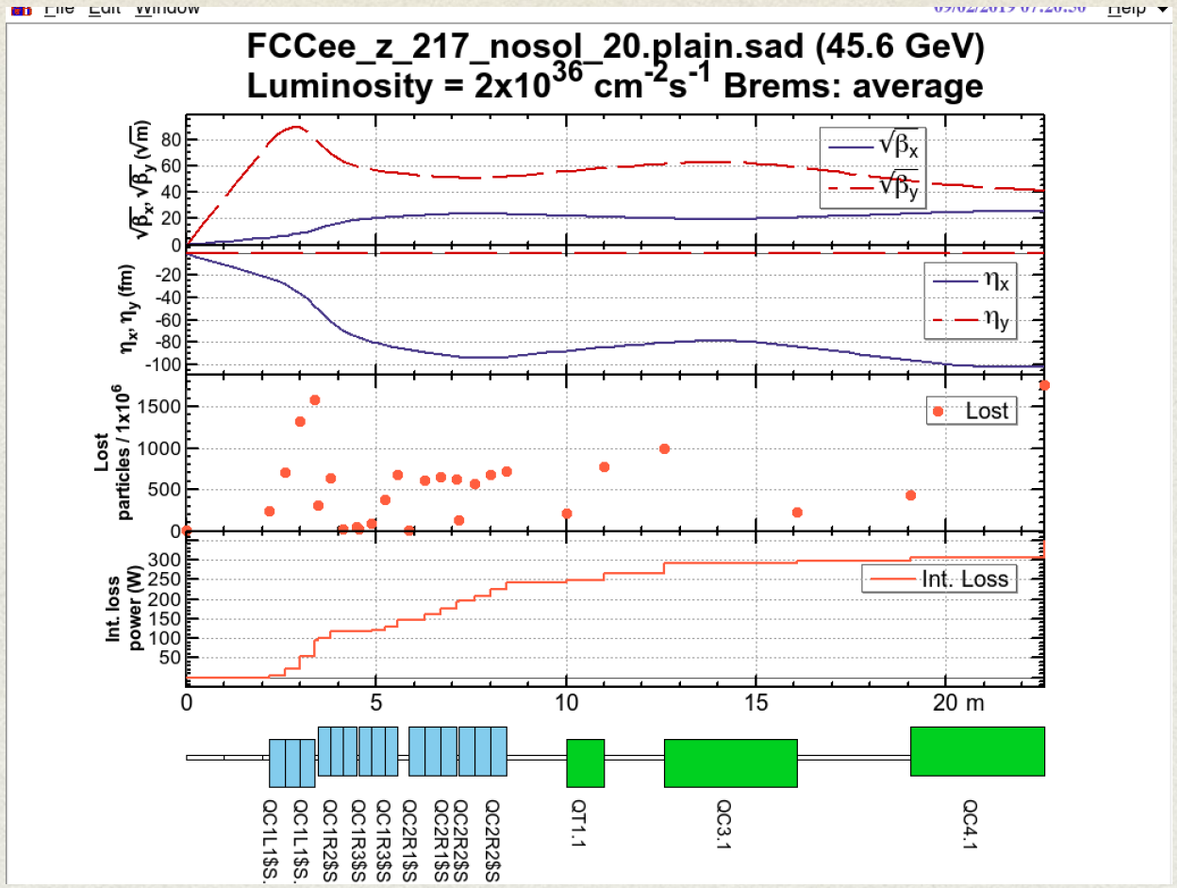



**before** beam-beam




**after** beam-beam

# Downstream beam losses (down to 25 m from the IP)



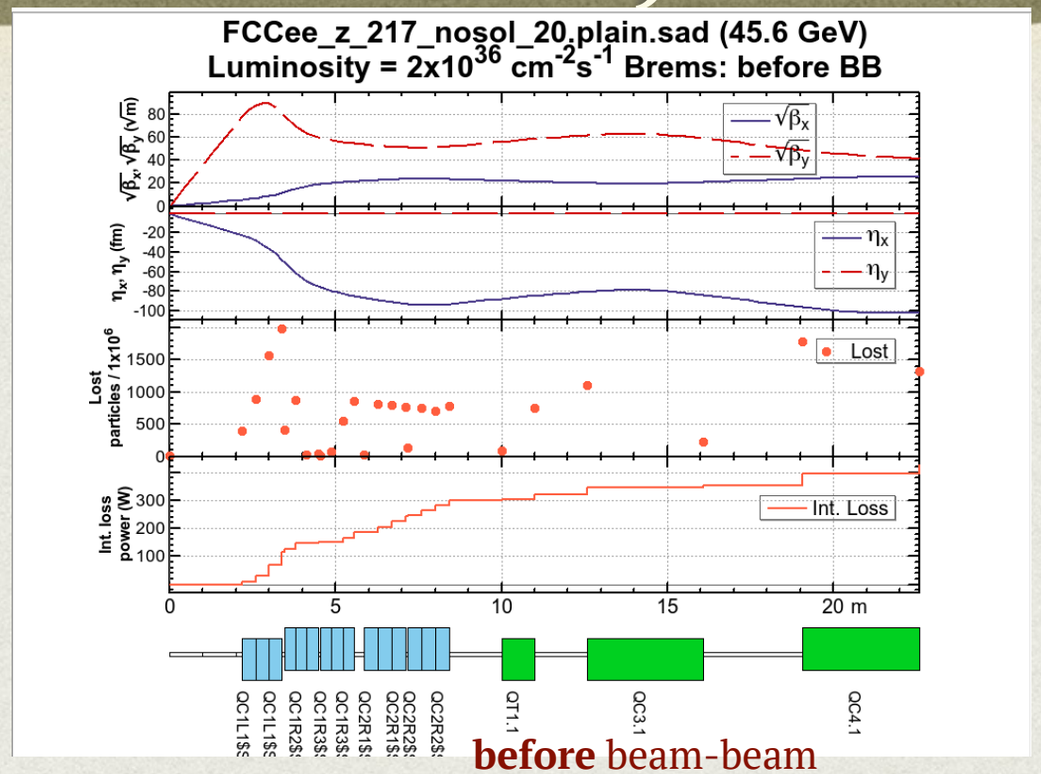

**average of before and after beam-beam**

- The losses within the first 3 quads (QC1):

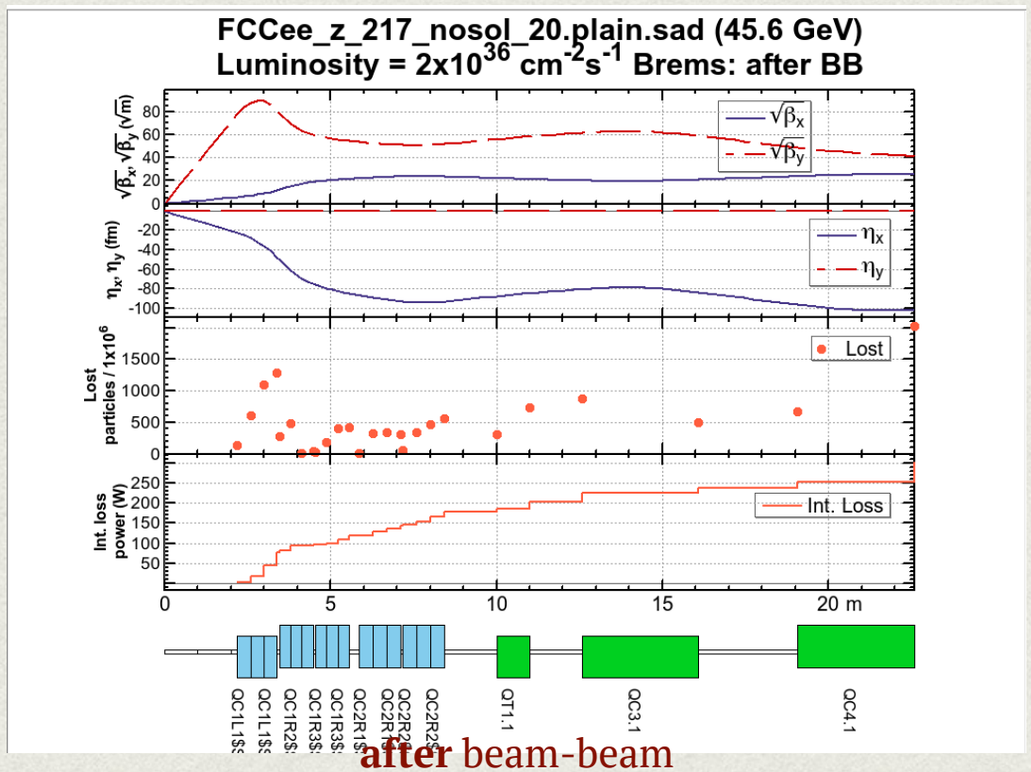
  before BB: 190 W

  after BB: 125 W

  average: 150 W

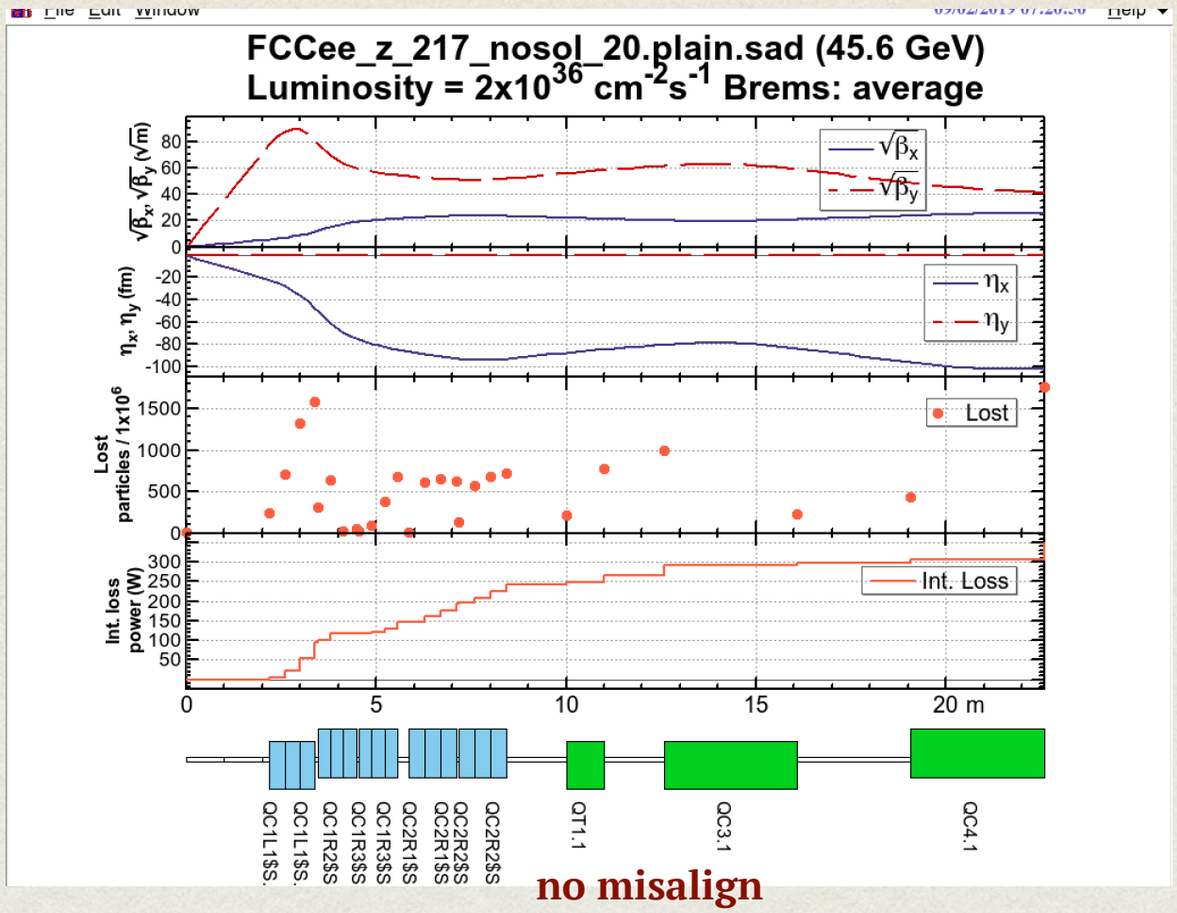



**before** beam-beam

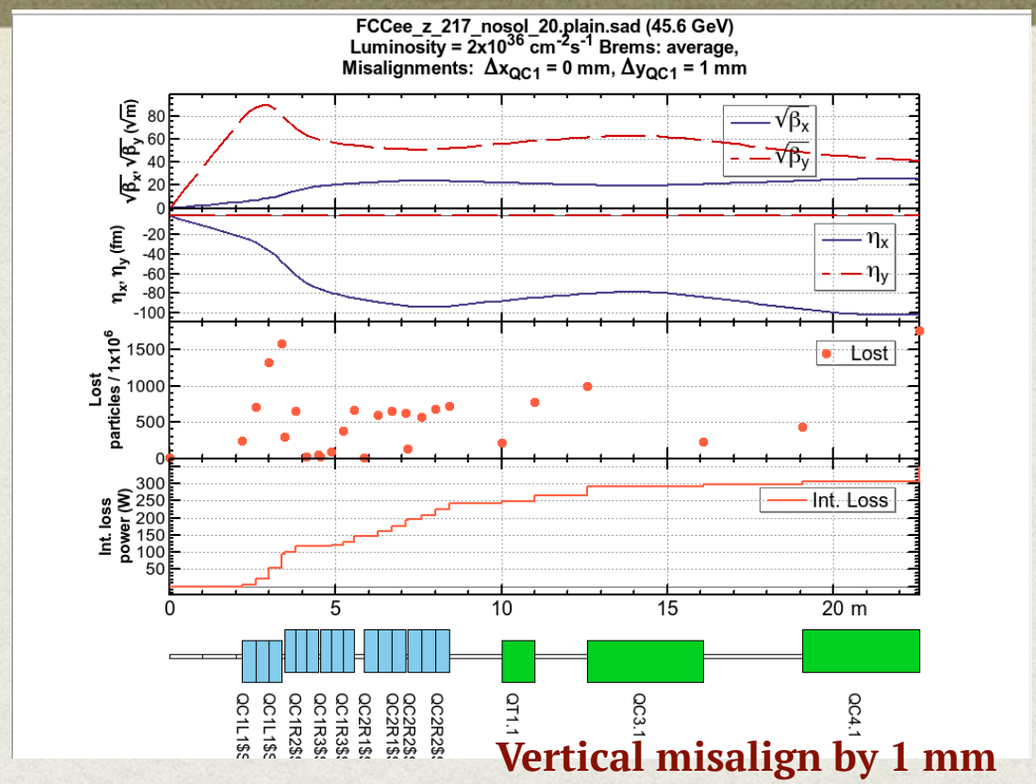



**after** beam-beam

# Misalignment of QC1

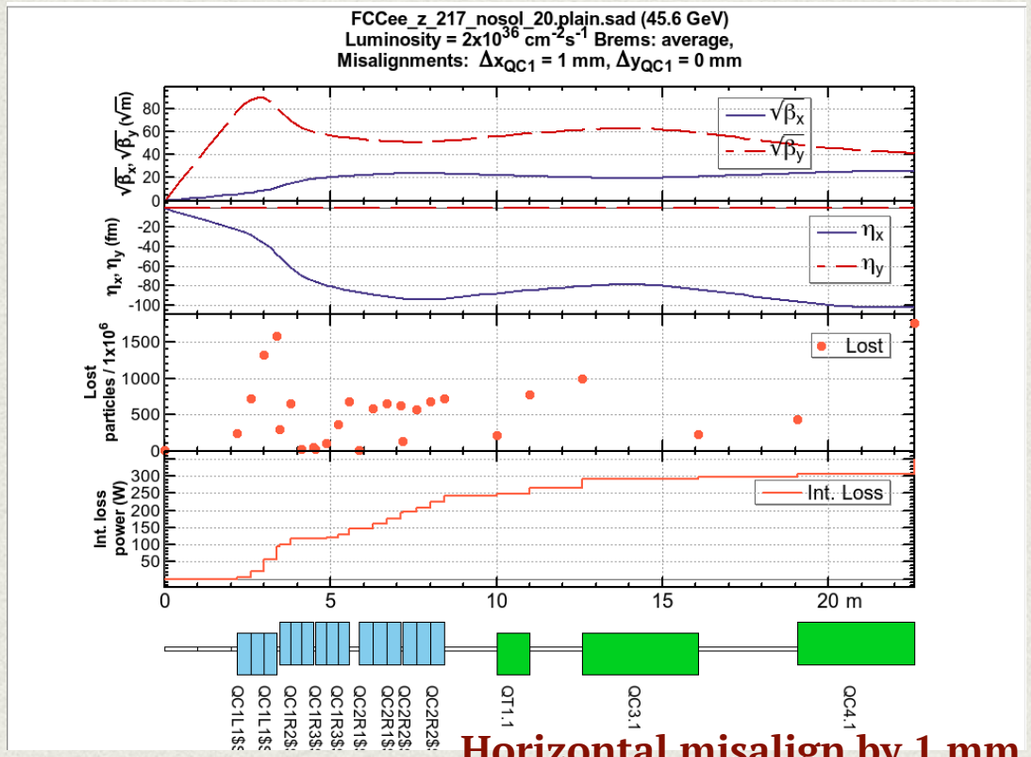



no misalign



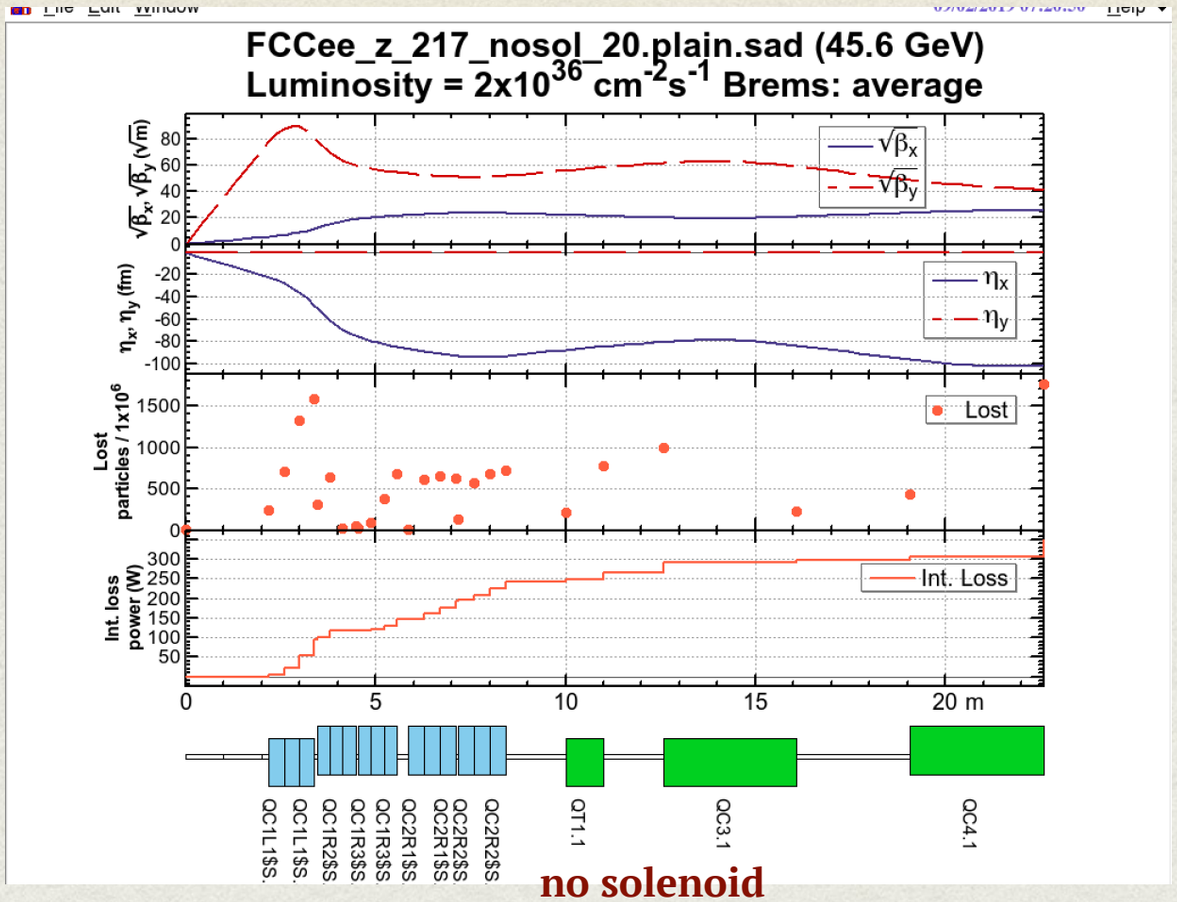

Vertical misalign by 1 mm

- No significant change in the beam loss due to misalignments of QC1 by 1 mm (horizontal/vertical).

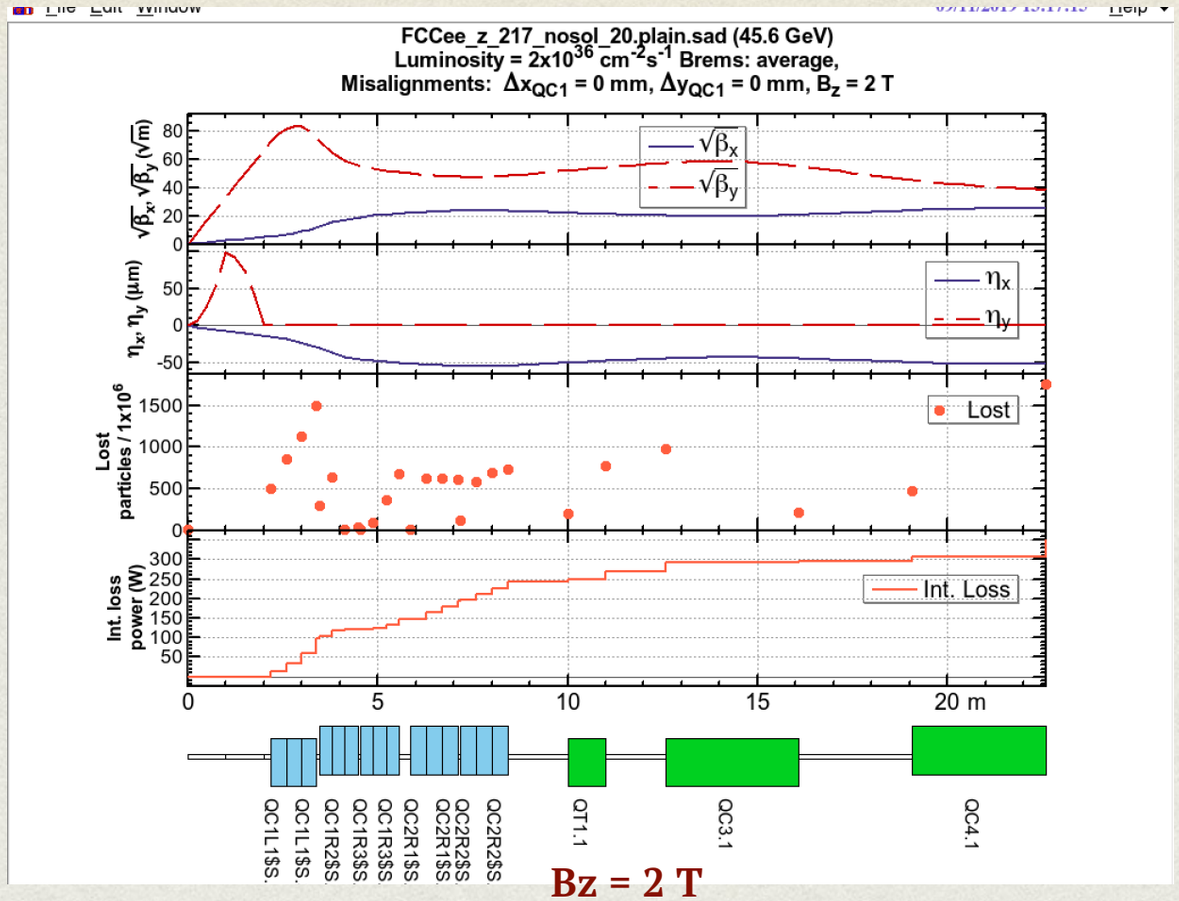



Horizontal misalign by 1 mm

# IP Solenoid




no solenoid




Bz = 2 T

- No significant change in the beam loss due to the IP solenoid with compensation (Bz = ±2T).

# Summary

- BBBrem has been implemented in SAD.
- Estimation of beam loss due to radiative Bhabha has been tried for an FCC-ee Z lattice.
- Beam losses:
    - 4 kW by 400 m downstream the IP.
    - 150 W within the first quad QC1
- The effect of beam-beam is about 20% on the loss at QC1.
- The result is neither sensitive to the misalignment of aperture at QC1, nor to the IP solenoid field.
- The tolerance of the final quadrupole for such amount of beam loss must be examined.
- Cross check with other method is necessary (eg. D. El Khechen's with GuineaPIG++ and SAD, at 94th optics meeting).