FD Jitter Tolerance Study

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Introduction

- Investigate three BDS designs L* 4.5 m, L* 4.0 m and L* 3.5 m.
- Using 500 GeV baseline parameters from TDR Table 2.1 and Table 8.2.
- Using elegant + GUINEA-PIG to simulate LUMI loss criteria for QF1/SF1/OC1 and QD0/SD0/OC0 offset with IP fast-feedback compensating.
- Three locations of FFB thin length kickers are simulated (beam direction).
 - At middle of QF1 and QD0
 - Before SDO
 - After QD0 (L* 4.0 m)
- Track 80k macro particles (e- & e+ side) from QF1 -> IP with RMS vibration in horizontal and vertical planes.

IP FFB kicker position

Simulate the kicker effect at three locations



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L* 3.5 m waist (FFB kickers 1.5 m upstream SDO)



- Track 80K macro particles (e- & e+ side) from QF1 -> IP with RMS SF1/QF1 and SD0/QD0 vibration in horizontal and vertical planes.
- Results show mean and range of luminosities from 100 consecutive pulses.

L* 3.5 m waist (FFB kickers right before SDO)



- Track 80K macro particles (e- & e+ side) from QF1 -> IP with RMS SF1/QF1 and SD0/QD0 vibration in horizontal and vertical planes.
- Results show mean and range of luminosities from 100 consecutive pulses.

L* 4.0 m waist (FFB kickers 1.27 m upstream SDO)



- Track 80K macro particles (e- & e+ side) from QF1 -> IP with RMS SF1/QF1 and SD0/QD0 vibration in horizontal and vertical planes.
- Results show mean and range of luminosities from 100 consecutive pulses.

L* 4.0 m waist (FFB kickers right before SDO)



- Track 80K macro particles (e- & e+ side) from QF1 -> IP with RMS SF1/QF1 and SD0/QD0 vibration in horizontal and vertical planes.
- Results show mean and range of luminosities from 100 consecutive pulses.

L* 4.0 m waist (FFB kickers after QDO)



- Track 80K macro particles (e- & e+ side) from QF1 -> IP with RMS SF1/QF1 and SD0/QD0 vibration in horizontal and vertical planes.
- Results show mean and range of luminosities from 100 consecutive pulses.

SLAO

L* 4.5 m waist (FFB kickers 1.25 m upstream SDO)



- Track 80K macro particles (e- & e+ side) from QF1 -> IP with RMS SF1/QF1 and SD0/QD0 vibration in horizontal and vertical planes.
- Results show mean and range of luminosities from 100 consecutive pulses.

L* 4.5 m waist (FFB kickers right before SDO)



- Track 80K macro particles (e- & e+ side) from QF1 -> IP with RMS SF1/QF1 and SD0/QD0 vibration in horizontal and vertical planes.
- Results show mean and range of luminosities from 100 consecutive pulses.

Summary



 The FFB kickers close to or after QDO have less negative impact on beam luminosity

Jitter tolerance of 2% luminosity loss

L*	3.5	4.0	4.5
Between QF1 QD0	< 25	21	100
Before QDO	< 25	42.6	<25
After QD0		25	

Summary

The luminosity of idea beam w/o waist shift is 1.36/1.51/1.45E34 cm⁻² s⁻¹ (L*4.5/4.0/3.5) from GUINEA-PIG. It is close to geometric luminosity of 1.47E34 cm⁻² s⁻¹ in TDR.

- Scanning the y waist the best luminosity is 1.69/1.70/1.58E34 cm 2 s $^{-1}$ (L*4.5/4.0/3.5) at y waist 405/300/240 $\mu\text{m}.$
- The jitter tolerances of three BDS designs are similar.
- The effect of distance of FFB kickers from SDO start to take effects with incresing RMS jitter.