INTERNATIONAL LINEAR COLLIDER

SLAC

SD0/QD0 Cryomodule Jitter Tolerance

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SLAC

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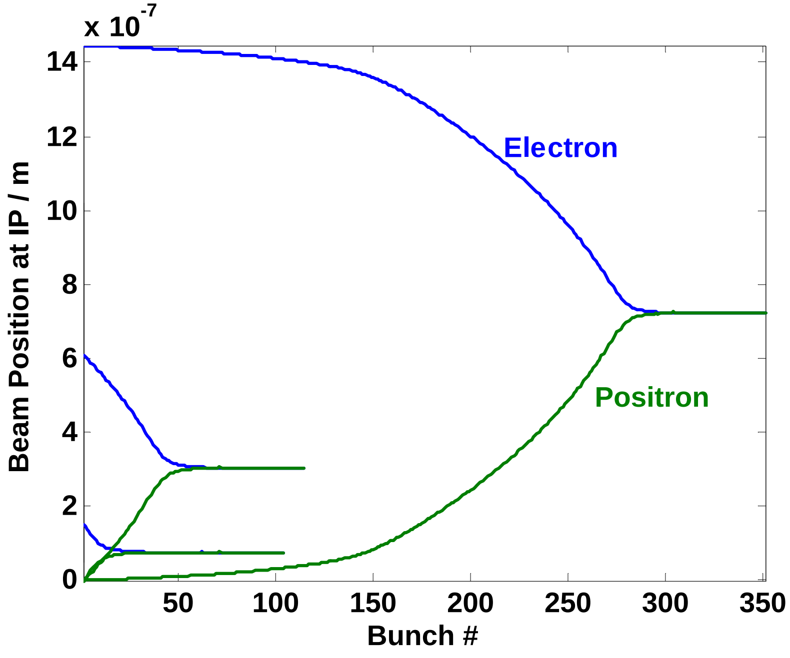
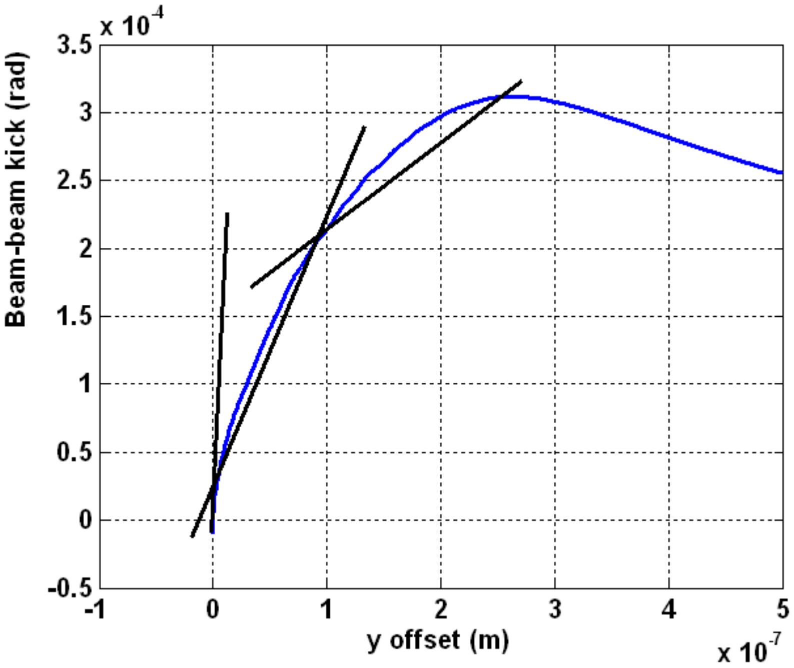
Overview

- Asses jitter tolerance on final cryomodule containing QD0/SD0.
- Calculate lumi-loss based on IP beam-beam offset and beam-growth through off-center passage through SD0.
- Use Lucretia + GUINEA-PIG to measure LUMI loss criteria for QD0/SD0 offset with IP fast-feedback compensating.

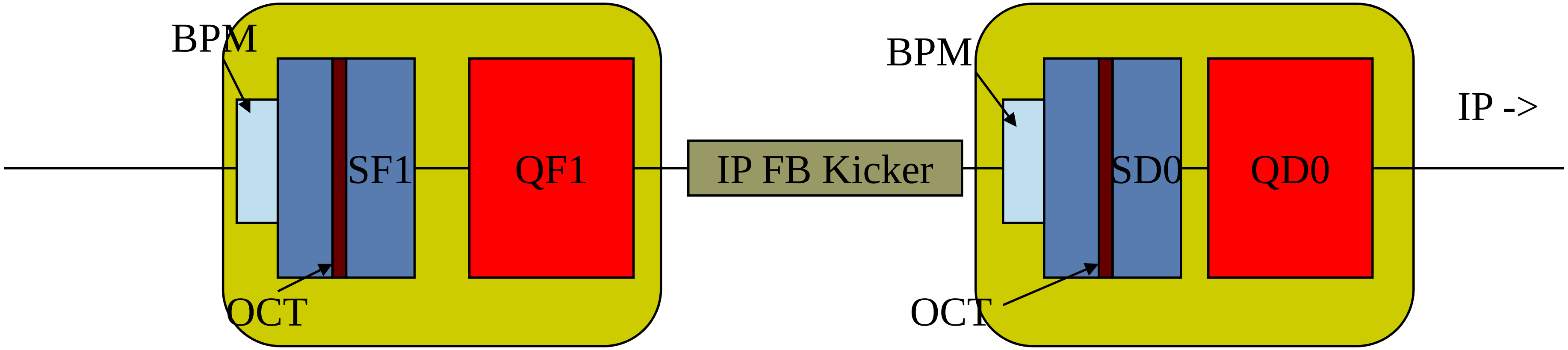
IP Fast-Feedback

- Use ILC IP FFB, tuned for 'noisy' conditions
  - Less than 5% lumi-loss with GM 'K' + 25nm component vibration (pulse-pulse) & ~ 0.1 sigma intra-bunch uncorrelated beam jitter.
- Assume BDS-entrance FFB has perfectly flattened beam train (flat trajectory into Final Doublet).
- No 'banana' effect on bunches.
- Calculate Luminosity from measured bunches, with mean of last 50 weighted to account for the rest of the beam train (2820 bunches).



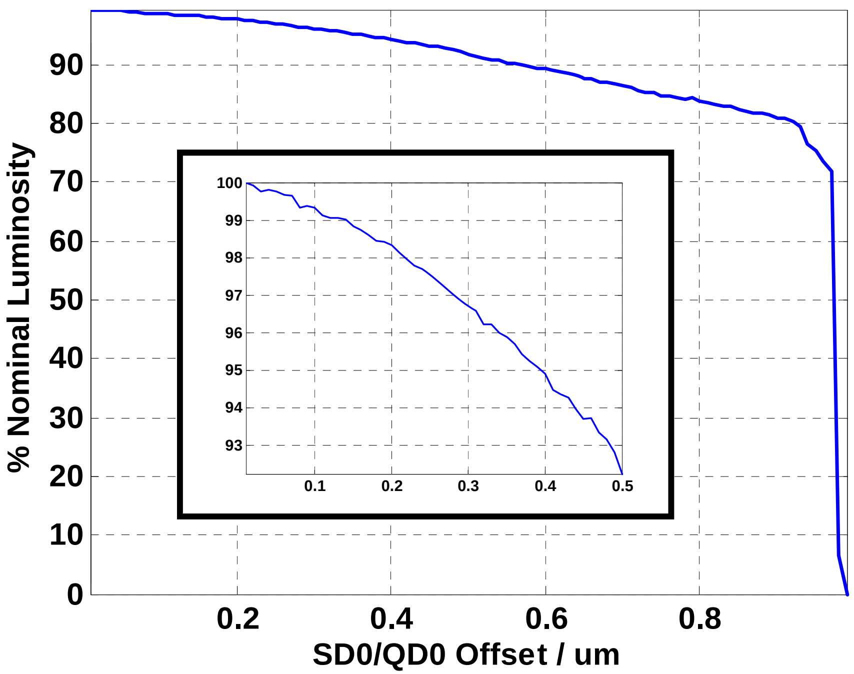


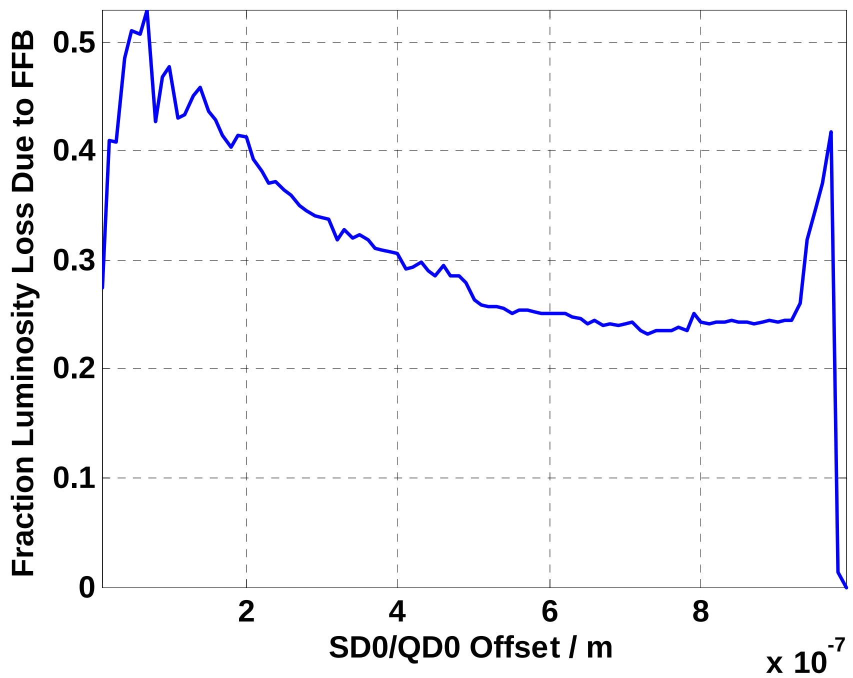
IP FFB Kicker Position



- IP FFB kicker in ~1m gap between 2 cryomodules near IP.
- Distance of kick from SD0 face effects lumi as beam is kicked off-center going through SD0.
- Advantage to using shorter kicker?

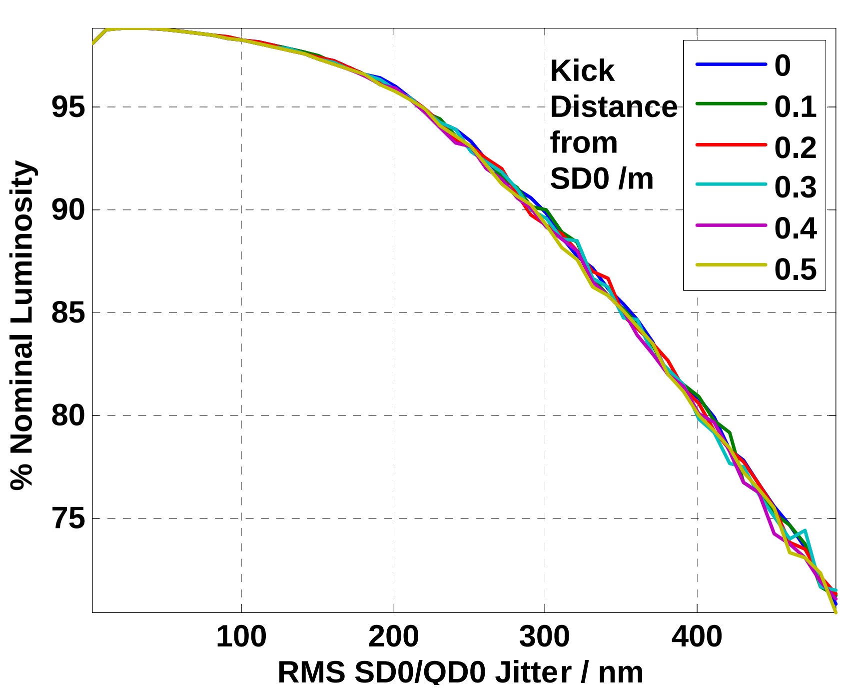
Effect of SD0/QD0 Offset

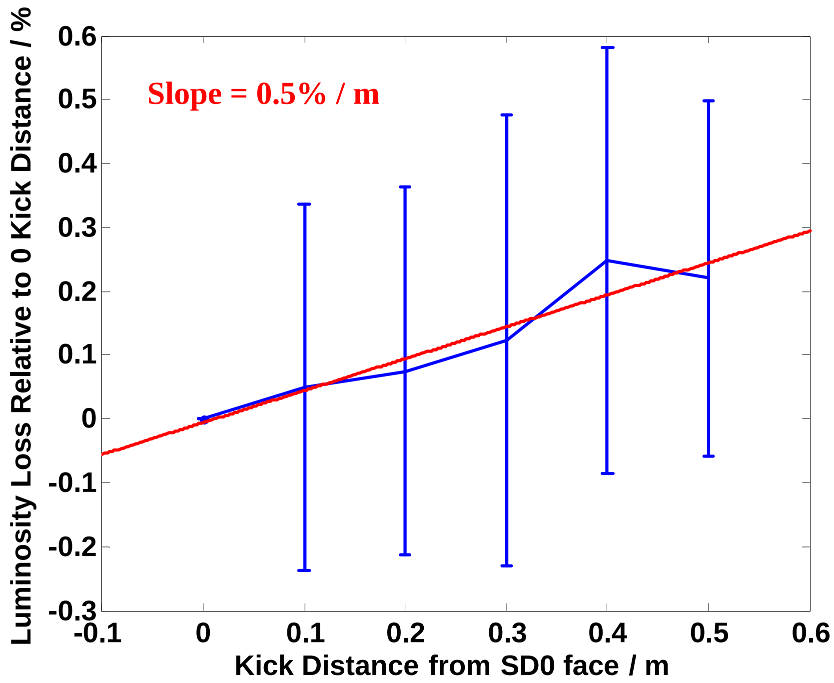




- Luminosity loss as a function of SD0/QD0 offset and relative importance of offset through SD0 vs. IP offset.
- Shows beam size growth through offset SD0 dominant over FFB beam offset conversion time.
  - e.g. at 500nm offset, ~75% of luminosity loss through beamsize growth effect, 25% through conversion time of FFB system.

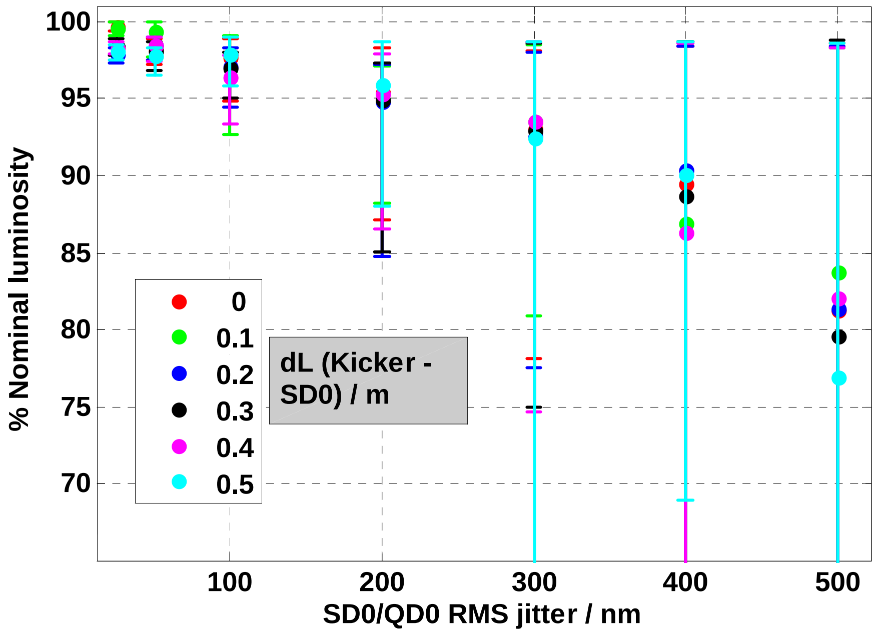
Luminosity vs. RMS Jitter and Kick Distance

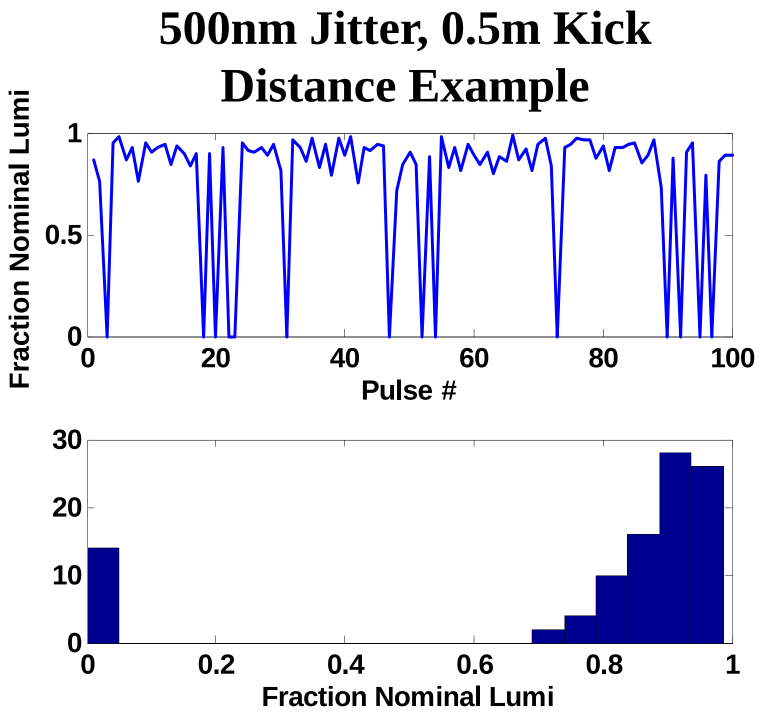




- Calculate Luminosity loss for different jitter / kick distance cases using 'SD0 lumi loss' and 'FFB lumi loss' look-up tables.
- Left plot shows % nominal luminosity with given RMS SD0/QD0 jitter and varying kick-SD0 distance.
- Right plot shows all jitter cases plotted vs. kick distance with respect to the luminoisty obtained at zero distance and shows a small increase in lumi loss with kick distance.

Tracking Simulation Results





- Track 80K macro particles (e- & e+ side) from QF1 -> IP with RMS SD0/QD0 vibration and varying kicker location.
- Results show mean and range of luminosities from 100 seeds (pulses).
- Zeros in right plot are cases where the beam-beam offset is enough that no beam-beam kick exists and the feedback system doesn't converge.

Summary

- Results show added luminosity loss due to jitter of SD0/QD0 cryomodule.
  - These effects need to be convolved with 'background' environment of GM and other jitter sources.
  - Don't just add this to previous lumi studies.
- Results are worse-case here where everything else is perfect, other errors (e.g. non-linear train shape) will mask this effect to some degree.
- Small effect due to kicker distance from SD0, probably not important.
  - It is fairly trivial to shorten length of kicker to ~0.2m if required.

IP FFB Stripline Kicker

- S.Smith design for ILC stripline kicker:
  - 2 amps -> 25Ω 1m stripline gives 100 sigma-y IP kick (100 ns risetime).
- e.g. FONT kicker:
  - 15 amps -> 50Ω 0.2m stripline (<100 ns risetime).
- Easily increase drive of ILC kicker to allow length to decrease factor 10.
- Possible for larger kicks with ferrite-loaded kicker.

20 mr Crossing Scheme Kicker

Parameter	Value
Length	1 m
Turns	1
Gap height	20 mm
Gap width	40 mm
Impedance	25 Ohms
Max kick	±130 nradians

Parameter	Value
Current	2 Amps
Voltage	43 Volts
Power	75 Watt
Inductance	2.5 μH
Rise time	100 ns (L/Z)

2 mr Crossing Scheme Kicker

Parameter	Value
Length	1 m
Turns	1
Gap height	180 mm
Gap width	180 mm
Impedance	12.5 Ohms
Max kick	±100 nradians

Parameter	Value
Current	13 Amps
Voltage	300 Volts
Power	4 kW
Inductance	1.3 μH
Rise time	100 ns (L/Z)