Effect of L* on Collimation Depth

Frank Jackson

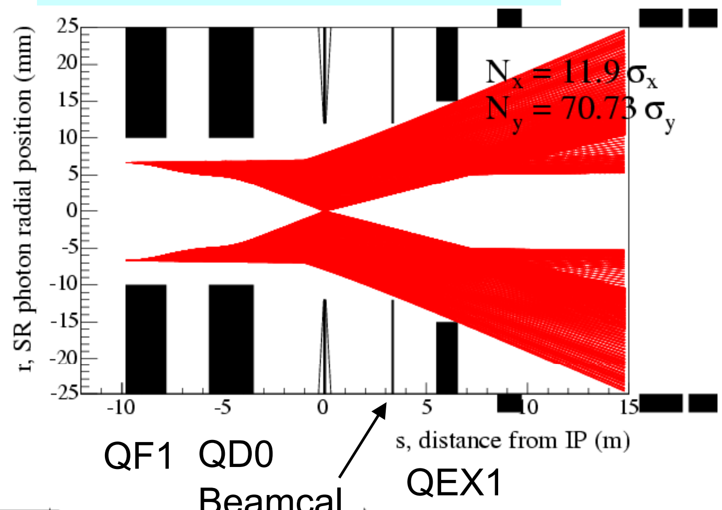
Daresbury Laboratory

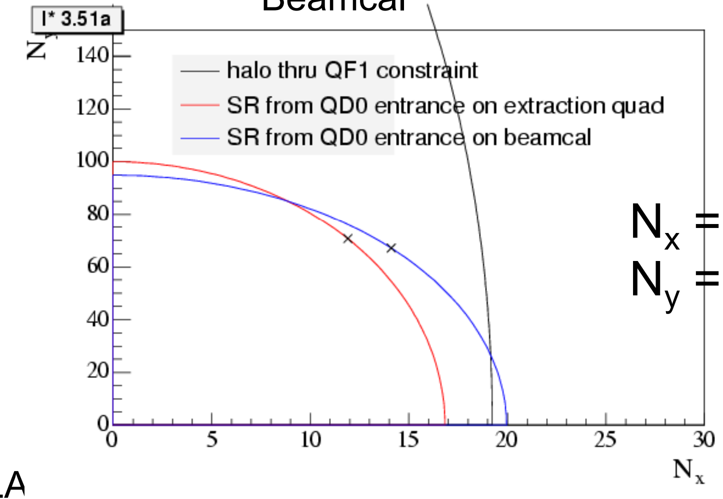
Introduction

- IR design directly determines BDS collimation depth
- In period where there is matrix of options
  - Different beam parameter sets
  - Different L*s
  - Different detectors
- Is collimation depth reasonable over the whole space?
- What issues do we need to consider in calculation?

Quick Method Overview

- Consider halo synch radiation in FD
- Ray tracing technique
  - Semi-analytical linear optics calculation (O. Napoly)
- Gives collimated halo size at FD entrance which allows SR clearance
- Solution is not unique, ellipse in x, y space
- Important constraints
  - Extraction quads
  - Beamcal
  - QF1 quad acceptance





$N_x = x/\sigma_x$
$N_y = y/\sigma_y$

Present IR Parameter Space

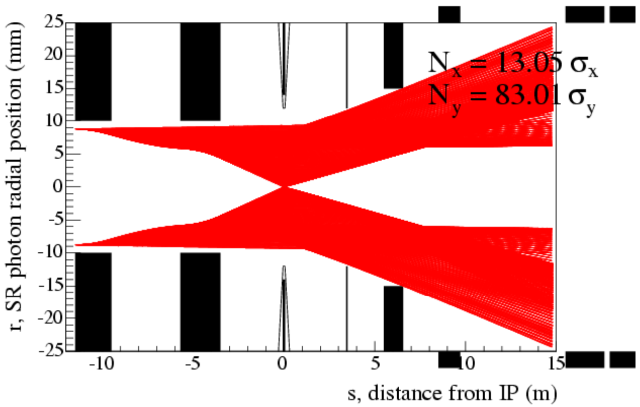
- Push-pull FD+extraction designs for L*=3.51, 4.0, 4.5m (A. Seryi, Y. Nososhkov)
  - Fixed positions for QF1 and first extraction quad
  - Push-pull QD0 and QEX1 for the 3 different L*s/detectors
  - Ex. quad positions and apertures increase with L* (15, 17, 26mm)
- Detector beamcal 'hole' aperture from Detector Outline Documents*
- Assume nominal parameter set

Concept	Beamcal hole r, z (mm)
SID	13.5, 2950
LDC	13, 3750
GLD	20, 4500

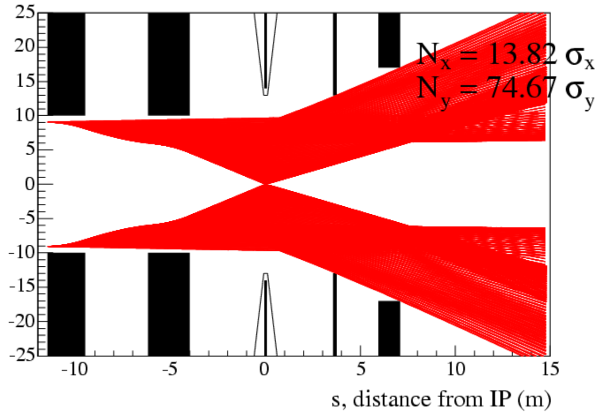
*see references at end

Nominal Collimation Depths

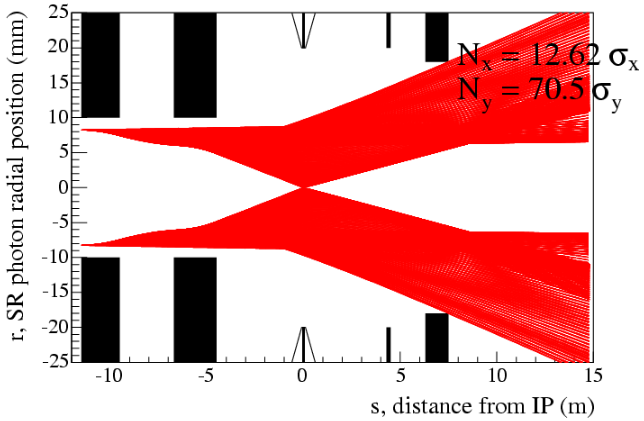
L* = 3.51m, SiD



L* = 4.0m, LDC



L* = 4.5m, GLD



- Naively expect collimation depths to tighten as L* increases
- Dependence on L* is not severe
- Wider SR fan in large L* partially compensated by wider extraction apertures

Preliminary Conclusions

- L* does not severely affect collimation depth
- Constraints of BeamCal, extraction apertures, QF1 acceptance all fairly close
  - Loosening one constraint does not help
  - Limited scope for loosening collimation depth by IR design
- Effect on wakefields estimate
  - RDR emittance growths 0.08% x and 4.4% y (for ½ σ beam jitter, spoilers and absorber w'fields)
  - Emittance growth increases at least with the square of the collimation aperture
  - So modest changes in collimation depth become significant, e.g. N_x=80$\rightarrow$70 gives 30% increase in emittance growth
  - None-uniqueness of collimation depths could offset this effect (trade N_x for N_y)

Parameter Sets

- High lumi parameter sets (and others)
  - β^* are $\times 2$ smaller than nominal
  - IP divergence is $\times\sqrt{2}$ bigger
  - Collimation depths $\times\sim\sqrt{2}$ tighter
  - Wakefield emittance growth $\times\sim 2$ bigger

IR Beam Orbit

- Detector field correction schemes (anti-solenoids, DID, Anti-DID) perturb the beam orbit and direction of the SR rays
- Max orbit perturbations of the order ~100 μm, 100 μrad (my guesses)
- Could lead to ~1 mm devations in SR rays at apertures

Other Issues

- Margins – how much SR can we tolerate on apertures?
- Realistic beams and IR geometry
  - Energy spread, jitter, halo population
  - Magnet and mask misalignment, beampipe thickness
- Is it possible (or worthwhile) to include precise estimates of all effects – or only consider worst-case scenarios/biggest effects?

Reference

Reference Information

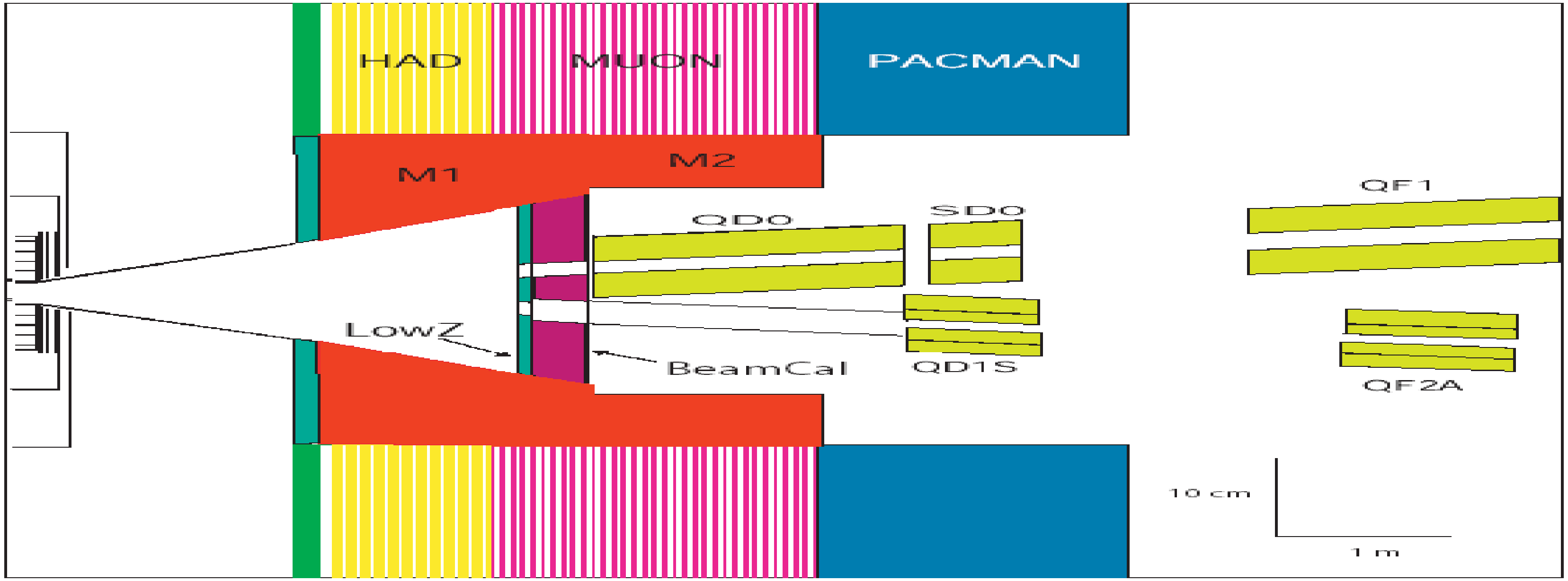
- Collimation half gaps 1.3 mm in x 0.7 mm in y
- Emittance growth much larger in y.
  - Spoilers gaps smaller, beta functions 30% larger
  - Phase relationships of y spoilers to IP
  - Energy spoiler has vertical gap and large beta function (compared to x)

BeamCal Info

- SiD r=13.5 mm at 2.95 m
- PTO for slide from SLAC ILC BDS weekly meeting 08 April 07 T. Maruyama

14 mrad crossing geometry

14 mrad crossing geometry in Geant 3 and FLUKA



Apertures:

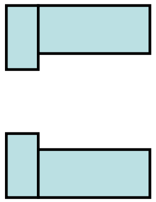
QD0

R=1.0 cm@z=-3.51 m

Beampipe@IP

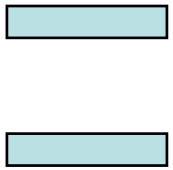
1.2 cm@0.0m

Low Z



1.35 cm
@2.85-2.95m

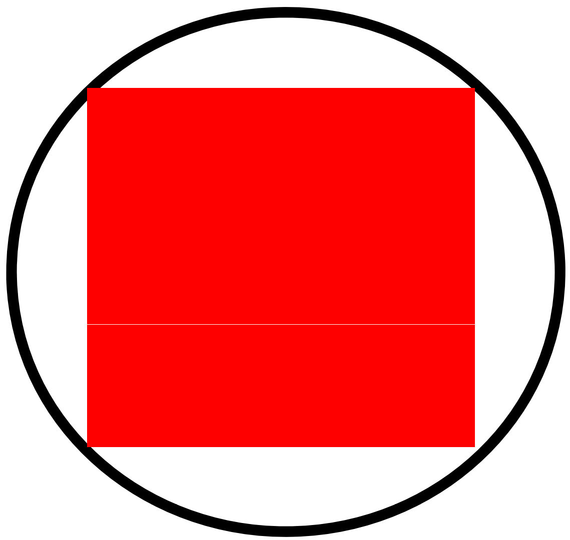
QD1S



1.5 cm
@5.5-6.56m

Why choose just one collimation depth …

- … when there is an ellipse of solutions?
- The one chosen is so that the SR fan is a square fitting inside the circular aperture constraint



Push Pull Schemes