CR2: Baseline optics to provide for a single FFS L* (QD0 exit – IP distance) optics configuration

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General Considerations / Comments

- Unequal L* is not a *fundamental design or cost issue*
  - **We have feasible optics solutions**

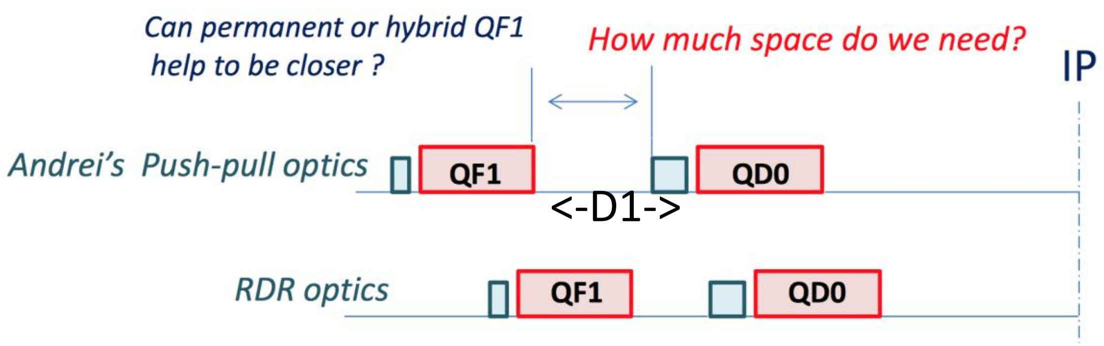
- Primary issue is operational lumi performance and risk mitigation
  - harder to quantify, so arguments tend to be more fuzzy
    - **But based on considerable experimental and theoretical experience with this FFS design**

- L* is a fundamental parameter that drives many critical design features of the BDS. As L* gets longer
  - Chromatic (and geometric) corrections become more challenging
  - Overall larger beta functions drive tolerances (field and alignment) become more demanding
  - Shielding IR from SR fan becomes harder
    - collimation depth becomes tighter for fixed IR apertures
    - tighter collimation tighter jitter tolerances from wakefields etc.

- Bottom line: for the accelerator, shorter is better, and

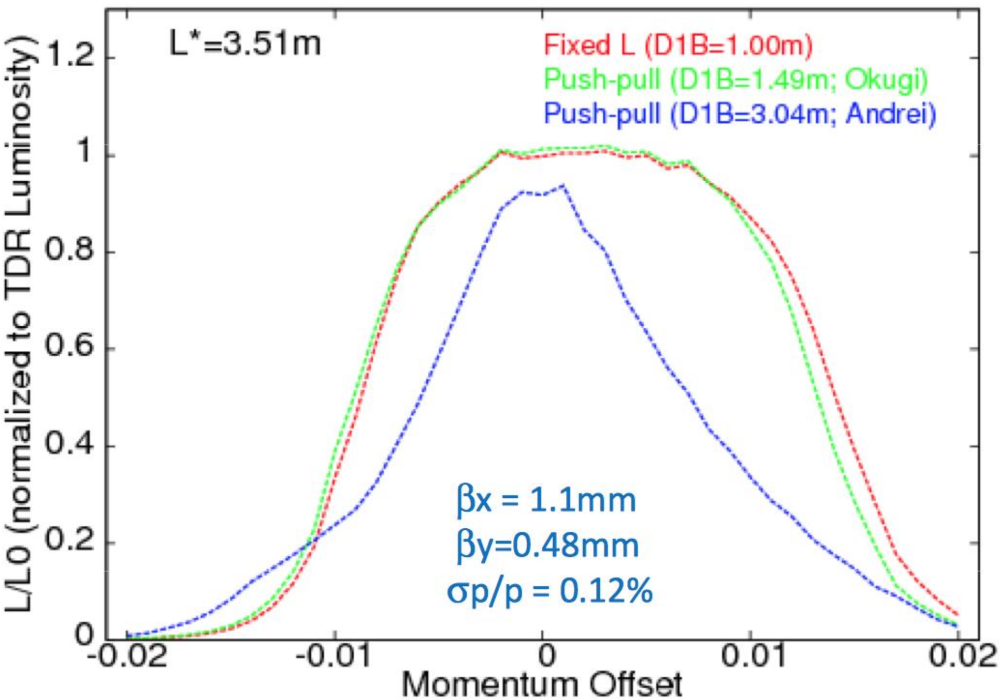
- Having different L* will cause significant tuning differences between detectors
  - both lumi and background
  - negative impact on push-pull recovery times
  - **difficult to guarantee equal luminosity performance**

QD0-QF1 Distance Constraint



T.Okugi

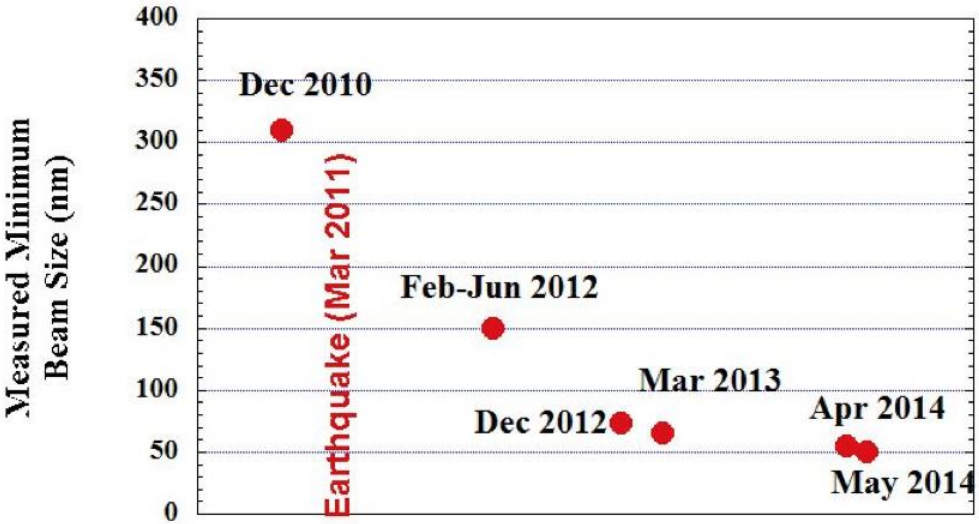
- Constraint of fixed QF1 position complicates "minimize L*" argument.
- Increased D1 distance degrades lattice performance
  - **More detailed lattice studies required to determine optimum L* + D1**
  - **May need flexibility to reduce D1**
  - **Working assumption that a common L*=4m is good compromise**

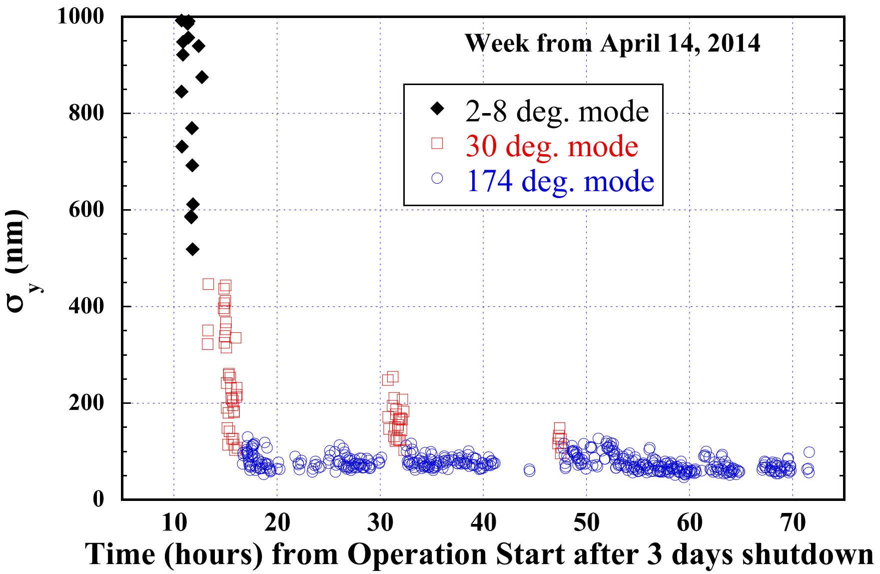


Impact of Changing L* Optics

- Errors (misalignment and field errors) within the FFS lead to a specific set of first and higher-order aberrations at the IP specific to the lattice configuration.
  - These are corrected using standard BBA techniques and more complex FFS knobs using sextupoles on movers.
- Tuning can be considered on 2 timescales:
  - (1) the few-hour (and then periodic to counter ground motion) application of multiknobs etc to maximise luminosity after some period of beam-off condition
  - (2) longer timescale period where the result of tuning iteratively gets better (ATF2 & FFTB experience has shown this behaviour).
- Change between L* configurations on periodic basis can be understood to be harmful in terms of losing the iterative work earned from (2).
- Impact of 1 vs. 2 L*'s driven by:
  - Function of (2)
  - Push-pull duration
  - Push-pull frequency
  - Luminosity tuning curve associated with (1)

ATF2 Experience

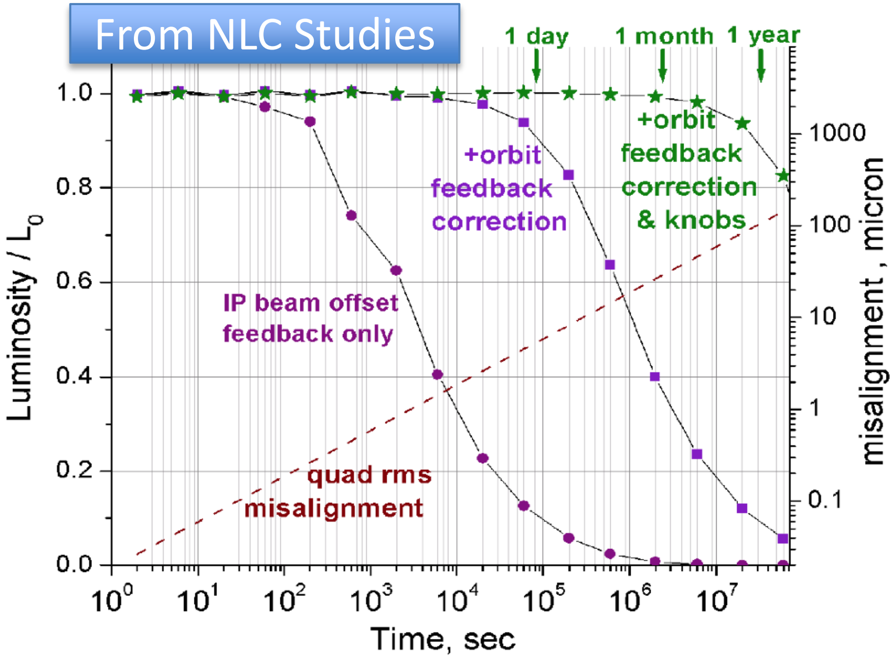




- Effects of "long-term" tuning efforts shown as beam size improvement over time (left plot)
- Time to re-tune after multi-day shutdown shown on right (~20 hours).

Simulations

From NLC Studies



Required βCOLL Apertures to prevent IR SR hits

Name	L^*=3.5m		L^*=4.5m	
	X / mm ($N\sigma_x$)	Y / mm ($N\sigma_y$)	X / mm ($N\sigma_x$)	Y / mm ($N\sigma_x$)
SP1	-	-	-	-
SP2	-	-	1.03 (9.3)	0.21 (25)
SP3	-	-	0.4 (21)	0.21 (203)
SP4	-	-	0.48 (**4.3**)	0.2 (24)
SP5	-	-	-	-

- After O(1 day), orbit control no longer sufficient to regain luminosity, need complex tuning algorithms (using sextupole movers etc).
  - This sextupole-based tuning is very sensitive to the exact lattice configuration and will take longer for a different FFS optics (after a ~1 day push-pull operation) than for a single solution.
- Very different collimation requirements for different L*'s
  - e.g. for IR SR collimation:
    - L*=3.5m : magnet apertures shield all SR generating particles from causing hits in IR
    - L*=4.5m : tight collimation required (~4σ)

Summary

- For least risk & optimal luminosity from accelerator tuning, prefer single L* optics solution.
- From detector groups:
  - SiD can allow $2.13 < L^* < 4.5$ (m)
  - ILD has more constraints, 4m may be possible as a minimum
- Working assumption and next steps:
  - Common L* = 4 m
  - Understand performance trade-offs for larger vs. smaller D1
  - Develop L*=4m optics (and associated BDS design items) and present performance (vs. 3.5 & 4.5) at LCWS
  - Detector groups need to design for 4m L* and (if strongly suggested by design studies) consider flexibility in D1 possible.