BDS review meeting Ichinoseki, 4th September

Nick Walker

113th ILC@DESY meeting — 19.09.2014

https://agenda.linearcollider.org/conferenceDisplay.py?confId=6465

BDS Lattice Review

Thursday, September 4, 2014 from **12:00** to **18:00** (Asia/Tokyo)

Description Charge of review meeting: review the current TDR baseline optics and assess the level of completeness from the viewpoint of optics, backgrounds & collimation, beam dynamics and diagnostics. Review the current state of the xsif decks in subversion repository and discuss future deck standards (AML/XML). Review the status of alternative FFS optics and review work required for formal comparison and potential future selection as baseline given CFS timing and resource constraints.

Thursday, September 4, 2014

12:00 - 13:30 TDR Baseline Optics Review: http://fuze.me/25893330

Review of work ongoing pertaining to the TDR baseline description.

Conveners: Nicholas Walker (DESY), Dr. Glen White (SLAC)

12:00 **Status of ILC decks** *15'*
Speaker: Mark Woodley (SLAC)
Material: Slides

12:15 **Status of baseline BDS optics design** *30'*
Speaker: Dr. Glen White (SLAC)
Material: Slides

12:45 **Extraction line system updates** *15'*
Speaker: Dr. Glen White (SLAC)

13:00 **3.5m/4.5m L* FFS optics matching** *30'*
Speaker: Dr. Toshiyuki Okugi (KEK)
Material: Slides

14:00 - 15:00 Diagnostics & Simulations: http://fuze.me/25893330

Conveners: Nicholas Walker (DESY), Dr. Glen White (SLAC), Dr. Stewart Boogert (Royal Holloway, University of London)

14:00 **Diagnostics** *30'*

14:30 **Cross-simulation support options (UAP/AML)** *30'*

15:30 - 18:00 TDR Baseline Lattice Discussions: http://fuze.me/25893330

Work ongoing on alternatives to the TDR baseline optics

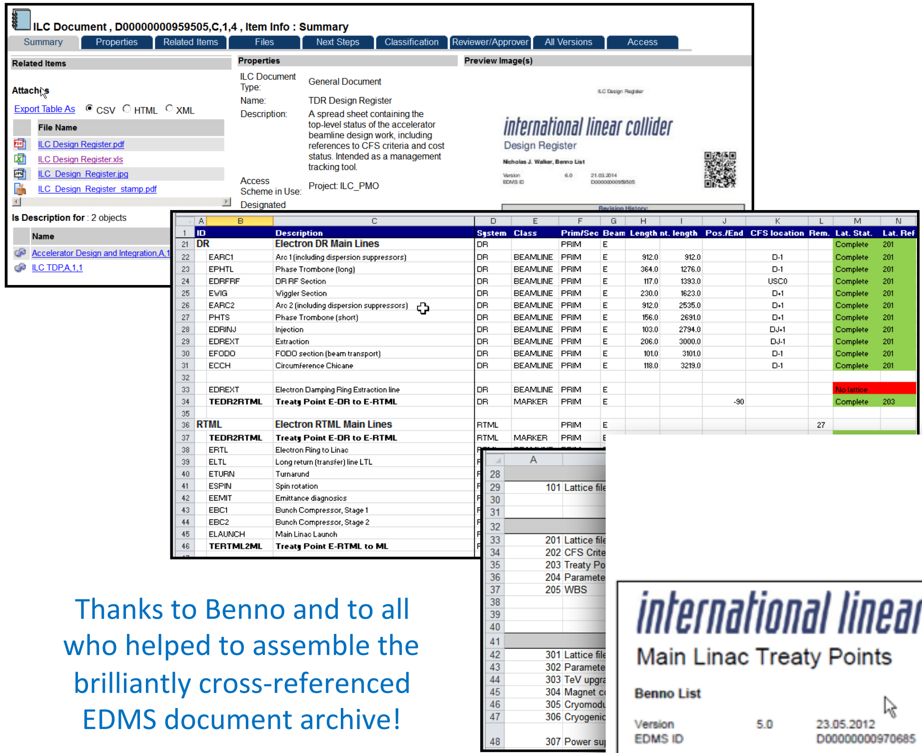
Conveners: Nicholas Walker (DESY), Dr. Glen White (SLAC)

Lattice integration (M .Woodley, SLAC)

- History: SLAC was responsible for complete lattice integration for the RDR
  - M. Woodley
  - Since 2008 (black December) not involved
- Picking up where (SLAC) left off in 2008
  - Thanks to some available money (but limited)
- M. Woodley currently trying to bring lattice files "up to TDR spec"
  - checking for errors in lattice decks
  - confirming TDR documentation
  - confirming overall lattice/tunnel lengths ("global timing")

Extremely pleased to have Mark back on board!

EDMS: ILC TDR Design Register



Thanks to Benno and to all who helped to assemble the brilliantly cross-referenced EDMS document archive!

BIG thumbs-up for EDMS
(and Benno :-)

EDMS: Treaty Point Definitions

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Main Linac Treaty Points

Benno List

Version 5.0 23.05.2012
EDMS ID D00000000970685

This document defines the treaty points between RTML, Main Linac, Positron Source Undulator section, and BDS.

Remarks	
1	~~Main Linac lengths are subject to change (final numbers after BTR at KEK, 10./20.1.2012), current estimates based on RDR lattice~~
2	~~Electron Linac final energy and length need final numbers for positron source undulator; currently, ELIN has 4 x 26 cavities more for 3.33GeV additional energy.~~
3	~~All alpha/beta functions based on RDR lattices~~
4	Treaty point TEML2PS between electron ML and undulator section assigns the whole
5	Undulator length: 66 modules with 2 undulators at 1.74m length -> 229.68m active length (see J. A. Clarke et al., Proc. EPAC08, MOPP070)

Revision History:

Version	Date	Author	Remark
0.9	25.11.2011	B. List	First Version
1.0	15.11.2012	B. List	Machine protection and collimation (MPSCOL) section moved to Main Linac
2.0	22.02.2012	B. List	Added final Main Linac Length
3.0	29.02.2012	B. List	New final Main Linac Length
4.0	03.05.2012	B. List	New twiss functions at ML start, values from Valery Kapin
5.0	23.05.2012	B. List	Split RTML to ML treaty points between KCS and DKS

Absolutely essential!

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Main Linac Treaty Points

Version 5.0 23.05.2012

Treaty Point	TERTML2ML		TEML2PS	TPS2EBDS	TPRTML2ML		TPML2BDS
	Electron RTML to Main Linac		Electron Main Linac to Positron Source (Undulator Section)	Positron Source (Undulator Section) to Electron BDS	Positron RTML to Main Linac		Positron Main Linac to BDS
Geometry							
HLRF Scheme	KCS	DKS			KCS	DKS	
x [m]	104,52450	104,85593	26,540	17,440	94,6204	94,9344	17,433
y [m]	0	0	0	0	0	0	0
z [m]	-14471,7801	-14519,1269	-3331,319	-2253,464	13279,10984	13323,95674	2252,514
ϑ [rad]	-0,00700	-0,00700	-0,00700	-0,00700	-3,13459	-3,13459	-3,13459
φ [rad]	0	0	0	0	0	0	0
ψ [rad]	0	0	0	0	0	0	0
d [m]	3,220	3,220	3,220	1,665	1,665	1,665	1,665
Optics Functions							
α_x [1]	-1,142		-2,4018	-2,4018	-1,142		-2,4018
β_x [m]	52,67		51,332	51,332	52,67		51,332
η_x [m]	0		0	0	0		0
η'_x [1]	0		0	0	0		0
α_y [1]	1,279		0,48877	0,4888	1,279		0,48877
β_y [m]	70,74		9,3954	9,395	70,74		9,3954
η_y [m]	0		0	0	0		0
η'_y [1]	0		0	0	0		0

Input:	ELIN				PLIN		
Main Linac Length [m]	11140,734	11188,082			11026,866	11071,714	

Reference: ILC SCRF Cryogenics parameters for KCS D00000000975575
ILC SCRF Cryogenics parameters for DKS D00000000991555

Integration status

subsystems	source	doc / file	comments
EDR / PDR	EDMS	D*0960185,G,1,1 dtc04.zip	DTC04 lattice (3238.7 m DR circumference)
ERTML / PRTML	EDMS	D*0977625,B,1,1 RTML2012a.zip	KCS lattice
EML / PML	DESY svn	ilclattice-ml-dks _BL20120608 .r234.tar.gz	A. Valishev / B. List DKS lattice: • svn branch: ILC2012dks_ML_3RFU_VK201206 • svn folder: ml-dks-BL20120608
EBDS / PBDS	EDMS	D*0972985,B,1,2 BDS2012b.zip	Glen and Edu are updating the BDS Final Focus and dump line lattices
PSOURCE	EDMS	D*0977535,B,1,1 ps-lattice-2012a.zip	W. Liu / W. Gai TDR lattice • described in IPAC2012 paper TUPPR041

- Picked up all EDMS lattice files
- Checked for geometry, agreement with TDR / TDD documents etc.
- Integrated and match optically (on-going)
- Found one “error” in BDS laser-wire chicane
  - cut and paste lattice file mistake
  - BDS lattice can be shortened by ~32m
- Other “inconsistencies” at the ~1m level.
- Total path length “error” calculated: 293.141 m (cf 293.6 m at previous workshops)

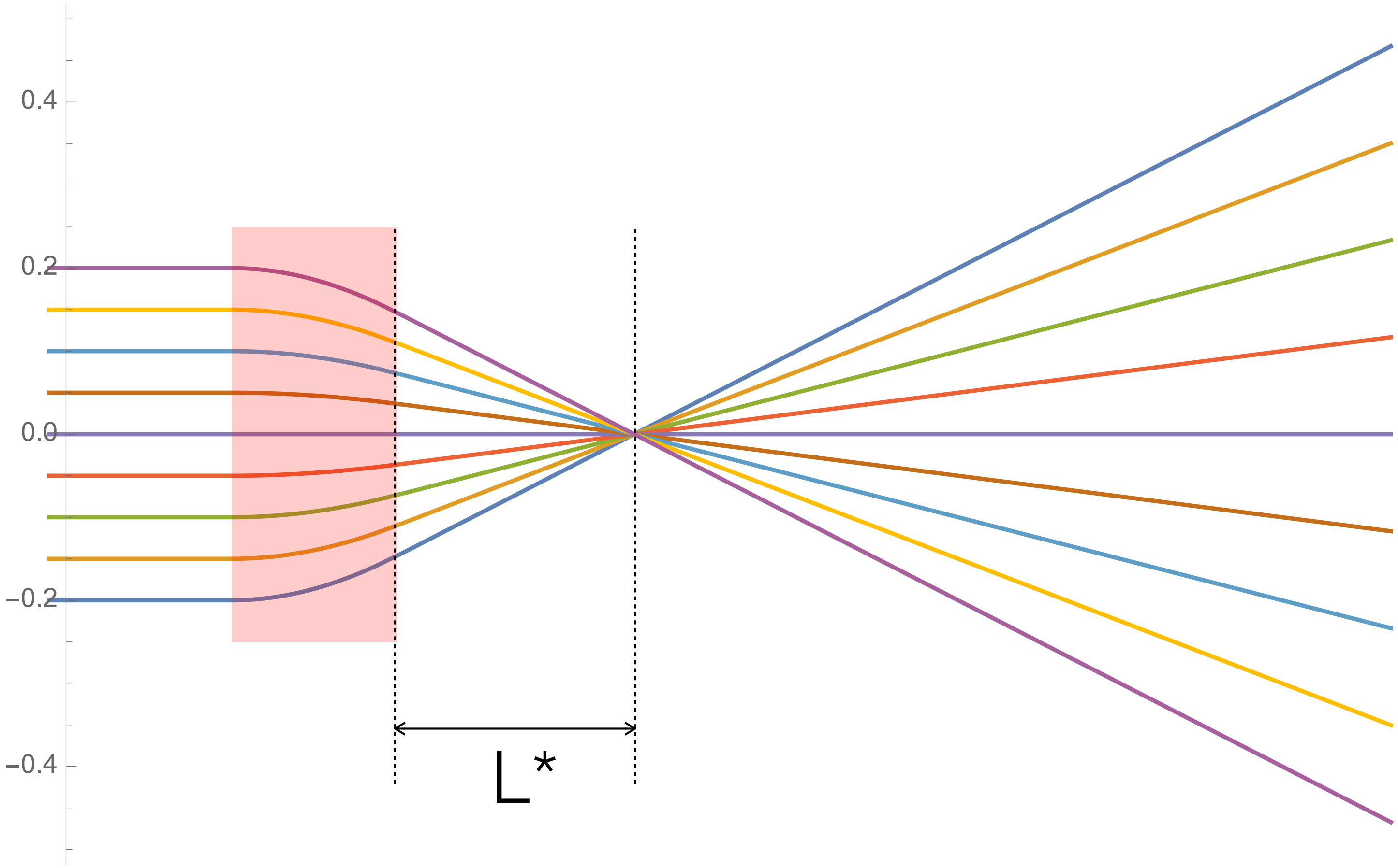
Next (integration steps)

- Include “auxiliary” lines (sources, dump lines etc)
- deck “clean-up” (including documentation)
- Aiming at new lattice release ILC2014a
  - will reflect correctly the TDR geometry
  - use as starting point for future “change requests”

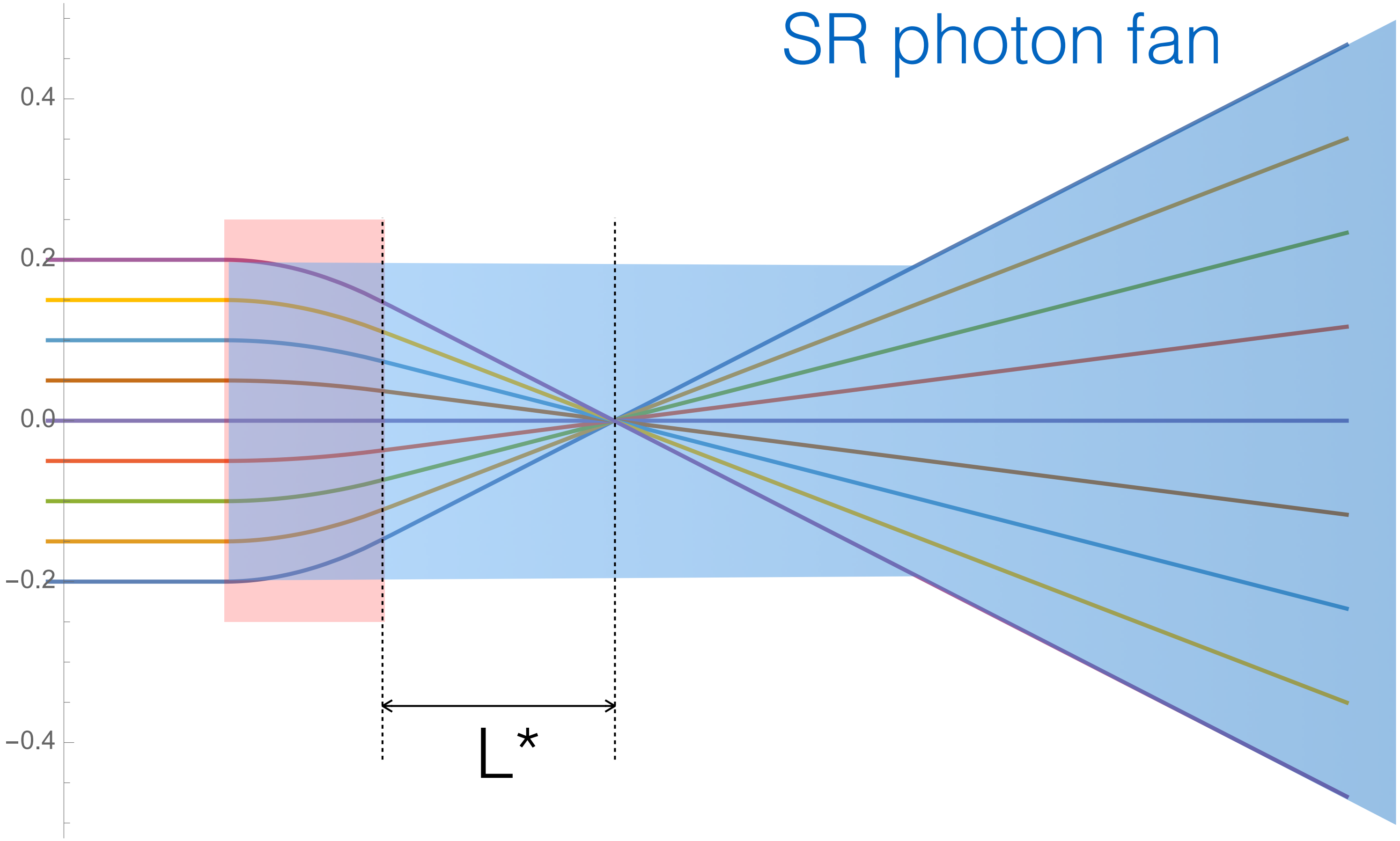
BDS-specific (Glen White, SLAC)

- **Consolidating BDS lattice to**
  - Reflect 250 GeV TDR push-pull solution (L* = 3.5/4.5)
  - Optical match: higher-order corrections (up to 3rd order)
  - Addition of new tuning magnets (ATF2 experience):
    - 4 new skew-sextupoles
    - Splitting QF7 (IP "image point") for diagnostic
- **New updated lattice will be part of ILC2014a release**

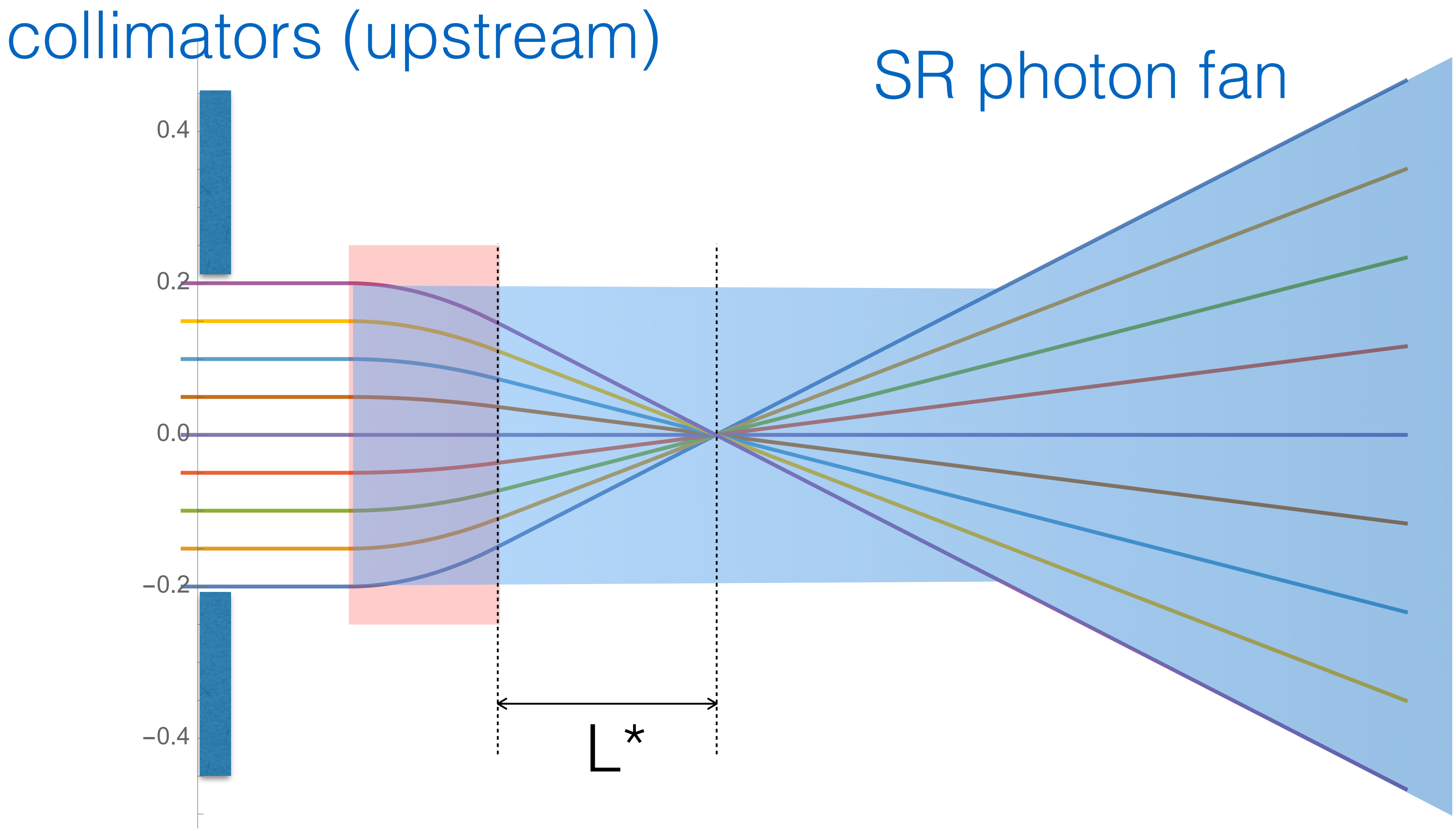
Collimation depth



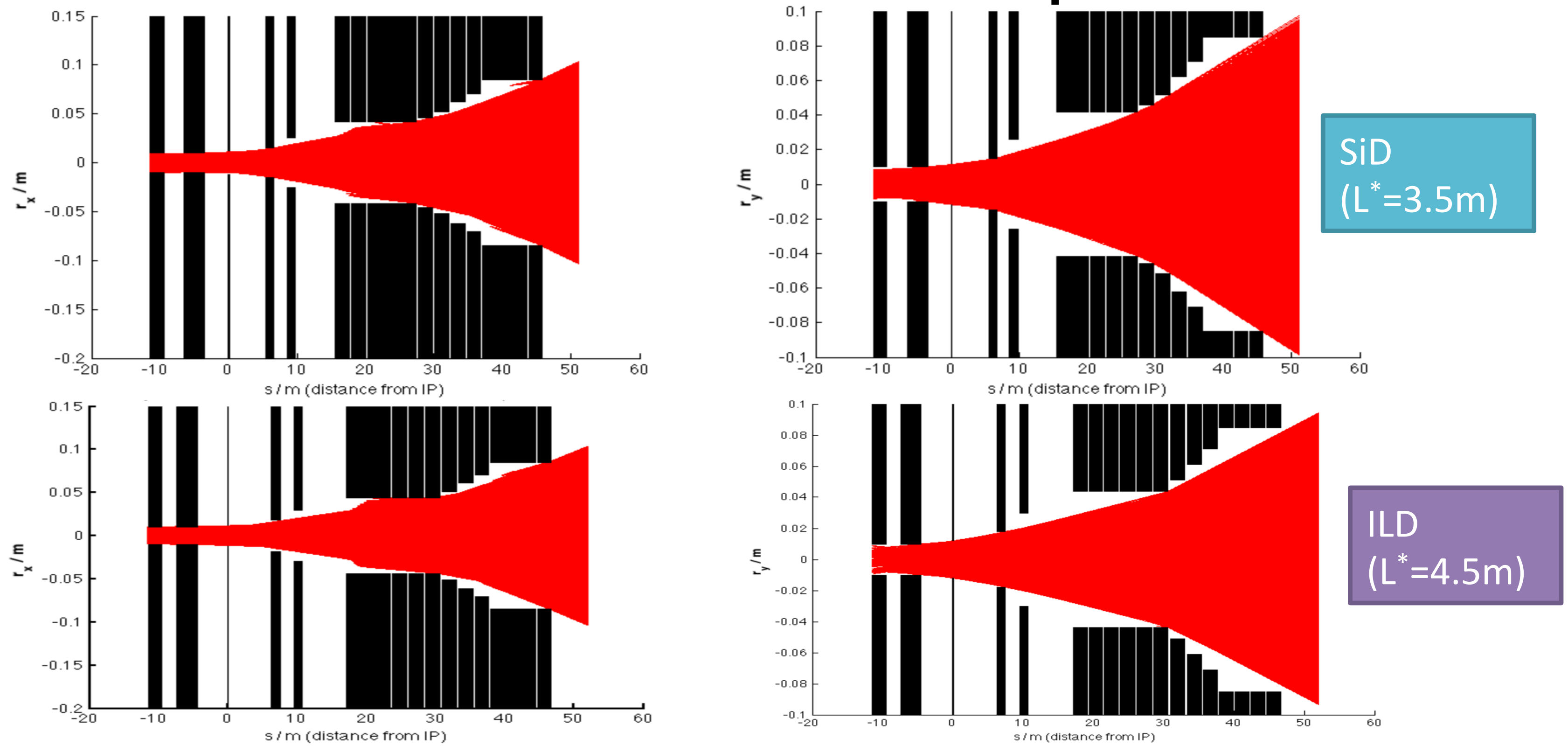
Collimation depth



Collimation depth



Calculate Collimation Depth to Set Betatron Collimator Apertures



- SR from particles covering all QF1 phase-space
  - Rays not hitting apertures shown
- Aperture @ IP = 14mm (SiD), 16mm (ILD) radius inner vertex detector layer (L=125mm)

Different L* require different solutions

Betatron Spoiler Apertures

Name	L^*=3.5m		L^*=4.5m		Existing Lattice	
	X / mm (Nσ_x)	Y / mm (Nσ_y)	X / mm (Nσ_x)	Y / mm (Nσ_x)	X / mm (Nσ_x)	Y / mm (Nσ_y) =RDR
SP1	-	-	-	-	0.3 (15)	0.25 (250)
SP2	-	-	1.24 (11)	0.2 (24)	0.3 (2.7)	0.2 (24)
SP3	-	-	0.5 (25)	0.22 (219)	0.3 (15)	0.25 (250)
SP4	-	-	0.59 (5.4)	0.22 (26)	0.3 (2.7)	0.2 (24)
SP5	-	-	-	-	0.42 (11)	0.25 (250)

- "-" = no collimation needed at this location to prevent IR SR hits.
  - (L*=3.5m optics completely shielded by magnet apertures)
- Tightest aperture: SP2/SP4 (X)
  - *2.7σ = 0.7% Beam loss = 36kW for existing lattice*
- TDR calls for 1-2E-5 main beam loss => 4.3σ tightest collimation aperture. (Max with all muon spoiler space filled = 1E-3 beam loss => 3.3σ)
  - **Tightest L*=4.5m aperture = SP4 = 5.4σ**

Also: extraction line apertures (losses)
collimator wake fields ~ a^{2-3}

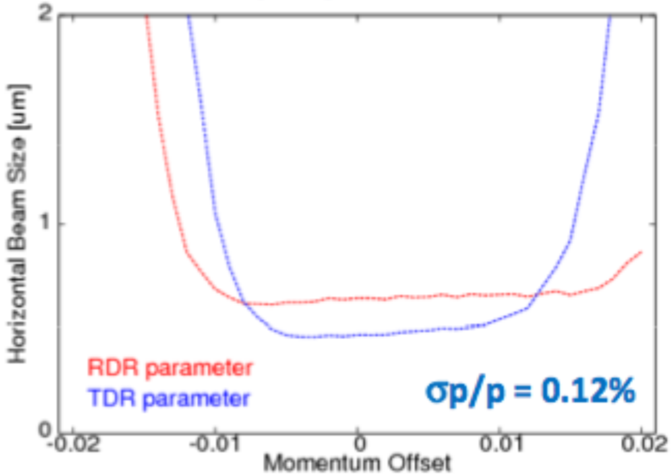
G. White

Optical "bandwidth" & tolerances

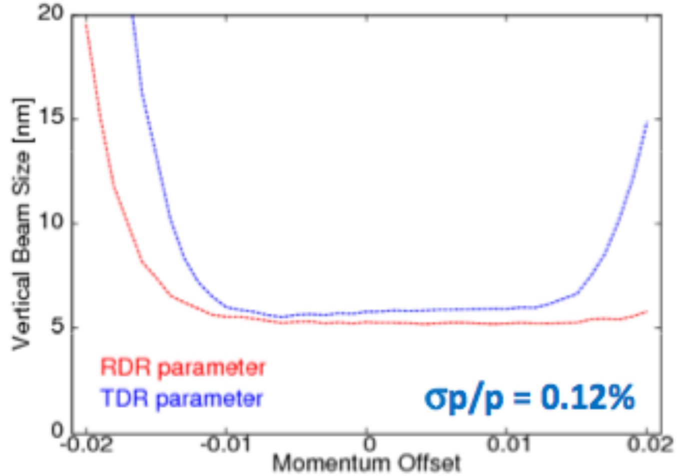
- Maximising "bandwidth" (dp/p acceptance) is the ultimate goal of FF designers
- Figure of merit for design work.
  - Linear optics, 2nd and 3rd order aberration corrections
- RDR (single L*) was last really optimised lattice
- Never really cross-checked for TDR "push-pull" optics
  - QF1 in separate cryostat and pulled clear of detector
  - QD0 integrated in (and moves with) detector

Performances of ILC RDR Optics (351LD0_135D1B)

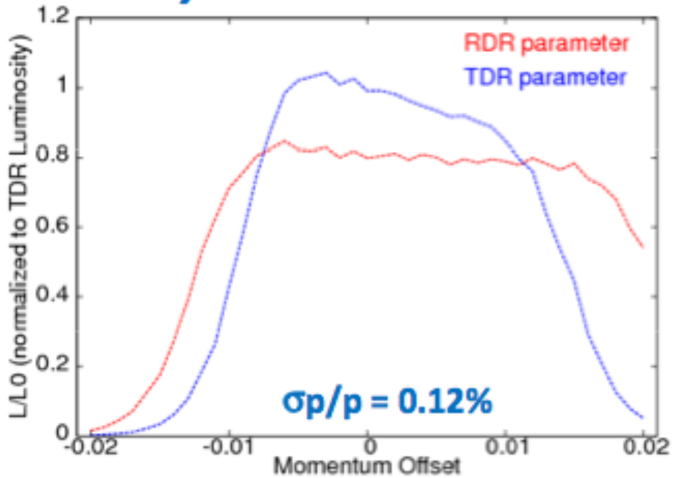
Bandwidth of sigmaX at E=250GeV



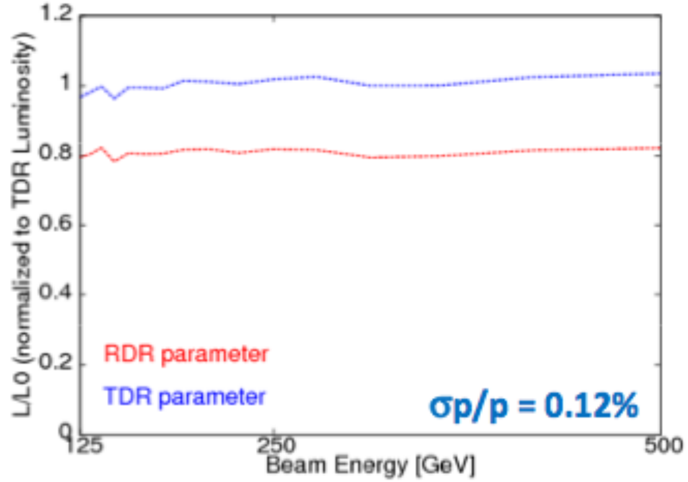
Bandwidth of sigmaY at E=250GeV



Luminosity Bandwidth at E=250GeV



Energy Dependence of Luminosity



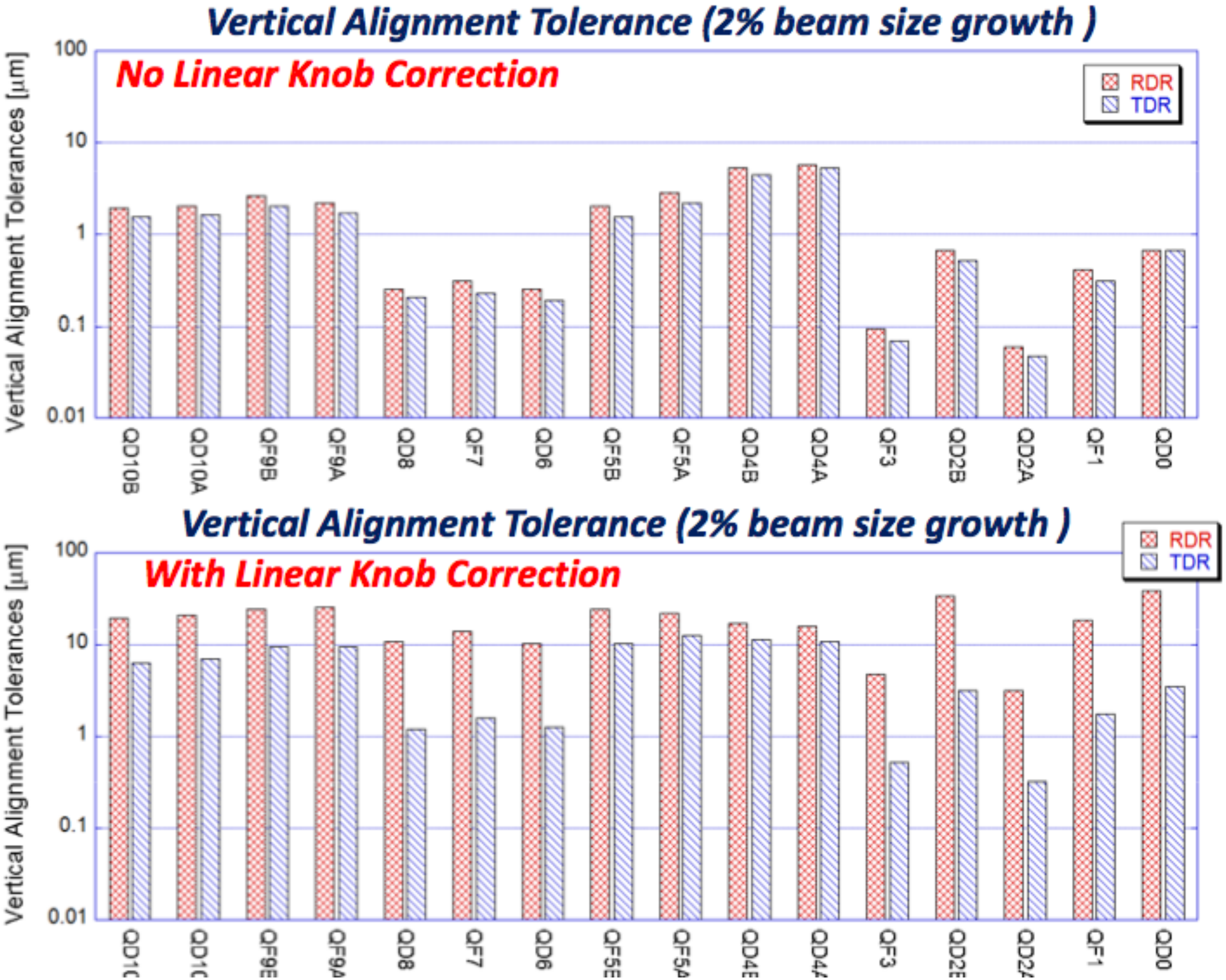
The peak luminosity was increased.

But, the luminosity bandwidth was reduced.

Toshiyuki Okugi (KEK)

Tolerances of ILC RDR Optics

Presented at LCWS2013 by T.Okugi



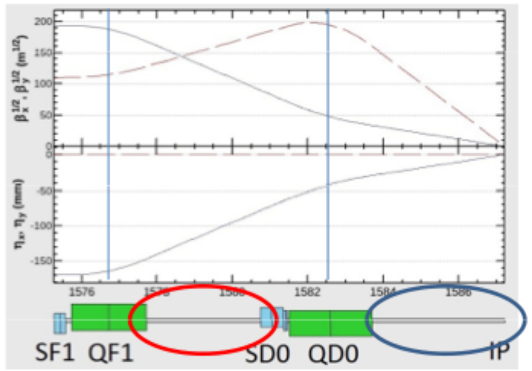
Toshiyuki Okugi (KEK)

TDR push—pull solution

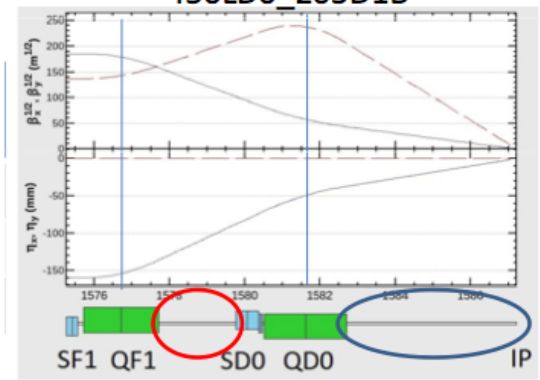
Toshiyuki Okugi (KEK)

h etc.

351LD0_304D1B

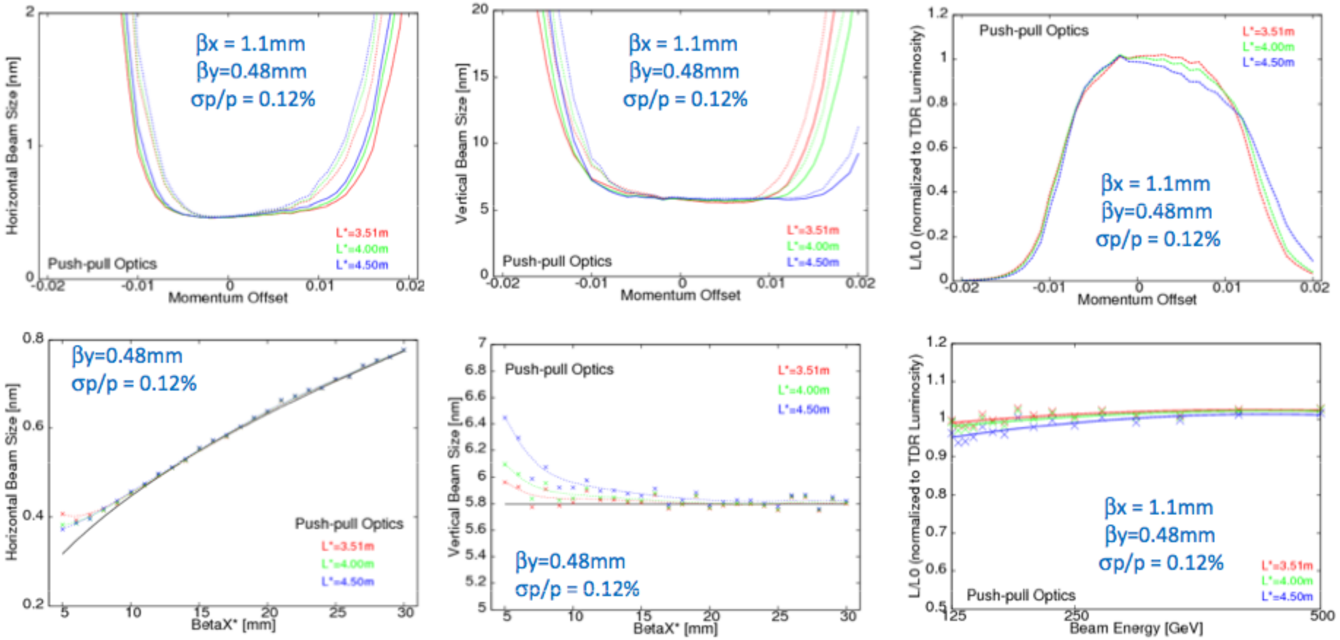


450LD0_205D1B



Optimization of Push-pull optics.

solid line ; core beam size
dotted line ; rms beam size



The bandwidth and aberration for L=3.51m and 4.50m was comparable to those for L*=4.00m optics.*

Not just L* but location of QF1 also seems critical

Achieved ~same BW performance for both L* (also for L* 7m !!) with small(er) D1

But! tolerance, collimation depth etc.

Common L*

- Theoretical optics solutions can be found for "arbitrary" L*
- However, with longer L*
  - Tolerances get tighter
  - Collimation depth gets smaller, and therefore
  - Collimator apertures get small (->wakefields)
  - Tuning *may* become more challenging
- In addition
  - Major change of optics during push-pull will strongly influence tuning time (luminosity and potentially backgrounds)
    - and therefore recovery time
  - Longer L* has higher performance risk
- Can we quantify these things?
  - We can try. But really requires substantially simulations of tuning etc.
- Change Request formally submitted by Glen White and myself