LINEAR COLLIDER COLLABORATION
Designing the world's next great particle accelerator

Status of ILC Decks

SLAC NATIONAL ACCELERATOR LABORATORY

U.S. DEPARTMENT OF ENERGY
Office of Science

Perspective

- I last worked on ILC at SLAC in December 2007, doing lattice integration with Peter Tenenbaum and Andrei Seryi
- our last "official" release of ILC lattice description files (MAD8 Extended Standard Input Format), corresponding to the RDR, was designated "ILC2007b"
  - http://www.slac.stanford.edu/accel/ilc/lattice/edr/ILC2007b
- since then others have carried on the lattice work (SB2009, 2012 updates for CFS, the TDR)
- some things that have changed since I last did ILC work:
  - DESY's ILC EDMS system (!)
  - offset Damping Rings in the central injector complex
  - 3.24 km circumference Damping Rings
  - Distributed Klystron Scheme (DKS) in Main Linacs
  - helical undulator for e+ production at high-energy end of e- Main Linac
  - relocation of e- MPS collimation and fast abort lines to u/s of the undulator
  - e- undulator-to-BDS dogleg line
- goals of present work:
  - collect set of most up-to-date decks which reflect the lattice described in the TDR
  - integrate deck sets for major subsystems (eSource, pSource, DRs, ELET, PLET)
  - reproduce TDR CFS geometry (EDMS Treaty Point coordinates)

EDMS: ILC TDR Design Register

ILC Document , D00000000959505,C,1,4 , Item Info : Summary

Summary | Properties | Related Items | Files | Next Steps | Classification | Reviewer/Approver | All Versions | Access

Related Items

Attachments

Export Table As ◉ CSV ○ HTML ○ XML

File Name
ILC Design Register.pdf
ILC Design Register.xls
ILC_Design_Register.jpg
ILC_Design_Register_stamp.pdf

Is Description for : 2 objects

Name
Accelerator Design and Integration,A,1
ILC TDP,A,1,1

Properties

ILC Document Type:	General Document
Name:	TDR Design Register
Description:	A spread sheet containing the top-level status of the accelerator beamline design work, including references to CFS criteria and cost status. Intended as a management tracking tool.
Access Scheme in Use:	Project: ILC_PMO
Designated	

Preview Image(s)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	ID		Description	System	Class	Prim/Sec	Beam	Length	nt. length	Pos./End	CFS location	Rem.	Lat. Stat.	Lat. Ref
21	DR		**Electron DR Main Lines**	DR		PRIM	E						Complete	201
22		EARC1	Arc 1 (including dispersion suppressors)	DR	BEAMLINE	PRIM	E	912.0	912.0		D-1		Complete	201
23		EPHTL	Phase Trombone (long)	DR	BEAMLINE	PRIM	E	364.0	1276.0		D-1		Complete	201
24		EDRFRF	DR RF Section	DR	BEAMLINE	PRIM	E	117.0	1393.0		USC0		Complete	201
25		EWIG	Wiggler Section	DR	BEAMLINE	PRIM	E	230.0	1623.0		D+1		Complete	201
26		EARC2	Arc 2 (including dispersion suppressors)	DR	BEAMLINE	PRIM	E	912.0	2535.0		D+1		Complete	201
27		PHTS	Phase Trombone (short)	DR	BEAMLINE	PRIM	E	156.0	2691.0		D+1		Complete	201
28		EDRINJ	Injection	DR	BEAMLINE	PRIM	E	103.0	2794.0		DJ+1		Complete	201
29		EDREXT	Extraction	DR	BEAMLINE	PRIM	E	206.0	3000.0		DJ-1		Complete	201
30		EFODO	FODO section (beam transport)	DR	BEAMLINE	PRIM	E	101.0	3101.0		D-1		Complete	201
31		ECCH	Circumference Chicane	DR	BEAMLINE	PRIM	E	118.0	3219.0		D-1		Complete	201
32														
33		EDREXT	Electron Damping Ring Extraction line	DR	BEAMLINE	PRIM	E						No lattice	
34		**TEDR2RTML**	**Treaty Point E-DR to E-RTML**	DR	MARKER	PRIM	E			-90			Complete	203
35														
36	RTML		**Electron RTML Main Lines**	RTML		PRIM	E					27		
37		**TEDR2RTML**	**Treaty Point E-DR to E-RTML**	RTML	MARKER	PRIM	E		0.0	-106.988			Complete	203
38		ERTL	Electron Ring to Linac											
39		ELTL	Long return (transfer) line LTL											
40		ETURN	Turnarund											
41		ESPIN	Spin rotation											
42		EEMIT	Emittance diagnosics											
43		EBC1	Bunch Compressor, Stage 1											
44		EBC2	Bunch Compressor, Stage 2											
45		ELAUNCH	Main Linac Launch											
46		**TERTML2ML**	**Treaty Point E-RTML to ML**											

	A	B	C	D	E
28				**RTML References**	
29	101	Lattice file	D00000000977625	Lattice RTML2012a, 2.3.12	
30					
31					
32				**DR References**	
33	201	Lattice file	D00000000960185	DTC Lattice file DTC02	dtc.zip
34	202	CFS Criteria	D00000000960265	DR CFS Criteria	DR Criteria 06-17-2011.pdf
35	203	Treaty Points	D00000000966225	Treaty points between PS, ES, DR and RTML	ILCDR_TreatyPointSpecifications_R2.docx
36	204	Parameters	D00000000960955	DR Parameters	DR parameters1.xls
37	205	WBS	D00000000958765	WBS	ILCDR_TDPII_WBS.xls
38					
39					
40					
41				**Global References**	
42	301	Lattice file	D00000000966355	ILC2007b lattice file	ILC2007b.zip
43	302	Parameters	D00000000925325	Global Parameter List	tdp2_machine_parameters1.xls
44	303	TeV upgrade parameters	D00000000965055	TeV upgrade parameters	TeV straw-man parameters v1.xlsx
45	304	Magnet counts	D00000000983695	Global magnet count	Magnet-overview.xlsx
46	305	Cryomodule counts	D00000000972665	Cryomodule count	
47	306	Cryogenics parts	D00000000991345	Overview over cryogenics parts	
48	307	Power supplies	D00000000921195	Overview over all power supplies (RDR) restricted!	07-02-28 ILC Magnet Power Supply List.xls

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

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, 19./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!

international linear collider

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

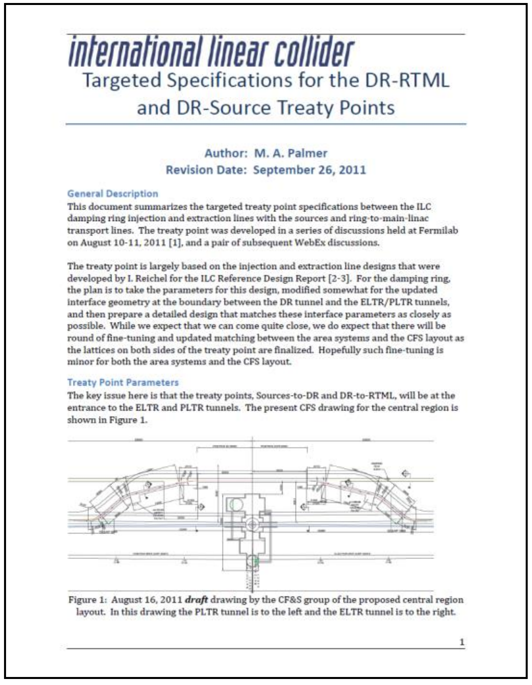
Deck Files Obtained and Integrated so far

subsystems	source	doc / file	comments
ESOURCE	EDMS	D*0976695,B,1,1 ES2012a.zip	Design registry (exit of bunchers to end of ELTR)
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

Recreating the TDR CFS geometry

subsystems	comments
EDREXT / PDREXT EDRINJ / PDRINJ	created by MDW from: • I. Reichel documents • TDR text • Treaty Point coordinate definitions
PTURN	small geometry changes in vertical dogleg (no matching)
ELTL / PLTL	converted by MDW for DKS (no matching): • lengthen ELTL FODO cell: 36.016 m to 36.141 m (ΔL = 47.348 m) • lengthen PLTL FODO cell: 35.912 m to 36.041 m (ΔL = 44.848 m)
UPT	created by MDW (August 2014): • END_EUND to target drift: L= 372.044 m
EBSY1 / EBSY2 PBSY1 / PBSY2	Redefinition errors discovered during "deck integration": • polarimeter chicanes were copied from *BSY2 to *BSY1 as separate laserwire detection chicanes • names of elements (bends and drifts) were not changed • names of parameters that defined bend and drift lengths were not changed • values of parameters that defined bend and drift lengths were changed in *BSY1 files • when *BSY1 file is loaded, LW chicane is 45.1 m long • when *BSY2 file is loaded, LW chicane is redefined to be 76.9 m long (ΔL = 31.8 m) • TDR CFS coordinates include BSY LW chicanes that are each 31.8 m too long PBDS is 0.95 m shorter than EBDS due to rematching between PBSY and PFFS • TDR CFS coordinates include shorter PBDS

Damping Rings: Injection / Extraction



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Targeted Specifications for the DR-RTML and DR-Source Treaty Points

Author: M. A. Palmer
Revision Date: September 26, 2011

General Description

This document summarizes the targeted treaty point specifications between the ILC damping ring injection and extraction lines with the sources and ring-to-main-linac transport lines. The treaty point was developed in a series of discussions held at Fermilab on August 10-11, 2011 [1], and a pair of subsequent WebEx discussions.

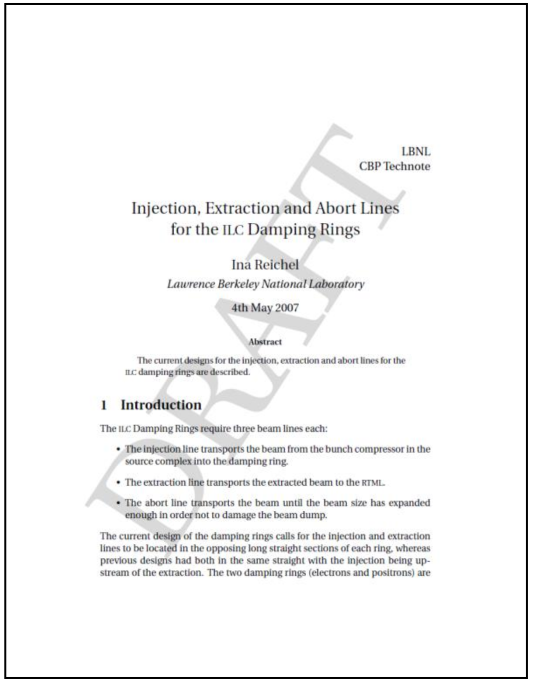
The treaty point is largely based on the injection and extraction line designs that were developed by I. Reichel for the ILC Reference Design Report [2-3]. For the damping ring, the plan is to take the parameters for this design, modified somewhat for the updated interface geometry at the boundary between the DR tunnel and the ELTR/PLTR tunnels, and then prepare a detailed design that matches these interface parameters as closely as possible. While we expect that we can come quite close, we do expect that there will be round of fine-tuning and updated matching between the area systems and the CFS layout as the lattices on both sides of the treaty point are finalized. Hopefully such fine-tuning is minor for both the area systems and the CFS layout.

Treaty Point Parameters

The key issue here is that the treaty points, Sources-to-DR and DR-to-RTML, will be at the entrance to the ELTR and PLTR tunnels. The present CFS drawing for the central region is shown in Figure 1.

Figure 1: August 16, 2011 ***draft*** drawing by the CF&S group of the proposed central region layout. In this drawing the PLTR tunnel is to the left and the ELTR tunnel is to the right.

1



LBNL
CBP Technote

Injection, Extraction and Abort Lines for the ILC Damping Rings

Ina Reichel
Lawrence Berkeley National Laboratory

4th May 2007

DRAFT

Abstract

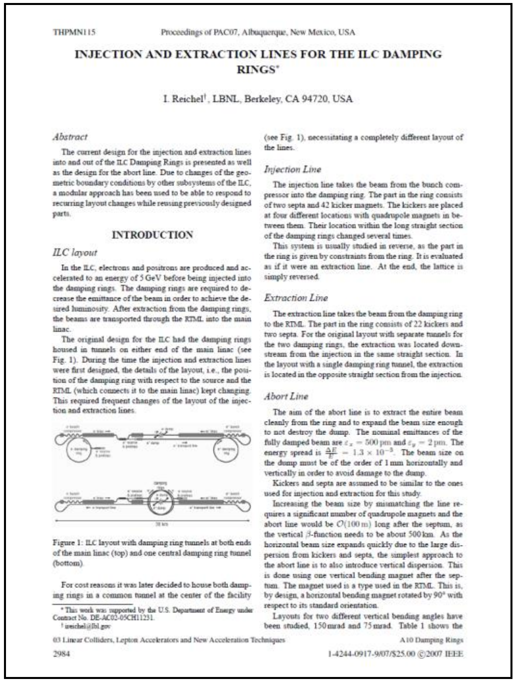
The current designs for the injection, extraction and abort lines for the ILC damping rings are described.

1 Introduction

The ILC Damping Rings require three beam lines each:

- The injection line transports the beam from the bunch compressor in the source complex into the damping ring.
- The extraction line transports the extracted beam to the RTML.
- The abort line transports the beam until the beam size has expanded enough in order not to damage the beam dump.

The current design of the damping rings calls for the injection and extraction lines to be located in the opposing long straight sections of each ring, whereas previous designs had both in the same straight with the injection being upstream of the extraction. The two damping rings (electrons and positrons) are



THPMN115 Proceedings of PAC07, Albuquerque, New Mexico, USA

INJECTION AND EXTRACTION LINES FOR THE ILC DAMPING RINGS*

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Abstract

The current design for the injection and extraction lines into and out of the ILC Damping Rings is presented as well as the design for the abort line. Due to changes of the geometric boundary conditions by other subsystems of the ILC, a modular approach has been used to be able to respond to recurring layout changes while reusing previously designed parts.

INTRODUCTION

ILC layout

In the ILC, electrons and positrons are produced and accelerated to an energy of 5 GeV before being injected into the damping rings. The damping rings are required to decrease the emittance of the beam in order to achieve the desired luminosity. After extraction from the damping rings, the beams are transported through the RTML into the main linac.

The original design for the ILC had the damping rings housed in tunnels on either end of the main linac (see Fig. 1). During the time the injection and extraction lines were first designed, the details of the layout, i.e., the position of the damping ring with respect to the source and the RTML (which connects it to the main linac) kept changing. This required frequent changes of the layout of the injection and extraction lines.

Figure 1: ILC layout with damping ring tunnels at both ends of the main linac (top) and one central damping ring tunnel (bottom).

For cost reasons it was later decided to house both damping rings in a common tunnel at the center of the facility (see Fig. 1), necessitating a completely different layout of the lines.

Injection Line

The injection line takes the beam from the bunch compressor into the damping ring. The part in the ring consists of two septa and 42 kicker magnets. The kickers are placed at four different locations with quadrupole magnets in between them. Their location within the long straight section of the damping rings changed several times.

This system is usually studied in reverse, as the part in the ring is given by constraints from the ring. It is evaluated as if it were an extraction line. At the end, the lattice is simply reversed.

Extraction Line

The extraction line takes the beam from the damping ring to the RTML. The part in the ring consists of 22 kickers and two septa. For the original layout with separate tunnels for the two damping rings, the extraction was located downstream from the injection in the same straight section. In the layout with a single damping ring tunnel, the extraction is located in the opposite straight section from the injection.

Abort Line

The aim of the abort line is to extract the entire beam cleanly from the ring and to expand the beam size enough to not destroy the dump. The nominal emittances of the fully damped beam are $\varepsilon_x = 500$ pm and $\varepsilon_y = 2$ pm. The energy spread is $\frac{\Delta E}{E} = 1.3 \times 10^{-3}$. The beam size on the dump must be of the order of 1 mm horizontally and vertically in order to avoid damage to the dump.

Kickers and septa are assumed to be similar to the ones used for injection and extraction for this study.

Increasing the beam size by mismatching the line requires a significant number of quadrupole magnets and the abort line would be $\mathcal{O}(100\,\mathrm{m})$ long after the septum, as the vertical β-function needs to be about 500 km. As the horizontal beam size expands quickly due to the large dispersion from kickers and septa, the simplest approach to the abort line is to also introduce vertical dispersion. This is done using one vertical bending magnet after the septum. The magnet used is a type used in the RTML. This is, by design, a horizontal bending magnet rotated by 90° with respect to its standard orientation.

Layouts for two different vertical bending angles have been studied, 150 mrad and 75 mrad. Table 1 shows the

* This work was supported by the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.
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03 Linear Colliders, Lepton Accelerators and New Acceleration Techniques A10 Damping Rings

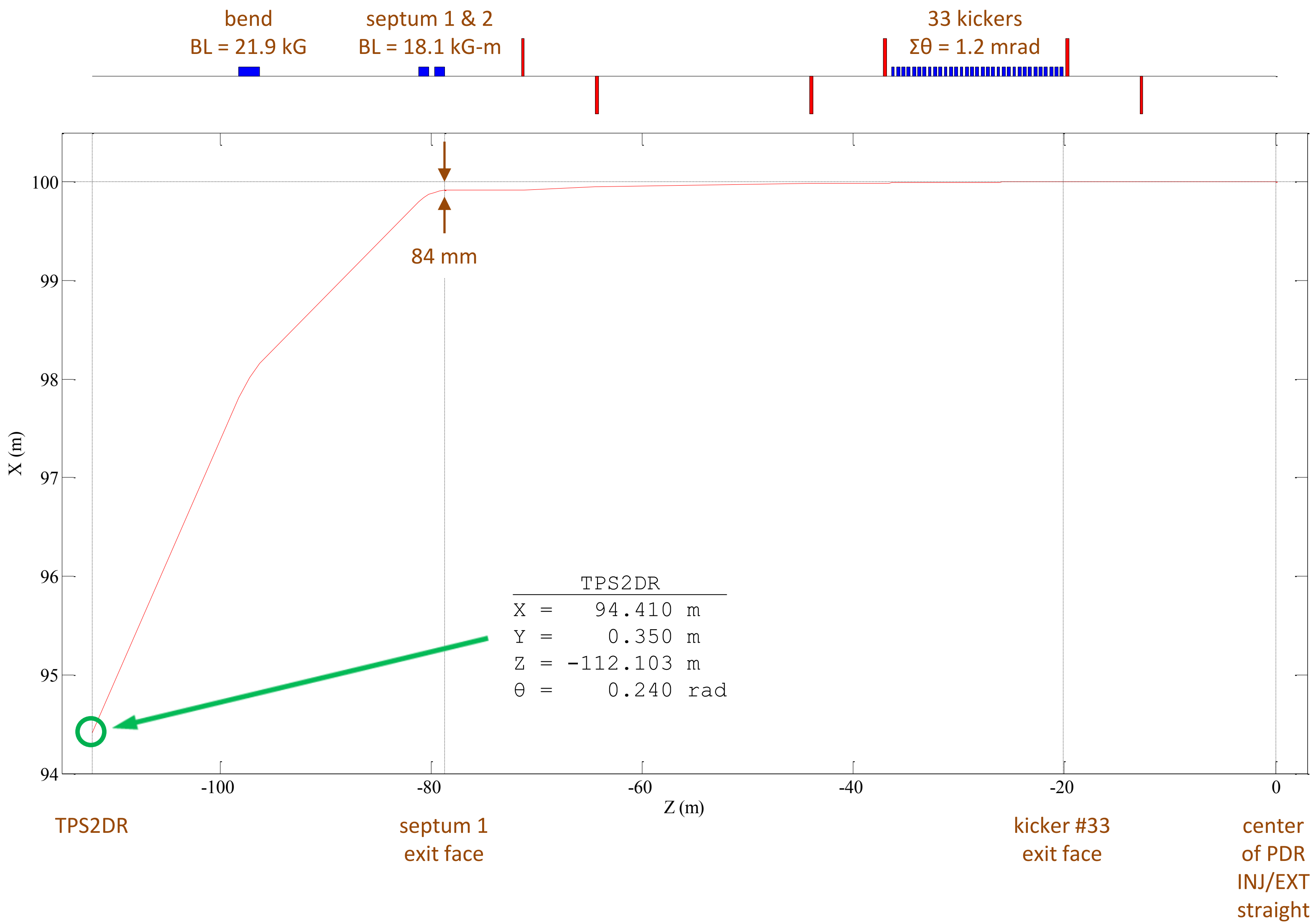
2984 1-4244-0917-9/07/$25.00 ©2007 IEEE

From the TDR (v3.II, section 6.9):

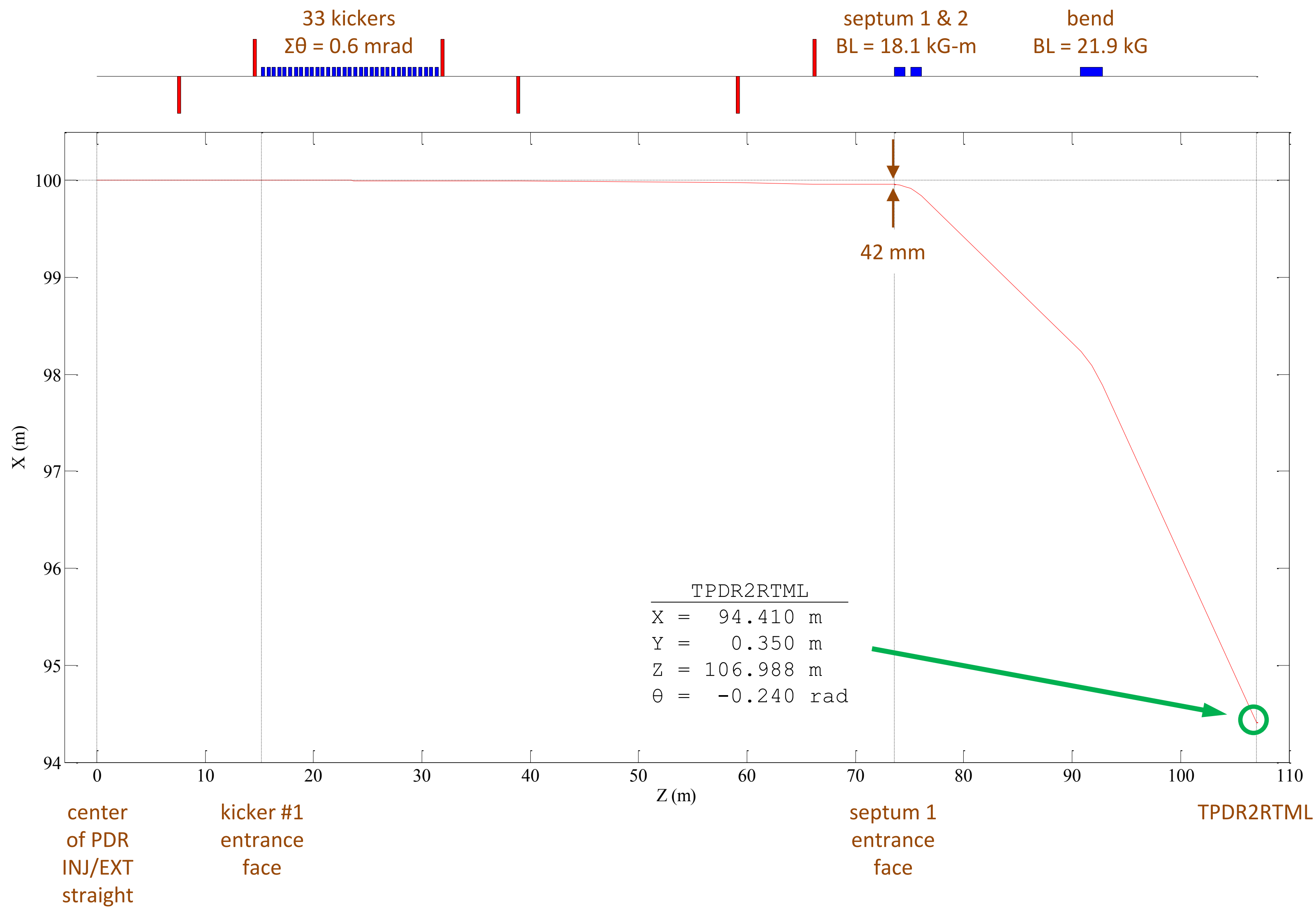
The kicker modules are 50 Ω stripline structures inside the vacuum pipe, each 30 cm long with a 30 mm gap. The required kick angle to extract the damped low emittance (∼0.5 nm rad) bunch is ∼0.6 mrad and nearly twice that for the large (∼7 × 10^{-6} mrad) injected bunch.

The septum magnets are modeled after the Argonne APS injection septa. The thin (2 mm) septum magnet has a 0.73 T field, and the thick (30 mm) septum magnet has a 1.08 T field. Each magnet has an effective length of 1 m.

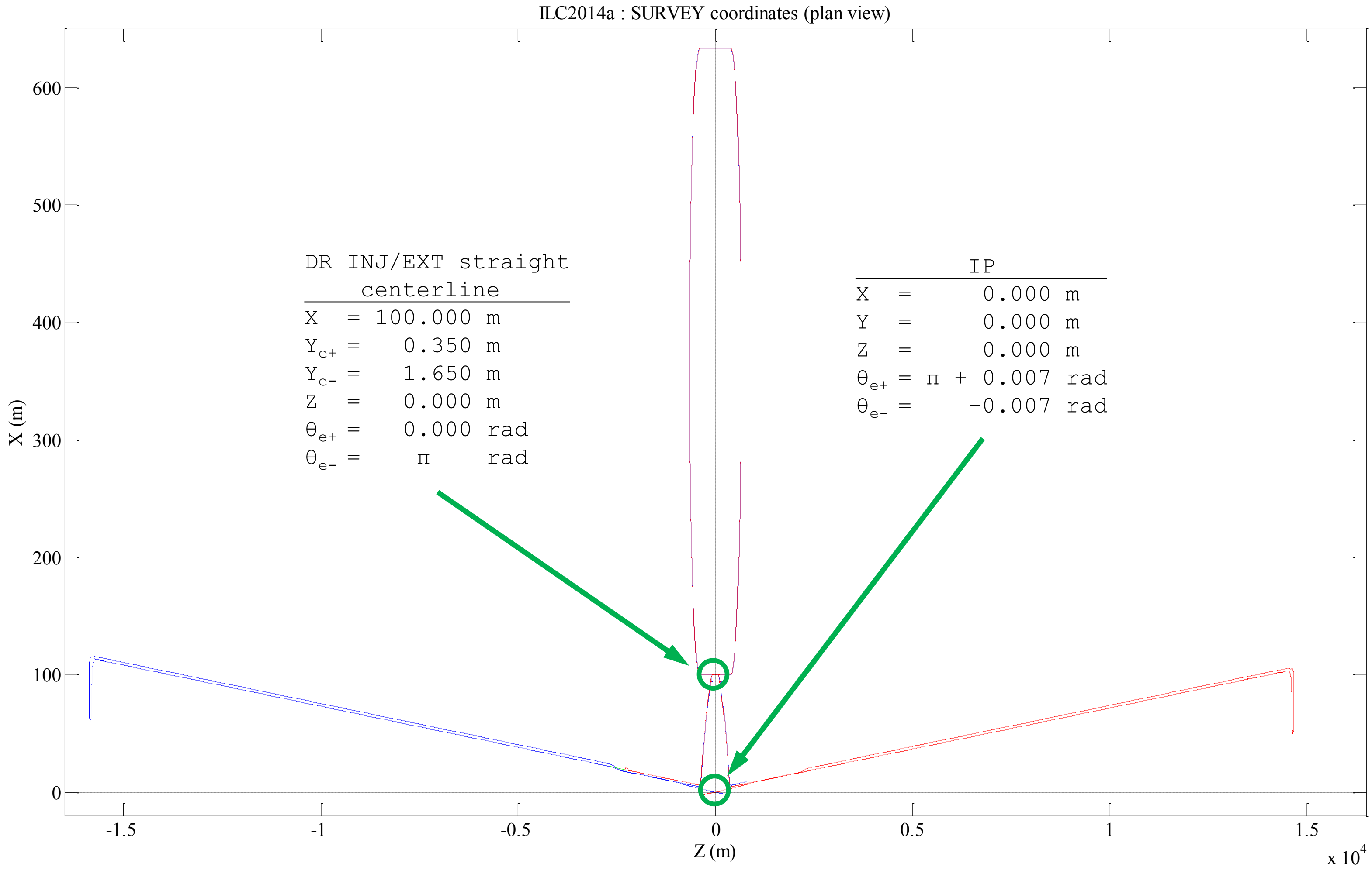
Positron Damping Ring (DTC04): Injection



Positron Damping Ring (DTC04): Extraction



eSource + EDR + ELET + UPT + pSource + PDR + PLET

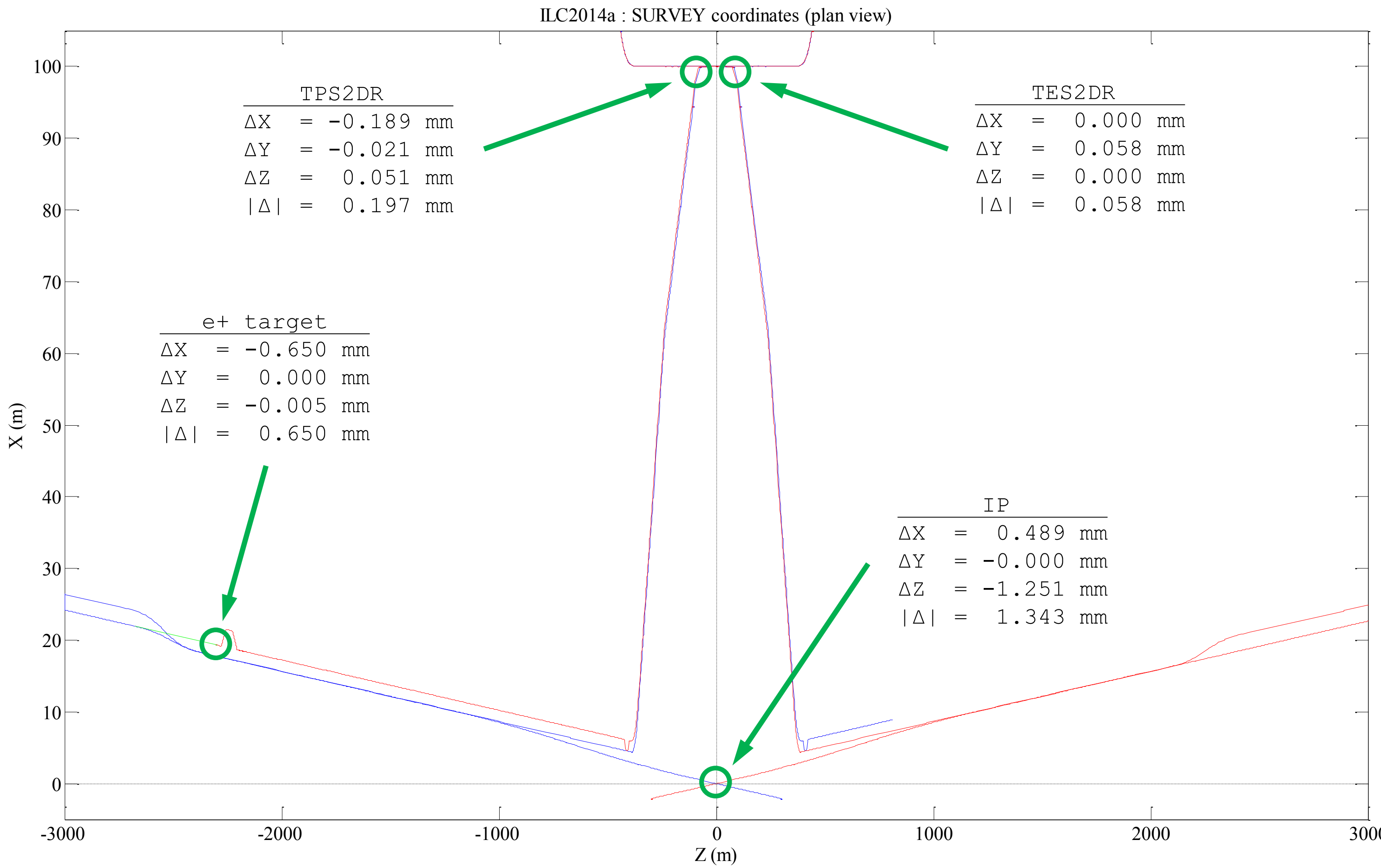


e- systems

undulator photons

e+ systems

Close-up: Central Region



Note: e-/e+ path length difference, modulo the DR circumference, is 293.141 m
(Ewan and Benno reported 293.6 m at the August 22 2014 ADI meeting …)

To Do List

- gather and integrate the remaining files
  - dump lines, abort lines, auxiliary source (?), …
- deck “cleanup”
  - remove unused stuff
  - eliminate redefinitions
  - make sure names are unique and follow some kind of naming convention
  - split magnets consistently
  - redefine deck “numbering” sequence
- check and fix the matching throughout
  - i.e. ELTL/PLTL, eSource, pSource
  - earth’s curvature following and vertical dispersion compensation
- decide how to handle lattice modifications that effect the CFS geometry
  - EBSY/PBSY laserwire chicane lengths
  - converting e- fast abort line in EBSY to DC tuneup line (?)
  - e-/e+ path length / global timing adjustments
- aim for a controlled and fully documented release of a complete “ILC2014a” deck set

Conclusions and Outlook

- using DESY EDMS system and SVN repository, MAD8 input files corresponding to the TDR for the major accelerator systems of ILC have been gathered and (partially) integrated
  - eSource, pSource, DRs, ELET, PLET
- the geometry of these systems has been verified to match the current CFS layout (sub-millimeter errors at Treaty Points)
- re-matching (Twiss) has been started … I'm presently working on the Source systems
  - LTRs need work
- after re-matching comes "deck cleanup" and standardization
- then comes documentation
- I estimate approximately 4 weeks of full-time work remains to be done to complete a packaged set of files (similar to ILC2007b) that can be released to EDMS, so an "ILC2014a" release in calendar 2014 seems possible … depending on **funding** and other commitments (i.e. LCLS-II, FACET, FACET-II, …)

From the TDR …

Figure 4.6
Optics of the LTR.