R&D for TDR

Summary of TDP R&D items and baseline changes to RDR – to be included and highlighted in TDR text

AD & I

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First critical review of the 'July TDR snapshot' – given by EC last week

TDP Milestones and Decisions

- **We listed milestones in the ‘R&D Plan’**
- **and recorded decisions through ‘Change Control’ (TLCC and BTR)**

- **Each TDR1 R&D section should include conclusions and refer to the relevant TDR2 section**
  - in some cases primary authors did not participate in change control and their sections report R&D without summarizing impact.
- **Examples for review (to be included in TDR):**

SCRF R&D Plan Milestones

Table 4-1: Milestones for the SCRF R&D Programme

Stage	Subjects	Milestones to be achieved	Year
S0	9-cell cavity	35 MV/m, max., at $Q_0 \geq 8\times10^9$, with a production yield of 50% in TD PHASE 1, and 90% in TD PHASE 2 [1), 2)]	2010/ 2012
S1	Cavity-string	31.5 MV/m, on average, at $Q_0 \geq 10^{10}$, in one cryomodule, including a global effort	2010
S2	Cryomodule-string	31.5 MV/m, on average, with full-beam loading and acceleration	2012

lan (release 2), has been revised to be the production yield of 50 % in the TDP-1.

; to be included in the milestone list in near future.

Table 3-2 Number of ILC-like (1.3 GHz) SCRF cavities manufactured, ordered and projected by the end of TD Phase 2.

	Before TDP	FY2008	FY2009	FY2010	Sum by Fy2010	TD PHASE -2 FY2011-2012
Americas	36	0	12	30+10	88	(TBD)
Asia JP	15	3	13		31	~10 + (TBD)
CN			1	1	2	
Europe (XFEL)	68	-		26* (640**)	94 (640)	(TBD)
Total	119	4	26	67	215 (+640)	~ 10 + (TBD

*) High-gradient program (ILC-HiGrade),

**) number of order under discussion (for XFEL).

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Table 4-5: R&D issues which are evaluated in S1-Global

Subject	Contents	Contributed by
Cool-down and cryogenic performance	Alignment and Frequency deviation Heat load	KEK, IHEP, DESY
Low-power RF	Tuner (motor and Piezo) test and frequency tuning Qt calibration HOM property Single pulse response to Piezo Tuner	KEK, FNAL, INFN
High-power RF Dynamic Heat Load	High gradient test with high-power RF	KEK, FNAL, DESY
LLRF Dynamic Heat Load	High gradient operation with high-power RF, control. and feedback	KEK, FNAL
Distributed RF	DRFS functioning with LLRF control/feedback	KEK, FNAL

System Test Goals

Specific string test goals, listed in order of importance, include:

- **Demonstrate stable acceleration at nominal parameters**. The nominal accelerating gradient specification for the RDR RF Unit is 31.5 MV/m, average, with 0.5% pulse to pulse RF amplitude stability / 0.5° pulse to pulse phase stability at any point during the ~1 ms RF pulse.
  - The demonstration should include feedback and related controls to achieve stable phase and amplitude at nominal ILC beam intensity
  - Evaluation and demonstration of operational gradient margin budget and
  - Demonstration of operation with a spread in cavity limiting gradients.
- **Tests of basic system parameters**
  - demonstrate operation of a RDR RF-unit or similar linac segment
  - determine the required power overhead under practical operating conditions
  - to measure dark current and x-ray emission, (this is to be used to establish precise radiation dose-rate limit vertical test acceptance criteria), and
  - to check for heating from higher-order modes in order to determine the dynamic cryogenic heat load with full beam current operation
- **Tests and optimisation of operational and logistical strategies**
  - developing RF fault recognition and recovery procedures
  - evaluating cavity quench rates and coupler breakdowns
  - testing component reliability
  - performing long-term testing of cryomodules, (including thermal cycling between beam operations), and
  - assembling the string an actual tunnel to explore installation, maintenance, and repair issues.

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Electron Source

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R&D Milestones:

mid 2010	Procurement of a coherent V18 laser
end 2010	Inverted DC gun prototype 2 at 120kV
	Final laser demonstration
	ILC beam demonstration (time structure) using 100kV SLAC SLC gun and cathodes
mid 2012	Installation of final ILC test facility (gun and laser) at JLab
end 2012	Final beam tests

Positron Source

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The positron source R&D programme can be separated into two categories:

1) R&D on critical components for the baseline source (undulator-driven).
2) R&D on alternative source technology (or for the auxiliary source).

R&D Milestones

Baseline R&D (Undulator-driven source)

end 2010	Completion of rotating target magnetic eddy-current tests
	Conceptual design study (feasibility) for magnetic flux concentrator
	Conceptual design study (feasibility) for liquid lithium lens
	Source parameters based on possible Nb_3Sn undulator design
mid 2011	Demonstration of target rotating vacuum seal using 'surrogate target'
	Horizontal cold-tests of 4m undulator prototype
	Conceptual design study (feasibility) for magnetic flux concentrator
end 2011	Analyse (simulation) of target shock-wave survivability
	Target radiation damage estimates (lifetime modelling)
	Radiation tests of ferrofluid (rotating seal)
end 2012	Prototype module of Flux Concentrator (funding permitting)
end 2013	Feasibility of Nb_3Sn undulator

Alternative / Auxiliary source R&D

end 2011	Boron-nitride window beam tests at KEK
	Liquid lead target beam tests at KEK

R&D Milestones:

DR

Remaining R&D on fast kickers

mid 2011	Demonstrate kick-angle stability with multibunch 3MHz extraction at ATF
mid 2011	Evaluate kicker impedance
end 2011	Complete and test SLAC fast pulser prototype

Low emittance tuning

end 2012	Demonstration of extracted 2 pm vertical emittance at ATF/ATF2 (multi-bunch)

RTML

R&D Milestones:

end 2010	Complete design of lattice, and evaluation of beam dynamics
end 2012	Demonstration of required phase stability at TTF2/FLASH

MDI

Machine detector interface R&D (engineering)

mid 2010	Finalisation of work plan and resources
end 2011	First draft of engineering requirements documents
mid 2012	Final draft of engineering requirements document
end 2012	Comprehensive design of the high-power main beam dumps
end 2012	SC final doublet prototype design and test

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CFS

Milestone for the CFS Group: Value Engineering

Improved Surface Building Facilities Criteria	01.2011

Milestones for the CFS Group: Development of Criteria

Accelerator Central Region Criteria Complete	01.2011
Central Region Design and 2D drawings Complete	06.2011
Main Linac – both alternative HLRF schemes Design and Drawings complete, each region	01.2012
Interaction Region Criteria Complete	01.2012

Baseline Design Complete	06.2012
Full 3D drawing set complete	06.2012
CFS cost estimates complete, each region	01.2012
Life-Safety analysis complete	01.2011
Review of CFS Design	03.2011

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Goals and Milestones for the siting effort are:

Site Specific Design Preliminary Evaluation	01.2011
Site Specific Design Final Evaluation	01.2012
Site Specific Design Cost Analysis	01.2012
Review of Site Specific Design Activity	06.2011

Risk assessment

The project-wide comprehensive process of estimating risk is a task for TD Phase 2:

1) Develop a clear and agreed-upon methodology a suitable matrix scoring system.
2) Clearly identify those design elements which remain high technical risk (across the entire project).
3) Score each component based on the status of the risk-mitigating R&D based on the prescribed methodology. This process will require a consensus-building approach across the TAG leaders and key experts.
4) Develop a practical mitigation strategy model. For example, what would the project do if post TDR progress was deemed unsatisfactory before construction start?
5) Estimate the cost for the mitigation effort, using costing guidelines similar to those used for the TDR.
6) Roll the resulting scoring and associated mitigation costs up to create a summary 'risk assessment' to be entered at the top level of the register.
7) Review the most serious register elements in detail to ensure the scoring, mitigation strategy and costing have been done consistently according to basic guidelines.

A comprehensive initial estimate for the Risk Register across the project should be an early goal in TD Phase 2. The register should then be maintained an updated as the remainder of the TD Phase R&D and AD&I activities progress, concluding with the publication of the TDR.

Milestones:

- Development and publication of methodology (end 2010)
- Initial canvassing of qualitative risk assessment across the Technical Areas (March 2011)
- Development of scores and ranking and final publication of final consensus (end 2011)
- Review / update of risk register for TDR (mid 2012)

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ML Baseline Review (KEK 01.2012

		Baseline Changes: to be fixed at KEK MLT BTR	RDR	Proposed (TDR)
1		Cavity gradient : (discussion led by R. Geng)		
	a	Cavity production and process recipe	no post-EP degreaser; cost based on different process	post-bulk EP visual inspection; 2nd process limited to HPR depending on test indication
	b	Define production yield including new parameters, such as radiation	20% cavities discarded	90% yield with two passes as needed
	c	Gradient spread of 31.5 MV/m +/-20 %, with sorting method,	0	+/-20%
	d	Gradient degradation after assembly into the cryomodule	35MV to 31.5MV/m (SB2009--> 35:34:31.5)	Given circulators will be used, statiscal (<> and σ) parameterization is best.
2		Cavity Integration (discussion led by H. Hayano)		
	a	Tuner, coupler, beam-flange, magnetic shield, and LHe tank	Flange: diamond, Coupler: 45 mm, Tuner: Not scissors-type, magnetic shield: outside	1) Blade tuner appears to meet performance requirements and is cheaper, 2) Coupler types can be plug-C
	b	Plug-compatible design to be allowed in case of cost equivalent or more cost effective.		cavity / coupler plug-compatibility
	c	Cavity delivery condition with LHe-tank, and cold-test sequence/monitor,	TESLA / TTF tank-off testing	follow E-XFEL deliverable specification
3		Cryomodule and Cavity-string Assembly (discussion led by P. Perini)		
	~~a~~	~~Cryomodule string configuration with 8 + (4+Q+4) + 8 cavity-string assembly~~	9 4Q4 9	~~8 4Q4 8~~
	b	Simplification of 5K radiation-shield; flow reversal	Complete 5K shield	no 'hard' lower 5K shield
	c	Split-yoke, conduction-cooled quadrupoles	pool boiling; not splittable	conduction cooled using high purity Al laminate
	d	EXFEL alignment scheme		Uses tracking technology and flange drill-point fiducials

4		Cavity and Cryomodule Test (discussion led by H. Hayano)		
	a	Power Coupler conditioning strategy	in-situ	
	b	Cold performance test: What fraction is to be cold tested? What is to be tested?	only 30% CM tested before installation	
5		Cryogenics (discussion led by T. Peterson)		
	a	Location and possible reduction of the number of cryo plants		
	b	Capacity optimization and heat balance with cryomodule heat-load		

ML BTR

6		HLRF (discussion led by S. Fukuda and C. Nantista)		
	a	KCS/DRFS/RDR-unit HLRF system configuration including backup power supply and utilities with the single tunnel design		
	b	Marx generator	Bouncer	Marx
	c	AC power with gradient spreads,	Done for SB2009	
	d	Adaptability against cavity degradation after installation into cryomodule, by using circulator and power distribution system,	Circulators	Circulators
	e	low-power and high-power option review		
	f	Tunable power distbribution system	P_k and Q_l remote control	
7		ML Integration (discussion led by C. Adolphsen)		
	a	Beam dynamics: Quadrupole/BPM periodicity, Q location, alignment, and beam tunability, Bunch spacing limit specially on KCS (requirement of DR beam dynamics)		
	b	Availability, reliability, and backup of cryomodules to be required	3% longer tunnel - empty, not equipped.	

TDR: *Traceability*

- **The TDR must have 'shelf life'**
  - The value of R&D and value of ILC Design has always been clear
  - Timeline is not clear

- **Design decisions must be 'traceable'**
- ***R&D sections in TD Report must include a summary and conclusions***
  - *and be appropriately referenced within TDR itself and within EDMS*
- ***Remaining work to be outlined***