GDE ML-SCRF: FuzeBox Meeting

Feb., 13, 2013

1. Reports from PMs

- ILC-GDE SCRF schedule
- Reports from the External Cost Review and actions/responses required

2. Reports from TA Group Leaders

- Cavity, Cavity Integration, Cryomodule, Cryogenics, HLRF, ML
  - **R. Geng, H. Hayano, P. Pierini, T. Peterson, S. Fukuda/C. Nantista, C. Adolphsen**

3. Special Discusssions

- Further works for TDR to be finalized
- Remark and Acknowledgments

SCRF: FY2013 Plan

M.	SCRF WebEx	GDE / International
12	19 (today)	13-14: ILC-PAC (KEK) 15: LC Symposium (Tokyo)
1	(16)	9, 16, 23, 30 (11, 18, 25, 2/1) External cost-review preparation mtgs. for SCRF
2	13 SCRF FuzeBox mtg)	6-7 External Cost Review (London) 21-22: ICFA/ILCSC (Vancouver) : Transition from GDE to the next organization, Linear Collider Board/Directorate (LCB/LCD)
5		13~17: IPAC (Shanghai) **27-31: ECFA-LC 2013 (DESY)**
6		12 ILC Event (KEK, CERN, Fnal) at 5:00 pm 12 – 14? (US) TTC topical WS on CW SRF at Cornell (proposed)
9		22-27: SRF2013 (Paris)
11		11-15: LCWS-2013 (Tokyo)

Completion of Technical Design Report to be printed by June, 2013

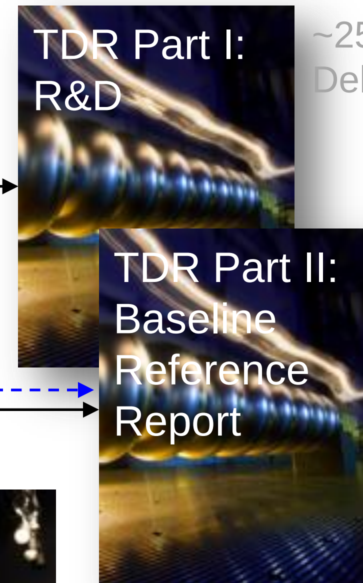
2007

2011

2013*

ILC Technical Progress Report (“*interim report*”)

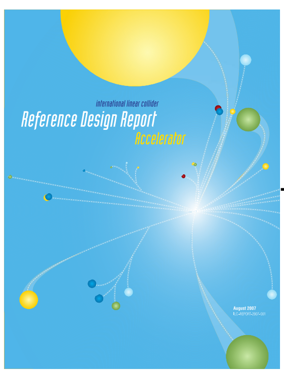
AD&I



~250 pages Deliverable 2

~300 pages Deliverables 1,3 and 4

Technical Design Report



Reference Design Report

* end of 2012 – formal publication early 2013

ILC TDR: External Cost Review

Windsor, UK, Feb. 6-7, 2013

Reviewers

- S. Akutagawa
- J. Bagger (observer)
- R. Brinkmann
- L. Evans (observer)
- N. Holtkamp (Chair)
- K. Dale
- P. Lebrun
- R. Rubinstein (PAC Secretary)
- E. Tada
- S. Uno
- T. Watson
- C. Zhang
- T. Shidara (ECR Scientific Secretary)

Reports from GDE:

• Introduction	B. Barish
• ILC design overview	N. Walker
• Cost methodology	G. Dugan
• SCRF system overview	A. Yamamoto
• HLRF:	
– Modulator PDS	C. Adolphsen
– Klystron, PD, MP	S. Fukuda
• SCRF	
– Cavity (RI study)	N. Walker
– Cryogenics	T. Peterson
– CM assembly (BN study)	V. Parma
– System test	M. Ross
• CFS	
– Overview	V. Kuchler
– Cost Basis- Asia	A. Enomoto
– Cost Basis – Europe	J. A. Osborne
– Cost Basis – Americas	V. Kuchler
– Regional Cost comparison	V. Kuchler
• Damping Ring	M Harrison
• Coventional Acc. Sys.	B. List
• Installation	F. Asiri
• Cost summary/roll-up	G. Dugan
• Schedule	M. Gastal
• Further R&D for cost driver	M. Ross
• Project Impl. Plan	B. Foster

ILC-TDR Cost Estimate: **SCRF Overview**

Akira Yamamoto (KEK)

for

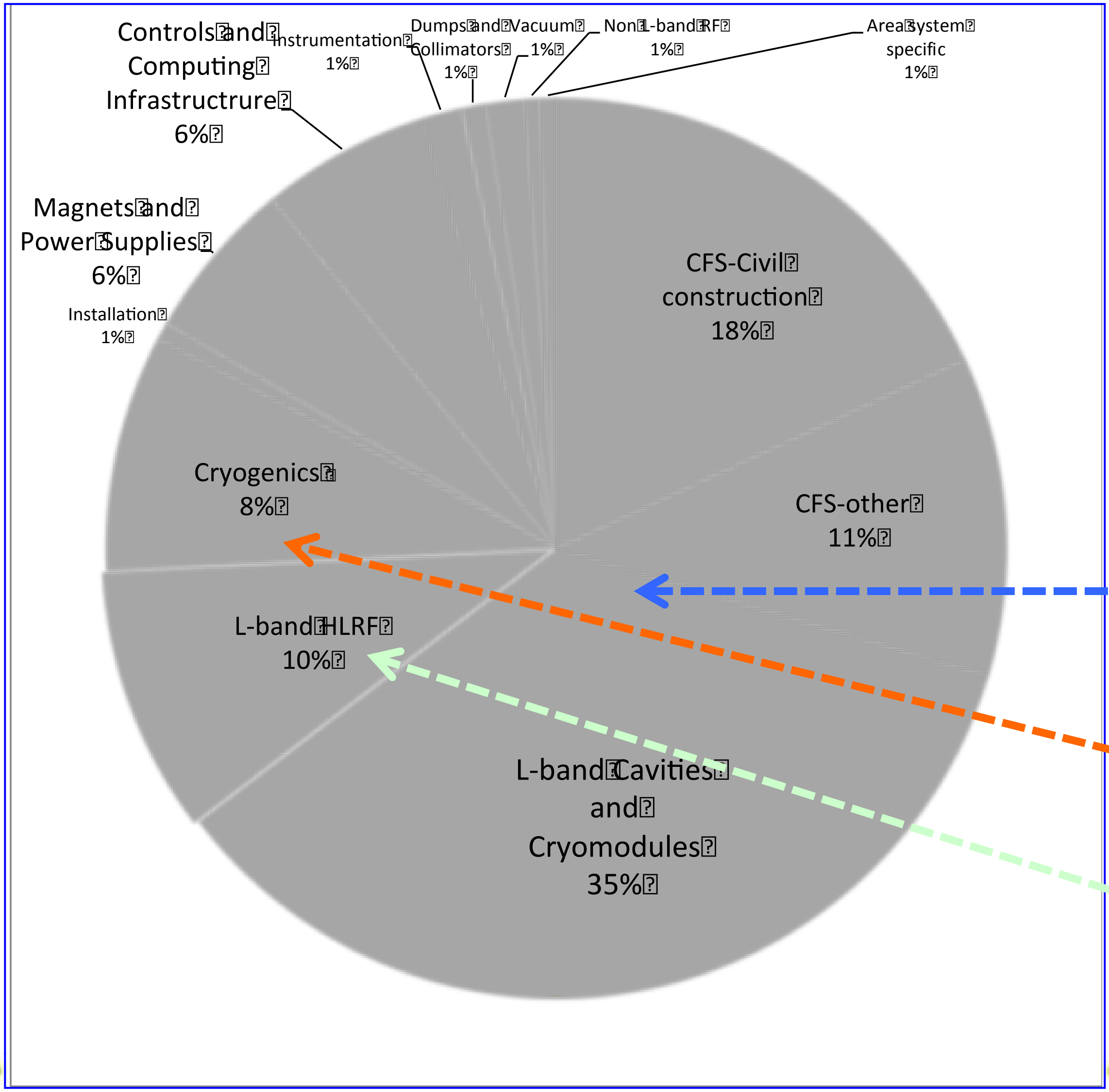
GDE Project Managers, Cost Engineers, and

SCRF Technical-Area Collaborators

To be presented at the ILC GDE External Cost Review,

Windsor, Feb. 6, 2013

Fraction of SCRF Cavity and CMs



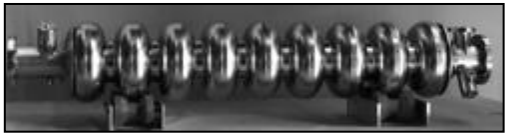
ILC total:
100 %
in TDR-FT basis

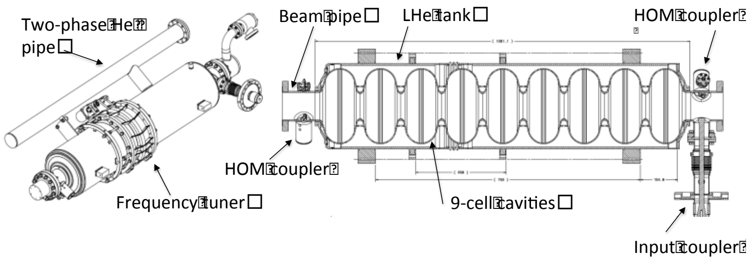
Cavity and CM :
→ 35 %

Cryogenics:
→ 8 %

HLRF
→ 10 %

Cavity/Cryomodule Fabrication





- Purchasing Material/Sub-component
- Manufacturing Cavity
- Processing Surface
- Assembling LHe-Tank
- Qualifying Cavity, 100 %
- Cavity String Assembly
- Cryomodule Assembly
- Qualifying CMs, 33 + 5 %

Cost uncertainty methodology

	Value basis	Premium
1	COTS or equivalent	5%
2	Procurement	8%
3	Vendor quote	10%
4	Industrial Study, mass production	20%
5	Engineering estimate: conventional technology	15%
6	Engineering estimate: R&D needed	30%

Examples:

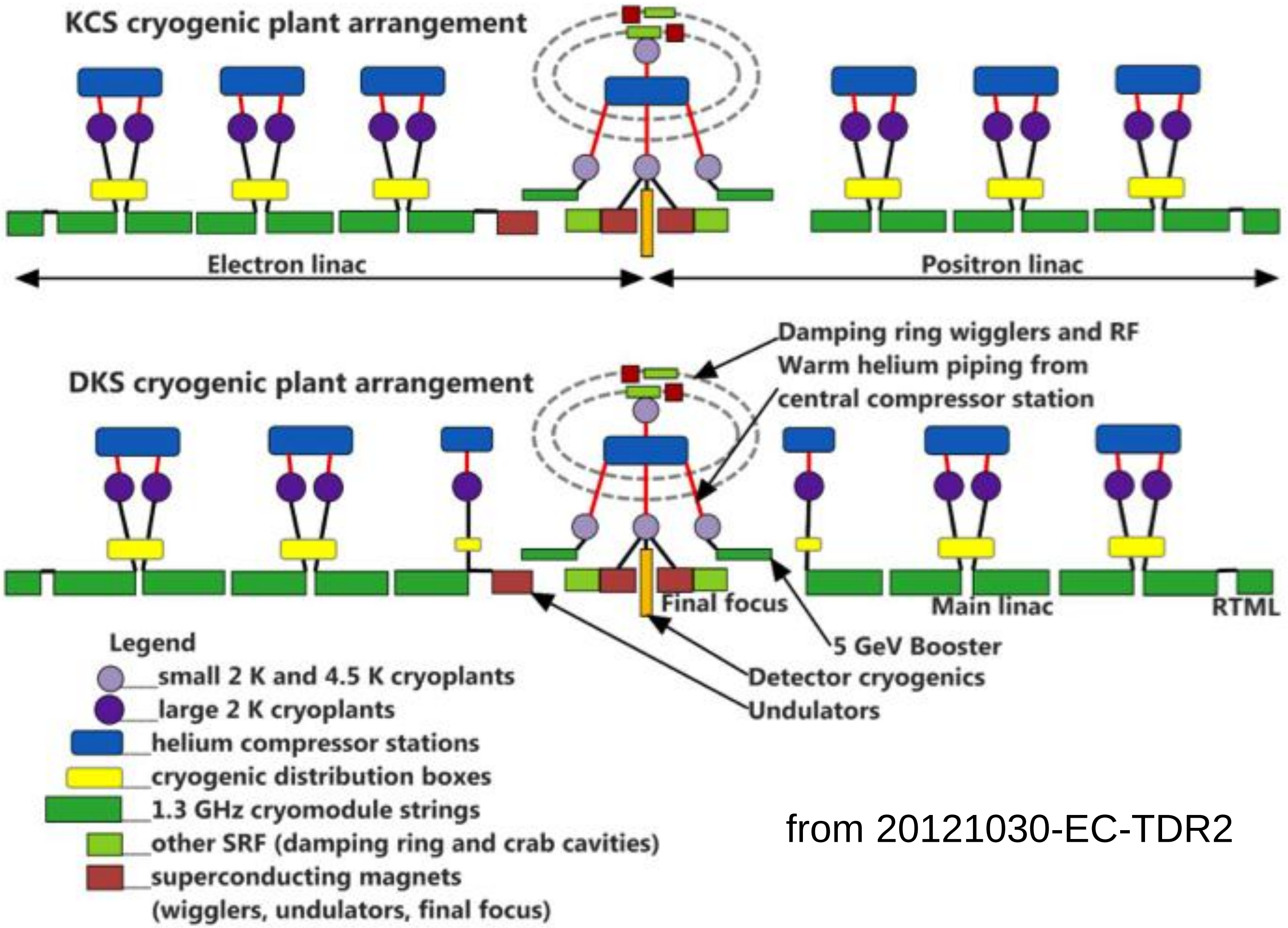
- Modulator (Engineering estimate, no R&D): basic 15%; quantity discount/2 = 33%/2 = 16%. Total cost premium = 31%
- Cavity superconducting material (Procurement): basic 8%; quantity discount/2 = 16%/2 = 8%; special premium = 20% (Nb price fluctuations). Total cost premium = 36%.

Cost Premiums for Cavity and CM

Sub-component	P/M (%)	S/M (%)	Reason for special premium
Superconducting material	36	20	Item subject to commodity fluctuations
Cavity resonator	20		Market dynamically fluctuated
Power coupler	16		
Tuner and helium vessel	21	5	Design change required
Cavity qualification, magnetic shield, shipping and handling	15		To be cost equivalent with that of EXFEL production
Magnet package	10		
Cryostat materials	26	10	Unusual procurement, no cost breakdown available
Cryomodule assembly	20		Further survey/investigation required
Cryomodule and magnet qualification, cryomodule shipping and handling	15		
Test and processing infrastructure	65	50	Maintenance/upgrade model not well defined
Cryomodule vacuum	15		To learn more from EXFEL
Total: Cavities and cryomodules	24		Linear sum of cost premiums for all cost elements

Cryogenics Configuration and Cost

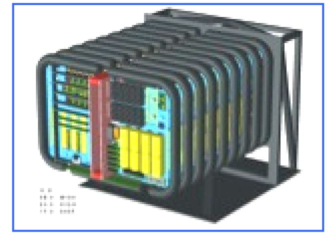
to be further reported by T, Peterson

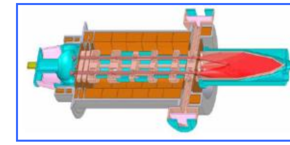


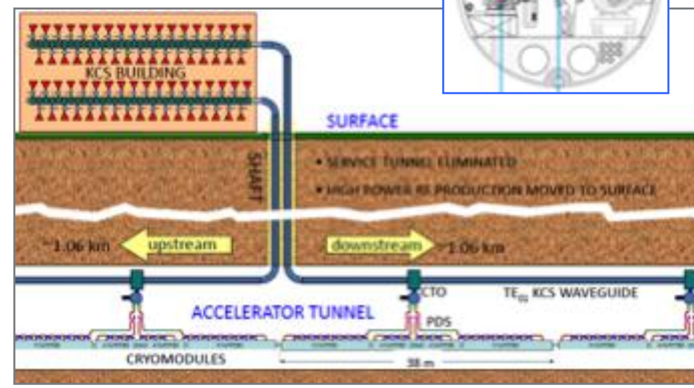
from 20121030-EC-TDR2

C. Adolphsen, S. Fukuda

HLRF and Power Distribution





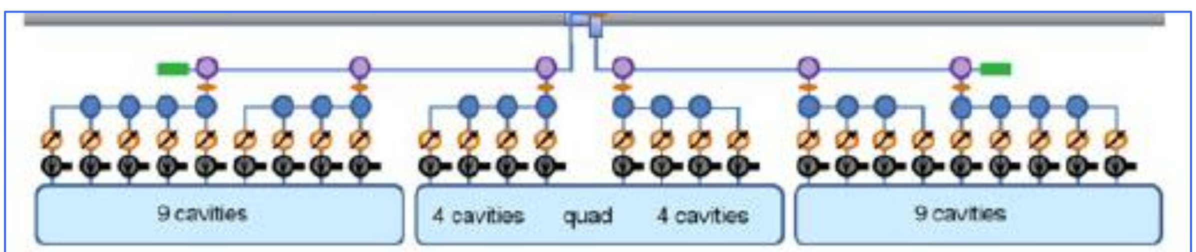


Klystron Cluster Scheme (KCS)

- Marx Modulators
- Clusters of klystrons
  (2 × ~ 30 10-MW MBK) on surface
- RF power distribution via major waveguide (300 MW)

Distributed Klystron Scheme (DKS)

- Marx modulator
- 10-MW MBK per 39 cavities
- Everything in tunnel



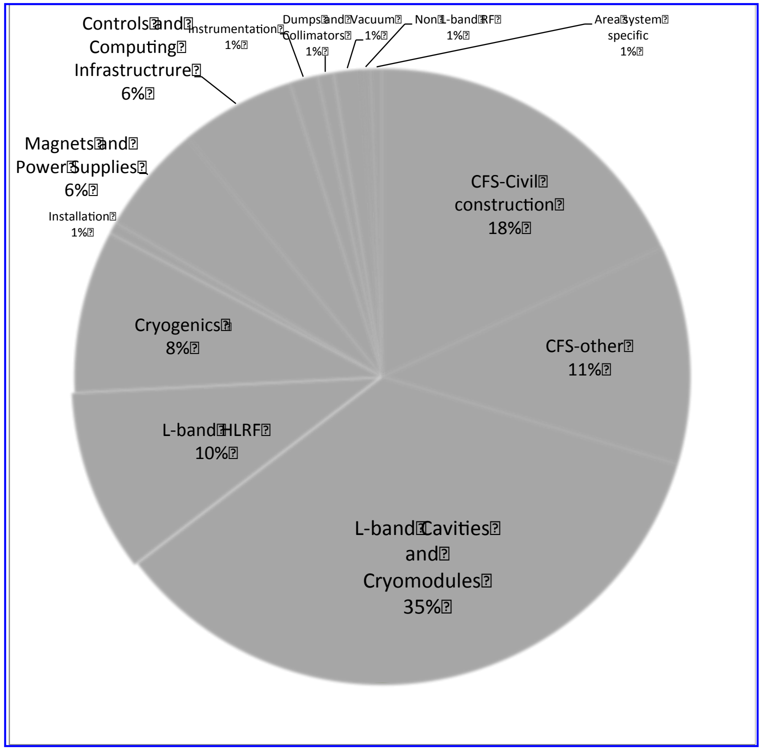
Summary of Cost Premiums for HLRF

Table 15. Cost premiums (at the 84% confidence level) for major cost elements of the L-band high-level RF. The cost premiums are stated as fractions of the median estimate M.

Sub-component	P/M (%)
Klystrons	10
Modulators	31
RF distribution (catalog items)	22
RF distribution (specialized devices)	32
Support infrastructure	15
Total (DKS): L-band high-level RF	21
Total (KCS): L-band high-level RF	22

Summary of SCRF Cost-estimate

	Fraction [%]	Uncertainty [%]
ILC total	100 %	24 %
SCRF		
Cav. & CM	35	24
Cryogenics	8	22
HLRF	10	21/22



Summary

- **SCRF cavity and Cryomodule** production cost estimates have been made in cooperation with industry, and realized with learning EXFEL experience.
- The cost estimates are based on that:
  - Industry should be accessible from any laboratories, and be responsible for fabrication based on "build-to-print" specification without without guarantee for the final/major performance such as field gradient.
    - Industrial cost include both infrastructure and manufacturing costs.
  - Laboratory is responsible for qualifying the performance.
    - Laboratory cost include both test infra-structure and test operation.
- **Cryogenics and HLRF** cost estimate has been with basis of vendor cost.

- Most of SCRF costs have been re-evaluated by referring EXFEL procurement experience and by specific cooperative works with industry.

- The cost estimate uncertainty evaluated to be in a range of 20 - 25 %.

ILC Cost Review Report

Digested for SCRF by AY

International/External Cost Review
Windsor, UK 7-8.02.13

What are the high priority steps in the near term before construction start

- **<u>Develop a plan for the next (transitional) phase</u> of engineering design leading to readiness to start construction.**
  - Develop key deliverables and prioritized activities and milestones needed for start of construction.
  - Seek funding for these activities and support for sufficient manpower commensurate with a project of this magnitude.
  - Create a resource loaded schedule that takes the comments into account and reevaluate the manpower distribution, M&S needs and space requirements.
- **Update the cost estimate and schedule with key missing items.**
- **<u>Develop a preliminary *ILC Project* Management Plan</u> suitable for negotiation with potential collaborators.**

The Elements in the cost estimate that need to be refined

- The cost estimate of the cavities seems overly optimistic given other project experience.
- Reassess the cost of cavity / cryomodule test assumption of doing it in the hub labs with no initial investment.
- The cost of manpower should be explicitly included. A clear understanding of manpower needs in the central versus hub teams is needed.
- Develop placeholders for the site specific cost

- Plus a lot of details

The Linac: SRF linac, cryogenics, component qualification

- **Findings**
  - Cost estimates for the components of the superconducting accelerator modules are based on the actual procurements of the EXFEL project and application of a 95% learning curve to account for economy of scale. An exception is the estimate for cavity fabrication, which is based on an industrial study by RI, yielding fabrication cost per cavity more than a factor of two lower than present EXFEL cost.
  - The cost estimate for module assembly is based on a detailed industrial study by BNG and is consistent with actual EXFEL cost.
  - Cost estimates for cryogenic plants are based on costs of existing large scale cryogenic installations and scaling accounting for system size and escalation.
  - Qualification of all cavities and one third of accelerator modules (+5% during initial production phase) as well as processing of all RF couplers is foreseen. The cost estimate assumes that test infrastructure will be available at different places worldwide and can be “rented”, so that only 25% (5% per year/5 years operation) of the cost to build the facilities is defined as the value for this cost item. Cost for power consumption and consumables is included. Personnel for operating the test facilities is included in the explicit labor estimate.

The Linac: SRF linac, cryogenics, component qualification

- **Comments**
  - Overall, cost estimates for linac components and module assembly are complete, realistic and on solid ground with the known costs of EXFEL. A moderate cost premium for these items is well justified, with the assumption of fully correlated cost risks (linear addition of cost premium) being very conservative. The estimate of explicit labor associated with this part of the project is reasonable.
  - For cavity fabrication, there is an opportunity for a steeper learning curve by streamlining the production processes, but the value derived from the RI study seems to be significantly less conservative than the assumptions for other components. The proposed processes still will have to verified in practice and it is likely that in the project realization the contracts will be split among more than two manufacturers, reducing the economic gain from scale.
  - The assumed facility costs for the component tests is too optimistic and the value quoted for electrical power costs for module tests is way too low in comparison with known operation costs for the EXFEL module tests.

The Linac: SRF linac, cryogenics, component qualification

- **Recommendations**
  - Define an updated value for the cavity fabrication which is in between what is obtained from EXFEL costs using a 95% learning curve and the value from the RI study (i.e. add 15 – 20% to the value presented in the TDR).
  - Increase the cost value for the test facilities, a reasonable approach may be to assume half of the total cost of building a new facility.
  - Re-assess the cost for power consumption of module tests.
- **Risks**
  - Maintaining the high gradient of cavities during the module assembly process is a challenge. Up to now, maintaining gradients above 30MV/m for all 8 cavities in a module have never been achieved in a first module assembly. It is uncertain which reliability of module assembly in this respect can be achieved in a larger production series.

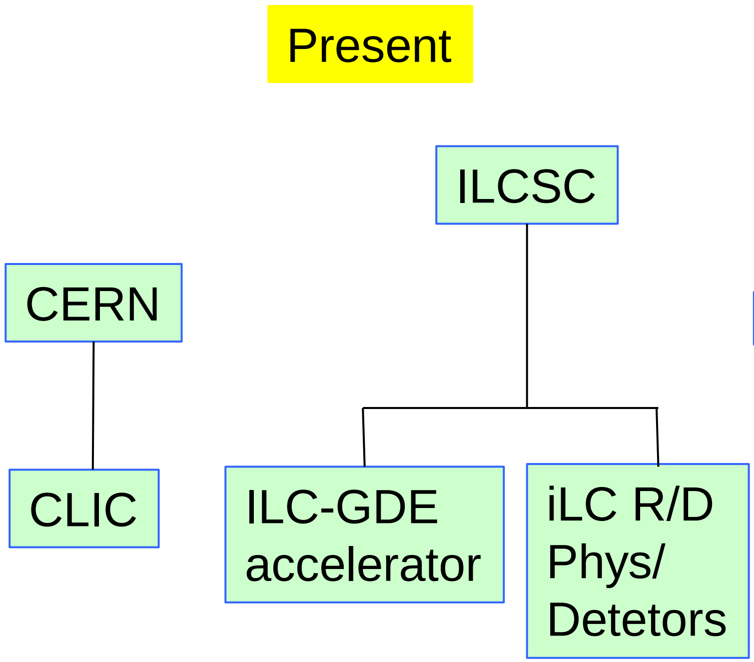
The Linac: High Power RF

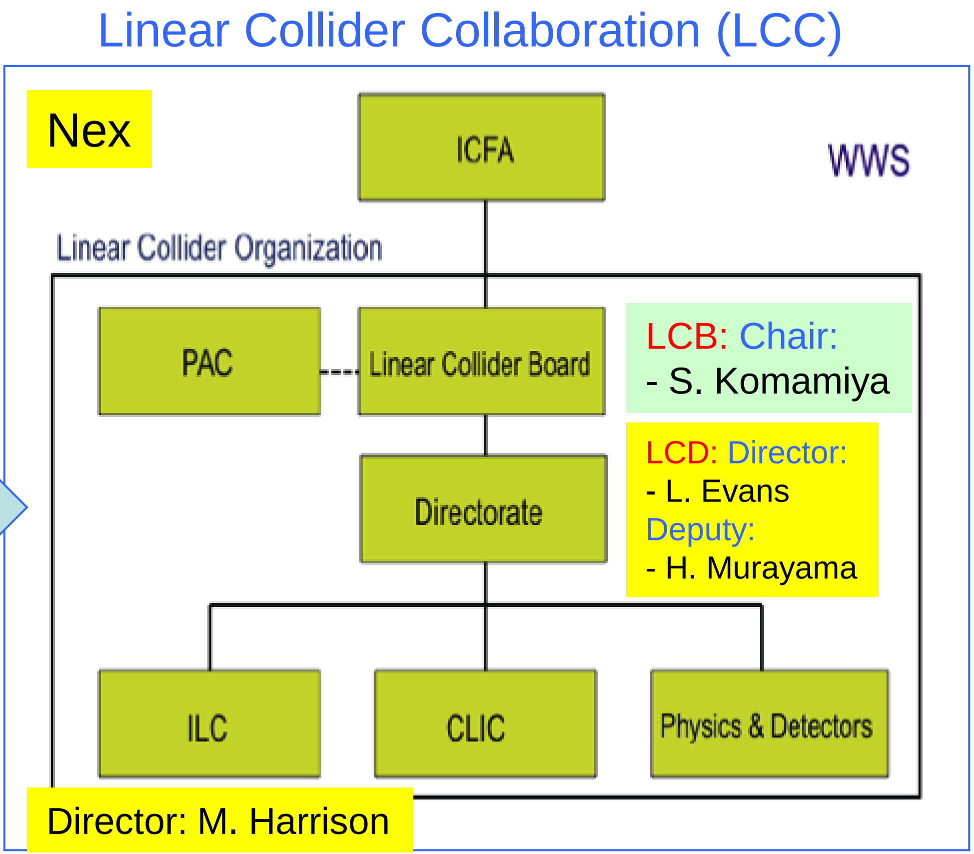
- **Findings**
  - Total is 749,3 MILCU; ~30% Klystrons, ~30%Modulators;~40% RF distribution.
  - ~80% of the cost come from vendor quotes and or catalogue items. XFEL cost are used as comparison
  - The RF distribution system for the KCS has not been sufficiently tested.
  - The labor rates in the cost estimate for the Modulators is too low.
  - LLRF is included under integrated controls & LLRF which is 357 MILCU and 800FTE.
- **Comments**
  - The design are well advanced. Costs are well justified. The necessary labor rate adjustment has a minor impact on the over cost for the modulators
  - Technical performance for all systems in the DKS has been verified
  - A remaining performance risk in the RF distribution for KCS could turn into the need for a second tunnel for FT sited. There is no other backup solution for the “big pipe”.
  - The cost estimate for integrated controls is aggressive.
- **Recommendation**
  - Fix the labor rate in the modulator estimate
  - In case the FT site is further pursued, verify the power distribution performance asap because of the major financial impact to the host.

Transition to the Next

- **Next Organization**

Transition to the Next ILC Organization





Role: Actions for the ILC Realization

- Detailed engineering design
- Further R&D for cost effective construction

Acknowledgements

- ***Many thanks for everybody***
  - who has been involved in the global cooperation for the ILC GDE SCRF and MT design and R&D works during ILC Technical Design Phase since 2007.

- ***We wish our further process***
  - to be successful to realize the ILC in our near future, under supervision by the new ILC organization, LCC, LCB, and LCD.