ILC TDR:
Cost Guidelines and Cost Basis

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Outline

- **General TDR cost estimate guidelines**
- **TDR new cost basis**
  - 75% of TDR estimate is based on the new cost basis, the rest is taken from the (escalated) RDR
  - Cost elements having a new cost basis:
    - Superconducting RF systems
    - High level RF power systems
    - Conventional facilities
    - Cryogenic systems
    - Conventional accelerator systems (damping rings and parts of the positron source)

Key cost guidelines (1)

- The specifications and quantities for each component or subsystem to be estimated should correspond to the design documented in the ILC TDR.
- The cost estimate for a component or subsystem should be the lowest world-wide vendor cost for the item, which is practical, feasible, and reasonable, for the required specification and quantity, consistent with the project schedule.
  - If price comparisons between regions or nations with different currencies need to be made to determine the lowest world-wide cost, the comparisons should be done on the basis of purchasing power parity.
- Various types of procurement models, involving at least two vendors (in one or several regions), learning curves, etc., may be assumed. However, the details of the procurement model, and the reasoning behind it, should be described in the basis-of-estimate documentation.

Key cost guidelines (2)

- The estimate should include tooling, instrumentation and infrastructure necessary for the fabrication, acceptance and testing of the item or subsystem, implicit labor (labor at the vendor), and transportation costs.
- Explicit labor is estimated in person-hours.
- Installed spares required for operational or reliability margins must be included. Spares which are not installed are not part of the construction project.
- The estimate must be made in terms of currency units as of the date of the estimate: that is, escalation during project construction is explicitly excluded.
- The level of detail in the cost estimate breakdown (number of cost elements in a given Area system) will be the same as for the RDR (or greater).

Key cost guidelines (3)

- Uncertainty characterization
  - The cost estimate should correspond to the median (50% probability point) in the cumulative cost distribution curve. Information on the shape of the differential cost distribution curve will also be provided, so that an assessment of the cost premium associated with a higher confidence level (84%) can be made.
  - Contingency is explicitly excluded.
- Basis-of-estimate documentation
  - The background assumptions and information used for the cost estimate and its uncertainty characterization must be documented in the basis-of-estimate documentation, which accompanies each cost estimate.
  - This information will be permanently stored in the ILC EDMS system.

Cost basis-Dressed SC cavity

Cost element (vendor x quantity)	TDR cost basis (quantity)	Reason for TDR choice	Other cost bases considered (quantity)
Superconducting material (2 x 8902)	EXFEL procurement (800)*	Large scale procurement of identical item	Vendor quotes (Heraeus,NingXia-OTC,Tokyo-Denkai), FNAL Cryomodule 3 actuals
Cavity fabrication and processing (2 x 8902)	Research Instruments Study (9000)	Scope and detail of the industrial study, extensive experience of vendor	EXFEL procurement (800), vendor quotes, industrial studies by Advanced Energy Systems and Mitsubishi
Power coupler (2 x 8012)	EXFEL procurement (800)*	Large scale procurement of identical item	FNAL Cryomodule 3 actuals (44), Advanced Energy Systems studies
Tuner (Blade) (2 x 8012)	EXFEL procurement (Saclay/EXFEL style) (800)*	Large scale procurement of similar item	FNAL Cryomodule 3 actuals (40), Advanced Energy Systems studies
Helium vessel (2 x 8012)	EXFEL procurement (800)*	Large scale procurement of similar item	FNAL Cryomodule 3 actuals (32), Advanced Energy Systems studies

* 95% Learning Curve used to estimate discount for ILC quantities

Cost basis-Cryomodule

Cost element (vendor x quantity)	TDR cost basis (quantity)	Reason for TDR choice	Other cost bases considered (quantity)
Conduction-cooled quadrupole (2 x 330)	Toshiba vendor quote (300)	Estimate of from reliable vendor, in correct quantity, with TDR design features	EXFEL procurement (100), FNAL Cryomodule 3 actuals (4), Advanced Energy Systems studies, FNAL internal cost study
Cryomodule component parts (2 x 927)	EXFEL procurement (100)*	Large scale procurement of identical item	FNAL Cryomodule 3 actuals (4), FNAL internal cost study, Advanced Energy Systems studies, Hitachi study
Cryomodule assembly (3 x 650)	Babcock-Noel Study (650)	Scope and detail of the industrial study, extensive experience of vendor	EXFEL procurement (100), Advanced Energy Systems studies, FNAL internal cost study, Hitachi study
Cryomodule Vacuum system (1855)	Taken from RDR: INFN estimate	RDR estimate based on catalog prices and vendor quotes, with some quantity discounts	

* 95% Learning Curve used to estimate discount for ILC quantities

Cavity/Cryomodule: other costs

- Cavity qualification:
  - All cavities to be vertically tested.
  - Test facilities provided by ILC regional collaborators.
  - M&S costs included. Labor included as explicit labor. Estimates from 2007 FNAL study.
- Coupler processing:.
  - Processing facilities provided by ILC regional collaborators.
  - M&S costs included. Labor included as explicit labor. Estimates scaled from EXFEL actuals.
- Cavity magnetic shield:
  - M&S costs included. Labor included in value estimate. M&S estimate from AES study.
- Cavity shipping and handling: Estimate from 2007 FNAL internal study.
- Cryomodule EDIA: Included as explicit labor. Estimate from 2007 FNAL study.
- Quadrupole qualification:
  - Test facilities provided by ILC regional collaborators.
  - M&S costs included. Labor included as explicit labor. Estimates from 2007 FNAL study.
- Cryomodule qualification:
  - About 38% of cryomodules to be tested.
  - Test facilities provided by ILC regional collaborators
  - M&S costs included. Labor included as explicit labor. Estimates scaled from EXFEL actuals.
- Cavity shipping and handling: Estimate from 2007 FNAL internal study.

Maintenance and upgrade costs for the processing and test facilities provided by the regional collaborators have been included in the value estimate.

Cost basis-L-band HLRF

Cost element (vendor x quantity)	TDR cost basis (quantity)	Reason for TDR choice	Other cost bases considered (quantity)
Klystron (2 x 240) (includes processing, with discounted infrastructure)	Toshiba vendor quote (150, 450)	Estimate from reliable vendor, in correct quantity	Advanced Energy Systems study (250,750)
Marx Modulator (2 x 240)	SLAC engineering estimate (1)*	Scope and detail of the bottoms-up estimate, experience of the estimator	Diversified Technologies vendor quote
RF distribution system (2 x 310)	SLAC/KEK engineering estimate (1)*	Catalog prices of conventional microwave components	
Supporting infrastructure	Taken from RDR: SLAC engineering estimate	RDR estimate had adequate cost basis	
High-level RF EDIA (explicit labor)	Taken from RDR (re-scaled): SLAC engineering estimate	RDR estimate had adequate cost basis	

* 95% Learning Curve used to estimate discount for ILC quantities

Cost basis-Conventional Facilities and Installation

Cost element	TDR cost basis
Civil Engineering-Americas site	Bottoms-up estimate by Fermilab, with unit cost information from contractors
Civil Engineering-European site	Bottoms-up estimate from contractors managed by CERN; Methodology similar to that used for CLIC
Civil Engineering-Asian sites	Bottoms-up estimate from contractor managed by KEK
Conventional Electrical Systems-Americas site	Bottoms-up estimate by contractor managed by Fermilab
Conventional Electrical Systems-Asian sites	Bottoms-up estimate by contractor managed by KEK
Conventional Mechanical Systems-Americas site	Bottoms-up estimate by contractor managed by Fermilab
Conventional Mechanical Systems-Asian sites	Bottoms-up estimate by contractor managed by KEK
Installation and handling equipment	Equipment estimates made by CERN, based on LHC experience; installation manpower, re-estimated using methodology developed for RDR, accounted for as explicit labor
Conventional Safety Systems	Separate estimates in Americas and Asian regions, each conforming to local code requirements
Survey and alignment	Estimates made by CERN, based on LHC experience

Cryogenics cost basis

- Main Linac plants:
  - Cost basis taken from RDR (based on LHC experience (1993) and 2006 Fermilab experience)
  - Nonlinear cost estimating relationship checked against 2010 JLab experience
- Smaller plants:
  - Cost basis taken from recent procurements for FNAL NML facility.
- Cryogenic distribution systems:
  - Linear cost estimating relationship based on procurement experience at FNAL, CERN and DESY.

Damping rings-new cost basis

- Magnets and power supplies:
  - New estimates developed for magnets, based on SLAC engineering estimates (same methodology as for RDR).
  - New estimate for distributed power supply system, based on SLAC engineering estimates (same methodology as for RDR).
- Vacuum system
  - New estimate for vacuum system with TDR electron cloud mitigation features.
  - Costs based on those developed for Super-KEKB, which has a similar system.
- Wigglers
  - New estimate based on experience with Cornell damping wigglers

Positron source-new cost basis

- Auxiliary source:
  - New estimates for scaled-down source developed by ANL based on experience.
- Remote handling for positron target
  - New estimate based on experience at IHEP.

Conclusion

- **The general TDR cost estimate guidelines have been presented.**
- **75% of the TDR estimate is based on the new cost basis; the rest is taken from the (escalated) RDR**
- **The new elements of the TDR cost basis have been described**
    - Superconducting RF systems
    - High level RF power systems
    - Conventional facilities
    - Cryogenic systems
    - Conventional accelerator systems (parts of the damping rings and the positron source)