Design Cost Board (DCB) Report

Peter H. Garbincius

GDE

Fermilab

Outline

- DCB Membership
- ILC RDR & schedules
- ILC GDE Organization
- Prior Cost Est. Studies
- Major Cost Drivers
- International Cost Ests.
- Cost Est. Guidelines
- Anticipated new Ests.
- U.S. Estimates/LCFoA

- U.S. Estimates/LCFoA
- What Will RDR Quote?
- WBS & Level of Detail
- Elements of Cost Model
- Basis of Estimate & Risk
- Working Model of Construction Schedule
- Near Term Activities
- Summary

Design Cost Board Members

- Tetsuo Shidara – KEK (Cost Engineer)
- Atsushi Enomoto – KEK
- Nobuhiro Terunuma – KEK
- Alex Mueller – ORSAY
- Jean-Pierre Delahaye – CERN
- Wilhelm Bialowons – DESY (Cost Engineer)
- Nan Phinney – SLAC
- Ewan Paterson – SLAC (Integration Scientist)
- Robert Kephart – Fermilab
- Peter Garbincius, Chairman – Fermilab (C.E.)

Reference Design Report

- Will include a cost estimate for the ILC as described in the

  Baseline Configuration Document (BCD)

  http://www.linearcollider.org/wiki/doku.php?id=bcd:bcd_home

- Due by the end of (calendar) 2006

- Barry would like estimate to within ± 20%

  very optimistic for this timescale!

RDR Schedule & Milestones

- December, 2005 – Frascati – Kick-off
  - preliminary instructions to groups
- March - Bangalore - instructions & status
  - monitor status of progress
    - first estimates due mid-June
- July – Vancouver – preliminary cost estimate
  - iterate and optimize cost vs. design
- November – Valencia – “final” RDR cost est.
- end 2006 – publish Reference Design Report

ILC GDE Organization

- Director – Barry Barish
- Regional Directors (3)
- Gang of Three **(Walker, Raubenheimer, Yokoya)**

Executive Committee

- RDR Management Team (new)
- Cost Engineers (3)
- Change Control Board
- Research &Development Board
- Design & Cost Board

ILC GDE Organization

Groups doing the work!

- **Area Systems Groups:**
  e- Source, e+ Source,
  Damping Rings, RTML,
  Main Linac,
  Beam Delivery System

- **Global Systems Groups:**
  Commissioning, Operations,
  & Reliability,
  Controls, Cryogenics,
  Conventional Construction,
  Installation, Integration (new)

- **Technical System Groups:**
  Cryomodules,
  SC RF Cavities,
  RF Power Systems,
  Vacuum Systems,
  Magnet Systems,
  Instrumentation,
  Dumps & Collimators

Prior Cost Estimating Studies

for Cold, SC RF technology Linear Collider

- TESLA Technical Design Report (2001)
- KEK Evaluation of TESLA TDR
- US Evaluation of TESLA TDR (2002)
- USLCTOS (2004)

New & Ongoing Cost Est Studies

- Revised Euro XFEL Cost Estimate (Feb 06)
- TTC Studies: CM Assembly, Couplers, EP

These studies are Confidential

The only numbers made public were the 8 high-level roll-ups of the TESLA TDR (not incl. XFEL increments):

Main Linac Modules	**1.131 B €**	**72%** (first three items)
Main Linac RF System	**0.587 B €**	
Tunnel & Buildings	**0.547 B €**	
Machine Infrastructure	**0.336 B €**	**concentrate**
Damping Rings	**0.215 B €**	**on major**
Auxiliary Systems	**0.124 B €**	**cost drivers**
HEP Beam Delivery System	**0.101 B €**	
Injection Systems	**0.097 B €**	
Total TESLA Estimate	**3.136 B €**	

Format and Scope of Cost Estimates

- Follows ITER "Value" & CERN "CORE" model for International Projects the ITER approach was reviewed by Dan Lehman *et al.* in July, 2002
- Does not include: R&D, contingency, internal (institutional) labor, escalation, G&A overheads, pre-construction, and commissioning activities.

- Least common denominator -
  minimizes construction cost estimate
- cost estimating metric, e.g. Basis of Estimate => contingency estimate, in-house labor, G&A, escalation, R&D, pre-construction, commissioning, etc.
- RDR will provide information for translation into any country's

Cost Estimating Guidelines

- preliminary - version 5 – 15march06 is outlined here – full version in back-up at end
- 500 GeV (250x250) + well-defined path to 1 TeV

  e.g. includes full length of Beam Delivery System
- common "value" + in-house labor (man-hr)
- construction = authorization → installation not incl. R&D, commissioning, operations, decommissioning – but need these estimates!
- construction ends for individual item when installed, before commissioning begins
- working model assumes a 7 year construction phase

- based on a call for world-wide tender: lowest reasonable price for required quality
- three classes of items in cost estimate:
  - **Site-Specific (separate estimates for each site) e.g. tunnel & regional utilities (power grid, roads)**
  - **Conventional components – global capability (single world est.) e.g. copper and steel magnets**
  - **High Tech – cavities, cryomodules, RF power - cost drivers – all regions want – 3 estimates**

Cost Engineers must determine algorithm to combine and present these multiple estimates

- Learning curve for ILC quantities $P = P_1 N^a$
  need parameters or costs for different N's
- Estimate & Prices – as of January 1, 2006:
  - exchange 1 M€ = $ 1.2 M = 1.4 Oku¥
  - raw materials, no taxes, no escalation
- contingency is excluded in "value" estimate
  need risk analysis → prob. dist. for cost est.
- one common design and footprint
  - need a common set of rules and codes
  - if none available, ILC may have to define

- All cost estimates must be treated as confidential within the GDE not to be publicly presented or posted on public web site

- GDE Executive Committee will determine publication policy for all elements of cost estimate

We anticipate cost estimates to be available from:

- TESLA TDR (2001 – high level roll-ups)
- expect input from XFEL cost estimate (Feb 06)
- current TTC studies (cryomodule, coupler, EP)
  will be too late for RDR est.
- KEK (in-house + consultant) – Cryomodule & RF
  anticipate available in 3-4 months
- LCFoA Cost Estimate for RF Units:
  Cryomodule, Klystron, RF Distribution, etc.
  contract still under discussion,
  anticipate initial est June 06, final Nov 06

- **JLab-Fermilab-SLAC (Funk-Stanek-Larsen)**
  in-house cost estimate study for RF unit.
  → bottom-up based on US experience:
  JLab, SNS, FNAL, SLAC (& TTF)
  parallel check of LCFoA cost estimate study.

- **Regional 4 site-dependent cost estimates (CERN, DESY, Fermilab, Japan) for Conventional Facilities**

What will RDR quote?

- **Quote lowest reasonable world-market value estimate for adequate quality**
- **Worry about low-balling "VALUE":**
  no matter we say, it will be remembered as
  one, single, FINAL cost number,
  all notes, caveats, fine print will be ignored
- **Cost Engineers to combine different estimates**
  4 sites (4 estimates or range of ests?)
  combine Euro, US, Japan component ests
  lowest, average, divisional model?

Current WBS (8march06)

ILC(Draft_v.1.0.10(8.3.2006)).wbs - SLAC WBS

File Edit WBS View Help

WBS | Materials | Labor Rates

WBS	Component
1	ILC International Linear Collider
1.1	Injection System
1.1.1	Electron Injection
1.1.2	Positron Injection
1.2	Damping Ring
1.3	Ring to Main Linac
1.4	Main Linac
1.5	RF System for Superconducting Linac
1.6	Beam Delivery System
1.7	Civil Engineering and Siting
1.7.1	In-house Engineering
1.7.2	Consultancy Engineering
1.7.3	Underground Facility
1.7.4	Surface Structure
1.7.5	Site Development
1.7.6	Miscelaneous
1.8	Infrastructure
1.9	Auxiliary System
1.9.1	General Control system
1.9.2	Engineer
1.9.3	Technician

1.8	Infrastructure
1.8.1	Administration
1.8.2	Cryogenic System
1.8.3	Power Distribution
1.8.4	Water Cooling
1.8.5	Injection Linac Tunnel
1.8.6	Electron RTML Tunnel
1.8.7	Positron RTML Tunnel
1.8.8	Damping Ring Tunnel
1.8.9	Main Linac Tunnel
1.8.10	Service Tunnel
1.8.11	Beam Delivery System Tunnel
1.8.12	Survey and Alignment
1.8.13	Machine Control System
1.8.14	Machine Protection System
1.8.15	Safety System
1.8.16	Module Test Facility
1.8.17	RF Test Facility
1.8.18	Engineer
1.8.19	Technician

Would like to have lowest elements at ~ few * 0.1% of total ILC estimate

Elements of the Cost Model

- Need estimates of most probable cost per WBS element and an indication of the anticipated probability distribution for costs.

- Median (50%), ± σ points of this distribution (or 90% point for upper limit) account for non-symmetric, high cost tail

  => Risk Assignment for the cost estimate

Elements of the Cost Model (2)

- Risk Assessment for Costs:
  ideally, a probability distribution
  for expected costs
  see R. Brinkmann at Snowmass 2005
  for application to Euro XFEL
- Watch out for Correlated Risks:
  labor costs,
  price of materials (e.g. steel, copper),
  price of electricity (for RF processing),
  etc.

Basis of Estimate

- description how cost estimate was obtained for each WBS element
- guide used for estimating the assigned level of contingency in the US
- similar to that used for assigning the probability distribution for costs

  by XFEL for risk analysis
- example below from RSVP experiment at Brookhaven National Lab

Contingency Table

	Risk Factor	Weight
WBS Element #___________ Element Name ______________________________		
Design Risk (check one of 4): (from RSVP at BNL, similar for US CMS, NCSX)		
__ Concept only	15%	1
__ Conceptual Design Phase: some drawings; many sketches	8%	1
__ Preliminary Design > 50 % complete; some analysis complete	4%	1
__ Detailed Design > 50% Done	0%	1
Technical Risk (check one of 8 and answer Yes or No to two questions):		
__ New design; well beyond current state-of-the art	15%	2 or 4
__ New design of new technology; advances state-of-the art	10%	2 or 4
__ New design; requires some R&D but does not advance the state-of-the-art	8%	2 or 4
__ New design; different from established designs or existing technology	6%	2 or 4
__ New design; nothing exotic	4%	2 or 4
__ Extensive modifications to an existing design	3%	2 or 4
__ Minor modifications to an existing design	2%	2 or 4
__ Existing design and off-the-shelf hardware	1%	2 or 4
Yes/No – does this element push the current state-of-art in Design?		either = 2
Yes/No – does this element push the current state-of-art in Manufacturing?		both = 4
Cost Risk (check one of 8 and answer Yes or No to two questions):		
__ Engineering judgment	15%	1 or 2
__ Top-down estimate from analogous programs	10%	1 or 2
__ In-house estimate for item with minimal experience and minimal in-house capability	8%	1 or 2
__ In-house estimate for item with minimal experience but related to existing capabilities	6%	1 or 2
__ In-house estimate based on previous similar experience	4%	1 or 2
__ Vendor quote (*or industrial study*) with some design sketches	3%	1 or 2
__ Vendor quote (*or industrial study*) with established drawings	2%	1 or 2
__ Off-the-shelf or catalog item	1%	1 or 2
Yes/No – are the material costs in doubt?		either = 1
Yes/No – are the labor costs in doubt?		both = 2
Schedule Risk (check one)		
__ Delays completion of critical path subsystem item	8%	1
__ Delays completion of non-critical path subsystem item	4%	1
__ No schedule impact on any other item	2%	1
Prepared by: ______________________ date: ________________		
Comments:		

BoE – Contingency Est. - example

1.1.2.3 Build Framistat	Category	Risk Factor	Weight	RF*Wgt
Design Risk: Conceptual Design Phase: some drawings; many sketches				
	Design Risk	8%	1	8%
Technical Risk: New design; nothing exotic				
No – does this element push the current state-of-art in Design?				
Yes – does this element push the current state-of-art in Manufacturing?				
	Technical Design **OR** Manufacture Risk	4%	**2**	8%
Cost Risk: In-house estimate for item with minimal experience but related to existing capabilities				
No – are the material costs in doubt?				
Yes – are the labor costs in doubt?				
	Material **OR** Labor Cost Risk	6%	**1**	6%
Schedule Risk: Delays completion of non-critical path subsystem item				
	Schedule Risk	4%	1	4%
	Suggested Contingency (sum) →			**26%**

Prepared by: ________________________ **date:** __________________

Comments:

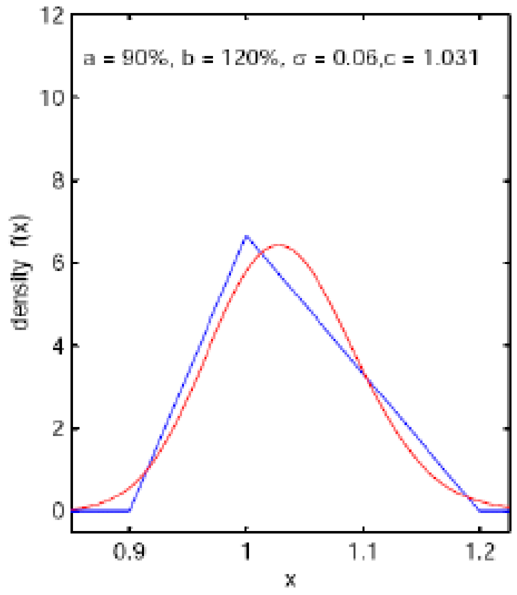
XFEL: Standard cost uncertainty categories

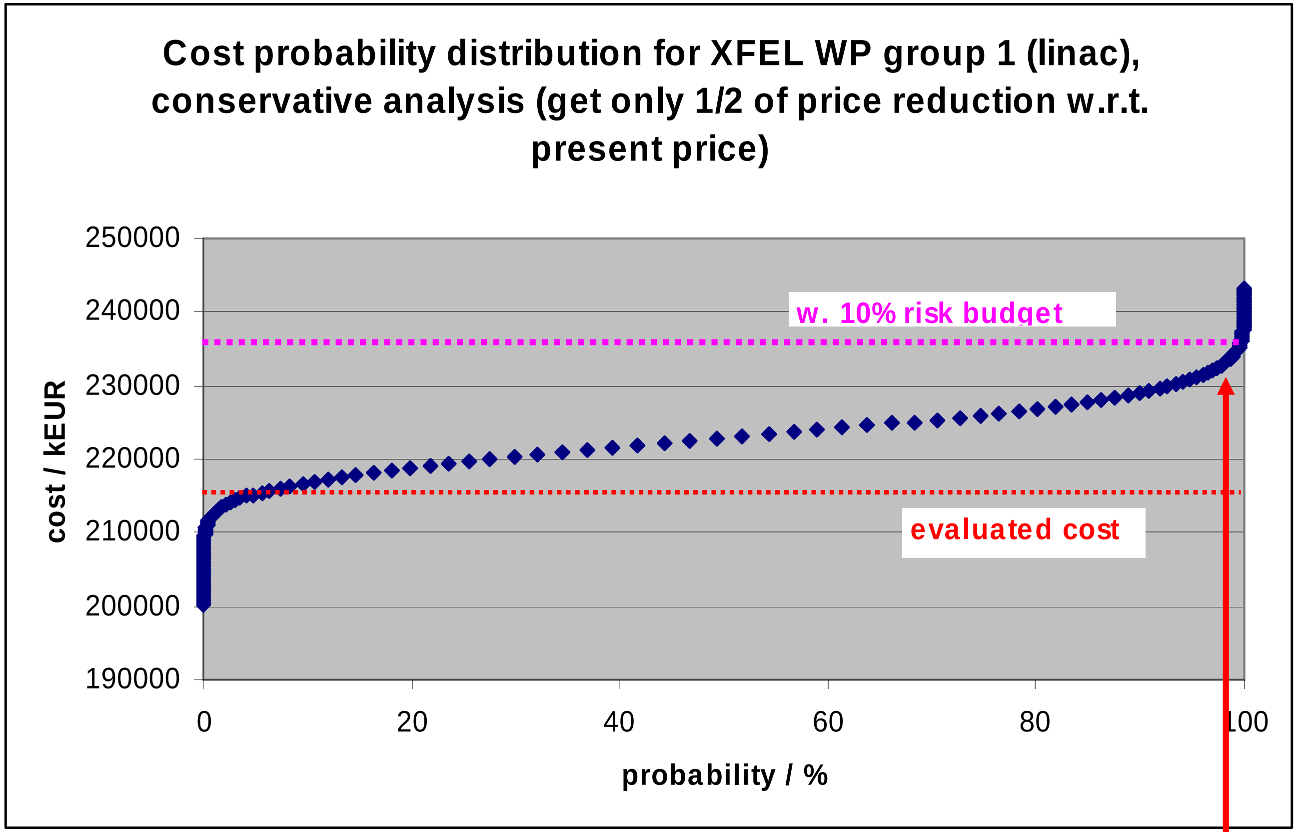
Category	definition	lower/upper range
C1	good experience and present price for this component/sub-system are available, no cost scaling for large quantities has been applied	-10% / +10%
C2	experience and present price for similar components/sub-systems are available, no or only minor scaling to large quantities has been applied	-20% / +20%
C3	present price is available, significant (>25%) cost scaling to large quantities has been applied	-10% / +20%
C4	present price is available, price from industrial study is used which results in significant (>25%) cost reduction for production of large quantities	-10% / +20%
C5	present price not available, price from industrial study is used	-10% / +20%
C6	required technology pushes state-of-the art, significant R&D still required	-10% / +50%
P1	personnel requirements well known due to present experience or with similar systems in previous large scale projects	-10% / +10%
P2	personnel requirements less certain or relatively large fraction of R&D included in this WP	-20% / +20%

Furthermore, raw material cost uncertainties (volatility of metal and currency markets) have been added where appropriate (e.g. Niobium sheets & parts)

XFEL: Result of maximum risk analysis

triangular &
log-normal
-10%,+20%
cost p.d.f. for
each element



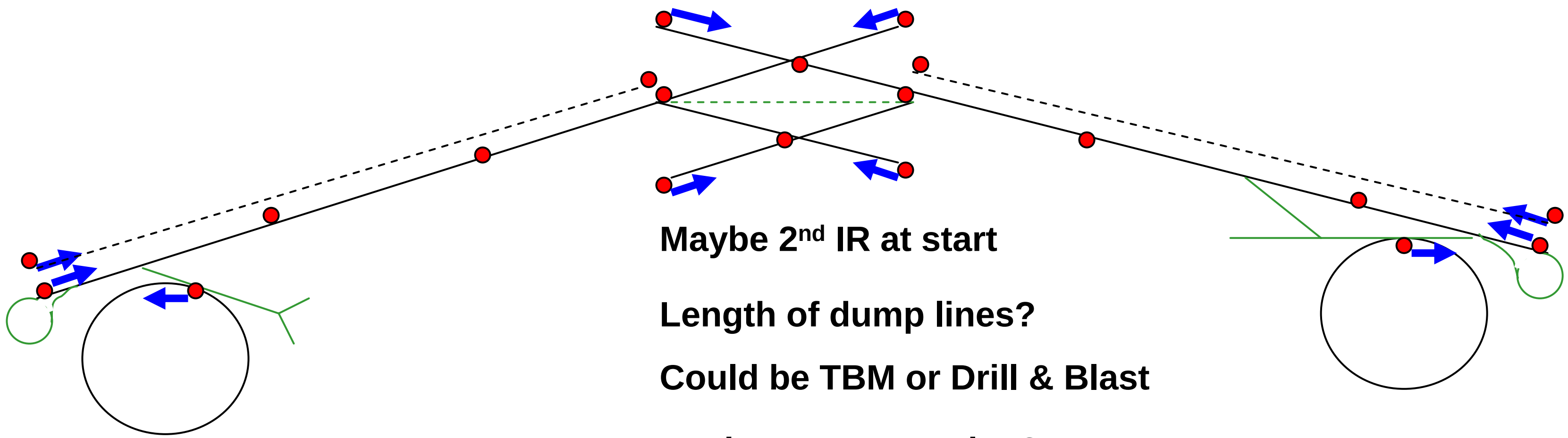


Reinhard: ask for "risk" funding to cover up to 98^{th} percentile

Sketch of Civil Construction Activities

use only for sizing production capacities for components

(my own view – definitely not to scale)



Maybe 2nd IR at start

Length of dump lines?

Could be TBM or Drill & Blast

Positron Bypass Line?

Drill & Blast or TBM?

Shafts (many!)

TBM tunnels (8 or 10)

Outline of PHG Construction Schedule Model for generating component cost estimate

- a working model!
- 7 years – after funding authorization => t0 through installation of all components
- need to start installation of components while civil construction continues:

t0+30 months: e- SRC, e+ Keep-Alive, RTML arcs

t0+33 months: DR   t0+47 months.: start ML

t0+65 months: last sec ML & BDS

t0+78 mo.: t0+6.5 yrs.: last components delivered

t0+84 mo.: t0+7 yrs.: last component installed

start commissioning each sub-systems as soon as its components are installed

Near Term DCB/RDR Activities

- Refine Cost Estimating Guidelines
- "Initial Questions for Area System Groups"

  needs to morph into

  "Recipe for Developing Cost Estimates"

  step-by-step formula, instructions

  for needed information
- DCB and RDR Management Team recently formed joint schedule and procedures

  for status discussions & milestones,

  started weekly status teleconferences

Summary on RDR Cost Estimating

- Organizing (still much to do) and
- Starting (just barely) on cost estimates
- Initial costs for discussion in July at Vancouver
  discuss complete estimate at Valencia in Nov
- Try for new cost estimate, esp. cost drivers:
  - likely for civil construction,
  - less likely for cavities, cryomodules, & RF
- Planning to quote ITER-like “VALUE”,

End of Presentation

Backup Slides

RDR Cost Estimating Guidelines

preliminary version 5 15march06-08:00

The following are preliminary guidelines for developing the RDR cost estimate. Since there are very different approaches to cost estimating in different parts of the world, it will be necessary to separately estimate construction costs, preparation and R&D, commissioning and operations. The center of mass energy is 500 GeV. Essential components for the 1 TeV option, which will be very difficult to add later, are included.

These estimates will be framed in terms of a common “value” of purchased components and total person hours of in-house labor. In general, the component cost estimate will be on the basis of a world-wide call for tender, i.e. the value of an item is the world market price if it exists. This also applies to the conventional construction and Consultant Engineering. The estimates should be based on the lowest price for the required quality.

There are three different classes of items which must be treated somewhat differently:

- **Site specific:** The costs for many aspects of conventional facilities will be site specific and there will be separate estimates for each sample site. These are driven by real considerations, e.g. different geology and landscape, availability of electrical power and cooling water, etc. Site dependant costs due to formalities (such as local codes and ordinances) are not included. Common items such as internal power distribution, water and air handling, etc., which are essentially identical across regions although the implementation details differ, can have a single estimate.
- **High technology:** Items such as cavities, cryomodules, and rf power sources, where there will be interest in developing expertise in all three regions (Asia, Europe and Americas), should be estimated separately for manufacture by each region. Costs should be provided for the total number of components along with parameters to specify the cost of a partial quantity. These estimates will be combined by some algorithm to be determined later.
- **Conventional**: Components which can be produced in all regions need not be estimated separately for manufacture in each region. The cost should be based on the lowest world market price.

In addition to these general comments, we list some specific guidelines:

1. The construction period extends from first funds authorization until the last component is installed and tested for each system. Necessary infrastructure must be estimated as part of the construction cost. Preparation and R&D costs should be estimated separately. The preparation phase includes the minimum items and activities needed to gain construction approval. Separate estimates are also needed for commissioning and beam tests and for operations.

2. The component cost includes external labor, EDIA, offsite QC and technical tests. In general, the estimate is the lowest world-wide cost for required quality. A single vendor is assumed, or in some cases, two vendors for risk minimization. No costs are assumed for intellectual property rights.

3. In-house labor is estimated in person-hours. Only three classes of manpower are used: engineer/scientist, technical staff, and administrative staff. Additional central staff will be needed for commissioning and operation,.

4. For large numbers of items, learning curves should be used to scale the cost decrease with quantity. The cost improvement is defined by the following equation:

$$P = P_1 N^a$$

where P is the total price of N units, P_1 is the first unit price and a is the slope of the curve related to learning [1]. The slope a is for large N also the ratio of the last unit price P_N and the average unit price $\langle P \rangle$. This will be described in more detail in the costing instructions. The value is calculated parametrically for the assumed 7 year given construction schedule.

5. Prices for raw material are world prices as of January 1, 2006, i.e. for copper, steel and niobium, etc. Prices for electrical power are those for the region as of January 1, 2006. Quantities should be stated explicitly so the cost can be scaled later.

6. The value unit needs to be defined. For now, one currency per region with fixed exchange rates should be used. The fixed exchange rates are:

   1 M€ = 1.2 M$ = 1.4 Oku¥.

   No tax is included. No escalation is used. The costs should be estimated as of January 1, 2006.

7. Contingency is for the moment explicitly excluded. In order to include it at a later stage, the technical groups should do a risk analysis, which will be used by the DCB to generate a probability distribution for the cost estimate. This will be described in more detail in the costing instructions.

8. There will be one common design and footprint, except for unavoidable site-specific differences, such as shaft location. Regional options such as utilizing existing machines can be proposed as alternates for cost savings. A common set of rules, codes and laws to satisfy all regions is used as long as the cost impact is not too significant. Where not covered by existing codes, a set of ILC standards must be developed which specify cost effective solutions, e.g. the distance between personnel crossovers for the two tunnels,

9. All cost estimates must be treated as confidential within the GDE (e.g. not to be publicly presented or listed on a publicly accessible web or wiki site). The Executive Committee shall determine the publication policy for all elements of the cost estimate.

These are the general guidelines, still working on specific instructions

References

[1] Department of Defense, United States of America, *Joint Industry Government Parametric Estimating Handbook*, Second Edition, Spring 1999.

No Contingency?

No! The European and Japanese methods assume that all the design and estimating has been done up-front, inclusively, so there will be no add-ons due to incomplete engineering or scope changes (all homework done at this stage) and that the estimates are statistically robust so over-runs in one area will be compensated by under-runs in another.

Contingency (2)

At this stage of project definition,
US estimates assume that engineering and cost estimating have NOT been completed to the ultimate level of detail.

In the US, contingency is added to cover:
- the missing level of detail,
- non-symmetric cost over/under-runs,
- and minor scope changes

RDR cost estimate will include Risk Analysis

WBS Level of Detail Desired

- **Would like to have estimates in lowest level presented to ~ a few x 0.1% of total ILC**
- **Graded approach, put effort onto cost drivers**
- **System Groups might need lower levels of WBS in order to produce their own cost estimate**
- **So far, WBS are guideline examples, intend to be modified to meet System Group needs (received WBS for CF&S, Controls, RF Power)**
- **Examples below are for Materials & Services (not internal labor) from USLCTOS**

Level of Detail Example (1)

cryogenics_WBS_28feb06.xls (other examples in backups)

LHC refrig. single units

%			
%	percentage of total materials cost for USLCTOS 500 GeV Cold option these percentages for USLCTOS are somewhat sensitive, they are listed just to give idea of level of detail that has been attained		
WB_6feb_PG_8feb (Follows USLCTOS)			This is what is on the web, the items 1.8.3.1.1.i
1.8.3 Cryogenic Plant and Distribution			were omitted. The green numbers on left are
4.08	1.8.3.1 Cryogenic Plants		percentage 4.08% of total USLCTOS 500 cold M&S
3.27	1.8.3.1.1 Cryo Refrigeration Unit (includes cryo distribution, but not civil utilities)		
This layer was not included - consider adding this layer to increase sensitivity			
	1.12	1.8.3.1.1.1	Cryo Cold Boxes
	0.68	1.8.3.1.1.2	Cryo Warm Compressor System
	0.12	1.8.3.1.1.3	Cryo Cold Compressor System
	0.11	1.8.3.1.1.4	Cryo Purification System
	0.13	1.8.3.1.1.5	Cryo Refrigeration System Controls
	0.10	1.8.3.1.1.6	Cryo Liquid Helium Storage
	0.17	1.8.3.1.1.7	Cryo Vertical Transfer Line
	0.16	1.8.3.1.1.8	Cryo Distribution Boxes 1,2,8
	0.11	1.8.3.1.1.9	Cryo Distribution Boxes 3,6,7
	0.16	1.8.3.1.1.10	Cryo Warm He Gas Header
	0.09	1.8.3.1.1.11	Cryo Vacuum Barriers
	0.19	1.8.3.1.1.12	Cryo System Installation Contracts
	0.04	1.8.3.1.1.13	Cryo Miscellaneous
	0.05	1.8.3.1.1.14	Cryo Feed Boxes
	0.04	1.8.3.1.1.15	Cryo End Boxes
0.25		1.8.3.1.2	Cryo Cooling Towers
0.04		1.8.3.1.3	Cryo Warm Helium Storage
0.04		1.8.3.1.4	Cryo Helium Gas (initial charge) **- should this be operating, not construction?**
0.00		1.8.3.1.5	Cryo Vacuum Barrier
0.01		1.8.3.1.6	Cryo Feed Boxes
0.01		1.8.3.1.7	Cryo End Boxes
0.17		1.8.3.1.8	Cryo Load Controls
0.30		1.8.3.1.9	Cryo Cold Bypass (1 kilometer) - what was this? fairly pricey!
	1.8.3.2 Cryogenic Distribution **- actually included above 1.8.3.1.1.i - so can discard this element**		

Level of Detail Example (2)

RF_WBS_phg_1march06.xls

	USLCTOS - 2003 - similar to WB_6feb_PG_8feb06.wbs		% of hardware
	(not including contract installaiton or CF&S for RF)		from USLCTOS
	1.5. 8.1 **RF System**	894	15.70%
	1.5.8.1.1 Modulator	894	6.68%
no	1.5.8.1.2 Pulse Transformer not here		0.00%
	1.5.8.1.3 Klystron	894	3.68%
	1.5.8.1.3.1 Klystron Tube	894	3.10%
	1.5.8.1.3.2 Solenoid	894	0.28%
	1.5.8.1.3.3 Socket	894	0.06%
	1.5.8.1.3.4 Roughing Pump/Controls	894	0.08%
	1.5.8.1.3.5 Dry Nitrogen Backfill System	894	0.16%
	1.5.8.1.4 RF Power Distribution and Interlocks	894	2.97%
	1.5.8.1.4.1 High Power Phase Shifter	894	0.13%
	1.5.8.1.4.2 High Power Splitter	0	0.00%
	1.5.8.1.4 3 Intertunnel Waveguide	1788	0.10%
	1.5.8.1.4.4 Waveguide to Feed Cavity #1	0	0.00%
	1.5.8.1.4.5 Cavity Feeds	894	2.80%
need to add	1.5.8.1.4.5.1 Circulators	14304	0.53%
need to add	1.5.8.1.4.5.2 Power Hybrid Couplers	14304	0.38%
need to add	1.5.8.1.4.5.3 Wavegude Small Sections	14304	0.36%
need to add	1.5.8.1.4.5.4 Three-Stub Tuner	14304	0.76%
need to add	1.5.8.1.4.5.5 RF Bellows	14304	0.25%
need to add	1.5.8.1.4.5.6 RF Signal Couplers	14304	0.00%
need to add	1.5.8.1.4.5.7 Low Power Loads	14304	0.51%
move	1.5.8.1.5 Low Level RF	894	1.91%
need	1.5.8.1.6 RF Drivers	894	0.34%
need	1.5.8.1.7 Auxiliary Equipment	894	0.13%

Total RF

Major RF Items

Still >> few * 0.1% can they be reduced?

Level of Detail Example (3)

cryomodule_WBS_phg_7march06.xls

1.2	Cryomodule							% of hardware
	1.2.1	Cryomodule		(same as above)				from USLCTOS
		1.2.1.1	SC Cavity Fabrication					
			1.2.1.1.1	Material				**2.43%**
				1.2.1.1.1.1	Niobium RRR 300			
				1.2.1.1.1.2	Niobium RRR 30			
				1.2.1.1.1.3	Niobium Titanium			
				1.2.1.1.1.4	Cryoperm			
			1.2.1.1.2	Resonator Production				**3.57%**
				1.2.1.1.2.1	Resonator Machining			
				1.2.1.1.2.2	electron-beam welding			
				1.2.1.1.2.3	Resonator Assembly			
			1.2.1.1.3	Tuners				0.80%
				1.2.1.1.3.1	Tuner Mechanics			
				1.2.1.1.3.2	Tuner Electronics			
				1.2.1.1.3.3	Piezo Tuner			
			1.2.1.1.4	Helium Vessel				**1.00%**
				1.2.4.1	Titanium Vessel			
		1.2.1.2	SC Cavity Assembly (above 1.2.2)					
		1.2.1.3	Cryostat Assembly (below 1.6)					
		1.2.1.4	Cryostat					0.84%
			1.2.1.4.1	Material				
				1.2.1.4.1.1	Black (Ferromagnetic) Steel			
			1.2.1.4.2	Vacuum Vessel				
		1.2.1.5	Cryostat Assembly					**4.14%**
		1.2.1.6	RF Power Couplers					**3.48%**
		1.2.1.7	HOM Couplers					0.13%
	1.2.2	SC Quadrupole, Corrector, Instrumentation						0.27%
		1.2.2.1	SC Quadrupole					
		1.2.2.2	Corrector Magnet					
		1.2.2.3	Beam Position Montor					
							total =	16.66%

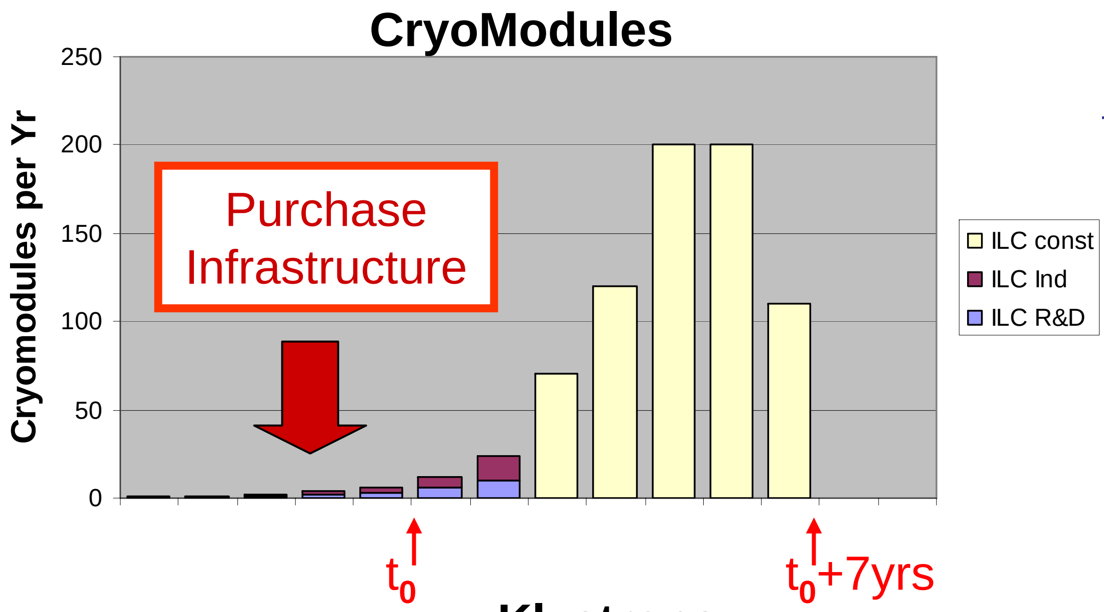
Reinhard Brinkmann - XFEL

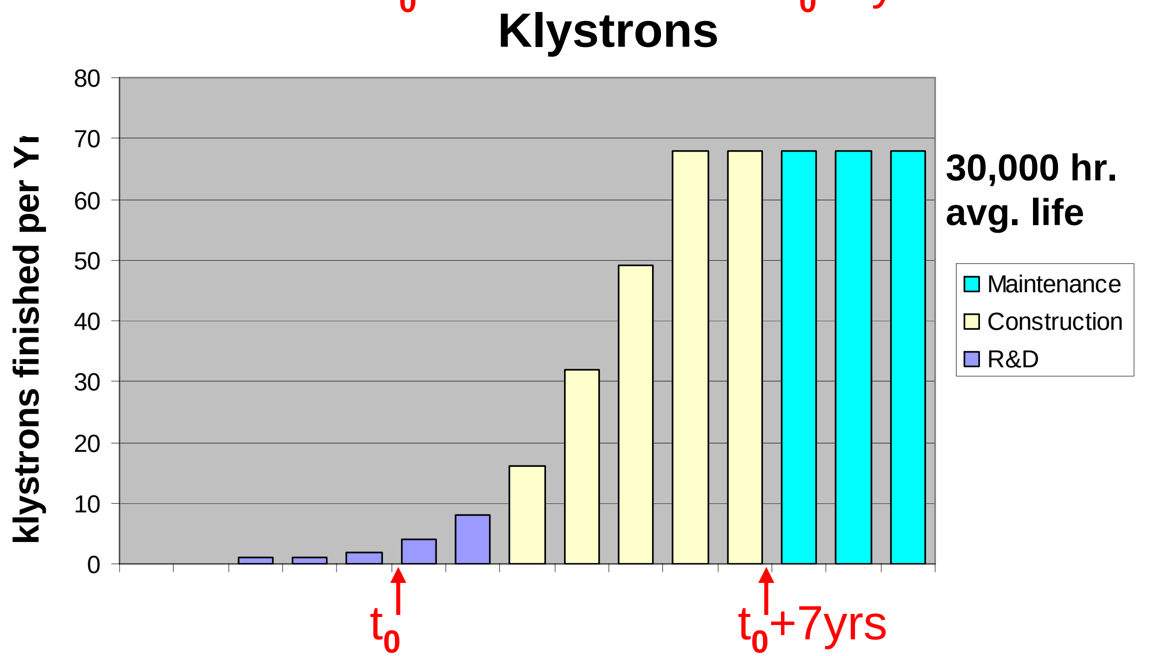
updated XFEL cost estimate now includes:

- in-house manpower
- overhead for central services & admin.
- request for “risk funding”

U.S. CryoModule & Klystron Production Model

- Bob Kephart's first guess at rate for 1/3 of total needed
- Ramp-up: R&D, Industrialization, Production





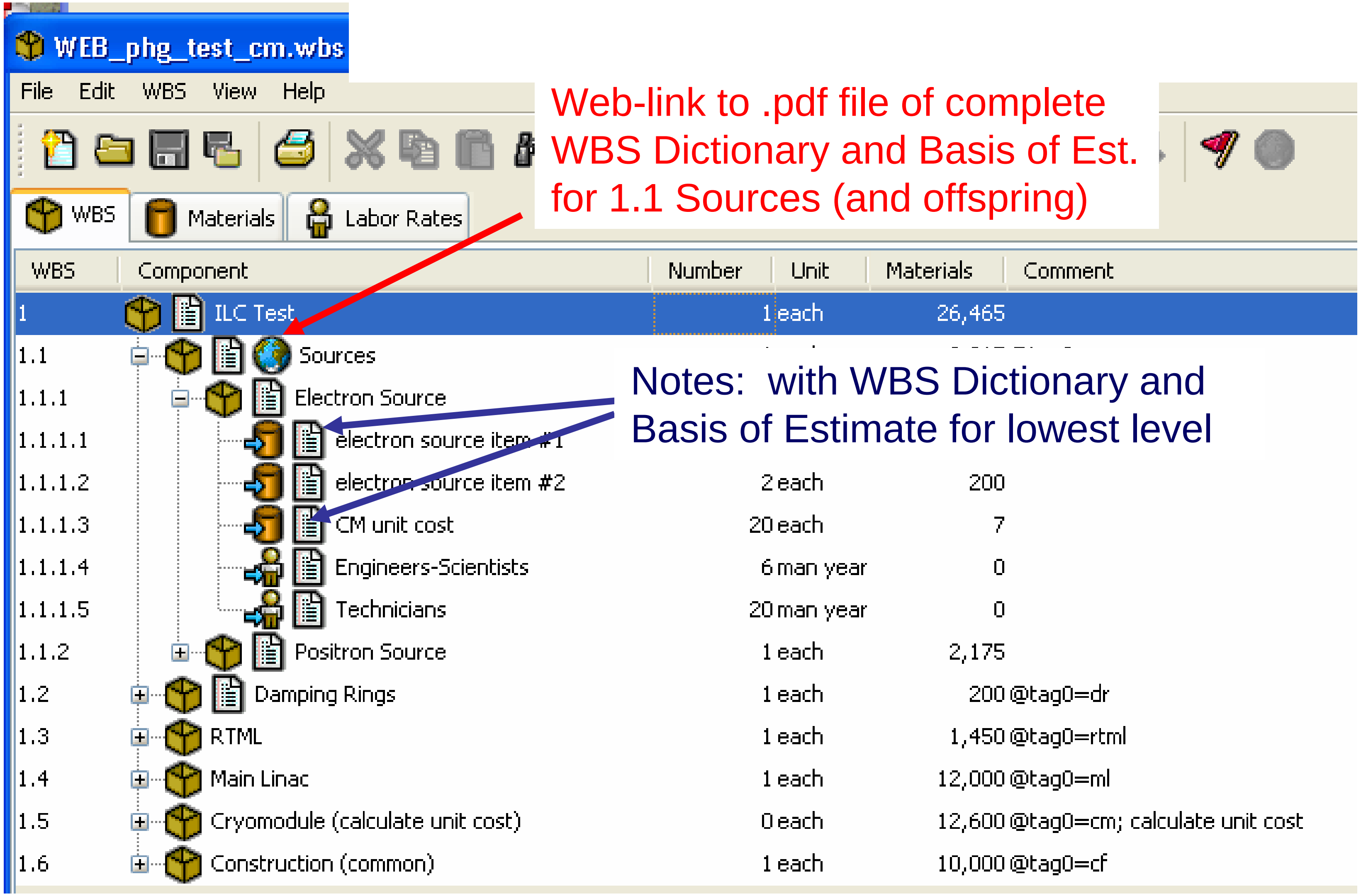
“Cost Estimating Deliverables” from Area System Leaders to DCB

- WBS structure modifications & additions which Area Systems need to produce cost estimate at required level of detail
- WBS Dictionary (description, boundaries)
- Basis of Estimate (see above template)
- Cost Estimate per unit (with uncertainty)
- number of units required – for cost table
- institutional labor est. – in person-hours

Logistics of WBS

- Responsibility of Area, Global, and Technical Systems Groups to provide "Cost Estimating Deliverables" to DCB
  (use an easy format for them:
  MS Word, EXCEL, text, etc.)
- Responsibility of DCB to get all that information into the WBS format.
- Here's an example of how we'll do it:

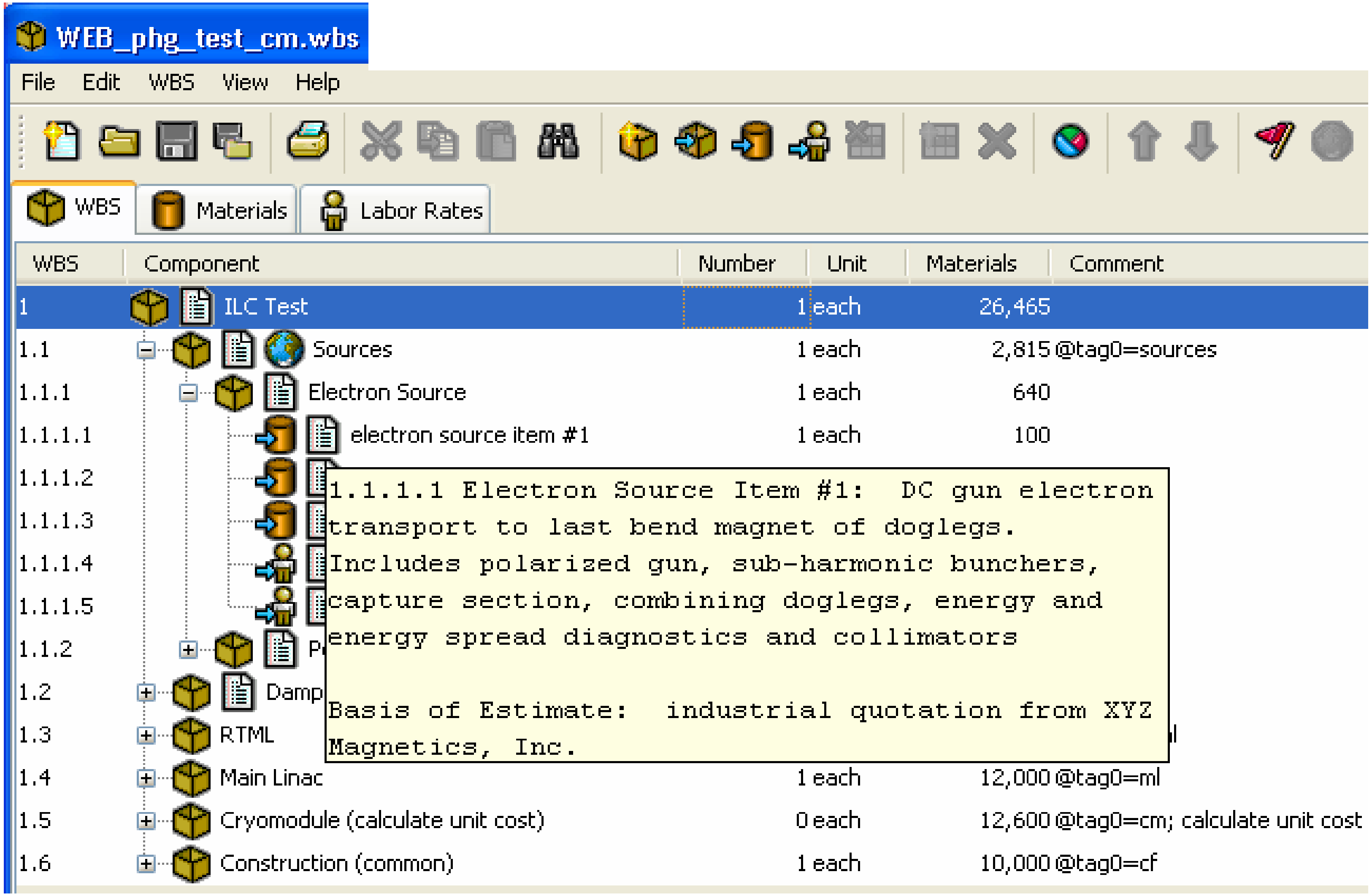
Example of WBS Tool Format & Info



WBS	Component	Number	Unit	Materials	Comment
1	ILC Test	1	each	26,465	
1.1	Sources				
1.1.1	Electron Source				
1.1.1.1	electron source item #1				
1.1.1.2	electron source item #2	2	each	200	
1.1.1.3	CM unit cost	20	each	7	
1.1.1.4	Engineers-Scientists	6	man year	0	
1.1.1.5	Technicians	20	man year	0	
1.1.2	Positron Source	1	each	2,175	
1.2	Damping Rings	1	each	200	@tag0=dr
1.3	RTML	1	each	1,450	@tag0=rtml
1.4	Main Linac	1	each	12,000	@tag0=ml
1.5	Cryomodule (calculate unit cost)	0	each	12,600	@tag0=cm; calculate unit cost
1.6	Construction (common)	1	each	10,000	@tag0=cf

Web-link to .pdf file of complete WBS Dictionary and Basis of Est. for 1.1 Sources (and offspring)

Notes: with WBS Dictionary and Basis of Estimate for lowest level


WEB_phg_test_cm.wbs
File Edit WBS View Help
WBS
Materials
Labor Rates
WBS | Component | Number | Unit | Materials | Comment
1 ILC Test 1 each 26,465
1.1 Sources 1 each 2,815 @tag0=sources
1.1.1 Electron Source 1 each 640
1.1.1.1 electron source item #1 1 each 100
1.1.1.2
1.1.1.3
1.1.1.4
1.1.1.5
1.1.2
1.2 Damp
1.3 RTML
1.4 Main Linac 1 each 12,000 @tag0=ml
1.5 Cryomodule (calculate unit cost) 0 each 12,600 @tag0=cm; calculate unit cost
1.6 Construction (common) 1 each 10,000 @tag0=cf
1.1.1.1 Electron Source Item #1: DC gun electron transport to last bend magnet of doglegs. Includes polarized gun, sub-harmonic bunchers, capture section, combining doglegs, energy and energy spread diagnostics and collimators
Basis of Estimate: industrial quotation from XYZ Magnetics, Inc.

Example of WBS dictionary and Basis of Estimate (for cost-estimated items)
highlighted sections are Peter's notes to authors

1.1 Sources: (dictionary for WBS element) provides electrons and positrons to the Damping Rings (define general boundary)

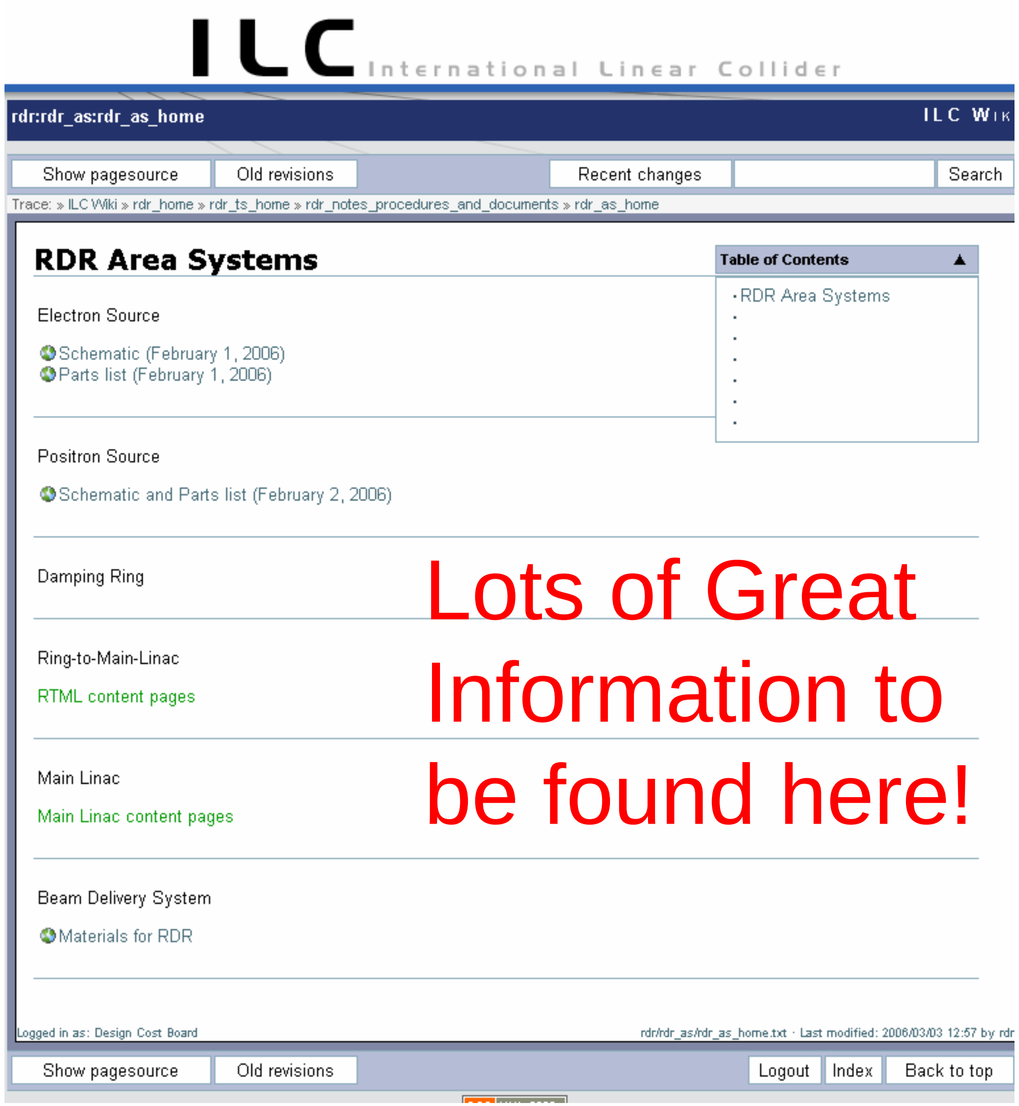
1.1.1 Electron Source: from polarized electron gun to electron Damping Ring injection (from ILC BCD Beamline Descriptions)

1.1.1.1 Electron Source Item #1: DC gun electron transport to last bend magnet of doglegs. Includes polarized gun, sub-harmonic bunchers, capture section, combining doglegs, energy and energy spread diagnostics and collimators (define more specific boundary, and say what's included in element)
Basis of Estimate: industrial quotation from XYZ Magnetics, Inc.

1.1.1.2 Electron Source Item #2: EBSTR: from exit of warm pre-accelerator section to entrance of first ELTR bend magnet. Includes 3 matching sections and 4-wire 2D emittance diagnostic section
Basis of Estimate: QQQ-lab engineering estimate, built similar item recently

1.1.1.3 Cryomodule: standard cryomodule
Basis of Estimate: use unit cost for CM developed in item 1.5

http://www.linearcollider.org/wiki/doku.php?id=rdr:rdr_as:rdr_as_home


ILC International Linear Collider

rdr:rdr_as:rdr_as_home — ILC Wiki

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Trace: » ILC Wiki » rdr_home » rdr_ts_home » rdr_notes_procedures_and_documents » rdr_as_home

RDR Area Systems

Table of Contents
- RDR Area Systems

Electron Source

- Schematic (February 1, 2006)
- Parts list (February 1, 2006)

Positron Source

- Schematic and Parts list (February 2, 2006)

Damping Ring

Ring-to-Main-Linac

RTML content pages

Main Linac

Main Linac content pages

Beam Delivery System

- Materials for RDR

Logged in as: Design Cost Board

rdr/rdr_as/rdr_as_home.txt · Last modified: 2006/03/03 12:57 by rdr

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Lots of Great Information to be found here!