updated after presentation & discussion

Cost Estimating for the AD&I Studies

proliferation of acronyms!

Differential Estimates
What we need from you!

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Fermilab

DESY – May 29, 2009

Introduction & Outline

- Now we need ***cost differentials***:
  How much could we save if we made this proposed change?
- Later in the Technical Design Phase – 2:
  we will need a ***complete new cost estimate*** (bottom-up)
- For Reference Design Report, we had

  estimate = $a + b + c$ new estimate => $a' + b + d$

  where d replaces c, but may have an ***updated estimate*** for a

  need to compare $a+b+c \Rightarrow a+b+d$ or $a'+b+c \Rightarrow a'+b+d$

  sometimes easy comparing $b \Rightarrow d$, sometimes b/d affects a/a'

  non-diagonal, coupled effects
- We need estimate comparison for ***same year*** => 2007 RDR
- What questions need to be asked for each AD&I study?
- Prior examples: Klystron Cluster & 230 GeV e-e+ studies

What information we need for each study?

- Descriptive text – what changes
- Configuration – number of new components,
  # and length of tunnel(s), sketches, 3D CAD, etc.
- Required utilities: power, cooling, cryogens
- Cost estimates for new components:
  e.g. overmoded waveguide and couplers
  for Klystron Cluster study,
  klystrons and modulators for DRFS
- Do old unit cost estimates change? Learn Curve?
- Use new ICET cost estimate template (enable macros)

http://www-ilcdcb.fnal.gov/example_26march09-Construction.xls

- Head to head comparison: old vs. new (CFS)

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RDR MAR 30 2007

A5
Main Linac
Denotes changed item
Denotes new Item

KLY Power Cluster Scheme for Aug 29 2008

Main Linac

						FINAL CONTRACT COST- in 2006 US$ (except where noted)						FINAL CONTRACT COST- in 2006 US$ (except where noted)		
						Man-Hours Total	$ Total					Man-Hours Total	$ Total	
1.7	Conventional Facilities					271,161 Man-Hrs	$ 1,160,918,226					173,933 Man-Hrs	$ 821,758,793	
						(still to be corrected RDR)	$ 1,116,055,056							
			QTY	Unit		Unit Cost	Extension	Section Total	QTY	Unit		Unit Cost	Extension	Section Total
1.7.1	CIVIL ENGINEERING					155,883	Man-Hrs	$ 737,794,472				111,674	Man-Hrs	$ 532,662,496
1.7.1.1	Engineering, study work and documentation							$ 38,581,023						$ 30,151,840
1.7.1.1.1	In-house Engineering		$90	/man-hr		$14,029,463	155,883		$90	/man-hr		$10,050,613	111,674	
	In-house Engineering		2%	%		$701,473,148	$ 14,029,463		2%	%		$502,530,659	$ 10,050,613	
1.7.1.1.2	Outsourced Consultancy Services							$ 38,581,023						$ 30,151,840
	Outsourced Engineering		6%	%		$701,473,148	$ 38,581,023		6%	%		$502,530,659	$ 30,151,840	
1.7.1.2	Underground Facilities							$ 593,008,308						$ 333,284,348
1.7.1.2.1	Shafts							$ 105,194,184						$ 112,024,494
	e- ML 14m dia. Shafts @ Points 5, 3 (2 x 425 vert ft)		259	vert m		$134,768	$ 34,904,783		259	vert m		$134,768	$ 34,904,783	
	e- ML 9m dia. Shaft @ Point 7 (1 x 425 vert ft)		130	vert m		$78,280	$ 10,137,260		130	vert m		$78,280	$ 10,137,260	
	e- ML 1500mm dia. Survey Shafts @ Points 3.1, 5.1 (2 x 425 vert ft)		259	vert m		$7,240	$ 1,875,160		259	vert m		$7,240	$ 1,875,160	
	e- ML 3 m dia shafts @ pts 14,15								259	vert m		$10,635	$ 2,754,465	
						$0						$0		
	e+ ML 14m dia. Shafts @ Points 2, 4 (2 x 425 vert ft)		259	vert m		$134,768	$ 34,904,783		259	vert m		$134,768	$ 34,904,783	
	e+ ML 9m dia. Shaft @ Point 6 (1 x 425 vert ft)		130	vert m		$78,280	$ 10,137,260		130	vert m		$78,280	$ 10,176,400	
	e+ ML 1500mm dia. Survey Shafts @ Points 2.1, 4.1 (2 x 425 vert ft)		259	vert m		$7,240	$ 1,875,160		259	vert m		$7,240	$ 1,875,160	
	e+ ML 3 m dia shafts @ pts 16,17								259	vert m		$10,635	$ 2,754,465	
						$0						$0		
	Surface Grouting of Points 2-5 14m dia. Shafts (4 x 425 vert ft)		4	ea.		$721,678	$ 2,886,710		4	ea.		$721,678	$ 2,886,710	
	Surface Grouting of Points 6-7 9m dia. Shafts (2 x 425 vert ft)		2	ea.		$541,258	$ 1,082,515		2	ea.		$541,258	$ 1,082,515	
	Surface Grouting of Points 2.1, 3.1, 4.1, 5.1 Survey Shafts (4 x 425 vert ft)		4	ea.		$270,629	$ 1,082,515		4	ea.		$270,629	$ 1,082,515	
	Points 2,3,4,5,6,7 - 14&9m dia. Shafts, finishing (stairs, conc. wall, elev.#2)		777	vert m		$7,254	$ 5,636,164		777	vert m		$7,254	$ 5,636,164	
	Surface Grouting of Points 14,15,16,17 Survey Shafts (4 x 425 vert ft)								4	ea.		$320,560	$ 1,282,240	
	ML Underground Potable Water (1/2 of Points 2 & 3)		1	ea.		$67,188	$ 67,188		1	ea.		$67,188	$ 67,188	
	ML Underground Potable Water (Points 4,5,6,7)		4	ea.		$67,188	$ 268,750		4	ea.		$67,188	$ 268,750	
	ML Underground Sanitary Sewer (1/2 of Points 2 & 3)		1	ea.		$67,188	$ 67,188		1	ea.		$67,188	$ 67,188	
	ML Underground Sanitary Sewer (Points 4,5,6,7)		4	ea.		$67,188	$ 268,750		4	ea.		$67,188	$ 268,750	
1.7.1.2.2	Tunnels							$ 389,191,025						$ 195,744,068
	e- ML 4.5m dia. Beam Tunnel, TBM Excavation (37,162 lin ft)		11,327	lin m		$7,171	$ 81,228,749		11,327	lin m		$7,171	$ 81,228,749	
	e- ML 4.5m dia. Service Tunnel, TBM Excavation (37,162 lin ft)		11,327	lin m		$7,171	$ 81,228,749		0	lin m		$0	$ -	
	e- ML 4.5m dia. Tunnels, Conc. Inv. (74,324 lin ft)		22,654	lin m		$1,351	$ 30,611,218		11,327	lin m		$1,351	$ 15,305,609	
						$0						$0		
	e+ ML 4.5m dia. Beam Tunnel, TBM Excavation (36,660 lin ft)		11,174	lin m		$7,171	$ 80,131,548		11,174	lin m		$7,171	$ 80,131,548	
	e+ ML 4.5m dia. Service Tunnel, TBM Excavation (36,660 lin ft)		11,174	lin m		$7,171	$ 80,131,548		0	lin m		$0	$ -	
	e+ ML 4.5m dia. Tunnels, Conc. Inv. (73,320 lin ft)		22,348	lin m		$1,351	$ 30,197,735		11,174	lin m		$1,351	$ 15,098,868	
						$0						$0		
	Provide Tunnel Construction Water Treatment Plant		4	ea.		$156,250	$ 625,000		4	ea.		$156,250	$ 625,000	
	Maintain and Operate Tunnel Construction Water Treatment Plant		4	ea.		$1,160,074	$ 4,640,295		4	ea.		$772,609	$ 3,090,436	
	Treatment of Tunnel Construction Water		4	ea.		$99,046	$ 396,185		4	ea.		$65,966	$ 263,859	
1.7.1.2.3	Halls													
1.7.1.2.4	Caverns							$ 66,214,274						$ 18,378,585
	e- ML Shaft Base Caverns D&B Excavation @ Points 3, 5, 7 (3 x 20,056 CY)		46,003	m^3		$605	$ 27,831,815							

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A5
Main Linac

					FINAL CONTRACT COST- in 2006 US$ (except where noted)				FINAL CONTRACT COST- in 2006 US$ (except where noted)	
					Man-Hours Total	$ Total			Man-Hours Total	$ Total
		(STILL TO BE CORRECTED IN RDR) e- ML Shaft Base Caverns D&B Excavation @ Points 2, 4, 6 (3 x 20,056 CY)	8,926	m^3	$605 $ 5,400,230		6,469	m^3	$605 $ 3,913,745	
		e- ML Points 3,5,7 D&B Exc. for Shield Doors (in Base Caverns) (3 x 959 CY)	2,199	m^3	$753 $ 1,654,522		2,199	m^3	$753 $ 1,654,748	
		e- ML Beam Dump Cavern D&B Excavation @ Point 3 (3,034 CY)	2,320	m^3	$753 $ 1,745,800		2,320	m^3	$753 $ 1,745,800	
		e+ ML Shaft Base Caverns D&B Excavation @ Points 2, 4, 6 (3 x 20,056 CY)	46,003	m^3	$605 $ 27,831,815					
		(STILL TO BE CORRECTED IN RDR) e+ ML Shaft Base Caverns D&B Excavation @ Points 2, 4, 6 (3 x 20,056 CY)	8,926	m^3	$605 $ 5,400,230		6,469	m^3	$605 $ 3,913,745	
		e+ ML Points 2,4,6 D&B Exc. for Shield Doors (in Base Caverns) (3 x 959 CY)	2,199	m^3	$753 $ 1,654,522		2,199	m^3	$753 $ 1,654,748	
		e+ ML Beam Dump Cavern D&B Excavation @ Point 2 (3,034 CY)	2,320	m^3	$753 $ 1,745,800		2,320	m^3	$753 $ 1,745,800	
					$0				$0	
		Shield Doors @ Base Caverns @ Points 2-7	6	ea.	$625,000 $ 3,750,000		6	ea.	$625,000 $ 3,750,000	
	1.7.1.2.5	Miscellaneous works				$ 32,408,826				$ 7,137,201
		e- Refuge Areas (14 ea @ 10' x 20' x 10')					1,653	m^3	$2,158 $ 3,567,869	
		e+ Refuge Areas					1,654	m^3	$2,158 $ 3,569,332	
		e- ML Personnel Crossovers, D&B Excavation (23 X 295.5 CY)	5,196	m^3	$2,158 $ 11,213,163		0	m^3	$0 $ -	
		e- ML Waveguides, Drill Excavation (968)	968	ea.	$5,156 $ 4,991,250		0	ea.	$0 $ -	
		e+ ML Personnel Crossovers, D&B Excavation (23 X 295.5 CY)	5,196	m^3	$2,158 $ 11,213,163		0	m^3	$0 $ -	
		e+ ML Waveguides, Drill Excavation (968)	968	ea.	$5,156 $ 4,991,250		0	ea.	$0 $ -	
	1.7.1.3	Surface Structures				$ 75,914,855				$ 122,001,510
	1.7.1.3.1	Central Lab Buildings								
	1.7.1.3.2	Detector Assembly Buildings								
	1.7.1.3.3	Office Buildings				$ 5,057,150				$ 5,057,150
		Points 4-7 Office Buildings (4 x 3,750 sq ft)	1,396	sq m	$3,623 $ 5,057,150		1,396	sq m	$3,623 $ 5,057,150	
	1.7.1.3.4	Service Buildings				$ 17,981,957				$ 25,799,102
		Points 2-7 Electrical Service Buildings (6 x 1,500 sq ft)	836	sq m	$2,805 $ 2,344,863		836	sq m	$2,805 $ 2,344,863	
		Points 2-7 Cooling Towers & Pump Stations Bldgs. (6 x 7,500 sq ft)	4,181	sq m	$2,805 $ 11,727,120		6,968	sq m	$2,805 $ 19,544,264	
		Points 2-7 Cooling Ventilation Buildings (6 x 2,500 sq ft)	1,394	sq m	$2,805 $ 3,909,975		1,394	sq m	$2,805 $ 3,909,975	
	1.7.1.3.5	Cryo- Equipment Buildings				$ 24,612,619				$ 24,612,619
		Points 2-7 Cryo - Warm Compressor Building (6 x 4,500 sq ft)	2,508	sq m	$4,108 $ 10,301,811		2,508	sq m	$4,108 $ 10,301,811	
		Points 2-7 Cryo - Surface Cold Box Building (6 x 6,250 sq ft)	3,484	sq m	$4,108 $ 14,310,809		3,484	sq m	$4,108 $ 14,310,809	
	1.7.1.3.6	Control Buildings								
	1.7.1.3.7	Workshops				$ 12,822,374				$ 12,822,374
		Points 4-7 Workshop Bldg. - Machine & Detector (4 x 11,250 sq ft)	4,181	sq m	$3,067 $ 12,822,374		4,181	sq m	$3,067 $ 12,822,374	
	1.7.1.3.8	Site Access Control Buildings				$ 782,556				$ 782,556
		Points 4-7 Site Access Buildings (4 x 750 sq ft)	279	sq m	$2,805 $ 782,556		279	sq m	$2,805 $ 782,556	
	1.7.1.3.9	Shaft Access Buildings				$ 14,658,198				$ 14,658,198
		Points 2-7 Shaft Access Buildings (6 x 9,375 sq ft)	5,226	sq m	$2,805 $ 14,658,198		5,226	sq m	$2,805 $ 14,658,198	
	1.7.1.3.10	Miscellaneous Buildings								
	1.7.1.3.11	User Facilities								
		KLY Cluster Buildings (no of klystron in surface average 60 to 64)								$38,269,509.84
		Points ,16,4,17,6,7,14,5,15,					12,128	sq m	$2,805 $34,017,342	
		Points 2,3					1,516	sq m	$2,805 $4,252,168	
	1.7.1.4	Site Development				$ 30,290,286				$ 47,244,801
	1.7.1.4.1	Off-site Site work								
	1.7.1.4.2	Network of Monuments								
	1.7.1.4.3	Construction Support								
	1.7.1.4.4	Site Preparation				$ 1,215,000				$ 2,025,000

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						FINAL CONTRACT COST- in 2006 US$ (except where noted)						FINAL CONTRACT COST- in 2006 US$ (except where noted)		
						Man-Hours Total		$ Total				Man-Hours Total		$ Total
		Points 2 - 7, Clearing, Grubbing, and Initial Site Preparation (6 sites)	6	ea.		$202,500	$ 1,215,000		10	ea.		$202,500	$ 2,025,000	
	1.7.1.4.5	Utility Distribution						$ 21,046,500						$ 33,817,500
		Points 2 - 7, Utility Corridors (Gas, DWS, San., Storm, Elec., Comm.)	6	ea.		$3,037,500	$ 18,225,000		10	ea.		$3,037,500	$ 30,375,000	
		Points 2 - 7, Septic Field / Tank or Sanitary Sewer	6	ea.		$101,250	$ 607,500		10	ea.		$101,250	$ 1,012,500	
		Points 2 - 7, Wells or DWS	6	ea.		$54,000	$ 324,000		10	ea.		$54,000	$ 540,000	
		Points 4 - 7, Elevated Water Tank	4	ea.		$270,000	$ 1,080,000		4	ea.		$270,000	$ 1,080,000	
		Points 4 - 7, Water Pump House	4	ea.		$202,500	$ 810,000		4	ea.		$202,500	$ 810,000	
	1.7.1.4.6	Road, Sidewalks & Parking Areas						$ 7,100,279						$ 9,940,391
		Points 2 - 7, Service Roads (6 sites x 1250 lin ft / site)	2,286	lin m		$1,107	$ 2,530,602		3,200	lin m		$1,107	$ 3,542,843	
		Points 2 - 7, Paved Areas (6 sites x 8750 sy / site)	43,896	sq m		$97	$ 4,266,691		61,454	sq m		$97	$ 5,973,368	
		Points 2 - 7, Flatwork (6 sites x 2,500 sq ft / site)	1,394	sq m		$217	$ 302,986		1,952	sq m		$217	$ 424,180	
	1.7.1.4.7	Landscaping						$ 726,007						$ 1,124,410
		Points 2 - 7, Landscaping	6	ea.		$67,500	$ 405,000		10	ea.		$67,500	$ 675,000	
		Points 4 - 7, Security Fencing (4 sites x 5,000 lin ft / site)	6,097	lin m		$53	$ 321,007		8,536	lin m		$53	$ 449,410	
	1.7.1.4.8	Environmental						$ 202,500						$ 337,500
		Points 2 - 7, Sediment & Erosion Control (6 sites)	6	ea.		$33,750	$ 202,500		10	ea.		$33,750	$ 337,500	
	1.7.1.4.9	Miscellaneous Site Works												
1.7.2		ELECTRICAL				37,585	Man-Hrs	$ 169,134,000				28,189	Man-Hrs	$ 126,850,500
1.7.3		AIR TREATMENT EQUIPMENT				2,561	Man-Hrs	$ 12,328,035				4,283	Man-Hrs	$ 20,618,471
	1.7.3.1	Engineering, study work and documentation						$ 806,507						$ 1,348,872
				/man-hr						/man-hr				
	1.7.3.1.1	In-house Engineering	$90			$230,431	2,561		$90			$385,392	4,283	
		In-house Engineering	2%	%		$11,521,528	$ 230,431		2%	%		$19,269,599	$ 385,392	
	1.7.3.1.2	Outsourced Consultancy Services						$ 806,507						$ 1,348,872
		Outsourced Engineering	7%	%		$11,521,528	$ 806,507		7%	%		$19,269,599	$ 1,348,872	
	1.7.3.2	HVAC Equipment						$ 11,521,528						$ 19,269,599
	1.7.3.2.1	OA & Exhaust Air Processing						$ 4,363,546						$7,272,576
		OA Supply/Exhaust Systems @ Points 2 - 7	6	ea.		$727,258	$ 4,363,546		10	ea.		$727,258	$ 7,272,576	
	1.7.3.2.2	Air-conditioning for Tunnels						$ 7,157,983						$11,997,023
		Beamline Tunnel A/C, e- ML	11,895	lin m		$90	$ 1,065,756		11,895	lin m		$90	$ 1,065,756	
		Beamline Tunnel A/C, e+ ML	10,394	lin m		$90	$ 931,267		10,394	lin m		$90	$ 931,267	
		Fan Coil Units	1	ls		$5,160,960	$ 5,160,960		1	ls		$0	$ -	
		Chilled Water cooling for RF Racks in surface (placeholder)	1	ls					1	ls		$10,000,000	$ 10,000,000	
	1.7.3.2.3	Air-conditioning for General Areas												
1.7.4		PIPED UTILITIES				266	Man-Hrs	$ 1,300,792				1,255	Man-Hrs	$ 6,153,112
	1.7.4.1	Engineering, study work and documentation						$ 107,405						$ 508,055
				/man-hr						/man-hr				
	1.7.4.1.1	In-house Engineering	$90			$23,868	266		$90			$112,901	1,255	
		In-house Engineering	2%	%		$1,193,388	$ 23,868		2%	%		$5,645,057	$ 112,901	
	1.7.4.1.2	Outsourced Consultancy Services						$ 107,405						$ 508,055
		Outsourced Engineering	9%	%		$1,193,388	$ 107,405		9%	%		$5,645,057	$ 508,055	
	1.7.4.2	Plumbing						$ 1,193,388						$ 1,988,979
	1.7.4.2.1	Potable Water												
	1.7.4.2.2	Sanitary Sewer												
	1.7.4.2.3	Sump Systems						$ 1,193,388						$1,988,979
		Dewatering Sump Systems at Points 2, 3, 4, 5, 6, 7	6	ea.		$198,898	$ 1,193,388		6	ea.		$198,898	$ 1,193,388	
		Dewatering Sump Systems at Points 14, 15, 16, 17							4			$198,898	$ 795,592	
	1.7.4.3	Fire Suppression												$3,656,078

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					FINAL CONTRACT COST- in 2006 US$ (except where noted)					FINAL CONTRACT COST- in 2006 US$ (except where noted)		
					Man-Hours Total		$ Total			Man-Hours Total		$ Total
		e- shafts						648	lin m	$128	$82,875	
		e-tunnels						11,327	lin m	$128	$1,448,950	
		e-caverns						1	ls	$306,000	$306,000	
		e+ shaft						648	lin m	$128	$82,875	
		e=tunnels						11,174	lin m	$128	$1,429,378	
		e+caverns						1		$306,000	$306,000	
	1.7.4.4	Fuel System Distribution										
1.7.5		PROCESS (COOLING) WATER			38,249	Man-Hrs	$ 187,609,926			17,433	Man-Hrs	$ 85,507,211
	1.7.5.1	Engineering, study work and documentation					$ 15,490,728					$ 7,060,228
	1.7.5.1.1	In-house Engineering	$90	/man-hr	$3,442,384	38,249		$90	/man-hr	$1,568,940	17,433	
		In-house Engineering	2%	%	$172,119,198	$ 3,442,384		2%	%	$78,446,983	$ 1,568,940	
	1.7.5.1.2	Outsourced Consultancy Services					$ 15,490,728					$ 7,060,228
		Outsourced Engineering	9%	%	$172,119,198	$ 15,490,728		9%	%	$78,446,983	$ 7,060,228	
	1.7.5.2	Primary Stations					$ 29,863,815					$ 22,961,983
	1.7.5.2.1	Cooling Towers & Pumping Stations					$ 19,875,852					$ 19,234,983
		Cooling Towers for Process Water	1	ls	$9,636,281	$ 9,636,281		1	ls	$12,081,000	$ 12,081,000	
		Cooling Towers for Chilled Water	1	ls	$5,200,237	$ 5,200,237		1	ls	$0	$ -	
		Tower Pump and Accessories for Process Water	1	ls	$1,842,963	$ 1,842,963		1	ls	$1,639,000	$ 1,639,000	
		Tower Pump and Accessories for Chilled Water	1	ls	$1,220,138	$ 1,220,138		1	ls	$0	$ -	
		Chilled Water Pump	1	ls	$1,191,250	$ 1,191,250		1	ls	$0	$ -	
		Controls	1	ls	$784,983	$ 784,983		1	ls	$784,983	$ 784,983	
		Pump for RF Surface water system (for 10 plants)	1	ls				1	ls	$2,416,000	$ 2,416,000	
		Heat Exchanger for RF Surface water system (for 10 plants)	1	ls				1	ls	$2,314,000	$ 2,314,000	
	1.7.5.2.2	Primary Stations and Piping					$ 9,987,962					$ 3,727,000
		Chillers	1	ls	$5,347,115	$ 5,347,115		1	ls	$0	$ -	
		Tower Piping for Process Water (surface)	1	ls	$821,952	$ 821,952		1	ls	$650,000	$ 650,000	
		Tower Piping for Chilled Water (surface)	1	ls	$489,039	$ 489,039		1	ls	$0	$ -	
		Tower Piping for Process Water (shaft)	1	ls	$1,679,547	$ 1,679,547		1	ls	$951,000	$ 951,000	
		Chilled Water Piping (surface)	1	ls	$286,335	$ 286,335		1	ls	$0	$ -	
		Chilled Water Piping (shaft)	1	ls	$1,363,974	$ 1,363,974		1	ls	$0	$ -	
		Piping RF Surface Water System (for 10 plants)	1	ls				1	ls	$2,126,000	$ 2,126,000	
	1.7.5.3	Secondary Stations					$ 142,255,383					$ 55,485,000
	1.7.5.3.1	Demineralized Water Stations and Distribution Piping					$ 69,245,357					$ 34,882,000
		Demineralized Pump/Skid System w/ Materials & Installation	1	ls	$69,245,357	$ 69,245,357		1	ls	$34,882,000	$ 34,882,000	
	1.7.5.3.2	Chilled Water Stations and Distribution Piping					$ 32,456,126					$ -
		Heat Exchangers (cavern)	1	ls	$1,726,838	$ 1,726,838		1	ls	$0	$ -	
		Distribution Pumps (cavern)	1	ls	$1,649,580	$ 1,649,580		1	ls	$0	$ -	
		Piping (cavern)	1	ls	$399,846	$ 399,846		1	ls	$0	$ -	
		Piping (tunnel)	1	ls	$19,274,532	$ 19,274,532		1	ls	$0	$ -	
		Piping Connections to End Equipment	1	ls	$9,405,330	$ 9,405,330		1	ls	$0	$ -	
	1.7.5.3.3	Water Stations and Distribution Piping					$ 14,473,690					$ -
		Water Stations and Distribution Piping	1	ls	$14,473,690	$ 14,473,690		1	ls	$0	$ -	
	1.7.5.3.4	Compressed Air					$ 2,404,000					$ 2,404,000
		Compressed Air	1	ls	$2,404,000	$ 2,404,000		1	ls	$2,404,000	$ 2,404,000	
	1.7.5.3.5	Process Water Distribution					$ 23,676,210					$ 18,199,000
		Heat Exchangers (cavern)	1	ls	$2,772,791	$ 2,772,791		1	ls	$1,845,000	$ 1,845,000	
		Distribution Pumps (cavern)	1	ls	$1,879,121	$ 1,879,121		1	ls	$1,601,000	$ 1,601,000	
		Piping (cavern)	1	ls	$661,007	$ 661,007		1	ls	$316,000	$ 316,000	
		Piping (tunnel)	1	ls	$16,515,925	$ 16,515,925		1	ls	$14,437,000	$ 14,437,000	

Page 4 of 5

ILC International Linear Collider

CONVENTIONAL FACILITIES & SITING - Americas Region

9/4/08

RDR MAR 30 2007

A5
Main Linac
Denotes changed item
Denotes new item

KLY Power Cluster Scheme for Aug 29 2008

A5
Main Linac

				FINAL CONTRACT COST- in 2006 US$ (except where noted)			FINAL CONTRACT COST- in 2006 US$ (except where noted)		
				Man-Hours Total		$ Total	Man-Hours Total		$ Total
	Piping Connections to End Equipment	1	ls	$1,847,365	$ 1,847,365		1 ls	$0 $ -	
1.7.6	HANDLING EQUIPMENT					$ 11,300,000		2,511 Man-Hrs	$ 11,300,000
1.7.7	SAFETY EQUIPMENT					$ 14,020,000		2,492 Man-Hrs	$ 11,216,000
1.7.8	SURVEY AND ALIGNMENT					$ 27,431,000		6,096 Man-Hrs	$ 27,431,000

LEGEND (AUG 21 2008)

- Changes in RDR $amount or quantities for the KLY cluster scheme
- New line item added for the KLY cluster scheme
- **Still to be corrected in RDR**

LEGEND (RDR Dec 2006)

- Main CFS WBS level (1.7)
- Second level of WBS (1.7.1 to 1.7.8)
- Third level of WBS
- Fourth level of WBS detail

CFS criteria for KlyCluster study

Criteria Comparison.xls [Compatibility Mode]

Draft - Started Jul 17 2008

DRAFT Sep 18 2008

blue shade indicate numbers that are arbitrarily adjusted to increase water delta T in post RDR

notable differences ??

Criteria Comparison - Main Linac RF (except where noted with *)

Items shown per RF (except where noted with *)	units	ILC						TESLA		XFEL		CLIC	Proj X
		RDR	POST-RDR (RF on & off) (from Shigeki, et. al.)	POST-RDR (RF on & off) (from Wilhelm)	RF Off?? (frm Adolphsen)	KLY Cluster (frm Adolphsen)	ILC CFS Workshop Jun 08	RF On	RF Off	RF On	RF Off		
*Tunnel Scheme		deep two-tunnel				single tunnel	??	near surface single-tunnel		near surface single-tunnel		???	near surface single-
Process Water Circuit (RF watercooled components)													
Collector Heat Load to water	KW	45.8 Shigeki/Adolphsen et. al.		30? (wilhelm)	60	45.8		31.9	91.13		282		
Location		service tunnel				surface	surface	tunnel		tunnel			
Collector Water Flow given	l/min	not given	37		37	37		35			282		
	gpm	not given	9.77		9.8	9.8		9.25			74		
Collector Water Delta T	C	not used	18		23	18					14		
	F	not used	32		42	32					26		
Maximum allowable Temperature	C	not given	87		87	87							
	F	not given	189		189	189							
Maximum allowable pressure	Bar	not given	15		15	15							
	Psi	not given	59		59	59							
Pressure drop	Bar	2	0.3		0.3	0.3							
	Psi	29	32		32	32							
Supply Temperature Stability		not given	none										
Circulator Heat Load to water (for 26 qty)	KW	not given	2.49										
Circulator quantity per RF		26						36		32			
Circulator Water Flow	l/min	not given	26.78					28.8					
	gpm	not given	7.1					7.6					
Maximum allowable Temperature	C	not given											
	F	not given											
Maximum allowable pressure	Bar	not given											
	Psi	not given											
Pressure drop	Bar	not given											
	Psi	not given											
Supply Temperature Stability		+ - 2.5 C											
RF Load Heat Load to water	KW	none	30.05										

KlyCluster est did not use Chilled Water!

Criteria Comparison.xls [Compatibility Mode]

Draft - Started Jul 17 2008

DRAFT Sep 18 2008

Criteria Comparison - Main Linac RF (except where noted with *)

blue shade indicate numbers that are arbitrarily adjusted to increase water delta T in post RDR

notable differences ??

Items shown per RF (except where noted with *)	units	ILC						TESLA		XFEL		CLIC	Proj X
		RDR	Use for VE Schemes: POST-RDR (RF on & off) (from Shigeki, et. al.)	POST-RDR (RF on & off) (from Wilhelm)	RF Off?? (frm Adolphsen)	KLY Cluster (frm Adolphsen)	ILC CFS Workshop Jun 08	RF On	RF Off	RF On	RF Off		
*Tunnel Scheme		deep two-tunnel				single tunnel	??	near surface single-tunnel		near surface single-tunnel		???	near surface single-
Chilled Water Circuit (Watercooled Racks and other heat load to air)													
Tunnel Space Temperature	C	29	> 40		> 40	Negligible 'Heat load to air' in the tunnel in this scheme??							
	F	85	**> 104 ?**		**> 104 ?**								
Tunnel temperature Stability	%	none	none		none								
Tunnel Space Humidity	%RH	non-condensing	none		none								
Heat Load to Air (waveguide) beam tunnel	KW	none given	5.9		5.9								
Heat Load to Air (RF component) svc tnl	KW	10.1	Ignored. (very warm tunnel space)??		Ignored. (very warm tunnel space)			assumed none (??) absorbed in tunnel wall		assumed none (??) absorbed in tunnel wall			
Heat Load to Air (non-rf component)	KW	16											
Heat Load to Air in w/m	w/m	687											
RACKS Total Heat Load per RF	KW	11.5	5.75 reduced to 50%			Only 1 KW remain in tunnel. (10 kw remain in surface							
RACKS Minimum supply temperature	C	non-condensing								18			
	F	non-condensing								64.4			
*Conceptual Design Scheme		watercooled racks supplied with blended cold water (from chilled water)	self contained racks with chiller supplied with process water (rack w chiller cost not by ofs)			only 1 kw rack in tunnel(ignored). The other cluster in surface used underfloor data center aircooling						existing cold water, available at the center point of the accelerator	
*Total load to Chilled Water (RF+Rack+non-RF)	KW	37.6			none	0							
*Supply Temperature used in chilled water	C	6	Chilled Water distribution- not used.		Chilled Water distribution- not used.	Chilled Water distribution- not used.				6			
	F	43								43			
*Delta T used in chilled water	C	10						12		6			
	F	18						21.6		10.8			
*Total Load for a representative water plant	MW	3.9											
*Total Flow per representative plant	l/min	5614											
	gpm	1483											
*Main Pipe Size in representative plant	mm	250											
	in	10											

Comparison of klyCluster vs. RDR Estimates

SENSITIVE COST ESTIMATE INFORMATION

Peter H. Garbincius and Tom Lackowski

August 22 2008 revised September 4, 2008

for incorrect +/- sign – changes higlighted in yellow

filename: klyCluster_estimate_4sept08.doc

note: Adjusted RDR Estimate => The total CFS base number has been corrected to reflect the actual costs of the shaft base cavern spaces that were based on overestimated, incorrect cavern volumes (6 * 15,334 m^3 = 92,0006 m^3) in the RDR estimate. The Americas' ML RDR estimate ($ 1,160.9 M) was first adjusted to more correct (6 * 2,795 m^3 = 17,852 m^3) shaft base cavern volumes (=> $ 1,116.1 M), to which the estimates for the alternative klystron placement was compared. This was done so that the savings reflected for the new klystron scheme were not artificially inflated.

This is for Main Linac only for 560 RF units	adjusted RDR estimate	klyCluster estimate	2007 $ difference (negative => savings)
Americas' only CFS Estimate (2006 unit costs)			
reference spreadsheets: 30march07, 29aug08	$ 1,116.1 M	$ 821.8 M	- $ 294.3 M
escalate difference 2006 => 2007 @ 1.106			- $ 325.5 M
CF&S institutional labor	271 K man-hrs	195 K man-hrs	- 76 K man-hrs

Remove ~ 2*11 meters of WR 650 wg per RF unit
between klystron and cryomodules through penetration
and across beam and service tunnels
at $ 249 per meter (2006) = $ 5.48 K/RF unit * 560 RF units
= $ 3.1 M escalate difference 2006 => 2007 @ 1.0323 -$ 3.2 M
I assume all other RF hardware, plumbing, & accessories are needed
HLRF WBS SUM 121906 rsl-mn.xls
PHG: I don't understand Ray Larsen's spreadsheet line 44 so just use his base quote of $ 249/meter

Add ~ 1,370 meters of RFpipe per 30 RF units
at $ 1 K per meter * 560 RF units +$ 25.6 M
estimate from Chris Adolphsen (28july08)

Add $ 20 K per RF unit for coaxial RF couplers * 560 RF units +$ 11.2 M
estimate from Chris Adolphsen (28july08)

Add extra control and LLRF cables, alcoves, RTML services in ML tunnel,
radiation shielding of tunnel electronics, & needed other stuff not estimated

total change in 2007 $ (negative => savings) +$ 33.6 M - $ 325.5 M = -$ 291.9 M

Note: This difference estimate is only for Main Linac (560 RF units). There are another similar 32 RF units and service tunnel for RTML. This covers 2*BC2(15 RF units each) + 2*BC1(only take 1 RF unit each since the 100% backup can be provided by the other high power RF drivers on the same RF pipe). So, as a first order, average estimate of the savings for the combined Main Linac + RTML-BC1 + RTML-BC2 would be to multiply by (560+32)/560 = 1.057. Notice that this coupling of RF drivers could also remove two RF driver systems for the backups for RTML BC1's which is approximately $ 1.164 M (2006) * 1.0323 = $ 1.2 M (2007) each. This could be partially offset by needs of 2 additional RTML shafts for these Rfpipes. Similar savings by removing second tunnel for Electron Source, Positron Source, and Beam Delivery Systems have NOT been considered yet.

Peter

230 GeV e+e- study was a 36-step process

PLC_studies_PHG_feb09.xls
tab: 230 e+e-

Michael Peskin wants to know how this cost scales with energy around 230 GeV, e.g. 200, 230, 260 GeV

This uses a conventional positron source, see Kuriki notes, instead of undulator
The 100 GeV Main Linacs are such that the end of the RTML is still within the position of undulator source so no interference for upgrade later
This method (see tab: Geometry) can go up to 259 GeV e+e- without interfering with undulator positron source

So what needs to be done:

Electron Source:

done	nothing to do, remains as is

Positron Source:

done	remove undulator insert cost, both civil and technical
done	removed Keep Alive Positron source, but re-used target, dump, collection stages from undulator source
done	keep positron source tunnel
done	add a conventional positon source in postron source tunnel (dual gun)
done	2.2 GeV electron source (assume you can get required 4.5 nC charge per bunch for same cost)
use same estimate	forced flow liquid lead production target - Sheppard had 3.9 M ILC in RDR, Kuriki-san says a few * $ 100 K
done	beam dump for XXX MW don't use 19 MW upgrade dumps => could use 5 MW dumps scaling by energy
done	then add same positron source OMD, acceleration, transport
did not add	Kuriki-san's Lithium Lens

Damping Rings: remain Identical from RDR design

done	remain Identical to RDR design

RTML:

done	keep 90-degree bends from DR, and 180-degree turn-arounds identical
	scale length and cost of long transport from 90-degree bend to 180-degree turn-arounds by length of main linac
	of course, problem is figuring out how much of this is what....
done	scaled length of long transport vacuum by 0.417 (see page 5)
done	removed 233 RETURNCELLEs = 4 quads, 3 trims, 2 BPMs each (see page 5)
done	scaled cost of power supplies by new cost of RTML magnets = 0.855 (see page 5-6)

Main Linac:

done reduce/scale energy/length by 2*(250-15)=2*235=470 to 2*(115-15)=2*100=200 = 0.425532

done remember to reduce length of service tunnel = shared with e- and e+ service tunnels (previously shared with BDS)

done How many RF units and magnets are needed w 560 238.2979 round to 240 120 per side

done How many cryo plants ? Was (per side) 5 2.12766 This is more than 2, we could have 3 smaller plants per side or two bigger plants per side - what is cost scaling?

scale by total energy for RTML + ML

done How many shafts needed? assume 2 each per side 14 m dia - same for base cavern

done Surface structures and site development - scale by number of sites => 6 => 4

done Learning Curve, 86% Wright => comparing 613 with 613-560+240=293 => extra cost for <RF and CM> is 1.173

this applies to ALL CM and RF units: e-, e+, RTML, and ML I'll call this "Learning Curve extra cost"

BDS:

done reduce length from 2620 meters each side to 800 meters each side 0.305344 remember full length service tunnel

reduce technical components & "utilities" 500 GeV to 230 GeV each side 0.46

Also:

reduce all utilities and common technical stuff

	technical	"utilities"	
e-	n.a.	n.a.	
e+	done	done	
DR	n.a.	n.a.	
RTML	done varies	ignore	see 8feb09 - page 7
ML	done 0.425	done 0.425	also scaled # sites by 4/6
BDS	done 0.46	done 0.46	
Exp Hall	n.a.	n.a.	
Common	n.a.	done 0.640	this is scaling common central transfomers for new total power at reduced energy

done see page 9: for outsourced engineering on surface structures + site development,

I used (average oursourced engineering rate) * (case multiplier) * (average surface + site)

where "average" = (European+Asian+Americas)/3

this really should have been

(European eng rate) * factor * (Euro surface+site)

plus (Asian eng rate) * factor * (Asian surface+site)

plus (Amercia eng rate) * factor * (America surface+site)

last step 36 => see pages 13-14

Questions & Comments on Nick's List

- ***e- Source:*** easy! where? service tunnel/caverns?
- ***e+ Source:*** keep undulator source, not conv e+ what is QWT?, what about Lithium lens? What is aux. e- linac for e+ production? Warm or cold? Where is it located wrt ML/BDS, undulator, RTML?
- ***DR:*** RDR had 6.7 km OSC6 - Susanna (today) has a 3.3 km DCO racetrack with straights = 2*1 km and R_{arcs} = 200 m => close to TBM turning limit need new estimate using new component #s
- ***RTML:*** remember impact of 210 m shorter single BC on long transfer lines – Nikolay has new # of similar comps – same (or scaled) RDR unit costs

Nick's List - continued

- ***Main Linac:*** need better estimates for 300 MW RF pipe & couplers, DRFS klystrons & modulators, space considerations for 1-tunnel and shafts
- ***BDS:*** what configurations will we estimate?
  500 GeV easily upgradable to 1 TeV
  Checks of design & simulation for traveling focus.
- ***Low-P:*** specify all configurations:
  half-number of klystrons, full number of klystrons, upgradability: during operations? 1 or 2 tunnels, with or without Klystron Cluster (easy on surface)
  Is immediate upgrade considered a cost saving?

Peter's simple ?s on central region

- impacts to RDR geometry
  - Length of new BDS? (~ same as old = ± 2226 m), where e- source, e+ source, RTML lines join? ***Ewan: anywhere***
  - Longer RTML lines, different e+ 5 GeV injection line to DR
  - Flexibility in locating e- Source => facilitate commissioning
  - Any ML needed d.s. of undulator? ***ε-growth acceptable***
  - Transverse offset of DR straights from ML/BDS line?
  - Will have enough n*7^0 dipole bends for Spin Rotation
  - Crowding: ML 250 GeV e- bypass, aux. e- drive for e+, γ-beam from undulator, e- RTML, target station with shielding (***how much?***), and don't forget serviceability
  - Do any of these systems require service tunnels or special service caverns?

Peter's Final Comments/Questions

- We've started to see updates to the risk register!
- How do we weigh a cost estimate impact versus machine availability?
- Yes, we all agree that we must work together to produce this new Strawman Baseline!
  Is there enough personnel resources to do it?
- Ewan asked for answers on Central Region Integration Case 3 by this afternoon ~ like now!
- Do we know what we need to do in order to have differential cost impacts for Albuquerque?

ICET cost estimate template (enable macros):

http://www-ilcdcb.fnal.gov/example_26march09-Construction.xls

discussion during & after presentation:

- Barry: how do we deal with currency exchange rate changes? Past and Future? PPP index? How complicated do we need to be?
- Nick: preparing for Albuquerque meeting: need deadline for submission of pre-information likely prioritization of studies (limited resources)
- Peter: need to better specify information needed from TAGLs and estimators
  Nick: show estimate info in ICET template require only simple TAGL input to be logged by ICET experts