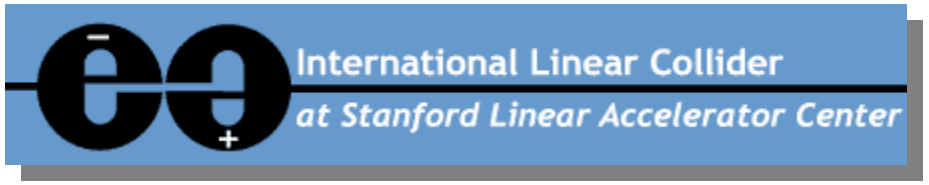


DUMPS, STOPPERS & COLLIMATORS

NLC 1999-ERA COST ESTIMATES

Eric Doyle

3 May 2006

Methodology & Status

- **Defined generic boundaries (mech/elect/civil)**
- **Identified all instances in NLC**
- **Assigned engineering names**
- **Tabulated numerical values of specs**
- **ID'd existing devices for use as cost models**
- **Cost estimates**
  - **Existing models/prototypes where possible**
    - ZDR (most estimates in this category)
    - SLAC Archives
  - **Bottom up cost where necessary/possible**
  - **Evolved from '99 – '01**

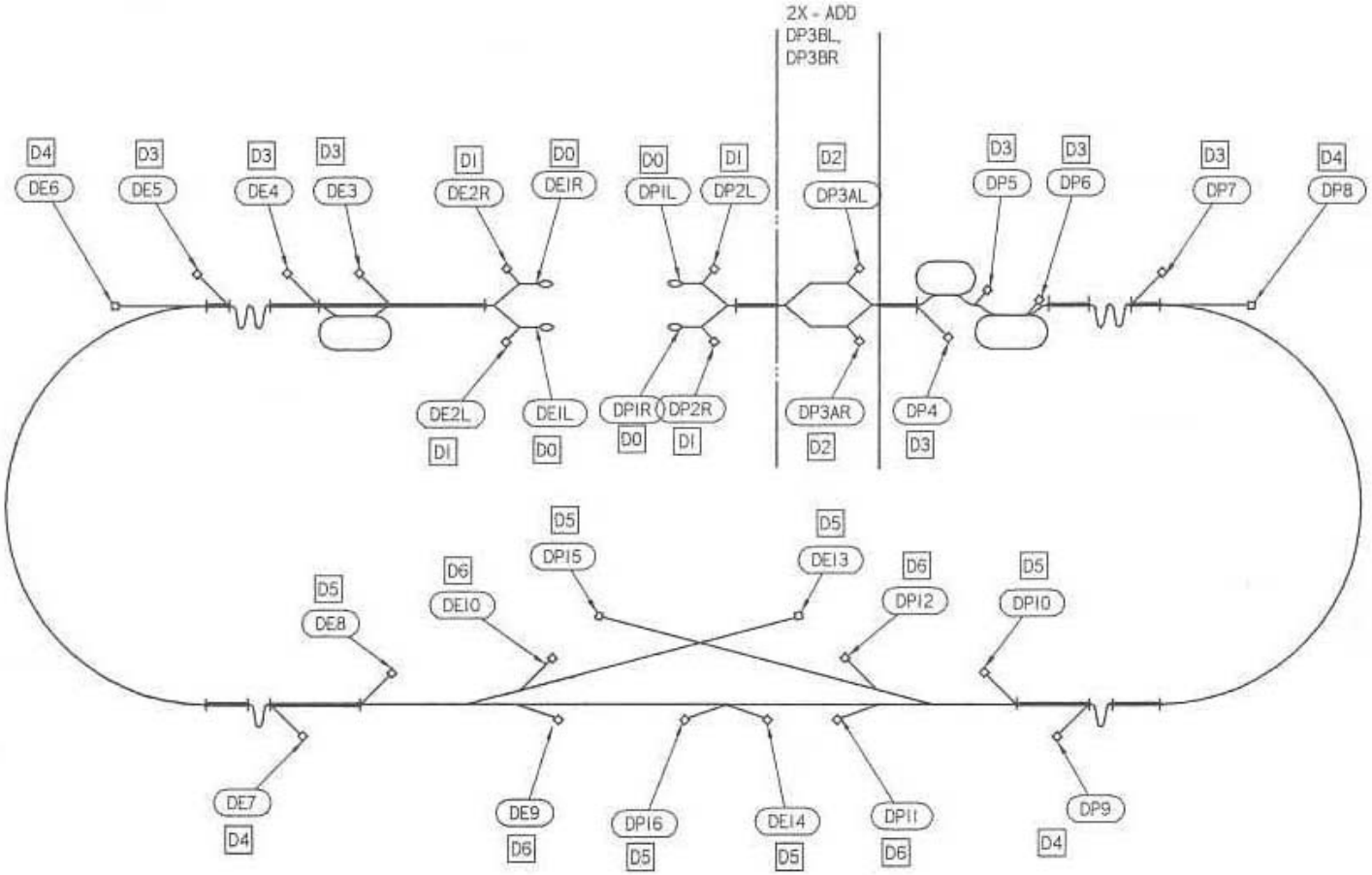
Dumps, Stoppers, Collimators 5/99 Summary

Dumps
Current Count: 23 total, ~6 styles
Prototypes Available
Mech Costs in WBS: ZDR
Controls Costs in WBS: ZDR
Rolled-up Cost: $4.6M

Stoppers
Current count: 67 total, ~7 styles
Prototypes Available
Mech Costs in WBS: 10kw Prototype (1998)
Controls Costs in WBS: ZDR
Rolled-up Cost: $2.4M

Collimators
Current Count: 106 total, ~15 styles
Mech Costs in WBS: ZDR
Controls Costs in WBS: Detailed Estimate (1994)
Rolled-up Cost: $9.1M

Dumps – System Layout



Dumps – Brief Specs

Area	Eng Name placeholder	Beam Energy	Power	Number
Injection - sources	D0	120KeV	<1.0 kW	4
Injection - sources	D1	80MeV	5 kW	4
Injection - sources	D2	240MeV	30 kW	4
Injection – DR + BC	D3	2GeV	65 kW	7
Injection – BC	D4	8GeV	250 kW	4
Beam Delivery	D5	750GeV	13 MW	6
Beam Delivery	D6	750GeV	140 kW	4

Eng Name placeholder	Type
D0	Cu cylinder, free convection/radiation cooling
D1	Cu cylinder, water cooled periphery
D2	Cu cylinder, water cooled periphery
D3	Al cylinder, water cooled periphery
D4	Al spheres in water bath + water cooled steel cyl
D5	Water bath + water cooled Cu plates
D6	Not decided, single bunch continuous operation

Dumps - Cost

dumps CD 0.4 cost 4/4/00 rev 5/10/00

Note: several dump prototype-models available for costing – see Reference Slides

unit costs

					mech unit costs (k$)			controls unit costs (k$)		
wbs	**dump I.d. (1)**	**engrg name**	**qty**	**prototype**	**m&s**	**ed&I (20%)**	**basis**	**m&s**	**ed&I (25%)**	**basis**
1.2.2.x	DP-1	EN_D1	1	exstg	18	3.6	zdr x 1.12	0	0	zdr x 1.12
1.2.2.x	DP-2	EN_D1	1	exstg	18	3.6	zdr x 1.12	0	0	zdr x 1.12
1.2.2.x	DP-3	EN_D2	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.2.2.x	DP-4	EN_D2	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.2.3.x	DP-5A	EN_D3	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.2.4.x	DP-7	EN_D3	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.2.4.x	DP-8	EN_D4	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.2.4.x	DP-9	EN_D4	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.4.2.x	DP-10	EN_D5	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.4.2.x	DP-11	EN_D6	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.4.2.x	DP-15	EN_D5	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.4.2.x	DP-12	EN_D6	0							
1.4.2.x	DP-16	EN_D5	0							
1.2.2.x	DE-01	EN_D1	1	exstg	18	3.6	bong	0	0	zdr x 1.12
1.2.2.x	DE-02	EN_D1	1	exstg	18	3.6	bong	0	0	zdr x 1.12
1.2.2.x	DE-1	EN_D1	1	exstg	18	3.6	zdr x 1.12	0	0	zdr x 1.12
1.2.2.x	DE-2	EN_D1	1	exstg	18	3.6	zdr x 1.12	0	0	zdr x 1.12
1.2.3.x	DE-3	EN_D3	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.2.4.x	DE-5	EN_D3	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.2.4.x	DE-6	EN_D4	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.2.4.x	DE-7	EN_D4	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.4.2.x	DE-8	EN_D5	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.4.2.x	DE-9	EN_D6	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.4.2.x	DE-13	EN_D5	1	exstg	140	28	zdr x 1.12	6.2	1.55	zdr x 1.12
1.4.2.x	DE-10	EN_D6	0							
1.4.2.x	DE-14	EN_D5	0							

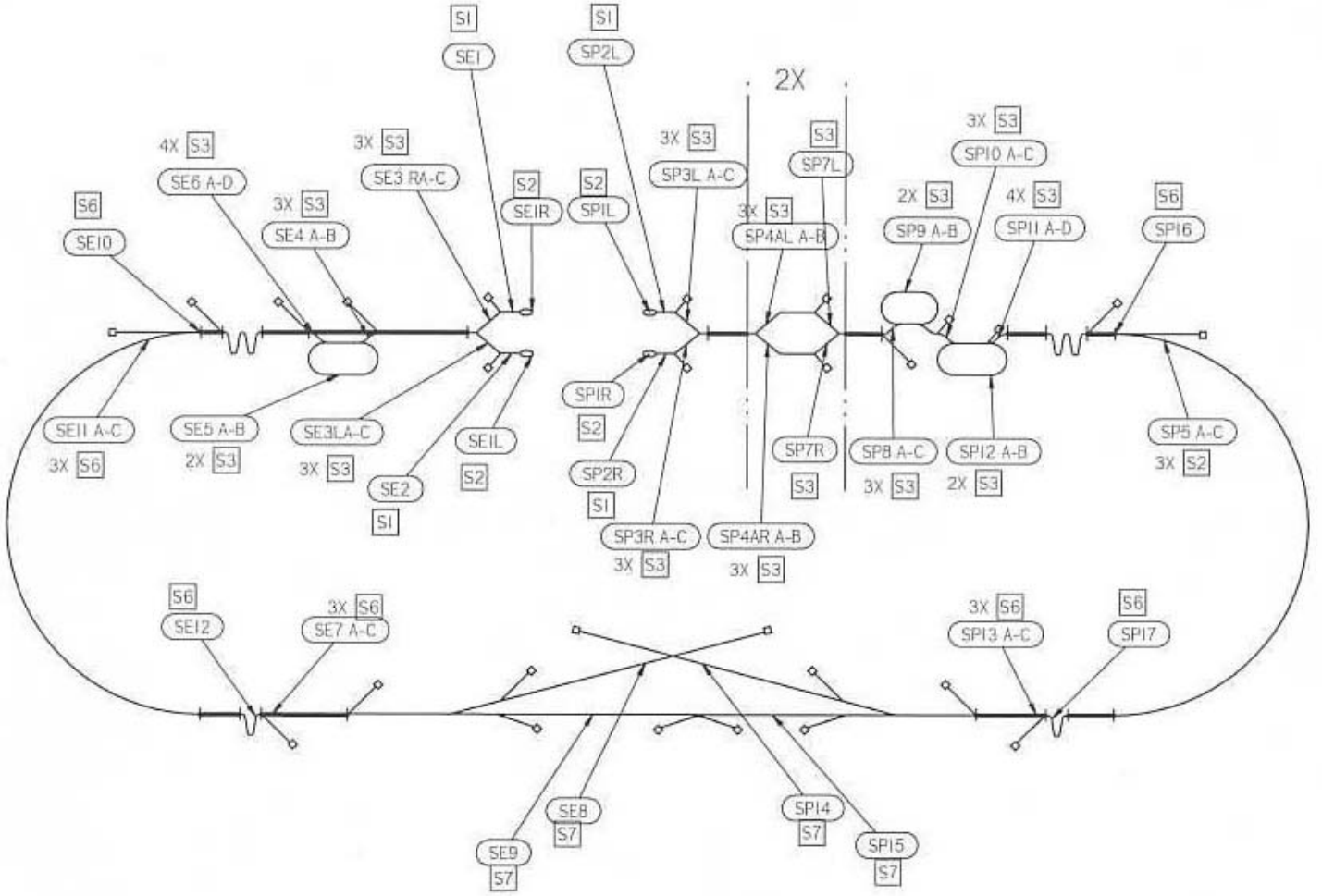
~1999 Cost Model & Caveats
Dump Vessel

Welded low-carbon stainless (316L) plate with robotic/semi-robotic window replacement

- **While few US facilities could handle the size, not really a technical challenge**
- **Welds X-rayed**
- **1965 costs scaled by Walz to produce 1996 estimate, which in turn scaled by Eriksson/Doyle to produce 1999 and 2001 estimate of $165k**
  - At the time materials priced at $50k
- **Recent discussions with Walz/Doyle lead do $1.5M upper limit for industrial production of a 20MW sized dump**

International Linear Collider
at Stanford Linear Accelerator Center

Stoppers – System Layout



Stoppers – Brief Specs

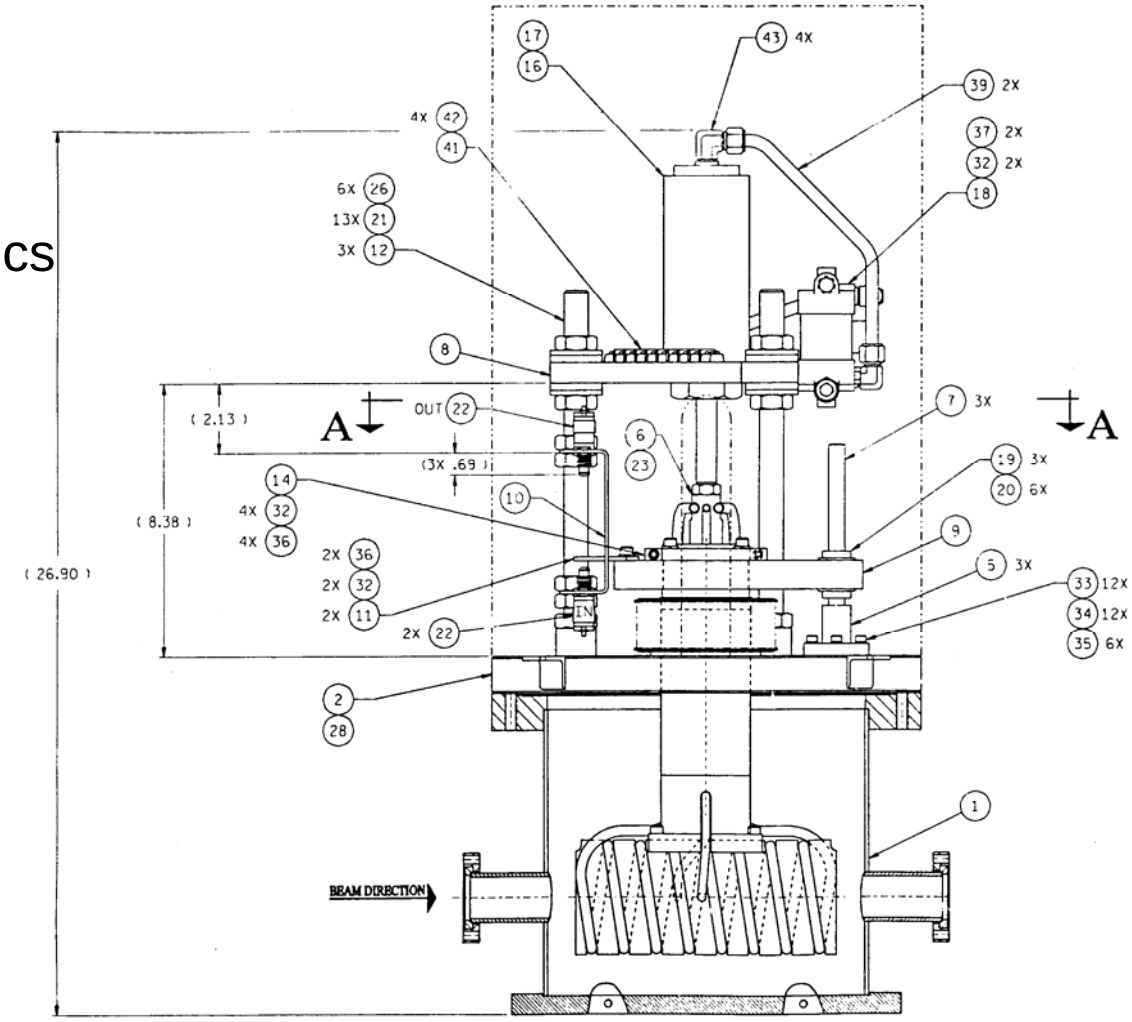
Area	Eng Name placeholder	Beam Energy	Duty cycle	Type	Number
Injection – sources	S1	120 keV	1 pulse	Quick stopper	4
Injection – sources	S2	120 keV	1 pulse	Laser safety stopper	4
Injection –sources, DR, BC	S3 *	80Mev – 8GeV	1 pulse	PPS stopper	63
Beam Delivery	S7	750 GeV	1 bunch @ 10Hz	1 bun, 10 hz inline tune up	4

* More than one design may be needed to fill this range of energies

Eng Name placeholder	Description
S1	TBD
S2	TBD
S3	Water cooled Cu slug, pneumatically actuated, like PEP II 10 KW
S7	Water cooled Cu slug, pneumatically actuated, precision minimum wakefield bore

Stopper - Model

Stopper Prototype
- PEP II Injection Diagnostics
- SA-344-660-67
-10 kw, 10 GeV
- 1999 cost available,
  not included yet



Stoppers - Cost

stoppers_cost CD 0.4 4/5/00 rev 5/10/00

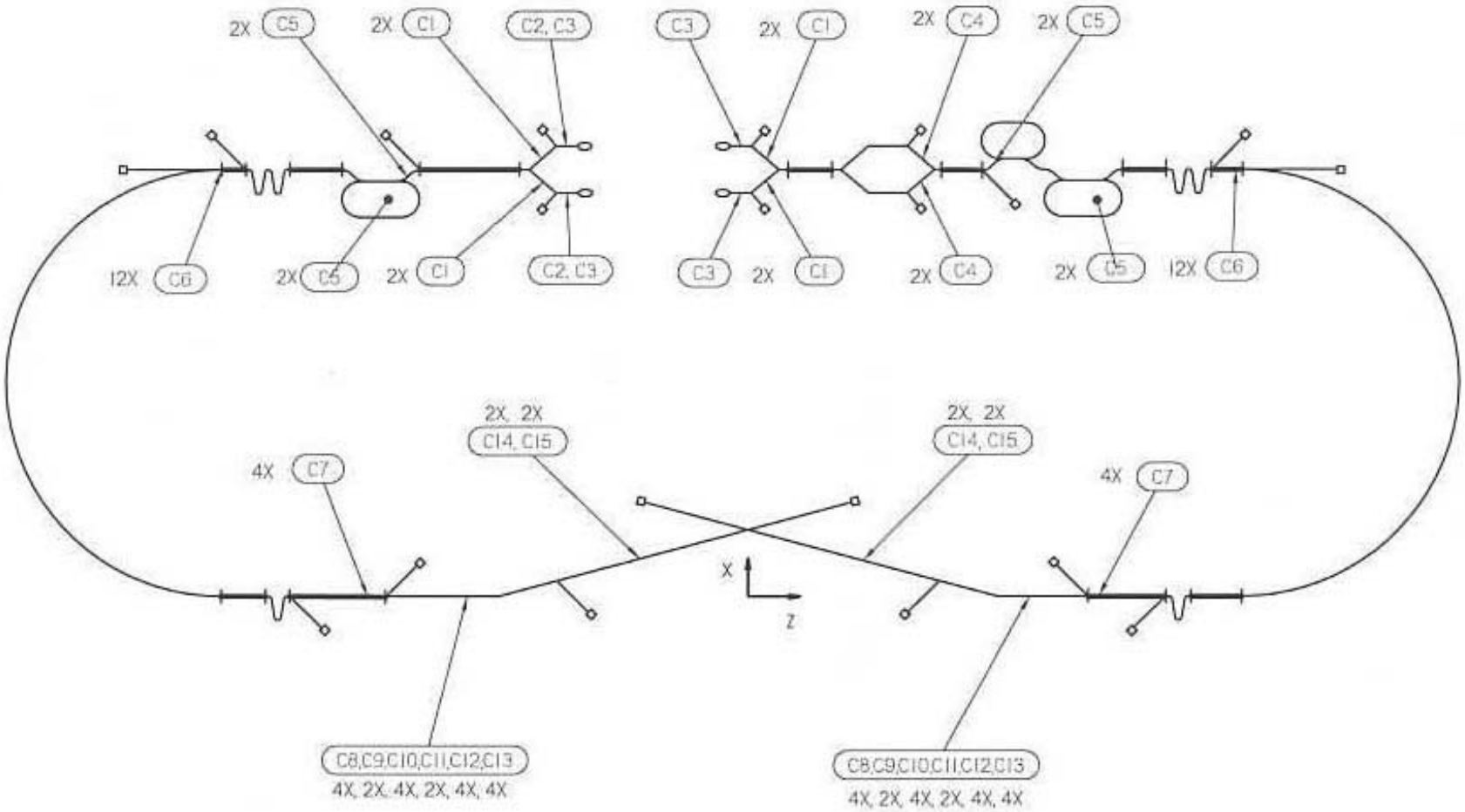
not included in roll-up @ this time

rev notes: 8 units removed from pre-linac areas, commercial markup = zero

unit cost estimates (2)

					mech unit costs (k$)			controls unit costs (k$)		
wbs	stopper I.d.	eng. name (1)	qty	prototype	m&s	ed&I (20%)	basis	m&s	ed&I (25%)	basis
1.2.2.x	SP-5 A-B	EN-S3	2	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.2.x	SP-6 A-B	EN-S3	2	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.2.x	SP-7	EN-S3	1	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.2.x	SP-8	EN-S3	1	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.3.x	SP-9 A-C	EN-S4	3	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.3.x	SP-10 A-C	EN-S5	3	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.3.x	SP-11 A-H	EN-S4	8	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.3.x	SP-12 A-C	EN-S5	3	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.4.x	SP-13 A-D	EN-S6	0	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.4.x	SP-14 A-D	EN-S6	4	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.4.2.x	SP-15	EN_D7	1	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.4.2.x	SP-16	EN_D7	0		21.2		PEP II inj diag ('98) x 1.06	6.2		zdr wbs x 1.12
1.2.2.x	SP-1	EN-S1	1	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.2.x	SP-2	EN-S1	1	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.2.x	SP-3 A-C	EN-S3	3	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.2.x	SP-4 A-C	EN-S3	3	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.2.x	SE-1	EN-S2	1	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.2.x	SE-2	EN-S2	1	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.2.x	SE-3 A-C	EN-S3	3	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.2.x	SE-4 A-C	EN-S3	3	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.3.x	SE-5 A-G	EN-S4	7	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.3.x	SE-6 A-C	EN-S5	3	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.4.x	SE-7 A-D	EN-S6	0	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.2.4.x	SE-8 A-D	EN-S6	4	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.4.2.x	SE-9	EN_D7	1	exstg	21.2	4.2	PEP II inj diag ('98) x 1.06	6.2	1.6	zdr wbs x 1.12
1.4.2.x	SE-10	EN_D7	0							

Collimators – System Layout



Collimators – Brief Specs

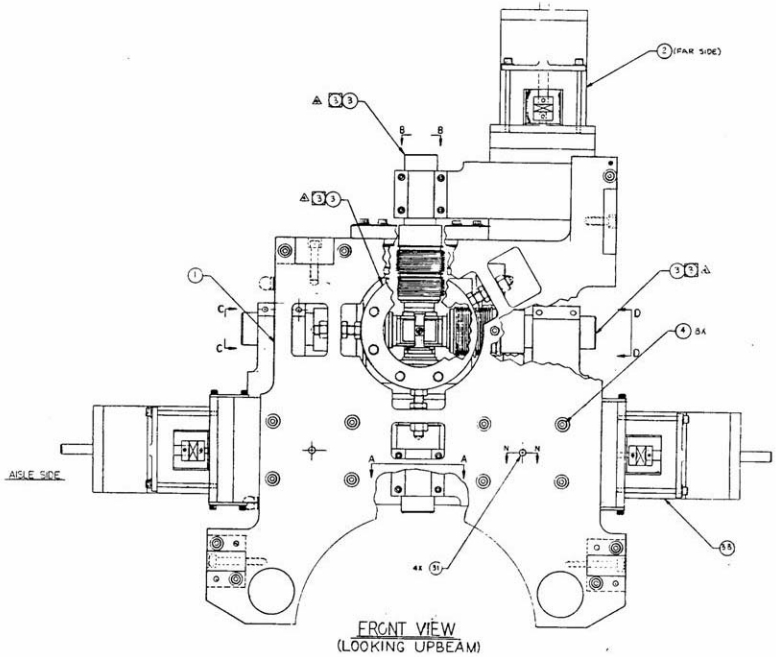
Area	Eng Name placeholder	Beam Energy	Beam power	Power Absorbed	Type	Number
Injection - sources	C3	120 keV	5kW		Jitter reducing iris	4
Injection - sources	C2	120 keV	5kW		Selectable pinhole	2
Injection - sources	C1X	120 keV	5kW		Energy defining, x	4
Injection - sources	C1Y	120 keV	5kW		Energy defining, y	4
Injection - sources	C4X	250 MeV	18kW		Energy defining, x	4
Injection - sources	C4Y	250 MeV	18kW		Energy defining, y	4
Injection -DR	C5X	2 GeV	50kW		X	4
Injection -DR	C5Y	2 GeV	50kW		Y	4
Injection Pre-collimation	C6	8 GeV	220kW		Pre-linac collimator	24
Linac	C7	750 GeV	13MW		Indexing surface one side only	8
Beam delivery	C8	750 GeV	13MW	~2W	Ti spoiler, adjustable, x	4
	C9	750 GeV	13MW	13kW	Cu absorber, adjustable, x	4
	C10	750 GeV	13MW	~1W	Adjustable spoiler, x	8
	C11	750 GeV	13MW	~1W	Adjustable spoiler, y	8
	C13	750 GeV	13MW	13kW	W absorber, fixed, round	16
	C12	750 GeV	13MW	0 dc; 1 b- train	Protection absorber, fixed, round	many

Eng Name placeholder	Type	Aperture
C3	Jitter reducing iris	TBD
C2	Selectable pinhole	TBD
C1X	Adjustable Titanium jaws	TBD
C1Y	Adjustable Titanium jaws	TBD
C4X	Adjustable Titanium jaws	TBD
C4Y	Adjustable Titanium jaws	TBD
C5X	Adjustable Titanium jaws	TBD
C5Y	Adjustable Titanium jaws	TBD
C6	Adjustable Titanium jaws	TBD
C7	Placeholder for possible future device	Indexing surface one side only
C8	Ti spoiler, adjustable, x,	1.2mm half gap
C9	Cu absorber, adjustable, x	2.0mm half gap
C10	Rotary consumable spoiler, x	.15 - .35mm half gap (.5 – 1 TeV)
C11	Rotary consumable spoiler, y	.15 - .35mm half gap (.5 – 1 TeV)
C13	Ti/Cu absorber	1mm radius bore
C12	Ti/Cu absorber	6mm radius bore

Collimators - Cost Models

Four Jaw Collimator Prototype

- SLC Sector 30
- SA-236-630-01
-1991 cost data available
  not included yet



Consumable Collimator

- NLC prototype
- ’00 – ’01 fabrication cost

International Linear Collider at Stanford Linear Accelerator Center

Collimator Costs

Some prototype-models available for costing not included yet – see Reference Slides

collimators CDR 0.4 3/21/00 rev 5/10/00
unit costs

(grey)	not included in this cost estimate
(yellow)	input data

rev notes: new cost for rot consum coll, new coll for gtl, commercial markup = zero

			proto	mech unit cost (K$)			controls unit cost (k$)		
wbs	**eng. Name (1)**	**qty**	**type**	**m&s**	**ed&I (.2)**	**basis**	**m&s**	**ed&I(.22)**	**basis**
1.2.2.x	EN-C3	2	exstg	36.0	7.2	zdr	16.0	3.52	zdr
1.2.2.x	EN-C2	1	exstg	36.0	7.2	zdr	16.0	3.52	zdr
1.2.2.x	EN-C2	2	exstg	36.0	7.2	zdr	16.0	3.52	zdr
1.2.2.x	EN-C1	4	exstg	36.0	7.2	zdr	16.0	3.52	zdr
1.2.2.x	EN-C3	2	exstg	36.0	7.2	zdr	16.0	3.52	zdr
1.2.2.x	EN-C1	4	exstg	36.0	7.2	zdr	16.0	3.52	zdr
1.2.2.x	EN-C4	4	exstg	36.0	7.2	zdr	16.0	3.52	zdr
1.2.3.x	EN-C5	2	exstg	40.7	12.21	zdr x 1.13 (a.r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.2.3.x	EN-C5	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.2.3.x	EN-C5	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.2.3.x	EN-C5	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.2.4.x	EN-C6	12	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.2.4.x	EN-C6	12	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	SPOCOLL	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	ABSCOLL	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	SPOCOLL	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	ABSCOLL	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	YSPOILER	2	exstg	78.3	23.49	prelim design	18.1	5.43	prelim design
1.4.2.x	XSPOILER	2	exstg	78.3	23.49	prelim design	18.1	5.43	prelim design
1.4.2.x	XABSORBR	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	YABSORBR	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	YSPOILER	2	exstg	78.3	23.49	prelim design	18.1	5.43	prelim design
1.4.2.x	XSPOILER	2	exstg	78.3	23.49	prelim design	18.1	5.43	prelim design
1.4.2.x	XABSORBR	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	YABSORBR	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	YSPOILER	2	exstg	78.3	23.49	prelim design	18.1	5.43	prelim design
1.4.2.x	XSPOILER	2	exstg	78.3	23.49	prelim design	18.1	5.43	prelim design
1.4.2.x	XABSORBR	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	YABSORBR	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	YSPOILER	2	exstg	78.3	23.49	prelim design	18.1	5.43	prelim design
1.4.2.x	XSPOILER	2	exstg	78.3	23.49	prelim design	18.1	5.43	prelim design
1.4.2.x	XABSORBR	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	YABSORBR	2	exstg	40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	EN-C14	0		40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	EN-C14	0		40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	EN-C15	0		40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)
1.4.2.x	EN-C15	0		40.7	12.21	zdr x 1.13 (a. r.)	18.1	5.43	zdr x 1.13 (a. r.)

Reference Slides

International Linear Collider at Stanford Linear Accelerator Center

Dumps - specs

dumps CD 0.4 specifications 4/4/00 rev 5/10/00

wbs	area	sub-area	dump ID (2)	qty	description	eng. name (1)	type	energy	beam size (3)	power	duty cycle	facilities
1.2.2.x	injection	sources	DP-1	1	polarized pos source left	EN_D1	Cu cyl, periph water cooled	80MeV	σ=1.5mm	10 kw	100%	.3gpm H2O
1.2.2.x	injection	sources	DP-2	1	polarized pos source right	EN_D1	Cu cyl, periph water cooled	80MeV	σ=1.5mm	10 kw	100%	.3gpm H2O
1.2.2.x	injection	sources	DP-3	1	pos capture section left	EN_D2	Cu cyl, periph water cooled	240MeV	σ=1.5mm	25 kw	100%	1gpm H2O
1.2.2.x	injection	sources	DP-4	1	pos capture section right	EN_D2	Cu cyl, periph water cooled	240MeV	σ=1.5mm	25 kw	100%	1gpm H2O
1.2.3.x	injection	damping	DP-5A	1	damping ring tuning dump	EN_D3	Al cyl, periph water cooled	2GeV	σ=1.5mm	50 kw	100%	6gpm, no Cu in water syst
1.2.4.x	injection	pre linac	DP-7	1	bc1	EN_D3	Al cyl, periph water cooled	2GeV	σ=.5mm	50 kw	100%	90gpm, rad water, no Cu in v
1.2.4.x	injection	pre linac	DP-8	1	pos pre linac beam abort	EN_D4	Al spheres/Al cyl, periph water cooled/steel cylinder	8GeV	σ=.5mm	220kw	100%	90gpm, rad water, no Cu in v
1.2.4.x	injection	pre linac	DP-9	1	pos pre linac bunch comp two beam	EN_D4	Al spheres/Al cyl, periph water cooled/steel cylinder	8GeV	σ=.5mm	220kw	100%	90gpm, rad water, no Cu in v
1.4.2.x	beam deliv	linac diag	DP-10	1	pos main linac	EN_D5	water/Cu plates,water cooled	750GeV	σ=.5mm	13 Mw	100%	1700gpm, rad water
1.4.2.x	beam deliv	final focus	DP-11	1	pos ff1 tuning	EN_D6	not decided	750GeV	tiny	140kw	1 bun 120hz	
1.4.2.x	beam deliv	dump line	DP-15	1	pos ir1	EN_D5	water/Cu plates,water cooled	750GeV	.4x.85	13 Mw	100%	1700gpm, rad water
1.4.2.x	beam deliv	final focus	DP-12	0	pos ff2 tuning	EN_D6				-		
1.4.2.x	beam deliv	dump line	DP-16	0	pos ir2	EN_D5	water/Cu plates,water cooled	750GeV	σ=.5mm	13 Mw		1700gpm, rad water
1.2.2.x	injection	sources	DE-01	1	low e polarimeter beam dump	EN_D1	Cu cyl, convect/rad cooled	120keV		5W	100%	
1.2.2.x	injection	sources	DE-02	1	low e polarimeter beam dump	EN_D1	Cu cyl, convect/rad cooled	120keV		5W	100%	
1.2.2.x	injection	sources	DE-1	1	polarized e source left	EN_D1	Cu cyl, periph water cooled	80MeV	σ=1.5mm	10 kw	100%	.3gpm H2O
1.2.2.x	injection	sources	DE-2	1	polarized e source right	EN_D1	Cu cyl, periph water cooled	80MeV	σ=1.5mm	10 kw	100%	.3gpm H2O
1.2.3.x	injection	damping	DE-3	1	damping ring tuning dump	EN_D3	Al cyl, periph water cooled	2GeV	σ=1.5mm	50 kw	100%	6gpm, no Cu in water syst
1.2.4.x	injection	pre linac	DE-5	1	bc1	EN_D3	Al cyl, periph water cooled	2GeV	σ=.5mm	50 kw	100%	90gpm, rad water, no Cu in v
1.2.4.x	injection	pre linac	DE-6	1	e pre linac beam abort	EN_D4	Al spheres/Al cyl, periph water cooled/steel cylinder	8GeV	σ=.5mm	220kw	100%	90gpm, rad water, no Cu in v
1.2.4.x	injection	pre linac	DE-7	1	e pre linac bunch comp two beam	EN_D4	Al spheres/Al cyl, periph water cooled/steel cylinder	8GeV	σ=.5mm	220kw	100%	90gpm, rad water, no Cu in v
1.4.2.x	beam deliv	linac diag	DE-8	1	e main linac	EN_D5	water/Cu plates,water cooled	750GeV	σ=.5mm	13 Mw	100%	1700gpm, rad water
1.4.2.x	beam deliv	final focus	DE-9	1	e ff1 tuning	EN_D6	not decided	750GeV	tiny	140kw	1 bun 120hz	
1.4.2.x	beam deliv	dump line	DE-13	1	e ir1	EN_D5	water/Cu plates,water cooled	750GeV	.4x.85	13 Mw	100%	1700gpm, rad water
1.4.2.x	beam deliv	final focus	DE-10	0	e ff2 tuning	EN_D6				-		
1.4.2.x	beam deliv	dump line	DE-14	0	e ir2	EN_D5	water/Cu plates,water cooled	750GeV	σ=.5mm	13 Mw	100%	1700gpm, rad water

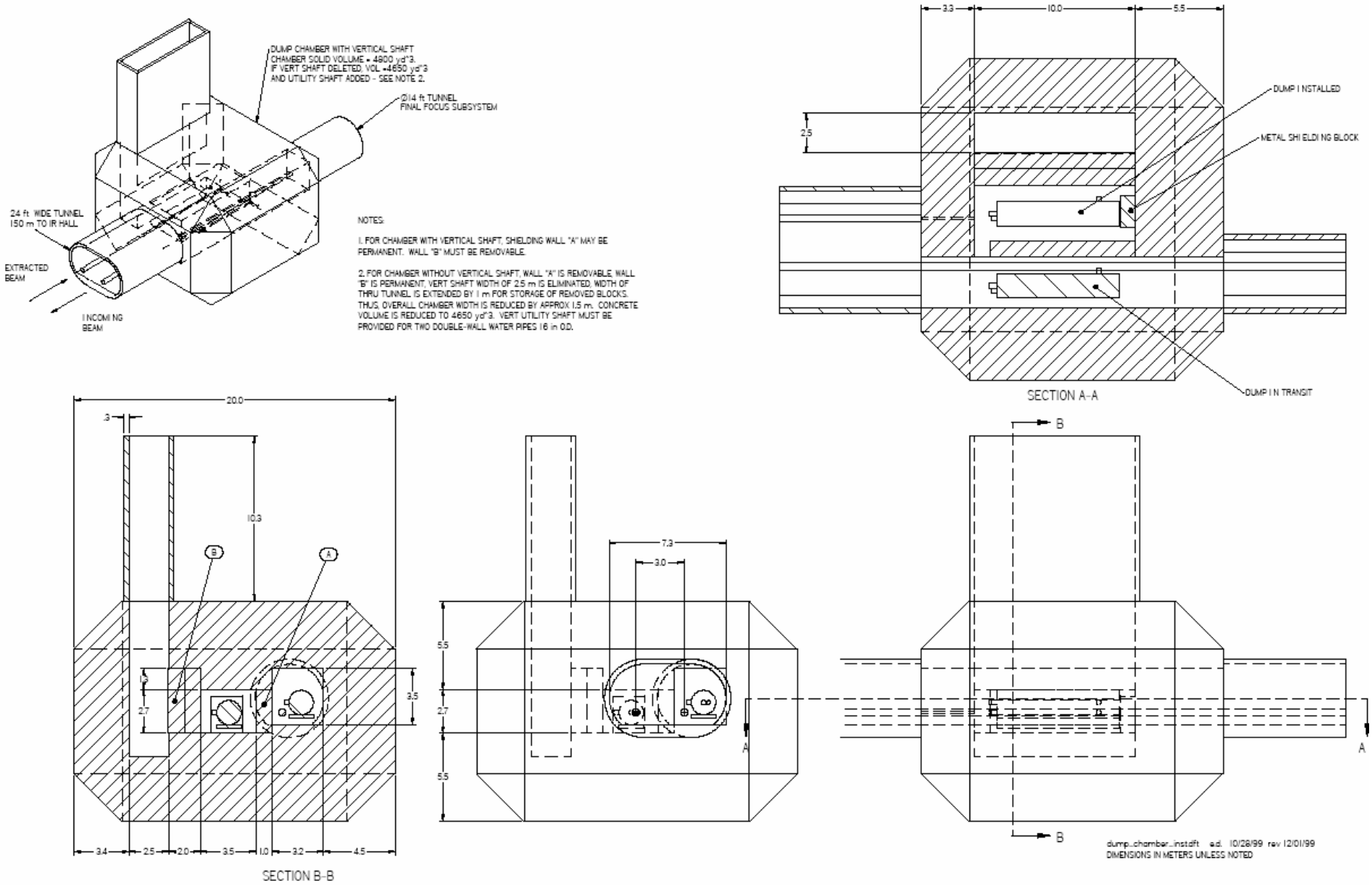
Dumps - Models

dumps CD 0.4 specifications 4/4/00 rev 5/10/00

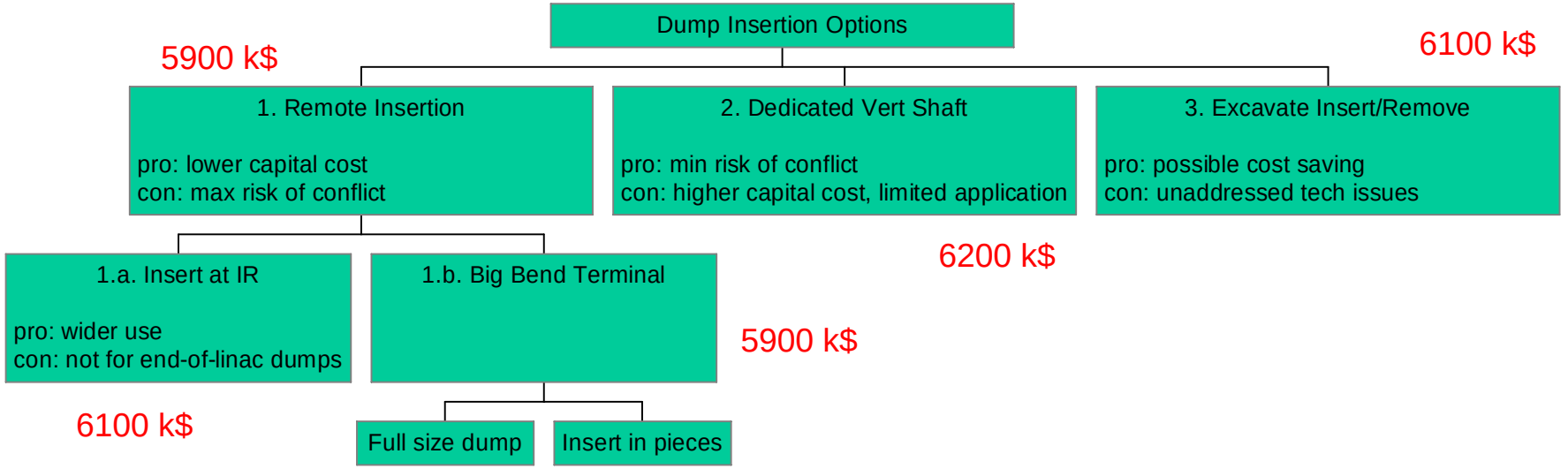
eng. Name	system	contact	type	energy	beam size	power	duty cycle	cost	year
EN_D1	PEP II inj diag stopper, w/o motion	Bong	Cu cyl, water cooled			10kW		23k (-)	1999
EN_D1	PEP II inj diag stopper, w/o motion	Bong	Cu cyl, water cooled			10kW		23k (-)	1999
EN_D2									
EN_D2									
EN_D3	SLC Extract/AD-235-089-00/FFTB	Walz	Al cyl, periph water cooled	70Gev		100kw	100%		1985
EN_D3	SLC Extract/AD-235-089-00/FFTB	Walz	Al cyl, periph water cooled	70Gev		100kw	100%		1985
EN_D4									
EN_D4									
EN_D5	"A" beam dump SA-903-010-01	Walz	water/Cu plates,water cooled			2.2MW	100%		1964
EN_D6									
EN_D5	"A" beam dump SA-903-010-01	Walz	water/Cu plates,water cooled			2.2MW	100%		1964
EN_D6									
EN_D5	"A" beam dump SA-903-010-01	Walz	water/Cu plates,water cooled			2.2MW	100%		1964
EN_D1	PEP II inj diag stopper, w/o cooling,motion	Bong	Cu cyl, rad cooled			10kW (-)		23k (-)	1999
EN_D1	PEP II inj diag stopper, w/o cooling,motion	Bong	Cu cyl rad cooled			10kW (-)		23k (-)	1999
EN_D1	PEP II inj diag stopper, w/o motion	Bong	Cu cyl, water cooled			10kW		23k (-)	1999
EN_D1	PEP II inj diag stopper, w/o motion	Bong	Cu cyl, water cooled			10kW		23k (-)	1999
EN_D3	SLC Extract/AD-235-089-00/FFTB	Walz	Al cyl, periph water cooled	70Gev		100kw	100%		1985
EN_D3	SLC Extract/AD-235-089-00/FFTB	Walz	Al cyl, periph water cooled	70Gev		100kw	100%		1985
EN_D4									
EN_D4									
EN_D5	"A" beam dump SA-903-010-01	Walz	water/Cu plates,water cooled			2.2MW	100%		1964
EN_D6									
EN_D5	"A" beam dump SA-903-010-01	Walz	water/Cu plates,water cooled			2.2MW	100%		1964
EN_D6									
EN_D5	"A" beam dump SA-903-010-01	Walz	water/Cu plates,water cooled			2.2MW	100%		1964

International Linear Collider
at Stanford Linear Accelerator Center

Beam Dump – Overview



Options Being Considered for Dump Insertion 12/7/99



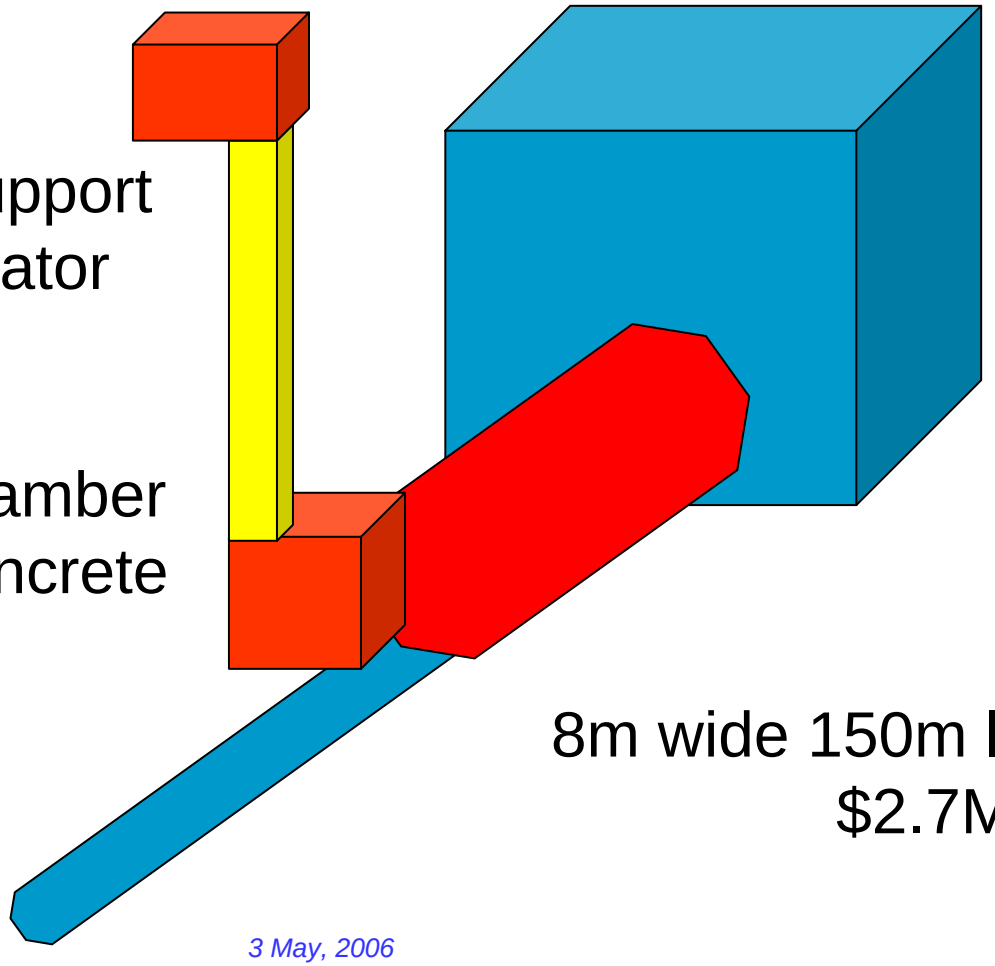
Beam Dump Chamber Cost - for Various Means of Insertion/Removal Rev 12/6/99	
CD-1 BASELINE	**COST (k$)**
Vertical shaft @ dump	
chamber, 2000 ft^2 (Clay - Lehman)	700
large vertical shaft, elevator, support building	1200
2 x 14' diam tunnel, 150 m long (2*1.1M)	2200
baseline cost	**4100**
ALTERNATIVES	**COST (k$)**
1. Use existing remote installation access - lateral insertion (Keller #1)	
400 ft^2 chamber, 5.5m walls, limited vert shaft [2]	2700
(limited vert shaft) [6]	-300
24' wide x 150m tunnel [2]	2800
vertical utility shaft (30" diam) [3]	5
support building [4]	700
total cost	**5905**
pro: slightly lower cost	
con: possible risk squeezing alongside beamline; constrains design of dump vessel; max conflict with other installation; must break beamline.	

~1999 Civil Costs

Support Bldg.
0.7M

Full access support shaft w/ elevator
0.5M

400 sq. ft. chamber with 5.5m Concrete walls
$2.8M



IR Hall

8m wide 150m long tunnel
$2.7M

~1999 Cost Model & Caveats
Civil

Three features dominate cost discussion:

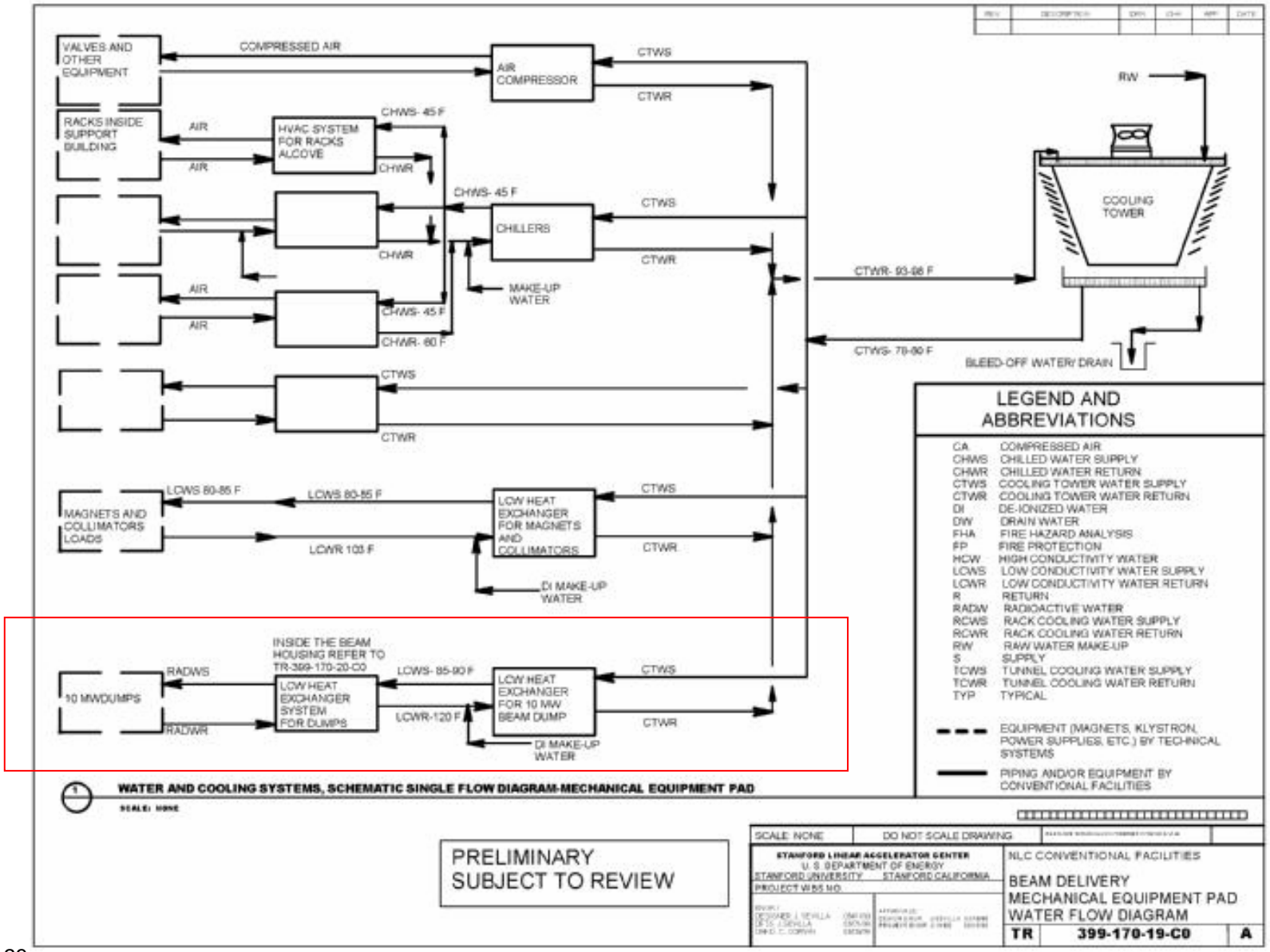
- **Depth**
- **Geology (how wet)**
- **Length of tunnel requiring "road-header" for excavation as opposed to tunnel boring machine**

2001 Model

- **Dry cavern with 145m of beamline @ 15m**
  - Surface pit construction techniques for both beamlines & vault
    - 3x more expensive if deep
    - 2x more expensive if wet
    - 3x more expensive per unit L x Area to road-head tunnel

ILC sites all wet &/or deep with beamlines 400-800m long

1999 NLC Mechanical Requirements



1999 Mechanical Costs

10MW cooling system (1st level)	$165k
Piping up support shaft	$80k
Intermediate cooling system	$225k
Cooling Tower	$137k
Total	$607k

Total Costs

Item	NLC-1999	Deep, Long, Wet ILC	ILC
Dump Vessel	$0.2M	x10	$1.5M
Mechanicals	$0.6M	Shaftx10	$1.4M
Civil-Dump Installation	$4.0M	x3x2	$24M
Civil-Extraction Lines	$2.7M	X3-6	$8-16M
Radioactive Waste	$0M		$0M
Total	$8.5M		$35-43M
	1999-2006 @ 3%/yr=1.23		$43-$53M

Stoppers - Specs

stoppers, CD 0.4 specifications 5/10/00
rev notes: 8 units removed from pre-linac areas, commercial markup = zero

									beam					
wbs	**contact**	**area**	**sub-area**	**stopper I.d.**	**qty**	**description**	**eng. name (1)**	**type**	**energy**	**power**	**size**	**duty cycle**	**elect/controls**	**comments**
1.2.2.x	D. Schultz	injection	pos target	SP-5 A-B	2		EN-S3	pps stopper	6GeV			1 b. train		use 5kw, cost: PEP II; DCS 3/23/99
1.2.2.x	D. Schultz	injection	pos target	SP-6 A-B	2		EN-S3	pps stopper	6GeV			1 b. train		use 5kw, cost: PEP II; DCS 3/23/99
1.2.2.x	D. Schultz	injection	pos target	SP-7	1		EN-S3	pps stopper	250MeV			1 b. train		use 5kw, cost: PEP II; DCS 3/23/99
1.2.2.x	D. Schultz	injection	pos target	SP-8	1		EN-S3	pps stopper	250MeV			1 b. train		use 5kw, cost: PEP II; DCS 3/23/99
1.2.3.x	McKee	injection	damping	SP-9 A-C	3	pre d.r. transfer	EN-S4	pps stopper	2GeV	40kw		1 b. train		use 500kw; Ross 9/7/98
1.2.3.x	McKee	injection	damping	SP-10 A-C	3	pre d.r.	EN-S5	pps stopper	2GeV	40kw		1 b. train		low energy, see Alan Fisher; Ross 9/7/98
1.2.3.x	McKee	injection	damping	SP-11 A-H	8	pre d.r. extract & transfer	EN-S4	pps stopper	2GeV	40kw		1 b. train		Ross 9/7/98
1.2.3.x	McKee	injection	damping	SP-12 A-C	3	d.r.	EN-S5	pps stopper	2GeV	40kw		1 b. train		low energy, see Alan Fisher; Ross 9/7/98
1.2.4.x	Scott	injection	pre-linac	SP-13 A-D	0	beam abort	EN-S6		10GeV			4 b. train		
1.2.4.x	Scott	injection	pre-linac	SP-14 A-D	4	b.c.	EN-S6		10GeV			4 b. train		
1.4.2.x	Tor	IRT-1	final focus	SP-15	1	1 bun	EN-S7		750GeV	20kw		1bun 10hz		
1.4.2.x	Tor	IRT-2	final focus	SP-16	0	1 bun	EN-S7		750GeV	20kw		1bun 10hz		
1.2.2.x	D. Schultz	injection	sources	SP-1	1		EN-S1	BCS quick stopper	120 keV			1 b. train		
1.2.2.x	D. Schultz	injection	sources	SP-2	1		EN-S1	BCS quick stopper	120 keV			1 b. train		
1.2.2.x	D. Schultz	injection	sources	SP-3 A-C	3		EN-S3	pps stopper	80MeV	3kw		1 b. train		use 5kw, cost: PEP II; DCS 3/23/99
1.2.2.x	D. Schultz	injection	sources	SP-4 A-C	3		EN-S3	pps stopper	80MeV	3kw		1 b. train		use 5kw, cost: PEP II; DCS 3/23/99
1.2.2.x	D. Schultz	injection	sources	SE-1	1		EN-S2	laser safety stopper	120 keV			1 b. train		
1.2.2.x	D. Schultz	injection	sources	SE-2	1		EN-S2	laser safety stopper	120 keV			1 b. train		
1.2.2.x	D. Schultz	injection	sources	SE-3 A-C	3		EN-S3	pps stopper	80MeV	3kw		1 b. train		use 5kw, cost: PEP II; DCS 3/23/99
1.2.2.x	D. Schultz	injection	sources	SE-4 A-C	3		EN-S3	pps stopper	80MeV	3kw		1 b. train		use 5kw, cost: PEP II; DCS 3/23/99
1.2.3.x	McKee	injection	damping	SE-5 A-G	7	spin rot. & transfer to d.r.	EN-S4	pps stopper	2GeV	40kw		1 b. train		low energy, see Alan Fisher; Ross 9/7/98
1.2.3.x	McKee	injection	damping	SE-6 A-C	3	d.r.	EN-S5	pps stopper	2GeV	40kw		1 b. train		
1.2.4.x	Scott	injection	pre-linac	SE-7 A-D	0	beam abort	EN-S6		10GeV			4 b. train		
1.2.4.x	Scott	injection	pre-linac	SE-8 A-D	4	b.c	EN-S6		10GeV			4 b. train		
1.4.2.x	Tor	IRT-1	final focus	SE-9	1	1 bun	EN-S7		750GeV	20kw		1bun 10hz		
1.4.2.x	Tor	IRT-2	final focus	SE-10	0	1 bun	EN-S7		750GeV	20kw		1bun 10hz		

Stoppers - Models

stoppers, CD 0.4 specifications 5/10/00
rev notes: 8 units removed from pre-linac areas, commercial markup = zero

eng. Name	system	contact	type	energy	beam size	power	duty cycle	cost	year
EN-S3	SA-344-660-66 pep	Bong	water cooled	10GeV		10kw			1998
EN-S3	SA-344-660-66 pep	Bong	water cooled	10GeV		10kw			1998
EN-S3	SA-344-660-66 pep	Bong	water cooled	10GeV		10kw			1998
EN-S3	SA-344-660-66 pep	Bong	water cooled	10GeV		10kw			1998
EN-S4									
EN-S5									
EN-S4									
EN-S5									
EN-S6									
EN-S6									
EN-S7									
EN-S7									
EN-S1									
EN-S1									
EN-S3	SA-344-660-66 pep	Bong	water cooled	10GeV		10kw			1998
EN-S3	SA-344-660-66 pep	Bong	water cooled	10GeV		10kw			1998
EN-S2									
EN-S2									
EN-S3	SA-344-660-66 pep	Bong	water cooled	10GeV		10kw			1998
EN-S3	SA-344-660-66 pep	Bong	water cooled	10GeV		10kw			1998
EN-S4									
EN-S5									
EN-S6									
EN-S6									
EN-S7									
EN-S7									

Collimator Specs

collimators CDR 0.4 3/21/00 rev 5/10/00 rev notes: new cost for rot consum coll, new coll for gtl, commercial markup = zero
specs
note: no costs for IRT2 & IR2

								beam		**collimator**					
wbs	**area**	**sub-area**	**coll i.d.**	**qty(1)**	**description**	**eng. name**	**type**	**energy**	**power**	**intercept (2)**	**aperture**	**pos'n tol.**	**d.o.f.**	**orient.**	**comments**
1.2.2.x	injection	e src		2		EN-C3	jitter reducing iris	120keV	5kw						DCS 3/23/99
1.2.2.x	injection	e src		1	gun test lab	EN-C2	selectable pinhole	120keV	5kw						
1.2.2.x	injection	e src		2		EN-C2	selectable pinhole	120keV	5kw						
1.2.2.x	injection	e src		4		EN-C1	energy defining, 2 ea x&y	120keV	5kw						y possibly static, DCS 3/23/99
1.2.2.x	injection	e src (p)		2		EN-C3	jitter reducing iris	120keV	5kw						DCS 3/23/99
1.2.2.x	injection	e src (p)		4		EN-C1	energy defining, 2 ea x&y	120keV	5kw						y possibly static, DCS 3/23/99
1.2.2.x	injection	p src		4		EN-C4	energy defining, 2 ea x&y	250MeV	20-30kw						
1.2.3.x	injection	ppdrt		2		EN-C5	1 each x&y	2GeV							like Al collim in slc e+ extraction, M Ross 9/7/98
1.2.3.x	injection	pmdr		2		EN-C5	1 each x&y	2GeV							like Al collim in slc e+ extraction, M Ross 9/7/98
1.2.3.x	injection	emdrt		2		EN-C5	1 each x&y	2GeV							like Al collim in slc e+ extraction, M Ross 9/7/98
1.2.3.x	injection	emdr		2		EN-C5	1 each x&y	2GeV							like Al collim in slc e+ extraction, M Ross 9/7/98
1.2.4.x	injection	ppl		12		EN-C6									
1.2.4.x	injection	epl		12		EN-C6									
1.4.2.x	beam deliv	collimation		2	energy slit	SPOCOLL	Be spoiler	750GeV	13 Mw	0.001	0.00264		2	horiz	.5RL, 50mrad taper, 1 bunch-safe
1.4.2.x	beam deliv	collimation		2	energy slit	ABSCOLL	Ti absorber	750GeV	13 Mw	0.001	0.004		2	horiz	20RL, 25mrad taper, Cu coat, 1 bunch-safe
1.4.2.x	beam deliv	collimation		2	energy slit	SPOCOLL	Be spoiler	750GeV	13 Mw	0.001	0.00264		2	horiz	.5RL, 50mrad taper, 1 bunch-safe
1.4.2.x	beam deliv	collimation		2	energy slit	ABSCOLL	Ti absorber	750GeV	13 Mw	0.001	0.004		2	horiz	20RL, 25mrad taper, Cu coat, 1 bunch-safe
1.4.2.x	beam deliv	collimation		2		YSPOILER	Rotary spoiler, vert	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		XSPOILER	Rotary spoiler, horiz	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		XABSORBR	Ti, Cu absorbr, horiz	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		YABSORBR	Ti, Cu absorbr, vert	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		YSPOILER	Rotary spoiler, vert	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		XSPOILER	Rotary spoiler, horiz	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		XABSORBR	Ti, Cu absorbr, horiz	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		YABSORBR	Ti, Cu absorbr, vert	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		YSPOILER	Rotary spoiler, vert	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		XSPOILER	Rotary spoiler, horiz	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		XABSORBR	Ti, Cu absorbr, horiz	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		YABSORBR	Ti, Cu absorbr, vert	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		YSPOILER	Rotary spoiler, vert	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		XSPOILER	Rotary spoiler, horiz	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		XABSORBR	Ti, Cu absorbr, vert	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	collimation		2		YABSORBR	W absorber, horiz	750GeV	13 Mw	0.001					
1.4.2.x	beam deliv	IRT1		0		EN-C14		750GeV	13 Mw						IRT1 only
1.4.2.x	beam deliv	IRT1		0		EN-C14		750GeV	13 Mw						IRT1 only
1.4.2.x	beam deliv	IRT1		0		EN-C15		750GeV	13 Mw						IRT1 only
1.4.2.x	beam deliv	IRT1		0		EN-C15		750GeV	13 Mw						IRT1 only
			tot	91											

notes: (1) in beam deliv, qty includes e+ & e- sides
(2) fraction of beam intercepted continuously

Collimator Models

collimators CDR 0.4 3/21/00 rev 5/10/00
models
rev notes: new cost for rot consum coll, new coll for gtl, commercial markup = zero

wbs	eng. Name	prototype	contact	energy	power	aperture	pos'n tol	d.o.f.	orient.	cost	year
1.2.2.x	EN-C3		D. Schultz								
1.2.2.x	EN-C2		D. Schultz								
1.2.2.x	EN-C2		D. Schultz								
1.2.2.x	EN-C1										
1.2.2.x	EN-C3		D. Schultz								
1.2.2.x	EN-C1		D. Schultz								
1.2.2.x	EN-C4		D. Schultz								
1.2.3.x	EN-C5	SA-234-108	Kulikov	30GeV		8mm diam					
1.2.3.x	EN-C5	SA-234-108	Kulikov	30GeV		8mm diam					
1.2.3.x	EN-C5	SA-234-108	Kulikov	30GeV		8mm diam					
1.2.3.x	EN-C5	SA-234-108	Kulikov	30GeV		8mm diam					
1.2.4.x	EN-C6										
1.2.4.x	EN-C6										
1.4.2.x	SPOCOLL	SA-236-630	DeBarger, Paul Stevens								
1.4.2.x	ABSCOLL										
1.4.2.x	SPOCOLL	SA-236-630	DeBarger, Paul Stevens								
1.4.2.x	ABSCOLL										
1.4.2.x	YSPOILER	rotary spoiler bottom-up (prelim)									
1.4.2.x	XSPOILER	rotary spoiler bottom-up (prelim)									
1.4.2.x	XABSORBR										
1.4.2.x	YABSORBR										
1.4.2.x	YSPOILER	rotary spoiler bottom-up (prelim)									
1.4.2.x	XSPOILER	rotary spoiler bottom-up (prelim)									
1.4.2.x	XABSORBR										
1.4.2.x	YABSORBR										
1.4.2.x	YSPOILER	rotary spoiler bottom-up (prelim)									
1.4.2.x	XSPOILER	rotary spoiler bottom-up (prelim)									
1.4.2.x	XABSORBR										
1.4.2.x	YABSORBR										
1.4.2.x	YSPOILER	rotary spoiler bottom-up (prelim)									
1.4.2.x	XSPOILER	rotary spoiler bottom-up (prelim)									
1.4.2.x	XABSORBR										
1.4.2.x	YABSORBR										
1.4.2.x	EN-C14										
1.4.2.x	EN-C14										
1.4.2.x	EN-C15										
1.4.2.x	EN-C15										