ILC Goals and Infrastructure Requirements

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Fermilab

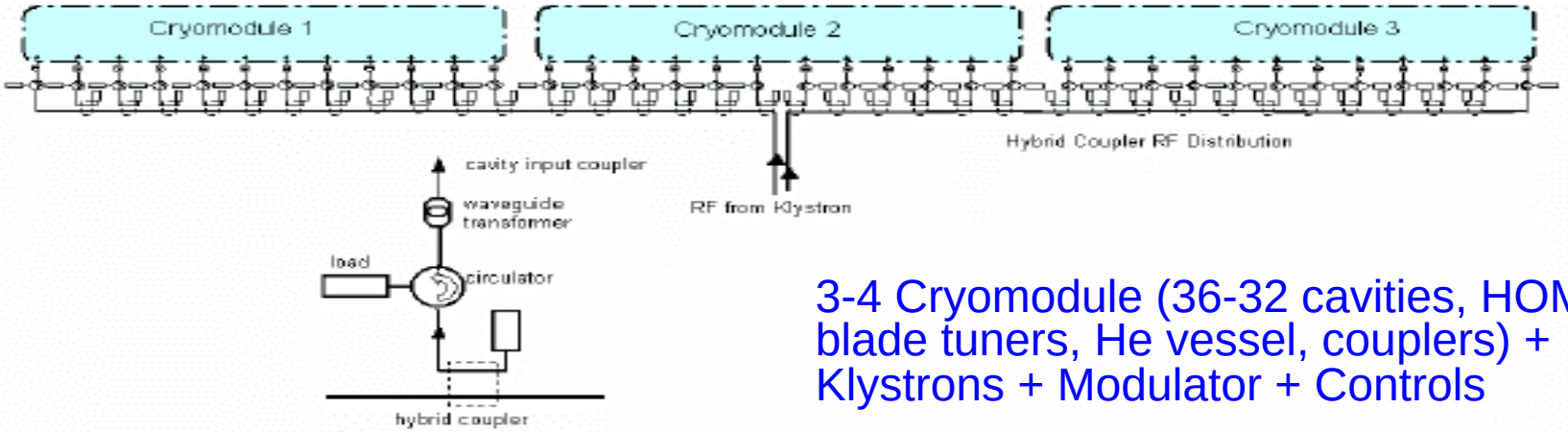
SMTF Meeting @ Jlab

9/30/04

Specific Goals for ILC: SMTF

- Demonstration of superconducting cavities with > 35 MV/m accelerating gradients operating at 1.3 GHz, in pulsed operation with a 1% duty factor and with high beam loading.
- Development of U.S. industrial capability for the fabrication of high performance SCRF cavities and associated infrastructures. High gradient pulsed test area:
- Accelerate beam to ~ 1 GeV utilizing high performance accelerating cavities (> 35 MV/m, Q> 1e10).
  - An electron beam source (ILC quality beam) and accompanying diagnostics

One ILC RF Unit Construction



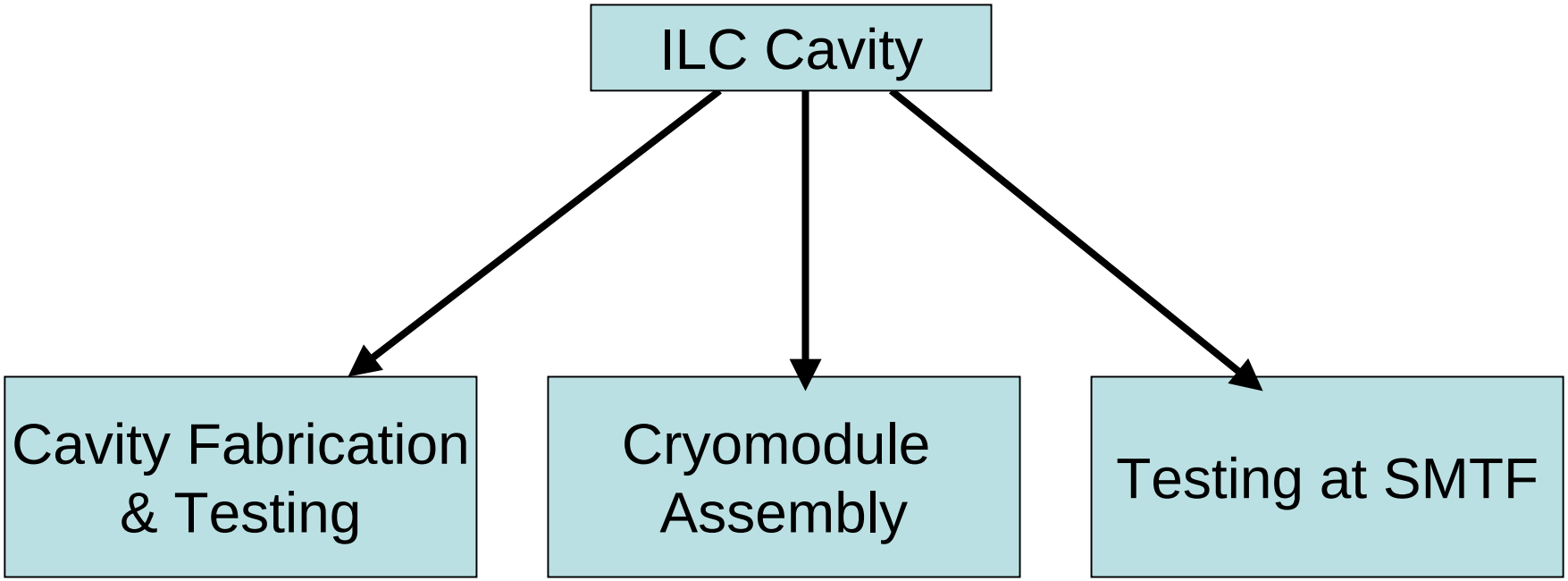
3-4 Cryomodule (36-32 cavities, HOM, blade tuners, He vessel, couplers) + Klystrons + Modulator + Controls

- FY05: 1 3.9 GHz cavity 3rd Harmonic
- FY05: 1 3.9 GHz cavity deflecting

} Finish the construction already in progress.

- FY05: Start fabrication of 1 cyromodule (8, 1.3 GHz cavities) (We are expecting to get 1 additional cryomodule from DESY)
- FY06-08: 3-4 cyromodule (8, 1.3 GHz cavities)
- FY05-07: 2 cryomodule (4, 3.9 GHz 3rd Harmonic cavities) FY05-07

US Laboratories Collaboration: A Model



- ILC cavities and associated components are produced by industries in collaboration with laboratories.
- Get industry involved early.

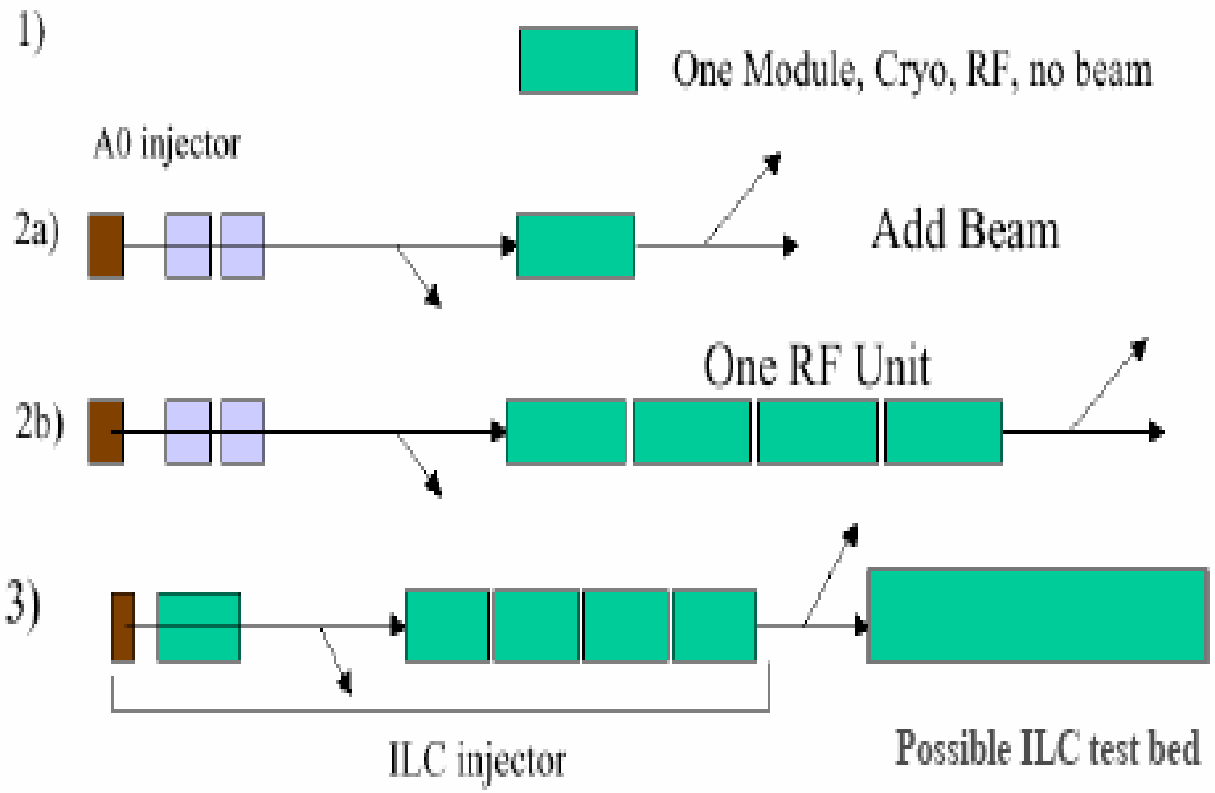
Development of a 1.3 GHz Cryomodule: US Collaboration: A Model

- Lab A: Niobium to Bare Cavity, BCP, Vertical Test
- Lab B: HOM, Single cavity He Vessel, Blade Tuner, Couplers
- Lab C: Electro-polishing, Assembly of the single cavity in He vessel, Horizontal test.
- Lab C: Cryostat
- LAB D: Assembly of cavities, quads, BPM, controls in cryomodule

Phases of ILC: SMTF

- Phase 1:
  - Installation of infrastructure culminating in the rf power tests of a single ILC cryomodule within the high gradient pulsed test area.
  - This cryomodule is anticipated to be provided by DESY.
  - Relocation and re-commissioning of the Fermilab NICADD Photoinjector in the SMTF.
- Phase 2a:
  - Initiate beam tests of a single ILC cryomodule utilizing the photoinjector.
- Phase 2b:
  - A complete ILC rf unit, consisting of four high performance cryomodules, fabricated by the SMTF collaboration with industrial partners.
  - Install, and operate this rf unit with beam
- Phase 3: At the end of Phase II a very significant facility will exist in US with opportunities for evolution in a variety of directions.
  - We anticipate that future development of the facility beyond Phase 2b will be determined in consultation with the ILC Global Design Initiative

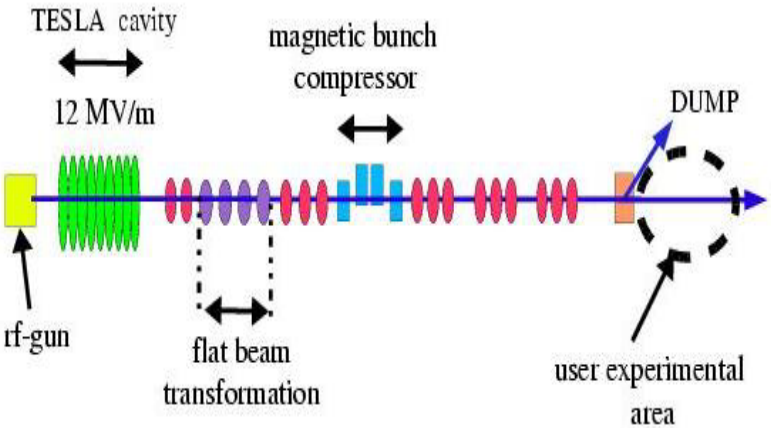
SMTF: Three Phase Approach



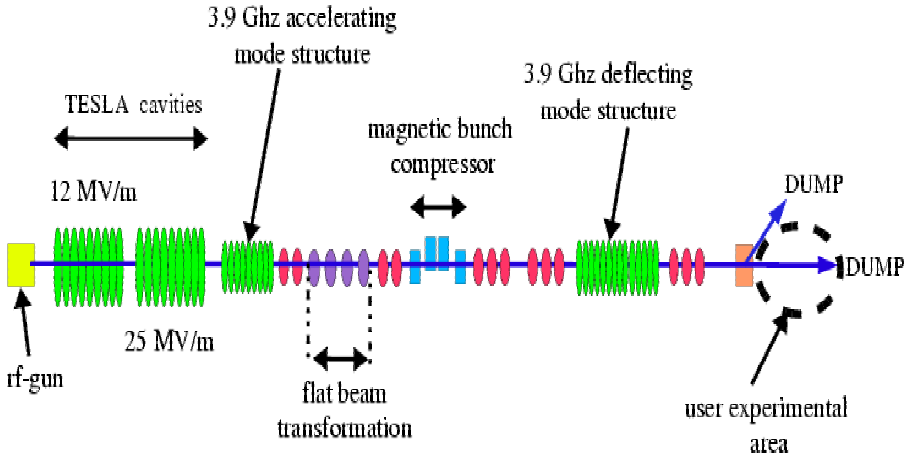
2005-06

2008-…

The Upgraded Fermilab NICADD Photoinjector Laboratory (FNPL)

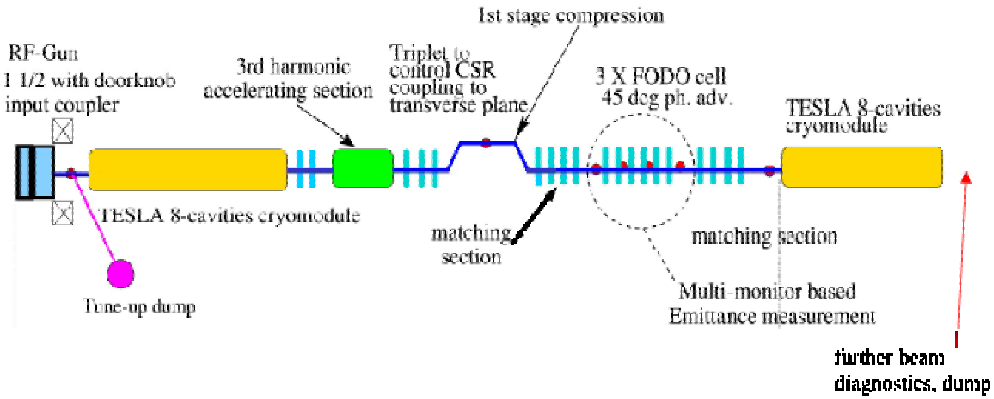


FNPL Upgrade



A Model for Size & Scope

Tesla TTF 2 Modules with beam compression



RF Power Requirement

RF						
Modulator Gun	x 5MW		yes			
Kly Gun	x 5MW					
Mod Tesla 1	x 300kw	build new #1				
Kly Tesla 1	x 300kw	x use old				
Mod Tesla 2		build new #2				
Kly Tesla 2	x rebuild in progress	x use rebuild	need spares			
Mod 3rdHar		start build	build new#3			
Kly 3rd Har 80KW	x ordered	required	required			
Kly replacement?		order new or ..				
Mod CKM	x assemble started		required before			
Kly CKM 4KW	x delivered					
Mod DESY 3rdHar					Saclay provide	
Kly Desy 3rdHar					use 80KW 3rdHar?	
Mod Inj TeslaModule			Use this for 1st m	5MW req		
Kly Inj TeslaModule				have spare		
LC RF unit, 4Module		1 mod sys req				
Modulator				req		
Kly 10 MW				req		
LLRF		new system req				

TESLA 8 Cavity Cryomodule Heat Load Estimate

	E_{acc} [MV/m]		Q		Rep Rate [Hz]	
	23.4		1.00E+10		5	
TESLA 9 cell module w/ Quad	**2K load [W]**		**5/8 K load, [W]**		**40/80 K load, [W]**	
	static	**dynamic**	**static**	**dynamic**	**static**	**dynamic**
RF load	-	4.95	-	-	-	-
Radiation	-	-	1.95	-	44.99	-
Supports	0.60	-	2.40	-	6.00	-
Input coupler	0.76	0.14	2.05	1.19	21.48	59.40
HOM coupler (cable)	0.01	0.27	0.40	2.66	2.55	13.22
HOM absorber	0.14	0.02	3.13	0.77	- 3.27	15.27
Beam tube bellows (12)	-	0.24	-	-	-	-
Current leads	0.10	0.01	-	-	13.00	5.00
HOM to structure	-	1.68	-	-	-	-
Coax cable (4)	0.01	-	0.03	-	0.08	-
Instrumentation taps	0.05	-	0.54	-	2.82	-
Diagnostic cable	0.07	-	0.82	-	2.48	-
Subtotal	1.74	7.31	11.32	4.62	90.13	92.89
Total	**9**		**16**		**183**	

Cryogenic @35 Mv/m and 5 Hz

Phase 1

Item	Qty [# or ft]	Heat Load 2K	Heat Load 5K	Heat Load 80K
TESLA Cryomodule	1	19	17	236
End cans	2	2		
A0 9-cell cavity	0	0	0	0
High Gradient 9 cell cavity	0	0	0	0
3rd Harmonic	0	0	0	0
Tunnel transfer line	1500		23	91
Feedbox & TRL	30	2	6	75
Total Estimated		24	46	402
Uncertanty Factor		1.3	1.3	1.3
Capacity Required		**31**	**59**	**523**

Phase 2a

Item	Qty [# or ft]	Heat Load 2K	Heat Load 5K	Heat Load 80K
TESLA Cryomodule	1	19	17	236
End cans	2	2		
A0 9-cell cavity	1	5	8	47
High Gradient 9 cell cavity	1	8	9	61
3rd Harmonic	1	6	9	61
Tunnel transfer line	1500		23	91
Feedbox & TRL	60	2	12	150
Total Estimated		43	78	646
Uncertanty Factor		1.3	1.3	1.3
Capacity Required		**56**	**101**	**840**

Phase 2b

Item	Qty [# or ft]	Heat Load 2K	Heat Load 5K	Heat Load 80K
TESLA Cryomodule	4	77	67	942
End cans	2	2		
A0 9-cell cavity	1	5	8	47
High Gradient 9 cell cavity	1	8	9	61
3rd Harmonic	1	6	9	61
Tunnel transfer line	1500		23	91
Feedbox & TRL	60	2	12	150
Total Estimated		101	128	1353
Uncertanty Factor		1.3	1.3	1.3
Capacity Required		**131**	**167**	**1758**

- 100 Watts of 2 deg K He is required for Phase 2b at 35 Mv/m and 5 Hz.
- One can operate the ILC section at a lower rate.