

#### A Sample Project Schedule for Cryomodule Design

#### Rich Stanek September 14, 2007

September 13, 2007

**KEK EDR Kickoff Meeting** 

# Cryomodule Design Schedule

- This schedule looks at the cryomodule design process up until a "Ready for Large Scale Production" date
- It creates logical links between tasks and does not impose an "end date"
- Type V becomes ILC-1 (first ILC prototype)
- Think of this as a "tool to help make decisions", dates and dependencies can change
- Initial Criteria
  - Include feedback from XFEL, STF, ILCTA into design process
  - Allow for a parallel ACD design effort
  - Down select to get the best overall design for ILC\_1
  - Cavity shape decision should be as late as possible and be driven by measured performance (data from test systems)
  - Provide for CM Pre-series production (same time est. as XFEL)

#### **Critical Links**

- Define the dates when test results are available
  - Get schedules for XFEL, STF, ILCTA (Hans, Norihito, Harry)
  - These dates DRIVE the schedule (VERY IMPORTANT)
    - Building, installing & testing cryomodules takes time
  - Important to DEFINE level of tests needed (in a CM operating in a string or just a bench test) => How do you define reliability?

Realistically:

- FLASH & XFEL will validate Type III+ design
- ILCTA will validate Type IV (low statistics)
- ACD design will be validated at STF-1 & STF-2 (low statistics)
- Type V (ILC\_1) Design takes dependencies from
  - Type IV Design Complete
  - Some portion of XFEL Pre-Series Complete
  - ILCTA Results Available
  - STF-1 Results Available

# Critical Links (Cont'd)

- Cavity Shape Decision
  - Allow different shapes in CM design model (so decision can be as late as possible)
  - Make cavity shape decision when data available:
    XFEL Pre-Series complete + STF-2 Results available and ILCTA has a full Type IV+ RF Unit
  - DRIVES THE "READY DATE" VERY LATE!
  - (See later slide for an alternative)
- Allow ACD Design to go on in parallel
  - Use KEK STF schedule information for this part of schedule
- At the very end, move forward with only one design that incorporates best of all worlds

## Critical Links (Cont'd)

- Industrialization of the Type V design starts as soon as Type IV design is complete
- Pipe size decision & cryogenic design goes quickly
- Able to make decision on Large Grain/Small Grain independent of cavity shape
- If there was considerable "float in the schedule" allow that task more time => people are busy so things take longer
- Many tasks go in parallel meaning lots of people are needed and international participation is required
  - Must get people to take responsibility for parts of the design and for delivering an evaluation for final decision on time
    - Evaluation = specification of parameters + quantification of all alternatives + criteria for validation + decision tree

IIL

#### **Milestone Dates**

•

ID	Task Name	Duration	Start	Finish	2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2 2 H1 H2
1	Ongoing Cryomodule Production	85.6 mone	Mon 8/3/07	Fri 12/26/14	V <sup>aran</sup> y
2	XFEL Schedule	84.7 mons	Tue 7/1/08	Fri 12/26/14	y y y y y y y y y y y y y y y y y y y
4	XFEL Pre-Series Results Available	0 mons	Man 6/28/10	Mon 6/28/10	♦ 8/28
9	ILCTA Schedule	61.66 mons	Tue 9/18/07	Thu 9/1/11	
10	Refrigerator #1 Operational	0 mons	Tue 9/18/07	Tue 9/18/07	8/18
11	CM1 (DESY kit) Complete	0 days	Wed 11/21/07	Wed 11/21/07	11/21
12	Cryo System Components Installed	0 mons	Man 6/16/08	Mon 6/16/08	l ♦ ene
14	CM1 Tests Complete	0 mons	Frl 10/3/08	Fri 10/3/08	♦ 10/3
15	Refrigerator #2 Operational	0 mons	Thu 7/31/08	Thu 7/31/08	♦ 7/31
16	INFN Places Order for CM2 Cold Mass	0 mons	Tue 10/16/07	Tue 10/16/07	10/18
18	CM2 Cold Mass Parts Available	0 mons	Man 6/23/08	Mon 6/23/08	♦ 6/23
20	CM2 Complete	0 mons	Mon 10/13/08	Mon 10/13/08	10/13
25	CM3 (Type IV) Complete	0 days	Wed 1/21/09	Wed 1/21/09	♦ 1/21
28	ILCTA Results Available	0 mons	Man 7/20/09	Mon 7/20/09	1 ◆ 7/20
30	ILCTA Running at Low Rep Rate	0 mons	Mon 12/6/10	Mon 12/6/10	♦ 12/8
32	ILC-like RF Unit Operations Begin	0 mons	Thu 9/1/11	Thu 9/1/11	♦ 8/1
33	STF-1 Schedule	20 mons	Mon 8/3/07	Fri 3/13/09	₩ <b>₩₩₩</b> ₩
39	STF-1 Results Available	0 mons	Frl 3/13/09	Frl 3/13/09	♦ 3/13
40	STF-2 Schedule	35.6 mone	Mon 3/16/09	Fri 12/2/11	
44	STF-2 CM Assembled (not tested)	0 mons	Fit 11/19/10	Fri 11/19/10	11/19
47	STF-2 Results Available	0 mons	Fri 12/2/11	Fit 12/2/11	12/2
48	BCD Cryomodule Design	68.66 mone	Wed 8/1/07	Fri 2/24/12	
49	Type IV Decign	6 mons	Thu 11/1/07	Wed 3/18/08	
50	Initial Drating Pkges Complete	0 mons	Thu 11/1/07	Thu 11/1/07	11/1
55	Type IV Design Complete	0 days	Wed 3/19/08	Wed 3/19/08	▲ 249
56	Type V (ILC_1) Design Desistons	69.66 mone	Wed 8/1/07	Fri 2/24/12	
57	Begin Type V (ILC_1) Design	0 days	Wed 3/19/08	Wed 3/19/08	4 3/19
77	Type V (ILC_1) Design Complete (w/o Cav Shape)	0 days	Mon 9/20/10	Mon 9/20/10	♦ 8/20
78	ACD Cryomodule Design	13 mons	Mon 3/17/08	Fri 3/13/08	
79	Type ACD Design	13 mons	Mon 3/17/08	Frl 3/13/08	
81	Type ACD Design Complete	0 mons	Frl 3/13/09	Fit 3/13/09	♦ 3/13
82	ILC Final Design	41 mons	Mon 2/27/12	Fri 4/17/16	
87	ILC_1 CM Accepted as new Baseline	0 mons	Fri 4/19/13	Fit 4/19/13	<b>♦</b> 419
89	Ready for Large Scale Production of ILC CM	0 mons	Fri 4/17/15	Fit 4/17/15	♦ 4/17

#### XFEL, ILCTA, STF

Т

		X	(FE	EL, ILCTA, STF
	Danaka	-	Finite	2007 I2008 I2009 I2010 I2011 I2012 I2013 I2014 I
Constant Constantial Constantian	15.5 (1997)	Marchany	PE STORES	HT H2
Ungoing Cryomodule Production	55 7 mm	The lot of	Ref Statement	
XFEL Sonedule	The set	The states	PERSONAL PROPERTY.	
XFEL CM Tender & Pre-Series		100 0100	ALC: SCHOOL ST	
XFEL Pre-Geries Results Available	0.0008	No. 67970	No. 102400	
CM for XFEL Fabrication	120 985	Too 6/2010	Main 12024/12	
CM for XFEL Test	57 465	Mar 102012	EA MUNICIPAL DIST.	
XTL Installation		March 100 (1)	Ex this for	
Unac Cooldown & Commissioning	51.65 mmm	Tree Protection	The Shine	
ILGTA Sonedule	21.4210,004	The state	The second	X and
Refrigerator #1 Operational	0 monte	THE MILESCO	The willing	
CM1 (DESY kit) Complete	e cays	Weet That Day	www.inclust	
Cryo System Components Installed	9 106 16	Mar Crister	10.00	
Cryo/Full RF Test of CM1	e meda	ALC: NO.	54 102/06	
CM1 Tests Complete	0 monte	Pit 10/5408	Paricolos	• 14G
Rerigerator #2 Operational	0 meta	THE MOTION	100 101/00	• 731
INFN Places Order for CM2 Cold Mass	9 106 16	THE TRANSPORT	1.4 1011/07	
Produce CM2 Cold Mass Parts	9 0004	Tee 10/16/07	SK-62300	
CM2 Cold Mass Parts Available	0 mone	Mon 6/23/08	Mc 6/23/00	•1 <sup>m</sup>
CM2 (US Cav+INFN Cold Mass) Ass'y	A INCIDE	104-52560	Mix 1313/00	
CM2 Complete	0 mone	Man 10/13/08	Man 1313/08	€_1013
Install CM2 Into ILCTA	2 (1616	The TO/TAKE	Non 12/0/08	
Cryo/Full RF Test of CM1& CM2	20684	100 120900	Mile 2024	
Produce CM3 Parts	9 (6016	The 32068	Wed 11(36/58)	
CM3 Ass'y	2 0616	The 11/27/68	Wed 181/99	
CM3 (Type IV) Complete	0 days	Wed 1/21/09	Wed 1(1/39	tan 🛉
Install CM3 Into ILCTA	2 06 04	Tee 213409	NET THE PARTY	
Full RF Unit Test (reduced rep rate)	4 10016	Tue 20169	Mon 7/26/09	
ILCTA Results Available	0 mona	Mon 7/20/09	Mon 7/26/09	<b>♦</b> _1128
Replace RF Unit with ILC Prototypes	18 (16 16	Tue //21408	REE 12/6/10	
ILCTA Running at Low Rep Rate	0 mone	Mon 12(8/19	Men 13AL/10	▲ 128
Install & Commission New Refrigerator	12 mone	Fil 10/1/10	Thu 8/1/11	
ILC-like RF Unit Operations Begin	0 mone	The 81/11	Thu \$75/11	🍑 10
STF-1 Schedule	20 monus	Man 9(2197	Pvi 2/13/99	
Cooldown 1 BL Cavity CM	3 mena	Mon 9/5/07	Pil 1123497	
Repair of LL Cavity CM	3 06 06	Min 9/5/07	PE TROMP	
Install 4 BL+2 LL Cavities in CM	4 (06/04	Man 11/26/67	Fd 314/00	
Cooldown 4 BL+2 LL Cavities in CM	8 /06/14	Non 2/17/08	Frankline	
Additional R&D Cooldown	7 mone	Min 9/168	Franke	
STF-1 Results Available	0 mone	Pi 2/15/09	Fd 3/13/09	¢ 212
STF-2 Sohedule	35.5 revenue	Mon 2/19/69	Pii13/3/11	ýy
Fabricate Cavities & CM Parts	13 (16.04	Min Artista	F8 312/10	
Fabricate & Process Cavities	13 mone	Mar. 2/16/09	Fd 3/12/10	
Assemble CM & Install in Tunnel	9 (1616	Mon 3/15/10	Fil 11/18/10	
STF-2 CM Assembled (not tested)	0.0616	FIL11/18/10	PE 11/18/10	▲ 11/10
High Pressure Gas Review	1.5 mena	Man 11/22/10	Fil 1201/10	
Cooldown CM & Commissioning of STE-2	12 mena	Non 1/5/11	Fd 13/3/11	
STF-2 Results Available	0 mone	Fil 120711	F#13/3/11	110
BCD Crysmodule Design	59.85 month	Wed STURY	Pvi 2(2412	
ACD Crysmodule Design	12 (1997)	Mee 2/17/02	Pvi 2/12/99	
LC Final Darigs	41 means	Mee 2/27112	Pvi 4/12/16	
				· · · · · · · · · · · · · · · · · · ·

### Design Work

. . .

• •	ilc iic		Des	sigr	n M	Vo	ork	•	
D	Task Name	Duration	Start	Finish 2	2007 20 H1 H2 H	08 21 1 H2 H	009 2010 1 H2 H1	) H2	2011 H1
1	Ongoing Cryomodule Production	95.5 mons	Mon 9/3/07	Fri 12/26/14	- V				
48	BCD Cryomodule Design	59.65 mons	Wed 8/1/07	Fri 2/24/12					
49	Type IV Design	5 mons	Thu 11/1/07	Wed 3/19/08					
50	Initial Drafting Pkges Complete	0 mons	Thu 11/1/07	Thu 11/1/07	●1 <sup>11</sup>	1/1			
51	Bid & Select Vendors for Fabrication	2 mons	Thu 11/1/07	Wed 12/28/07	H				
52	Finish Detail Drawings	2 mons	Thu 11/1/07	Wed 12/26/07	Ш				
53	Final 3D Model Completed	1 mon	Thu 12/27/07	Wed 1/23/08	6				
54	Final 2D Drawings Completed	2 mons	Thu 1/24/08	Wed 3/19/08	- Ē	1			
56	Type IV Design Complete	0 days	Wed 3/19/08	Wed 3/19/08		3110			
56	Type V (ILC_1) Design Decisions	69.65 mons	Wed 8/1/07	Fri 2/24/12				-	-
57	Begin Type V (ILC_1) Design	0 days	Wed 3/19/08	Wed 3/19/08	4	3/19			
58	Industrialization & DFM of Type IV	15 mona	Thu 3/20/08	Wed 5/13/09	h	I			
59	Pipe Sizes & Cooling Design	15 mona	Thu 3/20/08	Wed 5/13/09				1	
60	Quad Magnet & BPM Design	9 mons	Tue 7/21/09	Mon 3/29/10					
61	Quad Position & Design.	9 mons	Tue 7/21/09	Mon 3/29/10			IL-i-		
62	BPM Decision (data - FLASH, ATF, ILCTA'	6 mons	Tue 7/21/09	Mon 1/4/10					
63	Helium Vessel Desian	15.25 mons	Tue 7/21/09	Mon 9/20/10					
64	Ti versus SS Decision	6 mons	Tue 7/21/09	Mon 1/4/10					
66	Incorporate Final Tuner	3 mons	Tue 6/29/10	Mon 9/20/10				L.	
66	Tuner Design	6 mons	Tue 1/12/10	Mon 6/28/10				(	
67	Evaluate Blade, Ball Screw or Sliding Jack	6 mons	Tue 1/12/10	Mon 6/28/10					
68	Coupler Design	15 mons	Tue 5/5/09	Mon 6728/10					
69	Evaluate KEK & Orsay Couplers + DFM	15 mona	Tue 5/5/09	Mon 6/28/10			*  · ·		
70	Instrumentaion & Alignment Design	12 mons	Tue 7/28/09	Mon 6/28/10			-		
71	Supports & Transportation Design	12 mons	Tue 7/28/09	Mon 6/28/10					
72	Cavity Design	59.65 mons	Wed 8/1/07	Fri 2/24/12	a a state a st				
73	Cavity Shape Decision	3 mons	Mon 12/5/11	Fri 2/24/12	•				
74	Grain Size Decision	24 mons	Wed 8/1/07	Tue 6/2/09				411	
76	Magnetic Shielding Design	4 mons	Tue 12/29/09	Mon 4/19/10					
76	Inside/Outside Decision	4 mons	Tue 12/29/09	Mon 4/19/10			- H	411	
77	Type V (ILC 1) Design Complete (w/o Cay Sh	0 days	Mon 9/20/10	Mon 9/20/10				<b>6</b> 9/20	
78	ACD Cryomodule Design	13 mons	Mon 3/17/08	Fri 3/13/09			,	•	
79	Type ACD Design	13 mons	Mon 3/17/08	Fri 3/13/09					
80	Complete Type ACD CM Design	13 mons	Mon 3/17/08	Fri 3/13/09					
81	Type ACD Design Complete	0 mons	Fri 3/13/09	Fri 3/13/09			3/13		
82	ILC Final Design	41 mons	Mon 2/27/12	Fri 4/17/15					

# ilc.

.

#### **End Game**

ID	Task Name	Duration	Start	Finish	20	0 200	200	201	201	201	201	201	201	201
1	Ongoing Cryomodule Production	96.6 mons	Mon 8/8/07	Fri 12/28/14	•	ľ							,	
48	BCD Cryomodule Design	69.86 mons	Wed 8/1/07	Fri 2/24/12		1				•				
78	ACD Cryomodule Design	13 mons	Mon 3/17/08	Fri 3/13/09		•								
82	ILC Final Design	41 mons	Mon 2/27/12	Fri 4/17/16									•	
83	Review Existing Designs	1 mon	Mon 2/27/12	Fri 3/23/12						ł				
84	Finalize ILC Design Choices	2 mons	Mon 3/26/12	Fri 5/18/12						Ц				
85	Complete Drawings for ILC_1 CM	3 mons	Mon 5/21/12	Fri 8/10/12						հ				
86	Build 3 exact prototypes of ILC_1 CM (international)	9 mons	Mon 8/13/12	Fri 4/19/13							1			
87	ILC_1 CM Accepted as new Baseline	0 mons	Fri 4/19/13	Fri 4/19/13							•1	/19		
88	ILC_1 CM Tender & Pre-Series	104 wks	Mon 4/22/13	Fri 4/17/15							Ľ		Ŋ	
89	Ready for Large Scale Production of ILC CM	0 mons	Fri 4/17/15	Fri 4/17/15									<b>4</b>	/17

#### **KEK EDR Kickoff Meeting**

### **Results and Alternatives**

- If you follow the dependencies as described:
- Milestones

- ILC\_1 CM Accepted as Baseline4/19/13Ready for Large Scale Production of ILC CM4/17/15
- If you allow the dependencies change:
  - Decide on a cavity shape after STF-1 results available + STF-2 CM built but not tested + ILCTA running (but NOT new refrigerator => low rep rate) + Type ACD design complete
- Milestones
  - ILC\_1 CM Accepted as Baseline4/23/12Ready for Large Scale Production of ILC CM4/21/14



#### Summary

- What has been presented is just a very rough look at the cryomodule design process up to "Ready for Large Scale Production of ILC CM"
- Take the results as an indication of one scenario
- Changing the dependencies or durations will make the results very different
- Next step is to impose an end date and see how fast things have to go and what dependencies need to be dropped to meet it
- Very important to define the criteria for validation of a new design (upfront) => up to this Technical Group & PMs
  - # of parts fabricated and tested?
  - Hours of bench test / simulated behavior (lifetime test)?
  - Requirement to be tested in # of cryomodules?
  - Requirement for test with beam?