What XFEL Will Tell Us for the EDR by 2011

Hans Weise / DESY

GDE EDR PMO XFEL Liaison

Summary from ILC 2007

The European X-Ray Laser Project XFEL X-Ray Free-Electron Laser

XFEL: which ILC questions are answered?

- how to build a 100 accelerator module linac using TESLA Technology
- how to industrialize the SCRF on a 5% ILC scale
- how to extrapolate from TTF / FLASH by a factor of 20
  Remark: ILC eq. 20 XFEL
- how to start and organize an international project based on in-kind contributions

Hans Weise, DESY
ILC 2007, May 30, 2007

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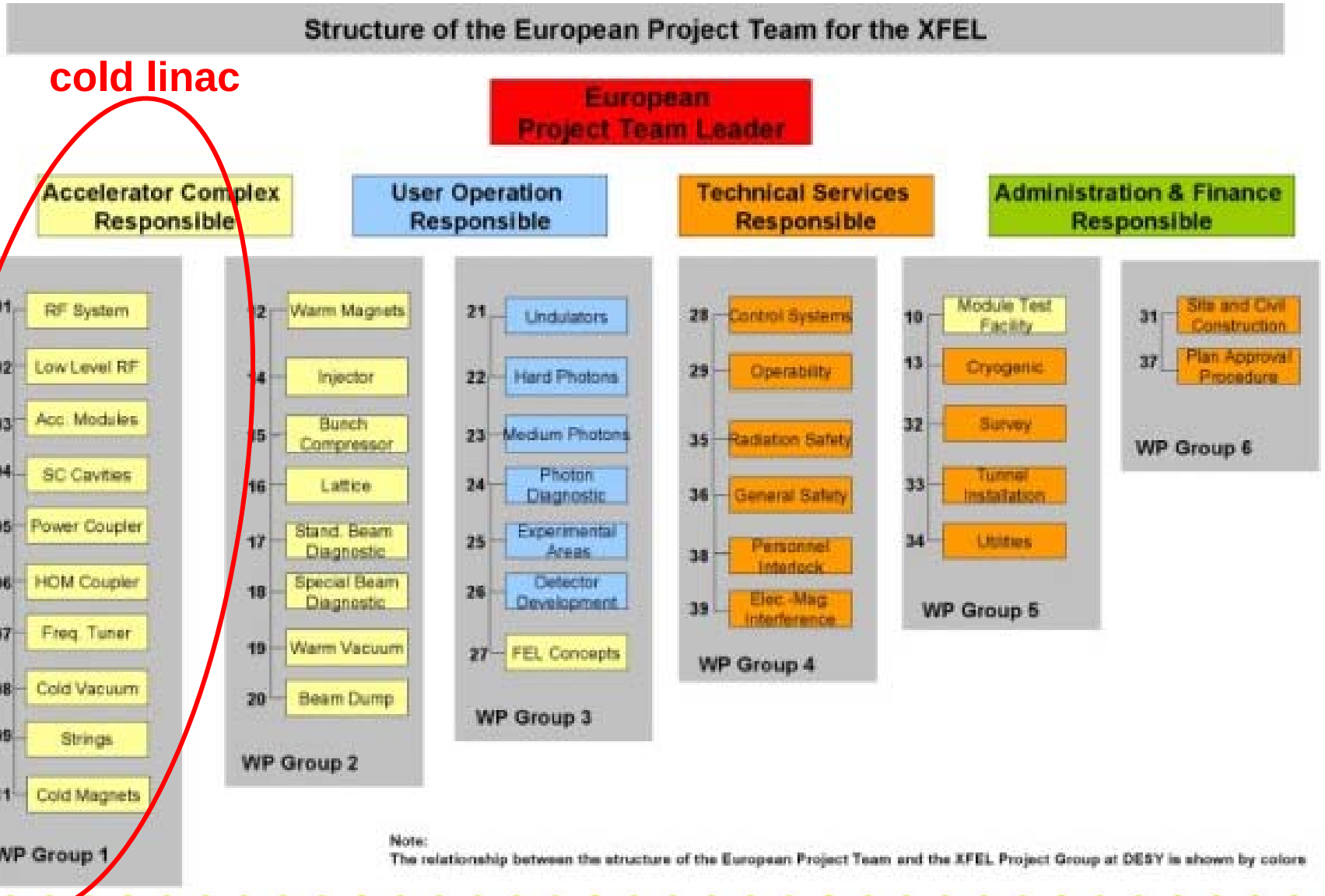
Outline

- How do we organize the XFEL project with its in-kind contributions?
- Components
- Schedule
- Tunnel
- Klystron / Modulators
- Modules
- Gradient

In-kind Contributions for the XFEL

- The XFEL accelerator complex is going to be built by an Accelerator Consortium coordinated by DESY (to be confirmed by the XFEL ISC)
- Many of the contributing countries like to contribute mostly in-kind
- The work package group WPG1 covers the cold linac
- The major players in the cold linac's WPs are well known from the TESLA Technology R&D effort
- Technology transfer between those major players i.e. between experienced collaborators seems to be relatively easy

XFEL Project Organization



XFEL WPG1 Discussions

The European X-Ray Laser Project XFEL X-Ray Free-Electron Laser

Common in-kind proposal for the superconducting linac of the XFEL WP3 – WP9 and WP11

presented by Hans Weise / DESY

for

CEA Saclay
CIEMAT
DESY
INFN
IPJ Swierk
LAL Orsay

Hans Weise, DESY
In-kind Review Committee Meeting, September 24, 2007

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Project Risk

The European X-Ray Laser Project XFEL X-Ray Free-Electron Laser

Approach to minimize the project risk for the XFEL cold linac

- With the goal to **define in-kind contributions to the superconducting linac of the XFEL**, a series of meetings was organized with the major players in the field.
- All meeting participants contributed with key components during the R&D effort of the TESLA Collaboration, i.e. can be seen as **experienced partners.**
- There might be additional interest by **'new-comers'** in the SCRF community. At this moment in time, the already identified interest of China is seen as a promising option but requires qualification of the institutes in terms of producing first prototypes of e.g. cold masses (the cryogenic unit of an accelerator module).
- Depending on the success and its timeline, new partners could either join the soon starting activities in the different laboratories, or, if the step from the current rapid start-up scenario with 100 modules to the final stage (116 modules) can be made, take some responsibility for additional accelerator sections.

Laboratories Involved

The European X-Ray Laser Project XFEL X-Ray Free-Electron Laser

Laboratories involved and their fields of interest

The following laboratories were involved in the discussion of the cold linac and agreed on the delivery of a common proposal for the in-kind contributions. Besides clarification of a few still open questions, the final official in-kind proposal will also require approval of the individual funding agencies.

Laboratory	Country	Fields of interest
CIEMAT	Spain	cold magnets, power supplies
LAL Orsay	France	main RF input coupler
DAPNIA Saclay	France	accelerator modules, cavities, cold beam position monitors (BPM), cold frequency tuners, 3.9 GHz harmonic accelerator section
INFN Milano	Italy	accelerator modules, cavities
DESY	Germany	accelerator modules, cavities, cold beam position monitors (BPM), cold frequency tuners, cold vacuum system
IPJ Swierk	Poland	HOM

Sharing the XFEL WPs

The European X-Ray Laser Project XFEL

Summary

		Laboratory	Country	Invest / M€	FTE	FTE / M€
Accelerator Modules	WP – 3	CEA Saclay	France	60%		43%
		INFN	Italy	19%		29%
		DESY	Germany	21%		29%
	sum			*100%*		*100%*
Superconducting Cavities	WP – 4	INFN	Italy	50%		34%
		DESY	Germany	50%		66%
	sum			*100%*		*100%*
		Received from WP-9				
Power Couplers	WP – 5	LAL Orsay	France	73%		52%
		DESY	Germany	27%		48%
		or				
		LAL Orsay	France	99%		100%
		DESY	Germany	1%		0%
	sum			*100%*		*100%*
HOM Coupler / Pick-up	WP – 6	IPJ Swierk	Poland	100%		100%
	sum			*100%*		*100%*
Frequency Tuners	WP – 7	DESY	Germany	100%		100%
	sum			*100%*		*100%*
Cold Vacuum	WP – 8	DESY	Germany	100%		100%
	sum			*100%*		*100%*
Cavity String Assembly / Clean Room Quality Assurance	WP – 9	CEA Saclay	France	90%		51%
		DESY	Germany	10%		49%
		Transferred to WP-4				
	sum			*100%*		*100%*
Cold magnets	WP - 11	CIEMAT	Spain	56%		10%
		DESY	Germany	44%		90%
	sum			*100%*		*100%*

Hans Weise, DESY
In-kind Review Committee Meeting, September 24, 2007

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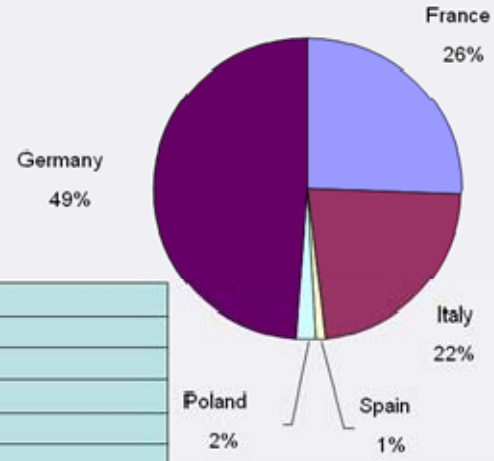
Proposed XFEL WPG1 in-kind Contributions

The European X-Ray Laser Project XFEL

XFEL WP 3-9 & 11 proposed distribution of in-kind contributions



Laboratory	Invest / M€	FTE / M€	Sum / M€	
CEA Saclay				
LAL Orsay				
INFN				
CIEMAT				
DESY				
IPJ Swierk				
Sum France				25.4%
Sum Italy				22.7%
Sum Spain				1.1%
Sum Poland				2.1%
Sum Germany				48.7%
Sum WP 3-9 & 11				**100%**

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Example: WP-3 Accelerator Modules

The European X-Ray Laser Project XFEL X-Ray Free-Electron Laser

WP – 3 Accelerator Modules

In-kind proposal

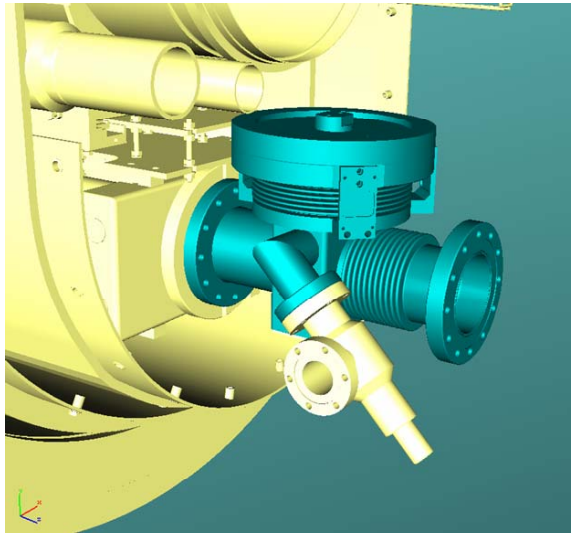
DAPNIA Saclay is proposing to take the responsibility for the assembly of **100%** of the accelerator modules, this including the so-called string assembly (see also WP-9). The assembly is planned to happen at Saclay, and would take advantage of the presently set-up new infrastructure. Industrial partners are required for the work to be done. In addition to the assembly **CEA Saclay** proposes to contribute **50% of the cold masses**, the cryogenic vessel of the accelerator module.

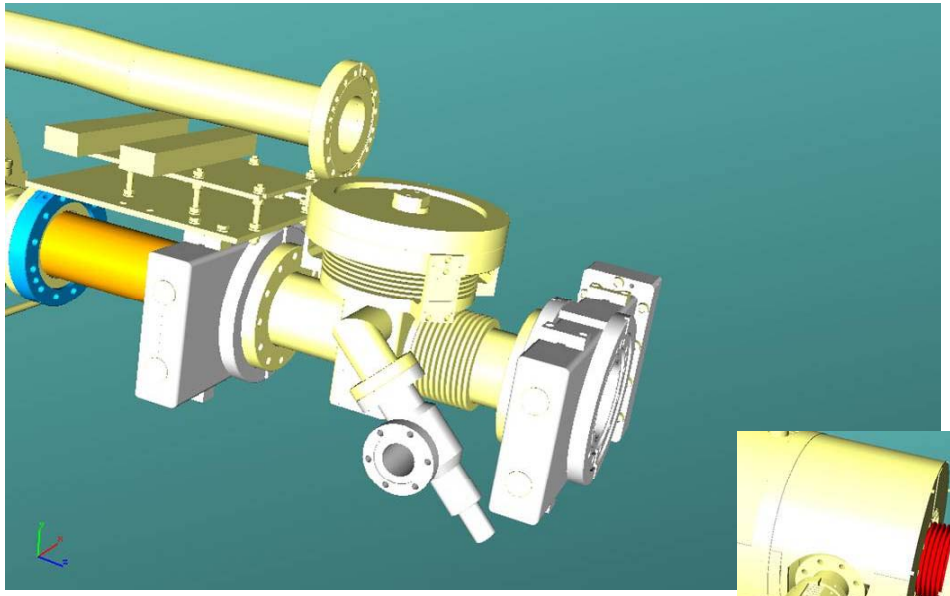
The other **50% of the cold masses would be a shared responsibility of DESY and INFN**. The cavity welding is seen independent of the WP-3 contribution (see WP-4).

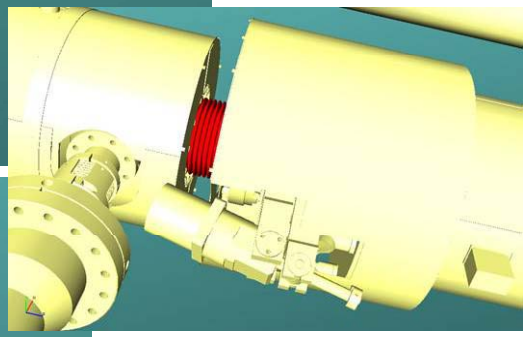
Value

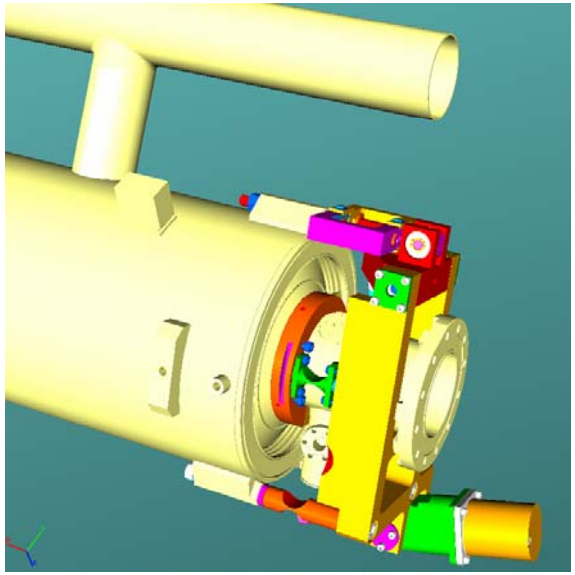
The value of this work package is xxxxx k€ total invest and xxxx FTEs (xxxxx M€). Following the in-kind proposal, approx. xxx M€ for the module assembly and xxx M€ for the cold mass production would be accounted as CEA Saclay investment, and approx. xxx FTEs, i.e. xxx M€ for personnel. The other 50% of the cold mass production, the qualification of the delivering companies, the tunnel installation and warm as well as cold commissioning are subject of further clarifications. So far it is assumed that DESY and INFN share this part equally (50% each of xxx M€ investment and xxxx FTE). Some initial investment of approx. xxx M€ was already taken over by DESY.

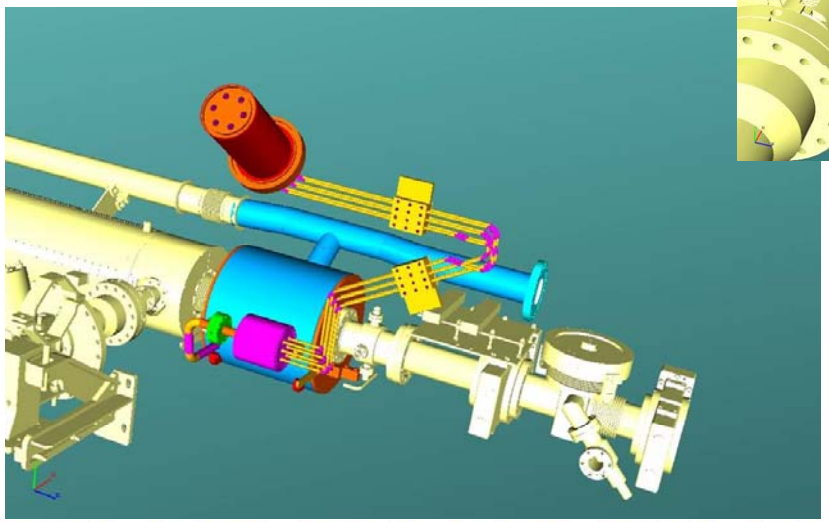
Other Examples











XFEL Info Useful for ILC, e.g.

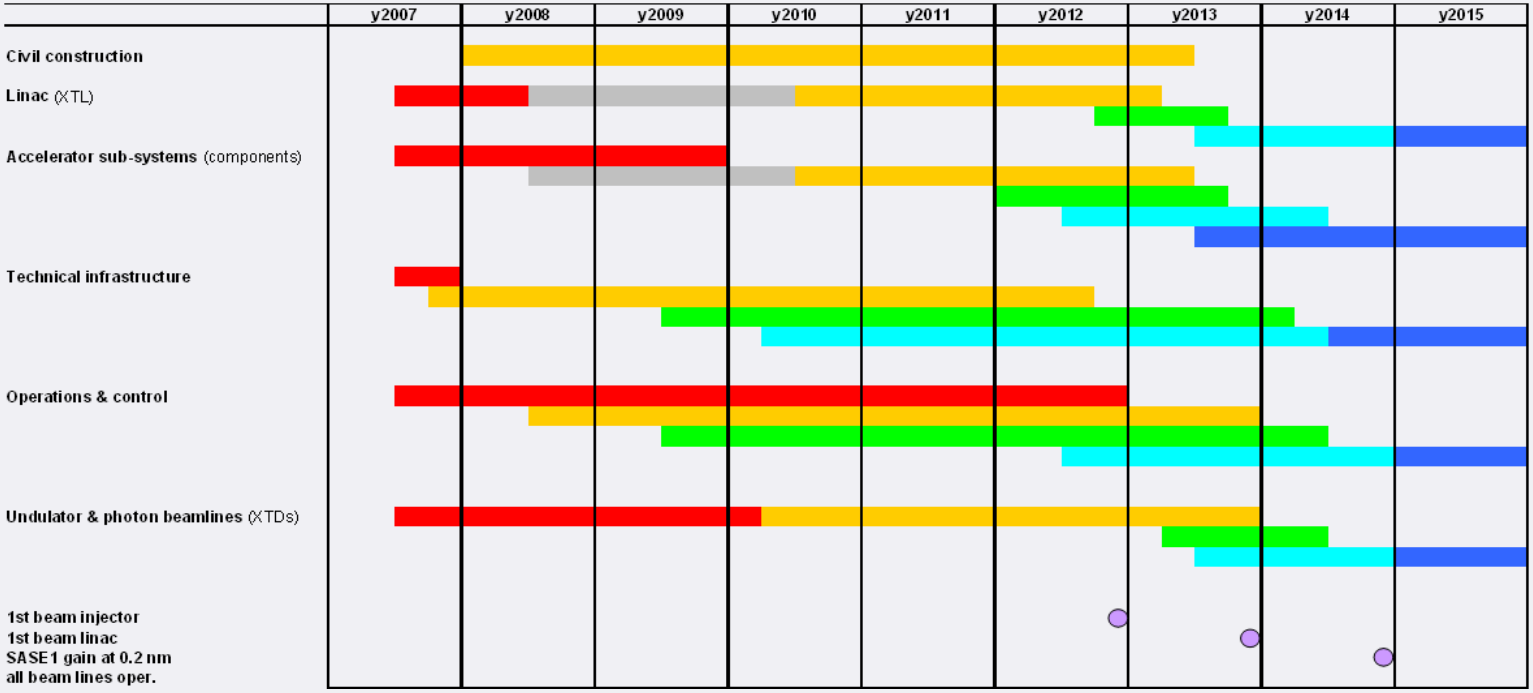
- rates at which vendors can build and process cavities, cryomodules and HLRF components
- cost of these items (although this may not be sharable)
- feasibility of a single tunnel design including the support of the cryomodules from the ceiling
- lifetime data for the klystron and modulators from tests at Zeuthen
- failure mechanisms (such as leaks) for the cavities and cryomodules from the testing program
- model for lab-industry interactions (if the LHC experience is any indicator, there will likely be a very close lab-industry working relation for XFEL and the ILC)

XFEL Components

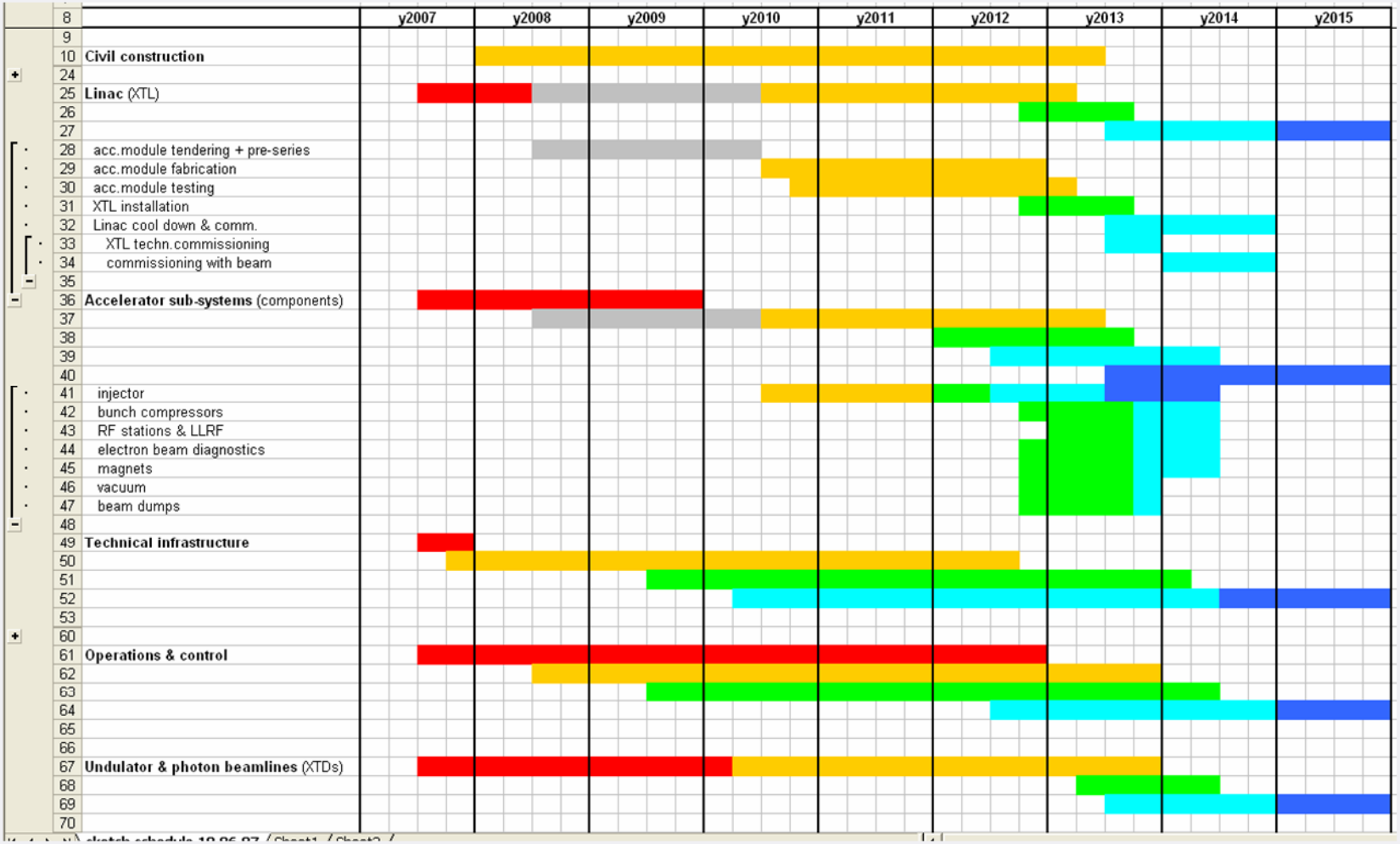
- XFEL needs
  - 808 cavities for
  - 101 accelerator modules, i.e.
  - 808 frequency tuners,
  - 808 RF main input couplers,
  - 1616 HOM pick-ups,
  - 101 HOM absorbers
  - etc.
- Due to the long leadtime all components need to be specified in 2008, the call for tender process to be started before end of 2008, orders be placed not later than beginning of 2009. Since the in-kind contributions are just close to be defined, a challenging task for all collaborators!!!

Overall XFEL Schedule

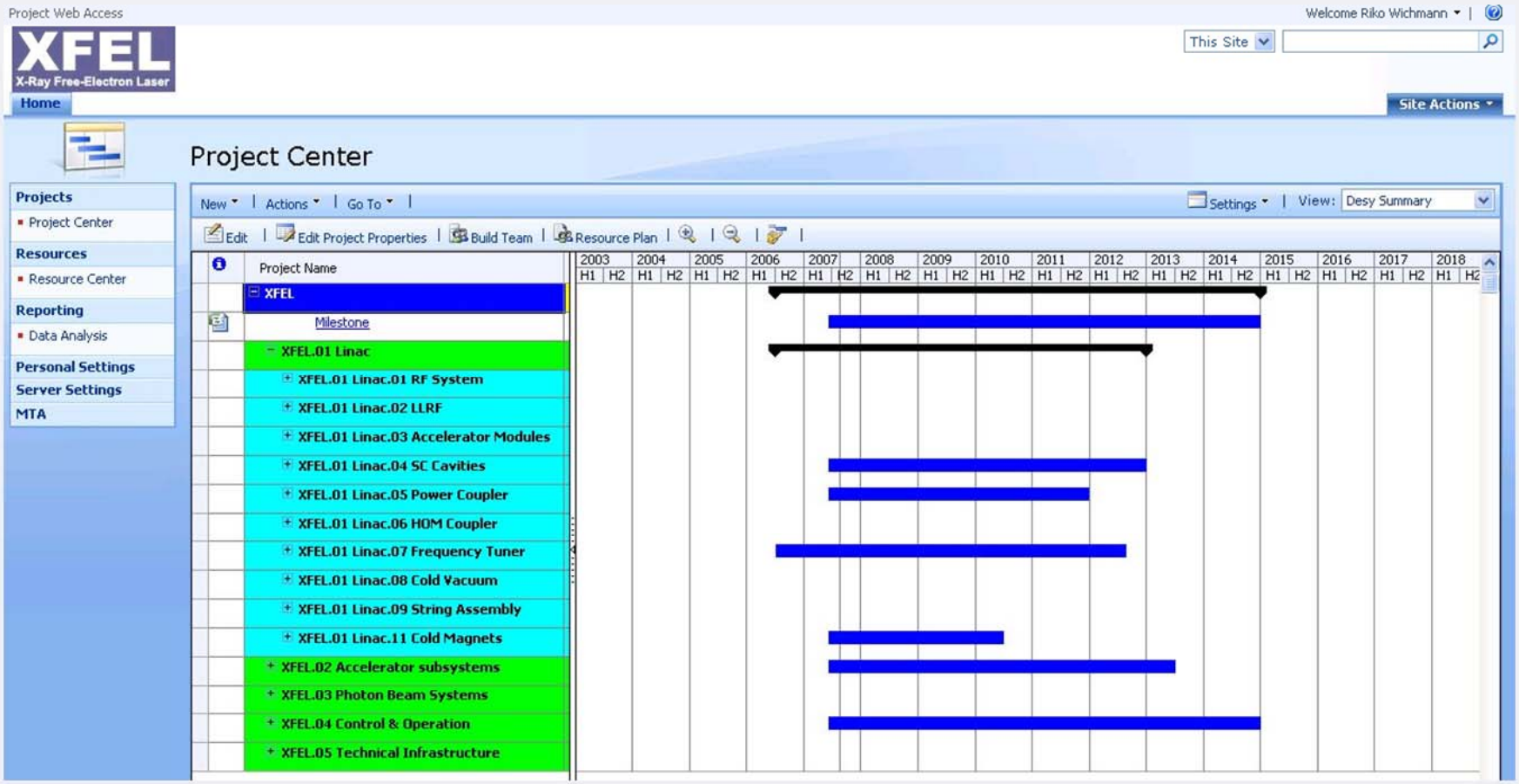
- We have the overall schedule promising first beam through the linac before end of 2013; this schedule can be used to determine earlier project milestones



Overall XFEL Schedule (Some Details)

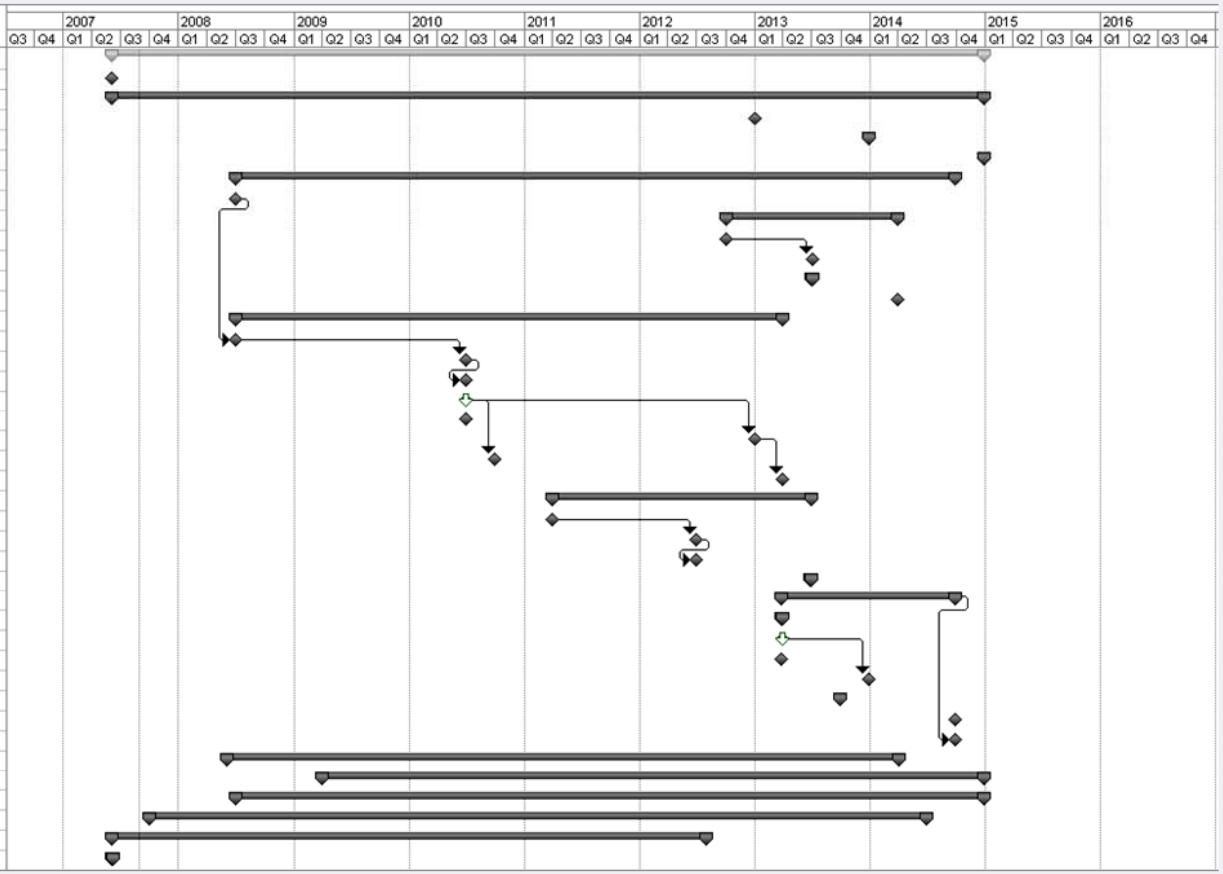


Hierarchical Structure of Project Plan



Top-Down Milestones as Initial Time Frame

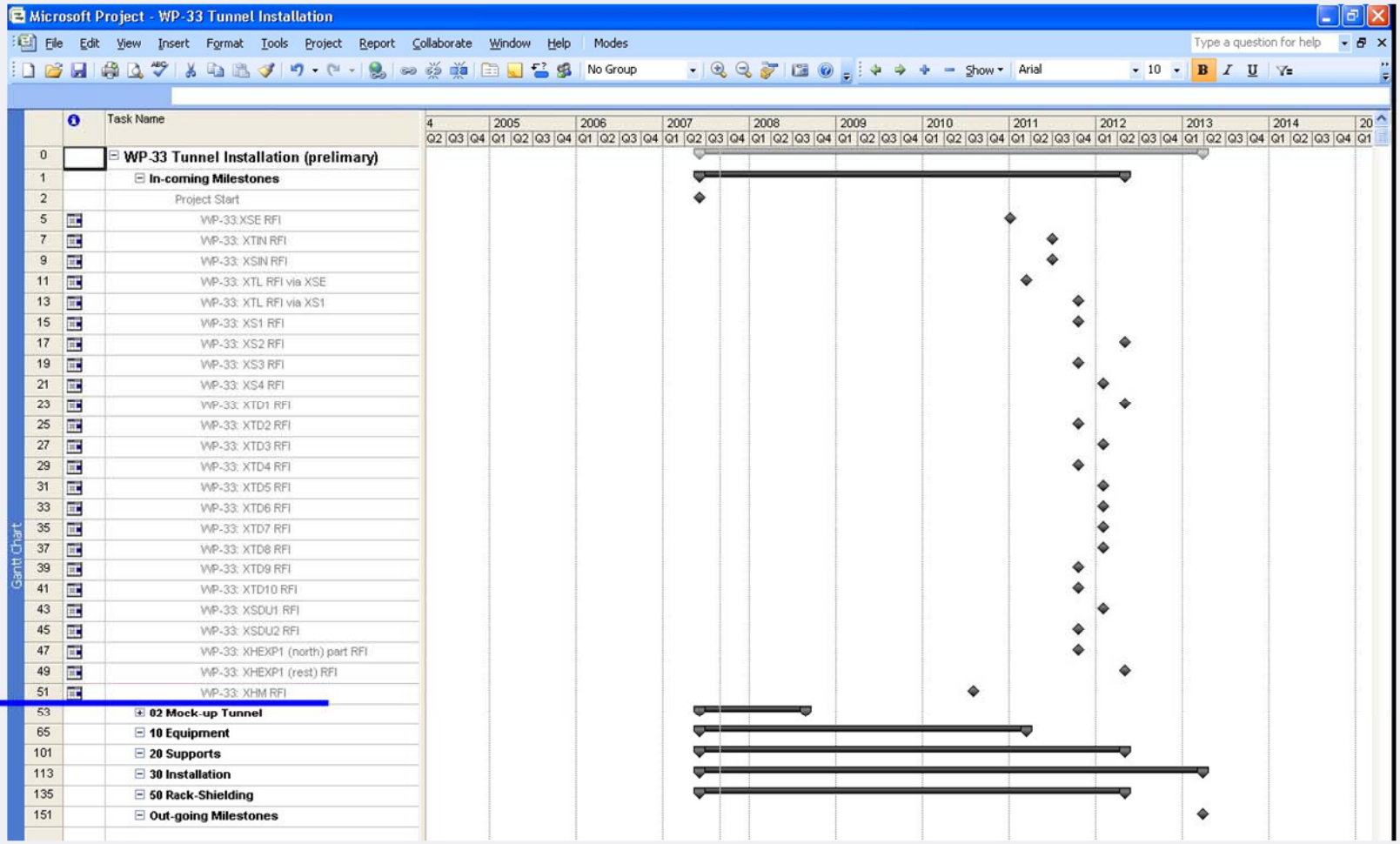
ID	Task Name
0	**Milestone**
1	**Project Start**
41	**XFEL Top-Down Milestones**
42	**1st beam in injector**
45	**1st beam in LINAC**
50	**1st SASE**
54	**WPG-1 LINAC**
55	design, prototyping, industrialization finished
56	**RF and LLRF (in XTL)**
57	start installation (inside XTL)
58	end installation
59	**Start Commissioning**
63	end commissioning
64	**Accelerator Modules**
65	start accelerator module tendering + pre-series
66	end accelerator module tendering + pre-series
67	**Start Fabrication**
68	start accelerator module fabrication
69	WP-11 start module fabrication
71	end accelerator module fabrication
72	start accelerator module testing
73	end accelerator module testing
74	**Installation**
75	start XTL infrastructure installation
76	end XTL infrastructure installation
77	**Start XTL machine installation**
81	**End XTL machine installation**
85	**Cool Down & Commissioning**
86	**Start XTL technical commissioning**
87	start XTL technical commissioning
88	WP-38: Start XTL Commissioning
90	end XTL technical commissioning
91	**Start Commissioning w Beam**
95	end commissioning with beam
96	LINAC ready for operation
97	**WPG-2: Accelerator Sub-Systems**
153	**WPG-3 Photon Beam Systems**
250	**WPG-4: Operation & Control Milestones**
257	**WPG-5: Technical Infrastructure Milestones**
296	**WPG-6: Civil Construction Milestones**
437	**XFEL WP Dependencies**



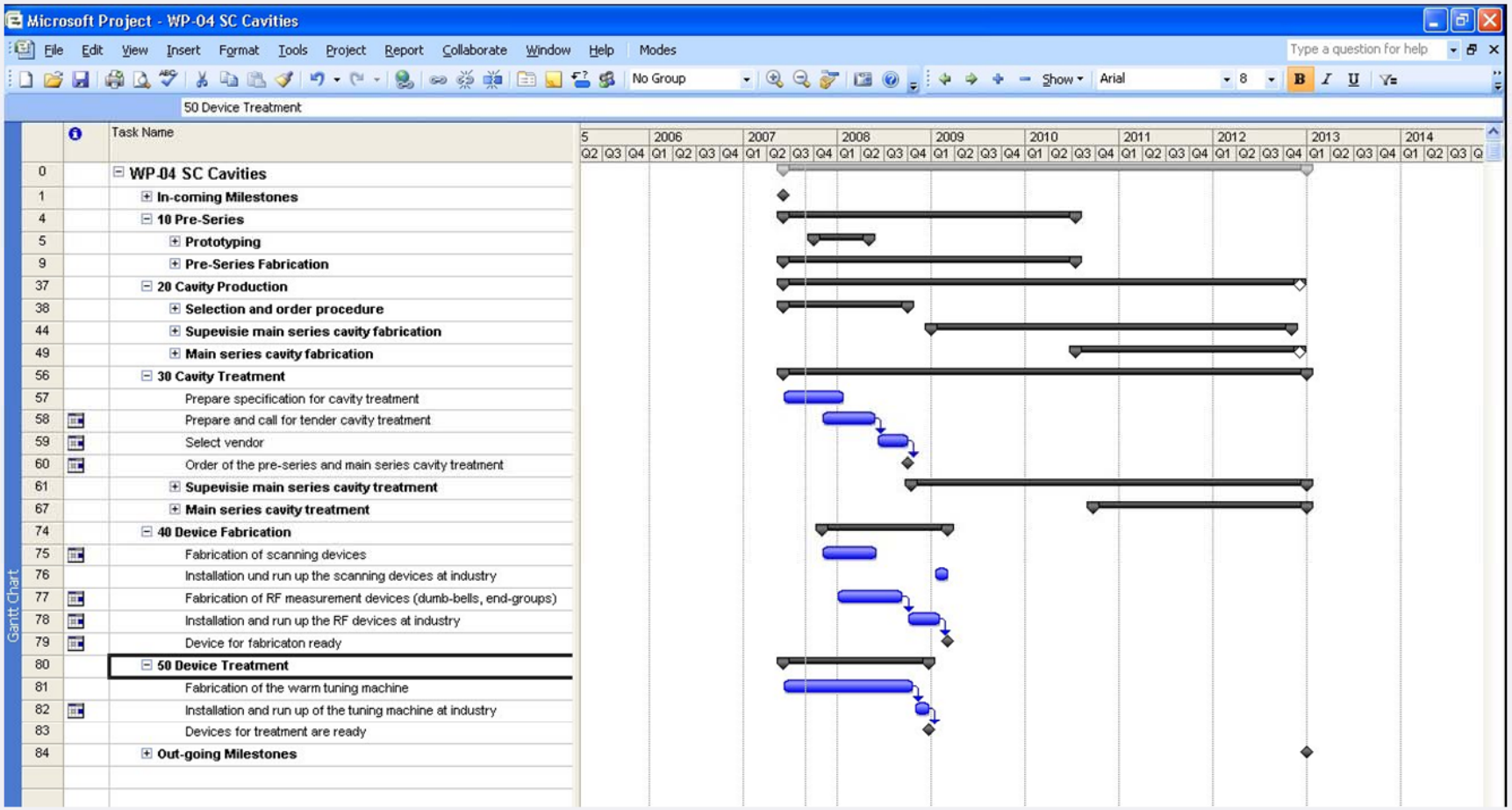
WP Plan Depend on Milestones from other Plans

Milestones from other plan

WP sub-structure



WP Detailed Planning Started



Scheduling Review on Sep. 26/27, 2007

XFEL Components

- XFEL needs
  808 cavities for
  101 accelerator modules, i.e.
  808 frequency tuners,
  808 RF main input couplers,
  1616 HOM pick-ups,
  101 HOM absorbers
  etc.

First 5-10% of modules in 2010, majority in 2011 / 2012

Tunnel installation finished spring 2013

- Overall rate: 1 module per week for 2 years
- Orders will be placed not later than 2009, so the prices are known on the basis of 5% ILC
- Component tests start in Q3/2010

end of 2010 approx. 5 modules, 40+40 cavities, coupler, …

mid of 2011 approx. 30 modules, 300 cavities, coupler …

XFEL Tunnel

- feasibility of a single tunnel design including the support of the cryomodules from the ceiling

end of 2010 we have no further 'experimental data';

pre-installation starts in 2011

BUT:

- **FLASH is lasing with the pulse cables going all along the linac…**
- **installation procedures will be trained at the mock-up**

XFEL Klystron / Modulator

- lifetime data for the klystron and modulators from tests at Zeuthen

end of 2010 we have lifetime data of all prototypes…

- **horizontal MBKs**
- **Modulators**

BUT:

- **already now we get first data about the MBKs**
- **AMTF module tests as well as coupler conditioning will to some extend use FLASH like modulators and 5 MW tubes**

XFEL MBK Klystron

Status (Sept.'07) of horizontal Toshiba MBK

Toshiba E3736H at test stand in August 2007 at Toshiba in Nasu, Japan

Test Results (Toshiba)

Peak Output Power at 117kV (MW)	10.3
Efficiency (%)	~67
Beam Pulse Length (ms)	1.7
RF Pulse length (ms)	1.5
Repetition Rate (pps)	10
Saturation Gain (dB)	50

- Factory Acceptance Test (FAT) in Nasu successfull on August 22/23, 2007
- Klystron will be shipped to DESY
- Site Acceptance Test (SAT) at DESY planned for end of this year

XFEL Accelerator Modules

- failure mechanisms (such as leaks) for the cavities and cryomodules from the testing program

Recently FLASH modules 6, 7, and 5 were tested quite successfully.

FLASH module 8 will be tested in Q1/2008.

FLASH module 3* will be 'destructively' tested before end of 2007, i.e. venting of cold unit.

Up to 3 more modules will be tested until end of 2009 (XFEL pre-series production).

The last FLASH modules were used for

T-cycling
quick coupler conditioning
extensive frequency tuner tests.

Cavity Gradients and S1

- Already the last FLASH modules are close to 30 MV/m.
- The XFEL cavity preparation may be close to the actual discussed ILC cav.prep. Thus the question comes up: what is the chance to get a large number of >31.5 MV/m cavities out of the XFEL program? All cavities will be vertically tested to their maximum gradient.
- Module 8 (and/or 8* (XFEL training)) might reach S1 already 2008 and be used at FLASH with beam in 2009. BUT… first assembly with industrial partners!

Summary and Outlook

The European X-Ray Laser Project XFEL X-Ray Free-Electron Laser

XFEL News

Hans Weise / DESY
XFEL Cold Linac, September 3rd, 2007, Saclay

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