Present status of TTF-cryomodules short overview

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Main features of XFEL-cryomodule design (TESLA/TTF –type III)

Each cryomodule consist of:

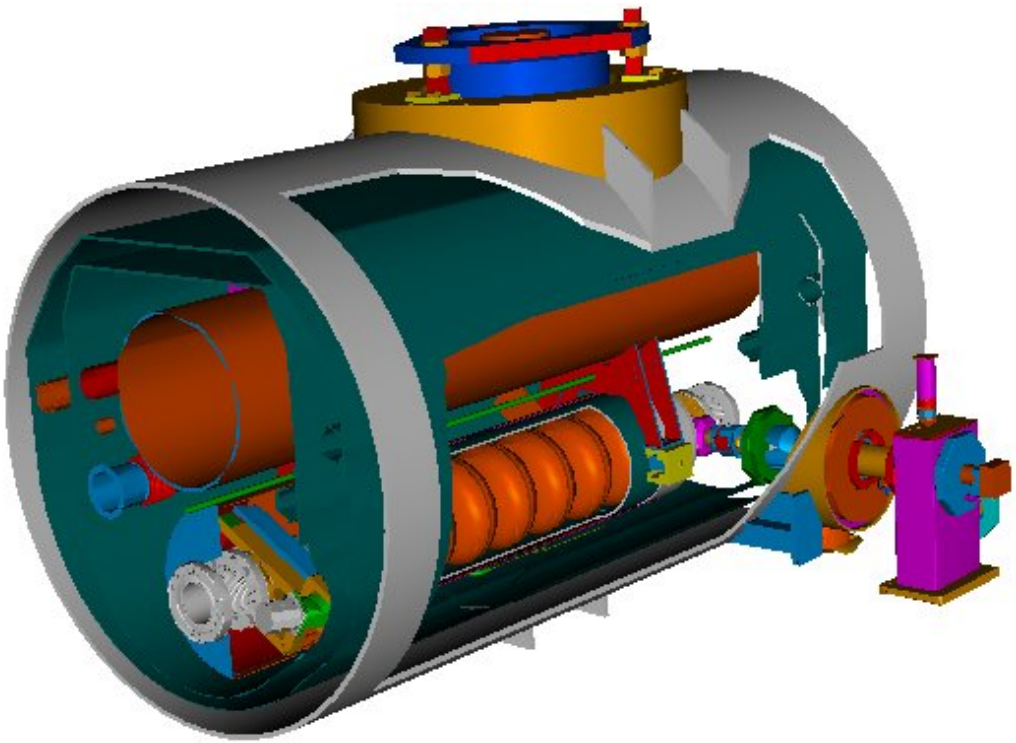
8 1.3 GHz 9-cell Nb cavities

1 magnet package

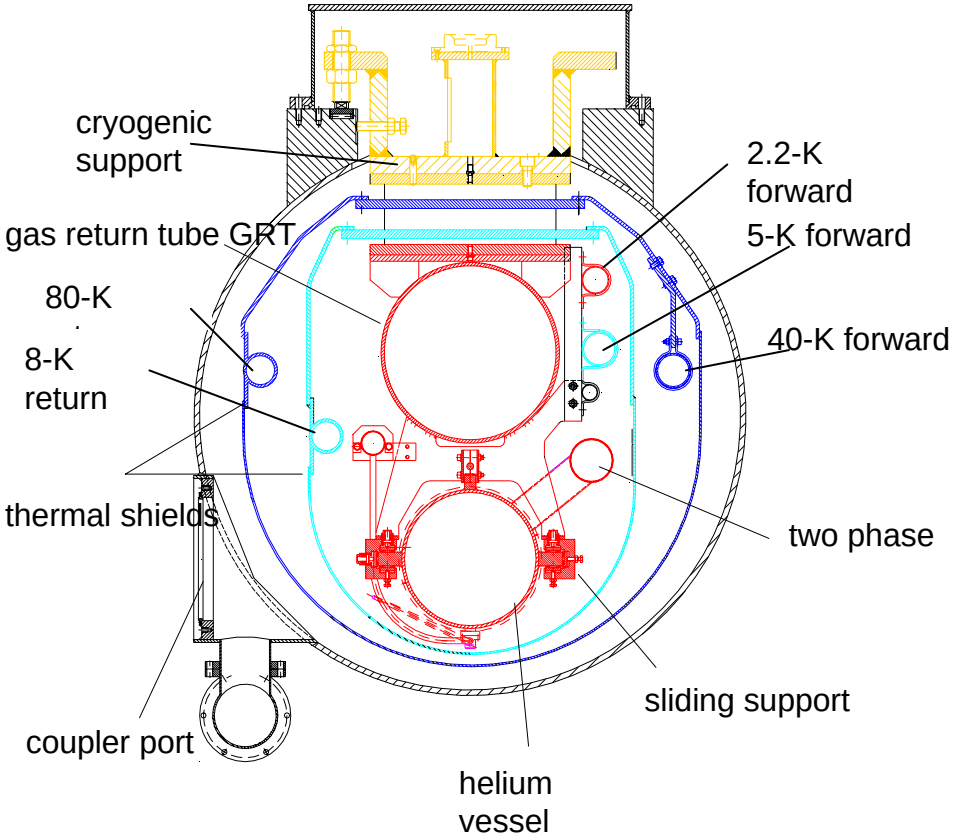
2 thermal shields

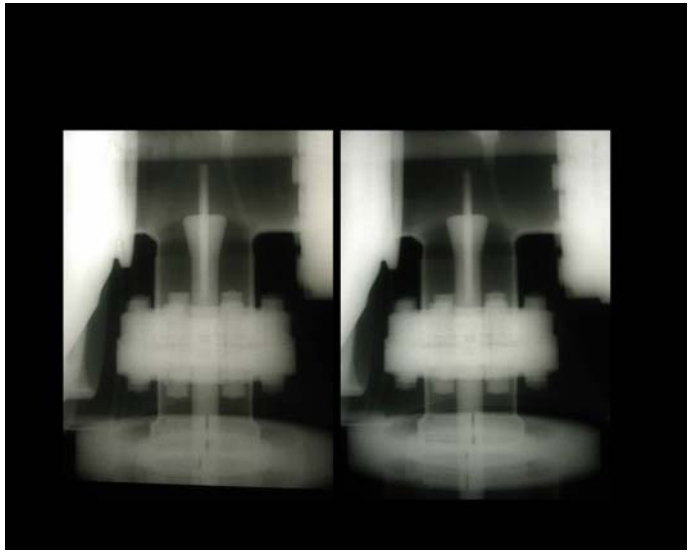
8 main RF couplers

8 cold tuners



Main features of XFEL-cryomodule design (TESLA/TTF –type III) cont.





300 K and 2K

Module 5 coupler 2

Cavity chain is fixed to an invar rod – couplers keep position

TTF-cryomodule design: results, static heat loads

-> **Measured static heat loads in line with the estimated theoretical values**

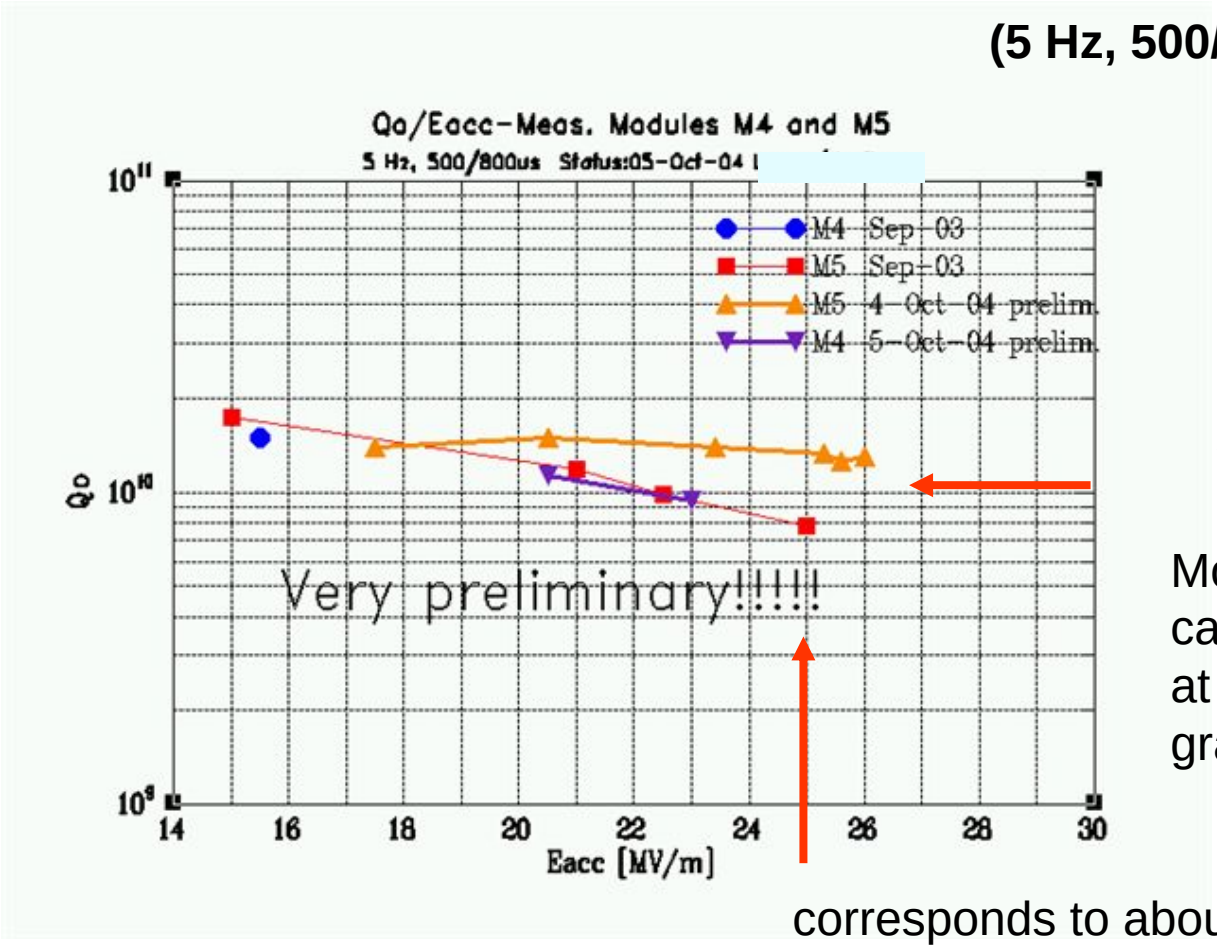
Designed, estimated and measured static Cryo-Loads TTF-Modules in TTF-Linac										
Module	40/80 K [W]			4.3K [W]			2 K [W]			Notes
Name/Type	Design	Estim.	Meas.	Design	Estim.	Meas.	Design	Estim.	Meas.	
Module 1 I	115.0	76.8	90.0 *	21.0	13,9	23.0 *	4,2	2,8	6,0 *	Open holes in isolation
Modul1 rep. I	115.0	76.8	81,5	21.0	13,9	15,9	4,2	2,8	5,0	2 end-caps
Modul 2 II	115.0	76.8	77,9	21.0	13,9	13.0	4,2	2,8	4,0	2 end-caps
Module 3 II	115.0	76.8	72.0 **	21.0	13,9	48.0 **	4,2	2,8	5,0 *	Iso-vac 1E-04 mb, 2e-caps
Module 1* II	115.0	76.8	73.0	21.0	13,9	13.0	4,2	2,8	<3.5	1 end-cap
Module 4 III	115.0	76.8	74	21.0	13,9	13.5	4,2	2,8	<3.5	1 end-cap
Module 5 III	115.0	76.8	74	21.0	13,9	13.0	4,2	2,8	<3.5	1 end-cap
Module SS	115.0	~76.8	72.0	~21.0	~13.9	12.0	~4.2	>2,8	4,5	Special, 2 end-caps
Module 3* II	115.0	76.8	75	21.0	13,9	14	4,2	2,8	<3.5	1 end-cap
Module 2* II	115.0	76.8	74	21.0	13,9	14,5	4,2	2,8	<4,5	2 end-caps
Module 6 EP	Type III, EP-Cavities Goal:Solution close to XFEL Modules									(Assembly End-04??)
										Modules under Test in TTF2-Linac

design value = 1.5 * estimated value

TTF-cryomodule design
results: dynamic losses

2K Dynamic heat losses of module 4 & 5 (type III) : about 3 W at 25 MV/m each

(5 Hz, 500/800µ s)



0.38 W/cavity

Most cavities can be operated at higher gradients !

corresponds to about 3 W each

X-FEL Cryomodule

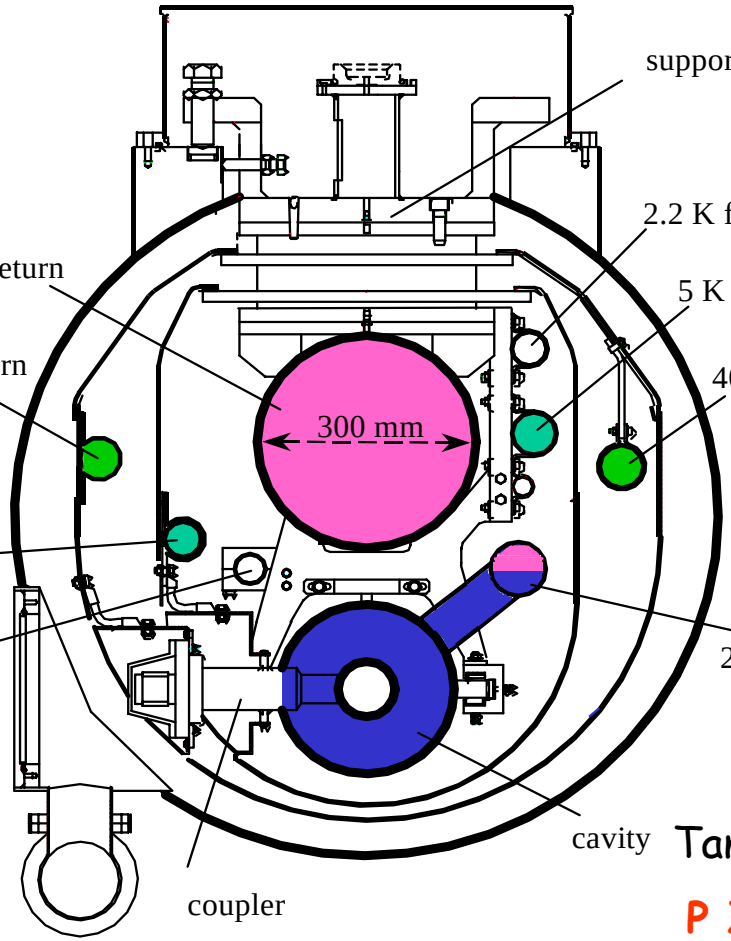
- TTF type III design baseline for X-FEL
- 8 cavities, 1 magnet package

Modifications:

- **smaller quadrupole (super-ferric), 2K cooled,typeIII support**
- **metal gaskets and/or welded connections (under discussion)**
- **different BPM**
- **length shall match the (lambda * N/2) condition**
- **ceramic HOM absorber between modules**
- **Piezo tuner**
- **larger diameter for shield helium process tubes (DN 80 for 40/80K)**
- **Safe-guard design**
- **Still open question: design changes needed to reduce vibrations ????**
- **industrialization**

Pressure vessel classification

DGRL Kat.I, Modul A, AD2000, Mat. 3.1 B



Kryomodulrohre PS X DN

Problem: Nb

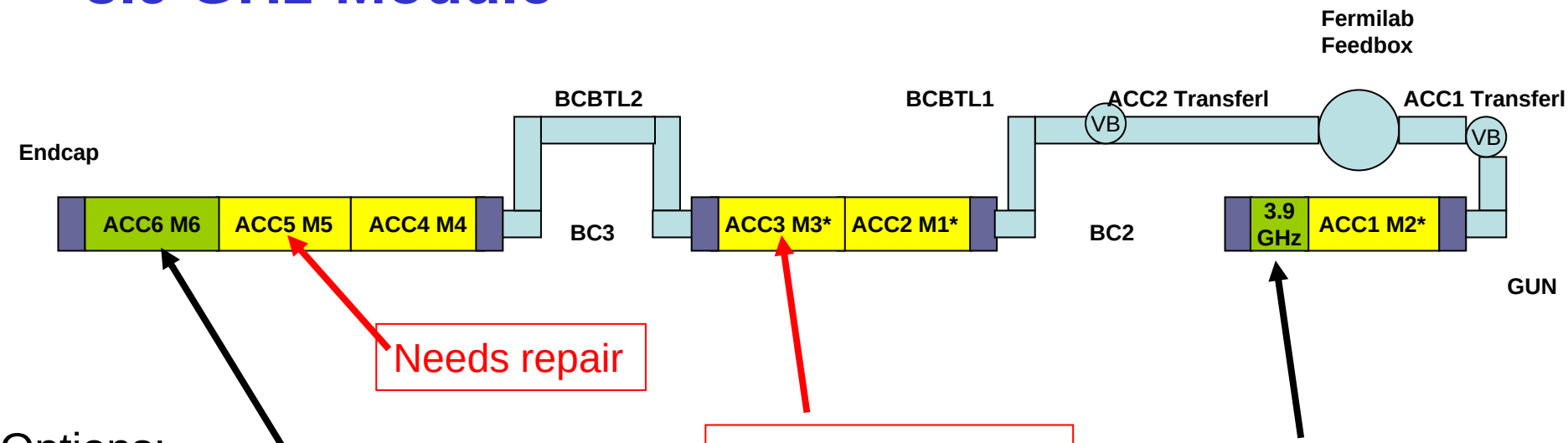
Cryomodule Plans

production No.(*)	type	required accelerating field	assembly date	comments	material
6	**TTF-III**	**> 35 MV/m**	**9 / 2005**	**ACC6 in VUV-FEL**	**complete**
7	**TTF-II**	**> 25 MV/m**	**10/ 2005**	**VUV-FEL spare**	**complete**
8	**TTF-III plus**	**> 28 MV/m**	**2006**	**XFEL preparations VUV-FEL spare**	**to be ordered**
9	**TTF-III plus**	**> 28 MV/m**	**2006**	**XFEL preparations**	**to b ordered**
10	**TTF-III plus**	**???? MV/m**	**2007**	**FNAL**	**To be ordered**
11	**XFEL-Prototype**	**> 28 MV/m**	**2007**	**XFEL-prototype**	**to be ordered**

(*) the production number does not necessarily define the order of assembly

Future cryo installations in the TTF-Linac

Additional Installations
-Module 6
-3.9 GHz-Module



Options:

- Module 6 installation spring 06
  installation on position ACC6

Motivation of cryomodule assembly Industrial Studies (IS)

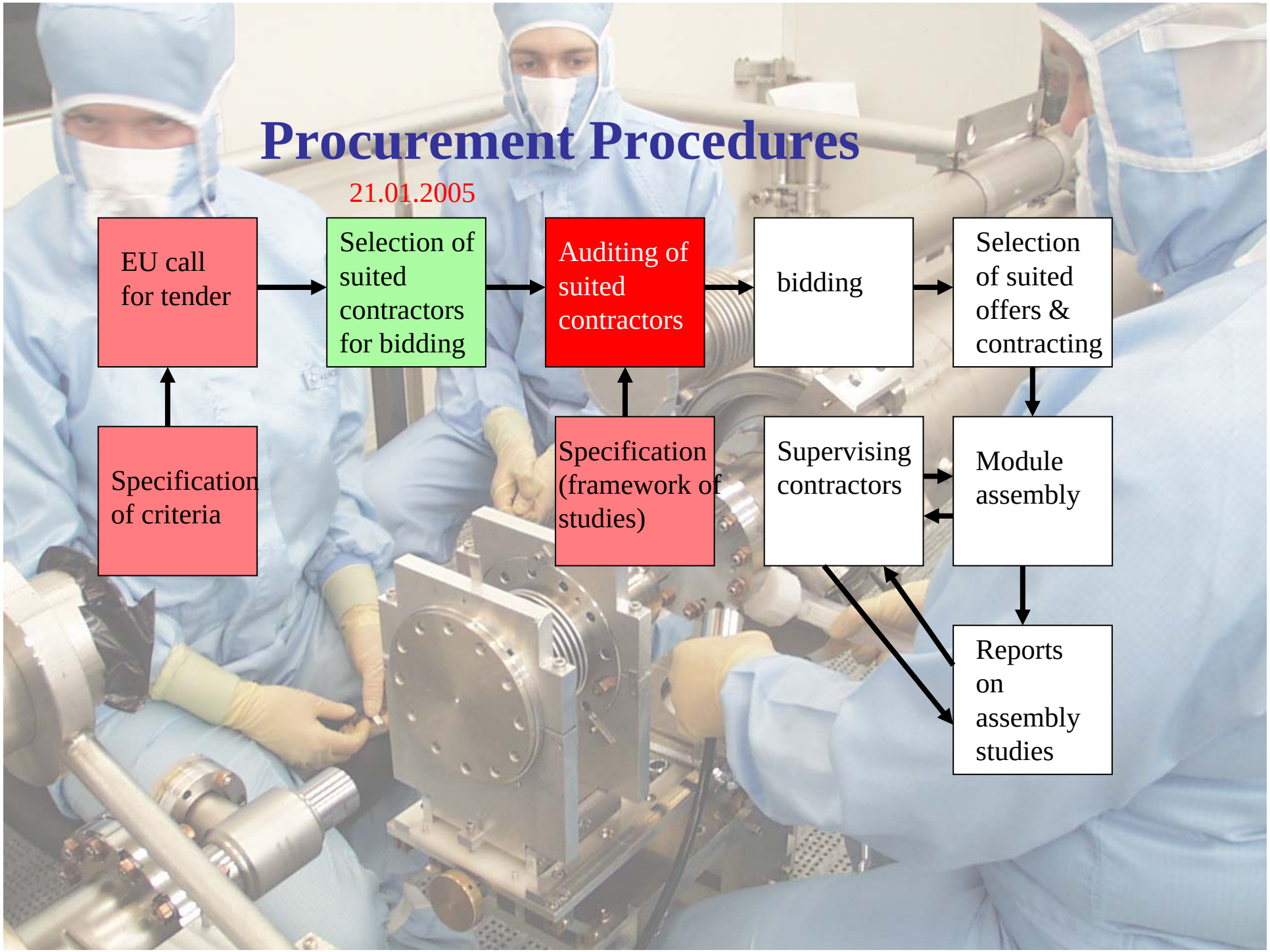
Preparation of the **European XFEL-Project** and other superconducting linac based FEL-light sources like the **BESSY FEL**

In particular, preparation of the serial production of about 120 XFEL-cryomodules for the European XFEL-Project

Input for the final design and assembly procedures for the XFEL-cryomodules

Procurement Procedures

21.01.2005



Scope of the IS

The **Deutsches Elektronen Synchrotron (DESY)** takes the action for the call for tender and contracting of the IS on behalf of the **TESLA-collaboration**, the **X-FEL project**, the **EUROFEL design study** and the Berliner **Elektronenspeichering-Gesellschaft für Synchrotronstrahlung m.b.H. (BESSY)**

The present cryomodule assembly procedures and some aspects of the present design shall be analyzed and questioned with respect to the most cost effective serial production.

The key aspects of the study are as follows:
1.2.1 Define the assembly procedure
1.2.1 Analyze cost-reduction and production efficiency measures
1.2.3 Analyze performance improvement measures
1.2.4 Supply a cost estimate for the module production

A substantial part of the IS shall be the presence of CONTRACTOR's experts during the assembly of two prototype cryomodules at DESY.

Prerequisites of the CONTRACTOR (key technologies)

1) Experience of serial production of large Particle Accelerator Components.
2) Experience of design and construction of Cryogenic Components used at liquid helium temperatures.
3) The Know-How of industrial serial production at hand.

4) Experience of applied Clean-Room Technology (10-100 ASTM)
5) Experience of applied Ultra-High-Vacuum Techniques (oil- and particle free).
6) General experience in the application of extensive and particular Low Tolerance Quality Assurance Procedures in the required fields

Cryomodule Assembly

All steps of the assembly procedures, in particular the assembly inside the clean room, can strongly affect the final performance of the cryomodule. The final accelerating gradients as well as the RF quality factors and the occurrence of dark currents are extremely sensitive to any contamination with particles caused during the assembly. Also the mounting of other equipment, like the tuners and main couplers, requires extreme care.

Clean room assembly

Assembly outside cleanroom

Schedule (preliminary)

Experts of the Contractor shall be present at the assemblies of modules 6 and 8

About 6 weeks are needed for each assembly

internal modul production number	design type	status of planning	assembly not before	comment
6	**TTF-III**	**scheduled**	**August 2005**	**35 MV/m high gradient module**
7	TTF-II	scheduled	September 2005	VUV-FEL linac spare module
8	**X-FEL**	**not yet scheduled**	**end of 2006**	**X-FEL prototype**
9	X-FEL	not yet scheduled	?	X-FEL prototype

Deliverables

Four reports on the specified issues:

1) Report on assembly of module 6

2) Report on assembly of module 8

3) Report on BESSY-FEL cryomodule special issues

4) Final report

The reports shall cover also special issues, as specified

These reports will be published as part of the EUROFEL-Study

Cost issues shall be covered in separated attachments to the reports. These attachments are confidential and will not be published.