# Draft: XFEL Module Meeting, April 08th, 2015

The meeting took place by video conference at CEA Saclay, LAL Orsay, INFN Milan and DESY Hamburg.

## 1. Participants

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Angelo Bosotti
Heiner Brück
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Sergiy Putselyk (SP)
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Nicholas John Walker
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## 2. Agenda

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6. Status and actions concerning modules "elsewhere" to be followed-up
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   c. XM23 (unstable cold leak, parking in "Reemtsma halls")
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   e. XM21 (intermediate tunnel storage)
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   i. XM12 (leaky, indistinct cold leaks, in the "Reemtsma halls")
   j. XM8 (leaky, never cold tested, in the "Reemtsma halls")
   k. XM-3 (no PED qualification, in the "Reemtsma halls")
   l. XM-2 (no PED qualification, in the "Reemtsma halls")
7. Status and actions at CMTB
   a. XM4 (re-testing after major coupler repair)
8. Open issues identified at the last meetings
9. AOB

## 3. Protocols of previous meetings

EV was unable to write and provide the protocol of the meeting at March 15th due to the breakdown of the office PC power supply.

## 4. Agenda

Everybody agrees with the agenda of the meeting. For clarity of the protocol, the agenda item 3.c has been inserted and the headline of the agenda item 3 reworded.

## 5. Status and actions of module assembly supply parts (cavities, couplers, etc.)

See slides at INDICO from SB.

***a. Couplers (available at LAL, ready for shipment to CEA, at CEA)***

Status:

- 370 (for 46 modules) cold and warm THRI coupler parts have been delivered by LAL to CEA.
- couplers up to XM46 are at CEA
- couplers for XM47 are ready for shipment
- small defects have been observed at the couplers foreseen for XM48
- two couplers have been rejected by LAL to RI before rf conditioning, six couplers are being processed
- since last week, 10 couplers where processed
- THRI couplers up to number 410 are at LAL
- the CPI coupler delivery status is still unclear; the couplers left CPI but didn't already arrive at LAL; CPI Europe has no information on the actual whereabouts and speculates they may be on a truck somewhere in Europe
- LAL may have difficulties providing eight coupler to CEA in week 16

***Actions:***

- today: delivery of four cold parts to CEA
- after the meeting: experts decision on how to deal with then defects at the couplers foreseen for XM48
- clarification of the CPI coupler delivery status

***b. Cavities (ready for shipment to CEA, at CEA)***

Status:

- all cavities for XM49 and one for XM50 are at CEA plus some spare cavities
- cavities up to XM53 are assigned to modules and are ready for shipment
- more cavities are ready for shipment which are not yet assigned to modules
- transportation boxes have been shipped back to DESY

***Actions:***

- DR, JS and SB will check the present whereabouts of cavity #81; according to the cavity string definition, this cavity belongs to XM47 but can actually not been found in the bunch of cavities for XM37 at CEA
- continue according to plan

***c. AOB - coupler pumping line delivery times***

***Action:***

- LL and CEA colleagues will cross check the coupler pumping line delivery times

## 6. Status and actions concerning modules at CEA

See slides at INDICO from SB.

### *a. XM46*

Status:

- waiting for the power couplers from LAL
- otherwise, everything is prepared at CEA to start the assembly

***Actions:***

- WK will immediately sent four could coupler parts to CEA
- tomorrow: assembly start

### *b. XM45*

Status:

- string assembly ongoing

***Actions:***

- continue according to plan

### *c. XM44*

Status:

- at the roll out area
- Titanium welding is ongoing

***Actions:***

- continue according to plan

### *d. XM43*

Status:

- at the alignment area

***Actions:***

- continue according to plan

### *e. XM42*

Status:

- at the cantilever area
- the assembly of 70 k shield will be finished today

***Actions:***

- continue according to plan

***f. XM41***

Status:

- at the warm coupler assembly area
- Case history cav. pos. 1: cavity #668 has been exchanged by #777 (spare) due to a leak at the gate valve assembly. Cavity #668 has been shipped to DESY for investigation, and re-preparation.
- Case history cav. pos. 5: cavity #610 has been exchanged by #788 (spare) due to fast cavity venting by mistake. Cavity #610 has been shipped to DESY for investigation and re-preparation.

***Actions:***

- continue according to plan

***g. XM40***

Status:

- at the shipment area

*Actions:*

- continue according to plan

***h. XM39***

Status:

- loading to truck is ongoing

***Actions:***

- today afternoon: truck leaves for DESY
- Friday morning: unloading in the AMTF

***i. AOB***

Status:

- A report on the investigations w.r.t. the contamination observed in CEA vacuum-systems has been prepared and sent to SB for comments before being distributed.

***Actions:***

- SB will provide his comments on the report on the investigations w.r.t. the contamination observed in CEA vacuum-systems to LL.
- continue with the module assembly according to plan

## 7. Status and actions concerning modules at AMTF

See slides at INDICO from SB.

### *a. XM38*

Status:

- the incoming inspection and the survey is ongoing
- Case history: The warm part of coupler #8 has been exchanged at CEA due to a leak found at the warm ceramic.
- Case history: During welding the 80 K shields the MLI blankets of the 8 K shield caught fire and about 1 $m^2$ was destroyed. The fire has been extinguished with $CO_2$. And the burned MLI blankets replaced. The cables have been visually inspected and electrically tested. The tuner motor movement has been re-checked and their proper operation after the fire and fire extinguishing verified. The event caused a loss of two to three days in assembly time.

***Actions:***

- continue according to plan

### *b. XM37*

Status:

- waiting for cabling
- incoming inspection and survey done, both ok

***Actions:***

- some discrepancies in the BPM measurements need to be clarified between Claire Simon and Dirk Nölle
- next: cabling
- continue according to plan

### *c. XM36*

Status:

- cabling ongoing
- Case history: The filter characteristic of three HOM2 cans are detuned:
  - at the alignment area, the filter characteristic of all HOM cans where still ok, SB provided data to JS
  - one HOM can shows a major detuning (cavity #021)
  - information from
  - this information still needs to be transferred to the experts

***Actions:***

- SB will inform JS, when he provided the data of the HOM2 filter characteristic to JS
- pending: transfer of the information on detuned HOM filter characteristic to experts
- continue according to plan

***d. XM35***

Status:

- waiting for testing

***Actions:***

- continue according to plan

***e. XM34***

Status:

- waiting for testing
- Case history: The gate valve at the q-pole side shows a misalignment of 1 mm. The fixations and are mechanically solid and not "wobbling". W.r.t. the beam dynamics, WD accepts this misalignment for the tunnel installation.
- Case history: MLI blankets have been found mechanically stuck between post brackets and posts. An in situ repair method and action has been applied a re-survey performed and the issue solved.
- Case history: Leak at the flange between the gate valve and the vacuum assembly used for venting. No additional cleaning is required at this area at the AMTF test stand.

***Actions:***

- continue according to plan

***f. XM33 at XATB1***

Status:

- insulation vacuum pumping is ongoing
- the coupler conditioning takes longer than expected caused by an unfavorable behavior of couplers
- Case history: MLI blankets have been found mechanically stuck between post brackets and posts. An in situ repair method and action has been applied a re-survey performed and the issue solved.

***Actions:***

- DK will be consulted if further coupler conditioning may be done in parallel with the cool down
- continue according to plan

***g. XM31 at XATB3 (leaving test stand, preliminary rf results)***

Status:

- the module just left XATB3
- MW presents the rf test results: the usable gradient of cavity #1, #3, #4 and #8 dropped to values near 20 MV/m; the average usable gradient is about 26 MV/m
- Case history: The HOM2 feed-through at the coupler #2 A-flange is leaky and has provisionally been rubber sealed.
- Case history: MLI blankets have been found mechanically stuck between post brackets and posts. An in situ repair method and action has been applied a re-survey performed and the issue solved.

***Actions:***

- specifying a waveguide distribution
- putting the module to the tunnel
- continue according to plan

***h. Wave guides (status of assembly, time foreseen for assembly to module)***

Status:

- waiting for the next waveguide specifications
- waveguides for XM20 finished and assembled
- waveguides for XM27 attached to module in week 15 (week, starting April 7$^{th}$)
- waveguides for XM30: no info at the meeting
- waveguides for XM29 (injector) will take longer than usual

***Actions:***

- clarification of the schedule of the waveguides for XM30
- fabricating and assembling waveguides as soon as distributions have been specified

***i. XM30 (waiting for wave guides)***

Status:

- waiting for waveguides
- waveguide distribution specified
- Case history: High heat loads are observed at the 5/8 K circuit. Nevertheless, basically all modules tested at XATB2 show this high values indicating a systematic problem at the test stand.
- Case history: oxidation at two couplers (#2 and #6) has been discovered
  - both couplers are viewed still ok to leave them as they are, hence they were not in situ cleaned or otherwise treated
  - during warm coupler processing no striking features have been observed

- during cold operation no striking features have been observed

***Actions:***

- putting the module to the tunnel

***j. XM29 (waiting for wave guides)***

Status:

- waiting for the waveguides
- Case history: The performance of the cavities #6 and #7 degraded during the dynamic load measurements (powering rf to all cavities at a time) with respect to the performance measured before by powering the cavities one after the next.
- Case history: The incoming inspection revealed moving the tuner motor at cavity #3 shifts the cavity frequency only halve of the expected value. This effect disappeared at cold.
- Case history: Particle contamination has been found in the long bellows connecting vacuum pump stands outside the clean room with the cavities in the clean room. This may also led to contamination of the XM29 cavities.

***Actions:***

- using the module for the injector
- waveguide tailoring; this will take longer for the injector than for modules foreseen for the main linac

***k. XM28 at XATB2***

Status:

- actually, rf testing is ongoing
- MW presents preliminary rf test results from the single cavity tests:
  - quite some quench limits are lower than measured in the vertical tests
  - average operating gradient: 26 MV/m
- Case history: Cavity and coupler #6 have been replaced in the clean room. Some confusion existed of which cavity documents have been stored in the EDMS for XM28. This has been cleared up by DK.
- Case history: Particle contamination has been found in the long bellows connecting vacuum pump stands outside the clean room with the cavities in the clean room.

***Actions:***

- next: heat load measurement
- next week end: warm up
- putting the module into the tunnel, if no striking features appear

### *l. XM27 (waiting for wave guides)*

Status:

- at waveguide assembly workstation in the AMTF
- ready for waveguide assembly
- Not understood effect: HOM characteristics varied from cool-down to cool-down.
- Case history: The static heat loads are two times the acceptance criteria. The dynamic heat load could not be checked due to leaky coupler push rod bellows preventing the corresponding test.
- Case history: The bellow of the coupler #6 push rod and bellow has been leaky leading to bad coupler vacuum requiring warm-up, replacement (½ hour) and cool-down again.
- Case history: After the coupler #6 push rod and bellow repair and subsequent module cool down, the coupler #1 push rod and bellow became leaky requiring blind flanging coupler #1 for the RF test. After warm up, the coupler #1 has been repaired and the MBOM corrected.
- Case history: A post cap showed a leak at a weld. It has been replaced by a post cap taken from XM22.

***Actions:***

- waveguide assembly
- next week Wednesday (April 15$^{th}$): putting the module to the tunnel

### *m. XM26 (module with CPI couplers, now to XATB3)*

Status:

- at installation at XATB3
- module cabled
- second survey check has been found ok
- Case history: The coupler waveguide boxes #3 and #4 require cleaning with citric acid; CPI has been informed correspondingly.
- Case history: MLI blanket remains have been found mechanically stuck between post brackets and posts. An in situ repair method and action has been applied a re-survey performed and the issue solved.
- Case history: cold coupler assembly done with the first CPI couplers; many nonconformities have been found, see protocol from February 4$^{th}$; the CPI coupler at cavity (#8) showed a $10^{-7}$ $\frac{\text{mbar l}}{\text{s}}$ leak; consequently it has been replaced by a THRI coupler
- Case history: The cavities suffered shocks beyond acceptable limits at the transportation from DESY to CEA. Therefore, they have been shipped back to DESY for vertical re-tests.

***Actions:***

- continue according to plan

***n. XM24 (leaky beam vacuum)***

Status:

- the beam vacuum is leaky and requires investigation: pump stations for leak investigation have been installed
- Coupler #4 needs to be repaired.
- Case history: The coupler #4 capacitor screws have not been tightened according to specification causing sparks during rf testing at the AMTF. To precede the AMTF test, blind flanging of the coupler was required. Before operation the warm coupler part needs to be investigated and repaired or replaced.
- Case history: The HOM rejection filter tuning is out of specification but still acceptable.
- Case history: A special cool down procedure has been applied cooing down cryogenic circuits one after the next to identify the cryogenic circuit with the cold leak. As a result the 2 K circuit has been found leaky at cold. A thicker Indium seal (3.5 mm) has now been used for tightening the GRP adapter connections and two times re-tightening of the the Indium seal connection after 6 and 8 hours waiting time applied (usual method due to the Indium flow characteristic).
- Case history: Coupler #2 became leaky at the push rod bellow requiring immediate warm-up and repair before cooling down again and finalizing the rf testing.
- Case history: Due to leaks at the different parts (process lines and couplers) the module has been cooled down four times.

***Actions:***

- visual inspection (if possible) of the inside with a borescope
- LL expects to provide information on the beam vacuum leak and to give a recommendation on the usability or un-usability of the module for tunnel installation
- LL will also keep CEA in the loop of information
- the time until when modules are still under warranty of ALSYOM need to be checked and cases of warranty need to be claimed in time
- only if the beam pipe leak is small enough (assessment from vacuum experts required): repair of coupler #4 followed by waveguide tailoring and tunnel installation

***o. XM20 (coupler repair, leak at coupler vacuum area, waiting for wave guides)***

Status:

- ready for transport to the tunnel
- waveguides attached

- Case history: After several attempts the coupler leak at coupler #8 has successfully been sealed.
- Case history: Investigating the coupler #8 remains of a rubber seal has been found in the CF flange area connecting the warm and cold coupler parts. The knife edge is damaged. After cleaning, the warm coupler part has been re-mounted using a special CF flange repair seal ring.
- Case history: While venting the insulation vacuum with Nitrogen after the warm-up the pressure in the coupler vacuum increased, too. Hence, there is a leak between the coupler and the insulation vacuum.
- Case history: The coupler #8 cannot carry more than 30 kW of RF power (corresponding to a cavity voltage of 10 MV/m) and has been blind plated for the test.
- Case history: Some vacuum event occurred at coupler pair #7 and #8.

***Actions:***

- tomorrow morning: the module will leave the AMTF for tunnel installation

***p. 3.9 GHz and 3HZ010 (test results)***

Status:

- PP reports on the successful 3HZ010 test: no degradation of the maximum gradient (vertical test quench limit above 21 MV/m) and no radiation and no field emission has been observed up to the quench limit at about 24 MV/m; the obtained is with $Q_L = 4.3 \times 10^6$ well in the expected range (design $Q_L = 3.2 \times 10^6$)
- the complete test cycle took two weeks form the time when the cryostat adapter entered the test stand to the time when the test stand was available for the subsequent test (module XM33 entering XATB1)

***Actions:***

- disassembly of warm coupler
- pulling 3HZ010 out of the cryostat adapter
- storing the cryostat adapter and its "yellow accessories" elsewhere

***q. AOB***

Status:

- In quite some modules, the usable gradient of cavity #4 dropped.
- Investigations on the AMTF to CMTB difference of the dark current measurements are required.
- module storage place for modules in the AMTF is tight
- Since December 2014: The measurement of the modules dynamic heat load is performed while the RF is running and the magnet is powered simultaneously, to save time.

***Actions:***

- The colleagues at CEA will investigate if they can identify an action during assembly which may explain the systematic drop of the usable gradient of cavities at the module string position #4.
- SP will try to re-calibrate the heat load measurement values taken at XATB2.
- freeing space in the AMTF
- EV is investigating, if modules with beam vacuum leak can be stored in the FLASH 2 hall.
- Still pending / now news: the dark current measurement setup will be tested with a "bad cavity" causing radiation:
  - w.r.t. the soft and hardware the setup is in operation
  - Torsten Schulz (MIN) is still checking the hardware set-up
  - the data calibration should be similar to the one at the CMTB – this is not the case due to an unknown reason
- Pending: Experts round discussion on the revision of the radiation values and criteria given in the module acceptance criteria.
- pending comment from EV on outgoing inspection (template)

## 8. Status and actions concerning modules "elswhere" to be followed-up

### *a. XM32 (intermediate tunnel storage)*

Status:

- the module is stored in the tunnel
- ready for testing

***Actions:***

- actually none

### *b. XM25 (intermediate tunnel storage, w/o cables)*

Status:

- the module is stored in the tunnel
- Case history: Some problem occurred w.r.t. the survey (data). Investigations by MEA2 revealed the middle post position requires a correction by 0.5 mm.

***Actions:***

- after being back from tunnel storage:
  - cabling
  - shifting the middle post by 0.5 mm for survey correction

### *c. XM23 (unstable cold leak, parking in "Reemtsma halls")*

Status:

- the module is in the "Reemtsma halls"
- Case history: January 14th the module entered XATB1. The full cold test cycle (inclining power RF, RF control an cryogenic load testing) has been performed. February 17th the module left XATB1.
- Case history: A cold leak between the cryogenic pipes and the insulation vacuum has been detected. This leak was still increasing when the test sequence finished mid-February.
- Case history: The module has undergone a full cold test cycle including RF, RF control and cryogenic load measurements.

***Actions:***

- repairing the module

### *d. XM22 (beam vacuum is leaky, next: moving to "Reemtsma halls")*

Status:

- the beam vacuum of the module has been pumped
- the module is stored in the tunnel
- The investigations of the beam line leak revealed two leaks: one in the area between cavity #2 and #3 and one between cavity #6 and #7, size about $10^{-5}\ \frac{\mathrm{mbar\,l}}{\mathrm{s}}$.
- Case history: Without being tested, the module left XATB2 for further investigation.
- Case history: Monday, February 2nd: A $10^{-4}\ \frac{\mathrm{mbar\,l}}{\mathrm{s}}$ leak at the beam line has been discovered. Due to the observed time delay between the spraying of Helium and the detection inside the beam vacuum volume the leak is expected somewhere at an inner position. Searching for potential causes, JS reports from cavity #50 at position 3 in the module. This cavity suffered from a beam tube flange leak at the first vertical test. It has been successfully re-worked by the manufacturer. At the second vertical test, everything was leak tight.
- Case history: Thursday, January 29th: A heat load 10 times nominal has been found. Over the weekend, the module warmed up for investigation. At Monday, visual inspection was performed after opening the sliding muffs and thermal shields underneath. No mechanical problem could be identified causing poor thermal insulation. Investigations performed so far:
  - T-sensor electronics as cause of a heating of the T-sensors like already observed at other module can be excluded, as the module (and XFEL series modules in general) does not contain this type of T-sensors.
  - The tuner electronics has been checked and no indication of a malfunction causing heating was found.
- Case history: Due to a leak venting the insulation vacuum caused by a loose fastening nut at an HOM feed-through at cavity #7 XM22 testing had to be

interrupted immediately and the module warmed up for repair. Before, this feedthrough passed all vacuum tightness tests inconspicuously. The Flange with the HOM feed-through has been exchanged. According to KJ this incident should be viewed as an individual case and no further action will be taken. Nevertheless, connecting cables to this feed through connectors require special attention to avoid any mechanical stress.

- Case history: the coupler #2 A-flange showed a leak:
  - an in situ repair has been applied exchanging the O-ring
  - note: nothing was found at the O-ring or the flange surface which could explain the leak – until now, at each such leak the origin could be identified visually
- Case history: A post cap has been dismounted form the module to replace a post cap of XM27 showing a leak at a weld.

***Actions:***

- from time to time: pumping the beam vacuum preventing further pressure increase (meanwhile in the mBar region) and thus particle transport caused by mechanical shocks from outside
- before performing any transport action: pumping the beam vacuum
- pending: moving the module to the "Reemtsma halls" or a more suitable place (FLASH 2 Hall) for storage (after beam line pumping!)
- repairing the module
- still pending w.r.t. the leak at the beam line
  - ON will check for potential anomalies during the module assembly

***e. XM21 (intermediate tunnel storage)***

Status:

- ready for testing
- stored in the tunnel

***Actions:***

- actually none

***f. XM17 (intermediate tunnel storage)***

Status:

- ready for testing
- stored in the tunnel

***Actions:***

- actually none

***g. XM16 (intermediate tunnel storage)***

Status:

- ready for testing
- stored in the tunnel

***Actions:***

- actually none

***h. XM15 (intermediate tunnel storage)***

Status:

- ready for testing
- stored in the tunnel

***Actions:***

- actually none

***i. XM12 (leaky, indistinct cold leaks, in the "Reemtsma halls")***

Status:

- the module is in the "Reemtsma halls"
- Case history: insulation vacuum shows a $10^{-6}$ $\frac{\text{mbar l}}{\text{s}}$ leak (for more details, see protocol from December 17th 2014 and previous protocols)
- RF tests revealed the performance of fife cavities dropped: #3, #5, #6, #7 and #8

***Actions:***

- pending decision on further investigation of the leak at the CMTB after intermediate storage at "Reemtsma halls"

***j. XM8 (leaky, never cold tested, in the "Reemtsma halls")***

Status:

- stored in the "Reemtsma halls" and wrapped
- Case history: A 3 x $10^{-7}$ $\frac{\text{mbar l}}{\text{s}}$ leak has been identified in the area of the 2 phase line and warm up pipe.
- cold RF tests have not been performed

***Actions:***

- pending decision on further investigation and repair

***k. XM-3 (no PED qualification, in the "Reemtsma halls")***

Status:

- stored in the "Reemtsma halls" and wrapped

### *l. XM-2 (no PED qualification, in the "Reemtsma halls")*

Status still like last weeks:

- stored in the "Reemtsma halls" and wrapped

***Actions:***

- actually none

## 9. Status at CMTB

### *a. XM4*

Status – unchanged w.r.t. the meeting at March 12th / no news:

- the insulation vacuum volume has been checked for leaks, its tight
- coupler conditioning finished
- ready for cool-down
- Case history: After the in situ repair of the warm couplers, the warm coupler conditioning (performed at the CMTB) took four to five times as long as usual and a lot of outgassing has been (and is still) observed. This is some hint on the additional time needed for the conditioning of the in situ repaired couplers at the modules installed at the L1. DK expresses concerns on the behavior of these couplers at operation on the longer term.
- Case history: Alignment data got permanently lost while changing alignment software at CEA. Hence, the module cannot be aligned in the XFEL in accordance to the needs of the beam dynamics. Most probably the module can be installed like it is in XFEL accelerator regions with higher beam energy.

***Actions:***

- proposal of AMFT team: cool-down just now; SP will contact Bernd Petersen accordingly
- continue according to schedule for a full rf test cycle with XM4
- week 17 (starting April 20th): performing a complete test cycle at CMTB
- if schedule and manpower permits; this is most likely the case:
  - week 19 (starting May 4th): RF-control tests
  - week 19 (starting May 4th): IOT tests (in parallel to RF-control tests)
  - week 20 (starting May 11th): CW and other tests

**10. Open issues identified at the last meetings**

There are actually none.

**11. AOB**

There are actually none.

Elmar Vogel incorporating some notes from Serena Barbanotti, April 20th, 2015

The post-meeting supplements in square brackets will be approved together with the protocol.