Challenges and Status of XFEL Module Assembly

O. Napoly, CEA-Saclay, Irfu/SACM

Attempted Outline

- Baseline Scenario
  - Goals
  - Phasing of Industrialization
- Preparation for Industrialisation
  - Input Data Readiness
  - Selection of Industrial Operator
- Implementation of Industrialisation
  - Management plan
  - Quality Plan
  - Industrialization Plan

XFEL Village at Saclay

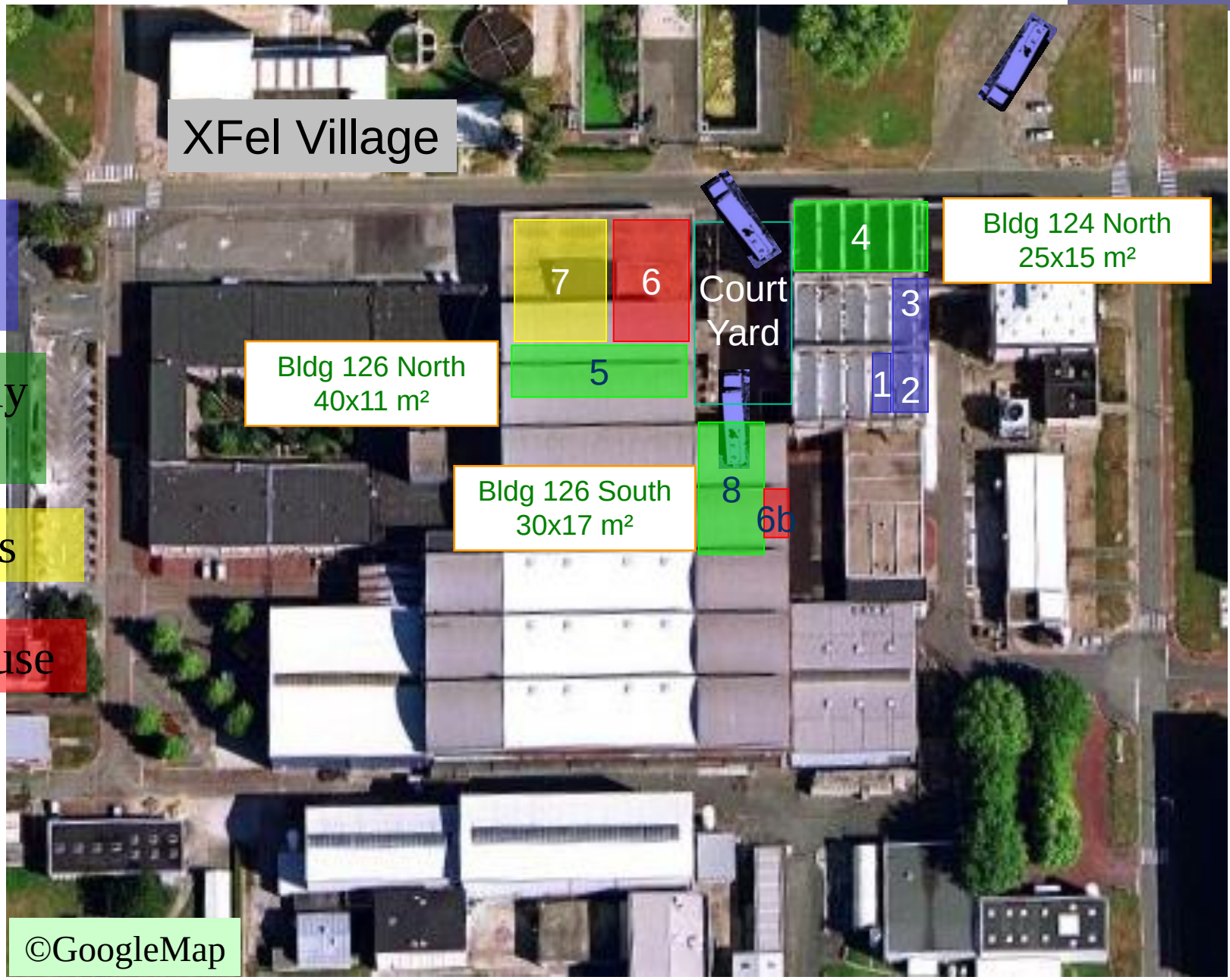
Overview of the Assembly Buildings

Clean rooms

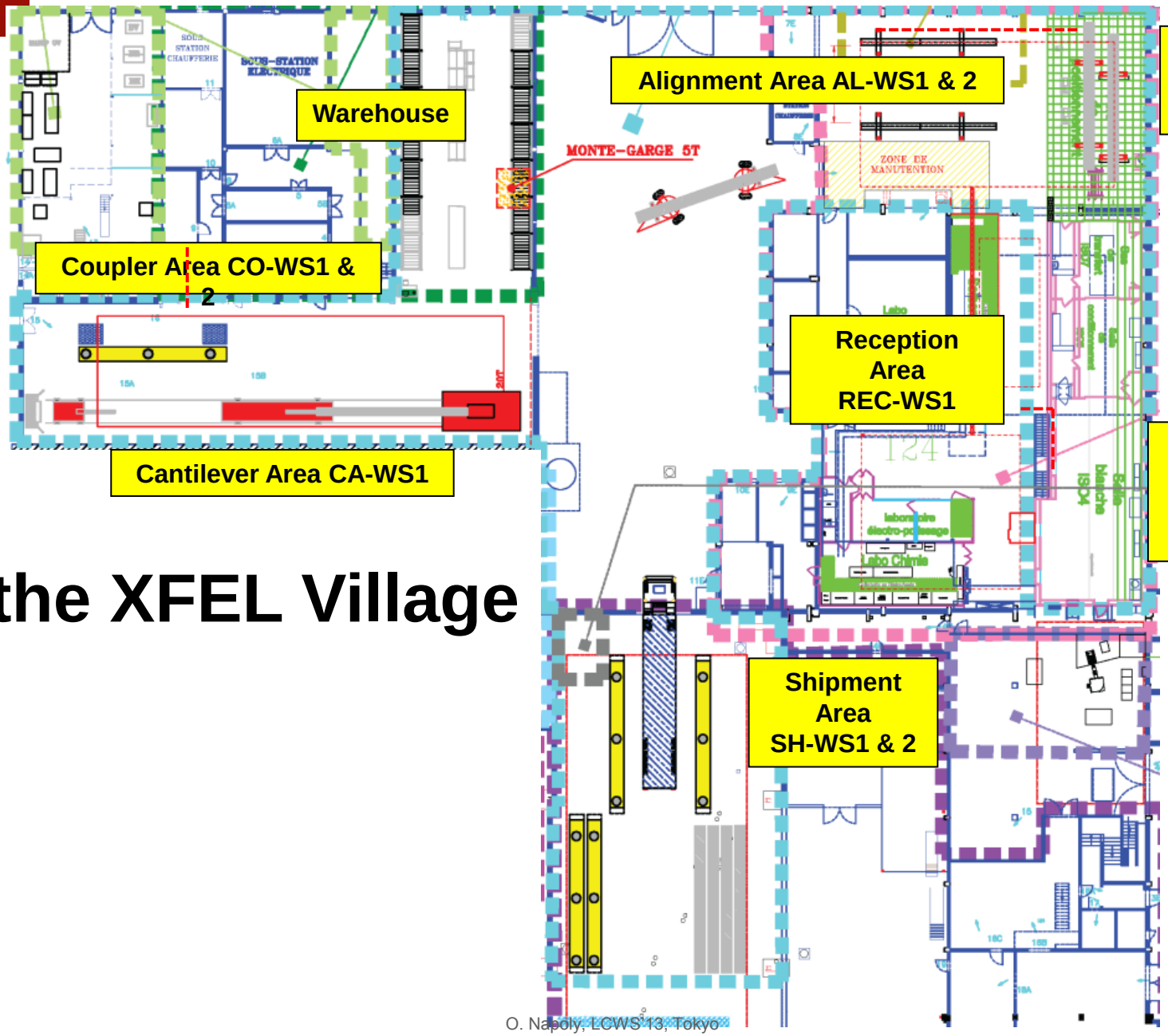
Assembly halls

Offices

Warehouse



Assembly Hall : Workstations



the XFEL Village

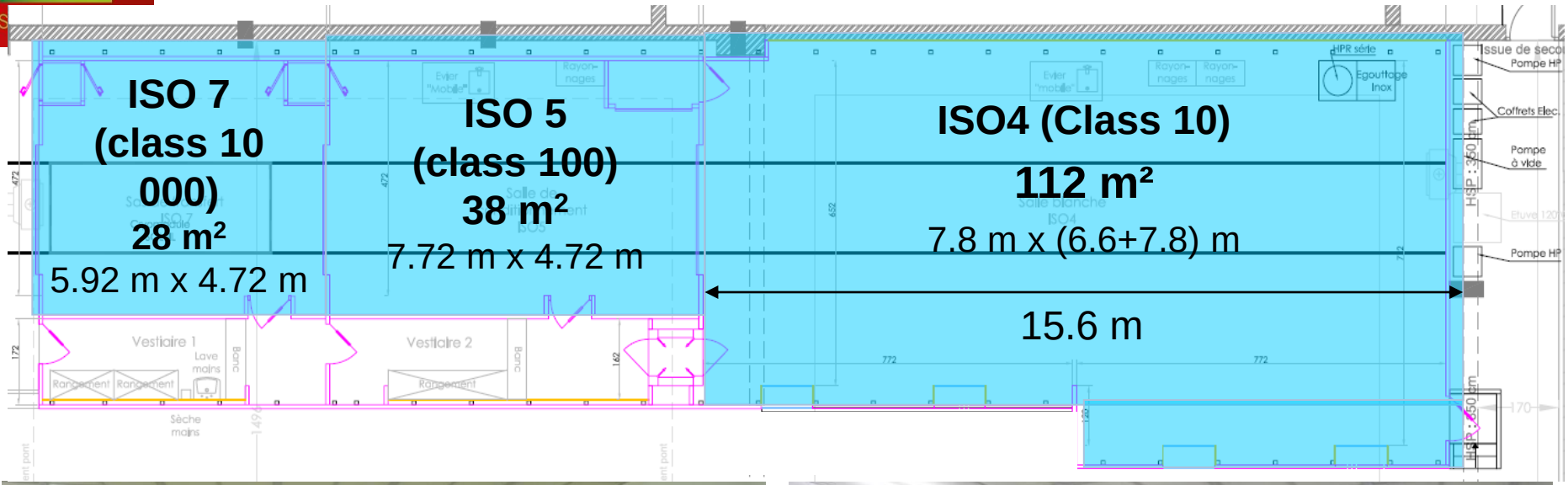
Organisation of Work Stations

1. **Clean Room Cold Coupler Area** (IS04-CC-WS1)
   - Cold coupler assembly
2. **Clean Room String Assembly Area** (ISO4-SA-WS1, ISO4-SA-WS2)
   - String connections (1 gate valve + 8 cavities + 1 Qpole unit)
3. **Roll-out Area** (RO-WS1, RO-WS2)
   - HOM tuning, magnetic shielding, tuners,…
   - 2Ph-tube welding, cold-mass connection
4. **Alignment Area** (AL-WS1, AL-WS2)
   - Cavity and quadrupole fine alignment
   - Coupler shields and braids, tuner electric tests
5. **Cantilever Area** (CA-WS1)
   - Welding of 4K and 70 K shields, super insulation
   - Quad current lead
   - Insertion into vacuum vessel and string alignment
6. **Coupler Area** (CO-WS1, CO-WS2)
   - Warm couplers + coupler pumping line
   - Control operations (electrical, RF)
7. **Shipment Area** (SH-WS1, SH-WS2)
   - CEA-Alsyom “acceptance test”
   - End-caps closing, N2-insulation, loading.

In full production, this chain of workstations will be fully occupied with 7 cryomodules (XM_{n-6} @ WS1,…, XM_n @ WS7) stationed for one week.

A Cryomodule Factory !

Clean Room Layout



May 2012
PXFEL2_2

December 2012
XM-3, with Alsyom

Assembly prototyping at Saclay

1. Coupler Cold Part assembly (ISO4-CC-WS1&2)

Assembly prototyping at Saclay

2. Cavity String assembly (ISO4-SA-WS1&2)

Assembly prototyping at Saclay

3. String dressing on Roll-out station (RO-WS1&2)

Assembly prototyping at Saclay

4. Alignment (AL-WS1&2)

Cryomodule Transfer

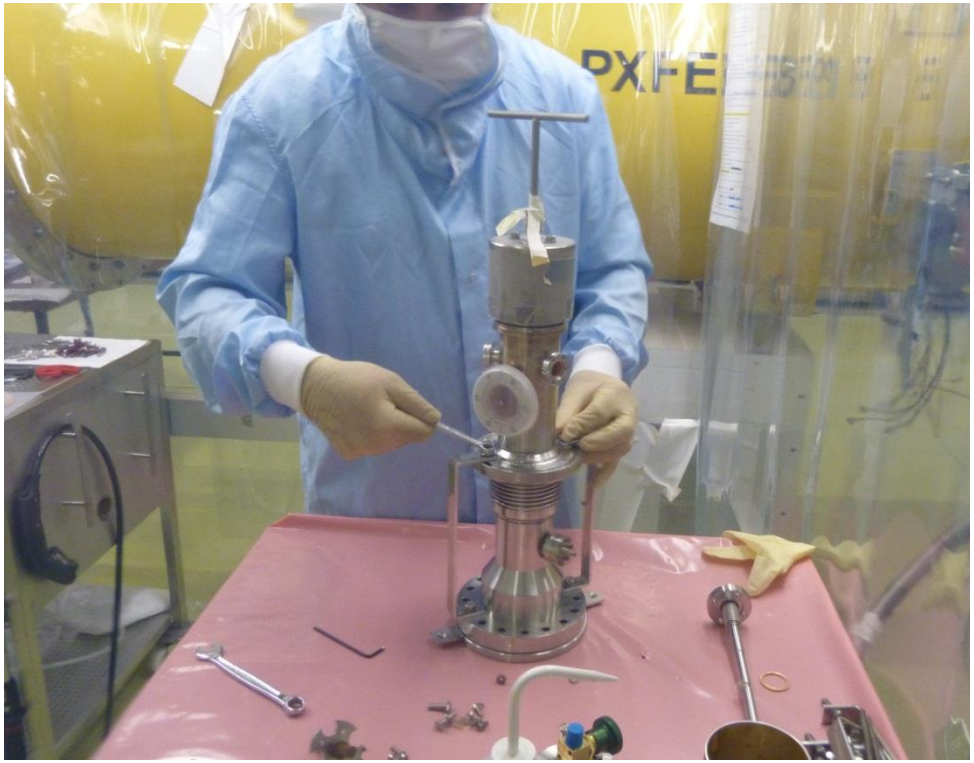
The electrical transfer vehicle is fully operational.
Spares have been ordered for all critical parts (e.g. battery, etc…)

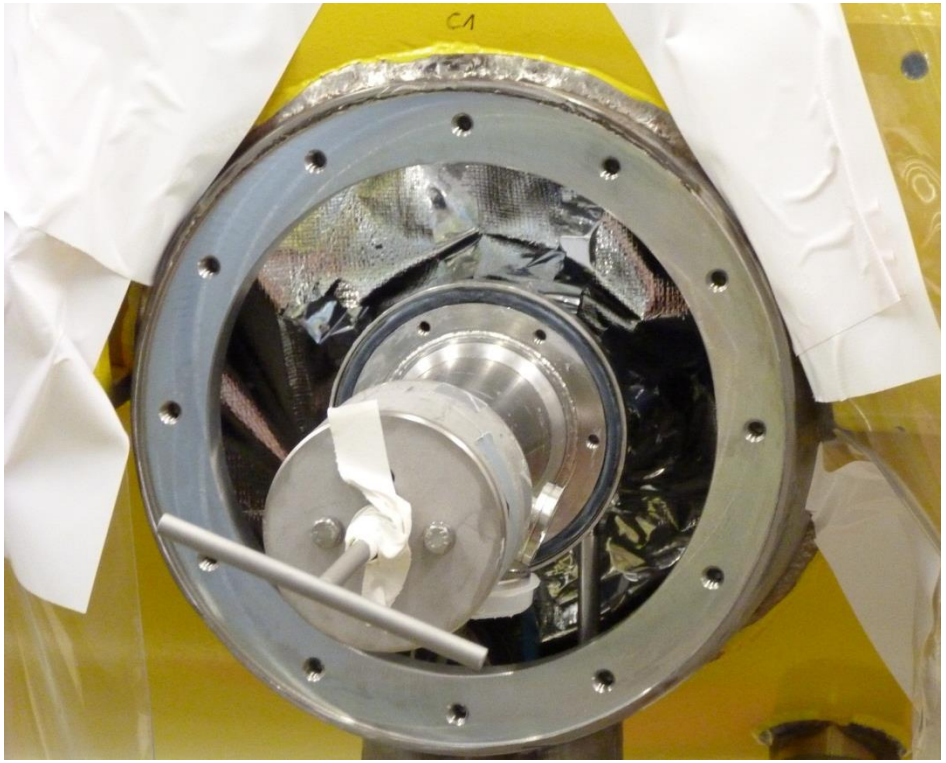
Assembly prototyping at Saclay

5. Cold Mass insertion (CA-WS1)

Assembly prototyping at Saclay

6. Coupler Warm Part assembly (CO-WS1&2)
    6.a coupler warm part assembly
    6.b coupler pumping line assembly





Assembly prototyping at Saclay

7. Final control and shipment (SH-WS1&2)

Challenge : Tooling vs. Indial Contract

Ideally the tooling definition should be included in the industrial contract.

This was impossible with our project timeline and readiness: e.g. the clean room was delivered in Nov. 2009.

The contract specifies that the Industrial Operator is only responsible of the standard tools, while CEA is responsible for the specific tools and their maintenance.

The contract is essentially 'Man and Engineering Power'

As a consequence, the industrial operator will criticize the infrastructure layout and the tooling made available to him:

e.g. cavity reception area,

e.g. cavity support and pre-alignment tools in the clean room,

e.g. layout of shipment vs. VV strorage area

Some of the criticisms come too early, missing the global scheme.

Some of the criticisms will lead to a better optimized production.

Input Data Readiness for the Industry Transfer

14/11/2013

	@ CfT	Kick-off	Prod
• Infrastructure and Tooling	80%	90%	100%
(in the broad sense, e.g. cavity supports)			
• Cryomodule Configuration	70%	85%	100%
• Cryomodule Documentation			
– PBS (or MBOM)	30%	70%	100%
– Availability of Drawings	30%	70%	100%
• Assembly Documentation (WBS)			
– Availabitity of Assembly Procedures	50%	75%	100%
– Availabitity of Control Procedures	50%	75%	100%
– Availabitity of Regulation (PED, Safety)	20%	75%	100%

(qualitative %)

Ideally, all ratios should be 100 % (cf. cavity production, or AMTF).

Industry cannot start production w/o 100% of Input Data in their Resource Planning software (ERP)

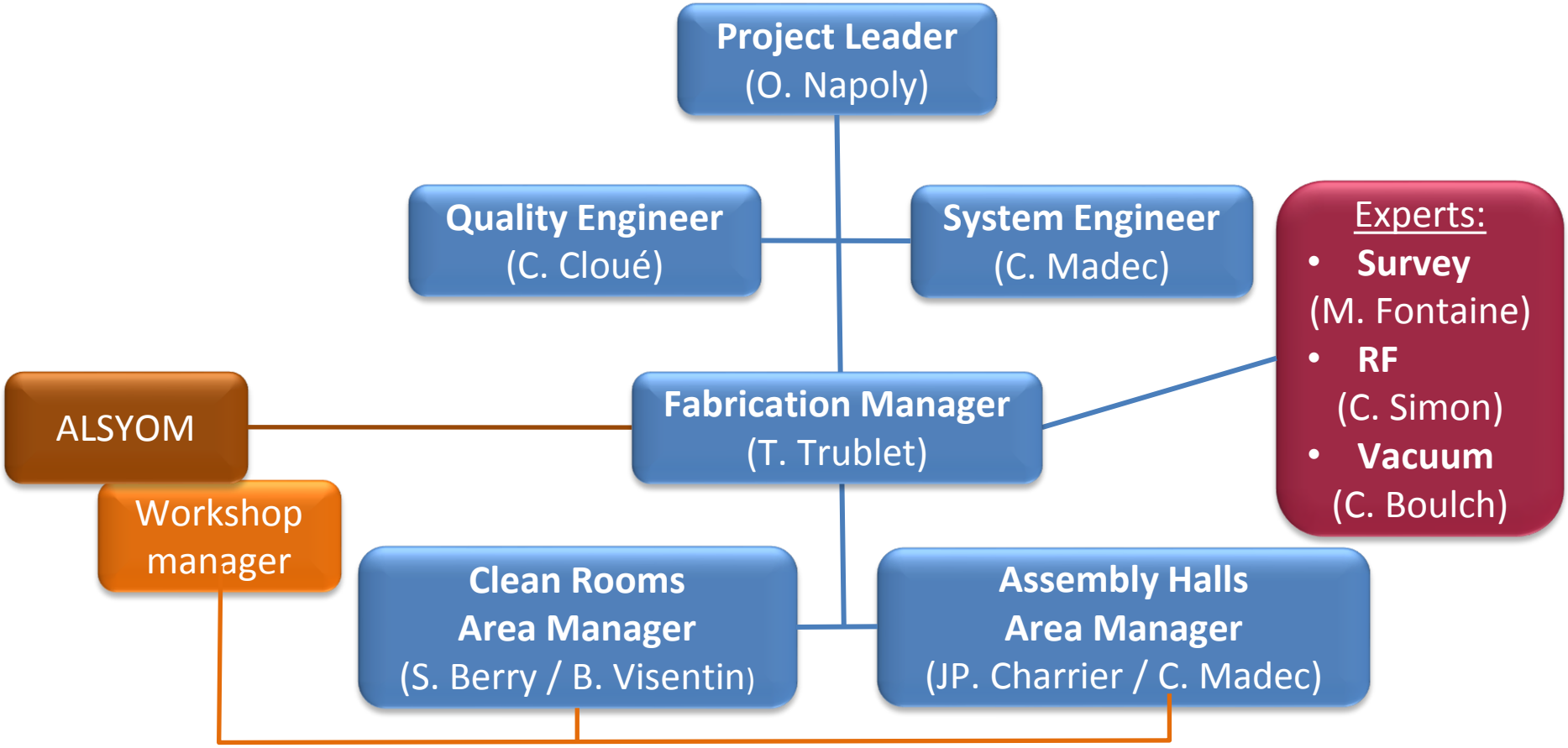
• Overall Quality of the Process (RF acceptance)	60%	60%	100%

Assembly Industrialization

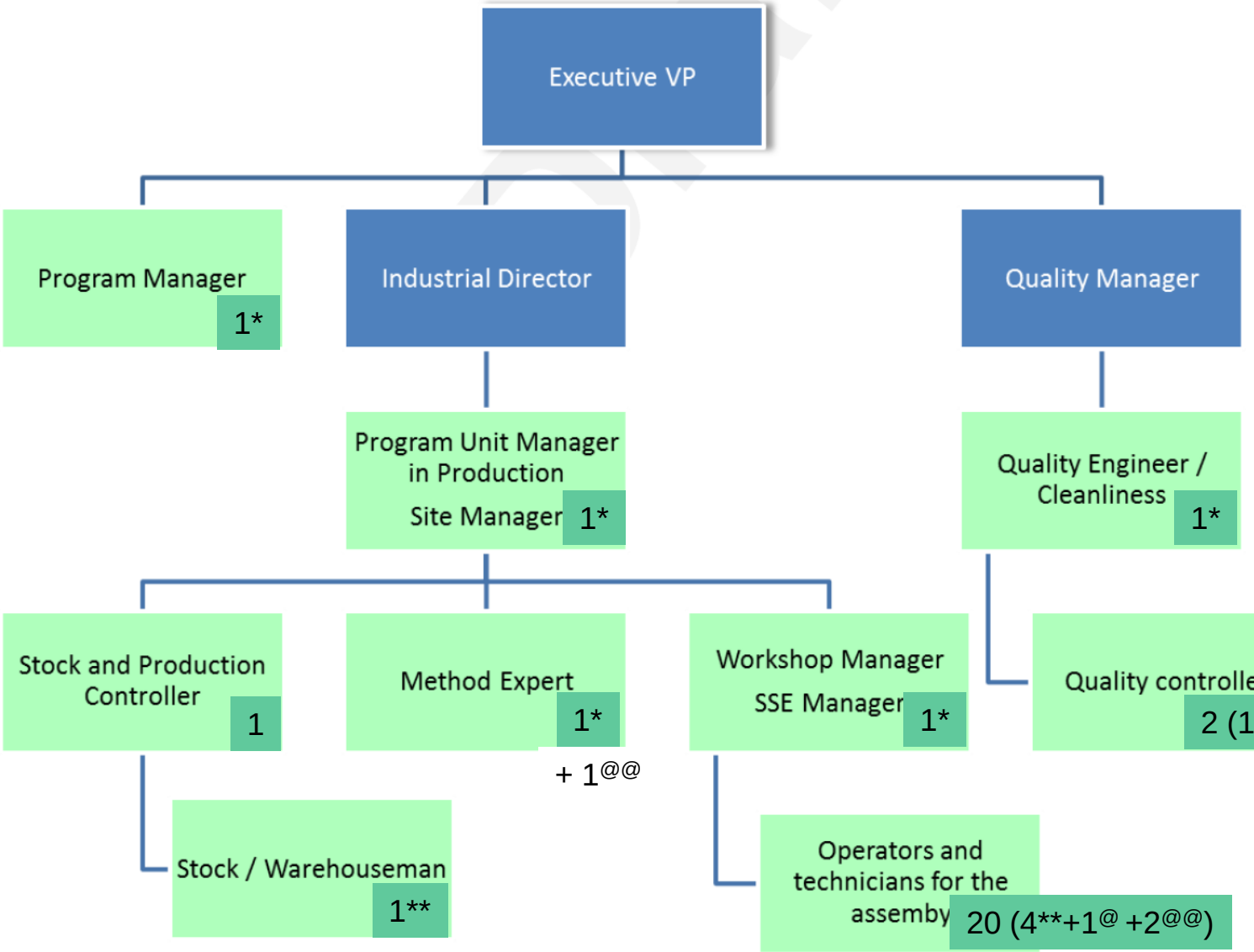
Selection of Industrial Contractor

- Tender process: ALSYOM, lowest bidder / best technical offer, has been selected by CEA.
- Up to 29 people will be on Saclay site during ~2 ½ years
- Fields of expertise requested:
  - Management (resource planning, stock, quality)
  - Engineering (method, drawings, tooling)
  - Clean room and cleaning
  - Vacuum
  - RF
  - Welding
  - Survey
  - Mechanical operations

CEA Organisation



Industrial Contract : ALSYOM Management Plan and Staffing



Off site

29 persons on site

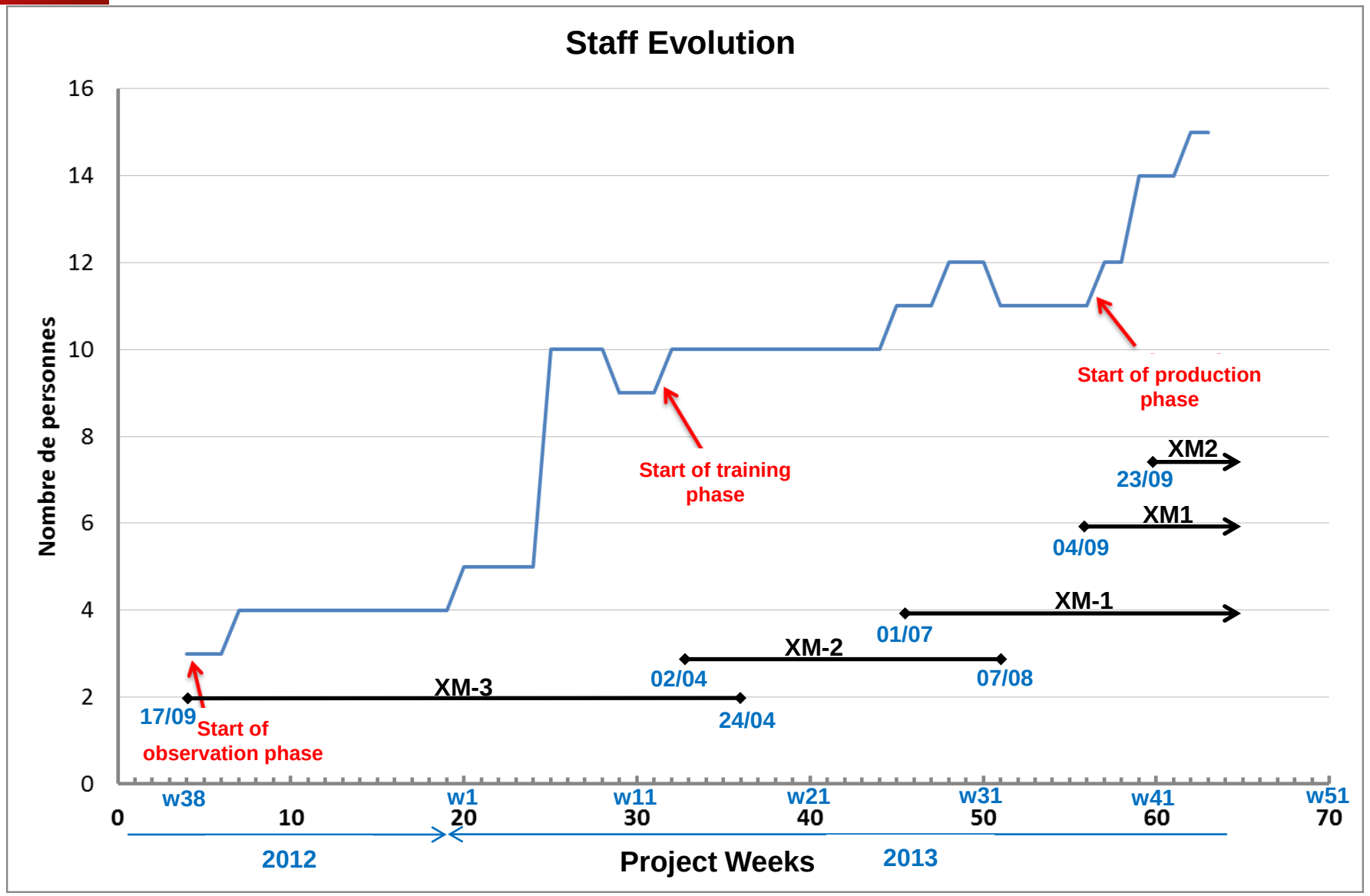
* arrived Sept. 2012

** arrived Feb. 2013

@ arrived June 2013

@@ arrived Sept 2013

Industrial Contract: ALSYOM Staffing



Observation Phase: XM-3

Phase 1: **observation phase** which covers the assembly of XM-3 by CEA with ALSYOM staff as observers.

XM-3, first pre-series module, is made with parts from XFEL production lines, except for **cavities** (large-grain cavities / RI) and **couplers** (TTF3 couplers / RI).

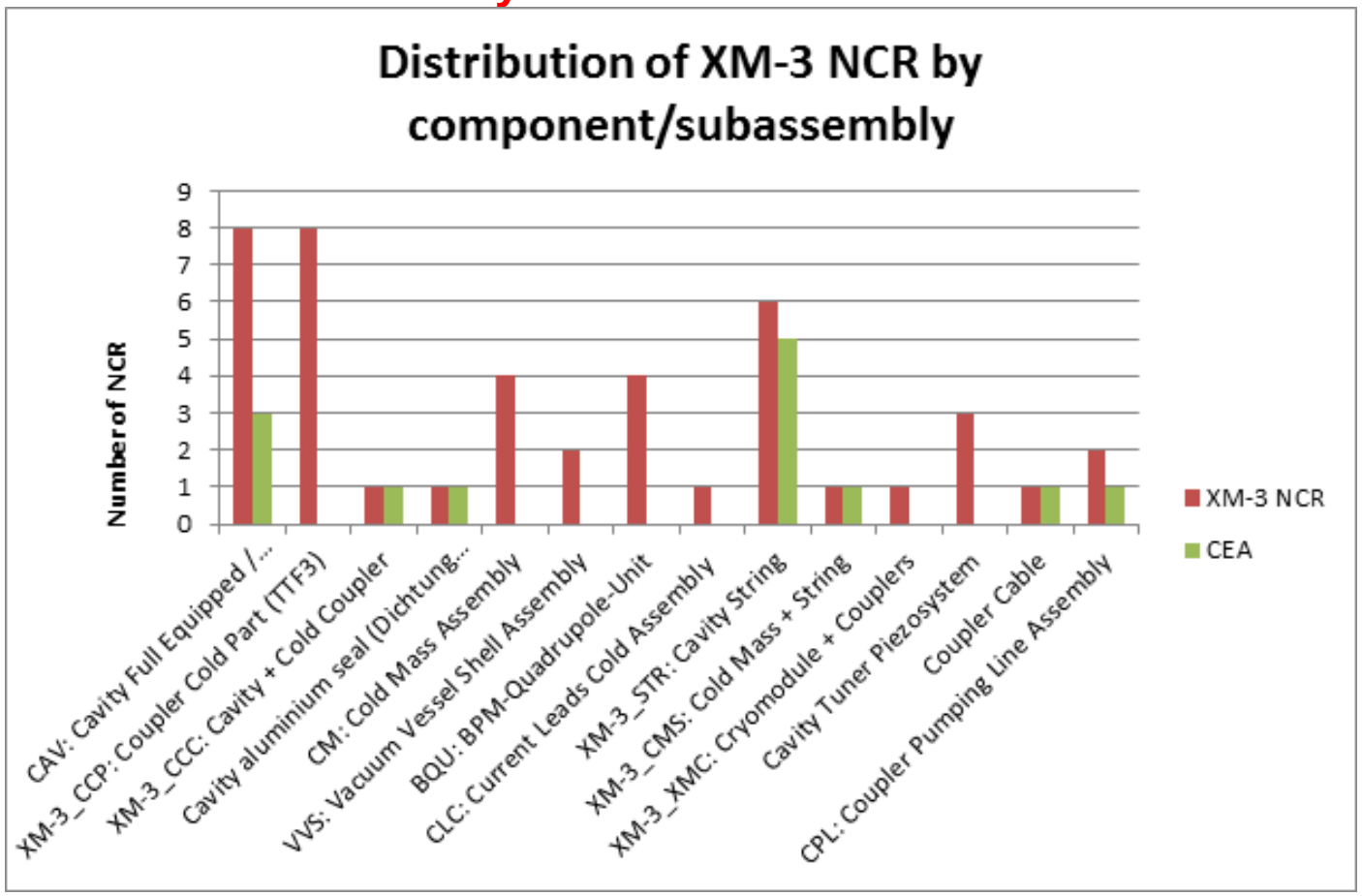
Assembly dates:
Foreseen*: 17 September 2012 – 20 December 2012
Achieved: 17 September 2012 – 24 April 2013

Assembly duration:
Foreseen*: 14 weeks
Achieved: 31 calendar weeks

* according to Alsyom contract schedule

Pre-Series XM-3: Non-Conformities

- **We have observed still many non-conformities**



In total **43 Non-Conformance Reports** (NCR) were issued for XM-3, some global, about 13 NCR under the responsibility of CEA: one main reason for 7 months assembly.

Pre-Series XM-3: Non-Conformities

• Cavities Non Conformity

Irfu / European XFEL	NON CONFORMANCE REPORT ~~CHANGE REQUEST~~	Reference	CEA-XFEL
		Page	1
		Date	23/10/12

EQUIPMENT:	CAVITY	SERIAL NUMBER:	XM-3	FILLED OUT BY:	
Occurrence phase :				**Integration level :**	**Workstatio**
Control :		Reception :		Part	X
Manufacturing :		Acceptance :		Subassembly	
Design/validation :		Destockage :		Equipment	
Integration :	x	Others :		Others	

Reception Ha

TITLE : Deviation of the Pin in the longitudinal position

DESCRIPTION :

We observed on the cavity AC158 that the assembly of the newly produced magnetic shield was too tight (cf. pictures page 2).
Under the indication from DESY, this led to the systematic measurement of the distance from the middle of the cavity bracket to the
AC158: 103 mm instead of he nominal 93 mm +- 2 mm.
This result was reproduced for all eight XM-3 cavities AC114, AC146, AC151, AC152, AC154, AC156, AC157, AC158

Reference documents :

TECHNICAL INVESTIGATIONS : | **Responsible (s)**

On the cavity was measured a deviation on the PIN (draw. 02L, pos. 4) in the longitudinal position:
The nominal distance from the cavity bracke centert to the PIN center is 93mm – measured ~103mm
The nominal distance from the coupler flange center to the PIN is (100,02mm) – measured ~96mm

CORRECTIVE ACTIONS (item concerned by NCR/CR) | **Responsible (s) :**

The connection of the cavity string to the cold mass will have to be given a particular attention in view of the shrinkage of the cold mass during cool-down.

PREVENTIVE ACTIONS (further item) | **Responsible (s) :**

Check of the helium tank dimensions for the industrially produced cavities.

CLASS :
MINOR :
MAJOR :
FINAL DECISIONS :
USE AS IS
WAIVER
REPAIR
DOCUMENTATION CHANGE
SCRAP
MODIFICATION
ACTION ON OTHER PRODUCT

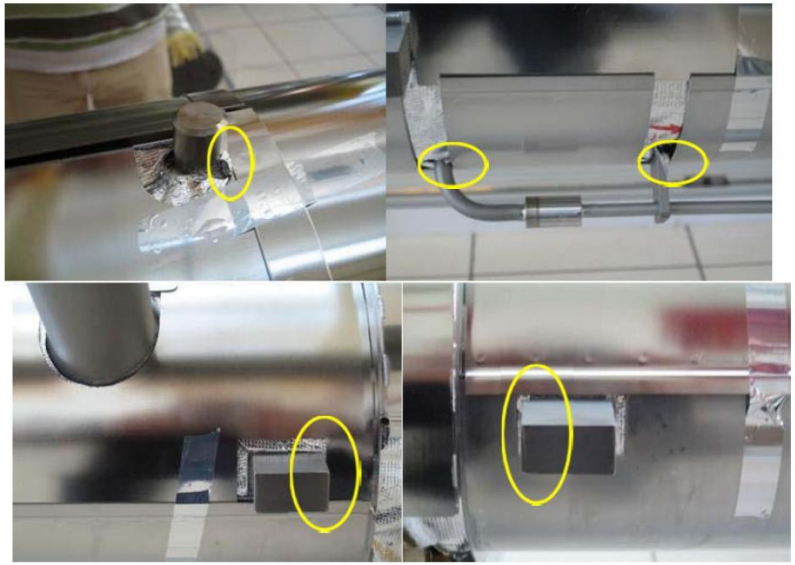
Clearance for actions	Technical Manager	Quality Assurance Manager	Project
CEA	J-P. Charrier	C.Cloué	O.N
Accelerator Consortium manager :	D. Reschke (CO)	-	E. Vog

:V

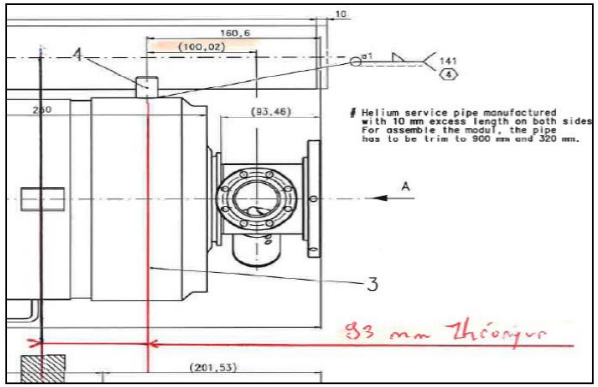
Irfu / European XFEL	NON CONFORMANCE REPORT / CHANGE REQUEST	Reference	CEA-XFEL
		Page	2
		Date	23/10/12

CONTINUATION SHEET

Assembly of the magnetic shield on the cavity AC158 :



Cavity drawing :



Pre-Series XM-3: Non-Conformities

• Couplers Non Conformity

Irfu / European XFEL	**NON CONFORMANCE REPORT**			Reference :	CEA-XFEL-RNC-13-073
				Page :	1
				Date :	19.03.2013
Enter either the "Physical Part EDMS-ID", or the "Fab. Part Name" + "Fab. Part EDMS-ID" + "Physical Part Serial Number".				**Physical Part EDMS-ID :**	??
Fab. Part Name :	??	**Fab. Part EDMS-ID :**	??	**Physical Part Serial No.**	??
Recorded by :	O. Napoly	**Location :**	CEA XFEL Coupler Area		
TITLE :	Water and broken ceramics in the cold part of the coupler AC3C28				
DESCRIPTION :					

When opening the cold ceramics cap of coupler AC3C28 connected to cavity n°4 of XM-3, we observed:
1) water falling out of the cap, and indeed the copper coating is oxidized (cf. pictures n°1 and n°2).
Water may have entered the cap though the valve during the washing of the coupler pair since one can see a trace of oxidation inside the cap in front of the valve hole (cf. picture n°3).
The level of water staying in the cap for about 6 months, is indicated by the darker lower area on the picture.
2) a broken ceramics (cf. pictures n°1 at 4h30 orientation, and n°4).
One can see traces of broken ceramics on the cap (cf. picture n°5) and also on the tool (cf. picture n°6).

Reference documents :

TECHNICAL INVESTIGATIONS :	**Responsible (s)**
1) The location (flange, valve, feedthrough) of the water leak from the washer-dryer is under investigation. There is no indication that the valve was loose. 2) We are investigating when the breaking of the ceramics happened: due to the presence of water, it could have happened only before the washing of the coupler pair, or when opening the ceramics cap.	S. Berry, F. Hoffman

CORRECTIVE ACTIONS (on Physical Part, or Equipment) :	**Responsible (s)**
1) The oxidation of the copper coating was removed by wiping it with sullfamic acid and rinsing with ethanol. Unfortunately, the copper coating has been localy removed completely (cf. picture n°7) 2) The broken ceramics piece was removed and the sharp brazing material layer (cf. picture n°8) was bend and folded as much as possible to prevent sharp edges.	S. Berry, F. Hoffman

PREVENTIVE ACTIONS (on Fabrication Part, or Equipment) :	**Responsible (s)**
1) Do not enter the cold coupler pairs in the ISO4 clean room through the washer-dryer until the origin of the water leak is found. 2) Preventive actions will be defined when the origin of the ceramics breaking is found.	S. Berry

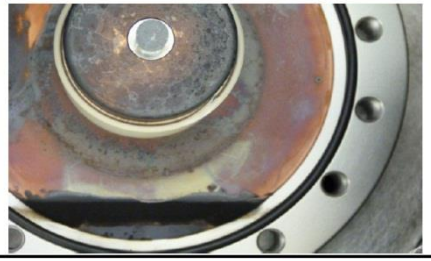
CATEGORY :		**FINAL DECISIONS :**	
Minor :		Action on Part :	Repair
Major :	X	Documentation :	

Clearance for actions	**Fabrication Engineer (Technical Manager)**	**Quality Manager**	**Project Manager (WPL)**
Unit responsible for involved product :	S. Berry, T. Trublet	C. Cloué	O. Napoly
Accelerator Consortium Manager :	E. Vogel	-	W. Kaabi, W-D. Möller

Irfu / European XFEL — **NON CONFORMANCE REPORT** — Reference : CEA-XFEL-RNC-13-073 — Page : 2 — Date : 19.03.2013

CONTINUATION SHEET

Picture n°1



Picture n°2

Pre-Series XM-3: Non-Conformities

- **Alignment CEA Procedure Non Conformity**

Irfu / European XFEL	NON CONFORMANCE REPORT	Reference : CEA-XFEL-RNC-12-068
		Page : 1
		Date : 20.12.2012

Enter either the "Physical Part EDMS-ID", or the "Fab. Part Name" + "Fab. Part EDMS-ID" + "Physical Part Serial Number".				Physical Part EDMS-ID :	
Fab. Part Name :		Fab. Part EDMS-ID :		Physical Part Serial No.	XM-3
Recorded by :	O.Napoly/M.Fontaine	Location :	CEA XFEL Alignment Area		
TITLE :	Cavity Alignement				
DESCRIPTION :	Problems during the cavity and quadrupole alignment				

The alignment of the cavities and quadrupole of XM-3 has been repeated three times until reaching a correct alignment.
1) During the first attempt (23/01/13), cavities n°1 to n°5 were released by mistake from the invar rod, hence shifting significantly from their longitudinal position.
2) After the second attempt (30/01/13), alignment was off tolerances mainly due to a wrong definition of the reference frame. The proper defintion was then instructed by DESY.
3) At the third attempt (08/02/13), alignment was on tolerances with good agreement between CEA and DESY data, but two **needle** bearings were found loose (cavity n°3 and n°5, tbc).
4) At the fourth attempt (20/02/13), the allignment was accepted by DESY, with a derogation for longitudinal position of the quadrupole (cf. Picture n°1).
XM-3 assembly was continued.

Reference documents :

TECHNICAL INVESTIGATIONS :	Responsible (s)
1) Prior to transverse alignment, cavities n°1 and n°3 were found 3 mm upstream from their nominal longitudinal position. The middle cavity n°5 was found 1.5 mm away from its nominal position. By mistake, cavities n°1 to 5 were unfastenned from the Invar rod: as a result, the string expanded towards its upstream end and cavity n°1 has been measured 14 mm off longitudinally. 3) the torques of the bush screws was checked systematically on the coupler side of the cavity string (vertical and horizontal bushes). The torque of the bushes pushing the loose needles bearings were not on specifications.	M. Fontaine, J-P. Charrier
CORRECTIVE ACTIONS (on Physical Part, or Equipment) :	**Responsible (s)**
1) DESY sent us the tools needed to displace the cavities longitudinally and the longitudinal alignment of the string was corrected (25/01/13). 2) CEA implemented the correct reference frame in the post-processing of the raw data. Agreement was then reached with DESY. 3) The torque of the bushes was checked along the string.The two bushes of cavity n°3 and n°5 were found incorreclty fastened. This is attributed to their seizure since the problem was fixed after manipulation of the bush by hand. Some bushes were dismounted and in one case the springs were not correctly piled up.	M. Fontaine, J-P. Charrier
PREVENTIVE ACTIONS (on Fabrication Part, or Equipment) :	**Responsible (s)**
3) In order to prevent the seizure of the bushes, it is envisaged to use vacuum grease. The depth of the bushes will also be checked In general, CEA will implement the practice where the surveyor is not involved in the cavity-quadripole re-alignment operations.	K. Jensch, J-P. Charrier

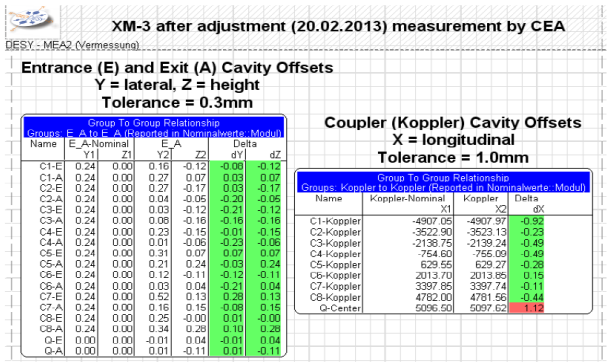
CATEGORY :		FINAL DECISIONS :	
Minor :		Action on Part :	
Major :	X	Documentation :	

Clearance for actions	Fabrication Engineer (Technical Manager)	Quality Manager	Project Manager (WPL)
Unit responsible for involved product :	M. Fontaine, J6P. Charrier	C. Cloué	O. Napoly
Accelerator Consortium Manager :	E. Vogel		K. Jensch, M. Schlösser

Irfu / European XFEL	NON CONFORMANCE REPORT	Reference : CEA-XFEL-RNC-12-068
		Page : 2
		Date : 20.12.2012

CONTINUATION SHEET

Picture 1: Final alignment data



Group To Group Relationship
Groups: E_A to E_A (Reported in Nominalwerte: Modul)

Name	E_A-Nominal Y1	E_A-Nominal Z1	E_A Y2	E_A Z2	Delta dY	Delta dZ
C1-E	0.24	0.00	0.16	-0.12	-0.08	-0.12
C1-A	0.24	0.00	0.27	0.07	0.03	0.07
C2-E	0.24	0.00	0.27	-0.17	0.03	-0.17
C2-A	0.24	0.00	0.04	-0.05	-0.20	-0.05
C3-E	0.24	0.00	0.03	-0.12	-0.21	-0.12
C3-A	0.24	0.00	0.08	-0.16	-0.16	-0.16
C4-E	0.24	0.00	0.23	-0.15	-0.01	-0.15
C4-A	0.24	0.00	0.01	-0.06	-0.23	-0.06
C5-E	0.24	0.00	0.31	0.07	0.07	0.07
C5-A	0.24	0.00	0.21	0.24	-0.03	0.24
C6-E	0.24	0.00	0.12	-0.11	-0.12	-0.11
C6-A	0.24	0.00	0.03	0.04	-0.21	0.04
C7-E	0.24	0.00	0.52	0.13	0.28	0.13
C7-A	0.24	0.00	0.16	0.15	-0.08	0.15
C8-E	0.24	0.00	0.25	-0.00	0.01	-0.00
C8-A	0.24	0.00	0.34	0.28	0.10	0.28
Q-E	0.00	0.00	-0.01	0.04	-0.01	0.04
Q-A	0.00	0.00	0.01	-0.11	0.01	-0.11

Group To Group Relationship
Groups: Koppler to Koppler (Reported in Nominalwerte: Modul)

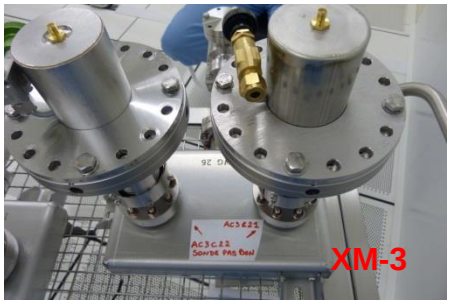
Name	Koppler-Nominal X1	Koppler X2	Delta dX
C1-Koppler	-4907.05	-4907.97	-0.92
C2-Koppler	-3522.90	-3523.13	-0.23
C3-Koppler	-2138.75	-2139.24	-0.49
C4-Koppler	-754.60	-755.09	-0.49
C5-Koppler	629.55	629.27	-0.28
C6-Koppler	2013.70	2013.85	0.15
C7-Koppler	3397.85	3397.74	-0.11
C8-Koppler	4782.00	4781.56	-0.44
Q-Center	5096.50	5097.62	1.12

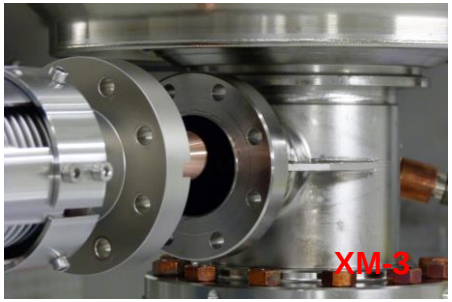
The Cavity Alignment Procedure had to be repeated 4 times, essentially due to mishandling by CEA and a technical problem on the needle bearings fixtures:
→ 1 month, instead of 3 days

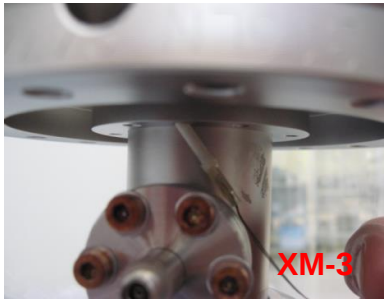
TTF3 Couplers vs. XFEL Coupler

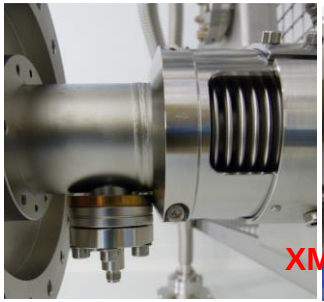
The first batch of XFEL Production couplers were delivered for the XM-1 assembly in June 2013

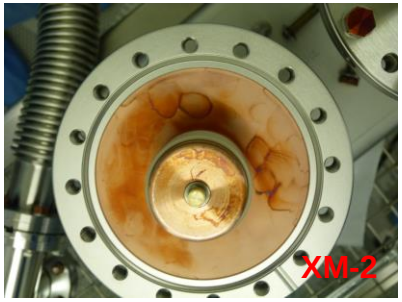
- TTF3 couplers are generating too many assembly problems: ceramics caps, bellow clamps, e-pick-ups, RF antenna.





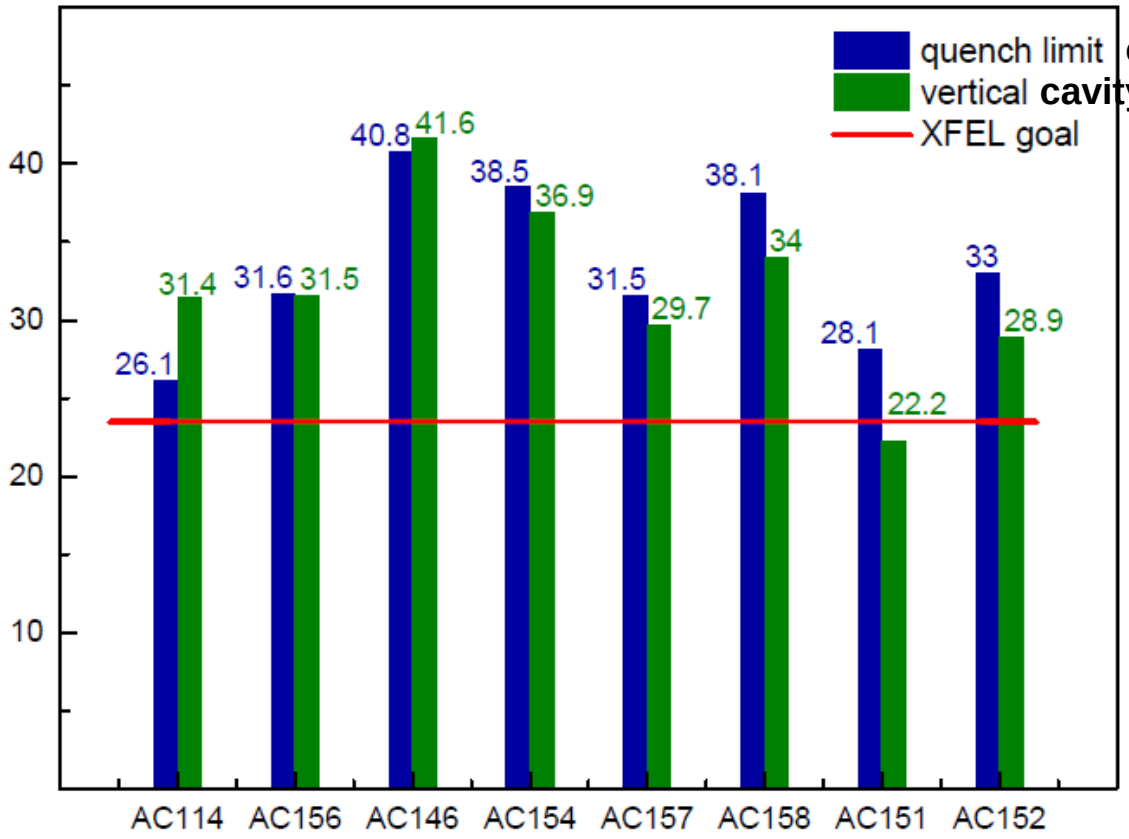




- Although from the same RF concept, the XFEL couplers did not reproduced these problems: from the assembly viewpoint, a **success**.

XM-3 RF Test Results



Gate valve	CV 1	CV2	CV3	CV4	CV5	CV6	CV7	CV8	BQU		
	AC114	AC156	AC146	AC154	AC157	AC158	AC151	AC152			
Eacc (VT)	31,4	31,5	41,5	36,9	29,7	38,8	22,2	28,9			
Fe limit (VT)	31,4	31,5	41	36,9	29,7	38,8	16,8	20		**229,6**	**MV**
CMTB	23,2	31,4	40,8	38,5	31,5	38,1	22,7	33		**231,8**	**MV**
										29,0	MV/m

XM-3 RF Test Results

A success for the Accelerator Consortium:

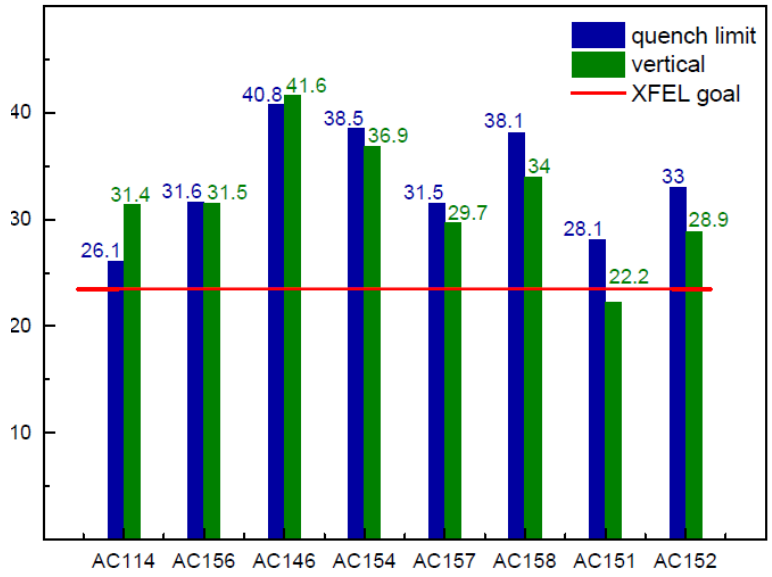
- ✓ Average individual cavity gradient: 32 MV/m
- ✓ Average cavity pair gradient: 29 MV/m
- ✓ Three cavities reach gradients above 38 MV/m
- ✓ Cryogenics losses are lower than specified.

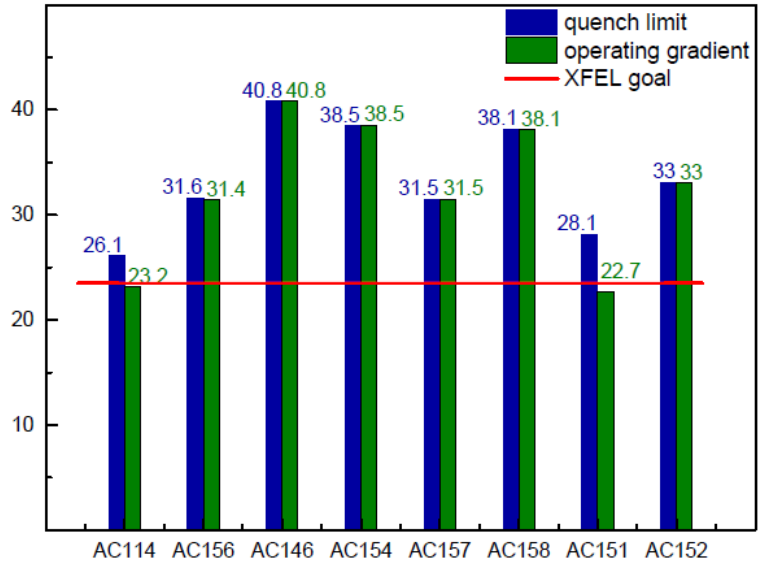
A success for WP03+WP09:

- ✓ Seven cavities are reproducing VT gradient
- ✓ The cryomodule reproduces gap of 230 MV
- ✓ Cavity 1 is degraded from 31 down to 23 MV/m useable gradient: gate valve/cav1 connection not for training !
- ✓ Qualifies CEA assembly team (100% string assembly by CEA), procedures and partially the production tool (ISO4 clean room, DESY pumping units, 3 mobile clean rooms, procedures, big tools)
- ✓ The clean room vacuum system was not complete (CEA cavity venting on rails)

A success for CEA:

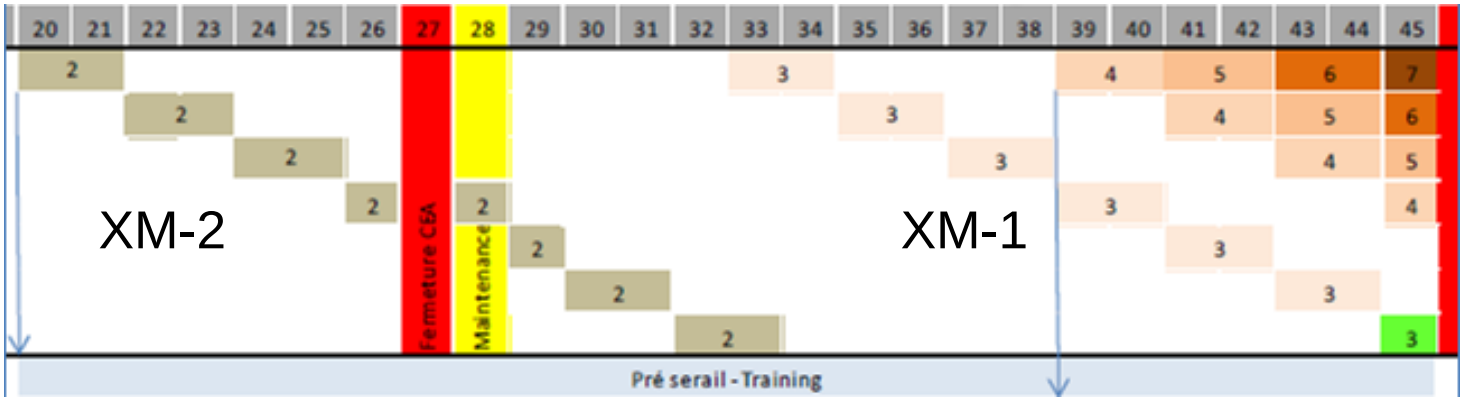
- ✓ XM-3 is the **assembly demonstration cryomodule** of CEA w.r.t. ALSYOM contract.



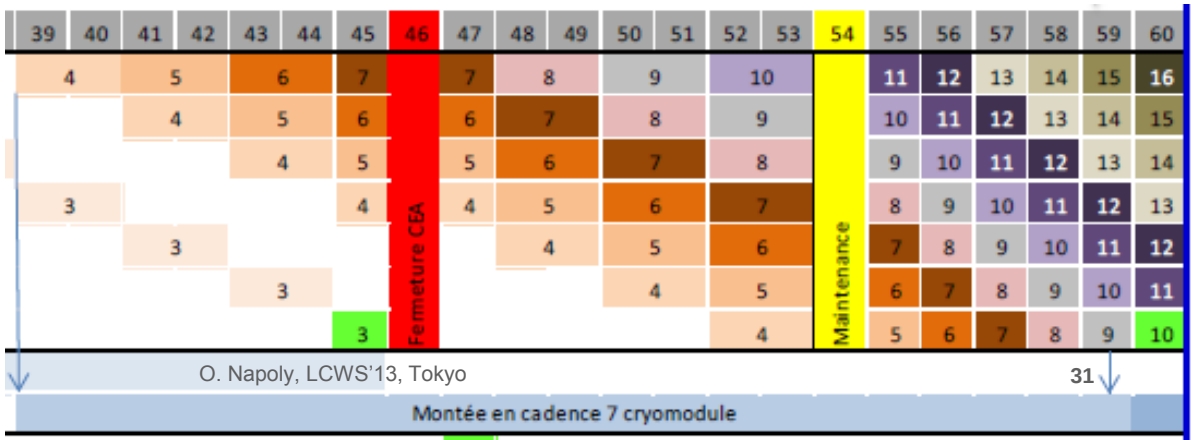


Industrial Contract Schedule

Phase 2 : **training phase** which covers the assembly of XM-2 and XM-1 pre-series modules by mixed CEA-Alsyom teams (co-activity or transfer of knowledge) over **6 months**.



Phase 3: **production phase** which covers the assembly of XM1 to XM100 series modules by Alsyom, under supervision by CEA, over **about 31 months**.



Training Phase: XM-2

Phase 2: **training phase** which covers the assembly of XM-2 and XM-1 in co-activity by CEA and ALSYOM.

XM-2, second pre-series module, is made with parts from XFEL production lines, including **cavities** (E. Zanon), except **couplers** (TTF3 couplers / RI).

Assembly dates:
Foreseen*: 2 January 2013 – 5 April 2013
Achieved: 2 April 2013 – 7 August 2013

Assembly duration:
Foreseen*: 14 weeks
Achieved: 18 calendar weeks

* according to Alsyom contract schedule

Training Phase: XM-2

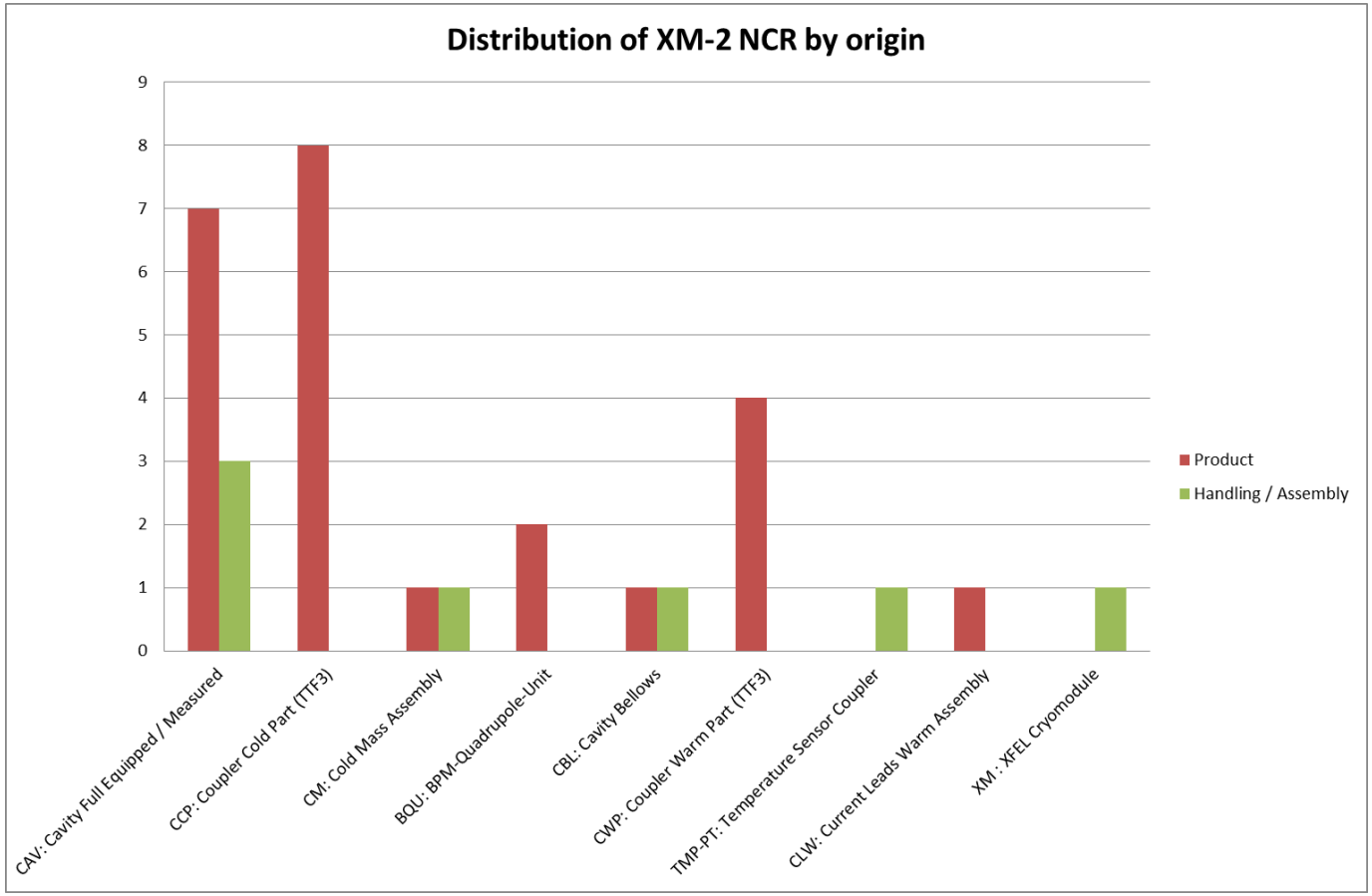
XM-2 is awaiting the RF test in AMTF/XATB3: the major non-conformity is a malfunction of the CEA vacuum system in the clean room leading to uncontrolled venting of the 8 cavities up to 2 - 7 hPa, when the specification from WP08 is 1 hPa. This may result is lower gradients.

The margin for RF acceptance is small: 2.2 MV/m

Shipped	**with**	**EZ004**									
Gate valve	CV 1	CV2	CV3	CV4	CV5	CV6	CV7	CV8	BQU		
	CAV00523	CAV00511	CAV00512	CAV00514	CAV00521	CAV00510	CAV00526	CAV0513	BQU-005-C		
Eacc maximum	27,0	26,2	26,1	33,0	33,4	28,8	27,3	22,1			
Fe limit @ 1E-2 mGy/mn	27,0	26,2	26,1	33,0	33,4	28,8	27,3	22,1		**206,4**	**MV**
AMTF										**?**	**MV**
									VT average	**25,8**	MV/m
									AMTF average	?	MV/m

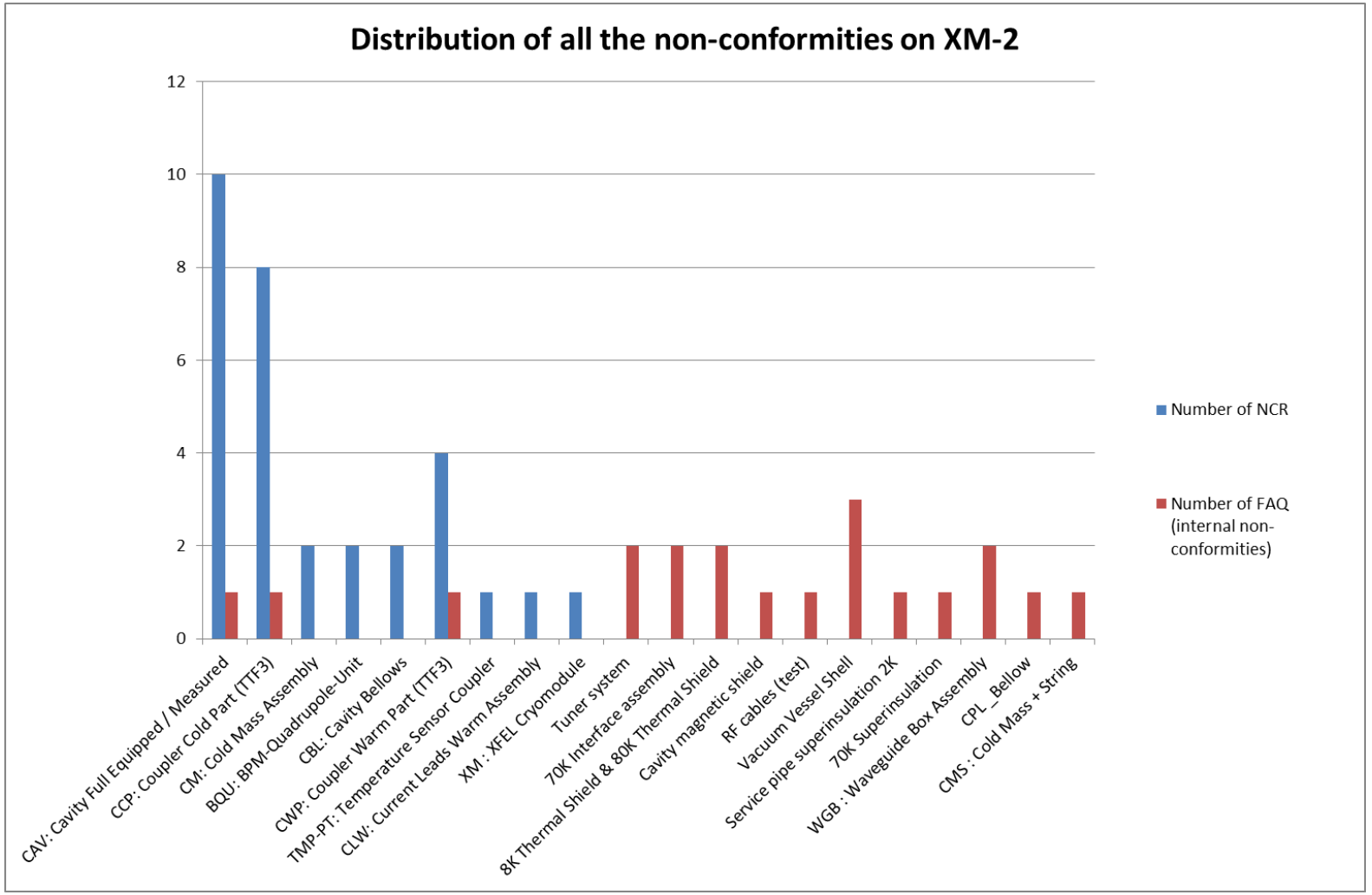
XM-2 String Order and VT performance

Pre-Series XM-2 :Non Conformities



In total **31 Non-Conformance Reports** (NCR) were issued for XM-2, about 7 NCR under the responsibility of CEA.

Pre-Series XM-2 : Quality Improvement Sheet



31 Non-Conformance Reports (NCR) + **20 Quality Improvement Sheet** (FAQ) were issued for XM-2, about 7 NCR under the responsibility of CEA.

Non-conformity processed on EDMS (1/2)

A FAQ is opened when a non-conformity is detected. The CEA representative decides if the non-conformity must be handled or not on EDMS.
(The corrective and preventive actions should be filled after the processing of the NCR on EDMS)

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Page 1 / 3

17/06/2013	FICHE D'AMELIORATION QUALITE - XFEL	FAQ 2013-0031-3C
Cryomodule : XM-2	N° OF : 80110599	
Nom Pièce : cavity bellows (CBL)	EDMS Fabrication Part : D*572557	
N° OF : 80110599	EDMS Physical Part id / N° série :	
Zone : Hall d'assemblage	Work Station : 5 - Roll-out area	
DOMAINE AFFECTE : ☒ PRODUIT ☐ PROCESSUS ☐ PROPRETE ☐ OUTILLAGE ☐ SECURITE		
DETECTION : ☒ EN PRODUCTION ☐ AUDIT INTERNE ☐ AUDIT EXTERNE ☐ AUTRE		

Description de l'anomalie (ALSYOM et/ou CEA)	Auteur : MADEC C. (CEA)

Présence de chocs sur deux soufflets inter cavités (cavité 7 et cavité 8).

Date de retour d'analyse souhaitée : 17/06/2013

Analyse/Commentaires (CEA)	Auteur : MADEC Catherine	Date : 17/06/2013

L'embout de la clé dynamométrique ne permet pas un serrage optimal

DECISION CEA	Responsable : CHARRIER Jean-Pierre	Date : 12/06/2013
Classification : ☒ MINEURE ☐ MAJEURE	Disposition Produit : Accepté en l'état	
☐ Non considéré comme une Non-Conformité	Actions Correctives : ☒ OUI ☐ NON	
☐ Non-Conformité avec traitement hors EDMS	Actions Préventives : ☐ OUI ☒ NON	
☒ Non-Conformité avec traitement via EDMS		

Si Traitement via EDMS → N° NCR : CEA-XFEL-NNC-13-103	Auteur : PLUVY Philippe

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Page 2 / 3

ACTIONS PREVENTIVES

1-
2-
3-
4-
5-
6-

Date : Clique

Date : Clique

LES ACTIONS

Commentair

Date : Clique

ACTIONS CORRECTIVES

FICHE D'AMELIORATION QUALITE - XFEL

DESCRIPTION DES ACTIONS A MENER (CEA)

1- Changement de l'embout de la clé dynamométrique
2- Une attention particulière doit être apportée lors du serrage en salle blanche.

Date : 12/06/2013 | Auteur : CHARRIER Jean-Pierre

MISE EN OEUVRE DES ACTIONS

Sur XM-1, un soin particulier a été apporté lors du serrage des boulons des soufflets entre cavités.
Le constat effectué sur les soufflets en sortie de salle blanche confirme l'amélioration.
Une investigation doit être apportée sur l'outillage utilisé pour le serrage (Clé).

Date : 03/09/2013 | Auteur PLUVY Philippe :

VALIDATION DES ACTIONS – EVALUATION DE L'EFFICACITE DES ACTIONS

LES ACTIONS MENEES ONT-ELLES ETE EFFICACES ? : ☐ OUI TOTALEMENT ☒ OUI PARTIELLEMENT ☐ NON

Commentaires : Amélioration à poursuivre – Cf FAQ-2013-0073

CLOTURE DES ACTIONS

☒ OUI ☐ NON

Date : 04/09/2013 | Auteur : CLOUE Christelle

Non-conformity processed on EDMS (2/2)

The NCR document uploaded on EDMS which is used for coordination, review and approval of its content, namely description of the NC, its corrective action and its preventive action.

Irfu / European XFEL	NON CONFORMANCE REPORT	Reference : CEA-XFEL-RNC-13-103-1
		Page : 1
		Date : 17/06/2013

Enter either the "Physical Part EDMS-ID", or the "Fab. Part Name" + "Fab. Part EDMS-ID" + "Physical Part Serial Number".				Physical Part EDMS-ID :	
Fab. Part Name :	XM-2_CMS: Cold Mass + String	Fab. Part EDMS-ID :	D00000000583027	Physical Part Serial No.	XM-2_CMS
Recorded by :	C. CLOUE / P. PLUVY	Location :	CEA XFEL Rollout Area		
TITLE :	Dents on cavity bellows between cavities 1/2 and cavities 7/8				

DESCRIPTION :

During operations in Roll Out WS, some dents have been observed on cavity bellow between cavities in position 1/2 (see Picture 1), and on cavity bellow between cavities in position 7/8 (see Picture 2).

Reference documents :

TECHNICAL INVESTIGATIONS :	Responsible (s)
Shocks probably generated during string assembly operations (bellows connections on cavities)	S.BERRY

CORRECTIVE ACTIONS (on Physical Part, or Equipment) :	Responsible (s)
NA	S.BERRY

PREVENTIVE ACTIONS (on Fabrication Part, or Equipment) :	Responsible (s)
Change tooling used in SA WS (torque wrench) to prevent to hit bellows during the string assembly	S. BERRY / M. MBELEG3

CATEGORY :		FINAL DECISIONS :	
Minor :	X	Action on Part :	Use As Is
Major :		Documentation :	

Clearance for actions	Fabrication Engineer (Technical Manager)	Quality Manager	Project Manager (WPL)
Unit responsible for involved product :		C. Cloué	O. Napoly
Accelerator Consortium Manager :			

1st distribution :

The Coordinator can fill-in the names of reviewers/approver(s), but does not have to because they are listed in the "History", or on the "Reviewer/Approver" tab (names might change there).

Date :	09.10.20xx	Reviewer :	A. MATHEISEN, L. LILJE

2nd distribution:

The Coordinator can fill-in the names of reviewers/approver(s), but does not have to because they are listed in the "History", or on the "Reviewer/Approver" tab (names might change there).

Date :	xx.xx.20xx	Reviewer :	

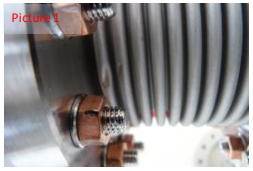
Closing :

Date :	xx.xx.20xx	By :		VISA :	

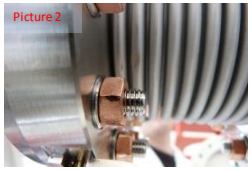
Irfu / European XFEL	NON CONFORMANCE REPORT	Reference : CEA-XFEL-RNC-13-103-1
		Page : 2
		Date : 17/06/2013

CONTINUATION SHEET

Picture 1



Picture 2



Non-Conformity Report , D00000001027445,A,1,4 , Item Info : Relations

Summary | Properties | Related Items | Files | Next Steps | Classification | Reviewer/Approver

Export Table As CSV HTML XML

EDMS -ID	Name	Description	Work Status
D00000001027445,A,1,4	CEA-XFEL-RNC-13-103	XM-2_CMS: Dents on cavity bellows between cavities 1/2 and cavities 7/8	Closed
Affects			
D00000010985499,A,1,1	XM-2_CMS	XM-2_CMS: Cold Mass + String	Executi
Attaches			
Is In Team Folder			
NCRs for XM-2,XFEL_WP03_Alsyom_Team	NCRs for XM-2	Non conformity reports for XM-2 cryomodule	

FAQ: Quality Improvement Sheet

All Non-Conformities are generating a 'FAQ' which is processed internally (Alsyom/CEA). The CEA Area Manager decides if it needs to escalate to NCR through EDMS.

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Page 1 / 3

11/07/2013	FICHE D'AMELIORATION QUALITE - XFEL	FAQ 2013-0045-3C
Cryomodule : XM-2	Détecteur : Fontaine Michel	
Nom Pièce : Enceinte à vide	EDMS Fabrication Part : D*574167	
N° OF :	EDMS Physical Part id / N° série : EZ004	
Zone : Hall d'assemblage	Work Station : 8 - Cantilever area	

DOMAINE AFFECTE : ☒ PRODUIT ☐ PROCESSUS ☐ PROPRETE ☐ OUTILLAGE ☐ SECURITE

DETECTION : ☒ EN PRODUCTION ☐ AUDIT INTERNE ☐ AUDIT EXTERNE ☐ AUTRE

Description de l'anomalie (ALSYOM et/ou CEA)	Auteur : MADEC Catherine

Le taraudage des trous des tilt-balls de l'enceinte à vide étant peint, nous avons dû passer le taraud pour pouvoir les visser.
(Chatillon Frédéric)

Date de retour d'analyse souhaitée : Cliquez ici pour entrer une date.

Analyse/Commentaires (CEA)	Auteur : MADEC Catherine	Date : 26/07/2013

Présence de peinture dans les filetages sur l'enceinte au niveau des positions des "Tilt balls".

DECISION CEA	Responsable : MADEC Catherine	Date : 26/07/2013

Classification : ☒ MINEURE ☐ MAJEURE

☐ Non considéré comme une Non-Conformité

☒ Non-Conformité avec traitement hors EDMS

☐ Non-Conformité avec traitement via EDMS

Disposition Produit : Retravaillage

Actions Correctives : ☒ OUI ☐ NON

Actions Préventives : ☐ OUI ☒ NON

Si Traitement via EDMS ➔ N° NCR :

Auteur : Choisissez un élément.

ALS

ACTIONS PREVENTIVES

1-
2-
3-
4-
5-
6-

Date : Clique

Date : Clique

LES ACTIONS

Commentair

Date : Clique

ALSYOM ALCEN

Page 2 / 3

FICHE D'AMELIORATION QUALITE - XFEL

ACTIONS CORRECTIVES

DESCRIPTION DES ACTIONS A MENER (CEA)

1- Passage d'un taraud pour rectifier le problème.
2-
3-
4-
5-
6-

Date : 26/07/2013 | Auteur : MADEC Catherine

MISE EN OEUVRE DES ACTIONS

Rectification faite.

Date : 26/07/2013 | Auteur CLIPPET Aurélien :

VALIDATION DES ACTIONS – EVALUATION DE L'EFFICACITE DES ACTIONS

LES ACTIONS MENEES ONT-ELLES ETE EFFICACES ? : ☒ OUI TOTALEMENT ☐ OUI PARTIELLEMENT ☐ NON

Commentaires :

CLOTURE DES ACTIONS

☒ OUI ☐ NON

Date : 26/07/2013 | Auteur : MADEC Catherine

FICHE D'AMELIORATION QUALITE - XFEL

Non-conformity processed internally

ALSYOM
ALCEN

Page 1 / 3

10/06/2013	FICHE D'AMELIORATION QUALITE - XFEL	FAQ 2013-0027-3C
Cryomodule : XM-2	N° OF : 80110599	
Nom Pièce : 70K Interface screws	EDMS Fabrication Part : D*573667	
N° OF : 80110599	EDMS Physical Part id / N° série : NA	
Zone : Hall d'assemblage	Work Station : 5 - Roll-out area	
DOMAINE AFFECTE : ☐ PRODUIT ☒ PROCESSUS ☐ PROPRETE ☐ OUTILLAGE ☐ SECURITE		
DETECTION : ☒ EN PRODUCTION ☐ AUDIT INTERNE ☐ AUDIT EXTERNE ☐ AUTRE		

Description de l'anomalie (ALSYOM et/ou CEA)	Auteur : CLIPPET A. (ALSYOM)

1- Impossibilité de fixer la vis argentée en position par la présence de la plaquette de connexion de la sonde température collée trop proche de l'emplacement de la tête de vis.
Coupleurs concernés : AC3C45 (1 vis) AC3C42 (1 vis) AC3C30 (1 vis) AC3 C39 (1 vis)

Date de retour d'analyse souhaitée : 11/06/2013

Analyse/Commentaires (CEA)	Auteur : CHARRIER Jean-Pierre	Date : 11/06/2013

Les plaquettes de connexion de sondes ont été collées trop près de la bride du coupleur (ce problème est lié à la configuration des sondes qui n'est pas une configuration de série).

Voir actions correctives à mettre en oeuvre.
Les coupleurs n'étant pas de série il n'y aura pas d'action de prévention

DECISION CEA	Responsable : CHARRIER Jean-Pierre	Date : 11/06/2013
Classification : ☒ MINEURE ☐ MAJEURE	Disposition Produit : Retravaillage	
☐ Non considéré comme une Non-Conformité	Actions Correctives : ☒ OUI ☐ NON	
☒ Non-Conformité avec traitement hors EDMS	Actions Préventives : ☐ OUI ☒ NON	
☐ Non-Conformité avec traitement via EDMS		

Si Traitement via EDMS ➔ N° NCR :	Auteur : Choisissez un élément.

ALSYOM
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Page 2 / 3

ACTIONS CORRECTIVES

FICHE D'AMELIORATION QUALITE - XFEL

DESCRIPTION DES ACTIONS A MENER (CEA)

1- Limer la tête de vis.

Date : 11/06/2013 | Auteur : CHARRIER Jean-Pierre

MISE EN OEUVRE DES ACTIONS

1 - La tête de vis a été limée par le technicien CEA.

Date : 12/06/2013 | Auteur PLUVY Philippe :

VALIDATION DES ACTIONS – EVALUATION DE L'EFFICACITE DES ACTIONS

LES ACTIONS MENEES ONT-ELLES ETE EFFICACES ? : ☒ OUI TOTALEMENT ☐ OUI PARTIELLEMENT ☐ NON

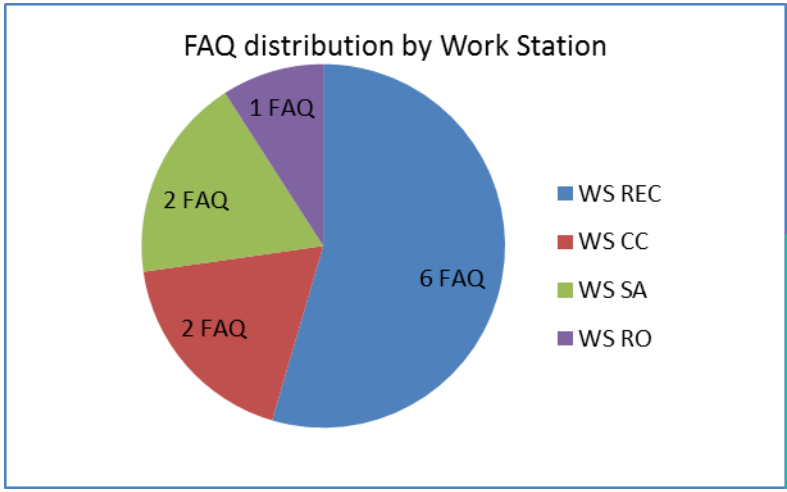
Commentaires :

CLOTURE DES ACTIONS ☒ OUI ☐ NON

Date : 13/06/2013 | Auteur : CHARRIER Jean-Pierre

Non-conformities on Cavities on XM-2

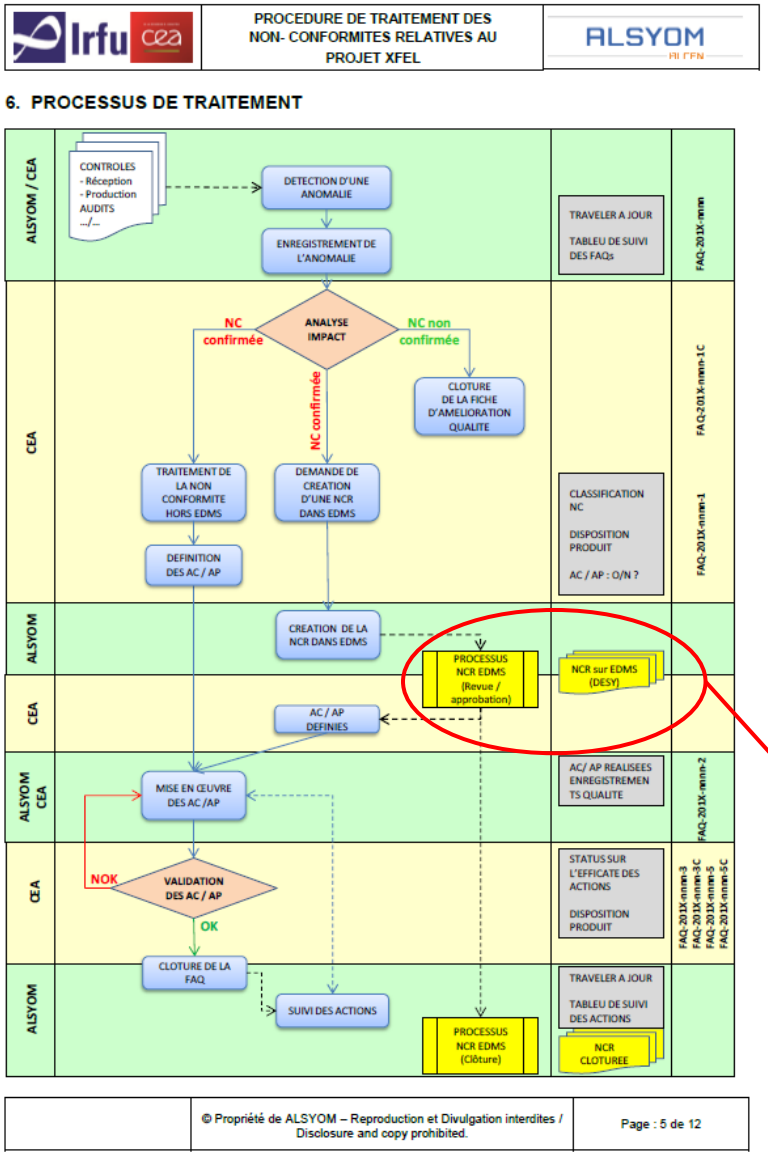
FAQ	Serial Number	WS	Origin	Object	NCR Number	Disposition
FAQ-2013-0002	CAV00512	REC	PRODUCT	Threaded rods too long on cavity beamtube adapter flange - short side	CEA-XFEL-RNC-13-077	Use as is
FAQ-2013-0003	CAV00510	REC	PRODUCT	High Q Antenna flange misoriented	CEA-XFEL-RNC-13-081	Use as is
FAQ-2013-0004	CAV00510	REC	PRODUCT	Cavity elbow valve mispositionned	CEA-XFEL-RNC-13-082	Use as is
FAQ-2013-0005	CAV00509 & CAV00512	SUP	PROCESS	Water entered inside 2Ph He pipe and tank during washing operation in the Belimed	CEA-XFEL-RNC-13-083	Reworked
FAQ-2013-0010	CAV00510 & CAV00514	CC	PROCESS	Water inside cavity elbow valve	CEA-XFEL-RNC-13-090	Reworked
FAQ-2013-0015	CAV00509, CAV00510, CAV00513, CAV00514, CAV00526.	REC	PRODUCT	Five cavities are out RF-measurement acceptance regarding the HOM RF rejection criteria	CEA-XFEL-RNC-13-094	Use as is
FAQ-2013-0017	CAV00509	SA	PRODUCT	Presence of visible particules inside beam tube	CEA-XFEL-RNC-13-096	Return
FAQ-2013-0018	CAV00523	REC	PRODUCT	High Q Antenna flange and Cavity flange (Long side) misoriented	CEA-XFEL-RNC-13-097	Use as is
FAQ-2013-0019	CAV00513	REC	PRODUCT	Flange of elbow valve is dirty	CEA-XFEL-RNC-13-098	Reworked
FAQ-2013-0020	4 CAVITIES	SA	PROCESS	Quick Cavity venting up to 6 mbar	CEA-XFEL-RNC-13-099	Use as is
FAQ-2013-0025	CAV_FE00513	RO	PROCESS	Presence of water in 8mm He tube	NA	Reworked

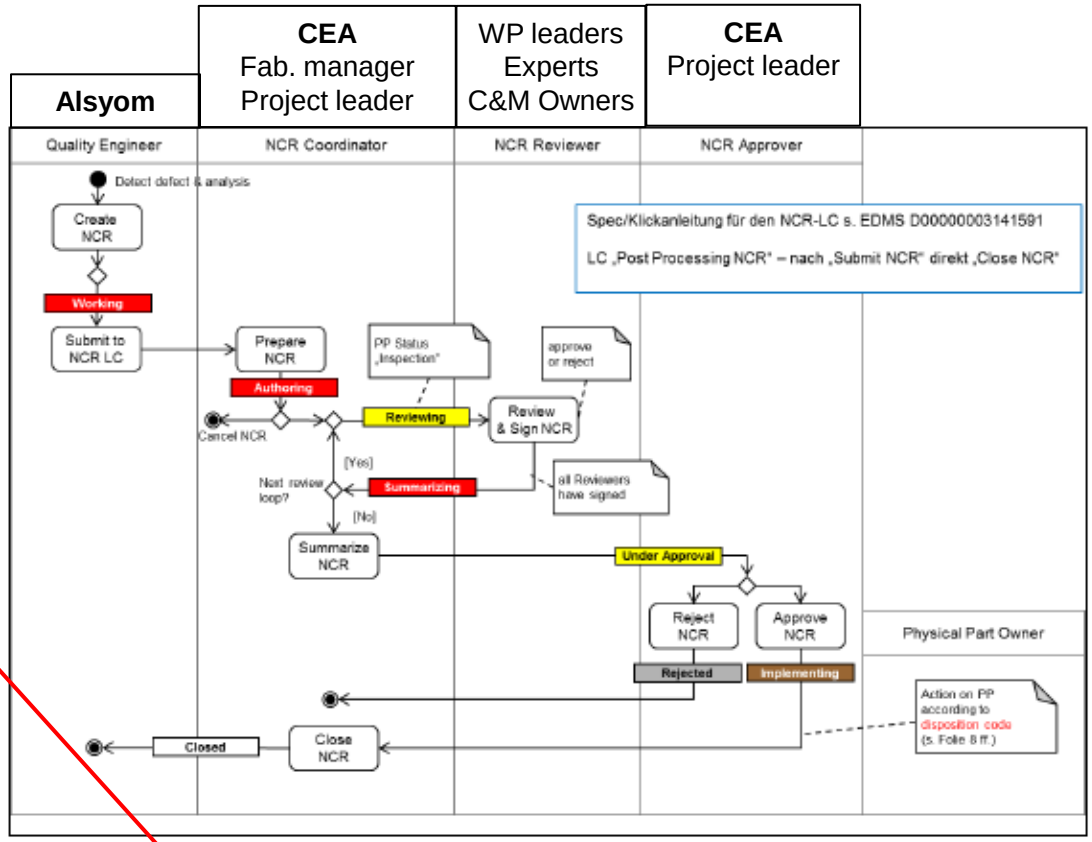


11 FAQ opened resulting in 10 NCR.
A non-conformity can affect several cavities

REC = Reception area
CC = Cold Coupler assembly area
SA = String Assembly area
RO = Roll-Out area

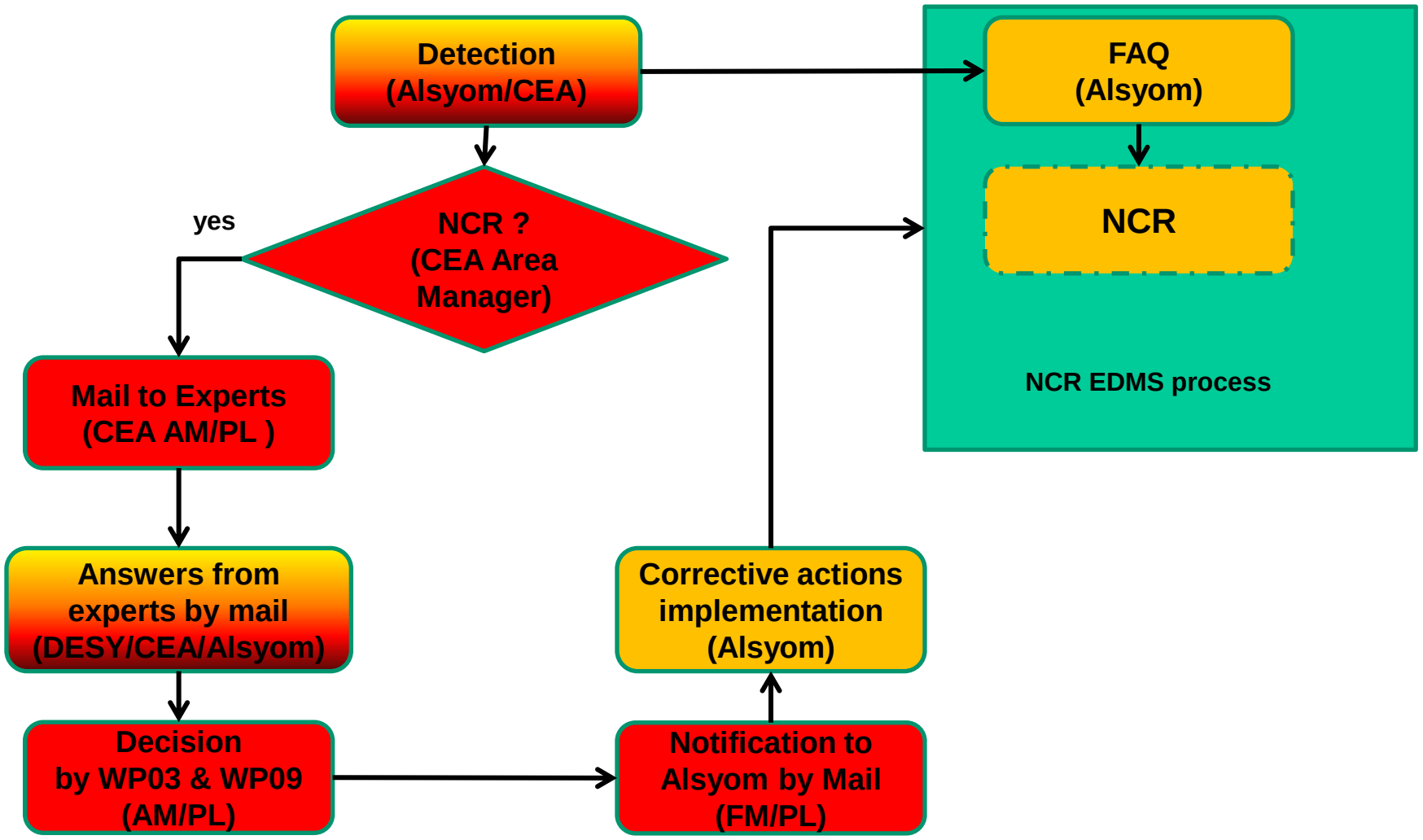
Decision Process for Non-Conformity





Lifecycle of a Non-Conformity under EDMS

Quick Decision Process for Non-Conformity



Training Phase: XM-1

Phase 2: **training phase** which covers the assembly of XM-2 and XM-1 in co-activity by CEA and ALSYOM.

XM-1, third pre-series module, is made with parts from XFEL production lines, including **cavities** (E. Zanon), **couplers** (Thales / RI) and first IHEP cryostat.

Assembly dates:
Foreseen: 1 April 2013 – 12 July 2013
Achieved: 2 July 2013 – …

Assembly duration:
Foreseen: 14 weeks
Achieved: …

* according to Alsyom contract schedule

XM-1 and XM1 on Roll-Out Area

Welding Issue n°1

1 - Qualifications

PED (TÜV-Nord) request:

1. Alsyom/SEIV certificate according to EN3834 '*Quality requirements for fusion welding of metallic materials*'
2. WPQR and WPS for all pipe (orbital) and lip welds (hand), i.e. procedures
3. welder certificates EN 287-1 (hand welds)
4. operator certificate EN 1418 (orbital welds)

The last three items have been obtained by Alsyom/SEIV in May 2013.

This is why:

a) XM-3 was welded by DESY (qualified body with qualified welders)
b) XM-2 was welded by SEIV (qualified welder and operator)
c) XM-1 was welded by SEIV (qualified welder and operator).

CEA and Alsyom are working on the EN3834 qualification.

Welding Issue n°2

2 - NDT by Radiography

TÜV-Nord requested systematic Non-Destructive Testing by X-Ray radiography (RT) for all the welds (17 welds) of the Helium 2K two-phase line along cavity string, for all the cryomodules.

These NDT come in addition to the systematic Visual Test (VT) and Leak Test (LT), and Paint Test (PT) for a couple of lip-welds.

This request is new and reached CEA in early September 2013.

This is why:

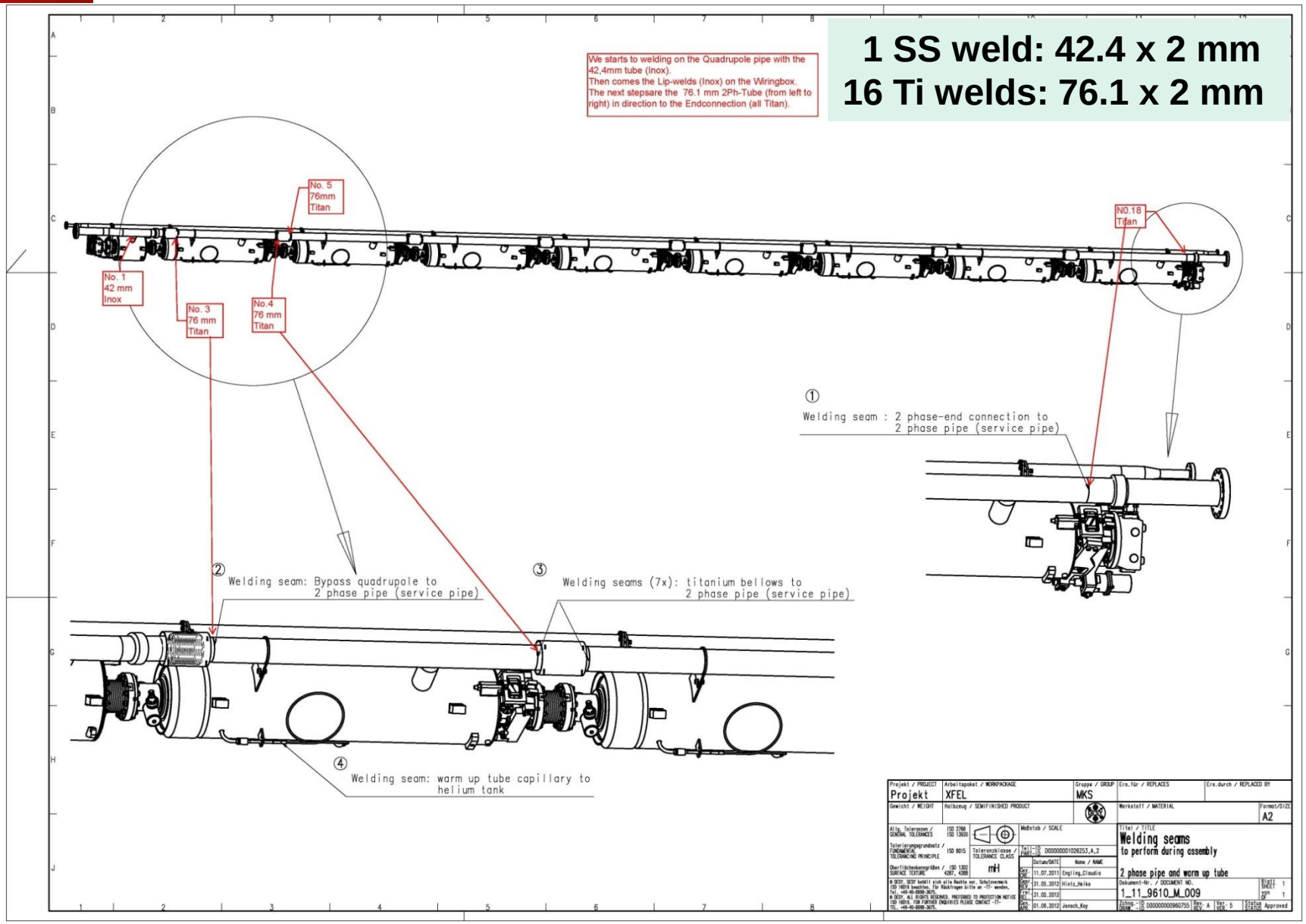
a) XM-3 and XM-2 did not undergo X-ray radiography, but systematic PT instead

b) XM-1 did undergo X-Ray radiography test, which failed.

Organizing and bringing NDT at Saclay is challenging:

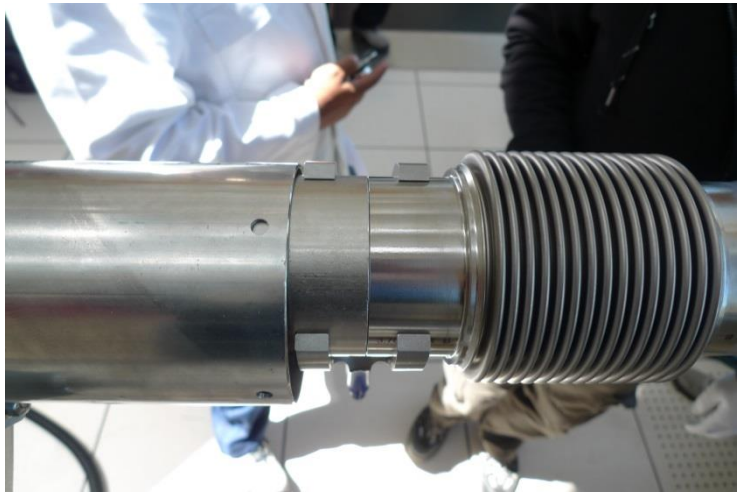
1) Contract: a call for tender needs to be organized for about 92 campaigns
2) Safety: CEA-Saclay has very strict safety regulations for implementing X-Ray radiography
   → *today 250 m radius outside area is controlled during the night, mobile lead shields (>6 mm) are under study to prevent outside radiation.*

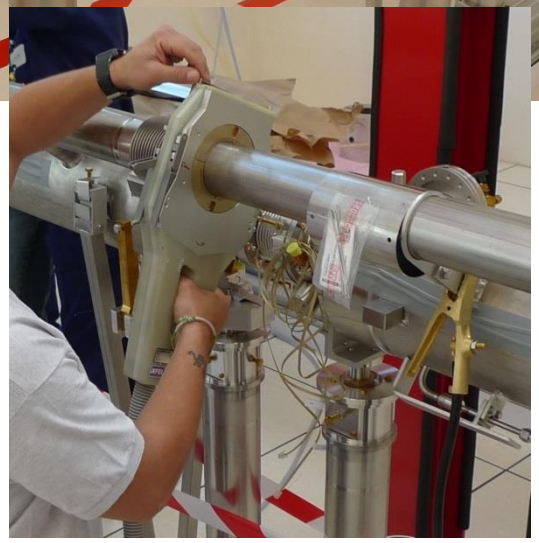
Orbital Welds of the Helium Tank (1/3)

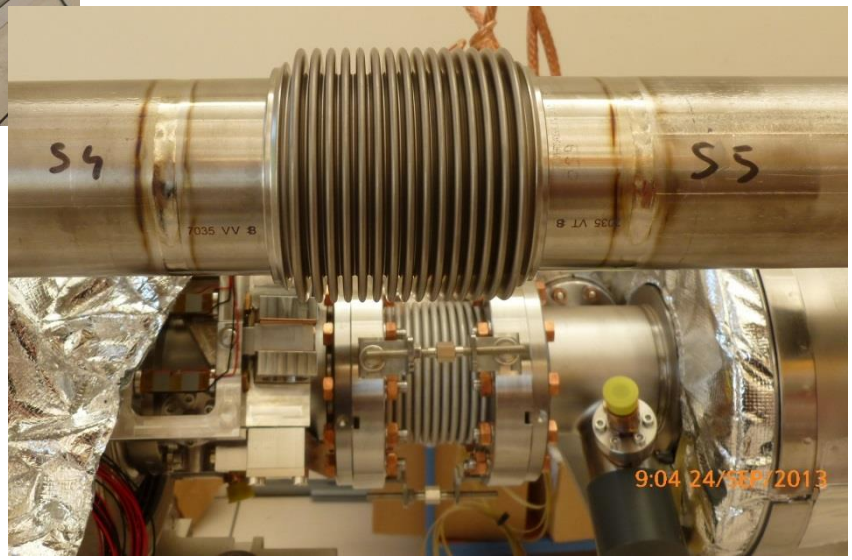


2-Phase Line Titanium Tube Welding

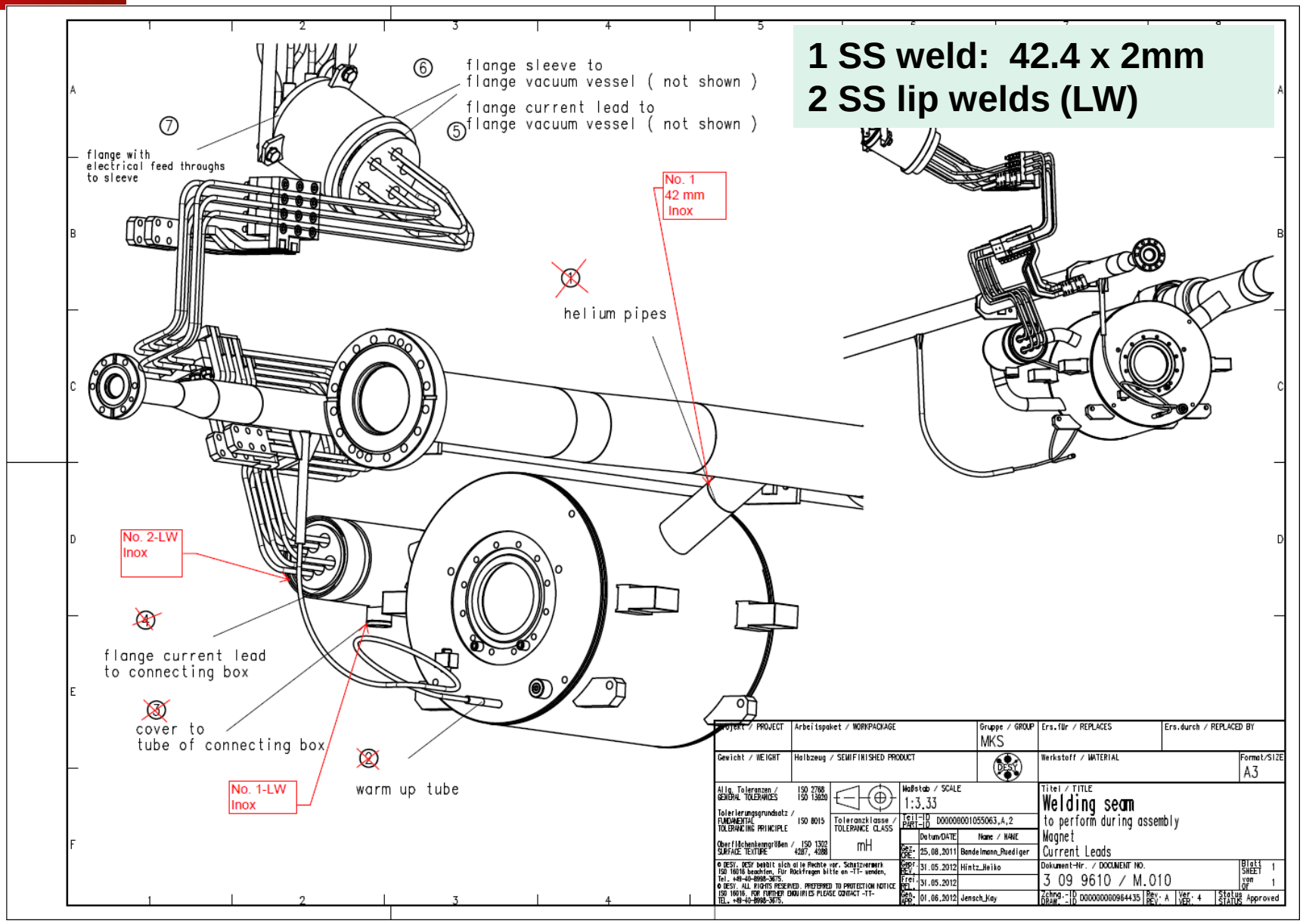
XM-2 string





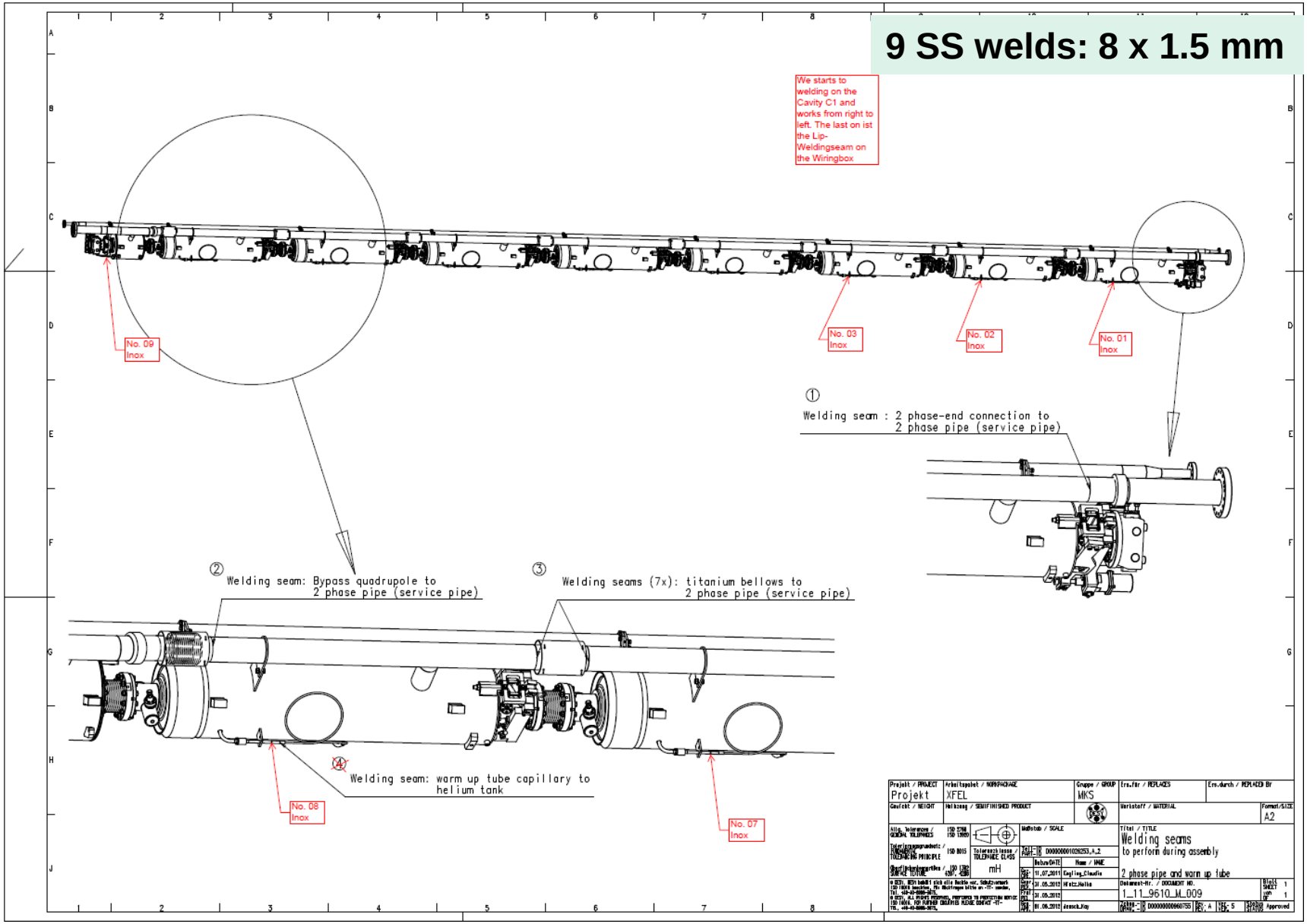


Stainless Steel Welds of the Helium Tank (2/3)



Orbital Welds of the Helium Tank (3/3)

9 SS welds: 8 x 1.5 mm



Welding Issue n°3

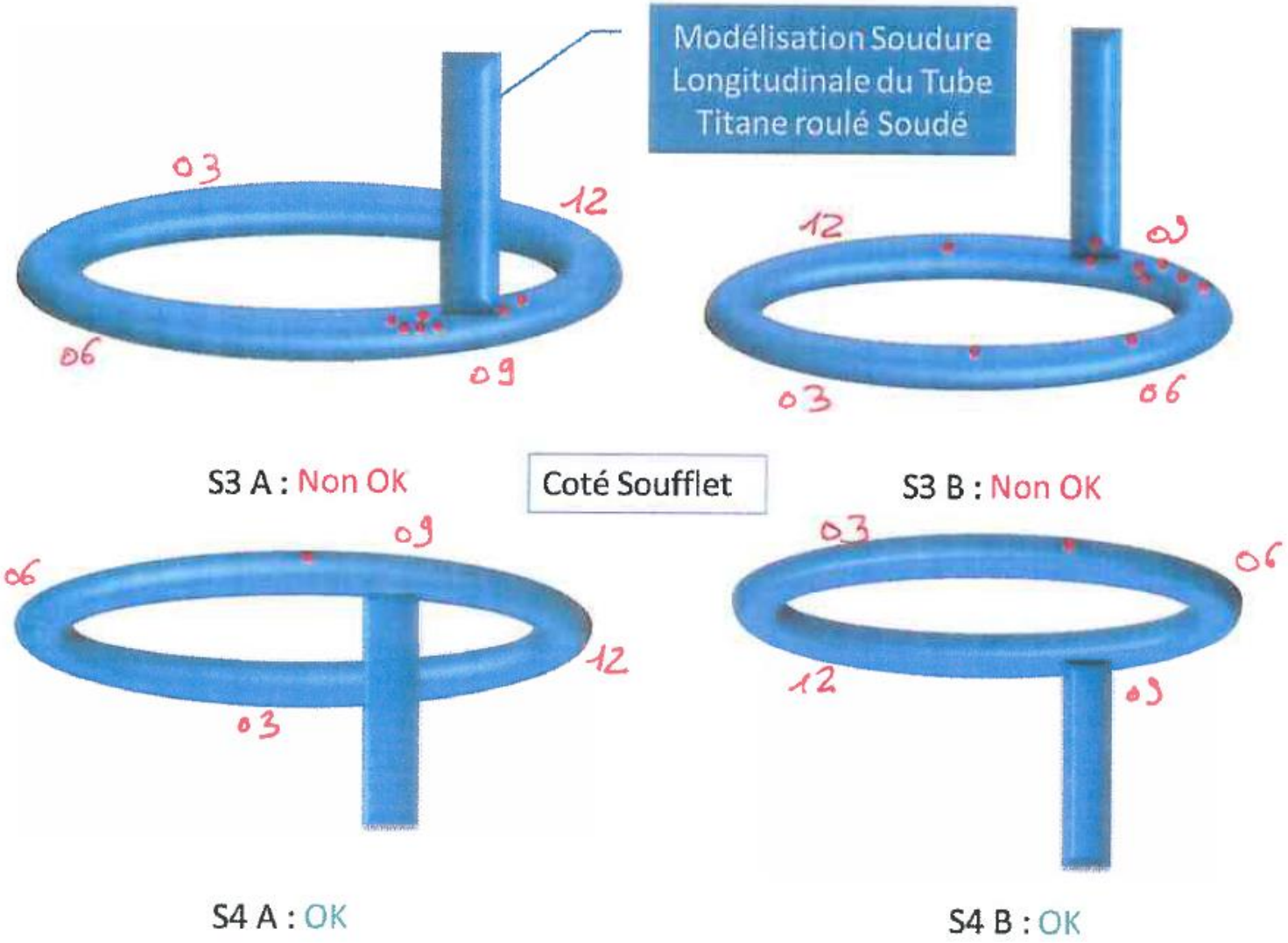
3 – Execution of NDT and TÜV

Module assembly at two different workstations will need to be synchronized (in the best case) or delayed (in the worst case) with the **external** action of NDT operators and of TÜV-Nord inspector, **on a weekly basis !**

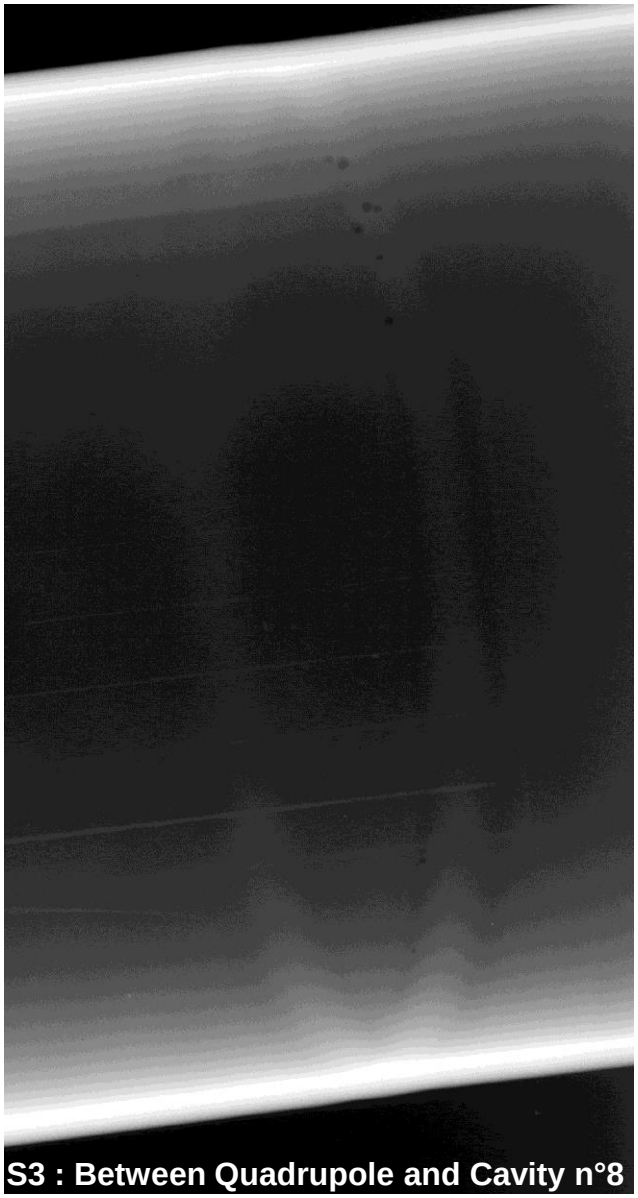
The time windows for these two visits is not more than 2 days.

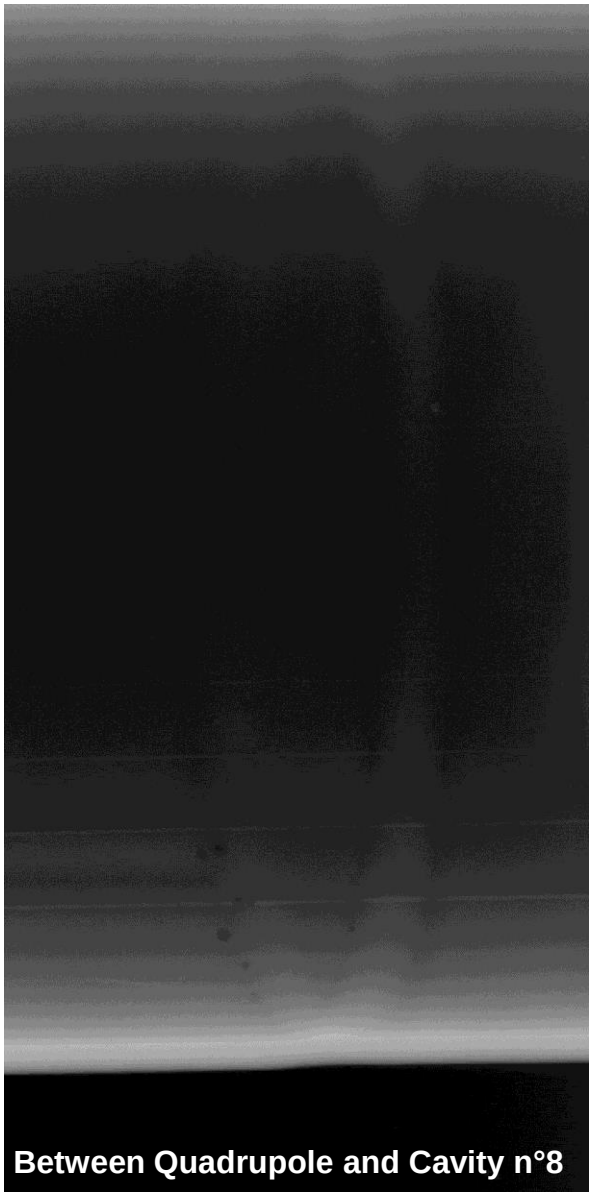
Welding Issue n°4

4 - Non-conform Welds (pores, or blow-holes) on XM-1



XM-1 Welding Problem on Titanium Tubes: Pores

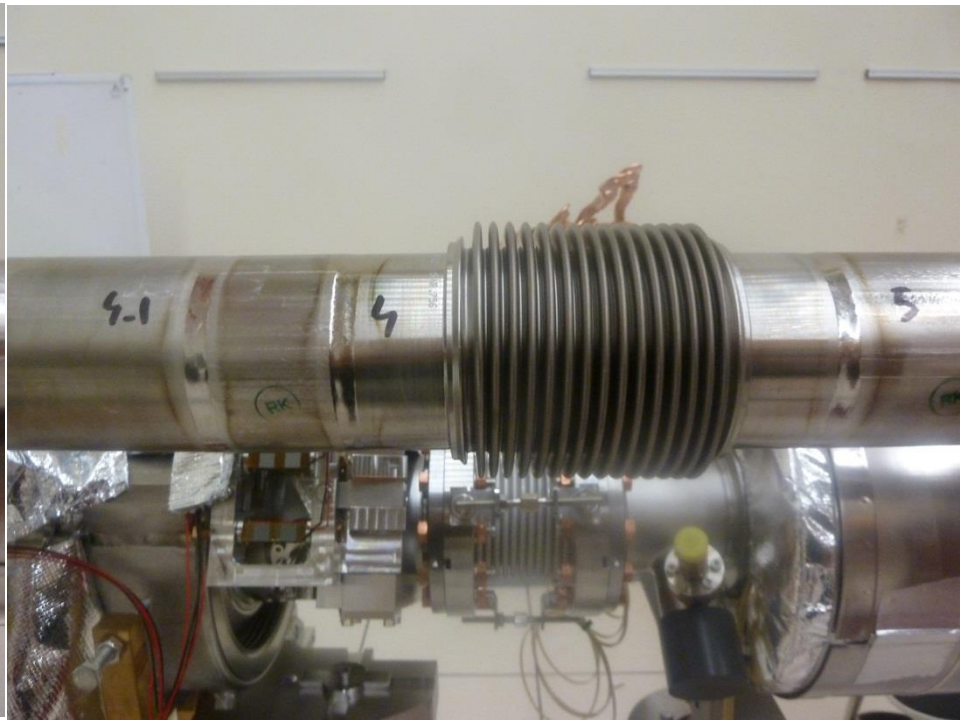




Reworking S3, S4 and S5 welds

- Under the asumption that better procedures could be applied at Saclay, the decision was made to rework all the Titanium welds on 16-17 October by DESY welders: in practice only four welds could be reworked.

S3 and S3-1 are conform, no defect.



S4-1 and S5 are not conform, pores again !

- The project worked out some improvements of the procedures and tools. CEA will check purity of gas and presence of oxygen in the welding arm.
- A new welding and X-Ray campaign is planned next week, W47

Production Phase: XM1

Phase 3: **production phase** which covers the assembly of XM1 to XM100 by ALSYOM, with a ramp-up phase until XM9

XM1, first production module, is made with parts from XFEL production lines, including **cavities** (E. Zanon), except **couplers** (TTF3 couplers / RI).

Assembly dates:
Foreseen*: 13 May 2013 – 23 August 2013
Achieved: 4 September 2013 – …

Assembly duration:
Foreseen*: 14 weeks
Achieved: …

* according to Alsyom contract schedule

Production Phase: XM1

Production Phase: XM2

Phase 3: **production phase** which covers the assembly of XM1 to XM100 by ALSYOM, with a ramp-up phase until XM9

XM2, second production module, is made with parts from XFEL production lines, including **cavities** (4 Zanon + 4 RI) and **couplers** (Thales / RI).

Assembly dates:

Foreseen*: 27 May 2013 – 9 September 2013

Achieved: 4 September 2013 – …

- 7 Thales/RI couplers are connected
- string assembly did not start

Assembly duration:

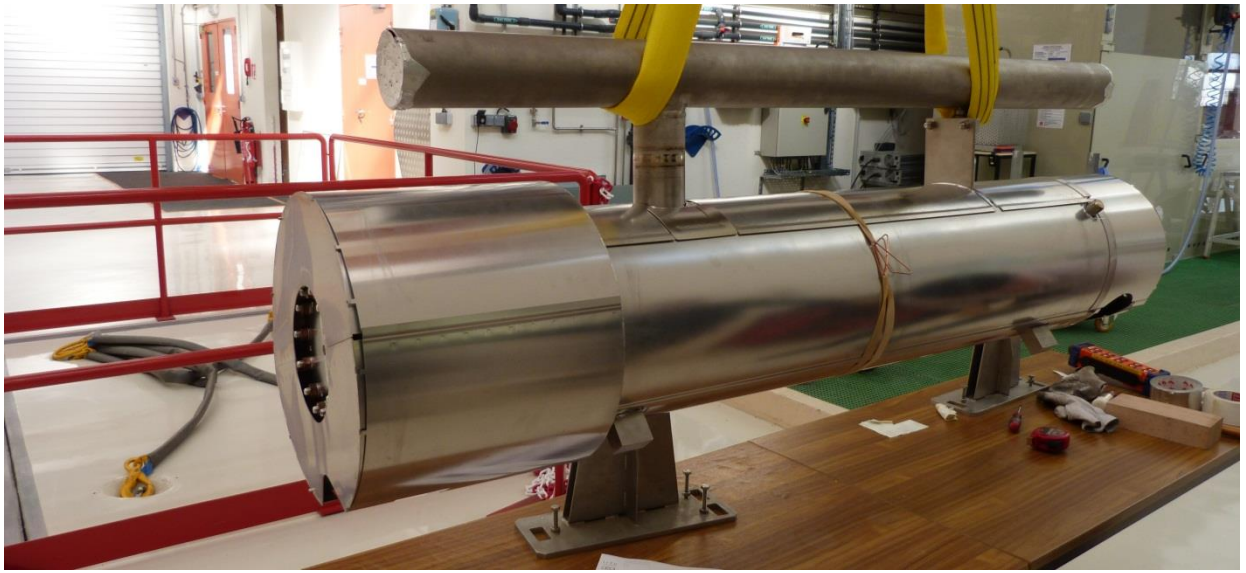
Foreseen*: 14 weeks

Achieved: …

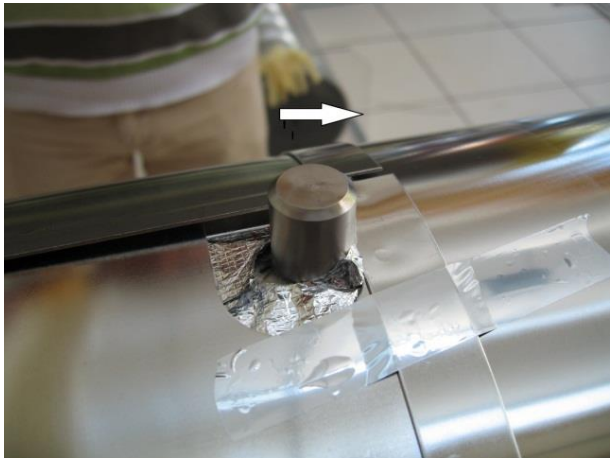
* according to Alsyom contract schedule

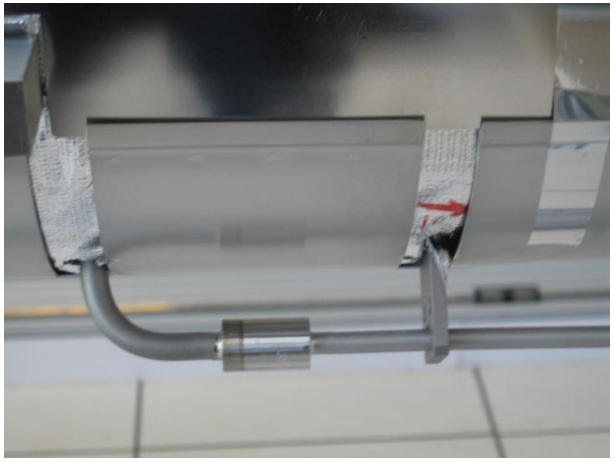
Magnetic Shieldings

Prototype by MecaMagnetic for PXFEL configuration (warm-up tube with flange)



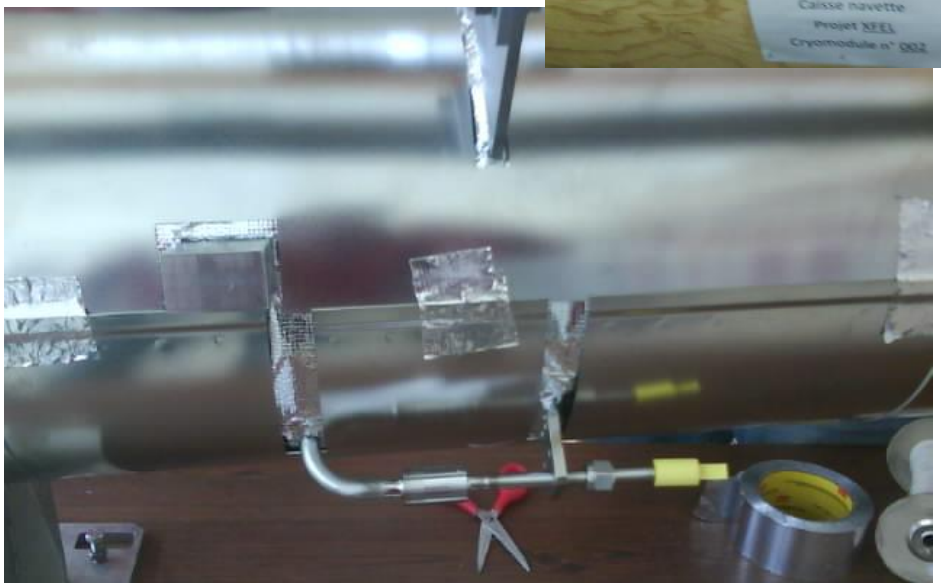
Pre-series by MecaMagnetic for XFEL configuration (warm-up tube with Ti/SS transition): benchmarking XM-3 cavities !





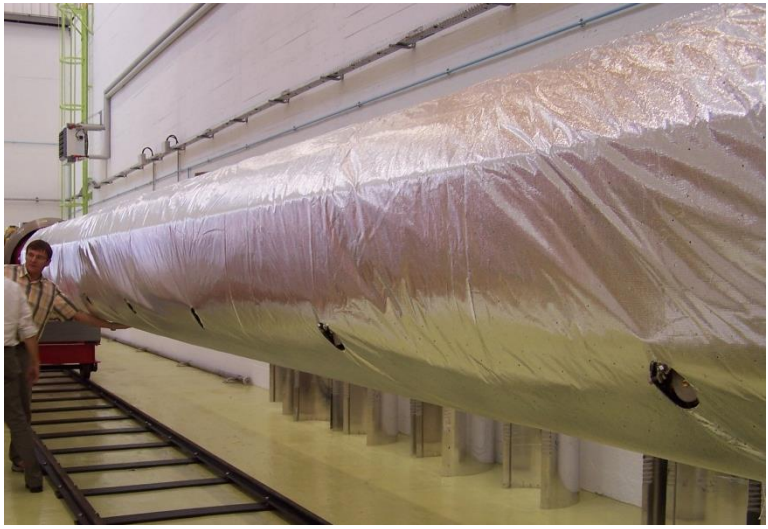
Magnetic Shieldings: XM-2

Series by MecaMagnetic for XM-3 and XM-2 cryomodules



Magnetic shields are qualified by the excellent dynamic cryogenic performance of XM-3

Super-insulation Blankets



Super-insulation blankets have been qualified (PXFEL2_1 and PXFEL3_1).

The 40/80 K super-insulation blanket (2x15 layers):

- costs about 4 k€
- saves 1 day on cantilever and about 7 p.day (balance at ~600 € / day)
- saves about 30 W @ 40 K with respect to multilayers (30 + 29 separators).

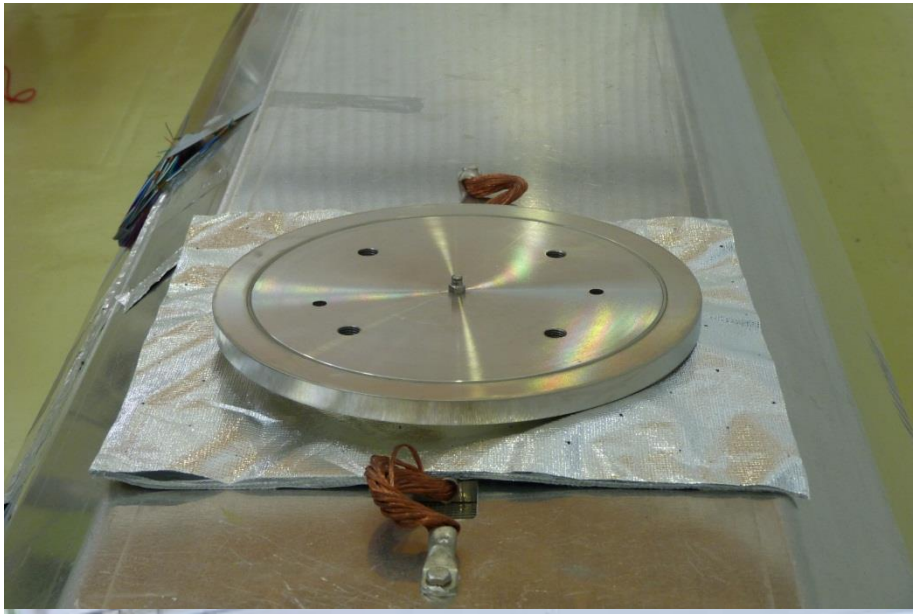
Cryo loss at	PXFEL 3	PXFEL 3_1 cooldown Dec 2011	PXFEL 3_1 cooldown Feb 2012	PXFEL 2_3 cooldown March 2013
40 / 80 K	134 W	96 W	97-102 W	95 W

Negotiations with Jehier allowed about 10% reduction / CfT offer, through:

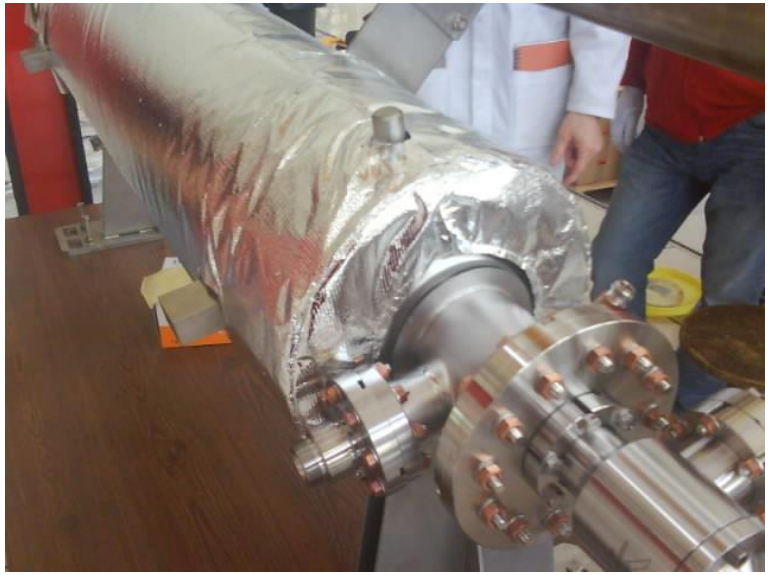
- more flexible (rapid) delivery rate
- simplification of 2K blankets fabrication

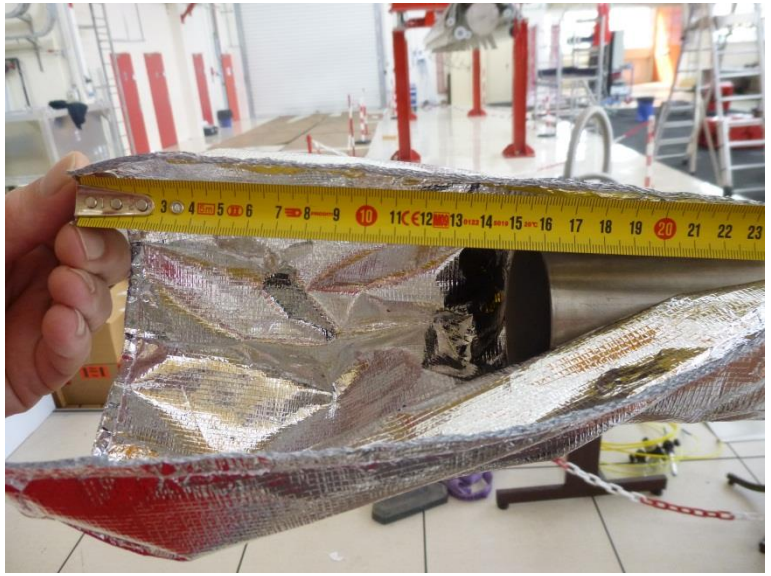
70 K blankets ordered in advance for XM-3, XM-2, XM-1 (delivered in June 2012)

70 K Blankets by Jehier



2 K Blankets by Jehier



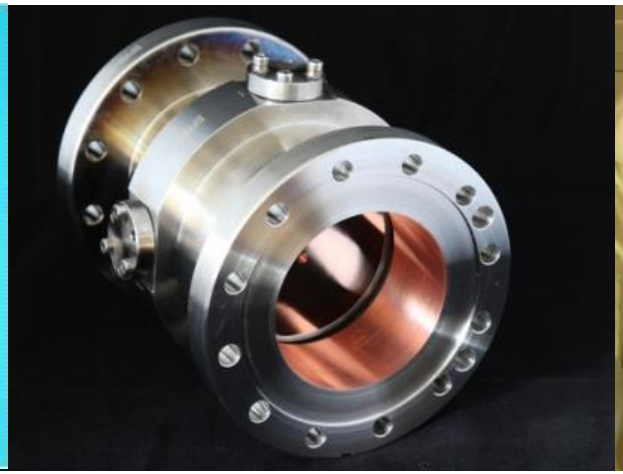


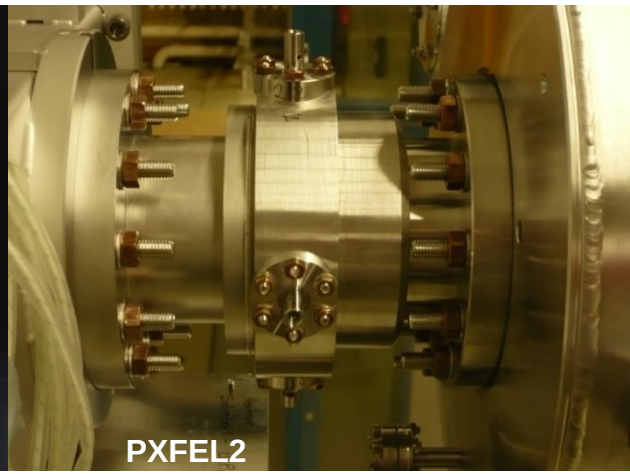
Cold Re-entrant Cavity BPM

31 XFEL cryomodules will be equipped with a cold BPM of the re-entrant type, designed, fabricated and equipped with FE electronics by CEA and industry. These BPM will be attached to the quadripole (upstream) and to the gate valve into a so-called BPM-Quadripole Unit (BQU) cleaned and assembled at DESY ISO4 clean room and later shipped to CEA/Saclay.

Although the specified XFEL resolution is 50 µm, the re-entrant cavity BPM has the potential for 1 µm resolution. In the FLASH warm beam line, 8 µm resolution was mearured in the past with prototype BPM.
This is a broadband BPM, although of the cavity type, the time resolution is 40 ns.

Two such BPM have been included in XM-1 and XM1

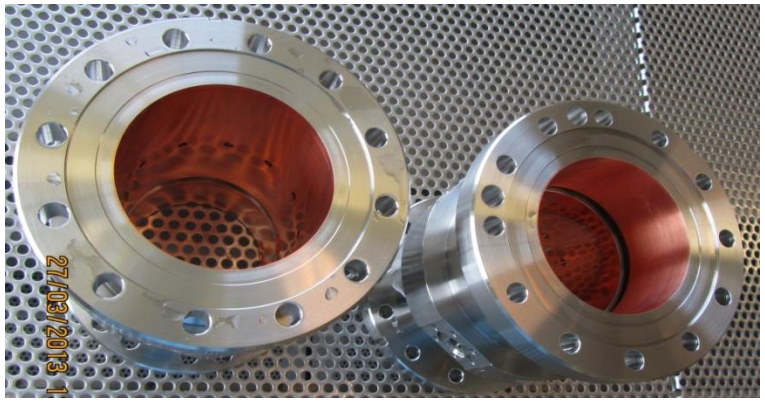


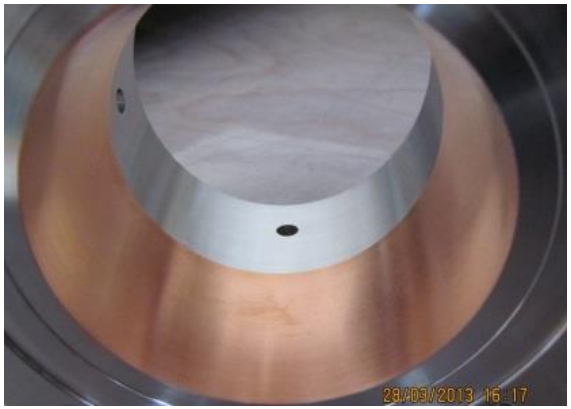


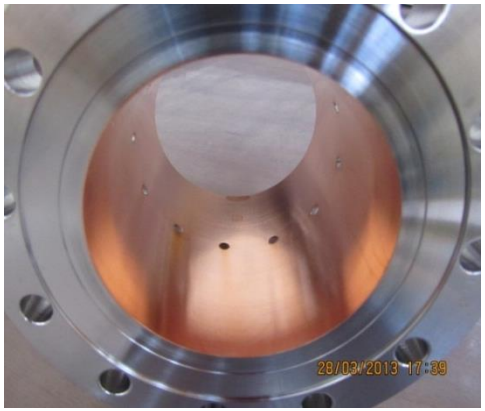
Cold Re-entrant Cavity BPM

Copper coating and fabrication status

Cleaning of the copper coating led to a tarnishing problem once.







The production of SS bodies is underway

Electronics Status

- RFFE electronics prototype received
- All functions are incremented
- RFFE under laboratory tests

Conclusions

- n°1 problem: cope with the industrialization equation « parts + procedures = cryomodule on specs »

XM-3 is a **success**, XM-2 RF test will be a critical result for qualifying the remainder of CEA equipment (pumping system)

- n°2 problem: schedule of 1 module / week in one shift after ramp-up **String Assembly still needs some work**

- n°3 problem: fast ramp-up schedule **Not OK yet**

XM-1 revealed the challenges and difficulties of the Helium tank welding: *qualification*, *radiography*, *conformity*

- n°4 problem : fastening hardware, procurement and cleaning **under control now**