



STATUS OF E-XFEL STRING AND CRYOMODULE ASSEMBLY AT CEA- SACLAY

C. Madec, CEA-Saclay, IRFU/SACM

CEA contributes to the
E-XFEL Cold Linac construction
through
String Assembly in Clean Room (WP9)
and **Module Assembly (WP3)**



Accelerator Module Assembly
assembly of 103 accelerator modules
with **1 per week throughput !**
operated by an **industrial contractor**
on the **Saclay** site.

Project Timeline

Our effort develops over the 3 phases:

Phase 1: 2008-mid 2010

- Preparation of Infrastructure and Tooling

Phase 2: August 2010 → August* 2012

- Pre-industrial studies subcontracted
- Training and Commissioning at Saclay with XFEL Prototype Modules (PXFEL2 and PXFEL3)

→leading to Restricted Call for Tender for Assembly Contract, July 2011

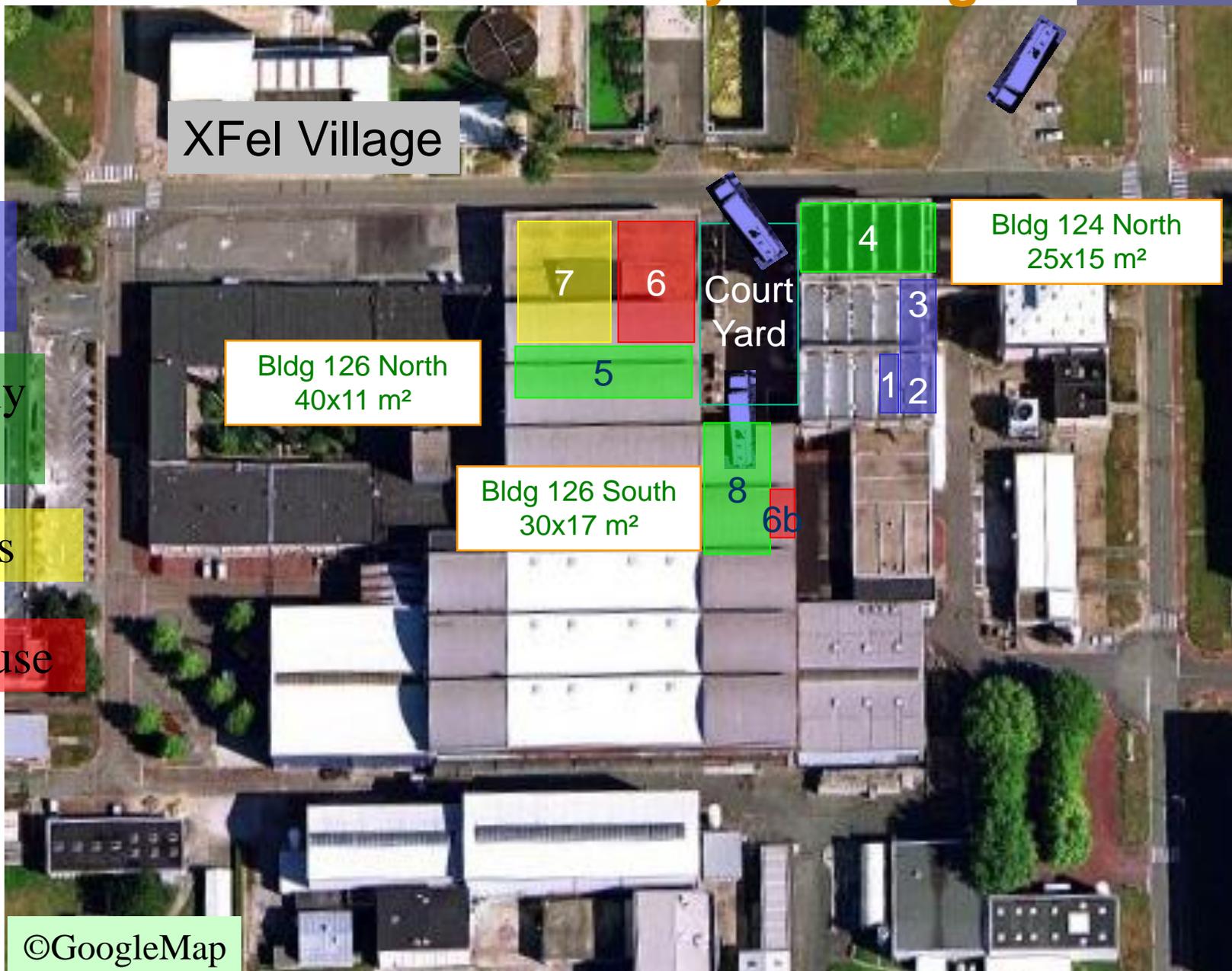
Phase 3: July 2012→ Q1-2015

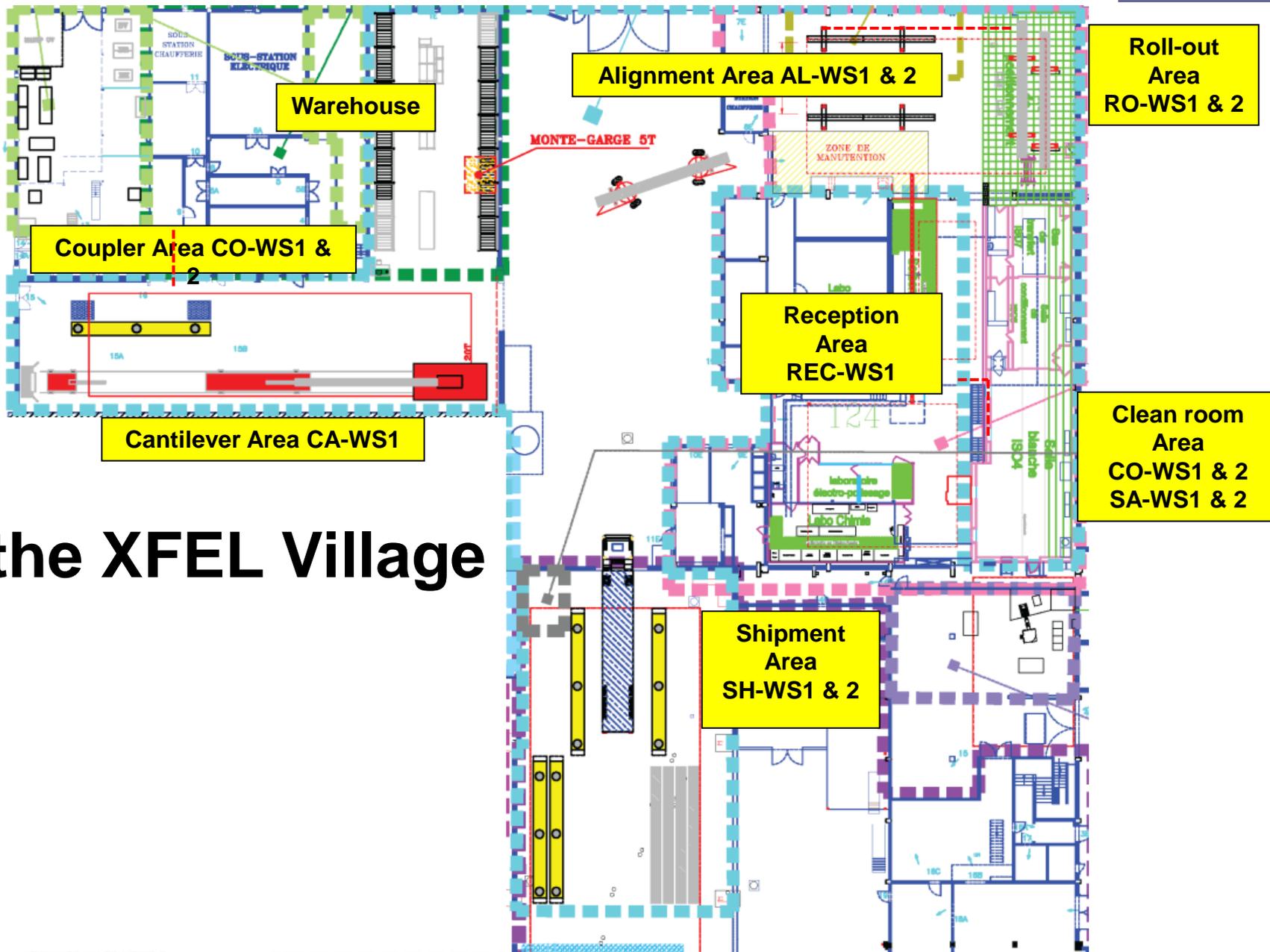
- XFEL module assembly by industry operator

Outline

- XFEL Village at Saclay
- Integration of cryomodule prototypes
PXFEL2, PXFEL3
- Definition and Schedule of industrial integration of XFEL cryomodules







the XFEL Village



- Assembly of XFEL prototype cryomodules (PXFEL2 and PXFEL3) at Saclay aims at:
 - Completing the training of the Saclay team;
 - Commissioning the infrastructure (XFEL Village)
- The team (~10 persons) has operated :
 - the module disassembly of PXFEL2_1 on August 24th, 2010
 - the module re-assembly of PXFEL2_1, tested at DESY
 - the string and module assembly of PXFEL3_1
 - using DESY cavity posts and clean room tools*
 - the string assembly of PXFEL2_2 (Dec.2011 – August* 2012)
 - using CEA cavity posts and clean room tools*

Cavity and Coupler Reception (ISO5-CR-WS1)

0.a Cavity and coupler reception

0.b Cavity and coupler washing



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



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



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



4. Alignment (AL-WS1&2)



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



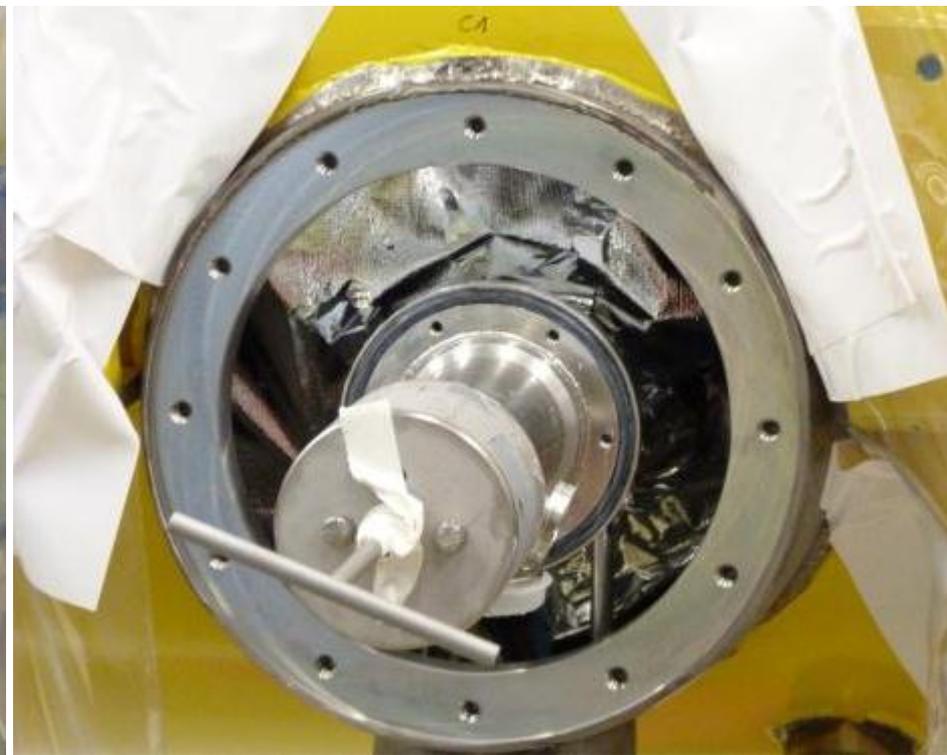
5. Cold Mass insertion (CA-WS1)



5. Coupler Warm Part assembly (CO-WS1&2)

5.a coupler warm part assembly

5.b coupler pumping line assembly



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



PXFEL3_1 CMTB Test

PXFEL3_1

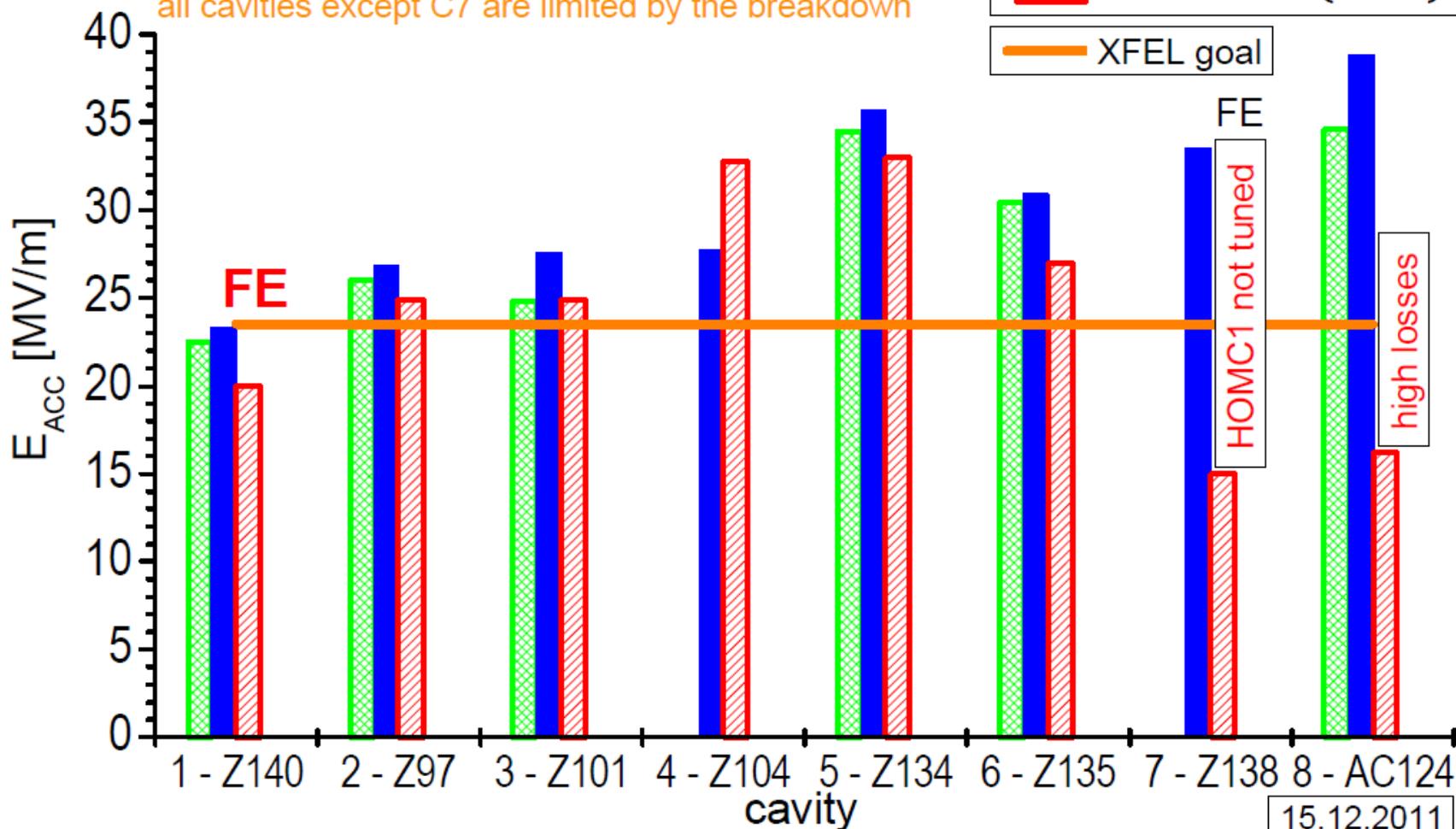
Cavities gradient limits

all cavities except C7 are limited by the breakdown

Cavity tests:

| | | |
|---|----------|--------|
|  | PXFEL3 | (10Hz) |
|  | Vertical | (CW) |
|  | CMTB | (10Hz) |

| | |
|---|-----------|
|  | XFEL goal |
|---|-----------|



15.12.2011

- PXFEL3_1 : cavity 1 (FE) and cavity 8 (HL) do not reproduce their VT performances. The causes is not identified:
 - coupler contamination through common waveguide box ?
 - particulate contamination during string assembly ?
 - shocks during transport CEA-DESY: (4g on frame, 1g on cryomodule) + (2g on frame ,2g on CM) events ?

⇒ Vibrations will be recorded during cold mass assembly and transfers on PXFEL2_2
- PXFEL3_1 : cavity 7 HOM2 badly tuned, lesson learned:

⇒ a successful RF measurement and HOM tuning campaign took place on PXFEL2_2 cavity string during Week 18, with the help of DESY and AMTF colleagues.

Acceptance Data Package

During the prototype phase, development of the quality assurance and quality control through the Acceptance Data Package (ADP) including:

- the certificate of conformity,
- the “as-built” configuration,
- the traveler,
- the test reports
- the non-conformities reports.

PXFEL2_2 ADP was built following our experience and needs, and it was delivered to DESY with the CM on Sept 4th, 2012 for approval.

The second CM acceptance stage will be based on the RF test at DESY.

Six NCR recorded for PXFEL2_2 string assembly

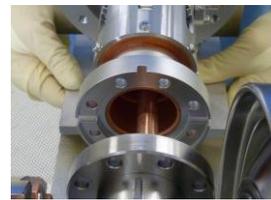
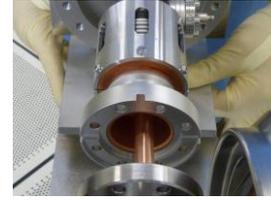
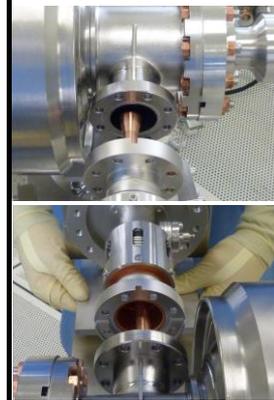
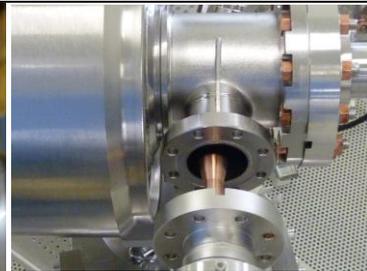
PROJET XFEL

ETAT DES NON CONFORMITES - NON CONFORMANCE STATUS

| NCR number | Model | Sub-assembly | Serial number | WS | MAJ /min | Date | Object | Corrective Action Status | Final Decision Date | Final Decision | Rédacteur |
|---------------------|-----------|------------------|-----------------|-----------|----------|------------|---|--------------------------|---------------------|----------------|------------|
| CEA-XFEL-RNC-11-011 | PXFEL 2_2 | Cavity | AC 147 | Reception | | 08/12/2011 | Orientation of the angle valve + pin of the HOM2 connector + vacuum above 10-5 mbar @ reception | | | quarantine | |
| CEA-XFEL-RNC-12-012 | PXFEL 2_2 | Cavities | AC150 & AC149 | ISO 4 CC | | 10/02/2012 | Water behind the flange of the elbow valve | | | use as is | |
| CEA-XFEL-RNC-12-013 | PXFEL 2_2 | Coupler | AC3C2 | ISO 4 CC | | 20/02/2012 | Coupler Antenna tilted | | | quarantine | |
| CEA-XFEL-RNC-12-014 | PXFEL 2_2 | Cavity | AC 150 | ISO 4 CC | | 20/02/2012 | Problem on cavity venting with UP34 | | | use as is | C.Madec |
| CEA-XFEL-RNC-12-015 | PXFEL 2_2 | Couplers | CP3C45 & CP3C46 | ISO 4 CC | | 22/02/2012 | Remise à la PA rapide | | | use as is | S.Berry |
| CEA-XFEL-RNC-12-016 | PXFEL 2_2 | Coupler / cavity | CP3C57 / Z 162 | ISO 4 CC | | 22/02/2012 | Outils monté à l'envers / pour pouvoir démonter l'outillage nécessitant d'enlever le coupleur. | | | | B.Visentin |

| Irfu | | European XFEL | | NON CONFORMANCE REPORT / CHANGE REQUEST | | Reference |
|--|-------------------|---------------------------|--------------------|---|----------------|--------------------------|
| EQUIPMENT: | | coupler | SERIAL NUMBER: | AC3C2 | FILLED OUT BY: | C. MADEC |
| Occurrence phase: | | Reception: | Integration level: | | Workstation: | |
| Control: | | Acceptance: | Part: | | CO | |
| Manufacturing: | | Destockage: | Subassembly: | | | |
| Design/validation: | | Others: | Equipment: | | | |
| Integration: | | Others: | | Others: | | |
| TITLE : Coupler antenna tilted | | | | | | |
| DESCRIPTION : | | | | | | |
| The coupler antenna is tilted in the horizontal plane, the coupler being in the support frame ready for connection to the cavity. The bellow holders were in position and tighten. | | | | | | |
| Reference documents : | | | | | | |
| TECHNICAL INVESTIGATIONS : | | | | Responsible (s) | | |
| The tilt of antenna axis was estimated at the half of the slot flange (for the leak test) i.e. 2.5 mm at the top of the antenna the tilt was about approximately 4 mm (cf. drawing page 4). | | | | | | |
| CORRECTIVE ACTIONS (equipment concerned by NCR/CR) : | | | | Responsible (s) : | | CLASS : |
| On Friday 17th, we dismantled the coupler AC3C2 from the cavity Z141 and checked the antenna (pictures page 2, during disassembly). The coupler is now mounted back on a TWG. | | | | | | MINOR : |
| | | | | | | MAJOR : |
| | | | | | | FINAL DECISIONS : |
| | | | | | | USE AS IS |
| | | | | | | WAIVER |
| PREVENTIVE ACTIONS (further equipment) : | | | | Responsible (s) : | | DOCUMENTATION CHANGE |
| | | | | | | REPAIR |
| | | | | | | SCRAP |
| | | | | | | MODIFICATION |
| | | | | | | ACTION ON OTHER PRODUCT |
| Clearance for actions | Technical Manager | Quality assurance Manager | Project Manager | | | |
| Unit responsible of involved product : | | | | | | |
| Upper level manager : | | | | | | |

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| Upper level manager : | | | | | | |



Example:

tilted coupler antenna

Assembly Industrialization

Assembly Industrialization

Contract for 103 CM integration awarded to ALSYOM in July 2012.

- The first phase (until Dec 2012), consists of :
 - the observation by ALSYOM of the assembly by CEA of the first pre-series cryomodule (XM-3)
 - the deployment of their industrial method based on the outputs of the prototyping
 - the set-up of the storage area,
 - the ERP (entreprise resource planning) parameterization
- The second phase :
 - training of the company team attended by the CEA team on the assembly of the second and third pre-series modules XM-2 and XM-1.
- The third phase : From XM1 on,
 - ALSYOM in charge of the series module assembly.
 - six months ramp-up period to reach the production rate of 1 CM per week.

CONCLUSIONS

The CM factory is ready to start the assembly of the XM-3 pre-series XFEL cryomodule on September 17th, 2012.