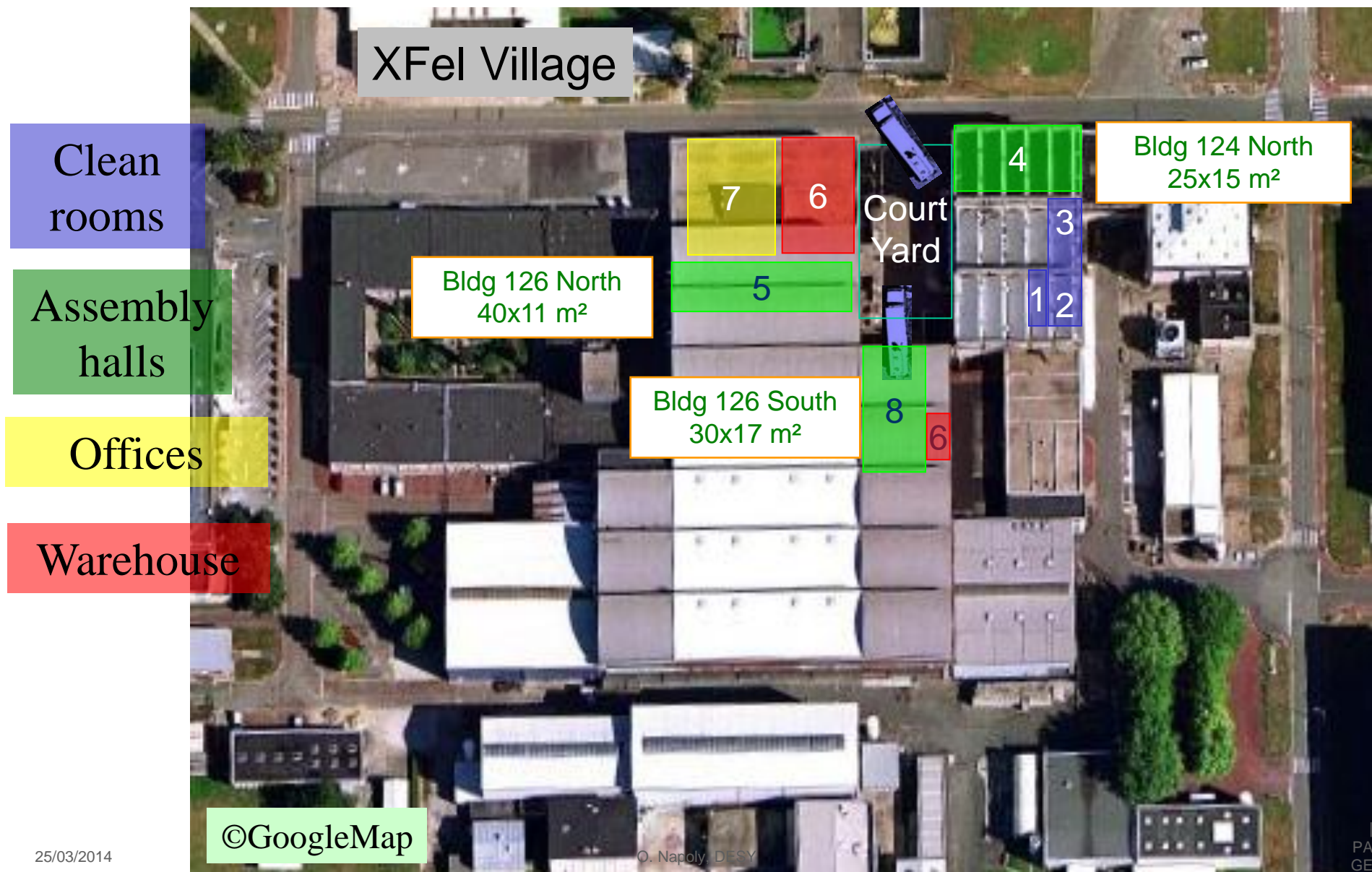


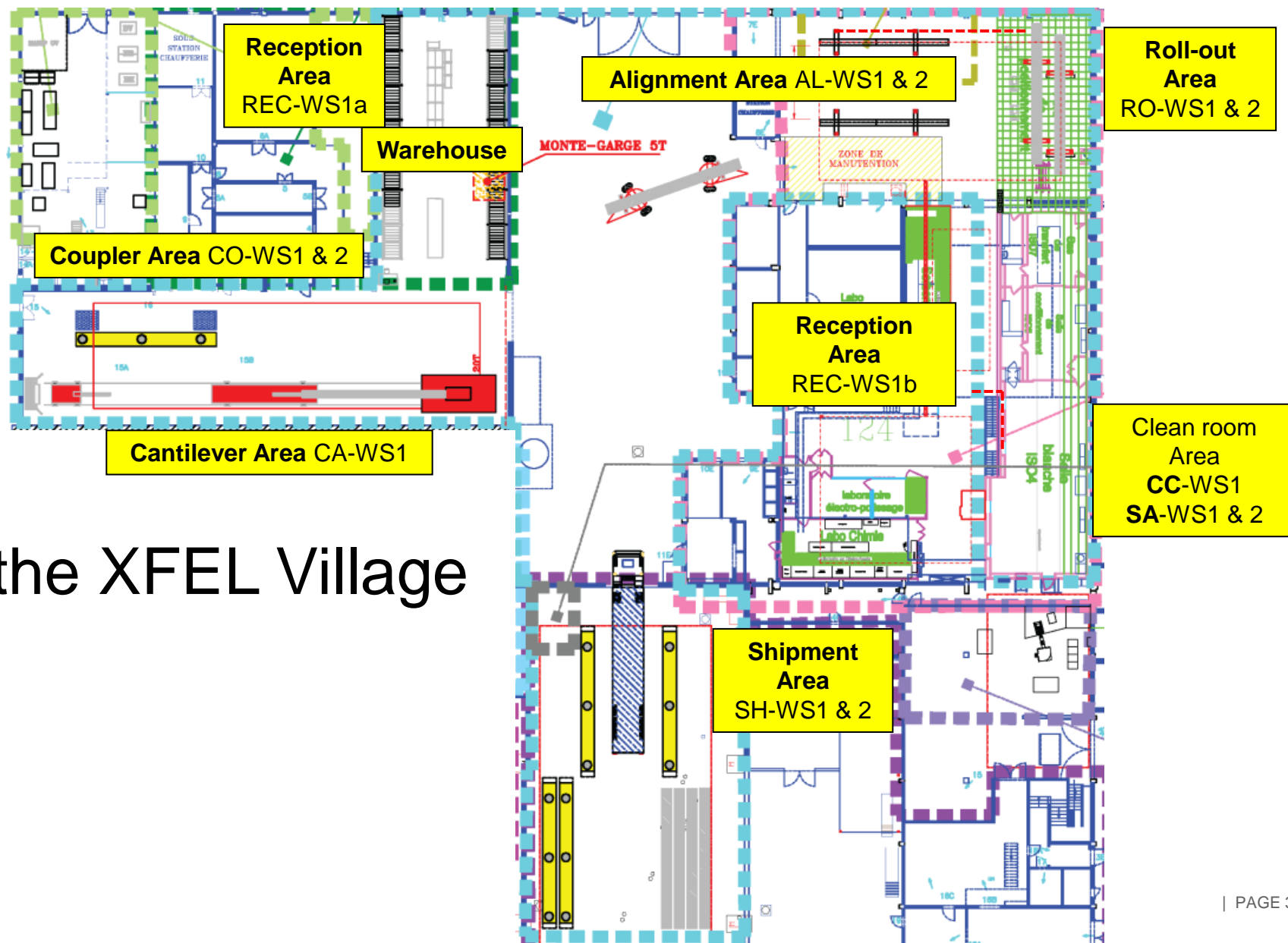
# XFEL Cryomodule Assembly : Industrial Execution



# Assembly Infrastructure: pre-built by CEA for company exploitation



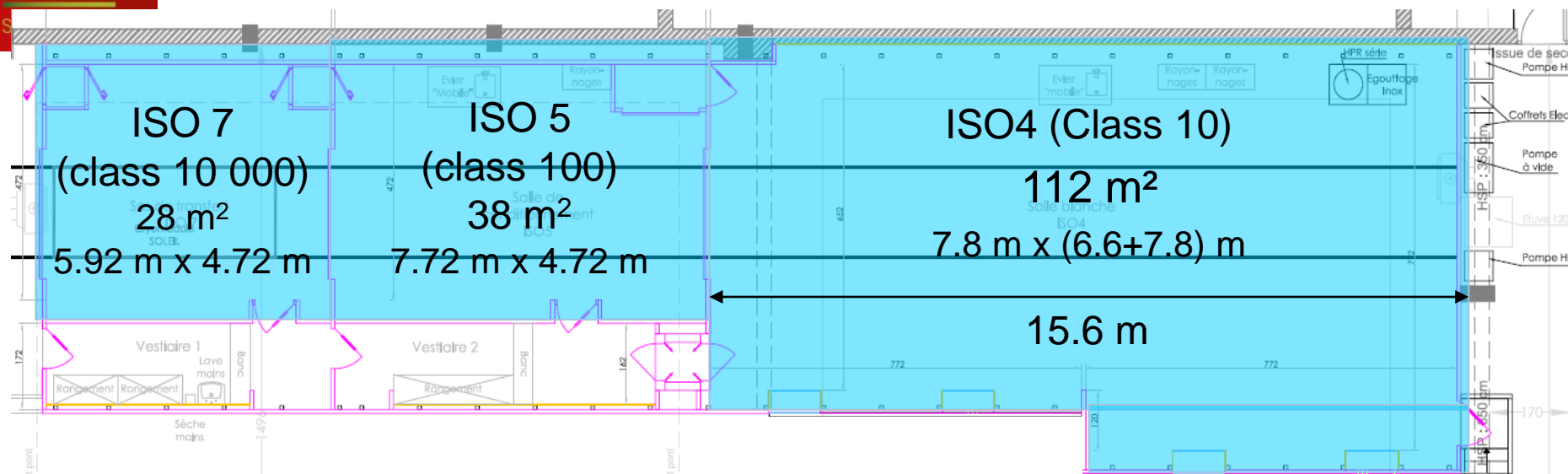
# Pre-Built Workstations in assembly halls



the XFEL Village



# Pre-Defined Clean Room Layout



# Organisation of Work Stations

## → breakdown model of assembly operations

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 !*

## Tooling vs. Industrial 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 storage 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

|                                                                                   | @ | CfT | Kick-off | Series |
|-----------------------------------------------------------------------------------|---|-----|----------|--------|
| • Infrastructure and Tooling<br><i>(in the broad sense, e.g. cavity supports)</i> |   | 80% | 90%      | 100%   |
| • Cryomodule Configuration                                                        |   | 70% | 85%      | 100%   |
| • Cryomodule Documentation                                                        |   |     |          |        |
| – PBS (or MBOM)                                                                   |   | 30% | 70%      | 100%   |
| – Availability of Drawings                                                        |   | 30% | 70%      | 100%   |
| • Assembly Documentation (WBS)                                                    |   |     |          |        |
| – Availability of Assembly Procedures                                             |   |     |          |        |
| • In English                                                                      |   | 50% | 75%      | 100%   |
| • In French                                                                       |   | 0%  | 0%       | 50%    |
| – Availability of Control Procedures                                              |   | 50% | 75%      | 100%   |
| – Availability of Regulation (PED, Safety)                                        |   | 20% | 50%      | 100%   |
| • Overall Quality of the Process (RF acceptance)                                  |   | 60% | 60%      | 100%   |

*(qualitative %)*

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

**Industry could start production w/o 100% of Input Data in their Resource Planning software (ERP)**

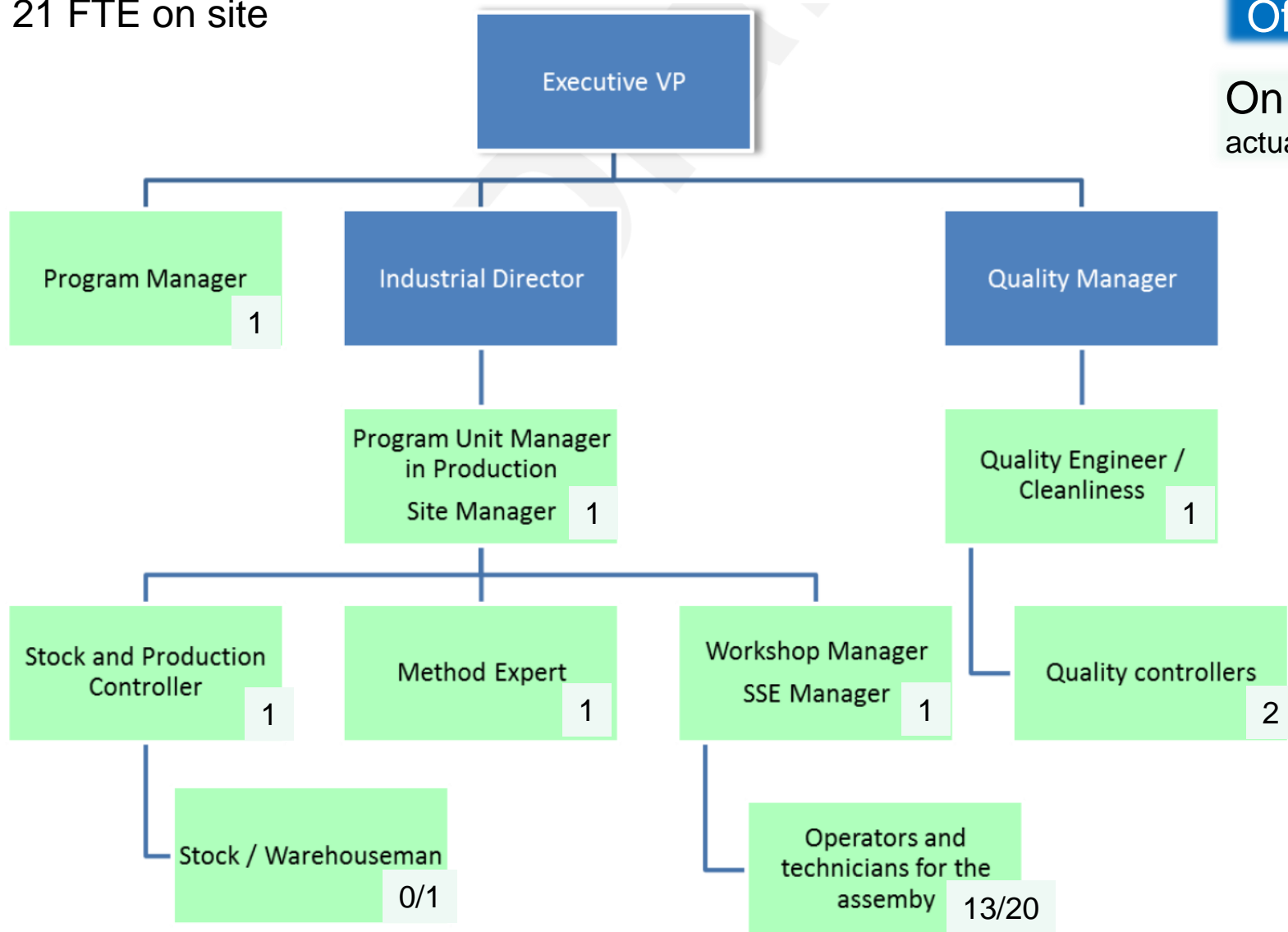
- Tender process: ALSYOM, lowest bidder / best technical offer, has been selected by CEA.
- Up to 29 people will be on Saclay site during ~2 ½ years
- Fields of expertise requested:
  - Management (resource planning, stock, quality)
  - Engineering (method, drawings, tooling)
  - Clean room and cleaning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





**XM-1 and XM1 on Roll-Out Area during welding investigations**

- 21 FTE on site

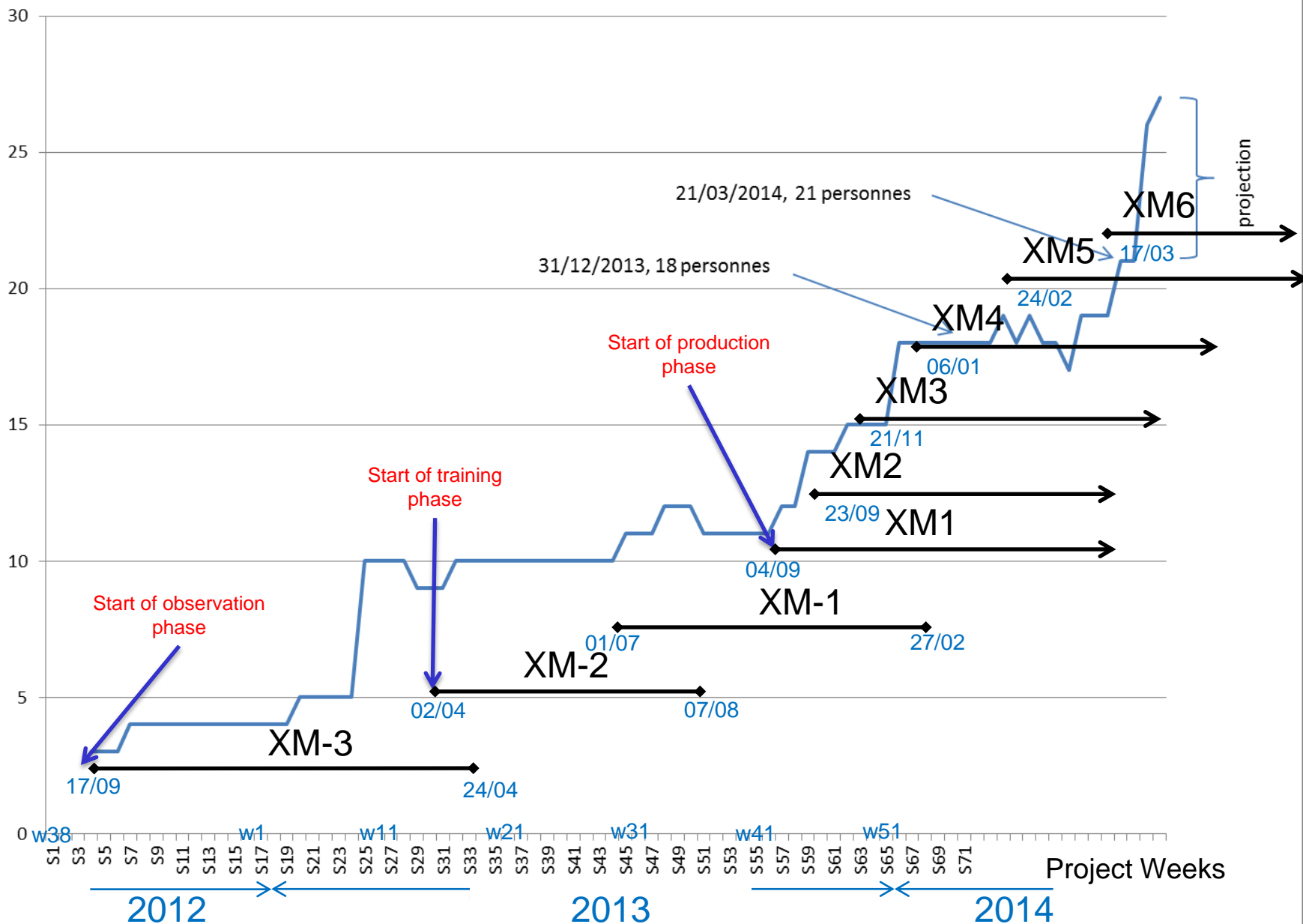


Off site

On site  
actual / foreseen

# ALSYOM Staff EVOLUTION & Planning

ALSYOM Staff only  
SEIV not incl.



## Technical Specification for XFEL Cryomodule Assembly

**REFERENCE :**

CEA-XFEL-TS-00001-01

Page : 99/99

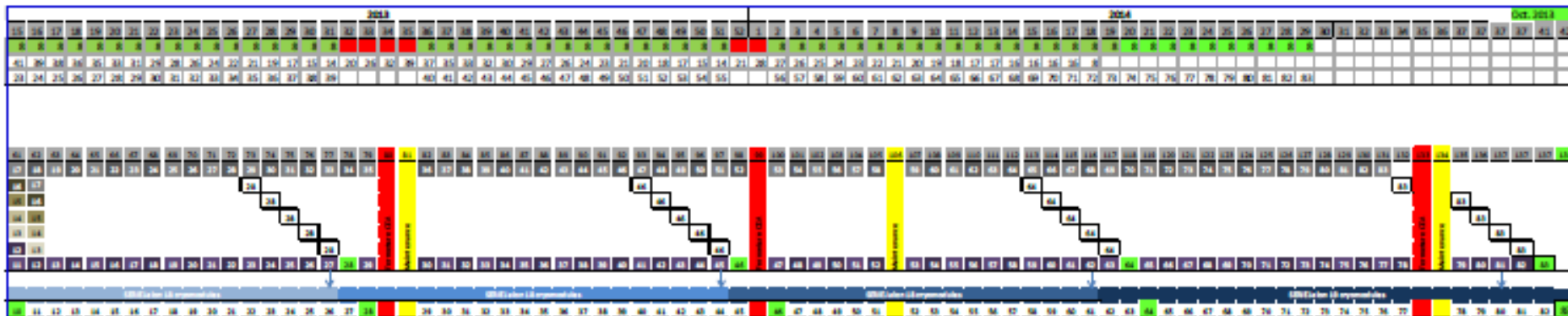
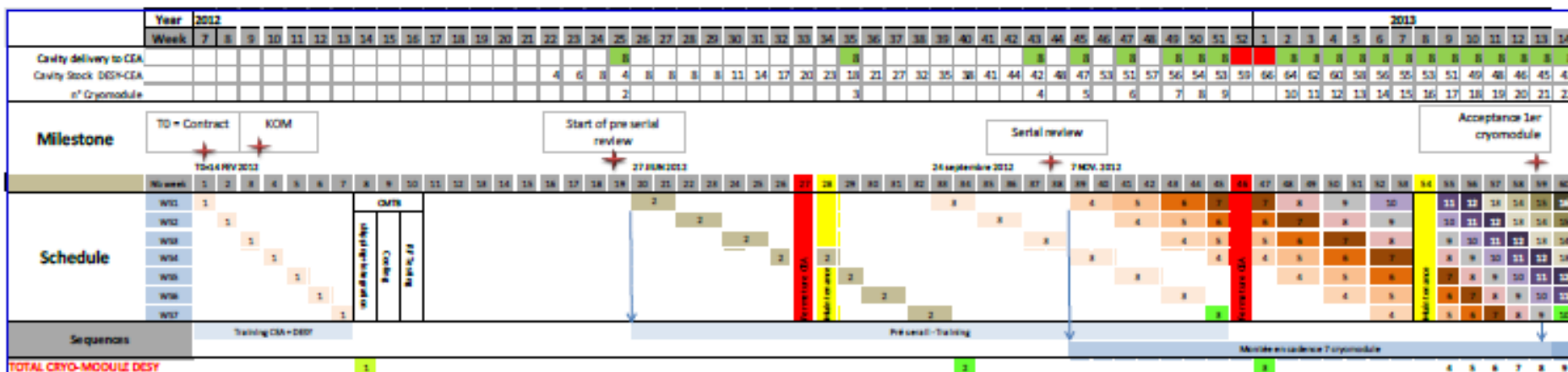
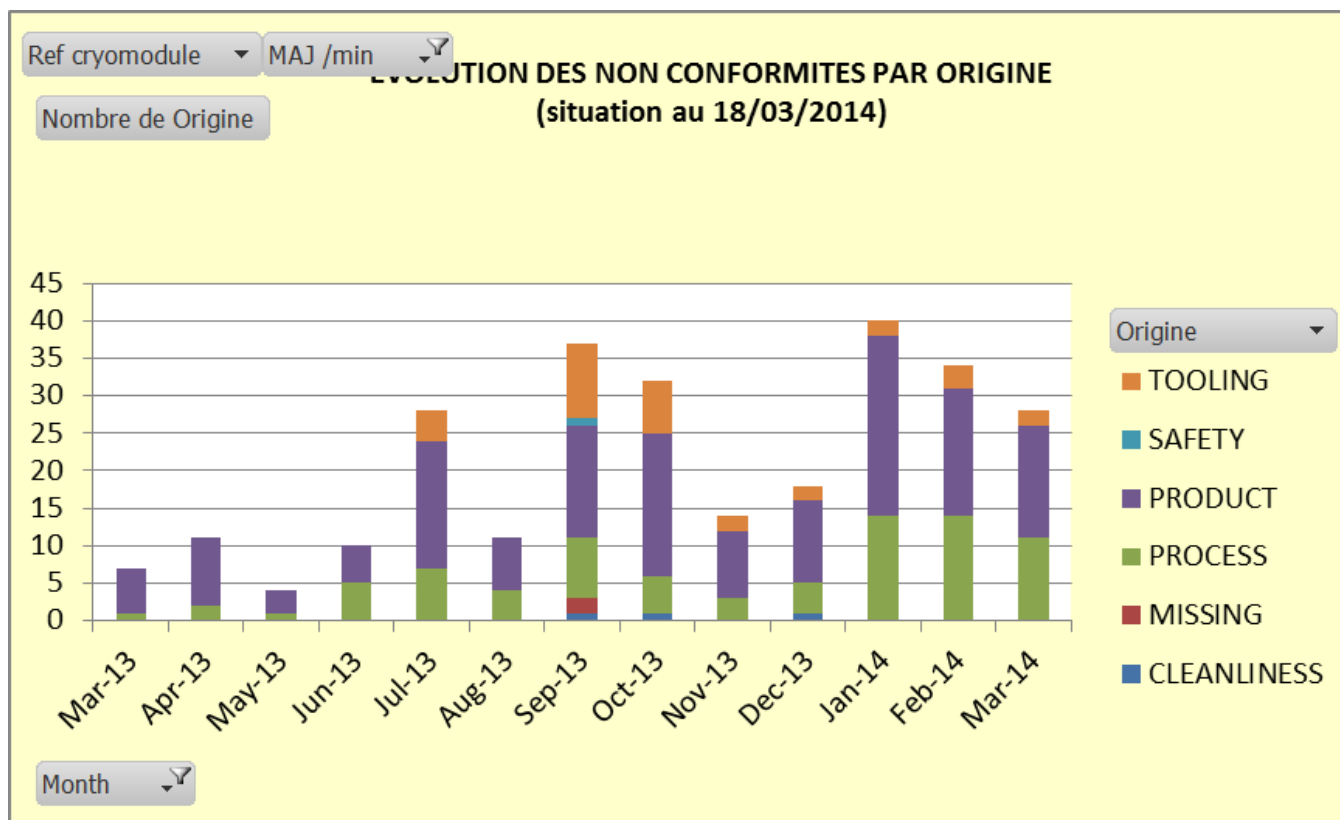


Figure 12-1 : schedule of the assembly according with the availability of cavity.



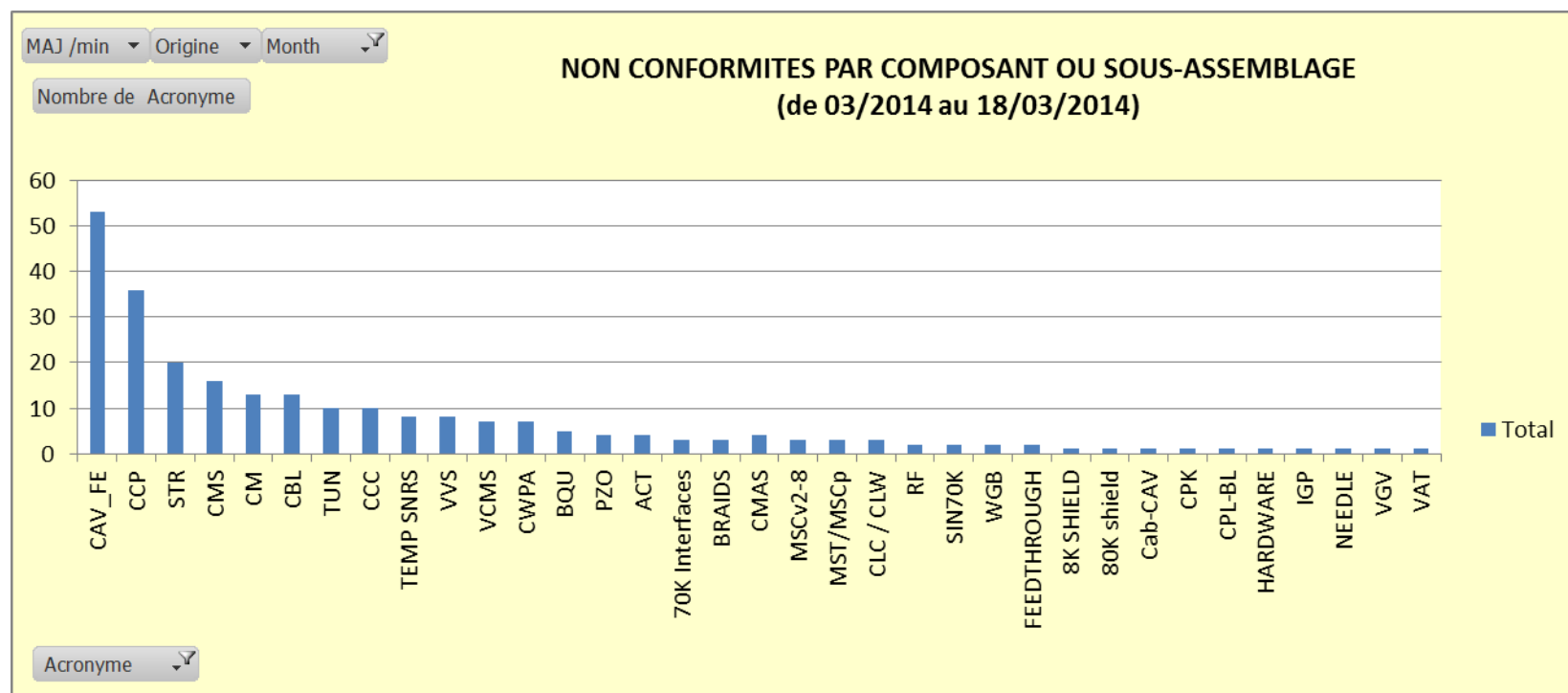
# ETAT DES NON-CONFORMITES - XFEL CRYOMODULE

## EVOLUTION DU NOMBRE DE NON CONFORMITES



# ETAT DES NON-CONFORMITES - XFEL CRYOMODULE

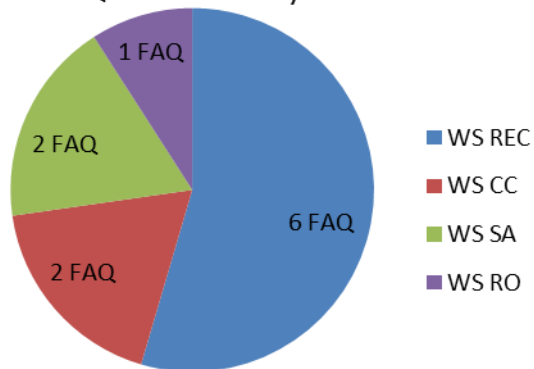
## REPARTITION DES NON CONFORMITES (FAQ) PAR COMPOSANTS (CUMUL DE 03/2013 au 18/03/2014)



# 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    |

FAQ distribution by Work Station



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

# ETAT DES NON-CONFORMITES - XFEL CRYOMODULE

## REPARTITION DES NON CONFORMITES PAR CRYOMODULE

