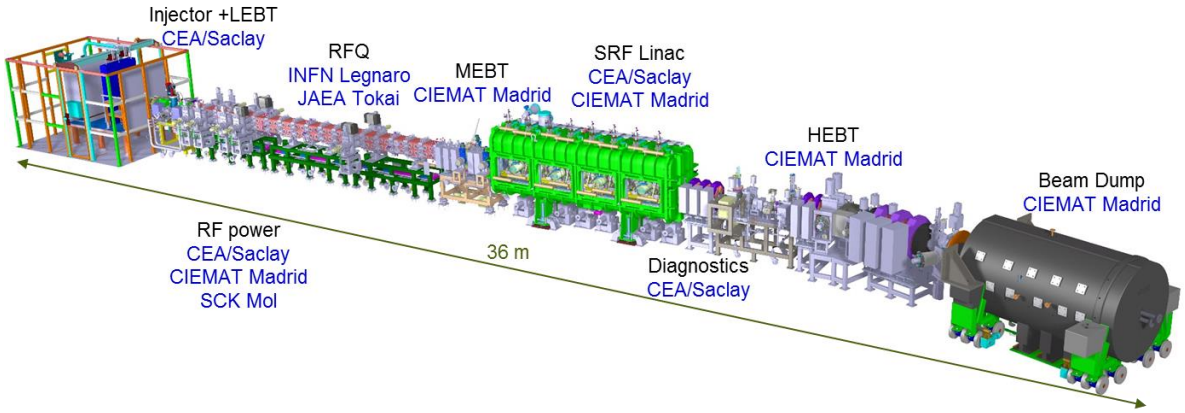
DE LA RECHERCHE À L'INDUSTRIE

ASSEMBLY OF THE IFMIF CRYOMODULE



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On behalf of the SRF-Linac Team

TTC Meetting - June 5th – 8th, Saclay

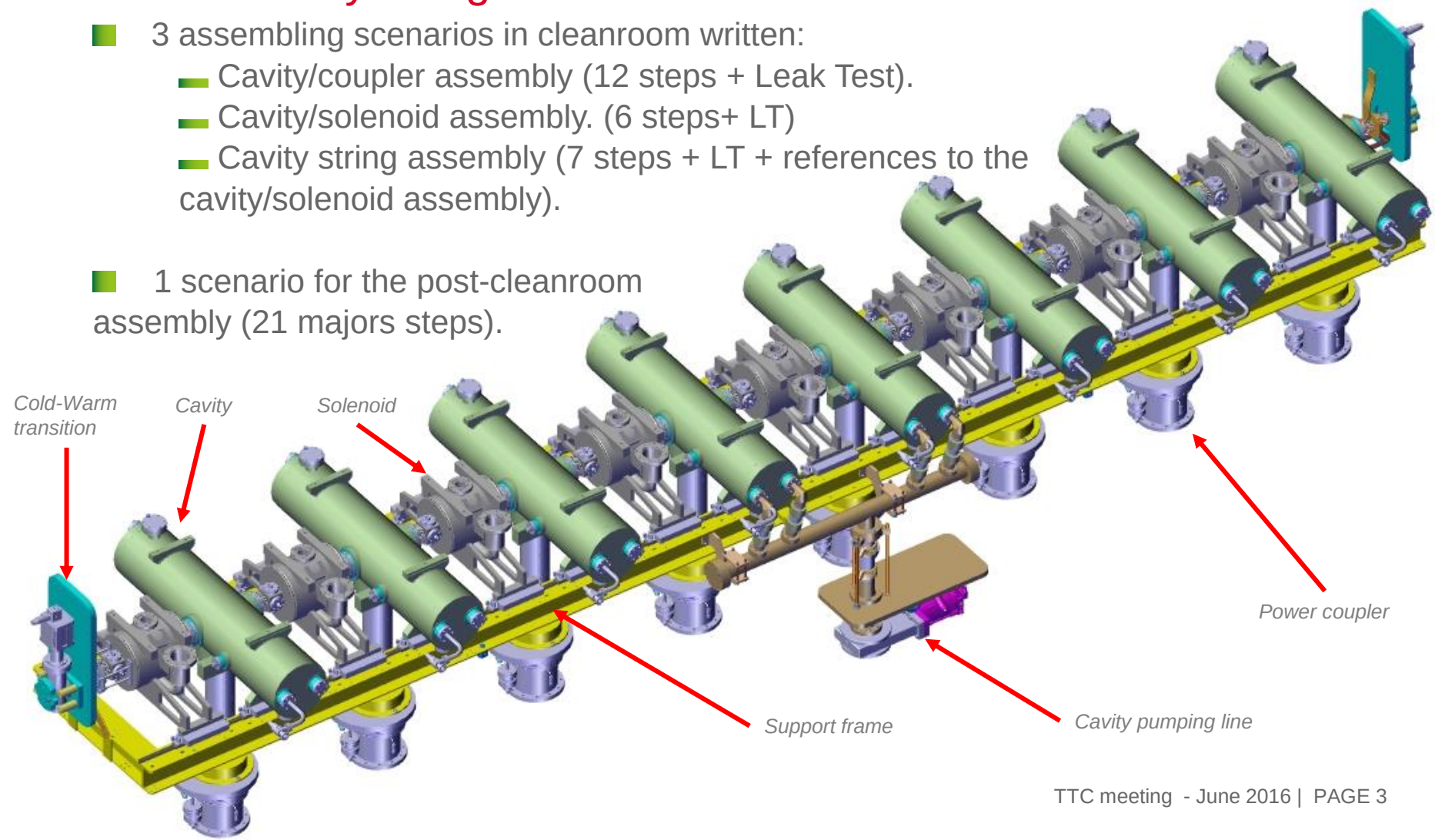
www.cea.fr

CONTENT

THE IFMIF CAVITY STRING

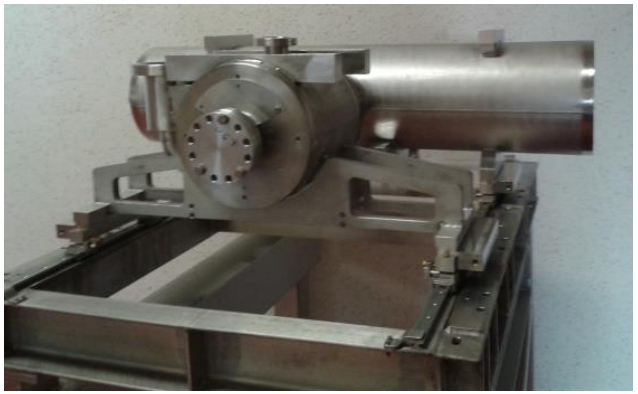
Cavity string

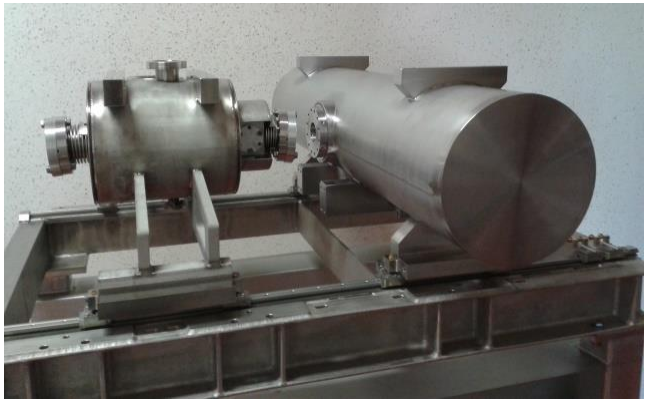
- 3 assembling scenarios in cleanroom written:
  - Cavity/coupler assembly (12 steps + Leak Test).
  - Cavity/solenoid assembly. (6 steps+ LT)
  - Cavity string assembly (7 steps + LT + references to the cavity/solenoid assembly).
- 1 scenario for the post-cleanroom assembly (21 majors steps).

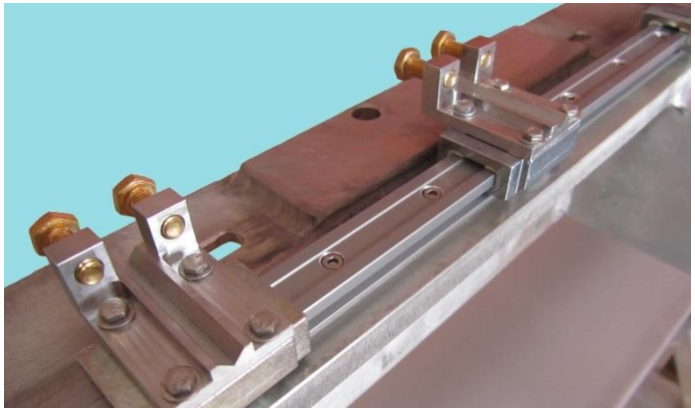


TEST AND TRIAL ON CAVITY STRING ELEMENTS

- To validate and / or improve the clean room assembly procedure and the associated tools a test bench as realistic as possible was needed.
- A frame, a little bit bigger than one eight of the final support and equipped with linear guides and the positioning system, was manufactured.
- Because of the late delivery of the final elements, a dummy cavity, a dummy solenoid and a dummy coupler were manufactured.







Auxiliary linear guide assembled on the support frame with two carriages equipped with positioning adjustment elements

TEST AND TRIAL ON CAVITY STRING ELEMENTS

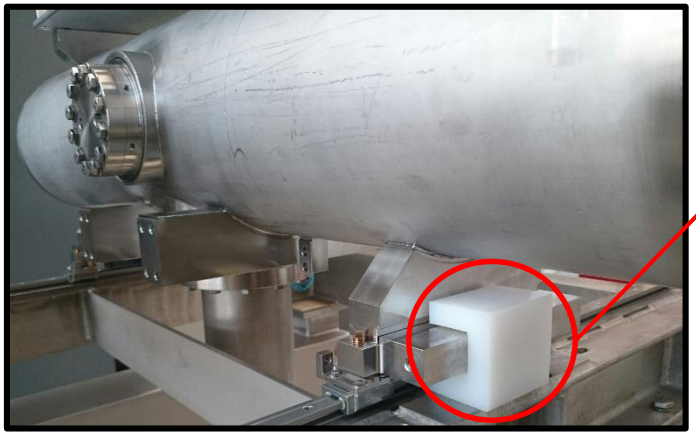
BPM's buttons of solenoid packages

- Cleaning test done in cleanroom ISO class 5.
- Ultra sonic bath + Ultra Pure Water (UPW) rinsing.
- Blowing with N_2, and particle courting.
  ⇒no particle emission after 1 min.

Checking the cleanliness

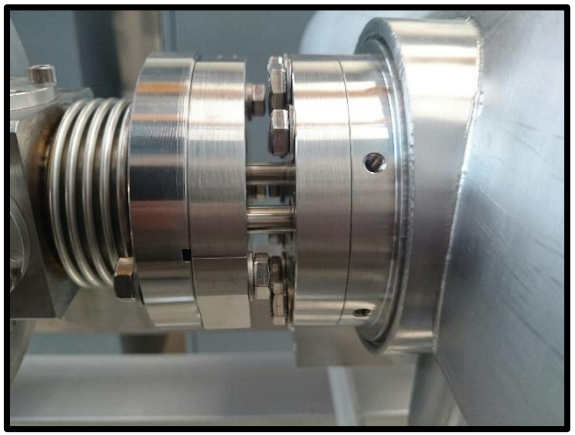
Trial Assembly outside the cleanroom

- Test the assembly procedure of a solenoid and a cavity equipped with its coupler.
- Tests were carried out with mock-ups.
- Led to some improvements (new adjustment screws, C-templates, carriages without slack)



Positioning of the cavity with the C-template

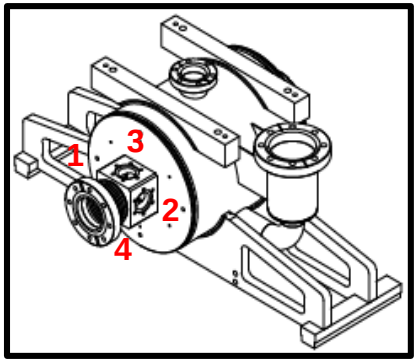
Calibrated gauges are used to with the C-template when positioning



Alignment flanges

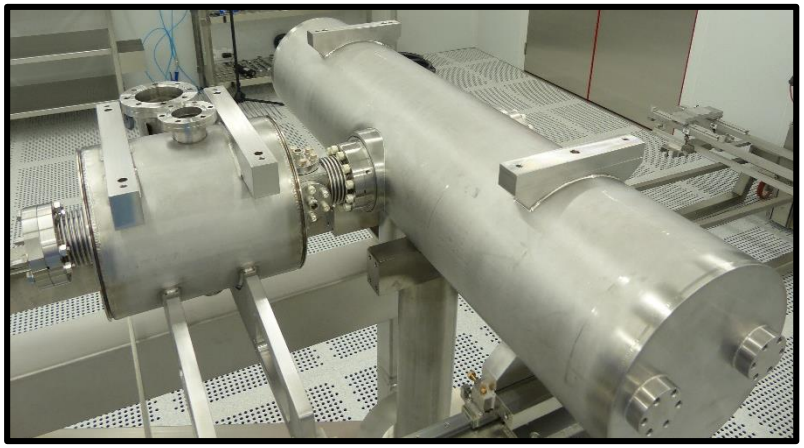
Trial assembly in cleanroom ISO 5

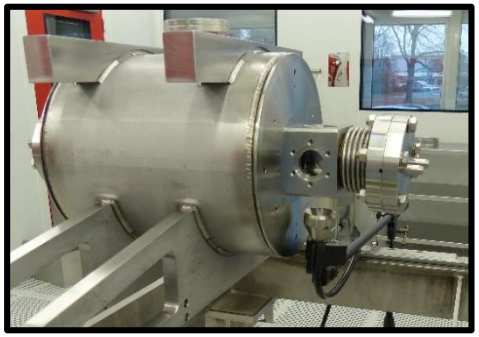
- Assembly of the button on the BPM.
  - Test an assembly sequence and configuration.
  - Despite there was no High Pressure Rinsing done, the monitoring showed good results.
  - To be confirmed on a real solenoid after a HPR.



Assembly sequence of the buttons

- Connection between the solenoid and the cavity (mock-ups).
  - Training outside of the cleanroom was very beneficial .
    ⇒ Quicker positioning and assembly of the elements.
  - The assembly test bench could be use to train the contractor in charge of the assembly.

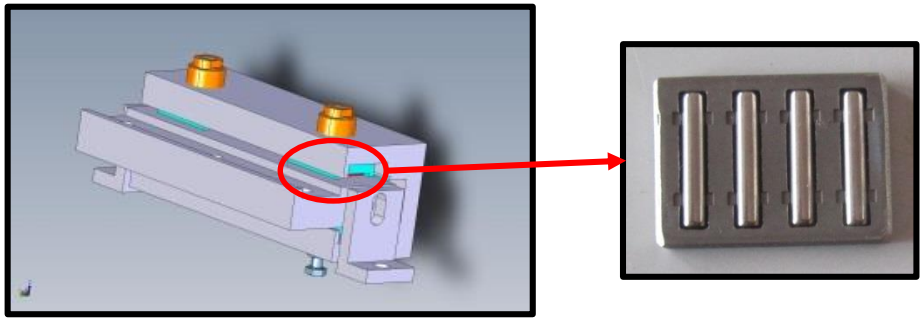

Cavity and solenoid connected


Particle monitoring during assembly of the buttons

TEST ON THE NEEDLE BEARINGS

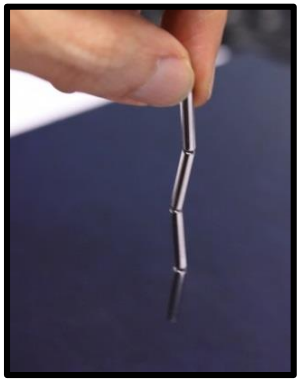
Needle bearings and C-shape elements

- Similar to the one used on X-FEL cryomodule, they allow to manage the thermal contraction of the support frame with respect to the cavity string



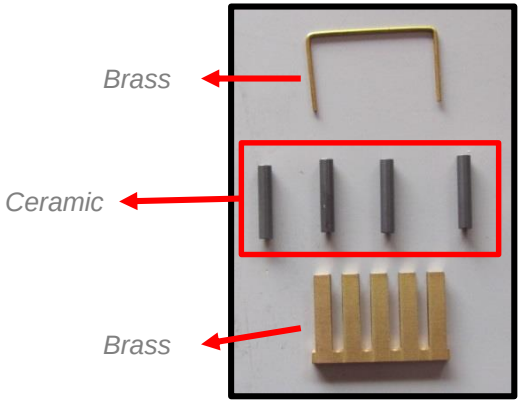
- Original bearings are subject to magnetization

Bearing cage and needles magnetized



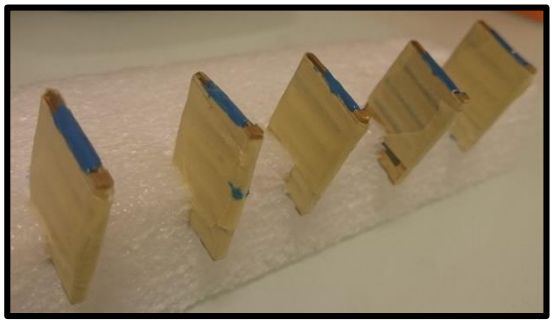
(*see TTC 2014: https://indico.in2p3.fr/event/10347/session/8/contribution/35*)

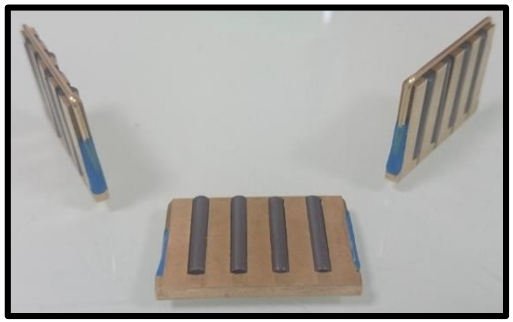
- CEA design new bearing without ferromagnetic materials

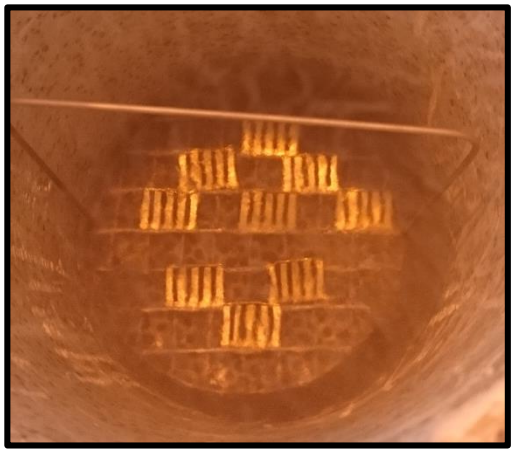


TEST ON THE NEEDLE BEARING

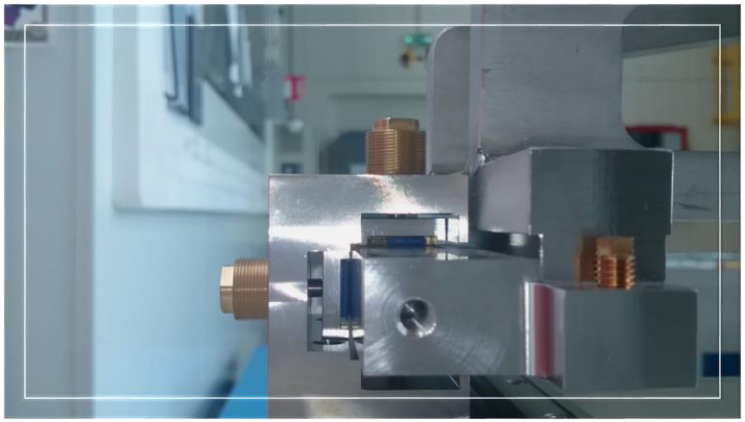
- The cage of the bearing was glued with Stycast®, followed by 3 thermal shocks in liquid N_2 (~77 k).

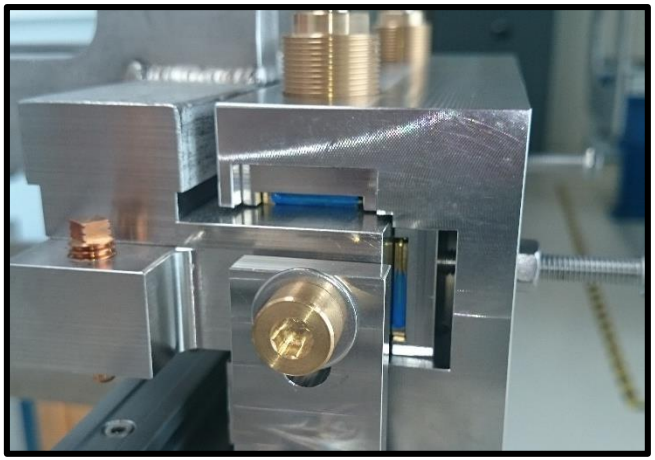






- No defect after the thermal shocks.
- The bearings were tested on the test bench and validated.



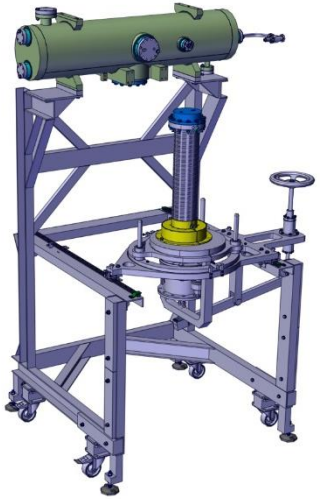


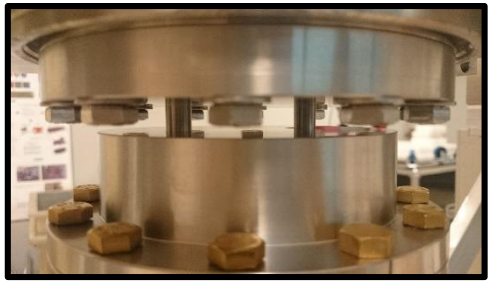
Test on the assembly tooling

- Currently tested with the mock-ups.
- Test on going with threaded shafts replacing bolts.

Level adjustment of the cavity on the tooling

Coupler ready for the fine alignment with cavity





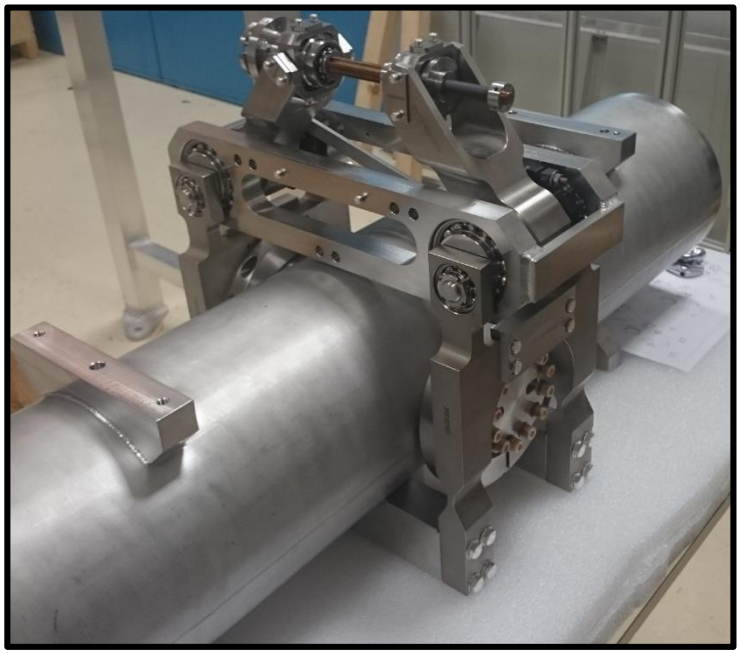
Alignment flanges in correct position

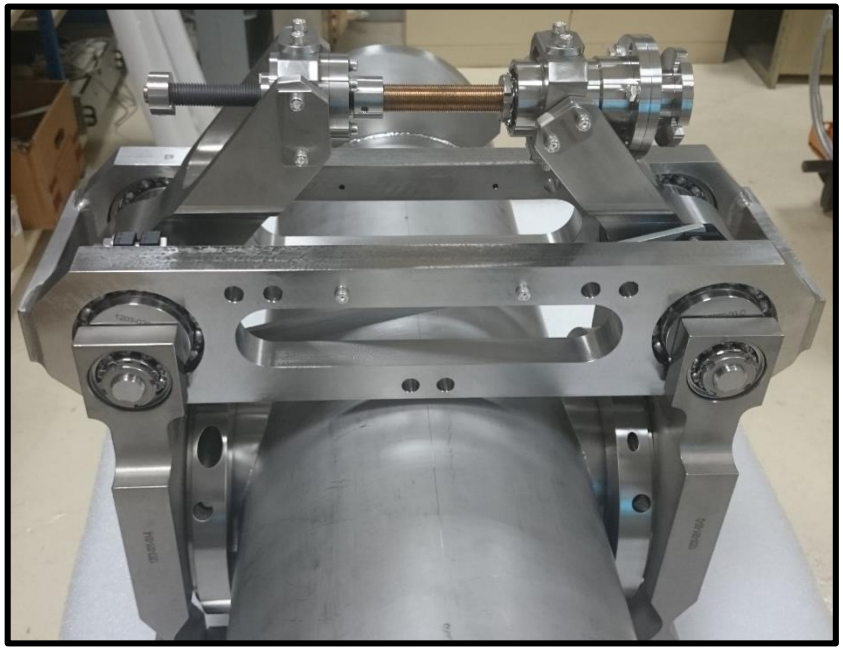
Assembly done

- The scenario will be tested in cleanroom in the frame of SatHori (test stand for a cavity/coupler assembly).
- If validated, this tool could be used for the assembly of the cavity / coupler assemblies of the cavity string.

Assembly of the first tuner

- Checking of the motor stoke and command.
- Trial assembly on the cavity mock-up.



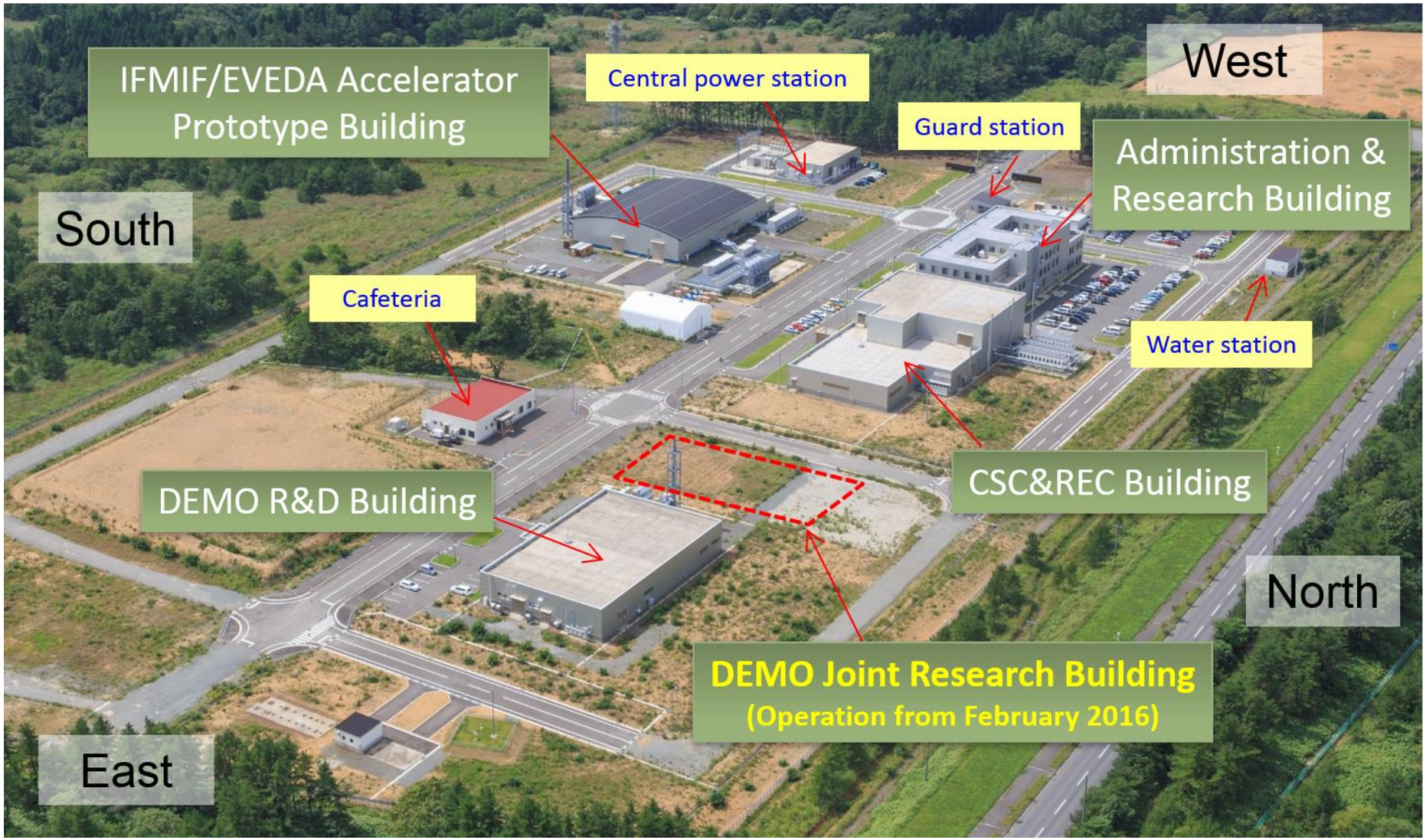


First cavity tuner assembled on the cavity mock-up

Assembly of the cryomodule at Rokkasho

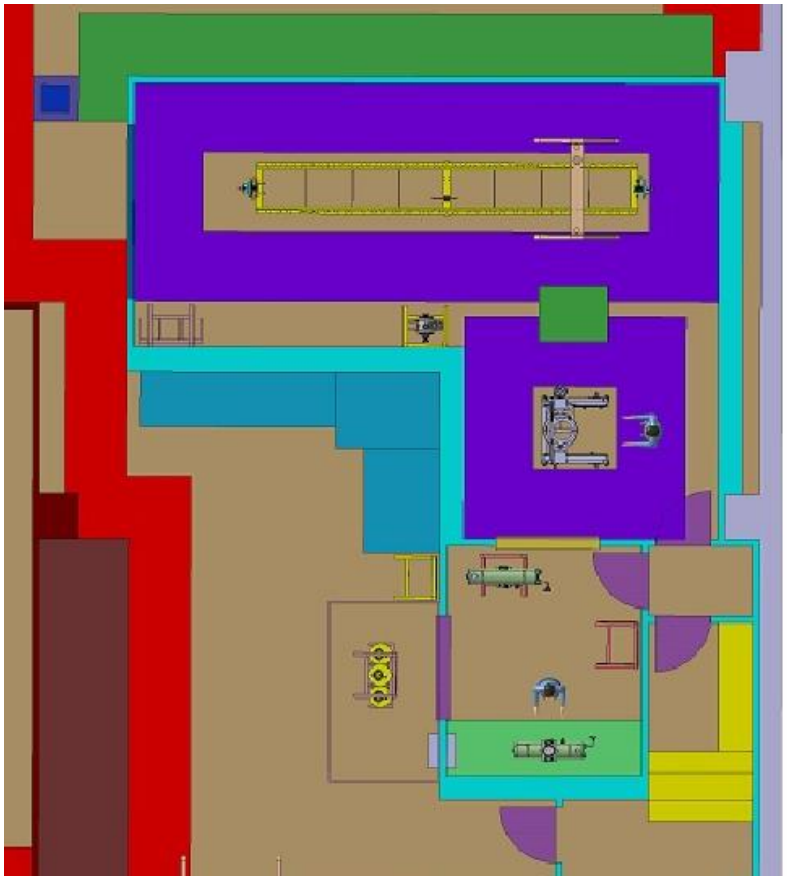
- September 2015: project decision to assemble the cryomodule in Japan, on the QST site at Rokkasho.
- A clean room will built by QST.
- F4E will be in charge of the assembly (sub-contracted), CEA will provide technical assistance.
- Cavities, couplers and solenoids will be validated in Europe, packed in double-sealed bags in ISO 5 before shipment to Japan.
- Cryomodule components (vacuum vessel, thermal shield, support frame, magnetic shield, helium circuitry …) are being manufactured in Europe.

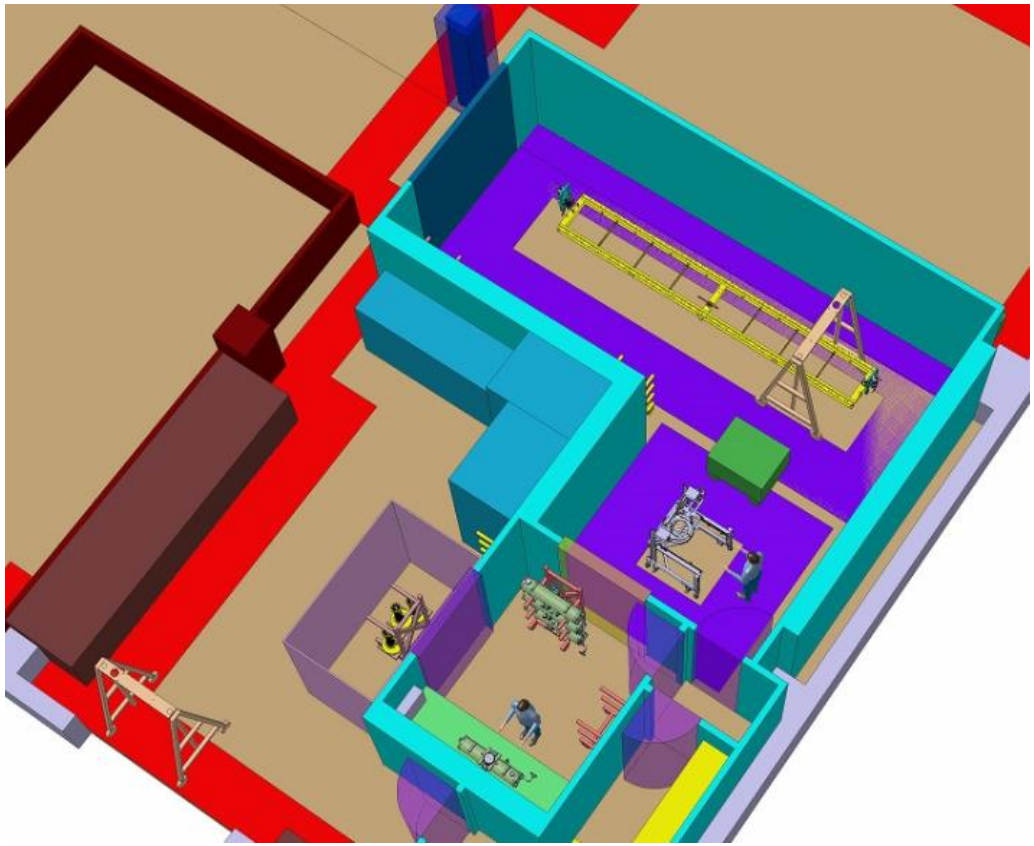
CLEAN ROOM AT ROKKASHO



CLEAN ROOM AT ROKKASHO

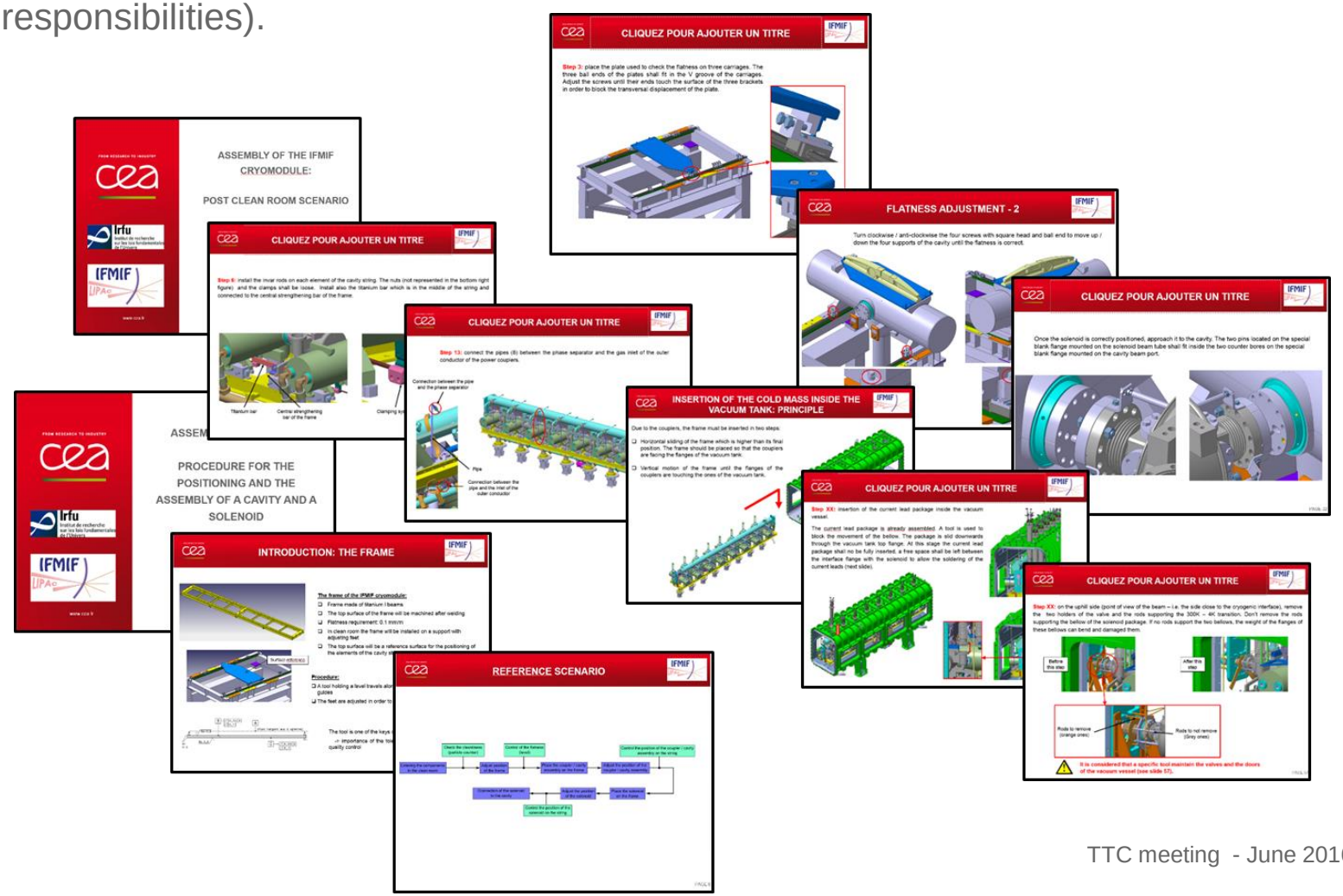
- QST manages the installation of the clean room and associated ancillary equipment.
- F4E and CEA provide technical input for the definition of the clean room requirements, including ancillary requirements.





ASSEMBLY STORYBOARDS

- Based on the assembly tests performed at Saclay, CEA has written assembly storyboards.
- Will be included as annexes in the technical specifications for the assembly contract (F4E responsibilities).



CONCLUSION

- Manufacturing the cryomodule components in Europe and assembling it in Japan is challenging.

- Importance of the quality control:
  - No workshop available at Rokkasho during the assembly.
  - Strong control during factory acceptance: every tapped hole shall be controlled on every component.
  - Every possible assembly should be tried before shipping to Japan (ex: magnetic shield in the vacuum vessel).
  - Magnetic hygiene: permeability control on every component close to the cavities.

- To prepare the clean room assembly, CEA performed assembly tests using mock-ups. These one could be used by the assembly contractor to train the operators.

Thank you for your attention

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