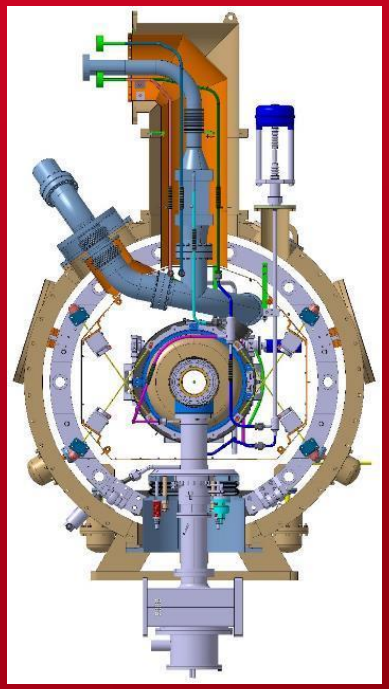
DE LA RECHERCHE À L'INDUSTRIE

cea



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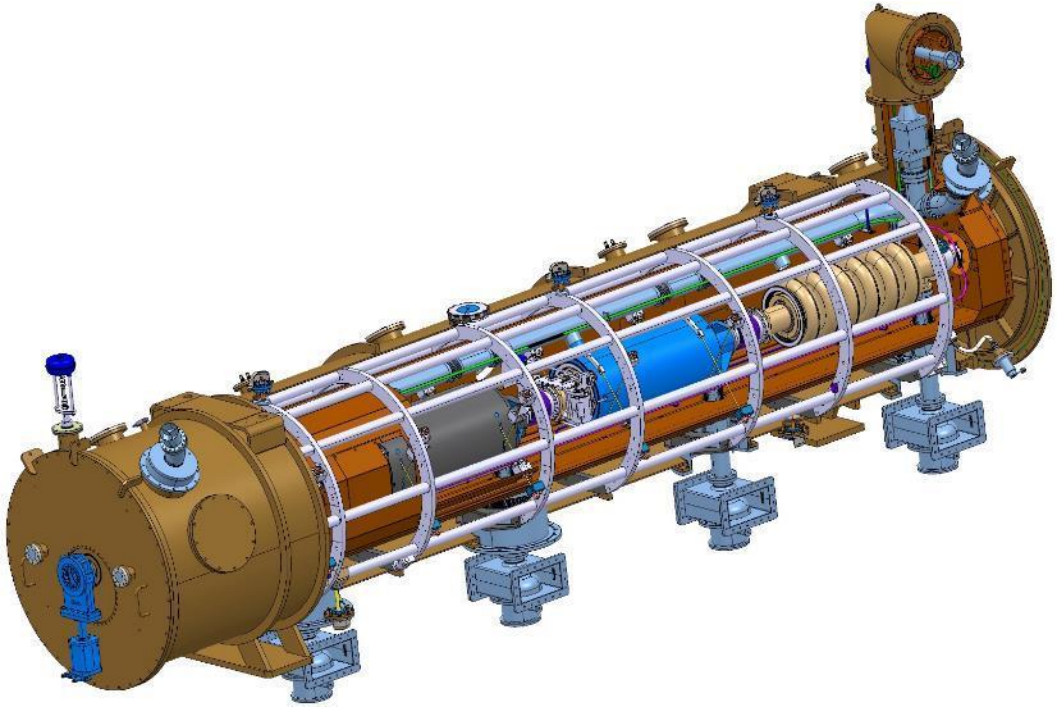
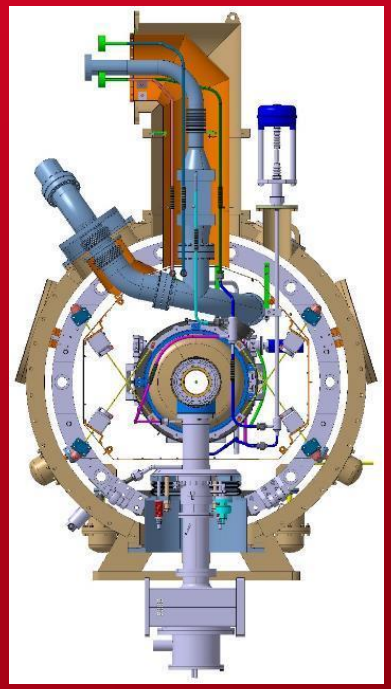
MODULE ASSEMBLY:

FROM ESS TO PIP-II



DE LA RECHERCHE À L'INDUSTRIE



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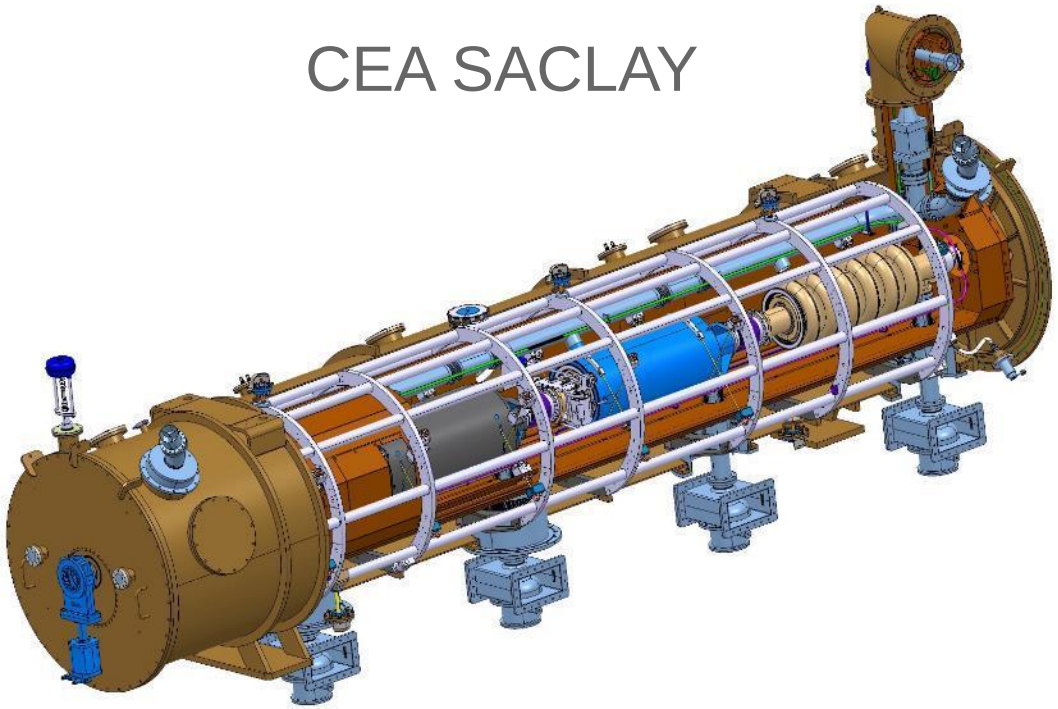
PREPARATION OF THE PRODUCTION OF THE 30 ESS ELLIPTICAL CRYOMODULES IN CEA SACLAY

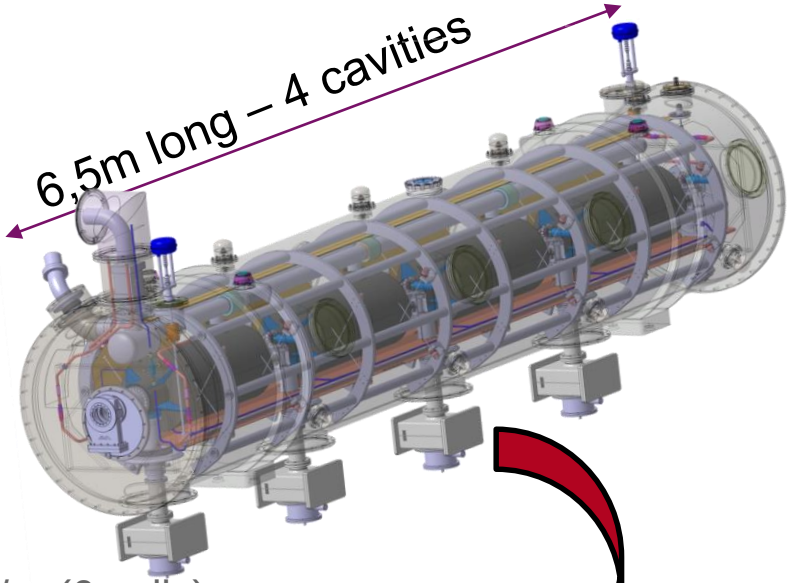


INTRODUCTION

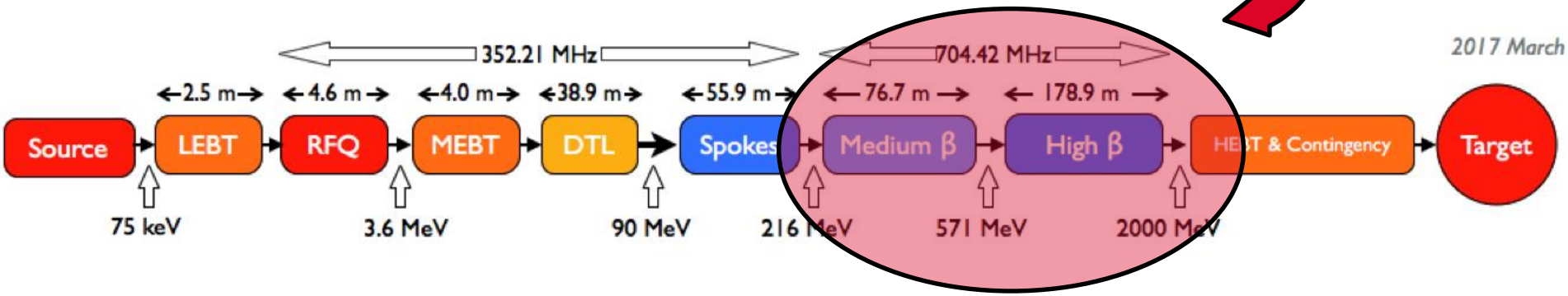
- As part of the ESS project CEA is in charge of assembling 32 elliptical Cryomodules including 2 demonstrators

- 2 Demonstrators
  - 1 cryomodule medium beta
  - 1 cryomodule high beta

- 30 series cryomodules
  - 9 cryomodules medium beta
  - 21 cryomodules high beta



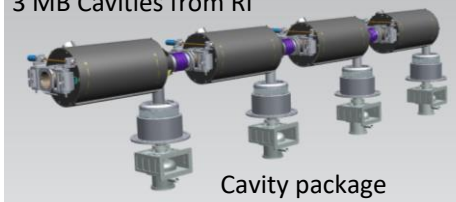
- MB cavity accelerating gradient = 16,7 MV/m (6 cells)
- HB cavity accelerating gradient = 19,9 MV/m (5 cells)



THE ACTORS OF THE CM PRODUCTION

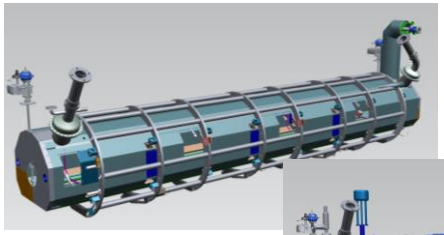
CEA

3 MB Cavities from RI



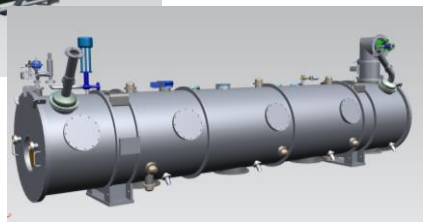
Cavity package

IPN



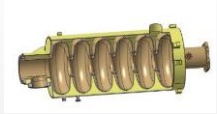
Cryostat

(inspired from JLAB/SNS)



INFN

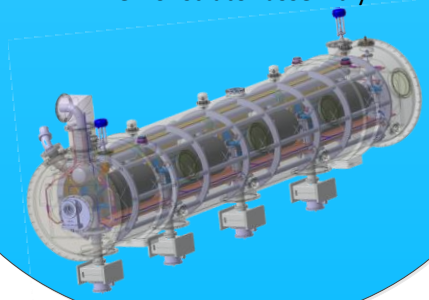
1 MB Cavity



ZANON

CEA Saclay

MB Demonstrator assembly



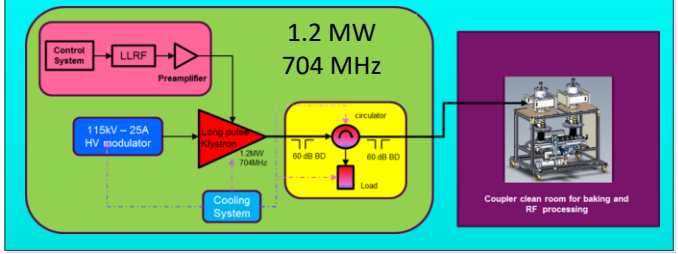
1 MB PROTOTYPE

CEA

CM RF power test stand
At Saclay

CEA

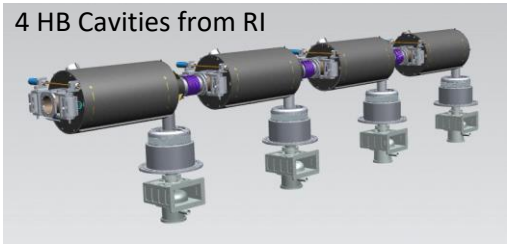
High Power RF Test Stand for
coupler conditioning at Saclay

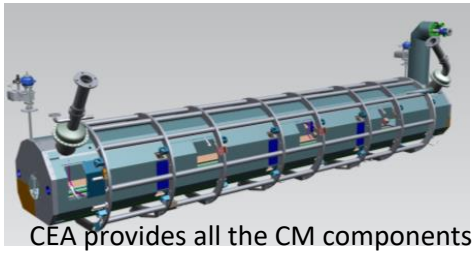


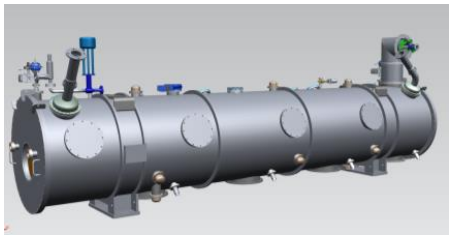
THE ACTORS OF THE CM PRODUCTION

CEA

4 HB Cavities from RI



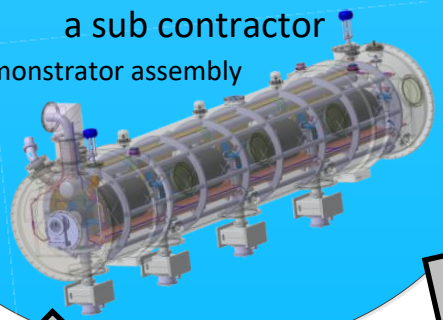




CEA provides all the CM components

CEA Saclay
And partially
a sub contractor

HB Demonstrator assembly



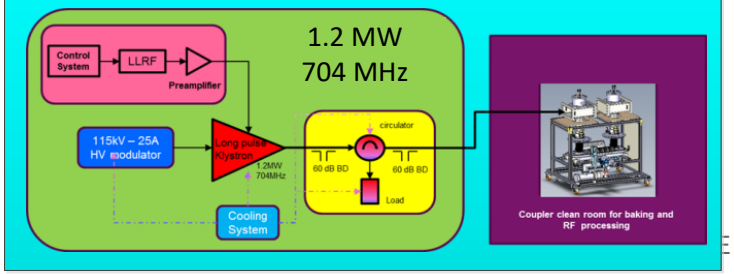
1 HB PRE-SERIES

CEA

CM RF power test stand
At Saclay

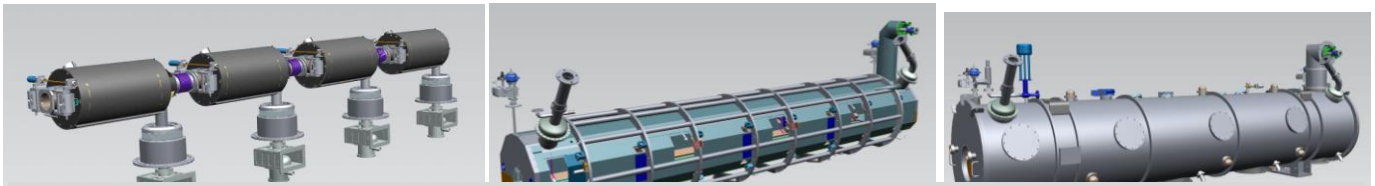
CEA

High Power RF Test Stand for
coupler conditioning at Saclay



THE ACTORS OF THE CM PRODUCTION

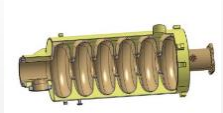
CEA



CEA provides all the CM components except the cavities

INFN

36 MB Cavities

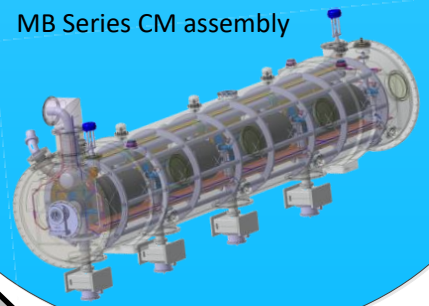


ZANON

ESS Cavity acceptance

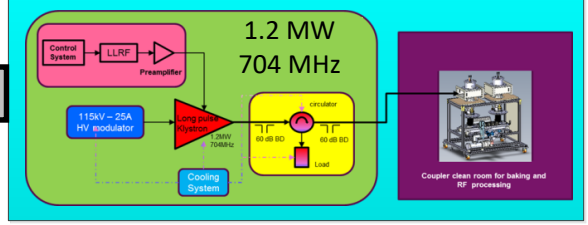
CEA Saclay sub contractant

MB Series CM assembly



CEA

High Power RF Test Stand for coupler conditioning at Saclay



3 first CM

CEA

CM RF power test stand At Saclay

9 MB Series Elliptical Cryomodules

ESS Lund

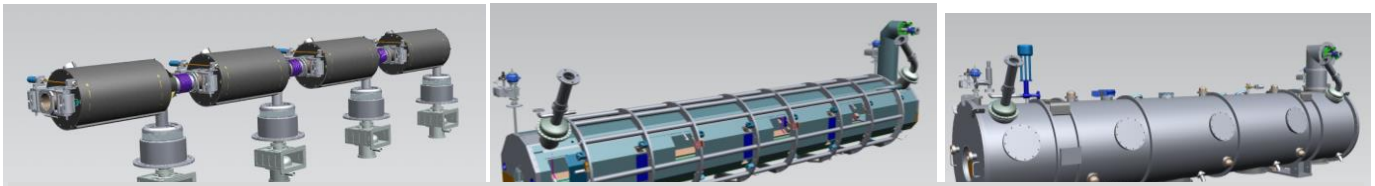
ESS preliminary Acceptance

ESS 2K RF POWER TEST at Lund

ESS final Acceptance

THE ACTORS OF THE CM PRODUCTION

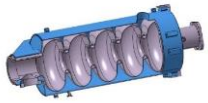
CEA



CEA provides all the CM components except the cavities

STFC

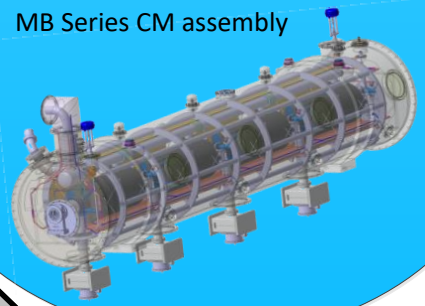
84 HB Cavities



ESS Cavity acceptance

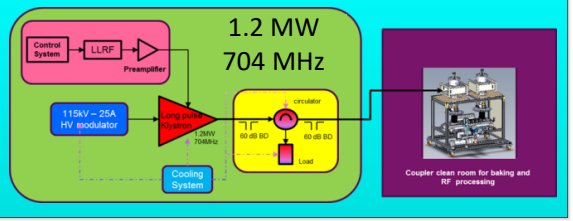
CEA Saclay sub contractant

MB Series CM assembly



CEA

High Power RF Test Stand for coupler conditioning at Saclay



21 HB Series Elliptical Cryomdules

3 first CM

CEA

CM RF power test stand At Saclay

ESS preliminary Acceptance

ESS Lund

ESS 2K RF POWER TEST at Lund

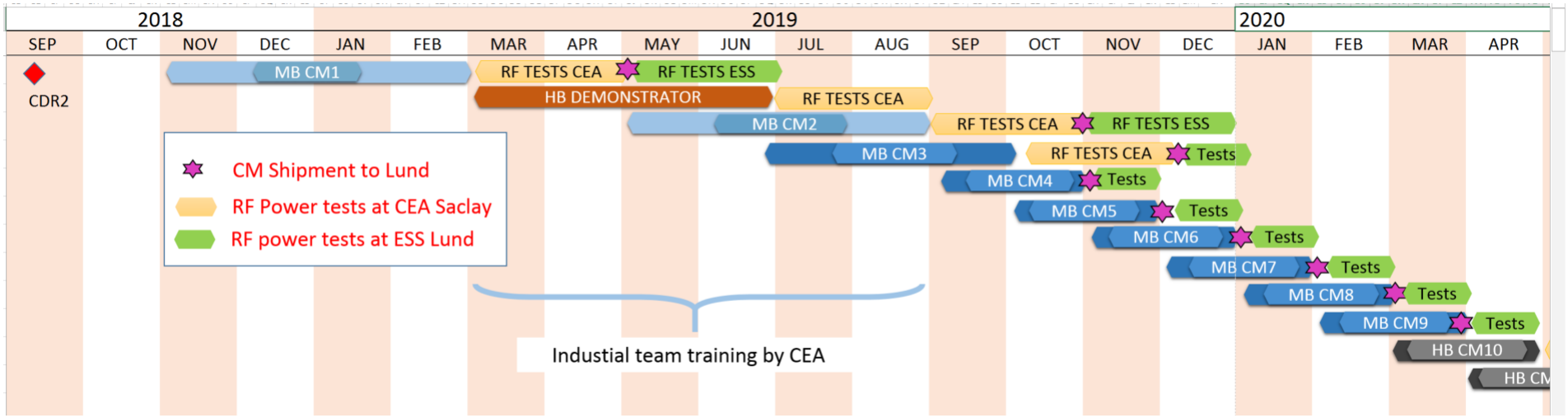
ESS final Acceptance

SCHEDULE

- The CDR2 will be held after the RF power test at Saclay on the MB Demonstrator (this summer)

- The 2nd cryomodule will be a MB CM for the series. Assembly is expected to take 4 months
- The 3rd CM will be the HB demonstrator. Assembly will also take 4 months
- The 4th CM will take 3 months and will start 1.5 months before the end of the 3rd CM.
- Afterwards, production will enter the nominal series phase where CM assembly will take 2 months, for a throughput of one CM every month

- 9 MB CMs will be produced in March 2020
- 21 HB CMs will be produced by the end of 2021



MANUFACTURING CONTRACTS

- CEA has nearly finished launching 60 manufacturing contracts
- **CEA has taken the risk of launching pre-series production before finalising all the RF tests on the demonstrator**
- At the end of each pre-series, an inspection is conducted before launching series production.
- For good schedule management of the cryomodule assembly process, we plan to store 2 sets of each component at Saclay.
- Stock will be managed using bar codes and most of the components will be identified by a serial number.
- A CEA team oversees the schedule, checks product quality at the manufacturing site (for the pre-series) and again at CEA Saclay

Vacuum vessel

Thermal shield

Spaceframe

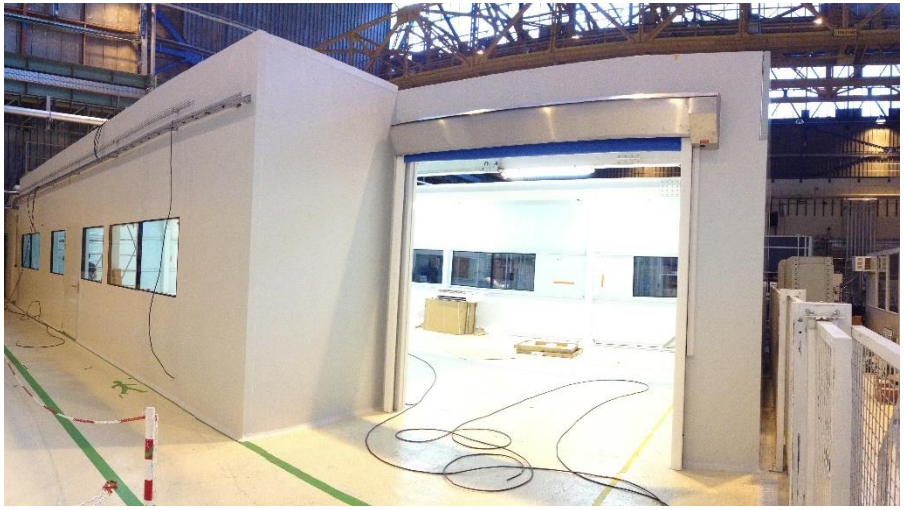
Magnetic shield

INDUSTRIAL INTEGRATOR CONTRACT

- An industrial integrator will be in charge of CM assembly with a contract based on a performance agreement
- Once CEA has trained the team, the contractor is then responsible for managing assembly.
- CEA ensures quality control and expertise.
- All assembly operations will be performed by the integrator in the same hall.
- **CEA keep in charge the coupler assembly and conditioning.**

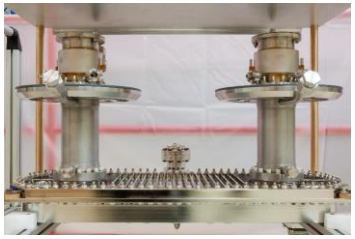
COUPLER PREPARATION AND CONDITIONING

- Assembly hall for the MB demonstrator will be used for assembling the series coupler and acceptance of cavity tuners
- Test stand for coupler conditioning
- 2 Klystrons :
  - 704 MZH – 1,2 MW
  - 704 MZH – 1,5 MW (partially delivered)



MB Demonstrator assembly hall

1,1 MW coupler

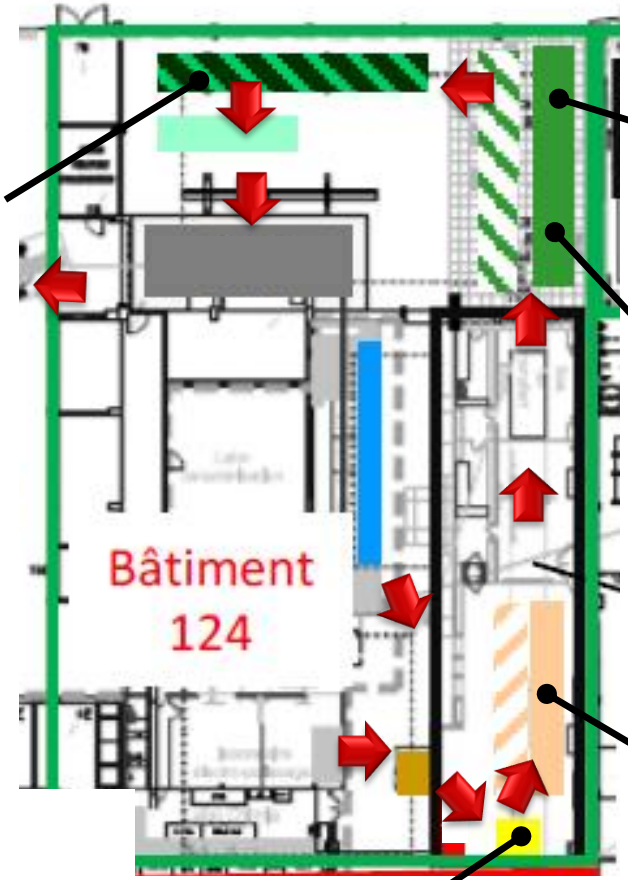


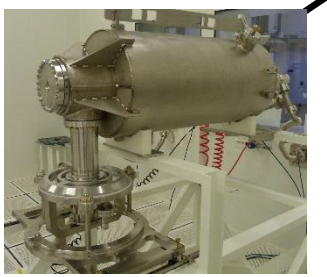
Conditioning monitoring

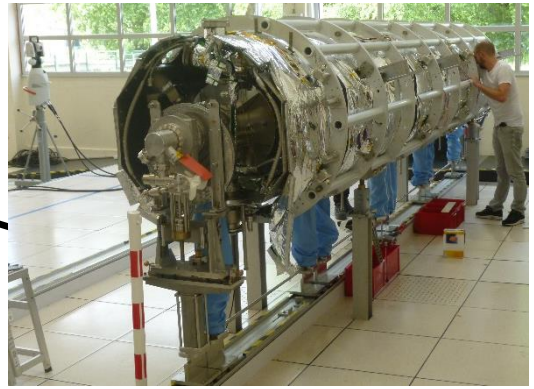
Baking Furnace

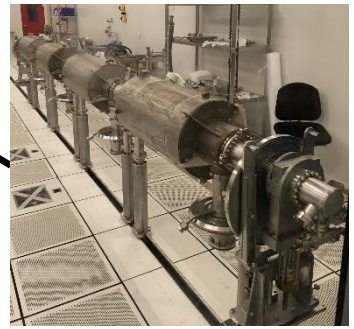
Coupler conditioning test stand

ASSEMBLY HALL – WORKSTATION LAYOUT



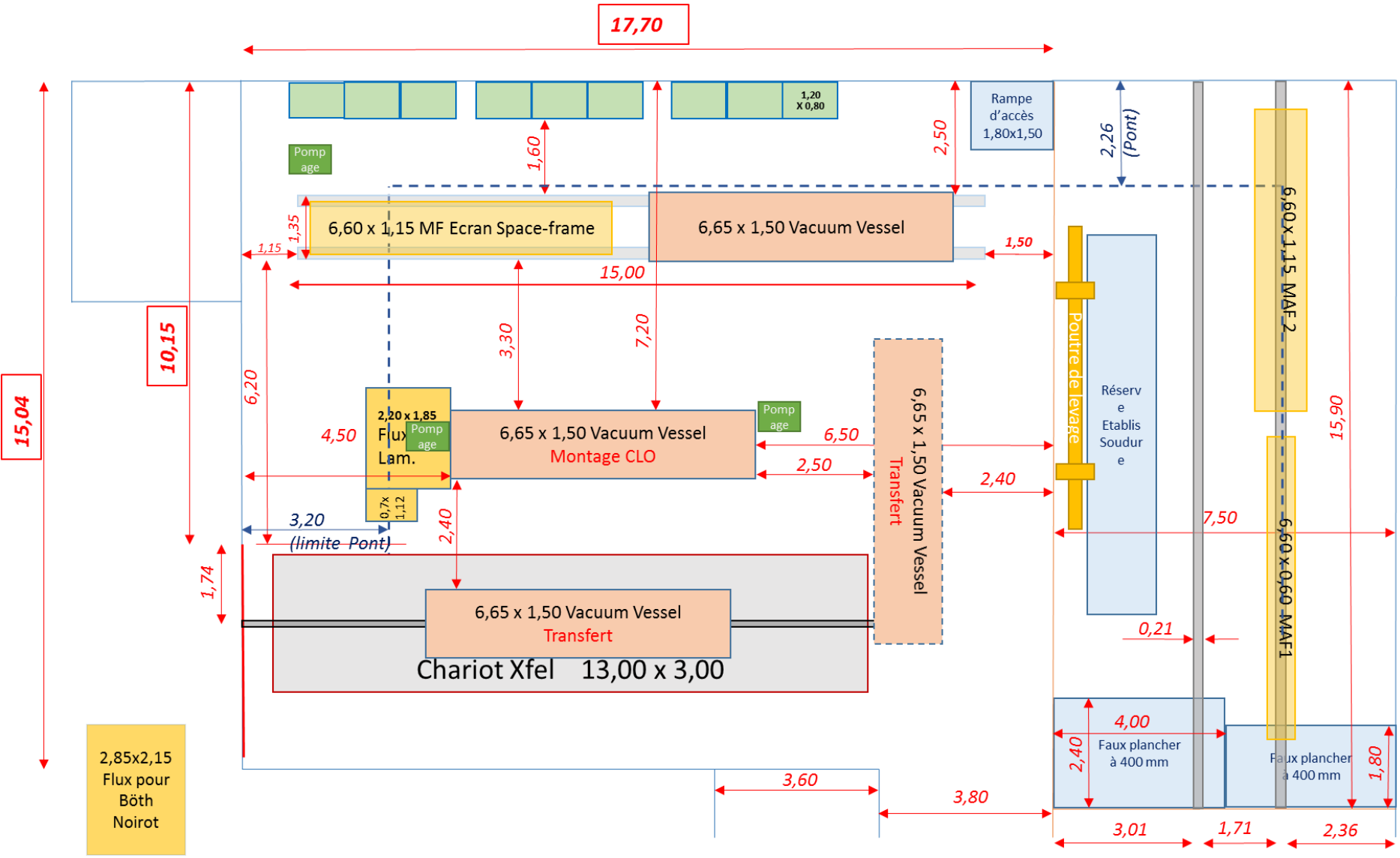




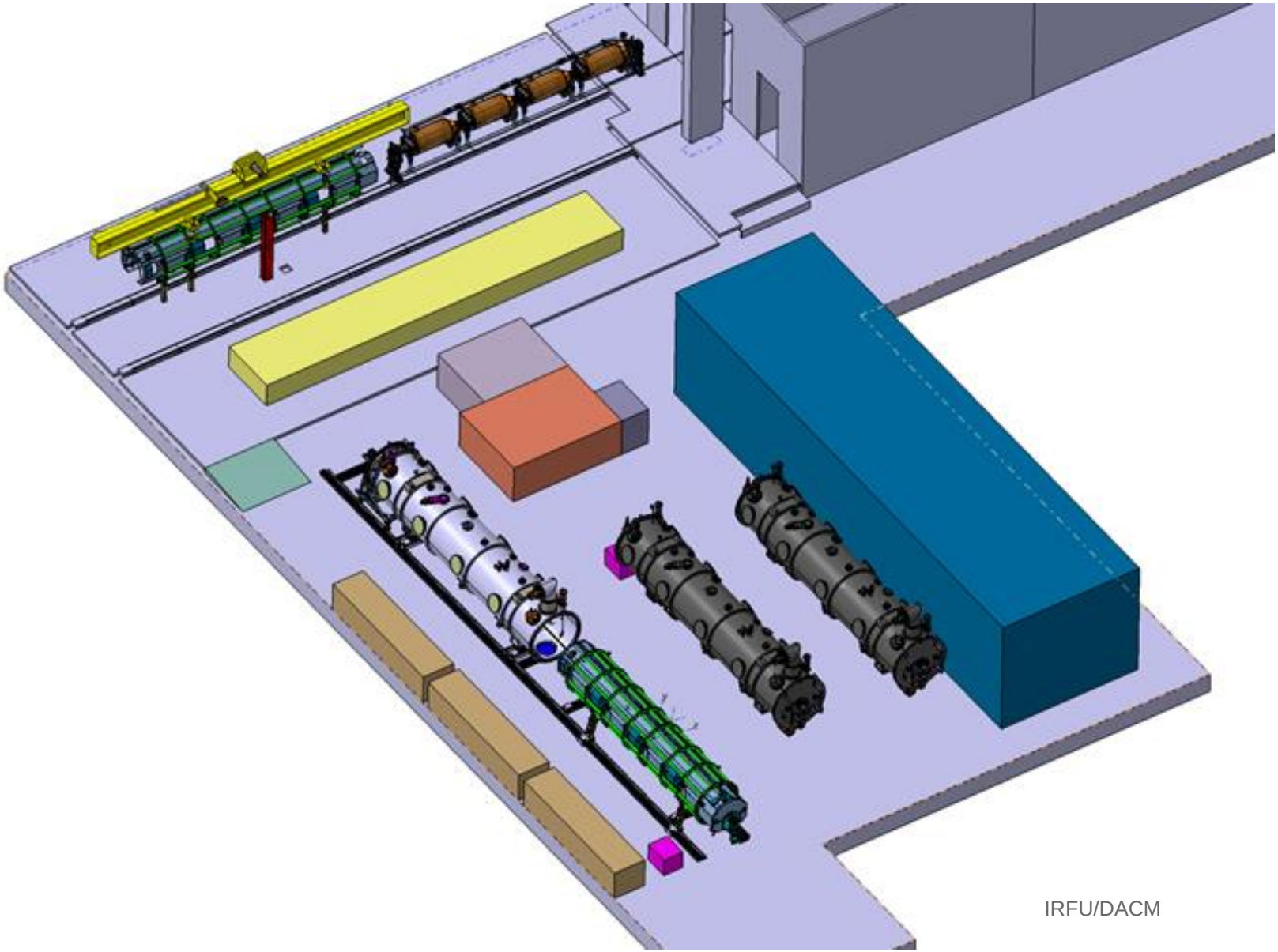


- Ultra-sonic bath cleaning
- Industrial washer
- Cavity - coupler assembly
- Cavity string assembly
- Cavity string dressing / spaceframe insertion
- Spaceframe preparation / cryostating
- Coupler bell assembly
- Cryomodule loading

ASSEMBLY HALL – WORKSTATION LAYOUT



ASSEMBLY HALL – WORKSTATION LAYOUT



ESS CM ASSEMBLY PROCESS

- For the integrator, the CM assembly process prepared is a line of 7 WS.

  1) Coupler assembly to the cavity (in clean room ISO4)
  2) Cavity string assembly (in clean room assembly ISO4)
  3) Cavity string dressing
  4) Spaceframe insertion (cavity string hanging in the equipped spaceframe)
  5) Cryostat assembly (introduction of cold mass into the vacuum vessel)
  6) Coupler bell assembly to cryostat
  7) Preparation of the shipment

- Most of WS are redundant or have a second set of tooling in case of incident

- During assembly ramp-up (~first four modules), total assembly duration is 4 months. After ramp-up, assembly duration = 8 weeks (40 working days !)

- Breakdown is roughly 1/3 duration in clean room (WS1-WS2) and 2/3 duration in assembly hall (WS3-WS6).

- Preparation for RF test and/or for shipment (WS7) is done in another building (XFEL Shipment building, not shown).

CM ASSEMBLY PROCESS

- The assembly duration of PIP-II should match that of ESS ramp-up, from 4 months down to 2 months.
- For PIP-II, an extension to assembly of three modules at all time, is feasible within the same hall. It should bring more flexibility.
- The two Rail systems in Clean Room and Roll-Out are separated by 1.8 m, while ESS cold mass is about 1.3 m wide: two assembly lines fit (hardly) in parallel.
- Two parallel assembly lines is not foreseen for ESS, but it could be envisaged as an accelerated production mode for PIP-II, if needed by the end of production.

Thank you for your attention

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DSM
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