

DE LA RECHERCHE À L'INDUSTRIE



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# SLHIP#7

8-9 JUNE 2017

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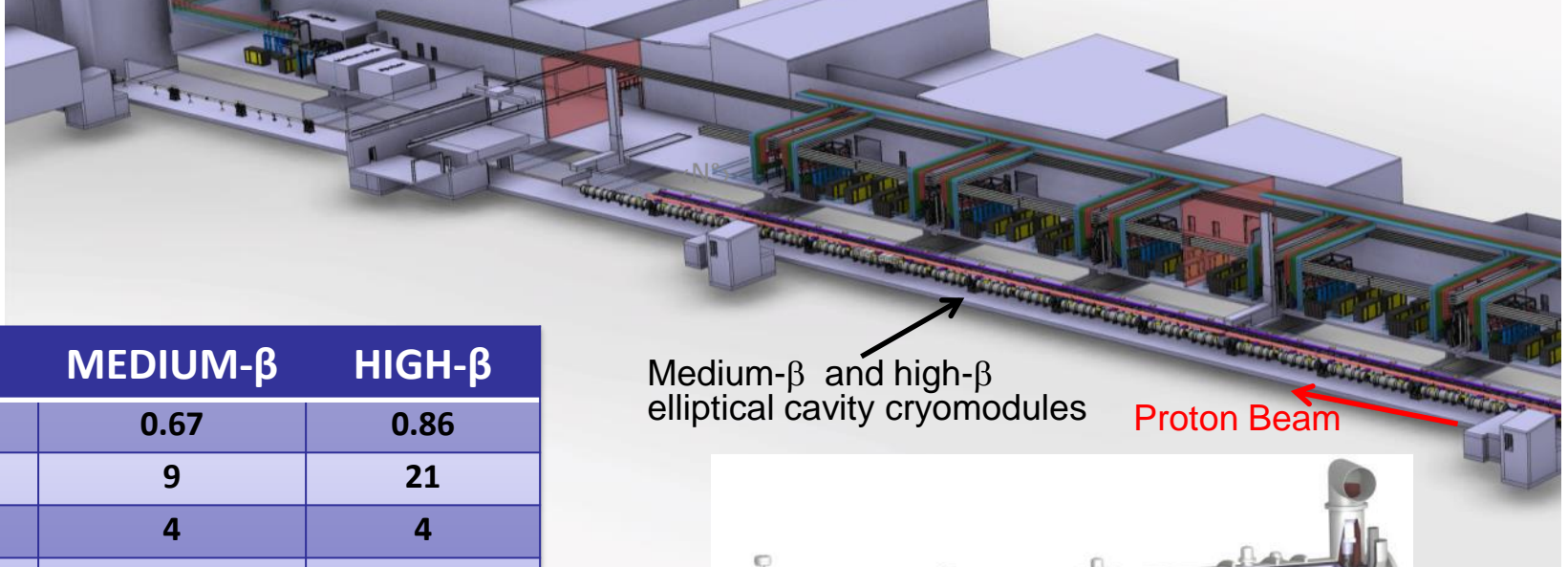
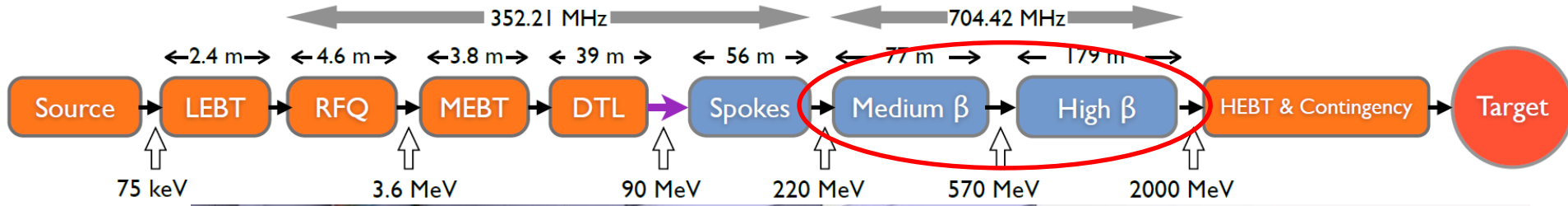
## PREPARATION OF THE PRODUCTION OF THE ESS ELLIPTICAL CRYOMODULES AT CEA SACLAY

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**PIERRE BOSLAND/FRANCK PEAugER**

- 1) Context
- 2) Cryomodule components procurements and assembly
- 3) Infrastructures preparation
- 4) Cryomodule prototyping status
- 5) Final remarks

# CONTEXT



	MEDIUM-β	HIGH-β
$\beta$	0.67	0.86
# CM	9	21
Cav. /CM	4	4
# Cav.	36	84
CM L [m]	6.584	6.584
Sector L [m]	77	179



- Fr-Sw Agreement:
  - Cooperation Agreement in the field of Neutron Accelerator Science to the ESS Design Phase
    - Medium-Beta Elliptical Cavity Cryomodule Technology Demonstrator (M-ECCTD)
      - design of the cryomodule (for M & H beta cryomodules)
      - components manufacturing (cavities, power couplers, tuners, etc.)
      - Preparation of the RF power test infra structure with cryogenics and C/C
      - RF power tests at 2K
- Schedules of the In Kind Contribution Agreement
  - AIK#1.1: Technical Management Scope of Work to the In-Kind Contribution Agreement signed between ESS-ERIC and CEA
  - AIK#5.1: High-Beta Elliptical Cavity Cryomodule Technology Demonstrator (H-ECCTD)
  - AIK#5.2: Elliptical Medium and High Beta Cryomodule Component Supply
  - AIK#5.3: Elliptical Cryomodules Engineering, Assembly and Test and Technical Assistance in Cavity Design, Manufacturing and Tests
  - AIK#5.5: Elliptical Cryomodules Installation and Commissioning



- Cryomodule requirements and interfaces
- Cryomodules transport
- Cryomodules test stand



- Design of the cryostat of the cryomodule
- M-ECCTD cryostat components procurements



UPPSALA  
UNIVERSITET *See Li, Han talk*

- High beta cavity + power coupler + piezo tuner tested at high power in horizontal cryostat in FREIA



*See A. Bignami talk*

- Medium Beta Cavities of the series:  
Design, procurement, test in vertical cryostat at  
DESY



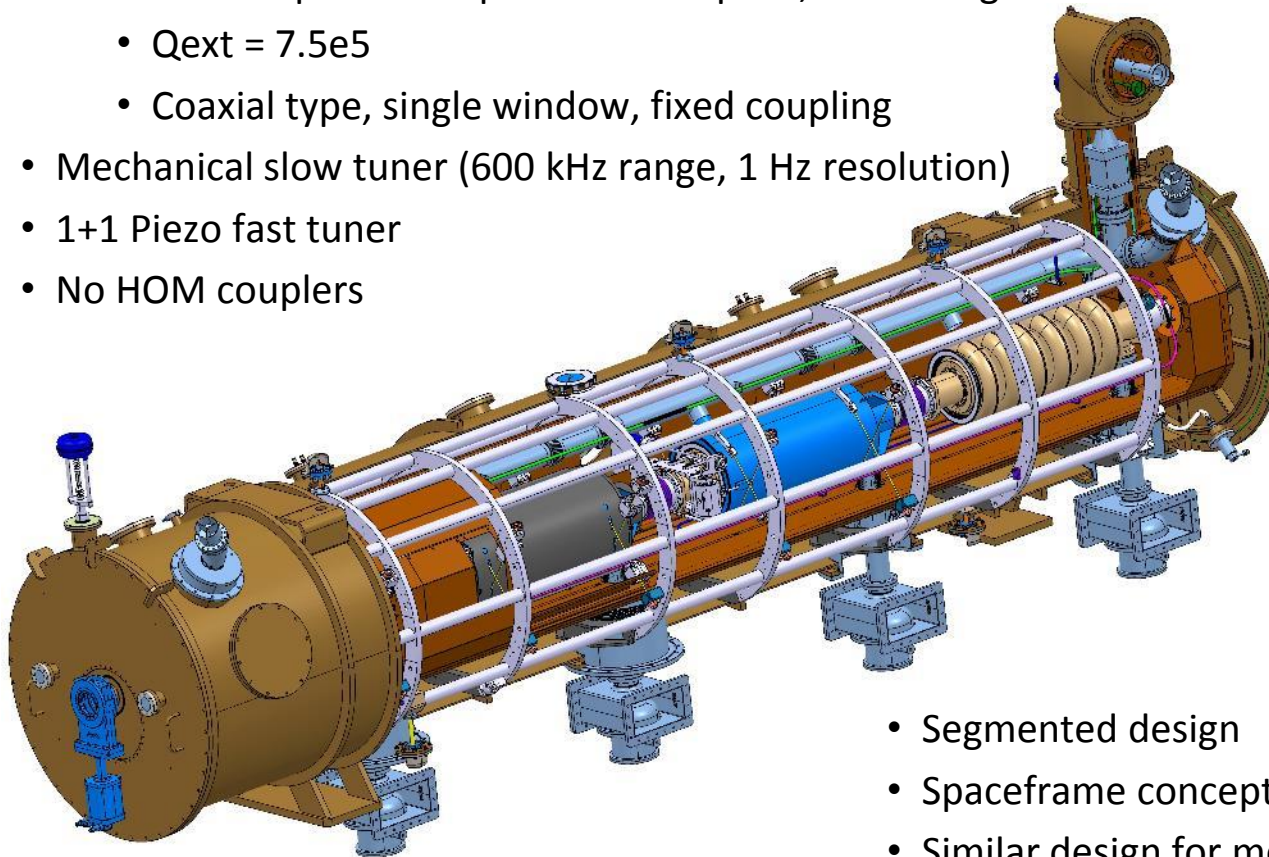
Science & Technology  
Facilities Council

*See A. Wheelhouse talk*

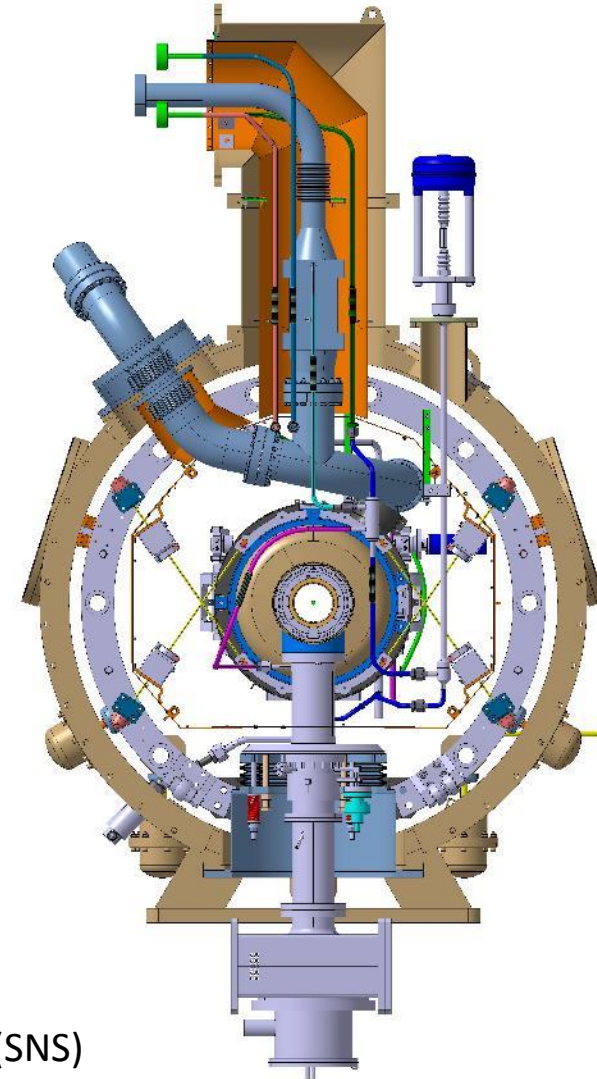
- High Beta Cavities of the series:  
Procurement, test in vertical cryostat at Daresbury



- 704 MHz, 3.6 ms RF pulse at 14 Hz
- Eacc = **16.7 MV/m** (M $\beta$ ) and **19.9 MV/m** (H $\beta$ ) ( $E_{\text{peak}} = 40/44$  MV/m)
- $Q_0 > 5e9$  at 2 K
- Fundamental power coupler: **1.1 MW** peak, 55 kW avg.
  - $Q_{\text{ext}} = 7.5e5$
  - Coaxial type, single window, fixed coupling
- Mechanical slow tuner (600 kHz range, 1 Hz resolution)
- 1+1 Piezo fast tuner
- No HOM couplers



6.6 m long



- Segmented design
- Spaceframe concept (SNS)
- Similar design for medium and high beta cryomodules

- Cryomodule components procurement plan:
  - Divided in several procurement contracts adapted to the skills of the companies
- RF power couplers:
  - produced by a company (PMB)
  - RF power conditioning performed by CEA at Saclay
- Cryomodules assembly :
  - Assembly rate of one cryomodule per month
  - Will be performed in the former “XFEL Village” which becomes officially now the “ESS Village”
    - Fully dedicated to the ESS cryomodule (no interference with other projects at Irfu)
  - Will be done by an industrial partner in the ESS village, under the supervision of a CEA team
    - The contract includes an industrialization phase and training on the three first cryomodules
    - Include clean room cavity string assembly, roll –out activities, alignment and cryostating (XFEL like)
- RF power tests of elliptical cryomodules at CEA Saclay:
  - 2 prototypes: medium & high beta M-ECCTD and H-ECCTD
  - 6 cryomodules of the series: first three cryomodules of each type medium & high beta

=> fast feedback on the quality of the cryomodule assembly

# CRYOMODULE COMPONENTS PROCUREMENT AND ASSEMBLY



# PROCUREMENT PLAN

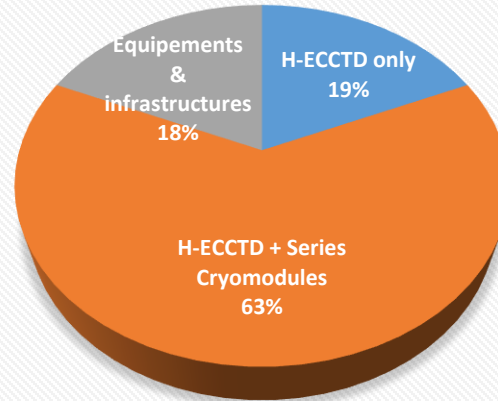
- Procurement plan deals with 40 contracts of  $\geq 1$  M€
- 32 contracts dedicated to components procurement

Order placed
Tendering launched
Tendering in stand by
Shared procurement with ESS
Tendering process in preparation

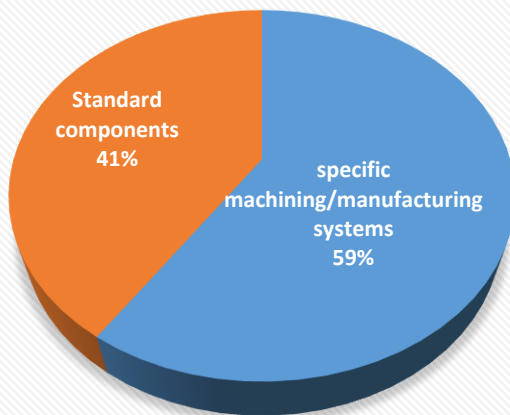
	Contract title	Qty	Company
1	Vacuum vessel	30 + 2	ACPP
2	RF power Couplers	120	PMB
3	Tuners (mechanical parts)	120	
4	Stepper motors for tuners	120+2	PHYTRON
5	2K Heat exchangers	31	
6	Coupling boxes for coupler conditioning	12 + 3	SDMS
7	Diphasic pipes, cryogenic circuits	31	
8	Intercavity belows / cold warm transitions	31	
9	Titanium belows for diphasic lines	31	
10	Cryomodule assembly at CEA Saclay	30	
11	Spaceframe	30 + 2	SDMS
12	Magnetic shieldings	120.	
13	Thermal shieldings	30 + 2	SDMS
14	Multi Layer Insulation	31	
15	Screws set (for clean room assembly)	.	
16	Piezo for tuners	240	
17	Cavity supports	31	
18	RF cable	120	
19	RF feedthrough	62	
20	Aluminium gaskets		
21	Copper gaskets	300	GAVARD
22	Internal instrumentation	31	
23	Vacuum gauge for couplers	120	
24	Cryogenic valves	62	
25	Thermal sensors (Cernox)	325 + 480	
26	Safety valve	31	
27	Pressure sensor	64	
28	Controlled safety valve	31	
29	Rupture disks	62	
30	Vacuum components	31	
31	Helium level sensor	62	
32	Thermal braids	31	•9

# PROCUREMENT PLAN

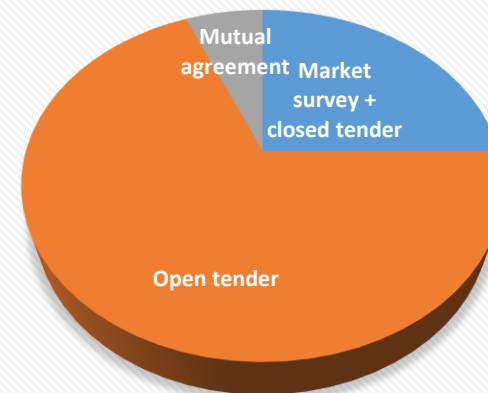
## Procurement contract allocation



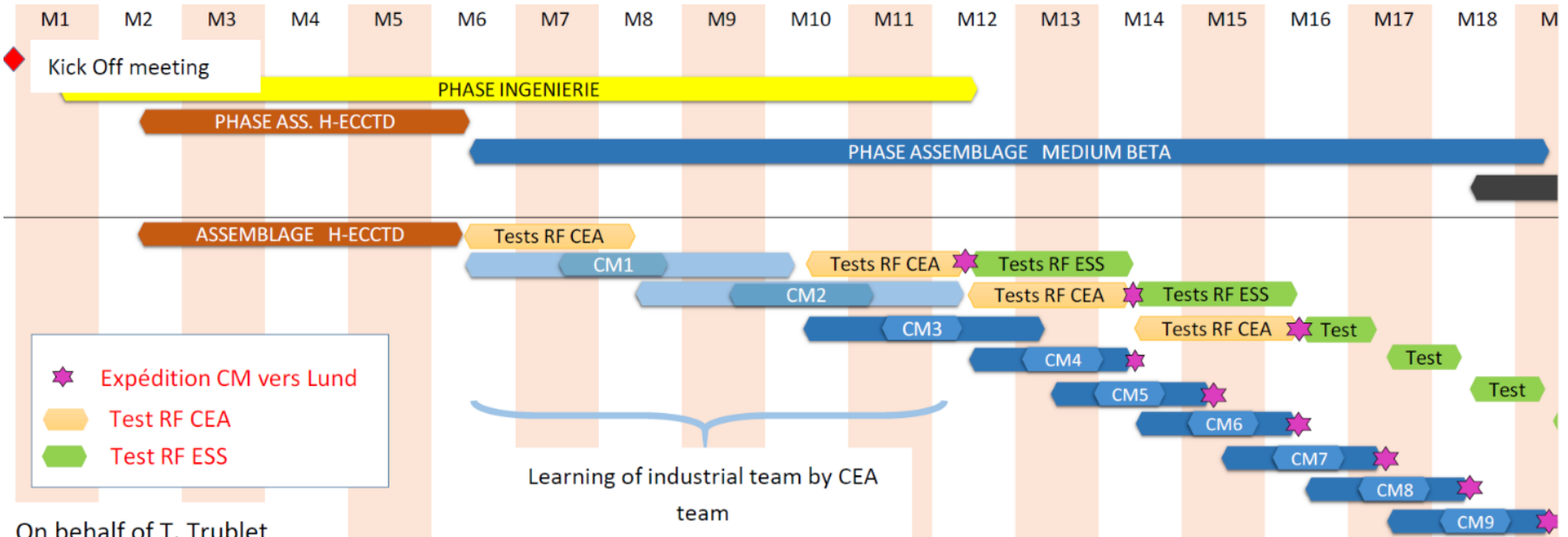
## Series Cryomodules contract distribution



## Series Cryomodules tender type



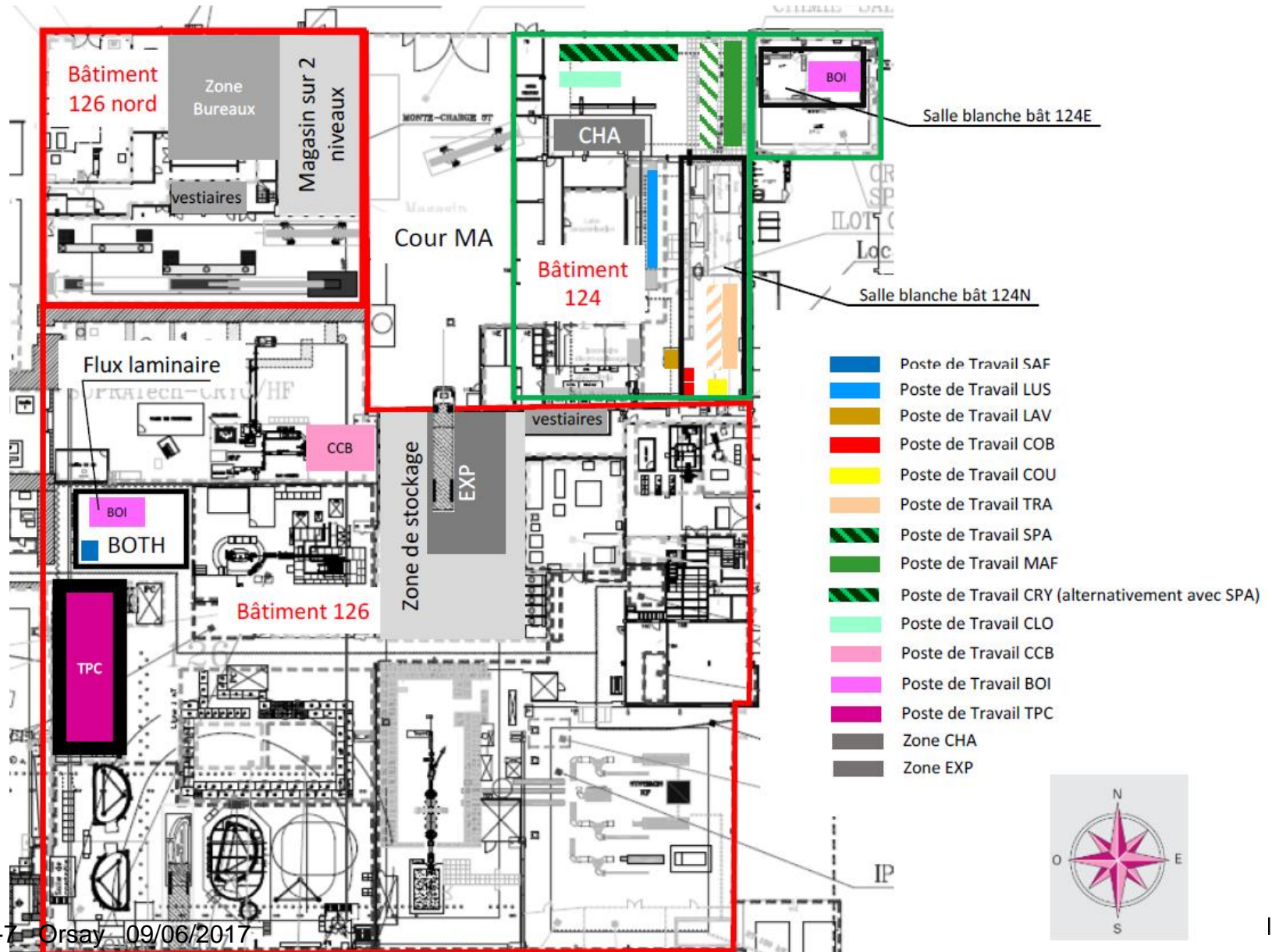
- Technical specification and tendering documents based on XFEL experience
- Engineering phase included in this contract:



- The market survey has been launched (limit date 10th of July 2017)

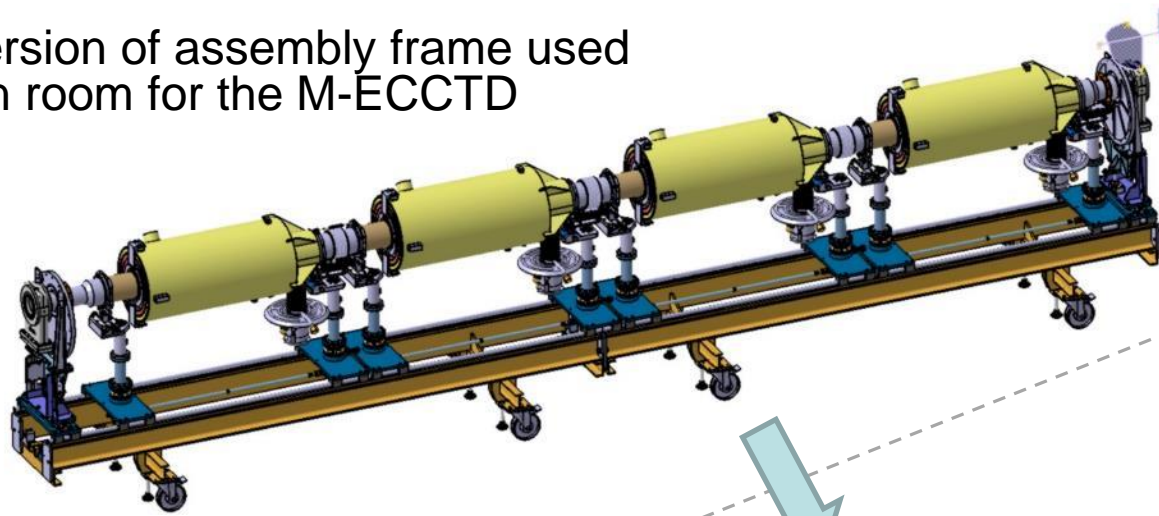
# INFRASTRUCTURES PREPARATIONS

# CEA SACLAY INFRASTRUCTURE FOR THE ESS CRYOMODULES ASSEMBLY

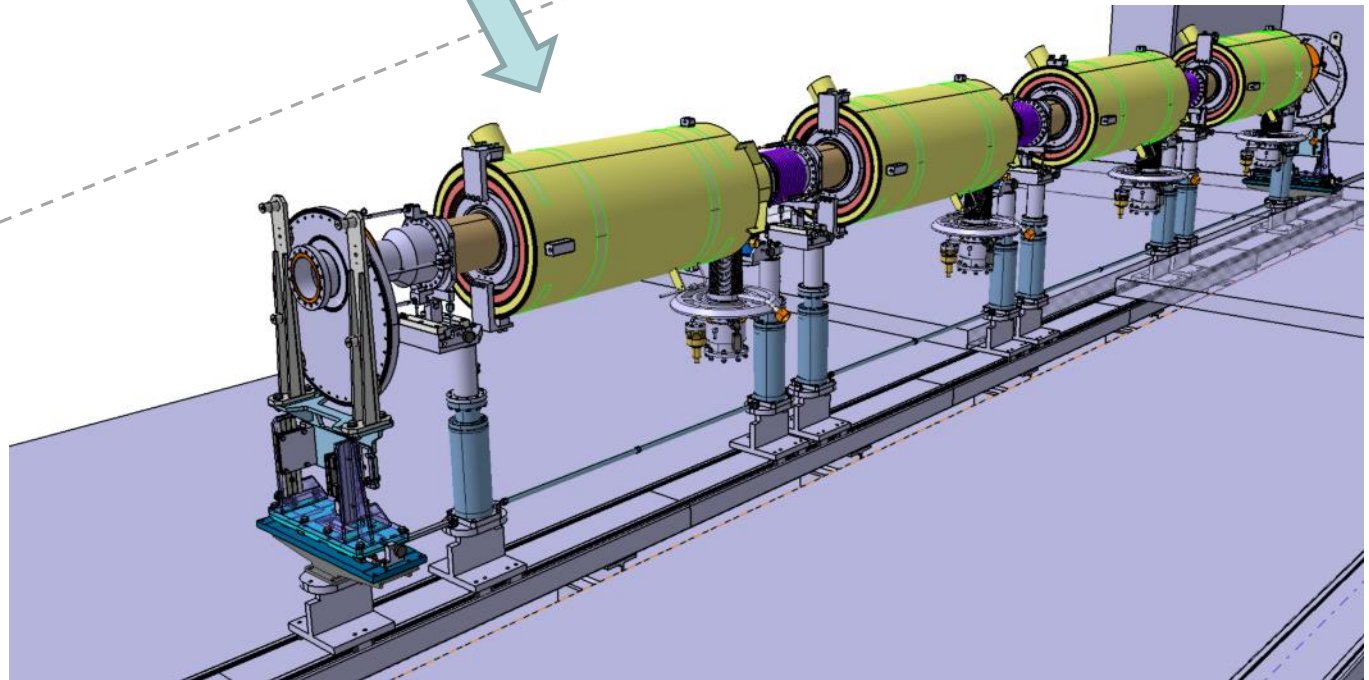




First version of assembly frame used in clean room for the M-ECCTD

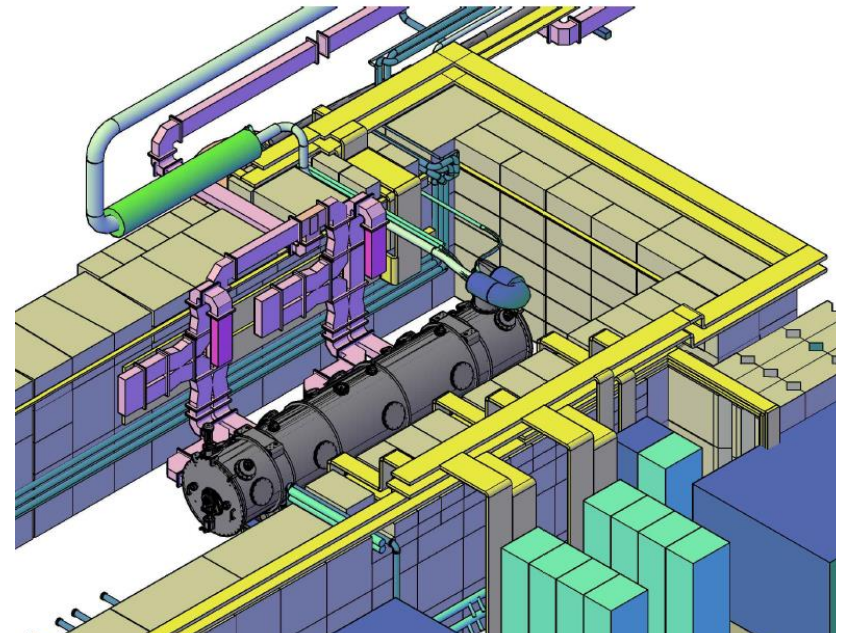
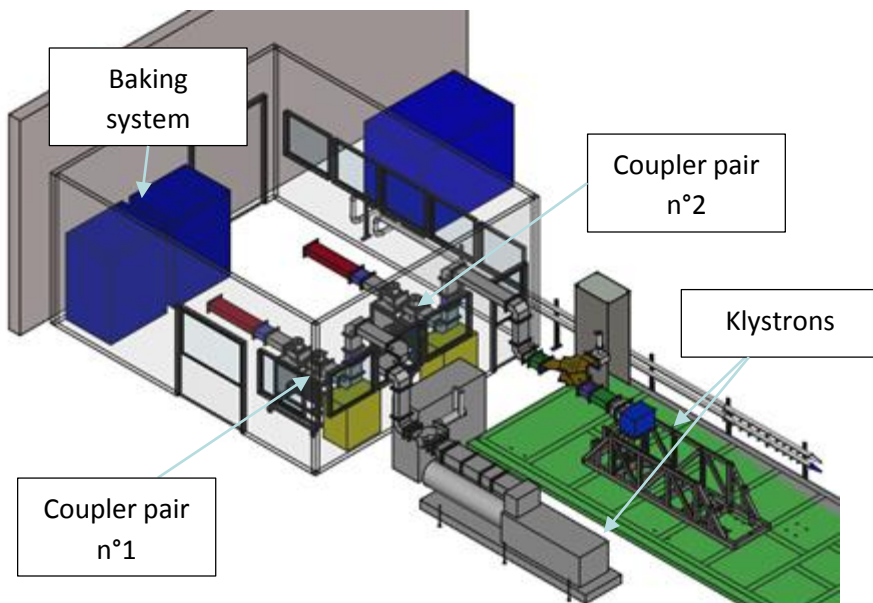


Next version





# HIGH POWER RF TEST STATIONS







# INFRASTRUCTURES PREPARATIONS: COUPLER RF CONDITIONING TEST STAND

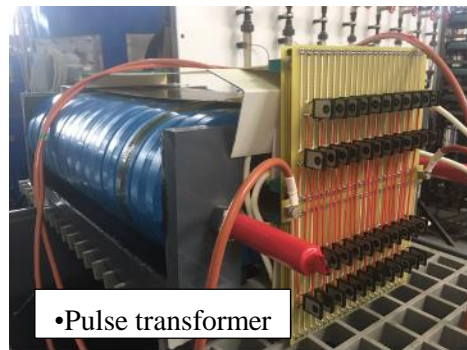
## ➤ New THALES klystron and modulator 1.5MW



• 1.6 MW – 704 MHz klystron



•Capacitor bank



•Pulse transformer



•RF pre-amplifier



•Control rack

# M-ECCTD

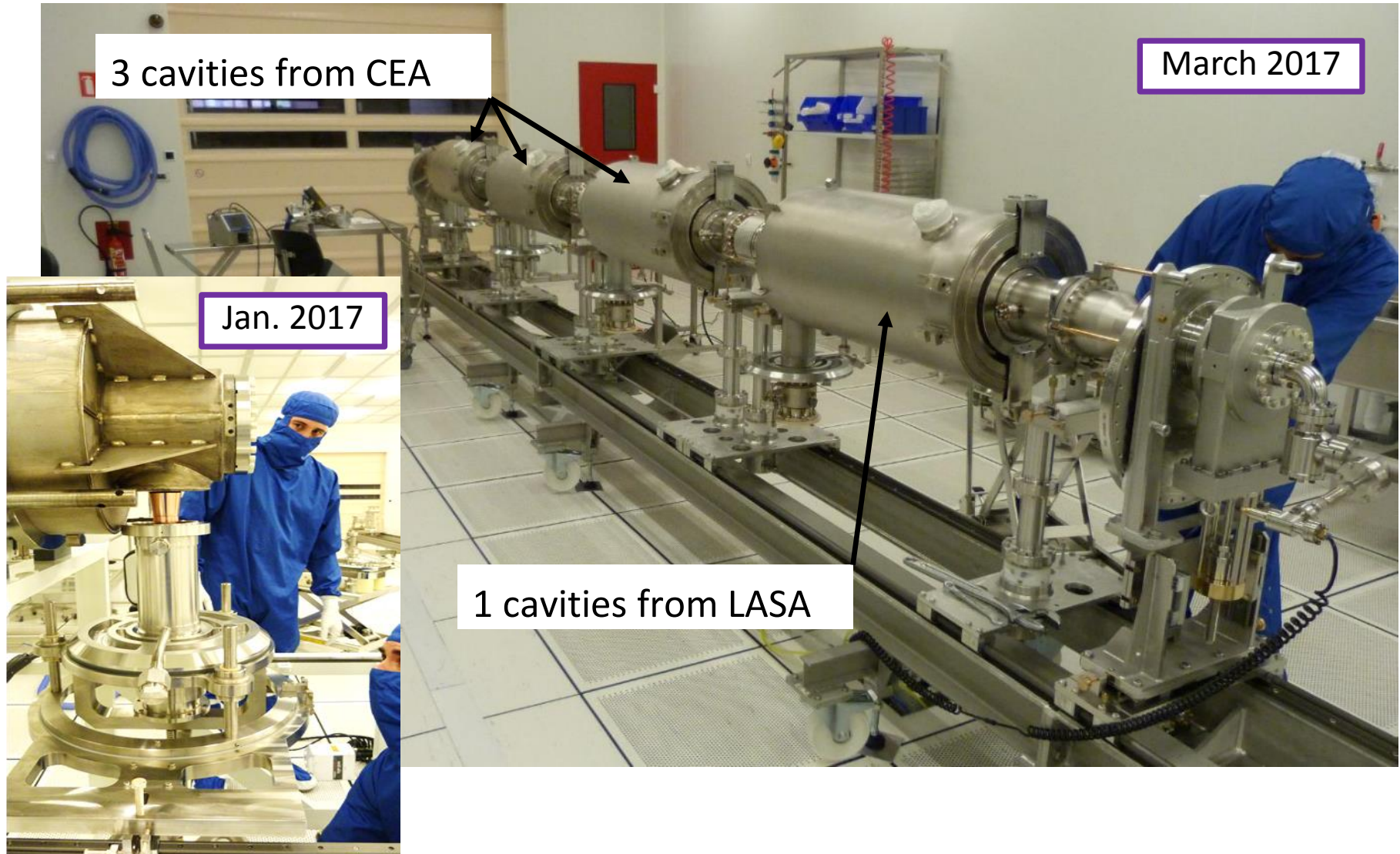
## PROTOTYPE CRYOMODULE

### STATUS

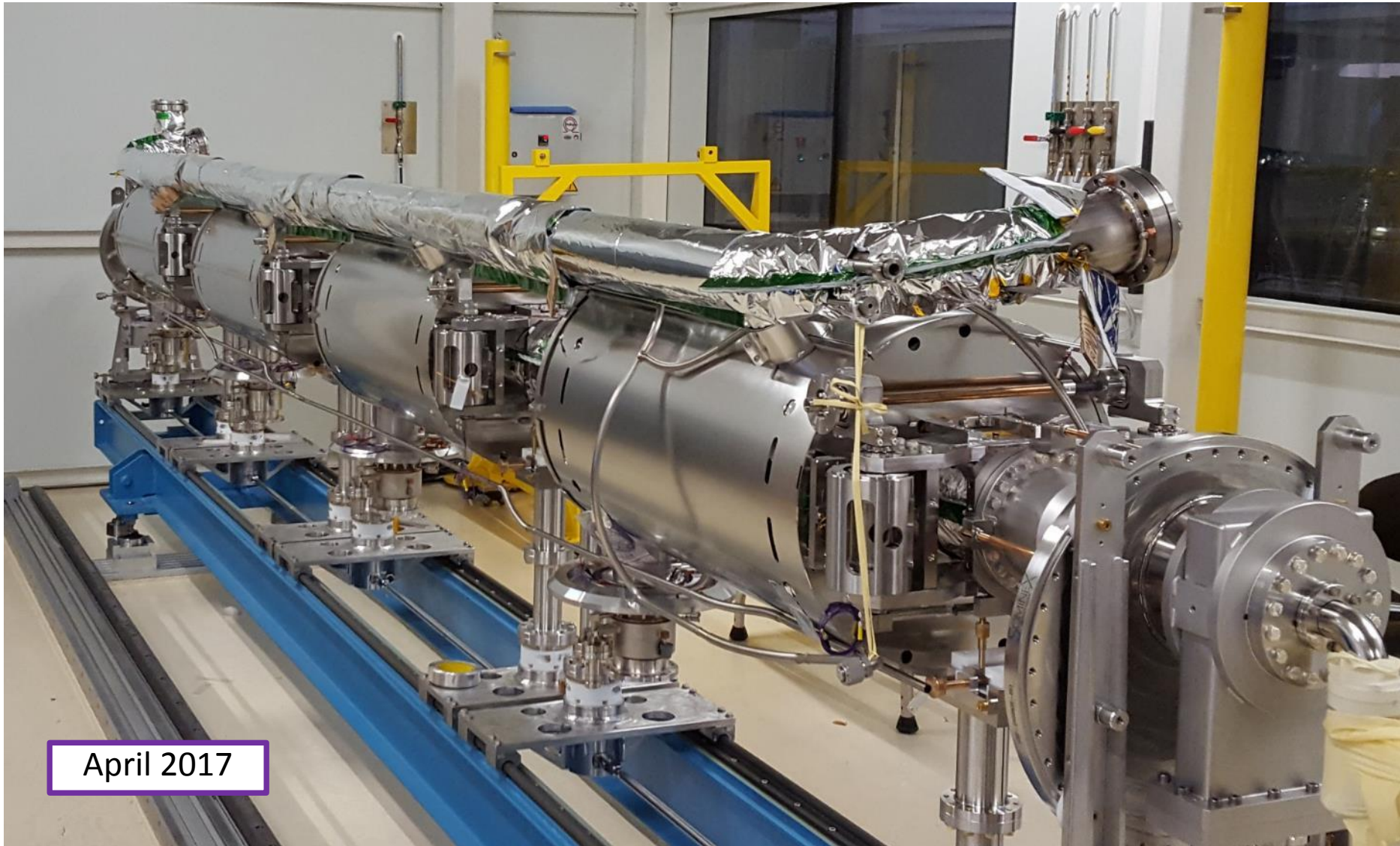
# CRYOMODULE ASSEMBLY TRAINING USING A MOCK-UP CAVITY











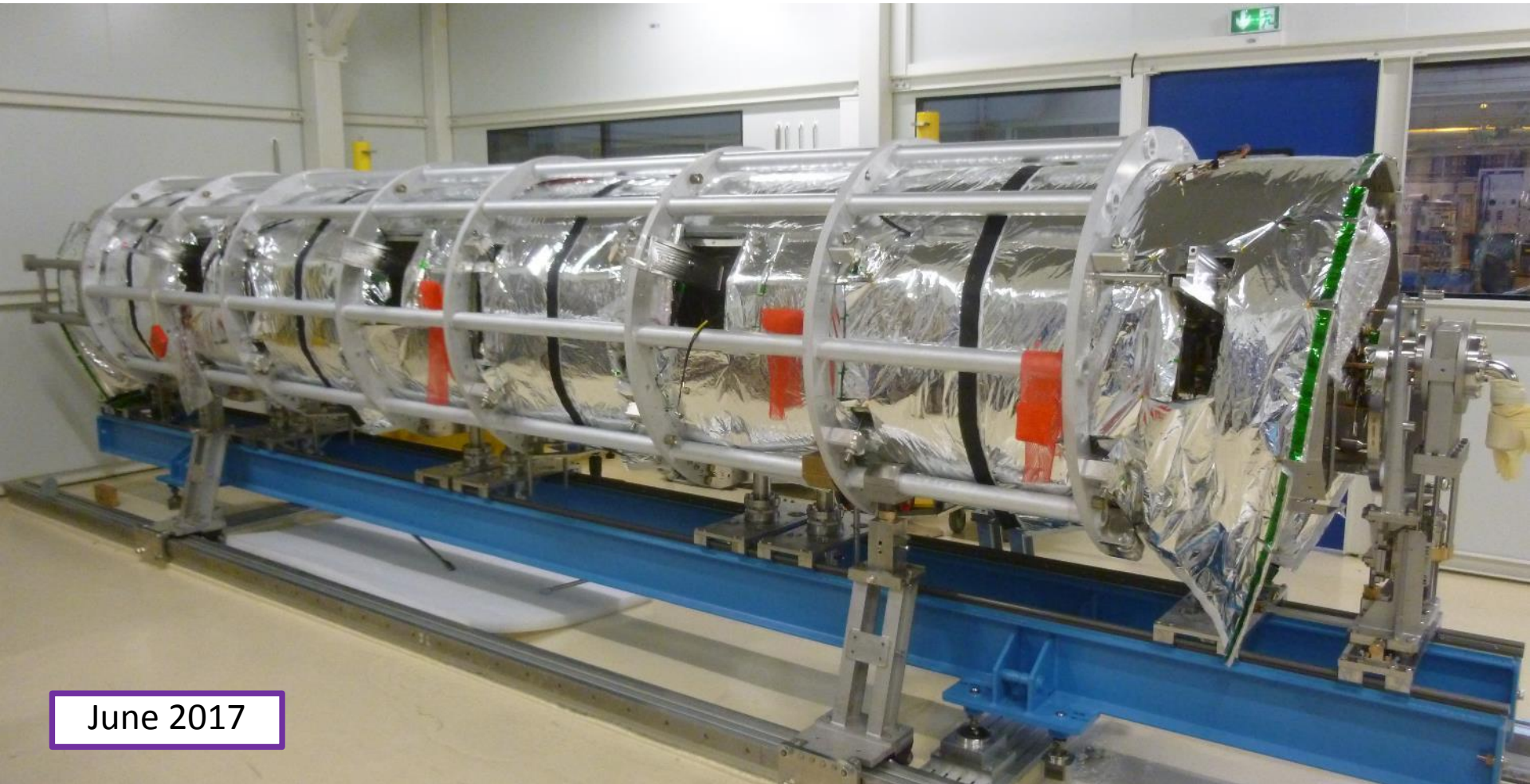
April 2017



May 2017







June 2017

## 3 activities in parallel:

- Prototype M-ECCTD :
  - finalize the assembly by the end of June
  - start of the tests at high RF power during summer (cool down in July)
- Launch of the contracts for the series (before end of tests of the M-ECCTD)
- Preparation of the infrastructure for the production of the series:
  - RF power conditioning of the power couplers
  - Clean room toolings and the different workstations outside the clean room for the assembly
  - Test stand for the tests of 8 cryomodules at high power

# Thank you

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