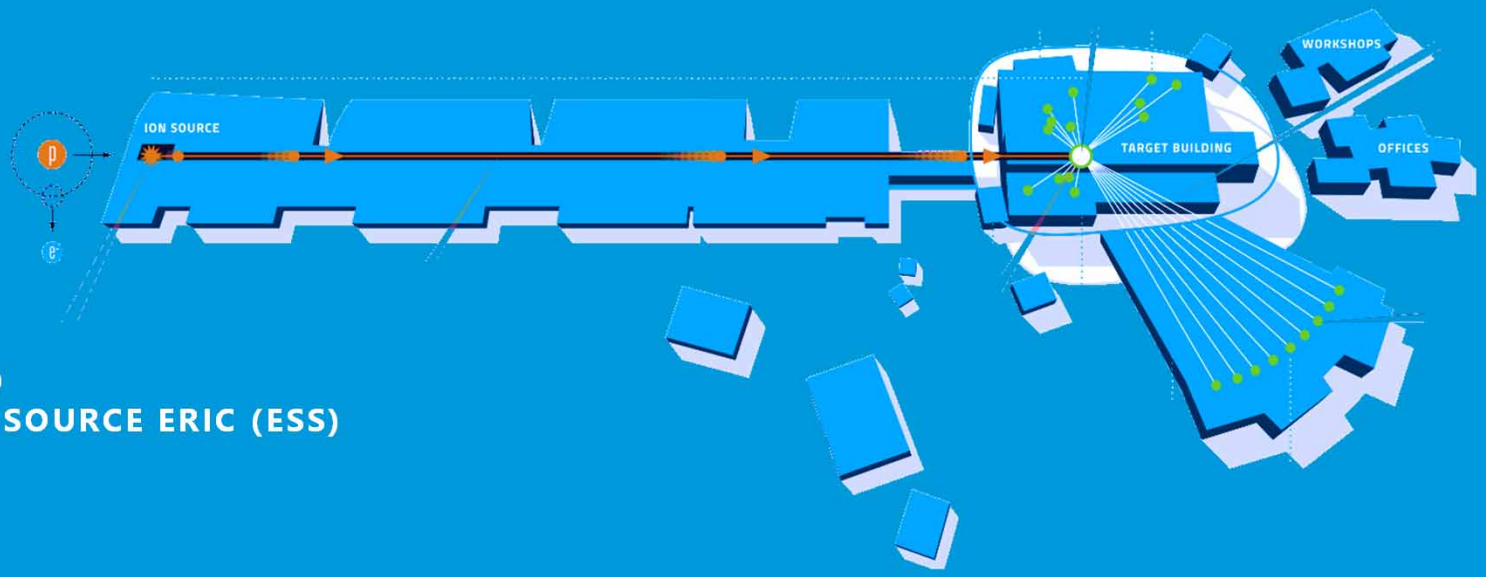
Progresses in the ESS Superconducting Linac Installation



HENRY PRZYBILSKI, CM INSTALLATION LEAD
ON BEHALF OF THE EUROPEAN SPALLATION SOURCE ERIC (ESS)

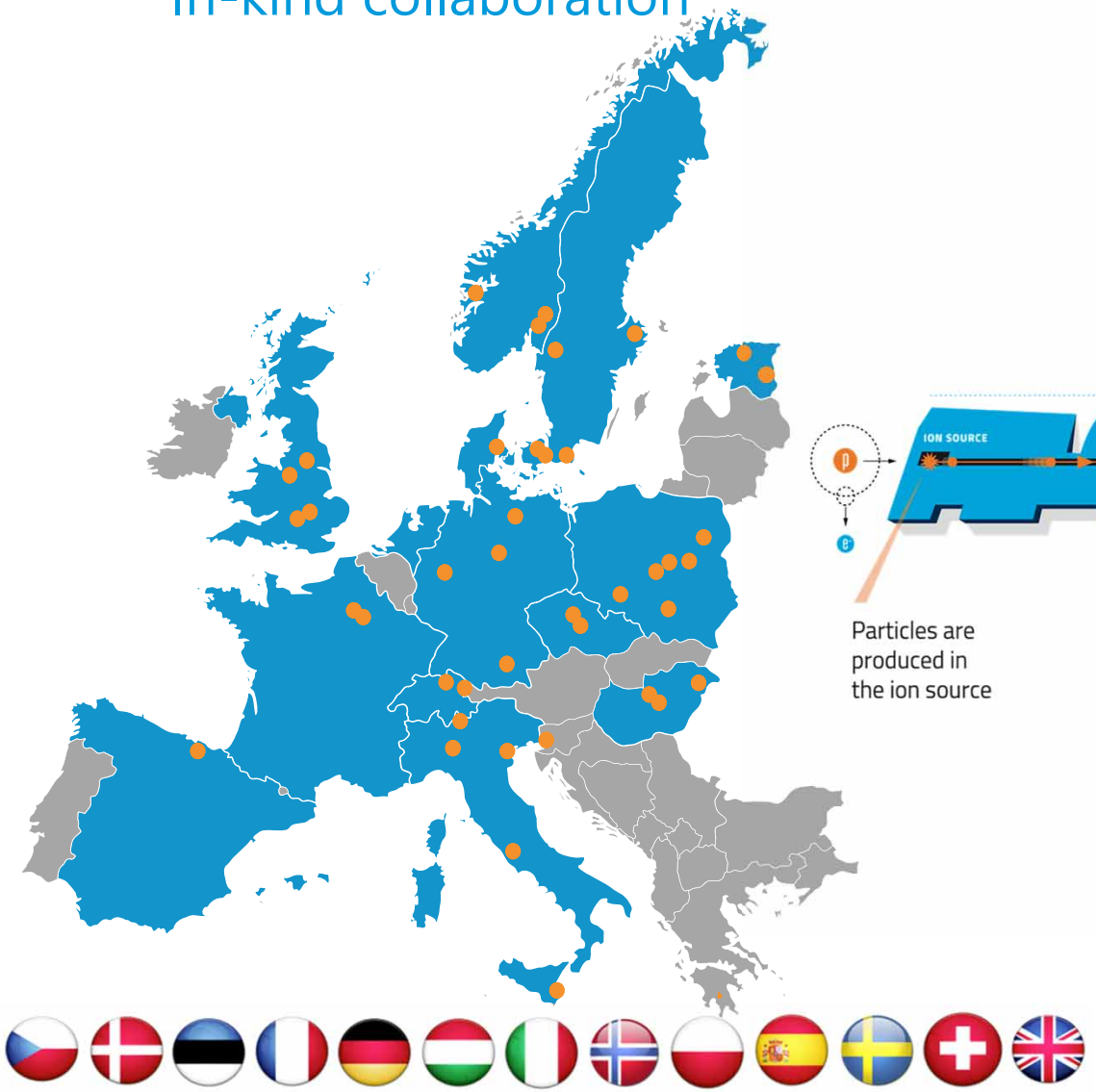
2023-06-26, SRF 2023, GRAND RAPIDS
MOIAA03

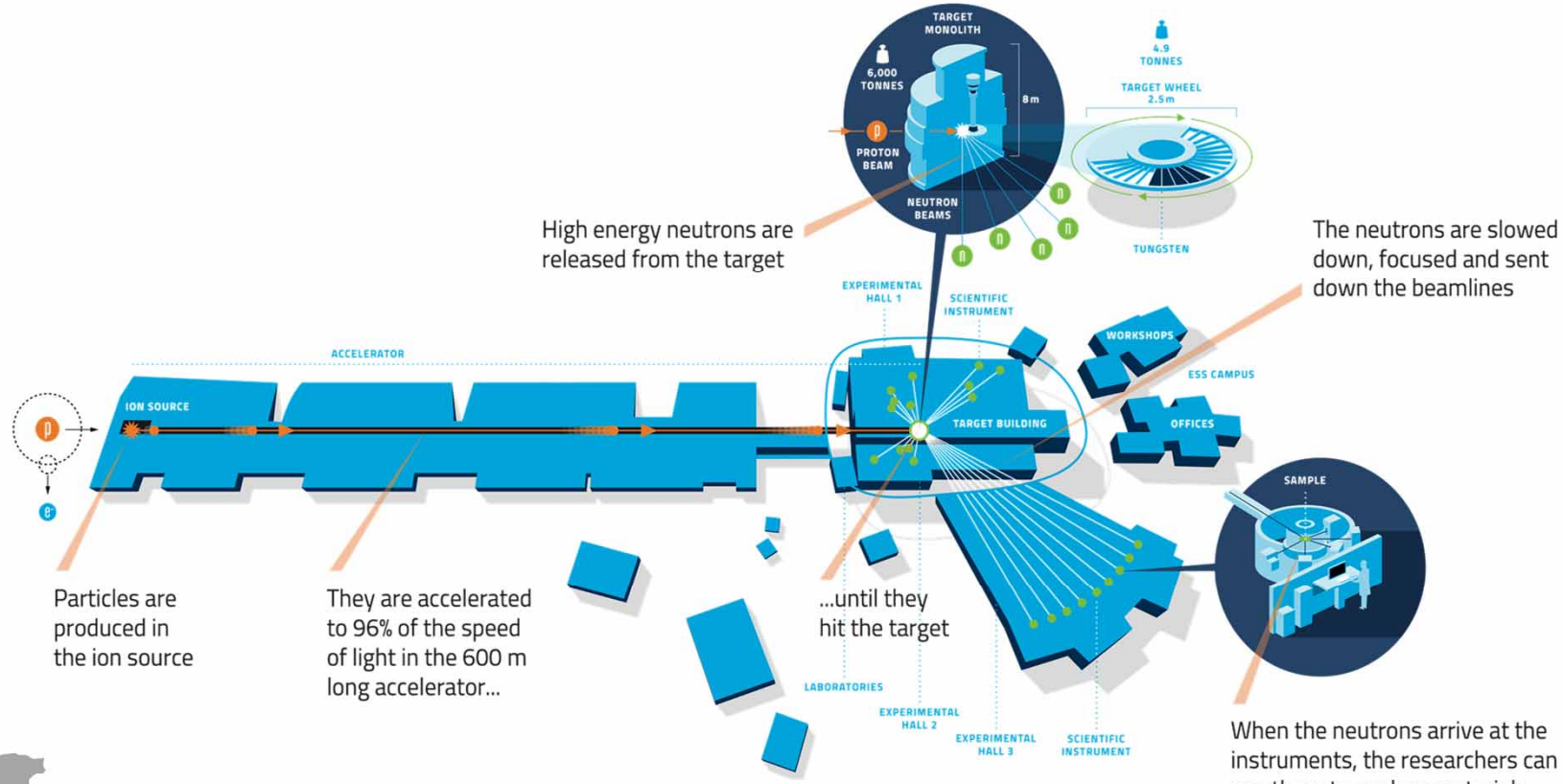
ESS overview

In-kind collaboration
Current status
- RFDS
- CDS
- CM delivery
- SPK & ELL tests

Unique international project

In-kind collaboration





2003
Concept design of ESS presented

2009
Decision to site ESS in Lund

2012
ESS design update phase

2014
Start of construction

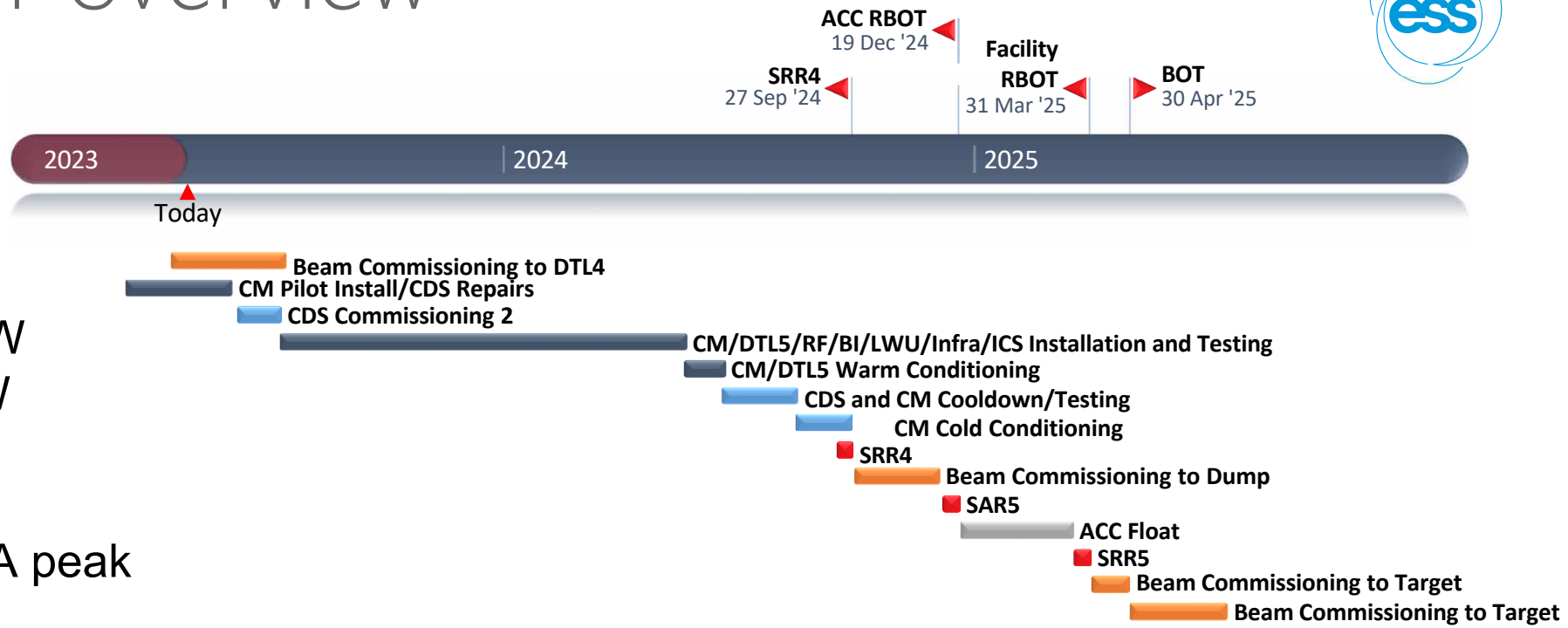
2019
Start of initial operations phase

2023
Today

2027
First science

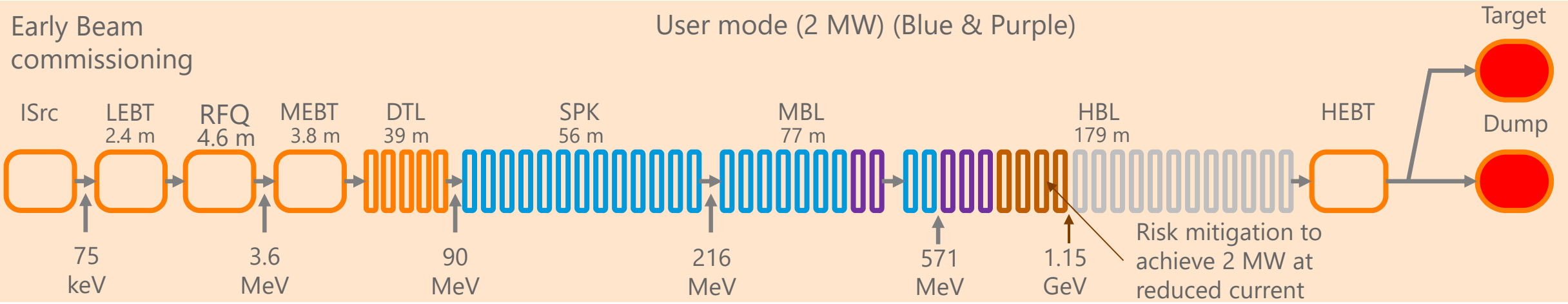
Accelerator overview

Current status



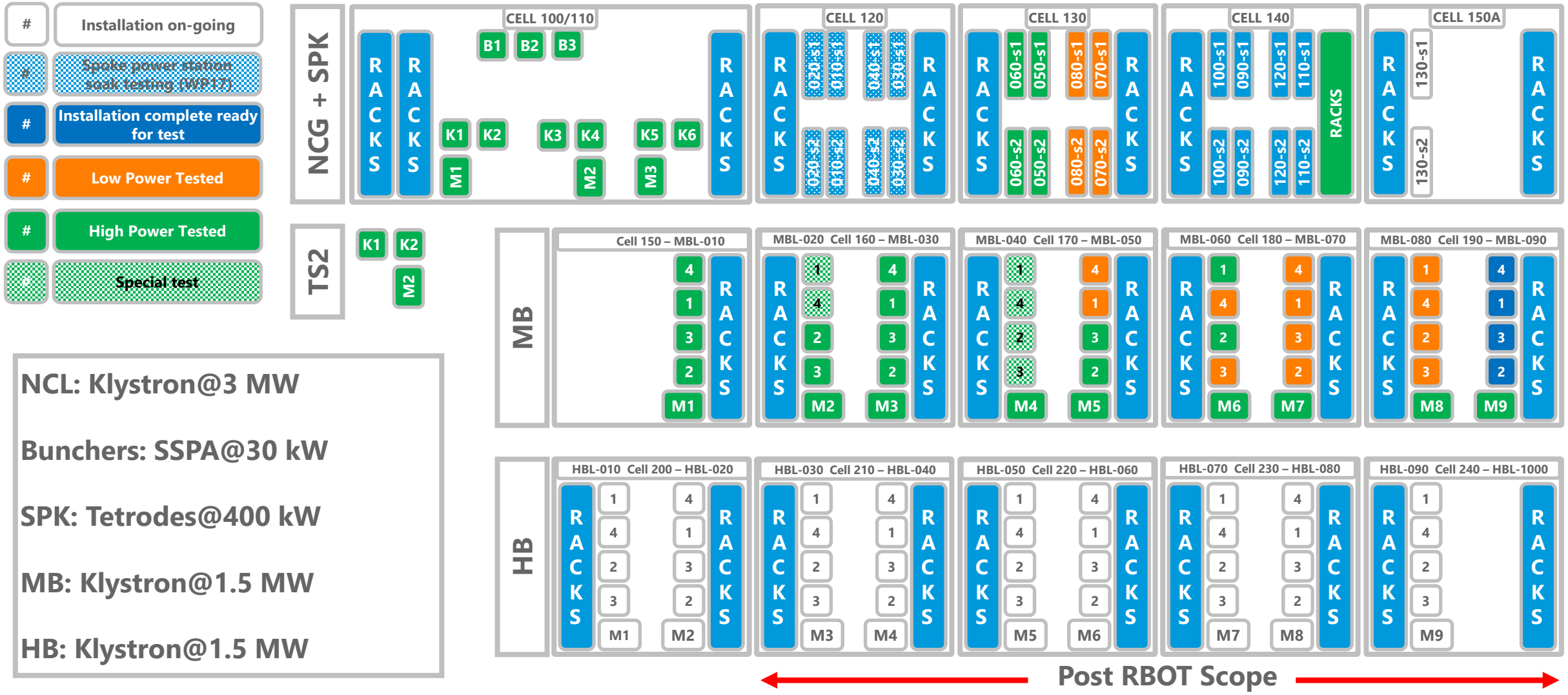
Key parameters:

Average Beam Power: 5 MW
Peak Beam Power: 125 MW
Beam pulse width: 2.86 ms
Beam energy: 2 GeV
Final Beam current: 62.5 mA peak
Repetition rate: 14 Hz



Accelerator overview

RFDS status



NCL: Klystron@3 MW

Bunchers: SSPA@30 kW

SPK: Tetrodes@400 kW

MB: Klystron@1.5 MW

HB: Klystron@1.5 MW

Accelerator overview

RFDS status – G02 gallery

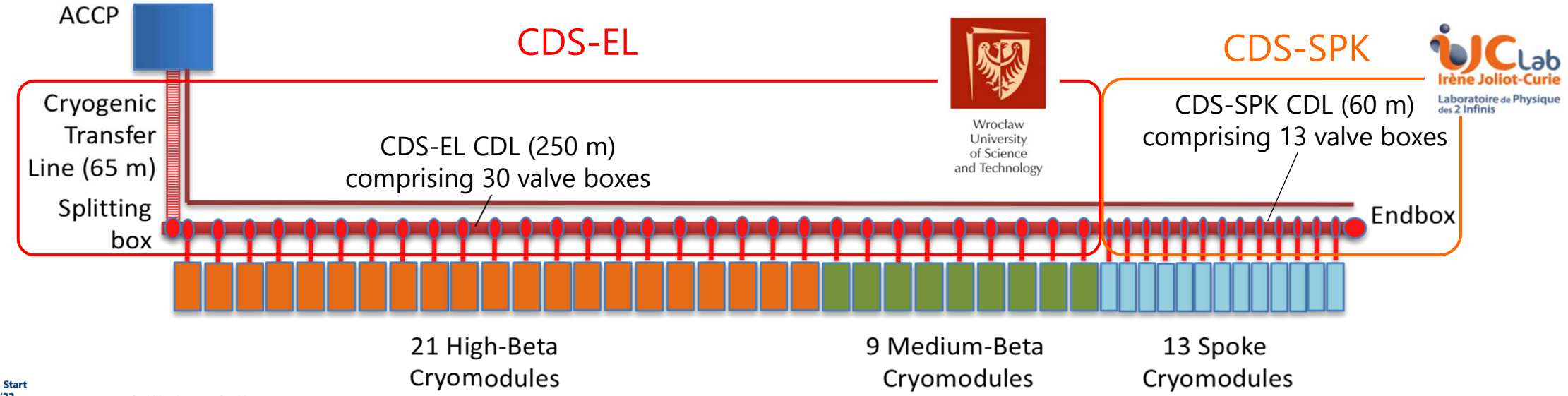
High beta modulator

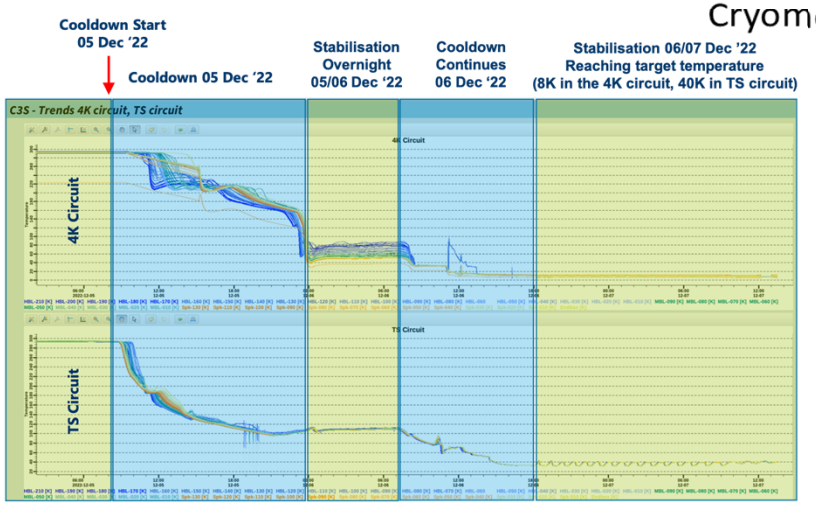
RF waveguides in the klystron gallery

Overview and Status of ESS RF Systems, M. Jensen, IPAC 2023

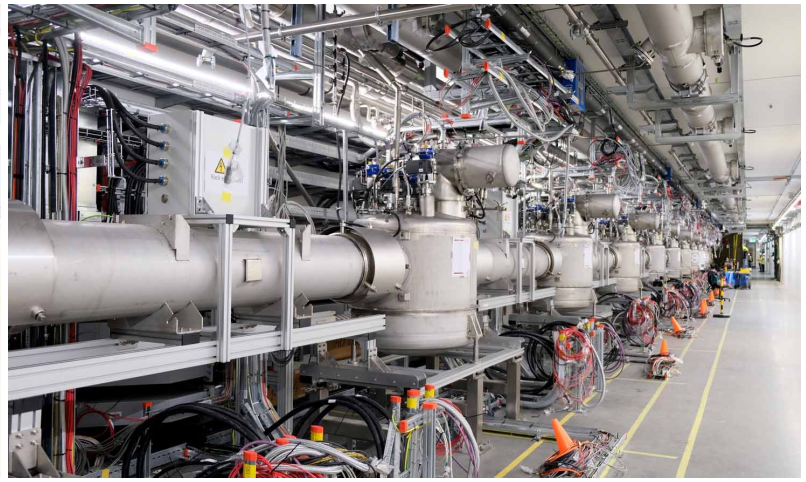
Accelerator overview

CDS status





... and then the fun just started...



P. Arnold, ECD 2023

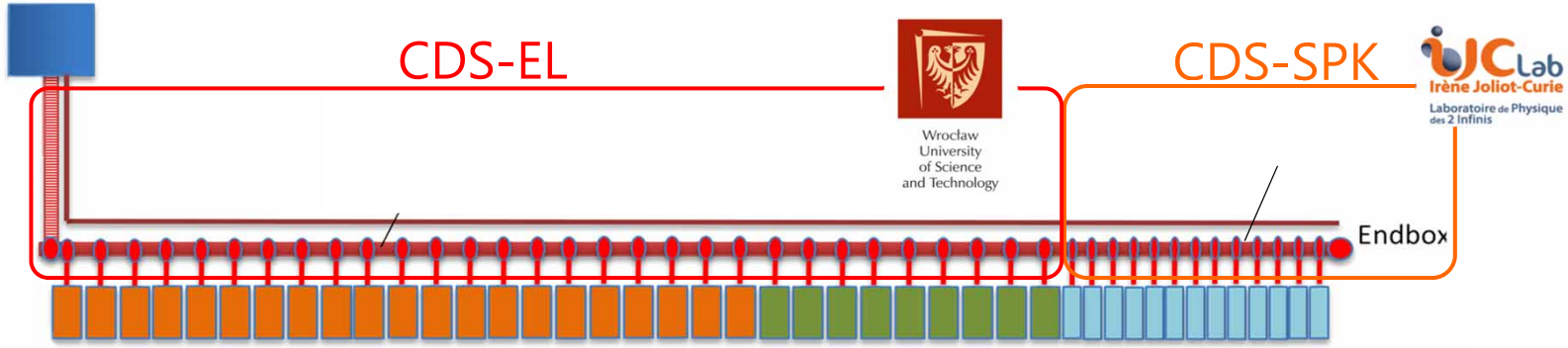
Accelerator overview

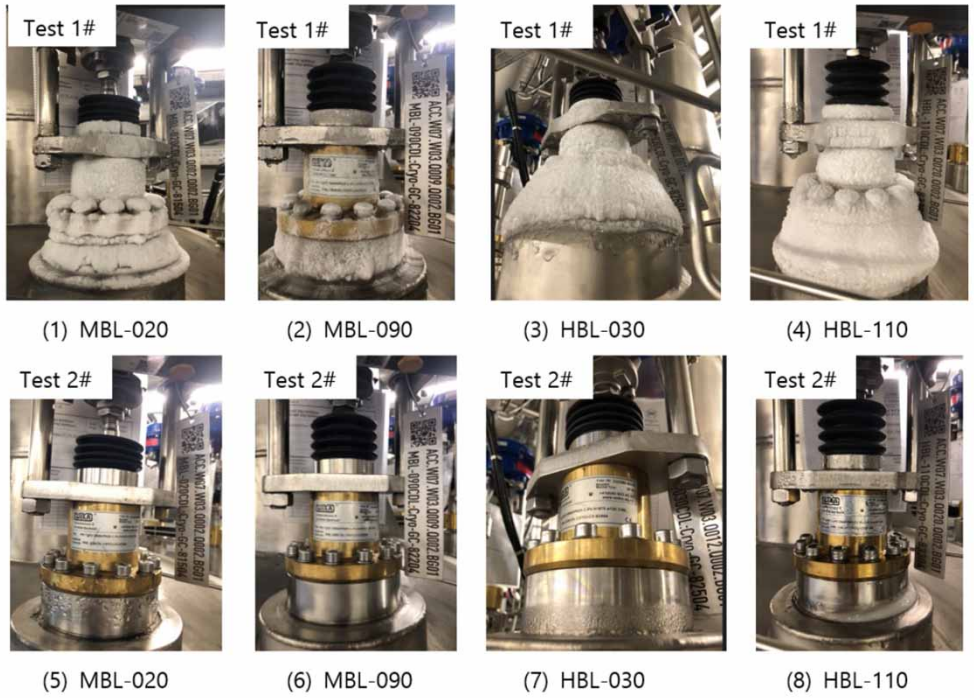
CDS commissioning

Leaky valve seats

SV calibration
<3 barg

Noise/vibration
25/30 CDS-EL



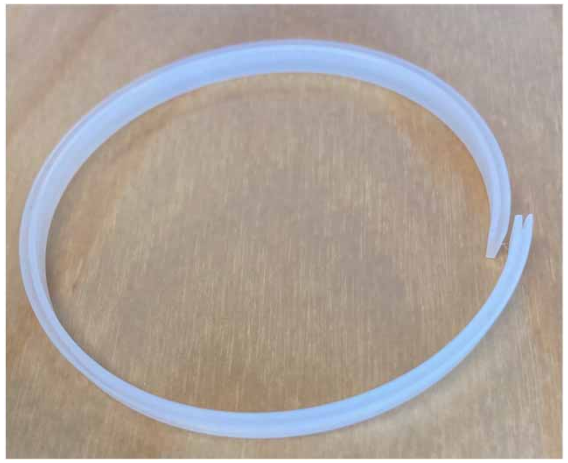


TAO effect CDS-EL (CV04 - VLP)
Endbox

Accelerator overview

CDS repairs - TAO

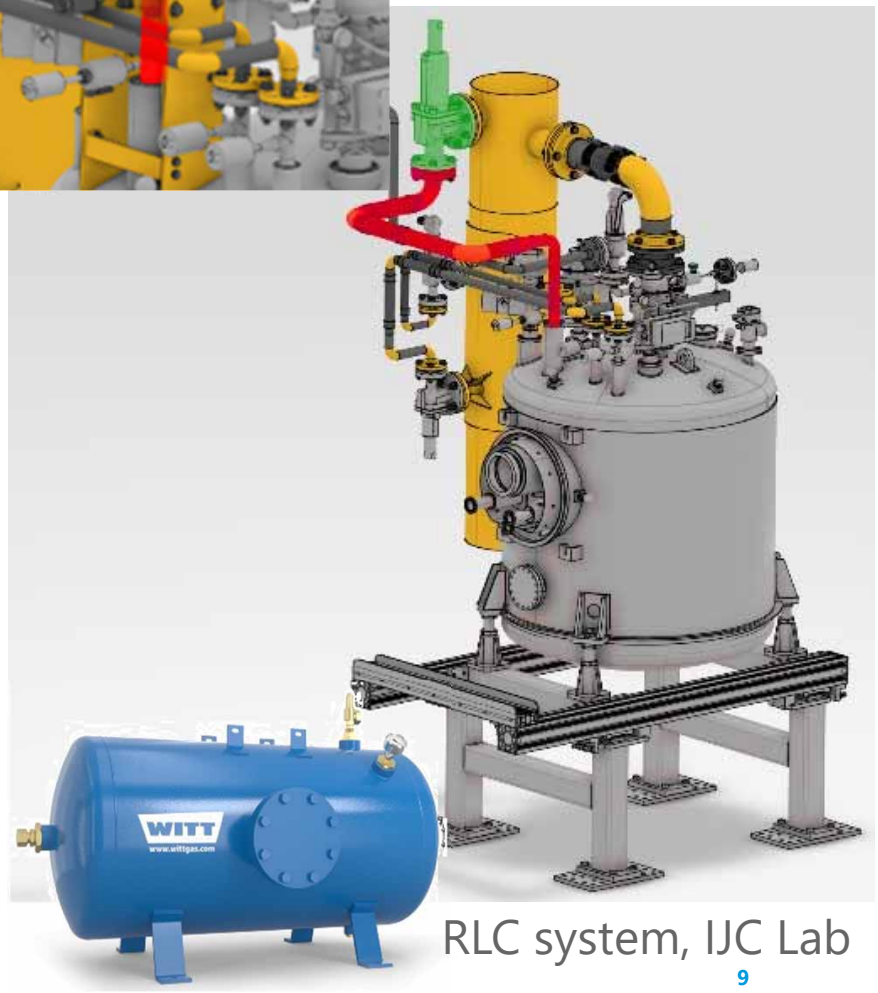
30 CV04 Valve stem dismounted



WEKA V-rings

CV04 Valve stem modified

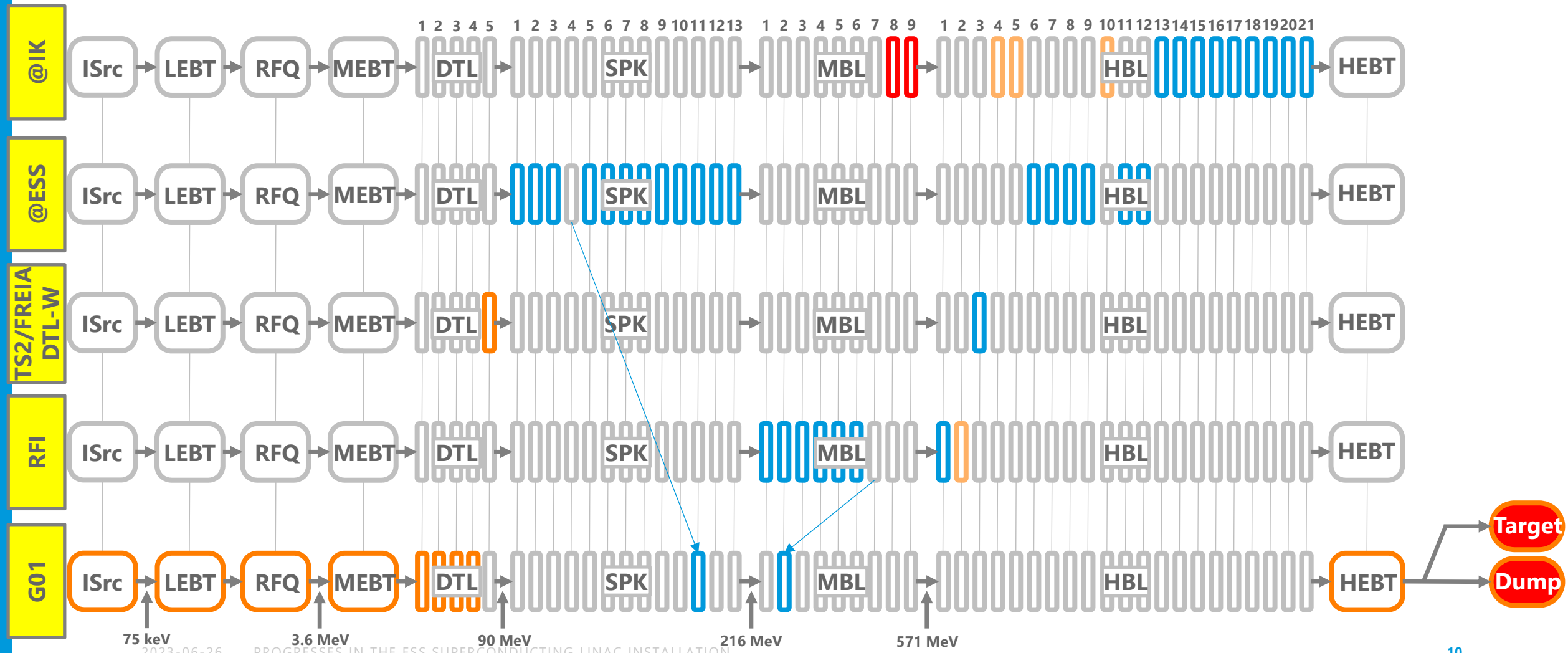
Endbox modifications



RLC system, IJC Lab

Accelerator overview

Cavity/Cryomodule status



Spoke Cryomodule

Status

Scope: 13 cryomodules + 1 spare

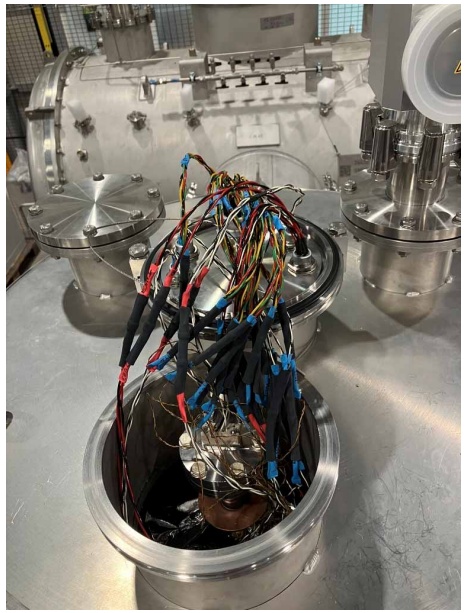
13 Cryomodules at ESS

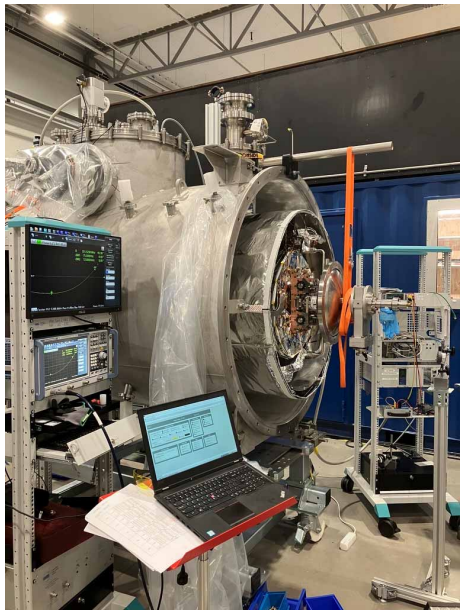
Non-conformities

- LHe level gauges
- Fasteners material
- Cold Tuning System – Stepper motor
  - VSS32 lifetime
  - Stepper motor replacement CM05/CM07/CM11 >100k revolutions
- Ready for Installation
  - Opening 11 CM
  - Elec. incoming / vacuum tests

Completion of Testing Series Double-spoke Cavity Cryomodules for ESS, Rocio Santiago Kern, Uppsala University, MOPMB094 - THIAA03

Performance Analysis of Spoke Resonators, Statistics from Cavity Fabrication to Cryomodule Testing, Akira Miyazaki, IJC Lab, THIAA04



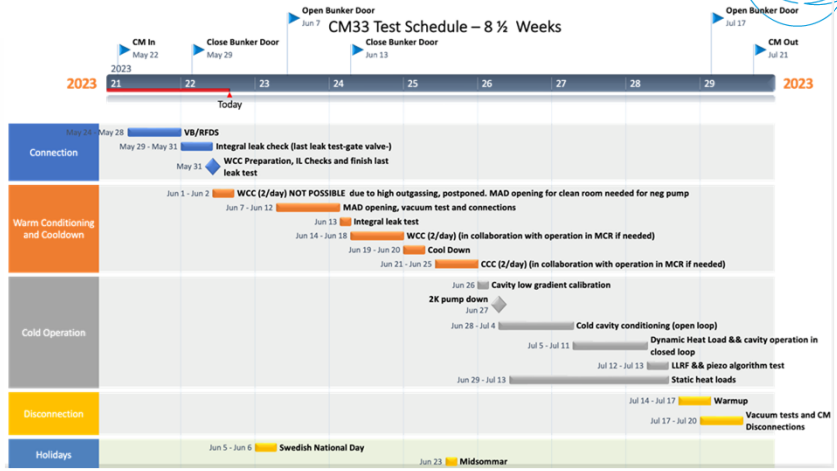


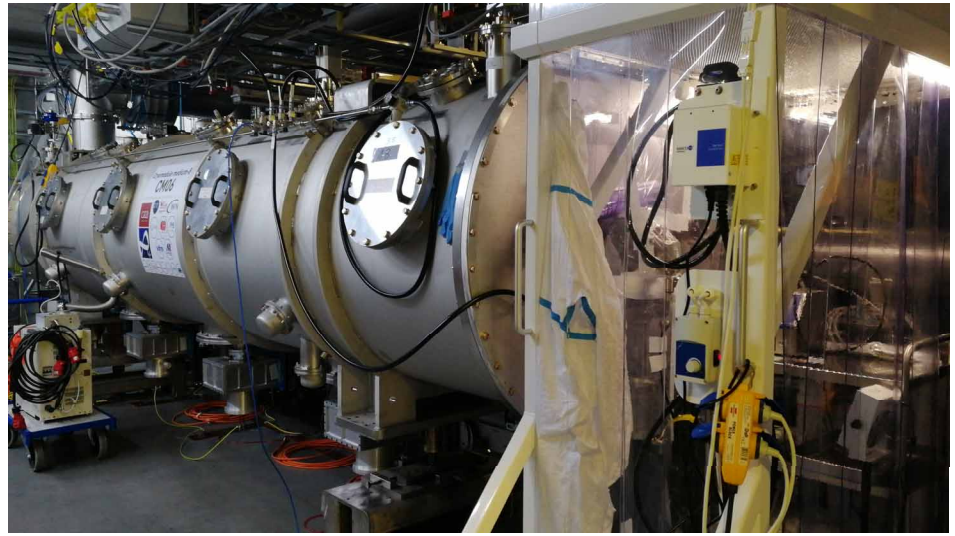
Elliptical Cryomodule

ESS Test stand 2 - Site Acceptance Test

Documented workflow -

Testing time (statistics)





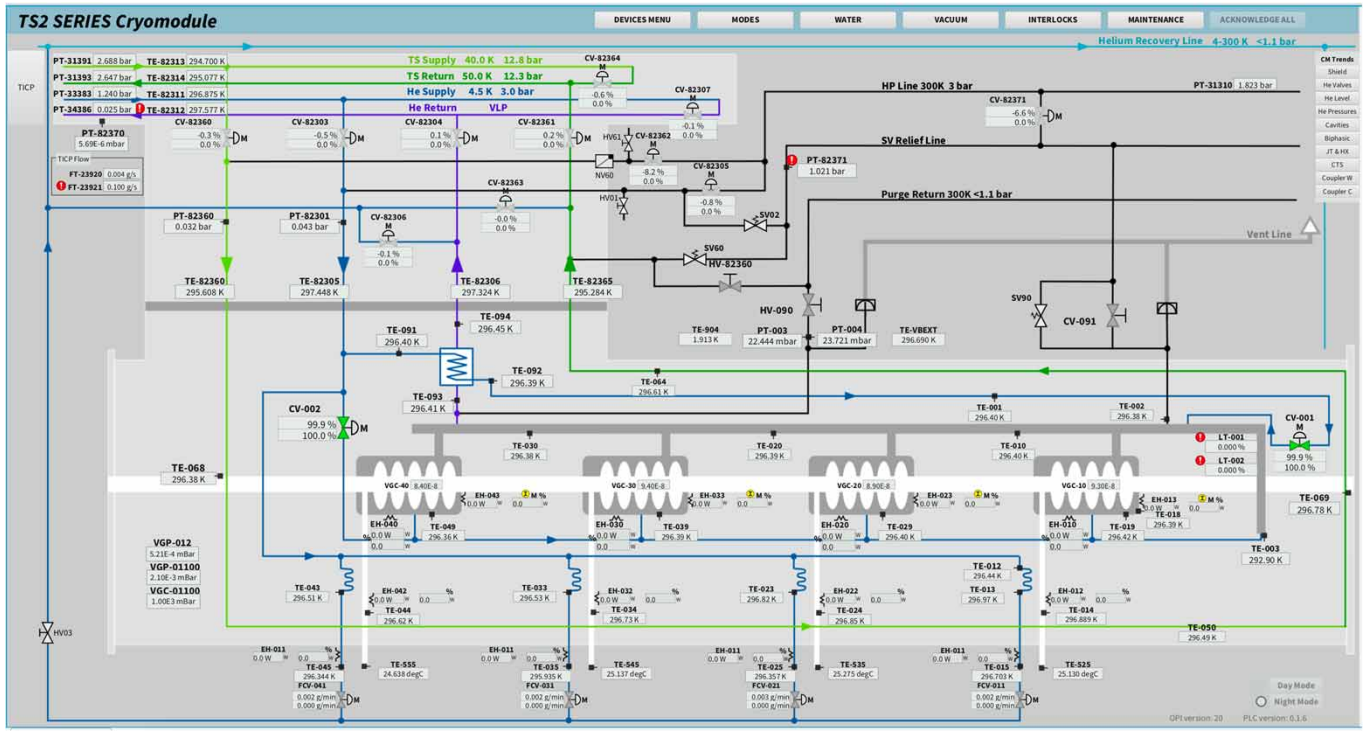
Transport, mechanical & electrical incomings

Preparation to Bunker (installation, vacuum, RF)

CM in the bunker (vacuum, cryo, RF)

Elliptical Cryomodule

Cryogenic operations



Installation, verification,

Cool-down TS-35K/4.2K/2K

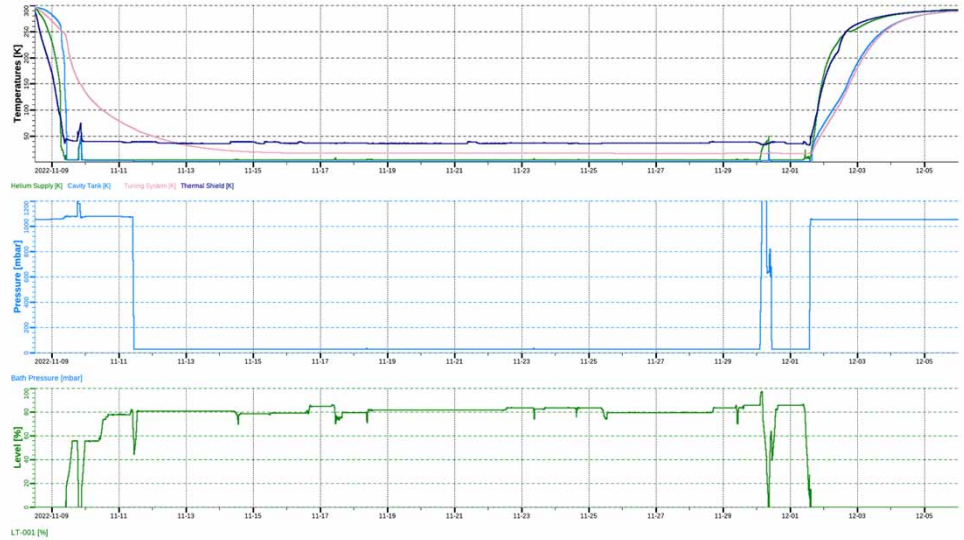
Stable conditions for SRF operation

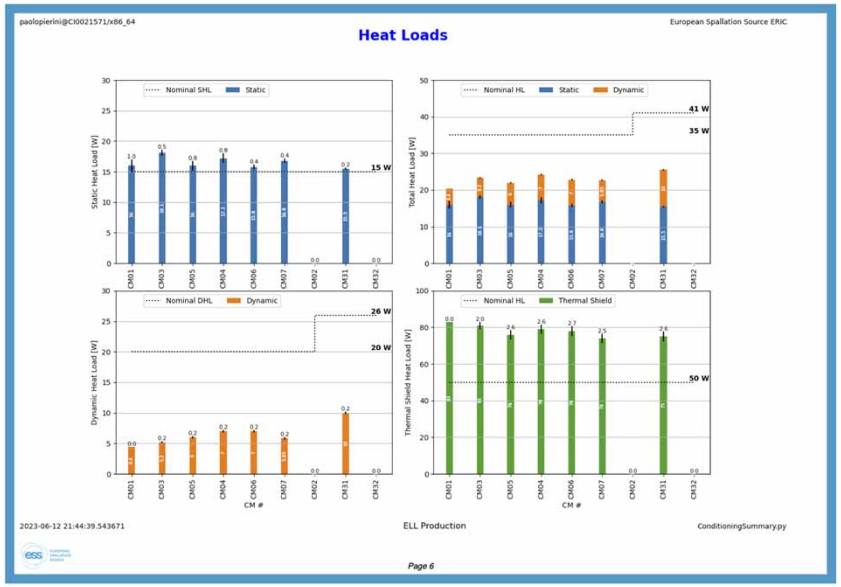
Heat load measurements
Cryo-performance studies

Disconnection

Warm-up

CM31

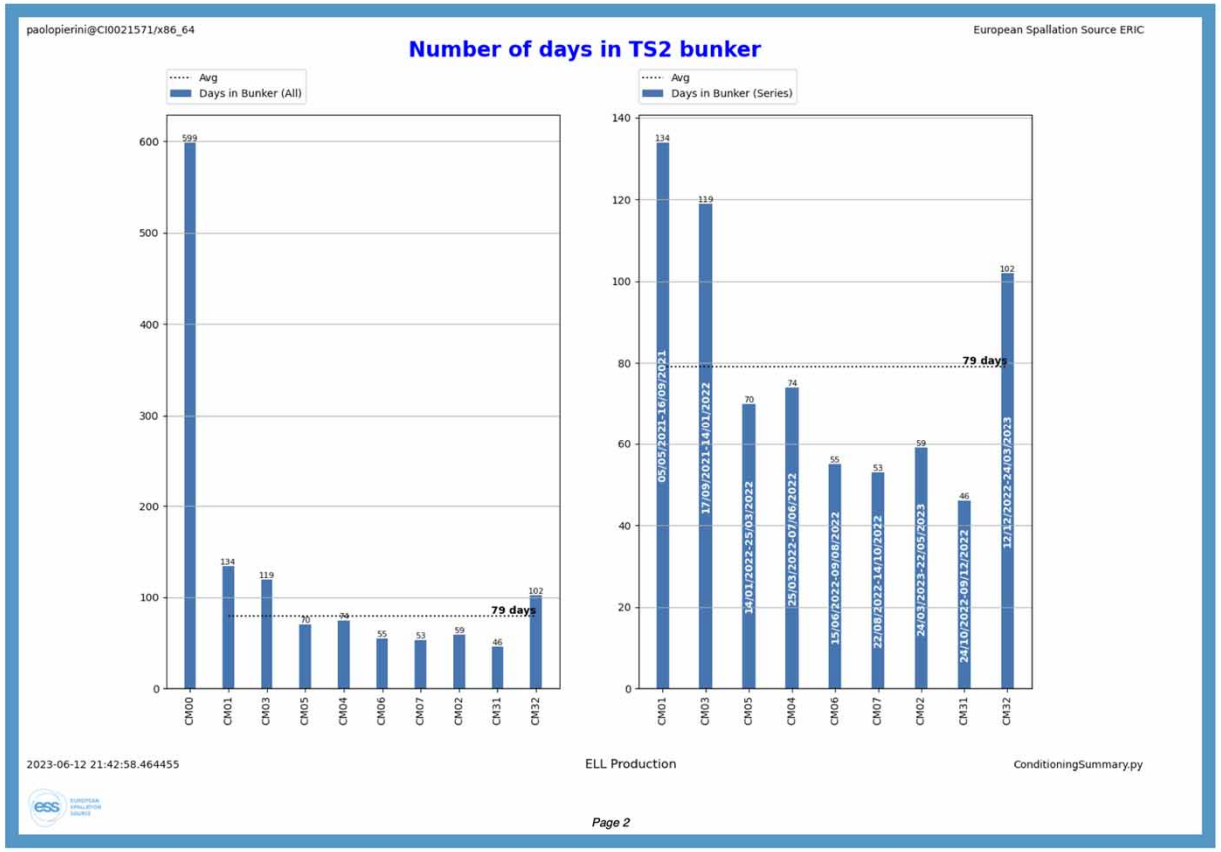


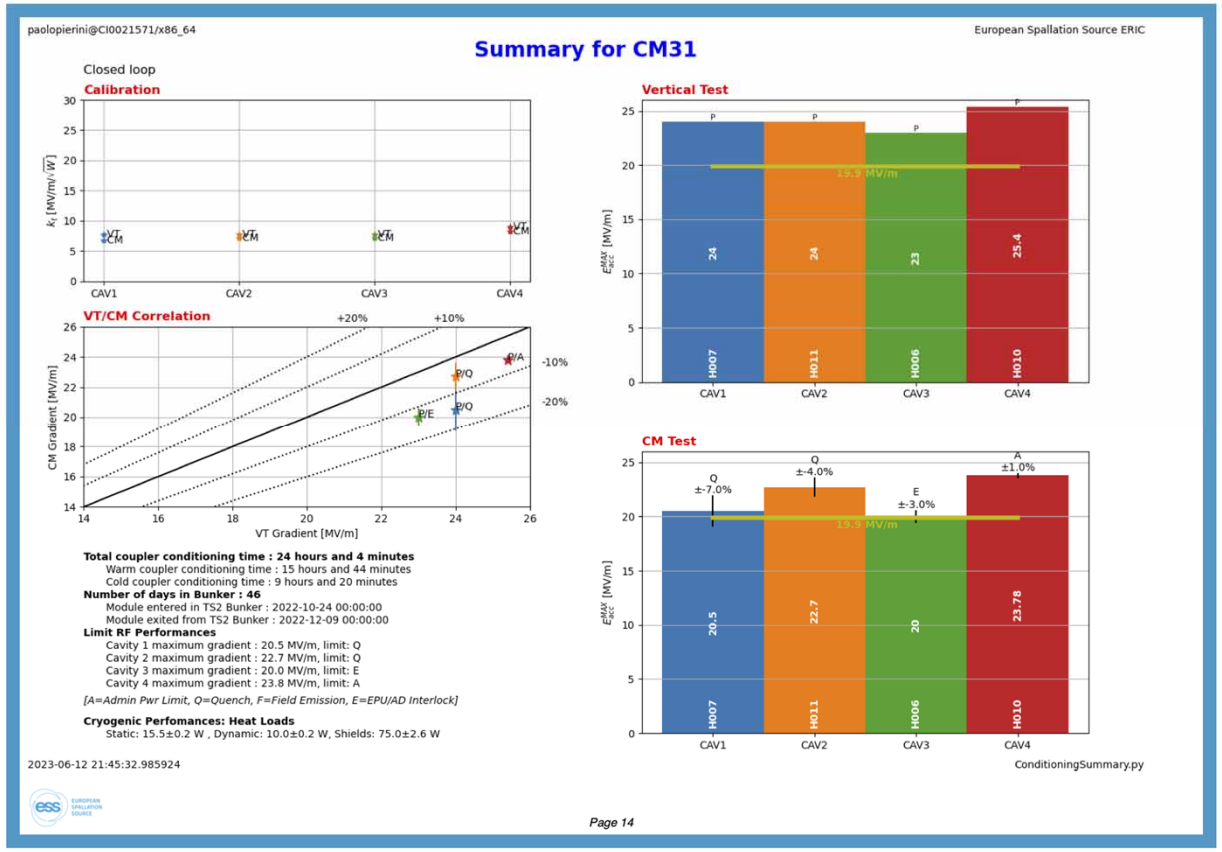


Elliptical Cryomodule

ESS test summary

CM00 used to commission the facility





Progress of Elliptical Cryomodule Testing at TS2, Philippe Goudket, ESS, Lund, MOPMB060

Pilot installation

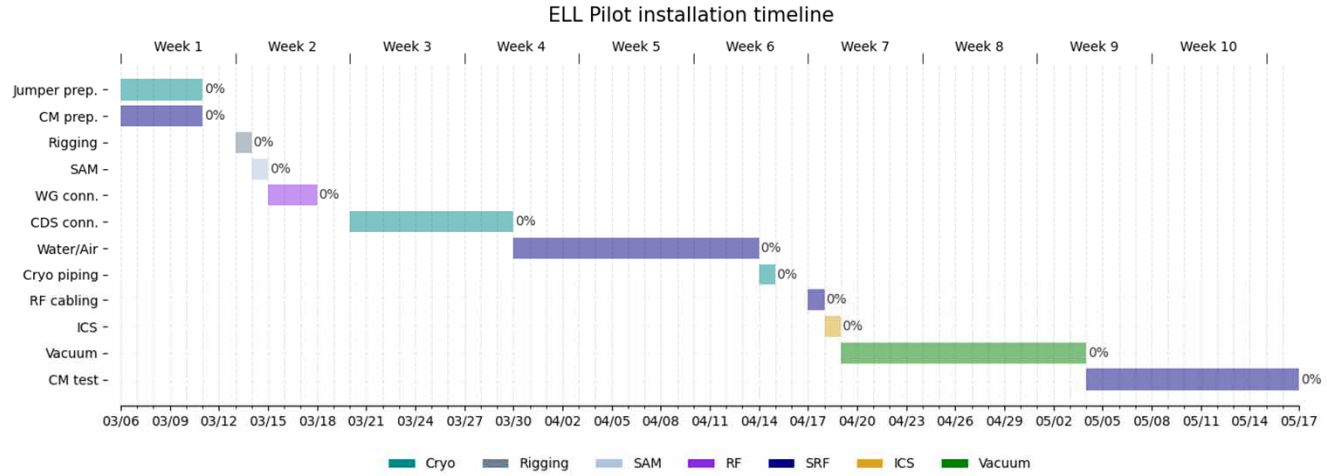
March’23 – June’23

Installation in the ESS tunnel

Spoke and Elliptical cryomodules

Complete installation scheme

1. Transport
2. Alignment(s)
3. CDS connections
4. SPK – Doorknob installation
5. RF waveguides connections
6. Vacuum tests
7. Piping work
8. Cable connections

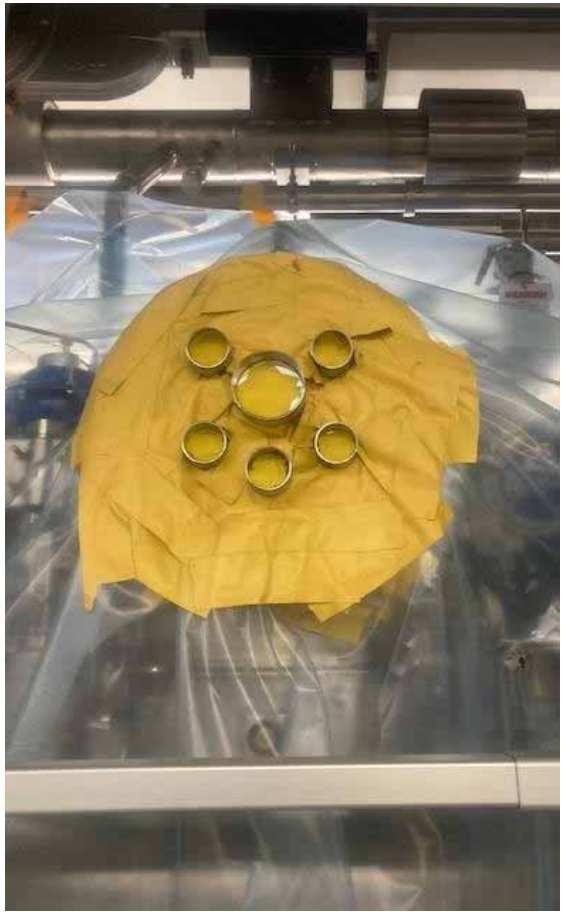


1 SPK CM and 1 ELL CM installed in parallel

Installation in the ESS tunnel

Preparation work

CDS SPK & ELL



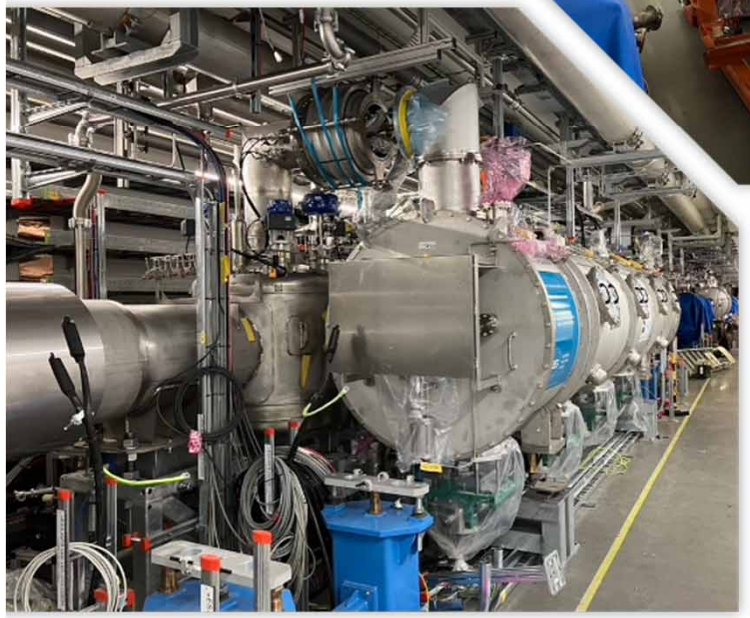
SPK CM

ELL CM

Installation in the ESS tunnel

Transport and positioning

ELL CM07 transport



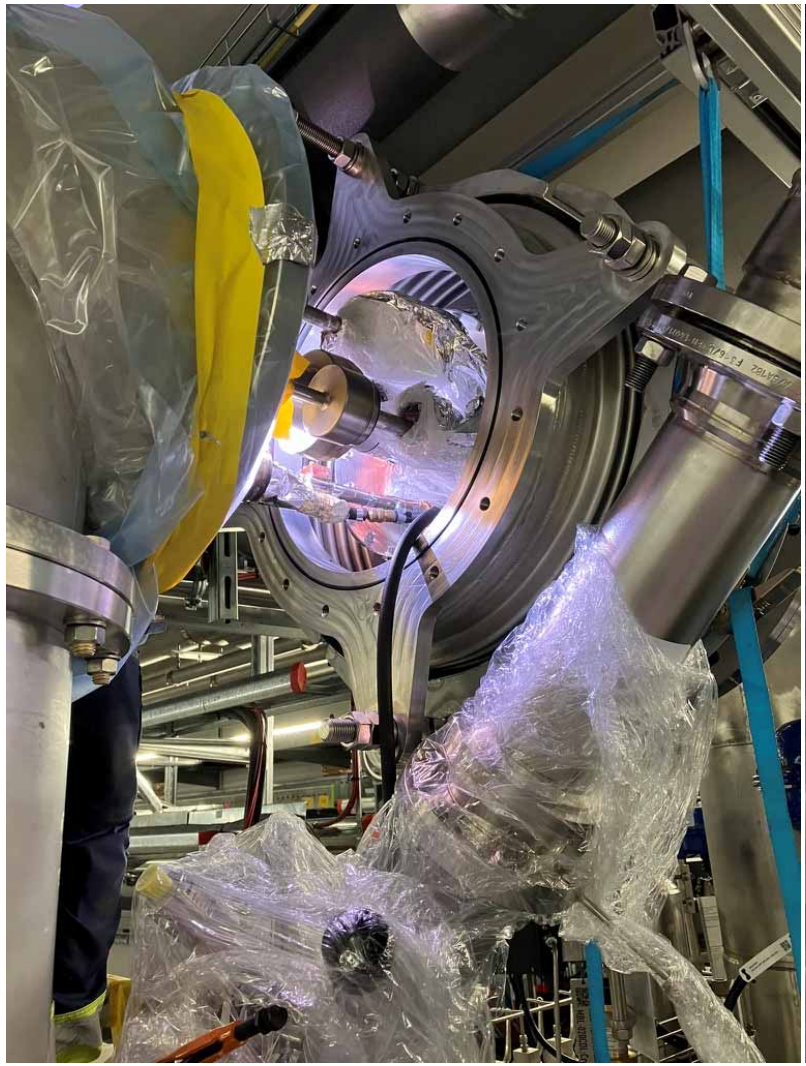
ELL CM07 on its support

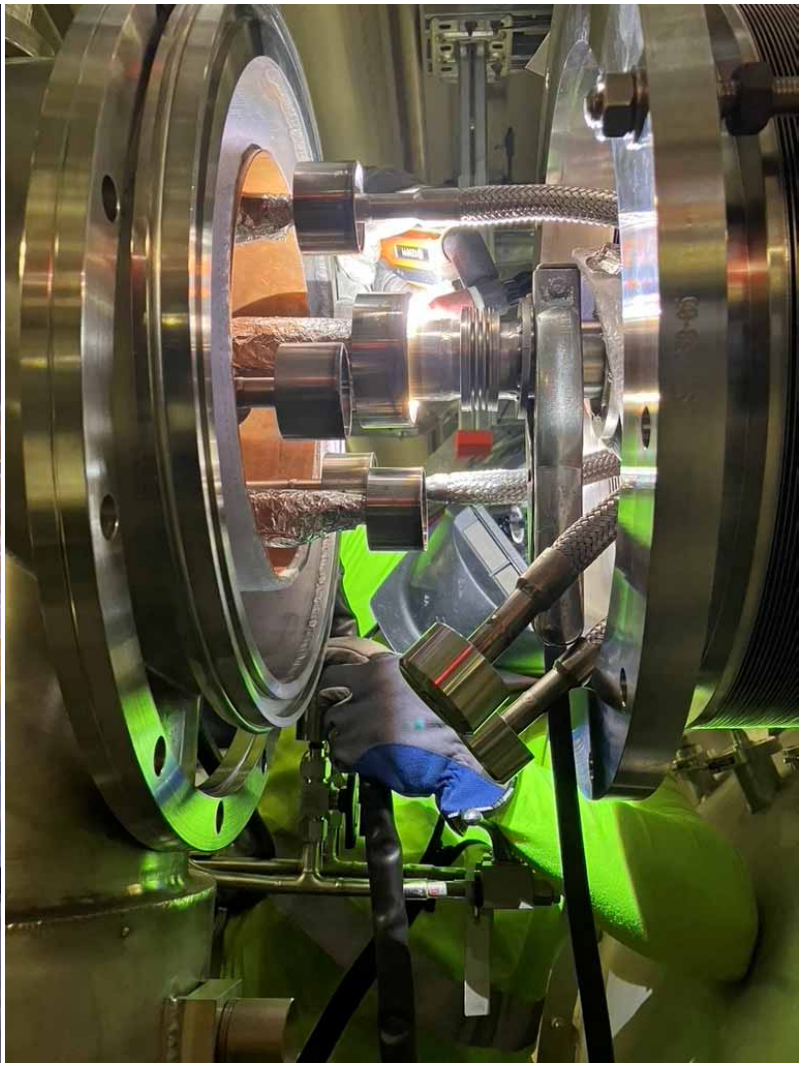
SPK CM04

Strong participation of the rigging and alignment groups

Installation in the ESS tunnel

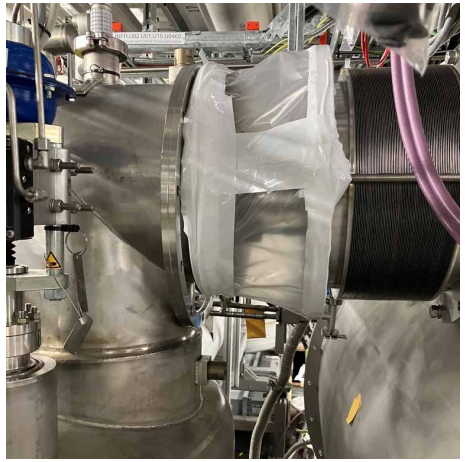
Connection to the CDS



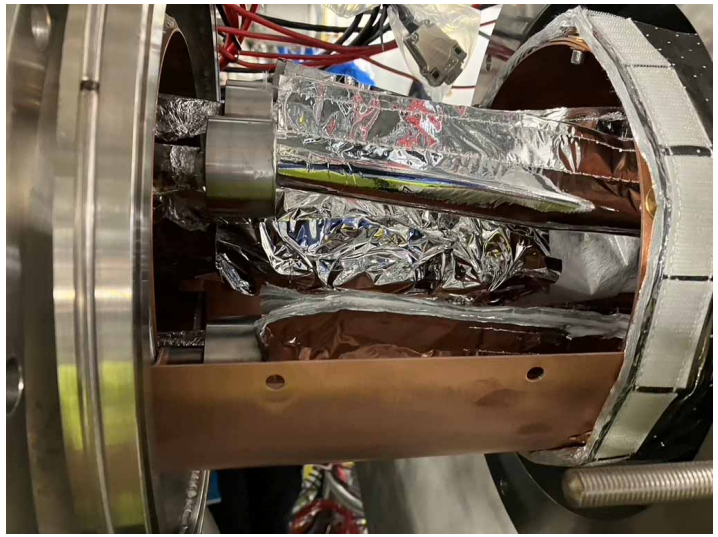


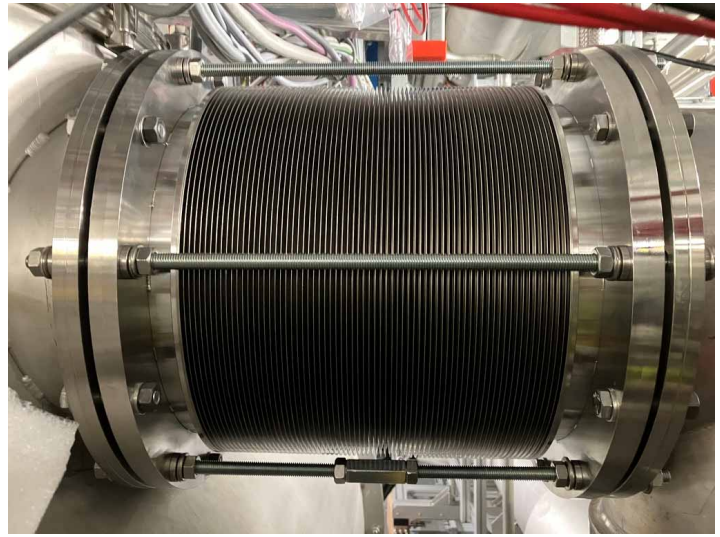
Installation in the ESS tunnel

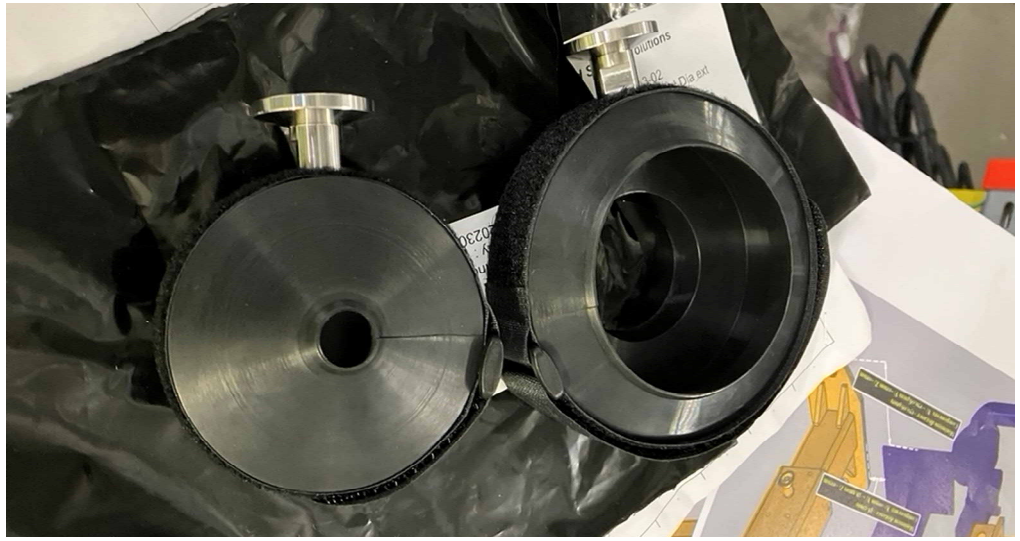
He leak tests and jumper connection



Bagging method / clamp shells

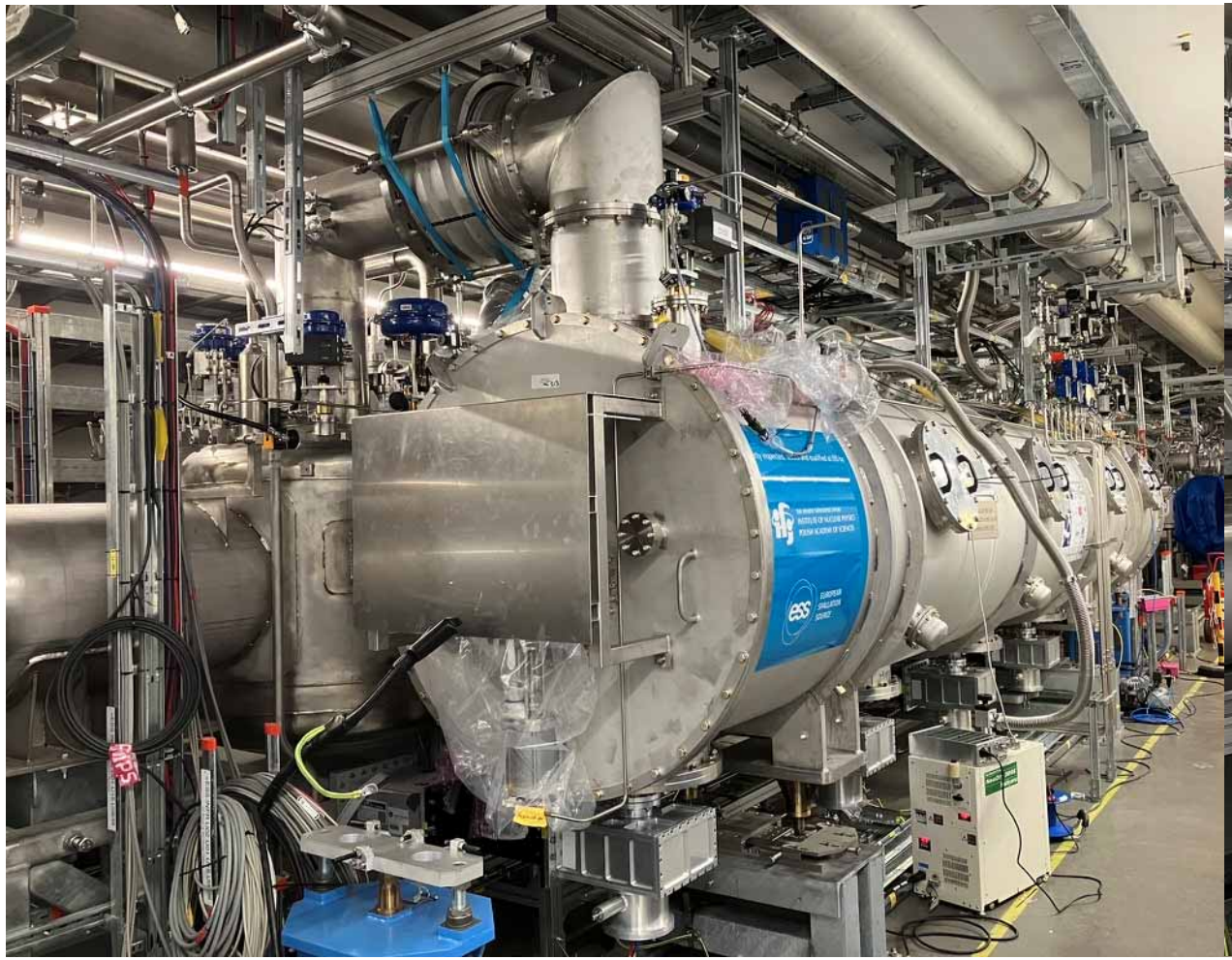


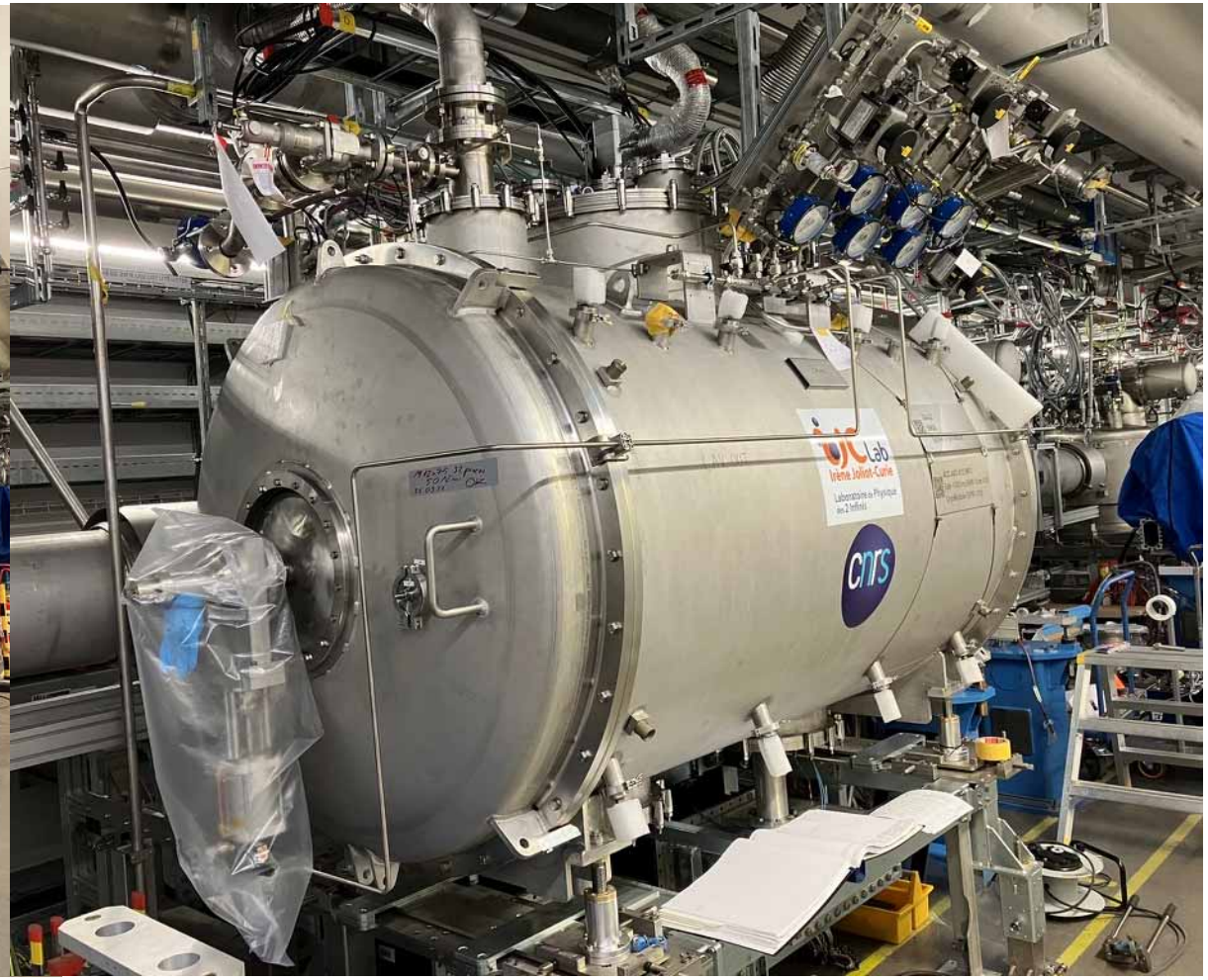




Installation in the ESS tunnel

Installation completed





Many more activities were completed such as the RF waveguides installation, cable connections and piping work!

Installation in the ESS tunnel

“Lessons learned”

The good installation procedure / sequence / tooling

Elliptical cryomodule (TS2 experience)

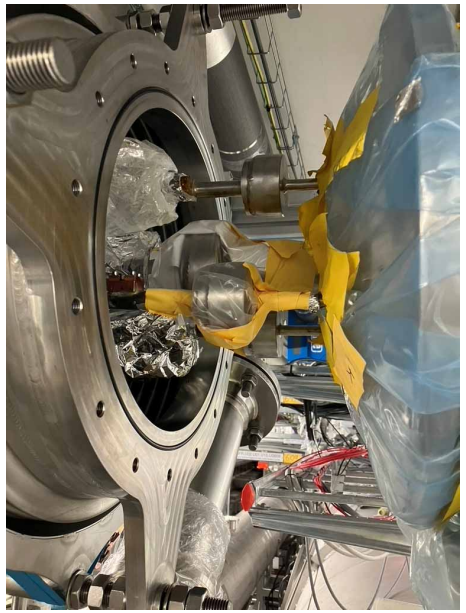
- Jumper DN450 bellows
- Process pipe cups / 1 leak found
- Waveguide connections

Spoke cryomodule

- Process pipe cups
- Doorknob assembly
- Access / clashes

Preparing the series installation

Getting ready to install 2 CM/month



Installation in the ESS tunnel

"Lessons learned"

The good installation procedure / sequence / tooling

Elliptical cryomodule (TS2 experience)

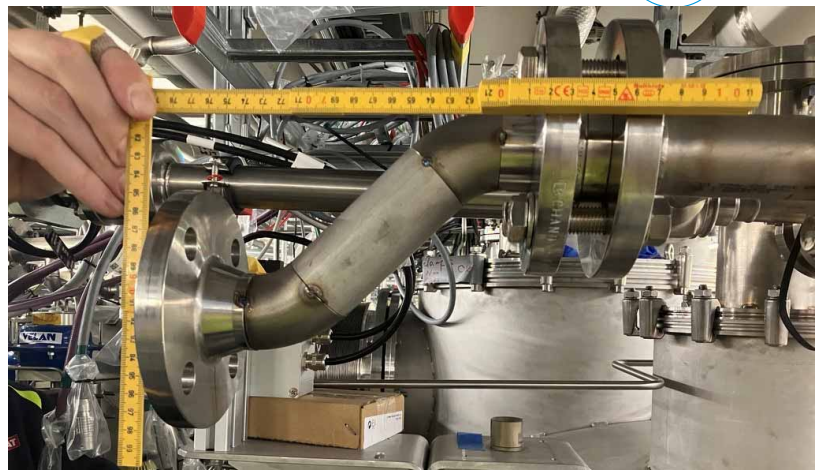
- Jumper DN450 bellows
- Process pipe cups / 1 leak found
- Waveguide connections

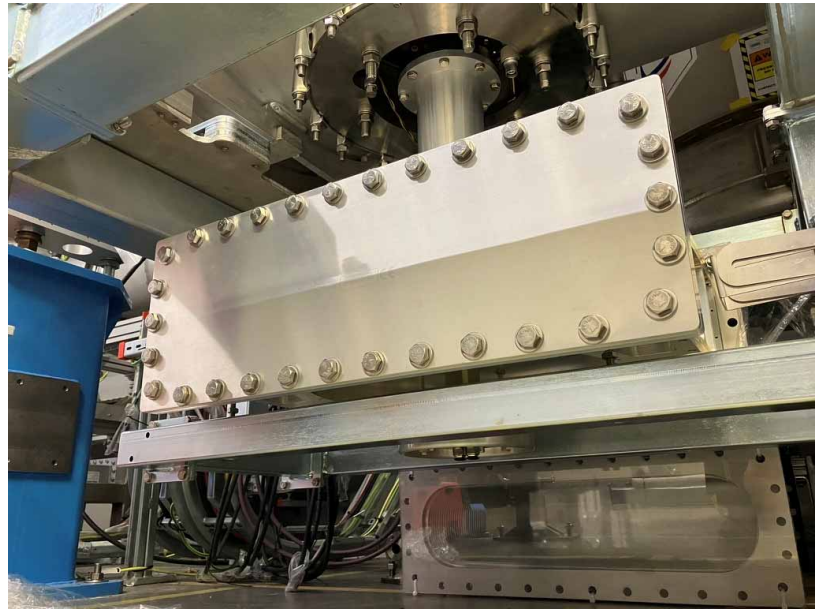
Spoke cryomodule

- Process pipe cups
- Doorknob assembly
- Access / clashes

Preparing the series installation

Getting ready to install 2 CM/month

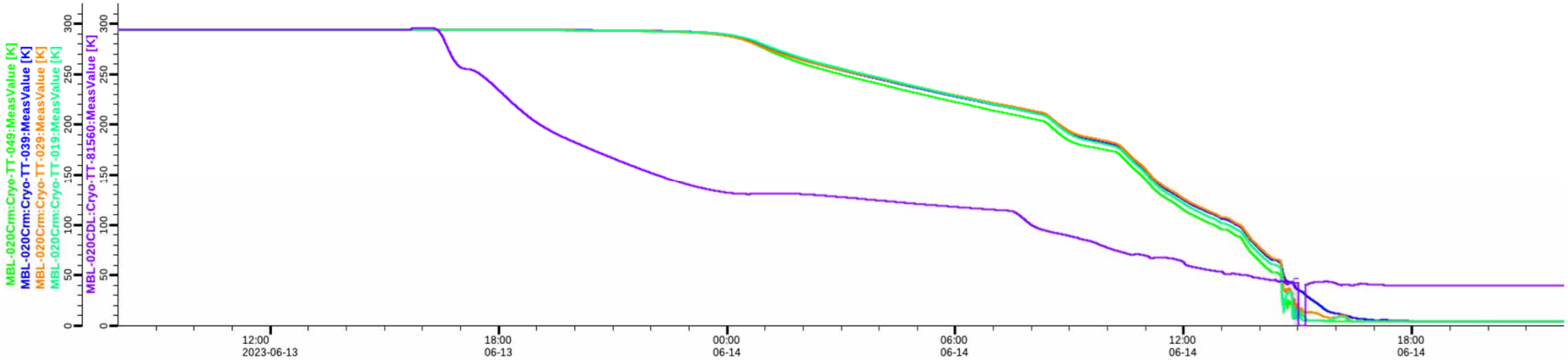




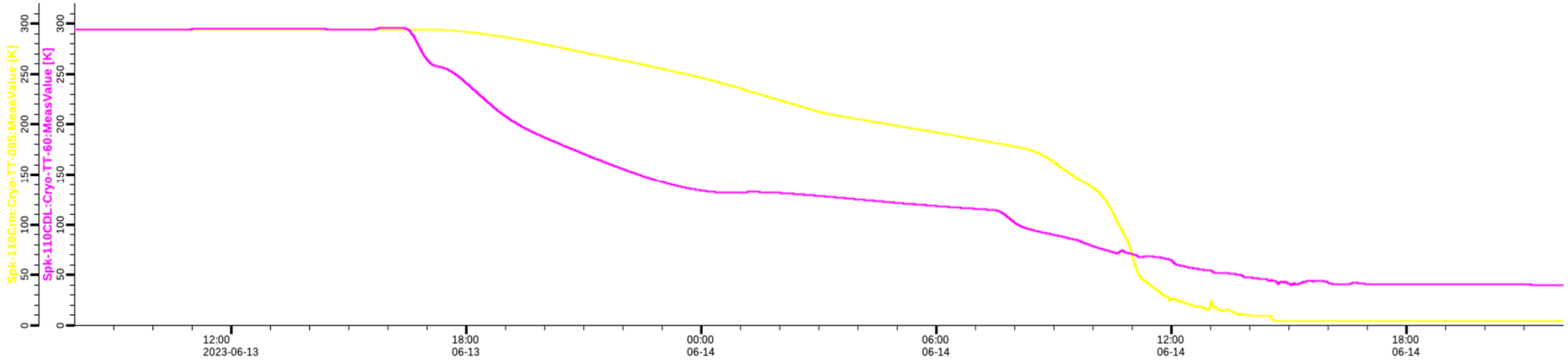
Cool down after the pilot installation

4K

ELL CM07



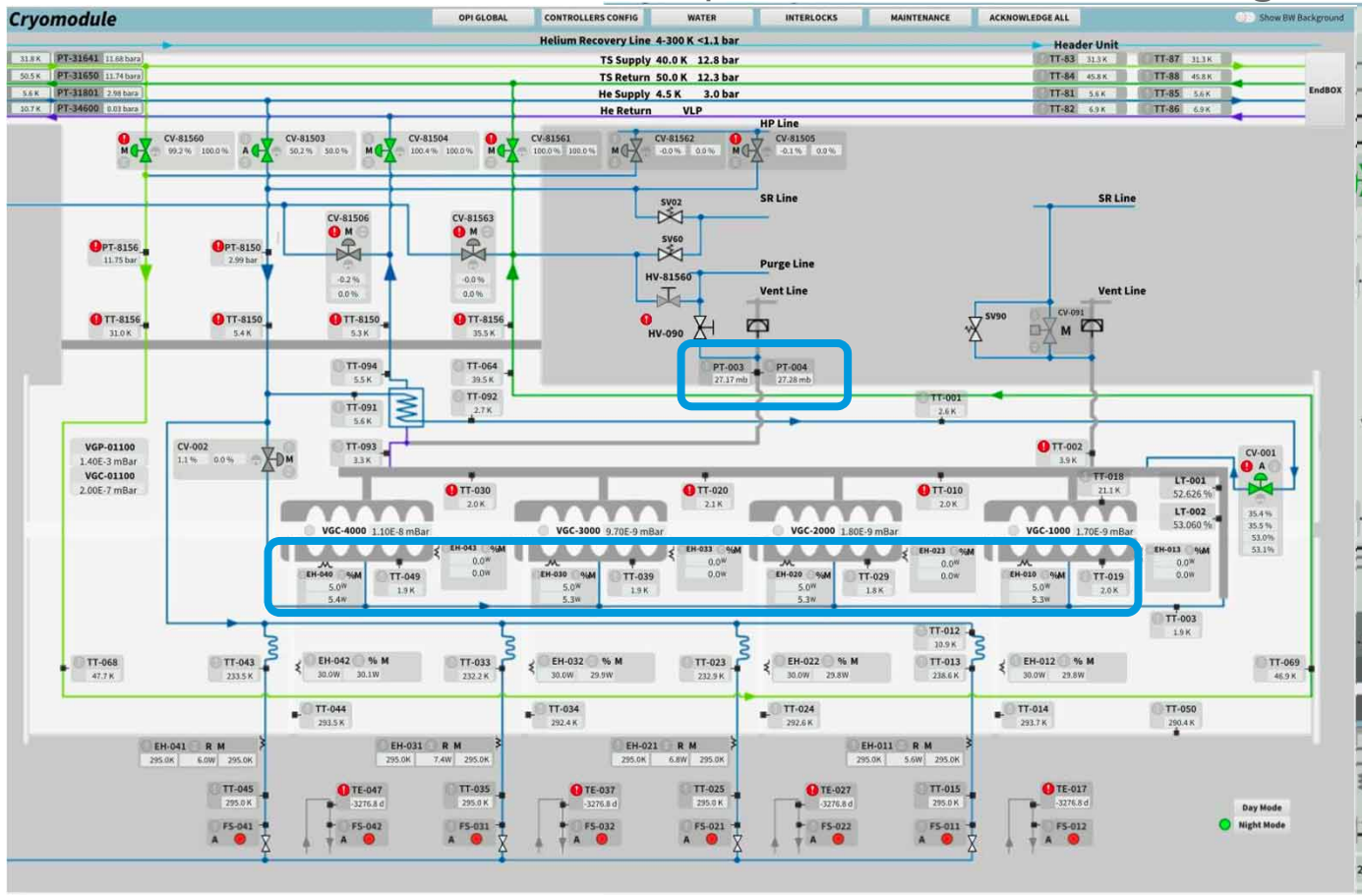
SPK CM04

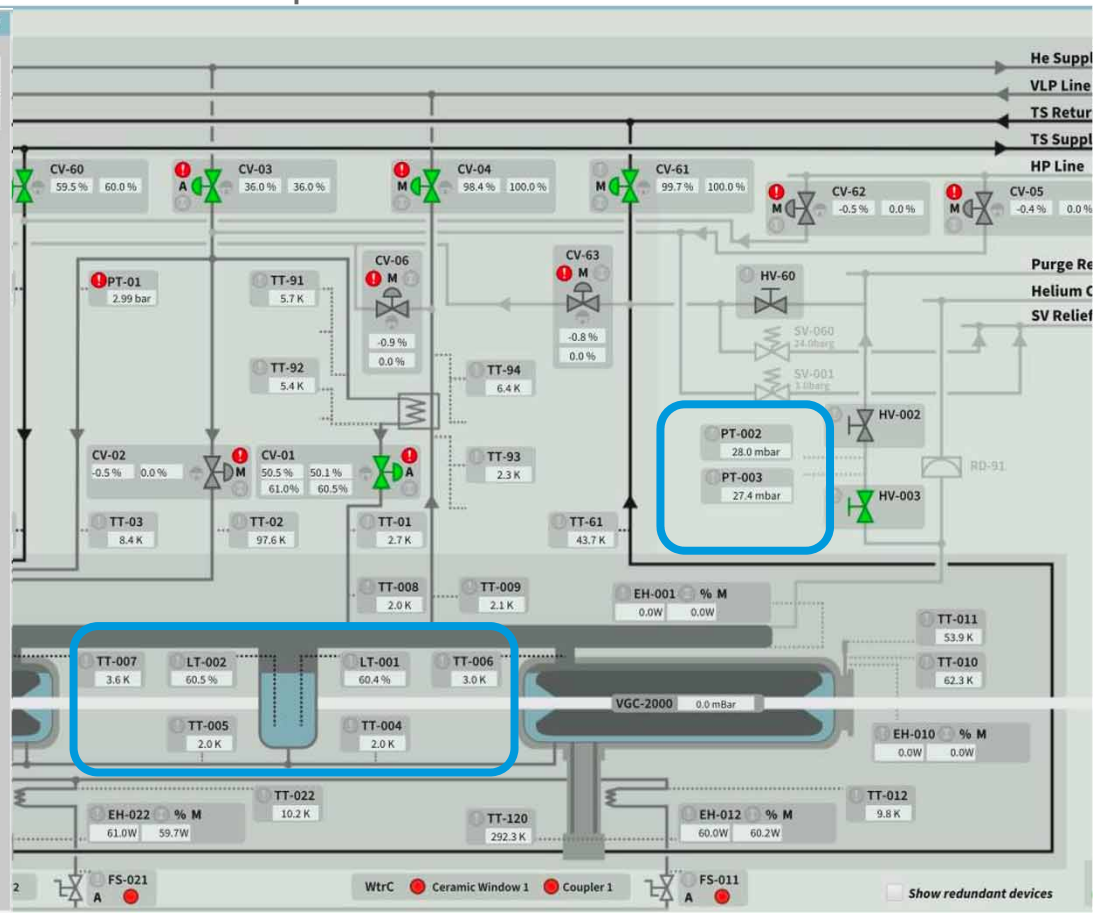


Cool down after the pilot installation

From 4K to 2K operations

ACCP Cold compressor start – LHe level regulation – no RF operations





ELL CM07 OPI

SPK CM04 OPI

Thank you for your attention