SPL

SPL R&D AT CERN

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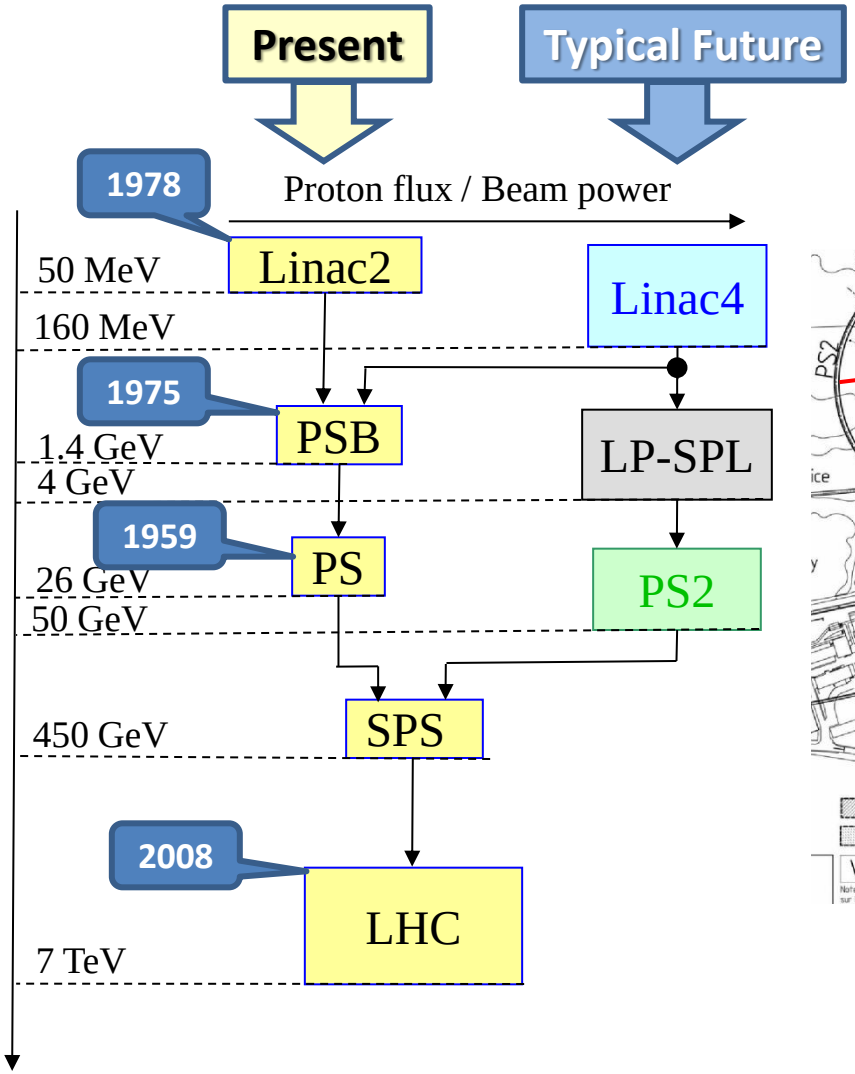
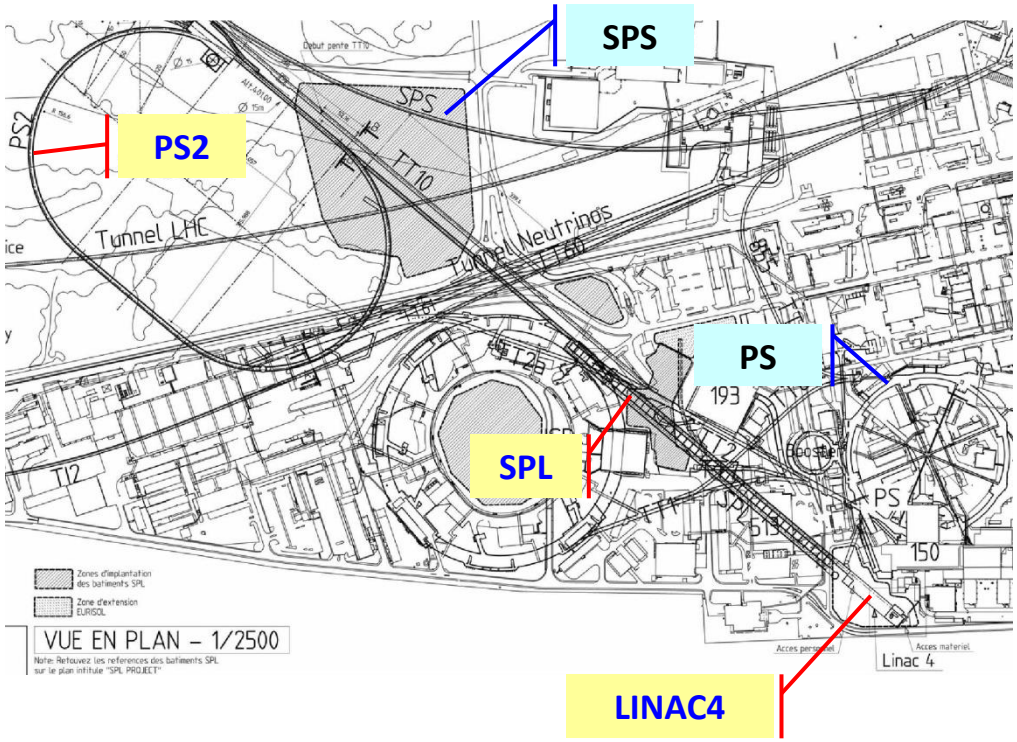
CERN motivation for the SPL R&D (1/3)

- Preserve the possibility of new injectors in the future (HE-LHC…)



LP-SPL: Low Power-Superconducting Proton Linac
PS2: High Energy PS (~ 5 to 50 GeV – 0.3 Hz)



CERN motivation for the SPL R&D (2/3)

- Options for neutrinos physics and/or Radioactive Ion Beam

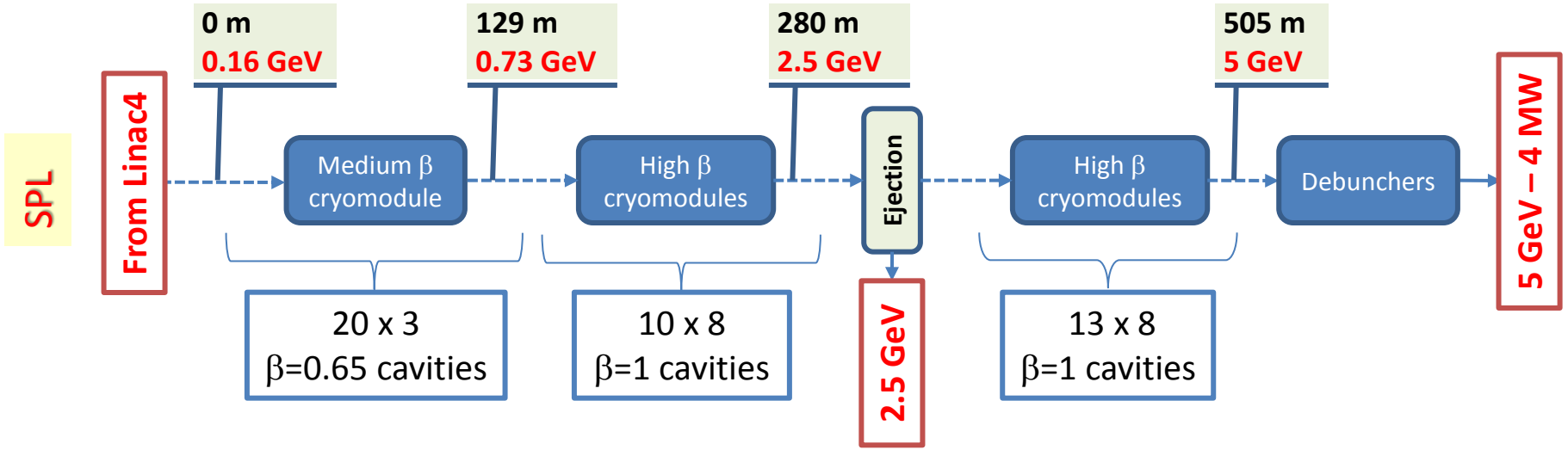
  Ex.: tentative layout of neutrino factory at CERN

CERN motivation for the SPL R&D (3/3)

- Update of CERN competencies in superconducting RF
- Upgrade of CERN infrastructure for superconducting RF (SM18 clean room, High Power RF, High Pressure Water Rinsing facility, Diagnostics for SC RF, New e-beam welding machine, Electropolishing installation, etc.)
- Synergy with other applications at CERN (LHeC electron linac, LEP-3…) as well as outside of CERN (ESS, ADS…)

SPL block diagram

- SC-linac [160 MeV ® 5 GeV] with ejection at intermediate energy



- Medium beta cavities beta = 0.65
- High beta cavities beta = 1

Length: ~500 m

SPL developments for cavities

- Medium beta cavities $\beta = 0.65$
  - Developed by IPN Orsay (Guillaume Olry et al.) to be tested at CEA Saclay in Cryho-lab

- High beta cavities $\beta = 1$
  - Developed by CEA Saclay (Guillaume Devanz et al.) to be tested at CEA Saclay in Cryho-lab

  - Developed by CERN for tests at CERN (SM18) in Short cryo-module of 4 cavities

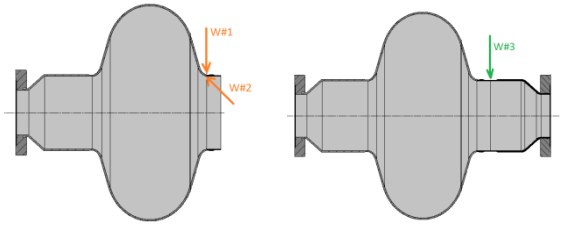
Niobium cavities from industry (RI)

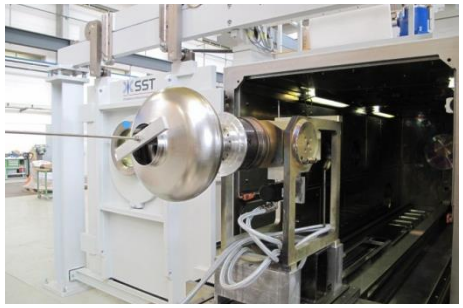
- 4 Niobium cavities fabricated and delivered by RI

Niobium cavities at CERN

REPAIR OF FIRST MONOCELL

Material defects observed after electro-polishing.
Repaired with new e-beam welding machine from outside (W#1 and W#3) and inside (W#2)

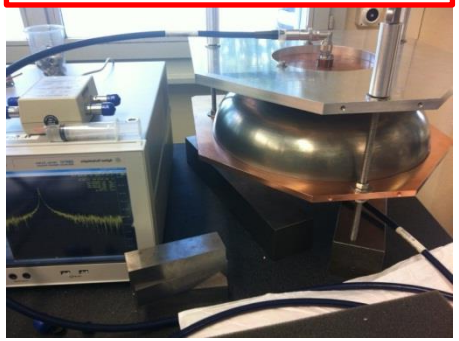




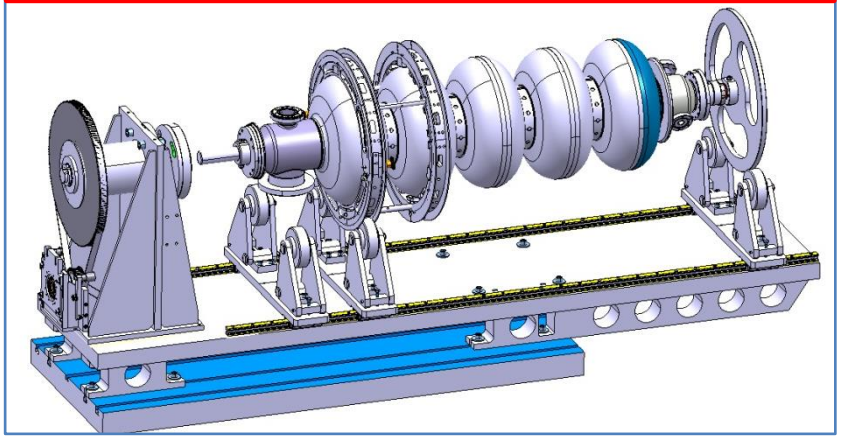
CAVITY FABRICATION AT CERN

Half-cells and beam tubes fabricated by spinning.

RF measurements.



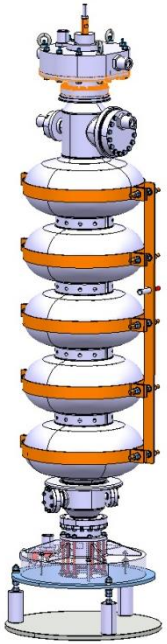
Tooling for EB welding of Nb cavity is fabricated.



New e-beam welding machine

SPL Electro-Polishing (EP)

Tooling for EP

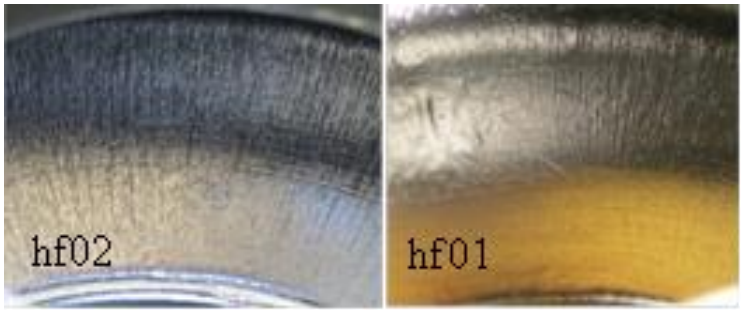


- 5 CELL ELECTROPOLISHING PREPARATION:

- Cathode and tooling manufacturing
- Improve main pump flow control and compressed air connection
- Allow crane direct acces to the electropolishing hut

- MONOCELL TESTS:

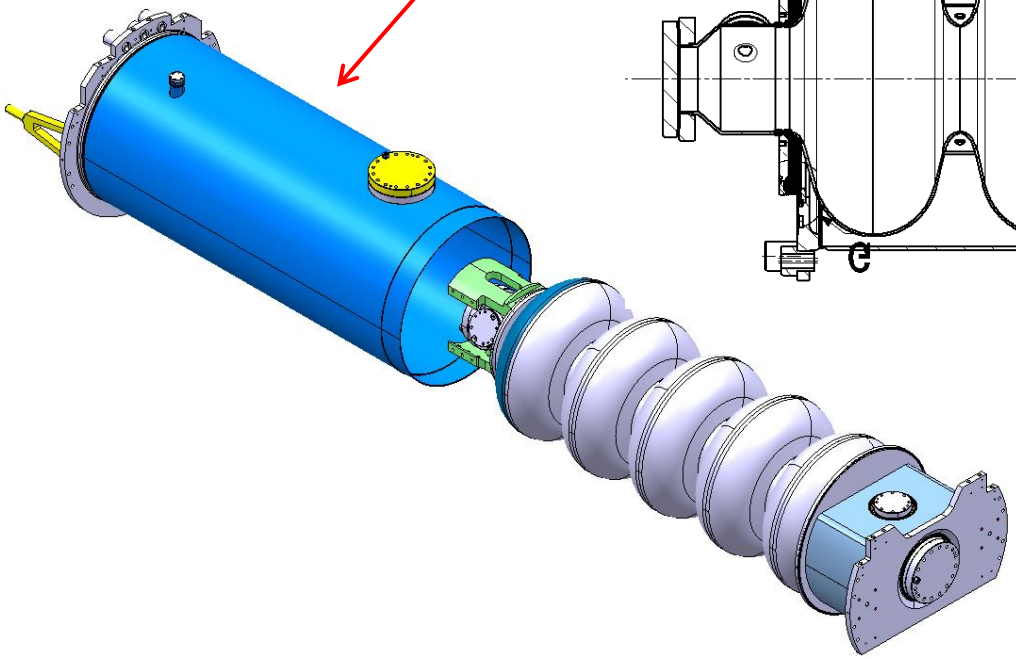
- A second set of electropolishing sessions were done to bring the total removed thickness to 200 microns.
- It was possible to set different working temperatures and compare them with the simulation data
- Working at lower temperatures results in less pitting.
- Cavity is currently undergoing RF test
- Paper TUP047 bat SRF with all multiphysics simulation details

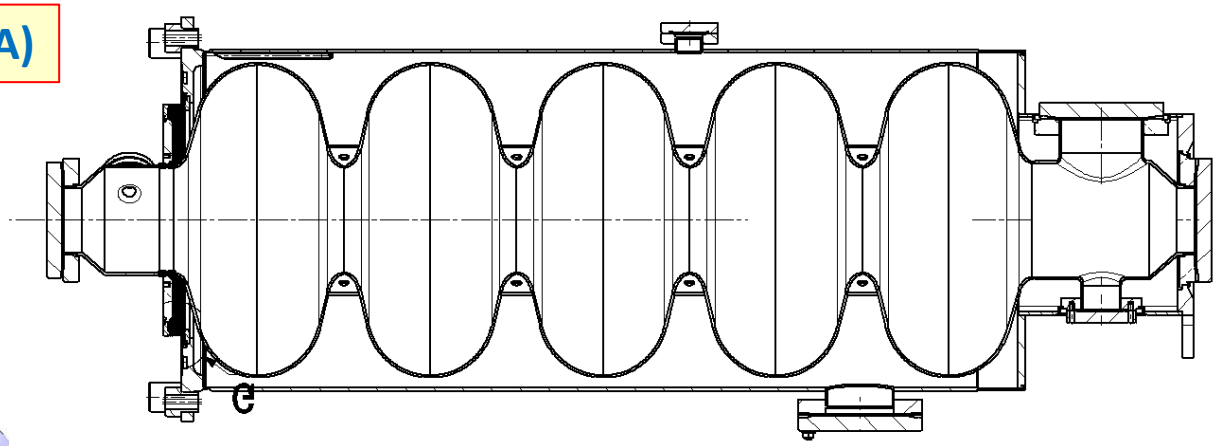


Temperature	Total current inward / A	
	Simulation	Real cavity
10 °C	21	18
15 °C	37	36
25 °C	70	57

Helium tank

Stainless Steel He tank (CEA)





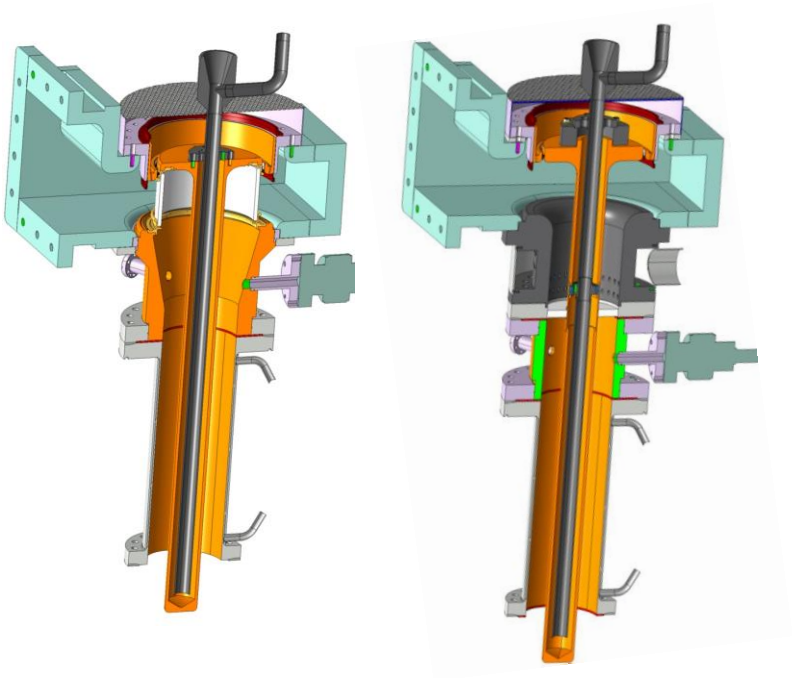
Helium tank designed by CERN (Stainless steel).
5 items under fabrication by CEA (with SDMS).

RF tests on couplers at CEA

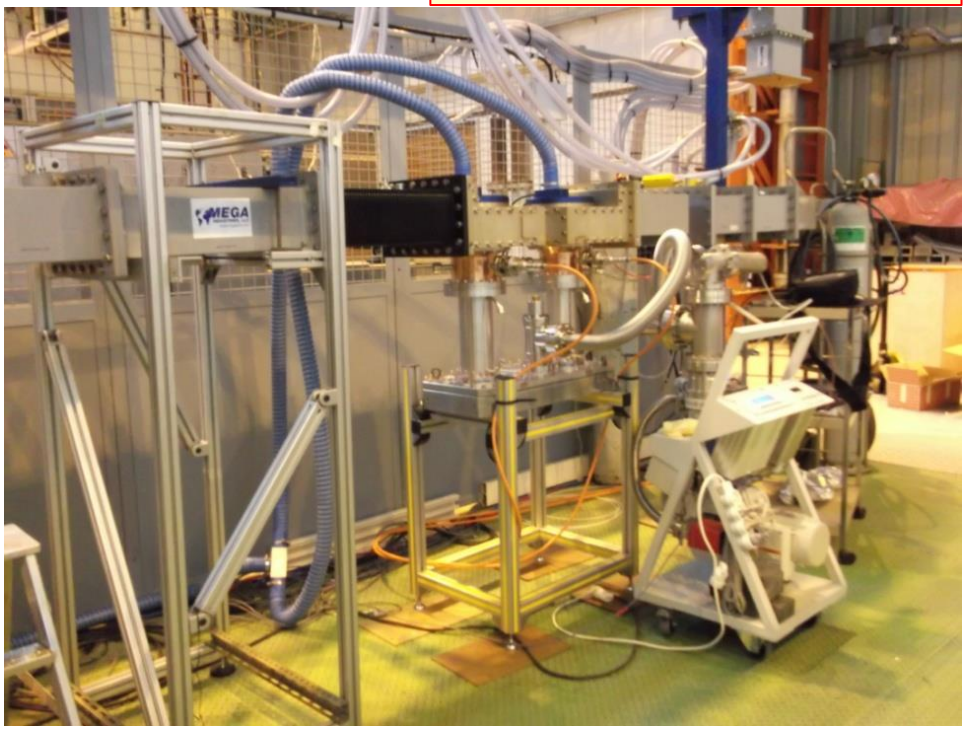
Development of
two types of couplers

Cylindrical window

Disk window



Test of RF couplers (CEA)

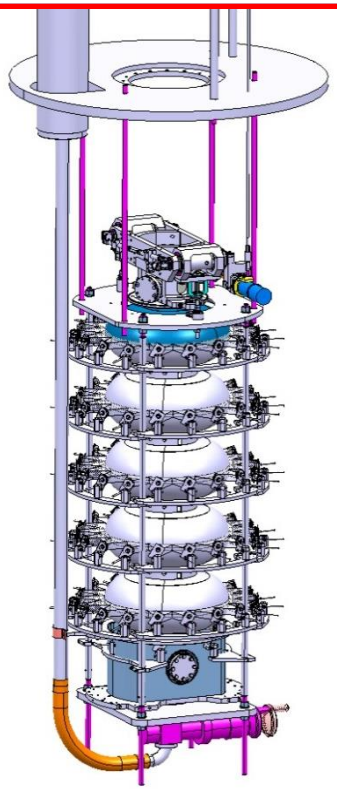


CEA test bench with
two SPL cylindrical window couplers,
Double Walled Tubes and Test Box cavity

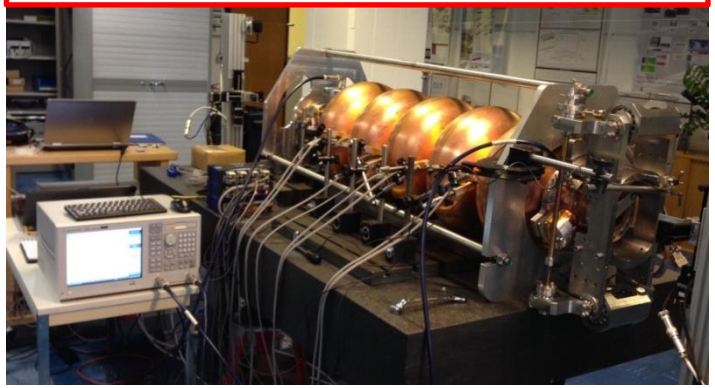
Tests systems and cavity reception area (Bdg. 252)

Reception area in bdg.252

Tooling for test in vertical cryostat: fabricated and available at CERN

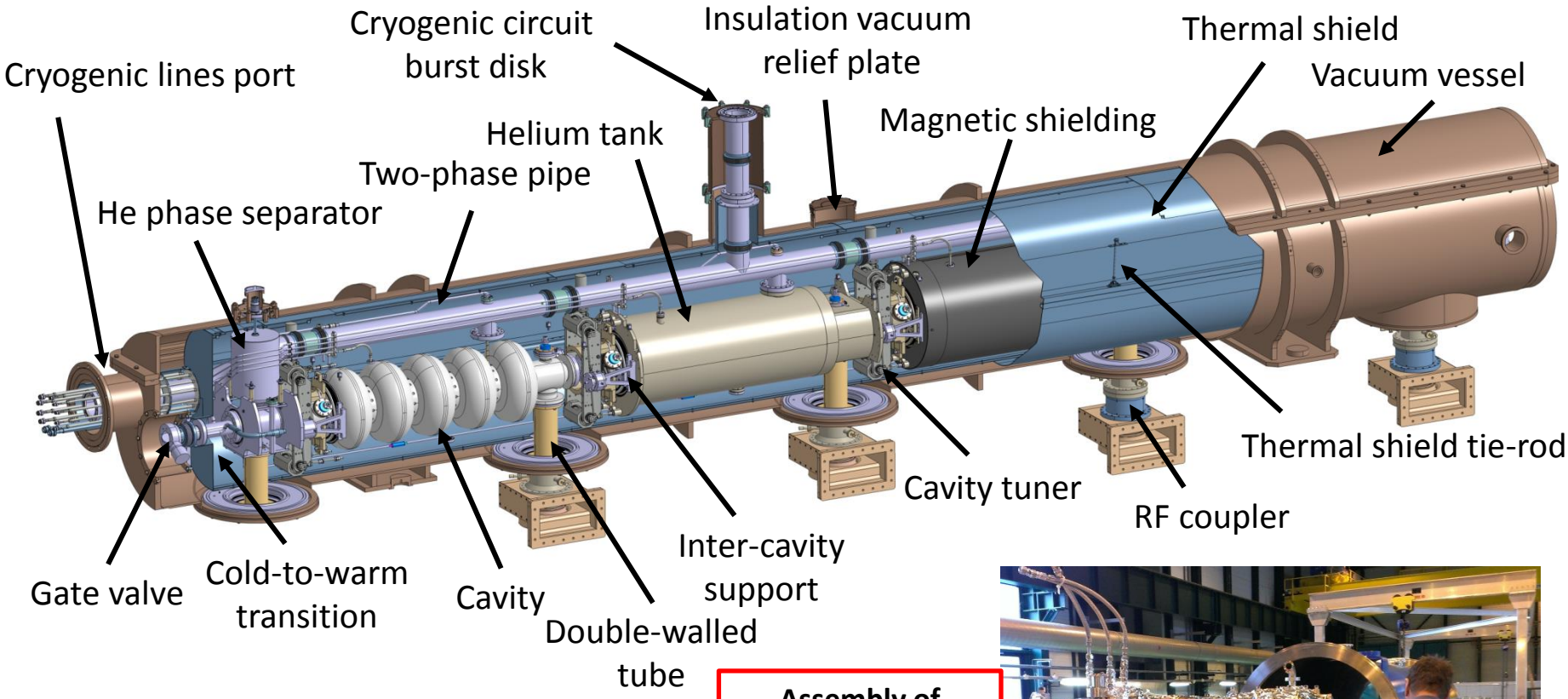


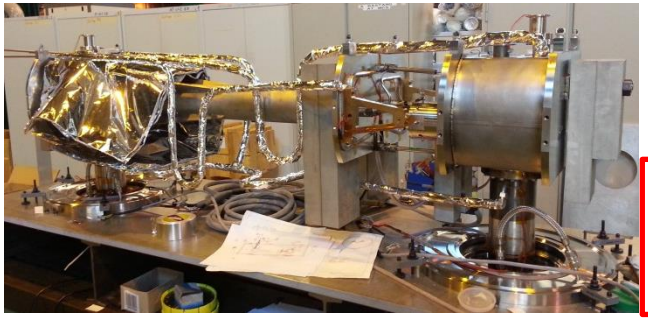
Cavity tuner: measurement of cavity detuning versus mechanical deformation.



Cell-by-cell tuning system with RF bead-pull and mechanical measurements.

SPL Cryomodule



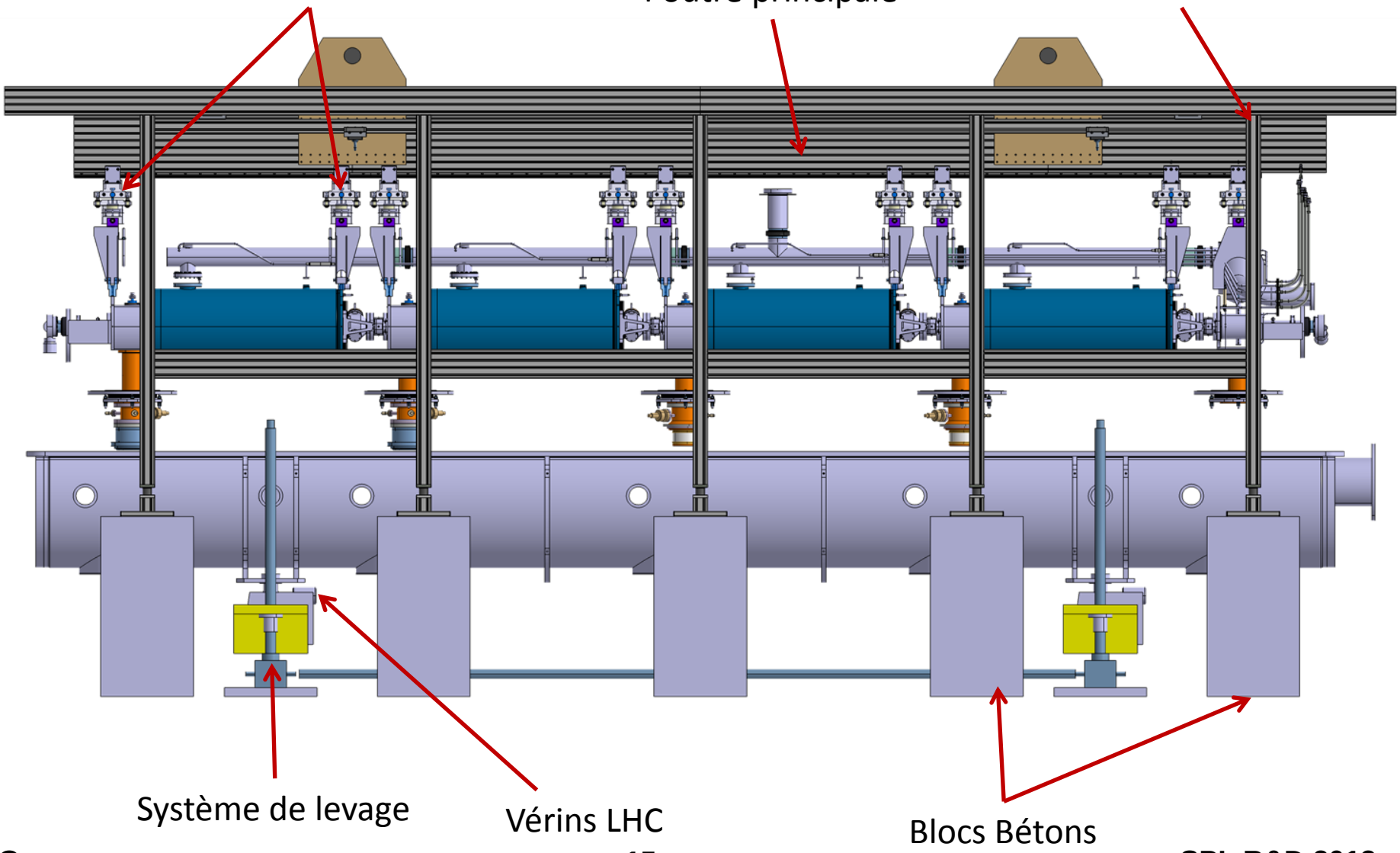


Inner part of supporting system mock-up

Assembly of supporting system mock-up

Cryo-module Assembly tooling

CNRS-IPNO

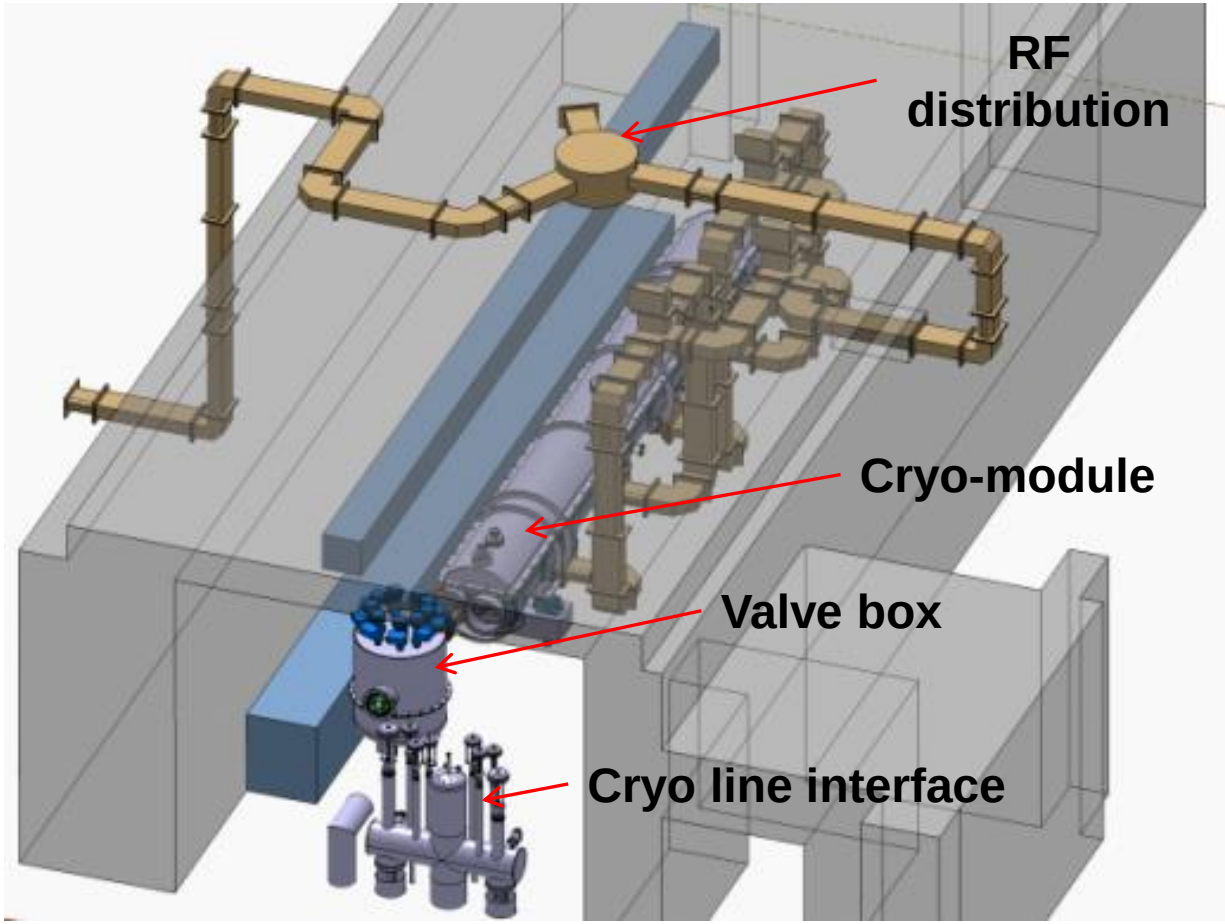


SPL SM18 infrastructure upgrade

1. Cryogenics
   - New cryogenic transfer line: commissioned December 2013
   - Modification of 2 Vertical Cryostats for 2K Operation: completed March 2013
   - Specifications of He distribution for Horizontal Cryostats (2K and 4.5 K operation) completed
2. SRF processing infrastructure
   - Main Clean Room Upgrade and Extension: to be finished in December 2013

   - Ultra-Pure Water Station delivered and commissioned: October 2013
   - Rinsing Cabinet delivered: October 2013
   - Diagnostics
     - 2nd sound measurement by OSTs: operational (more work required for interpretation…)
     - Temperature mapping system for SPL cavities: work in progress…

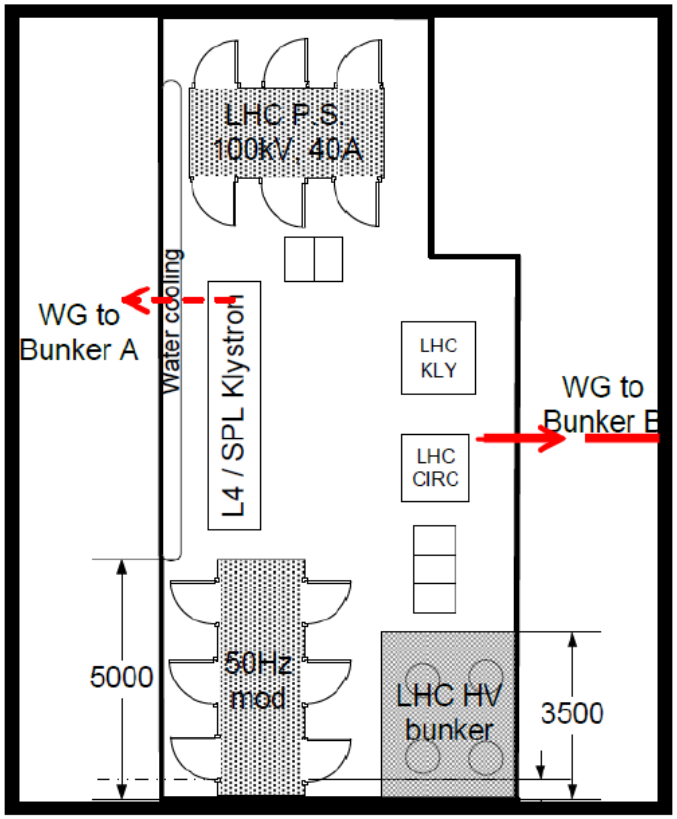
SM18 Bunker Infrastructure



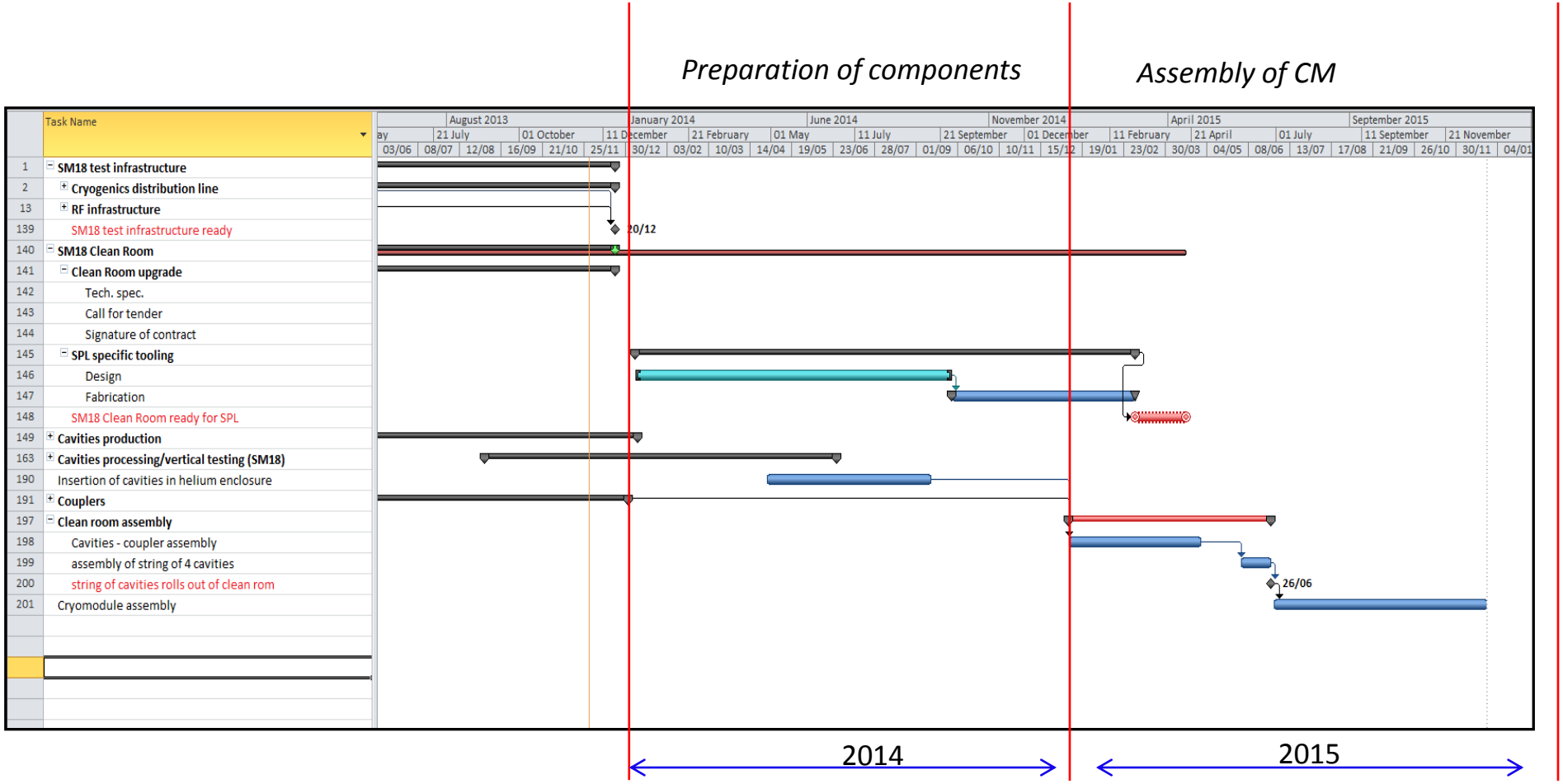
with support from CRISP program

SM18 High Power RF upgrade (704 MHz)

- 1.5 MW klystron – delivery beginning 2014
- Klystron modulator – delivery beginning 2014
- New Low Level RF at 704 MHz – by end of 2014



Master Schedule



SPL Summary

- Design and development of a new type of multi-cavity cryomodule,
- Design and development of “cheap” high power couplers (8 built; 2 successfully tested today).
- Extensive investment for superconducting cavities fabrication and test (e-beam welding machine, e-p bench, optical bench…)
- 2 five-cell copper cavities, one bulk-niobium monocell produced,
- 4 five-cell bulk Niobium manufactured by industry (RI),
- One five-cell bulk Niobium in fabrication at CERN with an R&D approach,
- Equipment for testing at high RF power (704 MHz) a string of 4 cavities cooled at 2 K in SM18

Update of CERN competencies in superconducting RF.

A string of four SPL 704 MHz β =1 cavities will start being tested in a short cryo-module at the end of 2015.