CEA STATUS OF THE CRYOMODULES FOR SARAF PHASE-II SUPERCONDUCTING LINAC

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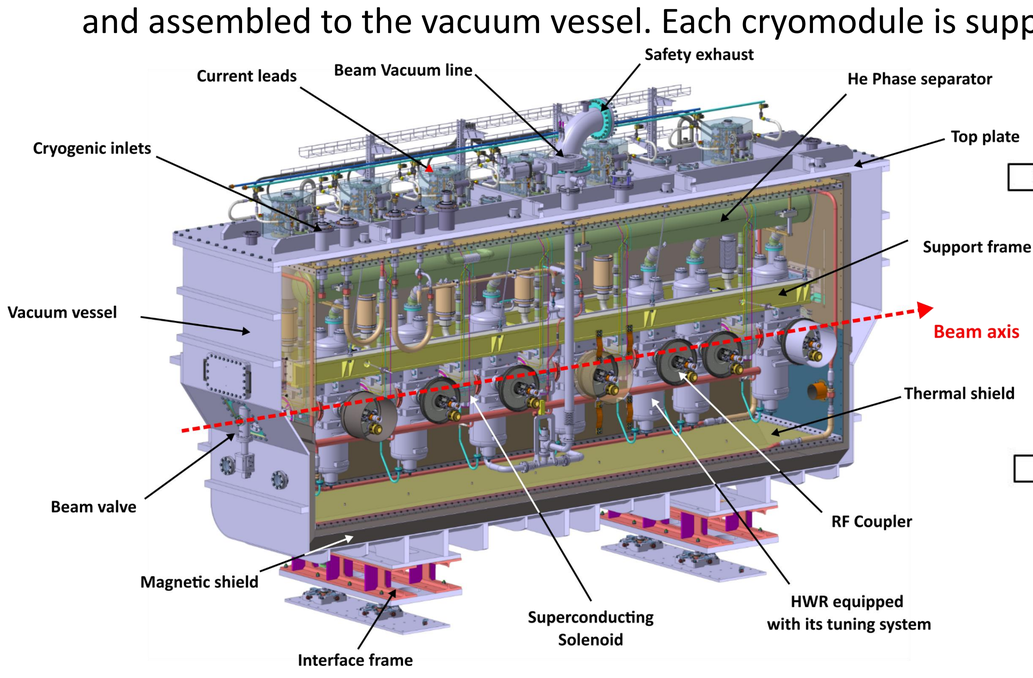
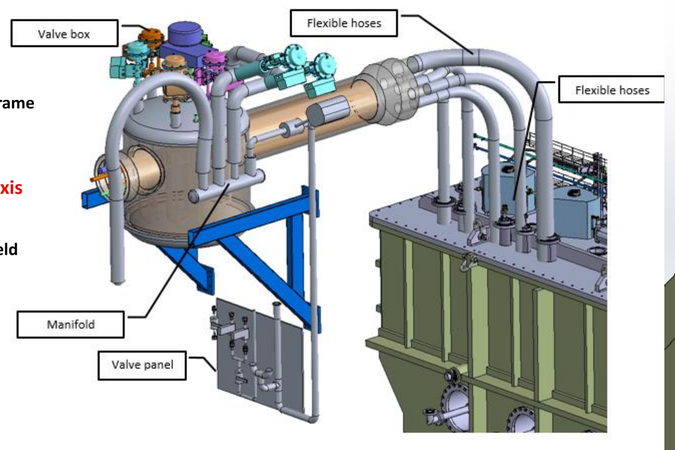
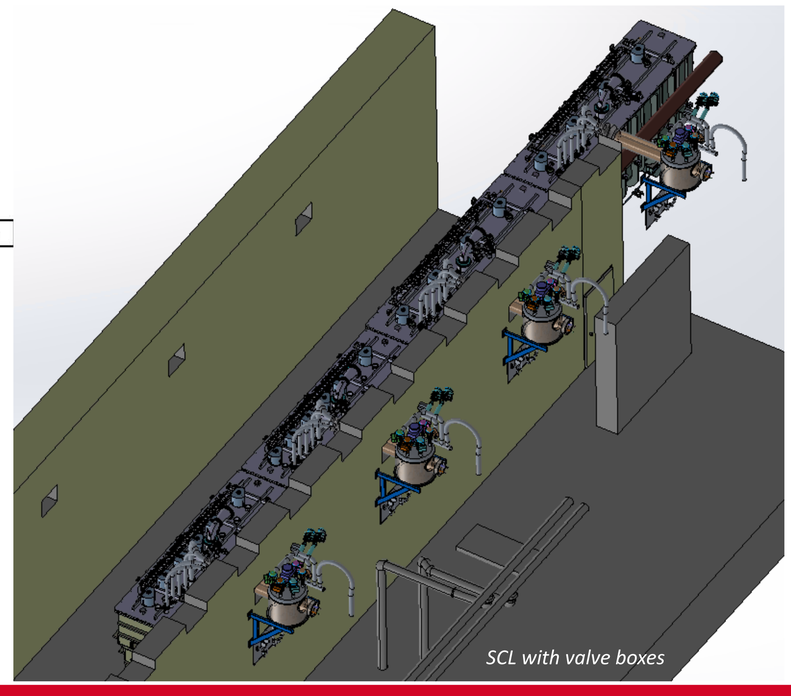
The SARAF SCL consists of 4 cryomodules, 4 warm sections with diagnostics at the end of each cryomodule and 4 valve boxes. The two first cryomodules host 6 and 7 HWR low-beta cavities (β= 0.091), 176 MHz, and 6 focusing superconducting solenoids. The two last identical cryomodules welcome 7 HWR high-beta cavities (β= 0.181), 176 MHz, and 4 solenoids.

CRYOMODULE PACKAGE OVERVIEW

The SARAF cryomodules are assembled by top loading, the cavity string made of solenoids and cavities is hung to the top plate by using a support frame and assembled to the vacuum vessel. Each cryomodule is supplied by a dedicated valve box.





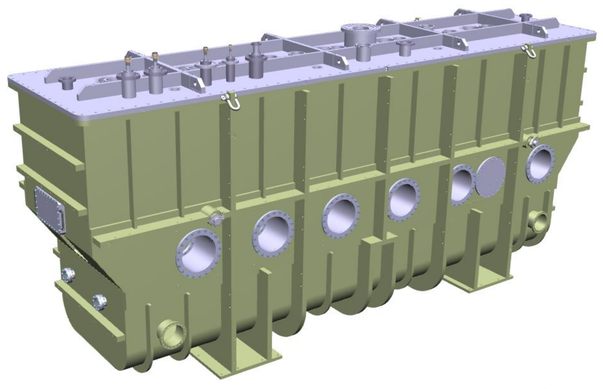

SCL with valve boxes

CRYOMODULE PACKAGE STATUS

The **C**ritical **D**esign **R**eview of cryomodules was done is March 2018. This review launched the detail design and drawing phases. Now, mains tenders are on going.

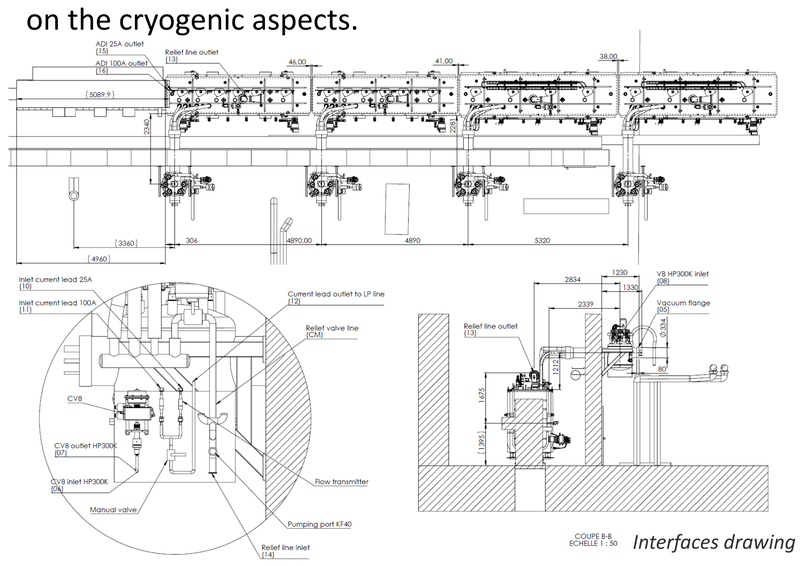
VACUUM VESSEL

Vacuum vessel and top plate are made of 304 L stainless steel and are optimized in order to limit the deformations due to the vacuum forces and cavity string load on tie rods attachments [1]. The vacuum vessel contract is on going, CM1 delivery in september 2020.


Low Beta vacuum vessel

INTERFACES

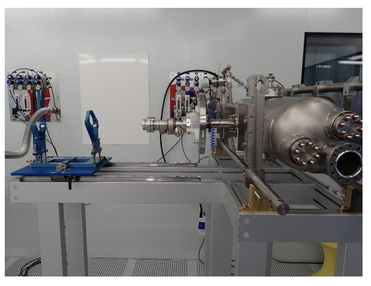
A signicant activity in 2019 was the definition of interfaces in accordance with customer infrastructure, particularly on the cryogenic aspects.

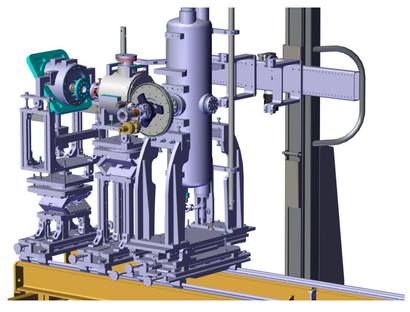


Interfaces drawing

CLEAN ROOM TOOLING

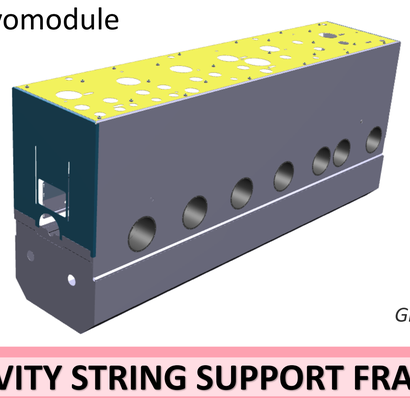
Assembly process and tooling have been studied particularly for clean room activities (including settings in all directions and axes needed for alignment). The cavity /coupler assembly bench was used and validated during the Equipped Cavity Test [2]


Cavity/Coupler assembly tooling


Cavity string assembly tooling

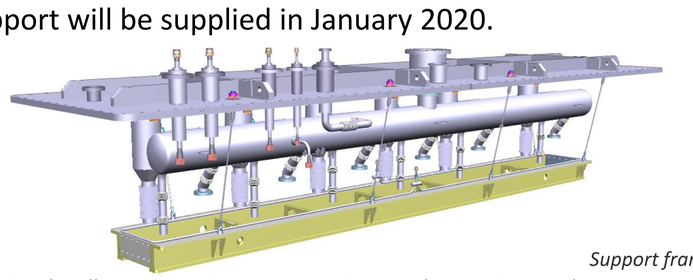
GLOBAL MAGNETIC SHIELD

A global magnetic shielding is used for SARAF's cryomodule in order to limit the external magnetic field at 2µT closed to the cavities. The shield is made of 2 main parts. The top part is connected to the top plate and the bottom part is sit in the vacuum vessel. A local cavity shield is provided in case of deterioted magnetic hygiene inside the cryomodule


Global magnetic shield

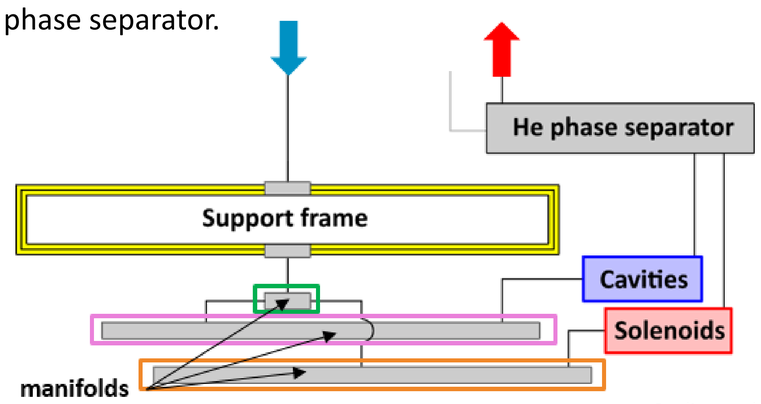
CAVITY STRING SUPPORT FRAME

The frame is made of welded titanium plates and attached to the top plate and vacuum vessel by tie rods made of Ti-6Al-4V. The cavity string is linked to the frame by homemade C-shaped elements in order to dissociate the cavity string to the longitudinal heat shrinking of the frame. The support frame tender is on going. CM1 support will be supplied in January 2020.

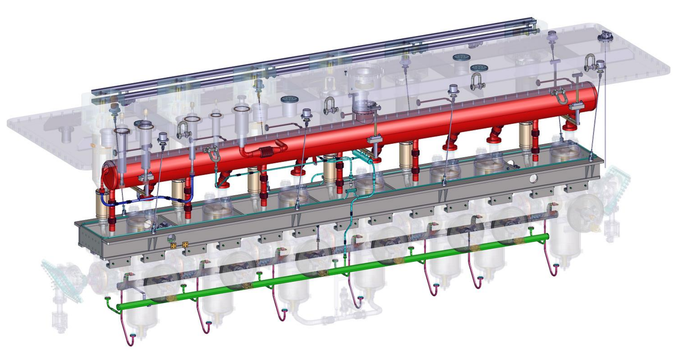

Support frame

CRYOGENIC CIRCUIT

Two different cryogenic paths are used. One for the cool-down and the other one for the LHe level regulation. In the first case, cold GHe circulates through the support frame and manifolds. Finally, the cold gas goes up by cavity/solenoid and is collected in the phase separator before going back to the cryoplant. In the second case, the cavity string cooled, LHe is directly injected in the phase separator.

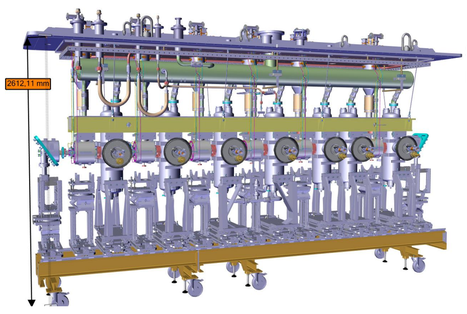


Cooling path

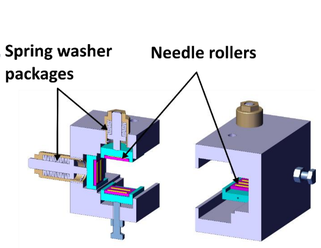

Cryogenic piping

CRYOMODULE ASSEMBLY

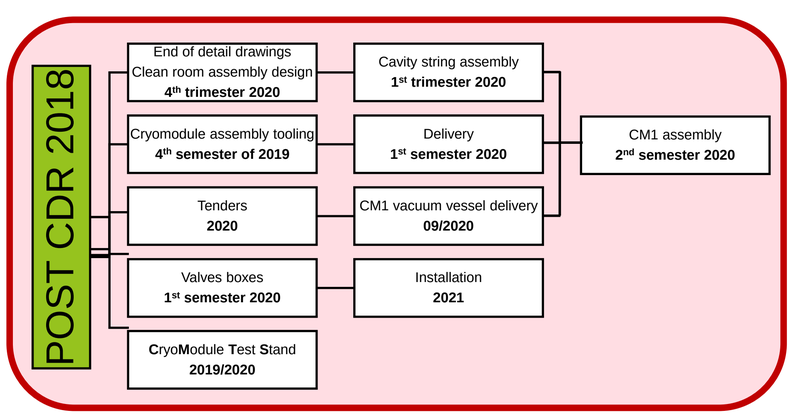
After cavity string assembly in clean room, the top plate is mainly prepared and equipped with top shields, phase separator, support frame. Finaly, the cavity string is transfered from the clean room tooling to the support frame thanks to C-shapped.



Cavity string loading



C-shapped



Provisional schedule

[1] R.Cubizolles, MOPVA042 - IPAC 2017 Copenhagen, Denmark
[2] O.Piquet, SARAF Equipped Cavity Test Stand (ECTS) at CEA, Melbourne, IPAC, 2019