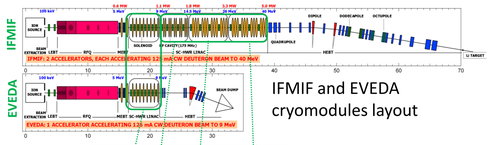
MAIN CHOICES AND PRELIMINARY DESIGN FOR THE IFMIF RF COUPLERS

P. Bosland, P. Bredy, M. Desmond, G. Devanz, H. Jenhani, A. Mohamed, J. Plouin*, CEA-Saclay, Gif-sur-Yvette, France

***Abstract**:* IFMIF (International Fusion Material Irradiation Facility) is the future neutrons irradiation facility that aims to qualify advanced materials for the fusion reactors successor to ITER (International Thermonuclear Experimental Reactor). The required neutrons flux is created from the irradiation of a lithium target by two high intensity deuteron ion beams (125 mA @ 40 MeV CW) produced by two parallel superconducting accelerators. The niobium cavities are Half Wave Resonators (HWR) at 175 MHz operating at 4.4 K. All cavities are equipped with the same power coupler designed to transfer a maximum power of 200 kW in CW. The present phase of the project, IFMIF-EVEDA, for Engineering Validation and Engineering Design Activities, is aimed to validate the technical options for IFMIF, by the construction of an accelerator prototype: 1 cryomodule with 8 HWRs and 8 couplers providing RF power up to 70 kW. Nevertheless, these couplers are designed to be able to operate at 200 kW, and they will be tested and conditioned at this power. This paper describes the overall operating requirements of these high power couplers, presents the main choices that have been made up to now and the RF design of the coupler components.

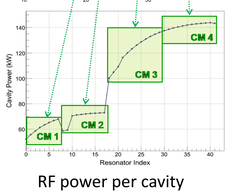
*juliette.plouin@cea.fr

RF COUPLERS FOR IFMIF-EVEDA

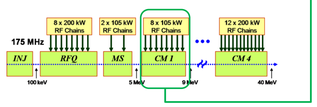


IFMIF and EVEDA cryomodules layout

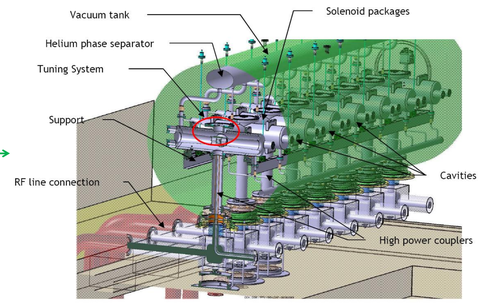
One single coupler will be used for all the HWRs in the IFMIF linac, able to operate with 200 kW cw RF power at 175 MHz



RF power per cavity



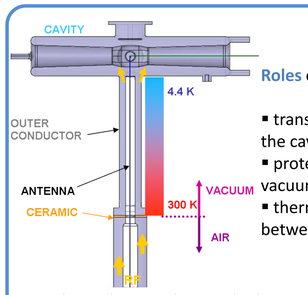
Scheme of the RF sources for the IFMIF linac



The EVEDA cryomodule

IFMIF-EVEDA SC beta=0.094 Half-Wave Resonator Study, E. Zaplatin, SRF 09* ***THPPO015*
The Superconducting Prototype LINAC for IFMIF, P. Bosland, these proceedings, SRF 09* ***FROAAU05*

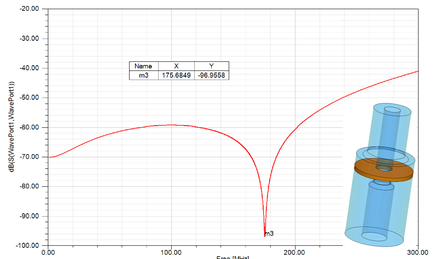
RF DESIGN OF THE WINDOW



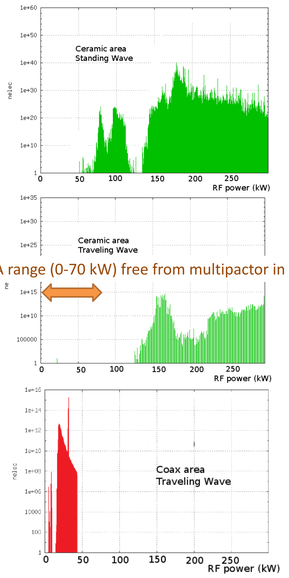
Roles of the coupler :

- transfer RF power to the cavity at 175 MHz
- protection of the cavity vacuum
- thermal transition between 4.4 K and 300 K

Coupler and HWR. The coupler has a **coaxial geometry** with a coaxial ceramic disc



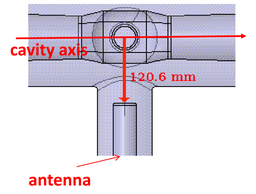
Reflexion diagram of the adapted window

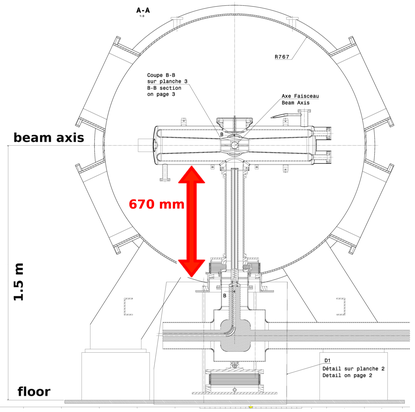


EVEDA range (0-70 kW) free from multipactor in TW

Multipactor in the window (vacuum side) *(code MUPAC : G. Devanz, Phys. Rev. ST Accel. Beams **4**, 012001 (2001))*

Coupling between antenna and HWR has been calculated : Qext = 5.7 10^4
⇨ distance from the extremity of the antenna and the cavity axis is 121 mm



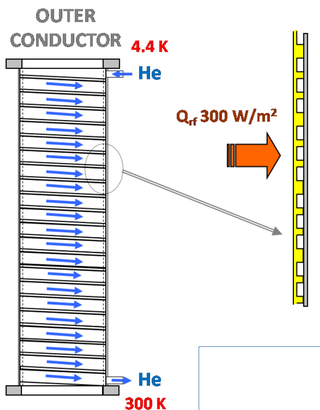


The distance λ/4 = 430 mm must be avoided for the distance between ceramic and cavity because it corresponds to a maximum of field in the ceramic in SW
⇨ thermal losses and heating
⇨ multipactor

The coupler has to fit under the cavity and the beam axis is fixed at 1.5m from the floor

⇨**The distance between ceramic and cavity has been fixed at 670 mm**

COOLING SYSTEM

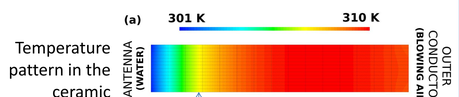


Antenna : kept at the room temperature to
- avoid radiation inside the superconducting HWR (radiation power is proportional to T^4)
- avoid temperature gradient around the ceramic (≠constraints)

Cooling is achieved with water circulating inside the antenna

⇨ **Whole antenna is kept at 300 K (+/-1K)**

It is envisaged to cool down the window's outer conductor with blowing air to lower the temperature gradient in the ceramic



Temperature pattern in the ceramic

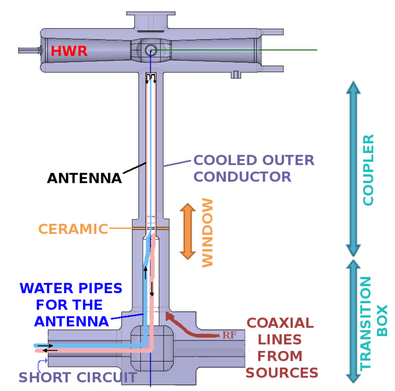
Cooled external conductor : from 300 K to 4.4 K
Cooling is achieved with helium gas, driven by a double walled outer conducotr

		Antenna cooling	
		water	forced air
Outer conductor cooling **SW**	forced air	301-310 K / **301 K**	320-326 K / 322 K
	air	301-315 K / 301 K	330-337 K / 322 K
Outer conductor cooling **TW**	forced air	301-305 K / **300 K**	311-315 K / 318 K
	air	301-308 K / 300 K	317-321 K / 318 K

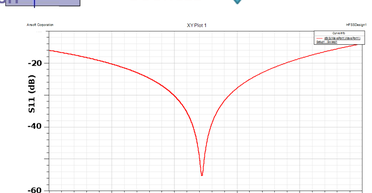
Temperature in the ceramic/tip of the antenna

T TRANSITION

T transition designed to allow the connection of the water pipes
Adapted at 175 MHz and tunable +/- 1MHz (circular aperture in one of the walls and penetration of a cylindrical plug)

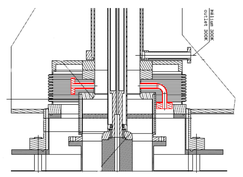


Reflexion diagram of the T transition



DIAGNOSTICS & BIASING

Diagnostics will be implemented near to the ceramic (vacuum side)
- vacuum gauge
- electron pick-up
- light detector



The implementation of a **biasing system** against multipactor will be possible for the future IFMIF linac with a modification of the the design of the transition box

MECHANICAL DESIGN AND TESTS

Flexible elements necessary to
- avoid misalignment thermal cycling from 300 K to 4.4 K
- protect the integrity of the ceramic disc

⇨Most parts of the **mechanical design** still have to be defined

The order for the study and the manufacturing of the power couplers is going to be launched.

High power tests and **RF conditioning** of all the couplers will be realized at **CIEMAT** up to 200 kW in cw
CIEMAT is in charge of the **RF test bench**

IMPLEMENTATION IN THE CRYOMODULE

- coupler in **vertical** position ⇨ ≠ mechanical stress on the ceramic due to antenna's weight
- connection to the cryomodule assured by a support for the T
- compensation system to ensure the mechanical interfaces