DESIGN OF THE MEBT REBUNCHERS FOR THE SPIRAL 2 DRIVER

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Abstract

The Spiral 2 project [1] uses normal conducting rebunchers to accelerate high intensity beams of protons, deuterons and heavier ions. All cavities work at 88 MHz, the beta is 0.04 and 3 rebunchers are located in the MEBT line, which accepts ions with A/q up to 6. The paper describes the RF design and the technological solutions proposed for an original 3-gap cavity, characterised by very large beam aperture (60 mm) and providing up to 120 kV of effective voltage.

REBUNCHER REQUIREMENTS

- Operation: R1: 120 kV, R2: 60 kV, R3: 120 kV;
- injector commissioning: emittance measurements after RFQ R1: 190 kV, pulsed;
- short distance on the line.

RF DESIGN

- 3-gap structure;
- two opposing quarter-wave stems;
- two capacitive tuners;
- inductive coupler.

The Micro Wave Studio software was used to obtain the mechanical dimensions of the cavity and the radio frequency parameters. Tables 1 and 2 illustrate the RF design and the mechanical dimensions of the cavities.

These dimensions were imposed by the structure of the line. We control the resonance of the cavity with two movables panels. The first one is used to obtain a good resonance frequency range, the second to adjust the working frequency with the electric field.

The output radio frequency amplifier available is 5 kW for 60 kV and 10 kW for 120 kV.

Table 1: RF Design Parameters

Electrode voltage At 120kV (Veff)	80 kV
TTF	0,38
Q	7800
Rs (kV_{eff}^2/ loss)	3680
Power loss (@120 kV)	4 kW
Max E field (pulsed)	11 MV/m
Max H field (pulsed)	17,4 A/m
Short circuit sensitivity	100. kHz/mm
Max trimmer sensitivity	140 kHz/mm

MECHANICAL STRUCTURE

The choice of a tank was made because it must be copper-plated.

Table 2: Mechanical Dimensions

Parameter	Mm
Beam diameter	60
Ring external diameter	90
Electrode ring length	32
Gap distances	13 .30 .13
Trimmer diameter	130
Trimmer stroke	15 to 45
Stem diameter	32 .40
Cavity central section sides	180x180
Cavity central section height	2*145
Cavity diameter	260
Cavity height	2*545
Flange to flange distance	280

MAGNETIC AND ELECTRIC FIELDS

Magnetic and electric fields were calculated with Micro Wave Studio.

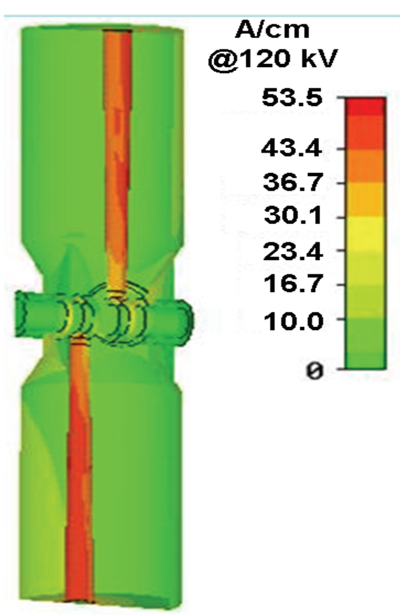


Figure 1: Stems current densities.

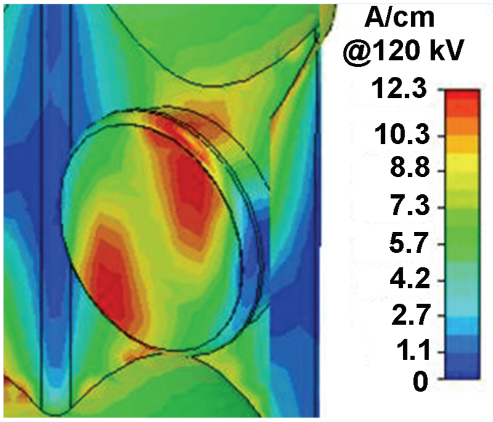


Figure 2: Movable panel densities.

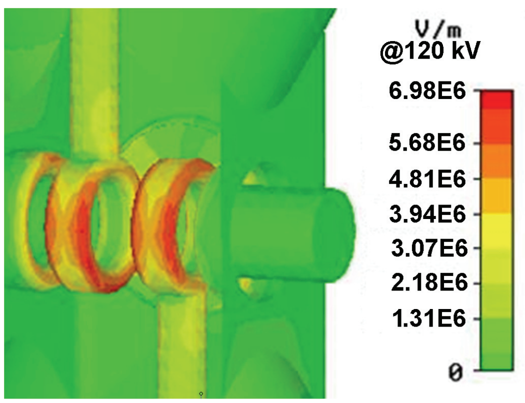


Figure 3 : Electric field on drift tubes.

MECHANICAL AND COOLING STUDIES

The external tank is made of copper-plated (70 µm) thick (5 mm) sheets, except for the central region which is milled in a solid block.

We use flexible belts as thermal and RF contact for the tuner.

The stems, beam ports, tuners, drift tubes are made of solid copper (Fig. 4).

Figure 4: Stem.

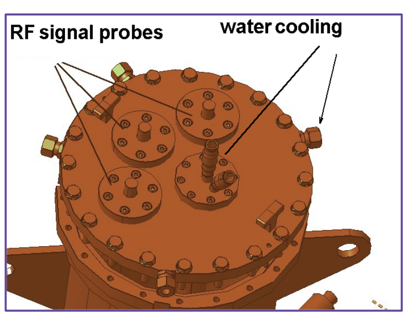
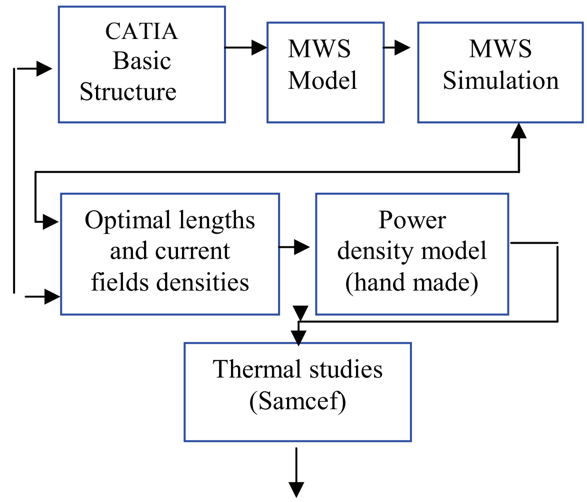


Figure 5: External tank.

Drawing Office

In collaboration with the drawing office we calculated the cooling system. The goal was to obtain two cooling circuits. The maximum temperature input, output is fixed to 18°C .

The Study Process



The current density obtained by Figs. 1 and 2 give us the power density on the cavity.

With the software SAMCEF we estimated the temperature in all the surface of the cavity. (See Fig. 6).

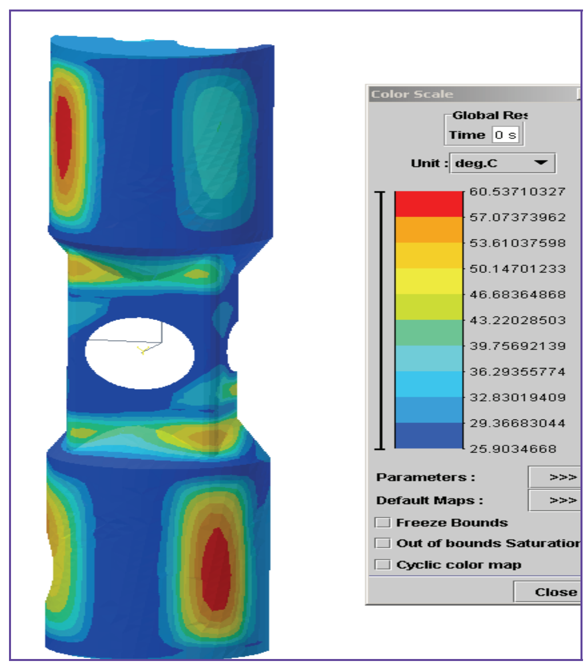


Figure 6: Copper-plated steel cavity temperature map.

The cooling system is realised with two circuits, one with a coupling loop with a flow of 2l/mn, and the second with the tank and feeder with a flow of 20 l/min.

Details of the power coupler with cooling system are shown in Fig. 7.

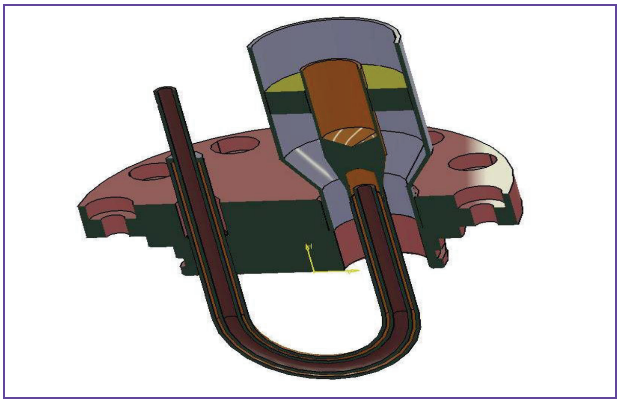


Figure 7: RF power coupler.

GENERAL DESIGN OF THE CAVITY

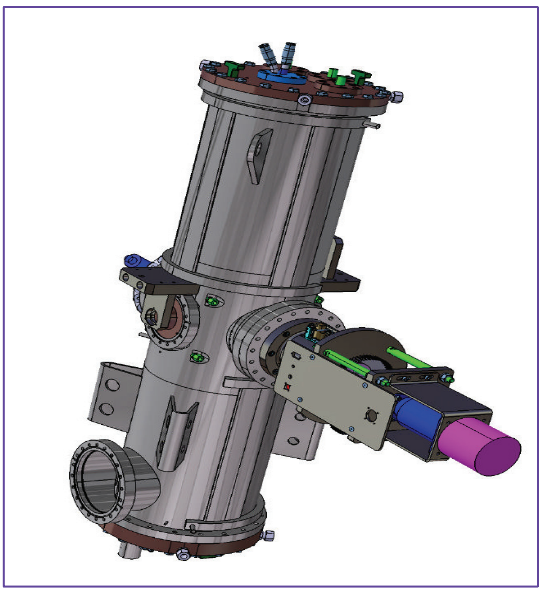


Figure 8: Cavity.

On the Stainless-steel tank we can see the cooling system. Observe the external tank made of cooper. The magnetic RF power coupler is under the cavity. On the right hand is the trimmer and its motorisation.

TRIMMER WITH FLEXIBLE BELTS

The general view is shown in Fig. 9..
We can see the tuner with the flexible belts.

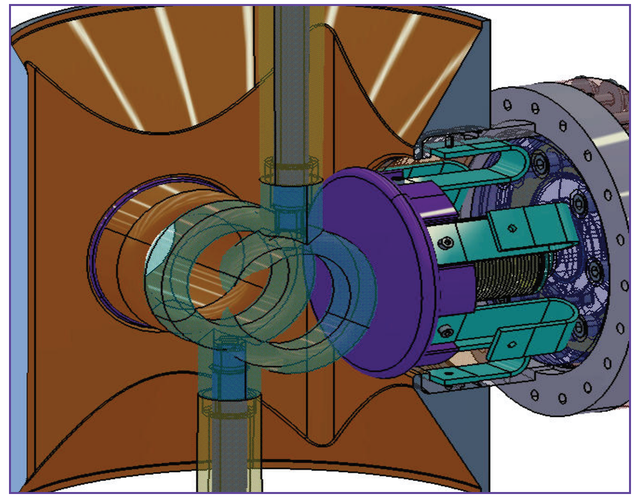


Figure 9: Movable panel.

The movable panel doesn't have any cooling system. The cooling is realised with the flexible belts in cooper.

MOTORISATION

The moving of the tuner is done by a walk-to-walk motor coupled to a reductor, see Fig. 10.

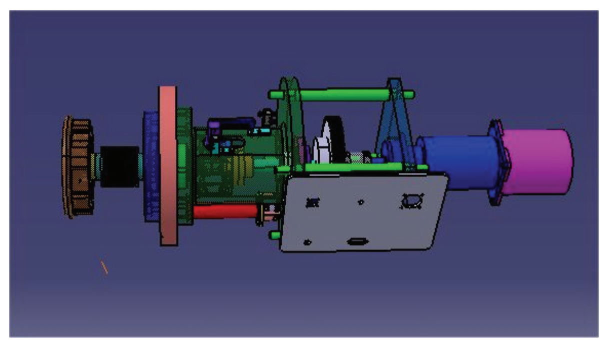


Figure 10: The motorisation.

CONTROL SYSTEM

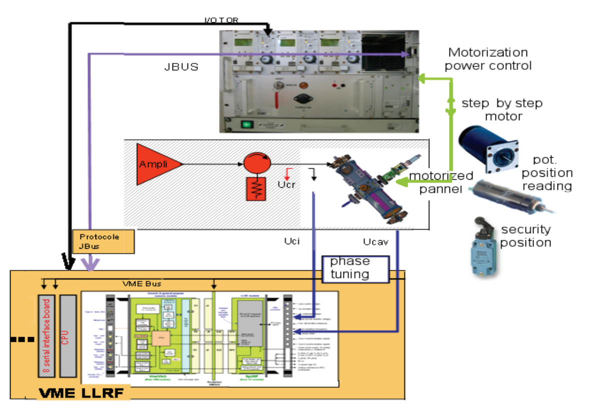


Figure 11: Control command for tuning.

Safety for the motor drive is obtained by electrical switches. A potentiometer gives a reading of the position of the trimmer.

We can move the motor either in MANUAL mode or via the control system.

CONCLUSION

An original RF structure has been designed to fit the SP2 requirement for the MEBT rebunchers. The proposed cavity has a high gradient, compactness along the beam axis and has tight alignment tolerances. The cavity design is now completed and the call for tender is in progress.

ACKNOWLEDGEMENTS

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REFERENCES

[1] T. Junquera et al., Proc. of EPAC 08, [2] MWS, Computer Simulation Technology, Darmstadt, Germany.