INTRODUCTION
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.

DESCRIPTION
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 5kW for 60kV and 10kW for 120kV.

Table 1: RF design parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrode voltage At 120kV (Veff)</td>
<td>80 kV</td>
</tr>
<tr>
<td>TTF</td>
<td>0.38</td>
</tr>
<tr>
<td>Q</td>
<td>7800</td>
</tr>
<tr>
<td>Rs (kVeff^2/ loss)</td>
<td>3680</td>
</tr>
<tr>
<td>Power loss (@120 kV)</td>
<td>4 kW</td>
</tr>
<tr>
<td>Max E field (pulsed)</td>
<td>11 MV/m</td>
</tr>
<tr>
<td>Max H field (pulsed)</td>
<td>17.4 A/m</td>
</tr>
<tr>
<td>Short circuit sensitivity</td>
<td>100. kHz/mm</td>
</tr>
<tr>
<td>Max trimmer sensitivity</td>
<td>140 kHz/mm</td>
</tr>
</tbody>
</table>

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

Table 2: Mechanical dimensions.

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

MAGNETIC AND ELECTRIC FIELDS
Magnetic and electric fields were calculated with Micro Wave Studio.

Figure 1: Stems current densities.
MECHANICAL AND COOLING STUDIES

The external tank is made of copper-plated (70um) thick (5mm) 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 (Figure 4).

**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 figure 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 figure 6)
The cooling system is realised with two circuits, one with a coupling loop with a flow of 2l/min, and the second with the tank and feeder with a flow of 20 l/min.

**GENERAL DESIGN OF THE 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 his motorisation.

**TRIMMER WITH FLEXIBLE BELTS**

The general view is shown below. We can see the tuner with the flexible belts.

**MOTORISATION**

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

**CONTROL SYSTEM**

The movable panel don’t have any cooling system. The cooling is realised with the flexible belts in cooper.
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**

Many people have been involved in this work but we would particularly wish mention D. Uriot for beam dynamics simulations, G. Le Dem for field-map macros, M. Malabaila and T. Dettinger for their explanations about the copper-plating process and M. Vretenar, H Vormann and their teams at CERN and GSI for their help and comments on the overall design.

**REFERENCES**