INTRODUCTION

Within the framework of the HIPPI (High Intensity Pulsed Proton Injector) programme, supported by the 6th PCRD of the European Union, the German research centre Forschungszentrum Jülich has proposed the multi-spoke cavity for the intermediate energy section ($\beta = 0.5$) of high power proton linear accelerators. The Nuclear Physics Institute of Orsay is associated with FZ Jülich for the prototype design, and before that, all preliminary mechanical studies.

1. CAVITY DESIGN

The design is optimized at first by the electromagnetic studies (FZ Jülich). The triple-spoke is made of niobium and defined as a multi-gap H-cavity. In the cylindrical outer conductor are picked three spoke tubes, which are rotated by 90 degrees from one to the next. The end cell of the cavity is conical, to minimize the magnetic field on the spoke surface. The multi-spoke superconducting cavity having a complicated geometry, a CAD code like CATIA V5 is required for its design.

2. INTERFACE BETWEEN CATIA AND CAST3M

In addition to drawing, the CATIA V5 code offers some interesting options to do a preliminary finite element modeling, and the meshing can be exported in an exchangeable format. The principal investigation consists in developing a dedicated program to geometrically analyse and rearrange the CATIA meshing and translate it into a specific Cast3m meshing, Cast3m is an efficient code for mechanical analysis. This interface allows to reduce considerably the delay of the mechanical studies.

3. STATIC ANALYSIS

The cavity deformation under vacuum conditions has been simulated. The meshing is composed of 21719 nodes and 66243 elements. Two possible means of fixation have been studied for the cavity, the former consists in fixing the beam pipes, and the latter in fixing four supports (figure 1) directly to the cryostat. It seems, after simulations, that the optimal wall thickness is 4mm. But for manufacturing reasons, the end cup wall is thinner. The use of torus shaped stiffeners can reduce the stress peak and also increase the cavity’s stability. The stress distribution with the four supports fixation type is presented in figure 3. The stress peak is about 15 MPa, largely lower than the elastic limit of the niobium.

4. DYNAMIC BEHAVIOURS

Six first eigen-modes are presented in the table below. With the torus stiffeners, the frequency of the first eigen modes has been considerably raised, to avoid the excitation from environment noise. The two first deformation modes are illustrated.

<table>
<thead>
<tr>
<th>mode 1</th>
<th>mode 2</th>
<th>mode 3</th>
<th>mode 4</th>
<th>mode 5</th>
<th>mode 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAST3M</td>
<td>138 Hz</td>
<td>259 Hz</td>
<td>379 Hz</td>
<td>403 Hz</td>
<td>436 Hz</td>
</tr>
<tr>
<td>ANSYS</td>
<td>150 Hz</td>
<td>275 Hz</td>
<td>392 Hz</td>
<td>406 Hz</td>
<td>439 Hz</td>
</tr>
</tbody>
</table>

CONCLUSIONS AND PERSPECTIVES

Mechanical studies for HIPPI multi-gap cavities have been successfully started at IPN Orsay in collaboration with FZ Jülich. The geometry and the stiffener optimizations have been discussed. Some other studies are planned, and the first prototype manufacturing is scheduled.