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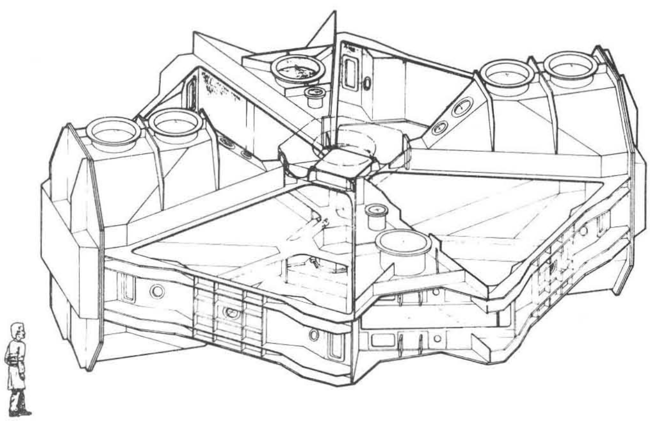
THE VACUUM CHAMBER OF THE GANIL SSC

J.M. BAZE - P. BERNARD - M. FELDMANN - C. LECOEUR.
GANIL - B.P. 5027 - 14021 CAEN, France

1. Introduction

The GANIL vacuum chamber is a monolithic vessel of stainless steel 316 (austenitic steel). Its main features are :

. diameter 9 m
. height 4,3 m
. total weight 57.000 kg (80.000 with jigs)
. volume 46 m3
. walls area 160 m2



View of the whole chamber without membranes

2. Description of the main features.

2.1 Why a monolithic structure?

The position in the very center of the SSC of the injection magnets and R.F. cavities allied to a lack of room between the resonators and the main magnets makes it very difficult to:

a) design a machine center outside the vacuum vessel compatible with the maintenance of injection elements;

b) construct the vessel of separated quarters with plane joints. Making tennis-ball-like joints would have required many hundred meters of thin welding to be done "in situ," jeopardizing the mechanical behaviour of the structure and the gas-tightness of the vessel. Moreover, it would have been very difficult to preserve the cleanliness of the shell.

The solution chosen allows reduction of the number and the length of seals and avoids the numerous reinforcing assemblies which the thin welding would have needed.

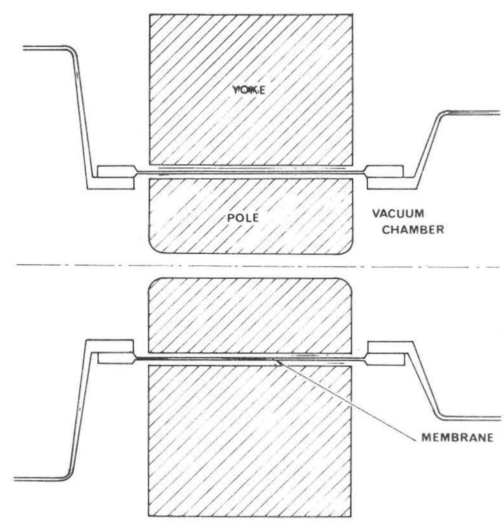
2.2 Membranes

The solution we adopted leads to putting the main magnets' poles in the vacuum. The continuity of the vacuum vessel is achieved by thin flat plates passing through a 10 mm gap provided between poles and yokes. The four lower membranes are welded to the shell in the workshop before cleaning the vessel; the four upper ones are manufactured independently and bolted in place when assembling the whole machine.

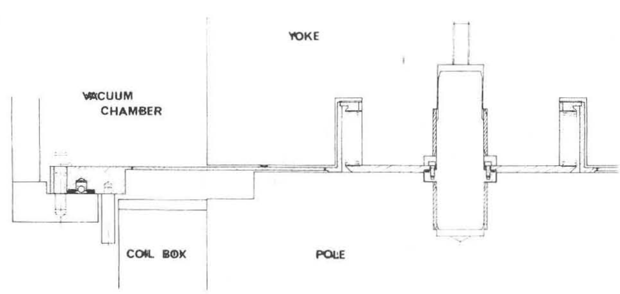
These plates must accommodate in the vertical direction all the coplanarity faults resulting from manufacturing and assembly tolerances which are estimated to a maximum of 2 mm. In the horizontal plane, the membranes must allow differential movements between magnets and vacuum chamber when pumping down the vessel or changing field in magnets (the study of magnets' mechanical behaviour showed a slight horizontal deflection of the upper part of the yoke).

To permit these horizontal movements, it is necessary to introduce between the membranes and the pole surfaces a lot of sliding disks spread all over the gap.

Friction tests under vacuum have been performed at GANIL to evaluate the friction coefficient of those disks for different combinations of materials as well as their performance in vacuum.



Principle of membranes



Practical realization of upper membrane

2.3 Sealings

Except for the large upper pole membranes, the machine will be provided with aluminium extruded seals (cross section figure 1).

Figure 1. (Cross section of aluminium seal).

For the membrane seals, it was quite impossible to design bolting lines strong enough to secure the two flanges. Fastening pins in between was also impossible because of the lack of room in this area. Consequently, at this particular place the machine will be equipped with elastomer seals.

2.4 Supports on main magnets

The monolithic shell is supported on the four magnets by three kinds of assemblies:

a) very strong vertical stiffness brackets on the lateral walls of the quarters as near as possible to the pole flanges;

b) radial thrust of the quarters on two big central rings put in the main magnets but horizontally disconnected from them;

c) pre-stressed tie-rods between yoke and shell inside the magnets.

2.5 Fabrication

The vacuum chamber will be made of separate

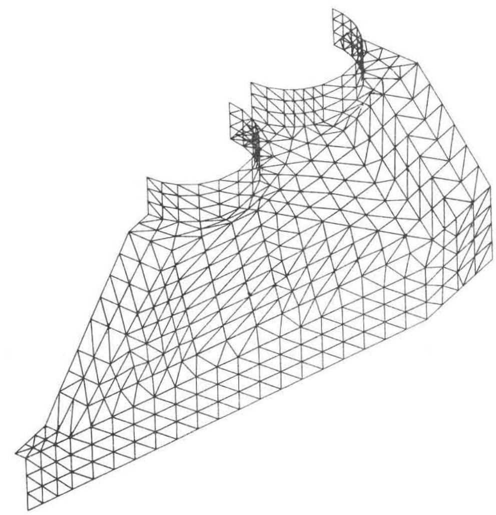
The machining of pole flanges and lower reference surfaces will be performed after the welding of sectors. This method was adopted in order to decrease the construction delay despite the greater care it requires.

3. Calculation

The analysis of this structure's behaviour has been completed using a finite element method of substructures (code CASTEM-CEA). The point was to check that possible deflections of the shell did not reach prohibitive amplitudes mainly in the area of metallic seals.

Using the fact that the whole vessel has got two vertical planes of quasi-symmetry, the computation has been done on one fourth of the shell. It was cut in 14 sub-structures able to be computed separately for local analysis.

The results confirmed that stresses are far from critical, and gave a precise idea of the deflection which will occur in the area of large seals. It gave also the map and amplitudes of reaction forces on the assemblies with magnets.



Mesh of a sub-structure (upper R.F. side shell without stiffeners and brakets).

4. Time table of the manufacturing

The manufacturing time table for the two chambers A and B of GANIL follows:

Parts common to the two chambers

a) April 1978 (To+3): approval of the general design.

b) September 1978 (To+8): completion of material supplies.

Chamber A

c) September 1978: manufacturing of separate elements begins.

d) March 1980 (To+26): beginning of assembly "in situ" of chamber A onto the magnets.

e) September 1980 (To+32): completion of the mounting of chamber A, and first gas-tight tests.

Chamber B

The time table of the second chamber follows that of the first, with a shift of 9 months.