LOW-BETA SC H-CAVITY FOR ESS

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Abstract

At present, many accelerators favour the use of SC cavities as accelerating RF structures. For some of them, like long pulse Spallation Source or Transmutation Facility SC structures might be the only option.

Here we present the results of based on spoke cavity geometry multi-cell H-cavity (700 MHz, β=0.2). Some technical details of cavity tuning and manufacturing are discussed.

The comparison of numerical simulations with first experimental results of 10-gap H-cavity copper model measurements are shown.

1 H-CAVITY DEVELOPMENT

As a first step of an experimental SC H-cavity investigation we plan to build 4-gap 700 MHz, β=0.2 cavity (Fig.1). The detailed results of multy-gap H-cavity geometry optimisation are published elsewhere[1]. The main cavity parameters are summarised in Table 1.

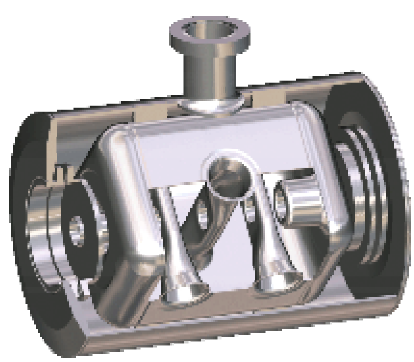

Figure 1: 4-gap H-cavity in LHe vessel.

Table 1: Some Parameters of 4-Gap H-Cavity

Frequency	MHz	775
β=v/c		0.2
R aperture	cm	1.5
βλ/2	cm	4.283
R_{cav}	cm	7.15
E_{pk} / E_{acc}		4.93
B_{pk} / E_{acc}	mT/MV/m	8.17
B_{pk} / E_{pk}	mT/MV/m	1.66

The spokes are supposed to be made by the deformation of bulk Nb pipes. To allow the spoke insertion through the holes in cavity walls the holes should fit the maximal spoke size in its middle part. Because of that the spoke outer parts are made conical with small radii at the ends. It allows to have plane 2D welding between spokes and walls (Fig.2).

For the cavity fine frequency tune the back walls of the structure can be used A frequency change is made by push-pulling this back planes. Electrically it means the last gap capacitance change and the possible frequency range change is defined by the last gap size. Here (Fig.3). the tuning is provided only on one side of the cavity. The field profile changes within +30/-20% by ±2 mm gap change.

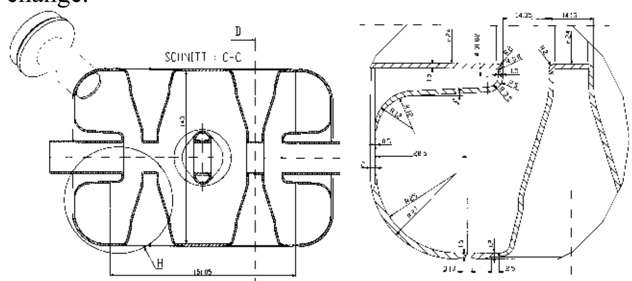

Figure 2: 4-gap H-cavity design.

The conjunction of back walls to the end electrodes is made round, which works like end plane stiffening. To give flexibility for their mechanic deformation the wall thickness of plane part of tuning plates is made thinner (0.6 mm). This lows the tuning force down to 1±0.5 kN for ±2 mm end electrode displacement.

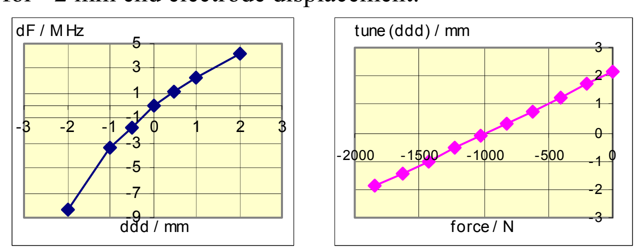

Figure 3: 4-gap H-cavity frequency shift and tuning force vs. last accelerating gap change.

The outer circumference of end plates also made round. Vacuum and coupling ports are supposed to be mounted on two cavity corners (Fig.2). The radius of end plane rounds equals to port radii. This lets again 2D welding between them.

Figure 4: 10-gap H-cavity copper model .

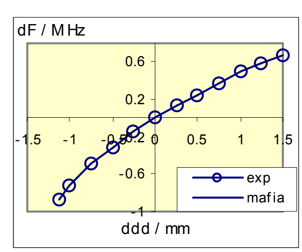

Figure 5: Cavity frequency shift vs. last accelerating gap change

For 3D numerical simulation verification and cavity tuning investigation 10-gap H-cavity copper model (700 MHz, β=0.2) has been built (Fig.4). The cavity and end plates are made from the 3 mm and 1 mm copper sheet respectively. The spokes have been machined from the bulk copper. For the cavity tune the deformation of the end plates is used. The results of the numerical simulations and first model measurements are shown on Fig.5.

2 END PLATE “DROSSEL” JOINT

To provide a surface chemical treatment and high pressure water rinsing vacuum and coupling ports supposed to be used. Nevertheless, the cavity complex geometry makes anxious about quality of final surface cleaning. This is a reason why we investigated and developed a specific “drossel” flange joint between end tuning plates and cavity walls (Fig.6). Such “drossel” flange is widely used in waveguide technique [2]. Most optimally this type of joint to use with circular waveguide connection. At the end of first waveguide that is to be connected with the other one there is a flange with a circular slot with a deep of about λ/4. The distance from the slot till a waveguide wall also λ/4. The second waveguide is connected with a gap to “drossel” flange. The gap between two flages might be considered like a radial RF line connected in series between waveguides. The circular slot is a coaxial transmission line connected in series to the radial line and shortened on its other end. Hence, the joint place between two waveguides is in the zero current point and doesn’t bring additional losses.

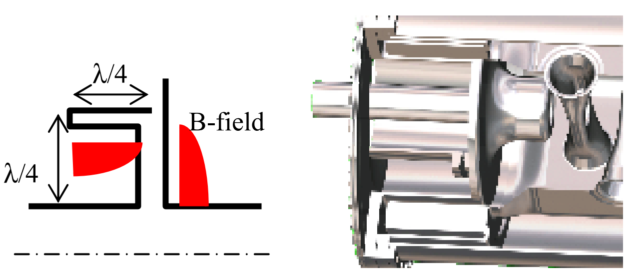

Figure 6: Low loss “Drossel” joint equivalent scheme and its realisation in H-cavity.

In our case because of cavity asymmetry the input impedance of the radial line is not homogeneous around cavity circumference. Fig.7 shows the magnetic field distribution along the coaxial RF line for two orthogonal planes. With a proper “drossel” flange design it is possible to reach a deviation of the magnetic field around joint within 1% of B_{pk}. This makes possible to use the dismountable tuning plate that in its turn gives the perfect conditions for inner cavity surface treatment.

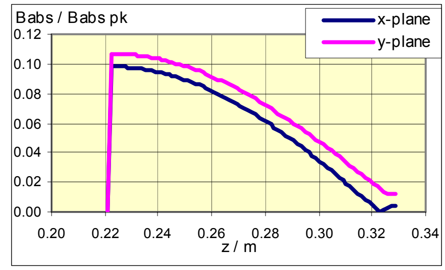

Figure 7: B-field distribution in “Drossel” joint.

The disadvantage of the RF “drossel” flange is its frequency dependence. On the other hand the limiting magnetic field magnitude for dismountable joint is around 2 mT. This gives reserve for non adjustments up to 5% of B_{pk}.

DESY-INFN blade tuner design [3] looks very attractive for multy-gap H-cavity frequency fine adjustment. Fig. 8 presents a provisional design of 10-gap 700 MHz, β=0.2 H-cavity with “drossel” end plate joints and blade tuner.

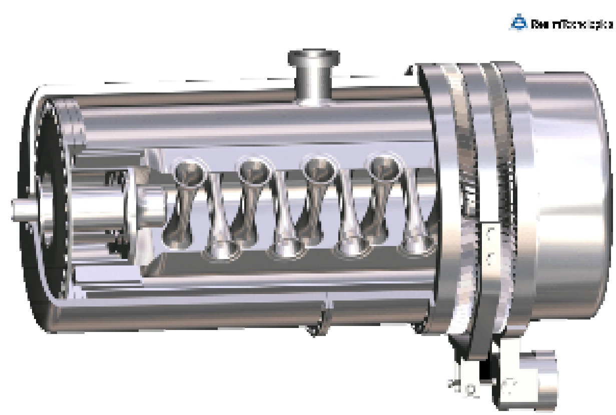

Figure 8: Provisional design of 10-gap H-cavity with “drossel” end plate joints and DESY-INFN blade tuner.

3 REFERENCES

[1] E. Zaplatin et al., "Low-b SC RF Cavity Investigations", SRF’2001, Tsukuba, Japan, 2001.
[2] I. V. Lebedev, "Technique and Devices of VHF", Vysshaja Shkola, Moscow, 1970.
[3] A. Matheisen, "Blade Tuner ",TTF Meeting, Saclay, 3-5.4.2002.