MULTI BEAM GENERATOR CAVITY FOR THE PROTON LINEAR ACCELERATOR FEEDING SYSTEM ON 991 MHz FREQUENCY GEOMETRY OPTIMIZATION

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Abstract

For the proton linear accelerator feeding system 800 kW input power value is required [1]. The system consists from pillbox cavity with six beam tubes connected to the rectangular waveguide as a power output system is designed. In case of using high voltage gun with modulated six-bunch injection, this system allows to transform the energy of electron bunches, which flies throw beam tubes, to accelerating section feeding power. Different types of the structure geometry were calculated. The whole structure consists both from generator cavity and accelerating structure, has been designed [2].

ACCELERATING STRUCTURE

Proton linear accelerator is based on the diaphragm-washers loaded structure [3]. The accelerating mode is E_{020} (see Fig.1). This kind of structure has a coupling coefficient bigger than in DLS or biperiodic accelerating structure (see Table 1).

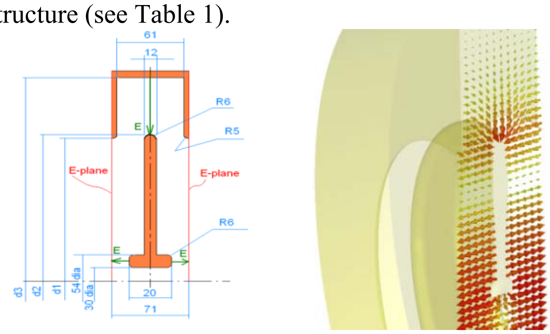

Figure 1.Accelerating structure geometry and field lines in it.

Table 1: Accelerating structure parameters

Parameter	Value
Q0	21376
rsh.ef, MOhm/m	19.16
rsh.ef/Q, KOhm/m	896
T	0.79
Ploss, kW	125
Eacc, MV/m	5.23
Emax/Eacc	1.85

THE CHOICE OF THE GENERATOR CELL GEOMETRY

E_{020} mode [3] was chosen as an operating mode in the resonator. This mode provides one field main maximum in the center of a pillbox cavity and local maximum across the perimeter (see Fig. 2).

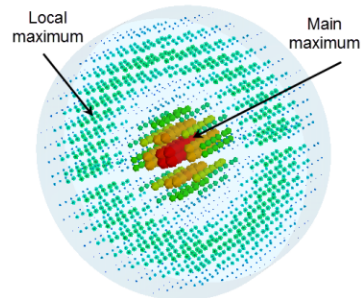

Figure 2: E_{020} mode field lines in a pillbox cavity.

By inserting beam channels in these maximums we can obtain local maximums centered in each channel (see Fig. 3).

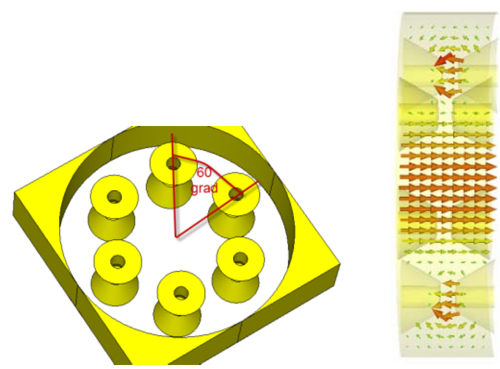

Figure 3: Modified structure.

Second geometry type is the geometry based on E_{310} mode (see Fig.4). On this mode the parasite center main maximum doesn't exist, thus all energy goes to the local maximums (see Fig.5) that will increase shunt impedance. The difference of shunt impedances along beam channels for these two most efficient structures is shown in the table 2.

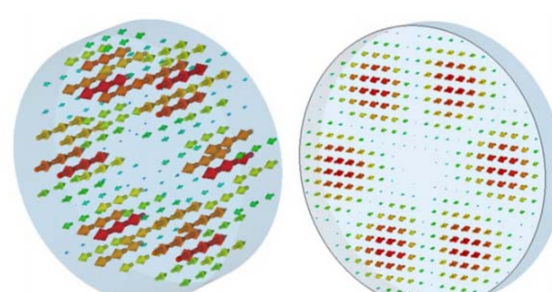

Figure 4: E_{310} field lines in the pillbox cavity.

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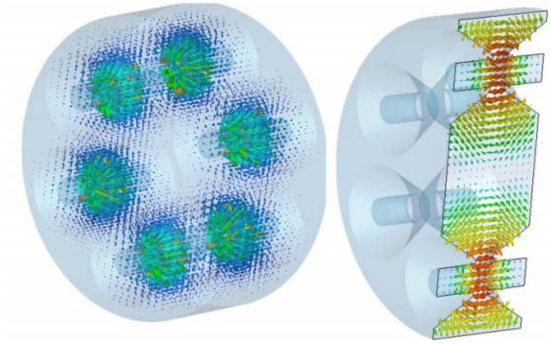

Figure 5: E_{310} lines in the tuned cavity.

Table 2: Different modes operating structures comparison

Cavity type	**E_{020}**	**E_{310}**
diameter, mm	466	341
rsh, MOhm/m	1.96	4.74

From the table 2 we see that the E_{310} mode based structure has a bigger efficiency. Another method of the shunt impedance increasing along the channels – is to put the coaxial core in the center of a resonator (see Fig. 6). By varying the diameter d3 of this core it is possible to obtain maximum shunt impedance in beam channels (see Fig. 7).

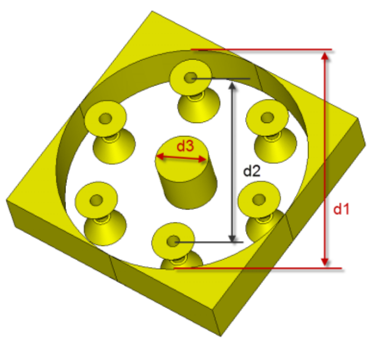

Figure 6: The geometry with a coaxial core.

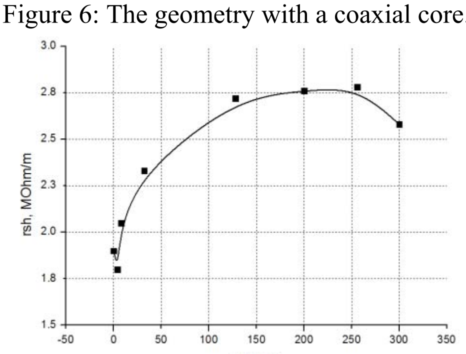

Figure 7: Rsh dependence from the core diameter.

From the Fig. 7 it is easy to see, that the maximum shunt impedance that it is possible to obtain in this geometry is equal to 2.8 MOhm/m, but the diameter of the resonator is so big: 737 mm. It means. that E_{310} based structure has the best efficiency and is the most suitable to be used in the accelerator feeding system. Now it is needed to calculate the power input in the accelerator to connect it with the generator cell.

POWER INPUT TUNING

This resonator is connected to the accelerating structure throw rectangular waveguide (see Fig. 8). The required coupling was obtained by changing window width w and the resonator radius.

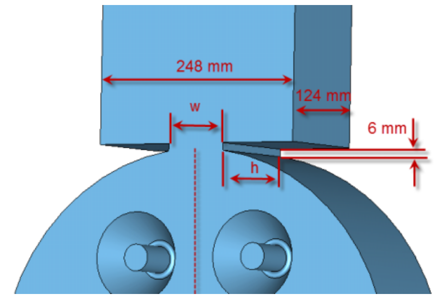

Figure 8: Waveguide to resonator connection

CONNECTING TO THE ACCELERATING STRUCTURE

On the Fig. 9 the connection between waveguide and accelerating structure is shown.

Coupling was tuned by coupling hole angle phi and by changing sizes d and z of the recess in the coupling cell. The dependence of the resonant peak from the recess diameter d with z=5mm and phi=29 grad is shown on the Fig. 10. There we can see that further increasing of the size d is unjustified, that's why next tuning step was changing recess depth z (see Fig.11).

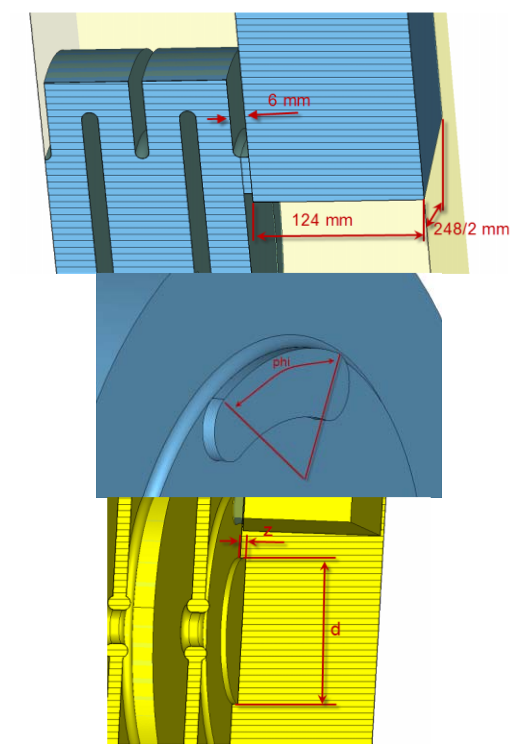

Figure 9: waveguide to accelerating structure connection.

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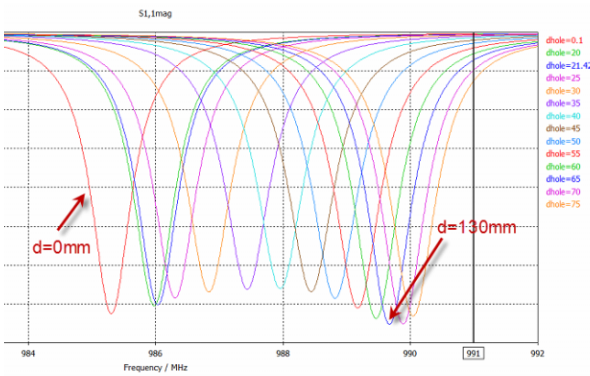

Figure 10: recess diameter variation.

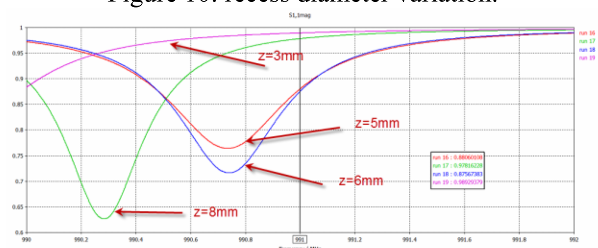

Figure 11: recess depth variation.

After the final tuning we can see the asymmetric field distribution in the accelerating structure (see Fig. 12).

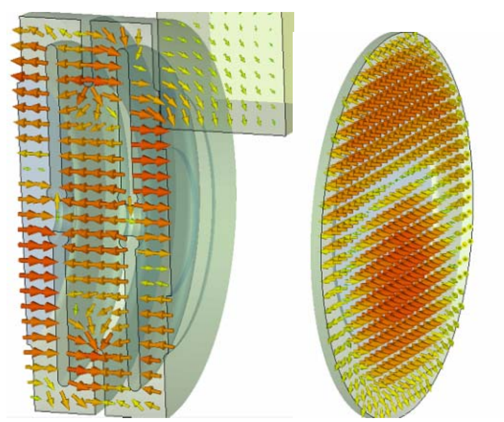

Figure 12: Asymmetric field.

The field symmetry was obtained (see Fig. 13) by increasing the diameter of the coupling cell of the accelerating structure and further coupling tuning.

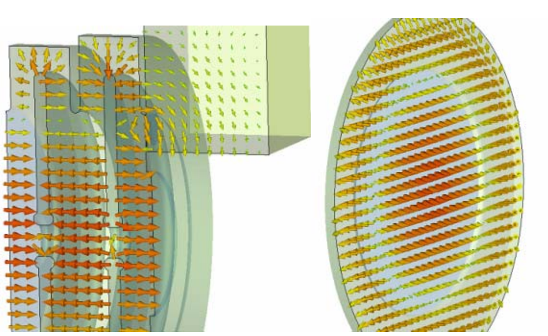

Figure 13: Tuned symmetrical field.

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