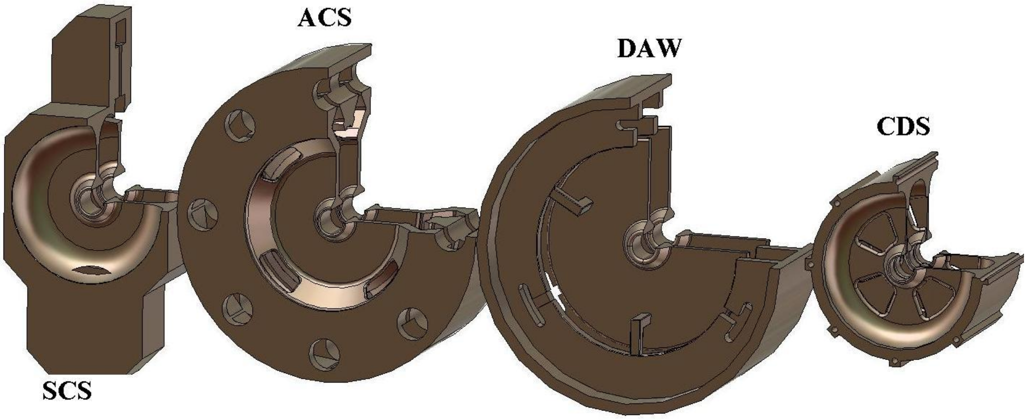
IPAC21

I.V. Rybakov, V.V. Paramonov
Institute for Nuclear Research of the RAS, Moscow, Russia

Determination of required tolerances and stop band width for cells manufacturing and tuning in compensated high energy accelerating structures.

The required value of the spread for accelerating field distribution comes from the beam dynamics conditions and for cavities in high energy hadron linacs is 1%. The standard deviation of the accelerating field distribution depends on the spread in frequencies of accelerating and coupling cells, stop band width and deviations in coupling coefficients. The deviations in frequencies for accelerating, coupling cells, coupling coefficients, are directly related with tolerances manufacturing tolerances for cells. The stop band width should be adjusted with cells tuning. Relations between standard deviation of field distribution and deviations in cells parameters, [1], are known. Together with relation between deviations in cells dimensions and cells parameters, [2], recommendations for cells manufacturing tolerances could be obtained. In relation to coupling coefficient of compensated accelerating structures (ACS, SCS, CDS, DAW) for high energy parts of linacs some recommendations for determination of optimal manufacturing tolerances and acceptable stop band are presented.



Comparison of accelerating structures for hadron linacs (tuned to 991 MHz operating mode frequency)

[1] *V.F. Vikulov* and *V.E. Kalyuzhny* // Tech.Phys., v. 50, 1980, pp. 773-779

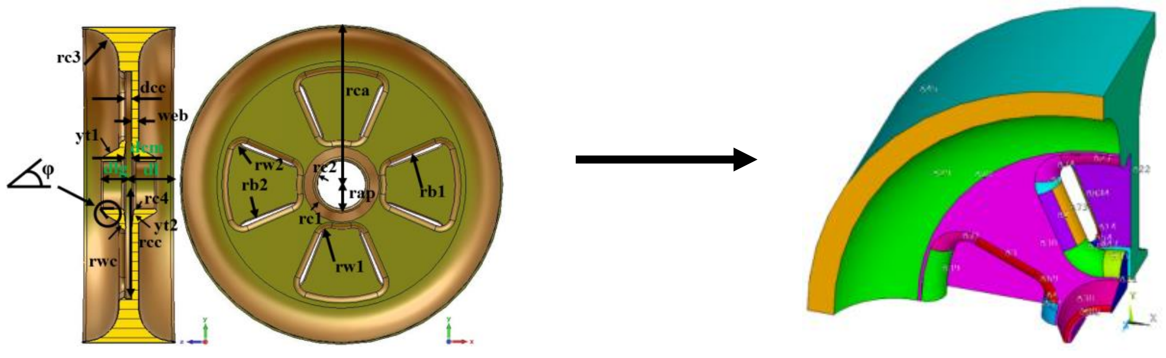
[2] I.V. Rybakov, V.V. Paramonov, A.K. Skassyrskaya // Proc. RuPAC 2016, pp. 291 – 293

$$\sigma_E^2 = \sigma_{E_f}^2 + \sigma_{E_k}^2$$

$$\frac{\delta f_{a,c}}{f_{a,c}\delta x_i} = \frac{\int_{S_i}\left(\varepsilon_0 \vec{E}_{a,c}^2 - \mu_0 \vec{H}_{a,c}^2\right)d\vec{S}}{4W_{a,c}} \qquad \delta k_c = \frac{\int_{S_i}\left(\varepsilon_0 \vec{E}_a \vec{E}_c - \mu_0 \vec{H}_a \vec{H}_c\right)d\vec{S}_i \Delta x_i}{\sqrt{W_a W_c}}$$

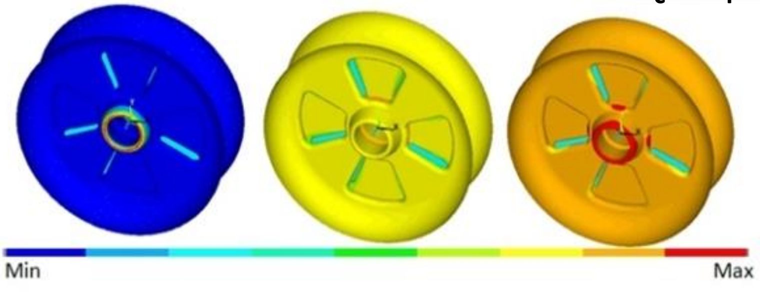
The accelerating field distribution spread is caused by accelerating mode, coupling mode frequencies and value of coupling coefficient deviations at the change of geometrical parameter δx_i. Required value for the spread is 1%.

To obtain the accelerating field distribution spread a technique based on ANSYS code was proposed.



The inner surface of the structure is divided by sub surfaces which correspond to geometrical parameters. (CDS structure presented as example)

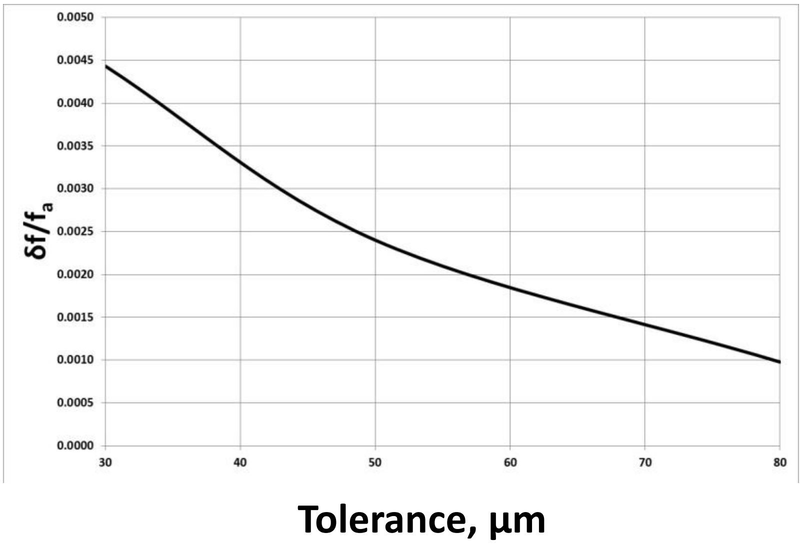
$(1/f_a)\delta f_a/\delta x_i$ $(1/f_c)\delta f_c/\delta x_i$ $\delta k_c/\delta x_i$



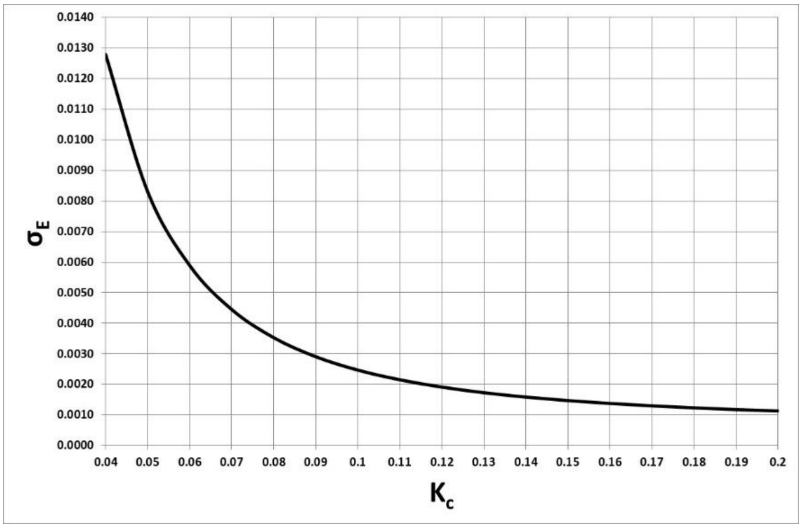
Tolerance µm	σ_{kc}	σ_{fa}	σ_{fc}
30	0,0011	0,0002	0,0011
50	0,0019	0,0004	0,0019
80	0,0031	0,0006	0,0029

Visualization – the density maps for deviations is showing the most sensitive areas for mode frequencies and coupling coefficient. From the ANSYS simulation one can get the optimal tolerance value.

Stop band width $\delta f = f_c - f_a$



The optimal tolerance value depends on acceptable stop band width and provides the accelerating field distribution spread less than 1 %. For the new CDS-based cavity for INR linac the 50 µm tolerance provides desired and acceptable stop band width 400 kHz.



With the coupling coefficient value of the hadron linac main part accelerating structure less than 5 % and acceptable stop band width of 400 kHz the accelerating field distribution spread is > 1%.

Conclusion

1. The ANSYS code-based technique for geometrical parameters deviation influence on frequency and coupling coefficient determination was proposed.
2. This technique's advantage is the only three numerical simulations require for optimal tolerance determination.
3. The importance of coupling coefficient value > 5% for the hadron linacs main part accelerating structures is shown.