Activities on the HE-Linac DTL cavity RF-design

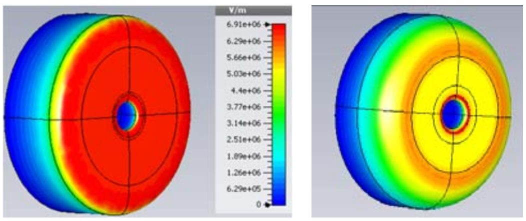
X. Du[1], *L. Groening*[1], *S. Mickat*[1], *A. Seibel*[1,2], *A. Orzhekhovskaya*[1]
[1]GSI, Darmstadt, Germany; [2]Goethe-University, Frankfurt, Germany

Abstract

The new 108 MHz Drift Tube Linac (DTL) of the UNILAC upgrade program at GSI is in the stage of designing and RF simulations. The DTL accelerates heavy ions with a maximum A/q of 8.5 from 1.4 MeV/u to 11.4 MeV/u. The planned accelerator consists of 5 tanks [1]. Several new features have been studied in the design for better performance regarding the peak surface field (E_{surf}), the shunt impedance (ZTT), and the electric field distribution.

Tube optimization

The optimizations started from existing Alvarez cavities at the UNILAC of GSI, with tank1 that has 3.6 MeV/u as output energy. The new tube shape, which is generated by smooth spline function, is used to replace the traditional shape that is based on blend and chamfer as shown in figure 1. With this new tube shape, the surface field is uniformly distributed on the surface of the drift tube keeping the shunt impedance constant, while the maximum E_{surf} is reduced by about 20%. The tube shape is the same for all cells in one cavity.



(a) (b)

Figure 1: The surface field distribution on new tube shape (a) and on the original tube shape (b).

Beta profile design

The tube sequence design is based on an optimized 3D tube model, predefined input energy, and maximum E_{surf}. The effective voltage is calculated from a single cell 3D model simulation, which provides the information of power loss, the transient time factor (TTF), maximum allowed E_{surf}, and the shunt impedance. The cell length is defined by the output energy of the former cell. The gap length is defined by the limit of maximum E_{surf} and the operational local frequency. The Visual Basic code in CST-MWS is used to perform continuous cell by cell design. Several different versions for DTL tank1 with different maximum E_{surf} and ZTT are weighted with respect to other considerations such as length of the tunnel and ability of RF power. We prefer a constant average electric field (E_0) with 1.0 Kilpatrick limit for maximum E_{surf}.

Field flatness

The designed electric field distribution may be disturbed in the real cavity due to perturbation, which is caused by mechanical errors. This effect may be decreased by post couplers. The simulation shows that by rotating specific stems in the cavity as shown in figure 2, the TM modes which are close to the operational mode, will be pushed away, and the sensitivity of field flatness to the local frequency uncertainty could be reduced significantly. The improvement is shown in figure 3.

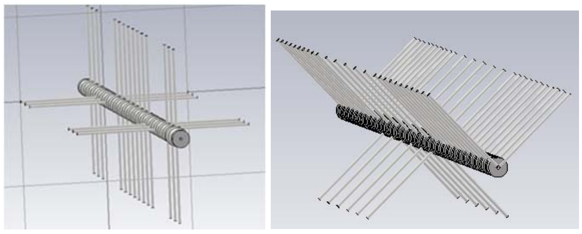


Figure 2: Stem arrangement for better field stability.

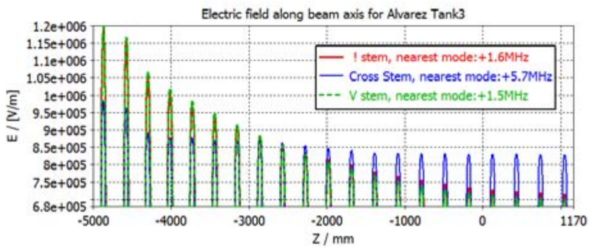


Figure 3: Electric field distribution with perturbation at the first cell of cavity.

The RF design of Alvarez cavities for UNILAC upgrade is in process, magnet design for Tank 1 has started, and the beta profile of other tanks will be designed with the same principle as tank1. A corresponding aluminium 1:3 Alvarez RF model is ordered for mechanical studies and RF measurement [2].

References

[1] S. Mickat et al., this report.
[2] A. Seibel et al., this report.

DOI:10.15120/GR-2015-1-FG-UNILAC-16