Cavity Design of a 7MeV 325MHz Proton APF IH-DTL for a compact Injector

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I

Introduction

Over the recent decades, with the development of particle accelerator physics and related technologies, providing energetic particles like protons to treat cancers is more and more efficient and practical. To be competitive, as a manufacturer of radiotherapy facilities, APACTRON is developing a new 7 MeV injector to replace the current Alvarez DTL for the Advance Proton Therapy Facility.

For the new injector, an interdigit H-mode Drift-Tube-Linac(IH-DTL) with Alternating-Phase-Focusing(APF) method working at 325MHz was employed. With the RF field established properly in the cavity, protons can be accelerated from 3MeV to 7MeV successfully. In this poster, the process of designing such an APF IH-DTL cavity and the latest design of the APF IH-DTL for the compact injector is going to be presented. Also, the characteristics of the cavity and parameters studying of RF are going to be demonstrated, including considerations of the cavity, the RF characteristics, geometric dimensions, the comparison between the calculated-voltage and required-voltages from beam dynamics.

II

Design procedure for APF IH-DTL

$$f \propto \frac{1}{\sqrt{L_e C_e}}$$

1.Construct a structure model based on the cell table, which determines the cell length, namely the synchronous phases sequence.

2. Segmentally adjust the diameters of the cavity to make the axial longitudinal E-field uniform.

3. Adjust the width of the End-Ridge-Cut to refine the E-filed near the both ends of the cavity.

4. Tune the resonant frequency of the cavity to 325MHz by adjusting the diameter of the cavity.

5. Iterate the step 2- 4 to refine the uniformity of axial longitudinal E-field and frequency of the cavity.

6. Refine chamfering radius of the outer edge of the drift tubes to make sure the maximum E-field is less than 29MV/m (1.6times EKilpat)

7. Export the 3D EM distribution to re-calculate the beam dynamics with a third-part code like TraceWin. Optimize the geometry and dynamics by doing co-iteration with each other.

8. Add the tuners, Couplers, Vacuum pipes. Iterate the step 2-4 if necessary. Redo the step 7 to make a check.

9. After the mechanical design of the cavity, re-construct the model in CST MWS. Make sure the E-field distribution and voltage distribution meet the requirement of dynamics.

III

Characteristics and structure of APF IH-DTL

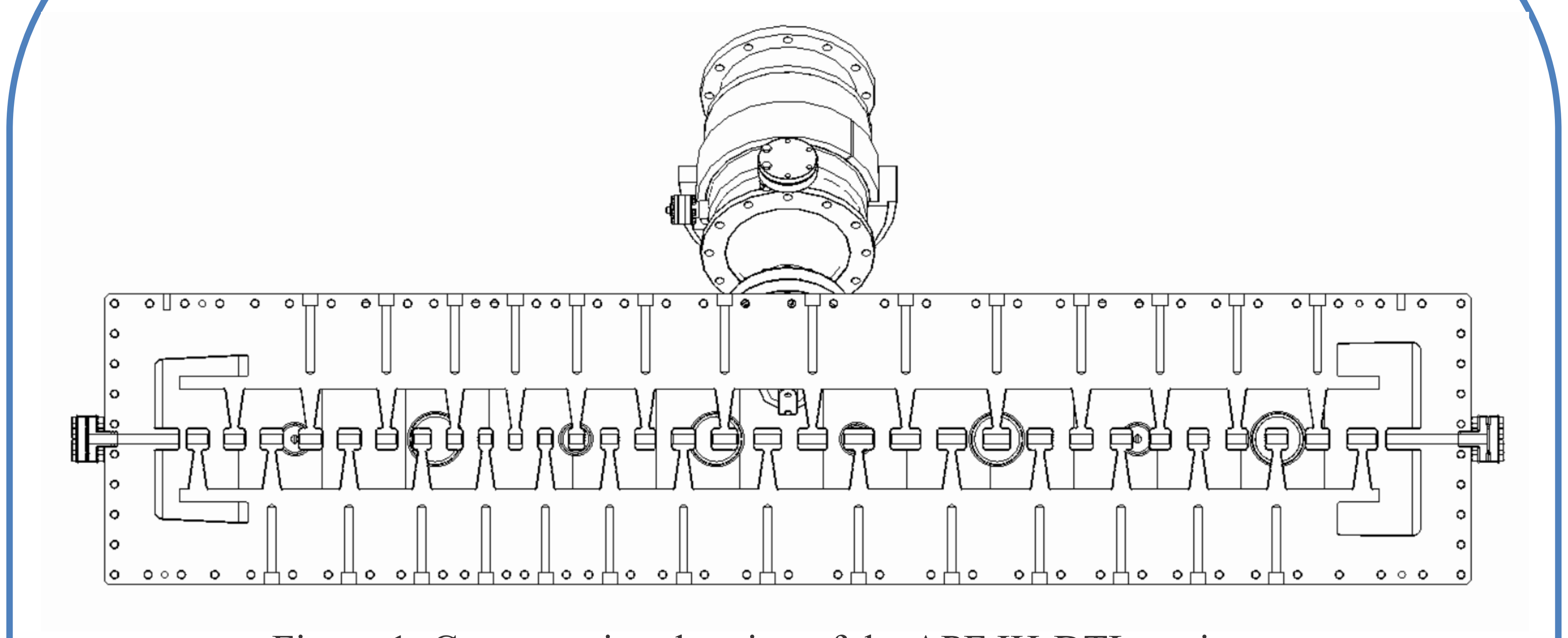

Figure 1: Cross-section drawing of the APF IH-DTL cavity.

Table 1: Characteristics of APF IH-DTL.

Items	Value	Unit
frequency	325	MHz
length	1514.6	mm
Input energy	3	MeV
Output energy	7	MeV
Unit cells number	32	-
Inner radius of the cavity	95.6-116	mm
Outer radius of the tube	13	mm
Inner radius of the tube	6	mm
Bravery factor of the cavity	1.53	-
Quality factor (0.8)	8900	-
Establishing field power (0.8Q)	195	kW
Woking mode	TE11(0)	-

IV

EM Field Distribution

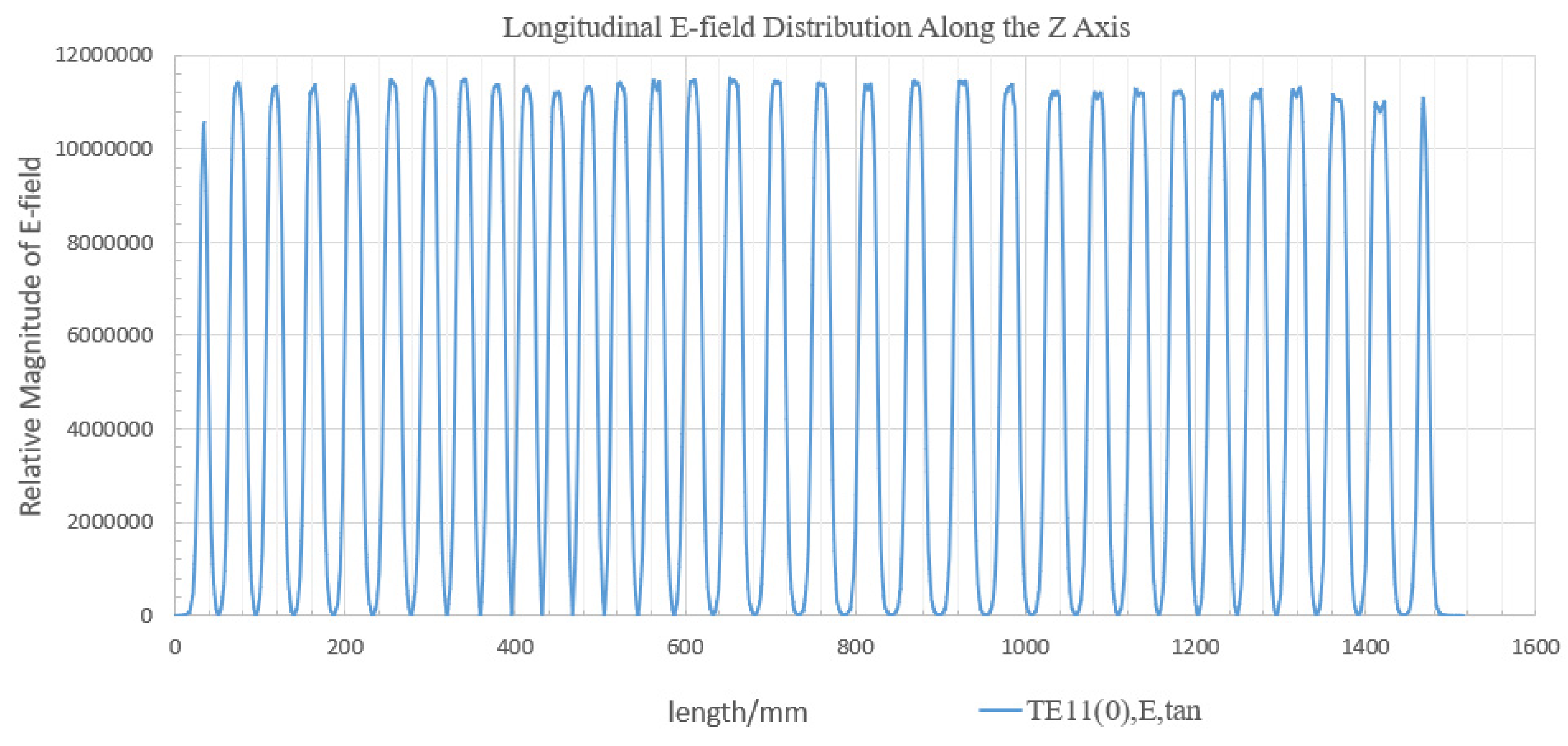

Figure 2: Longitudinal E-field Distribution along the Z Axis

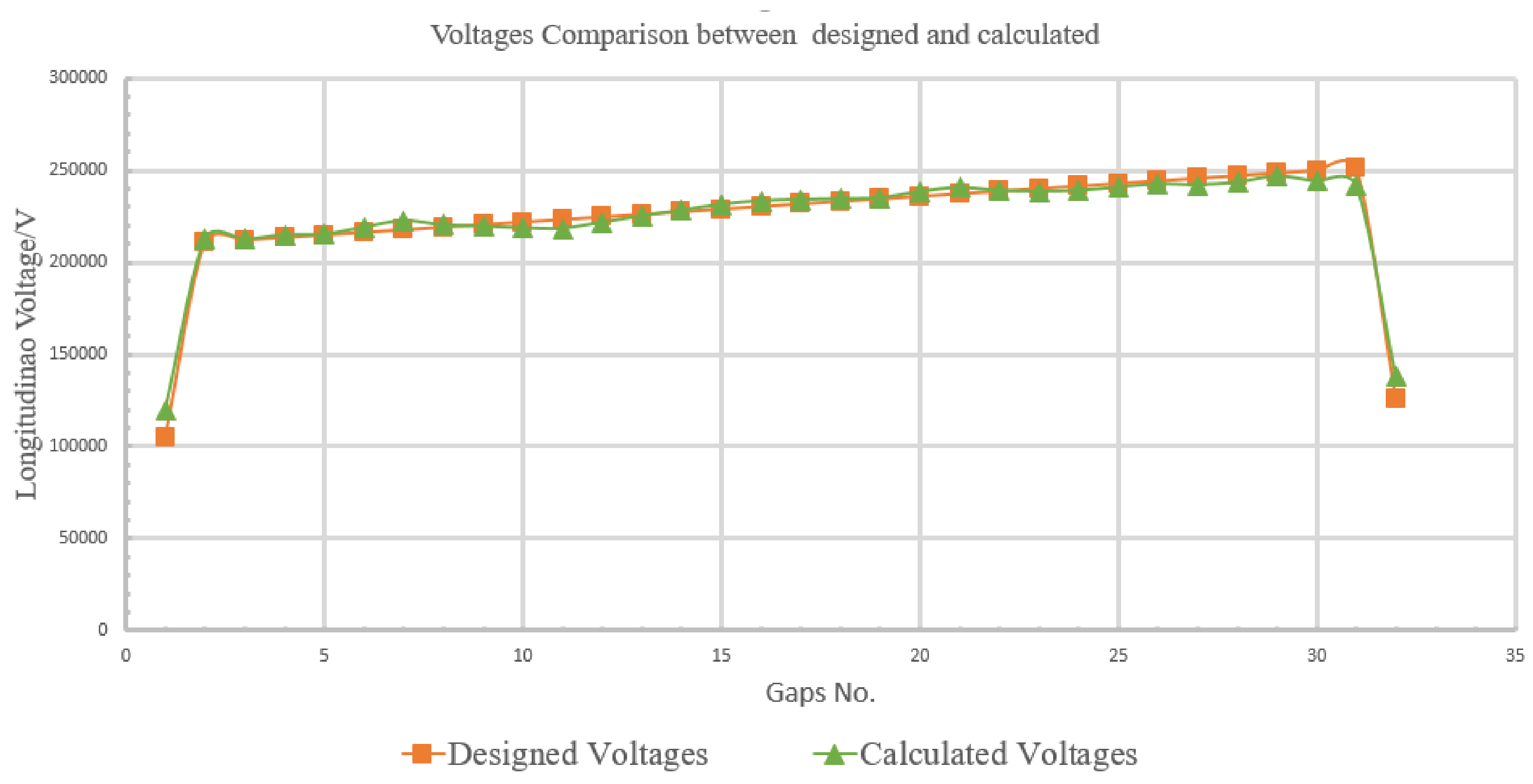

Figure 3: A comparison of voltage between the designed from dynamics and calculated by CST MWS.

V

Future Work

- Cavity fabrication is about to be started.
- Establishment of a tuning platform and clod test for the cavity.
- Establishment of a high-power test and acceleration test platform for the cavity.

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