VACUUM ANALYSIS OF A CORRUGATED WAVEGUIDE WAKEFIELD ACCELERATOR (A-STAR)

Vacuum Analysis of a high length to diameter ratio chamber.

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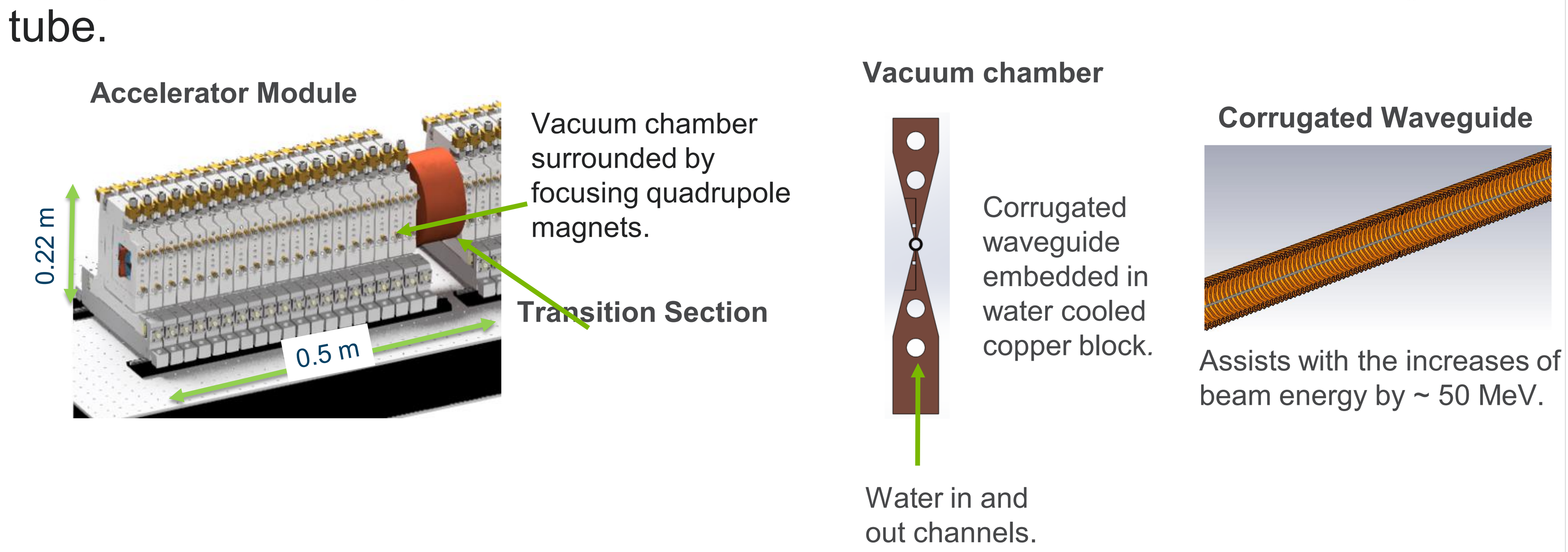
ABSTRACT AND MOTIVATION

The vacuum level in a 2-mmdiameter, 0.5-m-long copper corrugated waveguide tube proposed for a compact high repetition rate wakefield accelerator has been investigated. The analytical calculations have been found to be in good agreement with the result of computer modeling using the finite element method. A representative experiment has been conducted using a smooth copper tube with the same inner diameter as the corrugated tube.



VACUUM CALCULATION

we modeled the corrugated waveguide as a smooth tube with an effective diameter 3=2.26mm and an effective length = 0.95m that has the same surface area as a 2-mm-diameter, 0.517-m-long tube with corrugations. Calculated conductance is:

$$C(x) = 12.1\,\frac{d^3}{l}$$

$$P(\xi) = \pi R\,\frac{l^2}{12.1d^2}\,\xi\,(1-\xi)$$

Where, R is the outgassing coefficient, 3.6x10-11 torr* L/(cm2* s) for copper after backing [6, 9], we calculated the vacuum pressure at the center of the tube as $1.5\text{x}10^{-6}$ torr.

MOLECULAR FLOW FEA

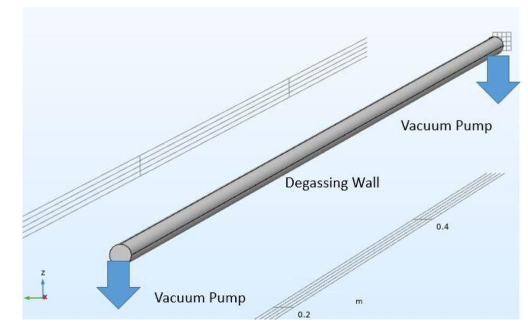


Fig. 1: The 517-mm-long, 2-mm-inner-diameter CWA without corrugation it is 0.26mm modeled as a 950-mm-long, 2.26-mm-inner-diameter smooth copper tube.

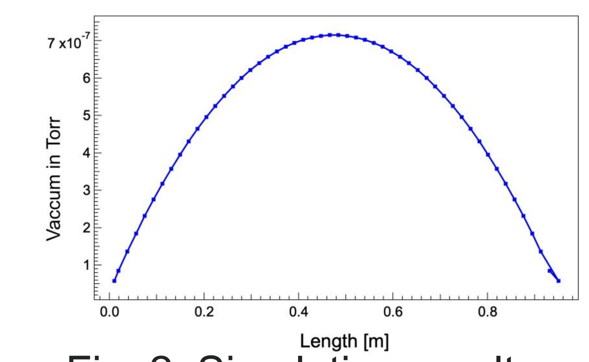


Fig. 2: Simulation result

VACUUM TESTING ON MOCK UP

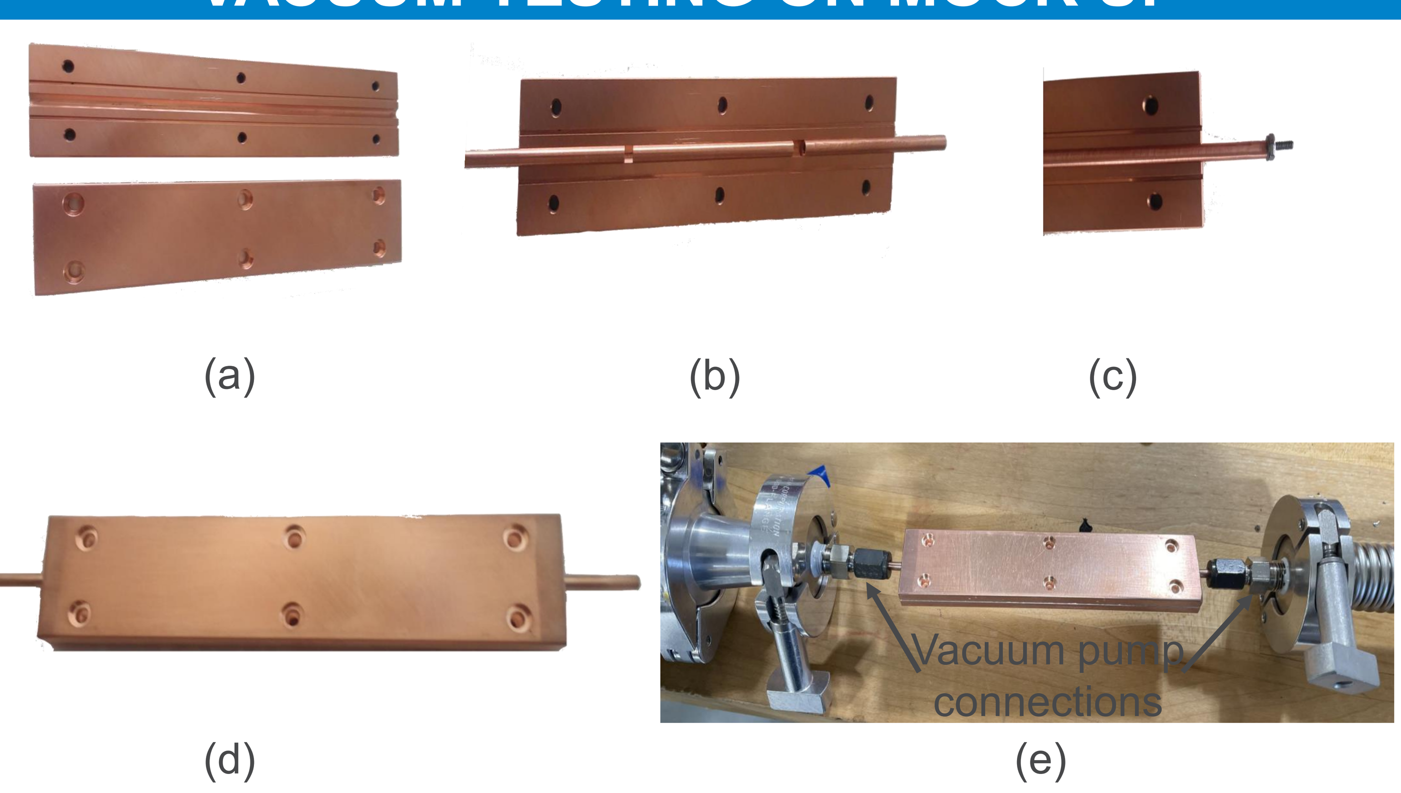


Fig. 3: Fabrication process for a mock-up vacuum chamber. (a) Preparation of two halves before brazing, (b) three 50-mm tubes assembled in the channel, (c) assembled vacuum chamber with titanium rod inserted for clamping via application of spring force, (d) brazed chamber without machining operation, and (e) vacuum chamber on testing rig attached with vacuum pumps.

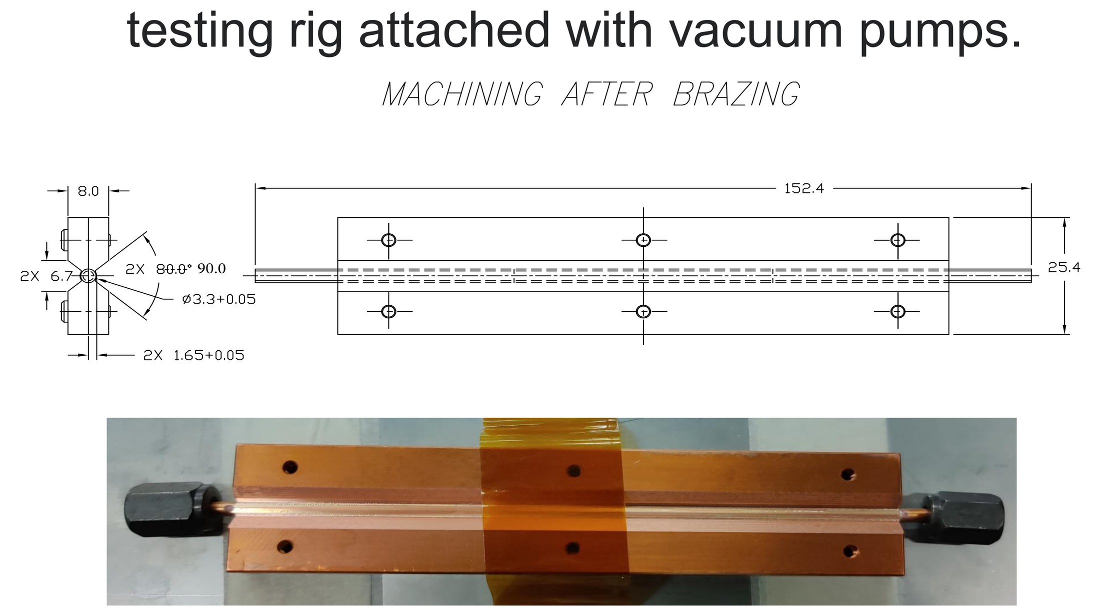


Fig 4: Vacuum testing with baking out process after machining the chamber

RESULTS

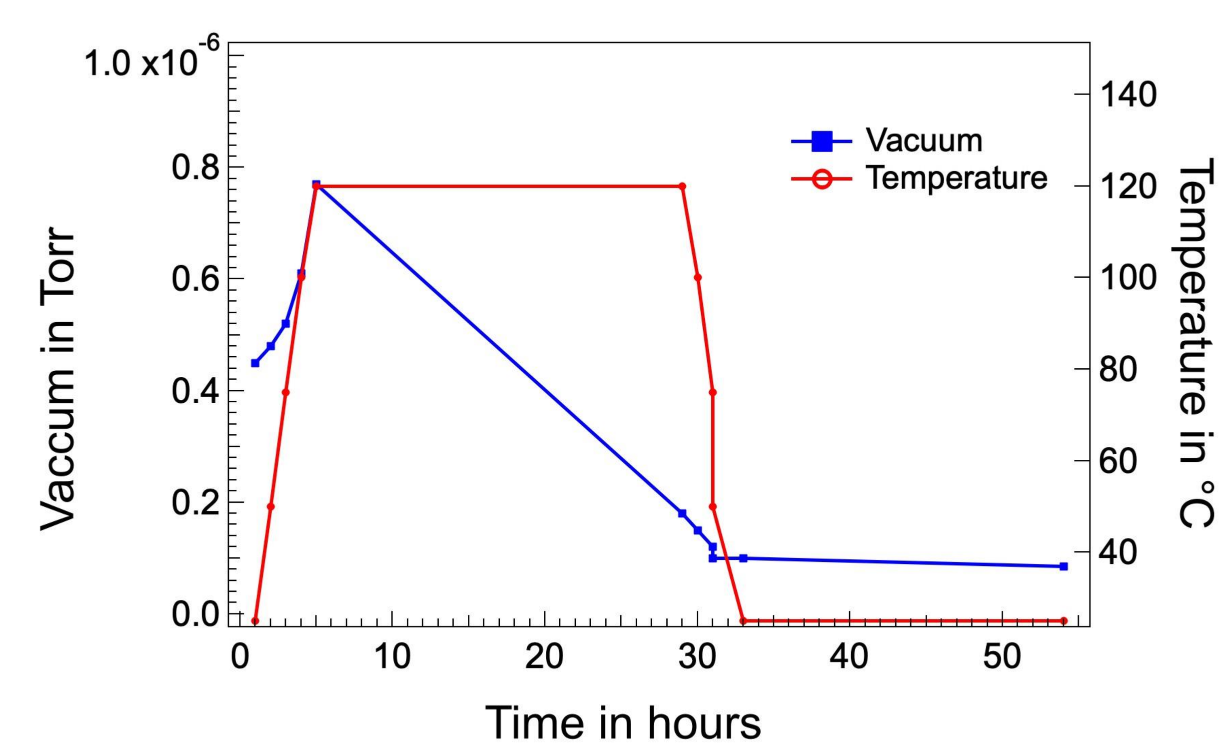


Fig. 5: Vacuum testing with baking out process.

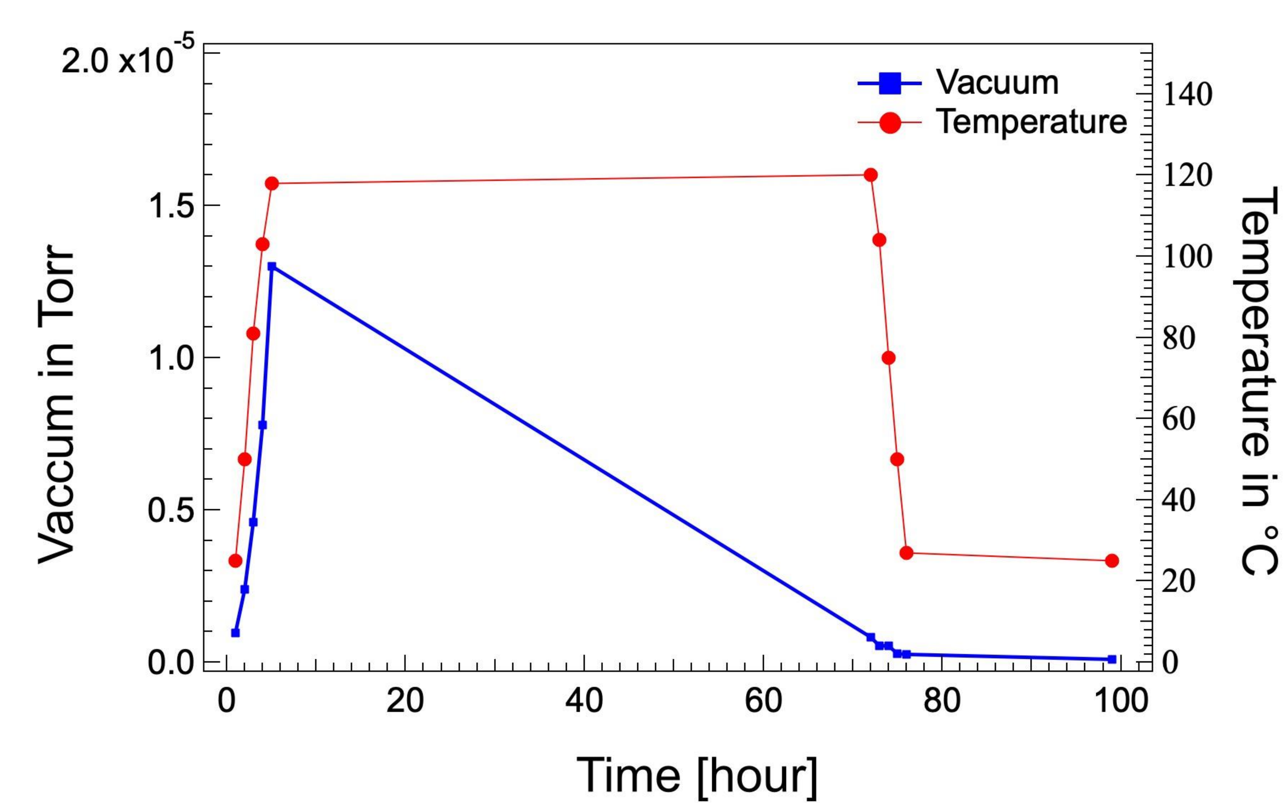


Fig. 6 : Vacuum testing with baking out process after machining the chamber

CONCLUSIONS

- The outgassing coefficient for the oxygen-free copper after backing was used to simulate the gas load. A maximum pressure of $7\text{x}10^{-7}$ torr and a line average pressure of $5.6\text{x}10^{-7}$ torr.
- The vacuum testing results shown in Figs. 5 and 6 using a mock-up vacuum chamber are in good agreement with each other. In both cases, the vacuum level improved after baking and sustained an equilibrium between outgassing and pumping that confirms the successful brazing process.
- Exposing the brazed tubes to atmospheric pressure over a large fraction of the circumference and length slightly degraded the vacuum pressure, which can be attributed to the thin section of the tube.

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