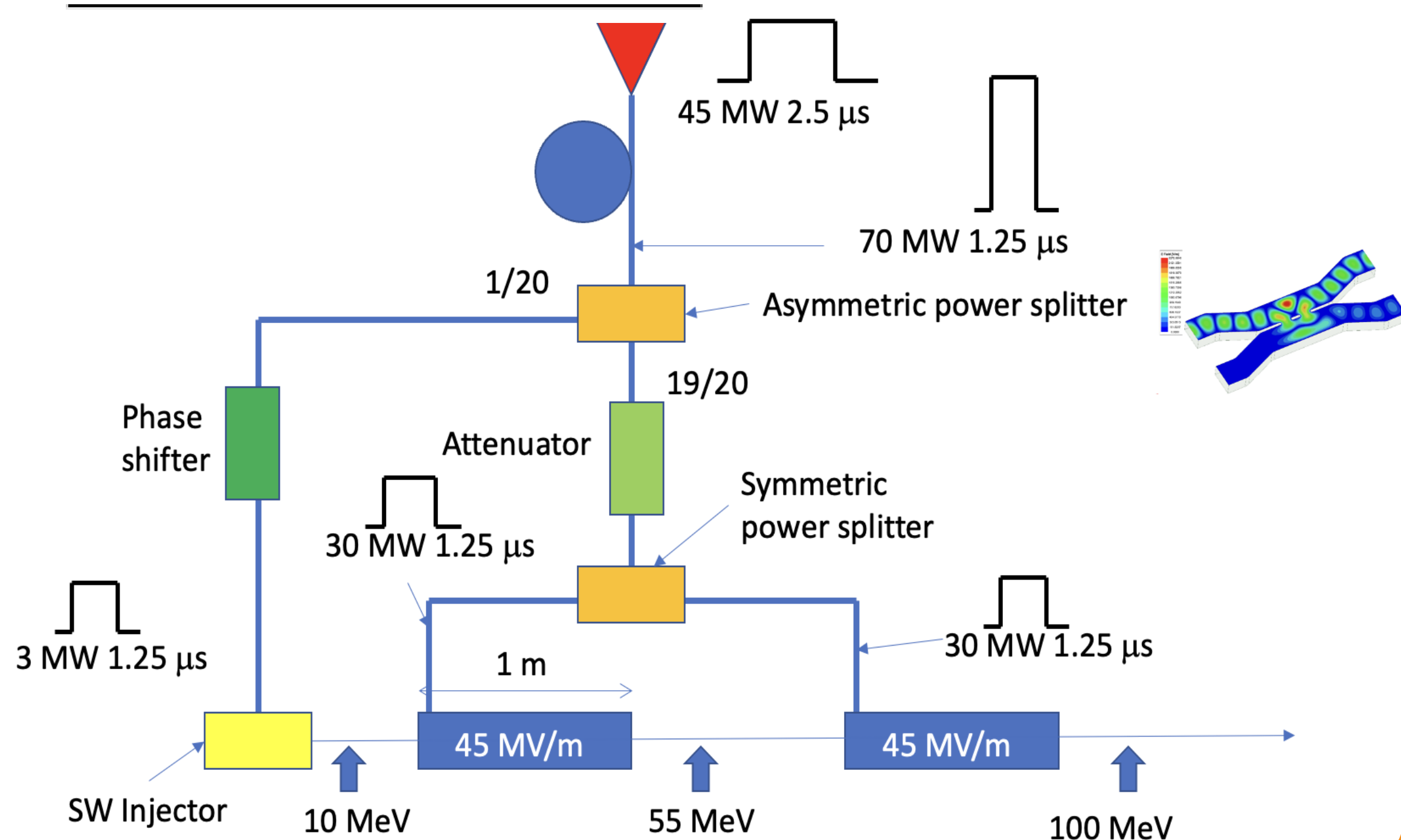


Abstract

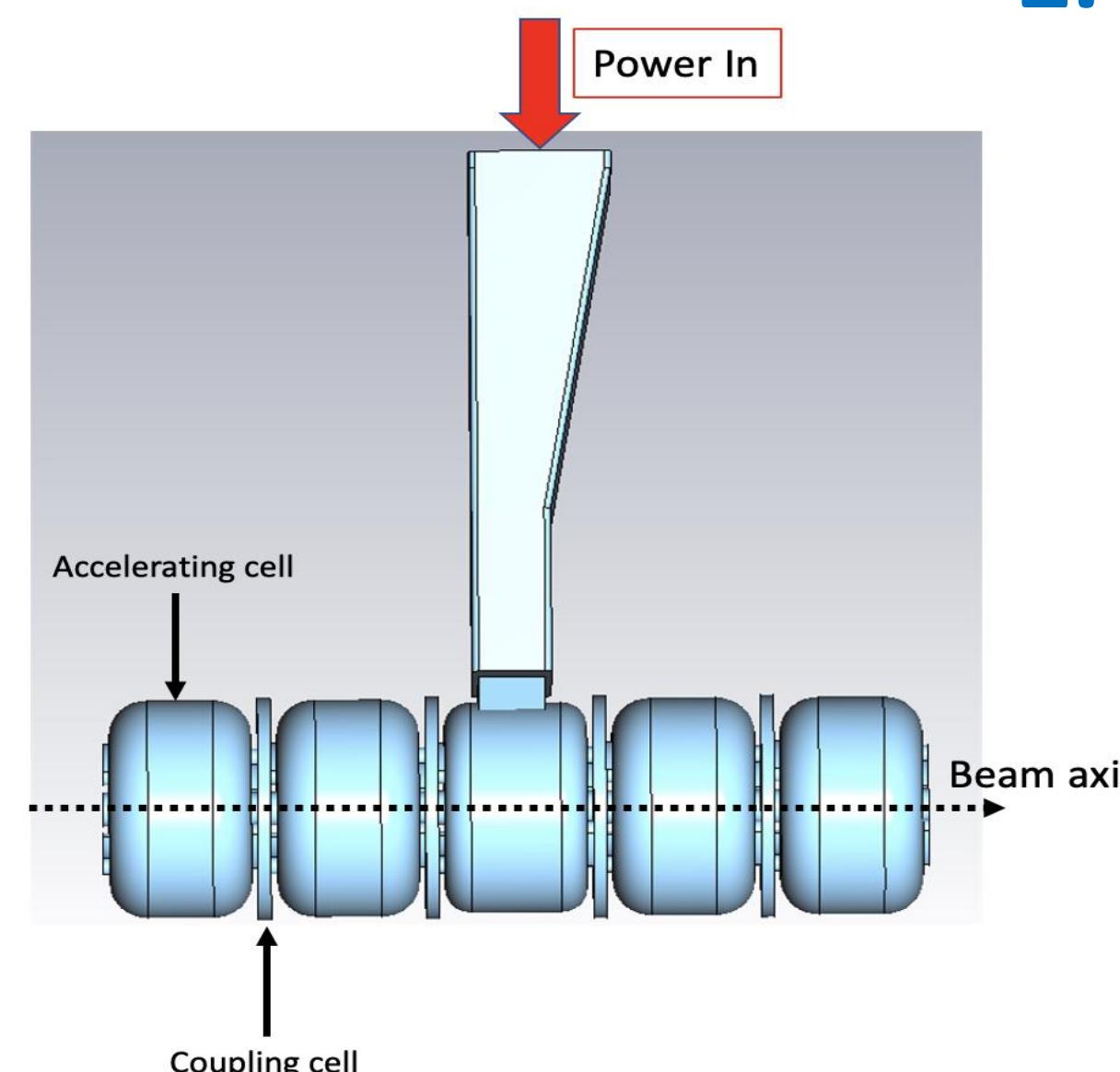
FLASH Radiotherapy (RT) [1] represents a revolutionary technique in cancer treatment, delivering high radiation dose rates exceeding 100 Gy/s in microsecond pulses. La Sapienza, University of Rome, in collaboration with INFN, is actively engaged in developing high-gradient C-band structures for a compact VHEE Linac in the FLASH regime (SAFEST Project) [2]. The RF electromagnetic design of the standing and traveling wave structures was carried out using CST Studio Suite. Following the design phase, we proceeded with the mechanical design and in-house fabrication of copper prototypes. To assess their performance, low-power RF tests were conducted at Sapienza University of Rome and the field measurements within the cavity were obtained using the bead-pull technique. Detailed analysis of the results obtained from a full-scale copper prototype revealed a significant agreement with the CST RF simulations. These prototypes serve as crucial milestones toward the final structure of the VHEE Linac

1. VHEE FLASH linac general layout [3]

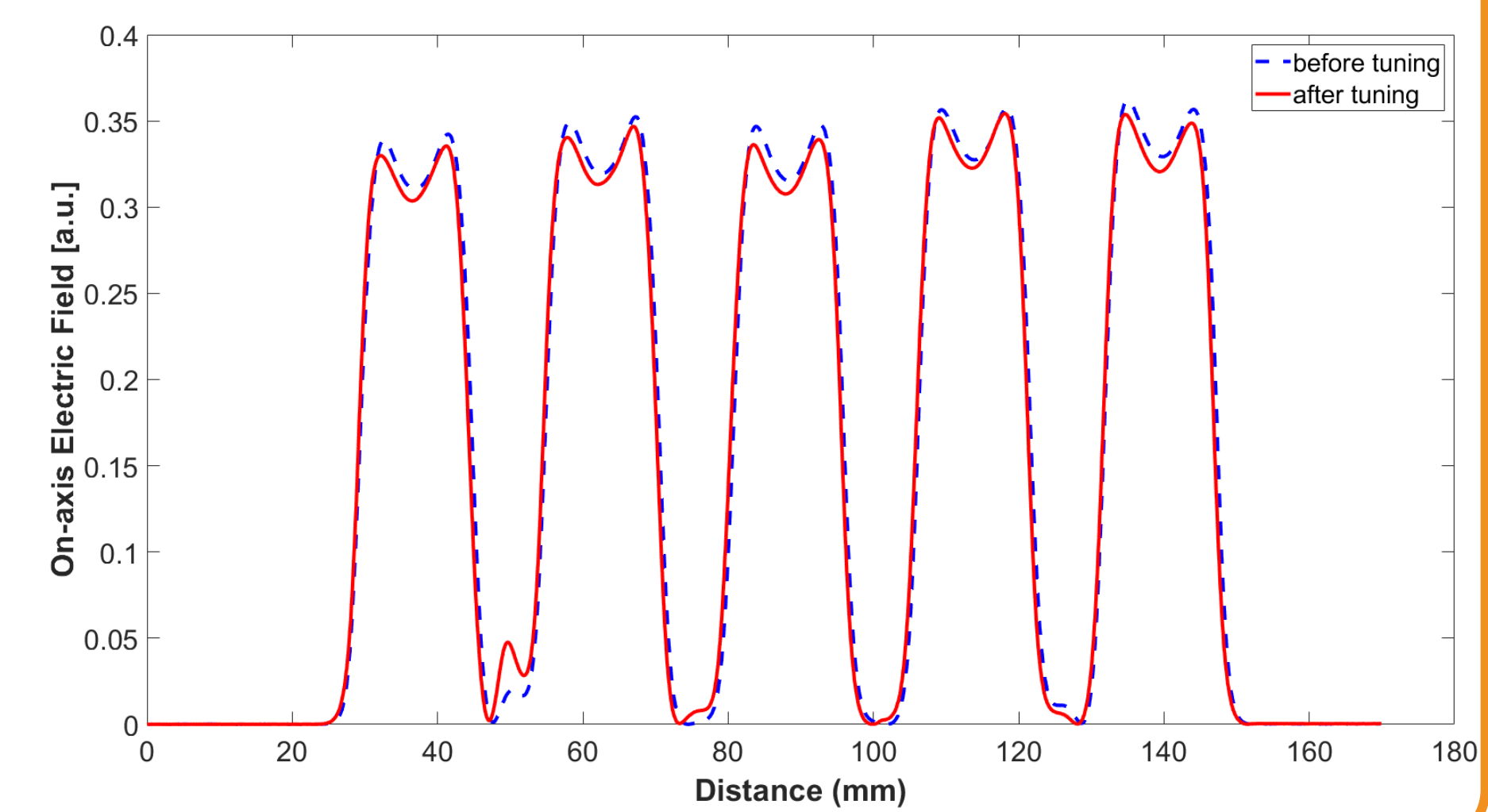
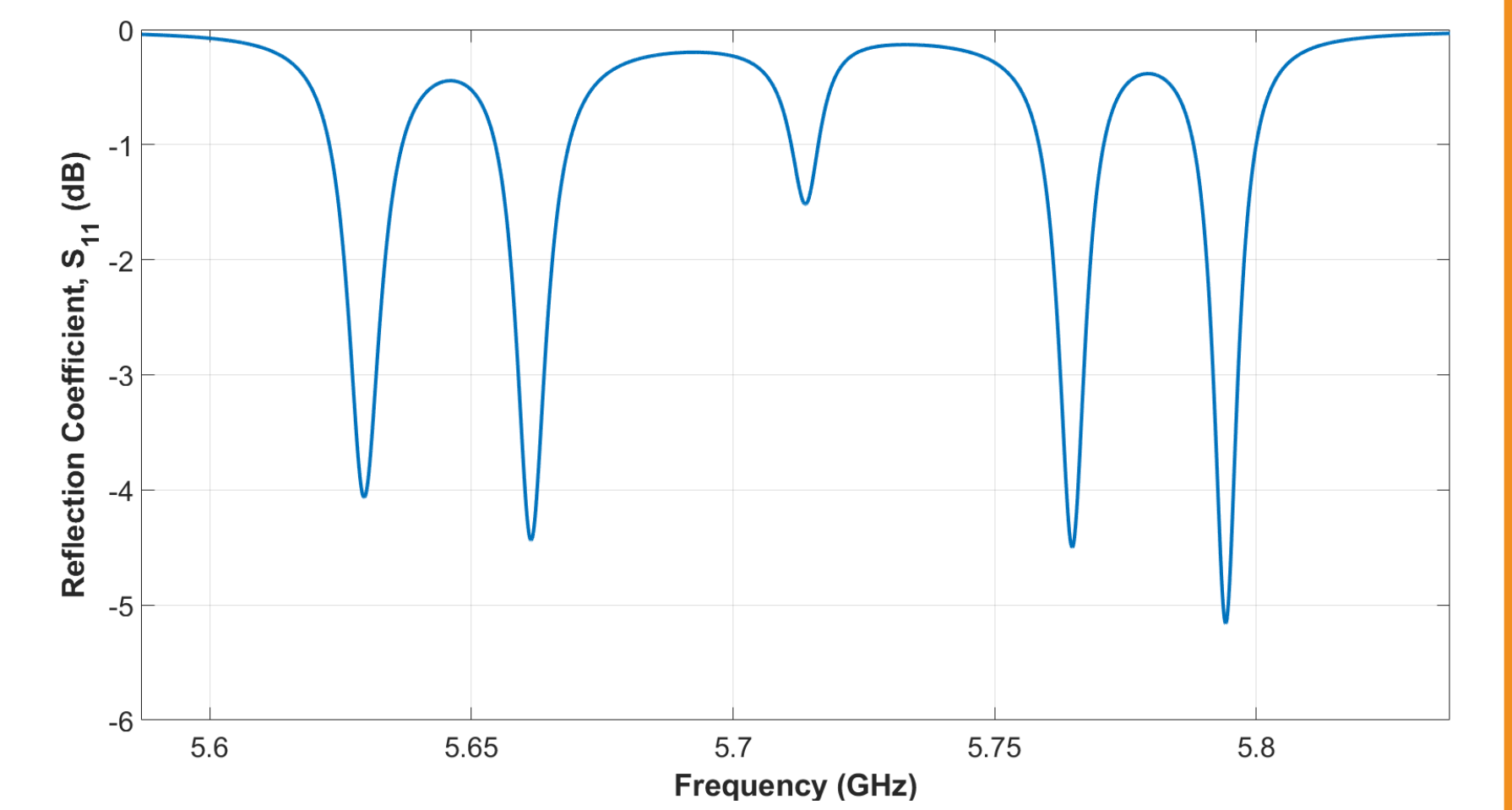
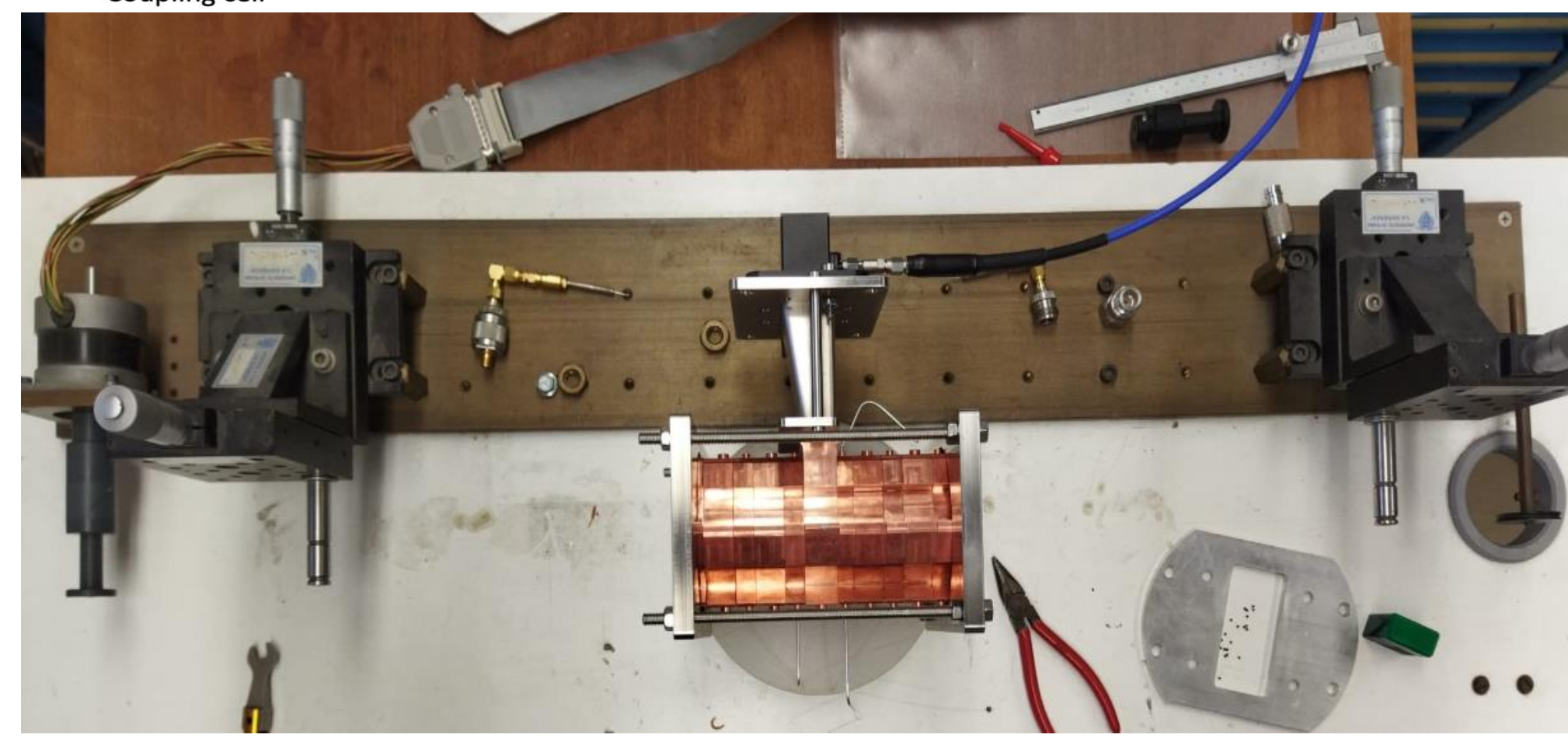
Description	Value
Frequency	5.7115 GHz
Beam energy	80 - 100 MeV
Pulse repetition frequency	100 Hz
RF Pulse duration	1,25 - 2,5 μ s
Nominal current	100 mA
In-pulse dose rate	> 10 ⁶ Gy/s
Dose per pulse	> 1 Gy
Average dose rate	> 100 Gy/s



2. Standing Wave Injector prototype test [4]

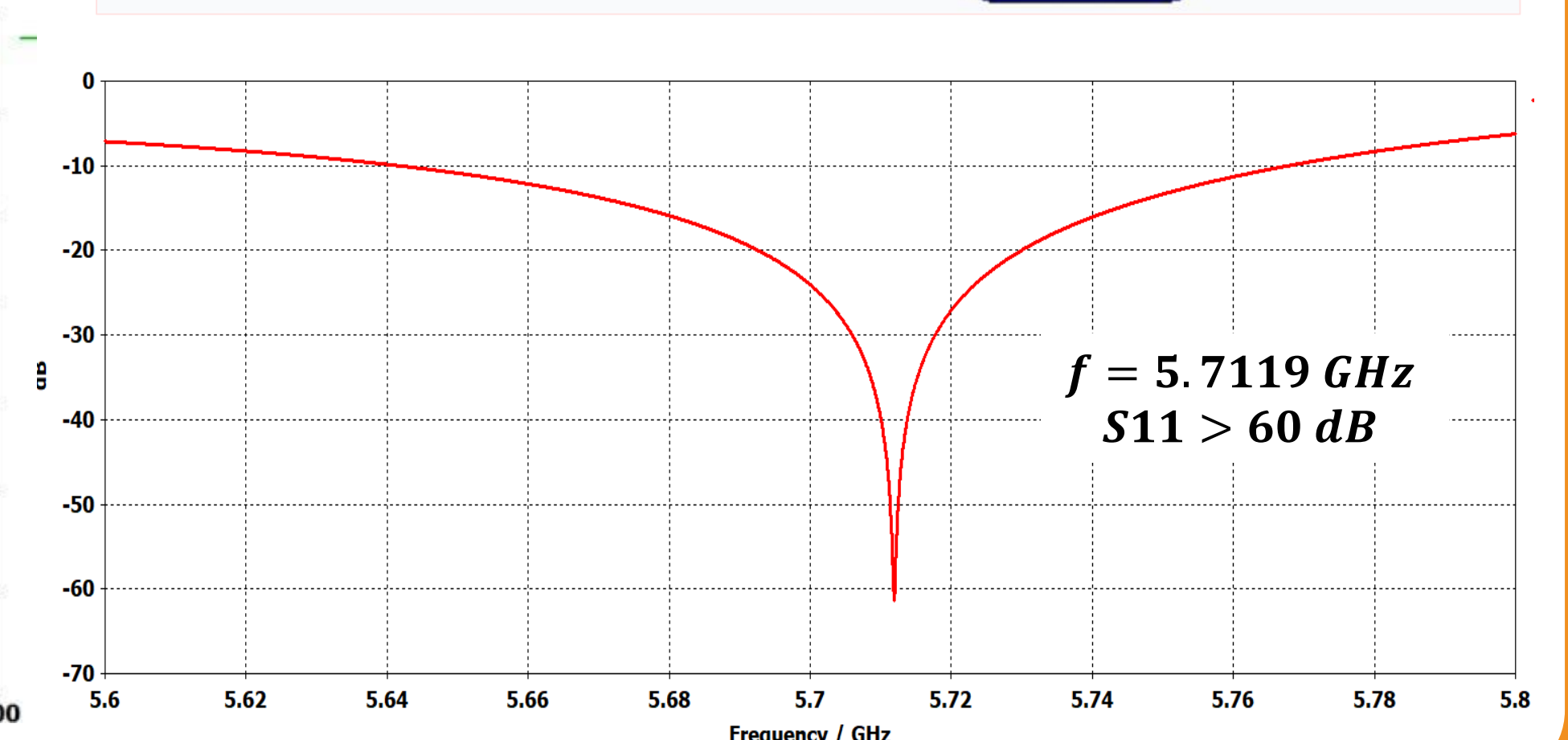
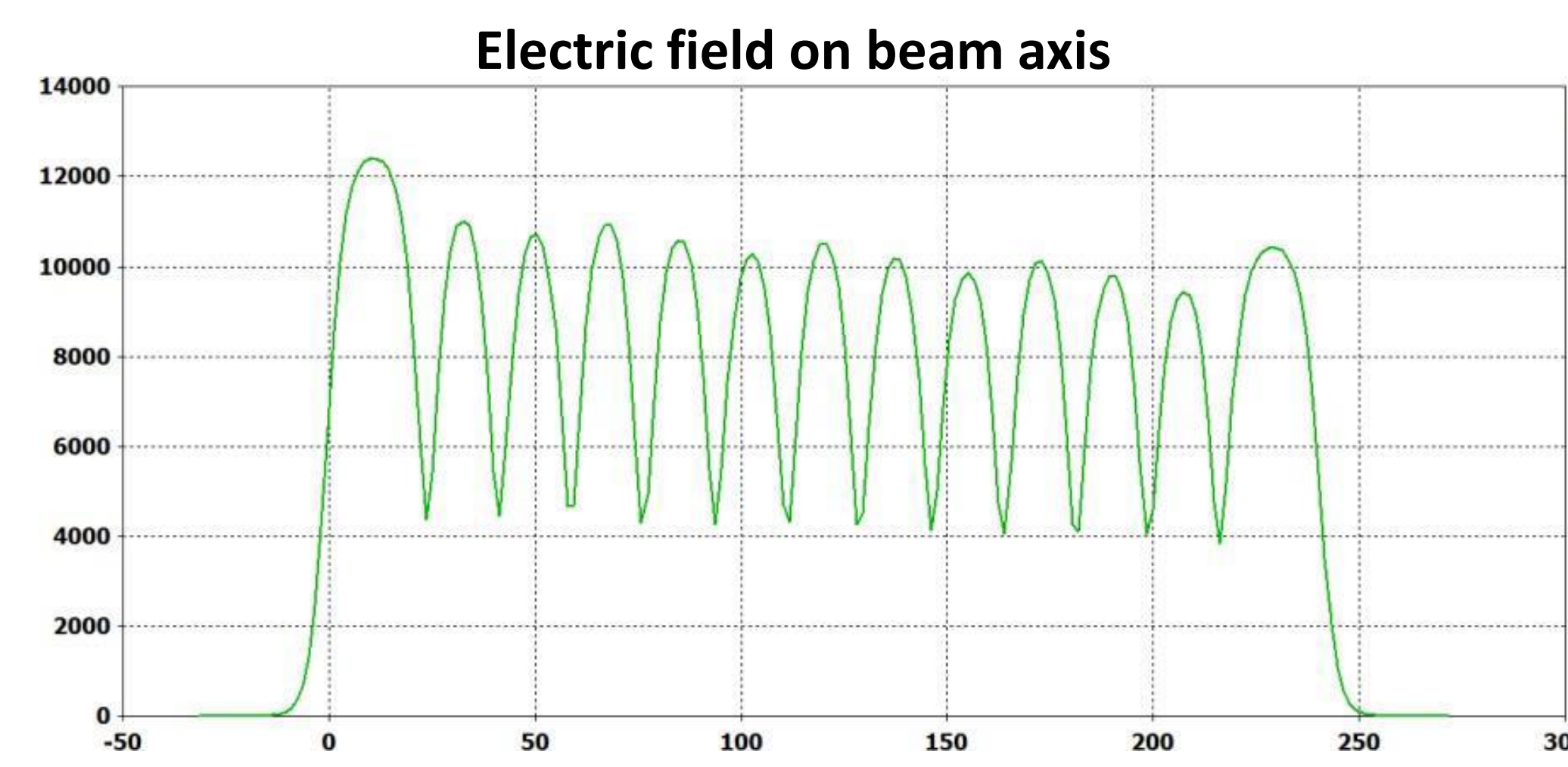
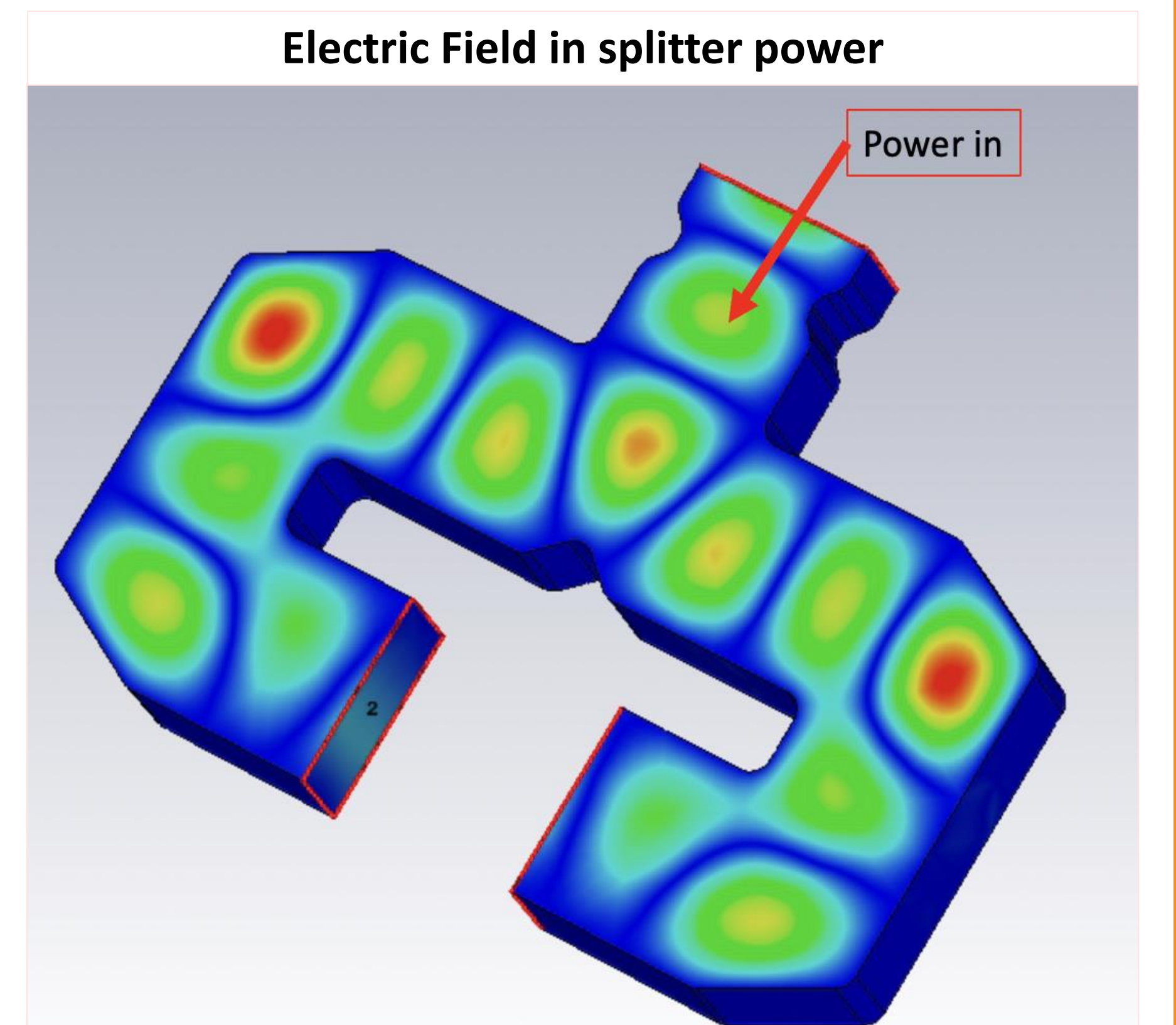
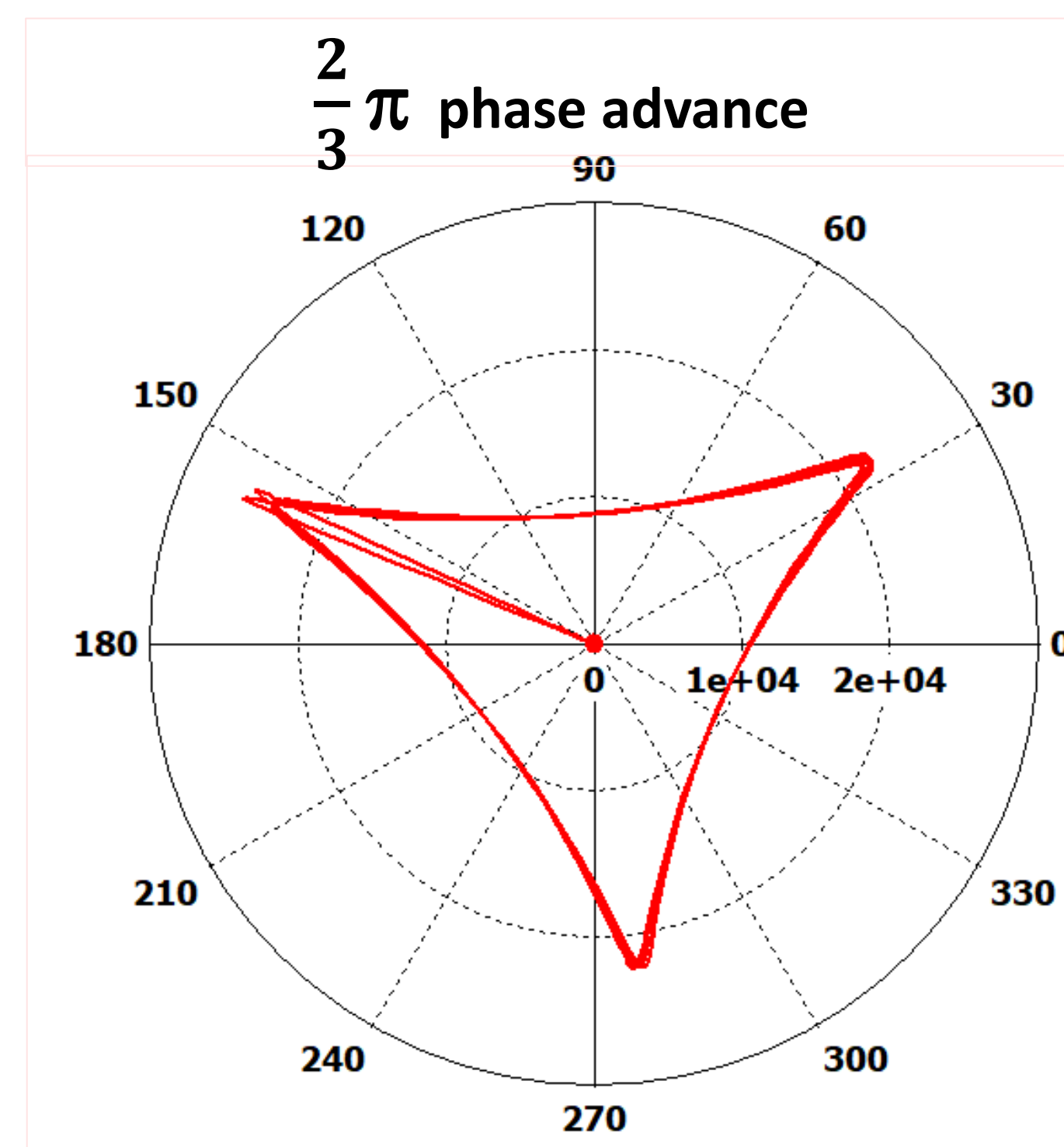
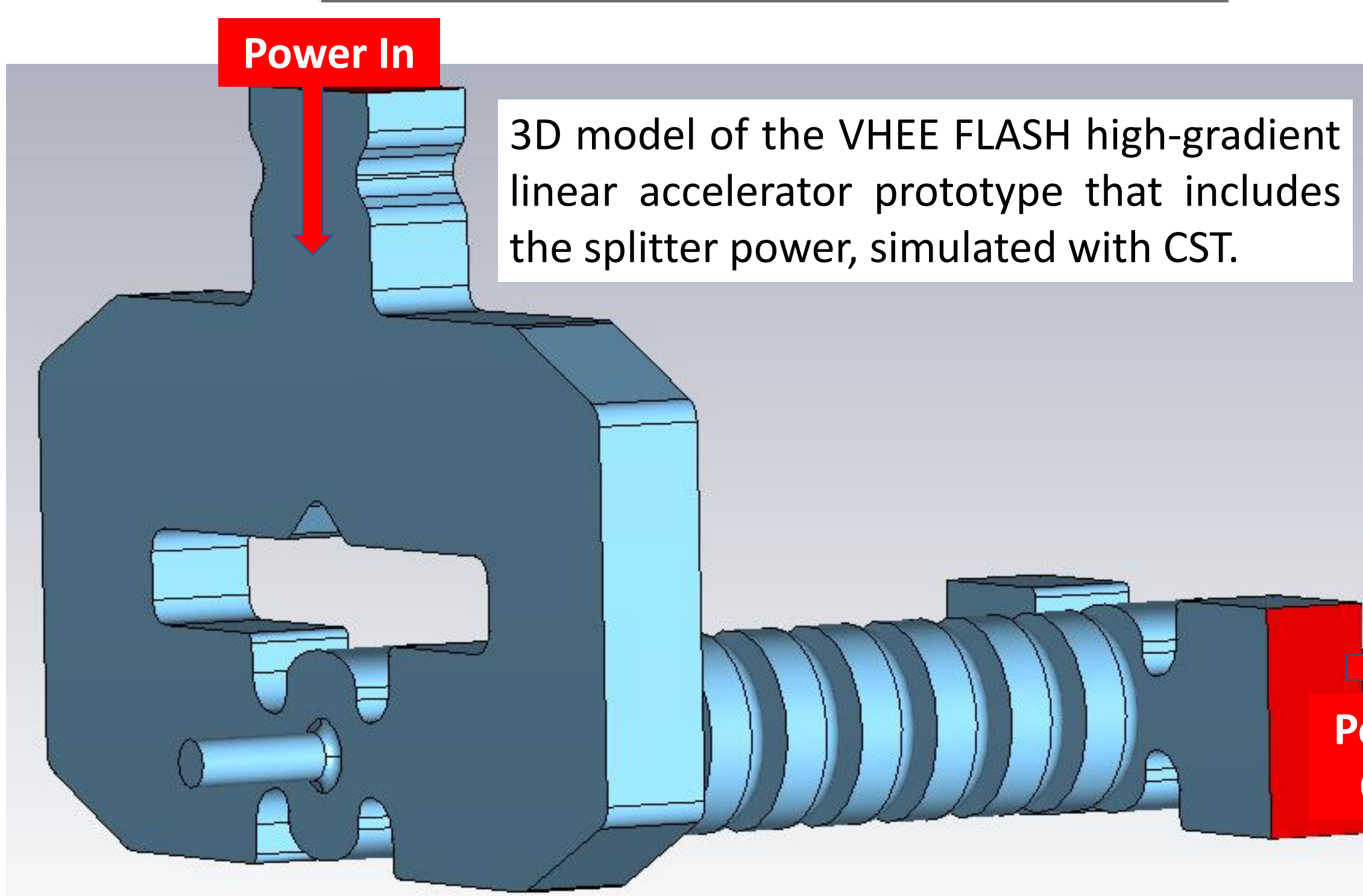


Description	Value
Frequency	5.7123 GHz
Prototype length	12,90 cm
Quality factor	11260
Shunt Impedance	115.94 M Ω /m
Waveguide-to-linac coupling β	1.3

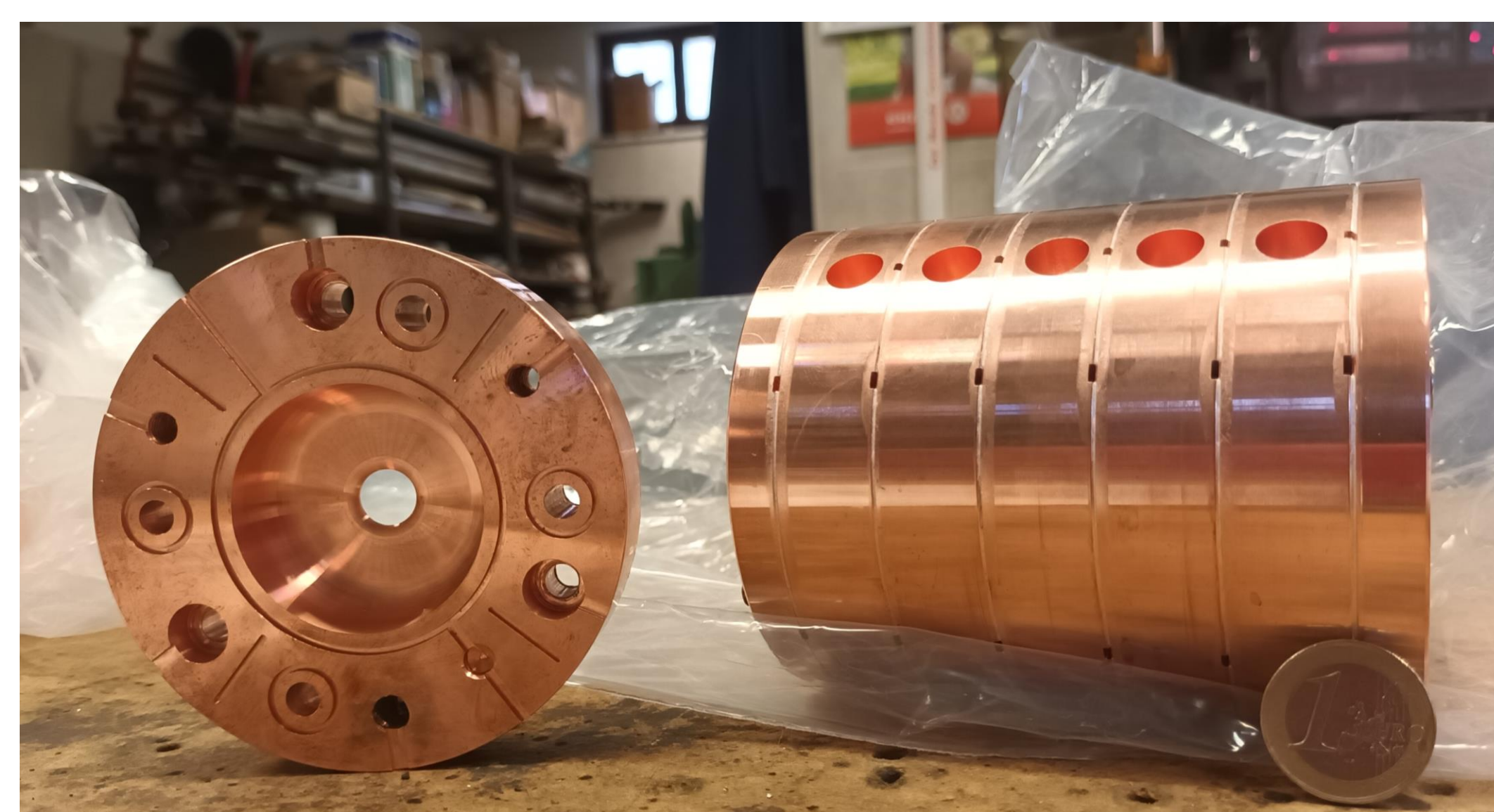
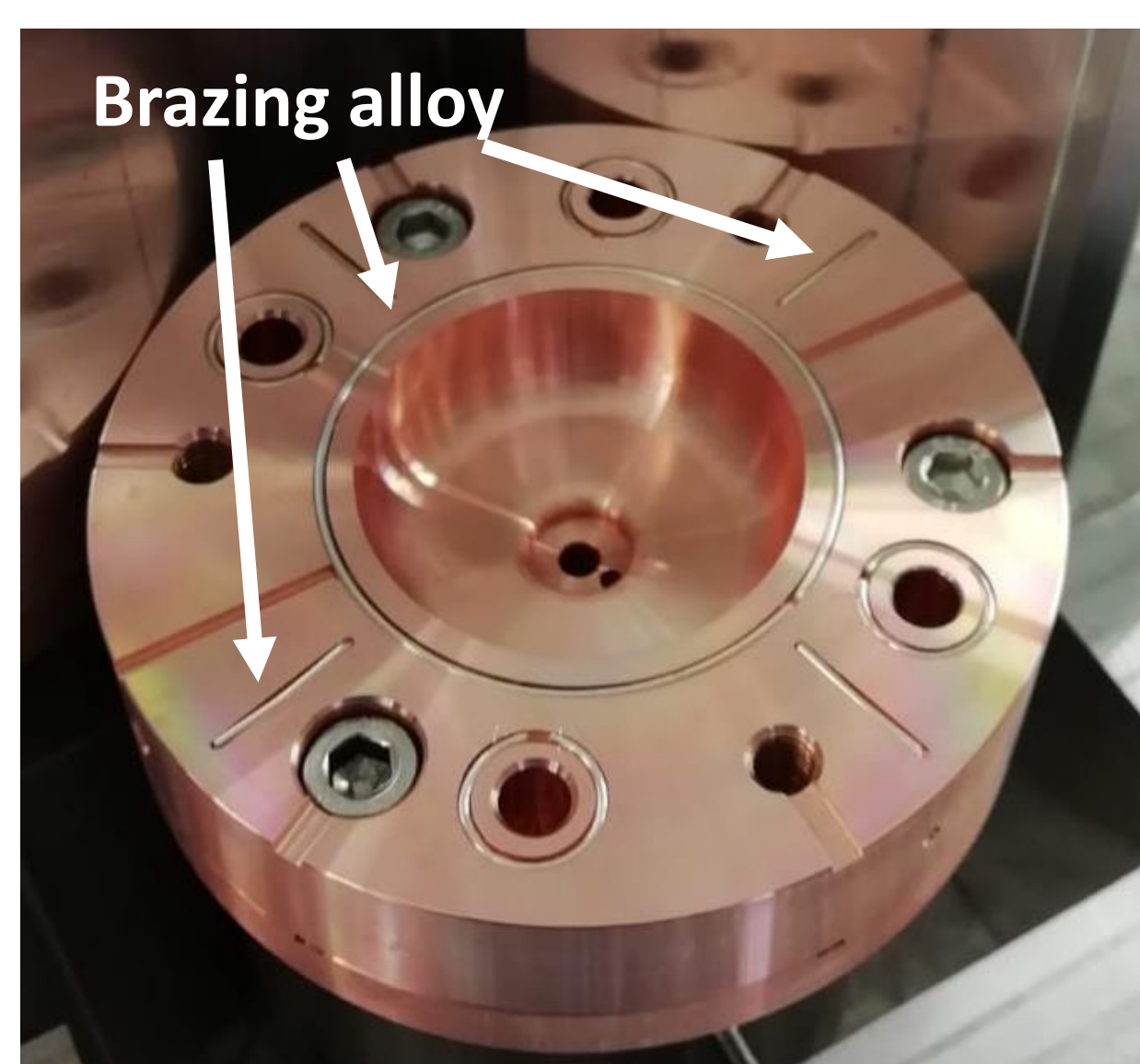
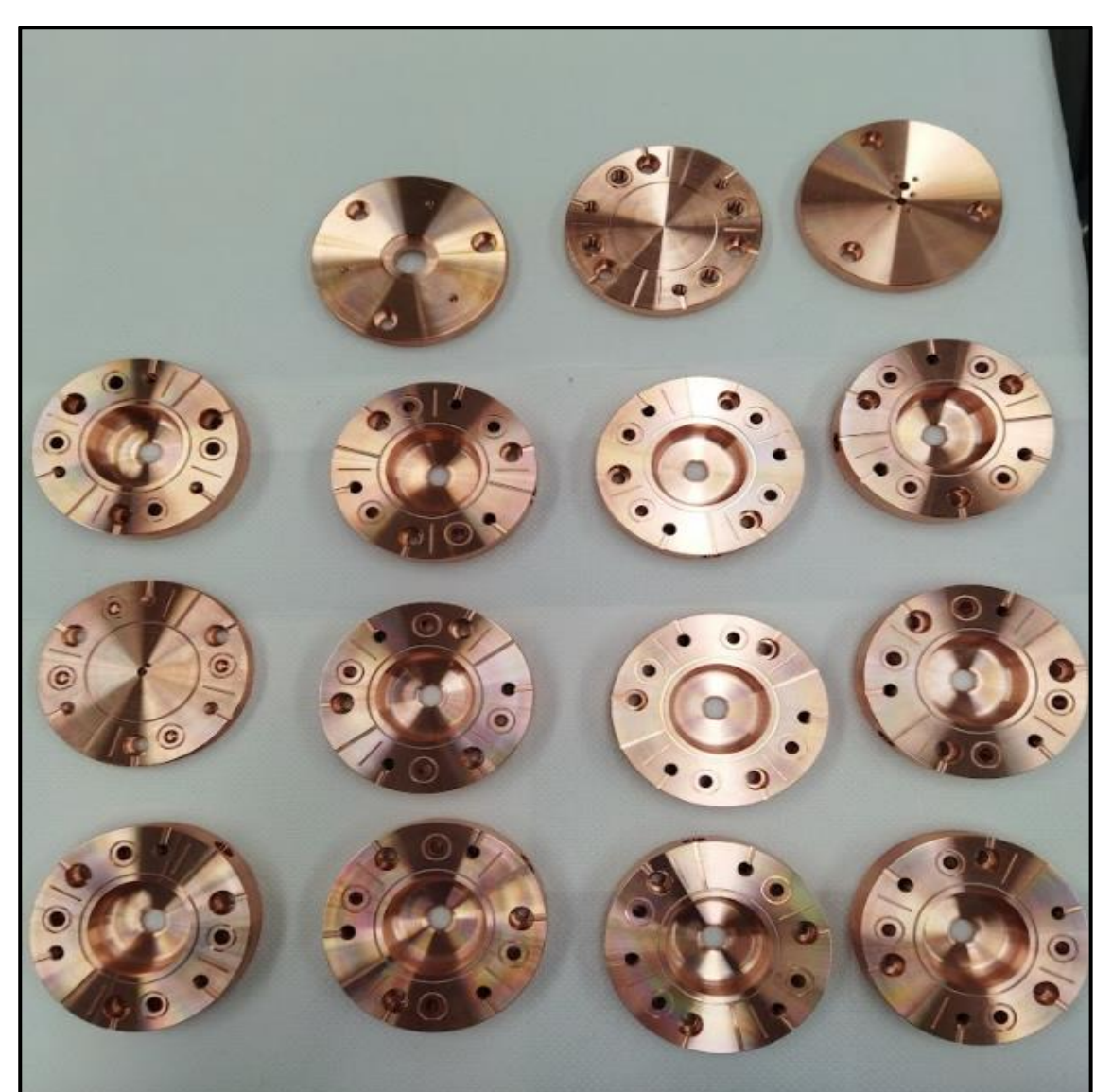


3. VHEE high gradient Traveling Wave design with splitter optimization

Description	Value
Type	Constant Impedance
Prototype length	10,55 cm
Iris radius	5 mm
Quality factor	10.000
Shunt impedance	100 M Ω /m



4. High gradient Sapienza-INFN prototype



In house building of the accelerating.

- The prototype of 5 cells without couplers have been brazed with Cusil at 785 degrees
- The brazing steps have been performed in the INFN LNF -FRASCATI oven.
- The prototype has been vacuum/mechanically tested after brazing.

Reference

- [1] V. Favaudon et al., Ultrahigh dose-rate FLASH irradiation increases the differential response between normal and tumor tissue in mice, Sci Transl Med. 6, 245ra293, 2014.
- [2] L. Faillace et al. Perspectives in linear accelerator for FLASH VHEE: Study of a compact C-band system, Physica Medica 104, 149-159, 2022.
- [3] L. Palumbo et al. Safest: A Compact C-band Linear Accelerator for VHEE-FLASH Radiotherapy, this conference THPM087.
- [4] L. Giuliano et al., RF Design and Measurements of a C-Band Prototype Structure for an Ultra-High Dose-Rate Medical Linac, Instruments 7, 10, 2023.