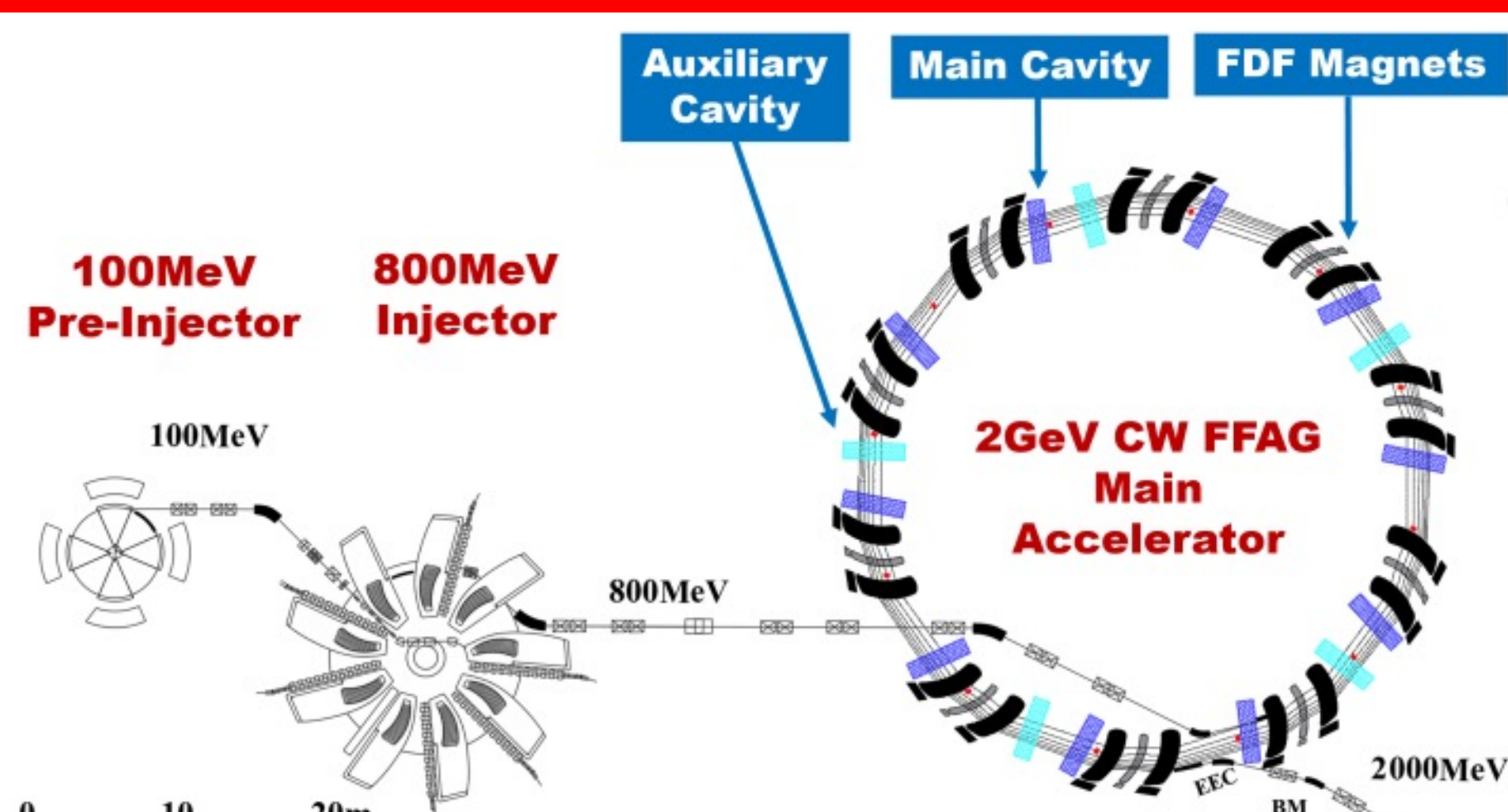


R&D studies on a 177.6 MHz 1:4 scale boat shape prototype RF cavity for the 2 GeV CW FFA

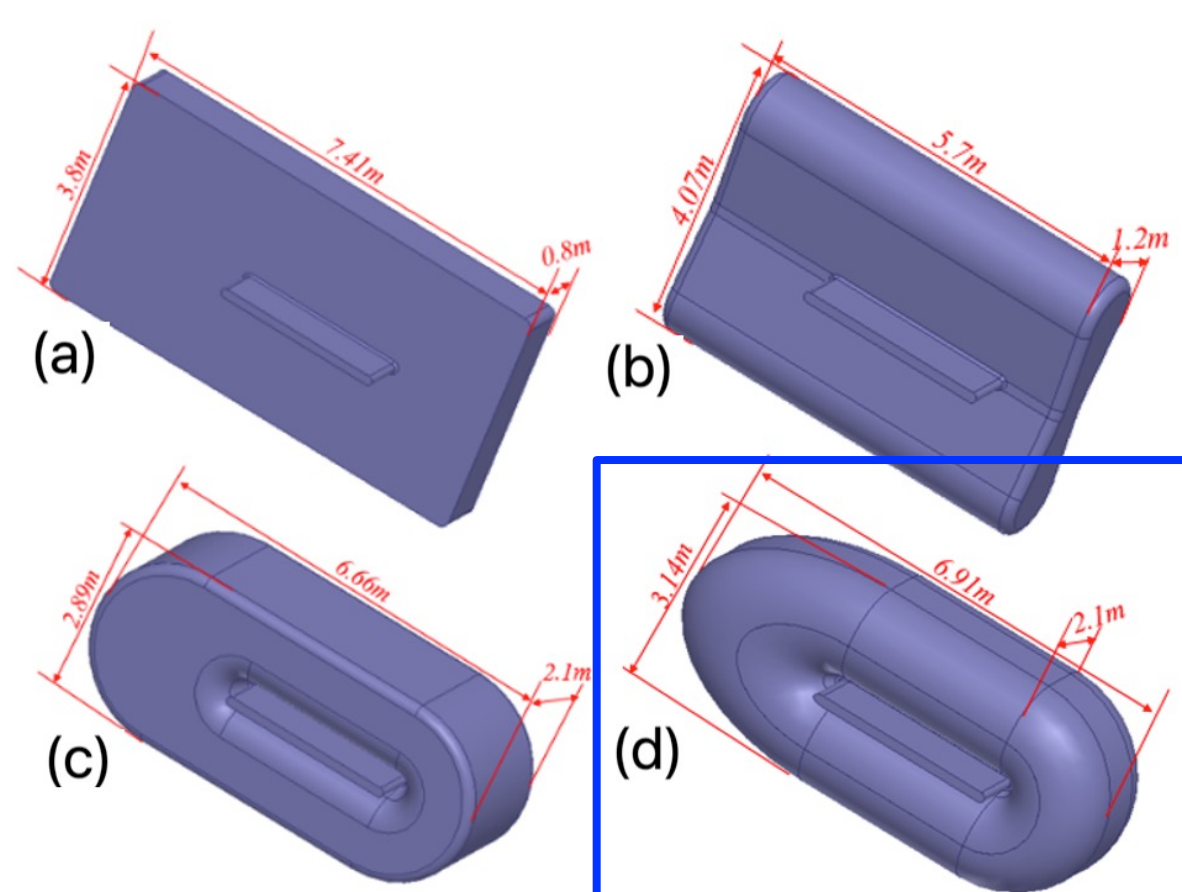
S. Pei[†], T. Zhang, Z. Yin, Y. Wang, J. Liu, S. Zhang, X. Zhu, L. Guan, F. Wang, M. Li, Z. Jin, G. Pan, G. Yang, Y. Jia, L. Wang, CIAE, China; Y. Xing¹, B. Li, S. Xia, IPP, CAS, China; ¹also at USTC, China

The 23th international conference on cyclotrons and their applications (CYC2022), Beijing, P. R. China, December 5-9, 2022

A proton circular accelerator complex composed of a 100 MeV separated radial sector cyclotron, an 800 MeV separated spiral sector cyclotron and a 2 GeV FFA was proposed and is being studied at CIAE. To satisfy the dynamics requirements of the FFA, NC RF cavity with high Q and R will be adopted. It is found that the boat shape cavity is the most promising candidate. Therefore, R&D on a 177.6 MHz 1:4 scale boat shape prototype cavity is being carried out to study all aspects of developing such a high-power cavity. In this scenario, self-consistent multi-physics coupled simulation study with ANSYS was carried out. This paper describes the method to deal with a mechanical model including hundreds of bodies in the FEM analysis and shows the simulation results. In addition, the manufacturing technology and some testing results are also presented.



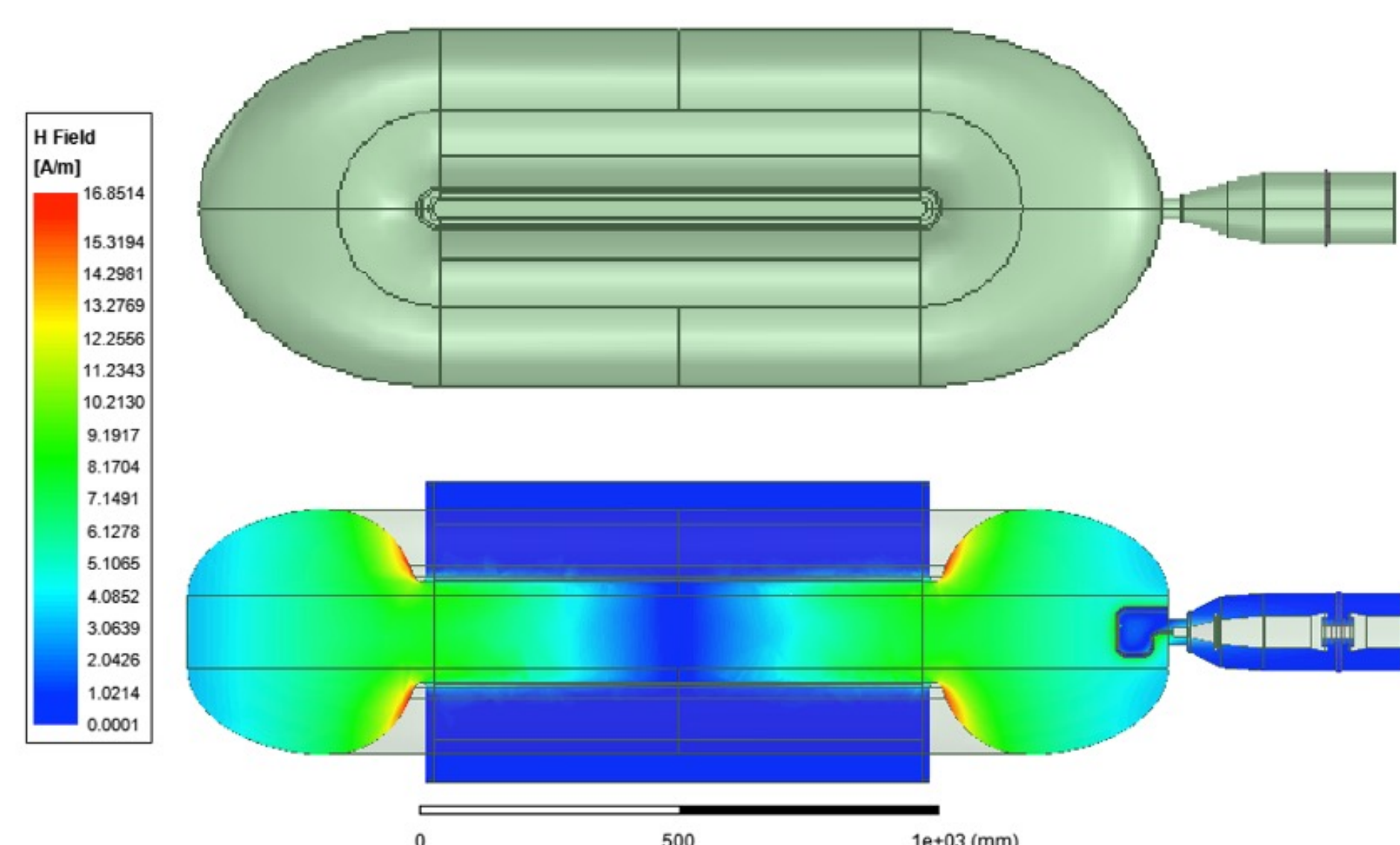
2 GeV, 6 MW accelerator complex proposed at CIAE



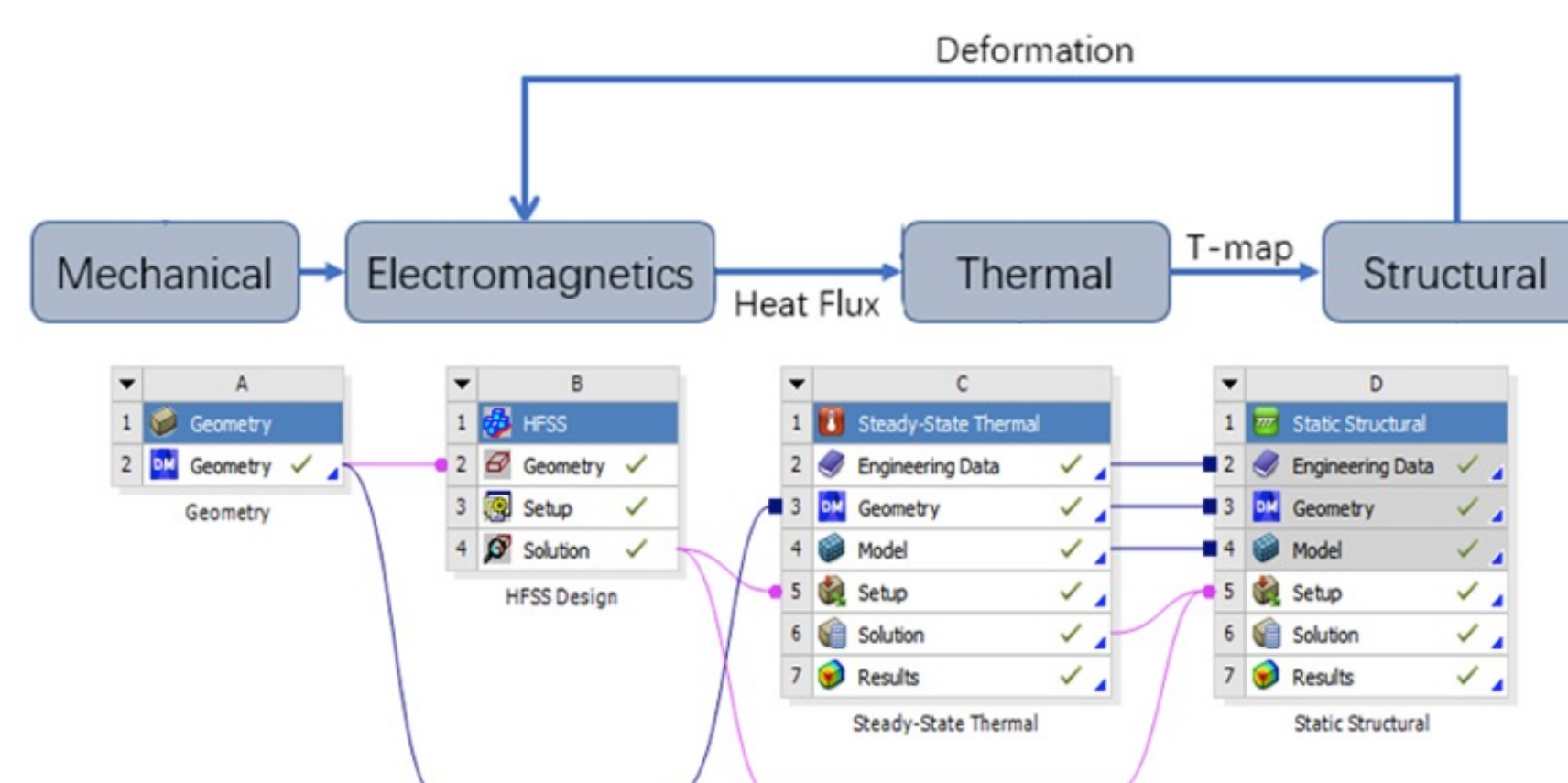
4 geometries of the waveguide type cavity

Parameters	Rectangular	Omega	Racetrack	Boat
Frequency (MHz)	44.42	44.41	44.38	44.40
Operating mode	TM110	TM110	TM110	TM110
Quality factor Q	58497	74673	85832	92100
Biggest shunt impedance in the beam channel (M Ω)	5.38	10.08	19.29	20.14
Smallest shunt impedance in the beam channel (M Ω)	2.43	2.15	10.41	10.95
Power dissipation for a highest accelerating voltage of 2 MV (kW, beam loading excluded)	743	397	207	199

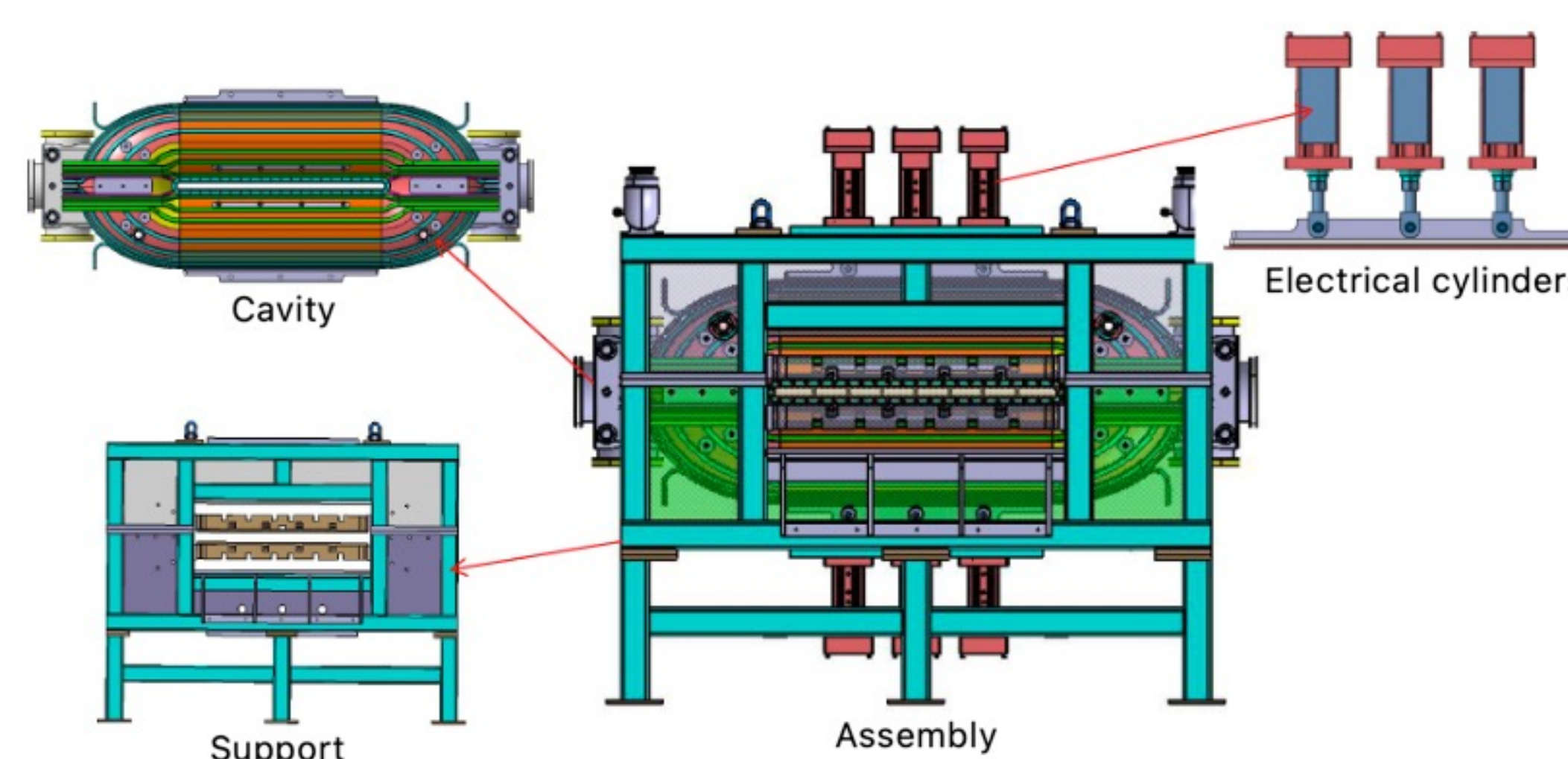
RF performance for the 4 geometries of the waveguide type cavity



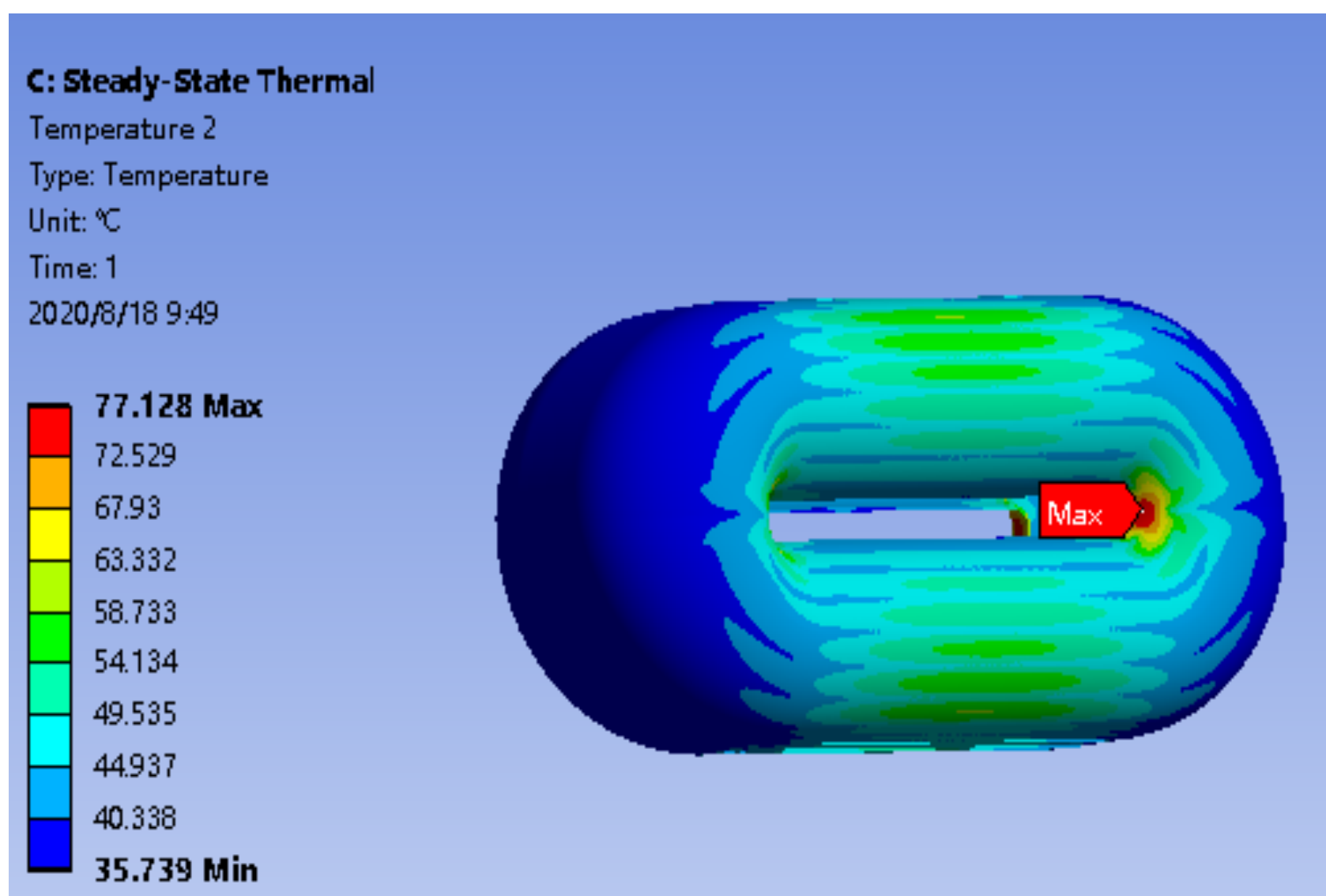
RF design of the 1:4 scale boat cavity and the coupler



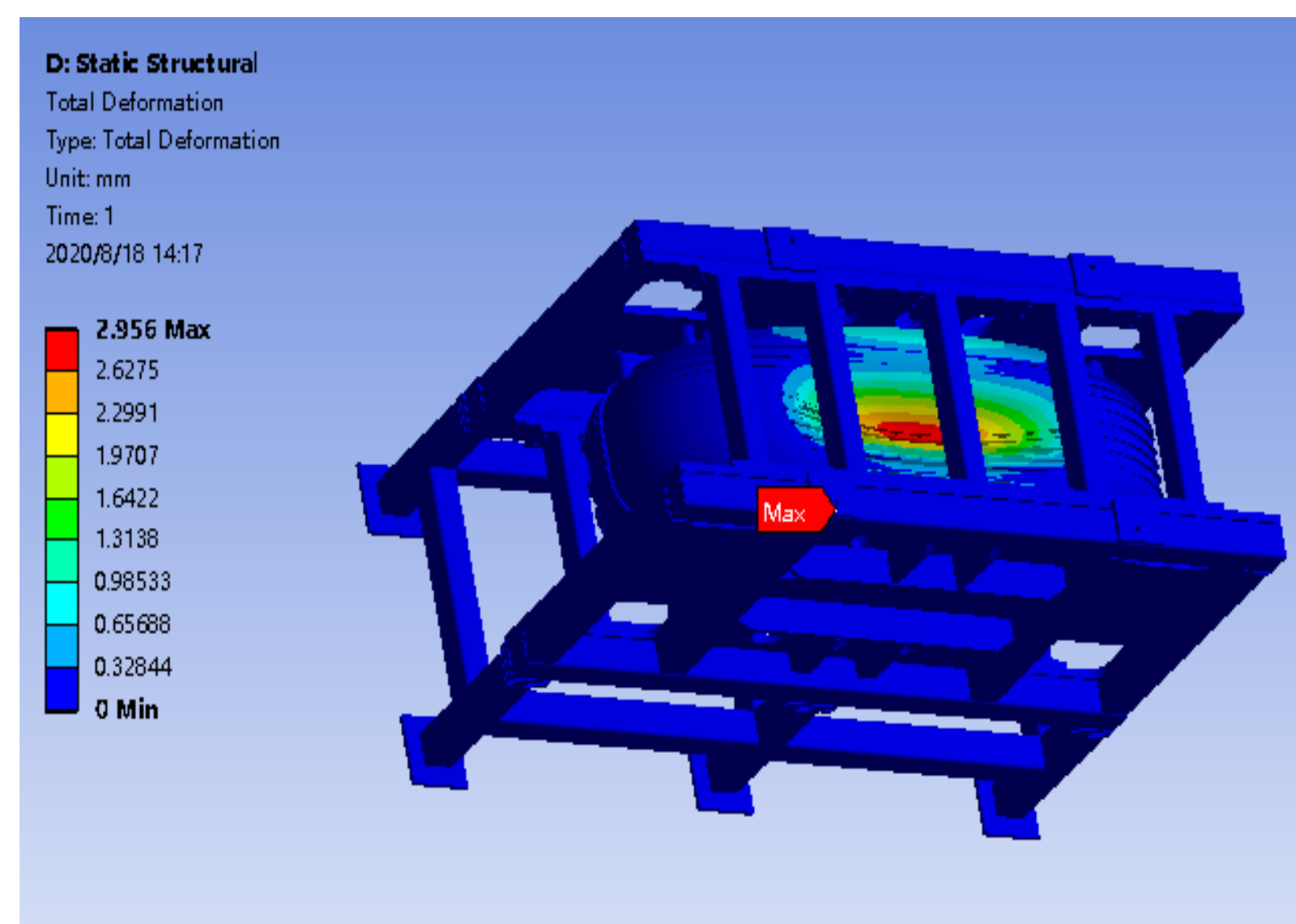
Workflow and the ANSYS Project Schematic



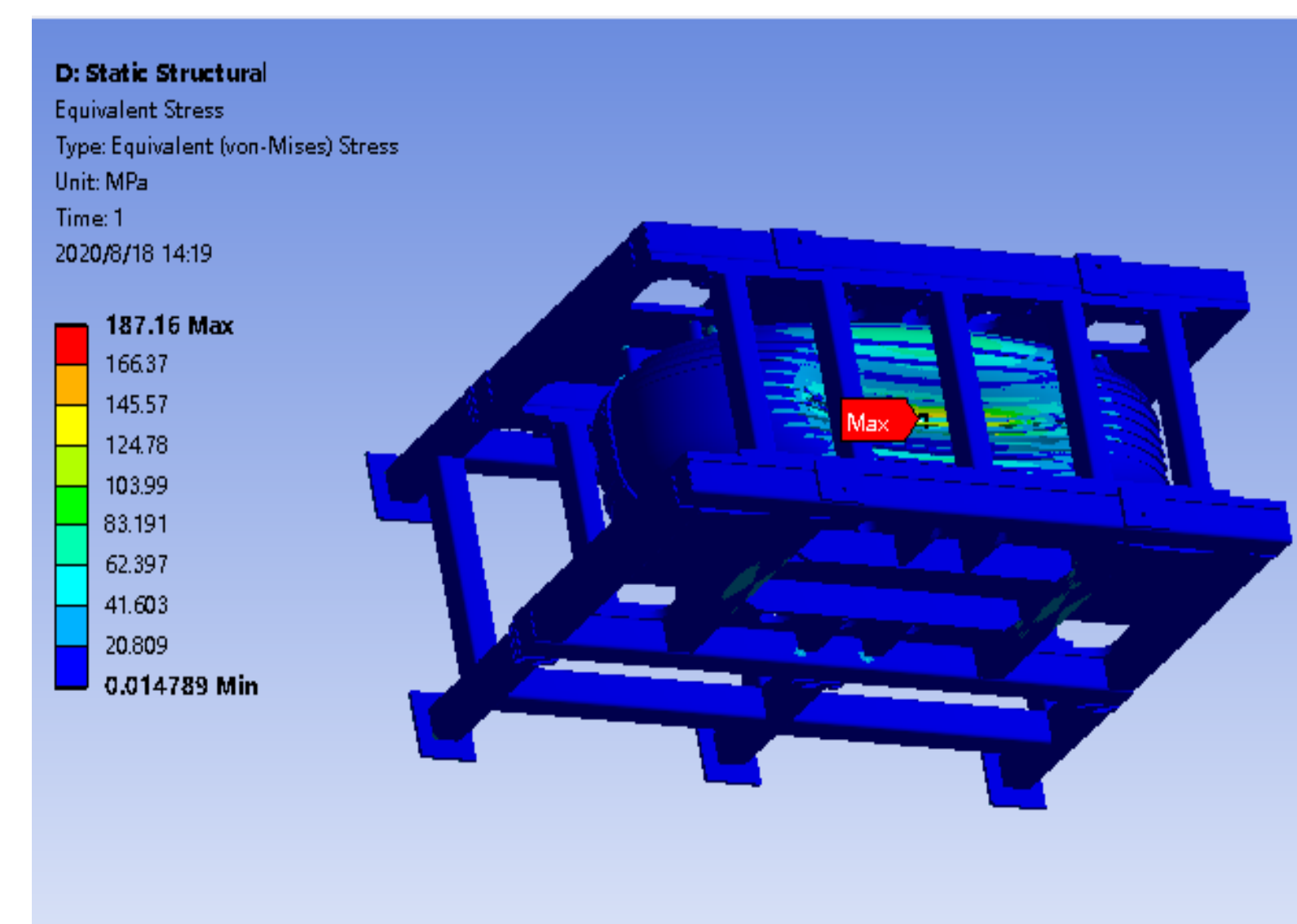
SolidWorks model of the cavity's assembly and disassembly



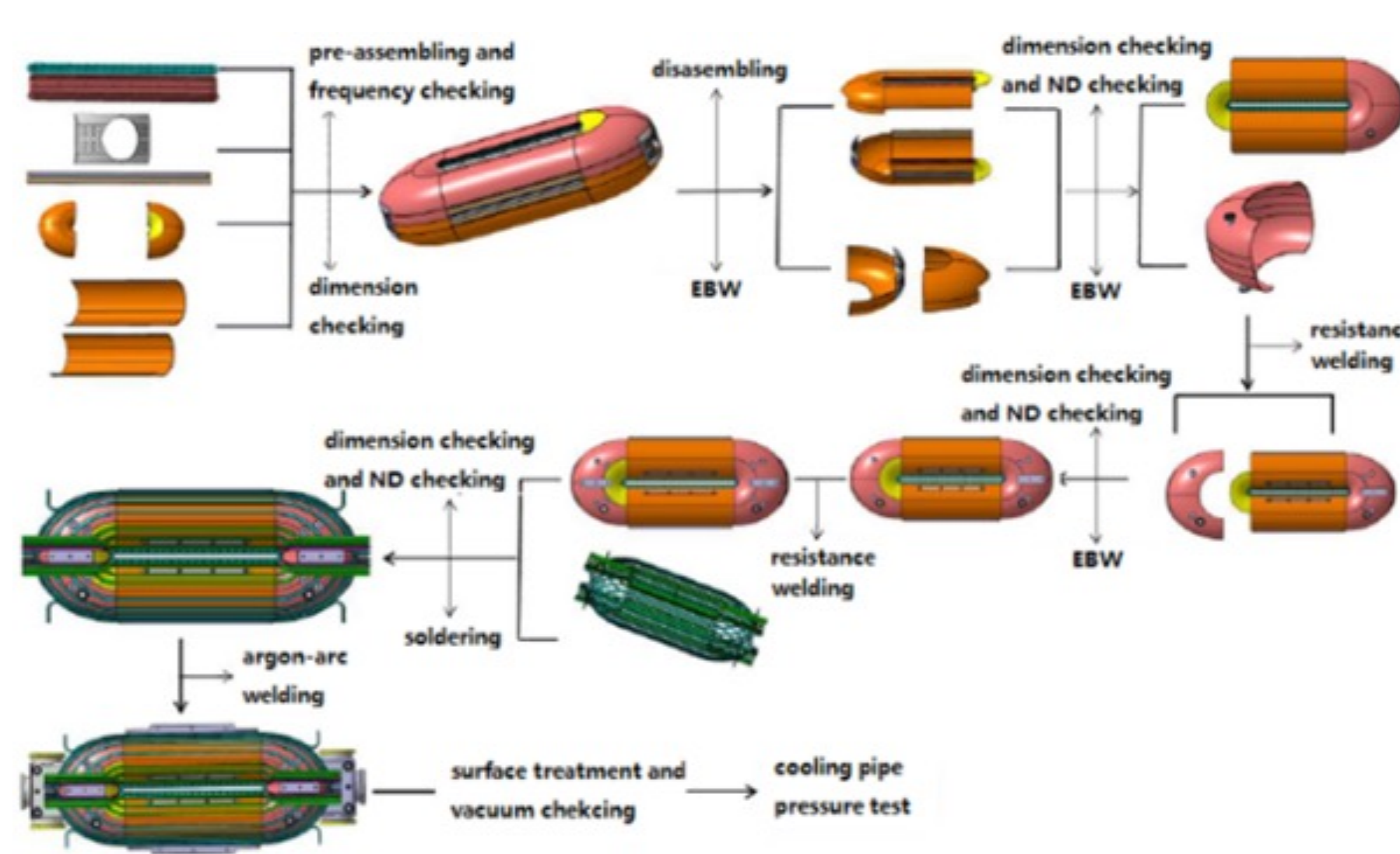
Temperature distribution on the cavity's copper walls



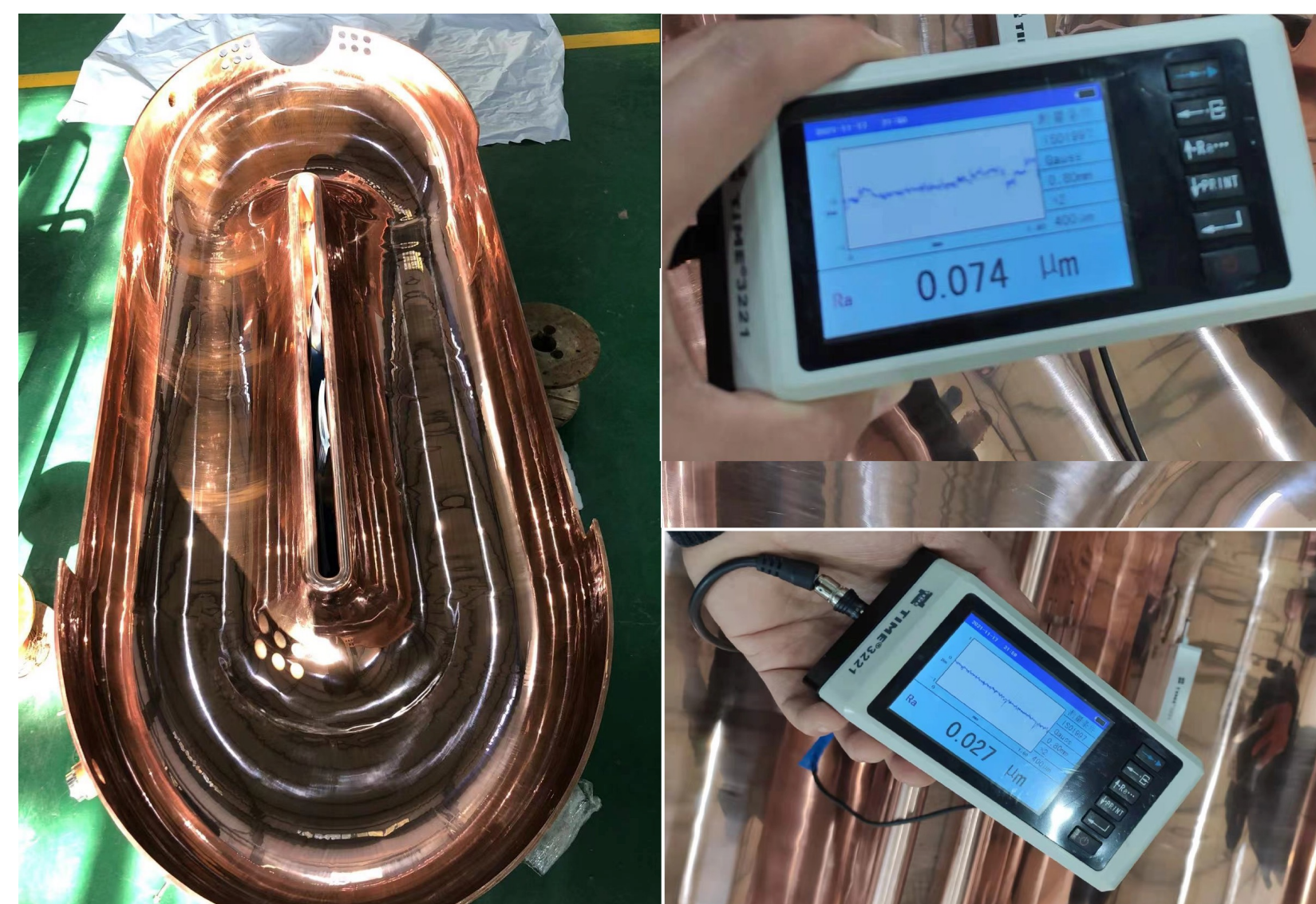
Total deformation for +176 kHz frequency tuning



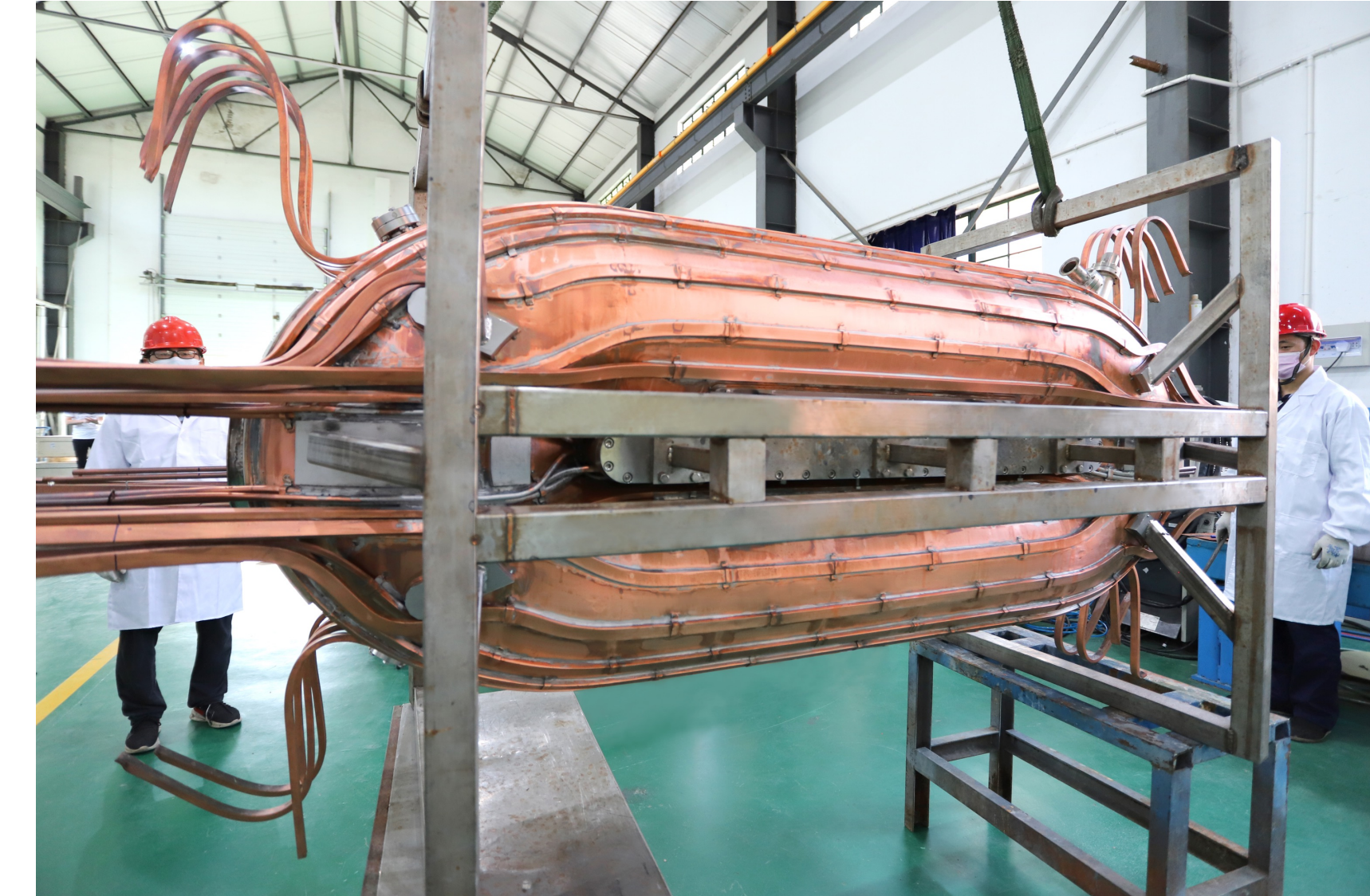
Equivalent stress for +176 kHz frequency tuning



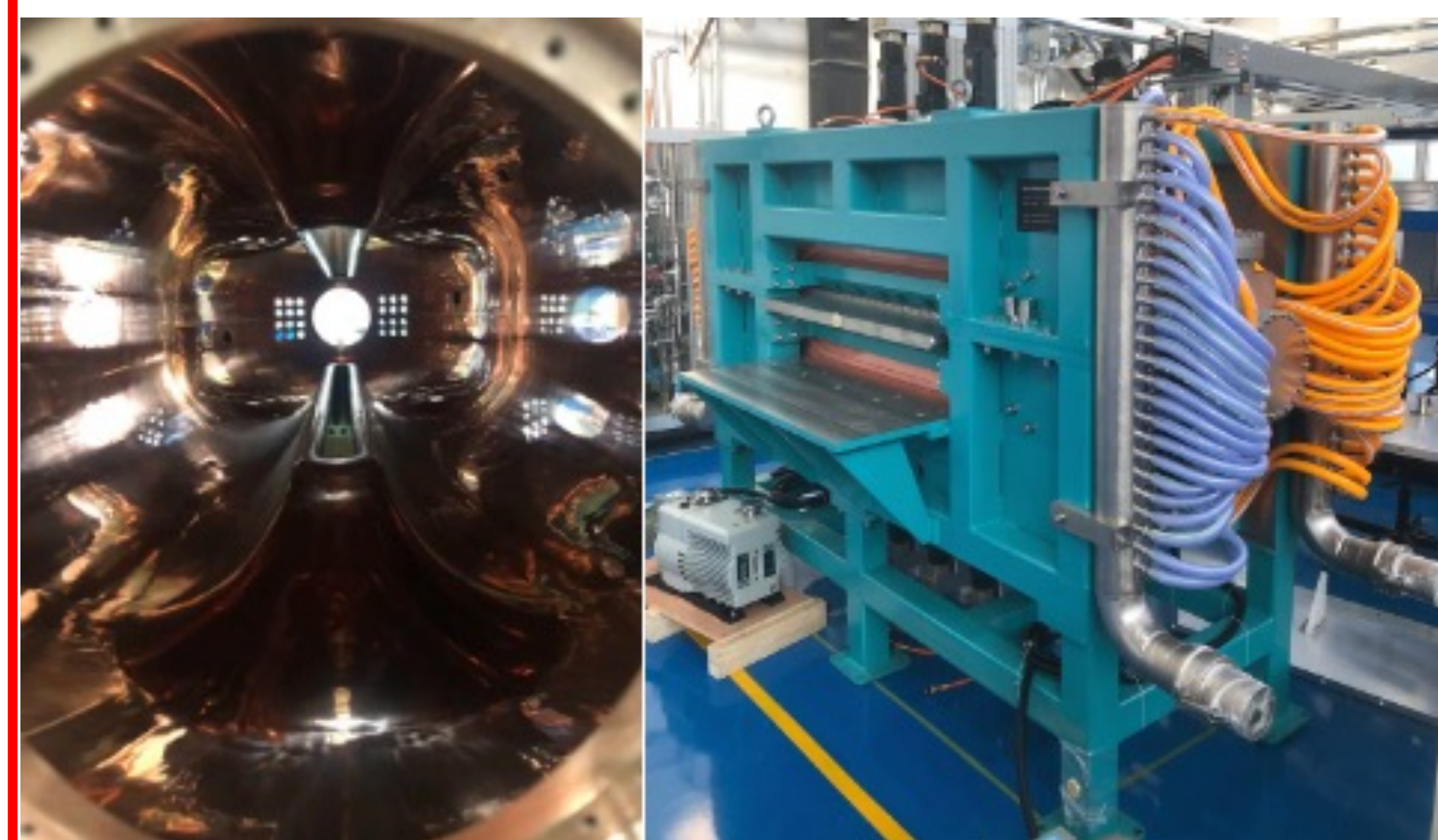
Cavity's mechanical fabrication process



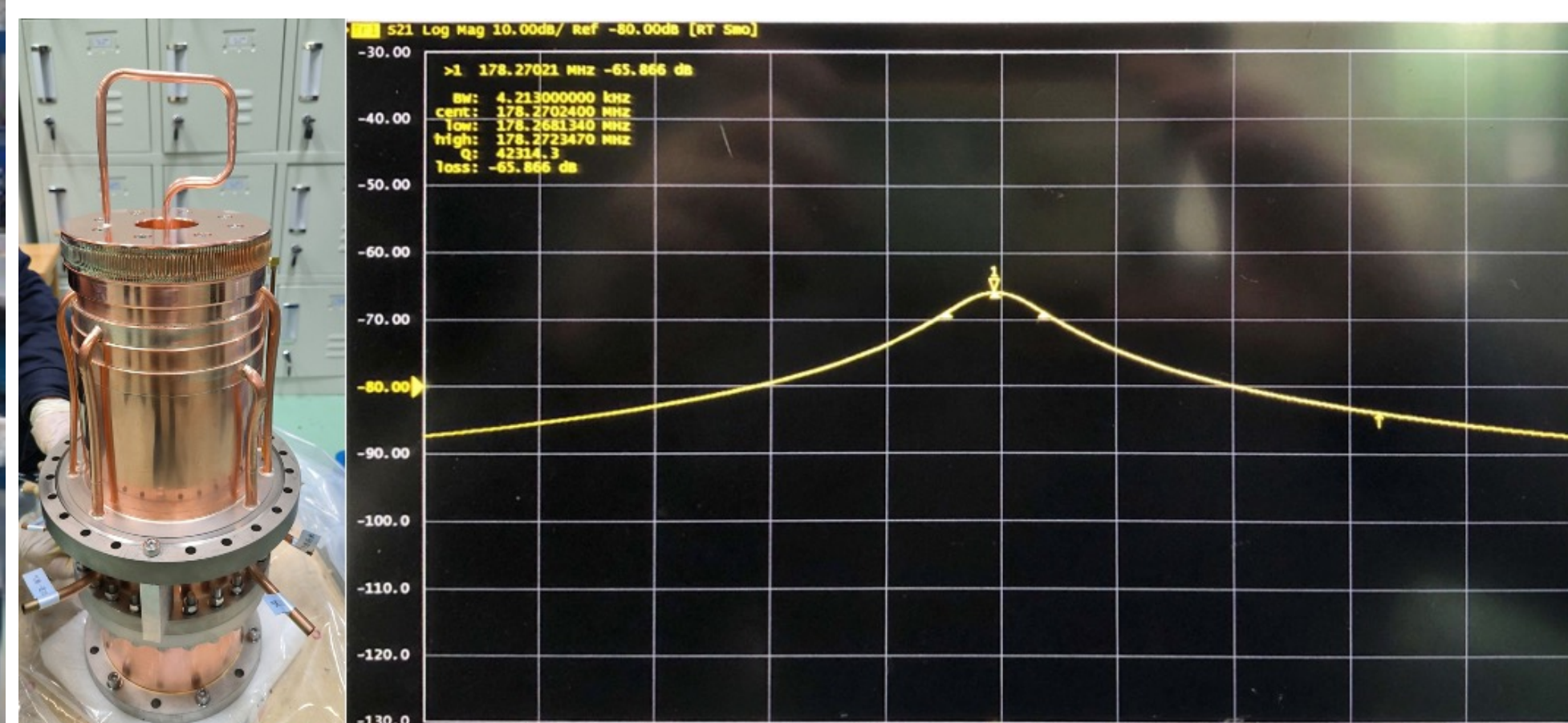
One of the two half-cavities and the surface roughness



Cavity outside look after the soldering of the cooling pipes



Cavity inside look and the cavity assembly at CIAE



Coupler and the unloaded Q measurement

A 177.6 MHz 1:4 scale boat shape cavity has been fabricated. Y/2 6mm thick TU1 copper plate was selected the cavity wall's raw material. The inner surface roughness of the cavity is better than 0.1 μm . The measured unloaded Q is not less than 42314.3, which is ~97% of the simulated value. The measured tuning range is ± 180 kHz with maximum deformations of ± 2.5 mm. The hot test is being prepared and will be launched in the very near future.