China Academy of Engineering Physics

Institution of Applied Electronics

MOPB010

DESIGN OF THE 2×4-CELL SUPERCONDUCTING CRYOMODULE FOR THE FREE-ELECTRON LASER

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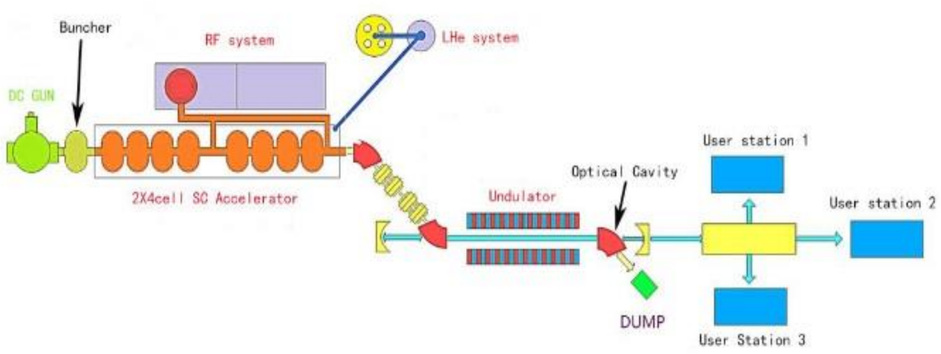
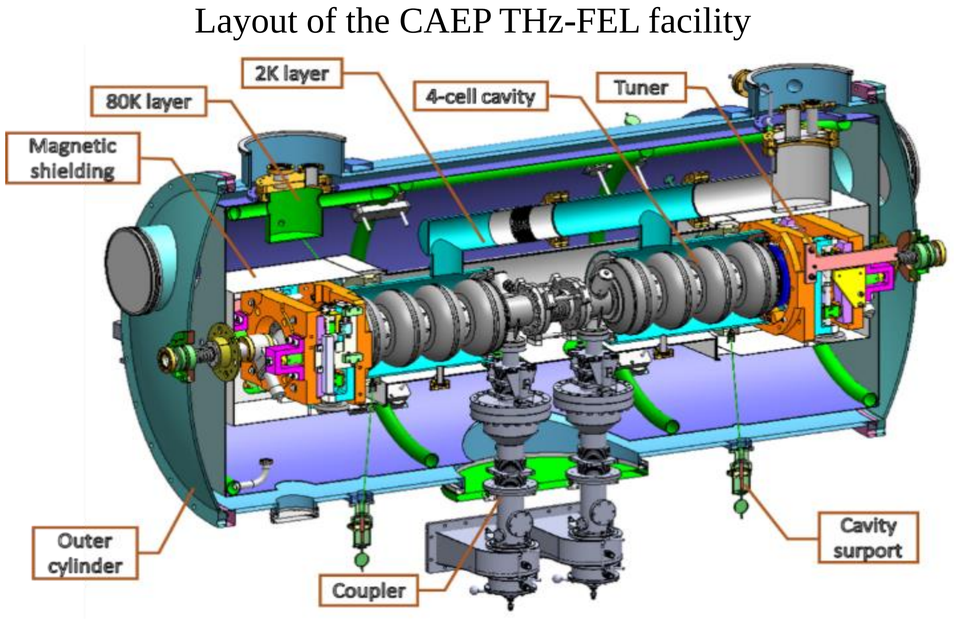
Abstract

A 2×4-cell superconducting linac module for the THz-FEL facility has been developed at the China Academy of Engineering Physics, which is expected to provide 6~8 MeV quasi-CW electron beams with an average current of 1~5 mA. The design of the cryomodule is presented in this paper. The dynamic and static heat load have been evaluated to reasonable level. The temperature distribution inside the cryomodule has been optimized by simulation, as well as mechanical structure and the magnetic shielding.

Introduction

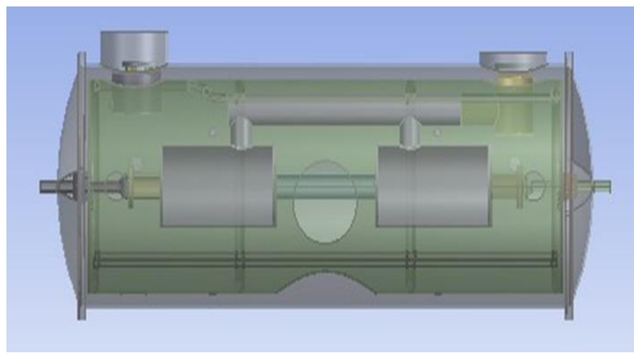


Layout of the CAEP THz-FEL facility

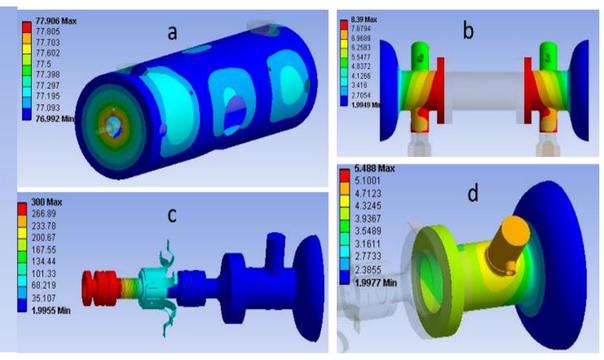


Schematic of the 2x4-cell Cryomodule

Thermal optimization



The simplified model in ANSYS Workbench

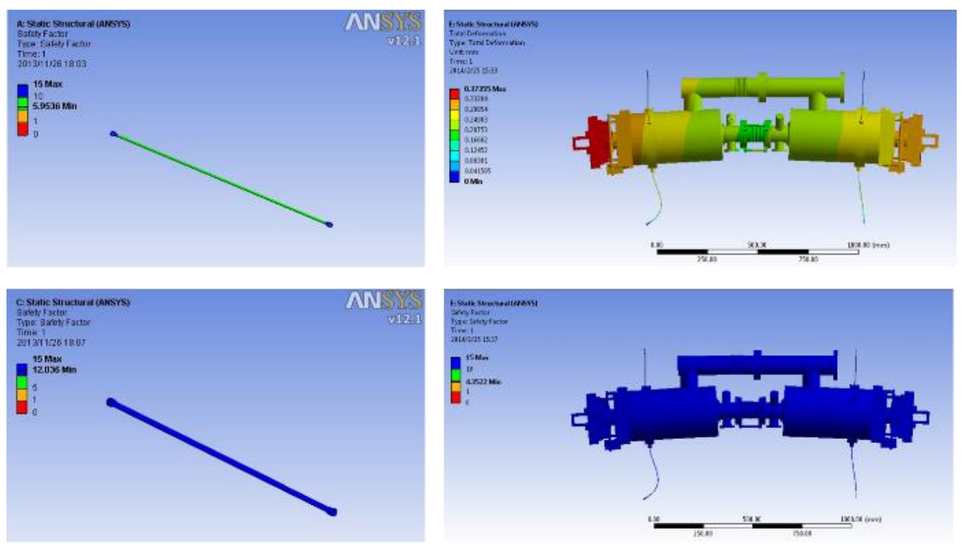


Simulated temperature distribution inside the cryostat

Components	Thermal loss
2K static losses	**~5.6 W**
Thermal radiation	0.9 m^2 × 1 W/m^2 = 0.9 W
Coupler static loss	1 W × 2 = 2 W
2 end bellows (stainless steel)	0.3 W
6 suspension sticks (titanium)	1.1 W
Tuner rod (stainless steel)	0.3 W
Cables	1 W
2K dynamic loss	**~22 W**
Cavity dynamic loss	10 W × 2 = 20 W
Coupler dynamic loss	1 W × 2 = 2 W

The 2 K thermal loss estimate for 2×4-cell cryomodule

Mechanical design



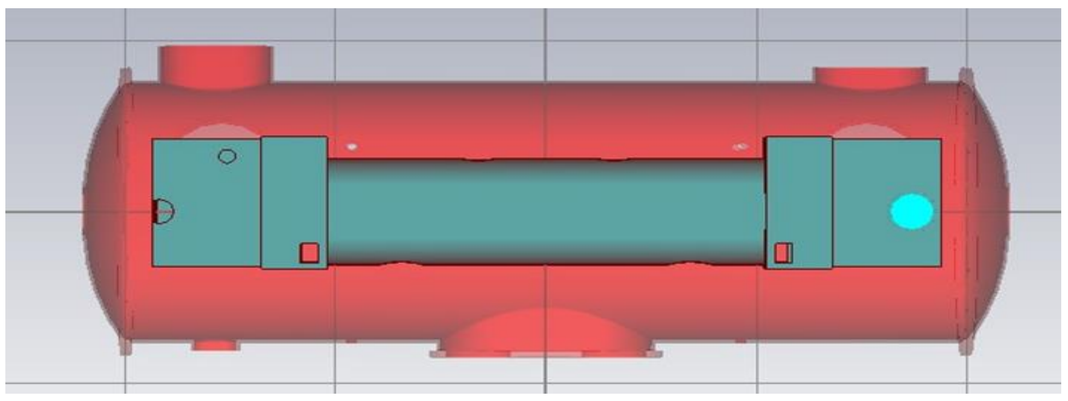
Simulated mechanical stress and deformation

Designed parameters

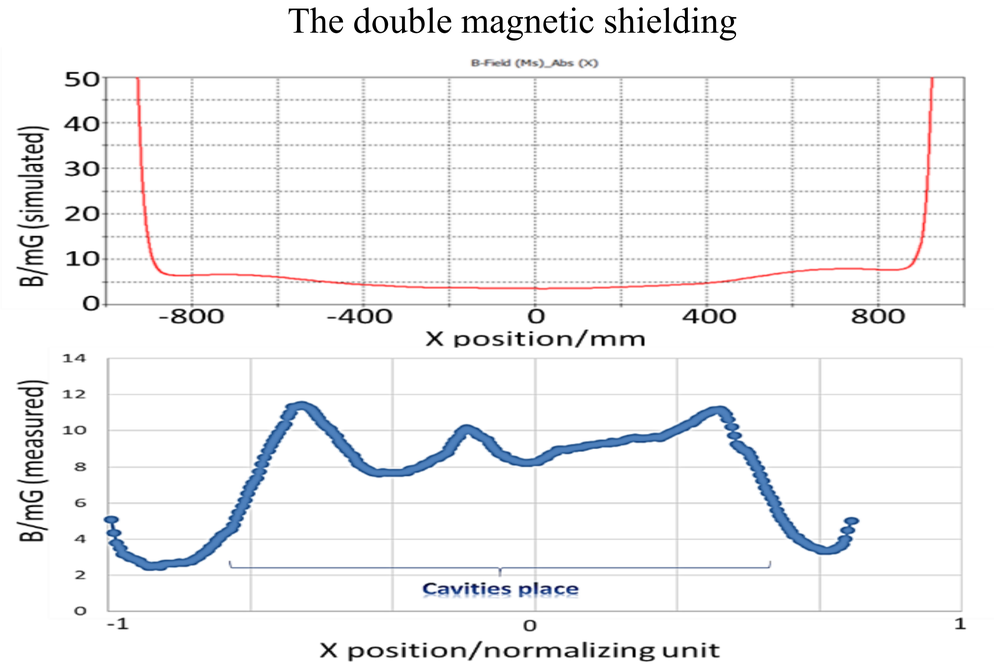
Parameter	Design value
Temperature	2 ± 0.1 K
2 K static load (theoretical)	5.6 W
2 K dynamic @ CW	≤ 22 W
2 K system max load	70 W
80 K static load	68 W
80 K dynamic @ CW	140 W
Thermal insulation vacuum	< 5×10^{-4} Pa
Helium pressure	30 ± 0.1 mbar
Magnetic field at cavities position	< 12 mG

Parameters of the 2×4-cell cryomodule

Magnetic Shielding



The double magnetic shielding



(top) Simulated and (bottom) measured magnetic field inside the double shielding.