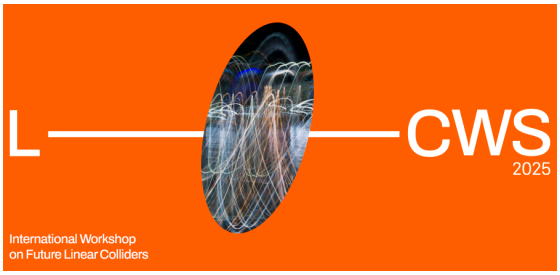

Contribution ID: **139** Type: **Poster**

Development of a 4000 W@4.5 K Helium Refrigerator for Accelerator Equipment in Isotope Preparatio

Tuesday 21 October 2025 19:40 (1 hour)

Particle accelerators serve as the core high-energy particle sources for isotope preparation and research facilities. Their magnet systems must maintain a superconducting state within an ultra-low temperature range of 1.9 K to 4.5 K to generate strong magnetic fields, which are essential for confining, guiding, and accelerating particle beams. Consequently, ultra-low temperature refrigerators constitute a critical low-temperature support system for the stable operation of high-energy particle accelerators.

To meet the ultra-low temperature refrigeration requirements of the accelerator facility at the Gansu Lanzhou Isotope Laboratory, this study focuses on the development of a 4000 W@4.5 K helium refrigerator. Addressing the system's demands for cooling capacity across multiple temperature zones (5 K–75 K, 50 K–75 K, and 4.5 K), alongside the core technical indicators of liquid nitrogen-free pre-cooling and low energy consumption, theoretical calculations and simulation analyses were conducted to compare the energy consumption characteristics of compressors under single-pressure and dual-pressure refrigeration cycles. On this basis, an energy consumption optimization scheme for the refrigerator under the liquid nitrogen-free pre-cooling mode was proposed, and its energy consumption was quantitatively compared with that of the traditional liquid nitrogen-precooled system.

Furthermore, this paper elaborates on the overall system composition of the 4000 W@4.5 K helium refrigerator, obtains key operating parameters through simulated load performance tests, and conducts a systematic analysis of the test data. The results demonstrate that the developed liquid nitrogen-free pre-cooled helium refrigerator can meet the refrigerating capacity requirements of the accelerator at the Lanzhou Isotope Laboratory, with its energy consumption level reaching the same standard as that of liquid nitrogen-precooled systems. This research provides a reference for the design of low-temperature systems in subsequent large-scale isotope facilities and accelerators.

Author: 杨, 坤 (中科富海科技股份有限公司)

Presenter: 杨, 坤 (中科富海科技股份有限公司)

Session Classification: Poster Session & Raffle ”estelas en la mar”

Track Classification: Sustainability, industry & applications