



Contribution ID: 190

Type: **Contributed Oral**

## **C3Or3D-06: Cooling the SPARC fusion reactor – A large-scale helium refrigerator designed for transient loads and high availability**

*Wednesday 21 May 2025 15:15 (15 minutes)*

A large-scale cryoplant is supplied by Linde Kryotechnik for the SPARC project, where a fusion reactor of type Tokamak requires a dedicated cooling. The cryoplant provides various combined cooling powers of up to 100kW shield load between 80K and 100K, up to 15kW at 15K and up to 25kW at 8K.

The compressor station consists of two large oil-lubricated screw compressors with variable frequency drives, an oil-removal system, and a gas management panel. In addition, the plant accommodates a purification unit. The refrigerator process, housed in a horizontal cold box, is based on a Brayton cycle with three turbine strings (6 LKT TED turbines) as well as special nitrogen pre-cooling. The 15K and the 8K cooling loops are each connected to heat exchangers of the primary cycle by a secondary loop, where cold circulators establish the demanded flows.

Due to the pulsed operation of the fusion reactor, the refrigerator will face transient loads and return temperatures, thus requiring unique solutions for process design and process control. To ensure high reliability even under these transient loads, the system is equipped with various redundancies regarding equipment and instrumentation.

Besides the steady-state operation, the cryoplant can provide around 300kW between 80K and 130K. Furthermore, due to the immense cold mass of the fusion reactor, a fast-controlled cooldown/warmup that offers more than 300kW is requested. Both requirements have been efficiently tackled by a special nitrogen evaporator design.

**Author:** Dr DIEHL, Markus (Linde Kryotechnik AG)

**Co-authors:** Mr MAI, Elias (Linde Kryotechnik AG); Mr DALESANDRO, Andrew (CFS Commonwealth Fusion Systems); Mr MITKOV, Alec (CFS Commonwealth Fusion Systems)

**Presenter:** Dr DIEHL, Markus (Linde Kryotechnik AG)

**Session Classification:** C3Or3D - Large Scale Cryogenic Systems VIII: Fusion Systems