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C1Or3B-04: Preliminary studies of the MINERVA cryogenic supply system

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MYRRHA (Multi-purpose hYbrid Research Reactor for High-tech Applications) will be the world's first research reactor powered by a particle accelerator. MYRRHA will be composed of a 600 MeV LINAC accelerator with a large number of cryomodules and a 100 MW thermal power subcritical nuclear reactor cooled by lead-bismuth.

The MINERVA project is the first phase of the MYRRHA project. It consists of a 100 MeV, 4 mA continuous-wave proton linear accelerator (LINAC) among other facilities. The MINERVA LINAC takes advantage of superconducting radiofrequencytechnology in order to provide acceleration from approximately 17 MeV to 100 MeV, using bulk niobium (Nb) single-spoke cavities cooled at 2 K by saturated superfluid helium (He II). Sixty accelerating superconducting cavities will be installed in 30 cryomodules (having two cavities each), for a superconducting section length of approximately 100 m. The MINERVA cryoplant will supply the required cryogenic cooling power of the LINAC through cryogenic lines and cryogenic valve boxes. MINERVA has also important requirements concerning operating modes: limitation of thermal cycles and high accelerator availability, which require a very high operation reliability for the cryogenic system.

The current paper presents the preliminary design of the MINERVA cryoplant and the strategy to comply with high reliability. It describes the LINAC cryogenic system architecture, the different operating modes, the heat loads, the cryoplant main requirements and the strategy to comply with high reliability in terms of redundancy and selection of components. The MINERVA cryoplant shall supply helium flows at 40 K for the thermal shielding, at 5 K for the cooling of the radiofrequency couplers and at the 2 K for the superconducting cavities in the cryomodules. The total equivalent power of the MINERVA cryoplant is about 3 kW at 4.5 K. The cryoplant is composed of a warm compression station including sub-atmospheric volumetric compressors and high-pressure helium gas storages both at room temperature, a refrigeration cold box with cold centrifugal compressors for the 2 K operation of the superconducting cavities.

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