

Cryogenic System for the MINERVA LINAC (MYRRHA phase 1)

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Abstract

The main aim of MYRRHA project is to construct an Accelerator Driven System (ADS) demonstrator for the transmutation of long-lived radioactive waste. It will include a subcritical reactor of 100 MW thermal power coupled with a Continuous Wave (CW) proton Linac accelerator. It will be composed of superconducting (SC) cavities and it will provide a 600MeV proton beam of 4mA intensity hitting a spallation target to obtain neutrons to feed the reactor. The main challenge of this Linac is an extremely high reliability performance to limit stresses and long restart procedures of the reactor. Indeed, beam interruptions could cause high thermal stresses and fatigue on the reactor structures.

Recently supported by Belgium government, the first phase of the MYRRHA project among other subjects includes the construction of a SC Linac proton accelerator with a final energy of 100MeV and a nominal intensity of 4 mA: the MINERVA SC Linac. It will be composed of 30 cryomodules housing 60 Single-Spoke SC cavities. The cavities will operate at 352 MHz in a superfluid Helium bath at 2K. A cryomodule prototype with its valve box is under construction as a part of R&D program at IPNO institute. One major goal of the MINERVA project is to test the reliability of such a Linac, and the operational results with a Cryogenic System are essential to check the technical feasibility of SC Linac accelerators for ADS applications. This article presents the results on preliminary studies of this cryogenic system. They include the analysis of high thermal loads induced by the CW mode operation of cavities (950 W@2K for 30 cryomodules) and minimal requirements for a Cryogenic Refrigerator with an equivalent power capacity of 2645 W @4.5 K (3970 W with 1.5 overcapacity factor). Each cryomodule is connected through a dedicated Valve Box to the Helium transfer line running along the Linac tunnel. A description of the cryogenic system features and initial models of the tunnel and associated buildings are presented.