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Performance of nitrogen heat tubes in cooling down of superconducting magnets

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Abstract

The paper describes the application of nitrogen-filled heat tubes for pre-cooling of the superconducting wiggler with "dry" cryostat (ANKA/CLIC Superconducting multipole wiggler 2015). In our design the first stages of cryo-coolers are connected to the magnet yoke by two heat tubes, which provide high heat transmission rate (up to 100 W per tube) in the temperature range from 300K down to 70K. When the nitrogen inside the tubes reaches its freezing point then the heat transmission becomes broken. The heat tubes allowed us to exclude application of liquid nitrogen from the process of pre-cooling of the magnet.

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1. Introduction

More than thirty years the superconducting magnet systems are developed in the Budker Institute of Nuclear physics for synchrotron radiation generation (Khrushchev et al. (2014)). A design of these magnets is based on low temperature superconductors operating at about 4 K temperatures. During two last decades several cryocoolers were used for magnets cooling. Due to limited cooling power of these cryocoolers in the initial stage of their operation the magnets are pre-cooled by liquid nitrogen. In case of using only the cryocoolers for this procedure it would take more than one week to cool down about 600 kg of the magnet cold mass to 4 K of temperature. Sometime using of cryogenic liquids by the synchrotron rings is very complicated. The performance of the heat tubes utilizing the high

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heat capacity of the first stage of the cryocoolers for initial cooling down of the superconducting wiggler cold mass is described in this paper.

2. Design of the double circuit system of the heat tubes

The cryostat design for ANKA-CLIC wiggler magnet Bragin et al. (2016) differs from the APS design Ivanyushenkov et al. (2015) as the first has the pre-cooling system, see Fig. 1 and Fig. 2.

The cryostat system has four cryocoolers. All first stages of these cryocoolers are thermally connected to cool the heat protection shield and the current leads. Total cooling capacity of these stages is about 250 W at 70 K of temperature. This cooling capacity may be used for initial cooling down of the superconducting wiggler and that may well decrease the total time of the wiggler start-up.

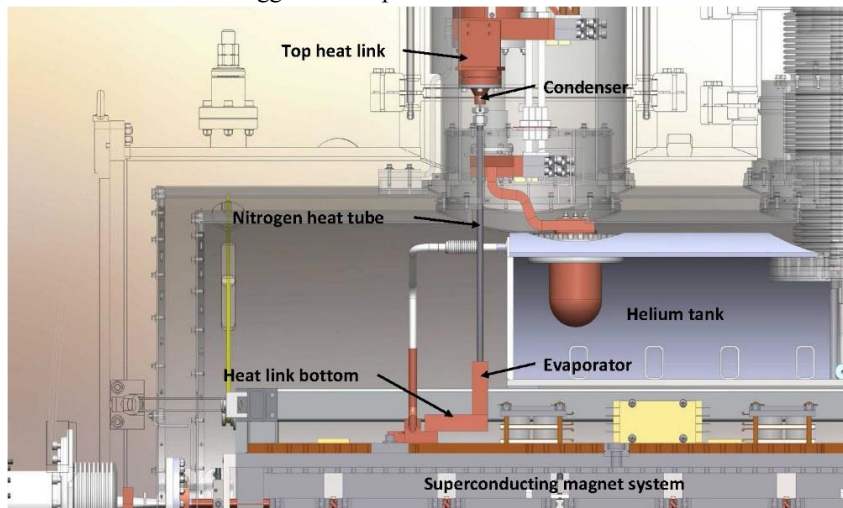


Figure 1. Cross section of the double circuit cooling system.

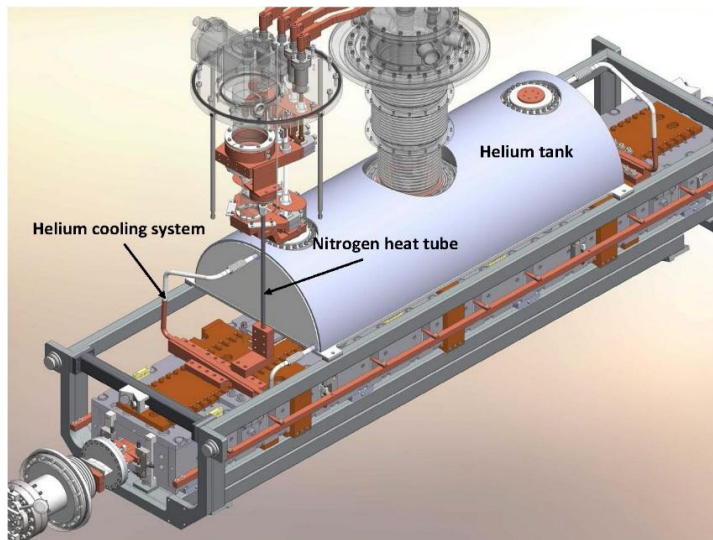


Figure 2 The 3D view of the double circuit cooling system.

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