Preface

Cryostats are technical systems that maintain equipment or cryogenic liquids at cryogenic temperatures. As such, they are one of the fundamental building blocks of cryogenic systems. Examples of cryostats include the magnet cryostats that comprise the majority of the Large Hadron Collider (LHC) at CERN, spaceborne cryostats containing sensors operating below 1 K, MRI cryostats found in most large hospitals, and large cryogenic liquid storage vessels. Cryostats that contain superconducting radio frequency cavities are frequently referred to as cryomodules, while cryostats whose principal function is to store cryogenic fluids are also referred to as dewars. Cryomodules and dewars are also covered in this work.

The proper design of cryostats requires the knowledge of many disciplines including cryogenic properties of materials, heat transfer and thermal insulation, instrumentation, safety, structures, and seals. One of the best ways to learn about cryostat design is to study the design choices and resulting performance of previous designs.

This book provides such a review. It starts with an introductory chapter on the principles of cryostat design including practical data and equations. This chapter is followed by a series of case studies on existing cryostats. The studies describe the cryostat and the design choices made along with the resulting performance of the cryostat. The cryostat examples used in the studies are chosen to cover the wide range of cryostat applications and the authors of each case are leading experts in the field, all of whom participated in the design of the cryostats being described.

Chapters 2 and 3 are case studies involving superconducting magnets for large particle accelerators. Due to the large numbers of magnets required in these cases, low heat leak, reliability, and cost are key requirements. Chapter 4 describes a one of a kind spaceborne dewar system whose requirements are very different than that of accelerator cryostats. Chapters 5 and 6 describe cryomodules that contain superconducting RF cavities in particle accelerators. As will be seen there are two broad families of these cryomodules (segmented and continuous) with different design drivers and approaches. Taken together these chapters describe a total of six different cryomodules and the evolution of cryomodule design from the 1980s to the 2010s can be seen. Chapter 7 presents special topics in cryostat design. These topics are of particular importance for MRI magnet cryostats; which provide the examples but are broadly valuable for all cryostats. A cryostat design for very low (50 mK) temperatures is described in Chap. 8. In addition to the lower temperatures, this cryostat has unique material requirements due to the need to keep the radioactive background of the associated experiment as low as possible. Transfer lines connect cryostats and are a type of cryostat themselves. Transfer line features, an overview of major transfer line systems, and a detailed case study of a transfer line are found in Chap. 9. The final chapter provides a summary by listing guidelines for a successful cryostat design. Extensive references throughout provide sources of further information.

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