PLENARY 1:
Tuesday Morning, 9:45 - 10:45 AM

Dilution Refrigeration, an Established Cooling Method for Quantum Technology

Matti Manninen, Bluefors, Helsinki, Finland

Dilution refrigeration is a cooling method to reach temperatures around or even below 10 mK. This temperature is much lower than any natural temperature in the universe, more than two decades lower than the temperature of outer space. Thus, dilution refrigerators can be used to cool down detectors for astronomy, or they can be used to study phenomena that are reachable only at extremely low temperatures. Quantum technology in particular is an emerging field of physics that typically requires ultra-low temperatures.

The working principle of dilution refrigerator was described in the 1950s and the first systems were built in the 1960s. At the same time cryocooler technology developed: Gifford-McMahon cryocoolers since the 1950s and pulse tube cryocoolers since the 1960s. These two technologies were merged in the 1990s when a dilution refrigerator was precooled with a mechanical cryocooler for the first time. These so-called dry dilution refrigerator systems are convenient to operate as they do not require daily helium transfers nor any additional infrastructure to liquefy helium. In addition, the diameter of the dry dilution refrigerator system could become larger as it did no need to fit inside a helium dewar anymore.

In the 2000s dry dilution refrigerator systems became commercially available. The field of quantum technology had a need for this type of systems thus these technologies started to grow together supporting one another. As the quantum systems become more and more complex, they require more wiring, more space and more cooling power. Today various dilution refrigerator models of different sizes are commercially available to support the user needs.

In this presentation the working principle (including the requirements for the precooling stages) and the history of dilution refrigeration are briefly described. Also, the cryogenic requirements for quantum technology are explained.