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Advanced Technology Applications of Novel HTS Magnet Technology

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***Abstract* — High Temperature Superconductor (HTS) magnets are currently considered as a backbone for fusion energy by Tokamak Energy (TE). Non-insulated (NI) and partially insulated (PI) HTS coil technology has made the magnet technology very robust, while capitalising on the total potential of HTS tapes. TE has been a pioneer in pushing NI & PI coil technology for HTS magnets, with a growing portfolio of intellectual property. HTS magnet technology developed at TE makes it simple to design, develop and operate the magnets, with reproducible results. A HTS magnet formed by a stack of NI pancake coils developed by TE achieved a peak field of 24.4 T at 21 K. NI magnets are extremely hard to quench but when forced to quench several times they display no or minimal changes in their superconducting behaviour. The demonstrated mechanical stability, reproducible manufacturing process, ease of operation and inherent quench stability, is a strong basis for a commercially viable technology.**

In the last two years, TE has examined several high DC field applications ranging from accelerator magnets, plasma thrusters, research magnets and medical imaging. TE is currently in collaboration with both the Paul Scherrer Institute (PSI) and Magdrive, actively involved in the design and development of HTS Superbend magnets for light sources and space thrusters respectively. Recently, an HTS coil developed by TE was tested to withstand rocket launch conditions. For high field magnets, it is often pointed out that the time constant of NI coil magnets is very large when compared with insulated magnets. This posed a significant challenge to enhance the turn-turn resistance, while retaining the advantages of the NI coil technology. TE has developed "partially insulated (PI)" coil technology, increasing the turn-turn resistance by several orders of magnitude but retaining the quench-safe benefits of NI coils at increasing scale. TE is actively developing this PI coil technology.

TE has also made significant progress towards HTS magnet auxiliary technologies such as flexible HTS current leads and cryogenic power supplies. We will present an overview of these technologies, and their potential for commercial aerospace applications.

Keywords (Index Terms) **— High field magnets, non-insulated (NI) coils, partial-insulated (PI) coils, space propulsion, satellite thrusters, accelerator magnets and medical imaging**

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