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Preliminary Design Study on HTS Toroidal Field Coils Using Non-Twisted Conductors and Cables

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High temperature superconductor (HTS) technology has been widely studied for various superconducting devices due to the capability of high magnetic field generation and its relatively strong strain resistance. Fusion magnet engineers also have made efforts to employ the HTS technology to their magnets, especially focused on the development of HTS cable-in-conduit conductor (CICC) such as twisted stacked tape conductor (TSTC) and conductor on round core (CORC) cables. Both cable schemes are based on the twisting of HTS tapes to reduce inductance variation and AC losses within magnet. In recent study, however, it was shown that twisted conductor decrease inductance variation only a few percent compared to the non-twisted counterpart, lower AC losses even up to half but still in the same high order of magnitude. In this study, we suggest an alternative solution that uses a long copper tape laminated with several HTS tapes, having three main advantages of: 1) mechanical robustness without the inherent mechanical issues resulted from the residual bending strain in the twisted HTS cables; 2) no limitation of winding length despite the relatively short piece length of HTS tapes; and 3) high thermal conductivity that can minimize the temperature gradient within the entire magnet even in conduction cooling condition. Technical issues for the development of HTS TF coils using the proposed copper-laminated long length HTS tapes and cables will be discussed in detail.

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