

## Design of High-Temperature Superconductor Current Leads for ITER

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In the framework of the European Fusion Programme, the Forschungszentrum Karlsruhe and the Centre de Recherches en Physique des Plasmas (CRPP) have successfully developed and tested a 70 kA high-temperature superconductor (HTS) current lead demonstrator. This binary HTS current lead consists of a conduction-cooled HTS part and a gas-cooled copper heat exchanger. The modular design of the HTS module is based on twelve HTS panels, forming a 12-fold prism. The results indicated that the use of HTS current leads would provide considerable savings in the refrigeration operation costs for ITER. In the present work, the optimisation of the cooling conditions (helium inlet temperature, warm end temperature of the HTS) of a binary HTS current lead with respect to the cooling power consumption and the required amount of HTS tapes is described. The aspects related to the pulsed operation of the HTS current leads for the CS and PF coils are also addressed. The maximum tolerable size and distribution of the contact resistance values at the warm and cold ends of the twelve HTS panels are defined. Based on the test results for the 70 kA HTS current lead demonstrator the temperature margin and the voltage level for quench detection are determined.