Contribution ID: **329** Type: **Poster Presentation**

# A High-current, IGBT-based Static Switches for Energy Extraction in Superconducting Power Circuits

*Thursday 7 July 2016 14:40 (20 minutes)*

The steadily increasing demand from the particle physics community for higher energies and higher integrated luminosity has reinforced the need for new accelerator equipment, often breaking with conventional technologies. One of the fields where new and innovative engineering is required and where interesting developments are on-going, is the domain of fast switching of high DC currents, such as it is recurrently required for rapid extraction of large quantities of stored energy in superconducting circuits.
The 30 kA opening switch, development at CERN within the global HL-LHC project, is an illustrative example of an innovative engineering required to satisfy the demands related to circuit protection. The paper presents the integration into an IGBT-based static DC switch of a variety of different, new design principles, such as a triple-busbar layout for optimized circuit symmetry, the extensive use of laminated, water-cooled busbars, and an optimized capacitive compensation of the parasitic inductances as well as a complete analysis of the thermal budget management of the individual IGBT modules. Results from direct liquid cooling of the IGBT' s will also be presented.
The paper will also include a presentation of a bipolar, redundant 1 kA IGBT switch which features an all-laminated busbar concept, elaborated for energy extraction in superconducting corrector circuit.

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**Session Classification:** Poster 2-B

**Track Classification:** Opening, Closing, and Solid State Switches