FastGrid

COST EFFECTIVE FCL USING ADVANCED SUPERCONDUCTING TAPES FOR FUTURE HVDC GRIDS

Newsletter #4
November 2019

FASTGRID AT A GLANCE

Dear readers,

The objective of FASTGRID was mainly to develop and provide superconducting advanced conductors suitable, from technical and economic points of view, for high voltage Fault Current Limiter (FCL). After nearly three very rich years, we have reached and even overstepped our objectives. The critical current per unit tape width reaches for example 670 A/cm-w at 77 K (1370 at 65 K) overcoming our initial objective by 30 %. These outstanding transport properties associated to increased electric fields (up to 180 V/m) lead to huge power dissipations during a fault. We recorded up to 70 GW/m^3 and 44 MW/m^2 thus exploring new territories. These performances have been reached on conductors with the lamination of a selected Hastelloy® shunt.

FASTGRID also investigated new solutions or routes. The 3rd newsletter reported the successful implementation of the CFD (Current Flow Diverter) tape architecture.

In this 4th newsletter we highlight the development of a new hot spot detection technique using optical fibers by EPFL. This innovation is a significant game changer allowing a speedy and extremely simple detection of even a single hotspot in the tape within 10 ms. It can be used in a wide range of superconducting applications.

Pascal Tixador

FASTGRID coordinator

FOCUS ON

Optical fiber sensing for fast hotspot detection in SFCLs

The detection of hotspots is a major issue for HTS applications. Since the Normal Zone Propagation Velocity (NZPV) is very low, the classical detection systems are very difficult to use making hotspot detection in superconductors very challenging. The goals of FASTGRID project include (but are not limited to) the enhancement of the NZPV through the CVD (Current Flow Diverter, see newsletter 3) and the development of an efficient and low-cost hotspot detection technique for SFCLs. A technique using optical sensing for quick hotspot detection has been developed and patented by EPFL. Although optical fiber sensing is a mature technique but using it for HTS applications as innovated at EPFL enables a very quick detection with a low-cost set-up, which is a very significant breakthrough not only for SFCLs but a wide range of HTS applications.

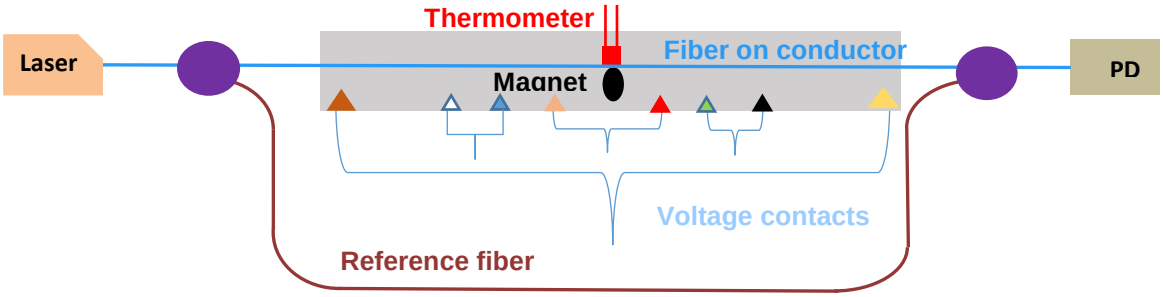


Figure 1. Experiment setup schematic

With the technique developed at EPFL, it is now possible to detect hotspots along the length of the superconductor and raise an alarm within 10 ms using an extremely simple and economically feasible setup. The technique which uses a Mach-Zehnder interferometer comprising two optical fibers one in contact with the superconductor and the other as a reference in addition to a laser source and a detector.

The light is split into the two fibers and recombined at the output where interference occurs. Without hotspots the interference pattern does not show rapid changing, on the contrary when a hotspot is present the changing path on the fiber attached to the conductor induces rapid periodic amplitude oscillations. These oscillations occur because of the changing difference in the light path in the two fibers. The rate at which the length and temperature of the heated region in the superconductor increases induces a rapid change in phase shift from 0 to 2π. This results in several rapid amplitude variations from 0 to 1 which is interpreted as the presence of a hotspot.

This technique is an extremely fast option to detect hotspots in SFCLs. The swift response combined with economic feasibility makes it a promising way to employ SFCLs on a large scale in the grid with an efficient device protection mechanism to prevent thermal runaways.

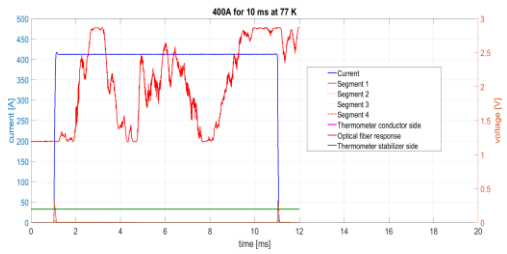


Figure 2. Experiment results showing optical fiber output for no quench

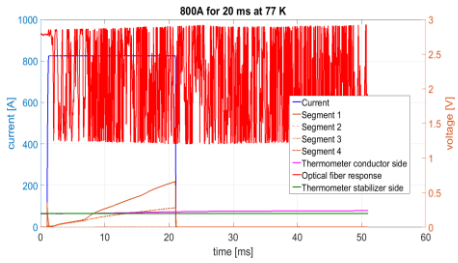


Figure 3. Experiment results showing oscillations in optical fiber output with quench

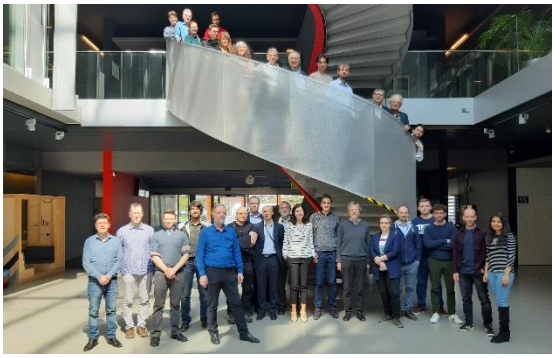
International Patent Application (provisional) n° PCT/IB2019/057271 filed on August 29, 2019

Title: "SUPERCONDUCTOR DEVICE"

In the name of: ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE (EPFL)

Inventors: Zhisheng YANG, Arooj AKBAR

6th Project meeting at EPFL, Lausanne



Members of the consortium at the 6th project meeting in Lausanne

The 6th project meeting of the Horizon 2020 EU Project FASTGRID, jointly managed by CNRS, France and KIT, Germany was hosted at the *Ecole Polytechnique Fédérale de Lausanne*, Switzerland on April 9-10, 2019.

The two-day meeting was the opportunity for the consortium members to discuss the results of the tests they had performed since last project meeting in Bratislava, Slovakia. The event also included parallel work package sessions and a guided tour of the Swiss Plasma Center on the EPFL campus. Next face-to-face project meeting will take place in January 2020 in Milano and will be hosted by RSE.

2nd Review meeting in Brussels

The second review meeting of the project took place in Brussels on July 17th 2019 with FASTGRID Project Monitor, Dr. Ewa Jedryka. This event was the opportunity for the coordinator and the Work Package leaders to present the results achieved in each WP related to material characterization and testing methodology of the HVDC smart module demonstrator. The team of scientists are grateful and satisfied for the positive remarks received and will strive to continue the high quality research that they want to stand for, for the energy research and innovation within Europe.

Members of the consortium participated in EUCAS 2019

At the recent European Conference on Applied Superconductivity 2019 in Glasgow, FASTGRID was well represented with posters, presentations or invited contributions and a booth from our industry partner THEVA.

EUCAS 2019 GLASGOW

The conference took place from Sept. 1st to Sept. 5th 2019

The contributions from FASTGRID members at EUCAS 2019 are listed below:

- *Optical fiber sensing for fast hotspot detection in SFCL* - Arooj Akbar, EPFL, Lausanne
- *Study of CC tapes damaged during fault current limitation at 66 K* - Marcela Pikarcikova, STUBA, Bratislava
- *Low temperature bonding of non-stabilized coated conductors tapes* - Edita Mikulášová, STUBA, Bratislava
- *Growth of CSD low fluorine YBCO superconducting layers on sapphire substrates* - Cornelia Pop, ICMAB, Barcelona
- *Current flow diverted coated conductors for advanced fault current limiters*, Pedro Barusco, ICMAB
- *New opportunities to enhance vortex pinning in solution derived YBCO thin films*, X. Obradors, ICMAB
- *Advances of the EC Project FASTGRID*, Pascal Tixador (Coordinator FASTGRID), Invited Poster
- *Development of 150 V/m HTS conductor for fault current limitation in high voltage DC networks*, Guillaume Escamez, SGI
- *Hot spot creation in coated conductors used for fault current limitation*, Fedor Gömöry, IEE, Bratislava

- *YBCO Coated Conductors obtained by slot die*, Roxana Vlad, Oxolutia, Bratislava

- *HTS coated conductor current limiting performance at temperatures lower than 77 K*, Moran Mosat, IEE Bratislava

- *Additional stabilization of REBCO coated conductors for Fault Current Limiters*, Michal Vojenciak, IEE, Bratislava

Other conferences were attended by FASTGRID members, including the CEC/ICMC in July 2019 in Hartford, USA and the International Conference on Magnet Technology in September 2019 in Vancouver, Canada.

Amélie Berthe joins FASTGRID at SGI

Amélie Berthe, R&D engineer at SGI

Amélie Berthe obtained her Masters in Electrical Engineering from INSA Lyon and went on to work as a Research and Development engineer at SuperGrid Institute on optimization and techno-economic analysis of SFCL. Subsequently she worked as a project leader on E-mobility at ENEDIS with focus on investigating the impact of electrical vehicles on distribution networks. Amelie joins FASTGRID as an experienced and very competent electrical engineer on optimization of SFCL design and testing procedures. We wish her all the best in her endeavours.

FASTGRID industrial partner Oxolutia has a new CEO

Dr. Xavier Amils obtained his PhD in Physics-Material Science with focus on Nanomaterials from Universitat Autònoma de Barcelona in 1999. Subsequently he expanded his portfolio with executive education from INSEAD – CEDEP in 2008. After working 16 years at Bekaert group in different capacities focused on Industrial, Engineering and Renewable projects, and aiding expansion of the company operations overseas in Europe and Asia, Dr. Amils has returned to his homeland for contributing in the new and innovative energy sector of Oxolutia and superconductivity. We are sure the EU programme FASTGRID and future EU endeavours in advancing materials development for the energy sector will benefit enormously from this step. We welcome Dr Amils heartily into the FASTGRID consortium.

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