Karlsruhe Institute of Technology

HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

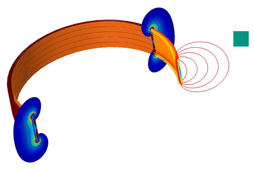
Institute for Technical Physics

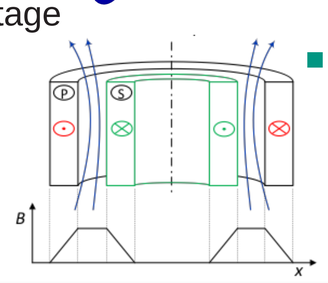
Design and Test of an Air Coil Superconducting Fault Current Limiter in Power Hardware in the Loop Station

J. Geisbüsch, Felix Kaiser, Wescley T. B. de Sousa and M. Noe

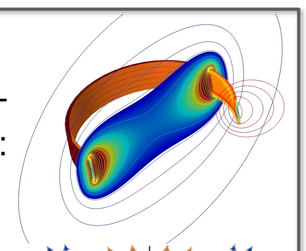
Motivation

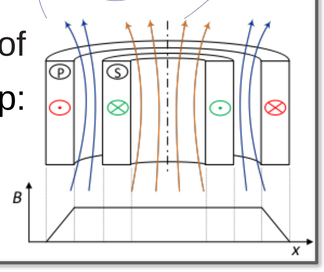
- Retrofit of usual air core reactors with short-circuited HTS tapes.
- Easy upscale to high voltage levels.
- Low cryogenics losses.
- Patent submitted.





- Left: Operation of the SFCL under normal conditions (top: COMSOL, bottom: schematic)
- Right: Operation in the state of fault current limitation (top: COMSOL, bottom: schematic)



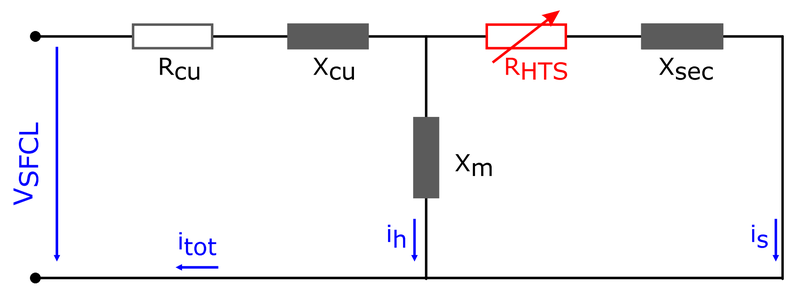


Objectives

1. Design and construction of a Air Coil SFCL;
2. Test of the Air Coil SFCL in the Power Hardware in the Loop (PHIL) facilities.
3. Development of benchmark models for real time simulations in Power Hardware in the Loop tests.

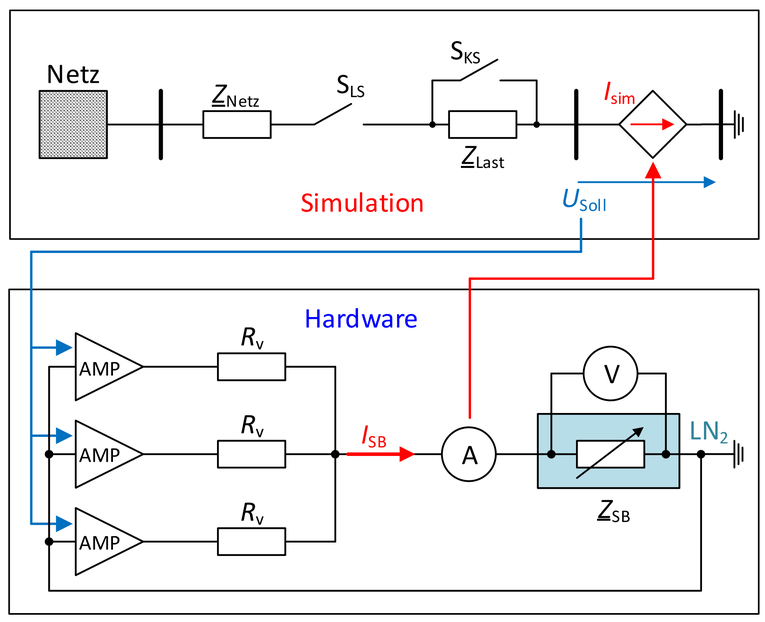
Approach

Parameter	Value
Inductance (primary)	2 mH
Resistance (primary)	50 mΩ
Nominal Current	10 A
Nominal Voltage	1.4 V
High	10.7 cm
Outer diameter	35 cm
Inner diameter	31 cm

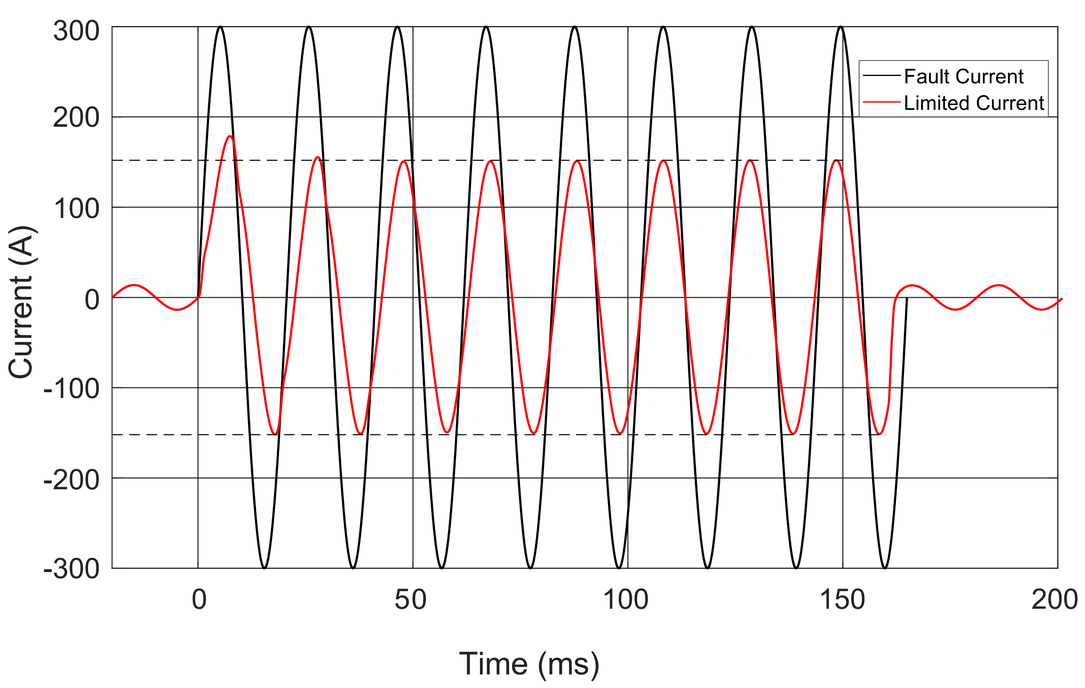


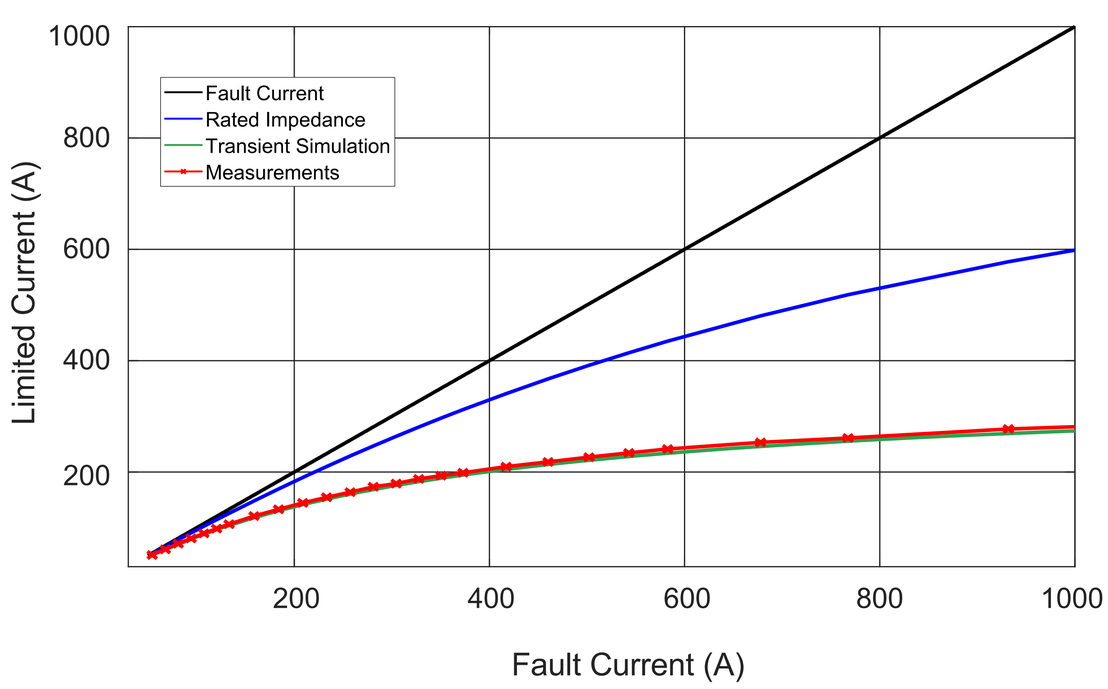
- Air Coil SFCL Design: Primary winding composed of copper and secondary composed of HTS Tapes.
- Under normal conditions the resistance of the secondary is neglegible and the total impedance of the SFCL coil is reduced. In the event of fault, the HTS tapes transit to the normal state and the total impedance increases.

- The Air Coil SFCL is connected to the simulation enviroment at the PHIL Station. The whole system is simulated whereas the Air Coil SFCL is a real component immersed in LN_2.



Results





- Fault current limited to approximately 49.7% of its peak value.
- Increase of 4.49% in the impedance of the Air Coil SFCL under fault conditions.
- High limitation factor for high fault currents.

Conclusions

- Scaled prototype successfully tested in real time simulation.
- 100 V, 600 A prototype successfully tested in laboratory.
- New project for tests in field in planning phase.
- Real-time model of the Air Coil SFCL can serve as standard benchmark.