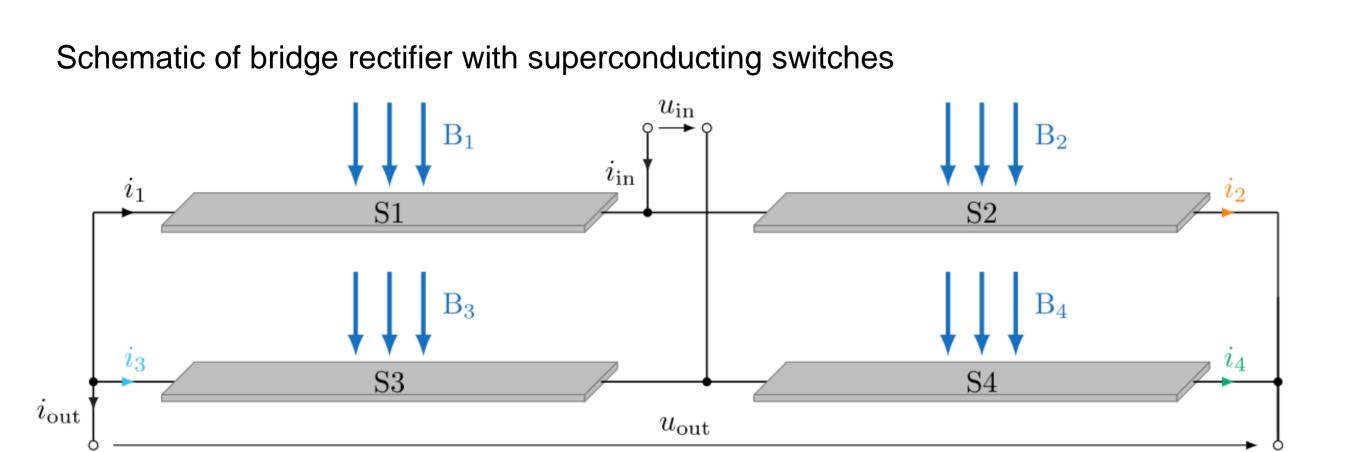


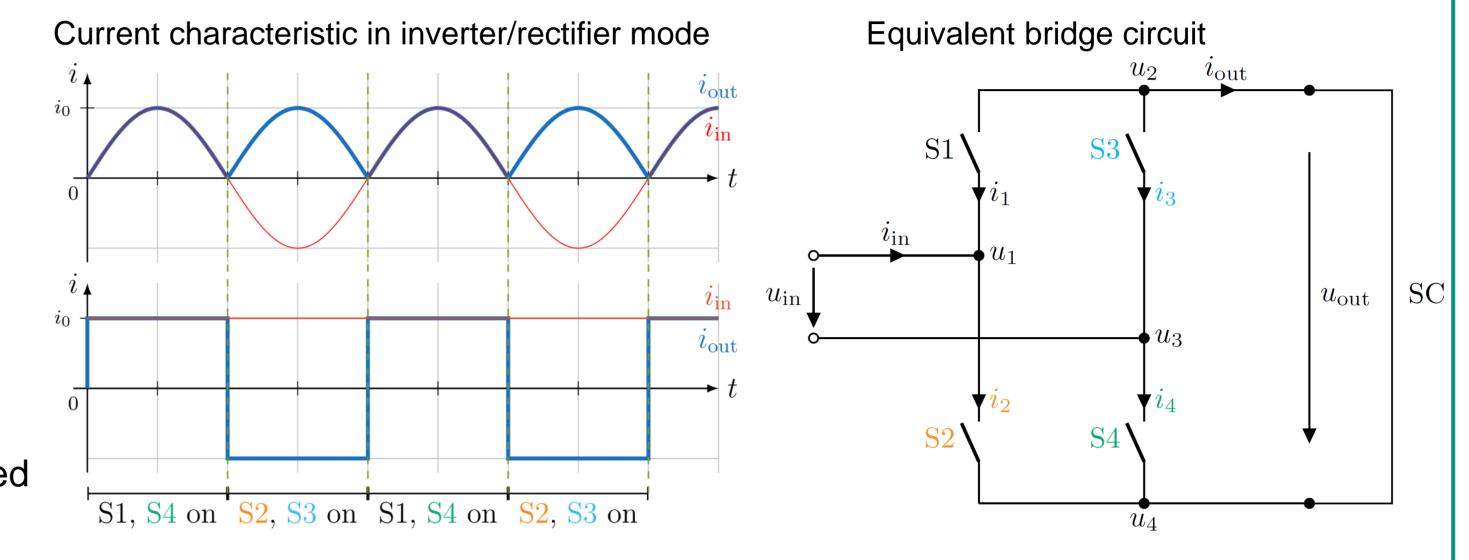
Karlsruhe Institute of Technology

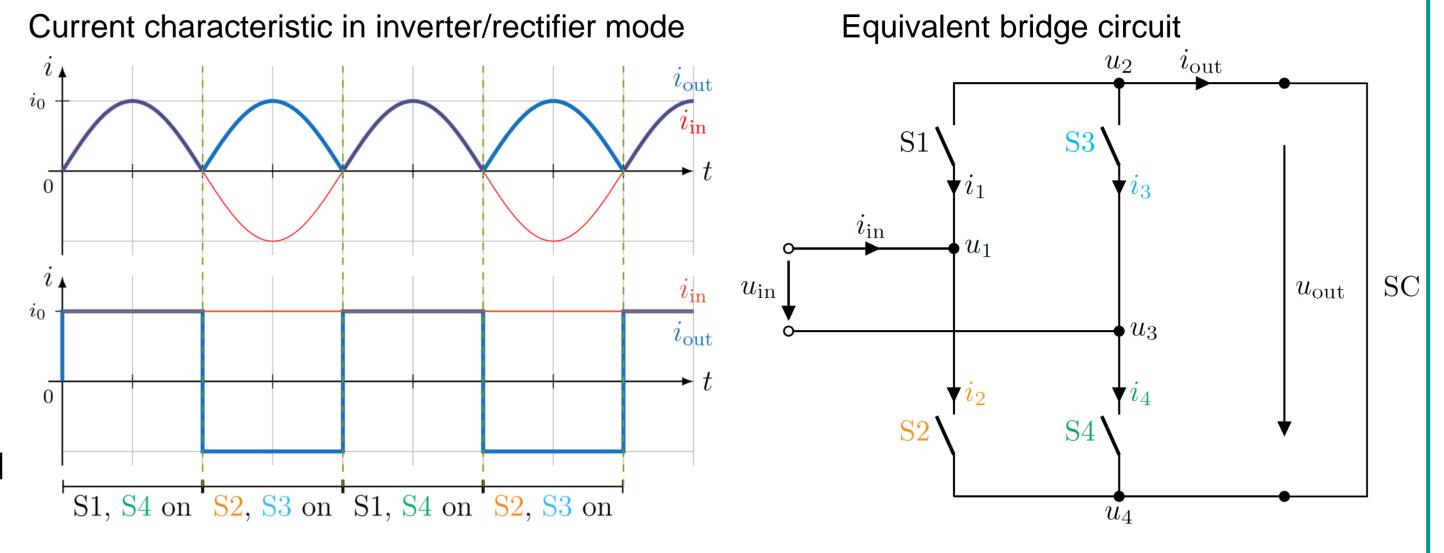
Institute for Technical Physics (ITEP) Hermann-von-Helmholtz- Platz 1 76344 Eggenstein-Leopoldshafen quoc.pham@kit.edu Presentation Code: 3-LP-IS-03S

Switching device with magnet field-triggered hightemperature superconducting switching units

Quoc Hung Pham and Mathias Noe







Fast superconducting switching units based on dynamic resistance implemented

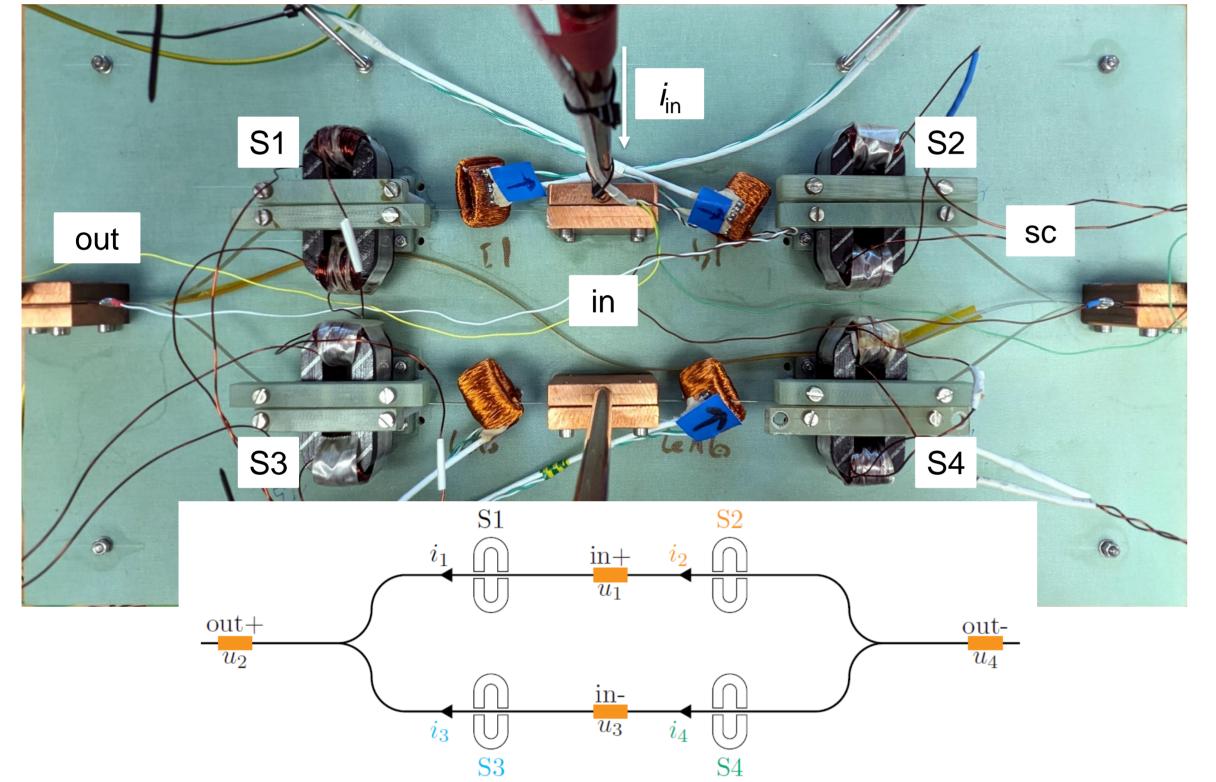
Multiple switching units combined into a fully superconducting power inverter

Experimental setup and first switching experiment

Main properties of HTS tape

Introduction

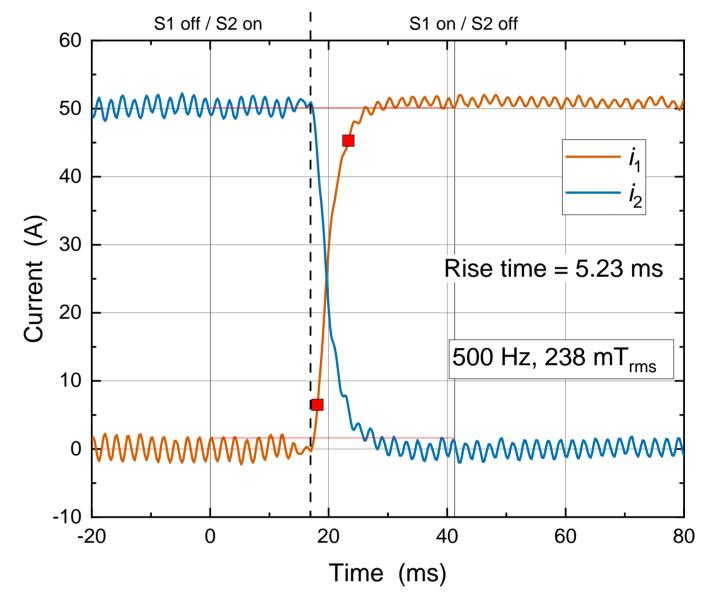
Assembled test circuit with sliced superconductor



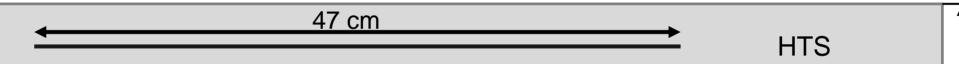
Superconductor	
Manufacturer	Superpower
Model	SF12100
Self-field critical current at 77 K	380 A
Thickness of Ag stabilizer layer	2 µm
Thickness of superconductor layer	1 µm
Thickness of substrate	100 µm
Resistance per length at RT	3.175 mΩ cm ⁻¹
Resistance per length at 77 K	$0.729 \text{ m}\Omega \text{ cm}^{-1}$
Critical temperature	92 K
Operation temperature	77 K

Geometry of the HTS tape

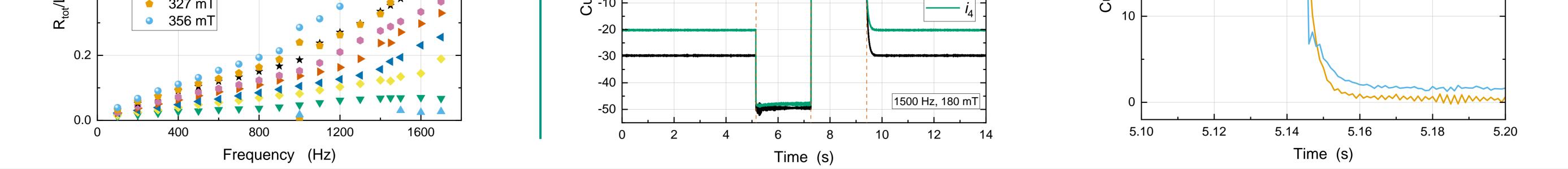




12 mm



Experimental results Dynamic resistance of HTS tape Inverter mode (1500 Hz, 180 mT) Structure of HTS tape and equivalent circuit Switching between three states: K_{Ag,top} No contact resistances between cap layer superconductor 3 $R_{\rm tot}$ buffer substrate switches $S1 i_1$ S3Switching time is dependent on the dynamic resistance and inductivity ⊶► sc $u_{\rm in}$ \mathbf{sc} $u_{\rm out}$ $| sc u_{in} |$ $u_{\rm in}$ $u_{\rm out}$ $u_{\rm out}$ R_{Ag,bottom} of the circuit S2↓. $S2 \downarrow i$ Higher resistances lead to faster *B*: 0 mT – 350 mT switching times *f*: 100 Hz – 1700 Hz 1 2 3 Current flow during switching operation with input current of 50 A Dynamic resistance per length S1 / S4 on S2 / S3 on S1 - S4 on S1 - S4 on 50 ■ 59 mT 0.8 $t_{0.1-0.9} = 4.7 \text{ ms}$ 90 mT 40 120 mT 30 150 mT 180 mT (mΩ cm⁻¹) 20 (²⁰ 210 mT (\mathbf{A}) 10 239 mT rrent urrent 268 mT 298 mT 0.4 327 mT -10



Conclusion and outlook

- For the first time, the feasibility of a fully superconducting power inverter based on the dynamic resistance of HTS tapes was demonstrated
- Upscaling of the dynamic resistance by increasing the active magnetic length is ongoing and enables fast switching times
- Variable dynamic resistance allows smooth switching operations Acknowledgments Low voltage and high current inverters are possible Special thanks to Prof. Dr. Tabea Arndt, Dr. Rainer Nast and Andrej Kudymow.

