

#FR22 

Eddy Current Flow Meter flow rate measurements in liquid sodium at the Superfennec loop

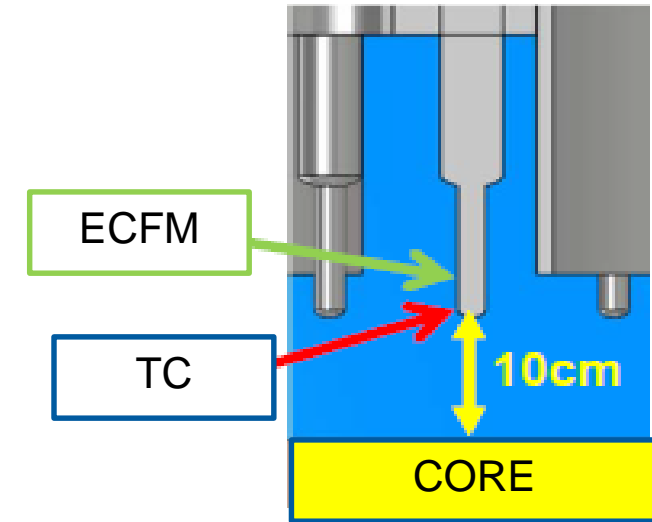
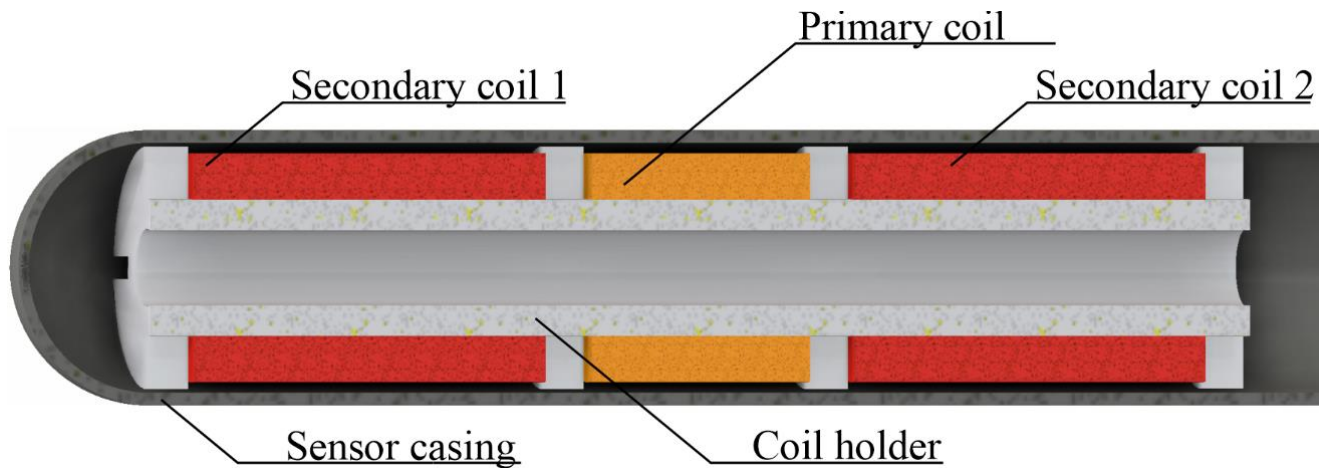
N. Krauter, K. Paumel, M. Girard, S. Eckert, G. Gerbeth

Institute of Fluid Dynamics · Department of Magnetohydrodynamics · Dr. Nico Krauter · n.krauter@hzdr.de · www.hzdr.de

Camera

The Eddy Current Flow Meter

- Eddy Current Flow Meters (ECFM) for coolant flow monitoring in fast reactors
- Inductive sensor consisting of 3 magnetic coils
- Measurement of mean velocity in a volume around the sensor
- Velocity range 0...4 m/s
- Resolution ± 0.1 m/s
- Operating temperature up to 650 °C
- L = 50 mm, \varnothing 11 mm

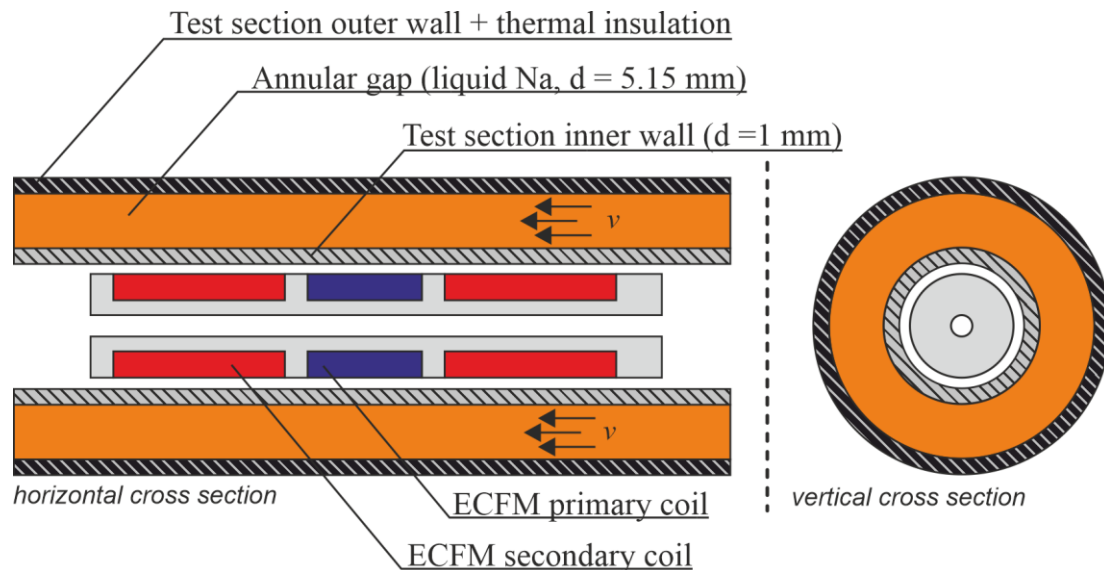


ECFM Prototype

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SUPERFENNEC Loop

- Located at CEA Cadarache in France
- Sodium inventory of 150 liters
- Temperatures up to 500 °C
- Used for training activities of sodium circuit operators
- Used for experimental campaigns like hydrogen detection or ECFM Eddy Current Flow Meter flow rate measurements

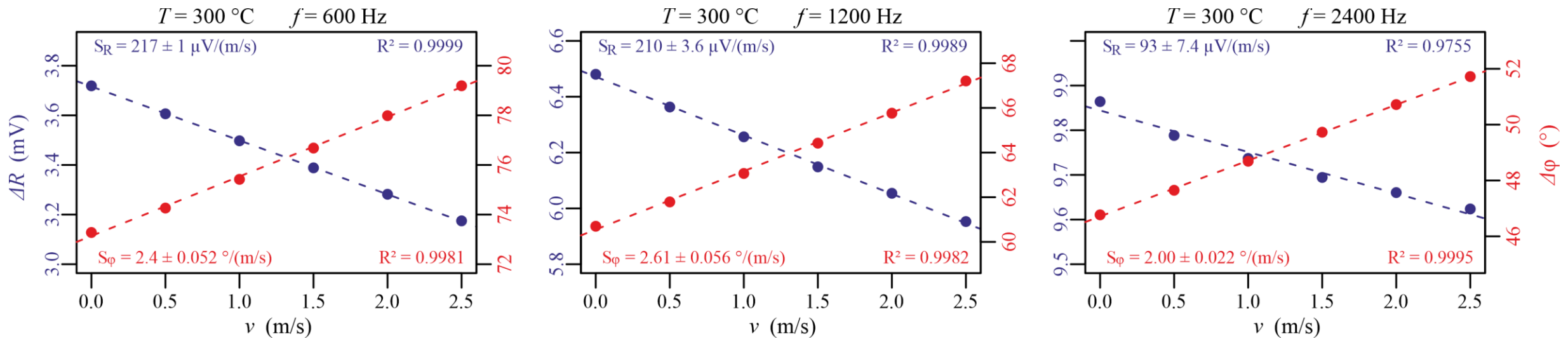


- ECFM measurements at 200°C, 250°C and 300°C
- Flow velocities of liquid sodium from 0 m/s to 2.5 m/s

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Measurement results at 300 °C

- Measurement of **magnitude** and **phase** of the ECFM output voltage
- Sensitivity S of the ECFM is changing with the excitation frequency f of the primary coil
- Linear relationship between flow velocity and magnitude or phase
- Linearity of results is expressed by R^2 (ideal linearity at $R^2 = 1$)

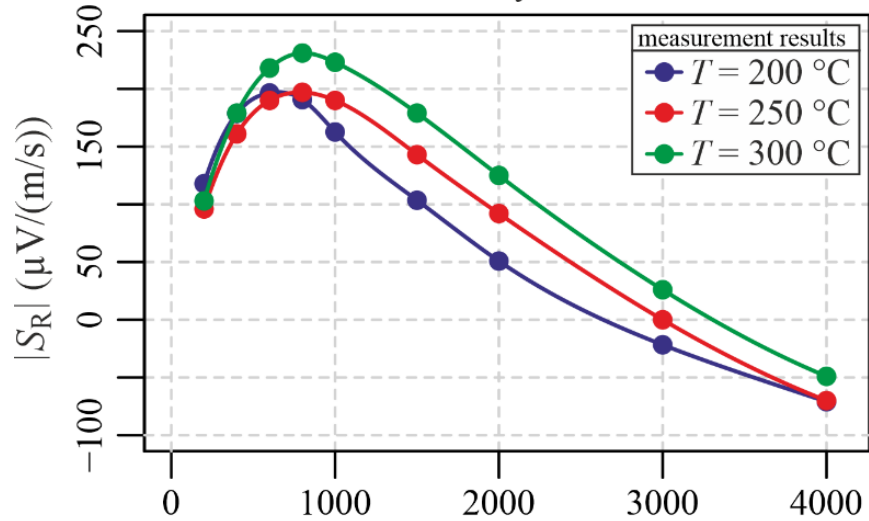


- For the **magnitude** the best results are obtained around 600 Hz
- For the **phase** the best results are obtained at higher frequencies

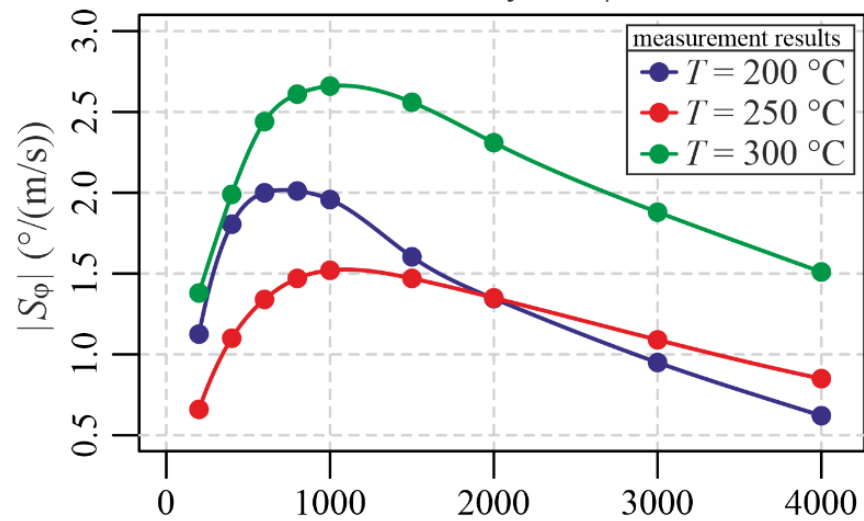
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ECFM sensitivity

sensitivity of ΔR



sensitivity of $\Delta\phi$



- For the magnitude, the frequency has a high impact on the sensitivity but the impact of changing temperatures is low
- For the phase, the frequency has a low impact on the sensitivity but the impact of changing temperatures is high

Conclusions

- Linearity between ECFM signal and flow velocity demonstrated both for measured voltage difference and phase shift
- Linearity becomes even better at higher temperatures in the range of 200 to 300°C
- Voltage measurement has optimal frequency at about 700 Hz, whereas phase shift is accurate over a wider range of frequencies

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