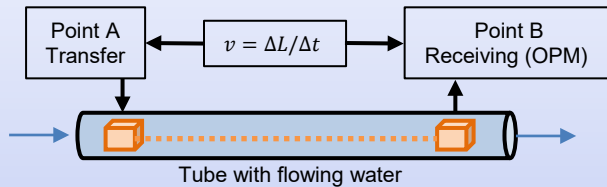


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Abstract

We present a novel flow metering procedure.

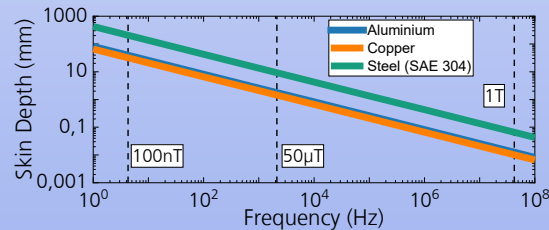
Magnetic information is transferred to and received from the flowing medium (Time-of-flight measurement). An OPM is used for signal detection.



Introduction

The ZULF regime yields beneficial features to flow metering like high penetration depth of low frequency RF-signals.

OPMs show an increased signal-to-noise ratio at low signal frequencies compared to induction coils and they don't require cryogenic cooling [1].



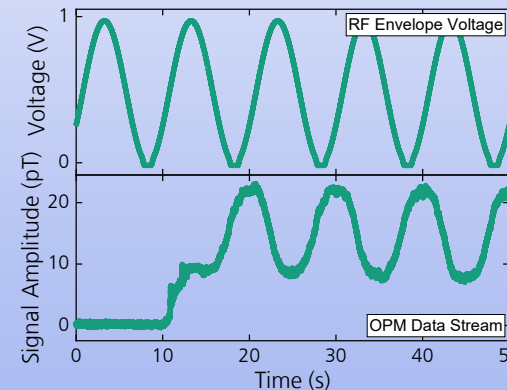
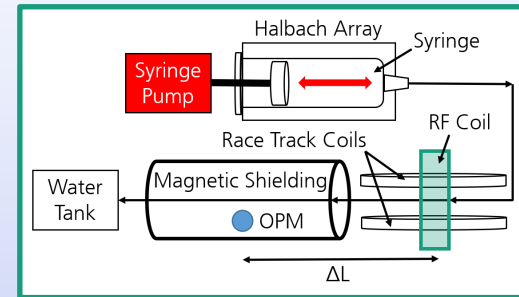
References

[1] Ya. S. Greenberg. Application of superconducting quantum interference devices to nuclear magnetic resonance. Rev. Mod. Phys. Vol. 70, Issue 101/1998, American Physical Society, DOI 10.1103/RevModPhys.70.175

Methodology

Setup and Procedure

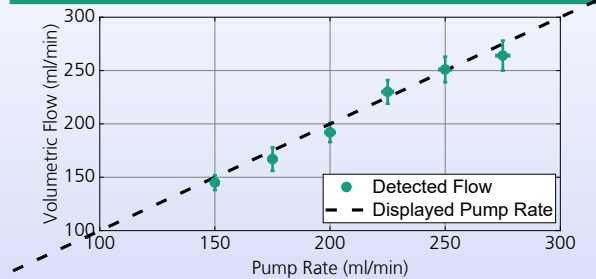
- Pre-polarization in a permanent Halbach magnet
- RF-Coils modulate pre polarized water
- Modulation is detected by an OPM in magnetic shield (<100nT ambient field) downstream
- Time difference Δt between RF modulation and detection yields flow velocity $v = \Delta L / \Delta t$
- Time-of-flight measurement



Data Acquisition

- Amplitude modulated RF pulses modulate water magnetization
- OPM detects signal trends analogue to the RF envelope
- No calibration needed

Results



The flow meter is capable of metering flow velocities of 12.3cm/s to 22.4cm/s with an average accuracy of 5%

Conclusion

We demonstrated the feasibility of flow metering using an OPM for signal detection operating at an ambient field of less than 100nT. The procedure is noninvasive and doesn't need calibration.

Further research will show the viability of the flow metering procedure for applications in research and industry. Goal: clamp-on flow meter similar to the clamp on ammeter (right).



Sponsors

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