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How MRI can assist Rheology?

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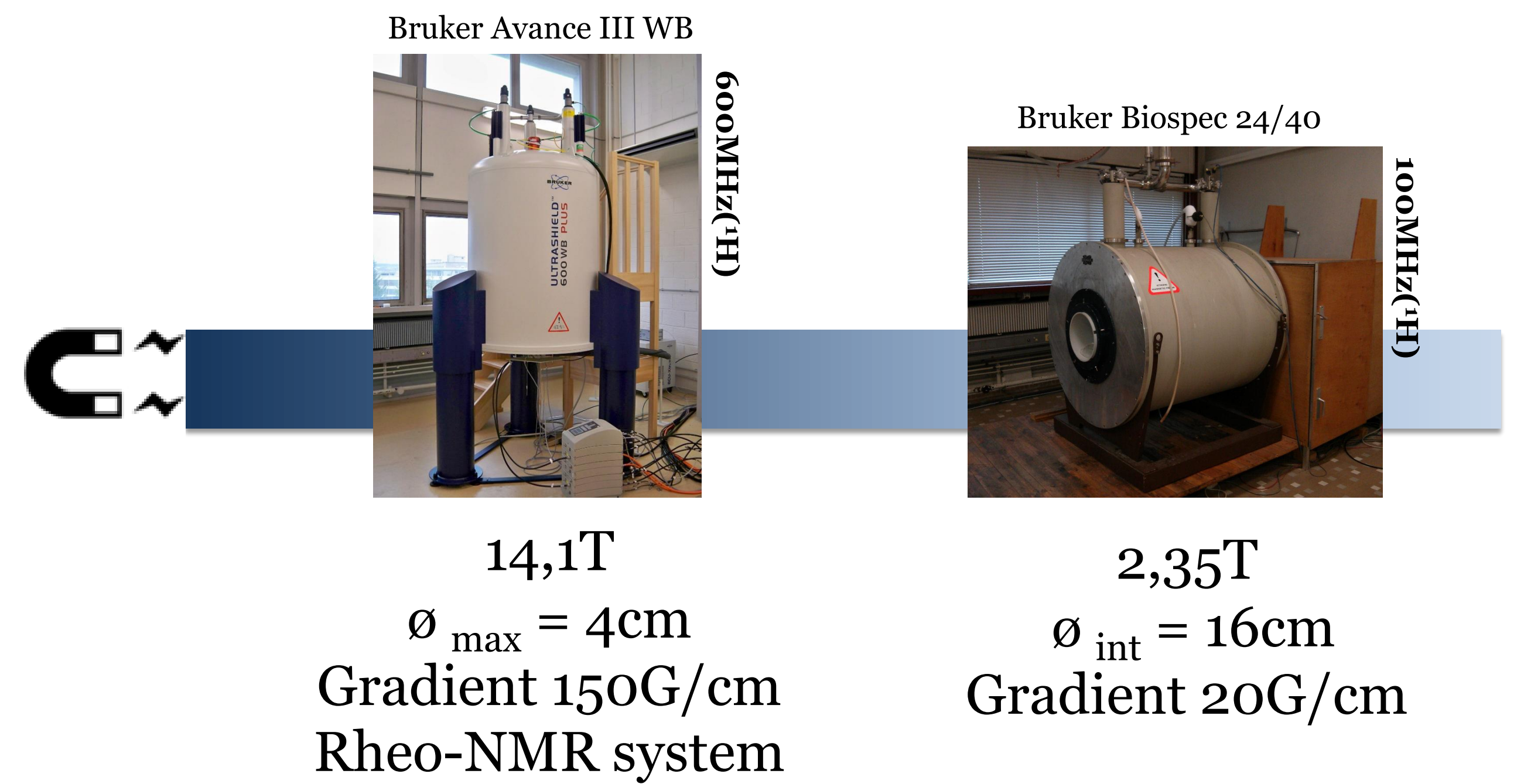
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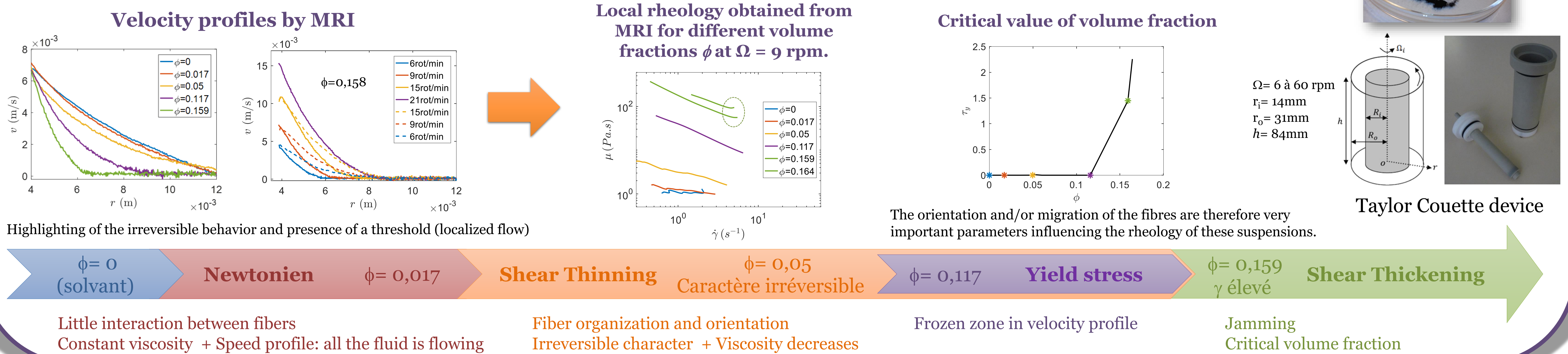
Introduction

Rheology is the study of the flow of matter in response to an applied force. The studied fluids are often complex and the standard macroscopic rheology analysis is not sufficient to understand certain phenomena associated with flow or material heterogeneities. A **local** rheology analysis is then crucial. In addition, the **MRI technique** is a convenient solution especially when the fluid is opaque. Here are three examples of application.



Thixotropic suspension

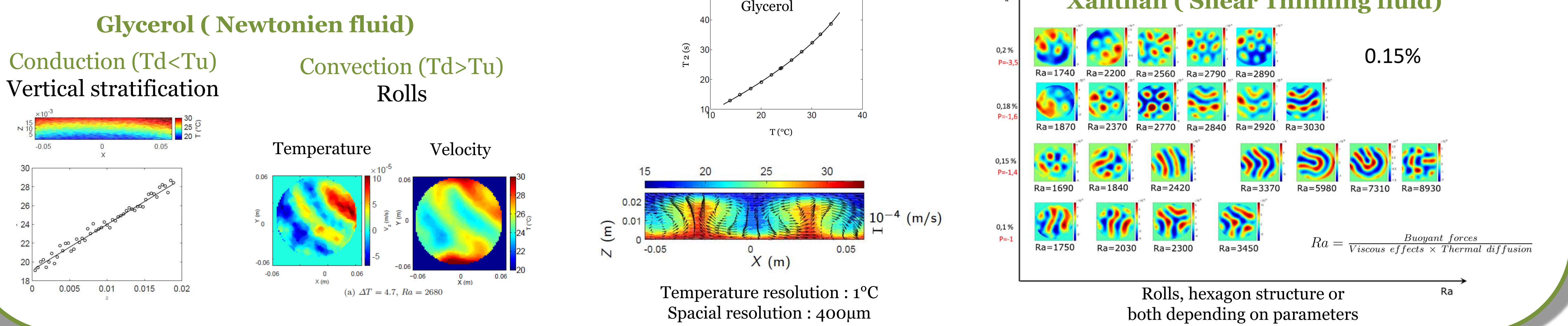
The study of **non-Brownian fiber suspension** rheometry in a Taylor-Couette device is done thanks to the velocity profiles obtained by MRI measurements (flow encoding spin-echo protocol). The local rheological data are acquired for different shear rates and volumetric fractions.



Temperature et velocity measurements

The study of thermal transfer by **conduction** and **convection** represents a wide field of industrial and environmental applications. We investigate the possibility to measure **velocity** and **temperature** profiles with MRI in a fluid layer submitted to heat transfer.

- Velocity measurements : spin-echo imaging sequence + gradient dipolar
- Temperature measurements : T2 calibration



Wall slip mechanism

We carried out a series of experiments with the aim of completing our knowledge of wall slip characteristics. The study is based on internal measurements of the velocity profile of inverse emulsion into a capillary tube. They are acquired using a flow encoding spin-echo protocol with in addition bipolar gradient pulses in order to encode the phase shift arising from the flow.

- linear variation of the velocity with the stress
 - At the approach of the yield stress value the velocity increases steeper \approx quadratic law
- \Rightarrow A change of both regime and physical process for wall slip when the yield stress fluid is in its liquid regime along the wall

