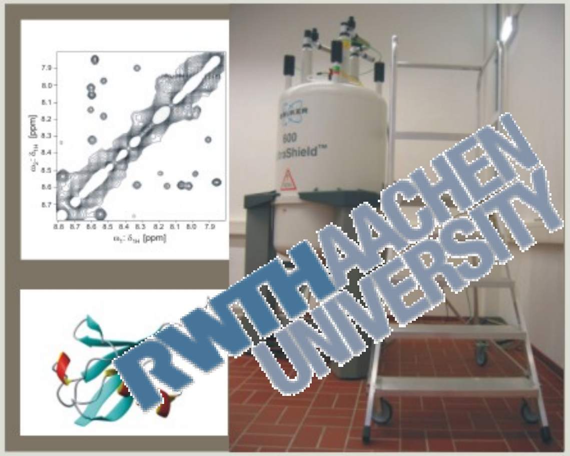
Introduction to Mobile NMR

www.springeronline.de

The Different Faces of NMR

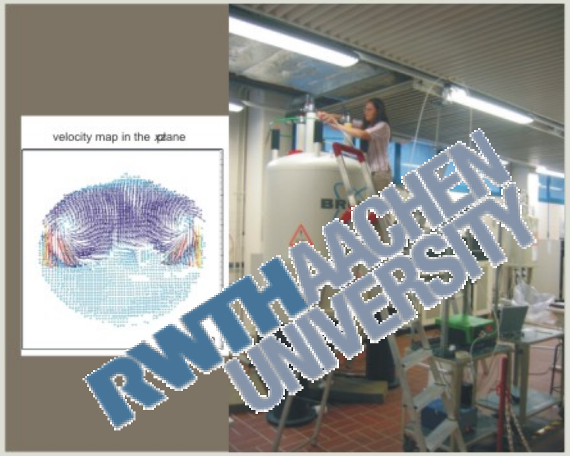
Chemistry: NMR Spectroscopy



Medicine: NMR tomography

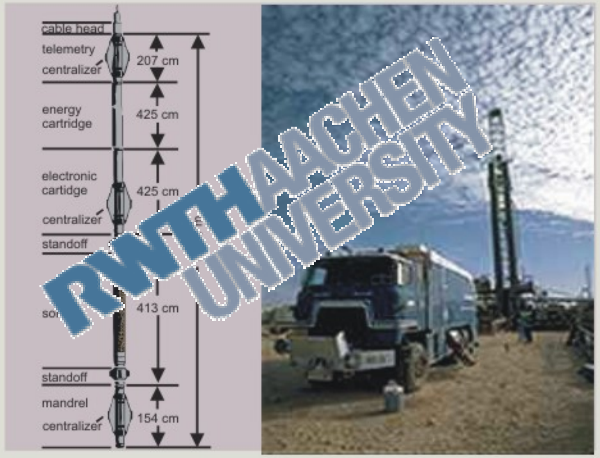
Materials Science: NMR tomography

Chemical Engineering: flow imaging



Quality Control: NMR relaxation

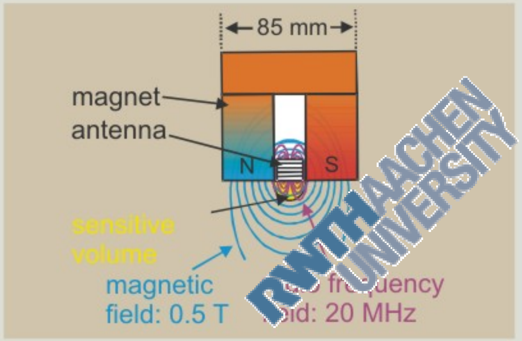
Oil Industry: NMR relaxation



Early NMR from One Side

G. Eidmann, R. Savelsberg, P. Blümler, B. Blümich, *The NMR MOUSE: A Mobile Universal Surface Explorer*, **J. Magn. Reson. A 122** (1996) 104 – 109.

R. GF Paetzold, G. A. Matzkanin, A. De Los Santos, *Surface Water Content Measurement Using Pulsed Nuclear Magnetic Resonance Techniques*, **Soil Sci. Am. Soc. J. 49** (1985) 537 – 540; Unilteral NMR moisture sensors with electro magnets: B. J. Hogan, *One-Sided NMR Sensor System Measures Soil/ Concrete Moisture*, **Design News**, May 5 (1986).



NMR-MOUSE and Mobile Spectrometer

MObile Universal Surface Explorer

www.aixnmr.com; www.act-aachen.com

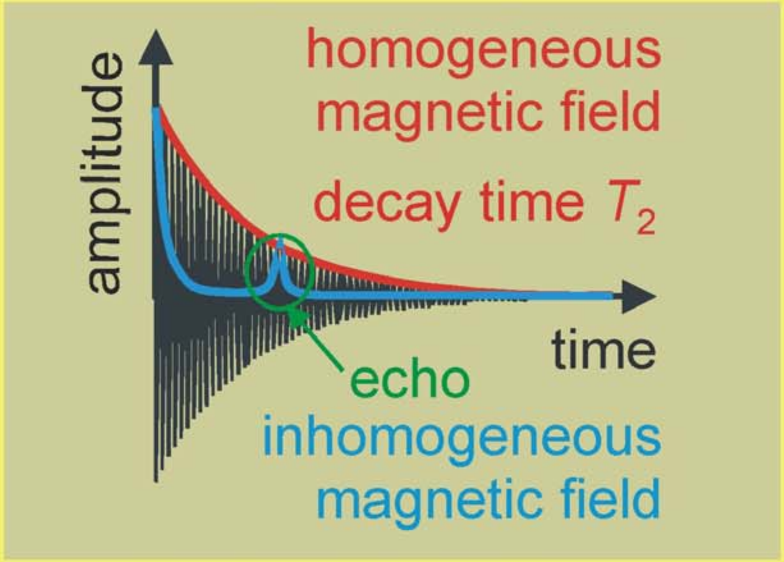
Bruker, Karlsruhe, Germany
ACT GmbH, Roetgen, Germany

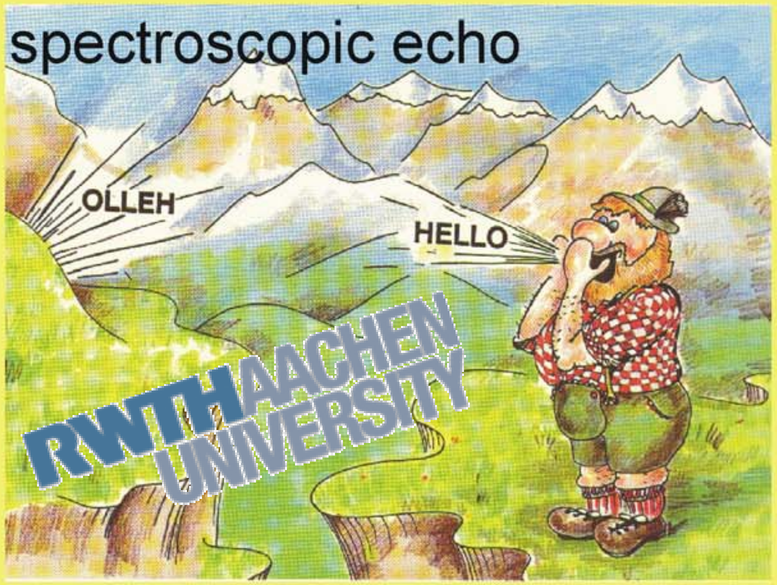
Magritec, Wellington, New Zealand
ACT GmbH, Roetgen, Germany

G. Eidmann, R. Savelsberg, P. Blümler, B. Blümich, *The NMR MOUSE: A Mobile Universal Surface Explorer*, **J. Magn. Reson. A 122**, 104 - 109 (1996)

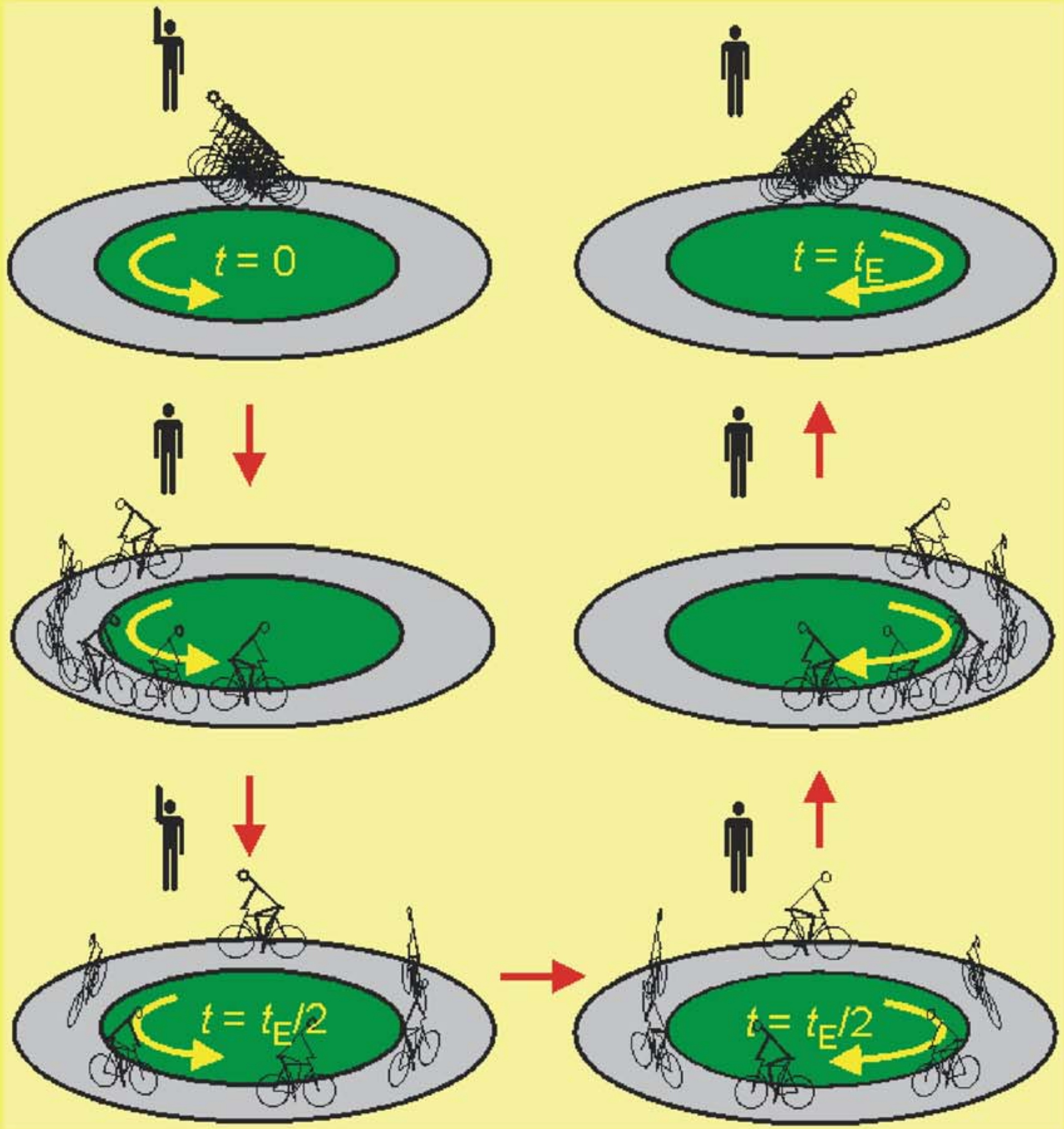
NMR in an Inhomogeneous Field

impulse response



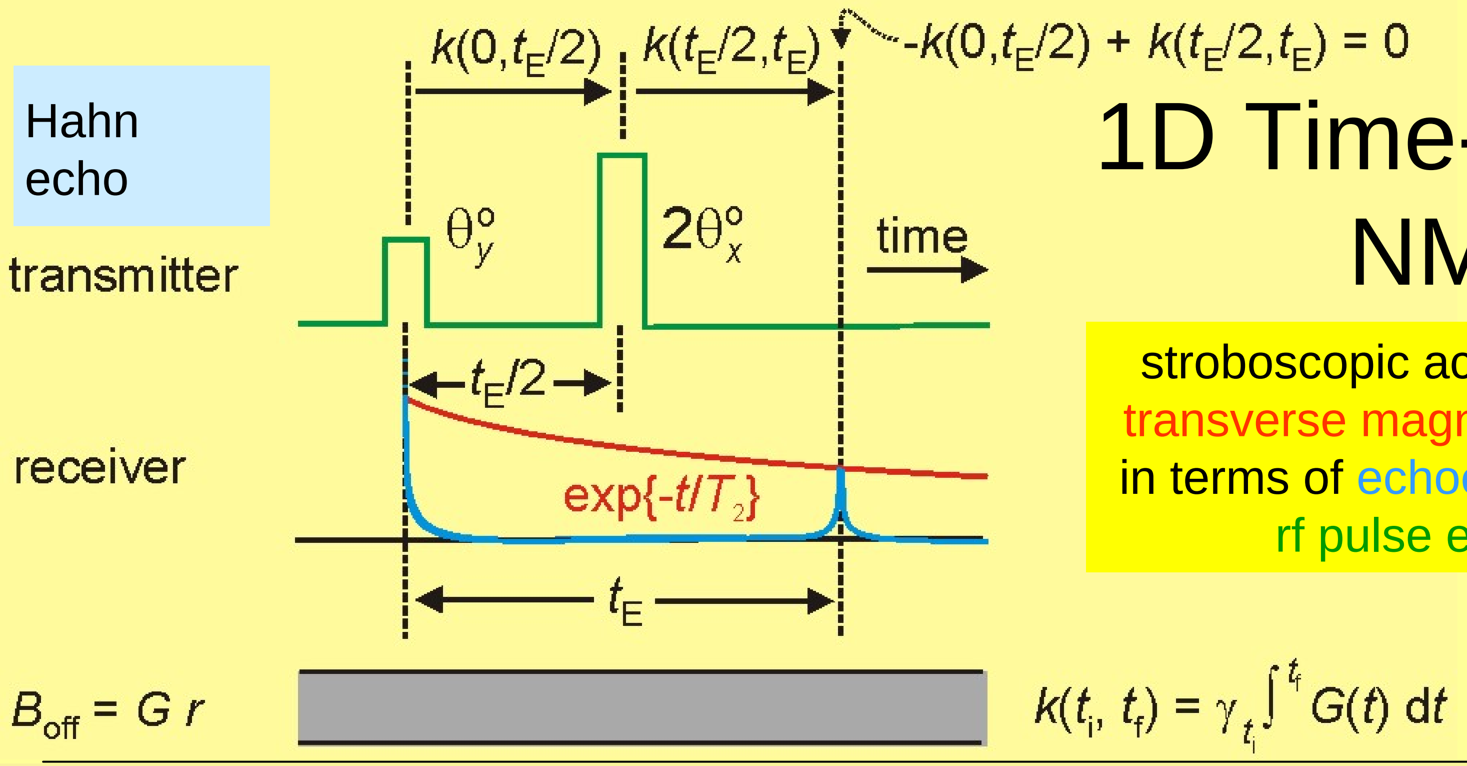


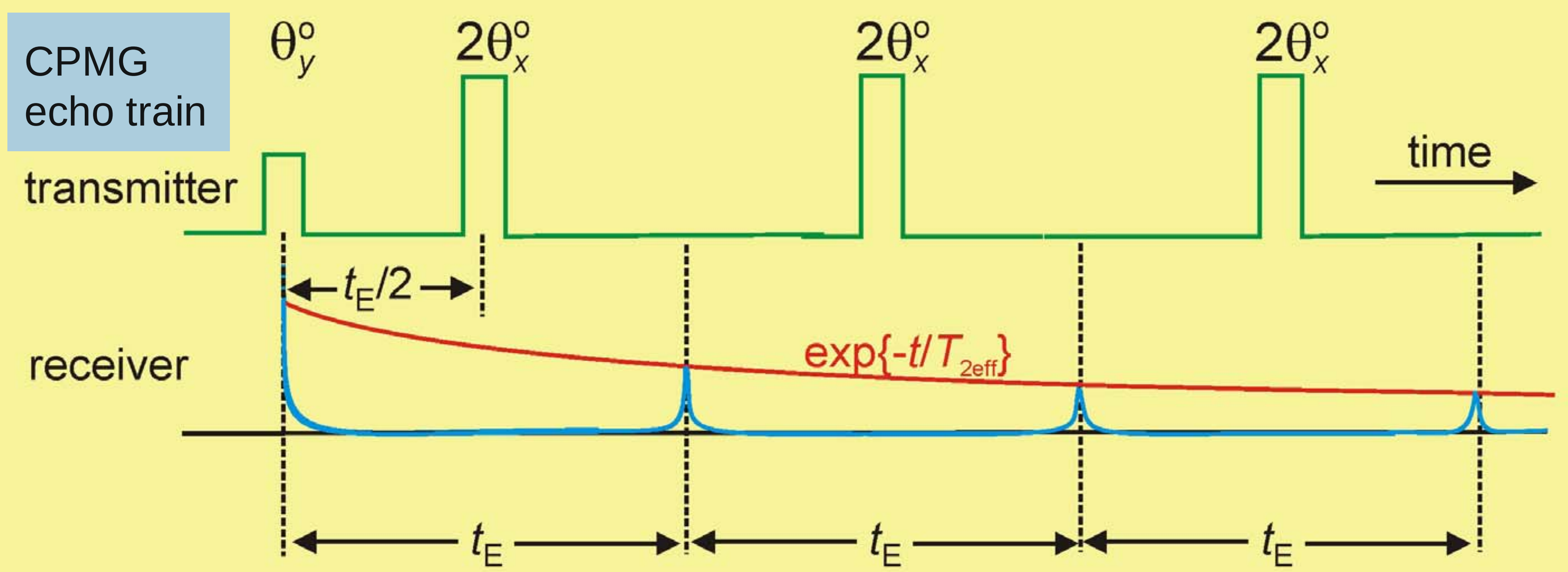
racetrack echo



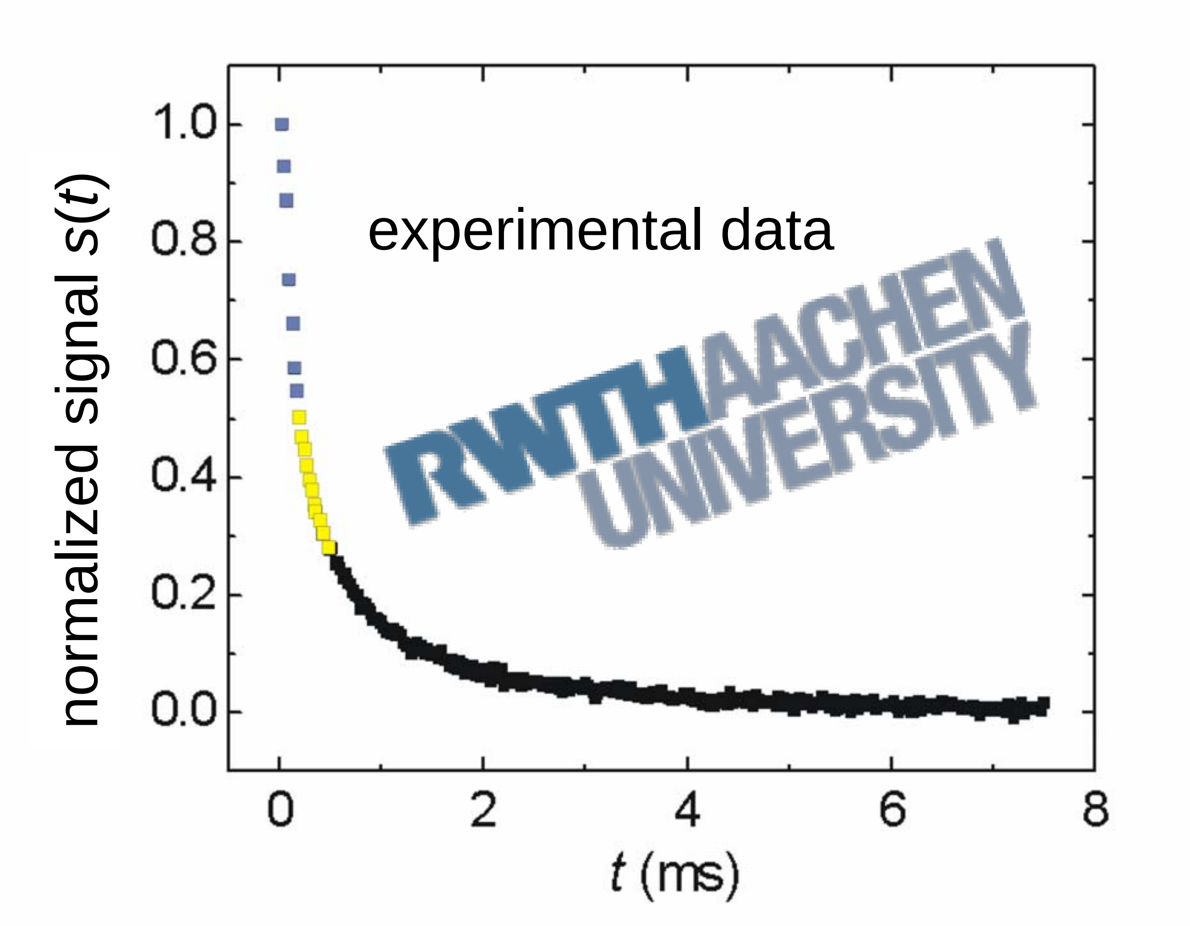
1D Time-Domain NMR

stroboscopic acquisition of the transverse magnetization decay in terms of echoes generated by rf pulse excitation





Analysis of CPMG Data



1) fit by a physical or mathematical model function, e. g.

$s(t) =$
$A \exp\{-(1/b)(t/T_{2\mathrm{eff}})^b\}$

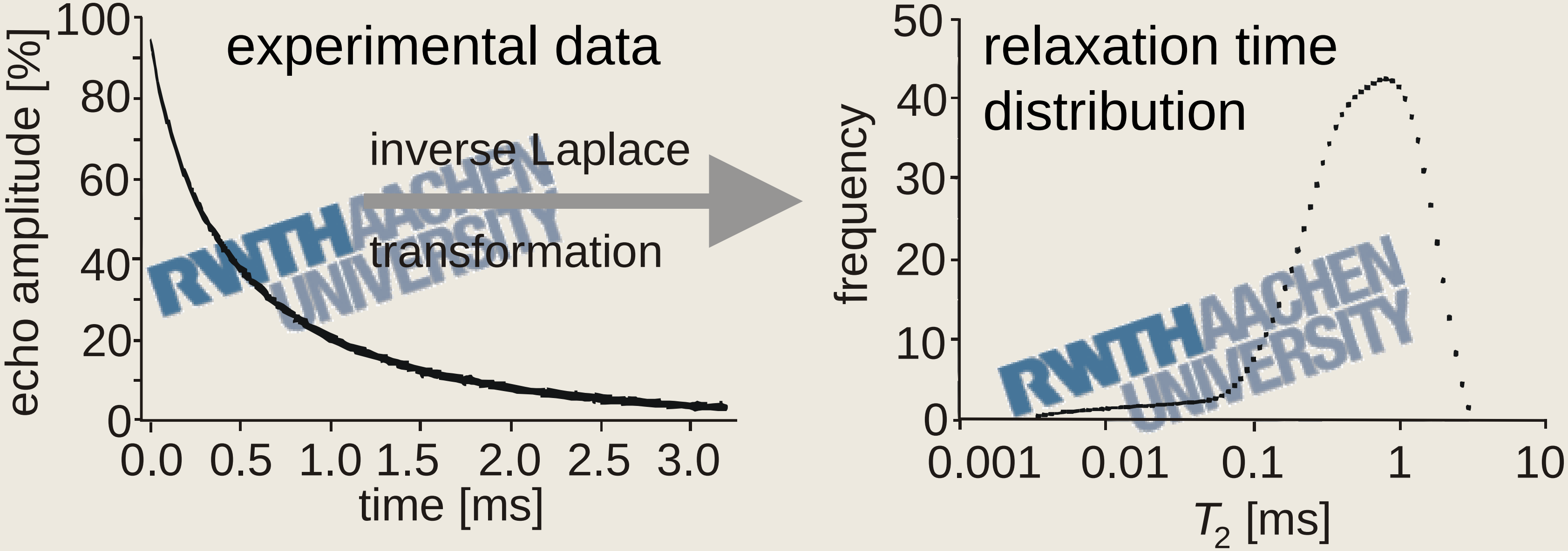
2) rapid data analysis without fit

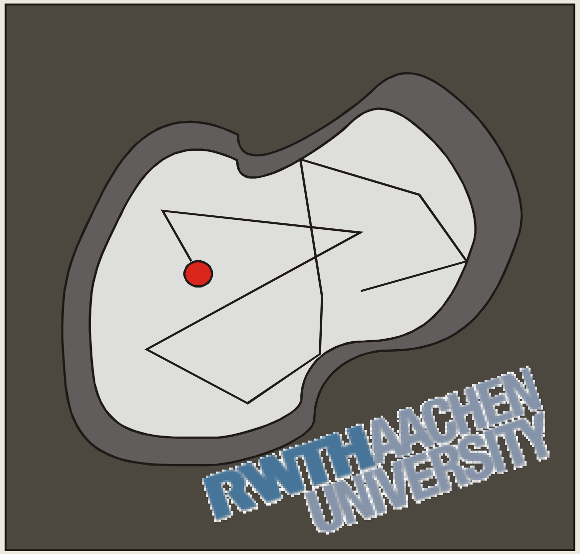
Definition of the relaxation parameter *w*:
w is an index of chain rigidity or crystallinity

$$w = \frac{\sum_{m,n} s(t_i)}{\sum_{p,k} s(t_i)}, \quad m < n < p < k$$

$$w \propto \frac{I_{\mathrm{crystalline}}}{I_{\mathrm{amorphous}}} = \frac{I_{\mathrm{crystalline}}}{100 - I_{\mathrm{crystalline}}}$$

Relaxation Time Distributions





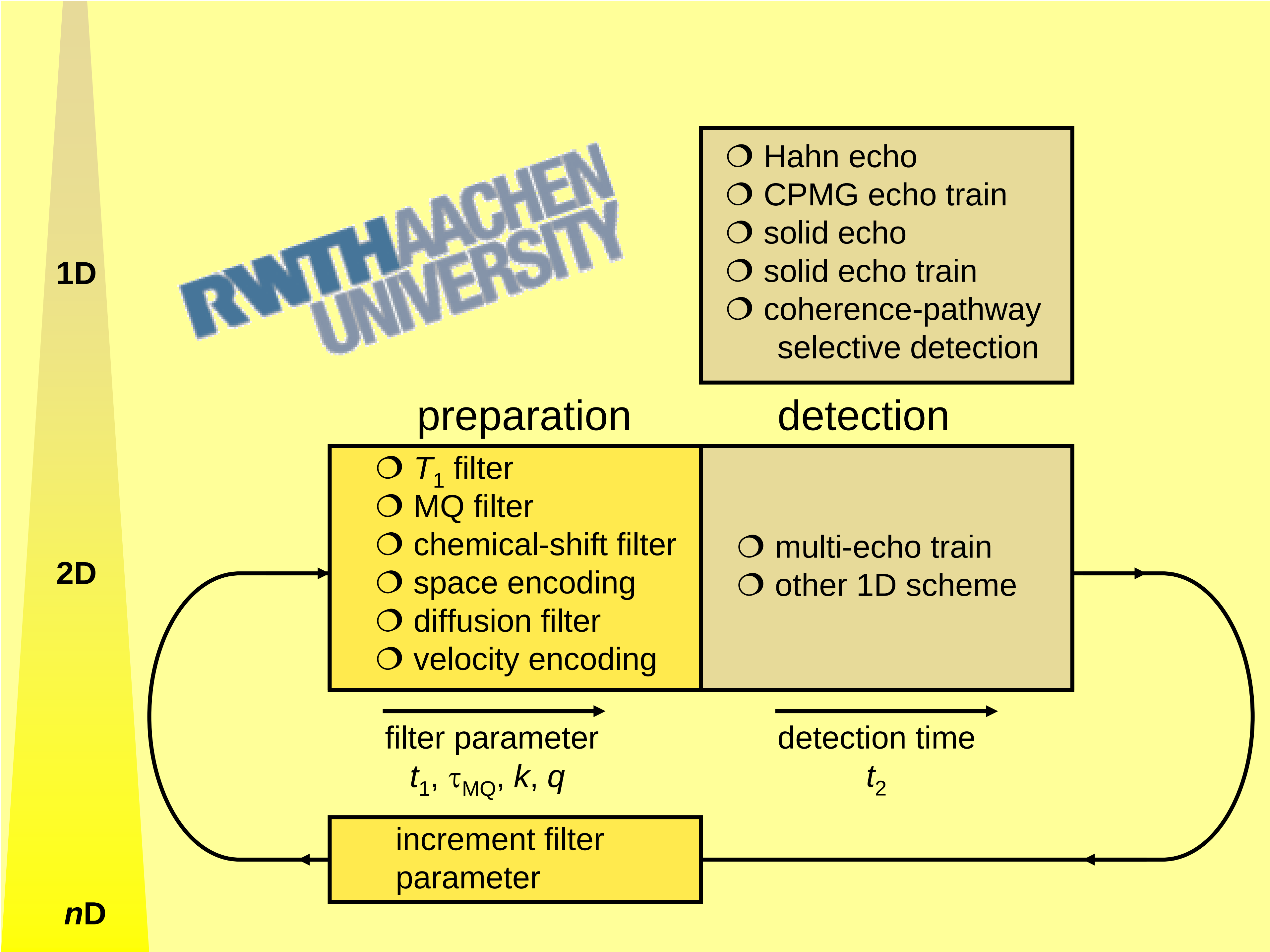
surface relaxation of fluids in in porous media:

$$\frac{1}{T_{2,\mathrm{CPMG}}} = \frac{1}{T_{2,\mathrm{bulk}}} + \rho_2 \frac{S}{V} + \frac{D\,(\gamma\, G\, t_E)^2}{12}$$

$$\frac{1}{T_1} = \frac{1}{T_{1,\mathrm{bulk}}} + \rho_1 \frac{S}{V}$$

S: surface area
V: pore volume
ρ: surface relaxivity
t_E: echo time

G. R. Coates, L. Xiao, M. Prammer, *NMR Logging*, **Halliburton Engery Services**, Houston, 1999.


1D
2D
nD
RWTH AACHEN UNIVERSITY
❍ Hahn echo
❍ CPMG echo train
❍ solid echo
❍ solid echo train
❍ coherence-pathway selective detection
preparation
detection
❍ T_1 filter
❍ MQ filter
❍ chemical-shift filter
❍ space encoding
❍ diffusion filter
❍ velocity encoding
❍ multi-echo train
❍ other 1D scheme
filter parameter
t_1, τ_{MQ}, k, q
detection time
t_2
increment filter parameter