



## Evaluation of NMR and other soil water content measurement methods at the point and field scale

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EGU General Assembly (2020) May 4-8, 2020

HS1.1.3. Innovative methods for non-invasive monitoring of hydrological processes from field to catchment scale

# goals & research questions



- comparison of different soil moisture measurement techniques at the point scale under field conditions
  - Time Domain Reflectometry (TDR)
  - Cosmic-Ray Neutron Sensing (CRNS)
  - Gravimetric soil samples
  - surface-NMR
- what can we learn about spatial variability of soil moisture combining these methods at the field scale?



CRNS

Steffen Zacharias



## Methods & devices

- NMR:
  - projection of static and pulsed oscillating magnetic field into the ground
  - detection of changes in the magnetic field caused by mobile & immobile hydrogen atoms
  - using four frequencies for varying depth
- TDR (3 devices):
  - Campbell HydroSense II
  - Imko HD2 with TRIME-PICO 32 Sensor
  - Campbell TDR 100
- gravimetric soil samples
- two different sites in Germany:
  - Volleyballfield (Sand) - with irrigated and dry points
  - Bad Lauchstaedt - with irrigated and dry points



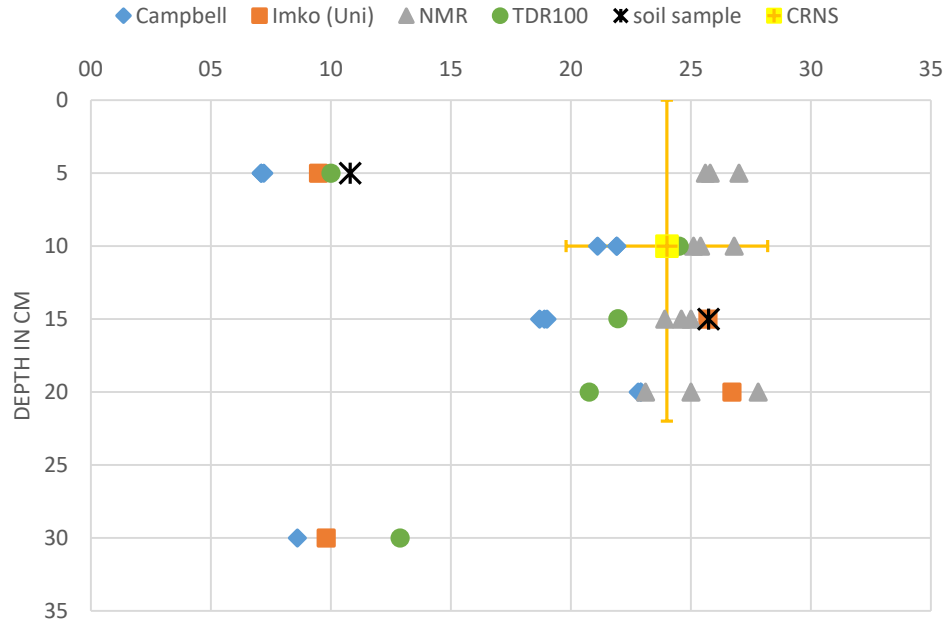
NMR:

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# Volleyballfield – first test



## Point 1 irrigated VWC %



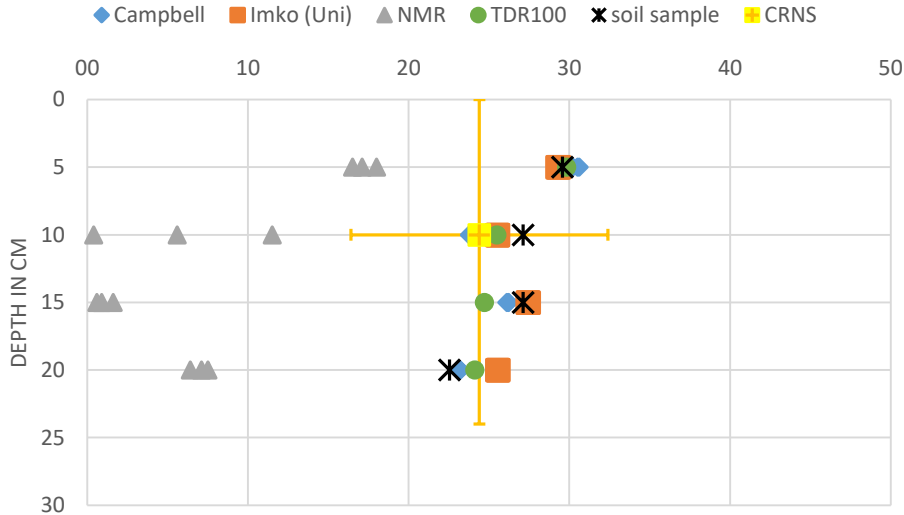
- good agreement of all techniques at depth from 10-20 cm
- NMR and CRNS overestimate volumetric water content (VWC) at the very shallow layer due to integration aspects

CRNS values as integrated depth: 0 – X cm

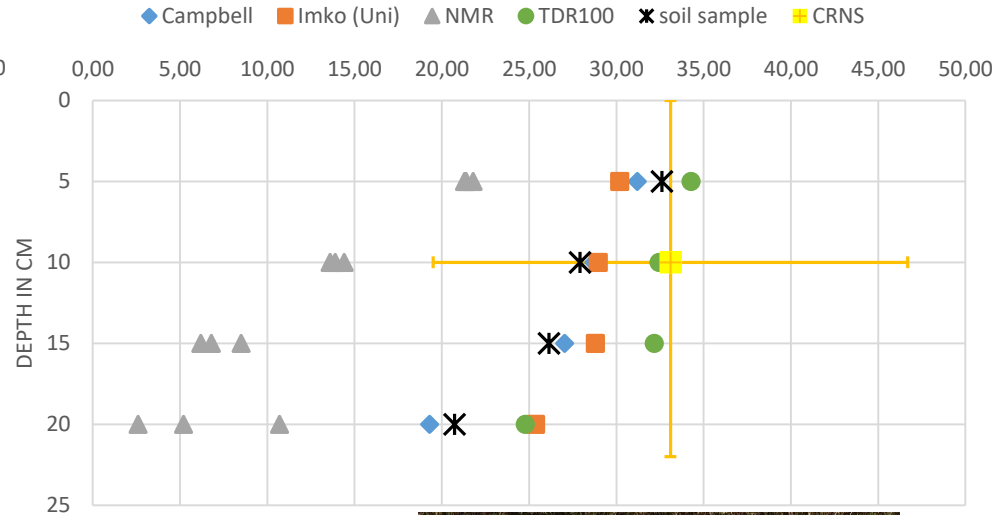
# Bad Lauchstaedt – irrigation experiment

- Irrigated area per point: 3x3 m
- BL-45 wet: 45 liter
- BL-65 wet: 65 liter

## BL-45-WET VWC %



## BL-65-WET VWC %



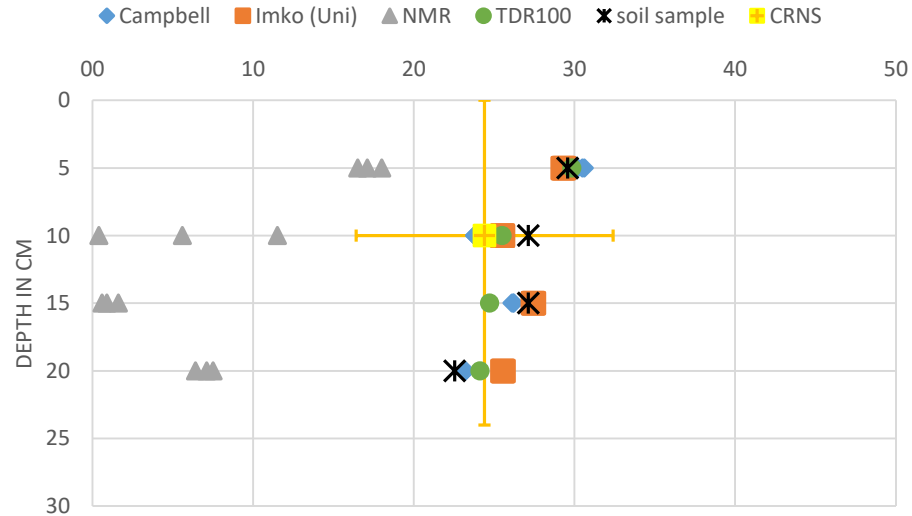
Soil texture:

Depth in cm	Sand %	Silt %	Clay %
0-10	6.4	67.2	26.5
10-30	6.2	66.5	27.3

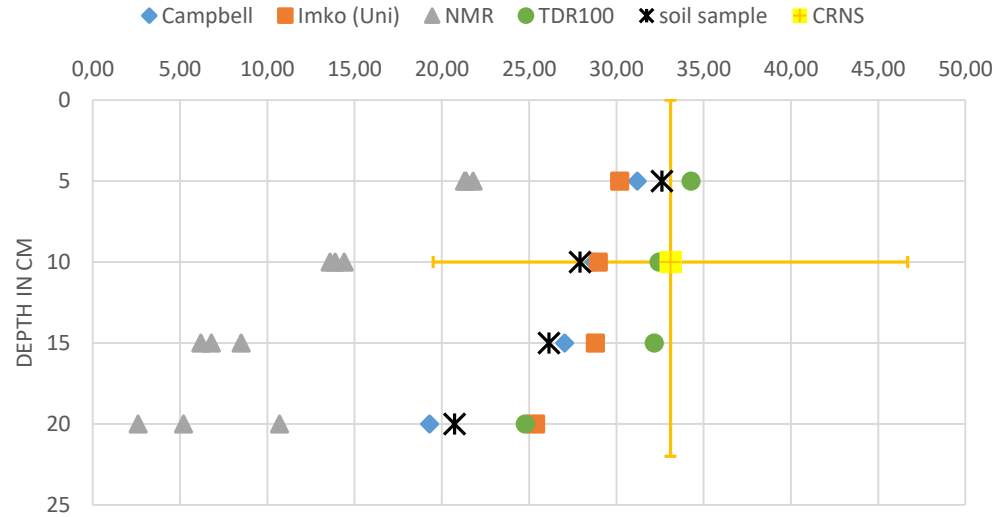


# Bad Lauchstaedt – irrigation experiment

## BL-45-WET VWC %



## BL-65-WET VWC %

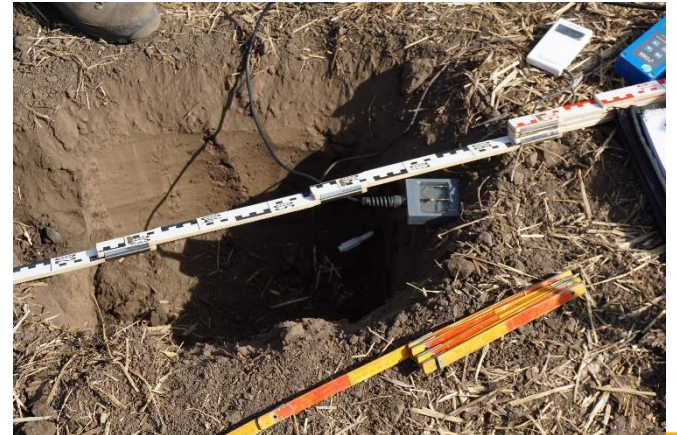


- good agreement of TDR and gravimetric method at all depth
- CRNS fits well with VWC with low vertical changes – in case of vertical variation of VWC overestimation of deeper layers due to integration aspects
- consistent understimation of VWC by NMR due to technical issues



## conclusion & perspective

- TDR in good agreement with in situ measured soil water content with core samples
- CRNS in good agreement with other methods as long as no vertical changes of water content occur
- NMR: probably thermally caused disturbances in NMR device exposed air temperatures around 30°C and direct sunlight
  - repeated NMR measurements required
- continuing investigation of spatial CRNS and EMI data with TDR and soil samples



Steffen Zacharias