Experimental Possibilities for nano/micro-Fe Research in VEGAS

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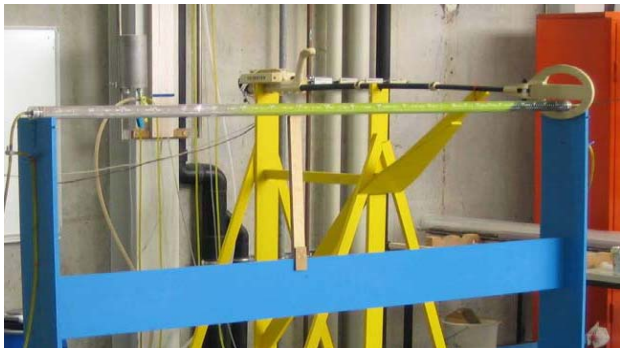
Opening

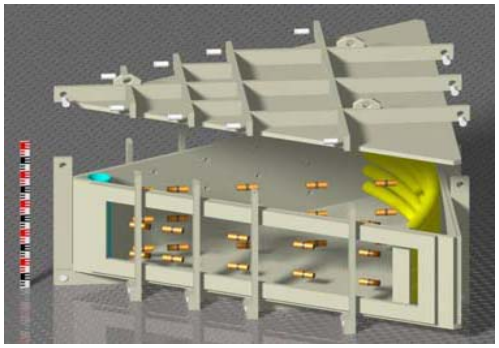
Research of ZVI-particles in the subsurface – Possibilities at VEGAS

Transport



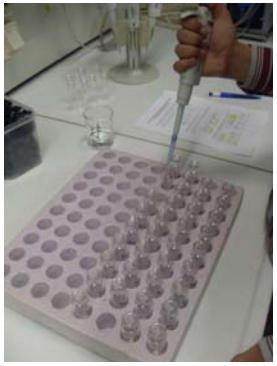
Columns (1D)

Flume (2D)



Large Scale (3D)

Reactivity



Batch

Columns

Experimental Methods to determine Reactivity: Batch

- Closed system
- Thermodynamic equilibrium
- Maximum contact between components
- With or without matrix material
- Variation of single parameters
- Suitability of reactant
- Side reactions or incomplete break down

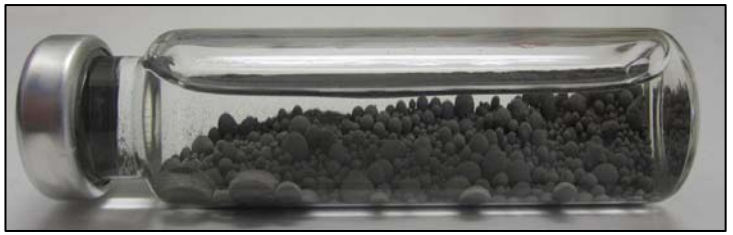
Information Obtained from Batch with Fe^0

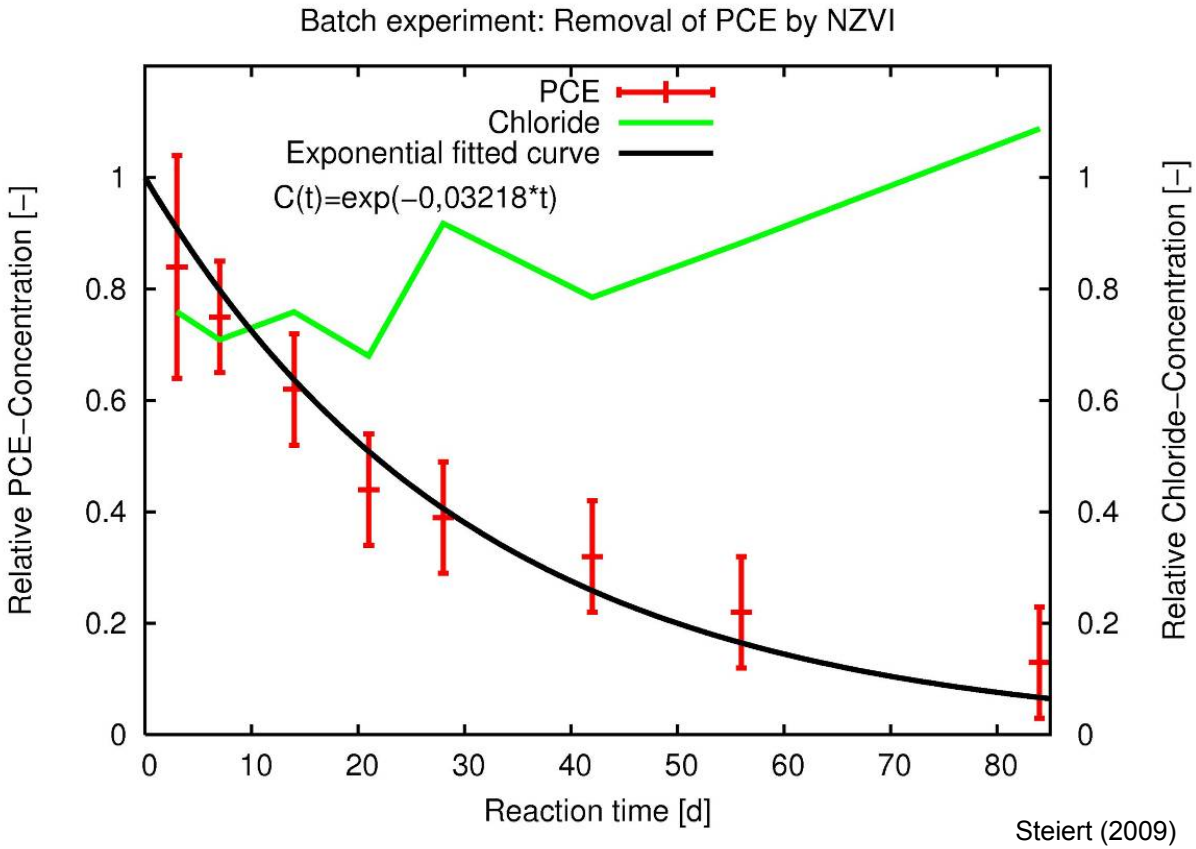
Removal of 50 mg/l PCE with 1 g/l Fe^0

$$C_2Cl_4 + 4\,Fe^0 + 4\,H_2O \rightarrow C_2H_4 + 4\,Fe^{2+} + 4\,Cl^- + 4\,OH^-$$

Data of Batch-Experiments

- to produce fast
- to understand easily

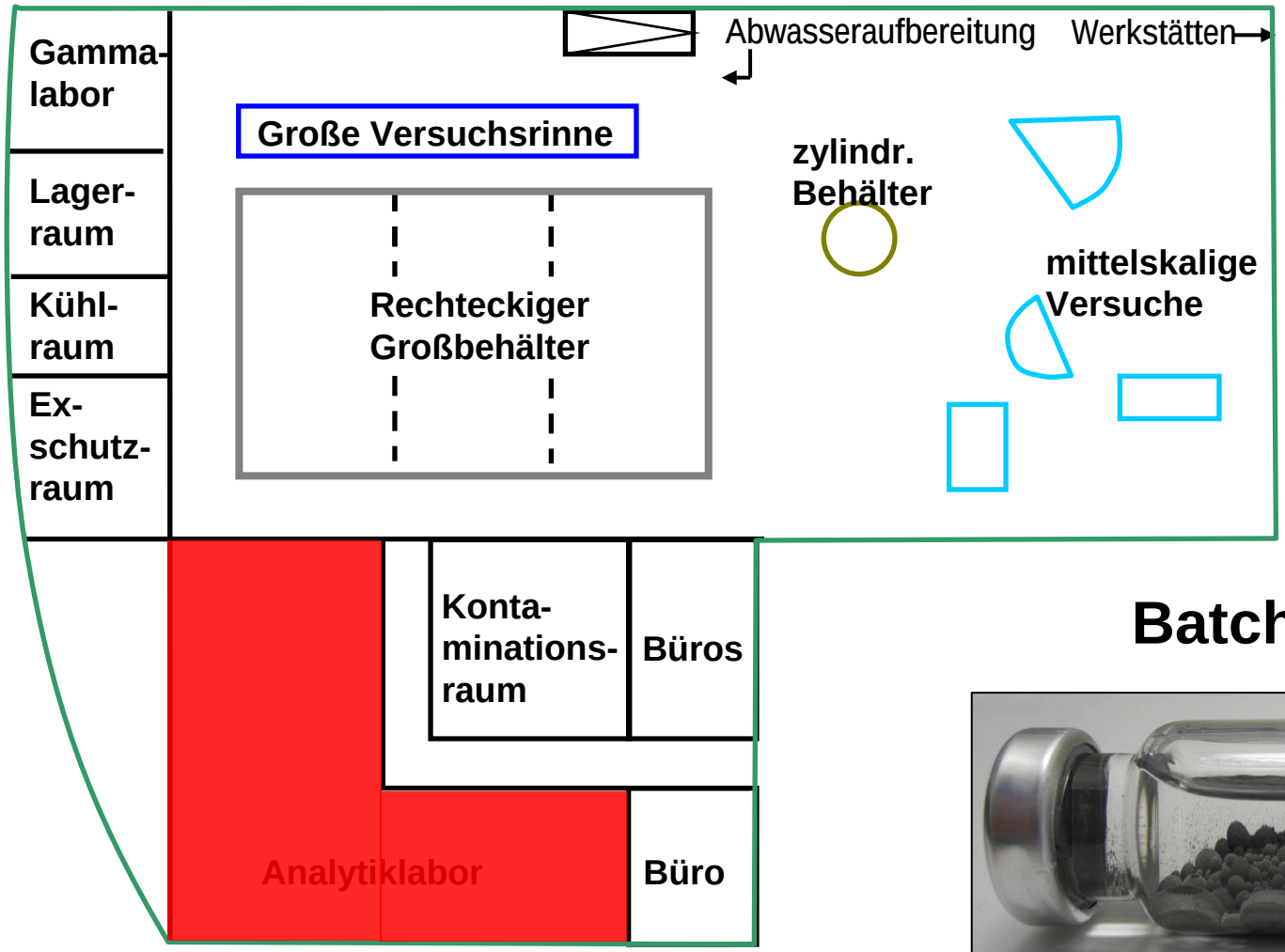


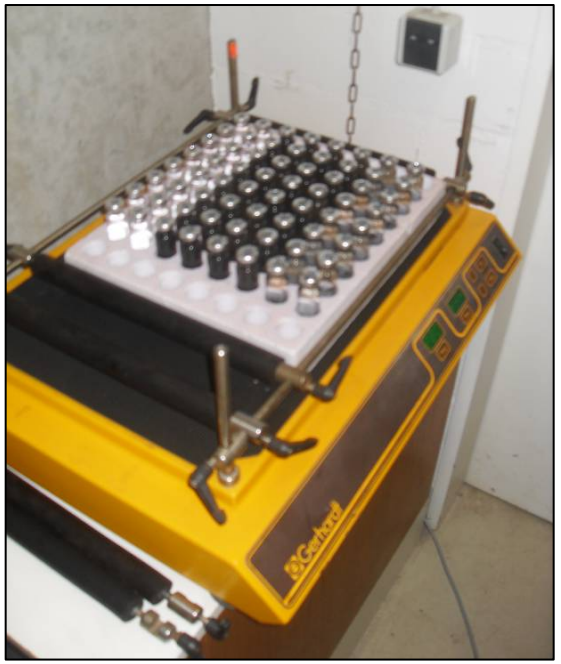


Steiert (2009)

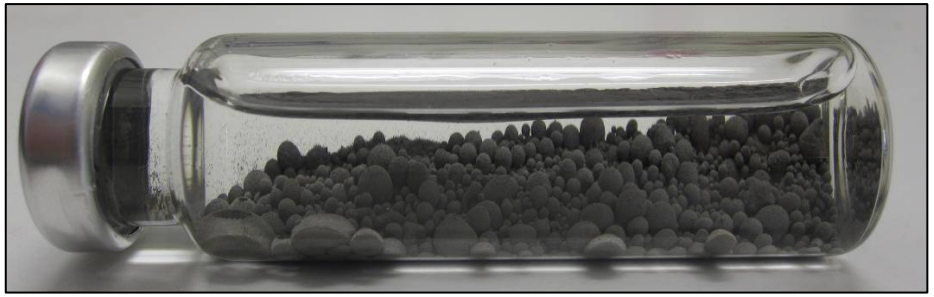
Experimental ZVI Methods in VEGAS: Batch

Layout Plan of VEGAS



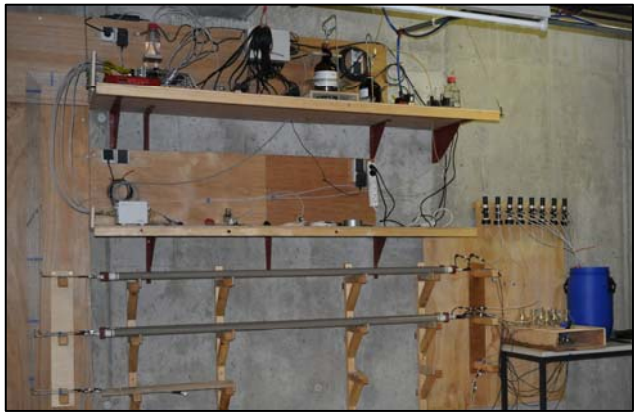


Batch-Experiments



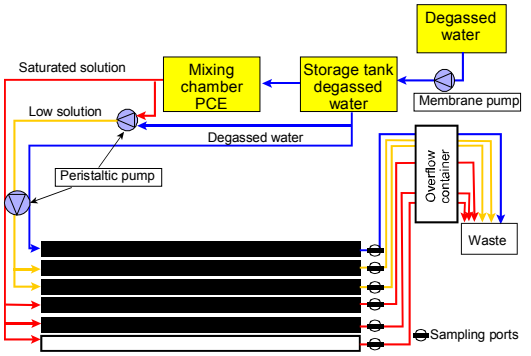
Column Experiments – Reactivity

Simulation of different remediation techniques:



Long term experiments without NAPL phase

→ Simulation of a reactive barrier (plume remediation)



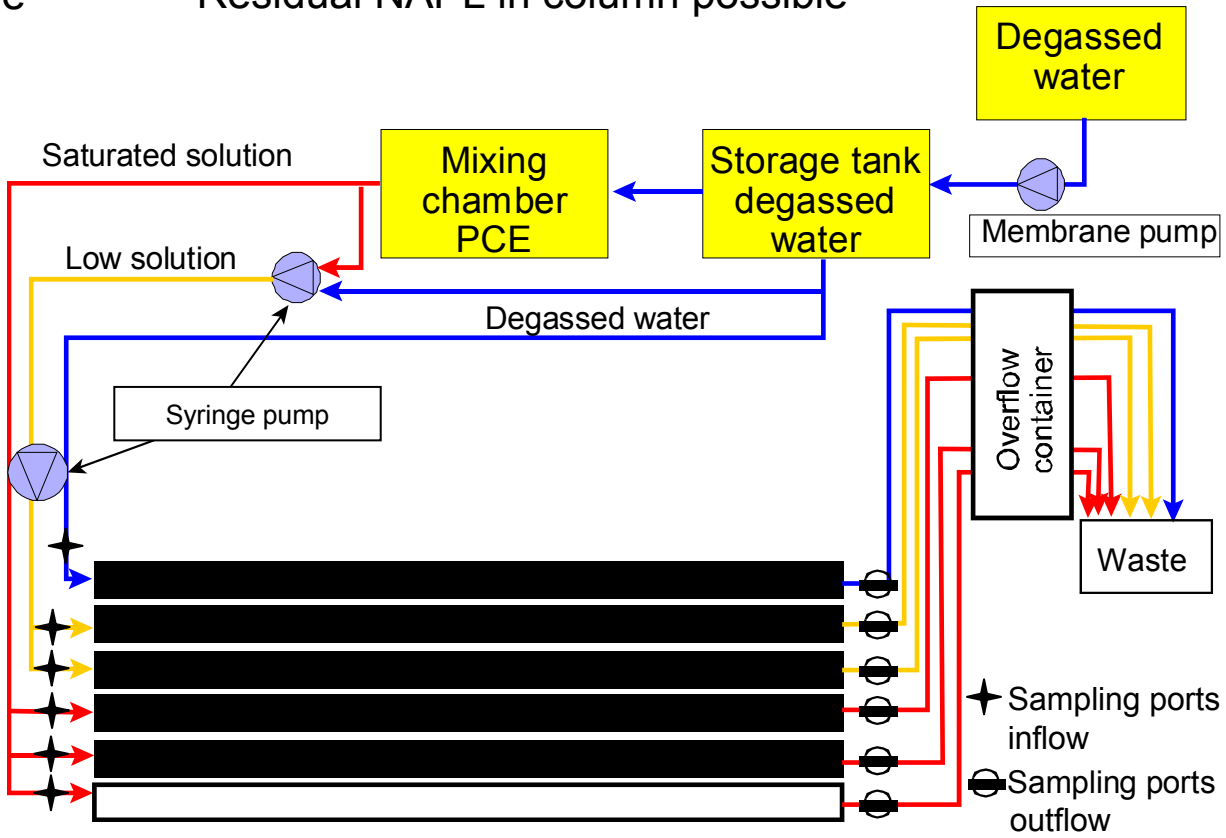
Long term experiments with NAPL phase

→ Simulation of a source zone remediation

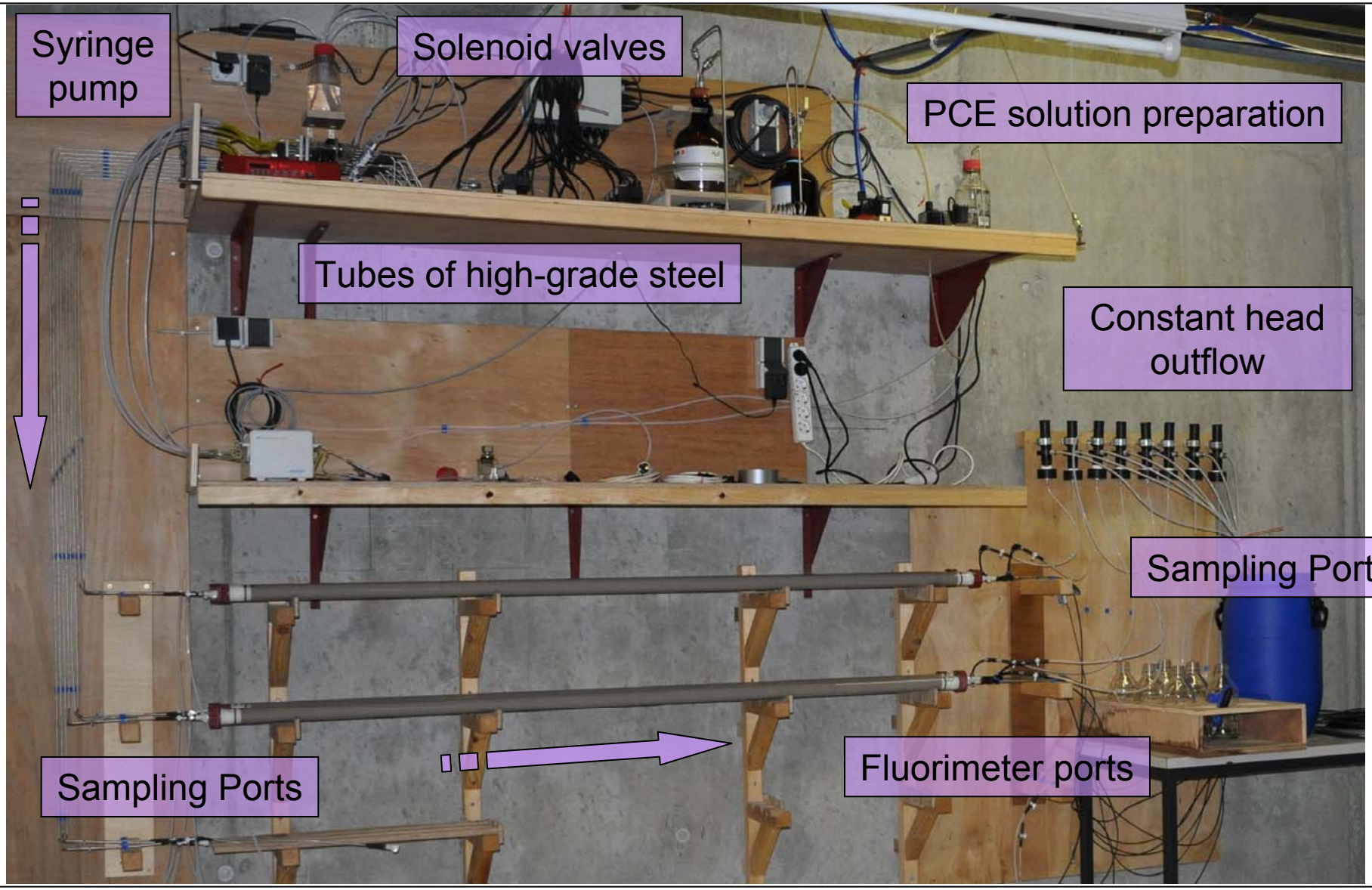
Column Experiments – Reactivity

Variable Boundary and Initial Conditions

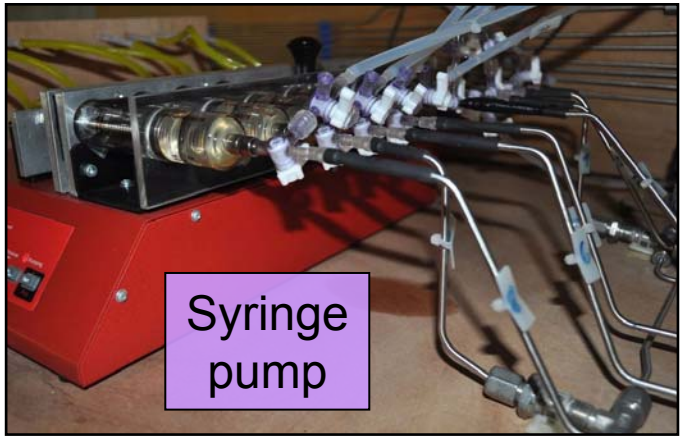
- Concentration of contaminant variable
- Additional components in water possible
- Addition of slaked lime to increase pH
- Fe^0 injected in the column
- Matrix premixed with Fe^0
- Continuous flow of water
- Contact time variable through flow rate
- Residual NAPL in column possible



Column Experiments – Reactivity



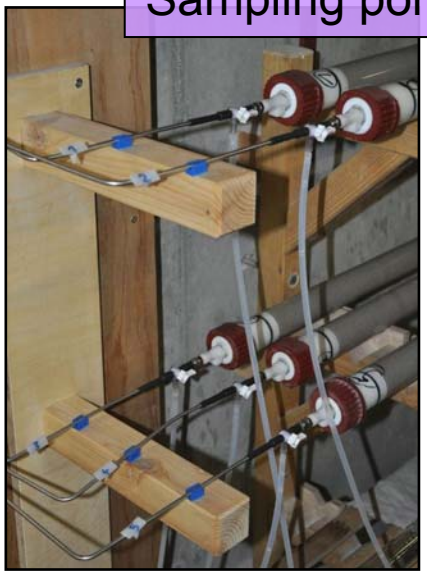
Column Experiments – Reactivity



Solenoid valves

PCE solution preparation

Sampling ports inflow



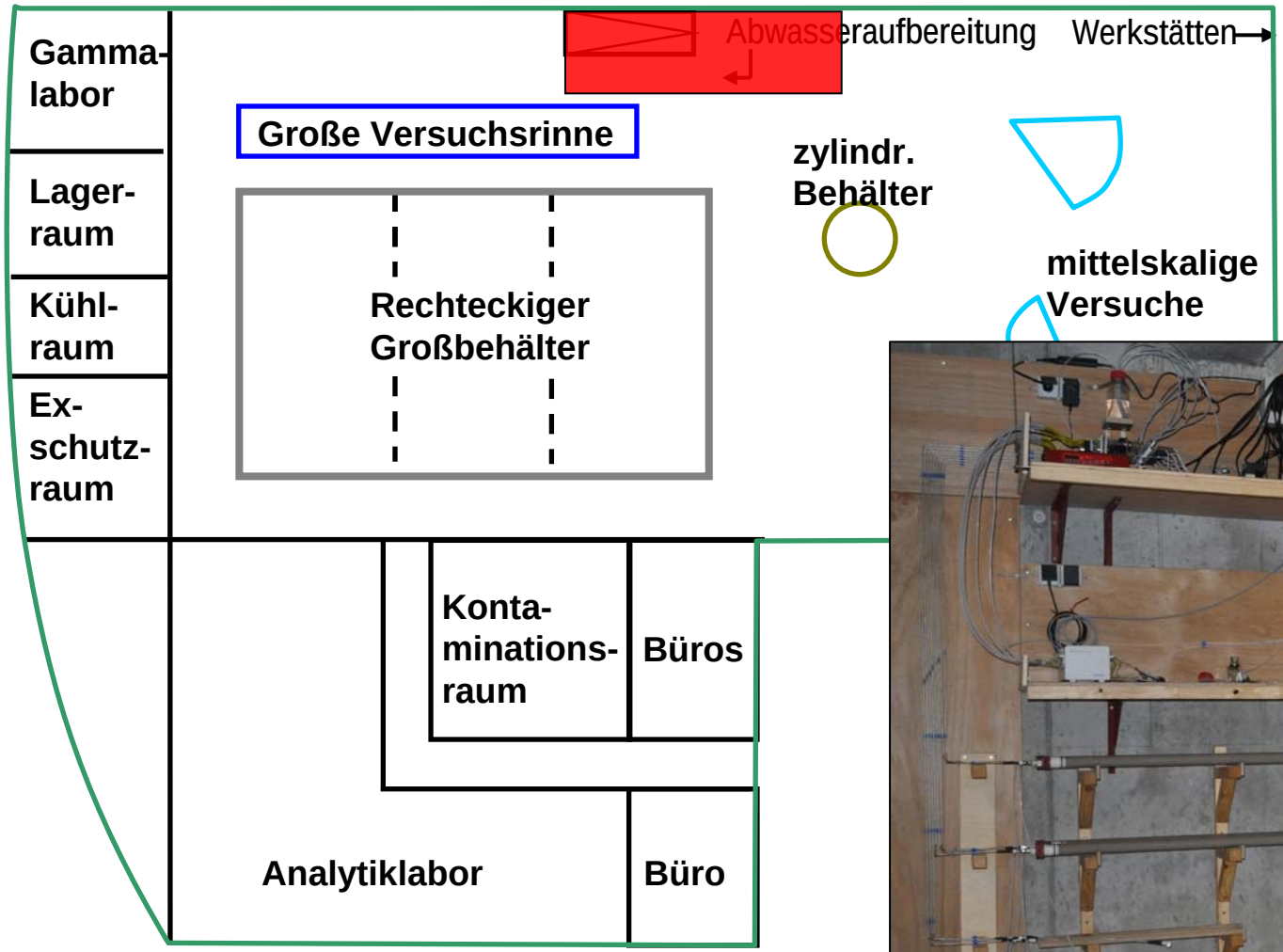
Sampling ports outflow

Fluorimeter ports

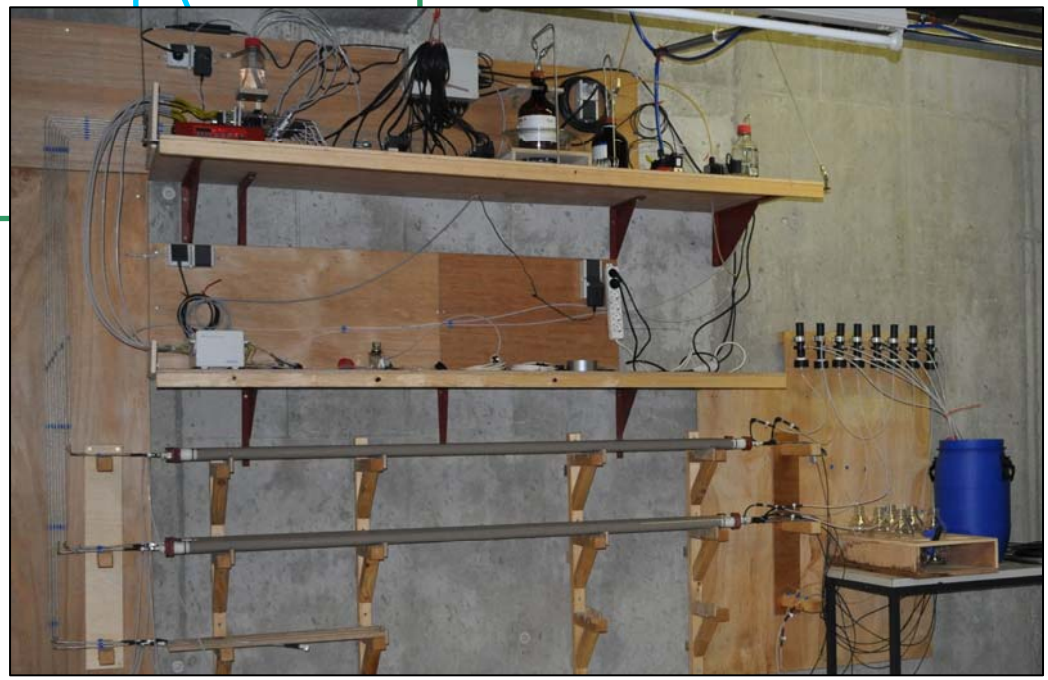
Constant head outflow

Experimental ZVI Methods in VEGAS: Column-Exp. – Reactivity

Layout Plan of VEGAS



Column-Experiments Reactivity



Column Experiments – Transport

Detection of changes in magnetic susceptibility

+ Uses modified commercially available metal (mine) detecter
+ High temporal and spatial resolution
+ Objective, quantitative reading
+ Total Fe^0: in suspension and attached to soil
± Integration of Fe^0 distribution due to influence of Fe^0 presence in direct vicinity of sensor

Column Experiments – Transport

Detection of Nano-Iron in the Subsurface

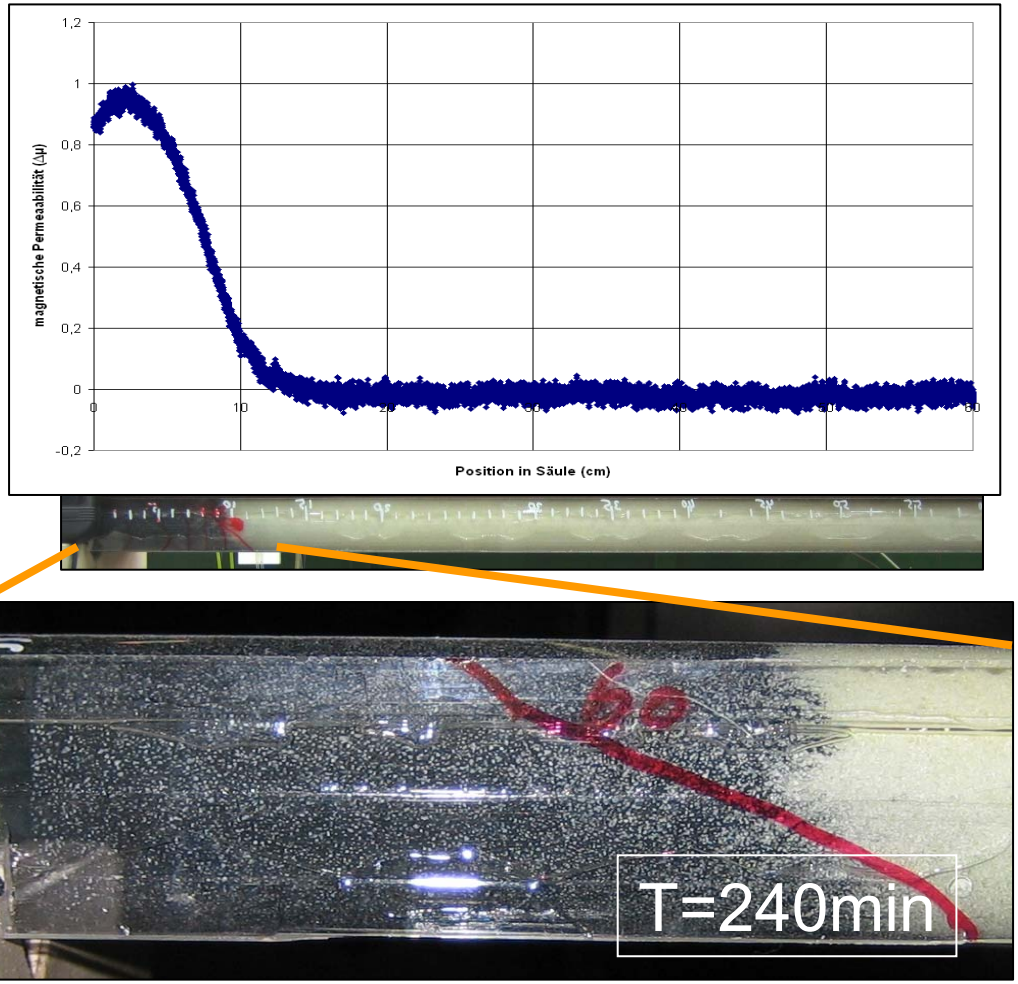
Geogenic iron content approx. 55 mg/cm³

➔ Analytical measurements not possible

Measurement technology needs to detect small concentrations of iron (mg/kg-range)

Measure non-destructive temporal variations of iron content

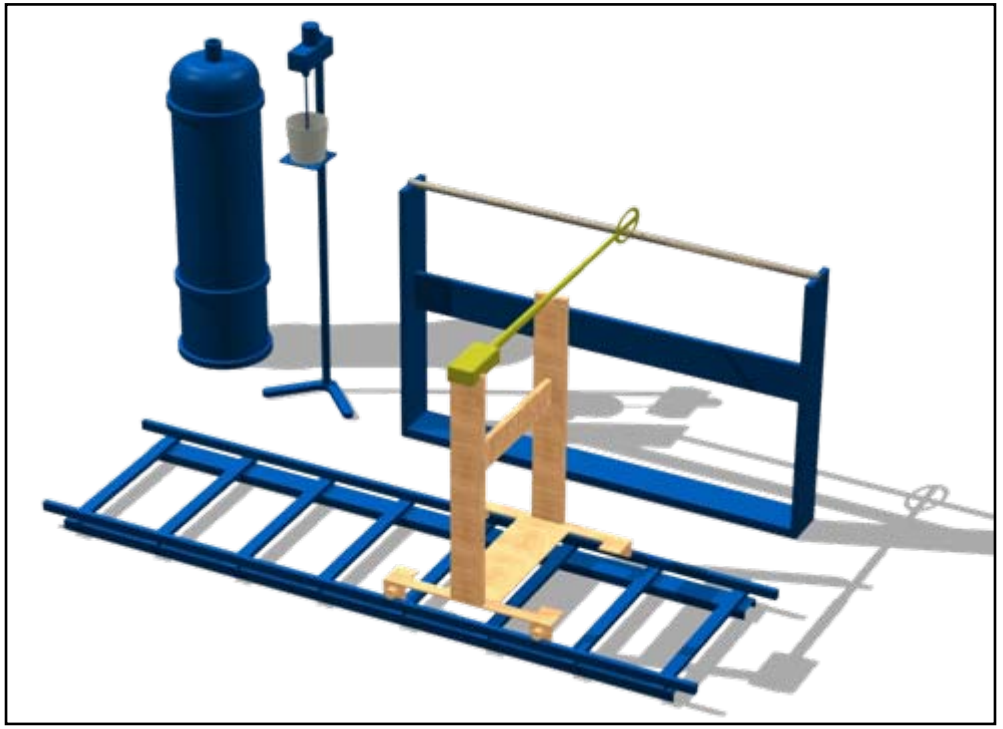
➔ Visual observation not sufficient; color nuances too small



Column Experiments – Transport

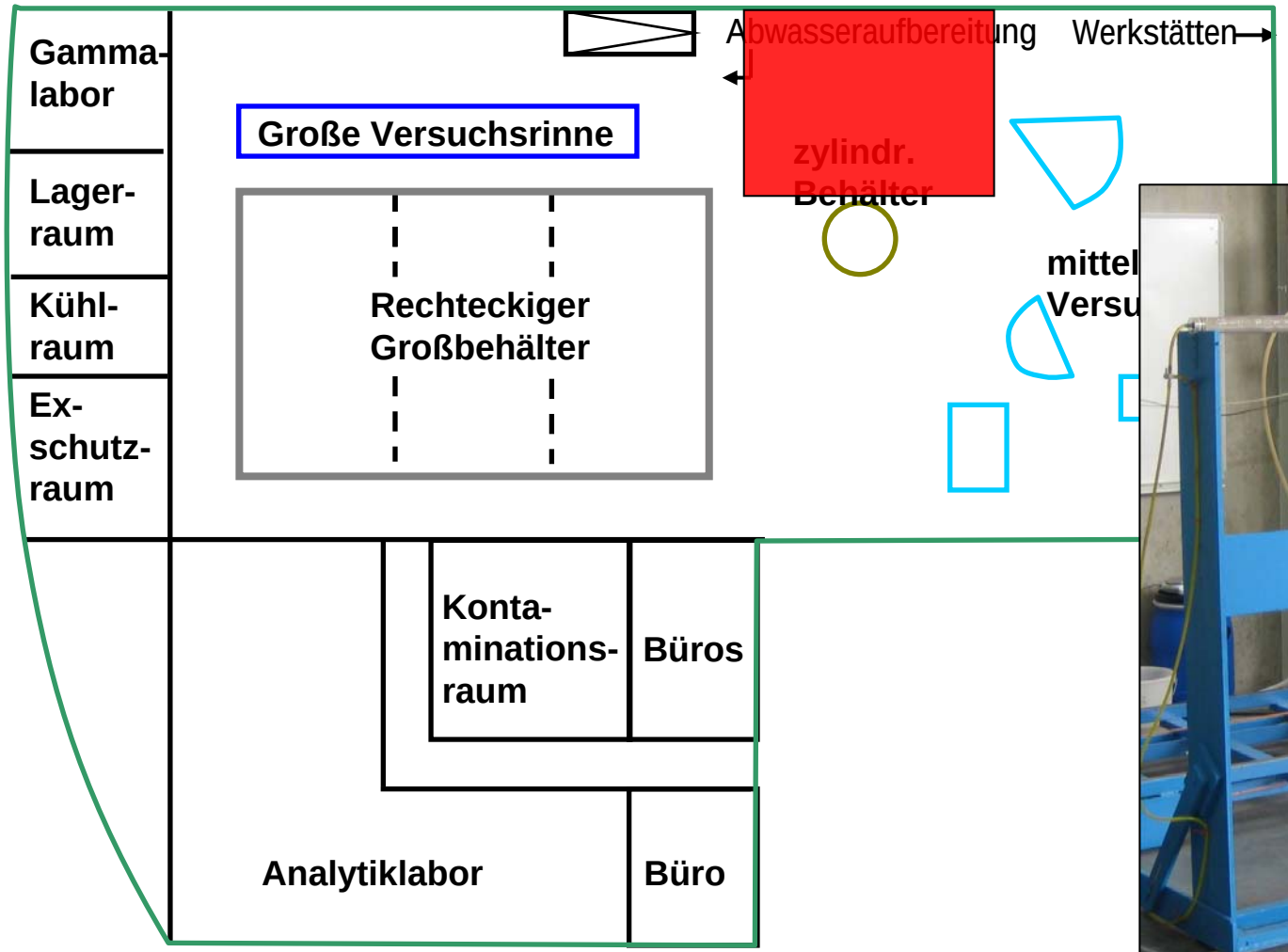
Parameters varied

- Concentration of nano-iron in suspension
- Flowrate
- Pre-treatment of suspension
- Grain size and grain size distribution



Experimental ZVI Methods in VEGAS: Column Exp. – Transport

Layout Plan of VEGAS

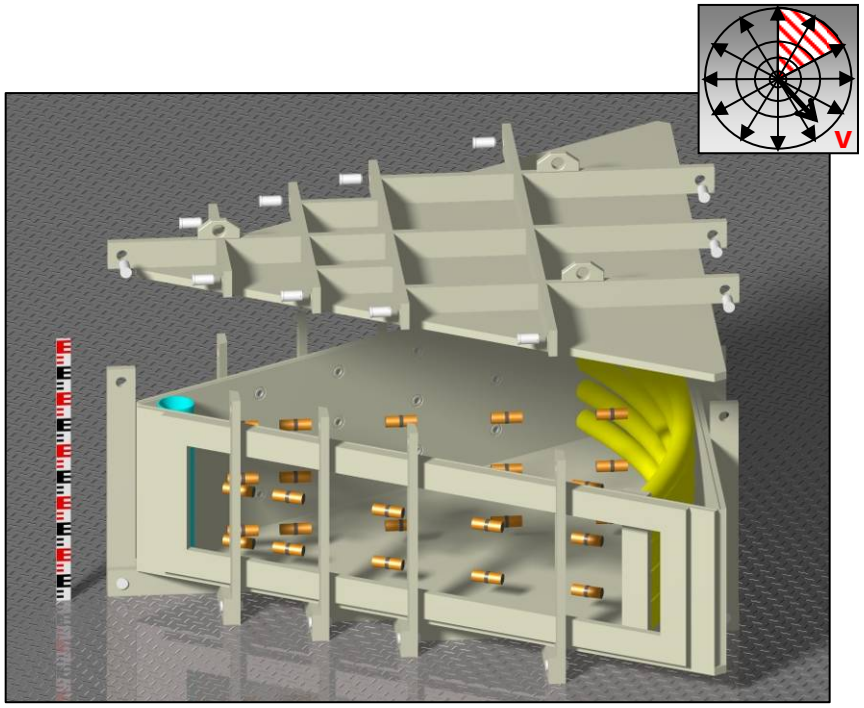


Column-Experiments Transport

Large Scale Experiment

- 60° triangular container to simulate the nZVI injection in a confined aquifer

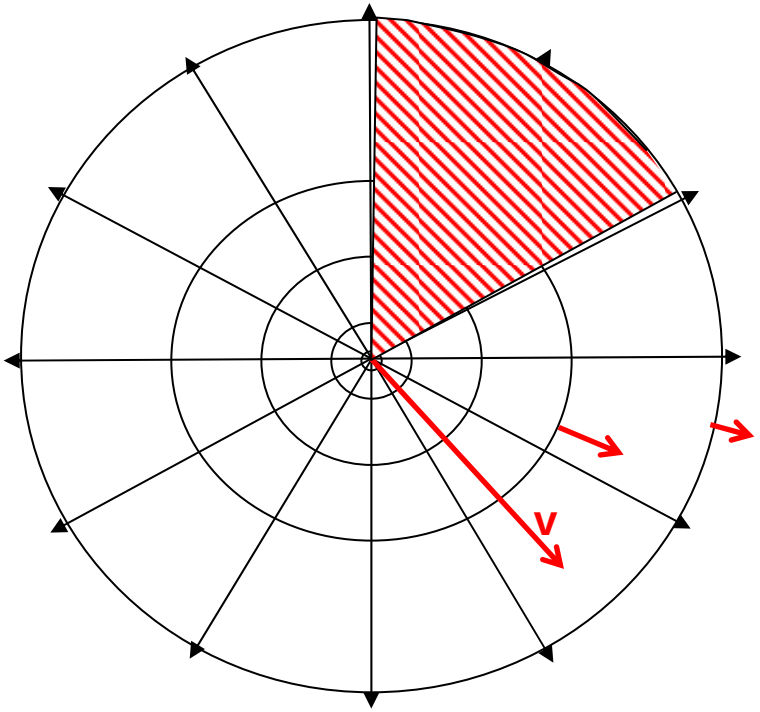
- In-situ sensors record Fe-BTC at different locations during injection

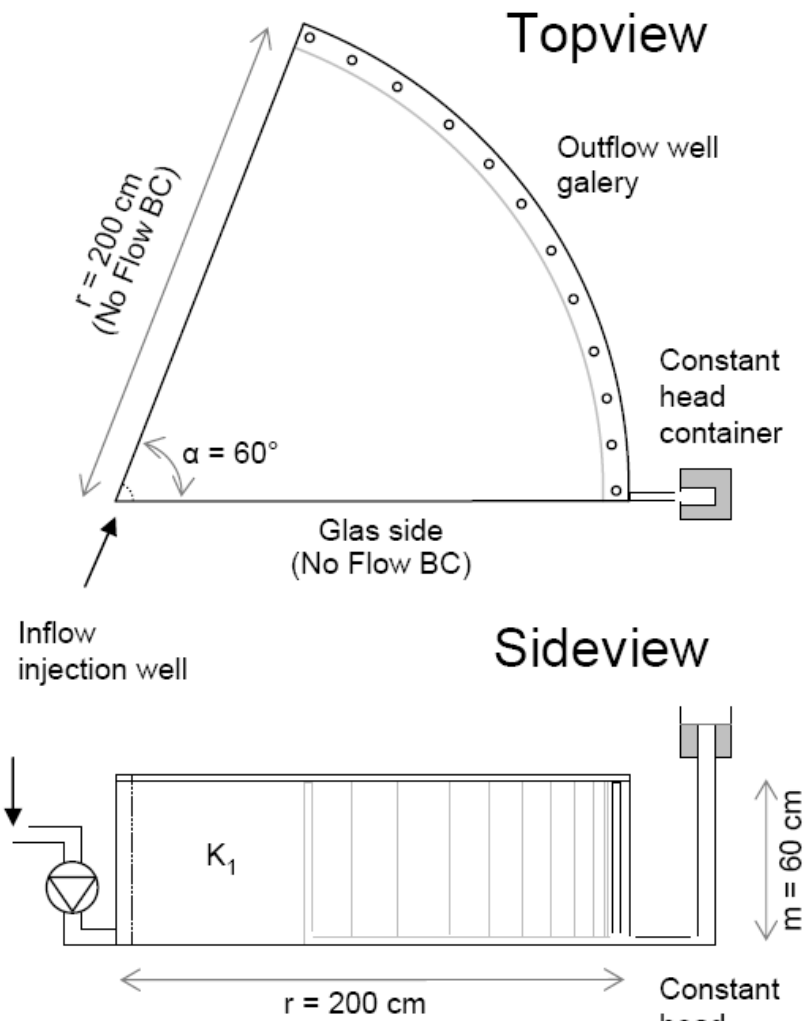


3D drawing of the container

(r: 2 m, α: 60°, h: 0.6 m)

Large Scale Experiment



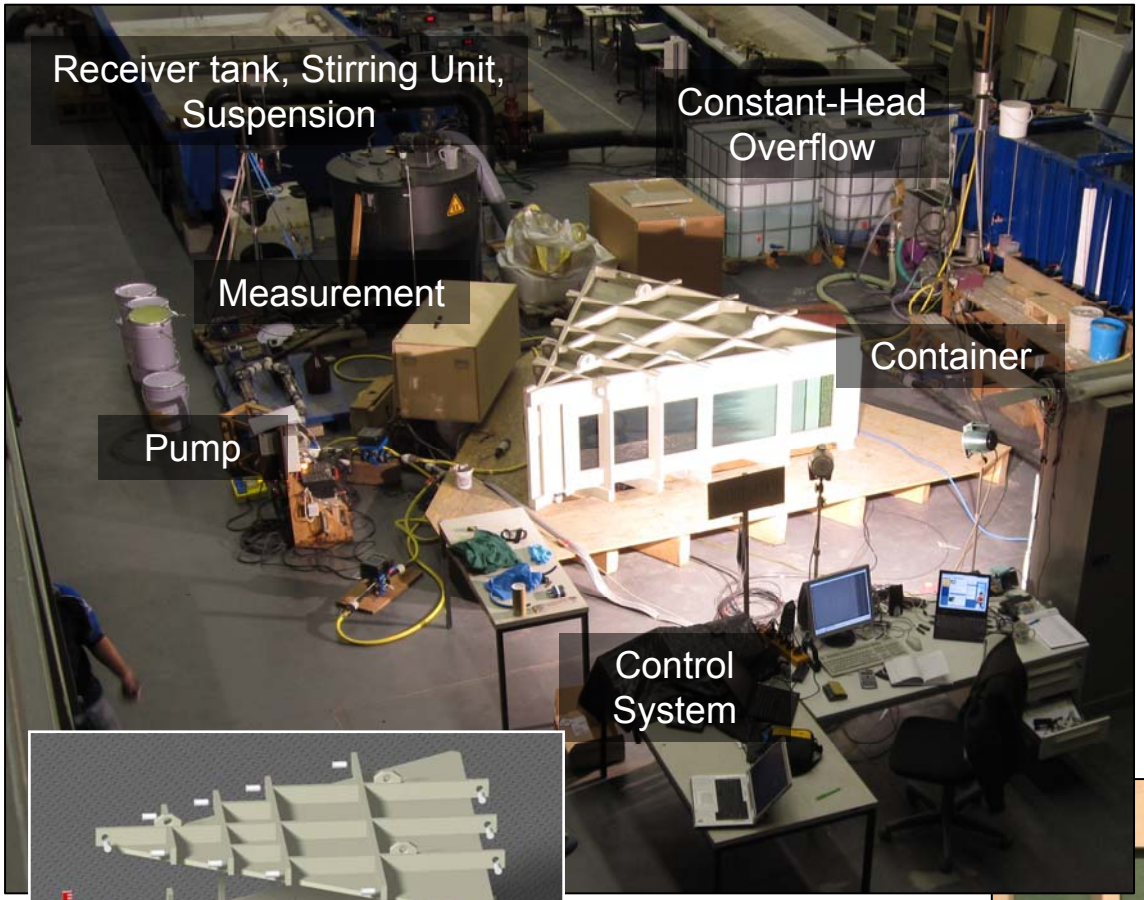


Large Scale Experiment

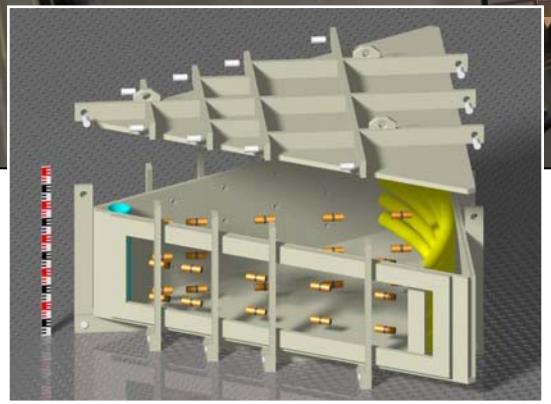
r = 200 cm - h = 60 cm - Q=500 l/h

Injection of nZVI in a container with a radial flow field

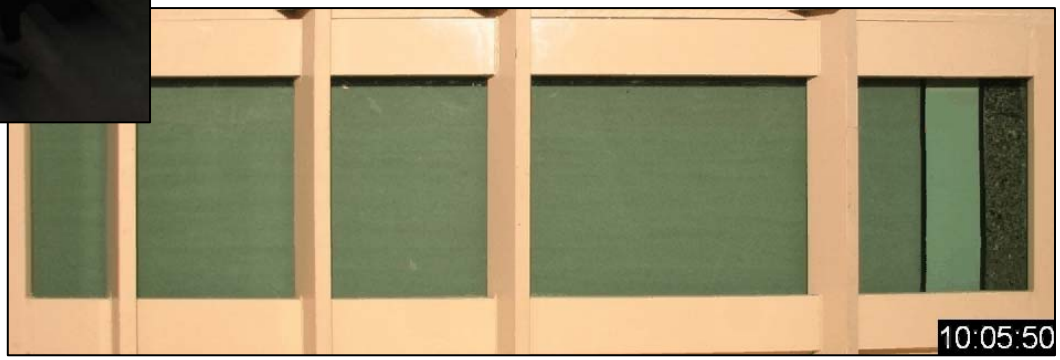
Large Scale Experiment



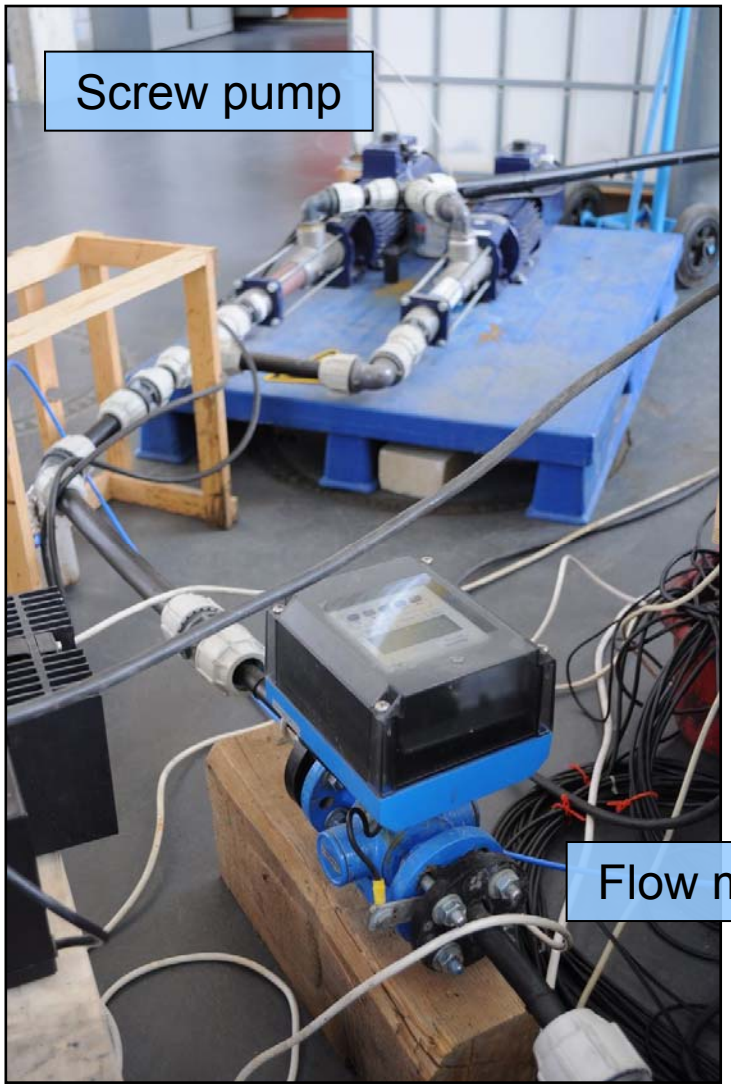
- Injection conditions based on results of column experiments
- Investigation of the transport under hyperbolic decreasing flow rates
- Definition and examination of optimal injection rates, injection technics (flow rates)
- Tests of measurement tools (transfer to the field)

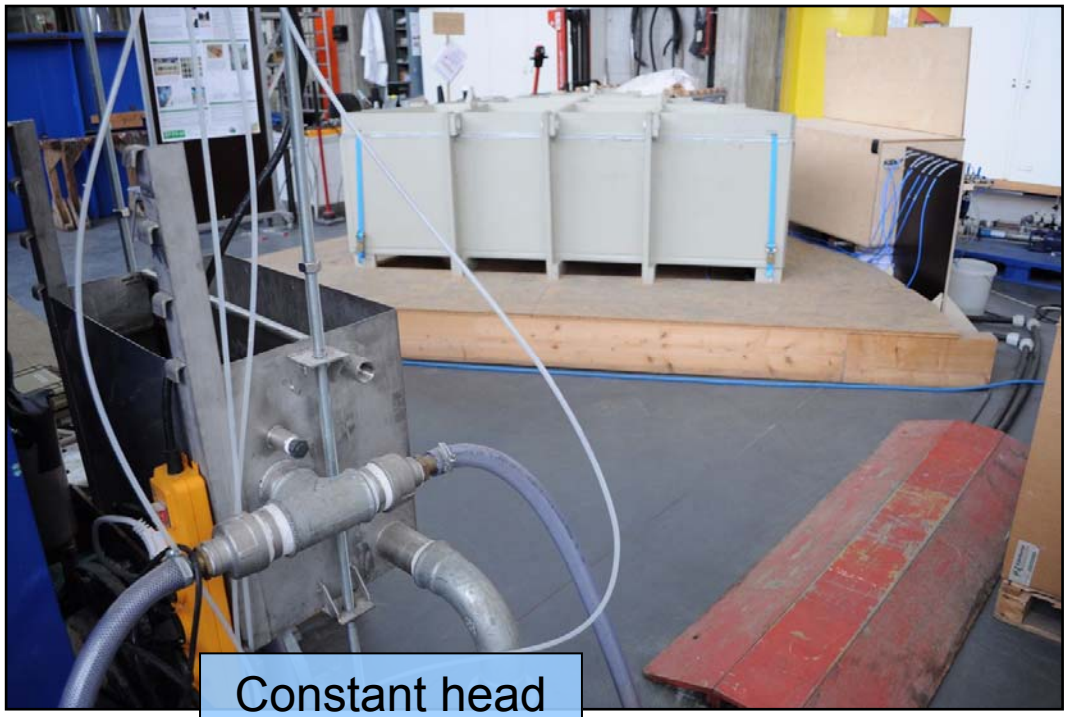


Container
r: 2 m, α: 60°, h: 0.6 m

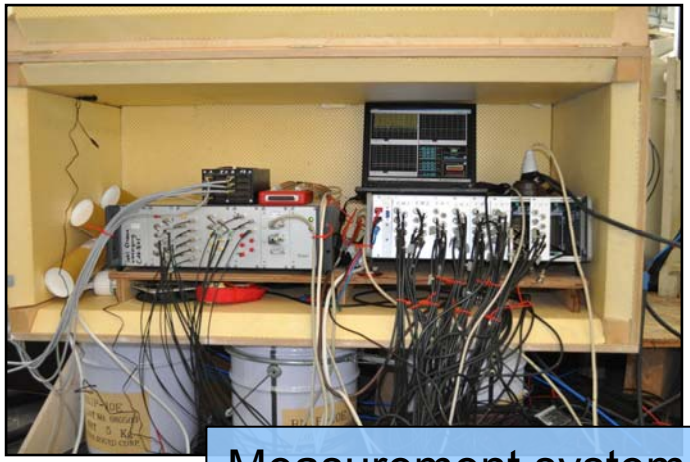


Large Scale Experiment – Details





Large Scale Experiment – Details

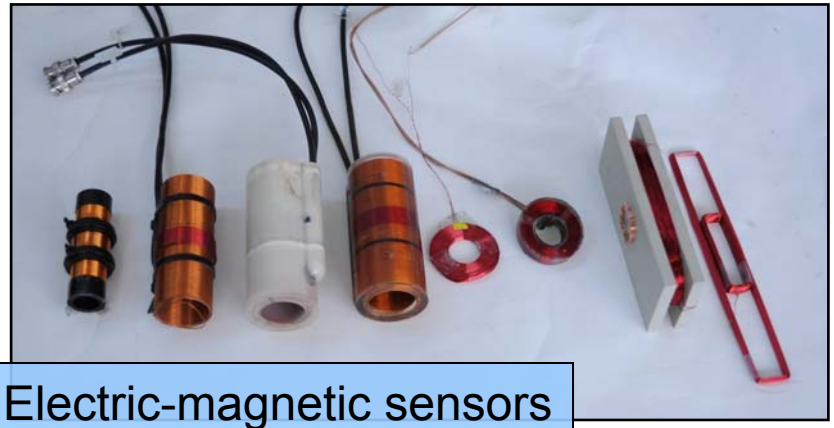


Measurement system

Pressure sensors

Link to pressure sensors

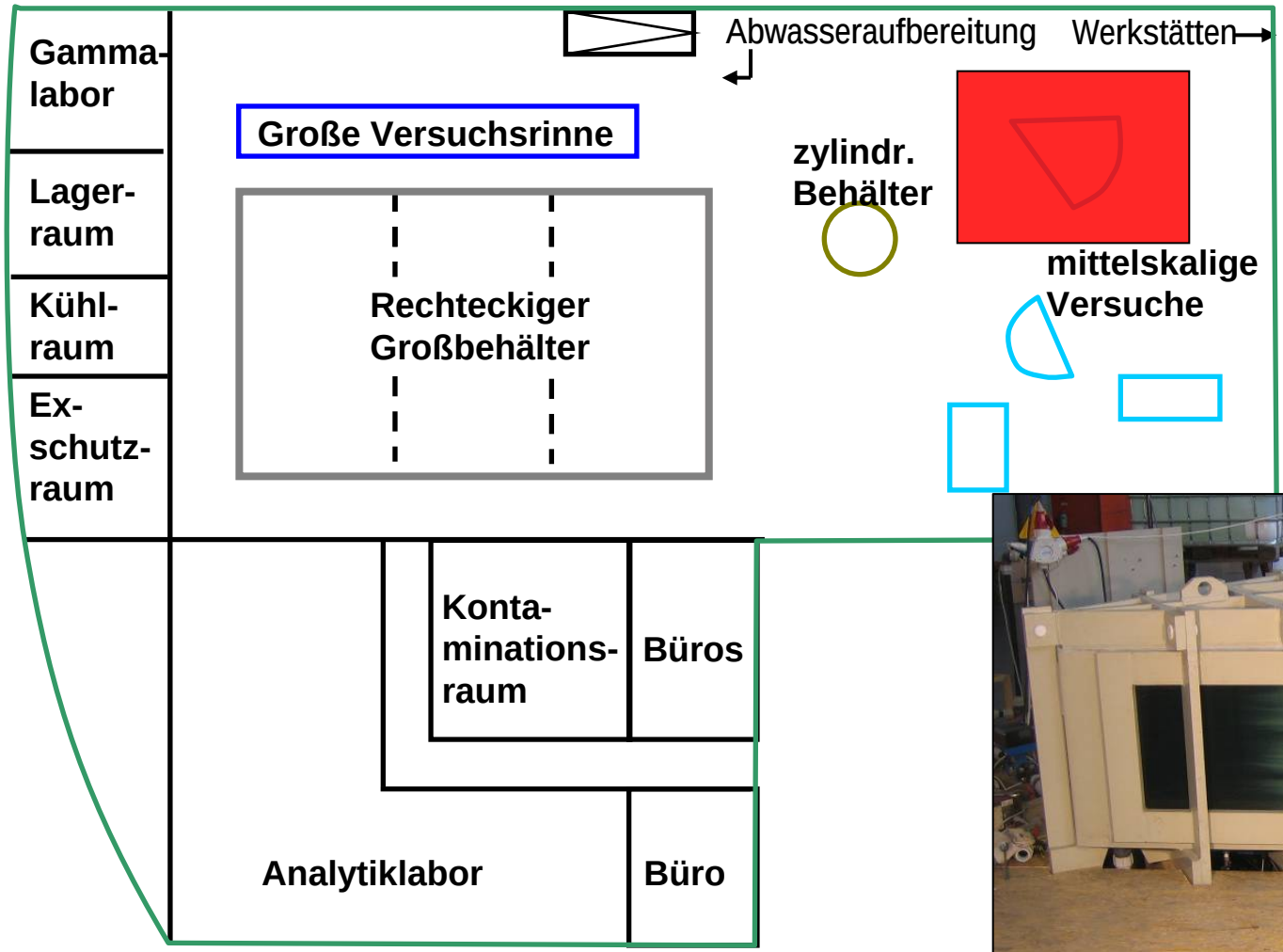
Fluorimeter ports



Electric-magnetic sensors

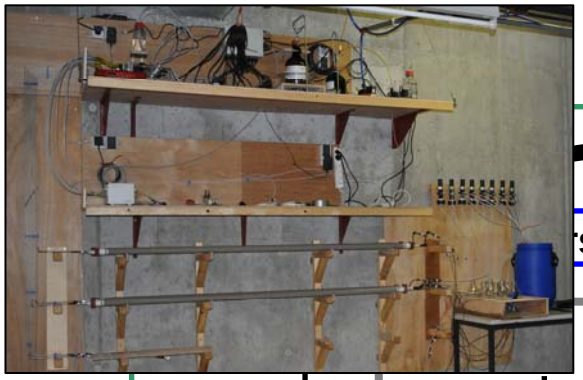
Experimental ZVI Methods in VEGAS: Large Scale Exp.

Layout Plan of VEGAS



Large Scale Experiments Transport

Experimental ZVI Methods in VEGAS: Conclusion



Layout Plan of VEGAS

Abwasseraufbereitung

Werkstätten

rsuchsrinne

zylindr. Behälter

mittelskalige Versuche

Kühl-raum

Ex-schutz-

Rechteckiger Großbehälter

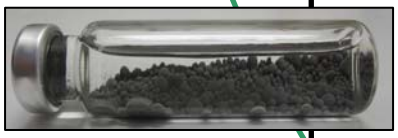
You are here!

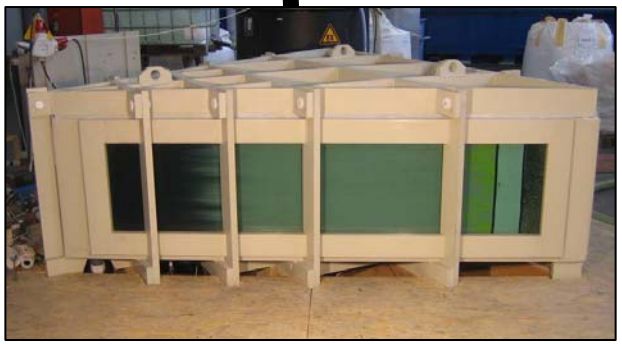
Konta-minations-raum

Büros

Analytiklabor

Büro





Batch-Experiments

Column-Experiments

Large Scale-Experiment

Thank you for your attention!

Feel free to go for a walk

in VEGAS

Versuchseinrichtung zur Grundwasser- und Altlastensanierung

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