Investigation of inhomogenieties in automotive fuel cell stacks

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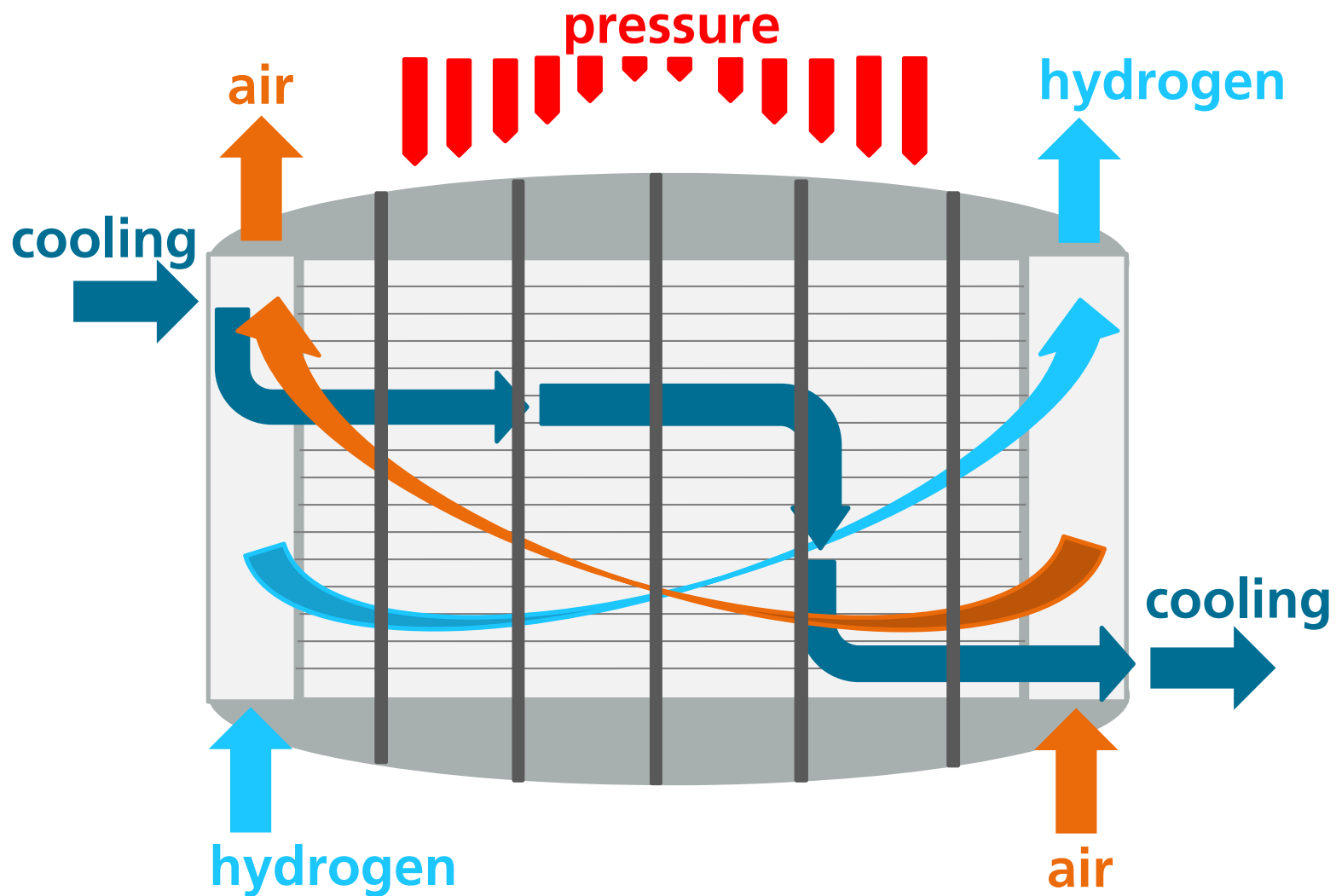Our research enables fuel cells.

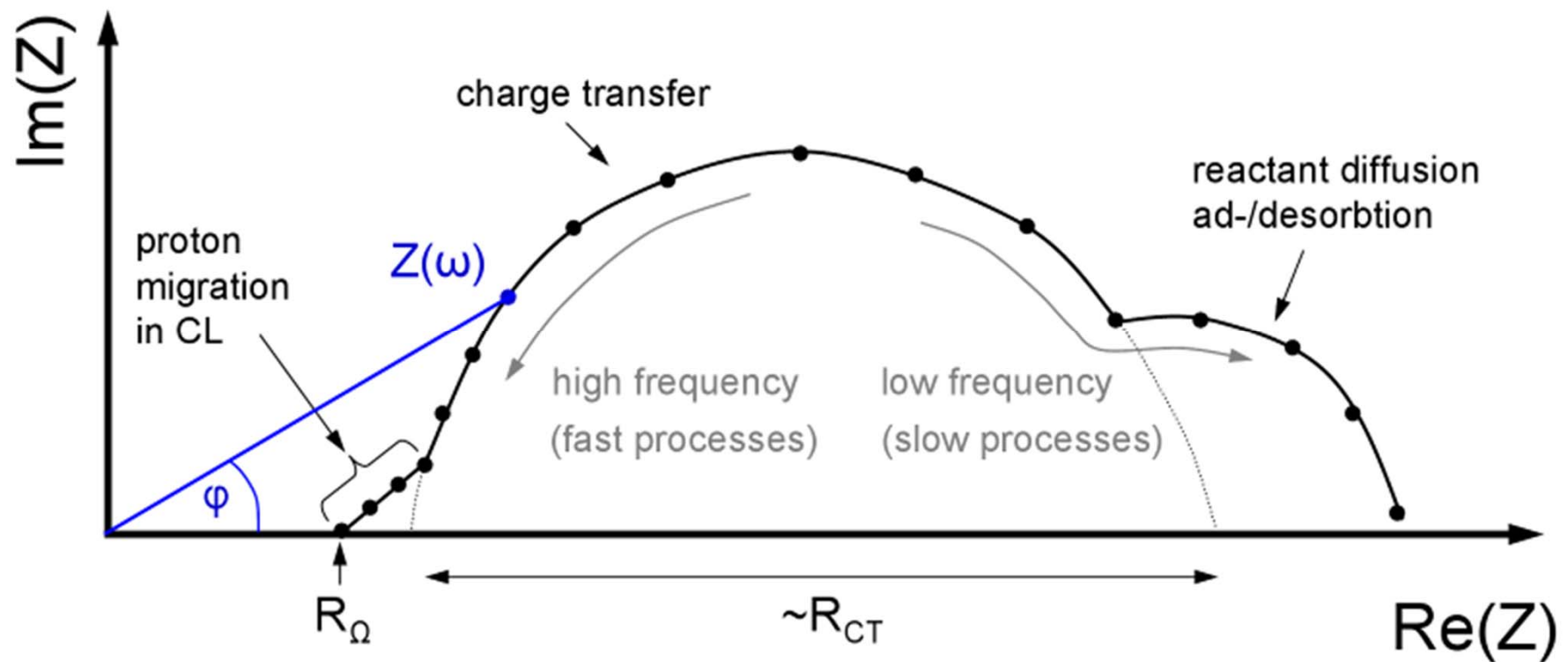Foto Joscha Feuerstein

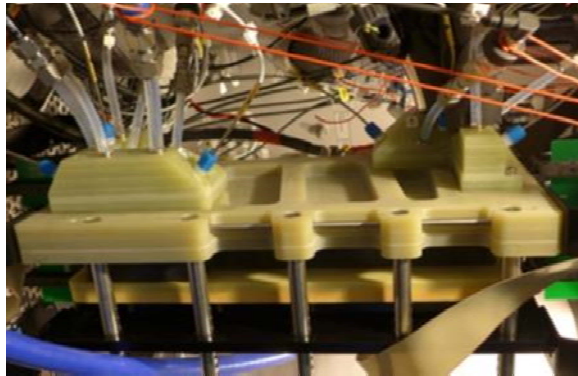Foto Joscha Feuerstein

Foto Joscha Feuerstein
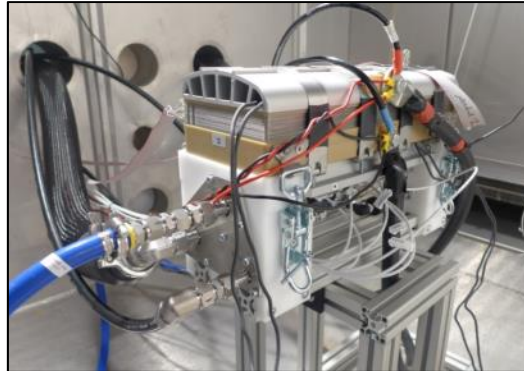
Do you know the flow distribution?

Impedance spectroscopy is a powerful tool to understand a stack.
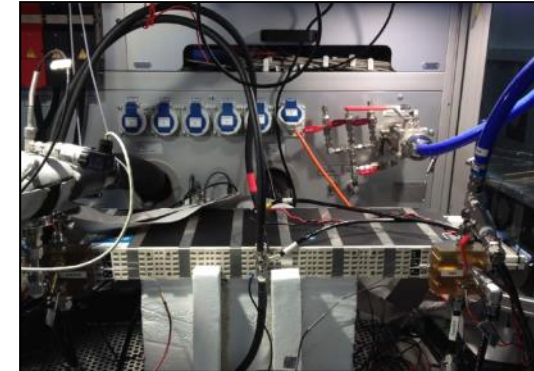
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We investigated 3 automotive stacks: Autostack CORE, Automotive Fuel Cell Company, Ballard

- AFCC
- 20 cell short stack
- Generation 3
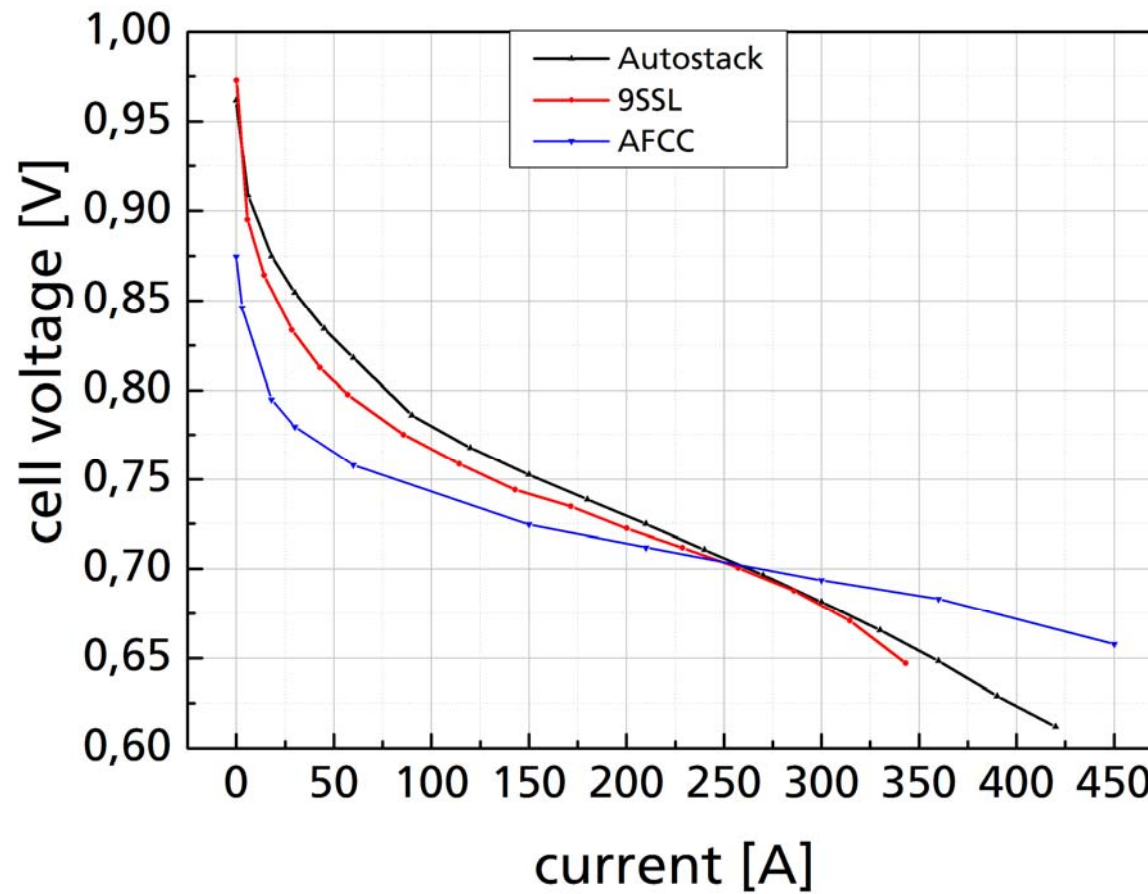- Partners are Daimler and Ford

- FCH JU project AutoStackCORE, ASC
- 20 cell short stack
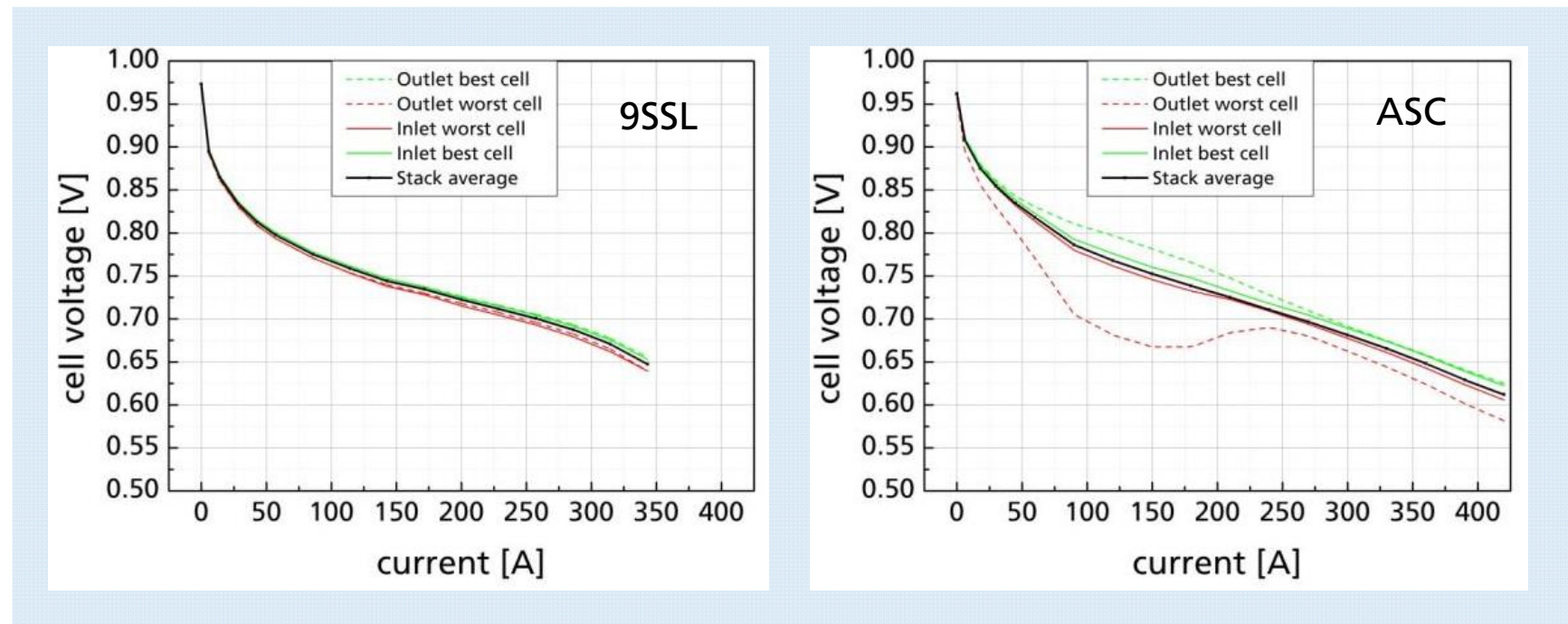- Evolution 1 design
- manufactured by Powercell

- Ballard 9SSL
- 90 cell full stack

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Comparison of polarization curves
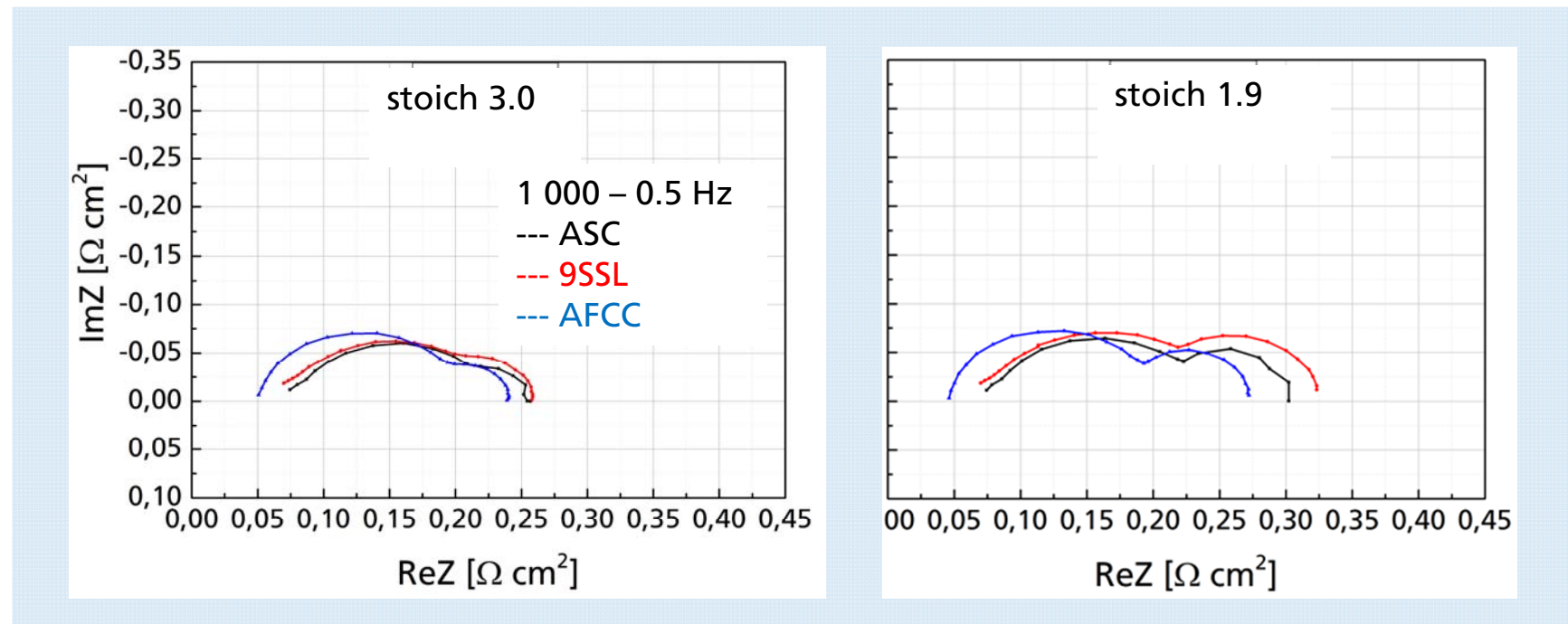
Closer look on single cell voltages
It is important to monitor CV at inlet and outlet

- 9SSL very homogeneous both at inlet and outlet

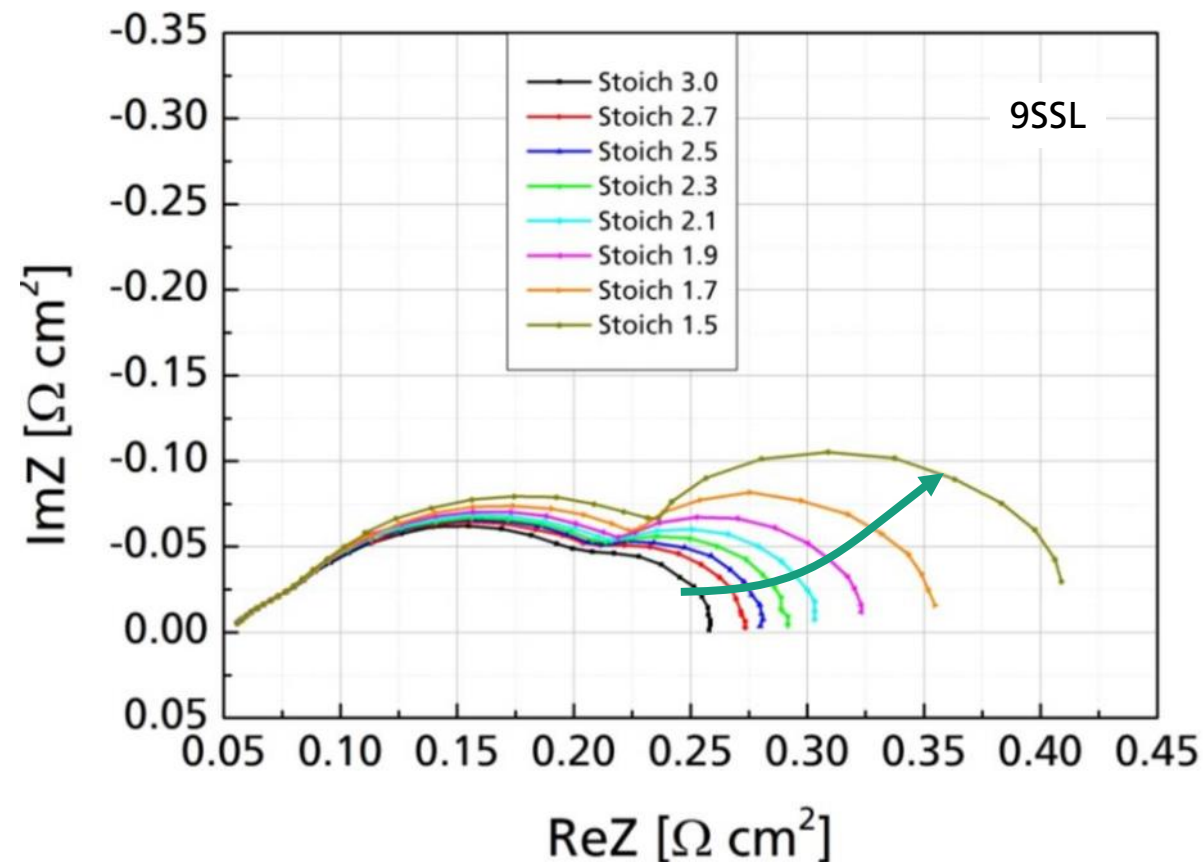- Higher cell voltage variation at outlet in case of ASC

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Comparing impedance spectra
Various cathode stoichiometries @ 0.5 Acm^{-2}

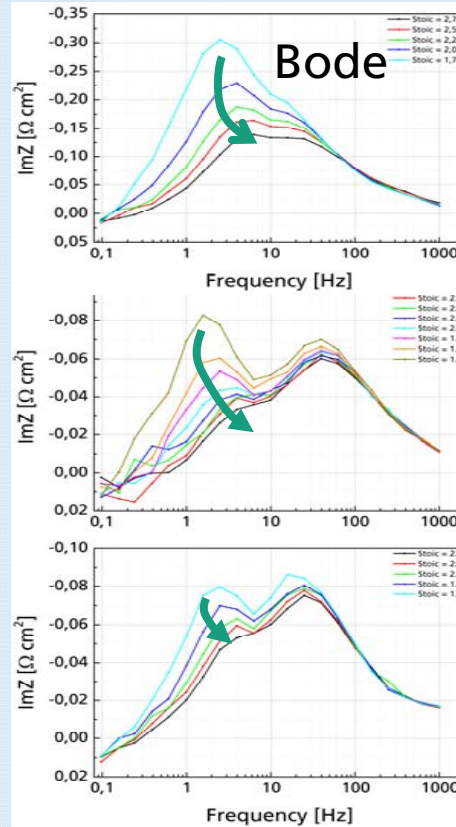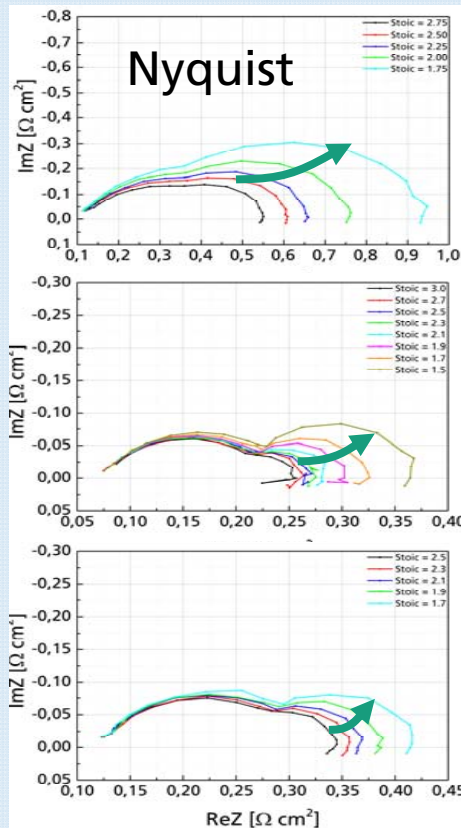- Growth of second arc with low air flow shows limited mass transport

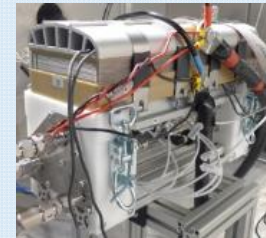# The low frequency arc is influenced by mass transport.

Mass transport is influenced by

- Diffusion (relatively independend from air flow)

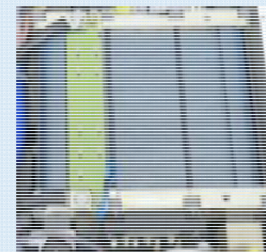- Concentration oscillation (depends from air flow)

Bode plot shows peak at a characteristic frequency:
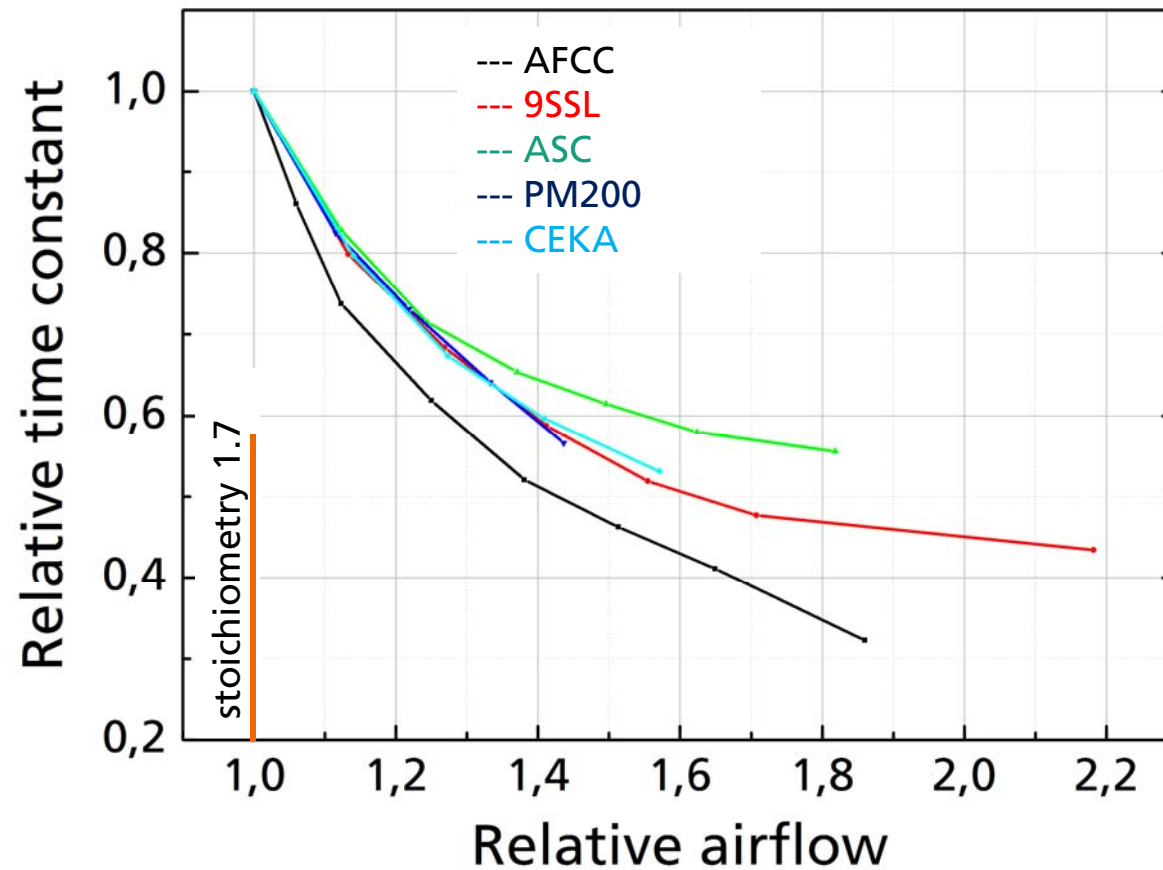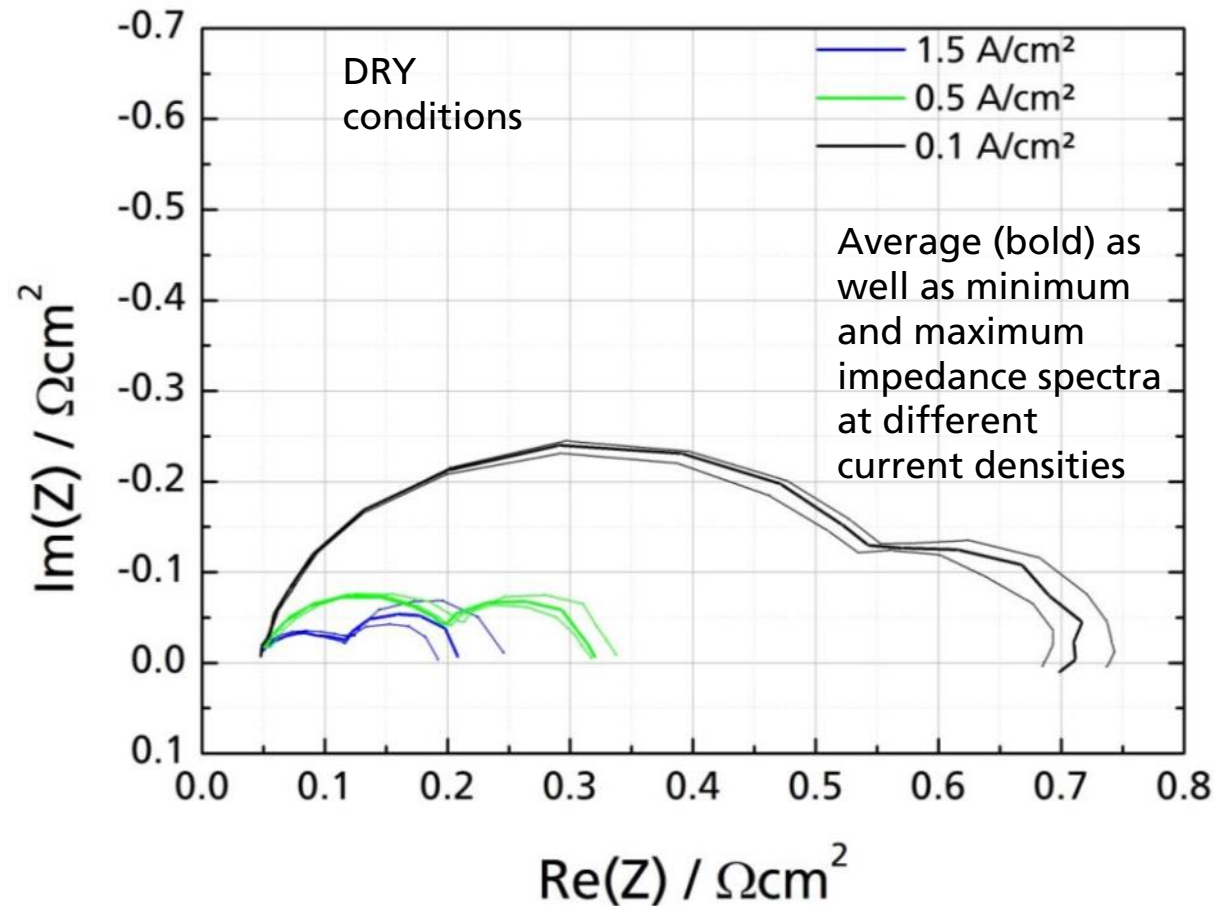# Time constant

Time constant represents gas residence time.

We are monitoring simultanously the single cell impedance within a stack.

Foto Joscha Feuerstein

Comparison of single cell behavior in a stack


EIS measurement with a frequency range from 1 kHz to 0.1 Hz with 5 points per decade in galvanostatic mode with 4 A AC perturbation amplitude.

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Single cell impedance allows to analyse the flow distribution in a stack with respect to operating conditions I
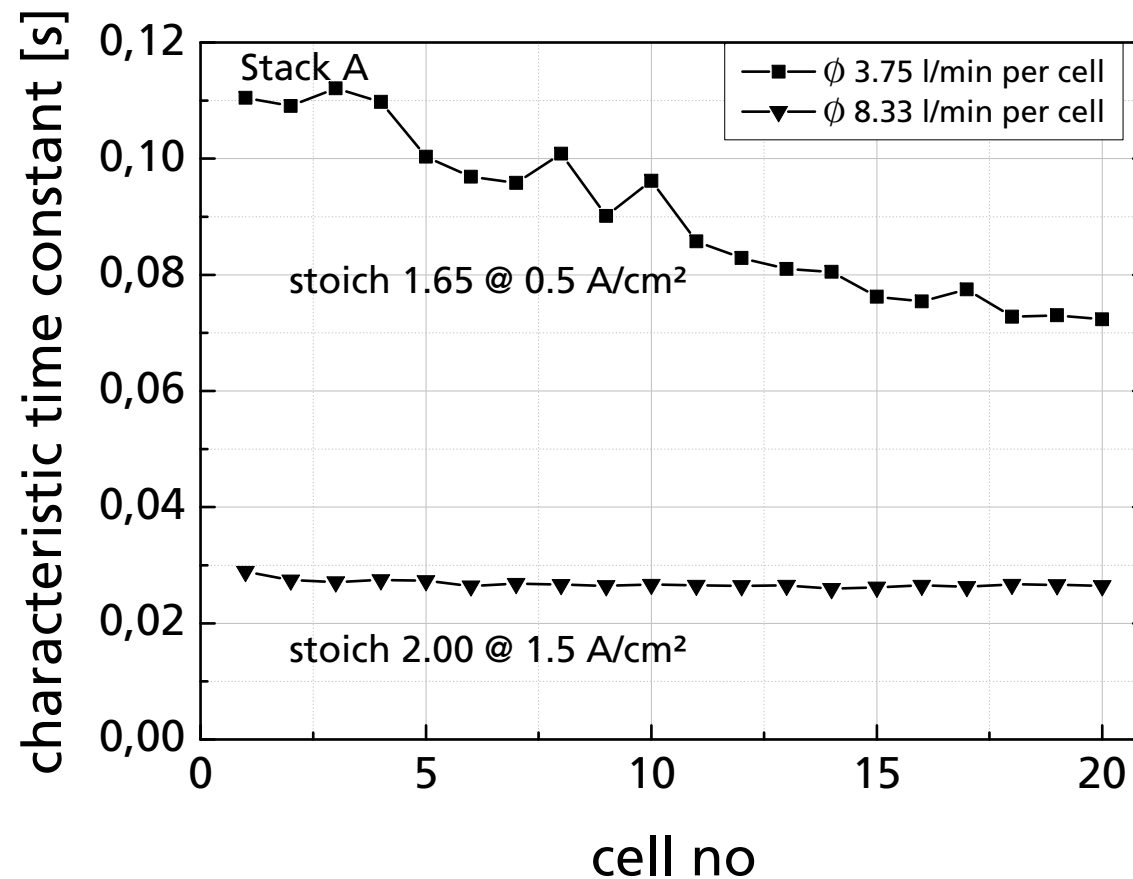
Single cell impedance allows to analyse the flow distribution in a stack with respect to operating conditions II
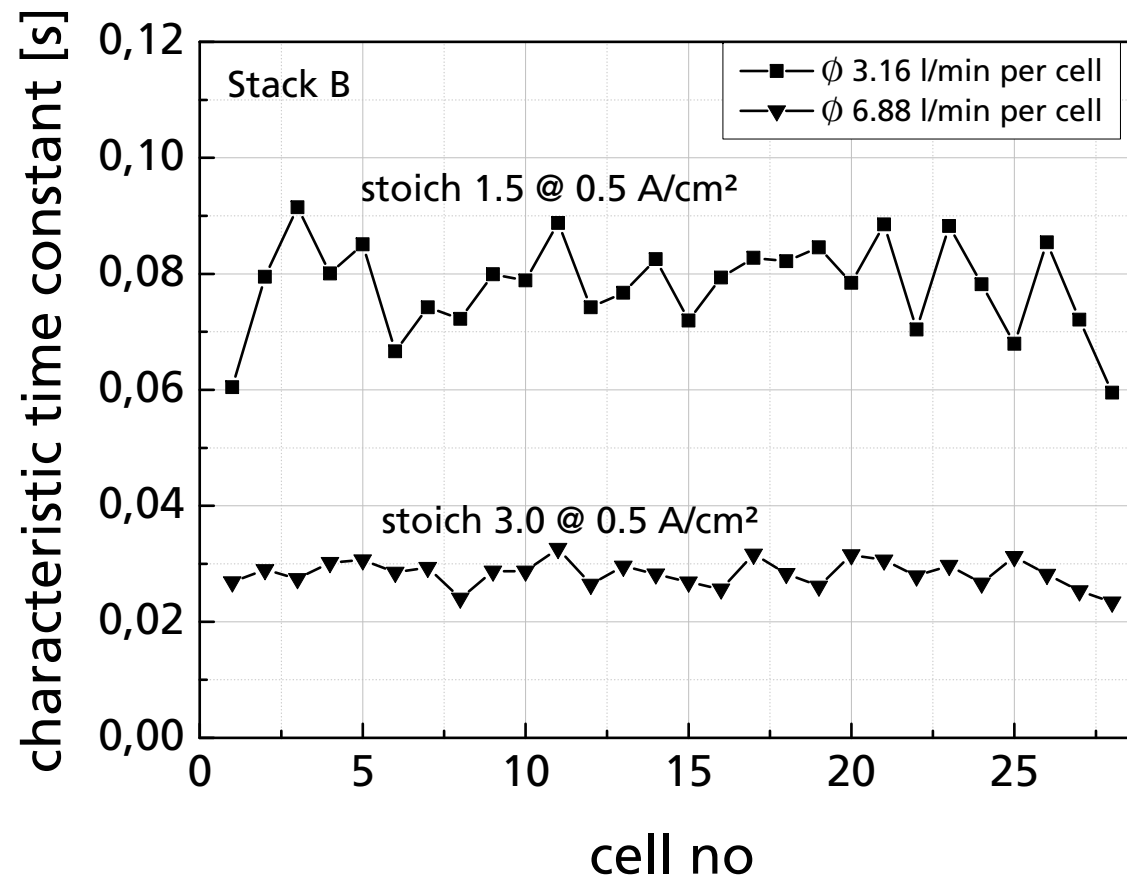
Conclusion

- Total stack performance might not reflect single cell performance

- Single cell impedance helps to understand gas flow distribution within a stack

- Single cell investigations within a stack is needed to optimize

  - stack design

  - operation strategy

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Acknowledgement

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Thank you for your attention.
You are heartly invited for a
good Freiburg roasted coffee at
our booth!

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Foto Joscha Feuerstein