balticFuelCells GmbH

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GERMANY

quickCONNECTfixture single cell tester for LT and HT PEM applications

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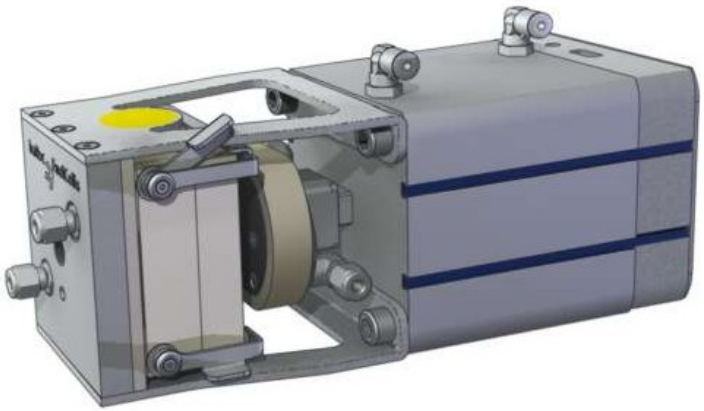

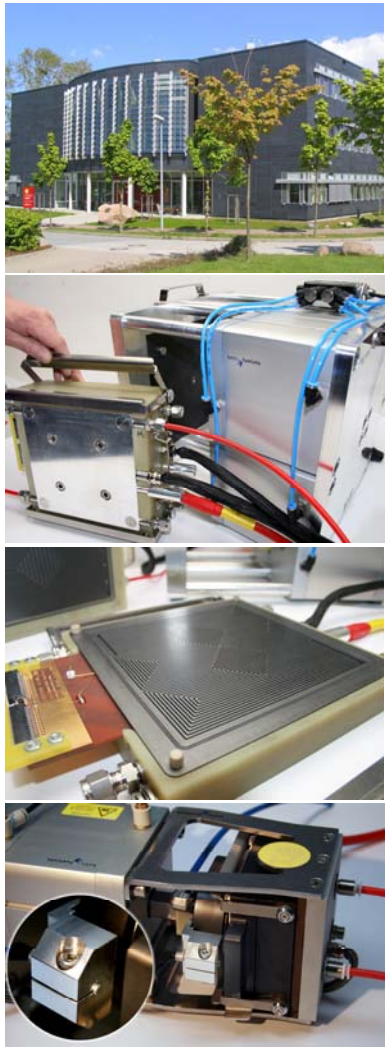

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- Evolution of qCf
- quickCONNECT (qCf) and cellFixture (cF) standards and customized designs
- Application fields QA/R&D
- OE dynamic hydrogen reference electrode (DHRE)
- OE compression measurement device (CMD)
- OE integrated current distribution sensor (CSL)
- OE integrated humidity sensor (HSE)

- NEW! short stack tester (novelty from Hannover fair 2009)

About balticFuelCells GmbH

2002 Formation of the Hydrogen Institute of Applied Technologies (HIAT) gGmbH in Schwerin, Germany

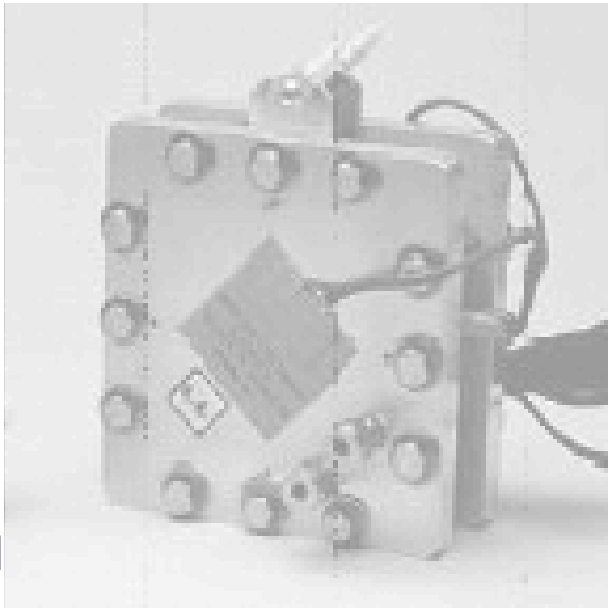
DMFC, PEFC, membranes, electrodes, test cells, stacks,
electrode technology, catalyst technology

2006 Formation of balticFuelCells GmbH as spin-off company from HIAT in Schwerin, Germany

Main business field: Testing equipment for PEMFC
Emerging business fields: GDE production, CCM production, Stack development
For DMFC and PEFC

Conventional test cell vs qCf

QA + R&D with conventional single cell tests



- disassembly / assembly is time-consuming
- high risk of mistakes in assembly
- Compression force applied using bolts and torque wrench
- Compression force applied to gaskets and active area
- Compression of active components depends on:

  - thickness and material properties of MEA/CCM

  GDLs, CCBs etc.

  - thickness and material properties of gaskets

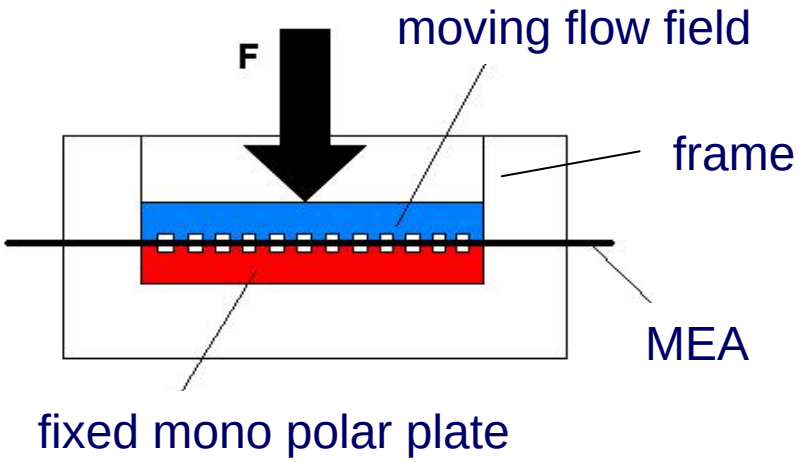
  - torque

what about reproducibility?

Conventional test cell vs qCf

the idea

→ **<u>design of a novel cell concept</u>** for the reproducible characterisation of all internal **Fuel Cell components (CCMs, MEAs, GDLs, CCBs, flowfields, etc.)**

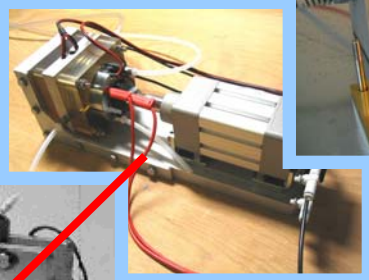


- adjustable pressure impact on the active Fuel Cell area (directly regulated by pneumatic actuator)
- independent of gaskets and overall thickness of internal FC-components
- quick and tool-less assembly of cellFixture into quickCONNECT
- simple exchange and verification of different flow field geometries

→ **fully reproducible conditions for R&D and QA!**

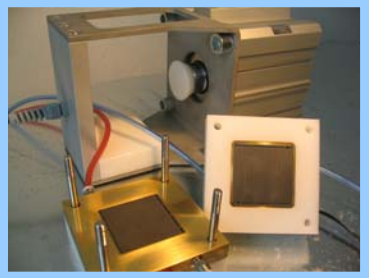
Evolution of *qCf*

beginning
diploma thesis
@ HIAT
2002/2003

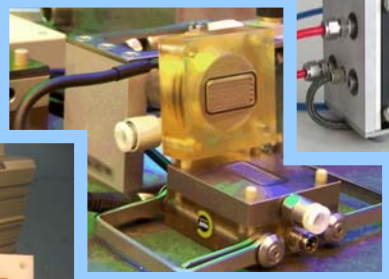


state of the art
- not suitable for reproducible characterizations and QA!

2nd stage
material improvm.



3rd stage
operation
comfort
→ Gen_0



- 400 mm
- 11 kg
- 160 W heating
- hand operated piston valve

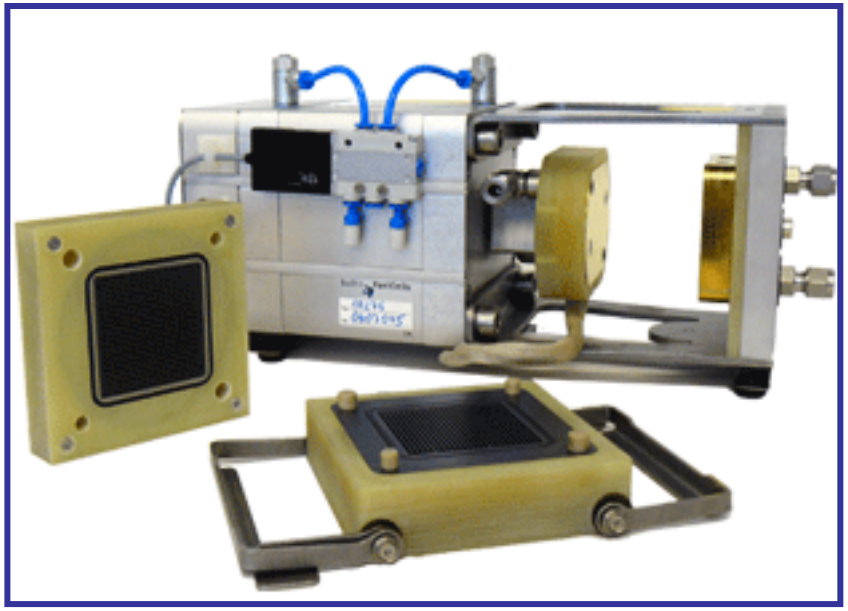
4th stage
quickCONNECTfixt
ure
→ Gen_0.1

5th stage
quickCONNECTfixture
series production
→Gen_1.0
launched @ HMI'2007

- 290 mm
- 5,9 kg
- 200 W heating
- electrical valve
- extra low ohmic resistance
- gold plated plates

>.. 20th century | 2004 | 2005 | 2006 | 2007

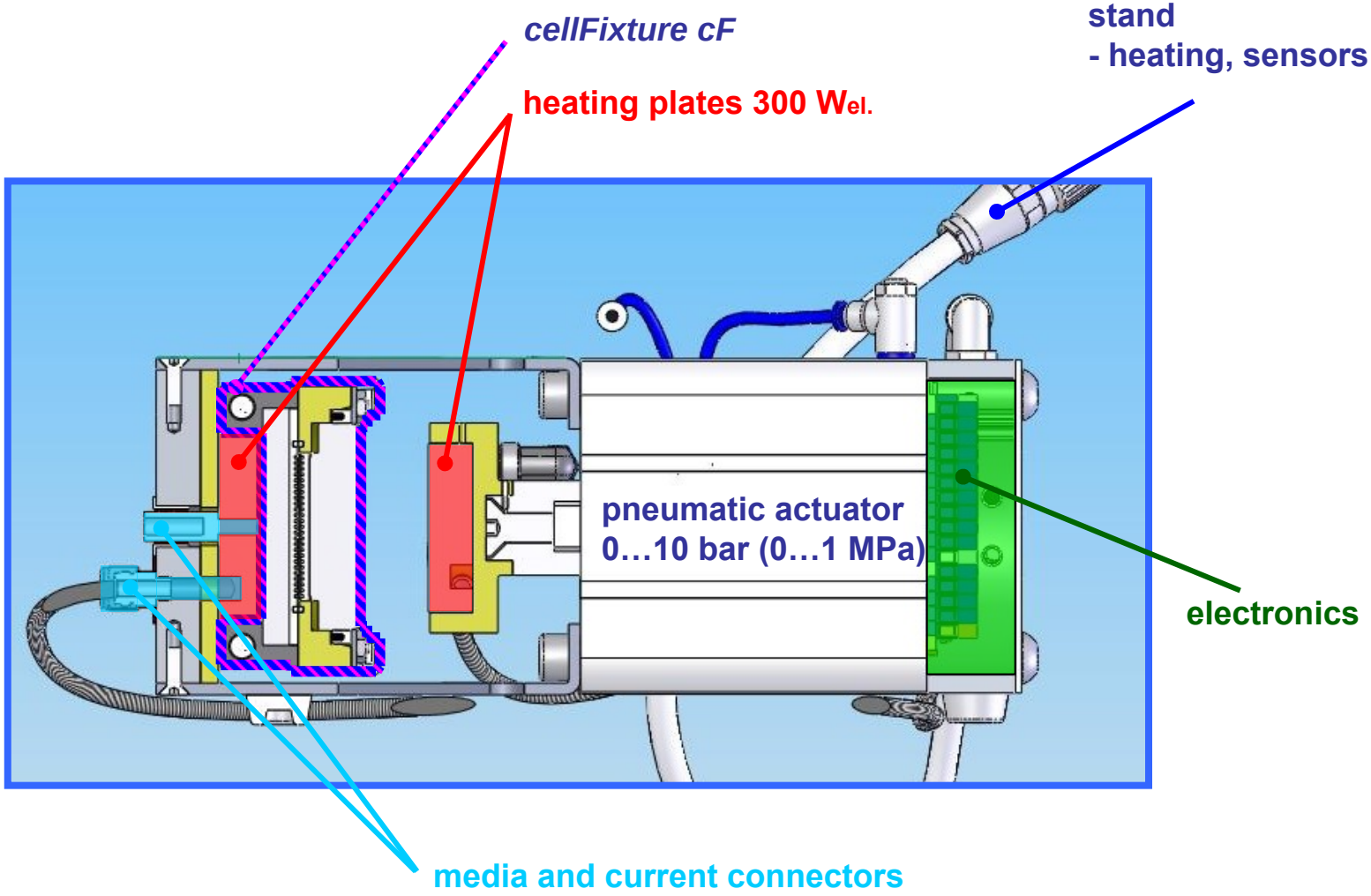
Evolution of qCf



2008: integrated sense frame for even further reduction of test cell contribution to ohmic losses during measurement
(Gen 1.1 25cm^2 and 50 cm^2 active area)

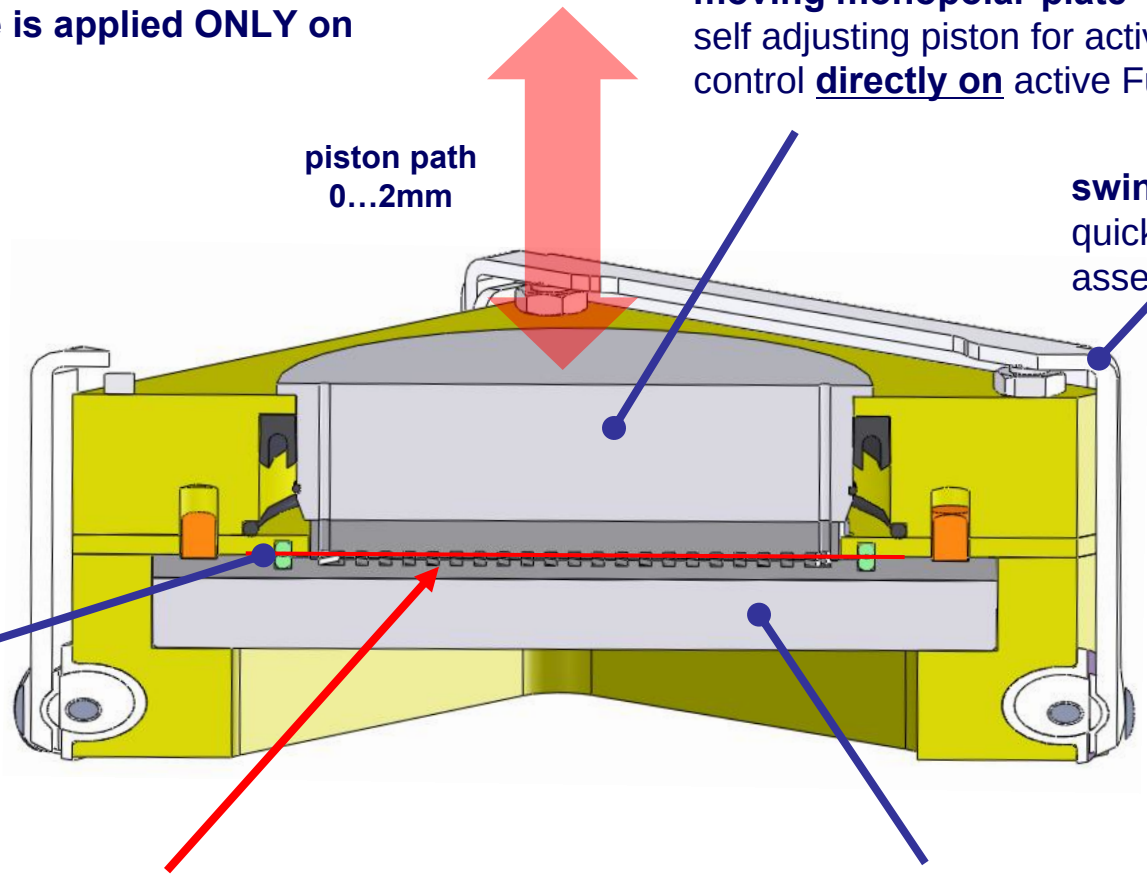
quickCONNECTfixture qCf

overview and cross section of qCf



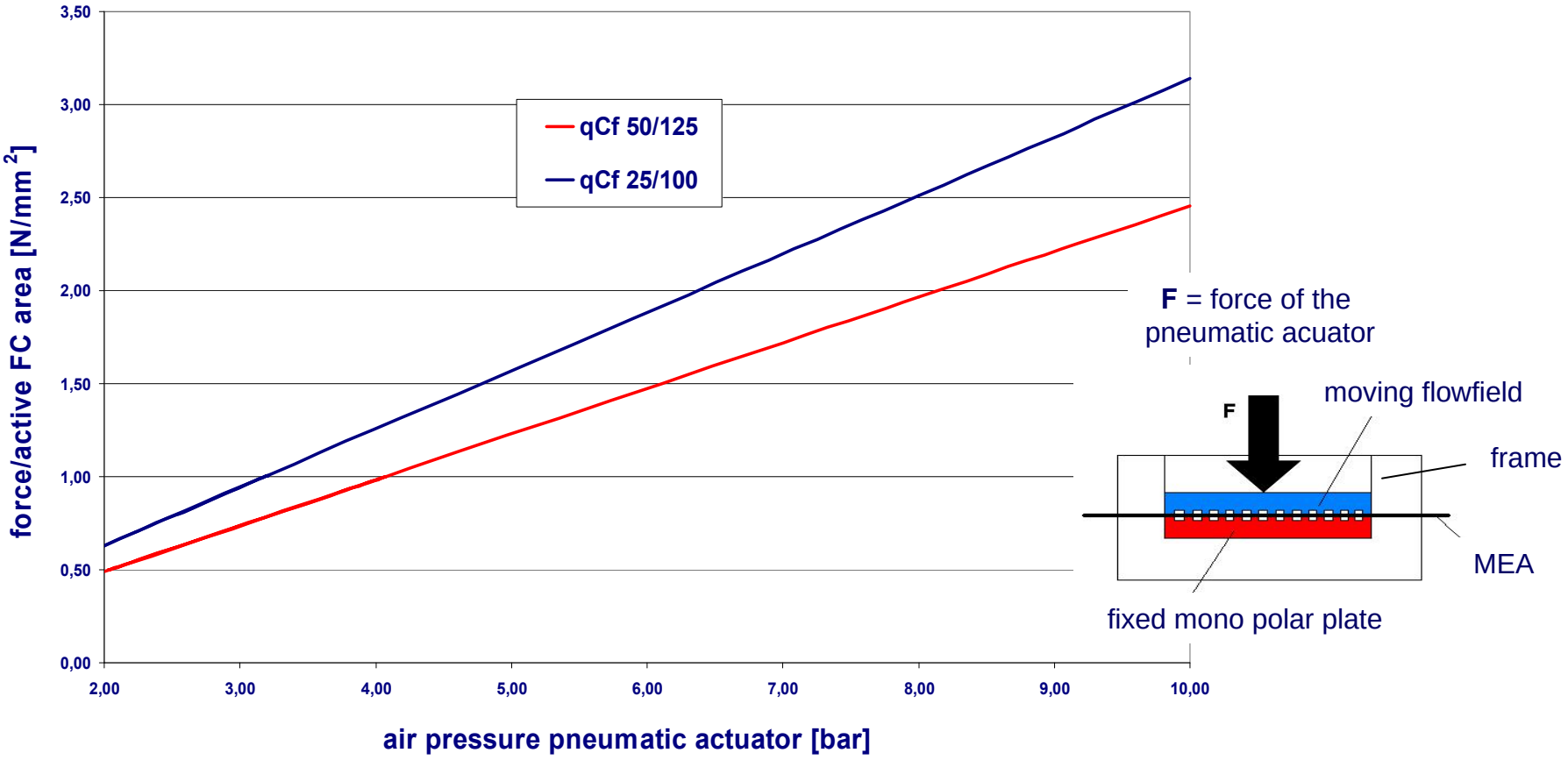
cellFixture cF cross-section & principle

- **advanced sealing concept allows adjustment of moving monopolar-plate**
- **contact pressure is applied ONLY on the active area**



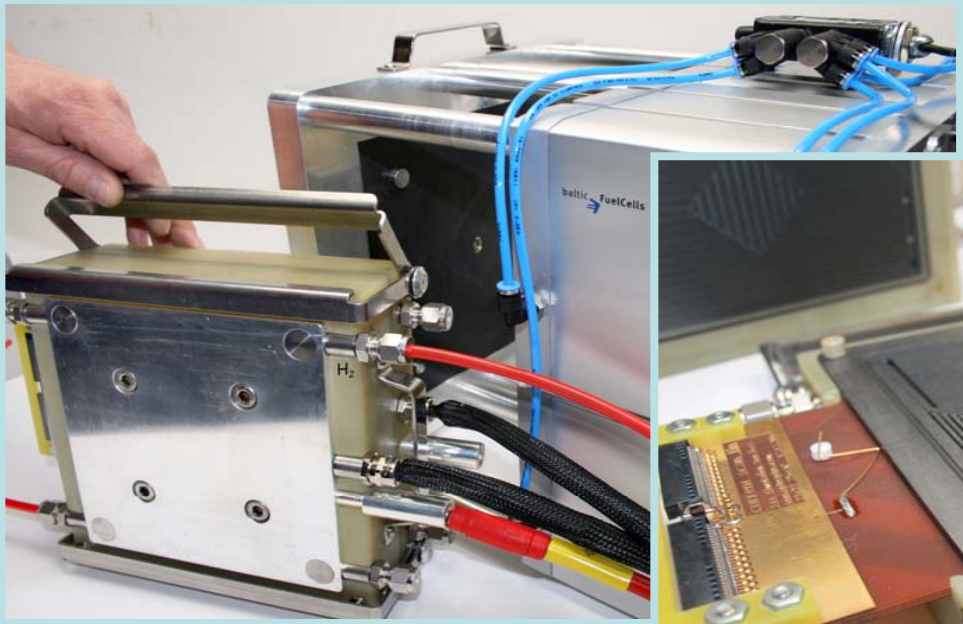
impact pressure on active area

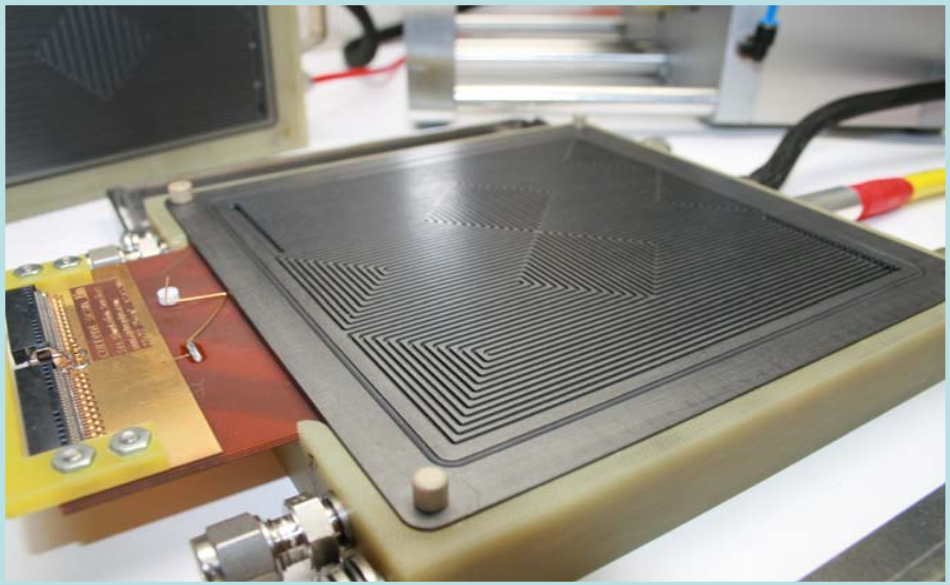
Control of impact pressure on active FC area by adjusting the air pressure of the pneumatic actuator!



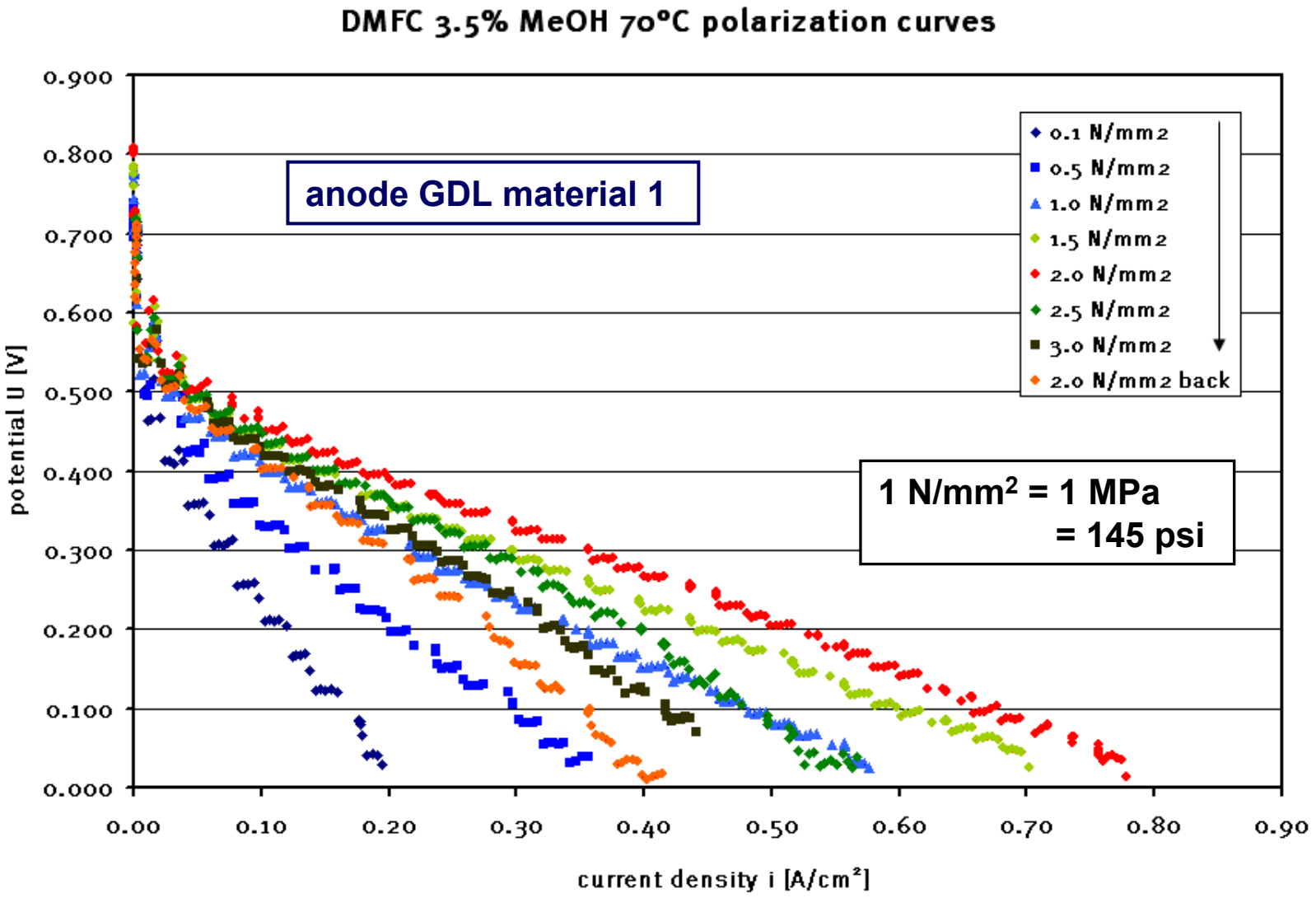
Standards and customized designs

- standard cell areas 25 and 50 cm^2 FC-area with CD-flowfields
- customised qCf with 2 … 268 cm^2 active area realised
- qCf-specific: liquid cooling/heating; integration of humidity sensors
- QA-specific: consulting in test bench questions and QA opportunities





Example: optimizing contact pressure



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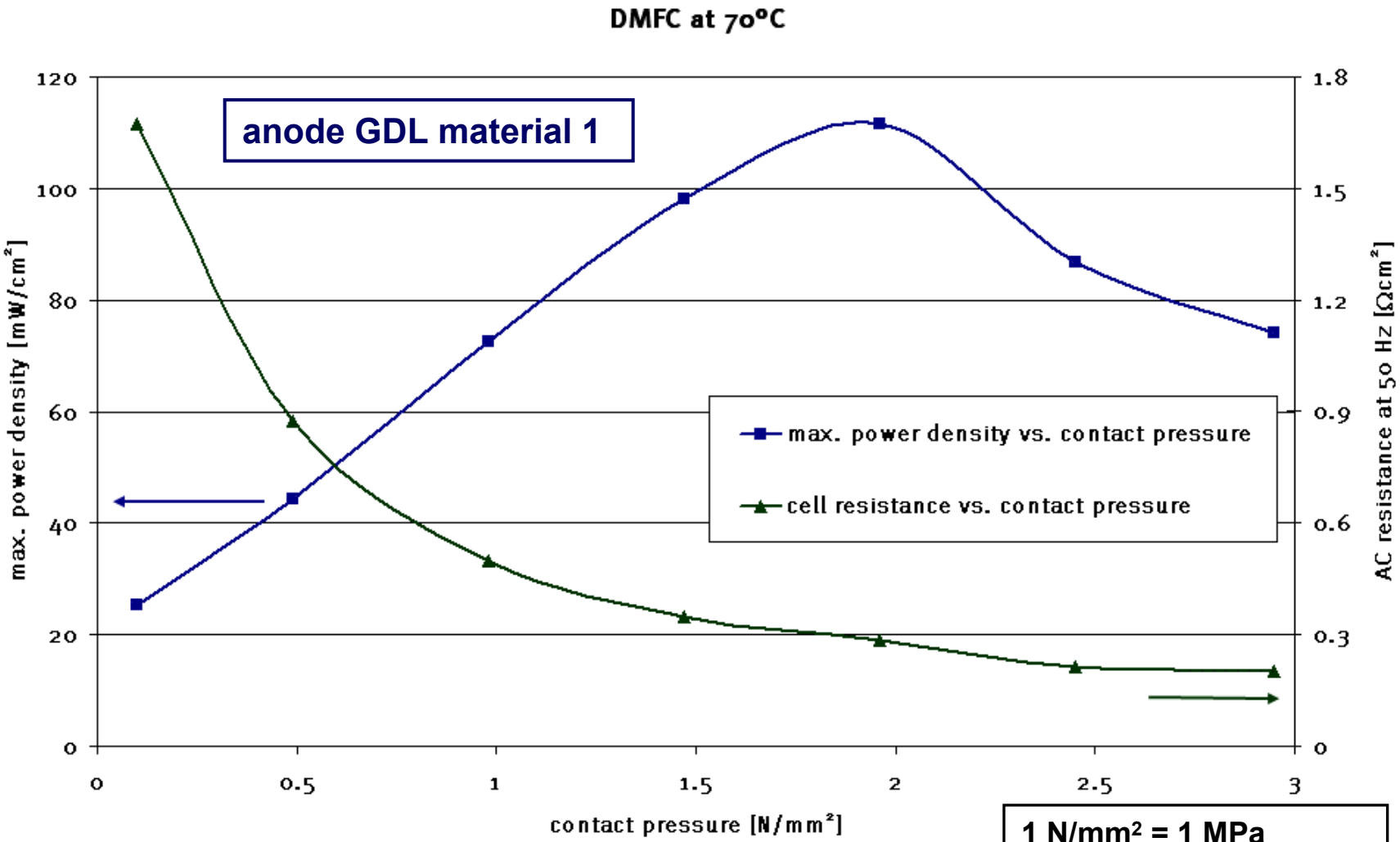
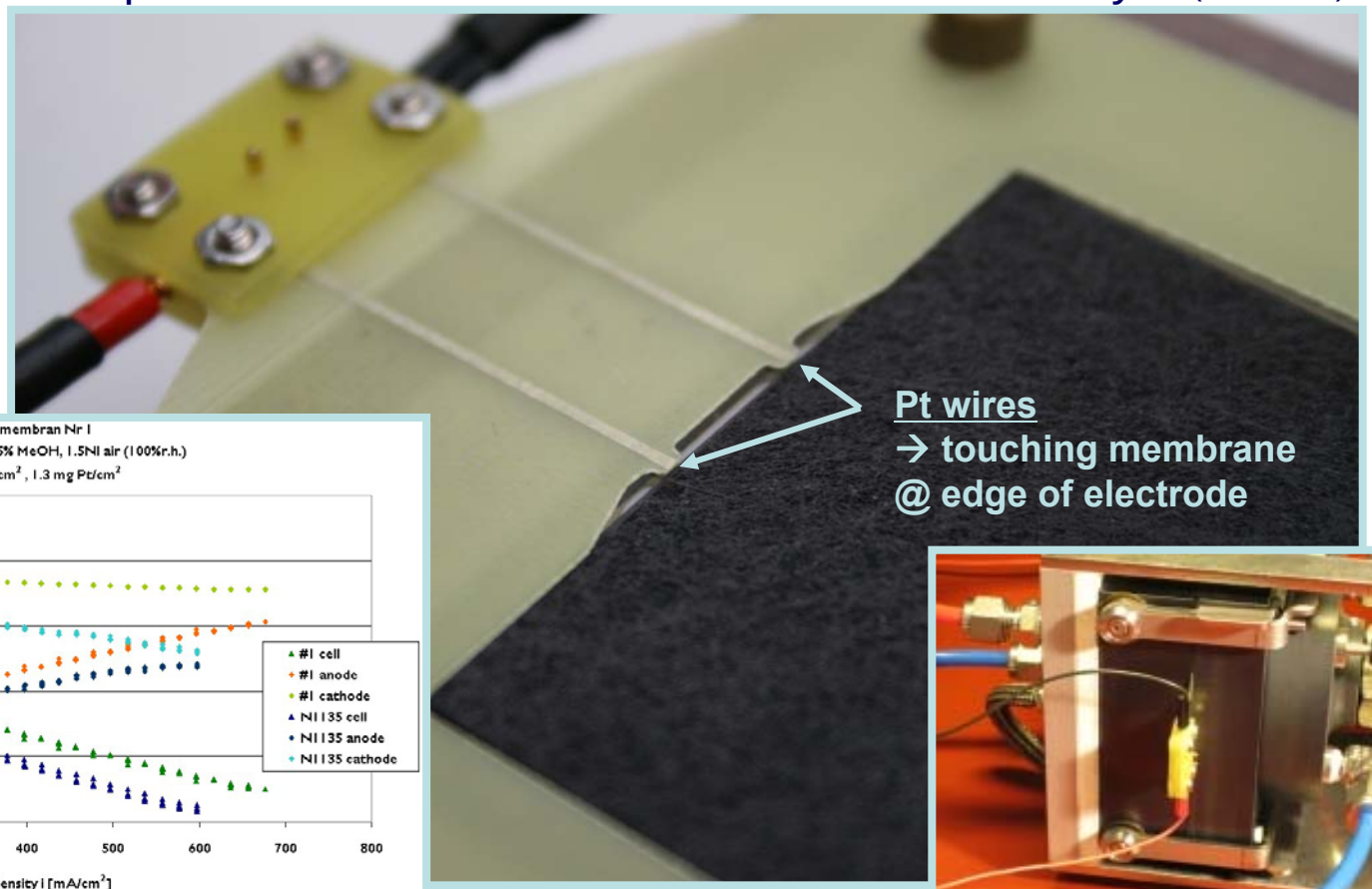


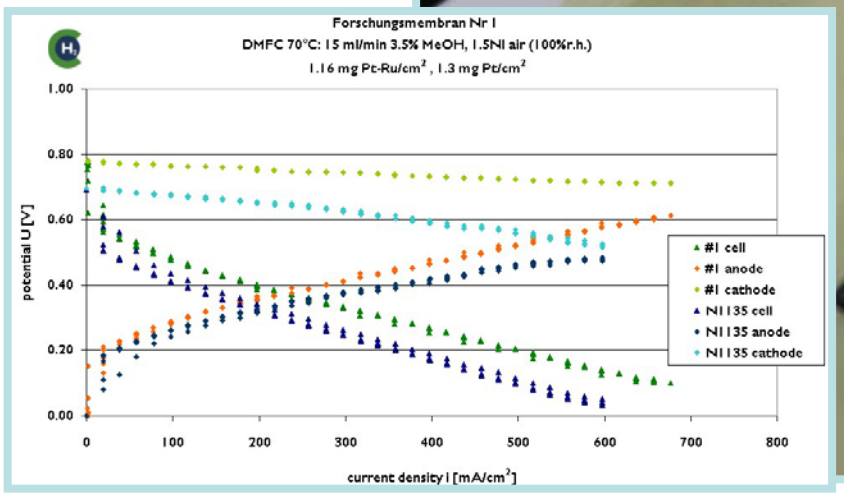
1 N/mm² = 1 MPa
= 145 psi

OE - DHRE

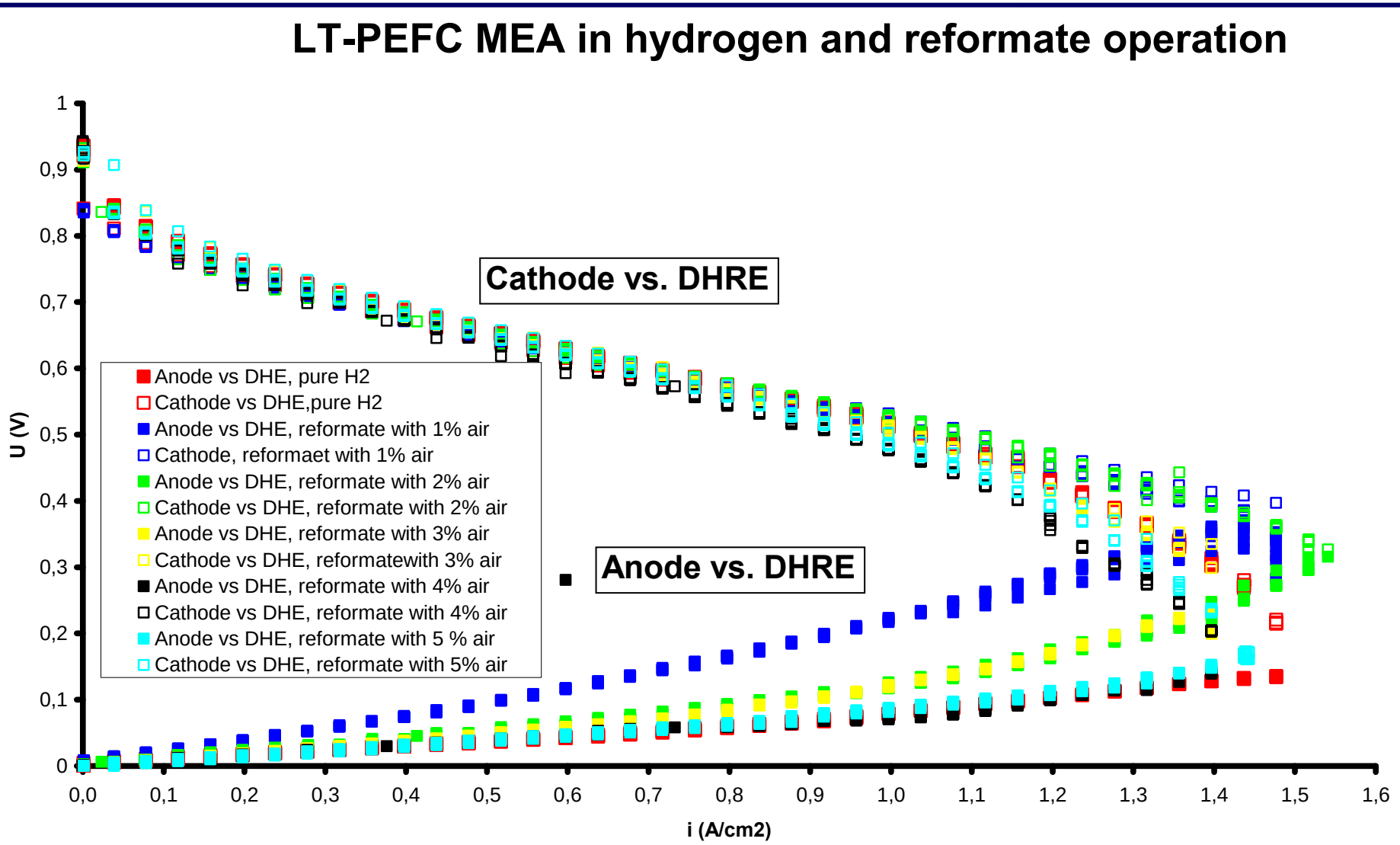
Dynamic
Hydrogen
Reference
Electrode

- anode and cathode contributions to over-potential
- targeted optimization of the separate electrodes
- simple installation on cathode side as additional layer (t: 0,2 mm)

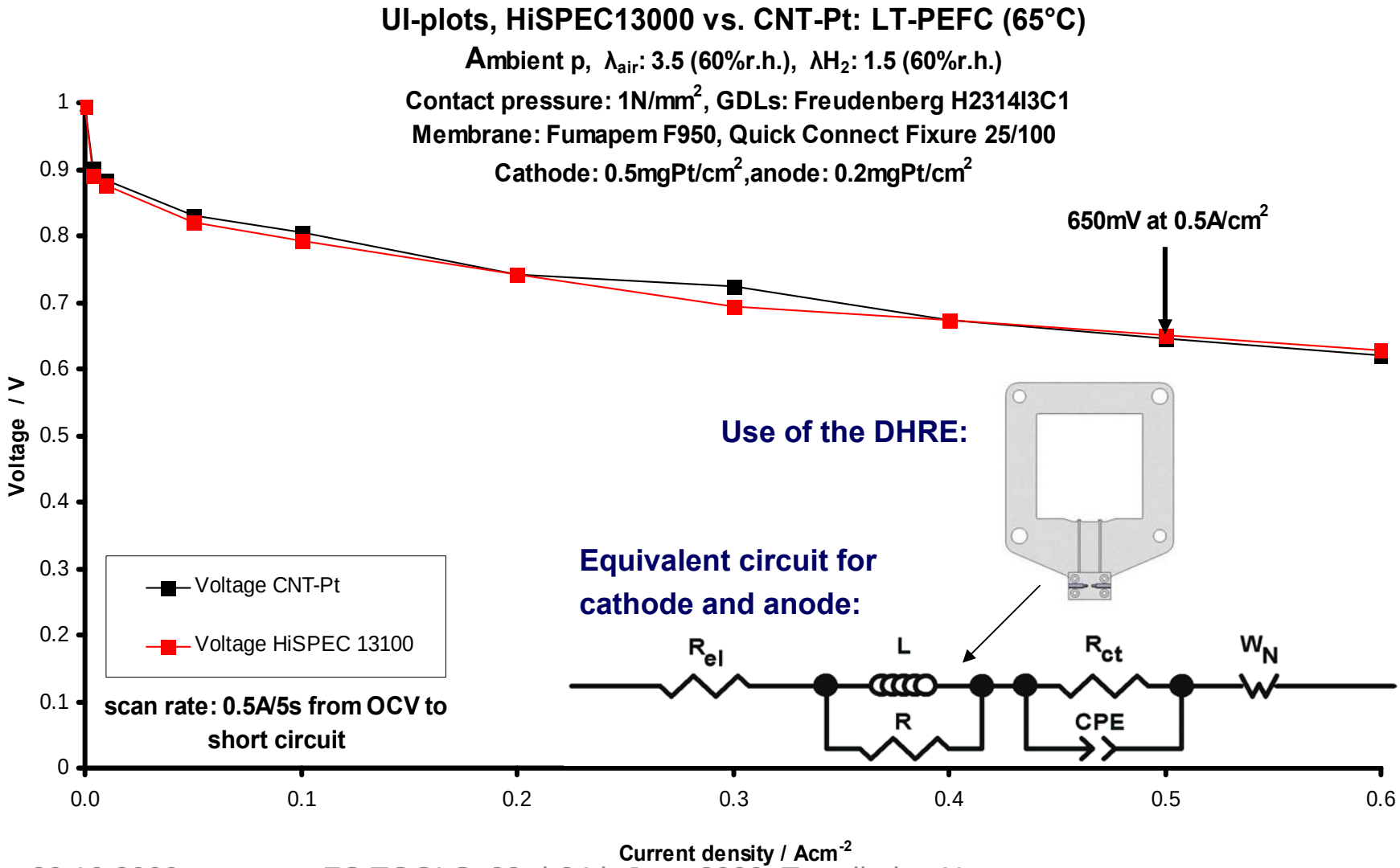




Example: finding optimum air bleed for reformate LT-PEFC

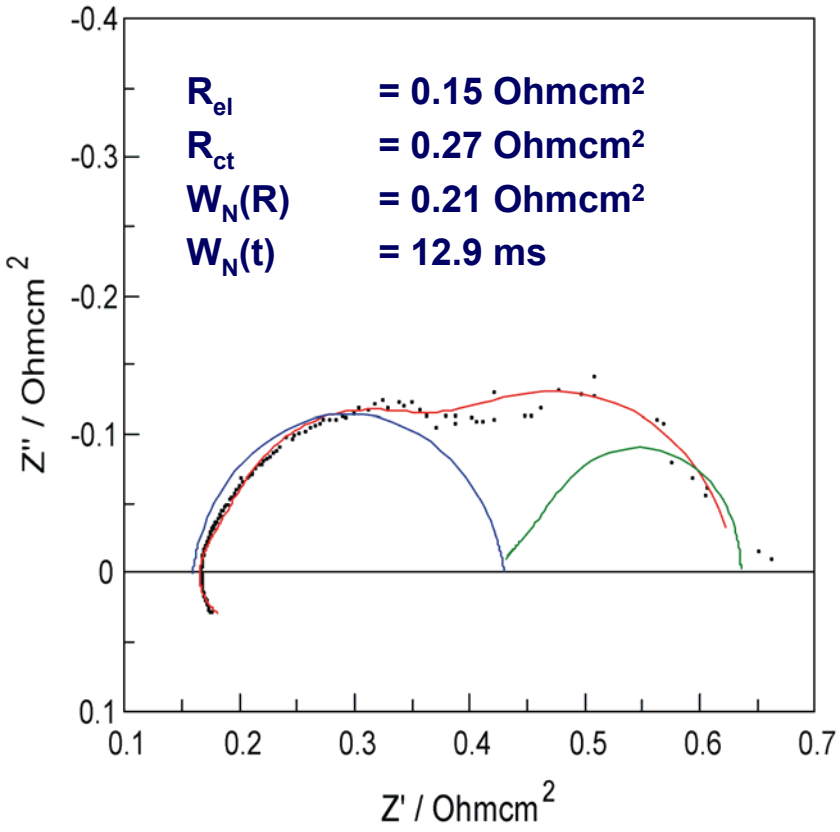


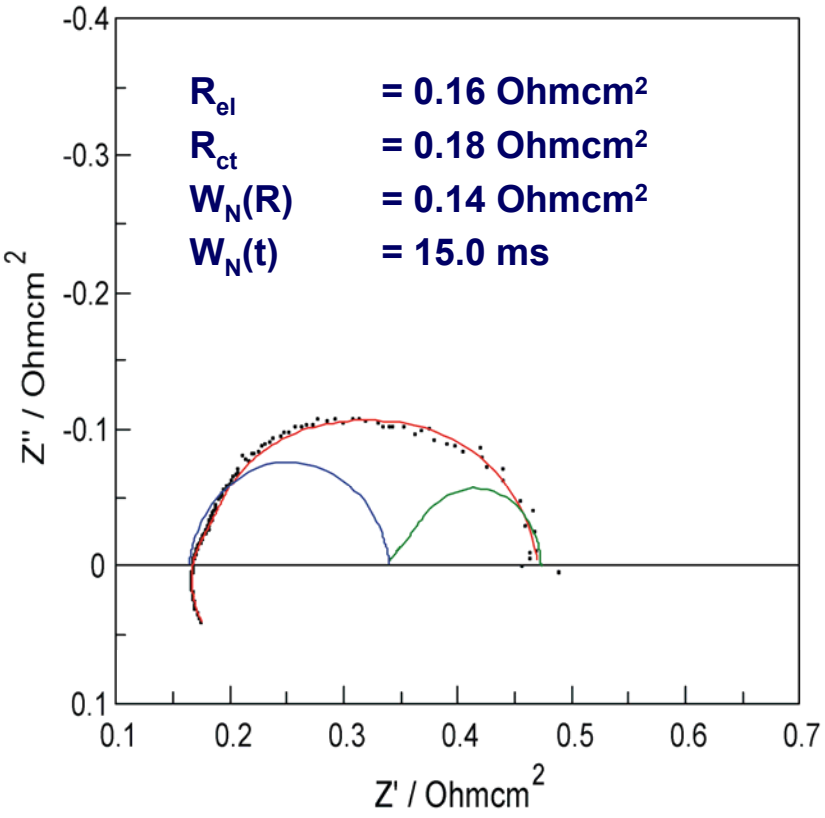
Example: electrode development



Example: Electrode development DHRE combined with EIS

Cathode impedance at 0.6A/cm² / Nyquist plots / 5kHz-100mHz, ZView 2.1b





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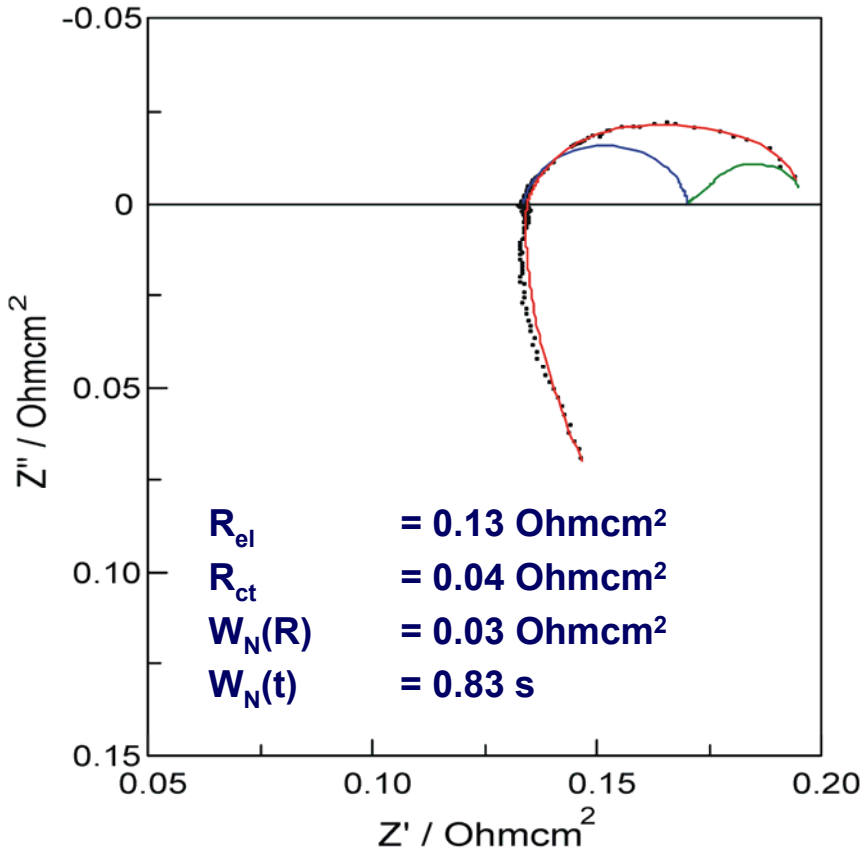
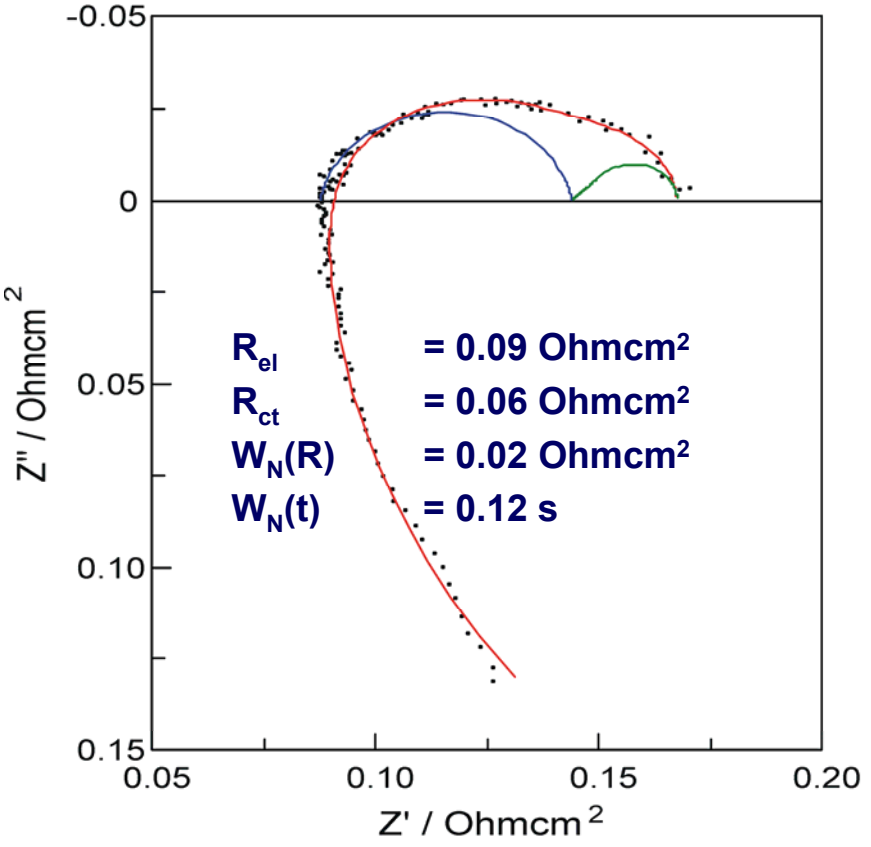
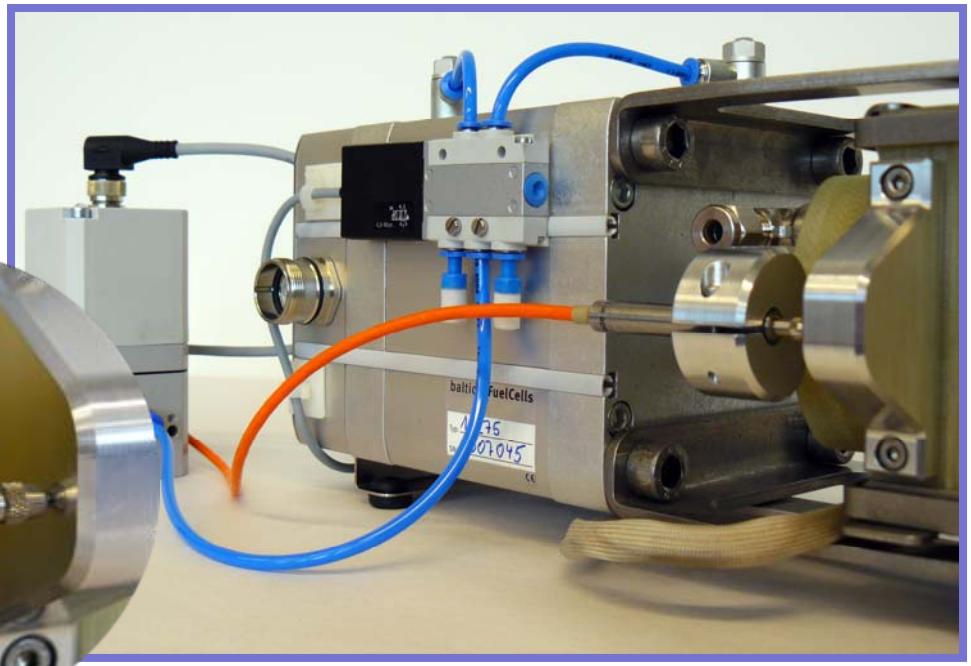




OE - CMD

compression measurement device CMD

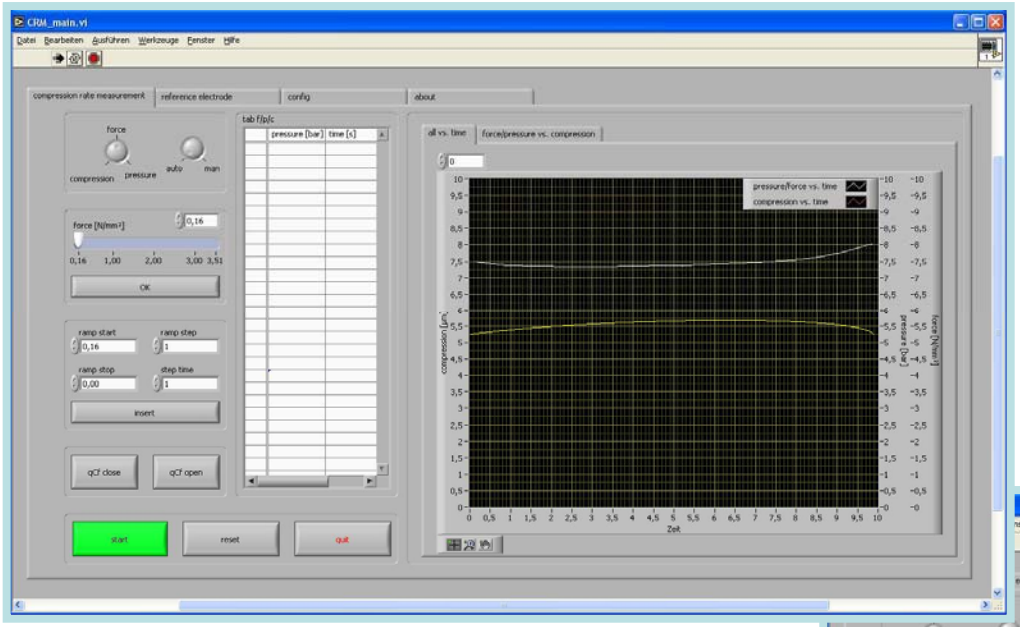
- Compression [%, µm] = f (F; pressure)
- Change of thickness = f(t) with constant or adjusted pressure impact
- for determination of thinning-effects of membranes (Res.: < 1 µm)
- Up to 180 °C



Zoom

electrically controlled precision pressure regulator

OE CMD screenshots of CMD qCf software

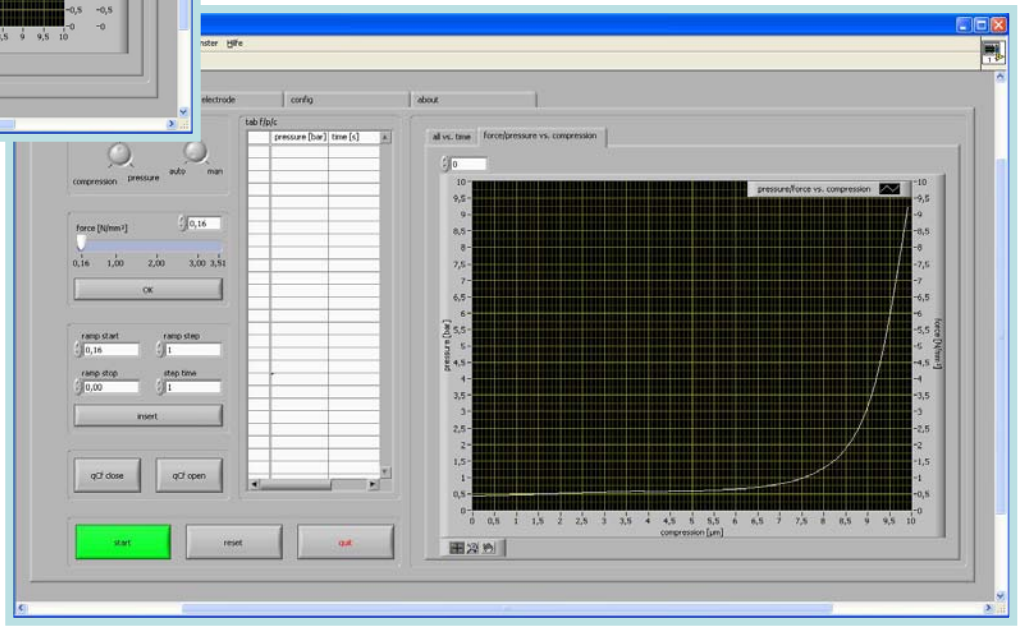


Software environment included in the CMD-package!

Modi#1:

compression & force vs. Time

[% or N / sec.]

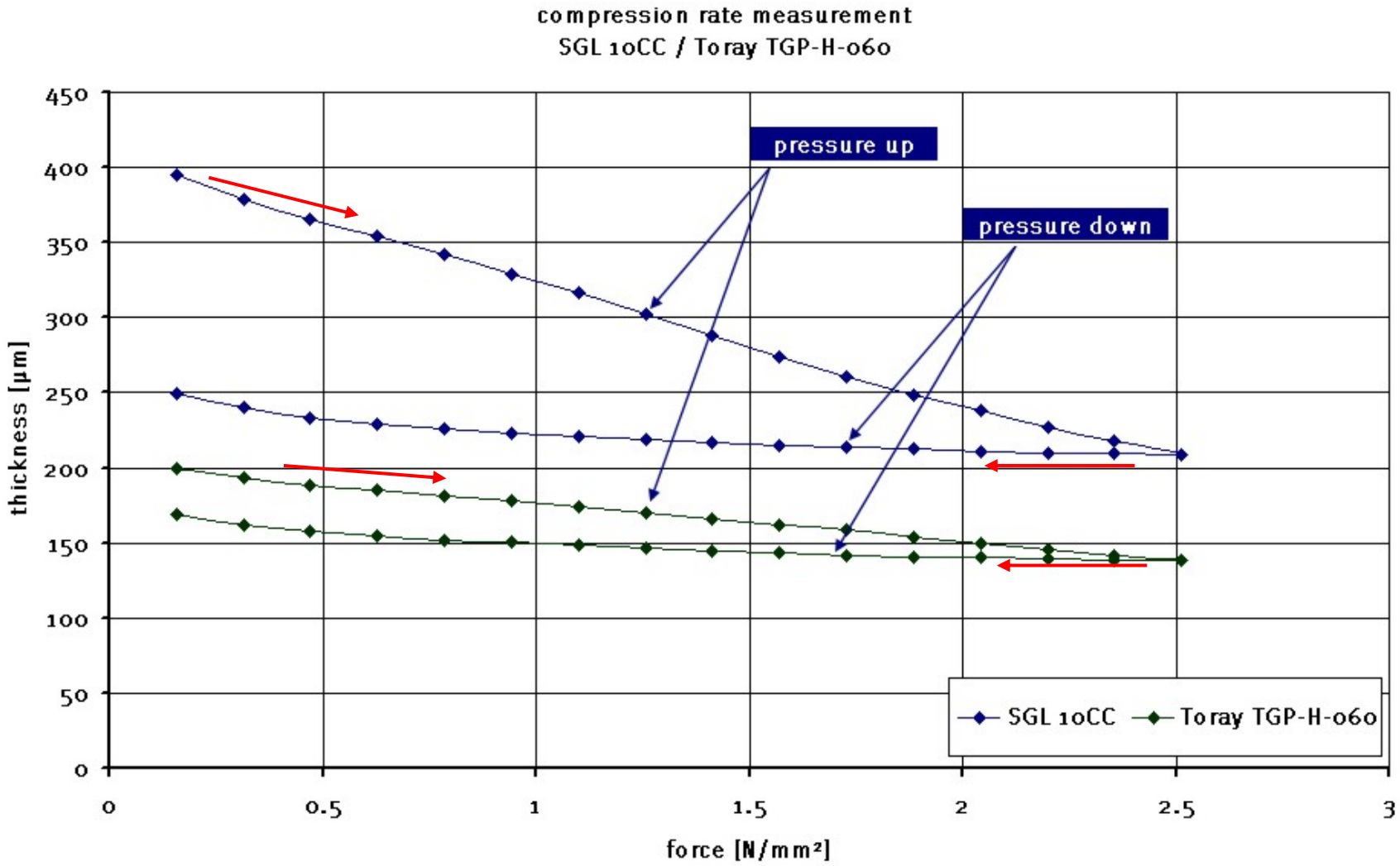


Modi#2:

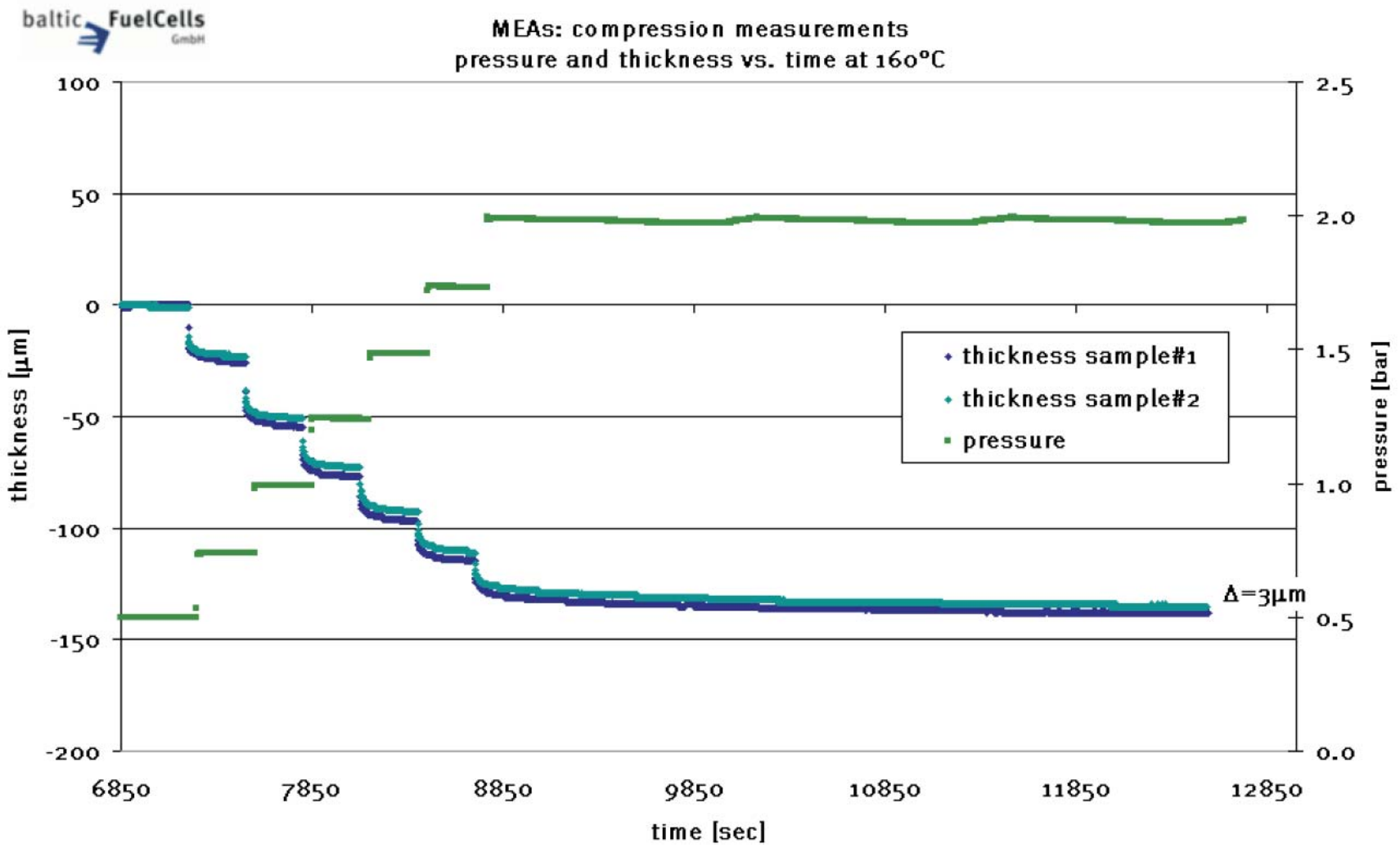
compression vs. Force

[µm / N/mm² or. bar]

Example: compression of GDLs

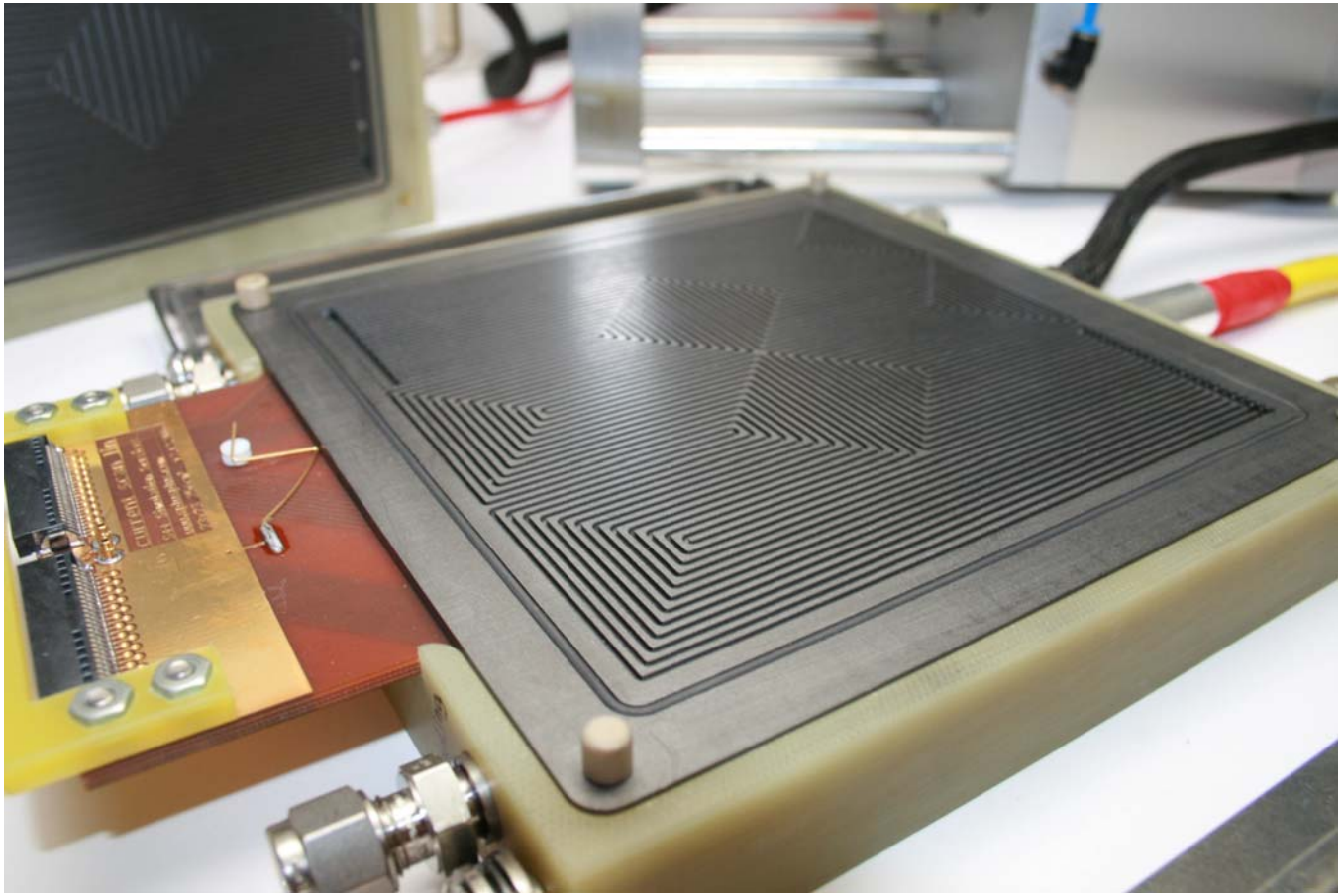


Example: compression of HT-PEFC-MEA



cF with integrated CSL

Current Scan Lin current density distribution sensor



Resolution:
7 mm x 7 mm
up to 2.5 A/cm2
up to 180 °C

Or HiRES
1 mm x 1 mm

Example: CSL for 225 cm^2 PEFC

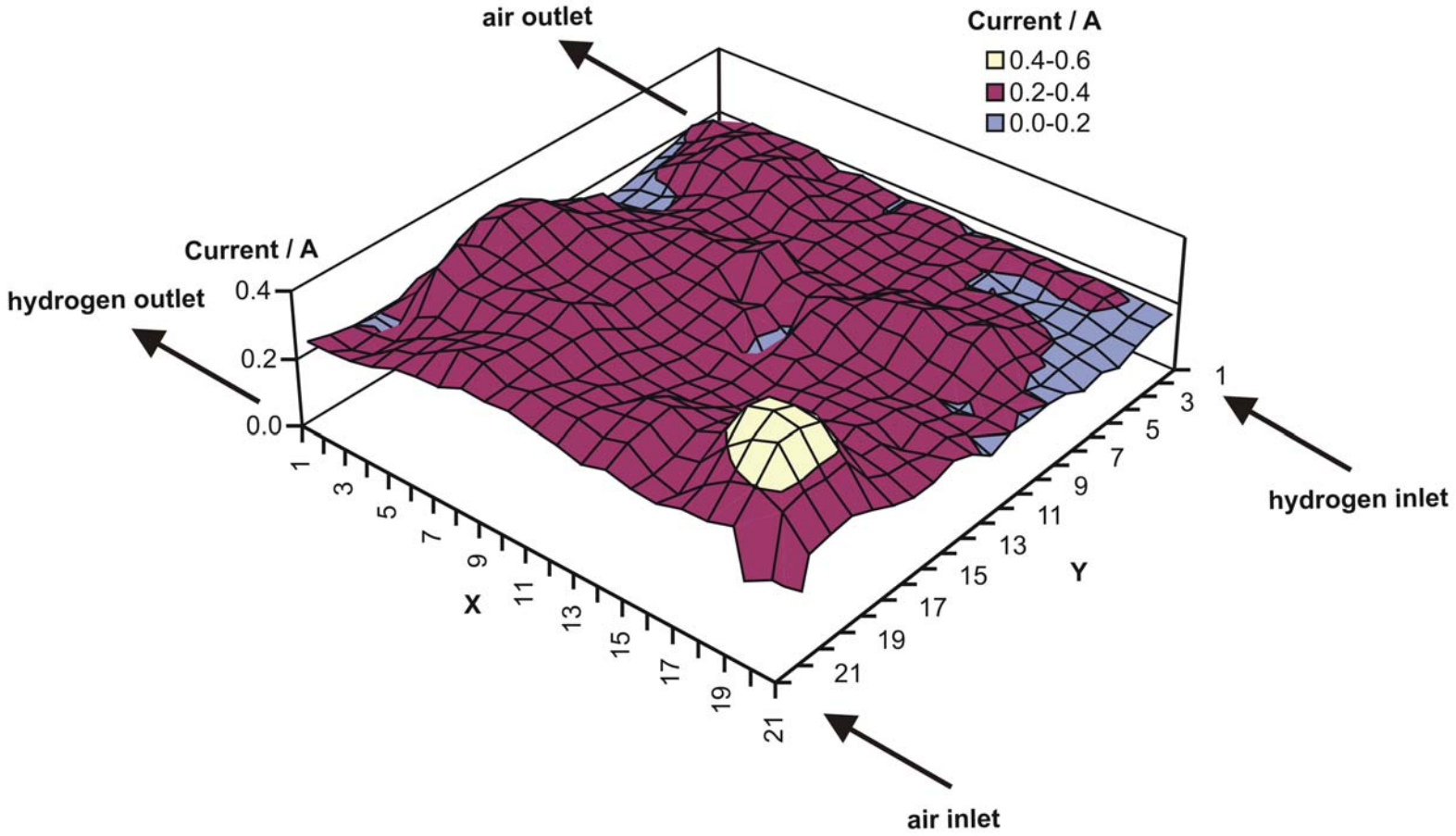


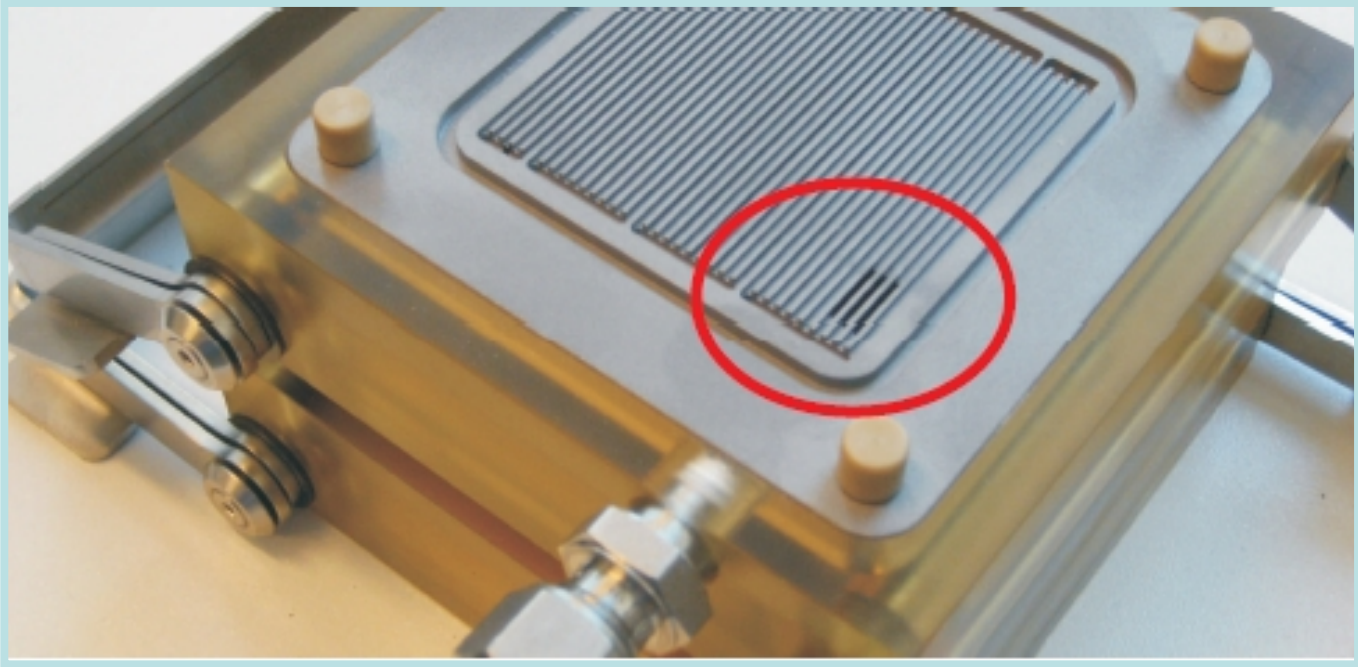
Fig. current density distribution of 225 cm^2 MEA at 65 °C, ambient pressure, air: λ = 3.5 (100% r.h.), H_2: λ = 1.5 (85% r.h.), 1N/mm^2 Average current density: 0.5 A/cm2; 21 x 21 segments

cF with integrated HSE 100

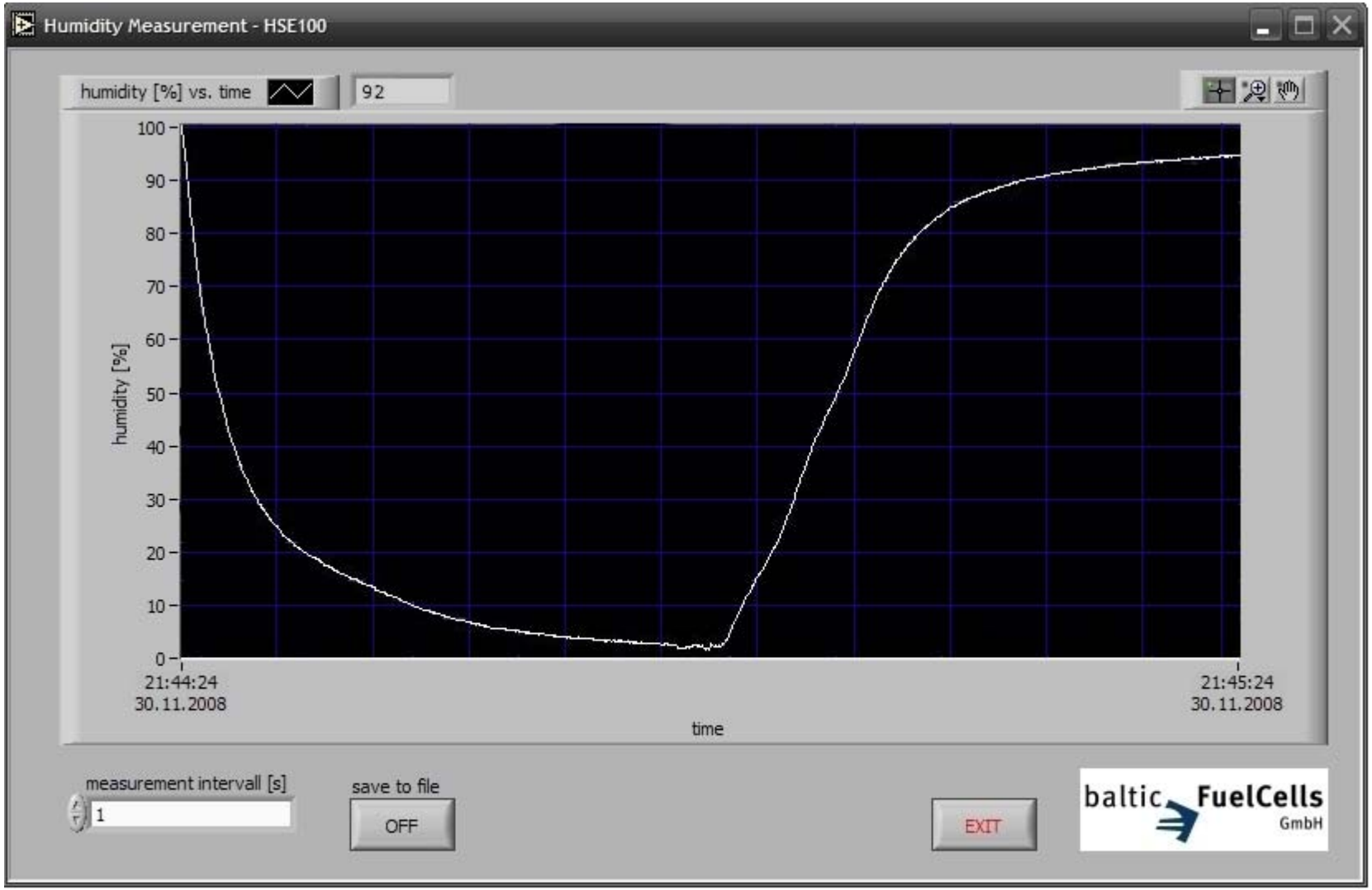
Integration of a

humidity sensor (capacitive)

in the channel ground of the flow field



HSE100 measurement (screenshot)



QA *quality assurance with quickCONNECTfixture*

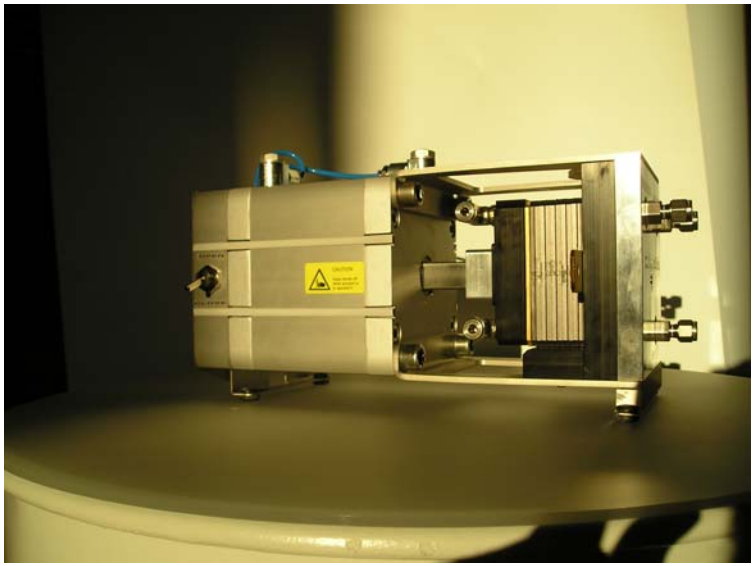
baltic FuelCells

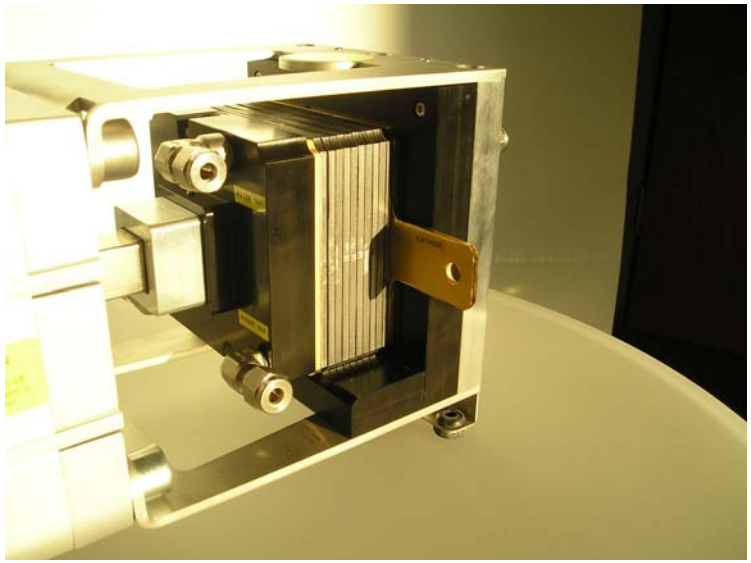
baltic FuelCells GmbH

all advantages of the qCf concept at a glance

feature	conventional test fuel cells	*quickCONNECTfixture*
adjustable contact pressure	○	✓
direct pressure impact on active fuel cell area	○	✓
operation up to 180°C	○	✓
no tools needed for exchange of specimen	○	✓
dismounting and mounting in less than one minute	○	✓
suitable for strong demands in quality assurance	○	✓
no decoupling of electrical or media supplies when dismounting	○	✓
optional equipment available	○	✓
online/in-situ thickness measurement (compression rate)	○	✓
easy exchange of flow fields	○	✓
adoption custom design	○	✓

New! Short stack tester





Endplates with media connections integrated in test frame
Example: 50 cm^2 active area, 5 cells, liquid cooling

Thank you for your attention!

I would like to welcome you at our booth!

Contact:

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www.balticfuelcells.de