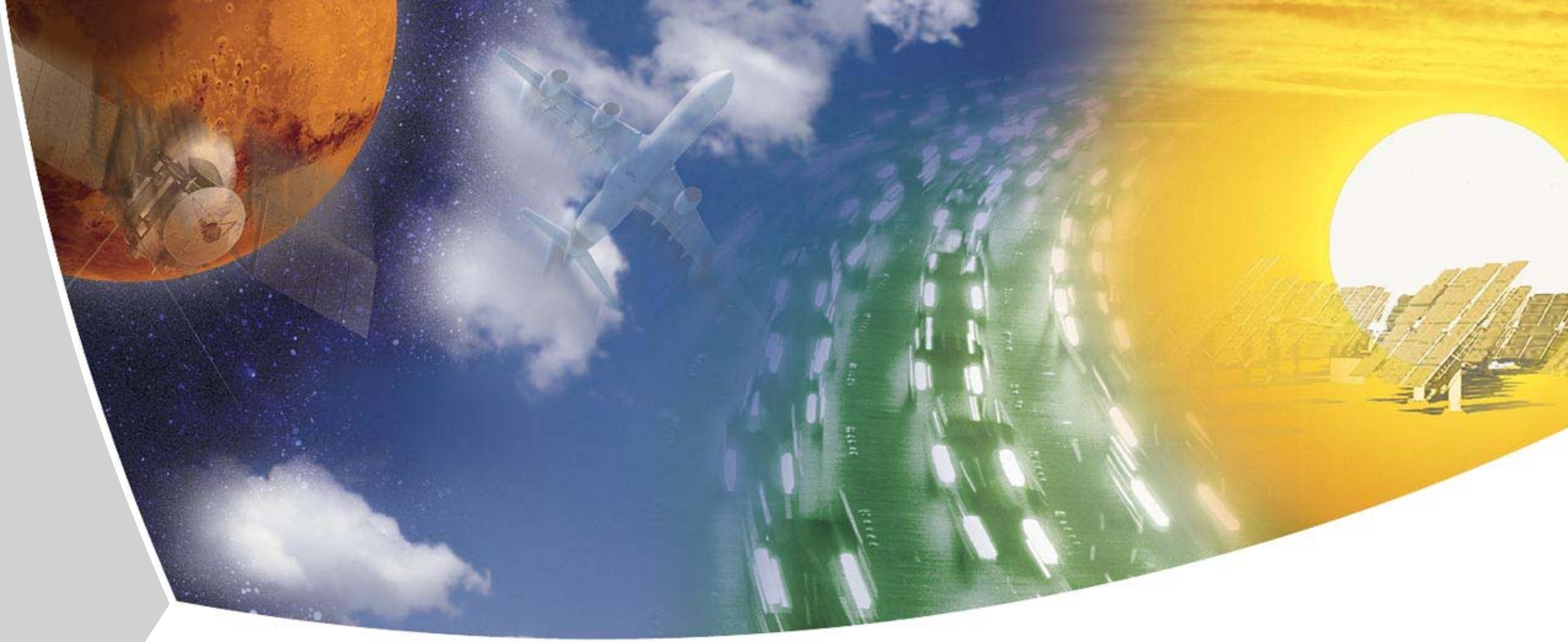


Key Areas for Future SOFC R&D – Basic Research

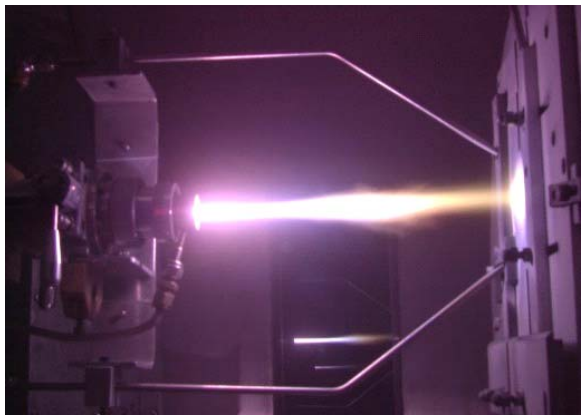
G. Schiller

Deutsches Zentrum für Luft- und Raumfahrt (DLR)
Institut für Technische Thermodynamik

European SOFC Stakeholders Workshop, November 26-27, 2008
National Palace of Culture, Sofia, Bulgaria

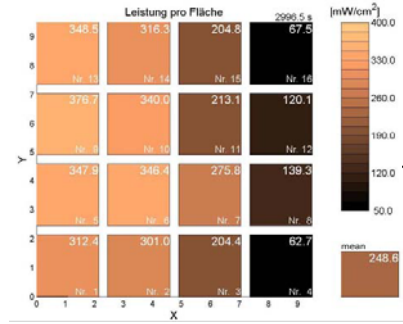
DLR Deutsches Zentrum für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

Fabrication of Metallic Supported Cells (MSC)



Analytics and Characterisation of Cells and Stacks (MSC, ASC)

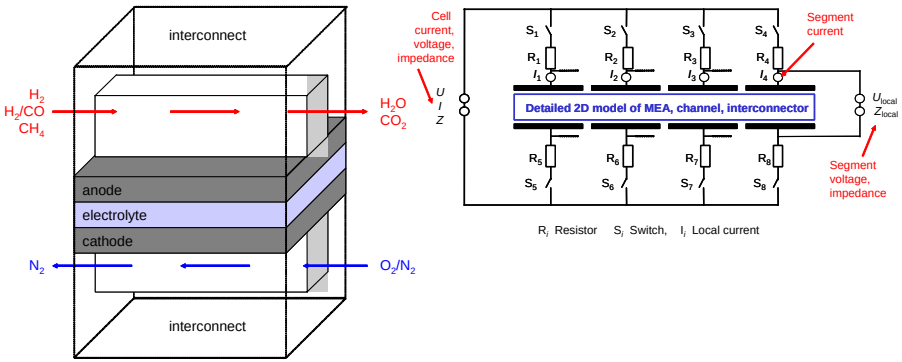
Fuel gas



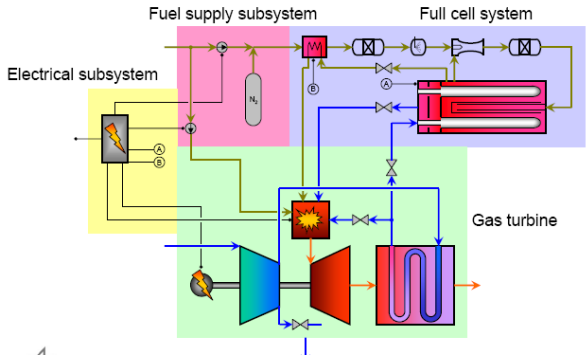
Air

SOFC Activities at DLR

SOFC Modeling



System Technolgy of Electrochemical Systems



Hybrid Power Plant

R&D Topics for SOFC Basic Research

- Detailed investigation of electrode processes during operation under real operating conditions (high current density, high fuel utilisation, reformate fuel) by applying spatially resolved measurements, modeling and post-analyses

  Aim: Homogeneous distribution of electrochemical performance and cell temperature

  Minimisation of cell degradation

- Detailed investigation of structure-performance relationships by applying different imaging methods

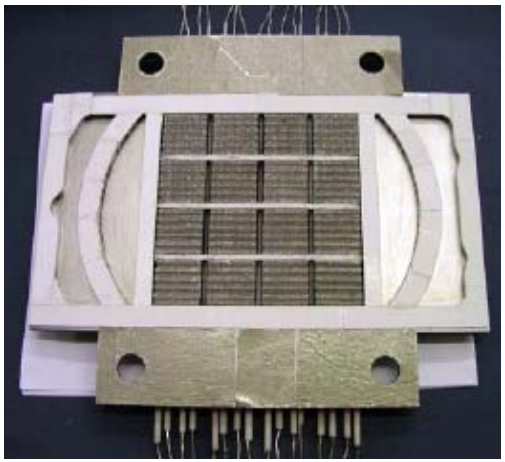
  Aim: Optimisation of electrode microstructure

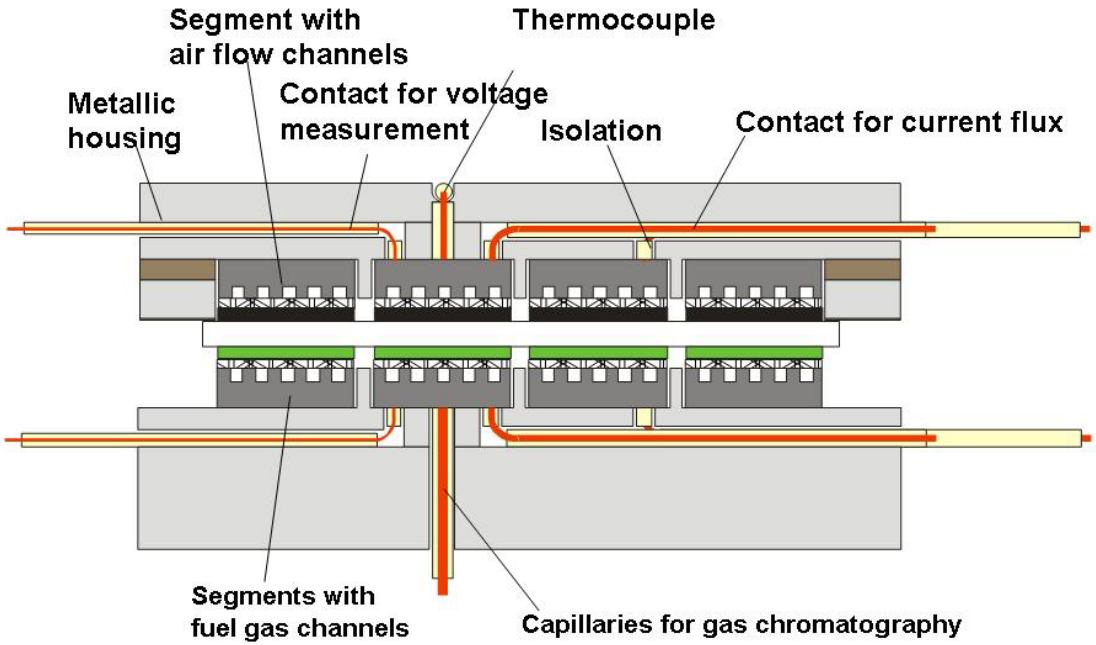
  Improvement of cell lifetime

- Detailed investigation of reaction mechanisms of contamination of SOFC anode by applying a combined experimental and modeling approach

  Aim: Prediction of electrochemical cell degradation through contamination with different species

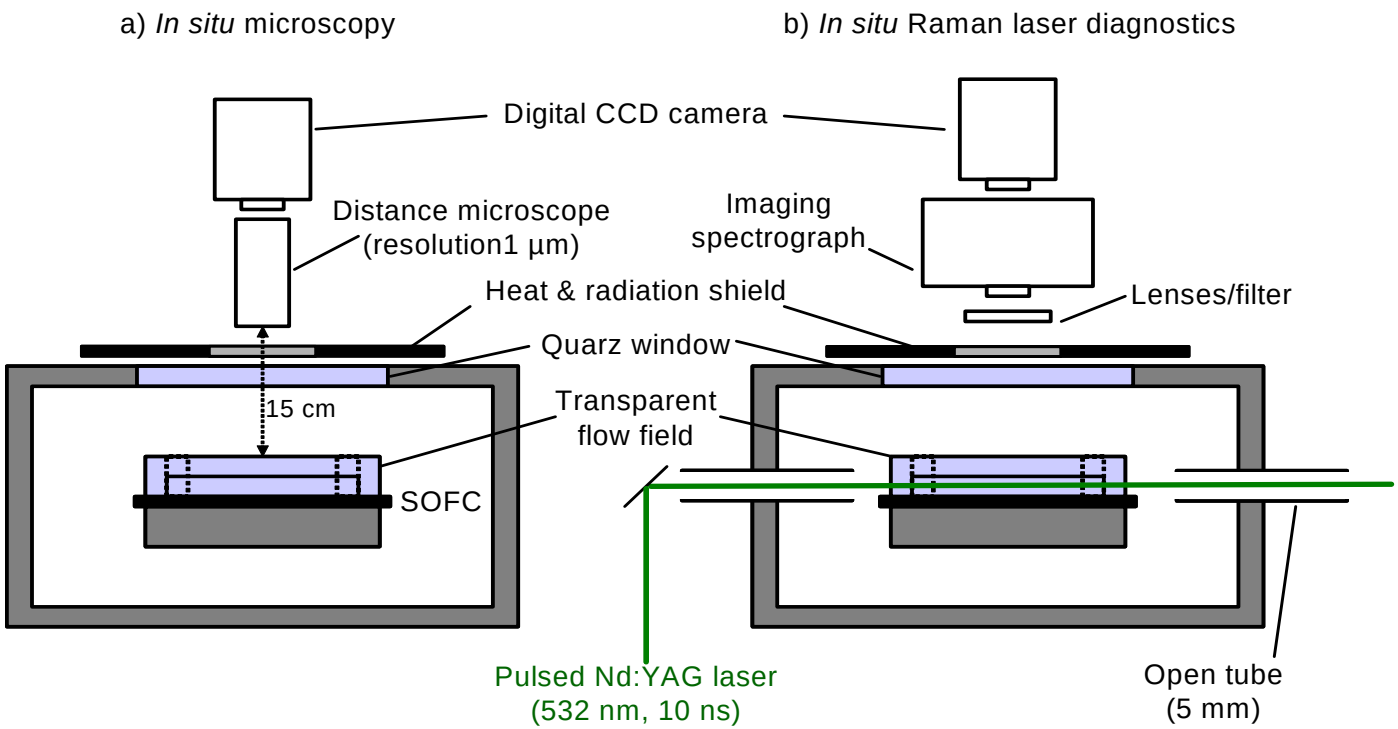
Measurement Setup for Segmented Cells





- 16 galvanically isolated segments
- Local and global i-V characteristics
- Local and global impedance measurements
- Local temperature measurements
- Local fuel concentrations
- Flexible design: substrate-, anode-, and electrolyte-supported cells
- Co- and counter-flow

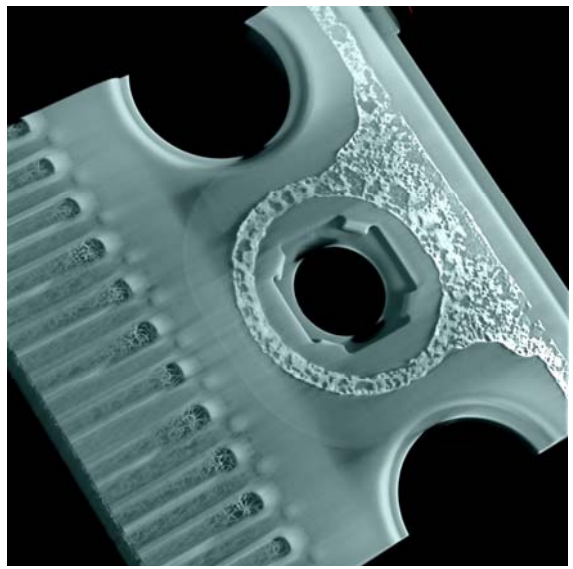
Potential for Optical Spectroscopies



X-Ray Tomography (CT) Facility at DLR

X-Ray CT Facility v|tome|x L450 at DLR Stuttgart

3 dimensional non intrusive imaging of SOFC cassette

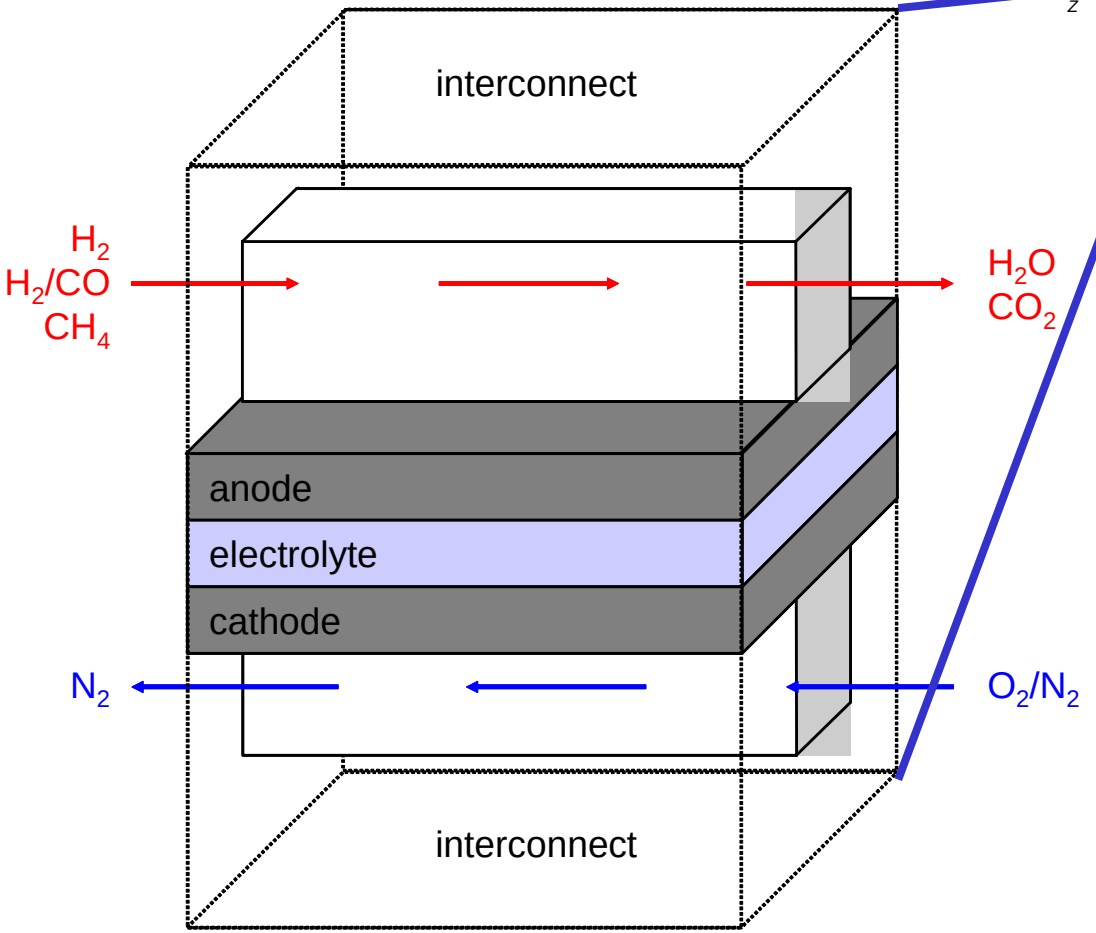


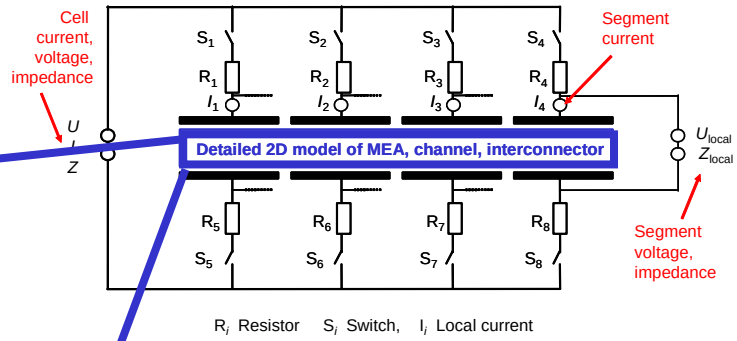
Ex Situ and In Situ Diagnostic Methods at DLR

- **Ex situ diagnostic methods:**
  - SEM/EDX
  - XPS
  - XRD
  - Dilatometry
  - Thermal analysis
  - Porosimetry (Hg intrusion, N_2 adsorption); TPDRO

- **Non-traditional in situ methods:**
  - Locally resolved measurements
  - Optical spectroscopies and x-ray tomography (Outlook)

Modeling and simulation

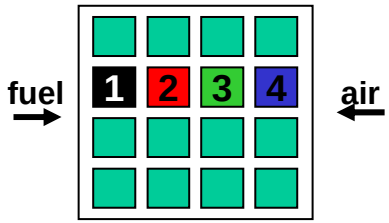




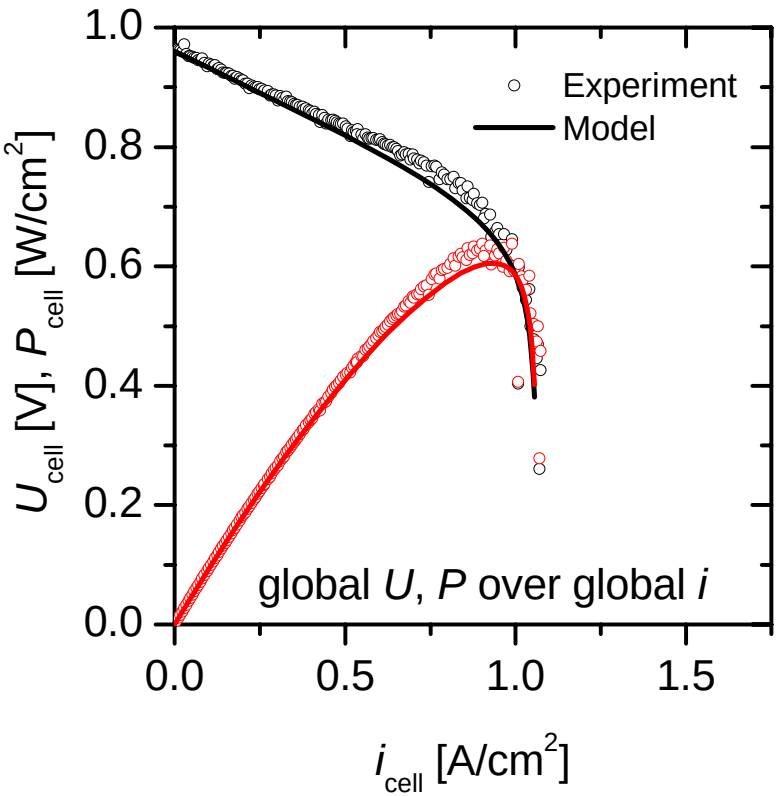
- Electrochemistry: Elementary kinetics
- Porous electrodes: Mass and charge transport
- Channels: Transient Navier-Stokes conservation equations (Mass, momentum, particles, energy)
- Interconnects: energy conservation

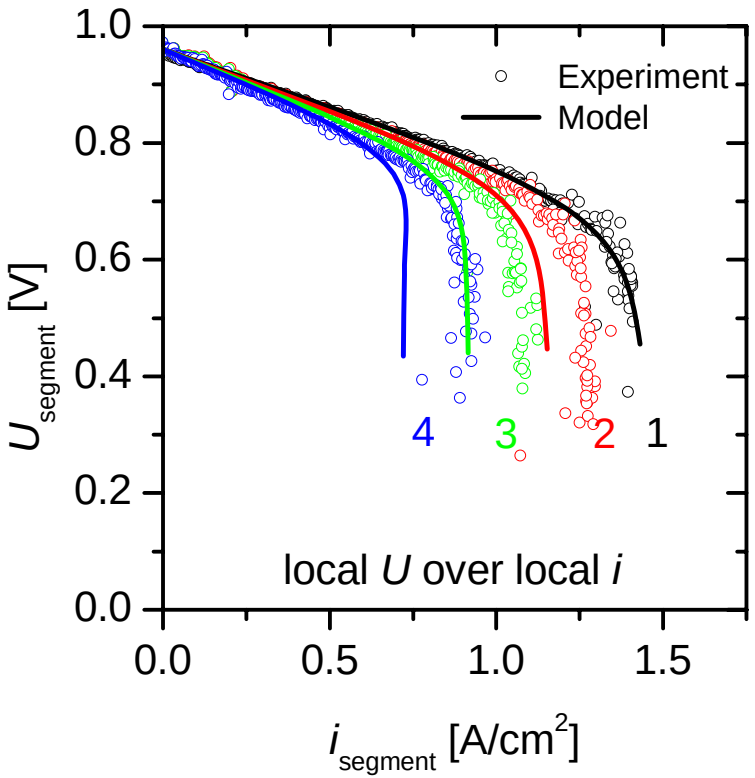
W. G. Bessler, S. Gewies, and M. Vogler, Electrochimica Acta 53, 1782-1800 (2007)

Full measurement and 2D simulation



- Anode: 50% H_2, 50% H_2O, fu_{max}= 60%; cathode: 50% O_2, 50% N_2





- Simulation is in qualitative agreement with experiment