

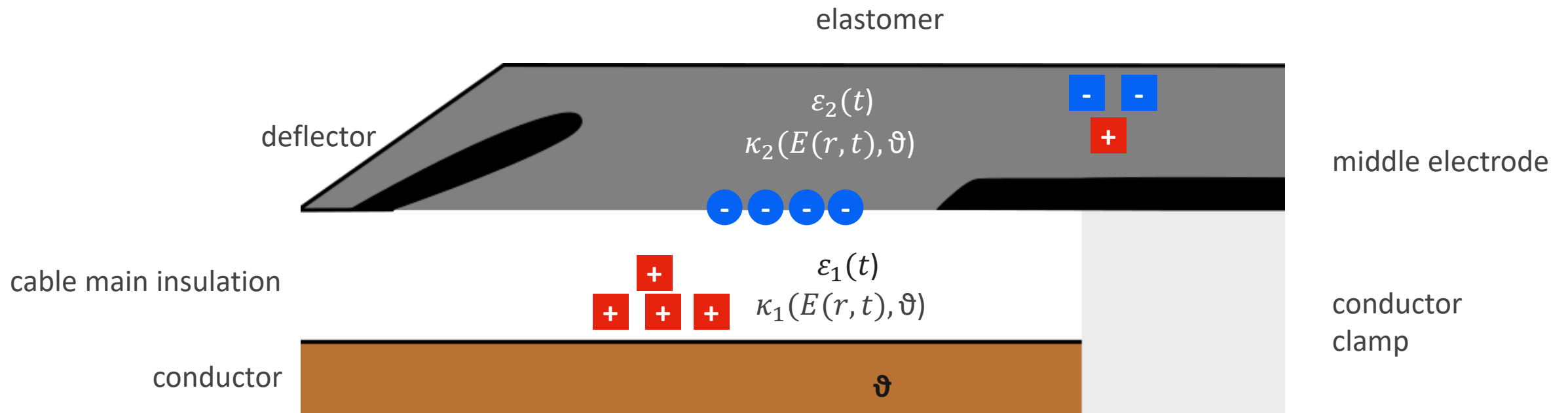
# Effects of Repeated DC Stress Application on Space Charges and Current in Silicone Rubber Plate Specimens

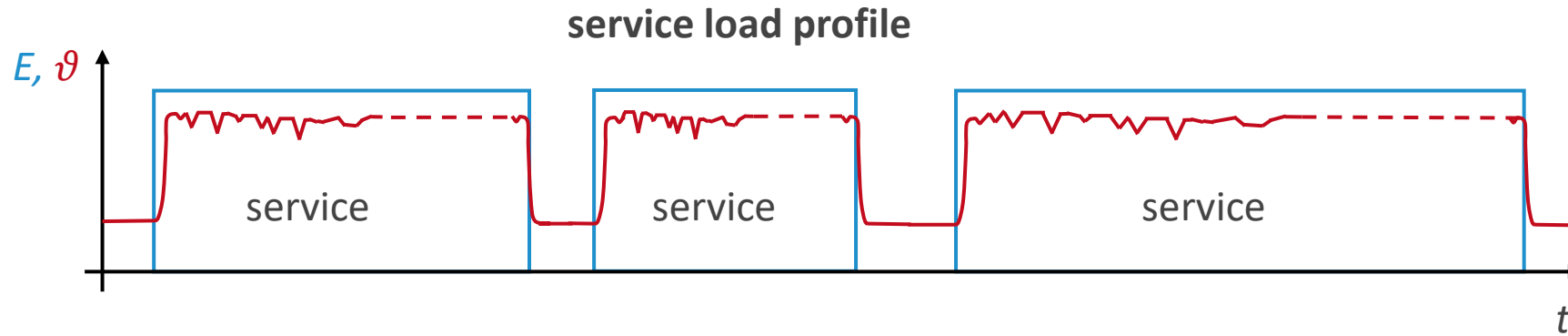
Felix Rösch, Patrick Rössler, Ronald Plath | TU Berlin, High Voltage Engineering

# Material Characterisation for HVDC Applications

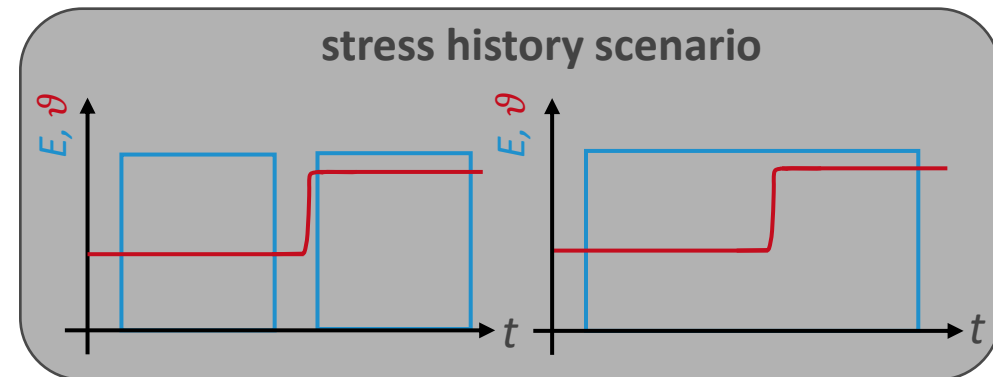
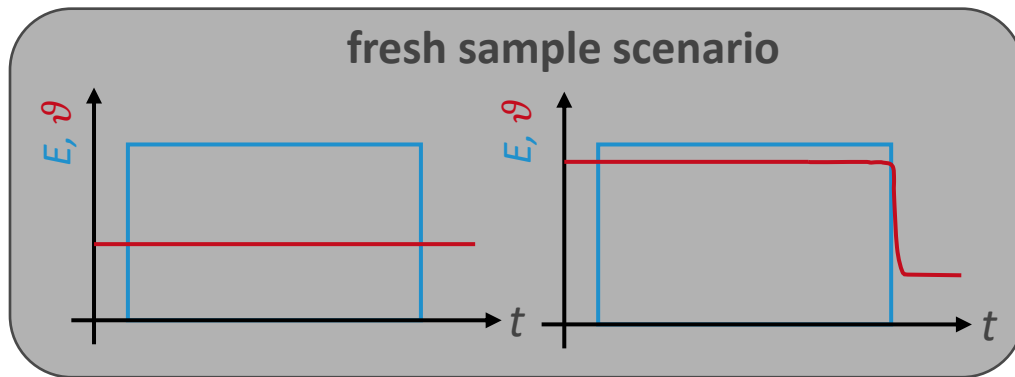


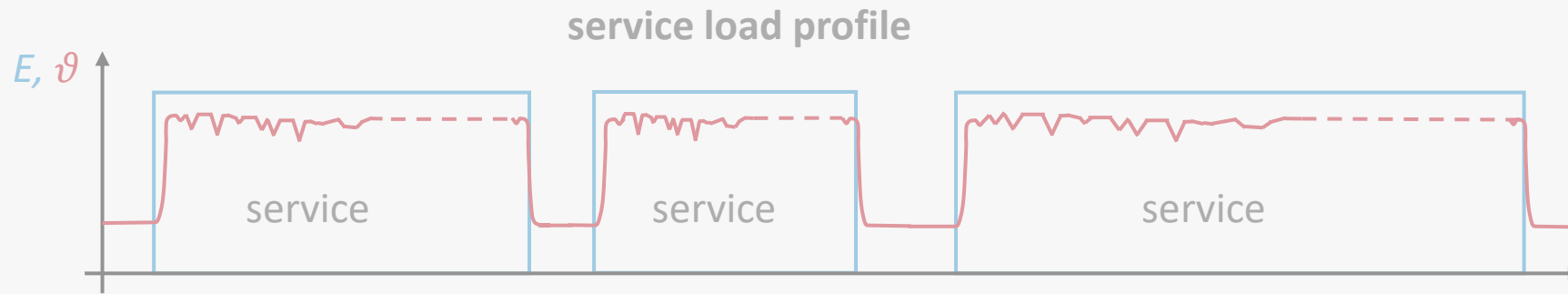
Control over the electric field distribution under all operating condition



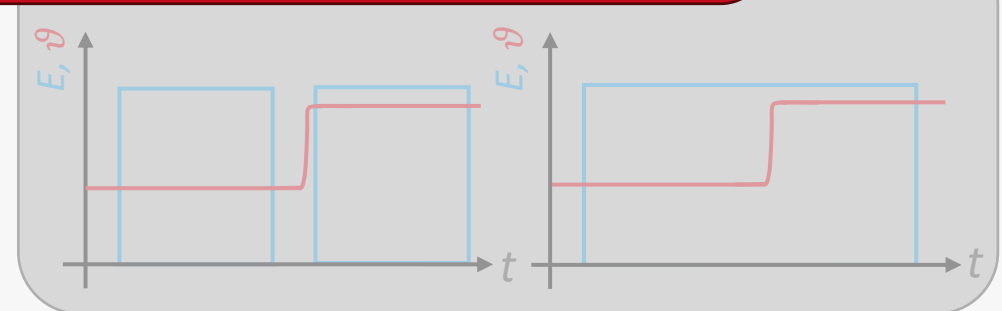
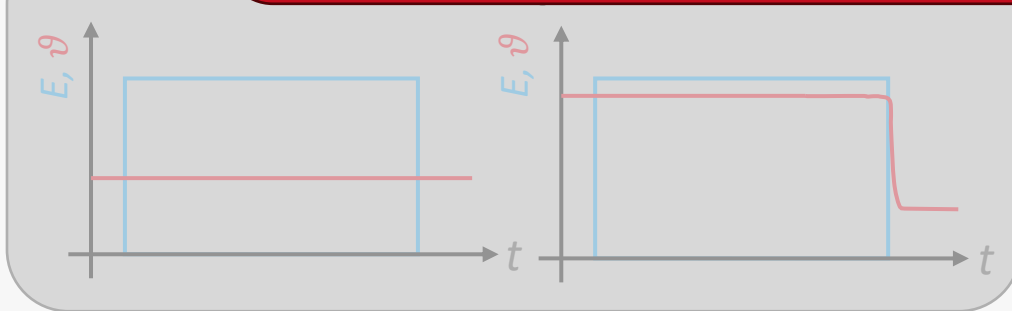


## Material characterisation in lab?





Do we need to consider electric stress history  
when characterising HVDC materials?



# Agenda



**Theoretical Considerations**

**Experiment Description**

**Results and Interpretation**

**Concluison and Outlook**

# Agenda



**Theoretical Considerations**

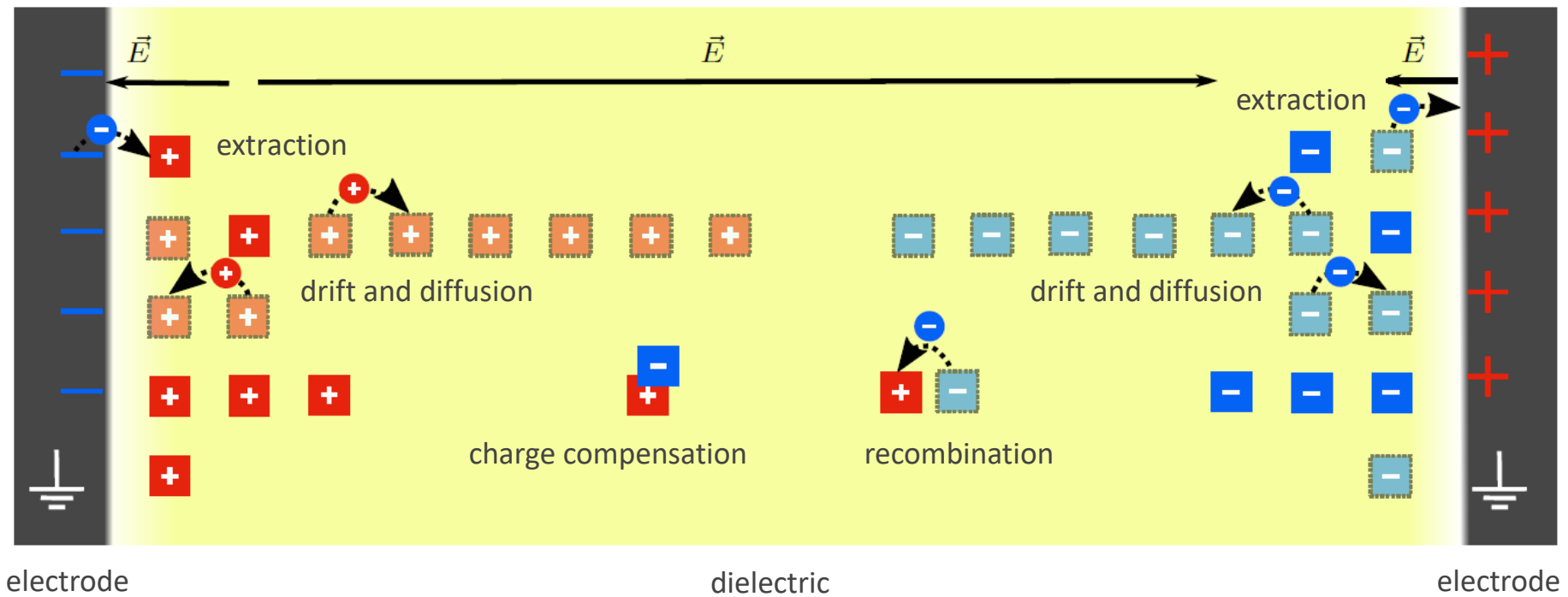
Experiment Description

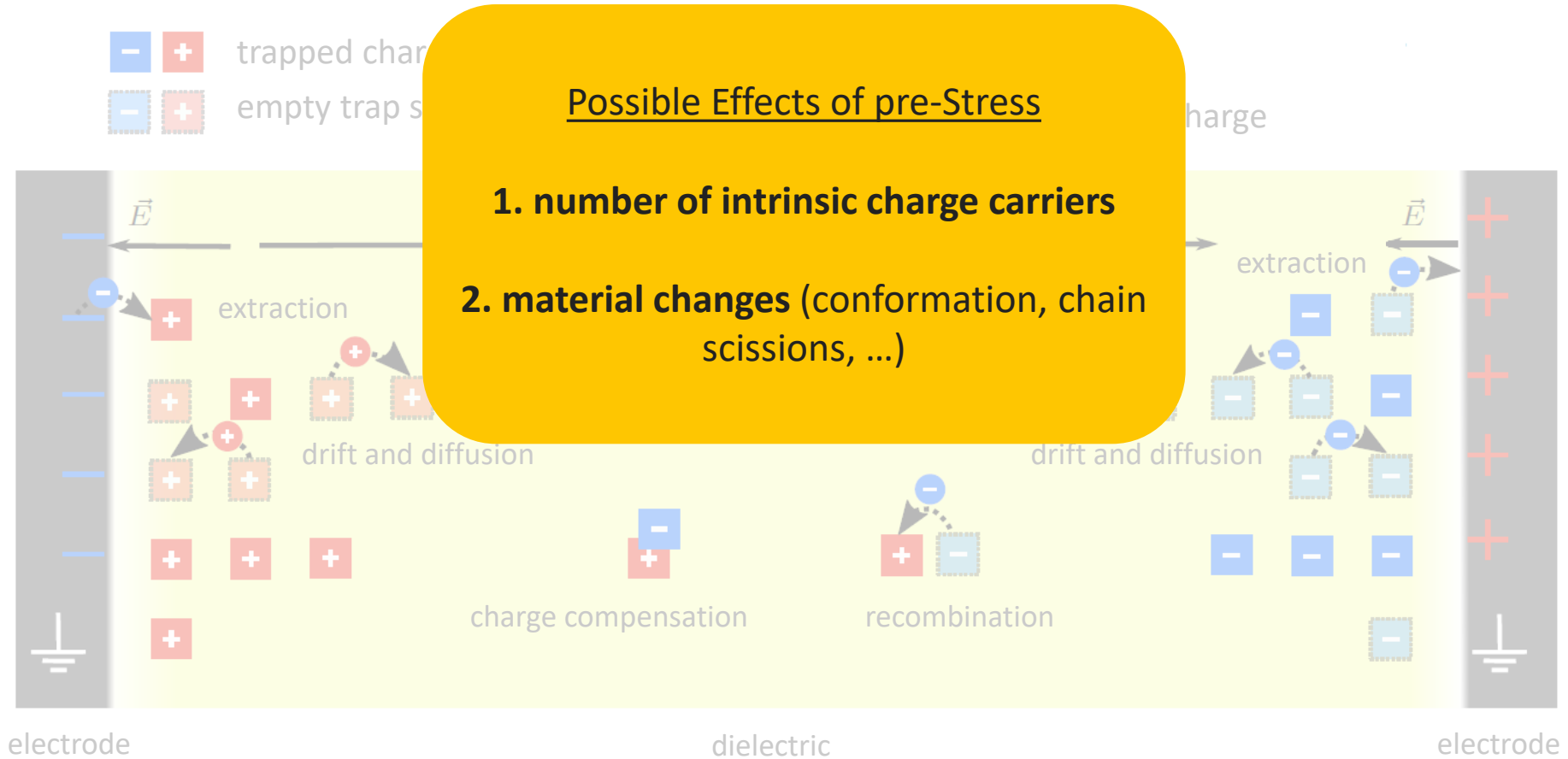
Results and Interpretation

Conclusion and Outlook

# Theoretical Considerations – Charge Decay

- + trapped charges
- + empty trap sites
- + electrons, holes
- influenced electrode charge





## Possible Effects of pre-Stress

1. number of intrinsic charge carriers
2. material changes (conformation, chain scissions, ...)

# Agenda



Theoretical Considerations

Experiment Description

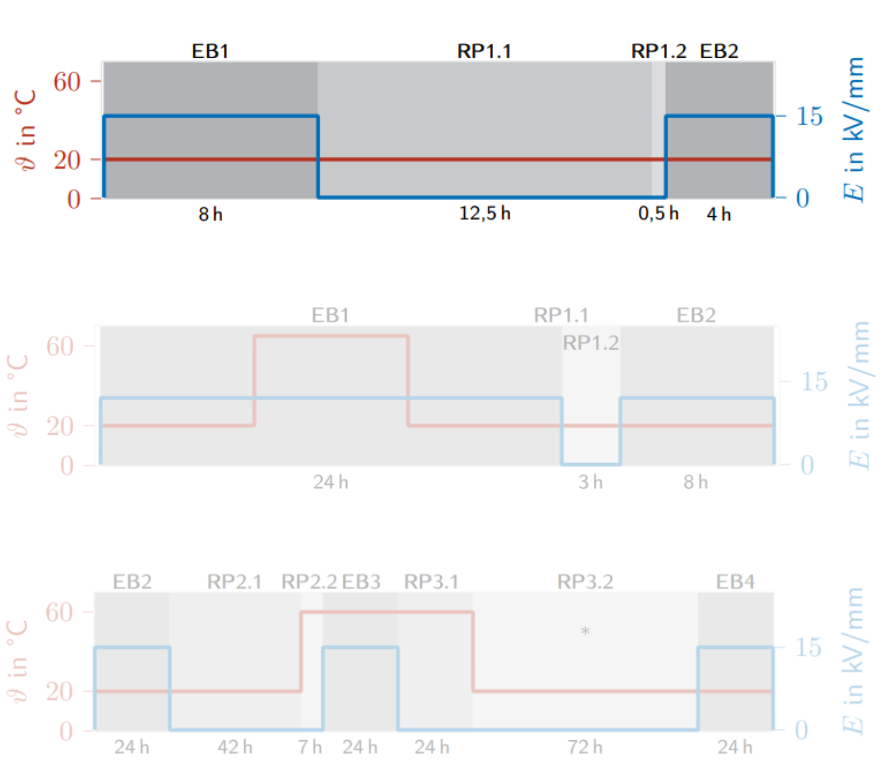
Results and Interpretation

Conclusion and Outlook

# Experiment Description

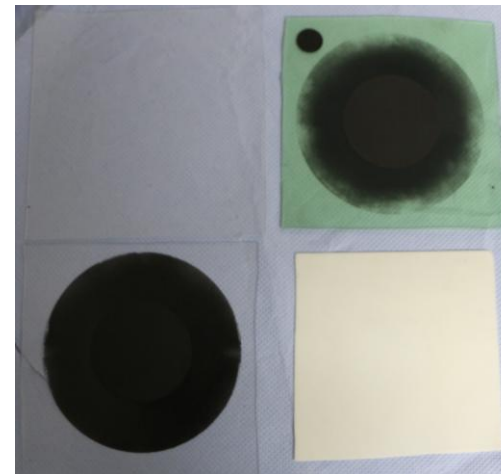


## Stress Profiles



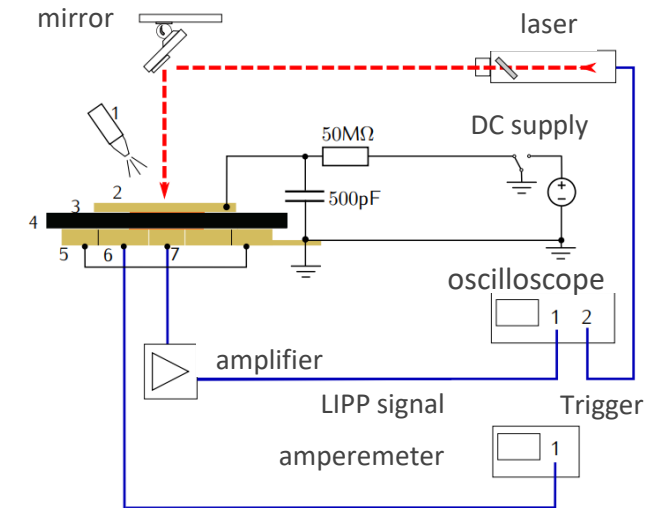
## Materials

6 different silicone rubbers varying electrode material, coupling and sample preconditioning



0,5 mm, 1 mm, 2 mm

## Measurement



modified from \*

Spelzhausen et al. „Parameter Optimization and Improvement of Space Charge Measurements with the Laser Induced Pressure Pulse Method“ in VDE Fachtagung Hochspannungstechnik 2018, isbn: 978-3-8007-4807-5.

more details in: [8,10]

# Agenda



Theoretical Considerations

Experiment Description

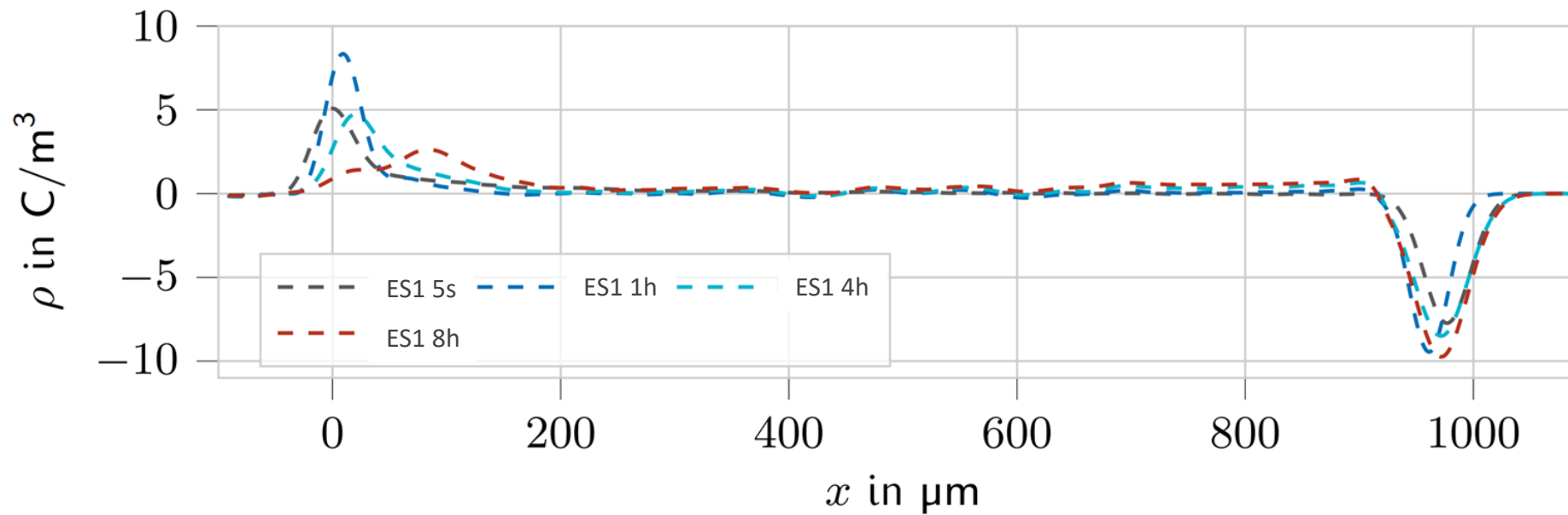
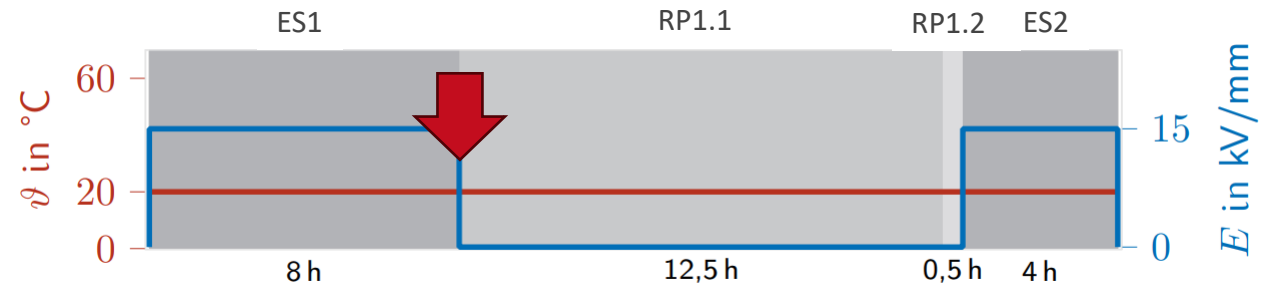
**Results and Interpretation**

Conclusion and Outlook

# Results LSR1



ES: electric stress  
RP: relaxation phase

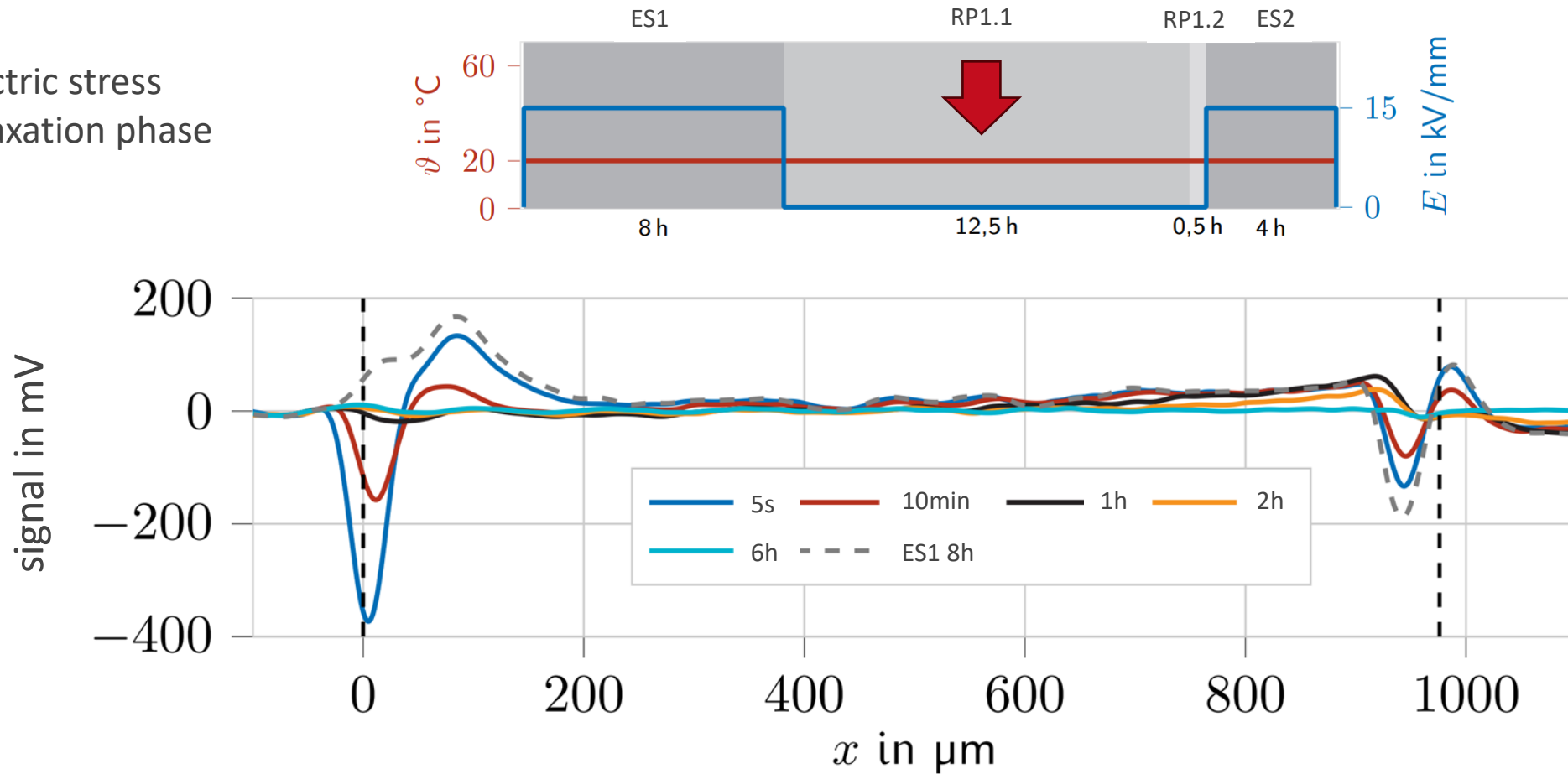


[10]

# Results LSR1



ES: electric stress  
RP: relaxation phase

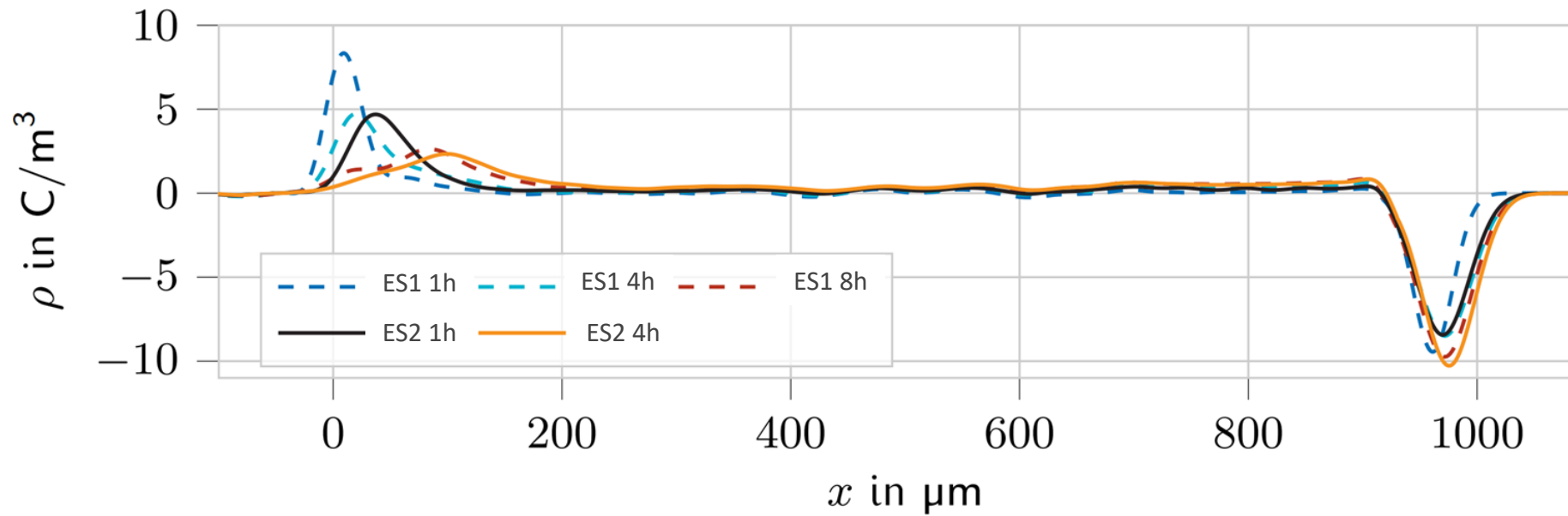
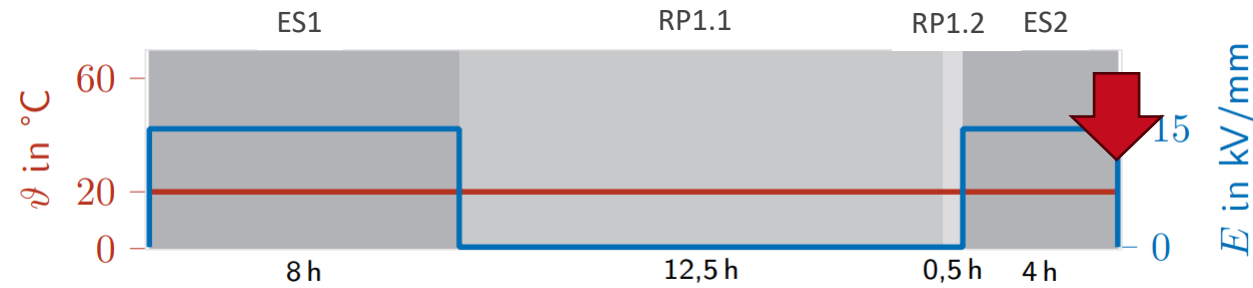


[10]

# Results LSR1

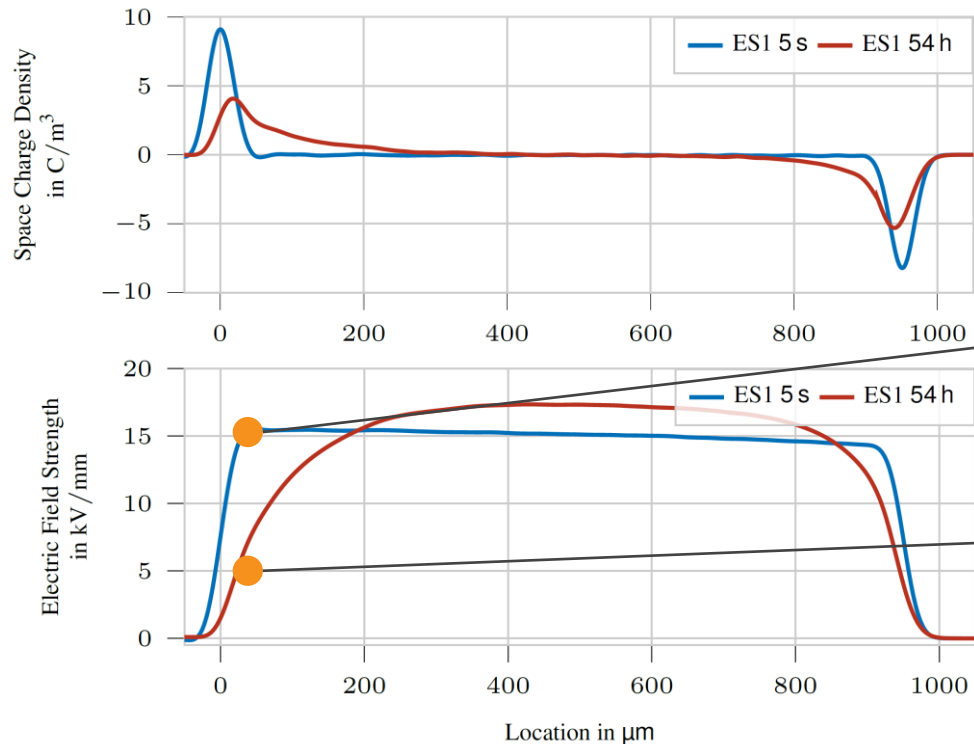


ES: electric stress  
RP: relaxation phase

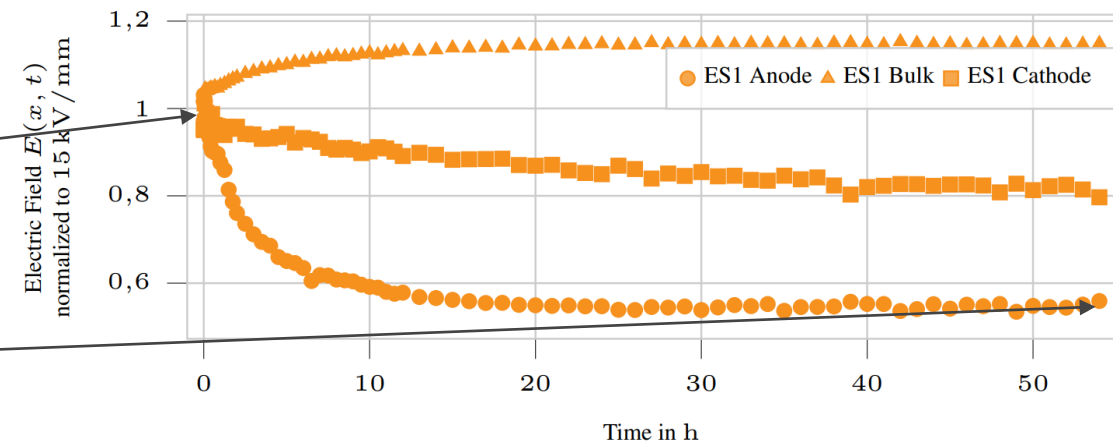


[10]

# Results: Correlating Space Charges and Current

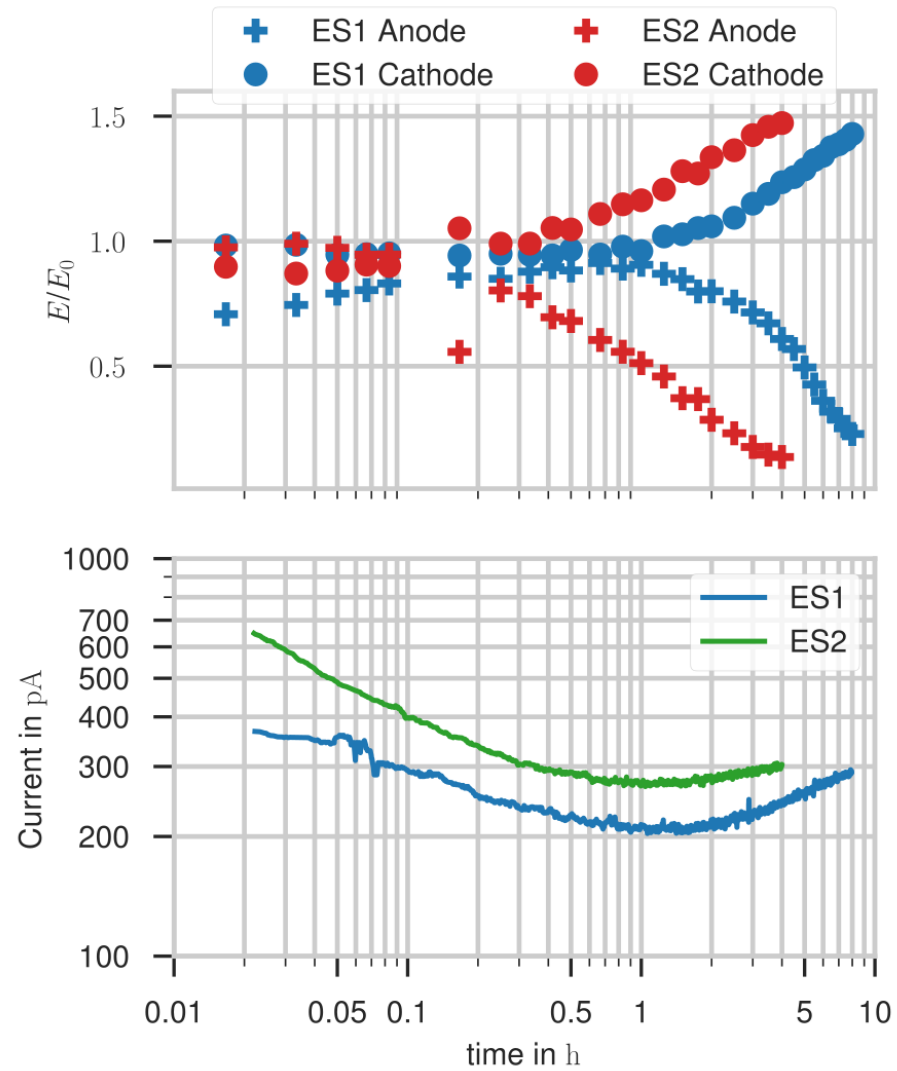


- 1) Calculate  $E(x)$  from  $\rho(x)$  from every single measurement
- 2) Determine  $E$  at certain points and plot over time

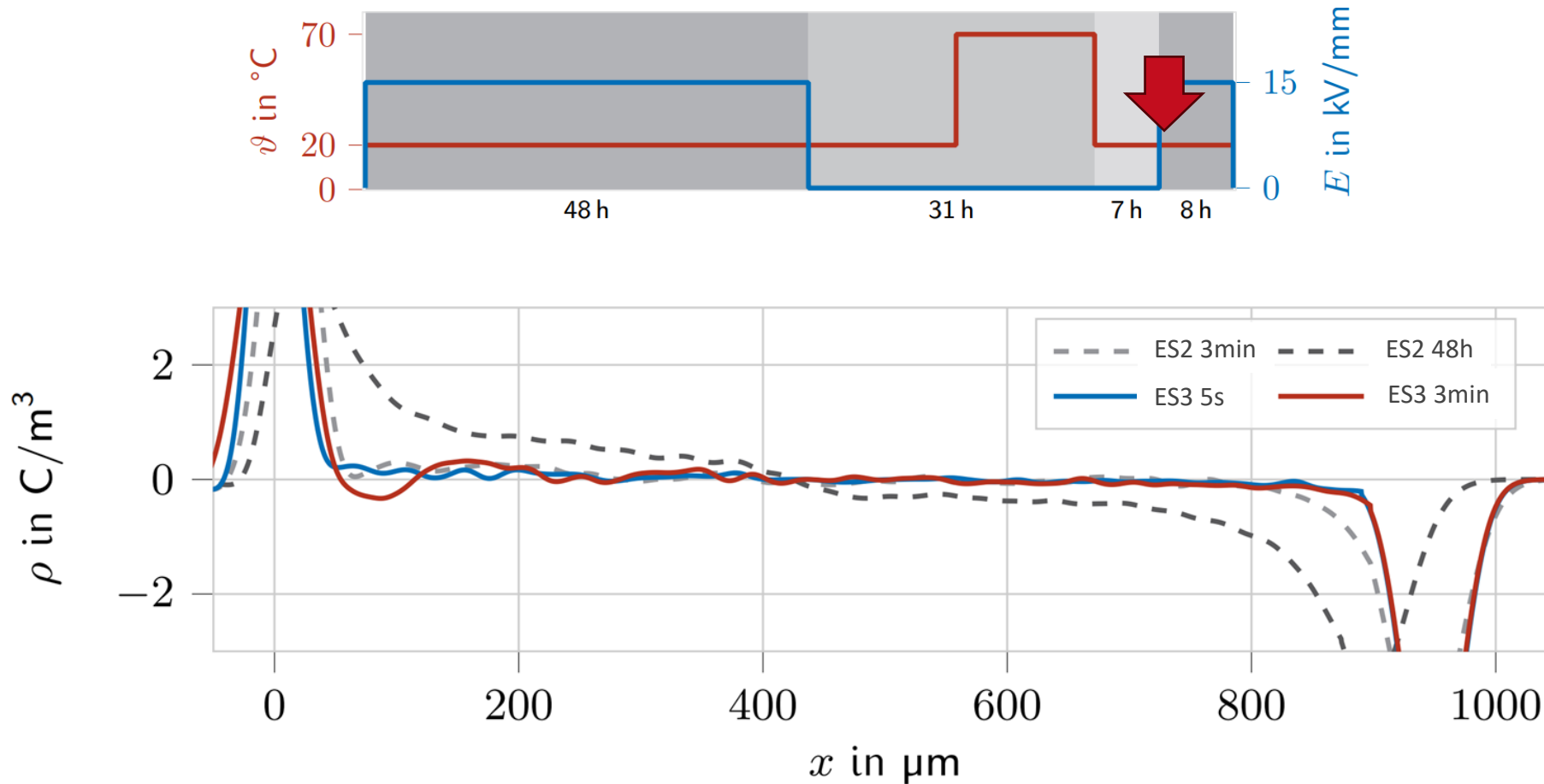


Space charge measurement results and derived electric field strength distribution

# Results LSR1

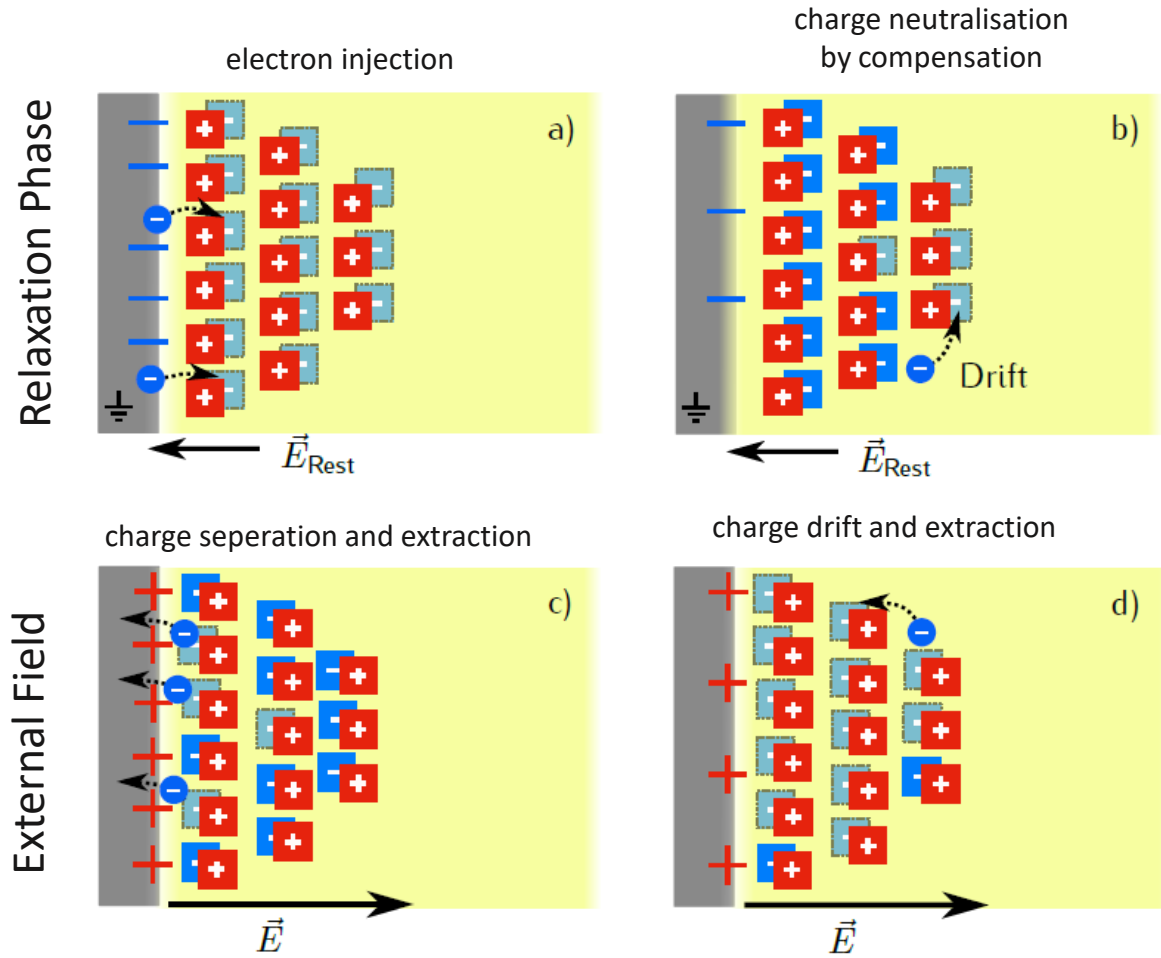


# Interpretation: Analysis of Space Charge Build-Up during the Beginning of Consecutive Electric Stress Application LSR3

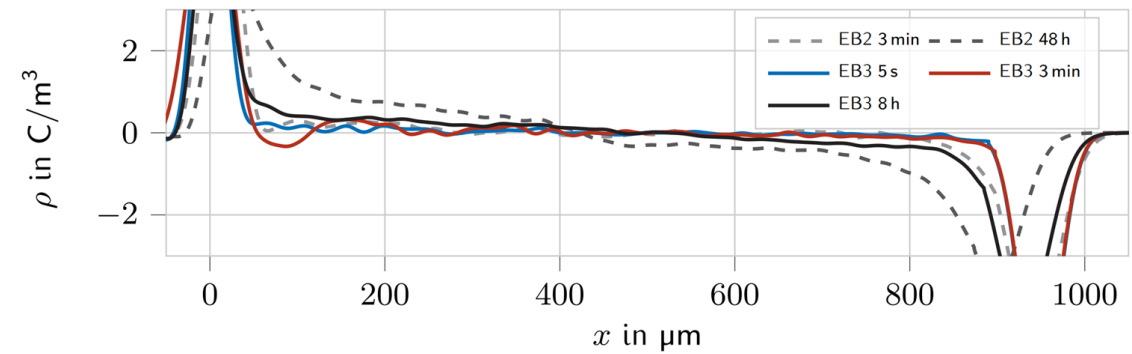
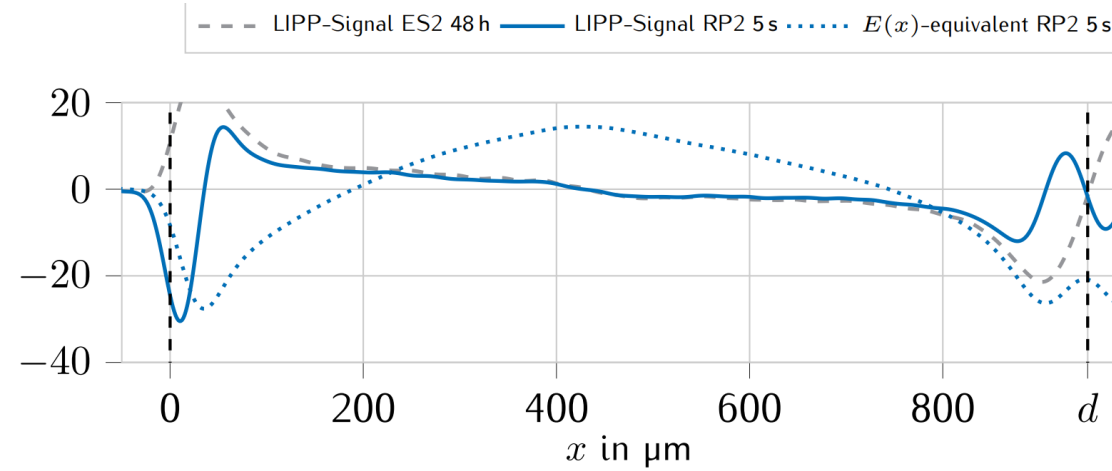


[10]

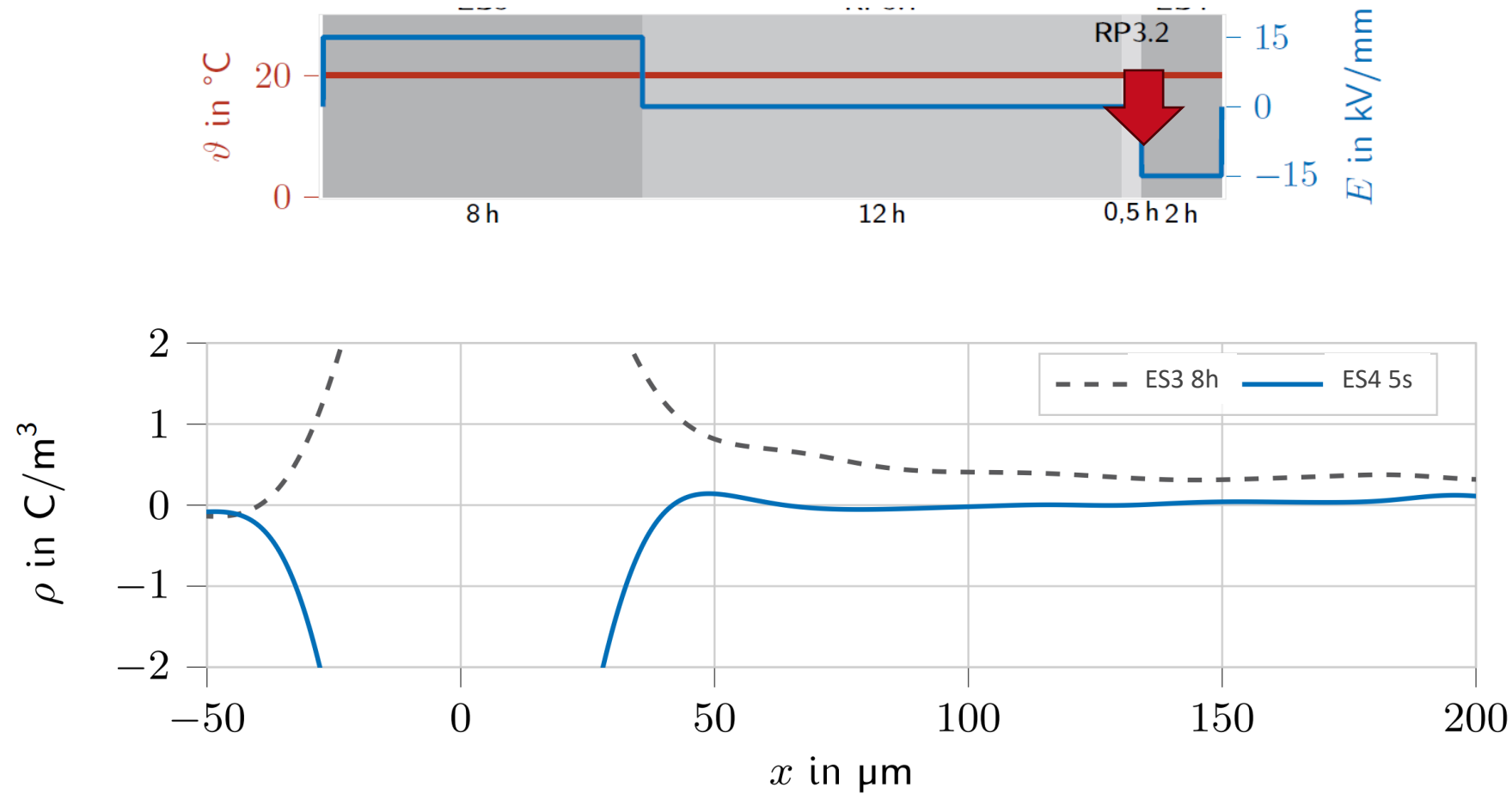
# Interpretation: Analysis of Space Charge Decay LSR3



space charge measurement  
signal and electric field equivalent  
in a. u.

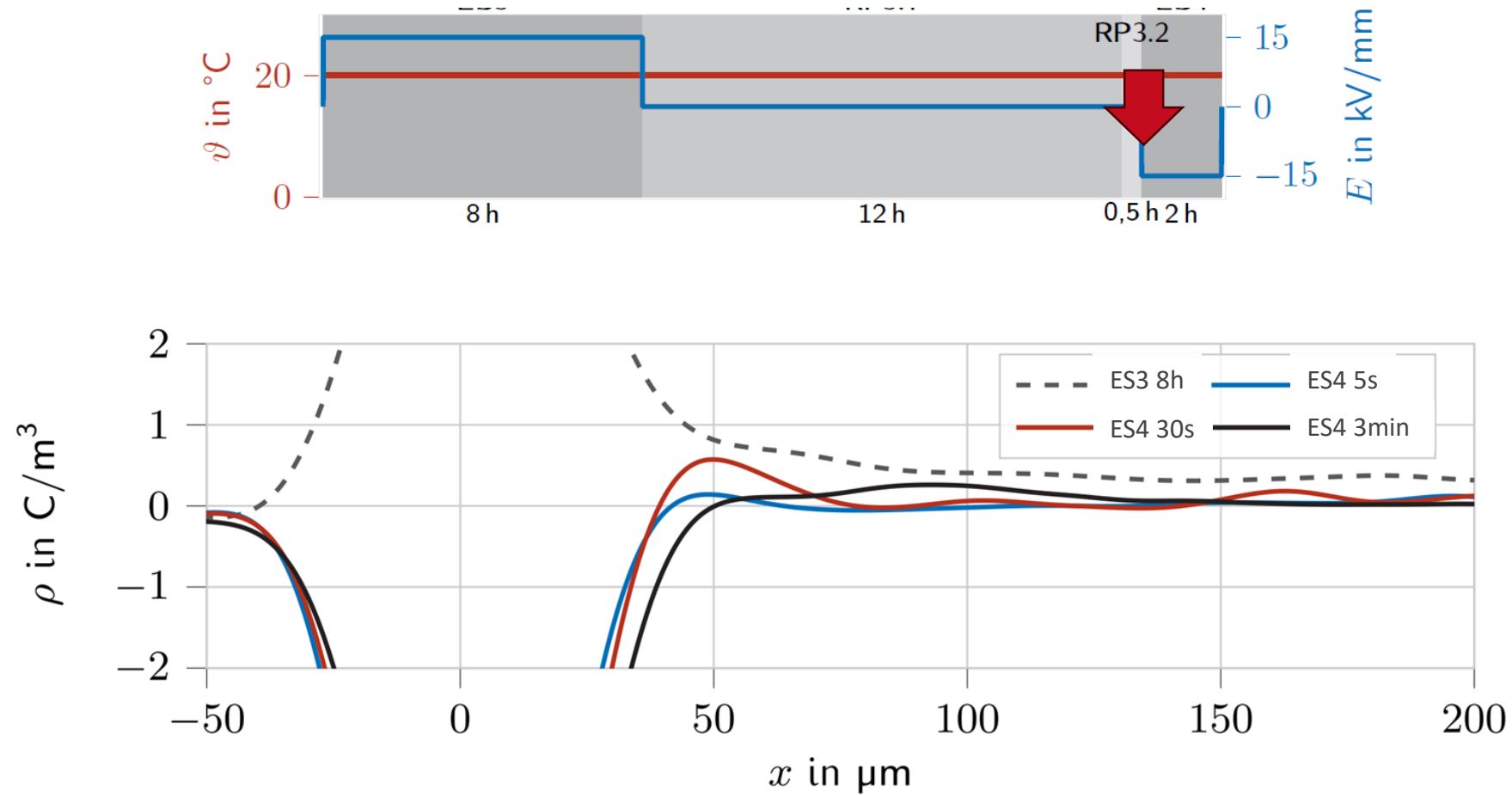


# Interpretation: Build-Up after Polarity Reversal LSR3



[10]

# Interpretation: Build-Up after Polarity Reversal LSR3



[10]

# Agenda



Theoretical Considerations

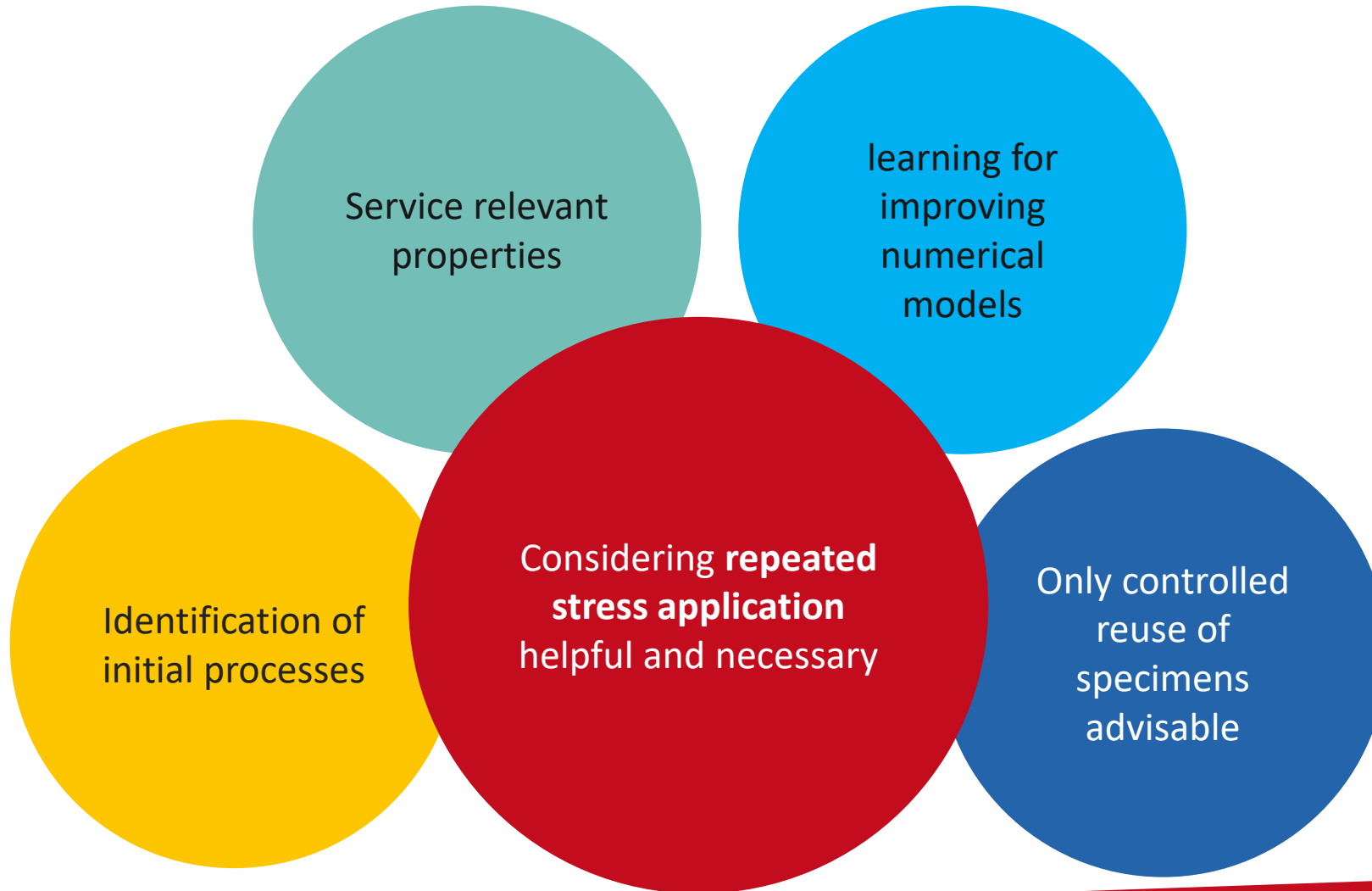
Experiment Description

Results and Interpretation

Conclusion and Outlook

Do we need to consider electric stress history  
when characterising HVDC materials?

# Conclusion



# Outlook

Further investigations with:

**other materials**  
(EPDM, XLPE, PP-TPE)

**multi-dielectric sample**  
arrangements

Thank you very  
much for your attention!

Parts of the work were funded by the German BMWF (Bundesministerium für Wirtschaft und Energie) as part of the ROSIS project (03EI4055A). The authors would like to thank Wacker Chemie AG for providing the specimens.

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- [9] Servane Haller, Maya Mourad, Sophie Iglesias und Martin Henriksen. “Investigation of DC properties of Silicone rubber compared to EPDM”. In: *8th Conference on Silicone Insulation*. 2022, S. 99–103
- [10] Felix Rösch „Einfluss elektrischer Mehrfachbelastungen auf Raumladungsprozesse und den Durchgangsstrom in Siliconelastomeren,” Doctoral Thesis, Technische Universität Berlin, Berlin, 2026 (*to be published*)