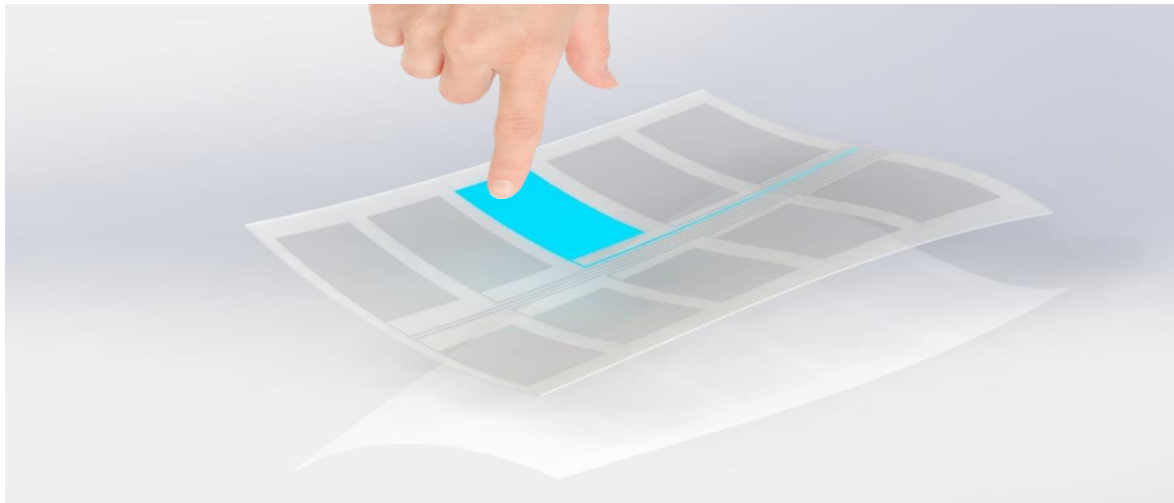

PRINTED FUNCTIONAL LAYERS FOR THE USE IN CONNECTED CAR APPLICATIONS

NanoCarbon - Annual Conference 2018

Würzburg, 27th of February 2018



Carsten Glanz, Dr. Marc Entenmann, Laura Boonen, Ivica Kolaric

Fraunhofer IPA

Technology consultant and innovation driver since 1959

- Operational budget of 70.8 million euros
- 25.8 million euros in industrial revenues
- More than 1,000 employees



New technical center "Gebäude D" in Stuttgart

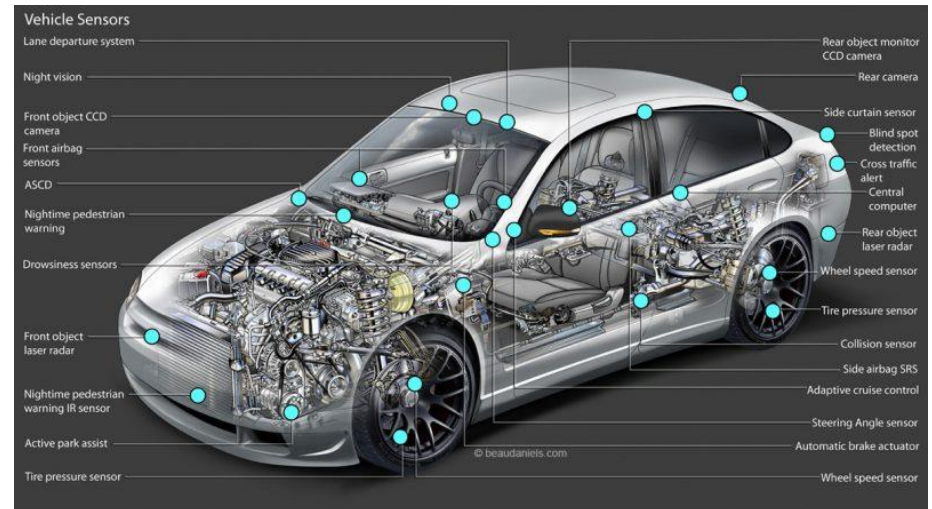


Fraunhofer Institute Center in Stuttgart

Note: key figures for 2016; IPA Stuttgart including locations in Rostock, Mannheim, Bayreuth and Vienna

Limitations

- Installation space
- Integration / Connection to electronic systems
- Design
- Functionality
- Cost
- Requirements of Automotive Industry



<https://carfromjapan.com/article/car-maintenance/types-of-sensors-used-in-automobile-engine>

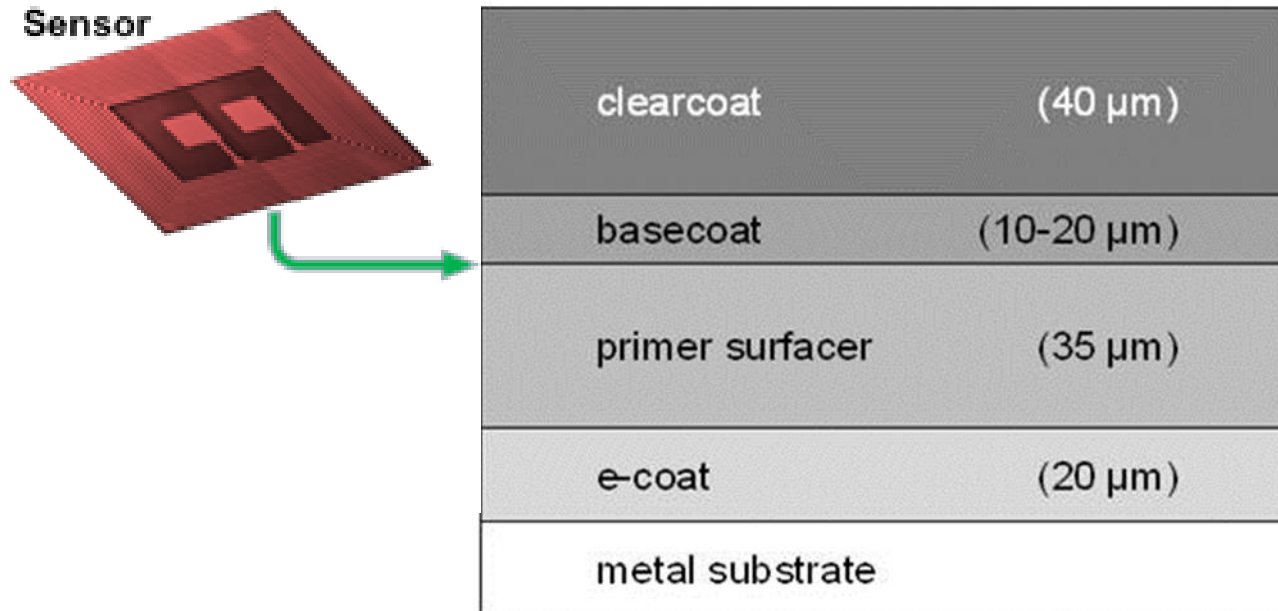
Motivation Smart skin

- Save installation space
- Integration of sensors with automatic processes
- Less cost intensive handwork
- Reduction of installation effort
- Personalization of the paint / car
- Hiding sensors
- Generating new functions in automotive skin

Case study „intelligent skin“

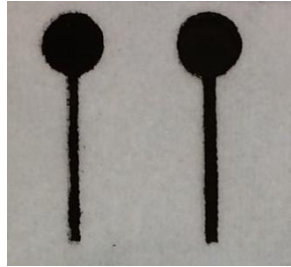


The Automotive Multilayer Coating System

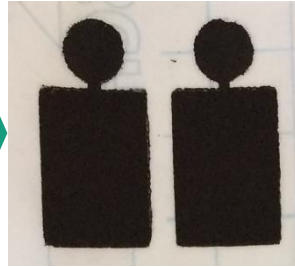


Manufacturing of screen printed proximity sensors

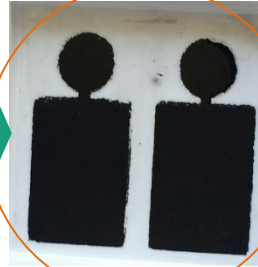
Substrate material: Adhesive foil (subsequently integrated)



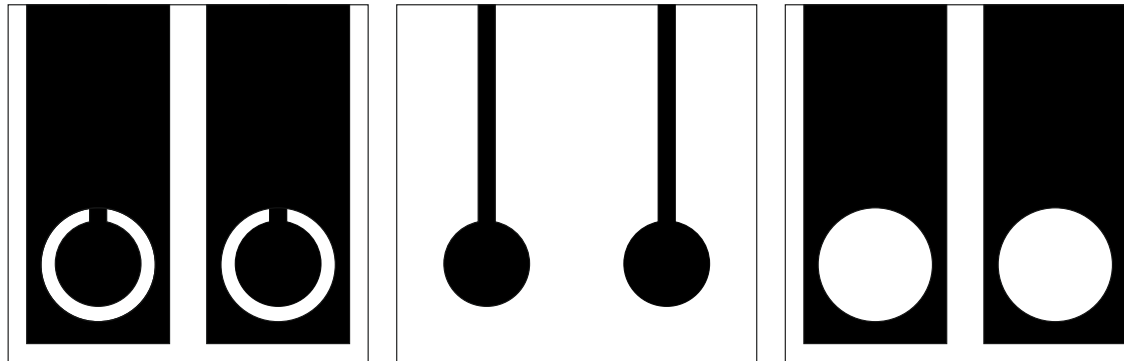
Sensing electrode



Shield electrode

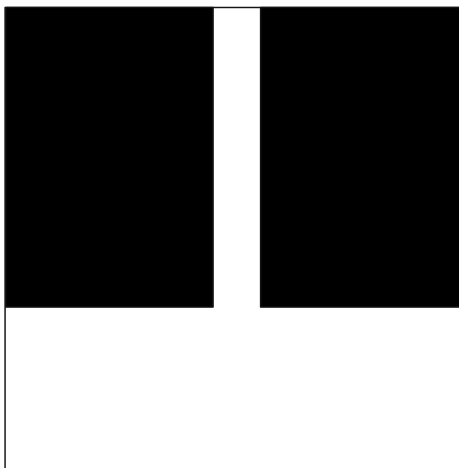


Sticked to substrate

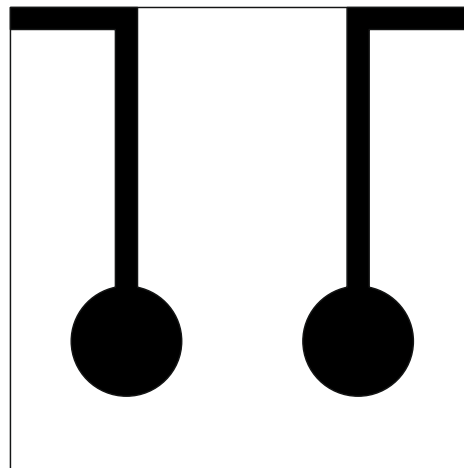


Coating Process

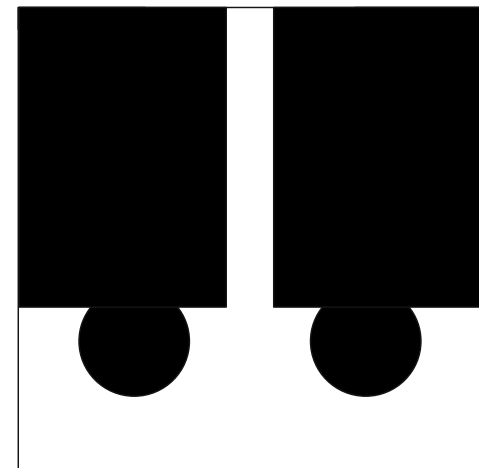
- Screen: PE AM 24-120 W-PW, 2x wet in dry printed
- Substrat: Neschen Foil, Filmolux
- Dispersion: CNT Dispersion for Screen Printing (2,25wt%)



Printed image on the front side of the film



Printed image on the backside



Full Design from Top Side

Production of first polycarbonate demonstrator

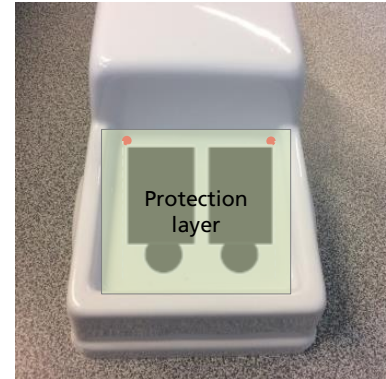
Preparing surface



Applying



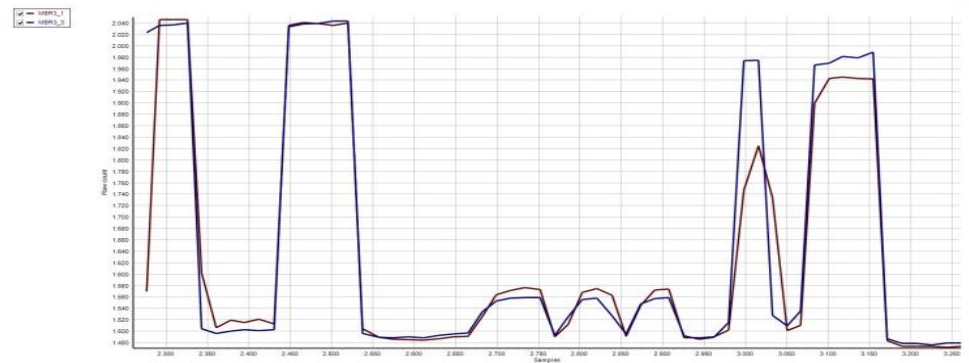
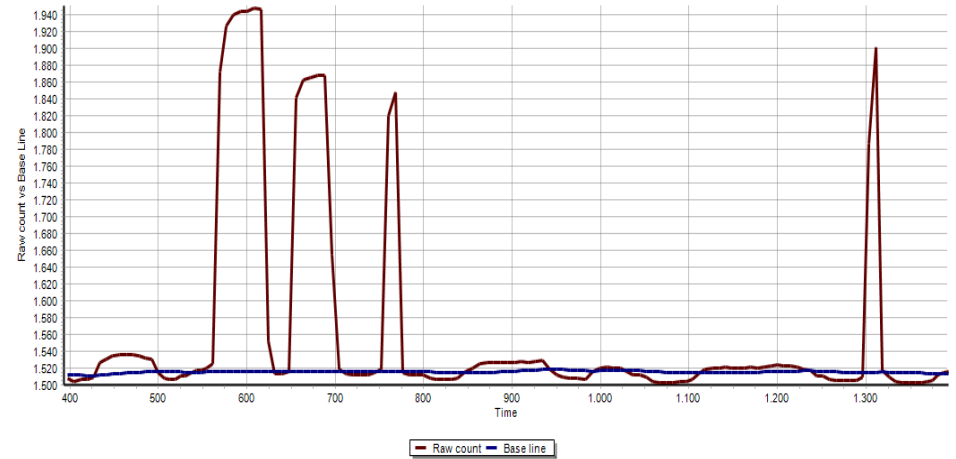
Protection layer



Final coating

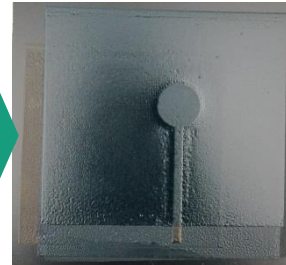
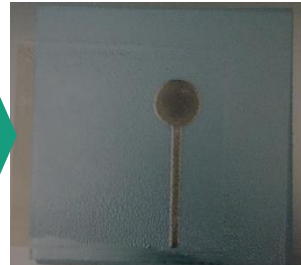


Testing of Sensor



Application Directly on Metal Car Body

Substrate material: Metal (direct integration)



Shield electrode

Insulator

Sensing electrode

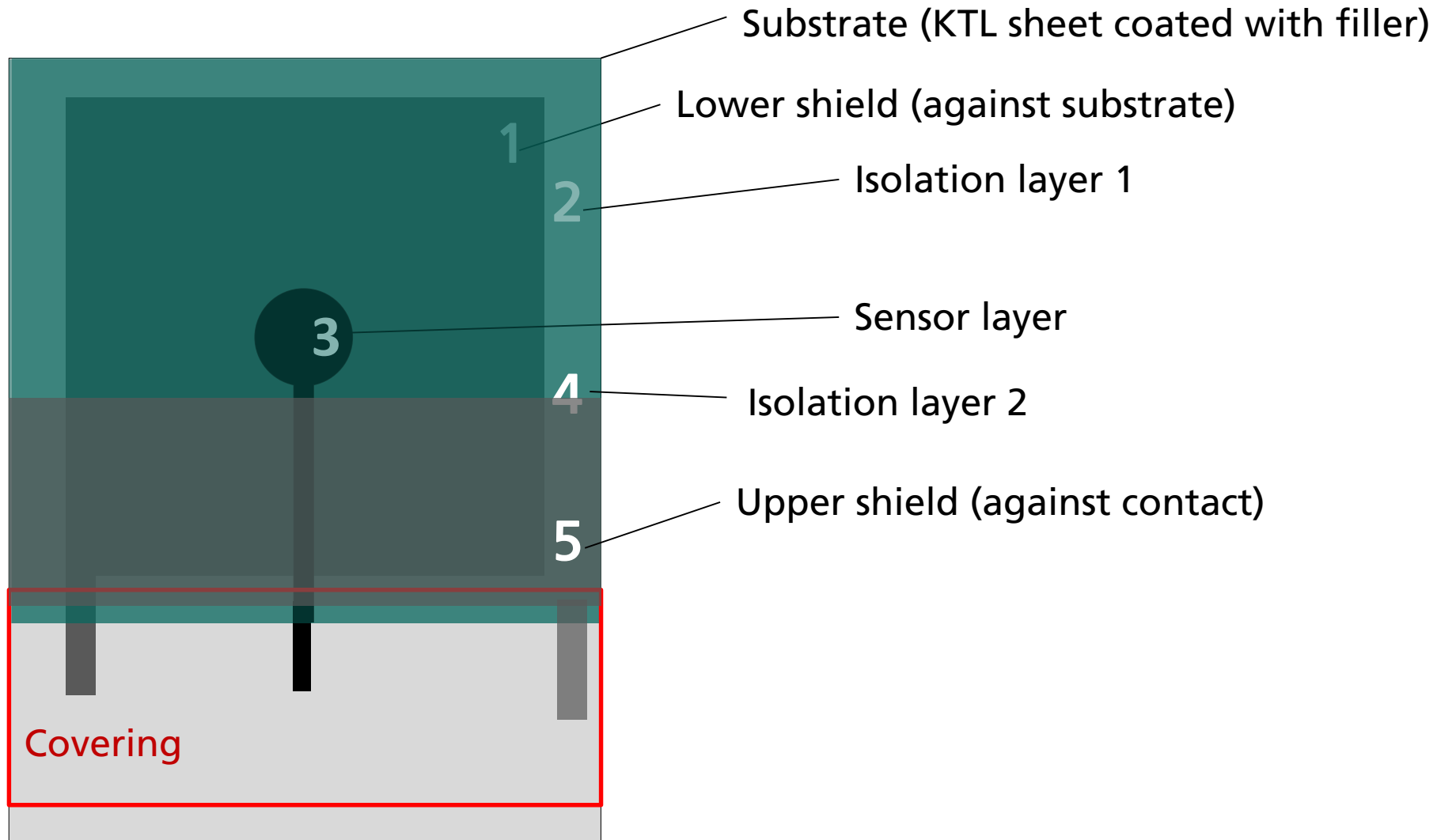
Insulator

Shield electrode

Painted

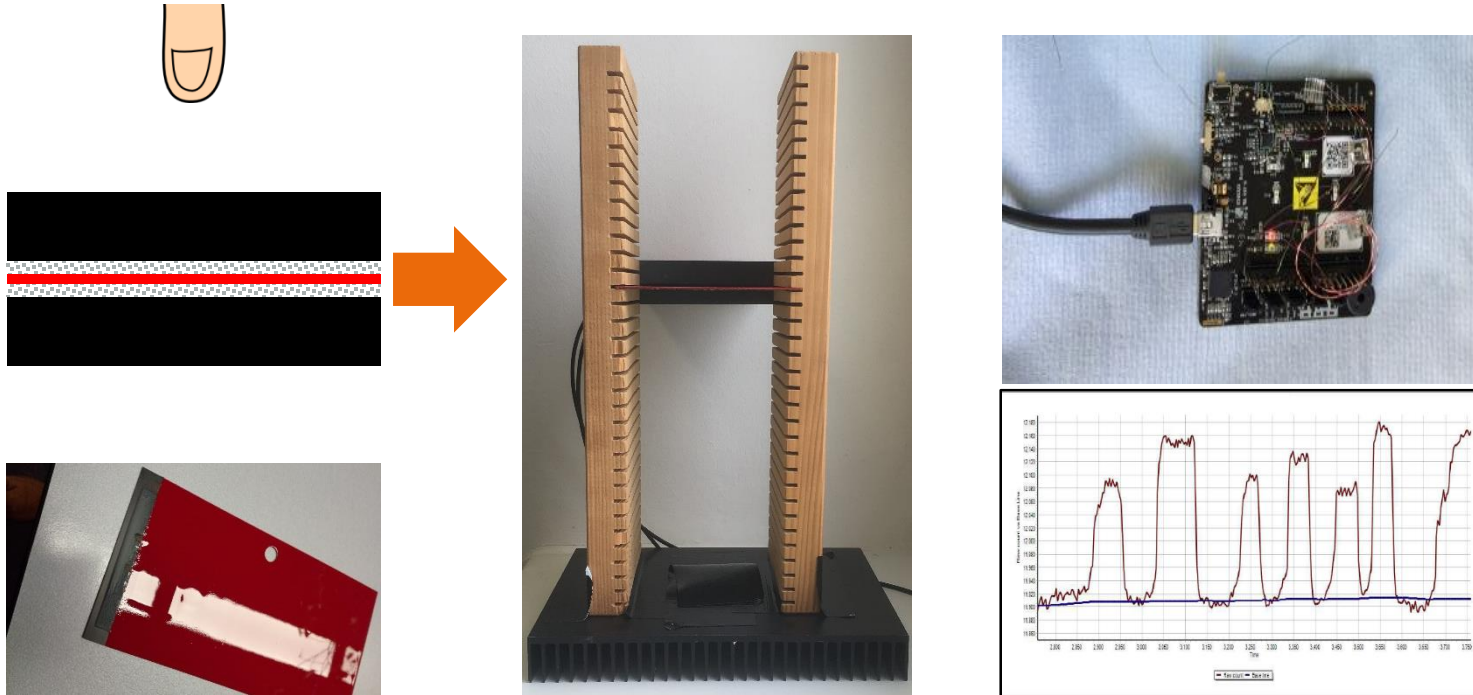
- Screen: PE AM 24-120 W-PW, 2x wet in dry printed
- Substrat: Direct on metal
- Electrode: Carbon black paint (industrial available) for Screen Printing
- Insulator: Isolation paint – automotive (industrial available)
- Lack: Automotive standard paint

Layout for electrical characterization



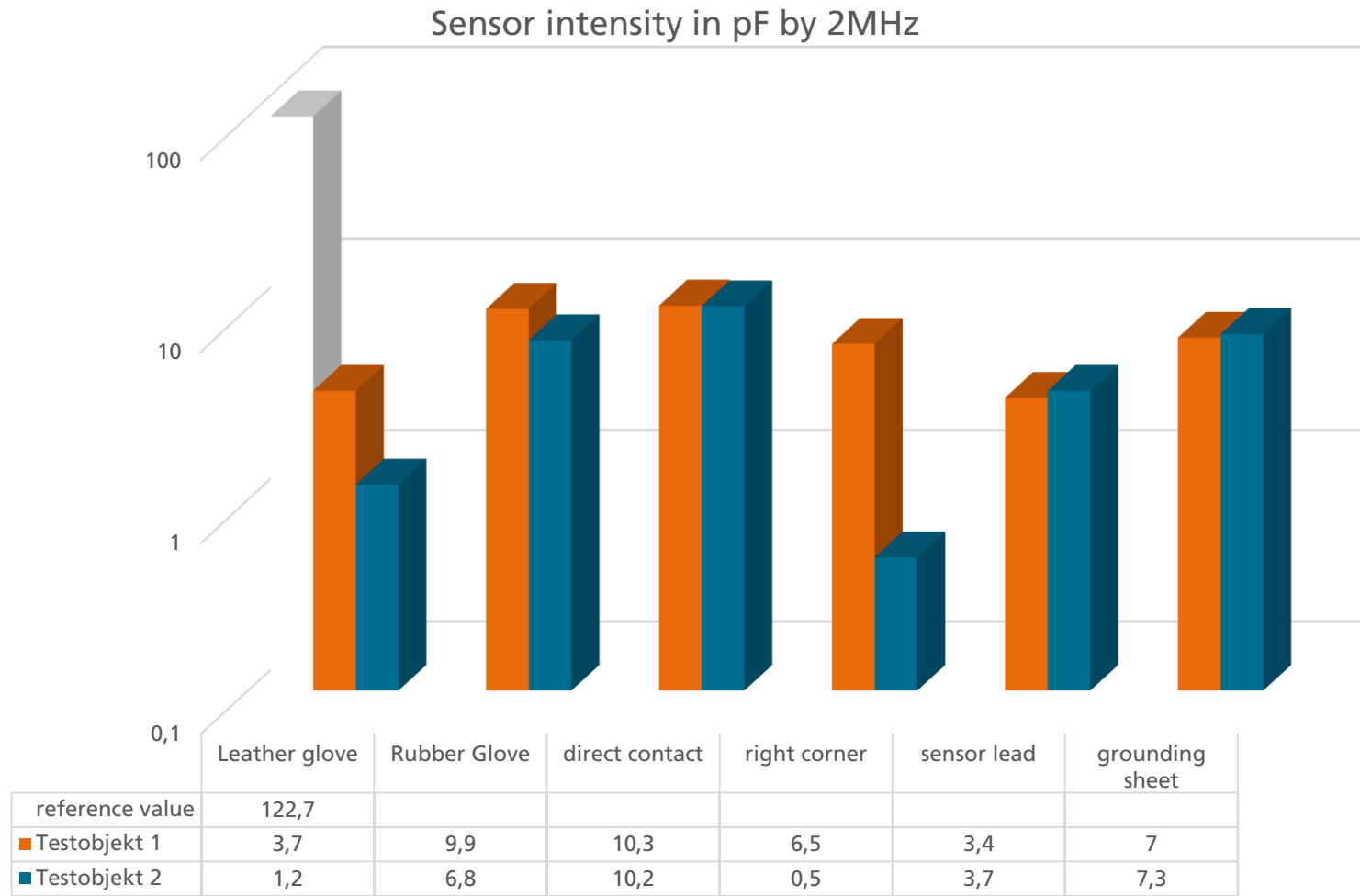
Distance-dependent measurement

Sensitivity measurement with different sample heights



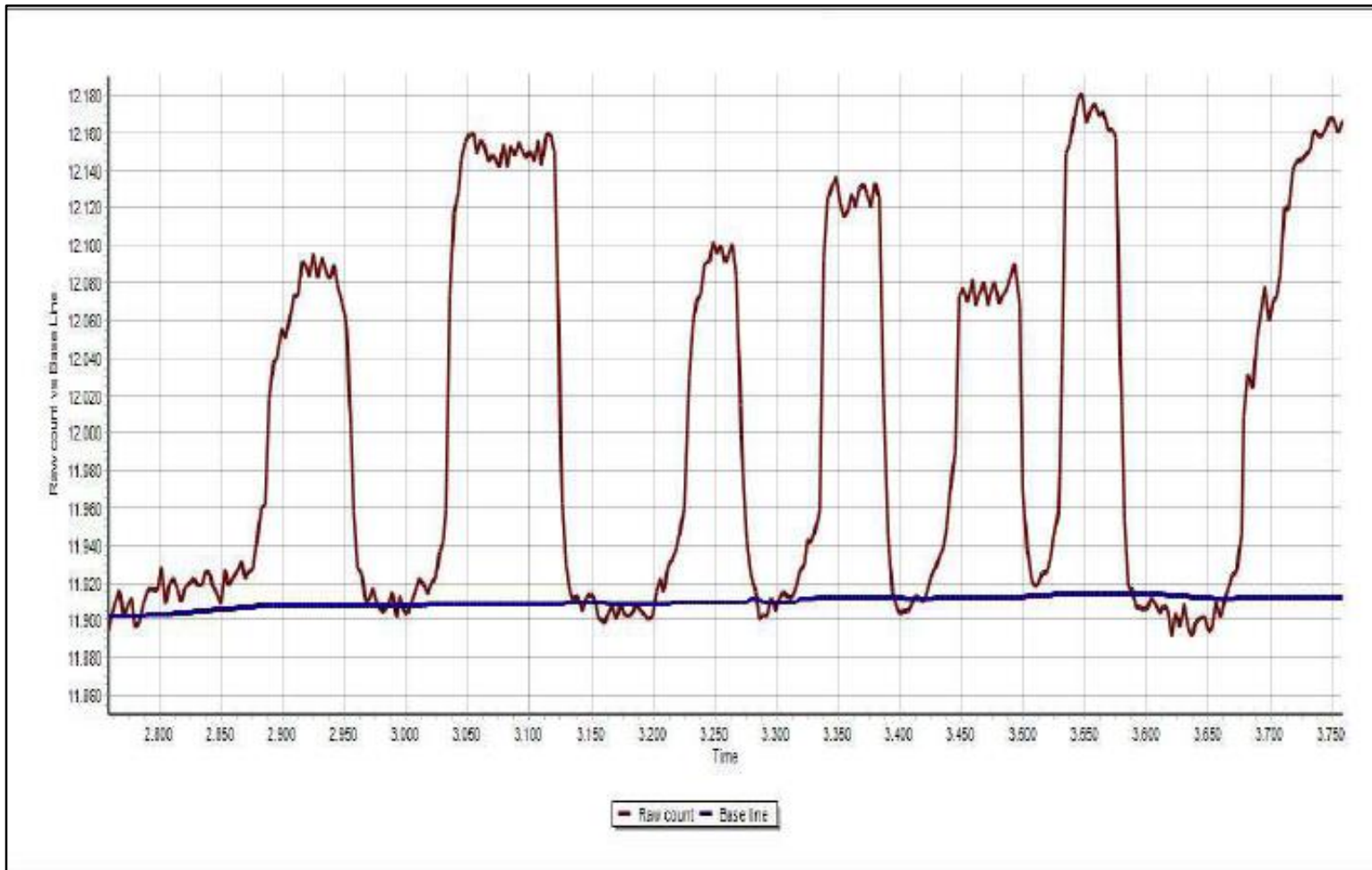
Distance-dependent measurement

Results



Distance-dependent measurement

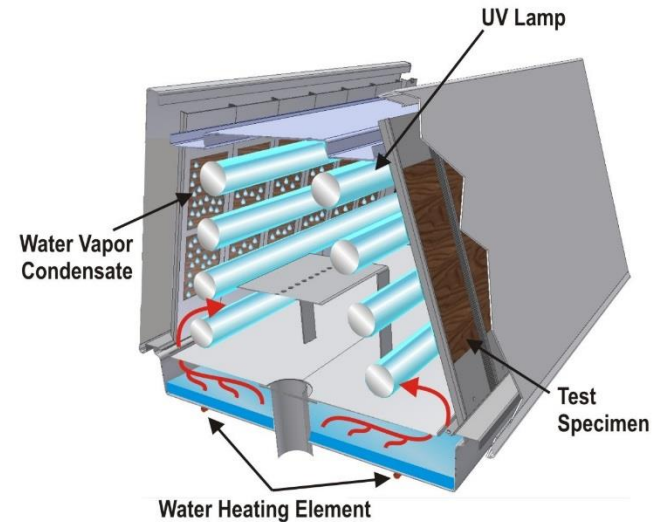
Results – capacitive changes / Cypress evaluation board



Automotive related long-term tests running

Artificial Weathering of Coatings

- Simulation and prediction of long term properties of coatings and pigments during outdoor weathering under hot and humid („Florida“) or hot and dry („Kalahari“) conditions
 - Changes of colour and gloss
 - Determination of light fastness of pigments and dyes
 - Onset of cracking and delamination
 - Changes in surface morphology
- ISO 11341 / ISO 11507; SAE J2020
- Additional thermo-cyclic electrolytic loading test



Next steps – automated coating

- Integration of interdigital structure
- Printing of sensor arrays
- Optimization of process for selective primer coating for high quality surface



Conclusion

- Integration of sensors in automotive skins is possible
- Production of multilayer systems with industrial relevant coating processes is possible
- Personalized skins can be realized
- Long-term tests are running

- Phase 3
 - Research for different types of printed sensors / antennas, contacting and sensor fusion
 - Modification of evaluation software / Implementation in automotive related electronic / software systems
 - Transfer to other industries / surfaces

Fraunhofer IPA

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