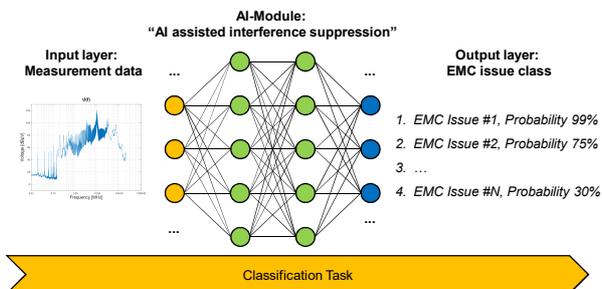


## AI based, feature sensitive analysis of EMC measurement results

- EMC measurements within the framework of product development
- Developers' responsibility: result interpretation and mitigation measures
- Up-to-date approaches like virtual prototyping are not profitable for KMU
- KMU approach: Lessons learned + best practice knowhow + try & error



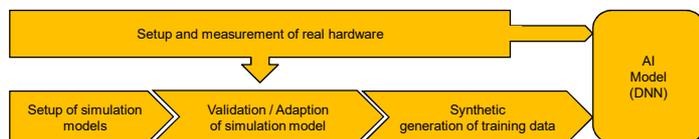
- Conversion of the EMC result analysis into a **classification task**
  - Where should the developer look for the design error?
- Reduction of time and cost requirements

## Positioning of EMC Test in the work of progressivKI

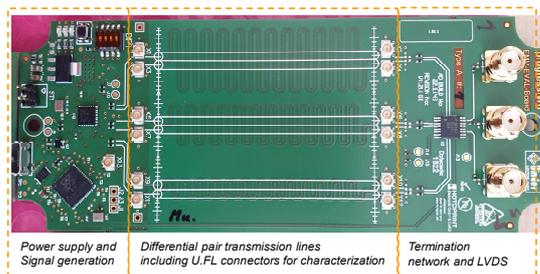
- Provision of EMC domain knowledge in an AI usable format
- Generation of AI training and test data by measurement of PCB-Setups
- Preparation and provision of the generated measurement data sets for the AI

## Hybrid data acquisition approach (measurement and simulation)

- Generation of training data by real measurements is time-consuming
- Transfer of the measurement environment into CST + model validation
- Data generation by field simulation<sup>1</sup> and EMC measurement



- Definition of hardware setups<sup>2</sup> for the variation of EMC issues:

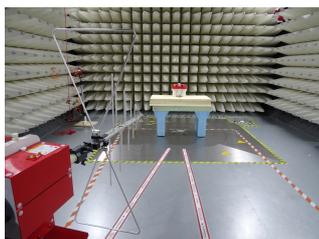


## PCB setup variation parameters for EMC measurements

- Measured variations based on a "golden sample"
- Additional variations in the supply line cable length and excitation frequency
- Coarse-stepped variations for real measurements

## Data acquisition using EMC measurements

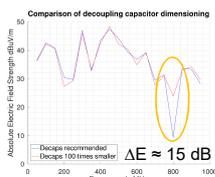
- Praxis relevance: Radiated emissions acc. to EN 55011
- Acquisition of in total 1440 measurement data sets
- Further measurements of conducted emissions and S-Parameters
  - Correlation between conducted and radiated emissions
  - Validation of the CST simulation models<sup>1</sup> → Increase training data sets



Setup for radiated emissions measurement acc. to EN 55011

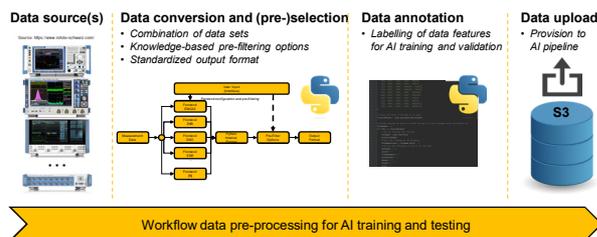
## Evaluation of the measurements for data quality assessment

- Variance in data sets needed for classification
- Variation of decoupling capacitors' value leads to stimulation of additional circuit geometries in the PDN acting as antenna structures (increased emissions)
  - But: Decreased dynamics due to spectral discretization ( $\Delta f = 50$  MHz)
- Further measurement of S-Parameters to get a finer spectral resolution



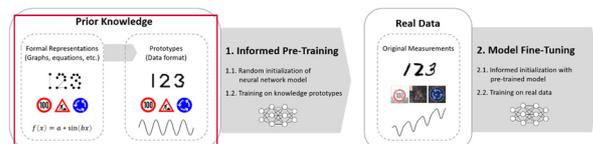
## Pre-processing and annotation of measurement data

- Different output data formats of EMC measurement systems and methods
- Need for standardization for AI processing pipeline
- Modular Python-based data conversion with knowledge-based pre-filtering
- Data annotation for training and test applications of the DNN
- S3-Storage connection to provide the annotated data to the AI workflow



## Outlook / Further research

- Informed DNN-pre-training with knowledge-prototypes based on [1]
- Improve the training performance for small sized training data sets
- Increase classification robustness in the presence of non-ideal effects
- Support in hardware construction by Herkules Resotec (KMU support group)



[1] Von Rueden, Laura, et al., „Informed Pre-Training on Prior Knowledge“, arXiv preprint arXiv:2205.11433, 2022

### Footnote(s):

- CST field simulation and model creation is part of the work of 15-ENAS.
- PCB manufacturing and component placement is done by 11-Binder and 08-UA-HOTOP.

Marcel Olbrich, M.Sc.  
Dr.-Ing. Sebastian Jeschke  
Michael Kleinen, M.Eng.

EMC Test NRW GmbH  
Research & Development  
D-44227 Dortmund – Germany



Project Office/R+D Coordination  
edacentrum GmbH  
Werner John (+49 52 51 - 54 39 300)  
Dieter Trejtnar (+49 51 11 - 93 68 74 65)  
progressivKI-office@mail.edacentrum.de

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www.edacentrum.de/progressivKI