PSPC - activities

Power System Protection Centre

Prof. Marjan Popov

Power System Protection Centre

Ir. Evita Parabirsing, Stedin

Ir. Kees Koreman - TenneT

Ing. Jacques van Ammers, GE

Prof. Dr. Marjan Popov, TU Delft

Ir. Maarten van Riet, Alliander

Ir. Frank Baldinger, Locamation

Prof. Mart van der Meijden, TenneT/TU Delft

Ing. Corne de Hoogh, Siemens NL

www.tudelft.nl/pspc

Research Centre for Advanced Power System Protection

Mission

To advance the research, education and knowledge transfer in power system protection by applying current and future technologies and ideas.

Vision

To provide a common platform among the utilities, manufacturers and academia by exchanging knowledge and results in order to improve existing solutions

On-going 5-year Project in the context of PSPC

- **Resilient Synchro-measurement-based Grid Protection Platform (ReSident)**

- Goal: The project deals with the design of a novel high-resolution synchronized measurement supported simulation platform, to reduce the risk of cascading events, as well as to classify and locate disturbances based on novel algorithms verified by actual data.

Partners: TenneT, Aliander, Stedin, GE and VSL

Composition of the research team and consortium

Research team:

- Matija Naglic 1.09.2018 – 1.09.2019, postdoc (completed) (ICT platform) - **FINISHED**
- Ilya Tyuryukanov 1.03.2019 – 1.03.2021, postdoc (control islanding/out of step protection) - **FINIHSED**
- Marko Tealane 1.10.2019-1.10.2020 (out-of-step protection) - **FINISHED**
- Nidarshan Veera Kumar 1.09.2019-1.09.2023 PhD student (disturbance detection/classification - thesis is being written
- Aleksandar Boricic 1.06.2019 – 1.6.2023, PhD student (voltage control/vulnerability analysis) - thesis **to defend on April 30, 2024**

Supervision: M. Popov / M. van der Meijden
Consortium: TenneT, Alliander, Stedin, GE,VSL

- Out-of-step

This Year on March 21/22 2024 next PAO on Protection !

On-going research projects supported and partly financed by PSPC

Tanumay Karmokar

Industrial Ph.D. Researcher | TU Delft
Faculty of EEMCS | IEPG

Specialist Engineer for HVDC Cables
TenneT TSO GmbH
Bayreuth, Germany

Industrial Doctoral Research *(Partner: TenneT TSO)*

- **Topic** — Characterisation of Dynamic Stresses on HVDC Cables upon DC Current Interruption in Meshed Grid Applications *(Project Start: Dec 2021)*
- **Promotors** — Prof. Marjan Popov, Dr. M. Ghaffarian Niasar
- **Research Goal**
  - Define a sustainable electrical interface between HVDC cables and DCCB up to 525 kV for different operational modes of DCCB.
  - Experimentally investigate the impact of representative cable stresses in comparison to

➢ Initial Findings

- Challenge is practice-based detailed impedance modelling of HVDC cables for investigating its transient behaviour.
- Voltage simulated at open end of 100 km long cable *(see Fig 1)*.
- Damping of reflections is mainly caused by screen resistance *(see Fig 2).*

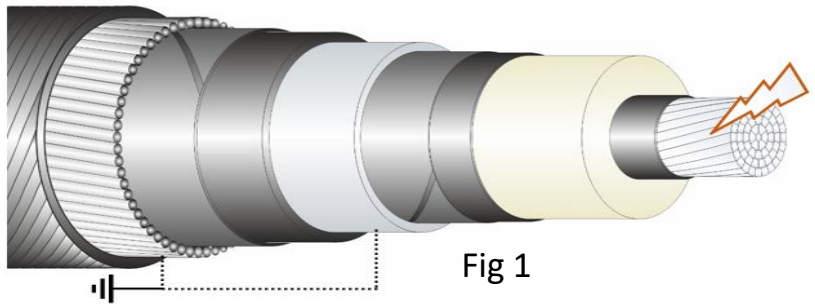


Fig 1

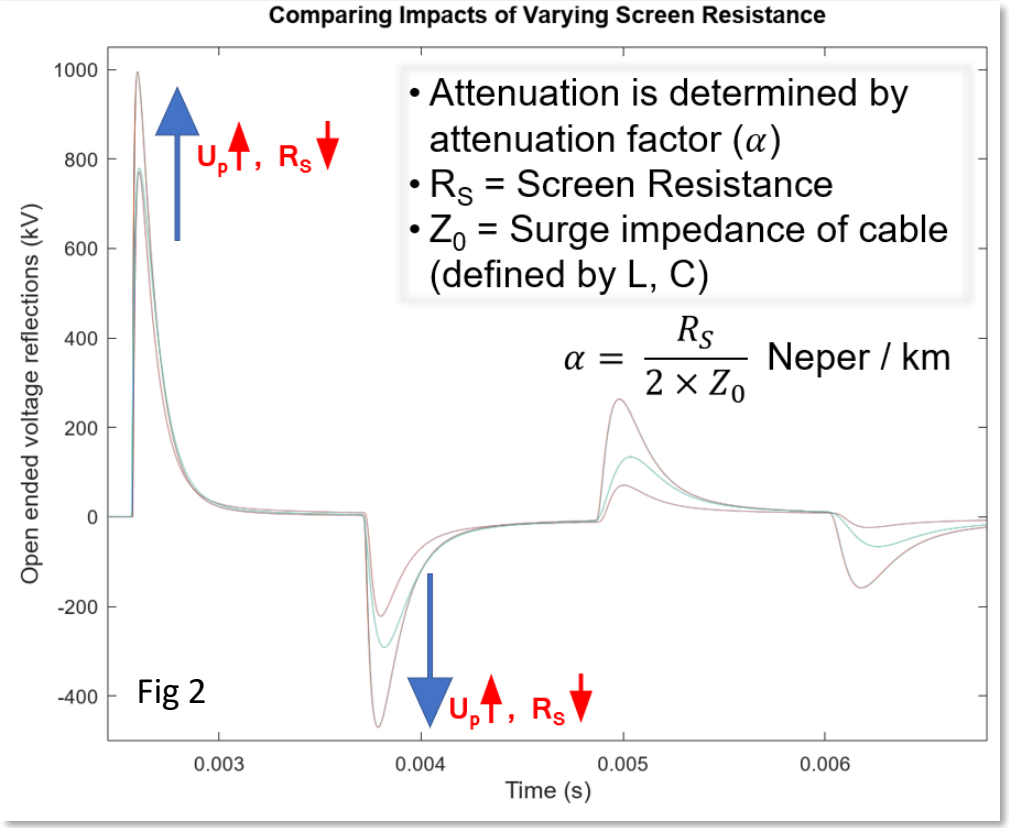


Fig 2

Three-phase high frequency power transformer modelling

Phd candidate: Farzad Nasirpour,
Promotors: Prof. M. Popov, Dr. M. Ghaffarian Niasar (2021-2025)

Research aims:

- Three-phase broad-frequency transformer modelling;
- Detailed studies of phenomena taking place in transformers;
- Developing a framework to obtain the model for different transformers with different sizes;
- Implementation of the model in EMTP environment for further studies regarding interaction of transformers with other parts of system;
- Defining protection solutions.

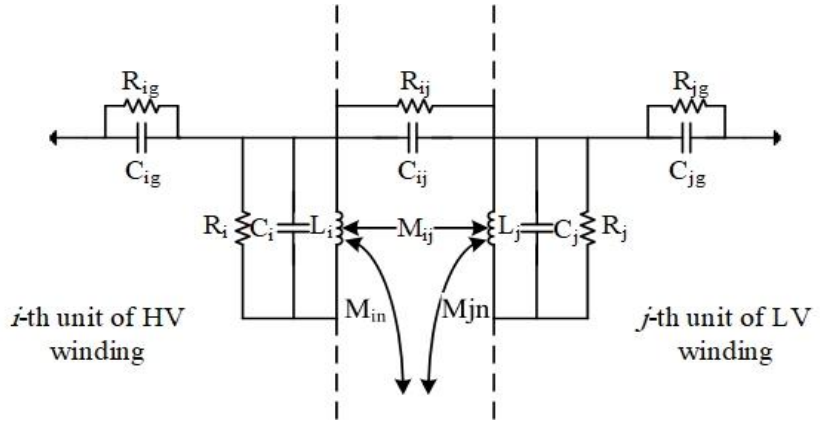


Fig. 1. The detailed model of a transformer.

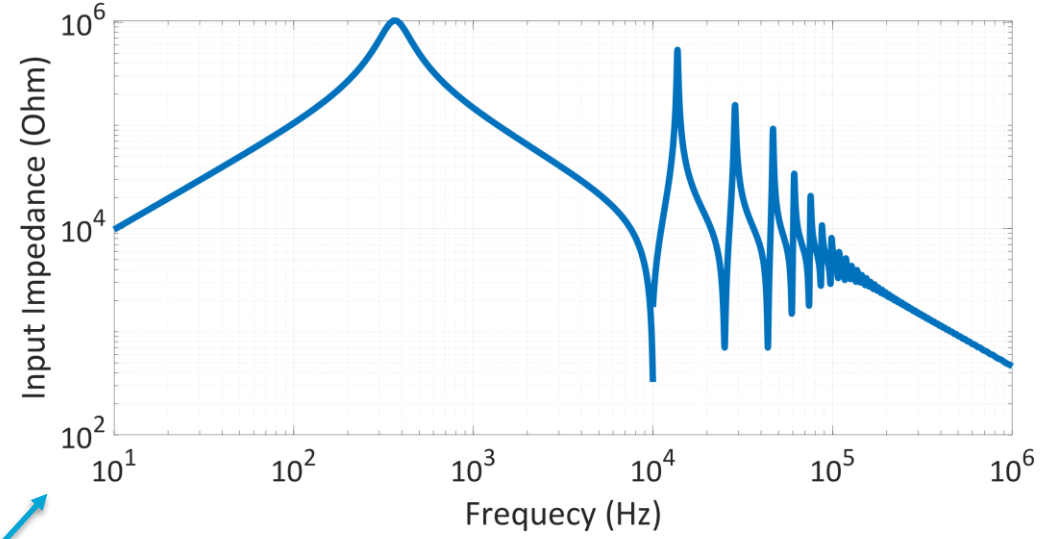


Fig. 2. Input impedance of an HV winding of a transformer obtained using the detailed model.

PRoteuS

TU Delft

Protection of transformers against fast transient and resonance overvoltage

Ph.D. candidate: Amir Heidary
Promotors: Marjan Popov, Mohamad Ghaffarian Niasar (2022-2026)

Research aims:

- Literature study of already used transformer protection method against fast transient and resonance overvoltage
- Detailed studies of the operation principle of the choke as a commercialized protection method (including analysis, FEM and EMTP simulations).
- High voltage laboratory evaluation of the choke
- Designing a novel method to provide comprehensive protection of transformer against fast transients
- High-voltage laboratory evaluation of the novel scheme

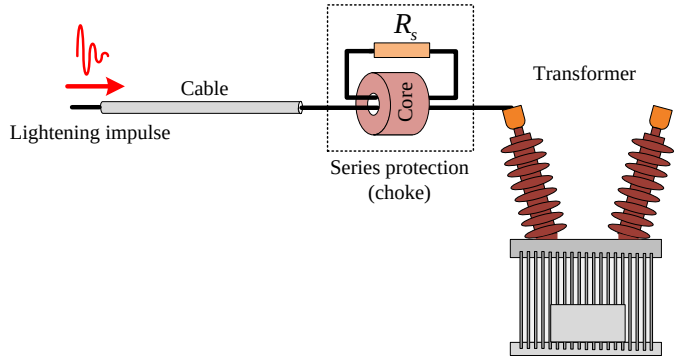


Fig. 1. implemented High-voltage laboratory setup

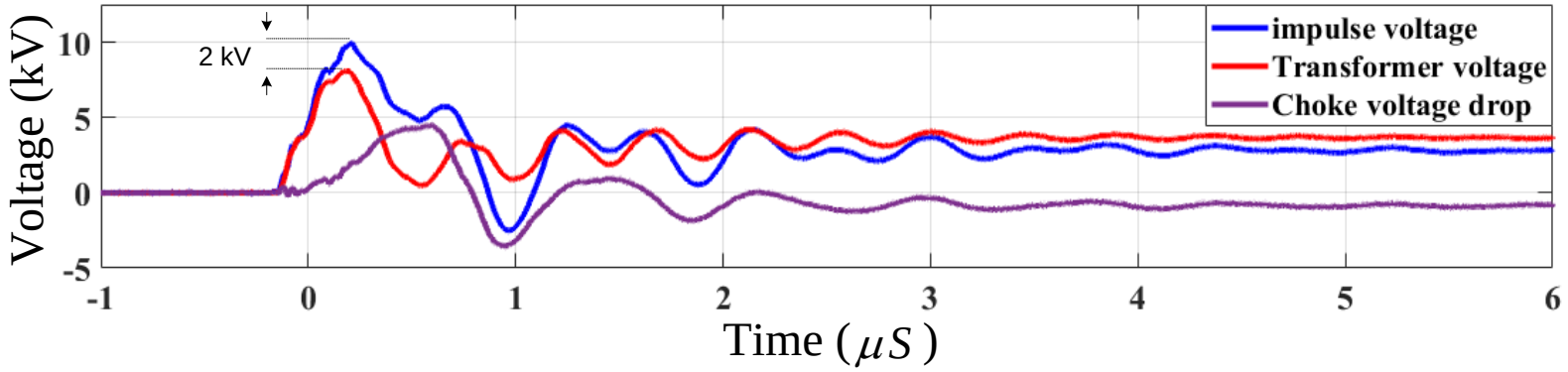


Fig. 2. High-voltage lightning test of laboratory transformer model with the choke protection

PRoteuS

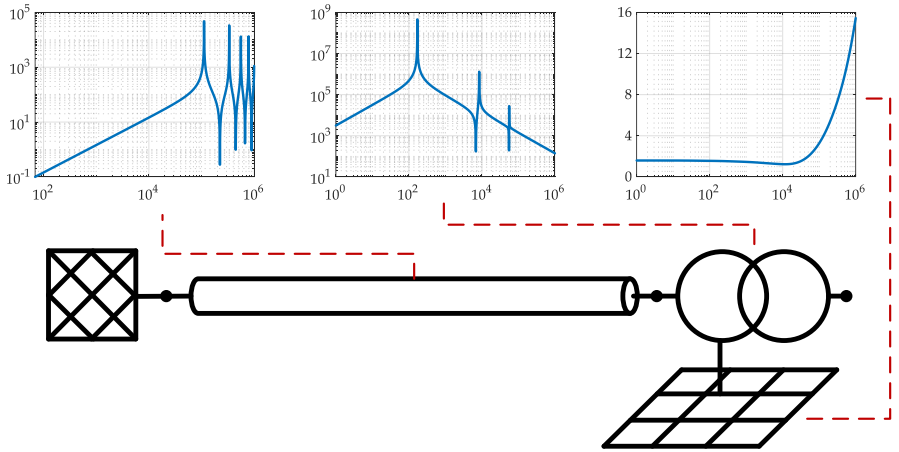
TU Delft

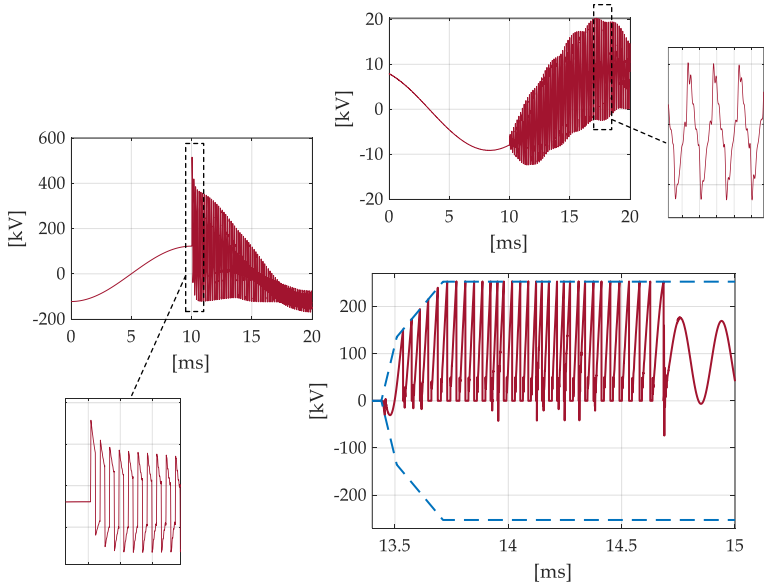
Analysis of Power System Transients Considering High-Frequency Behavior of Grounding System

PhD Candidate: Behzad Behdani,
Promotors: Prof. Dr. Ir. Marjan Popov, Dr. Ir. Mohamad Ghaffarian Niasar (2022-2026)

Research Aims:

- Wideband modelling of grounding systems in time- and frequency- domain;
- Developing a unified framework for analysis of transients in EMTP software;
- Detailed analysis of transient interactions between components: cable-transformer-ground;
- Identifying critical resonance frequencies emerged in the system;
- Characterizing the role of ground as a medium to damp surge energies.





PRoteuS

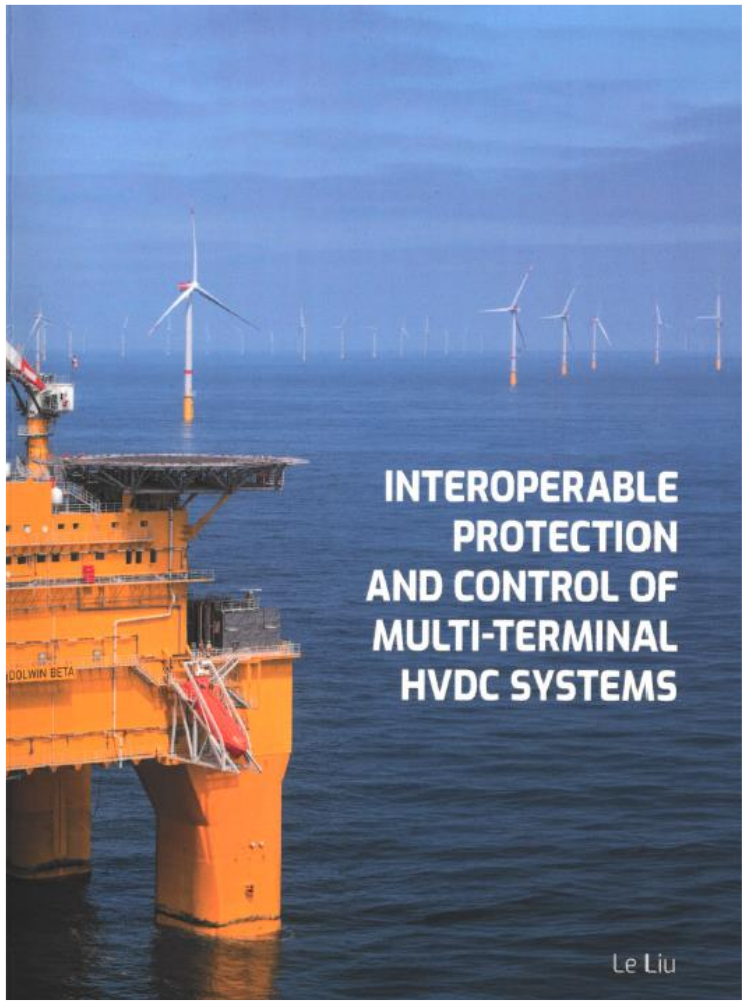
TU Delft

Robust Protection and Control Algorithms for MTDC System

Dr. Le Liu,

Promotors: M. Popov, Popov, A. Lekic

- DC fault detection and location, fault current interruption, new protection schemes
- Optimize the system transient performance under large disturbance from the perspective of the MMC control strategy disturbancesdisturbances



Nidarshan Kumaar
PhD Candidate

TU Delft
Faculty of EEMCS

Intelligent Electrical Power Grids

June 2019 - June 2023

Promotors:
Prof. M. Popov,
Em Prof. M. van der Meijden

Vision: Incremental learning of disturbance events with transforming power grid

RTDS Module for initial training

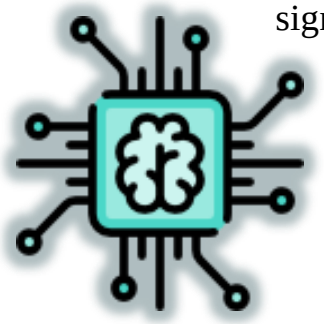
Real world labelled event data

Concept drifted real-world labelled event signatures

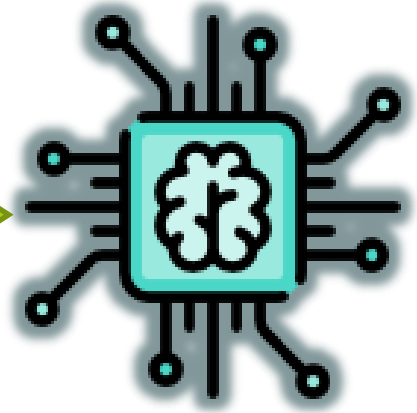
New set of unknown event signatures

Trained algorithm by RTDS grid model data at lab

Algorithm updating incrementally for grid specific event signatures



Algorithm adapting incrementally for concept shift of event signatures



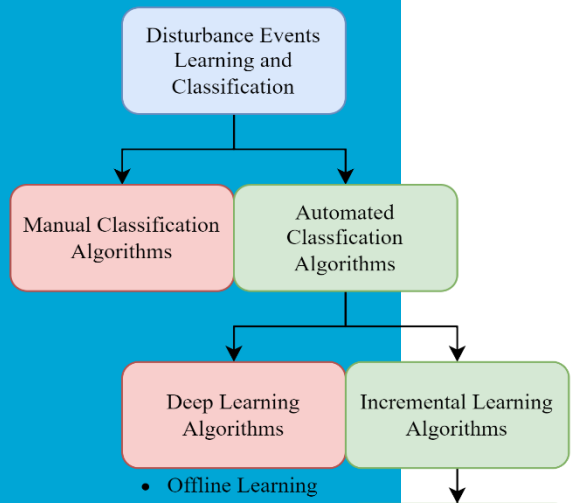
Algorithm adapting for new event class signatures without forgetting of old events

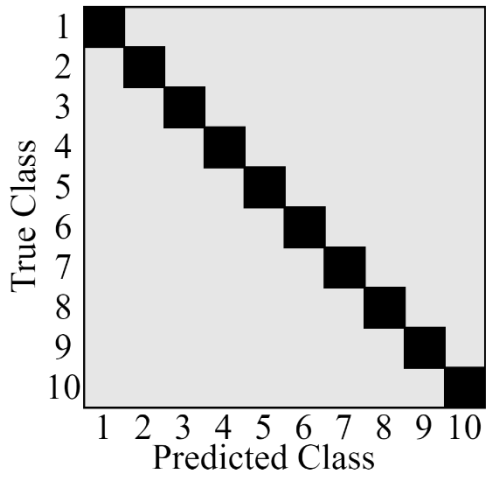
Real-time event detection, classification and localization

Mission: In order to prevent large blackouts, timely detection and classification of disturbances are needed. The application of AI algorithms for real-time detection and classification by using IED (intelligent electric devices) data is needed.

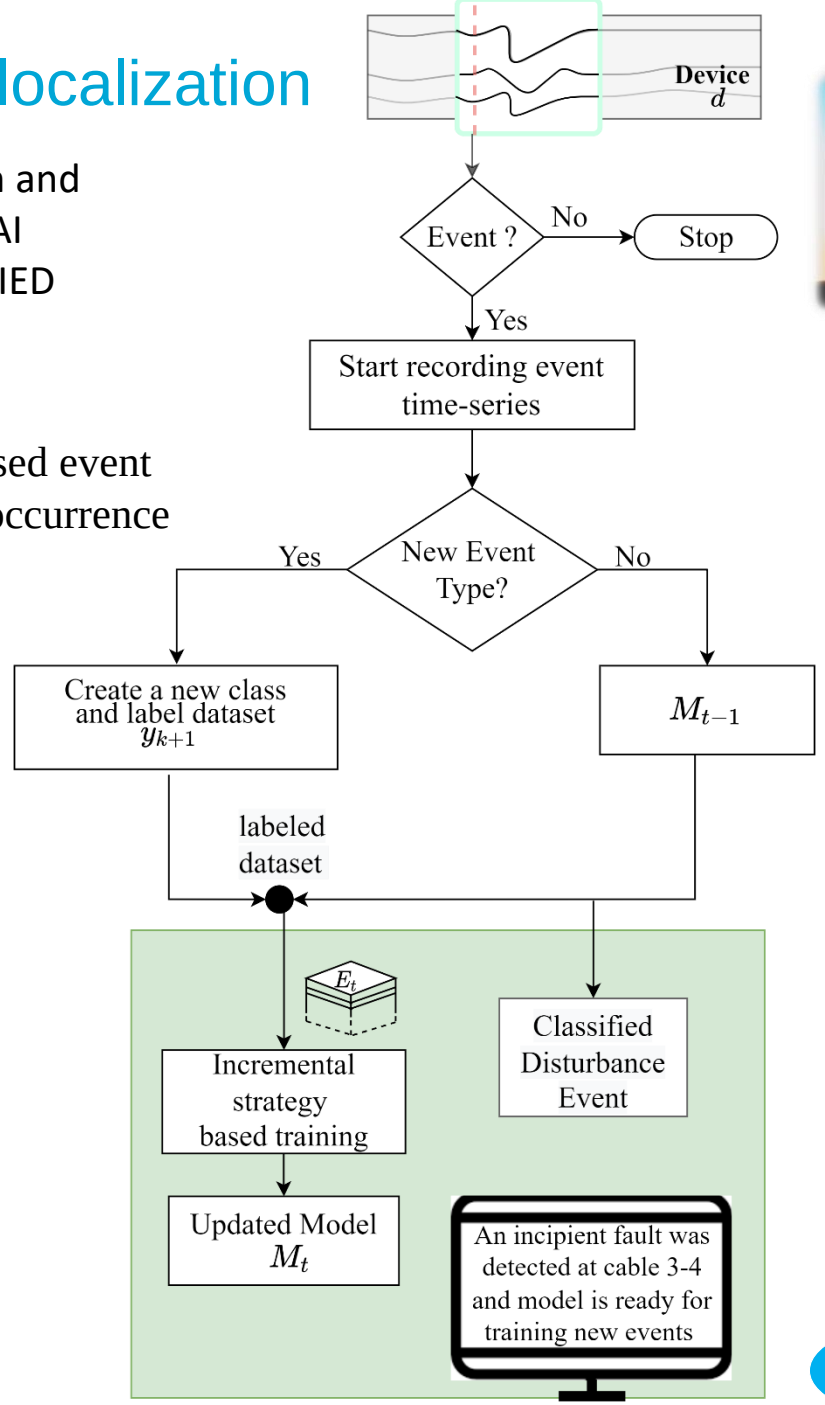
Goal: To develop a real-time expert system scheme by AI-based event detection, location, and classification in order to prevent the occurrence of severe faults and cascading events.

Courtesy: Siemens





Confusion matrix representing event classification accuracy.



Aleksandar Boričić
PhD Candidate

TU Delft
Faculty of EEMCS

Intelligent Electrical Power Grids

June 2019 - June 2023

Promotors:
Prof. M. Popov,
Em Prof. M. van der Meijden

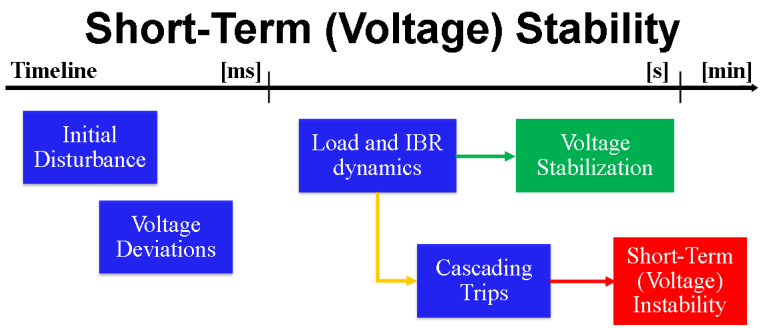
Vulnerability Assessment of Power Systems with High Penetration of Renewable Energy Sources

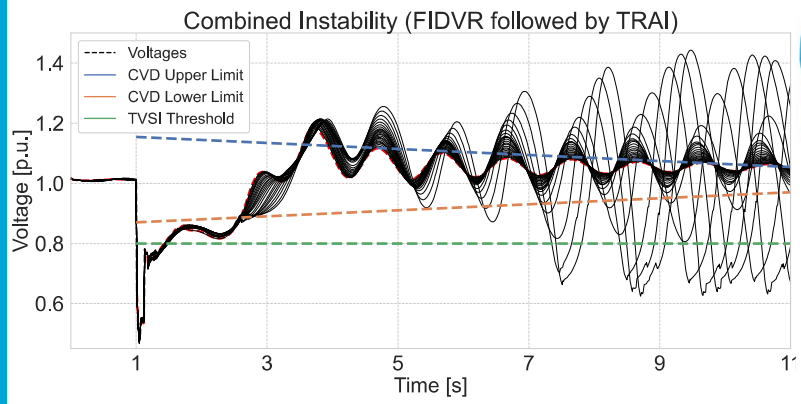
IEPG Intelligent Electrical Power Grids
http://iepg.ewi.tudelft.nl/

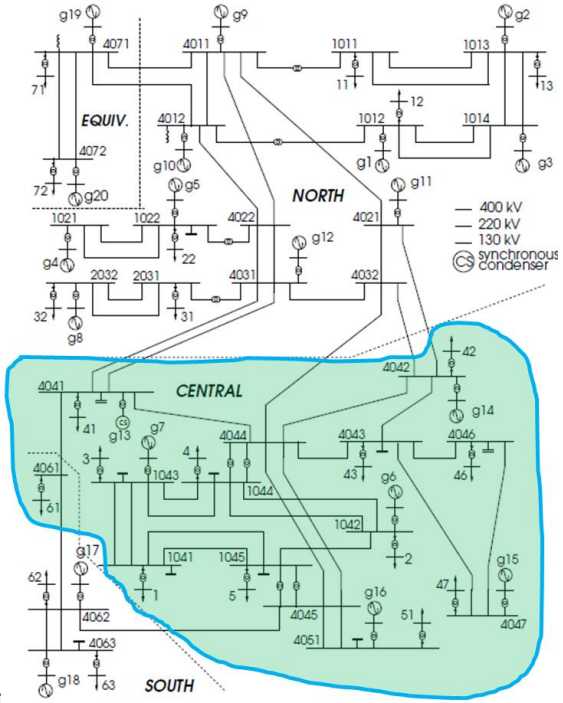
Goals of the research:

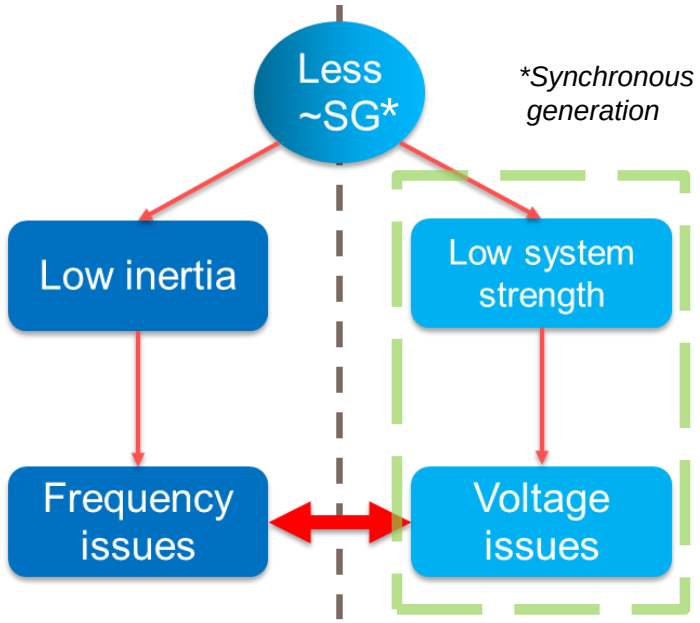
- Improve the understanding of modern power system dynamics, stability, and resilience with a high integration of renewables
- Develop novel vulnerability evaluation methods to support stable operation (prevent cascading) with a high integration of renewables

Part of the Resilient Synchromeasurement-based Grid Protection Platform project (ReSident)



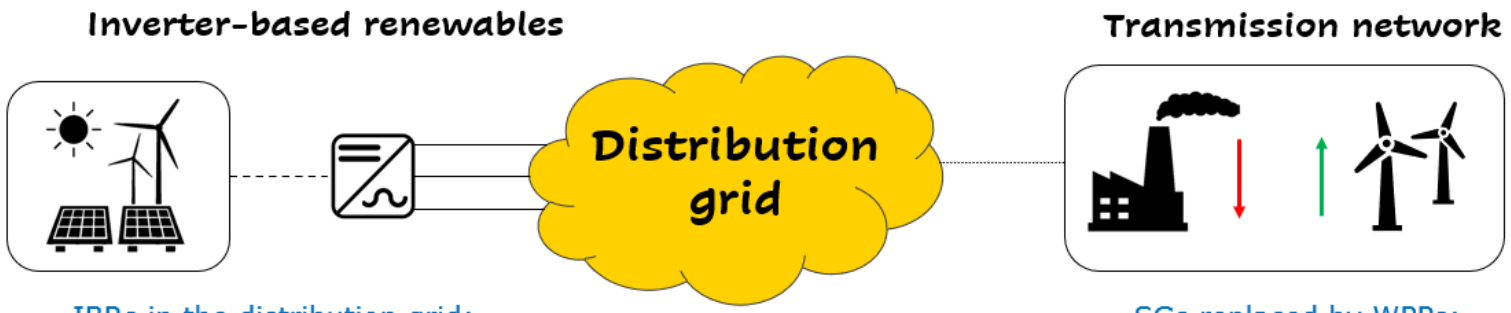






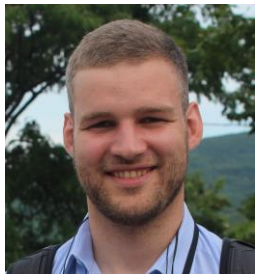
*Synchronous generation

Enabling interoperability of multi-terminal multi-vendor HVDC grids



IBRs in the distribution grid:
- Multiple short-circuit current sources
- Different short-circuit current characteristics

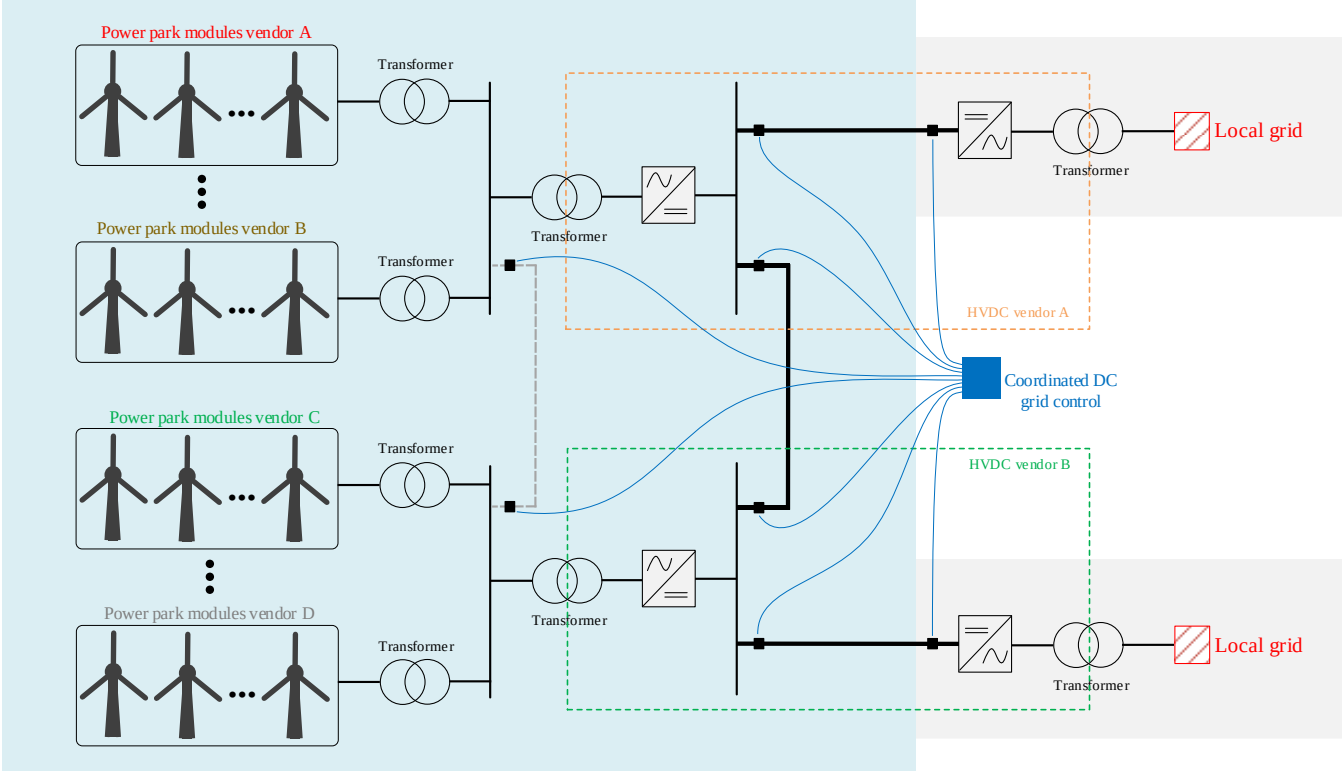
SGs replaced by WPPs:
- Lower short-circuit current contribution



Ir. Milan Jankovski

Supervised: Prof. M. Popov

Enabling interoperability of multi-terminal multi-vendor HVDC grids



Dr. Reza Bakhshi-Jafarabadi

Dr. Farzad Dehghan Marvasti

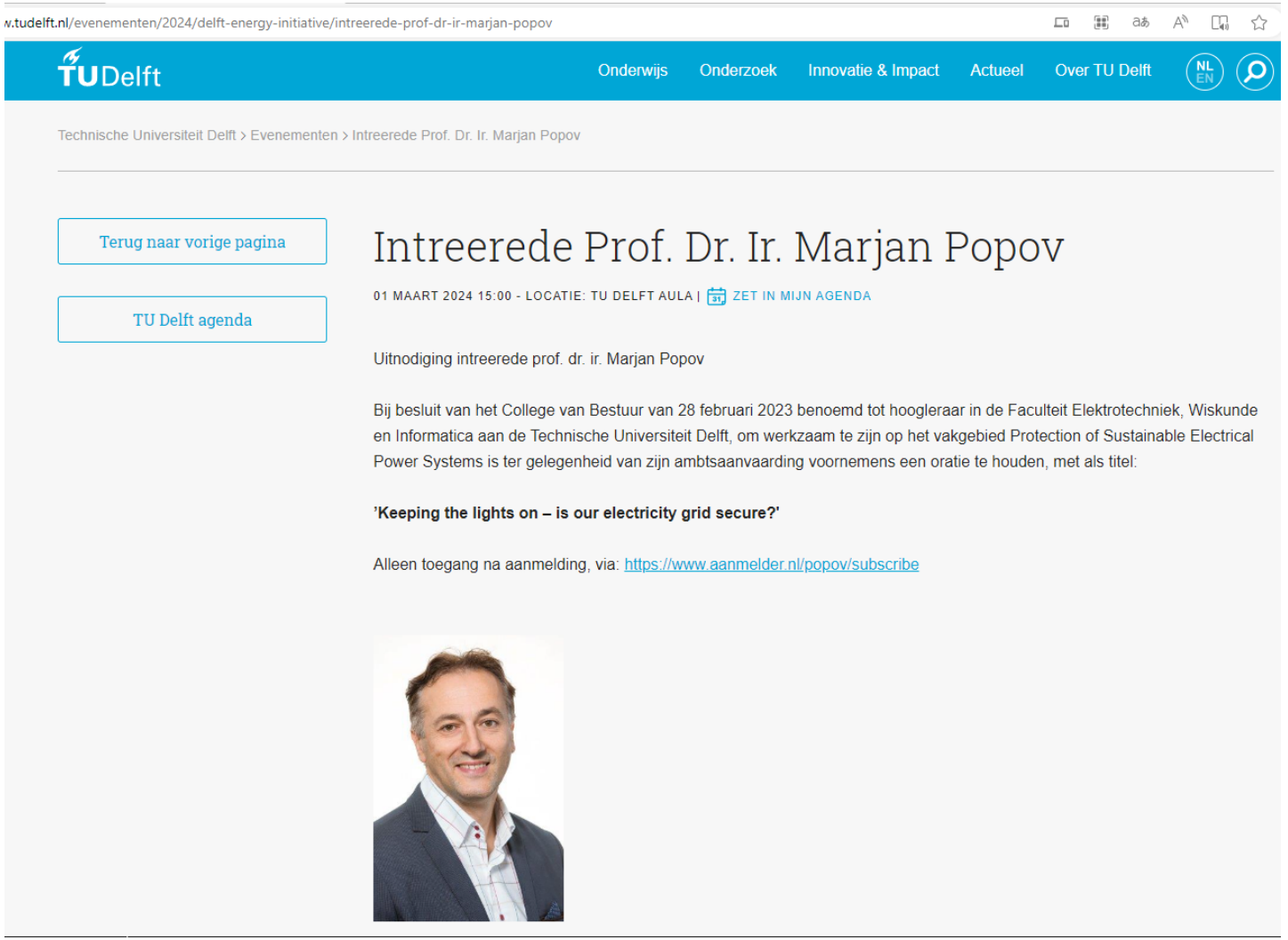
Ir. Rohan Kamat Tarcar

Ir. Ajay Shetgaonkar

Conducting interaction studies offline and HiL

Supervised: Prof. M. Popov, Dr. A. Lekic

Uitnodiging



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Technische Universiteit Delft > Evenementen > Intreerede Prof. Dr. Ir. Marjan Popov

Terug naar vorige pagina

TU Delft agenda

Intreerede Prof. Dr. Ir. Marjan Popov

01 MAART 2024 15:00 - LOCATIE: TU DELFT AULA | ZET IN MIJN AGENDA

Uitnodiging intreerede prof. dr. ir. Marjan Popov

Bij besluit van het College van Bestuur van 28 februari 2023 benoemd tot hoogleraar in de Faculteit Elektrotechniek, Wiskunde en Informatica aan de Technische Universiteit Delft, om werkzaam te zijn op het vakgebied Protection of Sustainable Electrical Power Systems is ter gelegenheid van zijn ambtsaanvaarding voornemens een oratie te houden, met als titel:

'Keeping the lights on – is our electricity grid secure?'

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