8th International Conference on Insulated Power Cables
Session C.9: Dynamic Cable Rating

Paper C.9.3: Online Ampacity Determination of a 220-kV Cable Using a Fibre Optical Cable Based Monitoring System

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Content

- Route of the 220-kV Cable Siems-Luebeck
- Ampacity of Power Cables
- Cable Embedding
- Cable Monitoring System
- Measuring Results
- Conclusion

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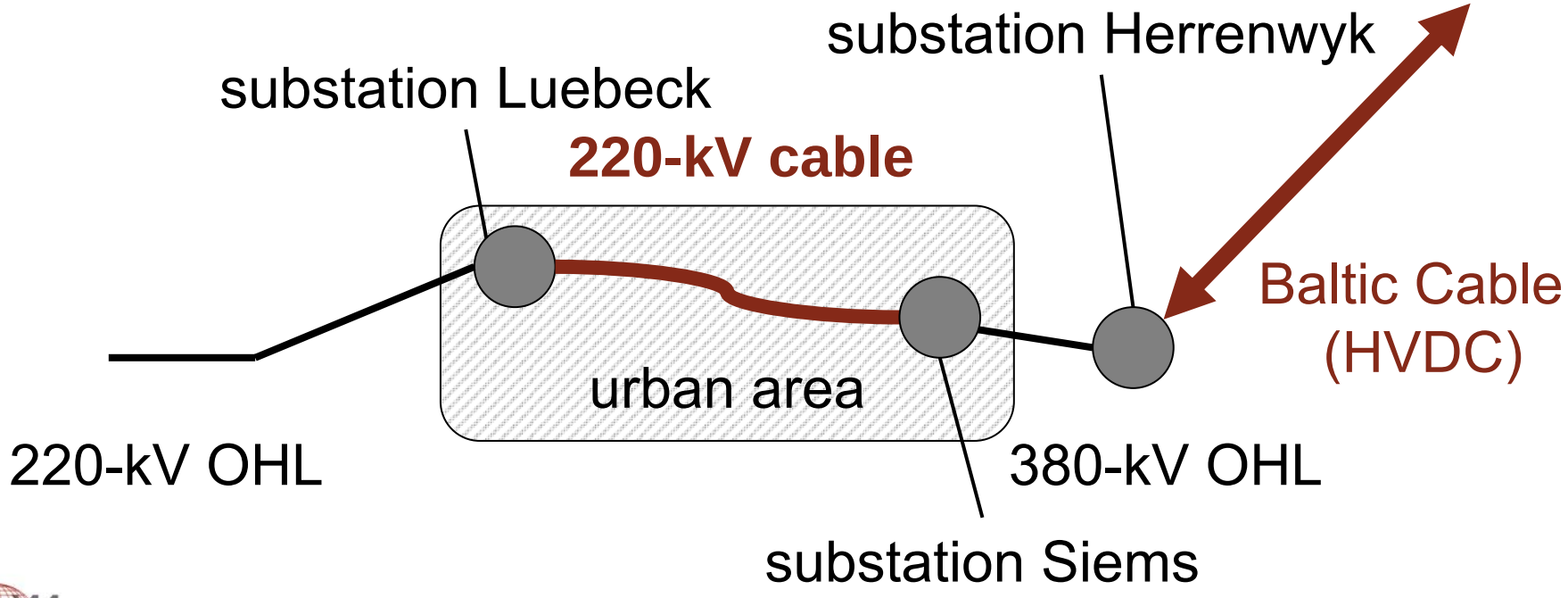
220-kV Cable Siems-Luebeck Route

- 220-kV XLPE-single-core cable (Milliken construction)
- Type N2XS(FL)2Y 3 x 1 x 1,200 mm² RMS/70 (manufacturer: NEXANS)
- cable length approx. 10 km (approx. 30 km phase length)
- depth under surface between 1.2 and 4 m



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Ampacity of Power Cables

- Ampacity of underground cables is limited by the maximum allowable temperature at the surface between conductor and insulation (90°C for the 220-kV cable Siems-Luebeck)
- Cable heats up due to the losses (electric and dielectric) occurring during operation
- Preload has significant effect on the temperature because of the cable's high heat capacity
- Cable embedding has to ensure an effective heat transfer between the cable and the surrounding soil
- A drying out of the soil has to be avoided, even in unfavourable conditions

Ampacity Increase

- With regard to soil drying out assumptions the maximum internal temperature of the cable (conductor temperature) is reached at a current load of 850 A (manufacturer's information)
- In the past a Distributed Temperature Sensing (DTS) Monitoring System without online ampacity determination (dynamic rating) was used
- Current and temperature data has been evaluated periodically, the ampacity of the monitored 220-kV cable could be increased from 850 A to 950 A as a static rating
- This corresponds to 38 MVA or respectively an increase of 12 %
- Currently a DTS Monitoring System by AP Sensing in combination with a dynamic real time temperature rating (RTTR) software by OSSCAD is used

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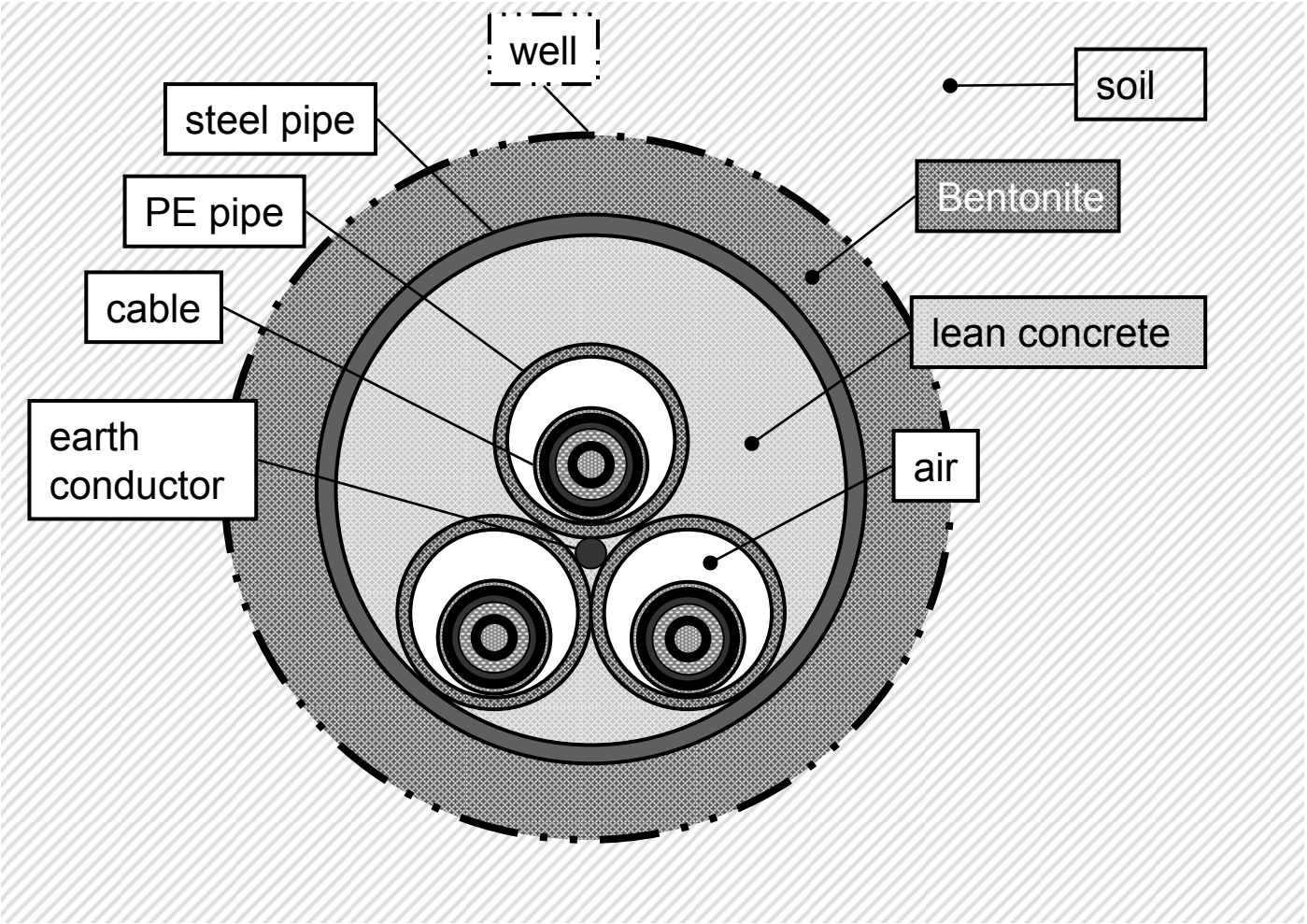
Power Cable Embedding

- The cables are protected by PE-pipes
- In populated areas these pipes were installed over long distances by means of horizontal directional drilling (HDD)
- In addition the three PE-pipes were partially embedded into a steel pipe
- The steel pipe was directly laid into the cable trench or inserted by a drilling method
- In case of using the drilling to insert the steel pipes, cavities were simultaneously flushed and filled with Bentonite
- Within the steel pipe the void between the steel pipes inner wall and the PE-pipes was filled with thermal conducting material (a sort of lean concrete)

Power Cable Embedding (Schemata)



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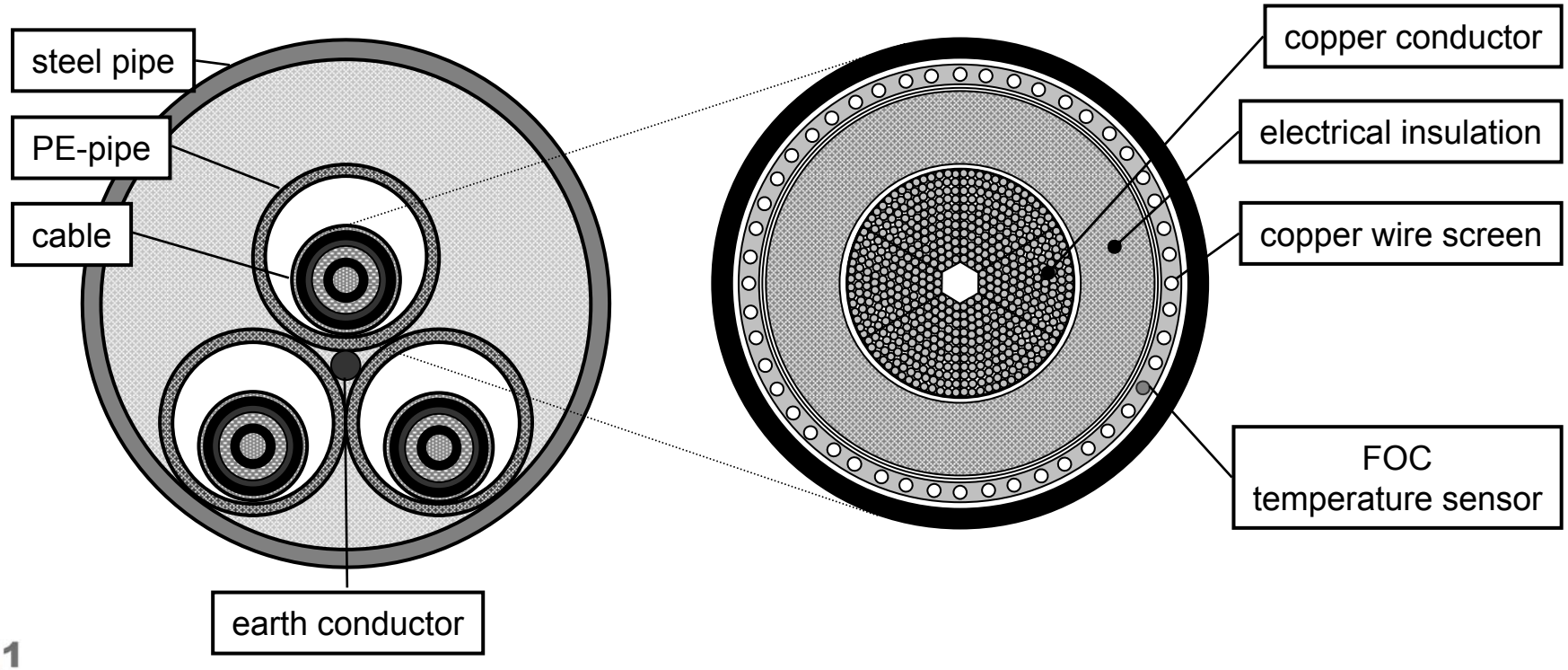
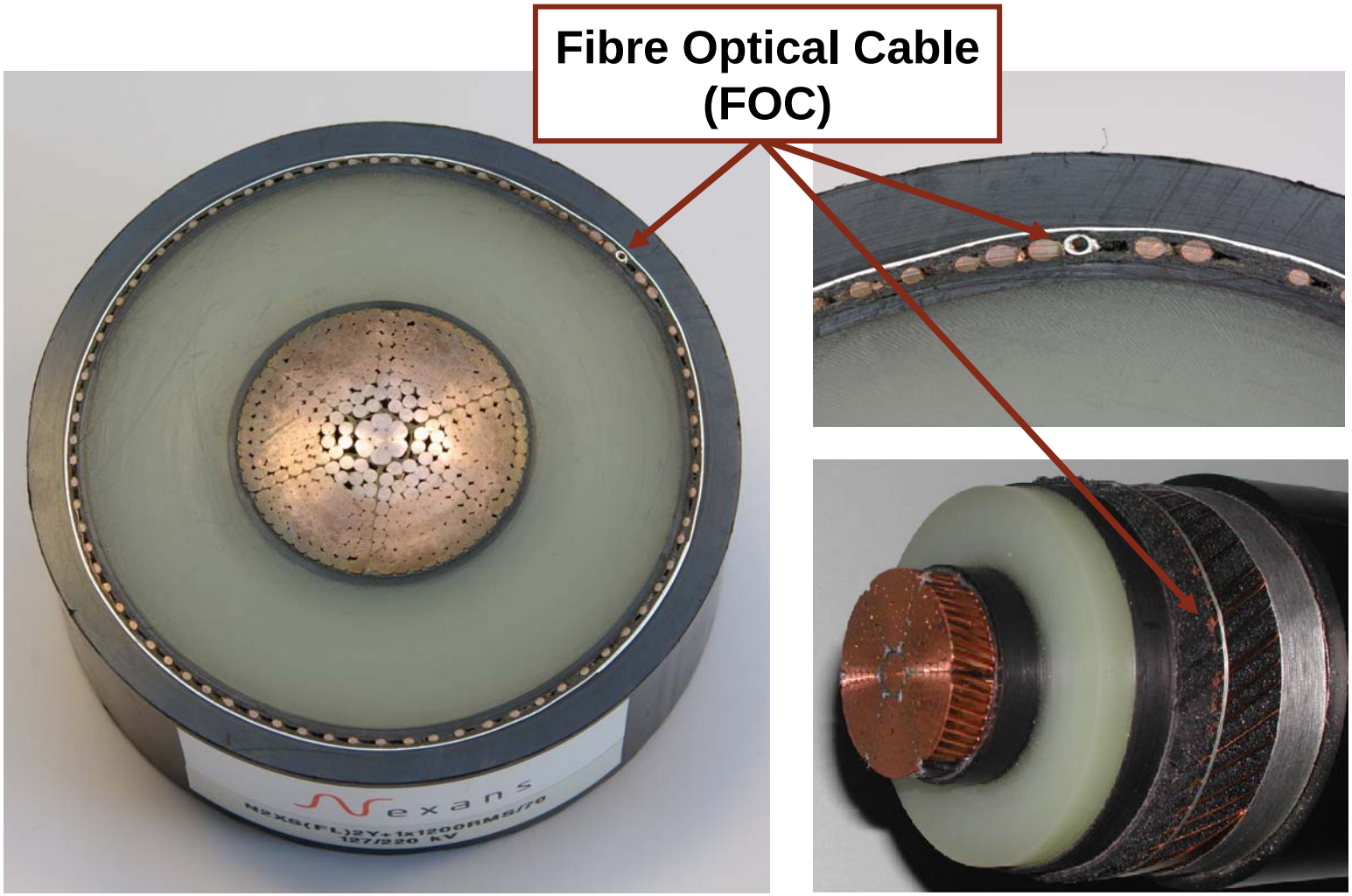
Cable Monitoring System

- A Linear Power Series Distributed Temperature Sensing (DTS) system by AP Sensing to measure the cable temperature in the sheath via FOC along the entire cable length (spatial resolution 1 m) is used
- FOC is integrated in the upper cable which has the highest thermal load

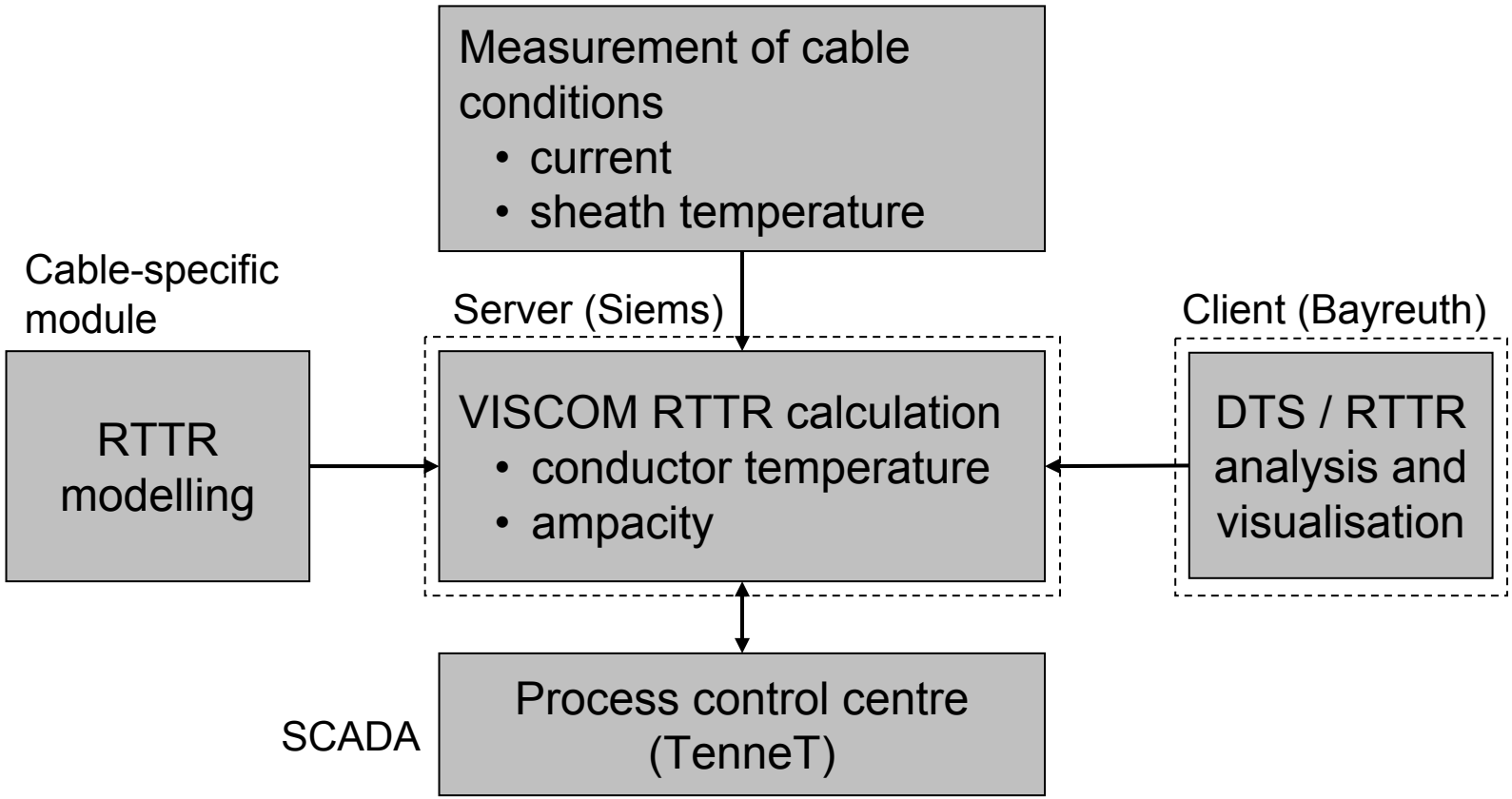


Cable Detail Photos



RTTR Software

- The ampacity is calculated online depending on actual load and surrounding conditions with the dynamic real time temperature rating (RTTR) VISCOM software by OSSCAD



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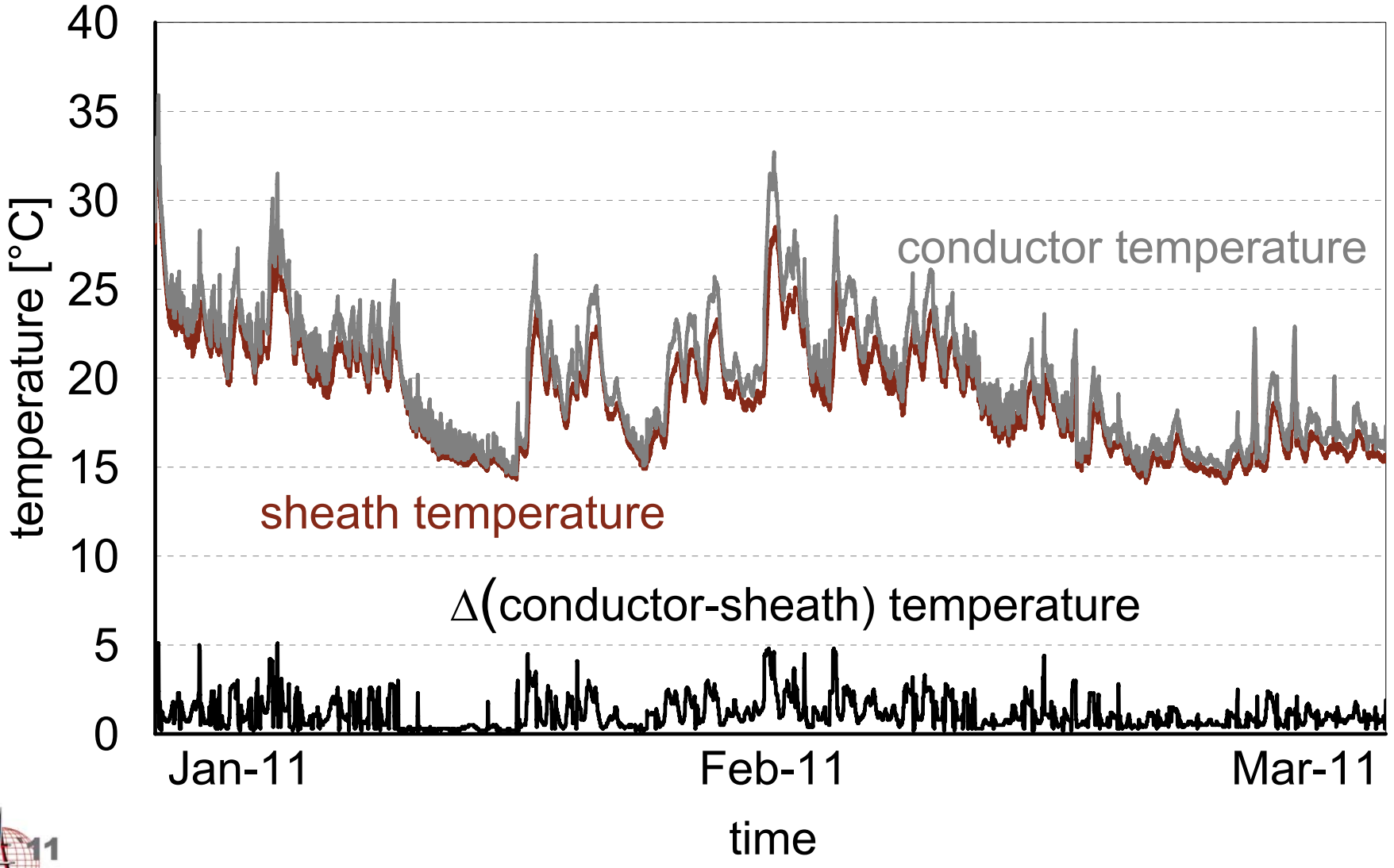
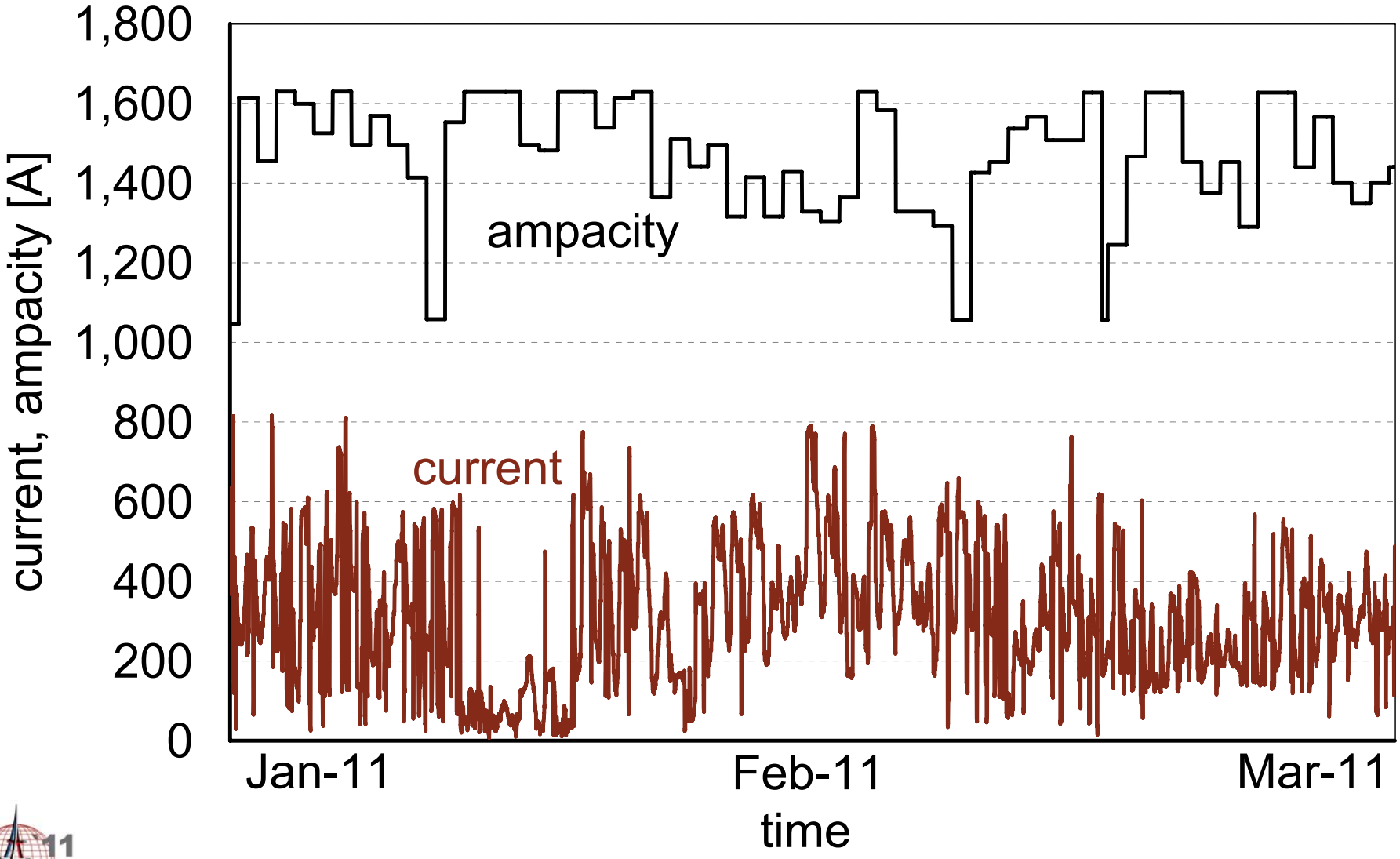
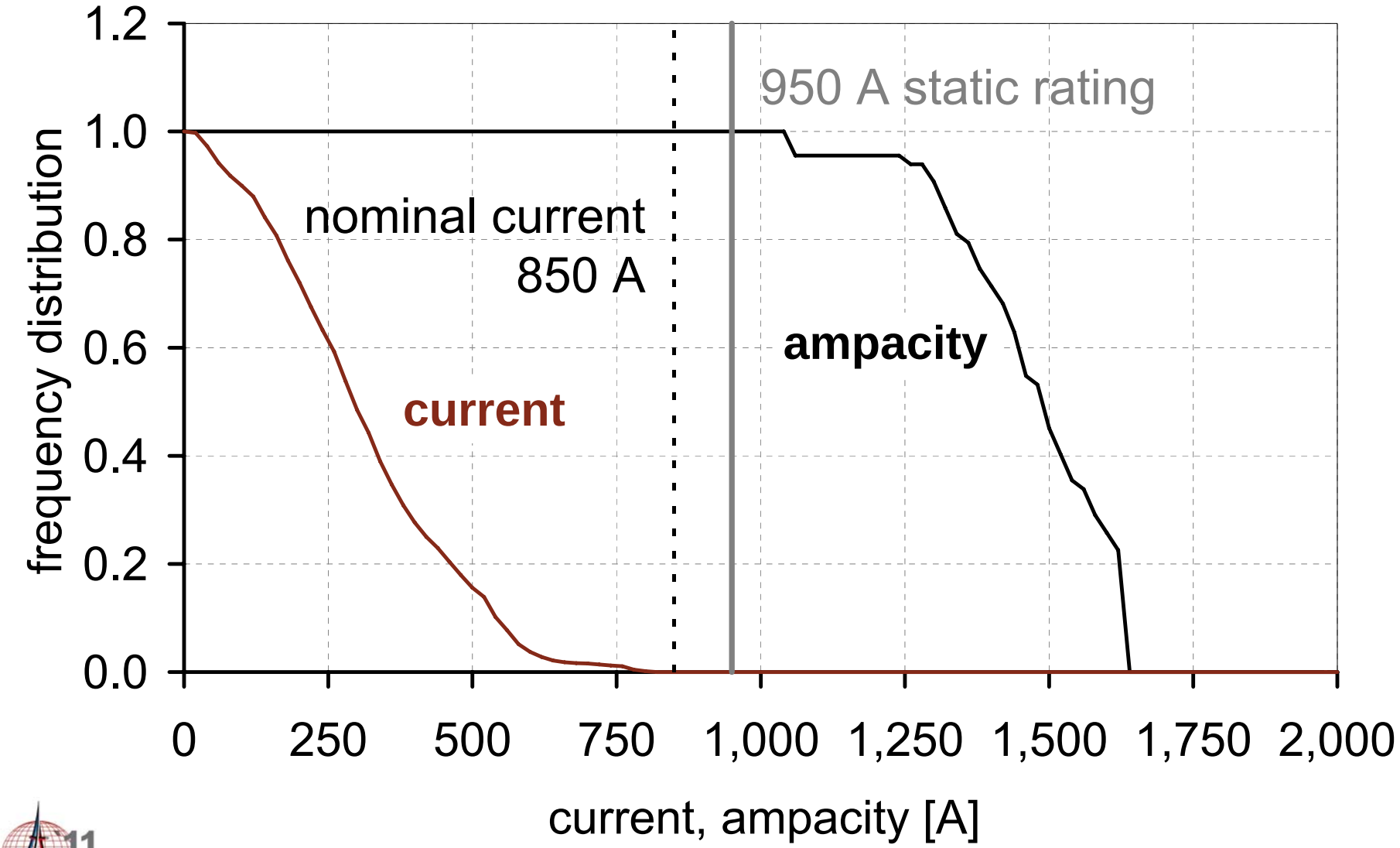
Maximum Conductor and Sheath Temperature



Ampacity and Current



Frequency Distribution of Current and Ampacity



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Conclusion

- To enable the dynamic rating of the 220-kV cable a real time monitoring system consisting of DTS and RTTR was installed, tested and integrated into the existing SCADA system
- Compared to the static rating of 950 A evaluated by the old measurement setup the new system delivers an online calculation resulting in higher ampacities
- The advantage of the online, dynamic rating system is the continuous determination of the ampacity
- This allows the use of higher ampacities in the operation centre also for short time periods
- In this application the cable monitoring system proved to be reliable and is reasonable for future applications

Thank you for your kind attention!

Dr. Michael Schmale

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