

PROMOTiON WP15.2.4

Short term PD behavior for SF6 and SF6 alternative gases – with defect

SuperGrid Institute, September 20th 2018



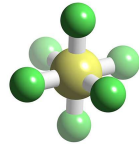
© PROMOTiON – Progress on Meshed HVDC Offshore Transmission Networks
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691714.

Agenda

- Context
- Test setup & Measuring system
- Results

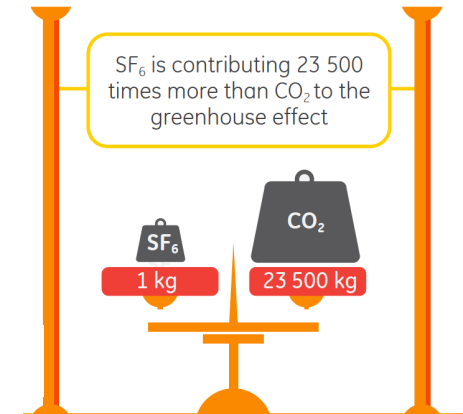


Context

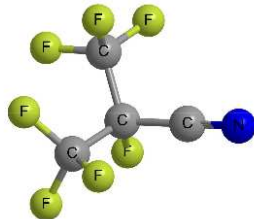


80% of all SF₆ is used in the transmissions industry

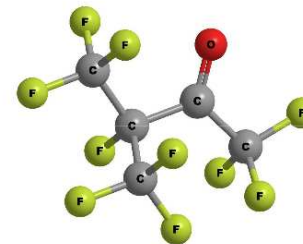
- SF₆ has a GWP 23500 higher than CO₂ and it has been included in the Kyoto Protocol list
- Different alternative gas mixtures are today proposed as substitute of SF₆. As they could be used in replacement of SF₆ in future DC GIS their electrical properties and principally partial discharge sensitivity and behavior need to be investigated
- Two alternative gases will be investigated and will be compared with SF₆



• **Fluoronitrile (NOVEC™ 4710)–CO₂ mixtures**



• **Fluoroketones (NOVEC™ 5110) – Air mixtures**



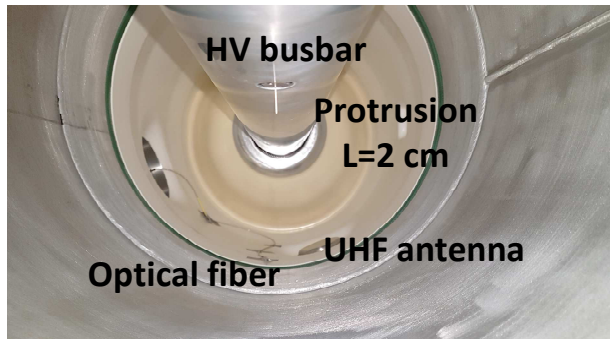
Gas mixture under study

Gas	Pressure (bar abs)			Equivalent pressure to SF6 (bar abs)
SF6	5			
	6			
	6.8			
Air Plus	Novec 5110	Technic Air	Mixture	
	0.5	7	7.5	5
	0.5	8.9	9.4	6
	0.5	10.5	11	6.8
FN-CO ₂ mixture	Novec 4710	CO₂	Mixture	
	0.32	7.68	8	5
	0.65	5.85	6.5	5

Performed test



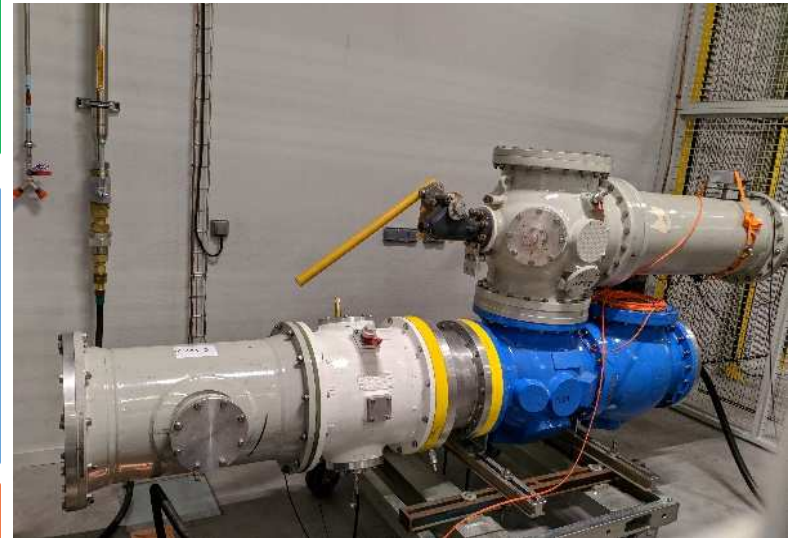
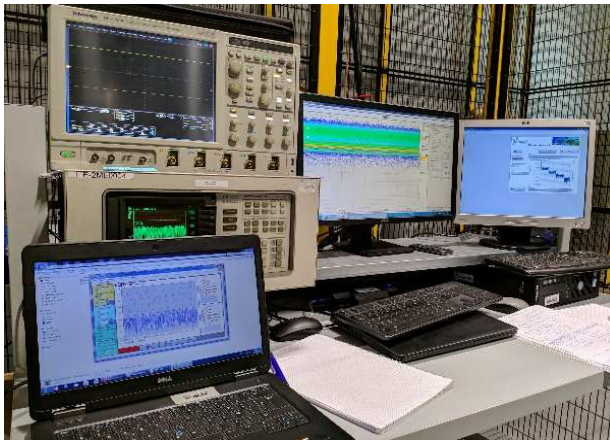
Test setup and Measuring systems



Conventional
measurement
100 kHz 400 kHz

Optical
Photomultiplier
(185-700 nm)
Keithley
picoammeter

UHF
High-pass filter
(300-2000MHz)
Pre-amplifier 36 dB
Spectrum analyser

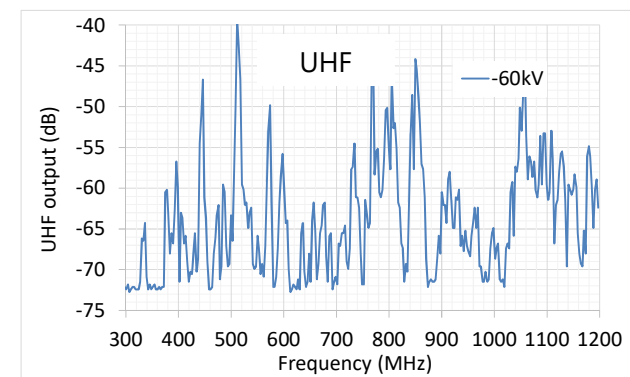
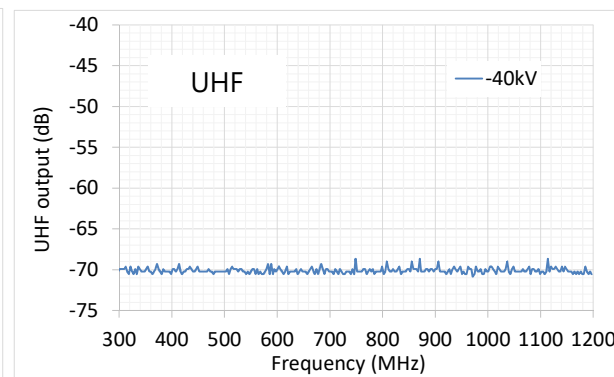
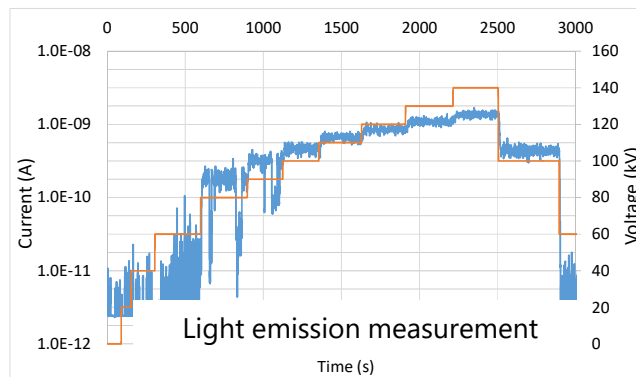
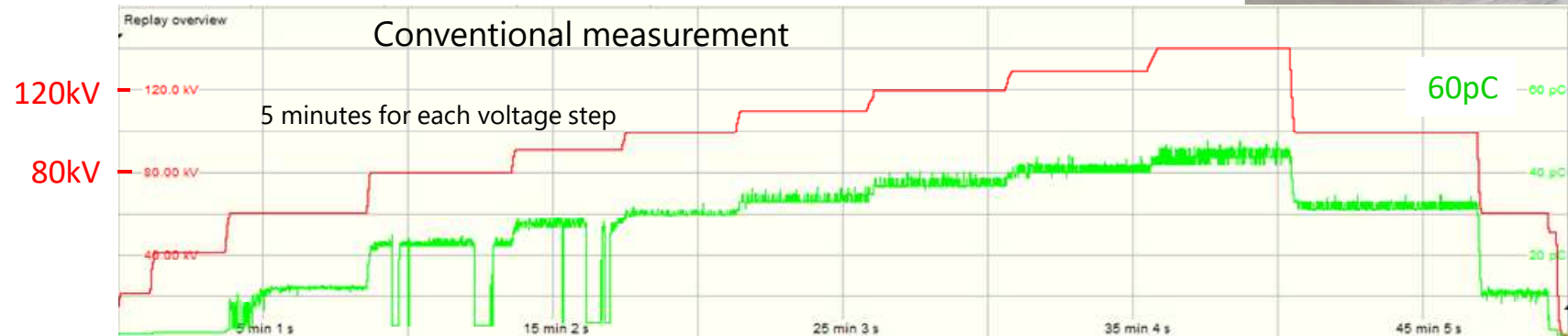
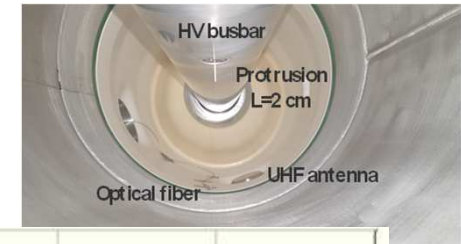


HFCT measurement is under progress



Results – SF6 as reference 5bar

PD behavior with 2cm protrusion in SF6 under negative DC voltage

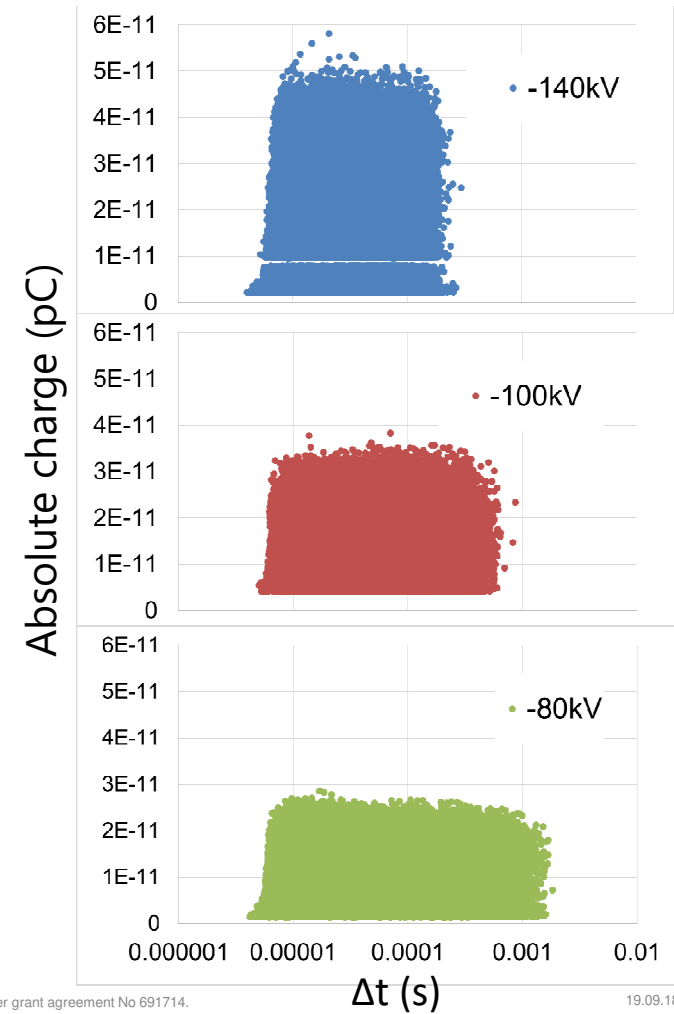


Results – SF6 as reference 5bar

Influence of DC voltage

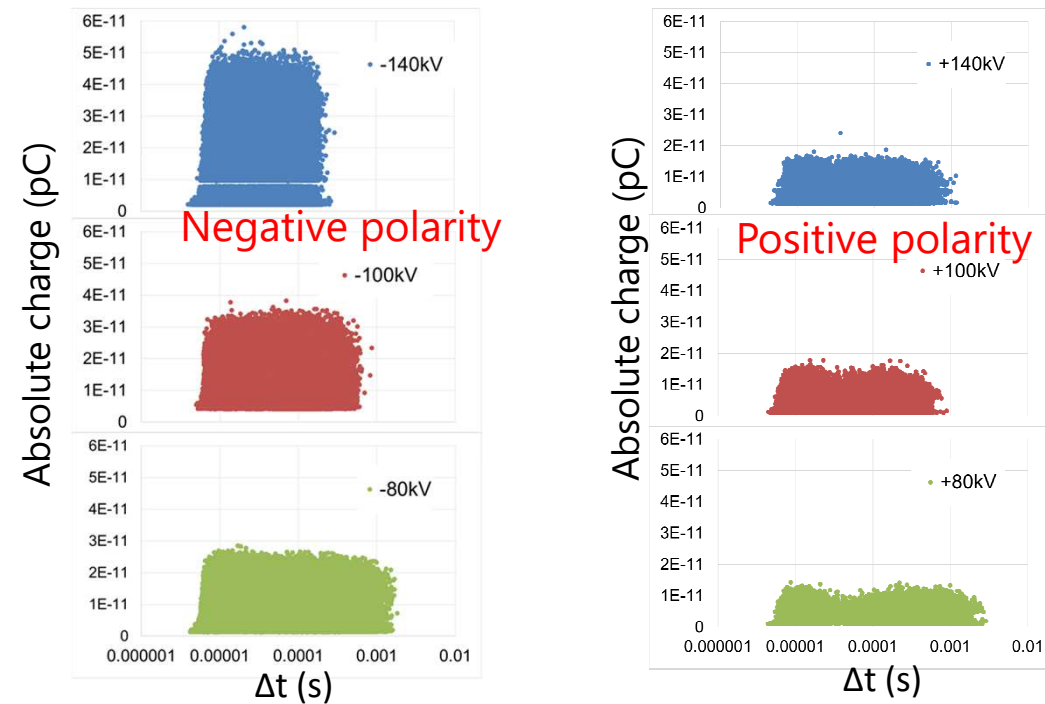
- With the increase of DC voltage
 - Discharge amplitude increases
 - Time between discharges decreases

Example for SF6@5b with negative polarity



Results – SF6 as reference 5b

Influence of DC polarity



- Higher discharge amplitude and lower time between discharge for negative polarity



Results – Comparison SF6, FN-CO2 10% and AirPlus

PD inception voltages for 5b SF6 equivalent dielectric strength

Gas type	SF6 at 5 bar abs		FN-CO2 mixture 10% at 6.5 bar abs		AirPLUS at 7.5 bar abs	
Polarity	POS	NEG	POS	NEG	POS	NEG
Vi [kV]	60 kV	- 55 kV	65 kV	- 50 kV	45 kV	-40 kV

- Higher inception voltage with positive polarity for all gases
- Same inception voltages for SF6 and FN-CO2 10% for both positive and negative polarities
- Lower inception voltage for AirPlus



Results – Comparison SF6, FN-CO2 10% and AirPlus

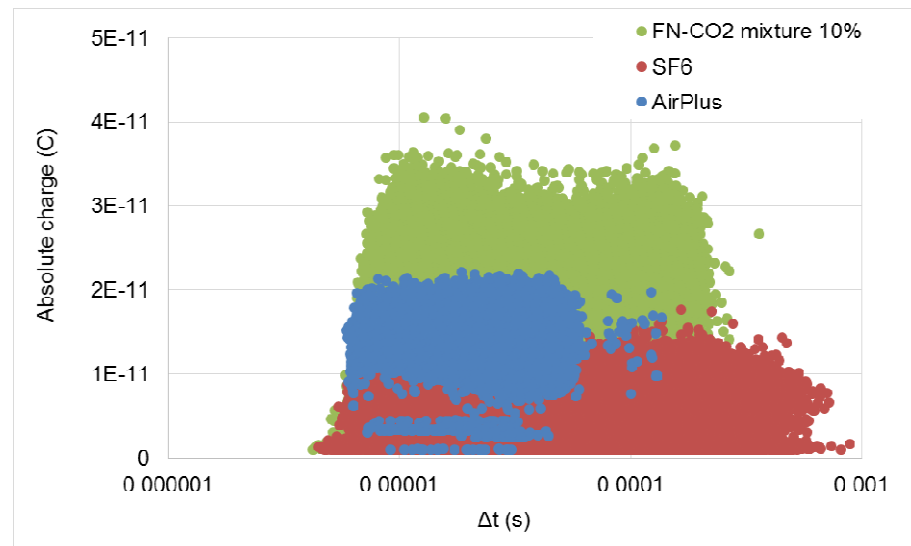
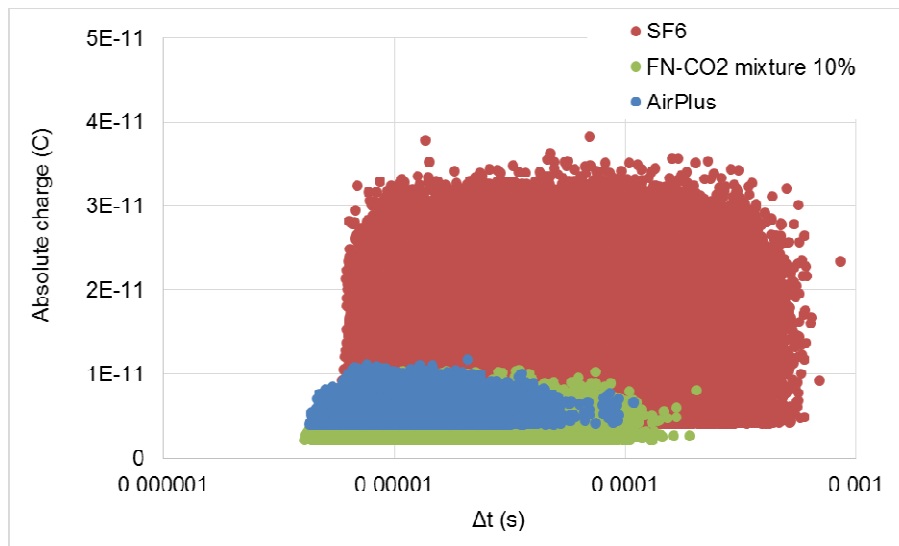
Lower time between PD impulses for alternative gases compared to SF6

Higher PD level observed for SF6 under negative polarity while it is observed for alternative gases under positive polarity

Negative polarity

100kV

Positive polarity



Planning

- Measurements with protrusion defect with the remaining gases
- Measurements with the other type of defect (metallic particle on insulator)



PROMOTioN WP15



© PROMOTioN – Progress on Meshed HVDC Offshore Transmission Networks
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691714.

APPENDIX

DISCLAIMER & PARTNERS

COPYRIGHT

PROMOTiON – Progress on Meshed HVDC Offshore Transmission Networks
MAIL info@promotion-offshore.net WEB www.promotion-offshore.net

The opinions in this presentation are those of the author and do not commit in any way the European Commission

PROJECT COORDINATOR

DNV GL Netherlands B.V.
Utrechtseweg 310, 6812 AR Arnhem, The Netherlands
Tel +31 26 3 56 9111
Web www.dnvgl.com/energy

CONTACT

Michael Gatzsche, R&D Engineer @ ABB
michael.gatzsche@ch.abb.com
+41 79 347 25 54

PARTNERS

DNV GL Netherlands B.V., ABB AB, KU Leuven, KTH Royal Institute of Technology, EirGrid plc, SuperGrid Institute, Deutsche WindGuard GmbH, Mitsubishi Electric Europe B.V., Affärsverket Svenska kraftnät, Alstom Grid UK Ltd (Trading as GE Grid Solutions), University of Aberdeen, Réseau de Transport d'Électricité, Technische Universiteit Delft, Statoil ASA, TenneT TSO B.V., Stiftung OFFSHORE-WINDENERGIE, Siemens AG, Danmarks Tekniske Universitet, Rheinisch-Westfälische Technische Hochschule Aachen, Universitat Politècnica de València, SCiBreak AB, Forschungsgemeinschaft für Elektrische Anlagen und Stromwirtschaft e.V., Ørsted Wind Power A/S, The Carbon Trust, Tractebel Engineering S.A., European University Institute, Iberdrola Renovables Energía, S.A., European Association of the Electricity Transmission & Distribution Equipment and Services Industry, University of Strathclyde, ADWEN Offshore, S.L., Prysmian, Rijksuniversiteit Groningen, MHI Vestas Offshore Wind AS, Energinet.dk, Scottish Hydro Electric Transmission plc, SCiBreak AB



© PROMOTiON – Progress on Meshed HVDC Offshore Transmission Networks
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691714.

19.09.18

13