Toward Evaluating the Performance of High Voltage Insulation for Aerospace

DTE Network+ Project progress report (June-December 2022)

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This document summarises briefly the progress against the plan of work proposed in the original grant application. Experimental work has been impacted by delays to workshop fabrication and a no-cost extension requested. A revised project plan to March 2023 is presented.

Progress Against Planned Work Packages

WP1 Finite-element analysis of electric field distributions in dielectric barriers with variable air pressure. Extensive electrostatic simulations were performed to determine critical electric fields in cables and flat insulation samples. Example study shown in Figure 1.

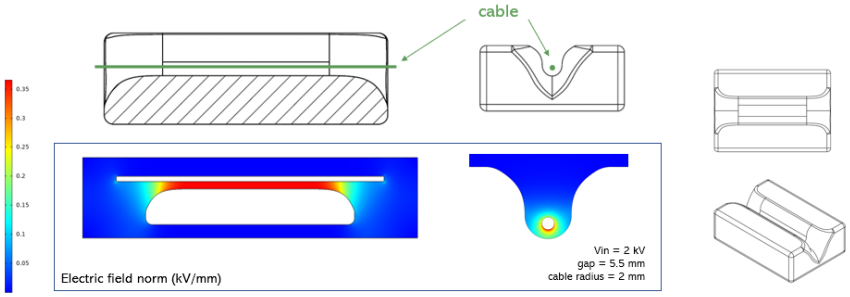

Figure 1: Example E-field simulation of an aerospace cable [left] with pseudo-coaxial grounding arrangement. Results used to optimise electrode design [right] for fabrication in WP2

WP2 Design and fabrication of custom electrodes and test cells for controlled partial discharge measurements in dielectric barriers. Novel electrodes designed and fabricated in-house to eliminate end-effects in partial discharge testing of cable samples (Figure 2). Using an open 'pseudo-coaxial' arrangement, we plan to use optical methods to detect discharges in the cable insulation system. New electrodes have also been manufactured for testing flat insulation samples.

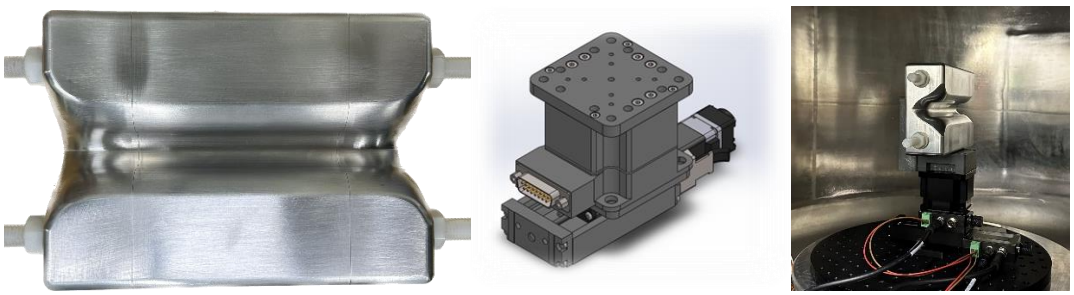

Figure 2: Cable PD test electrode. Finished 3-piece electrode [left], X-Z stage [centre], installed in atmospheric control vessel [right].

WP3 Experimental quantification of the effect of atmospheric conditions on partial discharge phenomena over the altitude range of an international flight. Flat sample tests are now underway, with a plan to publish initial results at ISH2023. Cable tests are delayed, pending delivery of a vacuum feedthrough from the workshop. We plan to start cable tests in January 2023.

WP4 Quantification of the effects of condensation and ice on the performance of the dielectric barrier. Supporting thermal modelling and electrode design are complete, with components ordered at the start of December. An undergraduate project is assigned to this work package, with evaluation and testing due to begin in February.

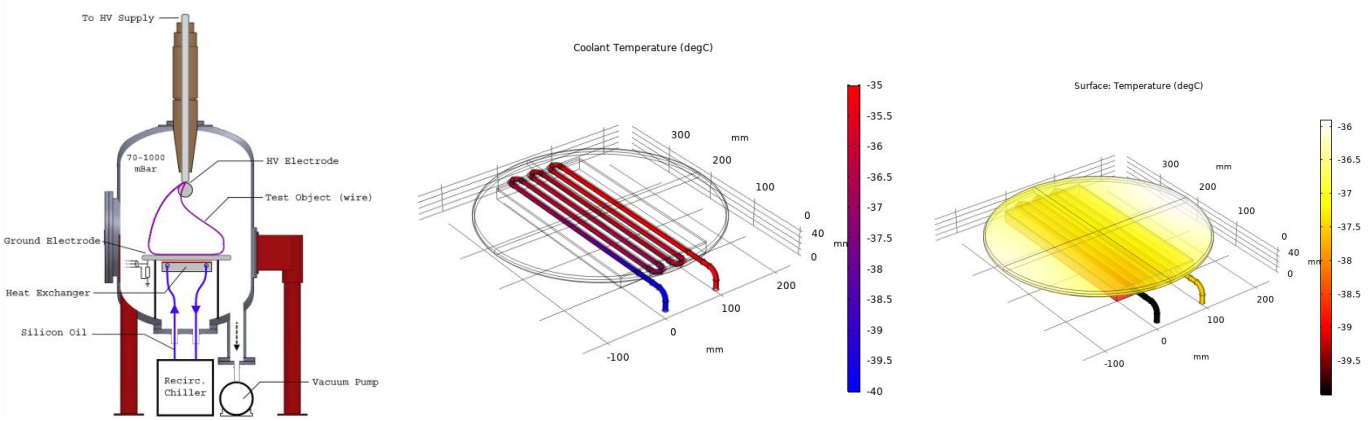

Figure 3: Direct cooling of a PD test electrode in controlled atmosphere by recirculating chiller. Vacuum system section view [left], simulated coolant temperature [centre], simulated electrode surface temperature [right].

WP5 Dissemination. Initial simulation work and flat sample tests were presented at ICOLSE 2022 in Madrid (September). Project progress presented at the DTE+ Network event in Cardiff (November). Abstracts submitted to ISH 2023 in Glasgow and GD 2023 in Greifswald.

Work Package Review and Revised Project Gantt Chart

Table 1: Project Work Packages and Progress

Work Package	Description	Outcomes & Deliverables	Status
WP1	Finite-element analysis of electric field distributions in dielectric barriers with variable air pressure	a) Library of parameterised electrostatic simulation models. b) Material properties and geometric shape parameters for WP2.	***Complete*** ***Complete***
WP2	Design and fabrication of custom electrodes and test cells for controlled partial discharge measurements in dielectric barriers	c) Calibrated test cells for WP3 & WP4	***Complete***
WP3	Experimental quantification of the effect of atmospheric conditions on partial discharge phenomena over the altitude range of an international flight.	d) Dataset, comprising partial discharge inception an extinction voltages, phase-resolved charge and energy measurements (where applicable), and measurement -correlated uv images.	Insulation coupon tests in progress. Cable tests pending component from Workshop. Due Q1 2023
WP4	Quantification of the effects of condensation and ice on the performance of the dielectric barrier.	e) Enhanced test capability of the controlled atmosphere hv test chamber. f) Extended dataset,	Awaiting parts delivery. Project student assigned to build and test. Due Q1 2023
WP5	Dissemination	g) Dissemination through the DTE+ network. h) At least one peer-reviewed journal paper, to be prepared on completion of the project. i) At least one conference paper (ICOLSE'22)	***Complete*** Due Q2-Q3 2023. ***Complete*.** Additional Papers in preparation for ISH'23 and GD'23

Table 2: Revised Project Plan to March 2023

WP	2022																								2023															
	Jun			Jul				Aug				Sep				Oct				Nov				Dec				Jan				Feb				Mar+						
1							a		b																																
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