Characterisation of a Corona-stabilised Switch in Alternative Gas Mixtures

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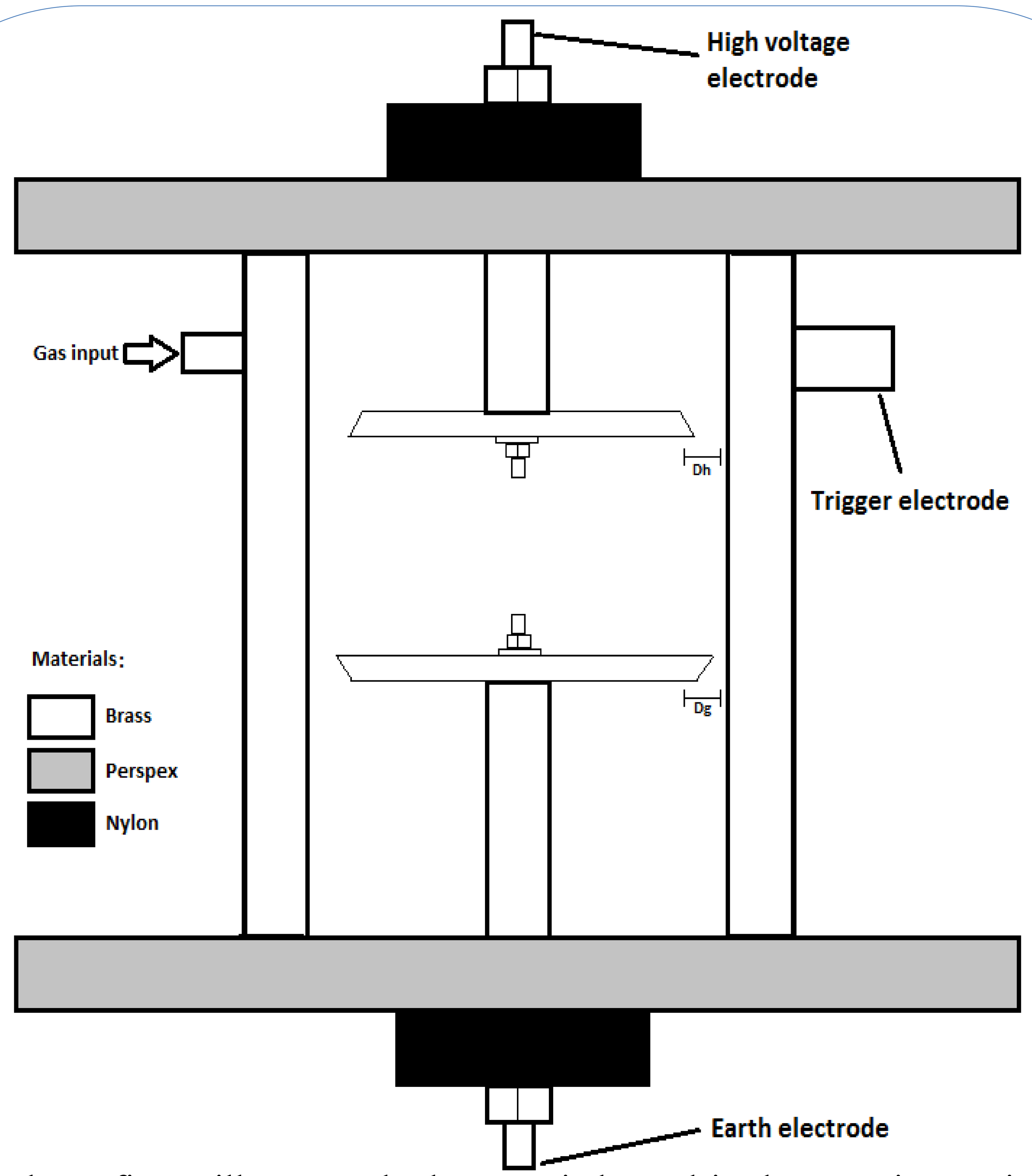
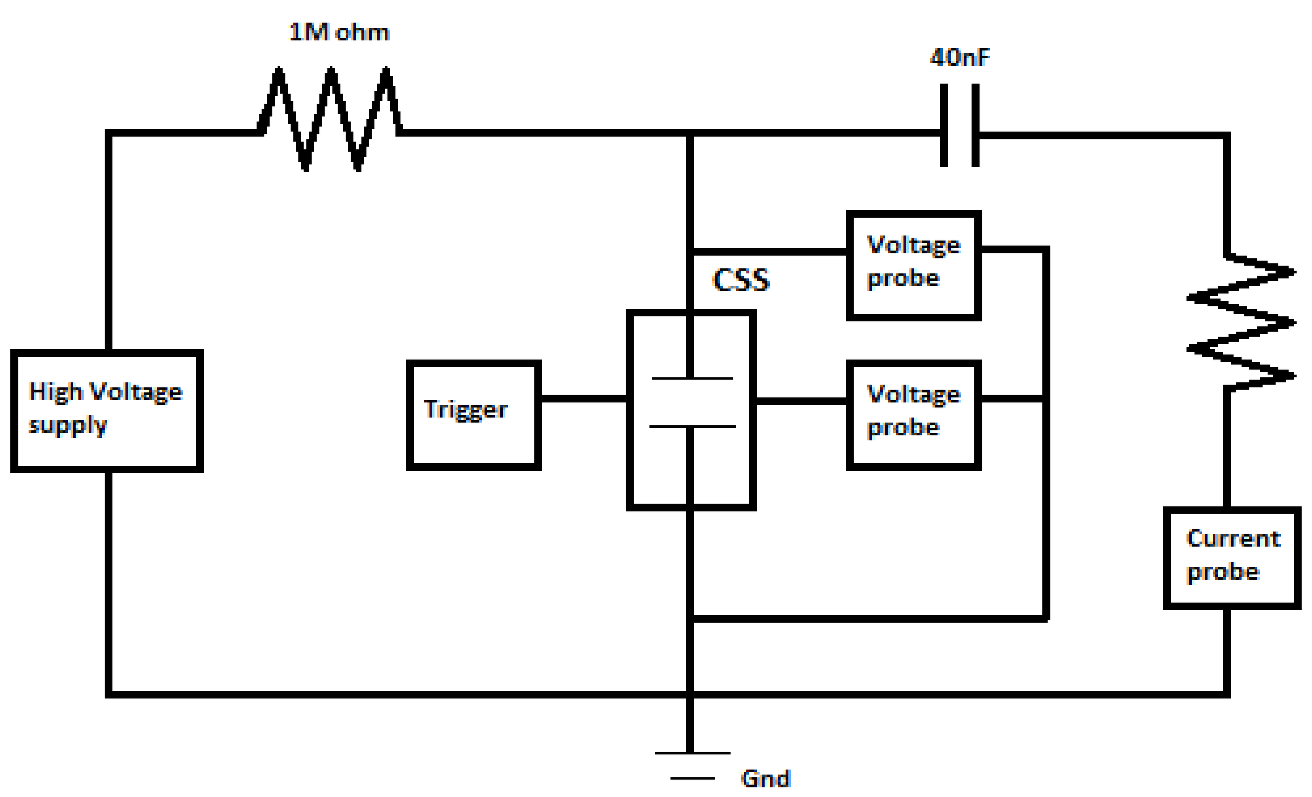
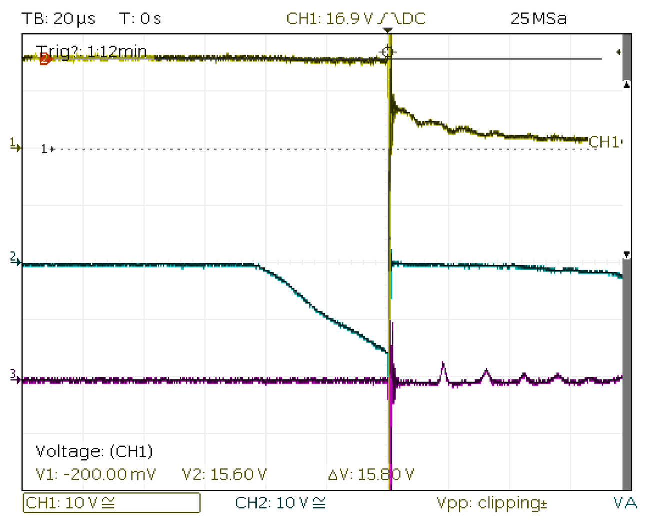
Introduction: Sulphur hexafluoride (SF_6) has traditionally been used as a switching medium within corona-stabilised switches (CSS). Due to its high global warming potential (GWP), however, other gases are under test in order to find a suitable alternative that can be used within CSS, without compromising on switching performance. Design changes may have to be made in order for the switch to remain at the high level of performance achieved when filled with SF_6. This poster reports preliminary results obtained using a CSS operated with the refrigerant 1,3,3,3-tetrafluoropropene, known as HFO-1234ze as the basis of the operating gas. The electronegativity of HFO-1234ze makes it an attractive option to SF_6 for switching applications. Additionally, the global warming potential (GWP) of this gas is 6 in a 100-year time horizon, compared to SF_6 with a value of 23900. The performance of the switch has been characterized in terms of triggering range, delay time and jitter over a range of pressures when filled with air as a reference, as well as with HFO-1234ze in various mixtures with buffer gas nitrogen (N_2) of the order of >80%. The results presented provide data on the feasibility of the approach of using HFO-1234ze as the operating gas in corona stabilised switches. It will also provide the initial basis for work refining the use of buffer gases and for the development of optimised switch configurations.

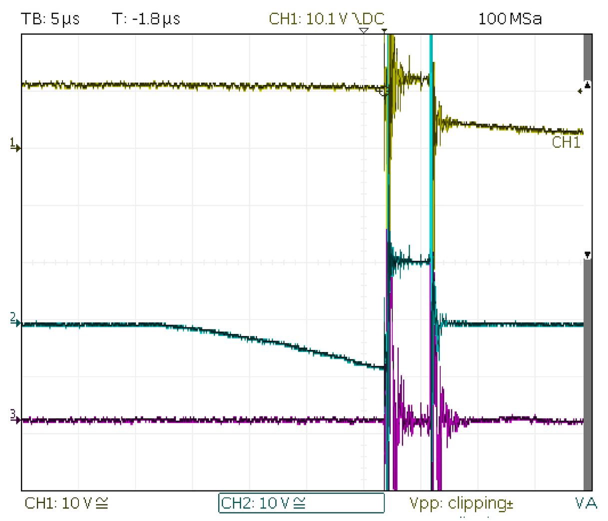


The above figure illustrates the brass switch used in the experimentation. A key is visible showing the different materials used within the switch. Dh and Dg determine the gap length of the HV – body and Body – Ground electrodes respectively. During the experimentation a Dh gap of 5mm and A Dg gap of 3mm remained constant.

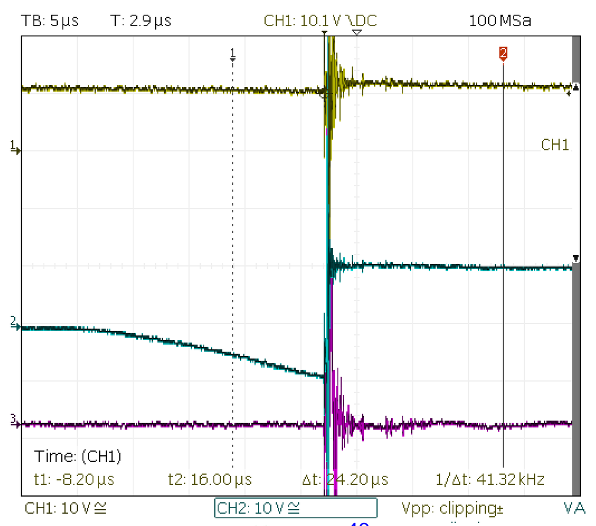




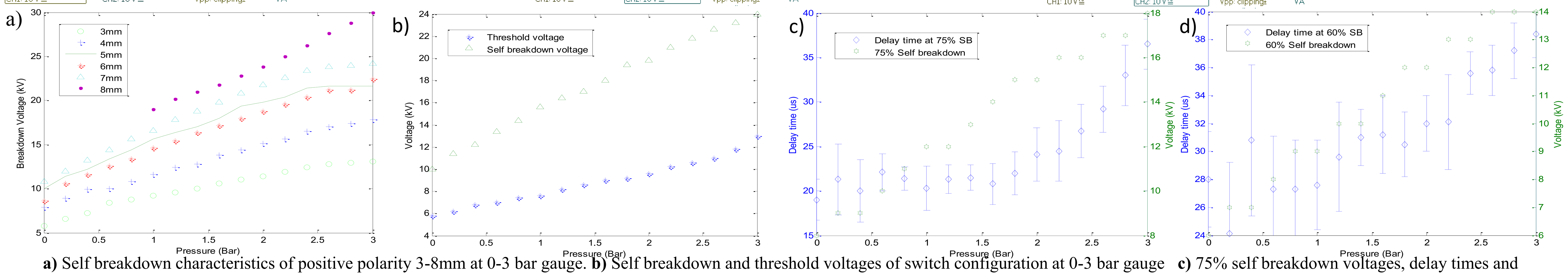
Waveform A: This waveform is showing fast switch closure with no or very quick t2. Occurs when distant enough from threshold voltage



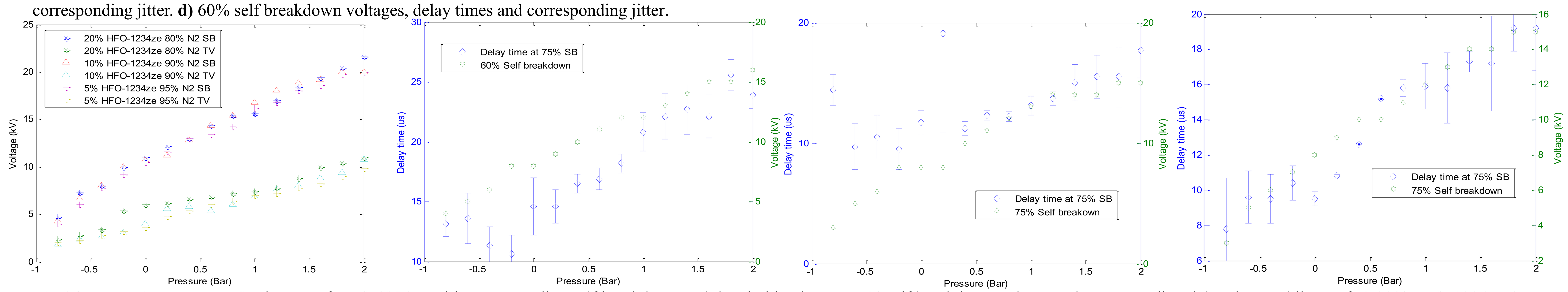
Waveform B: This waveform is showing the delay time when t2 appears and single gap closure appears before complete closure. Occurs when closer to threshold voltage.



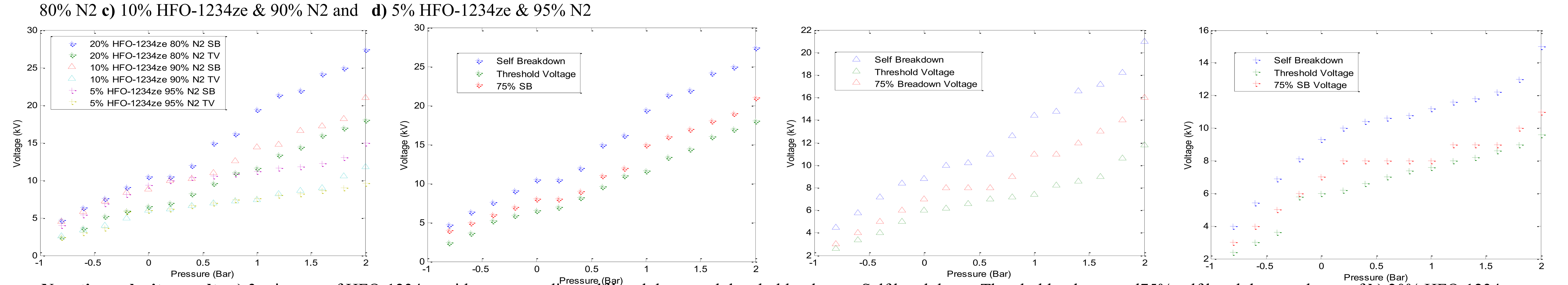
Waveform C: This waveform is showing the switch when the switch does not close and the body is the same potential as the applied



a) Self breakdown characteristics of positive polarity 3-8mm at 0-3 bar gauge. **b)** Self breakdown and threshold voltages of switch configuration at 0-3 bar gauge **c)** 75% self breakdown voltages, delay times and corresponding jitter. **d)** 60% self breakdown voltages, delay times and corresponding jitter.



Positive polarity results a) 3 mixtures of HFO-1234ze with corresponding self breakdown and threshold voltages. 75% self breakdown voltage and corresponding delay time and jitter of **b)** 20% HFO-1234ze & 80% N2 **c)** 10% HFO-1234ze & 90% N2 and **d)** 5% HFO-1234ze & 95% N2



Negative polarity results a) 3 mixtures of HFO-1234ze with corresponding self breakdown and threshold voltages. Self breakdown, Threshold voltagesand75% self breakdown voltage of **b)** 20% HFO-1234ze & 80% N2 **c)** 10% HFO-1234ze & 90% N2 and **d)** 5% HFO-1234ze & 95% N2

Discussion & Further work: So as seen from the above graphs from the experiments done, it is clear to see a different operation is established at the 3 different procedures. In air and positive polarity with the mixtures of HFO-1234ze the breakdown voltages relatively constant. Although in terms of delay time, in each of the mixtures present a clear change in operation time is apparent. This will be useful when voltage breakdown is to be measured which is the next step in the research process. In negative polarity in the HFO-1234ze mixtures there is a clear increase in self breakdown where at 2 bar, 20% HFO-1234ze and 80% N2 the switch operated almost 200% above when just measured in 100% N2. Delay time is next to be tested with negative polarity. From the negative switch characteristics however, as the 75% self breakdown is closer to the threshold voltage of that particular switch geometry the switch is theorised to have a longer delay time compared to that of the positive polarity.