



# Compact Sealed Spark Gaps

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## Objective

Investigate the practicality of a sealed spark gap switch that is smaller than commercially available spark gap switches.

## Technology Impact

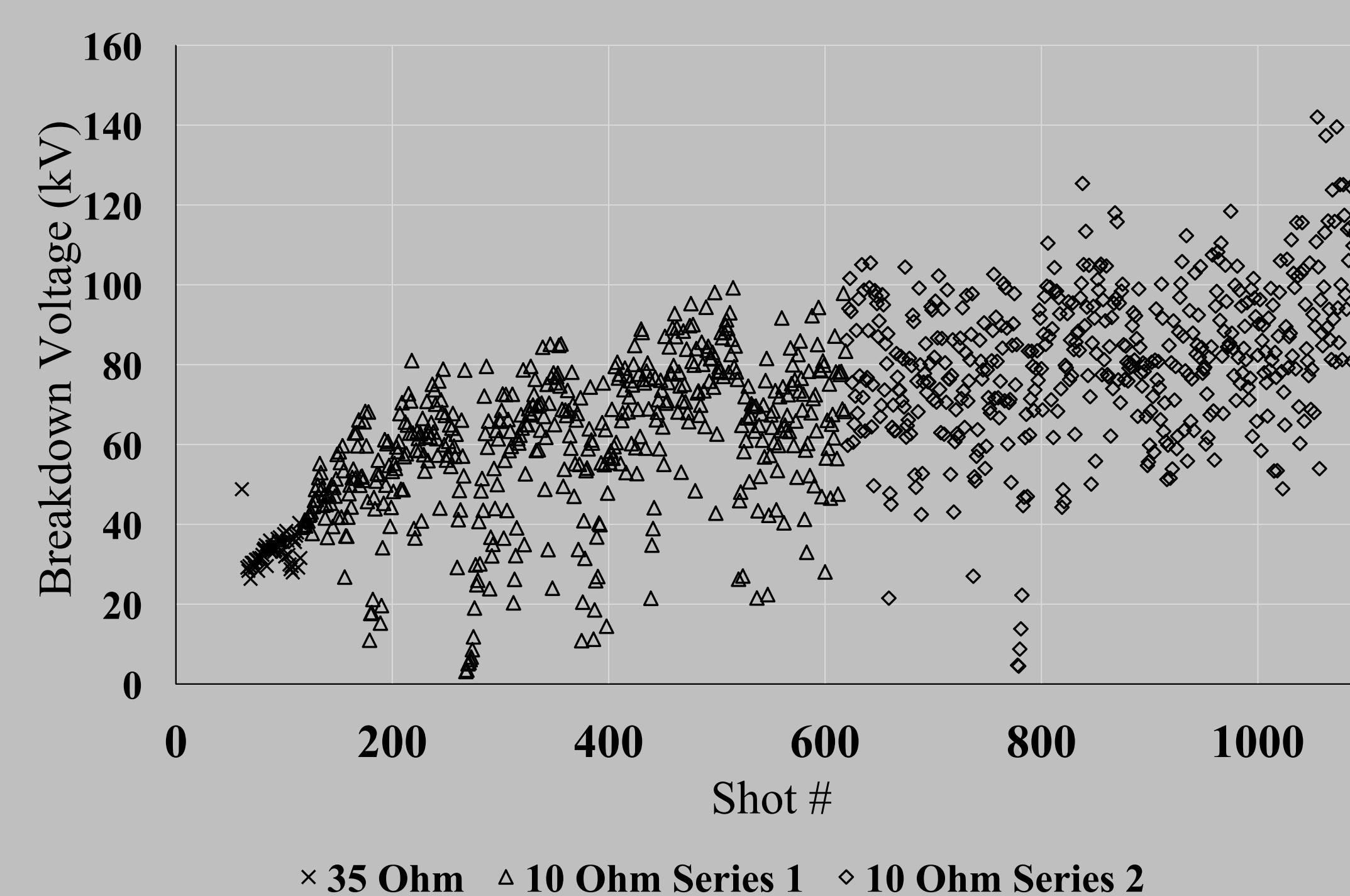
Enable long shelf life, compact pulsed power systems by removing the gas systems required for typical spark gap switches.

## Comparison of Commercial Spark Gap Switches

Switch	Volume (cm <sup>3</sup> )	Max Volt. (kV)	Min Volt. (kV)	Max Current (kA)	Lifetime
SNL Vacuum	83	70	2	10	1
SNL Gas	158	100	10	40	2500
Flash	740	50	5	100	10000
L3 T-670	740	100	18	100	10000
Flare	740	150	10	100	10000
Excitilies GP-74B	880	100	40	100	10000
L3 402	1168	100	25	100	10000
Excitilies GPV-6313	872	80	0.3	60	1
L3 T-508	7410	120	30	150	2000

## Experimentally Observed Conditioning Trend

- Breakdown voltage increased with increasing shot count
- Large variance in breakdown voltage between shots



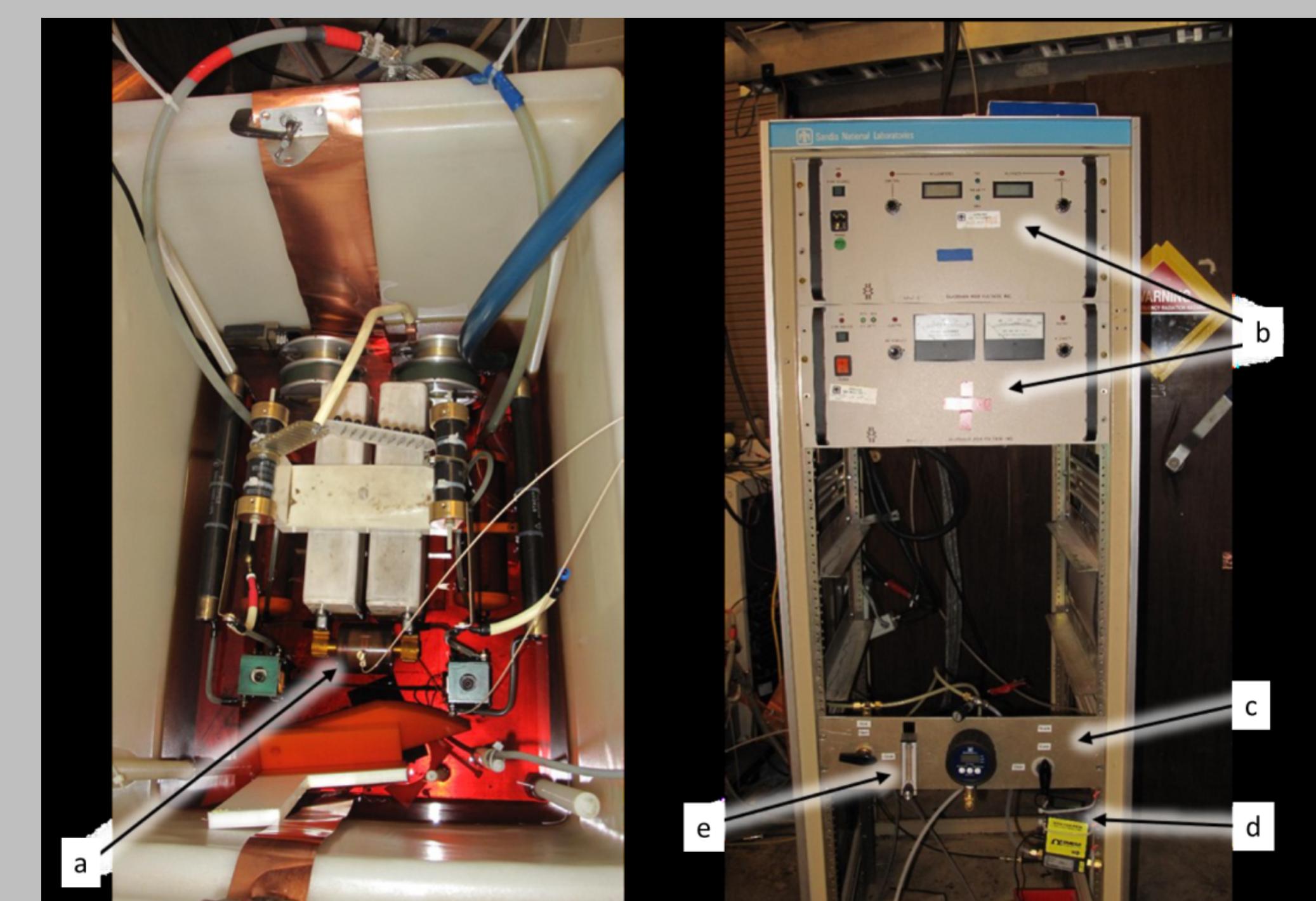
## Technology Summary

- Hermetically sealed vacuum spark gap switches
- Trigger ring at the midplane
- Goal: operating at 100 kV, 20 kA with high (>1000) lifetime

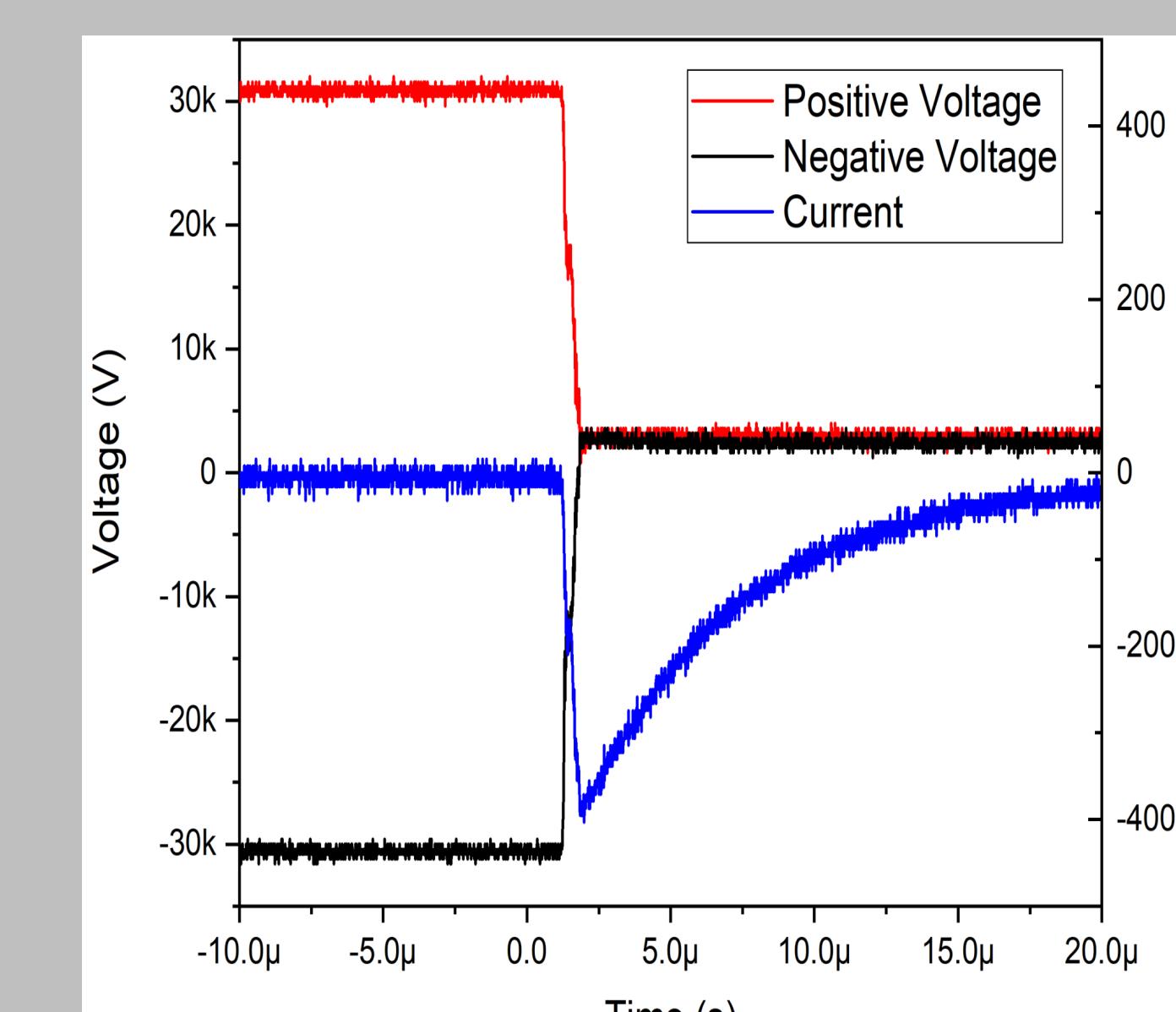


## Testing of Compact Sealed Spark gaps

- Spark gap switches were tested with bipolar +/- 50 kV across them, and discharged with 100 A – 10 kA peak current



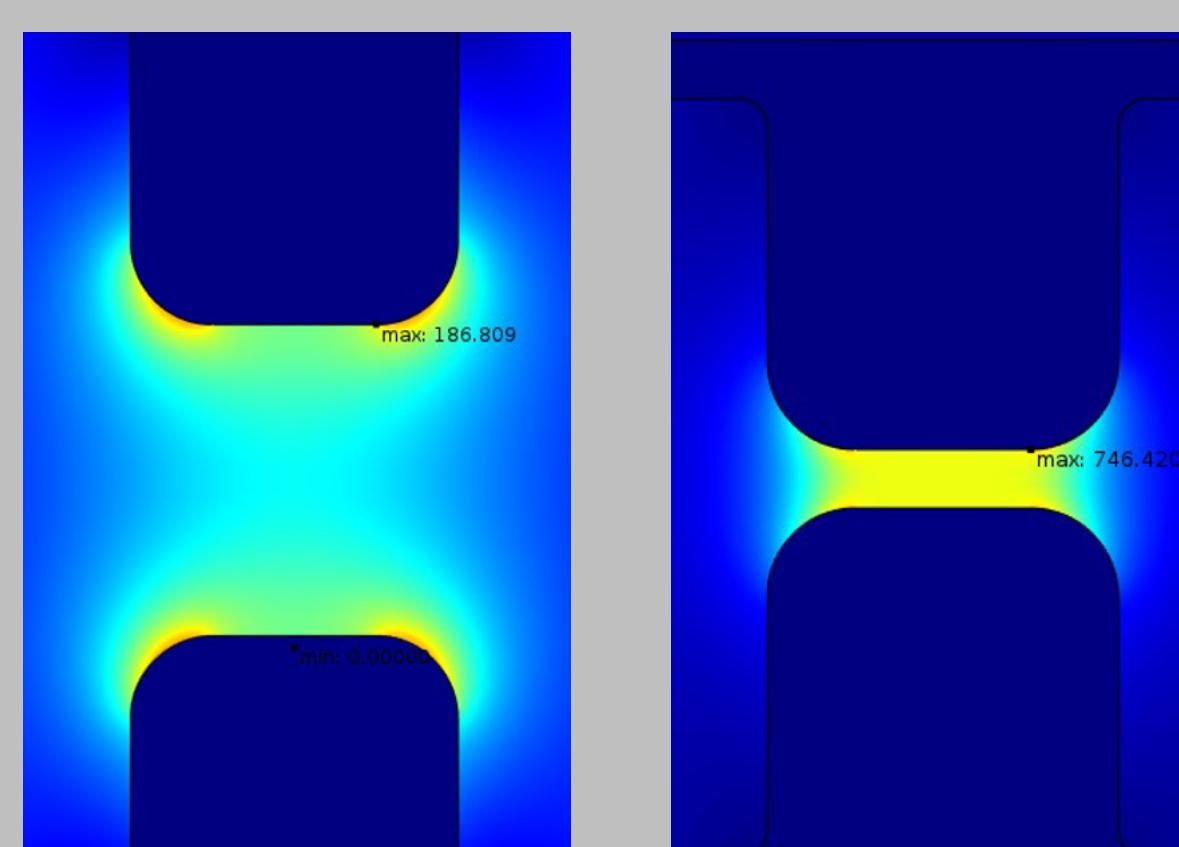
Photograph of the high energy testbed: a) spark gap switch under test, b) power supplies, c) gas control panel, d) digital flow gauge meter, e) flow gauge.



Typical waveform during triggered testing of sealed spark gap switches

## 2D Electrostatic COMSOL Simulation Results

- Electrode imperfections appear to be less impactful at shorter gap spacings.
- Larger gap spacing lead to higher self-break voltages but at lower electric fields.



Simulation Type	Gap Spacing (in)	Max E (kV/cm)	E_av (kV/cm)	Enhancement
No Defect	0.1	426	394	1.08
Defect	0.1	747	394	1.90
No Defect	0.2	240	197	1.22
Defect	0.2	425	197	2.16

## Conclusions

- Hermetically sealed vacuum spark gap switches for long shelf life
- Self-break voltage of 100 kV obtained
- Lifetime tested with 100 A – 10 kA peak output currents with no degradation in lifetime at 1000 shots
- Issues with variance in breakdown voltage

## Future Work

- Investigating different electrode material
- Conduct lifetime testing
- Optimize geometries
- Triggered testing