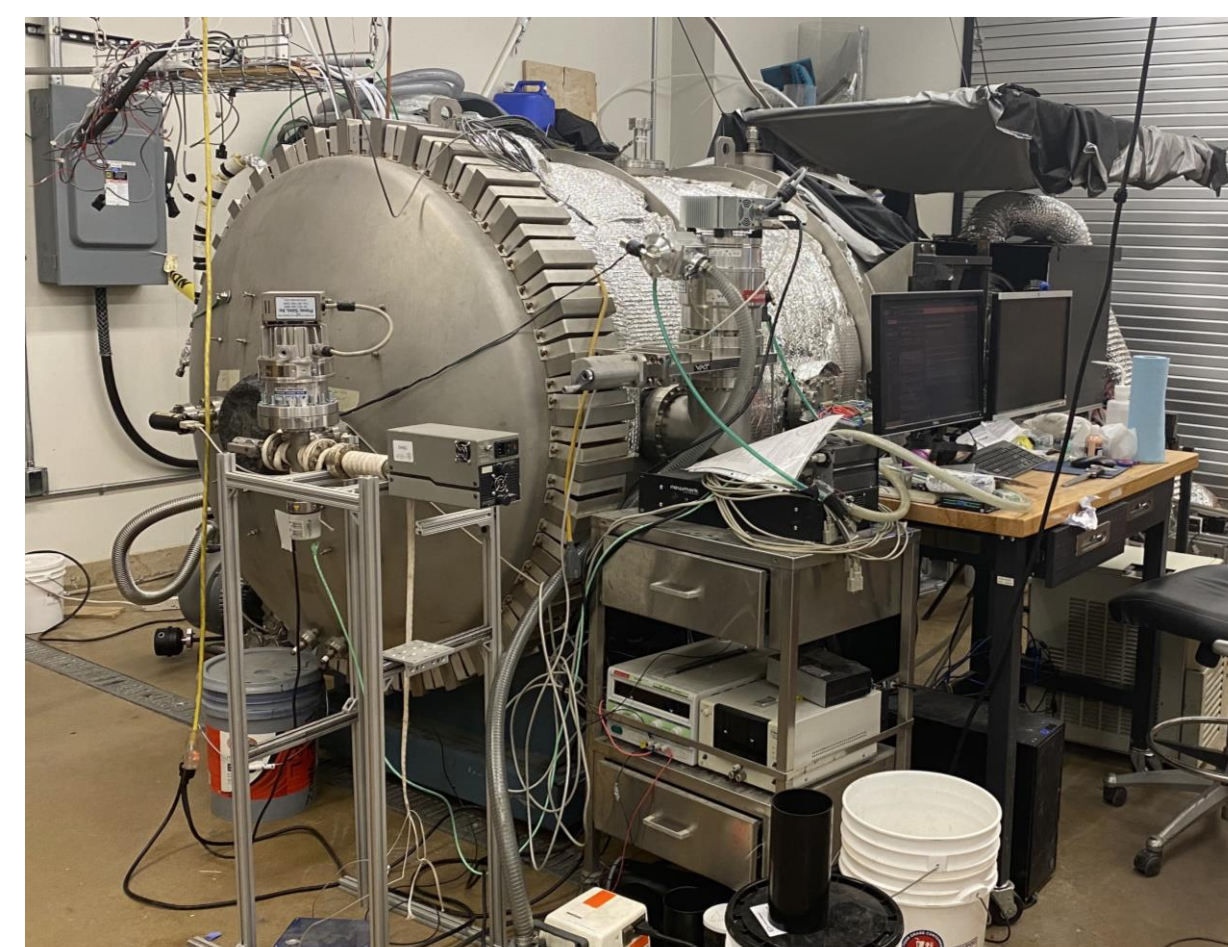


K. Liang, M. C. Tolton, P. A. García Suárez, C. Nesgaard, Orbital Mining Corporation (OMC), G. Merdzhanov, Zekalabs

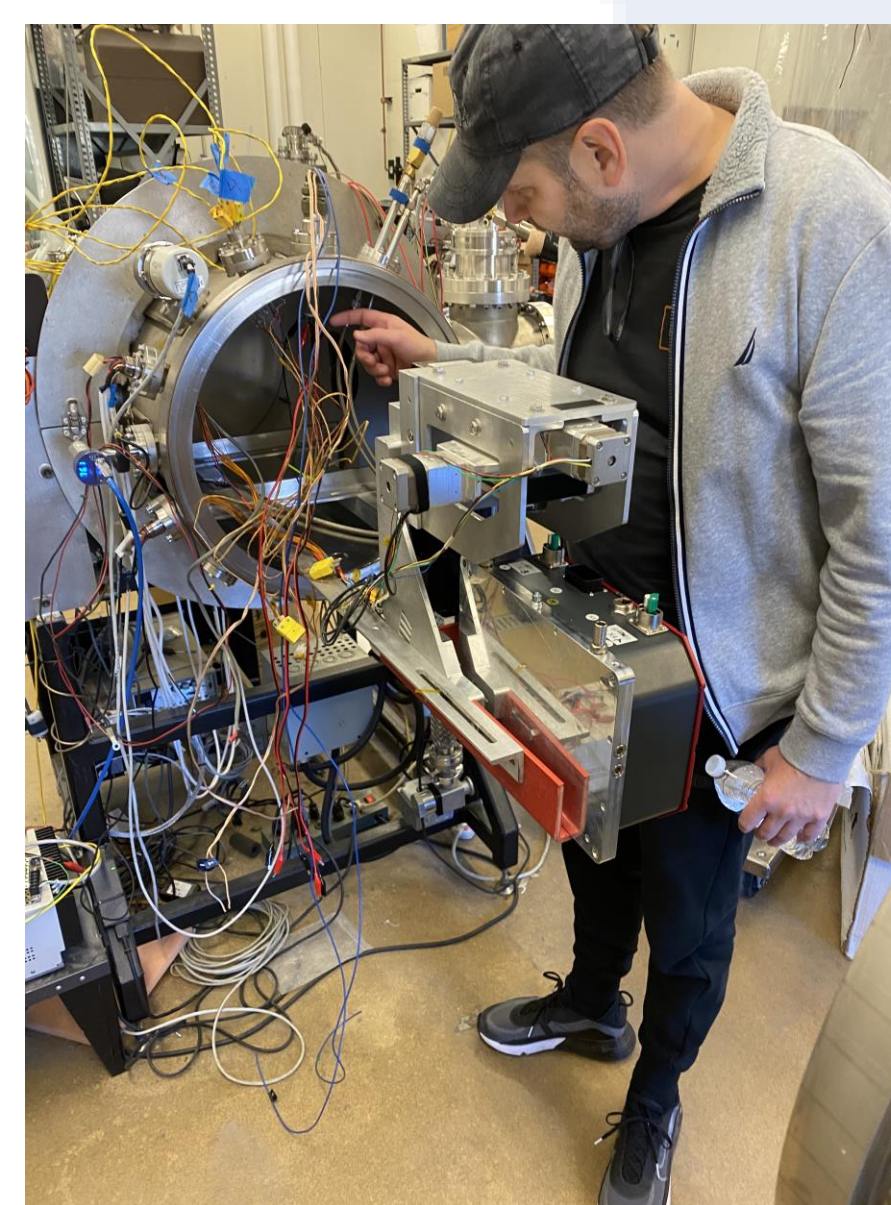
Introduction

Under NASA's Watts on the Moon competition, OMC designed and built a prototype electrical power transmission and storage system, adapting COTS components to survive the lunar night.

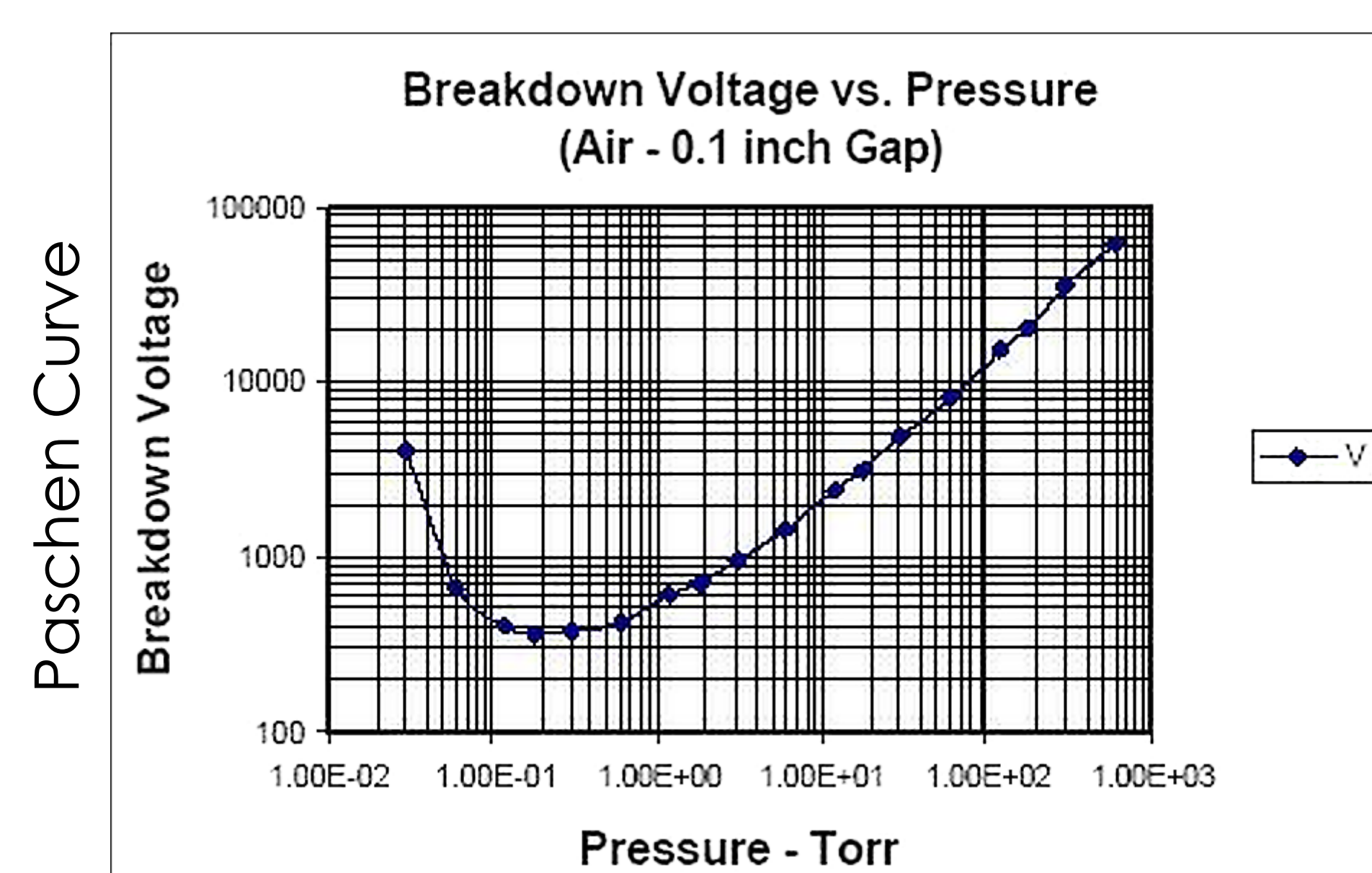
Materials and Methods



Vacuum chambers at Colorado School of Mines Space Resources Lab



Zekalabs 10kW Converters (left)

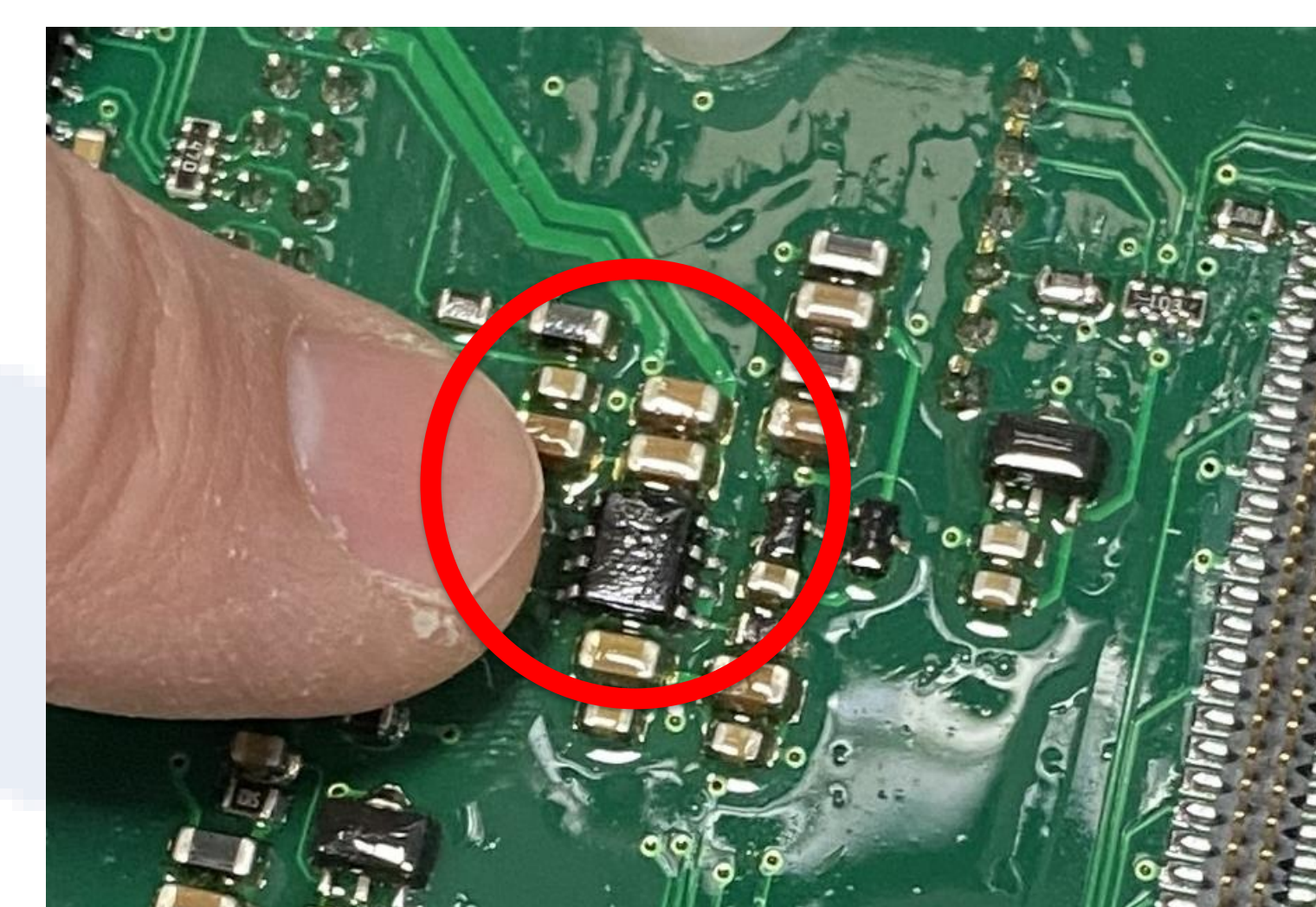
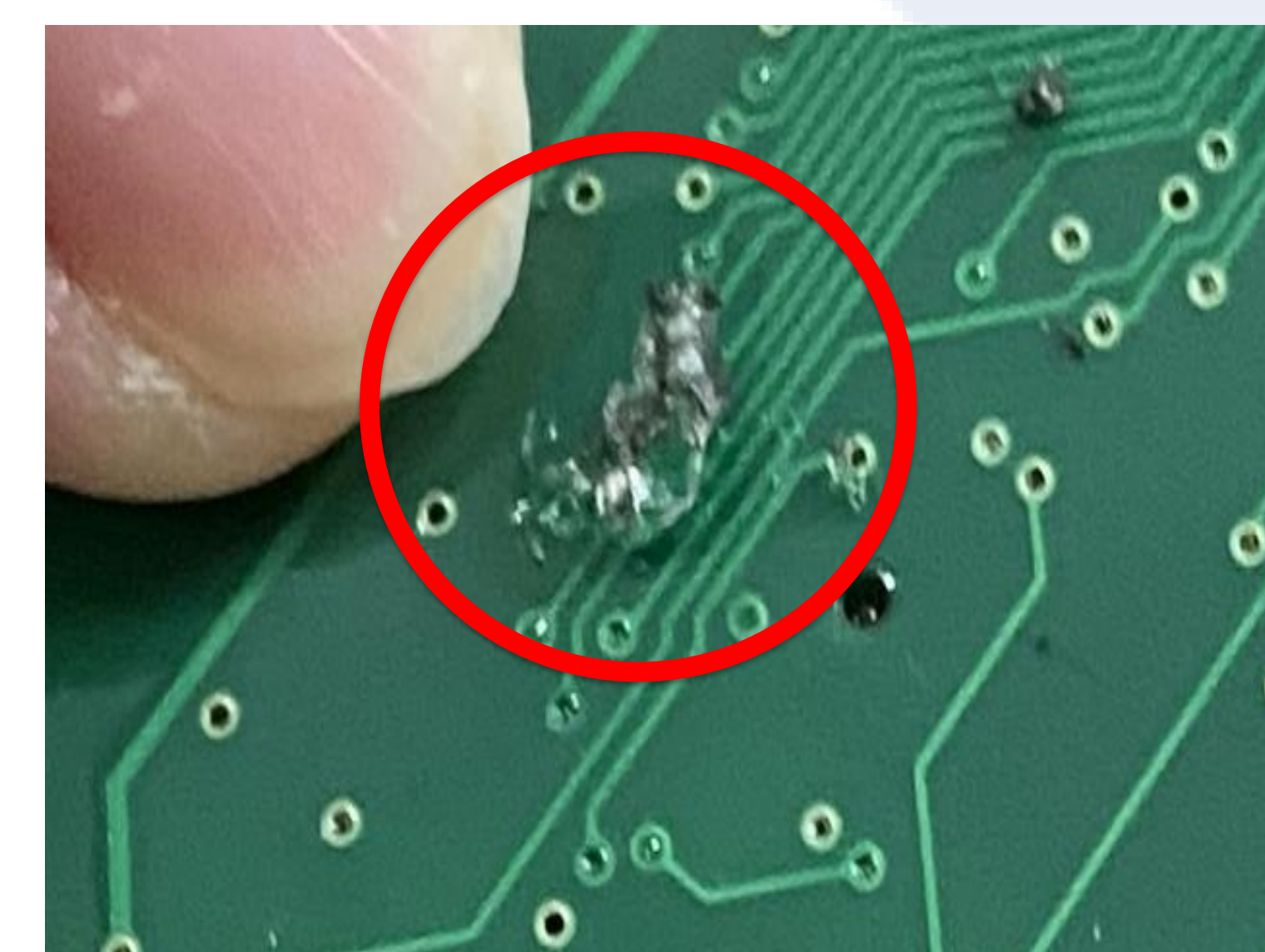
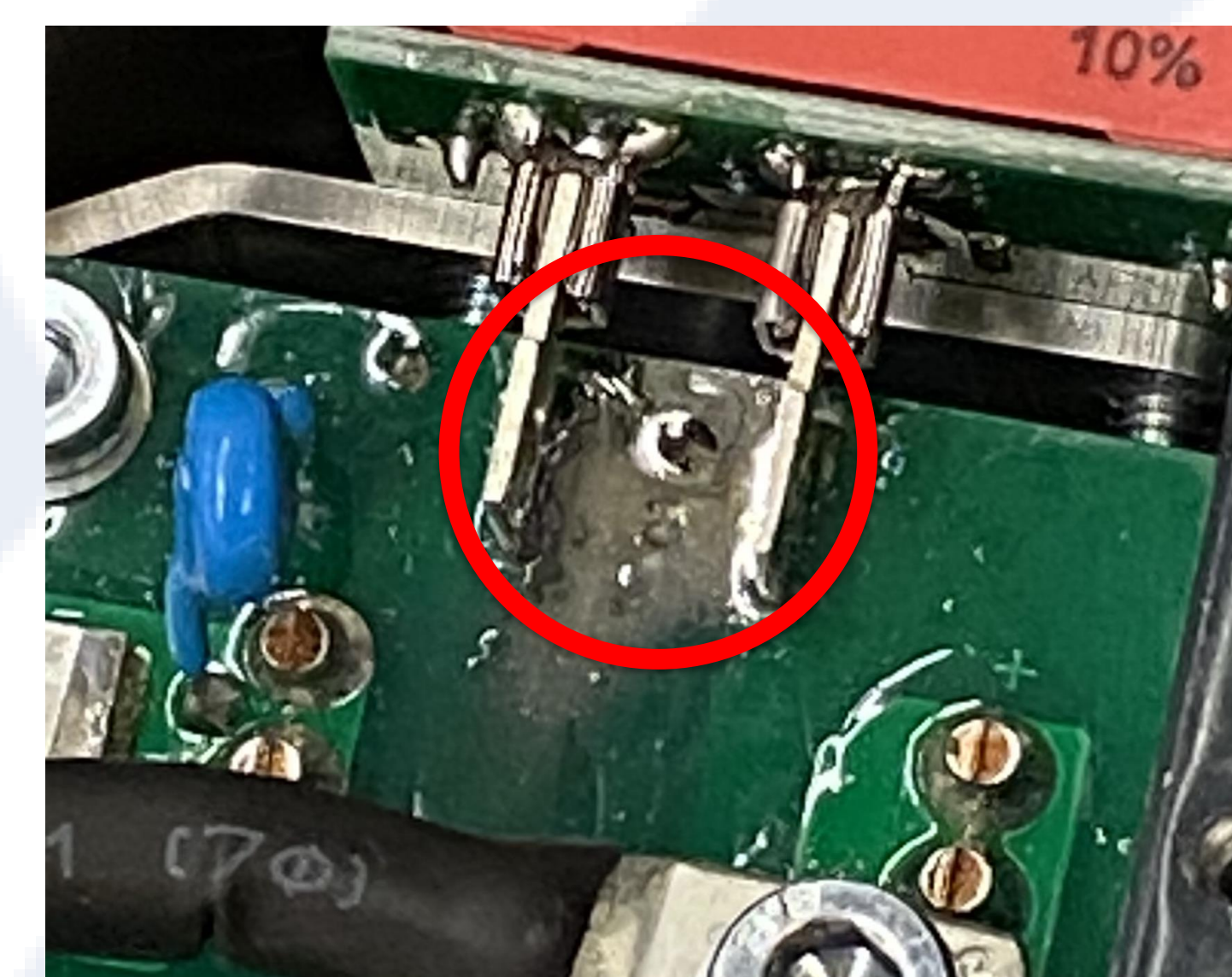


<http://www.highvoltageconnection.com/articles/paschen-curve.html>

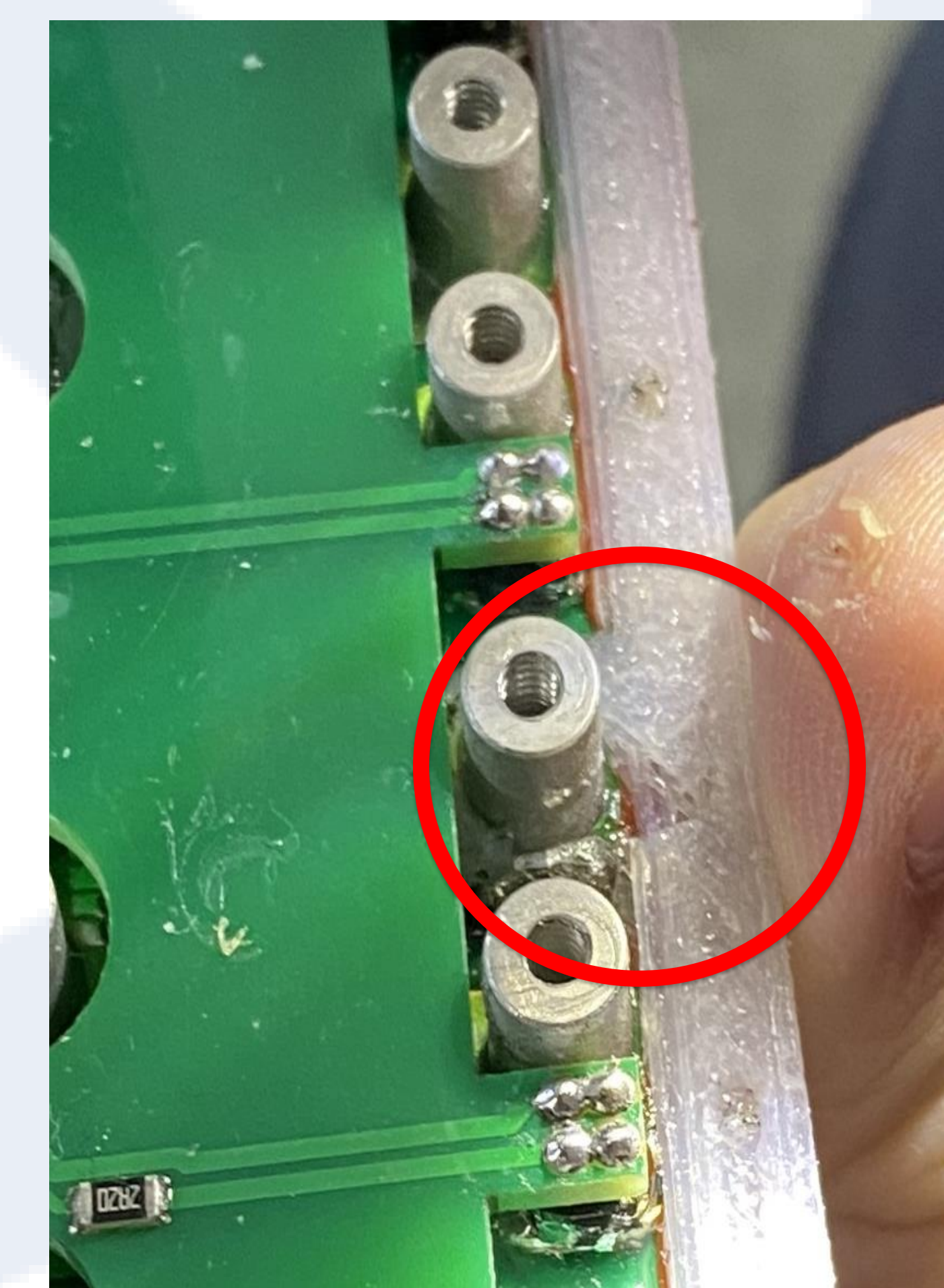
Preliminary Results

Background: OMC evaluated a prototype electrical transmission and storage system in vacuum (1–20 mTorr), including commercial off the shelf (COTS) 10kW DC-DC converters in 2023 (ongoing). Zekalabs provided forensic analysis, rebuilds, and technical support throughout testing.

Key Findings: Failure modes included vacuum arcing and explosive outgassing of protective gels. Vacuum arcing required both high power (1kW+) and higher temperatures (varied, above 30°C). Hypothesized failure mechanism involves heat increasing rate of outgas, which increases local partial pressure until voltage breakdown (see Paschen Curve). Additionally, outgassing of anti-corrosion coatings immediately resulted in shorting conditions. Even with testing & iteration, Modified COTS (MOTS) converters were estimated to be significantly cheaper than custom converters.



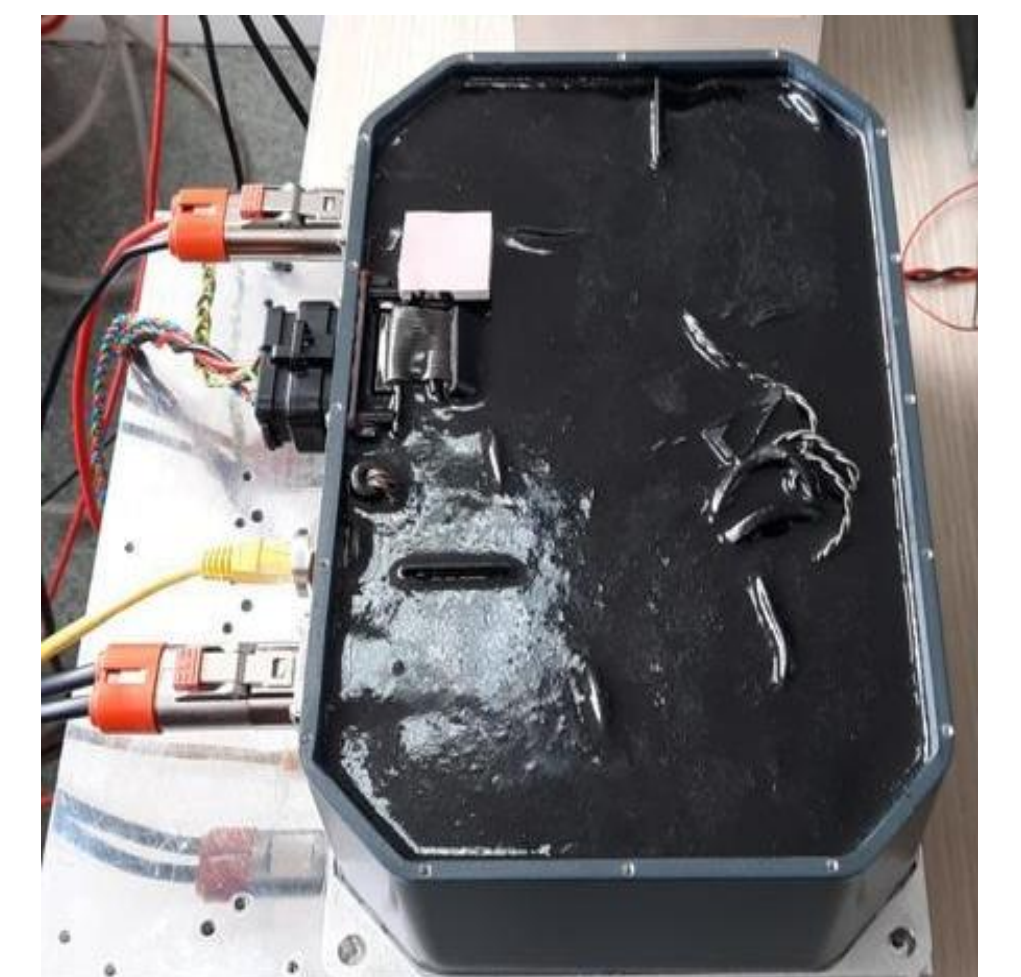
Vacuum arcing in many trials & components



Outgassing of protective gels

Conclusions

Conformal coating and polyimide tape are not enough to resist vacuum arcing at high temperatures.



Full potting removes the Paschen curve failure mode. Results are applicable to any higher power (1+ kW), higher voltage (600+ V) power electronics operating in imperfect vacuum (1–1000 mTorr).

Recommendations

- Conduct cost study between COTS / MOTS / custom
- Analyze components to identify outgassing materials
- Trace relevant specifications down to each component
- Partner with suppliers with robust technical skills for rapid iterations

Further information

Experimentation is ongoing. Updates: <https://www.orbitalminecorp.com/>