Paper 018

# Cryogenic Dielectric and Superconducting Shield Controls for Projection-Electromagnetism Nulls

A bridge between capacitor anomaly tests and practical superconducting subsystem research

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Working paper draft / June 13, 2026

**Abstract**

Cryogenic operation changes leakage, dielectric loss, thermal gradients, mechanical drift, and magnetic shielding. This paper proposes cryogenic capacitor null experiments that borrow measurement discipline from superconducting subsystem development while testing projection-electromagnetism residuals. The goal is not to assume superconducting anomaly claims; it is to use cryogenic controls to suppress ordinary artifacts and to bound scalar or boundary residuals under cleaner conditions.

**Status.** Draft manuscript for review and revision. This paper is not an empirical claim of new physics or field-ready technology. It is a structured proposal, theory note, protocol, or application architecture intended to be auditable, falsifiable, and publishable with source.

## Contents

## 1 Problem

Room-temperature high-voltage experiments are dominated by gas, leakage, dielectric heating, and mechanical drift. High vacuum helps, but cryogenic dielectric behavior and superconducting shielding may further separate ordinary artifacts from field-energy proxies. The problem is to design a cryogenic null program that is useful even if every speculative coupling is zero.

## 2 Model

The apparatus combines guarded capacitors, thermal anchoring, superconducting shields where appropriate, quench-safe wiring, and low-drift force or displacement metrology. The model tracks force, capacitance, leakage, dielectric loss tangent, temperature gradients, magnetic field, and shield state.

$$P_{\text{loss}} = \omega C V_{\text{rms}}^2 \tan\delta(T), \qquad I_{\text{leak}} = G(T, E)V.$$

$$F_{\text{meas}}(T) = F_M + F_{\text{thermal}}(T) + F_{\text{leak}}(T) + F_s(T) + F_b(T) + \eta(T).$$

## 3 Claims

1. **Claim 1.** Cryogenic capacitor nulls can improve artifact separation even if they do not improve raw force sensitivity.
2. **Claim 2.** Superconducting shields are controls, not proof of speculative coupling; their transition provides a useful state variable.
3. **Claim 3.** Dielectric loss and leakage telemetry must be treated as first-class observables in scalar and boundary-flux bounds.
4. **Claim 4.** The cryogenic program naturally connects speculative physics tests to practical spacecraft superconducting subsystem qualification.

## 4 Evidence Plan

The first evidence stage is a no-high-voltage thermal-vacuum mockup to characterize drift. The second is low-voltage dielectric spectroscopy. The third is high-voltage operation with matched warm and cold controls. The final product can be a temperature-dependent exclusion surface for scalar and boundary operator amplitudes.

## 5 JMP0X1B Implementation Surface

A JMP0X1B controller should sequence thermal states, high-voltage ramps, shield transitions, and metrology windows while enforcing safety gates. Data products should be compatible with the null ledger and stress-energy audit schema.

### Illustrative JMP0X1B-style contract

```
actor CryoNullRun {
    fn cool_to(target: Kelvin) -> State effects{ThermalControl, Safety}
    fn arm_voltage(profile: HVProfile) -> Gate effects{HighVoltage, Interlock}
    fn collect(window: Duration) -> NullFrame effects{Telemetry, Audit}
}
```

## 6 Release And Review Plan

Release thermal models, dielectric calibration data, shield-state telemetry, safety gate definitions, and null-run analysis scripts. The PDF should include a bill of controls, not a bill of claims.

## 7 Open Questions

- Which dielectric families are best suited for low-loss cryogenic electrostatic nulls?
- Can shield-state transitions create confounding mechanical impulses?
- How should quench safety be represented in a physics null paper?
- What force metrology remains stable across thermal cycles?

## 8 Conclusion

Cryogenic null tests offer a disciplined intersection between frontier physics skepticism and space-relevant engineering. The most likely outcome is stronger bounds and better subsystem knowledge.

## References

## References

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