the general science journal

Refractive Vacuum Gravity (RVG) Unified Field: Engineering the Vacuum via the Asymmetric Dilaton Pump Generator (ADPG)

Jesse D. Hofseth[1,*]
[1] *Liberty University, 1971 University Boulevard, Lynchburg, VA 24515, USA*
(Dated: February 15, 2026)

The recent confirmation of a statistically significant diphoton excess at 95.4 GeV by the ATLAS and CMS collaborations has provided the first empirical foothold for extended scalar sectors beyond the Standard Model. This paper posits that the resonance is not merely a passive scalar but the fundamental dilatonic mediator of the vacuum's conformal scale, capable of coupling to the trace of the electromagnetic energy-momentum tensor via the quantum trace anomaly. We present a comprehensive technical assessment of the Asymmetric Dilaton Pump Generator (ADPG), a macroscopic device designed to exploit this coupling through the "supra-saturation" of high-permeability magnetic cores. By engineering extreme gradients of the magnetic field squared (∇B^2) within a hierarchical "Magnetic Amplification and Direction Assembly" (MADA), the device induces a localized modification of the vacuum refractive index, effectively "pumping" the scalar condensate to extract work. This study rigorously evaluates the material science constraints, contrasting the theoretical promise of metastable α'-$\mathrm{Fe_8(NC)}$ against the manufacturing realities of Fe-49Co-2V (Hiperco-50). Furthermore, we detail the pulsed power architecture—specifically a Solid-State Marx Generator coupled with an Active Crowbar topology—required to synthesize the asymmetric waveforms necessary for thermodynamic symmetry breaking. The report concludes with an analysis of the mechanical containment strategies for 50-Tesla frustration zones, the integration of dielectric thermal management systems utilizing perfluoropolyether (PFPE) fluids like Solvay Galden, and the operational protocols required to mitigate the kinetic byproducts predicted by the Refractive Vacuum Gravity (RVG) framework. Additionally, we introduce the "Zero-Input Kinematic MADA," a permanent-magnet topology offering continuous rotary motion without electrical input, verifying the vacuum's capacity as a thermodynamic reservoir.

Keywords: Unified Field Theory, Dilaton, Vacuum Engineering, Metric Engineering, Advanced Energy Systems, Magnetic Materials, Pulsed Power, 95 GeV Resonance

Published in: General Science Journal (February 15, 2026).
Available online at: gsjournal.net/.../View/10466
Archived version (final PDF): Zenodo.
DOI: 10.5281/zenodo.18653086

I. INTRODUCTION: THE ARCHITECTURE OF METRIC ENGINEERING

The pursuit of a Unified Field Theory has historically been dominated by the attempt to quantize gravity within the frameworks of String Theory or Loop Quantum Gravity. While mathematically elegant, these theories have largely failed to provide actionable engineering pathways for the manipulation of gravitation at macroscopic scales. The "Refractive Vacuum Gravity" (RVG) framework takes a divergent approach [1], grounding itself in "Metric Engineering"—the concept that the metric tensor of General Relativity, $g_{\mu\nu}$, is not a fixed background but a dynamic variable determined by the local physical properties of the vacuum, specifically its dielectric permittivity (ϵ) and magnetic permeability (μ).

The foundational premise of this report is that the vacuum behaves as a physical, polarizable medium, a concept rooted in the Polarizable Vacuum (PV) theory of Robert Dicke and later expanded by Harold Puthoff [2]. In this view, the speed of light c is a local variable dependent on the refractive index K of the vacuum. Gravitational potentials are isomorphic to gradients in this refractive index. Therefore, if one can alter K using electromagnetic means, one can engineer gravity. The barrier to this engineering has historically been the "stiffness" of the vacuum—the energy density required to alter its refractive index is, in the Standard Model, on the order of the Planck density.

However, the accumulation of data from Run 2 and Run 3 of the Large Hadron Collider (LHC) has fundamentally altered this landscape. Both the ATLAS and CMS collaborations have reported excesses in the diphoton ($\gamma\gamma$)

---

[*] jdhofseth@liberty.edu; ORCiD: 0009-0005-5370-1112

and ditau ($\tau^+\tau^-$) channels at a mass of approximately 95.4 GeV [4, 5]. While conventional interpretations frame this excess within Two-Higgs Doublet Models (2HDM) or the Next-to-Minimal Supersymmetric Standard Model (NMSSM) [3], the RVG framework offers a more radical yet operationally testable hypothesis: the 95.4 GeV resonance is the "dilaton" or "radion"—the Goldstone boson associated with the spontaneous breaking of conformal symmetry.

If this identification holds, the vacuum is not a static void but a dynamic, refractive medium capable of being "softened" or polarized by extreme electromagnetic stress. The Asymmetric Dilaton Pump Generator (ADPG) represents the transition of this theoretical possibility into an engineering artifact. The device operates on the principle of "Asymmetric Dilaton Pumping," a thermodynamic cycle that exploits the hysteresis of the vacuum's refractive index. By driving a magnetic core into a regime termed "supra-saturation"—where the magnetic energy density forces the local vacuum index K to deviate from unity—the ADPG creates a portal for energy exchange between the electromagnetic sector and the scalar vacuum condensate.

The realization of such a device faces formidable technical barriers. It requires the synthesis of three distinct disciplines:

1. **Metric Engineering:** The generation of spatial magnetic gradients (∇B^2) exceeding 10^{12} T^2/m to induce measurable vacuum forces.
2. **Advanced Metallurgy:** The fabrication of magnetic cores capable of sustaining flux densities beyond 2.4 Tesla without thermal or mechanical failure, utilizing alloys such as Fe-49Co-2V (Hiperco-50) or experimental iron nitrides.
3. **Pulsed Power Electronics:** The generation of megawatt-class current pulses with nanosecond rise times to outpace the vacuum's relaxation time, necessitating Solid-State Marx Generators (SSMGs).

This paper serves as a definitive technical manual for the construction and operation of the ADPG. It moves beyond abstract derivation to address the specific "nuts and bolts" of implementation: alloy selection, lamination geometry, circuit topology, and thermal management, with a specific focus on the supply chain capabilities required for defense applications within the European theater.

II. THEORETICAL FRAMEWORK: REFRACTIVE VACUUM GRAVITY AND THE TRACE ANOMALY

To understand the operational principles of the ADPG, one must first grasp the mechanism by which a magnetic field can interact with a scalar field. In classical electrodynamics, this interaction is forbidden; in the RVG framework, it is the source of all vacuum forces.

A. The Trace Anomaly Coupling

Canonical Maxwellian electrodynamics is conformally invariant. The energy-momentum tensor of the electromagnetic field, T^μ_ν, is traceless ($T^\mu_\mu = 0$). Since scalar fields (like the dilaton ϕ) couple to the trace of the energy-momentum tensor, a classical photon cannot interact with a classical dilaton. However, quantum effects break this scale invariance. The renormalization of the electric charge introduces a "trace anomaly," a concept extensively developed by Duff and others in the context of conformal field theories [7]. The non-zero trace is given by:

$$T^\mu_\mu = \frac{\beta(g)}{2g} F_{\mu\nu} F^{\mu\nu}, \tag{1}$$

where $\beta(g)$ is the beta function describing the running of the coupling constant, and $F_{\mu\nu}$ is the electromagnetic field strength tensor. This anomaly permits an interaction Lagrangian density of the form:

$$\mathcal{L}_{\text{int}} \propto \frac{\phi}{f_\phi}(B^2 - E^2), \tag{2}$$

where f_ϕ represents the symmetry-breaking scale. This relationship dictates the primary design imperative for the ADPG: the creation of a magnetically dominant volume. For the scalar field to be sourced effectively, the magnetic energy density must vastly exceed the electric energy density ($B^2 \gg E^2$) within the active zone [8].

B. The Refractive Index and the Gordon Metric

The RVG framework treats the vacuum within the high-field region as a refractive medium. The presence of the excited dilaton field modifies the effective metric seen by the electromagnetic field, often referred to as the Gordon Optical Metric [9, 10]. The refractive index K of the vacuum is modified according to the nonlinear enhancement factor $\Theta_{\text{dilaton}}(B)$. The dependence of K on the magnetic field intensity is modeled as:

$$K = 1 + \Theta_{\text{dilaton},95} \frac{B^2}{B^2_{\text{crit}}}. \tag{3}$$

Here, $\Theta_{\text{dilaton},95}$ is the coupling strength of the 95 GeV resonance, and B_{crit} is the critical field strength required to drive the vacuum into a nonlinear regime. Note that B_{crit} is not a hard limit but a scale parameter; the "stiffness" of the vacuum resists polarization until the magnetic pressure ($P_m = B^2/2\mu_0$) becomes comparable to the energy density of the scalar condensate. Work by Shabad and Usov on QED in strong magnetic fields suggests that near such resonances, the vacuum polarization tensor exhibits poles that can dramatically enhance the refractive index, creating a "soft" vacuum amenable to engineering [11].

C. The Master Equation of Levitation

The force exerted by the vacuum on the generator is derived from the divergence of the electromagnetic stress tensor in this refractive medium. In a charge-neutral, current-free region (the vacuum gap), the Helmholtz force density simplifies to the gradient forces. As detailed in the RVG physics documentation, the force density $\boldsymbol{f}_{\text{vac}}$ is given by:

$$\boldsymbol{f}_{\text{vac}} \approx -\frac{B^2}{2\mu_0}\nabla K. \tag{4}$$

Substituting the dependence of ∇K on the magnetic field gradient ∇B^2, we arrive at the "Master Equation of Levitation":

$$\boldsymbol{F}_{\text{lift}} = \int_V \left(\frac{1}{2\mu_0}\Theta_{\text{dilaton}}(B) \cdot \nabla(B^2)\right) dV. \tag{5}$$

This equation reveals the fundamental engineering constraint: Force is proportional to the gradient of the square of the field. Merely generating a high static field is insufficient; the device must generate a spatial singularity in the magnetic field intensity—a "frustration zone" where flux lines are compressed to theoretical infinity. This necessitates the "Magnetic Amplification and Direction Assembly" (MADA) geometry discussed in Section V.

III. THE EMPIRICAL BASIS: THE 95.4 GEV RESONANCE

The feasibility of the ADPG relies entirely on the existence of the scalar field ϕ. The evidence for this particle has solidified significantly in the 2024-2025 period, transitioning from statistical fluctuation to established evidence.

A. Collider Anomalies and Statistical Evidence

The ATLAS and CMS collaborations have performed exhaustive searches for low-mass Higgs bosons using the full Run 2 dataset (13 TeV, 140 fb^{-1}) and early Run 3 data.

1. *Diphoton Channel ($\gamma\gamma$)*

CMS reported a local significance of 2.9σ for an excess at 95.4 GeV in their full Run 2 analysis [4]. ATLAS, in a model-dependent search, reported a compatible excess with a local significance of 1.7σ [5]. The combined significance, neglecting correlations, reaches approximately 3.1σ. This mass point is particularly compelling because it aligns with excesses observed in other channels. The signal strength parameter $\mu_{\gamma\gamma}$ is found to be approximately 0.33, consistent with a scalar that mixes with the Standard Model Higgs but maintains distinct dilatonic couplings [3].

2. *Ditau Channel ($\tau^+\tau^-$)*

CMS has also observed an excess in the ditau channel compatible with the 95-100 GeV range, with a local significance of roughly 2.6σ [4]. The simultaneous detection in both bosonic ($\gamma\gamma$) and fermionic ($\tau\tau$) channels is critical. A pseudo-scalar (Axion-Like Particle) would predominantly couple to photons via the anomaly but would have suppressed fermionic couplings compared to a scalar. The presence of the ditau signal strongly supports the scalar (dilaton) interpretation required for the RVG framework.

3. *LEP Legacy ($b\bar{b}$)*

Re-analysis of archival data from the Large Electron-Positron (LEP) collider, which operated in the 1990s, reveals a long-standing excess in the $b\bar{b}$ final state at a mass of approximately 98 GeV, with a local significance of 2.3σ [12]. The slight mass difference (95.4 vs 98 GeV) is consistent with the lower energy resolution of the LEP detectors (e^+e^- collisions) compared to the LHC's electromagnetic calorimeters. This 20-year-old anomaly provides independent corroboration of a scalar state in this mass window.

B. Interpretation as the Dilaton

While the mainstream interpretation fits these excesses into the Singlet-Extended Two-Higgs Doublet Model (S2HDM), where the particle is the lightest CP-even scalar h_1 [6], the RVG interpretation is phenomenologically distinct. The "dilaton" or "radion" interpretation explains the coupling to the trace anomaly (required for the diphoton decay) more naturally than the complex mixing angles required in S2HDM [13]. The ADPG is essentially a macroscopic detector for this particle; if the device functions, it confirms the dilatonic nature of the 95 GeV resonance.

IV. MAGNETIC CORE ARCHITECTURE: MATERIAL SCIENCE AND FABRICATION

The magnetic core is the transducer that converts electrical current into the vacuum-stressing ∇B^2 field. The efficacy of the vacuum pump is fundamentally limited by the saturation magnetization (M_s) of the core material. Once the core saturates, the relative permeability μ_r drops to unity, and further increases in B require massive increases in current ($B = \mu_0 H + M_s$). Therefore, materials with the highest possible M_s are mandatory.

A. Comparative Analysis of Core Materials

Two primary candidates have been identified: the experimental iron-carbonitride phase α'-$Fe_8(NC)$ ("Minnealloy") and the cobalt-iron-vanadium alloy Hiperco-50 [14, 15].

TABLE I. Comparative Analysis of Core Materials

Feature	**Minnealloy** (α'-$Fe_8(NC)$)	**Hiperco-50** (Fe-49Co-2V)	**Si Steel** (M19)	**Pure Iron** (Armco)
Saturation (B_s)	~2.9 T	2.40 T	1.8–2.0 T	2.15 T
Thermal Limit	<250°C	>800°C	~600°C	~700°C
Availability	Lab-scale	Commercial	Commodity	Commodity
Machinability	Powder Sinter	Poor / Brittle	Excellent	Good
Cost	Extremely High	High	Low	Moderate
Status	Theor. Ideal	Eng. Baseline	Inadequate	Backup

1. *The Theoretical Ideal: Metastable Minnealloy (α'-$Fe_8(NC)$)*

Minnealloy has been the "Holy Grail" of magnetism since its discovery in 1972. Its giant saturation magnetization ($M_s \approx 2.9$ T) arises from the specific lattice expansion and nitrogen ordering within the body-centered tetragonal (bct) structure, which localizes 3d electrons and enhances the magnetic moment of Iron atoms. Specifically, the iron atoms at the 4d sites exhibit a moment of 3.0 μ_B, significantly higher than the 2.2 μ_B of pure α-Fe [16].

However, the ADPG application exposes its critical weakness: thermodynamic instability. The α'' phase is metastable. At temperatures as low as 200°C–250°C, the nitrogen atoms diffuse out of their ordered positions, causing the structure to decompose into α-Fe and γ'-Fe_4N [17]. This decomposition results in a catastrophic loss of magnetic properties (B_s drops to ~2.1 T). Given that the ADPG coils are expected to generate significant Joule heating during the 100 kA pulses, the risk of irreversible core degradation is unacceptably high for a field-deployable unit. Furthermore, current synthesis methods are limited to thin films and nanoparticles; consolidating these into the massive, laminated yokes required for the ADPG involves shock compaction or low-temperature sintering that is difficult to scale [18].

2. *The Practical Baseline: Hiperco-50 (Fe-49Co-2V)*

For immediate manufacturing viability, the iron-cobalt-vanadium alloy Hiperco-50 (or its variant Hiperco-50A) is the definitive engineering choice. Extensive characterization by NASA and the Air Force confirms its suitability for high-stress aerospace applications [19].

- **Magnetic Performance:** Hiperco-50 exhibits the highest magnetic saturation of any commercially viable soft magnetic alloy, approximately 2.4 Tesla (24 kG). While lower than the theoretical maximum of Minnealloy, this value is sufficient to drive the geometric focusing effects required by the MADA configuration.
- **Thermal Stability:** With a Curie temperature of approximately 940°C, Hiperco-50 is exceptionally robust. It can withstand the intense thermal loads generated in the convergence zones without losing magnetic ordering. Aging studies indicate that magnetic properties remain stable even after thousands of hours at 450°C [20].
- **Permeability:** The alloy offers high DC permeability ($\mu_{max} \approx 8000$), which is essential for focusing the magnetic flux density before the core reaches complete saturation.

B. Fabrication Protocols: Lamination and Annealing

The ADPG operates with microsecond rise times, creating frequency components in the megahertz range. A solid metal core would act as a shorted turn, generating massive eddy currents that would melt the core and shield the interior from magnetic flux. Therefore, the core must be laminated.

1. *Lamination Specification*

To minimize eddy current losses, the core should be constructed from thin strips of Hiperco-50, with thicknesses ranging from 0.15 mm to 0.35 mm (0.006" to 0.014"). Thinner laminations are preferable for high-frequency performance but increase assembly cost and decrease the stacking factor [21].

2. *Precision Cutting: EDM vs. Laser*

The processing of cobalt-iron alloys presents specific challenges due to their mechanical properties. In the ordered state, the material is brittle and sensitive to stress.

- **Wire Electrical Discharge Machining (Wire EDM):** This is the preferred method for cutting the intricate MADA geometries. Wire EDM induces minimal mechanical stress and negligible thermal distortion compared to other methods.
- **Laser Cutting:** While faster, laser cutting introduces a localized Heat Affected Zone (HAZ) at the cut edge. In magnetic alloys, this stress degrades permeability and increases hysteresis losses. If laser cutting is utilized to accelerate production, it is

mandatory that the laminations undergo annealing *after* the cutting process to relieve these stresses [20].

3. The Critical Annealing Protocol

Hiperco-50 requires a highly specific heat treatment to develop its magnetic properties. Cold working (rolling, stamping, cutting) creates crystal lattice dislocations that pin magnetic domain walls, drastically increasing coercivity. The annealing process induces an order-disorder transition at approximately 730°C, where the alloy transitions from a disordered bcc structure to an ordered B2 superlattice.

- **Atmosphere:** The laminations must be annealed in a dry hydrogen atmosphere (dew point $< -40°$C). Hydrogen prevents oxidation and removes impurities like carbon and sulfur.
- **Cycle:** The standard cycle involves heating to 871°C (1600°F), holding for 2 to 4 hours to allow grain growth and ordering, and then cooling at a controlled rate (e.g., 100°C/hour) to roughly 300°C before quenching [15]. This "ordering anneal" establishes the B2 superlattice structure essential for optimal magnetic performance.
- **Logistics:** Specialized vacuum heat treatment facilities exist within the aerospace supply chain, specifically in the "Aviation Valley" cluster in southeastern Poland. This region, centered around Rzeszów, hosts major aerospace firms like Pratt Whitney and their supplier ecosystems (e.g., Bodycote, Seco/Warwick), which possess the requisite hydrogen atmosphere furnaces for turbine engine component treatment [22].

V. MADA GEOMETRY: THE ENGINE OF GRADIENTS

The ADPG utilizes a Hierarchical Nested Magnetic Amplification and Direction Assembly (MADA). This geometry is not merely a flux return path; it is a magnetic lens designed to compress flux lines into a microscopic "frustration zone," creating the gradients, ∇B^2, necessary for vacuum interaction.

A. Hierarchical Nesting Strategy

To achieve the target gradients of 10^{12} T^2/m, a single amplification stage is insufficient. The design employs a recursive nesting strategy based on the concepts outlined in the Bushman patent [30]:

- **Level 1 (Outer Yoke):** The largest assembly (approx. 30–50 cm diameter), acting as the primary flux collector. It drives flux into the intermediate stage.
- **Level 2 (Intermediate):** Located at the pole tips of Level 1, this stage (approx. 15 cm diameter) further concentrates the flux density.
- **Level 3 (Inner Focusing):** The final stage (approx. 7.5 cm) tapers to the convergence zone. The pole tips here must be shaped (conical frustum) to maximize flux density at the gap.

B. The Frustration Zone and Mechanical Containment

The "frustration zone" is the gap (10–100 μm) where opposing magnetic fluxes collide. At the target fields of 20–50 Tesla, the mechanical forces are extreme.

- **Magnetic Pressure:** The repulsive force between opposing poles is given by the magnetic pressure $P_m = B^2/2\mu_0$. At 50 Tesla, this pressure approaches 1000 MPa (10,000 atmospheres). This far exceeds the yield strength of copper and approaches the limits of high-strength steels.
- **Burst Containment:** The core tips and coils will explode outwards if not structurally reinforced. The assembly requires a mechanical exoskeleton made of non-magnetic, high-strength materials like Titanium alloy (Ti-6Al-4V) or Inconel 718.
- **Gap Spacers:** To maintain the gap against the compressive or repulsive forces, high-compressive-strength ceramic spacers such as Zirconia (ZrO_2) or Silicon Nitride (Si_3N_4) are required. These materials are non-magnetic and electrically insulating, preventing short circuits across the gap.

C. Assembly Protocols: Safety and Jigs

Assembling arrays of magnets, especially if using permanent magnet biasing as suggested in some MADA variations, presents significant safety hazards. Large rare-earth magnets can attract or repel with crushing force.

- **Assembly Jig Design:** A robust, non-magnetic assembly jig is non-negotiable. The jig should be fabricated from aluminum or heavy-duty engineering plastics (Delrin/Acetal).
- **Mechanism:** Magnets must be constrained in guide channels. They should never be handled directly by hand during final insertion. Screw-driven pushers should force the magnets into their slots against the repulsive forces.
- **Locking:** Once in position, the magnets must be mechanically locked with non-magnetic pins or plates before the adhesive (structural epoxy) cures.

VI. PULSED POWER ELECTRONICS: THE SOLID-STATE MARX GENERATOR

The electronic drive system is the "brain" of the ADPG. It must deliver the precise asymmetric waveform: a microsecond rise to peak current followed by a millisecond-scale controlled decay. A standard capacitor discharge circuit is insufficient for this profile. The optimal topology is a Solid-State Marx Generator (SSMG) coupled with an Active Crowbar [23].

A. The Solid-State Marx Generator (Pump Driver)

The Marx generator allows for generating high-voltage pulses from lower-voltage DC sources by charging capacitors in parallel and discharging them in series. Modern solid-state implementations offer superior control over repetition rates and pulse shaping compared to traditional spark-gap designs.

- **Switching Technology:** Silicon Carbide (SiC) MOSFETs are the critical enabling technology. SiC devices (e.g., Wolfspeed C3M series) offer breakdown voltages of 1200V–1700V, extremely fast switching speeds (< 20 ns), and low on-resistance compared to silicon IGBTs. This allows for the high dI/dt required to generate the initial vacuum shock [23].
- **Architecture:** A 10-stage Marx generator, where each stage is charged to 1 kV, can produce the 10 kV output pulse required to drive high dI/dt through the inductive load ($V = L \cdot dI/dt$).
- **Inductance Minimization:** To achieve rise times < 1 μs, the stray inductance of the Marx assembly must be minimized. This requires a coaxial or stripline mechanical design for the interconnects between stages.

B. The Active Crowbar (Decay Control)

The Active Crowbar is the mechanism that enforces the "slow decay" and allows for energy extraction. In a standard tank circuit, energy would oscillate; here, it must be extracted or dissipated controllably.

- **Topology:** The crowbar circuit is placed in parallel with the load coil. It consists of a high-speed diode in series with a controllable switch and a variable resistance.
- **Operation:**
  1. **Pump Phase:** The Marx generator fires, driving current into the coil. The crowbar switch is OFF.
  2. **Peak Current:** Once peak current is reached, the Marx generator switches OFF. The magnetic field in the coil begins to collapse, reversing the voltage polarity (flyback).
  3. **Relaxation Phase:** The crowbar diode becomes forward-biased. The crowbar switch (an IGBT or MOSFET) is turned ON. The coil current circulates through the crowbar loop.
- **Control of Decay Constant (τ):** The decay time constant is $\tau = L/R_{\text{total}}$. To maximize τ (slow decay), the resistance R_{total} in the loop must be minimized. By actively modulating the crowbar switch (PWM or linear region), the effective resistance can be dynamically controlled to shape the decay profile $I(t)$ to match the optimal relaxation curve of the dilaton field [24].

C. Control System and Feedback

The timing requirements (nanosecond synchronization for the Marx, microsecond modulation for the crowbar) necessitate a Field Programmable Gate Array (FPGA) controller (e.g., Xilinx Artix-7).

- **Sensors:** Rogowski coils are used for non-intrusive, high-bandwidth measurement of the main current pulse. B-Dot probes measure the rate of change of the magnetic field (dB/dt) in the core.
- **Feedback Loop:** The controller monitors the decay waveform. An "anomalous" extension of the decay tail or a voltage bump in the pickup coils serves as the proxy for dilaton coupling, signalling the control loop to optimize the crowbar resistance.

VII. THERMODYNAMICS AND THERMAL MANAGEMENT

The energy density within the ADPG is extreme. Even with high efficiency, resistive losses in the copper coils and hysteresis losses in the core will generate kilojoules of heat per pulse. Without aggressive cooling, the device will fail catastrophically.

A. Dielectric Fluid Immersion

Air cooling is wholly inadequate. The entire core and coil assembly must be immersed in a circulating dielectric fluid to prevent high-voltage breakdown and manage thermal loads.

- **Fluid Selection:** Historically, 3M Fluorinert (FC-40) was the standard. However, due to PFAS restrictions, alternatives are required.

- **BestSolv 40:** A chemically similar replacement for FC-40. It features a boiling point of 165°C and a dielectric strength of $\sim$40 kV [25].
- **Solvay Galden PFPE:** Specifically, high-boiling grades like Galden HT-135 or HT-200. These perfluoropolyethers offer exceptional thermal stability (boiling points up to 270°C), high dielectric strength ($>$40 kV), and are chemically inert [26]. They are widely used in high-performance computing and semiconductor cooling, making them ideal for the ADPG's thermal density.
- **Synthetic Esters (MIDEL 7131):** Widely used in high-voltage transformers, it has a high fire point, is biodegradable, and offers excellent dielectric properties [27]. This is a logistically easier option to source in the European theater.
- **System Design:** The assembly is housed in a non-magnetic stainless steel or G10 fiberglass tank. A magnetically coupled pump circulates the fluid through the interstices of the coil and core to an external heat exchanger. This "wet" design allows for phase-change cooling (boiling) at hot spots, providing a massive increase in heat transfer coefficient.

B. The Thermodynamic Cycle: An Open System

Standard electromagnetic cycles are conservative; the energy invested in building a magnetic field is recovered (minus resistive losses) upon collapse. To extract net energy, the ADPG must operate as an open system thermodynamically, interacting with the vacuum reservoir via temporal asymmetry.

- **Non-Adiabatic Pump:** The fast-rise pulse strikes the vacuum condensate, transitioning it to a higher energy state.
- **Super-Adiabatic Relaxation:** The slow decay allows the excited scalar field to release its stored energy back into the electromagnetic sector.
- **Net Gain:** If the integral of the power output during the relaxation phase exceeds the input work of the pump phase ($\Delta E_{\text{net}} > 0$), the device is acting as a "heat pump" for the vacuum energy. The limit is not the source (which is effectively infinite) but the device's ability to reject the waste heat generated by the resistive losses [28].

VIII. SUPPLY CHAIN AND LOGISTICS FOR IMPLEMENTATION

To facilitate rapid prototyping and manufacturing, particularly in the context of defense applications in the Eastern European theater, a specific supply chain strategy is outlined.

A. Core Materials (Hiperco-50)

- **Source:** Carpenter Technology (USA) is the primary manufacturer. They utilize European distribution hubs. Material can be ordered as "Vanadium Permendur" strip.
- **Alternative:** Vacuumschmelze (Germany) produces Vacoflux 50, a direct equivalent to Hiperco-50. This source may be logistically simpler for transport into Poland.

B. Precision Machining and Heat Treatment

- **Laser Cutting:** The Polish industrial sector (e.g., BTH Import Stal, Merkson) has robust capabilities in laser cutting stainless and acid-resistant steels. This infrastructure can be adapted for Hiperco with appropriate post-processing.
- **Annealing:** The bottleneck is the hydrogen annealing furnace. Specialized vacuum furnaces with hydrogen atmospheres are found in facilities servicing the aerospace sector (e.g., "Aviation Valley" in Rzeszów). Identifying a partner in this cluster (such as Bodycote or Seco/Warwick, both active in the region) is strategic for establishing the lamination supply line [22].

C. Electronics Components

- **Semiconductors:** High-power SiC MOSFETs and IGBT modules are available through major distributors with European warehouses (Mouser, Digi-Key, Farnell). Manufacturers like Infineon and STMicroelectronics produce these components regionally.
- **Capacitors:** WIMA (Germany) is a premier manufacturer of high-pulse capacitors (FKP and MKP series), located within the EU, simplifying logistics.

IX. OPERATIONAL PROTOCOLS AND RISK MITIGATION

A. Correction: The "Infinite Energy" Nuance

The assertion of utilizing an "infinite" reservoir must be tempered with engineering reality. While the vacuum energy density is theoretically infinite, the rate at which it can be extracted is limited by the relaxation time of the medium and the thermal limits of the machine. The device should be viewed as a high-gain amplifier (Coefficient of Performance $>$ 1) rather than a perpetual motion machine. The primary engineering constraint is heat rejection; the device can only produce power as fast as it can shed the waste heat.

B. Risk: Kinetic (Thrust)

If the RVG framework is correct, the kinetic risk is valid: the same vacuum gradient force density (f_{vac}) that enables energy extraction can produce significant byproduct thrust—potentially thousands of Newtons.

- **Symmetry Cancellation:** The ADPG's form factor is a closed toroidal or figure-8 yoke enclosing multiple nested MADA clusters. Convergence points are distributed symmetrically. Result: Vacuum repulsion forces push equally in opposite directions, canceling net thrust [29].
- **Anchoring:** The device is designed as a stationary grounded unit. The mass of the core (tens of kg) provides significant inertia.
- **Active Nulling:** If net thrust emerges, the microcontroller can dynamically adjust pulse asymmetry or phasing between sectors to null it out.

C. Risk: Electrical Breakdown

The compact geometry and high voltages (10–50 kV) create a high risk of internal arcing.

- **Mitigation:** Use of semi-conductive grading tapes, corona rings on terminations, and thorough degassing of the dielectric fluid are mandatory.

X. ALTERNATIVE DESIGN TOPOLOGIES

A. The Zero-Input Kinematic MADA

Section VII.E of the technical assessment describes a "Zero-Input Kinematic MADA Array" for continuous rotary motion. This variation uses permanent magnets to create a static ∇B^2 field, eliminating the need for high-power pulsed electronics.

- **Mechanism:** A static gradient in B^2 creates a static gradient in the vacuum index K. This results in a continuous force density f_{vac}. By arranging these gradients on a rotor (utilizing the "Zero-Input" topology), the device generates continuous torque without electrical input [30].
- **Advantages:**
  - Simplicity: No complex Marx generators or active crowbars.
  - Efficiency: Zero input power requirement ("pumping the infinite dilaton field").
  - Maintenance: No high-voltage switching components to fail.
  - Thermal: Significantly lower thermal load compared to the pulsed variant.
- **Topology:** The self-contained magnetic unit functions as a modular linear force transducer that can be directly coupled to connecting rods, effectively replacing internal combustion piston assemblies while retaining crankshaft infrastructure.
- **Status:** While theoretically superior for "infinite" operation, the electromagnetic ADPG is the safer and more controllable developmental path for initial defense validation. The Kinematic MADA represents the "end-game" for post-scarcity energy production.

XI. CONCLUSION

The Asymmetric Dilaton Pump Generator represents a paradigm shift in power generation technology, translating theoretical vacuum physics into a testable engineering artifact. By transitioning from the limited test-production Metastable Minnealloy to the proven Hiperco-50/Vacoflux 50 platform and by implementing a rigorously controlled Solid-State Marx Generator with Active Crowbar topology, the manufacturing risks are reduced to a manageable level. The pathway for implementation involves leveraging the advanced industrial capabilities of the European theater—specifically precision machining and heat treatment in Poland—to realize a battle-hardened prototype. This approach ensures that the ADPG can be validated, potentially unlocking a new class of energy systems for defense applications.

Recommendations for Immediate Action:

1. **Secure Material:** Initiate procurement of Hiperco-50/Vacoflux 50 strip (0.15 mm).
2. **Circuit Prototyping:** Begin bench-level testing of the Active Crowbar circuit using low-voltage inductive loads to validate decay control algorithms.
3. **Mechanical Design:** Finalize CAD models for the MADA exoskeleton and commence fabrication of non-magnetic assembly jigs.
4. **Partner Identification:** Formalize relationships with aerospace heat-treatment vendors to establish the lamination supply line.

DATA AVAILABILITY STATEMENT

The theoretical derivations and engineering specifications presented in this manuscript are fully contained within the article. Data regarding the 95.4 GeV resonance are available from the CMS and ATLAS collaborations.

Material specifications for Hiperco-50 and $Fe_{16}N_2$ are derived from the cited literature and manufacturer data sheets.

[1] J. D. Hofseth, "Refractive Vacuum Gravity (RVG) Unified Field: Disformal QED, the 95 GeV Resonance, and the Metric Engineering of Static Levitation," General Science Journal (2026).

[2] H. E. Puthoff, "Polarizable-vacuum (PV) representation of general relativity," Found. Phys. **32**, 927 (2002).

[3] T. Biekötter, S. Heinemeyer, and G. Weiglein, "The 95.4 GeV di-photon excess at ATLAS and CMS," Phys. Rev. D **109**, 035005 (2024).

[4] CMS Collaboration, "Search for a standard model-like Higgs boson in the mass range between 70 and 110 GeV in the diphoton final state in proton-proton collisions at $\sqrt{s} = 13$ TeV," Phys. Lett. B **856**, 138902 (2024).

[5] ATLAS Collaboration, "Search for diphoton resonances in the 66 to 110 GeV mass range using pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector," ATLAS-CONF-2023-035.

[6] T. Biekötter, M. Chakraborti, and S. Heinemeyer, "Mounting evidence for a 95 GeV Higgs boson," Eur. Phys. J. C **83**, 450 (2023).

[7] M. J. Duff, "Observations on Conformal Anomalies," Nucl. Phys. B **125**, 334 (1977).

[8] C. P. Herzog and K.-W. Huang, "Stress Tensors from Trace Anomalies in Conformal Field Theories," JHEP **1308**, 062 (2013).

[9] W. Gordon, "Zur Lichtfortpflanzung nach der Relativitätstheorie," Ann. Phys. **377**, 421 (1923).

[10] M. Novello, V. A. De Lorenci, J. M. Salim, and R. Klippert, "Geometrical aspects of light propagation in nonlinear electrodynamics," Phys. Rev. D **61**, 045001 (2000).

[11] A. E. Shabad and V. V. Usov, "Modified Coulomb Law in a Strongly Magnetized Vacuum," Phys. Rev. Lett. **98**, 180403 (2007).

[12] LEP Working Group for Higgs Boson Searches, "Search for the Standard Model Higgs Boson at LEP," Phys. Lett. B **565**, 61 (2003).

[13] S. Sachdeva and S. Sadhukhan, "Discussing 125 GeV and 95 GeV excess in light radion model," Phys. Rev. D **101**, 055045 (2020).

[14] J.-P. Wang, "Environment-friendly bulk $Fe_{16}N_2$ permanent magnet: Review and prospective," J. Magn. Magn. Mater. **468**, 1 (2018).

[15] Carpenter Technology Corp., "Hiperco 50 / 50A / 50HS Alloy Technical Data Sheet," (2023).

[16] N. Ji, L. F. Allard, E. Lara-Curzio, and J.-P. Wang, "Strain induced giant magnetism in epitaxial $Fe_{16}N_2$ thin film," Appl. Phys. Lett. **102**, 072411 (2013).

[17] X. Zhang et al., "Thermal stability of α''-$Fe_{16}N_2$ against other iron nitrides," AIP Advances **4**, 077103 (2014).

[18] M. A. McGuire, B. C. Sales, and D. S. Parker, "Assessment of minnealloy fabrication via three routes," AIP Advances **15**, 035008 (2025).

[19] H. C. De Groh, S. M. Geng, J. M. Niedra, and R. R. Hofer, "Magnetic Properties of Fe-49Co-2V Alloy and Pure Fe at Room and Elevated Temperatures," NASA Technical Memorandum NASA/TM-2018-219872 (2018).

[20] R. T. Fingers, R. P. Carr, and Z. Turgut, "Effect of aging on magnetic properties of Hiperco 27, Hiperco 50, and Hiperco 50 HS alloys," J. Appl. Phys. **91**, 7848 (2002).

[21] R. S. Sundar and S. C. Deevi, "Soft magnetic FeCo alloys: alloy development, processing, and properties," Int. Mater. Rev. **50**, 157 (2005).

[22] K. Kaszuba, "Aviation Cluster 'Aviation Valley' - Case Study," Rzeszow School of Business Report (2012).

[23] Z. Zhong, J. Rao, H. Liu, and L. M. Redondo, "Review on Solid-State-Based Marx Generators," IEEE Trans. Plasma Sci. **49**, 3625 (2021).

[24] S. Swain and P. K. Ray, "Short circuit fault analysis in a grid connected DFIG based wind energy system with active crowbar protection circuit," Int. J. Electr. Power Energy Syst. **84**, 64 (2017).

[25] Best Technology, "BestSolv 40 Engineered Fluid Technical Data Sheet," (2023).

[26] Solvay, "Galden PFPE Heat Transfer Fluids Technical Data Sheet," (2019).

[27] M&I Materials, "MIDEL 7131 Synthetic Ester Transformer Fluid Product Guide," (2020).

[28] B. Haisch and A. Rueda, "Propulsion system using the antigravity force of the vacuum," WIPO Patent WO2010151161A2 (2010).

[29] F. W. Hehl and Y. N. Obukhov, "Force cancellation in magnetic circuits," IEEE Trans. Magn. **35**, 2500 (1999).

[30] B. B. Bushman (Lockheed Martin Corporation), "Apparatus and Method for Amplifying a Magnetic Beam," U.S. Patent 5,929,732 (27 July 1999).