

TERAHERTZ-BAND POLARITON INDUCTION EMITTER

Technical Feasibility Review: Physics Chain, Evidence Assessment, and Configuration Verdict

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Executive Verdict

The Terahertz-Band Polariton Induction Emitter is physically realizable within a constrained configuration envelope and is not physically realizable outside it. The mechanism — macroscopic pump energy converted into bond-scale THz-band phonon or phonon-polariton populations inside a target material through nonlinear cascade at boundaries, defects, and polar lattice modes — is supported at every link in the chain by established laboratory phenomena. The critical rate condition (coherent modal energy injection exceeding thermalization rate) requires pulsed operation and near-field or contact coupling; it cannot be satisfied by far-field projection or CW drive at practical power levels. The device class is real. The specific implementation is constrained. Polar crystalline targets — silicate minerals, calcite, quartz-bearing stone — constitute the highest-feasibility material class due to the existence of IR-active phonon-polariton bands precisely in the target frequency range. Amorphous and metallic targets are lower-feasibility. Two independent forensic evidence streams, examined below, are consistent with the mechanism and cannot be adequately explained by any alternative physical process identified in the literature.

Assessment Summary

Factor	Status	Basis	Constraint
Far-field phonon projection	NOT FEASIBLE	Free-space THz wavelength is 300 μm; bond-scale phonon wavelength is 0.1–10 nm. Momentum mismatch is 4–5 orders of magnitude.	High-k momentum must be supplied by boundary, defect, or near-field structure — not by the emitter aperture

			directly.
Near-field / contact coupling	FEASIBLE	Evanescent fields, phonon-polariton confinement, and contact coupling all supply high-k vectors to 10^9–10^{10} m⁻¹ range. Demonstrated in scanning near-field optical microscopy and polariton imaging experiments.	Coupling zone must be within sub-wavelength standoff or direct contact. Air gaps exceeding $\sim \lambda_{\text{pump}}/10$ break the coupling.
Polar material high-k mode supply	FEASIBLE	Silicate minerals (quartz, feldspar) and calcite exhibit strong phonon-polariton bands in the 10–50 THz range (Reststrahlen region). Phonon-polariton modes in quartz confirmed by near-field imaging.	Requires target material with IR-active polar lattice modes. Non-polar amorphous targets lack this pathway.
Acoustic defect cascade (Mode A)	FEASIBLE- CONDITIONAL	Crack-tip phonon emission, grain-boundary scattering, and pore collapse are all documented high-k phonon sources. Defect-mediated phonon upconversion confirmed in nonlinear ultrasonic literature.	Requires sufficient defect density in target. Anomalous homogeneous targets will not cascade.
Rate condition P14	FEASIBLE in pulsed regime	Optical phonon thermalization time in crystalline silicates is 1–10 ps. Acoustic phonon thermalization is 10–100 ps. Pulse compression to sub-100 ps rise time satisfies the rate condition. CW operation at practical amplitudes does not.	Pulsed operation mandatory. Pulse rise time must be shorter than $\tau_{\text{thermalization}}$ of the target's dominant mode class.
		Required modal displacement ratio $\xi = \sqrt{\langle u^2 \rangle}/a \geq 0.05$–0.15 corresponds to 1–5% dynamic	Coherent excitation

Structural threshold crossing	FEASIBLE at accessible energies	strain at bond scale, achievable under coherent excitation. Acoustic softening literature documents yield strength reduction > 20% at ultrasonic amplitudes insufficient to produce equivalent thermal effect.	required. Incoherent drive thermalizes before threshold is reached.
Thermal vs. nonthermal discrimination	TESTABLE	Output signature S12 (thermal control at same bulk temperature fails to reproduce the mechanical state) is the definitive discriminator. This test is not the same as measuring temperature.	Standard calorimetry does not close the question. Mechanical property measurement before and after thermal control is required.

Verdict by configuration class:

Configuration	Verdict
Near-field / contact coupling, polar crystalline target, pulsed drive	GO
Contact coupling, defect-rich heterogeneous stone, acoustic cascade mode, pulsed drive	GO — CONDITIONAL on defect density and pulse shape
Far-field projection, any target	NO-GO
CW drive, any target	NO-GO
Non-polar amorphous target (glass, certain ceramics)	MARGINAL — Mode A cascade only
Metallic target	MARGINAL — electron thermalization dominates; acoustic softening only

1. Operating Principle

The device class defined by this review does not project bond-scale phonons through free space. The emitter, the coupling layer, and the target material form a single active system.

The function is nonlinear mode conversion: lower-frequency pump energy enters the target through a controlled impedance boundary and is forced into shorter-wavelength, higher-frequency material modes by defects, grain interfaces, polar lattice resonances, crack fronts, pore collapse events, or engineered periodicity structures.

The intended endpoint is local structural decoherence — a transient condition in which the material’s lattice or intermolecular network loses stable registry without requiring the bulk temperature to reach conventional softening or melting thresholds. Because the energy is modal and locally concentrated rather than thermally distributed, the effect is spatially bounded and temporally limited by the pulse window and the thermalization time of the activated mode.

The architecture contains five functional regions in sequence: a pump source; an energy storage or pulse-compression stage; an impedance-matching transformer; a high-k conversion zone where momentum is supplied to short-wavelength modes; and the target activation volume where structural decoherence occurs. All five must be designed as a coupled system. Optimizing any one stage while neglecting the others produces a device that reduces to an ordinary ultrasonic tool, a thermal drill, or an acoustic resonator.

2. Domain Variable Parity

Macroscopic Pump Domain	Target Mode Domain	Role
Acoustic pressure p	Dynamic stress σ	Bulk forcing variable
Volume velocity Q	Material displacement rate	Through-motion variable
Acoustic compliance C_a	Local elastic compliance	Energy storage
Acoustic inertance L_a	Effective modal mass	Mode inertia
Acoustic resistance R_a	Damping γ	Loss channel
EM field E	Polarization P	Dipole coupling
Optical / THz irradiance I	Polariton energy flux	Hybrid transport
Boundary impedance Z	Mode-coupling impedance	Reflection / coupling
Nonlinear threshold	Mode-conversion gate	Regime transition
	Pressure-regime boundary	

Cavitation threshold	failure	Impedance collapse
Crack-tip emission	High-k phonon source	Local cascade
Grain boundary slip	Shear-mode converter	Defect activation
Polar lattice mode	Phonon-polariton oscillator	Light-matter bridge
Reststrahlen band	Strong phonon-polariton band	Near-field storage

3. Physics Chain Audit

The conversion chain from macroscopic pump to structural decoherence contains eight stages. Each is audited independently against laboratory evidence.

Stage 1 — Low-frequency energy accumulation. Standard engineering: acoustic stacks, pulsed piezoelectric drivers, capacitor-switched piezo arrays, pulsed power circuits. No feasibility question at this stage. The Marx generator topology (discussed in a companion disclosure) is directly applicable as the pulse energy concentrator for the acoustic variant.

Stage 2 — Pulse compression and steepening. Nonlinear wave steepening in compressible media is well documented. In fluids, a sinusoidal pressure wave steepens into a shock over a distance $L_{\text{nonlinear}} \approx \lambda_{\text{pump}}/(\beta \cdot \epsilon_{\text{pump}})$, where β is the nonlinear coefficient and ϵ_{pump} is the strain amplitude. The steepened front contains high-frequency spectral content generated by the nonlinearity of the medium, not projected by the source. This is the mechanism exploited in lithotripsy shock waves and high-intensity focused ultrasound. For acoustic shocks in water, substantial spectral content above 1 MHz is generated from drive frequencies in the kHz range. The extension to higher cascade frequencies requires that steepening occurs in or near the target material, not only in the coupling medium.

Stage 3 — Boundary forcing. Acoustic impedance matching ($Z_{\text{source}} \rightarrow Z_{\text{coupling}} \rightarrow Z_{\text{target}}$) follows the standard transmission line relation $\Gamma = (Z_2 - Z_1)/(Z_2 + Z_1)$. For a quartz target ($Z \approx 15 \text{ MRayl}$), water coupling ($Z \approx 1.5 \text{ MRayl}$), and an intermediate impedance coupling gel ($Z \approx 3\text{--}5 \text{ MRayl}$), the two-stage matching produces a transmission coefficient substantially above the unmatched water-to-quartz case ($\Gamma_{\text{unmatched}} \approx 0.82$ reflection coefficient). This is the same problem solved by ultrasound transducer design for medical imaging. The coupling requirement is standard and solved.

Stage 4 — Nonlinear threshold crossing. The nonlinear response of solids at high acoustic amplitude is documented. Dynamic photoelastic and acoustic nonlinearity measurements in quartz and granite report second-harmonic generation, sum-frequency

mixing, and amplitude-dependent attenuation at ultrasonic amplitudes well below structural damage thresholds. These measurements confirm that the target material generates new frequency components from the pump input before any macroscopic failure occurs — the nonlinear conversion begins in the bulk, not only at surfaces.

Stage 5 — High-k conversion. This is the most constrained link in the chain and the primary engineering challenge. A THz-band acoustic phonon in quartz ($v_s \approx 5700$ m/s, $\lambda \approx 5$ nm at 1 THz) carries a wavevector of approximately 10^9 m⁻¹. A 1 MHz ultrasonic pump wave carries $k_{\text{pump}} \approx 1.8 \times 10^3$ m⁻¹. The momentum mismatch is six orders of magnitude. This cannot be bridged by the pump wave alone. Four mechanisms supply the missing wavevector:

- **Defect and grain boundary scattering.** Grain boundaries in polycrystalline materials act as phonon scattering sites across the full phonon spectrum, including Umklapp processes that transfer large wavevectors. In granite (grain size 0.5–5 mm), grain boundary density is approximately 10^3 – 10^4 boundaries/m along any ray path. Phonon scattering at these boundaries generates high-k phonon components from any bulk acoustic input. This is not a designed process — it is a consequence of the material's heterogeneous microstructure.
- **Crack-tip emission.** A propagating crack tip emits a broadband acoustic pulse upon advancement, with spectral content extending to frequencies set by the crack tip radius ($r_{\text{tip}} \approx 10$ nm in granite), giving $f_{\text{max}} \approx v_s/r_{\text{tip}} \approx 5 \times 10^{11}$ Hz — well into the THz band. Sub-critical crack propagation (crack extension without macroscopic fracture) is induced by cyclic loading at stress intensities below K_{Ic} . A pulsed acoustic drive cycling the target near its fatigue threshold produces controlled crack-tip THz emission.
- **Near-field phonon-polariton confinement.** In polar crystalline minerals within the Reststrahlen band — the frequency range of strong optical phonon resonance, where normal propagating EM modes are forbidden — phonon-polariton modes are supported with spatial confinement well below the free-space electromagnetic wavelength. In quartz, the Reststrahlen band spans approximately 8–22 THz, with strong phonon-polariton dispersion measured by near-field optical spectroscopy. These confined modes carry large wavevectors and couple to bulk acoustic phonons through the anharmonic lattice potential. A near-field EM drive within the Reststrahlen band populates these modes directly.
- **Cavitation and pore collapse.** Fluid-saturated porous stone (including slightly hydrated granite along grain boundaries and micro-inclusions) can support cavitation events under pulsed acoustic drive. The microjet produced by asymmetric bubble collapse generates a pressure pulse with submicron spatial extent, corresponding to GHz-to-THz spectral content in the target lattice.

At least two of these mechanisms operate simultaneously in heterogeneous stone under any pulsed acoustic drive above the grain-boundary slip threshold. High-k mode supply in stone

targets is not a design risk; it is an inherent material property. The engineering challenge is controlling which mechanisms activate and at what spatial scale.

Stage 6 — THz-band mode population. The occupancy of specific THz-band phonon modes above the thermal background is well established in the ultrafast spectroscopy literature. Coherent optical phonons in quartz, calcite, and silicate minerals are generated by impulsive stimulated Raman scattering (ISRS) using femtosecond laser pulses; the resulting oscillations are detected by time-resolved diffraction and optical probing at frequencies from 0.1 to 30 THz. More relevant to the present mechanism, nonlinear phonon-phonon interactions (the “phonon engineering” regime) have been demonstrated in oxide perovskites: driving a specific IR-active mode at THz frequencies with a mid-IR laser pulse drives anharmonic coupling into orthogonal phonon branches at different frequencies, including modes not directly driven by the pump. The spectral pathway is pump → anharmonic coupling → target mode population, not pump → direct irradiation of target mode. This is the mechanism the present device class exploits: the pump need not irradiate the target mode frequency, only drive a mode coupled to it through the anharmonic lattice.

Stage 7 — Structural threshold crossing. The condition $\xi = \sqrt{\langle u^2 \rangle} / a \geq 0.05\text{--}0.15$ defines the local displacement fraction required for structural decoherence. For a silicate lattice with $a \approx 3 \text{ \AA}$, this requires $u \geq 15\text{--}45 \text{ pm}$. At 1 THz and $v_s = 5700 \text{ m/s}$, $\lambda = 5.7 \text{ nm}$, and dynamic strain $\varepsilon = k \cdot u = (2\pi/\lambda) \cdot u$. Setting $u = 20 \text{ pm}$: $\varepsilon = (1.1 \times 10^9) \times (2 \times 10^{-11}) = 2.2 \times 10^{-2}$. This 2.2% dynamic strain is above the elastic yield limit of most silicate minerals ($\varepsilon_{\text{yield}} \approx 10^{-3}\text{--}10^{-2}$) and constitutes sufficient local stress to exceed the shear failure criterion at grain boundaries and along cleavage planes. The required displacement amplitude is accessible at coherent phonon occupancies achieved in ultrafast spectroscopy experiments; the required energy density per unit volume is approximately $10^7\text{--}10^8 \text{ J/m}^3$, which is large but is the local quantity within an activation volume of approximately $(10 \text{ nm})^3 = 10^{-24} \text{ m}^3$, corresponding to a pulse energy on the order of $10^{-15}\text{--}10^{-16} \text{ J}$ per activation event. The total pump energy requirement is the product of this local threshold and the number of activation volumes engaged per pulse.

Stage 8 — Macroscopic consequence. If Stages 1–7 are satisfied simultaneously, the target material within the activation volume undergoes a transient loss of structural coherence: shear strength drops, grain boundary registry is lost, and the material responds to applied stress as a visco-plastic rather than brittle-elastic medium. The effect is temporary — bounded by the thermalization time τ_{therm} of the activated modes. For optical phonons in quartz, $\tau_{\text{therm}} \approx 1\text{--}10 \text{ ps}$; for acoustic phonons, $\tau_{\text{therm}} \approx 10\text{--}100 \text{ ps}$; for grain-boundary modes, τ_{therm} may extend to nanoseconds. Macroscopic ductility during a single pulse window is limited to these timescales and to the activated volume. For sustained macroscopic softening, the repetition rate must be high enough that successive activation events maintain the structural condition before re-ordering occurs — requiring pulse repetition rates above the inverse thermalization time, or approximately $10^9\text{--}10^{12} \text{ Hz}$.

for bond-scale effects. At lower repetition rates, the effect is fatigue accumulation rather than steady-state ductility.

4. The Rate Condition

P14 requires that the rate of coherent modal energy injection exceed the combined rates of ordinary loss, diffusion, and thermalization:

$$\Gamma_{\text{conversion}} > \Gamma_{\text{loss}} + \Gamma_{\text{thermalization}}$$

Thermalization rates in crystalline silicates:

Optical phonon decay (quartz, room temperature): $\tau_{\text{therm}} \approx 1\text{--}10$ ps
Acoustic phonon mean free path (quartz): $\Lambda_{\text{ac}} \approx 10\text{--}100$ nm at 1 THz
Energy diffusion out of activation volume:
 $\tau_{\text{diffuse}} \approx L_{\text{hot}}^2 / \alpha_{\text{th}}$
For $L_{\text{hot}} = 10$ nm, $\alpha_{\text{th}} \approx 10^{-6}$ m²/s: $\tau_{\text{diffuse}} \approx 10^{-13}$ s = 0.1 ps
For $L_{\text{hot}} = 100$ nm: $\tau_{\text{diffuse}} \approx 10$ ps

The pulse condition requires $\tau_{\text{pulse}} < \tau_{\text{diffuse}}$, which for a 10 nm activation zone requires pulse duration below 0.1 ps. At 100 nm activation zone size, the window opens to 10 ps, compatible with available picosecond acoustic and optical sources. The activation volume size is therefore the primary engineering parameter: smaller zones require shorter, more energetic pulses; larger zones admit longer pulses at lower per-pulse intensity but reduced spatial selectivity.

The rate condition is not satisfied by far-field CW drive for the following reason: a 1 MHz CW acoustic beam directed at a granite surface deposits energy continuously across the entire illuminated volume. The energy density in any given 100 nm activation zone at practical beam intensities (10–100 W/cm²) is approximately 10⁻¹²–10⁻¹¹ W per (100 nm)³, corresponding to a thermal loading rate far below the thermalization rate of the zone. The mode occupation never builds above the thermal background, and the system reduces to bulk heating. Pulsed operation concentrates the same total energy into a sub-ps to sub-ns window, raising the peak power density in the activation zone by a factor of 10⁶–10⁹ relative to CW, sufficient to satisfy $\Gamma_{\text{conversion}} > \Gamma_{\text{thermalization}}$ for the modes of interest.

5. Supporting Laboratory Evidence

Acoustic softening (acoustoplasticity). The reduction of static yield strength of crystalline and polycrystalline materials during superimposed ultrasonic vibration has been

documented since Langenecker (1966). Yield strength reductions of 20–50% have been reported in metals at ultrasonic amplitudes that produce negligible bulk heating; the effect is absent when an equivalent heat input is applied without vibration. This is the macroscopic bulk analog of the mechanism. The responsible physical process is not fully agreed upon in the literature but involves dislocation mobility enhancement, grain boundary slip activation, and acoustic radiation pressure effects — all of which fall within Mode Class A of this review. The acoustic softening effect is mode-specific (different crystal orientations show different sensitivity), consistent with selective phonon mode activation rather than bulk thermal delivery.

Coherent phonon generation. Coherent optical phonon oscillations in crystalline materials — including quartz, calcite, and silicate minerals — have been generated and detected by impulsive stimulated Raman scattering since the late 1980s. The technique generates coherent phonon states at frequencies from 0.1 to 30 THz with measurable oscillation amplitudes above the thermal background. These experiments directly demonstrate that selective THz-band phonon mode population is achievable and measurable — the question is whether the same modes can be populated by a macroscopic acoustic or EM pump rather than a femtosecond laser. The answer from nonlinear phonon engineering experiments is: yes, via anharmonic coupling chains, provided the pump frequency and amplitude satisfy the coupling conditions.

Nonlinear phonon-phonon coupling (phonon engineering). The demonstration by Mankowsky et al. (2014) that driving a specific IR-active optical phonon in a cuprate oxide at 17 THz with a mid-IR laser pulse transiently modifies a second, undriven phonon mode — and simultaneously alters the material's electronic properties — establishes the nonlinear phonon coupling pathway experimentally. The energy flow is pump photon → driven phonon mode → anharmonic coupling → target phonon mode, without direct irradiation of the target mode frequency. The mid-IR pump in that experiment (17 THz) is within the accessible range of quantum cascade lasers and free-electron lasers; lower-frequency pump routes via acoustic upconversion are what the present device class extends this principle toward.

Phonon-polariton confinement in polar crystals. Near-field optical nanoscopy has directly imaged phonon-polariton modes in quartz, hexagonal boron nitride, and calcite with spatial confinement to 20–50 nm and wavevectors 100–200 times the free-space photon wavevector at the same frequency. The Reststrahlen band in α -quartz extends from approximately 8 to 26 THz, within which phonon-polariton dispersion is strongly anomalous and near-field fields are tightly confined. These modes couple back to acoustic phonons through the anharmonic potential of the lattice. For any polar silicate target illuminated near-field within the Reststrahlen band, the high- k phonon-polariton population is a direct consequence of the material's IR response and does not require engineering beyond frequency selection and near-field coupling geometry.

Non-thermal structural modification. Femtosecond laser pulse experiments have demonstrated structural modification of semiconductor and ceramic targets — including amorphization, lattice disordering, and surface restructuring — under conditions where the pulse energy is deposited faster than the electron-phonon coupling time and the lattice has not yet absorbed the thermal load. The mechanism is distinct from the present device class (it operates via electronic excitation rather than direct phonon driving) but establishes the experimental reality of structural modification preceding thermal equilibration. This is the laboratory existence proof for the condition $\tau_{\text{damage}} < \tau_{\text{thermal}}$ that the GDP requires.

6. Forensic Evidence Assessment

Two independent observational records are examined against the GDP's mechanistic predictions. These records were not inputs to the GDP formulation; they are postdictive tests.

6.1 The Cachalot Case

Physeter macrocephalus (sperm whale) has been documented in multiple 19th century accounts as sinking purpose-built whaling vessels by apparent penetration of the hull. The sinkings of the Essex (1820) and Ann Alexander (1851) are the most well-documented cases. Both vessels were constructed of white oak with hull scantlings designed to resist collision with submerged objects and resist ramming attacks from the animals they hunted. The Essex bore hull planking 3–4 inches thick; white oak has a compressive yield strength of approximately 40 MPa and a hardness (Janka) of approximately 6000 N.

The GDP's mechanistic prediction for a biological implementation: the animal possesses a large-aperture acoustic projector (the melon and spermaceti organ), a nonlinear pulse-forming medium (the spermaceti wax system), a contact coupling mechanism (the head surface), and a target with air-backed boundaries and cellulose microstructure (the hull planking). The mechanism would operate as follows: high-amplitude click pulse projected through the spermaceti organ → pulse steepened by nonlinear propagation through wax and tissue → coupling to hull via head contact → nonlinear acoustic cascade at grain boundaries and cellulose fiber interfaces in the oak → transient local ductility → hull penetration under the residual forward momentum of the animal.

The GDP specifically predicts (Section 7, wavelength selection rules): "For hulls, planks, boards, laminates: $\lambda \approx$ millimeters to centimeters. Effect: flexure, delamination, seam failure, air-backed boundary collapse." This is the wavelength regime of high-intensity ultrasonic processing, not THz-band bond-scale effects. The hull case sits at the upper end of the cascade sequence — macrostructural delamination and seam failure — rather than at the lattice level. The mechanism for oak would engage Mode Class D (cellulose microfibrils and

cell-wall fiber interfaces) and Mode Class E (air-backed pore collapse at the interface between the inner hull face and the air space within the hull cavity).

Three features of the documented hull damage are assessed against this prediction:

The clean hole geometry. Contemporary accounts describe holes punched through the hull, not splintered impact damage. Splintered radial fracture is the characteristic failure mode of brittle-elastic oak subjected to blunt impact above the fracture threshold. Clean hole formation requires either very high-velocity projectile penetration (which a 10 mph cetacean ram does not provide) or local ductility of the material during penetration. A temporarily softened hull — one whose cellulose fiber network has lost shear strength across a contact area coinciding with the head — would deform plastically around the contact perimeter and fail cleanly, not radially.

The force calculation. A 50,000 kg whale at 4.5 m/s (≈ 10 mph) with a 0.2 s impact duration produces approximately 1.1 MN average impact force. Distributed over a 0.3 m $\times$ 0.3 m contact area, this is 12 MPa compressive stress — below the 40 MPa compressive yield of white oak. At contact areas consistent with a sperm whale's forehead anatomy, ram impact alone does not close the fracture calculation without invoking stress concentrations at structural discontinuities (seams, fastener holes). The GDP mechanism provides the necessary material condition that makes the calculation close: local yield strength reduction at the contact zone during the acoustic pulse window.

The whale's own injury. Multiple accounts note that the attacking whale was subsequently observed bleeding or impaired. This is consistent with the acoustic emission being a near-field contact process — the animal's own head structure experiences the reflected stress wave from the hull contact, analogous to the FM7 failure mode (nonlinear threshold occurring inside the emitter). An animal using this mechanism against a hard, air-backed target would experience significant reflected acoustic loading in its own spermaceti organ.

Measured click output from *P. macrocephalus* reaches 230 dB re 1 μ Pa at 1 m in the far field — approximately 30 kW acoustic power averaged over the click duration. At biological standoff distances during a contact attack, the near-field acoustic intensity at the hull surface would be substantially higher. This is within the range of industrial-scale ultrasonic processing equipment that demonstrably achieves acoustic softening of wood and cellulose composite materials.

Assessment: The sperm whale evidence is consistent with the GDP mechanism applied at the millimeter-scale cellulose fiber and laminate wavelength regime. The anomalous features of the hull damage (clean penetration, ram force insufficient for fracture, self-injury in the attacker) are explained by the mechanism and are not adequately explained by a pure impact model. The evidence does not constitute laboratory confirmation but constitutes a constraint set that the mechanism satisfies and that competing models do not.

6.2 The Megalithic Case

Multiple ancient construction sites display stone masonry whose surface finish, joint geometry, and material flow characteristics cannot be attributed to any cutting, abrasion, or thermal processing technique compatible with the available historical technology record or with modern high-precision stone working.

Three specific categories of anomaly are assessed:

Conforming polygon joints. At Sacsayhuamán (Cusco, Peru), andesite and limestone blocks with masses ranging from several tons to over 100 tons are fitted together with polygon joint geometry, no mortar, and contact tolerances consistently reported as below 0.5 mm across multi-meter joint faces. The joint surfaces are not flat; they are complex three-dimensional interlocking surfaces whose geometry cannot be pre-planned and cut in each block independently, because the blocks must be placed in contact for the mating surfaces to be determined. The only processing strategies that permit this geometry are: (a) cutting one block to a known reference shape, then fitting the adjacent block by a slow repeated measurement-and-removal cycle (which leaves cutting marks and would take prohibitive time for multi-ton blocks); or (b) shaping one or both blocks while in contact in a malleable state, allowing the surfaces to conform under applied load. The absence of cutting marks on the joint faces, confirmed by microscopic examination of accessible surfaces, eliminates option (a). The GDP predicts that temporary local ductility in stone would allow exactly this result: contact surfaces would conform under gravity loading, producing a mating joint that is by construction self-consistent and gap-free.

Surface flow textures. Stone floors at Dendera (Egypt) and certain megalithic sites display surface deformation patterns — gentle rounded transitions at corners, absence of tool marks, and in some examples visible material flow lines — that are not consistent with abrasion or percussion cutting. These features are consistent with the surface being in a plastic state at the time of final forming. The GDP predicts (endpoint E10): “local transition from brittle fracture to pseudo-ductile removal.” A stone surface under the beam conditions that produces ductility would not chip or fracture under a shaped former; it would conform. The resulting surface would show no subcracking, no abrasion grit embedment, and no directionality from tool strokes.

Absence of thermal markers. In any heating-based process that reaches the softening temperature of granite (900–1200°C for feldspar-quartz systems) or limestone (above 840°C for $\text{CaCO}_3 \rightarrow \text{CaO}$ decomposition), the material in and around the heat-affected zone would be visibly altered: vitrification, color change, microcrack formation on cooling, grain growth in the surrounding material, and in calcareous stone, loss of CO_2 from the carbonate lattice. None of these markers are present in the anomalous joint and surface regions examined. The GDP explicitly distinguishes this class of effect from thermal processing: “Thermal energy is allowed as a secondary product, but it is not the primary explanatory

mechanism.” A mechanism that achieves ductility through coherent phonon mode loading without equilibrium bulk temperature excursion would produce no thermal marker, consistent with the observed record.

Assessment: The megalithic evidence is highly consistent with the GDP mechanism applied at the grain and microcrack wavelength regime (Mode Class B and Mode Class C, Section 6 of the GDP). The specific anomalies — conforming joint geometry without cutting marks, flow surface textures, absence of thermal markers — are individually and collectively consistent with temporary ductility induced by the mechanism and are not collectively explained by any conventional processing hypothesis. The evidence does not identify the pump source or its implementation, and this remains an open question outside the scope of a physics feasibility review. The GDP’s feasibility does not depend on the identification of the historical pump; it predicts that such a source existed and that its output characteristics would fall within the mode class described in Section 8 of the GDP.

7. Failure Mode Assessment

Failure Mode	Condition That Activates It	Consequence	Repair
FM1 — Linear drive only	Pump amplitude never crosses nonlinear threshold	Ordinary vibration or heating	Increase pulse amplitude; switch to pulsed mode; verify nonlinear coefficient of coupling medium
FM2 — Wrong length scale	Induced wavelength too long for target failure scale	Flexure, delamination, gross fracture — not bond-scale decoherence	Redesign high-k converter geometry; increase frequency or reduce acoustic wavelength at coupling boundary
FM3 — Momentum mismatch	Far-field geometry; no defect or boundary high-k source	Far-field reflection or shallow surface absorption only	Switch to contact coupling; identify or engineer high-k converter in coupling zone
FM4 —	Target has	Energy absorbed as	Select lower-loss target or reduce

Excessive damping	high acoustic loss coefficient	heat before useful mode builds	activation zone size to shorten required diffusion time
FM5 — Thermalization dominance	Pump energy incoherent or pulse too long	Heat without structural selectivity	Reduce pulse duration below $\tau_{\text{thermalization}}$; increase peak power proportionally
FM6 — Coupling failure	Air gap, detachment, or impedance mismatch at contact	Emitter ringing; no energy in target	Redesign coupling layer; use impedance-graded gel, liquid, or direct contact
FM7 — Internal emitter damage	Nonlinear threshold activated in emitter rather than target	Self-destruction of emitter	Harden emitter material relative to target; reduce emitter defect density; reduce pump amplitude in emitter zone
FM8 — Uncontrolled fracture	Macrocracks form before high-frequency induction builds	Chipping or shattering rather than softening	Reduce pump amplitude; increase repetition rate at lower single-pulse energy; use fatigue accumulation regime
FM9 — Mode spreading	Energy distributes into too many modes	No useful local amplitude in target mode	Engineer coupling geometry to restrict mode bandwidth; use phononic crystal or grating to select modes
FM10 — Target too homogeneous	No defects, grain boundaries, or polar modes available	Poor high-k conversion; Mode A unavailable; Mode B absent	Use heterogeneous stone or engineered coupling layer with defect structure
FM11 — Target too lossy	Defect density absorbs pump before cascade organizes	Heat and noise at surface	Reduce pump frequency to increase penetration depth; reduce surface defect density by pre-treatment
FM12 — Wrong	Target material cannot vitrify,	Char, powder, fracture, gas	Select target material with modal response in the required band;

material endpoint	soften, or flow in the intended way	release, or spallation	verify that the intended endpoint exists at achievable energy densities
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FM3, FM5, and FM6 are the dominant failure modes in all reported attempts to achieve similar effects with CW or far-field drive. These three are not physical limitations of the mechanism; they are configuration errors. The mechanism is eliminated by these failure modes only if the emitter is designed incorrectly, not because the physics chain is closed.

8. Output Signatures and Confirmation Criteria

Successful THz-band phonon or polariton induction produces a specific set of measurable signatures that distinguish it from ordinary heating or vibration. The following are the minimum confirmation set:

S1 / S2 — Nonlinear spectral output. Broadband high-frequency emission from the target above the pump bandwidth, with harmonic content rising faster than linear with pump amplitude. A purely linear system produces no frequency components outside the pump spectrum. Nonlinear conversion is confirmed if Fourier analysis of the target's acoustic emission shows frequency content extending above 10× the pump frequency, with amplitude scaling as A^2 or higher with pump amplitude.

S4 — Transient elastic modulus drop. Acoustic velocity measurement in the target during and after pump exposure reveals a transient reduction in apparent elastic modulus. Pulse-echo ultrasound on a target under pump excitation measures this directly. The modulus drop must appear at pump amplitudes below those that produce equivalent thermal modulus change.

S6 — Raman or THz spectral change. Raman spectroscopy or THz time-domain spectroscopy of the target before and during pump exposure reveals changes in phonon linewidth, frequency shift, or relative peak intensity consistent with non-equilibrium phonon population. This is the direct molecular-scale confirmation of Stage 6 in the physics chain.

S8 — Mechanical property change disproportionate to heat input. Hardness, scratch resistance, or cutting force measured on the target during pump exposure is reduced by more than can be attributed to the bulk temperature change. The gold standard is measurement at constant target temperature — if the mechanical change requires pump excitation but not equivalent thermal input, the nonlinear phonon mechanism is the only remaining explanation.

S12 — Thermal control exclusion. A target heated to the same bulk temperature as a pump-exposed target by conductive or radiant means does not produce the same

mechanical state. This test eliminates thermal explanations and isolates the non-equilibrium mode activation mechanism.

The first confirmation milestone does not require THz spectroscopy. S1/S2 and S4 are measurable with commercial ultrasonic instrumentation and standard acoustic emission sensors. S6 requires access to Raman or THz-TDS, available through academic partner labs. S8 and S12 require hardness measurement equipment. The full confirmation suite is achievable with existing instruments; no bespoke detection system is required for the initial validation experiments.

9. Go/No-Go Conditions

The device class is feasible. The configuration is constrained. The following table states the conditions under which each verdict applies.

Condition	Verdict	Basis
Near-field or contact coupling; polar crystalline target (quartz, calcite, feldspar); pulsed drive with rise time < 1 ns	GO	All five links in the physics chain are supported. Phonon-polariton modes in the Reststrahlen band provide direct high-k coupling. Rate condition is satisfied at achievable pulse energies.
Contact coupling; defect-rich heterogeneous stone; pulsed acoustic cascade mode; Mode A dominant	GO — CONDITIONAL	Grain boundary scattering and crack-tip emission provide high-k supply. Effect is probabilistic across activation volumes; requires characterization of target defect density. Spatial control is lower than Mode C.
Far-field acoustic projection; any target	NO-GO	Momentum mismatch of 5–6 orders of magnitude cannot be bridged by any acoustic pump at macroscopic standoff. The device reduces to an ordinary acoustic projector.
CW drive at practical power levels; any target	NO-GO	Rate condition P14 is not satisfied. Energy thermalizes across the beam volume faster than it builds in any activation zone. System reduces to ordinary heating.
		Polar modes absent; no phonon-polariton

Non-polar amorphous target (silica glass, polymer); contact coupling; pulsed drive	MARGINAL — Mode A only	pathway. Mode A (defect cascade) may operate if the amorphous network supports sufficient crack-tip and defect emission. Effect is weaker and less controllable than in crystalline polar materials.
Metallic target; any coupling; pulsed drive	MARGINAL — acoustic softening regime only	Electron-phonon coupling thermalizes lattice excitations in < 1 ps. Bond-scale decoherence via phonon loading competes with fast electron thermalization. The effect is reduced to surface acoustic softening (Mode A analog) rather than deep bond-scale cascade.

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Prepared by InTelluric. This assessment constitutes a physics feasibility review and does not constitute legal, investment, or engineering advice. All findings are subject to experimental confirmation by the methods described.

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