

OQG MEGA: 35 kHz and beyond

Coupled hill-depth and pulse characterization

V0.2 | 20 October 2026 | 100 Vpp | Characterization before component selection

The higher-frequency study reaches lift-sized conditional forces. At 35 kHz, the 10 g reference gives 83.0 N average reaction against the prescribed external field. This is a requirement study: the field source, its reactions, and the high-frequency device response must still establish whether that force can exist in an actual assembly.

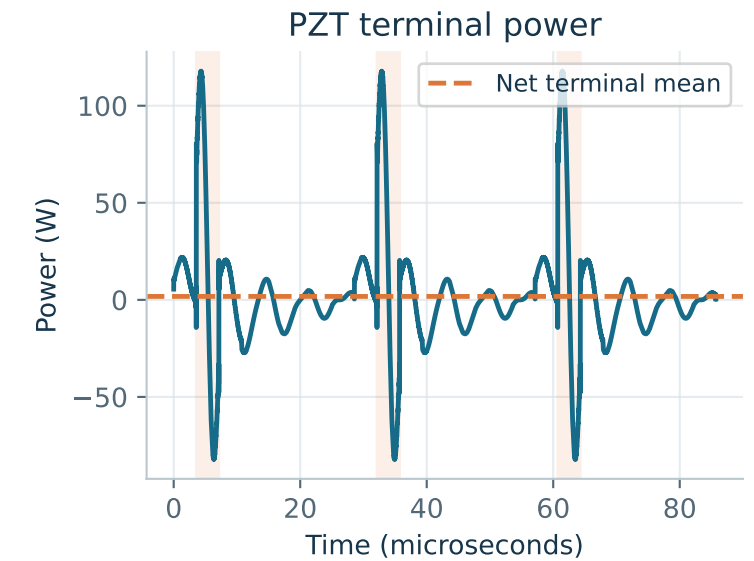
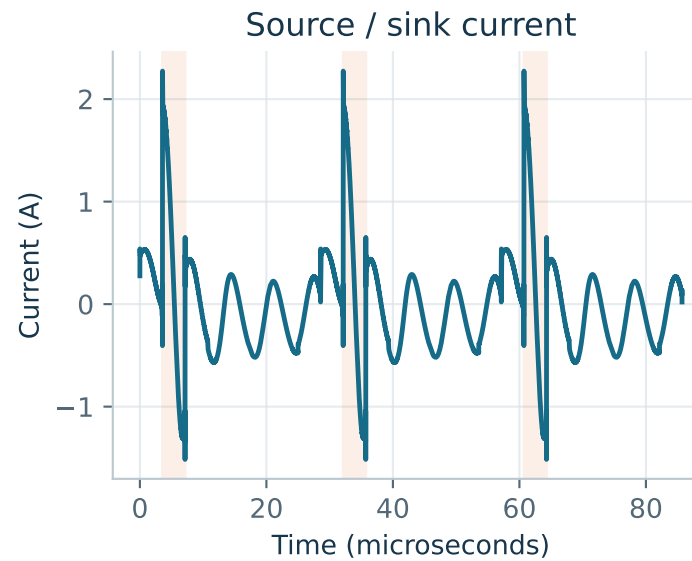
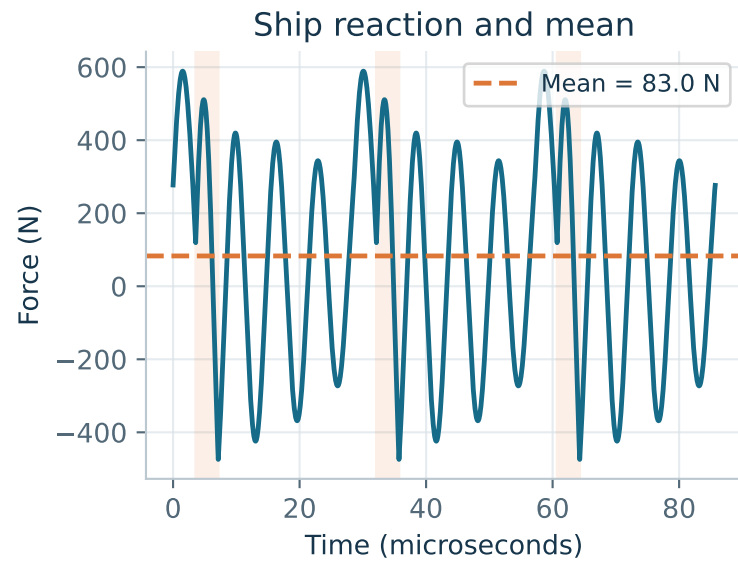
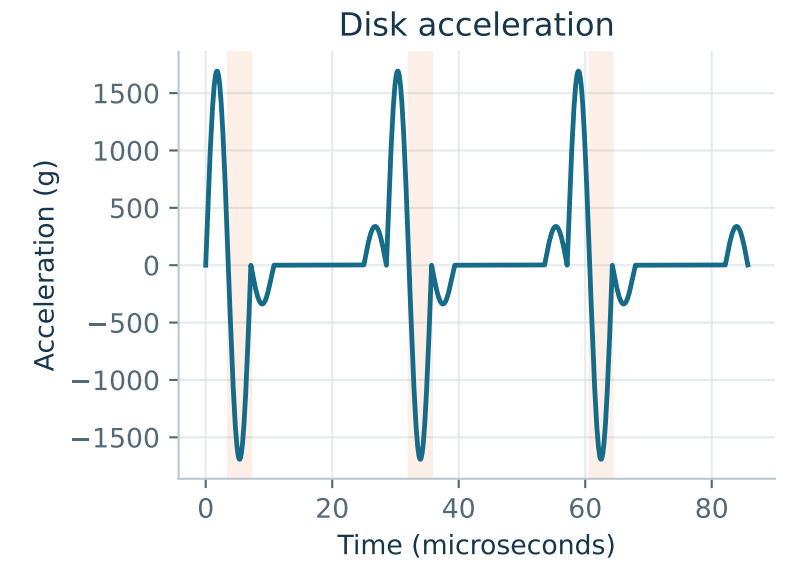
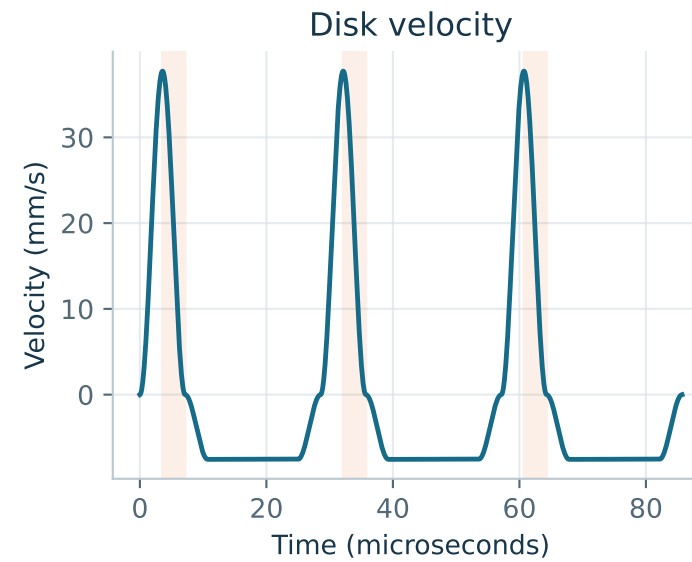
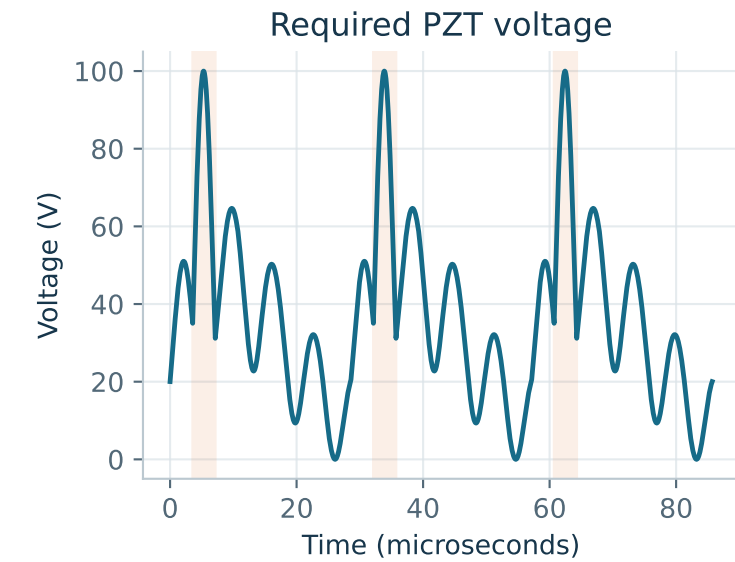
Calculated quantity	1 kHz reference	35 kHz reference
Outward stroke	304.8 nm	134.8 nm
Peak outward velocity	2.438 mm/s	37.73 mm/s
Peak cycle acceleration	30.64 m/s ²	16,595 m/s ² (1,692 g)
Conditional average thrust	0.1139 N	82.99 N
Driver input / thrust per input watt	0.0490 W / 2.33 N/W	3.037 W / 27.33 N/W
Depth, 1 - bmin	1.54e-22	4.98e-20

One coupled hill: $b = 1$ remains fixed at the end of restoration. The hill is twice the largest disk-plus-stack kinetic energy in the cycle. Its depth and restoring gradient come from the same force-work integral; neither is varied independently.

What changes the interpretation: the 35 kHz reference requires about 445 N of additional preload and a capacitive-current spectrum reaching roughly 1.12 MHz. The old 50 N preload is inadequate. The modeled driver input excludes unknown field-source and auxiliary power.

35 kHz: repeated powered-restoration cycles

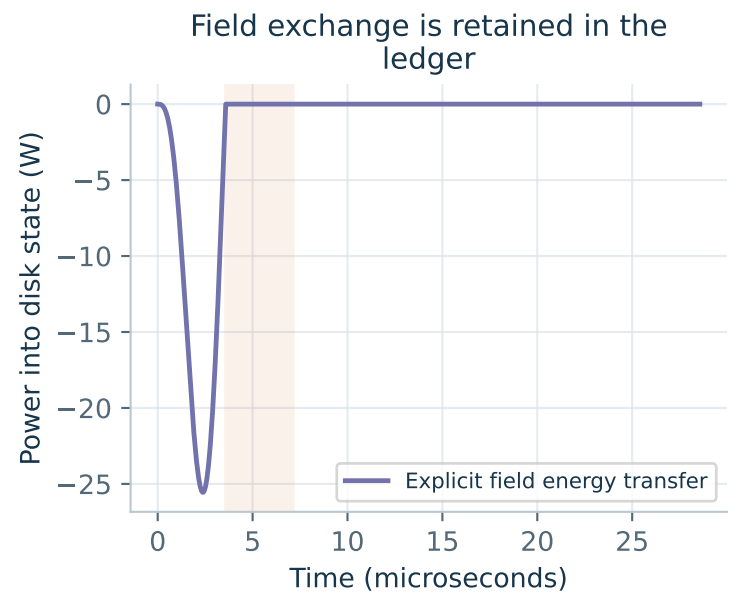
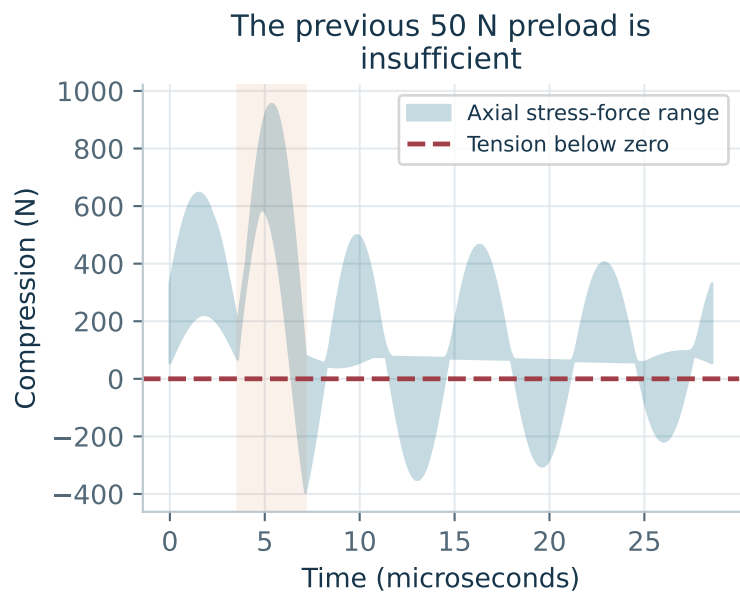
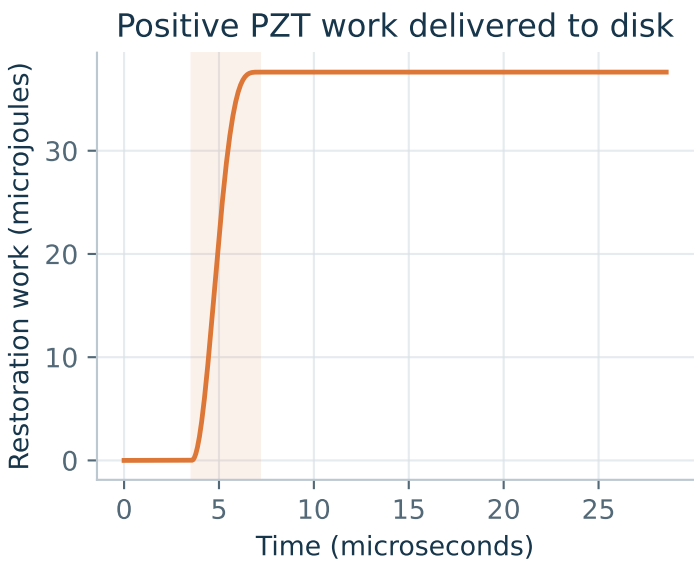
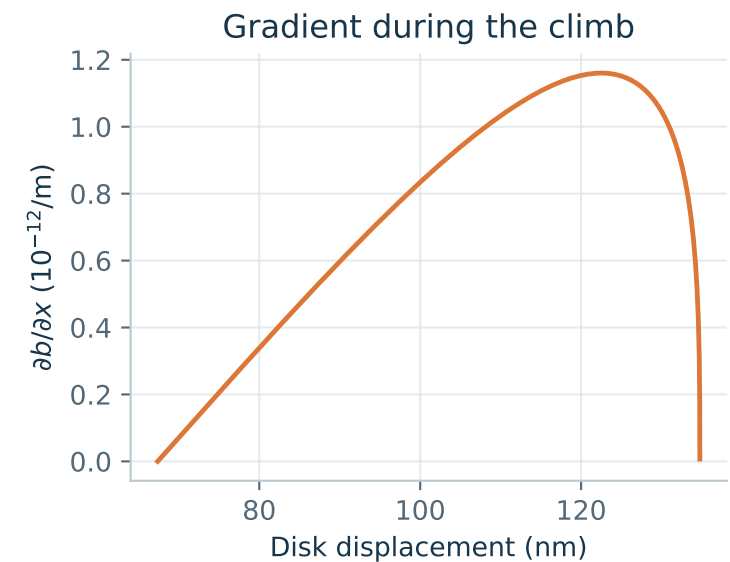
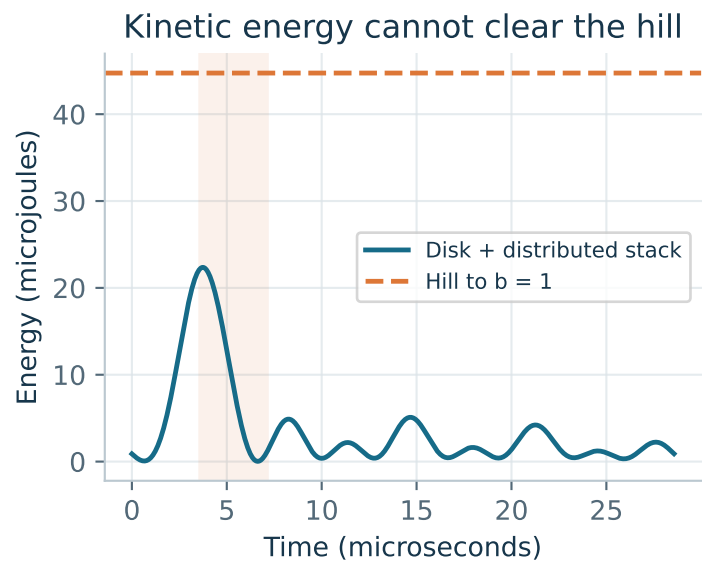
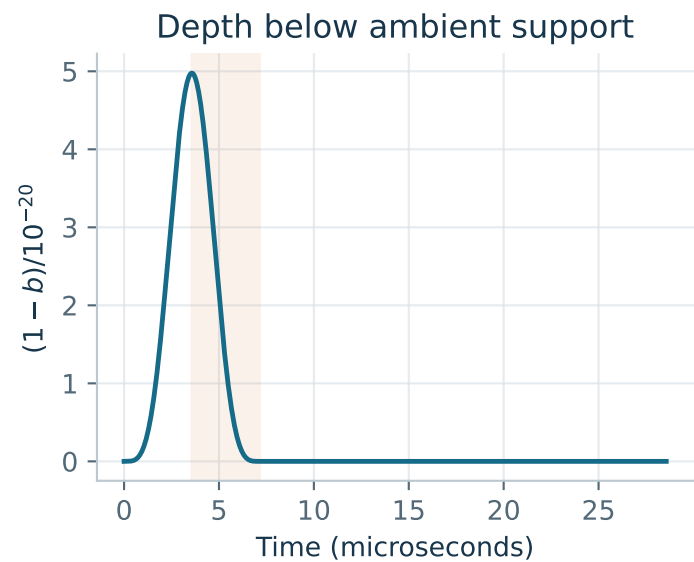
10 g disk | 100 Vpp | 28.57 microseconds per cycle | 7.14 microseconds outward stroke



Orange bands: powered restoration to $b = 1$. Negative terminal power is recoverable electrical energy.
Conditional external-field load; 100% impulse retention. Driver input = 3.04 W; thrust/driver power = 27.3 N/W.

Hill depth and restoring gradient come from one load

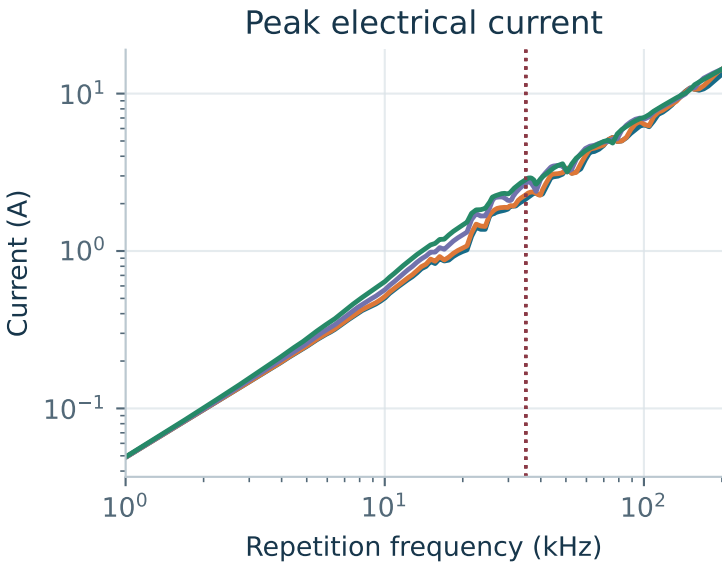
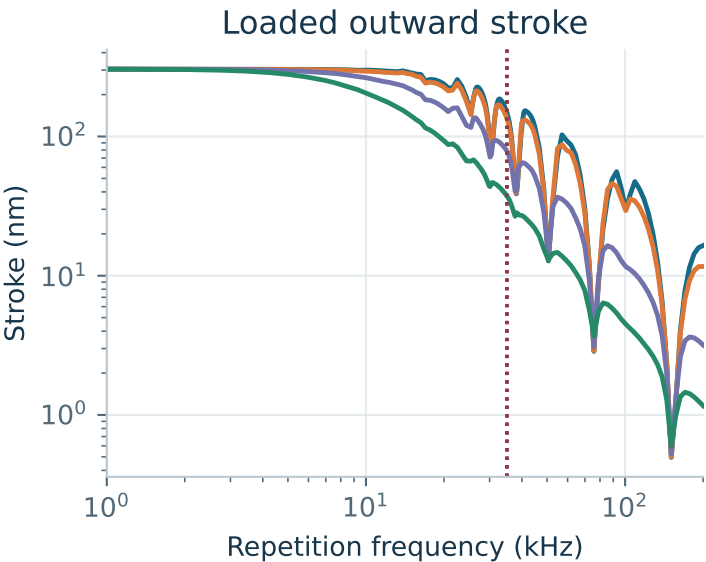
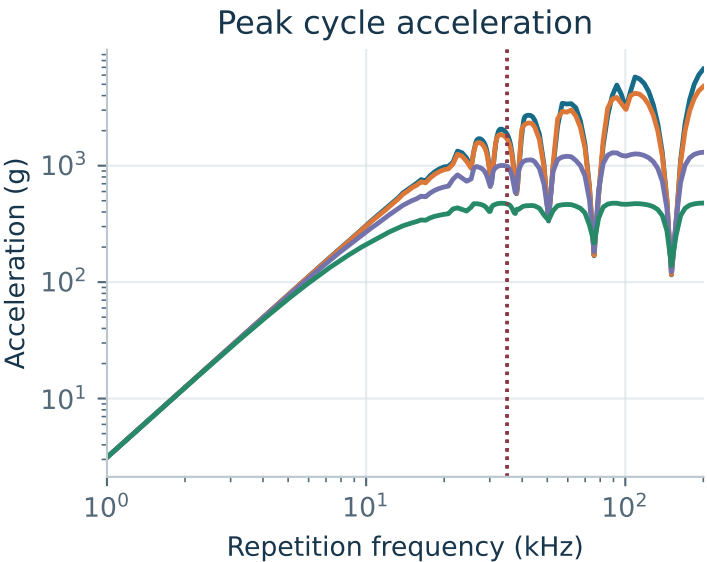
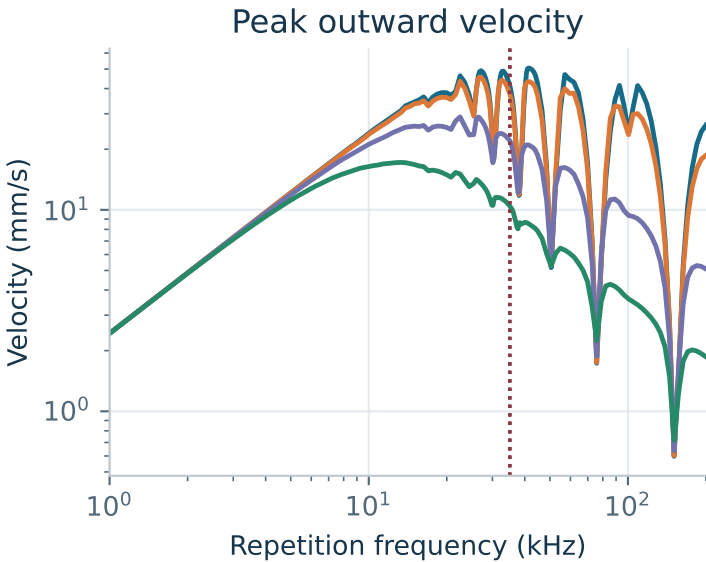
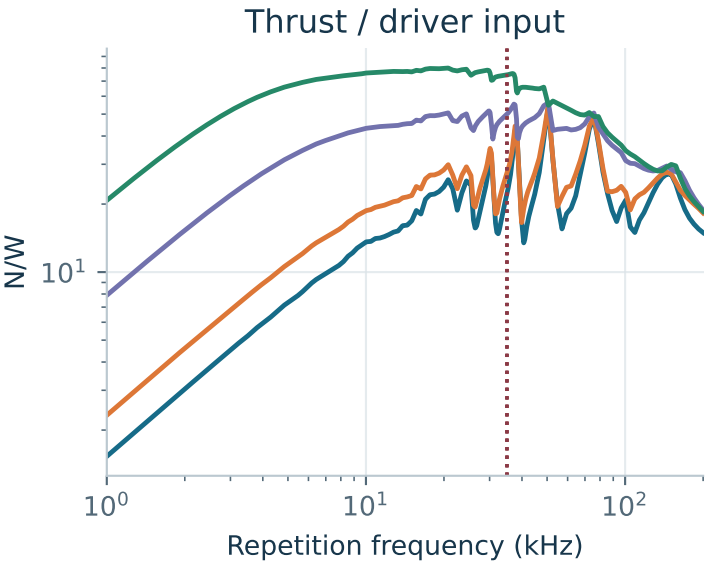
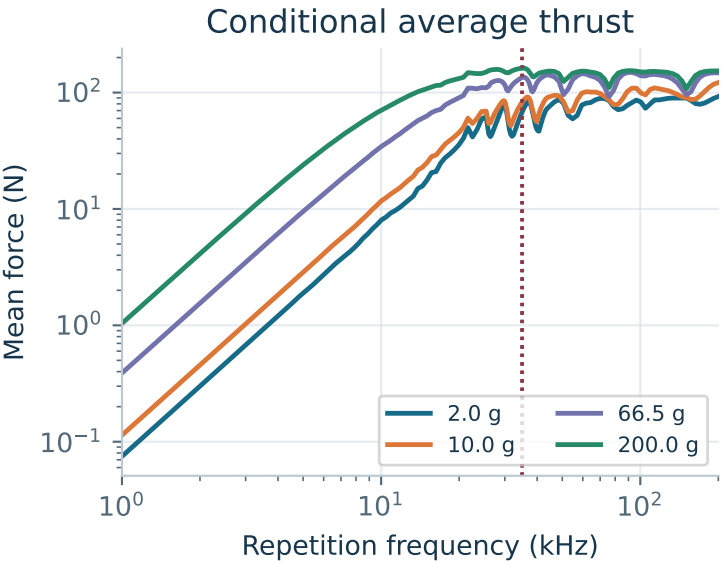
$b = 1$ is fixed at restoration completion | Hill energy = 2 x maximum disk-plus-stack kinetic energy



Hill = 44.74 microjoules; peak kinetic energy = 22.37 microjoules; minimum additional preload = 445 N.
A small dimensionless depth can have a large force over a short stroke. The source of this spatial field remains to be calculated.

Frequency and mass response: 1 to 200 kHz

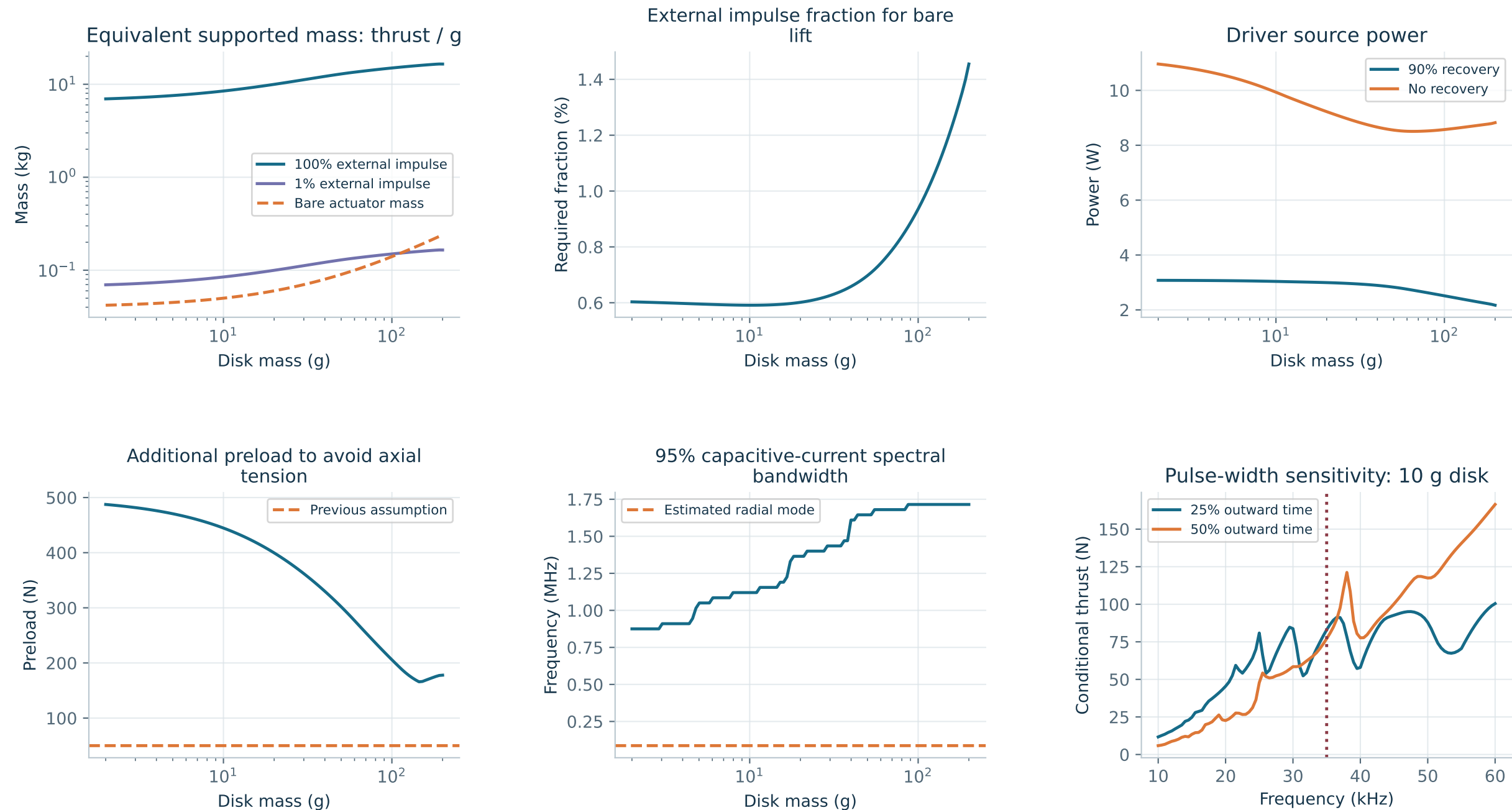
Voltage held at 100 Vpp | Outward stroke is solved from the axial dynamic load | Dotted marker: 35 kHz



Prescribed field load and ideal external impulse retention. Curves are axial-model requirements, not validated MEGA performance. Increasing frequency does not preserve stroke or guarantee a larger velocity; wave motion, inertia, and the uphill load change the response.

35 kHz: lift thresholds and actuator demands

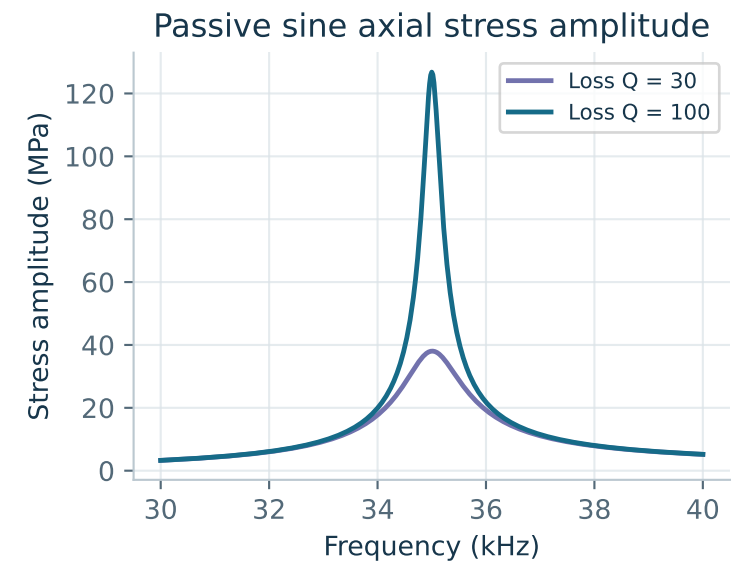
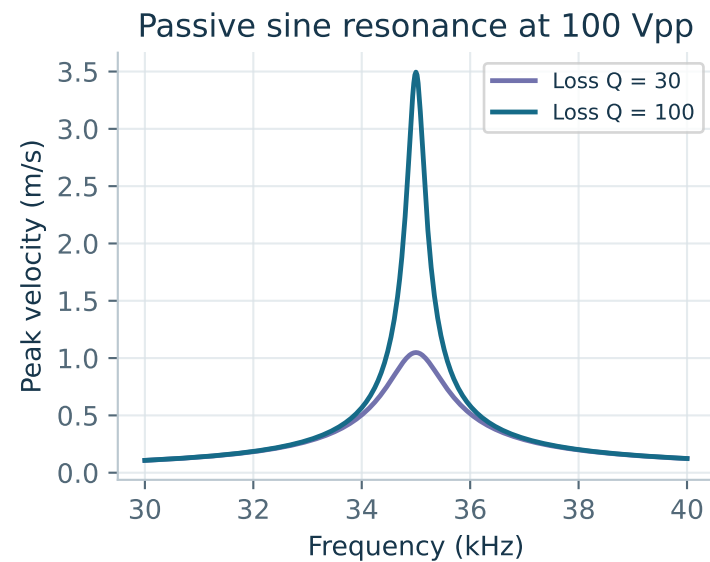
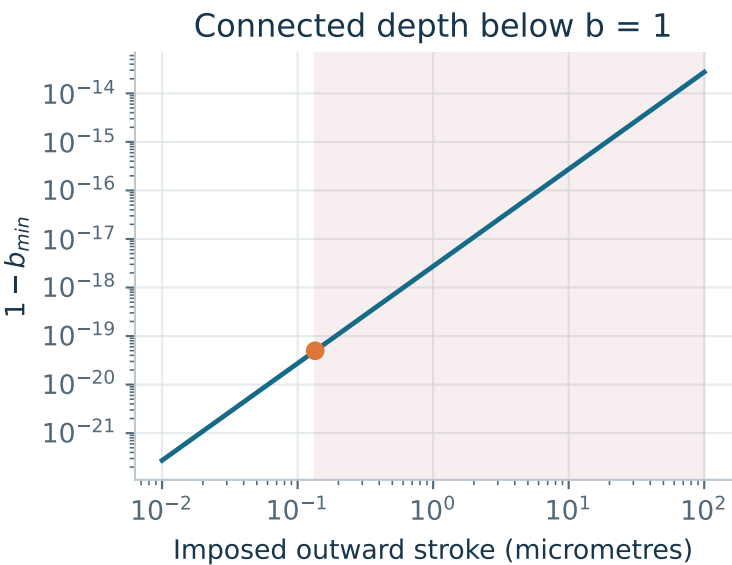
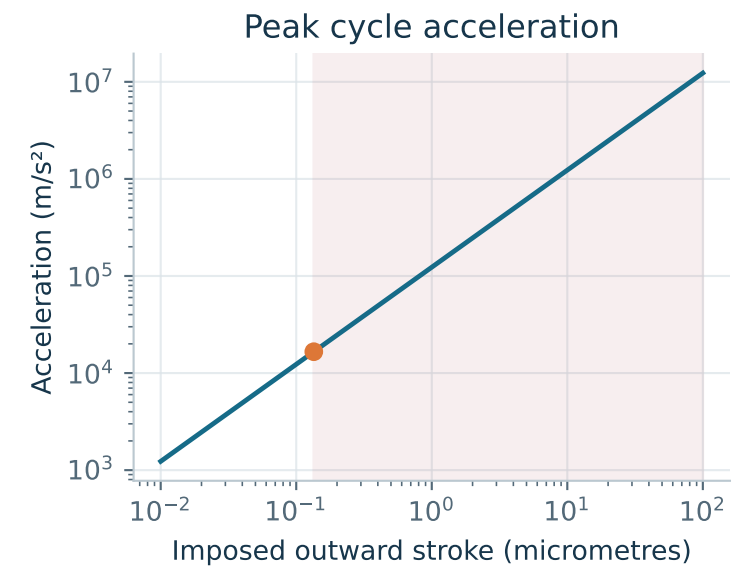
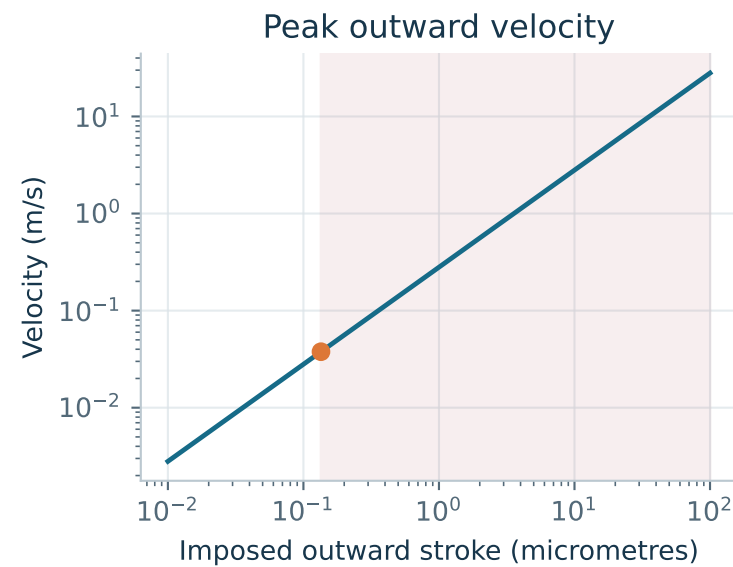
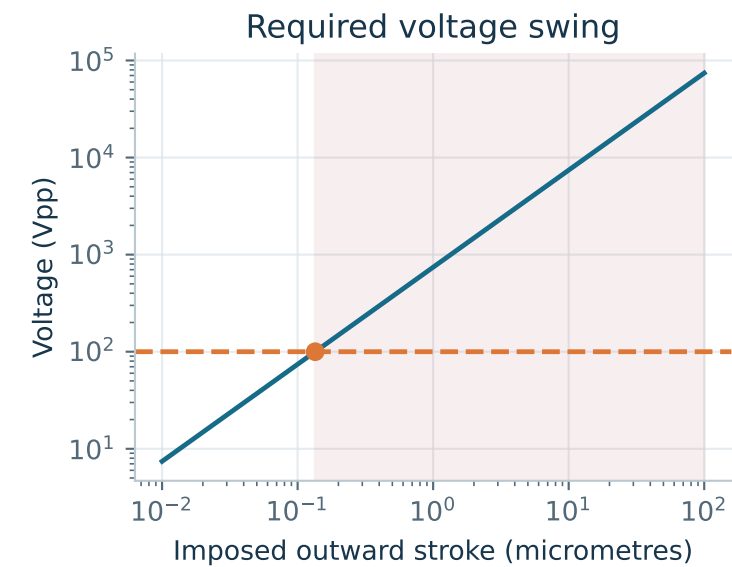
Powered upward thrust comparison | Bare mass includes the disk and 40.03 g ceramic stack only



No supported payload is certified. Preload hardware, driver, cooling, power source and structure must be included in the final lifted mass. External impulse retention is unknown; zero retained external impulse gives zero whole-assembly thrust. Radial and mount modes are not modeled.

Extreme motion: the voltage and stress it would require

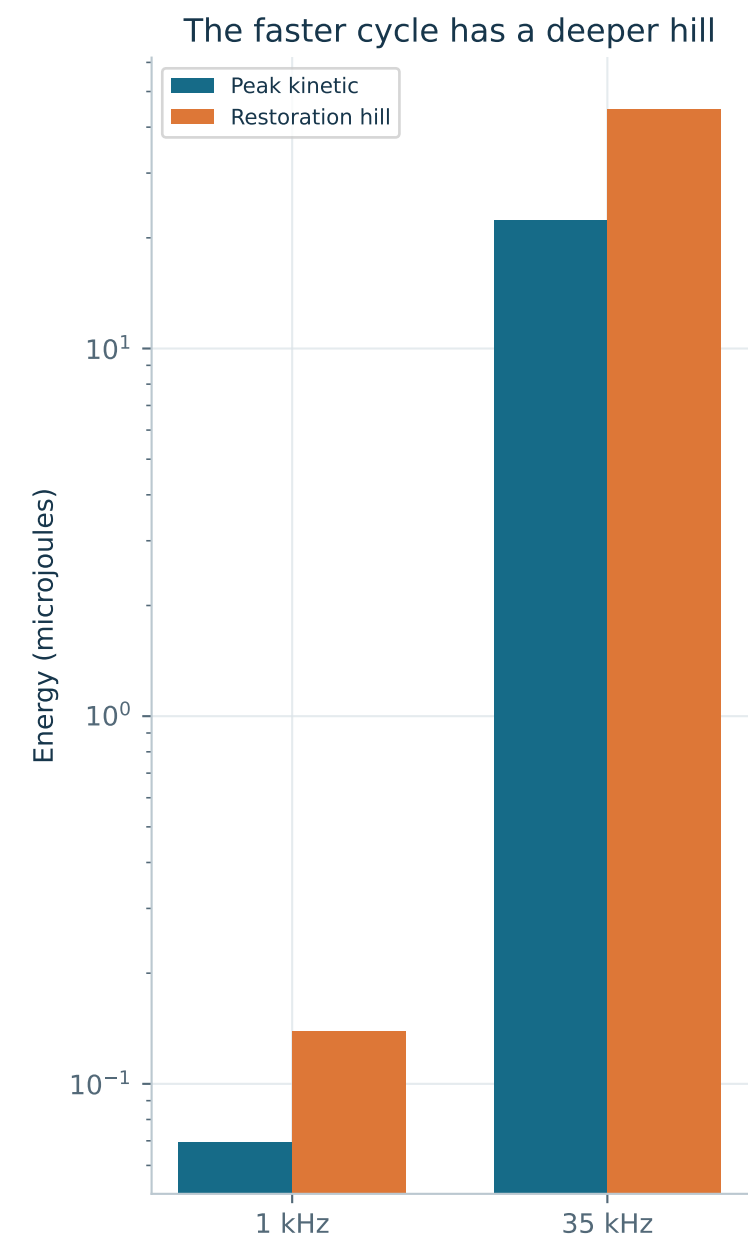
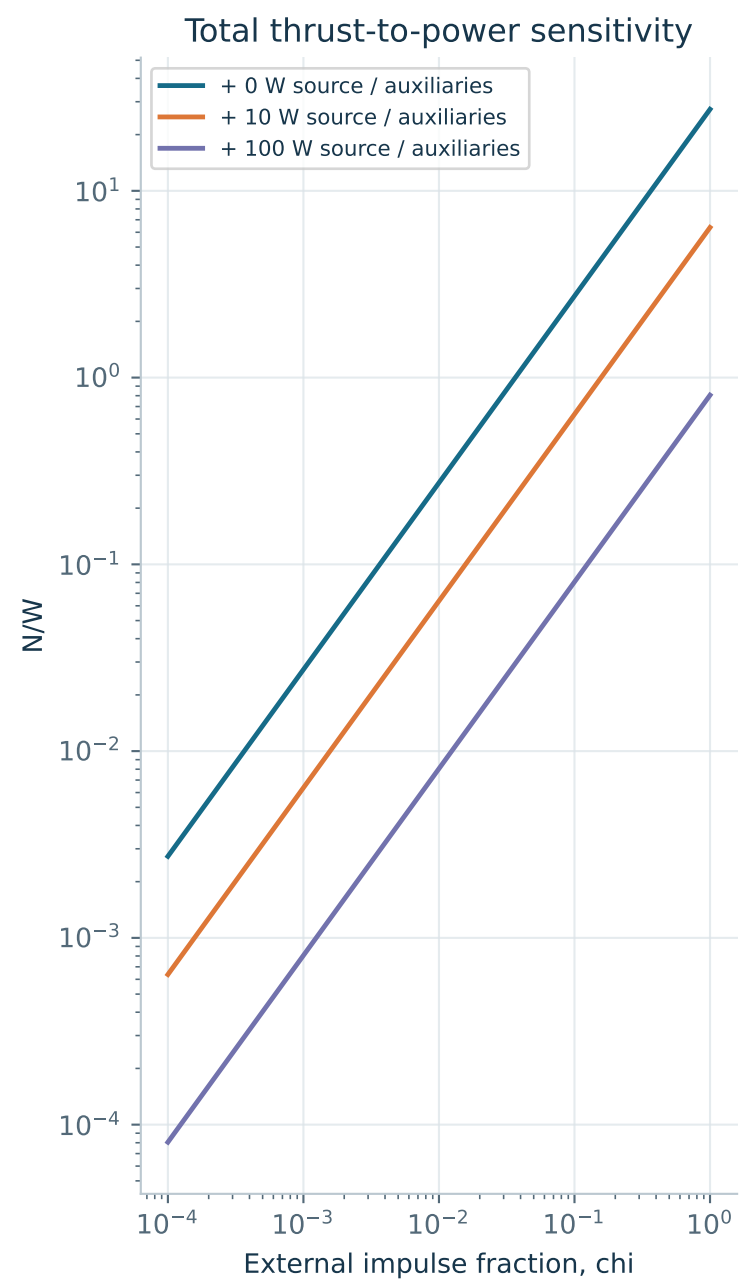
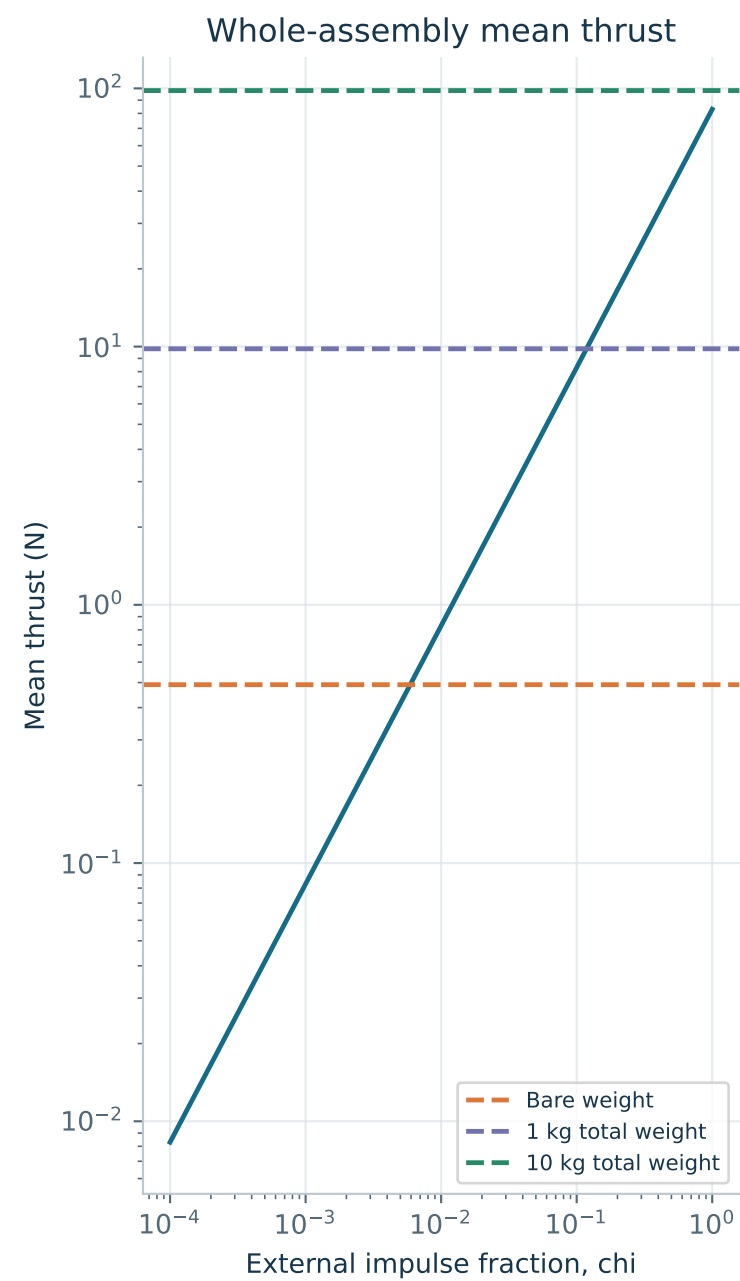
Top row and lower left: imposed 35 kHz pulse strokes | Orange marker is the actual 100 Vpp solution



Red shading exceeds the fixed 100 Vpp budget; these points are demands, not achievable fixed-voltage operating points.
Passive control: 66.48 g tuned disk; Q = 100 gives 3.50 m/s and 7.7e+05 m/s², but zero average thrust and unvalidated high stress.

From the prescribed hill to a complete lift claim

10 g, 35 kHz reference | chi is the fraction of modeled impulse retained after all source reactions



$F_{\text{system}} = \chi \times F_{\text{model}}$; $P_{\text{system}} = P_{\text{driver}} + P_{\text{source}} + P_{\text{aux}}$. This sensitivity changes the accounting, not the solved stroke.
The field source and its reactions must determine chi and added power together. A conservative onboard-only reaction cannot provide net thrust.

Reading the higher-frequency results

What the larger numbers mean for the proposed restoration mechanism

The depth and gradient are linked. The 35 kHz hill is 44.74 microjoules, compared with 0.1388 microjoules at 1 kHz. Restoring it over a short distance requires a much steeper force profile. A small dimensionless change in b does not by itself imply a small force: distance and the mc^2 energy scale matter.

Kinetic energy alone is insufficient. The largest combined disk and stack kinetic energy is 22.37 microjoules, half the hill. The PZT delivers 37.62 microjoules of positive work to the disk during restoration. The electrical, elastic and distributed kinetic stores are included; they must be replenished over repeated cycles.

The lift comparison is now explicit. At complete external impulse retention, 82.99 N corresponds to 8.463 kg of supported total mass. The modeled bare actuator is only 50.03 g, but preload hardware, electronics, power supply, structure, cooling and payload are not included. This compares powered thrust with weight; it does not establish gravity cancellation.

35 kHz does not define the entire pulse spectrum. A 25%-duration outward stroke at 35 kHz lasts 7.14 microseconds and contains substantial harmonics. The estimated radial mode is 86.6 kHz, inside the calculated drive spectrum. The new axial wave model is more informative than the earlier lumped approximation, but a coupled radial, axial and mount model is needed before calling this an achievable operating point.

Extreme velocity brings a different load problem. The passive linear sine model, tuned to 35 kHz with a 66.48 g disk, reaches 3.50 m/s and 768,594 m/s². It also predicts 126.8 MPa oscillatory axial stress and has zero average thrust. Adding the powered hill changes the load, so its passive resonance gain cannot simply multiply the thrust curve.

The next calculation is the source response. The model now produces large conditional forces. The decisive remaining step is to calculate the driven supporting-field gradient, its energy cost, and the reaction on the entire assembly from the same OQG source solution, then combine that with measured mechanical and electrical response. Increasing frequency alone cannot resolve those questions.

Appendix A: coupled field and distributed dynamics

The $b = 1$ endpoint is fixed; a voltage command does not independently determine the supporting field

Coupled energy and force. $H = m c_0^2 (1 - b_{\min}) = \text{integral over restoration of } G \, dx$. The chosen load family sets $H = 2 \max(K_{\text{disk}} + K_{\text{stack}})$. With $h = 2H/v_{pk}^2$, $U_g = -h v^2/2$ during extension and $G = -h a$ during deceleration. During release, the explicit field term is $P_b = -h v a$; during restoration $P_b = 0$. This satisfies $dU_g/dt = P_b + Gv$ along the path. It is a prescribed field-load requirement, not a solved source configuration.

Kinematics. For normalized extension time $u = ft/D$, $x = X[u - \sin(2\pi u)/(2\pi)]$, $v_{pk} = 2Xf/D$, and outward $a_{pk} = 2\pi Xf^2/D^2$. At unchanged stroke, 1 to 35 kHz multiplies speed by 35 and acceleration by 1,225. At fixed voltage the loaded stroke changes, so the full solution is used. The return includes smooth speed ramps and a constant-speed interval.

Axial wave solution. For $E^* = E(1 + i \omega \tau)$, $\kappa = \omega \sqrt{\rho/E^*}$, and prescribed harmonic tip displacement U , $u(z) = U \sin(\kappa z)/\sin(\kappa L)$. The rod dynamic stiffness is $Z_{rod} = A E^* \kappa \cot(\kappa L)$. The required voltage follows $\theta V = [Z_{rod} + \kappa l - m \omega^2]U + G$. The response is scaled until $\max(V) - \min(V) = 100 \, \text{V}$, then biased to 0-100 V.

Stored motion and stress. $K_{\text{stack}} = \text{integral } \rho A (du/dt)^2 dz / 2$, rather than a fixed fraction of stack mass at all frequencies. Internal motion can persist while the tip is at rest. Axial compression is $C = P_{\text{preload}} + \theta V - EA du/dz - E \tau A d^2u/(dz dt)$. Both ends and interior points are checked; the minimum added preload prevents negative C within the axial model.

Why a small depth can still have a large force. In the weak-depth limit, $G = m c_0^2 \partial_x b$. The integral of that gradient across the climb fixes the depth. At this reference the resulting fractional inertia change is only about $3(1-b_{\min})$, or 1.49×10^{-19} . Thus these large conditional forces arise from the prescribed spatial gradient, not a large inertial-mass variation.

Appendix B: power, lift accounting and verification

All reaction forces and all power inputs must close at the assembly boundary

Reciprocal electrical model. $Q = C_s V + \theta x$, with $C_s = C_f - \theta^2/k > 0$. Current includes dQ/dt and harmonic dielectric loss. Over a steady cycle, $E_{\text{terminal}} = H + E_{\text{mechanical loss}} + E_{\text{dielectric loss}}$. Driver power is $f(E_{\text{positive}}/0.95 - 0.90 E_{\text{returned}})$. At 35 kHz it is 3.037 W with recovery and 9.925 W without recovery; net PZT terminal consumption is 1.775 W.

Complete momentum balance. $F_{\text{ship}} = m a + \int \rho A u_{tt} dz + G$. The periodic mass-momentum derivatives integrate to zero, leaving $J_{\text{model}} = \int G dt$. Let χ describe the fraction remaining after source reactions: $F_{\text{system}} = \chi F_{\text{model}}$. The complete input is $P_{\text{system}} = P_{\text{driver}} + P_{\text{field}} + P_{\text{aux}}$. The plotted χ sensitivity is not an independent device control; the source solution must determine momentum transfer and energy together.

Lift thresholds. For the 10 g reference, the bare disk-plus-stack weight requires $\chi \geq 0.591\%$. A 1 kg total supported system requires $\chi \geq 11.8\%$. Zero external momentum transfer gives zero net thrust, regardless of internal acceleration. These thresholds assume the prescribed mechanical cycle can be realized. They are not verified lift capacities.

Numerical checks. The reference energy closure error is $2.8e-06$ relative; impulse closure is $4.3e-19$ N s. Doubling the phase resolution and increasing axial quadrature changes thrust by 0.000246% and driver power by 0.0207%. Every sweep maintains 100 Vpp and positive disk restoration work, with hill energy greater than all peak kinetic energy. A zero-field control gives zero cycle impulse.

Unresolved device physics. The chosen one-dimensional geometry omits radial and mount modes, nonlinear strain and electrostriction at $2f$, bonds, thermal drift, contact loss, field-source power and field recoil. Manufacturer dielectric data at 1 kHz are extrapolated across the harmonics. These omissions matter strongly for the extreme cases. The curves characterize requirements and sensitivities; they are not a parts selection or an optimized design.

Appendix C: inputs and primary sources

Published material values and frequency context are separated from chosen load and loss assumptions

Item	Value used	Status
Stack geometry	10 layers; 25.4 mm diameter; 1 mm per layer	Illustrative geometry retained from V0.1
SM111 density / modulus / d33	7900 kg/m ³ / 73 GPa / 320 pm/V	Manufacturer table [2]
Relative permittivity / loss tangent	1400 / 0.004	Tabulated at 1 kHz; spectral extrapolation assumed
Continuum loss parameter	$\tau = 1/(2 \pi \times 35,000 \times 100)$	Chosen loss Q = 100 at 35 kHz; not a measured assembly Q
Hill / pulse / preload spring	H = 2 Kmax; D = 0.25; kl = 0.05 k	Fixed load family; D = 0.50 sensitivity also shown
Driver recovery	95% delivery; 90% energy return	Illustrative electronics; added source power unknown

[1] T. J. Desiato, **Mach Effect Gravity Assist Warp Drive in Operational Quantum Gravity**, V0.7, 20 October 2026. Field, work and complete-cycle momentum balances, and Appendix C.

[2] STEMINC, [Piezo Materials Properties](#), SM111 column.

[3] Fearn et al., [Mach Effects for in Space Propulsion: Interstellar Mission](#), NASA NTRS 20190000915, NIAC award NX17AJ78G. Appendix B, printed B5, identifies 35 kHz experimental operation. This supplies frequency context, not a validation of the present OQG model.

[4] Physik Instrumente, [Dynamic Operation](#). Added load and clamping affect resonance and transient response.

[5] Physik Instrumente, [Electrical Operation of Piezo Actuators](#). Current, losses and waveform bandwidth constrain dynamic operation. Web sources accessed 20 October 2026.

The NASA report discusses experimental MEGA devices; the modeled OQG field-load family has not been calibrated to those measurements.