

OQG MEGA: repeated-pulse characterization

V0.1 | 20 October 2026 | Fixed-voltage load study before component optimization

Result: the reference cycle satisfies the requested powered-climb condition: the gravitational energy rise exceeds all moving kinetic energy, and the PZT continues delivering positive work while the disk slows.

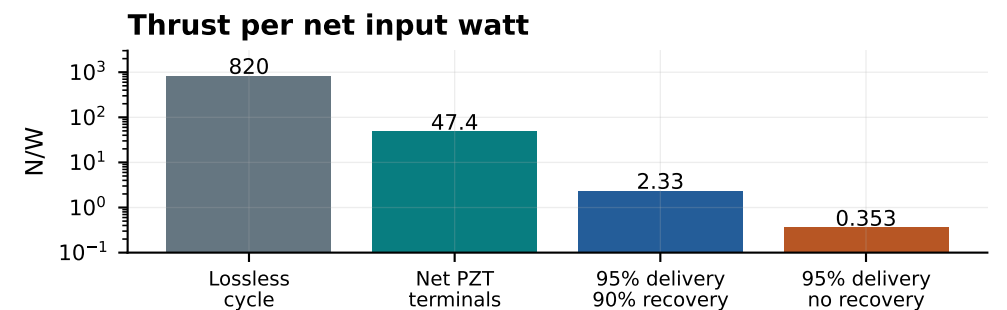
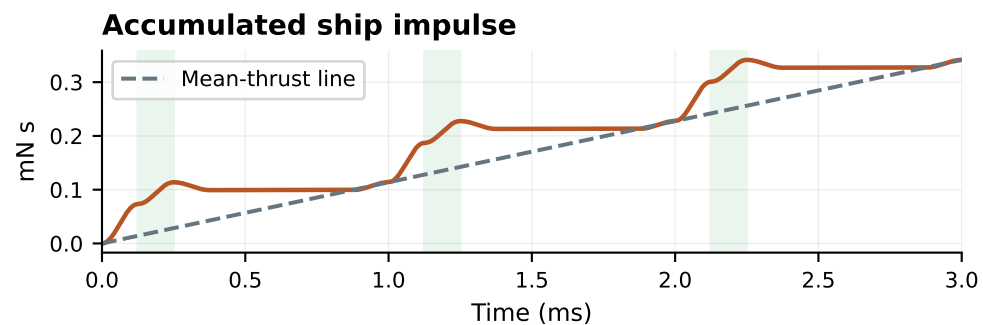
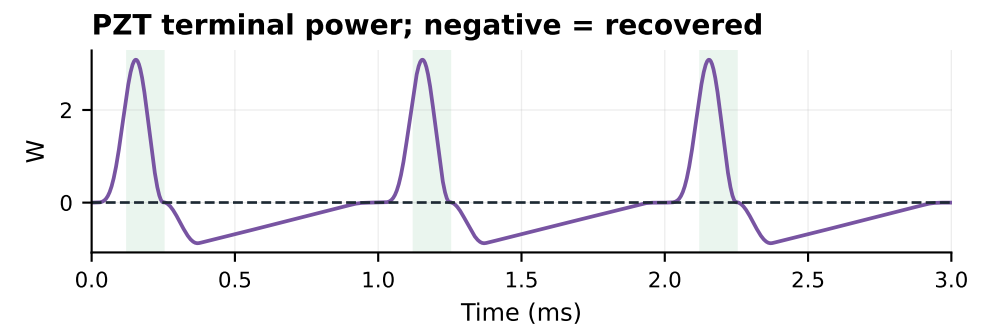
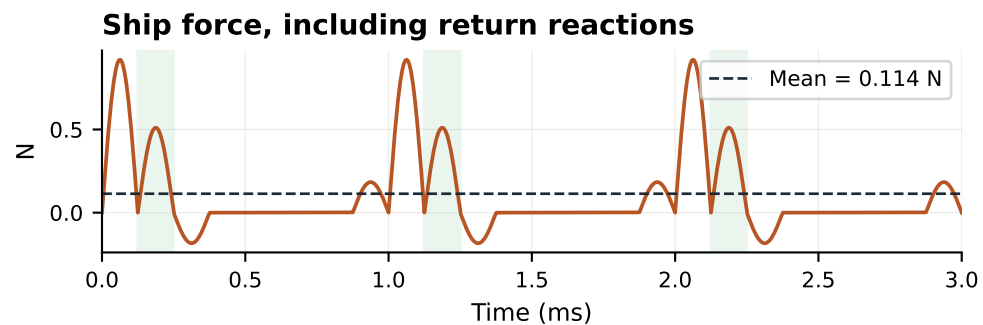
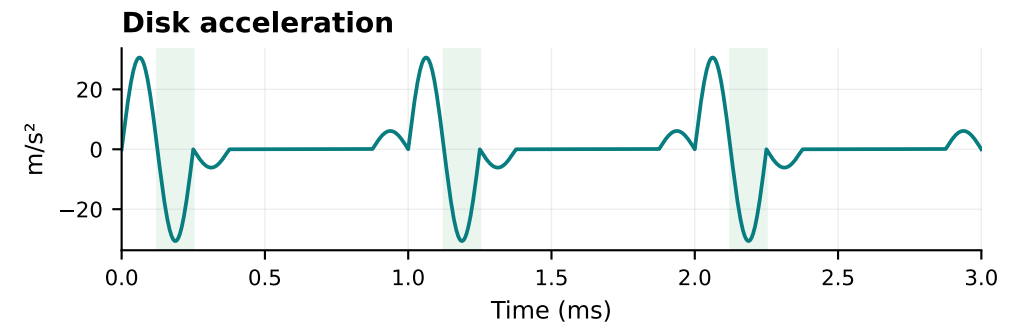
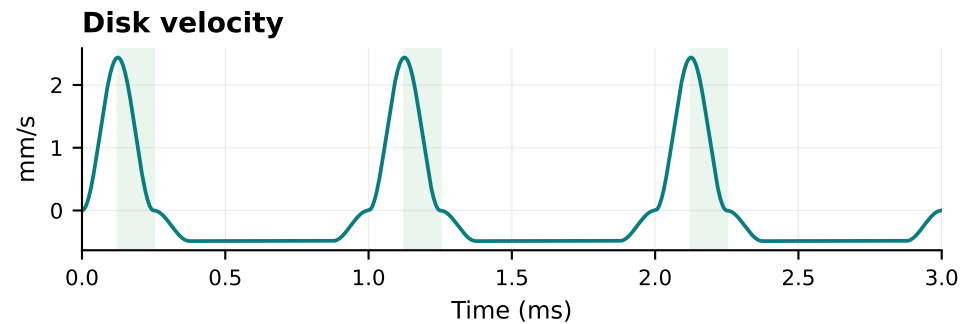
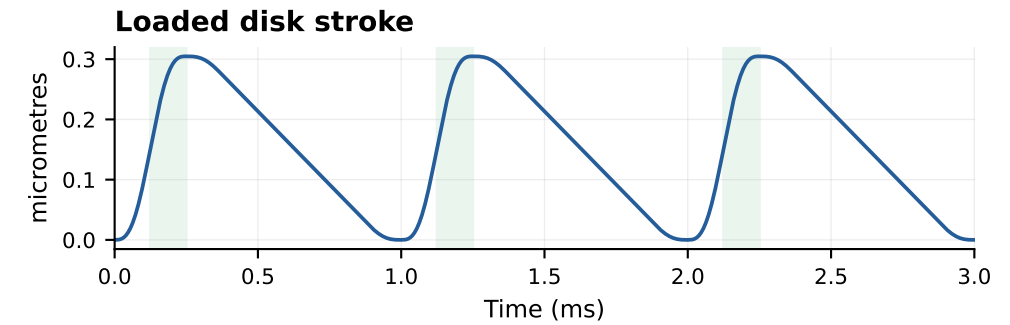
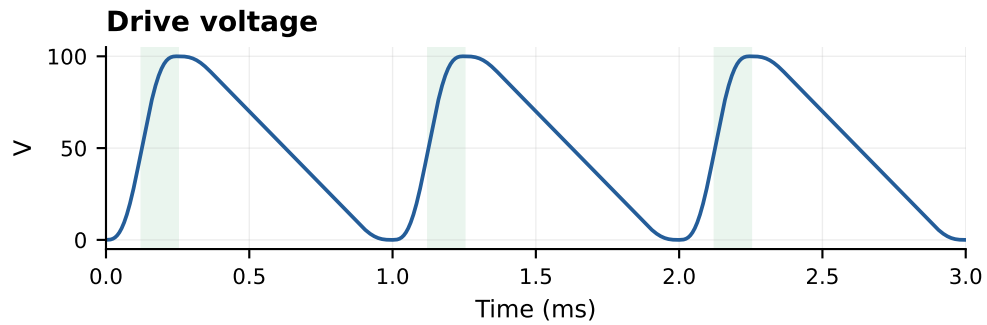
Interpretation: these are conditional requirements, not a computed SM111 thrust prediction. The supporting-field load and its phase are prescribed. A driven scattering/stress solution must establish them and the external reaction momentum.

Reference inputs	Value / status	Calculated reference quantities	Value
Drive swing	100 Vpp, shifted to 0-100 V	Loaded stroke	0.3048 micrometres
Stack	10 x 25.4 mm x 1 mm SM111 elements; illustrative geometry	Peak speed / acceleration	2.438 mm/s / 30.64 m/s ²
Disk and pulse rate	10 g; 1 kHz; 25% extension / 75% return	Conditional average thrust	0.1138 N
Hill energy	2 x disk-plus-stack peak kinetic energy	Net PZT / driver source power	2.399 / 48.91 mW
Mechanical losses / preload	Chosen assembled Q = 100; spring stiffness = 5% of stack; 50 N preload	Thrust per driver-input watt	2.327 N/W
Driver scenario	95% forward delivery; 90% recovery; zero extra control power	Peak current / force compression	48.86 mA / 50.0-106.7 N

The five plot sheets that follow show repeated pulses, energy restoration, mass/frequency sweeps, load requirements, and sensitivity to hill height and electrical recovery. Dotted curves and hatching identify extrapolation beyond the stated bandwidth screen.

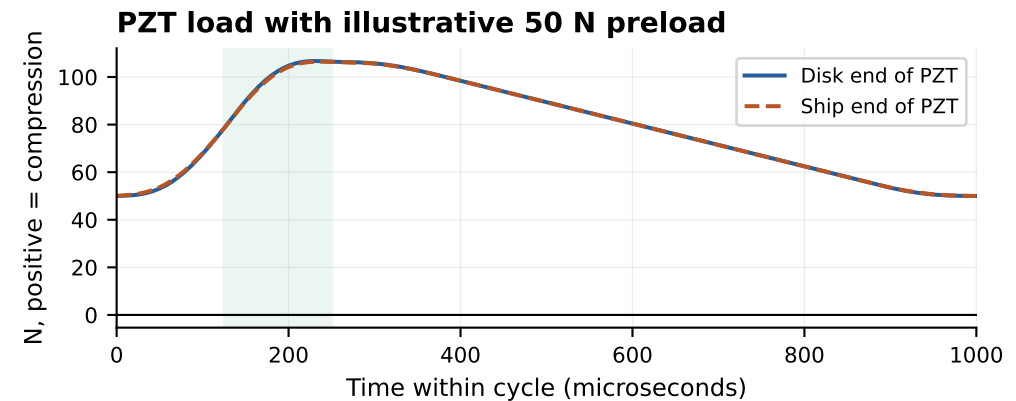
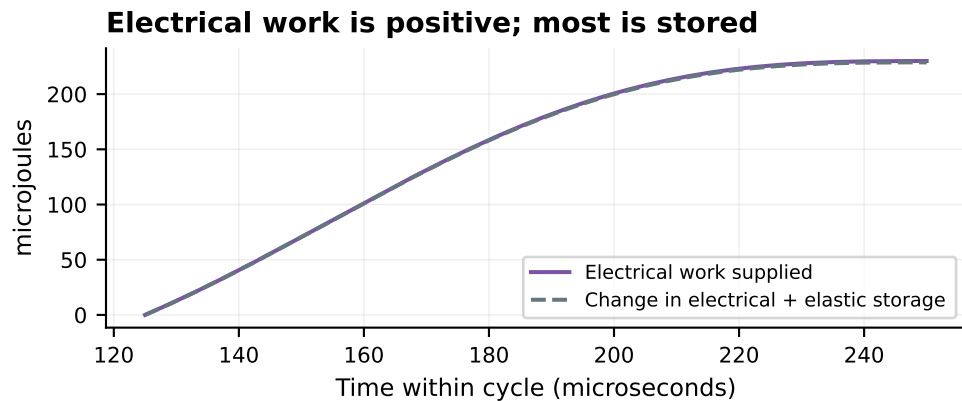
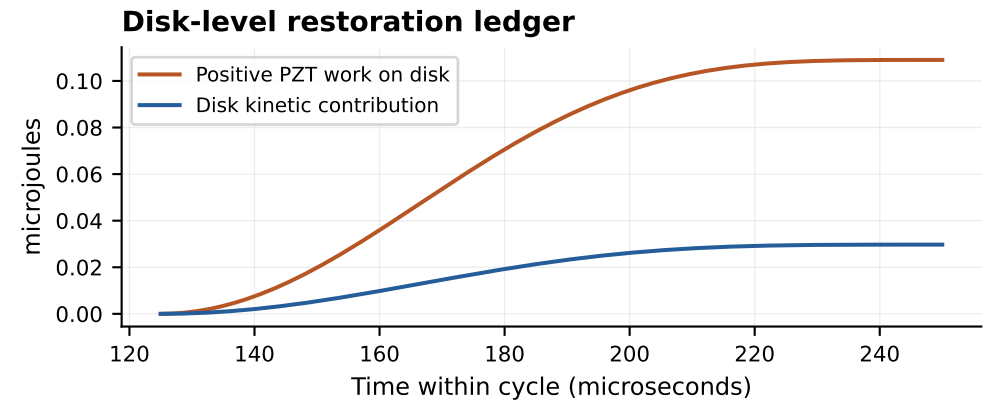
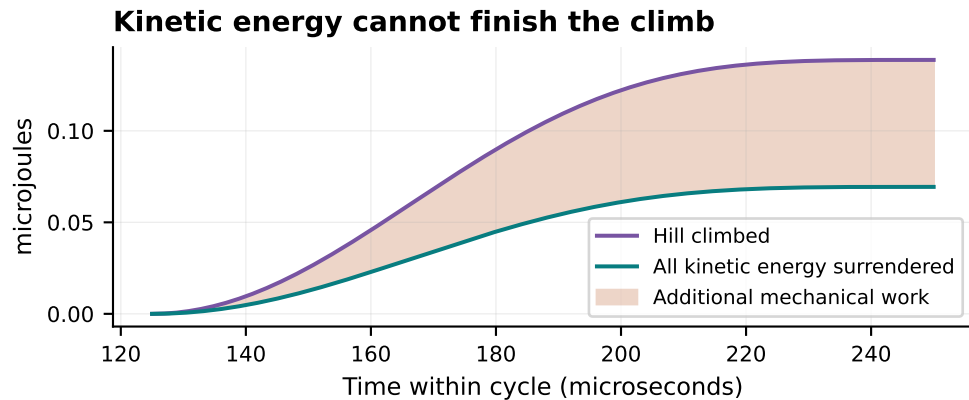
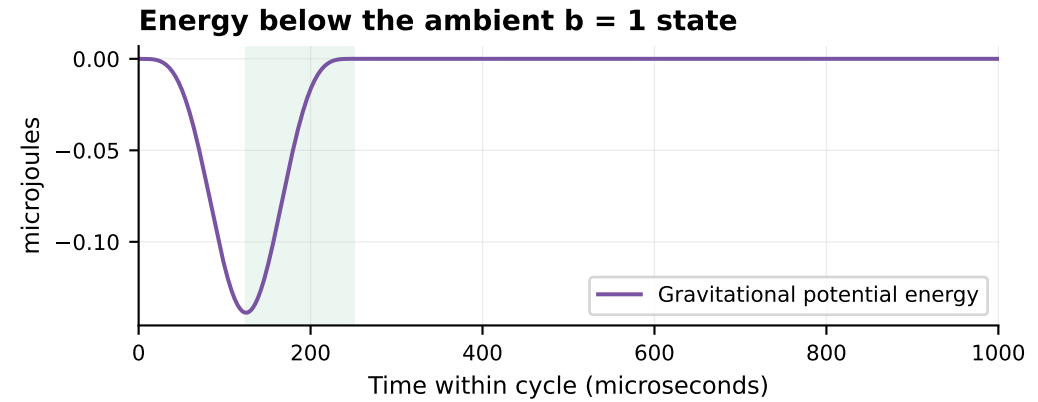
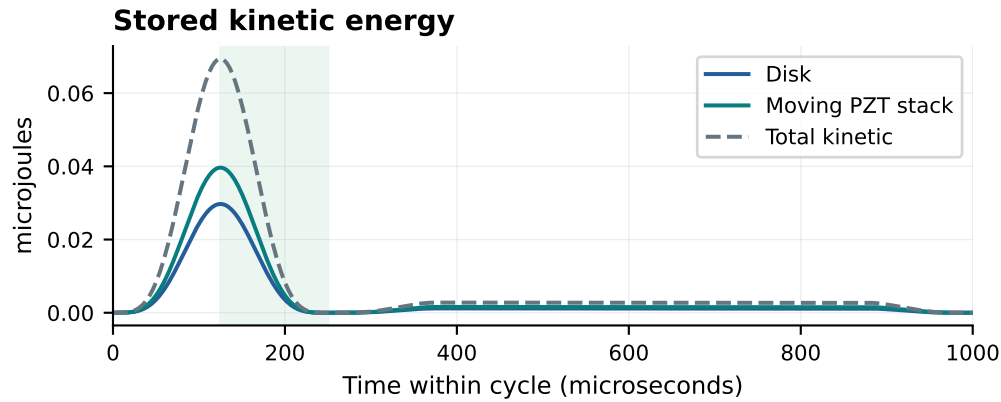
Repeated pulses: force peaks and average thrust

Reference: 100 Vpp (0-100 V), 10 g disk, 1 kHz, hill = 2 x total peak kinetic energy. Steady cycles; startup is excluded.



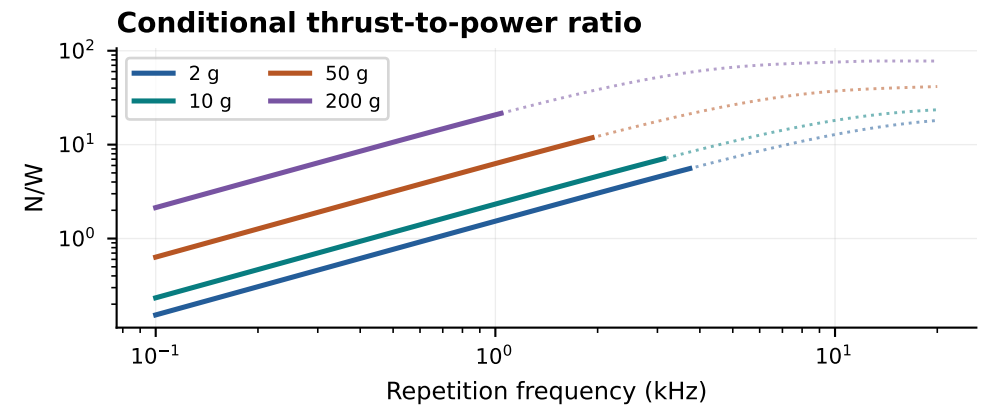
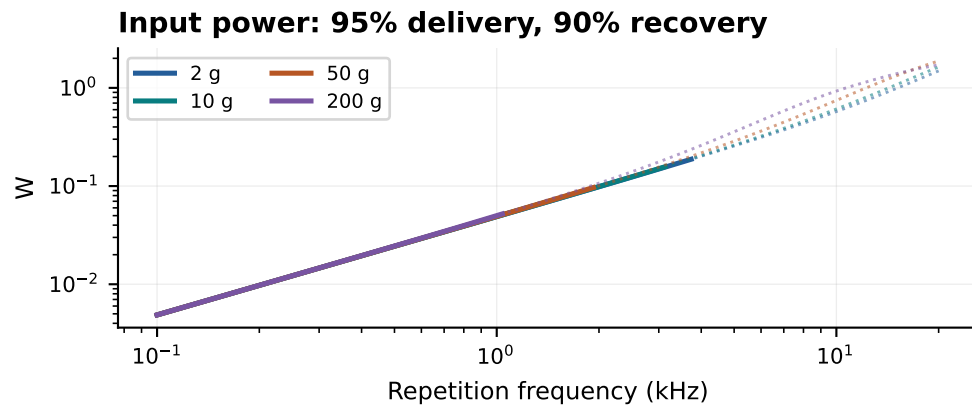
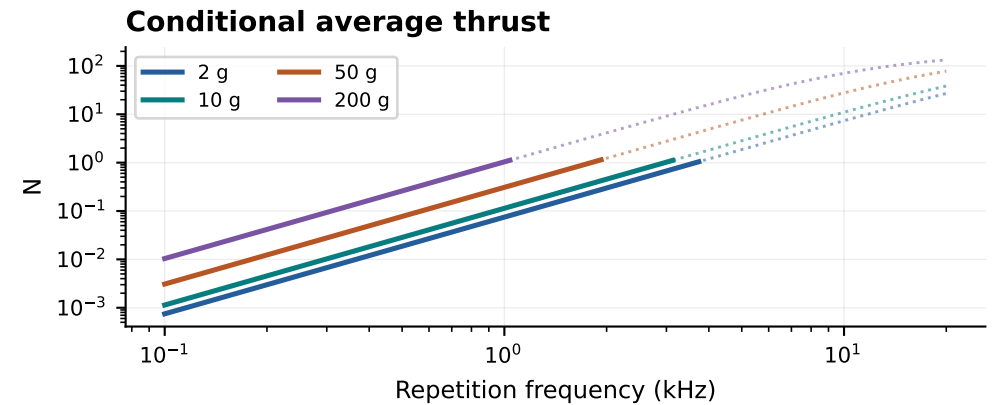
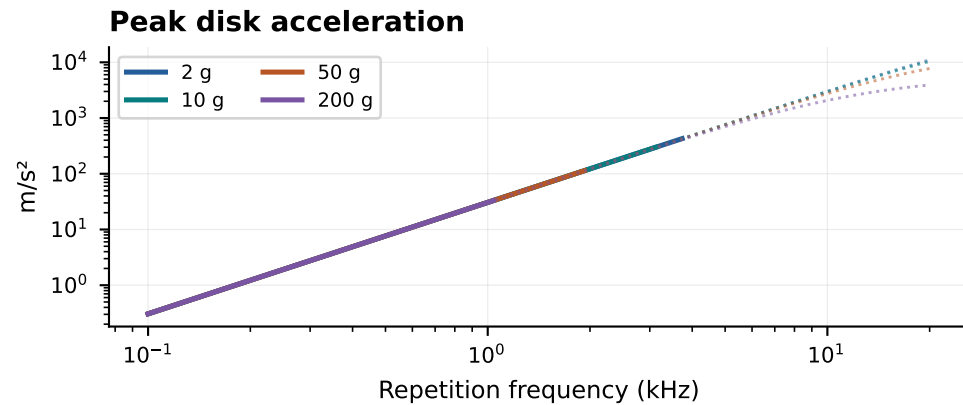
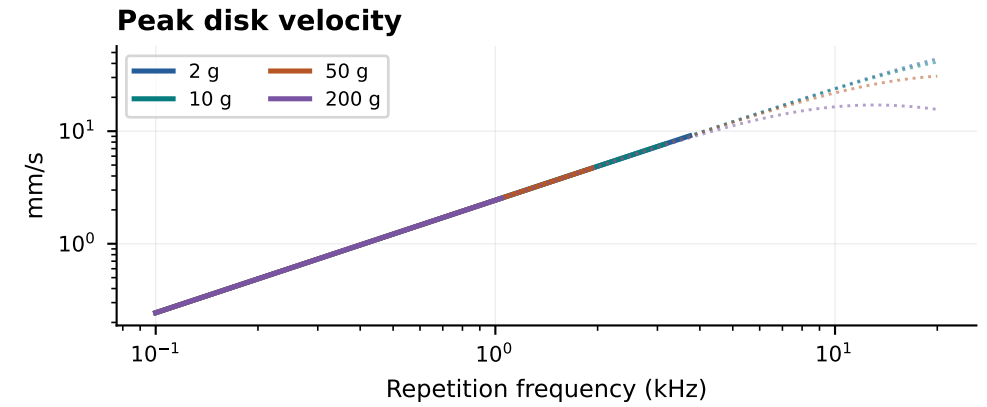
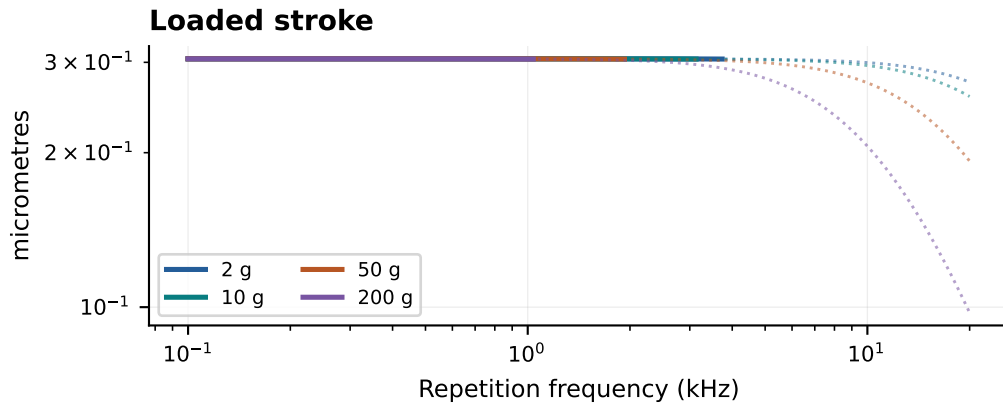
The hill requires positive work during restoration

Reference cycle. Green shading = outward motion while slowing. Force is still transmitted to the ship during this interval.



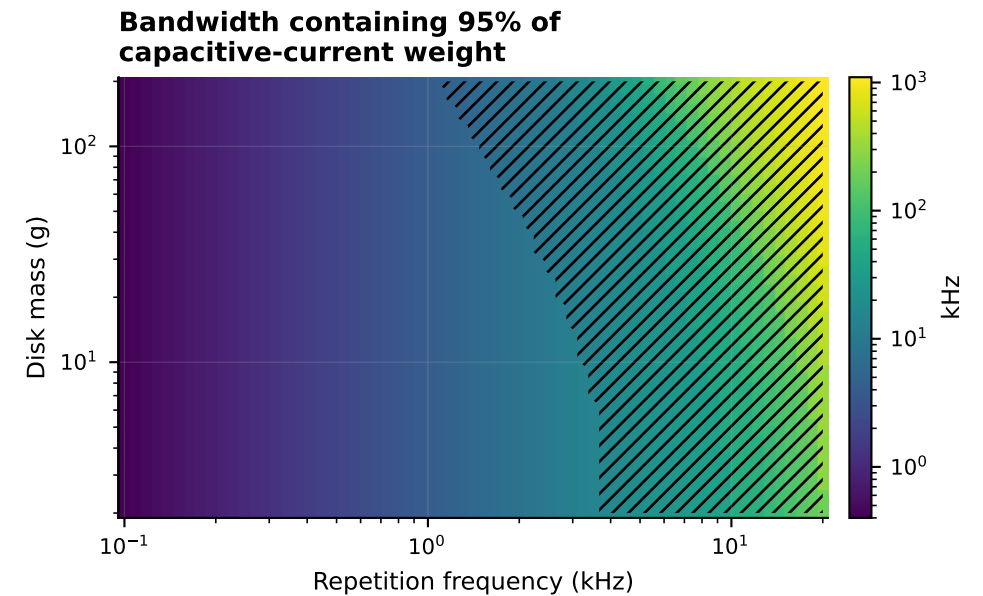
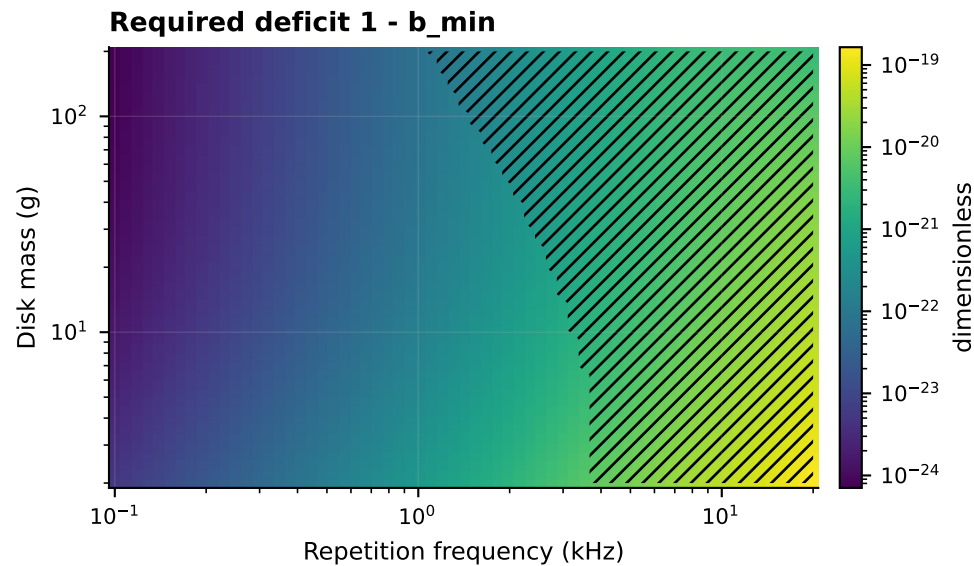
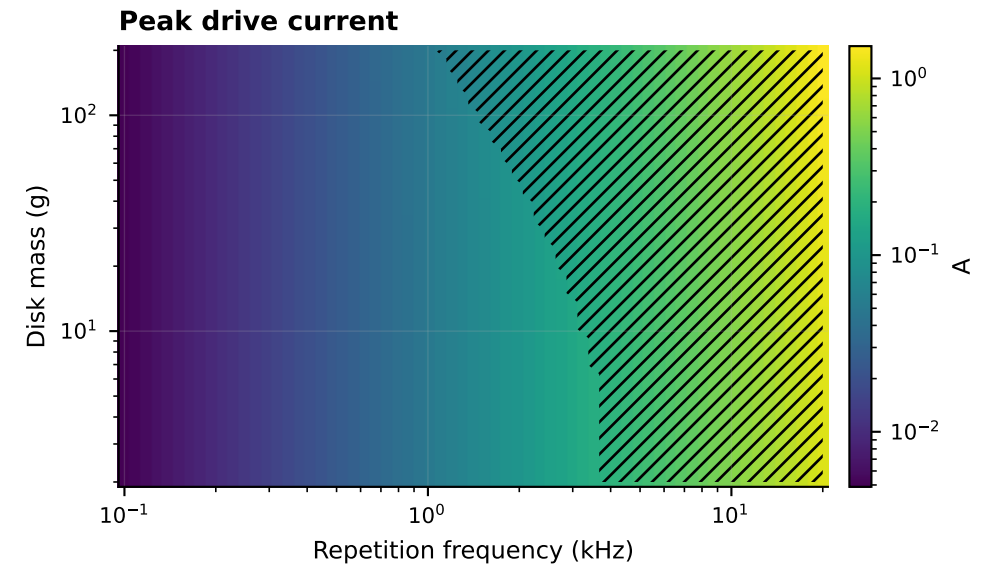
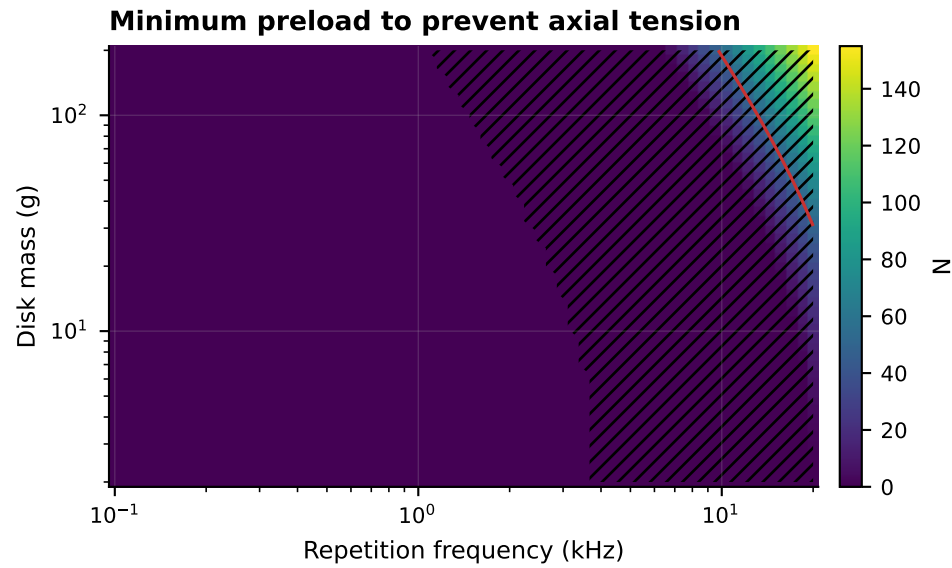
Mass and repetition frequency at the same voltage swing

100 Vpp in every calculation; drive shape is adapted to preserve the selected motion. Solid = bandwidth screen passed; dotted = extrapolation.



Mechanical and electrical demands

Hatching marks pulse bandwidth beyond the screening range. Preload is the minimum for zero axial tension; no allowable tensile stress is assumed.

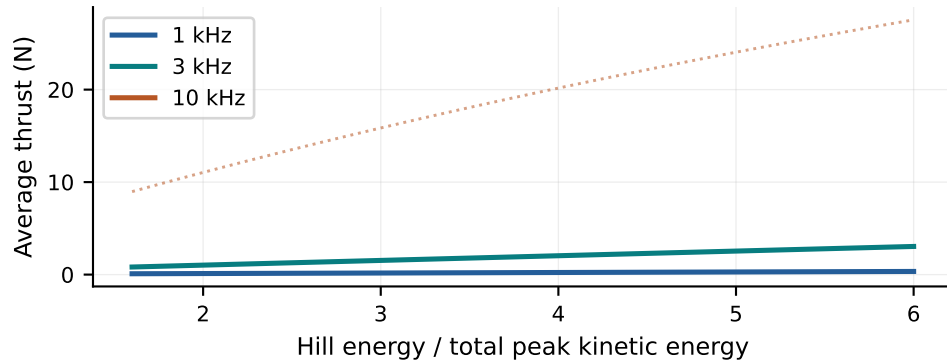


Red contour, if present: 50 N preload threshold. Hatching is a model-limit screen, not a measured instability boundary.

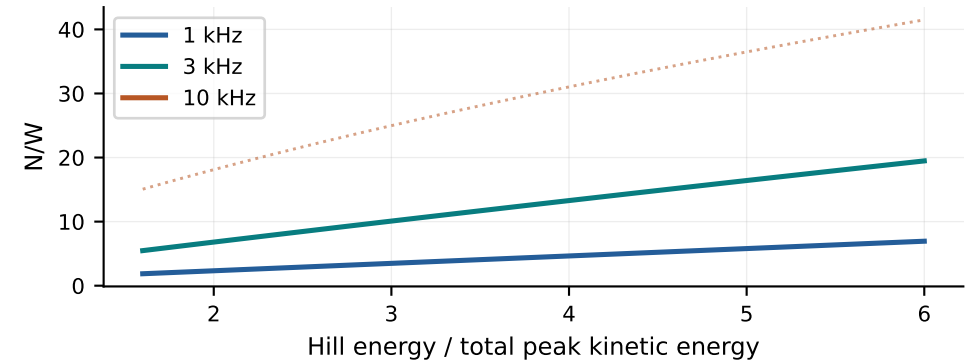
Sensitivity: hill height, energy recovery, and source costs

All curves retain 100 Vpp. These are parameter studies, not a parts optimization. Full external impulse retention is assumed unless labeled.

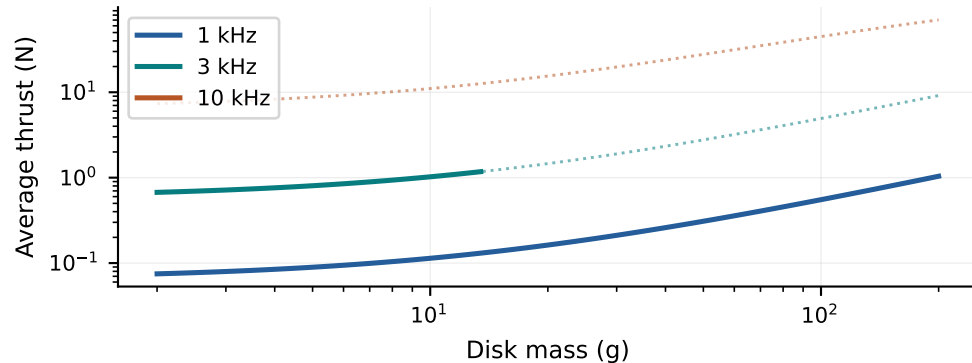
Increasing required hill energy



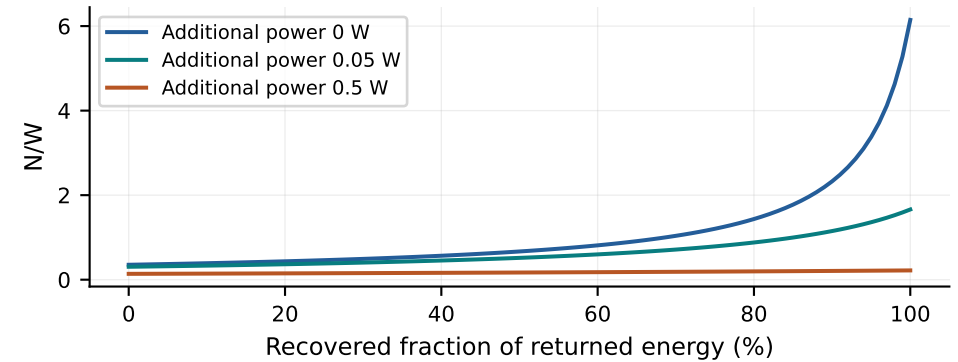
Thrust per driver-input watt



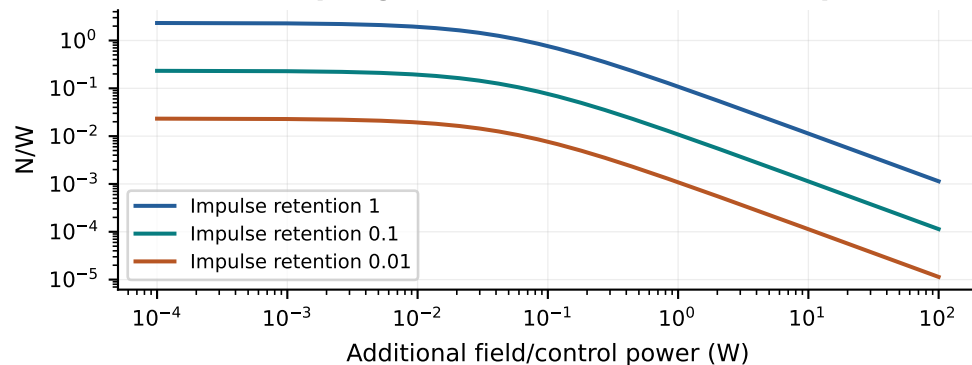
Mass sweep at fixed frequency



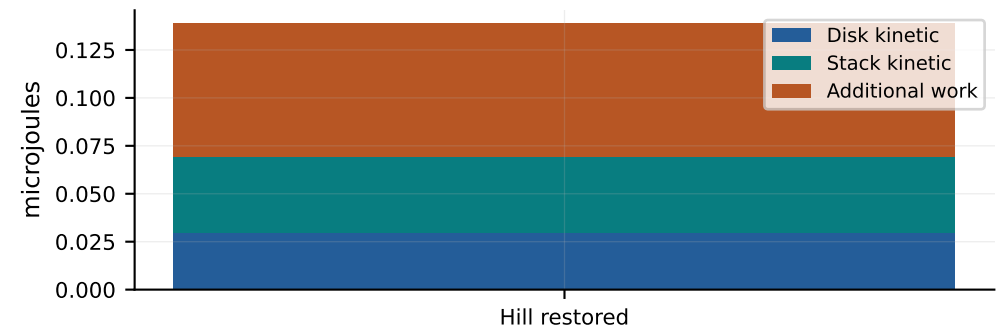
Electrical recovery matters



External coupling and control cost remain inputs



Reference hill: half kinetic, half added work



How the characterization is constructed

Definitions and balances | Inverse dynamics at the same voltage swing

1. Finite stiffness and moving stack: The loaded stroke is solved from the voltage demand, rather than set equal to free stroke. For disk mass m and stack mass m_s , the kinetic-energy coefficient is $m_e = m + m_s/3$, while the moving momentum coefficient is $m_p = m + m_s/2$. This follows from the assumed linear axial stack displacement.

2. The gravitational hill: During extension, $U_g = -\lambda K_{\text{total}} x$; $\lambda = 2$ in the reference. The inward environmental load during restoration is $G = -\lambda m_e a$, with a negative while slowing. The release half changes the supporting state explicitly in time; its energy transfer is retained in the cycle ledger. These phase relationships are specified load conditions.

3. Required work: The hill is 0.13875 microjoules. Disk kinetic energy supplies 0.02972 microjoules, stack kinetic energy supplies 0.03966 microjoules, and another 0.06937 microjoules is required beyond both. Positive work delivered by the PZT to the disk is 0.10903 microjoules. Electrical work also charges recoverable storage; it is not all consumed.

4. Fixed V_{pp} and thrust: $V_{\text{raw}} = [(k + k_l)x + d v + m_e a + G]/\theta$, where k is stack stiffness, k_l preload stiffness, d damping, and $\theta = k N d^3/3$. Scale the stroke until the voltage swing is 100 V. Net ship force is $m_p a + G$. Its full-cycle impulse is $\lambda m_e v_{\text{peak}}$; average thrust is repetition frequency times that impulse.

5. Electrical power: Charge $Q = C_s V + \theta x$, where $C_s = C_f - \theta^2/k$ and C_f is free capacitance. Motional current and harmonic dielectric losses are included. Source power is $f(E_{\text{plus}}/\eta_{\text{delivery}} - \eta_{\text{recovery}} E_{\text{minus}}) + P_{\text{additional}}$. At the reference, 306.28 microjoules enter and 303.88 microjoules return at the PZT terminals each cycle; net use is 2.399 microjoules.

6. Tension and internal reactions: Compression is checked at both stack ends, including preload, preload-spring stiffness, damping, disk inertia, environmental load, and distributed stack inertia. The spring and damping reactions remain onboard. Minimum required preload is reported without inventing a tensile-strength rating.

What these plots establish, and what remains open

Scope, physical interpretation, validation, and primary sources

A small b change is an important finding. Applying the manuscript relation $\Delta U_g = m c^2(1 - b_{\min})$ gives $1 - b_{\min} = 1.54 \times 10^{-22}$ in the reference. The corresponding fractional axial inertia increase is about 4.63×10^{-22} . This load model therefore does not produce a large inertial-mass swing. Its conditional thrust is supplied by the required spatial supporting-field gradient.

Next model inputs: determine $b(x,t)$, field/control energy, and whole-assembly external stress from the driven material response; then insert measured stack impedance, nonlinear strain and $2f$ response, assembled modes, preload ratings, and driver limits. The present hill ratio cannot be treated as an independently available hardware setting.

Frequency screen: the 95% capacitive-current spectral bandwidth must remain below 20% of the smallest estimated loaded axial, longitudinal-rod, or radial frequency. This is a conservative analyst-selected screen. It is not a manufacturer operating limit or a resonance/stability solution. The 1 kHz reference passes; extrapolated regions are marked.

Numerical checks: reference energy closure error is $1.1e-08$, momentum closure error is $2e-07$, and a zero-field passive control gives zero net cycle impulse. A fourfold time-grid refinement changes driver power by $7.2e-09$ fraction. These verify the stated model, not its uncalculated field source.

Material data versus assumptions: SM111 d33, modulus, density, permittivity and 1 kHz loss tangent come from the manufacturer. Stack geometry, $Q = 100$, preload, drive efficiencies and fixed spectral loss tangent are explicit reference choices. SM111 ceramic $Q_m = 1800$ is not assigned to the assembled system.

Sources

[1] STEMINC, Piezo Material Properties (SM111). [Manufacturer table](#).

[2] Physik Instrumente, [Forces & Stiffness](#); [3] [Dynamic Operation](#); [4] [Electrical Operation](#). Accessed 20 October 2026.

[5] T. J. Desiato, Mach Effect Gravity Assist Warp Drive in Operational Quantum Gravity, V0.7, 20 October 2026, Eqs. (6), (9)-(23), (26)-(28).