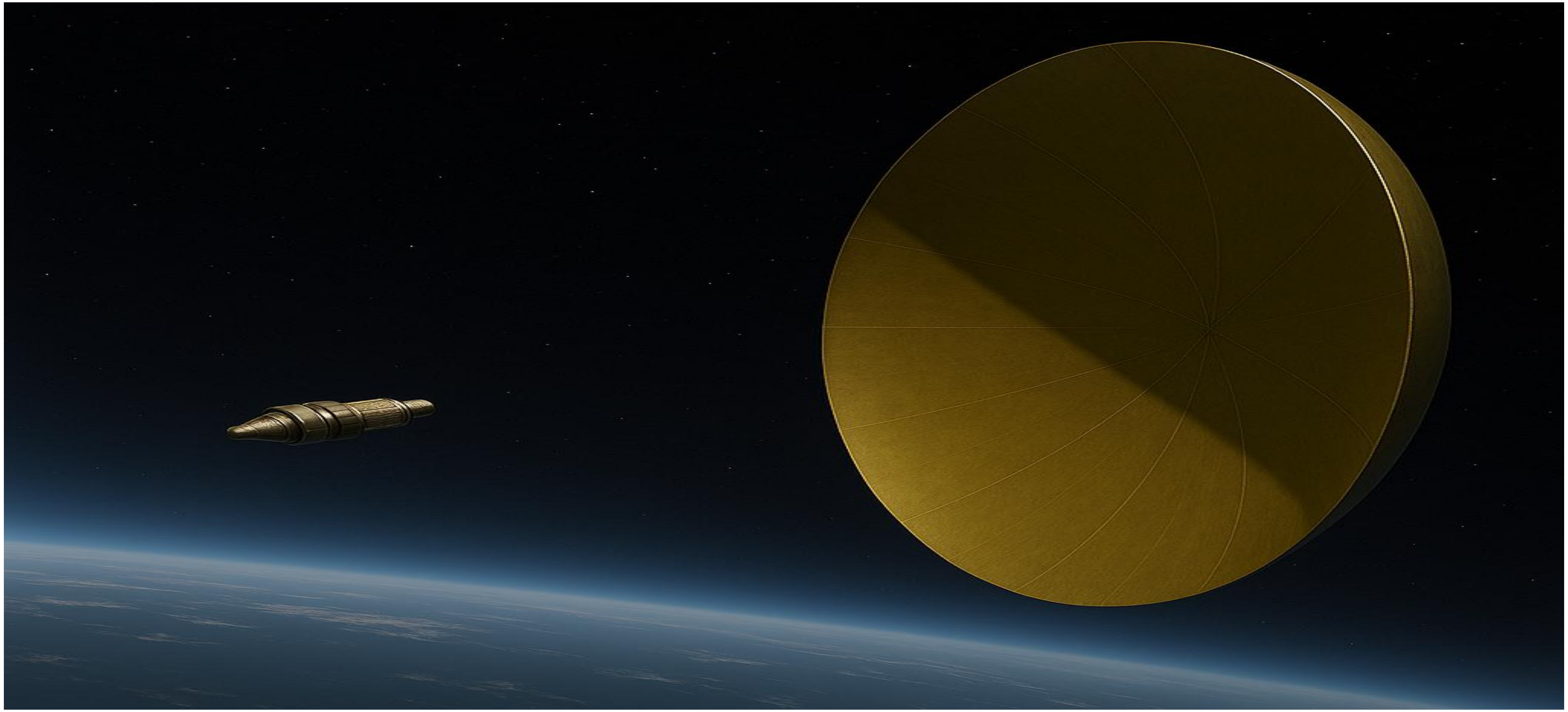
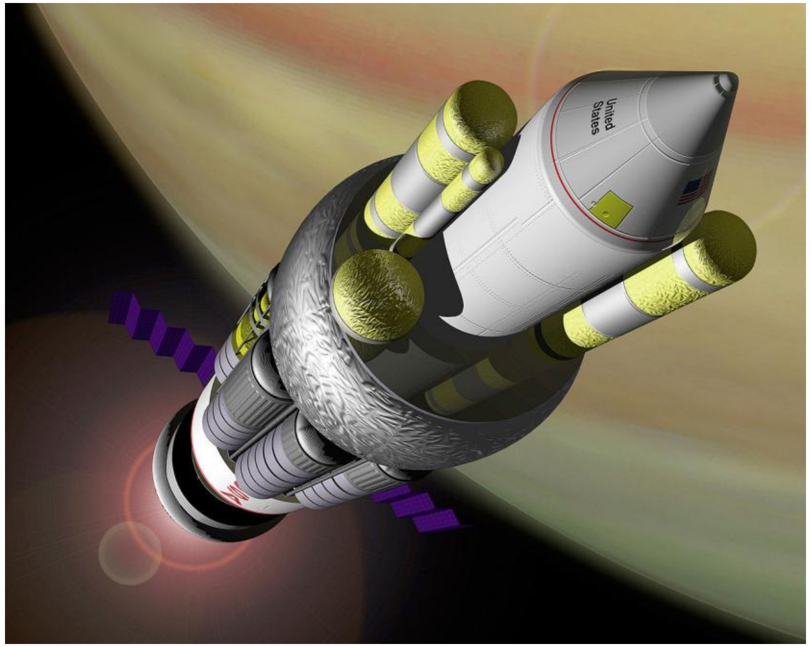


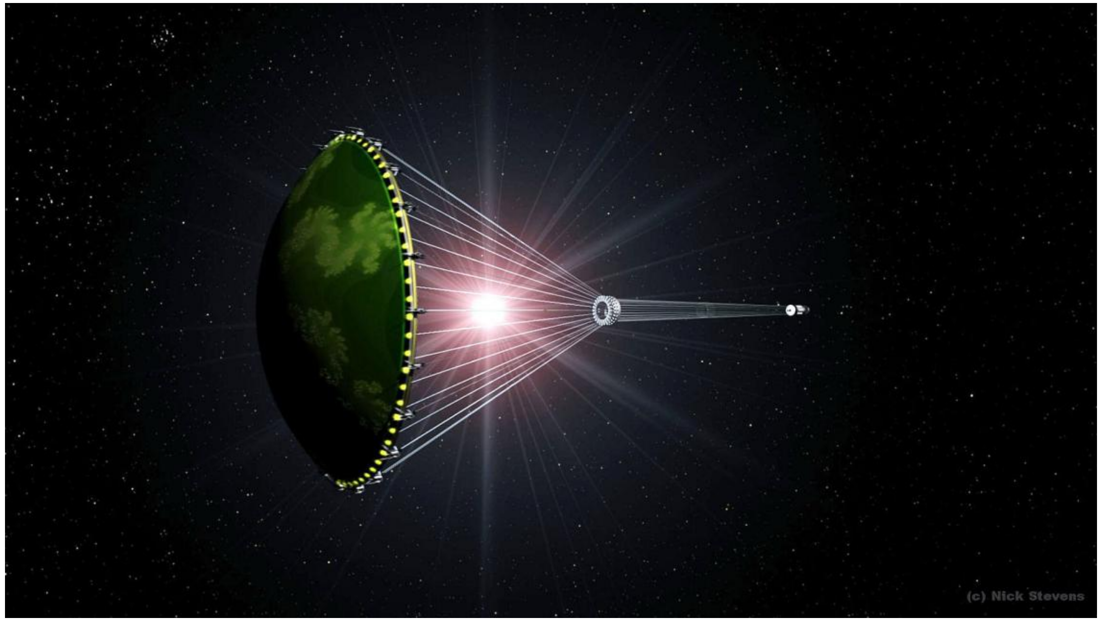
Bombshot

A. A. Jackson, Ph.D, AFAIAA, FBIS

Triton LLC
Houston Texas

Triton Systems





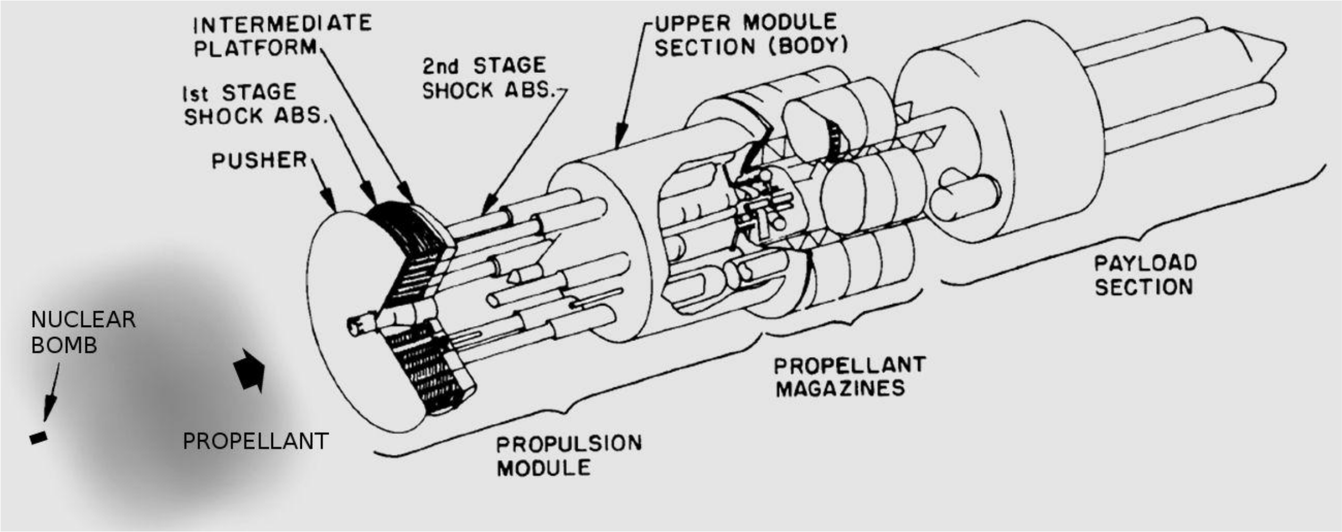
Orion
1949

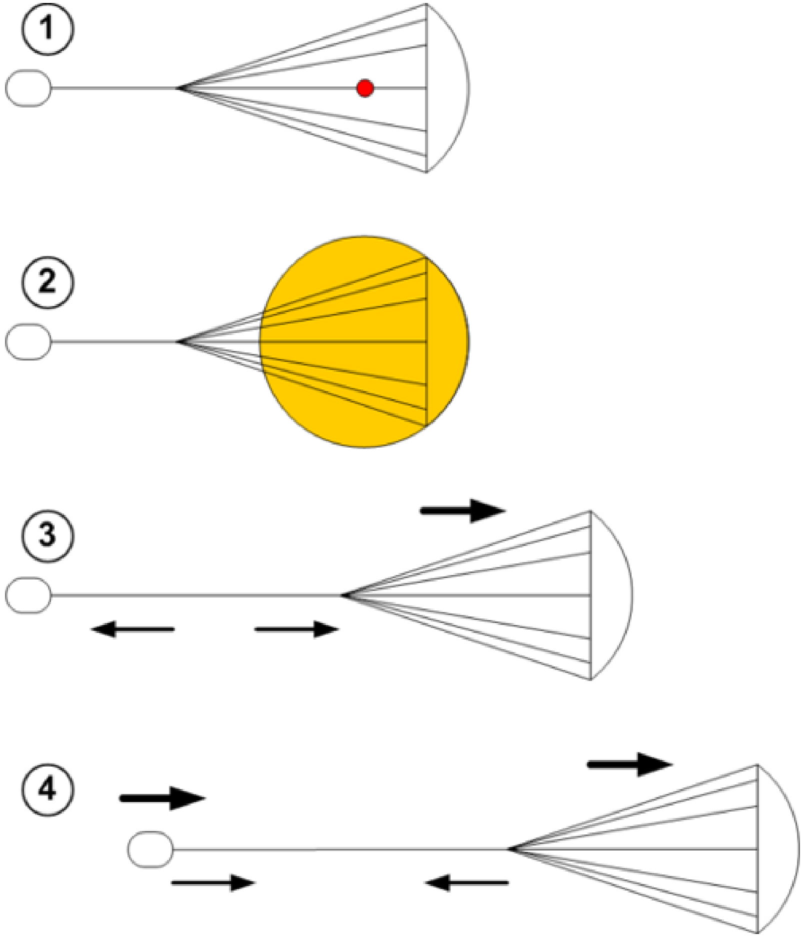
Staircase
2010

Medusa
1993

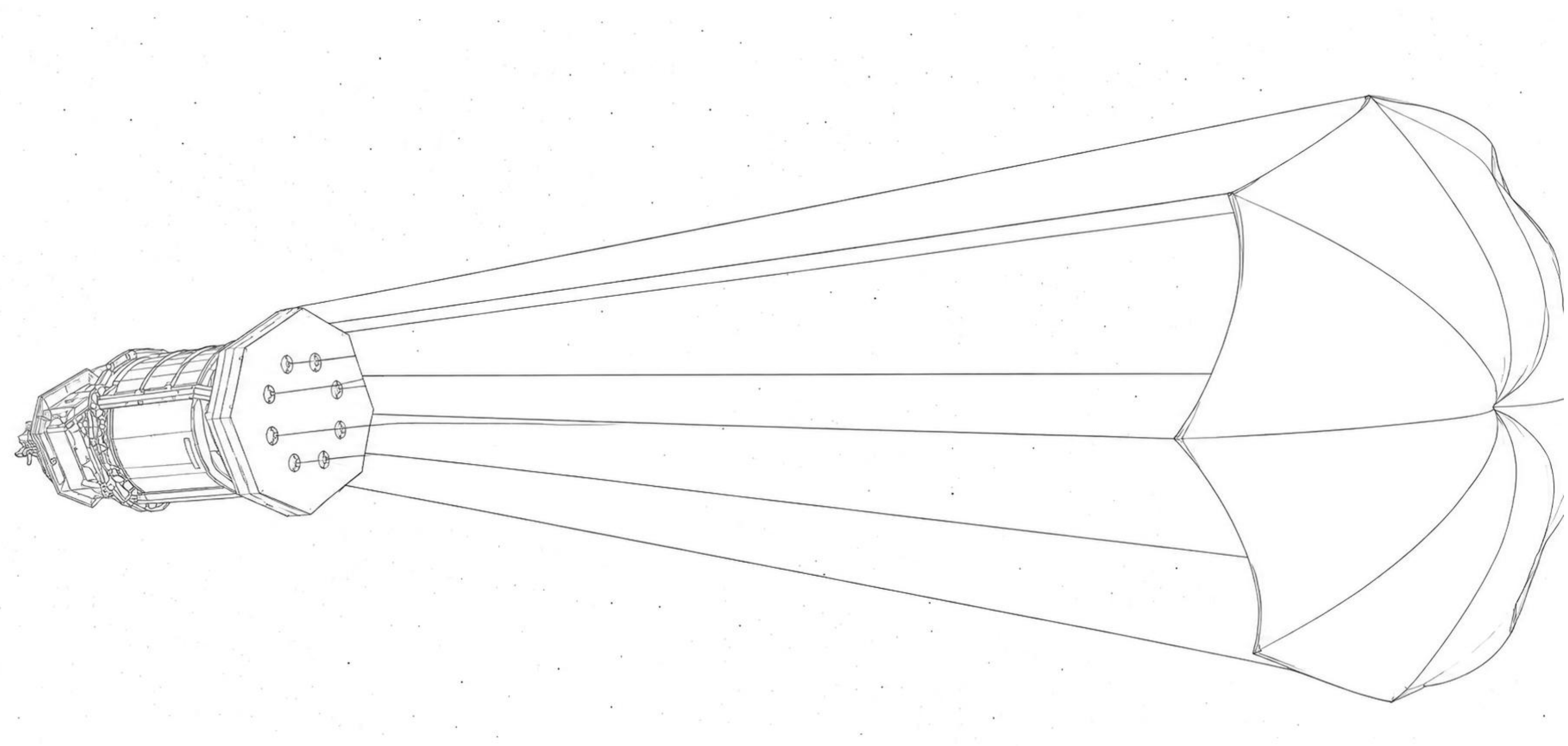
Note: Concept not Subject to the Rocket Equation

Orion and Medusa





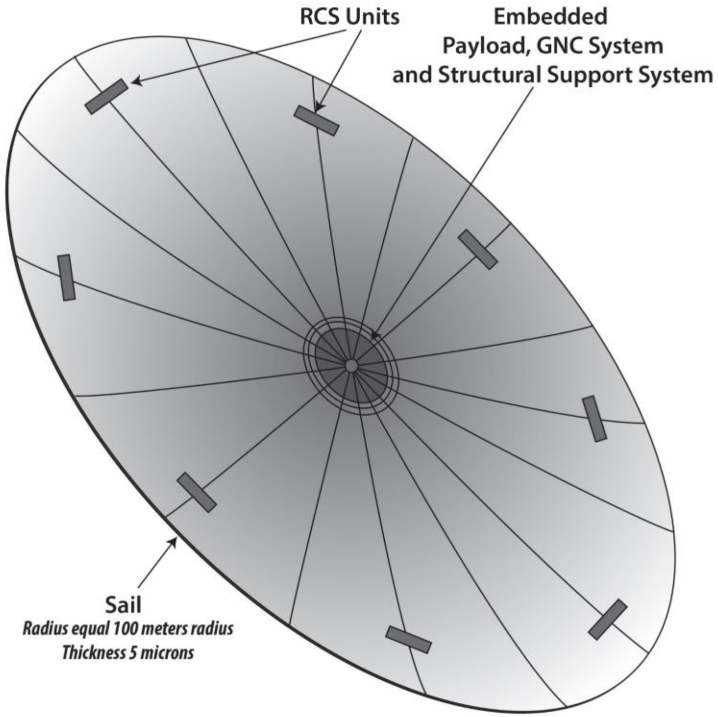
Stair Case

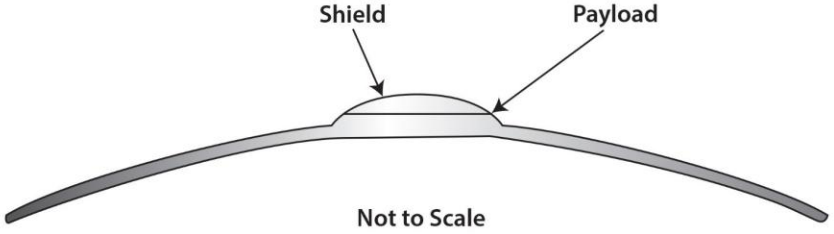


Mission Goals Summary

Goal	Requirement / Constraint	Notes
Achieve Relativistic Cruise Velocity for an Instrumented Probe	Reach ~0.1c baseline, stretch goal 0.2c	Use ≤ 1000 nuclear pulse units; canonical case ~666 units for 2 kt pulses
Enable Interstellar Science Return	Deliver ~25 kg payload (science + GNC) intact	Payload must survive propulsion and interstellar cruise
Demonstrate Nuclear Runway Propulsion	Graphene sail driven by nuclear plasma bursts	Circumvents classical rocket equation; Orion/Medusa heritage
Manage Physical Constraints	Thermal < 4500 K Stress < 130 GPa Accel ≤ 20,000 g	Safe standoff distance ~7 km for canonical case
Reduce Pulse Count via Pulse Shaping	Apply Gaussian temporal shaping	Reduces peak heating & stress, increases coupling efficiency
Construct a Feasible Runway	~15 million km runway length (~39 lunar distances)	Pulse spacing grows with velocity; Δt ≈ 1.2 s clean schedule
Protect Payload During Cruise	Forward Whipple-like shielding	Sail trails aft; shielding mitigates ISM gas/dust erosion
Test Advanced Nuclear Device Concepts	Casaba-like shaped nuclear charges	Explore feasibility of narrow, high-velocity plasma jets over km standoff

Candidate Model





Candidate Vehicle and Delta V

Vehicle Component	Dimension	Characteristics
Sail	100 meters radius	Layered Graphene
Sail Layer Thickness	5 microns	Optimized for thermal flux rejection
Payload Mass M_p	25 kg	Scientific Package plus GNC system.
Structure Mass M_s with GN&C system	25 kg	Rigging, sensors and reaction control system.
Sail Mass	355 kg	Integrated vehicle

$$\Delta v = \sqrt{\frac{2\eta Y_e M_b}{M_s^2}}$$

Y_e = Yield, kt,

M_b = Mass of Bomb or Propellant, kg,

M_s = Mass of the Sail, kg

$\eta = efficenty$

Pulse Fills the 'Sail' Exactly

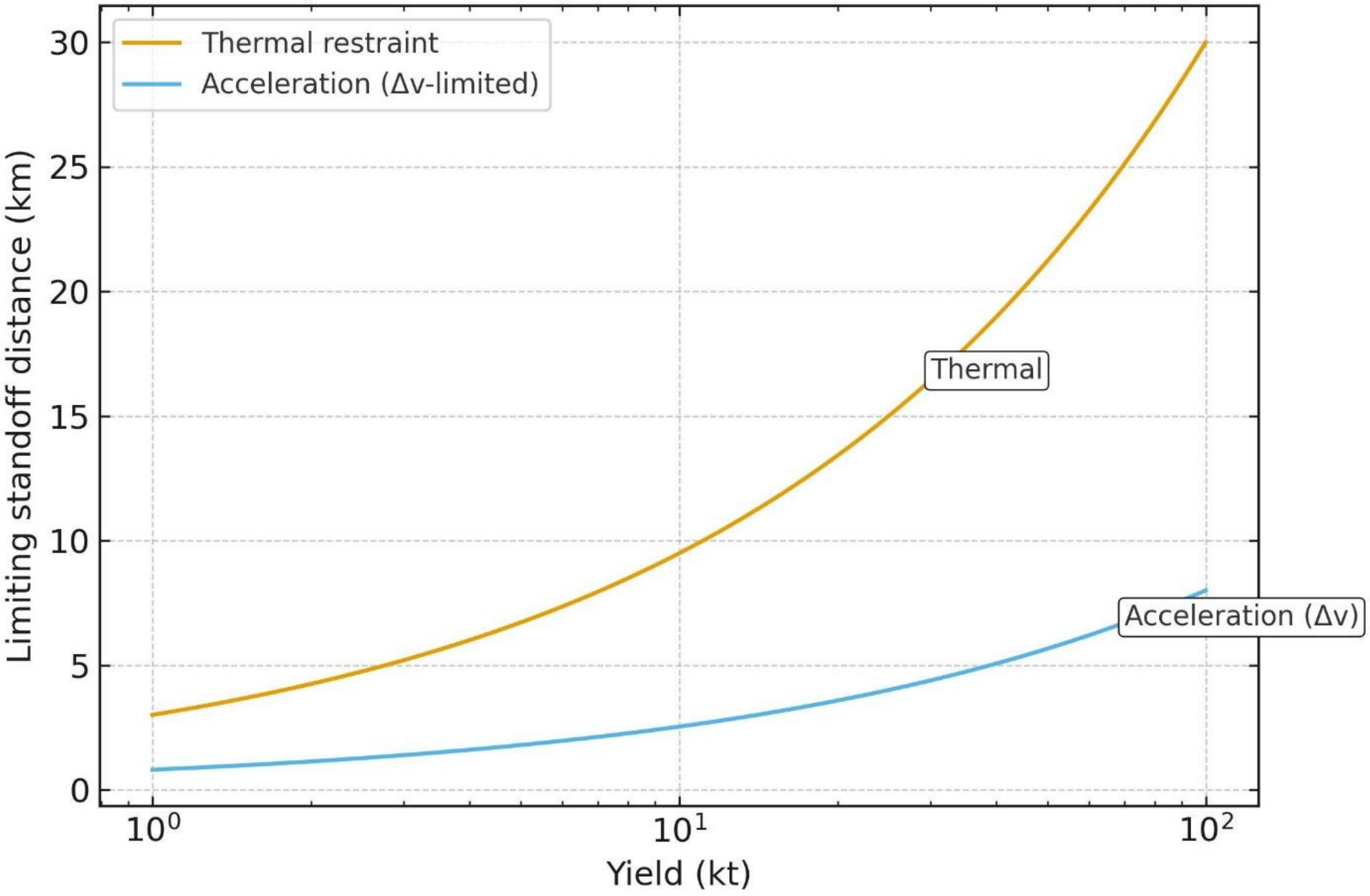
Physical Constraints Free Expansion

$$R_{\text{mech}} = \sqrt{\frac{Y_e}{4\pi\sigma_{\text{yield}} \cdot \Delta t \cdot A}}$$

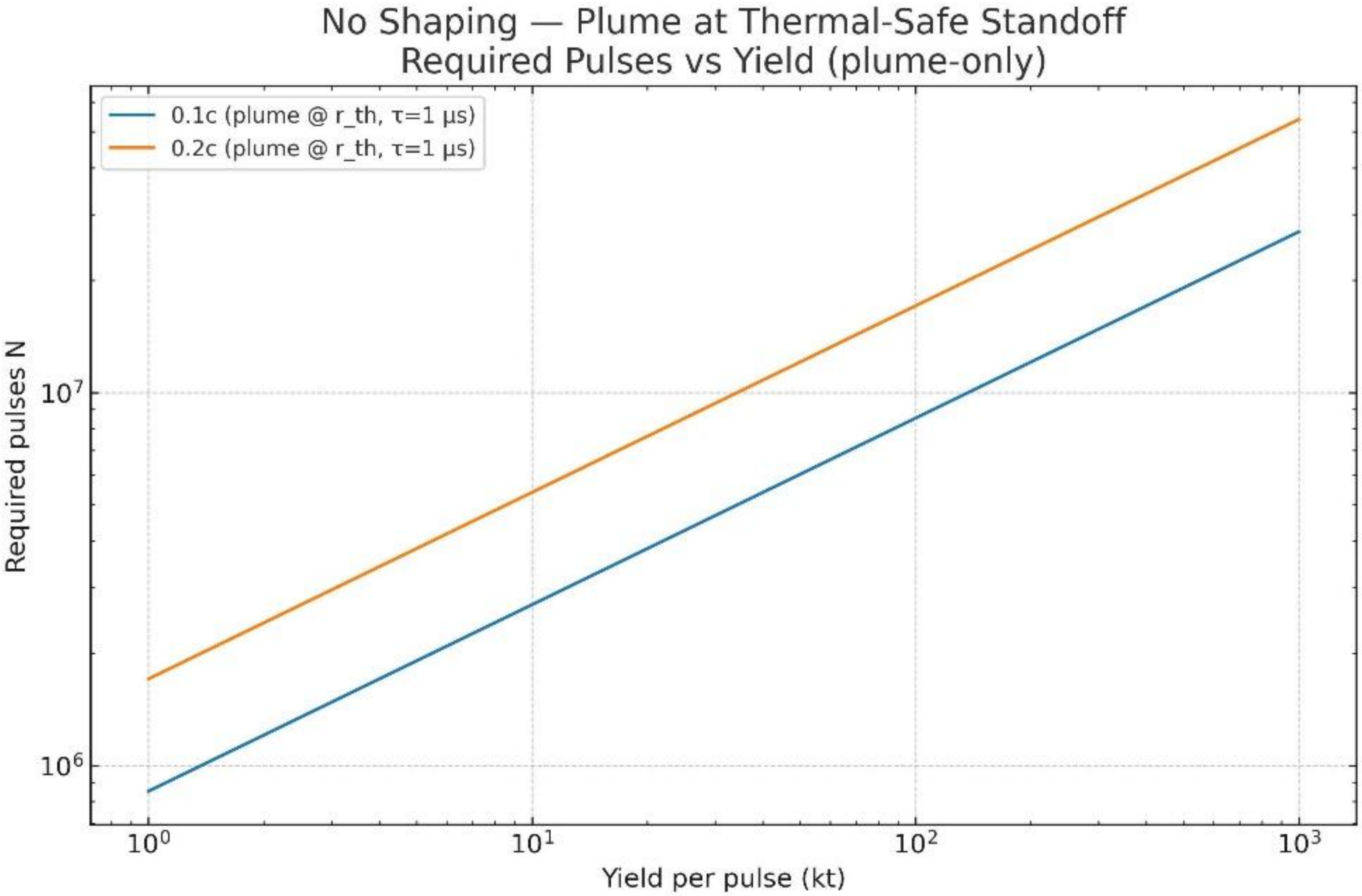
$$R_{\text{thermal}} = \sqrt{\frac{Y_e \cdot \Delta t}{4\pi s c_p (T_{\max} - T_0)}}$$

$$R_{\text{acc}} = \left[A \, \frac{2Y_e}{v_e} \, \frac{1}{M \, a_{\max} \, \Delta t}\right]^{1/2}$$

- σ_{yield} = Mechanical stress limit
- A = ‘Sail’ area
- Δt = Inpuse duration
- c_p = Specific heat capacity
- $T_{\max}$ = Melt/Sublimation Temperature
- T_0 = Initial temperature (ambient).
- Y_e = Yield
- $A_{\max}$ = Max acceleration
- M = Mass of the ‘sail’.
- V_e = velocity of the plume
- s = areal density



$$\Delta t \geq \frac{\sqrt{Y_e M_s}}{\sigma_{yield} A_s}$$


No Shaping — Plume at Thermal-Safe Standoff
Required Pulses vs Yield (plume-only)
0.1c (plume @ r_th, τ=1 μs)
0.2c (plume @ r_th, τ=1 μs)
Required pulses N
10^7
10^6
10^0
10^1
10^2
10^3
Yield per pulse (kt)

Shaping: Directed Plume … Perfect Fill

Normalized Gaussian function in time:

$$S(t;\sigma) = \frac{1}{\sqrt{2\pi}\sigma}\exp\left(-\frac{t^2}{2\sigma^2}\right).$$

The width parameter σ (or equivalently the FWHM,

$$\Delta t \ \geq \ \frac{\sqrt{Y_e M_s}}{\sigma_{yield} A_s}$$

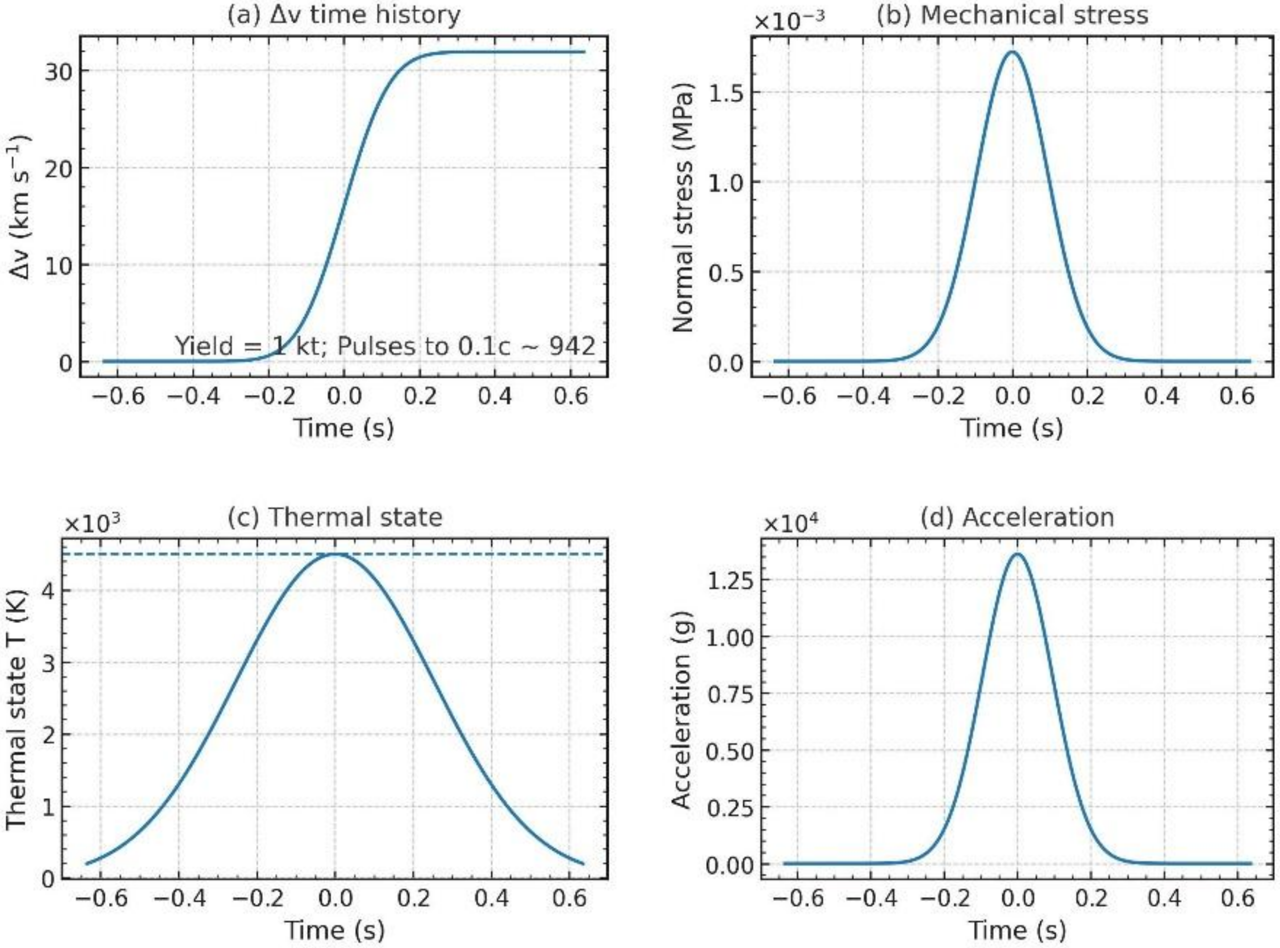
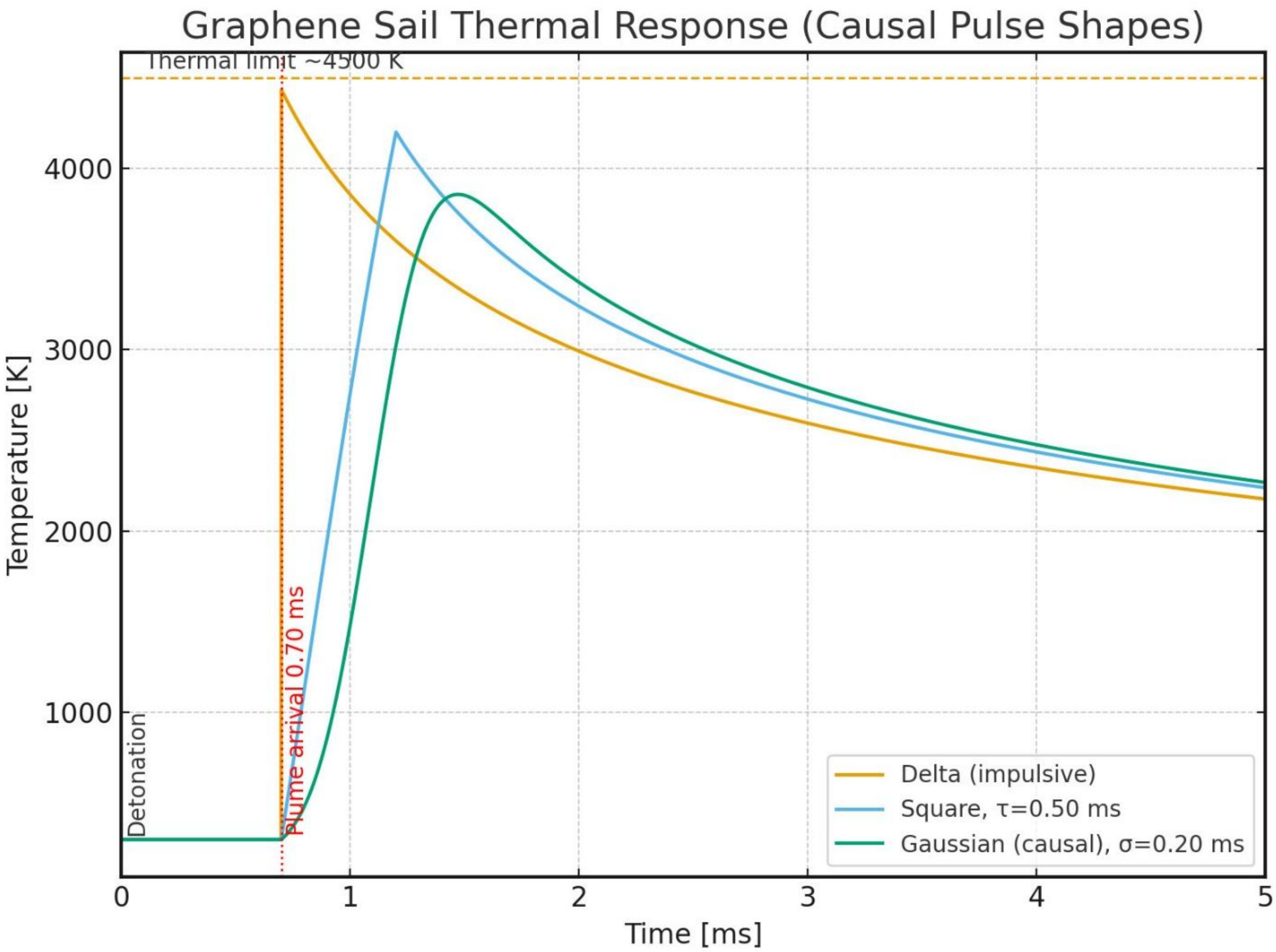
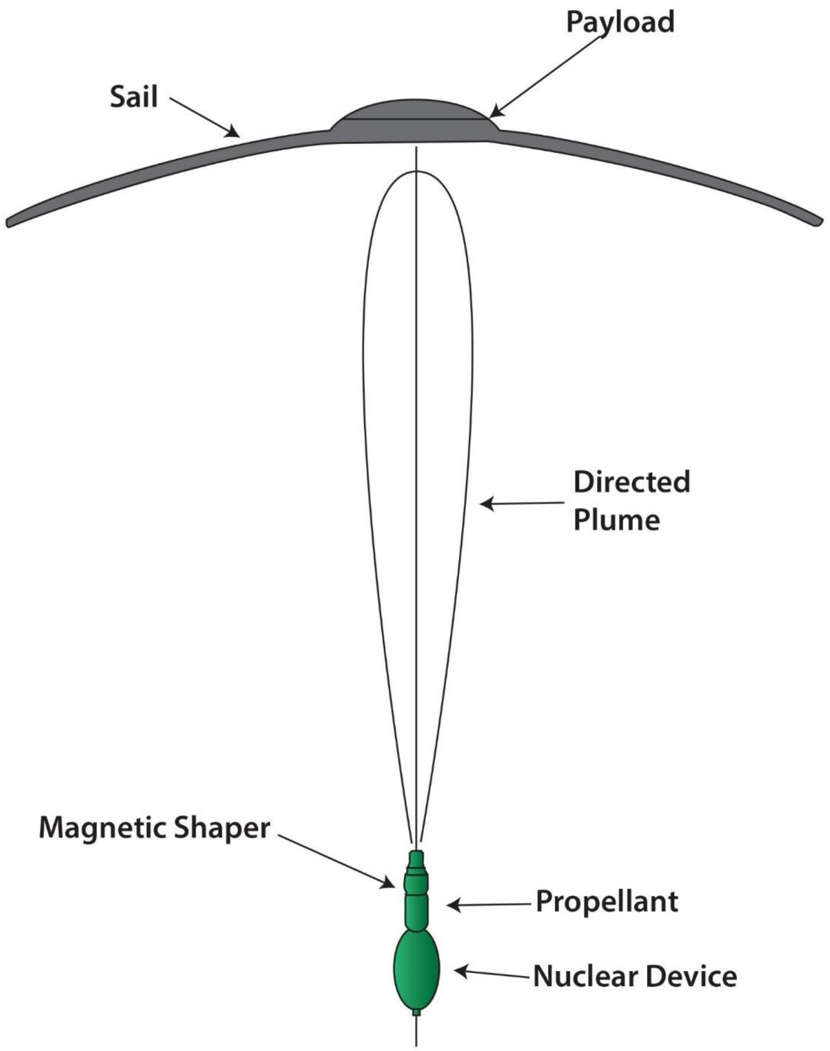


Table 6 Yield and Count comparisons for two different yields.

Parameter	Yield = 1 kt	Yield = 2 kt	Yield = 10 kt
Peak acceleration (g)	13618.23	19259.1	20000.0
Peak normal mechanical stress (Pa)	721.7	2434.8	2528.5
Peak temperature (K)*	4500.0	4500.0	4500.0
Pulse Delta-v (km/s)	31.9	45.2	101.0
Pulses to 0.1c (relativistic)	942	666	298
Pulses to 0.2c (relativistic)	1903	1346	602


Graphene Sail Thermal Response (Causal Pulse Shapes)
Thermal limit ~4500 K
Temperature [K]
4000
3000
2000
1000
Detonation
Plume arrival 0.70 ms
Time [ms]
0
1
2
3
4
5
Delta (impulsive)
Square, τ=0.50 ms
Gaussian (causal), σ=0.20 ms

Schematic representation of a single pulse

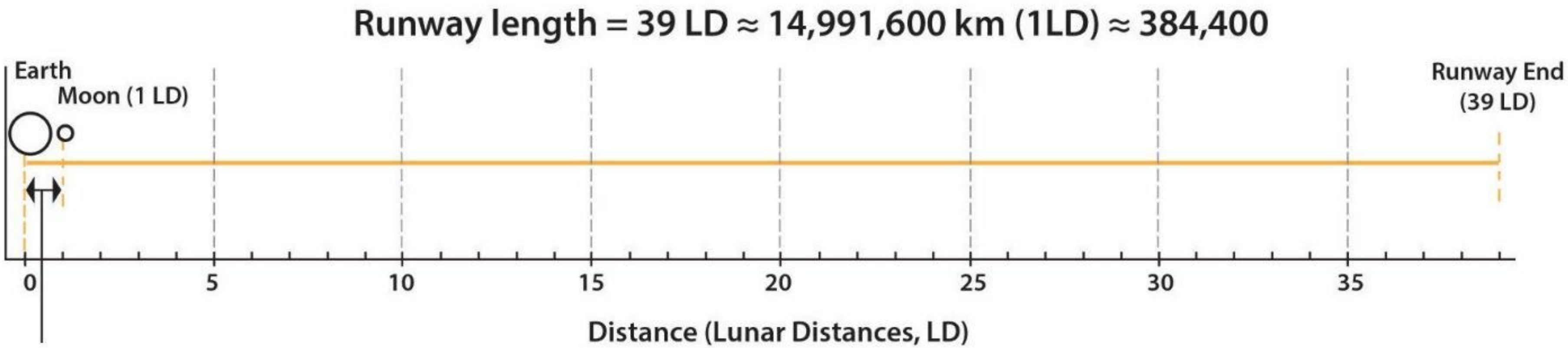


Nothing to scale

Runway : Pulse Spacing

Pulse number	Accumulated Speed	Spacing
Pulse 1	$v \approx 45\ \mathrm{km\ s^{-1}}$	54 km
Pulse 100	$v \approx 4\,501\ \mathrm{km\ s^{-1}}$	5 401 km
Pulse 400	$v \approx 18\,006\ \mathrm{km\ s^{-1}} \approx 0.060\ c$	21 607 km
Pulse 666	$v \approx 0.1\ c$	35 975 km

Total burn time = $n\Delta t$ = 799 seconds.



Runway

Variable Speed Runway

Interesting that the total number of units becomes 385

Runway Inventory

Yield Range (kt)	Pulse Units	Fraction (%)
1–10	140	36
10–100	110	29
0.1–1 Mt (100–1000 kt)	90	23
1–10 Mt (1000–10000 kt)	35	9
>10 Mt	10	3

Conclusions

The following are the characteristics of this approximate analysis of the nuclear runway.

1. Constraint Analysis – Among mechanical, thermal, and acceleration limits, the thermal constraint (graphene sublimation) dominates the required standoff distance. (Fabrication of the Graphene configuration of somewhat speculative here.)

2.

   2. Pulse Shaping as Enabler – Temporal shaping of nuclear pulses reduces peak heating and stress, allowing operation at safe ~7 km standoff distances. Extremely precise pulse shaping is a speculation it may not be a possibility.

3.

   3. Canonical Case Results – For a 100 m radius, 5 µm thick graphene sail of ~400 kg mass:
      - 1 kt pulses require ~942 shots to reach 0.1c.
      - 2 kt pulses reduce this to ~666 shots.
      - 10 kt pulses achieve 0.1c in ~298 shots but approach acceleration and stress limits.

4. Runway Feasibility – The runway length for the 2 kt case (~39 lunar distances, ~15 million km) is daunting but potentially constructible with autonomous placement of pulse units. The phasing and spacing demand precise guidance and control of the pulse unit and the sail, left to future technological development.

5. Shielding Requirements – At cruise speeds up to 0.2c, payload survival requires forward Whipple-like shielding. The added mass is small compared to sail mass and does not materially change pulse counts.

6. Engineering Outlook – The nuclear runway concept is theoretically consistent within known material limits, but it depends on advanced nuclear pulse-shaping devices beyond today’s demonstrated technology. Key open problems are:

- Feasible design of Casaba-like shaped nuclear charges.
- Precision deployment and synchronization of hundreds of pulse units.
- Robust sail deployment and guidance, navigation and control of both the sail-ship and the pulse units.