



# Thor – A Hypersonic Revolution

*Moving Hypersonic Testing, Suborbital, and Orbital Launch toward Air Express Frequency/Prices  
Transforming U.S. Military Force Projection and Commercial Transport Capabilities*

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8 RIVERS

**THOR**  
Launch Systems

# 8 Rivers Capital

- Solving significant world problems by building the infrastructure of tomorrow
  - Cheaper, better, transformative technologies
- 2011-16 built >\$1B in value (mostly NET Power)



- Demo 2017
- Zero emissions and cheaper
- Will show video of site



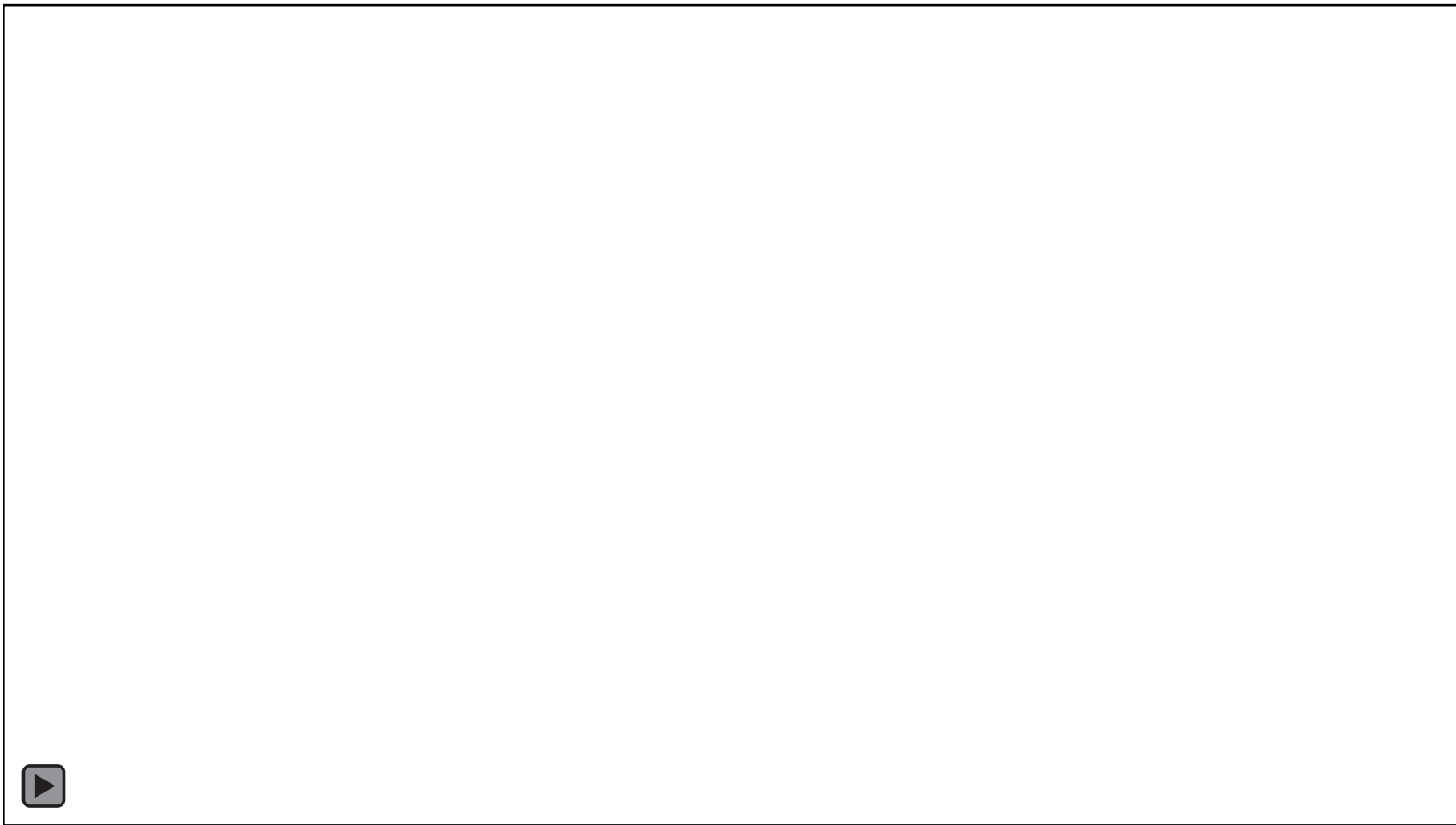
- Optical coms that work like RF
- Billion-fold increase in spectrum
- Commercial sales in progress
- 100% secure - intercept proof



- Suborbital and space launch
- Can approach air cargo rates
- Electric propulsion
- Not chemical or magnetic
- Extensive independent validations
- Will show video

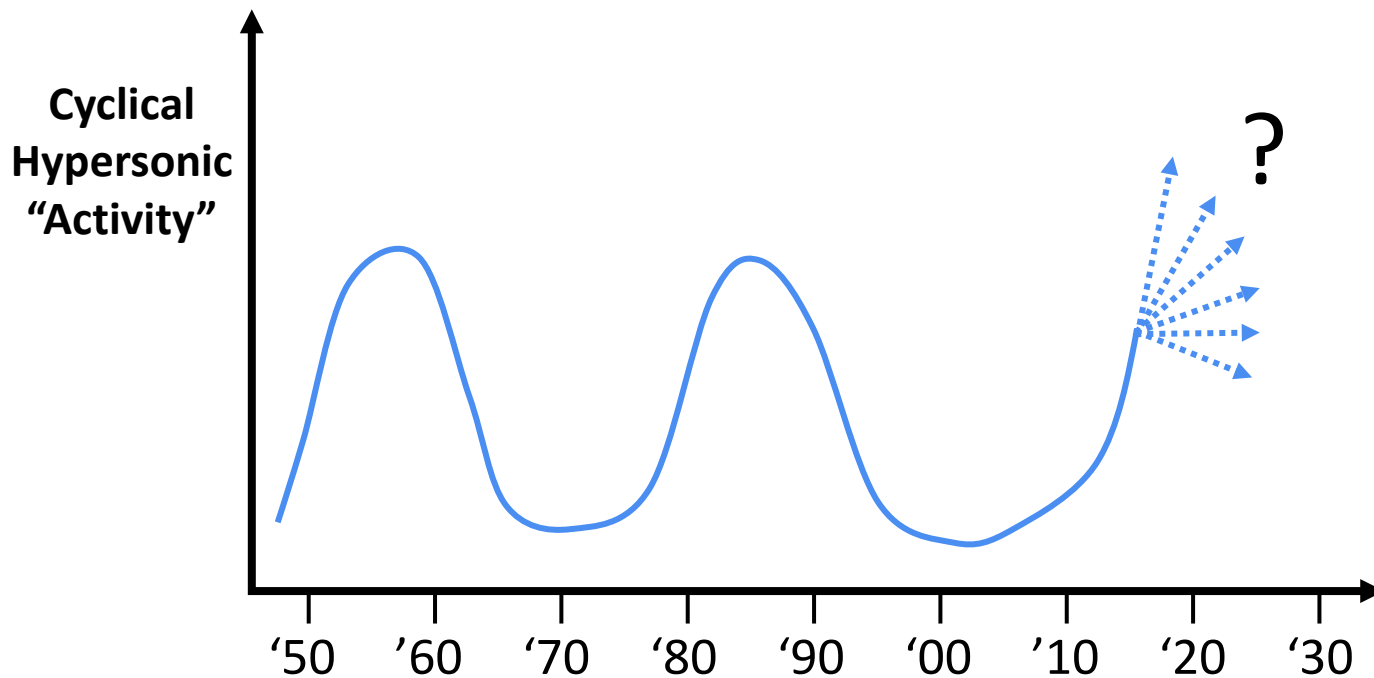


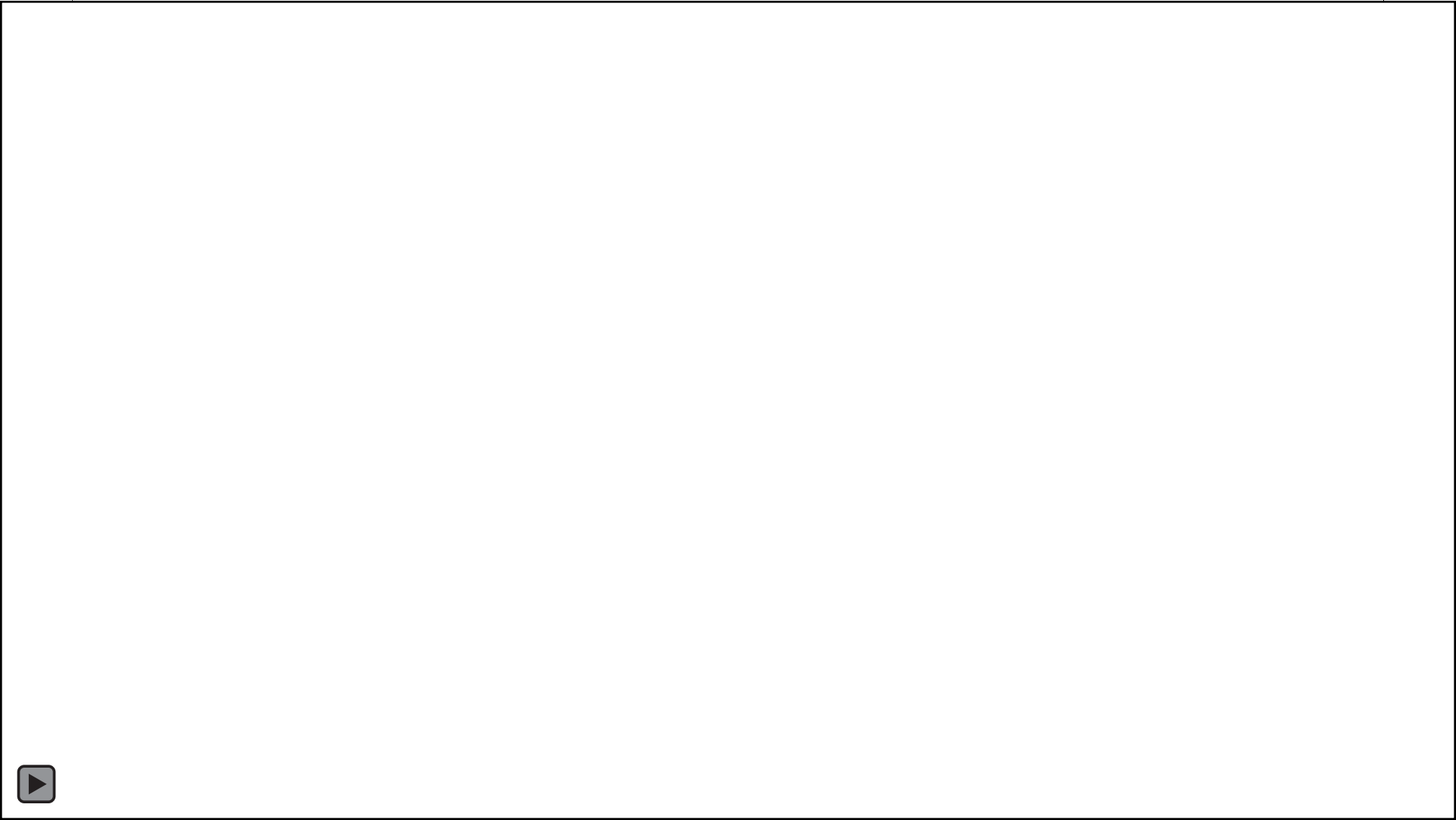
# NET Power site – LaPorte, Texas, January 23, 2017



# The Story of Hypersonics to Date

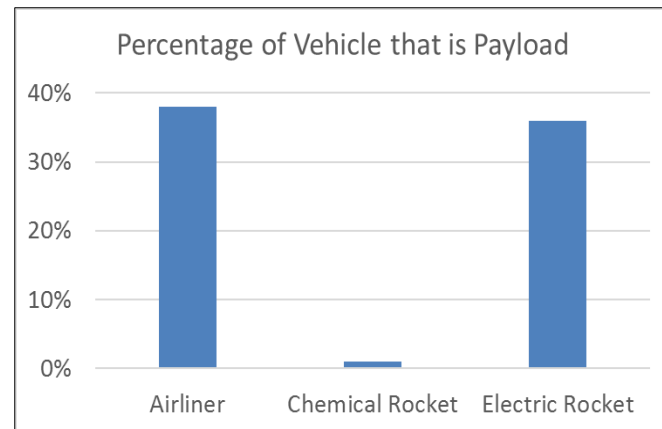
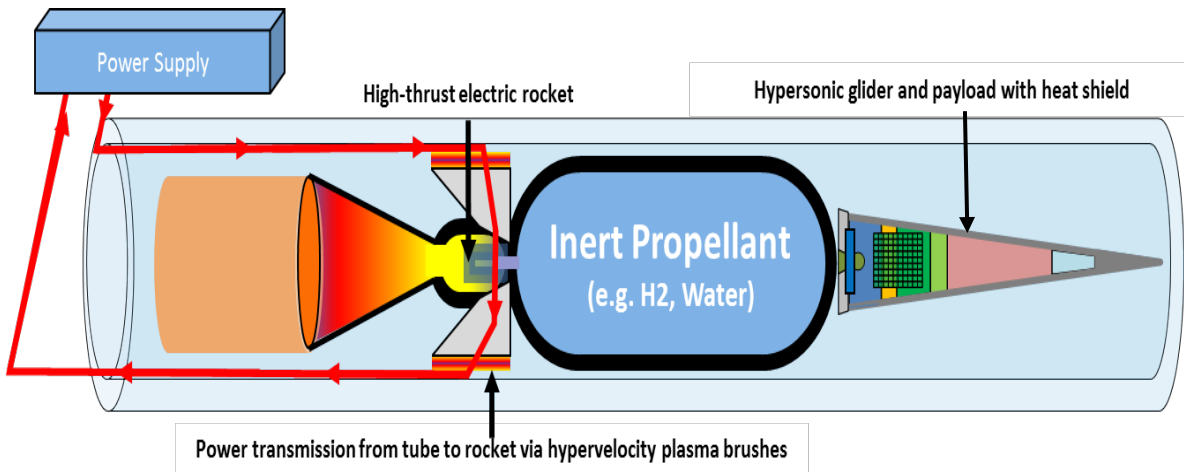
Both ground testing and flight testing too expensive  
Need breakthroughs in technology as well as more \$'s





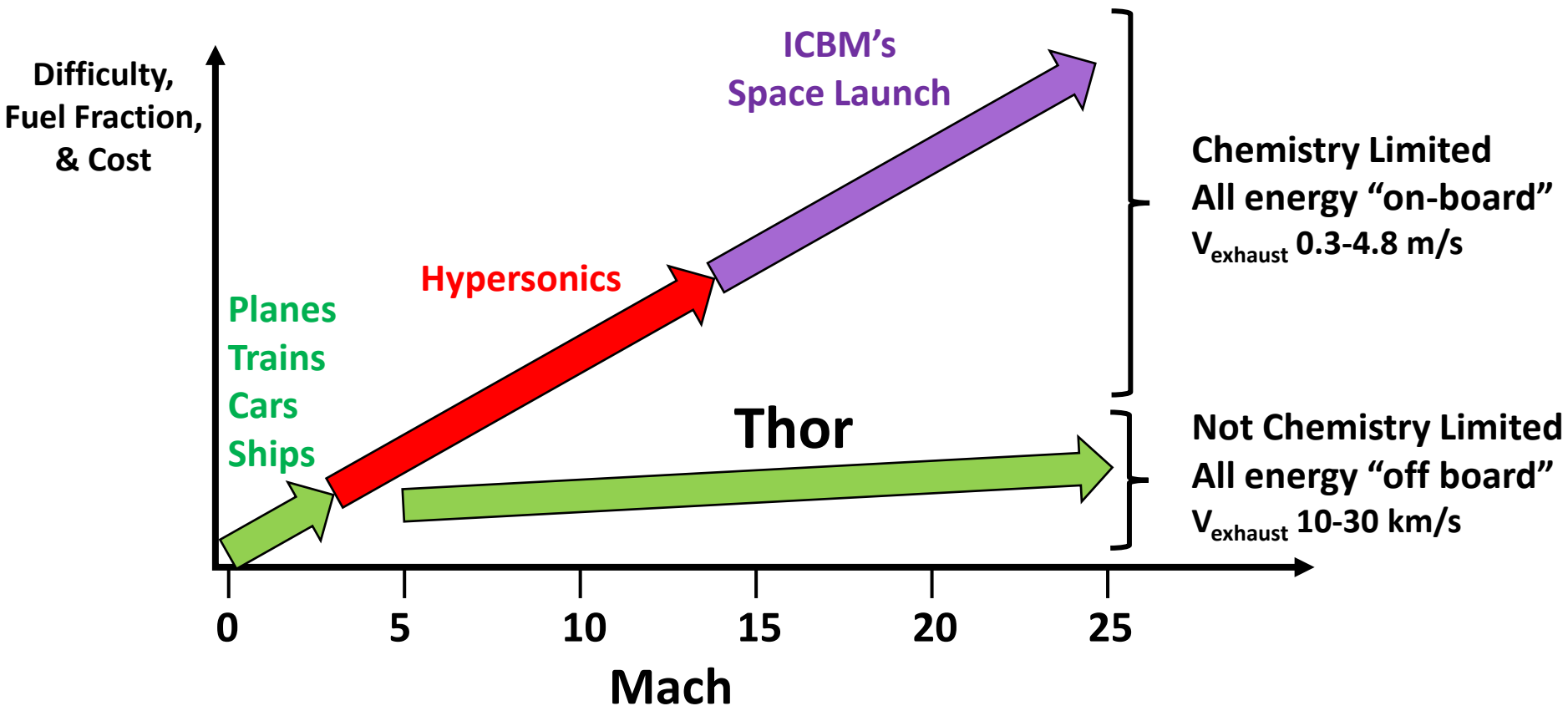
# Summary of how Thor works

- Electric rocket, not chemical rocket → 850-2000 sec Isp's gives 20-50% payload single stage
- Inert propellant safety – water for example – electrically heated at many GW with many GJ
- Cheap power supply – many GW, many GJ
- Power transmitted down launch tube walls
- Evacuated horizontal tube – aircraft like launch – vehicle pitches and climbs after tube exit
- Power supply, tube, sliding brushes, electric rocket, heat shield, 200G payloads all demonstrated



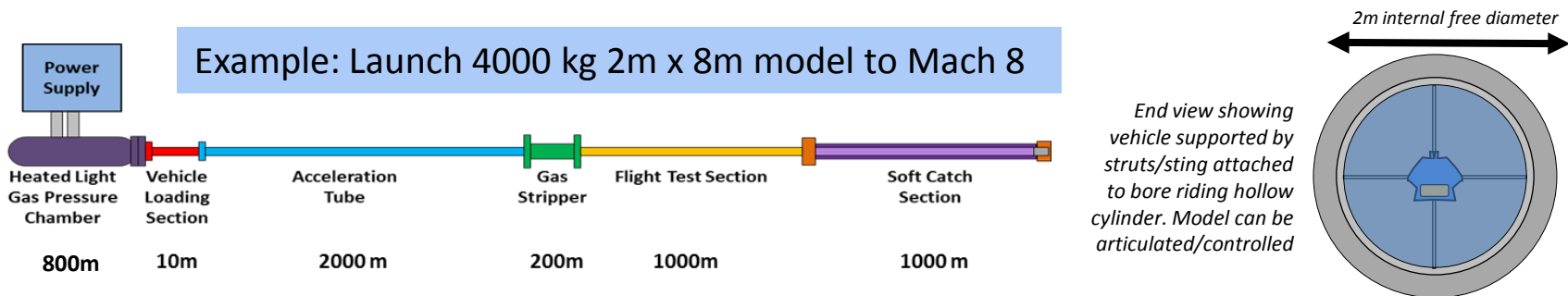


# Enables Technology Breakthrough

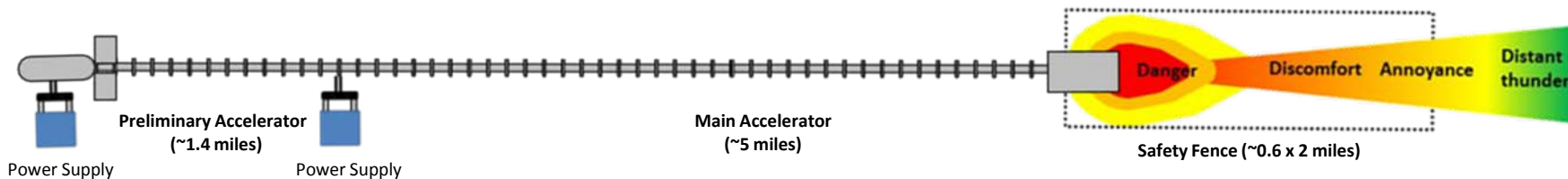


# Thor Applications: Hypersonic Ground Testing, Suborbital Logistics, Space Launch

## Hypersonic Testing: Low cost, daily, full scale, real atmosphere, with model recovery/reuse



## Hypersonic Launch: Responsive, high-launch cadence 'Hyperport'



**Mass delivery of payloads anywhere on Earth in 45 minutes ... every few minutes**

# Thor: Readiness and Technical Validation

*System based on integration of demonstrated component technologies*

## Leading experts validation (No showstoppers found)

- Five MIT faculty (independent review)
- Dr. Michael Griffin\* (Previous NASA Administrator)
- Dr. Ray Johnson\* (Previous Lockheed CTO)
- Leading aerospace company
- DOD TRMC
- DARPA TTO
- NAS/NAE Panel, NRL, FAA, and multiple EPC's

## Subsystems Overview

### Existing Componentry Deployed in Space and Launch Systems

- Aerobody
- Avionics
- Payloads
- Control systems
- Re-entry systems

### Thor Componentry Deployed Elsewhere

- Power supply
- Heat Shield
- Electric rocket
- Conductive plasma brush

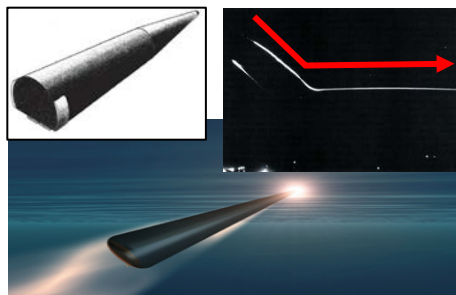
### Required Work

- Component verification
- System integration and demonstration

*"Thor technology components are currently available or soon will be. Engineering the Thor technical components into an efficient launch system will be challenging but certainly doable. A **confidence probability exceeding 0.9** is predicted for complete engineering and implementing the Thor tube powered electric rocket system"*

### Dr. Wesley Harris (External Expert Review\*)

- Current: Charles Stark Draper Professor of Aeronautics and Astronautics at MIT; Member of the National Academy of Engineering
- Former: Associate Administrator for Aeronautics at NASA; Head of the MIT Department of Aeronautics and Astronautics (2003-2008)
- PhD Aerospace and Mechanical Sciences, Princeton University



*Extensive RV, MARV, AMaRV flight history. Thor will start with cones and other proven shapes at L/D 2.0. Thor enables low cost frequent tests. Max Q environment only lasts ~ 2 seconds*



*Thor-equivalent power supply, built and deployed in 1988 under direction of Thor-technical founder, Dr. Miles Palmer*

# Thor Projections Based on EPC estimates

- **Hypersonic testing – 2-3 years**
  - Full scale tests up to Mach 8/Mach 18
  - Real atmosphere altitude range tank or free flight launch
  - Daily testing at low cost
- **Suborbital transportation – 2-4 years**
  - Projections indicate air express like pricing feasible at high volumes
  - First system perhaps ~ 500-5000 kg payloads
- **Space launch – 3-6 years**
  - Projections indicate commercial viability at 5-10 launches per year
  - First system perhaps ~ 200-500 kg payloads