

Phoenix Missile Hypersonic Testbed (PMHT)

Project Concept Overview



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(ARTIST'S RENDITION)

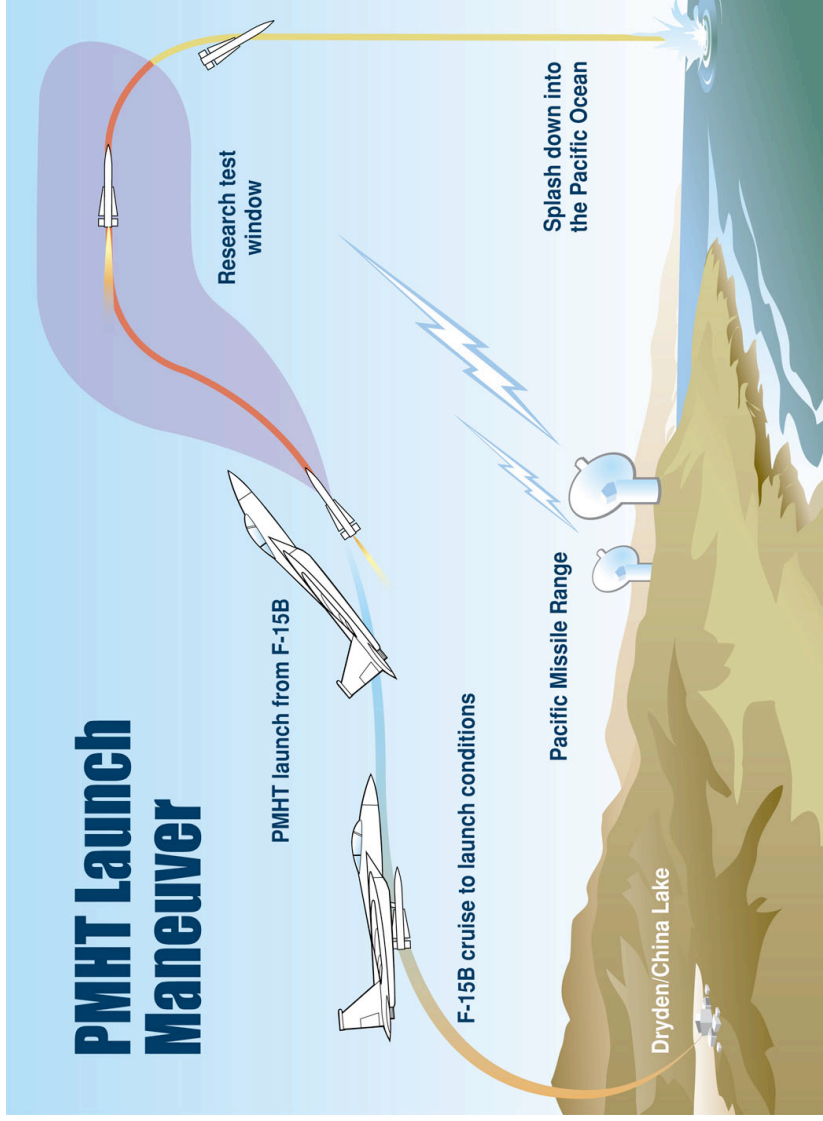
Need and Goals

- Need:
 - A low cost hypersonic research flight test capability to increase the amount of hypersonic flight data to help bridge the large developmental gap between ground testing/analysis and major flight demonstrator X-planes
- Goals:
 - Develop an air launched missile booster research testbed to:
 - Accurately deliver research payloads
 - Through programmable guidance
 - To hypersonic test conditions
 - At low cost
 - With a high flight rate

Objectives

- 5.5 ft³ of payload capacity
- Exceed (with different trajectories):
 - Mach 5 with at least 500 psf dynamic pressure
- or
- Dynamic pressure of 2000 psf with at least Mach 3
- Unit test cost under \$500K
- Test flight rate minimum of 2 flights/year
- Utilize surplus air launched missiles and NASA aircraft

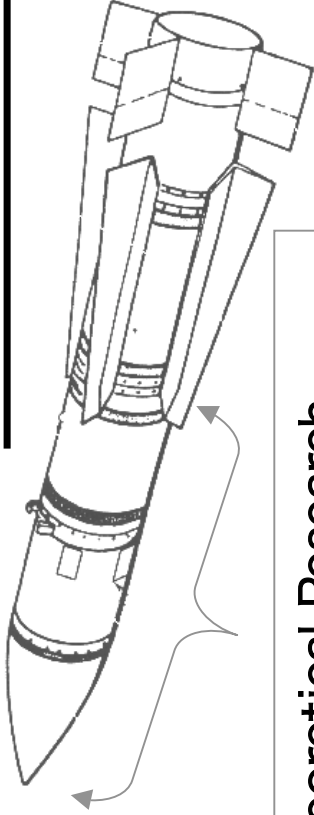
PMHT Concept



- Utilize surplus AIM-54 Phoenix missiles from US NAVY as booster for Supersonic/Hypersonic Flight Research
- Utilize surplus F-14 hardware to mount Phoenix missile to NASA F-15B
- NASA F-15B operates from Dryden Flight Research Center
- F-15B transits to Pacific Missile Test Range at specified launch conditions (alt/Mach)
- Missile launch from F-15B and internally guided to test condition(s)
- Missile descent and splashdown into the Pacific
- Alternate mission profile could be operated over land within restricted airspace and impact the ground for payload recovery

PMHT would be air-launched from NASA F-15B using F-14 launch hardware from within F-15B flight envelope and internally guided to test condition

PMHT Configuration



Theoretical Research

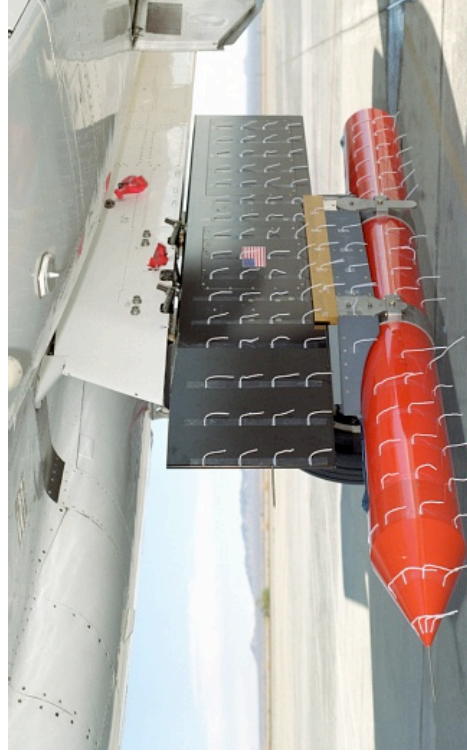
Payload Capability

Diameter - 15 inches
Length - 89 inches
Effective Volume - ~7 cu ft.
Allowable Weight - ~250 lbs.

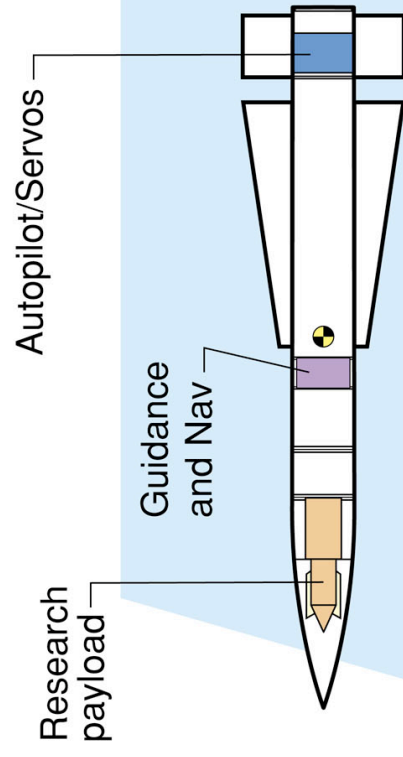


Utilize surplus flight-proven F-14 hardware

Design Concept



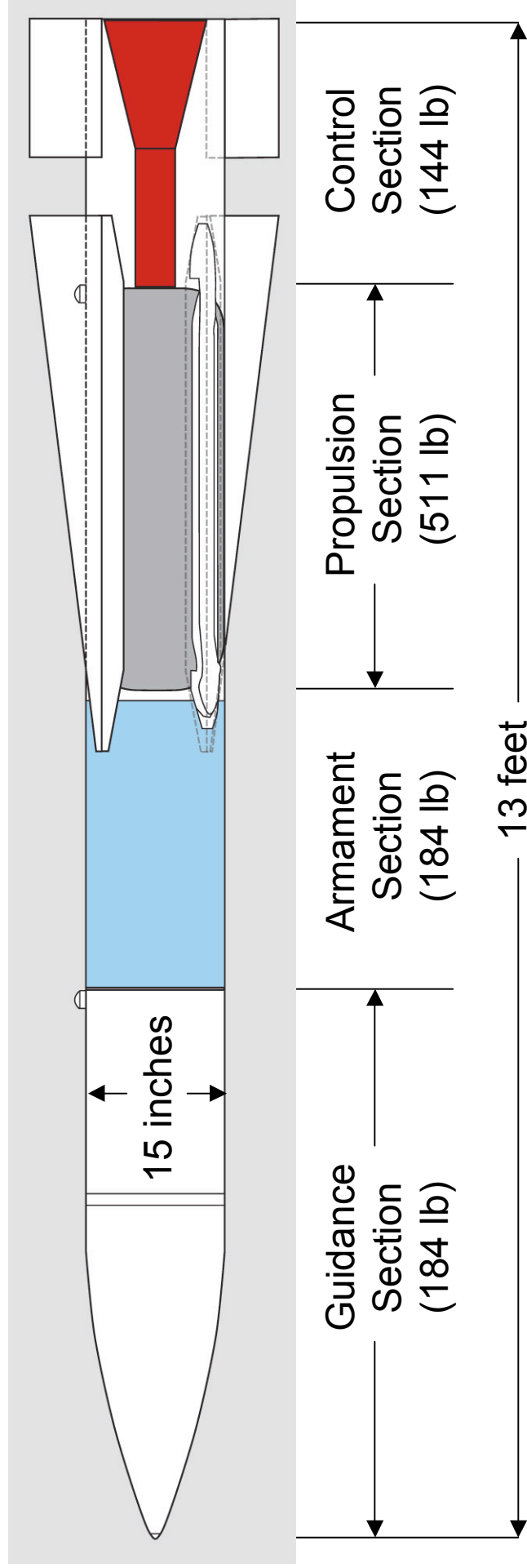
Utilize experience with F-15B flight test fixtures such as PFTF



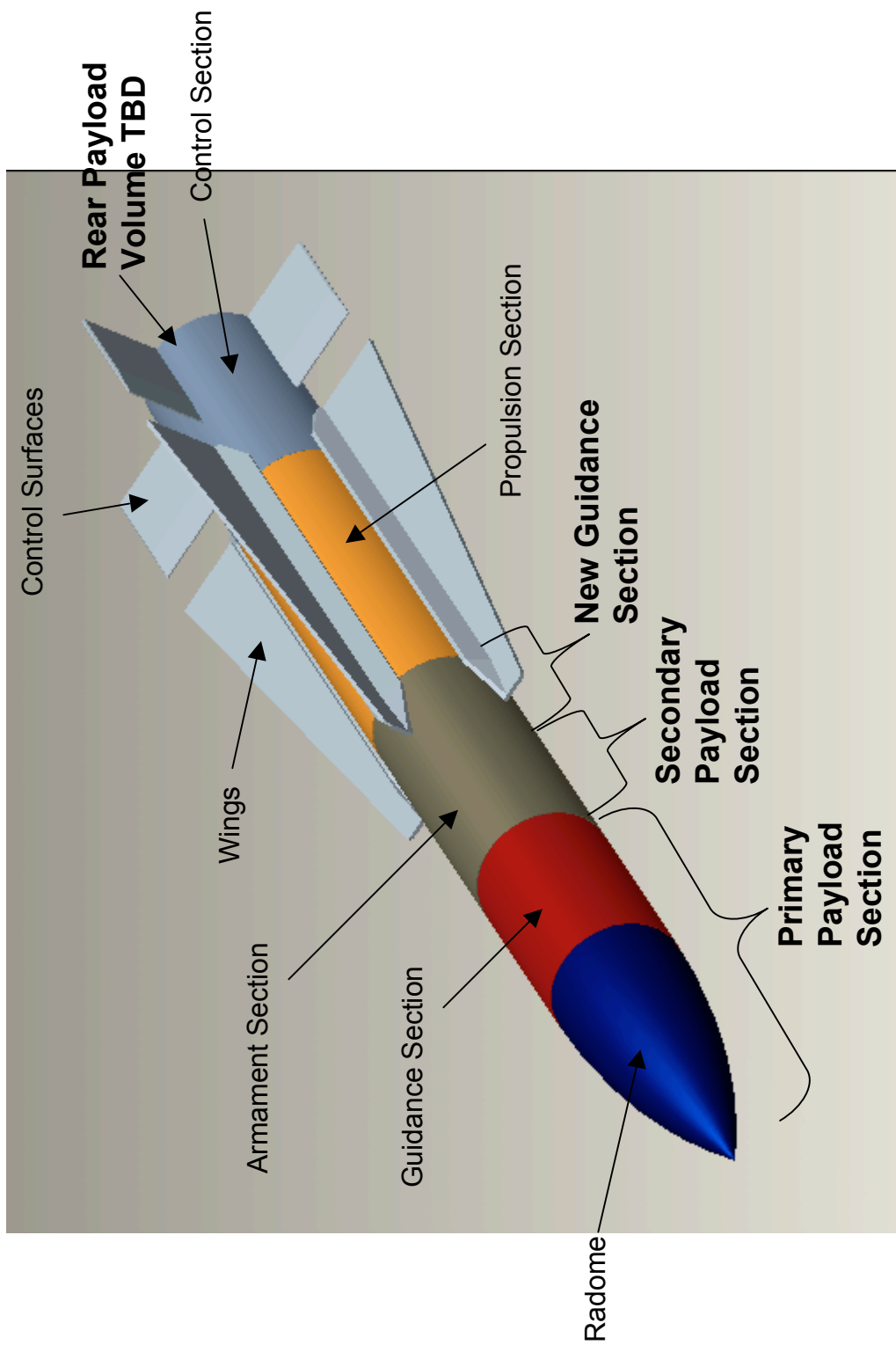
AIM-54 Internal Hardware Schematic



- All internal components removed from guidance and armament sections to make space for payload and new guidance computer and INU
- Components to be removed include warhead, old guidance computer, and radar tracker

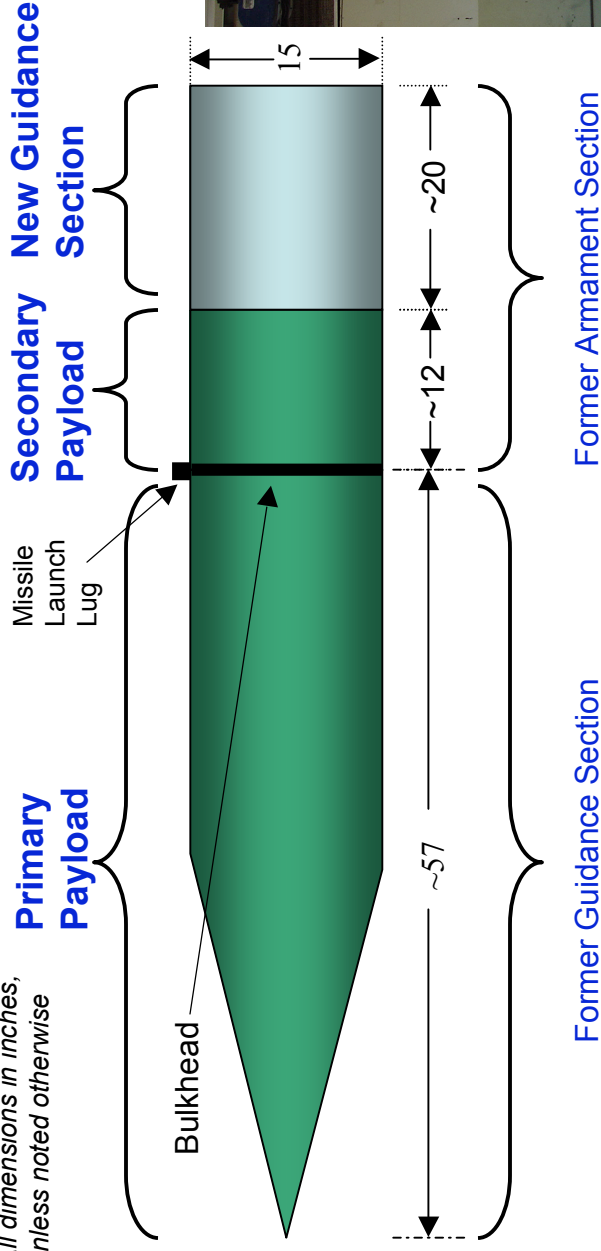


Basic Payload Concept



New Guidance and Armament Section Profiles

All dimensions in inches, unless noted otherwise

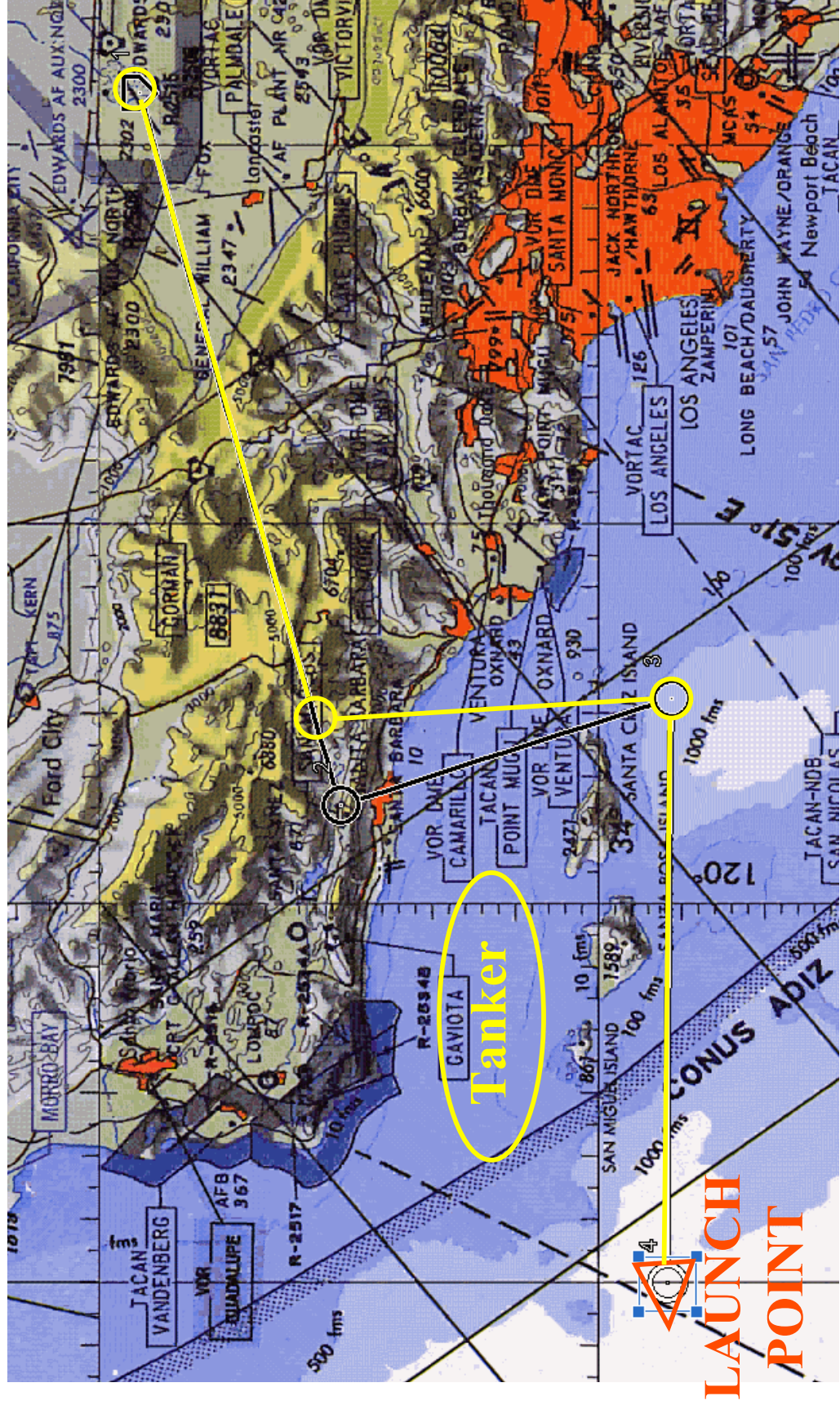


- Payload volume consists of two areas (primary and secondary) separated by a bulkhead at the location of a launch lug
- All internals of guidance and armament sections removed
- Secondary payload immediately aft of primary
- Length of secondary payload is TBD, but in the neighborhood of 12-18 inches
- Payload instrumentation and power interfaces are TBD

Missile Preflight Activities

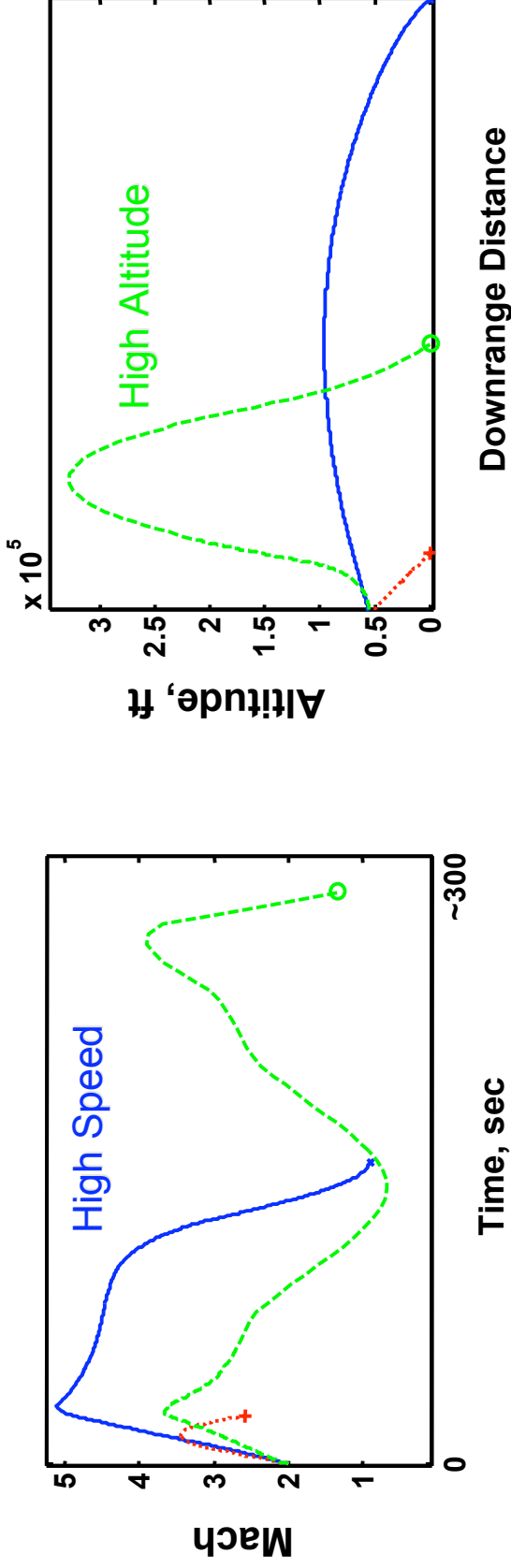
- Mount the payload-integrated missile on the aircraft
- Power aircraft using external ground power
- Power Phoenix on external power via cockpit switched power relay
- Connect Ground Servicing Equipment (eg. Laptop) to Phoenix GSE port
 - Upload guidance waypoints for planned trajectory
 - Upload controller and/or payload constants
 - Collect Phoenix telemetry via hardware to GSE
- Verify system health and safety monitoring from aircraft rear cockpit display
 - Payload and missile systems instrumentation data available through on-missile data bus
- Verify INS performance
- Command MOAT (Mission on Aircraft Test) from rear cockpit
- Ready A/C for takeoff

Notional Ground Path

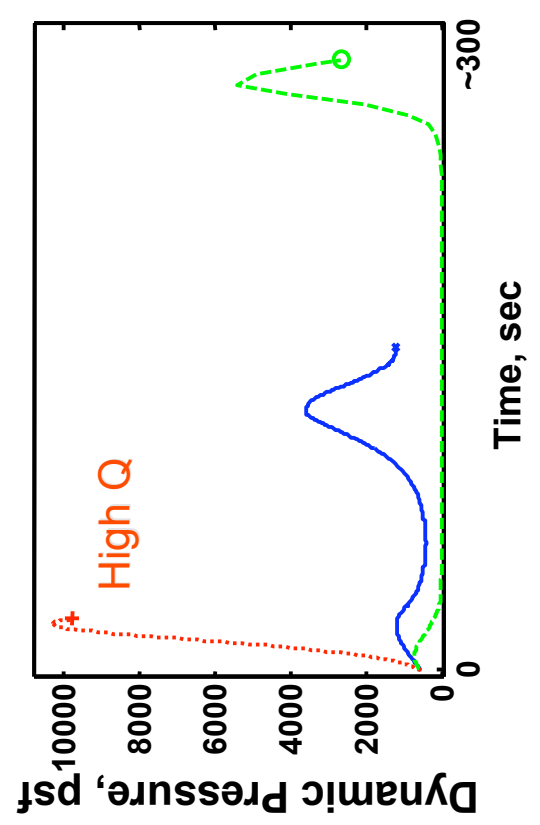


Missile data is telemetered through Western Missile Pacific Test Range to Control Room for Immediate Data Review

Sample Theoretical Trajectories



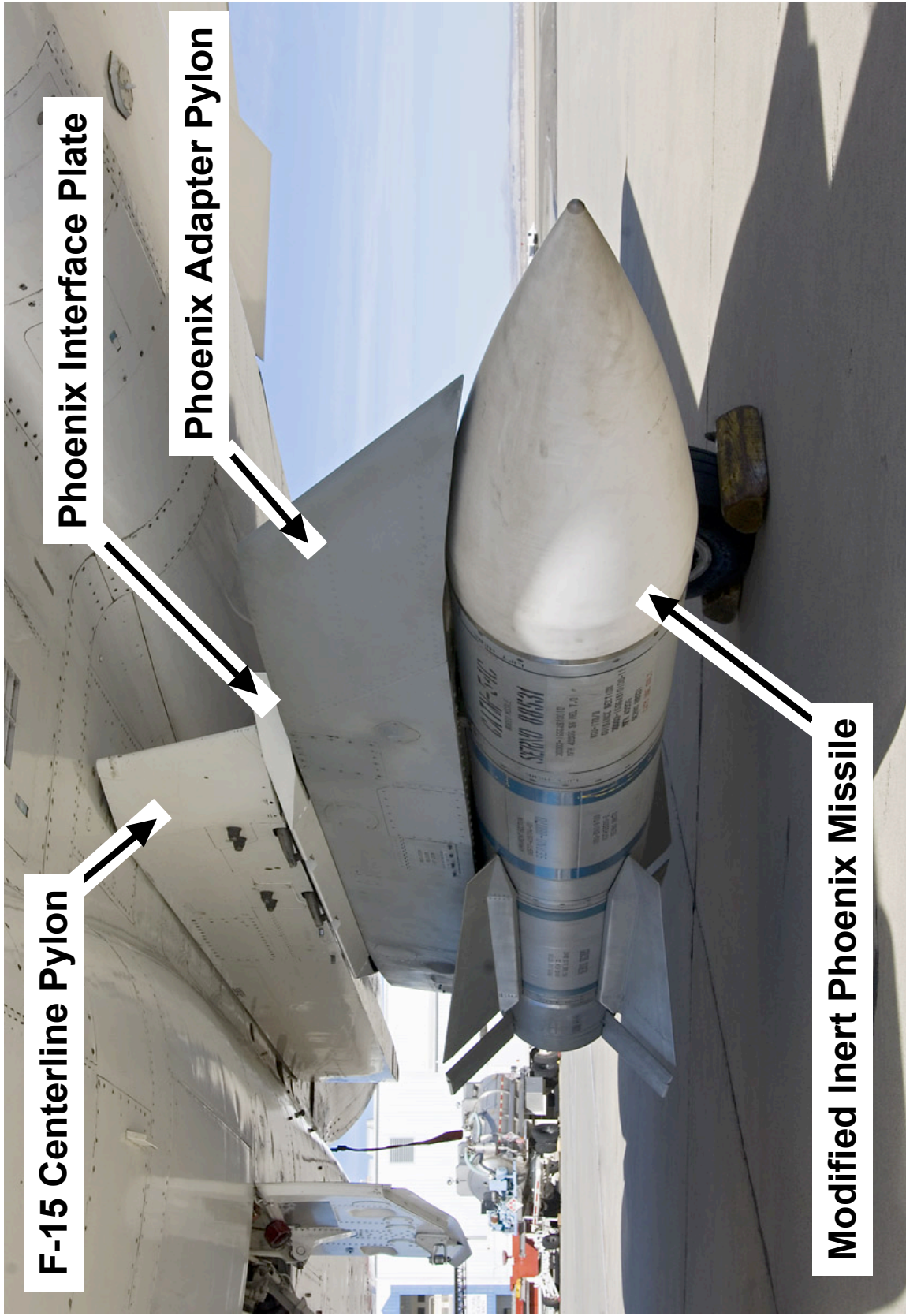
- The missile is capable of reaching useful high-speed test conditions
 - 8 seconds > mach 5.0
 - 50 seconds > mach 4.5
 - Weight reductions improve performance
- High altitude test conditions in excess of 300kft are also kinetically possible
 - Controllability of the store will limit this to <150kft without additional control mechanisms
- High dynamic pressure test conditions are also kinetically possible
 - Structural and actuator authority limitations will reduce capability from kinetic theory



F-15B / Phoenix Missile Fit-check
November 14, 2006



Phoenix Adapter Pylon



Possible Research Program Participants

- University Collaboration
 - Interested in utilizing the ARMD NASA Research Announcement (NRA)
- Industry Collaboration
- NASA Specific
 - ARMD
 - ESMD
 - SMD
- Other Government Agencies
 - DoD
 - DARPA
 - etc.

Possible Payloads

- Propulsion
 - Super/hypersonic inlet flight validation
 - Scramjet engine component validation including combustors and isolators
 - Fundamental combustion and flameholding
- Aerodynamics
 - Boundary layer laminar to turbulent transition experiment
 - External burning for transonic drag reduction
 - Supersonic parachute testing
- Systems
 - High speed flush air data system (FADS) validation
 - Avionics system flight validation
- Materials & Structures
 - High temperature seals
 - High temp leading edge validation
 - High temp instrumentation
 - TPS validation
- Guidance, Navigation, and Controls
 - Hypersonic control law validation
 - High speed GPS testing
- Science
 - High altitude research
- Others?

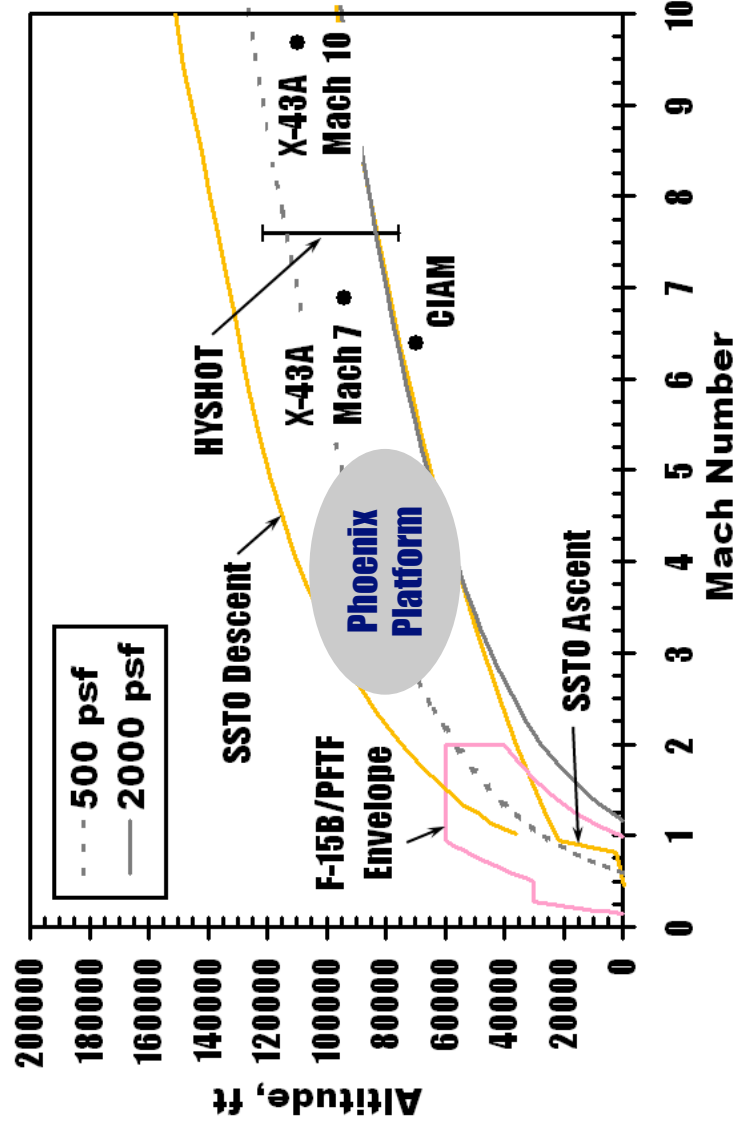


Estimated Development Milestone Schedule

- Evaluation of system performance envelope (*prelim. estimates complete*)
- Aircraft/missile separation analysis (*prelim. estimates complete*)
- Aircraft/adaptor pylon hardware interface design and fit check (*complete 10/14/06*)
- Aircraft performance analysis with captive missile (*prelim. estimates complete*)
- Development of 6-DOF Simulation (*in progress*)
- System requirements definition (*in progress*)
- Aircraft/missile GVT (Mar 07)
- System Requirements Review (SRR) (Mar 07)
- Aircraft/adaptor pylon electrical interface definition (Apr 07)
- Miniaturized guidance & flight control computer prelim. design (Apr 07)
- FTS and TM system prelim. design (Apr 07)
- Prelim. navigation & control law development (Apr 07)
- Preliminary Design Review (PDR) (May 07)
- Initial envelope expansion & performance flights with captive inert missile (Jun 07)
- Critical Design Review (CDR) (Nov 07)
- HIL/MIL V&V ground testing (FY08 Q2)
- Aircraft/missile separation flight test (FY08 Q3)
- Live fire flight test (FY08 Q4)
- Research payload flight tests (as nec. In FY09 and out)

Phoenix Fills Gaps in Flight Test Envelopes

- Bridges the large developmental gap between ground testing/analysis and major flight demonstrator X-planes *and*
- Bridges the gap between envelopes of existing piloted/ unpioted flight test platforms



- Provides subscale flight research data beyond the envelopes of existing piloted/unpiloted flight test platforms to increase the amount of relevant flight data
- Air-launch allows launch altitude, attitude, and location to be flexible
- Guided testbed allows placement of payload at desired conditions
- Research payload can be checked-out in a captive-carry flight environment at altitudes
- Leverages NASA Dryden's existing aircraft assets and NAWC Weapons Division's operational experience

Questions?

