MIT
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The Security Implications of Missile Defense- A Policy Perspective

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Beijing, China
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An Important Observation About What Drives the US Missile Defense Program

Extremely Important

US Missile Defense Policy is shaped mostly by US DOMESTIC POLITICS

A Comment on the State of US Domestic Politics

Paul Krugman,
Nobel Prize Winner in Economics and New York Times Columnist

Commenting on the US debate over economic priorities:

"what we have … is a political culture in which one side sneers at knowledge and exalts ignorance, while the other side hunkers down and pretends to halfway agree."

Paul Krugman, *Dumbing Deficits Down*, New York Times, March 10, 2011

Why Some Americans Believe Missile Defense is a Necessity

- Some US leaders genuinely believe that missile defense is needed.
- They believe it is needed because of the "moral superiority" of "American Values."
- Since the US is "inherently good," and is also wiser than other world cultures, missile defense allows the US to promote good around the world, without fear of retribution.
- They are not interested in the practical technical problems of whether a missile defense can be built.
- They simply assume that American ingenuity can solve any problem if enough money is committed to it.

The US Domestic Politics of Missile Defense

- Other political leaders see missile defense as an opportunity to portray their DOMESTIC political opponents as not concerned with defending the US from dangerous foreign enemies.
- Opponents of missile defense believe that it cannot be made to work, and that it would also be destabilizing.
- The democratic party has been an opponent of missile defense, but it has adopted a political strategy of "pretending that it could work" while at the same time trying to limit the program.
- This approach has been a political disaster, because the real issue is that there is no existng science or technology that could ever produce reliable and robust missile defenses.
- The democratic strategy of pretending that missile defenses could work has created a group of senior government officials who would now have to admit they were wrong. This creates yet another domestic political barrier to reversing these ill-advised programs

The US Domestic Politics of Missile Defense

- Before Obama took office he expressed skepticism about whether existing science could produce workable missile defenses.
- Once he became President, he decided to "give his opponents what they want" by "pretending his administration had a better idea of how to build such defenses." (The Phased Adaptive Approach)
- The Obama Administration now says that the better idea is the "Phased Adaptive Approach" to missile defense.
- In reality, the "Phased Adaptive Approach" has no technical merit. Later in this talk I will show why this is the case.
- The Obama announcement of the "Phased Adaptive Approach" was initially effective in creating a false understanding that progress in missile defense had been achieved. This political subterfuge is now beginning to unravel as analysis is made available to the public.
- As will be discussed later in this talk, US missile defense systems have seriousl and fundamental technical flaws. These technical flaws are ignored because of the dominance of domestic politics.

- The Obama Missile Defense Plan
- The "Phased Adaptive Approach"
- Initially Announced by President Obama on Thursday, September 17, 2009
- Elaborated on in the Ballistic Missile Defense Defense Review, signed out by Secretary of Defense, Robert Gates, on February 1, 2010

The Ballistic Missile Defense Defense Review

- *Ballistic Missile Defense Review* was directed by the President and mandated by Congress.
- It was conducted over ten months.
- Co-led by:

  Under Secretary of Defense for Policy,
  Michelle Flournoy

  Under Secretary of Defense for Acquisition, Technology and Logistics,
  Ashton B. Carter

  The Vice Chairman of the Joint Chiefs of Staff,
  James E. Cartwright

- Signed out by Secretary of Defense, Robert Gates, on February 1, 2010.
- It appears to have been conducted without any independent or competent scientific input.
- It describes the Nation's "New" Plans, Policies, and Strategies in Ballistic Missile Defense.
- According to the Department of Defense, which had oversight responsibility for the Review, it was conducted in coordination with many "other stakeholders."
- This suggests that the report was more of an internal political negotiation, rather than a technical review of the issues.
- The other "stakeholders" was the Department of State, the Department of Homeland Security, the Intelligence Community, the White House National Security Staff, and the Office of Management and Budget.

The Underlying Assumptions that Form the Foundations of the Ballistic Missile Defense Defense Review

- There are no basic or fundamental scientific problems that need to be solved in order to make it possible to build reliable and robust exo-atmospheric defenses.
- The key technologies needed to deploy reliable and robust exo-atmospheric ballistic missile defenses have been proven.
- Obtaining reliable and robust ballistic missile defenses is simply a matter of deploying the right numbers of interceptors and sensor systems to support them.
- There are some improvements to existing missile defense technologies that would be helpful, and will be implemented, but essentially everything that is needed to build reliable and robust missile defenses is already in-hand.
- The "new" national policy and strategy generates a vast and ambitious acquisition, deployment and national security strategy that is based on the *presumption* that the US can build robust and reliable global and regional ballistic missile defenses.
- If the United States cannot build reliable and robust ballistic missile defenses, the arguments for and reality behind this national strategy falls apart. This would then, with near certainty, result in massive US national security failures in the next decade.

The Underlying Assumptions that Form the Foundations of the Ballistic Missile Defense Defense Review

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The Technical Achievements Presumed by the Ballistic Missile Defense Review are Codified in Numerous Statements

- **The United States is *currently protected against limited ICBM attacks*.**

  This is a result of investments made in the ground-based midcourse defense system (GMD) by the Bush and Clinton administrations over the past decade.

- **This advantageous position of the US has made it possible to counter the projected ICBM threat from North Korea and Iran for the *foreseeable future*.**

- **However, given the uncertainties about the future ICBM threat, including the time-period in which it could mature, the United States *will have to continue to invest heavily in the GMD system so as to maintain this advantageous position*.**

- **In the area of regional ballistic missile defenses "recent successes" have demonstrated that the US can now rely on missile defense systems like the Navy's Standard Missile 3 (SM-3) ballistic missile defense system and the Army's Patriot and THAAD systems.**

- **The Navy's SM-3 system has proven so reliable in its tests that the US will push hard for major upgrades and deployments.**

- **The SM-3 Block IA will be upgraded to the Block IB (in 2015), to the IIA (in 2018) and to the IIB (in 2020). These upgrades will enhance the already substantial US capability to defend the Continental US from ICBM attack.**

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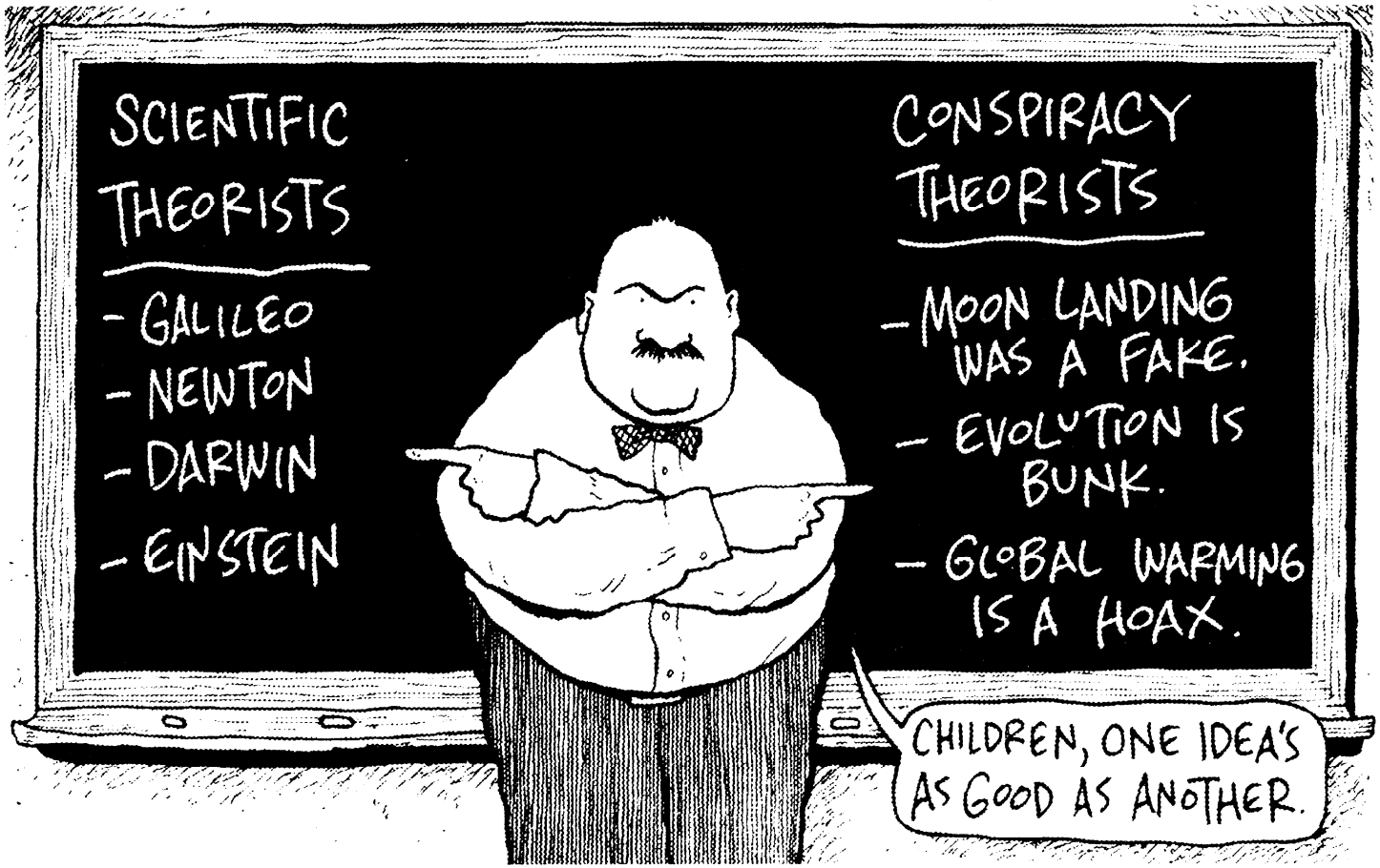
The Basis for the Ballistic Missile Review

- *The Ballistic Missile Defense Review* **is supposed to be a document that is based on a technical assessment within a political context.**
- **In reality, the** *Ballistic Missile Defense Review* **is a purely political document that has no basis in technical truths.**

A National Defense Strategy Based on Provably False Assumptions

- **Assumptions Used by the DoD for GMD Performance Cannot Possibly be Known Hence, Actual Performance of the GMD is Unknowable**
- **The Record of "Proven Reliability" of the Navy's SM-3 Interceptor Actually Shows that the SM-3 Will Be Highly Unreliable in Actual Combat Conditions**



MISSILE DEFENSE THEORISTS

- NO SCIENTIFIC PROBLEMS
- TECHNOLOGY IS ALREADY IN-HAND
- CURRENT MISSILE DEFENSE SYSTEMS WORK
- US SELF DECEPTION ABOUT ROBUST MISSILE DEFENSES WILL CAUSE PROLIFERATORS TO GIVE UP

Tony Auth Philadelphia Inquirer, Universal Uclick

Financial Assumptions and Strategies Equivalent to the Assumptions and Strategies in the Ballistic Missile Defense Review

- **Assumption:**

  The US has an essentially limitless supply of money and no meaningful level of debt.

- **Strategy that Builds on Assumption:**

  The US can address its current economic crisis without any concerns about financial or debt limitations.

Potential Consequences of Current Ballistic Missile Defense Strategy

- The United States could damage its relations with allies and friends by pushing on them false and unreliable solutions to real security problems.
- The United States will antagonize both Russia and China with massive defense deployments that have the appearance of being designed to be "flexibly" adaptable to deal with Russian and Chinese strategic forces.
- The negative effects of a costly and energetic US program that appears to be aimed at blunting Russia's strategic retaliatory strike forces will sow distrust of the US within the Russian government and will create significant barriers to future arms reductions efforts.
- If arms reductions efforts with Russia come to a halt, this will have serious adverse effects on Russian and US efforts to maintain the viability of the Nonproliferation Treaty of 1968, which is already under considerable pressure due to the US-India Nuclear Deal and lack of past progress in arms reductions.
- By deploying systems that are easy to defeat, the United States could fail to deter, or actually stimulate, ballistic missile proliferation. With near certainty we can expect proliferators like North Korea and Iran to introduce highly effective countermeasures against the missile defense-systems (GMD, SM-3, THAAD, and possibly even Patriot) that the US has currently chosen to emphasize. These proliferators could, and likely would, sell these countermeasures to client states.

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Another Example of the Dominant Influence of Domestic Politics on US Ballistic Missile Defense Planning

- North Korea is only one successful flight test away from demonstrating a launch vehicle that could be used as an ICBM that would range the entire Continental United States. The United States could become vulnerable to such an ICBM threat, because it is building the wrong missile defense-systems to deal with it.
- There are alternative defense-systems that could defend the United States from ICBM attack from North Korea and Iran. The new missile defense strategy de-emphasizes these defense-systems in favor of unproven, unworkable, and far more expensive systems.

Basic Outline Obama Missile Defense Plan (Announced on Thursday, September 17, 2009)

- Put Aside (NOT Scrap Flawed) Plan to Deploy 10 Interceptors in Poland and an X-Band Radar in the Czech Republic (Change one flawed plan for another).
- Immediately Use Aegis Ships Armed with SM-3 Block IA Interceptors to Provide Some Defense for Southeastern Europe
- Deploy SM-3 Block IB Interceptors on the Ground As Needed to Enhance Defense Coverage and Number of Interceptors
- Deploy Forward-Based X-Band Radars to Provide Tracking, Discrimination and Engagement Functions for the Defense
- Continue Modernizing the SM-3 Series of Interceptors Towards the Eventual Deployment of SM-3 Block IIA for Full Defense-Coverage of Europe by 2018
- Develop and Use a New SM-3 Block IIB Interceptor for Enhancing Interceptor Firepower Against ICBMs for Defense of the US
- No Mention of Boost-Phase Against Non-Mobile ICBMs Launched from Fixed Sites

Issues Addressed and Raised by the Obama Missile Defense Plan (Announced on Thursday, September 17, 2009)

- The Plan "Puts Aside" a Defense System that had No Chance of Working and that Addressed a Threat from Iran that Does Not Now, and May Never, Exist
- The Plan Focusses Attention on Iran's Short-Range Conventionally-Armed Ballistic Missiles.
- It Uses Much Lighter, Less Expensive, and Therefore Potentially Many More Interceptors to Address Existing Iranian Capabilities to Launch Many Tens of Shorter Range Conventionally-Armed Ballistic Missiles that Could be Used to Attack Targets in Southeastern Europe (Turkey, Greece, etc.)
- The Choice to Go to Many Interceptors Implies an Emphasis on Defending Against Conventionally Armed Ballisitic Missiles. At $10 million + per Interceptor, It Is Hard to Understand Why There is No Emphasis on Passive Defense.
- The Interceptors Could be Readily Deployed on Ships or on Land, Where They Can Be Located for Optimal Defense of Potential Targets.

Issues Addressed and Raised by the Obama Missile Defense Plan (Announced on Thursday, September 17, 2009)

- **The Interceptors, Which Home on the Infrared Signals from Attacking Missiles at High-Altitude Will Still Be Susceptible to Certain Infrared Countermeasures. However, As Long As the Attacking Ballistic Missiles are Not Nuclear-Armed, the Effects of Successful Countermeasures Will be Much Diminished Relative to Attacks that Utilize Nuclear-Armed Ballistic Missiles.**

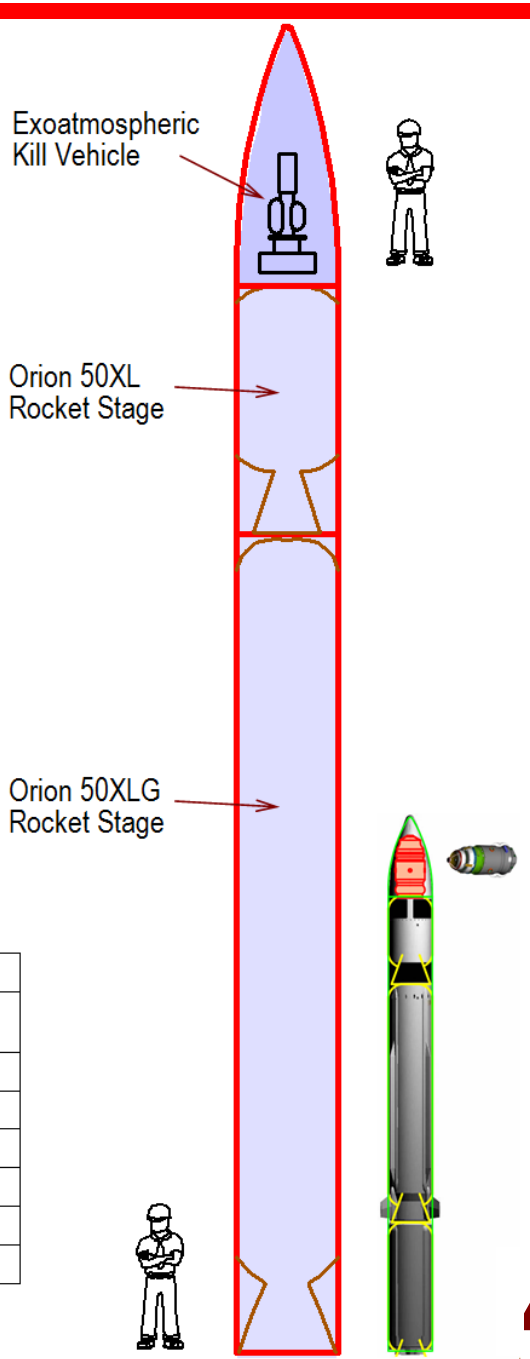
The Rise of the "Phased Adaptive Approach" as a Replacement for the European Missile Defense System

The Phased Adaptive Approach Simply Replaces a Small Number of Heavy Ground-Based Interceptors with Numerous Light Sea-Mobile

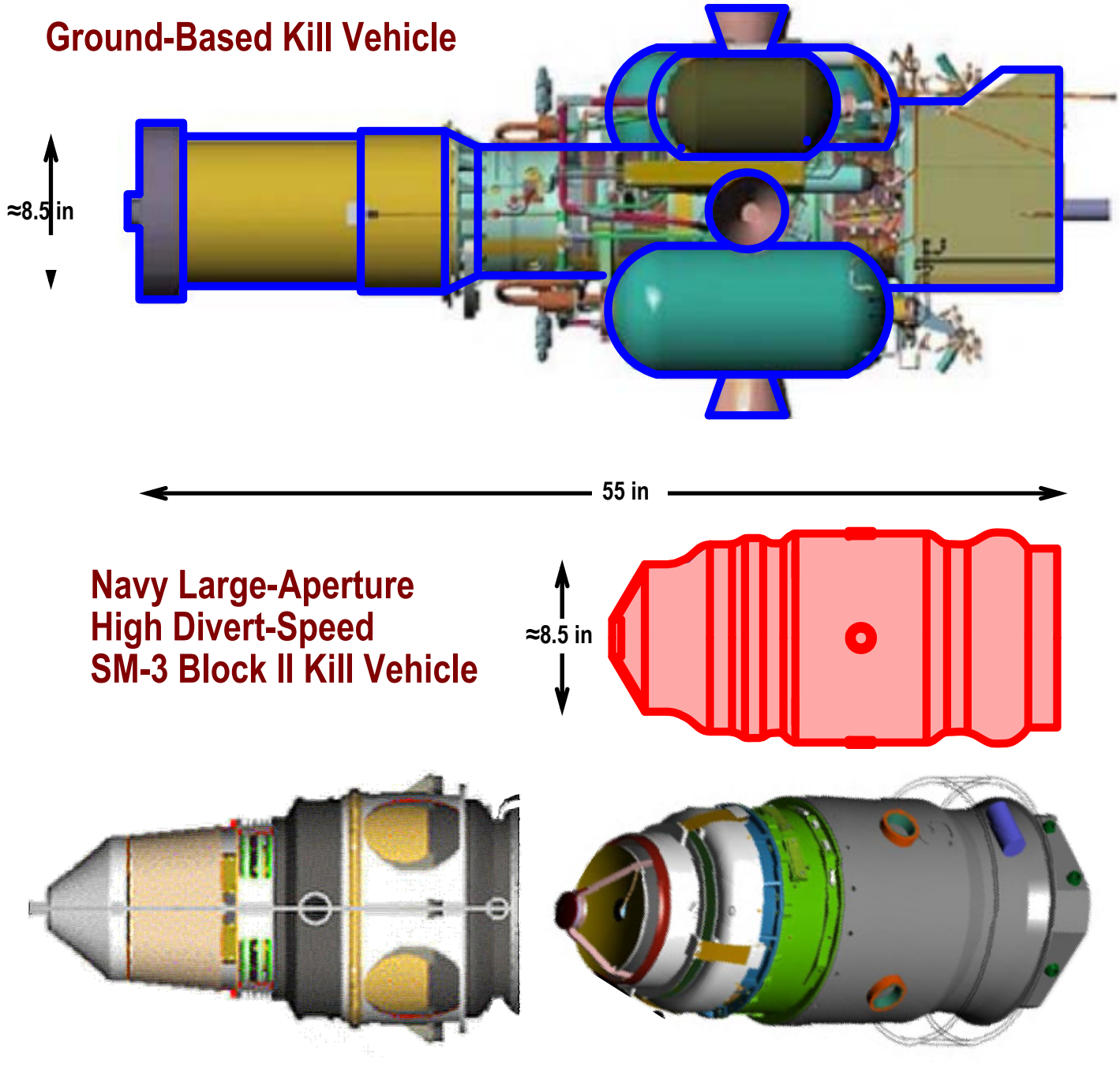
Orbital Sciences Ground-Based Interceptor and Raytheon Exoatmospheric Kill Vehicle

Estimated Dimensions and Weight of the National Missile Defense Launch Vehicle			
Rocket Components	Length (ft)	Diameter (ft)	Component Weight (lbs)
Shroud	11.6	4.17	200
Payload (Kill Vehicle)	–	–	155
Payload Adaptor	–	–	–
1st Stage (Orion 50XLG)	33.8	4.17	37,800
2nd Stage (Orion 50XL)	11.7	4.17	9,500
Total	51.4	–	47,655

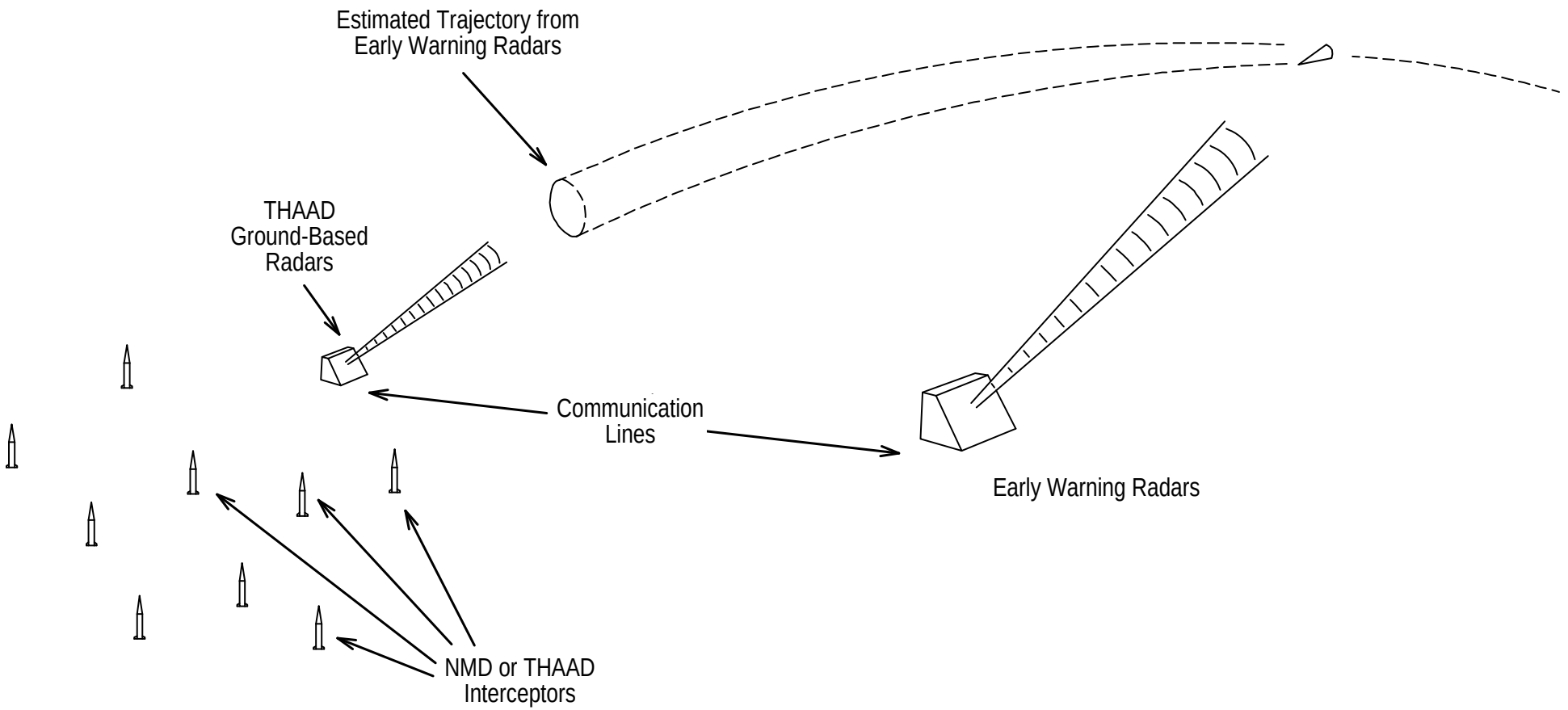
Estimated Performance Parameters of the National Missile Defense Launch Vehicle							
Rocket Components	Burn Time (sec)	Vacuum Specific Impulse (sec)	Vacuum Thrust (lbs)	Component Weight (lbs)	Propellant Weight (lbs)	Empty Weight (lbs)	Empty/Full Mass Fraction
Shroud	–	–	–	200	–		
Payload (Kill Vehicle)	–	–	–	155	–		
Payload Adaptor	–	–	–	–	–		
1st Stage (Orion 50XLG)	70	295	149,500	37,800	35,480	2,320	0.0614
2nd Stage (Orion 50XL)	70	289	36,000	9,500	8,680	820	0.0859
Total	140	–	–	47,655	–		



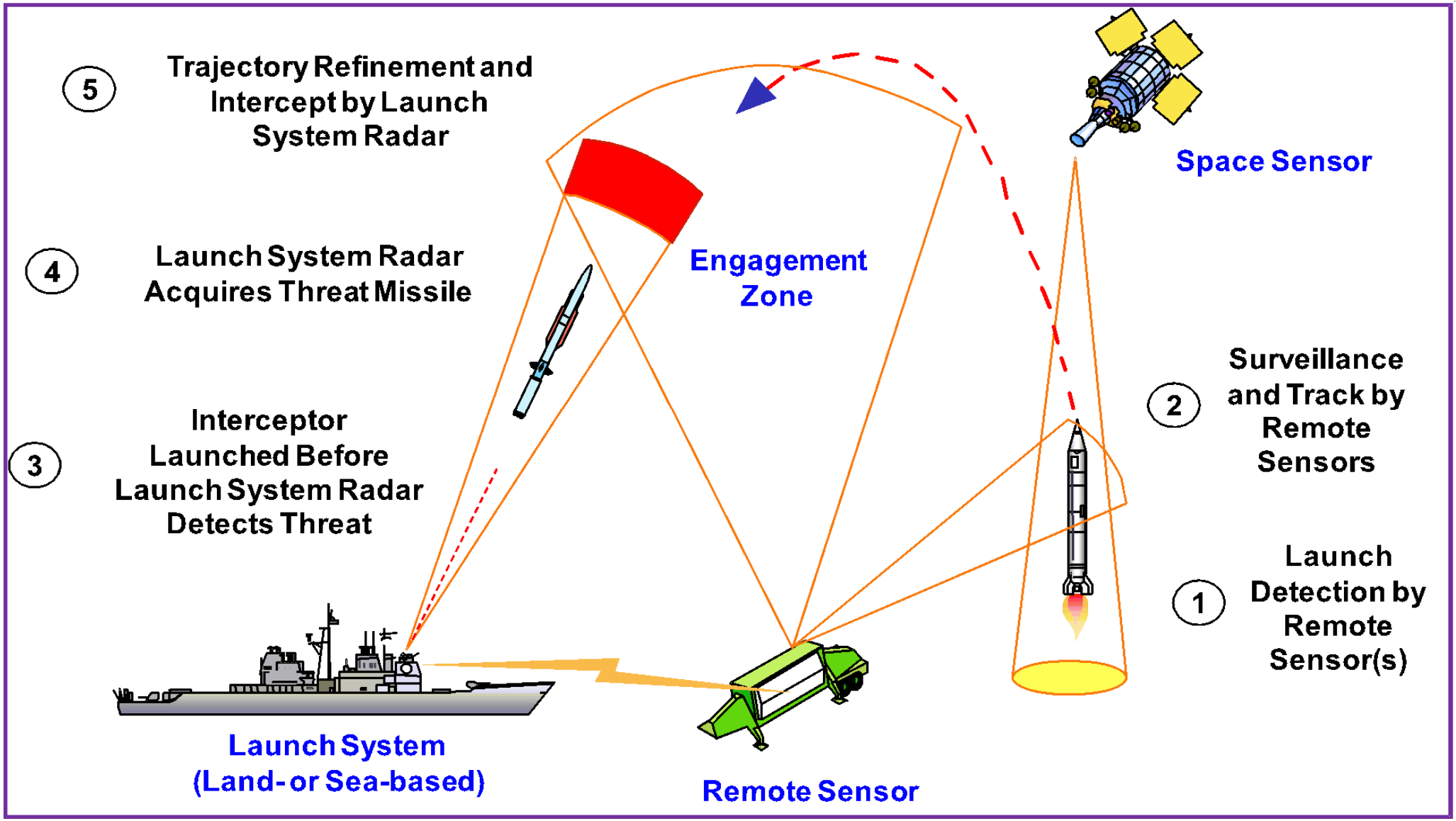
Comparative Dimensions of the Exoatmospheric Ground-Based Kill Vehicle and Different Generation Navy Aegis Kill Vehicles



Basic Functional Architecture of a Baseline and Expanded National Missile Defense



Navy Aegis Concept of Operation
Ship Radar Inadequate, Land Radar Marginal, and Interceptor Acceleration and Speed Low



Radar Search, Acquisition and Tracking Capabilities in the Phased Adaptive Approach is Very Weak

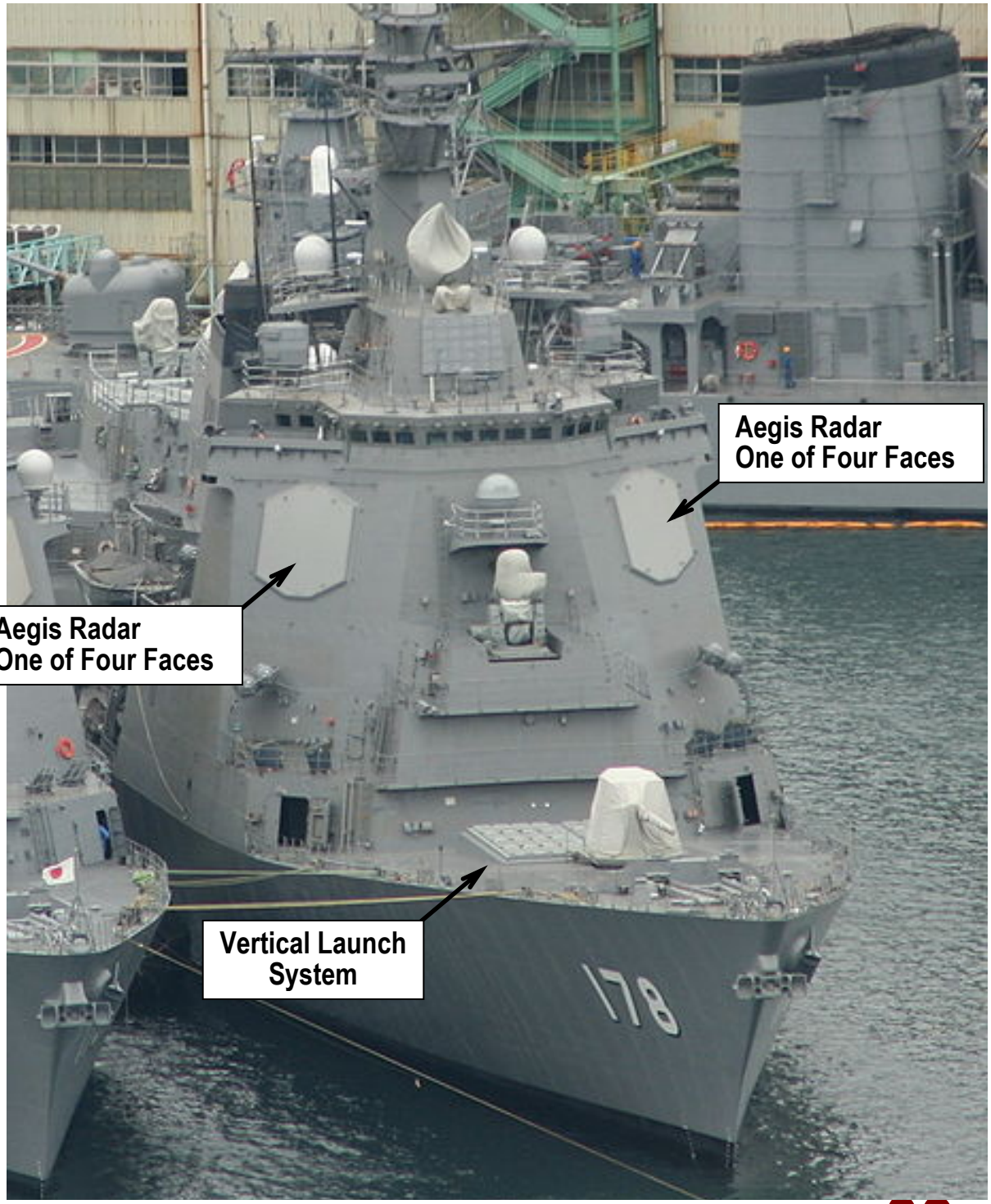
Aegis Cruiser and Destroyer Radar System

Radar Characteristics

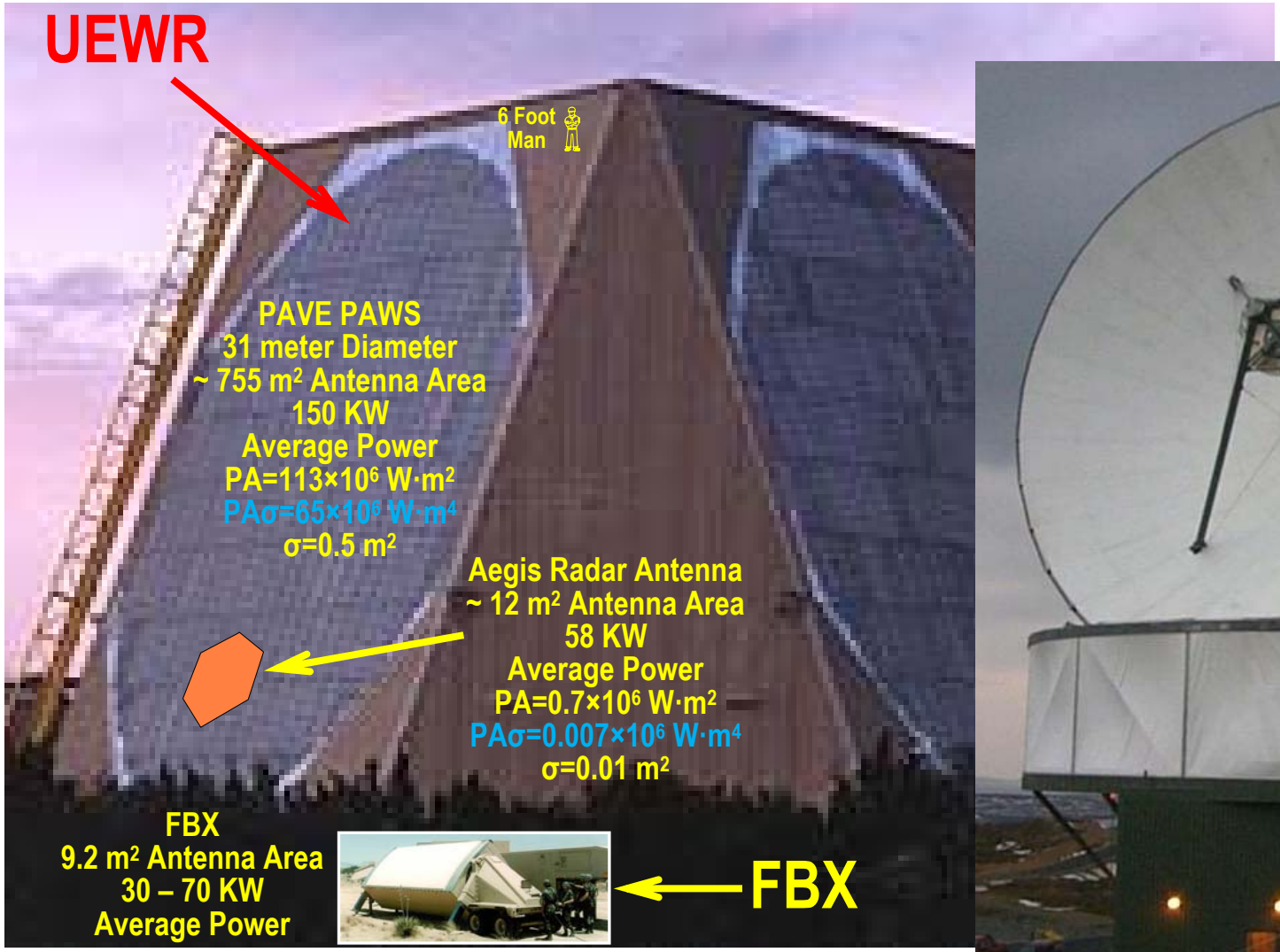
Average Power per Radar Face = 58 KW
Face Area = 12 M^2
3.3 GHz Frequency (S-Band)
Assumed System Losses = 10
Known System Temperature = 500°K

Estimated Performance per Dwell

Range Against 1M^2 Target ≈ 900 – 1000 km
(Single 0.1 Second Dwell)
Coherent S/N = 56, Incoherent S/N ≈ 20 -25
Range Against 0.01M^2 Target ≈ 250 – 300 km
(Single 0.1 Second Dwell)
Coherent S/N = 56, Incoherent S/N ≈ 15 -20
Beam Width:
1.5° × 1.5° ≈ 2 Square Degrees per Dwell



Comparison of the Relative Sizes and Average Power of the Fylingsdale UEWR, the GLOBUS II Radar at Vardo, Norway, and the Forward-Based X-Band (FBX) Radar



Aegis Radar
Average Power per Radar Face = 58 KW
Face Area = 12 M^2
3.3 GHz Frequency (S-Band)

The Forward-Based X-Band Radar (FMX) Has Limited Acquisition Abilities Against 0.01 m^2 Cone-Shaped Warheads at Ranges Greater Than 600 to 700 km and Against 0.001 m^2 Targets at Ranges Greater Than 300 to 400 km

FBX Range ≈1300 km Against Targets with RCS 0.1 m² to 0.2 m² Targets

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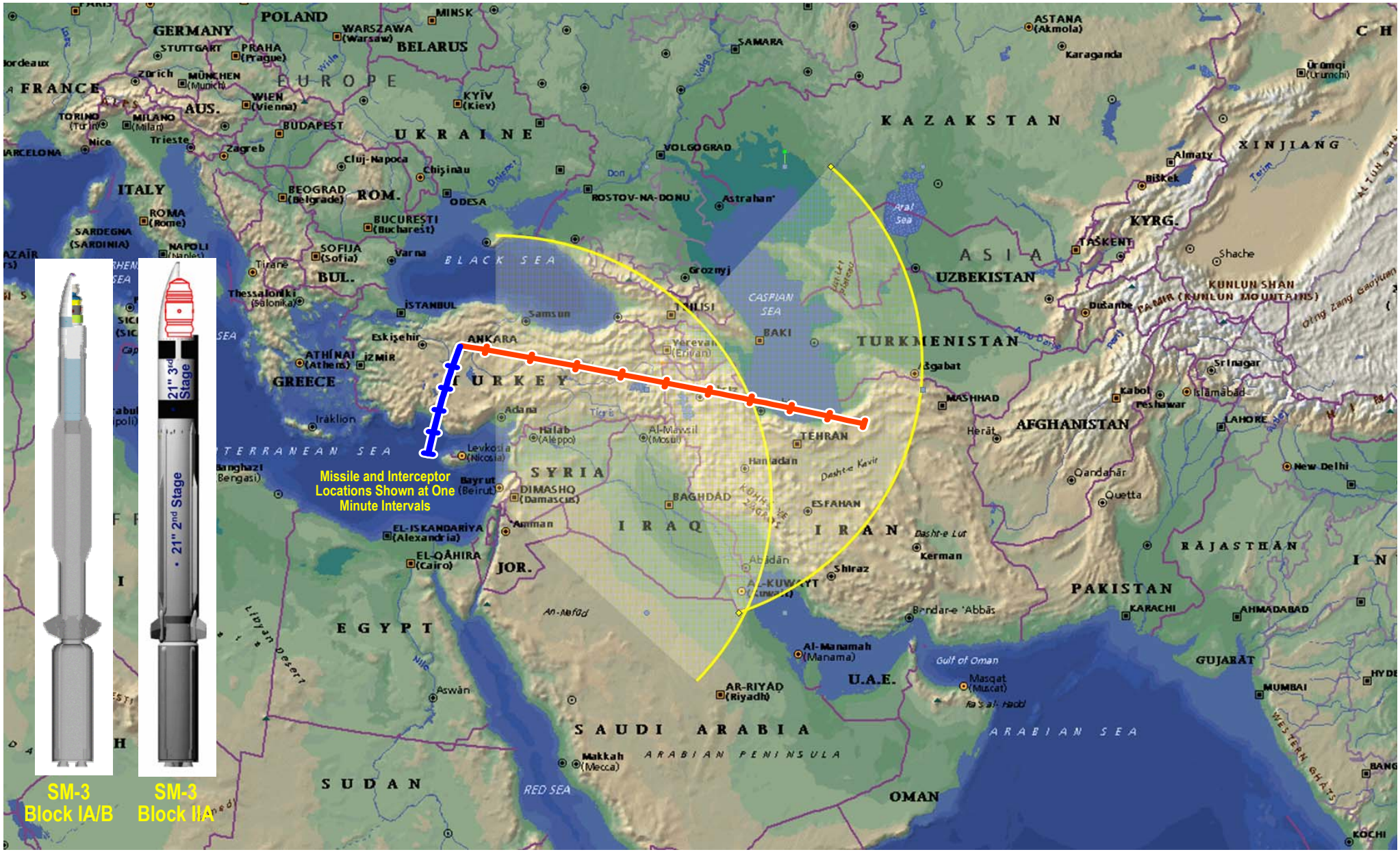
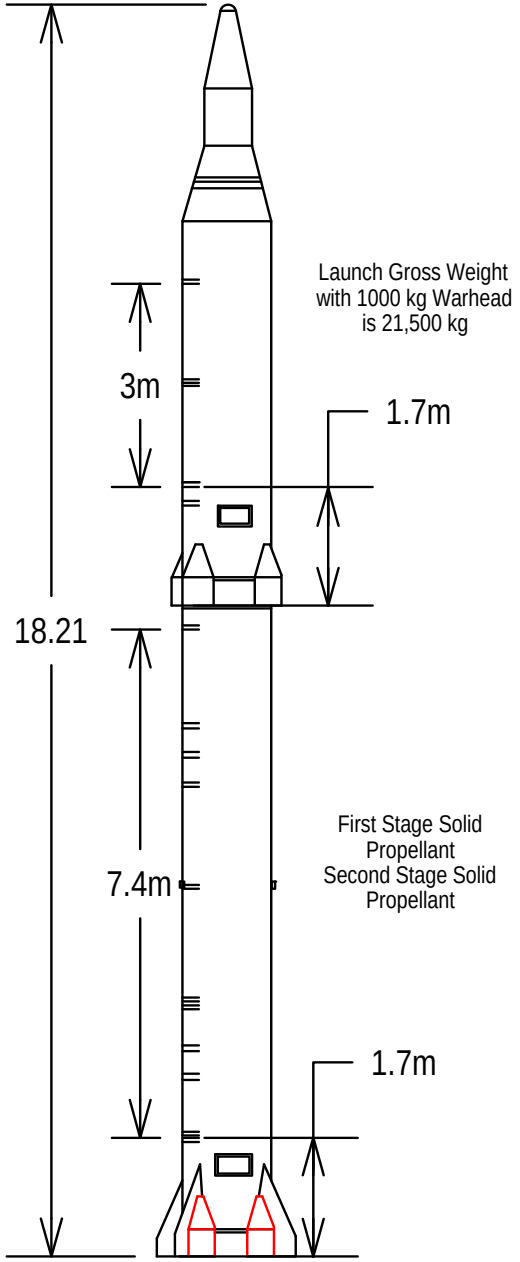
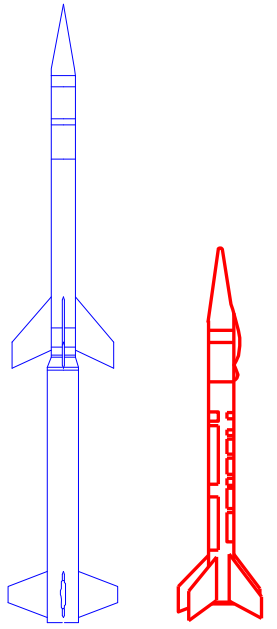


FBX Range ≈1300 km against Targets with RCS 0.1 m² to 0.2 m² Targets

Missile Defense Targets



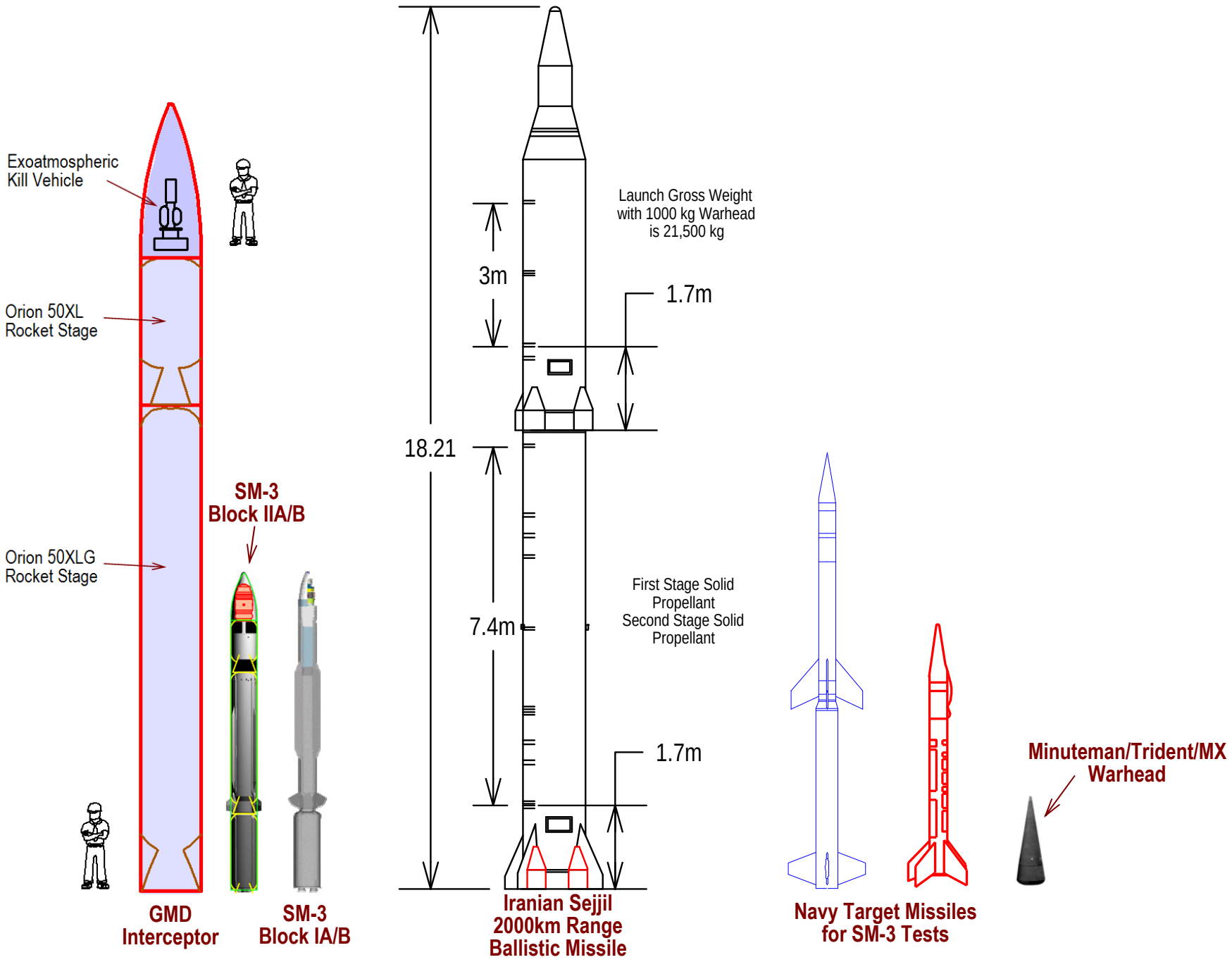
Iranian Sejjil
2000km Range
Ballistic Missile



Navy Target Missiles
for SM-3 Tests

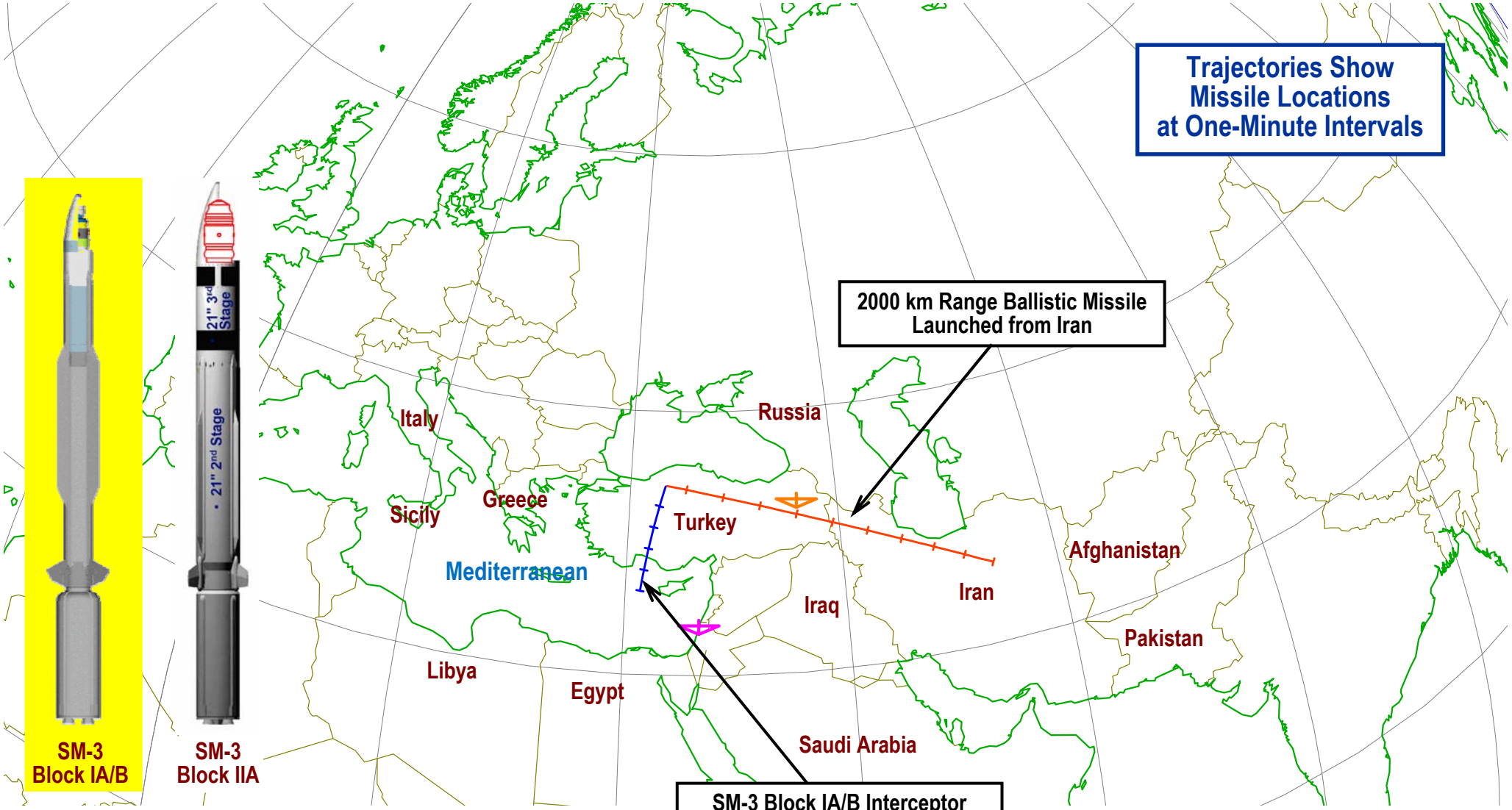
Minuteman/Trident/MX
Warhead

Missile Defense Targets and Interceptors



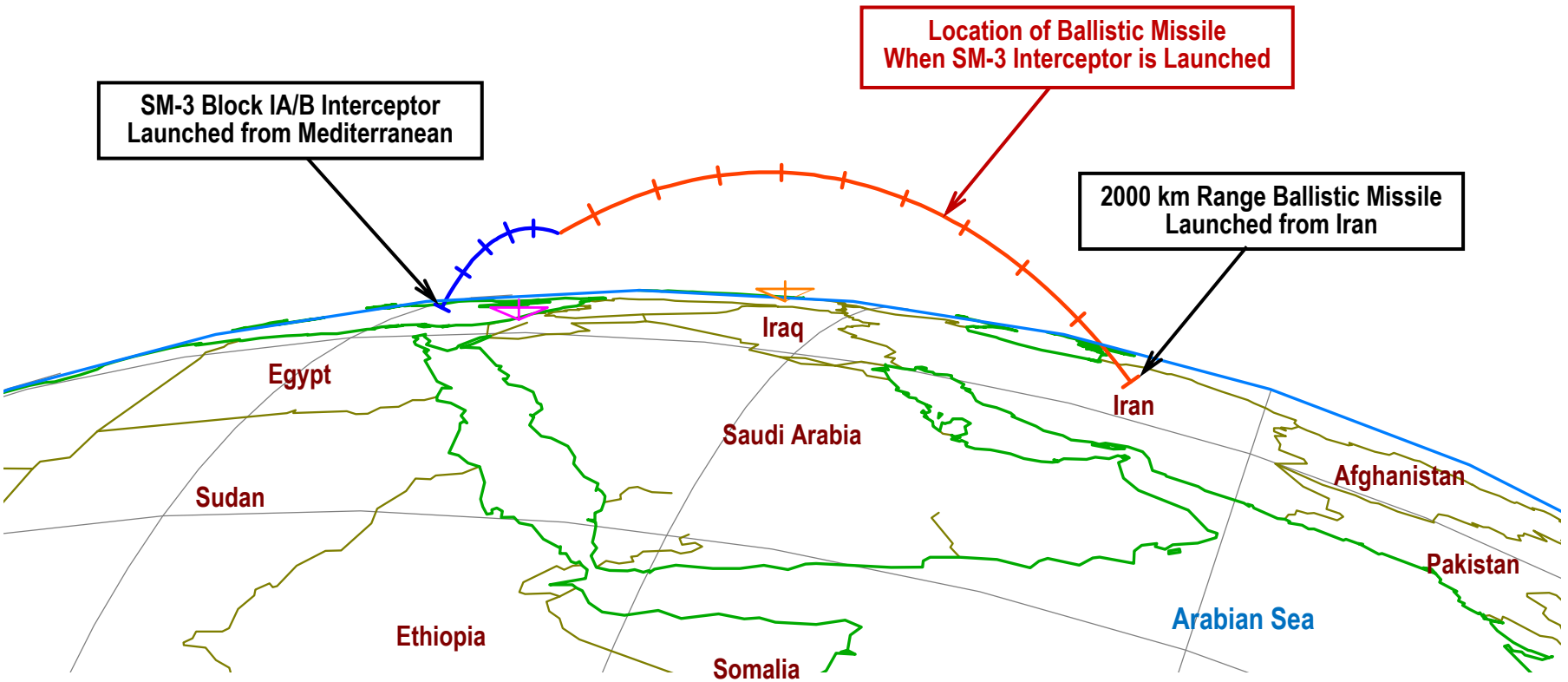
Notional Intercept Trajectory of Standard Missile 3 Block IA/B (SM-3 Block IA/B) Against 2000 km Range Iranian Ballistic Missile

Obama Missile Defense Plan (Announced on Thursday, September 17, 2009)

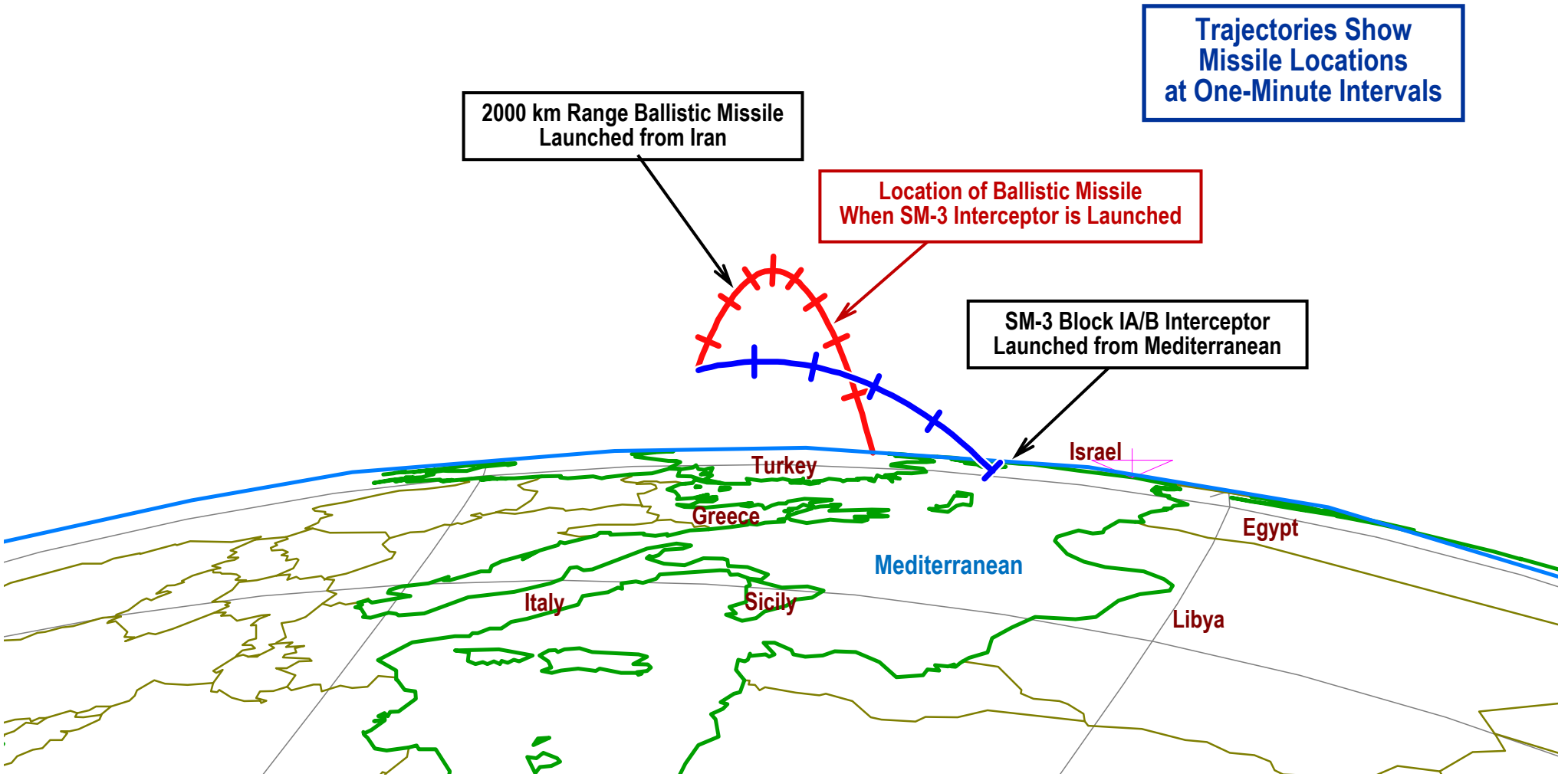


Notional Intercept Trajectory of Standard Missile 3 Block IA/B (SM-3 Block IA/B) Against 2000 km Range Iranian Ballistic Missile

Trajectories Show Missile Locations at One-Minute Intervals



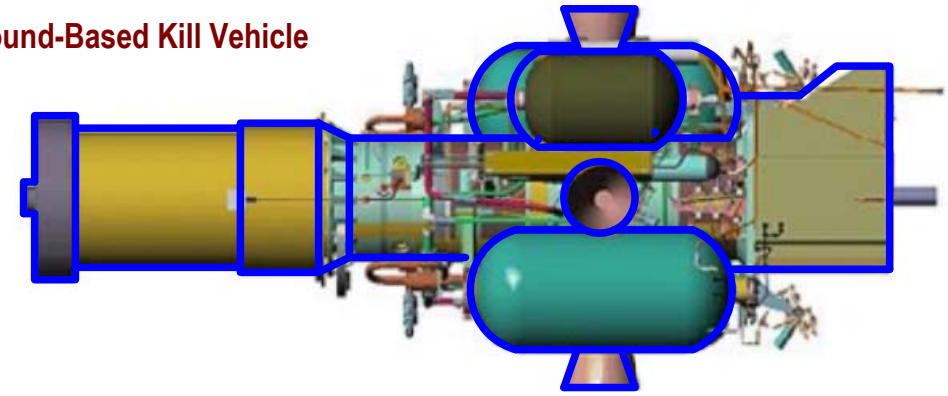
Notional Intercept Trajectory of Standard Missile 3 Block IA/B (SM-3 Block IA/B) Against 2000 km Range Iranian Ballistic Missile



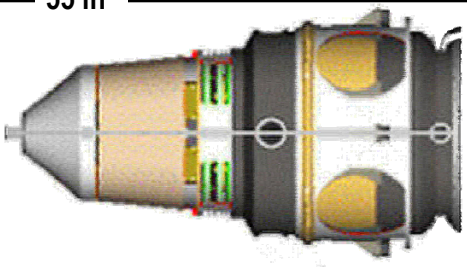
All the Interceptors in the GMD and PAA Systems Home on Targets Using Infrared Telescopes

The Same Basic Physics Governs the Homing of All the Kill Vehicles

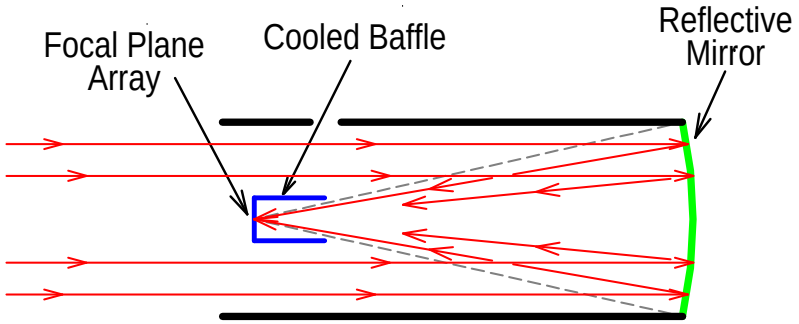
Ground-Based Kill Vehicle



Navy SM-3 Block IA Kill Vehicle



All the Kill Vehicles Use a Telescope and Infrared Sensors for Homing on Targets



What the US Defense Planner Expects the Kill Vehicle to See

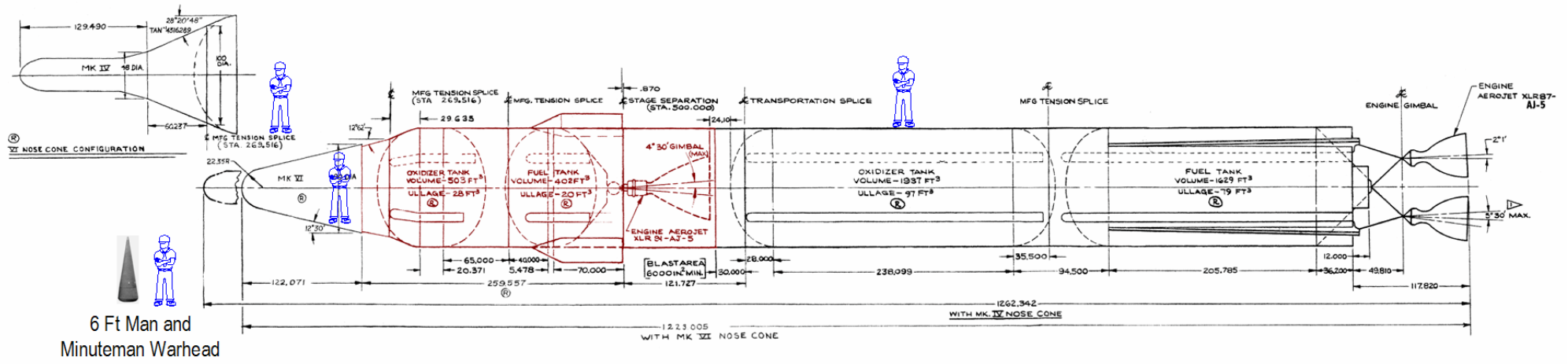
What the Defense Planners Expect the Infrared Sensor on the Homing Interceptor to See

What the US Kill Vehicle Might Actually See

What the Infrared Sensor on the Homing Interceptor Might Actually See!

False Targets Cloud Created in Army Ballistic Missile Development Agency Test Using a Titan II ICBM on January 10, 1975, Signature of Fragmented Tanks (SOFT),

Booster Fragmentation



Titan II outboard configuration.
6 July 1960. The Martin Co., Denver.

False Targets Cloud Created in Army Ballistic Missile Development Agency Test Using a Titan II ICBM on January 10, 1975, Signature of Fragmented Tanks (SOFT),

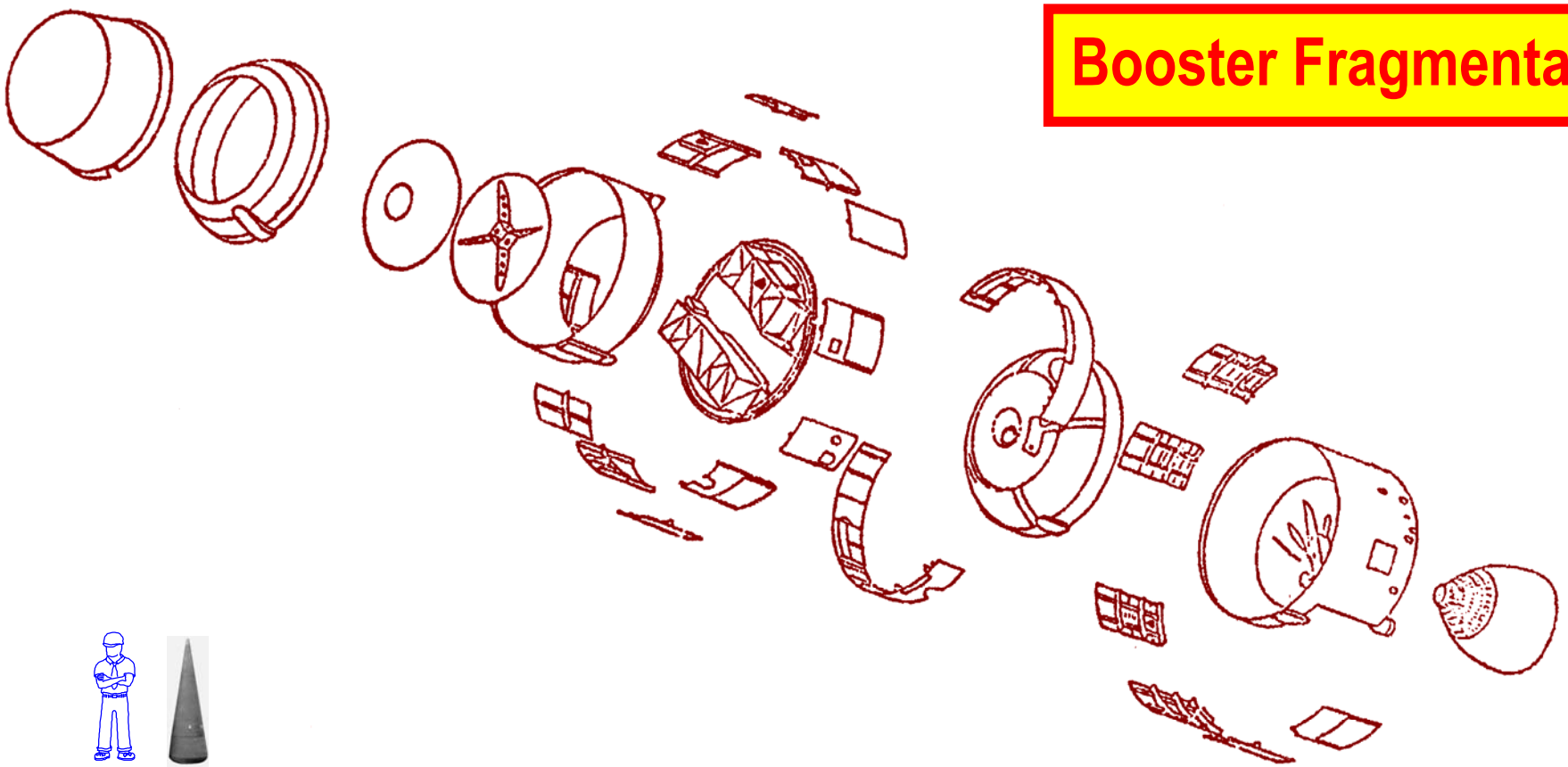
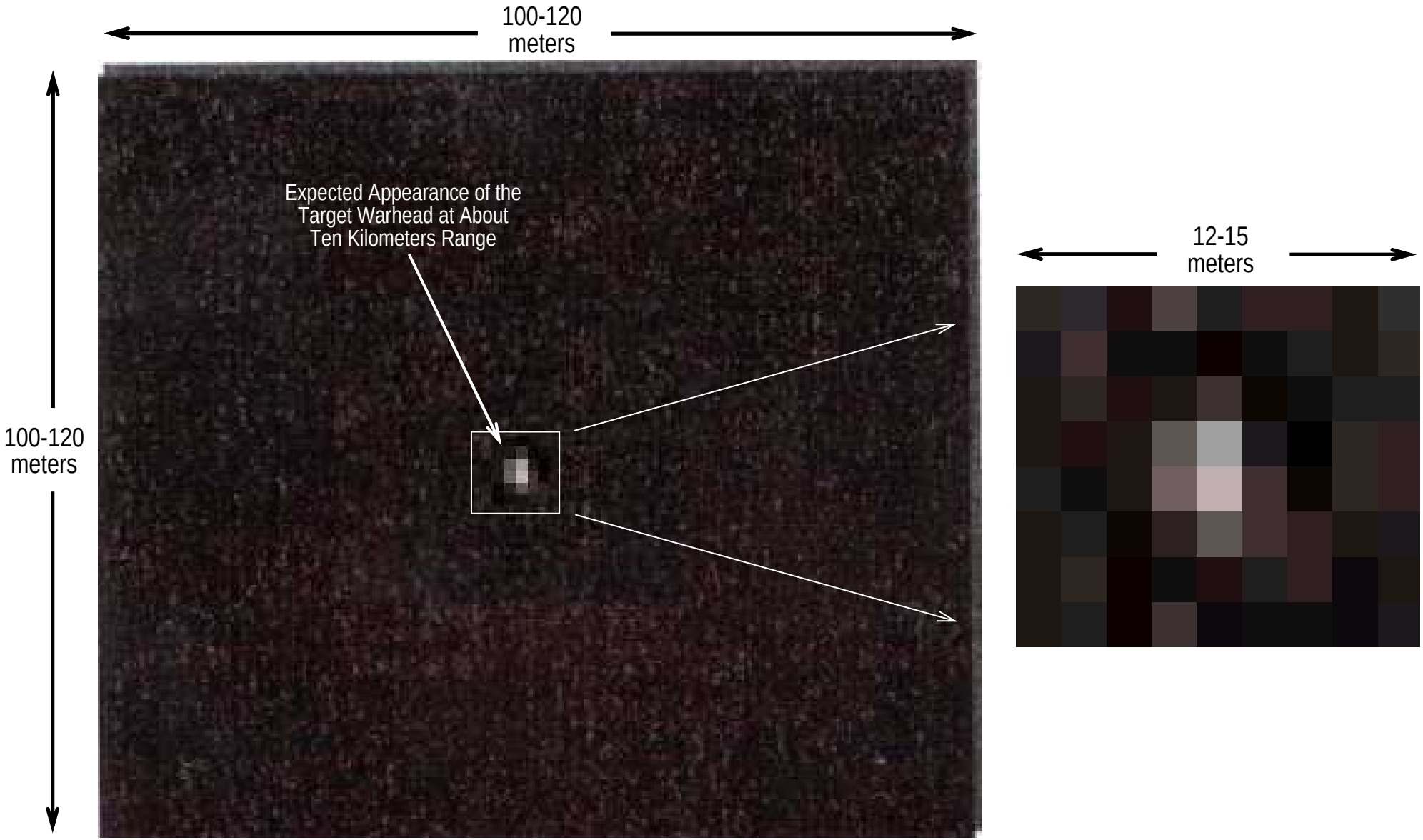
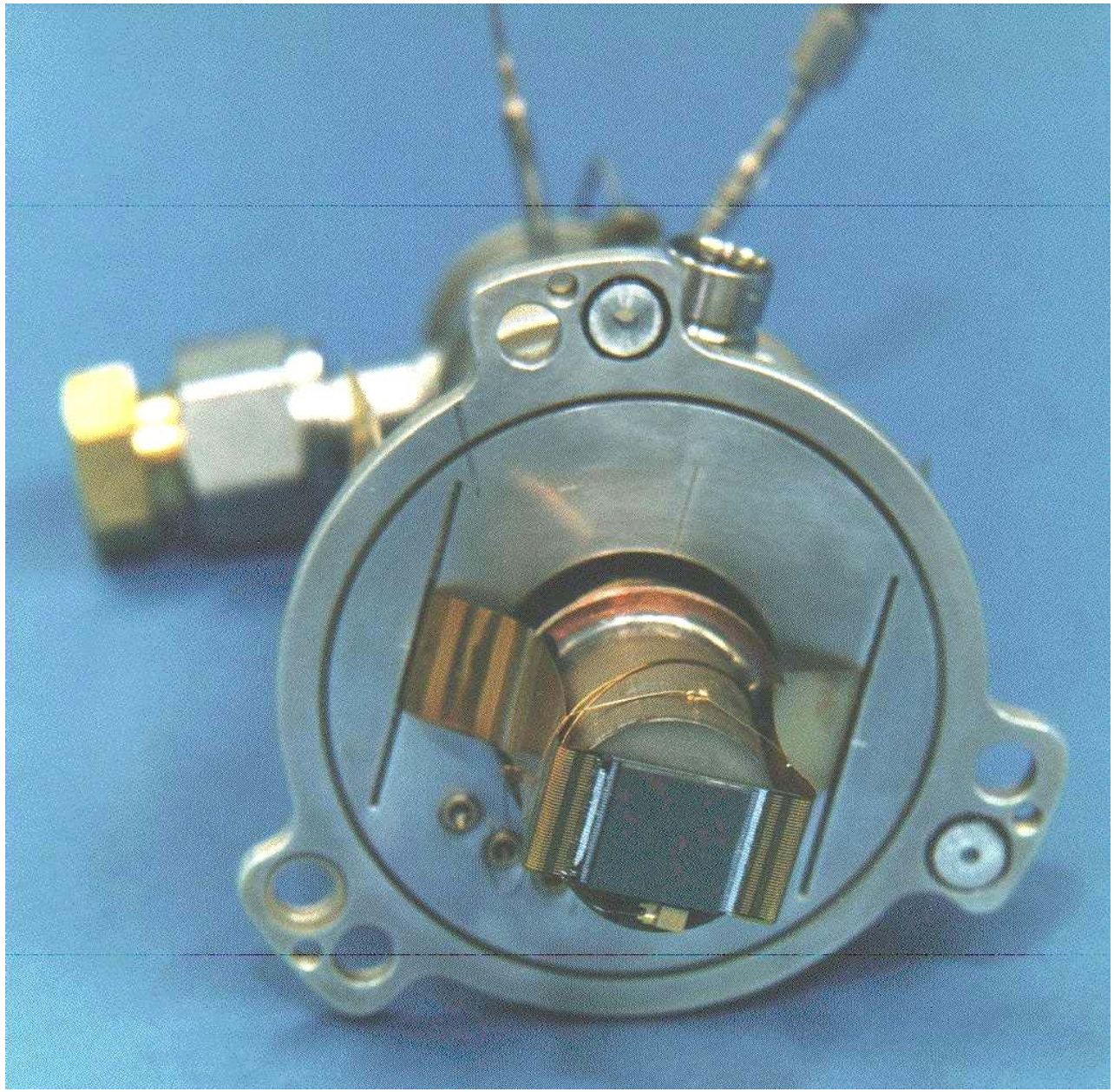


Figure 8.4. The Signature of Fragmented Tanks experiment cut the Stage II of Titan II ICBM B-27 (62-008) into the numerous pieces shown above. The resulting debris cloud was used to test the ability of the Safeguard Anti-Ballistic Missile radar system to discriminate between debris from the upper stage and the reentry vehicle. From David K. Stumpf , "Titan II, A History of a Cold War Missile Program," The University of Arkansas Press, Fayetteville, Copyright 2000, pages 200-201

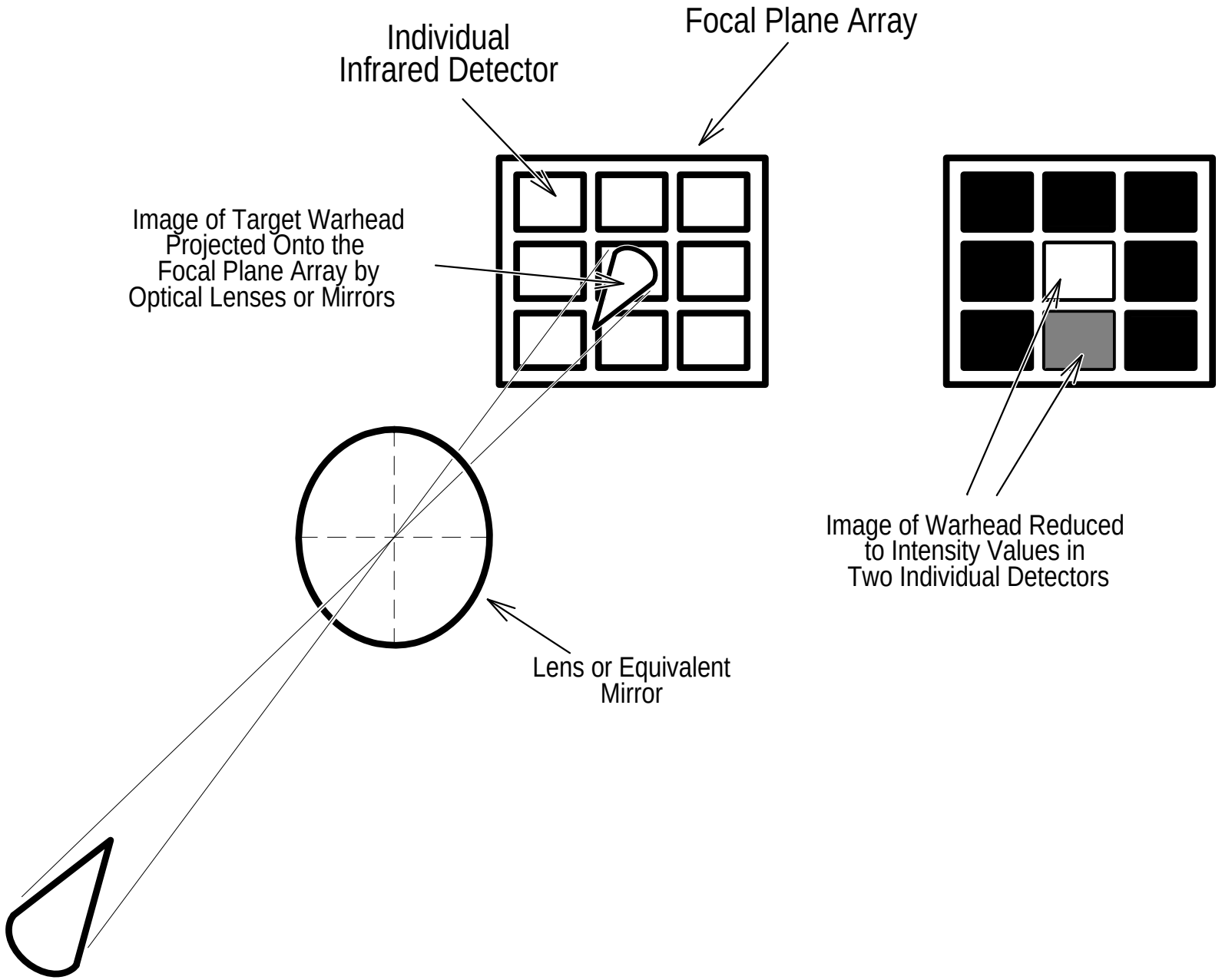
How Objects Appear to the Kill Vehicle



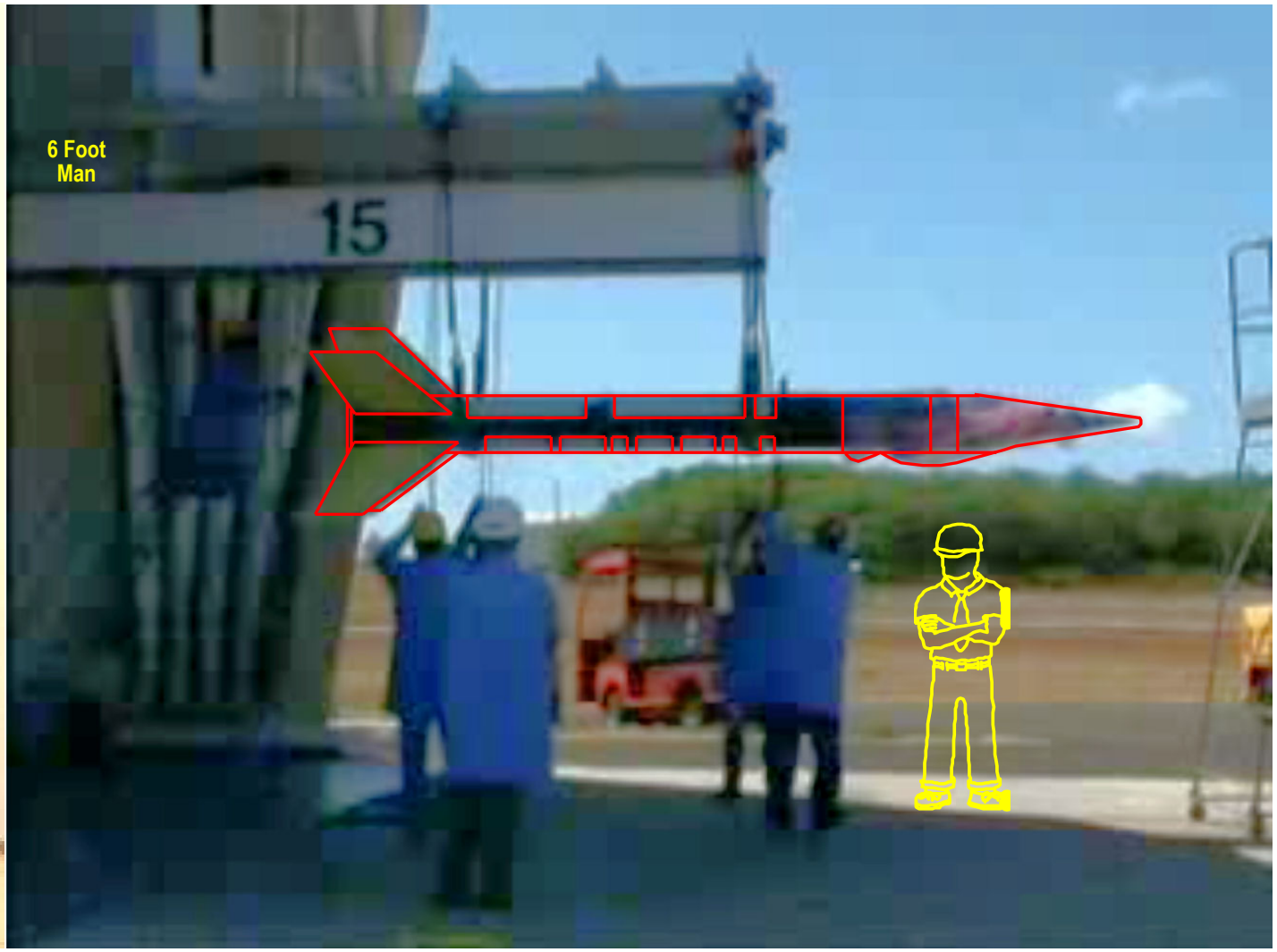
Focal Plane Array from the IFT-1A NMD Experiment



Resolution Limits Associated with Current Exoatmospheric Kill Vehicle Technology



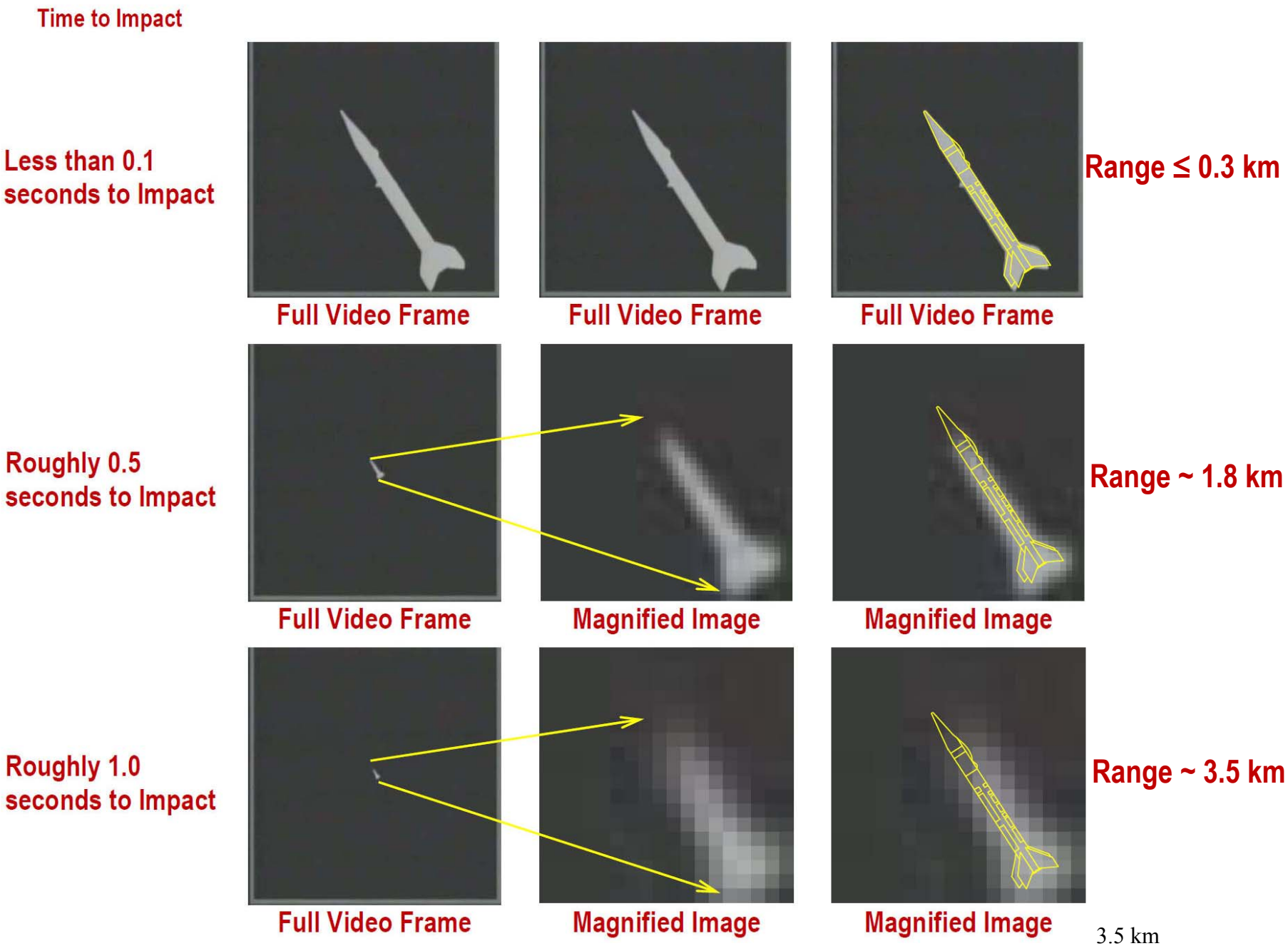
Current Testing of Missile Defense Systems



Current Testing of Missile Defense Systems

Terrier orion

Current Testing of Missile Defense Systems



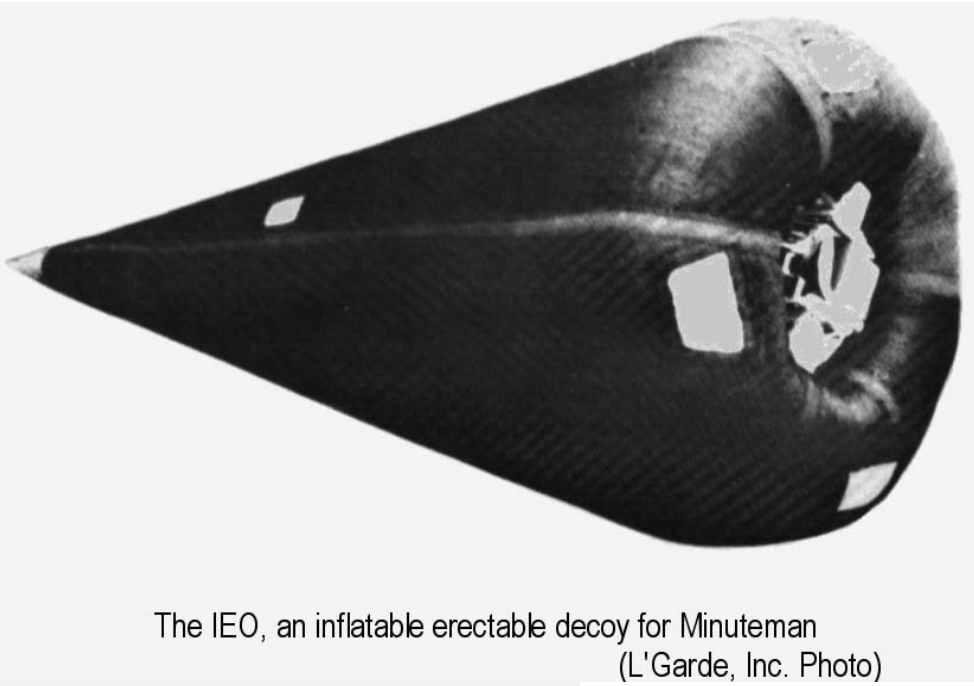
Conclusion from US Navy Videos of "Successful Intercepts

Simple countermeasures that disguise the location of the warhead from the infrared homing sensors are very easy to implement and Will Drastically Reduce the Chances of Hitting a Target

These Could Be Used as Decoys
or to Surround Warheads Disguising Them as Balloons

Balloons that Have Been Flown in Space

The Kill Vehicle Must Determine Which of These Are Warheads and Which are Decoys from 500 Kilometers Range!

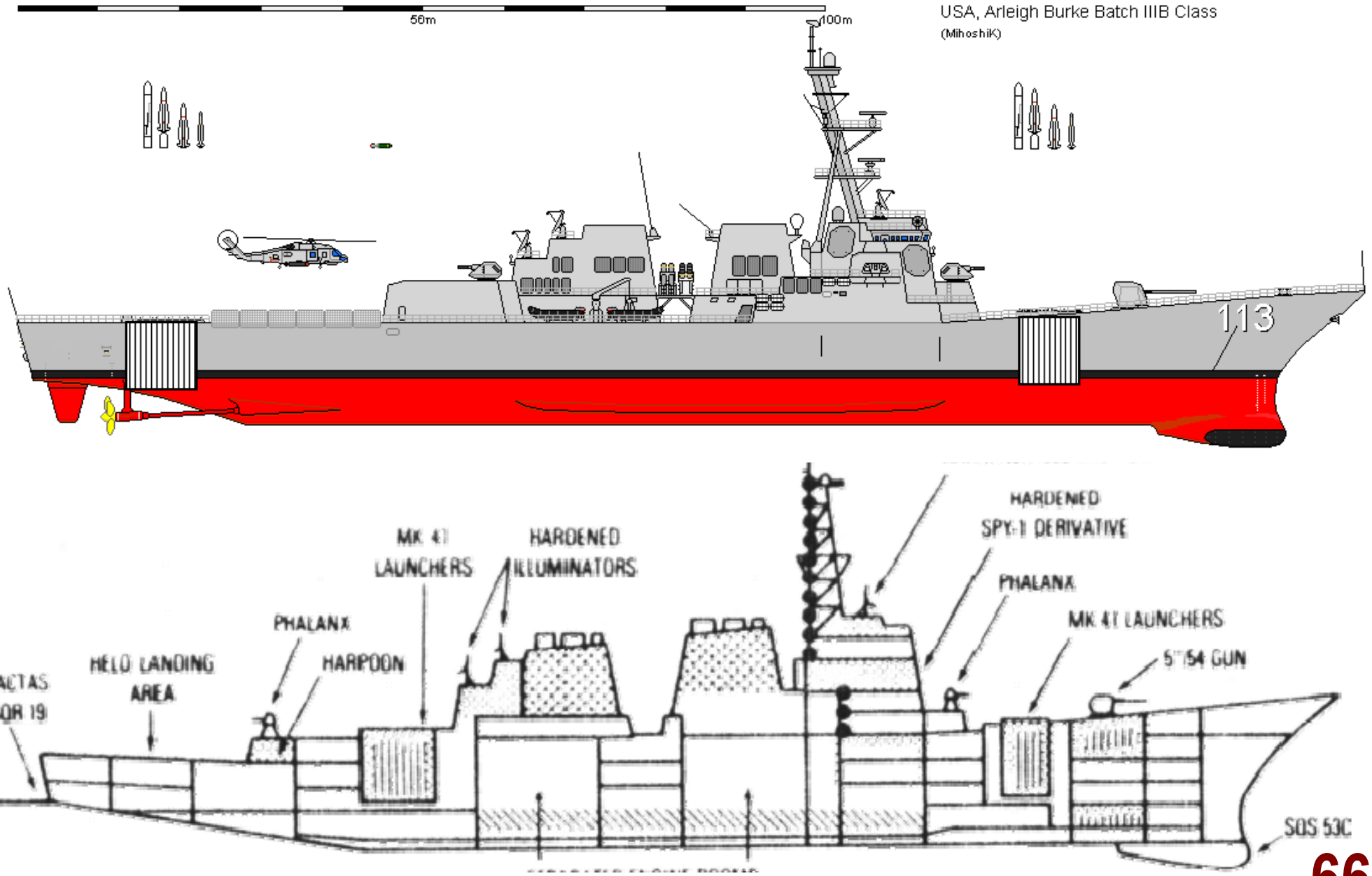


The IEO, an inflatable erectable decoy for Minuteman
(L'Garde, Inc. Photo)

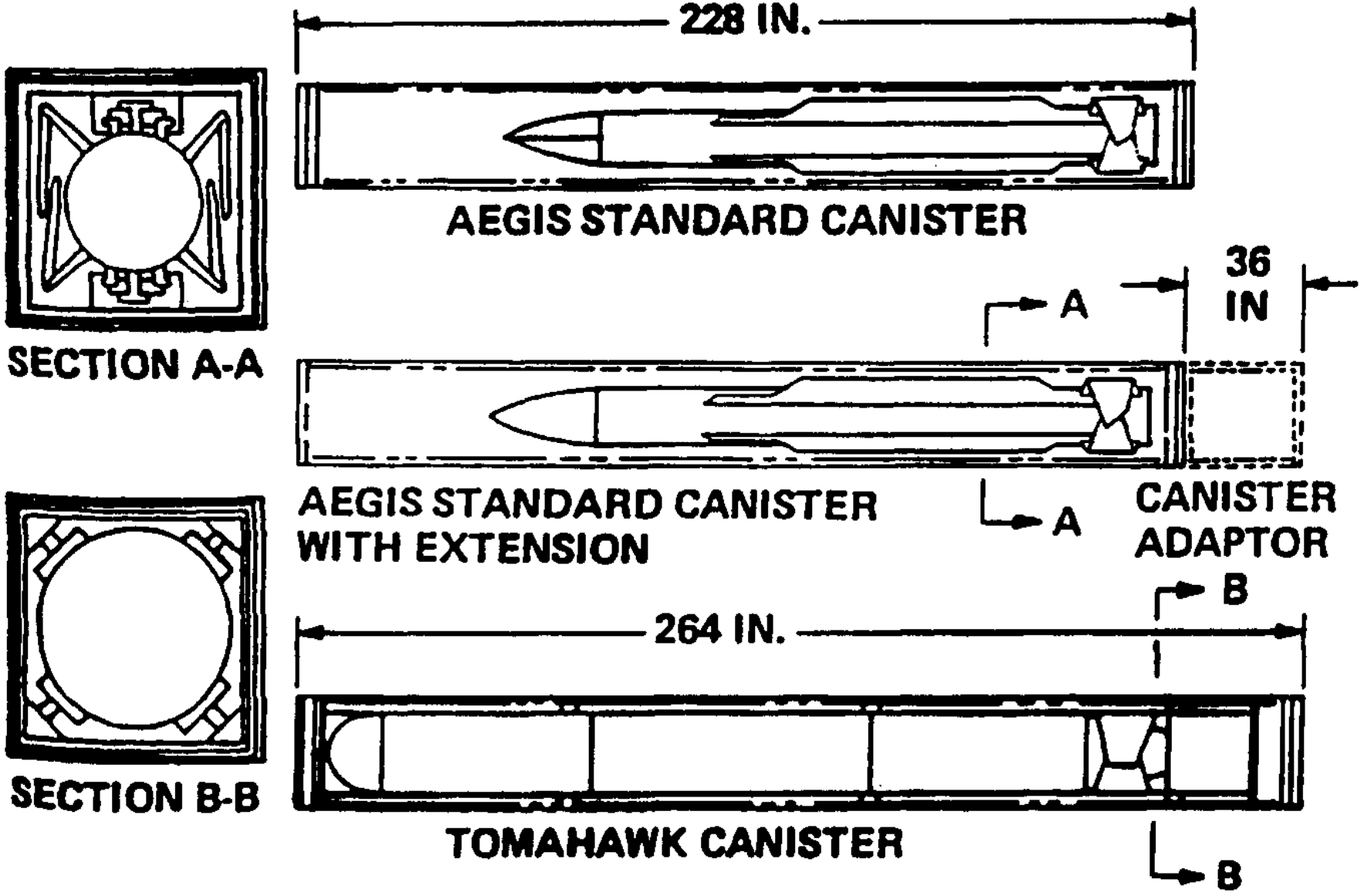
Mk 12A Minuteman III Reentry Vehicle

Why the SM-3 Missile Defense Could Appear to Be Threatening Even Though Its Capabilities are Obviously Limited

Locations of the Vertical Launch System Boxes on Two Different Variants of the DDG-51 Navy Destroyer



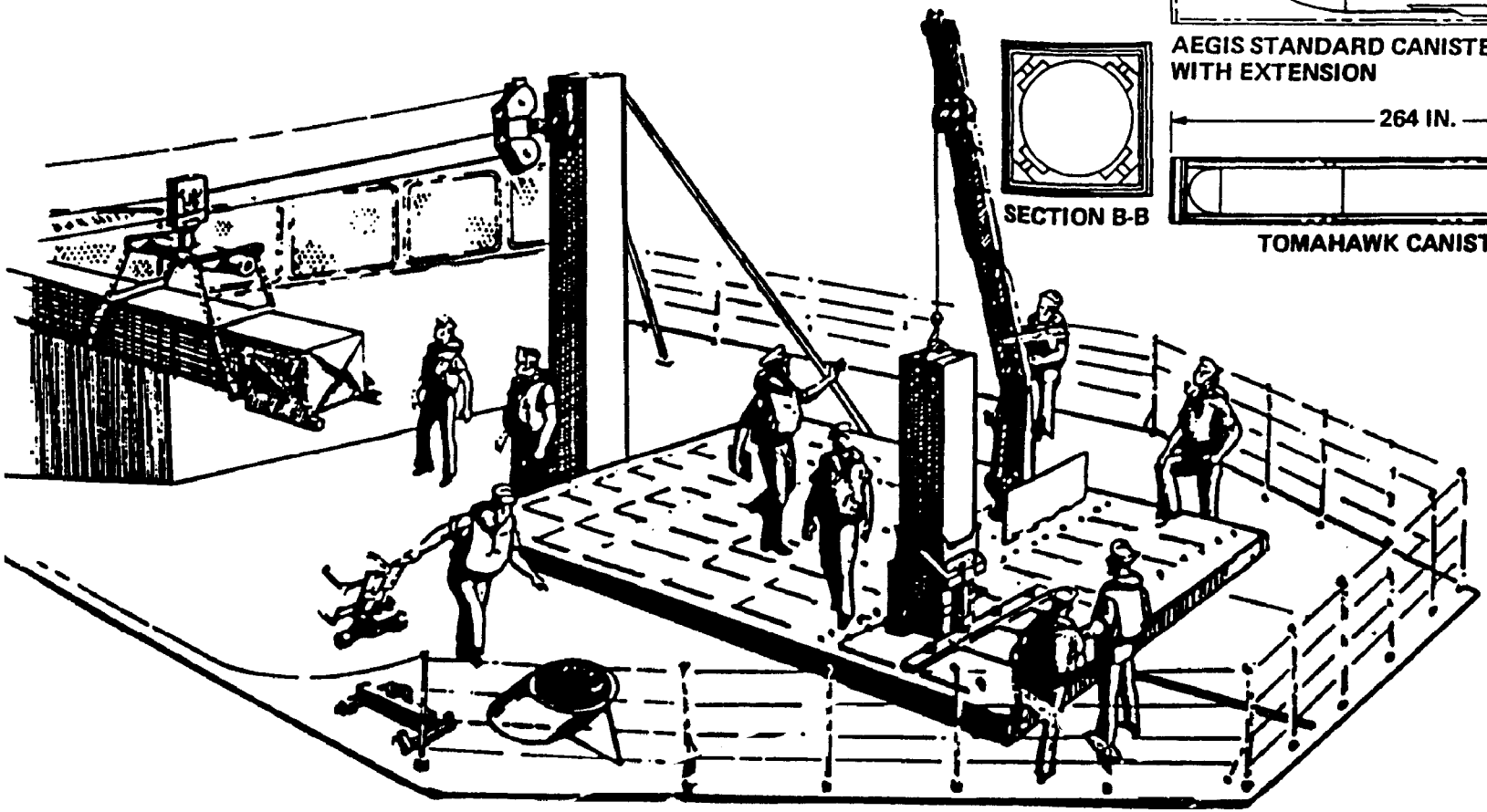
Basic Characteristics of the Vertical Launch System Components

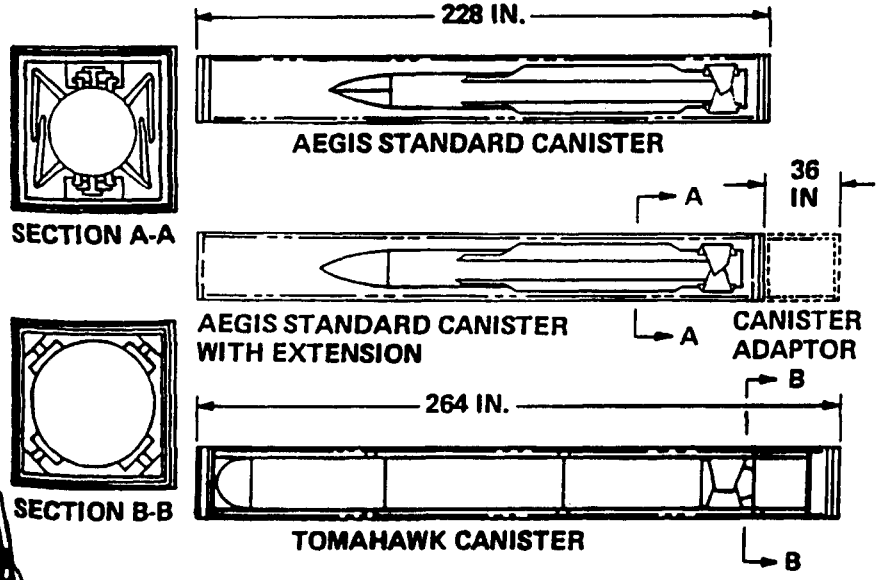


SM-3 Block IIA
21” Diameter
4,000 lb
Interceptor

Aegis Block IA Interceptor and Vertical Launch Cannister

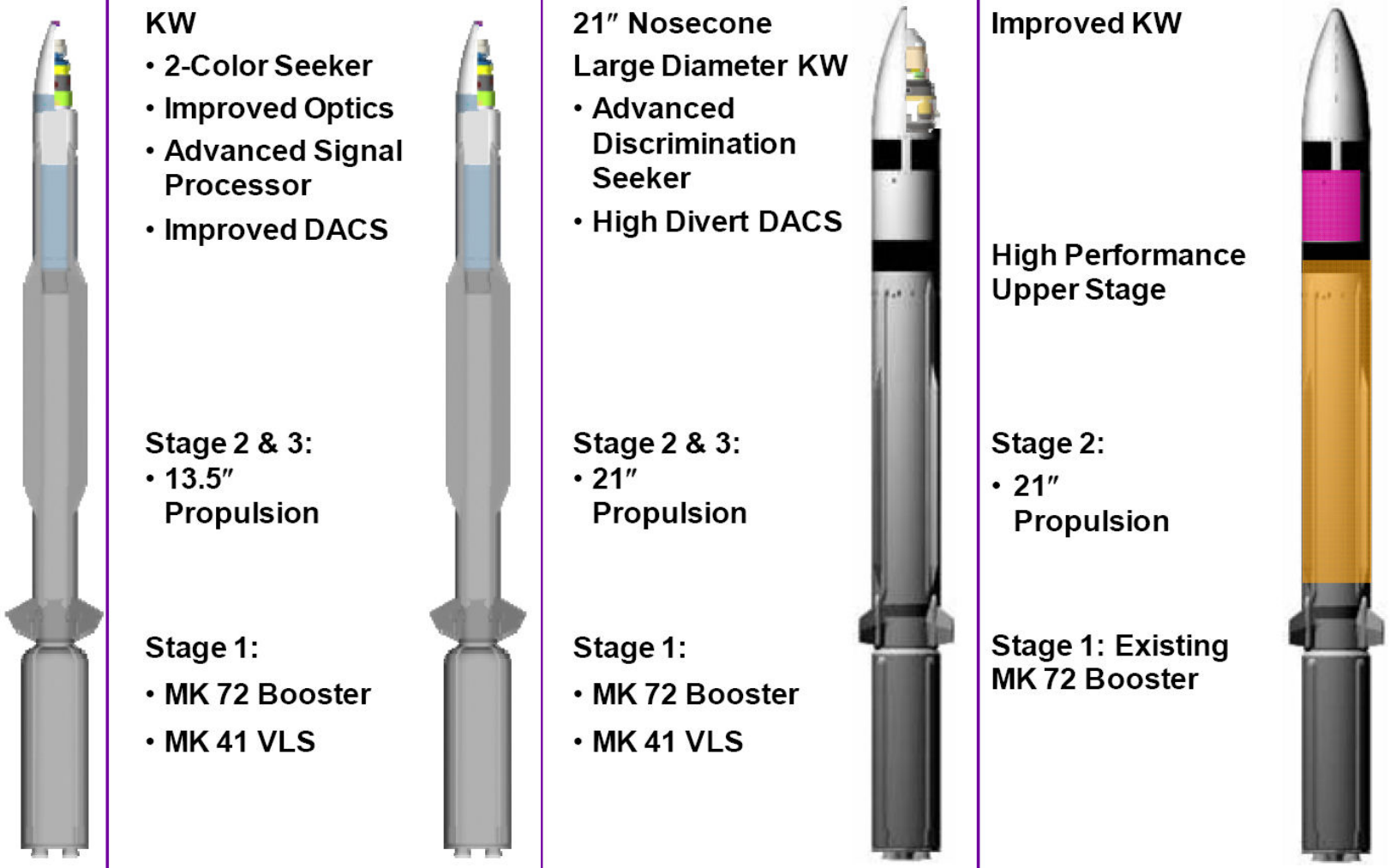
Basic Operational Characteristics of the Vertical Launch System Components





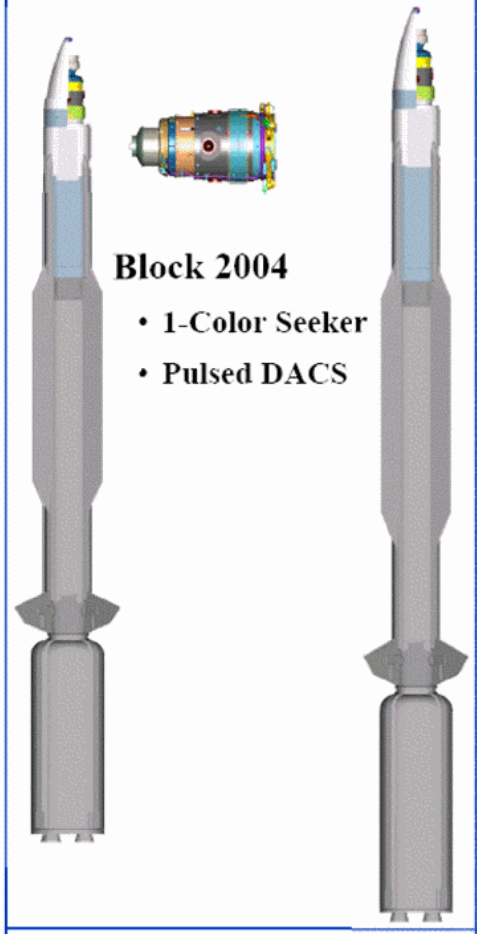
Variants of the Aegis SM-3 Interceptor and Kill Vehicles

	Burnout Speed ≈ 3 km/sec		Burnout Speed ≈ 4.5 km/sec	Burnout Speed ≈ 5.5 – 6 km/sec
	Block IA	***Block IB***	***Block IIA***	***Block IIB***
	Kill Warhead (KW) • 1-Color Seeker • Divert & Attitude Control System (DACS)	KW • 2-Color Seeker • Improved Optics • Advanced Signal Processor • Improved DACS	21″ Nosecone Large Diameter KW • Advanced Discrimination Seeker • High Divert DACS	Improved KW
	Stage 2 & 3: • 13.5″ Propulsion	Stage 2 & 3: • 13.5″ Propulsion	Stage 2 & 3: • 21″ Propulsion	High Performance Upper Stage Stage 2: • 21″ Propulsion
	Stage 1: • MK 72 Booster • MK 41 Vertical Launch System (VLS) Compatible	Stage 1: • MK 72 Booster • MK 41 VLS	Stage 1: • MK 72 Booster • MK 41 VLS	Stage 1: Existing MK 72 Booster



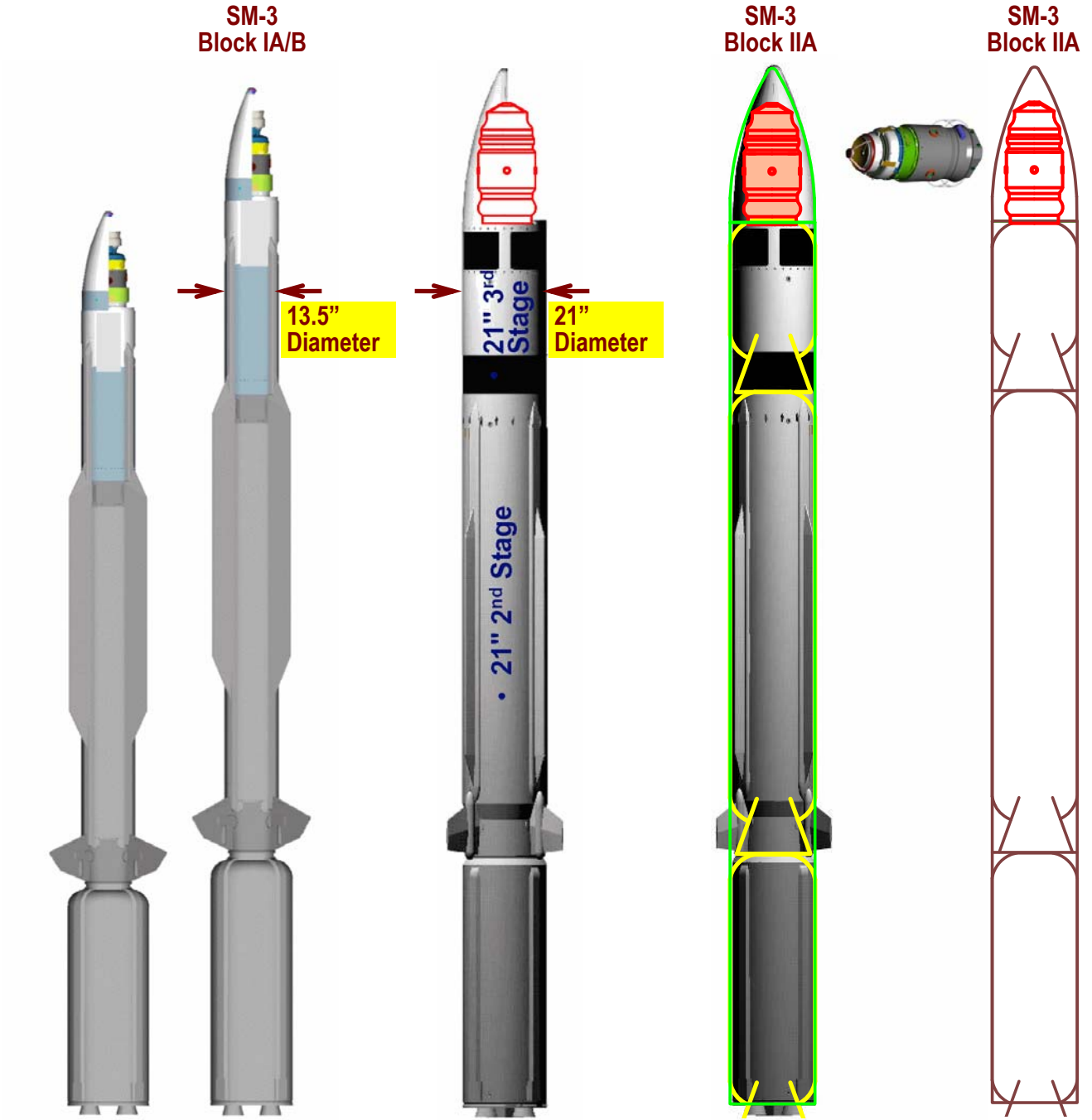
AEGIS BMD SM-3 EVOLUTION. The SM-3 is being fielded in "blocks" as technology advances, enabling improved defense through upgrades to the interceptor.

Aegis BMD SM-3 Evolution Plan

Block IA	Block IB	Block II	Block IIA
 Block 2004 • 1-Color Seeker • Pulsed DACS	• 2- Color Seeker - Increased IR Acquisition - Improved Discrimination • TDACS - Increased Divert - Lowers AUR Cost • All-Reflective Optics (ARO) • Advanced Signal Processor (ASP)	High Velocity Variant  • Block IB Seeker • 21" Propulsion - 2nd & 3rd Stage - Increased Missile Vbo = xx • 21" Nosecone • MK 41 VLS Compatible	High Divert Variant  • Large Diameter KW - Advanced Discrimination Seeker - High Divert DACS • 21" Propulsion - 2nd & 3rd Stage - Increased Missile Vbo = yy • 21" Nosecone • MK 41 VLS Compatible 
Block 2004	Block 2008	Block 2010 / 2012	Block 2012 / 2014

Funded Since PB06 | Capability Change From Previous Block

Variants of the Aegis SM-3 Interceptor and Kill Vehicles



Model Interceptor Parameters

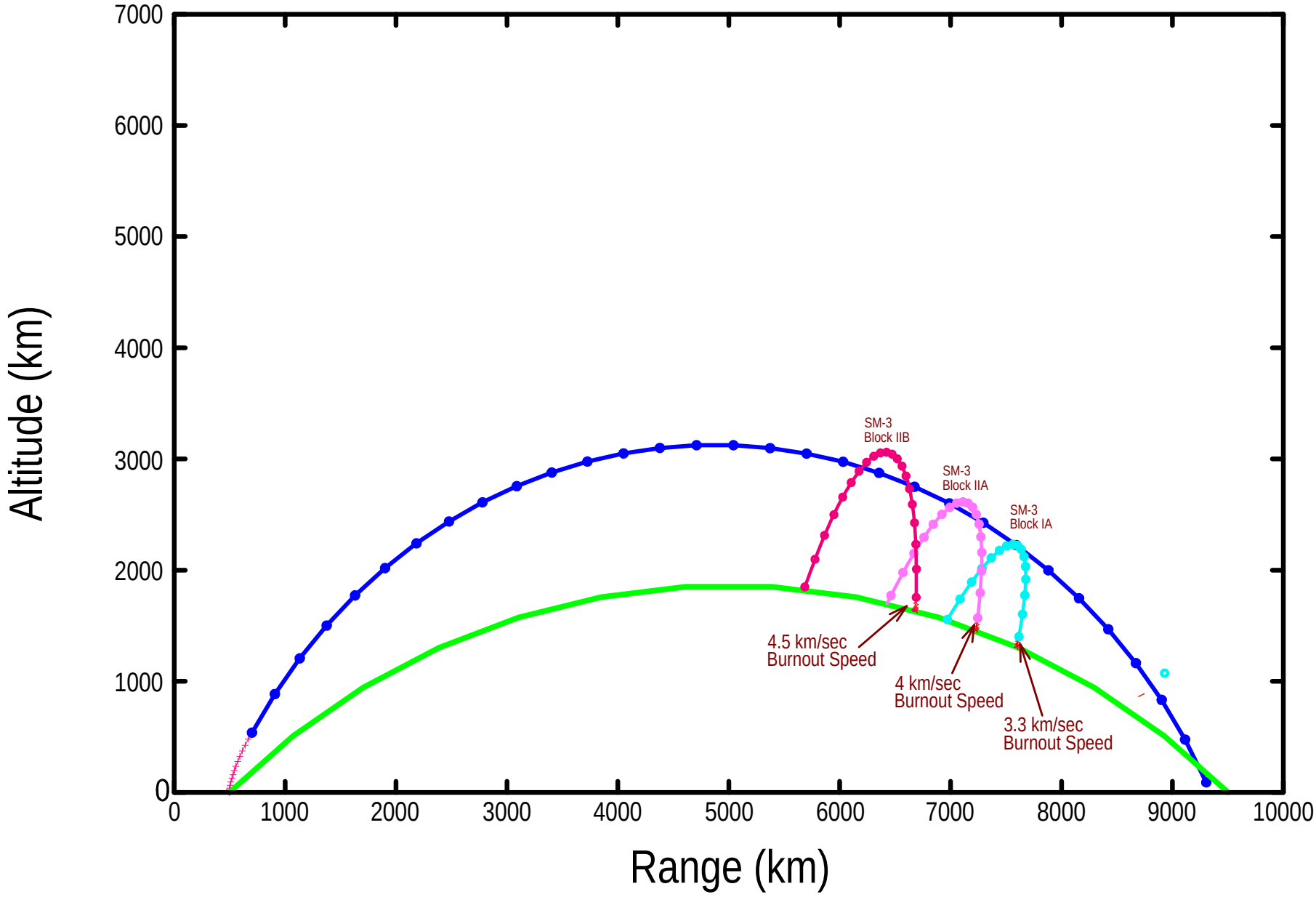
Kill Vehicle
Weight≈132? lbs

Third Stage Motor
I_{sp}≈289 sec
Weight≈600 lbs
Fuel Load≈0.90

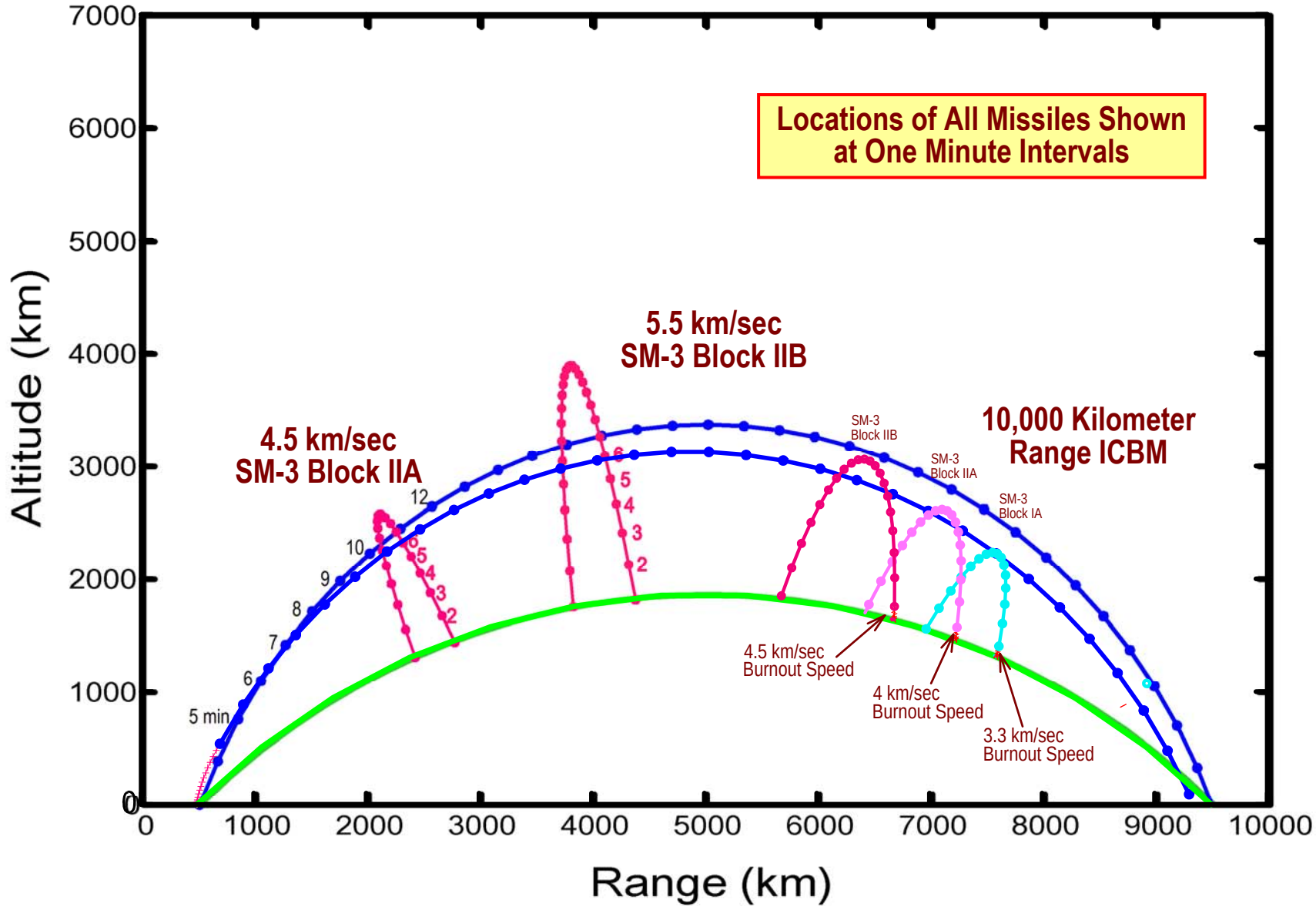
Second Stage Motor
I_{sp}≈280 sec
Weight≈2000 lbs
Fuel Load≈0.85

First Stage Motor
I_{sp}≈220 sec
Weight≈1200 lbs
Fuel Load≈0.75

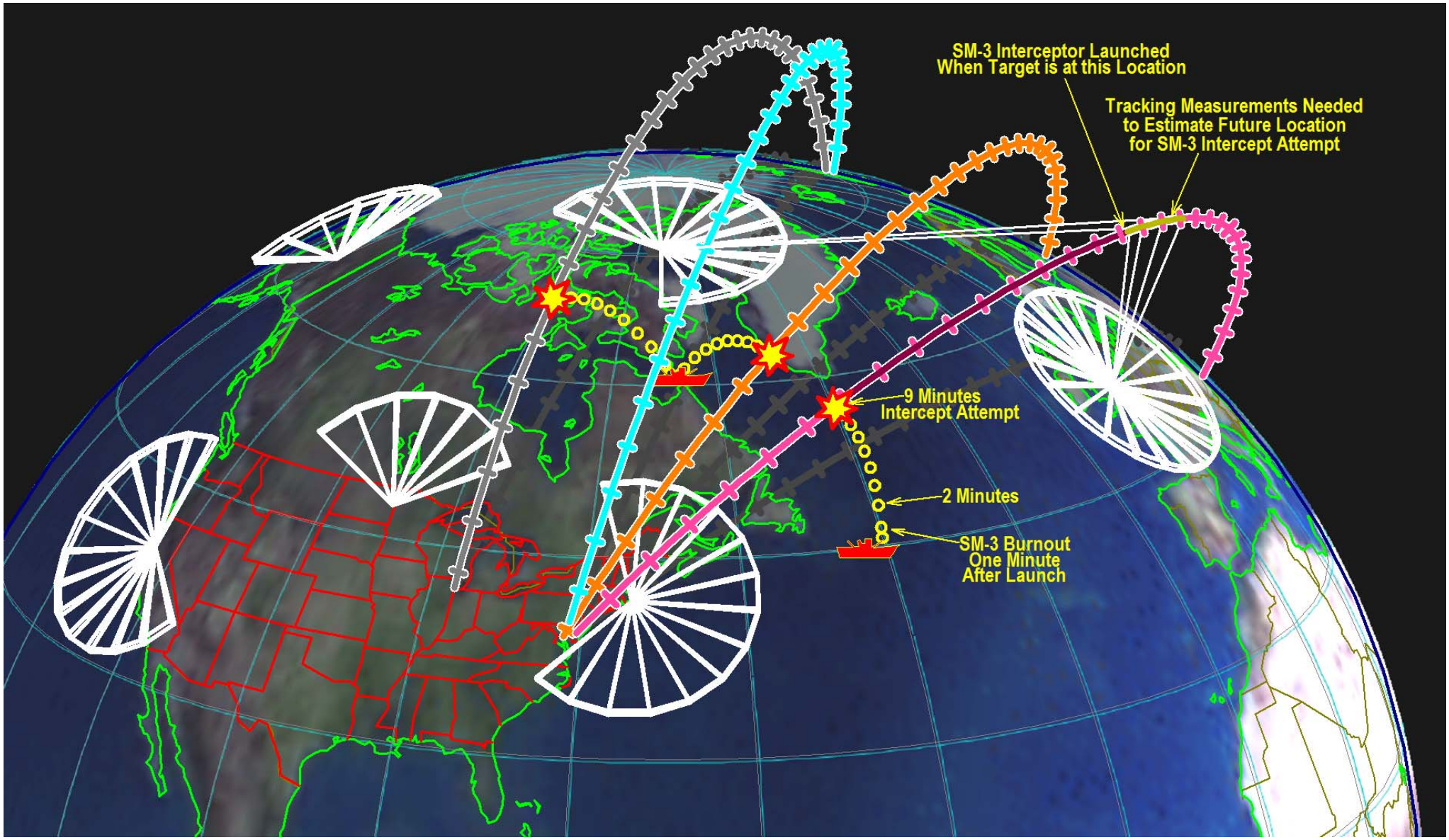
Capabilities of the Future 4.5 km/sec and 5.5 km/sec Variants of the SM-3 Block IIA and Block IIB Interceptors to Engage ICBMs



Capabilities of the Future 4.5 km/sec and 5.5 km/sec Variants of the SM-3 Block IIA and Block IIB Interceptors to Engage ICBMs



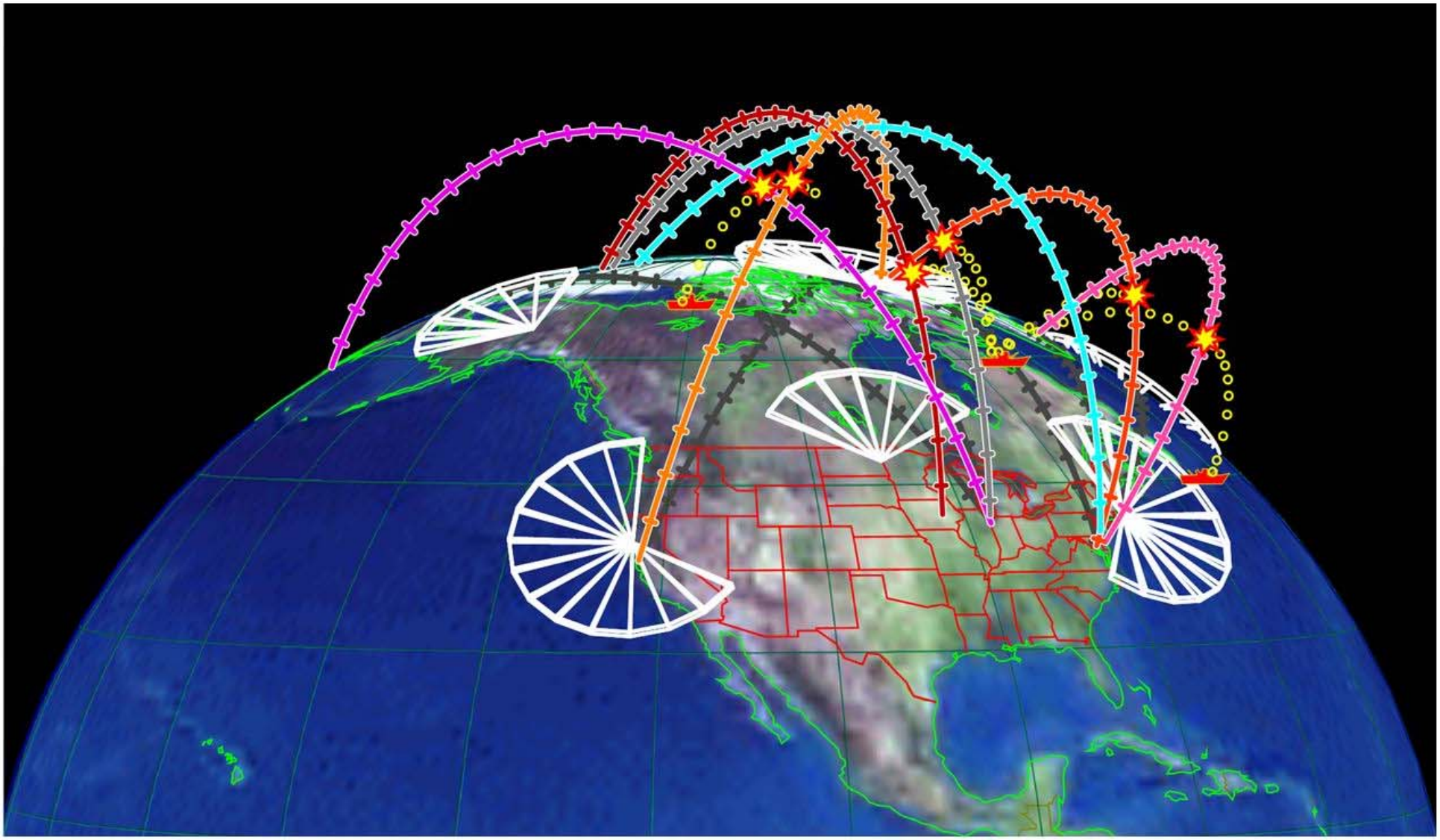
Kinematic Capabilities of Future 4.0 km/sec and 4.5 km/sec Variants of the SM-3 Block II Interceptors to Engage ICBMs



Kinematic Capabilities of a 4.5 km/sec SM-3 Block IIA Interceptor

All ICBM Attack Corridors from Russia to the United States Could Be Covered by Suitably Placed SM-3 Aegis-Armed Destroyers

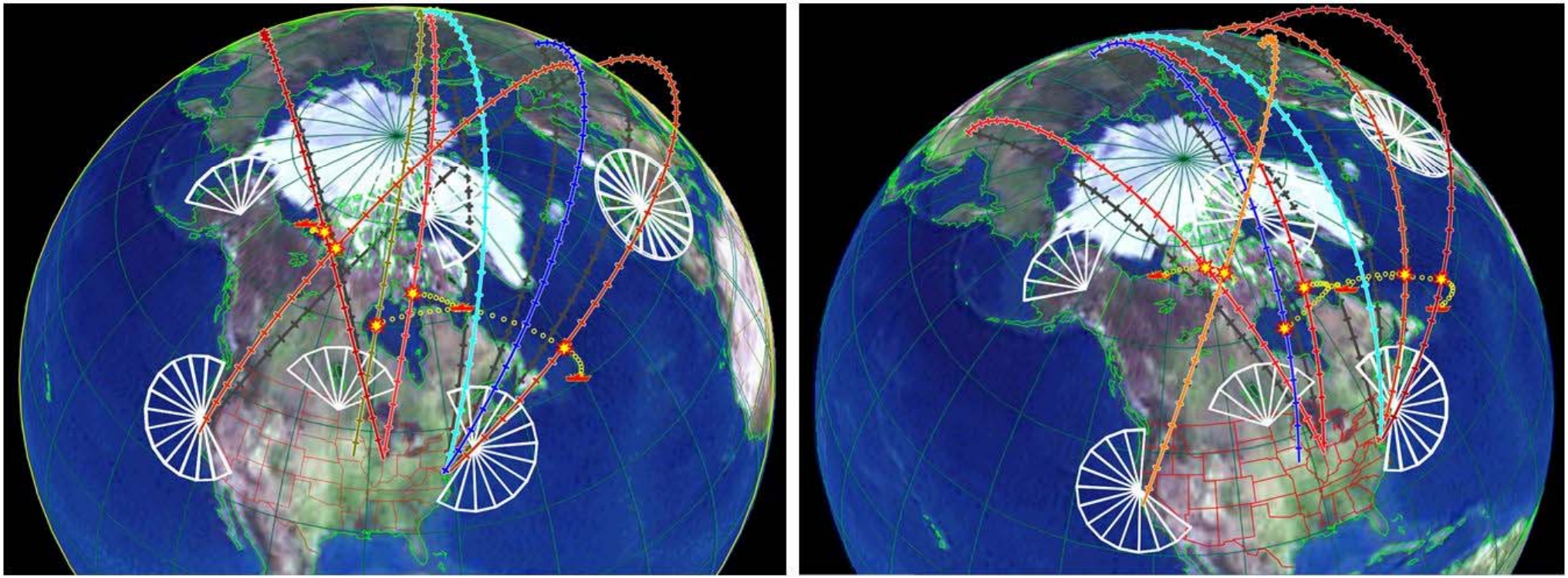
All ICBM and Interceptor trajectory locations marked at one minute intervals.



Kinematic Capabilities of a 4.5 km/sec SM-3 Block IIA Interceptor

All ICBM Attack Corridors from Russia to the United States Could Be Covered by Suitably Placed SM-3 Aegis-Armed Destroyers

All ICBM and Interceptor trajectory locations marked at one minute intervals.



The End Result of the Phased Adaptive Approach and the US Domestic Political Failures that Led to It

Military planners have the responsibility of looking towards future threats.
Increase in number and speed of the Interceptors
Increase in the capabilities and numbers of radars
Concerns about possible prior damage to nuclear forces from pre-emptive strikes.
Interceptors with small nuclear weapons

Result, military planners may recognize that the current defense system has limited capabilities, but they will have to consider and plan for possible future expansions and upgrades of the system.

One way to deal with such circumstances would be for China to expand its nuclear forces and to also increase its emphasis on countermeasures.

Hence, the US preoccupation with missile defenses that have little capability gets the worst of two worlds, defenses that are not reliable, and adversaries who could react as if the defenses actually could work.

An example from history.
Vast expansion of US nuclear strike forces in response to the Russian Moscow missile defense