

# National Air & Space Museum Steven F. Udvar-Hazy Center And Its "Big Five"

Col Scott Willey, USAF (Ret)  
Lifetime Learning Institute NoVA  
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# What Does UHC Have for Visitors?

- 200+ aircraft (all real)
- 150+ major space objects
- Display cases
- IMAX Theater
- Gift shop
- Engen Tower
- Flight simulators
- Innovations in Flight and other family days

# Aircraft Hangar



# South from the Scenic Overlook



# North from the Scenic Overlook



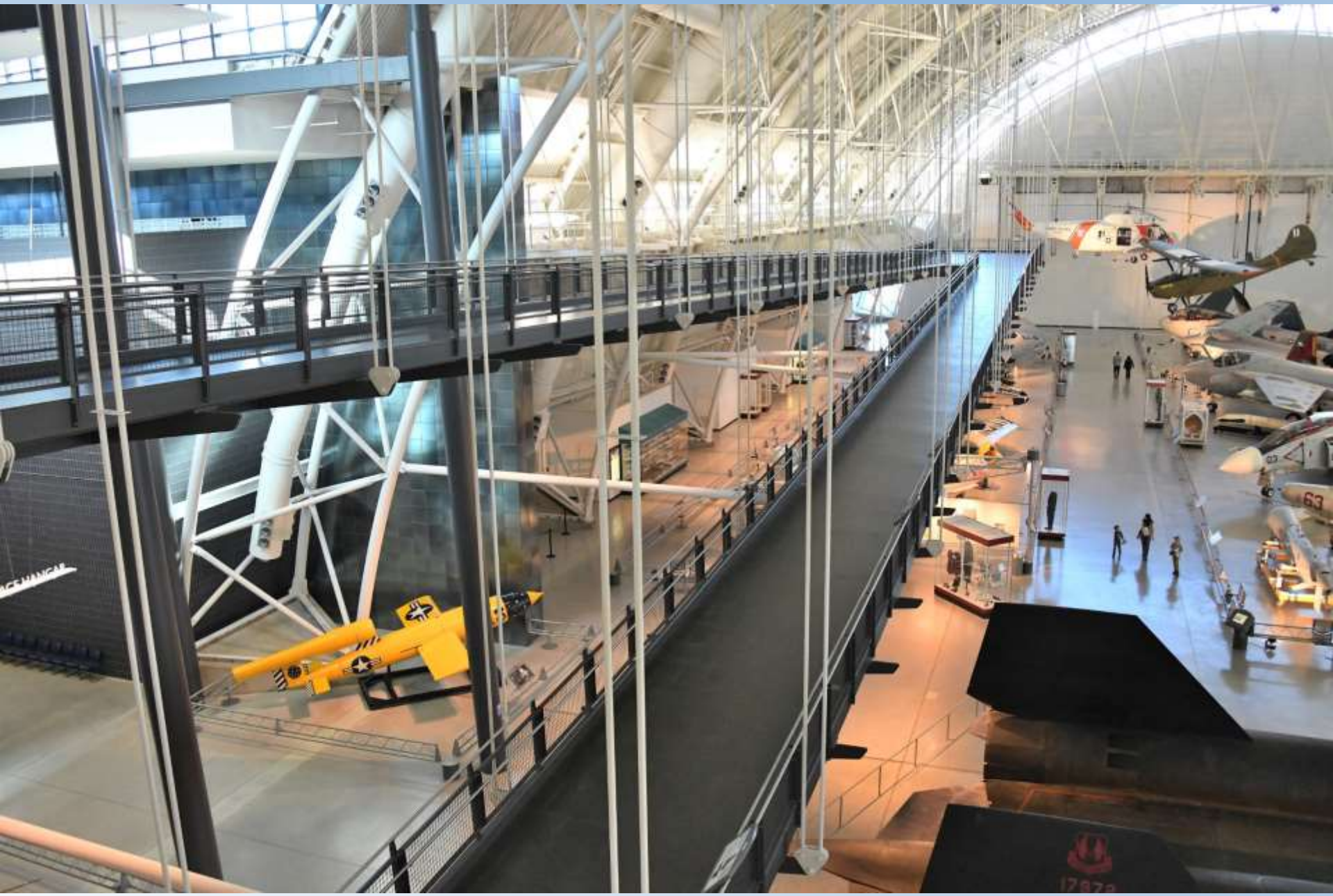
# Early Flight



# West Mezzanine



# West Ramp





# East Ramp



# Space Hangar



# Space Hangar North Side



# Space Hangar South Side



# Scenic Overlook—Restoration



# Restoration



# Restoration



# Donald Engen Tower





# View from the Tower



# View from the Tower



# Free Public Tours



# Display Cases



# IMAX Theater



# Innovations in Flight Day



# Ample Parking



# The Big Five



# The Big Five

- What are they?
  - Boeing B-29 Superfortress *Enola Gay*
  - Anglo-French Concorde
  - Boeing 367-80 *Dash 80*
  - Lockheed SR-71 Blackbird
  - Boeing Space Shuttle Orbiter *Discovery*
- Why included?
  - Popular or well known
  - Famous event
  - Really look cool
  - Happen to be big, imposing artifacts

# Boeing B-29 Superfortress *Enola Gay*



# Three Prioritized Targets

- Hiroshima
- Kokura
- Nagasaki
- First one with good weather was the target



# Aircraft on Hiroshima Mission

Serial No.	Name	A/C, Crew	Task
44-86292	Enola Gay, 82	Tibbets, B-9 (mod)	Strike
44-27353	The Great Artiste, 89	Sweeney, C-15	Instruments
44-86291	Necessary Evil, 91	Marquardt, B-10	Photo
44-27301	Straight Flush, 85	Eatherly, C-11	Hiroshima Weather
44-27298	Full House, 83	Taylor, A-1	Nagasaki Weather
44-27303	Jabit III, 71	Wilson, B-6	Kokura Weather
44-27354	Big Stink, 90	McKnight, B-8	Strike Spare

# Enola Gay Crew 6 Aug 1945



Shumard—Asst FE

Nelson—Radio

Stiborik--Radar

Duzenbury--FE

Caron—Tail Gun

Van Kirk

Parsons

Navigator

Weaponer

Tibbets

Lewis

Beser

ECM Jeppson

Ferebee

Airplane  
Cmdr

Pilot

Wpn Test

Bombardier

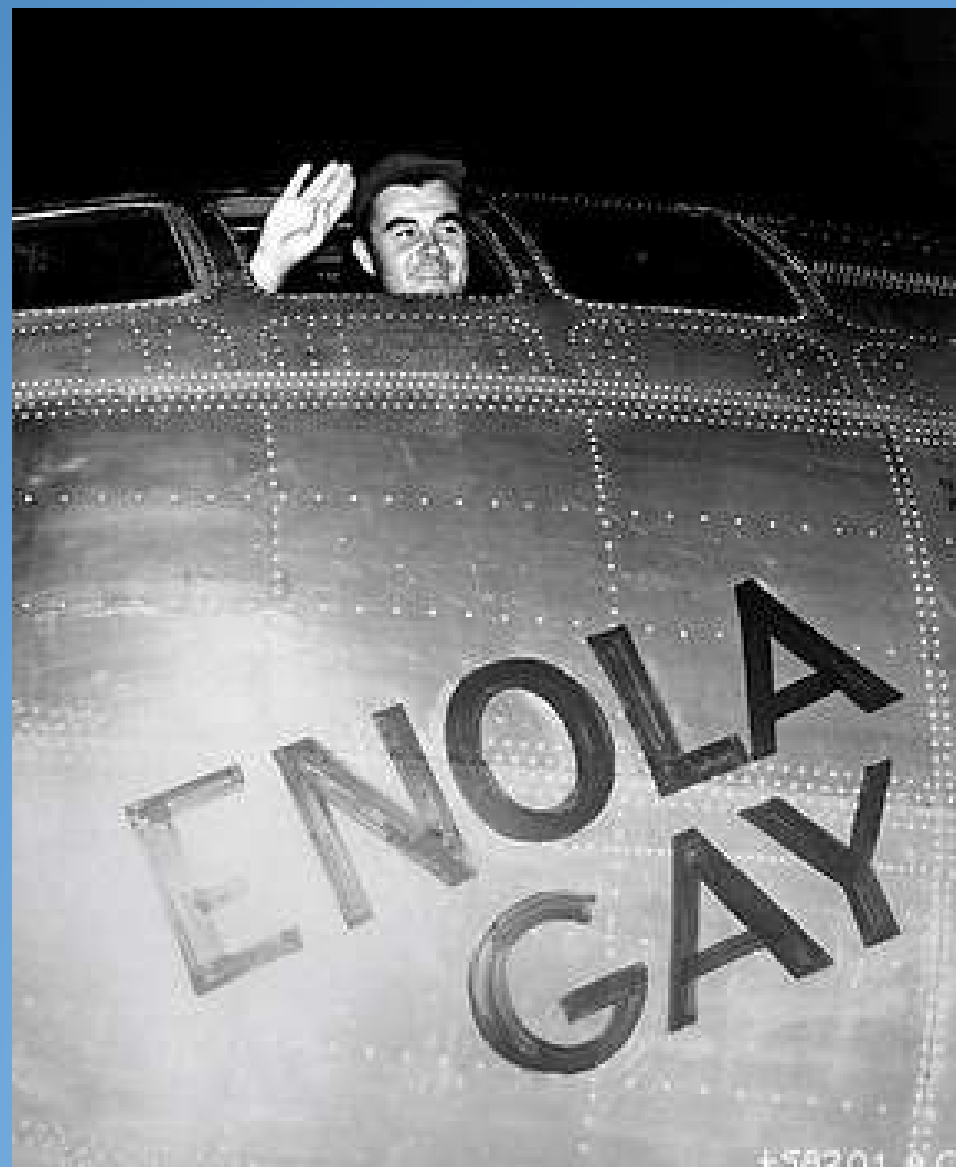
# *Little Boy* L-11 Loading 5 Aug 1945



# Mission Briefing Parsons/Tibbets

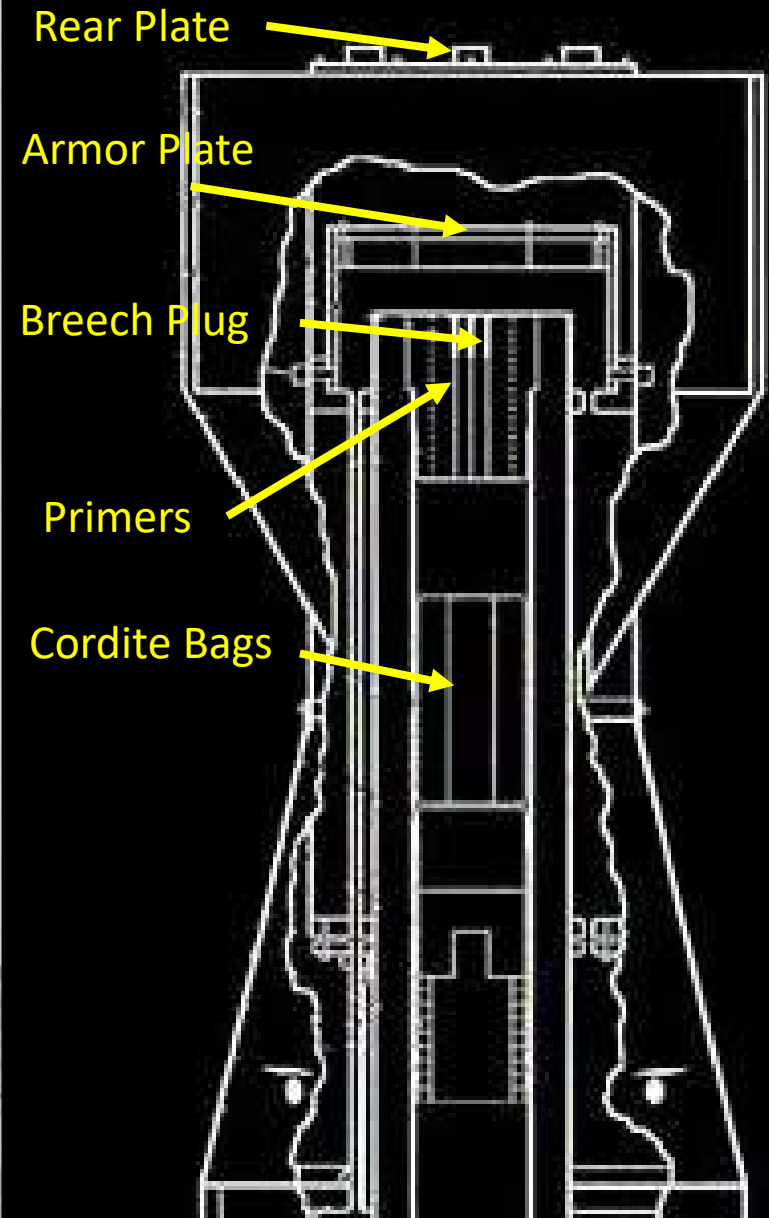
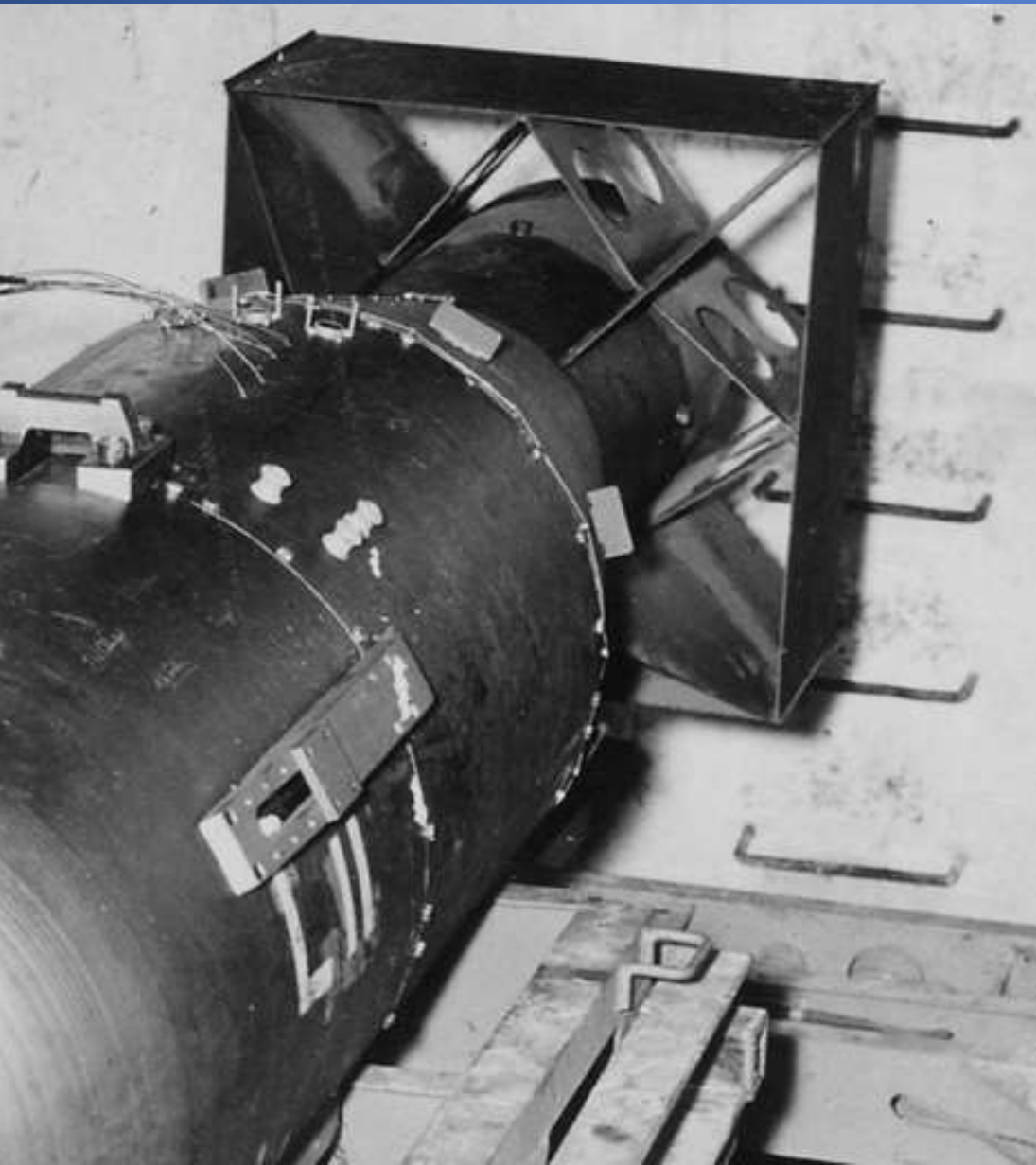


# Pre Departure 6 Aug 45

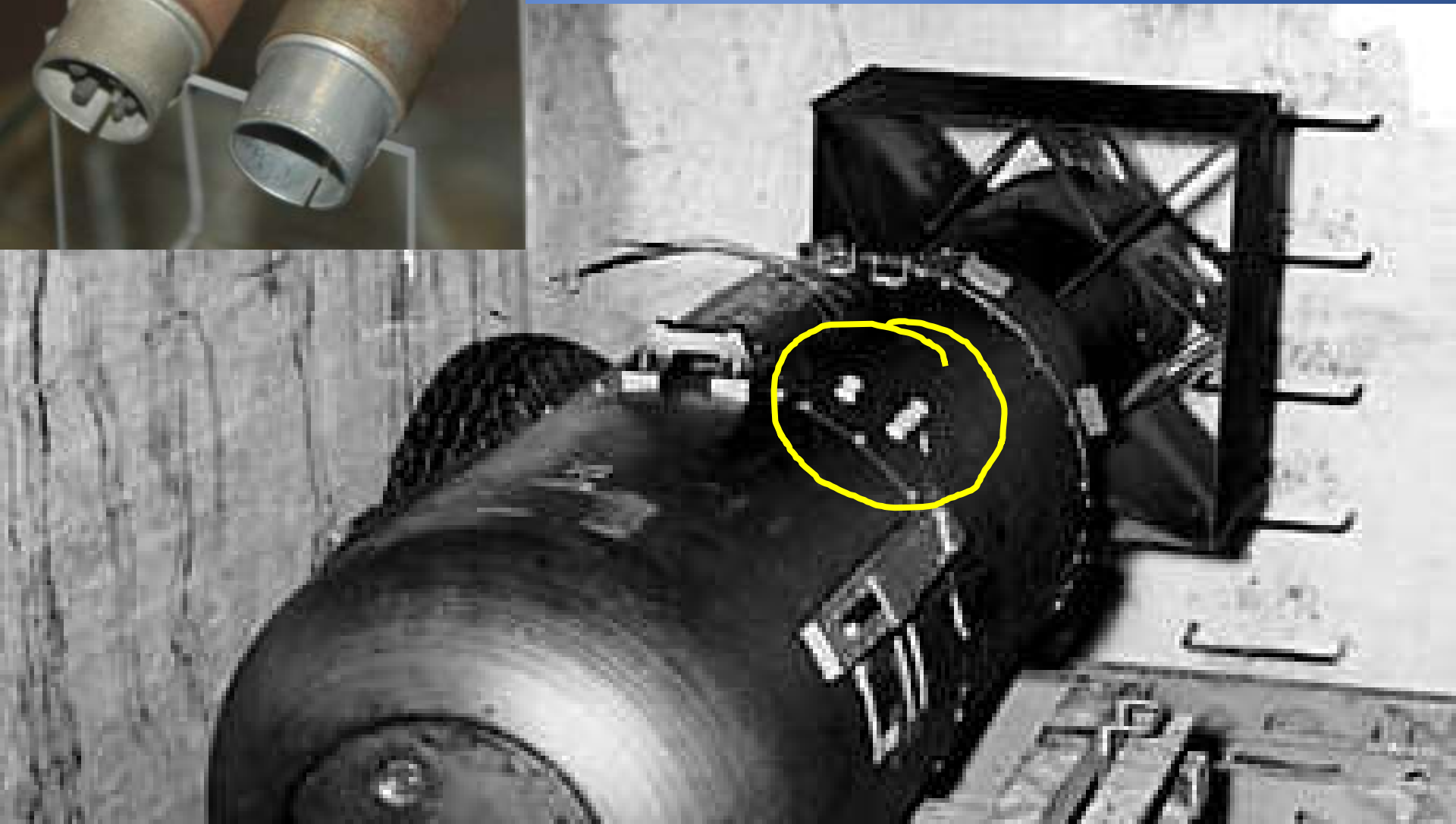




# Bomb Assembly Completion



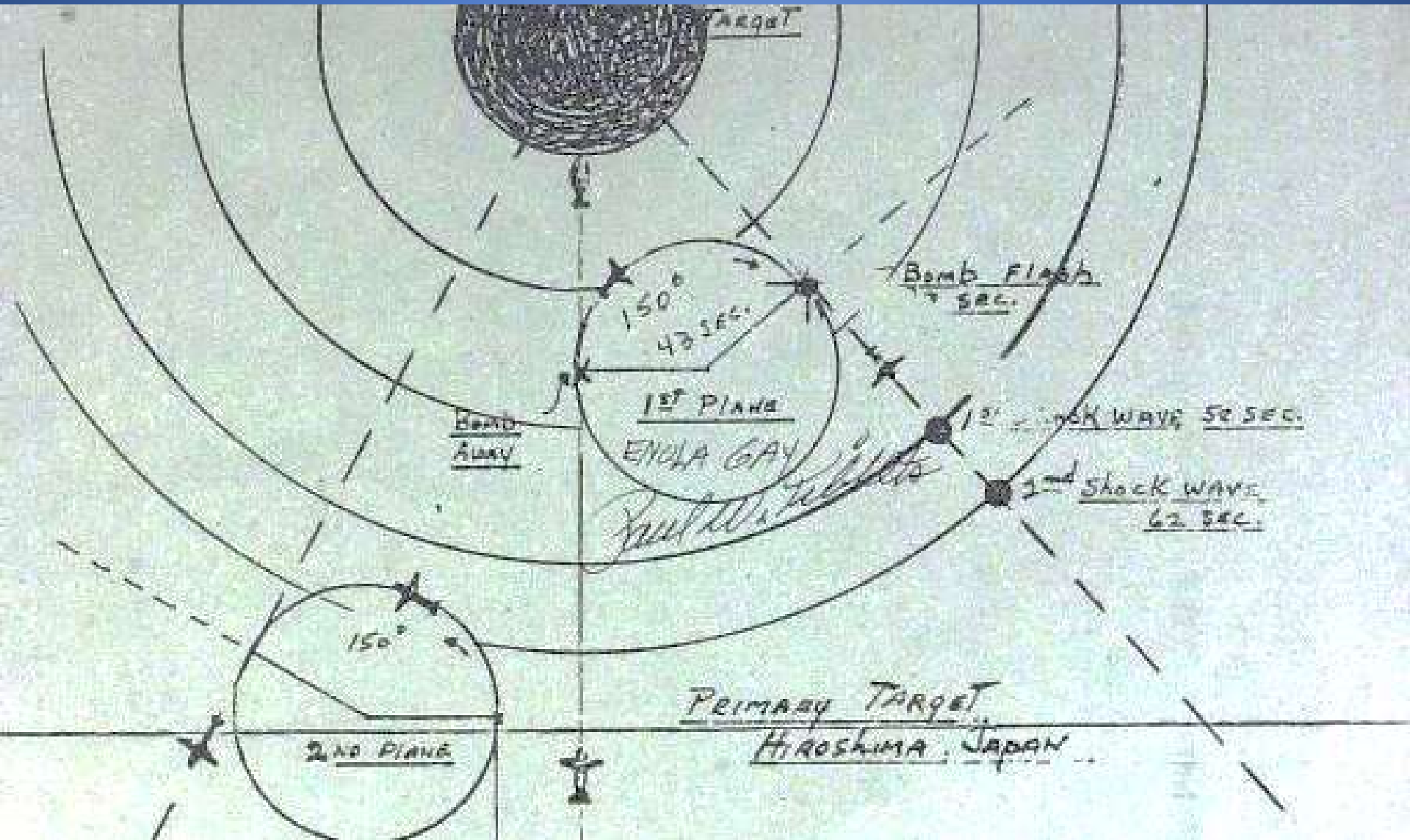
# Arming Plugs

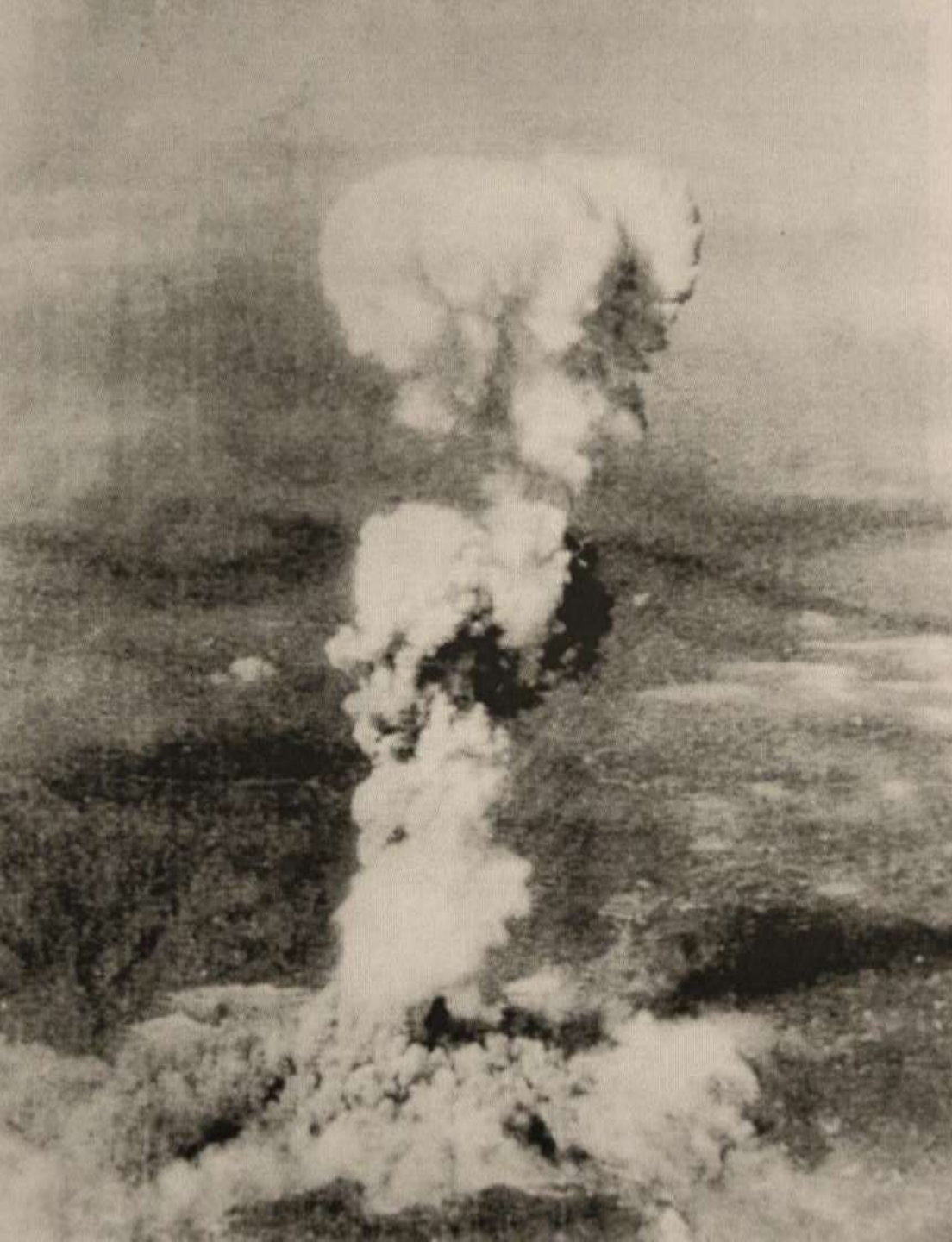


# Hiroshima Before Attack



# Attack Profile





# Hiroshima Cloud

- About 30,000 ft over city 2 min after blast
- Picture by tail gunner Caron
- Used group photo officer's K-20 still camera



# Hiroshima—Before and After



# Under the Bomb



# Industrial Promotion Hall (Atomic Bomb Dome)





# Results—Hiroshima

- Little Boy
  - $15 \pm 20\%$  kt TNT-equivalent yield
  - Dropped at 31,600 ft, 328 mph
  - $1903 \pm 50$  ft burst altitude
- City
  - 6.33 sq mi—4.70 destroyed (75%)
  - 245,000 people (343,000 before evacuations)
    - 60-70,000 killed (110,000 by end of year)
    - 50,000 injured
  - 90,000 buildings—65,000 unusable

# Anglo-French Concorde



# History

- First studies early 1950s
- Study contract 1959
- Draft UK/FR treaty Nov 1962
  - 50/50 work split
  - Sud (FR) and BAC (UK)
- Ads predicting 350 acft 1967
- First flight: FR 2 Mar 69, UK 9 Apr 69
- Scheduled service start 21 Jan 76
- M2.04 (1350 mph) at 55-60,000 ft
- Final service
  - FR 30 May 2003, UK 24 Oct 2003
  - F-BVFA to NASM 12 Jun 2003



# Fleet Size

- Only 20 built
  - 2 proto, 2 pre-production
  - 16 production (2 retained for test)
  - 7 each to BA and AF
- Pic: BA fleet 1986
- 18 on display now
- Note: Boeing flew 747 same year (1969) and built over 1550



# Interior

- 100 seats
- Lots of overhead in aisle
- Much like other acft
- A bit noisy
- Windows warmed up



# Nose

- High AOA at low speeds
- Nose droops for fwd visibility
- Inner (yellow arrow) and outer windscreens
- Inner exposed when nose drops



# Accident

- 25 Jul 2000
- AF 4590 Paris to NYC
- Conflicting views on cause
  - Hit part dropped from DC-10
  - Tire burst, fuel tank ruptured
  - Engines surged
  - Unable to maintain flight
- Hit hotel
- 109 in acft, 4 in hotel killed
- Fleet grounded over a year

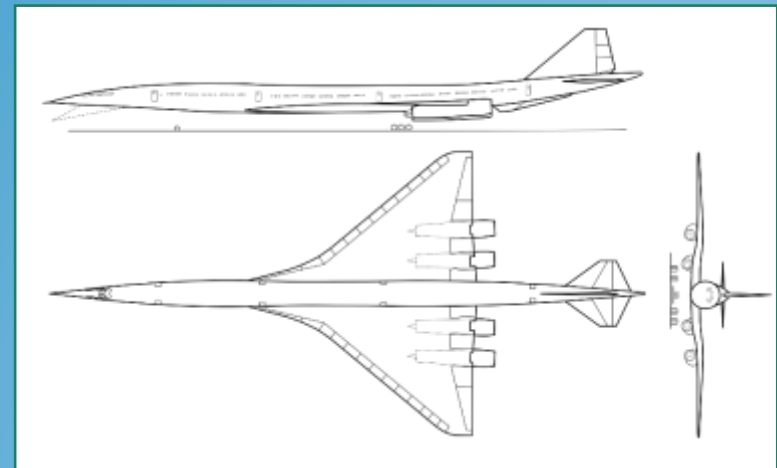


# “Competition”

- USSR – Tupolev Tu-144 “Concordski”
  - Flew before Concorde (31 Dec 1968)
  - Cargo service: Dec 1975 – Jul 1983
  - Pax service: Nov 1977 – Jun 1978
  - 16 built, 103 scheduled flights, 2 crashes



- US – Boeing 2707
  - Far bigger, faster, longer range
  - Mockup built
  - Never produced for many reasons





# Why Concorde Stopped Flying

- Aging airframes and design
  - Maintenance costs rising
  - Airbus declined to provide spare parts
- Very limited market
- Limited routes because of sonic boom
- Reduction in passenger service after 9-11
- Crash in Paris 2000
- Economics
  - Far better subsonic aircraft competition
  - Fuel cost rising

# Boeing 367-80 *Dash 80*



# *Dash 80*

- Idea conceived 1950
  - Boeing development of podded-engine, swept-wing B-47
  - Introduction of de Havilland Comet
- Model 367-80
  - Approved by board 1952
  - First flight 15 Jul 1954
  - Used for demos to civil and military reps
  - Led to development of KC-135 and 707
  - To NASM with 2350 hrs and 1691 flights



# The Big Demonstration

- Seafair
  - Annual Seattle event
  - Neighborhood and city events
  - Parades, block parties, etc.
  - Seafair Cup – hydroplane racing
- Boeing invited AIA and IATA reps to 1955 Seafair Cup
  - 6 Aug 1955
  - *Dash 80* to do flyover
  - “Tex” Johnston gave viewers a bit more



Blue Angels over Lake Washington  
Seafair 2007

# The Famous Roll



# Results

- 800+ C/KC-135/derivatives built
- 1000+ 707/720 airliners delivered
- “Most socially significant aircraft in NASM collection” — Willey
  - Fundamental transportation change
  - Ocean liners/piston airliners/long-distance trains gone
  - World shrank



# Lockheed SR-71 Blackbird



# Blackbird Fleet

- A-12 (15)
  - Reconnaissance
  - Single-seat
  - CIA 1967-68
- YF-12A (3)
  - Interceptor
  - USAF—not produced
- SR-71 (32)
  - Reconnaissance
  - Two-seat
  - USAF—1968-1990





# SR-71 Records

- July 1976 Bicentennial
  - Absolute speed – 2193 mph
  - Absolute sustained altitude – 85,069 ft
  - Absolute 1000 km closed course – 2092 mph
- UHC SR-71 972 records
  - New York to London – 1 hr 57 min
  - London to Los Angeles – 3 hr 47 min
  - Los Angeles to Dulles – 1 hr 4 min
    - St Louis to Cincinnati – 8.5 min
    - Kansas City to Dulles – 26 min
  - Coast to coast – 1 hr 8 min (unofficial)
  - First operational mission in Europe (RAF Mildenhall)

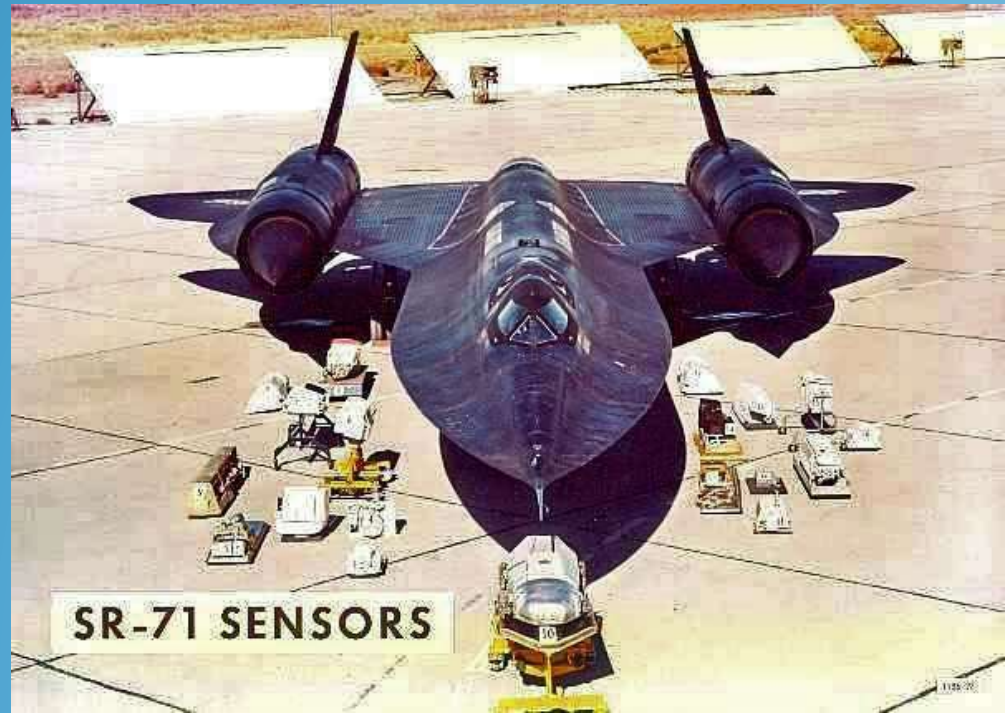
# Aircrew Mission Responsibilities

- Pilot – Aircraft Commander
  - Aircraft and mission
  - Flies A/C
  - Engine Inlet control
  - Air refueling/fuel mgt
- Reconnaissance Systems Officer – Navigator
  - Navigation
  - Sensor controls
  - Tanker rendezvous
  - Defensive systems operation
  - Checklist execution
  - Most radio calls
- Joe Kinego



# SR-71 Sensors

- Multiple sensor combinations
- Noses: training, synthetic aperture radar, optical bar camera
- Side bays: technical objective cameras, electromagnetic (ELINT) reconnaissance system, mission recorders, radar recorders, et al.
- Center bay: terrain camera

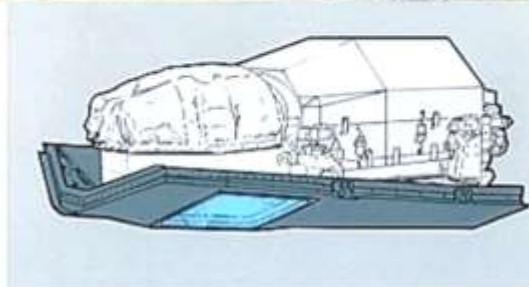


# Optical Bar Camera

- Wider area coverage
- 100,000 (eventually 150,000) sq mi coverage in an hour



Optical BAR Camera (OBC)

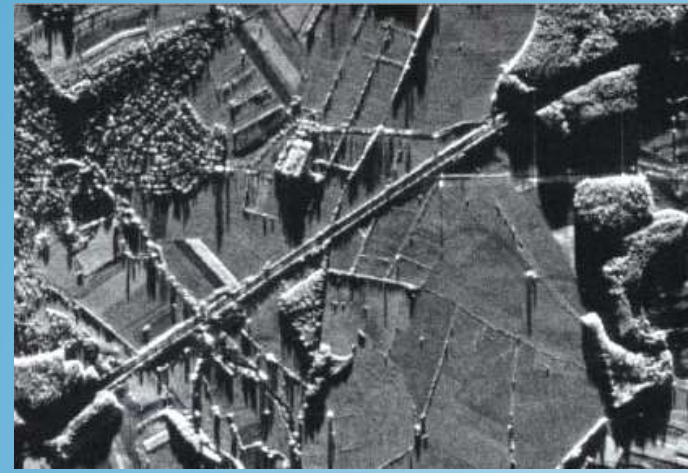
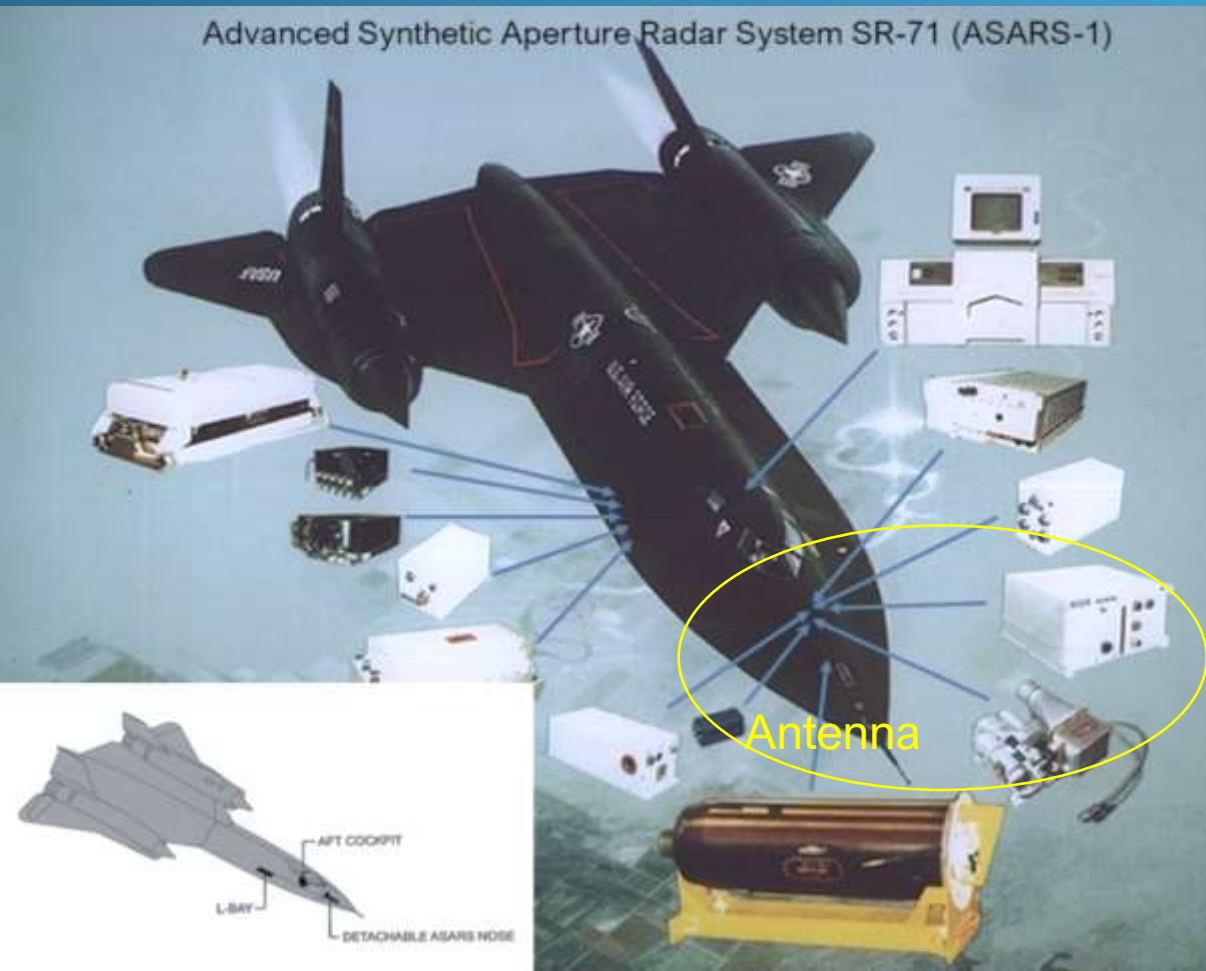


Camera Mounted on Nose Hatch Door



# ASARS-1

- All weather, day-night
- Stationary and moving ground targets
- 100,000+ sq mi coverage in one hour



# Technical Objective Camera (TEOC)

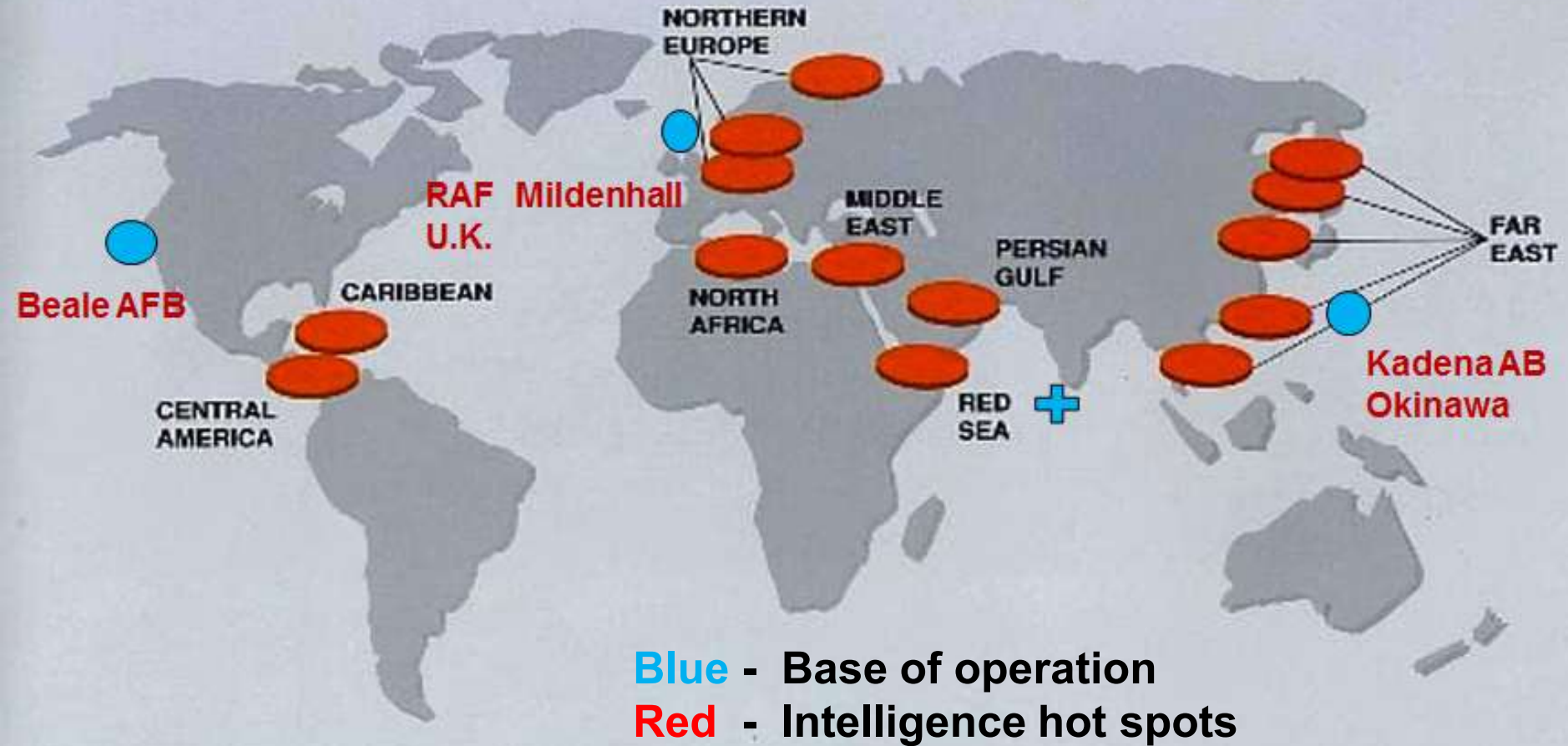
- Seattle Kingdome from 80,000+ ft
- Black & white film
  - Most used
  - Best picture resolution (4-6 in)
- Processing time 1-3 hr depending on film type



# Operating Locations

- Beale AFB CA (home base)
  - Cuba, Nicaragua, Panama, USSR
- Kadena AB Japan
  - North Korea, North Viet Nam, China, Eastern USSR, Middle East
- RAF Mildenhall UK
  - USSR, East Germany, Baltic, Libya, Middle East
- Eielson AFB AK
  - USSR
- Seymour Johnson AFB NC
  - Arab/Israeli 1973 war
- Diego Garcia, Indian Ocean
  - Middle East, Far East

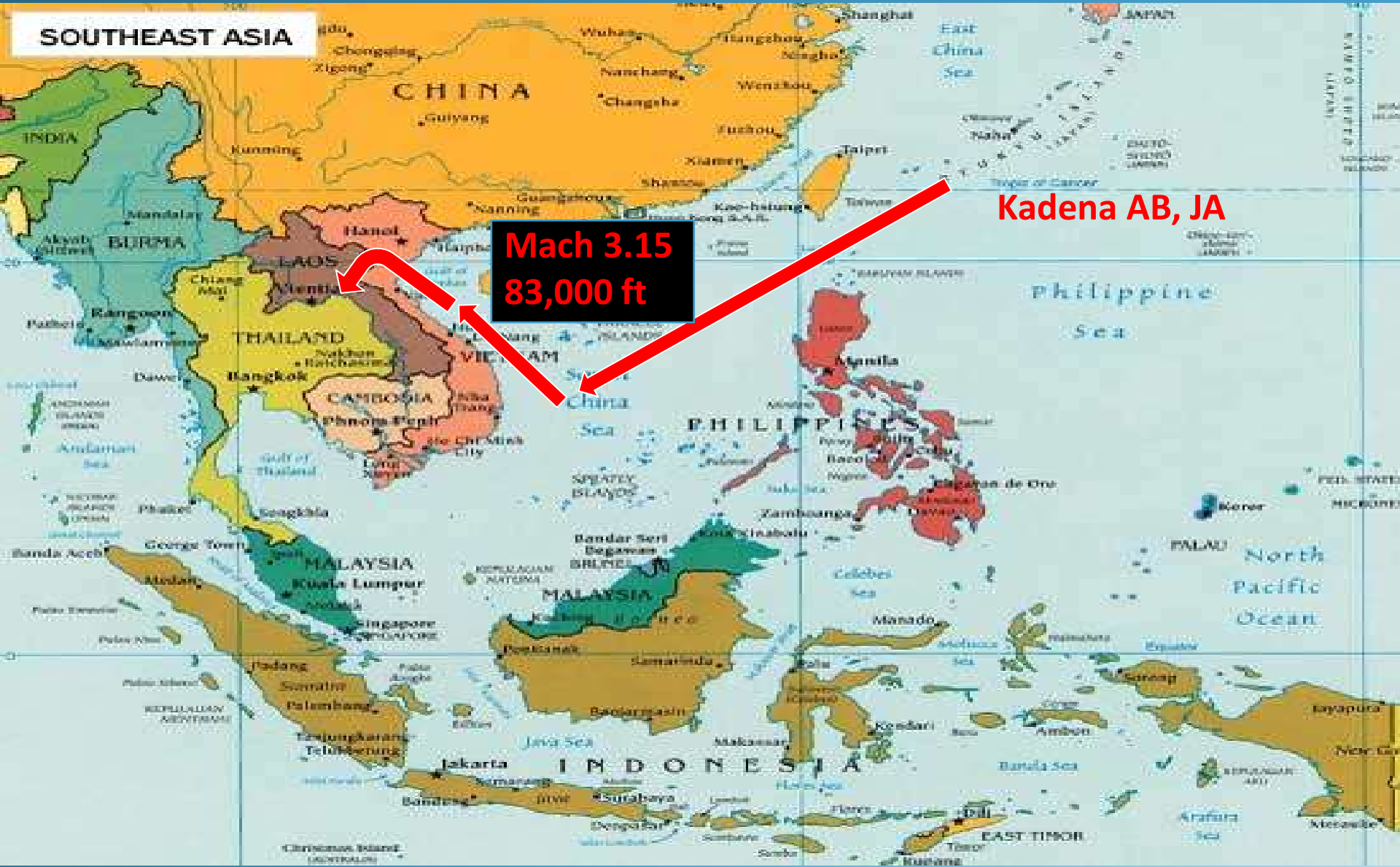
# Major Cold War Theaters of Operation





# War in Vietnam

## Enemy SAM & Troop Movements



SOUTHEAST ASIA

Mach 3.15  
83,000 ft

Kadena AB, JA

# Petropavlovsk – Vladivostok

## Soviet Naval Movements

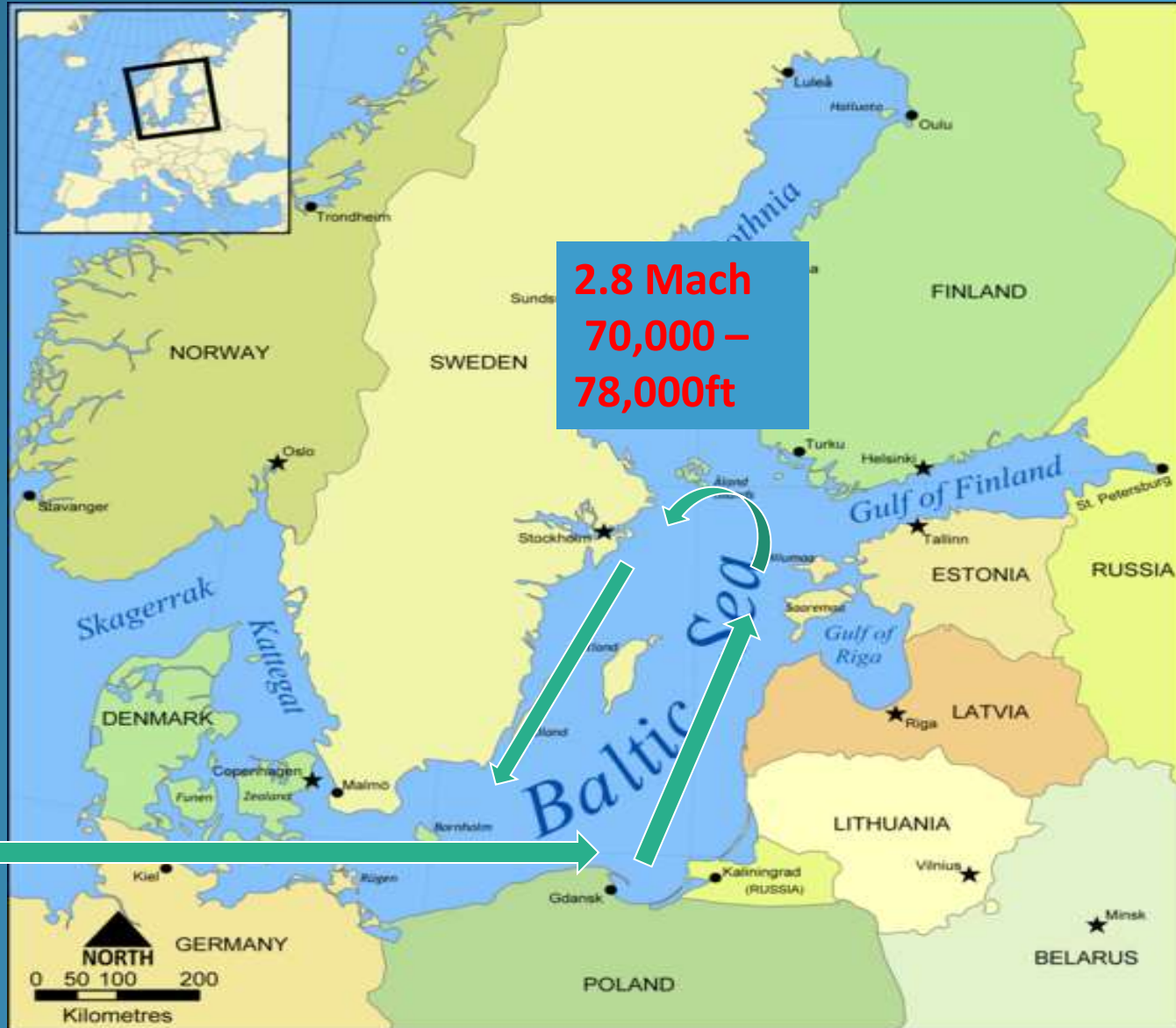


# Cuba / Nicaragua

## Missile and Aircraft Deployment and “Politics”



# Warsaw Pact Missions – Baltic Troop Rotations and Placement



# Murmansk USSR Ballistic Missile Fleet



# Libya April 1986

## Post-Strike Reconnaissance



# Refueling

- Integral part of almost all missions
- KC-135Q or KC-10A
- Most takeoffs
- Longer range missions



# Farewell to Fleet 1990

- Cold War over (threat diminished)
- Too costly (\$85,000/flight hour)
- Never had real-time datalink





# Boeing Space Shuttle Orbiter *Discovery*



# US Human Spaceflight Before Shuttle

- Mercury
- Gemini
- Apollo
- Apollo Applications

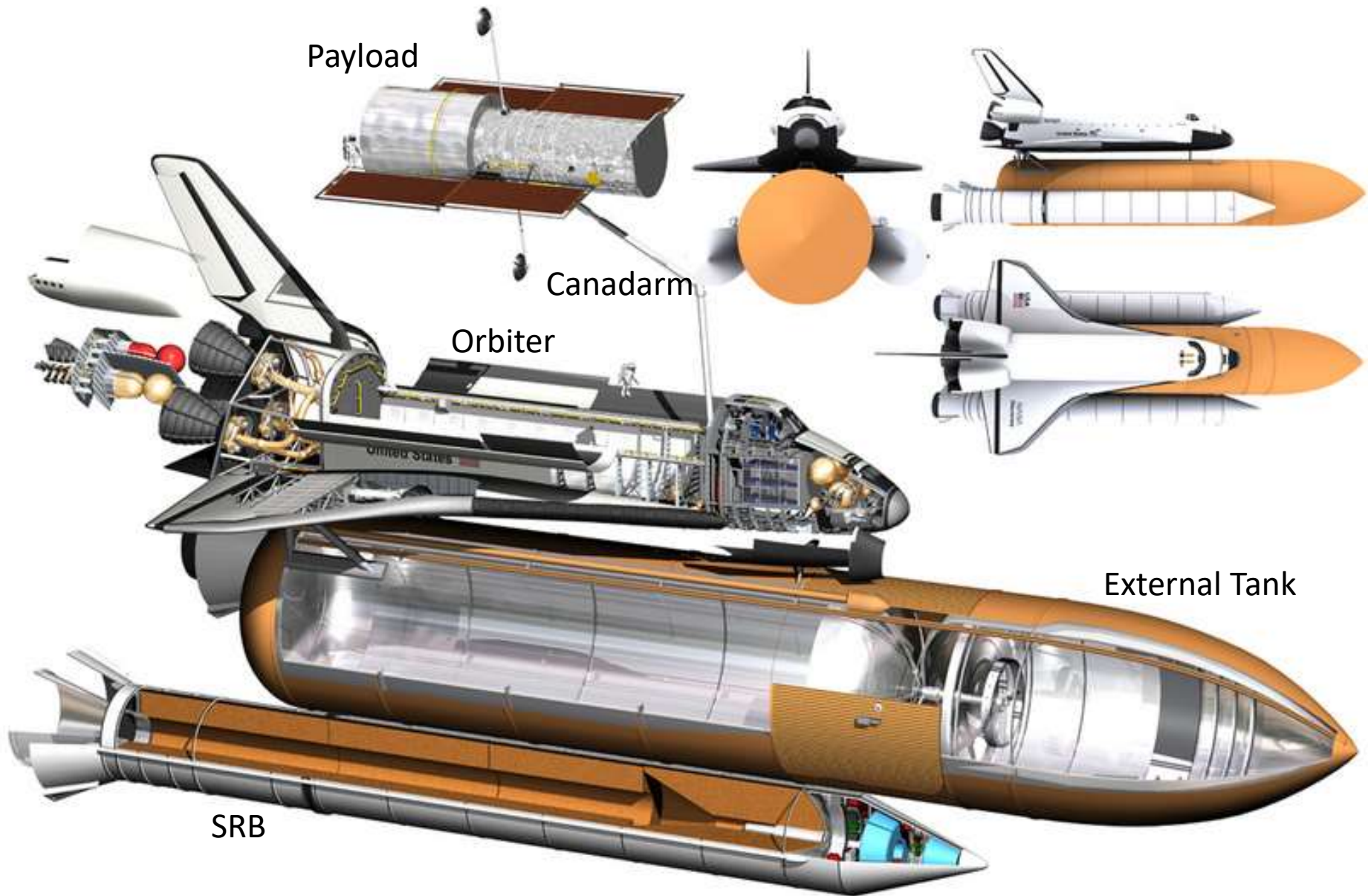


# Why the Shuttle?

- Longtime dream of reusable spacecraft
- Von Braun Paradigm
  - Shuttle-station-Moon-Mars
  - From early 1950s
- Serious studies from 1950s
- Many political considerations
- Formal NASA program 1969
  - Economics—fully reusable
  - Ready access to space
  - Fascination with spaceplane



# Space Shuttle System



# System Statistics

A photograph of the Space Shuttle Columbia in orbit above Earth's cloud-covered surface. The shuttle is oriented vertically, with its nose pointing downwards. The orbiter is attached to the external tank and solid rocket boosters. The background is a deep blue space with white clouds of the Earth's atmosphere.

- Total Stack
  - 184 ft high
  - 4.5M lbs
- Orbiter
  - 122 ft L, 78 ft S, 57 ft H
  - Payload Bay 60 x 15 ft
- Engines
  - SSME ~400k lbst each
  - SRB 3.3M lbst each
- Max Speed 17,800 mph
- 6 orbiters
  - 5 space rated
  - 2 lost w/14 crew
  - 1 aero test orbiter
- 135 missions
- 21,152 orbits, 537M mi
- 1,333 days (3.65 yr)
- Crew
  - 306 men, 49 women
  - Age 28-77



*Enterprise OV-101*



*Columbia OV-102*



*Endeavour OV-105*

# The Orbiters



*Challenger OV-099*

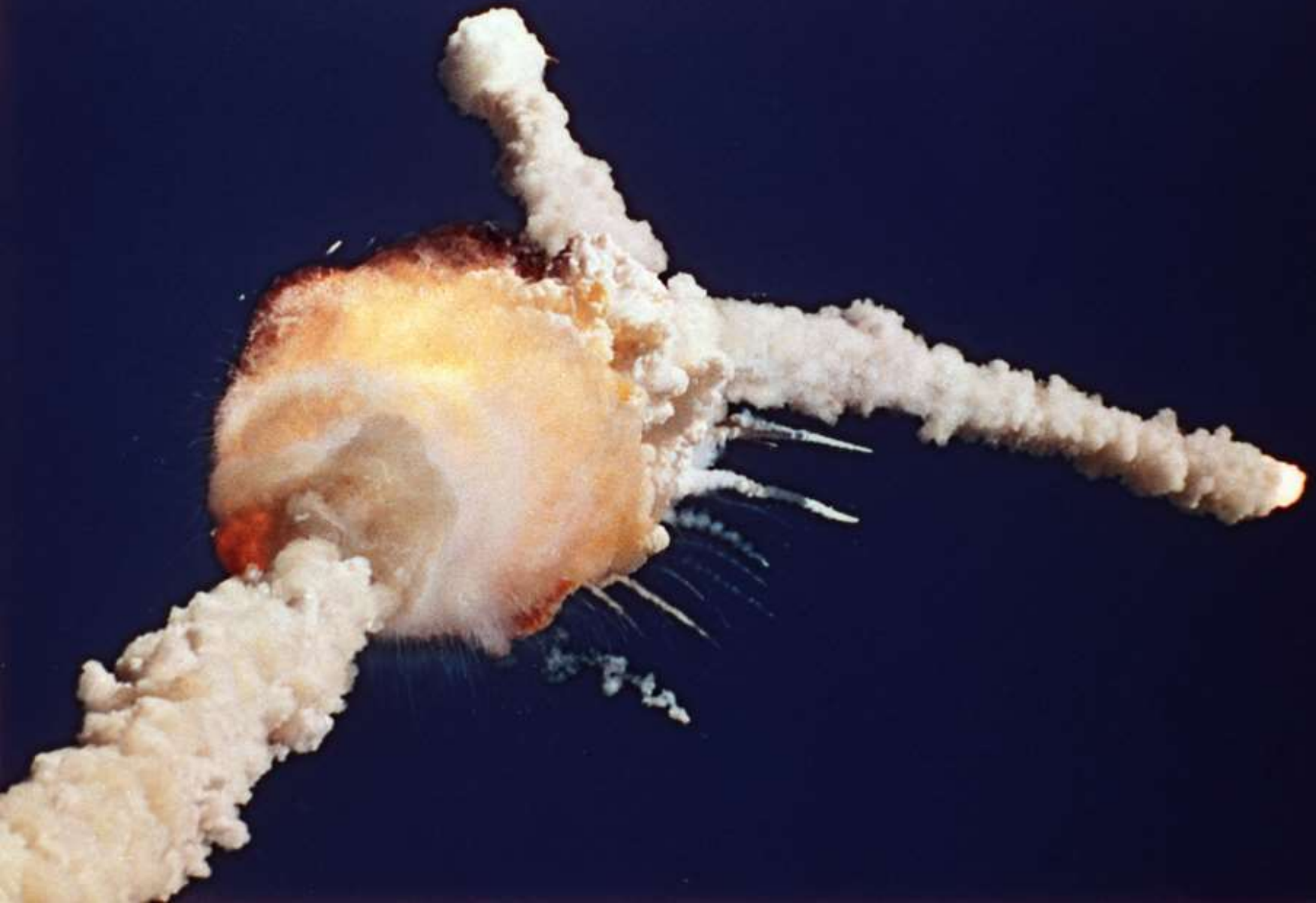


*Atlantis OV-104*



*Discovery OV-103*

# *Challenger* (1986)



# *Columbia* (2003)





# Examples of Space Shuttle Missions



A sample of why the Shuttle  
was such a tremendous asset

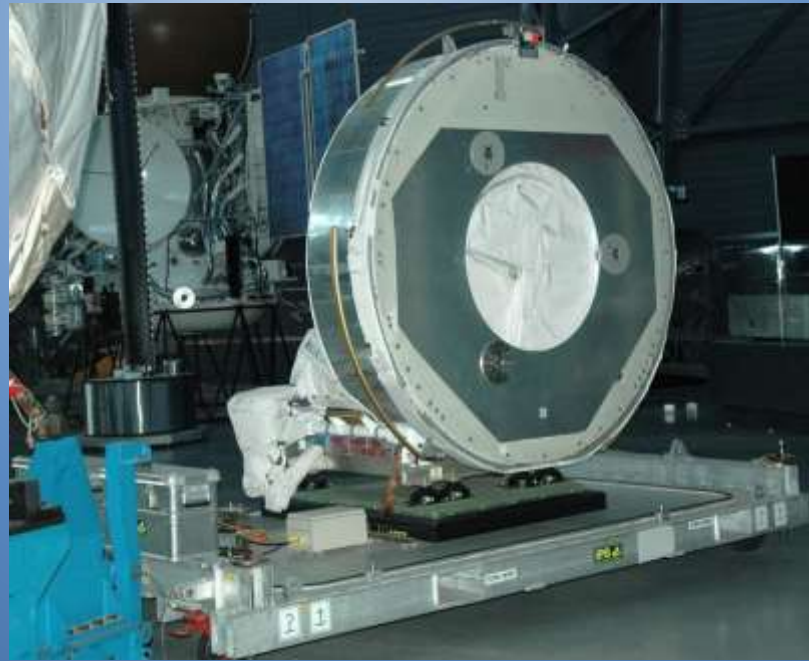
# Spacelab

- Designed/built by ESA—on 32 missions
- Interim space station—modular laboratory
- NASM lab 9 trips 1983-97 (other one 7 trips)
- Components
  - Lab module
  - Igloo
  - Pallets
- Joined by tunnel



# Spacelab

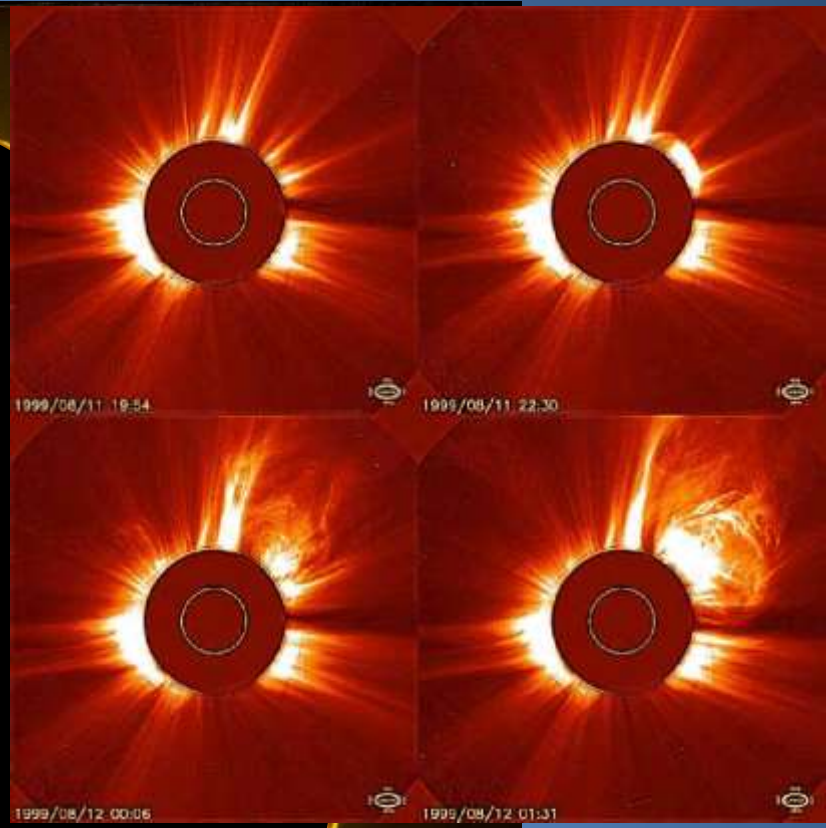
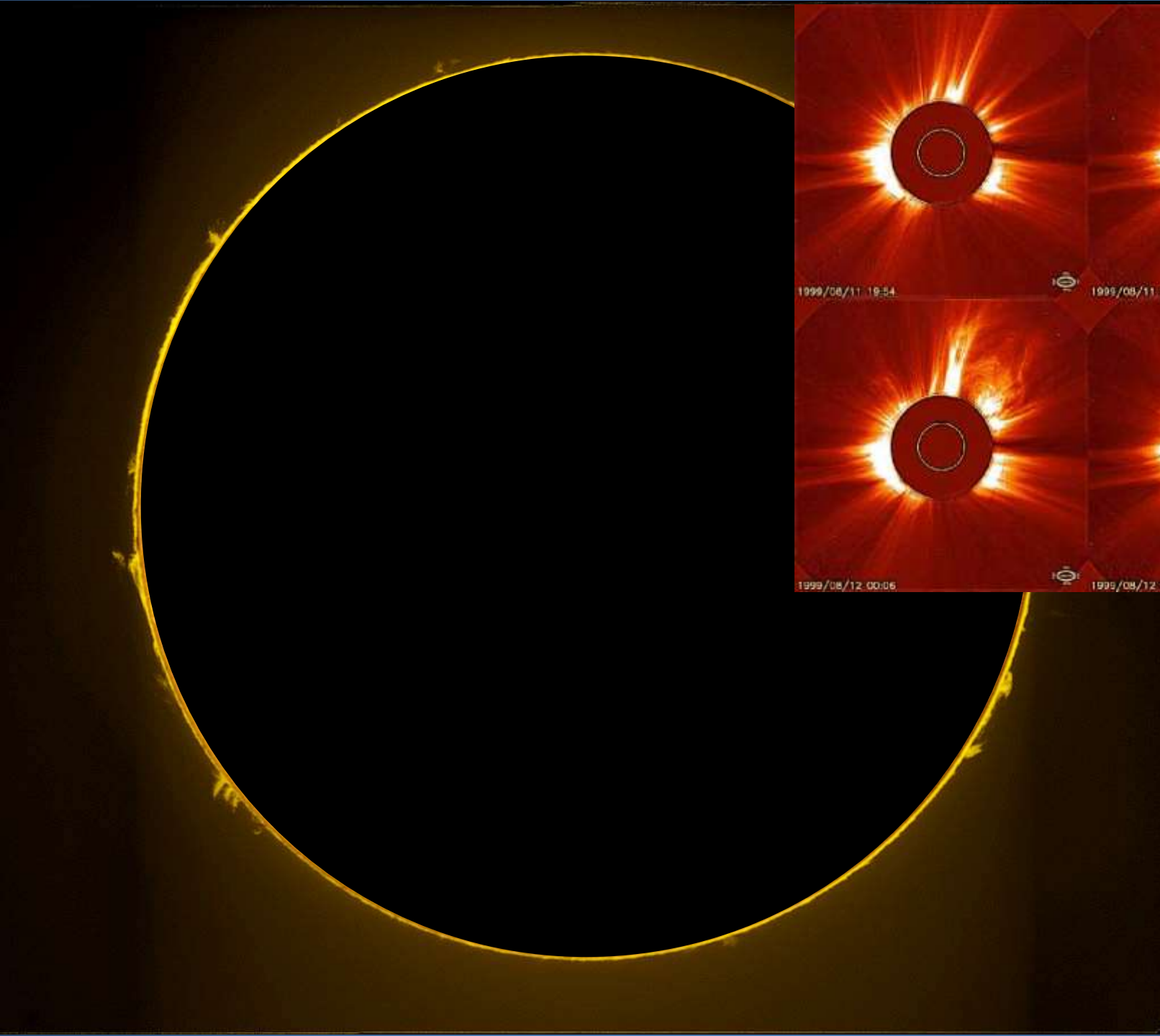
- Joggle tunnel
- Instrument Pointing System
- Igloo



# Spartan 201

- US payload
- Taken up 5 times (Apr 93 – Nov 98)
- Solar observations
  - Put in parallel orbit
  - Retrieved
  - Occulted photosphere to observe corona
  - Helped understand Solar Wind



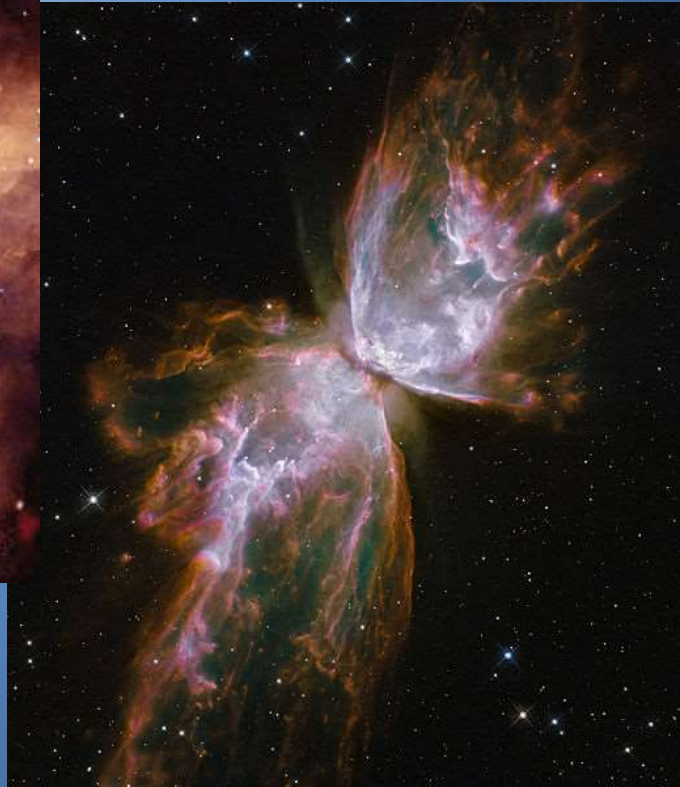
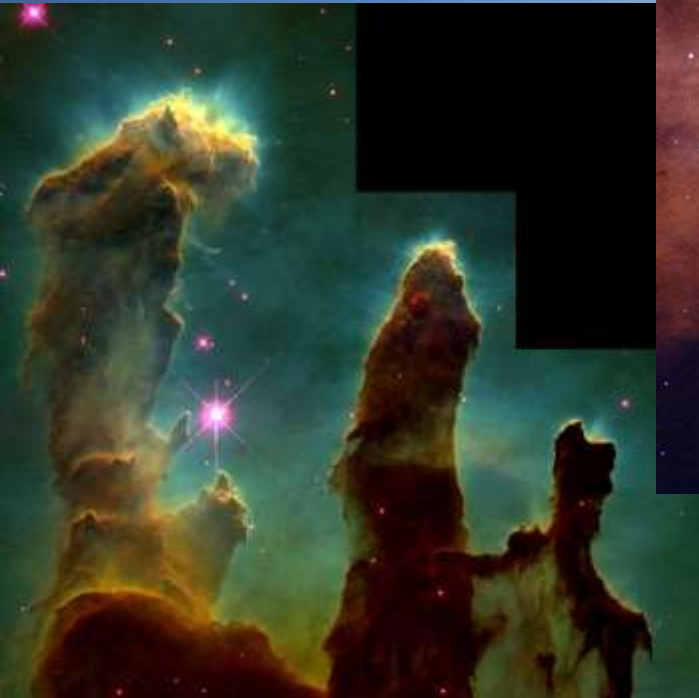


# Hubble Space Telescope

- A NASA Great Observatory
- Launched by *Discovery* Apr 90
- Five servicing missions
  - Two by *Discovery*
  - 1993/97/99, 2002/09
  - Repairs, new instruments, etc.
- Vast discoveries
- Development test unit displayed at NMB

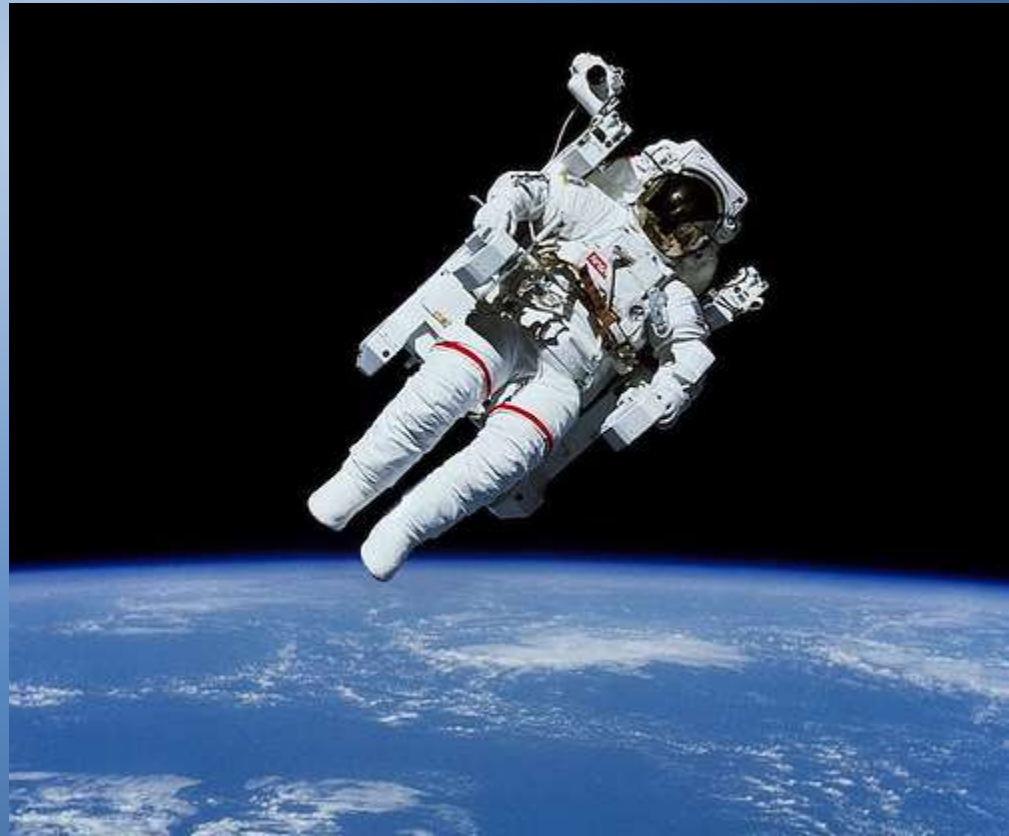


# Hubble (cont)



# Manned Maneuvering Unit

- Backpack propulsion device
- First non-tethered EVA 7 Feb 84
- Flown by 4 astronauts on 3 missions





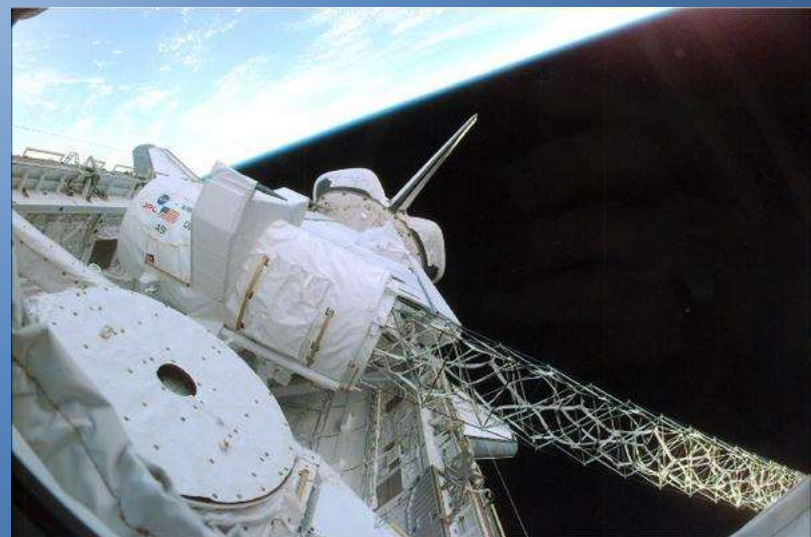
# TDRS

- Tracking and Data Relay Satellite
- 12 orbited (first Apr 83); 3 from *Discovery*
- Real-time, continuous comm coverage
- Served Shuttle, ISS, Hubble, et al.



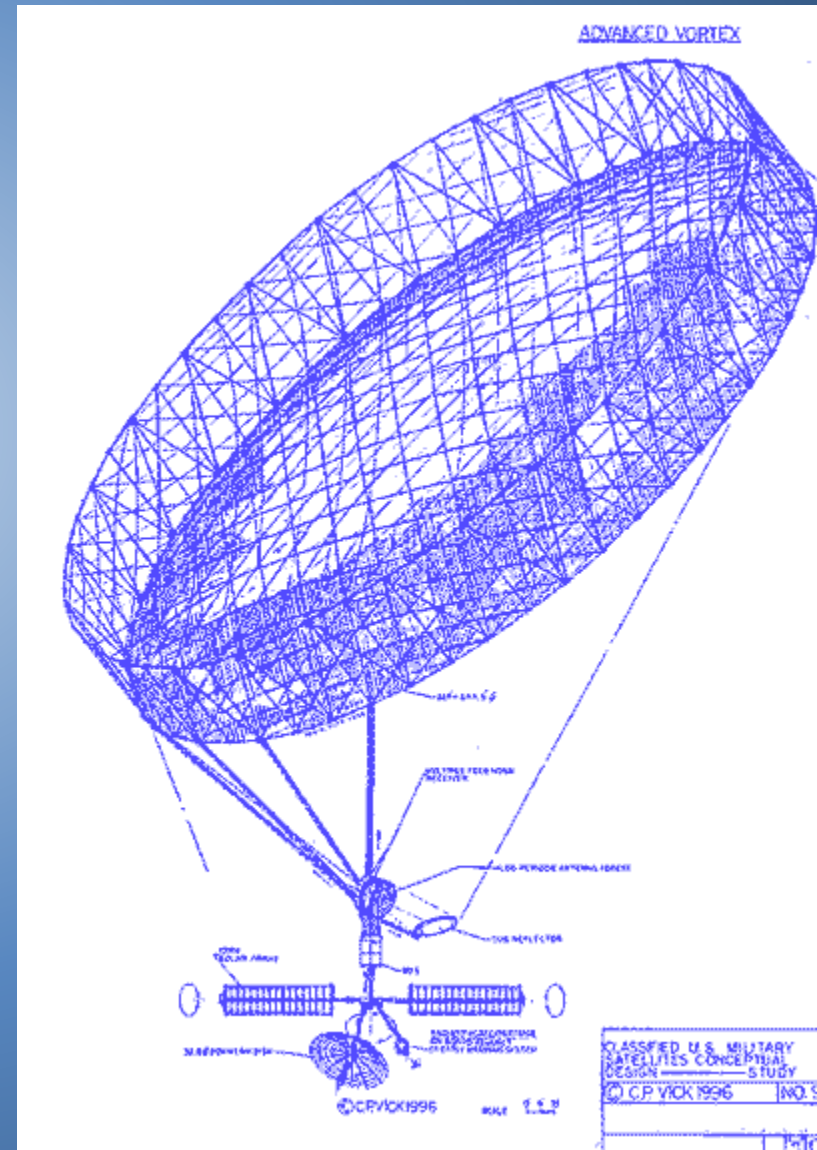
# Shuttle Radar Topography Mission

- *Endeavour*, 11 days, Feb 00
- Mapped 80% of Earth in 3-D
  - 56°S to 60°N
  - 30m resolution over US
- Two radar antennas
- Displayed at UHC



# Classified DoD Payloads

- Examples
  - Magnum SIGINT
  - DSCS communications
  - Lacrosse radar imaging
  - SDS communications
  - Misty reconnaissance
- All military crews
- Special control procedures
- *Discovery* last orbiter that performed these missions



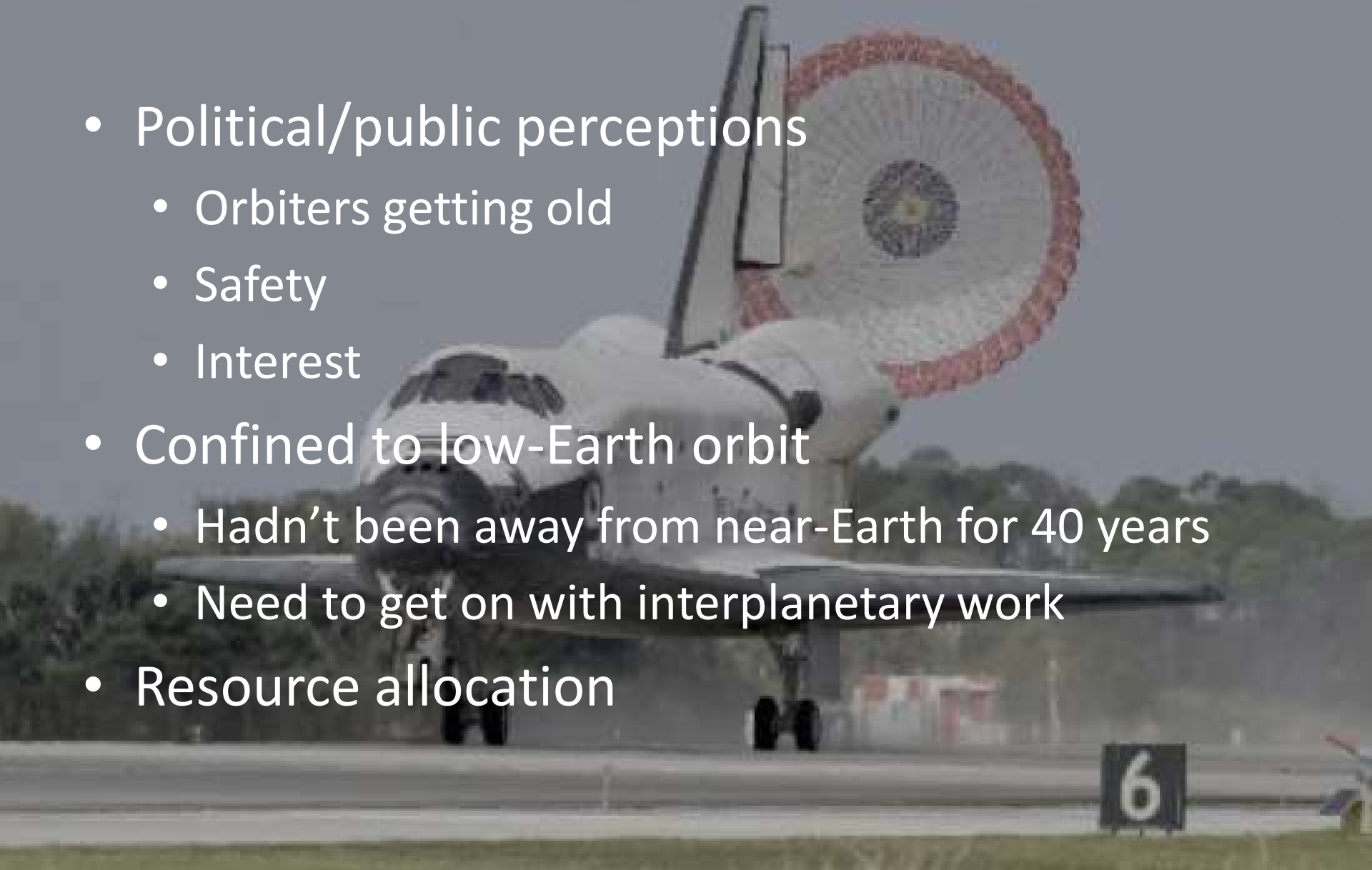
# International Space Station (ISS)

- Inhabited microgravity and space environment research lab
- US, Russia, Japan, Canada, Europe
- First component 1998
- Manned since 2000
- About 220 mi above Earth
- 37 Shuttle flights to ISS
- *Discovery* delivering module



# Why Did Shuttle Program End?

- Political/public perceptions
  - Orbiters getting old
  - Safety
  - Interest
- Confined to low-Earth orbit
  - Hadn't been away from near-Earth for 40 years
  - Need to get on with interplanetary work
- Resource allocation



Questions?

