



X-59 eXternal Vision System (XVS)

Randall E. Bailey

NASA Langley Research Center

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Outline



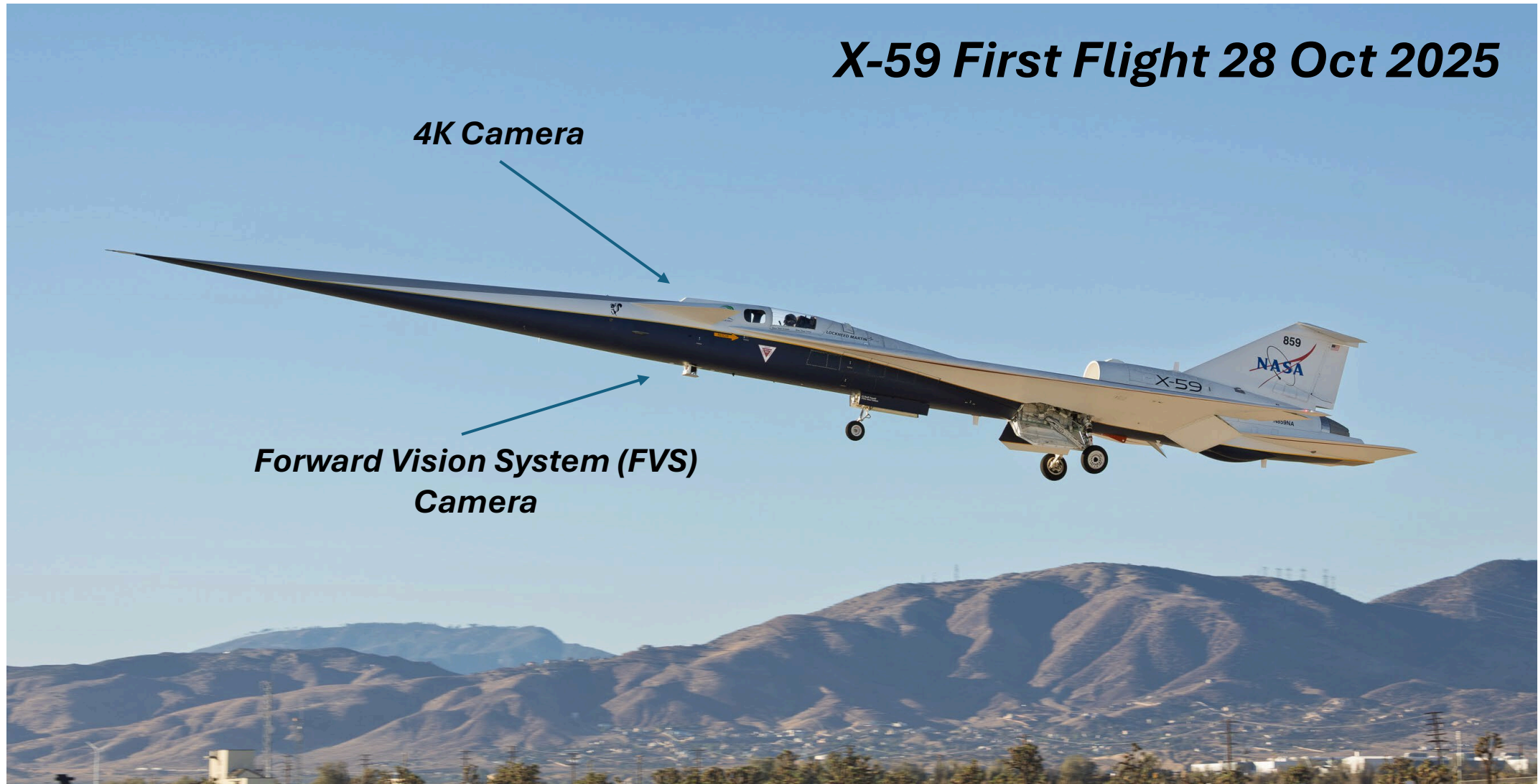
- Introduction
 - X-59: Quiet SuperSonic Technologies (QueSST)
- eXternal Vision System Design
- Phase 1 Flight Testing
- Future Development, Forward Work

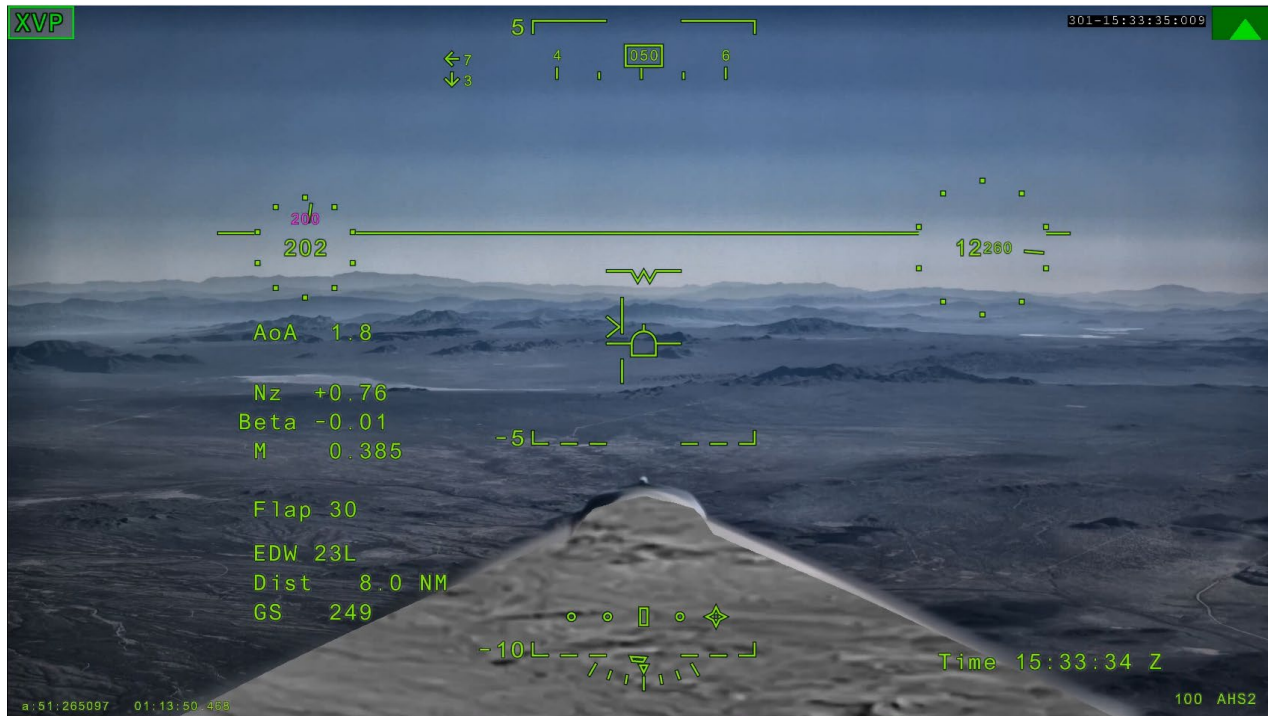
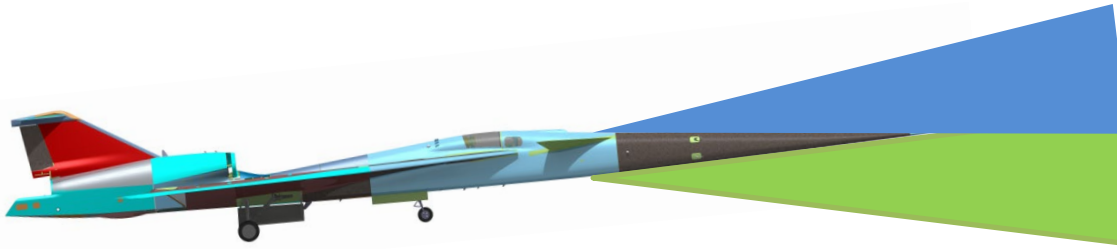


Low Boom Flight Demonstrator X-59



X-59 First Flight 28 Oct 2025

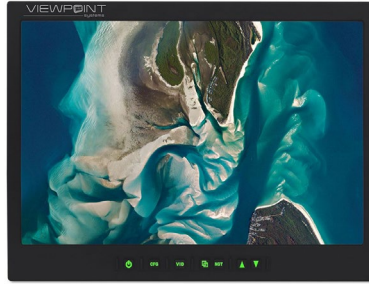




- eXternal Vision System (XVS)
 - Primary Function: Imagery – Window “equivalent”
 - Secondary Function: Head-Up Display (HUD) Symbology
- Imagery
 - 4K Camera
 - Forward Vision System (FVS)
 - Collins Enhanced Vision System (EVS-3600) Camera
 - Synthetic Vision System (SVS)
 - Computer-Generated Imagery

XVS Overview – Components

XVS Display



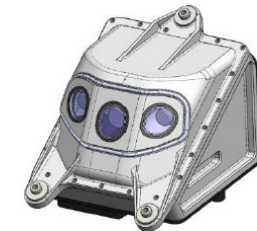
XVS 4K Camera



XVS Control Panel



Forward Vision System



XVS Pallet



XVS Maintenance Panel



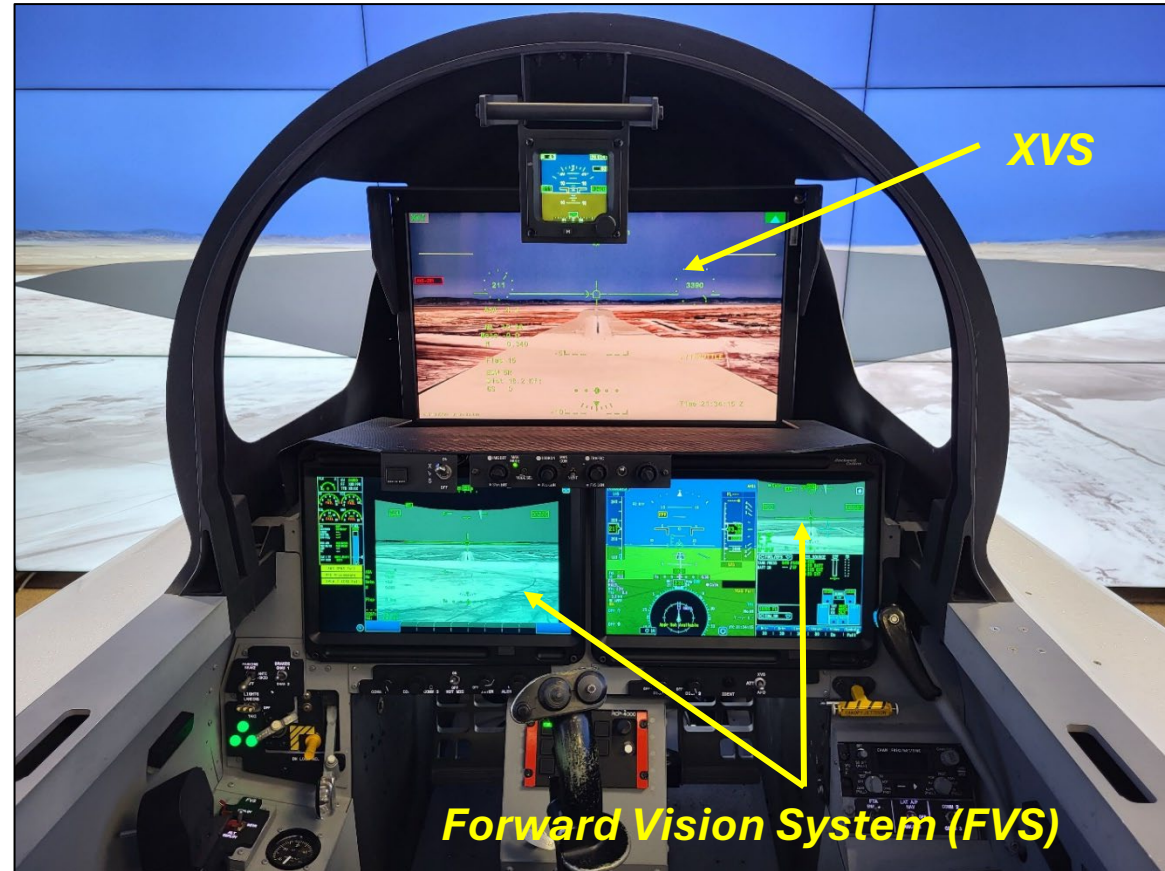
*Trenton System THS2085 HDEC 2U
rack-mounted computer*



In Aircraft



In Simulator





XVS Video



- XVS: Mission-Critical But Redundancy Added Where Possible / Practical
 - Two XVS processors running in parallel
 - Video controller:
 - Switches to 'healthiest' processor / video output in one 60 Hz frame
- Data Rates
 - Pushing uncompressed Ultra-High Definition (UHD) video to XVS display
 - ~12 GigaBits per second
 - On-board video recording
 - 20 Mbits/sec
 - Telemetry of video to AFRC control room
 - 6 Mbits/sec



Videos





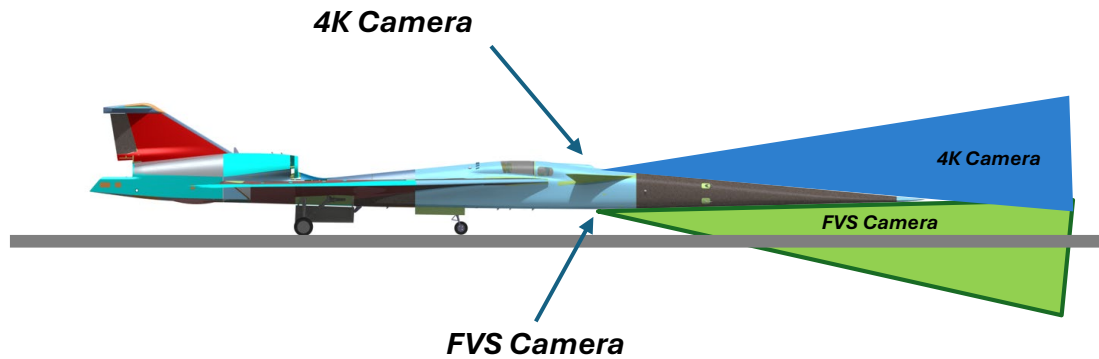
XVS Challenges



- XVS designed for QueSST Low Boom Flight Demonstration Mission - “Phase 3”
 - Currently in Phase 1: Airworthiness
 - XVS Designed for Continual Upgrades
 - Software Changes
 - Head-Up Display symbology
 - Improving image quality
 - Equipment Obsolesce
 - XVS displays procured ~2018
 - New displays with improved display readability
 - Window “Equivalence” Testing
 - See-and-Avoid:
 - Surrogate Aircraft Testing - AIAA Paper 2020-3087
“eXternal Vision System Development and Testing for X-59 Low Boom Flight Demonstrator”
 - Use of Autonomous Dependent Surveillance-Broadcast (ADS-B) data for XVS Head-Up Display traffic locator boxes

FVS Camera Parallax During Surface Ops

- Nominal Mode
 - 4K camera with FVS providing “nose fill”
 - *FVS aligned with 4K camera for flight operations*



- Parallax Compensation
 - Ground mode to reduce parallax distortion





Failure Mode Effects



- XVS: Mission-Critical
 - Why not flight critical?
 - 2 extremely qualified test pilots
 - Clear view thru canopy
 - Not too dissimilar to flying from back-seat of other fighter aircraft
 - Forward Vision System availability
 - Highly reliable, COTS equipment
 - Mission planning
- XVS Designed for “Pseudo-Redundancy”
 - Redundancy in equipment/design where it made sense
 - SW designed to Level B / C vice Level D
 - Significance that XVS plays in pilot-vehicle interface
- Failure Mode Effects Analysis
 - Simulations supported mission-critical design
 - Combination of failures:
 - XVS
 - Radar Altitude
 - FVS
 - Adaptive Flight Displays
 - Biggest increment in workload is loss-of-AFDs with Loss-of-XVS
- Assessing XVS Reliability during Phase 1 Flight Testing
 - Restricted Airspace Ops with Chase Aircraft



Summary



- X-59 XVS
 - First operational deployment of eXternal Vision System technologies in all phases of flight
 - Successful to date
 - Challenges exist/remain
 - Working toward operationally ready system for Phase 3
 - “Routine” operations in the National Air Space (NAS) in support of QueSST mission
- Industry-Government Interest in X-59 & XVS Technologies:
 - RTCA SC-213 planning development of XVS Minimum Aviation System Performance Standards

