GENERAL DYNAMICS
Armament and Technical Products

F-35 Lightning II STOVL/CV Gun System Update

Presented by:

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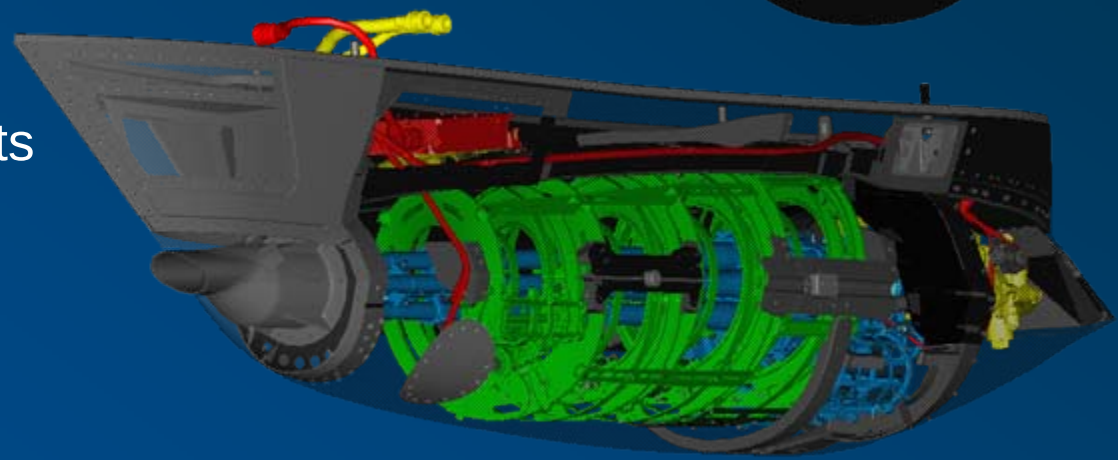
Presentation Outline

- System Description
- Achievements since March 2007
- Engineering Test Results
  - Power
  - Dispersion & MPI
  - Interface loads
  - Gun motion
  - Design improvements
- Pod Fatigue Test Status
- Path Forward



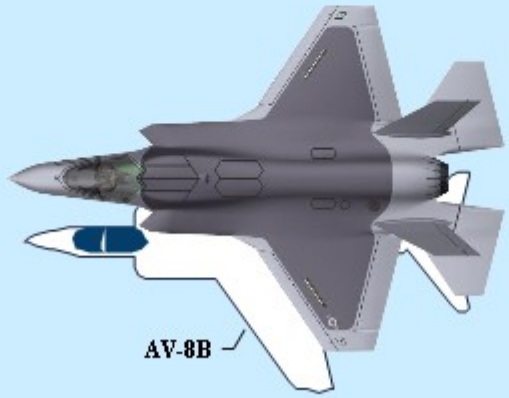
Lockheed Martin F-35 Variants

CTOL

Span (ft)	35
Length (ft)	50.5
Wing Area (ft²)	460

STOVL

Span (ft)	35
Length (ft)	50.5
Wing Area (ft²)	460



CV

Span (ft)	43
Length (ft)	50.8
Wing Area (ft²)	620

STOVL/CV Gun System

GSCU & electrical

PT & hydraulics

Gun & transfer unit

Helical feed system

Engine Nacelle vent inlet

Electrical & hydraulic connections

Bulb seal

Aft bulkhead captive fasteners & pin

Purge inlet

Fwd bulkhead captive fasteners & pin

Transparent:

Inner tube, LH side skin & access doors

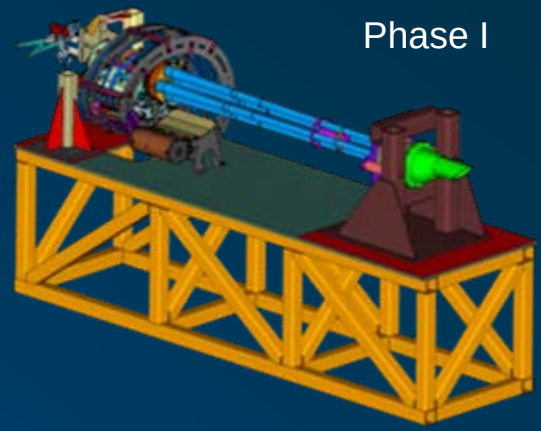
Weapon Bay Door stops

Purge exhaust

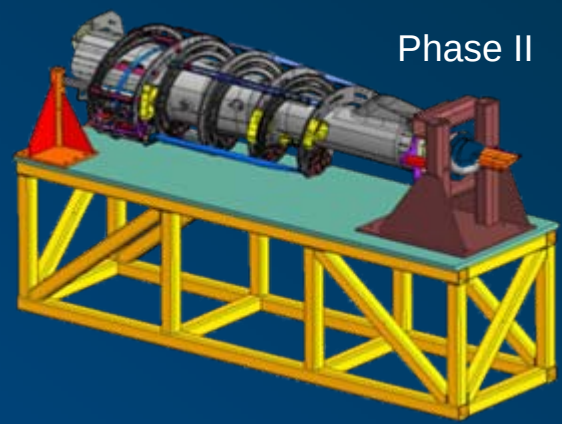
Achievements since March, 2007

- Successfully completed Phase I engineering fire testing
  - Handoffs optimized
  - Initial evaluation of helix functionality, dispersion, and power
  - Interface loads and gun motion measured
  - Recoil track design improvement implemented
- Began Phase II engineering fire testing
  - GSCU operation verified, including reverse clearing
  - Dispersion and power measured
  - Design improvements implemented for carrier durability and safing/firing cam operation,
- Fired 5,000+ and cycled 1,300+ rounds to date

Phase I



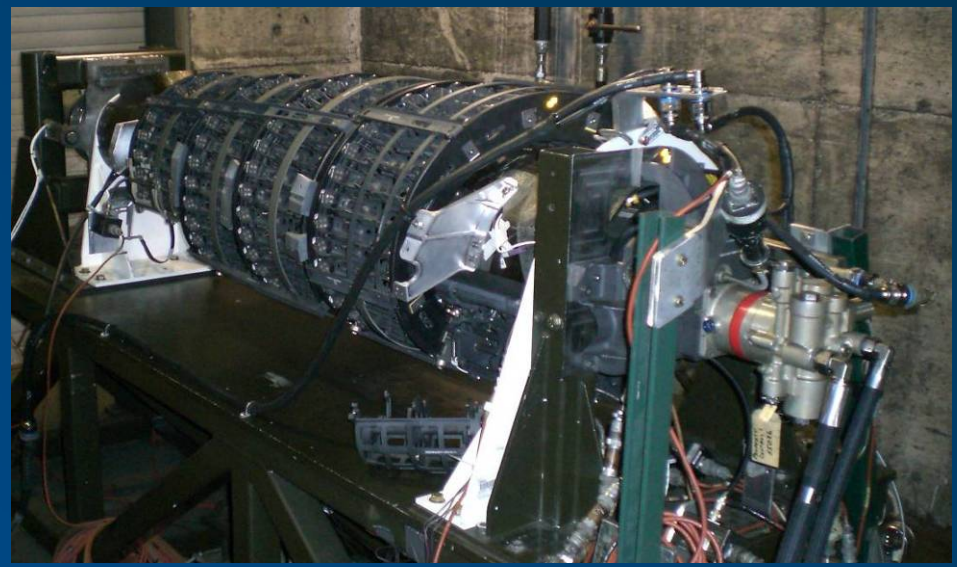
Phase II



Test - Phase II Focus

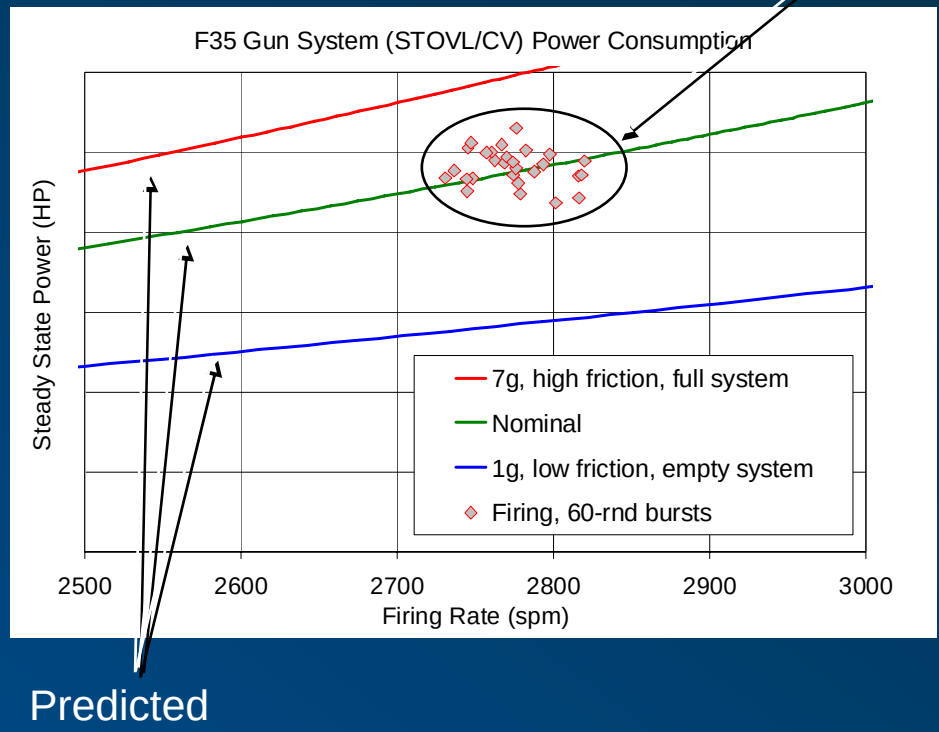
- Overall gun system functionality
  - Integration of GSCU, software, full feed system
- Validate design changes
  - Carrier durability
  - Safing/firing cam
  - Recoil track durability
- Dispersion
- Power

Firing video



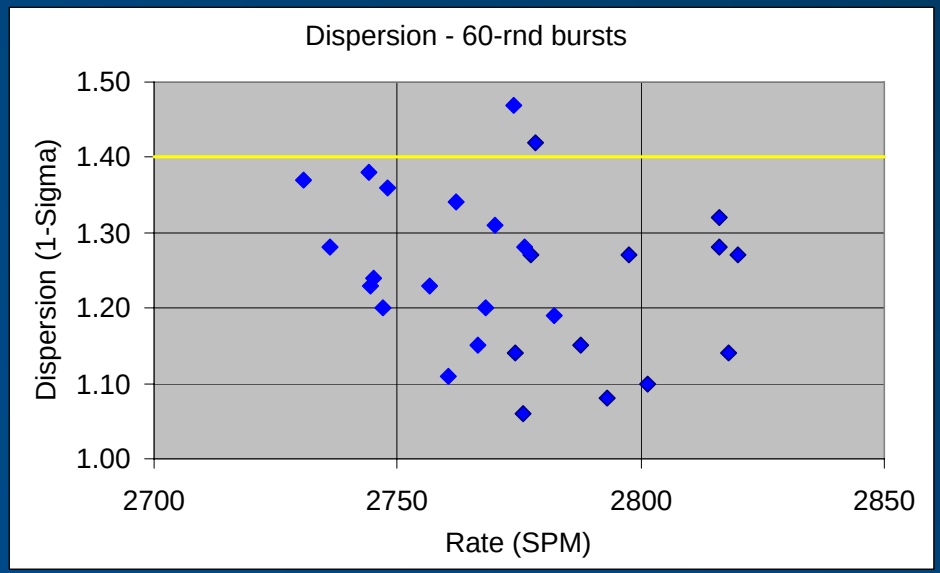
Test - Power

- System power is within expected range
- Hydraulic drive motors achieved acceleration and rate requirements



Test - Dispersion

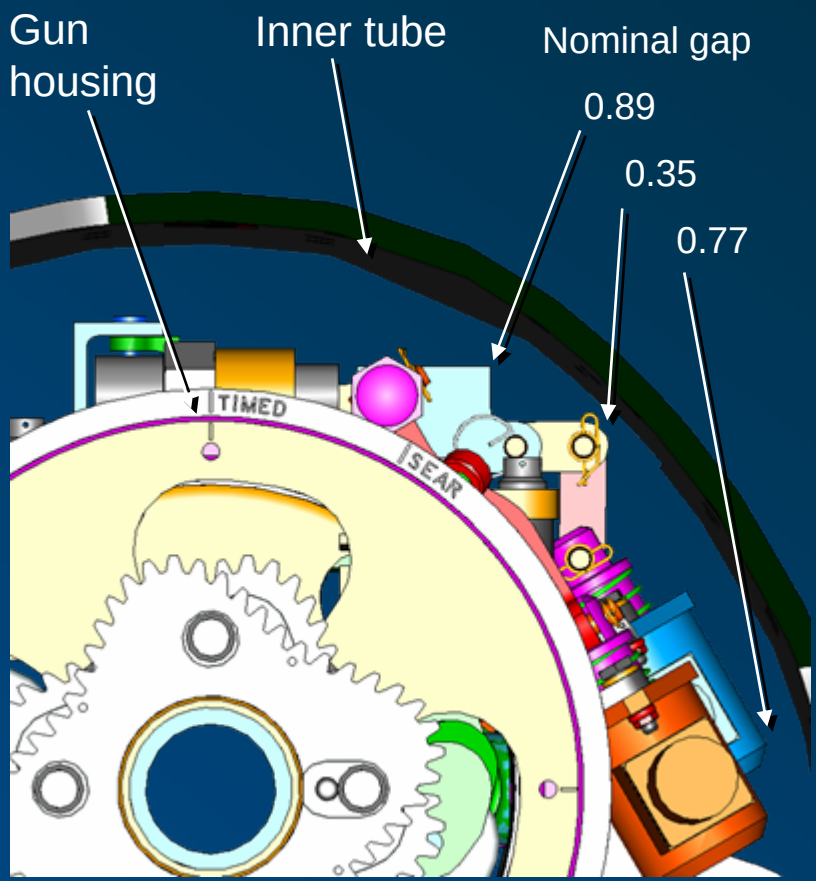
- Requirement
  - Dispersion - 1.40 milliradians one-sigma (minimum 54 rnds)
- Firing conducted with 60-rnd bursts



- Testing planned to evaluate impact from firing rate, start-up characteristics, burst length, and usage

Test – Gun Motion

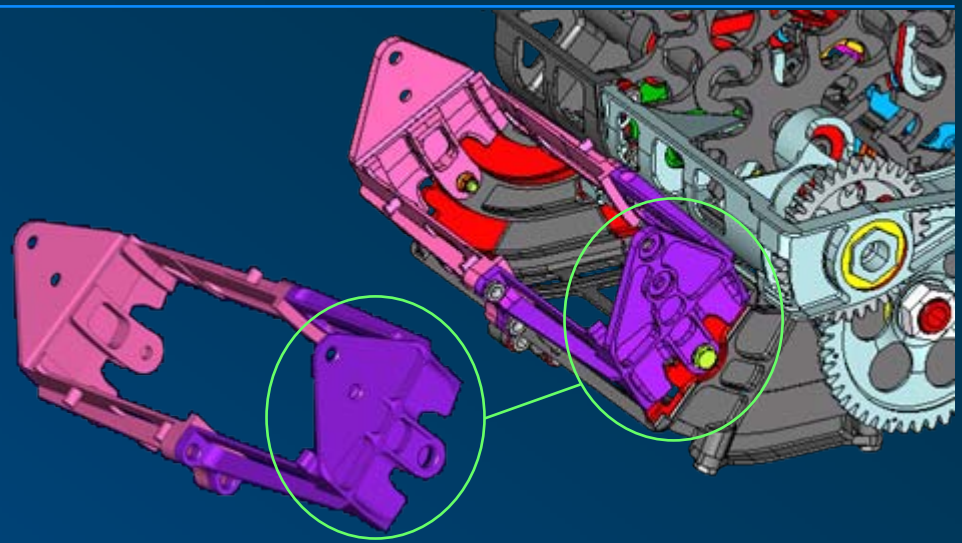
- Monitored gun motion –
  - Aft cover (vertical & lateral)
  - Forward vertical (via turnaround housing)
  - Forward lateral (opposite firing/safing cam)
- Worst case measured motion in area of greatest concern (safing/firing cam) is ~0.25”
- Slot will be incorporated on deliverable tube to accommodate gun motion/function

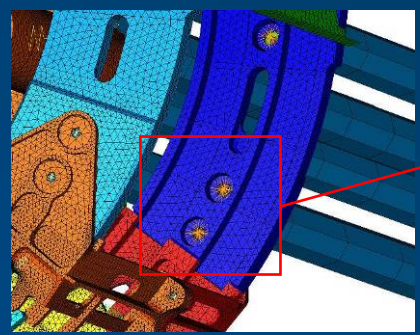


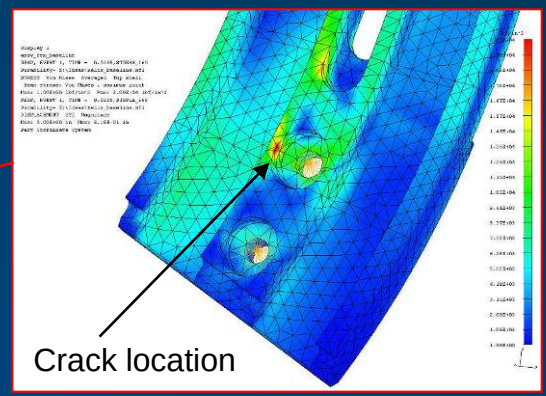
VIEW – Aft looking forward

Design Improvements – Recoil Track

- Forward recoil track crack observed at 668 rnds
- Static and dynamic analysis conducted to optimize redesign
  - Track adapter softened & track locally beefed up
- Results
  - Static 0.625” displacement testing showed a stress reduction of 30%
  - Dynamic analysis indicates >25% reduction in the stress
  - Crack has not reappeared since softened track adapter and new track installed
  - Monitoring will continue

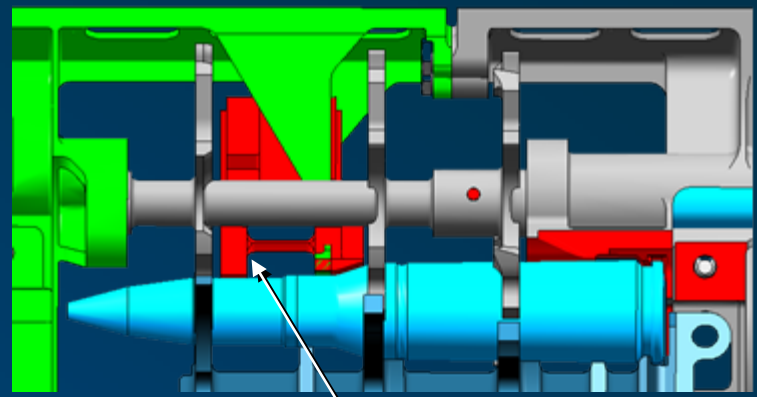


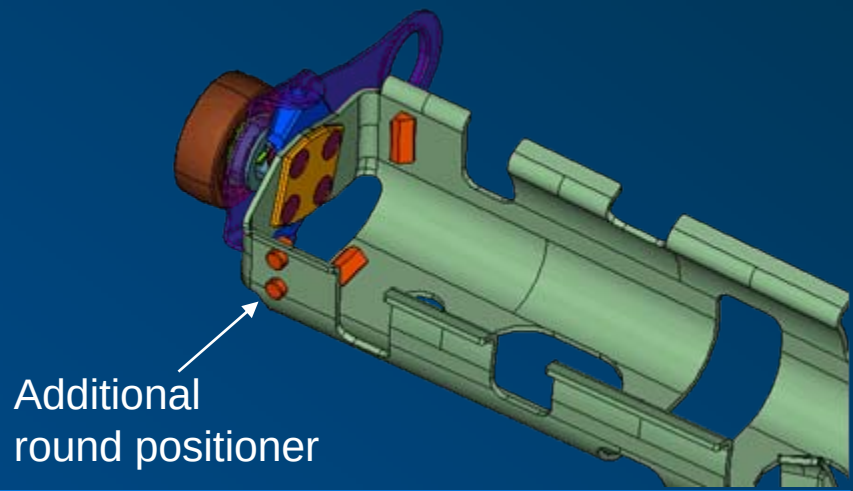




Design Improvements - Handoffs

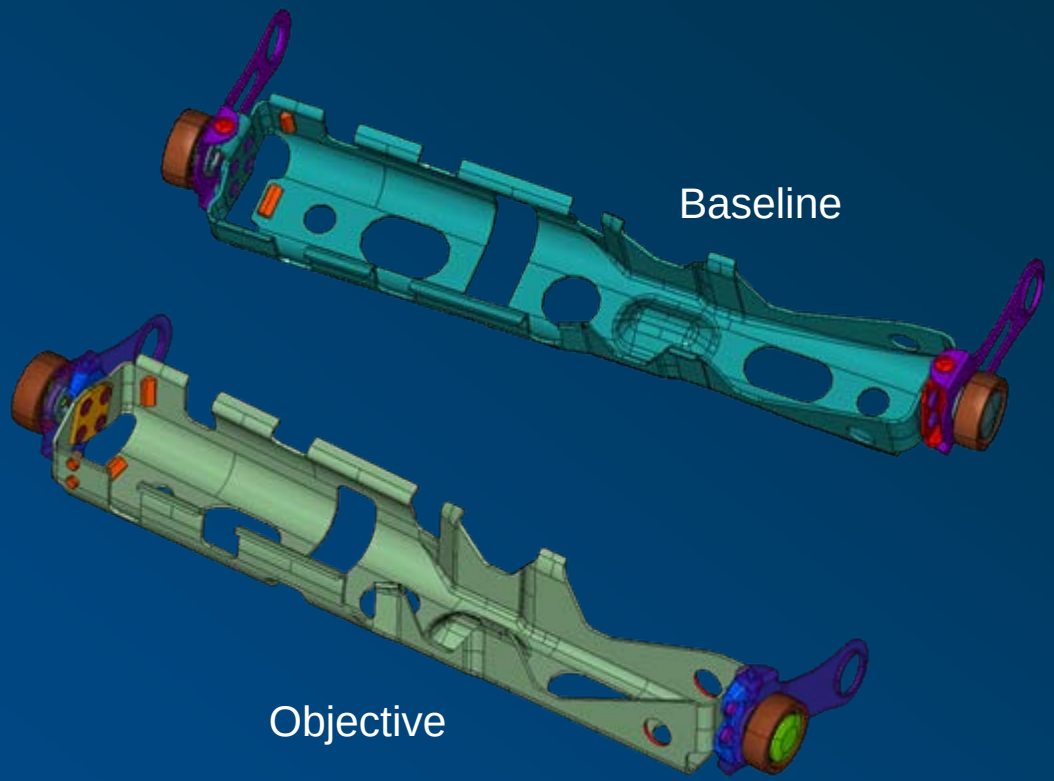
- Handoffs from the carrier to gun (and visa versa) required very little adjustment
  - Slight transfer unit sprocket tip massaging required
  - Projectile guide added to improve robustness of handoff from carrier to turnaround
  - Additional round positioner added to carrier to ensure axial control of round during turnaround unit approach





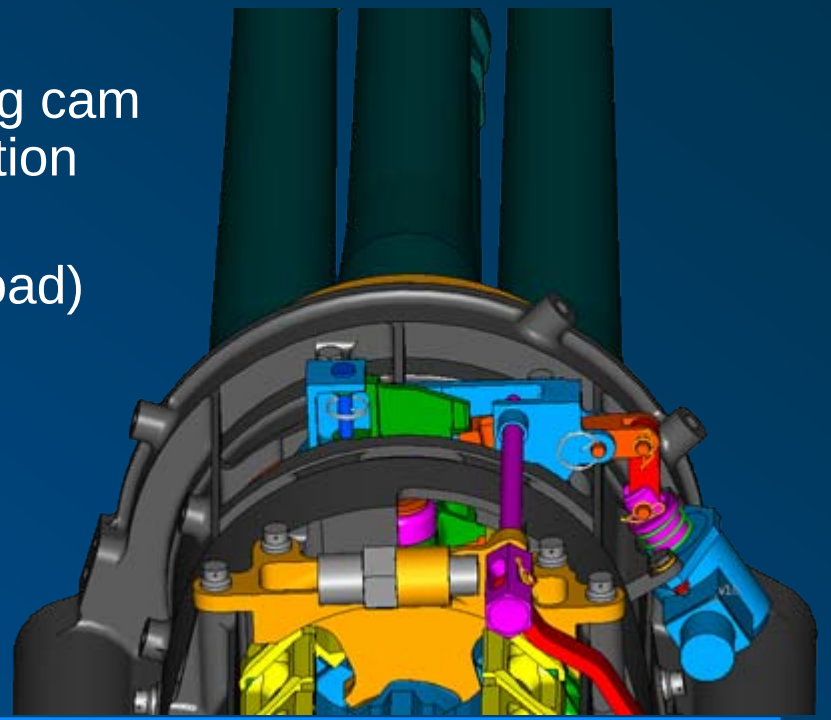
Design Improvements - Carrier

- Dynamic loads measured during test are ~4X greater than the design to loads due to gaps and dynamic response of carrier, requiring significant redesign of the carrier assembly
  - More robust roller retainer
  - Machined blocks replace sheet metal tabs
  - Simplified & stiffened carrier body
  - Directly supported link & link pin
  - Improved link material & geometry
  - Extended rim retainer in turnaround unit is under investigation



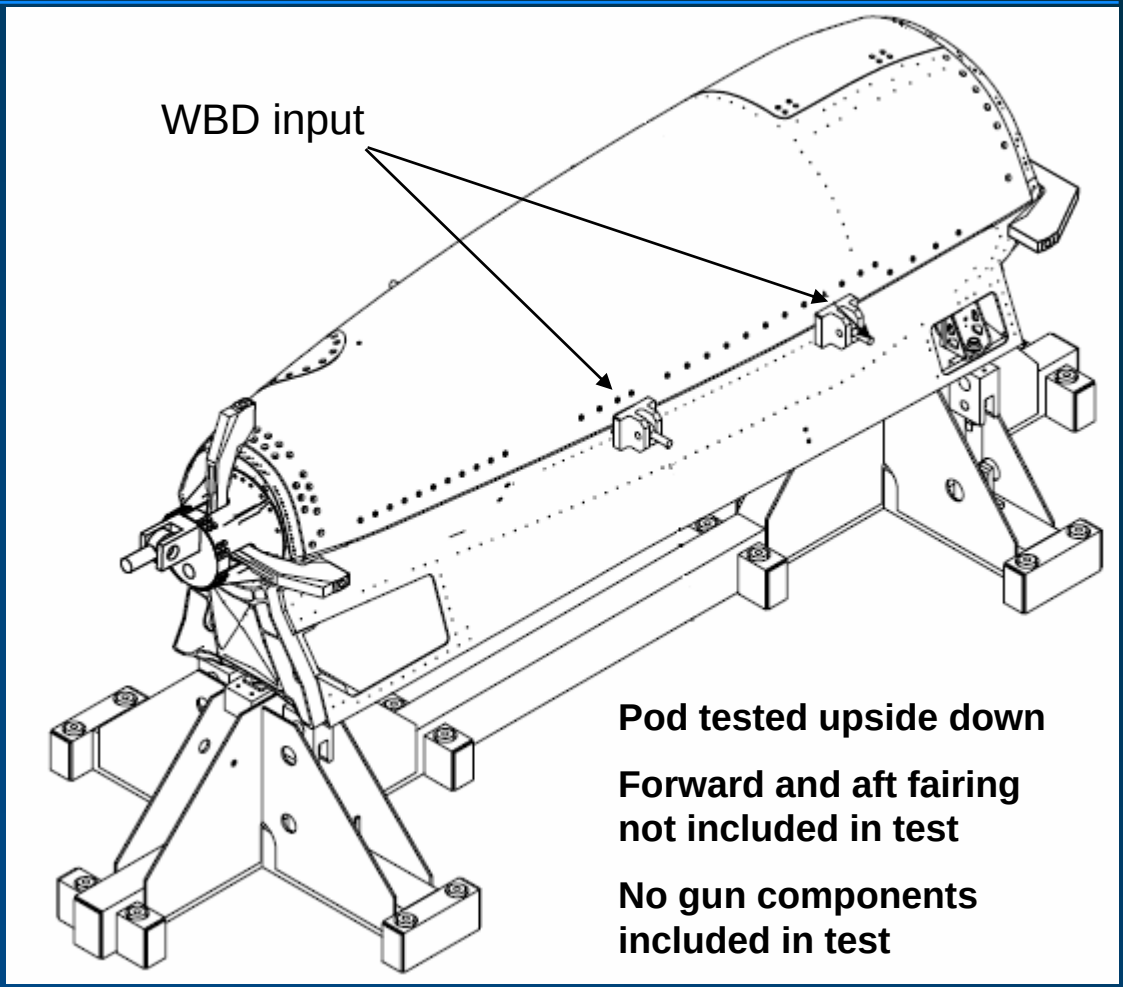
Design Improvements – Firing/Safing Cam

- Significant bouncing of firing lever observed
- Gun could fire without firing solenoid engaged if safing pin was damaged/removed
- Range evaluation . . .
  - Reducing clearance between firing cam and gun housing improved condition
  - Clearance reduction coupled with increased link length (higher preload) eliminated phenomena
- Actions
  - Use firing data to optimize firing/safing cam interface
  - Update hardware and verify fix



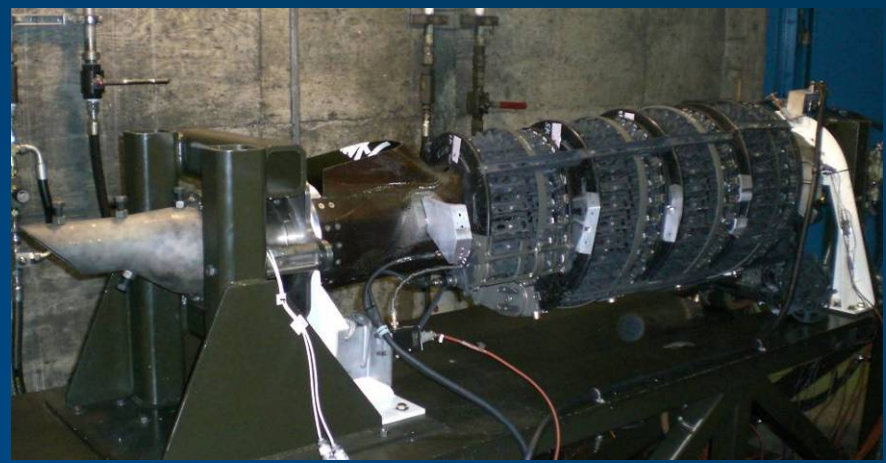
Pod ETU Testing

- Conducted on Pod engineering test unit (ETU)
- Test scheduled for 2nd quarter 2008
- Vibe - gun recoil load fatigue test, equivalent to 36,000 rounds
- Limit load – Gunfire and Weapon Bay Door (WBD) loads



Path Forward

- Complete Engineering Test
  - ~9,000 rounds remaining
  - Verify system durability and functionality
  - Verify carrier life
  - Integrate Pod
- Complete Pod ETU testing
- STOVL/CV 36,000 Round Qualification Test



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