Full-Scale Crash Test of a Civil Helicopter

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The Fourth Triennial International Aircraft Fire and Cabin Safety Research Conference, November 15-18 2004

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Overview of Crash Test

- Second crash test of a helicopter in Japan
- Crash trajectory determined by guided rail method
- Cooperation with Mitsubishi Heavy Industries, Ltd. (MHI)
- Test on February 25, 2004 at Aerospace Center Aerodrome Branch of JAXA

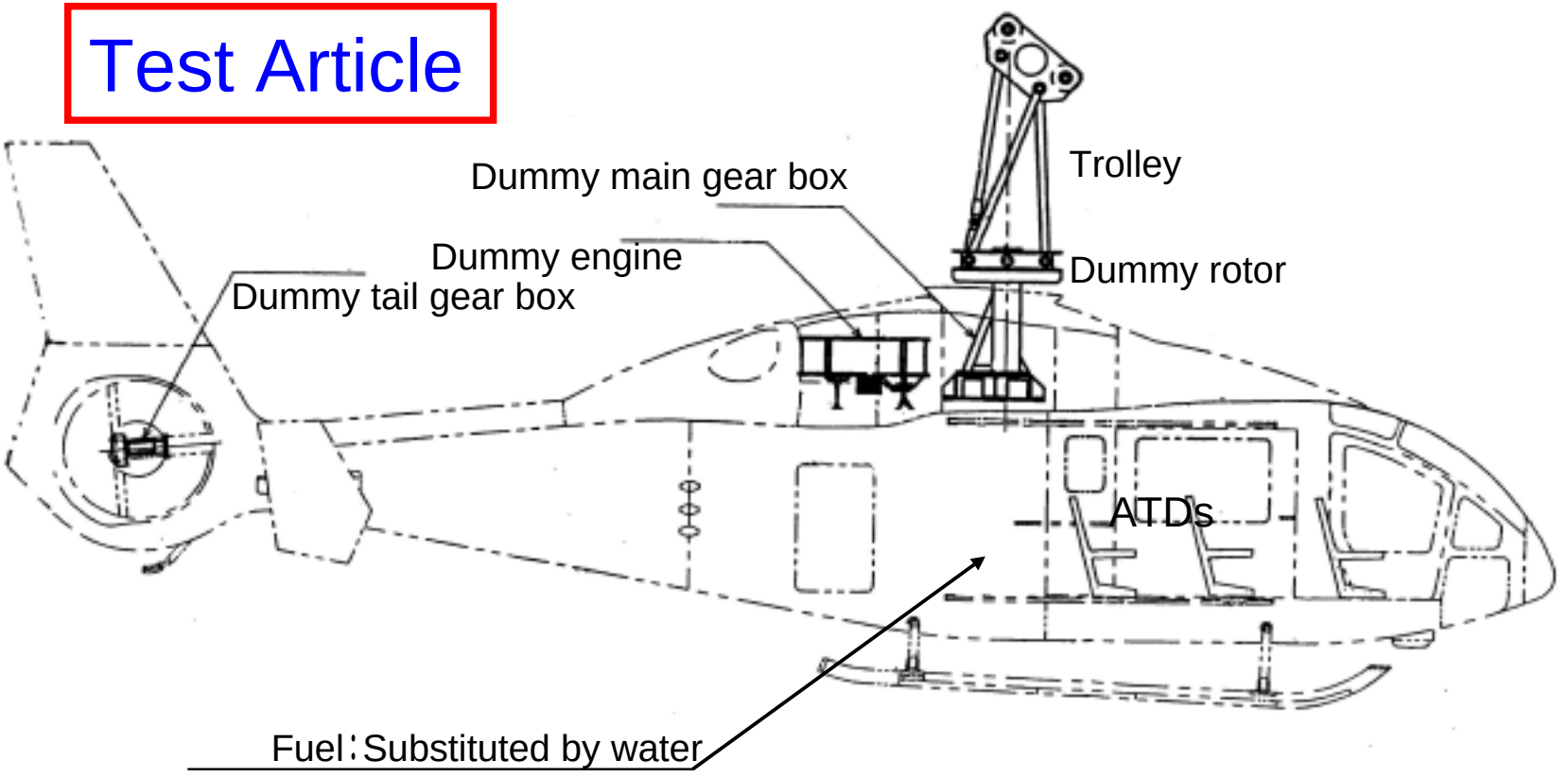
Overview Video Picture of the Test

Offered by MHI

Objective

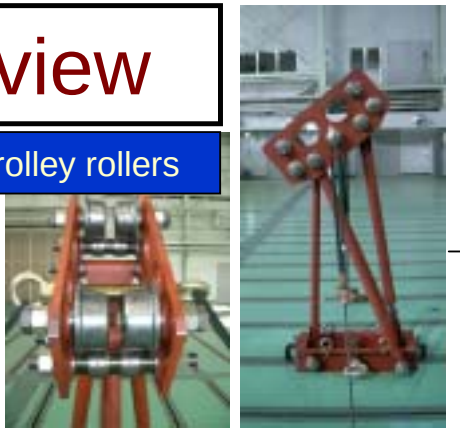
1. Determine the impact response of a helicopter to a full scale crash test
2. Validate helicopter analytical computer model against actual crash test data
3. Develop guided rail method to conduct crash testing
4. Evaluate performance of NAL developed pilot seat shock-absorbing device

Test Article



- A prototype of Mitsubishi MH2000A multi-purpose helicopter
- Total weight：4,500 kg(10,000 lbs)
- Number of seats : (pilots 2, passengers 8)
- Anthropomorphic Test Dummies
  (7 Hybrid II ATDs, 1Hybrid III ATD)

Facility Overview



Trolley rollers

Suspended Test Article

Test Conditions

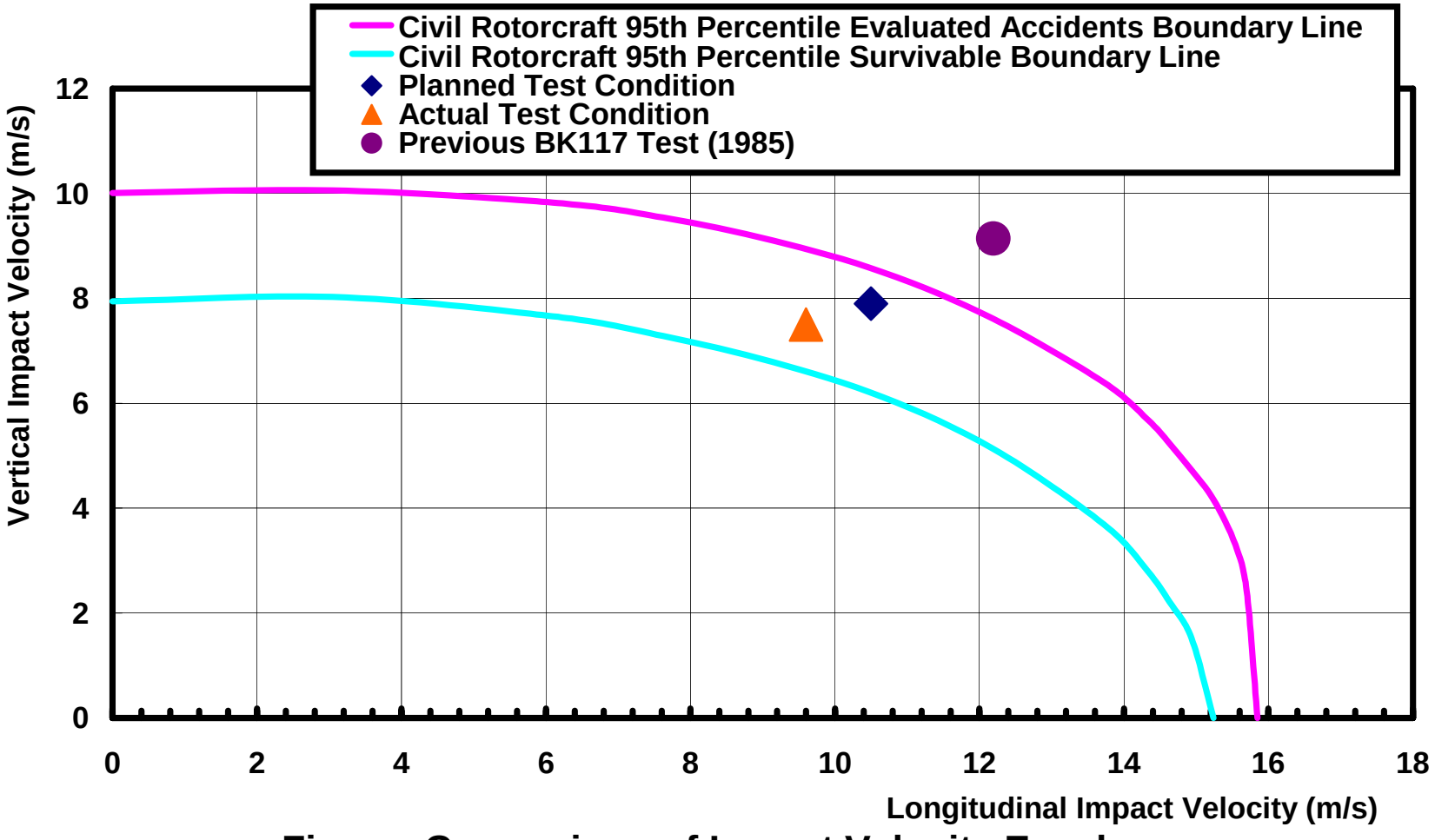


Figure: Comparison of Impact Velocity Envelope

Test Conditions (Continued)

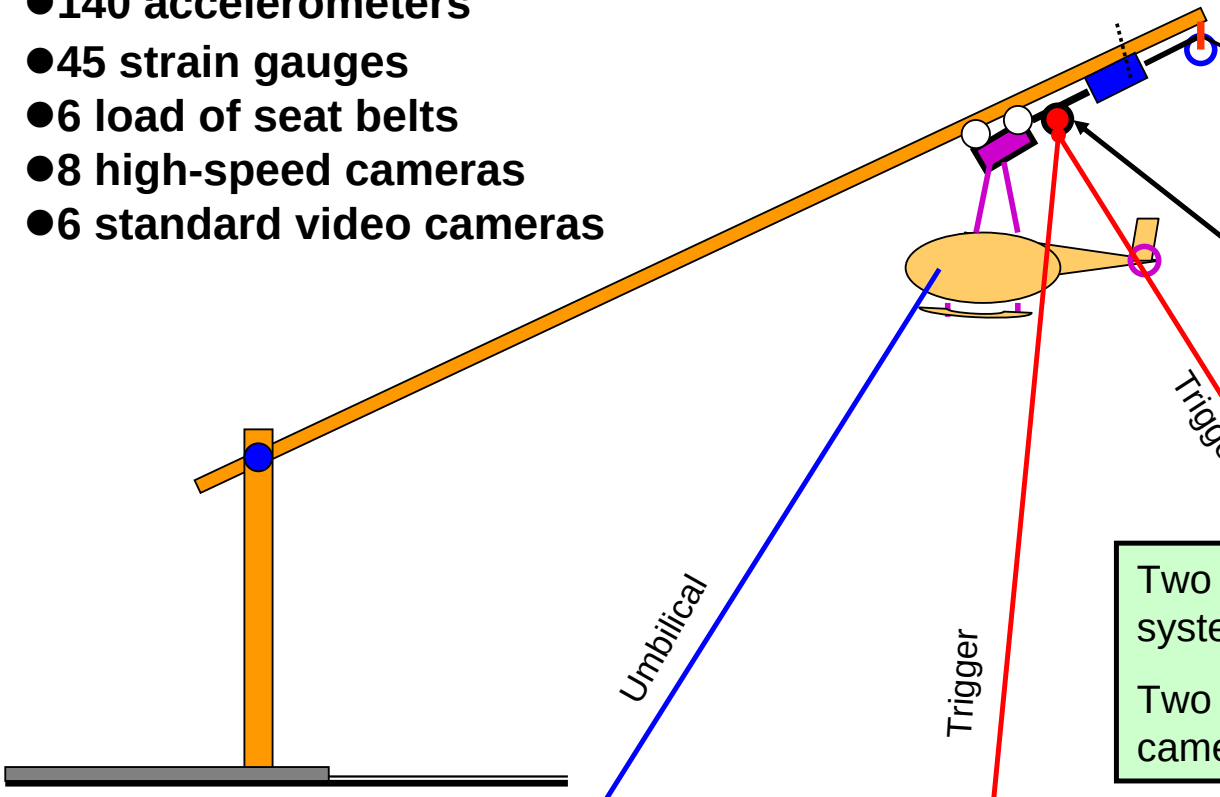
- Velocity components (Planned)
  - Vertical : 7.9 m/s (26 ft/sec)
  - Longitudinal : 10.5 m/s (34 ft/sec)
  - (derived from the vertical component of the dynamic seat test condition and an approach angle of 37 °)
- Pitch angle
  - +4 °
  - (Half of 8 ° angle which a line from the skid to the tail makes with the horizontal)

Test article slides down I-beam (14.8 m), drops on concrete surface

- Beam angle : 36 °
- Height of test : 9m
- Height of free fall : 0.3m (from end of beam)

Data Acquisition

- **140 accelerometers**
- **45 strain gauges**
- **6 load of seat belts**
- **8 high-speed cameras**
- **6 standard video cameras**



Trigger device

Trigger

Trigger

Umbilical

Two onboard data acquisition systems

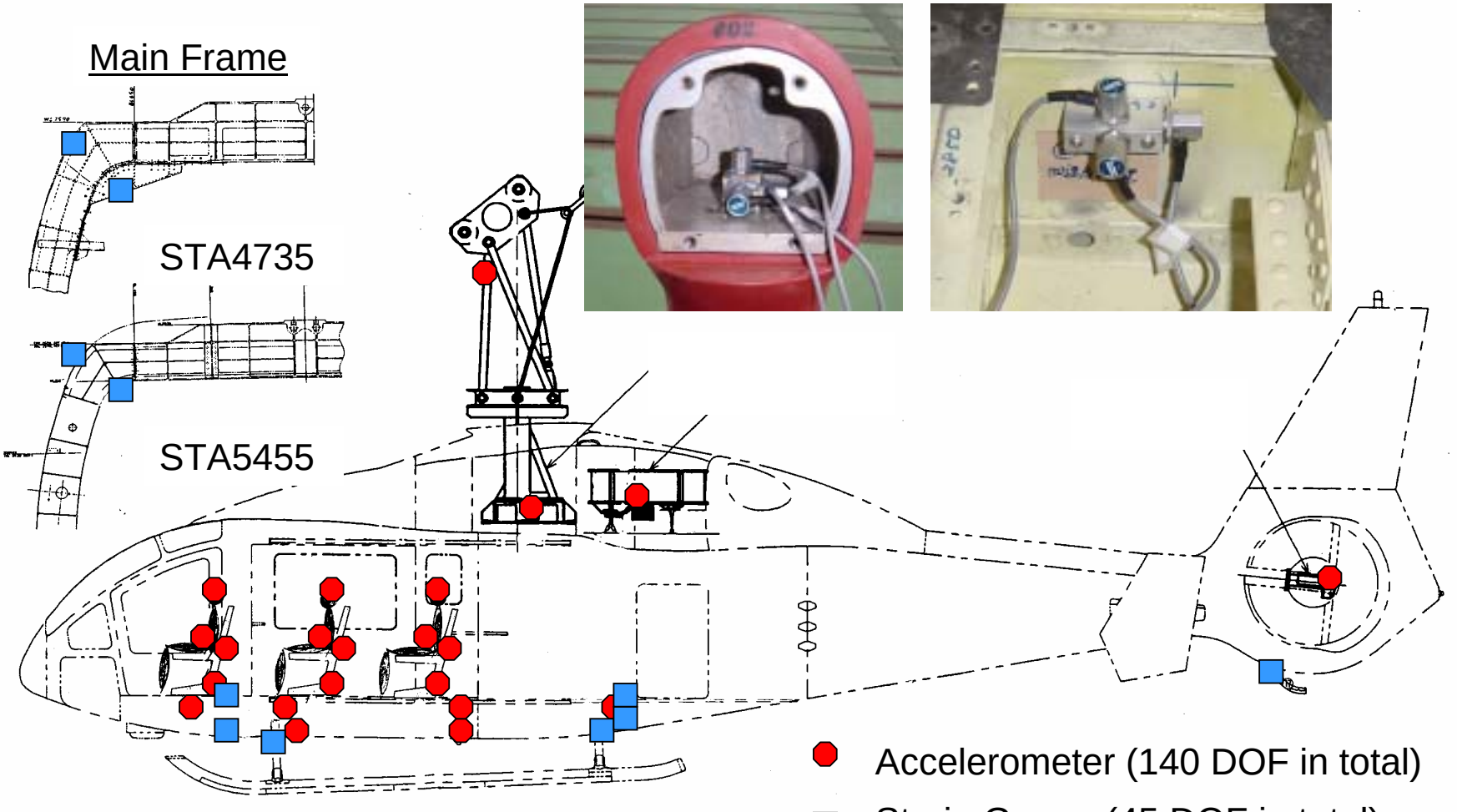
Two onboard high-speed cameras

Ground data acquisition System

Signal distribution device

Four high-speed cameras

Sensor Installation

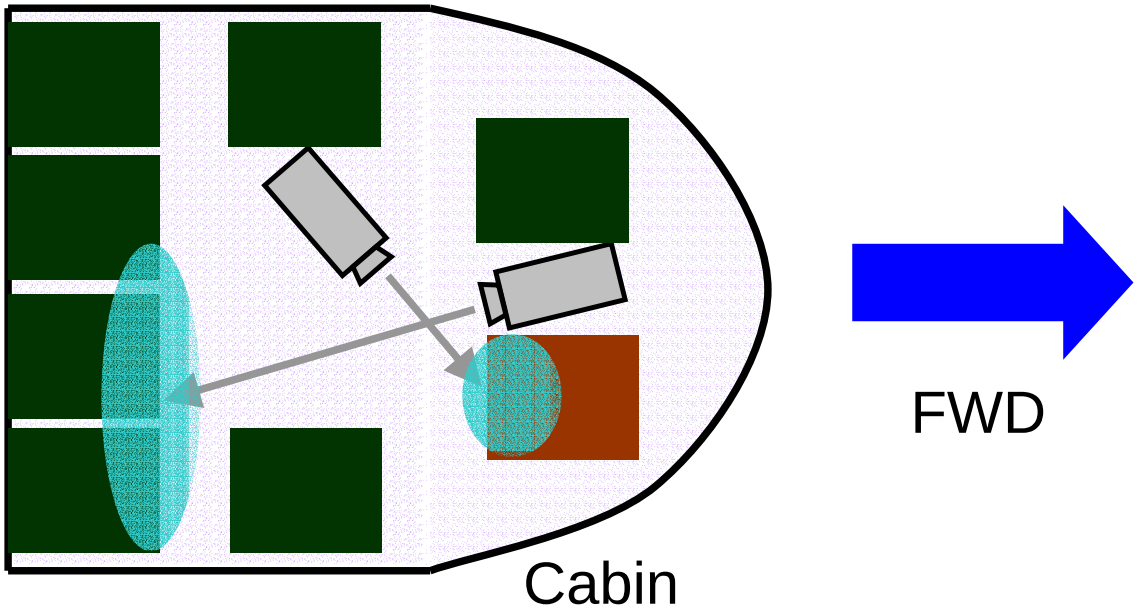


Pretest Overview of Onboard Measurement Devices

Onboard data acquisition systems

Onboard high-speed camera

On-board High Speed Camera Position



Standard MH2000 seat

Pilot seat with JAXA energy absorbing device

High speed camera

Four Meter High Mock-up Test

Mock-up test:

2m → 4m → 5m Step-up verification of our test method

Video Picture of the Test from Backside

Offered by MHI

High-Speed Video Picture of the Test

High-Speed Video Picture of the Test

Offered by MHI

Overall Post-test

Test Results from Analysis of High-Speed Camera Pictures

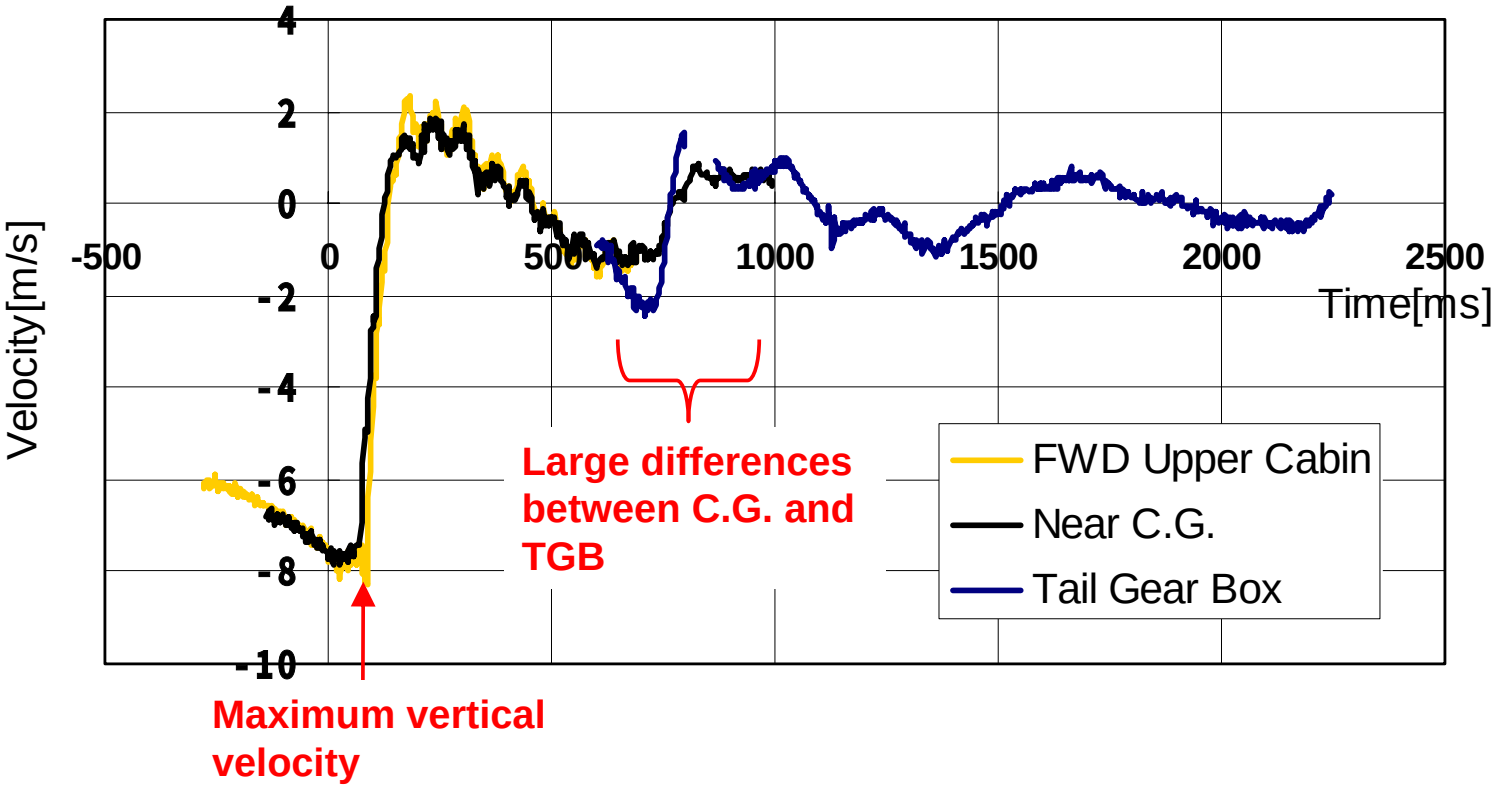
- Impact velocity components

  Vertical: Planned 7.9m/s ⇒ Actual 7.5m/s
  (- 5.1% error)

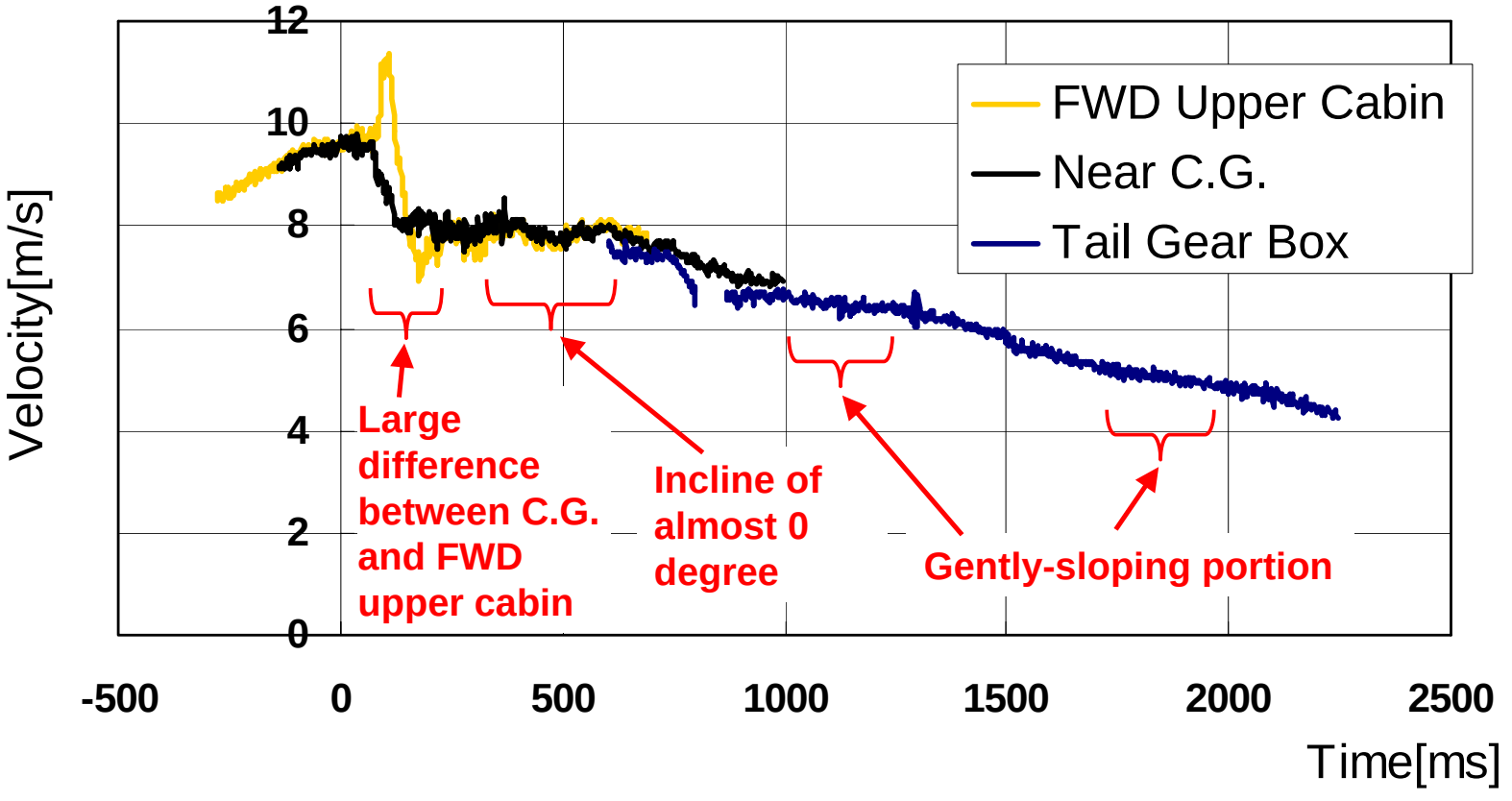
  Horizontal: Planned 10.5m/s ⇒ Actual 9.6m/s
  (- 8.6% error)

- Pitch angle: Planned +4 ° ⇒ Actual +2.7 °

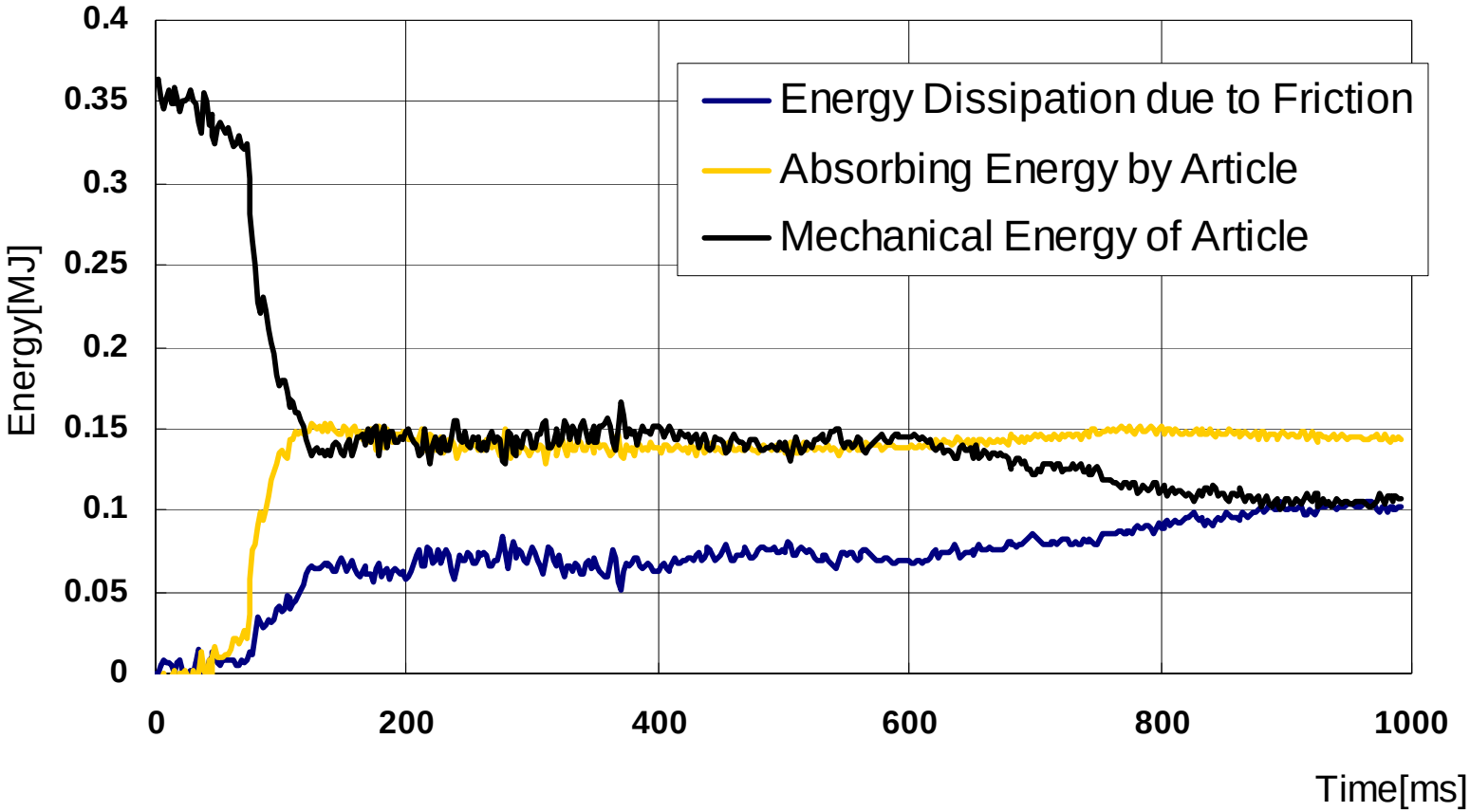
Vertical Velocity



Horizontal Velocity

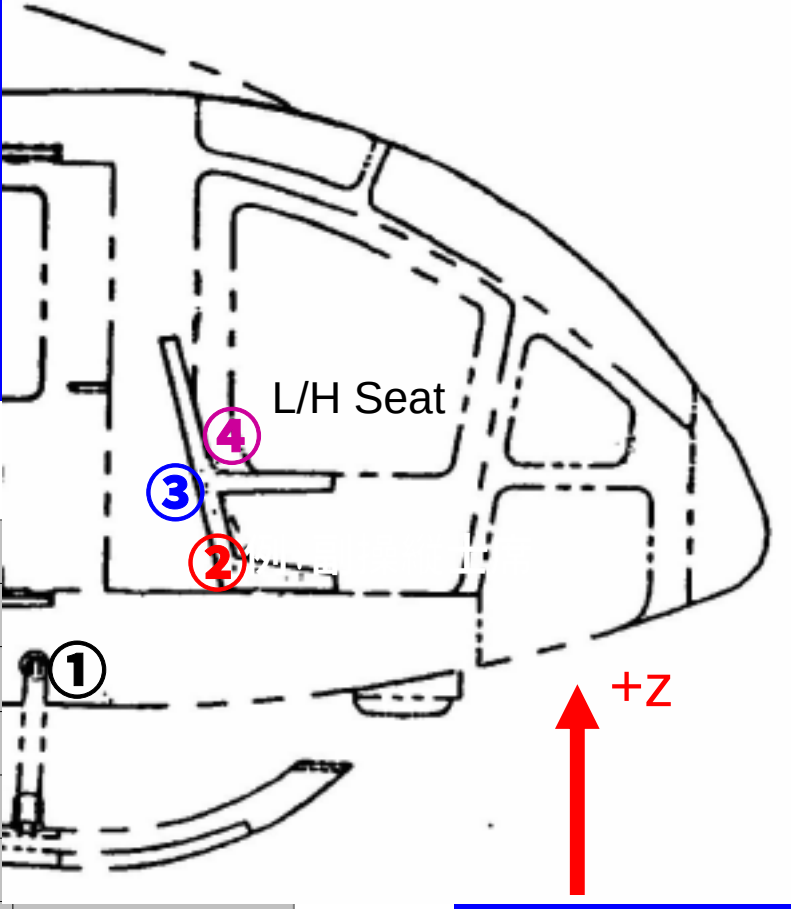


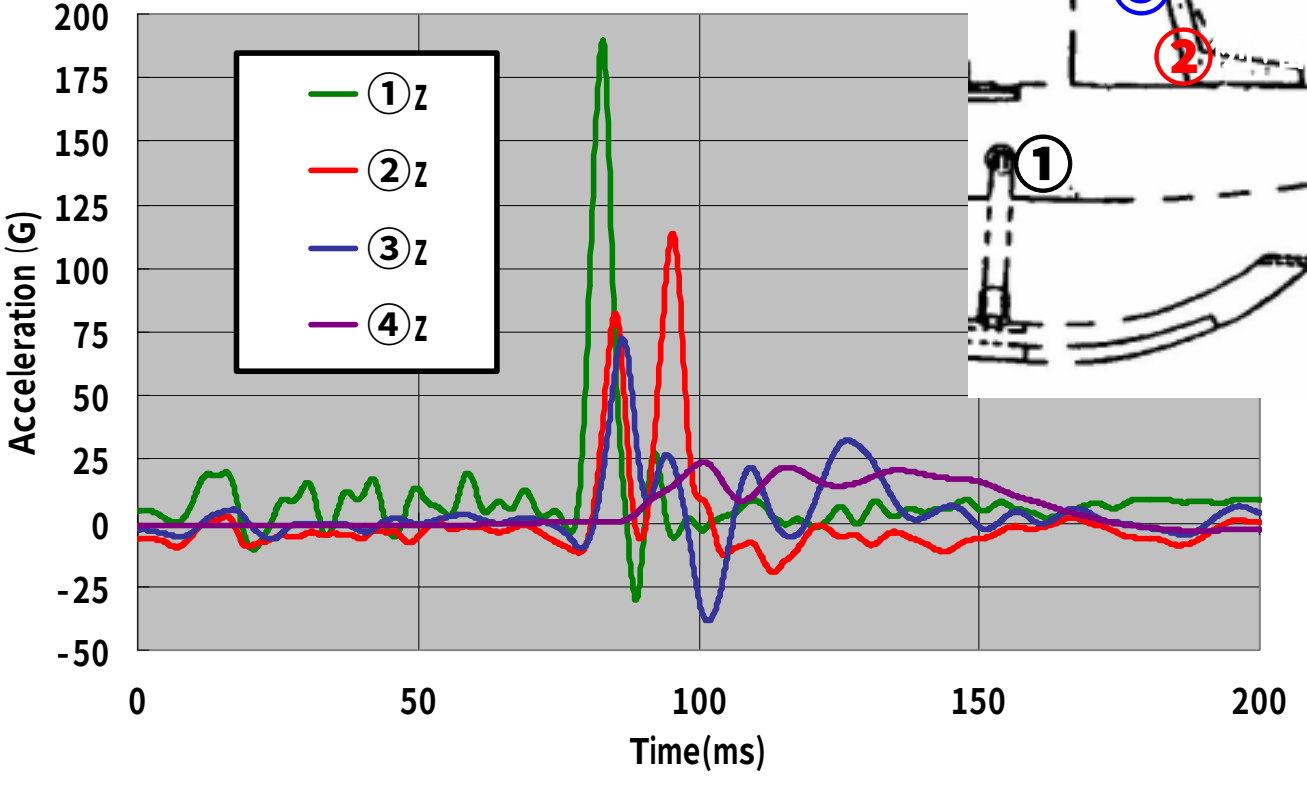
Energy Dissipation



Sample Accelerations

T_0 = landing skid impact.





Standard MH2000 Seat

Wire bender energy absorber

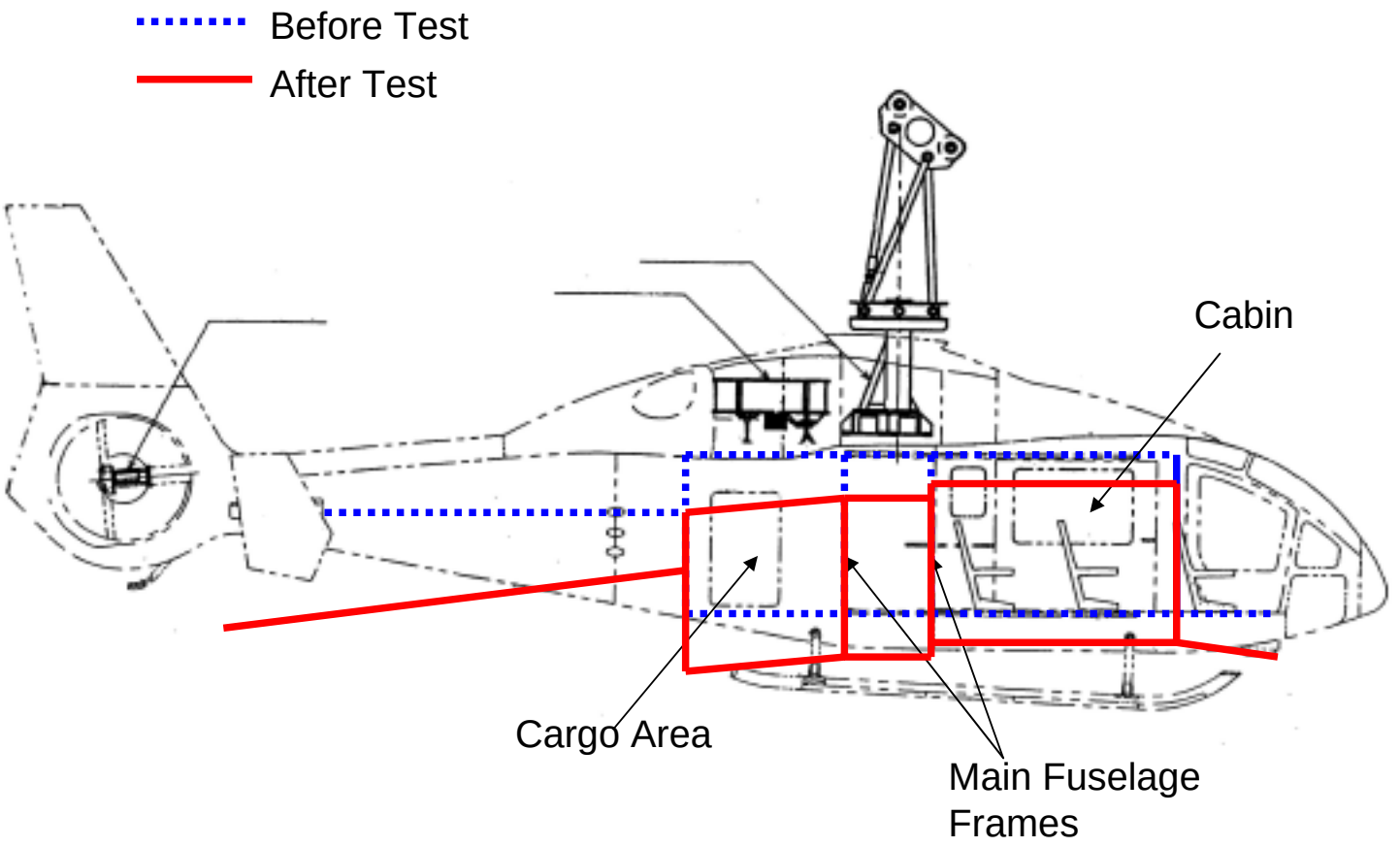
JAXA Energy Absorbing Device

Pretest

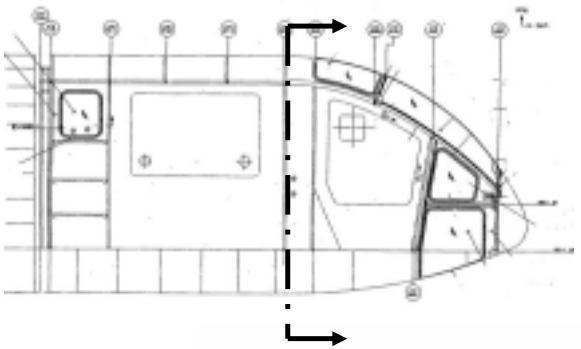
Post-test

Did not function properly due to off-axis loading

Deformation of Structure after Impact

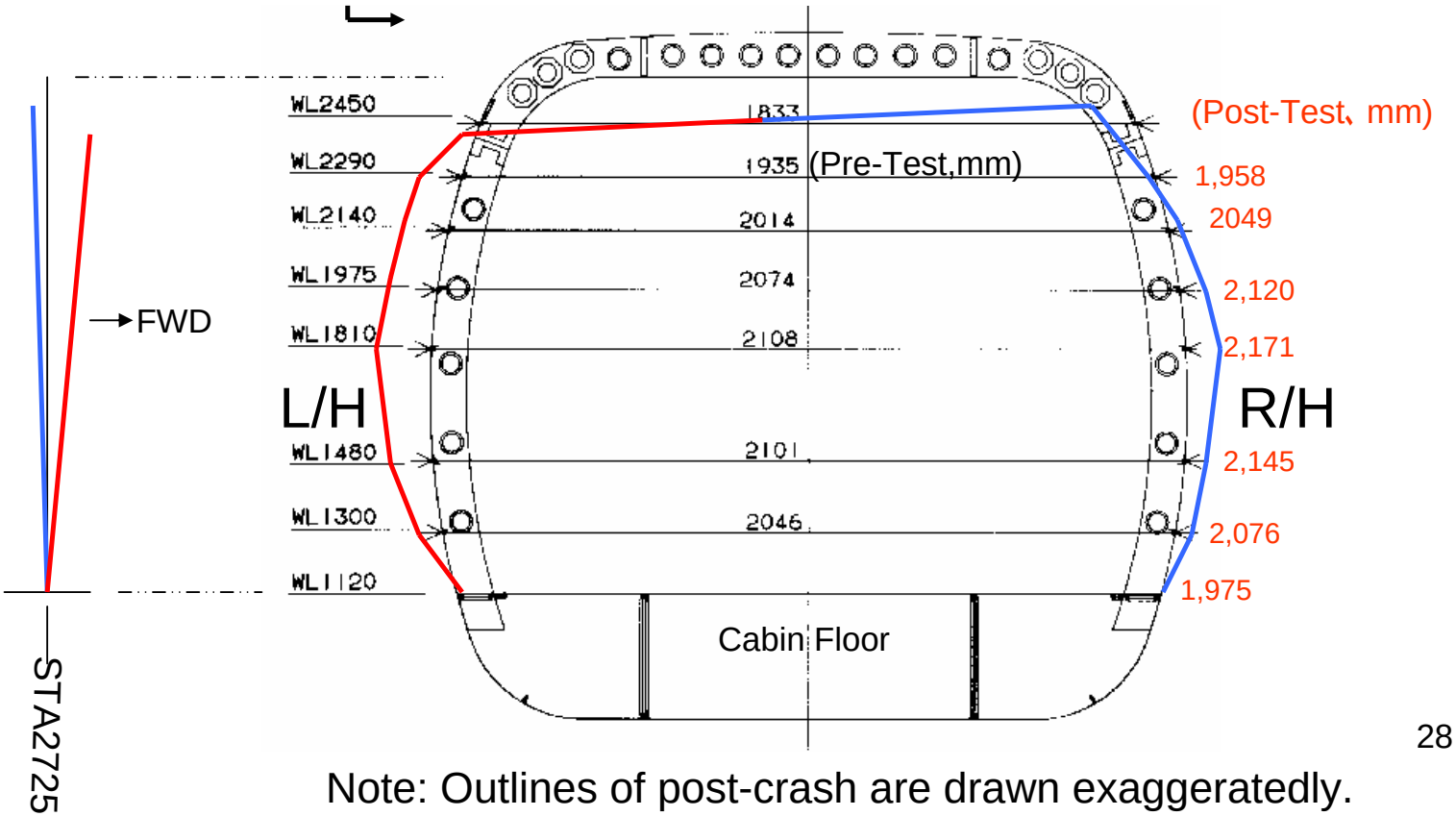


Cabin Deformation of STA 2725 Cross Section



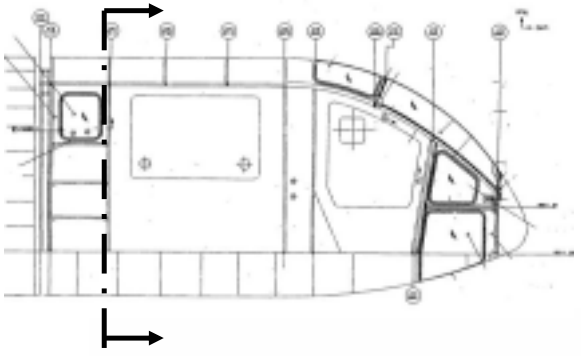
Crash Distances of the Cabin

* Cabin Ceiling Height：-19～-50mm
* Cabin Ceiling to L/H Side：26～30mm
* Cabin Ceiling to FWD Side ：
  -8mm(R/H)～9mm(L/H)mm



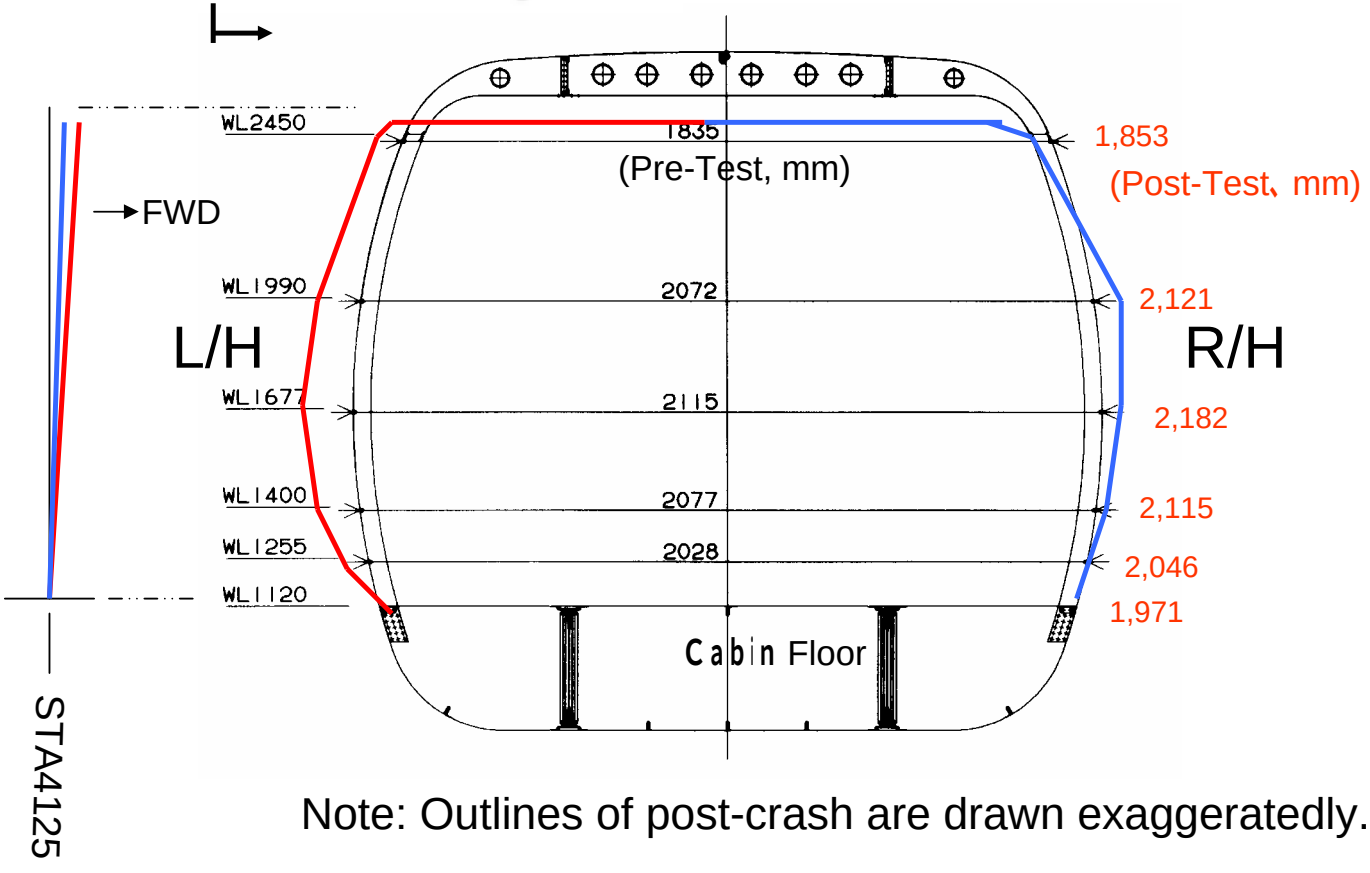
Note: Outlines of post-crash are drawn exaggeratedly.

Cabin Deformation of STA 4125 Cross Section



Crash Distances of the Cabin

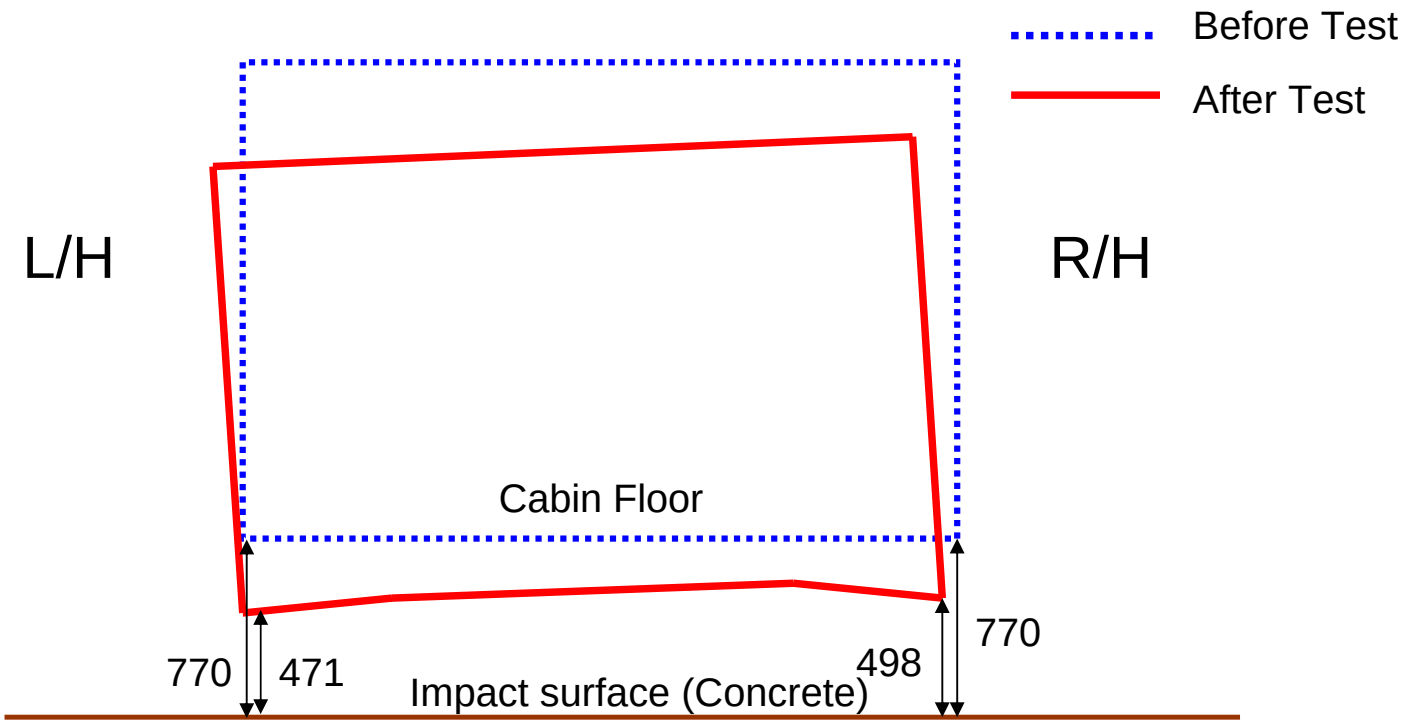
* Cabin Ceiling Height：-22～-23mm
* Cabin Ceiling to L/H Side：23～24mm
* Cabin Ceiling to FWD Side ：
  8mm(R/H)～13mm(L/H)mm



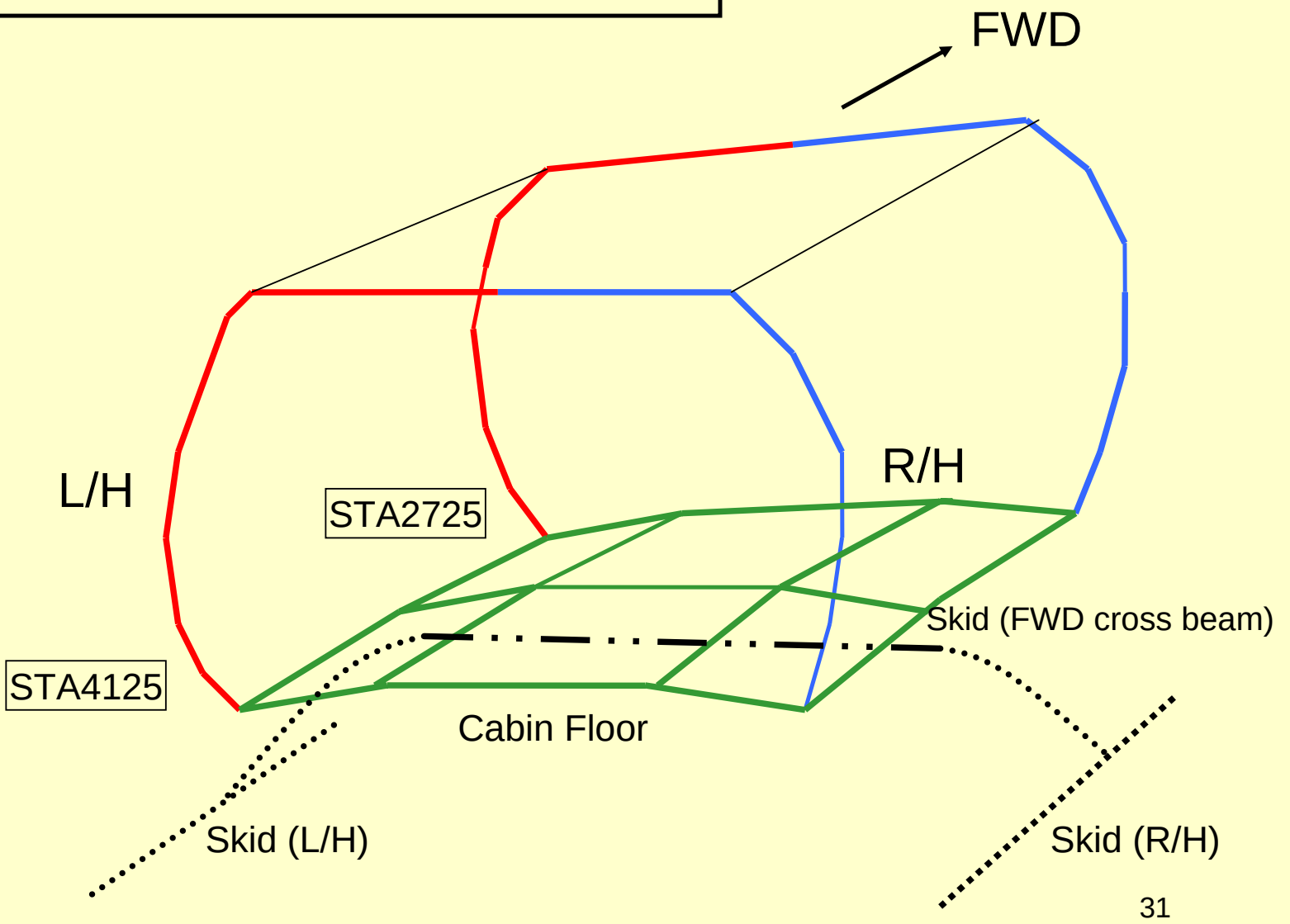
Note: Outlines of post-crash are drawn exaggeratedly.

Schematics of Rear View of Cabin

Cross Section Near STA 4010



Overview of Cabin Deformation



Conclusion

- Able to successfully acquire real time helicopter crash data for verifying full-scale helicopter analytical computer model and for being utilized as reference for new helicopter design
- Able to utilize guided rail method to conduct a crash test