NHTSA

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Development & Evaluation of a New Chest Deflection Measurement Sensor for the Large Omnidirectional Child (LODC) ATD

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Background: HIII 10 YO vs. LODC

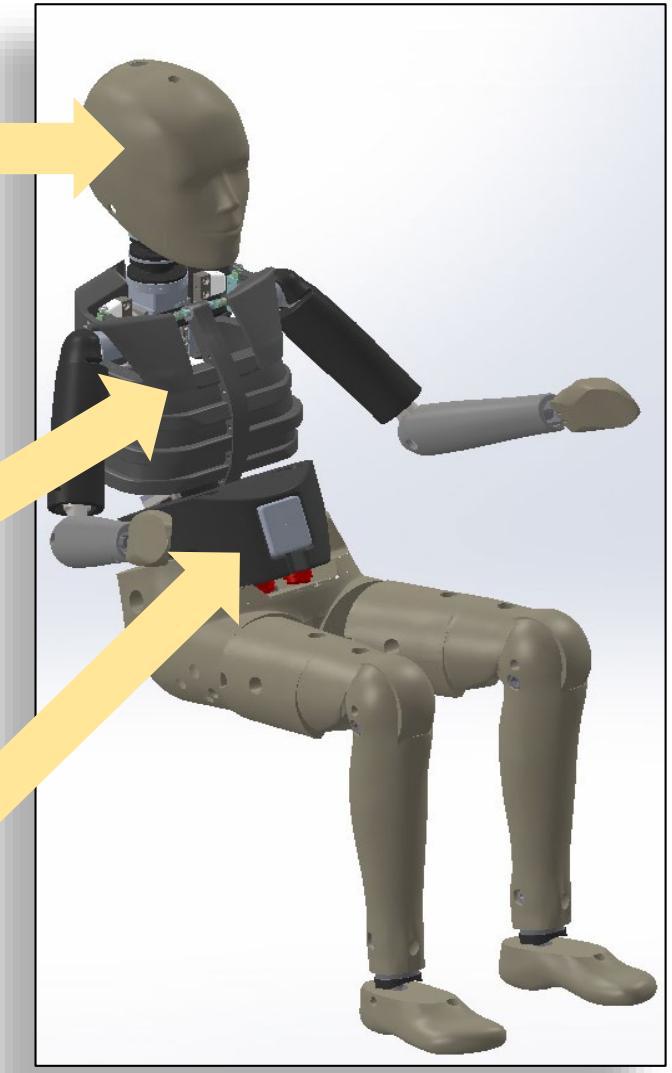
- Drawbacks of the HIII 10YO ATD led to the development of the LODC[1]
  - Rigid spine caused improper head kinematics and neck loads
  - Pelvis / abdomen were not suitable for detecting abdominal loads
  - Head, neck, thorax and abdomen were not biofidelic according to latest data
  - Upright seating posture was not representative of actual child seating data

[1]Stammen et al. “The Large Omnidirectional Child (LODC) ATD: Biofidelity Comparison with the Hybrid III 10 Year Old,” Stapp Car Crash Conference (2016).

Head has inertial/mass properties matching pediatric data

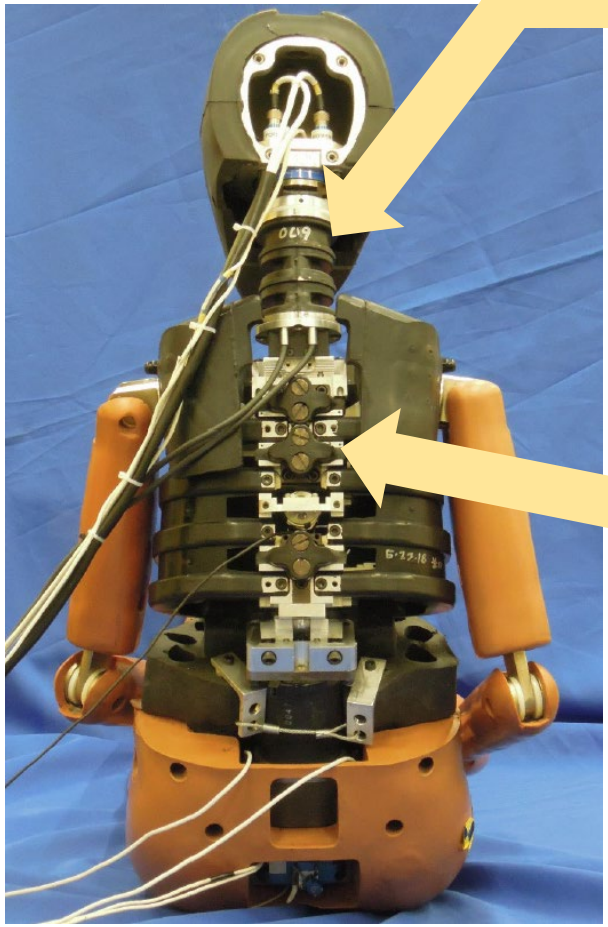
Shoulders and thorax reflect pediatric anatomy and mimic pediatric response

Biofidelic, instrumented abdomen to measure belt-induced loading



Anthropometry matches actual seated child data

Neck can elongate and allows for free Z axis rotation; response matching pediatric data



Flexible cervicothoracic & thoracic spine for more biofidelic head trajectory and neck loads

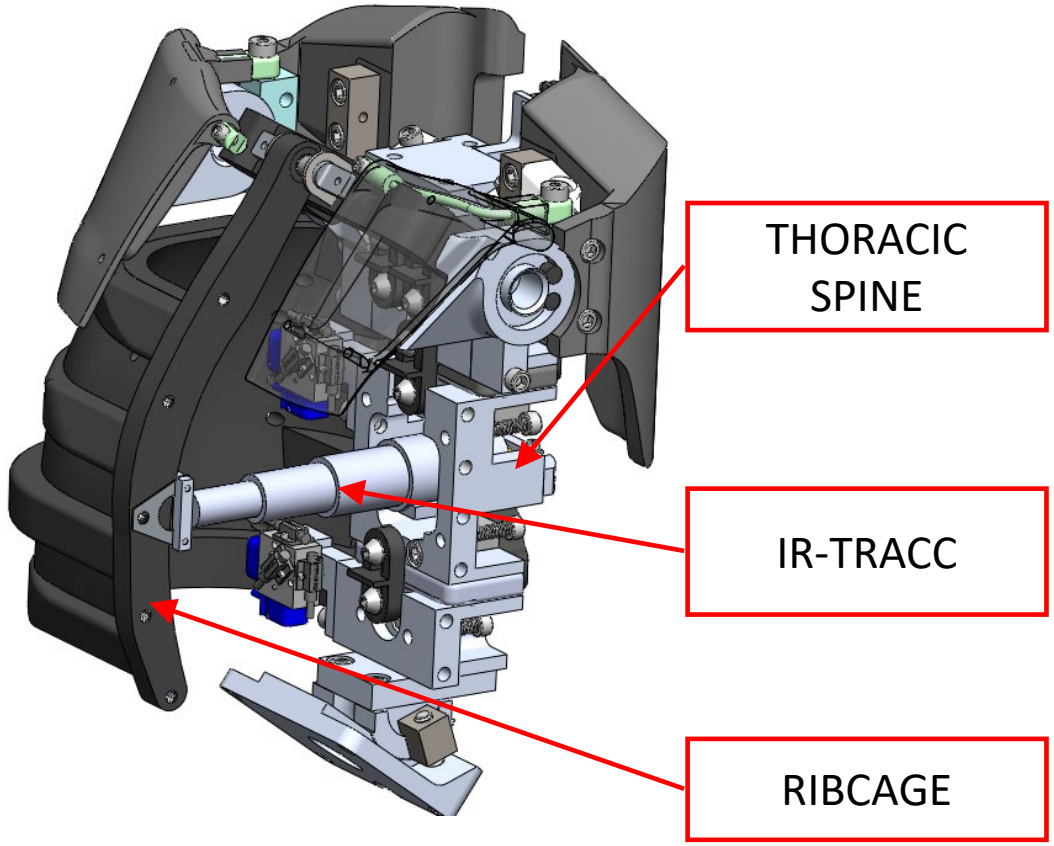
Docket NHTSA-2019-0110: NHTSA Crashworthiness Research - LODC Documentation

Motivation: Pediatric Thorax Injuries

- Thorax is an important body region to protect in motor vehicle crashes
- Injury data shows that the types of injuries are different in children than for adults (Arbogast et al. 2012)
  - Pulmonary contusions more common than rib fractures
- Need an accurate way to measure risk of these injuries
- Current method we are using in LODC is IR-TRACC

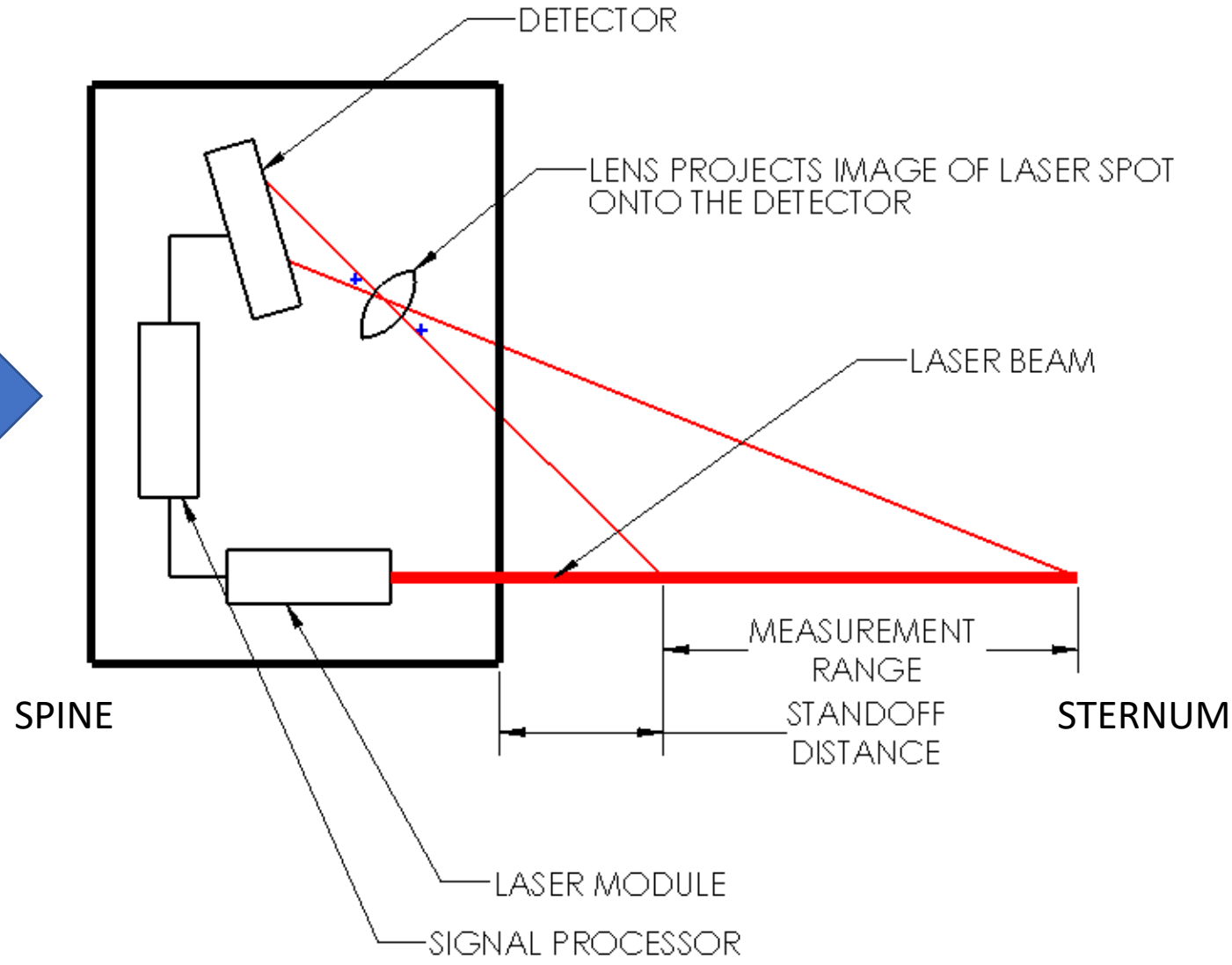
Motivation: Issues with IR-TRACC in LODC

- Reasons why we are pursuing a laser system instead of IR-TRACC
- Because of internal space limitations and the flexibility of the dummy:
  - IR-TRACC has bottomed out in oblique and frontal tests causing loss of good data and damage to the sensor
  - No room for multiple sensors

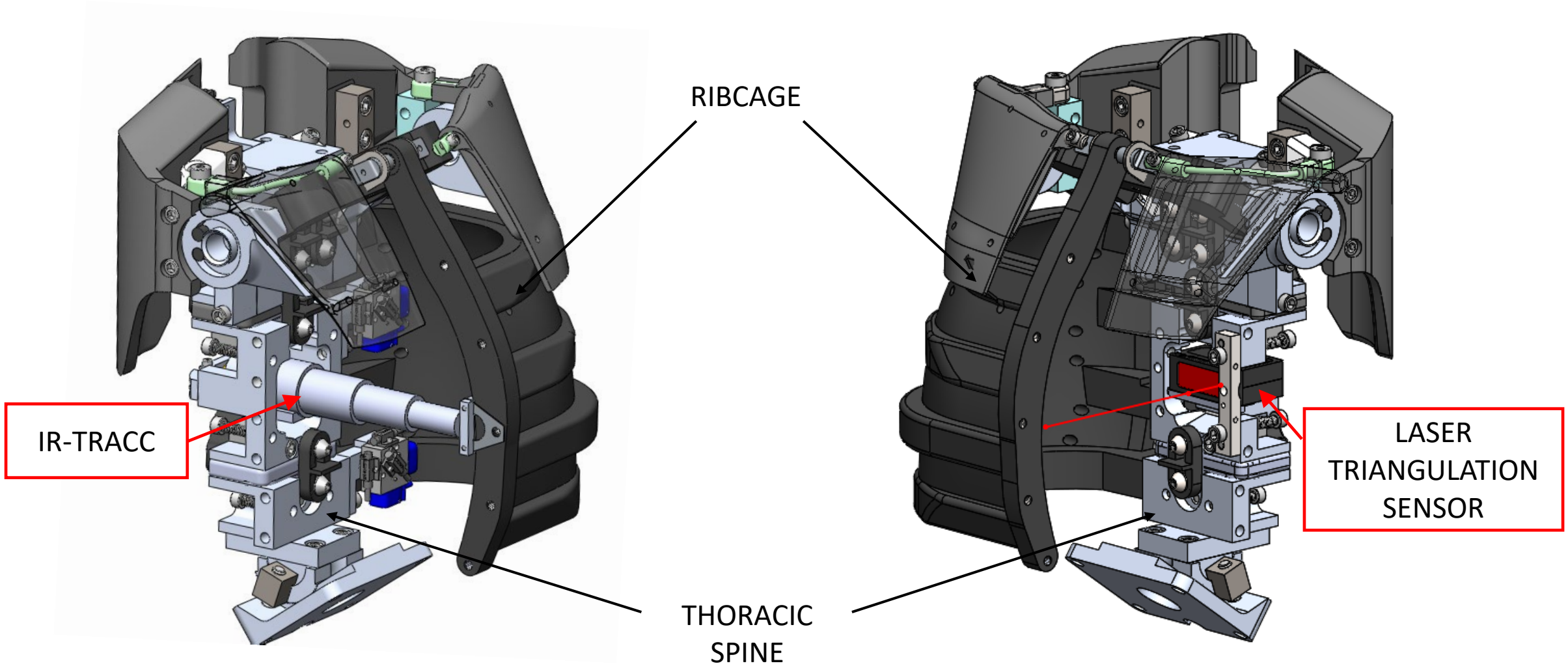


Laser Triangulation To Measure Chest Deflection

Althen ADL 802-20/100
Range: 20 -120mm



IR-TRACC vs. Laser System

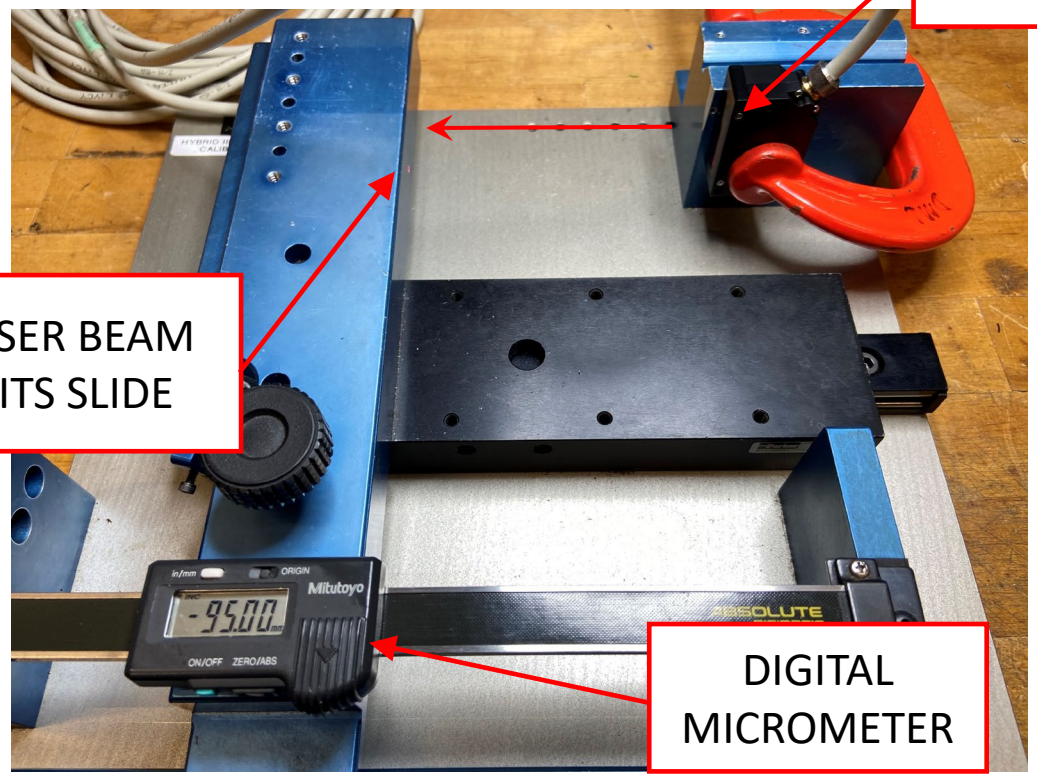


Objective

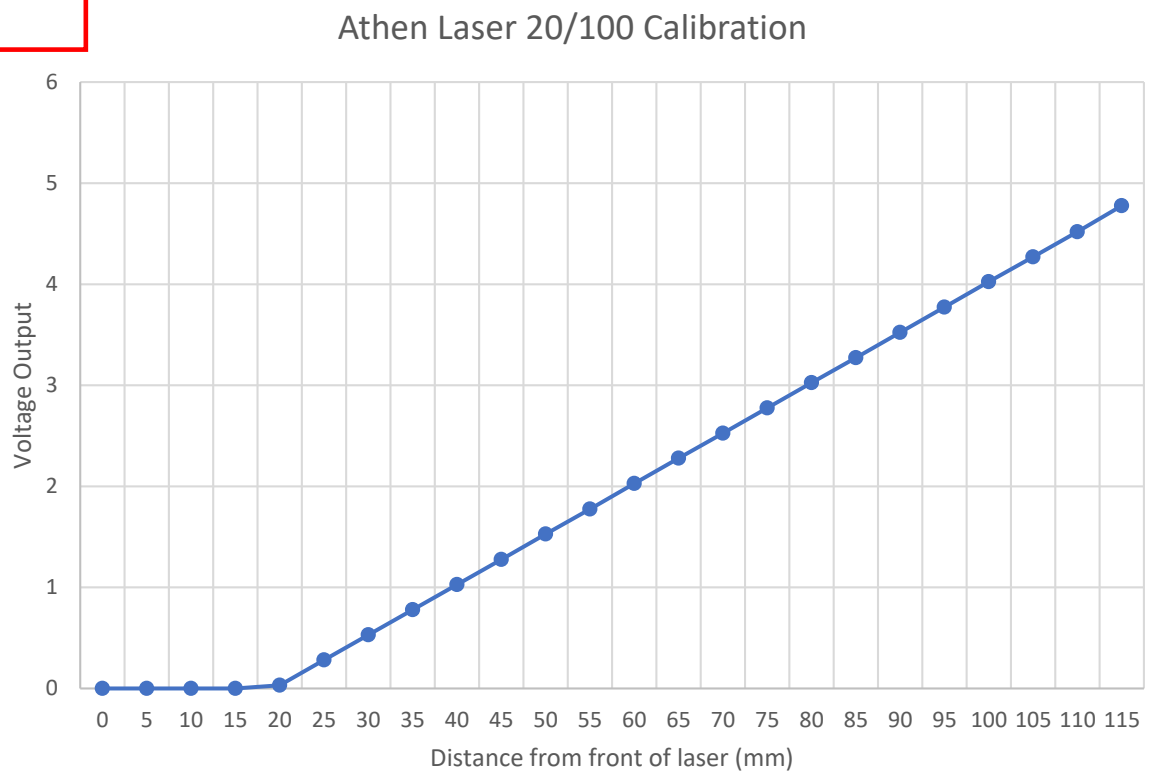
- Evaluate a new laser system to determine:
  - Measurement equivalency to IR-TRACC
  - Durability
  - Whether it solves the issues observed with IR-TRACC

- Conduct tests in four different conditions:
  - Static calibration
  - Quasi-static thorax compression
  - Thorax probe impact
  - Rear impact sled

Results: Static Calibration Test

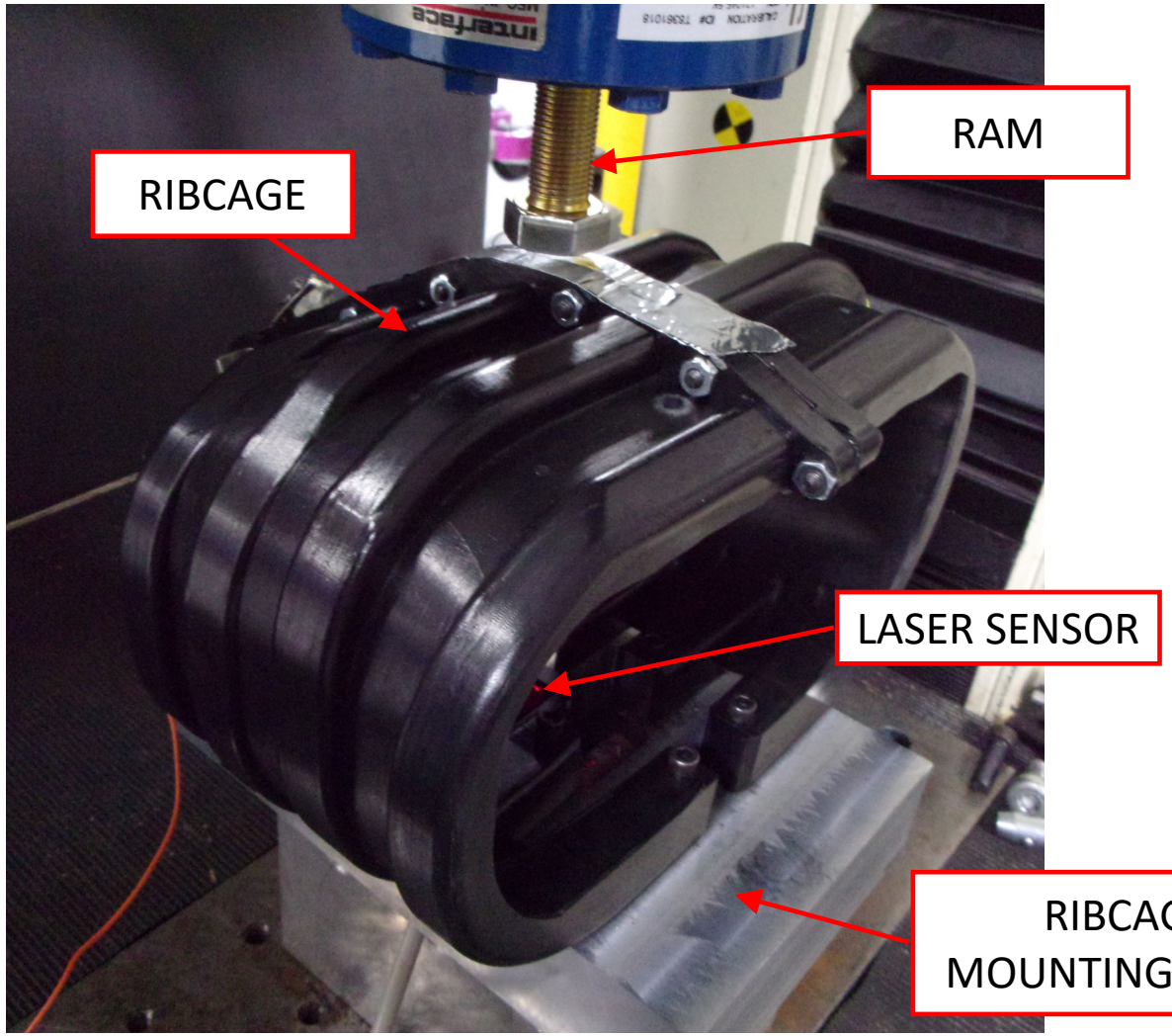


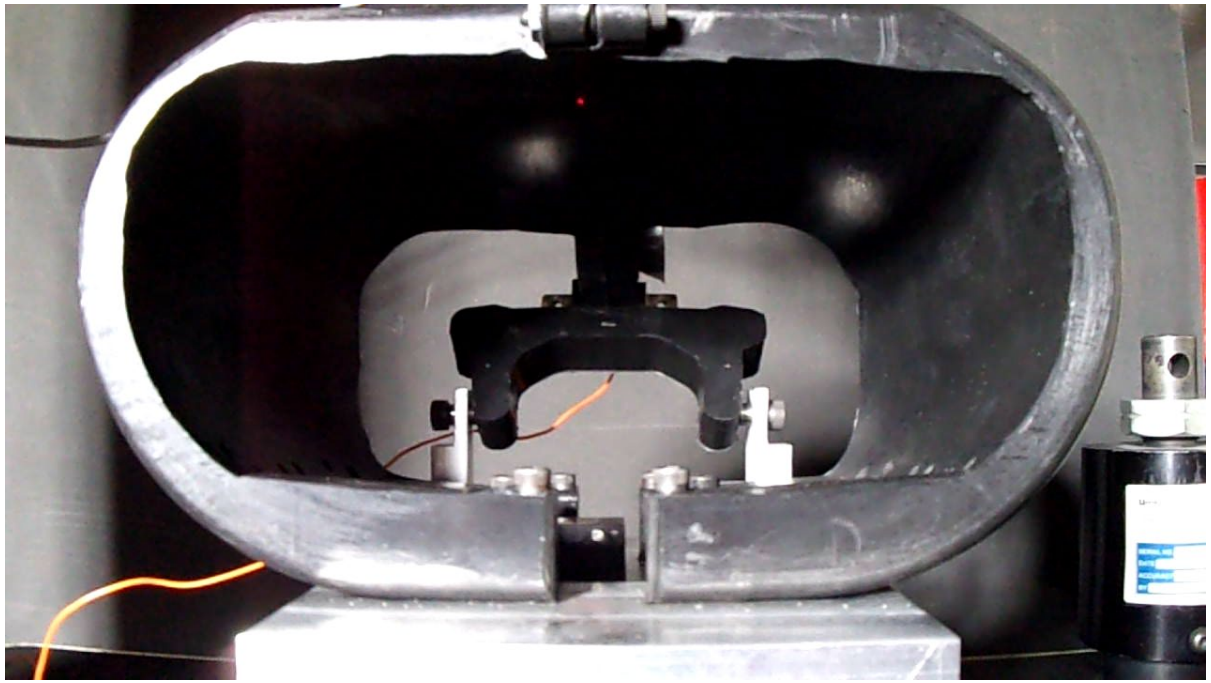
Calibration Fixture



Linearity = .17%

Results: Quasi-static Thorax Tests





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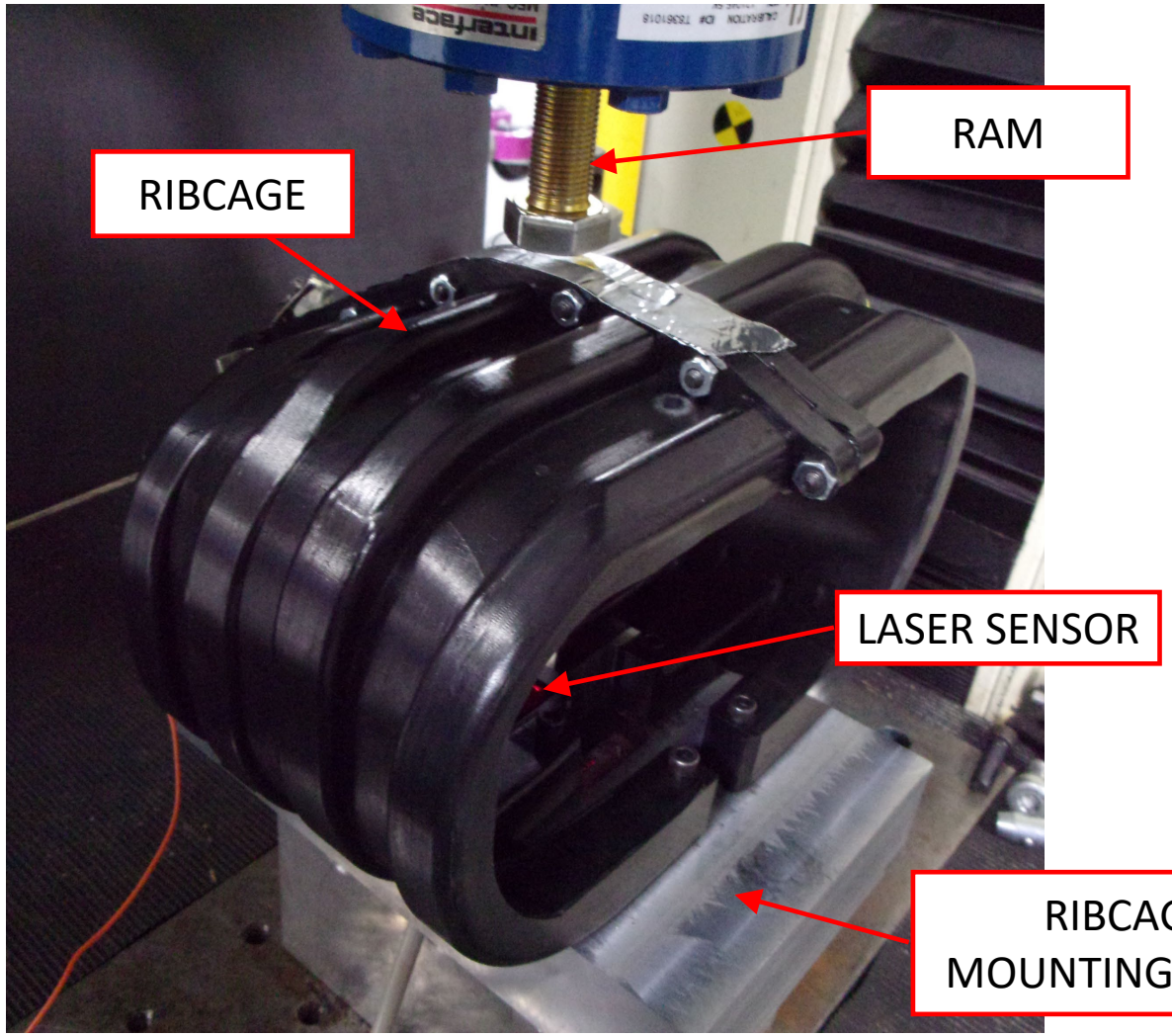
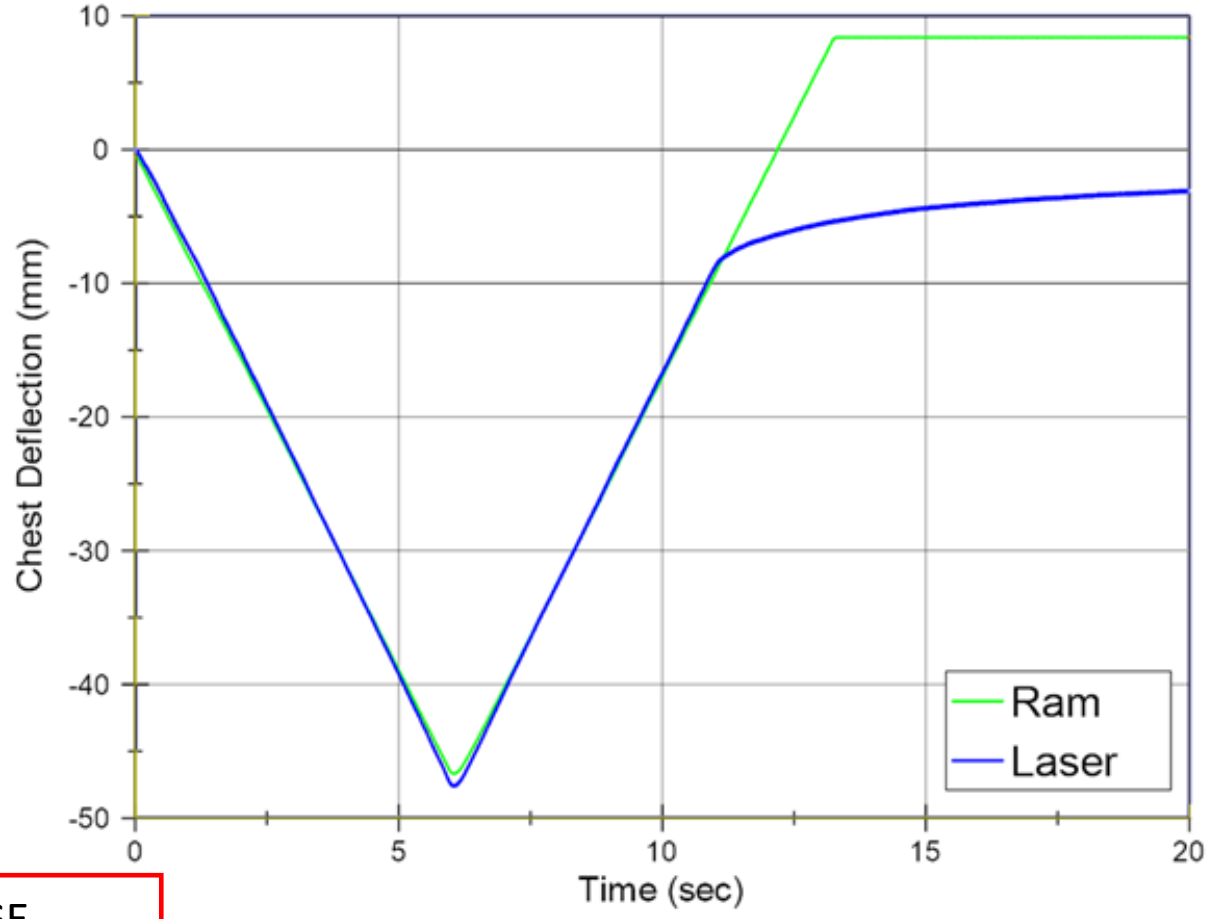
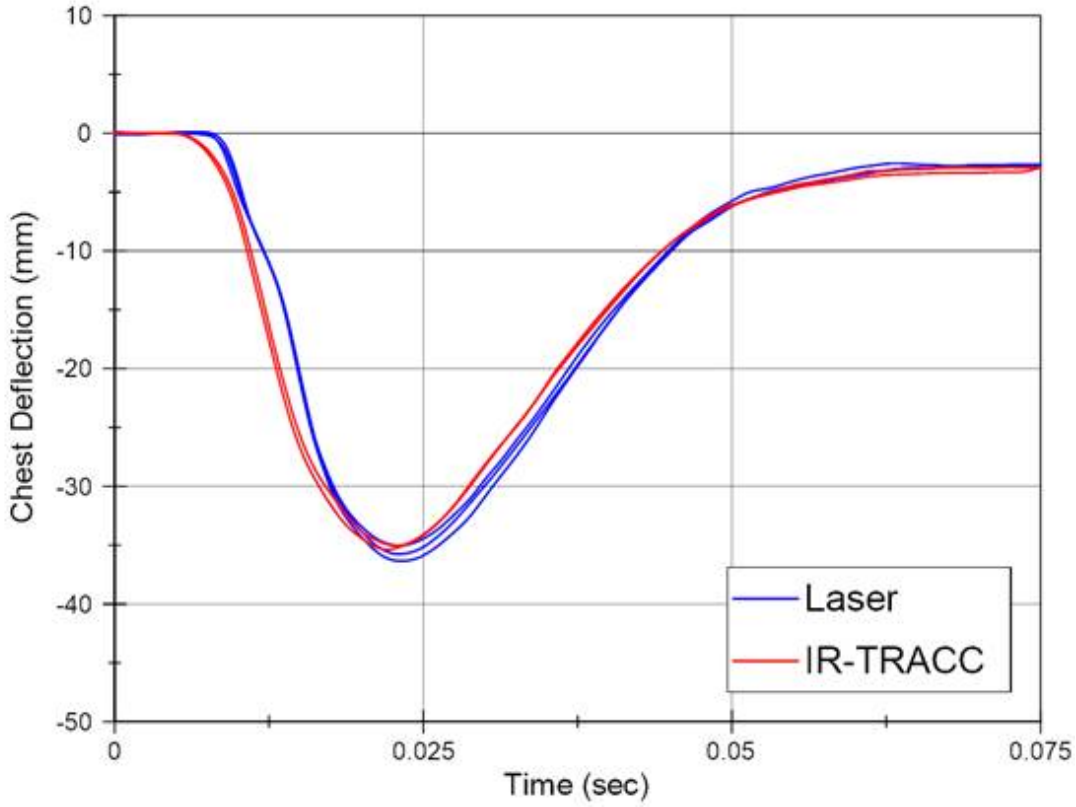




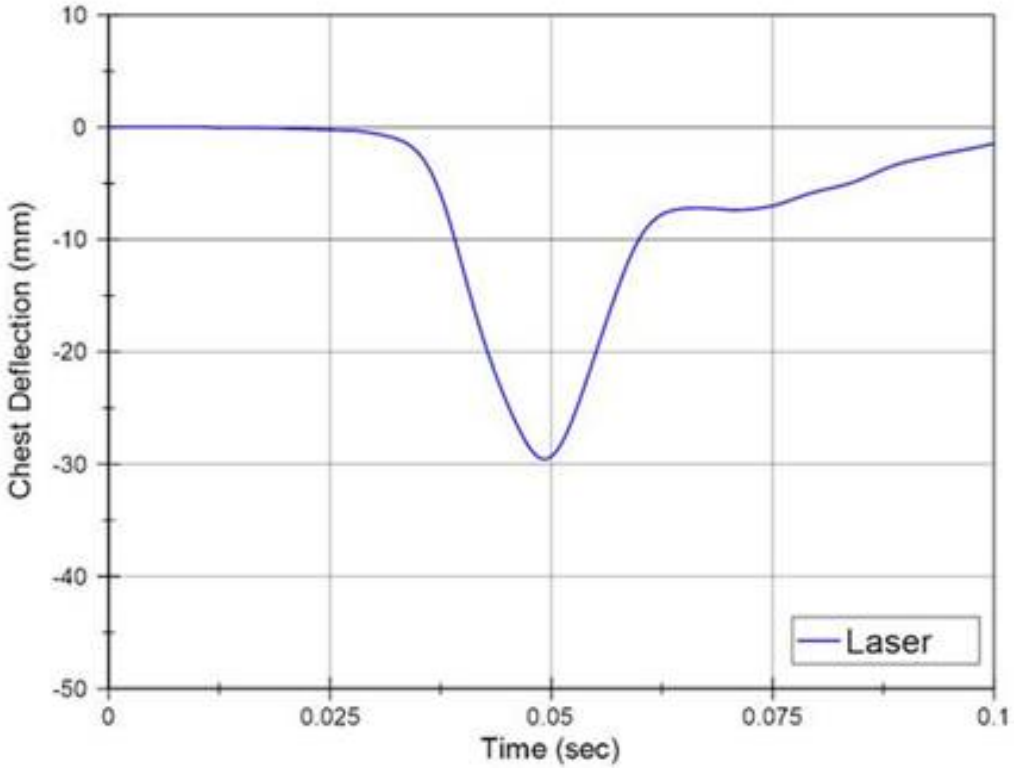
Results: Thorax Probe Impacts

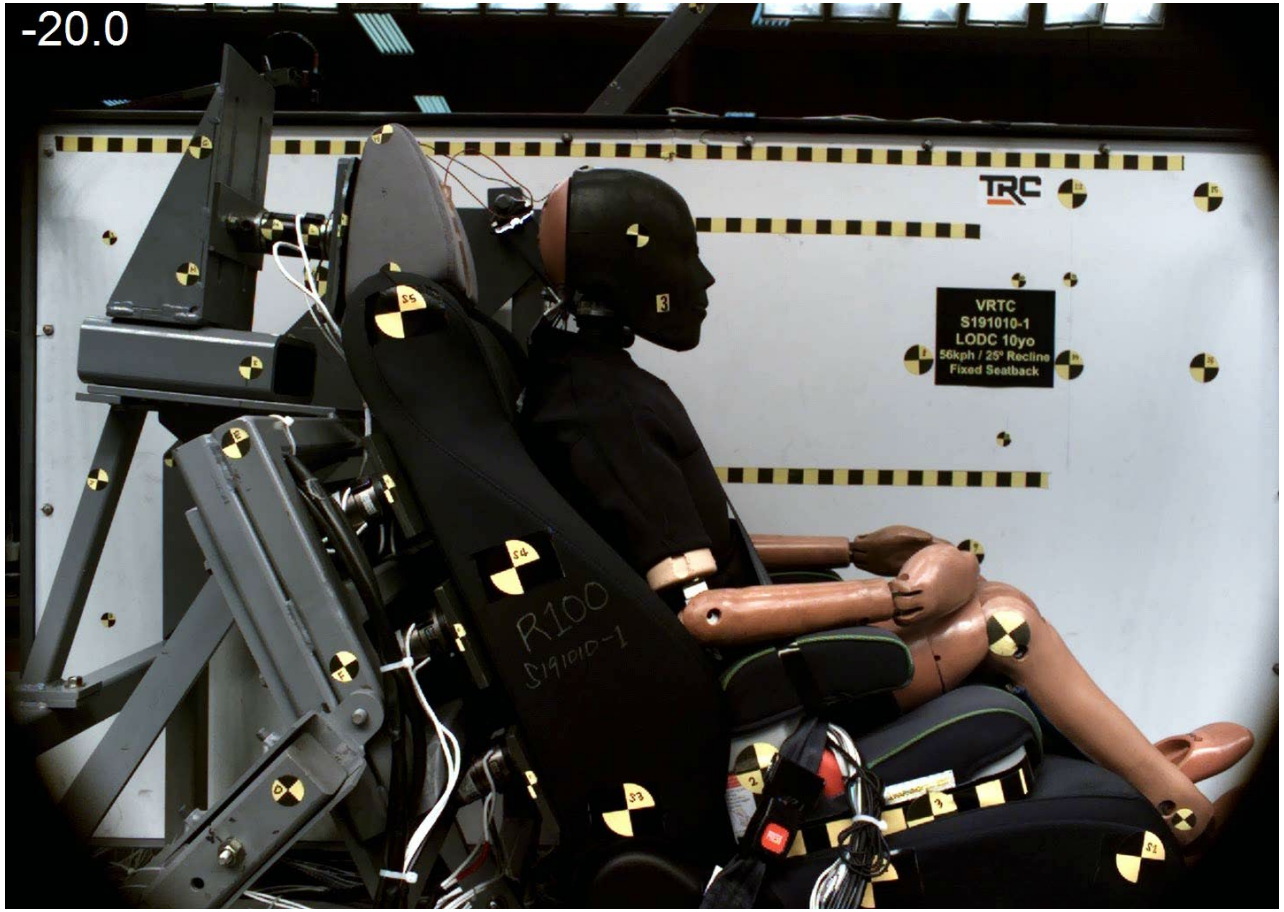
- Part 572 (HIII 10YO) Test Conditions
  - 6.89 kg probe @ 6.0 m/s



Results: Rear Impact Sled Tests

- High speed, 35 mph (56 kph)
- Seated on a backless booster
- Reclined 25° seatback



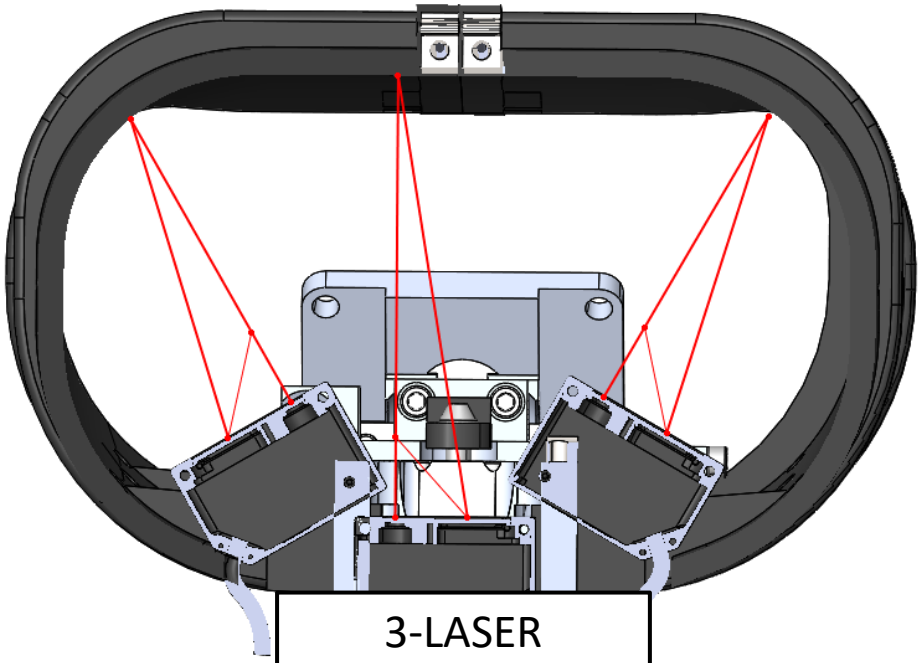


Summary

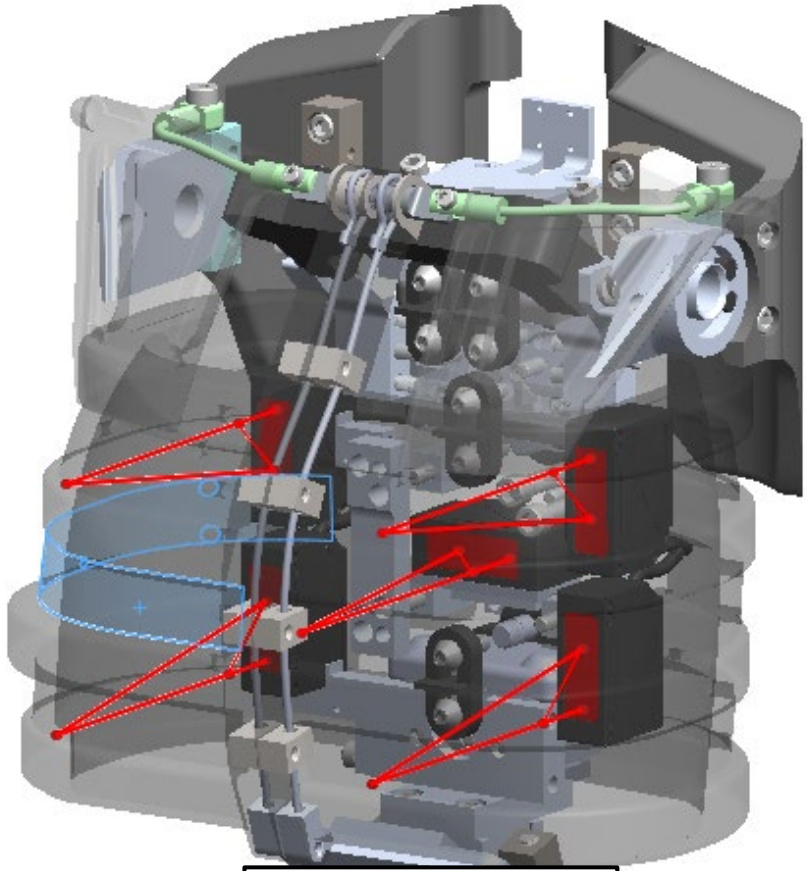
- Laser provides a linear response and good signal quality
- Signal matches known displacement
  - Quasi-statically and dynamically
- The sensor appears to be durable enough for crash testing
- Preliminary results show that the laser is an accurate and reasonable alternative to the IR-TRACC sensor

Future Work: Multi Point Laser Measurement

- More testing to examine dynamic performance
- Integration of multiple lasers into thorax
  - Multi-point laser measurement



3-LASER CONFIGURATION



5-LASER CONFIGURATION