

# Flex GT Testing of US Vehicles

NHTSA's Vehicle Research and Test Center (VRTC)

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Flex TEG Meeting

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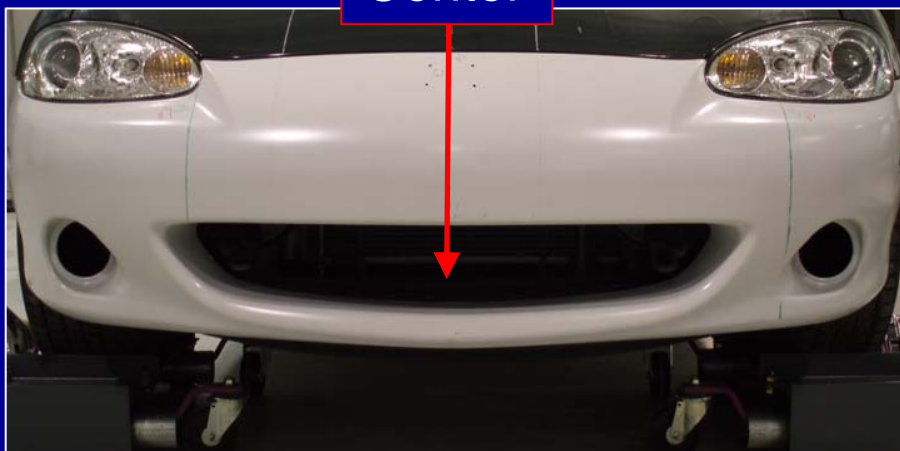
BASt, Cologne

# Goals

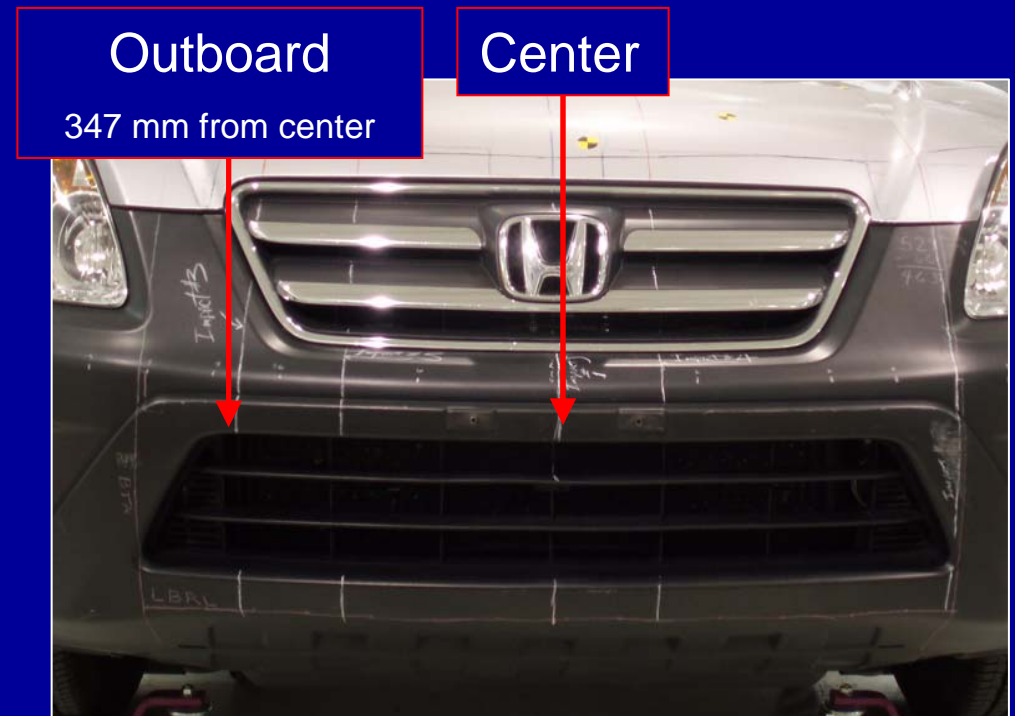
- Gain experience with Flex GT
- US vehicle performance with Flex GT
- Understand the effect of changing impact height as a substitute for added body mass

# Tests Performed

2002 Mazda  
Miata



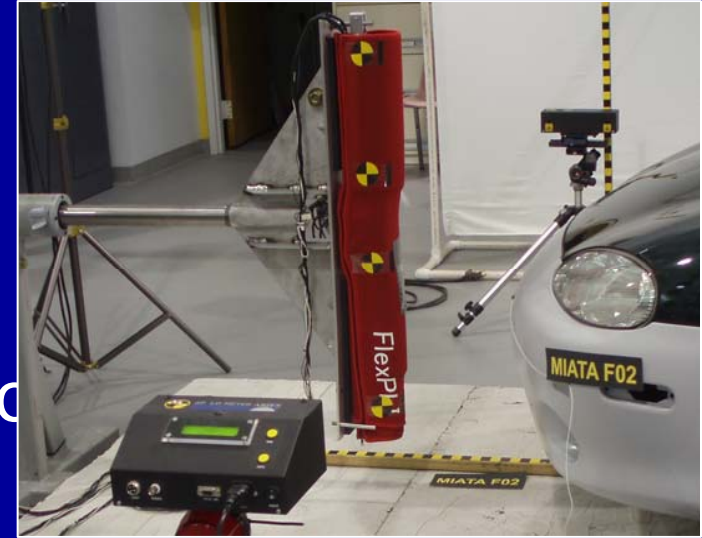
2005 Honda CR-V



- Each location: 25 mm / 75 mm above ground reference level
- Two additional tests performed on Miata at 75 mm for repeatability

# Method

- Flex GT (SN 06)
- GTR procedure (except test height\*)
  - 11.1 m/s (+/- 0.2 m/s) by laser/video
  - All points within test zone
  - Orientation:  $\pm 5^\circ$  axial rotation,  $\pm 2^\circ$  pitch and roll by video
  - Test height: 25 mm & 75 mm\* above ground reference level
- Flex GT certification following every test

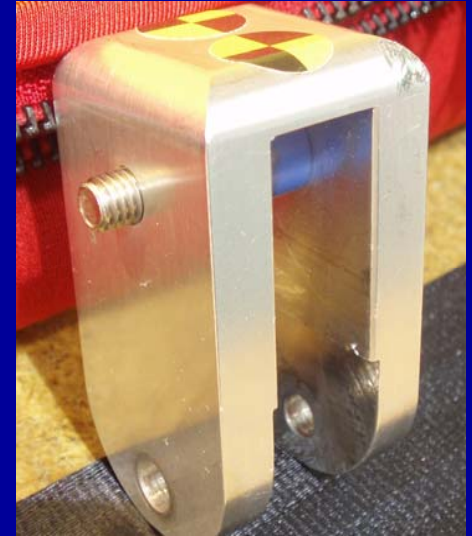


# Results

- Test Experience and Repeatability
- Injury Measurements for CR-V and Miata
  - Compared to proposed injury limits
  - Compared to prior test results with TRL
  - 25 mm and 75 mm results compared
- Damage to the Flex GT

# Test Experience

- Orientation ( $\pm 5^\circ$  axial rotation)
  - Improvement over TRL and FlexPLI
  - Roller and flat knee area help reduce spin
- Orientation ( $\pm 2^\circ$  pitch and roll)
  - Roll tested in speed shots
  - Pitch confirmed for each test (affected by deformation of launch plate)



# Repeatability

3 tests: Mazda Miata, Center impact, 75 mm impact height

	Femur Bending Moment N-m			Tibia Bending Moment N-m				Knee ligament elongations mm		
	A3	A2	A1	A1	A2	A3	A4	ACL	PCL	MCL
Mean	112	179	253	389	342	264	205	10.3	7.4	26.0
Standard deviation	4.73	5.03	3.51	8.66	1.73	11.8 5	9.85	0.21	0.32	0.25
Coefficient of Variation	4.2%	2.8 %	1.4 %	2.2 %	0.5 %	4.5 %	4.8%	2.0%	4.3%	1.0%

# Injury Measures: CR-V and Miata



# TRL

## Honda CR-V



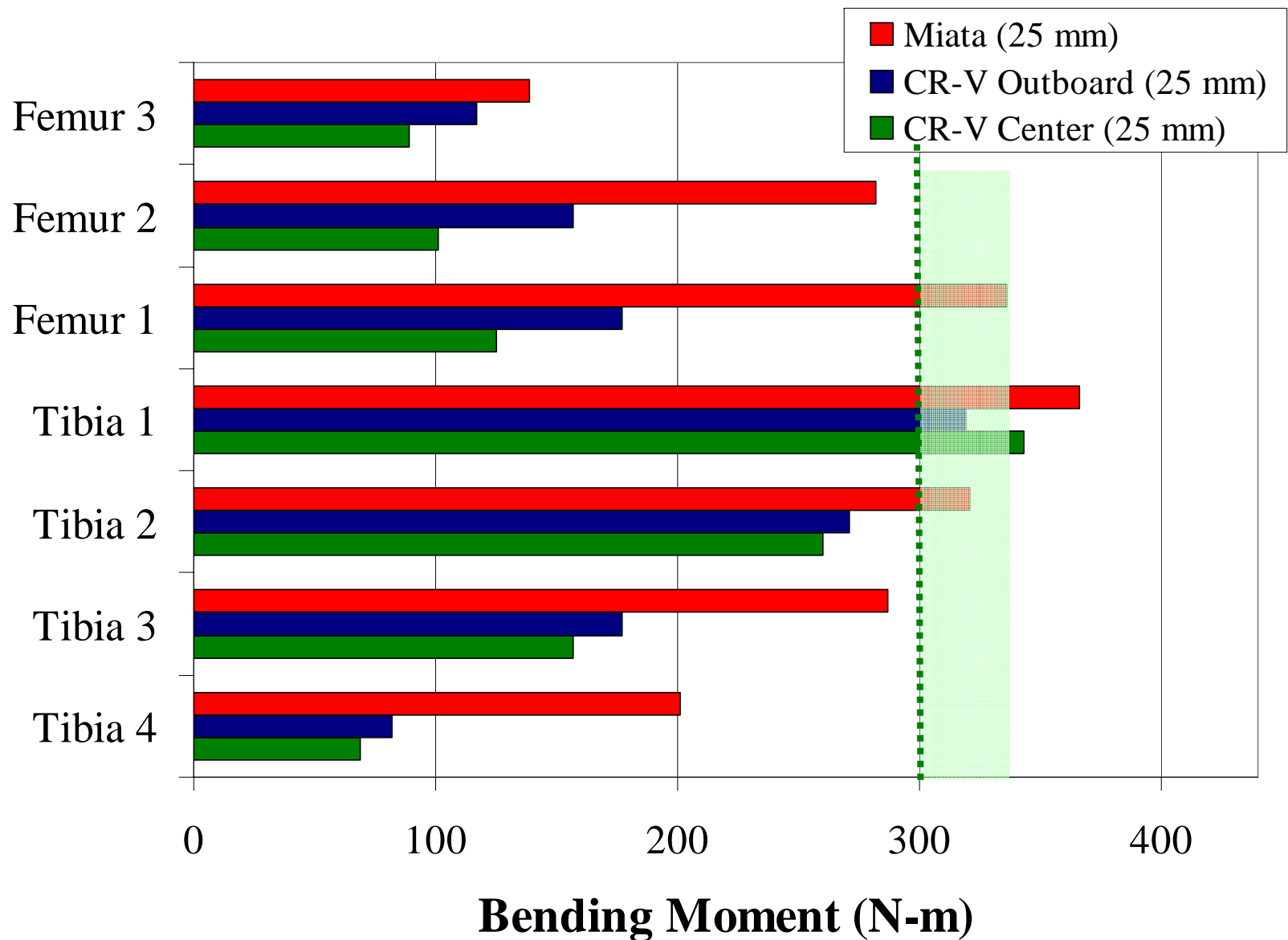
# Flex GT



## Mazda Miata

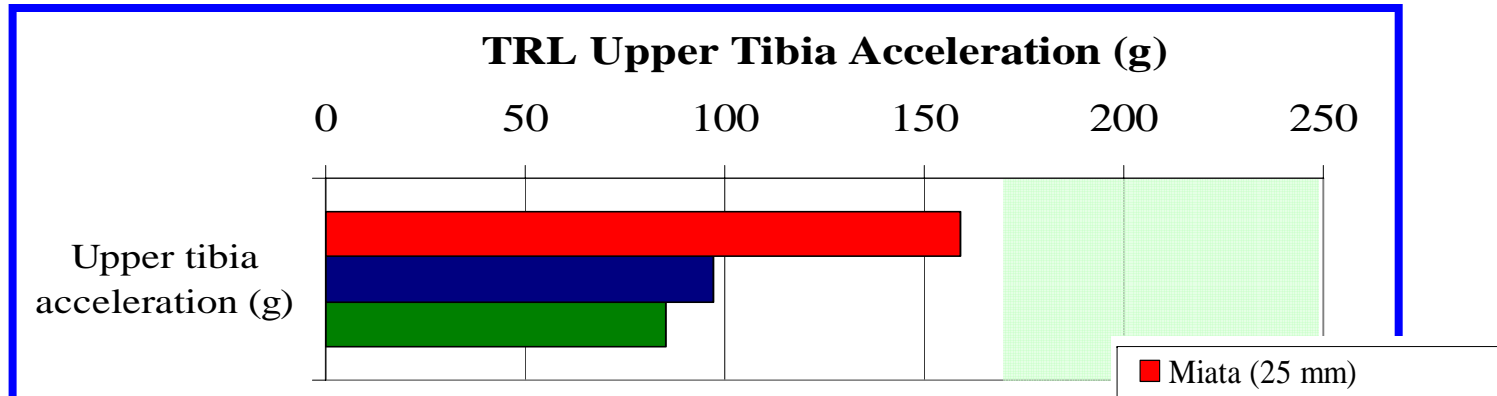


# Results: Bending moments

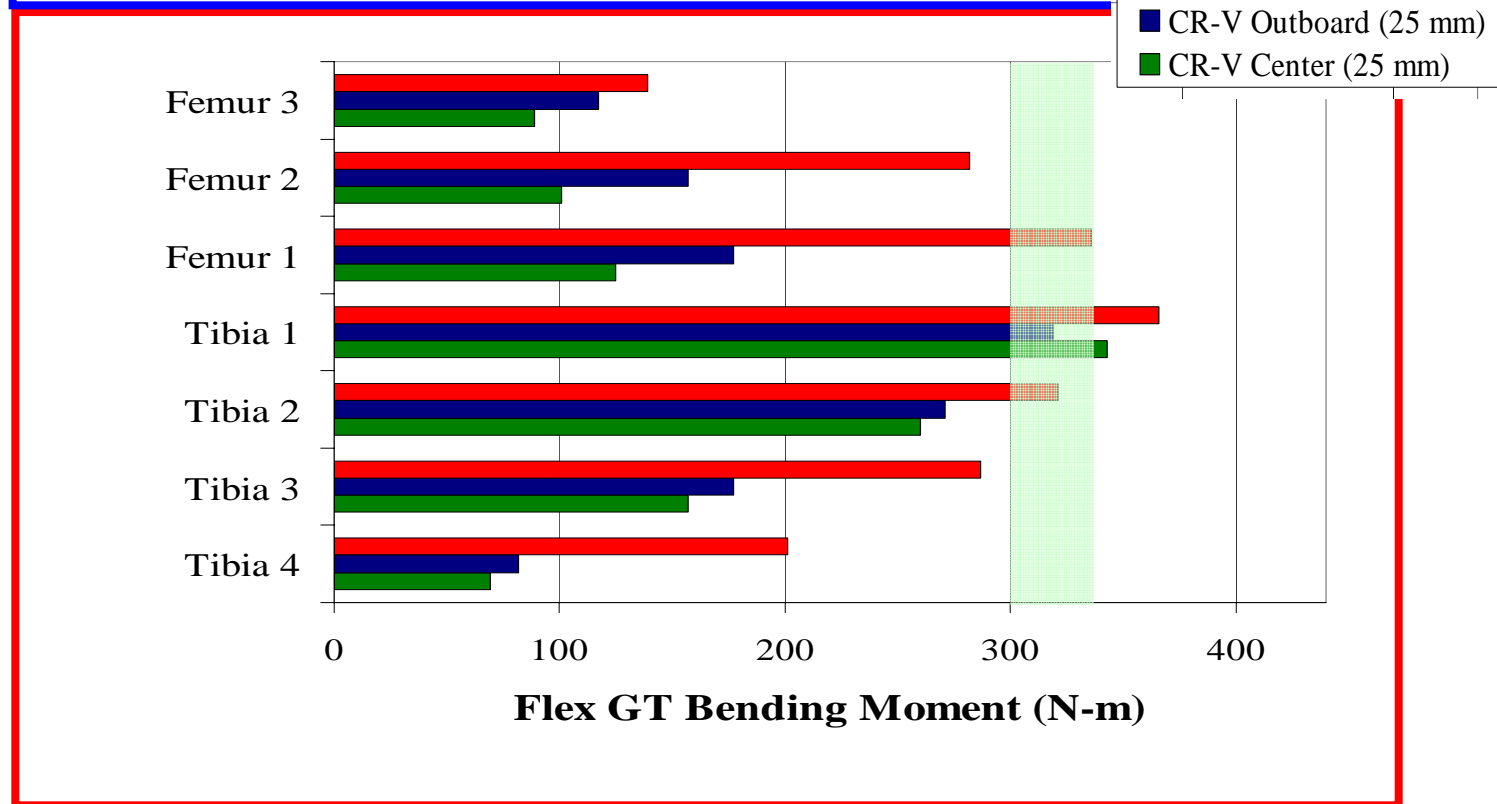


# Comparison to TRL: Fracture Measures

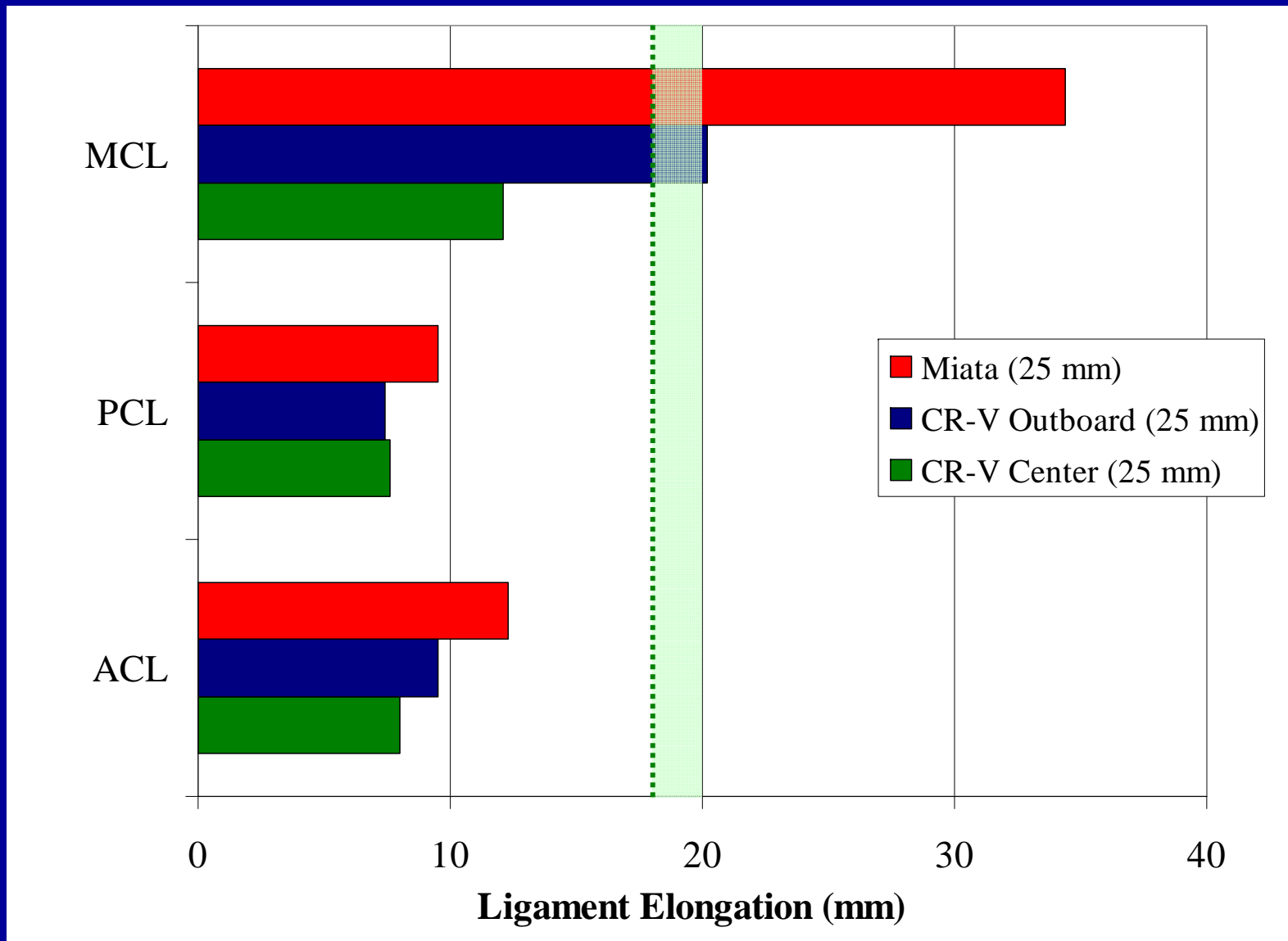
TR  
L



FLEX  
GT

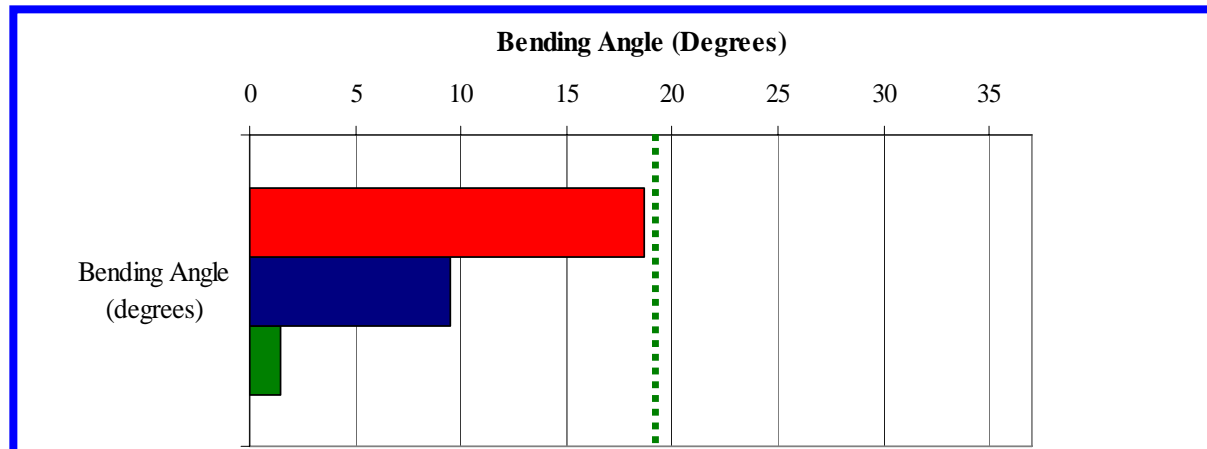


# Results: Ligament Elongation

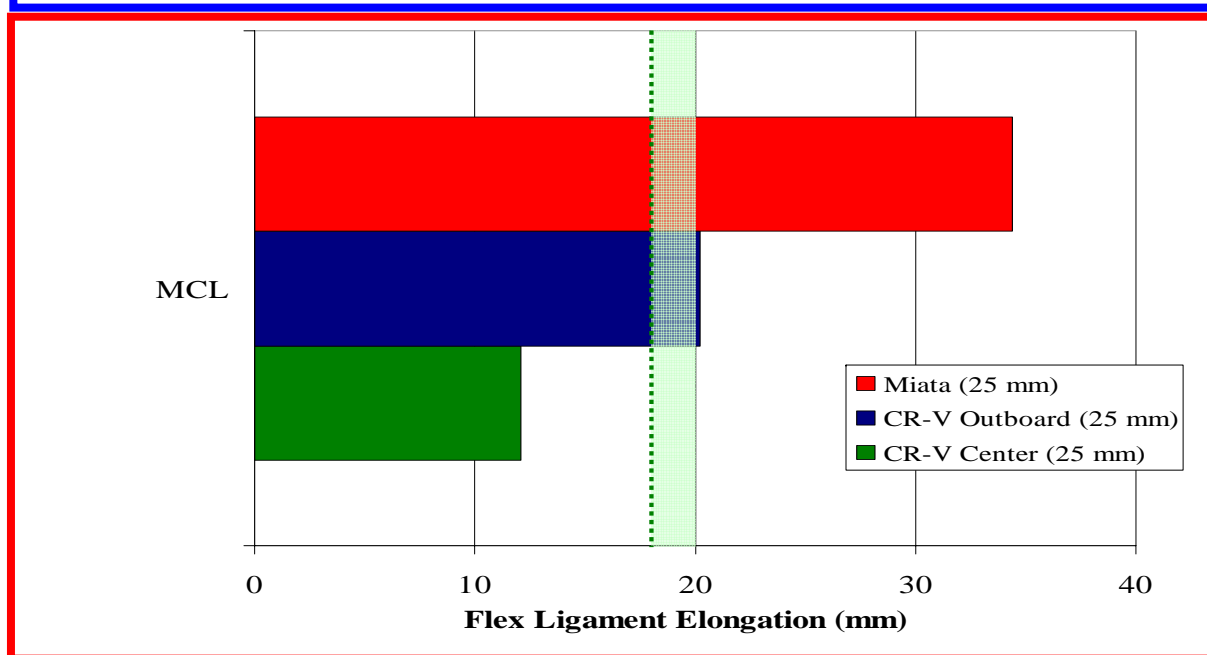


# Comparison to TRL: Knee Bend Measures

TR  
L

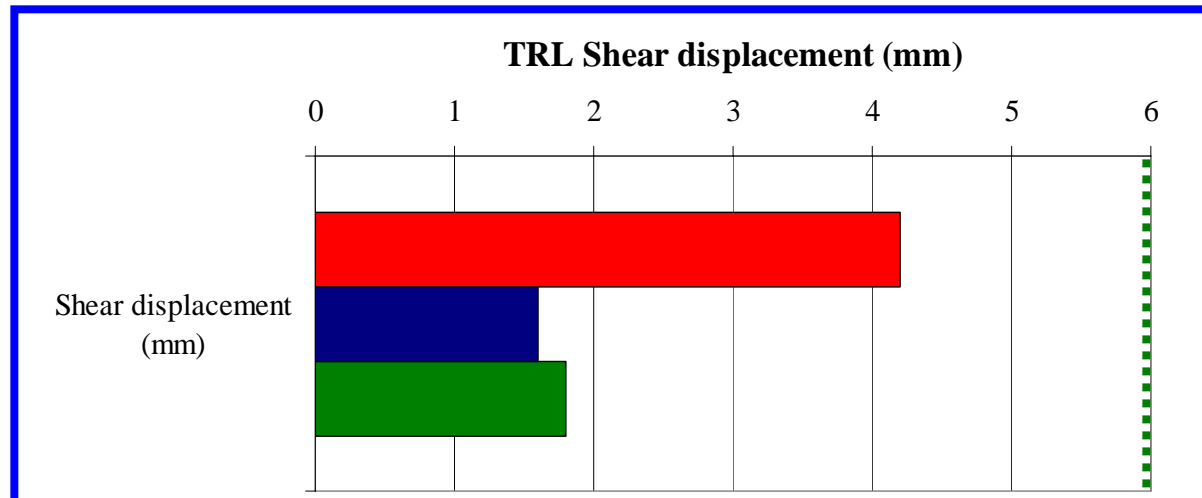


FLEX GT

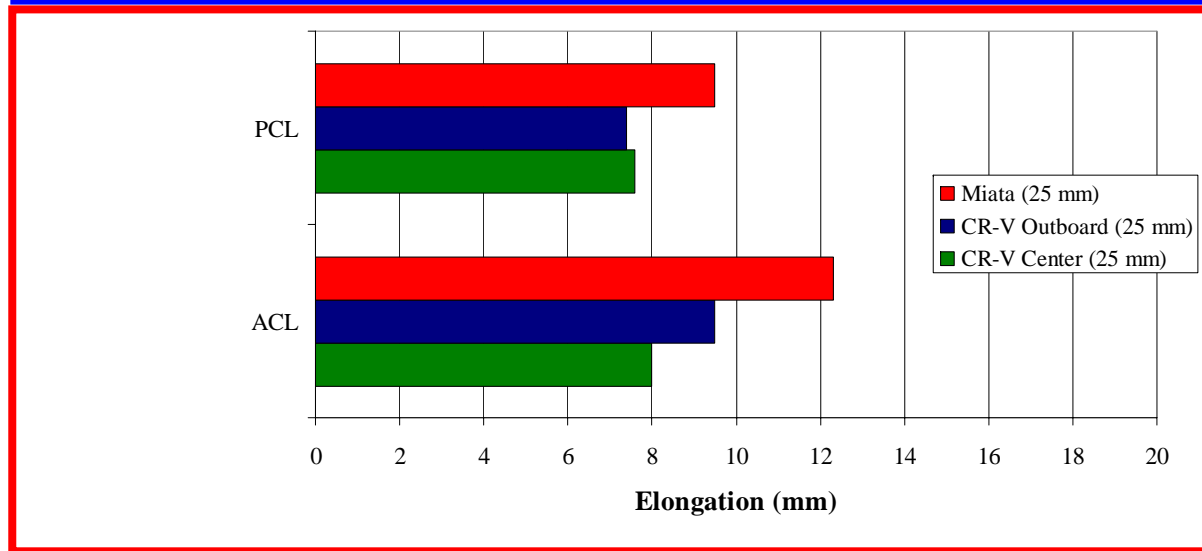


# Comparison to TRL: Shear Measures

TRL

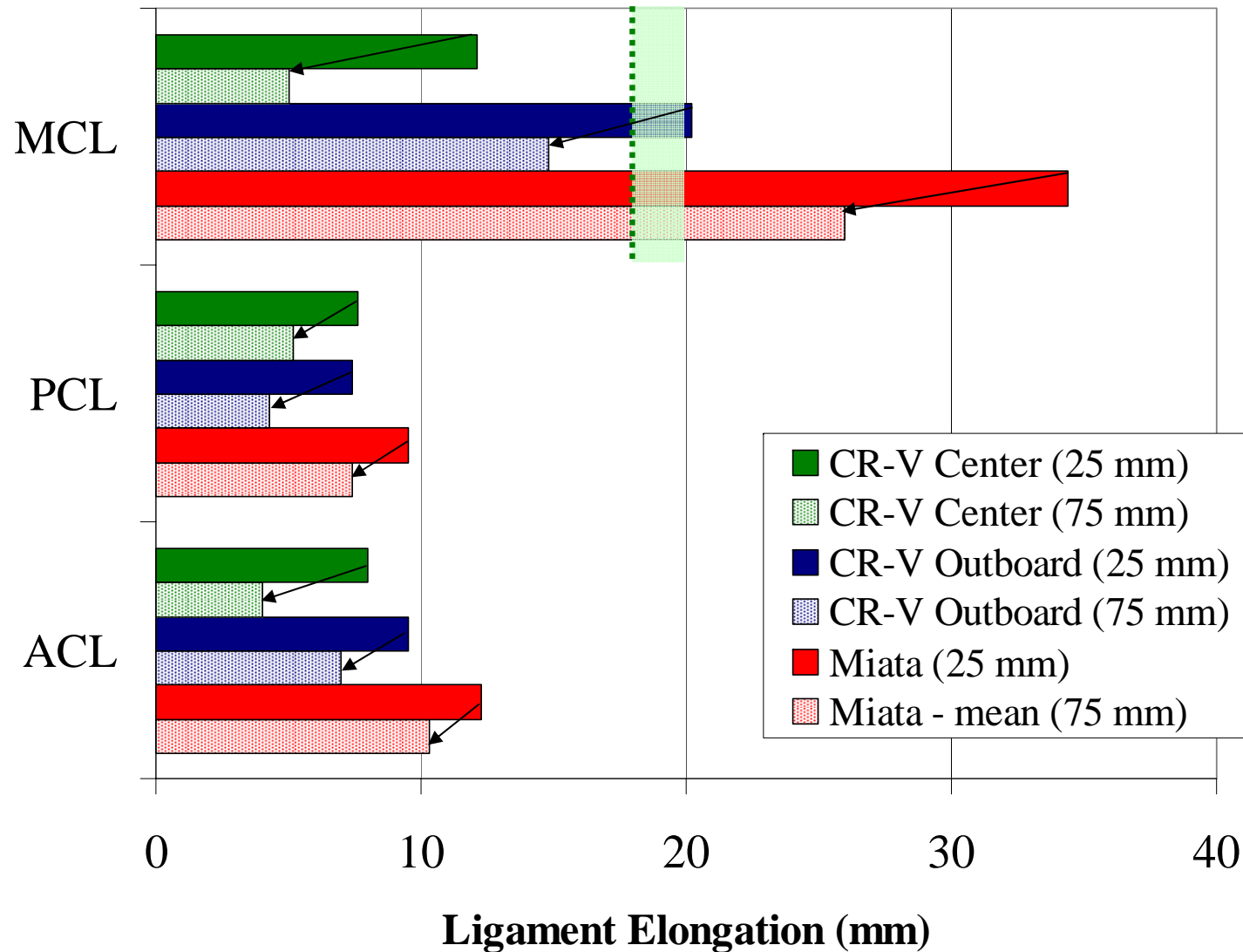


FLEX GT



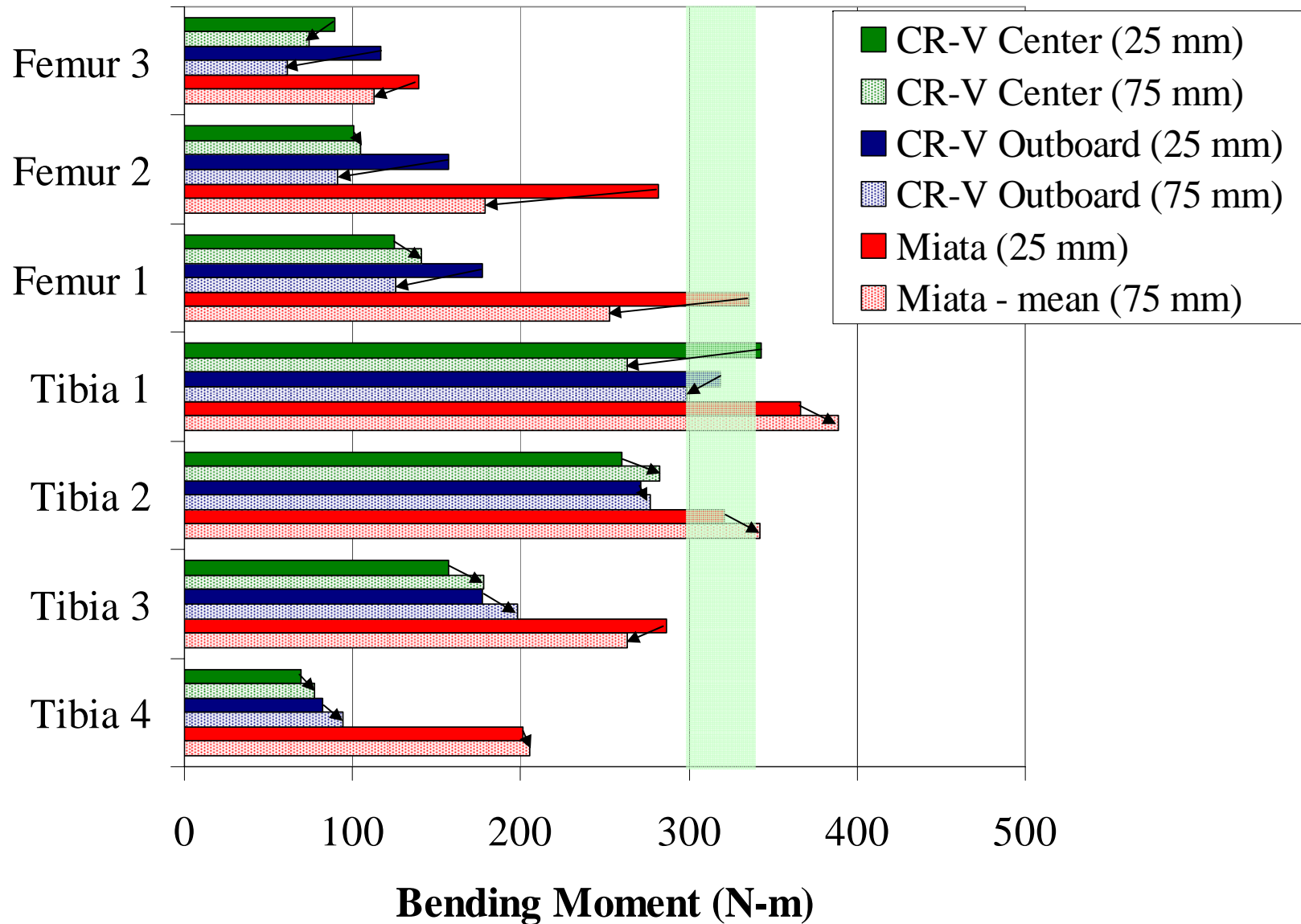
# Ligament Elongation

## 25mm vs. 75mm (Launch Height)



# Bending moments

## 25 mm vs. 75 mm (Launch Height)





25 mm impact height (GTR)

75 mm impact height

Honda CR-V

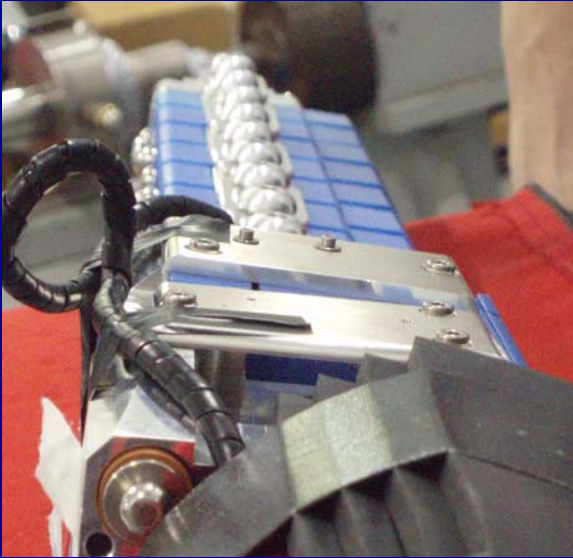


Mazda Miata

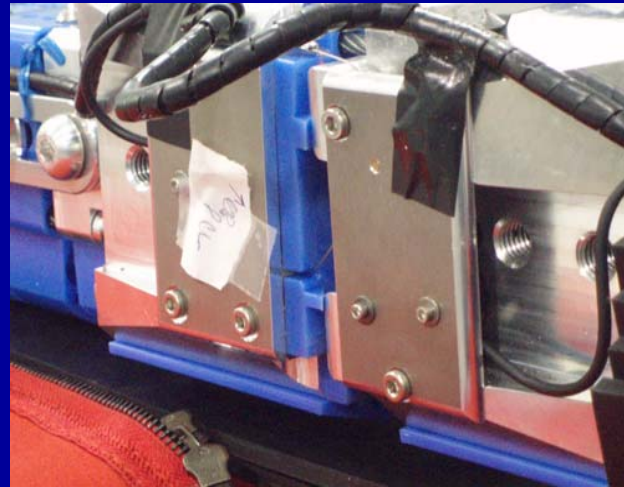


# Flex-GT Damage

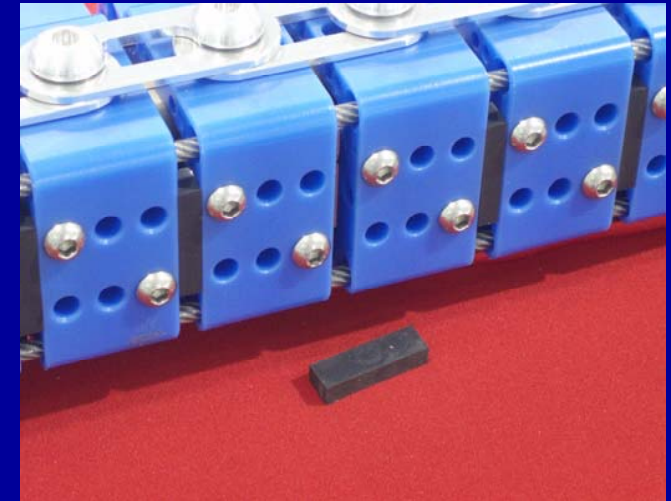
# Mechanical



Knee Twist



Bent Tabs



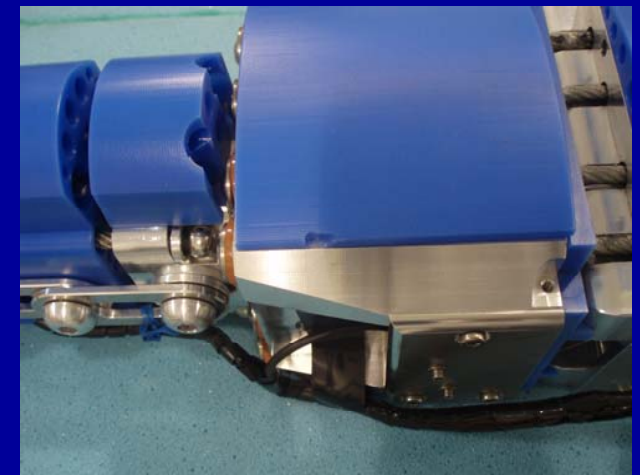
Rubber Spacer



Damaged Casings



Seized Bolt/Sleeve



Tibia Plate Damage/Rotation

# Mechanical (cont.)

- Zippers need to be made more durable
  - Broken pull rings due to repeated high tension when assembling leg
- Slices and cuts were common
  - When does accumulated damage require replacement of flesh?
- Addition of threaded holes in standard location for accelerometer attachment at knee
  - Recommended for impact speed redundancy & comparison to TRL-measured tibia acceleration



# Electrical

- We had 10 – 12 instances of a broken cable in our testing
- Improvements needed:
  - Better routing scheme
  - Dull sharp edges on knee structure
  - Stronger wire covers
  - Smaller bundle (can redundant gauges be coupled somehow to reduce the number of wires?)
  - Onboard DAS is a very good solution!

# Summary

- Test experience and repeatability
  - Improved axial rotation with new roller support
  - Excellent repeatability
- Injury evaluation
  - Flex GT results ranked severity of impacts similarly to TRL testing but indicated higher injury severity
  - At least one Flex GT proposed injury limit exceeded for all three impact locations for 25 mm impact height
  - Effect of raising impact height to 75 mm varied
- Damage and durability
  - Several minor issues but no catastrophic damage
  - Need to test more aggressive vehicles to evaluate durability for US fleet