



ATD Seating in Highly Reclined Seats

SAE Government Industry Meeting

April 04, 2019

Outline

- Background – What and Why
- Overall Approach – How
- One Example – THOR 50th Percentile Male seating
- Observations
- Seating Data for All ATDs

Background

- Many ongoing studies of PMHS, ATDs, human models in reclined seats
- How do current ATDs sit in reclined seats?
- Examine the range of positions that the ATD could assume in a current production seat
- 2012 Honda Odyssey driver seat used
 - Seat back reclined the most amongst the seats immediately available for this study
- Eight ATDs used in this study:

H-III 50th M, H-III 5th F

THOR 50th M, THOR 5th F

WSID 50th M, WSID 5th F

BioRID 50th M

LODC* 10 YO

Overall Approach

- Identify landmarks on the ATD that should be recorded using CMM
 - Include IR-TRACC locations, some rib locations, tilt sensor values
- Collect vehicle interior trim locations (B-Pillar, lower window opening, upper and lower edge of armrest, seat cushion) to record where the ATD head, ribs, and pelvis are relative to the interior
- At each seat back angle:
 - All seatback angles measured at head restraint post
 - Record the locations (CMM), document with photos
 - (0,0,0) at front door striker, X- forward, Y-to the right, Z-down
 - Record the shortest distances between the back of the head to the head restraint/seat back, and the shoulder landmark to the seat back, head angle, pelvic angle, tilt sensor values (when available) for each test

Overall Approach (Contd.)

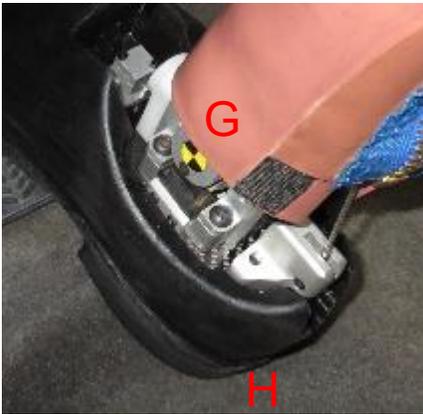
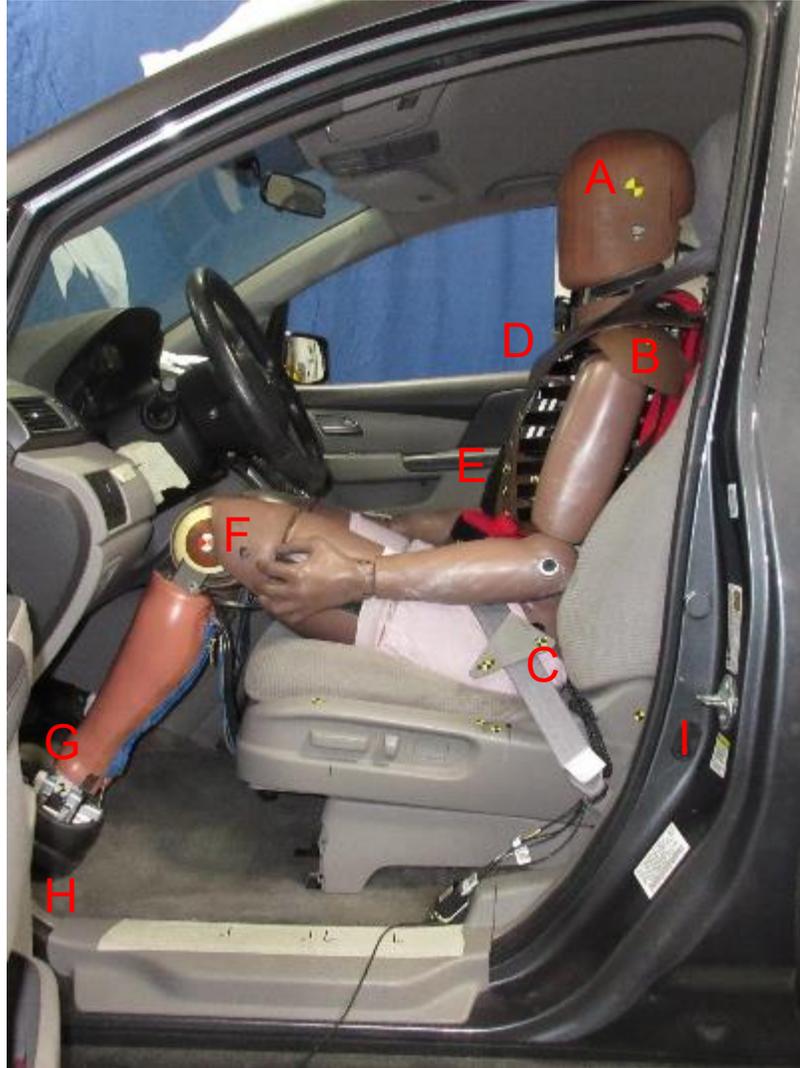
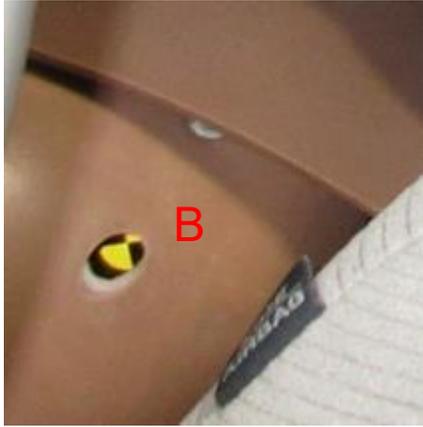
- Start with the ATD seated as in commonly used test procedures (FMVSS, NCAP), if available
- Optionally, move the seat to the rearmost seat track location for the ease of seating the ATD
 - Data collected can be translated forward to the baseline seat track location
- Recline the seat back in 5° increments, push down on the knees and push back on the upper body (perpendicular to the seat back); wait 5 minutes; measure

Overall Approach (Contd.)

- When the seat back is fully reclined, move the H-point forward by 25 mm.
 - Assumption: Humans will scoot forward on the seat when reclined
- Rotate the seat pan and seat back to the maximum reclined angle
 - Assumption: Humans will tilt back the seat pan when reclined
- Adjust ATD to maximum reclination (usually at the neck bracket and spine)
 - Assumption: Users of the ATD will set the ATD to the most “erect” configuration to get closer to the seat back

THOR 50th Percentile Male

THOR 50th - Target Locations



List of targets

- A Head
- B Shoulder
- C H-point
- D Chest (all targets)
- E Abdomen (both IR-TRACC)
- F Knee
- G Ankle
- H Heel point
- I Striker (0,0,0)

Head, T1, T6, T12, Pelvic angles from tilt sensors

Baseline and Most Reclined Overall Views



Seat Full Rear, Mid-Angle; Seatback at 11.4° (OSCAR)
Slouch



Hip forward, seat tilted up



Above w Neck adjusted 2 notches

THOR 50th - Baseline Seating

- Seat mid-track, seat pan lowest height, mid angle, seat back at 11.4°
- Pelvic angle = 32.5°, Slouch Torso Position

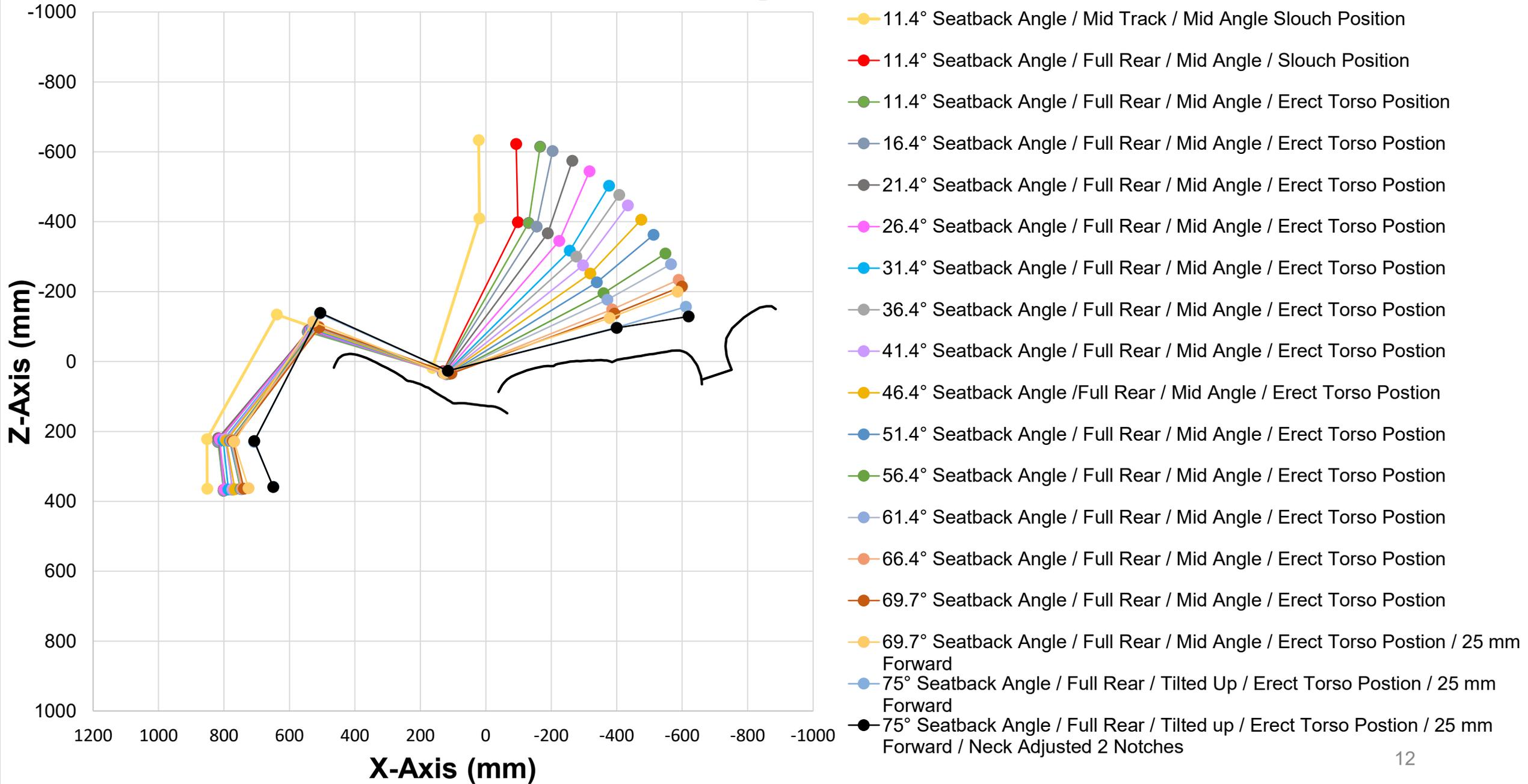


THOR 50th – Most Reclined

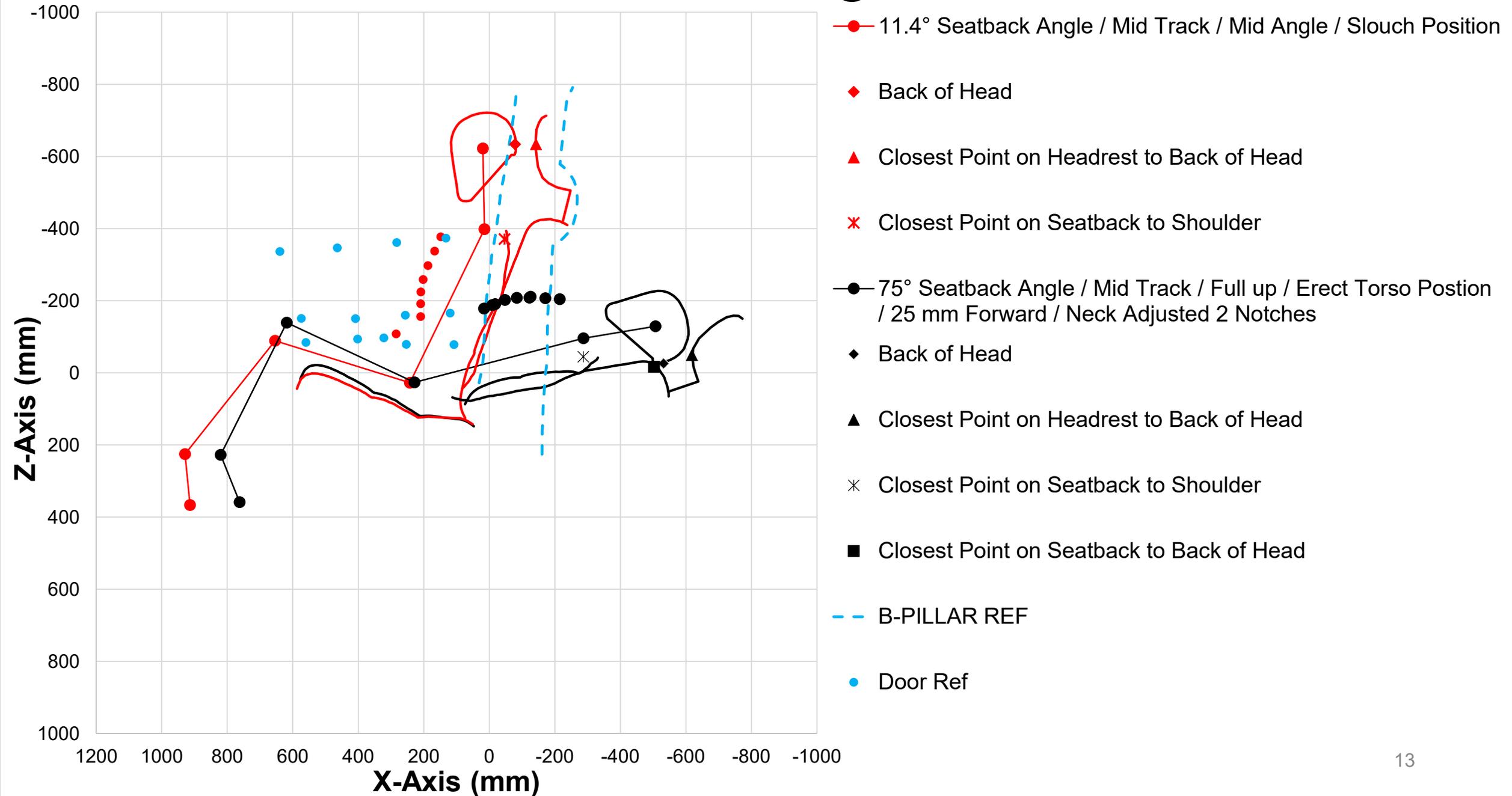
- seat back 75 °, pelvis 25 mm forward, full rear with cushion tilted up, neck adjusted 2 notches



Reclined Seating THOR 50th Male



Reclined Seating THOR 50th Male

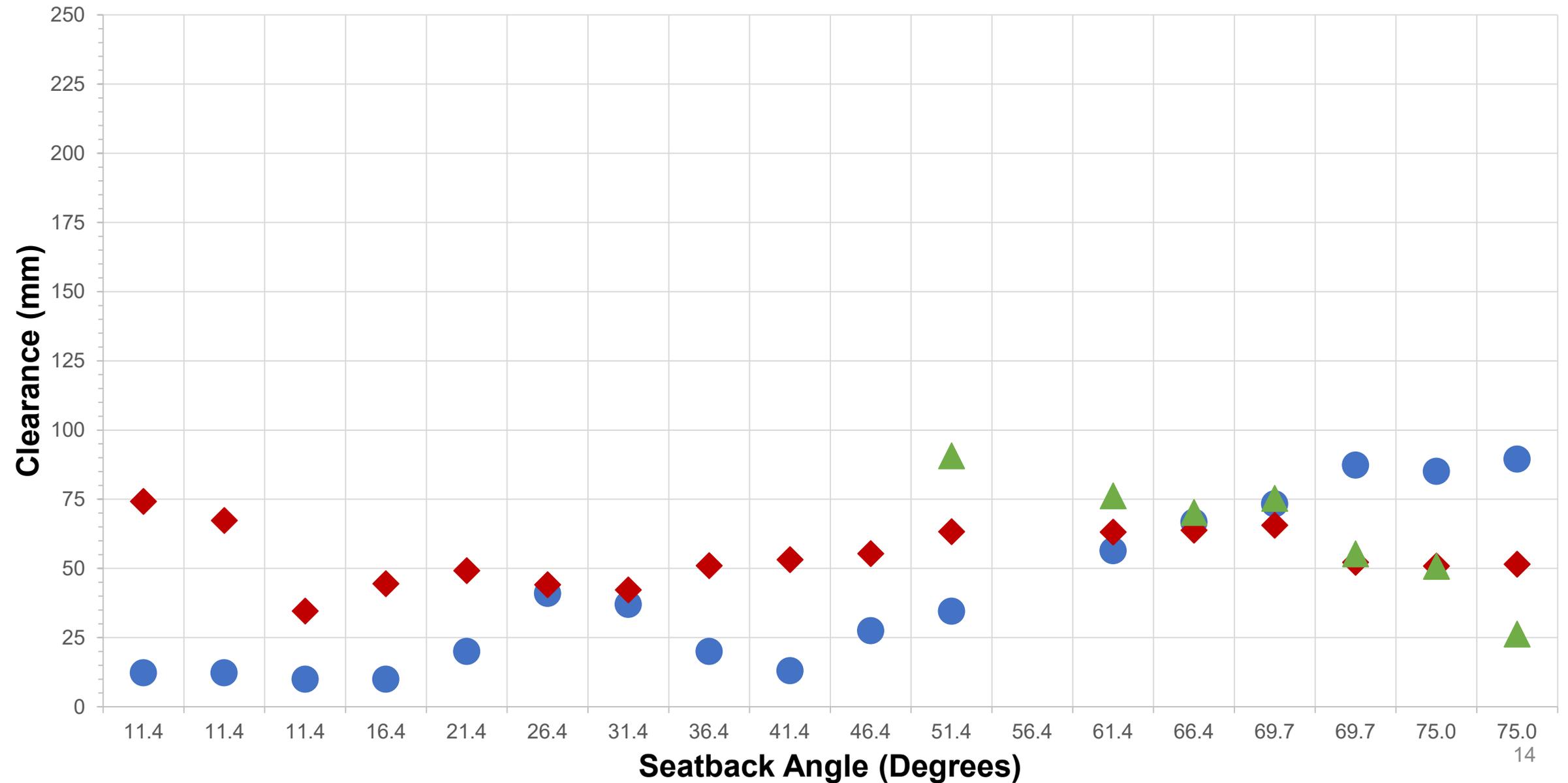


THOR 50th Male - Clearances

● Back of Head to Headrest

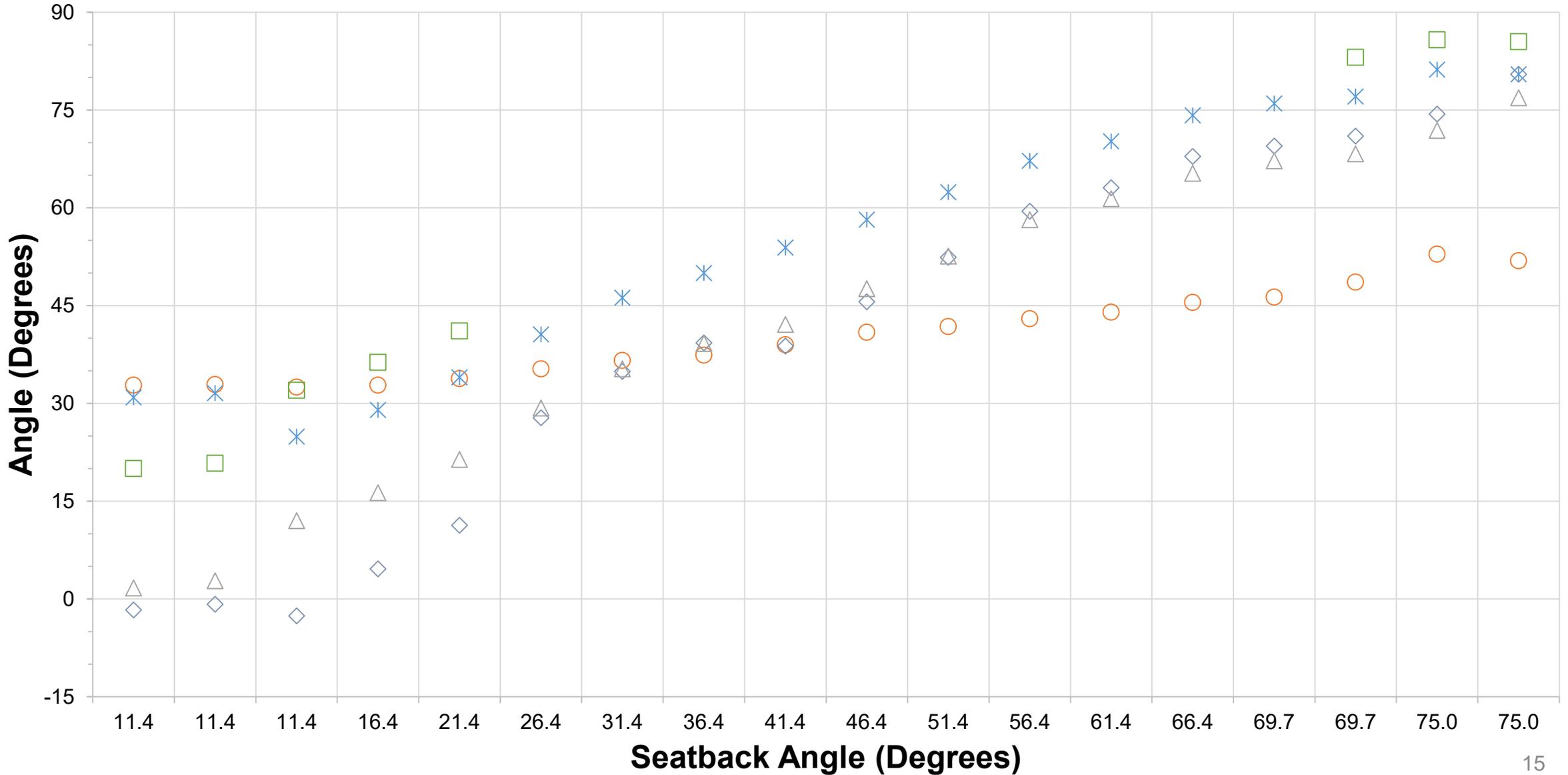
◆ Shoulder to Seatback

▲ Back of Head to Seatback



THOR 50th Male - Angles

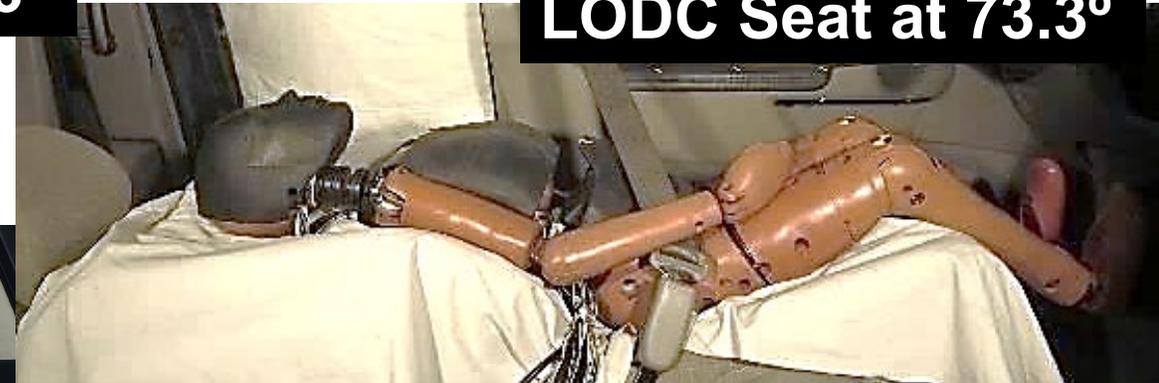
○ Pelvis ◇ Head △ T1 □ T6 * T12



Observations

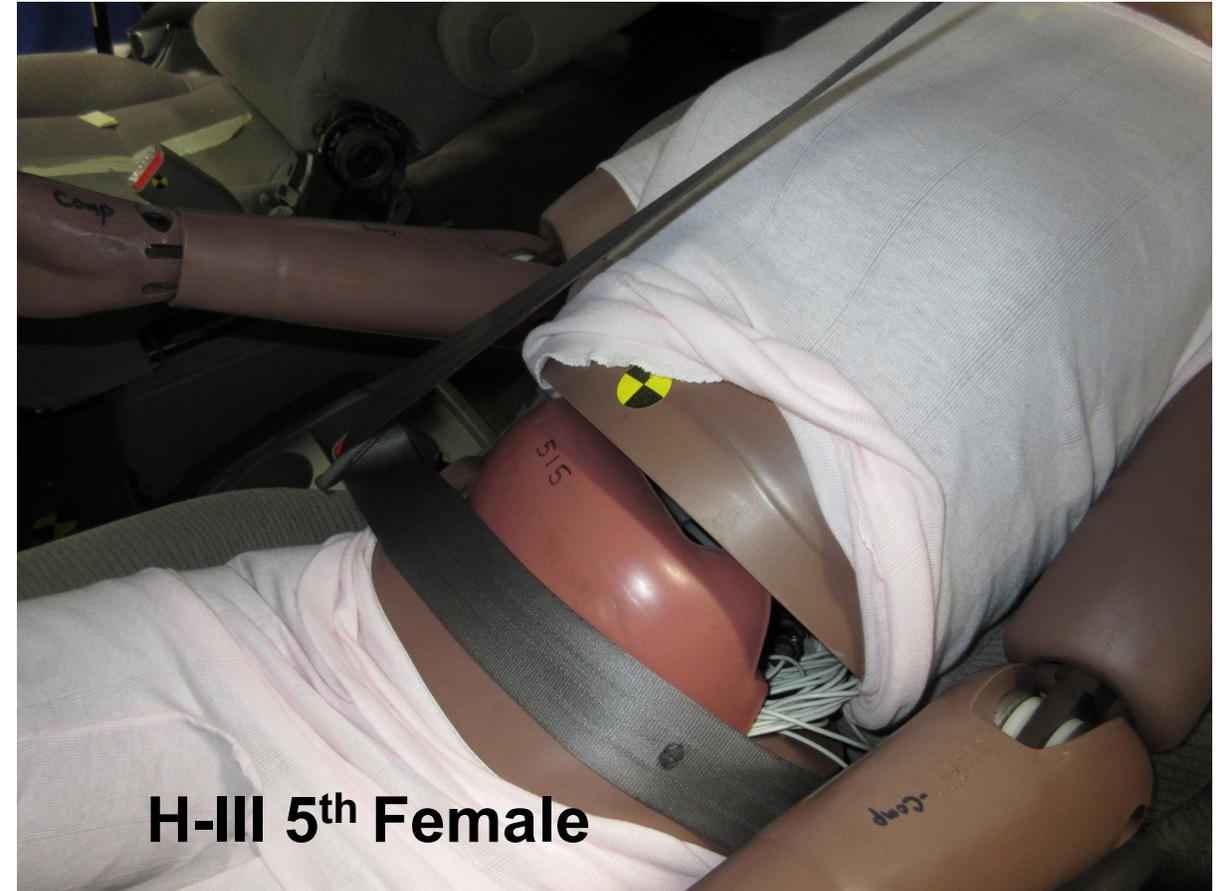
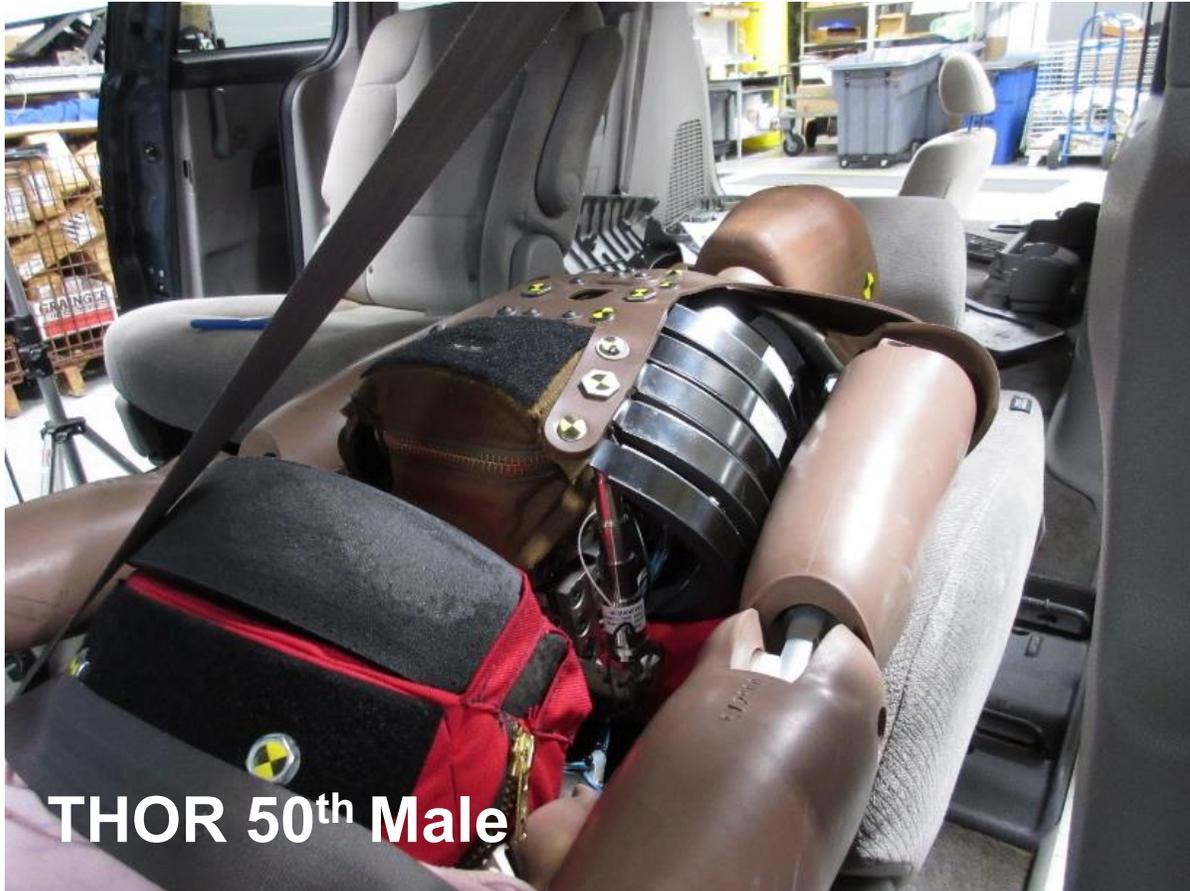
Observations

- The shape/size of lumbar support has a noticeable effect on head/shoulder clearances for Hybrid III and BioRID dummies
- The THOR, LODC and WSID spines flex to allow more reclined postures



Observations (Cont.)

- A large gap develops between pelvic flesh and thorax assembly.
- Pelvic angle increases (THOR 50M: $33^\circ \rightarrow 53^\circ$; H-III: $21^\circ \rightarrow 47^\circ$)
- Frontal impacts would likely result in submarining. Abdominal inserts may need to be re-designed for reclined seating use.



Observations (Cont.)

- Large gaps develop between the head and head restraints or shoulder and seat back for certain dummies (with stiffer spine. e.g. H-III)



Observations (Cont.)

- The neck, spine-pelvis attachment flexible rubber element is deformed. May have questionable performance (creep) and shortened life

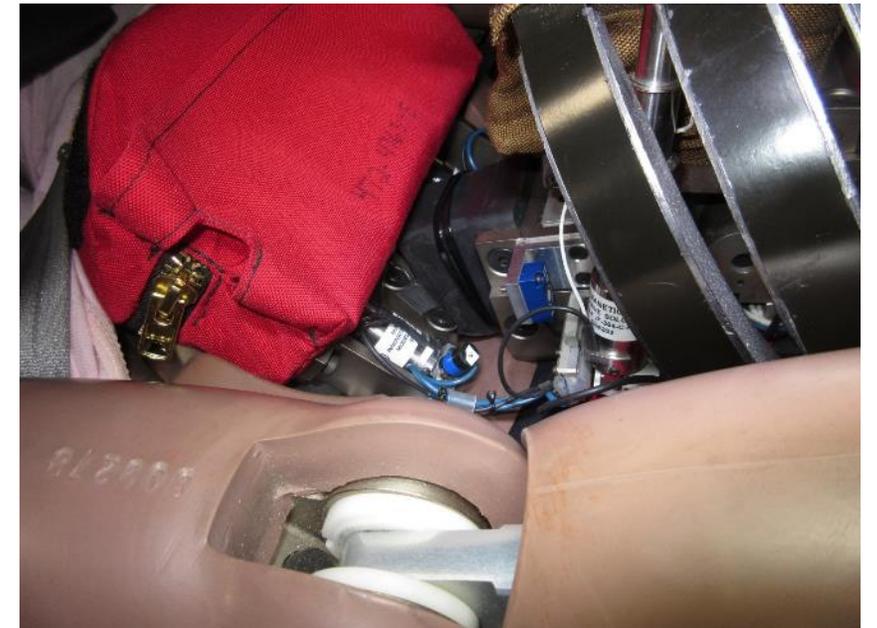
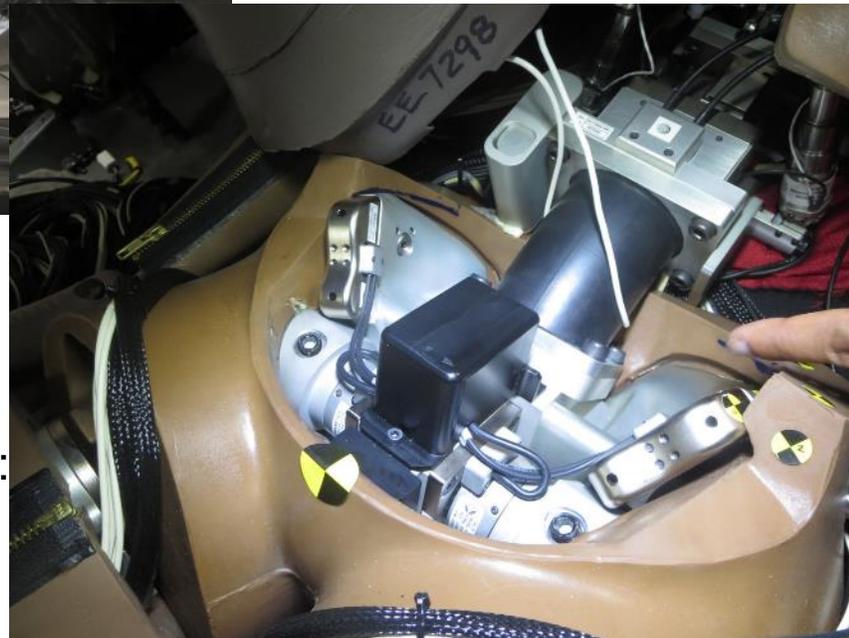
T12 – pelvic angle:
-2° to 30°



THOR 50th

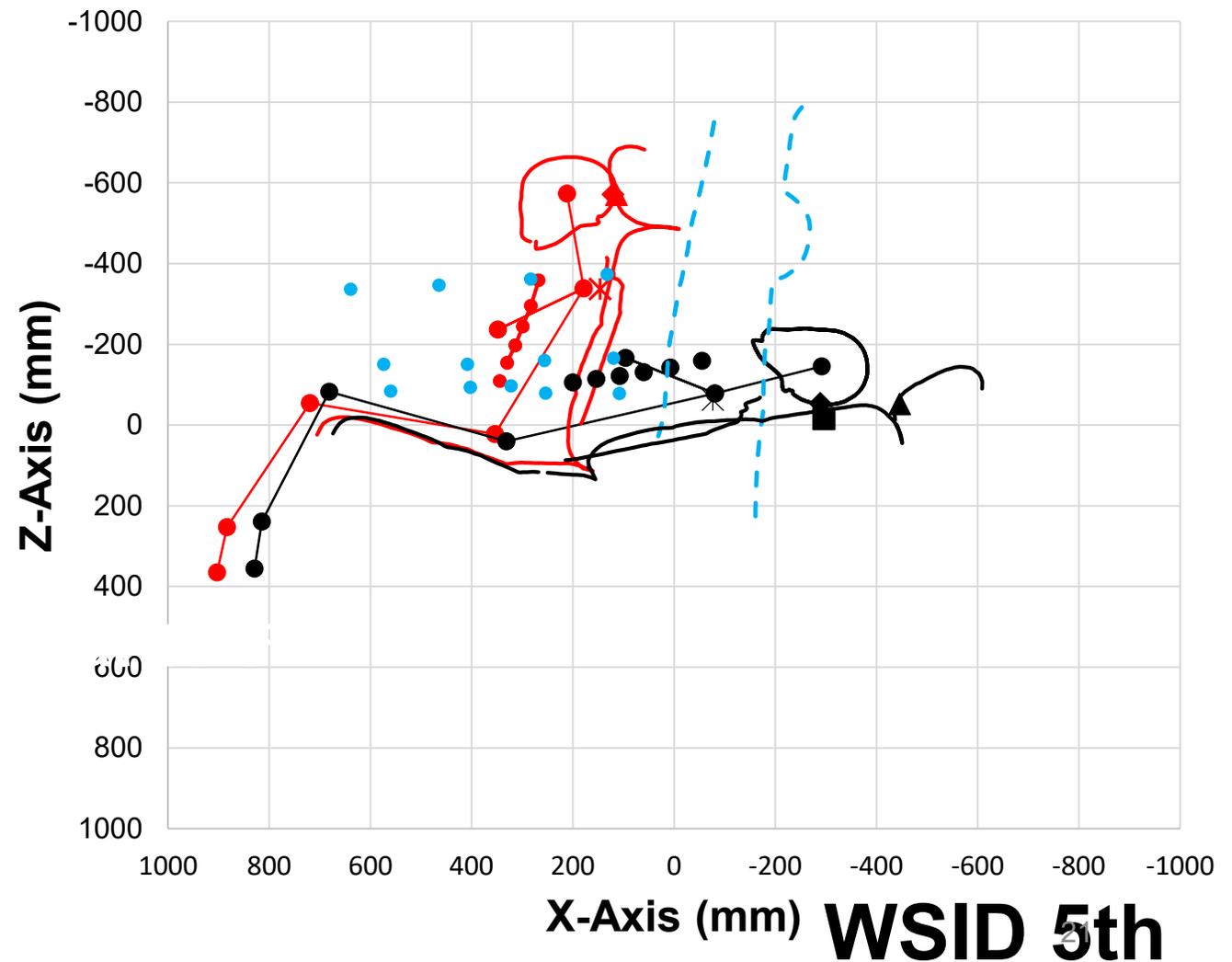
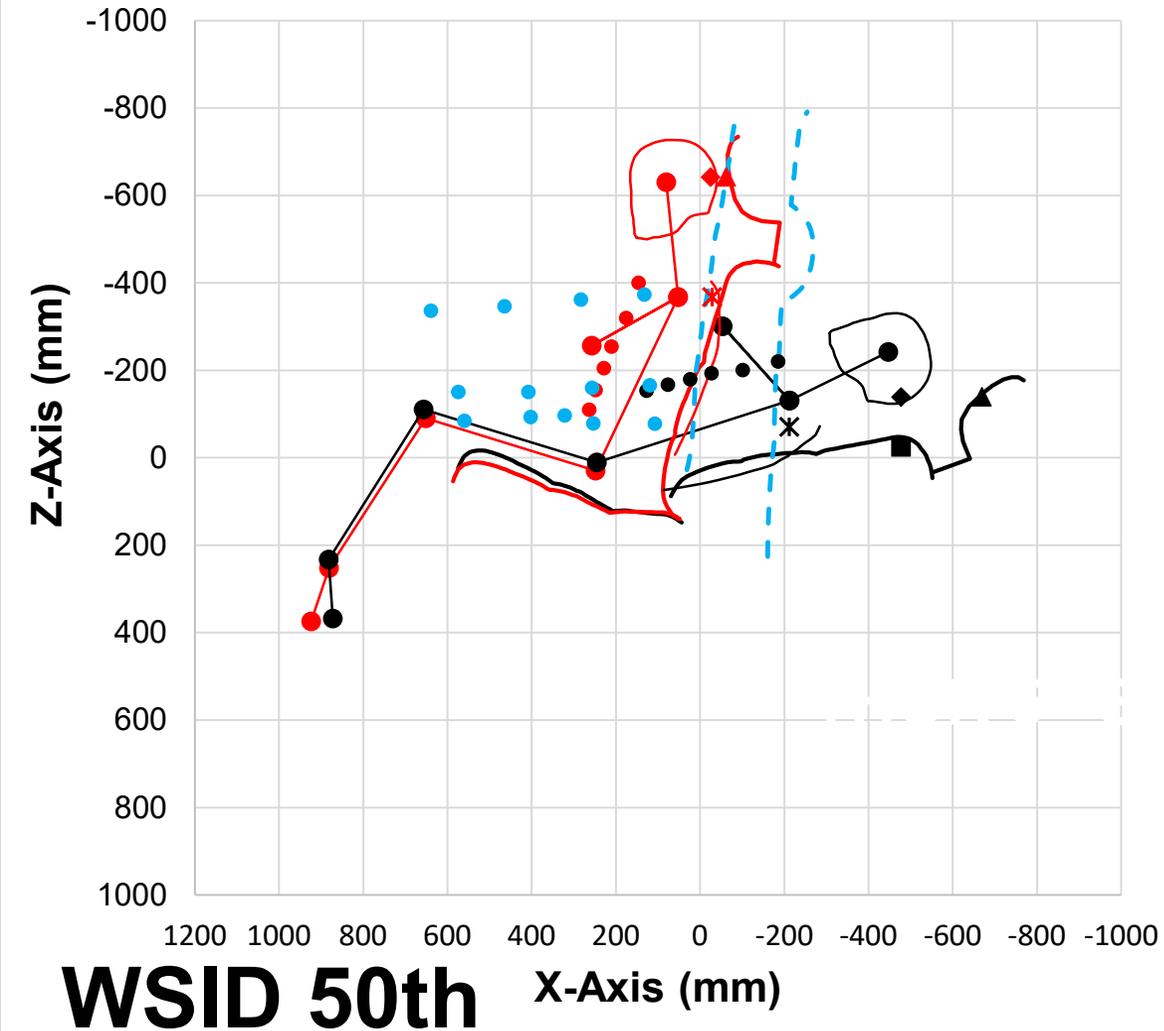
THOR 5th

lower thorax – pelvic angle:
6° to 25°



Observations (Cont.)

- Side impact ATDs: Changes locations of the head, shoulder and ribs relative to curtains, daylight opening, B-pillar, armrest, door structures



Observations (Contd.)

- Just because one can force an ATD into a certain seating position does not mean that it will give meaningful results (biofidelity not established)
- Can be useful in comparing ATD responses to PMHS and Human Body Models to establish (or not!) biofidelity under those conditions
- Help with redesign of ATDs, vehicle interior, seats, primary and supplemental restraints
- Useful for addressing ATD use in front, side, rear impacts
- Repeat with specific seat being considered



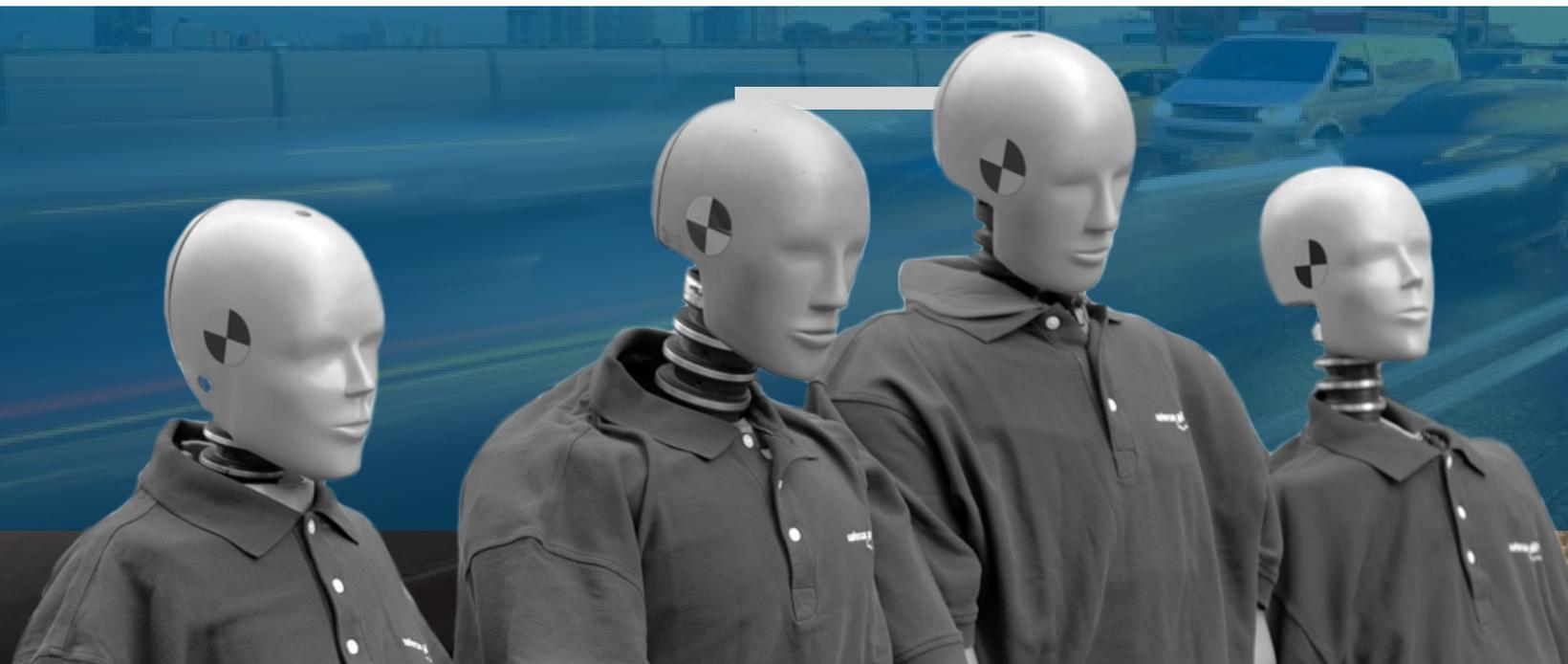
NHTSA

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

www.NHTSA.gov

<https://www-nrd.nhtsa.dot.gov/database/VSR/bio/QueryTest.aspx>

BioDB Test # 11903 - 12029



THOR 5th Female

THOR 5th Female - Target Locations



List of targets

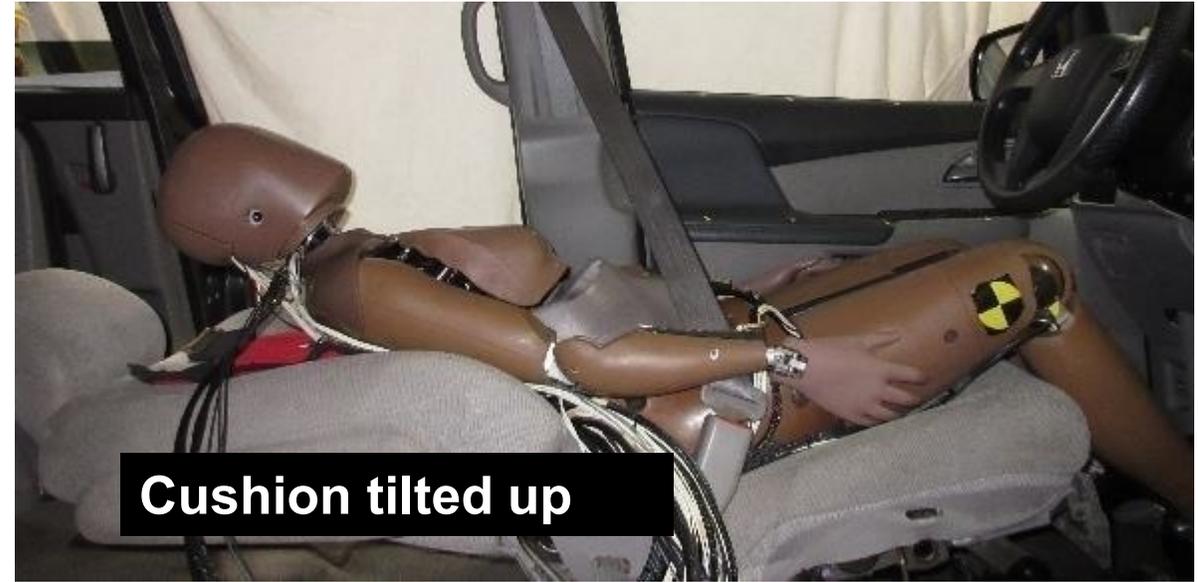
- A Head
- B Shoulder
- C H-point
- D Chest (all 4 targets)
- E Abdomen
- F Knee
- G Ankle
- H Heel point
- I Bridge of nose
- J Back of head

Head, Upper, Mid, Lower Thorax, Pelvic angles from tilt sensors

Baseline and Most Reclined Overall Views



Seat Full Rear, Mid-Angle; Mid-Height; Seatback at 11.4° (Head level)



Cushion tilted up



Hip forward and cushion tilted up

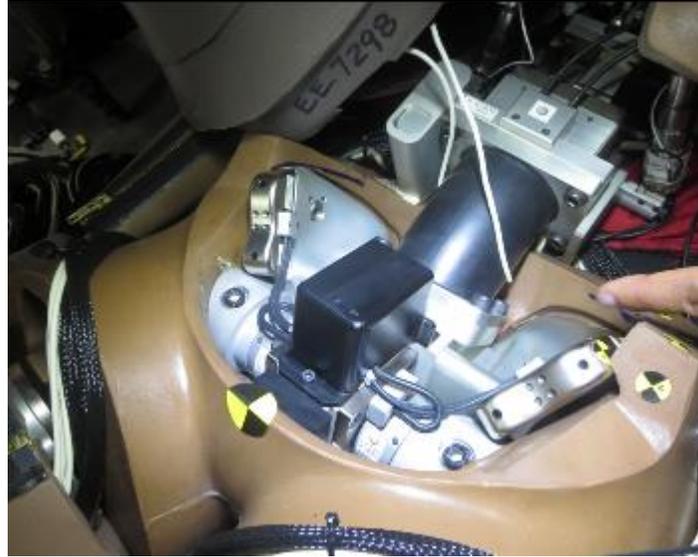
THOR 5th Female - Baseline Seating

- Seat Full Forward, seat pan mid height, mid angle, seat back at 19.4°
Pelvic angle = X: -0.1°, Y: 28.1°

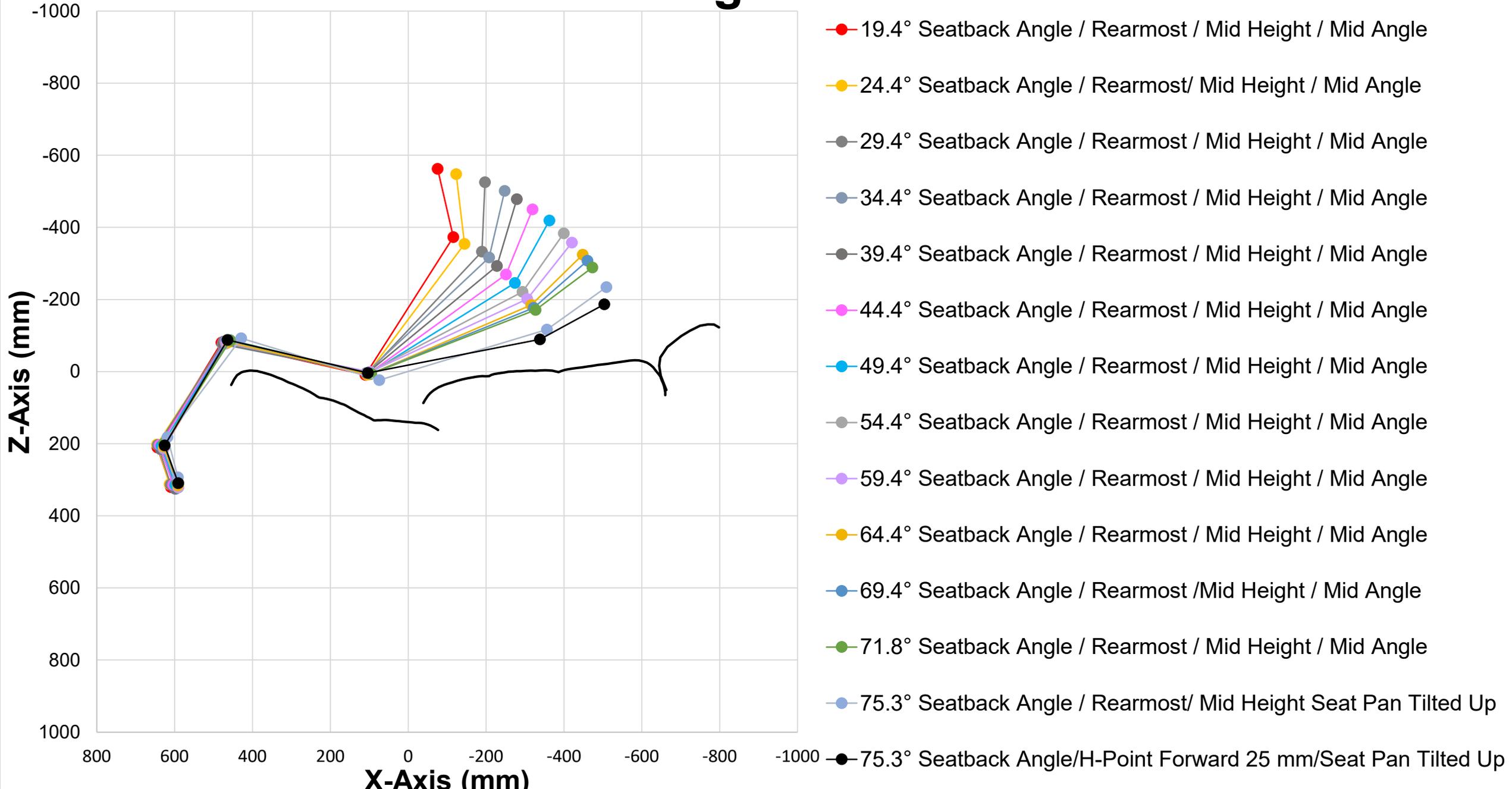


THOR 5th Female - Most Reclined

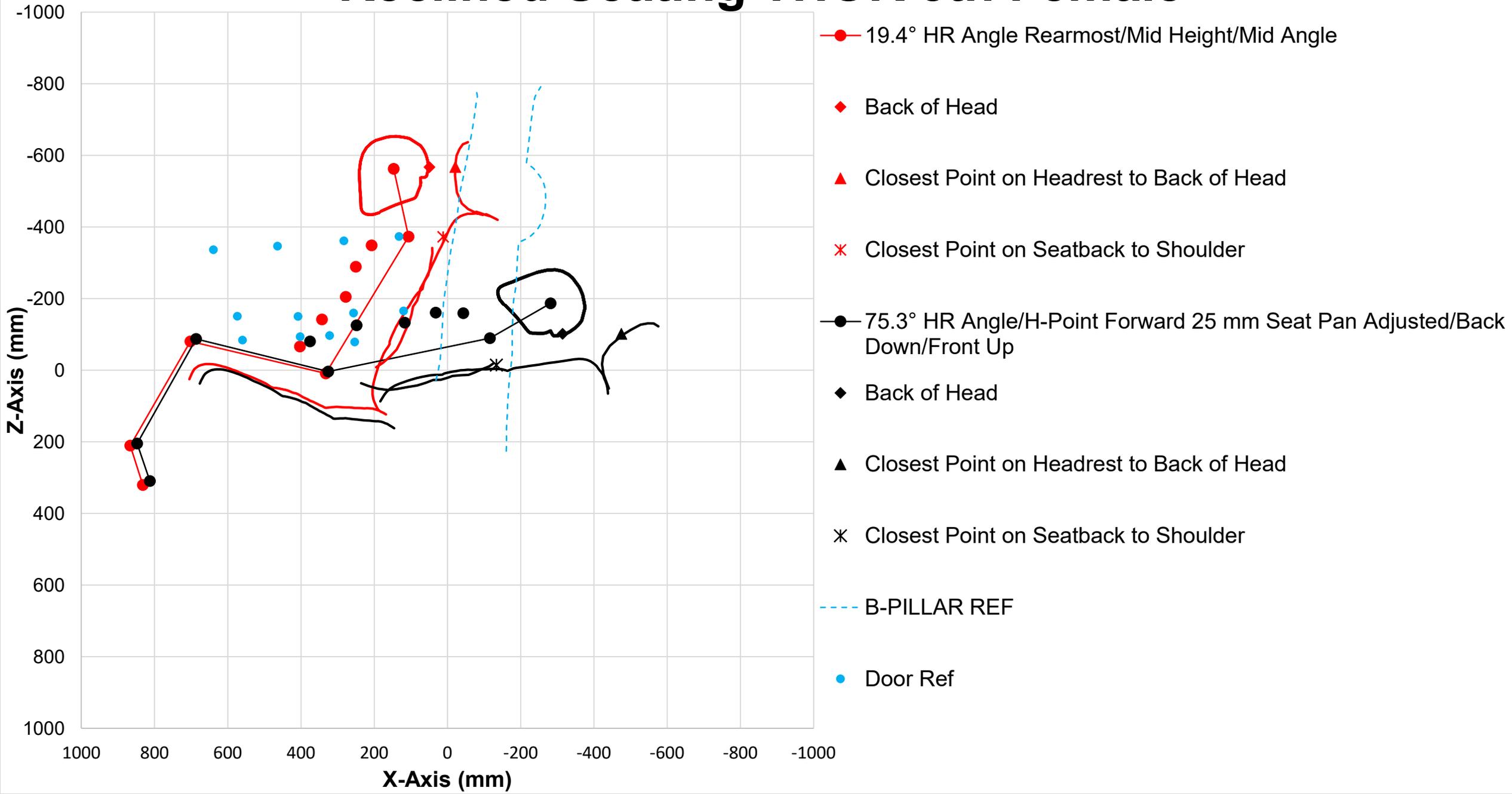
- H-Point Forward 25 mm Seat Pan Adjusted/Back Down/Front Up at 75.3°- Pelvic angle = X: -2.3°, Y: 59°



Reclined Seating THOR 5th Female

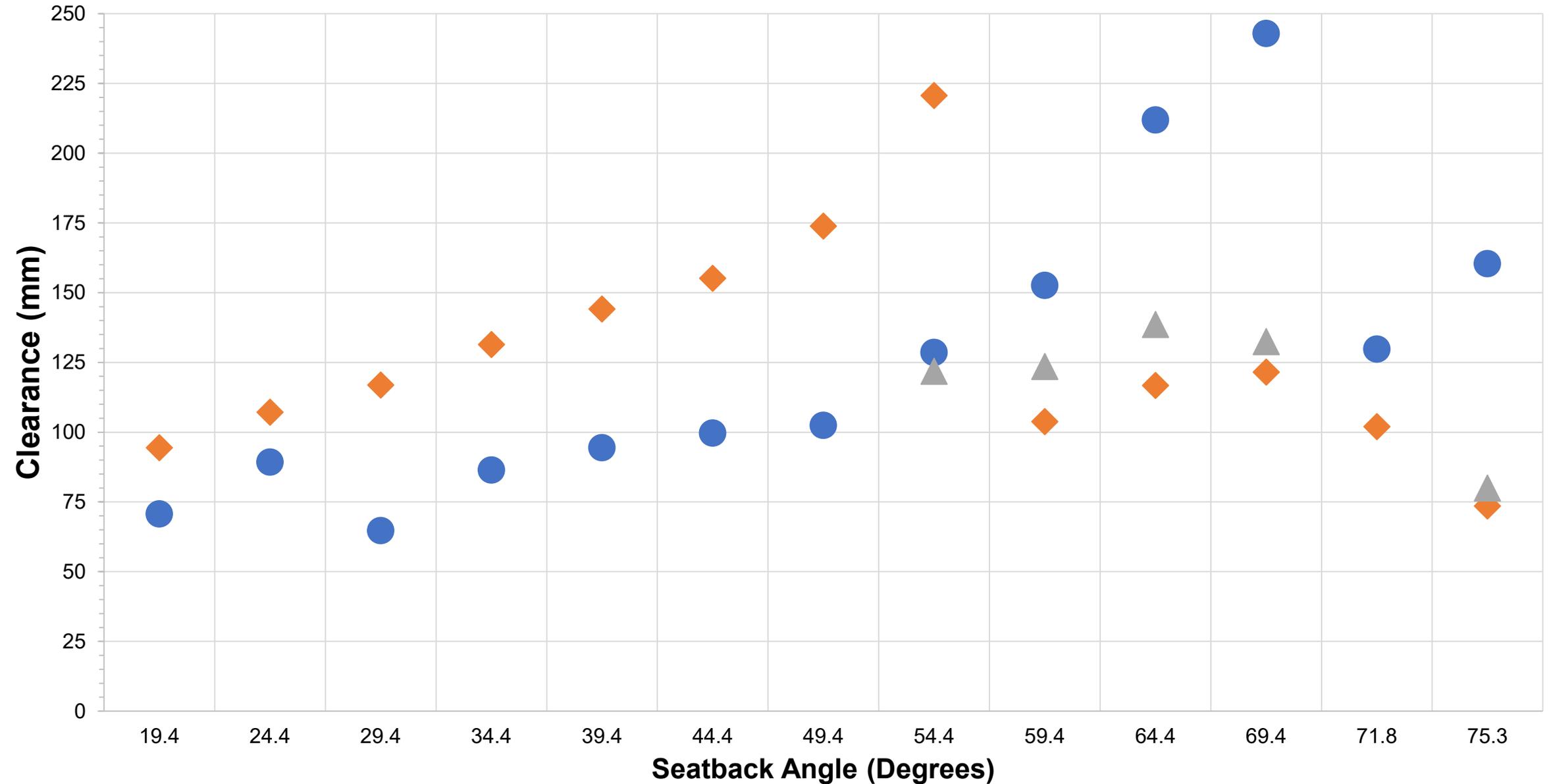


Reclined Seating THOR 5th Female



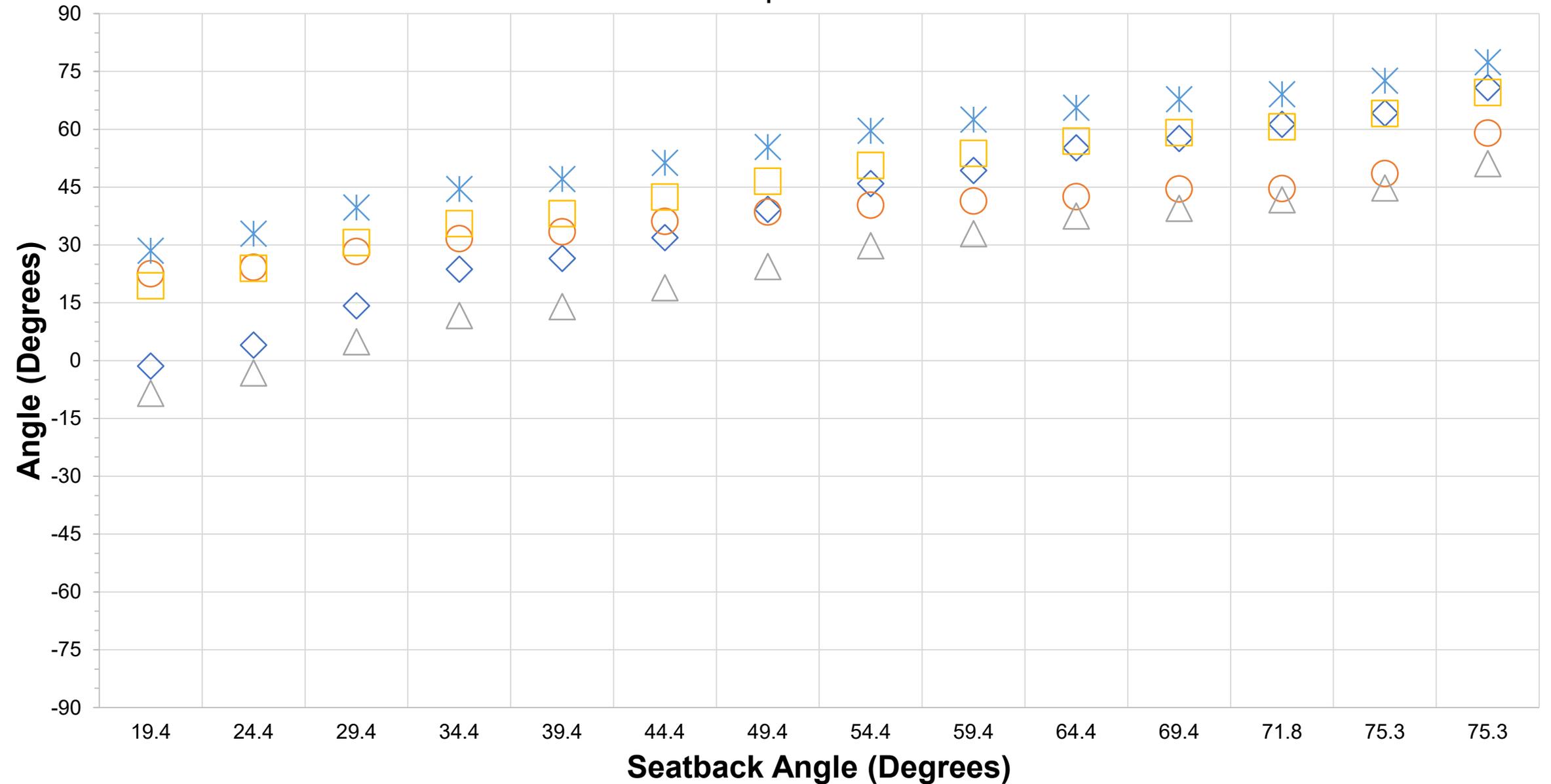
THOR - 5th Female

● Back of Head to Headrest ◆ Shoulder to Seatback ▲ Back of Head to Seatback



THOR - 5th Female

◇ Head ○ Pelvis △ Up Thrx □ Mid Thrx ✖ Low Thrx



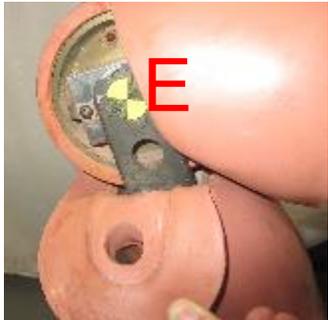
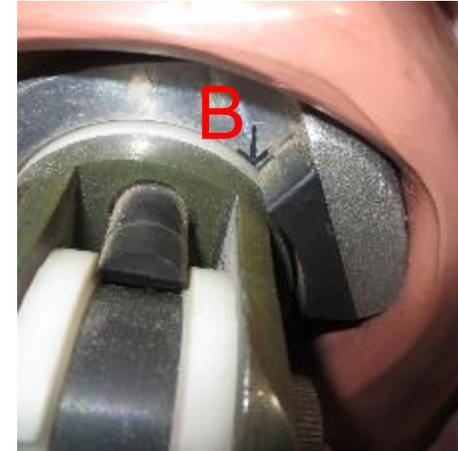
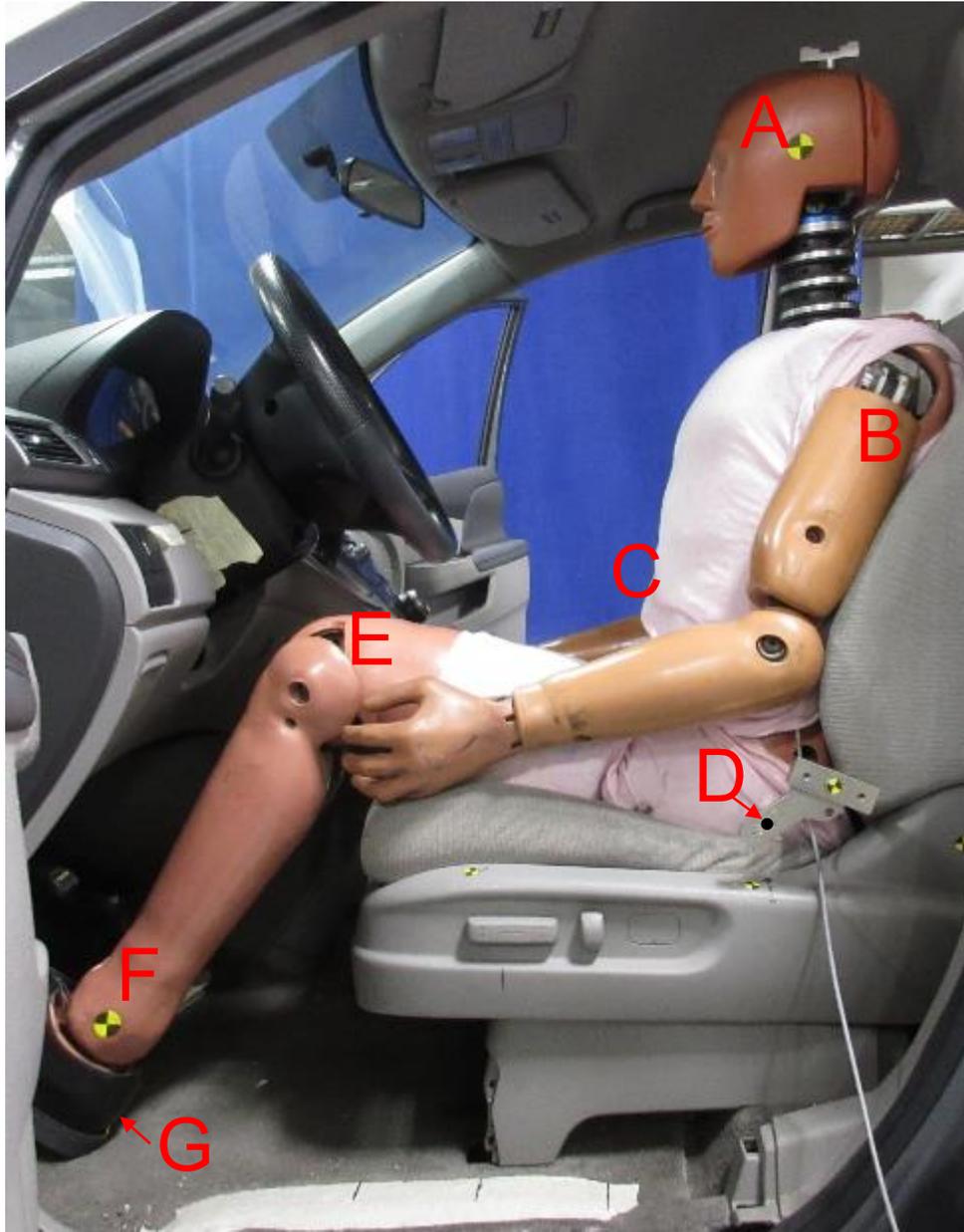
H-III 50th Percentile Male

H-III 50th Male - Target Locations

List of targets

- A Head
- B Shoulder
- C Abdomen
- D H-point
- E Knee
- F Ankle
- G Heel point

Head, Pelvic
angles



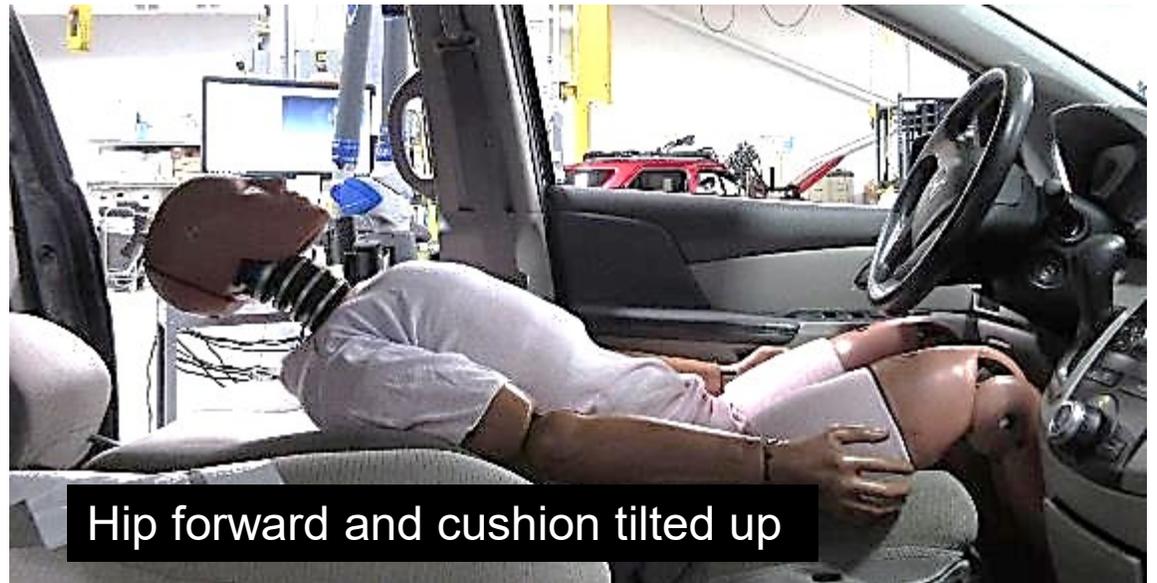
208 and Most Reclined Overall Views



Seat Mid Track, Mid-Angle; Lowest-Height;
Seatback at 12.5° (OSCAR)



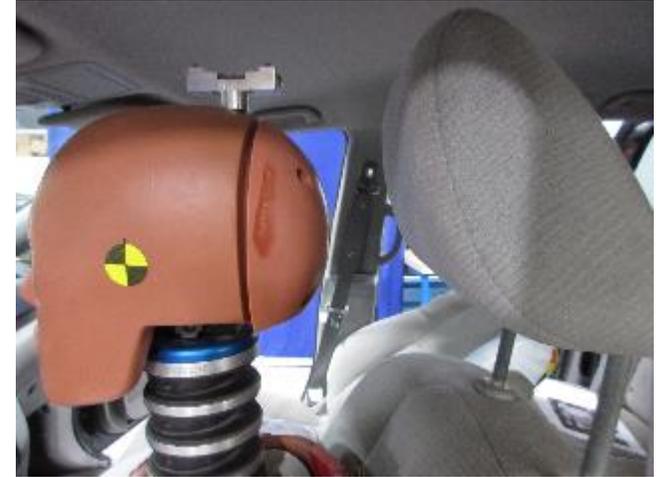
Hip forward



Hip forward and cushion tilted up

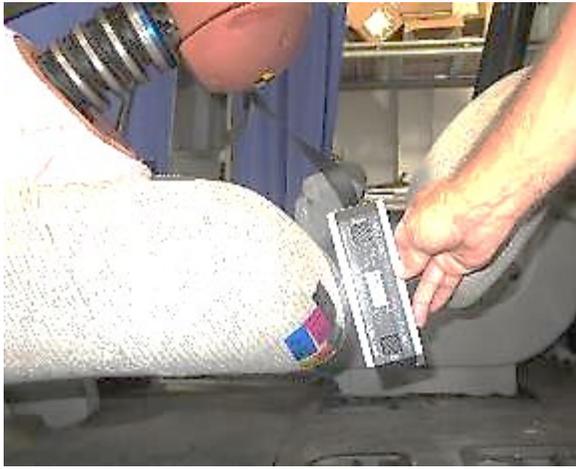
H-III 50th Male - 208 seating

- Seat mid track, seat pan lowest height, mid angle, seat back at 12.5°
- Pelvic angle = 23.9 °, Head level (neck 3 notches rear of 0)
- D-ring at full up



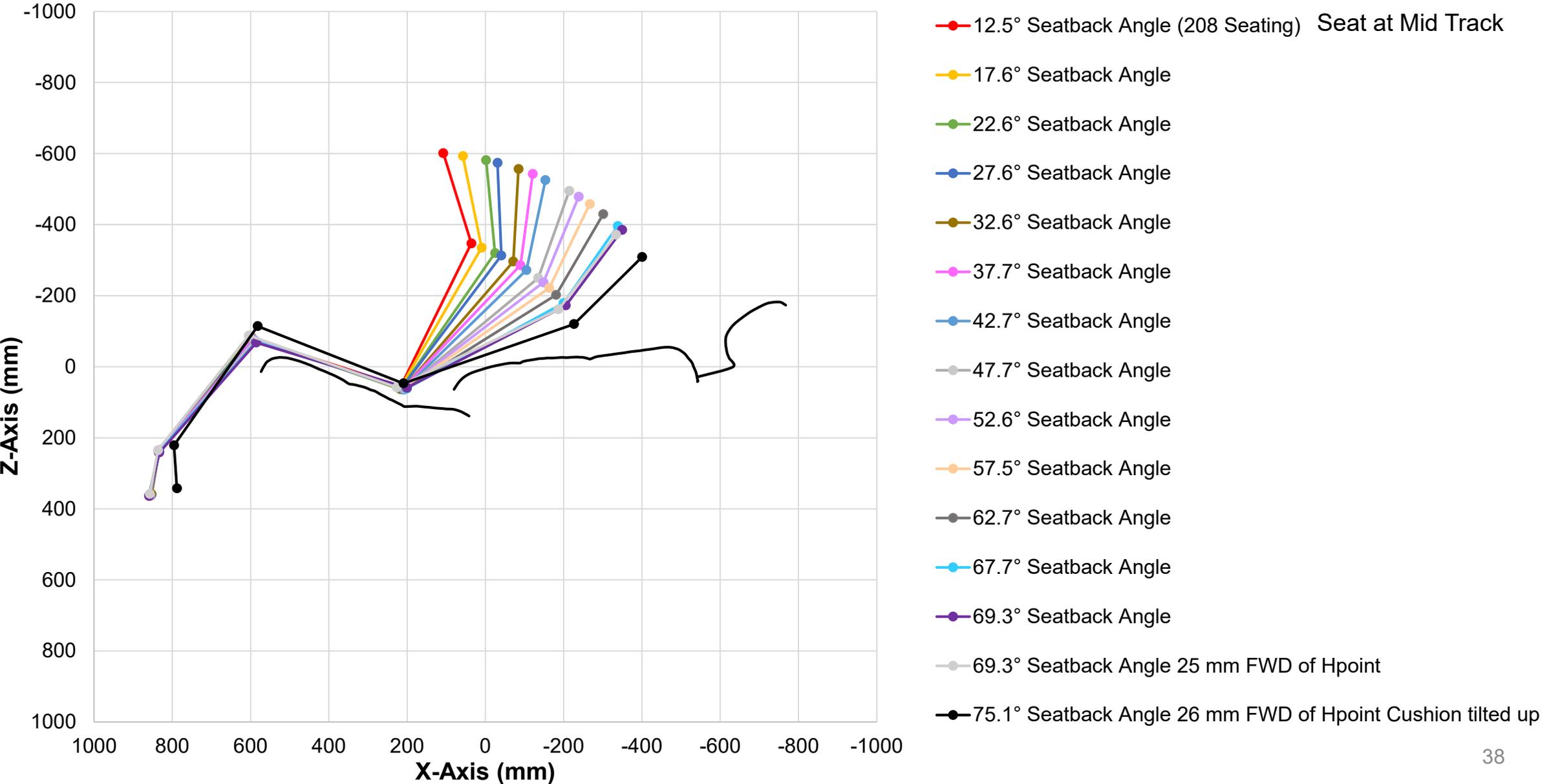
H-III 50th Male – Most Reclined

- seat back 75 deg - pelvis 25 mm forward - cushion tilted up

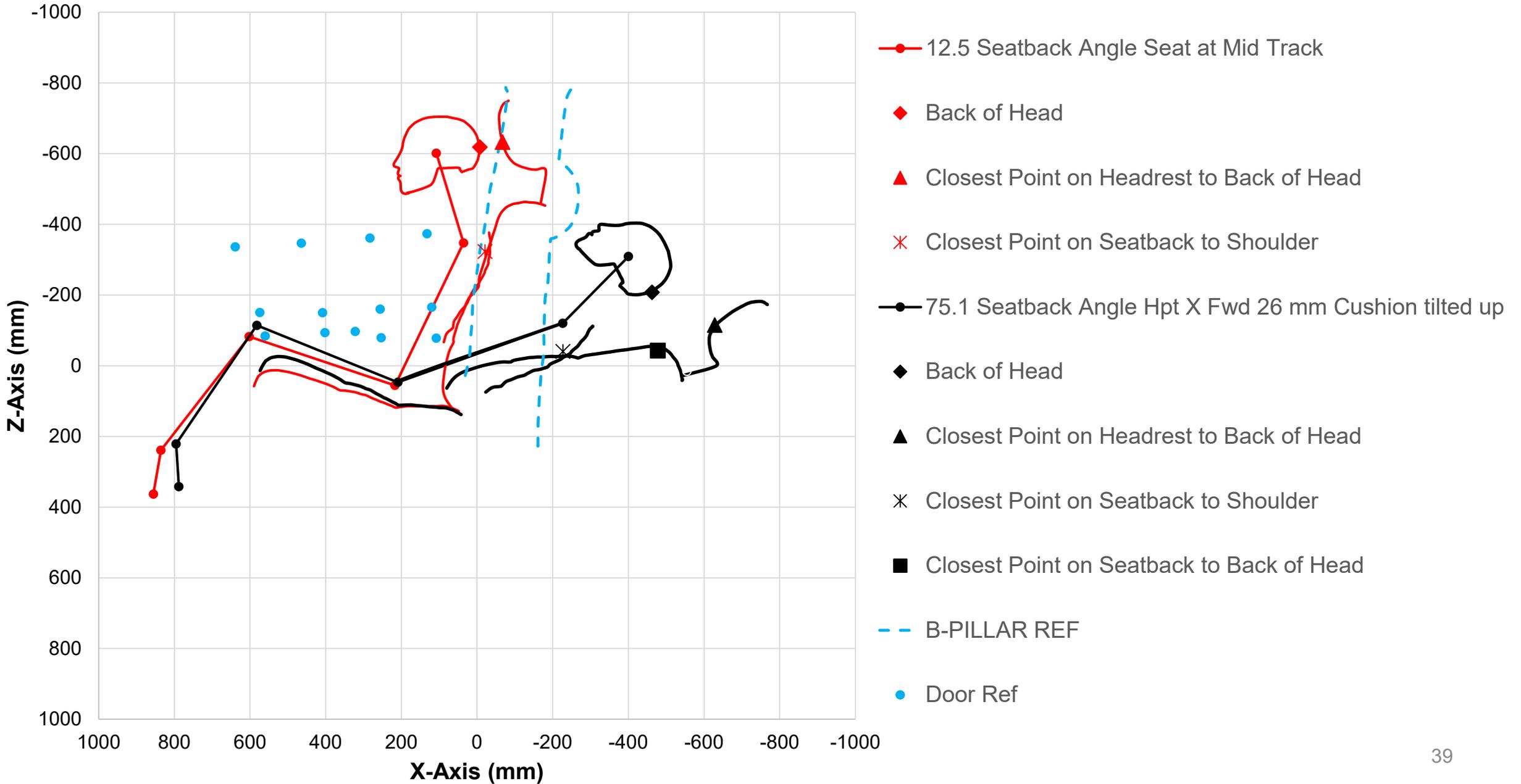


Reclined Seating H-III 50th Male

Head, Shoulder, H-point, Knee, Ankle, Heel Locations



Reclined Seating H-III 50th Male

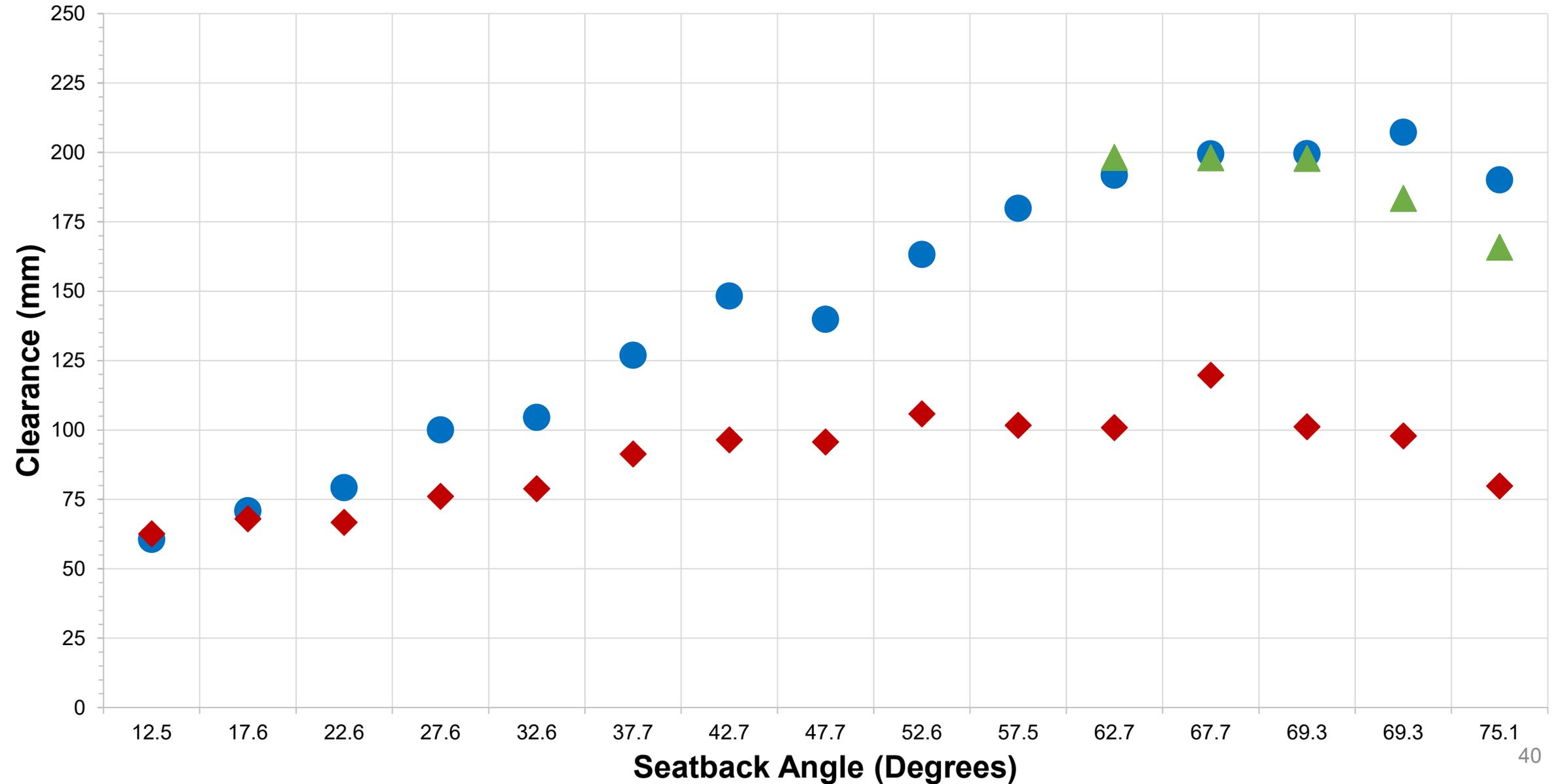


H-III 50th Male - Clearances

● Back of Head to Headrest

◆ Shoulder to Seatback

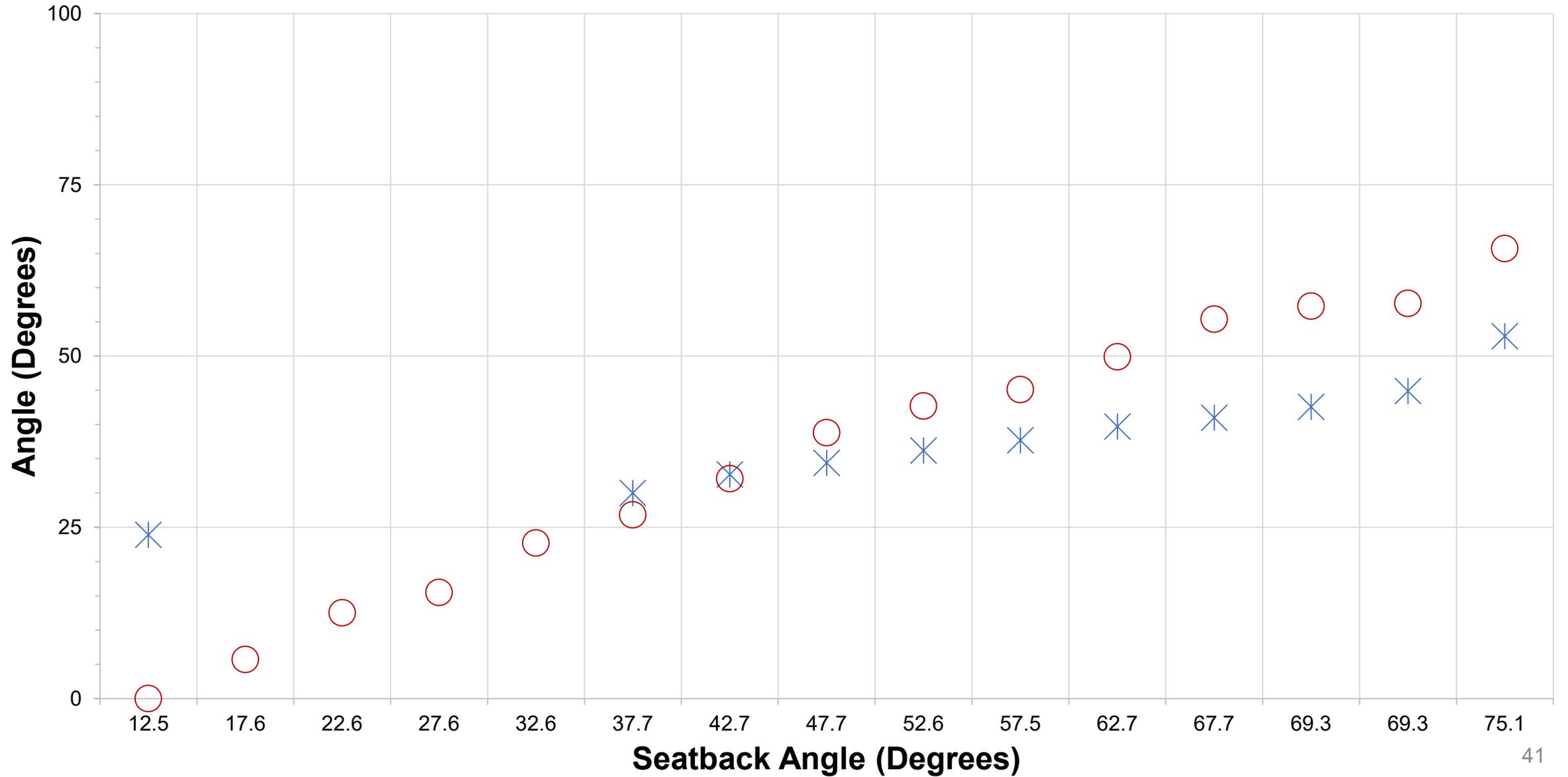
▲ Back of Head to Seatback



HIII - 50th Male - Angles

× Pelvic Angle

○ Head Angle



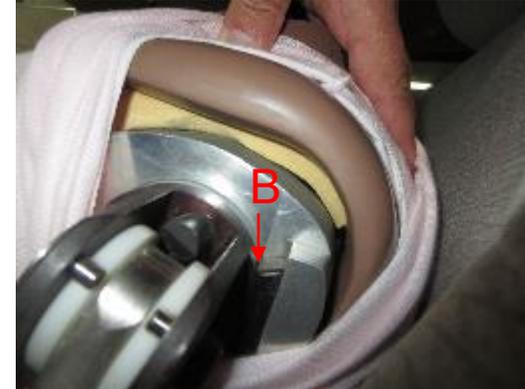
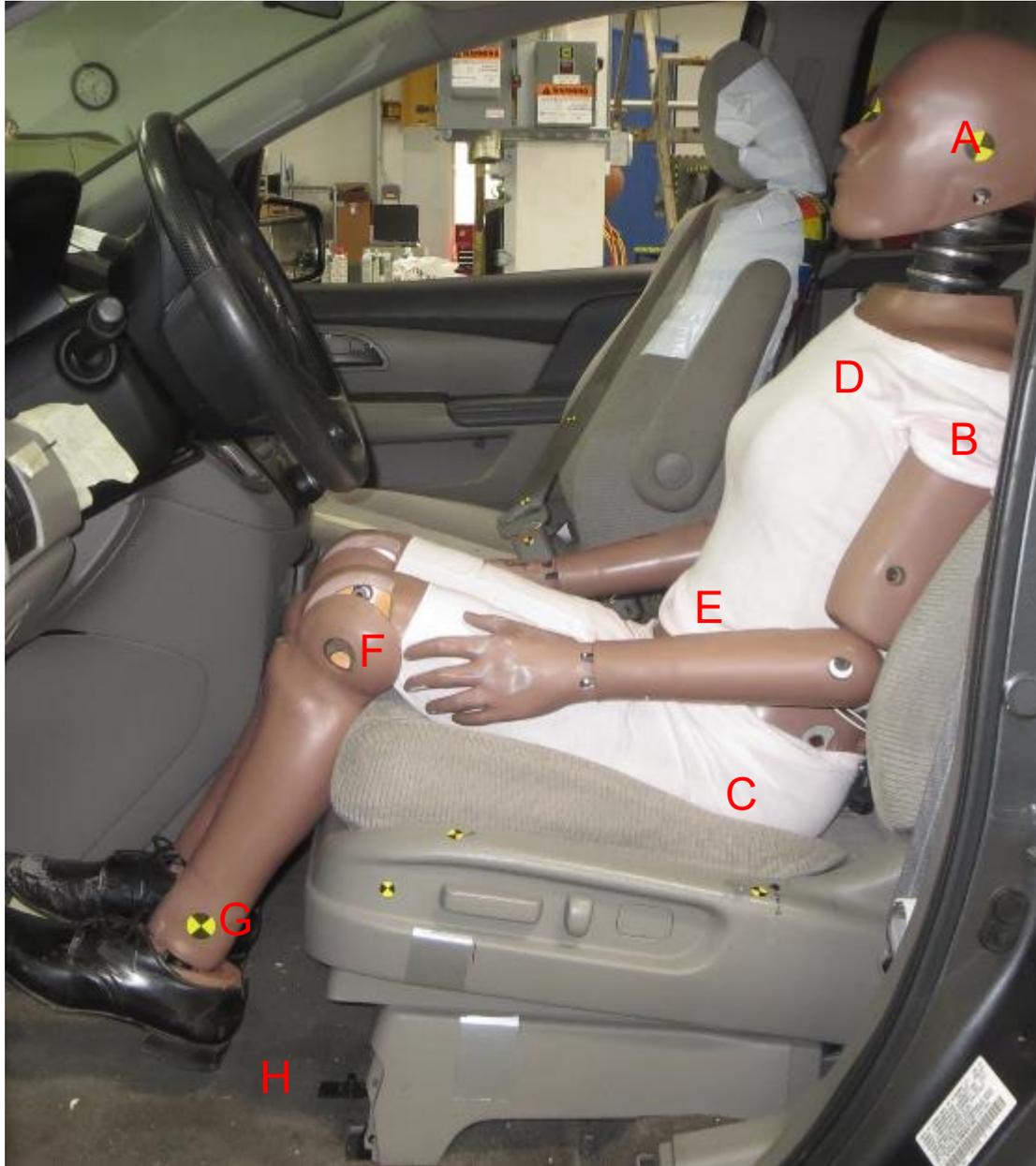
H-III 5th Percentile Female

H-III 5th Female - Target Locations

List of targets

- A Head
- B Shoulder
- C H-point
- D Chest
- E Abdomen
- F Knee
- G Ankle
- H Heel point

Head, Pelvic angles



208 and Most Reclined Overall Views



H-III 5th Female - 208 Seating

- Seat full forward, seat pan mid height, mid angle, seat back at 15.3° to get head level
- Pelvic angle = 20.6°, D-ring at full down



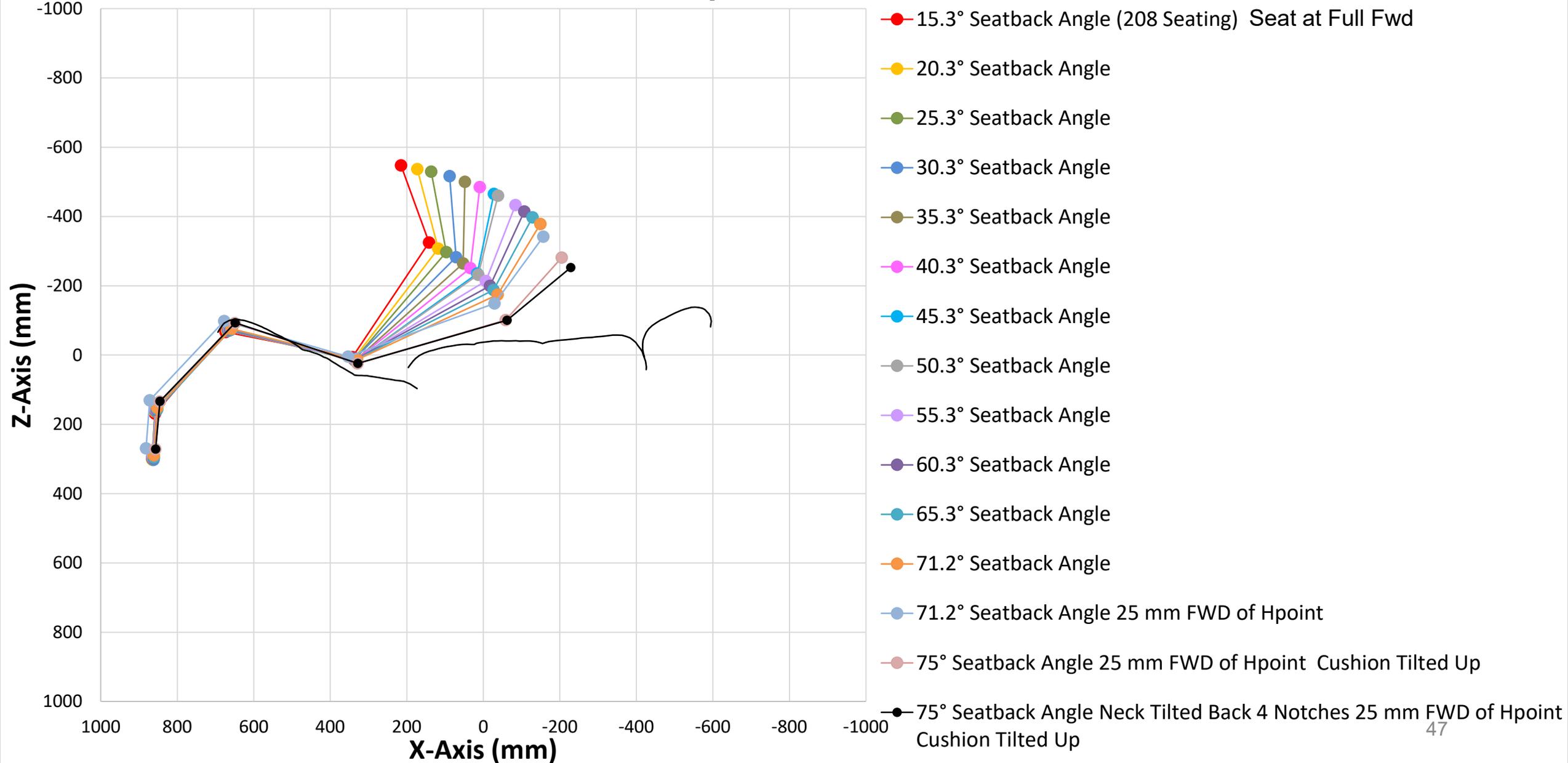
H-III 5th Female – Most Reclined

- seat back 75 deg
- pelvis 25 mm forward
- cushion tilted up
- head tilted back 4 notches

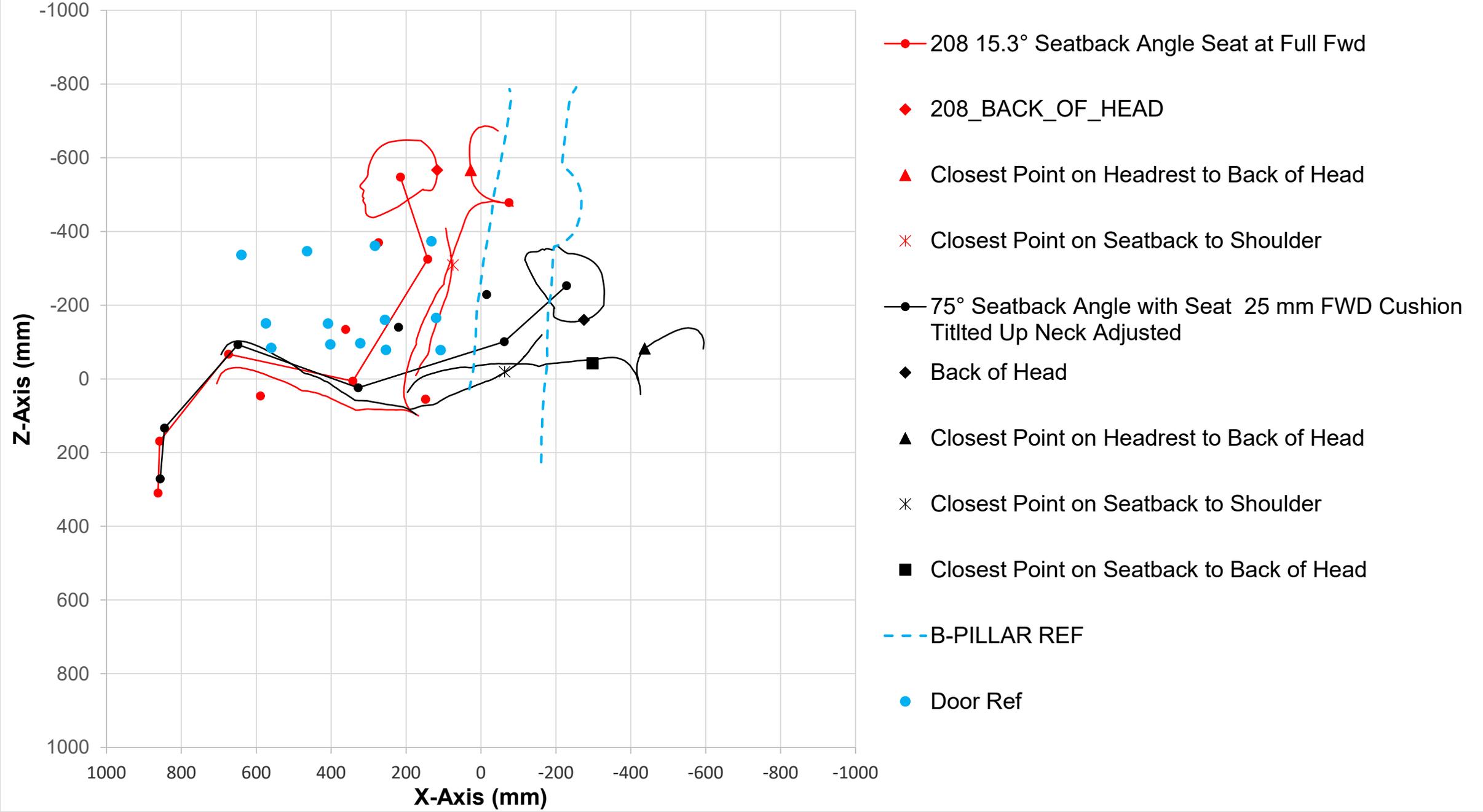


Reclined Seating H-III 5th Female

Head, Shoulder, H-point, knee, Ankle, Heel Locations

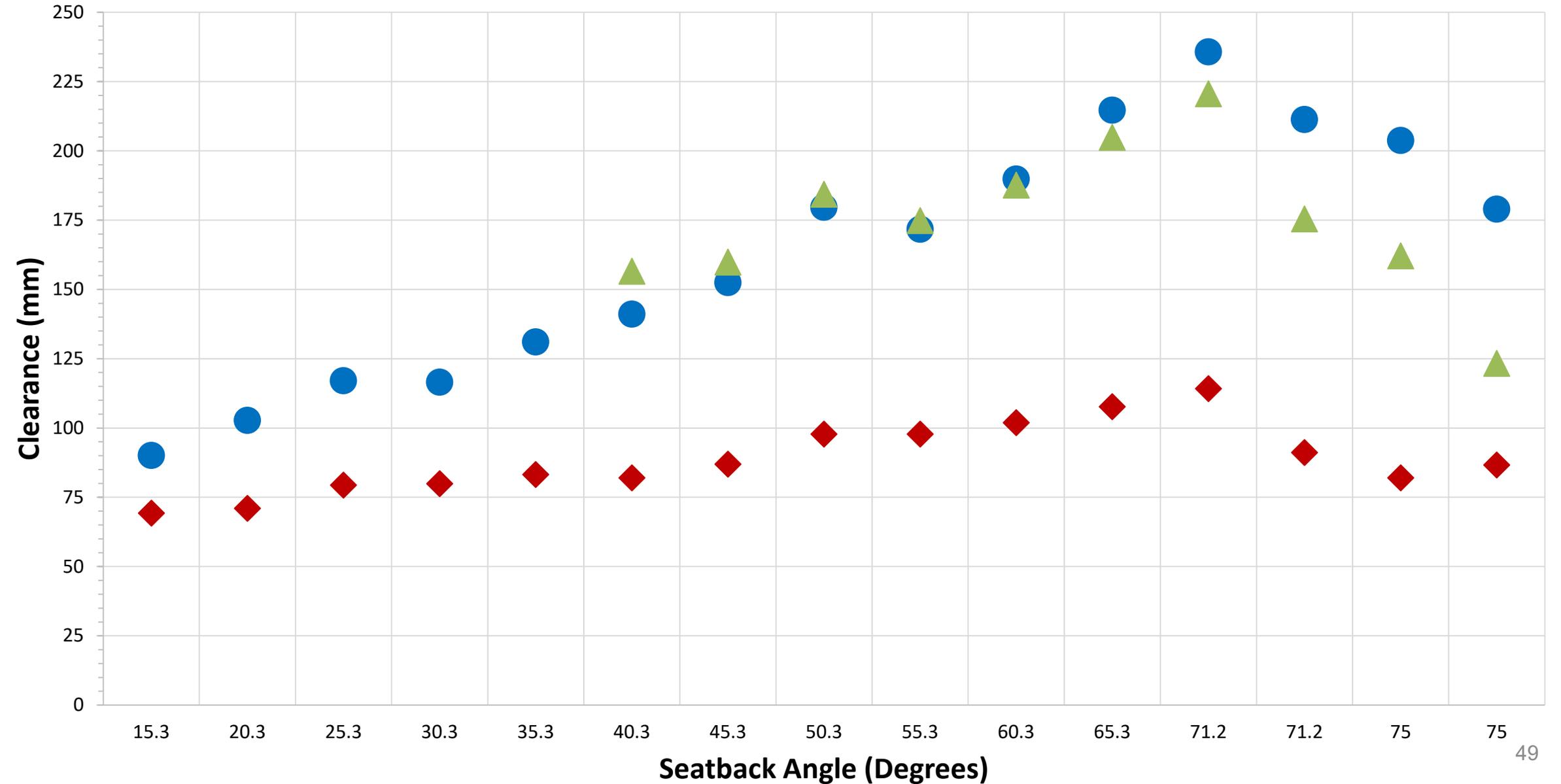


Reclined Seating H-III 5th Female



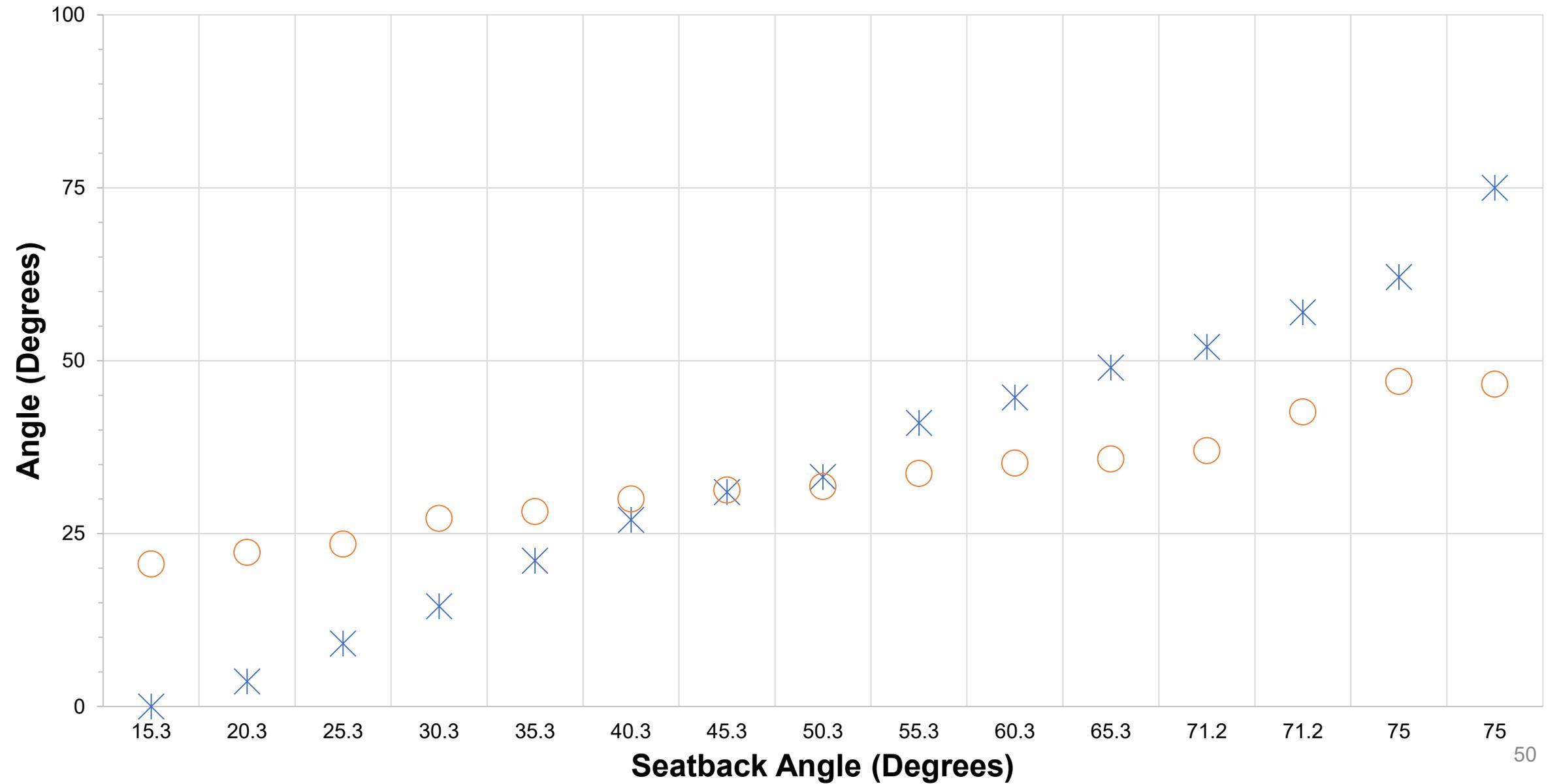
HIII - 5th Female - Clearances

● Back of Head to Headrest ◆ Shoulder to Seatback ▲ Back of Head to Seatback



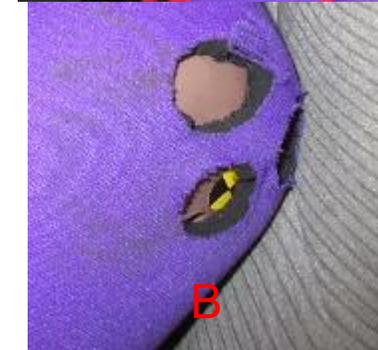
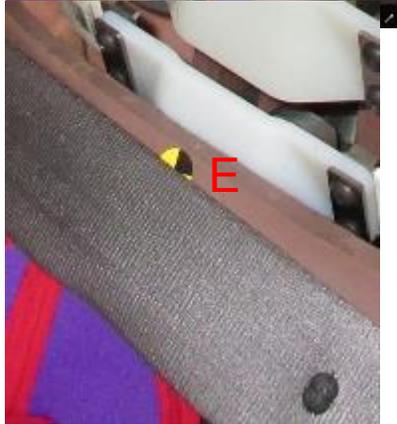
HIII - 5th Female - Angles

✱ Head ○ Pelvic



World SID 5th Percentile Female

WSID 5th - Target Locations



List of targets

- A Head
- B Shoulder
- C H-point
- D Chest (all ribs top center)
- E Abdomen
- F Knee
- G Ankle
- H Heel point
- I Elbow

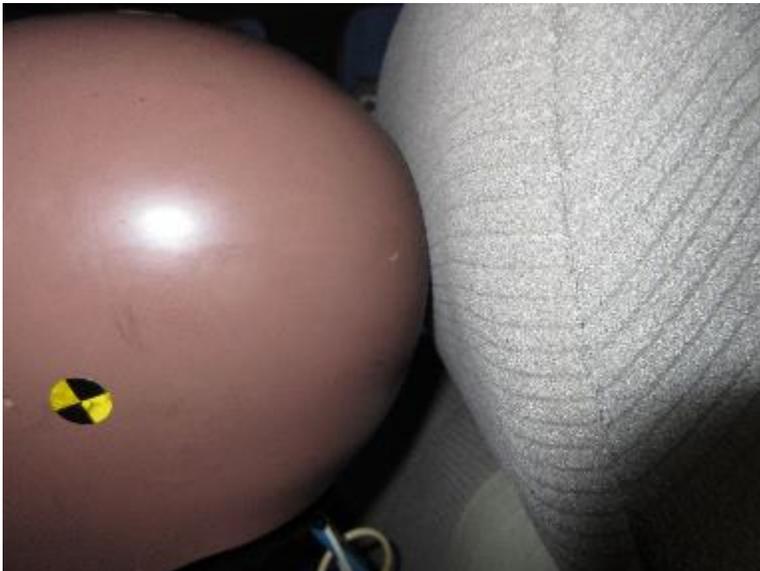
Head, Thorax, Pelvic angles from tilt sensors

Baseline and Most Reclined Overall Views



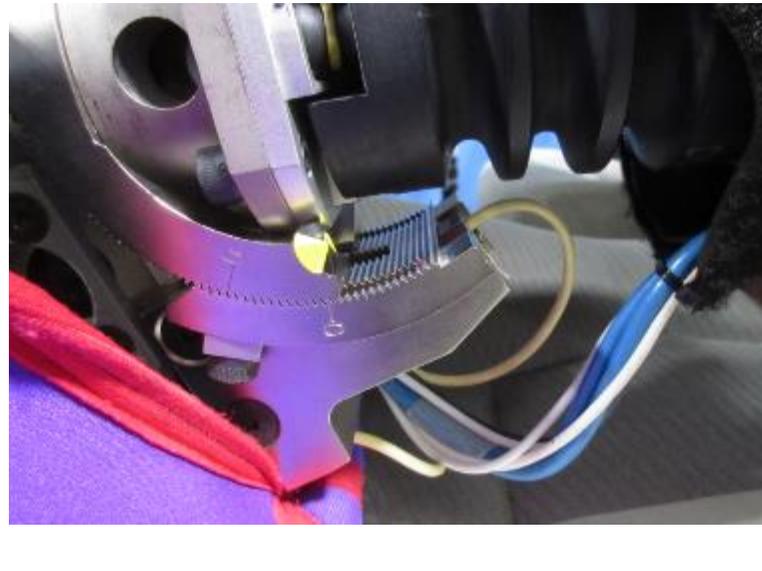
WSID 5th - Baseline Seating

- Seat full forward, seat pan mid height, mid angle, seat back at 11.4° (-6 deg rib angle)
- Pelvic angle = 20.7 °

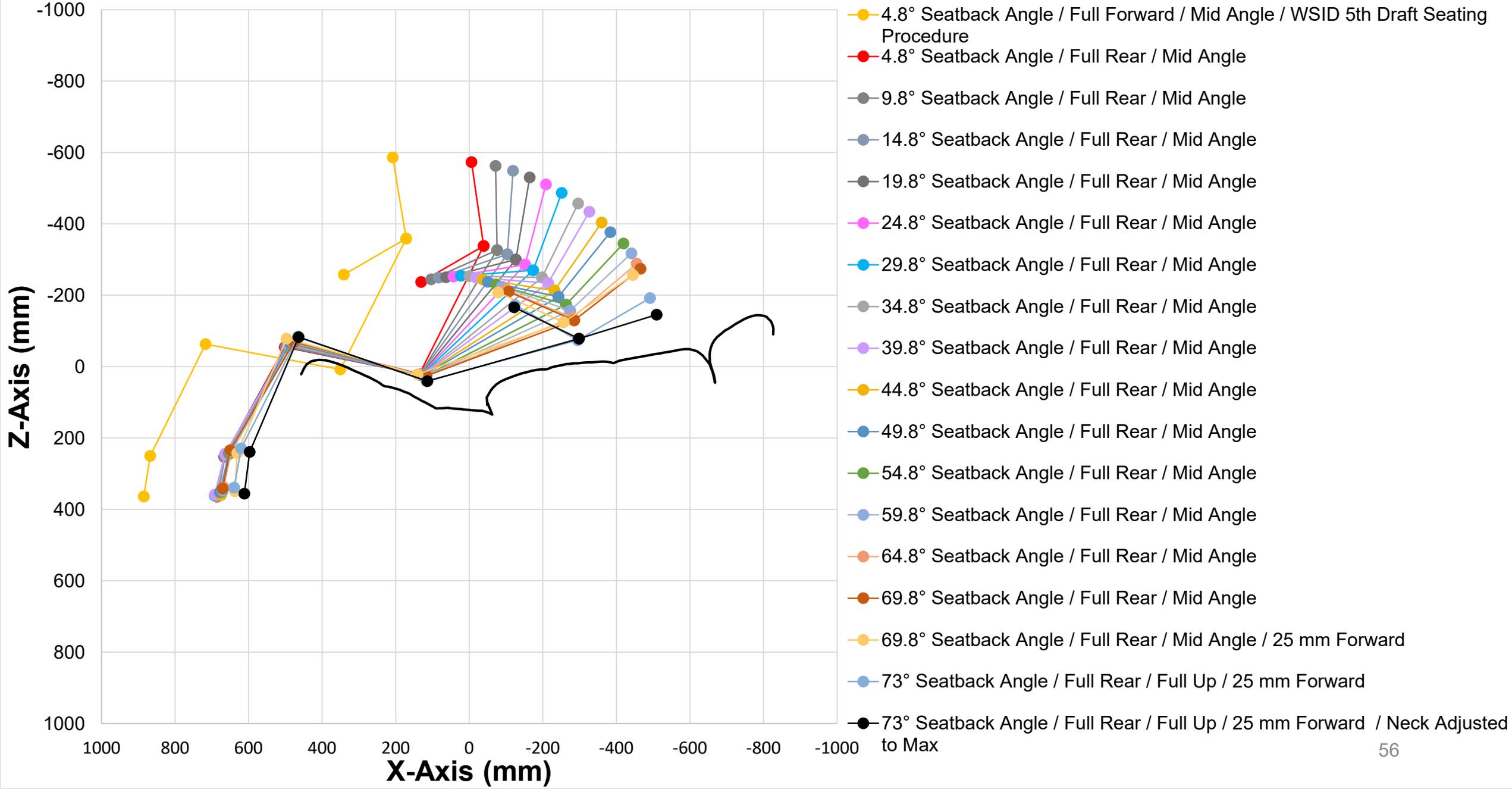


WSID 5th – Most Reclined

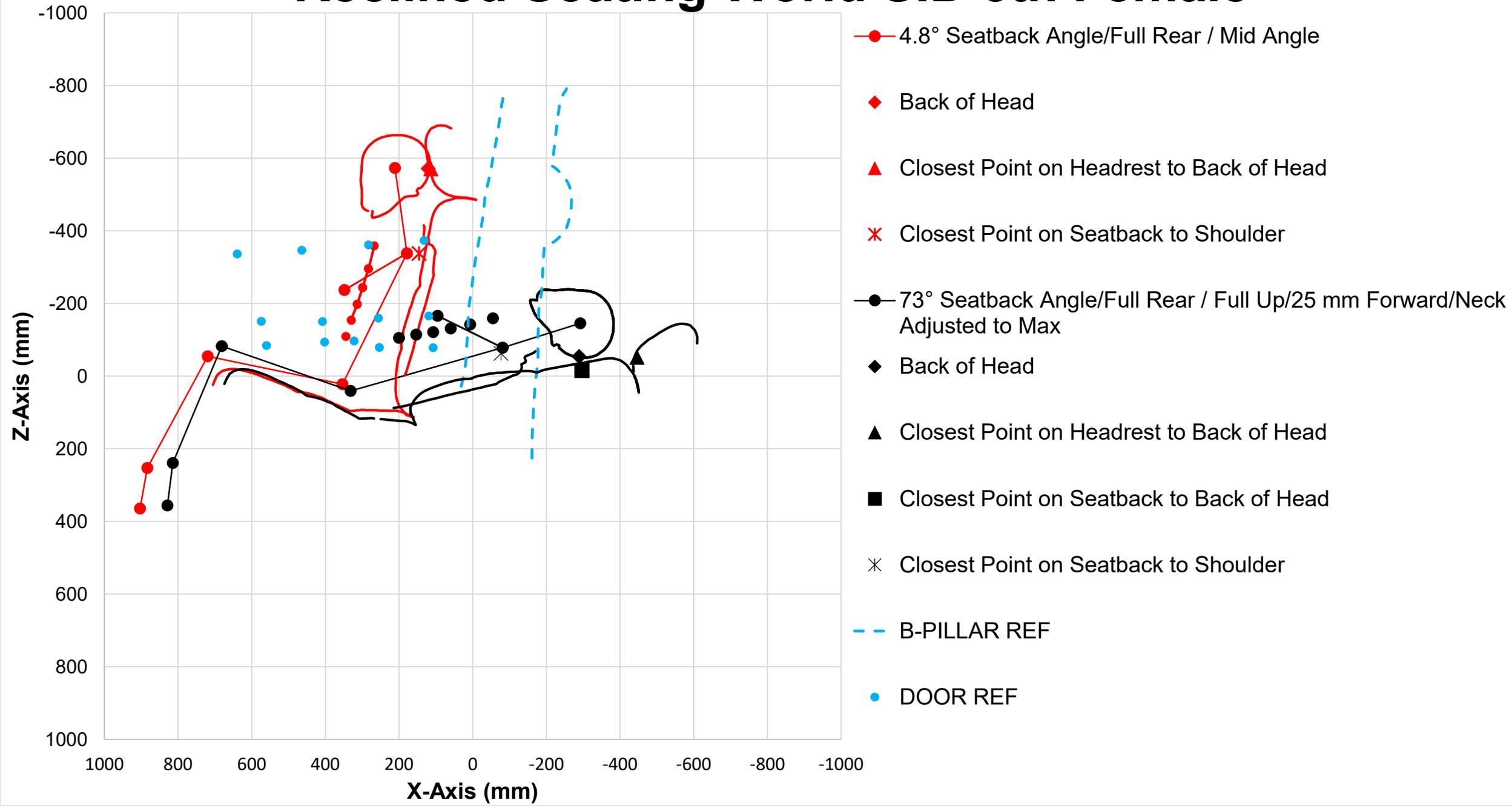
- Seat back 75 °, Pelvis 25 mm forward, Full rear with cushion tilted up, Neck adjusted to max



Reclined Seating World SID 5th Female

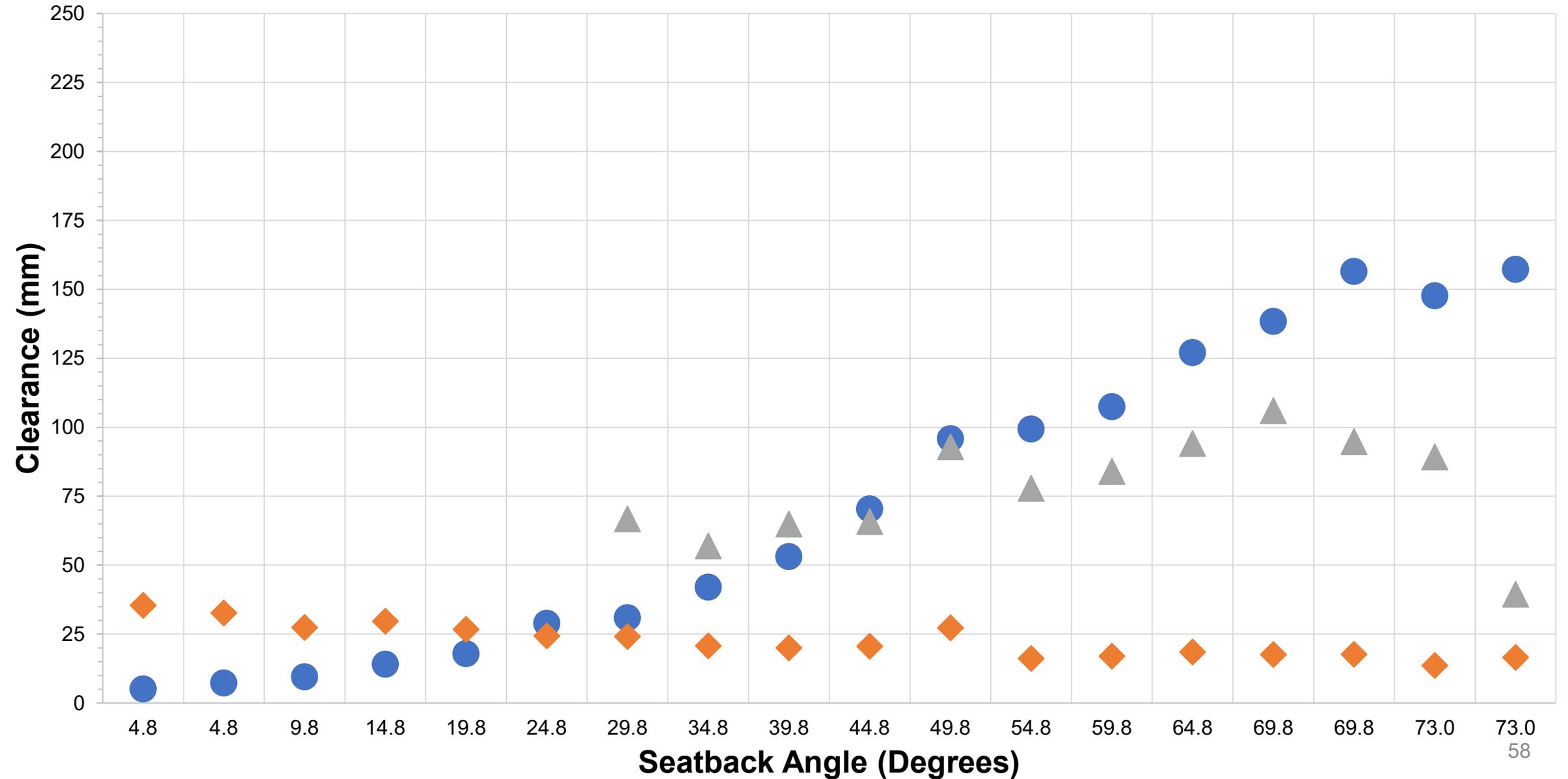


Reclined Seating World SID 5th Female



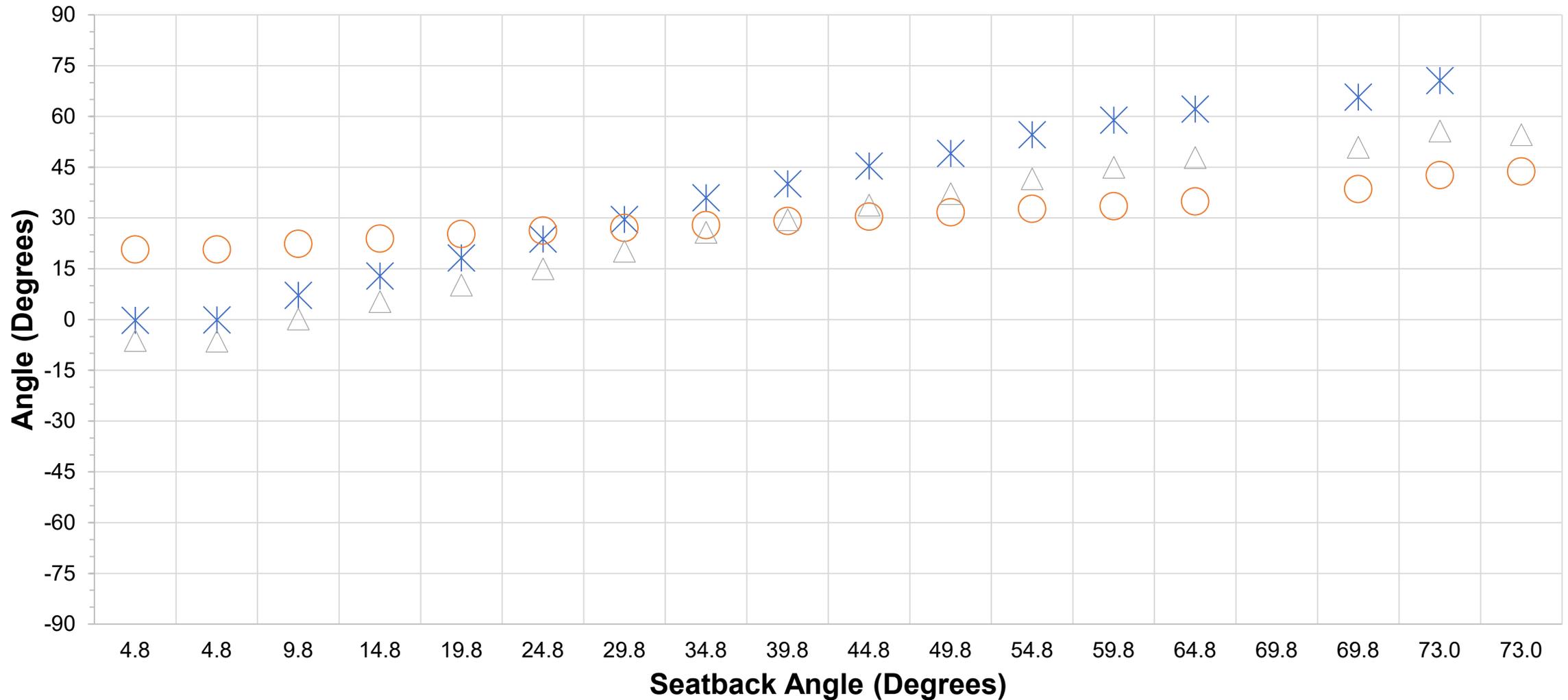
WSID - 5th Female - Clearances

● Back of Head to Headrest ◆ Shoulder to Seatback ▲ Back of Head to Seatback



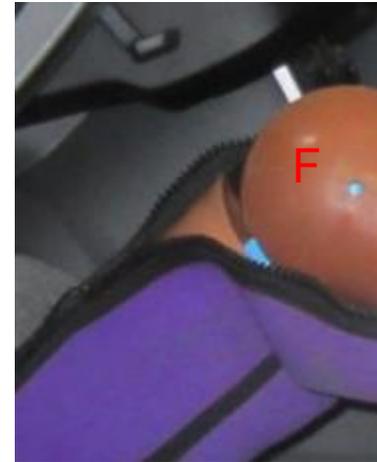
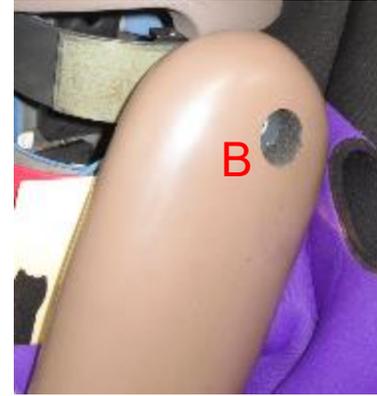
WSID - 5th Female - Angles

* Head ○ Pelvis △ Torso



World SID 50th Percentile Male

WSID 50th - Target Locations

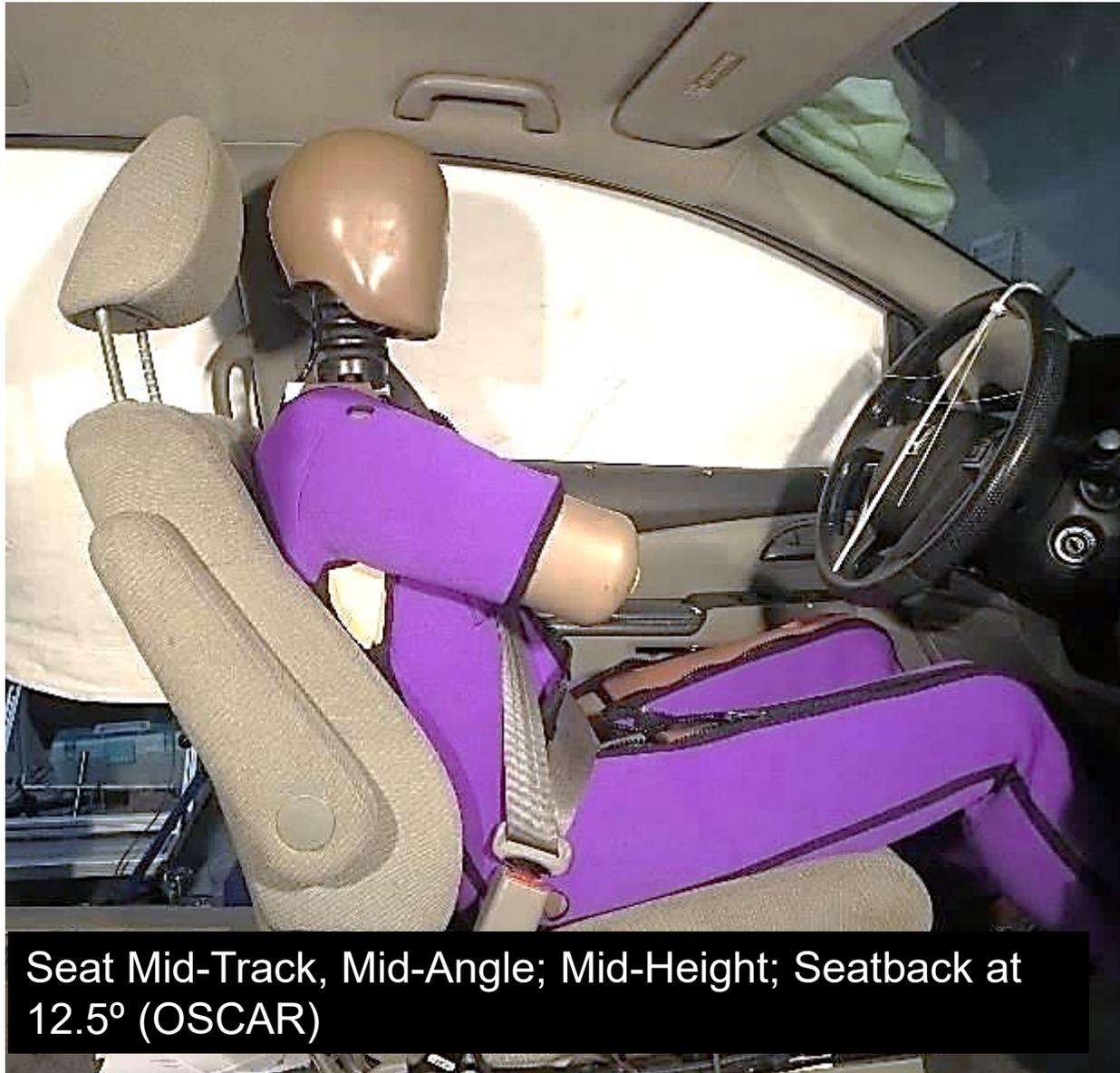


List of targets

- A Head
- B Shoulder
- C H-point
- D Chest (top bolt on each rib)
- E Abdomen
- F Knee
- G Ankle
- H Heel point
- I Elbow

Head, Thorax,
Pelvic angles
from tilt sensors

Baseline and Most Reclined Overall Views



WSID 50th - Baseline Seating

- Seat mid track, seat pan lowest height, mid angle, seat back at 12.5° - Pelvic angle = X: -0.7°, Y: 0.4°

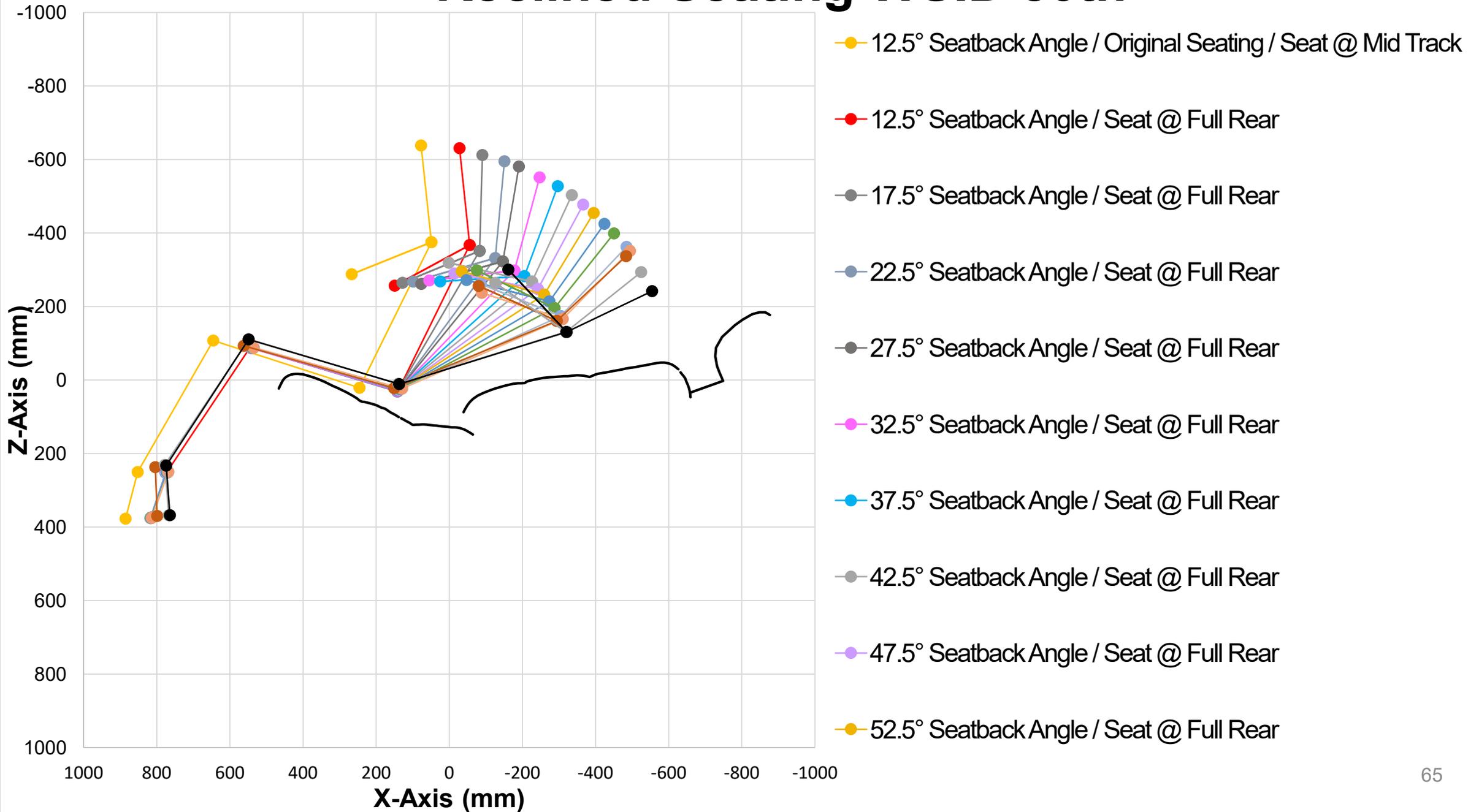


WSID 50th - Most Reclined

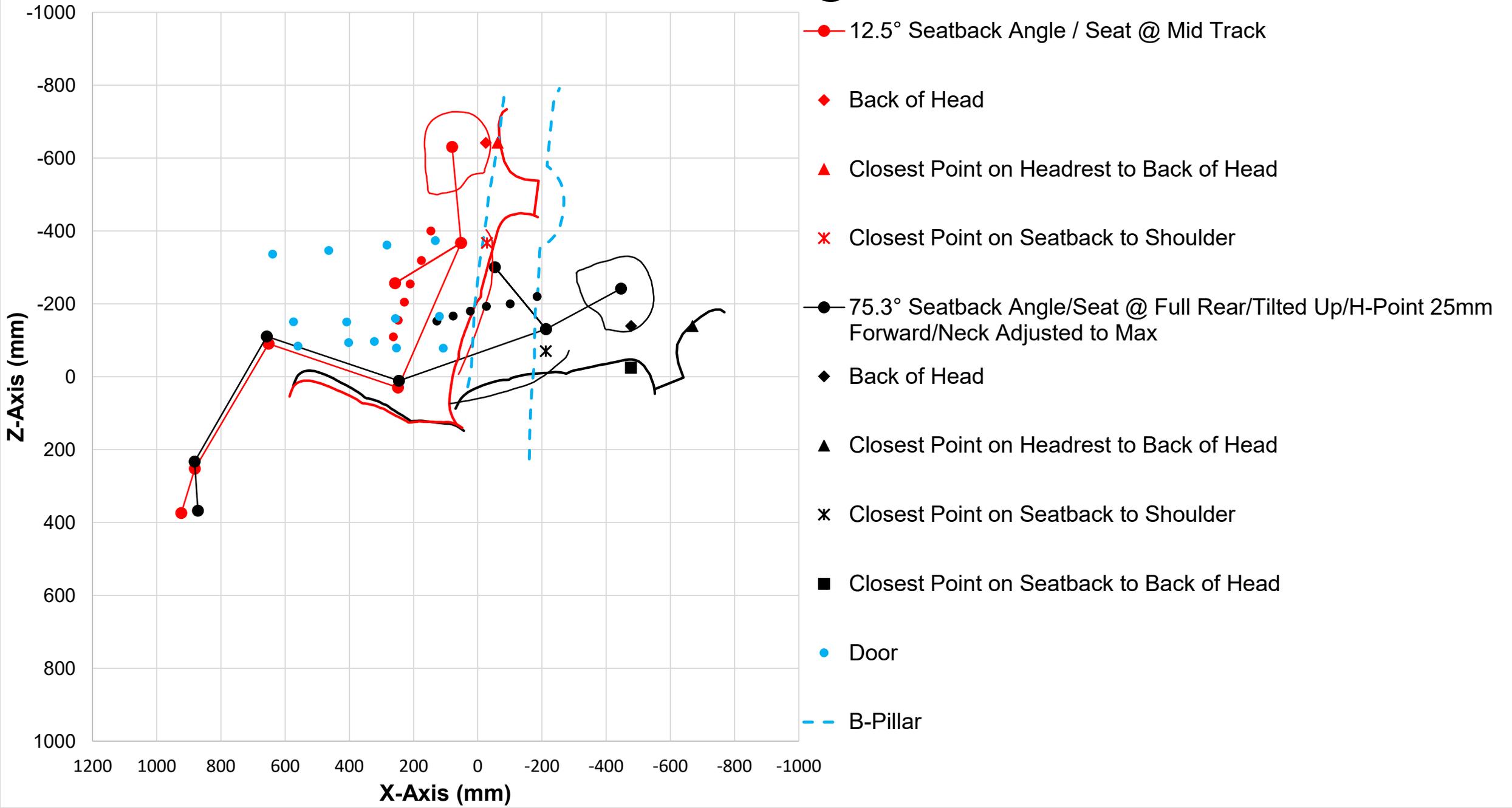
- 75.3° Seatback Angle - Seat @ Full Rear - Tilted Up - H-Point 25mm Forward - Neck Adjusted to Max



Reclined Seating WSID 50th

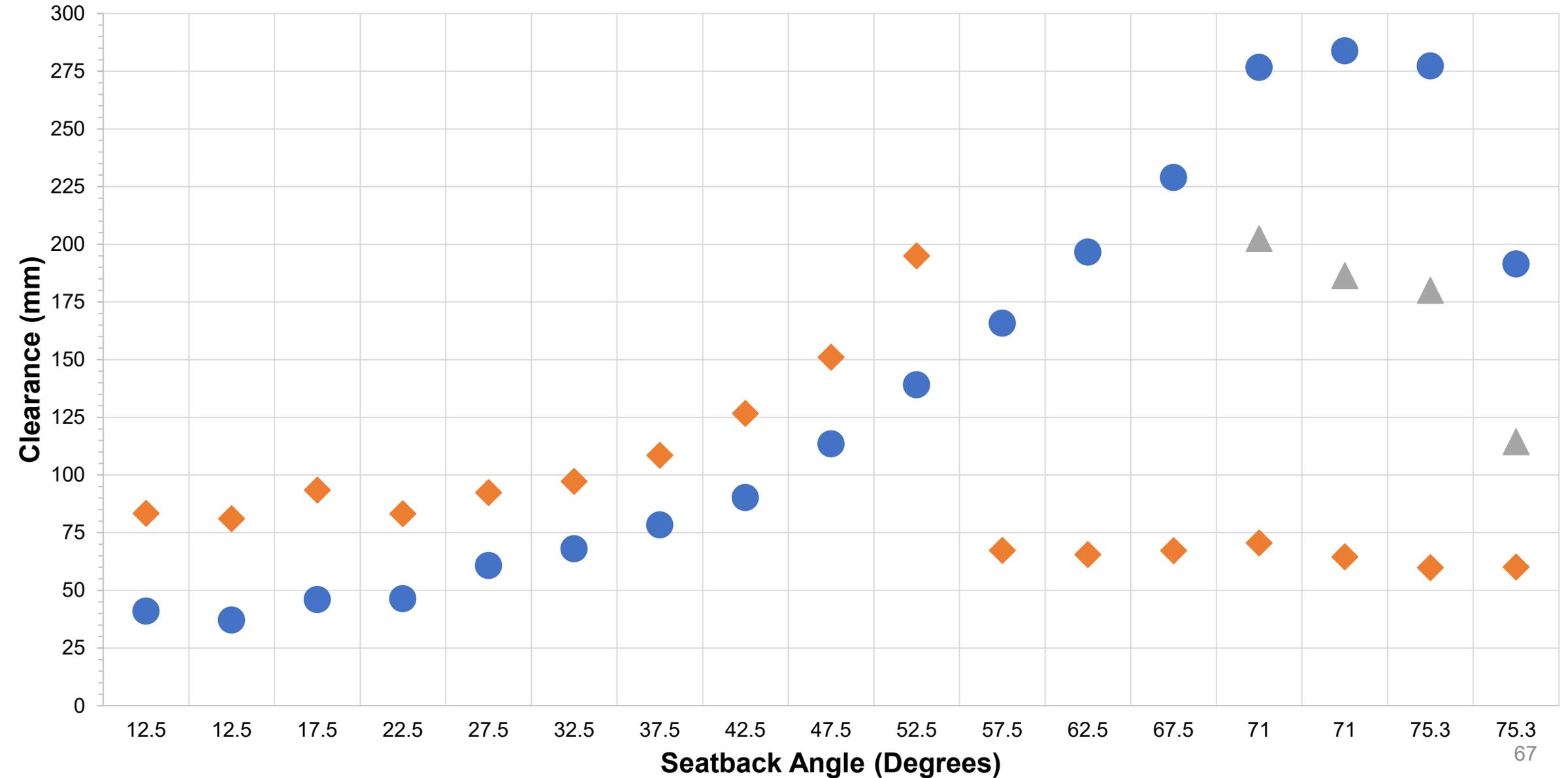


Reclined Seating WSID 50th



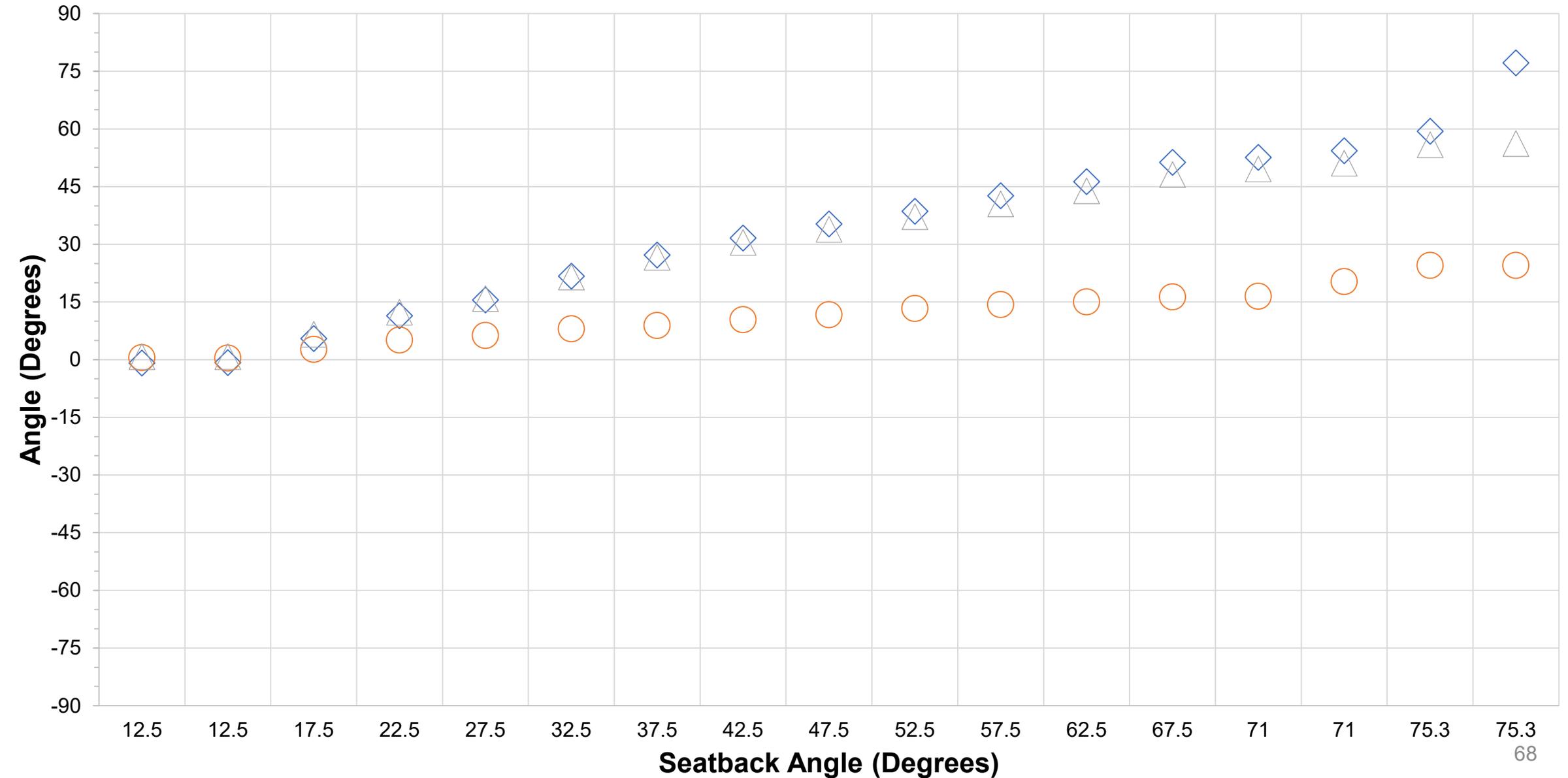
WSID - 50th Male - Clearances

● Back of Head to Headrest ◆ Shoulder to Seatback ▲ Back of Head to Seatback



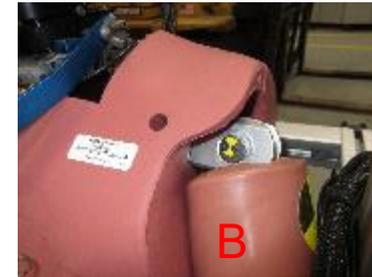
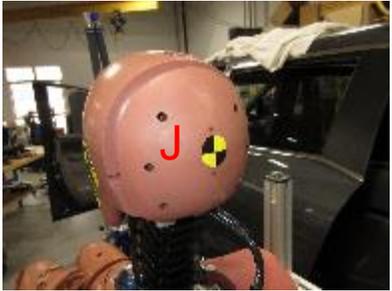
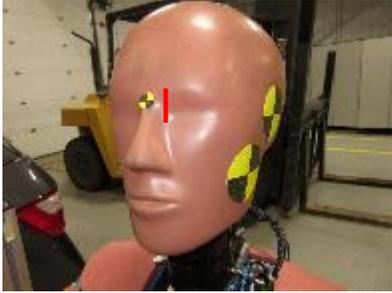
WSID - 50th Male - Angles

◇ Head ○ Pelvis △ Thorax



BIORID 50th Percentile Male

BIORID 50th - Target Locations

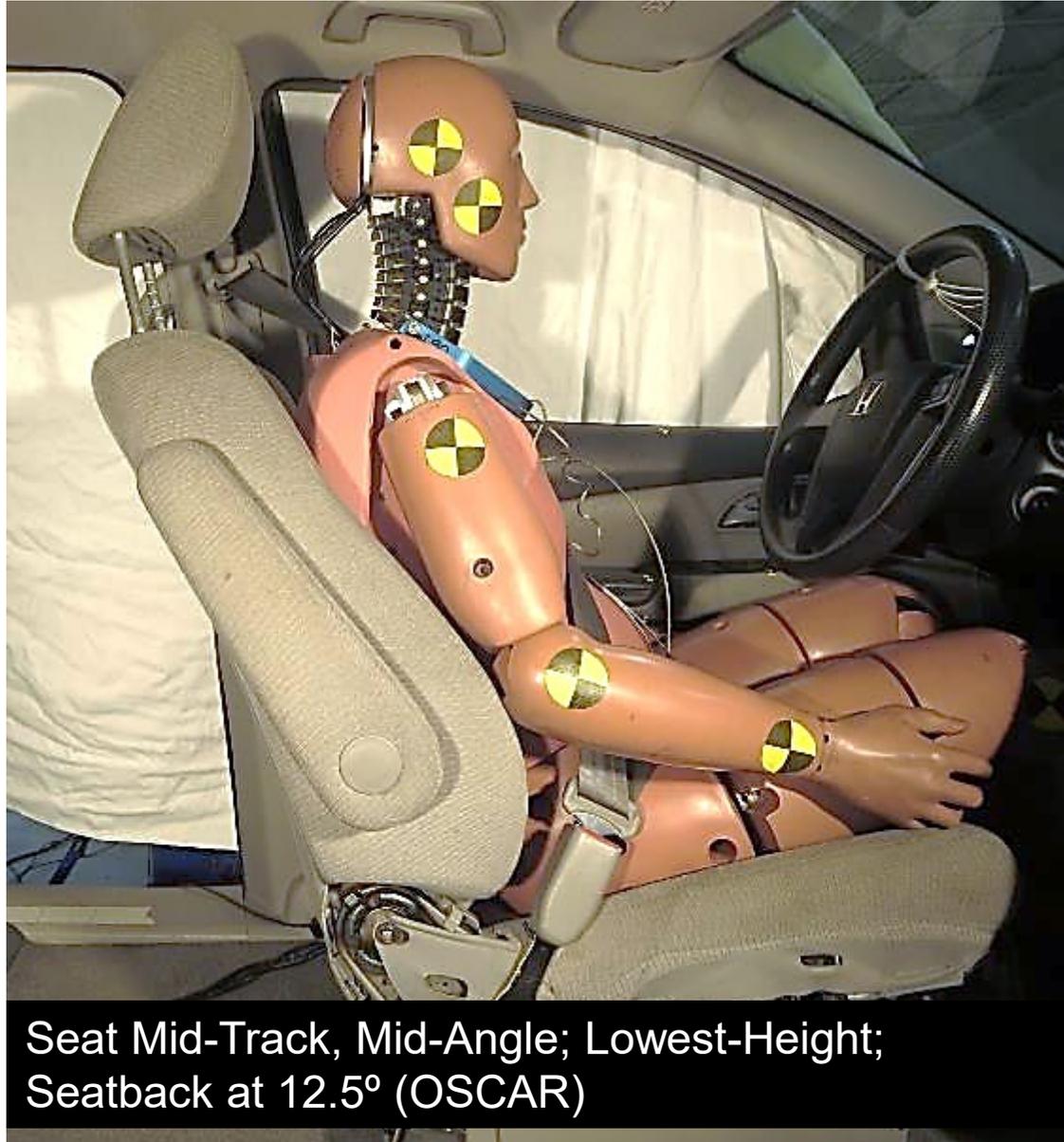


List of targets

- A Head
- B Shoulder
- C H-point
- D Chest Point 1
- E Chest Point 2
- F Knee
- G Ankle
- H Heel point
- I Bridge of nose
- J Back of head

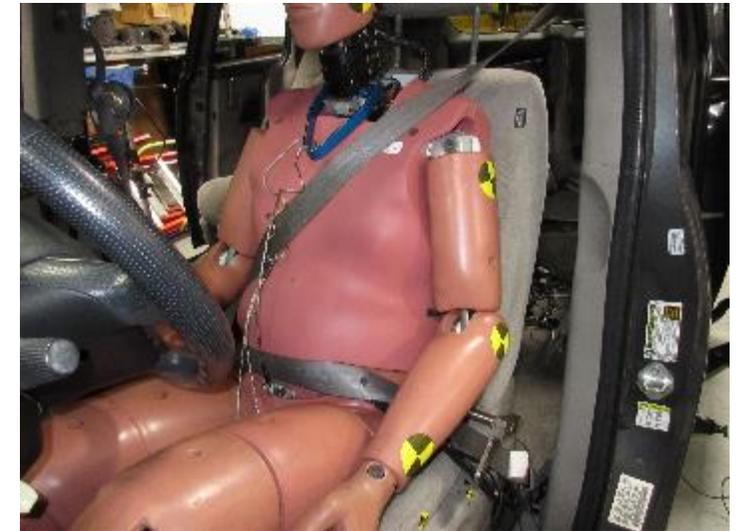
Head, T1, T12, Pelvic
angles from tilt sensors

Baseline and Most Reclined Overall Views



BIORID 50th - Baseline Seating

- Seat mid track, seat pan lowest height, low angle, seat back at 12.5°
Pelvic angle = X: -0.1°, Y: 29.5°



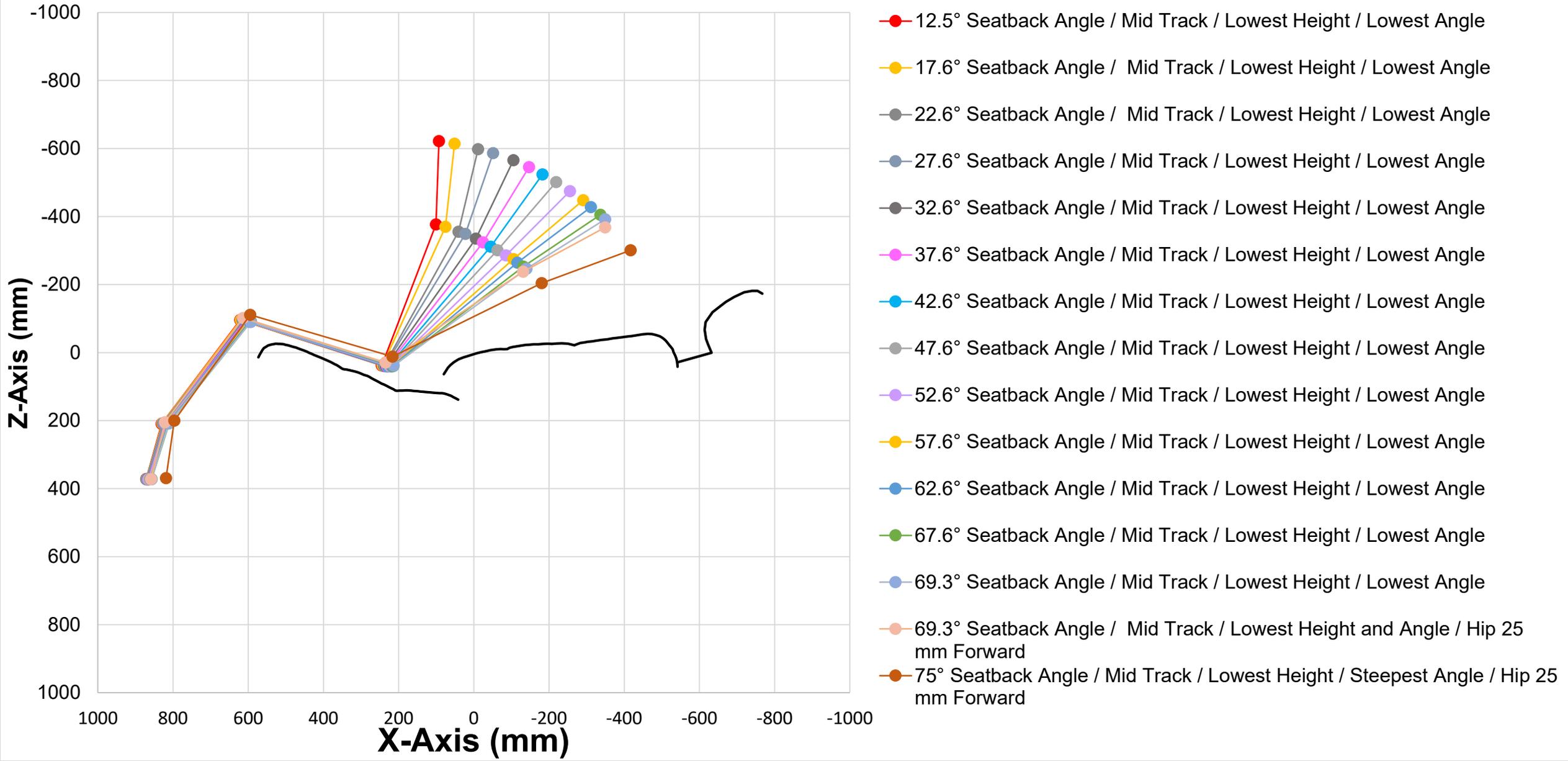
BIORID 50th - Most Reclined

- Seat mid track, cushion low height, high angle, seat back at 75°- Pelvic angle = X: 1.4°, Y: 58.2°

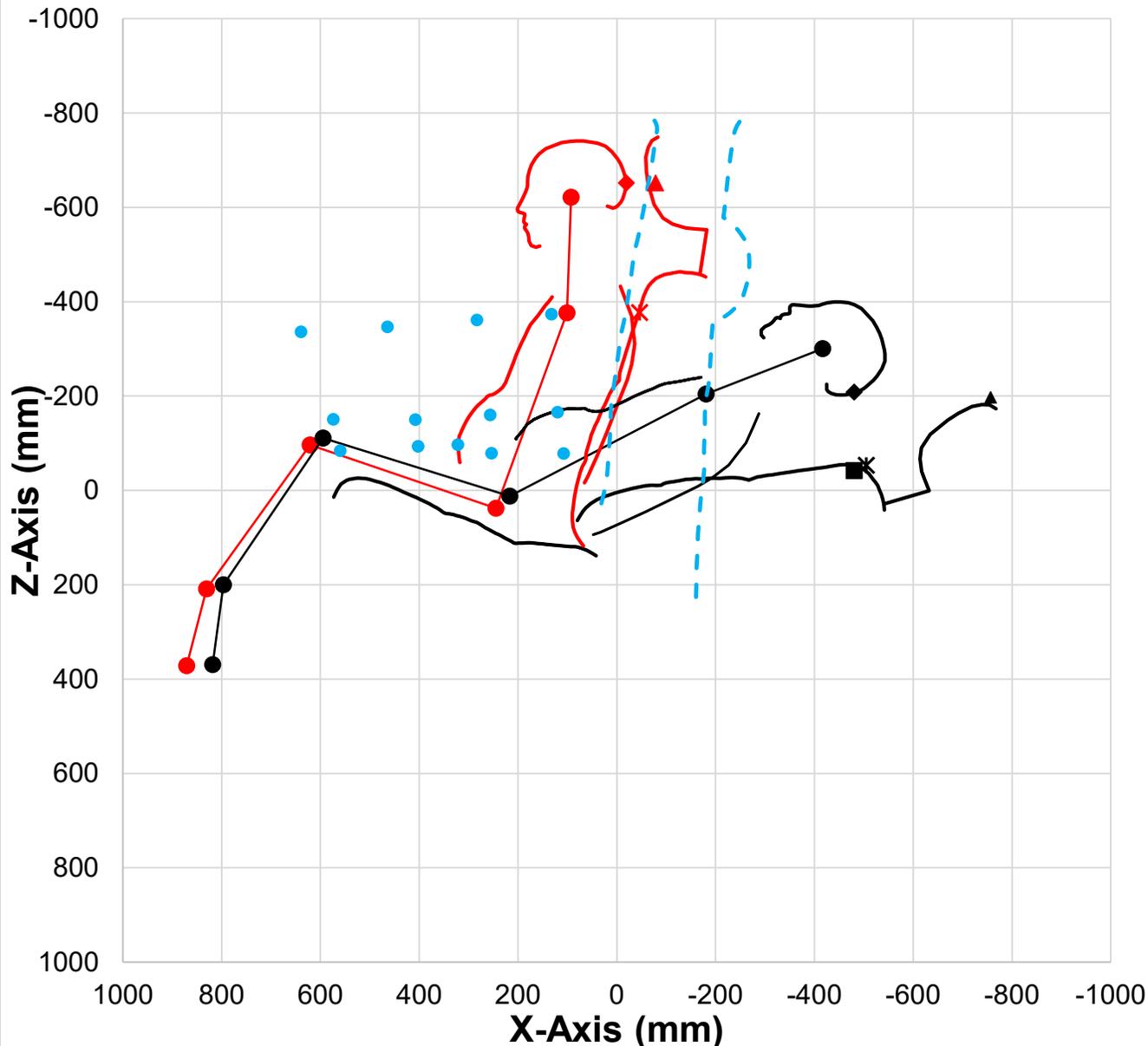


Reclined Seating BIORID 50th

Head, Shoulder, H-point, knee, Ankle, Heel Locations



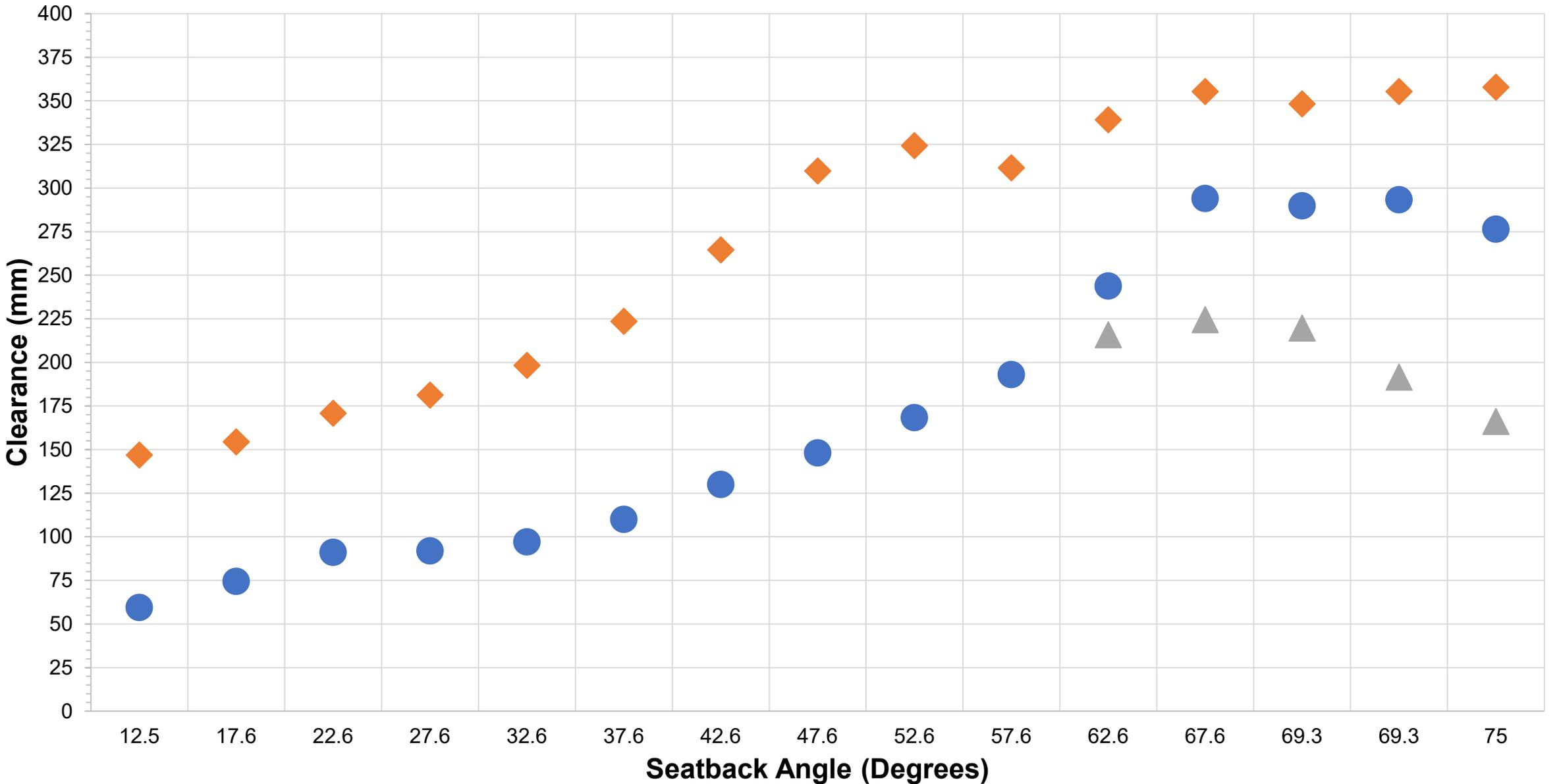
Reclined Seating BIORID 50th



- 12.5° Seatback Angle / Mid Track / Lowest Height / Lowest Angle
- ◆ Back of Head
- ▲ Closest Point on Headrest to Back of Head
- ✕ Closest Point on Seatback to Shoulder
- 75° Seatback Angle / Mid Track / Lowest Height / Steepest Angle / Hip 25 mm Forward
- ◆ Back of Head
- ▲ Closest Point on Headrest to Back of Head
- Closest Point on Seatback to Head
- ✕ Closest Point on Seatback to Shoulder
- - B-PILLAR REF
- Door Ref

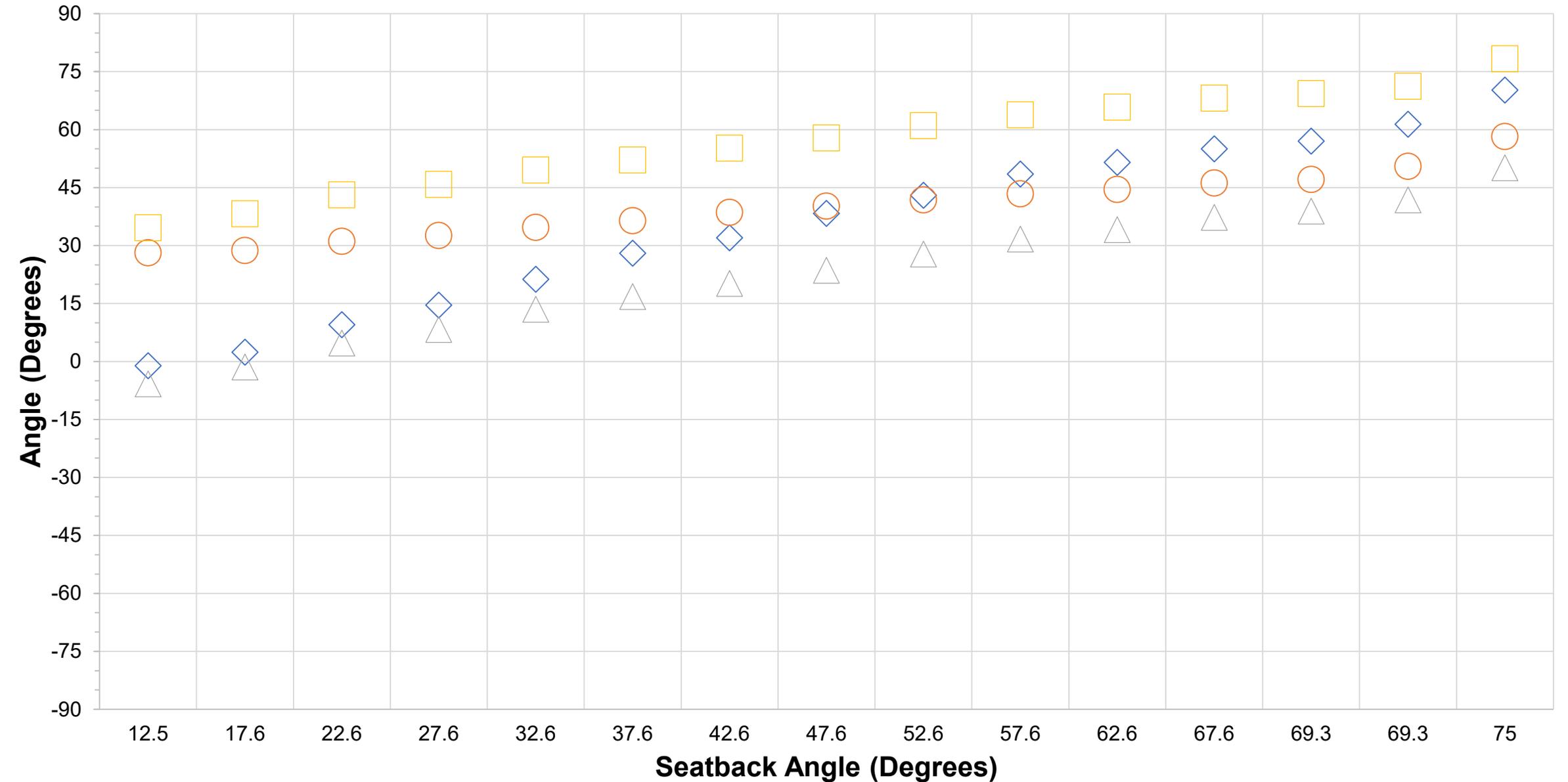
BIORID - 50th Male - Clearances

● Back of Head to Headrest ◆ Shoulder to Seatback ▲ Back of Head to Seatback



BIORID - 50th Male - Angles

◇ Head ○ Pelvis △ T1 □ T12

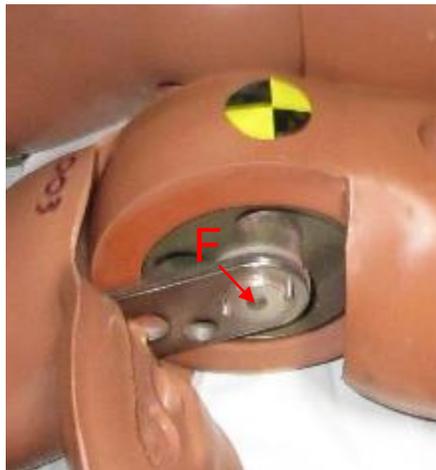
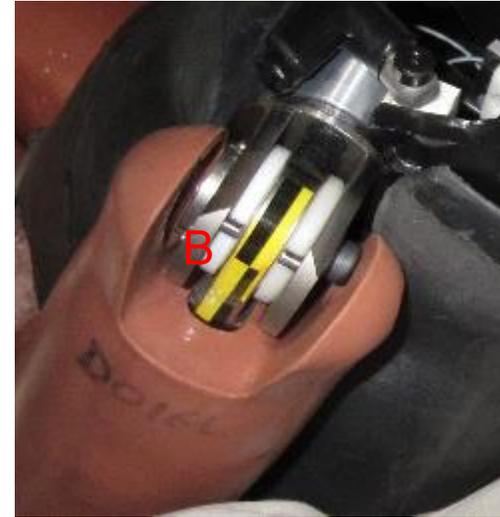
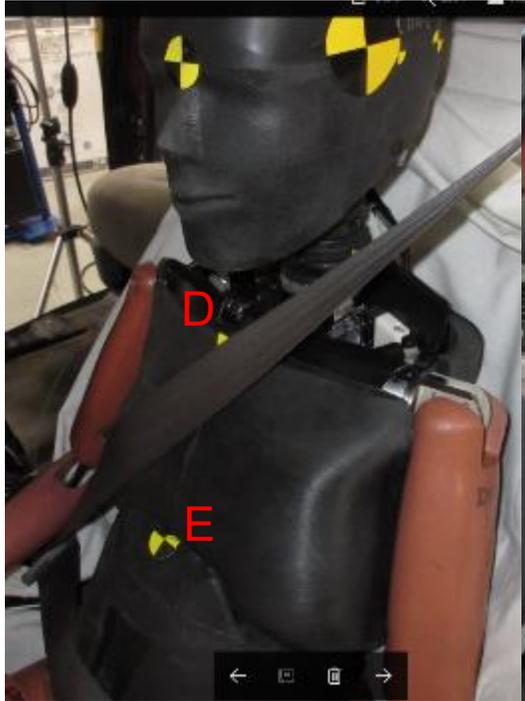


LODC 10YO

LODC 10YO- Target Locations

List of targets

- A Head
- B Shoulder
- C H-point
- D Chest
- E Abdomen
- F Knee
- G Ankle
- H Heel point



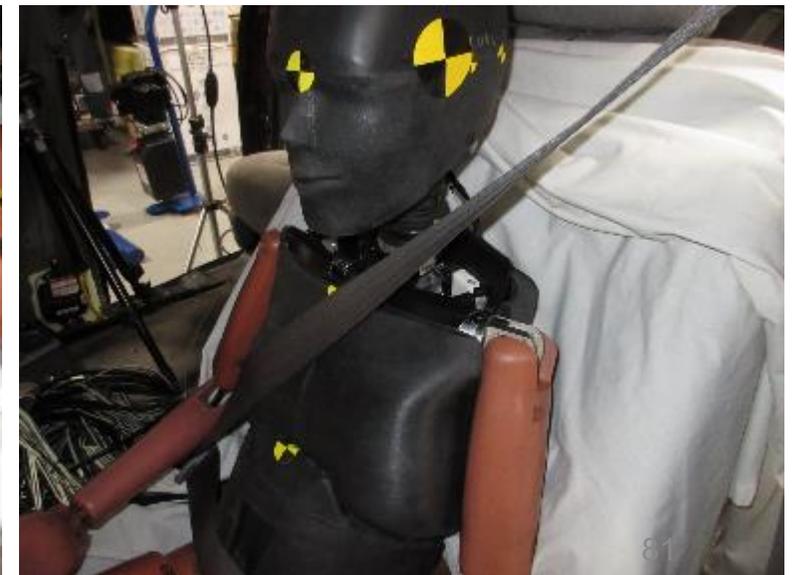
Head, Torso angles from CMM
Pelvic angles from inclinometer

Baseline and Most Reclined Overall Views



LODC 10YO - Baseline Seating

- Seat full forward, seat pan mid height, mid angle, seat back at 15.1°, Pelvic angle = 33.9°, D-ring at full down

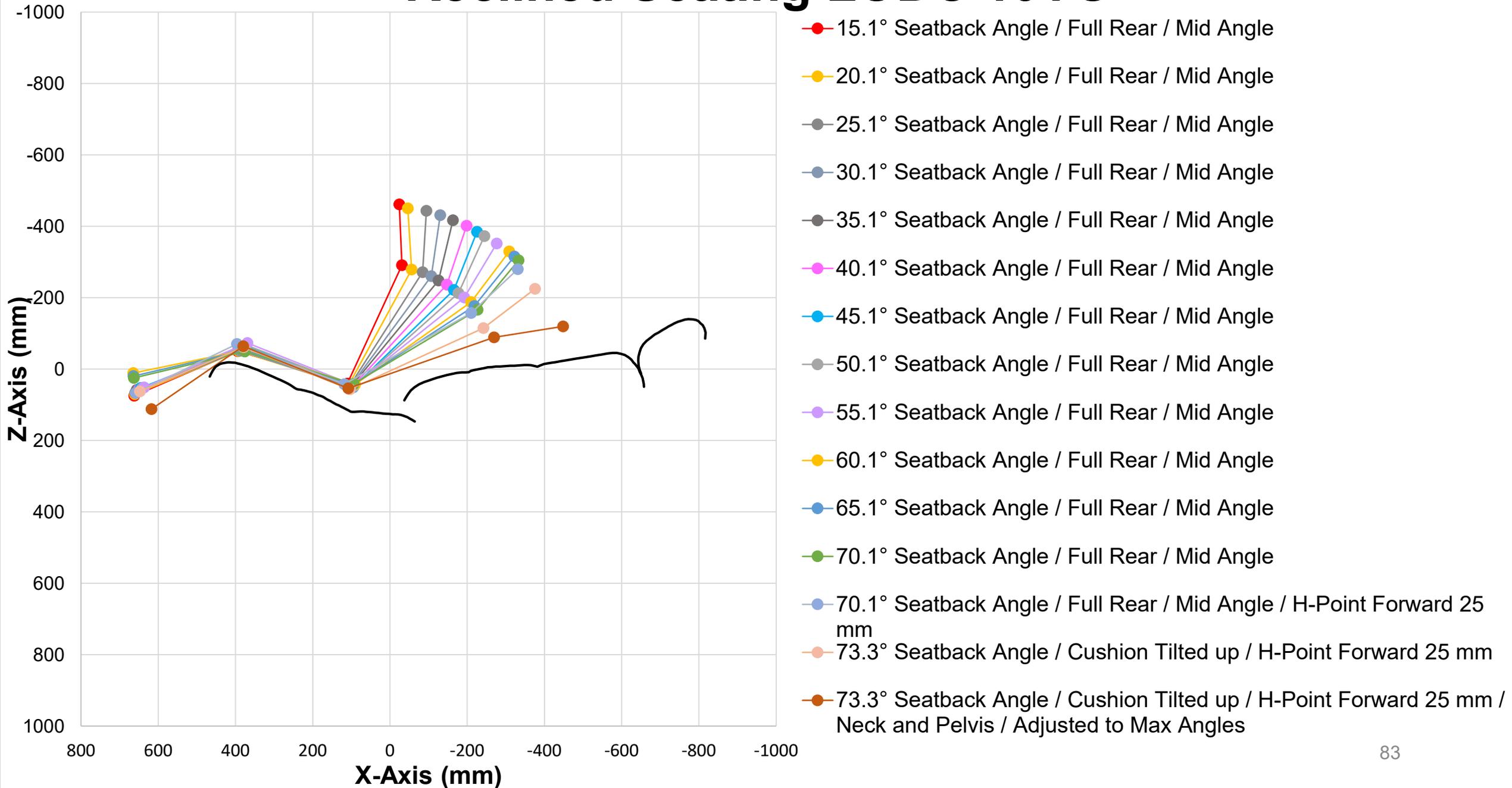


LODC 10YO – Most Reclined

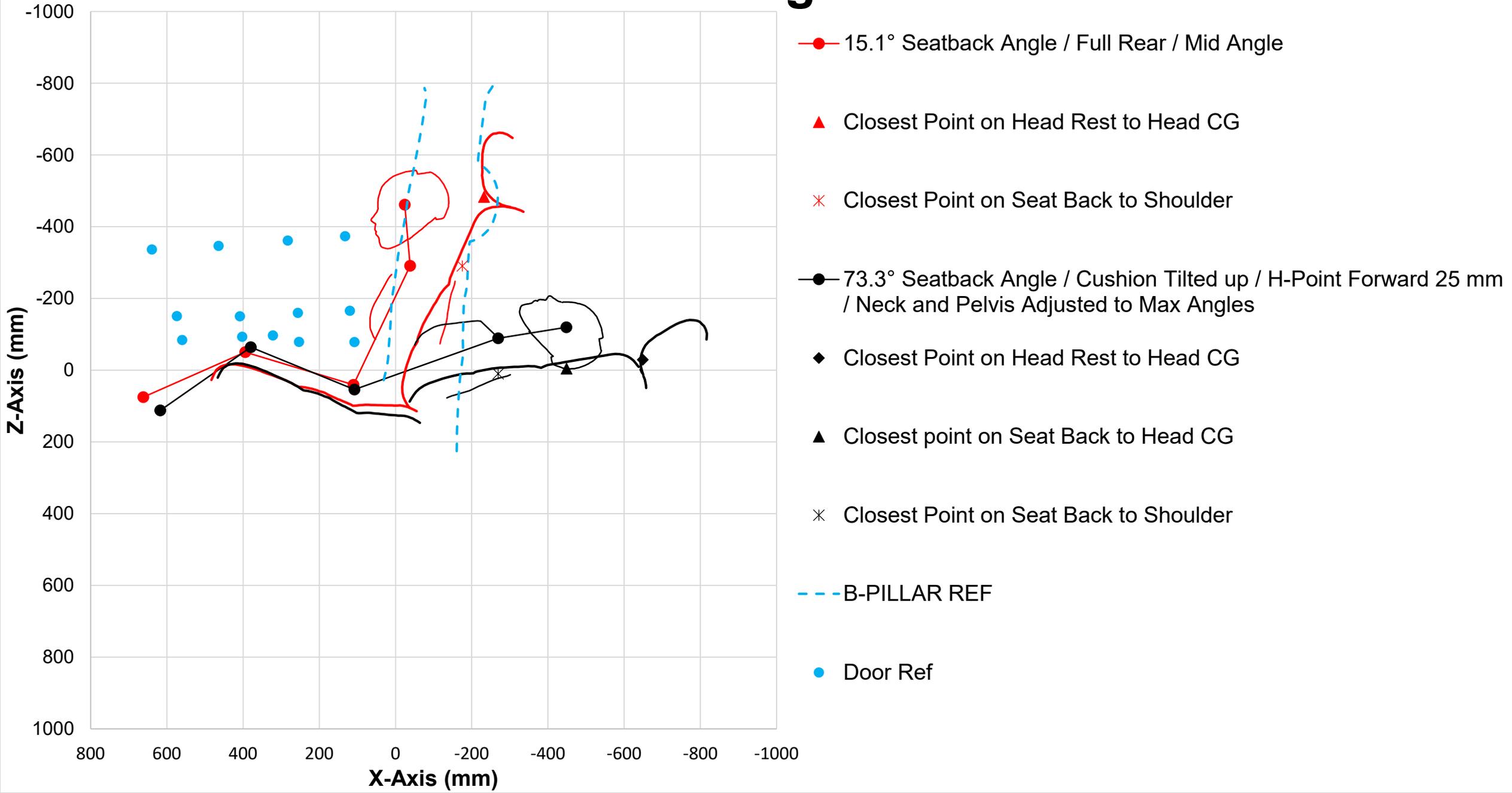
- seat back 73.3 ° - pelvis 25 mm forward - cushion tilted up - neck and pelvis set to max angles



Reclined Seating LODC 10YO

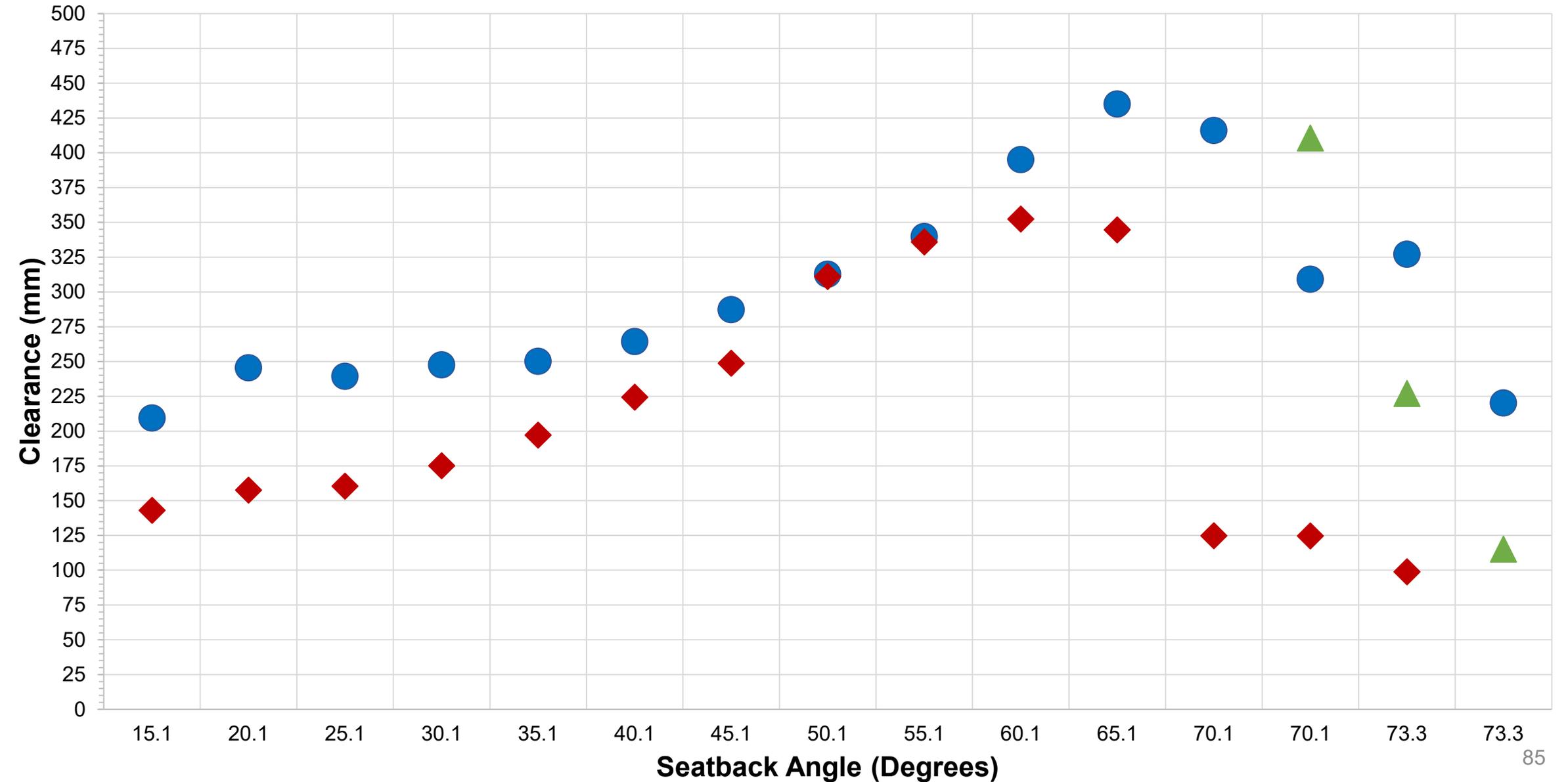


Reclined Seating LODC 10YO



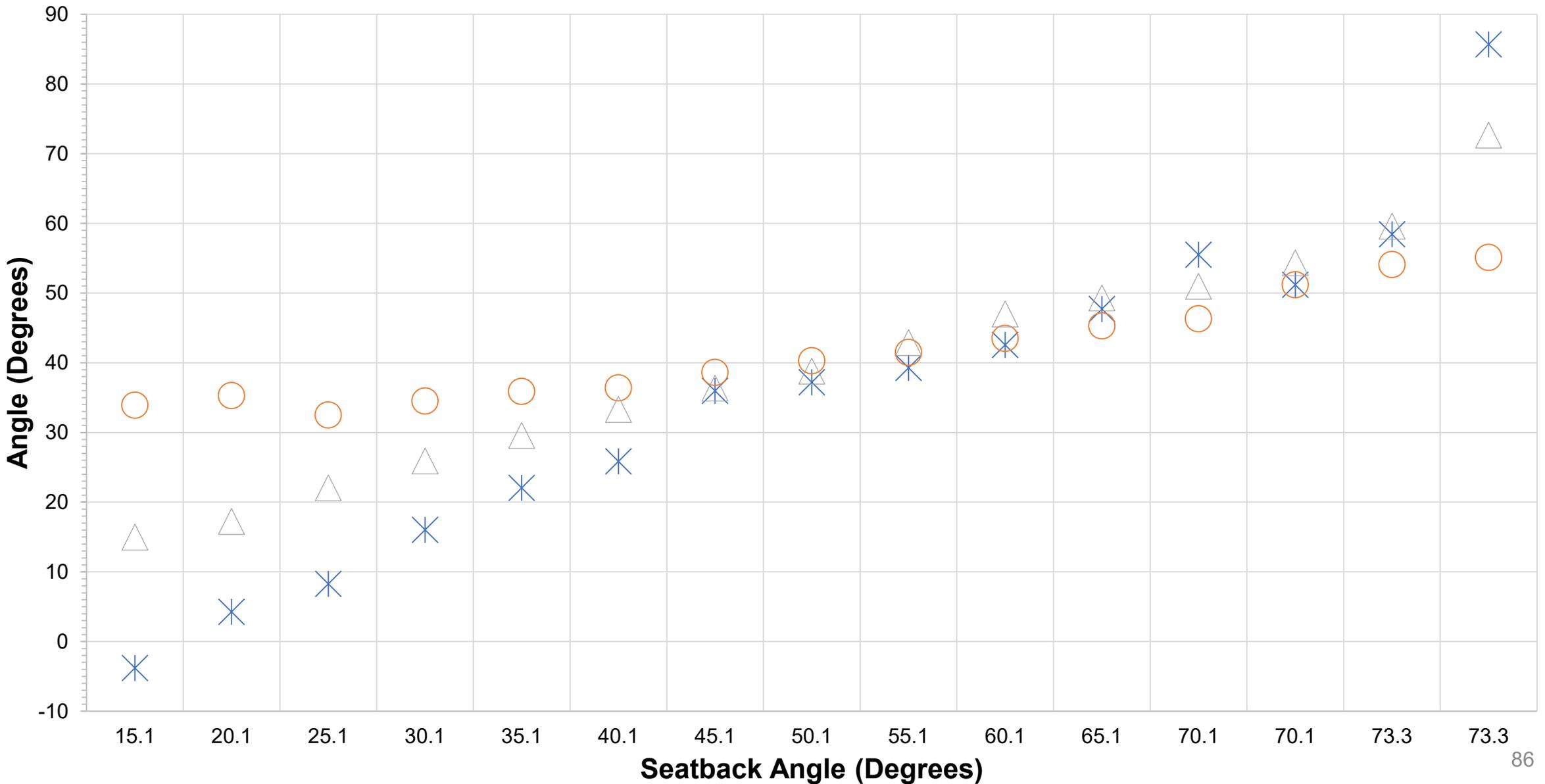
Reclined Seating LODC 10YO - Clearances

● Closest Point on Head Rest to Head CG ◆ Closest Point on Seat Back to Shoulder ▲ Closest point on Seat Back to Head CG



Reclined Seating LODC 10YO - Angles

✖ Head Angle ○ H-Point Angle △ Torso Angle





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End

