

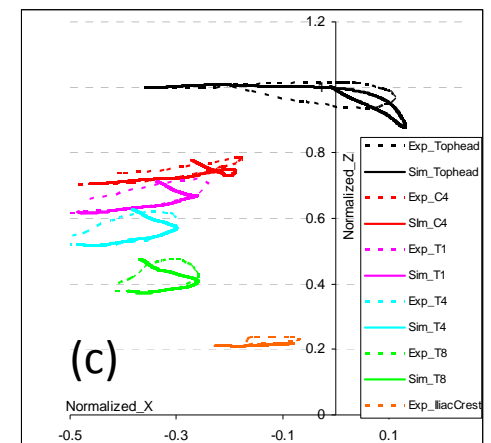
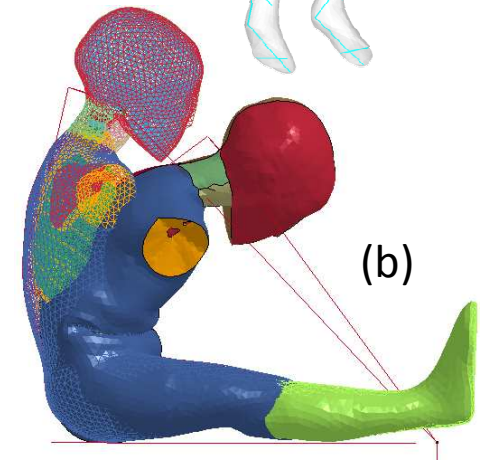
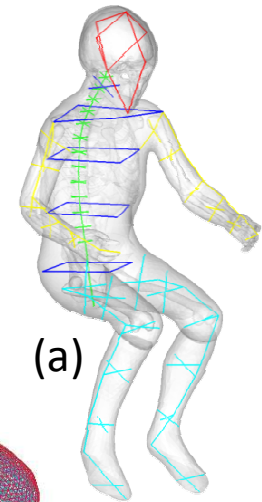
# Human modeling and Q6 kinematics

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Ifsttar

# 6 Y.O. Human model

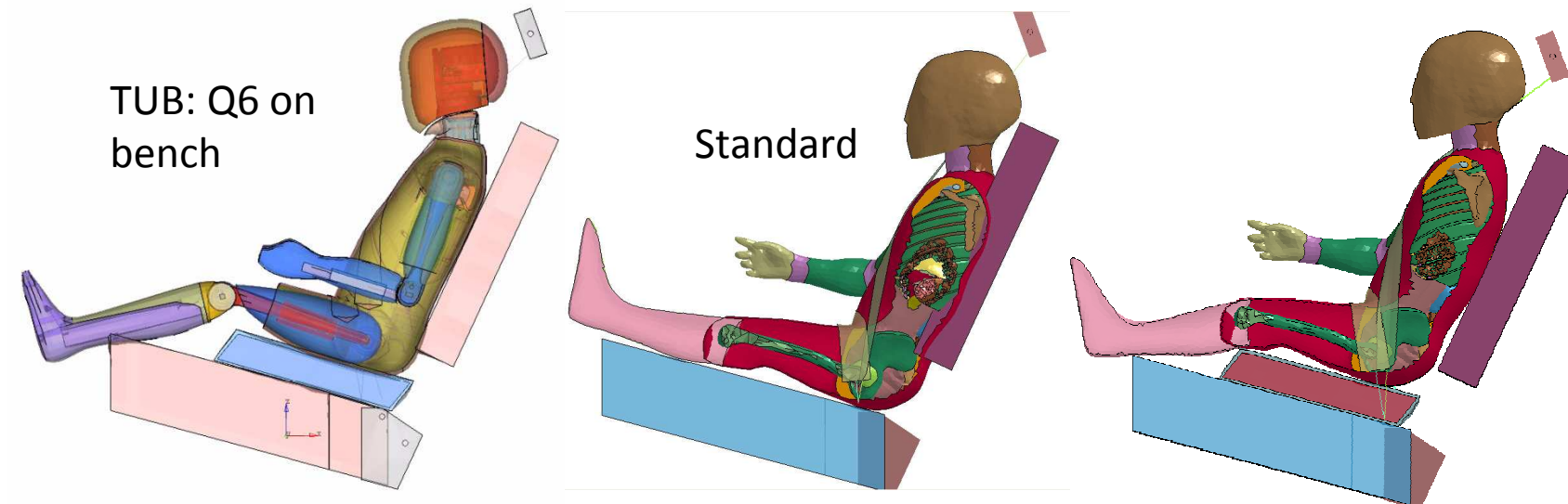
- Geometry: child CT scans + non linear geometrical scaling to match GEBOD anthropometry (a)
- Extremities, head neck simplified (Articulated RB, torso deformable).
- Validation (based on child PMHS data unless otherwise noted): reasonable response for
  - Thorax: diagonal belt<sup>1</sup>, hub impact<sup>2</sup>, distributed belt<sup>1</sup>
  - Abdomen: lap belt loading lower abdo<sup>1</sup>, lap belt loading upper abdo<sup>1</sup>, lap belt loading (porcine scaled)<sup>3</sup>
  - Lumbar region: torso flexion test (HIII 6YO setup, (b))<sup>4</sup>
  - Kinematics: low level deceleration (child volunteers, (c))<sup>5</sup>, sled pulse with harness<sup>6</sup>
  - To do (looking for additional info for these setups): sled pulse with shield<sup>7</sup> and abdomen hub impact, attempt to scale adult data on submarining?
  - Covers most datasets available child datasets
- MODEL STILL EVOLVING
  - Work on stability, relative stiffness of spine regions, adding Kallieris, etc



References: 1) Kent et al., (2009, 2011); 2) Ouyang et al. (200?); 3) Rouhana et al (1989), 4) Part 572; 5) Arbogast et al (2011); 6) Wisnans et al (1979); 7) Kallieris et al (1976)

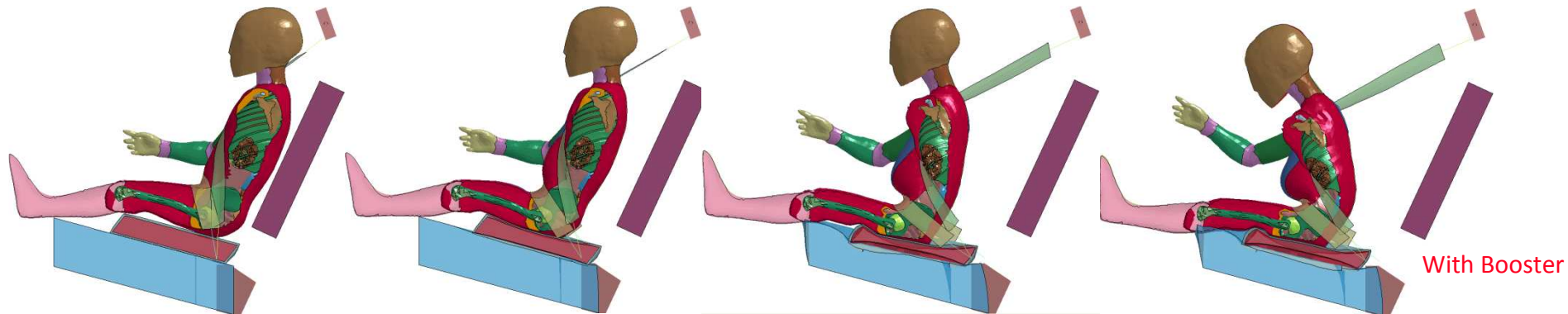
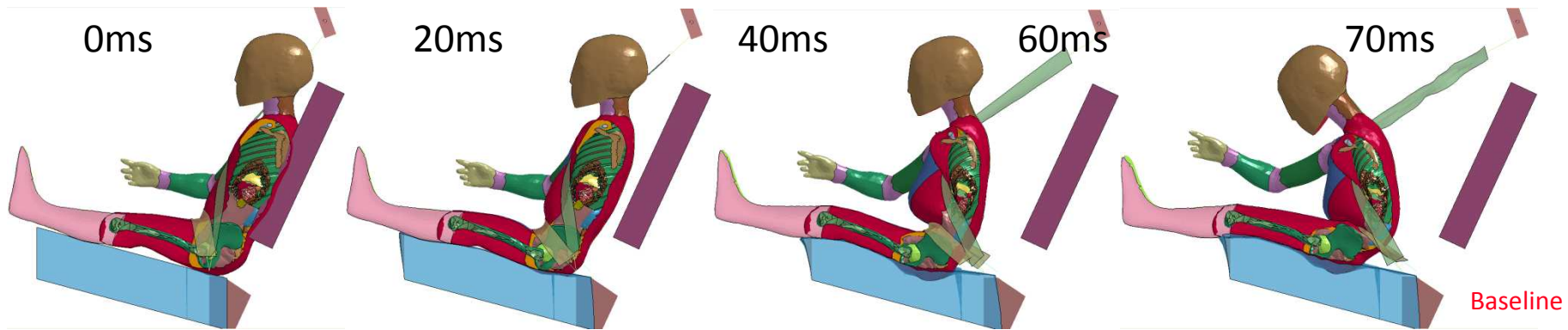
# Sled testing

- Bench model provided by TUB (developed during CASPER) + some minor modifications
- Positioning:
  - Standard: within the same space as the dummy belts used by TUB
  - On simplified booster (provided by TUB)



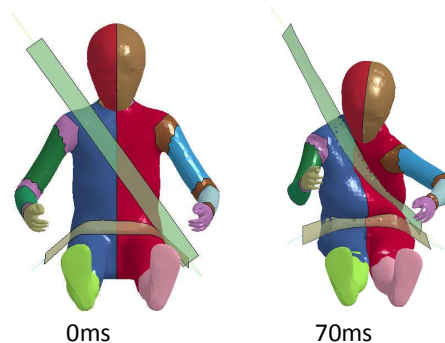
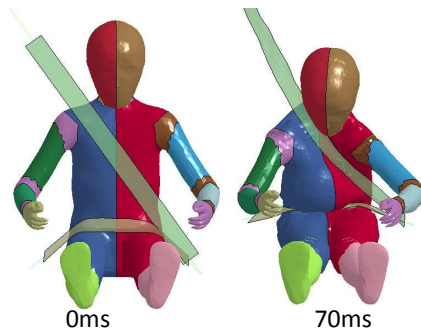
# First results with the human model

- Model submarines (and abdomen is loaded) on standard bench without CRS
  - And also on flattened bench
- Model does not submarine (abdomen is not loaded) when CRS is used
  - And also when no CRS is used but spine is rigid, or foam stiffness is 10x higher
- Belt slippage on thorax seems less than on the dummy



BASELINE CASE

With Booster



# Perspectives

- Results are different from dummy tests
- Continue work on human model to increase confidence
  - Scaled adult tests (e.g. Luet et al., 2012), Kallieris tests
- Look for improved positioning procedure
- Continue collaboration with TUB to look for parameters that could affect dummy response