BETA

SIMULATION SOLUTIONS

# Groundbreaking Simulation Solutions

*physics on screen*

# Bringing Human Body Models to life. The future in Safety simulations.

Lambros Rorris
BETA CAE Systems International AG
Thanasis Lioras
BETA CAE Systems SA

## HBMs For Safety

- Human body models solve many problems of safety simulations
- Matured enough to be used in production
- Autonomous driving, out of position load cases, protection of vulnerable road users (pedestrians, cyclists etc.)

- Notoriously difficult to handle and integrate into CAE safety workflows

# ANSA HBM Positioning Tool

- A novel approach to HBM Positioning
- Advanced integrated MBD solver and morphing algorithms used in parallel
- Works on HBMs with the simple addition of an ANSA metadata file.
- Each HBM its own unique meta data file.
- Support for all HBMs on all Solvers

## Advantages

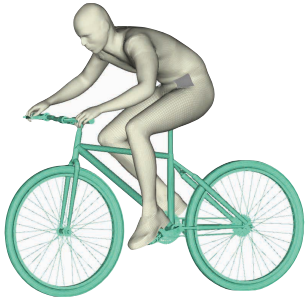
- Real time articulation and positioning of an HBM
- Easy-to-use interface. WYSIWYG
- Handles most movements even with large displacement
- Skip pre-simulation
- Address difficult positioning scenarios

## Coupling with all Safety tools of ANSA

- The HBM tool is integrated with all Safety tools
- As simple to use as the Dummy positioning tool

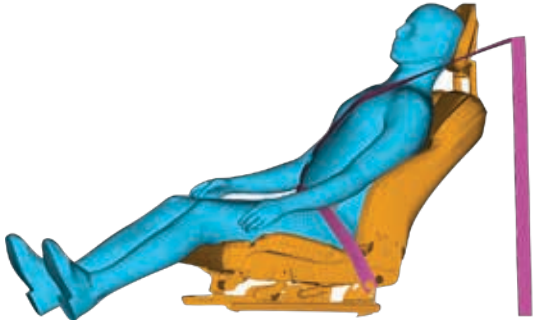
# Difficult positioning Scenarios

Pedestrian



Bicycle Rider

Motorcycle Rider



Autonomous vehicles

# Challenging Postures - Cyclist Posture

- Address two challenges
- Create and adapt a Bicycle model
- Position the HBM on the Bike

Easy Entry Bike

Racing Bike

## Bicycle Configurator – Sizing tool

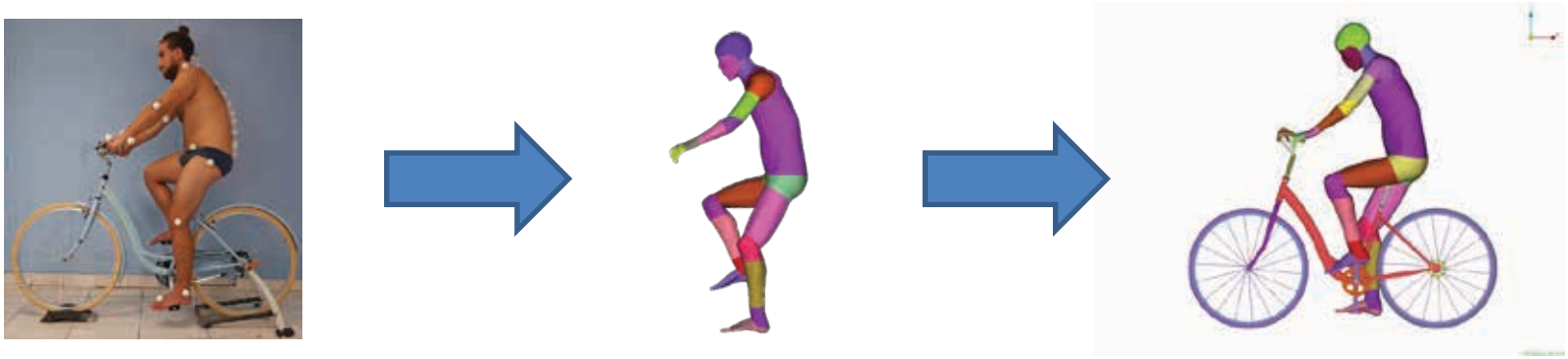
- Set up an HBM cyclist load case, using the bicycle configurator combined with the HBM positioner
- Morphs the bike FE-model automatically in order to fit with the desired HBM variant
  - Bike Size
  - Handlebar position
  - Seat Height
  - Pedals position
- LS-DYNA bike FE model available

# Cyclist Posture – Measurements

- Determine the Cyclist’s posture
- Validate the kinematics of the HBM required to achieve the desired posture
- Create a robust automatic procedure to map measurements to the HBM

# Cyclist Posture – Measurements - Positioning

# Tools and data for Car - Cyclist crash simulations



- Build a Library of models
- Bikes (City, Racing, E-Bike)
- Cycling Postures of various HBMs

# Motorcyclist Posture – Measurements - Positioning

# Challenging Postures - Reclined Seat

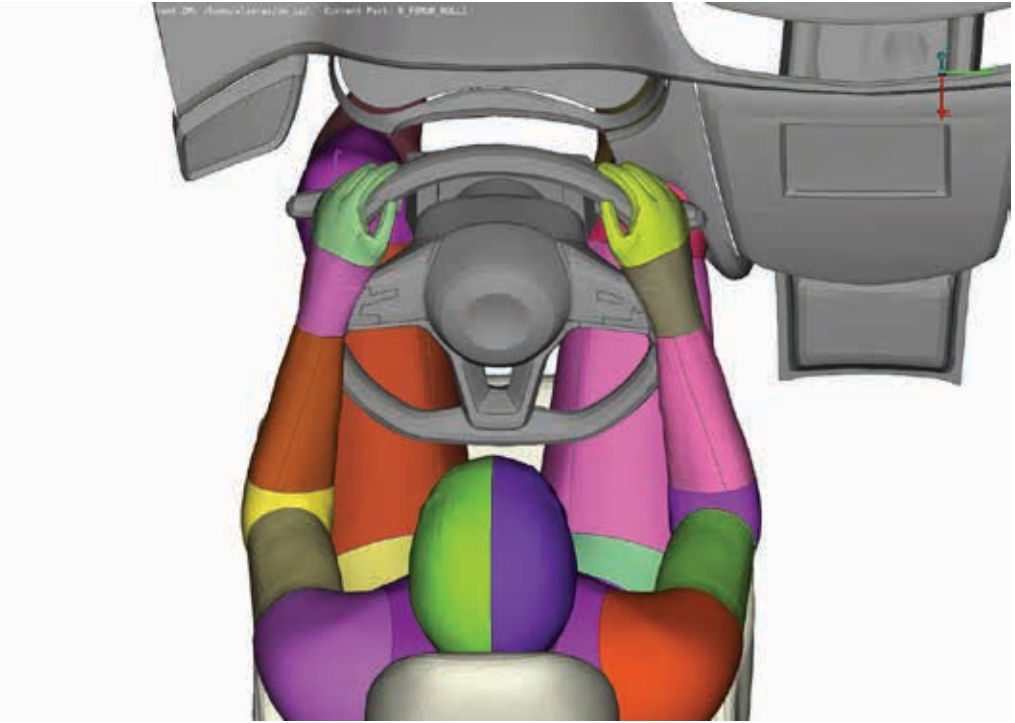
- Reclined Seat
- Define the ratio of pelvis tilt,
- Lumbar Spine tilt
- Offer the possibility of user defined pelvis tilt

# Kinematic Biofidelity – Ankle rotation

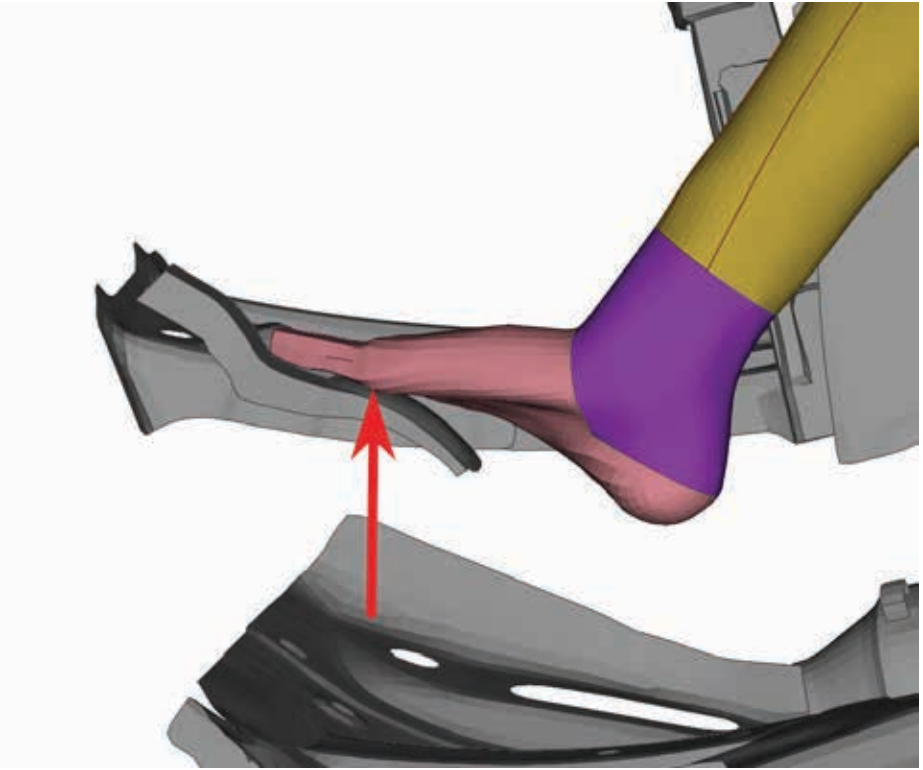
# Kinematic Biofidelity – Forearm rotation

# Point Cloud Matching

# Automatic hand / finger positioner



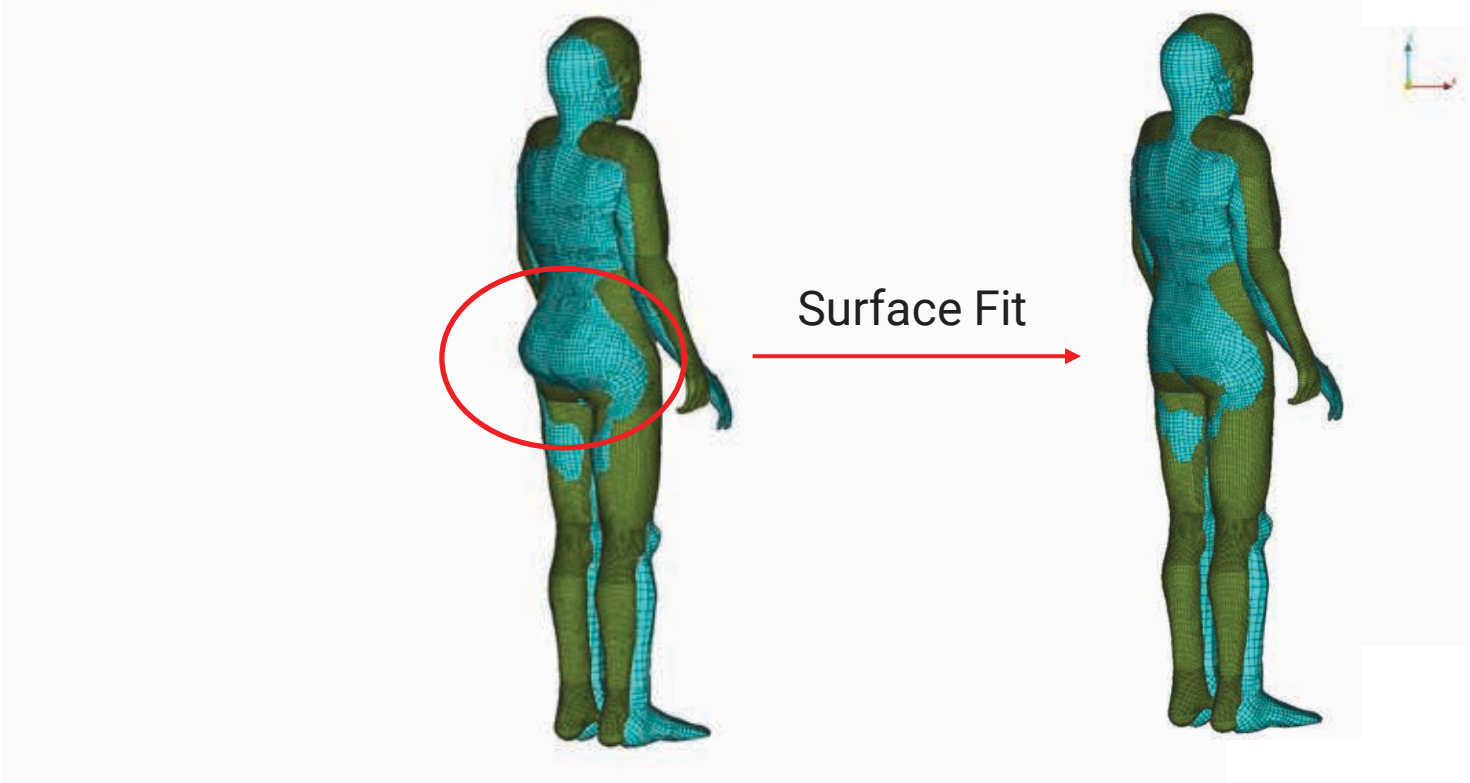
# Contact Detection



## Variants Creation – BMI change

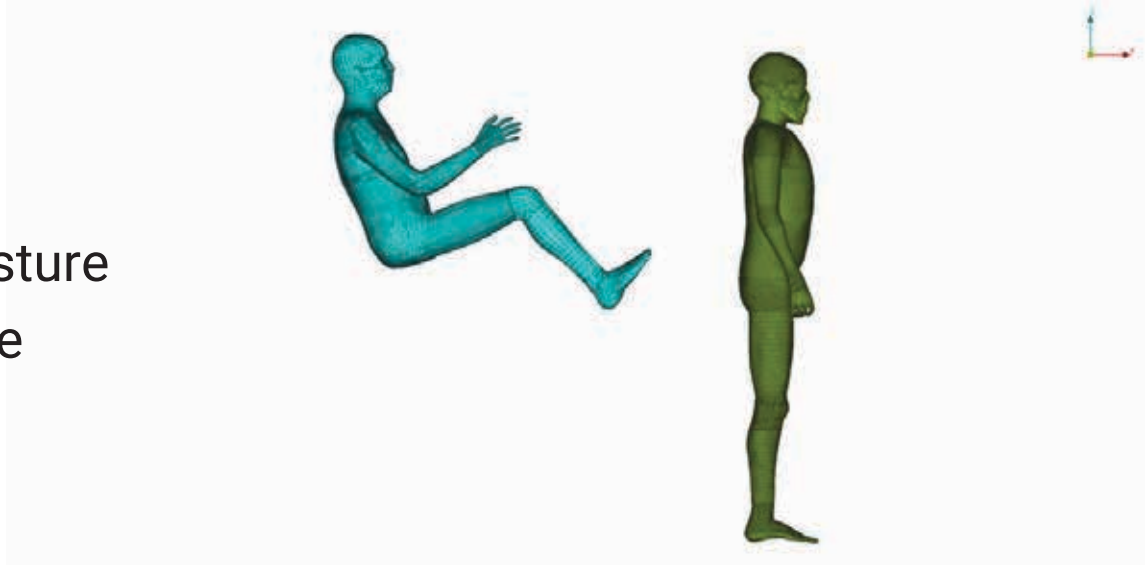
- HBM Variant tool
- Create BMI variants from a base HBM
- Create fat tissue
- Morph internal organs

# Variants Creation - From seated to standing



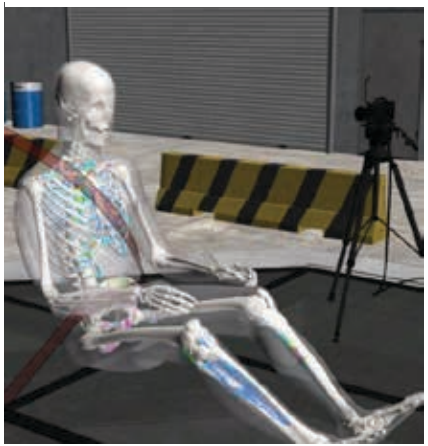
# Variants Creation

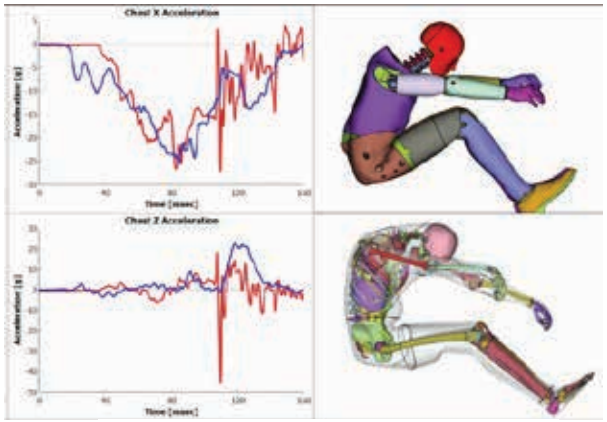
- Morph to target surface
- Even if it’s in a different posture
- Even if it’s in a different size



# Post-Processing of GHBMC Human Models with  META

Human Body Models Post






Occupant Injury Criteria tool

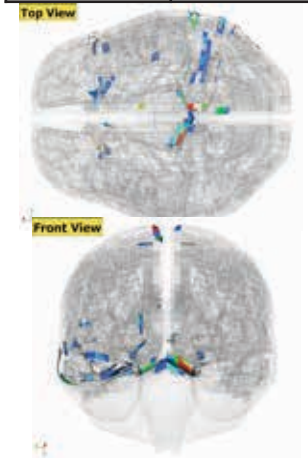
# META - PPTX reports

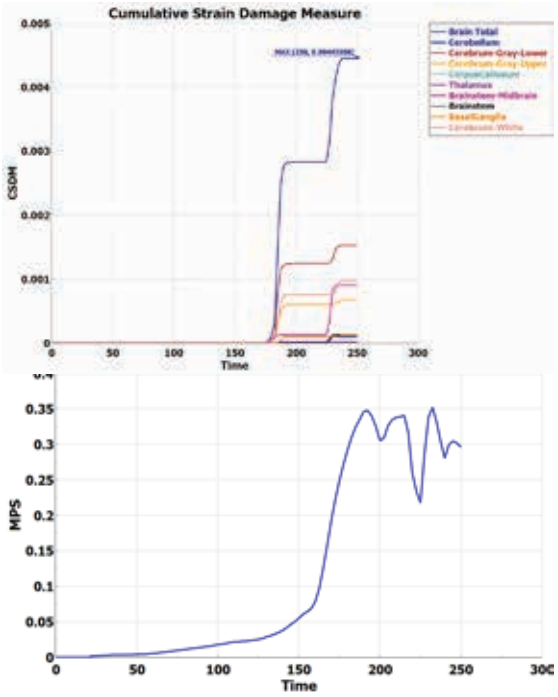
- Injury calculations
- Kinematics animations
- Strain contour plots
- Functionality for interactive evaluation of the results in META.

# META - PPTX reports

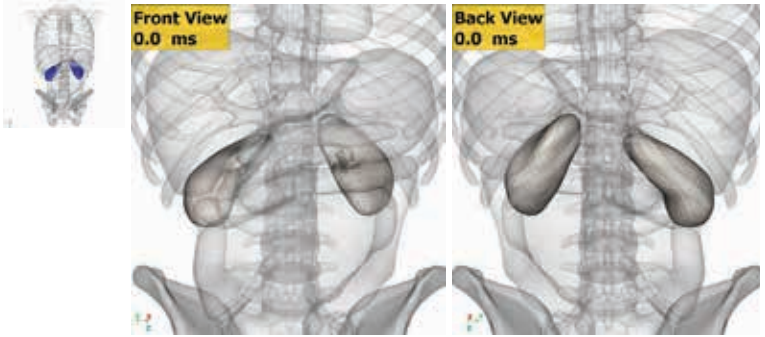
# META - Brain Cumulative Strain Damage Measure (CSDM)

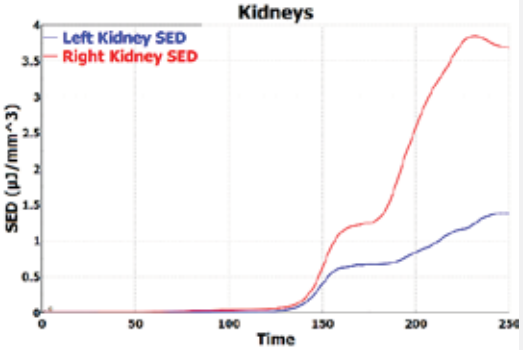
| Metric Name | Value |
|---|---|
| MPS Threshold | 0.25 |
| Injured Volume | 4878 mm^3 |
| Total Volume | 1093714 mm^3 |
| **CSDM** | **0.0045** |

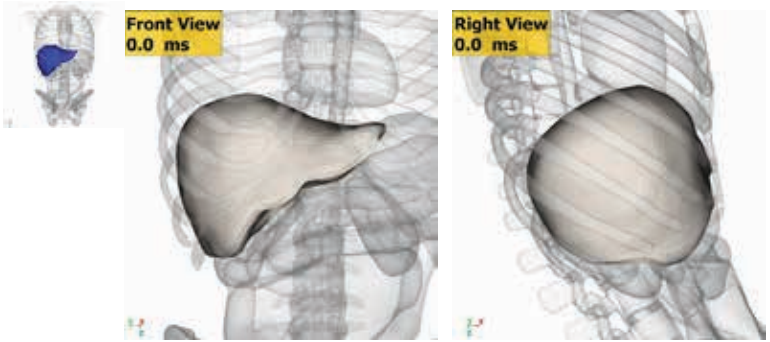


# META - Abdominal Soft Tissue Organs Strain Energy Density (SED)



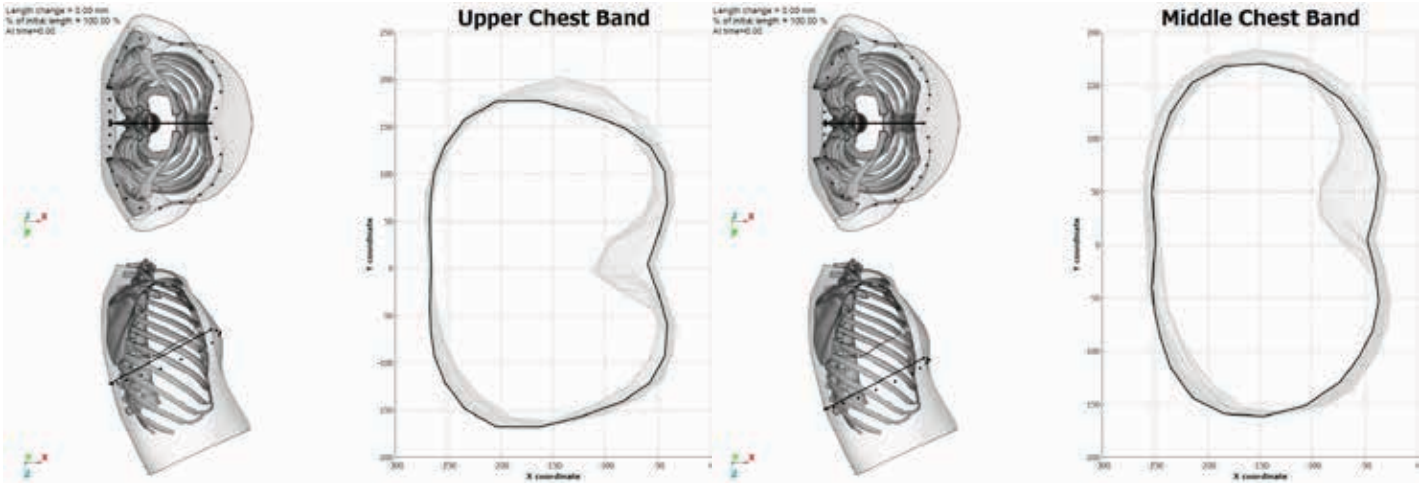




| Left Kidney | Value |
|---|---|
| Max Strain Energy Density (SED) | 1.38 µJ/mm^3 |
| At Time | 246.7 ms |
| **Right Kidney** | **Value** |
| Max Strain Energy Density (SED) | 3.85 µJ/mm^3 |
| At Time | 231.5 ms |

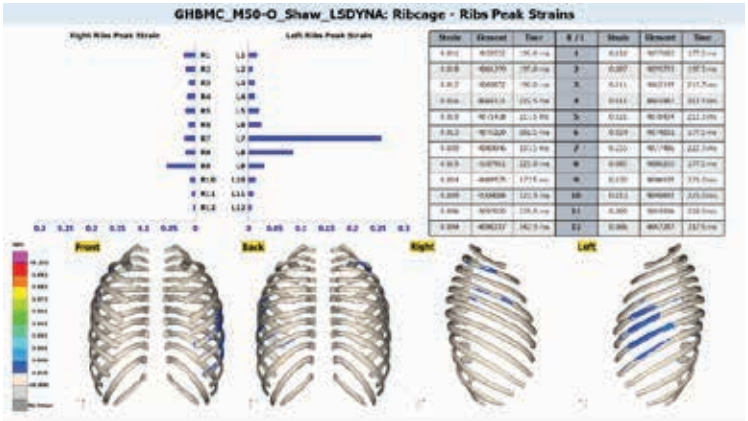
- Currently for SAFER
- GHBMs and THUMS supported in the next version

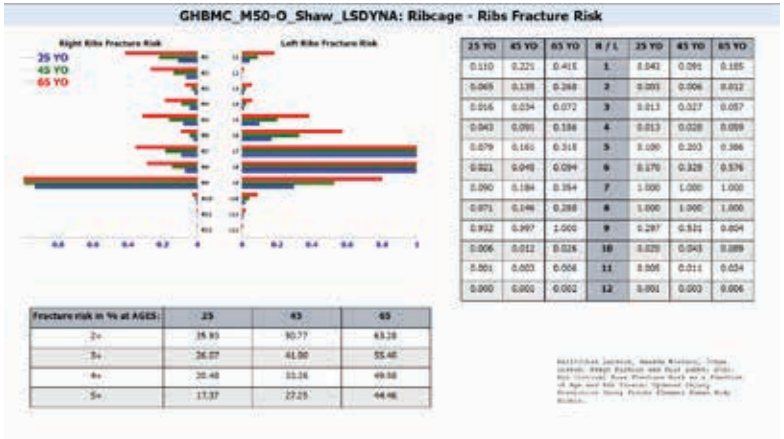
# META - Chest-bands deformations




| Metric Name Chest-Band | Max Compression | % of Initial length | At Time |
|---|---|---|---|
| Upper Chest-Band | -56.73 mm | 75.62% | 207.50 |
| Middle Chest-Band | -30.80 mm | 86.37% | 210.00 |
| Lower Chest-Band | -0.03 mm | 99.99% | 122.50 |

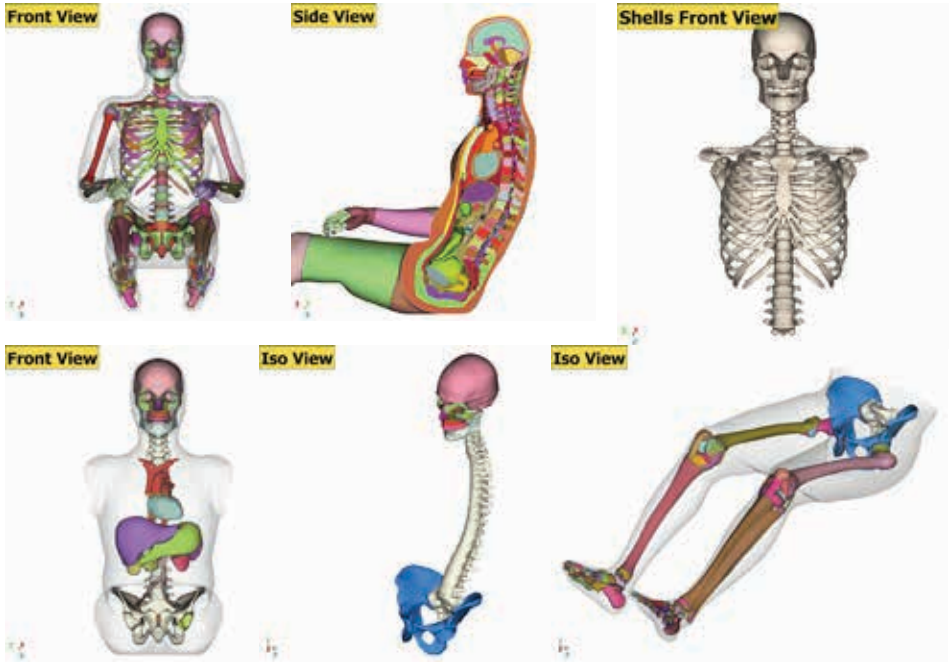
# Ribs Fracture Risk calculation



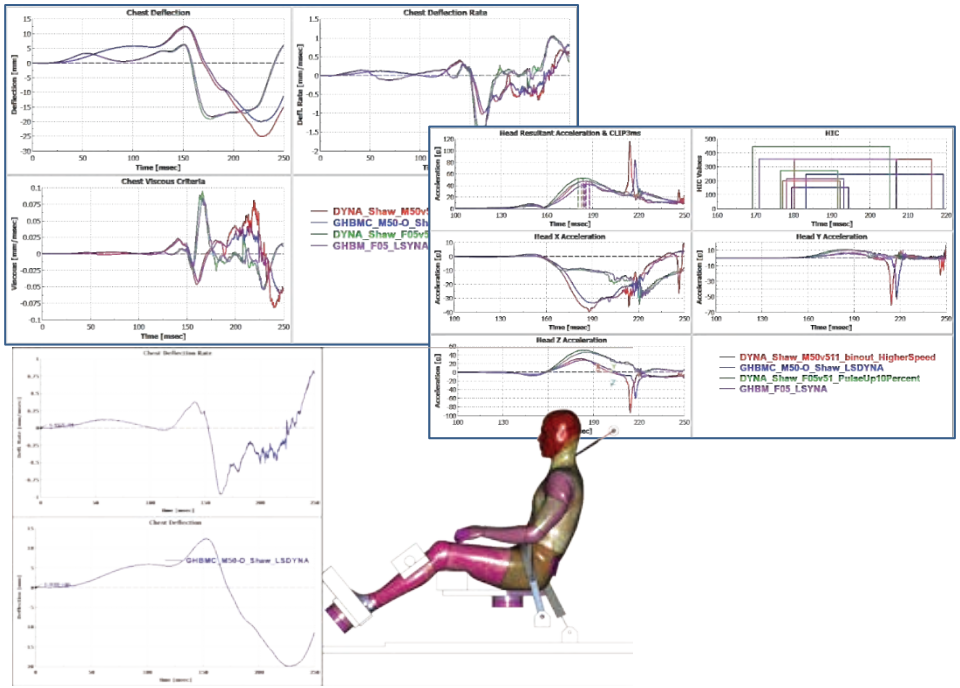

- Currently for SAFER
- GHBMs and THUMS supported in the next version

# META - Kinematics & Strain Contours



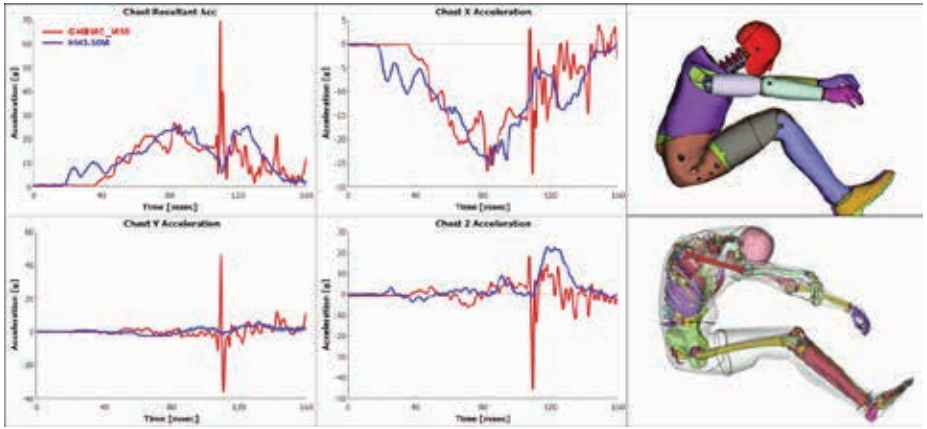
# META - Occupant Injury criteria tool

- Extract time history results (similar to ATDs)
- Overlay and compare multiple HBM simulation runs
- Overlay and compare results from different solvers



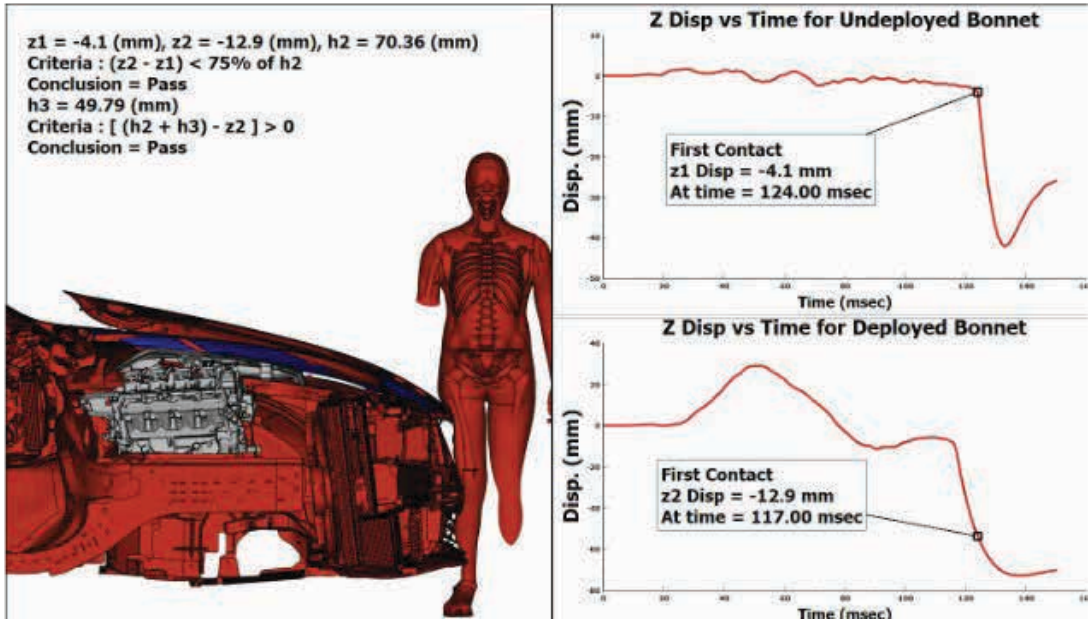
# META - Occupant Injury criteria tool

- Overlay HBM and ATD time history results
- Calculate Injury Criteria similar to ATDs

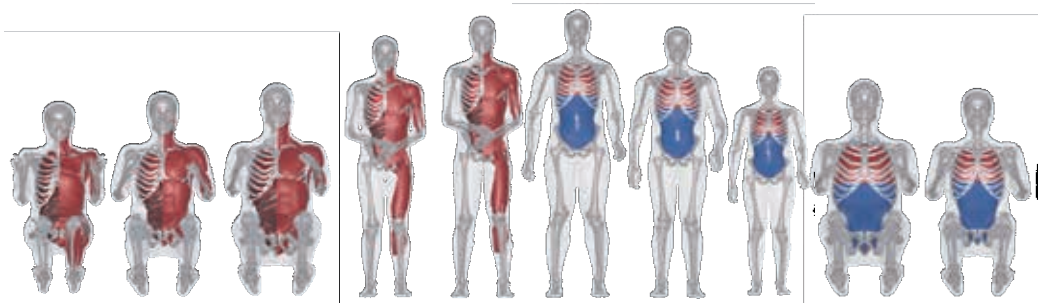


# META - Deployable Bonnet System Assessment

- Timing of System Deployment evaluation
- Bonet Deflection due to Body Loading assessment

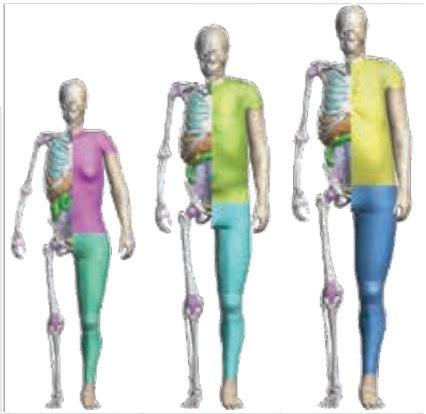


# GHBMC Support

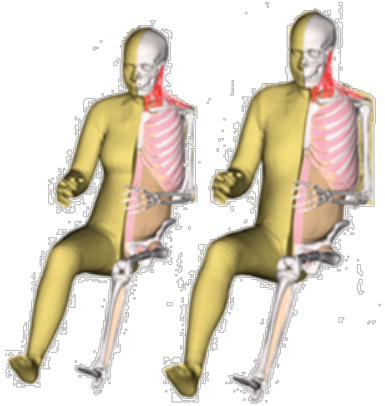


| | F05-o | M50 – o | M95-o | M50-P | M95-P | M95-PS | M50-PS | F05-PS | M95-OS | M50-oS |
|---|---|---|---|---|---|---|---|---|---|---|
| LS Dyna | ** | ** | ** | ** | * | * | * | * | ** | ** |
| VPS | * | * | | | | | | | | |
| Radioss | | * | | | | | | | | |

# THUMS, SAFER and VIVA+ Support



| | AF05 | AM50 | AM95 | AF05 | AM50 | AM95 |
|---|---|---|---|---|---|---|
| LS Dyna | ** | ** | ** | ** | ** | * |

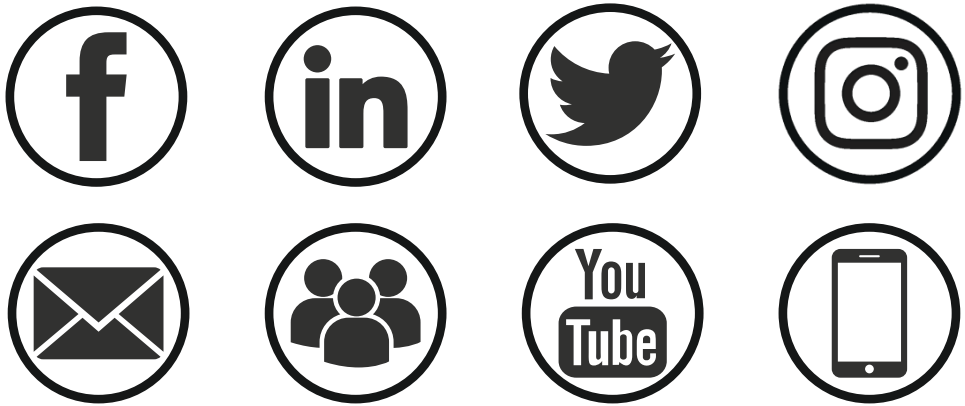


SAFER and VIVA+
- AM50-O
- M50-O

## Conclusion

- Support HBMs in current CAE processes pre and post
- Handle them as simple as ATDs
- Offer tools for variant creation
  - Changing BMI
  - Changing Postures
  - Adapting to different anthropometric data
- Support Universities and OEMs in many research projects

BETA
SIMULATION SOLUTIONS




## Stay connected