Robustness Analysis in Safety Simulations

BETA CAE Systems S.A.

L. Rorris, Y. Kolokythas, A. Lioras

Outline

- Background
- ANSA tools and features for safety simulations
- Automation deployment
- Complete test case

Background

Challenges in all types of safety analysis

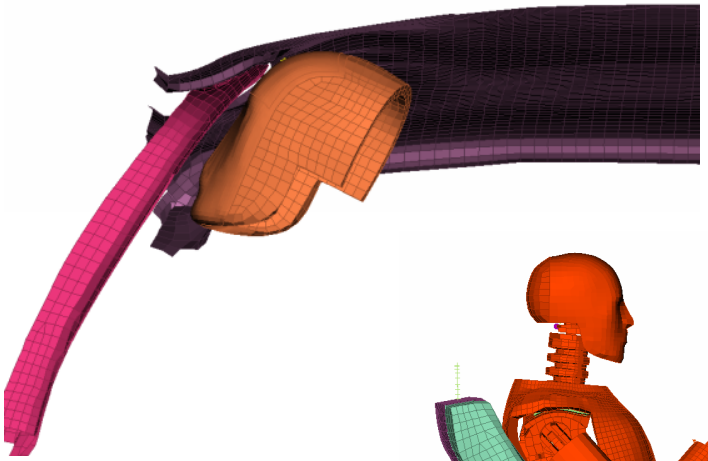
- Labtests and simulations have a high degree of uncertainty
- Highly dependent on positioning
- Sensitivity due to high number of affecting parameters
- Increasing number of regulations, loadcases and severity

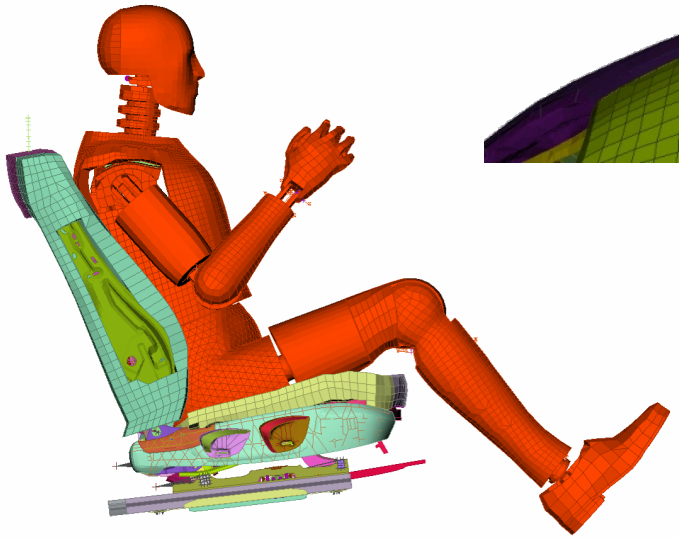
A stochastic approach is needed in order to meet the requirements

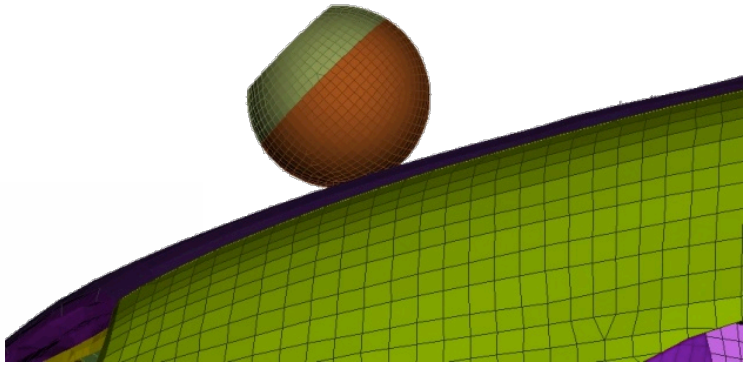
The Robustness tool is the Instrument provided by BETA CAE Systems

Robustness Analysis – Why?

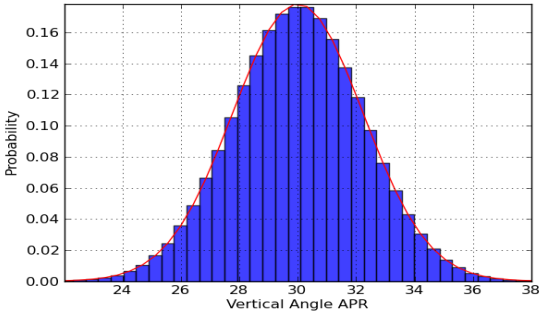
- Check Robustness and stability of safety analysis
- Be certain about the behaviour of the model
- Which parameters affect system behaviour?



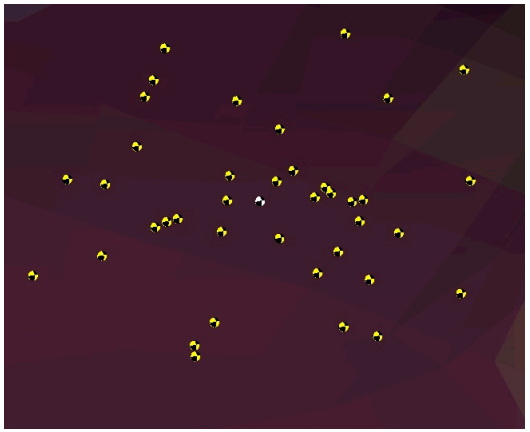




Stochastic Analysis – How?

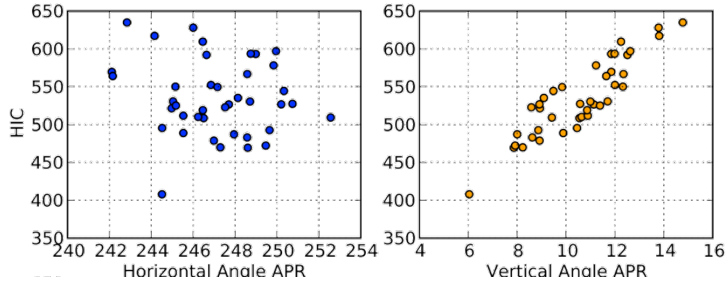


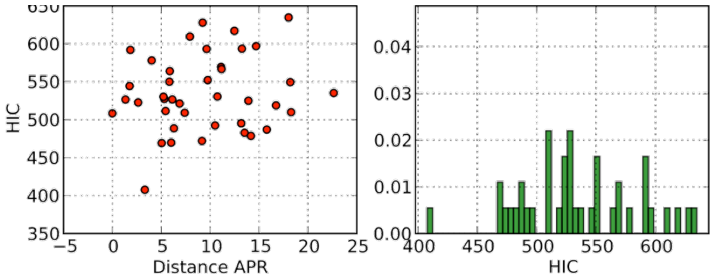
- Parameterize input values



- Create a results scatter with repetitive experimentation following a distribution method (Normal, Uniform, etc)

- Analysis of the scatter, study of the model's stability





What do we need?

- We need powerful pre-processing tools

  - with automated positioning according to regulations
  - massive output of loadcases
  - high accuracy

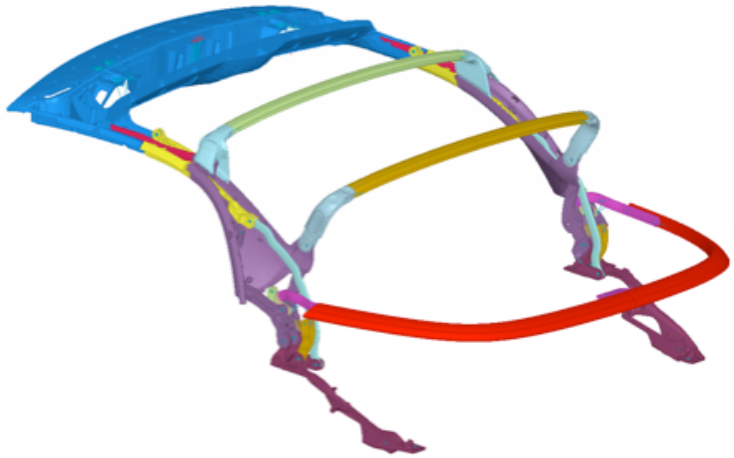
- Statistical instrument to create and analyze the experiment scatter

- Automatic report generation and overall summary of results

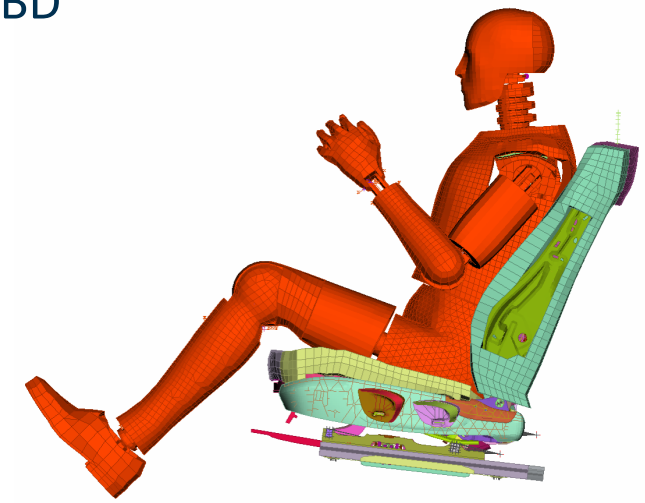
The ANSA Safety Environment

The ANSA Kinematics Tool

- Multi-Body Dynamics Solver
- Capable to perform complex movements
- Seat – dummy joint movement
- Other areas of application like
  Active hood, Convertible roof tops, suspensions, etc

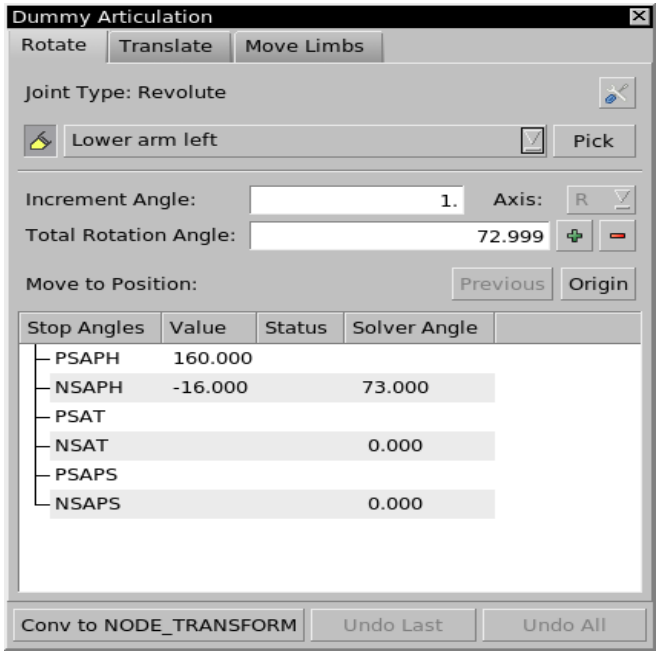


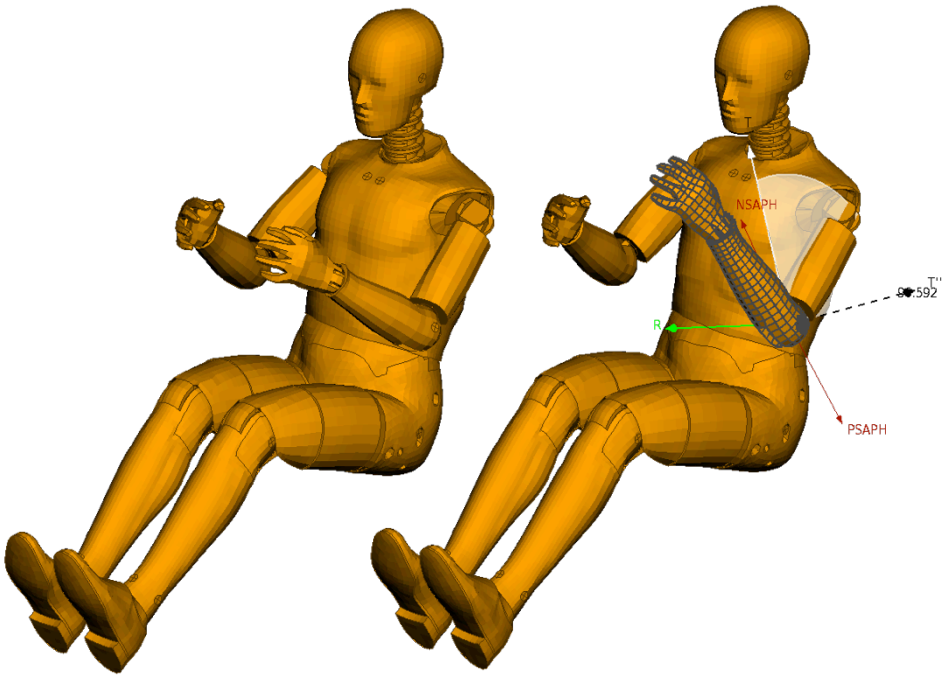
- Automatically converts an FE model into MBD model
- It hides the complexity from the safety engineer
- Predefined configuration
- Predefined positions
- Export transformation information



Dummy Handling

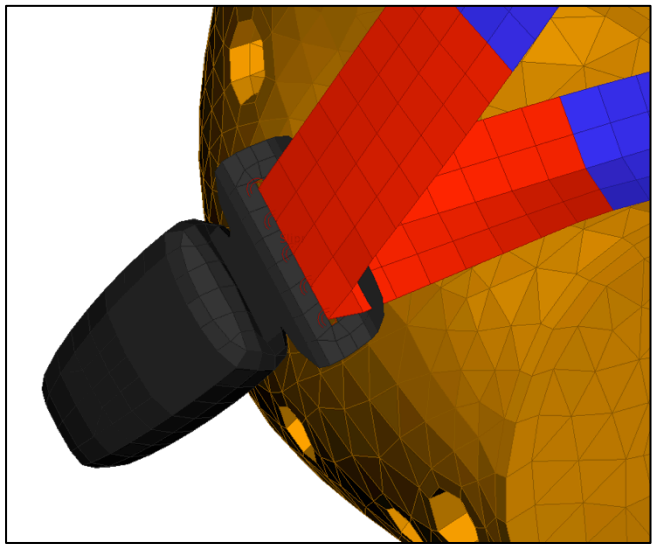
- Powerful and user friendly GUI
- Support of all the popular dummy model manufacturers Humanetics, LSTC, Simulia, Dynamore etc.
- Export the transformation keywords
- Script driven and automated





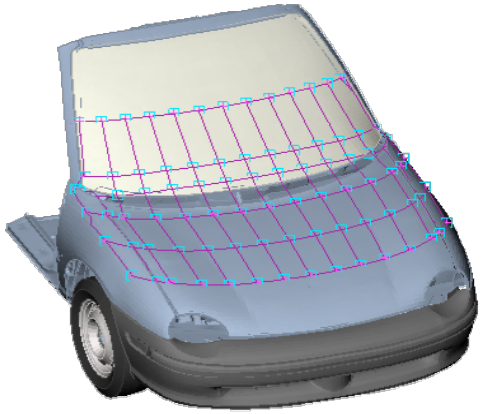
Seatbelt Tool

- Seatbelts are ANSA entities. The seatbelt can be automatically re-created
- Fully support of LS-DYNA 2D belts
- Interactively edit the path of the belt to improve quality
- Automatic belt passing through a 3D slipring
- Interaction with Dummy positioning and kinematics tool
- Script driven and automated



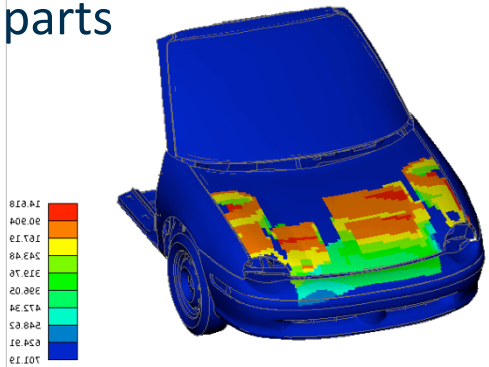
Pedestrian Safety Tool

- Support all the popular protocols for leg- and headform
- EuroNCAP – Grid, EU Phase 1 - 2
- JNCAP, TRIAS 63



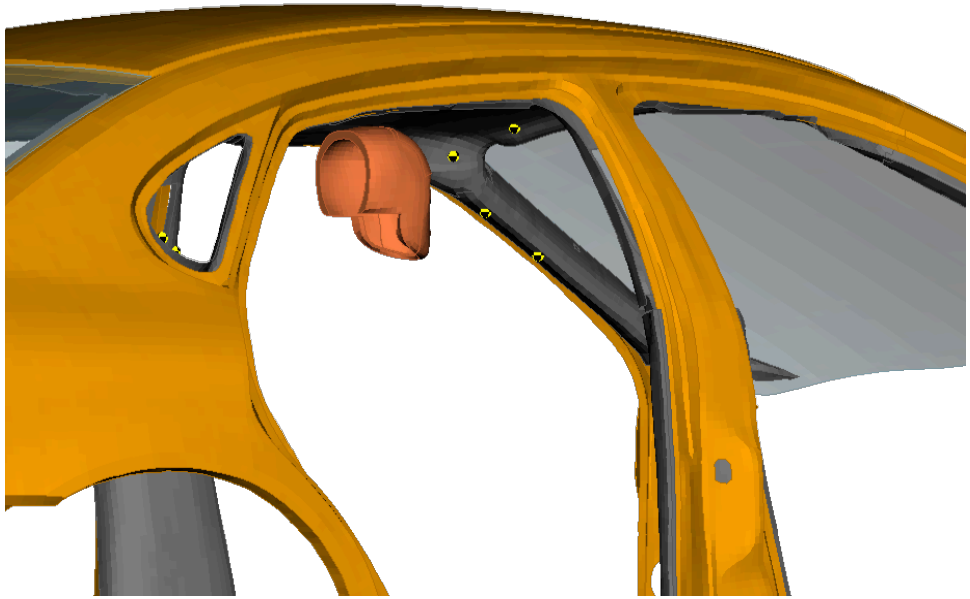
- Automatic creation of curves defining areas per regulations and protocols
- Ability to modify reference line calculations
- Target points creation per configurable resolution
- Target point Entity that keeps all the target information

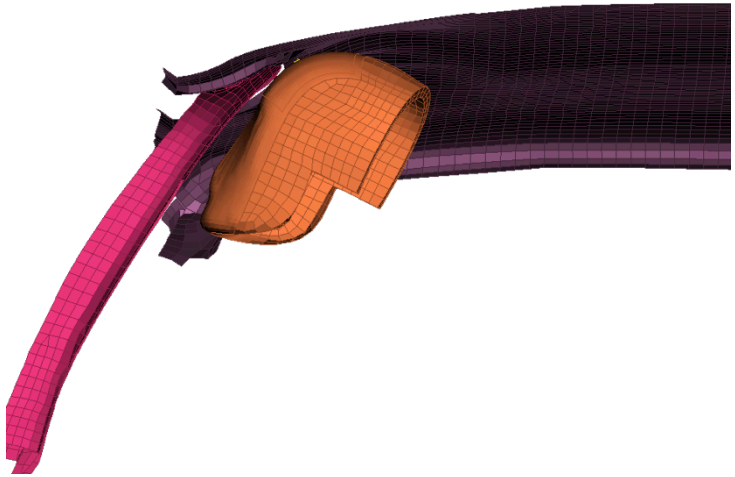
- Identification of worst points based on underlying hard parts
- Position with a contact based algorithm.
- Script driven and automated Mass positioning output – Output transformation matrices



FMVSS 201U

- Automatic creation of target points per the regulation
- Contact based algorithms closely replicating the regulation movements
- Mass positioning output – Output transformation matrices



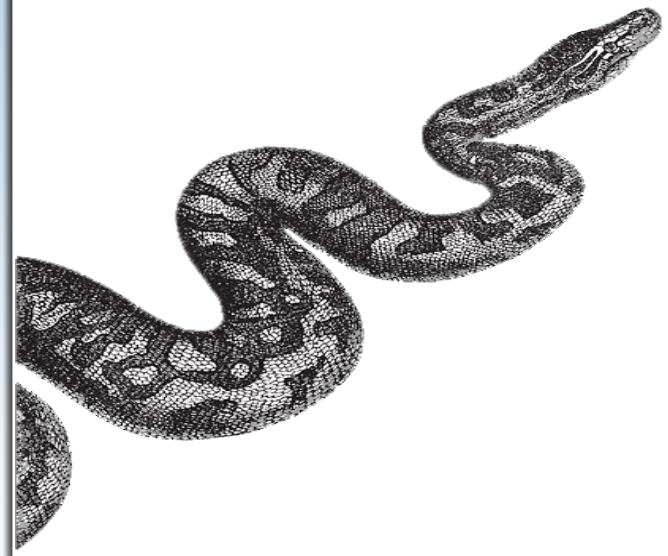


- New positioning algorithm allows automatic positioning of the headform in difficult areas

Pre-Processing Recap

Available advanced instruments providing the capability to:

- Automatic Positioning
- Massive Output
- Script and No GUI Driven processes
- Python Programming Language embedded in ANSA v14 and mETA v14

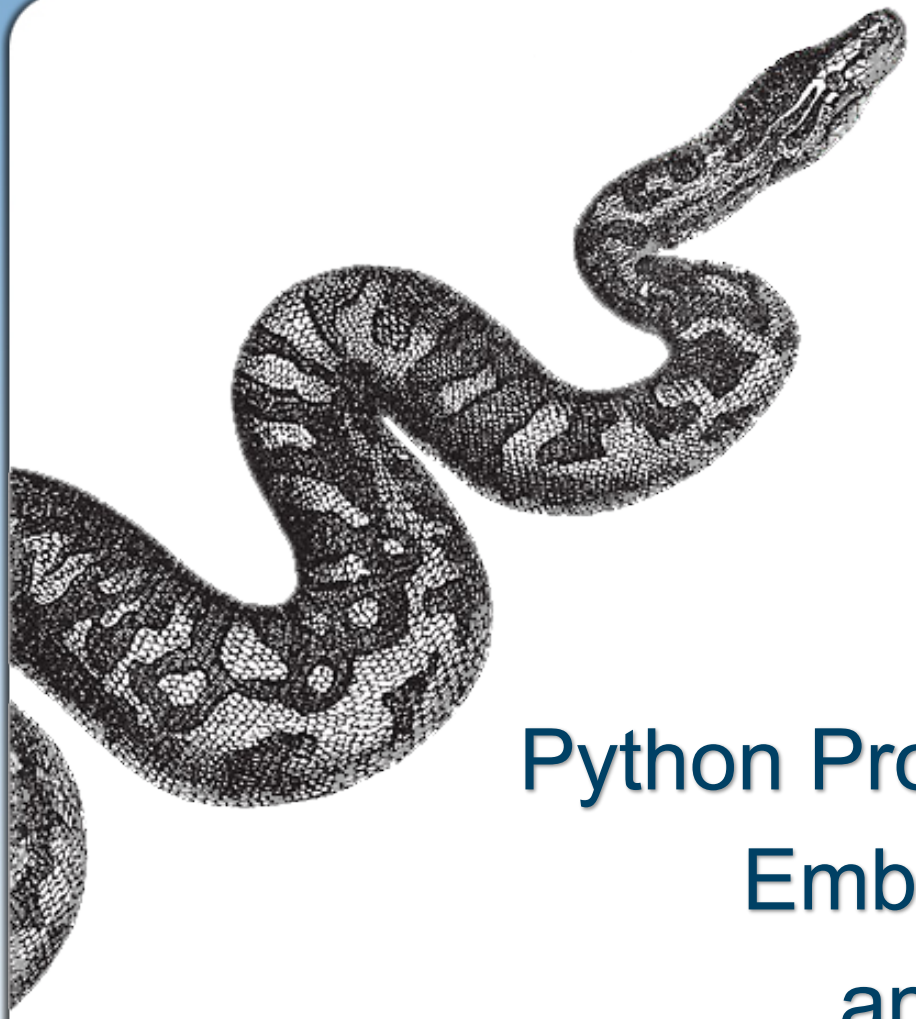


- High level object oriented programming language
- Clean and expressive syntax
- Large standard library
- Large selection of third party scientific libraries
- Language of choice for computational sciences and engineering

ANSA Scripting Language

ANSA Scripting Current State

- Rich API library
- Easy to use C-like scripting language
- Custom made language



Python Programming Language Embedded in ANSA and META v14

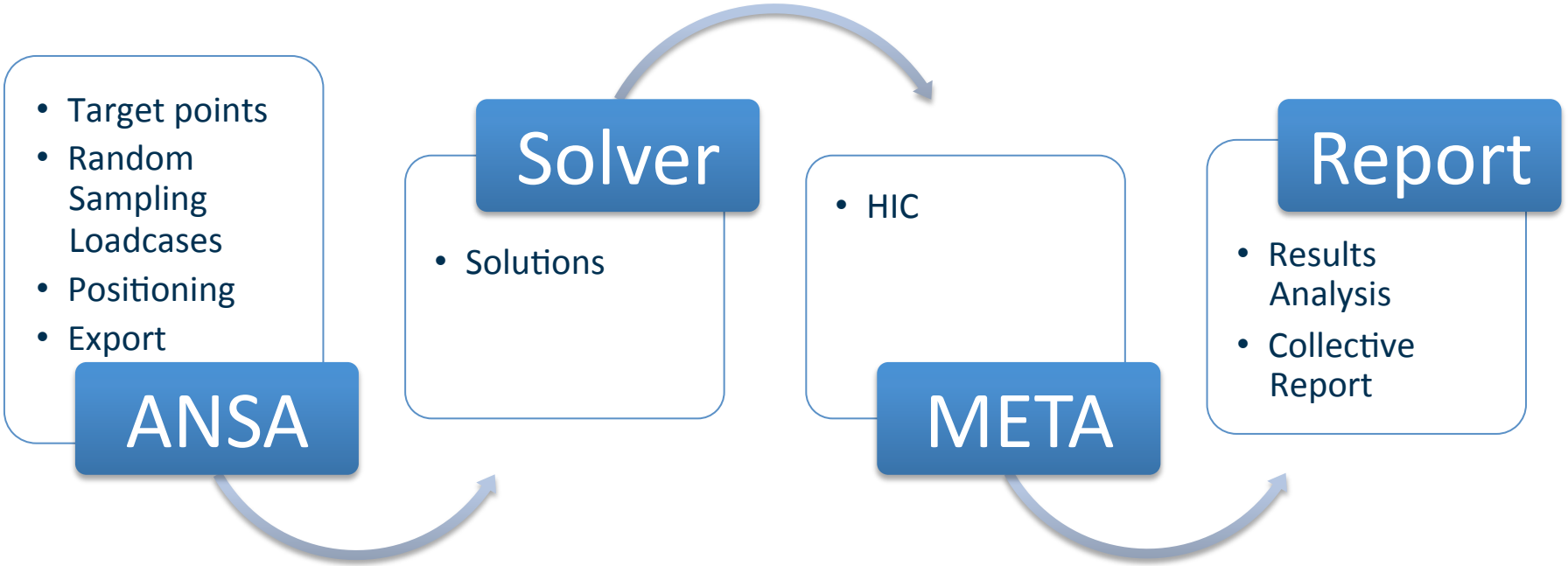
Python Programming Language

- High level level object oriented programming language
- Clean and expressive syntax
- Large standard library
- Large selection of third party scientific libraries
- Language of choice for computational sciences and engineering
- The new ANSA API in an extension of Python

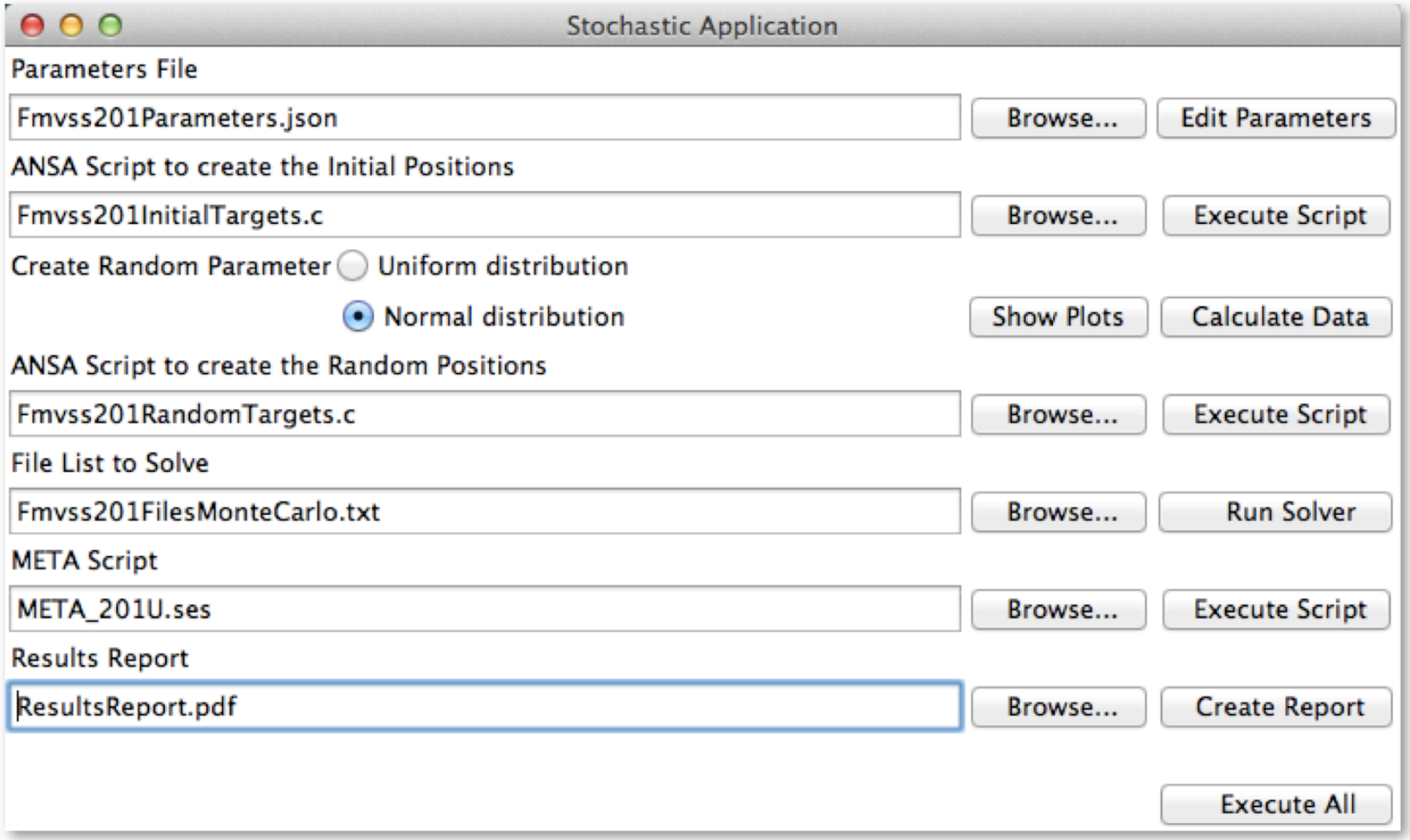
The Robustness Tool (FMVSS 201U study case)

Process

Automatic Process Driven by the ANSA's Robustness Tool



Robustness Tool Interface

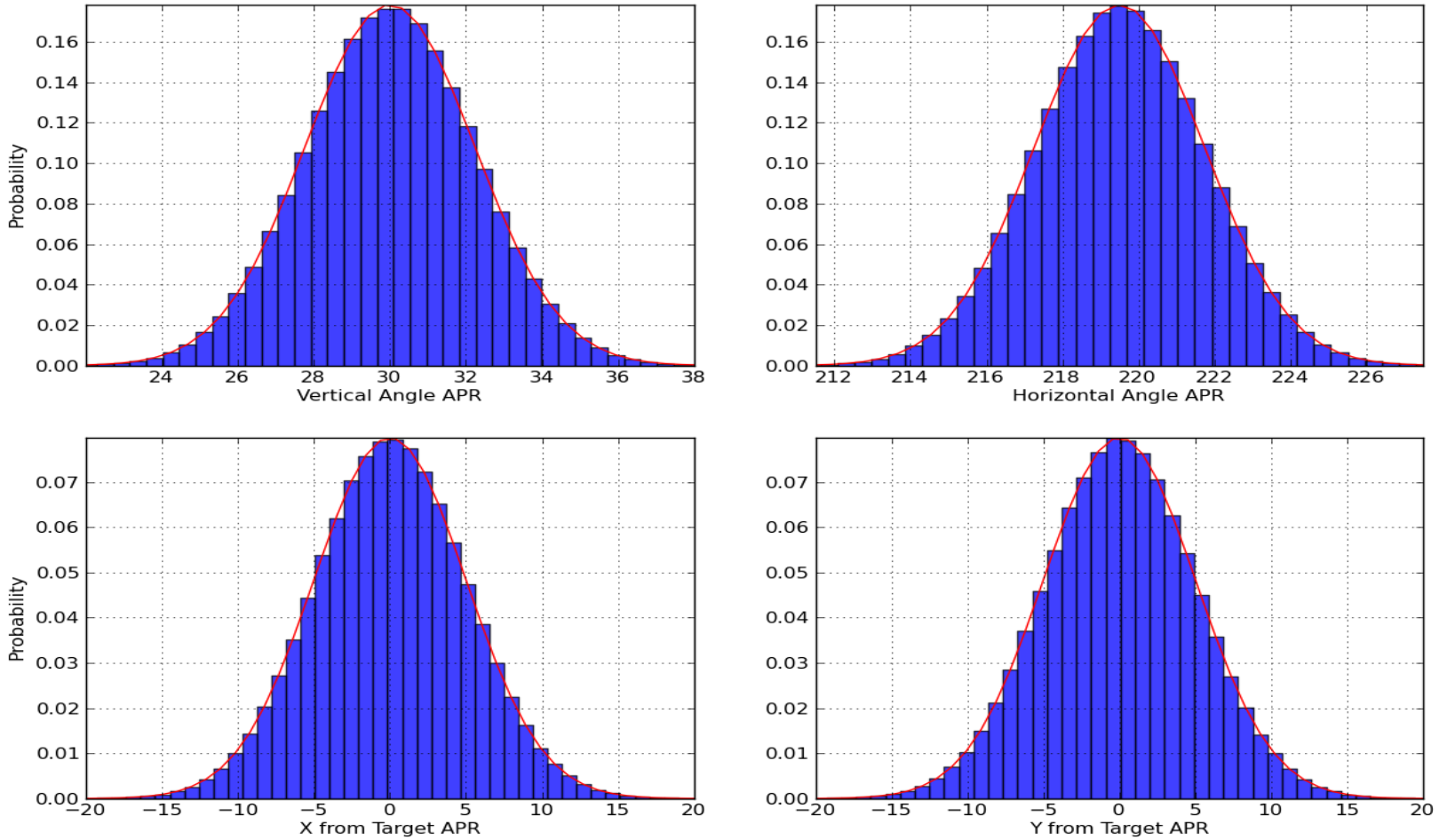


Stochastic Analysis of FMVSS 201U

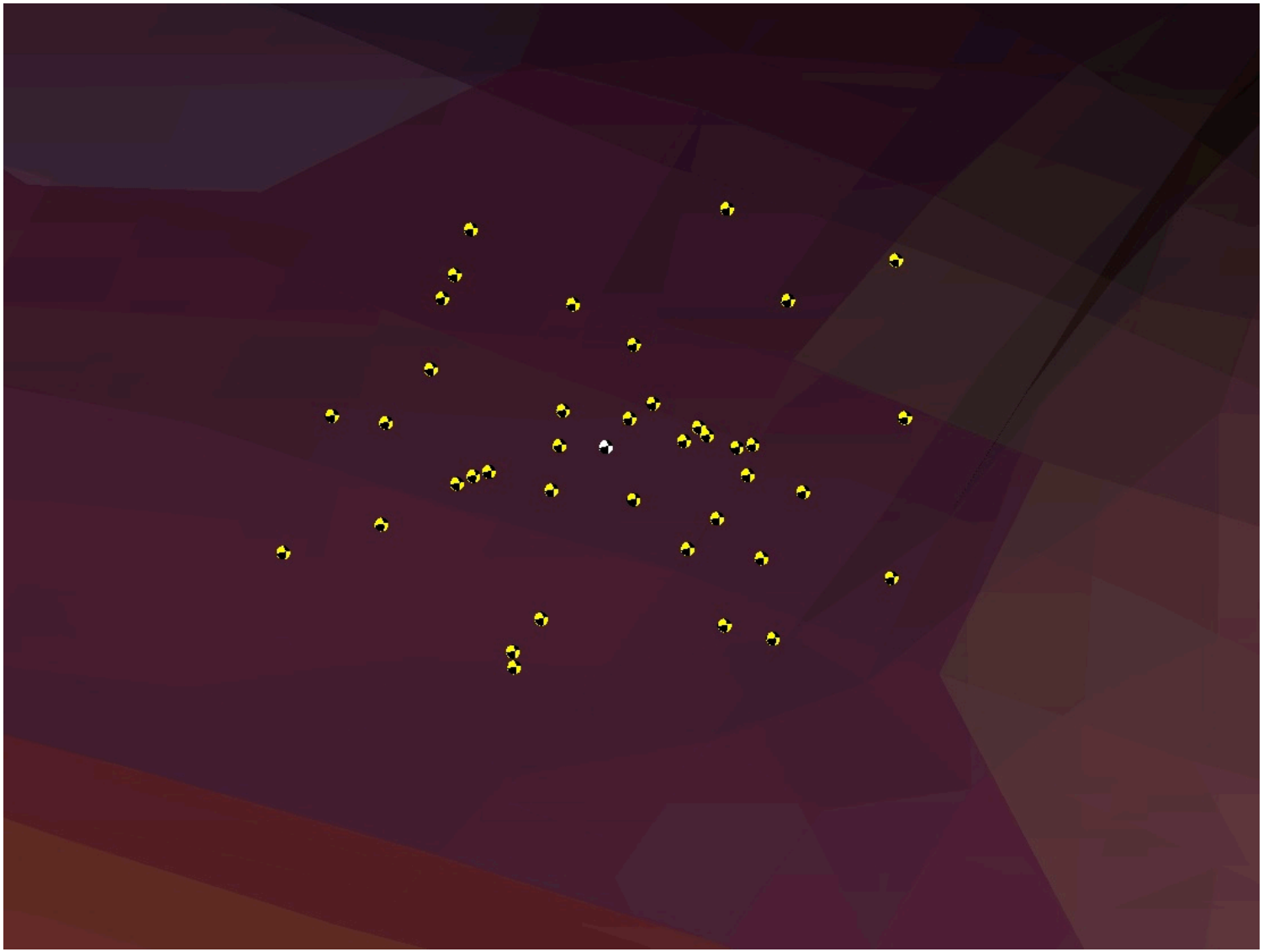
- Select Parameters
- Select Ranges
- Select Distribution Type

Parameters	Range	Distribution Type
Horz. Angle	+7.5 / -7.5 deg	Normal
Vert. Angle	+7.5 / -7.5 deg	Normal
X from Target	+15.0 / -15.0 mm	Normal
Y from Target	+15.0 / -15.0 mm	Normal

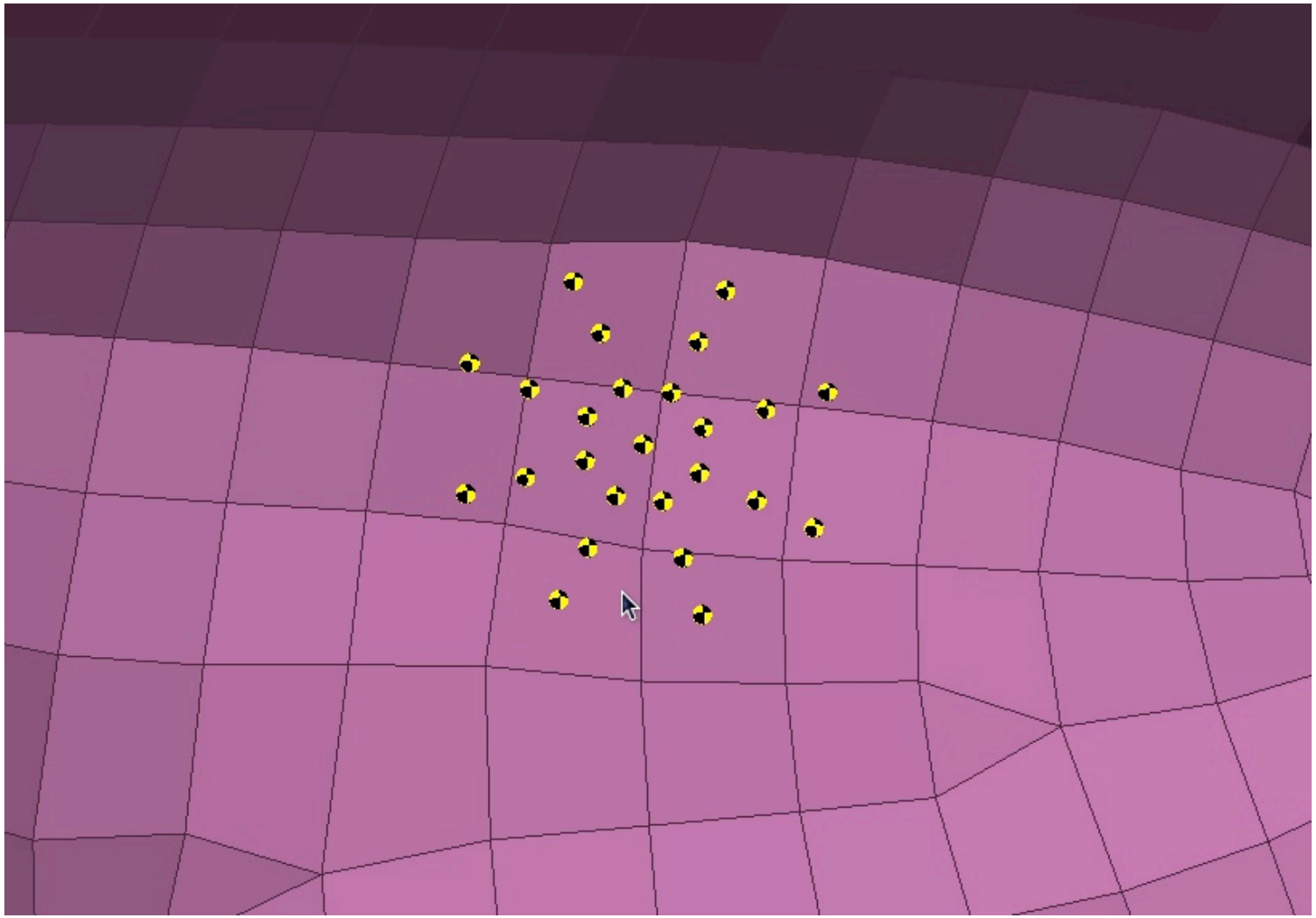
Distribution



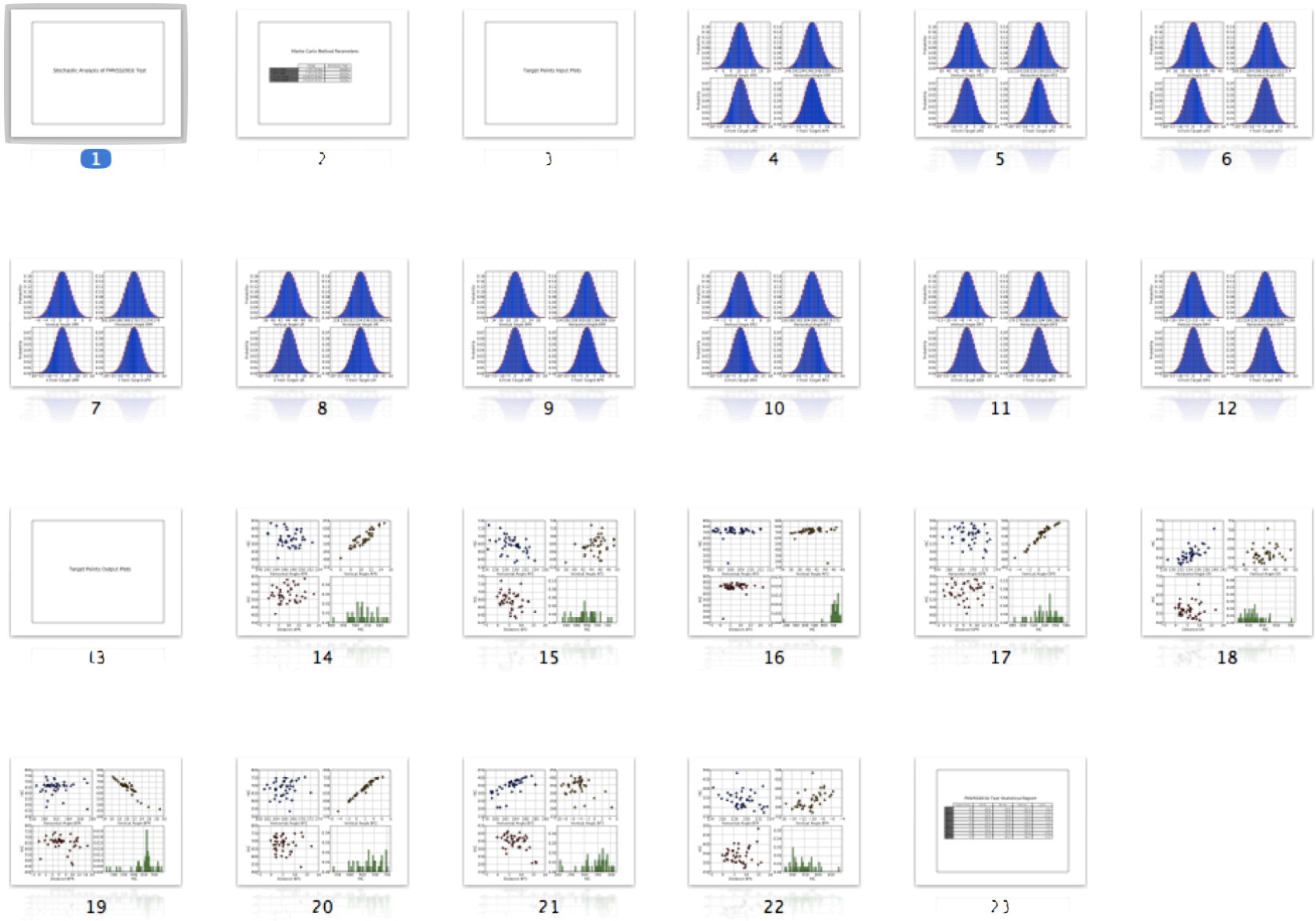
Normal Distribution



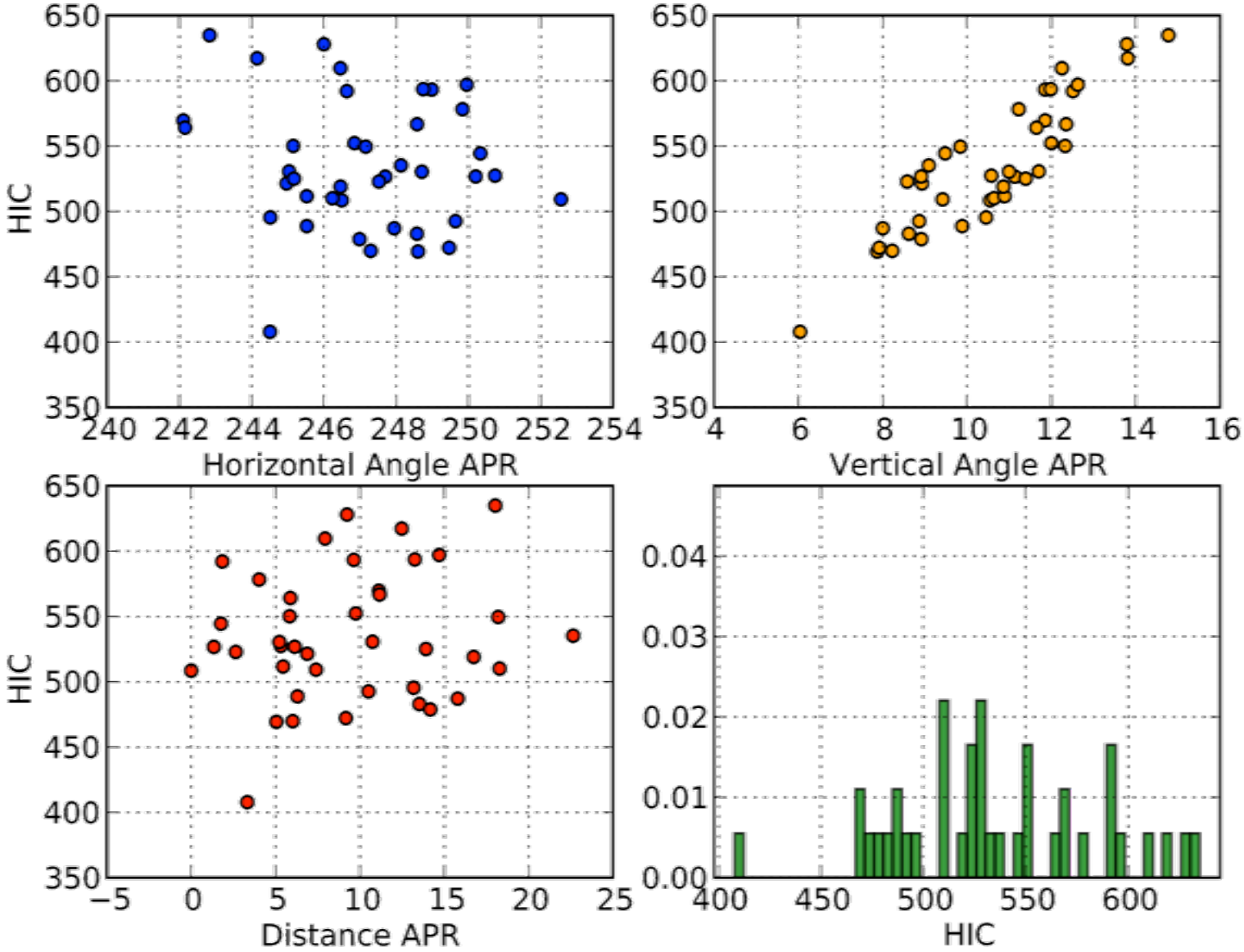
Uniform Distribution



Robustness Tool Report



Results



Instability Measure

Test	Number of Tests	min HIC	max HIC	mean HIC	CV(%)
APR	40	407.81	634.84	534.74	9.18
AP2	40	631.94	728.42	676.34	3.19
AP3	40	166.54	785.64	711.52	13.25
OPR	40	483.59	574.39	541.1	4.00
UR	40	513.53	707.05	569.03	6.42
BPR	40	462.25	739.94	648.75	9.28
BP2	40	532.02	754.00	679.77	7.43
BP3	40	207.78	411.97	342.36	14.52
BP4	40	271.08	483.41	339.67	12.65

What were the objectives?

- Identify and communicate the special characteristic and challenges of safety analysis
- Provide a powerful CAE environment with tools which meets the specialness of safety analysis
- Propose a stochastic approach through Robustness on Safety
- Introduce the Robustness tool in ANSA

Thank you…

…and visit us at our booth in the hall or at www.beta-cae.gr.

For questions and support:

ansa@beta-cae.gr