



Test case showing how to deal with test scatter in simulation optimisation

N. Rutjes

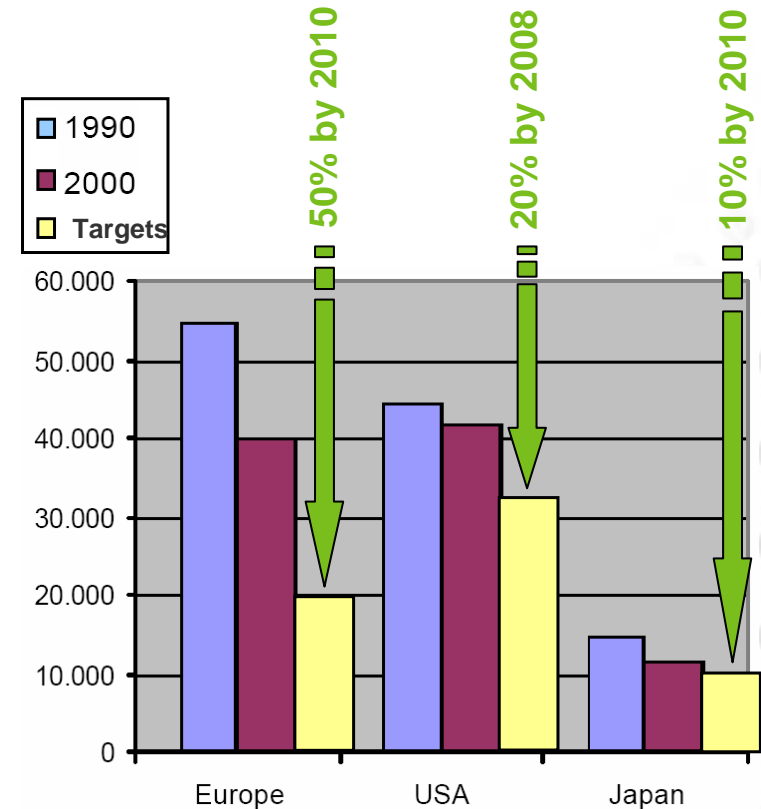
E. Van Hassel

Introduction

- Governments worldwide have set **ambitious targets for injury and fatality reduction** in traffic accidents
- Consumers are becoming increasingly safety conscious



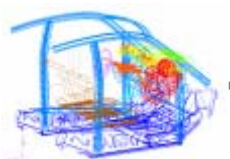
Car manufacturers use safety for product differentiation and image building.



Introduction



Baseline test or simulation



Geometry

Input

Efficient MADYMO Simulations



Mode Frontier

Design Optimisation

Innovative sled testing BASIS+

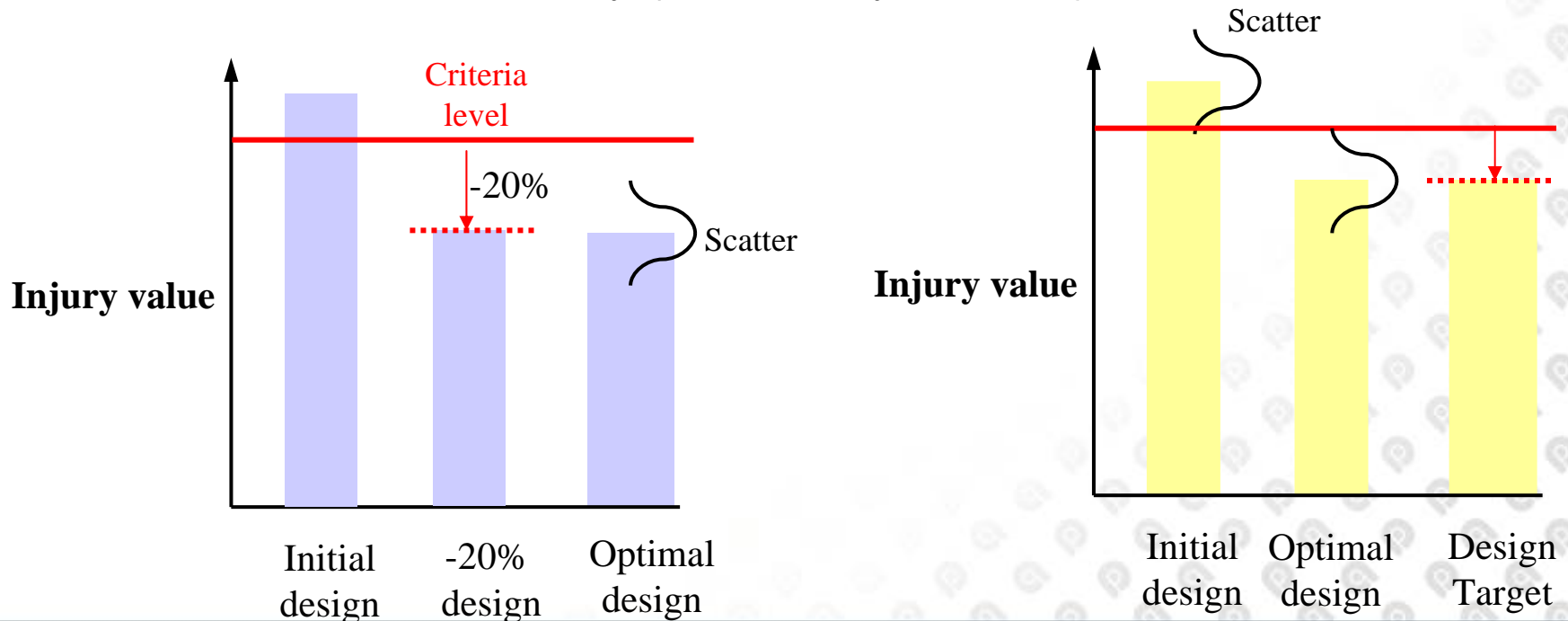


Minimise number of full-scale crash tests

Introduction

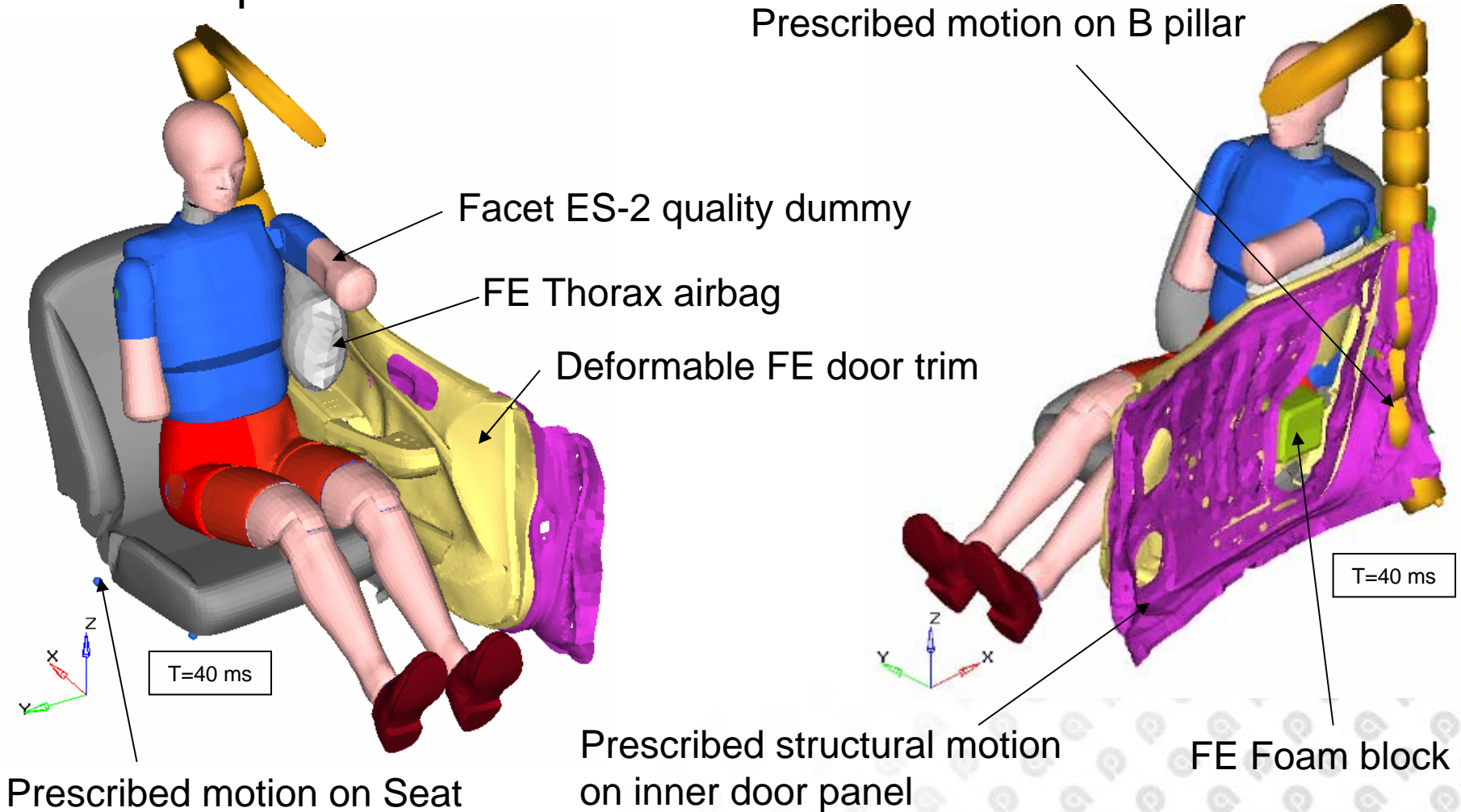
Repeated laboratory experiments show scatter due to:

- Testing tolerance (position, ...)
- Variation of dummy hardware
- Hardware variability (restraint system, ...)





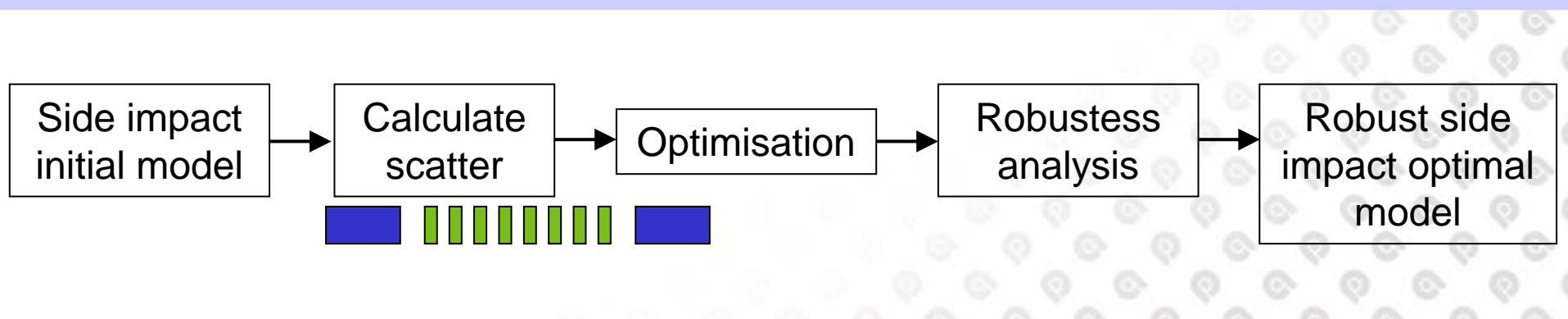
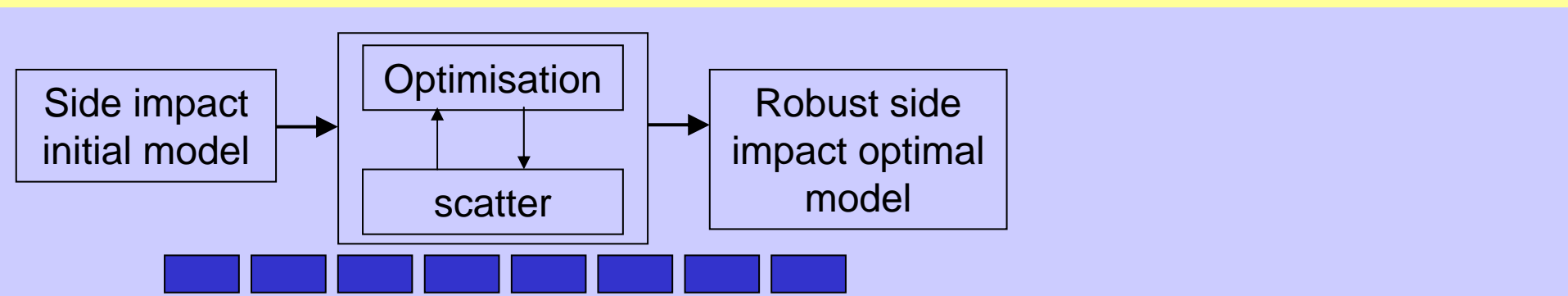
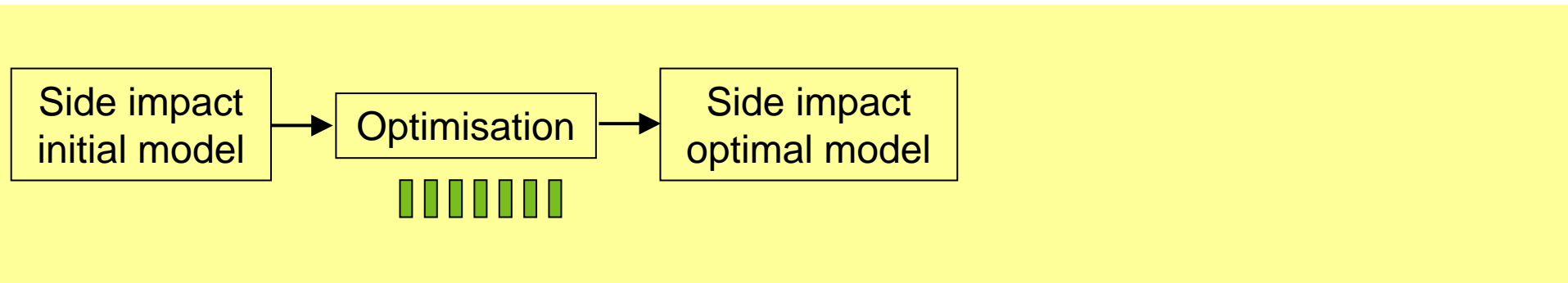
Introduction

- Side impact model



Method

 = 1 simulation
 = stochastic set of simulations

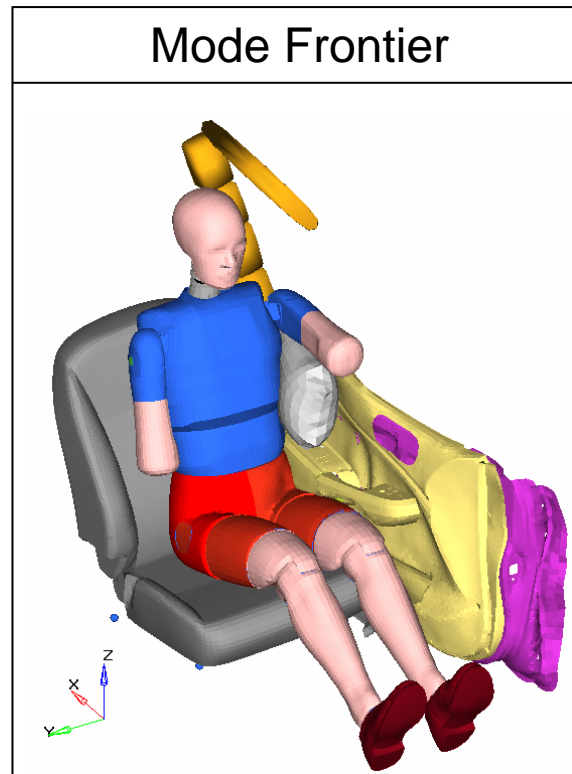


Method

- Stochastic analysis: calculate scatter

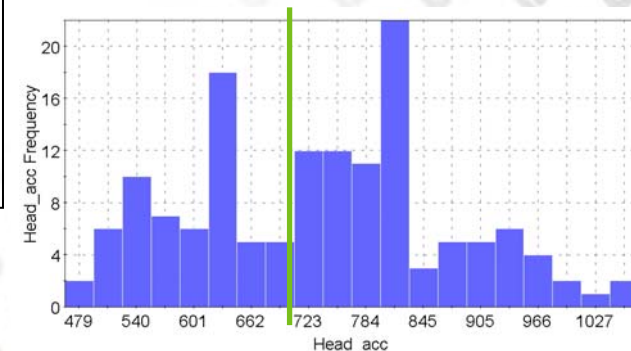
Parameters Mean & STD

- Testing tolerance (7) →
- Variation of dummy (12)
- Hardware variability (6)



MORDO: Montecarlo sampling n=150

→ Scatter on output (injury) parameters



Method

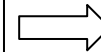
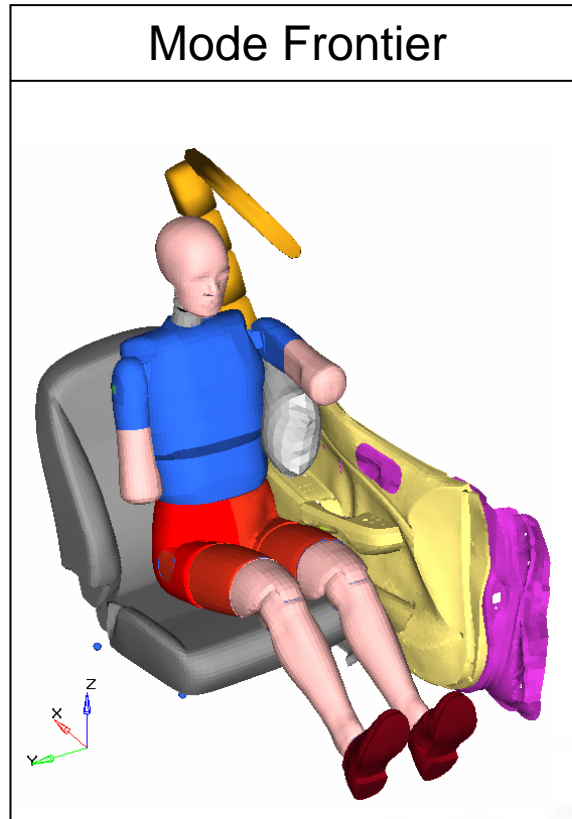
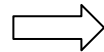
- Optimisation

Redesign parameters

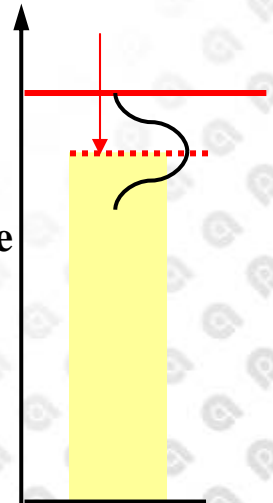
- Door trim stiffness
- Door foam block stiffness
- Airbag venting

+

Injury parameter
TEST SCATTER



Injury value

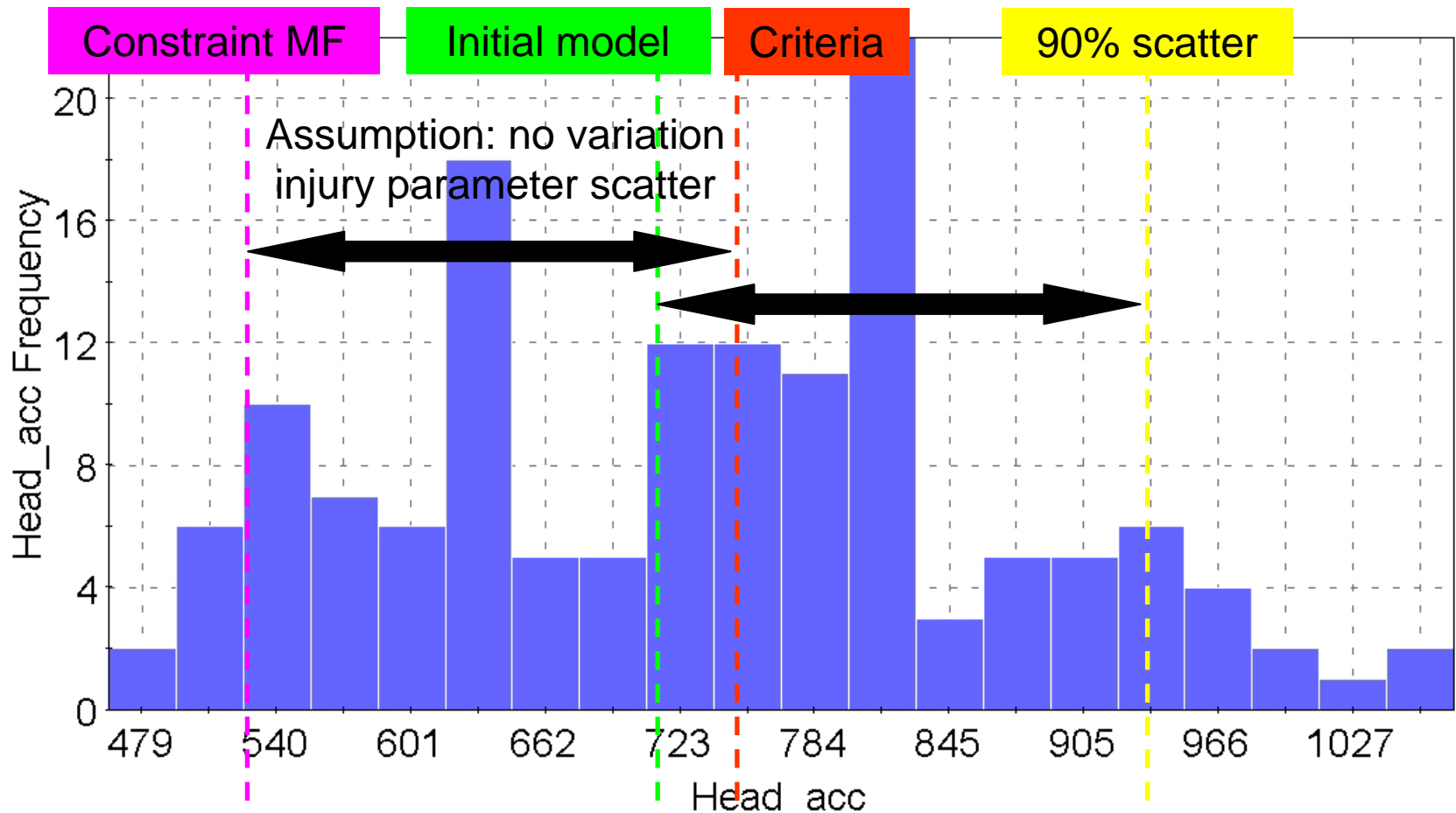


Design
Target

Multi Objective Genetic
Algorithm (MOGA)

Method

- Objective: minimal modifications on vehicle
- Constraints: (example Head acc)

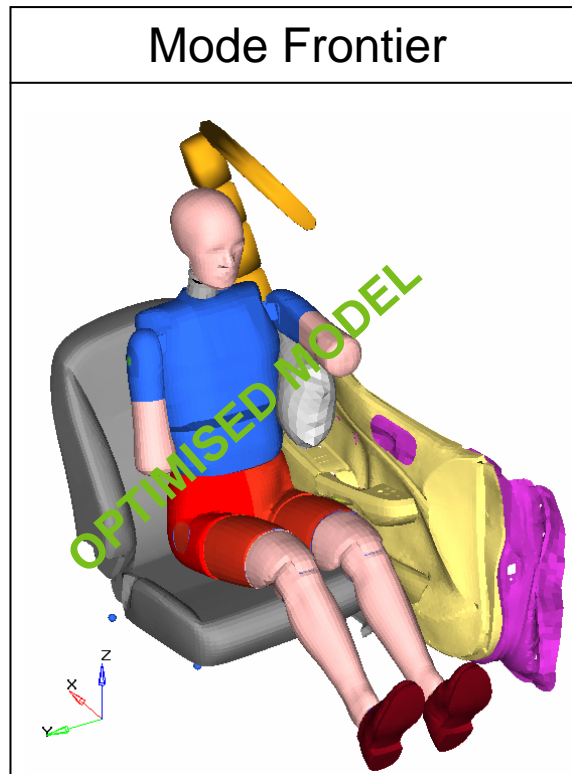


Method

- Robustness analysis

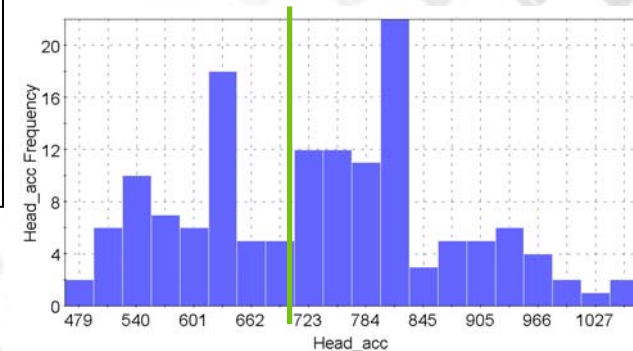
Parameters Mean & STD

- Testing tolerance (7) →
- Variation of dummy (12)
- Hardware variability (6)

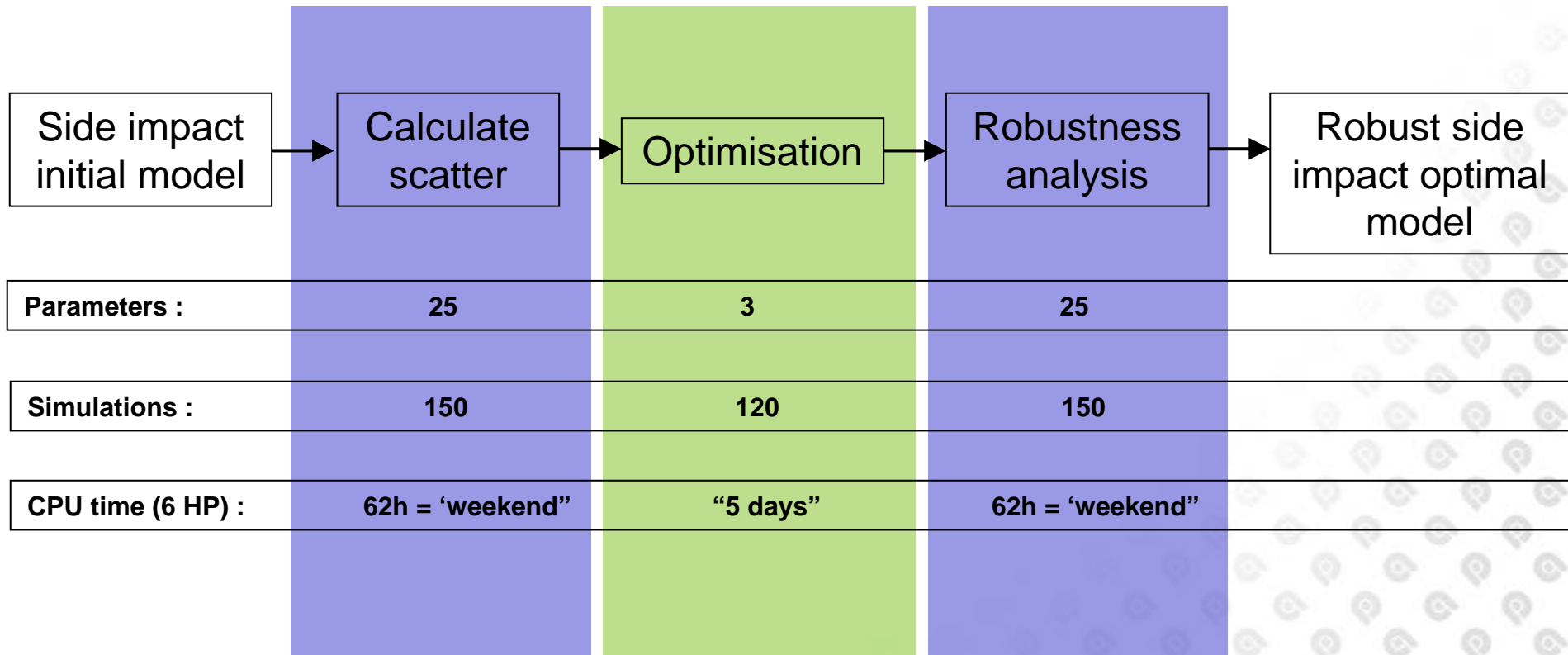


MORDO: Montecarlo sampling n=150

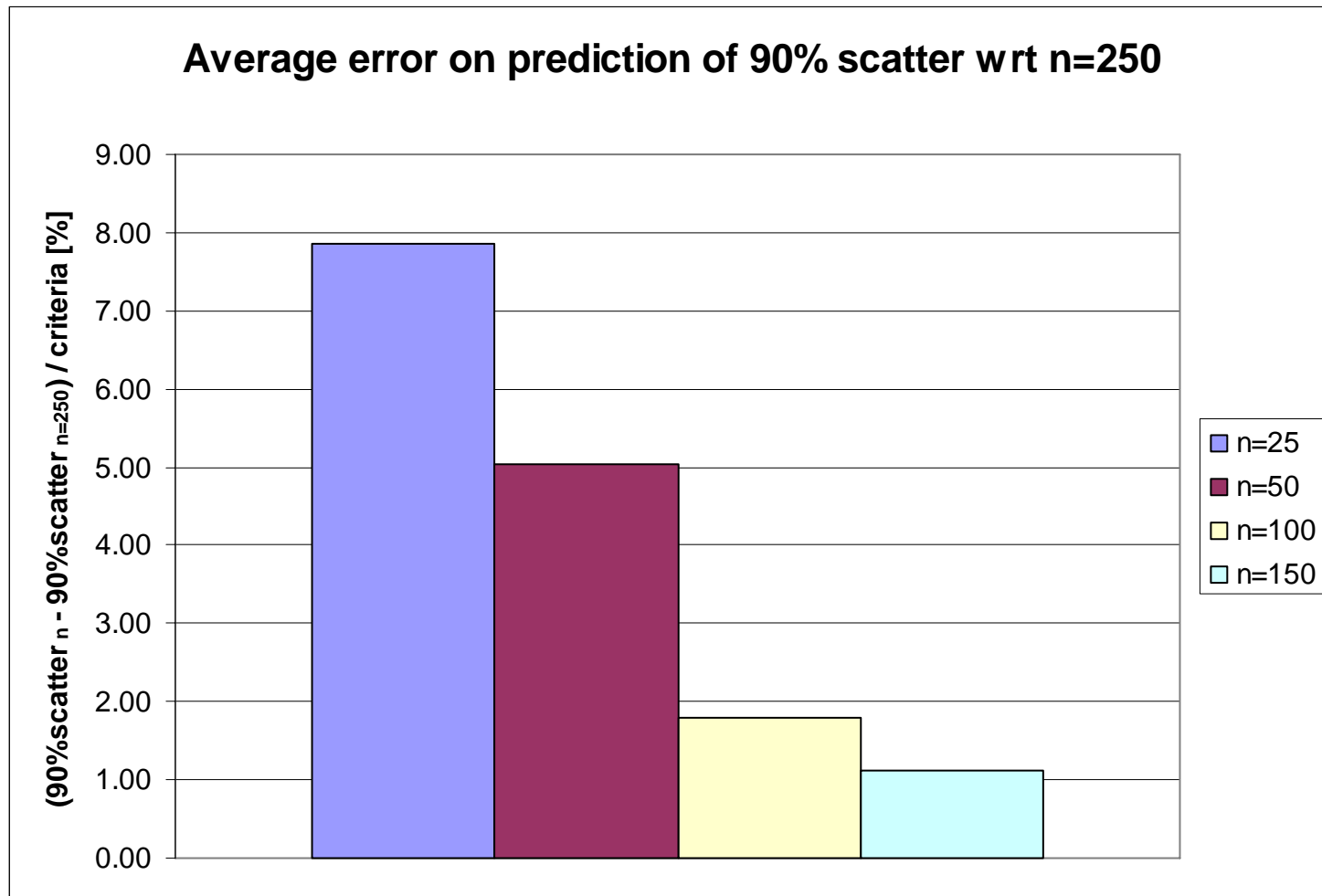
→ Scatter on output (injury) parameters



Results

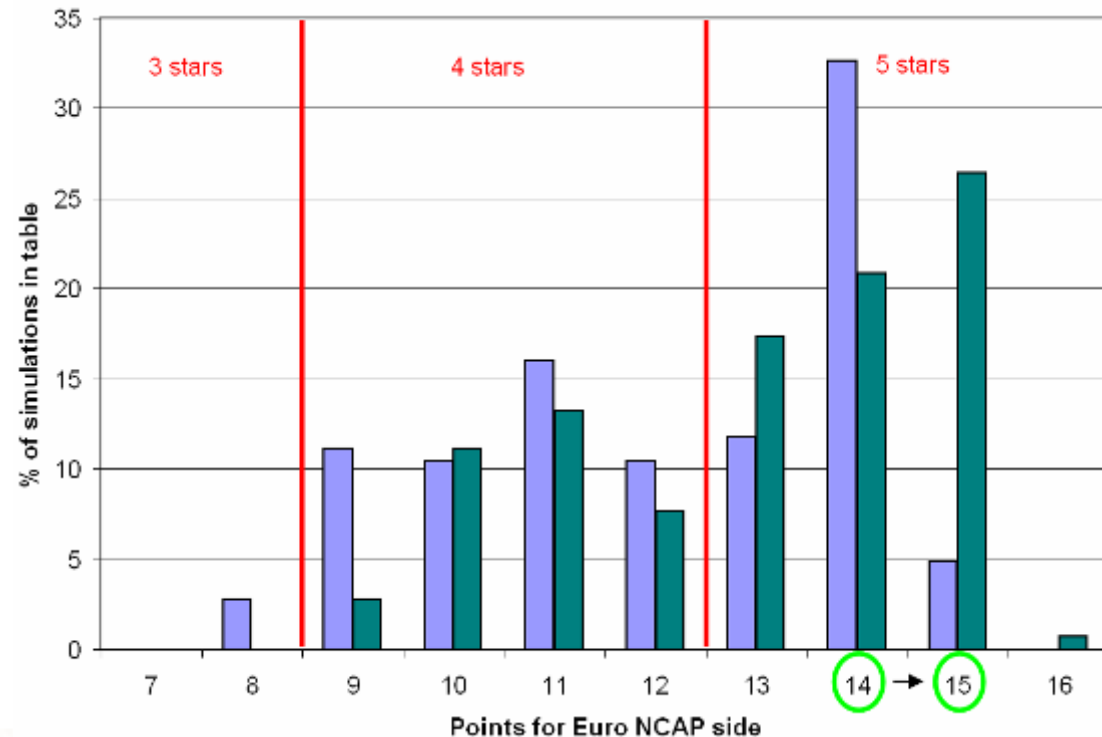


Results



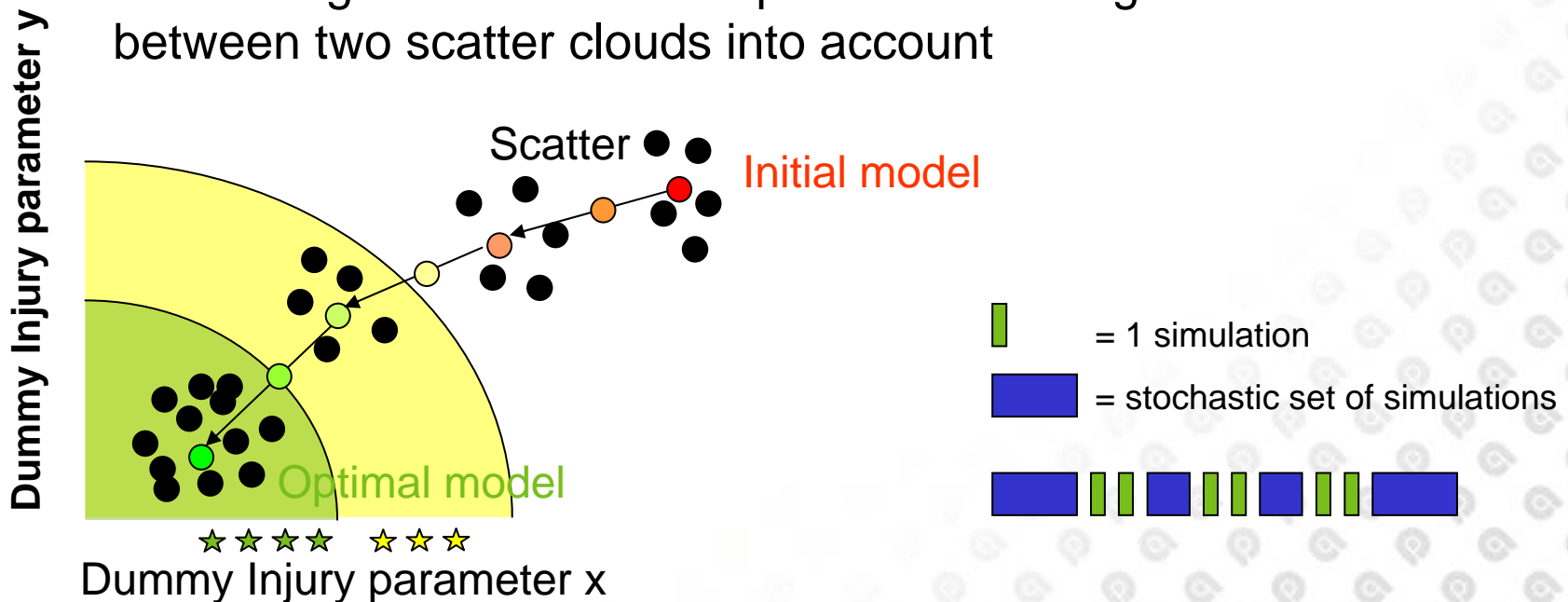
Results

- Simulation results:
 - Scatter injury parameters initial model and optimal model high similarity
 - 5 stars: 50 % initial (blue), 65 % optimal (green)



Discussion

- Robust optimisation possible with large cluster?
- Wishes for Mode Frontier:
 - Create parameters that characterise scatter for optimisation process, for example x % scatter
 - Include algorithm for robust optimisation taking zone between two scatter clouds into account



Questions

Questions?