Prediction of Simulation Results with Integration of SDMZIP in SCALE SDM Solutions

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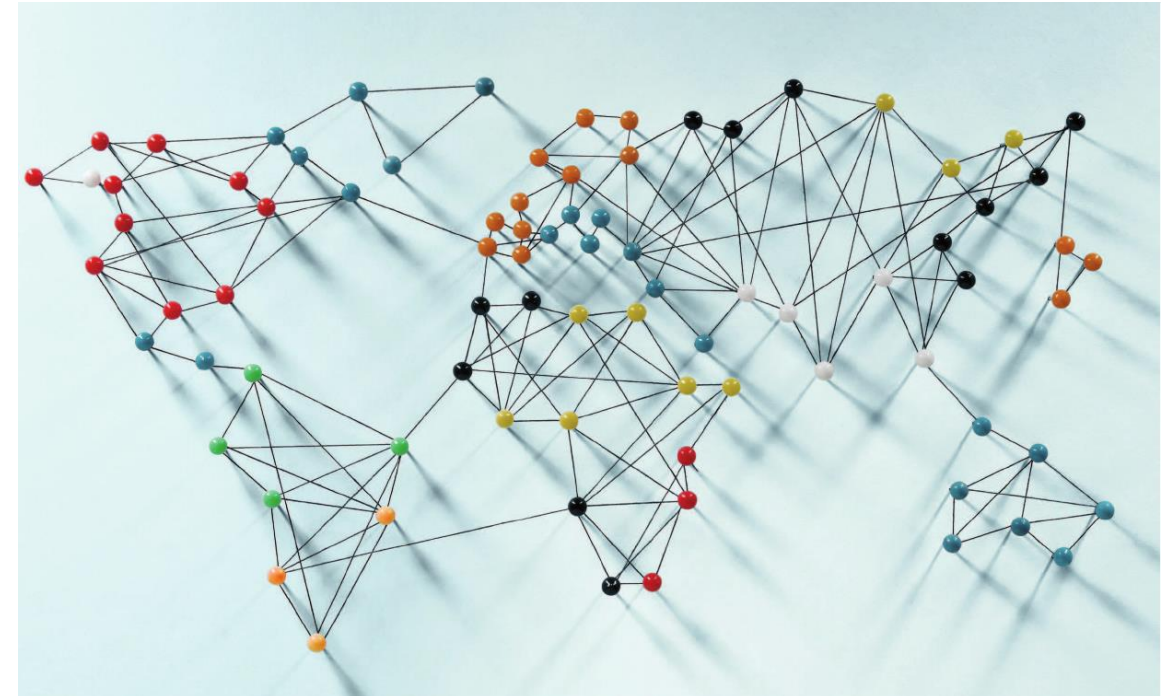
[1]SCALE GmbH

[2]SIDACT GmbH

automotive CAE Grand Challenge 2020
September 29 - 30, 2020
Hanau, Germany

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Outline

- Motivation & Aims

- Prediction tool

- Integration into SDM system
  - Requirements and workflow
  - Case study

- Conclusions & Outlook

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Motivation & Aims

- **Motivation**

  - Virtual design driven by many iterations

  - Each iteration costs computational time

  - Fast prediction for overview and decision of important test cases
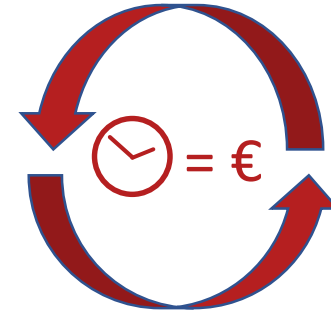
- **Aims**

  - saving time

  - reliable predictions ✓

  - First step towards more complex ML methods

  - All in one package: design, predict and visualize (SDM system integration)
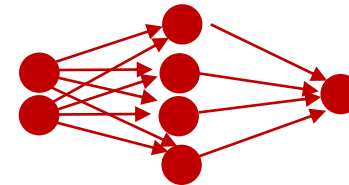
Prediction tool

ls-dyna | prediction

- Full analysis results without solver
- PCA
- SDMZIP

- Limitations
  - Predictions within linear range
  - No extrapolation
  - More predicted entities -> more base simulations necessary

- Developed by SIDACT *(Stefan Mertler)*
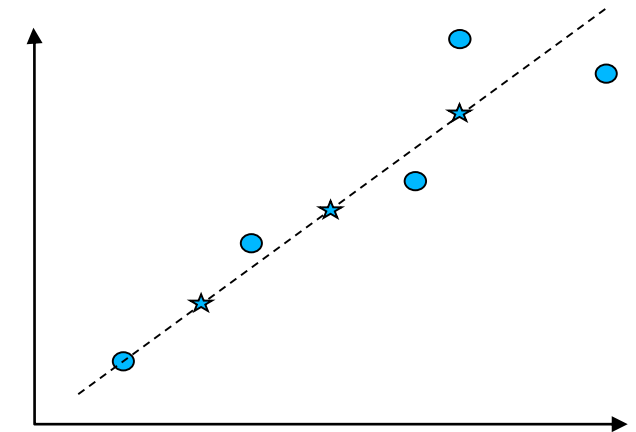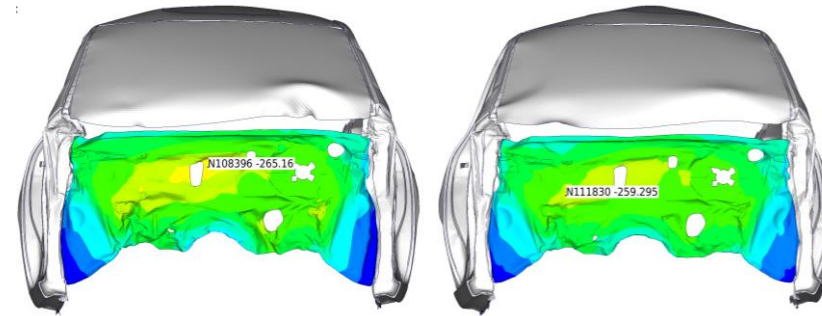
Known key values ⬤
New key values ★

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Integration into SDM System: SCALE.model

- **Required components**
  - SCALE SDM
  - Solver:
    - LS-Dyna
    - prediction tool
  - A4, Geco
  - SDMZIP

switch between model and results

version control for overall project

version control for selected objects

product structure

model variants

model data

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Integration into SDM System: SCALE.result

- ### Required components
  - #### SCALE SDM
  - #### Solver:
    - ##### LS-Dyna
    - ##### prediction tool
  - #### A4, Geco
  - #### SDMZIP

switch between model and results

filtering

model variants

result data

Compare run and test data

Bottom View Crash

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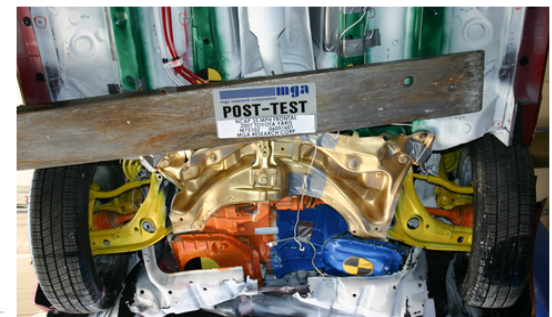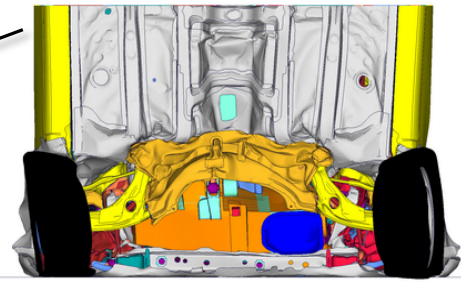
Integration into SDM System: Workflow

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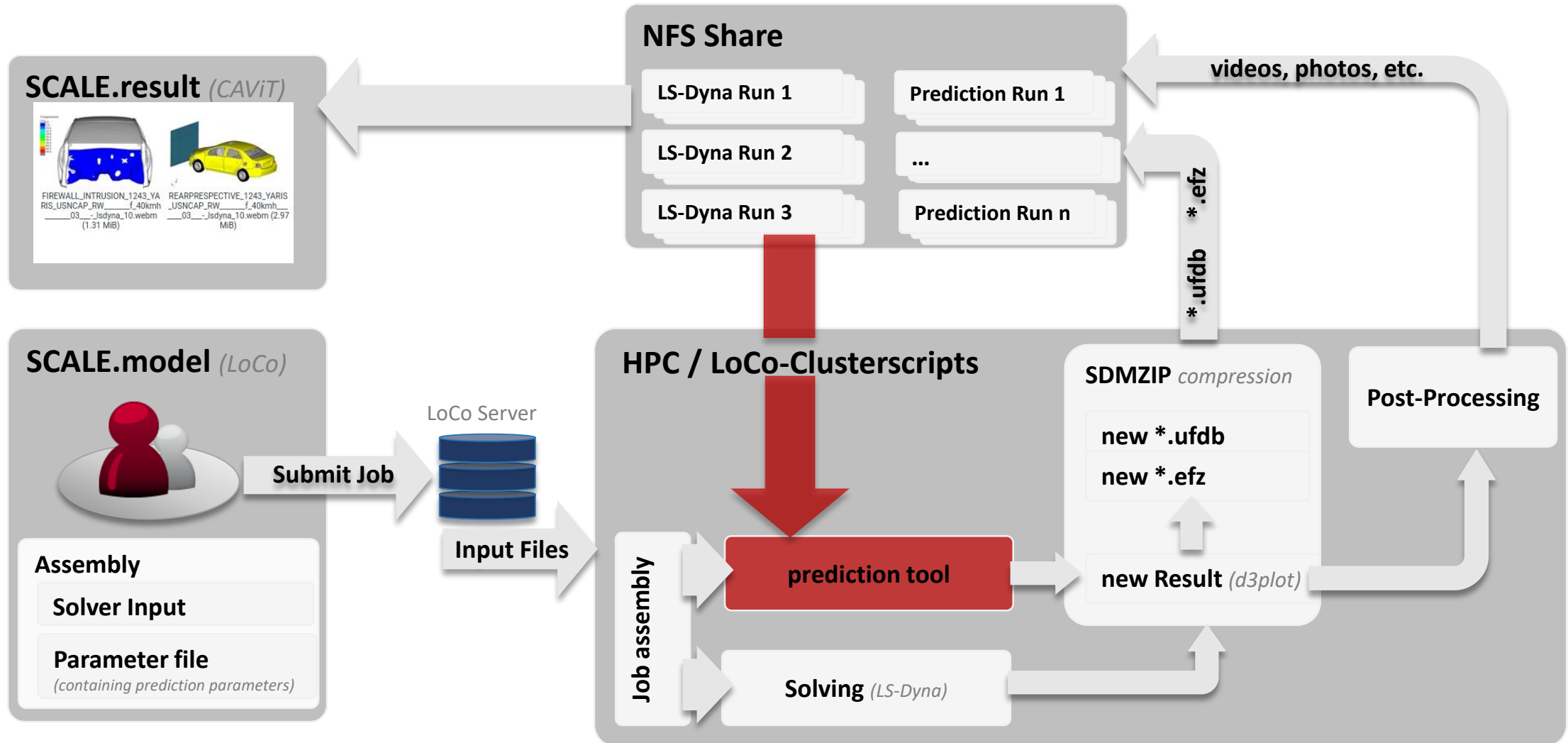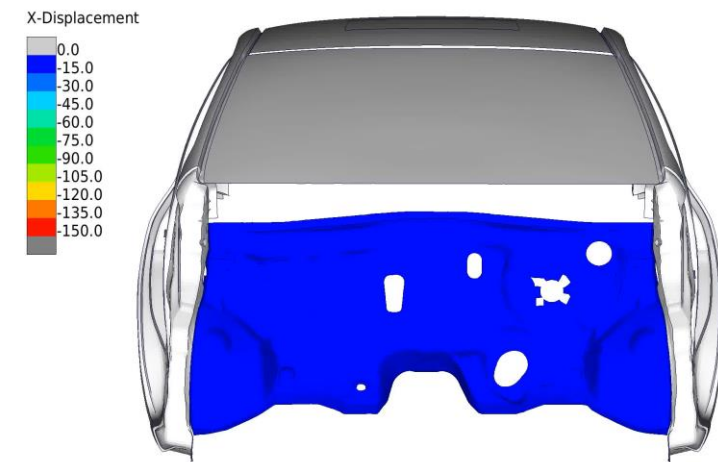
Integration into SDM System: configuration
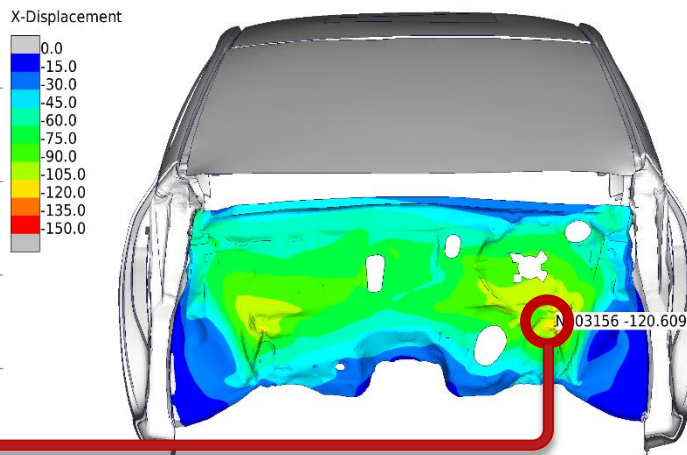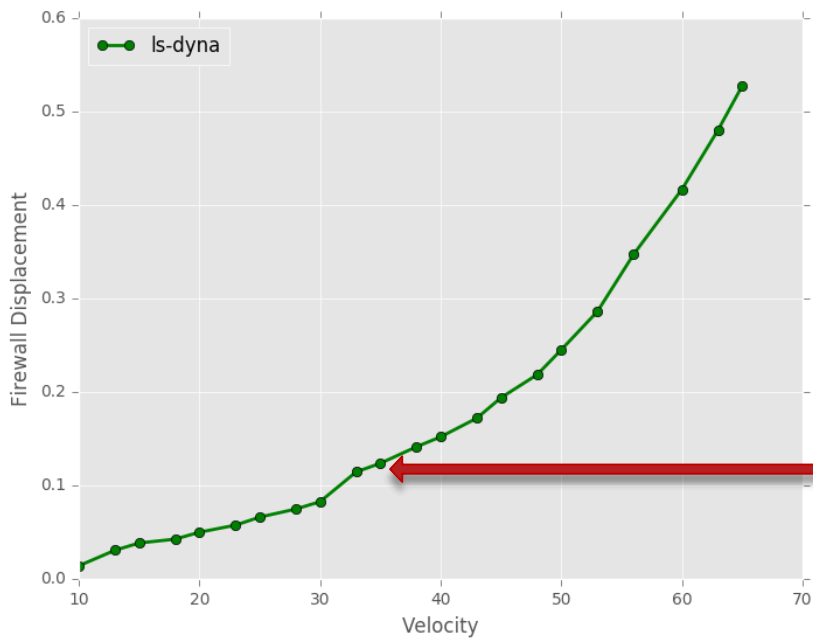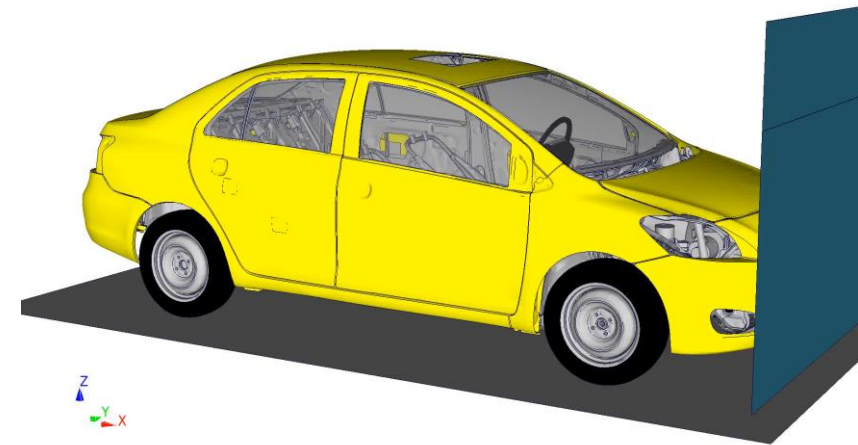

3 ls-dyna base runs

21 prediction runs

configuration:
Solver = prediction tool

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Prediction: full factorial analysis

- Yaris
- Frontcrash with variable velocity (10 - 65kmh)
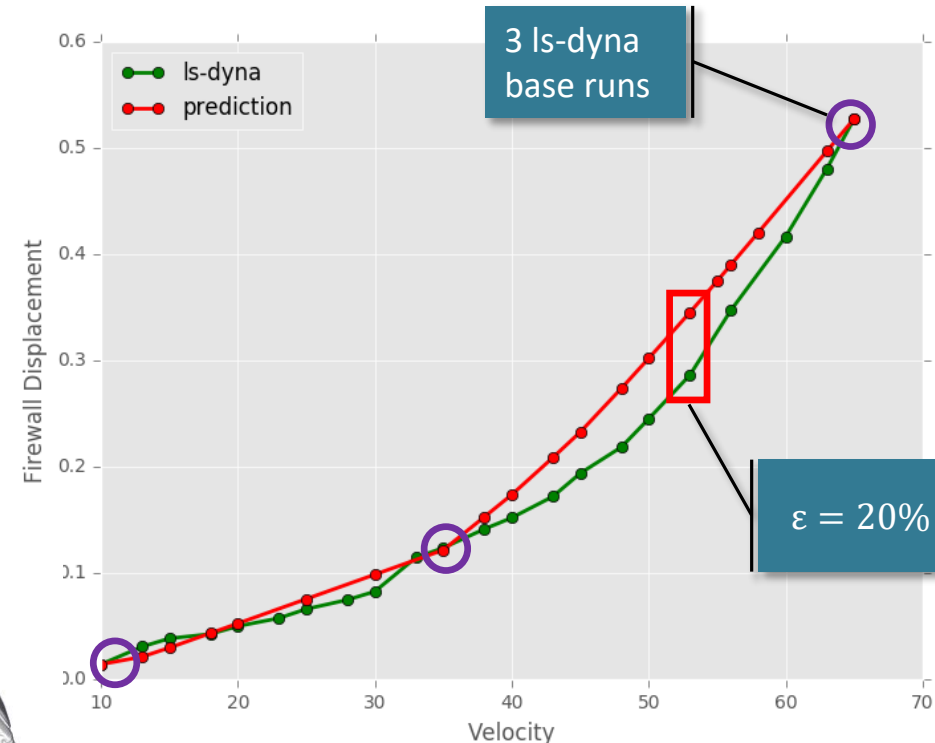- Measure: Firewall displacement

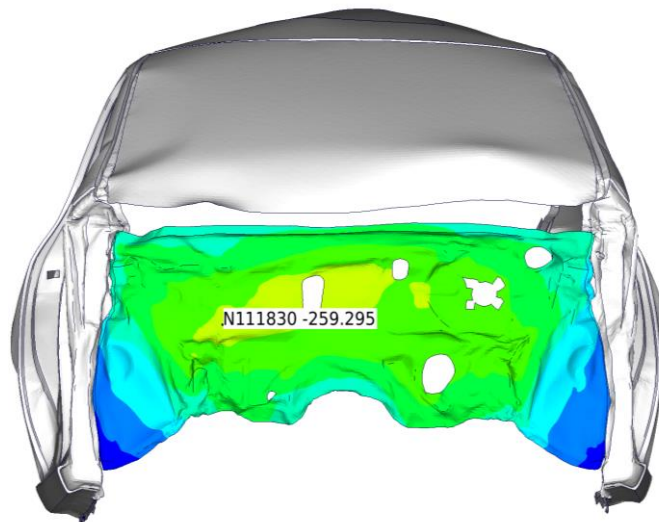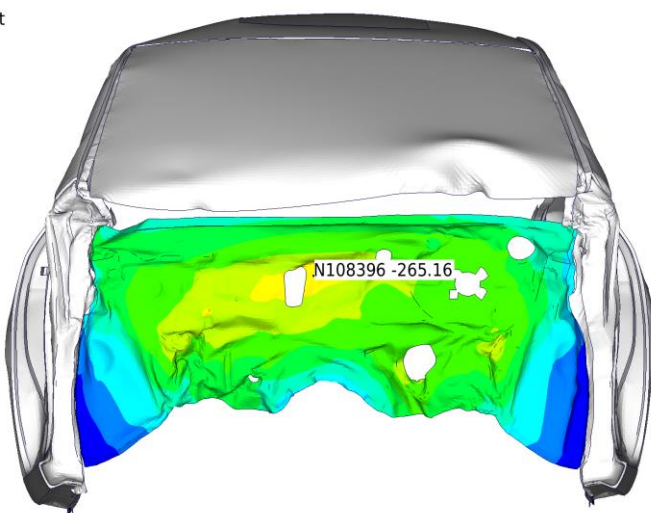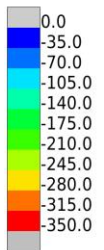SIDACT GmbH   SCALE   carhs. Empowering Engineers

Prediction: validation and error analysis

- All: 24 run / ls-dyna: 3 runs / predicted: 21 runs

- Mean error $\bar{\varepsilon} = 12\%$ (worst: 31%; best: 1.9%)

$\varepsilon = 20\%$

ls-dyna | prediction

X-Displacement

| 0.0 |
| -35.0 |
| -70.0 |
| -105.0 |
| -140.0 |
| -175.0 |
| -210.0 |
| -245.0 |
| -280.0 |
| -315.0 |
| -350.0 |

N108396 -265.16

N111830 -259.295

3 ls-dyna base runs

$\varepsilon = 20\%$

Predicition: benefits

- Getting a d3plot file without having to use a solver

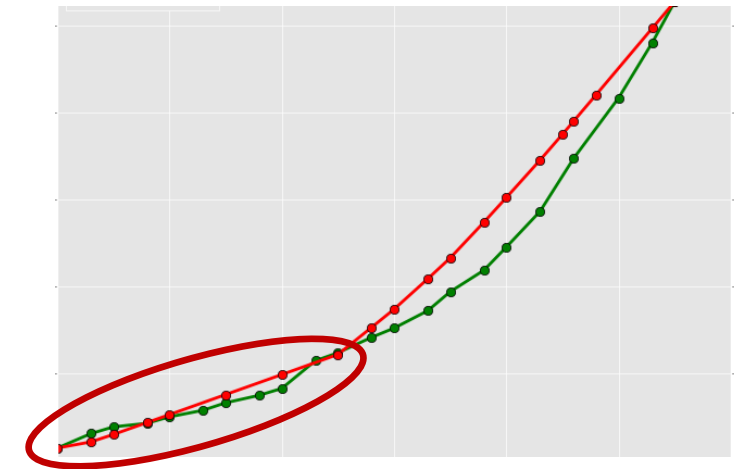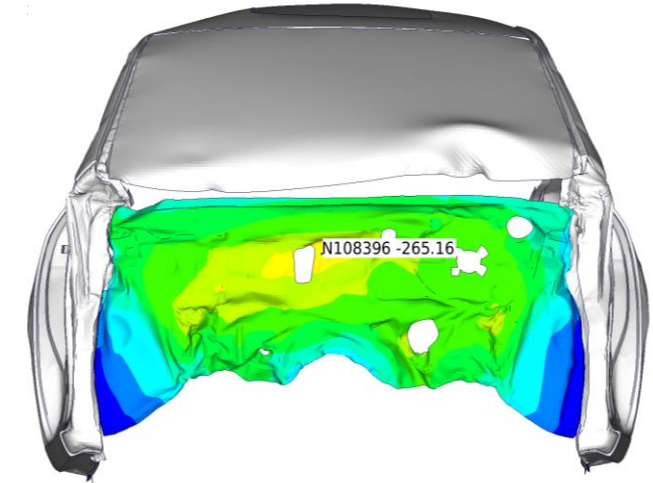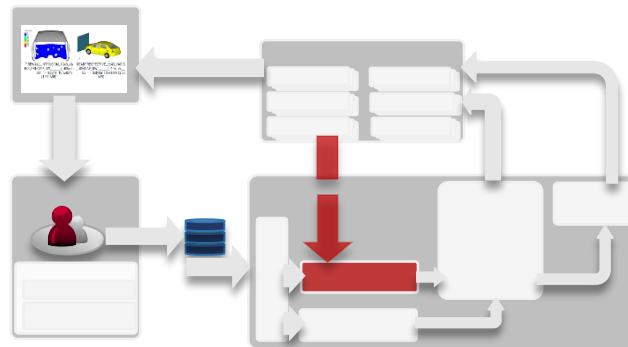- Run-Time 🕐
  - LS-Dyna (12CPU): 8h10min 😴
  - Prediction (1CPU): 0h02min ☕

- Good accuraccy for linear correlation

- Integration into Tool-Chain

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Reference solution using meta modell (quadratic polynomial)

- **SCALE.result AdOn** *(under development)*

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Reference solution using meta modell (quadratic polynomial)

- Polynomial regression
- Mean error = 15% (worst: 4
- No full solver output (d3plo

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Comparison prediction <-> quadratic metamodel

- **prediction** ——————
  - linear
  - d3plot included

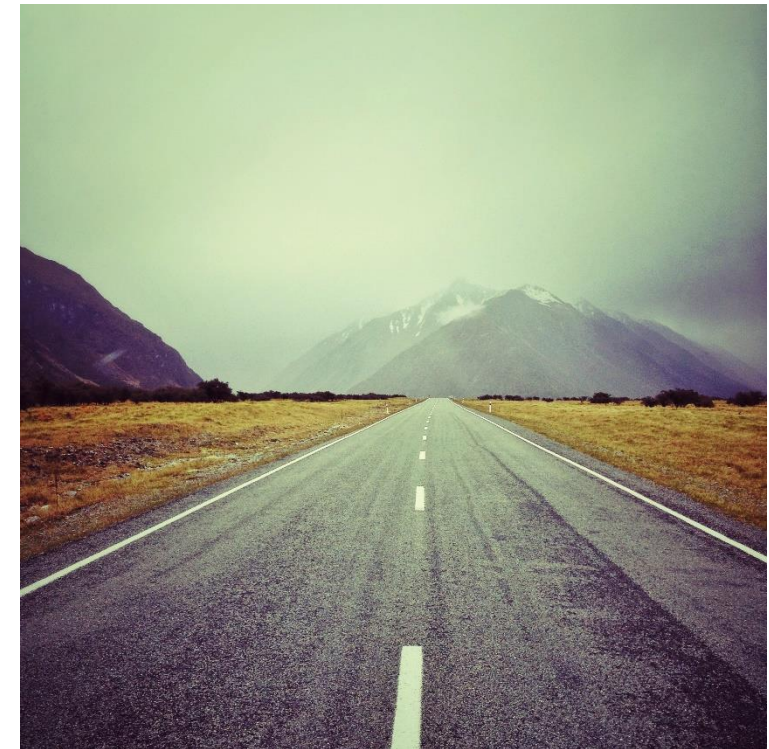- **metamodel** ——————
  - quadratic
  - cheap, fast, easy
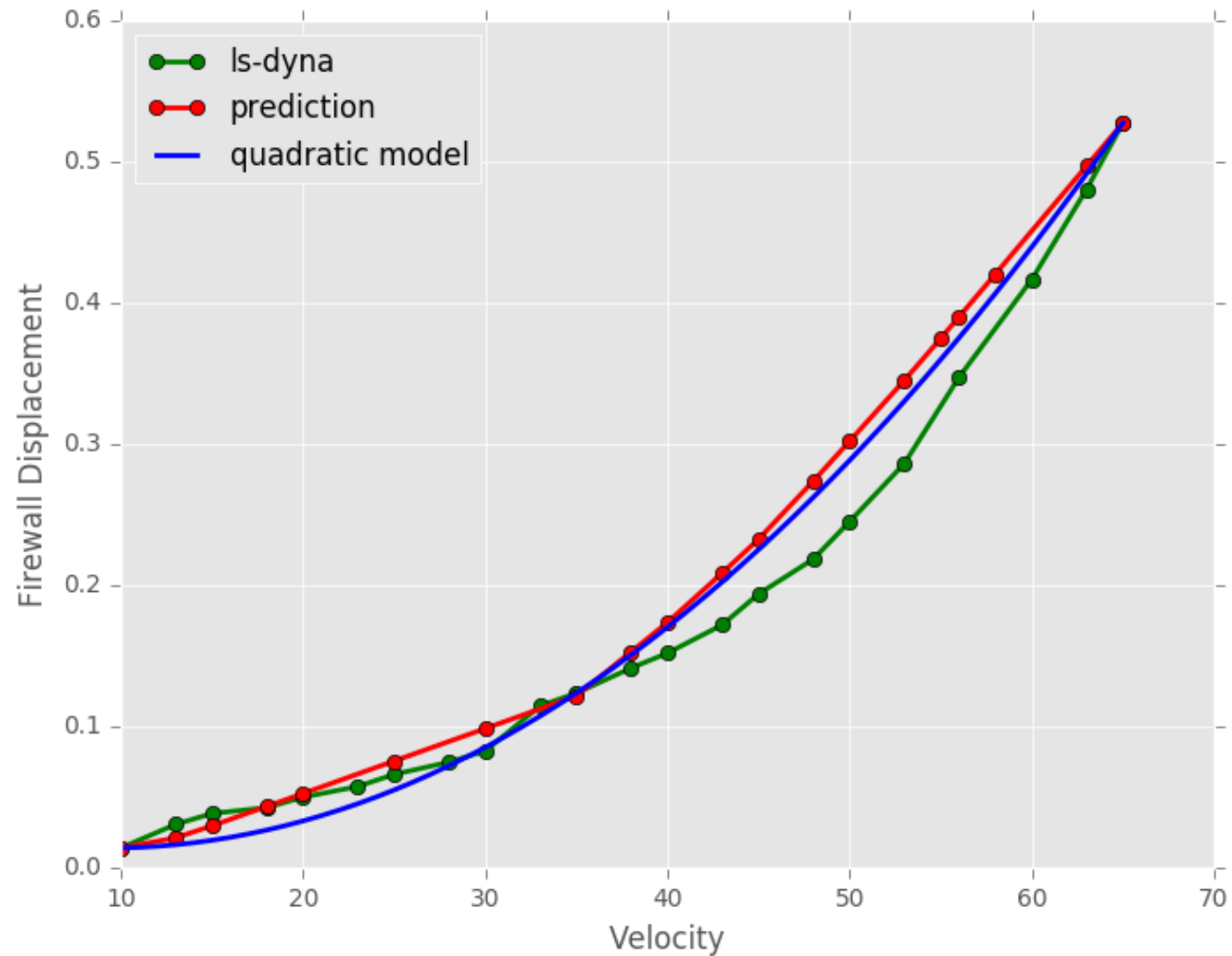
Conclusions & Outlook

- **Conclusions**

  - Integration into CAE-Workflow

  - Results for given example quite accurate

  - Less simulations and computational time necessary

- **Outlook**

  - Prediction tool has to be investigated further

    - E.g. more dimensional predictions

  - Integration of other (ML) methods into SDM system

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