

# Enabling Big Data Analysis in SDM Systems

## Add-on based Integration of ML Methods

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# Integration of Advanced third-party Data Analysis Approaches into SDM Systems

**Leichsenring, F.,** Liebscher, M., Thiele, M. - *SCALE GmbH*  
Abdelhady, N., Borsotto, D. - *SIDACT GmbH*  
Kracker, D. - *Dr. Ing. h.c. F. Porsche AG*

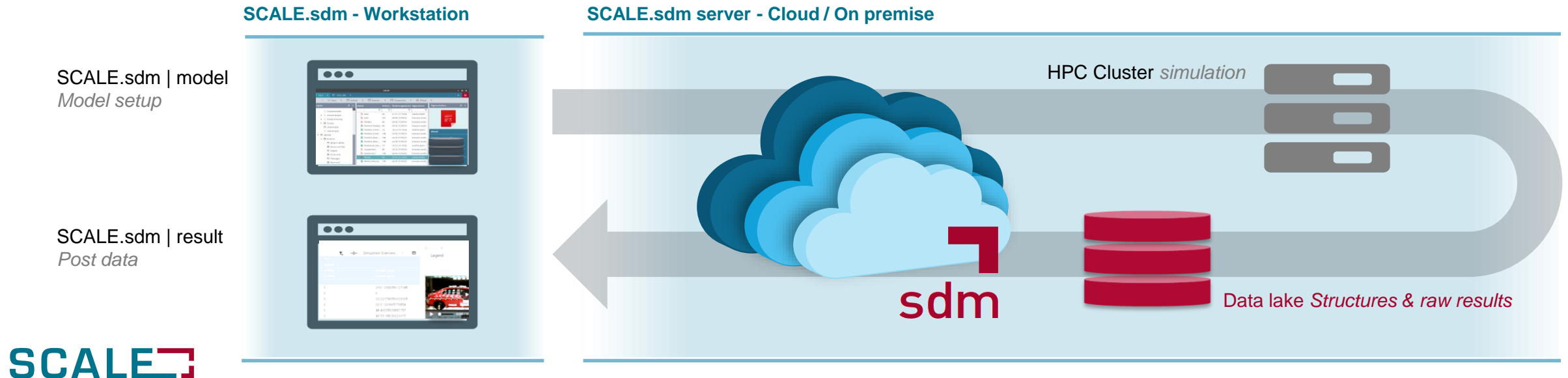
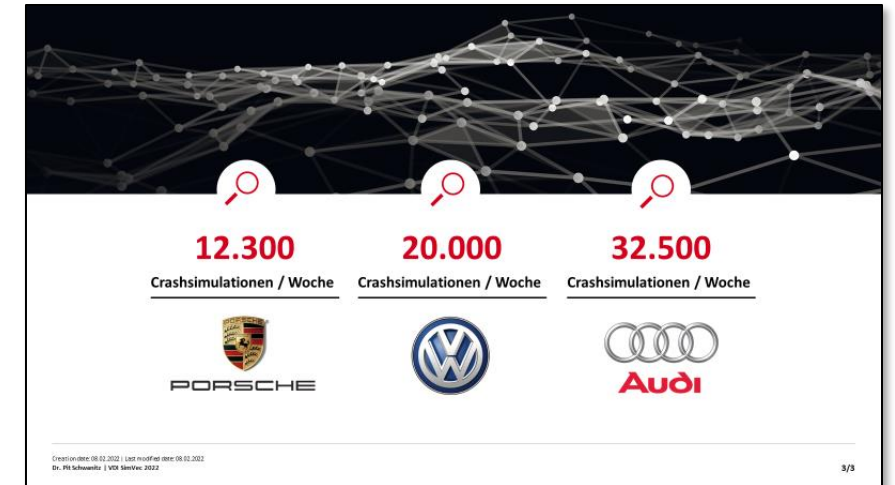
18<sup>th</sup> - 19<sup>th</sup> October 2023 LS-DYNA Conference, Baden-Baden

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# Motivation

## Large Data sets available in SDM Systems

- Huge number of simulations every day
- Some OEMs with > 1.5 Million simulations per year  
*(just crash domain only)*
- Data stored at central place



# Motivation

## Advanced ML/AI Methods:

- often custom / proprietary
- SDM provides standard methods
- Domain-specific methods required  
*(specific methodologies are often required but not part of standard software or implementations)*
- ML/AI Methods custom developed  
*(in-house, proprietary or even open-source based)*

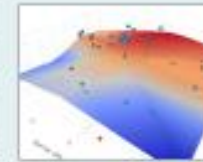


## Key Features

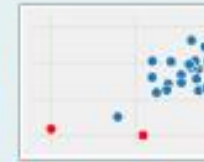
### Available



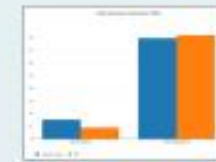
**Correlation**  
Anthill plots



**Visualization**  
Scatter plots  
w response surfaces



**Outlier Detection**  
for scalars



**Sensitivity Analysis**  
nonlinear Sobol indices

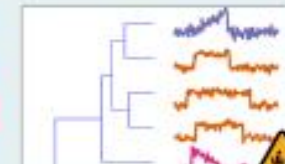


**Meta Modeling**  
NN based / Polynomial

### In Development / Integration options



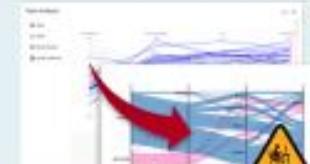
**Amazon QuickSight  
Amazon Sagemaker**  
Serverless Analysis Solution  
<https://aws.amazon.com/de/quickights/>



**Time Series Classification**  
Labeling / Error Detection  
Q3/2021



**SIDACT/SCAI  
Event Detection**  
Outlier Detection on  
Simulation / Part level



**Permissible Design Ranges**  
Detects input ranges leading  
to permissible designs

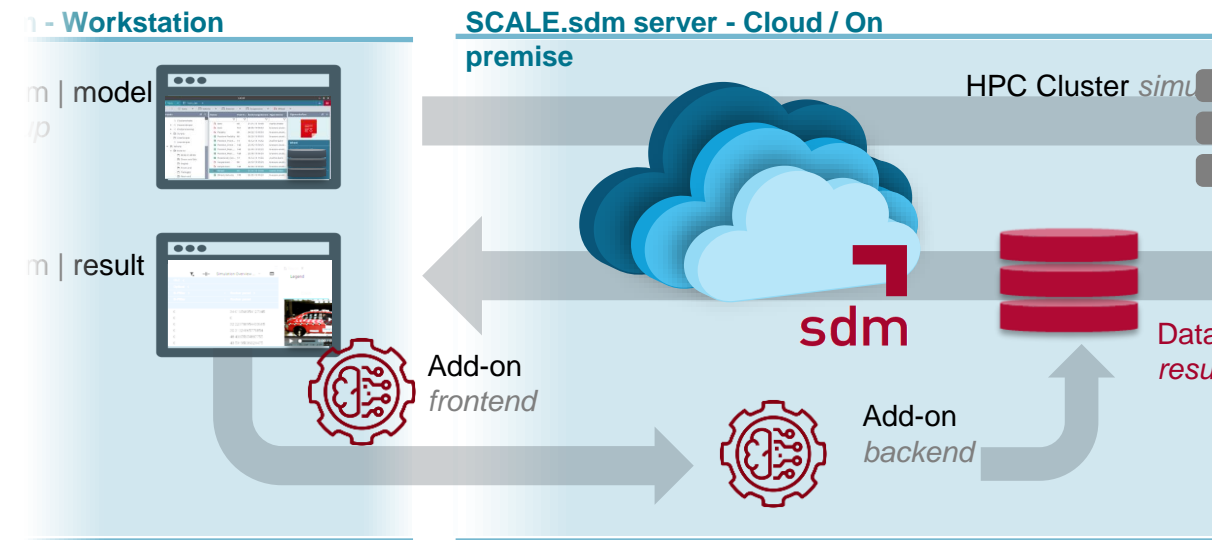
# Motivation

## Problem

- Application of AI/ML methodologies implies scanning large data sets
- Implementation close to data required vs. custom implementation

## Solution @ SCALE.sdm

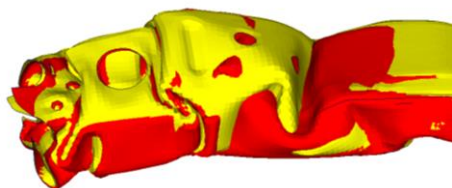
- Add-on concept available
- Distribution of own code to **backend** and **frontend** side in SCALE.sdm possible
- Full structured access to data within server environment



# Example SIDACT Event Detection: ML based anomalie detection

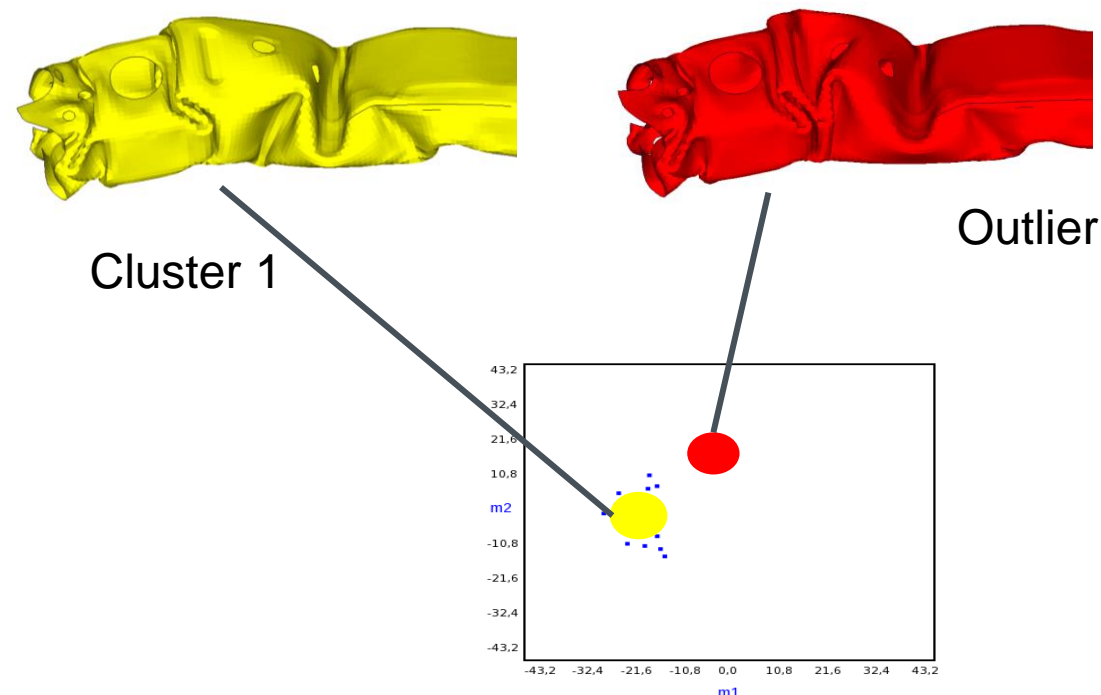
## What is an event?

- Unknown/unwanted behavior
- anomalies in field variables

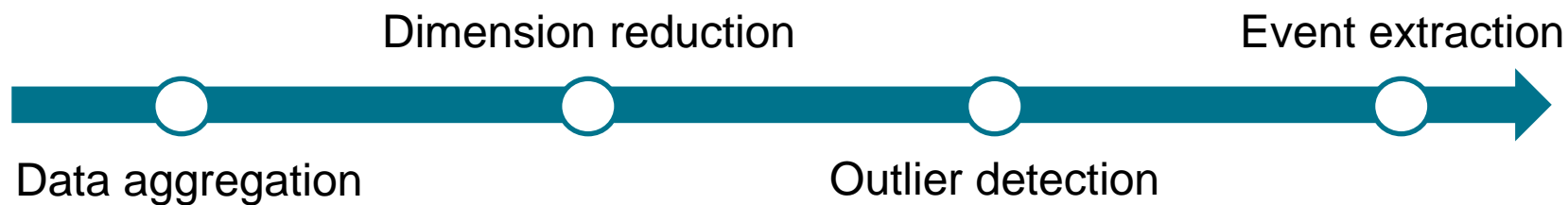


## Event Properties

- Location/Parts
- Outlier Score
- Event type



## Basic Workflow





# Example SIDACT Event Detection: ML based anomalie detection



Scan all incoming simulations



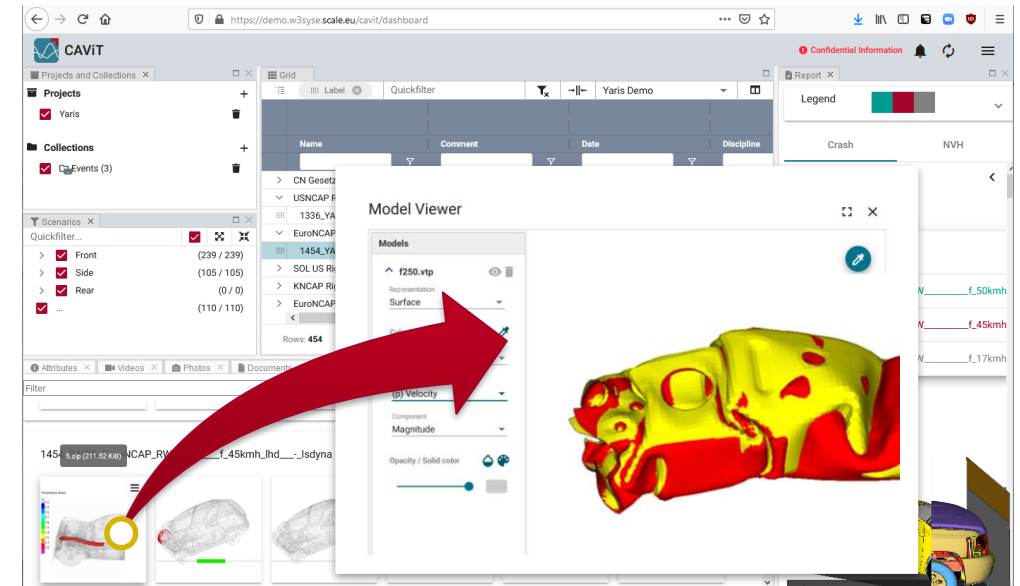
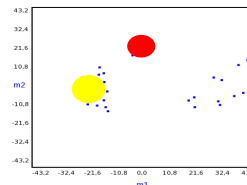
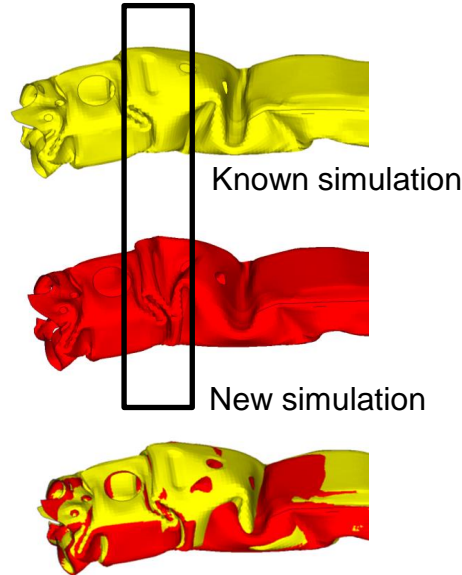
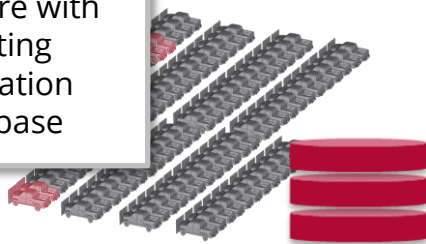
Detect anomalies (*events*)



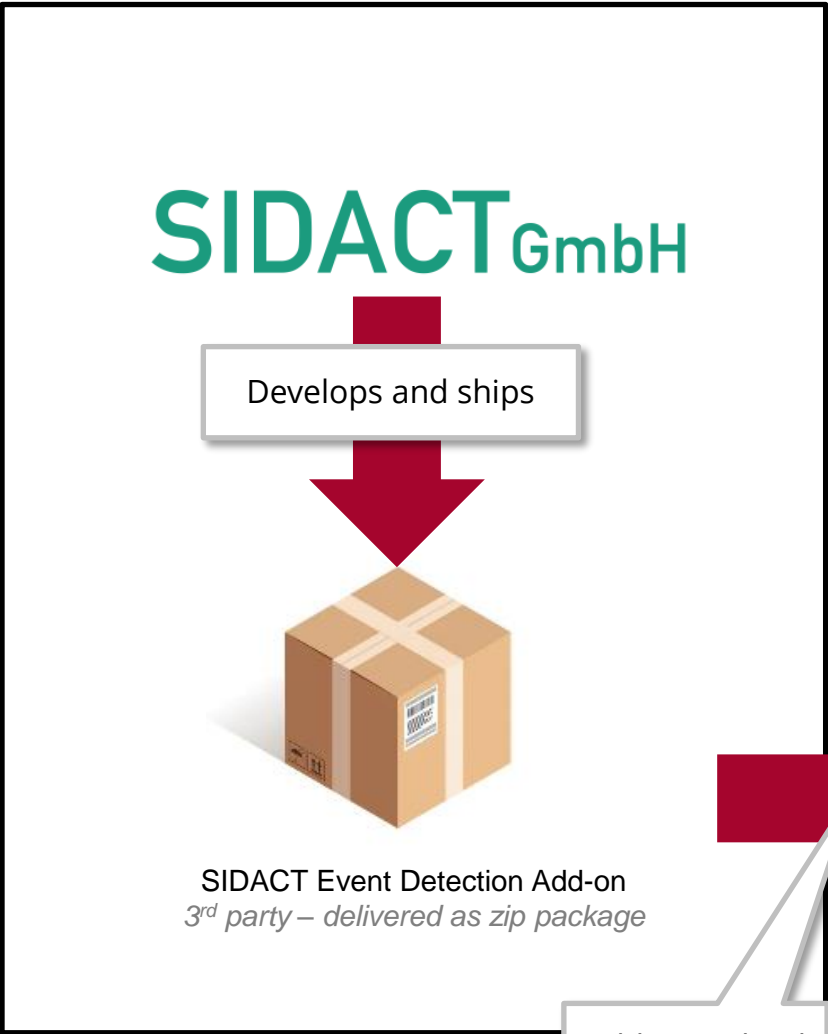
Integrate Process and Evaluation in SCALE.sdm



Compare with existing simulation database



# SIDACT Event Detection Add-on



Add-on upload

## Frontend



## Backend



Admin

- MDM
- Result
- Project
- Add-ons**
- User Management
- Announcements
- Jobs
- Settings

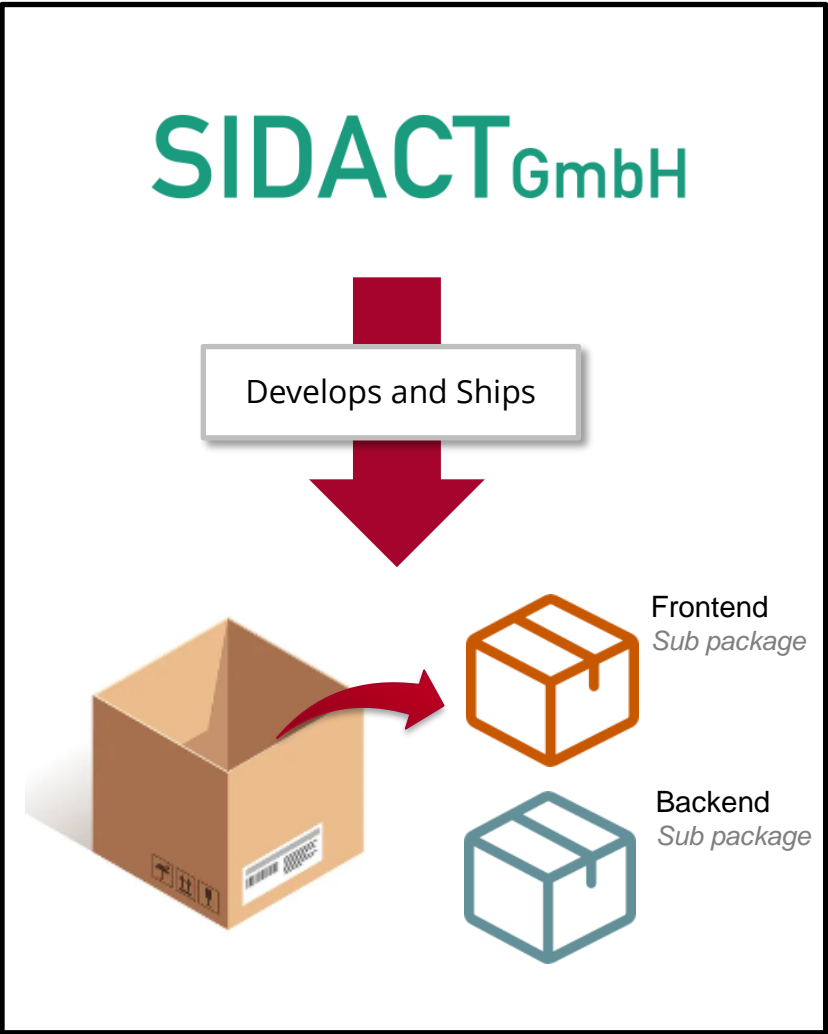
Add-ons

Schedule	Name	Version	Modified	Type	Next Execution	Status
→	3D Viewer	4.1.0	Sep 26, 2023, 8:44:05 AM	Browser Add-on	-	<input checked="" type="checkbox"/>
→	Event Detection	b3ad9926b	Sep 27,			<input type="checkbox"/>
→	Show in SCALE.model	f1b1af4c	Sep 27,			<input type="checkbox"/>
⌚	Scale Backup	0.1.1	Sep 17,			<input type="checkbox"/>
→	ISO-MME Format	1.1.4	May 23,			<input type="checkbox"/>
→	NVH Report	1.0.0	May 23,			<input type="checkbox"/>
→	SCALE.Model Tools	0.0.0	May 23,			<input type="checkbox"/>

SCALE.sdm  
Add-on management  
console



# SIDACT Event Detection Add-on

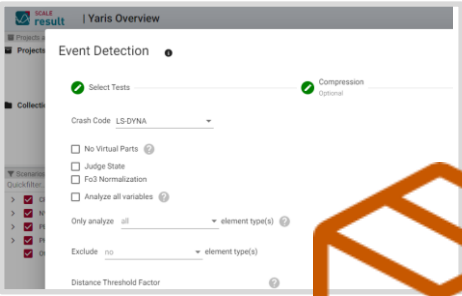


## Frontend

SCALE.sdm | result  
Post data



Extends frontend



## Backend



Extends backend

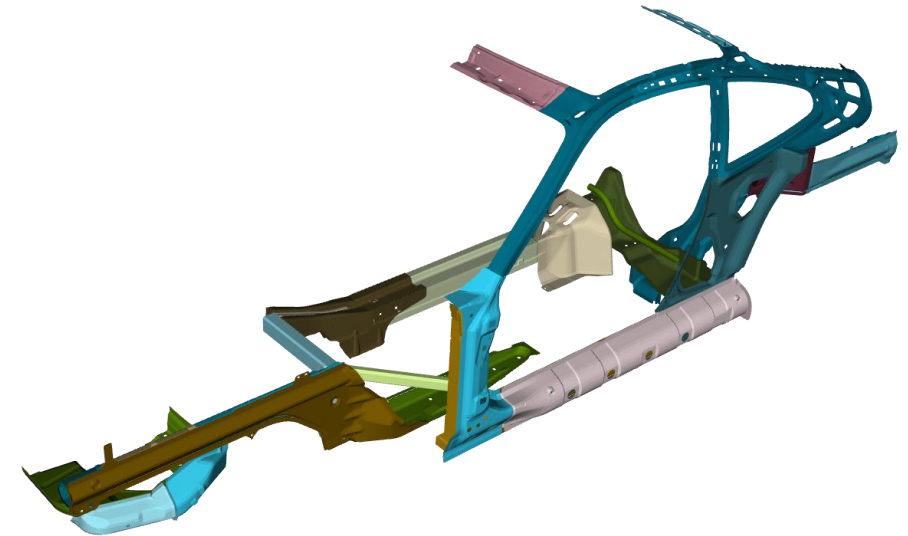
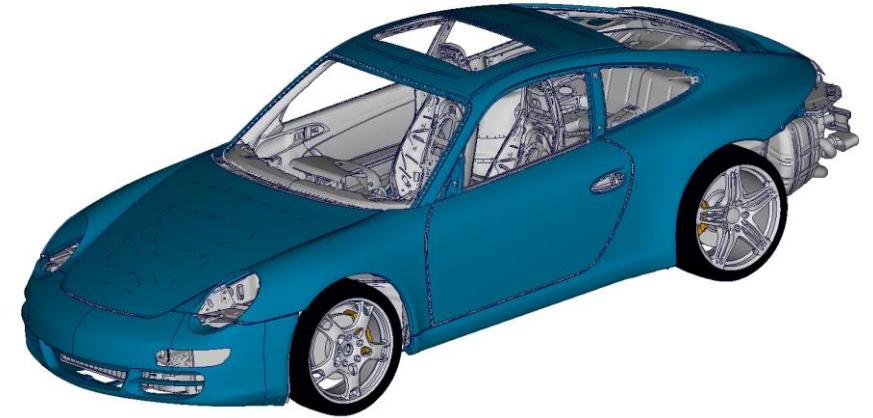


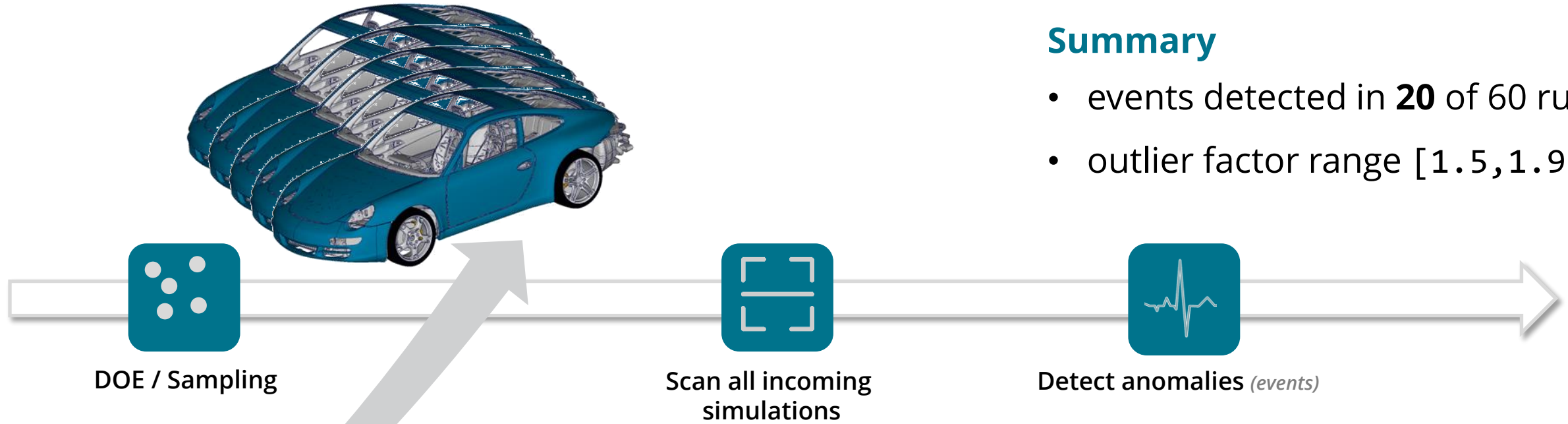
### Loadcase USNCAP Rigid Wall

- Vehicle Speed 56 km/h
- 100% frontal

### Design of experiments

- sheet metal thickness of **38** parts  
[0.8,2.5];[1.5,5.0] mm
- **60** simulation runs





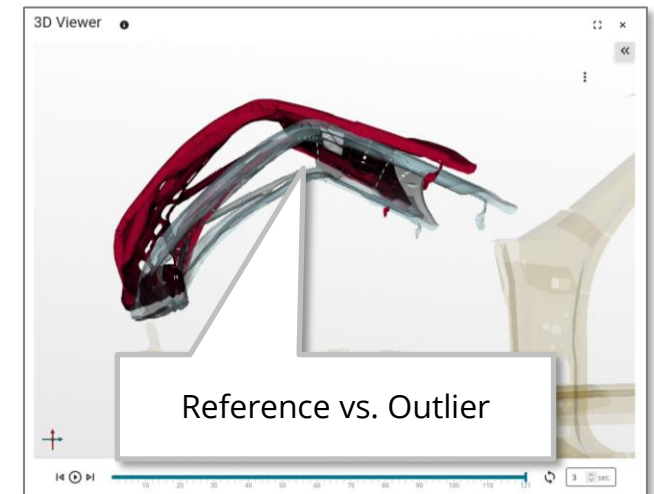
### Summary

- events detected in **20** of 60 runs
- outlier factor range [1.5, 1.98]



Event run 175 (Hood area)

Event with max. score





## CAT & CAE

Compare simulation and physical tests



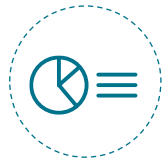
## Evaluation

Visualize and evaluate all key results



## Assess Results

Assess with respect to project targets



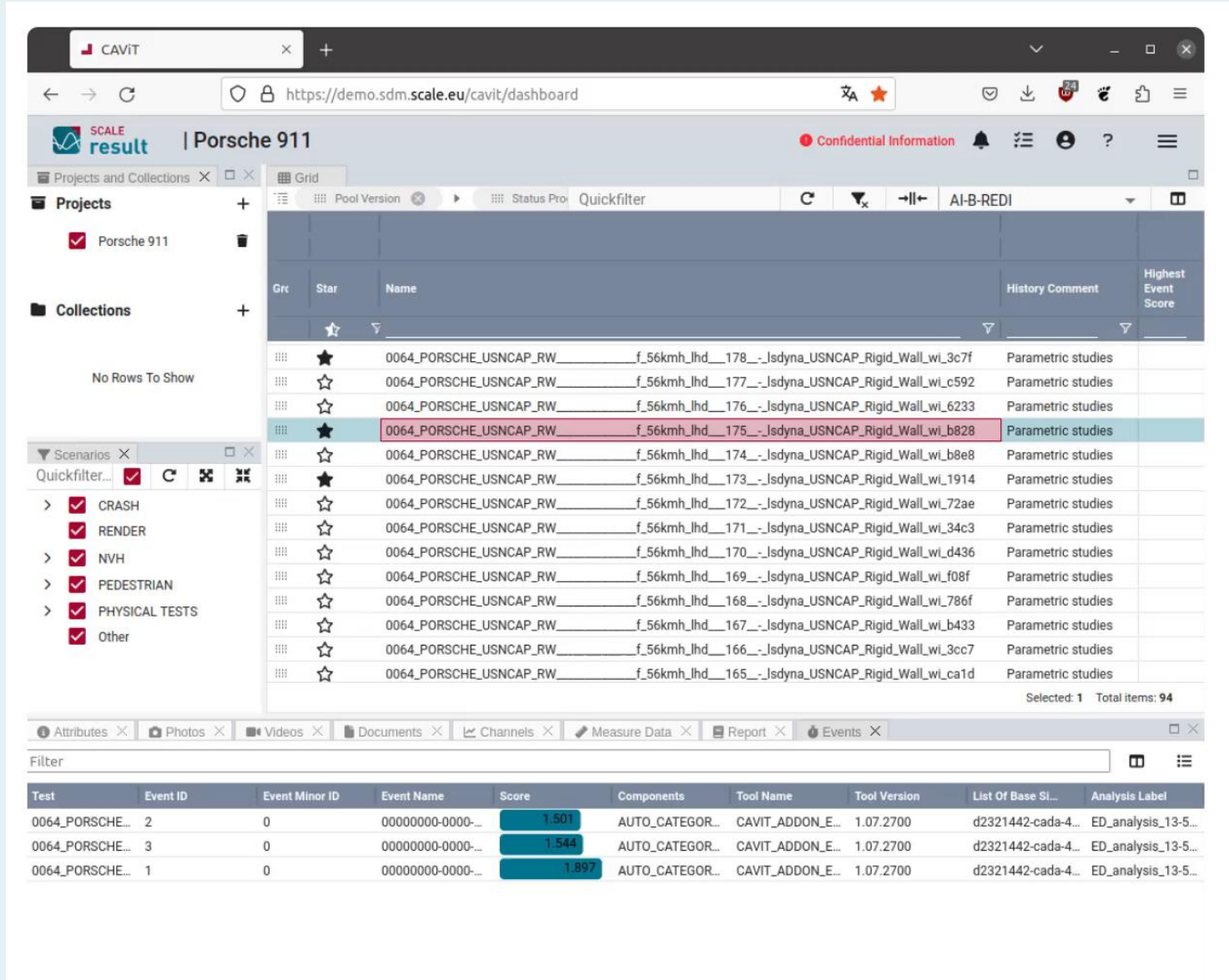
## Reporting

Comprehensive and interactive reports



## Data Analysis

Machine Learning and Data Mining



The screenshot displays the SCALE.result CAViT web application interface for the Porsche 911 project. The interface includes a sidebar with navigation options like Projects and Collections, a main content area with a table of results, and a bottom section with a detailed data table.

**Projects and Collections:**

- Projects: Porsche 911
- Collections: No Rows To Show

**Scenarios:**

- CRASH
- RENDER
- NVH
- PEDESTRIAN
- PHYSICAL TESTS
- Other

**Results Table:**

Grp	Star	Name	History Comment	Highest Event Score
0064_PORSCHE_USNCAP_RW	★	f_56kmh_lhd_178_._Isdyna_USNCAP_Rigid_Wall_wi_3c7f	Parametric studies	
0064_PORSCHE_USNCAP_RW	☆	f_56kmh_lhd_177_._Isdyna_USNCAP_Rigid_Wall_wi_c592	Parametric studies	
0064_PORSCHE_USNCAP_RW	☆	f_56kmh_lhd_176_._Isdyna_USNCAP_Rigid_Wall_wi_6233	Parametric studies	
0064_PORSCHE_USNCAP_RW	★	f_56kmh_lhd_175_._Isdyna_USNCAP_Rigid_Wall_wi_b828	Parametric studies	
0064_PORSCHE_USNCAP_RW	☆	f_56kmh_lhd_174_._Isdyna_USNCAP_Rigid_Wall_wi_b8e8	Parametric studies	
0064_PORSCHE_USNCAP_RW	★	f_56kmh_lhd_173_._Isdyna_USNCAP_Rigid_Wall_wi_1914	Parametric studies	
0064_PORSCHE_USNCAP_RW	☆	f_56kmh_lhd_172_._Isdyna_USNCAP_Rigid_Wall_wi_72ae	Parametric studies	
0064_PORSCHE_USNCAP_RW	☆	f_56kmh_lhd_171_._Isdyna_USNCAP_Rigid_Wall_wi_34c3	Parametric studies	
0064_PORSCHE_USNCAP_RW	☆	f_56kmh_lhd_170_._Isdyna_USNCAP_Rigid_Wall_wi_d436	Parametric studies	
0064_PORSCHE_USNCAP_RW	☆	f_56kmh_lhd_169_._Isdyna_USNCAP_Rigid_Wall_wi_f08f	Parametric studies	
0064_PORSCHE_USNCAP_RW	☆	f_56kmh_lhd_168_._Isdyna_USNCAP_Rigid_Wall_wi_786f	Parametric studies	
0064_PORSCHE_USNCAP_RW	☆	f_56kmh_lhd_167_._Isdyna_USNCAP_Rigid_Wall_wi_b433	Parametric studies	
0064_PORSCHE_USNCAP_RW	☆	f_56kmh_lhd_166_._Isdyna_USNCAP_Rigid_Wall_wi_3cc7	Parametric studies	
0064_PORSCHE_USNCAP_RW	☆	f_56kmh_lhd_165_._Isdyna_USNCAP_Rigid_Wall_wi_ca1d	Parametric studies	

Selected: 1 Total items: 94

**Filter:**

Test	Event ID	Event Minor ID	Event Name	Score	Components	Tool Name	Tool Version	List Of Base SI...	Analysis Label
0064_PORSCHE...	2	0	00000000-0000...	1.501	AUTO_CATEGOR...	CAVIT_ADDON_E...	1.07.2700	d2321442-cada-4...	ED_analysis_13-5...
0064_PORSCHE...	3	0	00000000-0000...	1.544	AUTO_CATEGOR...	CAVIT_ADDON_E...	1.07.2700	d2321442-cada-4...	ED_analysis_13-5...
0064_PORSCHE...	1	0	00000000-0000...	1.897	AUTO_CATEGOR...	CAVIT_ADDON_E...	1.07.2700	d2321442-cada-4...	ED_analysis_13-5...



## CAT & CAE

Compare simulation and physical tests



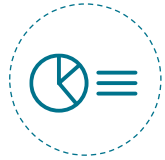
## Evaluation

Visualize and evaluate all key results



## Assess Results

Assess with respect to project targets



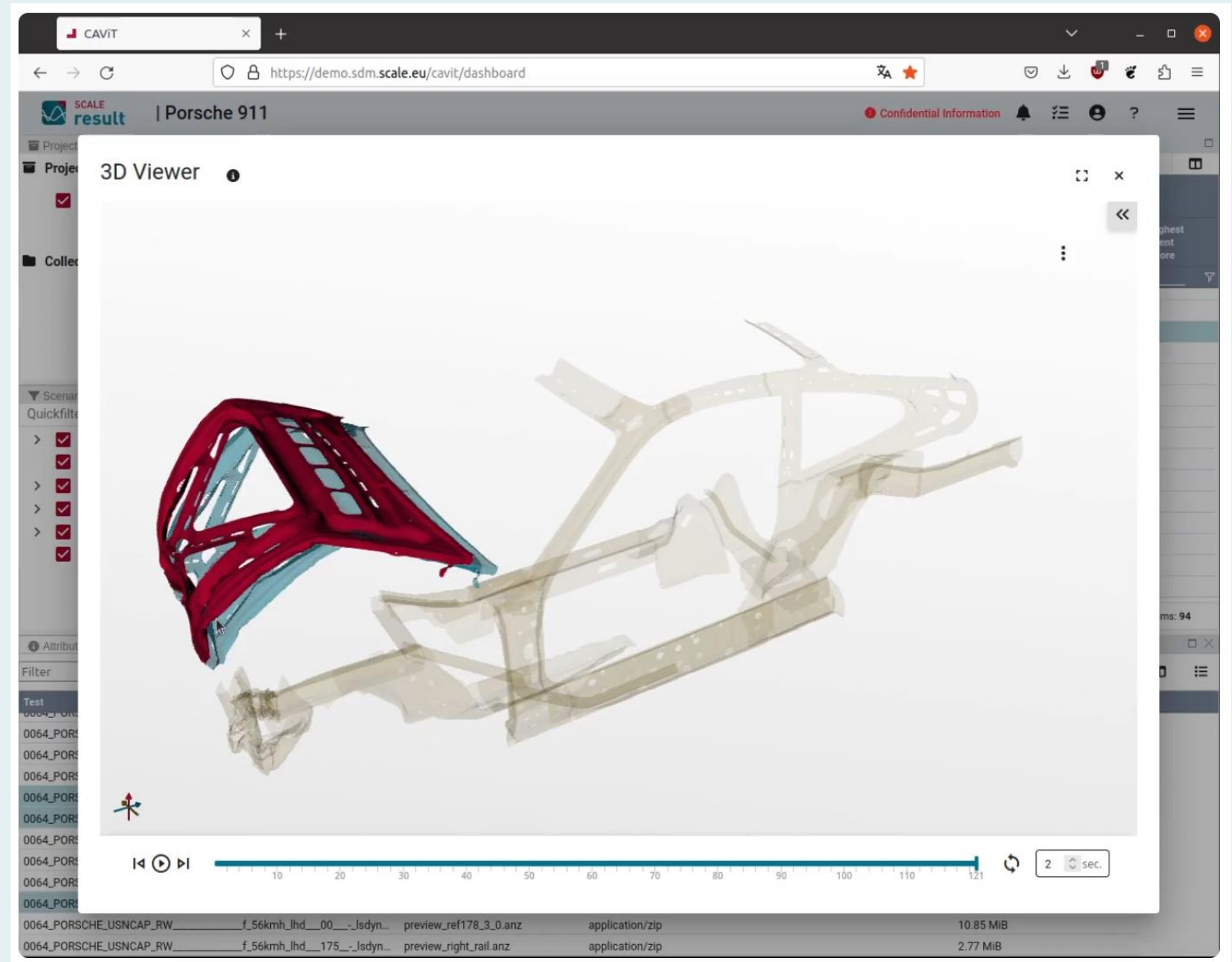
## Reporting

Comprehensive and interactive reports



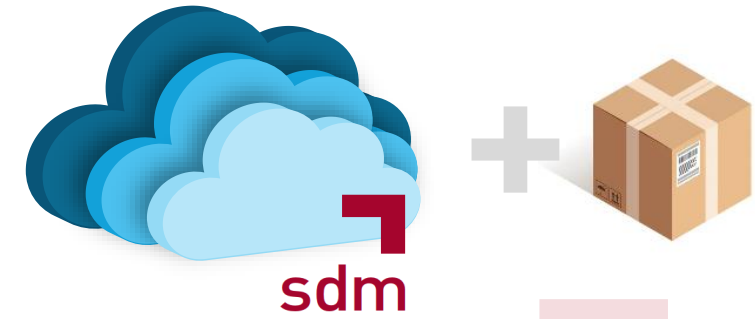
## Data Analysis

Machine Learning and Data Mining



# Summary

- SDM Systems provide structured data sets
- Application of AI/ML methodologies implies scanning large data sets
- Often Domain-specific custom ML-methods  
*(specific methodologies are often required but not part of standard software or implementations)*
- Add-on concept enables custom ML-methods and UI extensions in SDM-Systems
- Example Application: Event Detection by SIDACT



## CAT & CAE

Compare simulation and physical tests



## Data Analysis

Machine Learning and Data Mining



## Event detection

Anomaly detection by SIDACT GmbH





# Thanks for your attention!

SCALE 

Request  
Demo Login

[info@scale.eu](mailto:info@scale.eu)





# Further Information

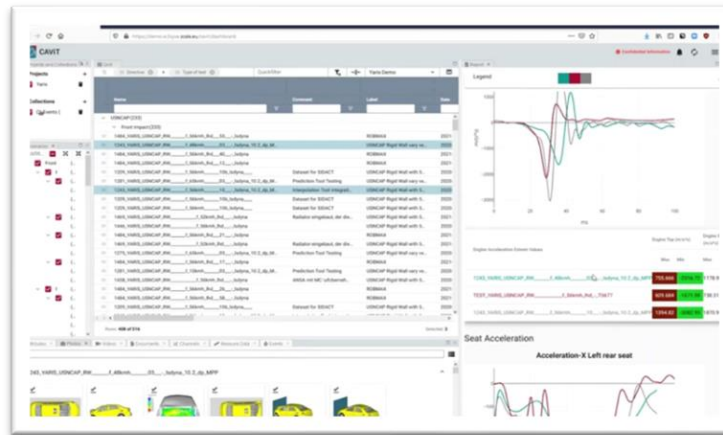
## Product Overview and Demo

All SCALE.SDM modules [~100min]



## Online Demo

demo.sdm.scale.eu



## Youtube



<http://y2u.be/3UO0EuvfjR0>



<http://y2u.be/oFO8lbpyFdE>

## Request a Login



[info@scale.eu](mailto:info@scale.eu)