

Automated Evaluation and Reporting of Simulation and Test Result Data integrated with CAE Process Workflow

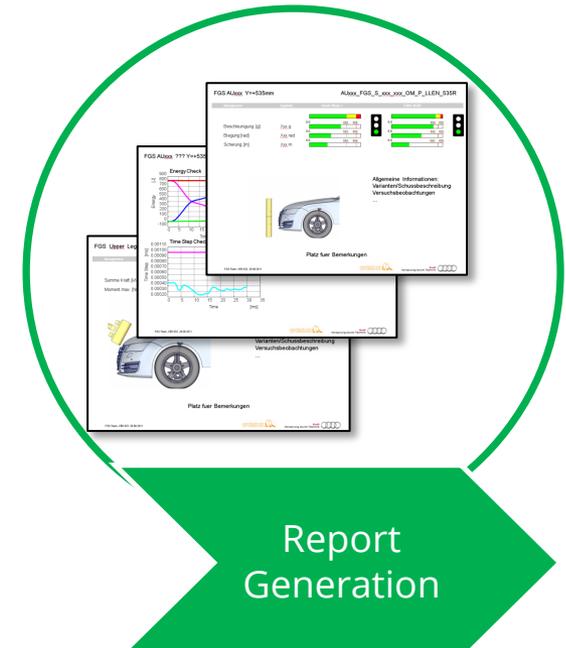
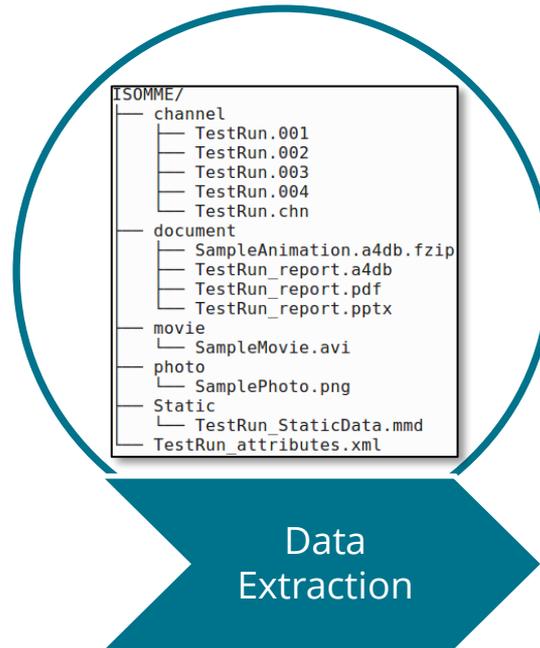
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SCALE GmbH

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Koblenz
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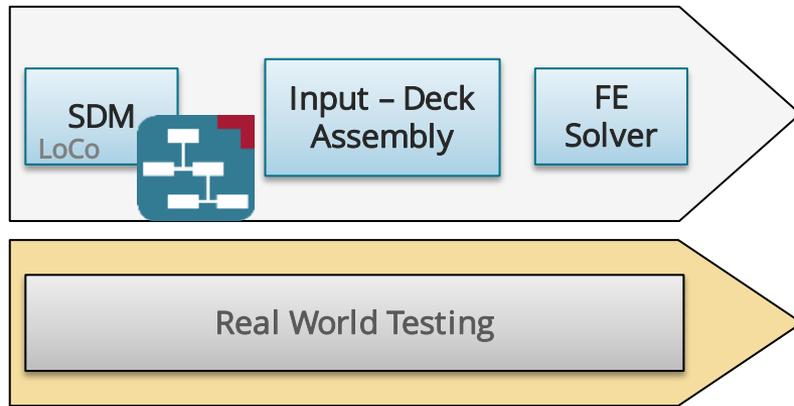
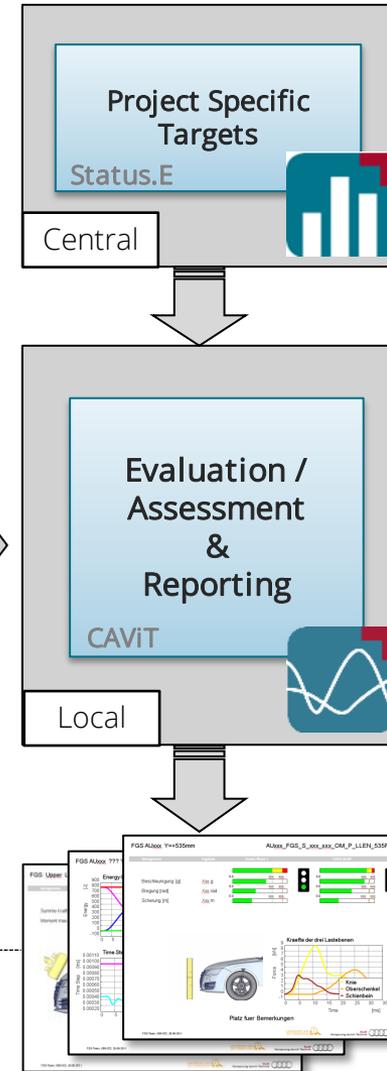
Agenda

- Focus: Automated CAE Process Workflow
- Result Data Extraction and Modification
- Automatic Report Generation
- Summary

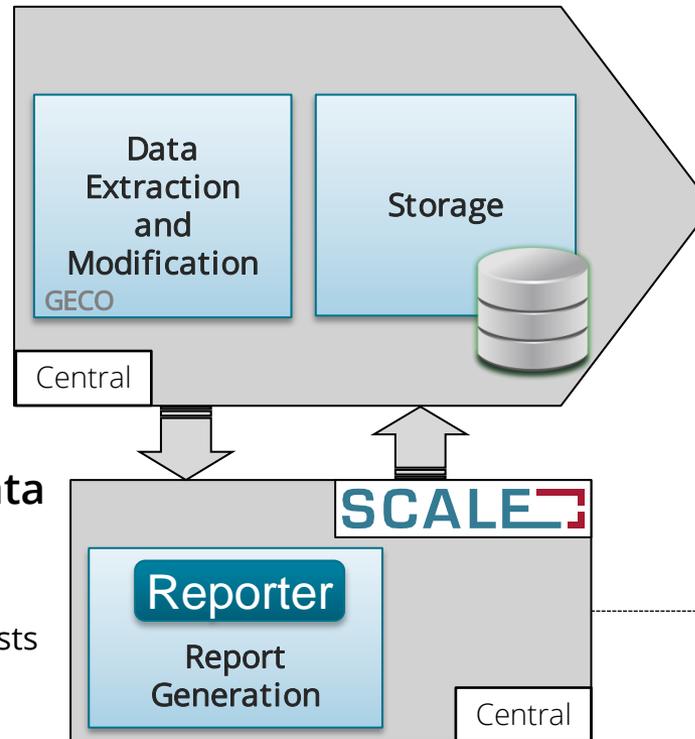


CAE Process Workflow

- **SDM: Simulation Assembly and solving triggered on compute cluster via LoCo** 
 - Parallel to the real world testing
- **Standard Postprocessing on cluster integrated with LoCo:**
 - KeyResults in ISOMME Format generated from GECO
 - SCALE Reporter creates Report Documents (Batch Mode)



- **Interactive Assessment of Test Data in CAViT** 
 - Report Pages and Tests selection for comparison b/w Simulations & Physical Tests
 - Project specific rating and targets from Status.E 



Result Data Extraction and Modification

Input

Physical Test Results

ISO-MME Data

GECO Directives

XML Files

Simulation
Results

Data Extraction
and Modification

GECO

GNS Animator 4



ESI Visual Viewer



BETA META Post

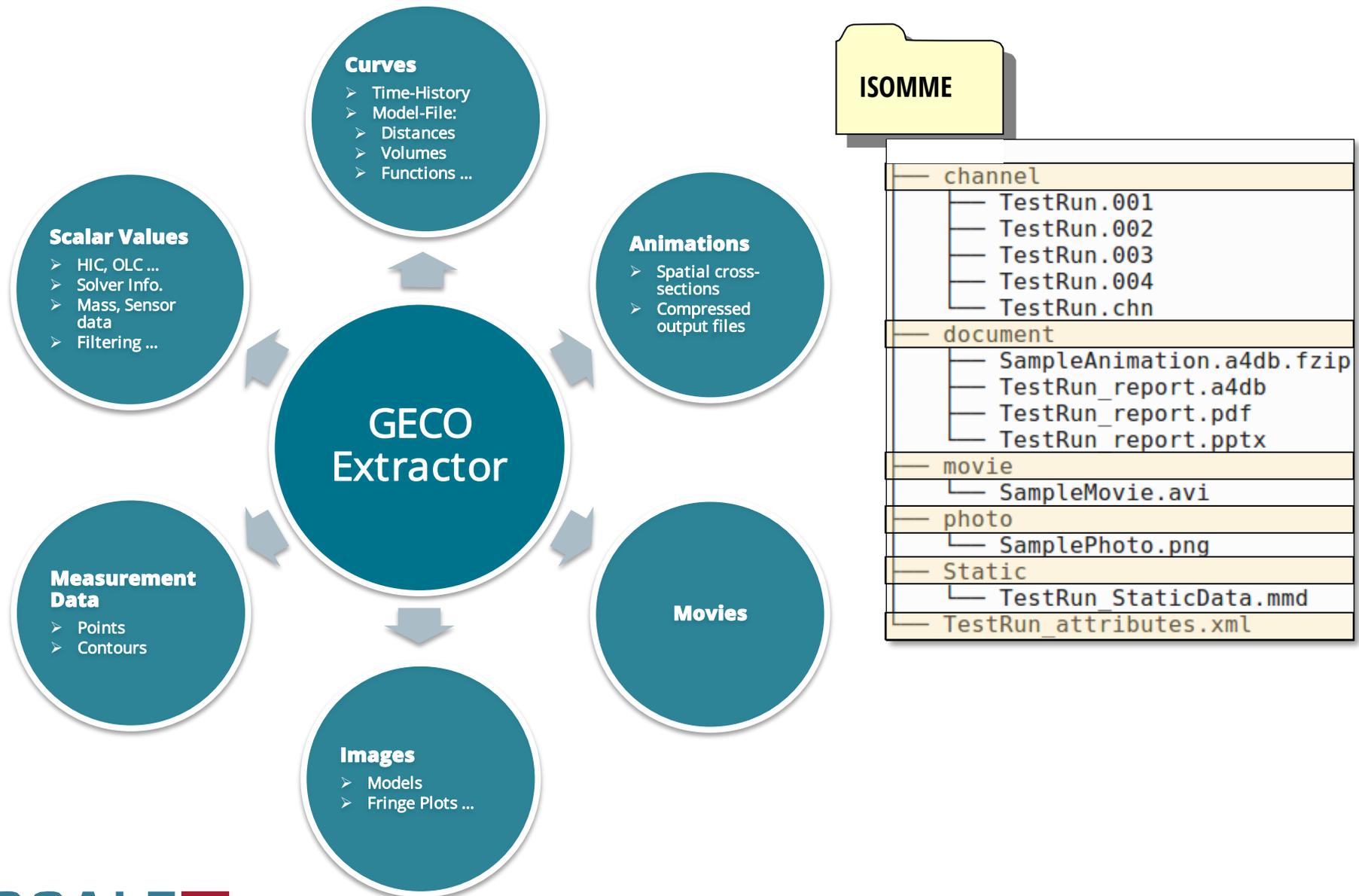


Output
ISOMME Data

```
ISOMME/  
├── channel  
│   ├── TestRun.001  
│   ├── TestRun.002  
│   ├── TestRun.003  
│   ├── TestRun.004  
│   └── TestRun.chn  
├── document  
│   ├── SampleAnimation.a4db.fzip  
│   ├── TestRun_report.a4db  
│   ├── TestRun_report.pdf  
│   └── TestRun_report.pptx  
├── movie  
│   └── SampleMovie.avi  
├── photo  
│   └── SamplePhoto.png  
├── Static  
│   └── TestRun_StaticData.mmd  
└── TestRun_attributes.xml
```



GECO: Key-Results



GECO: Result extraction

- Example for GECO Extractor directives
 - Occupant Safety – Dummy Head Acceleration Curve

```
<?xml version="1.0" encoding="utf-8"?>
<postprocessing>
  <postdata>
    <!-- Extraction of Head-Acceleration Curve in x-Direction -->
    <channel code="11HEAD0000H3ACXP" title="Head_Acceleration_X_prefiltered">
      <extract>
        <id>90010011</id>
        <category>Node</category>
        <function>X-Acceleration</function>
      </extract>
    </channel>
    ...
    <!-- Filtering of Head-Acceleration Curve -->
    <channel code="11HEAD0000H3ACXA" title="Head_Acceleration_X">
      <modify>
        <calc>cfc(1000, {11HEAD0000H3ACXP})</calc>
      </modify>
    </channel>
    ...
    <!-- HEAD HIC15 computation -->
    <value code="1.1.H3.R.O.DUMMY_HEAD_HIC_15_MS" title="Head HIC (15 ms)">
      <modify>
        <calc>hic({11HEAD0000H3ACRA}, 0.015)</calc>
        <dimension>AC</dimension>
      </modify>
    </value>
  </postdata>
</postprocessing>
```

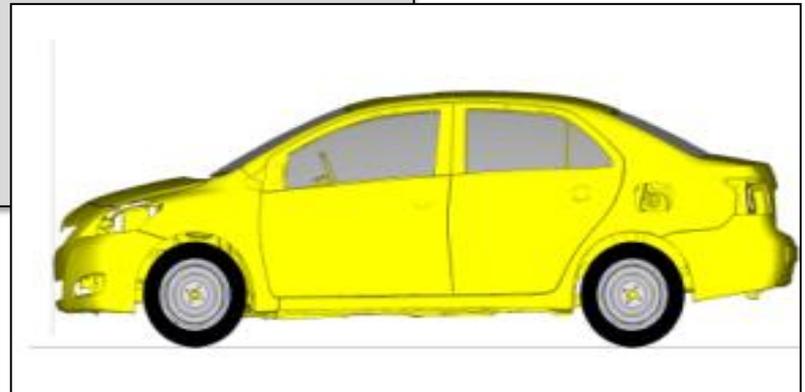


GECO: Result extraction

■ Example for GECO Extractor directives

■ Image Extraction

```
<?xml version="1.0" encoding="utf-8"?>
<!-- Animator image extract: use of raw-option -->
<postprocessing>
  <configuration>
    <include-ses target="model">../../PATH/TO/COLORS.SES</include-ses>
  </configuration>
  <postdata>
    <image code="imageID" title="title of the picture">
      <modify>
        <time>fir</time>
        <view>
          <camera>left</camera>
        </view>
        <raw-options>
          ...
        </raw-options>
      </modify>
      <output>
        <size width="1920" height="1080" />
        <type>png</type>
      </output>
    </image>
  </postdata>
</postprocessing>
```

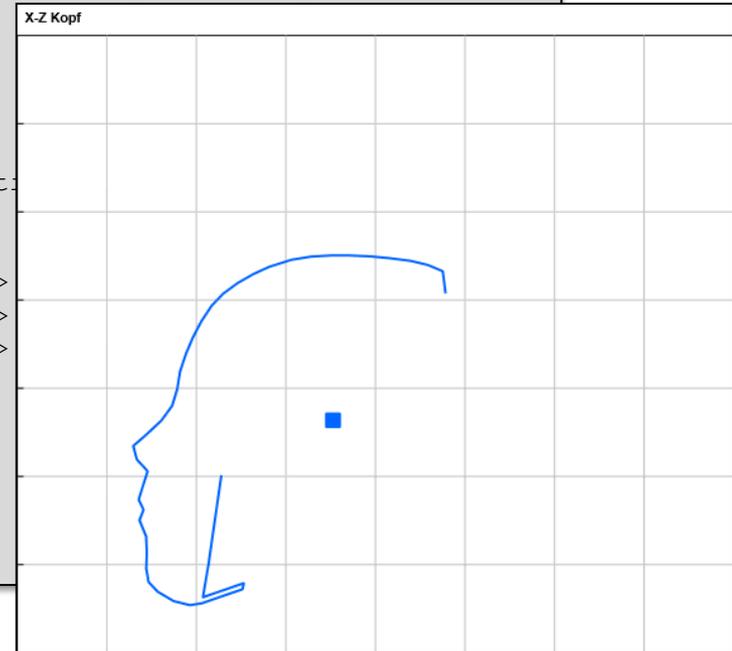


GECO: Result extraction

■ Example for GECO Extractor directives

■ Measurement Data

```
<?xml version="1.0" encoding="utf-8"?>
<!-- Animator image extract: use of raw-option -->
<postprocessing>
  <configuration>
    <variable name="contourPID_Head_6" value="123456"/>
  </configuration>
  <postdata>
    <measurement>
      <contour code="16FEMRUP00PR3D00" title="Dummy-Head-Contour">
        <extract>
          <cross-section>
            <id type="PID">{{contourPID_Head_6}}</id>
            <plane direction="xz" refpointID="{{contourNID_DummyHead_6}}"/>
          </cross-section>
        </extract>
      </contour>
    </measurement>
    <measurement>
      <point code="16HEADCG00PR3D0X" title="Posit...>
        <extract>
          <from-curve>
            <source-x>11HEADPR00H3DCXP</source-x>
            <source-y>11HEADPR00H3DCYP</source-y>
            <source-z>11HEADPR00H3DCZP</source-z>
          </from-curve>
        </extract>
      </point>
    </measurement>
  </postdata>
</postprocessing>
```



GECO: Process Integration

LoCo Integration

Databases
Directives within project-independent components (e.g. barriers or dummy)

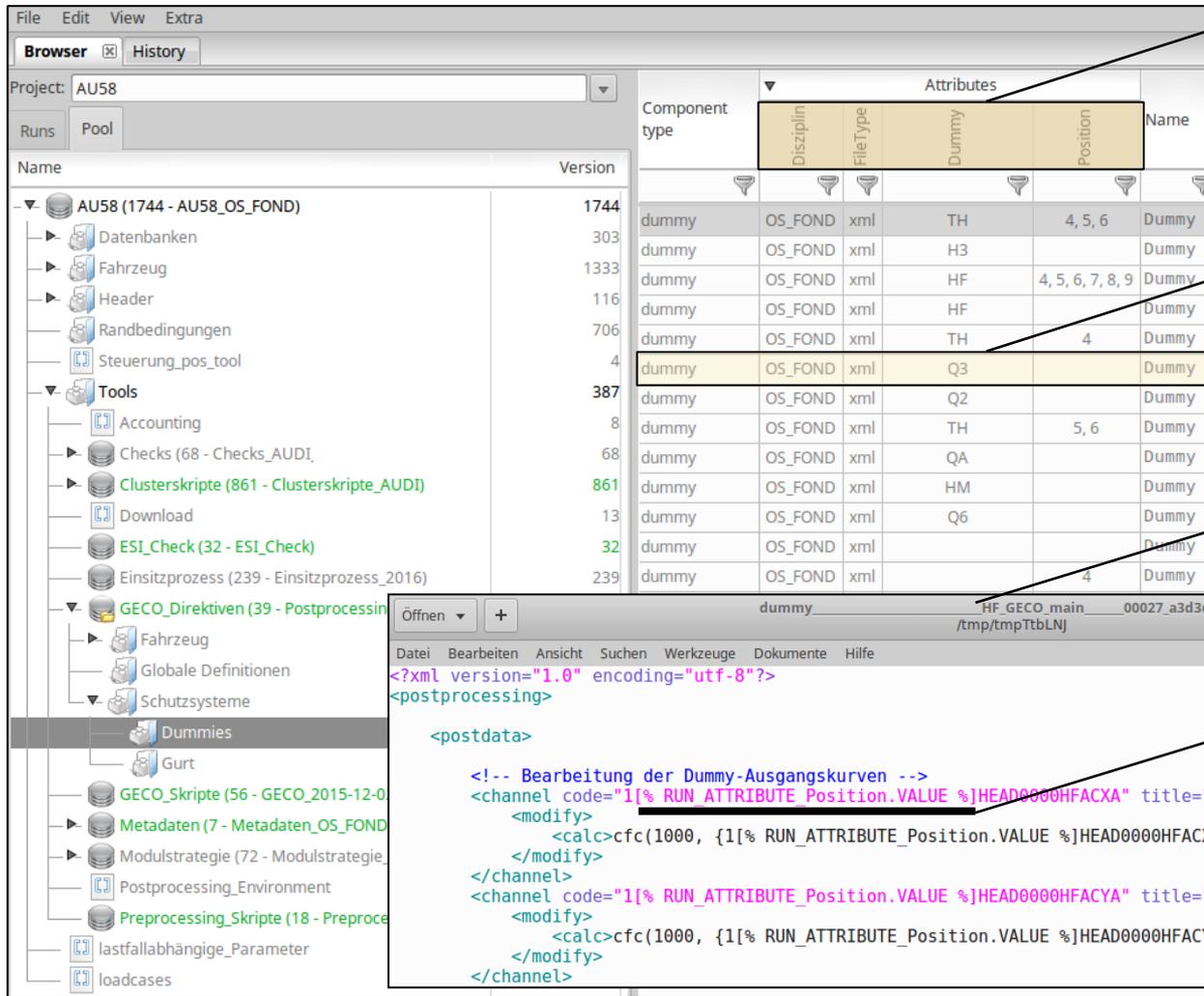
GECO Pool
General and project-independent modules

GECO Scripts
Process Configuration and execution.
(Compilation of GECO Directives ...)

Name	Version	Component type	Name
AU58 (1744 - AU58_OS_FOND)	1744		
Datenbanken	303		
Fahrzeug	1333		
Header	116		
Randbedingungen	706		
Steuerung_pos_tool	4		
Tools	387		
Accounting	8		
Checks (68 - Checks_AUDI_Pamcrash)	68		
Clusterskripte (861 - Clusterskripte_AUDI)	861		
Download	13		
ESI_Check (32 - ESI_Check)	32		
Einsatzprozess (239 - Einsatzprozess_2016)	239		
GECO_Direktiven (39 - Postprocessing_OS_FOND)	39		
Fahrzeug	24		
Globale Definitionen	27		
Schutzsysteme	32		
Dummies	28		
Gurt	16		
GECO_Skripte (56 - GECO_2015-12-02)	56		
Metadaten (7 - Metadaten_OS_FOND)	7		
Modulstrategie (72 - Modulstrategie_2016)	72		
Postprocessing_Environment	1		
Preprocessing_Skripte (18 - Preprocessing_Skripte_...)	18		
lastfallabhängige_Parameter	176		
loadcases	17		

GECO: Process Integration

LoCo Integration



Component type	Disziplin	FileType	Dummy	Position	Name	
	dummy	OS_FOND	xml	TH	4, 5, 6	Dummy
	dummy	OS_FOND	xml	H3		Dummy
	dummy	OS_FOND	xml	HF	4, 5, 6, 7, 8, 9	Dummy
	dummy	OS_FOND	xml	HF		Dummy
	dummy	OS_FOND	xml	TH	4	Dummy
	dummy	OS_FOND	xml	Q3		Dummy
	dummy	OS_FOND	xml	Q2		Dummy
	dummy	OS_FOND	xml	TH	5, 6	Dummy
	dummy	OS_FOND	xml	QA		Dummy
	dummy	OS_FOND	xml	HM		Dummy
	dummy	OS_FOND	xml	Q6		Dummy
	dummy	OS_FOND	xml		4	Dummy

```
<?xml version="1.0" encoding="utf-8"?>
<postprocessing>
  <postdata>
    <!-- Bearbeitung der Dummy-Ausgangskurven -->
    <channel code="1[% RUN_ATTRIBUTE Position.VALUE %]HEAD0000HFACXA" title="Head_Acceleration_X">
      <modify>
        <calc>cfc(1000, {1[% RUN_ATTRIBUTE_Position.VALUE %]HEAD0000HFACXP})</calc>
      </modify>
    </channel>
    <channel code="1[% RUN_ATTRIBUTE_Position.VALUE %]HEAD0000HFACYA" title="Head_Acceleration_Y">
      <modify>
        <calc>cfc(1000, {1[% RUN_ATTRIBUTE_Position.VALUE %]HEAD0000HFACYP})</calc>
      </modify>
    </channel>
  </postdata>
</postprocessing>
```

LoCo Attributes
GECO Directives arranged according to their relevance for the loadcase

LoCo Component
GECO Directives can be defined in the Solver Include (eg. *COMMENT for LS-DYNA)
XML Files

Editing GECO directives directly from LoCo

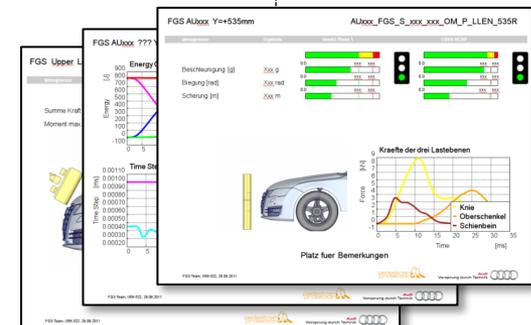
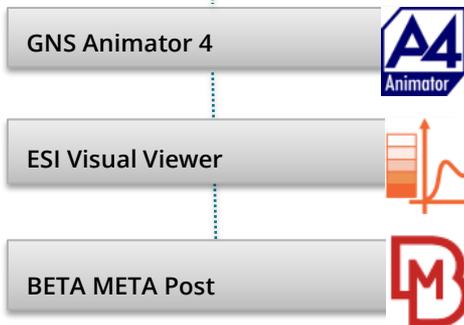
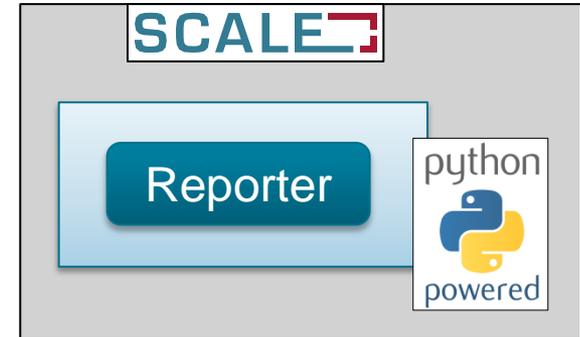
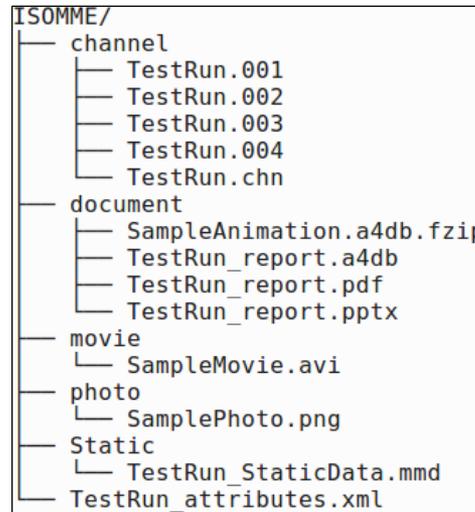
Use of LoCo parameter substitution within directives

Report Generation

Data Extraction
and Modification

Output
ISOMME Data

Report Generation



- Reports are represented by a Document-Object-Model
 - Tree like logical structure with page elements are defined as the tree nodes
 - Dynamic Page generation with enhanced capabilities like conditions, error-handling and loops
- Integrated with LoCo in the standard process (cluster), can as well be generated locally via CAViT, facilitating comparing results of multiple tests.

Report Generation

Report Python Code

Page
Renderer

Report
Pages

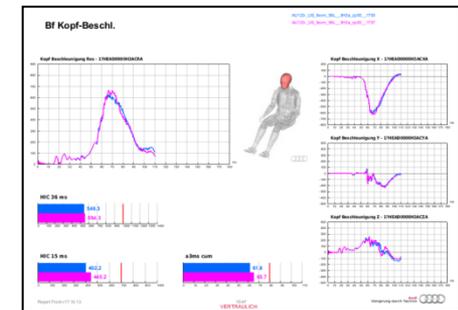
SCALE

Reporter



```
def createPageLayout(presentation, tests):%  
    model = PageModel(presentation)%  
    report = model.addGroup(title='Sitzsicherheit')%  
    # Status%  
    caption1 = report.addGroup(title='Status', tag="caption1")%  
    caption1.addEntry(%  
        title="Übersicht",%  
        command=lambda this: create_page_overview(%  
            presentation,%  
            tests=tests,%  
            title=this.title.split('(')[0]),%  
        selected=True%  
    )%  
    caption1.addEntry(%  
        title="Übersicht Whiplash C_IASI / IHS (VSA)",%  
        command=lambda this: create_page_overview_whiplash_ciasi(%  
            presentation,%  
            tests=tests,%  
            title=this.title.split('(')[0]),%  
    )
```

GNS Animator 4
Session Code



pagelayout.py

pages

init .py

page_sample_1.py

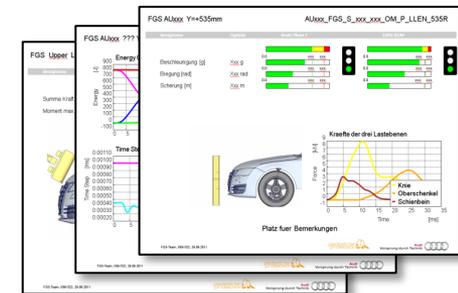
page_sample_2.py

page_sample_3.py

report.py

```
1 # -*- coding: utf-8 -*-  
2 %  
3 import os%  
4 from util import get_report_path%  
5 %  
6 %  
7 def createTitlePage(presentation, test, version, **kwargs):%  
8 %  
9 # Add Page to the presentation%  
10 page = presentation.addPage(**kwargs)%  
11 %  
12 # Add Image on the page%  
13 image = page.addImage(%  
14     os.path.join(get_report_path(), "resources", "pic_title.png"))%  
15 image.position = (0.0, 0.0)%  
16 image.size = page.realSize%
```

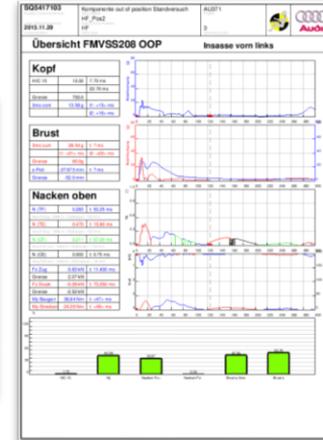
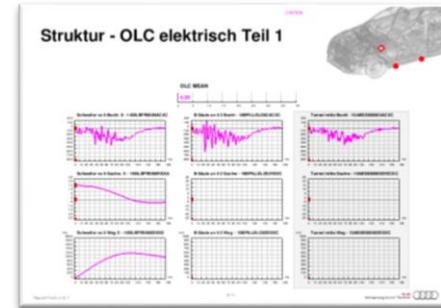
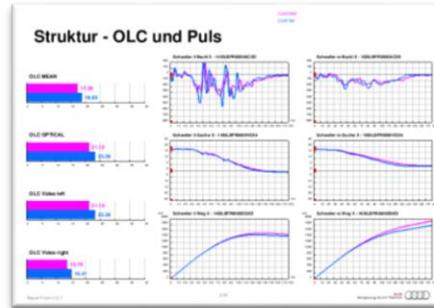
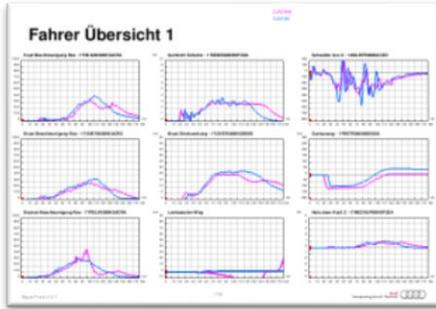
Powerpoint
Module



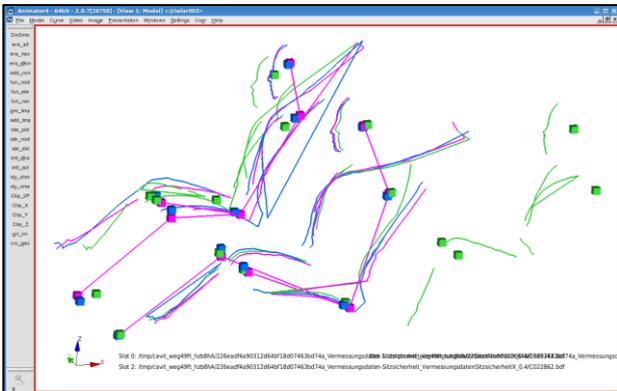
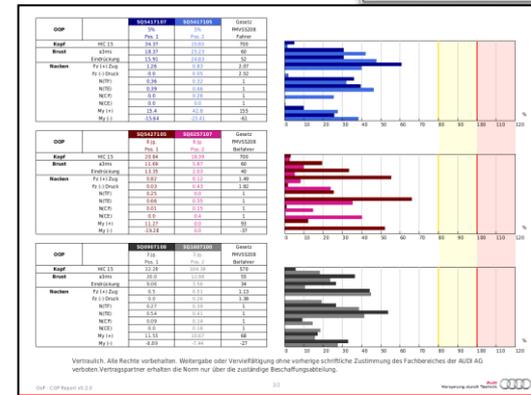
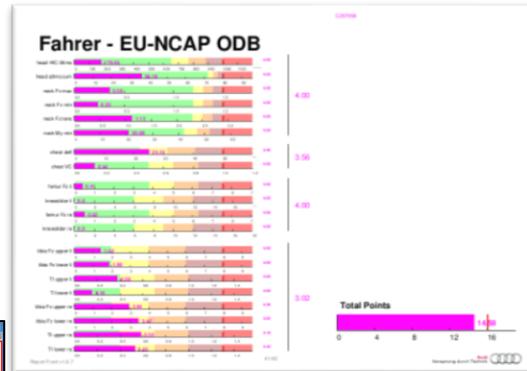
SCALE

Report Generation

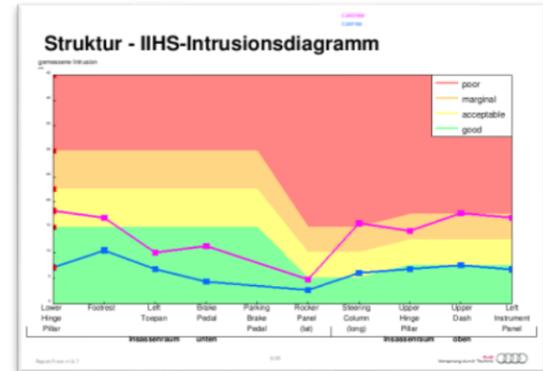
Examples of Application



Item	Value	Unit	Limit	Status
Head	1.1	g	1.1	OK
Chest	1.1	g	1.1	OK
Neck	1.1	g	1.1	OK
...



Item	Value	Unit	Limit	Status
Head	1.1	g	1.1	OK
Chest	1.1	g	1.1	OK
Neck	1.1	g	1.1	OK
...



Report Generation

- CAViT - interactive report application
 - Comparison of physical test and simulation

The screenshot displays the CAViT V2.36.0-DEMO-2 (Rev. 9cbc0b781) interface. The main window is divided into several panes:

- Sitzungen:** Shows a list of sessions, including 'YARIS' and 'YARIS Demo (ver. 18.10.15)'.
- Projekte:** A tree view showing project structure with 'YARIS' selected.
- Szenario:** A tree view showing test scenarios like 'Front', 'Europa', 'NAR', 'FMVSS 208', 'FMVSS 301', 'US-NCAP', 'IIHS', 'NHSTA oblique', 'Japan', 'China', 'Korea', 'Sensor', 'Sonstiges', and 'Heck'.
- Yaris Demo:** A list of selected properties for the demo, including 'Project Name', 'Datum', 'Versuchsart', 'Project Data', 'Allgemeine Infos', 'Engine', 'Rearseat', 'OLC', and 'Airbag'.
- Tabelle:** A data table with columns: Tag, Project Name, Datum, Versuchsart, and Project Data (Allgemeine Infos, Engine, Rearseat, OLC, Airbag). The table contains two rows of data for '06221_6221' and '0829_YARIS_USN'.
- Eigenschaften:** A properties panel showing a list of isocodes and their corresponding values for the selected project.

Tag	Project Name	Datum	Versuchsart	Project Data
				+ Allgemeine Infos + Engine + Rearseat + OLC + Airbag
06221_6221			Front Impact	YARIS 1799.36 -34.8266 353.923 Double TTF
0829_YARIS_USN			Front Impact	YARIS 1799.36 -34.8266 353.923 Double TTF

Isocode	Name	Wert
06221_6221 (42 Elemente)		
0.0.00.D.O.GENERAL_INFORMATION_CUSTOMER_PROJECT_REF_NUMBER	0.0.00.D.O.GENERAL_I...	YARIS
0.0.00.D.O.GENERAL_INFORMATION_CUSTOMER_TEST_REF_NUMBER	0.0.00.D.O.GENERAL_I...	06221_6221
0.0.00.D.O.GENERAL_INFORMATION_CUSTOMER_TEST_RELEASE_LEVEL	0.0.00.D.O.GENERAL_I...	1
0.0.00.D.O.GENERAL_INFORMATION_DIRECTIVE	0.0.00.D.O.GENERAL_I...	USNCAP
0.0.00.D.O.GENERAL_INFORMATION_STATE_OF_PROCESSING	0.0.00.D.O.GENERAL_I...	Versuch abge...
0.0.00.D.O.GENERAL_INFORMATION_TEST_MODE	0.0.00.D.O.GENERAL_I...	Front Impact
0.0.00.D.O.SIMULATION_DURATION	0.0.00.D.O.SIMULATIO...	0.1001
0.0.00.R.O.GENERAL_INFORMATION_CLUSTER_ARCHITECTURE		default
0.0.00.R.O.GENERAL_INFORMATION_SIMULATION_WALLTIME		9991
0.0.00.R.O.GENERAL_INFORMATION_TOTAL_NUMBER_OF_CYCLES		100020
1.0.00.D.O.VEHICLE_SPEED	1.0.00.D.O.VEHICLE_S...	15.555555556
1.0.00.R.O.ENGINE_BOTTOM_MAX	Engine Bottom max	1799.36
1.0.00.R.O.ENGINE_BOTTOM_MAX_TIME	Engine Bottom max time	0.0370997
1.0.00.R.O.ENGINE_BOTTOM_MIN	Engine Bottom min	-2839.01
1.0.00.R.O.ENGINE_BOTTOM_MIN_TIME	Engine Bottom min time	0.0310999
1.0.00.R.O.ENGINE_TOP_MAX	Engine top max	1360.24
1.0.00.R.O.ENGINE_TOP_MAX_TIME	Engine top max time	0.0414992
1.0.00.R.O.ENGINE_TOP_MIN	Engine top min	-3272.29
1.0.00.R.O.ENGINE_TOP_MIN_TIME	Engine top min	0.0318995
1.0.00.R.O.REARSEAT_LEFT_MAX	Rear Seat Left max	-34.8266

Report Generation

- CAViT - interactive report application
 - Comparison of physical test and simulation

The screenshot displays the CAViT software interface with two main windows open: 'Auswahl der Tests' (Test Selection) and 'Seiten des Reports' (Report Pages). The 'Auswahl der Tests' window shows a table with two rows of test configurations. The 'Seiten des Reports' window shows a tree view of report sections, with 'YARIS Report' selected and its sub-items checked.

Test	Color
06221_6221	Green
0829_YARIS_USNCAP_RW_f_56kmh	Red

Section	Sub-section	Status
YARIS Report	Overview	Checked
YARIS Report	Global Energy	Checked
Yaris Report	Engine Acceleration	Checked
Yaris Report	Seat Acceleration	Checked
Yaris Report	OLC	Checked
Yaris Report	Barrier	Checked
Yaris Report	Side Deformation	Checked
Yaris Report	Bottom Deformation	Checked
Yaris Report	Fringe Plot	Checked

Report wizard – Test selection and color assignment

Report wizard – Page selection

This screenshot shows the 'Project Data' selection window in the CAViT interface. It features a tree view where various project-related items are checked, including 'Allgemeine Infos', 'Engine', 'Rearseat', 'OLC', and 'Airbag'.

0.0.00.R.O.GENERAL_INFORMATION_CLUSTER_ARCHITECTURE		
0.0.00.R.O.GENERAL_INFORMATION_SIMULATION_WALLTIME		default
0.0.00.R.O.GENERAL_INFORMATION_TOTAL_NUMBER_OF_CYCLES		9991
1.0.00.D.O.VEHICLE_SPEED	1.0.00.D.O.VEHICLE_S...	100020
1.0.00.R.O.ENGINE_BOTTOM_MAX	Engine Bottom max	15.5555555556
1.0.00.R.O.ENGINE_BOTTOM_MAX_TIME	Engine Bottom max time	1799.36
1.0.00.R.O.ENGINE_BOTTOM_MIN	Engine Bottom min	0.0370997
1.0.00.R.O.ENGINE_BOTTOM_MIN_TIME	Engine Bottom min time	-2839.01
1.0.00.R.O.ENGINE_TOP_MAX	Engine top max	0.0310999
1.0.00.R.O.ENGINE_TOP_MAX_TIME	Engine top max time	1360.24
1.0.00.R.O.ENGINE_TOP_MIN	Engine top min	0.0414992
1.0.00.R.O.ENGINE_TOP_MIN_TIME	Engine top min time	-3272.29
1.0.00.R.O.REARSEAT_LEFT_MAX	Rear Seat Left max	0.0318995
		-34.8266

Report Generation

- CAViT - interactive report application
 - Comparison of physical test and simulation

The screenshot displays the CAViT software interface. The main window shows a 3D model of a car (Yaris) with a red body and blue wheels, viewed from a side profile. The interface includes a menu bar (File, Model, Curve, Video, Image, Presentation, Windows, Settings, User, Help), a toolbar, and a sidebar with various options. The report window is titled "YARIS Demo Report" and contains the following text:

Report: v0.0.0

1/1

SCALE

	Wert
ERAL_I...	YARIS
ERAL_I...	06221_6221
ERAL_I...	1
ERAL_I...	USNCAP
ERAL_I...	Versuch abges
ERAL_I...	Front Impact
ULATIO...	0.1001
	default
	9991
	100020
ICLE_S...	15.5555555556
max	1799.36
max time	0.0370997
min	-2839.01
min time	0.0310999
	1360.24
time	0.0414992
	-3272.29
	0.0318995
max	-34.8266

Report Generation

- CAViT - interactive report application
 - Comparison of physical test and simulation

CAViT - V2.36.0-DEMO-2 (Rev. 9c9cb0b781)

YARIS Demo Report

Report: v0.0.0

SCALE

Overview

Test Name	Test Protocol	Test Type	Velocity
#021_021	USNCAP	Front Impact	56.0 km/h
#029_YARIS_USNCAP_RW	USNCAP	Front Impact	56.0 km/h

SCALE

Engine Acceleration

Test name	Engine Top (m/s²)		Engine Bottom (m/s²)	
	Max	Min	Max	Max
#021_021	1369.24	-3272.29	1799.36	-2839.01
#029_YARIS_USNCAP_RW	1369.24	-3272.29	1799.36	-2839.01

SCALE

OLC Overview

Electrical Mean [g]

O [g]	E [g]	O [g]	E [g]
35.83	35.83	35.61	35.62
35.83	35.83	35.61	35.62

Optical Mean [g]

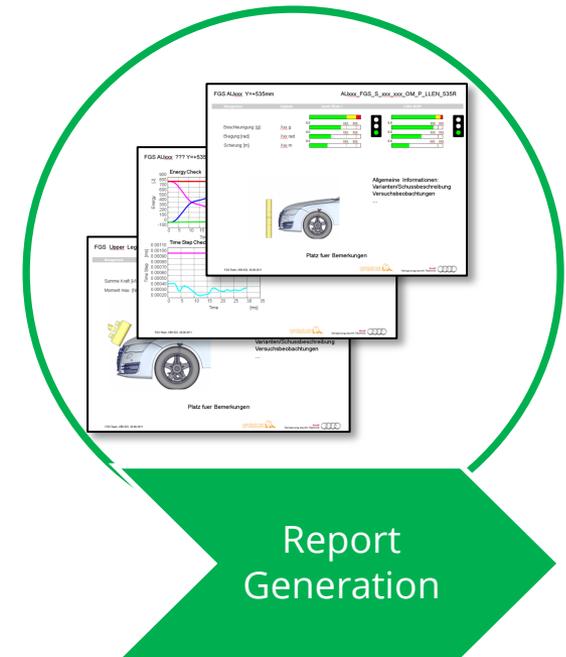
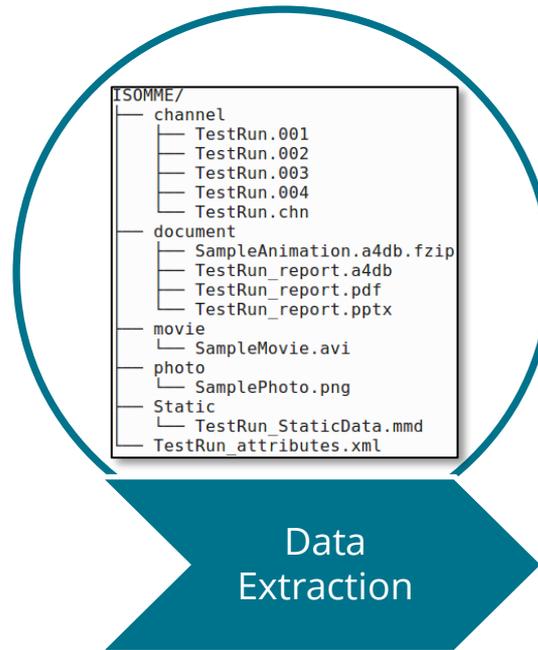
O [g]	E [g]	O [g]	E [g]
41.41	41.28	34.71	34.7
41.41	41.28	34.71	34.7

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Summary & Outlook

■ Result extraction

- Finalization of LS-DYNA and Abaqus extraction
- Solver-independent output descriptions (directives)
- Result browsing GUI to support users creating directives



Thank You!

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