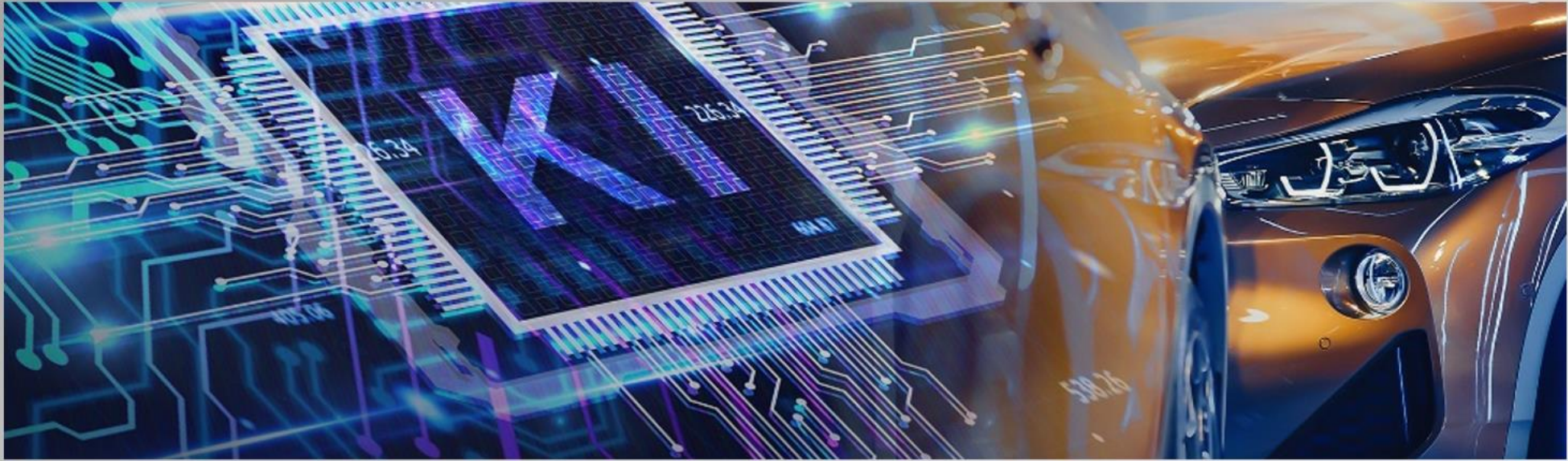




AI for Collision Management

Intelligent DMU

Erika Cammi | Mercedes-Benz AG

Thu., 1 October 2026 | nh Frankfurt Airport West | Raunheim, Germany

- PLM-System Integrated Packaging Process
- Collision Management
- Artificial Intelligence
- Technical Approach
- Challenges and Way Forward

PLM-SYSTEM INTEGRATED PACKAGING PROCESS

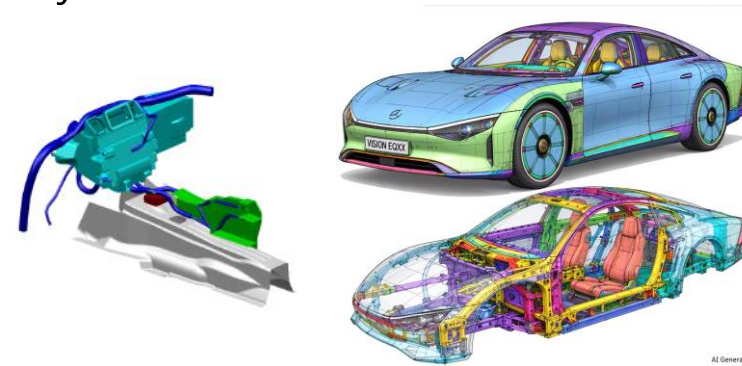
Definition – Packaging Process

Packaging is the structural and geometrical assurance with regard to **freedom from collisions** and compliance with distance requirements from installation spaces and, as far as technically possible, the ability to build a vehicle on the digital mock-up.

For this purpose, components that are described using 3D geometries are arranged in the DMU system to form a buildable vehicle. Geometries are represented in JT-Format

For the packaging examination, certain geometries are selected and combined into an examination environment (arrangement). Three selection criteria play a central role:

- the right **Construction Space**
- the right **Variant**
- the right **Revision Status**



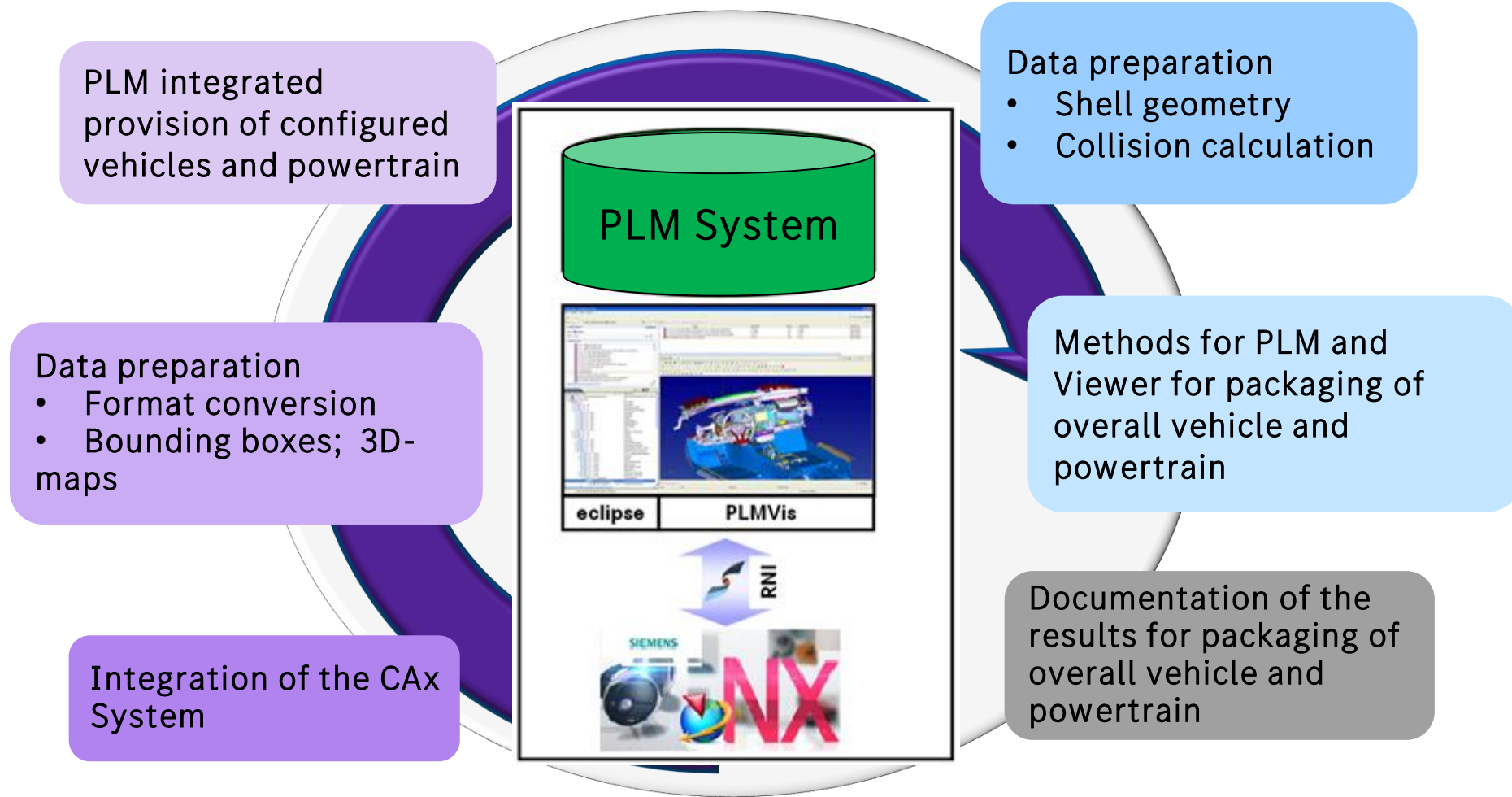
Preprocess

Packaging
examination

Evaluation

Resolution

PLM Integrated Packaging Process



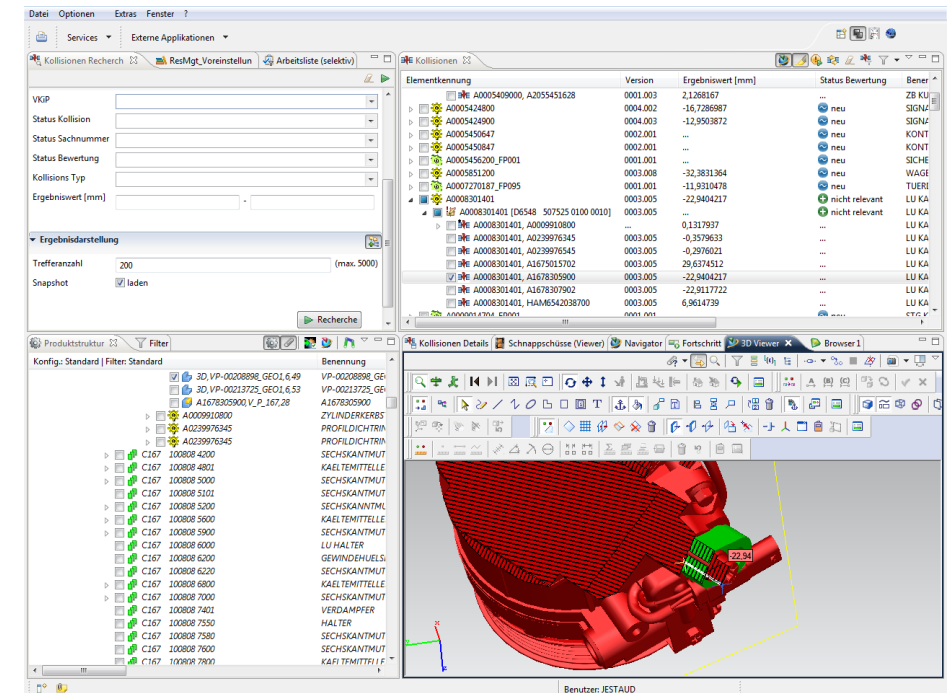
COLLISION MANAGEMENT

Collision and Result Management

- **Objective:** digital vehicle validation
- **Method:**
 - Definition of the scope of the investigation (reference vehicles or 150% vehicles)
 - static rule-based collision calculation
 - Make results available in the PLM System for rating.

AI is helping the packager by recommending the evaluation of some of the collisions

- Collision and results management is an essential part of the integrated packaging process



Schema – regel based collision management

Assignment of the responsible person (VKiP)

Zugewiesene Regeln

Regeln, die auf das selektierte Strukturelement angewendet werden:

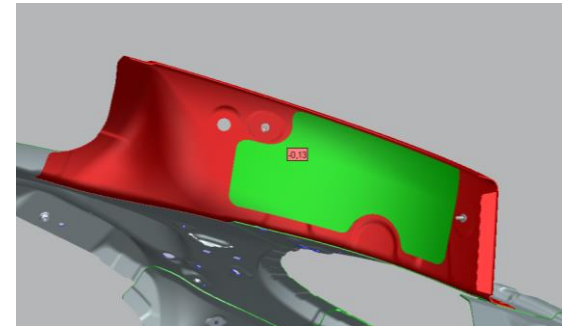
Strukturelement	Benennung	AA	VKiP	PosV	Löschen	VKiP (M...
USC_P167_NAG-3_OM6...	NAG-3_MOPF_fuer_OM654	*	Prantl,Stefan (e1y50)	☐	☒	e1y50:*,
USC_P167_NAG-3_OM6...	NAG-3_MOPF_fuer_OM654	FC		☐	☒	e1y50:*,
USC_P167_NAG-3_OM6...	NAG-3_MOPF_fuer_OM654	FV		☐	☒	e1y50:*,
USC_P167_NAG-3_OM6...	NAG-3_MOPF_fuer_OM654	FX		☐	☒	e1y50:*,



Collision calculation in the high performant processing computer pool

Creation of the Vehicle Context

- OVIP_540_0260_FX_DPT-AV_1 - C540 - C540 02 - C540 06 - C540 08 - C540 12 - C540 20 - C540 49 - C540 98 - GEO_540_AGGREGATE - GEO_540_BAURAUM - SPS_540_SNP_BUENDEL	- FX_All_Geostückliste_ENG_mit_PTR_Bauteil... - GLC-KLASSE BEV - FAHRZEUG GESAMT - KLAPPEN / KOTFLUEGEL - TUEREN - FAHRZEUG - ANBAUTEILE AUSSEN - UNTERDRUCKANLAGE - MOTOR- / GETRIEBEPERIPHERIE - NACHRUESTUNGEN UND ZUBEHOER - BR540 Geo-Daten Aggregate - BR540 Geo-Daten Bauraum-Beschreibung - BR540 Sekundäre Prod.-Struktur (Bündler für...
---	---



Collision partners

Definition of the calculation rules

Regelkombinationen von SmaDia2 Struktur-Elementen

Linker Partner	Rechter Partner	Typ	Distanz	Kommentar	Letzte Änderung
USC_P167_W_C-HAG197_ALU	C167 08	collision	0		:
	C167 50	collision	0		:
	C167 24	collision	0		:
	C167 26	collision	0		:
	C167 30	distance	30		:
	C167 28	distance	25		:

Ausnahmen und Ausschlussregeln

Element	Typ	Kommentar	Letzte Änderung
C167 901295 0100 0010	ExpandPosV		akrawiet: 11:04:07 11:08:2015
C167 901295 0100 0020	ExpandPosV		akrawiet: 11:05:28 11:08:2015
C167 901295 0100 0001	ExpandPosV		akrawiet: 11:05:30 11:08:2015
C167 800095 0100 0001	ExpandPosV		xs01254: 13:15:43 26:08:2015

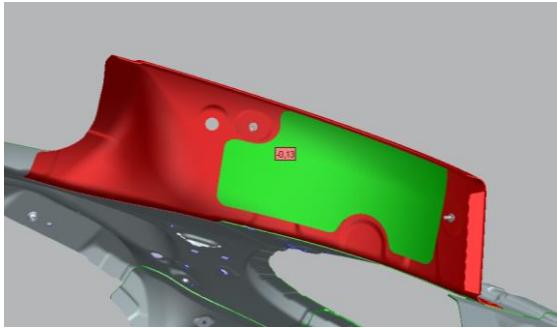
Berechnungs-Regeln | Code Mapping | Pattern Regeln / Gruppen



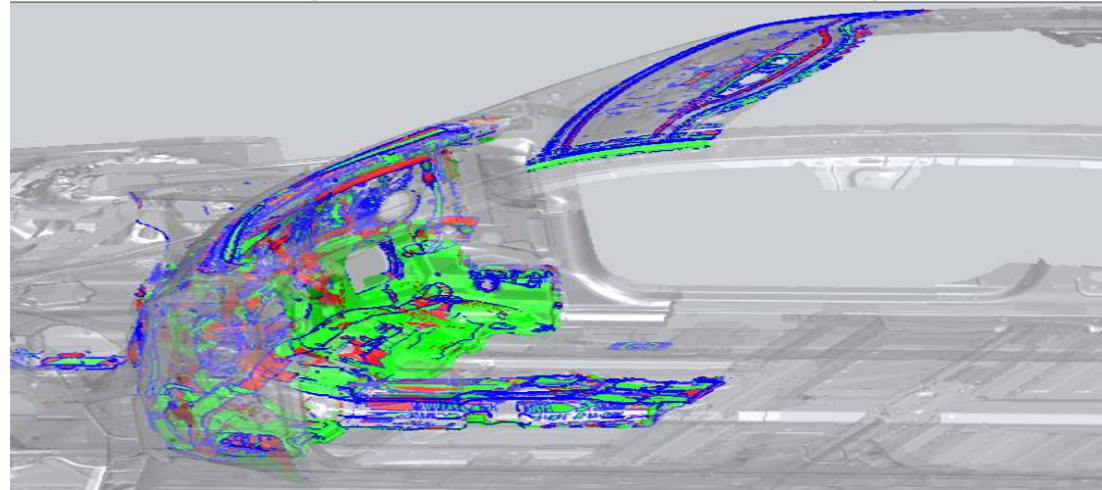
Compare and log the results into the database

Packaging Perspective in the Collision Management Tool

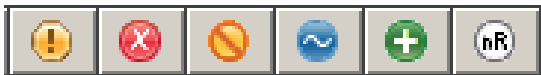
Visualization of collisions in Body in White



Collision partners



Possible ratings:

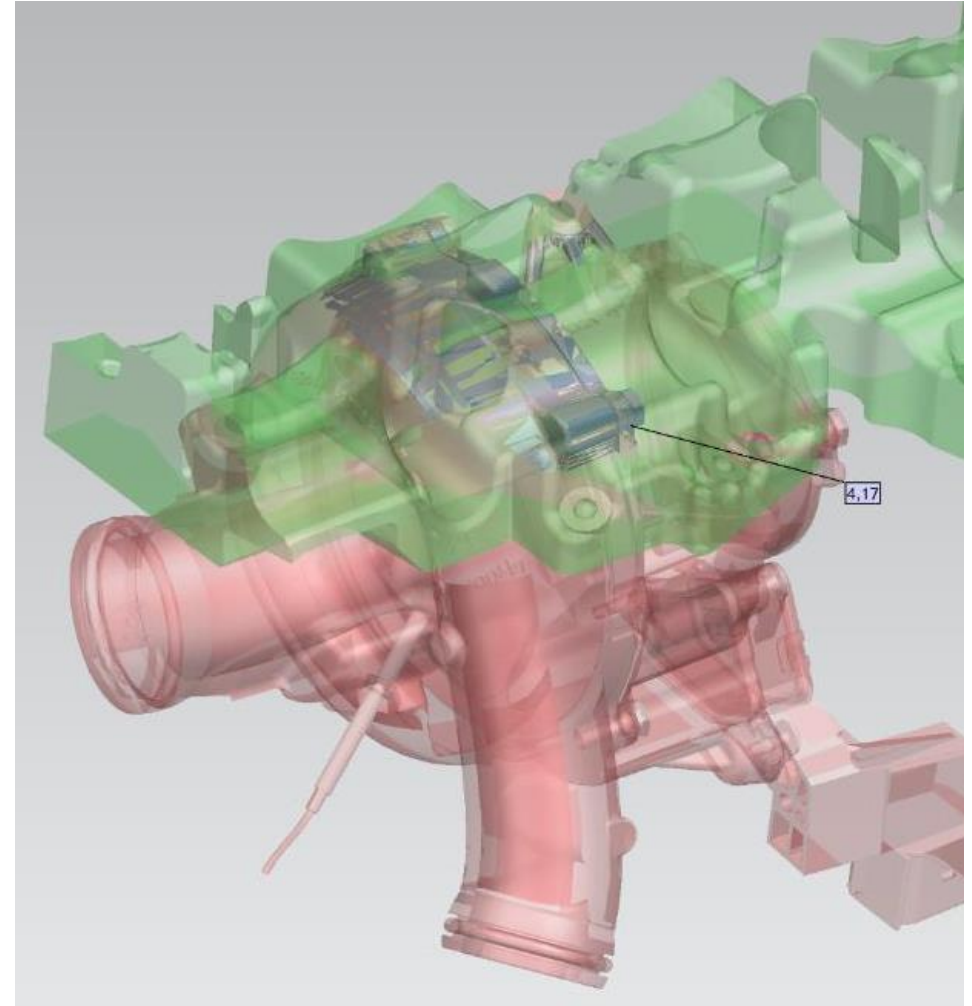


Elementkennung	Benennung	Partner Benennung (Relation)	Ergebniswert [mm]	Hausdorff Abstand	Status Kollision	MB-KI Bewertung	MB-KI Sicherheit	Ext-KI Bewertung	Ext-KI Sicherheit
> ☐ A0009905025	EINNIETSCHRAUBE	...	-15,28	...	neu	...	...	...	...
> ☐ A9250954544	DACHRAHMEN VO UT	...	-15,24	...	falsch positi...	...	...	...	...
> ☐ A9250527544	QUERTRAEGER VO FO-SITZ	...	-15,21	...	relevant	...	...	...	...
> ☐ A9250706444	RADEINBAU HI AU V-TEIL ...	...	-15,16	...	relevant	...	...	...	...
> ☐ A9250706444 [C581 041436 01	RADEINBAU HI AU V-TEIL ...	...	...	...	...	...	...	...	...
> ☐ A9250706444, HR05800000	RADEINBAU HI AU V-TEIL ...	NAHTABDICHTUNG AUFBAU HI IN	-15,16	1,31	+ nicht relevant	unbekannt	0,41	unbekannt	0,2
> ☐ A9250706444, HR05800000	RADEINBAU HI AU V-TEIL ...	NAHTABDICHTUNG SEITENWD LADES...	-7,04	1,26	+ nicht relevant	nicht relevant KI	0,65	unbekannt	0,44
> ☐ A9250706444, A925026604	RADEINBAU HI AU V-TEIL ...	VERSCHLUSSSTOPFEN	-2,99	...	+ nicht relevant	...	...	...	...
> ☐ A9250706444, A925026624	RADEINBAU HI AU V-TEIL ...	ABDAEMPUNG RADLAUF HI IN RE	-2,16	2,67	+ nicht relevant	unbekannt	0,24	unbekannt	0,07
> ☐ A9250706444, A925224204	RADEINBAU HI AU V-TEIL ...	ABDAEMPUNG RADLAUF HI IN RE	-2,16	2,67	+ nicht relevant	unbekannt	0,24	unbekannt	0,07
> ☐ A0009907635, A925070644	RADEINBAU HI AU V-TEIL ...	LU RADLAUFABDECKUNG HI RE	-1,81	1,3	relevant	nicht relevant KI	0,64	unbekannt	0,44
> ☐ A9250706444, A925071704	RADEINBAU HI AU V-TEIL ...	LINSENKOPFSCHRAUBE MIT BUND UN...	-1,5	1,5	+ nicht relevant	unbekannt	0,39	unbekannt	0,44
> ☐ A9250706444, HR05810000	RADEINBAU HI AU V-TEIL ...	VERSTAERKUNG LAENGSTRAEGER AU ...	-0,92	0,72	relevant	unbekannt	0,49	unbekannt	0,47
> ☐ A9250706444, A925026394	RADEINBAU HI AU V-TEIL ...	ABDAEMPUNG C-SAEULE VERSTAERK...	-0,18	0,15	+ nicht relevant	unbekannt	0,49	unbekannt	0,85
> ☒ A9250706444, A925071504	RADEINBAU HI AU V-TEIL ...	ABDAEMPUNG RADLAUF HI VO OB RE	-0,13	0,13	+ nicht relevant	nicht relevant KI	0,7	unbekannt	0,71
> ☐ A9250706444, A925071384	RADEINBAU HI AU V-TEIL ...	C-SAEULE AU RE	-0,1	0,1	+ nicht relevant	unbekannt	0,5	unbekannt	0,71
> ☐ A9250504644, A925070644	RADEINBAU HI AU V-TEIL ...	C-SAEULE AU UT RE	-0,08	0,07	+ nicht relevant	unbekannt	0,39	unbekannt	0,74
> ☐ A9250706444, A925026824	RADEINBAU HI AU V-TEIL ...	RADEINBAU VO RE	-0,04	0,04	+ nicht relevant	unbekannt	0,39	unbekannt	0,58
> ☐ A9250706444, A925071844	RADEINBAU HI AU V-TEIL ...	LU ABDAEMPUNG RADEINBAU UT RE	-0,04	0,04	+ nicht relevant	unbekannt	0,4	unbekannt	0,89
> ☐ A9250706444, A925071844	RADEINBAU HI AU V-TEIL ...	RADEINBAU AU UT RE	-0	0	+ nicht relevant	unbekannt	0,38	unbekannt	0,56

ARTIFICIAL INTELLIGENCE

Objective and benefit estimation

- Reduction of manual effort in the assessment of collisions in the Packaging process
- Standard DMU use cases should be automatically evaluated by the artificial intelligence
- Quality and efficiency increase by reducing the essential scopes
- Judgment of the user continuously improve the AI

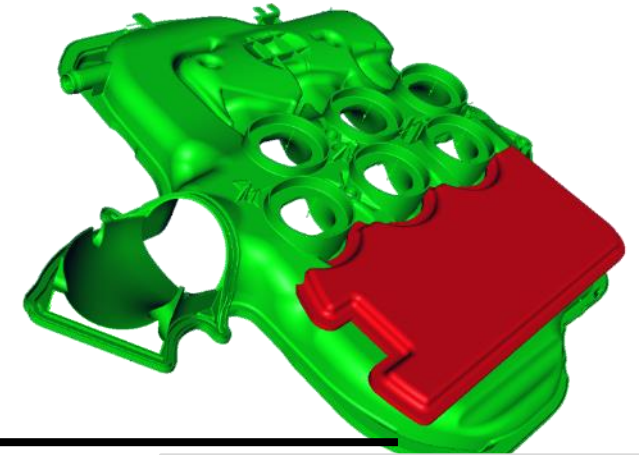
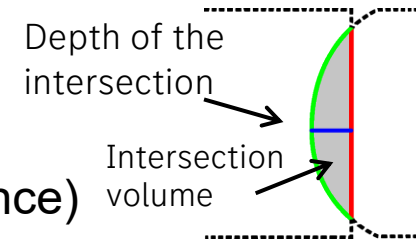


Innovation Levels to Automate Collision Management

as Implemented in Cooperation with Invenio GmbH

1. Calculation Algorithm

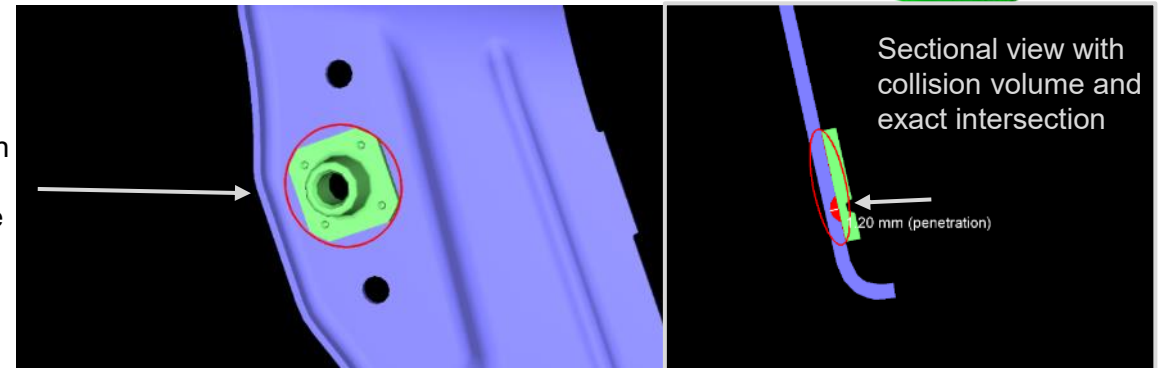
- Intersection-JTs instead of sections
- more exact intersection depth (Hausdorff distance)



2. Representation of the Results

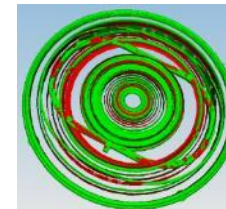
- intelligent section and
- View / Camera position

Detailed view with marking of the problematic issue

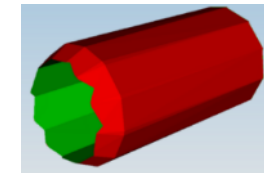


3. Automatic Rating

- Artificial Intelligence and
- learning algorithms (*in future prospective)



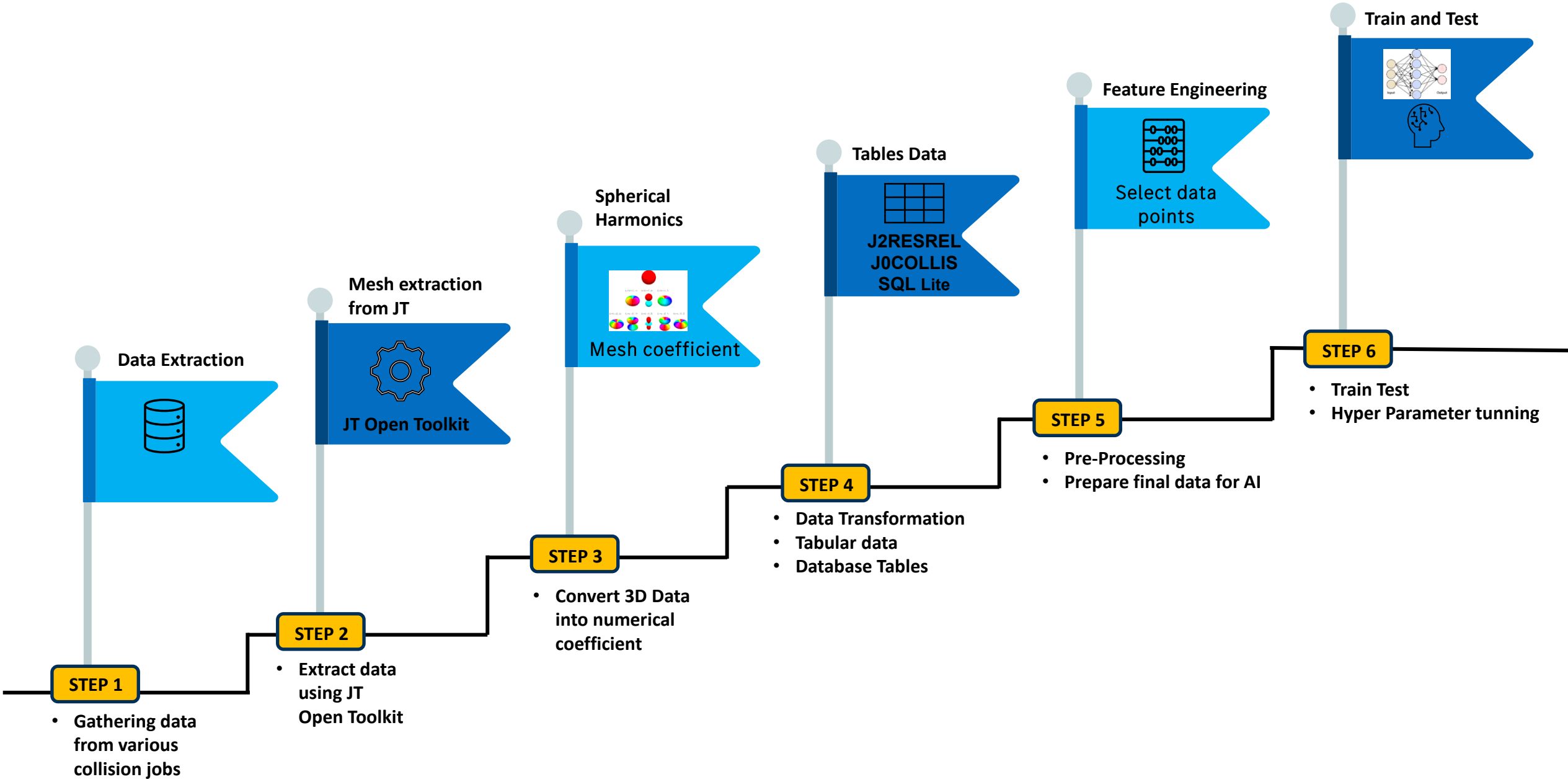
Sealing systems



Screws

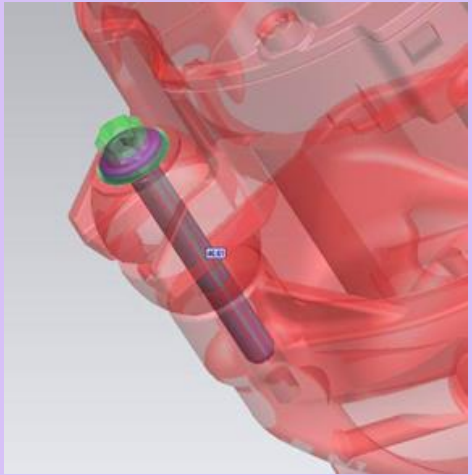
TECHNICAL APPROACH

Collision Management and AI Process



Input Parameters to Train the Neuronal Network and Results

Collision partners in Engineering Client



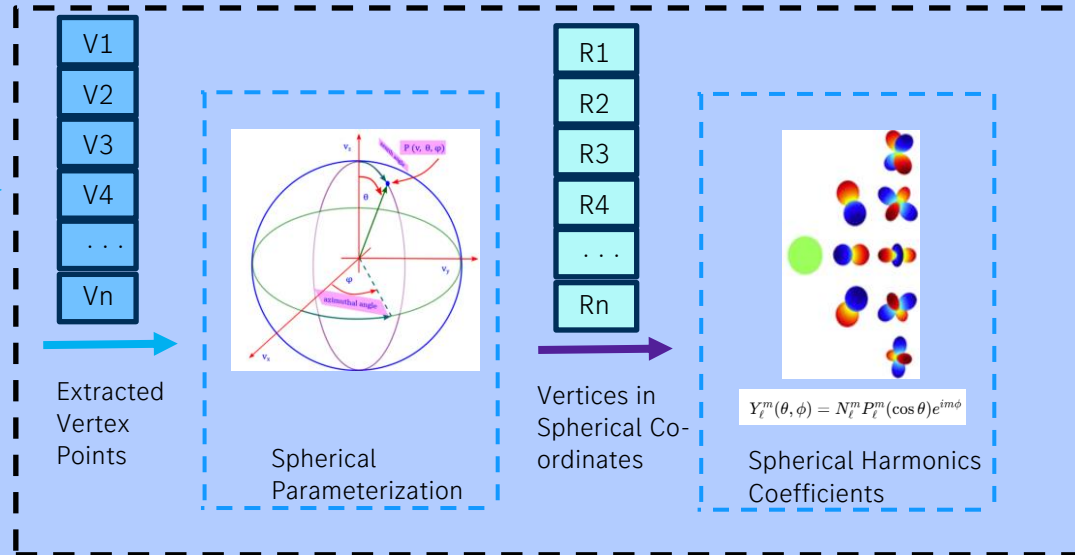
Intersection volume from collision calculation (purple)



Input Schematic representation



Processing



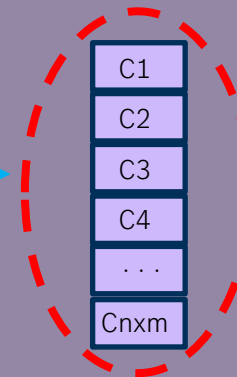
Algorithm in STC for the calculation of Spherical Harmonics

Output Schematic representation:



(The more coefficients are used the better the form will be reproduced)

Feature Vector



Spherical Harmonics (121)

Hausdorff Distance

Result minimum distance

Nomenclature Model1 and Model 2

Main Module1 and Main Module 2

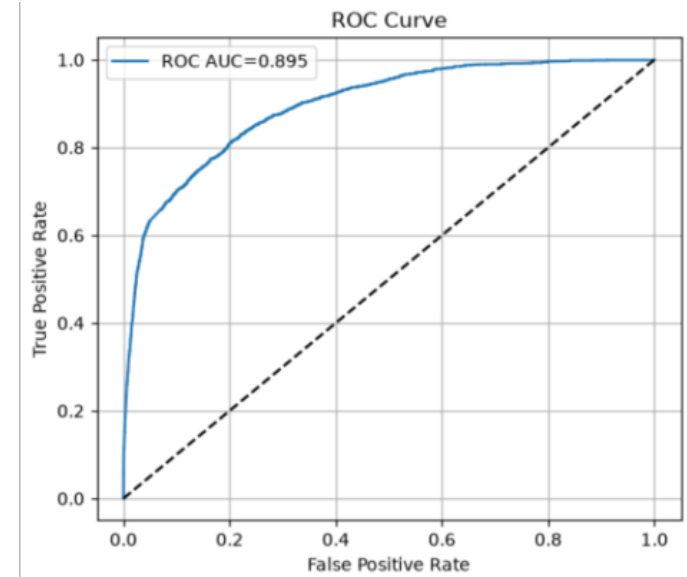
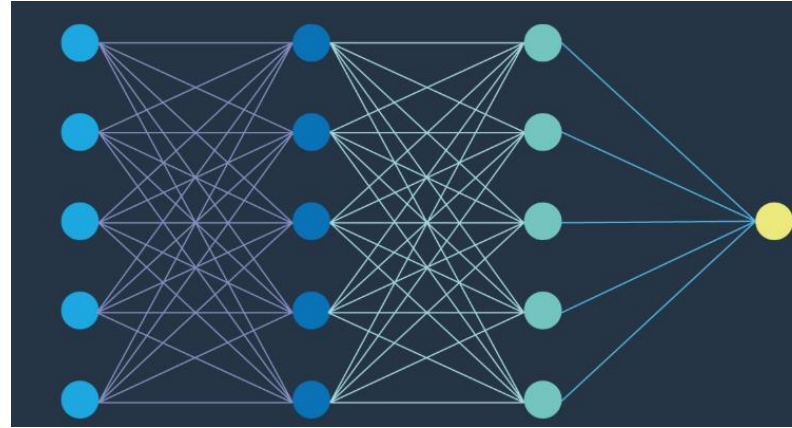
Output – Recommender for Rating:

- Not Relevant / Unknown
- Certainty in %

Neural Network: Binary Classification

Accuracy ~86%

Supervised Approach



Element identifier	Result value [mm]	Hausdorff distance	Status collision	Collision ID	OBID	Material
> A9070011498	-184.12	...	relevant	...	BhumGGewgut1-usr_wgubNSI	...
> A9070014198	-14.75	...	relevant	...	usr_wgub00000000B80B5022	...
> A9070014398	-21.73	...	relevant	...	usr_wgub00000000B80D7005	...
✓ A9076905500	-1.83	...	relevant	...	BgEnYViwgut1-usr_wgubmpl	...
A9076905500 [C907 121624 0200 0060]	...	...	...	...	BhbdFphwgut1-usr_wgubCML	...
A9070011298, A9076905500	-0.27	0.27	not relevant	614598	usr_wgub00000000149A9FCB2	...
A9070011498, A9076905500	-1.36	1.13	relevant	611865	usr_wgub00000000CBA2A85	...
A9070011798, A9076905500	-1.83	...	not relevant	...	...	...
A9070012198, A9076905500	-1.83	...	not relevant	...	...	...
✓ A9076906000	-1.85	...	relevant	...	BgEnYmbwgut1-usr_wgubmq4	...
A9076906000 [C907 121624 1200 0060]	...	...	...	...	BhbdFphwgut1-usr_wgubCML	...
A9070011398, A9076906000	-0.28	0.27	not relevant	613964	usr_wgub00000000149A9FB38	...
A9070011498, A9076906000	-1.36	1.13	relevant	609211	usr_wgub0000000000CBA28FE	...
A9070011898, A9076906000	-1.85	...	not relevant	...	...	...
A9070011898, A9076906000	-1.85	4.2	not relevant	608537	usr_wgub00000000098393F6D	...
A9070011898, A9076906000	-0.81	0.8	not relevant	608531	usr_wgub00000000098393F67	...
A9070012298, A9076906000	-1.85	...	not relevant	...	...	...
A9070012298, A9076906000	-1.85	124.98	not relevant	608525	usr_wgub000000000904ED311	...
A9070012298, A9076906000	-0.81	0.8	not relevant	608521	usr_wgub000000000904ED30D	...
A9070022998, A9076906000	-0.28	0.27	not relevant	614088	usr_wgub000000001FD9672DE	...
> A9077150000	-6.41	...	relevant	...	Bfmjgffwgut1-usr_wgubAjG	...
> A9077150100	-3.15	...	relevant	...	Bfmjklwgut1-usr_wgubAtH	...
> A9100003198	-8.47	...	relevant	...	Acmgswewgut1-usr_wgubn2H	...
✓ A9100010098	-9.57	...	relevant	...	BdnmzQdwgut1-usr_wgubwx4	...

Input Features

Planned Features

3D Files Coefficient

Result Minim Distance

Hausdorff Distance

User Rating

Material info

....TBD

CHALLENGES AND WAY FORWARD

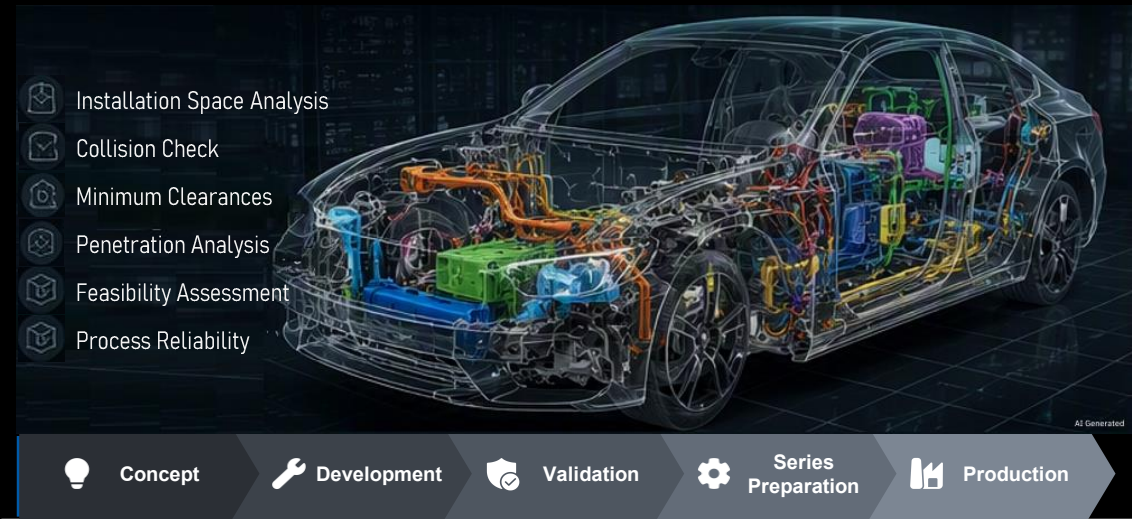
Open points and development possibilities

- Increase the data basis of the AI
- Increase the Input for the neuronal network (Material information, Nomenclature, Main Module, Organizational Unit or Project)
- Learning AI – improving continuously based on the rating of the users
- Automatically evaluations of collisions with an AI confidence above a certain threshold
- Performance improvements

ONE PAGER: AI FOR COLLISION MANAGEMENT

Mercedes-Benz Packaging Process - Collision Management 4.0

Digital Construction Space – Freedom from Critical Collisions – Efficiency



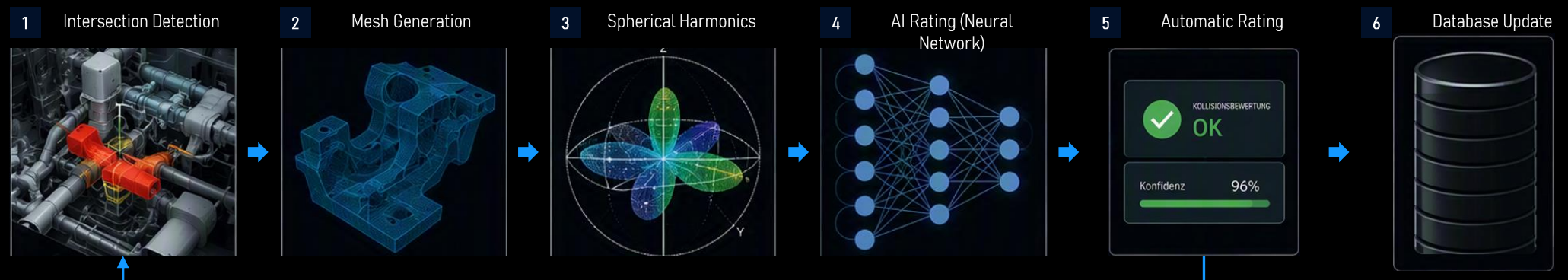
Integration into the Development and Production Process

End-to-End Digital Process with Highest Data Quality



AI-Supported Packaging Process - Collision Management 4.0

From the intersection to the intelligent rating



Objective: self-learning AI – continuous improvement through feedback



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Thank you for
your time,
your energy,
and your invaluable insights.