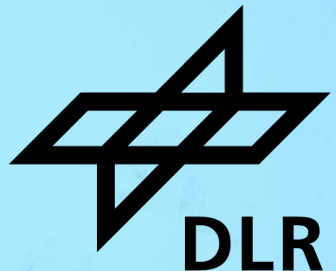# FROM THE REAL TURBINE BLADE TO THE DIGITAL COMPONENT TWIN – COMPARISON OF METHODS AND CHALLENGES

DEUTSCHER LUFT- UND RAUMFAHRTKONGRESS 2024
30.09.2024

Y. Chodvadiya, P.-B. Ebel, A. Kamtsiuris, E. Grishchenko
German Aerospace Center (DLR)

Needs for Digital Component Twins

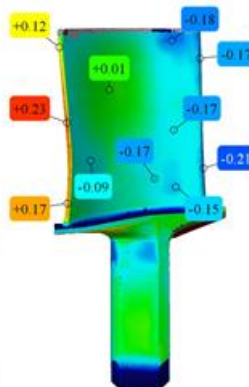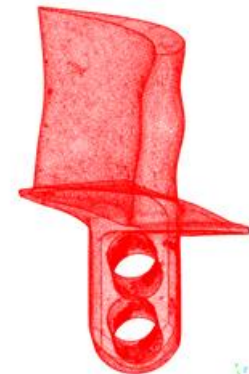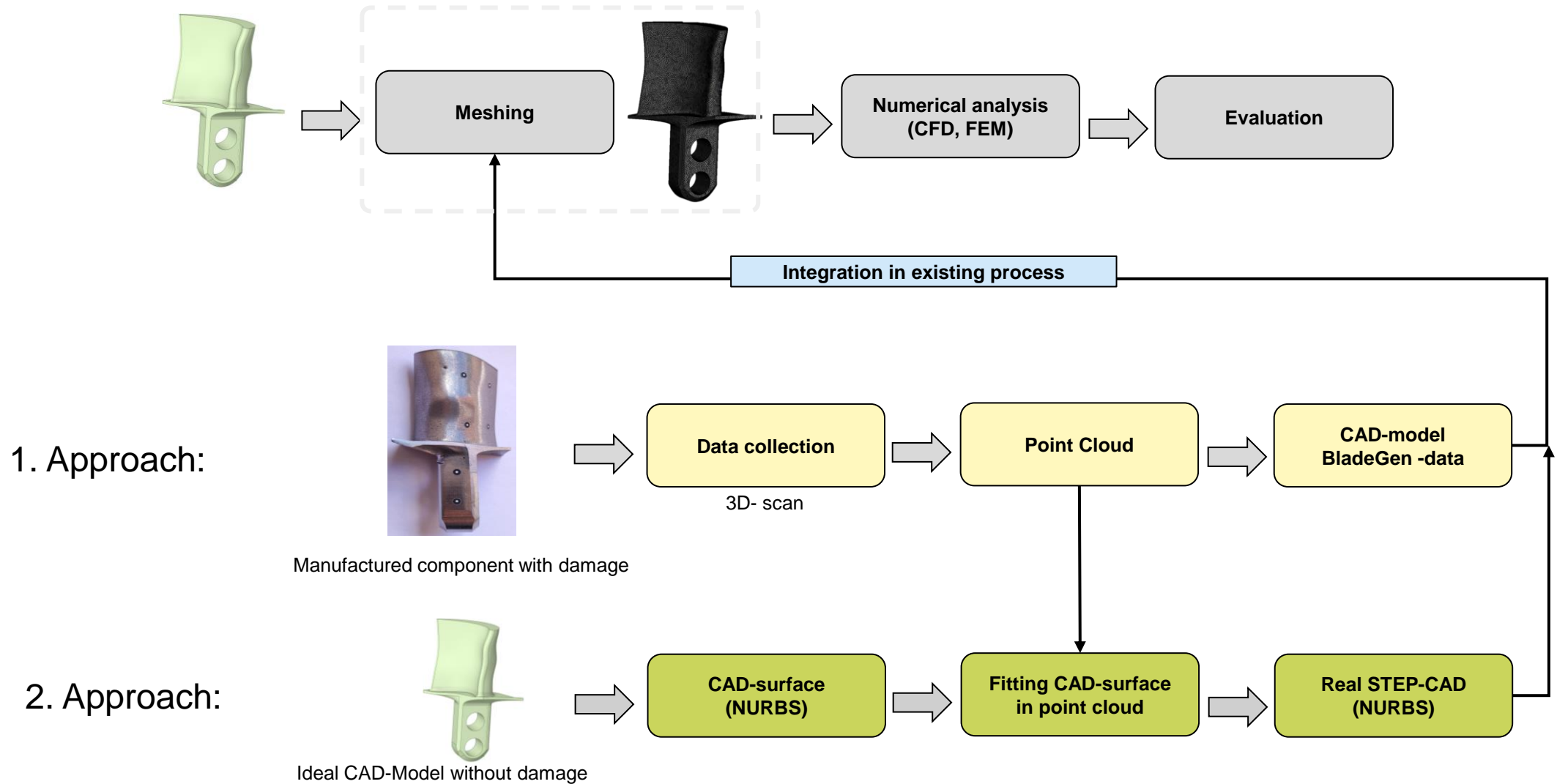## Design to production to design

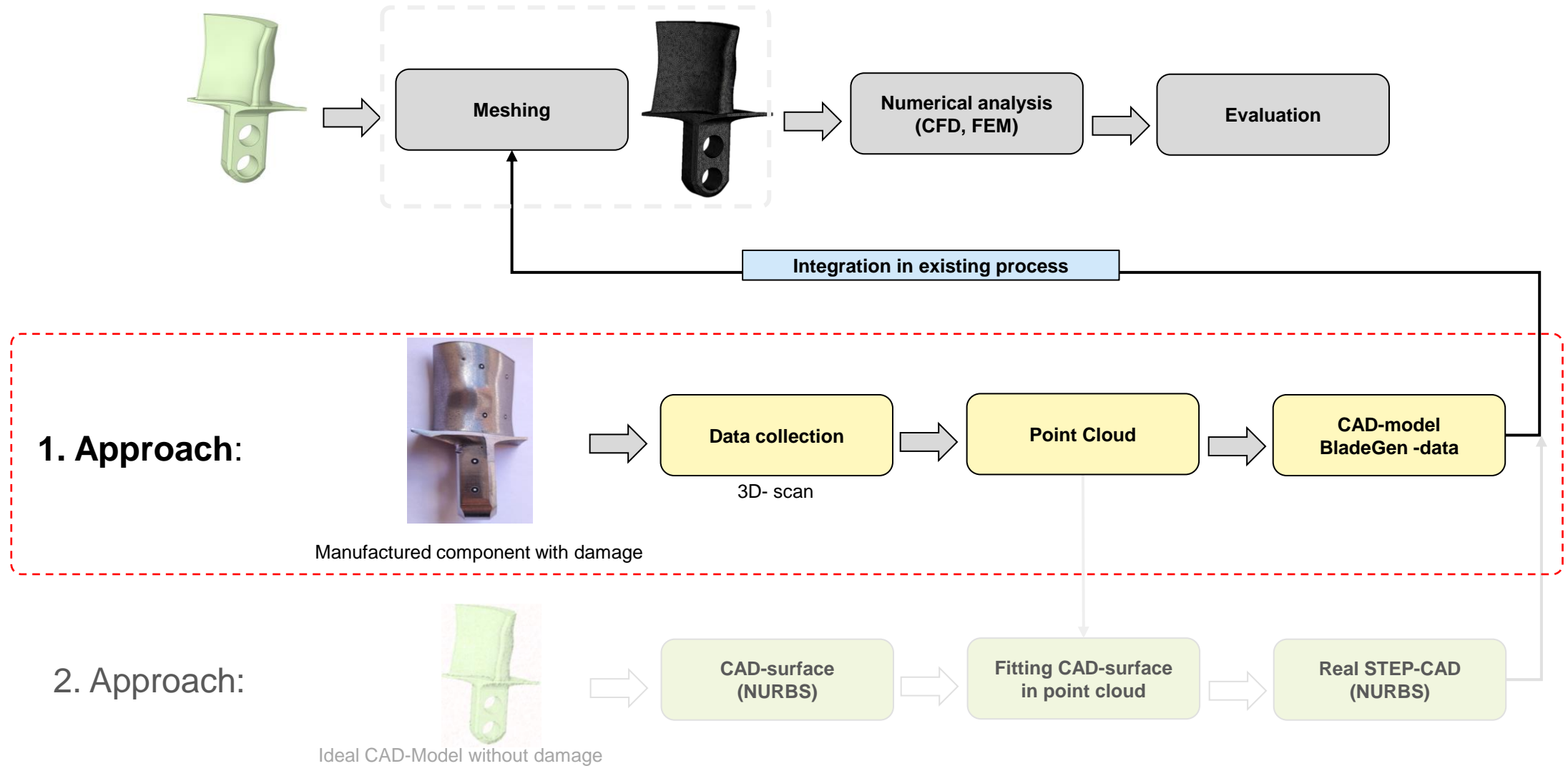| Production deviation	Quality control	Degradation and damage of materials

Reverse engineering, end-to-end process
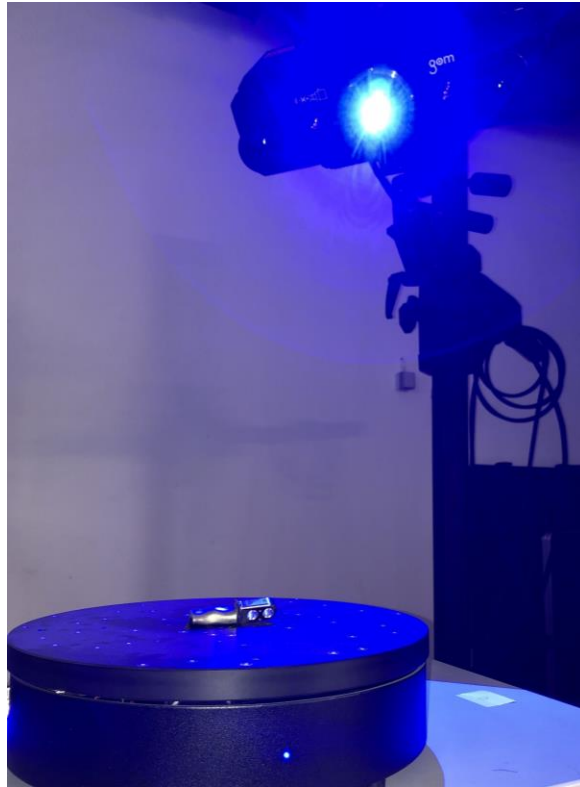
Current Process and Desired Process

Meshing → **Numerical analysis (CFD, FEM)** → **Evaluation**

Integration in existing process

1. Approach:

Manufactured component with damage

Data collection
3D- scan
→ **Point Cloud** → **CAD-model BladeGen -data**

2. Approach:

Ideal CAD-Model without damage

CAD-surface (NURBS) → **Fitting CAD-surface in point cloud** → **Real STEP-CAD (NURBS)**

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Fitting CAD-surface in point cloud

Real STEP-CAD (NURBS)

1. Approach: 3D Scanners

GOM ATOS 5 + GOM software suite

- Two camera + one projector
- Resolution: 8 MP / 12 MP
- Measuring volumes: MV170, MV500, MV1000
- Measuring area (MV170) 185 × 140 × 140 mm³
- Auxiliary markers and markers on the object
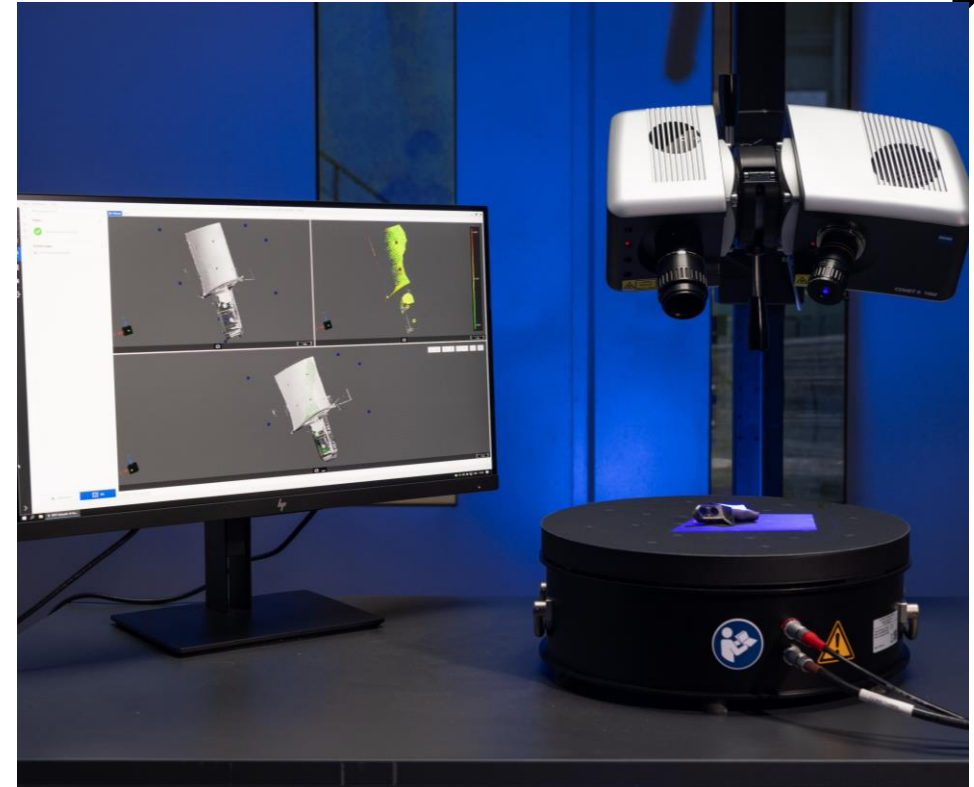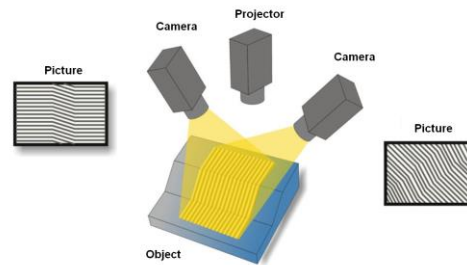
Zeiss Comet 6 16M

- One camera + one projector
- Resolution: 4896 x 3264 (16 MP)
- Measuring volumne: 81x54x40 mm³ (measuring field 80) to 656x437x400 mm³ (measuring field 700)
- Auxiliary markers on tables

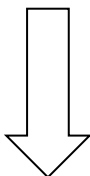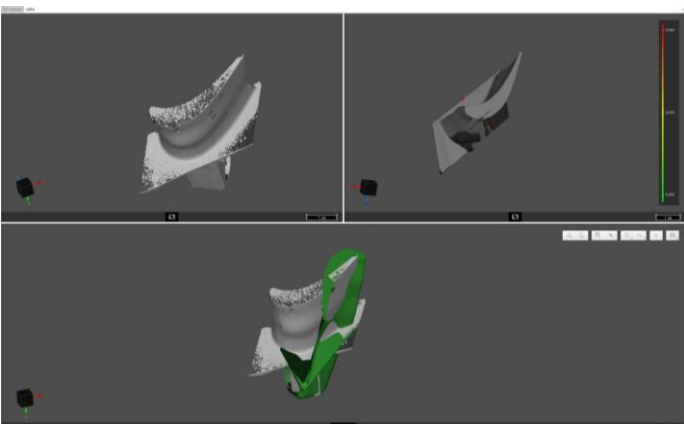# 1. Approach: 3D Scanning Procedure

Calibration of the measuring field
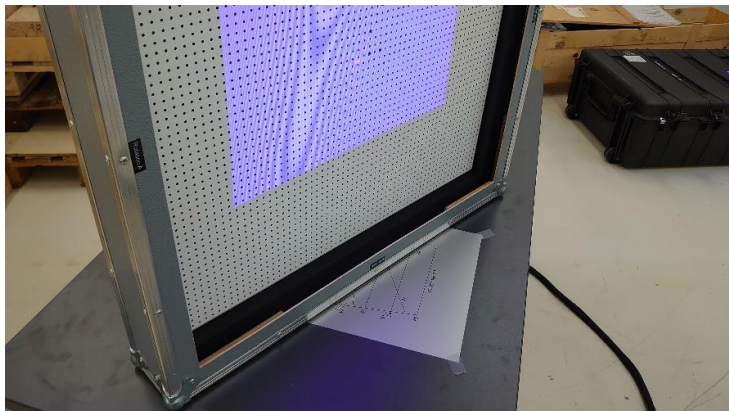
Scanning with turntable and auxiliary markers
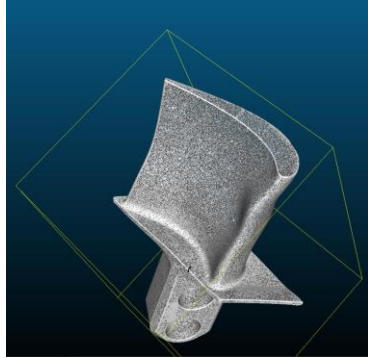
Overall model triangulation as a .STL network
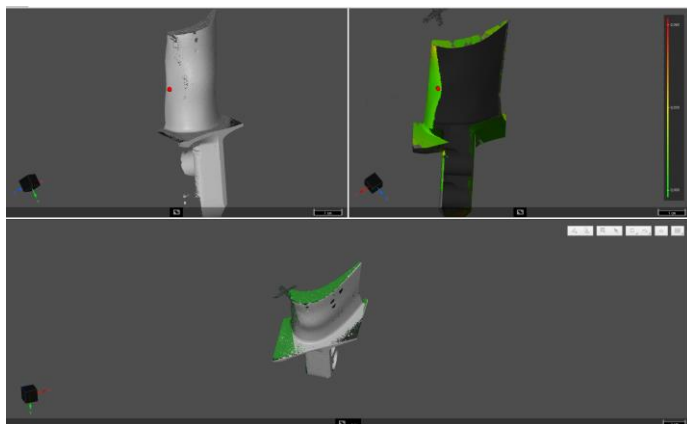
Aligning individual scans
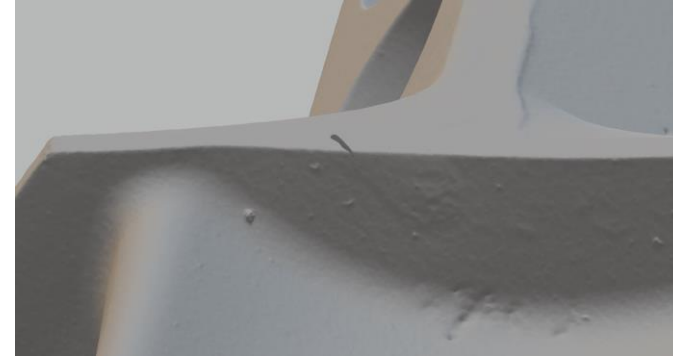
Y. Chodvadiya et. al: DLR-Project DigECAT, 30.09.2024
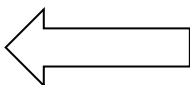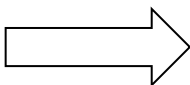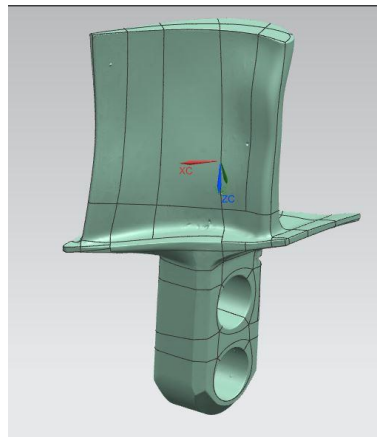
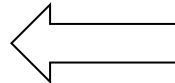# 1. Approach: 3D Scan to Finite Element Mesh

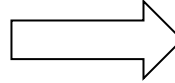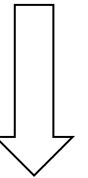**Scanned point cloud - .stl file**

Smoothening and cleaning

Surface to solid CAD Model

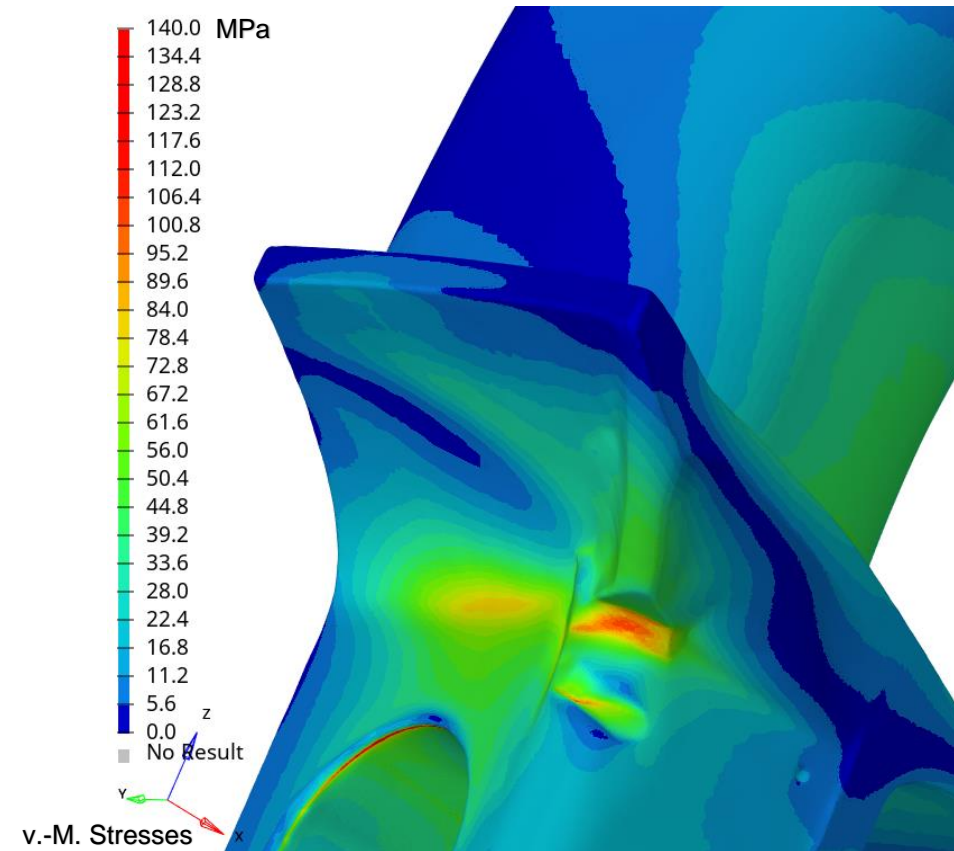**Water tight surface and reconstruction**
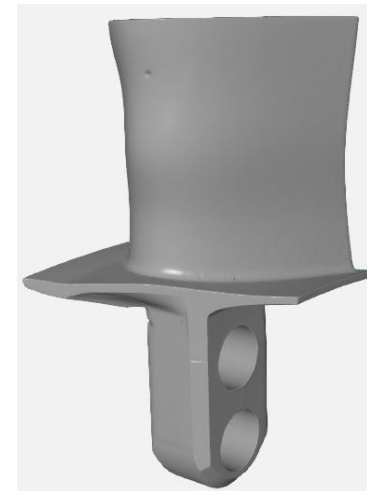
Ideal CAD model

Scanned CAD model

Ideal CAD model

Scanned CAD model

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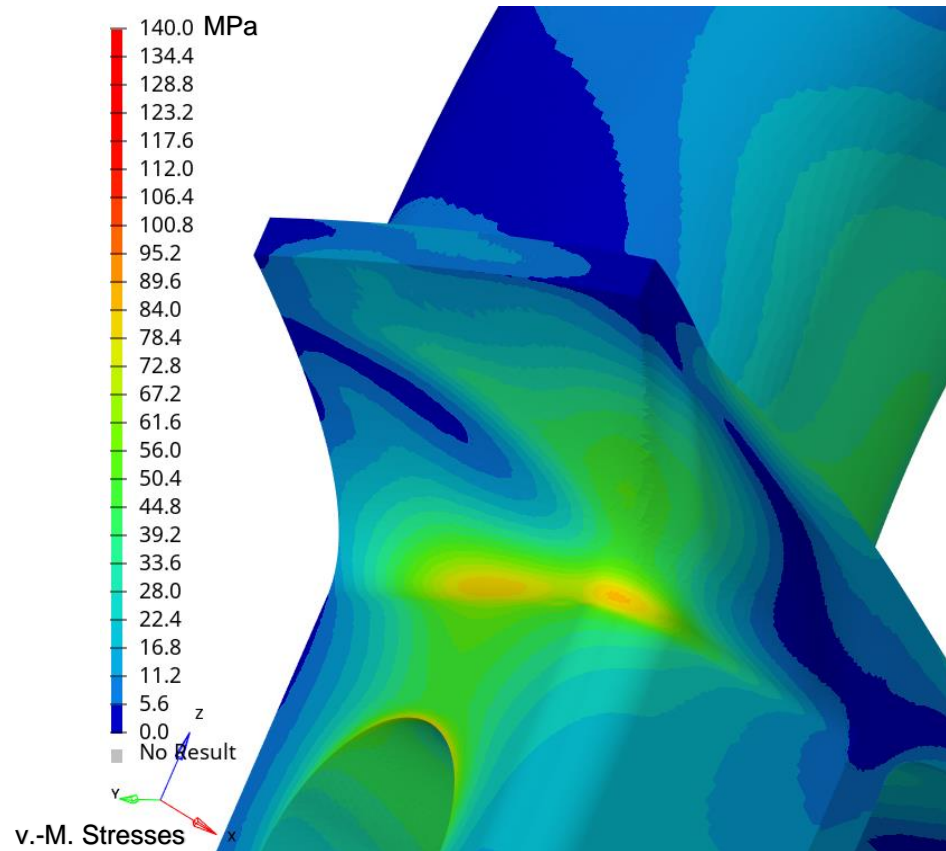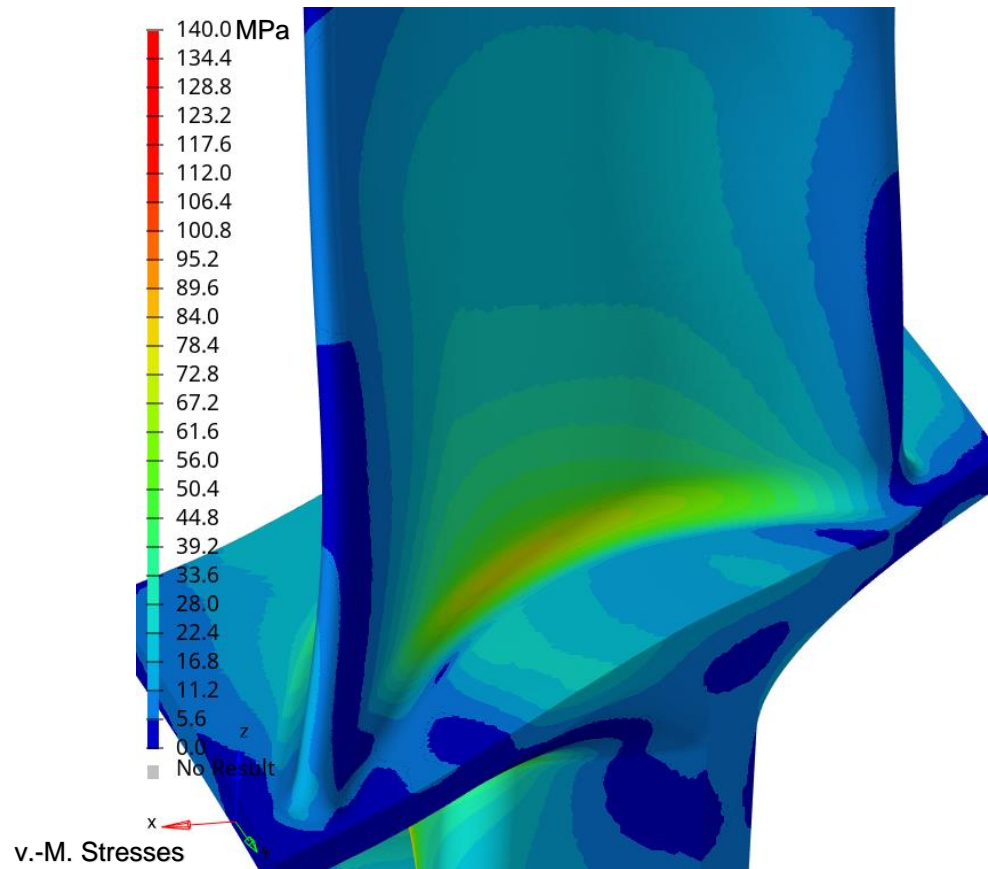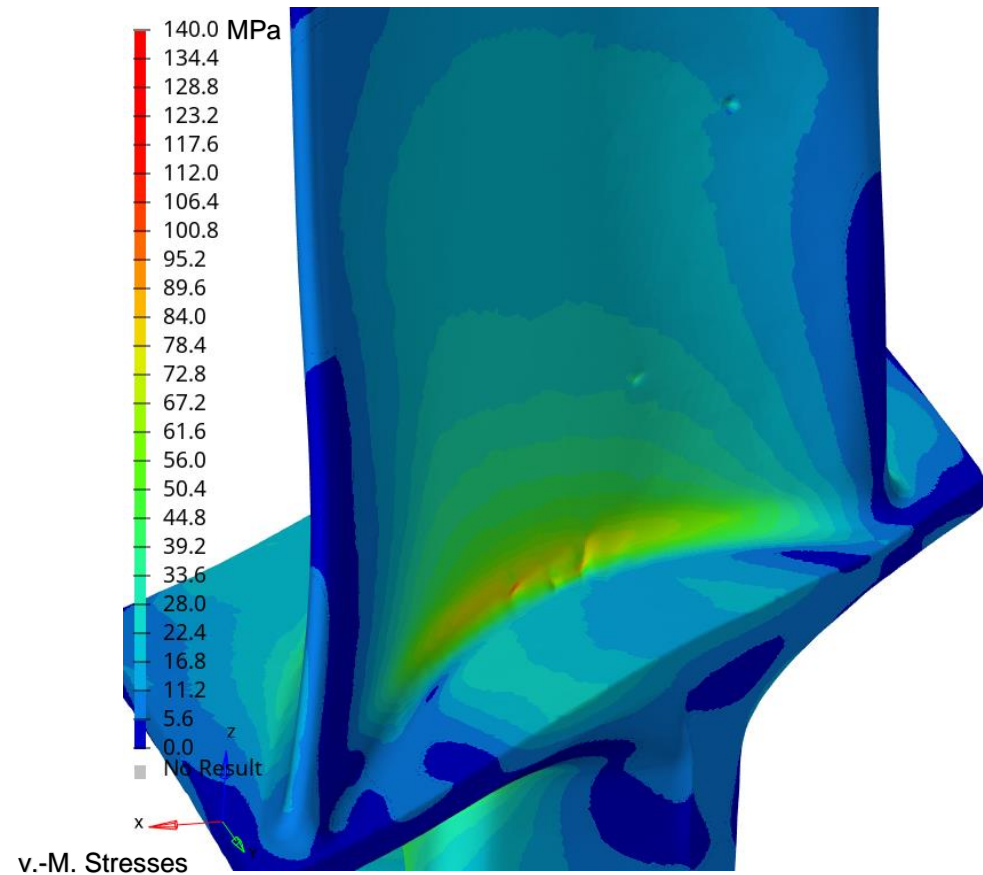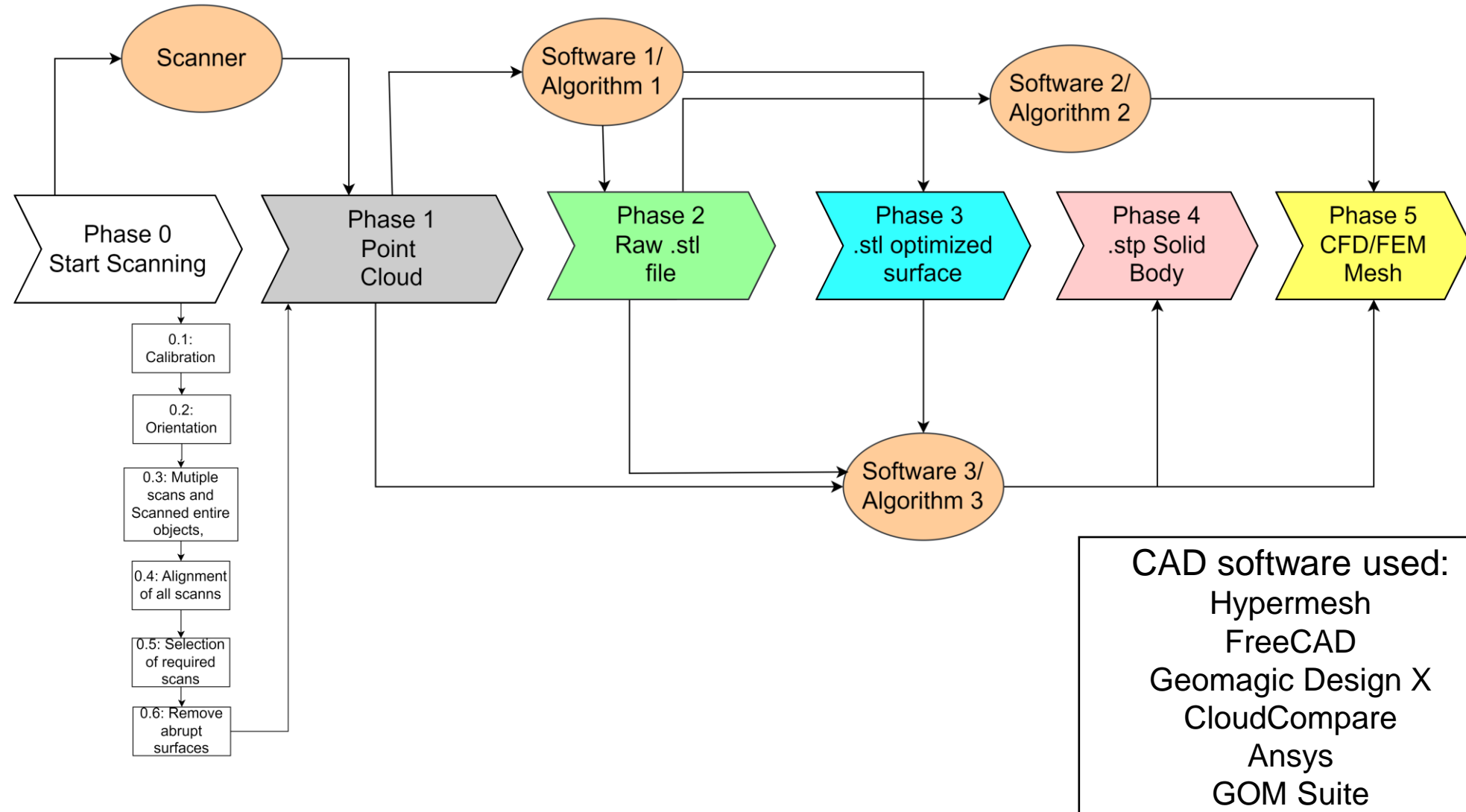
- Reconstruction parameters and defects

maximale Tiefe 0,299 mm
maximale Tiefe 0,282 mm
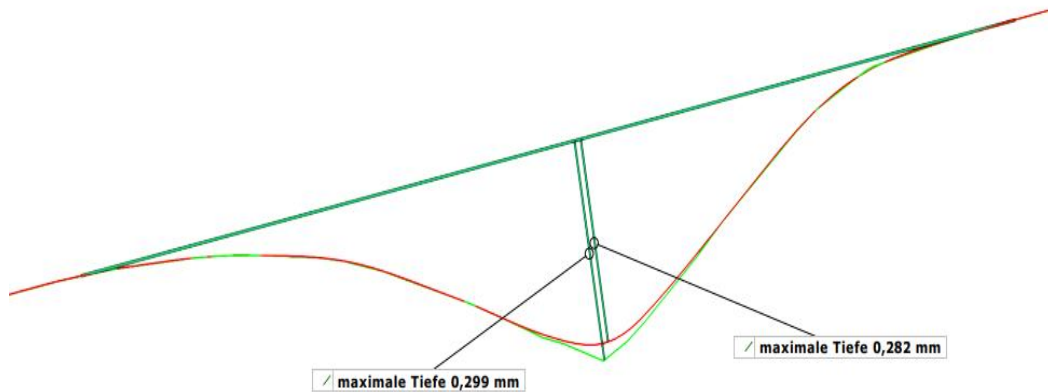
764 panels
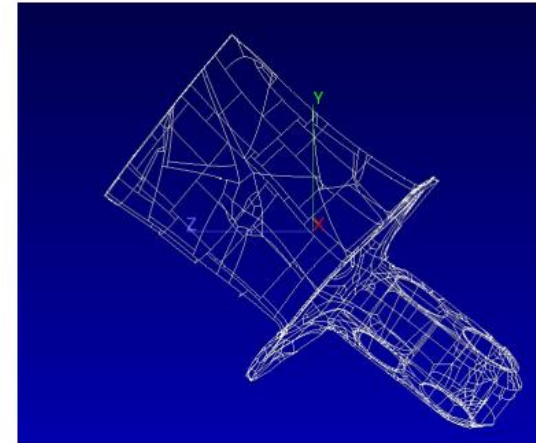
11017 panels
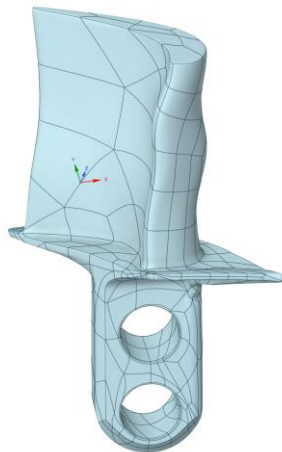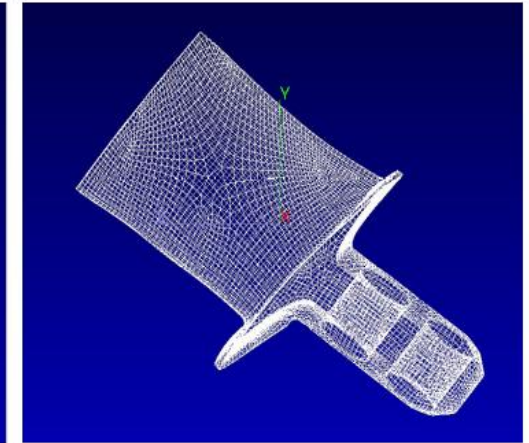
Scanner 1:	**Scanner 2:**
• No gaps and less noise in point cloud	• Gaps and noise in point cloud
• Less manual work	• More manual work
• Less Data points, less accurate	• More Data points, more accurate

- No parametric CAD model

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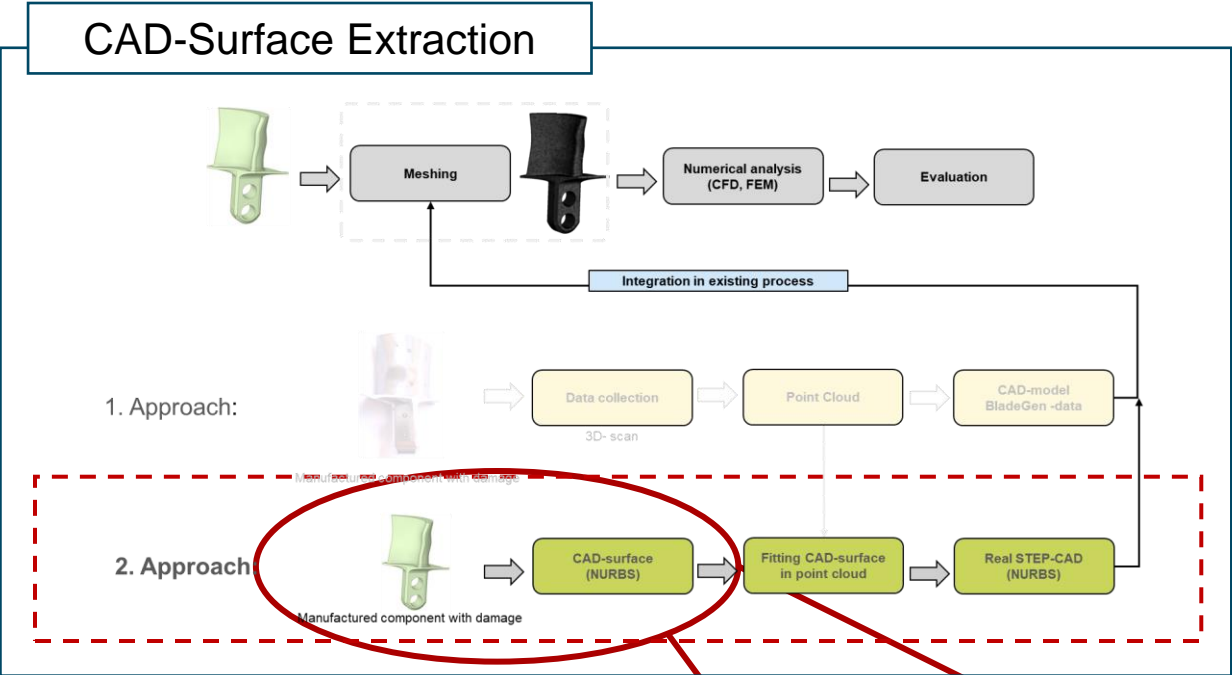CAD-surface (NURBS) → Fitting CAD-surface in point cloud → Real STEP-CAD (NURBS)
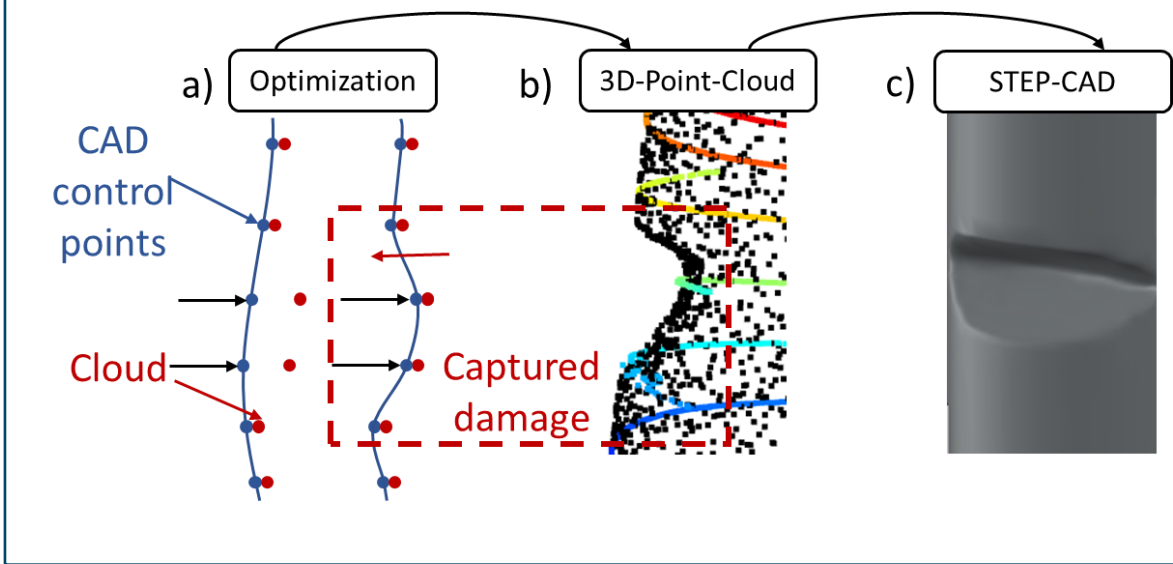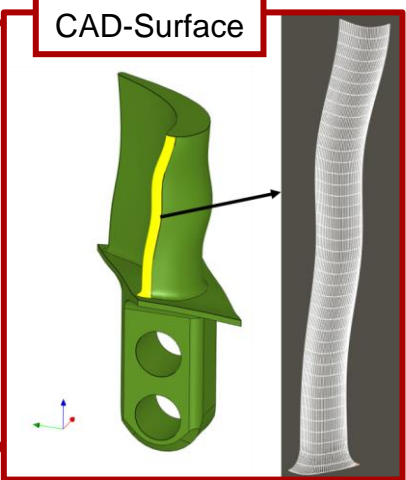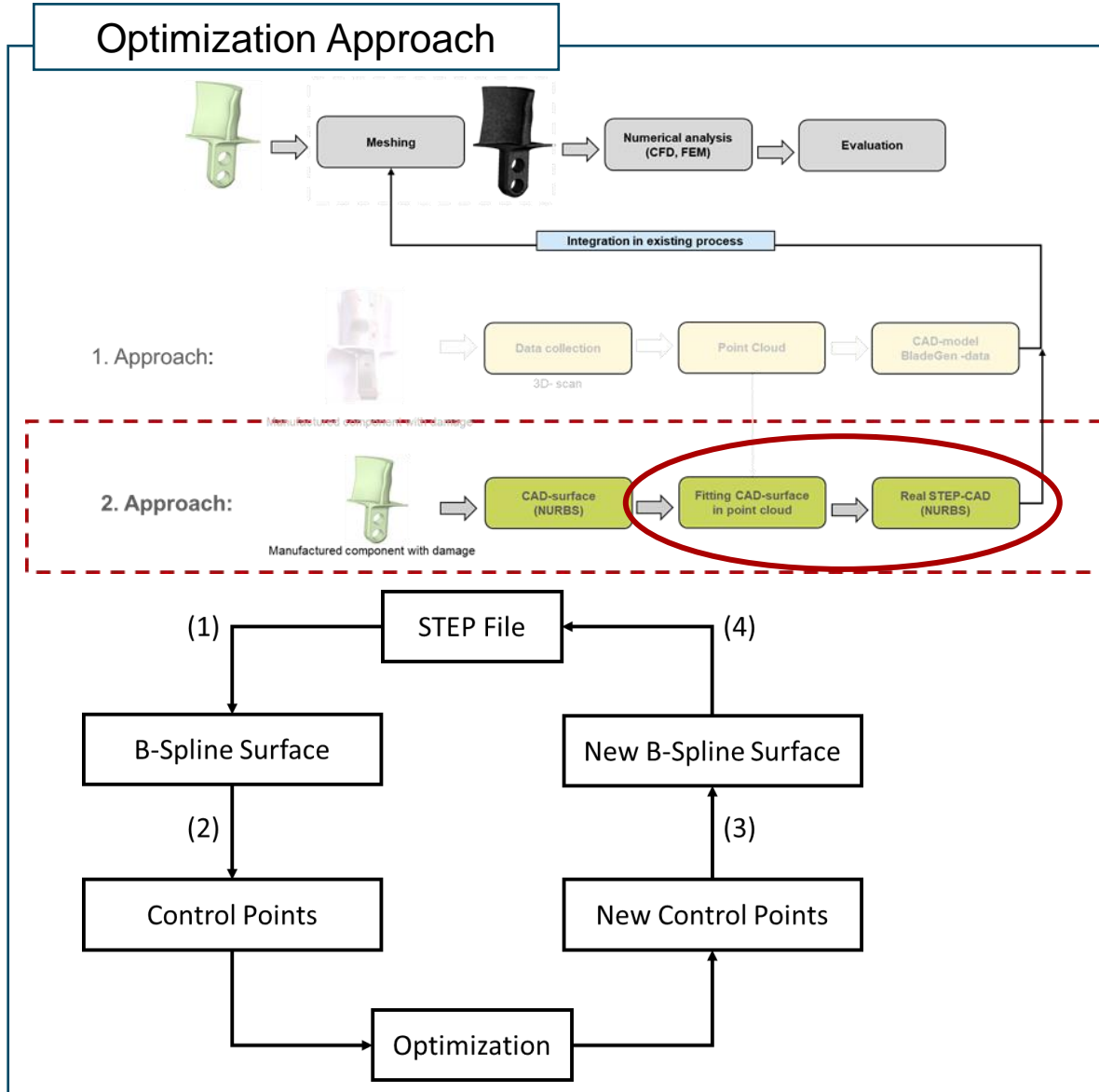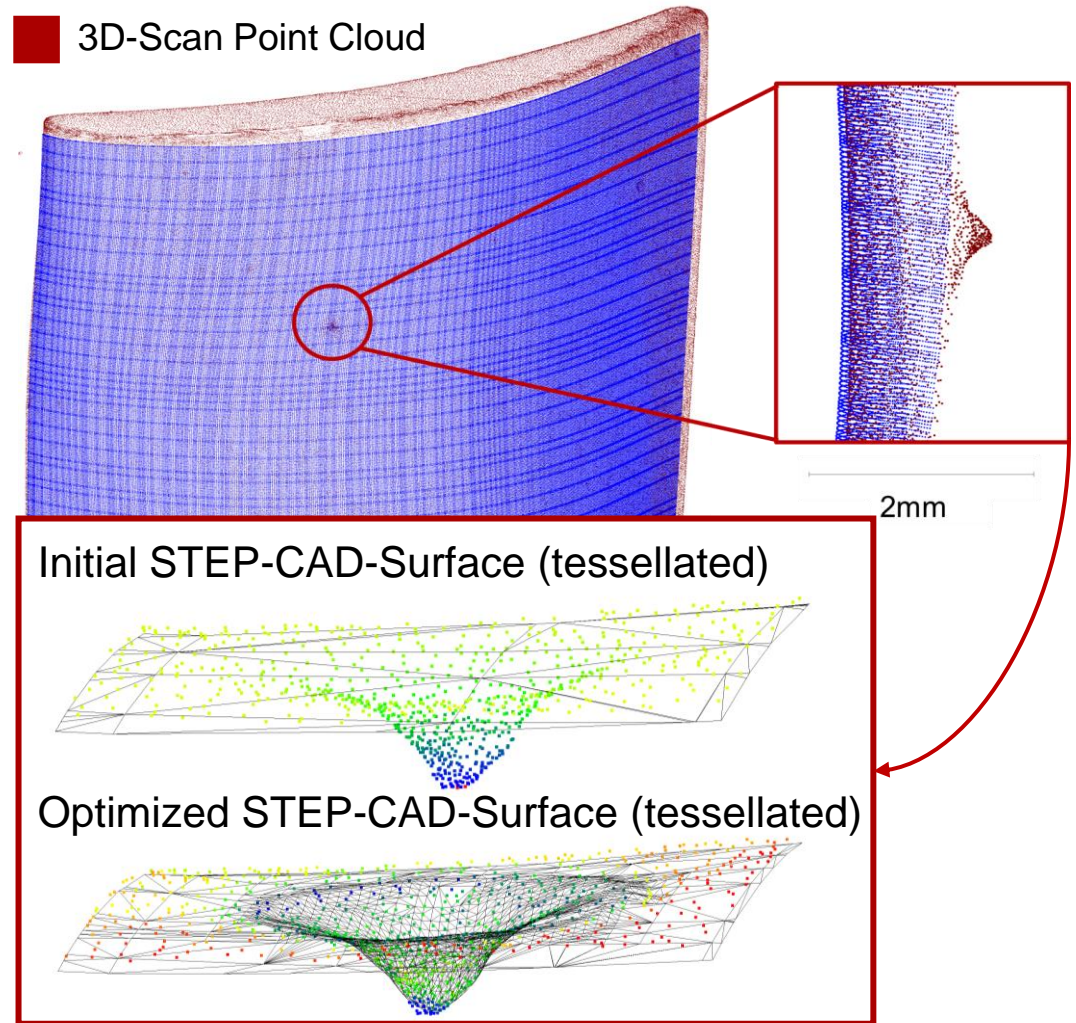
CAD-Surface Extraction

General Approach: Local CAD-Surface Adaptation

CAD-Surface

Optimization Approach

CAD-Surface Fitting

- 🟦 CAD-Surface Control Points
- 🟥 3D-Scan Point Cloud

2mm

Initial STEP-CAD-Surface (tessellated)

Optimized STEP-CAD-Surface (tessellated)

2. Approach: Results

Original blade

Adapted STEP-CAD
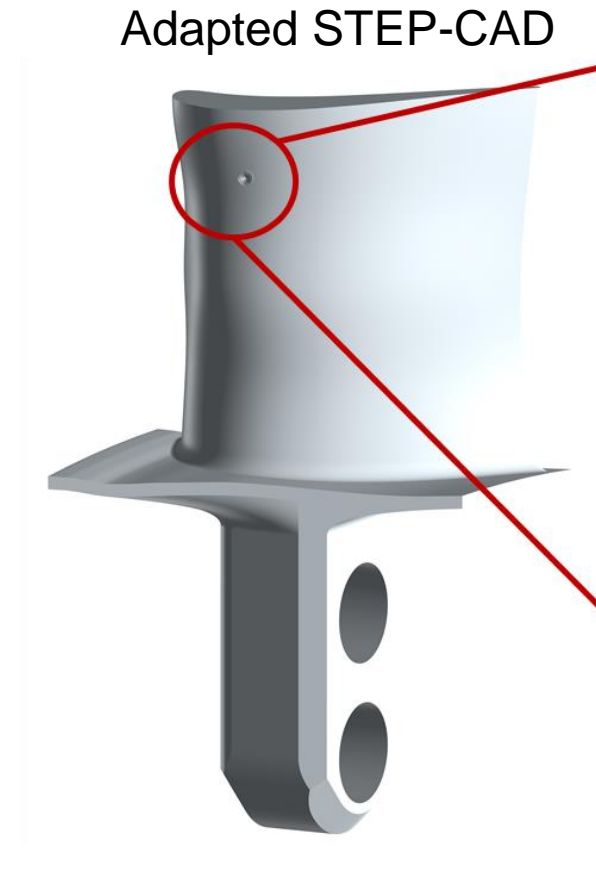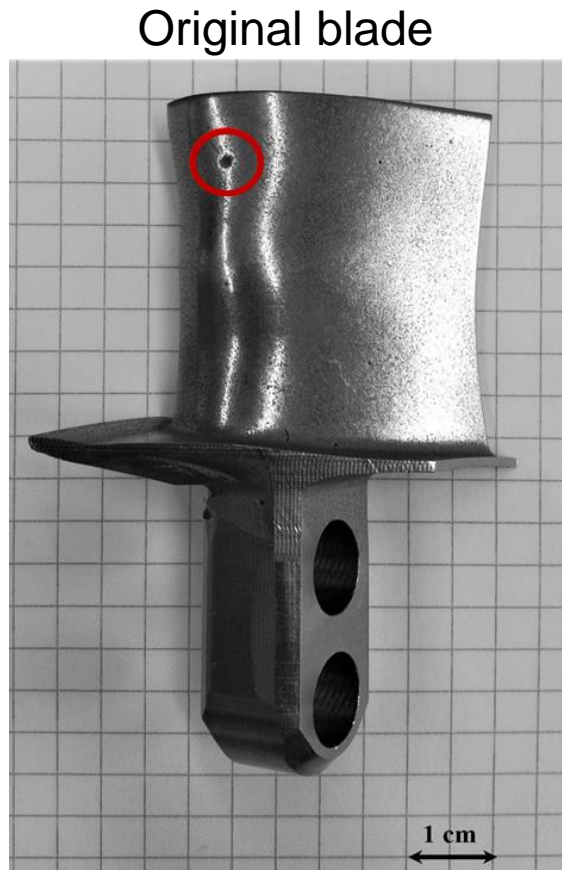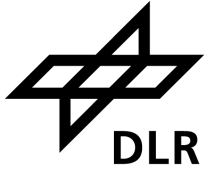
Locally fitted CAD-surface

A - A

aligned   initial

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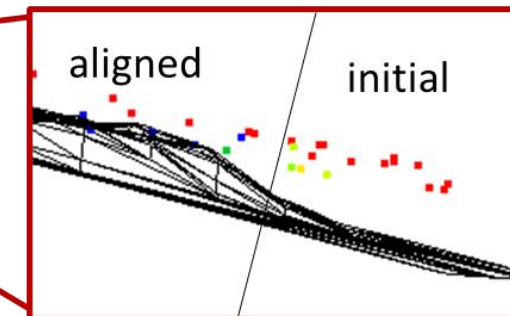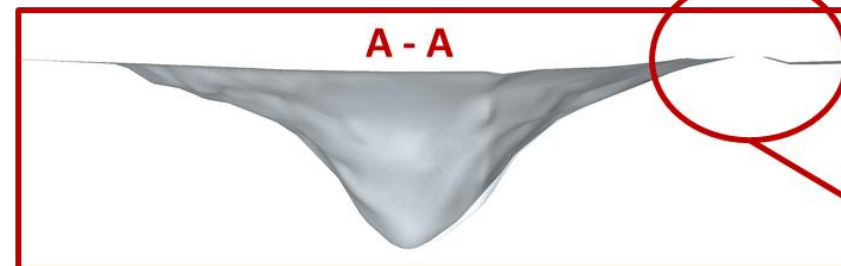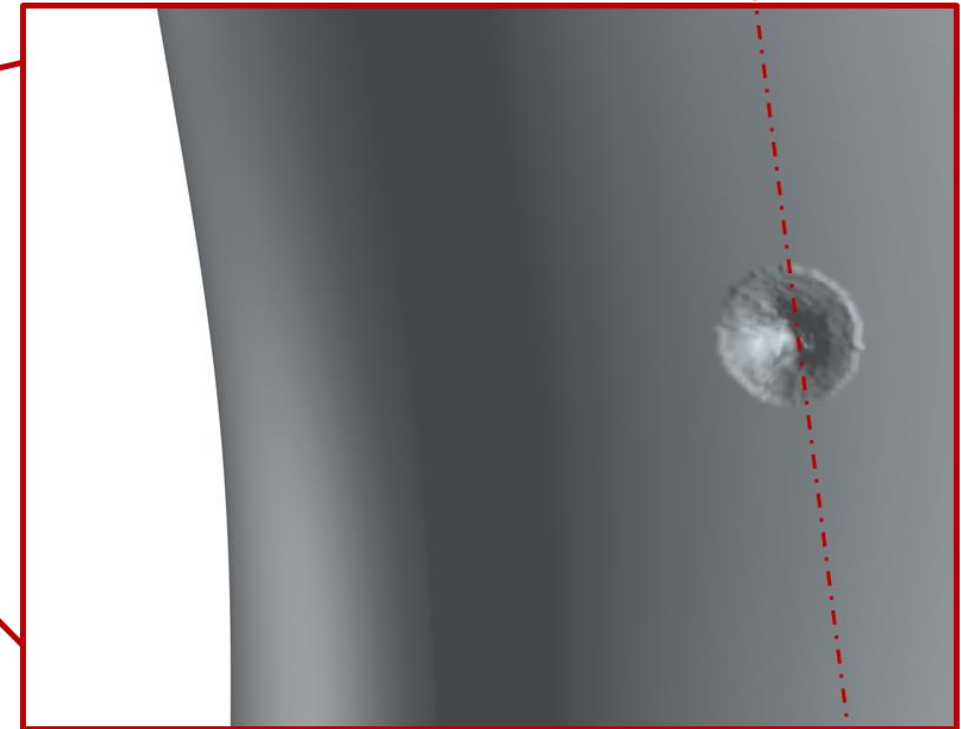
Compare of Results in Dent Area

a) Approach 1 and Scanner 1
b) Approach 1 and Scanner 2
c) Approach 2 and Scanner 2

a)

b)

c)

Point Cloud: 287.822 points

Point Cloud: 794.369 points

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Conclusion and Outlook

Approach 1

- Digital Component Twin is usable, further improvements required
- Improve conversion and area generation
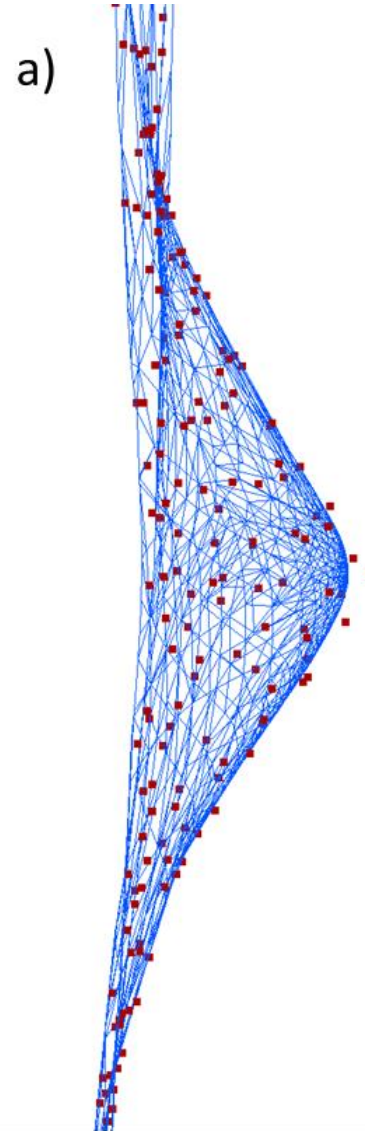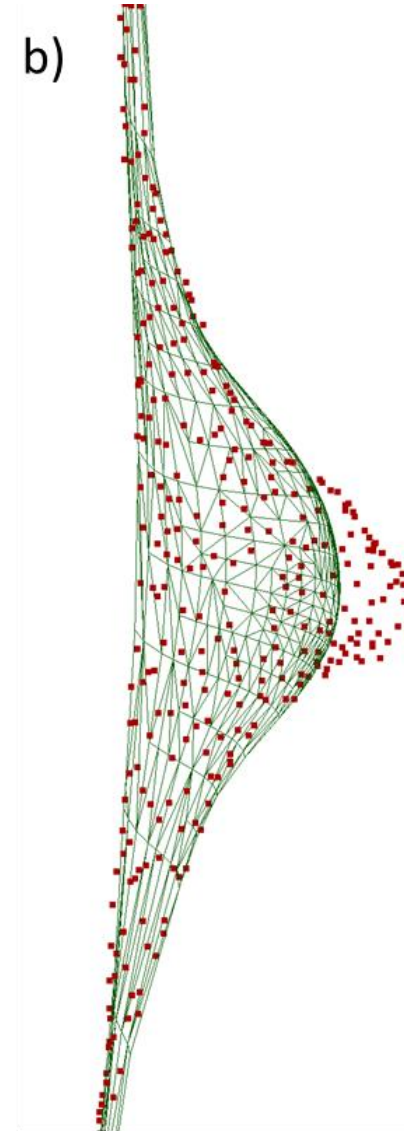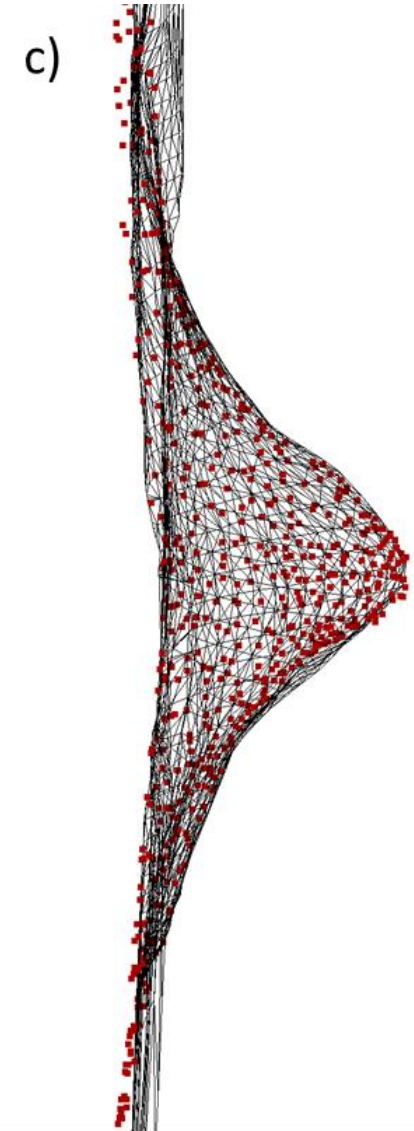- Improve usability of the output for specialist disciplines
- Routines for detail capture and accurate replication
- Find alternatives to additional commercial tools (e.g. OS software, e.g. existing CAD software, in-house developments, ...)
- Supplement optically non-scannable areas

Approach 2

- Creating Digital Component Twin with local CAD-Surface-Adaptation is possible
- Improve Pre-Processing alignment
- Testing the created CAD-data in simulation environments
- Extension to further damage classes with artificially created damages in CAD
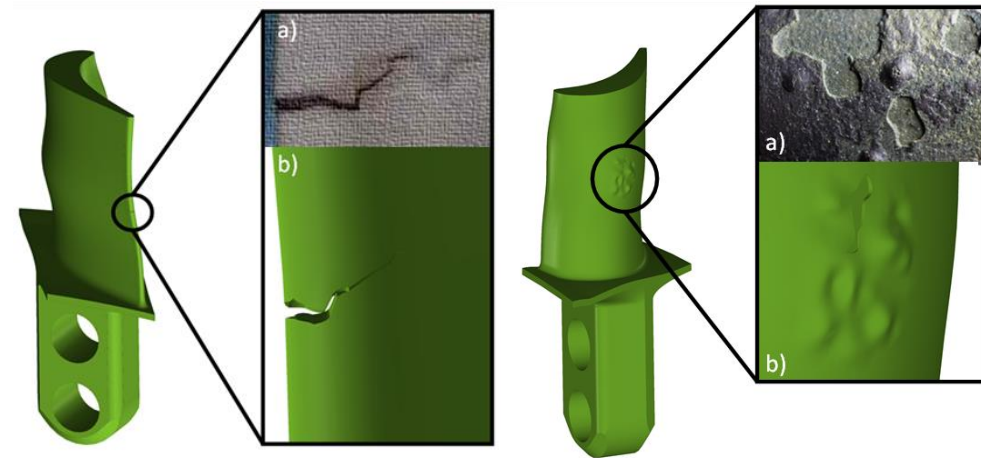
Artificially created damage classes in CAD

Thank you for your attention!

DLR-PROJECT DigECATt: **HTTP://S.DLR.DE/9OKJX**

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