Co-funded by
the European Union

3D OP

Optimization of Production by 3DoP

3DoP Exhibition

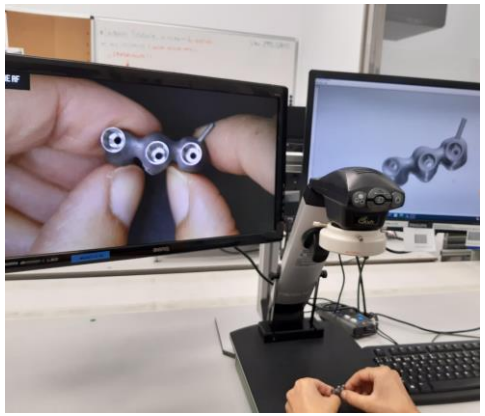
Work Package 4: Automated, dedicated AM Production line for affordable 3D printed dental implants and aligners

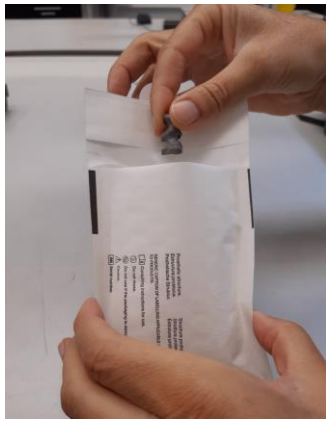
3D OP
3D printing
Optimised
Production

WP4 Objectives

- In the dental prosthesis manufacturing workflow, bottlenecks are identified mainly after additive manufacturing and/or in combination with milling
  - Current Dental Prosthesis manufacturing workflow (simplify)

Different dental parts, specially design for a pacient





Objective 1	AM Identification
Objetive 2	AM Quality Control
Objective 3	AM Handling &Transportation

From Manual process to Automated Process

WP4

AM Identification
AM Quality Control
AM Handling & Transportation

Increase Productivity
Quality Control total accuracy
Automated Logistics

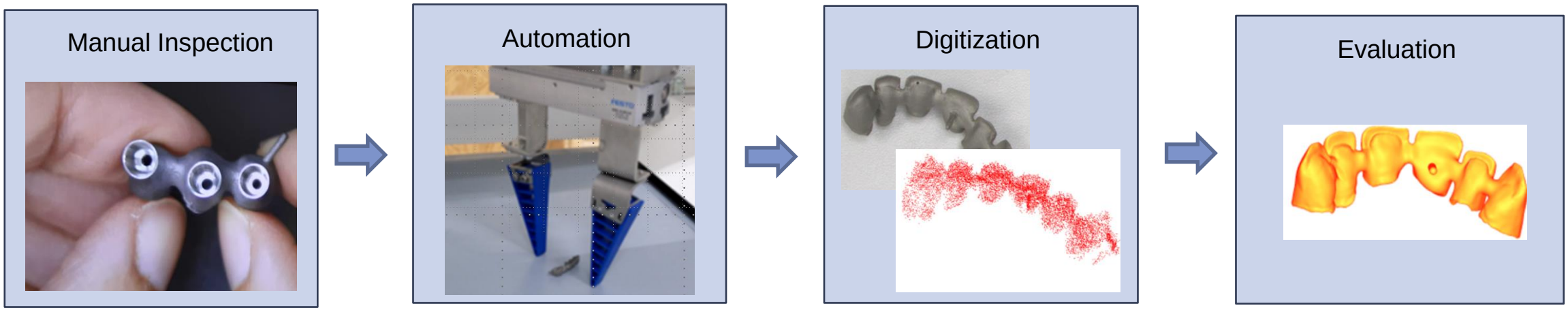
WP4 Challenge & Innovation

Challenges:

- All the **dental parts different**, **unique geometry**
- **Different types of materials**
- **Identify parts** with flawless precision(zero false positives) and at **high speed** (cycle time 5 seconds)
- **360 degrees measurements of shape**
- High accuracy measurement of **seating geometry** of screwed metal products with up to 10 µm tolerance

Innovative Steps:

- Transformation of a ***resource-intensive manual process*** into a ***fast and accurate automated process***
- **Integration automation modules toward end2end automated manufacturing system**



Consortium Collaboration WP4 Formnext

Is a dental production centre of custom-made dental prostheses using CAD/CAM technology.

Is a Dutch innovative & professional 3D printing company with experience in various industries, including industry, medical, food & agri, automotive, and aerospace.

Is a Spanish multinational and pioneer in integrative dentistry 4.0 & digital solutions, active in manufacturing CAD/CAM dental prostheses.

AM-Flow Technology provider of automated Identification, Sorting, Bagging & Quality Control for Additive Manufacturing Factories.

As a global player in digital reality solutions, **Hexagon** combines sensor, software, and autonomous technologies to take advantage of rapidly increasing amounts of data boosting efficiency, productivity, quality, and safety.

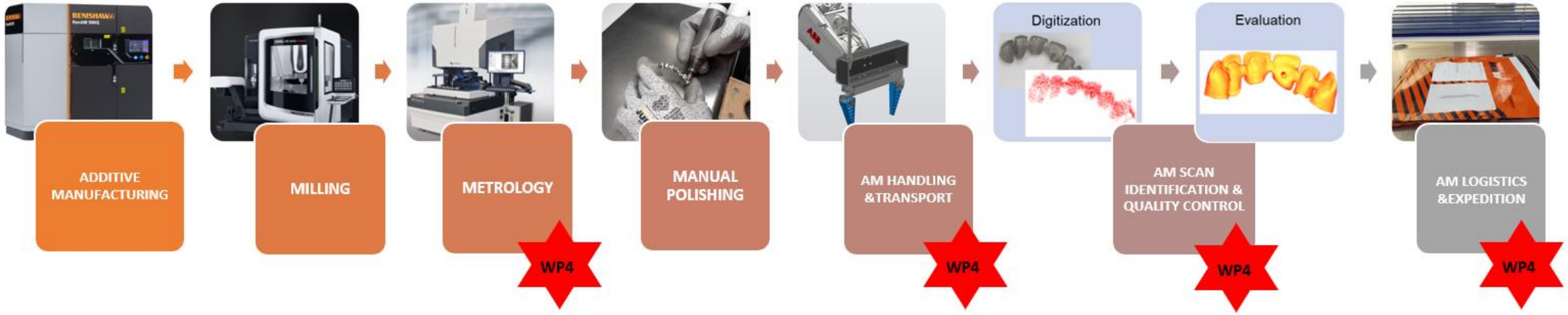
As a strategic high-tech solutions partner, **Sioux** develops, innovates, and assembles complex high-tech systems with advanced Software, Mathware, Electronics, and Mechatronics.

Being an innovative player in safe automation and Industry 4.0, **WWA (World Wide Automation)** proactively develops robotic solutions for manufacturing processes with safety – cybersecurity & safe cooperation between robot and human – as a high priority.

WP4 Expected outcome/Solution

Expected outcome:

- Robots for handling dental parts
- Process integrated quality control
- Inspection system for shape comparison and identification
- High Accuracy Bore Hole Inspection system

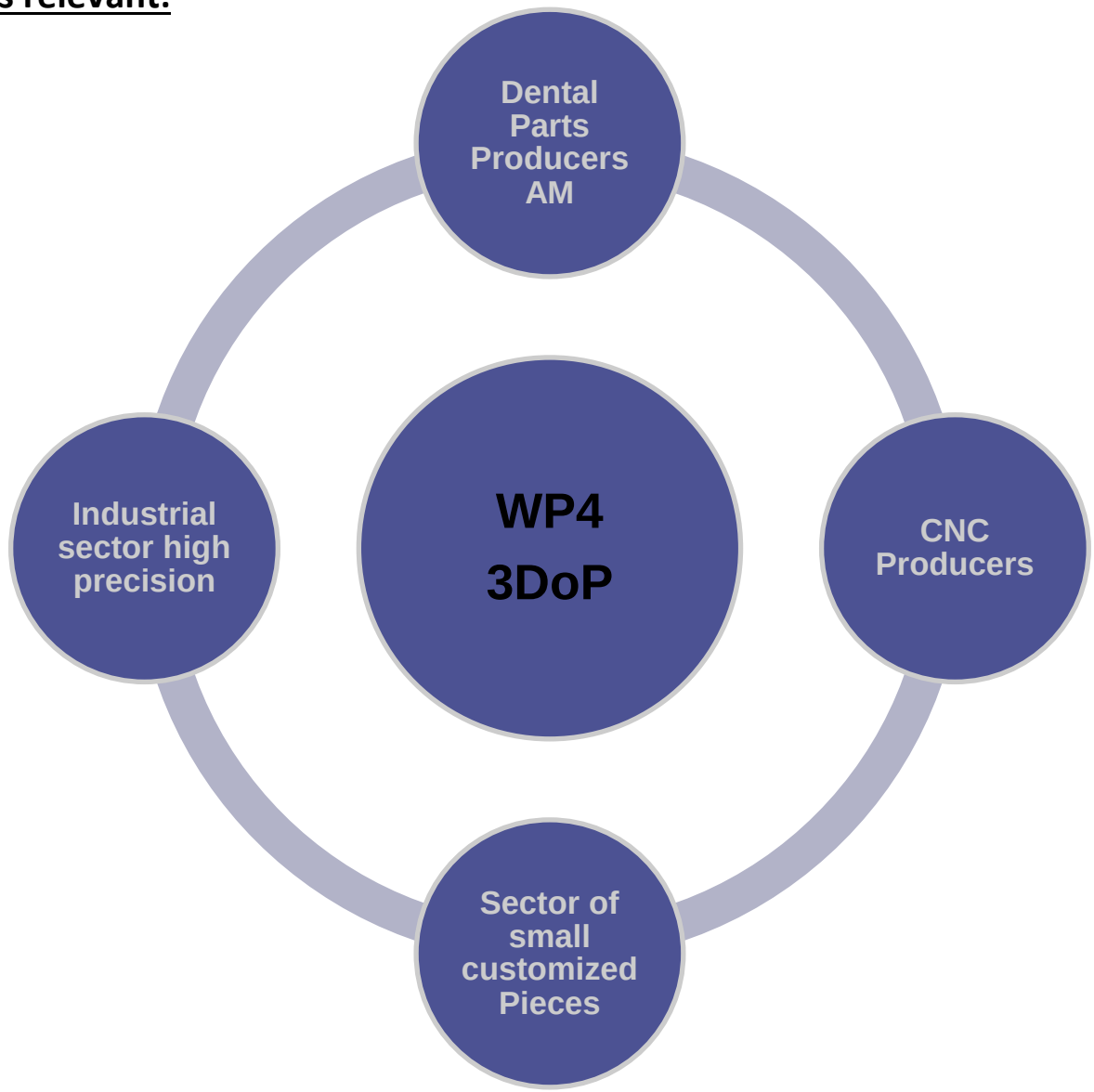


Expected Impact:

- Transformation of a ***resource-intensive*** manual ***process*** into a ***fast and accurate automated process***
  - ✓ Automated process /No human Intervention, (Currently 1 worker/each 100 ud dental parts for Identification, QC &Expedition)
  - ✓ Quality Control: Increase accuracy (Currently, 1% human error QC).
  - ✓ Early Identification of scrap
  - ✓ Save time after postprocessing
  - ✓ Increase efficiency with less human intervention

Possibilities for engagement

For Whom this is relevant:



3DOP – WP4 Dental quality control – High Accuracy Bore Hole Inspection

Motivation

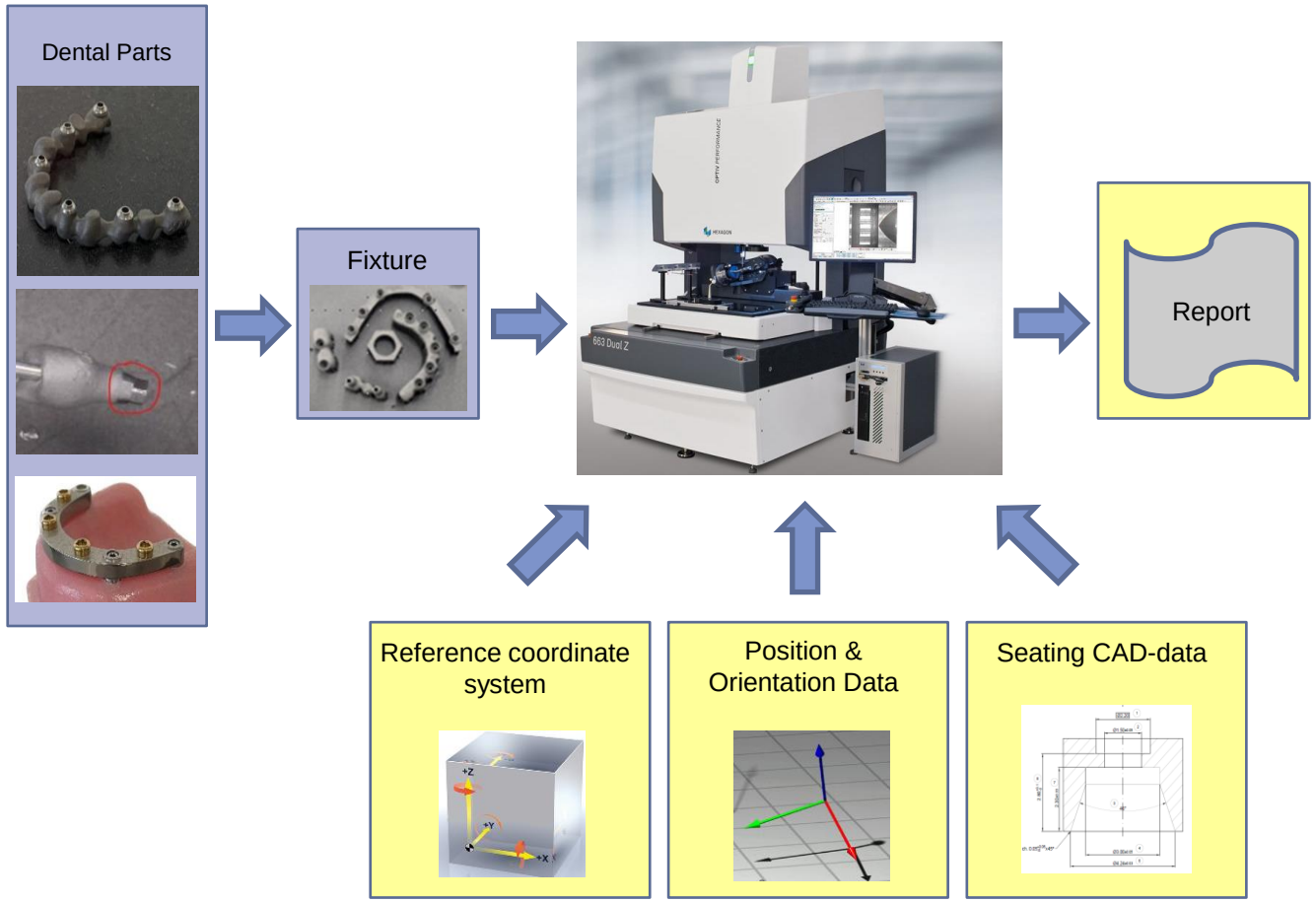
- **Screwed prothesis need to suit very tight** on patients implants. If tolerance is not kept this will cause **pain to the patient**:
  - bacteria may settle within larger gaps and **cause stomatitis**,
  - orientation deviation from nominal will **cause forces and implants of the patient which causes pain**.

High Accuracy Bore Hole Inspection

- Besides geometry itself , this approach provides information **on position and orientation of seating / holes enabling virtual gap measurement**
- Quality Inspection on screw-based metal prothesis, bars and inserts :
  - **CAD-based measurement** of hole and seating geometry
  - Local min. **tolerance 10 µm** requires high accuracy metrology device
- **Automatic measurement cycle** with manual loading / unloading

Challenges

- **Machined shiny surface** with steep flanks and very small feature
- **Tight tolerances**
- **Orientation of the hole** is individual of each hole



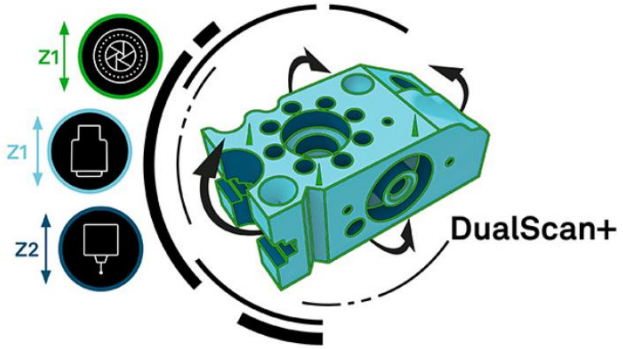
3DOP – WP4 Dental quality control – High Accuracy Bore Hole Inspection

Innovative Approach

- Usage of **Hexagon multisensory coordinate measuring device OPTIV M DualScan+ 664** equipped with
  - Camera sensor
  - Tactile scanning probe
  - Optical point sensor
- **Stacked rotary stage** for flexible orientation of the workpiece.
- Using **fixture / information / CAD-data of machining.**
- Inspection **direct after machining**

Benefits of the Solution

- **Process integrated** quality control direct after machining.
- **Production cost savings** due to early identification of scrap parts.
- **More satisfied patients** due to better fit on implants.



HEXAGON metrology partner innovation consulting

3DOP – WP4 Dental quality control – High Accuracy Bore Hole Inspection

WP4: Handheld assisted 3d quality control team

Jingming
Optics

Oksana
Events to 3D

Bidisha
Pointclouds

Sander
Project lead

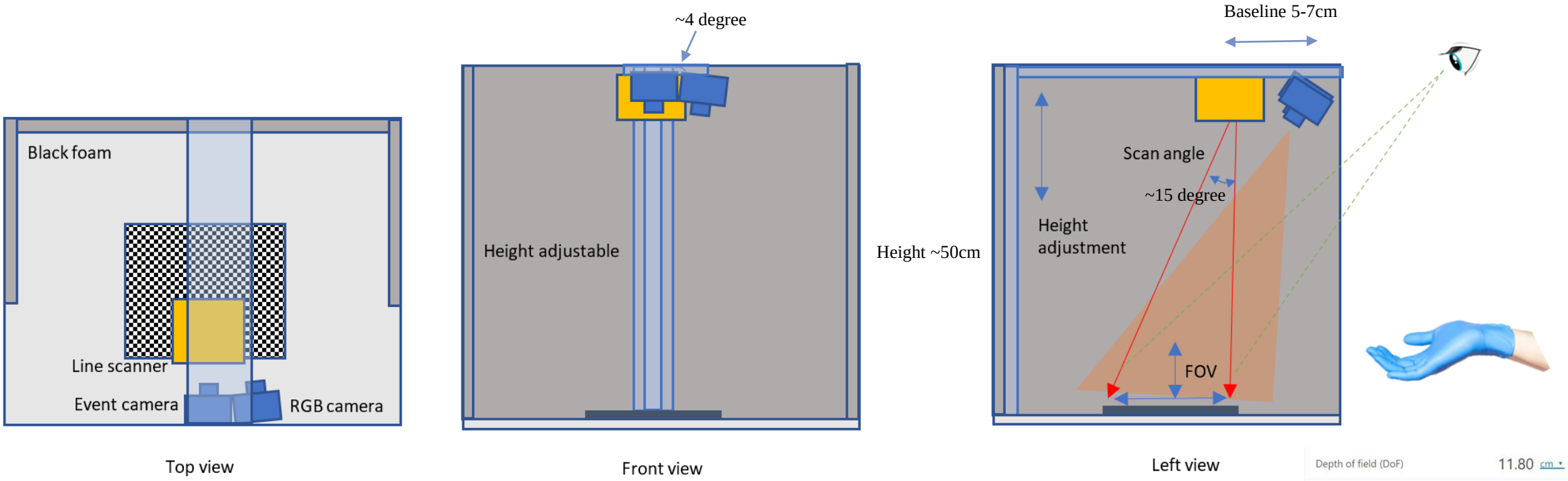
Thijs
System architect

Arash
Software

Jurriaan
Mathware

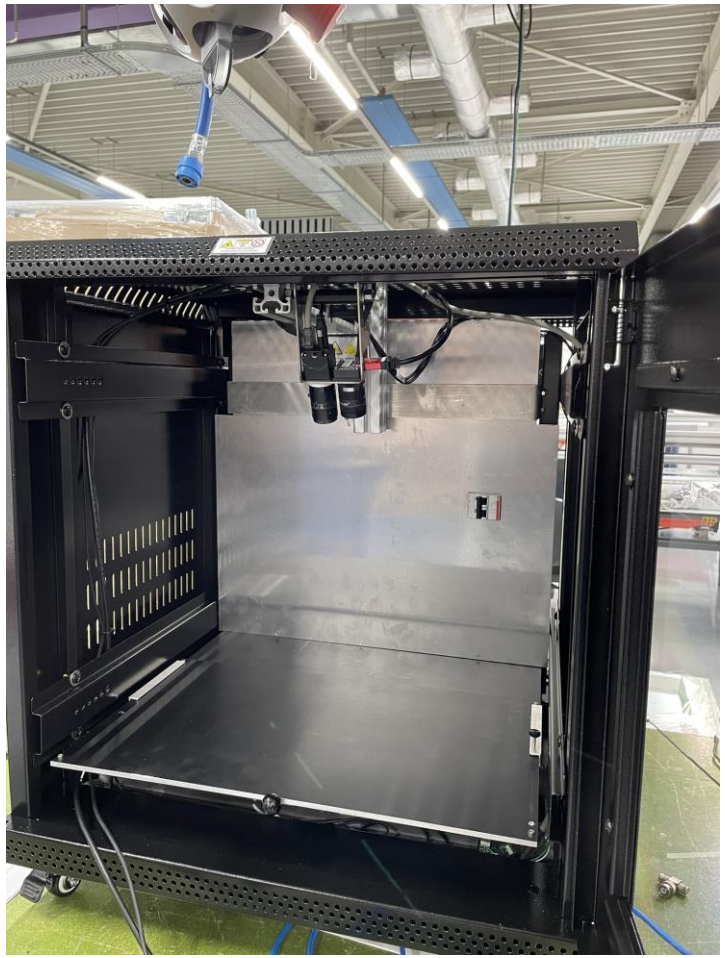
and many others, like Jacques (safety), John (construction), Evgeniya (image tech lead), Michiel (physics)…

WP4: Handheld assisted 3d quality control setup



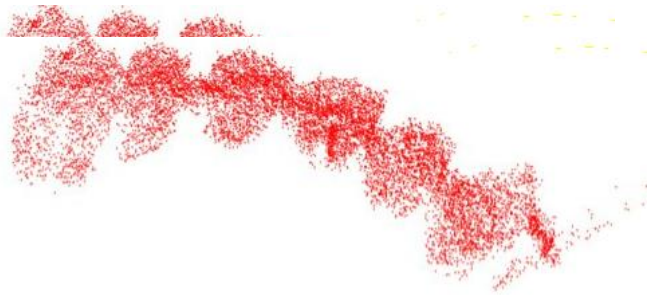
- Event and RGB cameras are placed to have similar view angle of operator's eyes for convenient visual inspection
- The line laser scanner can scan the region and avoid direct reflection to the eyes

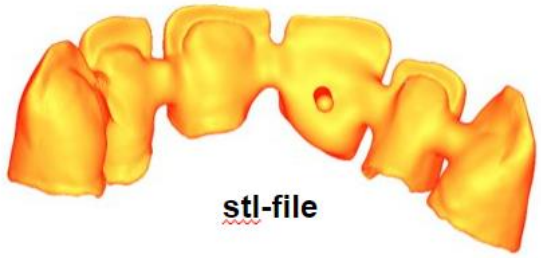
WP4: Handheld assisted 3d quality control HW

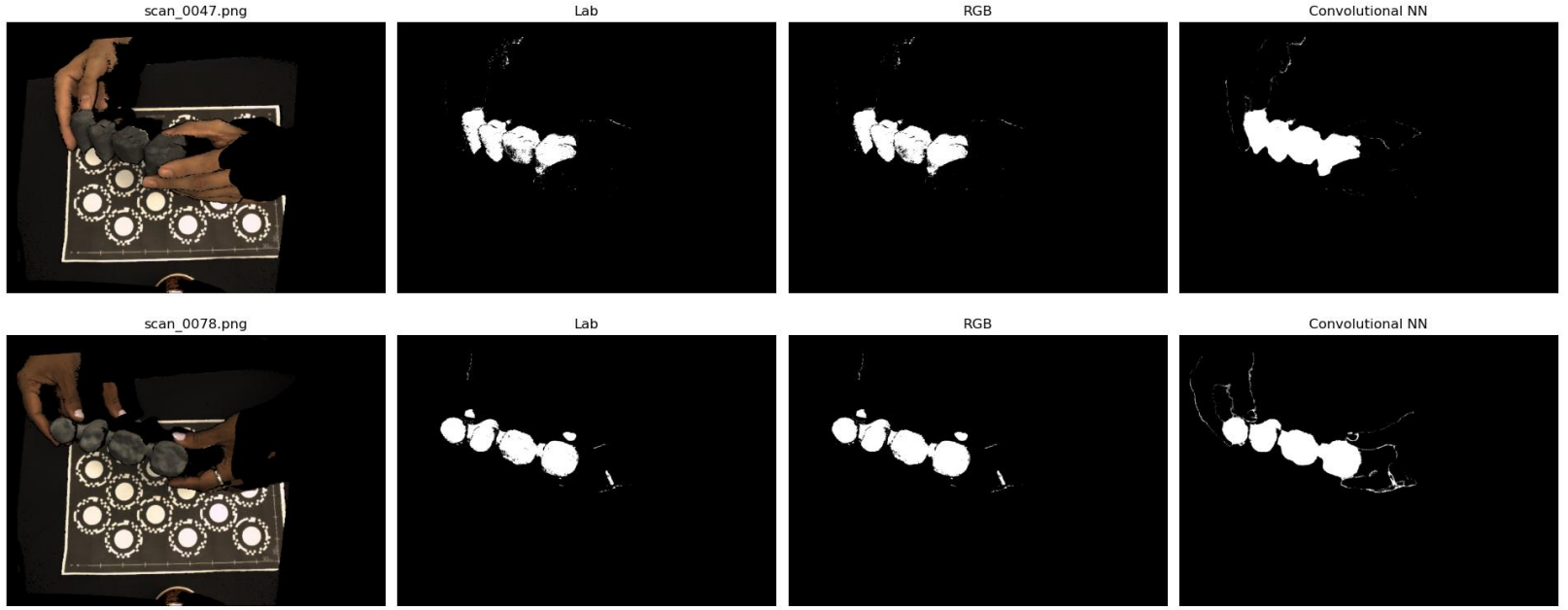


- Invisible, harmles & accurate lasers so people do not look into bright or flickering light
- CERN camera technonology (event camera) to create accurate pointclouds from moving/handheld objects
- Coloured pointclouds that can be used for quality control and AI

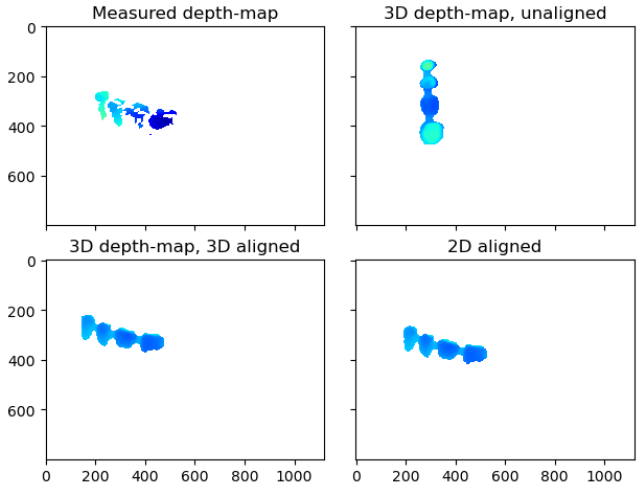
WP4: Handheld assisted 3d quality control MW/SW

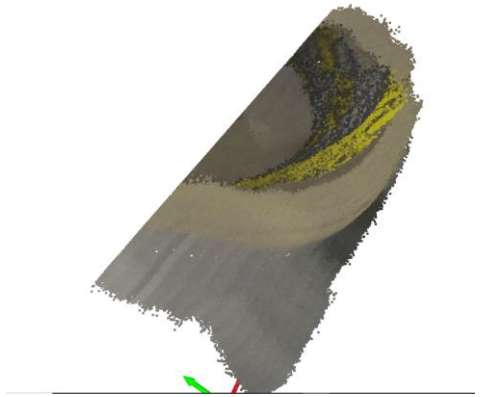






Isolating the object





Fast object alignment

SIOUX TECHNOLOGIES

WP4: Handheld assisted 3d quality control

- Two deliverables
  - D4.3: Hardware
    - November 2023
    - 99% finished
      - Still waiting for the fine laser line to arrive…
  - D4.5: Algorithms and Software
    - March 2024
    - On track

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