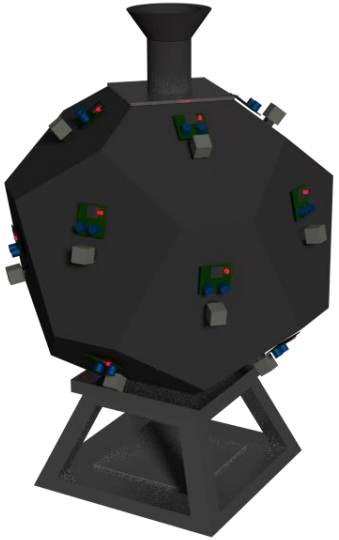

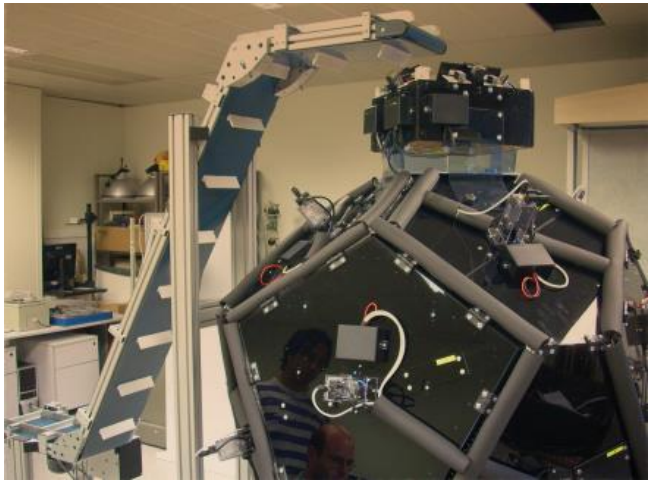

ZG3D

Quality Control
for
Industrial inspection

Zero Gravity3D

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Who are we?

About us

- Technology Center founded in 1994 specialized in **Research, Development, Innovation and advanced services delivery in ICT** *(Information and Communication Technologies).*

- Key figures in **23 years**:

> 120
professionals

Highly skilled team of researchers and technicians

> 250
R&D&i projects

Broad experience and knowledge acquired, developing and transferring **new ICT technologies and services**

> 170
associated companies

We offer **added value** to companies (training, technology and market watch,…)

> 300
clients

More than 500 projects with companies, focused on **improving efficiency, processes and products**

- **Our main goal**: to help and support companies to innovate in their processes and services to be more competitive in an increasingly globalised market.

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What are we doing here today?

About us

- ITI works very closely with the **industrial sector**, doing applied research and innovation, and applying ICT technologies to improve processes and increase productivity and competitiveness of the companies we develop projects with.

- One of our areas of interest, with a highly specialized team, is **Computer Vision**.

- From our interaction with the automotive industry chain, some years ago we faced a problem of **Classification** and **Quality Control** from several manufacturing companies dealing with bulk materials and mixed parts:

  - *Detection of mixtures*
  - *Metrology (Geometric Dimensioning and Tolerancing - GD&T)*
  - *Defect detection (volumetric, surface...)*

- And today we want to show you how we have solved this problem … with **ZG3D**.

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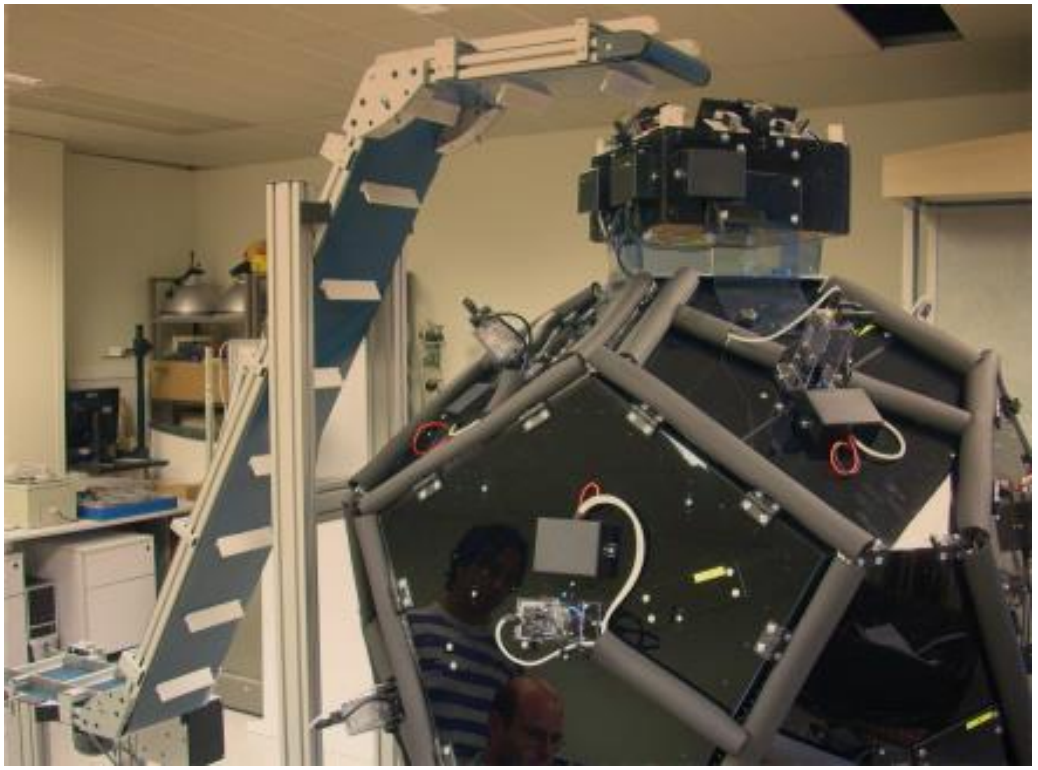
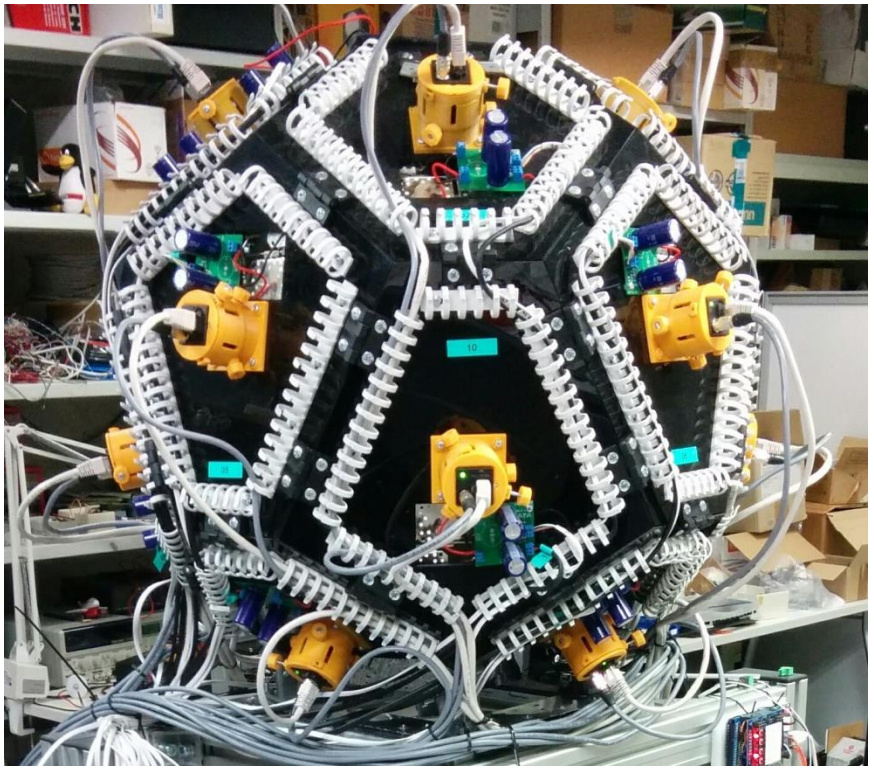
A new approach to 3D QC

Introduction

- Two prototypes with different sizes and part feeding systems.
- A unique scanner with a 16 camera configuration to quickly and precisely “freeze” every part under inspection, without manipulation and without occlusions.





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Introduction

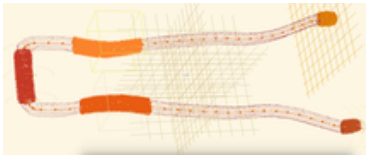
Advantages:

- ✔ **Classification** and **QC** tasks.
- ✔ Full **reconstruction** generated from simultaneous 16-image capture.
- ✔ Whole production assessment by **100% part inspection**.
- ✔ Capture and analysis process **without mechanical handling**.

The **process** of each object consists of three phases:

- Acquisition

- 3D reconstruction process



- Inspection, against a model

Example objects

Introduction

The task: **Quality Control of objects with a 3D structure**

- High cost of **mechanical handling**
- Variable **shapes** and **sizes**
- Need for control:
  - **GD&T**
  - Surfaces
  - Volume
- Classification

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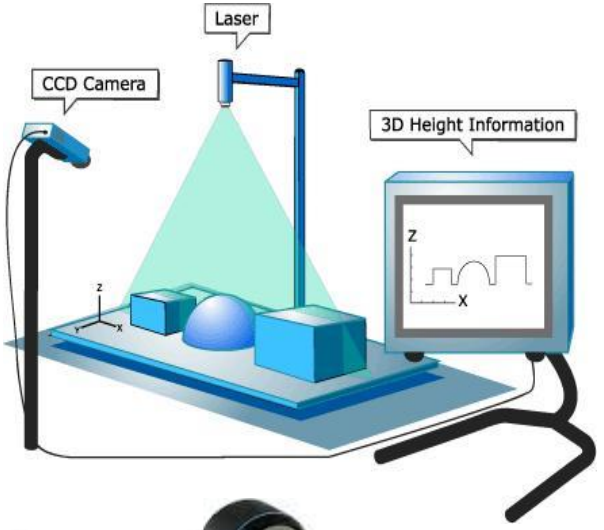
Other industrial QC solutions

On a **conveyor** or with **mechanical handling**

- Active
  - Time of flight
  - Structured light
  - Modulated Laser
  - Conoscopic Holography
  - Axial Tomography
- Passive
  - Stereoscopy
  - Photometrics
  - Silohuettes



Acquisition solution proposed

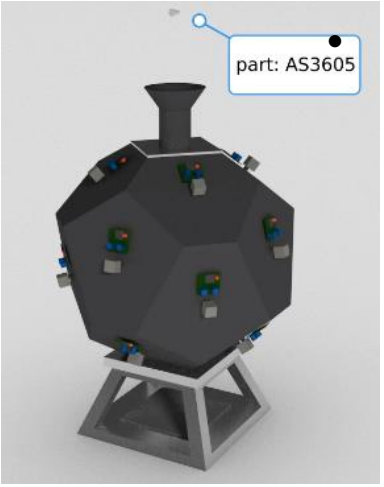
Introduction

Main concept:

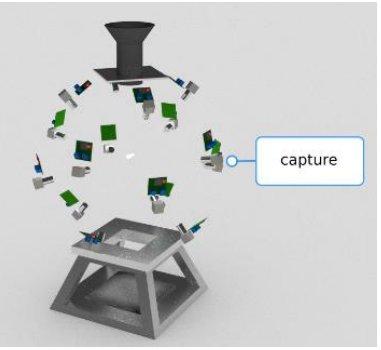
- **Free fall**
- Top feeding hopper or another impulsion system

Advantages:

- **Simple** mechanics
- **Scalable** architecture
- Complete 3D object reconstruction with **no handling occlusions**
- **Classification & Inspection** with the same inspection machine
- No hardware **reconfiguration**
- **Flexibility: only one device to check different parts, without system readjustments for each reference.**



Top feeding hopper



- Bottom impulsion launcher

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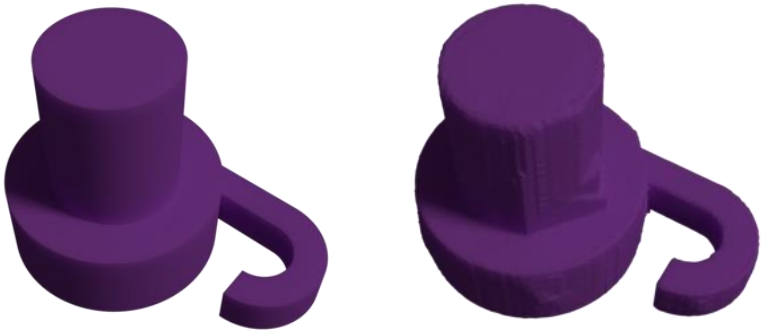
Acquisition solution proposed

Introduction

Main features:



- **Reference models** from CAD or machine learning by capturing good part samples.
- **Tolerances** easily defined.
- **Scalability** of the computing system to meet production throughput
- **Configurability** of:
  - Useful volume
  - Spatial resolution
  - Number of parts per minute

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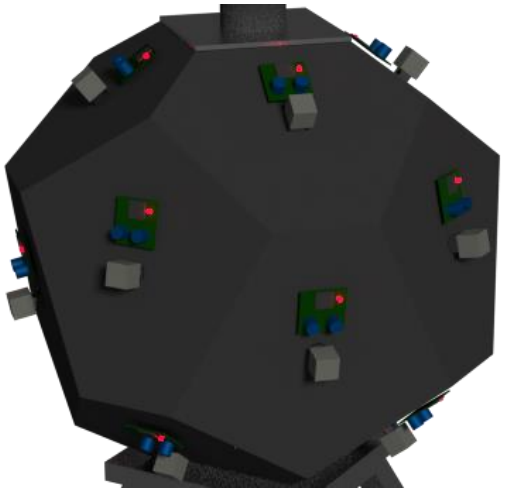
Object capture

3D Reconstruction

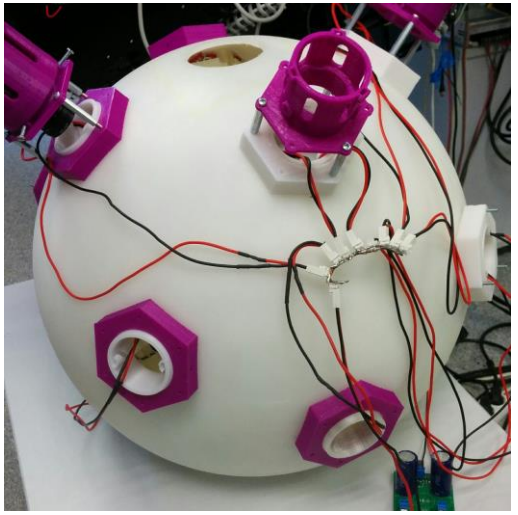
Multi-view 16 cameras:

- **Multiple camera multi-view**.
  - 16 synchronized cameras
  - Configurable useful volume inside the chamber

- **Simple mechanical structure**.
  - Polyhedron with one camera in each face.
  - Simple sphere with evenly distributed cameras.



Polyhedron



Sphere

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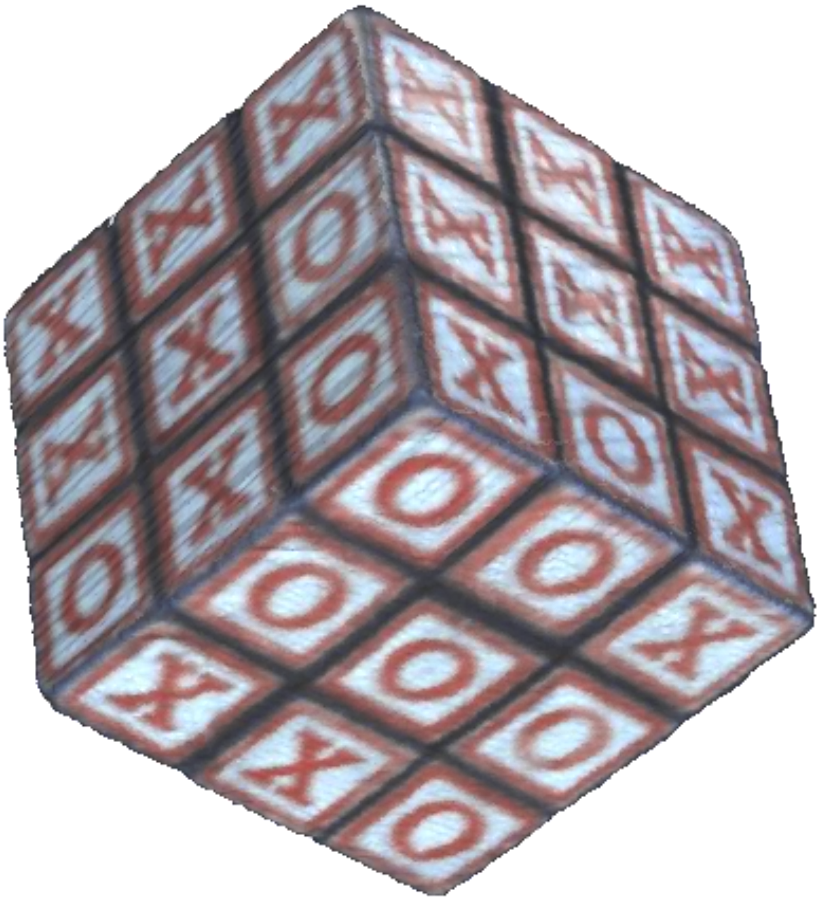
3D Reconstruction

- A projective texturing step is performed to increase 3D model **visual quality** whenever needed
- **Each area is projected** to the cameras more closely parallel to their normal
- **Results** combine dot product of projection vectors weighted with area normals

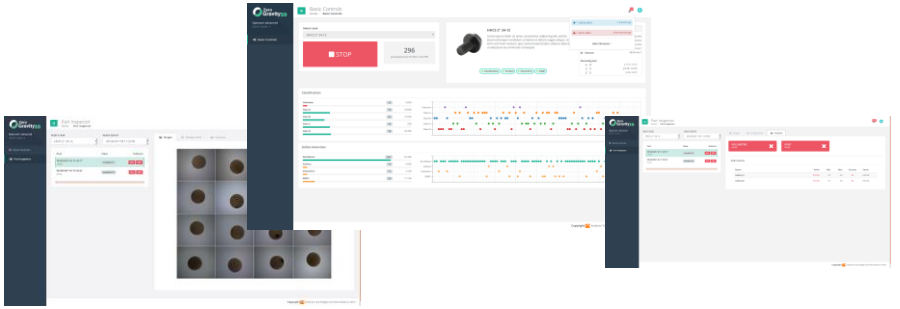


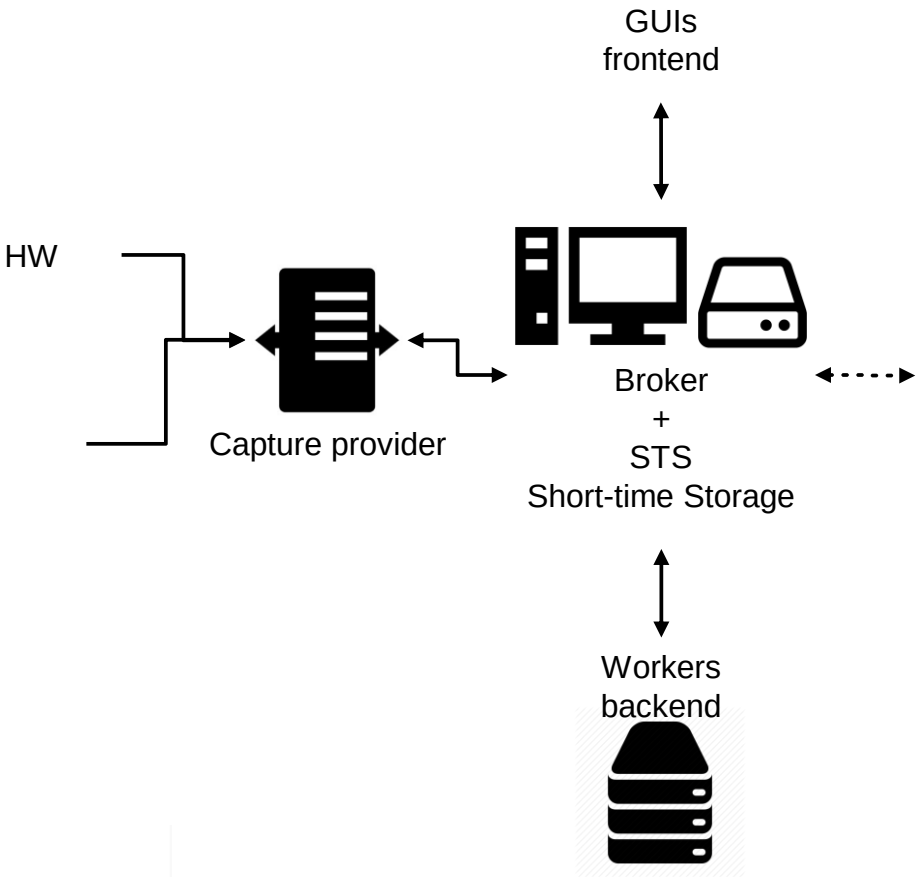
Architecture

System

A distributed architecture organized in 4 levels:

- Capture
- Processing
- Storage
- User Interface





Long **T**erm **S**torage (for traceability):

- Camera Callibration
- Background imgs.
- Object images
- **Results**

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Applications

- Good! There is a new approach to QC in 3D, but …
  - **What can I do with it in my production line?**

    and
  - **How can I introduce it in my production process?**

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Classification

Applications

- **What can I do with it in my production line?**
  - **Classification tasks**: Do you imagine the task of classify these parts in their respective sets? There are around 3000 different P/Ns in this image …

  - Well, imagine it because it is a real task, and it is manually done every day…
  - And... **with ZG3D you can automate the process.**

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Screening

Applications

- **What can I do with it in my production line?**
  - **Screening tasks**: Do you imagine the task of **manually** screening a batch of screws, or nuts, or washers? … Where is Wally??

  - Then, imagine it, because it is a common problem (very serious in automotive industry and others) to introduce a mix of parts in a shot peening machine (e.g. when a change of P/N is done for the next batch, or in manipulation processes, because the parts are small and there is a huge set of different P/Ns under production every day.
  - And... **with ZG3D you can automate the process.**

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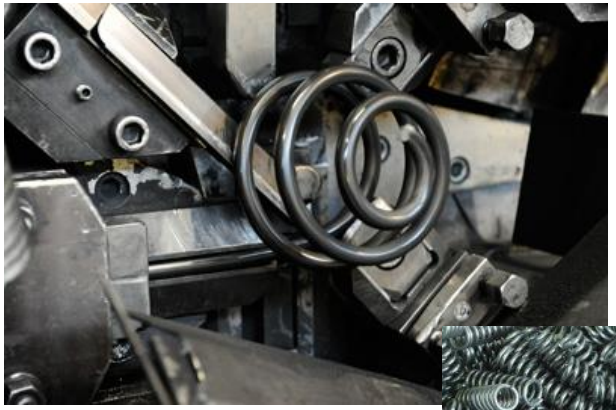
Quality Control

Applications

- **What can I do with it in my production line?**
  - **QC tasks**: Do you imagine the task of **manually** control the quality of every single spring that is manufactured every day for critical or high quality products? …



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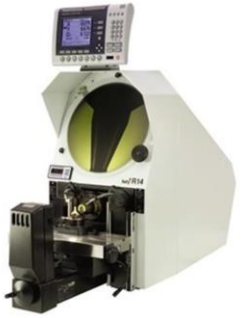
Quality Control

Applications

- **What can I do with it in my production line?**
  - **For sure!!** You don't need to imagine it, because you are spring manufacturers!! And you are doing it every day …
    - Every day, the QC guys review a set of samples from production line with high precision lab machines or VMM like profile projectors, 3D Laser Scanners, digital measuring microscopes and also with direct manual measurements …



    - And, what happens when you need to do QC over the full production? Then the costs increases due to the manual process, but with ZG3D you can automate the process, **over the full production.**

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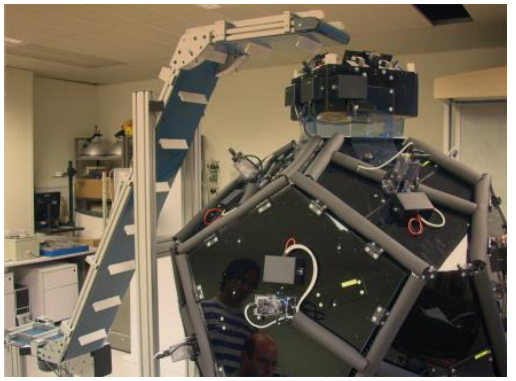
Deployment

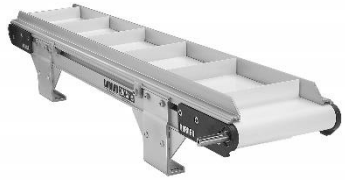
Applications

- **How can I introduce it in my production process?**
  - **It's easy, ZG3D** can be introduced easily in your layout, just at the first step after the spring machine output, or after the annealing process



Good

Bad



To customer

To scrap

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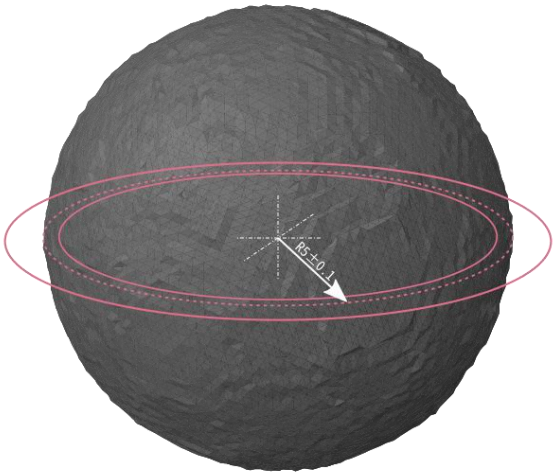
How does ZG3D work?

Simple test

- Test set composed of wood balls with **different defects**:
  - Different sizes
  - Surface marks
  - Holes, strikes or missing material

- **QC** performed in different ways::
  - GD&T: Radius
  - Volumetric
  - Surface



Example

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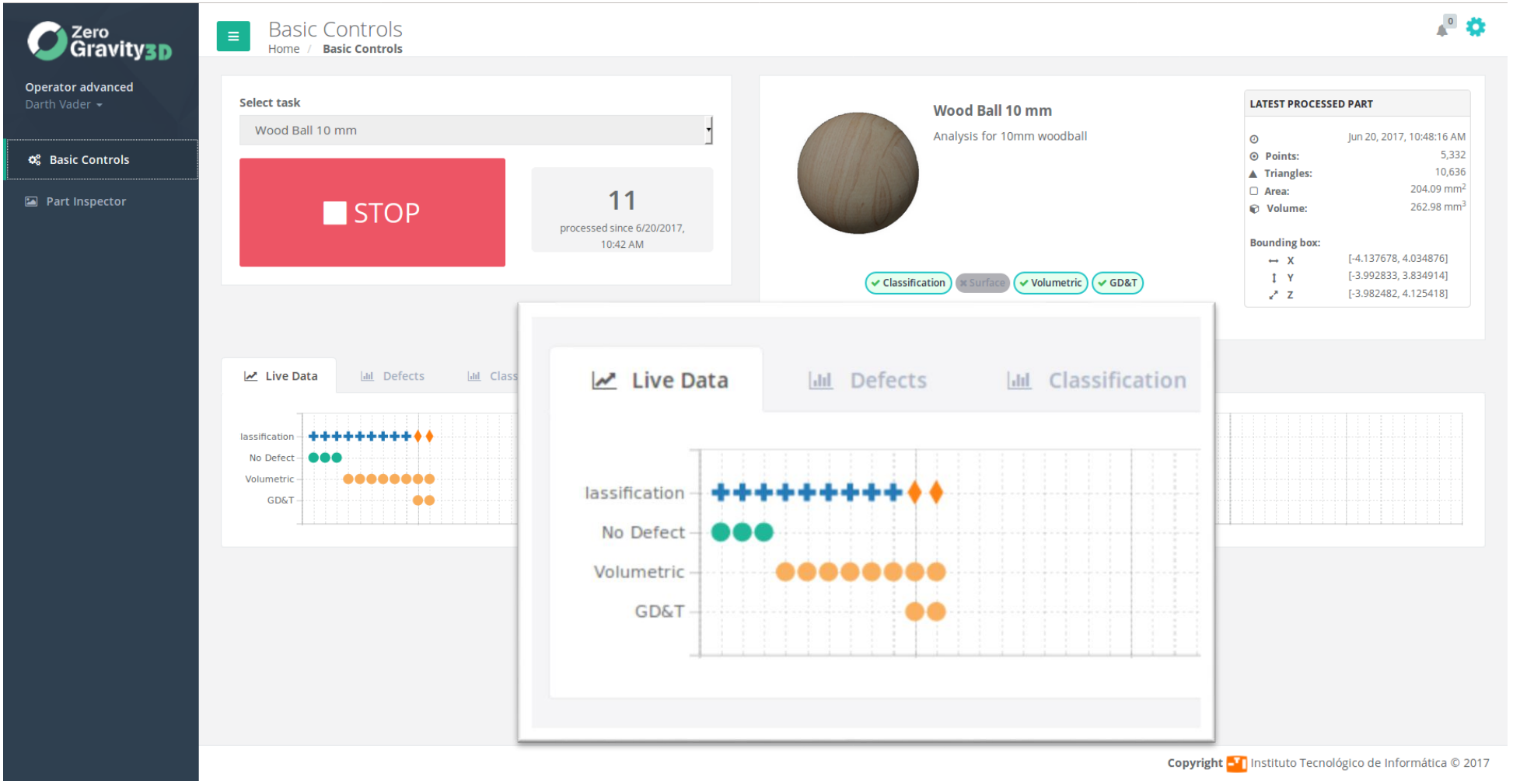
UI – Basic Controls
Live Data Processing

Example



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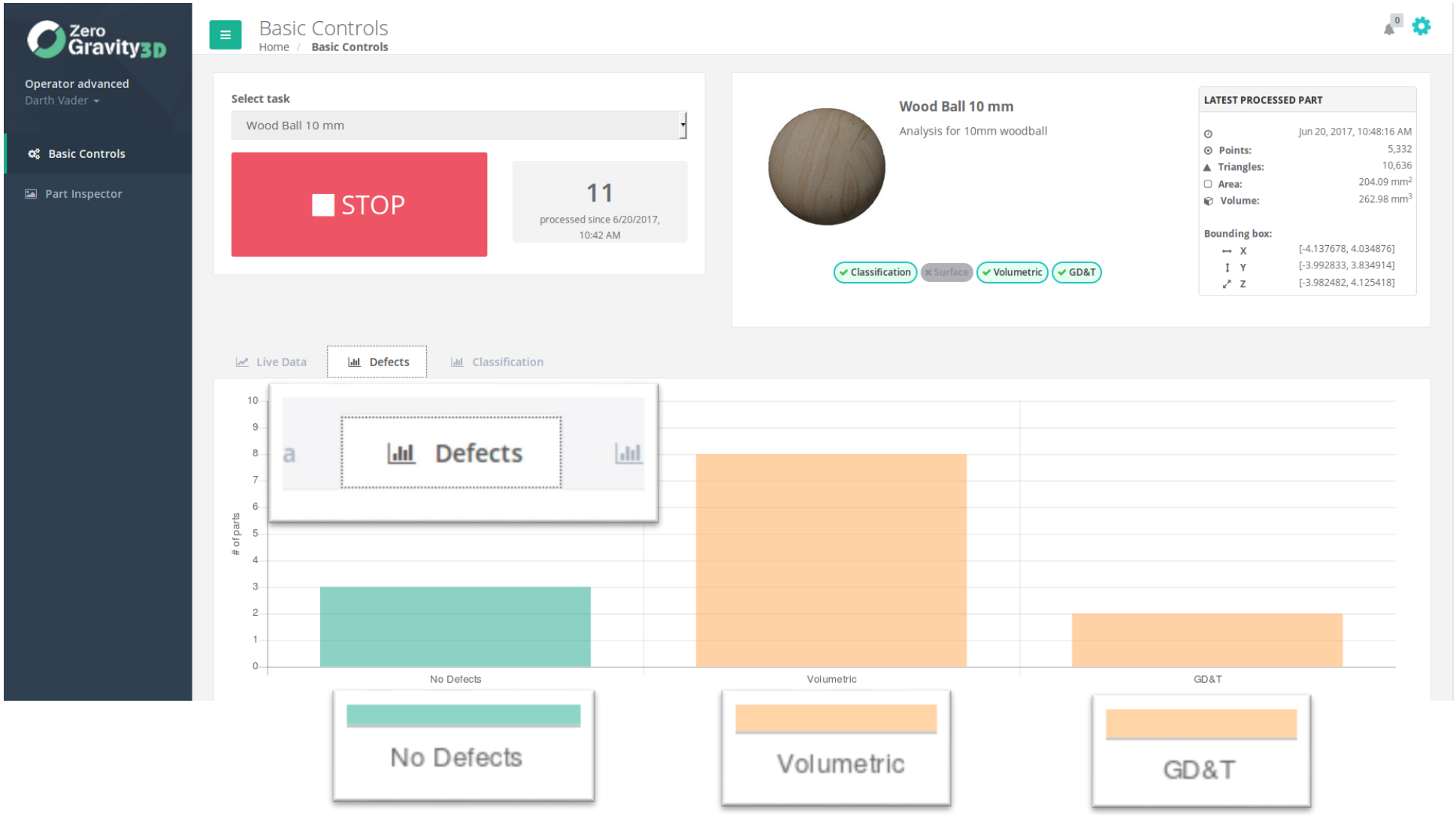
UI – Basic Controls Defects

Example



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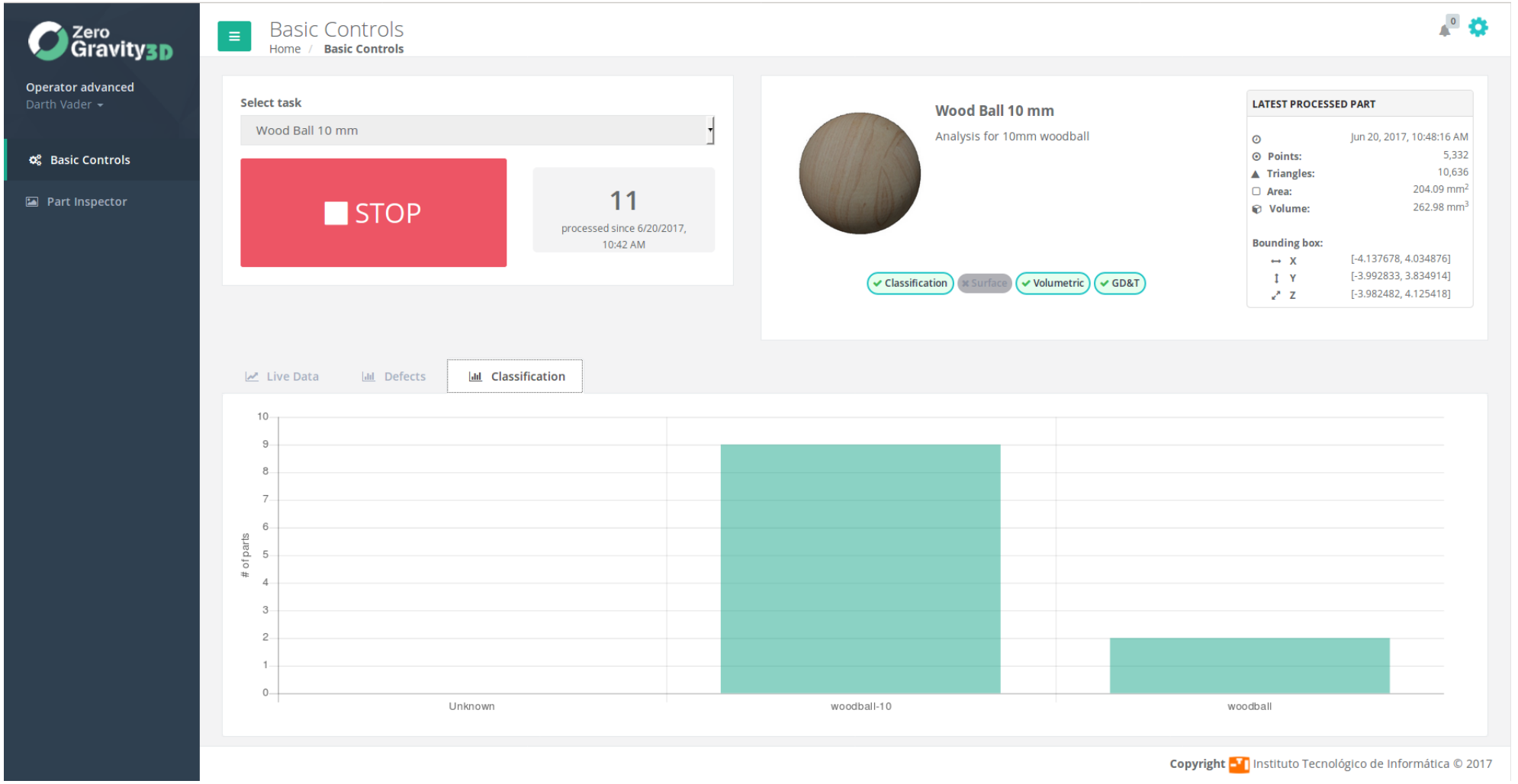
UI – Basic Controls Classification

Example



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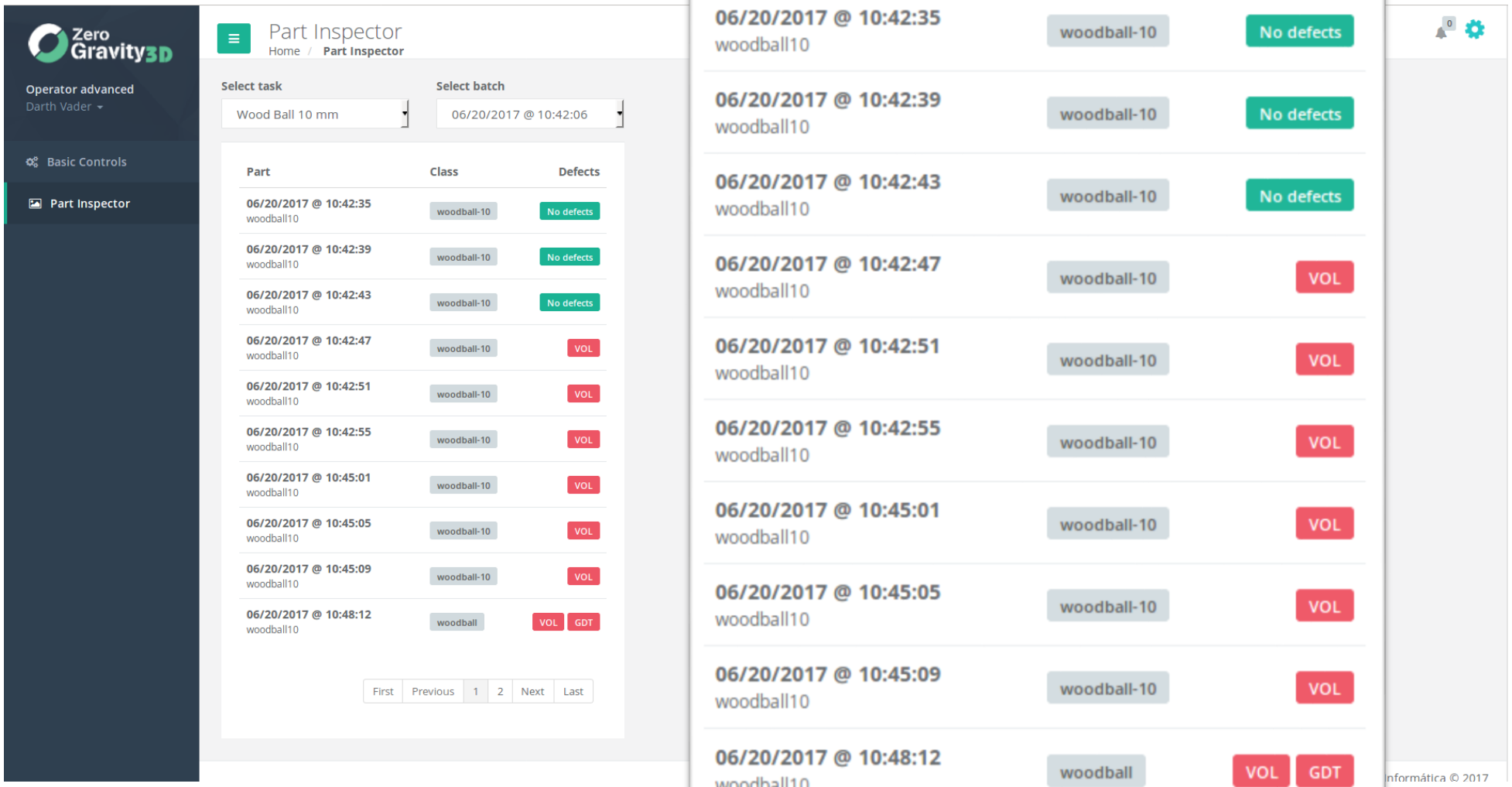
UI – Part inspector
Batch History

Example



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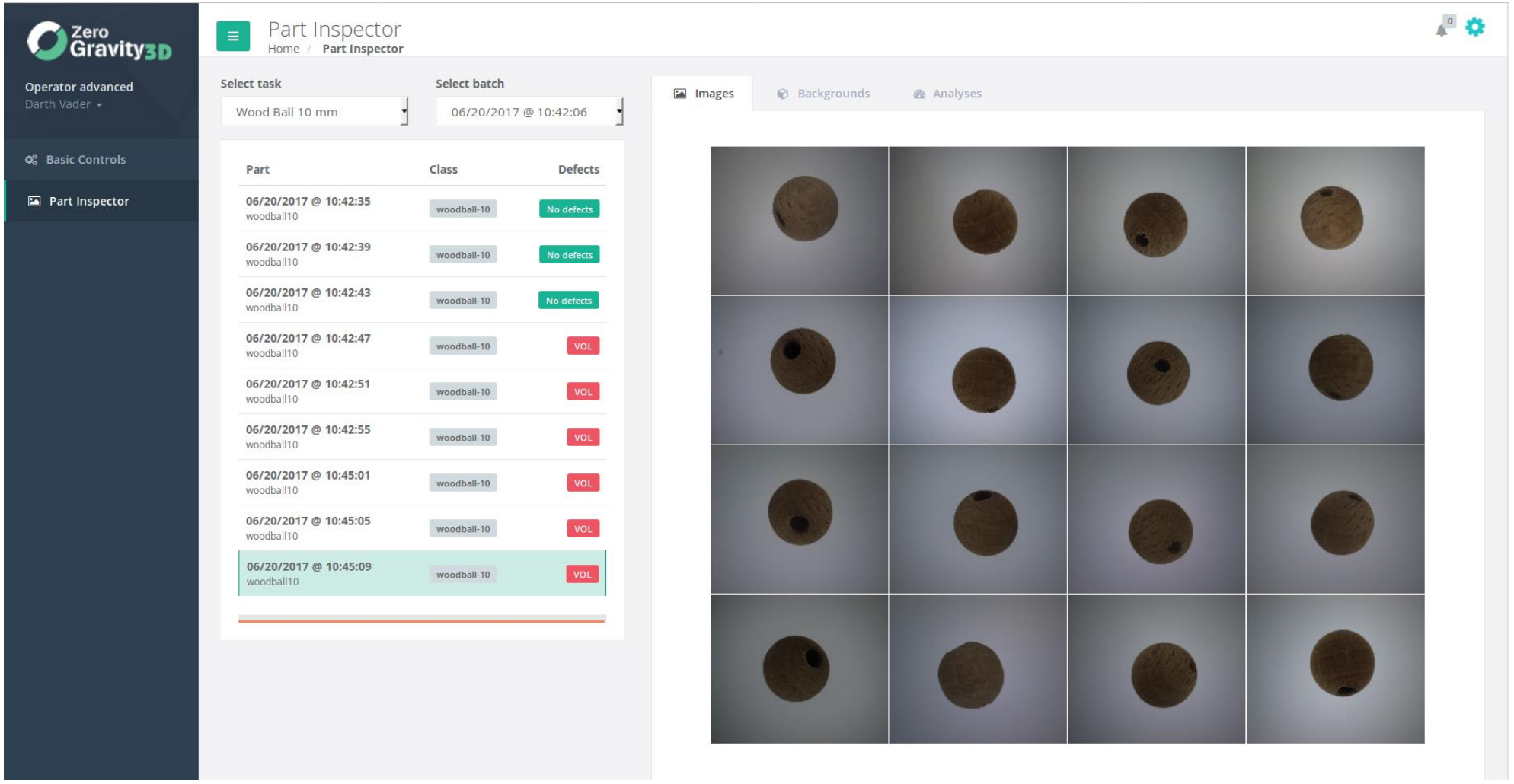
UI – Part inspector
Images (part with defect)

Example



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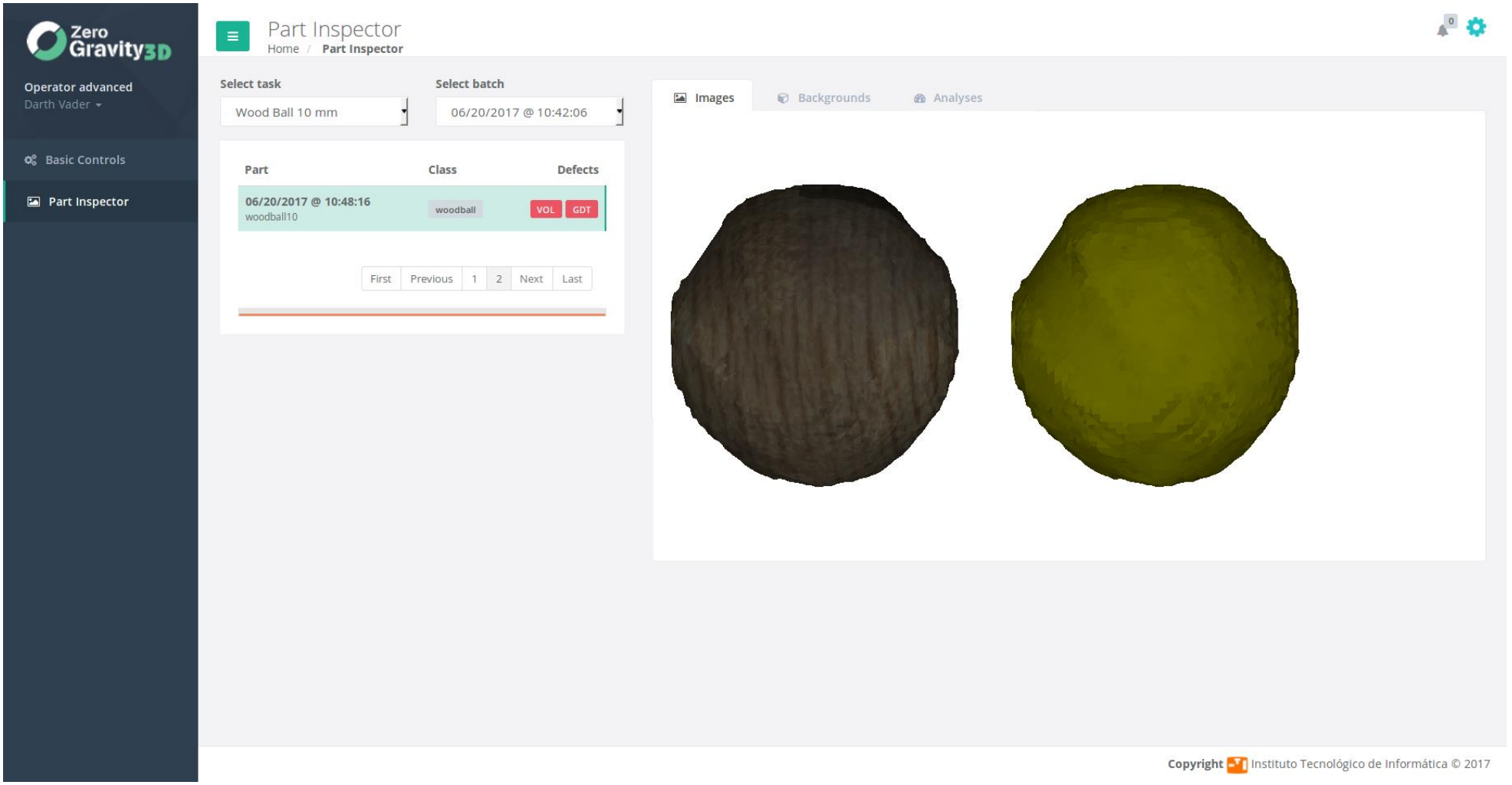
UI – Part inspector
3D Reconstruction

Example



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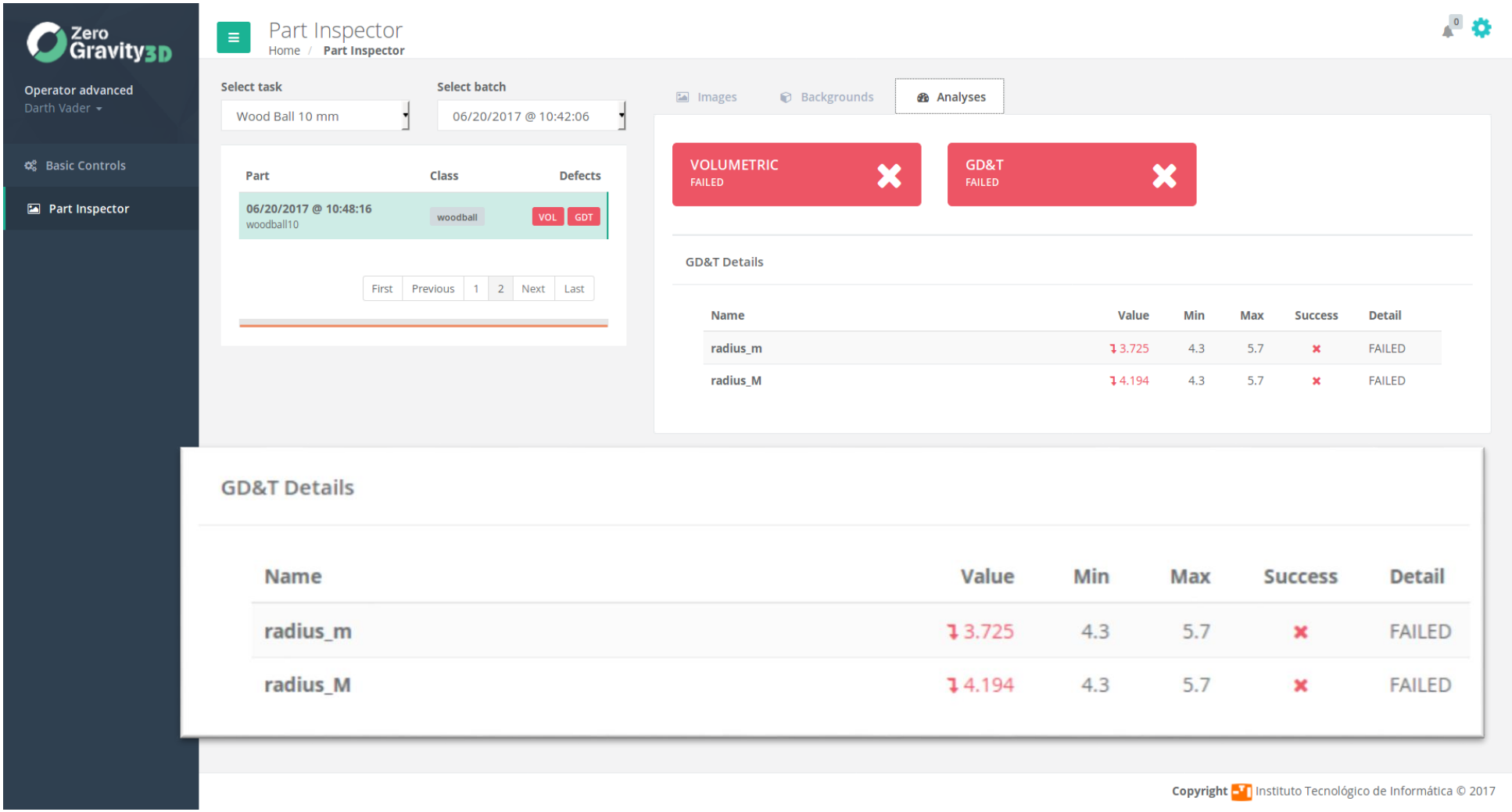
UI – Part inspector
Part results

Example



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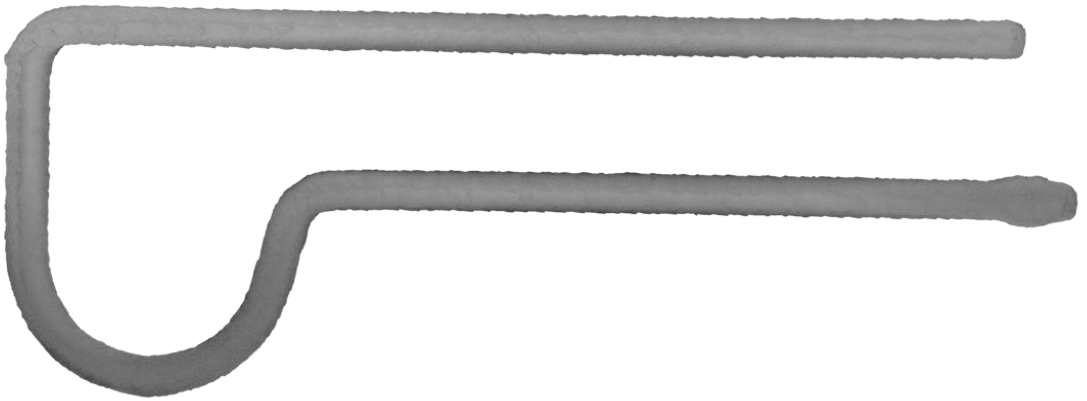
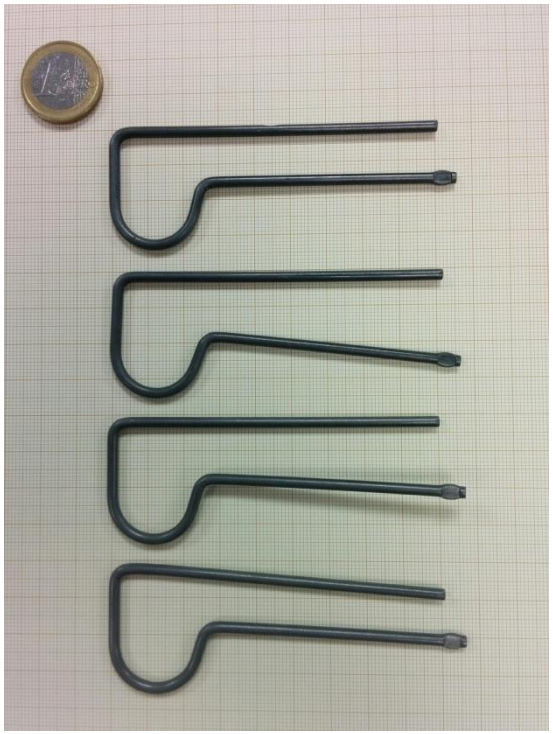
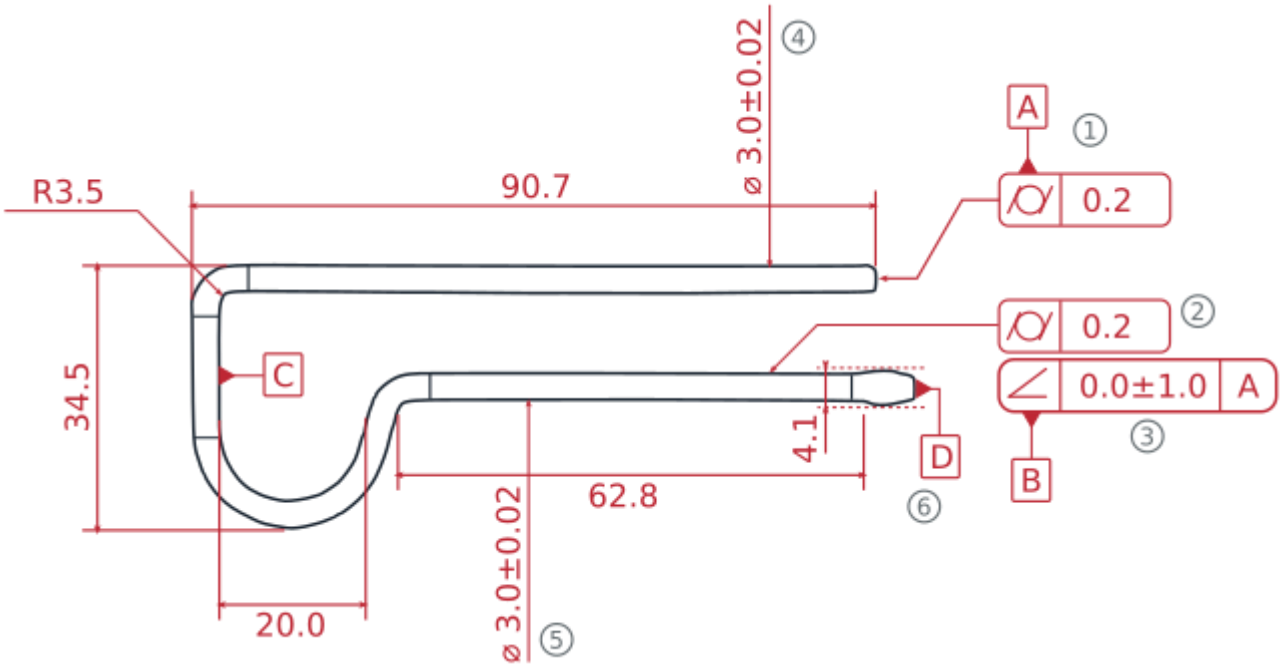
Springs – Example 1

Results

- Metrology and GD&T performed in 6 dimensions:
  1. cilindricity
  2. cilindricity
  3. angularity
  4. radius
  5. radius
  6. radius







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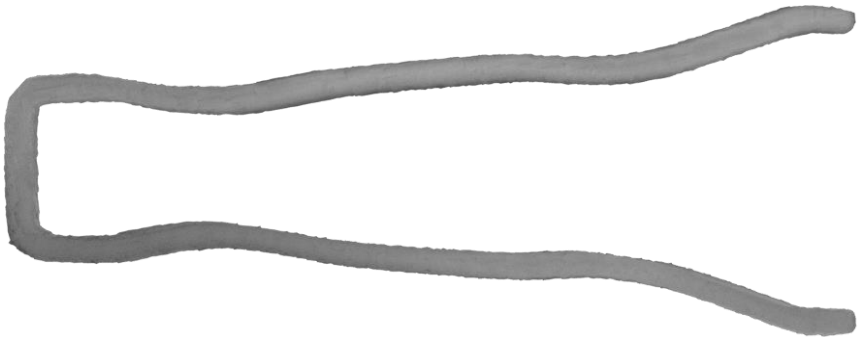
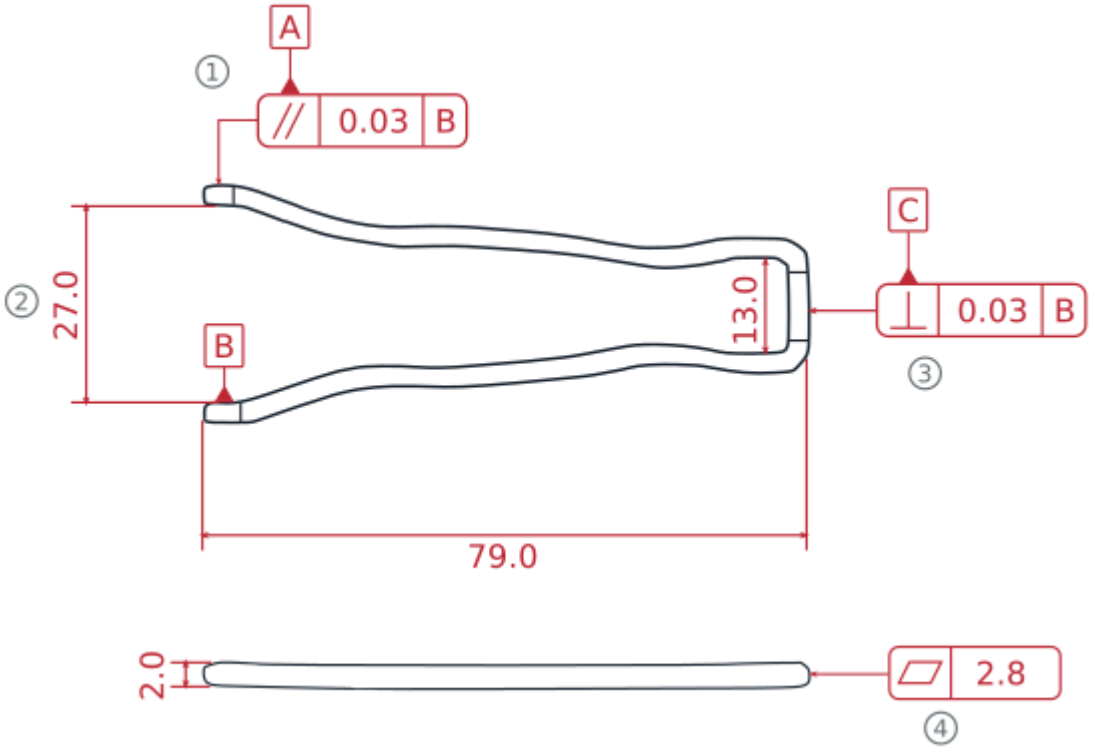
Springs – Example 2

Results

- GdnT performed in 4 dimensions:

① parallelism
② absolute distance
③ perpendicularity
④ flatness





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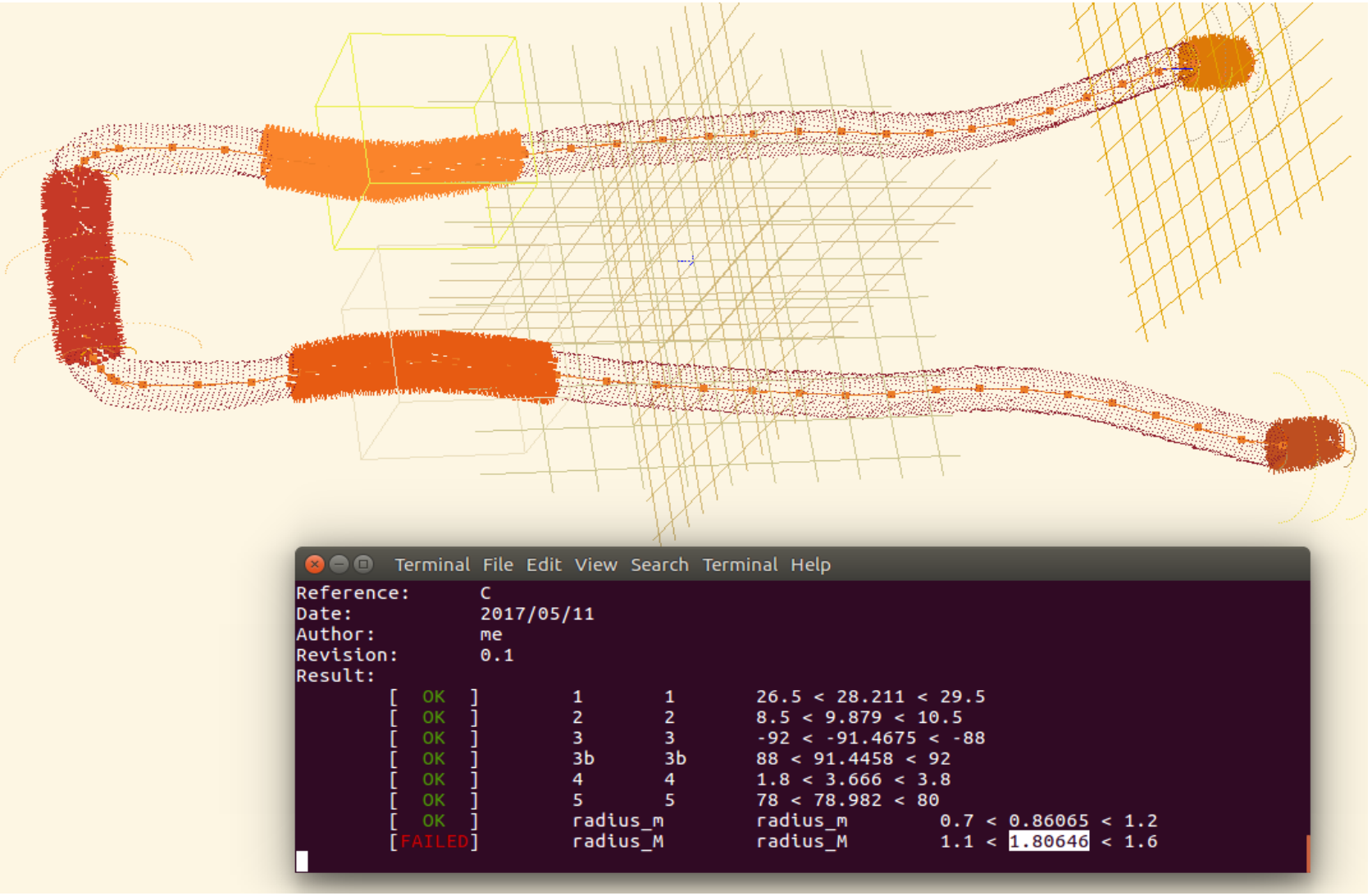
Real springs – Example 2

Results

- 3D analysis for Gd&T



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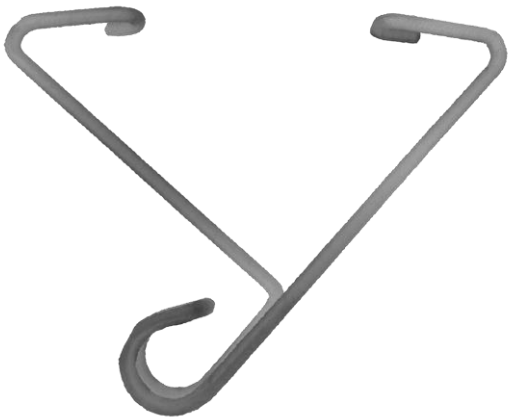
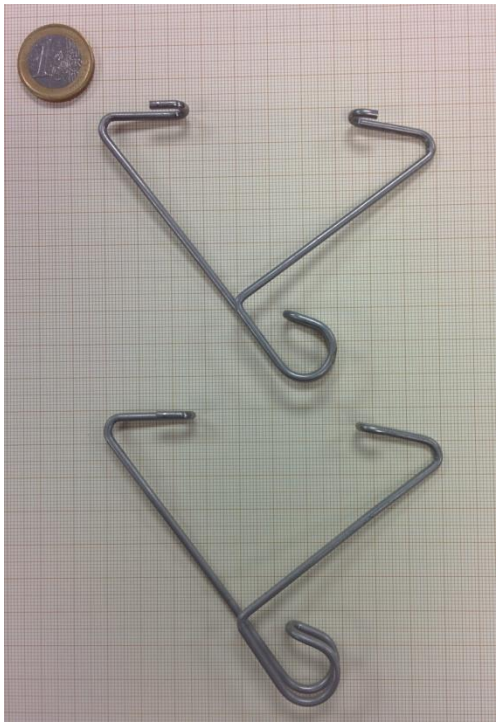
Real springs – Example 3

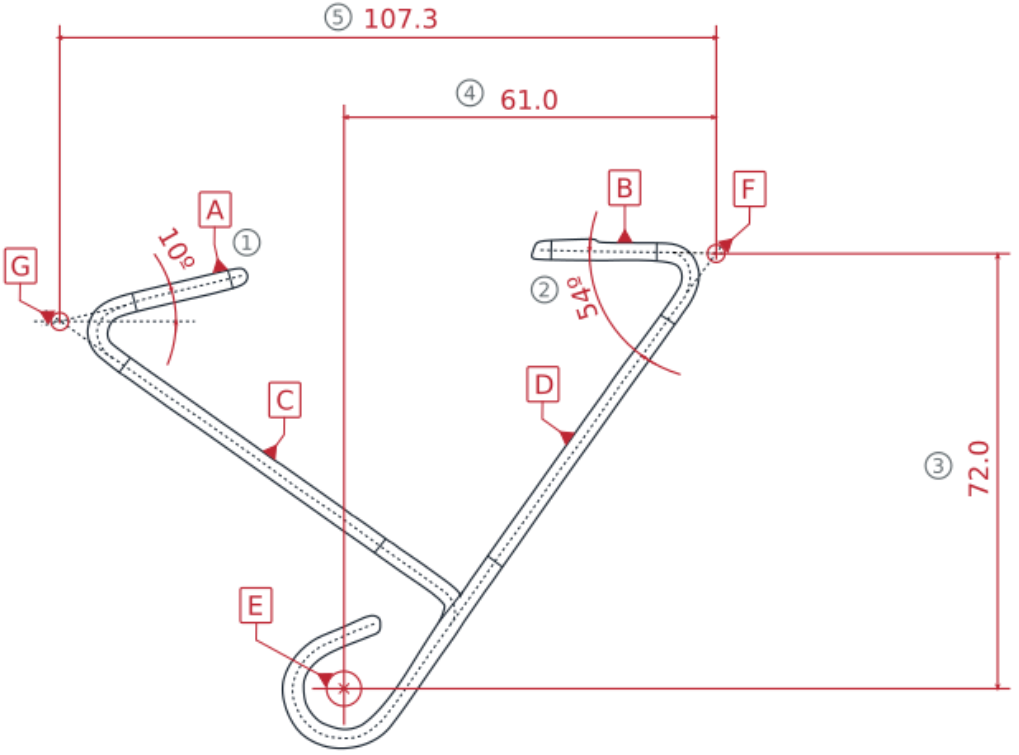
Results

- Gd&T performed in 5 dimensions:

① absolute angle
② absolute angle
③ absolute distance
④ absolute distance
⑤ absolute distance







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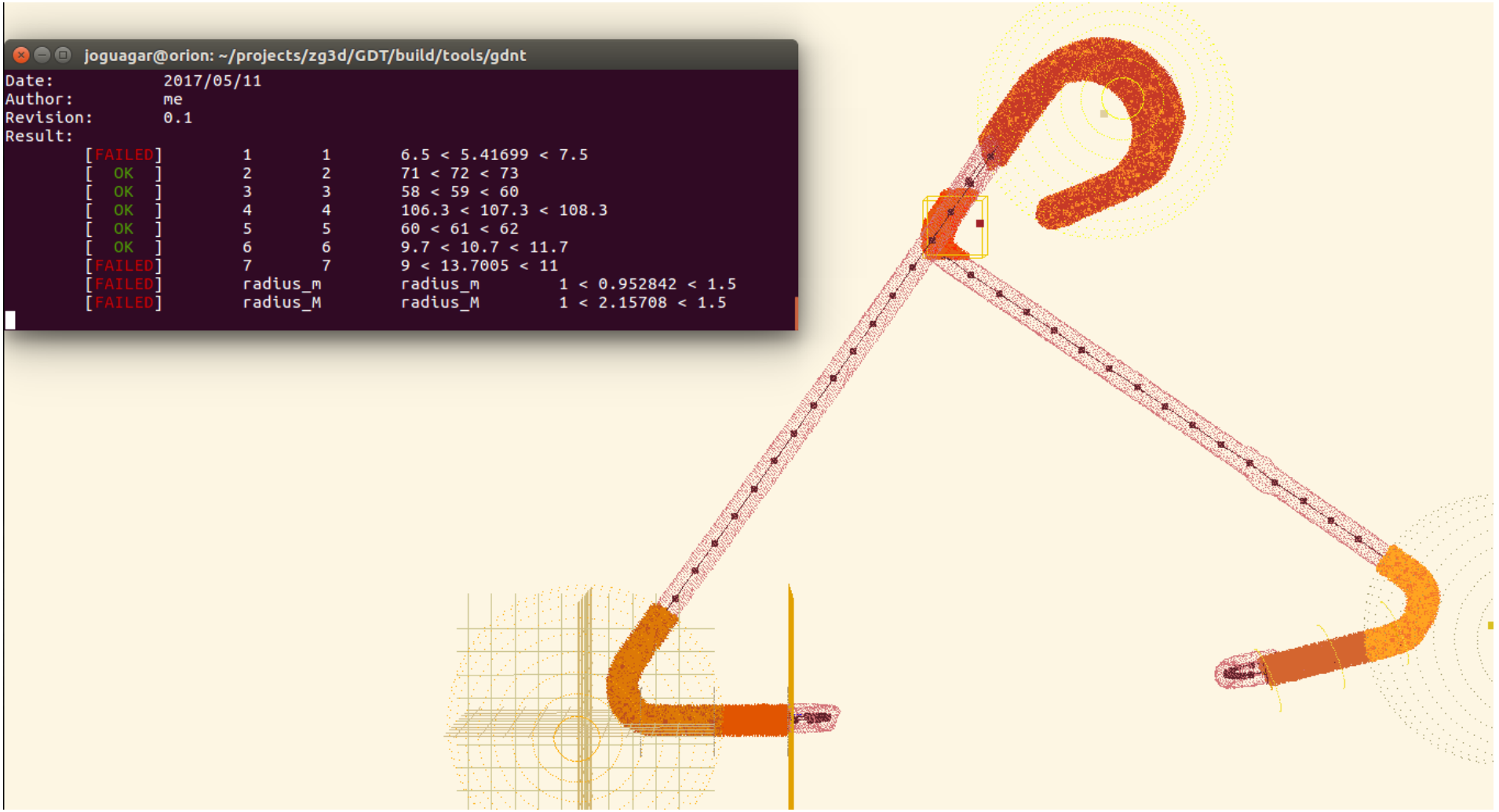
Real springs – Example 3

Results

- 3D debugging for GdnT



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Technical Specs

Results

Specifications:

- **Maximum part size:** Up to a maximum of **120 mm** could be scanned with the current *maxi3d* prototype acquisition device.
- **Precision**: Able to detect surface defects **of 0.2 mm**.
- **Power consumption**:
  - Acquisition device: less than **75 W** at a constant rate of **15 part per minute** (16 camera shot + flashes).
  - Computing hardware: depending on configuration, but it could be as low as a standard industrial PC.

Zero Gravity3D

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Advantages and main features

Summary

Summary:

- **New and unique** patented **acquisition device** with a 16 camera configuration, developed by ITI in close contact with the industry. ZG3D is a multi-view system for inspecting 3D objetcs from **simultaneous views**.

- Innovative acquisition concept. A 3D inspection system **without mechanical handling and without hidden faces.**

- Free fall operation allows to deal with a wide range of objects **without specific manipulators**

- **Scalable**, including 3D reconstruction and comparison check against reference models.

- **Fast process**, the technology allows to capture as many objects as possible with the only restriction that no occlusions appear among them. Using several CPU's or multicore systems, the throughput is only bounded by the mechanical limitations of the conveyors.

- The **size** of the objects and the **resolution** of the reconstruction **can be adapted** to the task without instrinsic limitations.

- **Inspection of 100%** of the production and detection of complex defects is achievable with total flexibility.

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Current status

Summary

- Prototype **validated in laboratory with real parts** from different tasks: classification, defect detection in airplane engine parts and in dental prothesys.
- **Now working on** the construction of a **pre-industrial prototype** to validate the technology in a real scenario.
- **Looking for industrial partners** to collaborate in the manufacturing, commercialization and maintenance, to reach end customers in the industrial sector.

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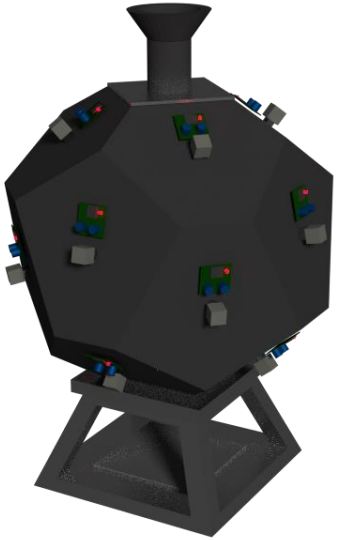

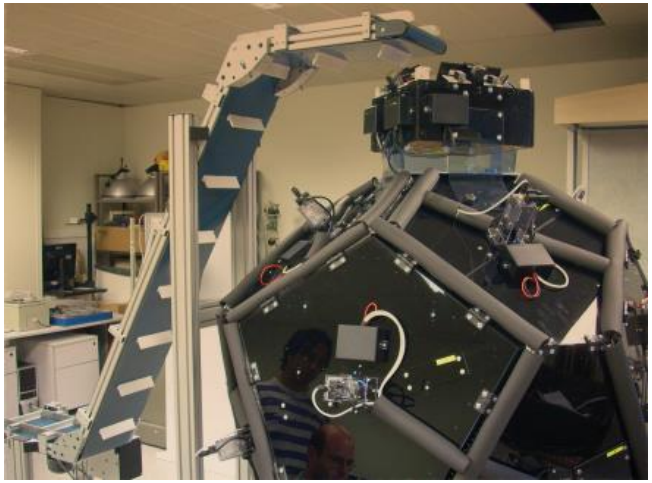

http://www.zerogravity3d.es/en

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