3D-Forensics / FTI

Mobile high-resolution 3D-Scanner and 3D data analysis for Footwear and Tire Track Evidence

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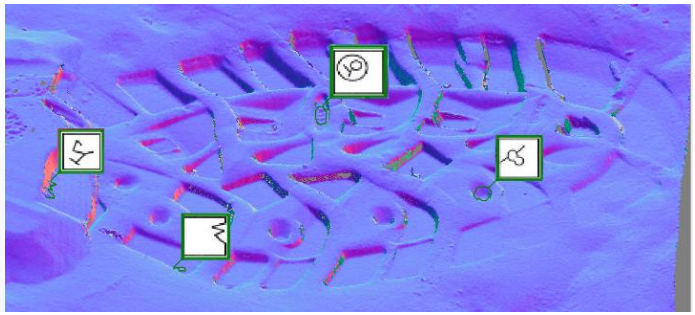
Roland Ramm, Fraunhofer IOF

Crabbe Consulting Ltd
Lucas instruments GmbH
GEXCEL Srl
DelftTech BV
Fraunhofer IOF



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Projects 3D-Forensics and 3D-Forensics/FTI

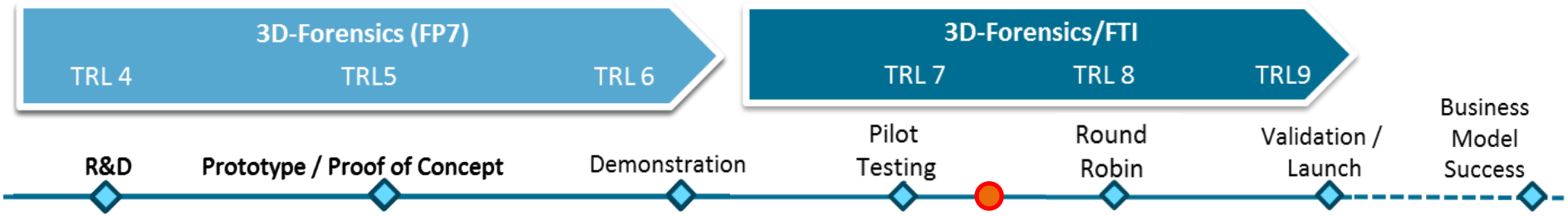
- **Development** and **Introduction** of **optical 3D scanning** to secure and analyse footwear / tyre impression traces

3D-Forensics

- FP7 – „Advancing contemporary forensic methods and equipment“
- 01/05/2013 – 31/08/2015
- Partners: 7
- Objective: Prototype (TRL6)

3D-Forensics/FTI

- Horizon2020 – „Fast Track to Innovation“
- 01/07/2016 – 31/12/2018
- Partners: 5 (+7 associated end users)
- Objective: Advanced Prototype / Product



Partners 3D-Forensics and 3D-Forensics/FTI

RTO and research consultant

Participant organisation name
Fraunhofer Institute for Applied Optics and Precision Engineering
Crabbe Consulting Ltd
Crime Scene Unit Zeeland – West-Brabant
DelftTech BV
LUCAS Instruments GmbH
Enclustra GmbH
Gexcel SRL

Public End User

Companies developing and suppling hardware and software

Company with crime scene forensic expertise

Agenda

- **Problem / Motivation**
- Development of the 3D-Forensics system
  - 3D scanner
  - 3D analysis software
- Introduction of the 3D-Forensics system

Problem: Typical traces at Crime Scenes

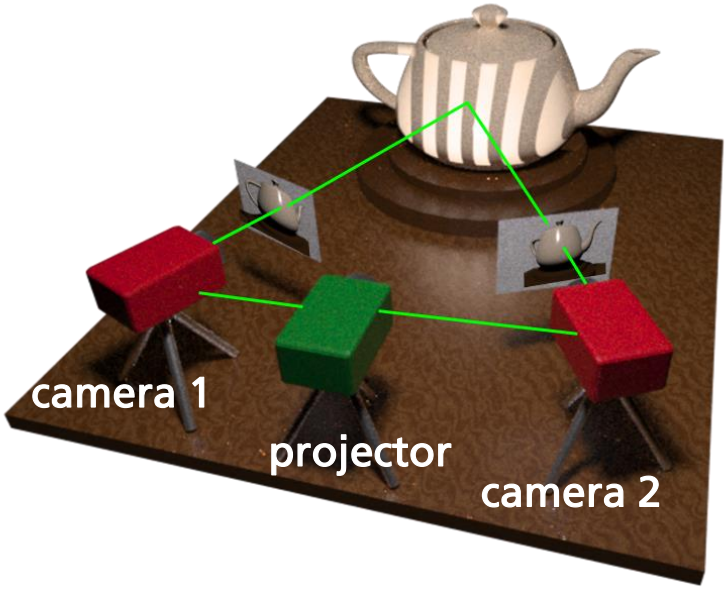
Diversity of traces at crime scenes in a certain period of time in the region Zeeland (NL)

Trace type	Frequency %
Biological	10.38
Dactyloscopical	2.26
Gloves	5.54
Clothing	0.04
Microsopic traces (fibers / glass / …)	28.22
Digital Recordings	0.16
Footwear and tyre traces	**22.91**
Toolmarks	30.48

- Footwear and tyre impressions are common traces at crime scenes (because the criminals cannot „fly“)
- They can be used to identify suspects and convict criminals
- They have a great importance to identify links between crime scenes or suspects ► Forensic Intelligence

Motivation: Plaster casting vs 3D scanning

- Footwear and tyre impressions are typically recorded by **plaster casting** (if time and circumstances allow it) or simple photography (but which captures only limited information value)
- **Optical 3D scanning** can improve the securing and investigation of impression traces ► **Stereo-based pattern projection** (structured light)



Optical 3D scan of an impression

Motivation: Plaster casting vs 3D scanning

Classic – Plaster casting

- Time up to 1,5 hour on scene
- Influence of weather
- Choose priority of technique
- Multiple processes at the impression
- Dirty
- Transport (fragile)
- Storage of evidence
- Selection because of amount of work
- All work done by expert

3D-Forensics - 3D scan

- **Time (several seconds) on scene**
- **Almost no influence of weather**
- More evidence because of easiness = more identifications
- **Non destructive**
- Clean
- **Digital storage**
- Pre-selection evidence
- Evidence can be sent digitally and even printed by 3D printer

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3D-scanner: Prototype

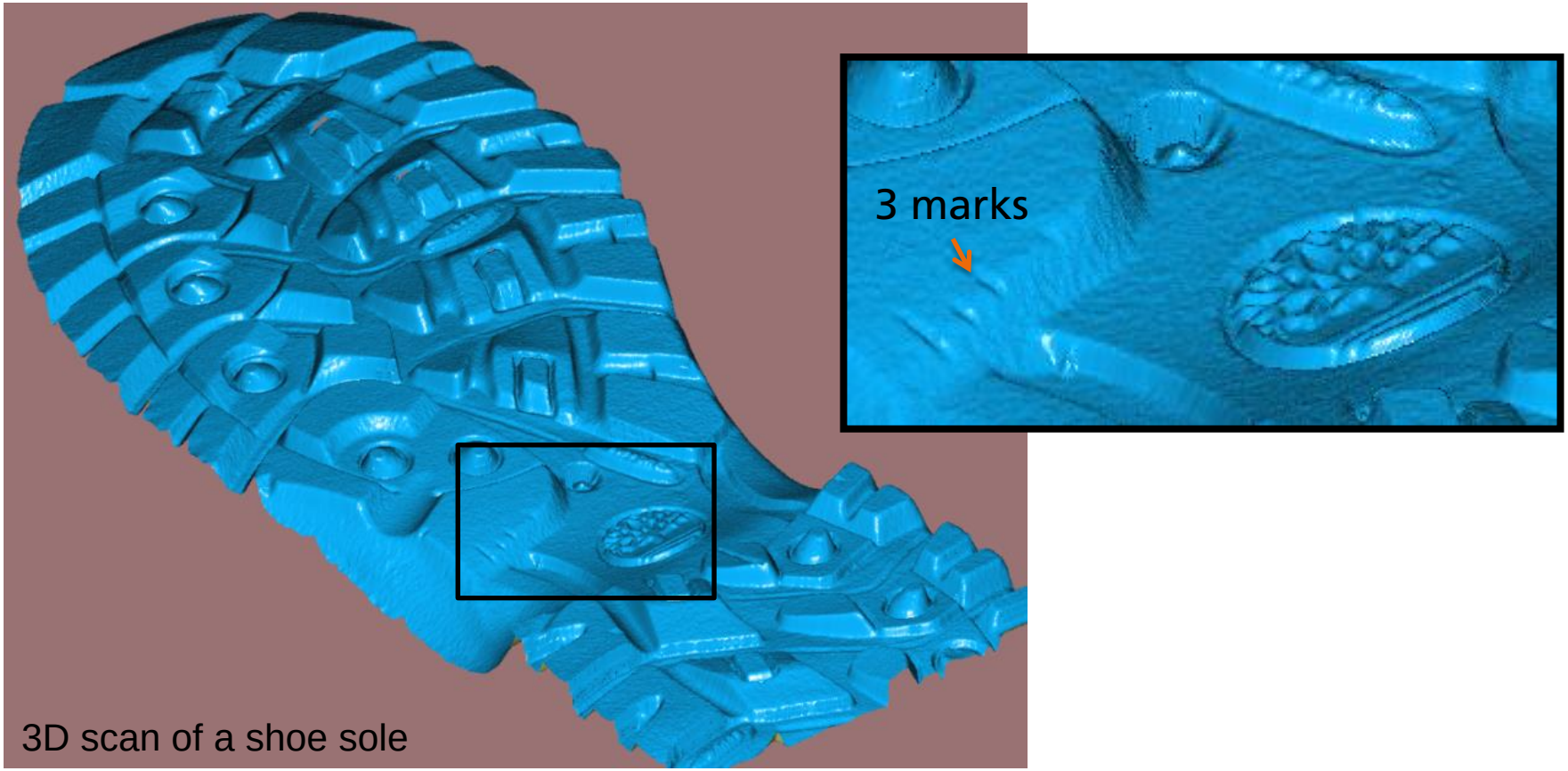
Highly resolved 3D and color	Simple to use: 1 trace in one shot	Compact, battery driven
Application outdoors mobile, handheld	Equipment for bright sunlight	Easy to transport

3D-scanner: Prototype specifications

Confidential – not in Public version for wider release

3D-scanner: Prototype capabilities

- Details are important **individual characteristics** of shoes

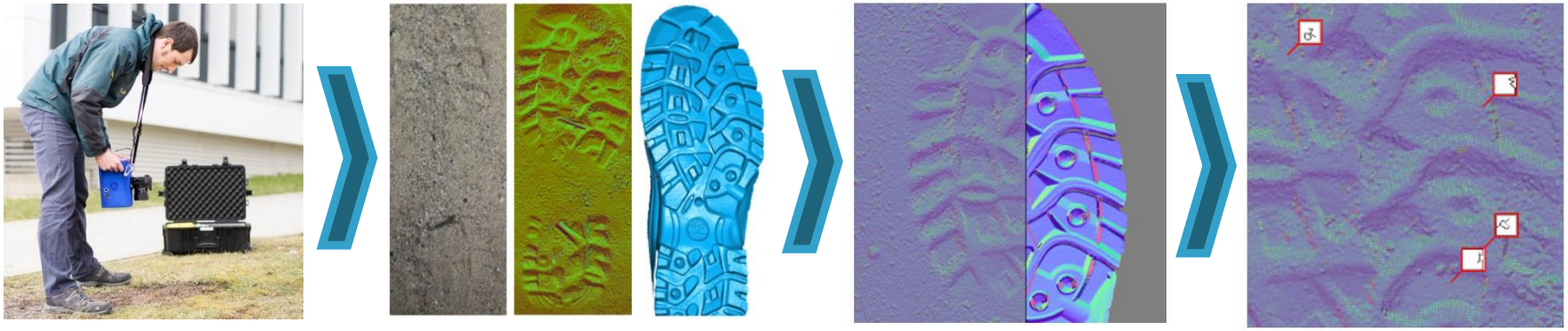


3D scan of a shoe sole

3D-Forensics system: „from crime scene to court“

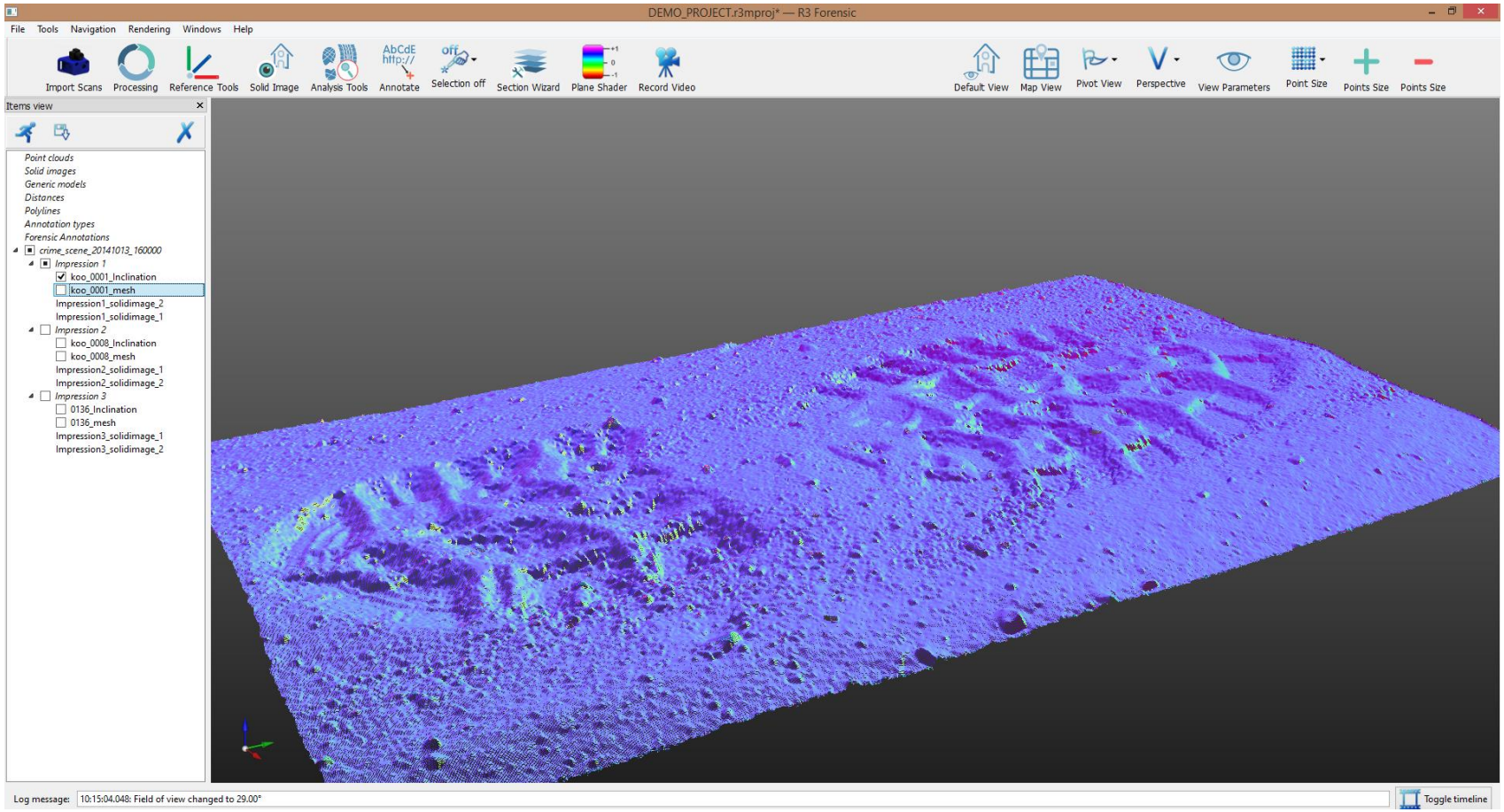
- Traditional securing and analysis procedure

- New 3D scan based procedure mimics the traditional procedure



3D analysis software: R3 Forensic Prototype

- **R3 Forensic**: Simple user interface – different shadings - colour



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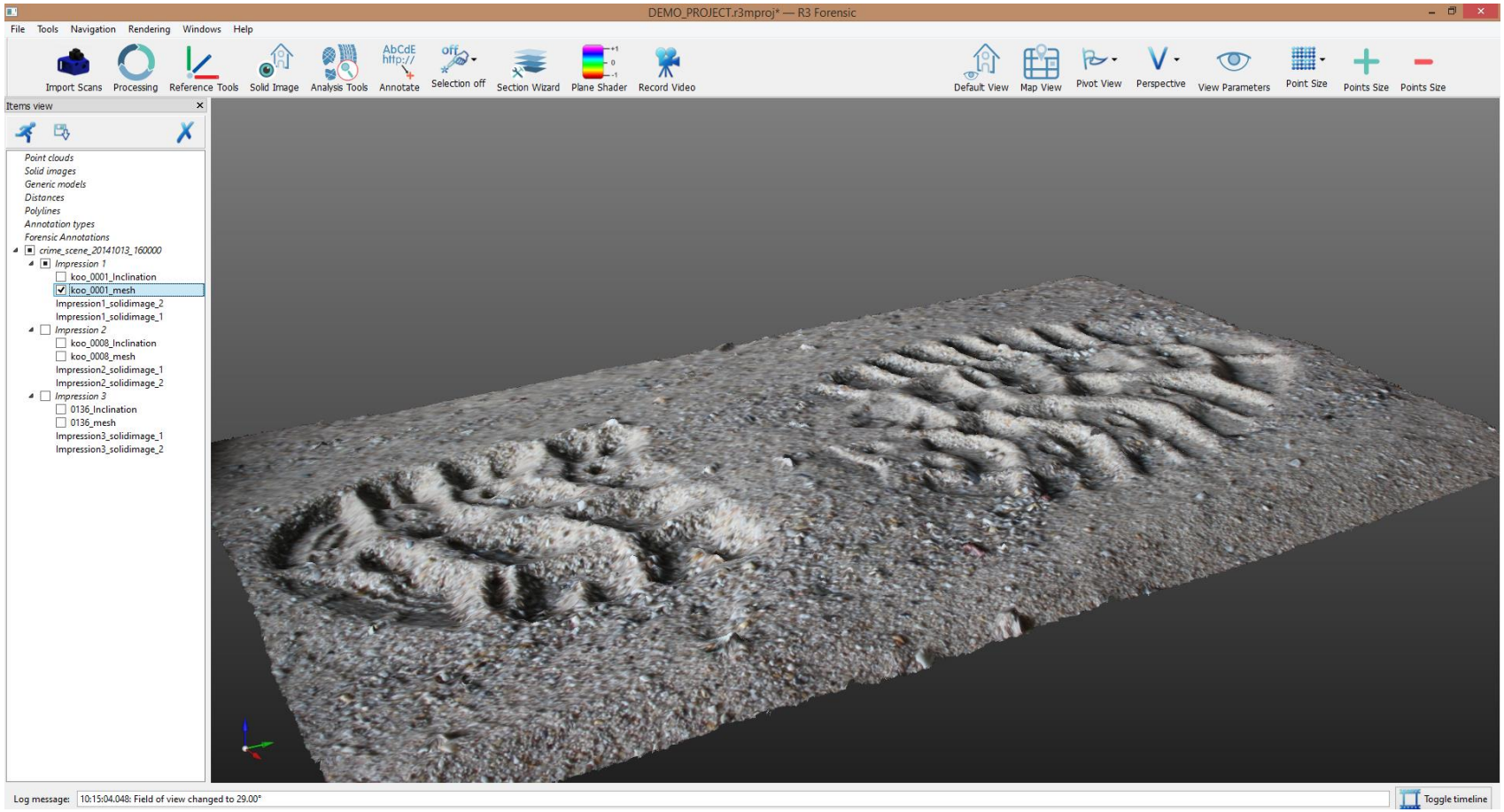


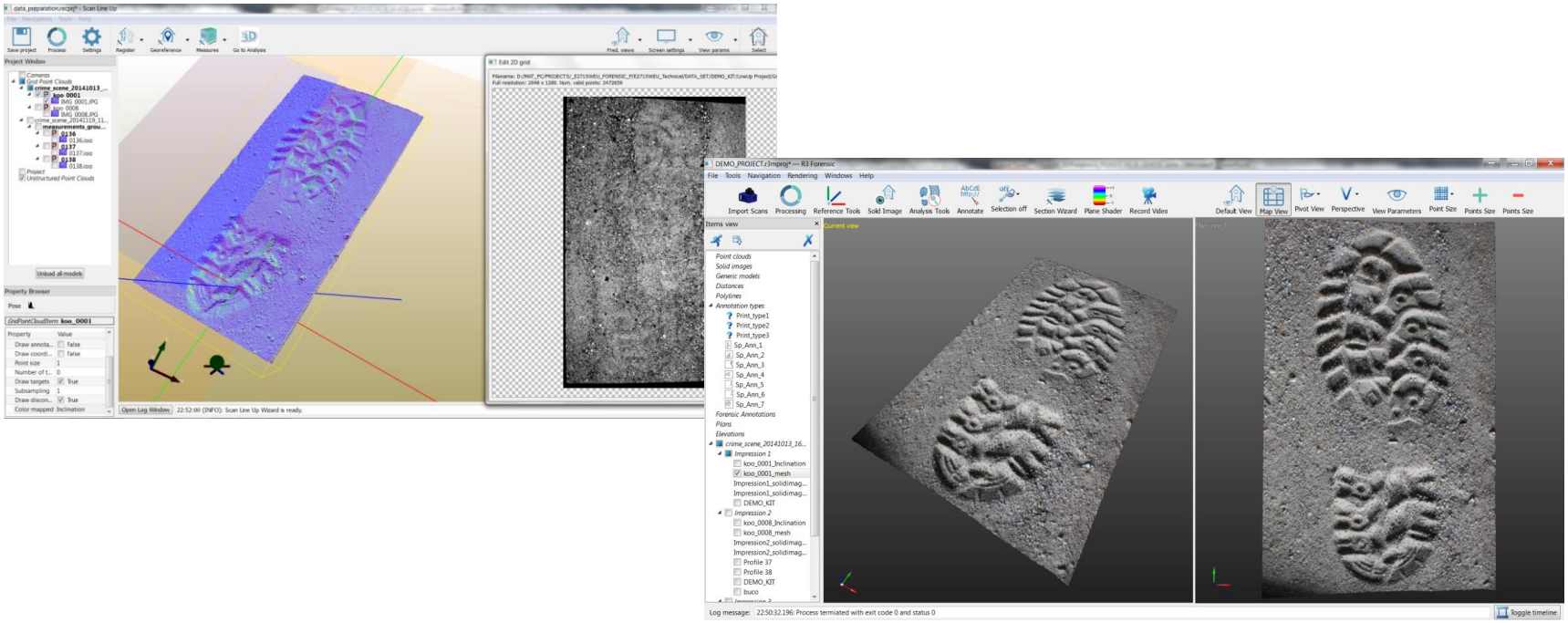
3D analysis software: R3 Forensic Prototype

- Two-stage process

Phase 1
Import / Preprocessing

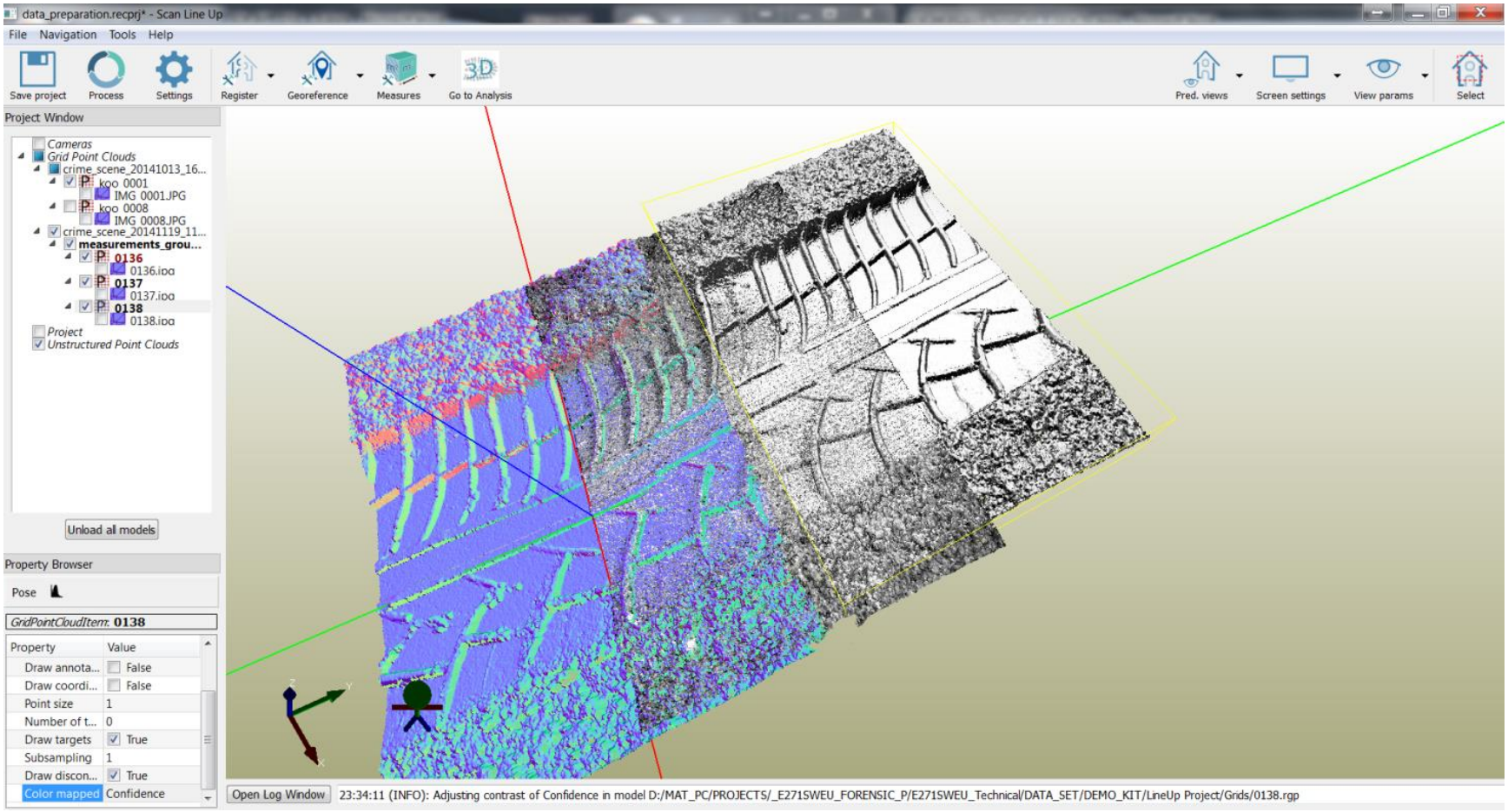
- Preprocessing, Stitching & Registration
- Meshing + Colour mapping

Phase 2
Analysis



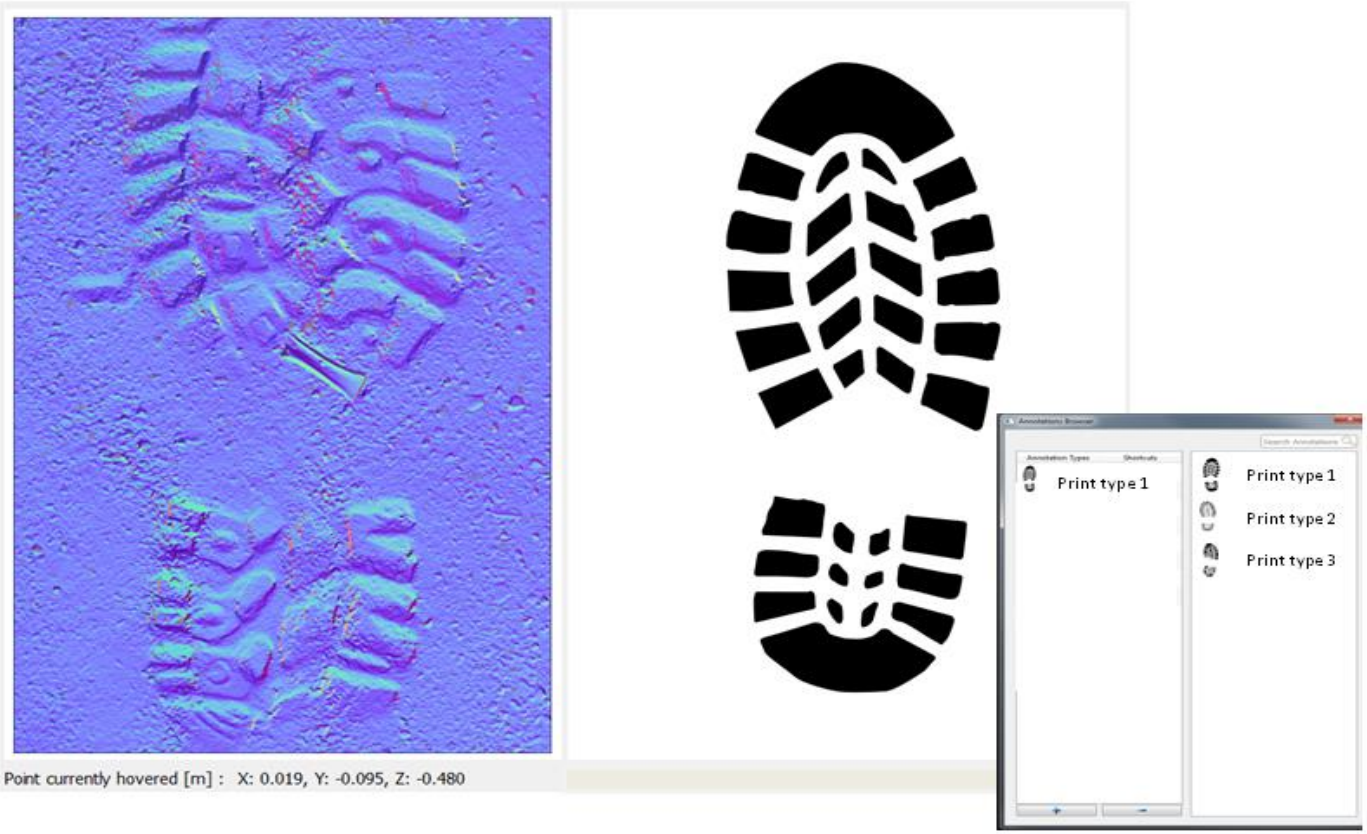
3D analysis software: R3 Forensic Prototype

- Preprocessing and simple stitching of single scans

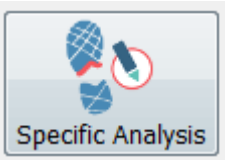


3D analysis software: R3 Forensic Prototype

Class characteristics, like type and size

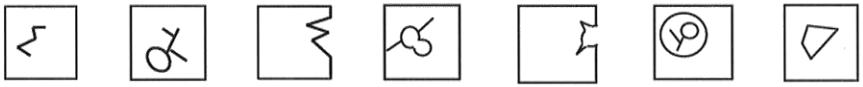


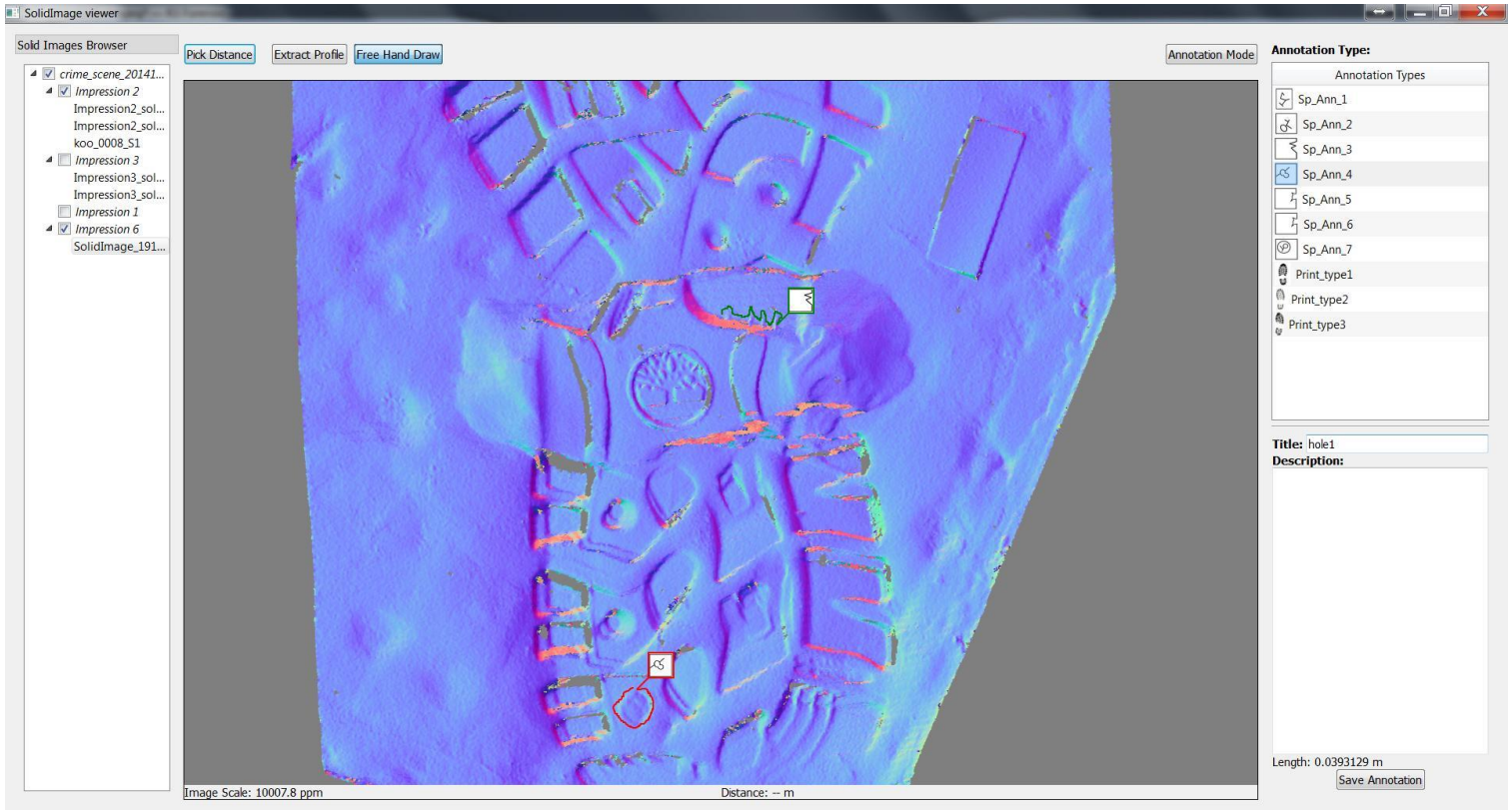
3D analysis software: R3 Forensic Prototype



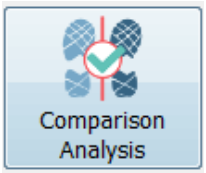
Individual characteristics

Import of pre-defined identification characteristics

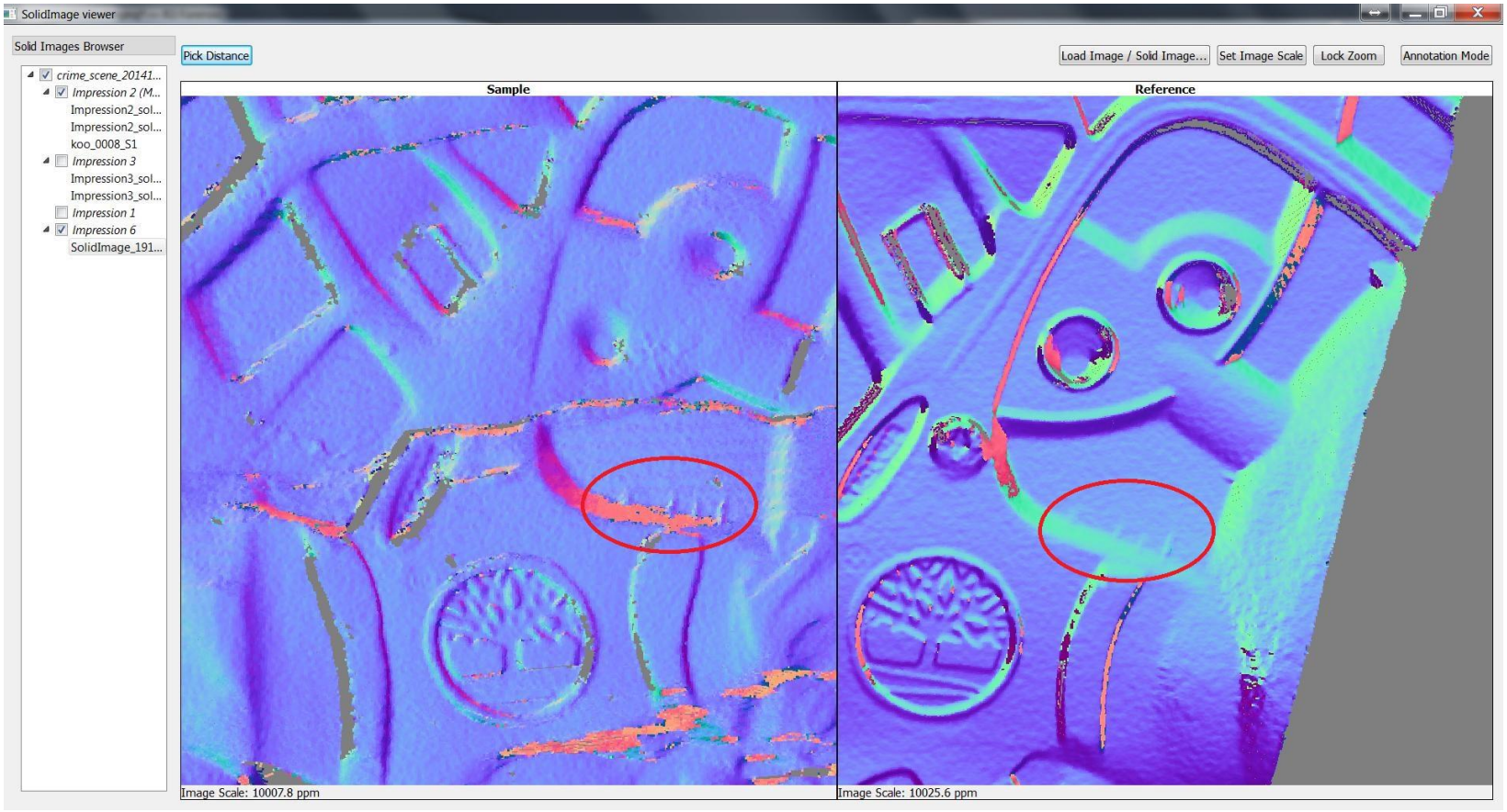




3D analysis software: R3 Forensic Prototype



Comparison of datasets



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- **Introduction of the 3D-Forensics system**

Introduction of the 3D-Forensics system

(1) **Familiarisation testing**
Initial introductory training by 7 end users

(2) **Pilot testing**
System demonstration in small operational area and in a controlled manner to identify the operational benefits and any further improvements

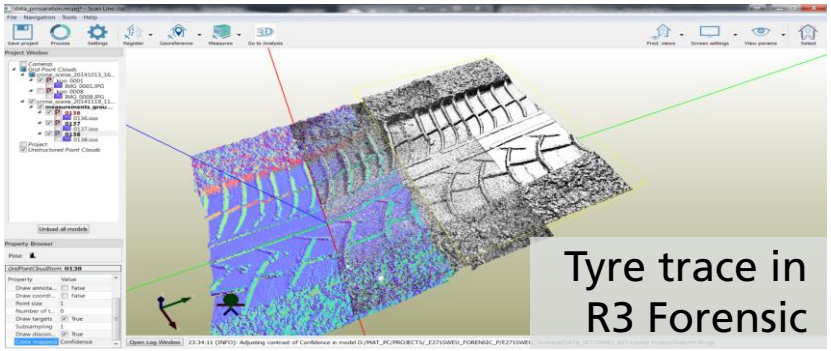
- ► receive feedback and suggestions for technical improvements to be implemented in the advanced prototype (TRL9)

(3) **Round robin testing**
Performance verification, reproducibility tests by different users

(4) **Validation** (in an accredited process)

System testing: Loan of prototypes

- Testing of typical materials / objects
- Evaluation of usability
- Varying scan settings / environments
- Evaluation of software tools

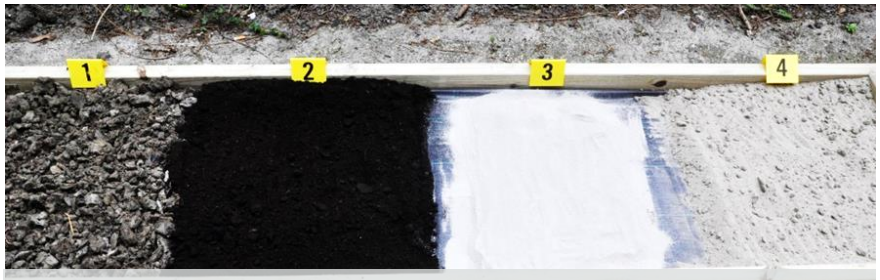


Tyre trace in R3 Forensic

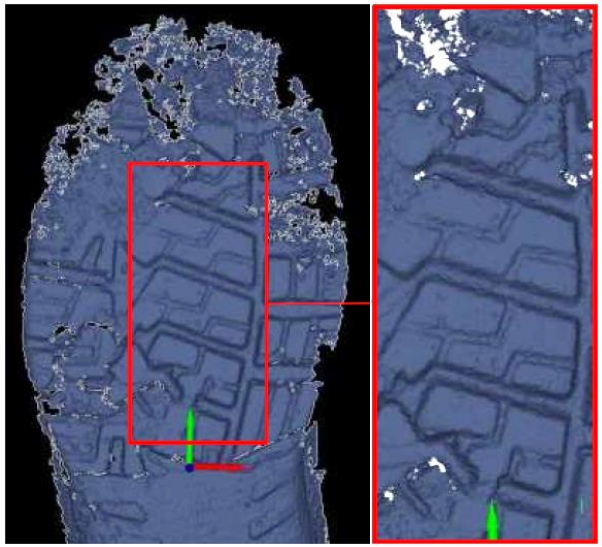
Handheld

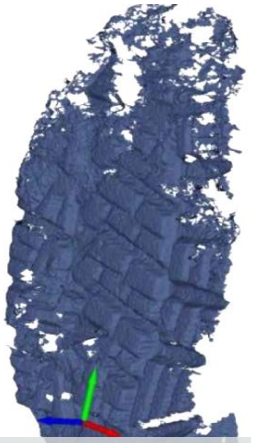
Tripod

Shadow box



Clay Soil Mortar Sand





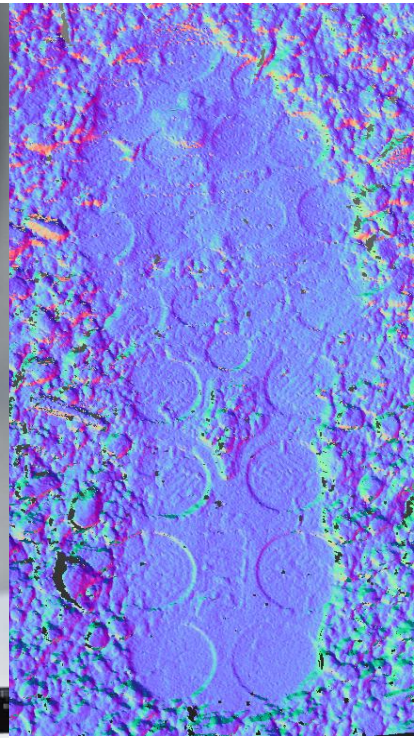
3D scan in snow

System testing: Evaluation of data

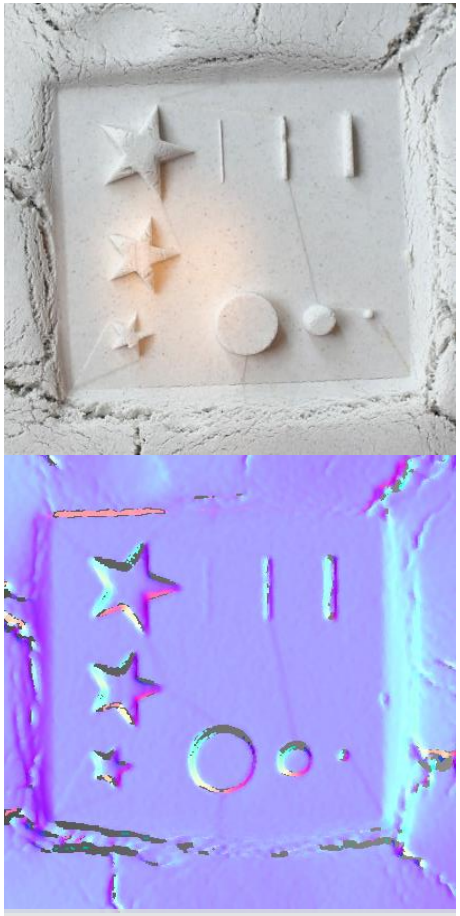
- Evaluation of data quality
- Comparison to other techniques

Photo

Plaster cast



3D-Scan



Resolution specimen

Round robin test and Validation

- Feedback from first testing phase is used to improve the prototypes
- **Round robin test** is then a first step to demonstrate the **validity of the 3D-Forensics system**:
  - Different users scan the same traces
  - Different users analyse and compare the same 3D datasets
- **Validation** means:
  - Create a **body of evidence** (data and its analysis) to convince criminal justice systems
  - Prepare a **comprehensive documentation** about the usability of the overall 3D-Forensics system for the application on footwear and tyre impressions from crime scene to court
  - Develop **quality control procedures** for end users

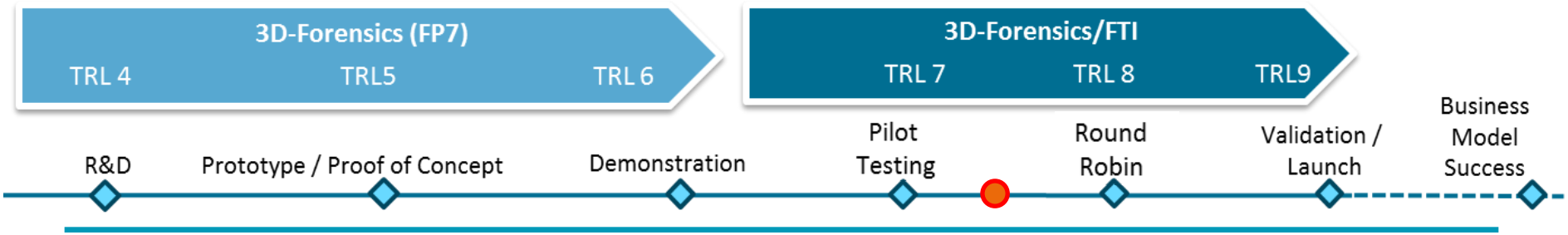
Round robin test and Validation

- **Important frameworks for validation:**
  - Criminal law (incl. procedure)
  - Standards
    - ISO/IEC 17020:2012, Conformity assessment - Requirements for the operation of various types of bodies performing inspection
    - ISO/IEC 17025:2005, General requirements for the competence of testing and calibration laboratories
  - Guidelines: ILAC-G19:08/2014, Modules in a Forensic Science Process, UK Forensic Science Regulator, Home Office Scientific Development Branch, *Digital Imaging Procedures……*
  - ….

Summary

- The projects 3D-Forensics and 3D-Forensics/FTI pursue the **Development** and **Introduction** of a new method to capture and analyse footwear and tyre impressions by **optical 3D scanning**
  ► **„from crime scene to court“**

- Next steps:
  - 2017/18 >> Technical improvement to reach an advanced prototype
  - 2018 >> Round robin testing on a set of traces and datasets
    >> Validation in an accredited process
  - 2018/19 >> Product launch



Thanks for the invitation and your attention!

More information about 3D-Forensics?

http://www.3D-Forensics.eu

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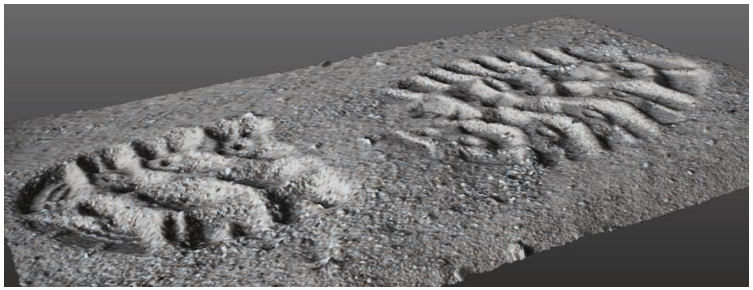

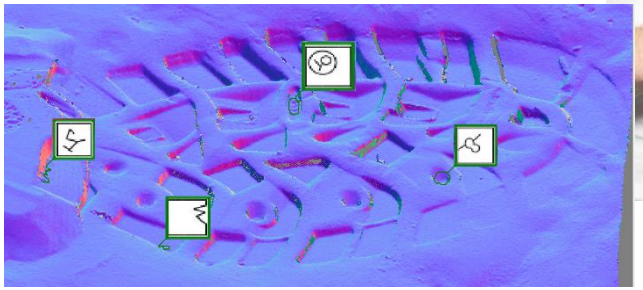

More information about 3D scanning?

http://s.fhg.de/3DM

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