Optical quality assurance procedures for the sensors of CBM STS Detector

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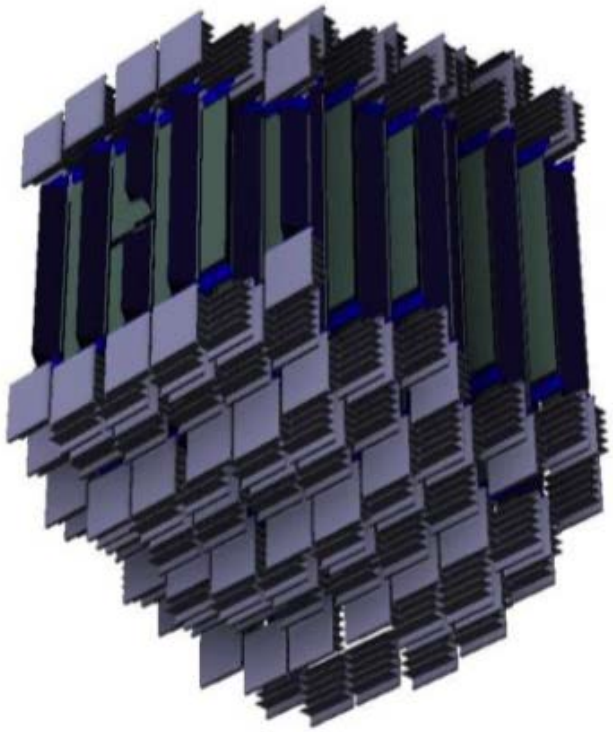
Overview

- Optical inspection setup
  - Overview
  - STS Sensors
  - Inspection principles
  - Capabilities
  - QA software
- QA Database
- Cable QA
- Summary

Silicon Tracking System (STS) detector

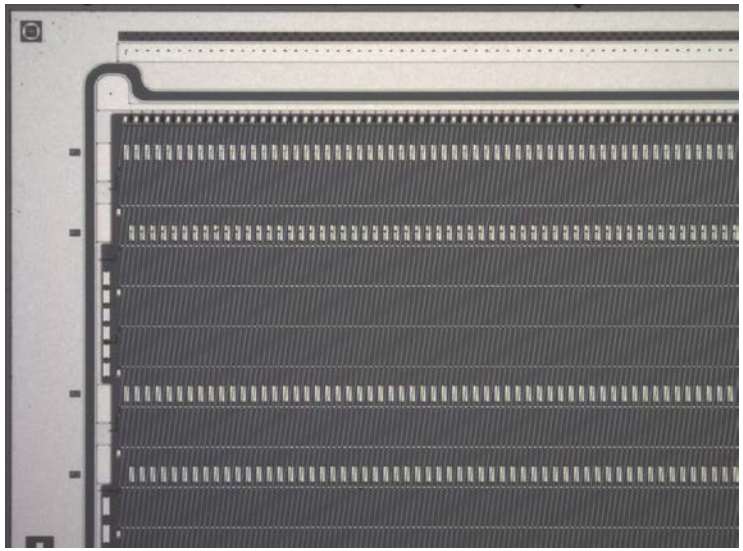
- Compact detector built out of ~1300 silicon microstrip sensors
- Very Compact (~2 m^3), defined by dipole magnet aperture
- 8 layers of sensors
- 40 kW of thermal power dissipated -> high heat density



STS detector without thermal insulation

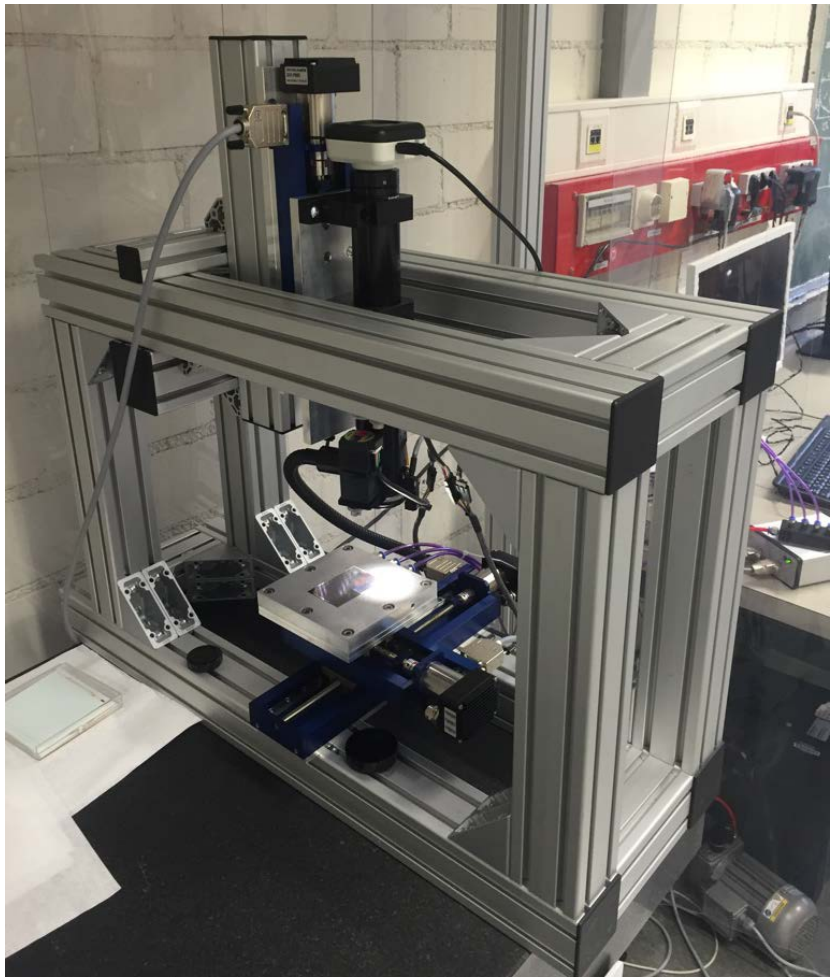
STS Sensors

- Double-sided micro strip Si sensor
- 0° (n-side), 7.5° (p-side) stereo angle
- 58 µm strip pitch
- 1024 strips per side
- 6.2x12.2, 6.2x6.2, 6.2x4.2, 6.2x2.2 cm^2 form factors
- 2 manufacturers (CIS, Hamamatsu)



Optical inspection setup

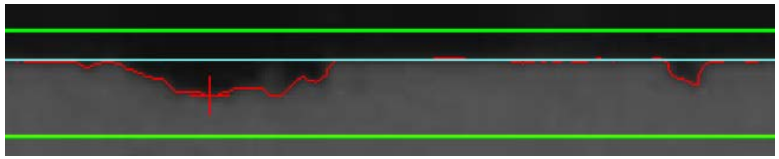
- Flexible design to support inspection of different objects (different sensor size-types from CIS and Hamamatsu, sensor micro-cable inspection)
- Low hardware dependence, adaptable to almost any hardware
- Configurable QA procedures as plug-ins
- Report building, storage, viewing and manipulations
- Constant improvement in performance (inspection times 1 hour -> 4 min per sensor side)



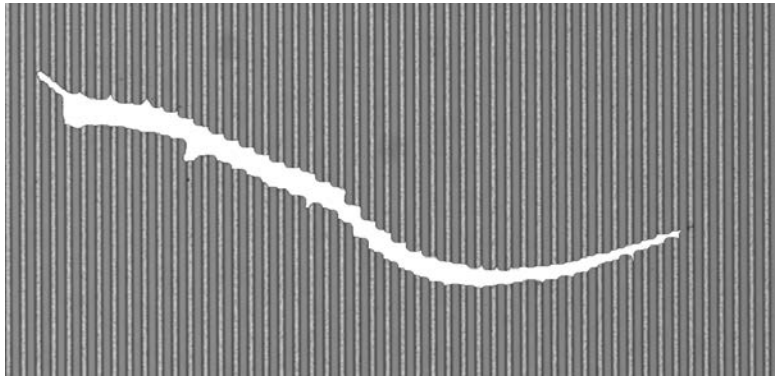
Inspection setup capabilities

Possible to detect:

- Dust particles and other foreign objects on the surface
- Scratches
- Single element integrity
  - bias resistors
  - strips
  - pads
  - guard ring
- Sensor edge defects & parallelity
- Possible any deviation from clean pattern (pattern/texture matching)

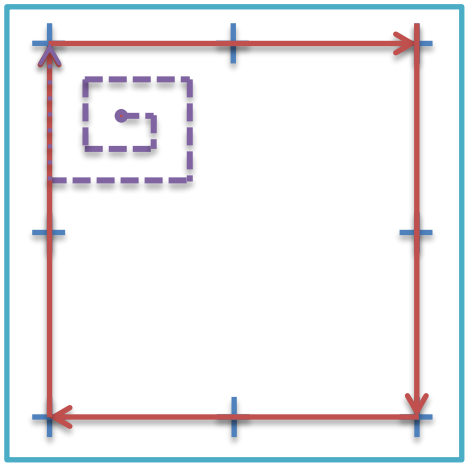


Edge profile



Recofnized surface scratch

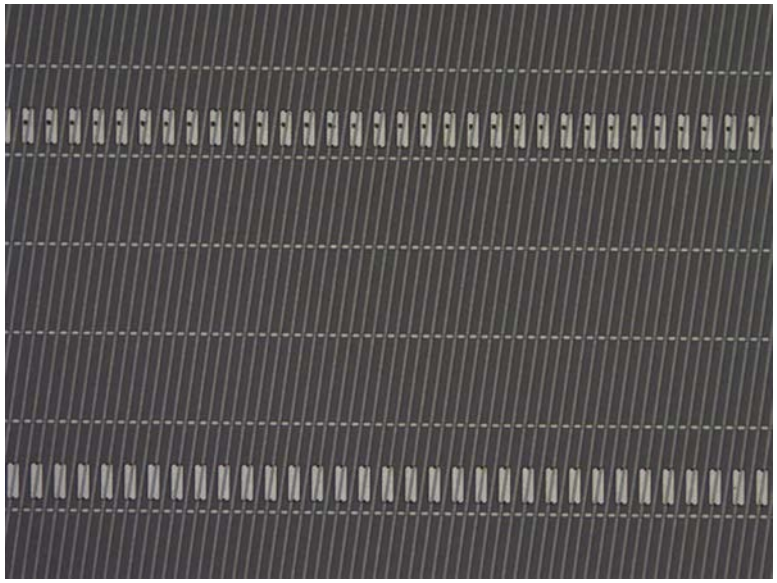
Calibration and scan

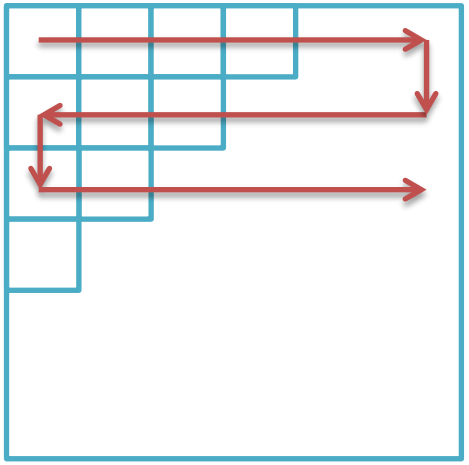


Calibration movement pattern

$$\vec{x}_m = \mathrm{S} \cdot \mathrm{C} \cdot \mathrm{R} \cdot \vec{x}_s$$

Extract **S**tretching, **C**onversion, **R**otation matrices

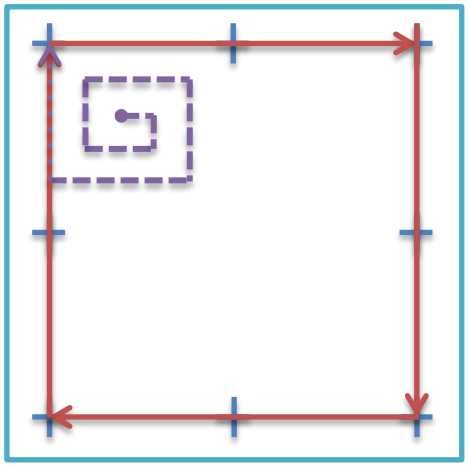




Scan movement pattern

Images sent to defect analysis

Calibration and scan



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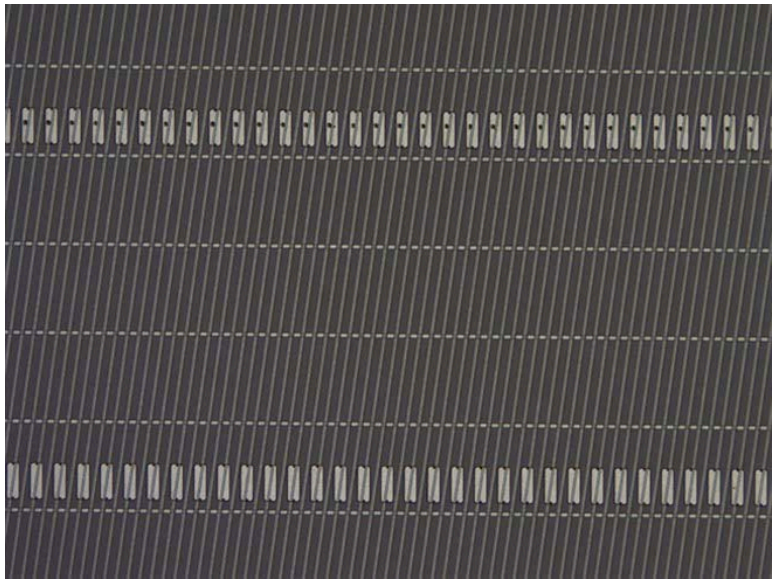
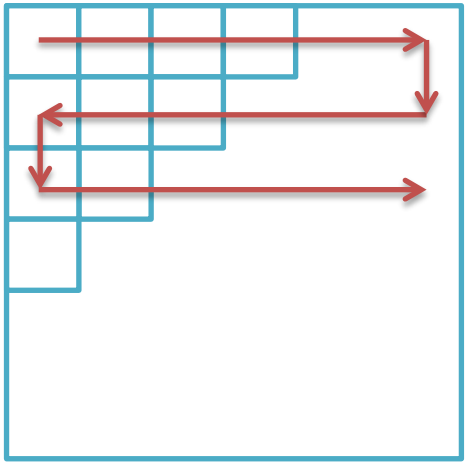


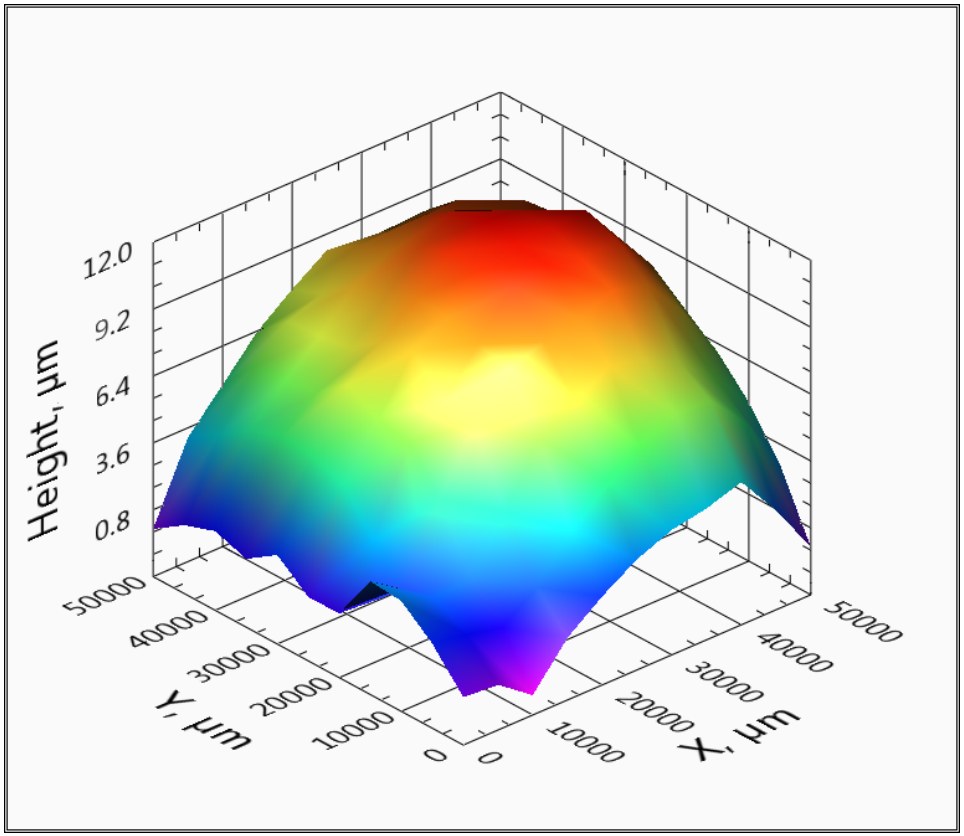


Scan movement pattern

Images sent to defect analysis

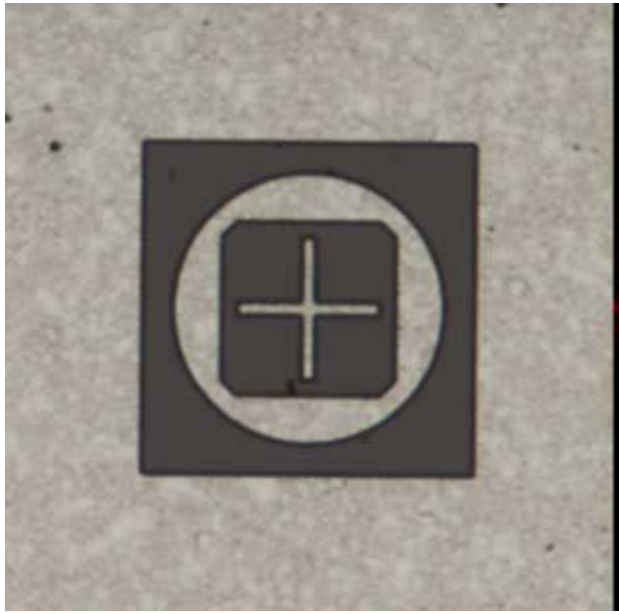
Sensor height map (warp)

- Autofocusing used to measure height maps
- Focus values measured across sensor
- Precision of ~ 1 µm

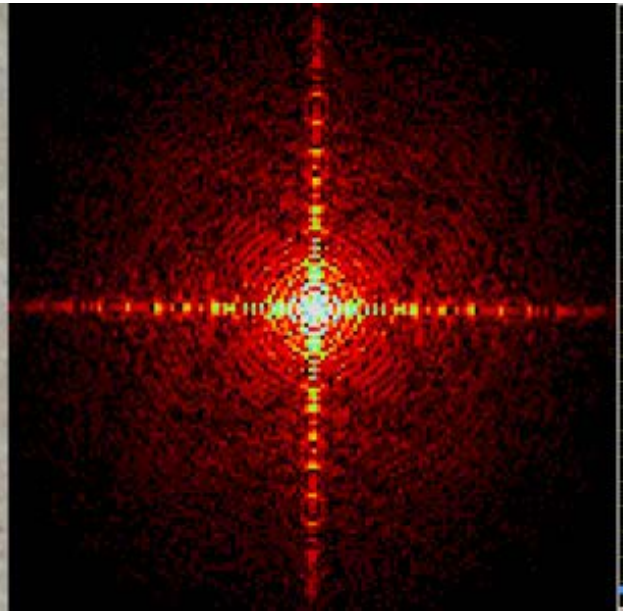


Height map of 5x5 cm central region of a CBM06C6 sensor

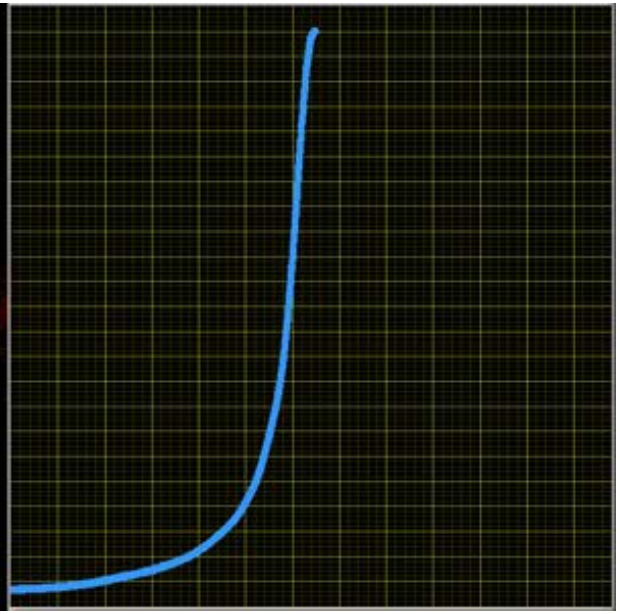
Autofocusing



Source Image at different focus values

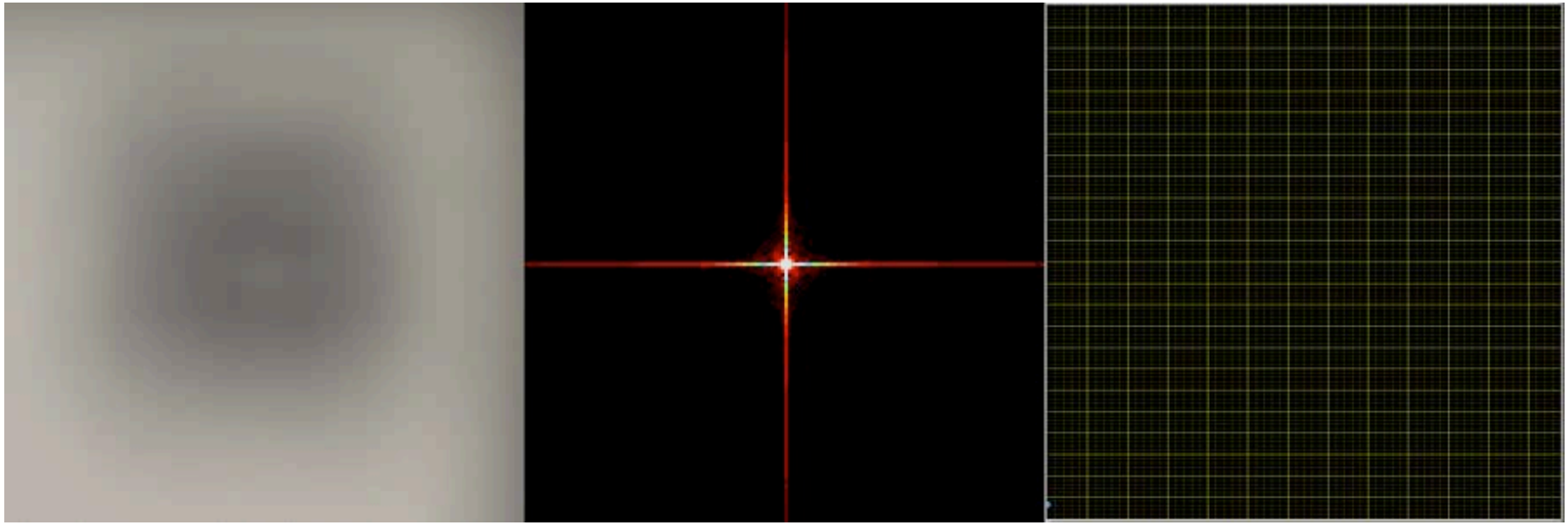


Fourier transformed complex image



Total amplitude of the transformed image

Autofocusing

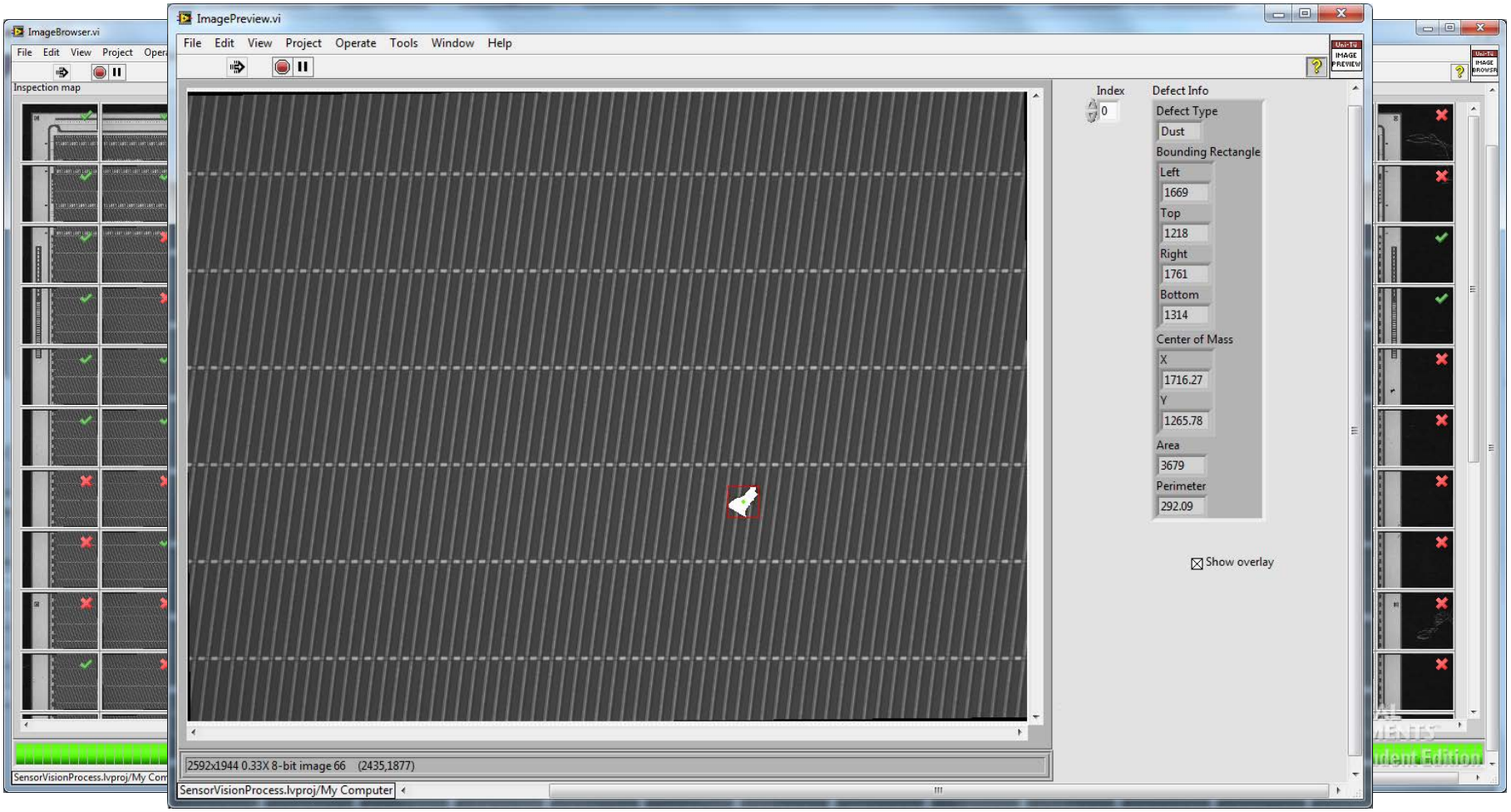


Source Image at different focus values

Fourier transformed complex image

Total amplitude of the transformed image

Inspection reports



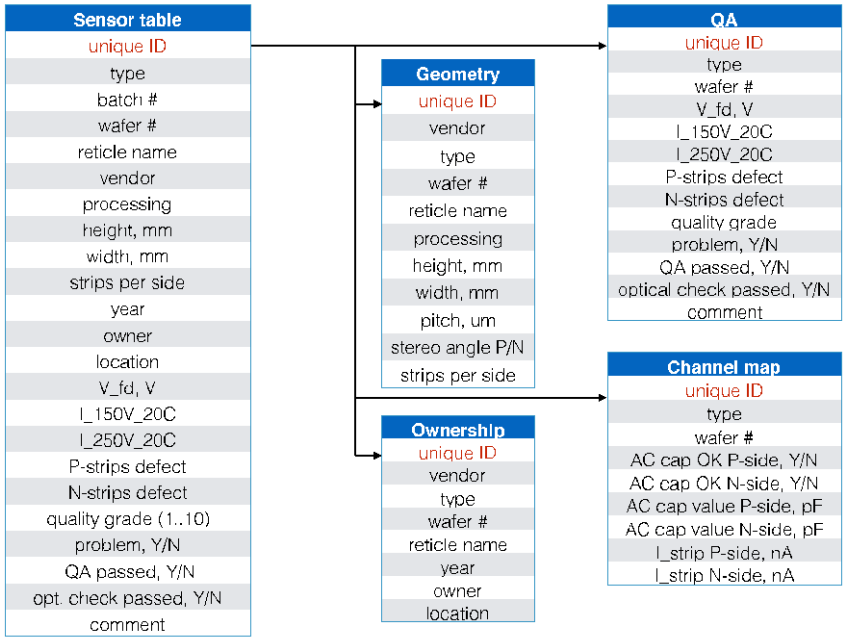
Single ROI with defects inspected, results with information (class, center of mass, area, etc.)

Database

- Reports formed during analysis to be stored in Database
- Centralised data storage for CBM – FairDB

- 1 full inspection is 12.2 GB per 6x6 sensor (n and p sides)
- Up to 40 TB of images needs to be stored -> tape storage **gStore** from GSI

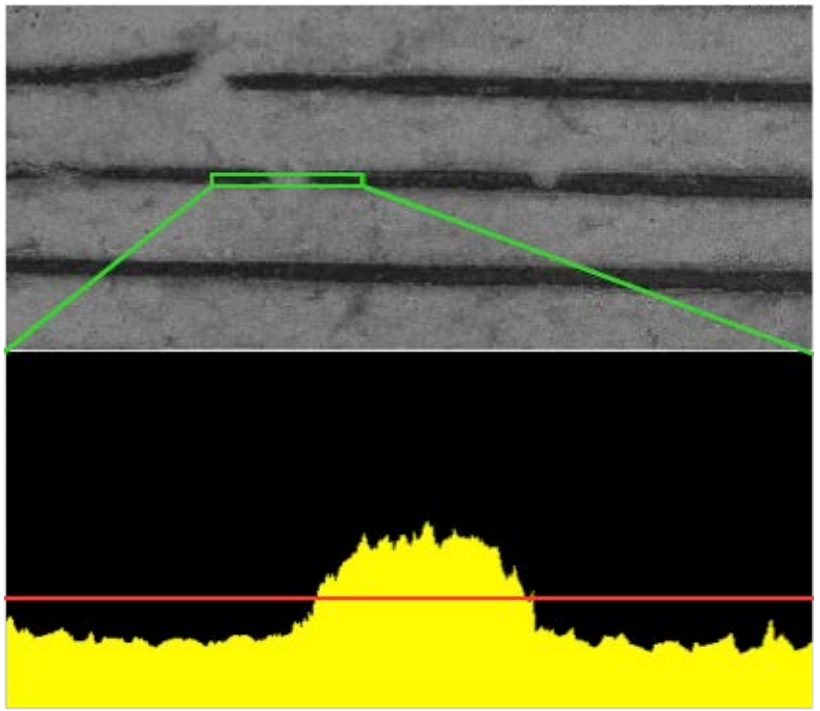
- Database interfaces are currently being developed

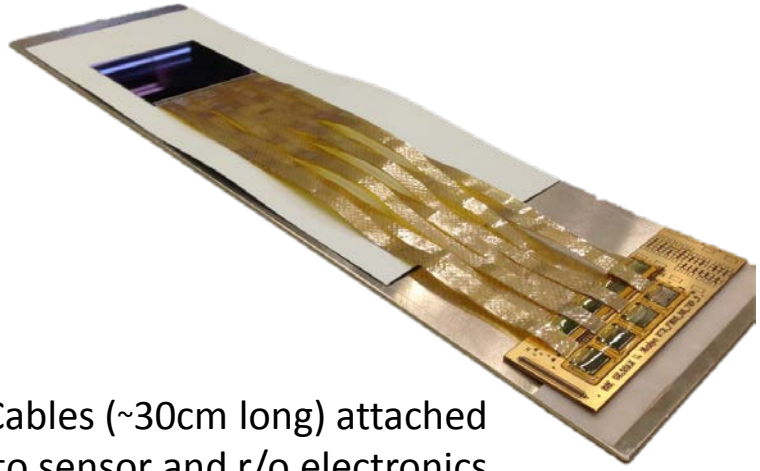


DB Entity structure, Courtesy D. Bertini

Cable QA

- The system is capable to test the quality of microcables and detect:
  - Broken lines
  - Defect lines
  - Foreign objects on the surface
  - Other metal defects





Cables (~30cm long) attached to sensor and r/o electronics

Summary

- The setup is operational and being constantly improved
- Shifting focus to inspection methods
- Inspection result storage in FairDB and gStore
- Inspection methods are further developed and improved
- Able to recognize single defects/features
- Development towards operation with trained students
- Waiting for first batches -> QA statistics, improved QA criteria

Backup. Optical inspection setup

1. 5 MP Microscope camera (Motic)
2. Motorized 12x zoom (0.58x – 7x) & 3mm fine focus (Navitar)
3. 3-Zone vacuum chuck (Custom made) with Becker 150 mbar vacuum pump
4. XYZ – Motor stages (Faulhaber/Movtec SMC- 300 servo motors) 200/75/75 mm range
5. Direct light source, 600 lm, 5700K (Starlight Roma LED3)

Controlled from LabView