ITk Visual Capture Machine

MoEDAL meeting

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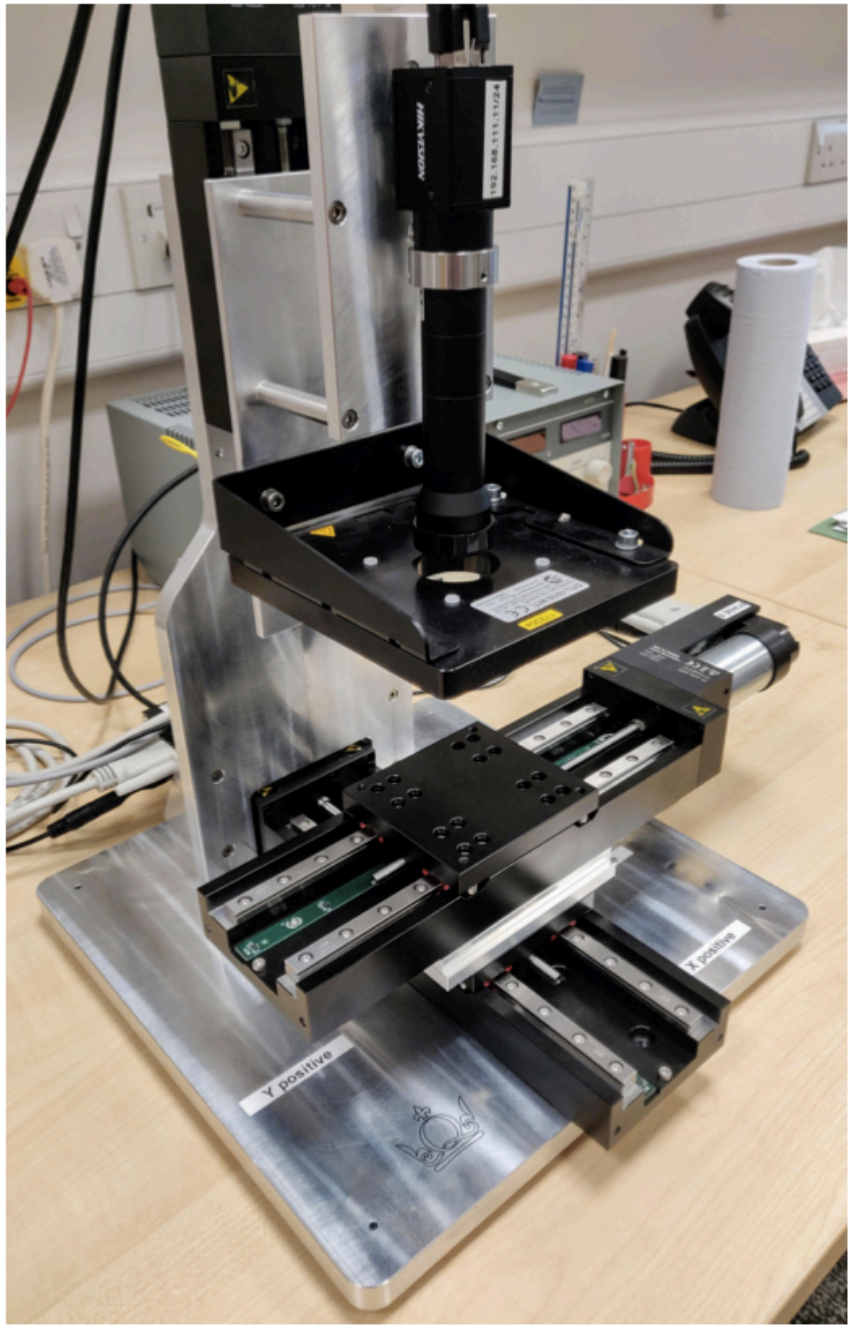
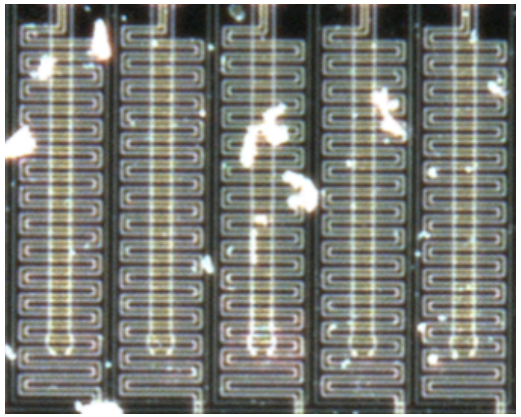
ITk visual capture overview:

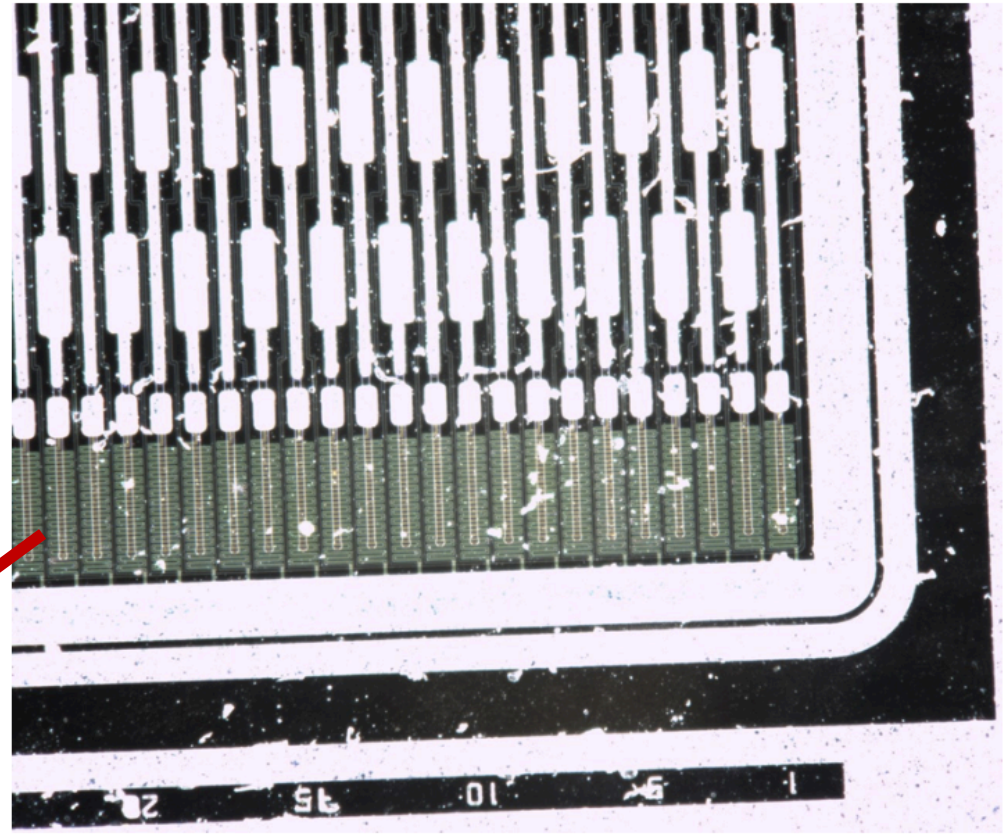
- The ATLAS ITk visual capture is designed to perform a scan over a 2D area capturing an image at each step.
- The current design is intended to scan over a 100 mm x 100 mm area.
- It can image at a resolution where a pixel in the captured image corresponds to approximately 1 µm x 1 µm.
- Used to perform a visual quality check on the ITk silicon sensors.
- **It is possible to exchange components in order to suit different needs.**



Specification:

- X – Y stages (15cm each) are used to scan across the sensor, Z stage (5cm) to adjust focus.
- The system runs on a LabVIEW installation (developed and tested on 2017 version).
- Images are saved as .bmp files, each 15.7 Mb.
- Vacuum jig installed to ensure flatness of sensor.
- Uniform light source (dome light), reasonable bright, can easily be swapped for another.
- Clearly resolves ~7µm wide resister tracks (below).

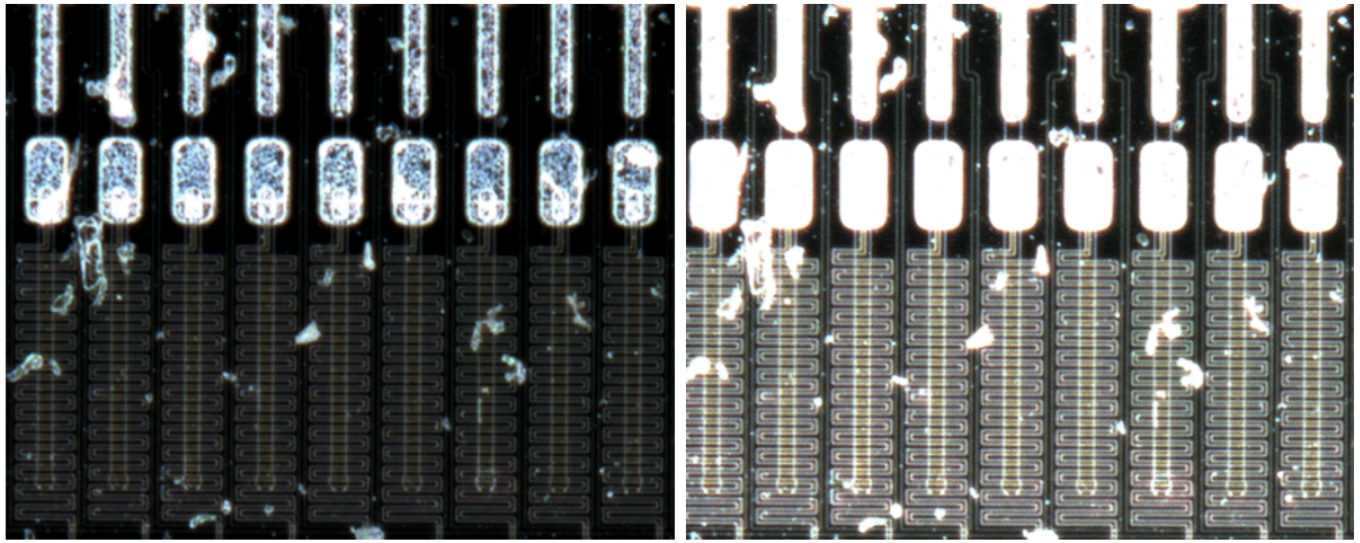




Features:

- Images can be captured in greyscale if appropriate to reduce file size & potentially speed up system.

- Adjustable camera settings directly from scanning software to improve dynamic range; (brightness, sharpness, exposure time & gain).



- Built-in view finder for manual inspection.

- System for identification of samples, i.e. by barcode or similar number.

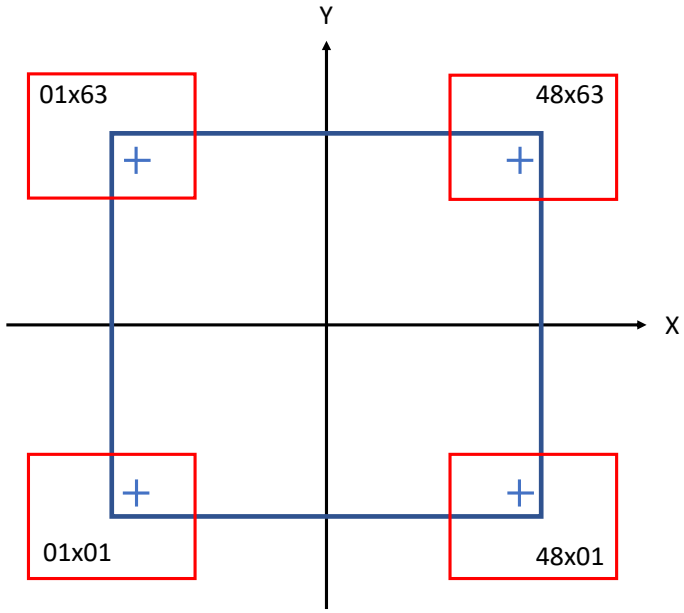
- Sequential naming scheme to indicate where the tile came from in image e.g. XX_YY

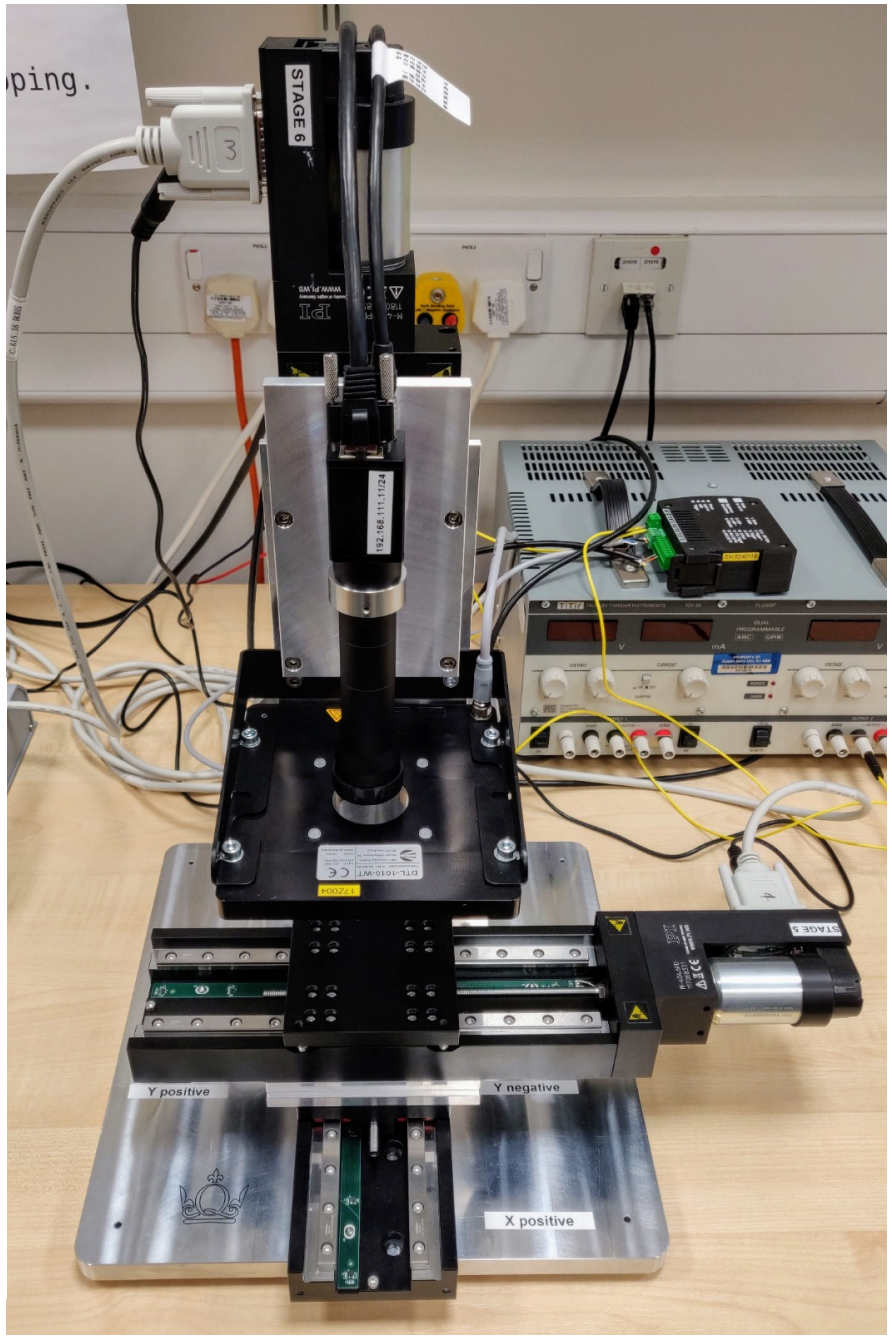
Issues overcome:

- Mechanical rails hold camera steady to avoid shaking.
- Changed orientation of scan to help remove blurred images.
  - Previously perpendicular to support stand causing vibrations to propagate.
- Improved time for full scan, potential to improve speed further..

Scanning:

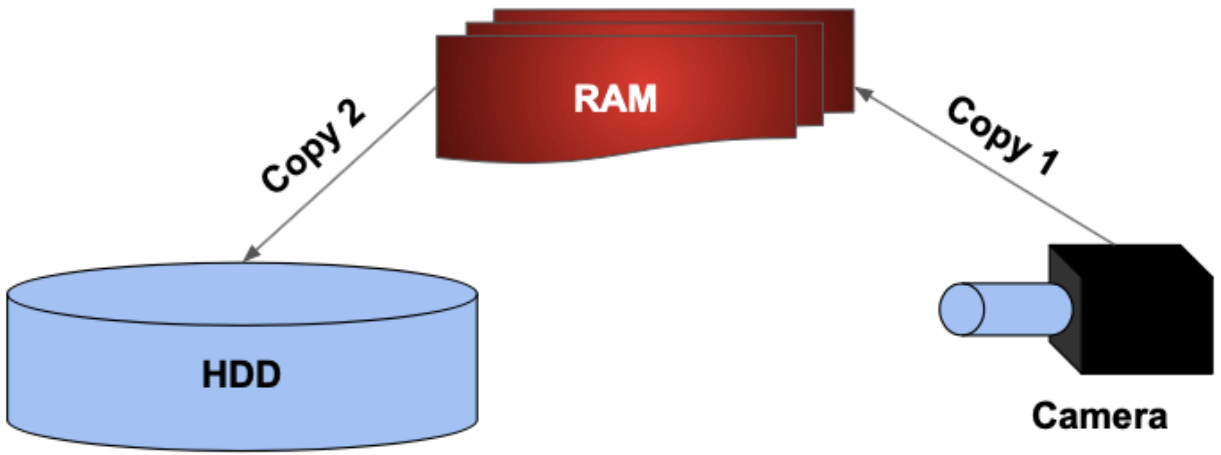
- Adjust camera features as required.
- Set four fiducials of the sensor and start scan.
- Currently takes 1 hr 45 mins to scan 100 mm x 100 mm sensor resulting in 3024 images (~47.5 GB).



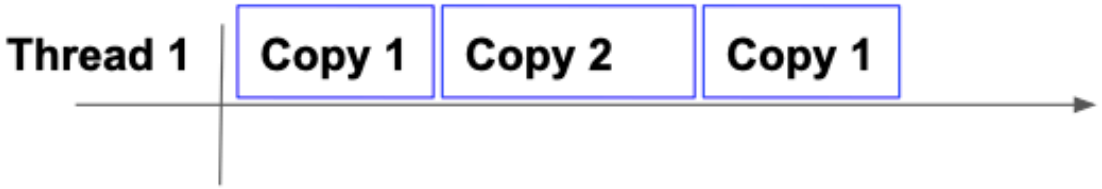


Possible speed improvement:

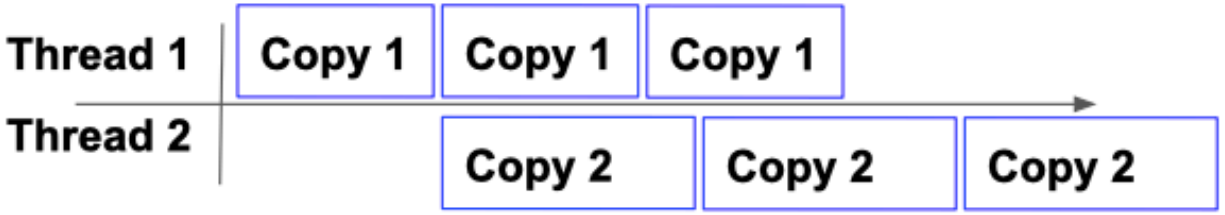
- Performing these copies dominates the scanning time.
- Trivial speed up by building system with SSD and DDR4 RAM with high clock speed.



Current single-threaded approach



Multi-threaded approach, faster but depends on relative time of copies.



*** Not yet implemented ***

Application to MoEDAL:

- To scan both sides of the MoEDAL test samples would take ~ 3 hrs 30 mins.

- Scaling to a 25 cm x 25 cm sample, a scan would take ~11 hrs per side with the current setup resulting in ~300 GB of data (18,900 images).
  [To scan 1m^2 of NDT would correspond to ~4.8 Tb]

- Very high precision stages, in theory can focus onto back/front layer of plastic.

- It's possible to scan the whole sheet with no human intervention (only scanning from one side) but the code would need changing.
  - If the user sets the front and back positions in advance, it could just be programmed into the scan.
  - current stages would cause issue as 150 mm travel range.

- Potentially 1 MoEDAL sample could be scan per day taking ~22 hrs and up to 600 GB.

MoEDAL

Summary:

- ITk visual capture machine is used as part of the quality check process for the new sensors.
- It’s able to scan across a 2D area and capture high resolution images at each step.
- Adjustable camera features.
- Could be adapted to work for image capturing of the MoEDAL experiment.

BACK UP

Lists the off-the-shelf parts required to build one sensor scanner.

Part	Model	Manufacturer	Quantity
Motor controller	C-884.4DC	PHYSIK INSTRUMENTE	1
Long linear stage (X, Y)	M-404.6PD	PHYSIK INSTRUMENTE	2
Short linear stage (Z)	M-404.1PD	PHYSIK INSTRUMENTE	1
Camera	MV-CA050-GC	HIKVISION	1
Lens	MVL-MY-4-110-MP	HIKVISION	1
Flat dome light	SVL-DTL-1010 (WHITE)	MBJ	1
Light mount	SVL-wallmount-flatdome-10	MBJ	1
LED Controller	SVL-CTR-50	MBJ	1

Camera is listed as a 5Mpix camera and is used with x4 lens on this system to get the ~1um resolution that was desired.

Information on the stages.

	M-404.1PD M-404.2PD M-404.4PD M-404.6PD M-404.8PD				
Travel range	25 / 50 / 100 / 150 / 200	25 / 50 / 100 / 150 / 200	25 / 50 / 100 / 150 / 200	mm	
Integrated sensor	Rotary encoder	Rotary encoder	-		
Sensor resolution	4000	2000	-	Cts./rev.	
Design resolution	0.25	0.012	0.16	µm	typ.
Minimum incremental motion	0.25	0.1	0.2	µm	typ.
Backlash	0.5	2	2	µm	typ.
Unidirectional repeatability	0.5	1	1	µm	typ.
Pitch	75	75	75	µrad	typ. over 100 mm
Yaw	75	75	75	µrad	typ. over 100 mm
Velocity	50	1.5	3	mm/s	max.
Reference switch repeatability	1	1	1	µm	typ.