Update

Scott Williams

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Introduction

- IBIC2020
- Software status
- Hardware status

IBIC2020

IBIC2020

- Presented poster at IBIC
- Submitted paper for proceedings of IBIC
- Reference number - THPP35
- Paper, poster attached to agenda
- Closing remarks - Can submit extended version of paper to Physical Review Accelerators and Beams (PRAB), suggested deadline 2020-01-31

Software status

Software status - Update

- Implemented and tested new focal score, both in images from ThomX beamline and Coordinate Measuring Machine (CMM) at University of Melbourne.
- Started setting up automatically generated software documentation. Still plan to do out of source documentation as well.
- Planning to open source after further tidying, testing.
- Analysis software tested on ThomX control room, still working on getting it fully working and tested for all users/configurations.

Software status - Prospects

To do:

- Integrate analysis software with rest of Tango controls - ie. Running as part of overall machine daily calibration
- Finish documentation, instructions, manuals etc

Hardware status

Hardware status - Update

- Nicolas and Alexandre have set up the lens control system in situ at ThomX
- Lenses can be remotely and manually controlled from control room!
- The lenses have been focused manually from the control room!
- Autofocusing still to be implemented.
- Aperture has been adjusted, but we haven't visibly seen improvements in depth of field - more analysis required

Lens focus movement and autofocusing

Focus movement - Introduction

- To focus the lens onto the screen we will need to scan the lens across a series of points, take images, and determine which is the most in focus.
- Focus scores tested in situ at ThomX and on a Coordinate Measuring Machine (CMM) at the University of Melbourne. The CMM was used to check what an ideal case where the imaging plane is parallel to the camera sensor plane.
- Different focus scores have been tested, Fourier filtering and comparing the ratio of the image pixel intensity after applying a high pass convolution to the original (equation one of Shen, Hodgson, and Hahn 2006)

Focus movement - Introduction

- Equation 1 of Shen, Hodgson, and Hahn 2006 was fairly effective and straightforward. This score is given by:

$$F(z) = \frac{\sum_x \sum_y \left[f(x,y) \bigotimes i_z(x,y) \right]^2}{\sum_x \sum_y \left[i_z(x,y) \right]^2}$$

Where $i_z(x,y)$ is the pixel intensity at point (x,y), and $f(x,y)$ is a high pass filter, which we took from Shen, Hodgson, and Hahn 2006 as:

$$\begin{bmatrix} -1 & -2 & -1 \\ -2 & 12 & -2 \\ -1 & -2 & -1 \end{bmatrix}$$

- Convolution with filter can be seen as intensity of pixel minus the average surrounding pixel intensity
- Advantage/disadvantage: No tuning of Fourier window/frequency selection. Makes it straightforward to implement, but we can't broaden response window easily (to be discussed shortly)

Focus movement - Tracking focus score on CMM

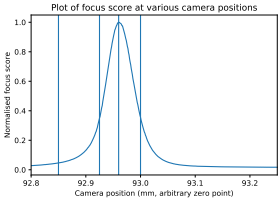
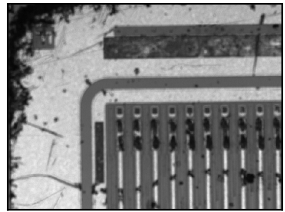


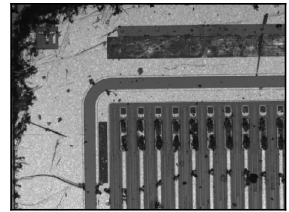
Figure 1: Focus score computed at various CMM camera positions

Position summary (CMM)

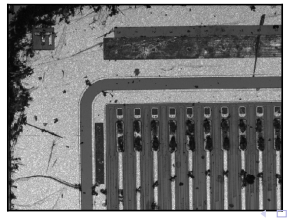
Position: 92.8(mm)



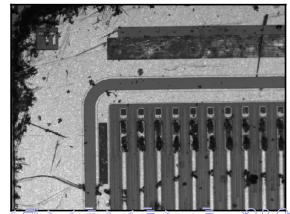
Position: 92.925(mm)



Position: 92.96(mm)



Position: 93.0(mm)



Focus movement - Tracking focus on pictures taken using ThomX cameras

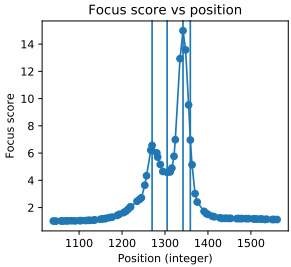
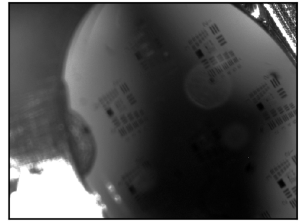
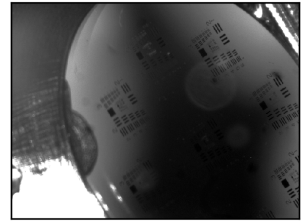


Figure 2: Focus score computed at various ThomX lens positions

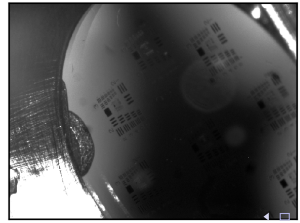
Position: 1270



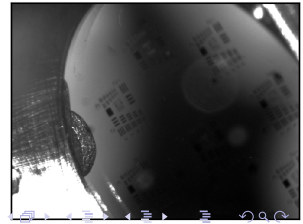
Position: 1305



Position: 1342



Position: 1359



Focus movement - Conclusion

- Focus score used gives good quantitive measure of whether image is in focus
- Can still have issues with focusing on different parts of image, masking required
- As seen in figures 1, 2 we have a very narrow peak. This could lead to a long time to autofocus if we are required to scan many points. Nicolas has posited that using a Fourier ratio method we could do a broad based scan, find the approximate location of peak(s) and then scan on a finer interval.
- Scan time dominated by moving the lens and image acquisition
- Focusing time could also be increased by using a lookup table as an estimate of where to scan first

Hardware status - prospects

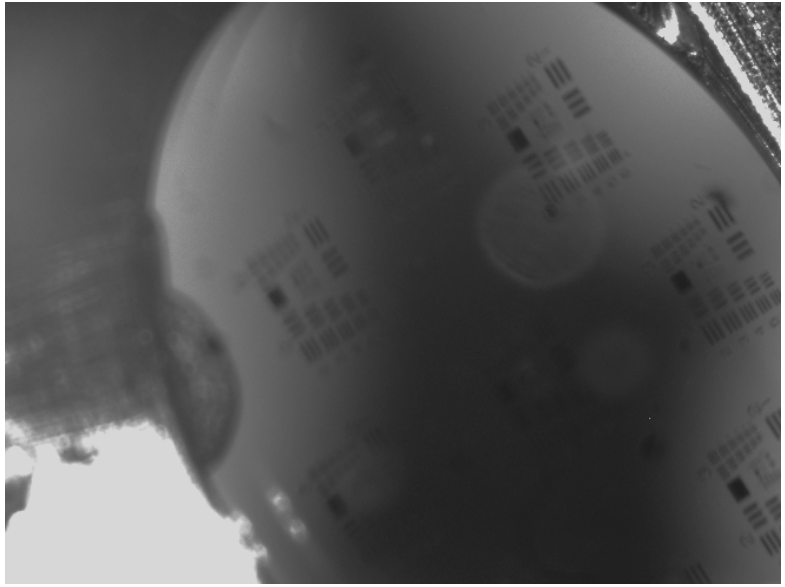
- Upon reflection of discussions during IBIC2020, there is some interest in further documentation or instructions in how best to connect to and control lenses
- It is still unclear how small the aperture would have to be to eliminate depth of field effects - Another aperture scan will be done.
- Also planning to see if depth of field can be measured/quantified with a lens focus scan

Overall conclusion

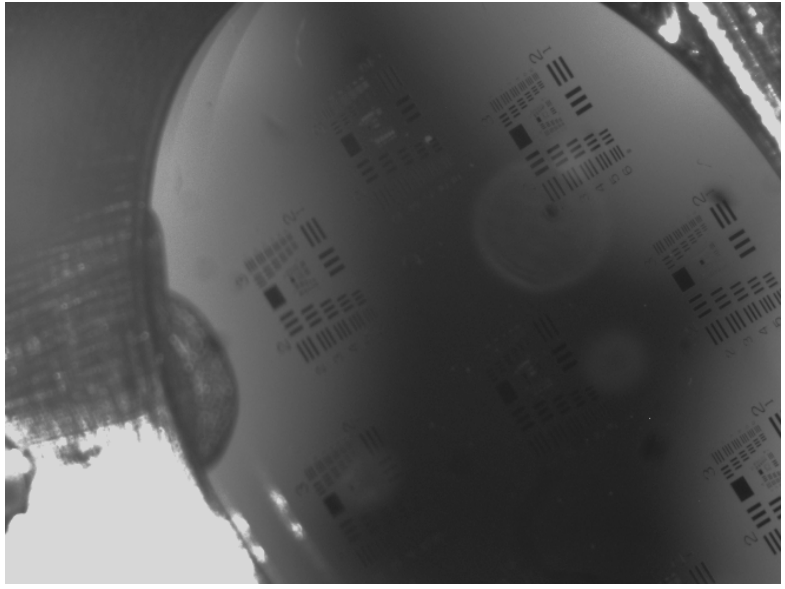
- Presented work at IBIC2020
- Moving to document software
- Lens control and autofocus being implemented in ThomX, still to be optimised

Backup

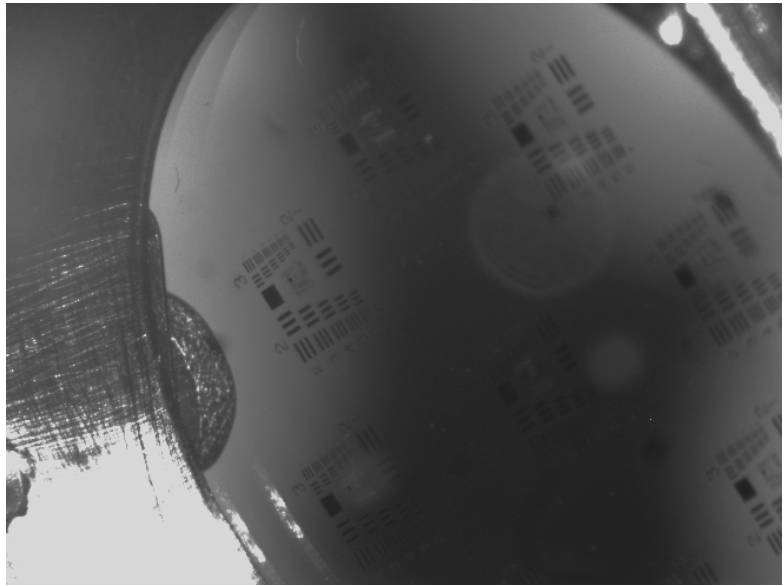
ThomX cameras - position 1270



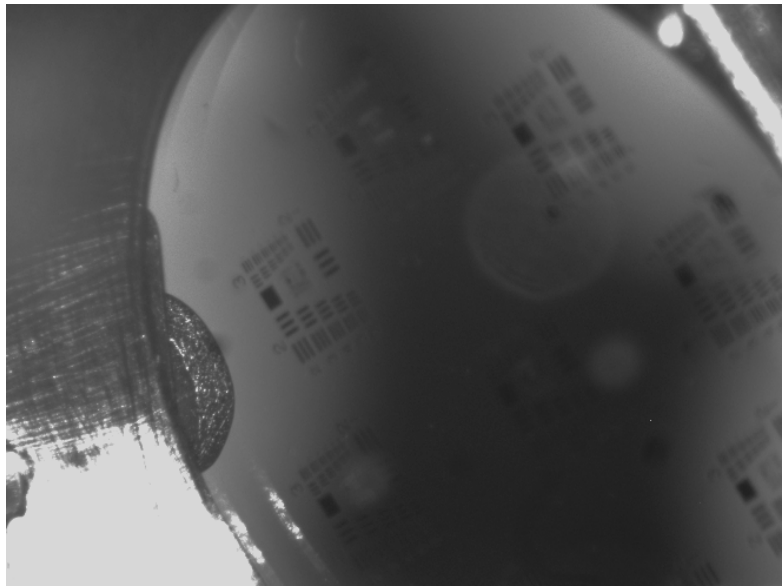
ThomX cameras - position 1305



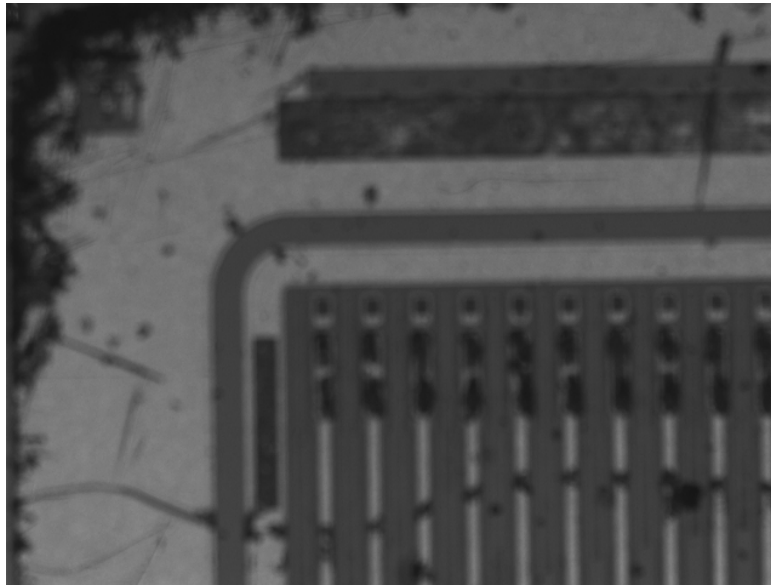
ThomX cameras - position 1342



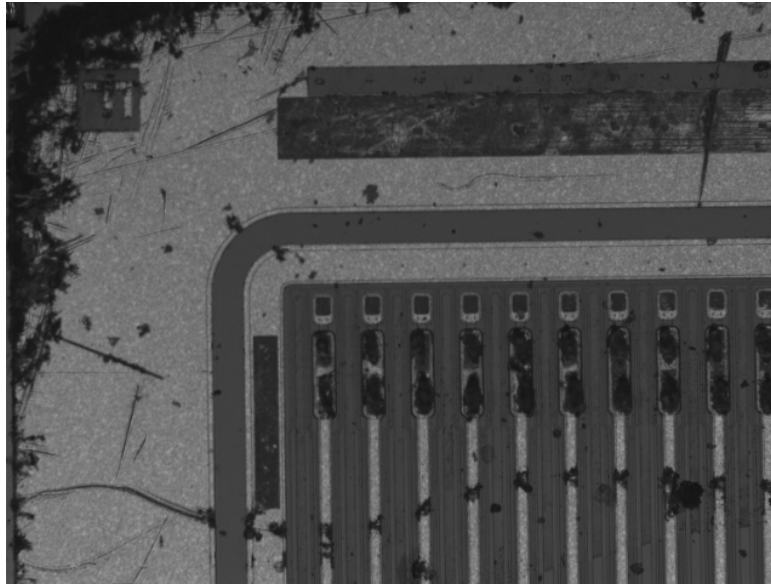
ThomX cameras - position 1359



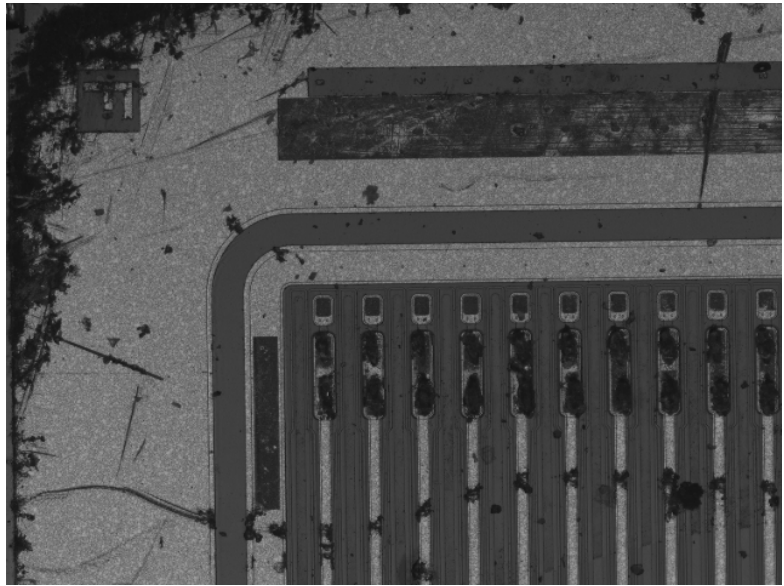
CMM - Position 92.8



CMM - Position 92.925



CMM - Position 92.960



CMM - Position 93.000