

Imaging Challenges at Diamond



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Bath 28th Jan – 1st Feb 2019

Drift, alignment and other problems...

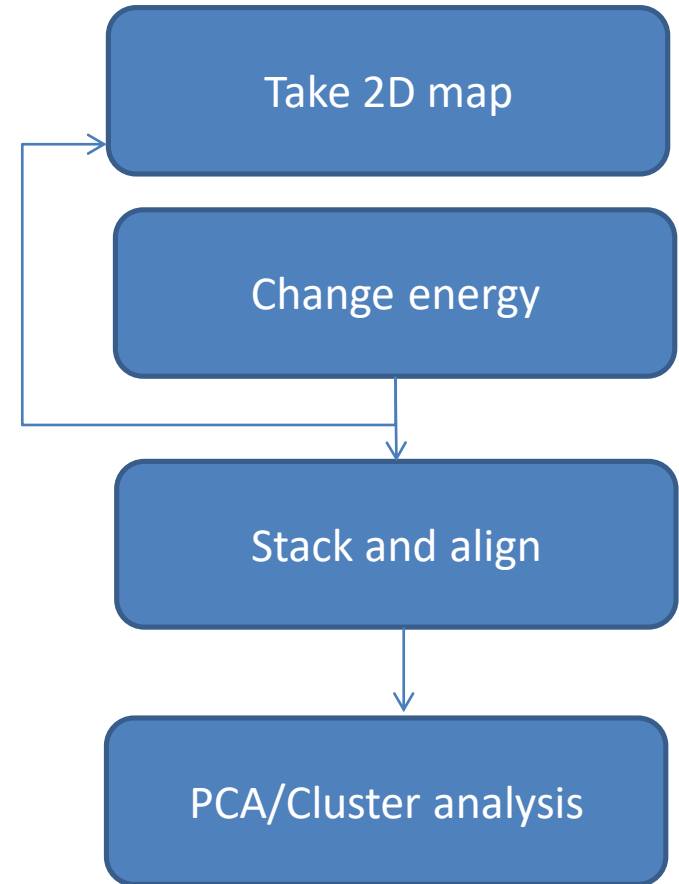
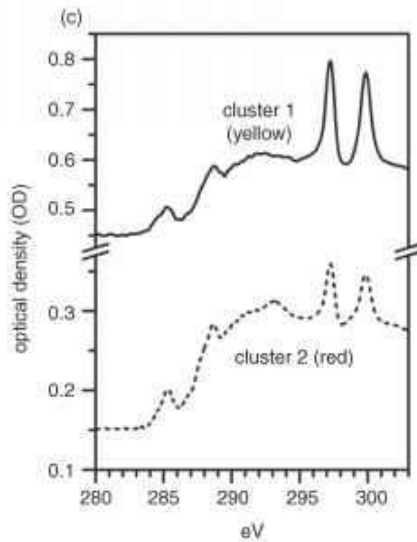
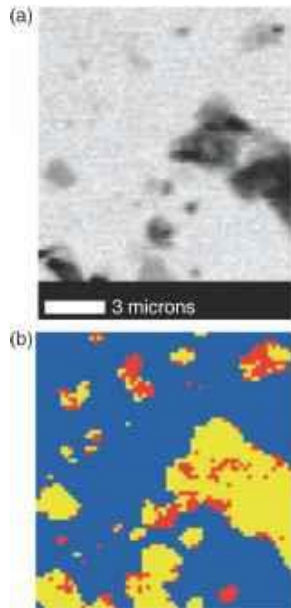
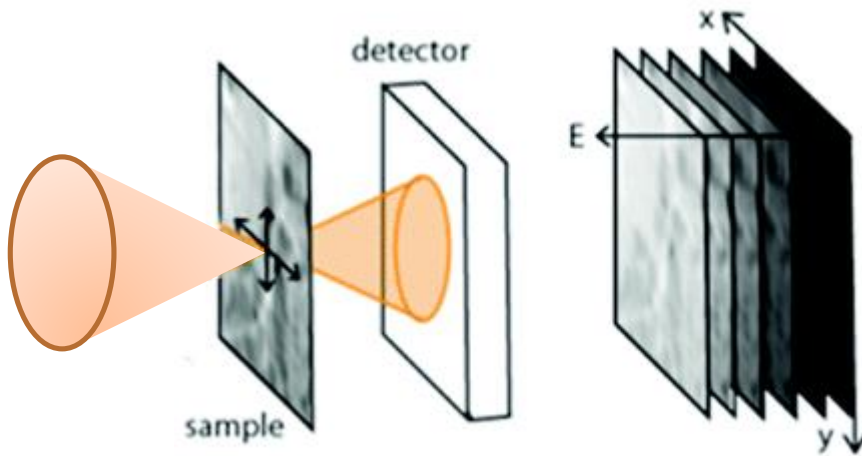
Science focus:

- Sources
- In-situ experiments

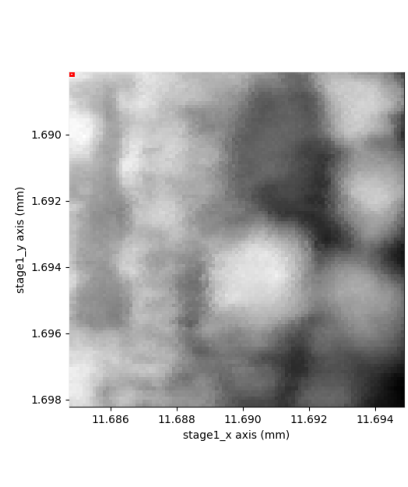
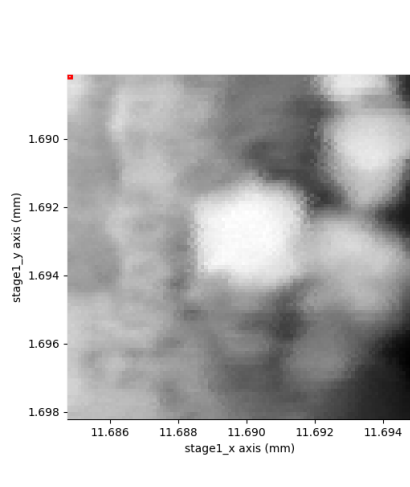
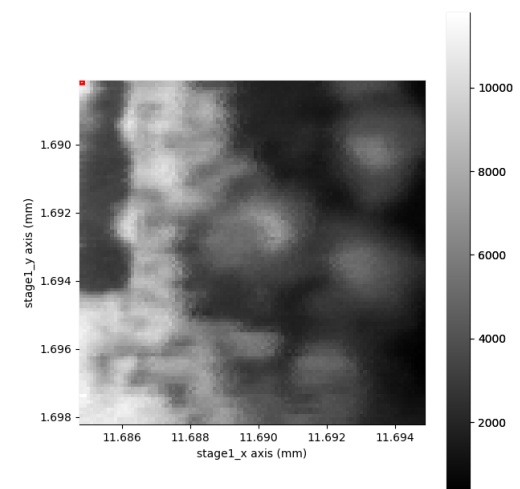
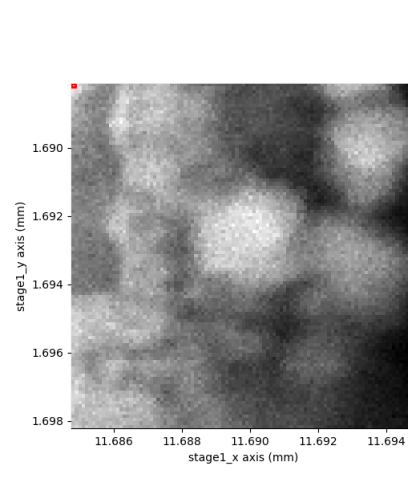
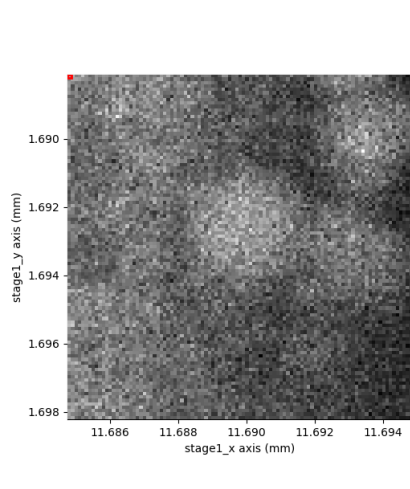
Imaging Experiments at Diamond:

- Overview of a scanning experiment
- Overview of a 3D and 4D tomography experiment
- Challenge - how can make experiments faster with sampling.

Hyper-spectral data



Example images



Data quality...

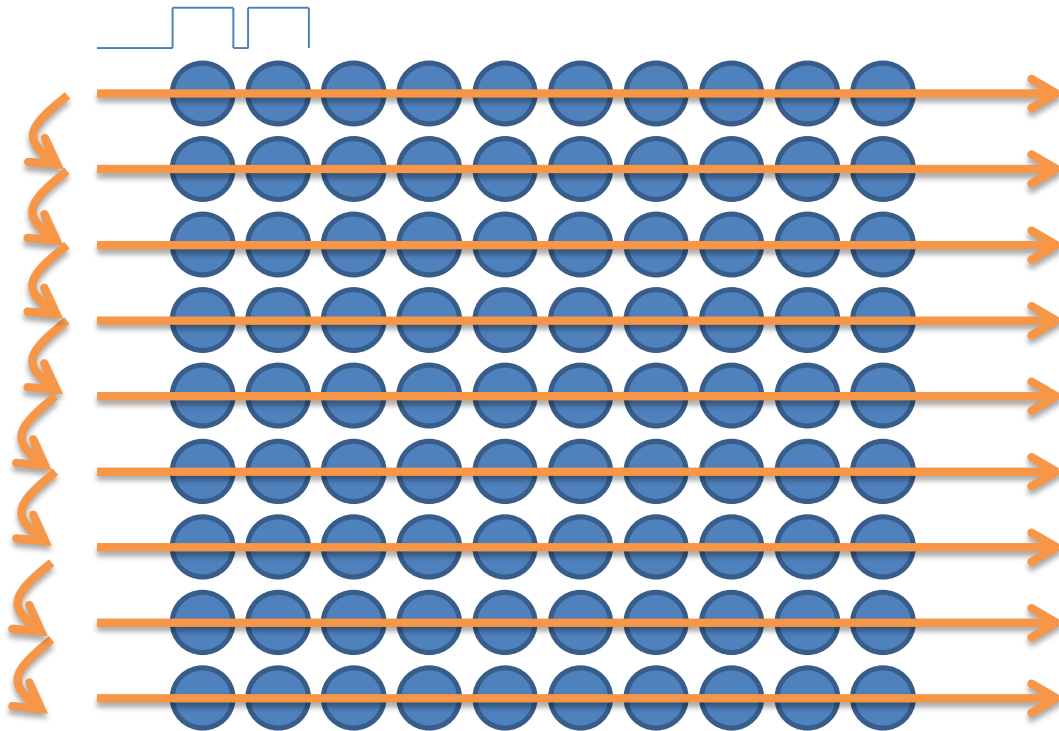
- The result depends on the alignment of the stack
 - Misaligned –
 - extra PCA components
 - Spikes, slopes
 - Missed/blended features
- Image alignment ?
 - FFT
 - Depends on structure
 - Never really works for small images - e.g. 30x30 pixels ?
 - Intensity
 - Manual
 - Often still needed

Data quality...

- We know if the alignment is good by the PCA result
 - Can we align data based on reducing the number of PCA components found or reducing noise?
 - Producing best result rather than relative image comparisons ?
 - Dealing with motion drift...

X-ray scanning experiment :

Current experiment....



Slow drifts

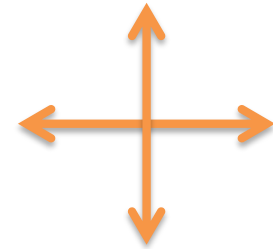
Image offset

Fast scanning direction

Row shift horizontally

Slow scanning direction ?

Compress or vertical row shift?



In-situ corrections

- If the sample is going to drift I have to make the scan area big enough to compensate - wasted time !
- How can I track/compensate the drift during the experiment ?
 - Most reliable way to track and correct motion to minimize scan area and post experiment corrections ?
 - Prediction method ?

Nano-tomography

Conventional tomography

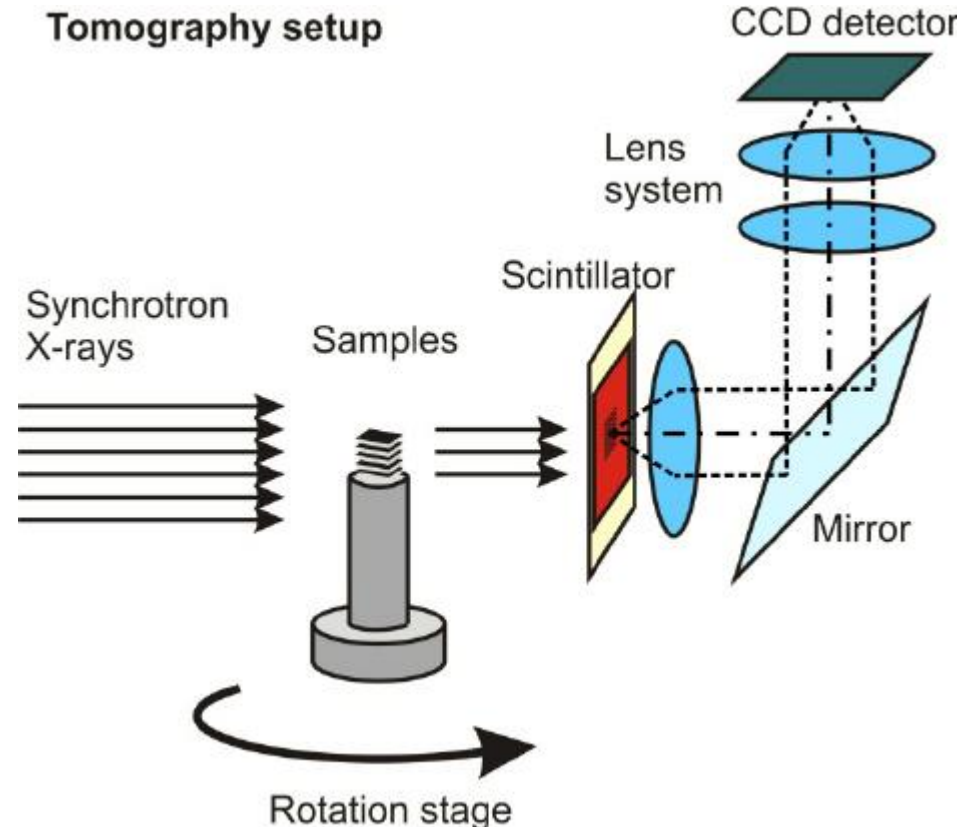
10's micron resolutions

- Rotate the object about centre of rotation
- Alignment issues around wobble slight movements
- Most rotation stages have eccentricity or wobble by 1-5 μ m.

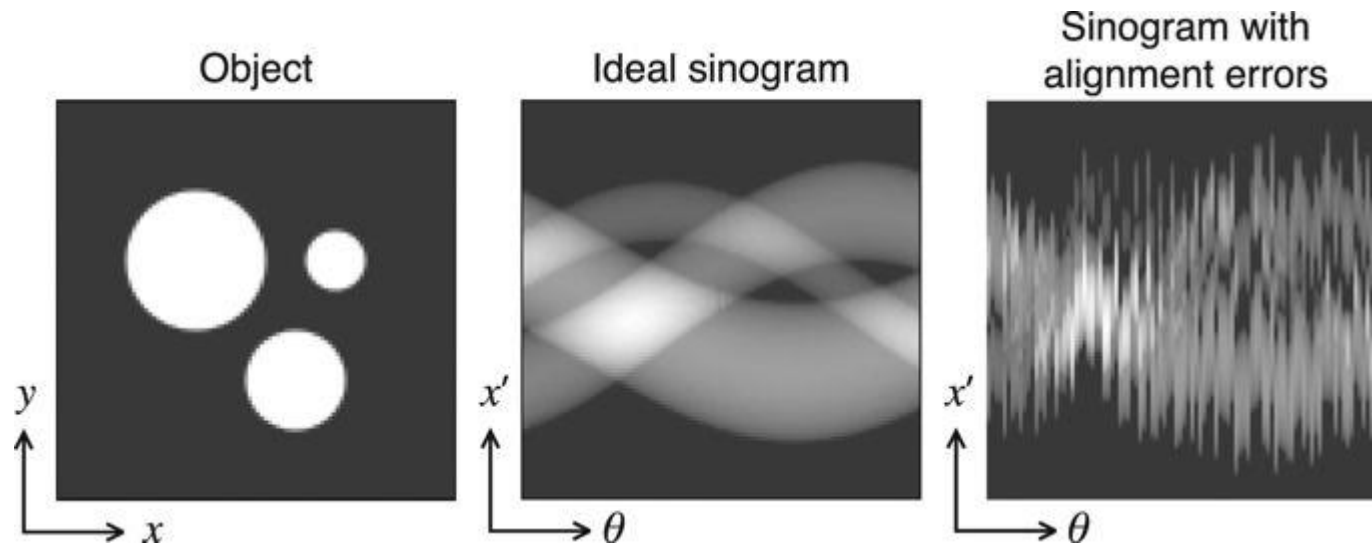
Nano-tomography

- Scan range at each angle is 10 μ m
- Uncertainty in stage position is a few μ m

Alignment of all images to a centre of rotation is more challenging....



Nano-tomography



Inverse problem – but how to align the data to get a good result

Context...

- Diamond generates several petabytes data a year
- Some experiments (AM) – several hundred Tb's
- Scientist should worry about what image means not how to align, remove noise etc.
- 2 years from taking data to publishing
- Data rates increasing $> \times 2$ every 6 months
 - Building a backlog !