

Muscles and tracheal network *during flight*

NewScientist Life

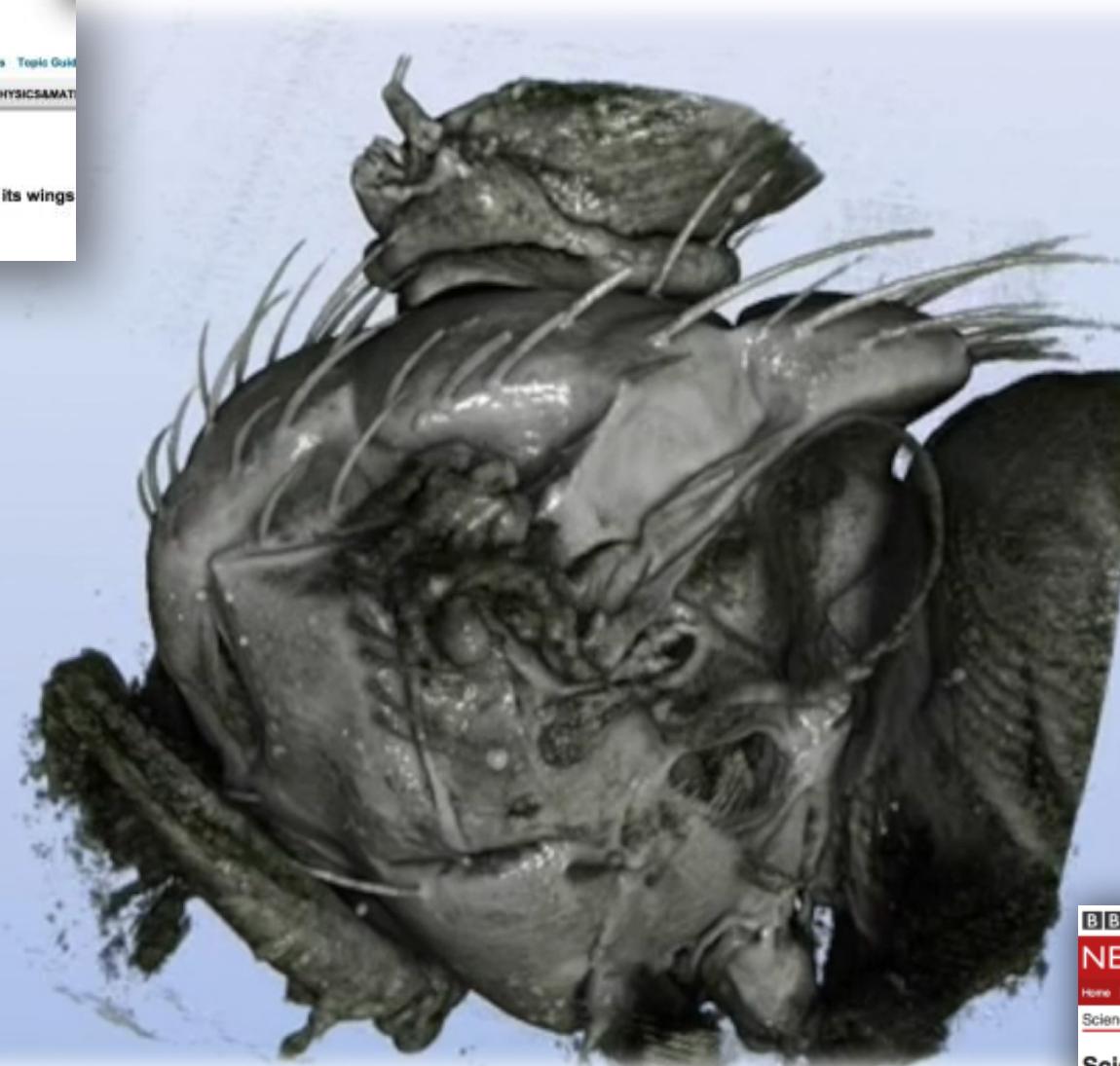
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Surreal X-ray movie reveals how a fly beats its wings

| 21:00 25 March 2014 by Jacob Aron
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Walker et al., PloS Biology (2014) & Mokso et al., SciRep (2015)

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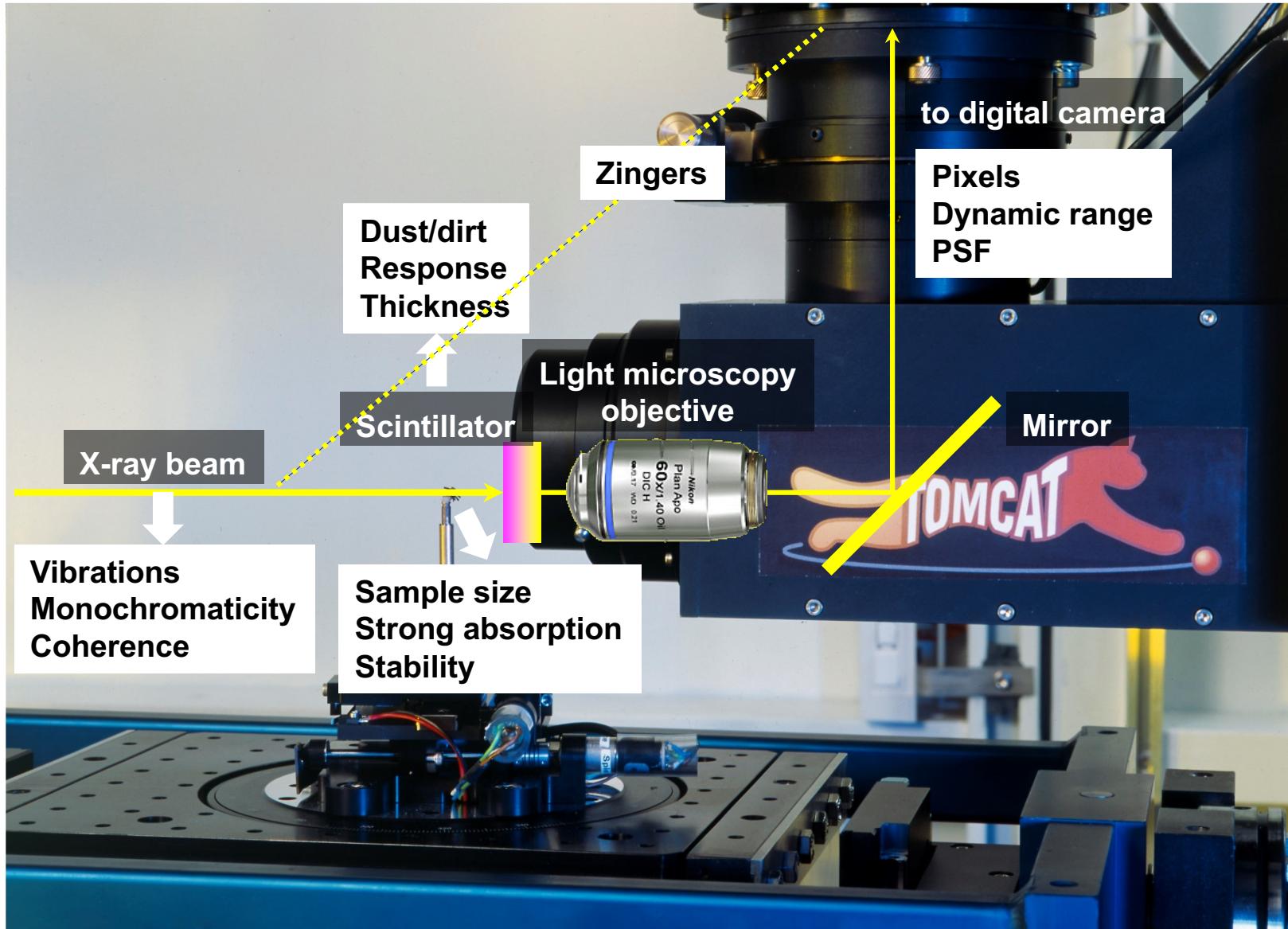
Scientists film inside a flying insect

By Victoria Gill
Science reporter, BBC News

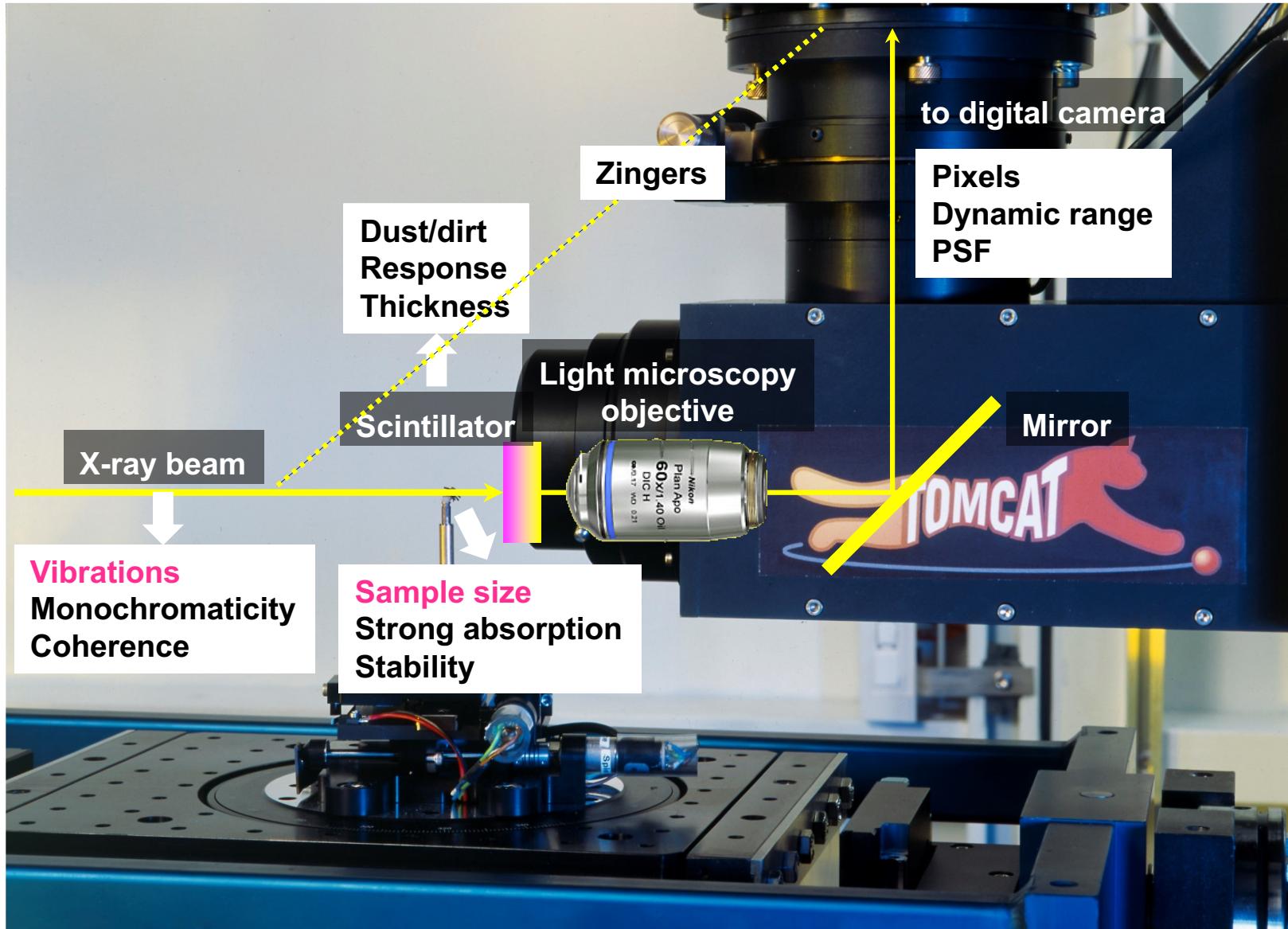
26 March 2014 Science & Environment

Practical issues

Practice – Standard microtomography setup



Practice – Standard microtomography setup



Flat field correction

- Beer-Lambert law

$$\text{Measurement} \rightarrow I(E) = I_0(E) e^{-\int \mu(E) dl}$$

Flat field
correction

$$-ln \frac{I(E)}{I_0(E)} = \int_L \mu(E) dl$$

Flat field correction

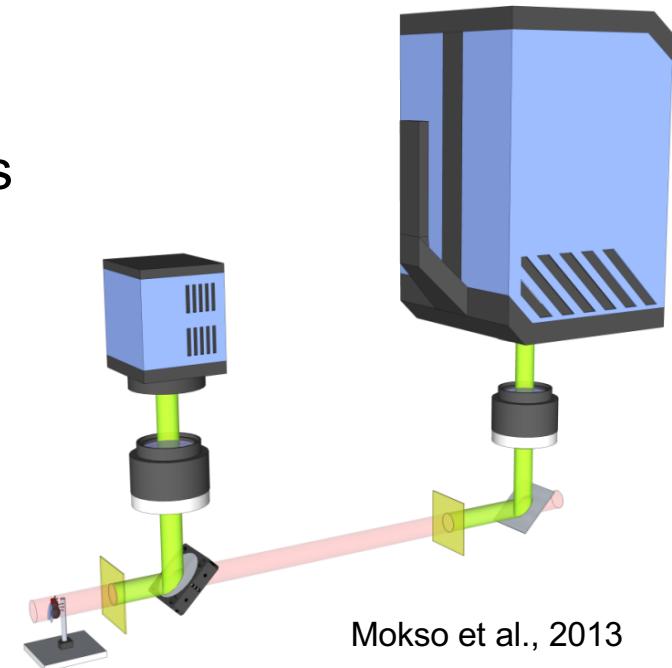


Exposure time: 1 ms
Frame time: 25 fps (40x slower)

Flat field correction

- Resulting artifacts
 - Ring/band artifacts
 - Non-quantitative
 - Resolution degradation

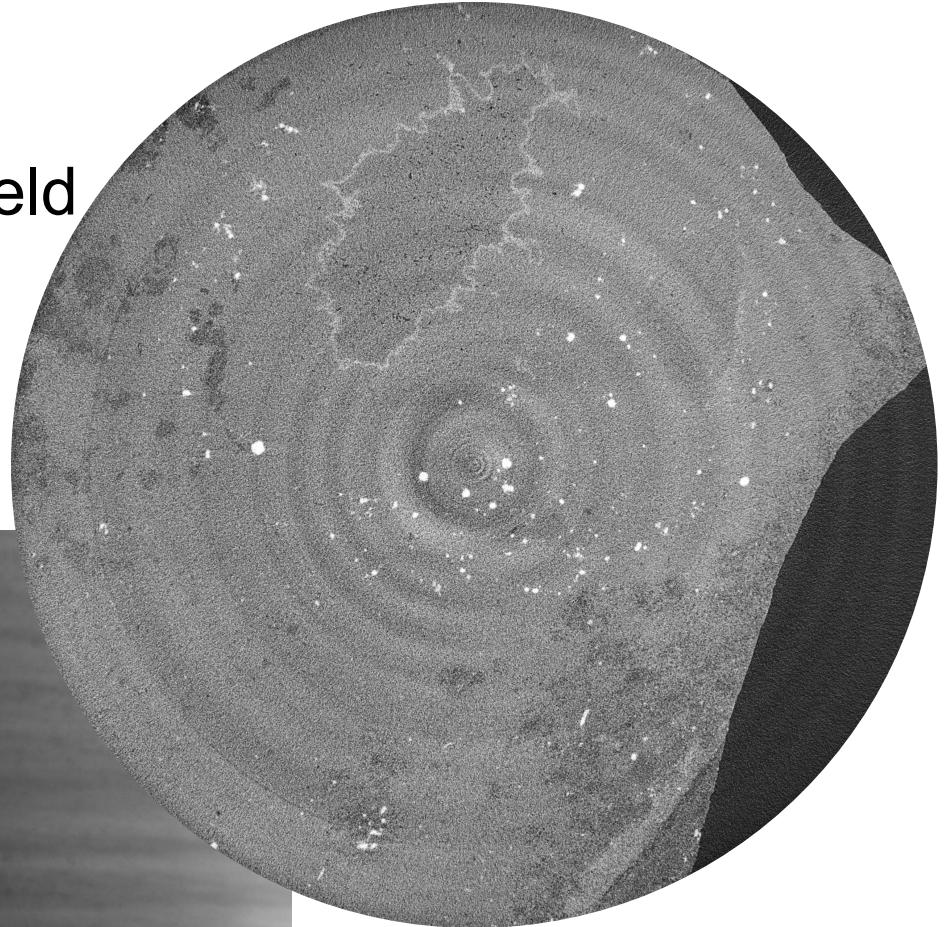
- Solutions
 - Average flat-field or intermediate flat-fields
 - Flat-field tracking
 - Adaptive time-dependent normalization
Titarenko et al., 2010
 - Dynamic intensity normalization using eigen flat field
Van Nieuwenhove et al., 2015
 - Dual camera acquisition



Flat field correction

- Correction with average flat field

- 100 flat field images
- 40 keV



Courtesy of S. Bengtson

Flat field correction

- Dynamic intensity normalization using eigen flat fields
 - Principal Component Analysis of flat fields
 - Selection of most important eigen flat fields
 - Projection specific flat field as linear combination of most important eigen flat fields.

Van Nieuwenhove at al., 2015

Flat field correction

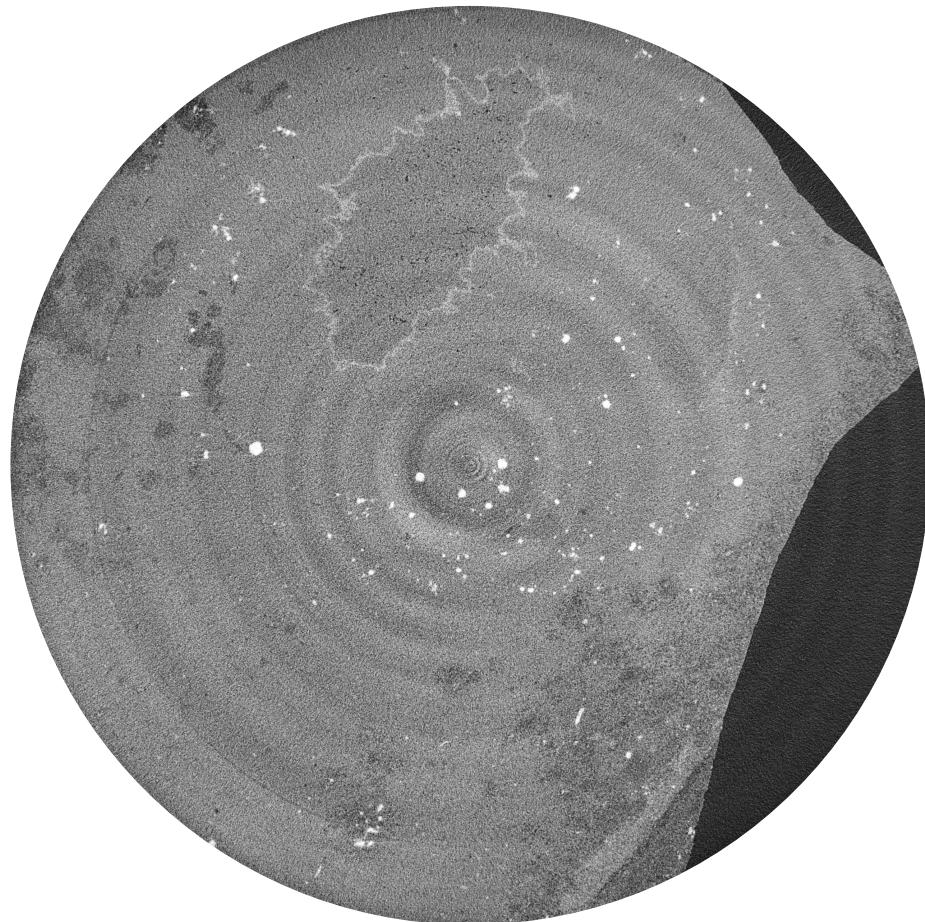
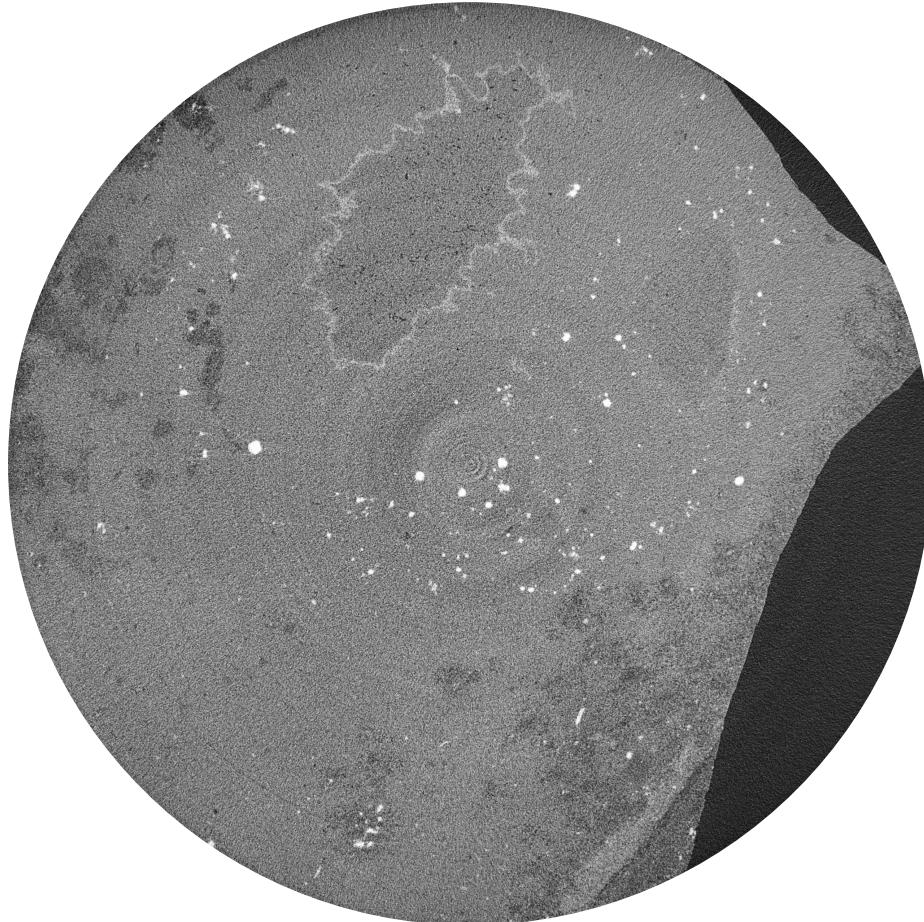
- Dynamic intensity normalization using eigen flat field



Courtesy of S. Bengtson

Flat field correction

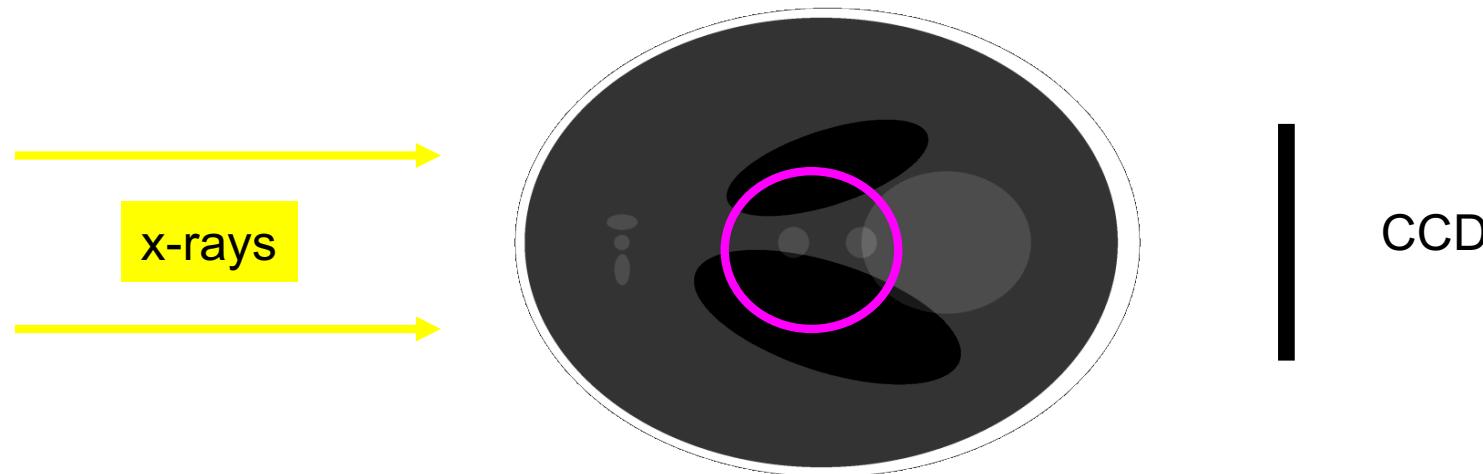
- Dynamic intensity normalization using eigen flat field



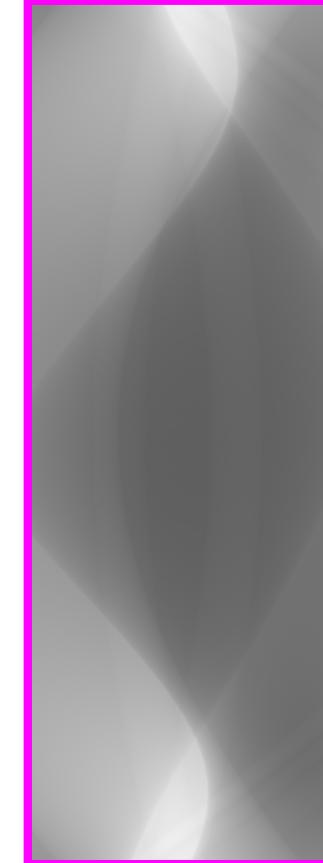
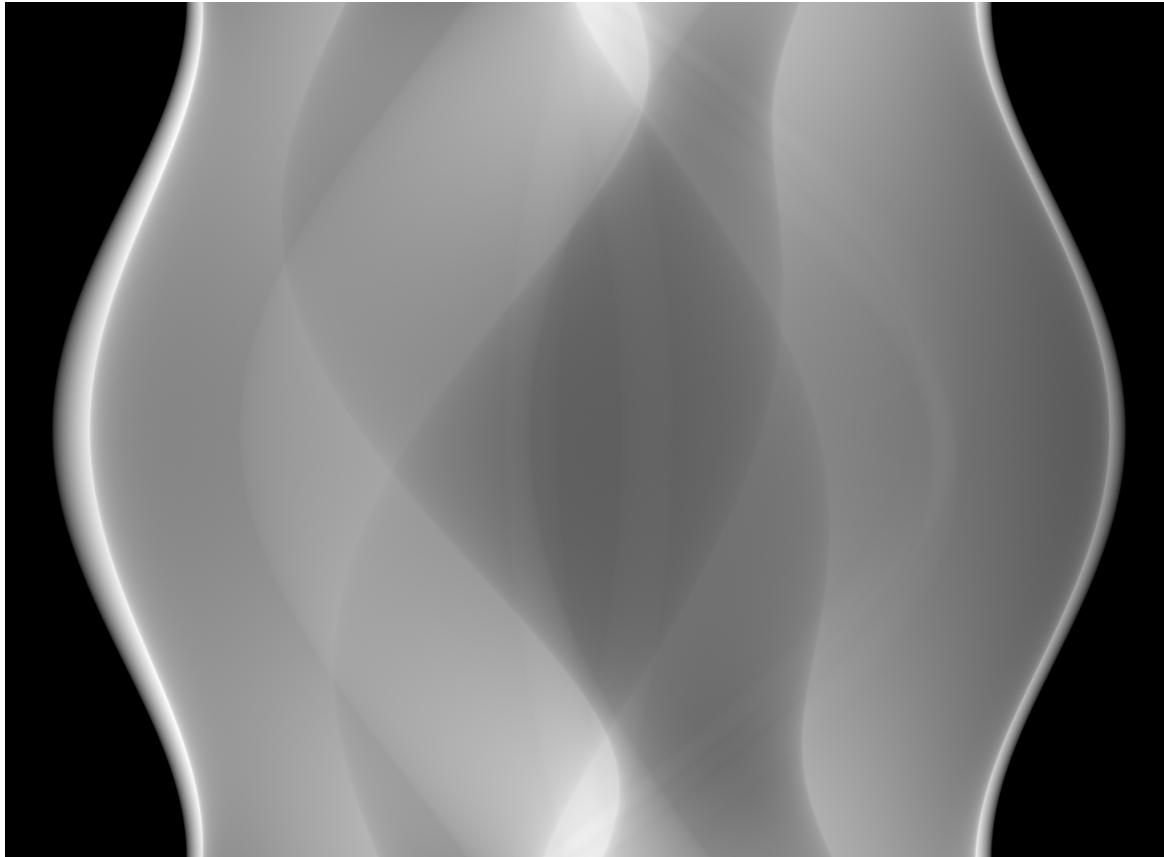
Courtesy of S. Bengtson

Local tomography artifacts

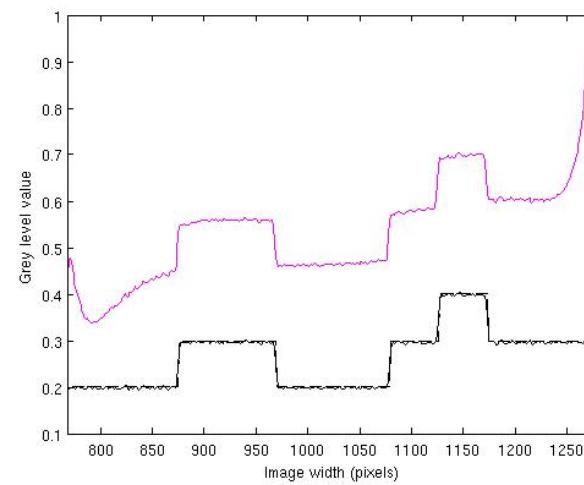
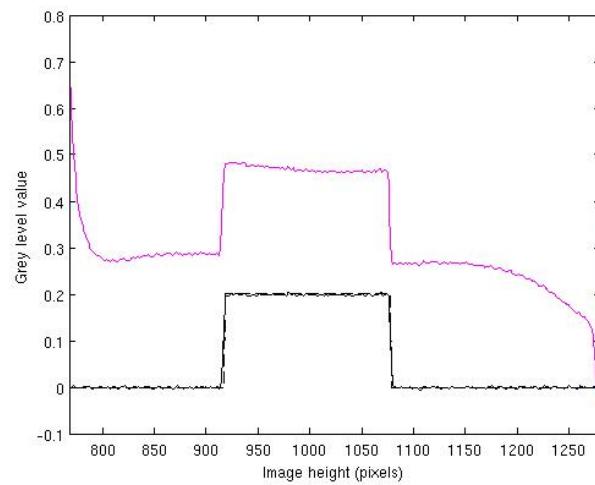
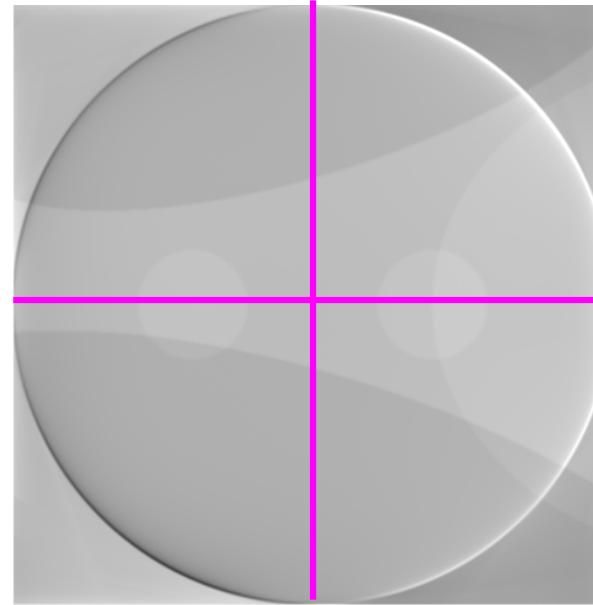
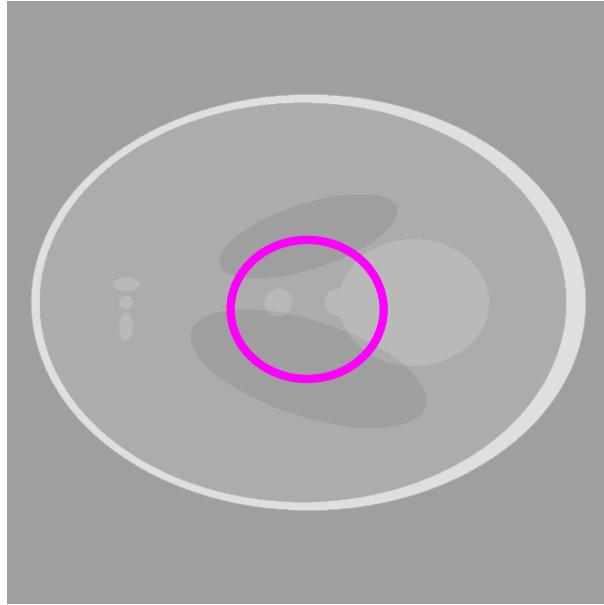
- Large object at low resolution – insufficient resolution for features of interest
- Tesselation – time consuming, computationally heavy
- Larger detectors – expensive, inefficient
- Ill-posed reconstruction problem



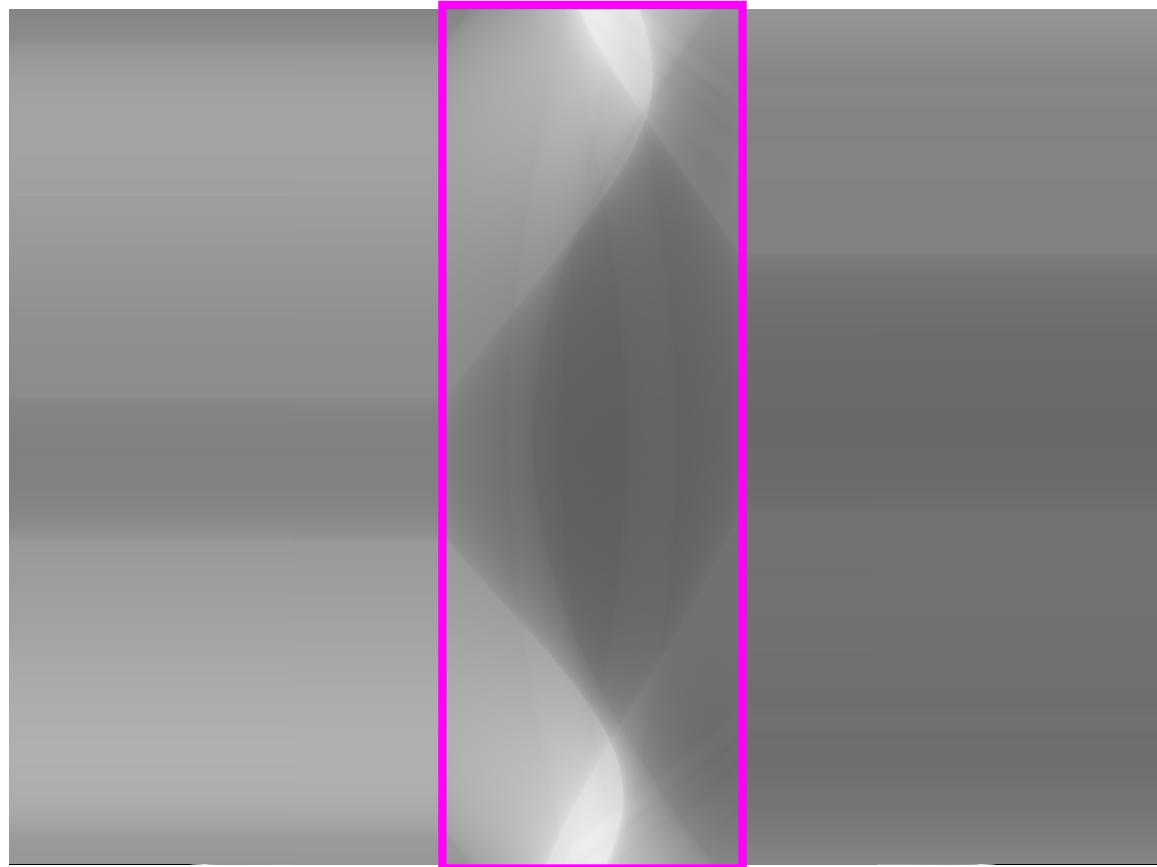
Local tomography artifacts



Local tomography artifacts

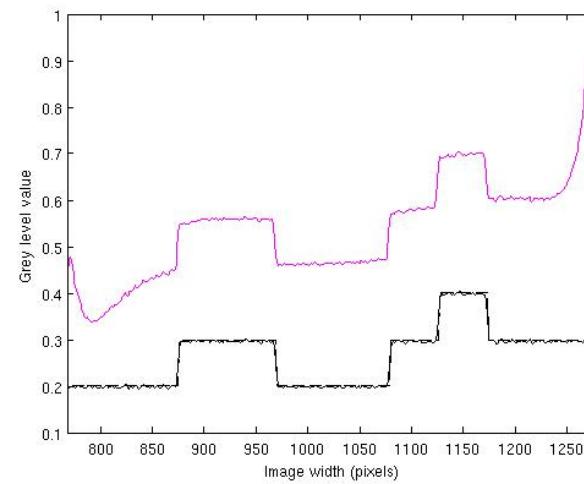
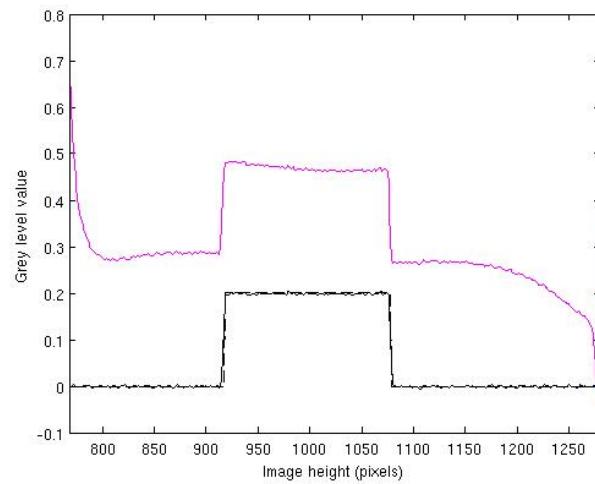
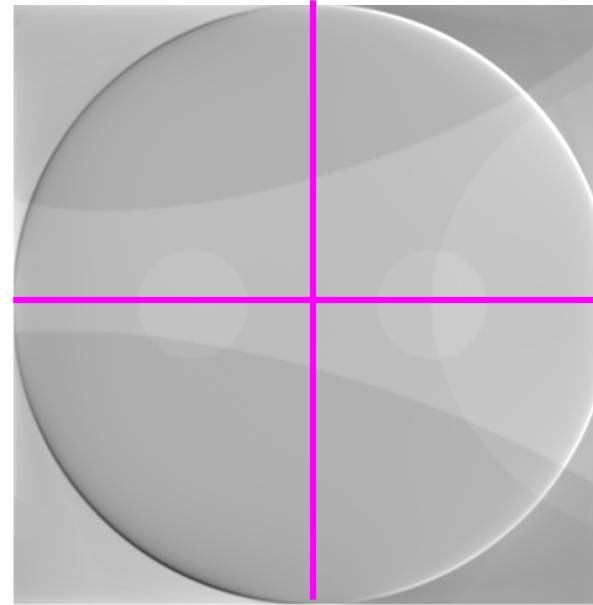
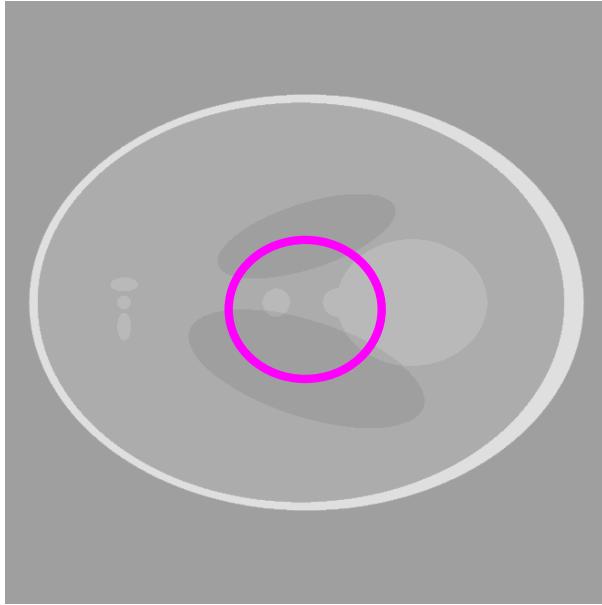


Local tomography artifacts

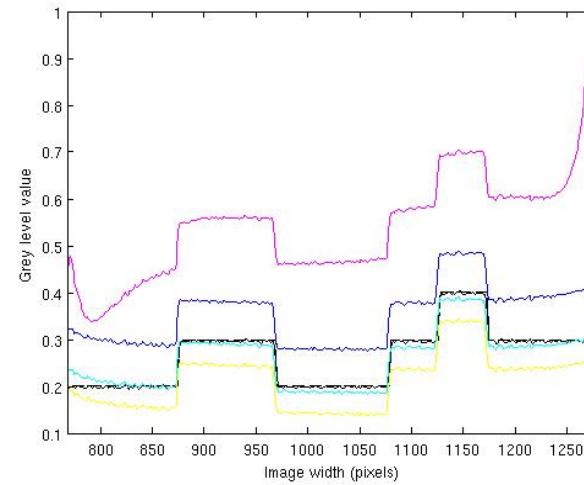
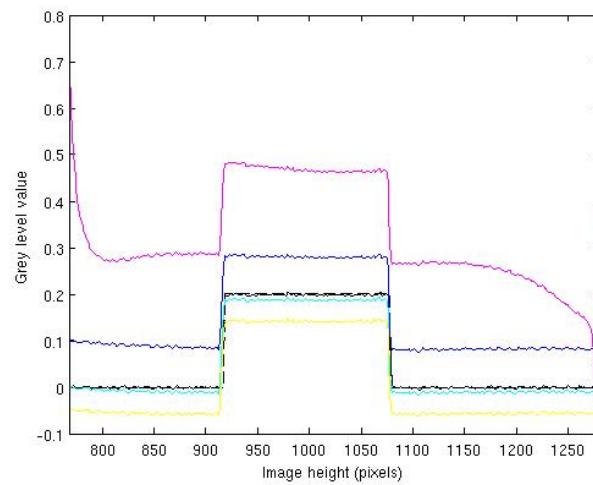
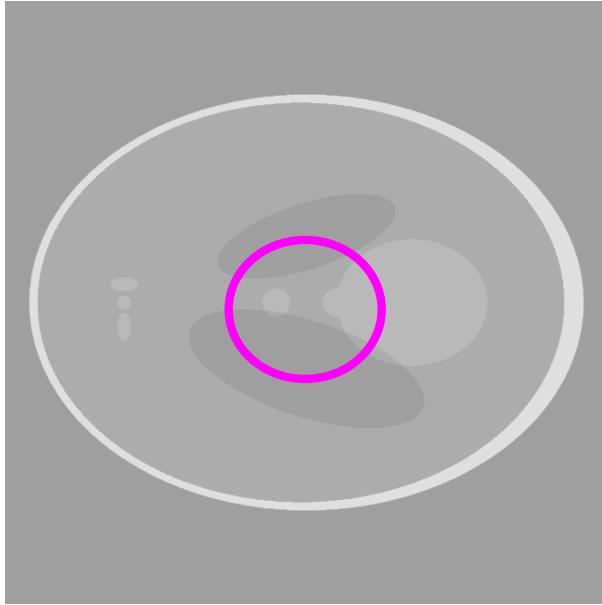


Marone et al., SPIE, 2010
Kyrialeis et al., J. Microscopy, 2010

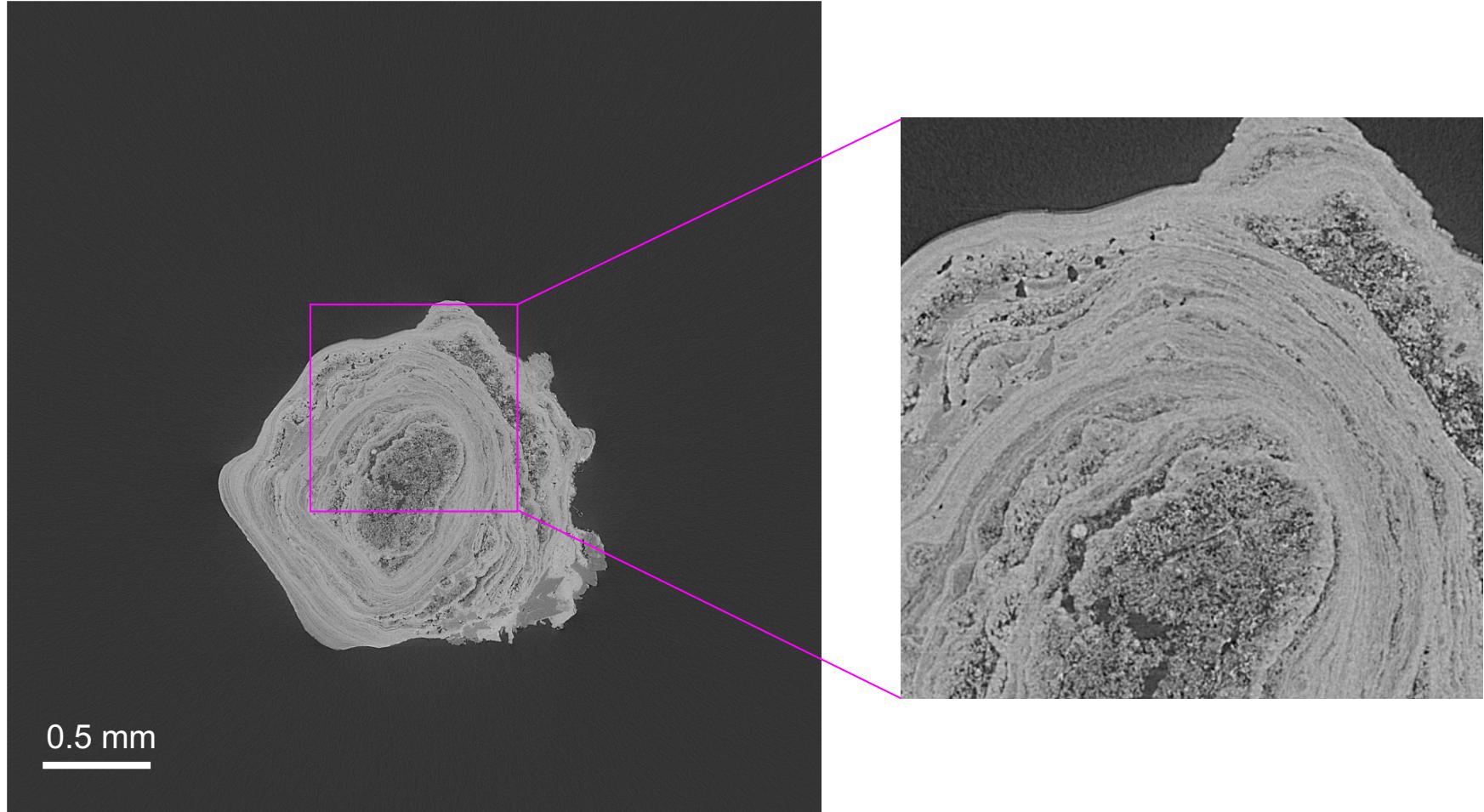
Local tomography artifacts



Local tomography artifacts



Local tomography artifacts



Marone et al., SPIE, 2010