



**“1B\_PC.avi”, “2B\_PC.avi” & “3B\_PC.avi”**

- **1024  $\mu\text{m}$   $\times$  1024  $\mu\text{m}$**
- **Al 0.1 mm**
- **$R_1 = 20$  m (1B), 34 m (2B) & 138 m (3B)**
- **$\sigma_d = 5$   $\mu\text{m}$ ,  $\sigma_{s,h} = 320$   $\mu\text{m}$  &  $\sigma_{s,v} = 16$   $\mu\text{m}$**
- **25 keV**

# Phase retrieval: Phase contrast CT, and alternative reconstructors

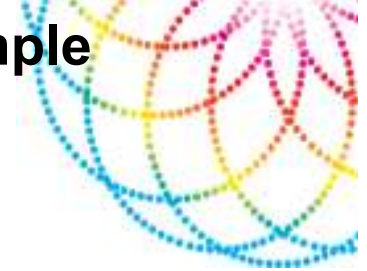


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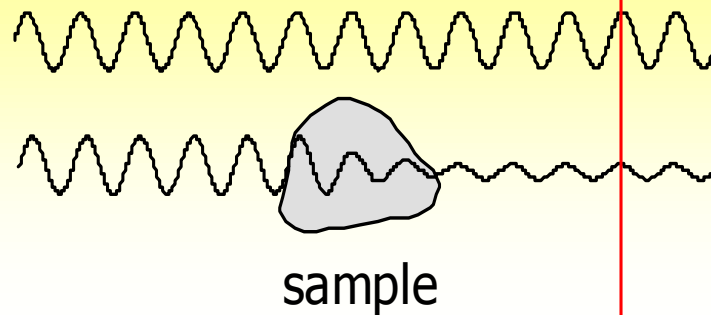


CT@IMBL workshop – 21<sup>st</sup> March, 2017

wave-optics picture of X-ray beam passing through a sample  
where only absorption or only phase effects occur -  
X-ray refractive index given by  $n(\lambda) = 1 - \delta(\lambda) - i\beta(\lambda)$



Absorption ( $\beta$ )

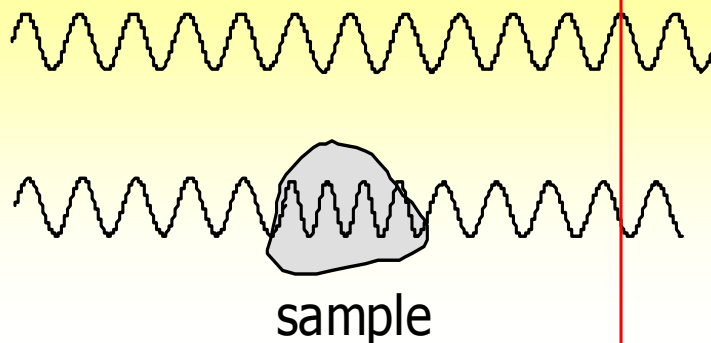


reference wave

pure absorption

sample

Phase Change ( $\delta$ )



reference wave

pure phase  
change

sample

$$\mu = 4\pi\beta/\lambda$$
$$\sim O(\lambda^3)$$

$$\Phi = -2\pi\delta/\lambda$$
$$\sim O(\lambda)$$

# absorption and phase data for Carbon



| E(keV) | $\lambda(\text{\AA})$ | $t_a(\mu\text{m})$ | $t_p(\mu\text{m})$ |
|--------|-----------------------|--------------------|--------------------|
| 0.25   | $\sim 50$             | 1.3                | 1.2                |
| 1.2    | $\sim 10$             | 4                  | 3                  |
| 12     | $\sim 1$              | 5000               | 30                 |
| 50     | $\sim 0.25$           | 435,000            | 133                |

$\mu$  = linear absorption coefficient

$\phi$  = phase difference/unit length

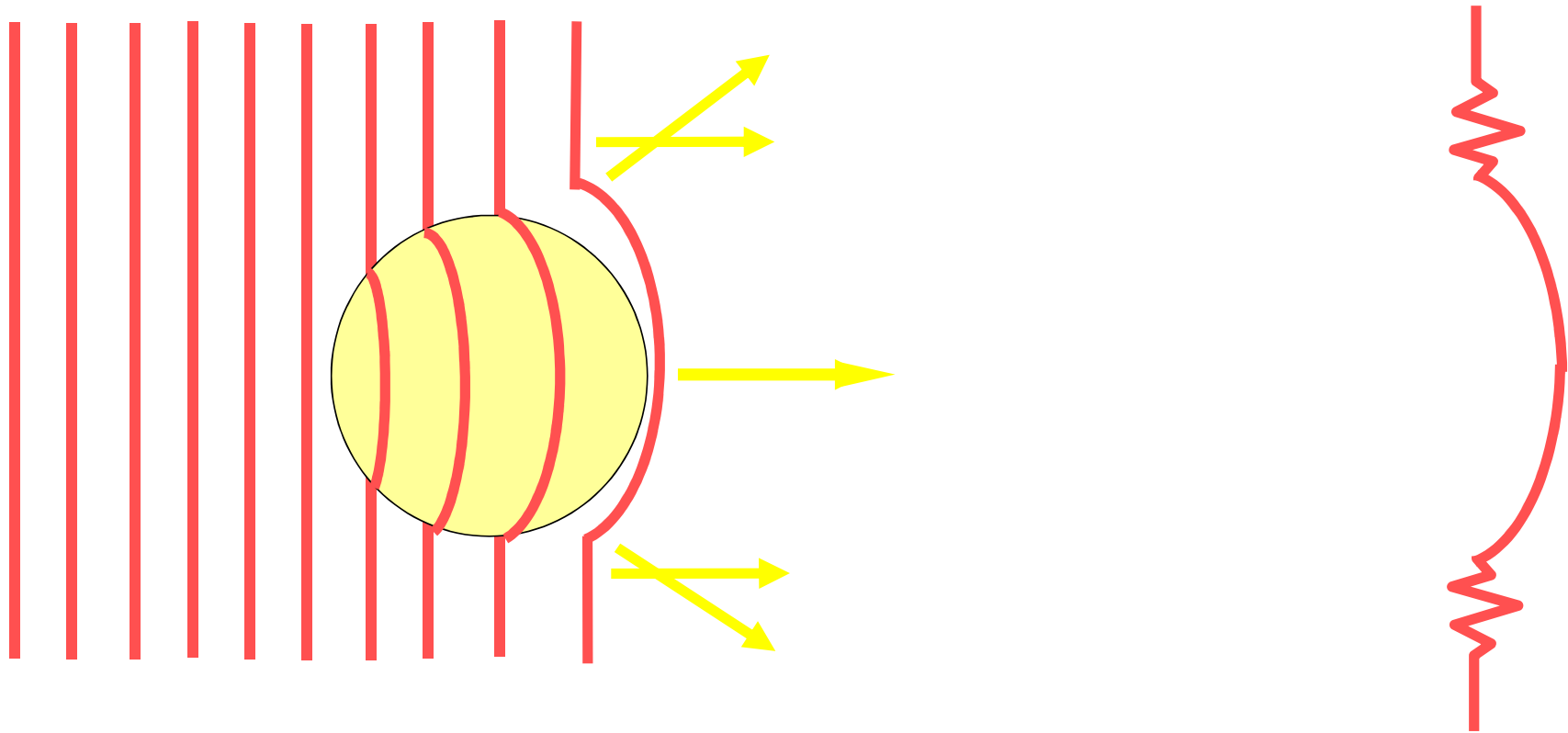
absorption thickness  $t_a \mu = 1$

phase thickness  $t_p \phi = 2\pi$

# phase-contrast mechanism



**A phase gradient represents a change in direction of propagation ...**

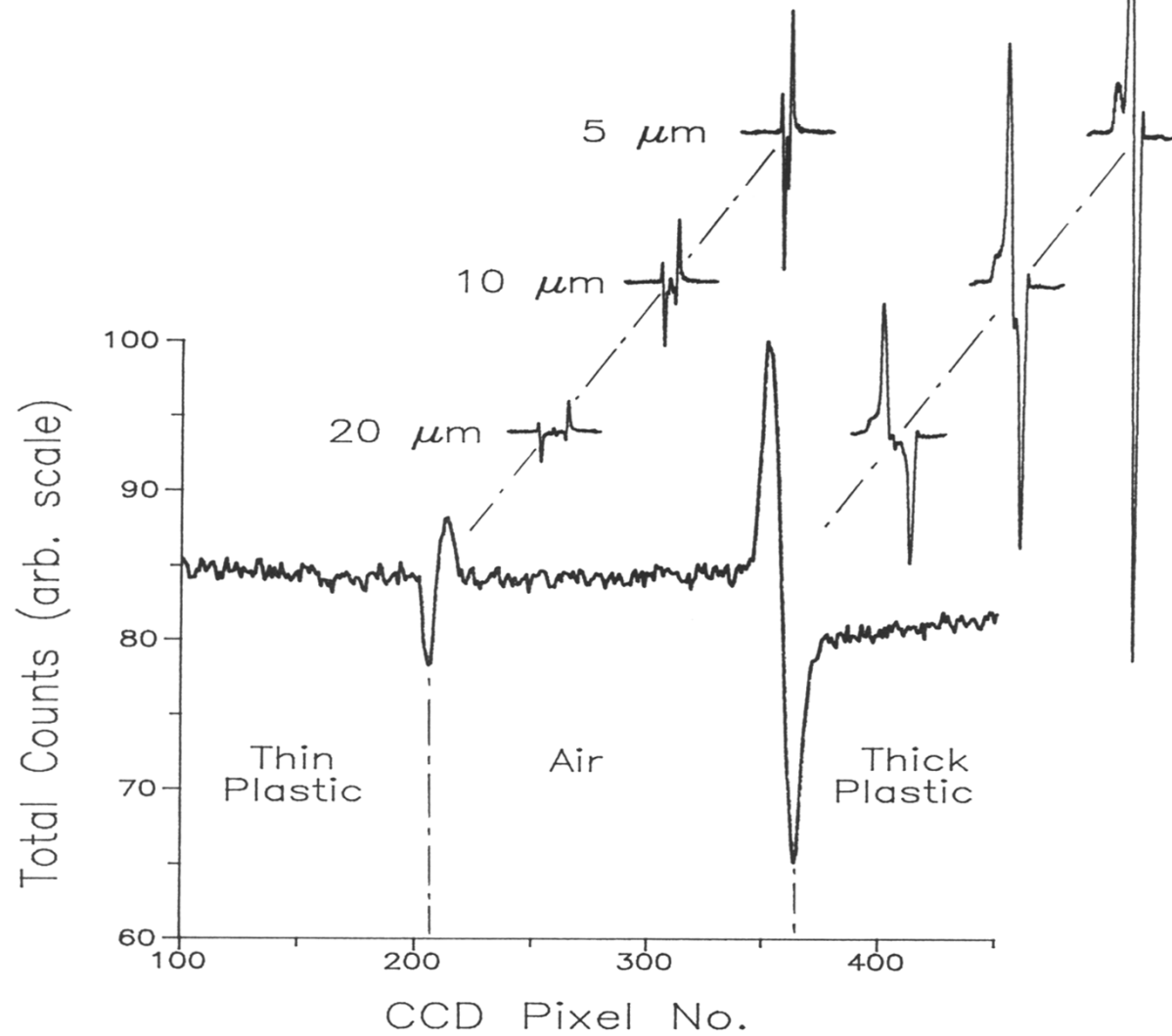
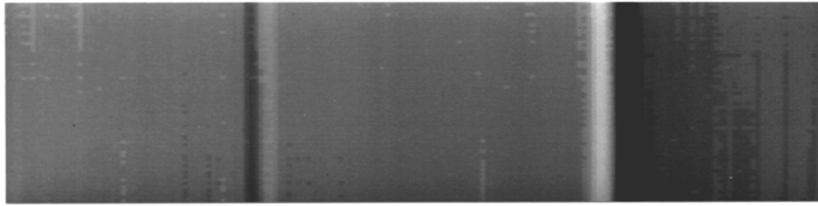


**... leading to interference.**



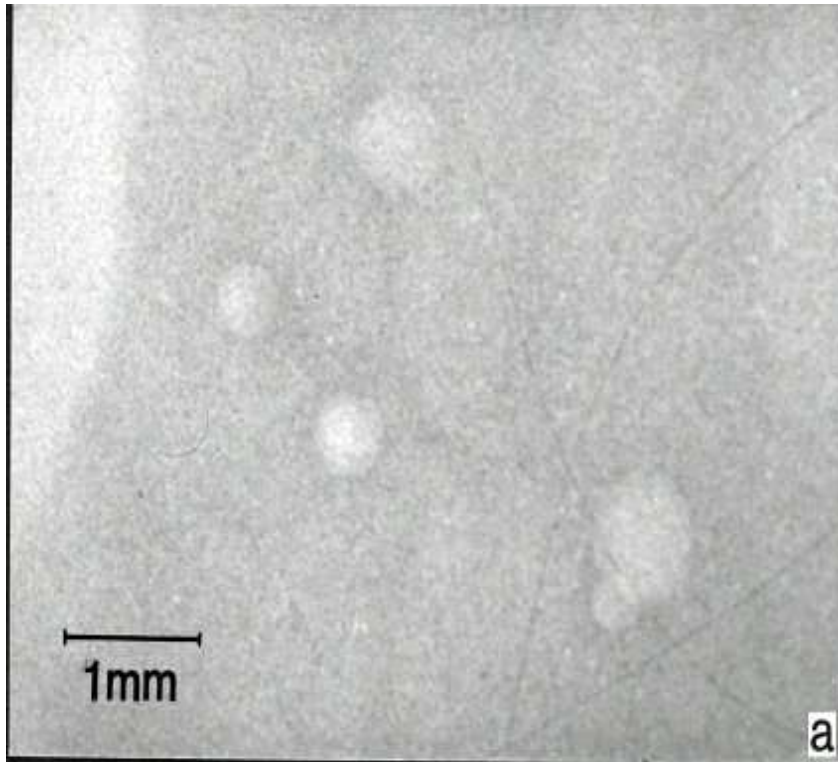
# phase contrast/ refraction



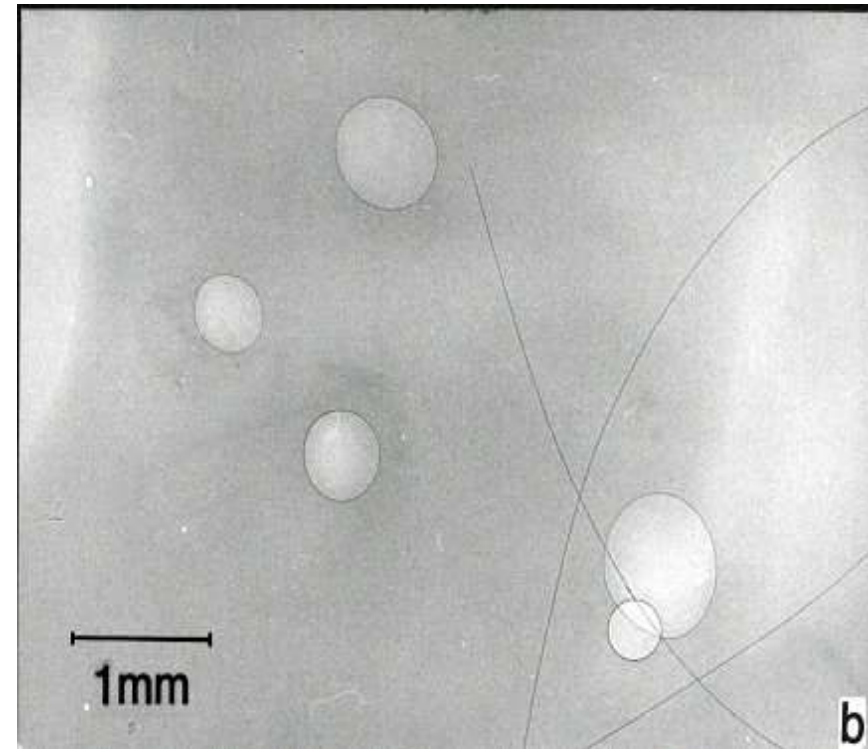


**pure  
phase  
object**

# images of a polymer glue containing $10\text{ }\mu\text{m}$ fibres and bubbles



**contact image**



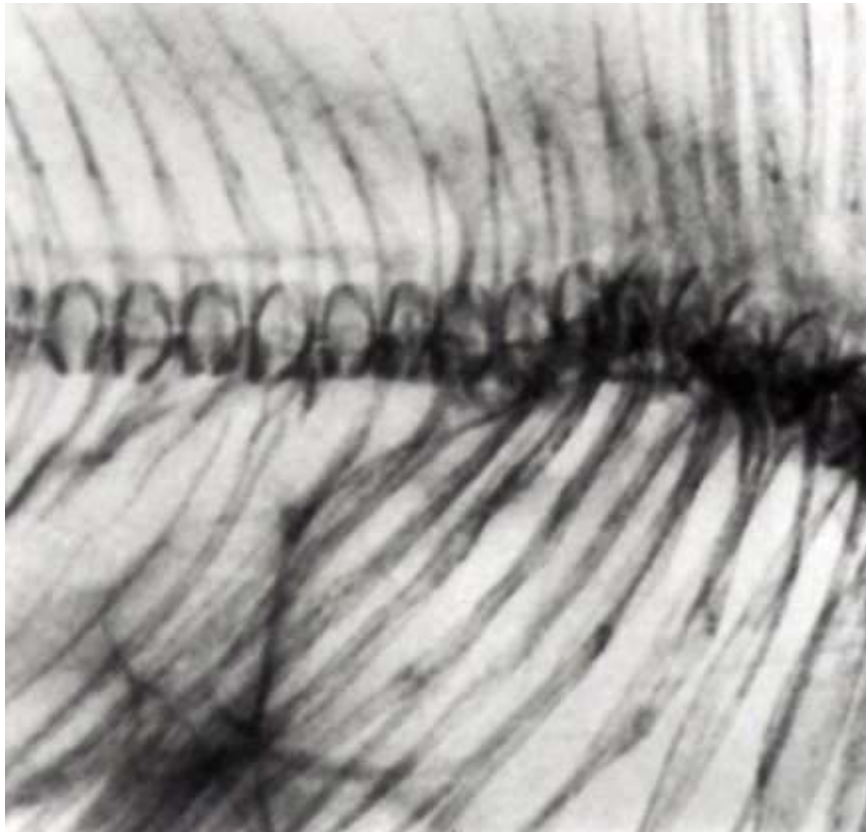
**phase-contrast  
image**



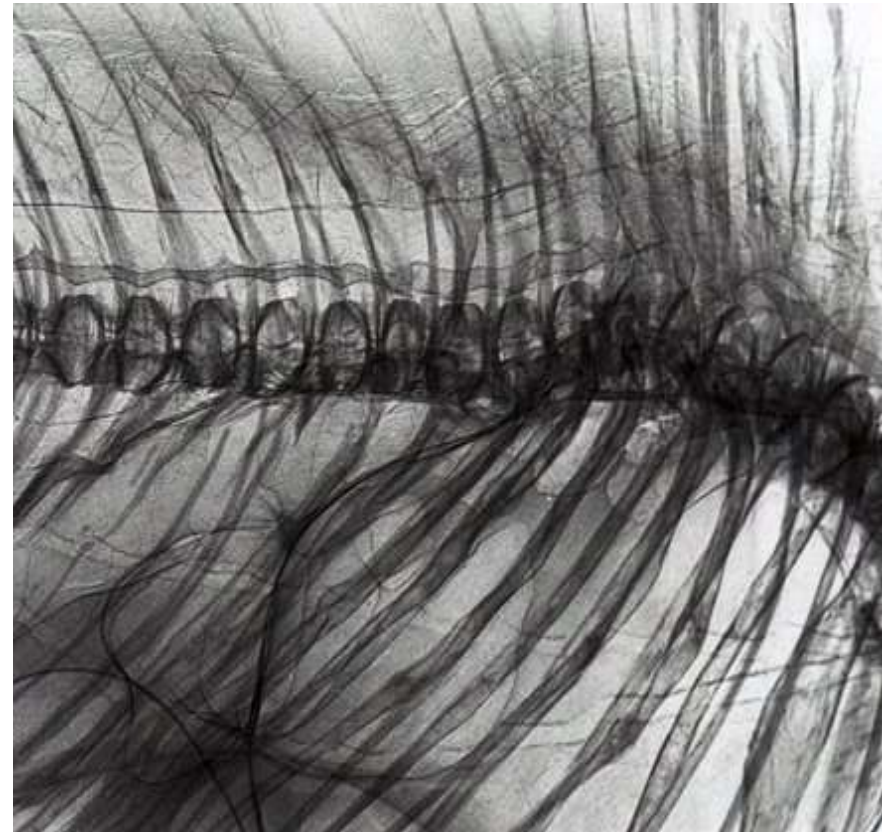
# image comparison



## images of a small aquarium fish - spine

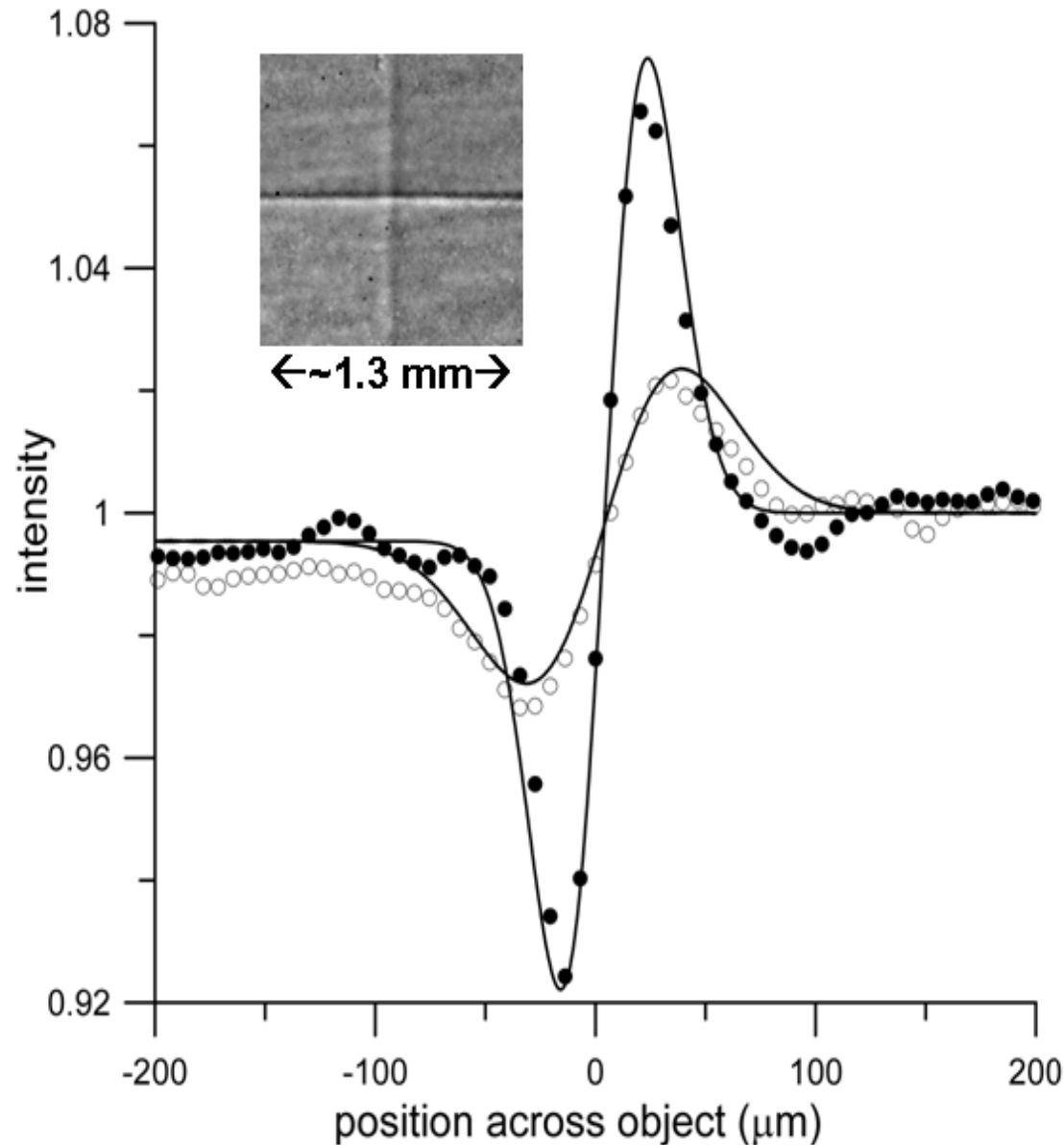
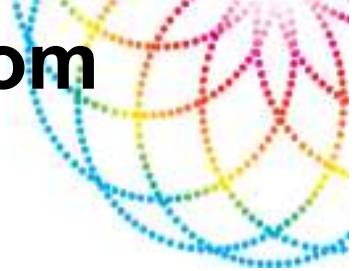


**contact image**



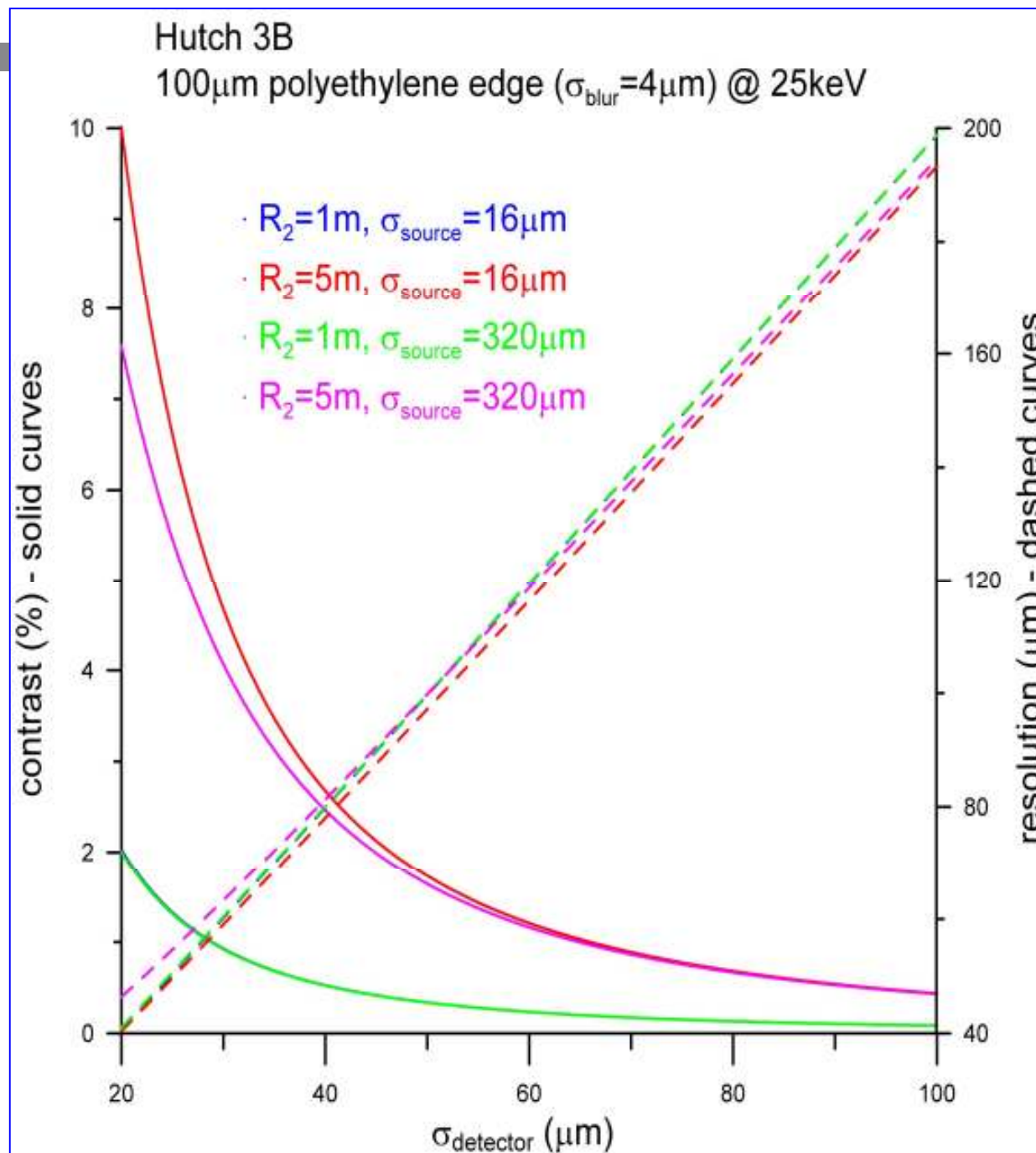
**phase-contrast image**

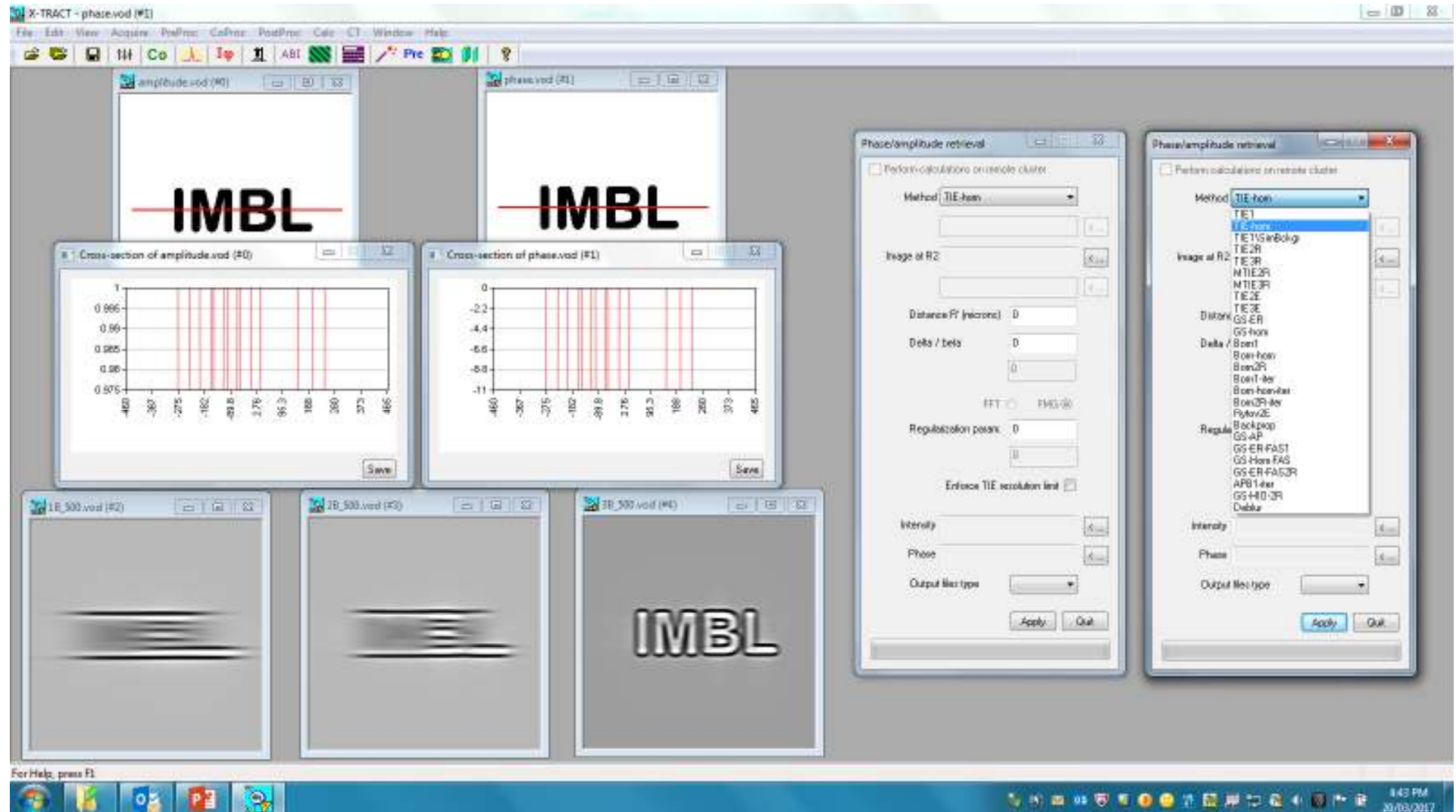
# first quantitative experimental results from Imaging and Medical Beamline (IMBL)



Quantitative phase-contrast data for refinement of experimental parameters such as source size

# source & detector considerations







## **CSIRO Manufacturing/ IMBL, Australian Synchrotron**

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# **Thank you for your attention**



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