



“1B_PC.avi”, “2B_PC.avi” & “3B_PC.avi”

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

Phase retrieval: Phase contrast CT, and alternative reconstructors



Australian Synchrotron

Andrew Stevenson
IMBL/ MCT, Australian Synchrotron
& CSIRO Manufacturing

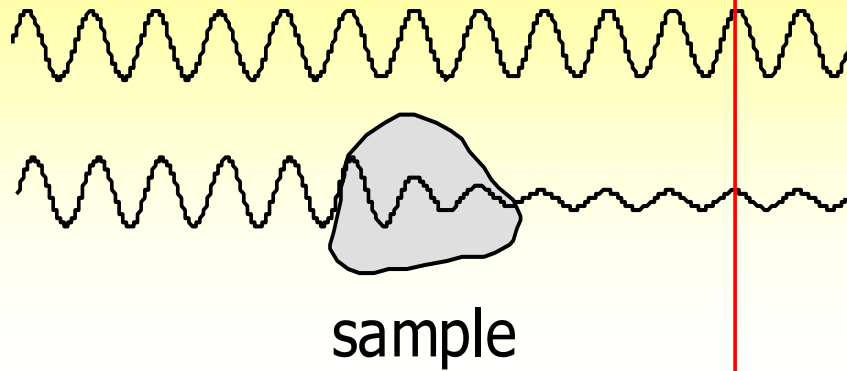


CT@IMBL workshop – 23rd October, 2017

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 (β)



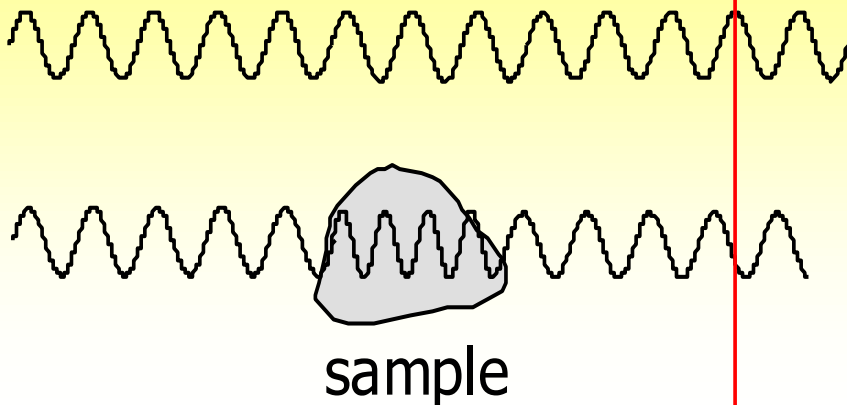
reference wave

pure absorption

sample

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

Phase Change (δ)



reference wave

pure phase
change

sample

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

absorption and phase data for Carbon



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

μ = linear absorption coefficient

ϕ = phase difference/unit length

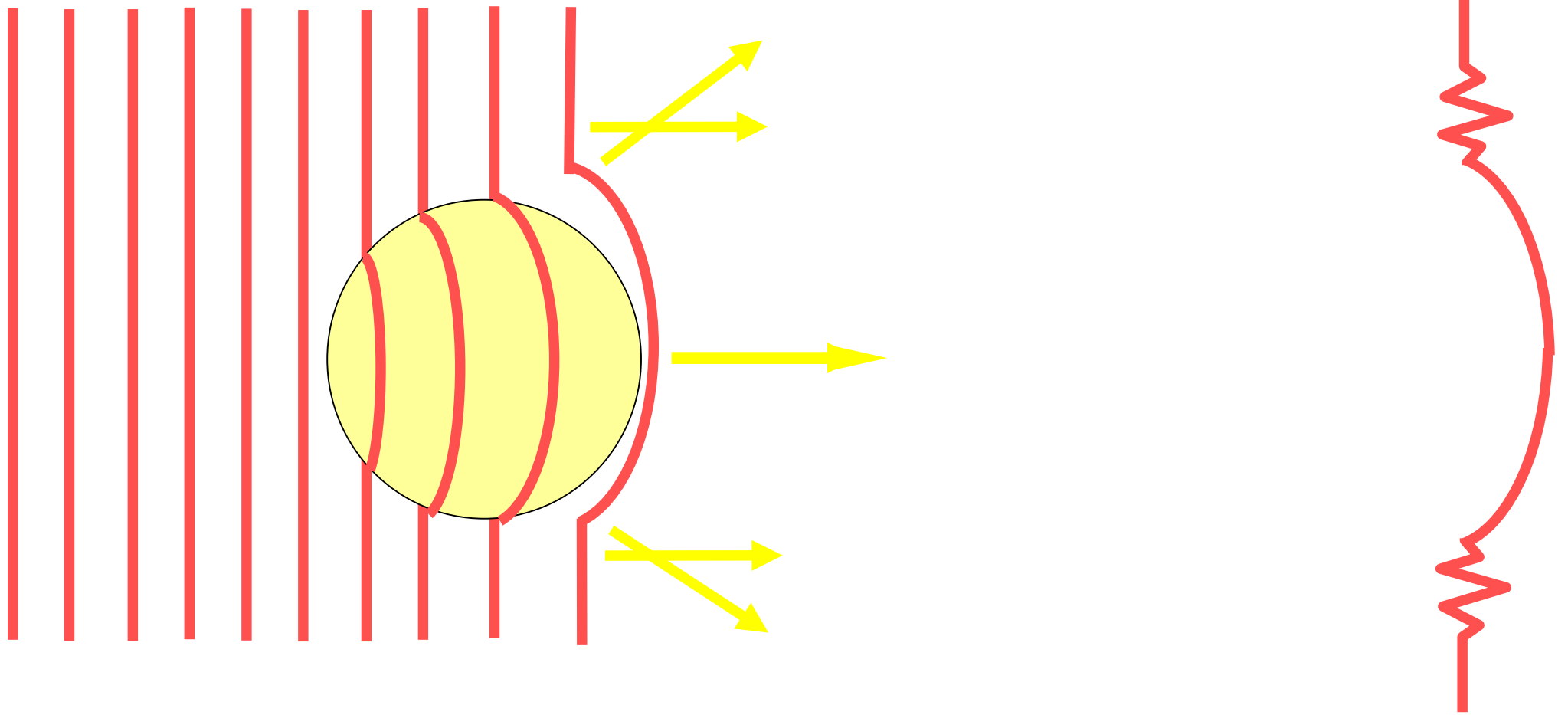
absorption thickness $t_a \mu = 1$

phase thickness $t_p \phi = 2\pi$

phase-contrast mechanism

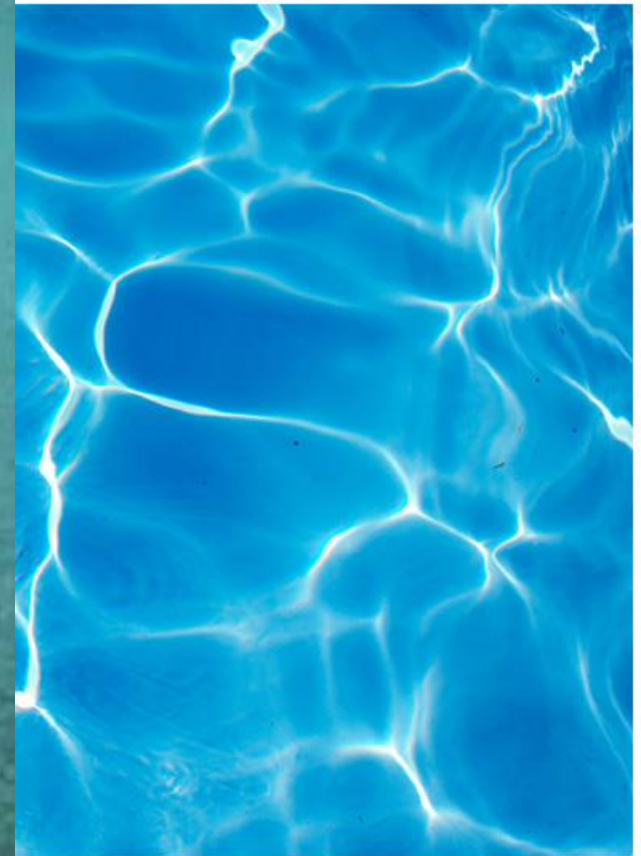


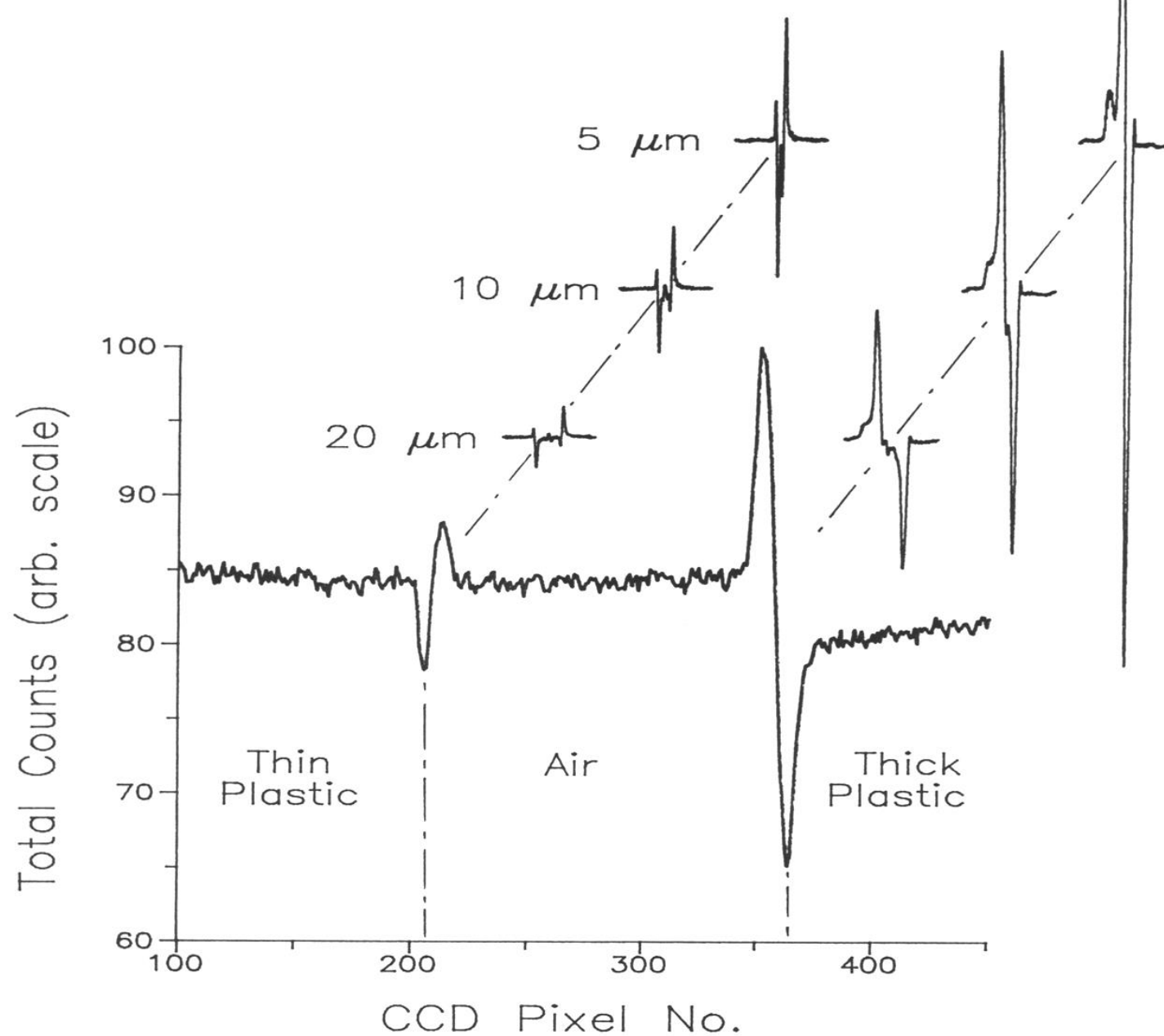
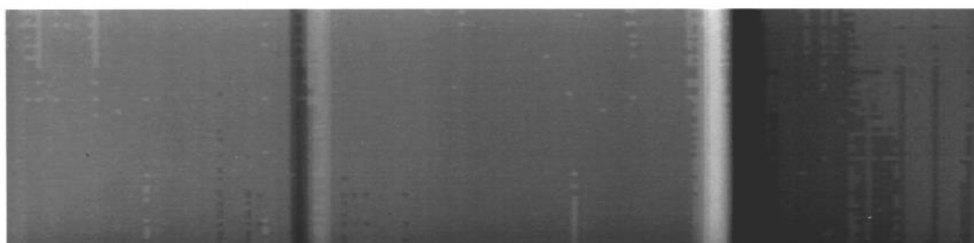
A phase gradient represents a change in direction of propagation ...



... leading to interference.

phase contrast/ refraction

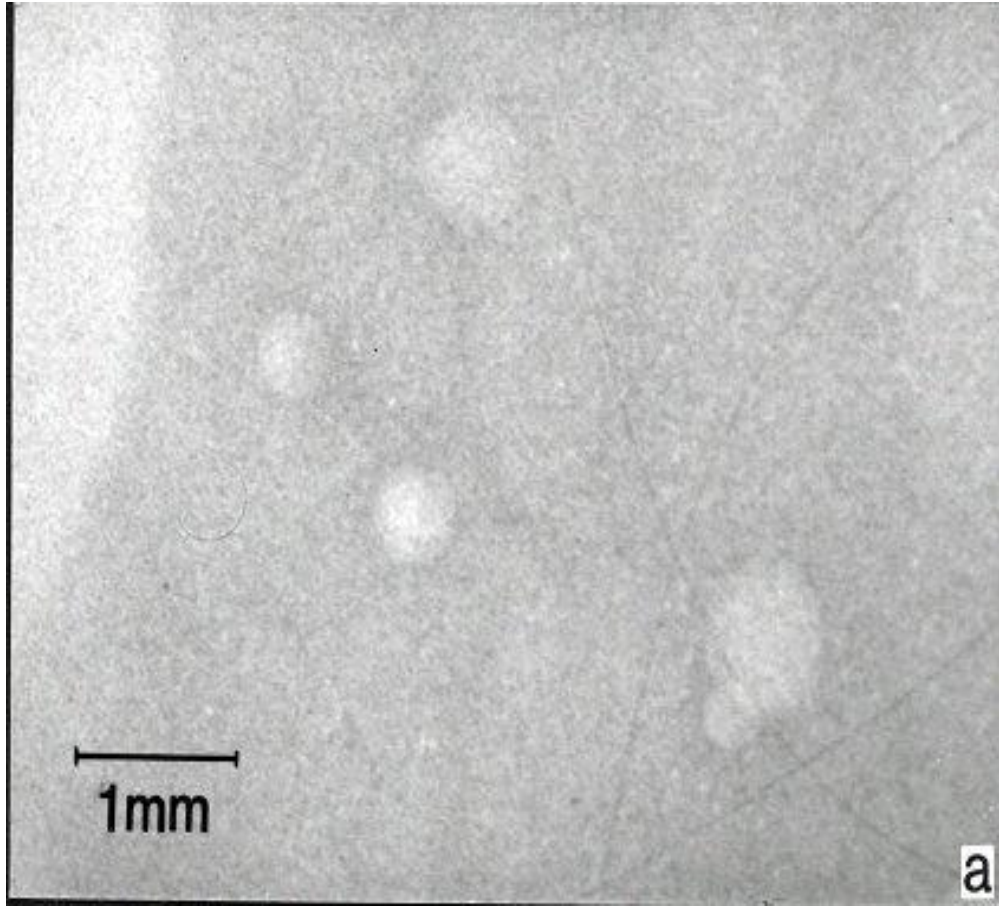




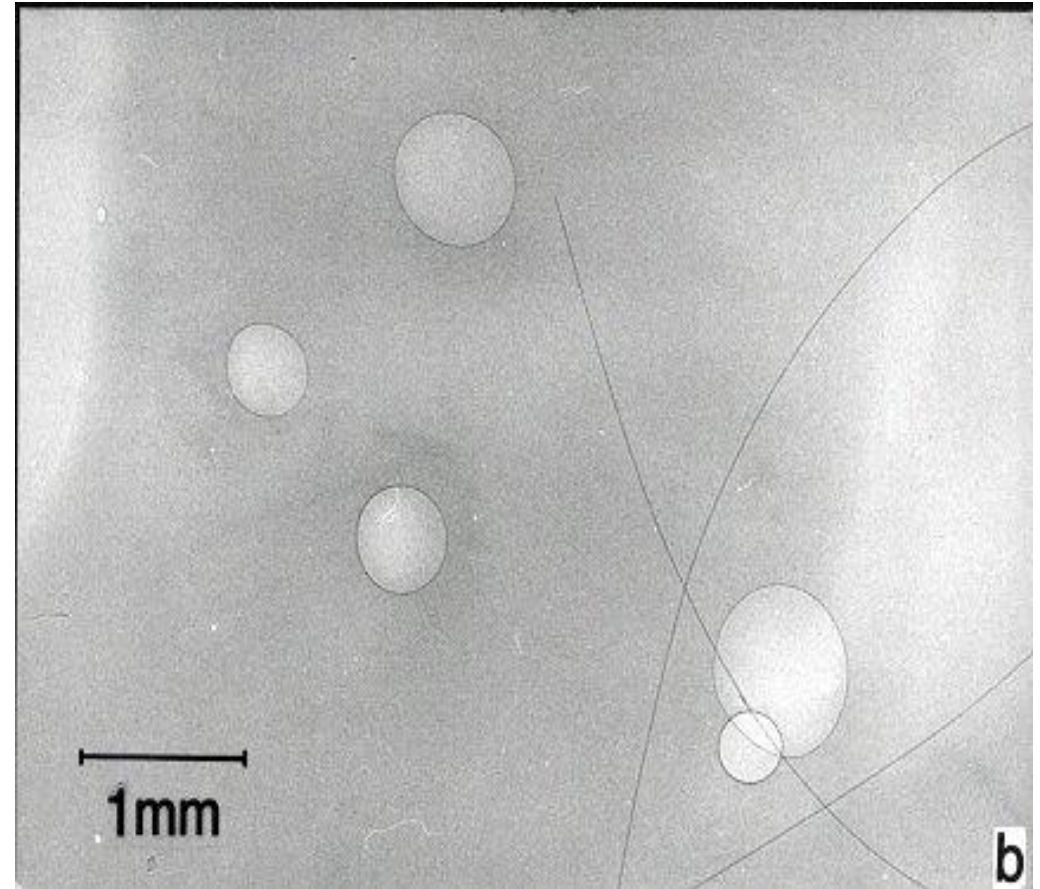
**pure
phase
object**



images of a polymer glue containing 10 μm fibres and bubbles



contact image

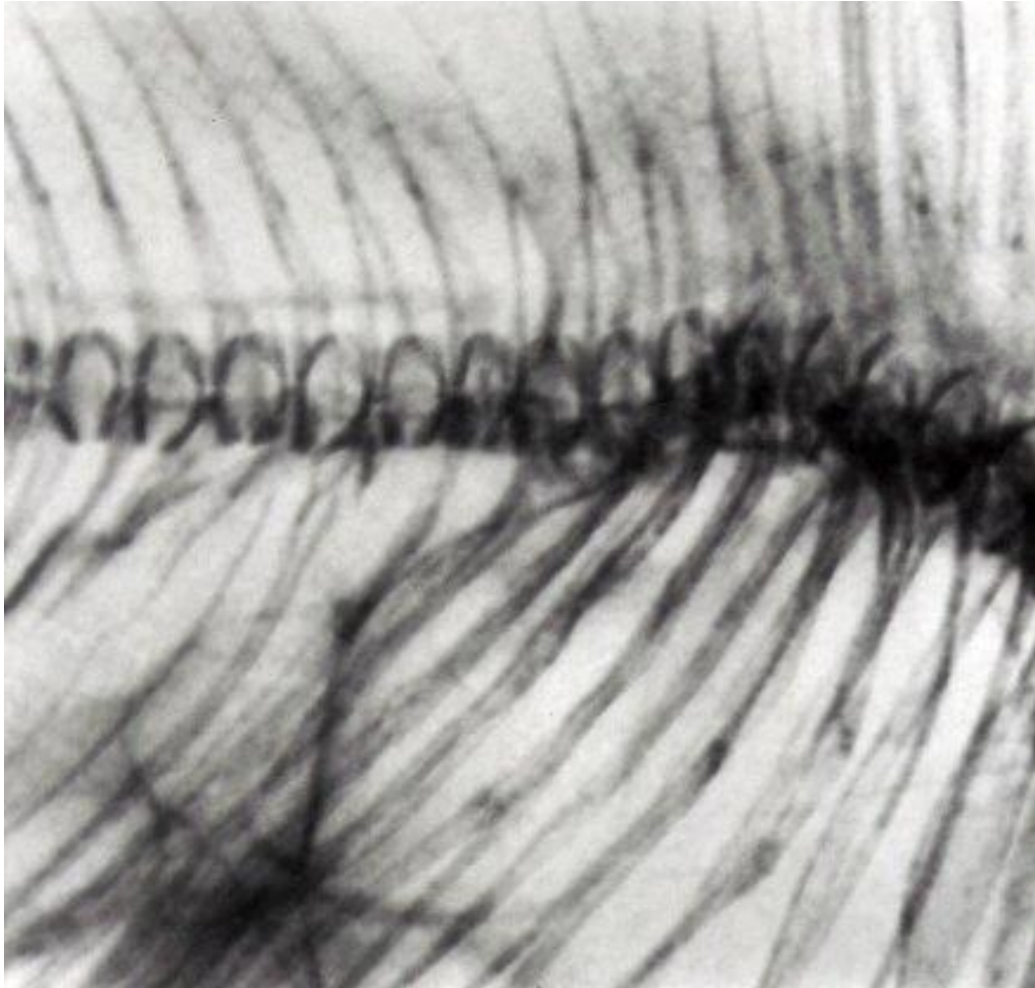


**phase-contrast
image**

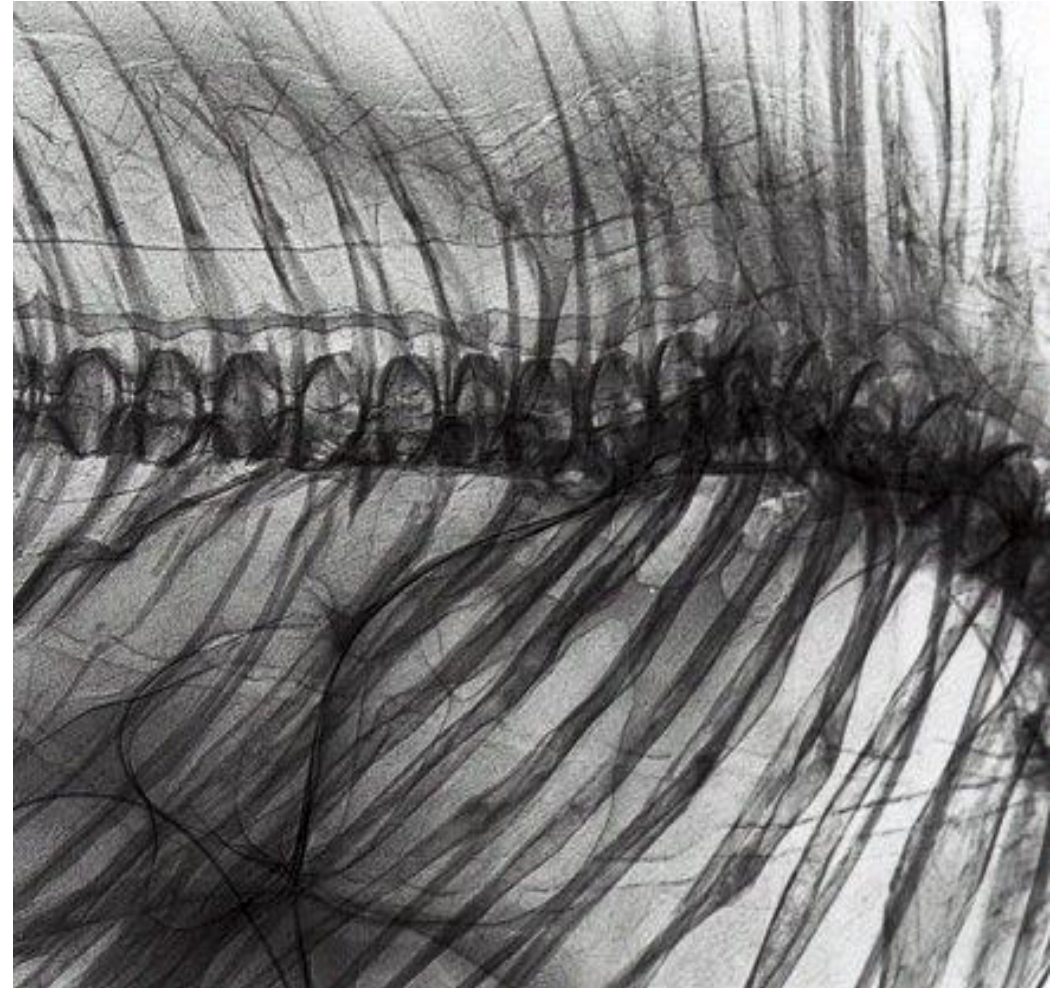
image comparison



images of a small aquarium fish - spine

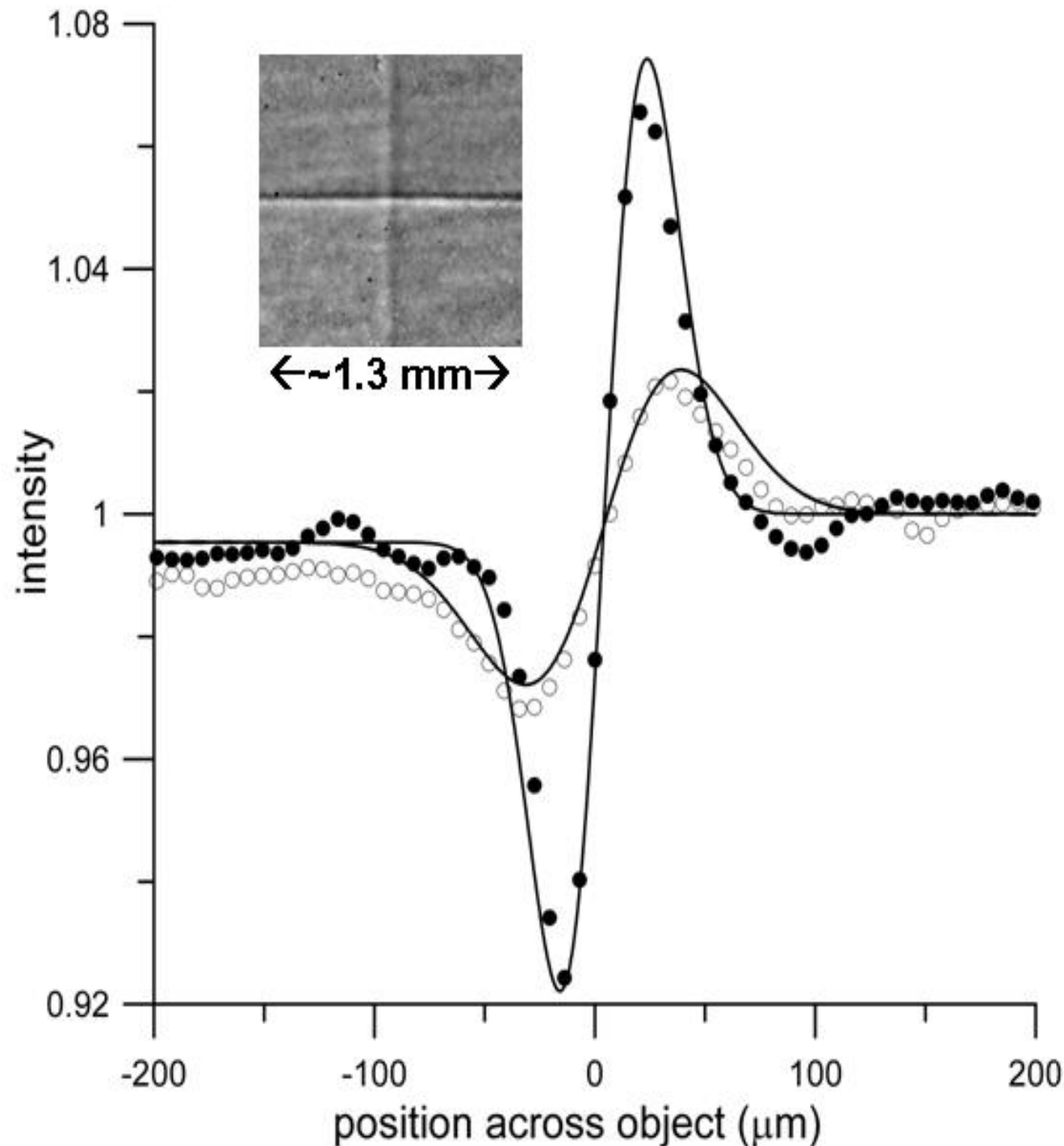


contact image



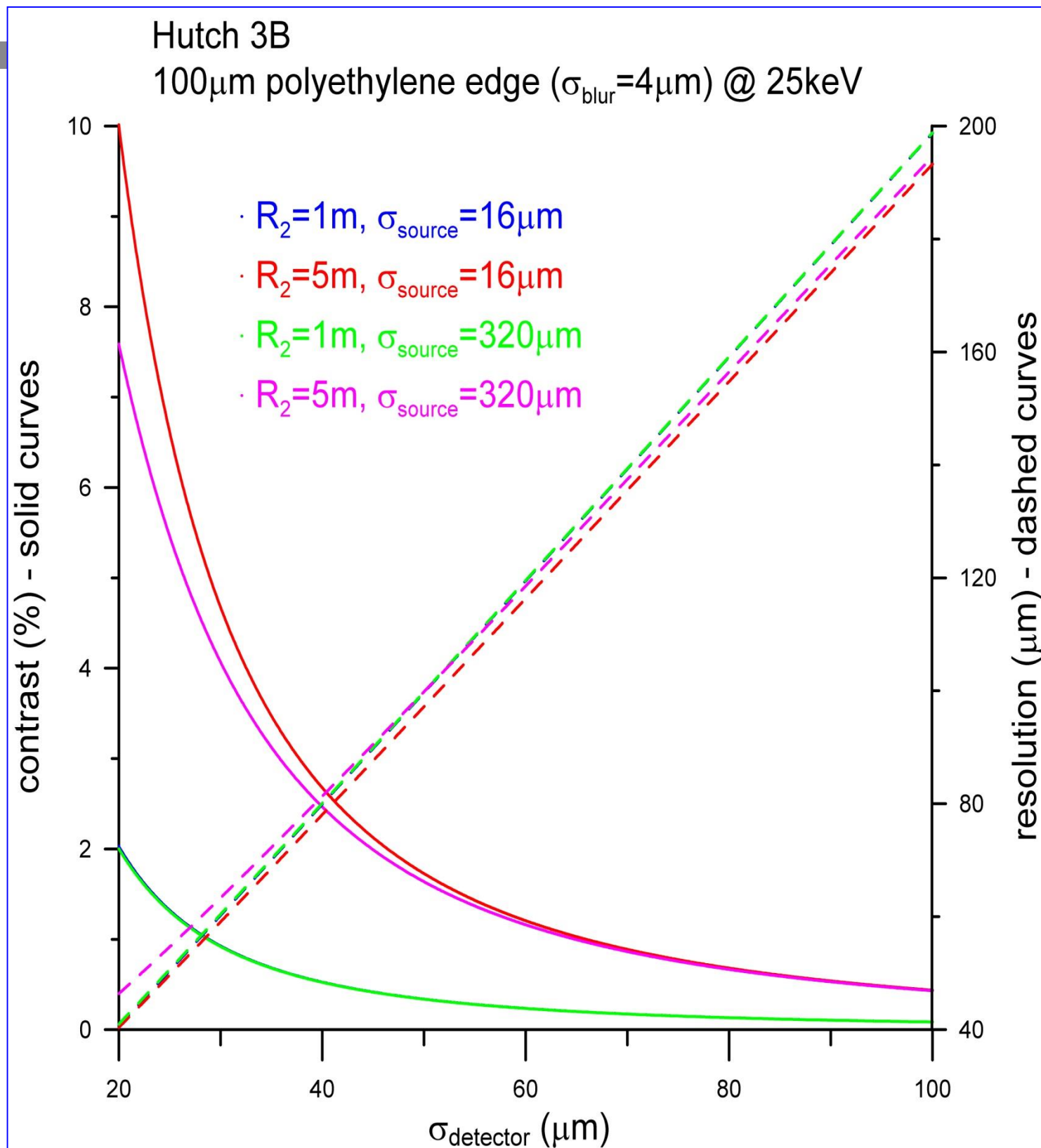
phase-contrast image

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



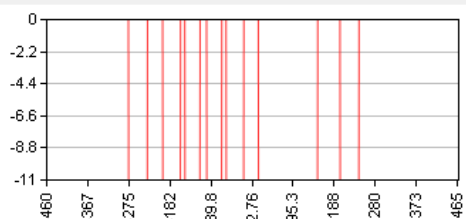
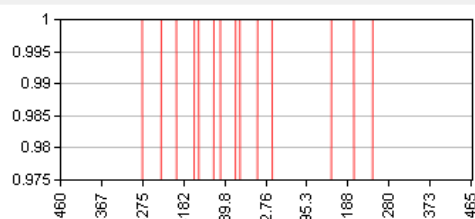
amplitude.vod (#0)

phase.vod (#1)

~~IMBL~~~~IMBL~~

Cross-section of amplitude.vod (#0)

Cross-section of phase.vod (#1)



Save

Save

1B_500.vod (#2)

2B_500.vod (#3)

3B_500.vod (#4)

Phase/amplitude retrieval

☐ Perform calculations on remote cluster

Method: TIE-hom

Image at R2

Distance R' (microns): 0

Delta / beta: 0

FFT ☐ FMG ☒

Regularization param.: 0

Enforce TIE resolution limit ☐

Intensity

Phase

Output files type

Apply Quit

Phase/amplitude retrieval

☐ Perform calculations on remote cluster

Method: TIE-hom

Image at R2

Distance R' (microns): 0

Delta / beta: 0

FFT ☐ FMG ☒

Regularization param.: 0

Enforce TIE resolution limit ☐

Intensity

Phase

Output files type

Apply Quit



CSIRO Manufacturing/ IMBL/ MCT, Australian Synchrotron

Dr Andrew Stevenson

Phone: +61 3 9518 5945

Email: andrew.stevenson@csiro.au

or andrew.stevenson@synchrotron.org.au

Thank you for your attention



Australian Synchrotron

