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

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

Phase retrieval: Phase contrast CT, and alternative reconstructors

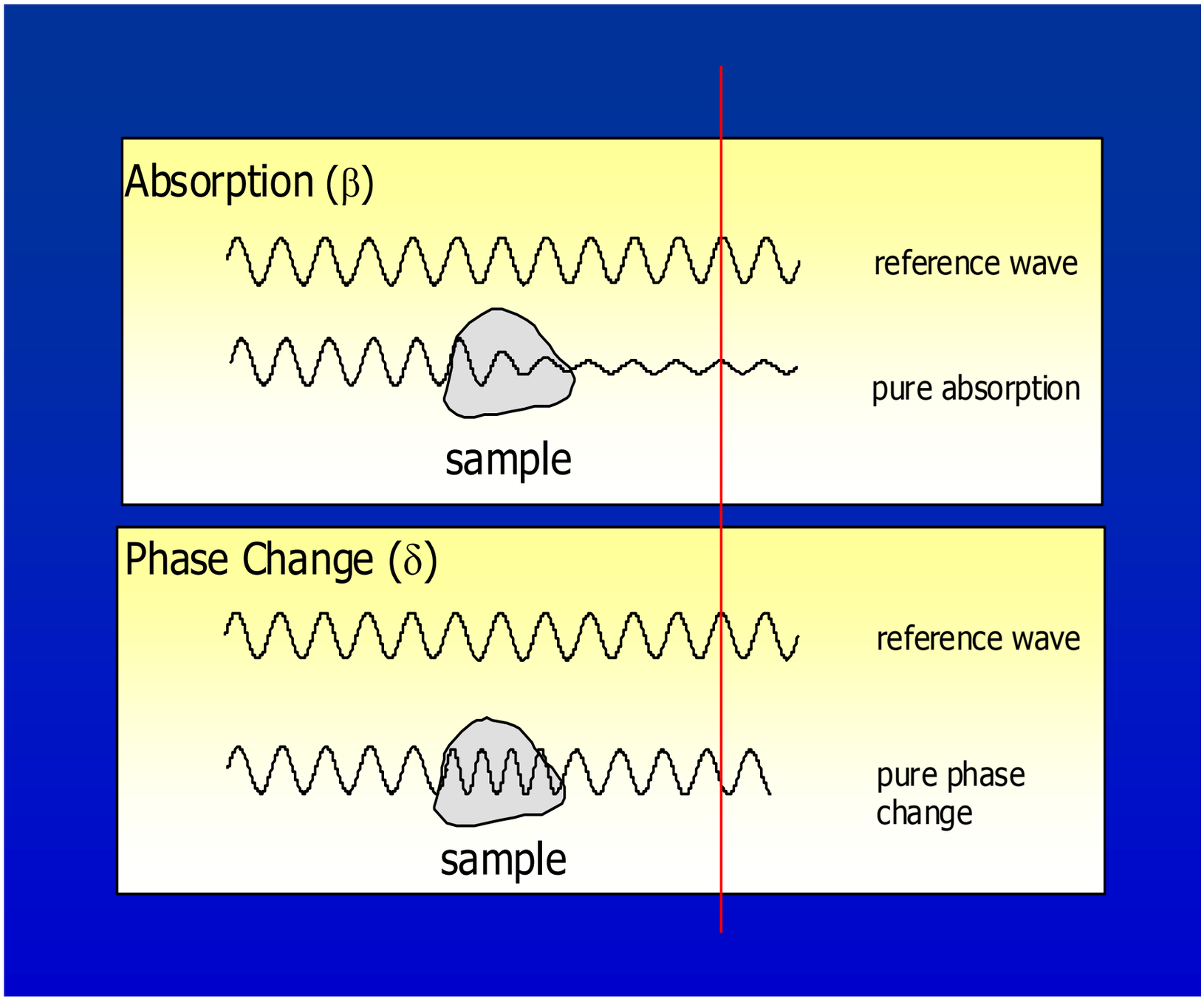
Australian Synchrotron

Andrew Stevenson
MCT, Australian Synchrotron
& CSIRO Future Industries

CSIRO

CT@IMBL workshop – 18th March, 2019

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 $n(\lambda) = 1 - \delta(\lambda) - i\beta(\lambda)$



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

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

absorption and phase data for Carbon

E(keV)	λ(A)	$t_a(\mu m)$	t_p (μm)
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

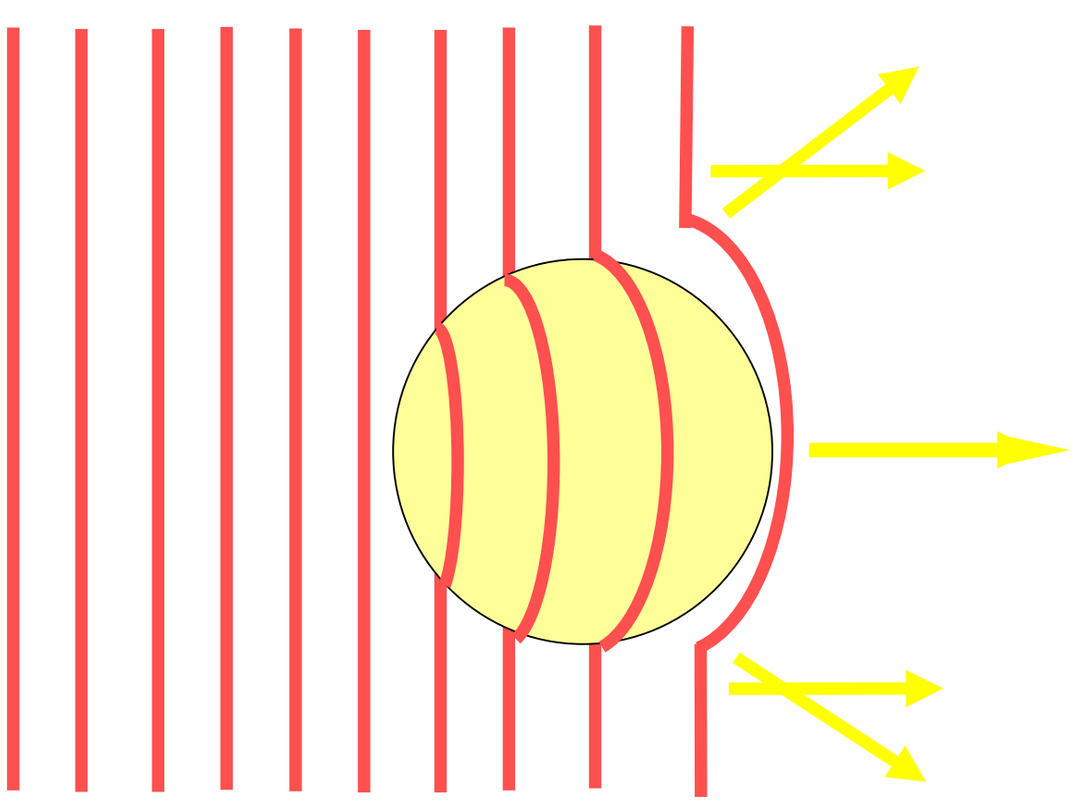
ϕ = phase difference/unit length

absorption thickness $t_a \mu = 1$

phase thickness $t_p \phi = 2\pi$

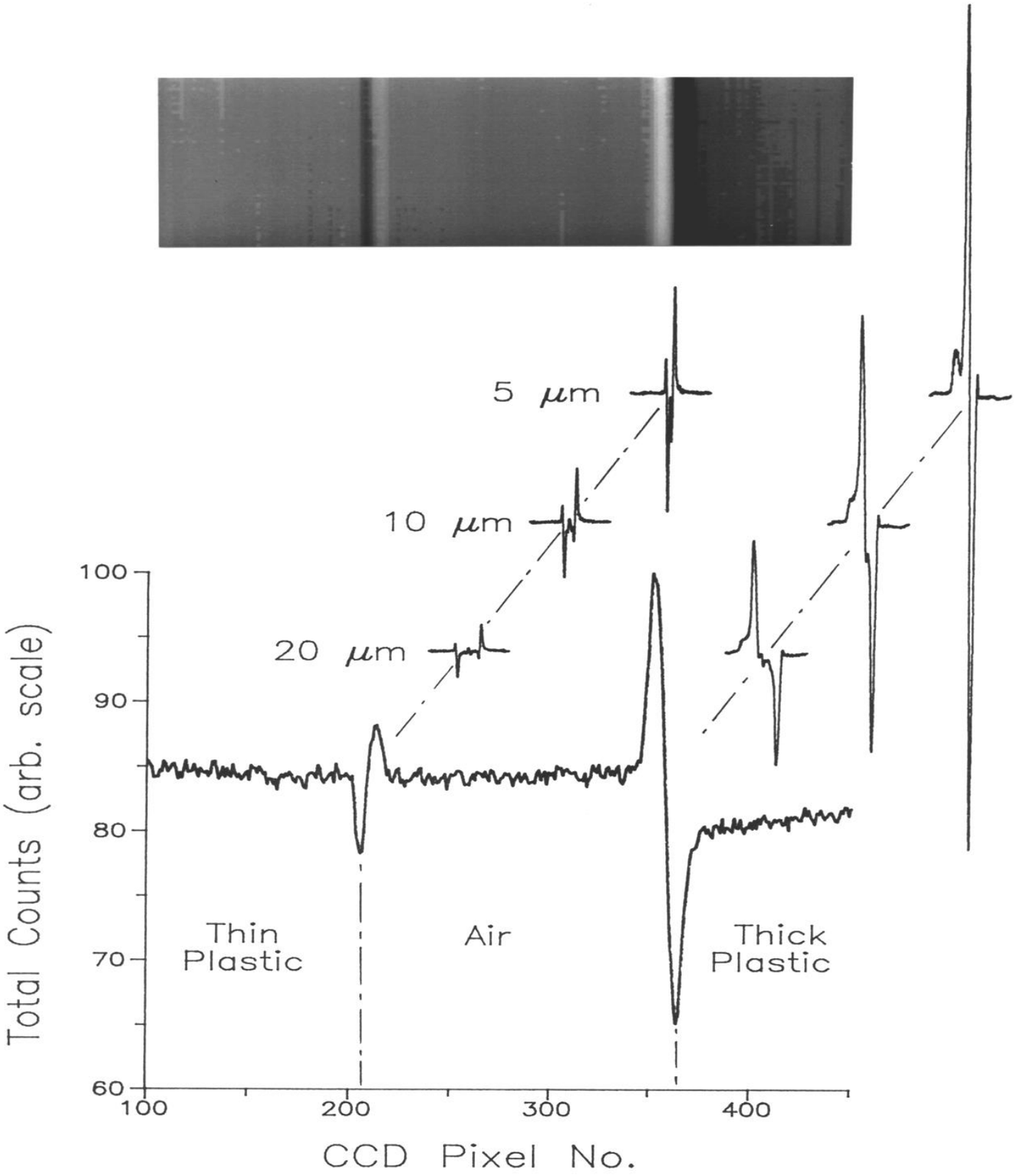
phase-contrast mechanism

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



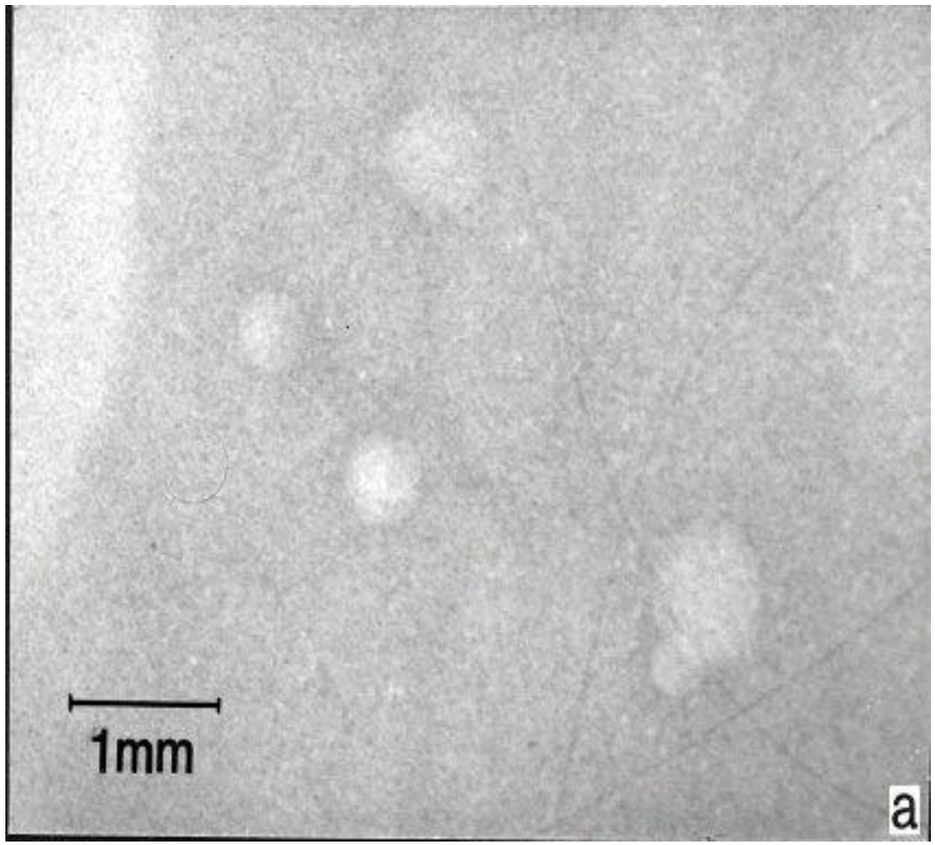
… leading to interference.

phase contrast/ refraction

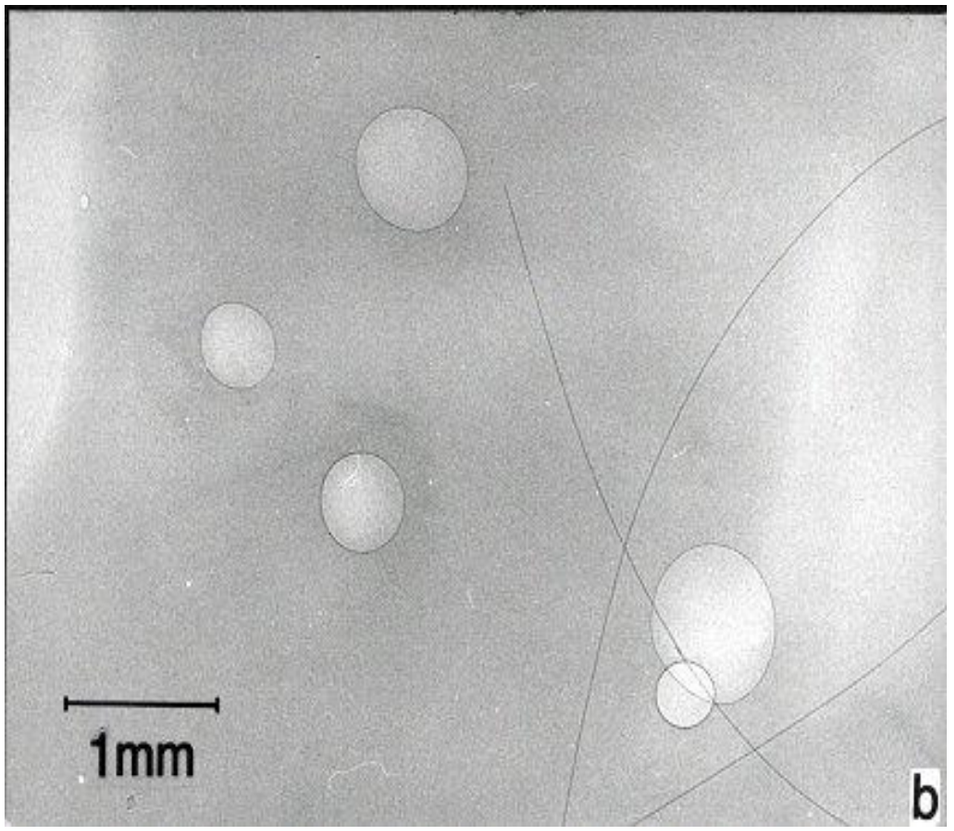


pure phase object

images of a polymer glue containing 10 μm fibres and bubbles



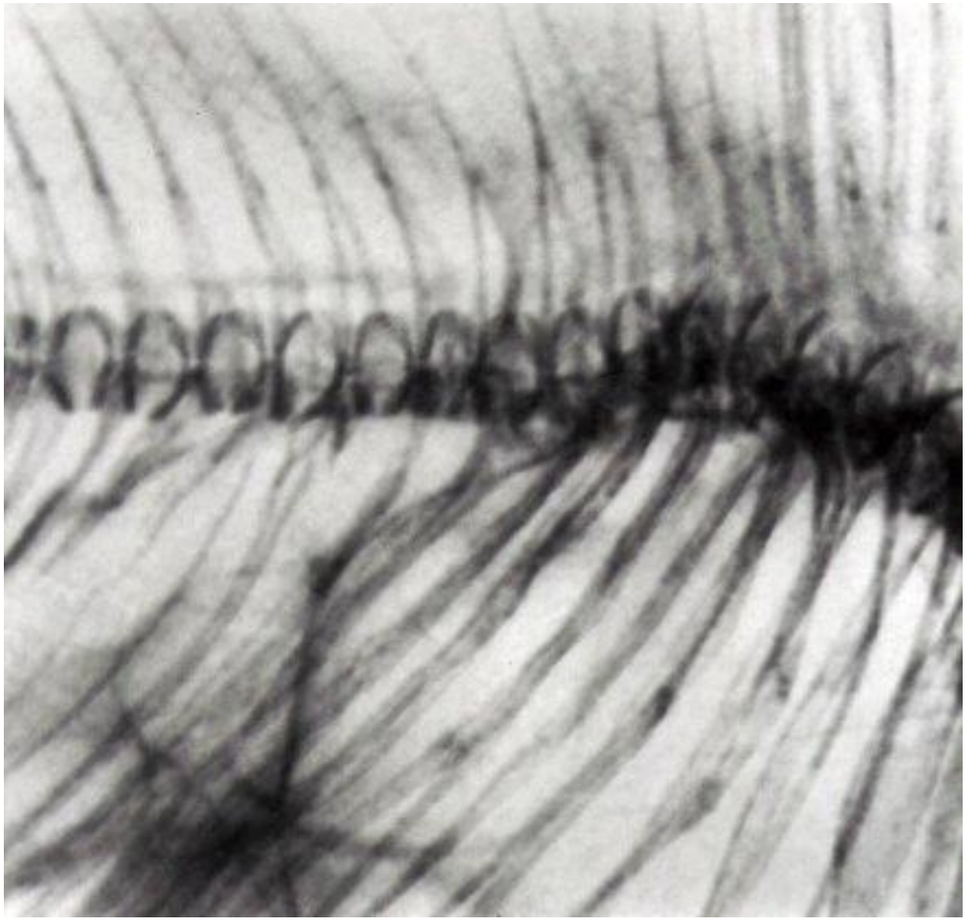
contact image

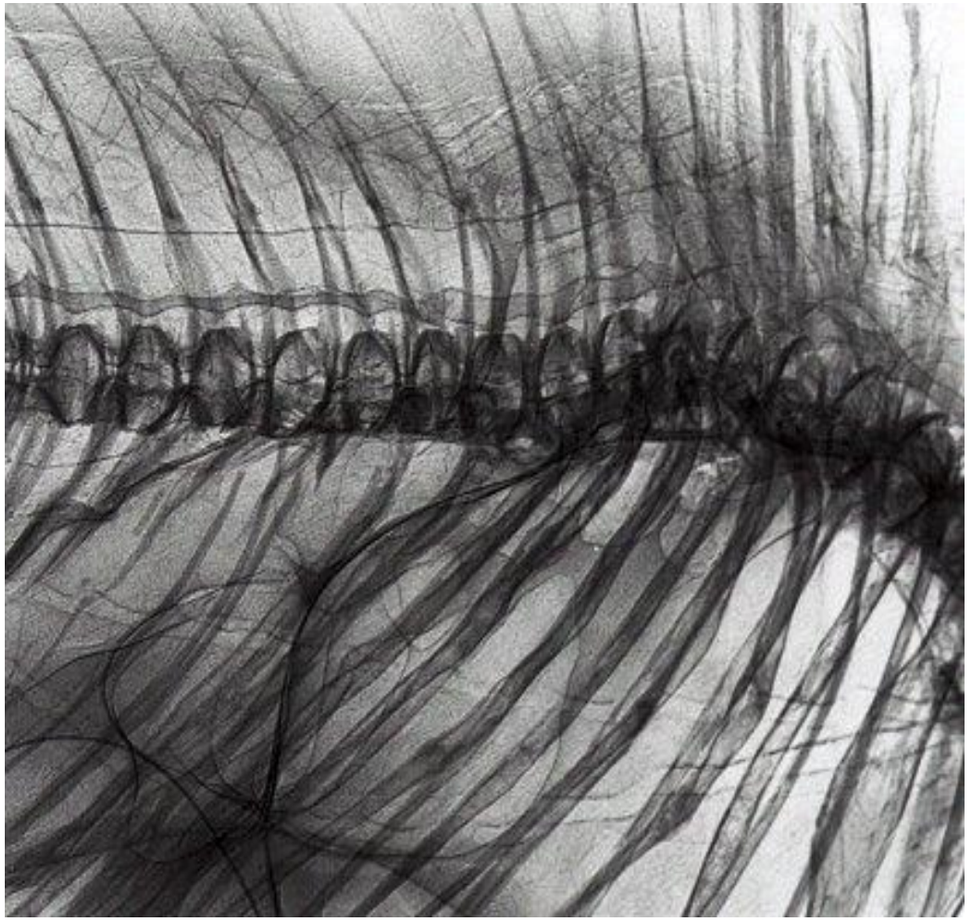


phase-contrast image

image comparison

images of a small aquarium fish - spine

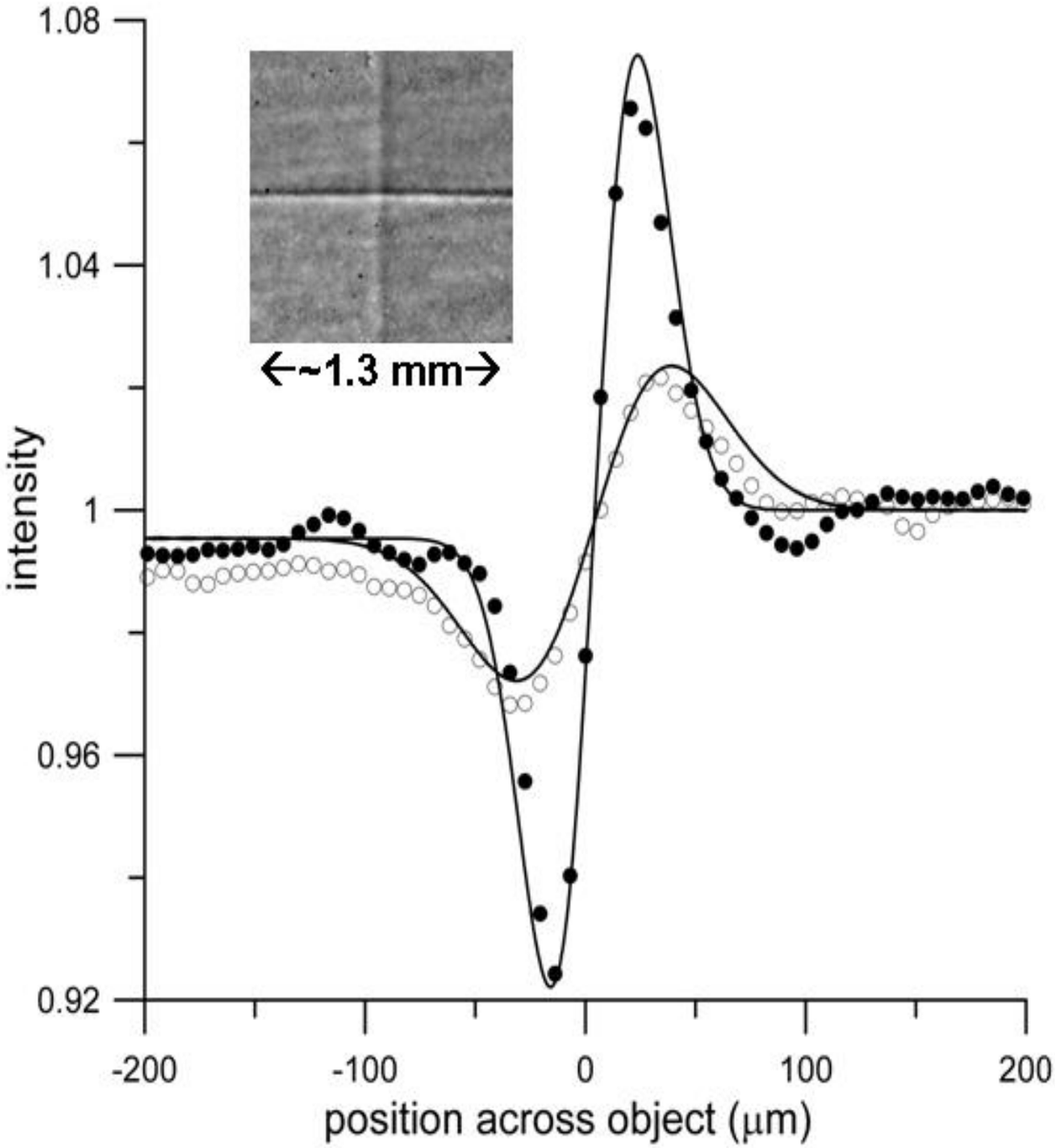




contact image

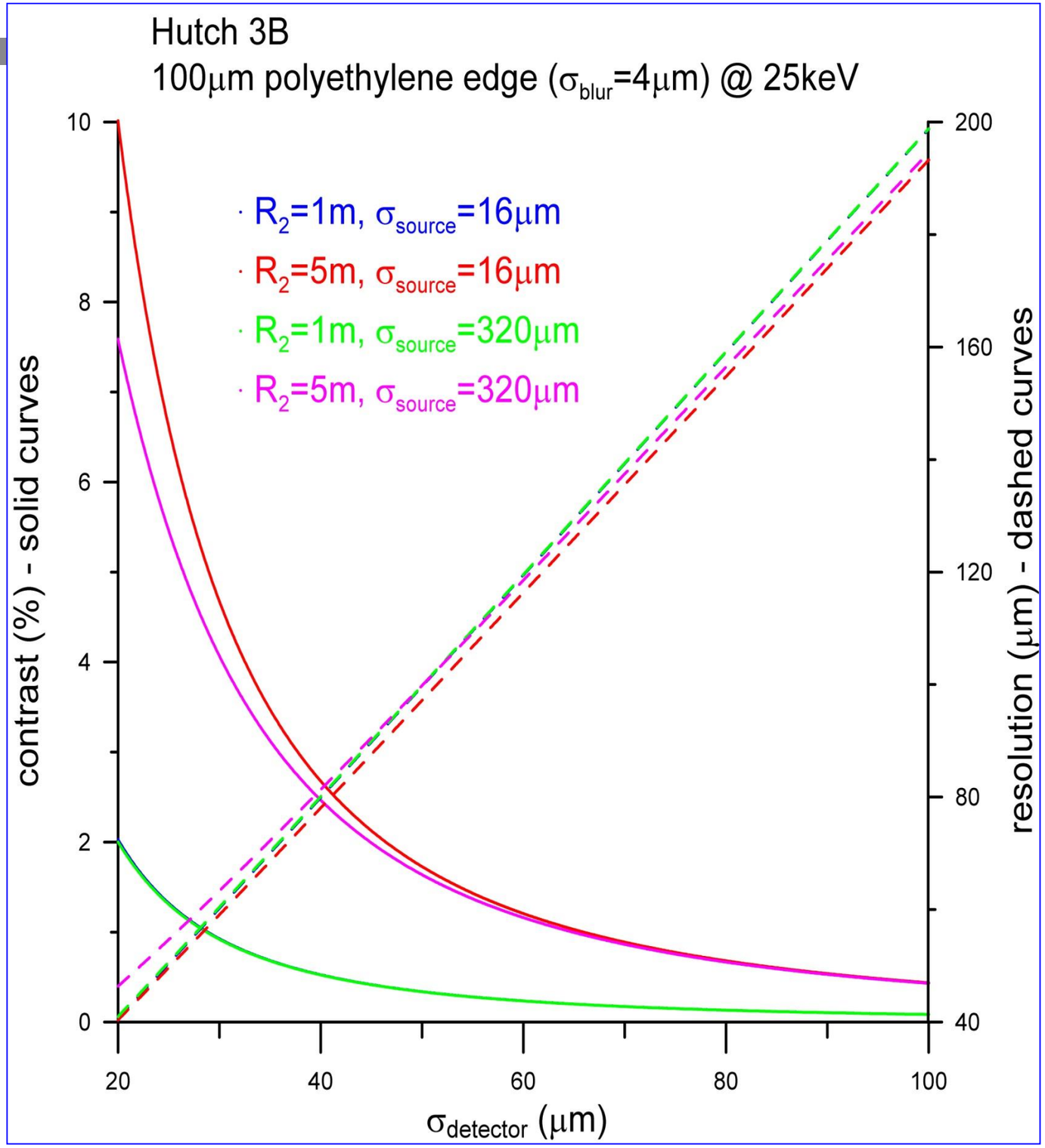
phase-contrast image

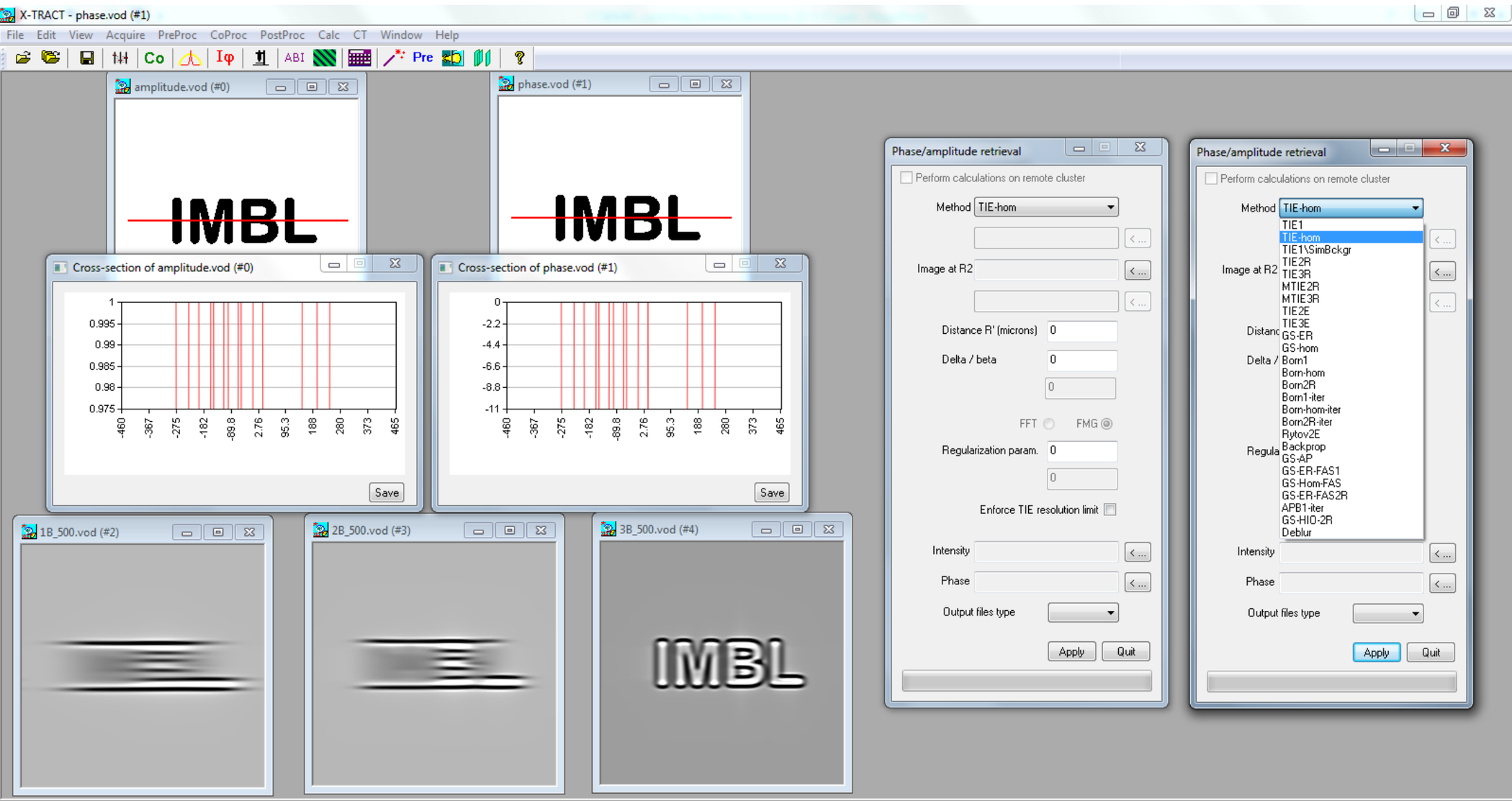
first quantitative experimental results from Imaging and Medical Beamline (IMBL)



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

source & detector considerations




X-TRACT - phase.vod (#1)
File Edit View Acquire PreProc CoProc PostProc Calc CT Window Help
amplitude.vod (#0)
IMBL
phase.vod (#1)
IMBL
Cross-section of amplitude.vod (#0)
1
0.995
0.99
0.985
0.98
0.975
-460 -367 -275 -182 -89.8 2.76 95.3 188 280 373 465
Save
Cross-section of phase.vod (#1)
0
-2.2
-4.4
-6.6
-8.8
-11
-460 -367 -275 -182 -89.8 2.76 95.3 188 280 373 465
Save
1B_500.vod (#2)
2B_500.vod (#3)
3B_500.vod (#4)
IMBL
Phase/amplitude retrieval
Perform calculations on remote cluster
Method TIE-hom
Image at R2
Distance R' (microns) 0
Delta / beta 0
0
FFT FMG
Regularization param. 0
0
Enforce TIE resolution limit
Intensity
Phase
Output files type
Apply Quit
Phase/amplitude retrieval
Perform calculations on remote cluster
Method TIE-hom
TIE1
TIE-hom
TIE1\SimBckgr
TIE2R
TIE3R
MTIE2R
MTIE3R
TIE2E
TIE3E
GS-ER
GS-hom
Born1
Born-hom
Born2R
Born1-iter
Born-hom-iter
Born2R-iter
Rytov2E
Backprop
GS-AP
GS-ER-FAS1
GS-Hom-FAS
GS-ER-FAS2R
APB1-iter
GS-HIO-2R
Deblur
Image at R2
Intensity
Phase
Output files type
Apply Quit
For Help, press F1
4:43 PM
20/03/2017

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Thank you for your attention

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