Computerised X-ray Imaging for Grain Diagnostics

P. Strumillo*, A. Staworzyński*, S. Grundas, J. Niewczas****

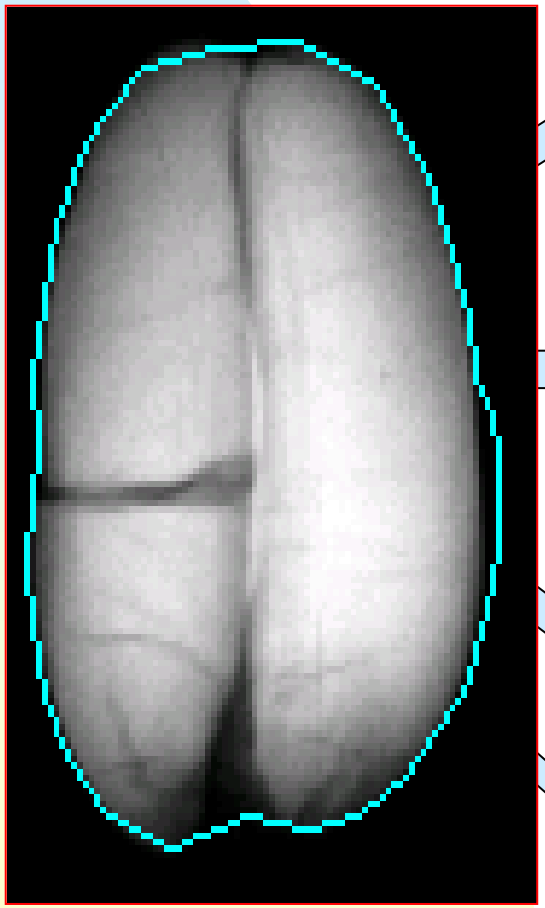
*Technical University of Lodz,
18 Stefanowskiego, 90-924 Lodz, POLAND

**Institute of Agrophysics, Polish Academy of Sciences, 4 Doswiadczalna,20-236 Lublin, POLAND

Contents

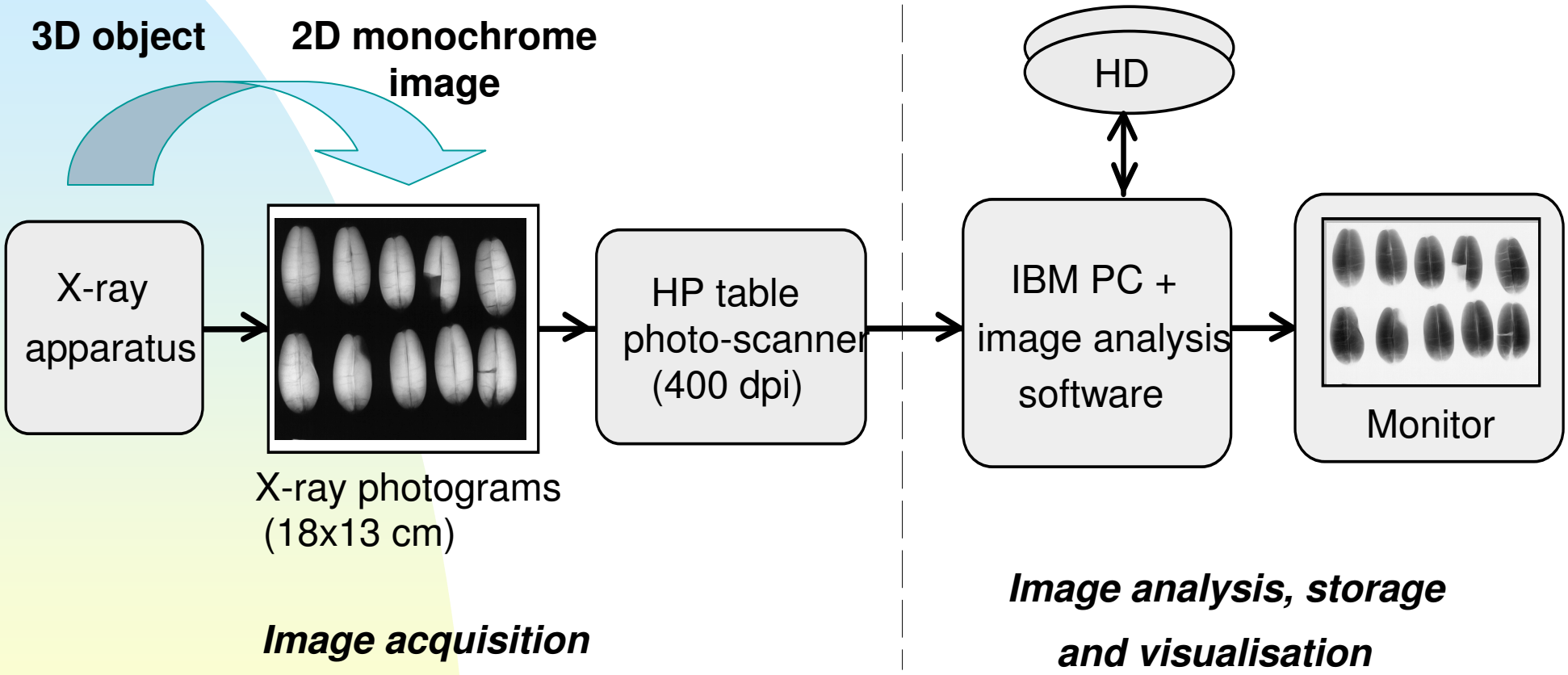
- Introduction
- Why X-ray imaging of grains?
- Image acquisition
- Image processing methods
- quantification of kernel damages
- Software packages *Grains*, ***Grains II***
- Conclusions

Why X-ray imaging of grains?

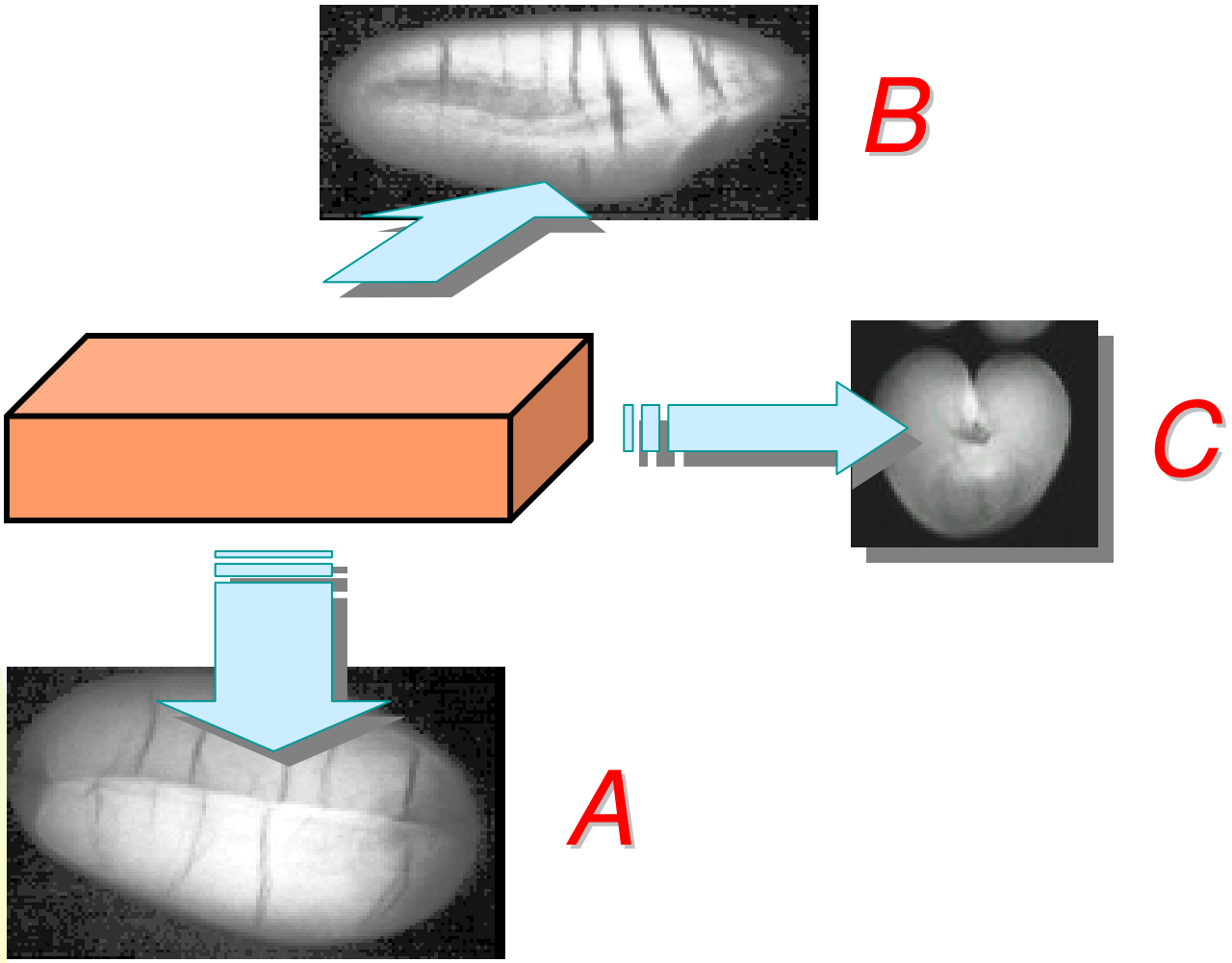


- Provides information about internal grain structure (e.g., groove profile, germ shape, kernel damages, etc.)
- Provides excellent visualisation quality (i.e., high spatial and grey scale resolution)
- Is a non-destructive diagnostic method
- Is relatively cheap

Image Acquisition and Processing

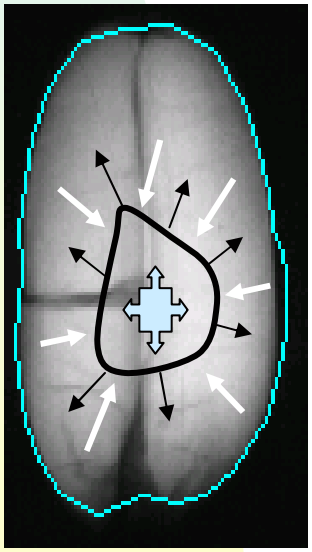


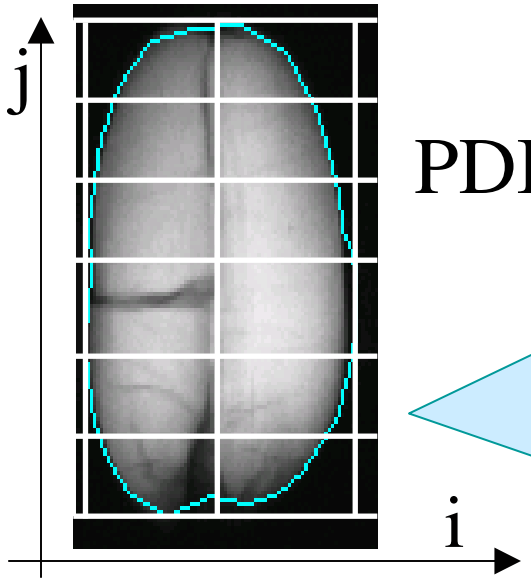
Scanning projections



Analysis steps of grain X-ray images

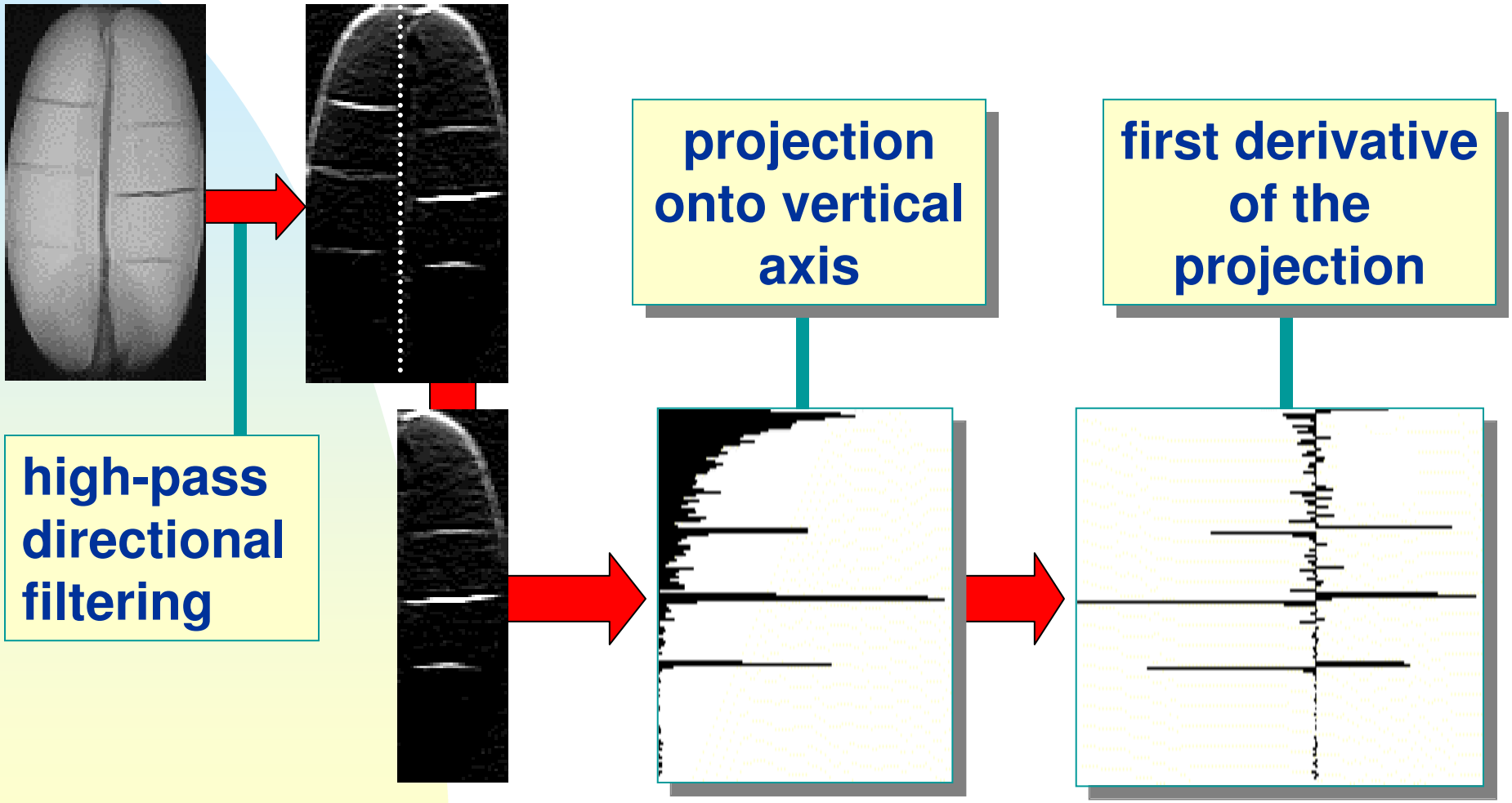
- detection of grain boundary in an image
- calculation of geometrical and statistical parameters o grain kernel
- computation of damage indices



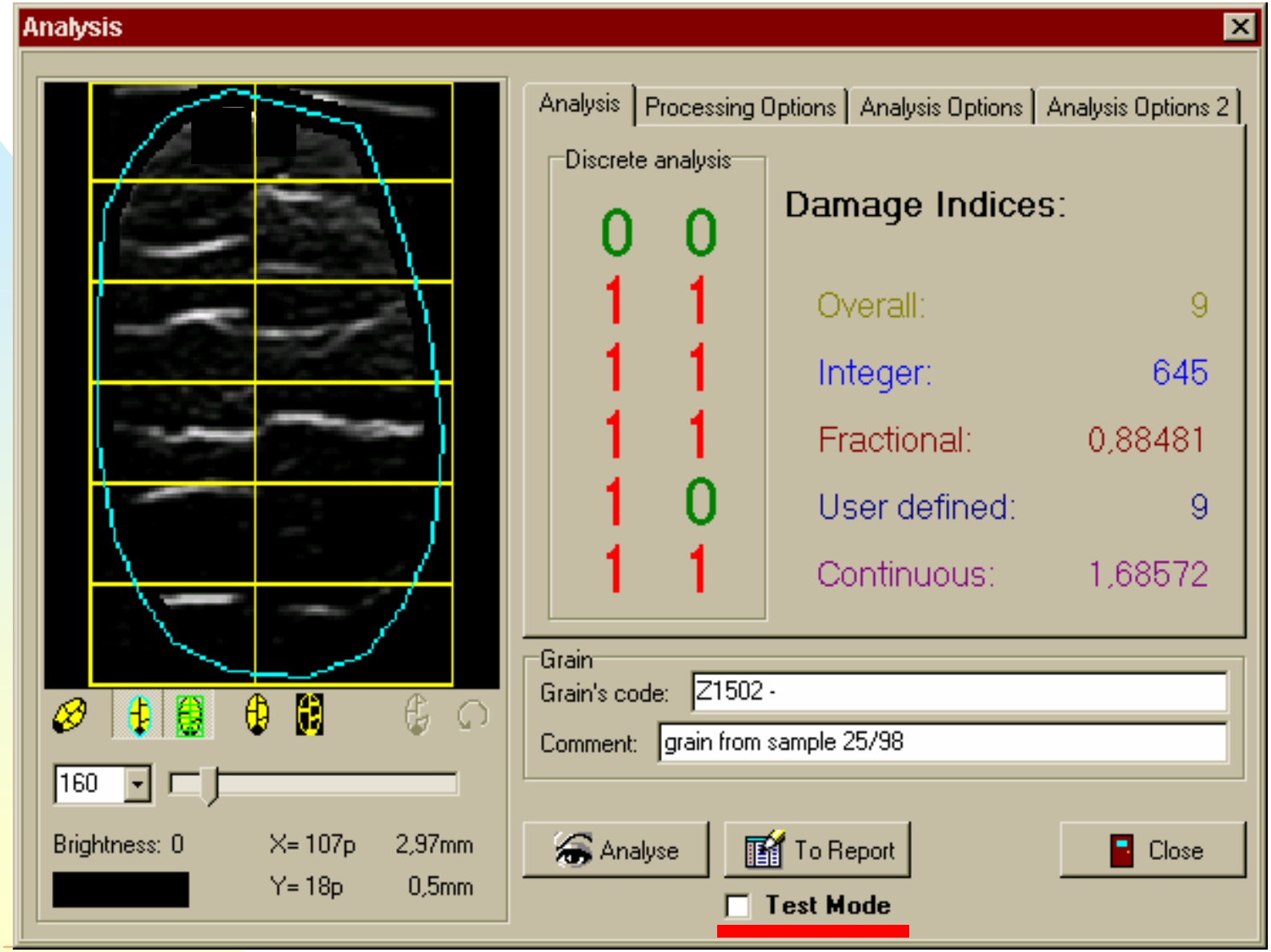


$$PDI = \sum_i \sum_j w_j d_{ij}$$

Quantification of kernel damages



Automatic PDI calculation in GRAINS II



Software package GRAINS - *main capabilities*

- Menu driven (works in Windows 95)
- Loads and displays X-ray grain images (axonometric projections, pseudo-colours)
- Measurements of main grain geometric features (e.g., area, shape factors)
- Computes image statistics (e.g., image histogram, mean, median of grain image)
- Calculates grain damage indices
- Generates spreadsheets

Software package GRAINS II - *main capabilities*

- menu driven (works in Windows 95/98/NT)
- loads and displays X-ray grain images
- **automatically calculates grain damage indices**
- generates reports (including comparisons between automatic and “manual” PDI quantification)
- features simple **IP** (Image Processing) script language
- provides easy link to GRAINS package

Analysis results*

v_1	v_2
1	1
0	0
0	0
1	1
1	0
0	0
1	1
0	1
0	0
1	1

PDI	Accuracy [%]
binary (Hamming)	84,5
Overall	91,7
Integer	95,4
Fractional	95,4

*) for sample counting 108 annotated grain kernels

Conclusions

- ***GRAINS*** and ***GRAINS II*** are software packages specially developed for X-ray diagnostics of wheat kernels
- they are result of **interdisciplinary** effort
- ***GRAINS I/II*** can be suitable for analysis of other plant materials

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- advanced **computer vision** (i.e., *image processing + computational intelligence*)
  $\Rightarrow$ methods required for further advancements