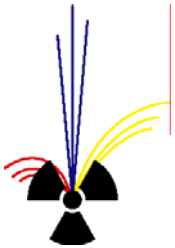


SVENSK FÖRENING FÖR RADIOFYSIK
Swedish Society of Radiation Physics
(Member of IUPESM)

Image quality
Technical/physical aspects

Nationella kvalitetsdokument för digital radiologi
AG1

Michael Sandborg och Jalil Bahar
Radiofysikavdelningen Linköping

2007-05-10

Requirements on QA-tests

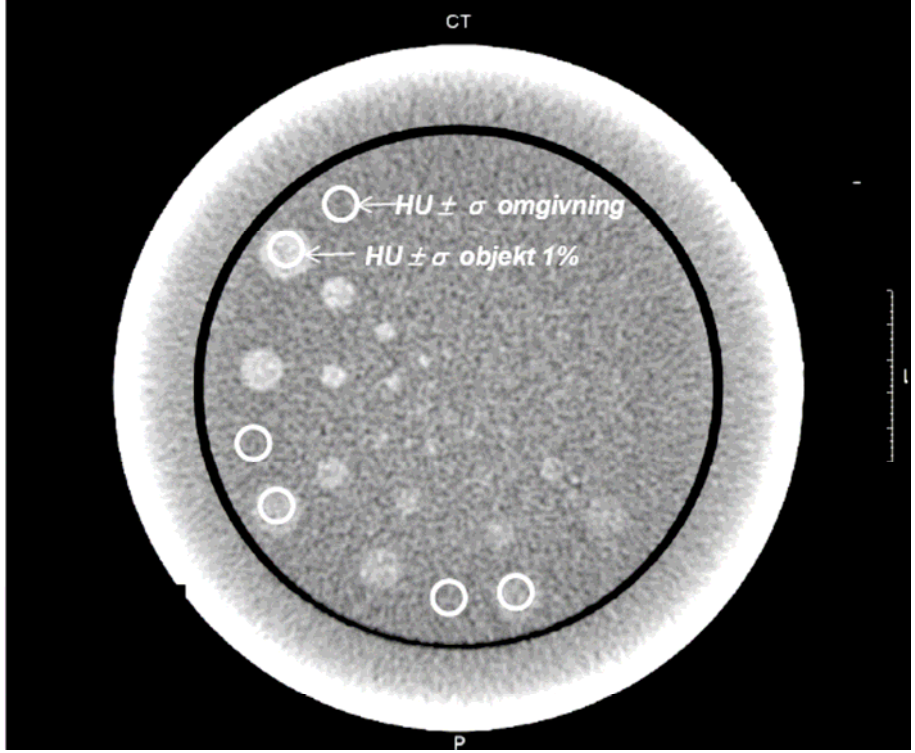
- Objective
- High precision
- Quick and simple
- Available
- (Universal and automatic)

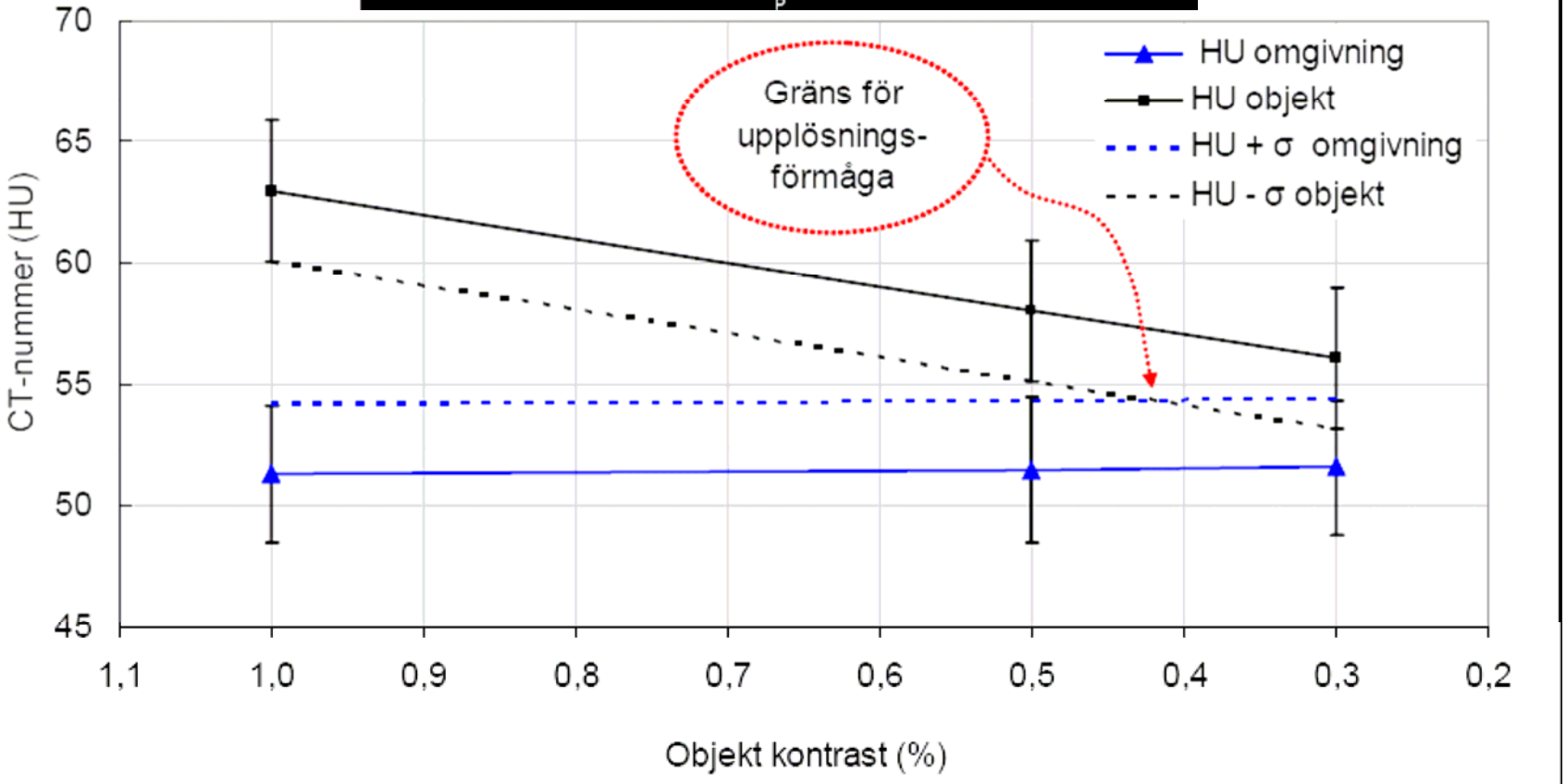
Inspiration from

Statens strålskyddsinstitut
Projekt P1069.98

Utvärdering av datortomografers doseffektivitet

Peter Hägglund, Rolf Johansson och Göran Wickman
Institutionen för strålningsvetenskaper Umeå Universitet


CT
HU ± σ omgivning
HU ± σ objekt 1%
P


70
65
60
55
50
45
CT-nummer (HU)
1,1
1,0
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
Objekt kontrast (%)
Gräns för upplösnings-förmåga
HU omgivning
HU objekt
HU + σ omgivning
HU - σ objekt

Method

- Objective measures to characterise imaging systems (or detector) performance exists
  - i.e. MTF, NPS, NEQ and DQE
  - Difficult to adapt and time-consuming
- but simple visual evaluation of test phantoms are often used in practice ...
  - # of visible low- and high-contrast details
  - Simple but rather imprecise (subjective)

Suggestion

- **LDI: Low-contrast Detection Index**

  is

  – Objective

  – Precise

  – Reproducible

  – Semi-quick?

Material

- Leeds To10 phantom (SN174)
- Philips Digital Diagnost (2001)
- 4 x 5 cm PMMA blocks
- Barracuda MPD kerma-meter
- Same image processing (Unique) ‘Bäcken’
- FDA=100 cm
- 25 x 25 cm field size
- No table top cushion
- Manuel exposure

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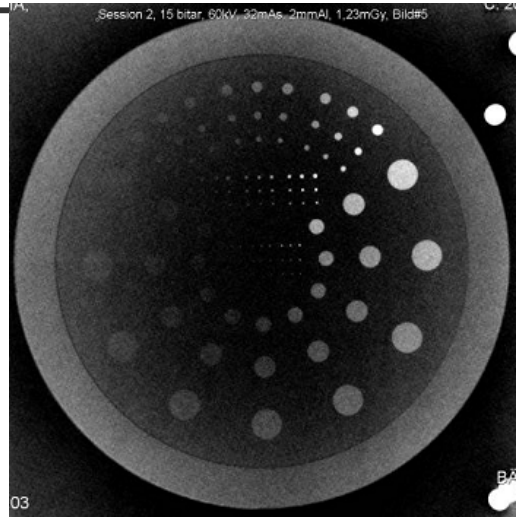
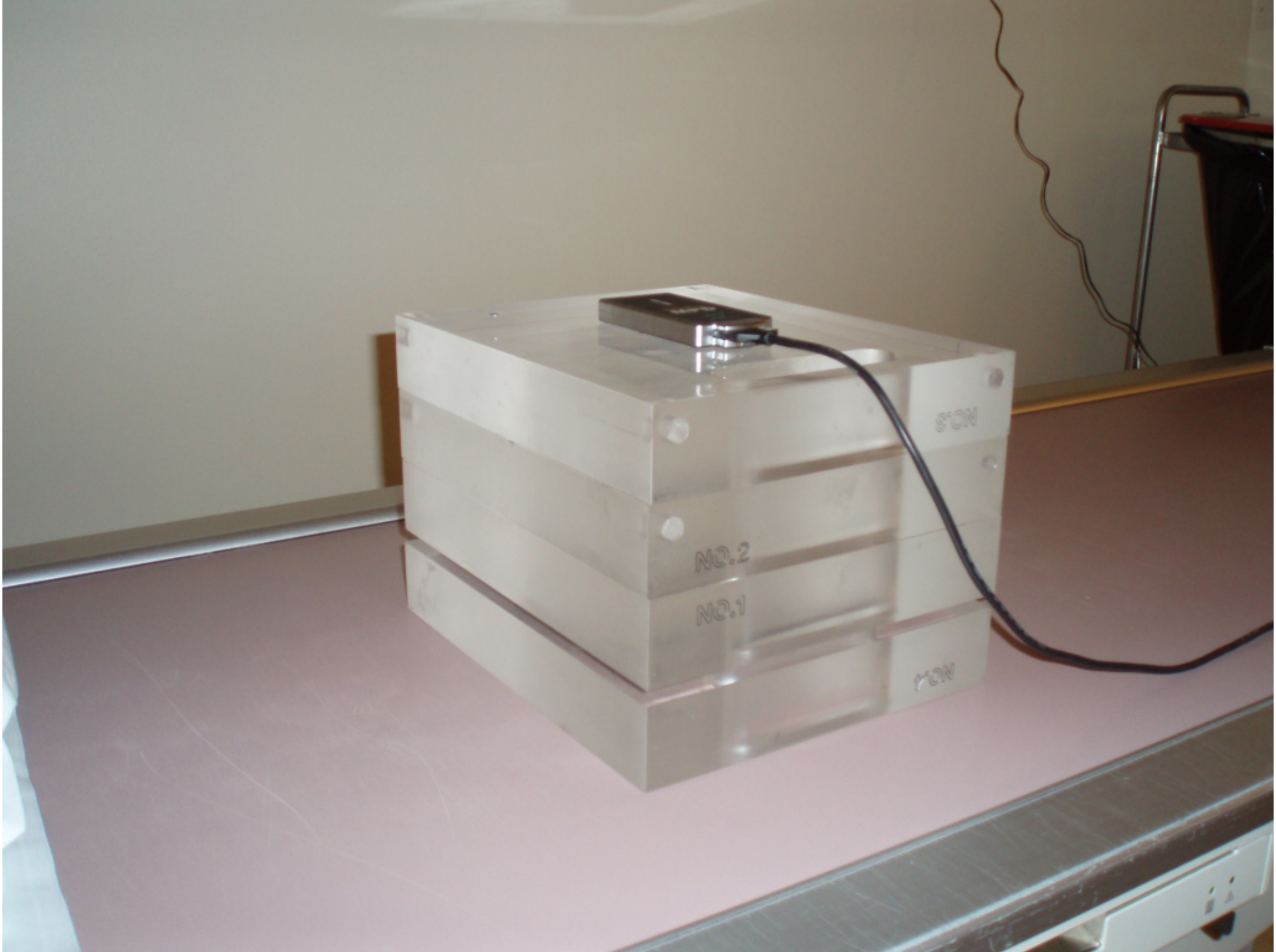
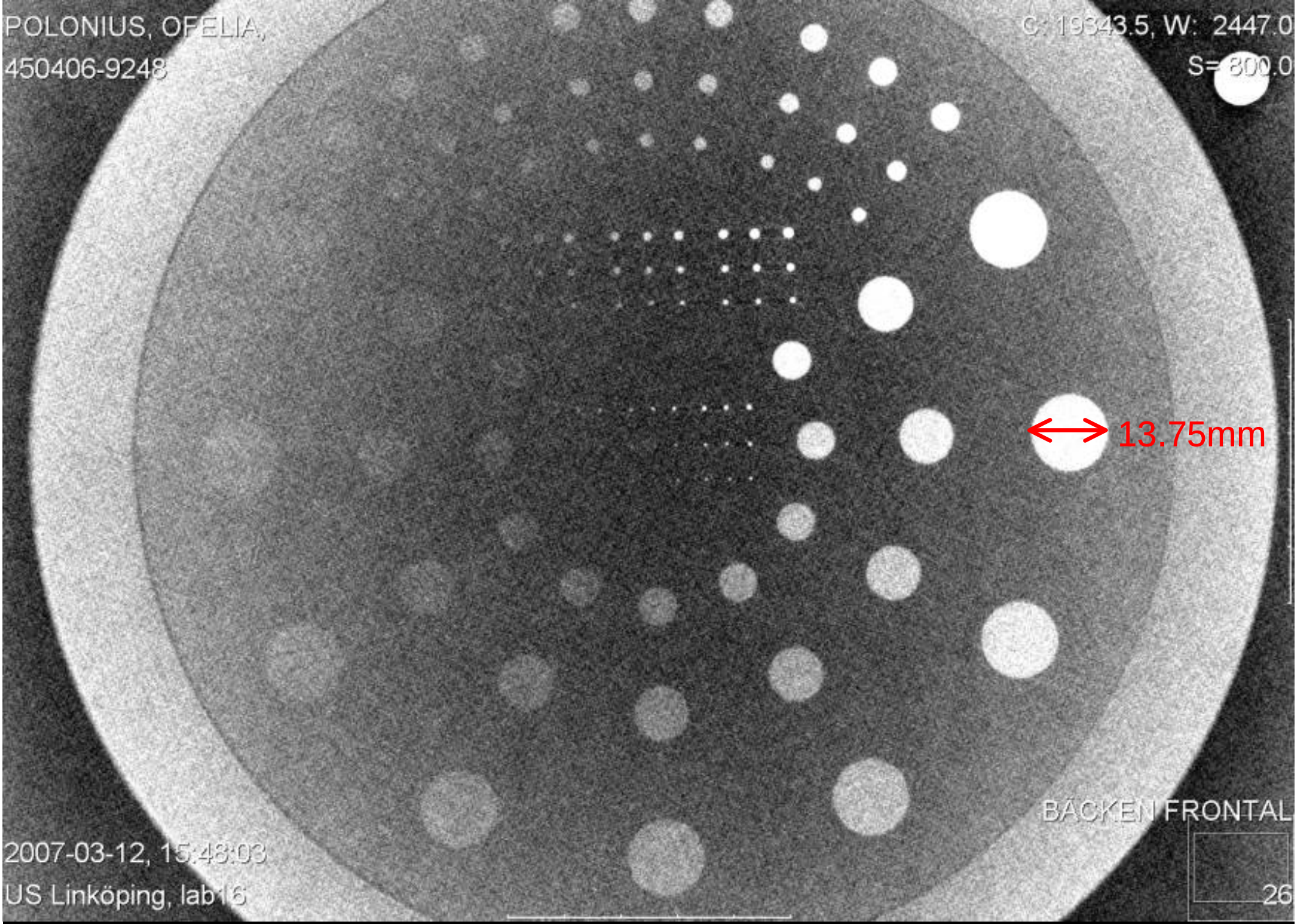
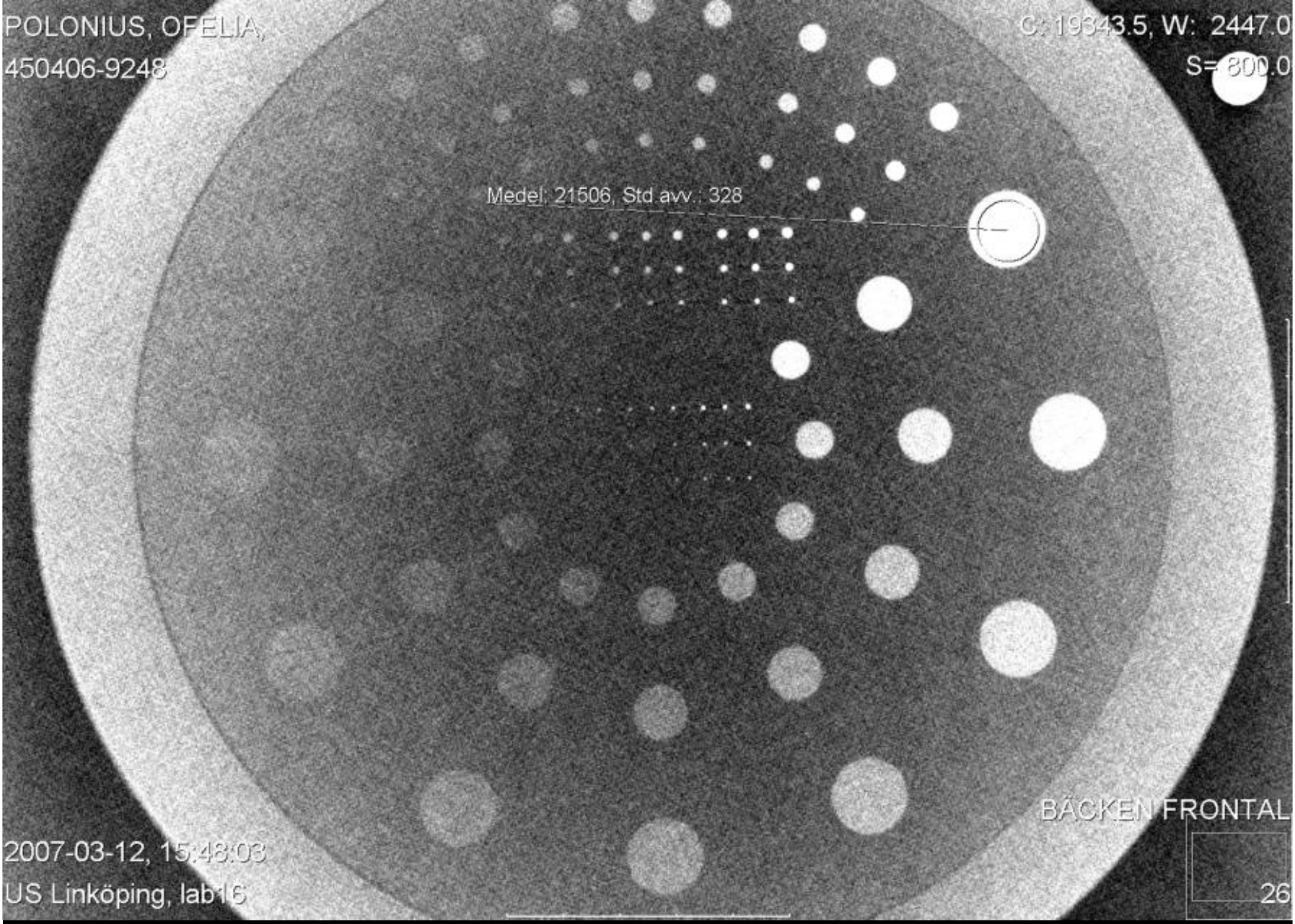


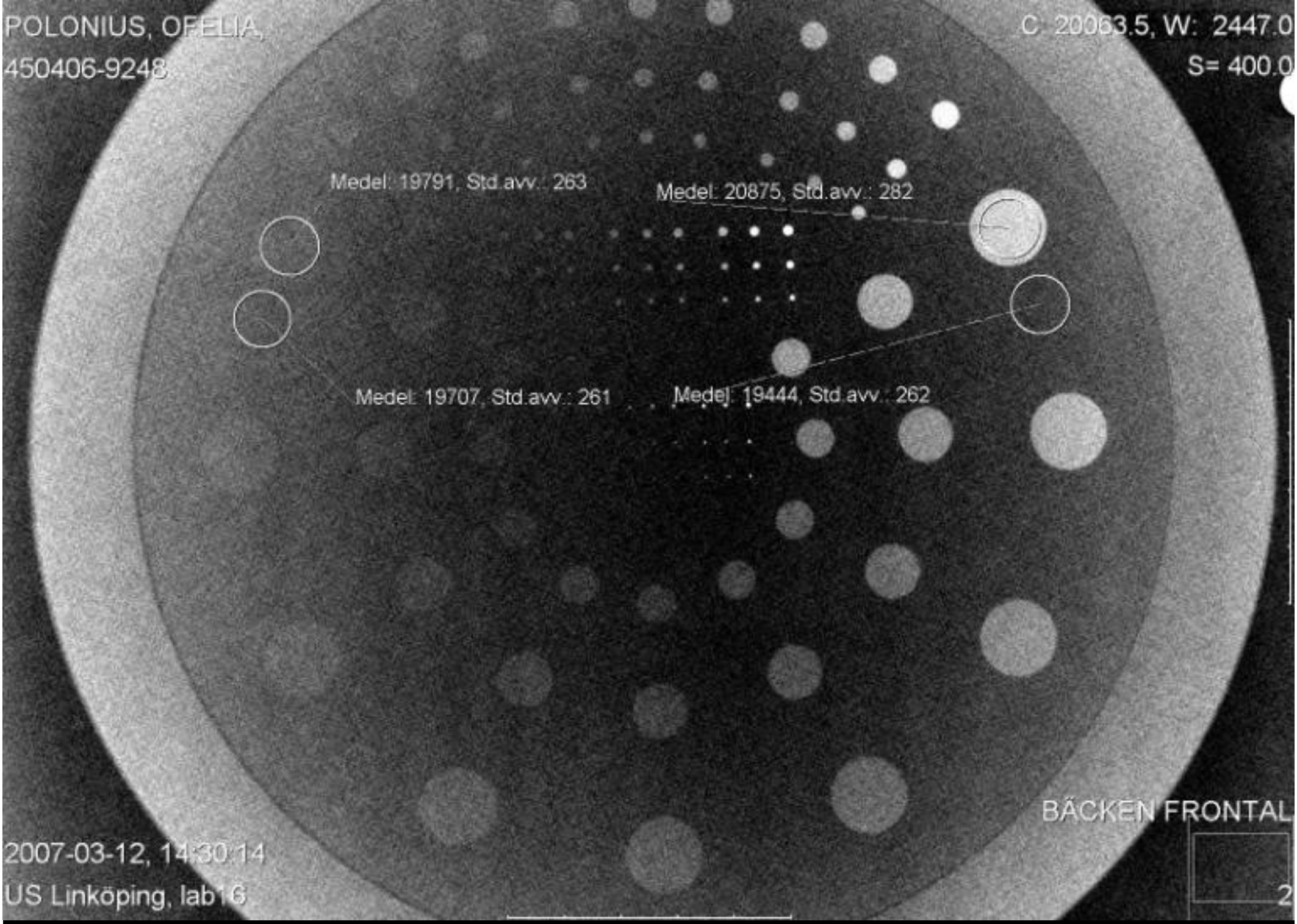

NO.2
NO.1



Zoom to pixel-to-pixel

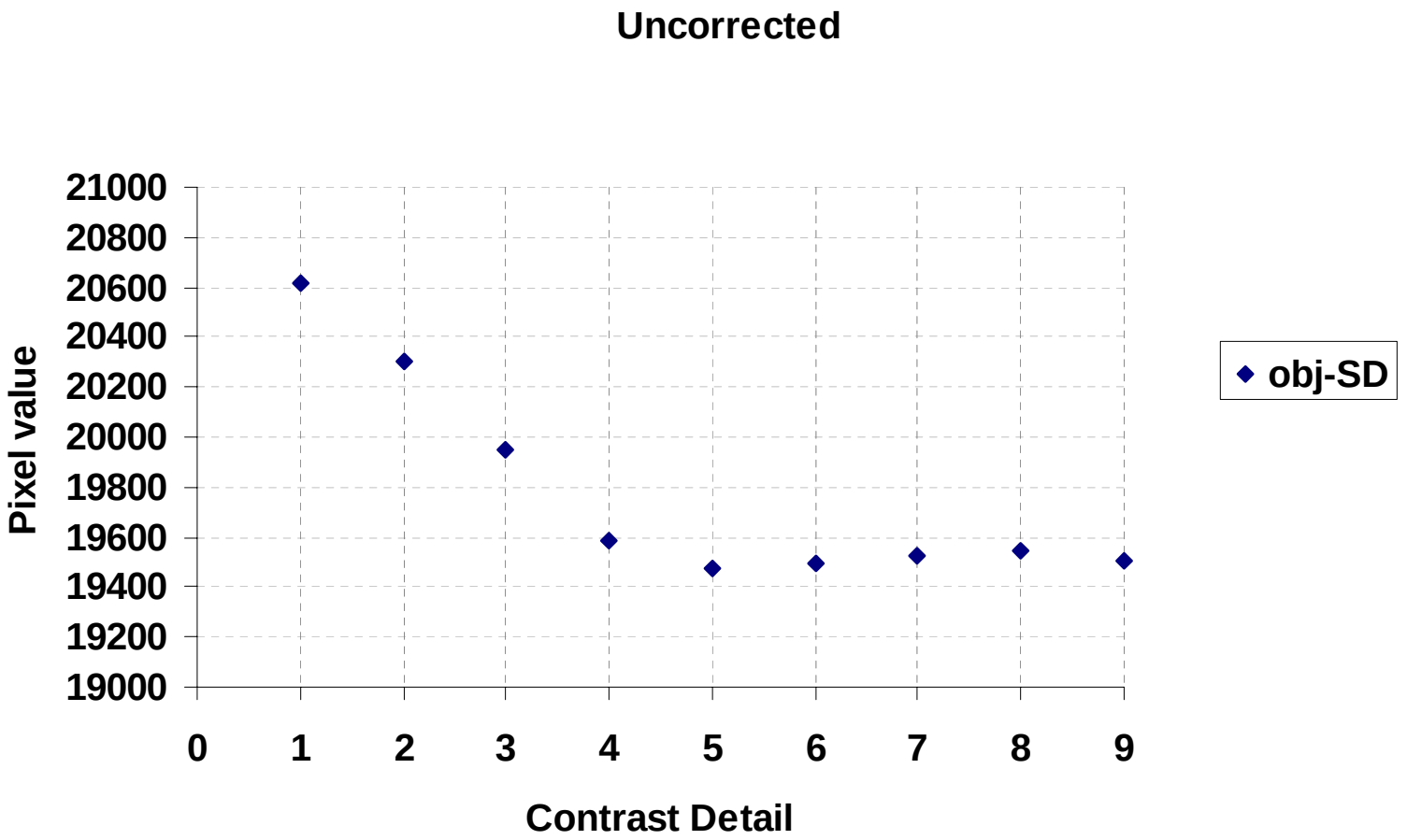


A circular ROI is applied. Average p.v. and s.d. is measured

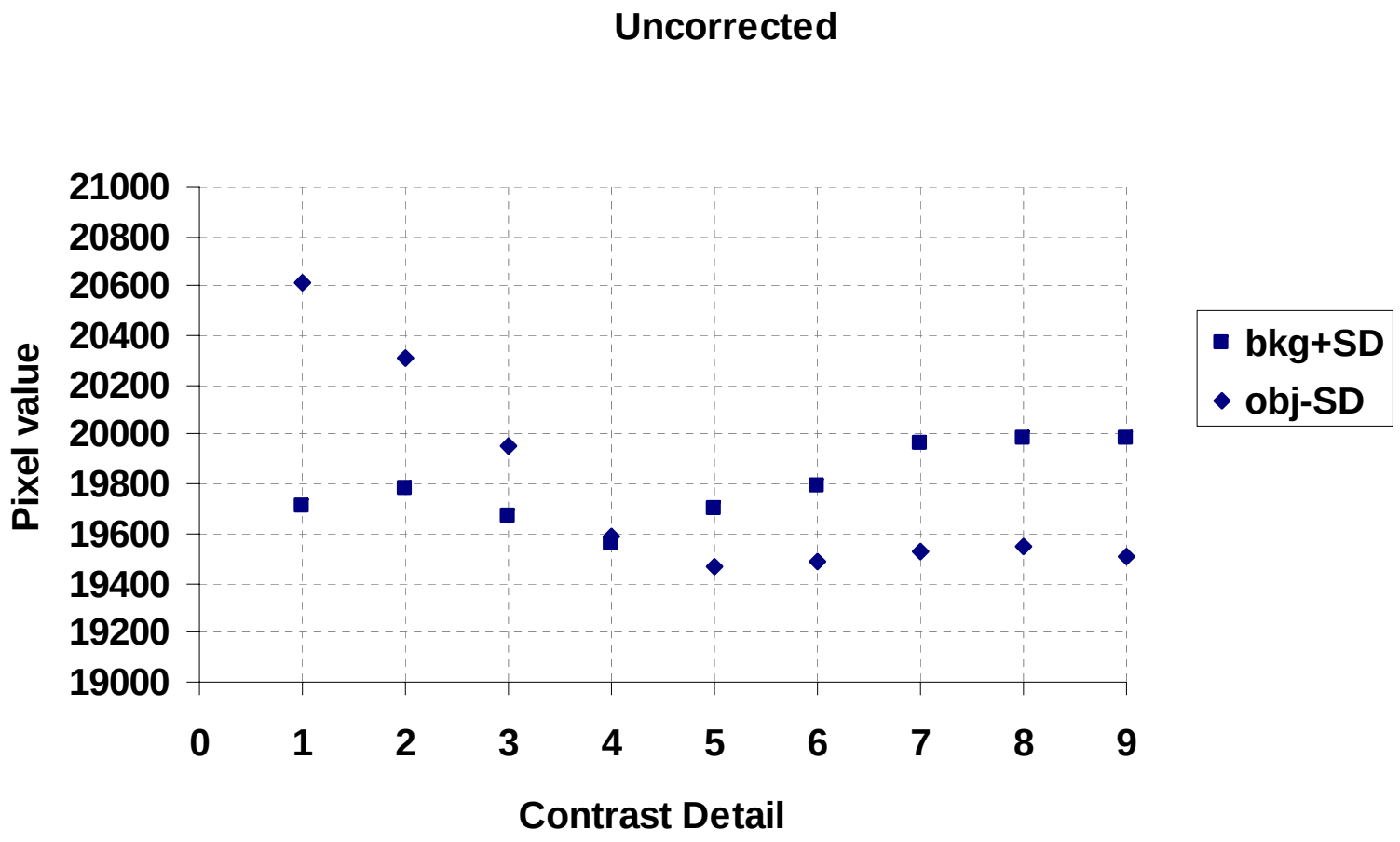


Measure p.v. and s.d. on top and beside the detail

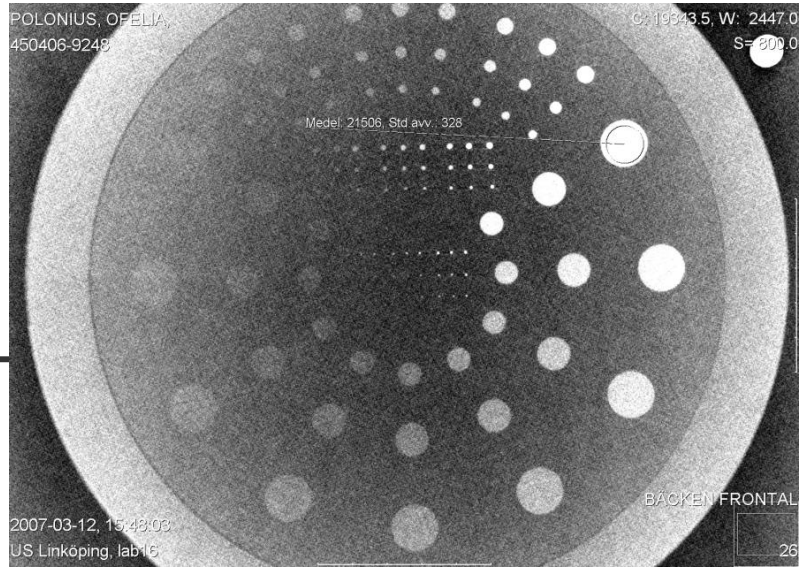
Method


Uncorrected
Pixel value
21000
20800
20600
20400
20200
20000
19800
19600
19400
19200
19000
0
1
2
3
4
5
6
7
8
9
Contrast Detail
obj-SD

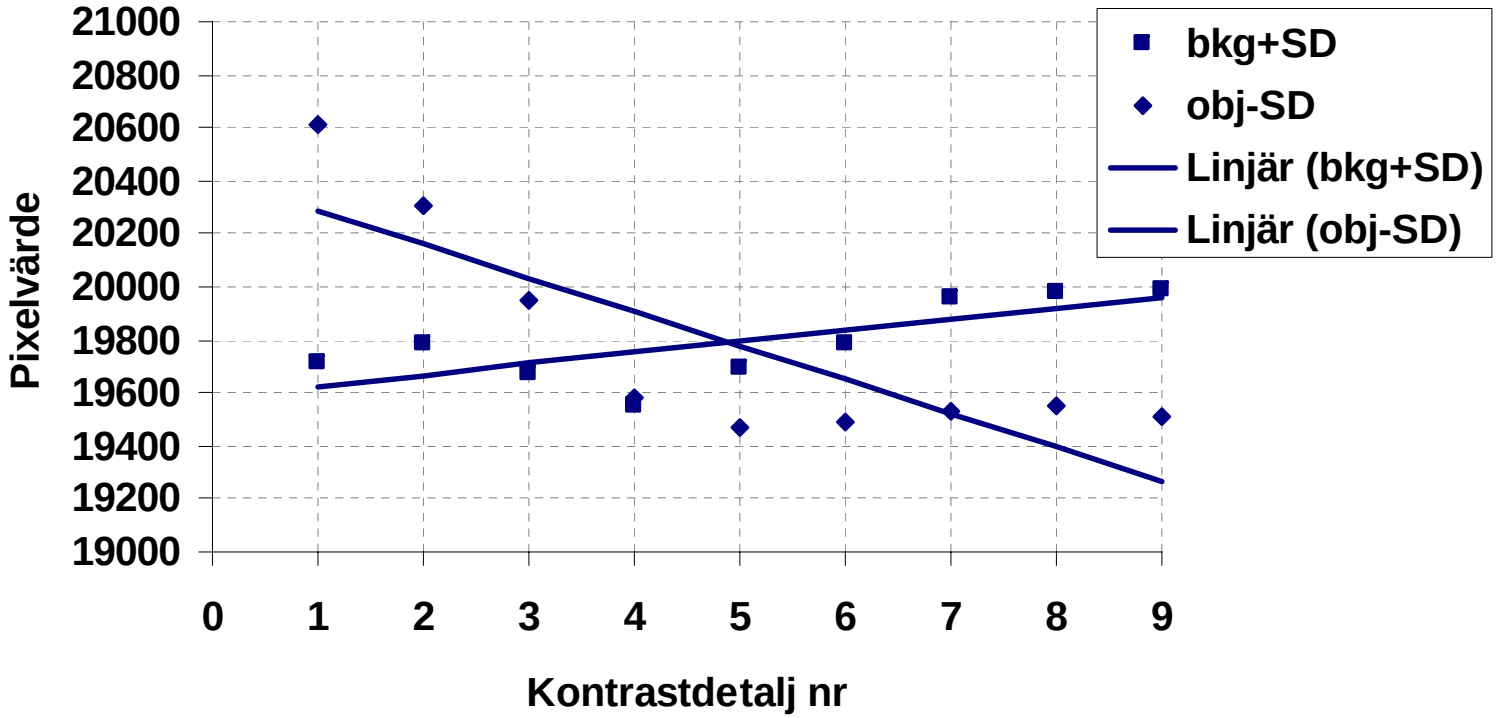
Method


Uncorrected
Pixel value
21000
20800
20600
20400
20200
20000
19800
19600
19400
19200
19000
0
1
2
3
4
5
6
7
8
9
Contrast Detail
bkg+SD
obj-SD

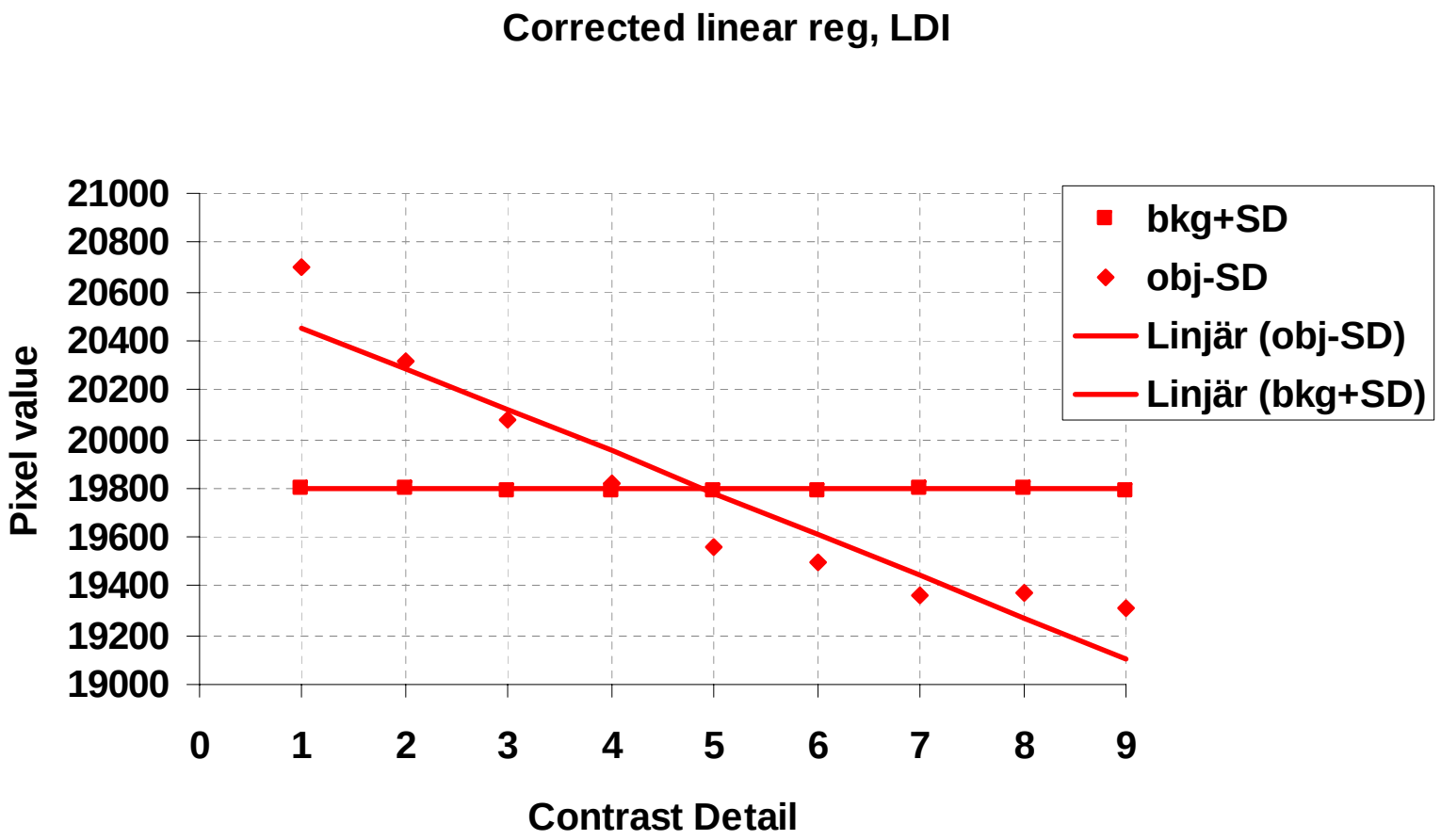
Method



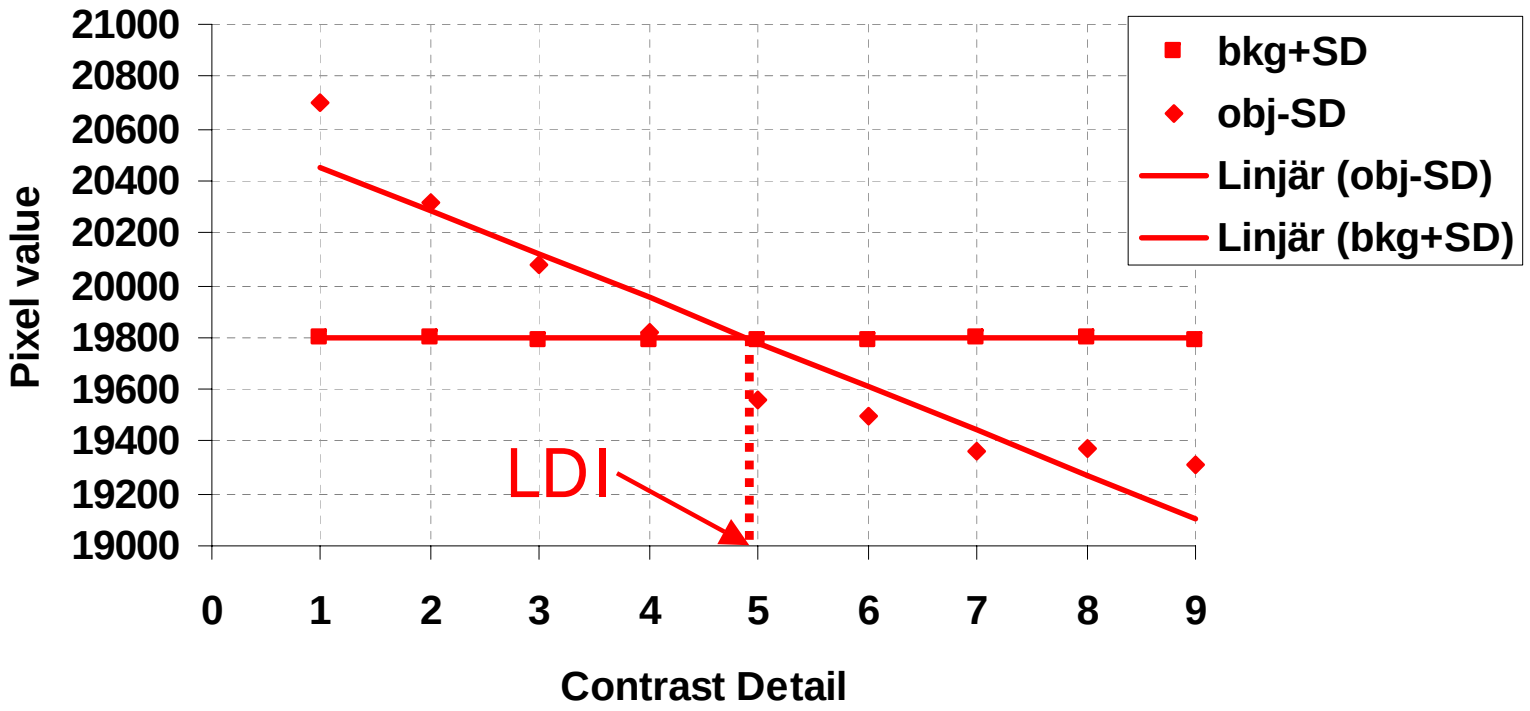
Uncorrected linear reg, LDI



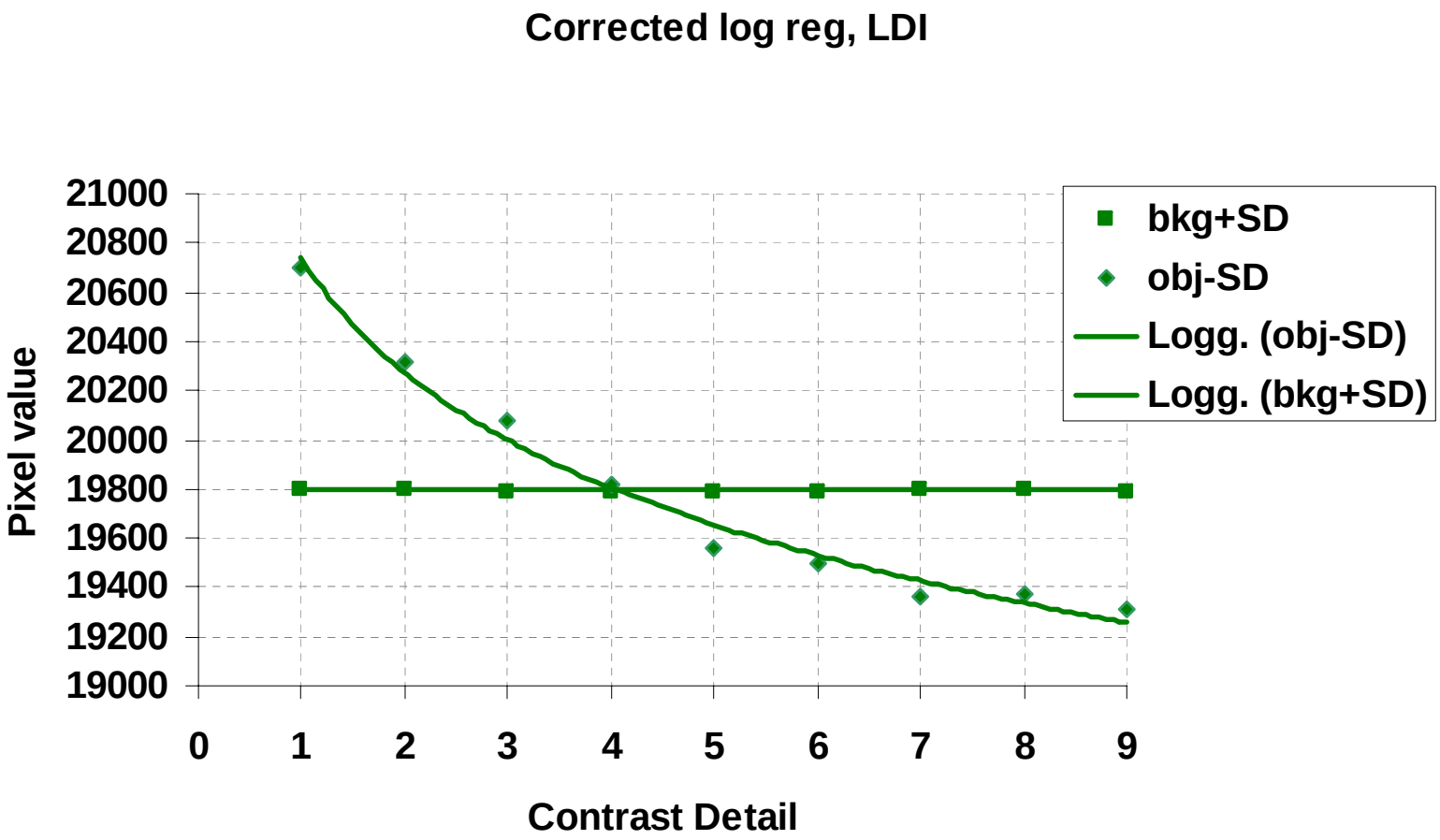
Method


Corrected linear reg, LDI
Pixel value
21000
20800
20600
20400
20200
20000
19800
19600
19400
19200
19000
0
1
2
3
4
5
6
7
8
9
Contrast Detail
bkg+SD
obj-SD
Linjär (obj-SD)
Linjär (bkg+SD)

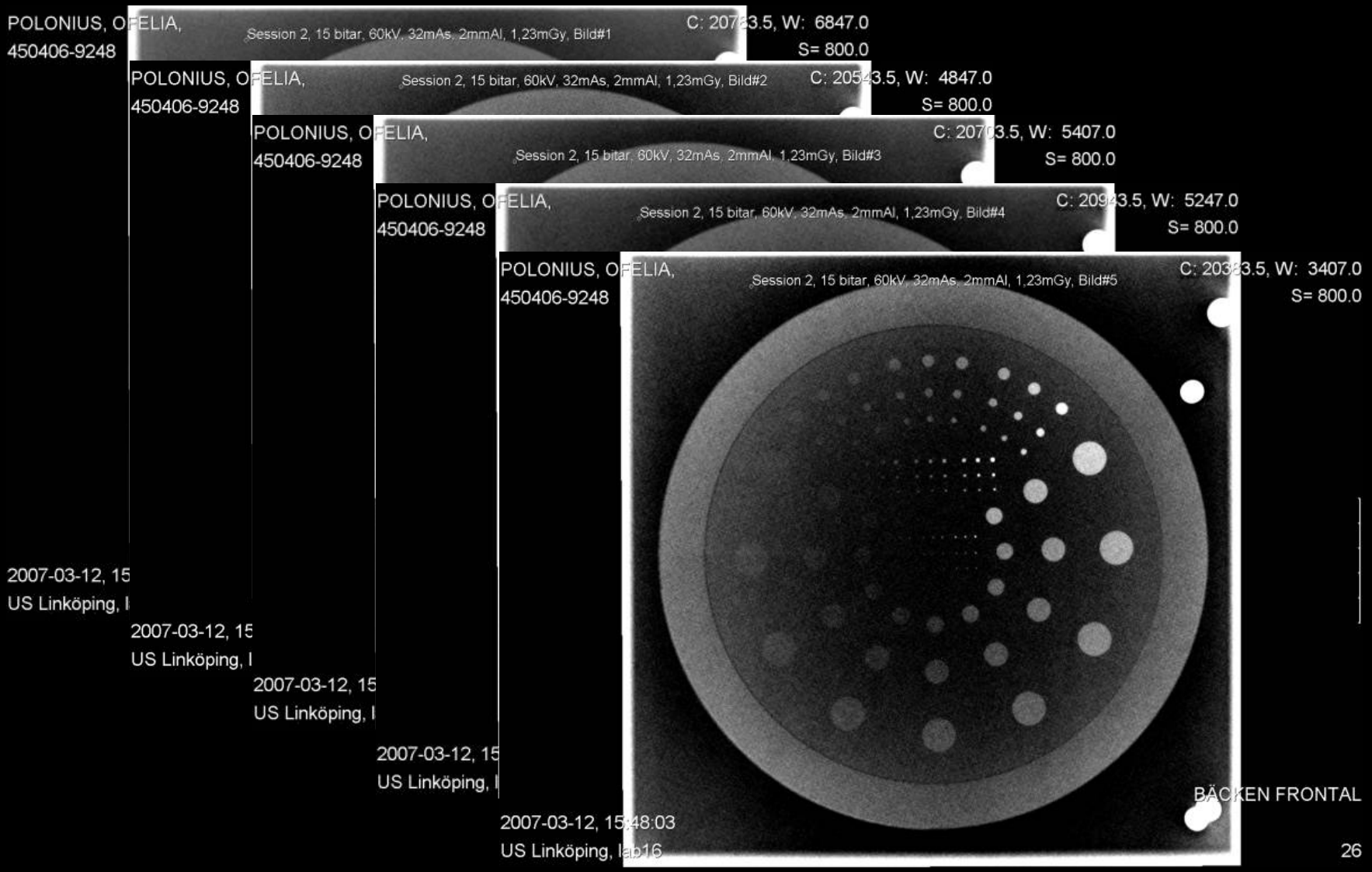
Method


Corrected linear reg, LDI
Pixel value
21000
20800
20600
20400
20200
20000
19800
19600
19400
19200
19000
0
1
2
3
4
5
6
7
8
9
Contrast Detail
LDI
bkg+SD
obj-SD
Linjär (obj-SD)
Linjär (bkg+SD)

Method

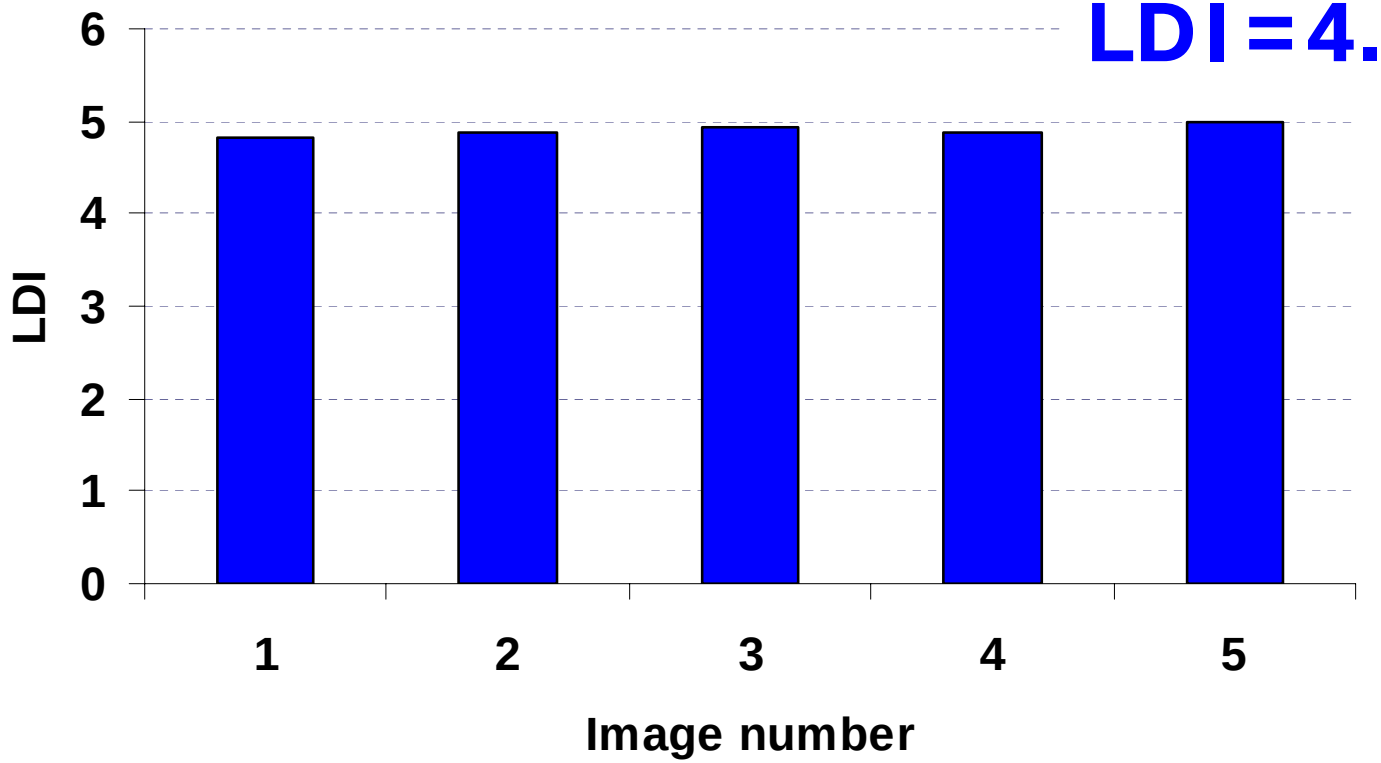

Corrected log reg, LDI
Pixel value
21000
20800
20600
20400
20200
20000
19800
19600
19400
19200
19000
0
1
2
3
4
5
6
7
8
9
Contrast Detail
bkg+SD
obj-SD
Logg. (obj-SD)
Logg. (bkg+SD)

Repeat 3-5 times

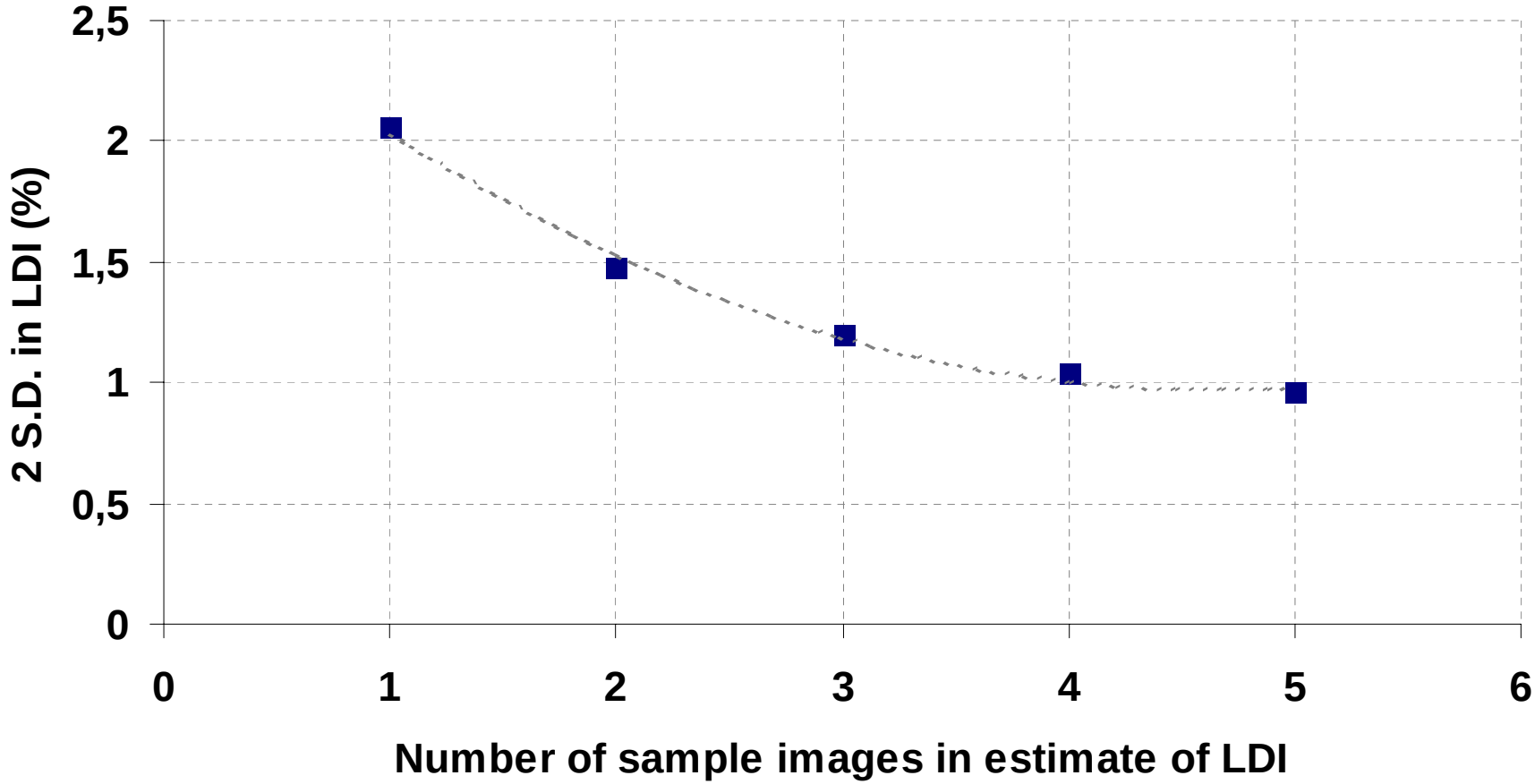


Method

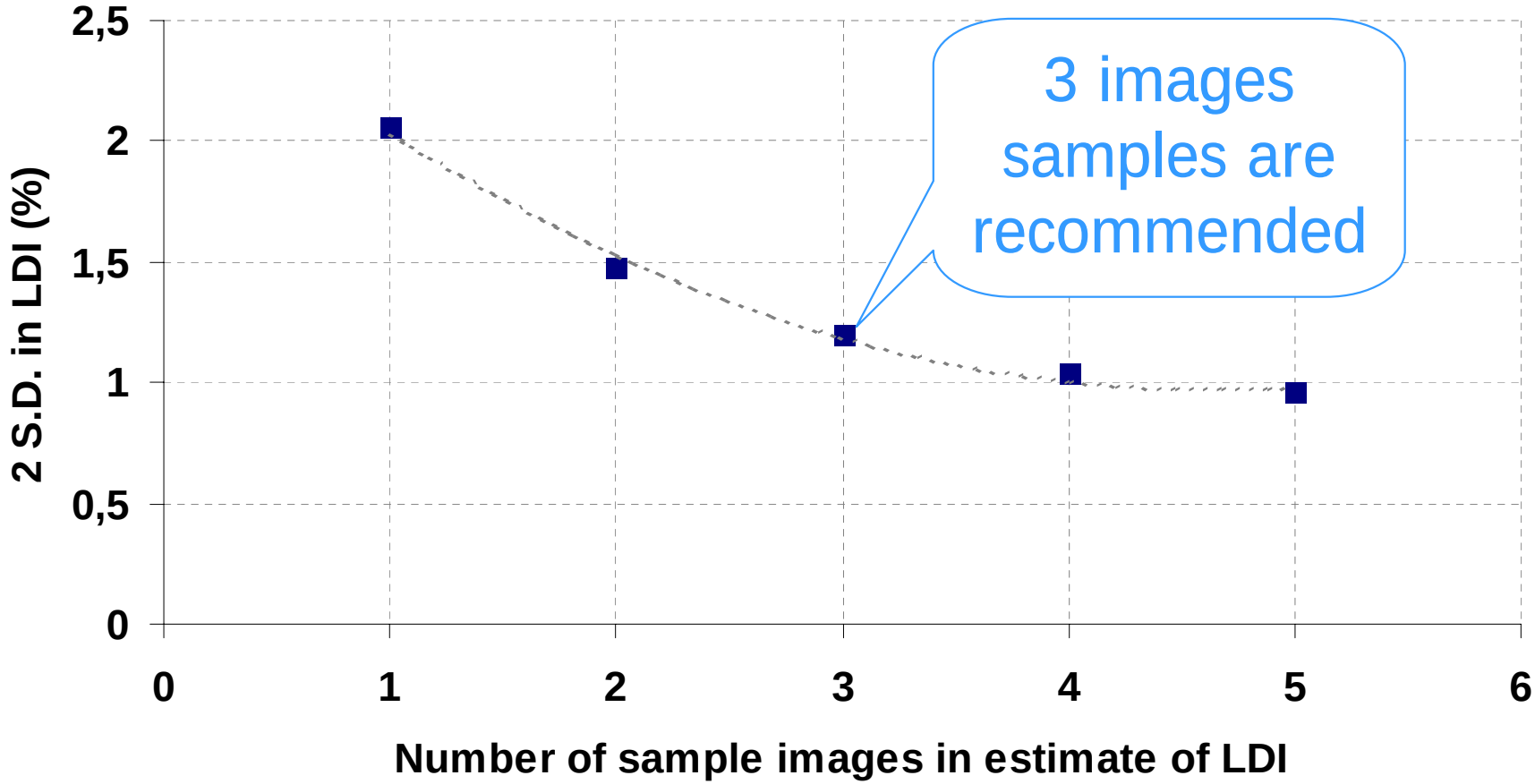
5 image samples



Results: Uncertainty



Results: Uncertainty



Uncertainty

Michael Sandborg och Jalil Bahar Radiofysikavdelningen Linköping

Uncertainty

- Uncertainty is stable with
  - Bit-depth
  - Detector dose

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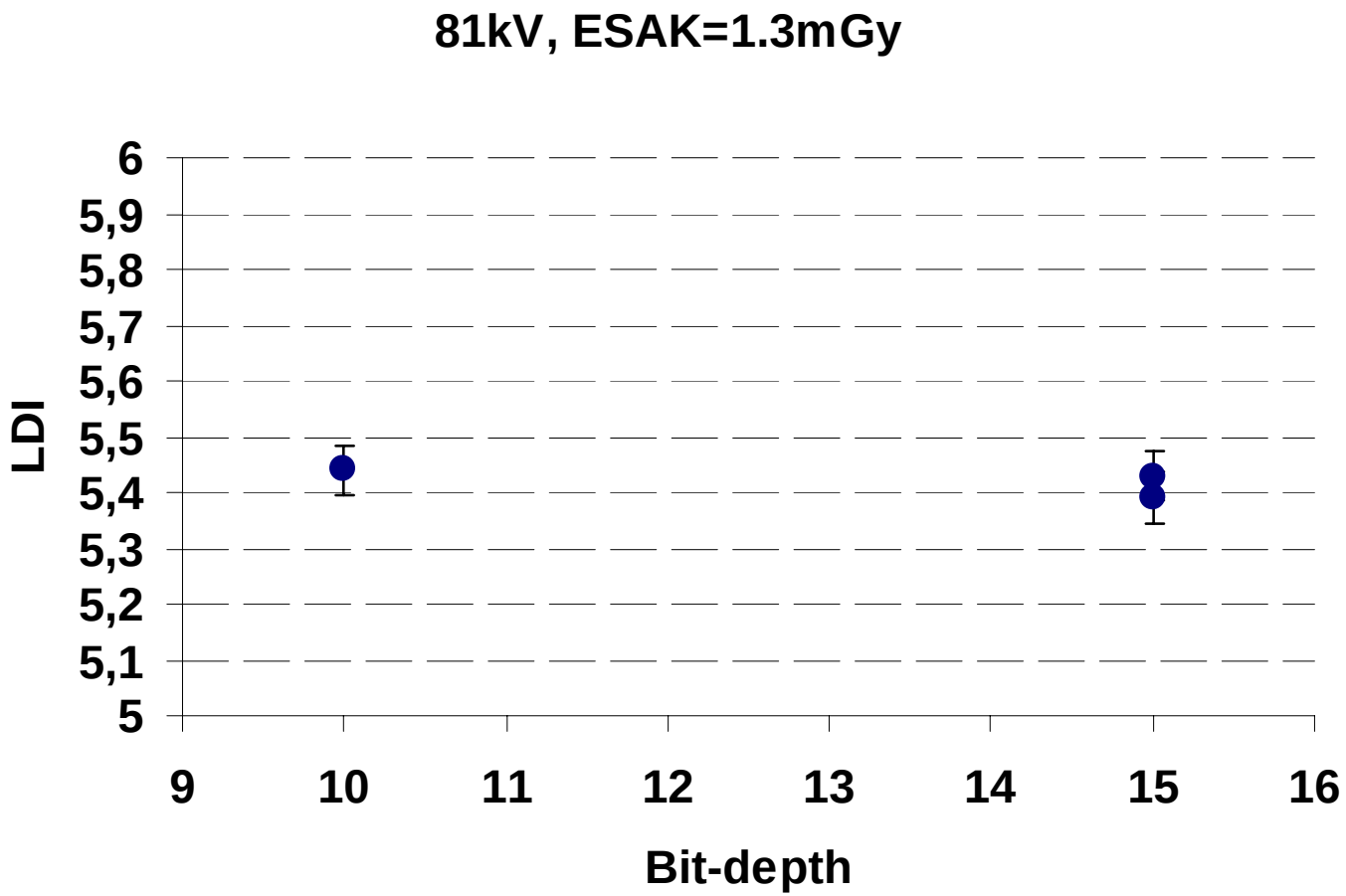
Applications / tests of method

- LDIs dependence on
  - bit-depth
  - kV
  - ESAK

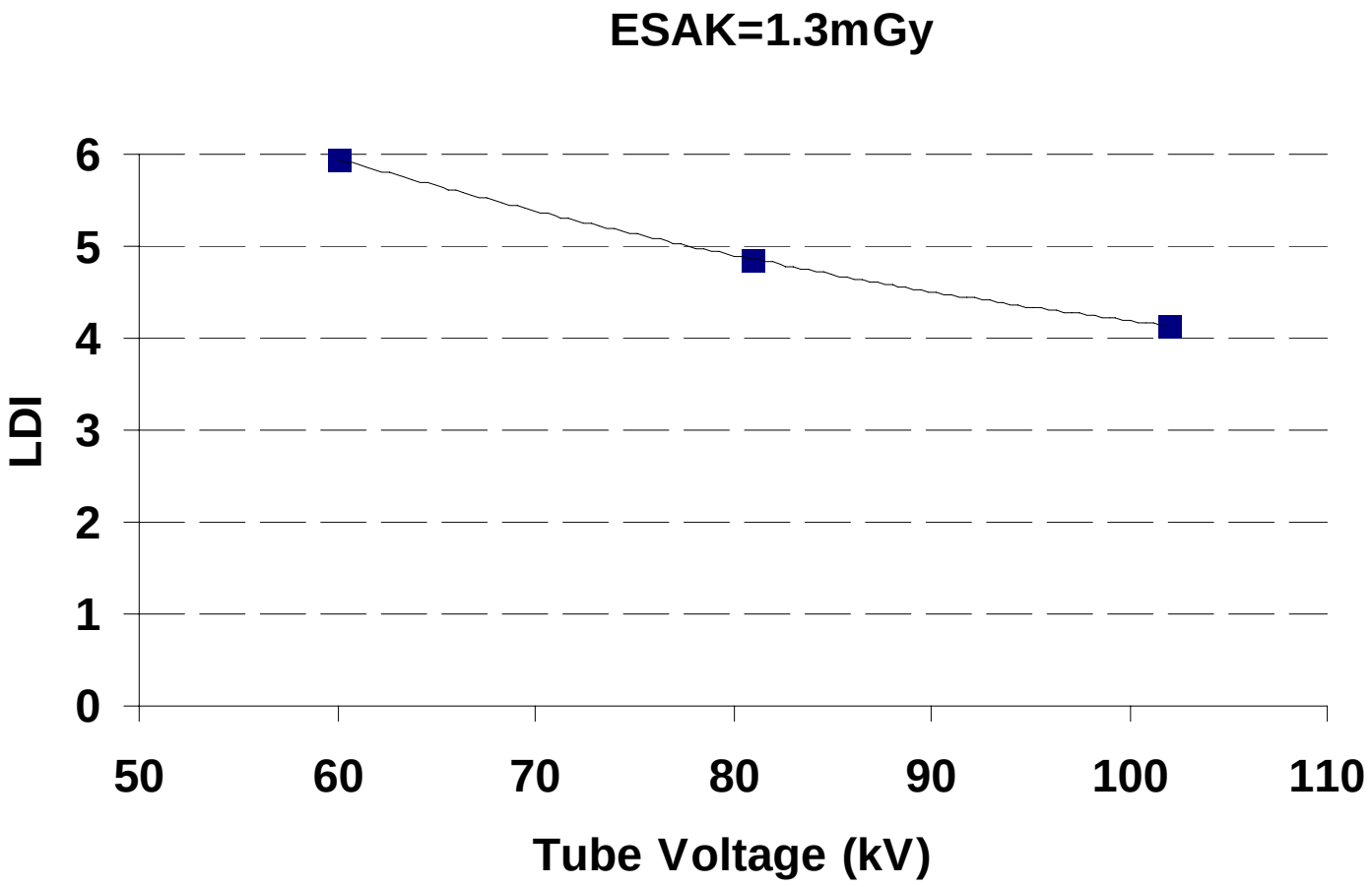
Results: Different Bit depth



Mann-Whitney
p=0.91

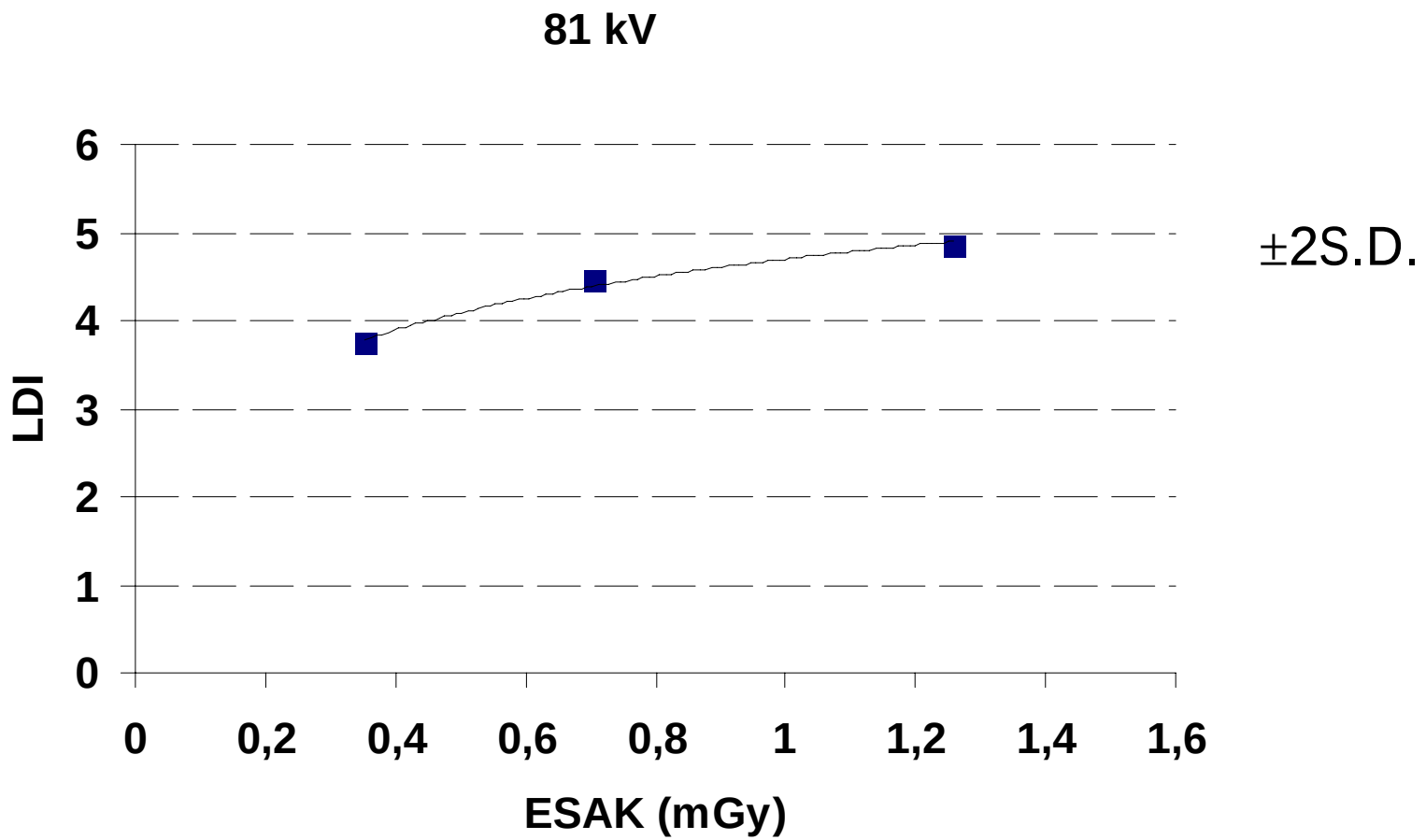
±2S.D.

Results: Different kV



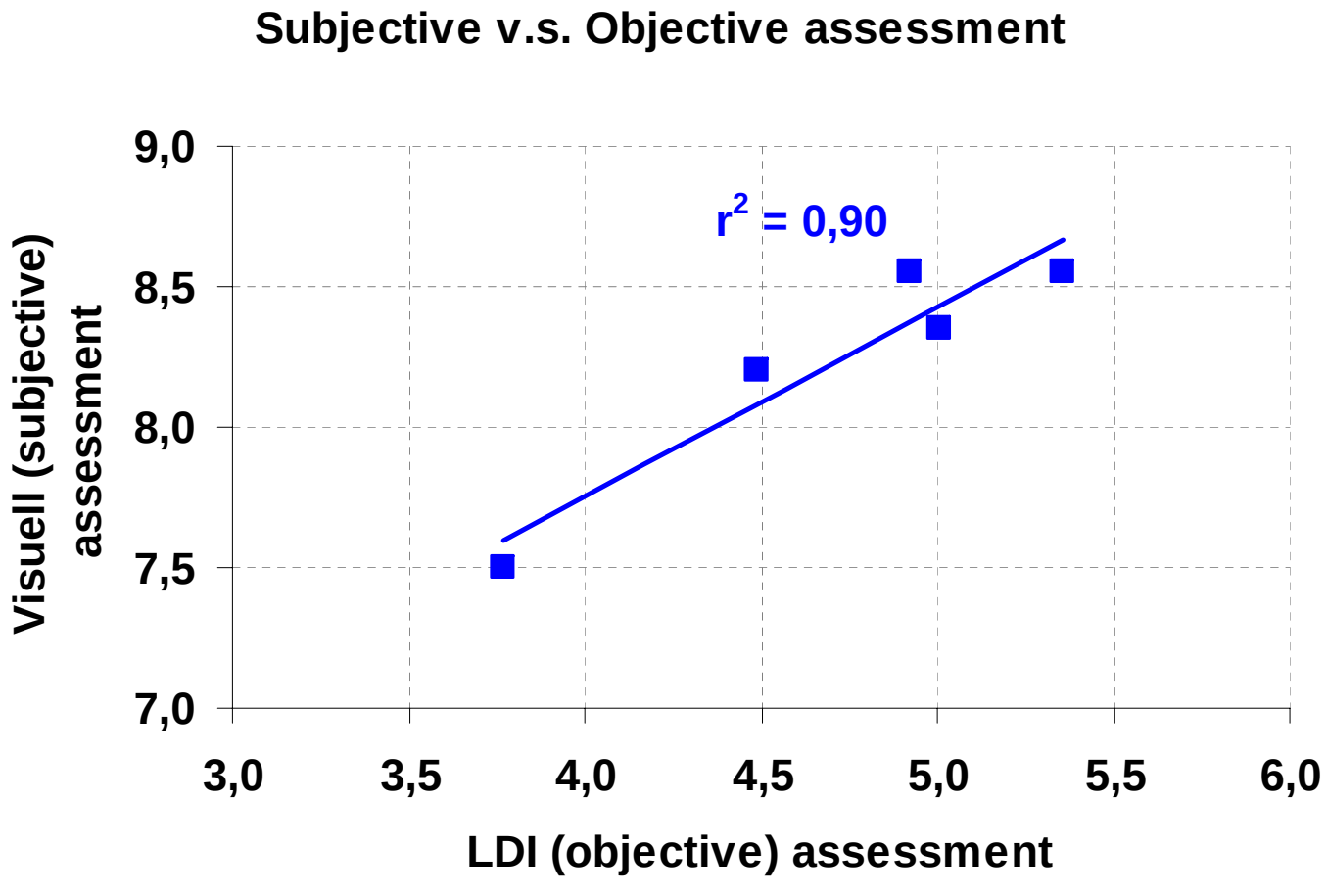
±2S.D.

Results: Different ESAK



±2S.D.

Results: Correlations



Conclusions and further work

- LDI method seem ´appropriate´ for QA-test
- Further tests and validations of sensitivity to different
  - image processing schemes
  - dynamic range of image data
  - X-ray units
  - sizes of contrast detail
  - test phantoms
- Automatic image assessment with software

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Comments ? !

Comments ? !

- Please send comments and suggestions for improvement to
  - Jalil.Bahar@lio.se or
  - Michael.Sandborg@lio.se