

Energy Dependence in Dental Imaging with Medipix 2

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Outline



- Purpose
- Dental imaging with Medipix2
- Narrow energy window imaging
- Influence of tissue
- Discussion about energy and flat field corrections
- Discussion about charge sharing influences in imaging

Purpose

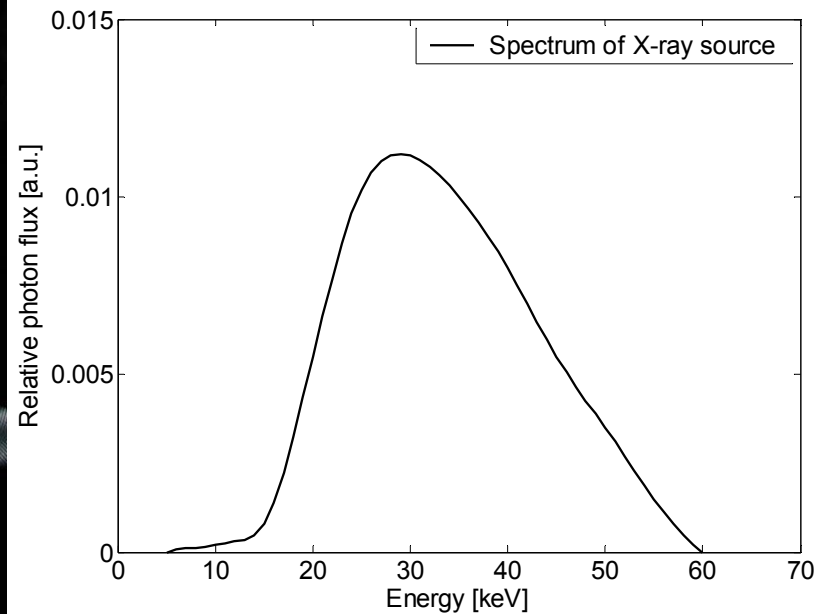
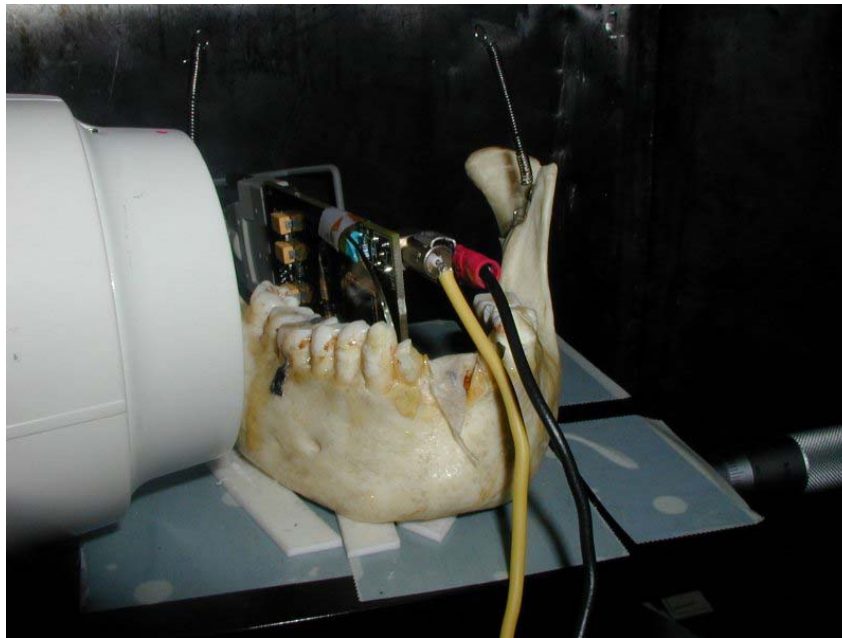


- Is it possible to increase the achieved contrast in images taken with a wide energy dental source by applying the energy discrimination in Medipix2?
 - Increased contrast -> possibility to decrease the dose delivered to patients.
- Can Medipix2 be used as a tool in development of sources for medical imaging applications?

Experiment

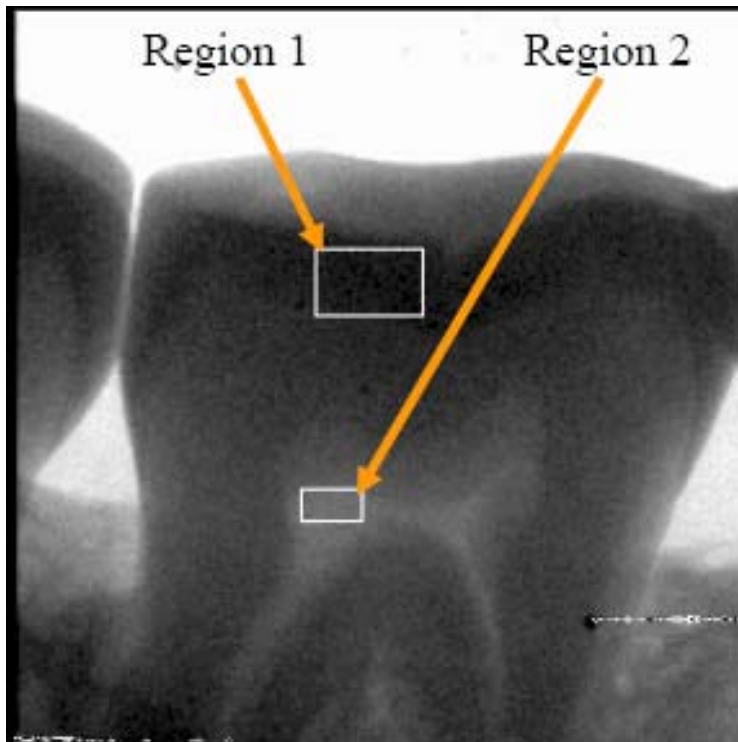


- **Dental X-ray source 70 kV**
- **Medipix2 silicon detector system**



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Dental images

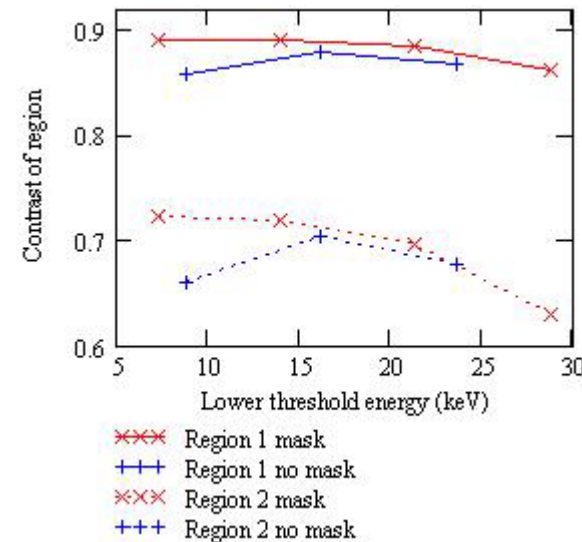


- Image quality
 - Many ways to measure
 - Signal to noise ratio (SNR) relates to necessary dose
- Here:
 - The achieved contrast is evaluated for two regions with high respective low absorption.
 - Contrast is not dose dependent

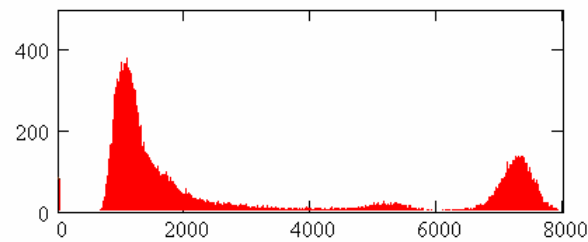
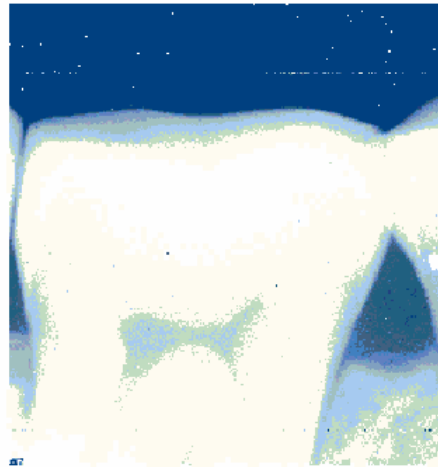
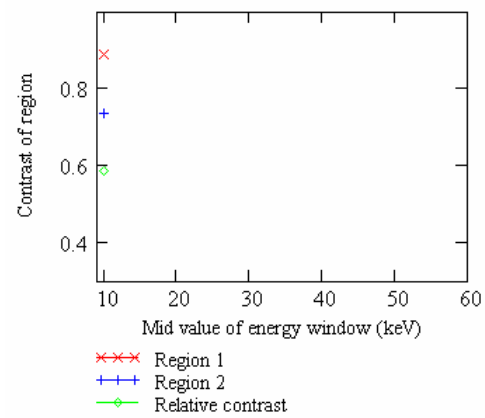
Photon counting



- Photon counting with selectable energy thresholds adjustable for all pixels
 - Without mask the contrast decreases when the low threshold setting is close to the noise edge
 - The tooth is more transparent to higher X-ray energies



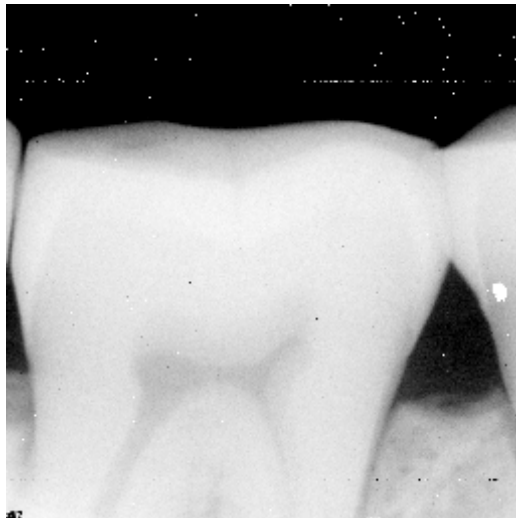
Energy interval ≈ 4 keV



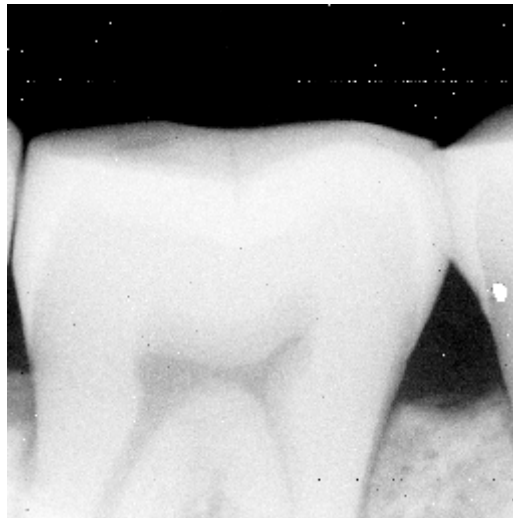
ENERGY = 9.85 keV

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Energy interval images



8 - 10 keV



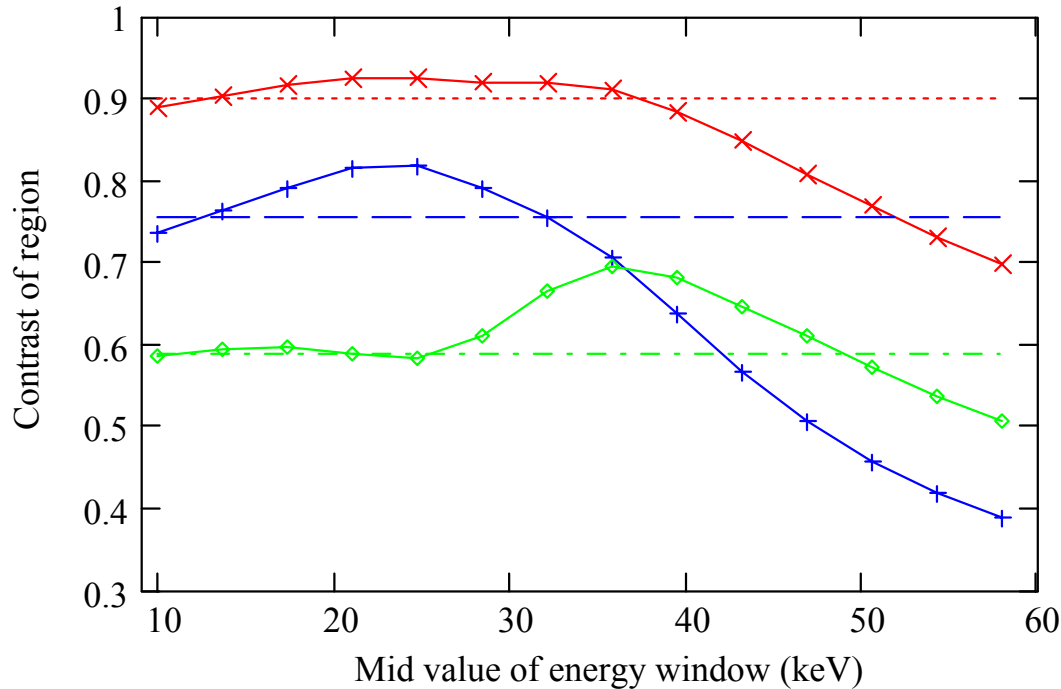
34 -38 keV



56 - 60 keV

- The absorption in the tooth decreases when the photon energy increases

Energy interval contrast



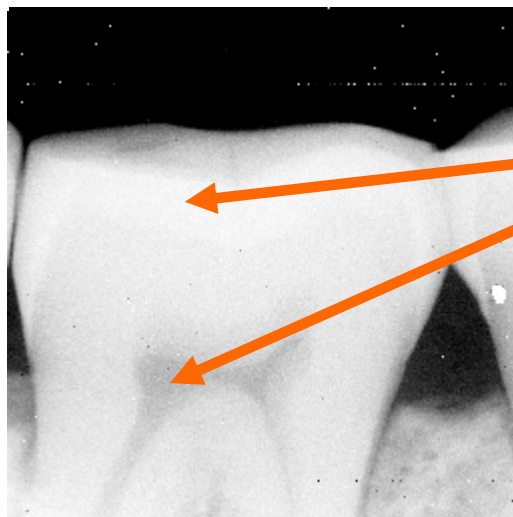
- Region 1
- Region 2
- Relative contrast
- Region 1 full spectra
- Region 2 full spectra
- Relative contrast full spectra

Maximum relative contrast when region 2 starts to become transparent

Inverval or full spectra



- The relative contrast can be improved by applying an energy interval in dental imaging

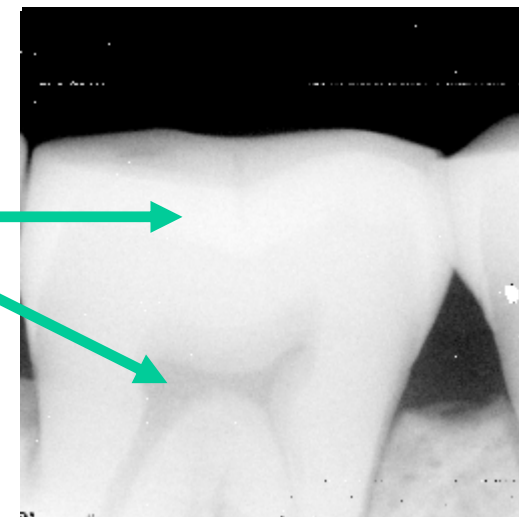


34 - 38 keV

Relative contrasts

0.70

0.59



8 - 70 keV

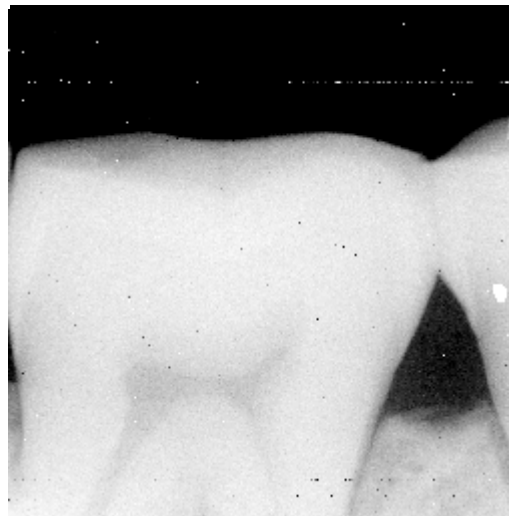
Water influence



- 10 mm water in front of source to imitate scattering and absorption in tissue.



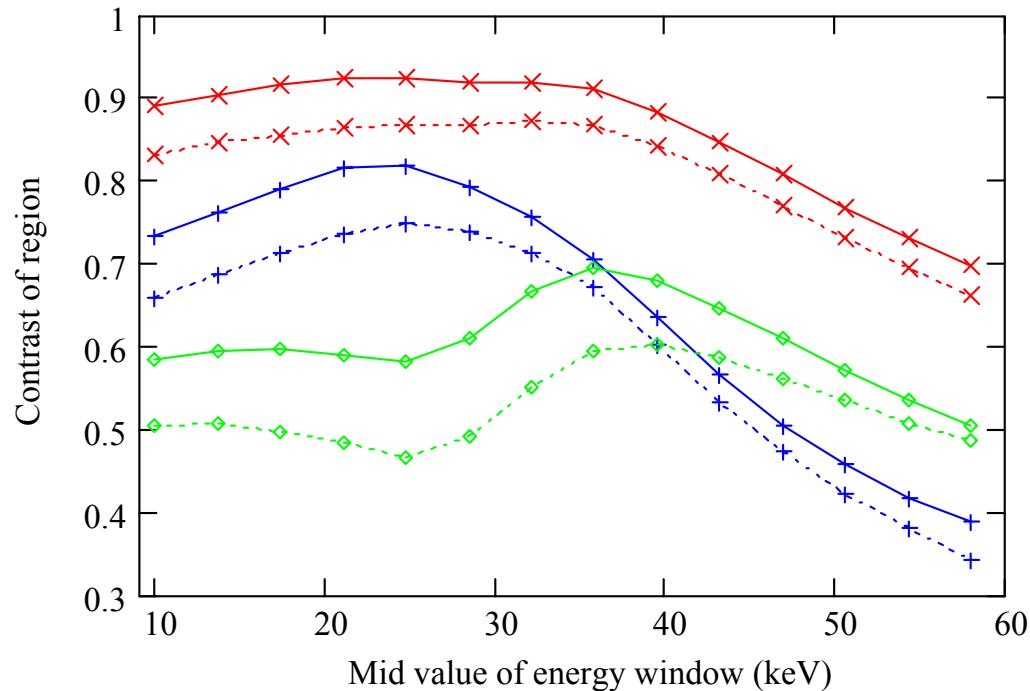
Without water



With water

Number of counts
outside object
decreases 46 %

Contrast with water



- ××× Region 1
- ××× Region 1 water
- +++ Region 2
- +++ Region 2 water
- ◇— Relative contrast
- - -◇- - Relative contrast water

The contrast decreases
Maximum contrast shifts to higher energies

Image correction

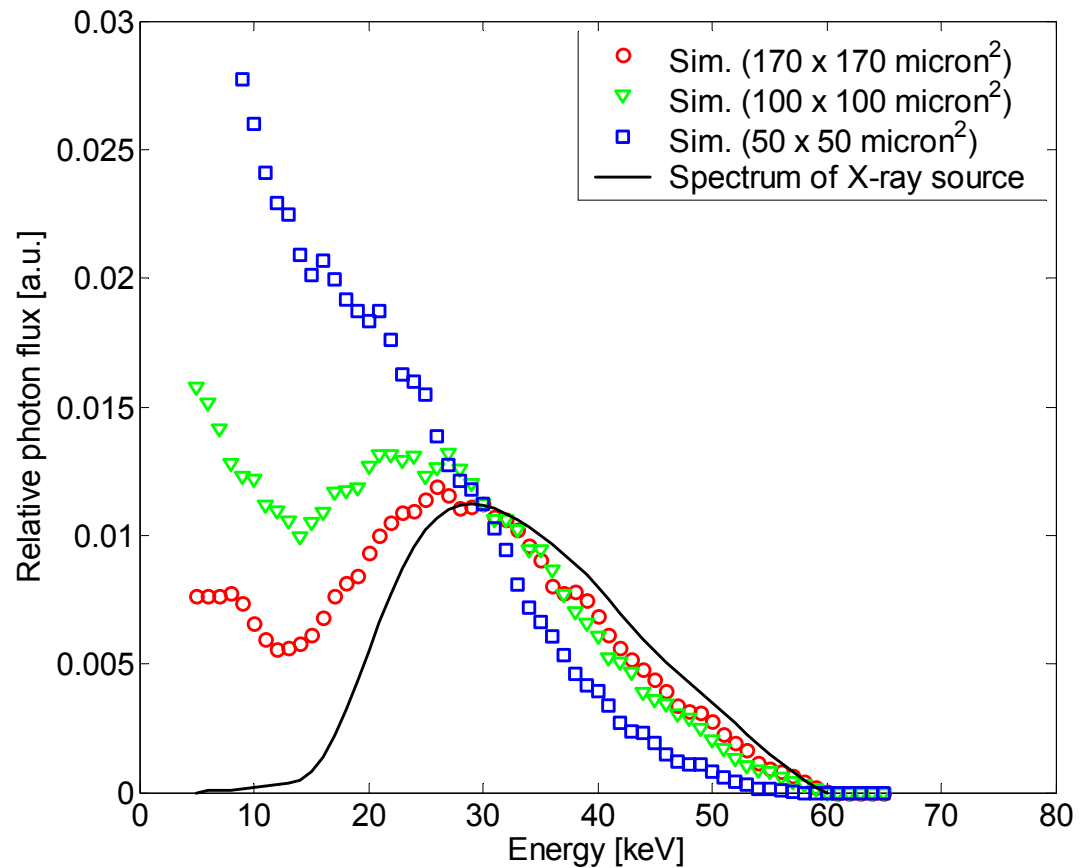


- A three bit energy mask calibrated towards the lower threshold noise edge is used
 - High threshold mask is copied from low threshold mask
- Flat field correction for each set of threshold settings is applied

Charge sharing



- High energy hits are divided into several lower energy counts
- Simulation presented at IWORID01.
H.-E. Nilsson et al.,
Nucl. Instr. And Meth. A
487 (2002) 158.



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Charge sharing



- Results in redistributed spectrum
 - It is not possible to exclude unwanted high energy contributions to the image
 - Low energy results in this work are not "clean results" due to charge sharing
- Charge sharing also decreases the spatial resolution
- Charge sharing can be suppressed by increased bias voltage

Further investigations



- This study shows that Medipix 2 can be used as a tool for improvement of sources in medical imaging applications
- The “optimal” energy interval depends on application and must be considered by medical expertise

Conclusions



- It is possible to improve the contrast in dental images achieved with Medipix2 by applying energy window discrimination
 - Relative contrast increase: 18 %
- It is possible to decrease the dose delivered to dental imaging patients in by improving the energy profile of dental sources