

Superiority of multi-energy color X-ray for breast specimen radiography.

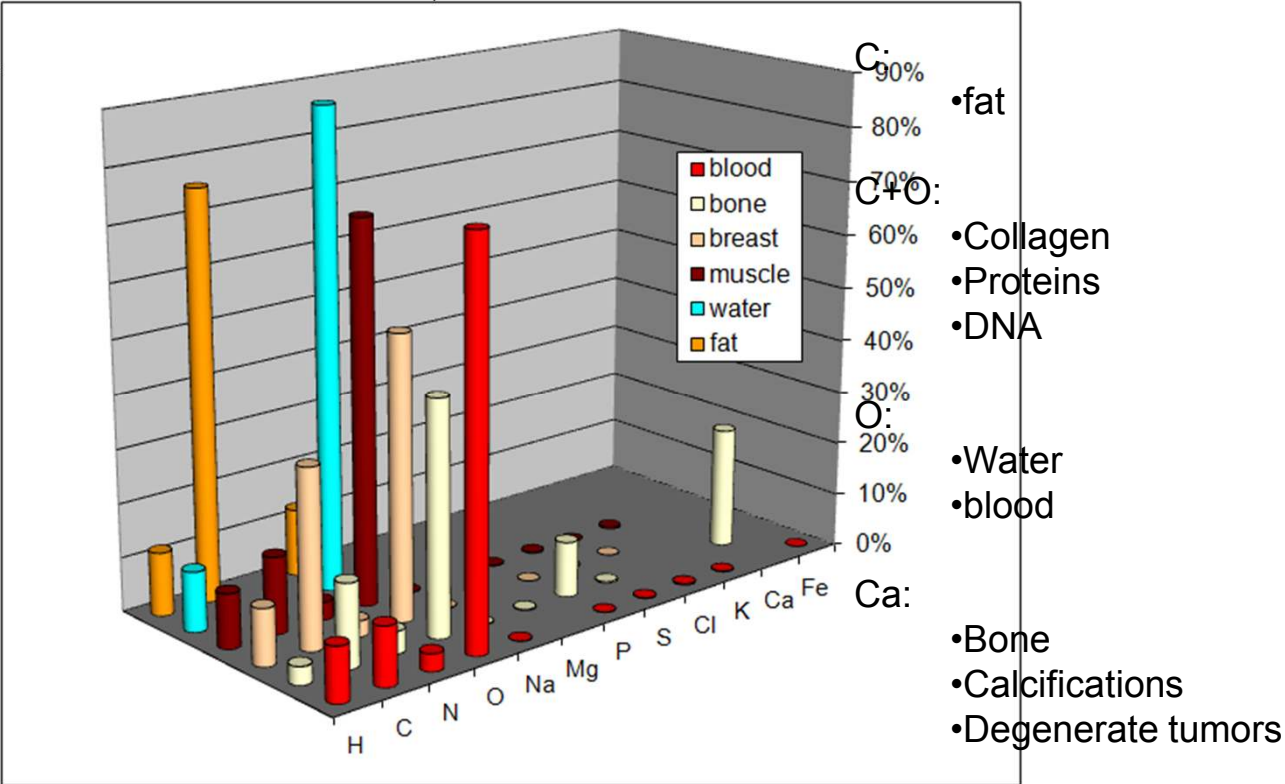
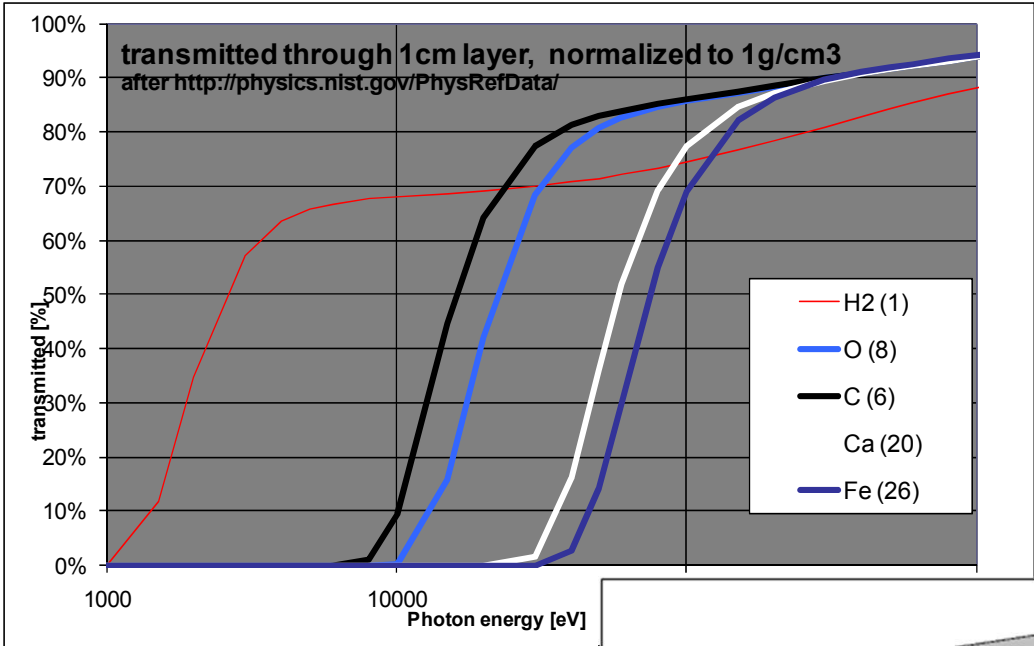
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Purpose

- To establish the contribution of multi-energy X-ray of excised surgical breast specimens in the determination of the size and the multifocality of cancer lesions.

Methods

- From 18 breast specimen resections for cancer (17/18) (11 IDC NOS and 6 special types) or benign pathology, size and multifocality of the lesion were assessed by ultrasound, mammography and multi-energy (“color”) specimen X-ray. Results were compared to macroscopical and microscopical pathological evaluation (ground truth). The color X-ray image was produced by a triple energy (22-30-40 kVp) acquisition of each specimen on a GE senographe, whereby the luminance is the average luminance of the original images after applying an *inverse Beer’s law* transform, and the chrominances are derived for the luminance ratios between the original images [1]. The presence of tumor, microcalcifications, size and multifocality were evaluated.



Results

Multi-energy X-ray detected all tumors. Clearly enhanced visibility of tumor versus benign tissue, tumor borders and heterogeneity (necrosis, bleeding) was observed. Microcalcifications and neovascularisation were readily identified. Compared to the color X-ray image, ultrasound and initial X-ray underestimated the size of the lesions in 16 patients (mean 13.8 mm, range 0.3-30, $p < 0.005$). This would increase the radiological tumor stage in 28 % (5/18) of patients. A significant size difference between macroscopical evaluation and color X-ray was seen ($p < 0.02$). In 31% (5/18) multifocality of the lesion was identified by the color X-ray only.

Breast carcinoma specimen
"Poorly differentiated invasive duct" type.

Color X-ray created from exposures at 22, 30 and 40kVp

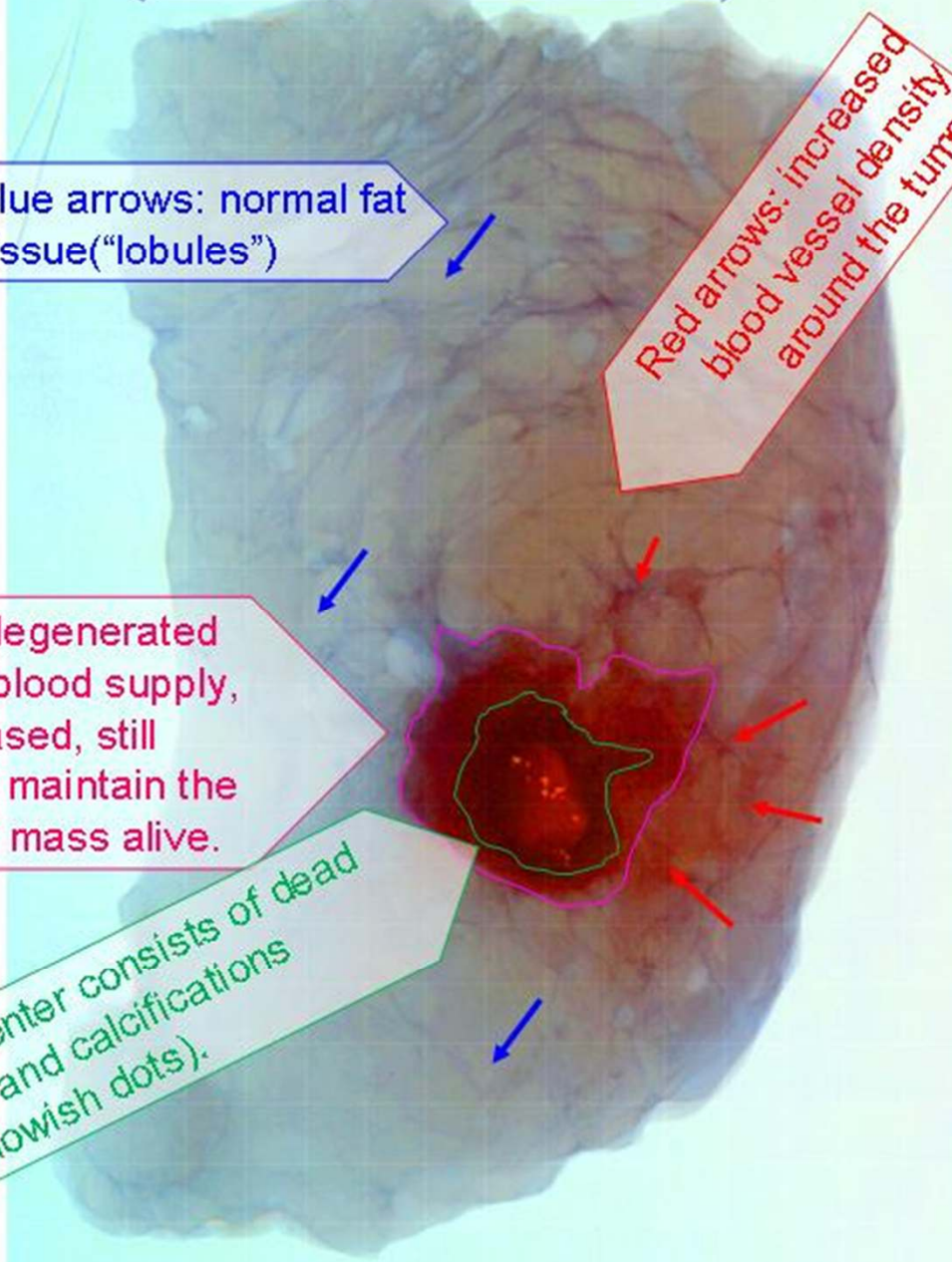
10cm

blue arrows: normal fat
tissue("lobules")

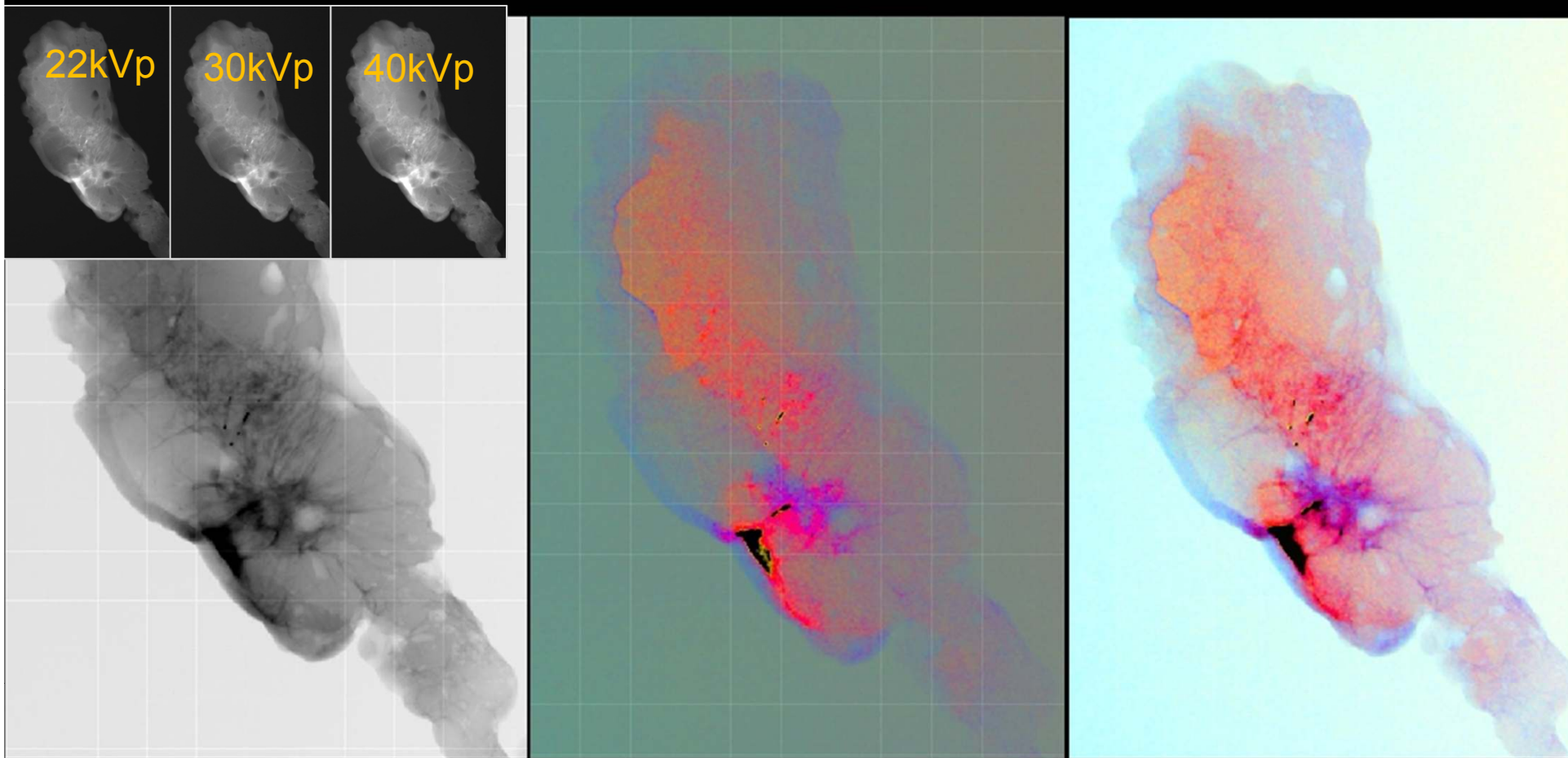
Red arrows: increased
blood vessel density
around the tumor

the tumor is degenerated
because the blood supply,
though increased, still
insufficient to maintain the
whole cancer mass alive.

The center consists of dead
cells and calcifications
(yellowish dots).



“Color” X-ray images of a breastcancer specimen. Images are obtained by pixel-wise digital operations on 3 classic DR X-ray exposures at 22, 30 and 40kVp.



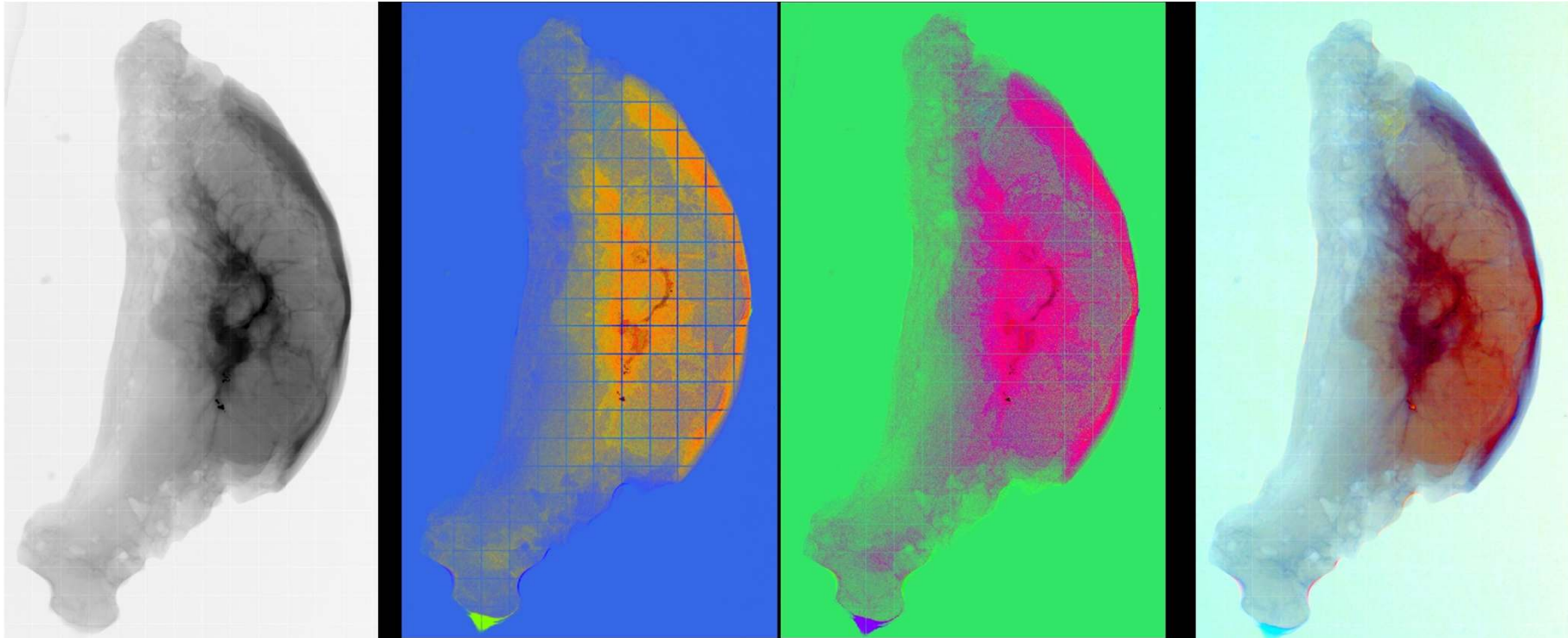
Classic B&W (“luminance”) X-ray image (average of 3 exposures at 22, 30 and 40kVp)

Chrominance only, obtained from differences between the exposures at 22, 30 and 40kVp

Combination of the luminance and the chrominance image

Highly invasive apocrine carcinoma with highly differentiated ductal carcinoma in situ.

The center of the tumor contains calcifications. Neovascularisation around the tumor can be seen. The B&W X-ray underestimated the tumor size.

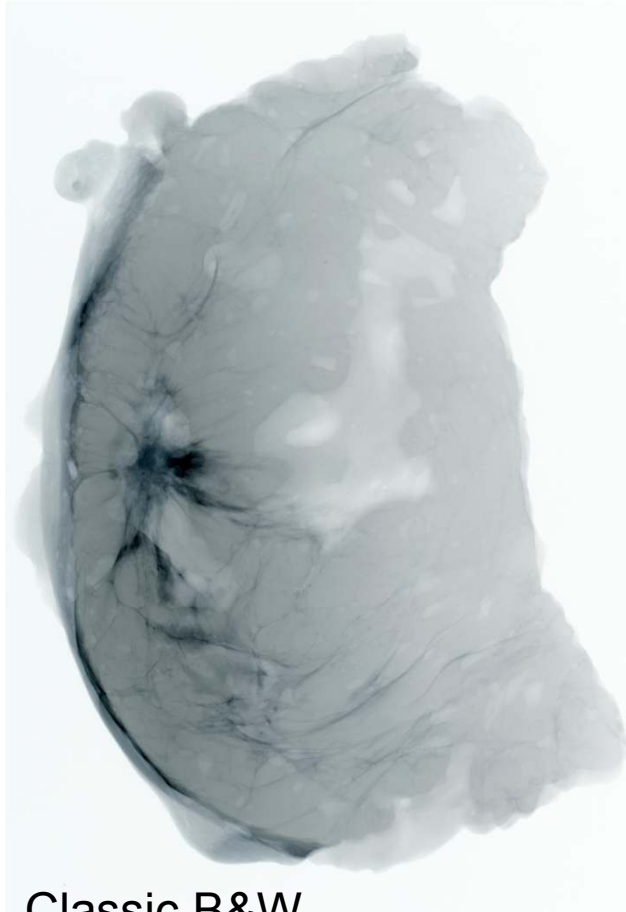


Classic B&W (“luminance”) X-ray image (average of 3 exposures at 22, 30 and 40kVp)

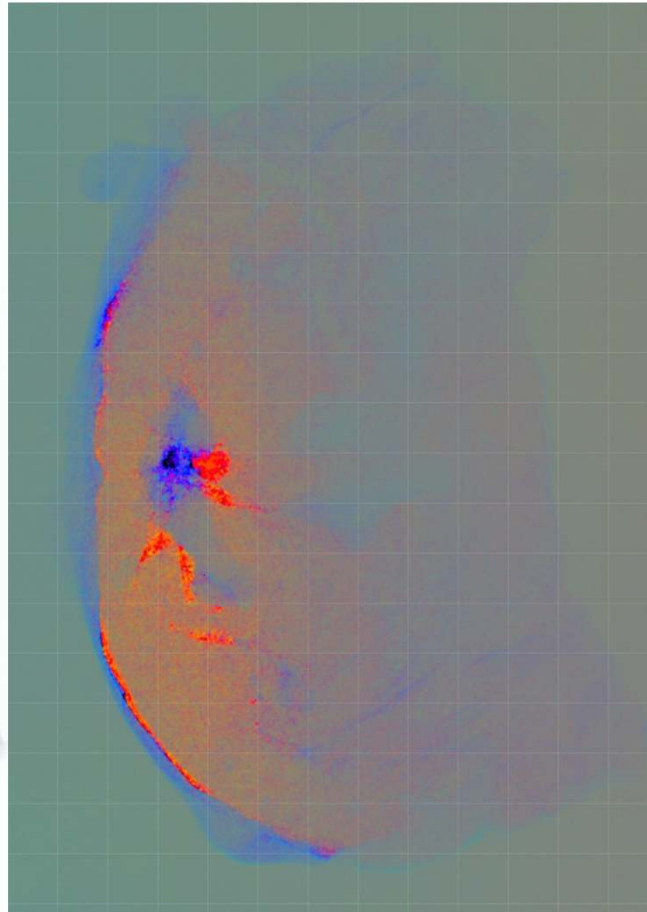
Two “Chrominance Only” images, obtained from differences between the exposures at 22, 30 and 40kVp

Combination of the luminance and the chrominance image

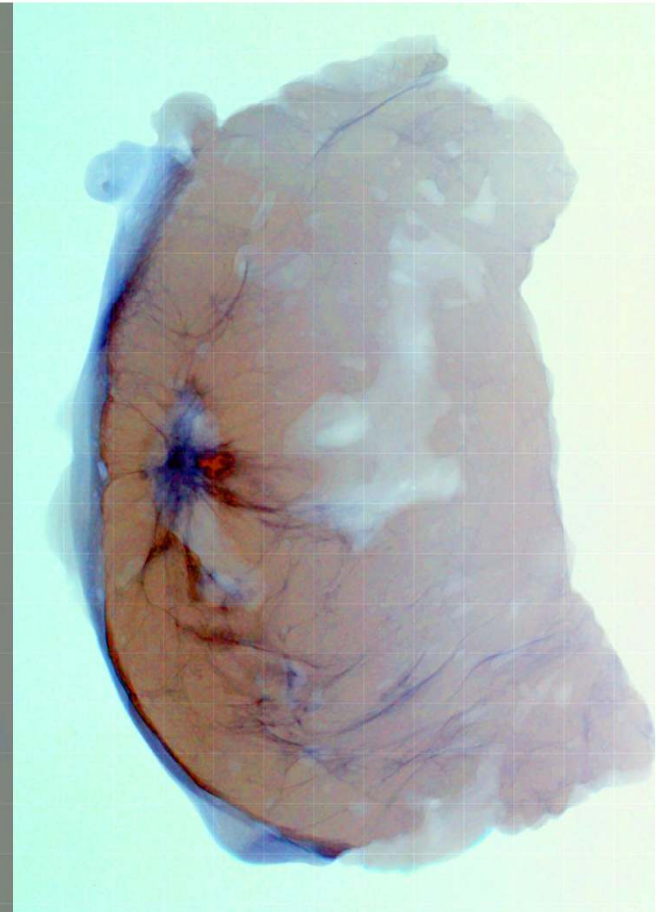
Poorly differentiated invasive lobular carcinoma.
The multi-energy X-ray was able to detect multifocality.



Classic B&W
("luminance") X-ray
image (average of 3
exposures at 22, 30
and 40kVp)



"Chrominance Only" image,
obtained from differences
between the exposures at 22,
30 and 40kVp



Combination of the
luminance and the
chrominance image

Conclusion

- Multi-energy breast specimen X-ray shows a more reliable tumor size measurement and enhanced detection of multifocality.

Reference

- [1] B. Dierickx, N. Buls, C. Bourgain, C. Breucq, J. Demey, B. Dupont, A. Defernez, “Multi-energy X-ray imaging for mammography”, BHPA symposium, Brussels, 5-6 feb 2010.