Development of the J-PEM for breast cancer detection and diagnosis using positronium imaging

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Breast cancer is the most leading cause of death among women in both developing and developed countries. Numerous efforts have been made to improve the accuracy of breast cancer diagnosis using different imaging modalities. Mammography (and its modifications like CESM and DBT) is one of the most effective and popular modalities used for breast cancer screening and detection[1]. Ultrasound and magnetic resonance imaging have also been used to detect breast cancer in high risk patients. Currently, there are still limitations regarding routine application of these techniques, so new methods – like J-PEM (Jagiellonian Positron emission tomography) are needed. J-PET group aim is to design, construct and establish the characteristic performance of the J-PEM , based on a novel idea with plastic scintillators[2,6] and wavelength shifter (WLS) readout.[2,3,4,5]

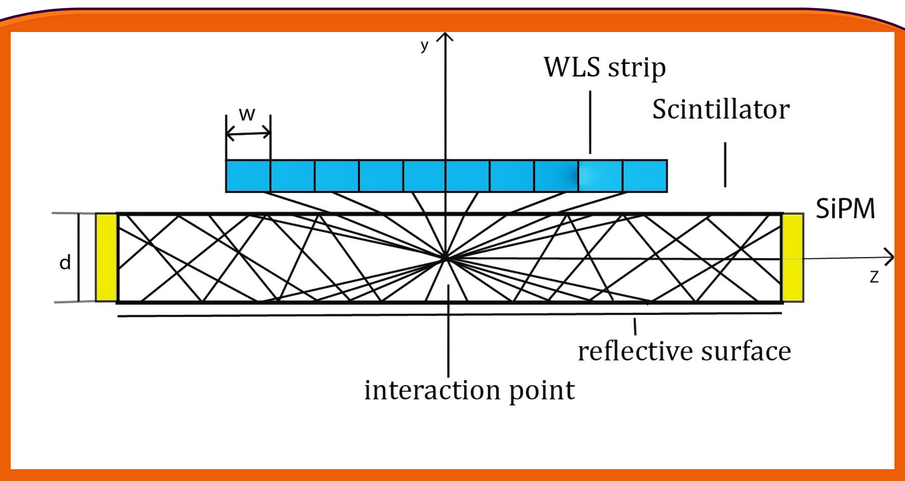

Fig.1.Schematic drawing illustrating application of WLS strips for the determination of the coordinates of the interaction point in a scintillator strip [3].

Motivation

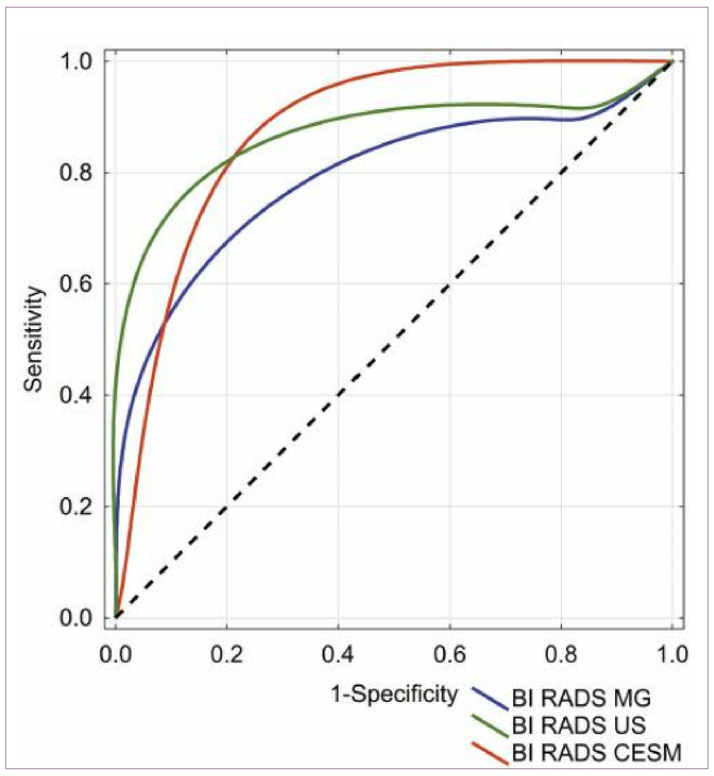

Fig1. Receiver operating characteristic curves (ROC) based on BI-RADS for conventional mammography (MG), ultrasonography (US) and contrast enhancement spectral mammography (CESM)[6]

Examination	Sensitivity	Specificity	Accuracy
MG	90% [82%; 95%]	22% [11%; 38%]	69% [61%; 77%]
US	92% [84%; 96%]	20% [9%; 35%]	70% [62%; 78%]
CESM	100% [96%; 100%]	27% [14%; 43%]	78% [70%; 85%]
p-value: MG *vs*. US	0.77	0.99	0.99
p-value: MG *vs*. CESM	0.004	0.81	0.04
p-value: US *vs*. CESM	0.01	0.57	0.03

Table 1. Shows the Sensitivity, specificity, and accuracy of MG, US and CESM.

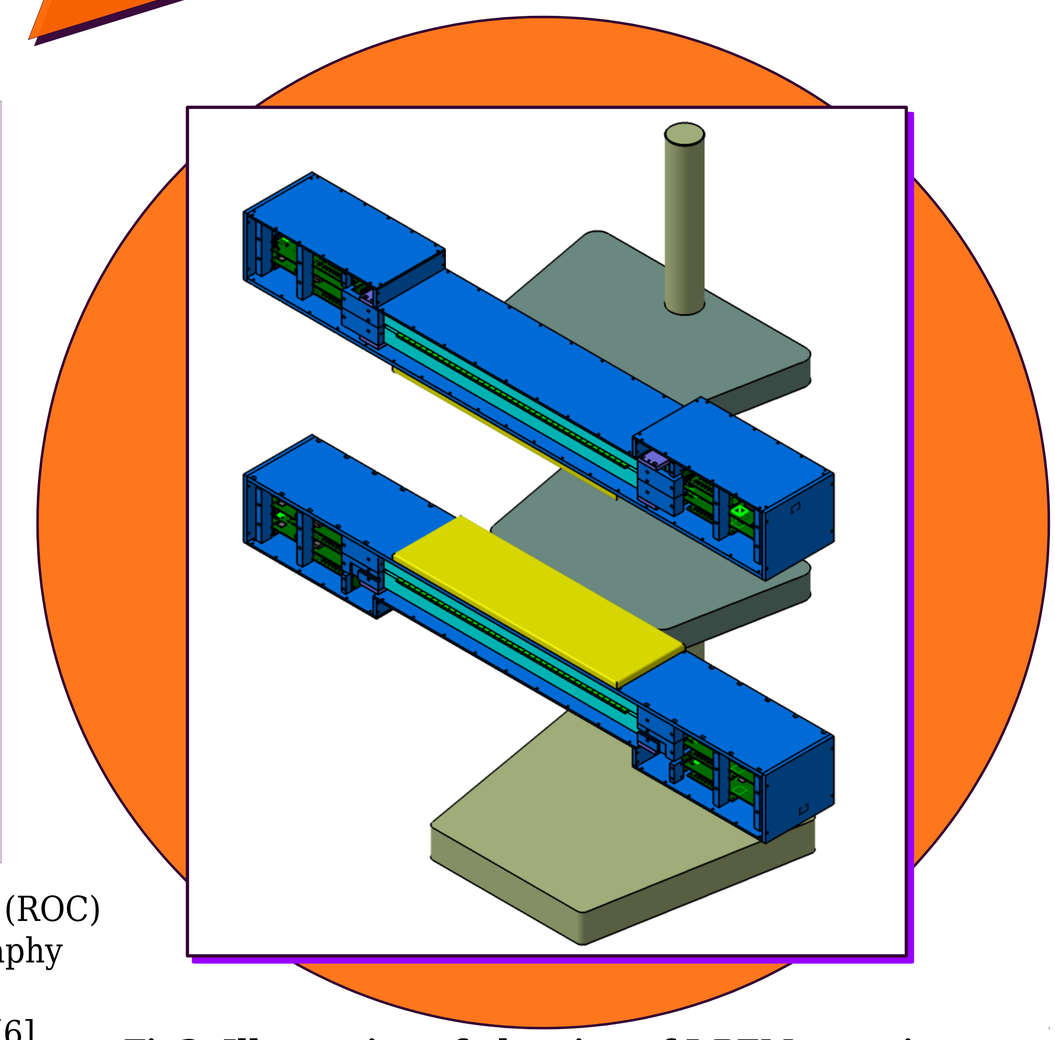

Fig3. Illustration of drawing of J-PEM,contains two module each module has three layers;two layers of plastic scintillators and one WLS

Fig 4. Amplitudes measured in individual WLS strips in a typical event presented as a function of the strip coordinate and a Gaussian fit applied for determination of the coordinate of the gamma quantum interaction point [3,4]

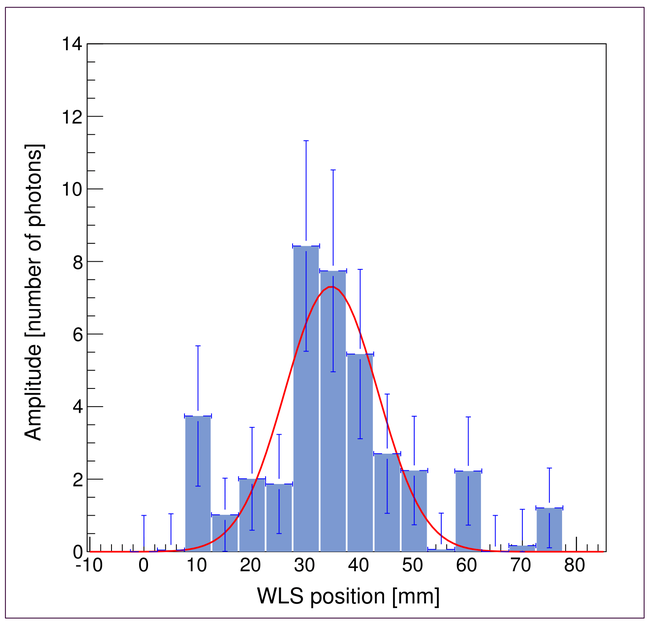

Fig.5. Distributions of reconstructed z–coordinates of the gamma quantum interaction for three different positions of the 22Na source differing by zΔ=10mm. Super imposed lines denote Gaussian fits to the distributions.

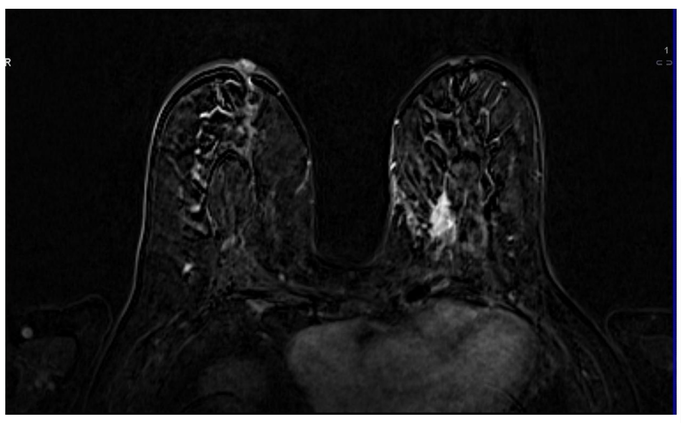

Fig. 2 Example images of breast cancer A- Ultrasound, B- Contrast-enhanced MRI, C- Digital Mammography

Reference

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Conclusion

There has been a lot of efforts made to detected and diagnosis the breast cancer in its early stage.
J-PEM can be a new diagnostic method that enables accurate detection of malignant breast lesions, high negative predictive value, and a false-positive rate. This improvement will be possible by the employment of plastic scintillators combined with WLS strips.