The Present and the future of Breast Cancer diagnosis

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Motivation

Breast cancer is the most leading cause of death among women in both developing and developed countries. Medical imaging plays an important role for breast cancer screening, for classifying and examining indistinct breast abnormalities, as well as for defining the extent of breast tumors [1]. One of the most widespread modalities currently available is the Positron Emission Mammography (PEM). J-PET group aim is to design, construct and establish the characteristic performance of the J-PEM (Jagiellonian Positron emission tomography), based on a novel idea with plastic scintillators[2,3] and wavelength shifter (WLS) [4,5] readout.

Methods

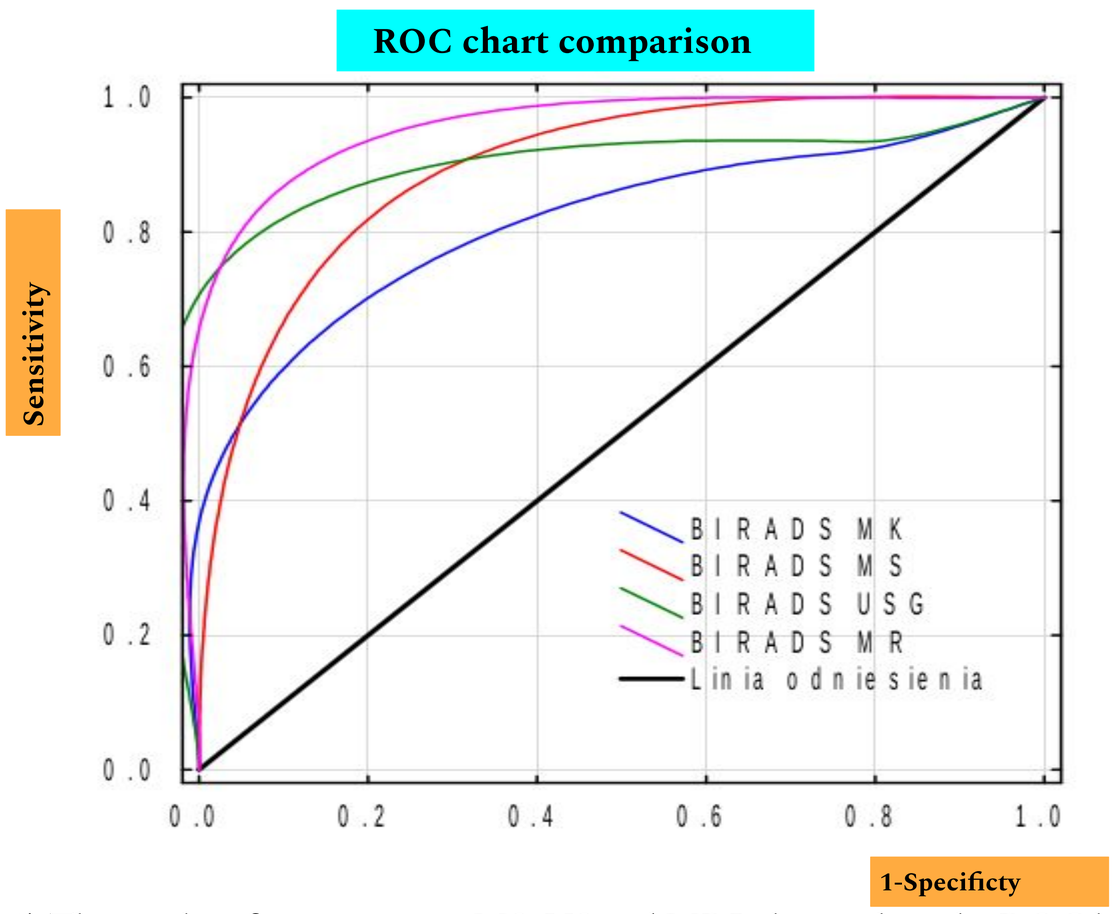
The analysis included 131 lesions. All patients underwent mammography and ultrasonography examinations. The cases pertained to 114 patients, among whom 98 had one lesion, 14 had two lesions and one patient had three lesions detected. The lesions were cancers in 92 cases (70%) and the remaining 39 cases (30%) appeared to be benign.
The results of the diagnostic test based on BI RADS are presented below, including the assumption that the value >=4 is interpreted as malignant while BI RADS<4 is benign.

Table 1: Comparison between the cM, sM, US and MRI

Specification	cM	sM	US	MR
Sensitivity	91.3%	100.0%	93.5%	100.0%
Specificity	28.2%	25.6%	23.1%	20.5%
ACC	72.5%	77.9%	72.5%	76.3%
PPV	75.0%	76.0%	74.1%	74.8%
NPV	57.9%	100.0%	60.0%	100.0%

* ACC - Accuracy, * PPV - Positive predictive value, * NPV - Negative predictive value
On the basis of the above presented results it can be stated that sM is the most effective examination in breast cancer diagnostics due to its highest sensitivity, accuracy, PPV and NPV.

ROC chart comparison



1) The results of examinations MS, US and MRI obtained on the ROC basis do not statistically differ, while the difference between cM examination and the other show that cM is less effective in cancer detection.

2) ROC curves are plotted created by calculating sensitivity and 1-specificity for different sets of threshold or cut-off values.

Table 2: Comparison between the cM, sM, US and MRI on the basis of area under the curve

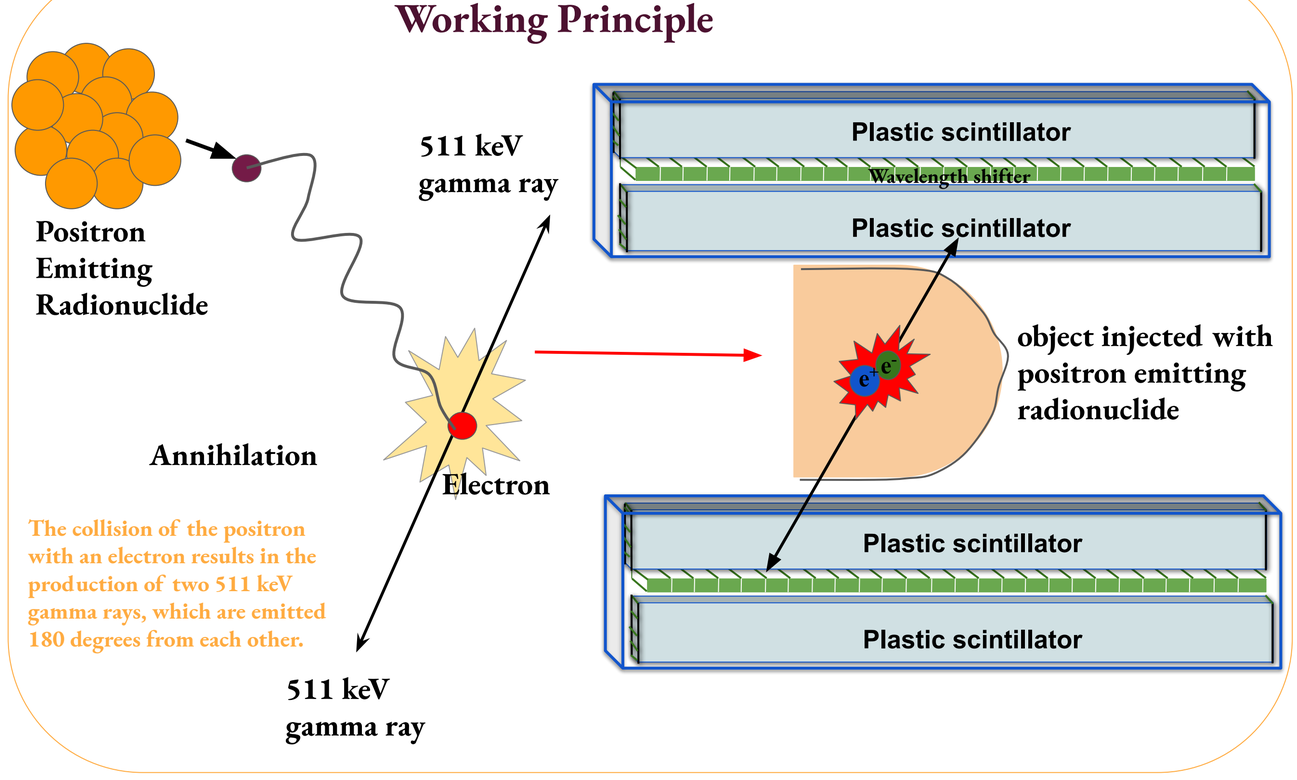
	cM	sM	USG	MR
AUC	0.72	0.825	0.854	0.897
p	<0.001	<0.001	<0.001	<0.001

All examinations enable cancerous lesions diagnosing – MRI has the biggest area under the curve AUC and basing on this test it is considered the most effective. For all of the above examinations the most optimal cut-off point is BI RADS 5.

Material and Result

1) The prototype system consists of a single module of plastic scintillators, built from two layers of plastic scintillator (6x24x500 mm) [2,3] and the wavelength shifters (3x10x100 mm) [4,5].
2) Each scintillator bar is attached at both ends to silicon photomultipliers for the signal readout.
3) Data processing will be handled by specifically developed front-end boards based on field-programmable gate array (FPGA) chips.

Working Principle



1) Positron Emission Mammography (PEM) is a dedicated and well-recognized technique to diagnosis the breast cancer.
2) In PEM, these gamma rays are detected by striking a pair of dedicated gamma radiation detectors placed above and below the breast.
3) Once the gamma rays are detected, they are amplified by photon-sensitive photomultipliers and translated into an electrical signal that becomes digitized and is stored as computer memory [7].

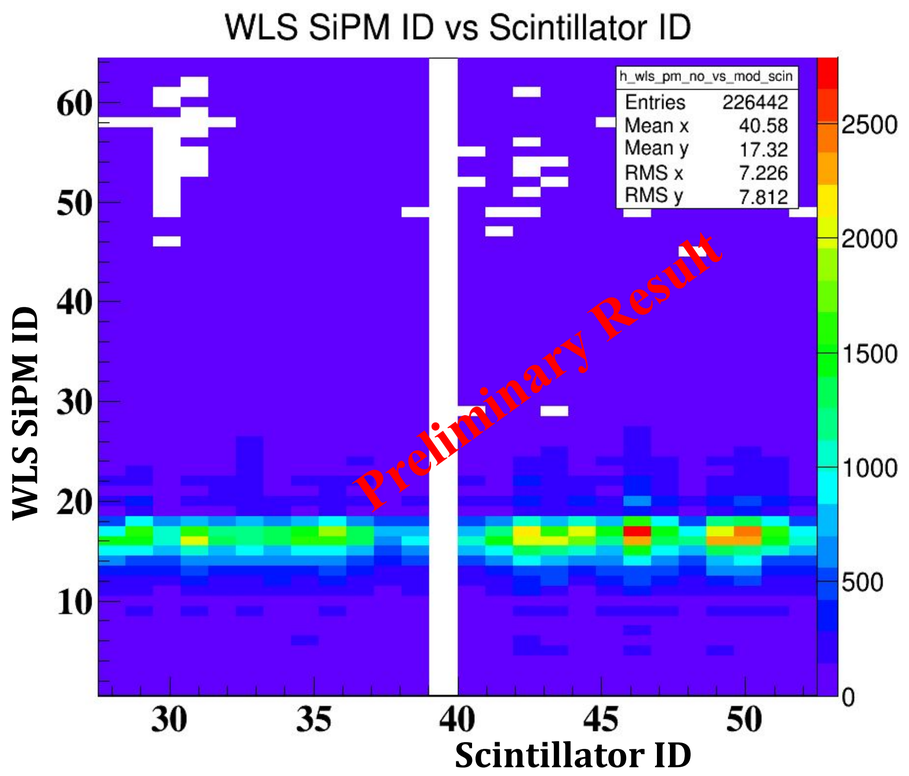


Fig.3 Distribution of of WLS SiPM ID over the scintillator ID. Source was placed at the center with slit width 4mm.

We take one of the y projection of the histogram.

Analysis of a raw data without any cut and tune in we are able to get 15 mm of z resolution.

Conclusion

1) There has been a lot of efforts made for detection and diagnosis the breast cancer in its early stage.
2) The analysis of the hospital data was done. Which shows that the MRI has the highest sensitivity but the lowest specificity out of cM, sM and USG.
3) We have constructed the J-PEM using the plastic scintillator and wavelength Shifters. First prototype is ready for the measurement and is under the stage of analysis.

Reference

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