Time calibration of the J-PET detector

M. Skurzok[(a)], M. Silarski[(a)]
on behalf of the J-PET Collaboration
(a) M. Smoluchowski Institute of Physics, Jagiellonian University, 30-348 Cracow, Poland

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The **Jagiellonian Positron Emission Tomograph (J-PET)** project carried out in the Institute of Physics of the Jagiellonian University is focused on construction of the first prototype of PET scanner which allows for the simultaneous 3D imaging of the whole human body using organic scintillators. The J-PET prototype consists of 192 scintillator strips forming three cylindrical layers which are optimized for the detection of photons from the electron-positron annihilation with high time- and angular- resolutions. In this poster we present method of time calibration and synchronization of the whole J-PET detection system by irradiating each single detection module with a **^{22}Na** source and a small detector providing common reference time for synchronization of all the modules.

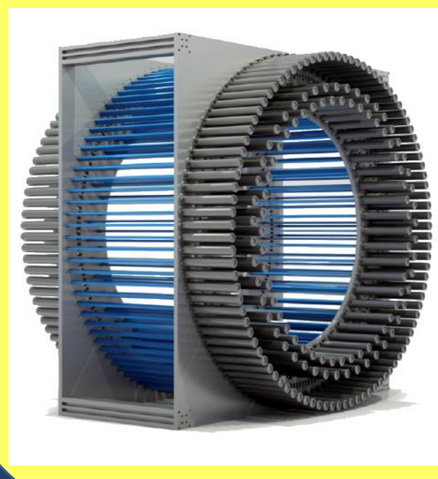
Introduction

Positron Emission Tomography (PET)

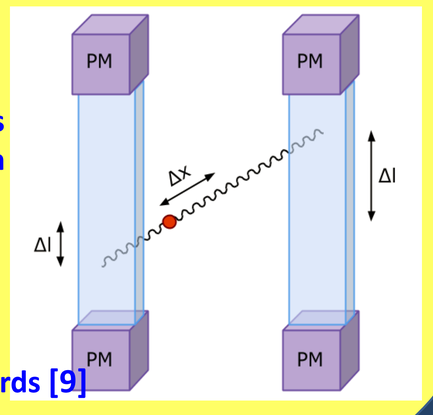
» important tool in medical diagnostics, in particular in oncology, cardiology, neurology, gastrology and psychiatry
» all commercial PET devices are build from scintillation crystals [1-2]

➢ **J-PET is the first Positron Emission Tomography scanner built from plastic scintillators [3-8]**

- relatively cheap and easy to shape
- very good time measurement resolution
- place of photons interaction extracted solely from the time instead of energy deposition measurement



- 85cm diameter
- 192 scintillator strips with low attenuation forming 3 layers
- readout from both sides of each module
- triggerless DAQ and digital front-end boards [9]



Calibration procedure

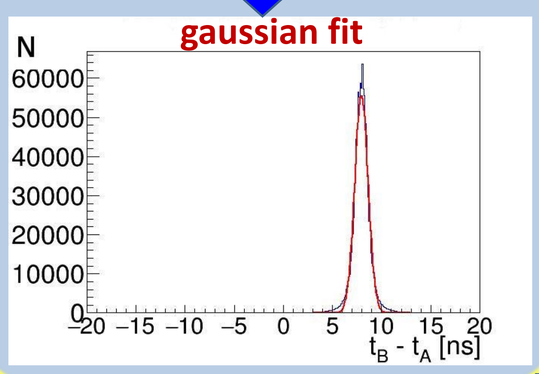
» analysis carried out using **the J-PET Framework software** [10]

$t_A = t_A^{true} - off_A$
$t_B = t_B^{true} - off_B$

"A-B" synchronization (of each separate module)

$\Delta t_{AB} = t_B - t_A = c_1$

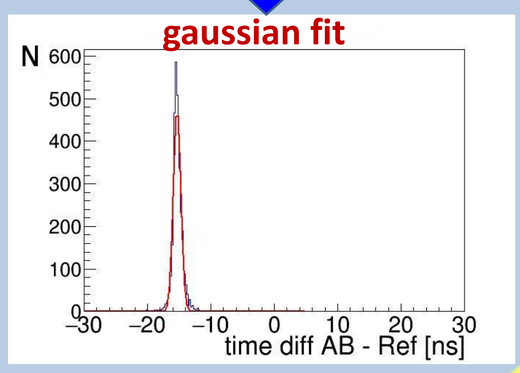
gaussian fit



simultaneous synchronization of all modules in a single layer

$\Delta t_{ref} = (t_A + t_B)/2 - t_{ref} = c_2$

gaussian fit



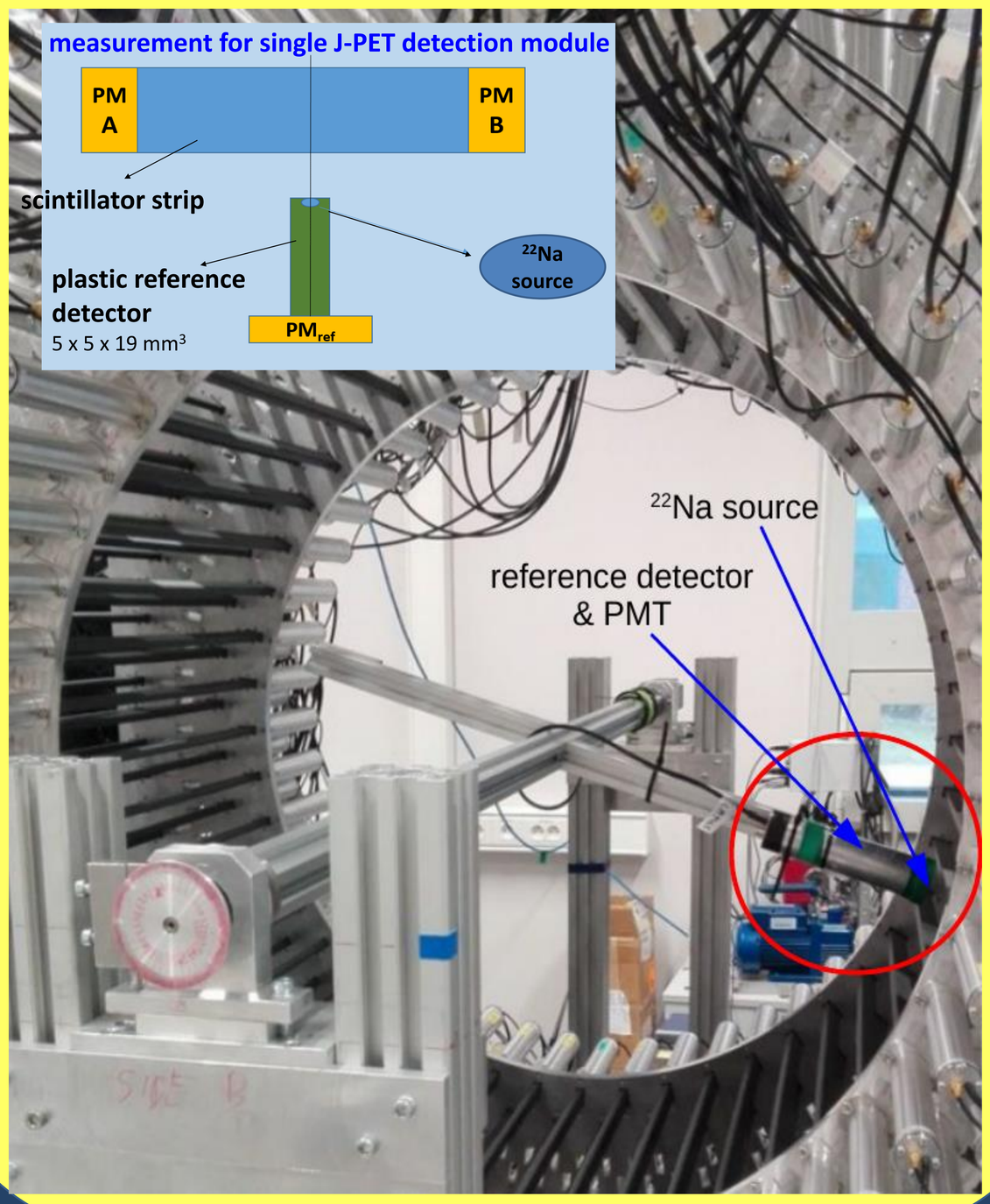
$off_A = c_1/2 - c_2$ | $off_B = -c_1/2 - c_2$

synchronization between layers (with respect to the first internal layer)

c_2 for layer 2 and 3 corrected with time constants Δt_{L2-L1} and Δt_{L3-L1}

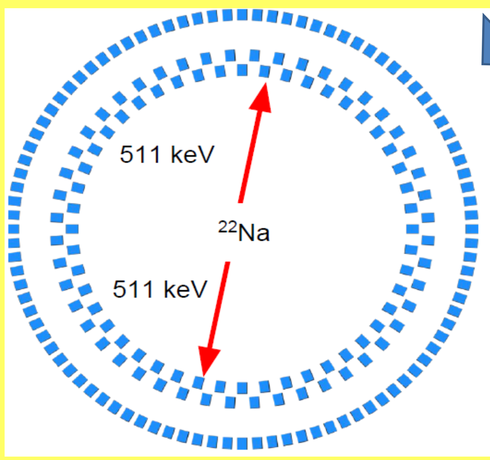
$\Delta t_{L2-L1} = \Delta R_{L2-L1}/c = 0.1418 \pm 0.0033$ [ns]
$\Delta t_{L3-L1} = \Delta R_{L3-L1}/c = 0.5003 \pm 0.0033$ [ns]

Measurement with reference detector

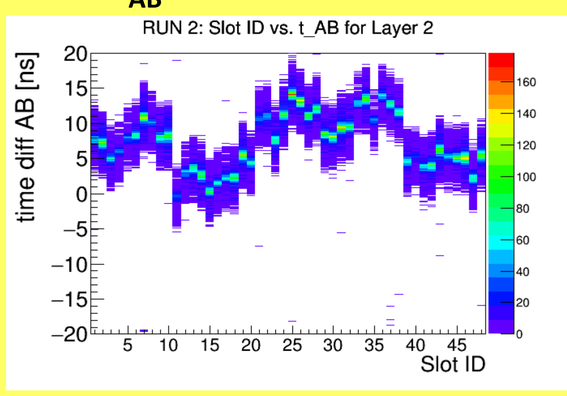


Validation of calibration

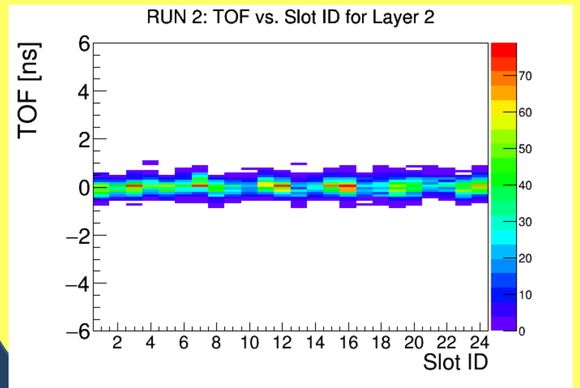
Analysis for independent measurements performed using a collimated ^{22}Na radioactive source installed in the geometrical center of the J-PET barrel [11].



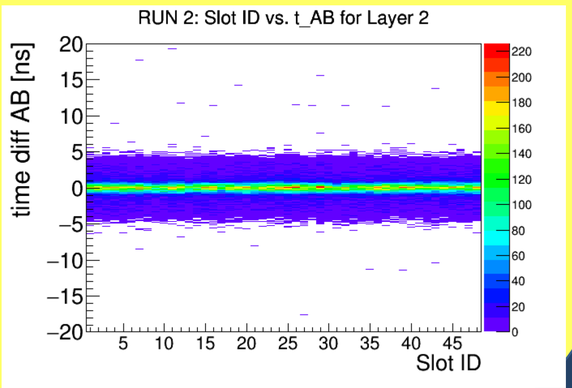
Δt_{AB} before calibration



TOF after calibration



Δt_{AB} after calibration



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