

# easyPET: characterization of a concept prototype following the NEMA NU 4-2008 standard

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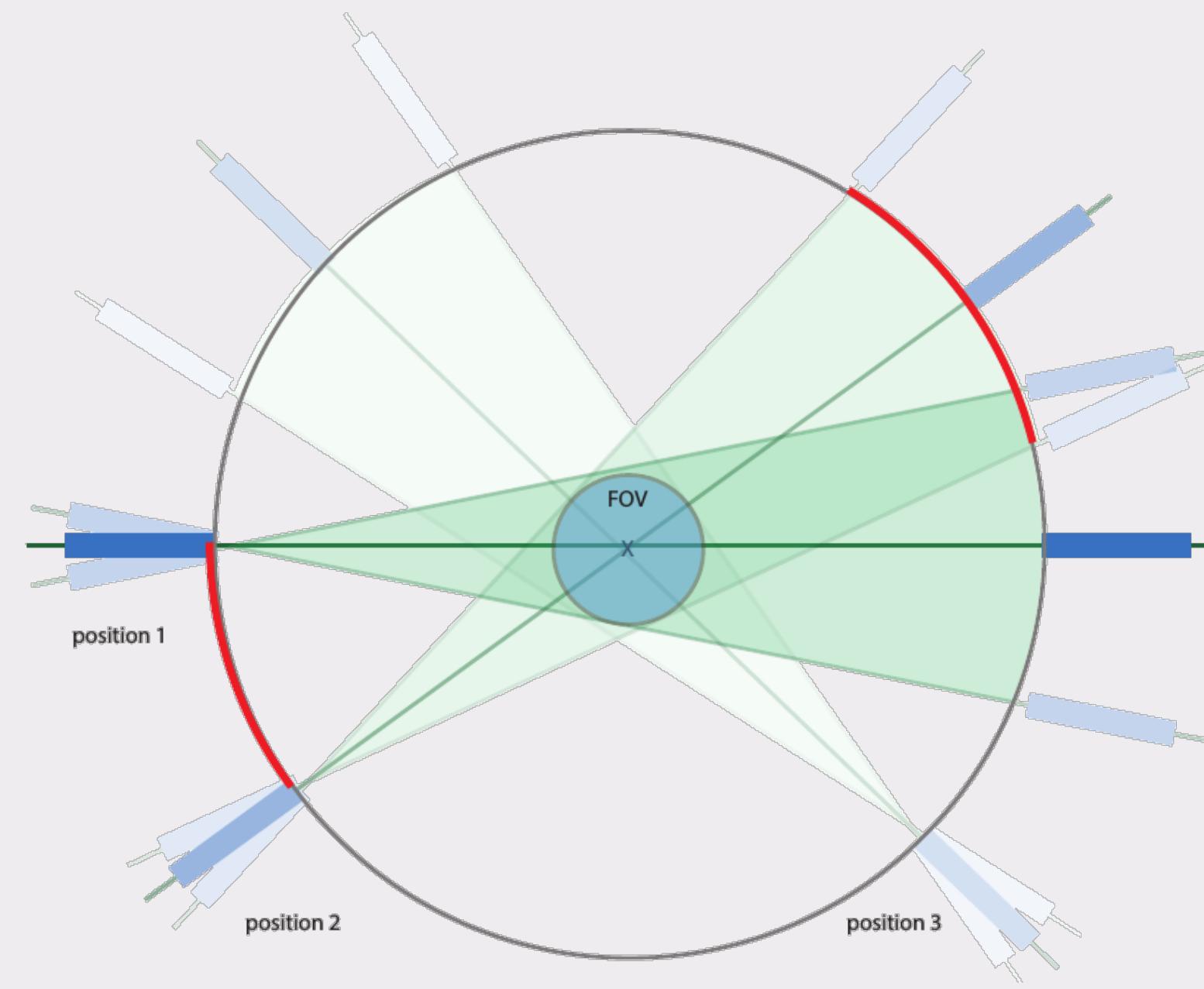


## Abstract

EasyPET is a new concept of a PET scanner using an innovative acquisition method based on two rotation axes for the movement of detector pairs. The concept allows achieving high and uniform position resolution over the whole field of view (FoV), by eliminating parallax errors due to the depth of interaction (DOI), which are typical of ring based PET systems. The absence of DOI effect, does not impose limitations on the proximity of the detector elements to the FoV and therefore favours the sensitivity of the system. Full axial imaging is possible with easyPET using only a small number of detector elements.

A small concept demonstrator for 3D imaging with 16 + 16 detector cells was built, based on LYSO scintillators coupled to SiPMs, covering a 50 mm diameter  $\times$  34 mm long field of view. The technology used in the detector cells allows operation in strong magnetic fields, in the Tesla scale region. A comparison between simulation results obtained with GATE and experimental results will be presented in terms of system performance, namely position resolution and sensitivity, following NEMA NU 4-2008 standards. In addition, simulations of a scaled up version of easyPET for preclinical purposes will be presented and discussed.

## Operation Principle



**Acquisition method** - based on **2 rotation axes** for the movement of detector modules.

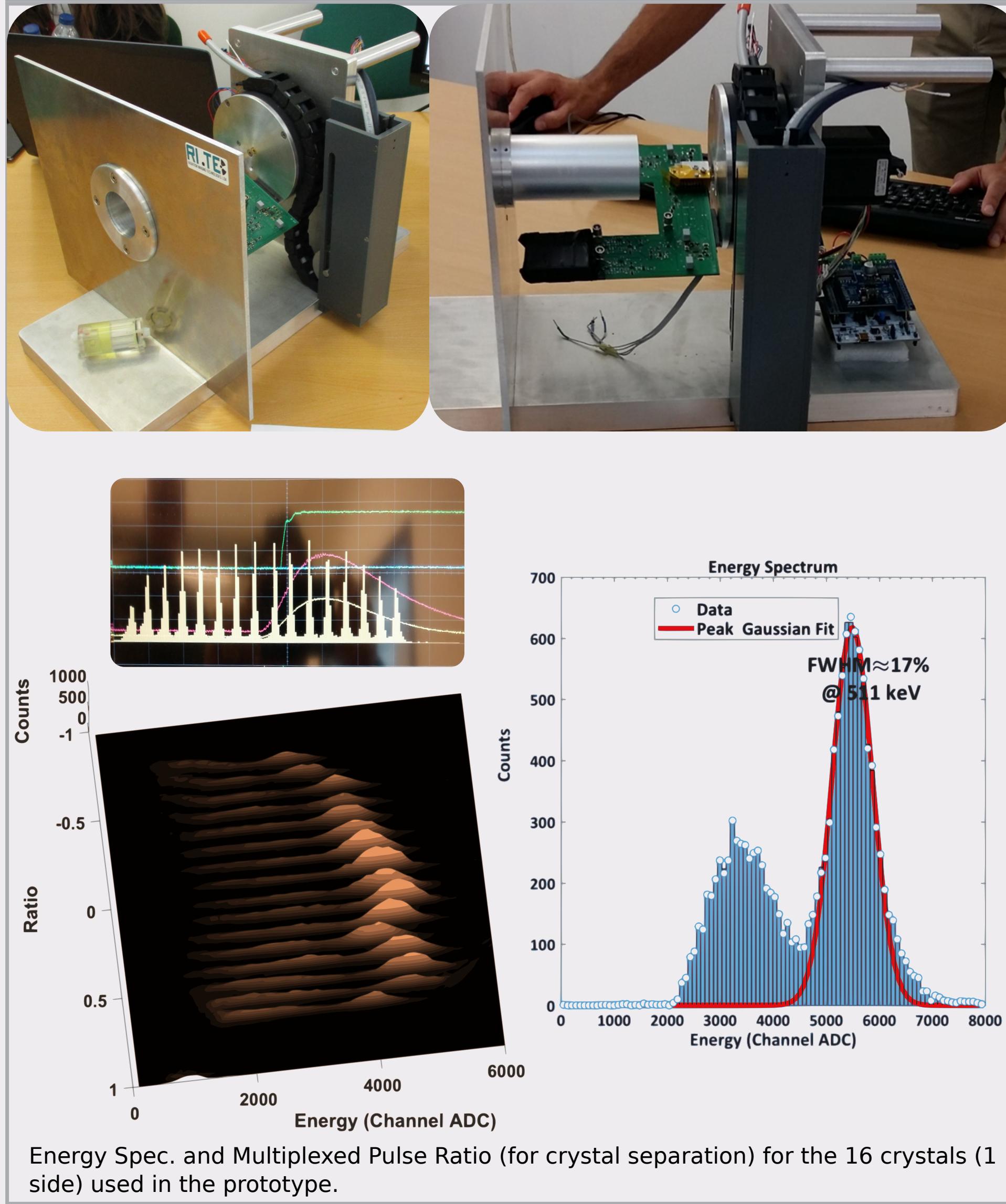
**Allows full axial imaging** (full animal body) with a small number of crystals.

**High spatial resolution and uniformity** over the **whole FOV**.

**Eliminate the parallax error** due to depth of interaction (DOI):

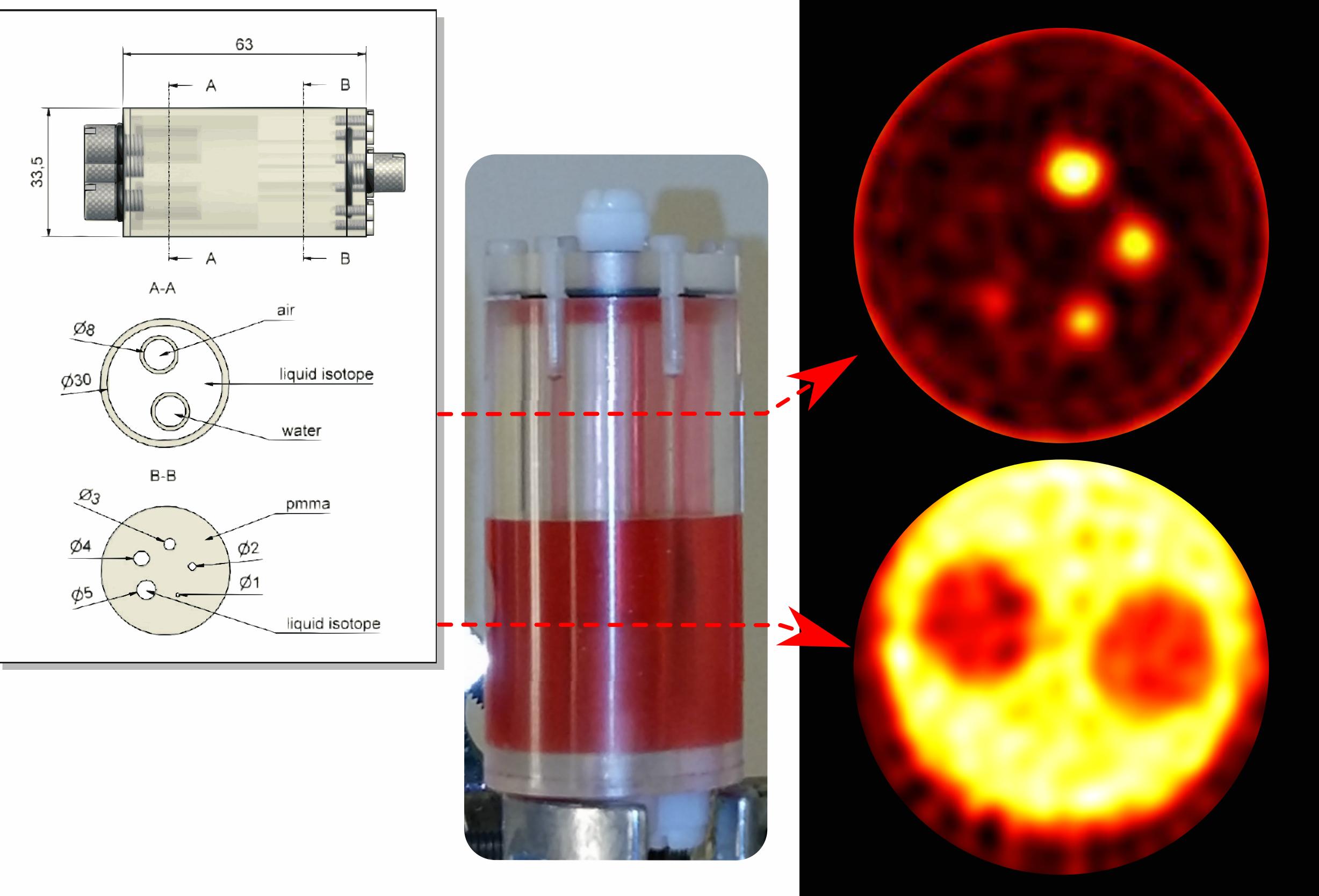
- does not impose limitations on the proximity of the detector elements to the FoV;
- favours system sensitivity.

## The easyPET demonstrator



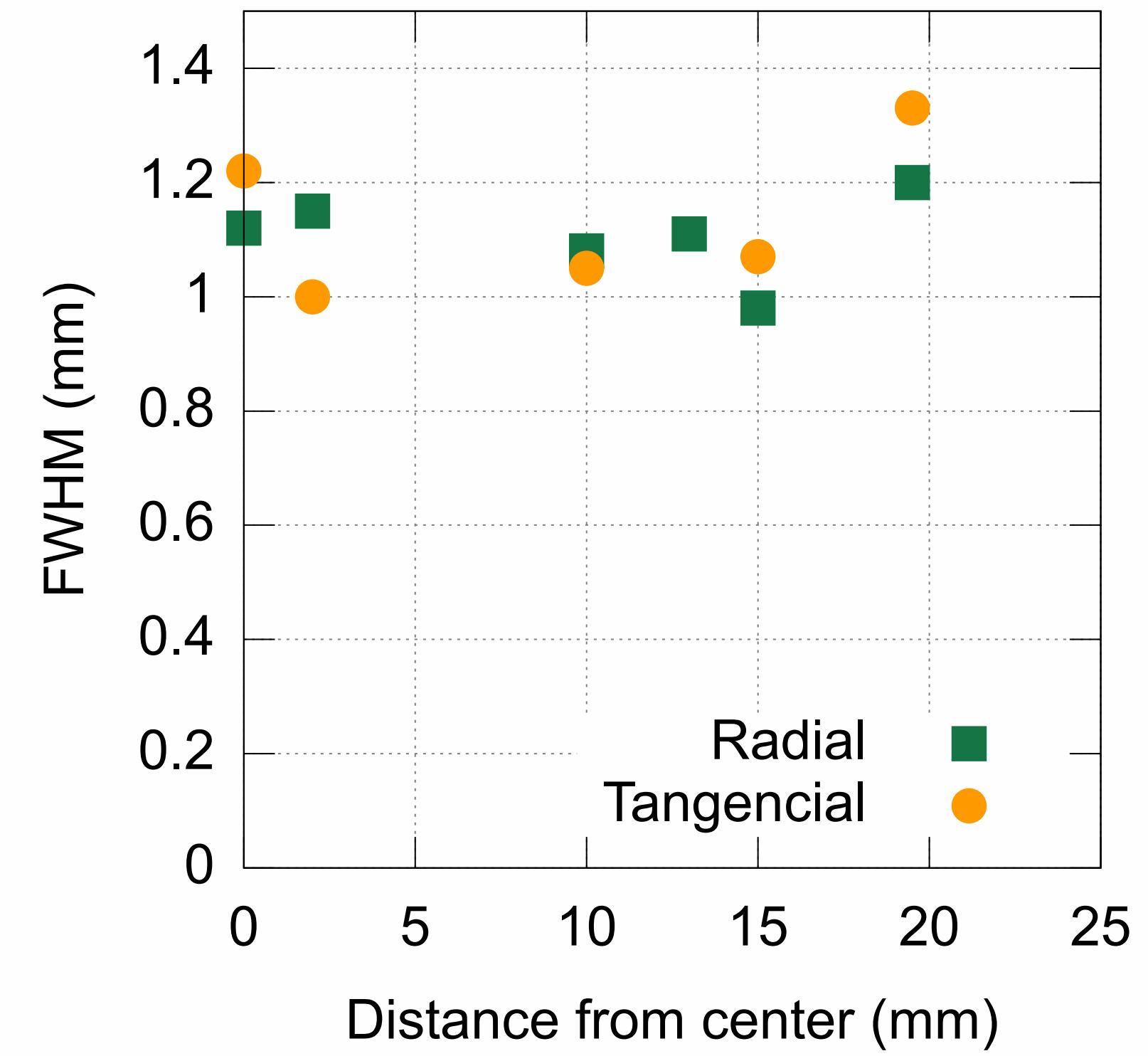
## easyPET demonstrator (16 + 16 : 2 x 2 x 30 mm LYSO crystals) : Experimental results

### NEMA NU 4-2008 Micro-PET IQ phantom

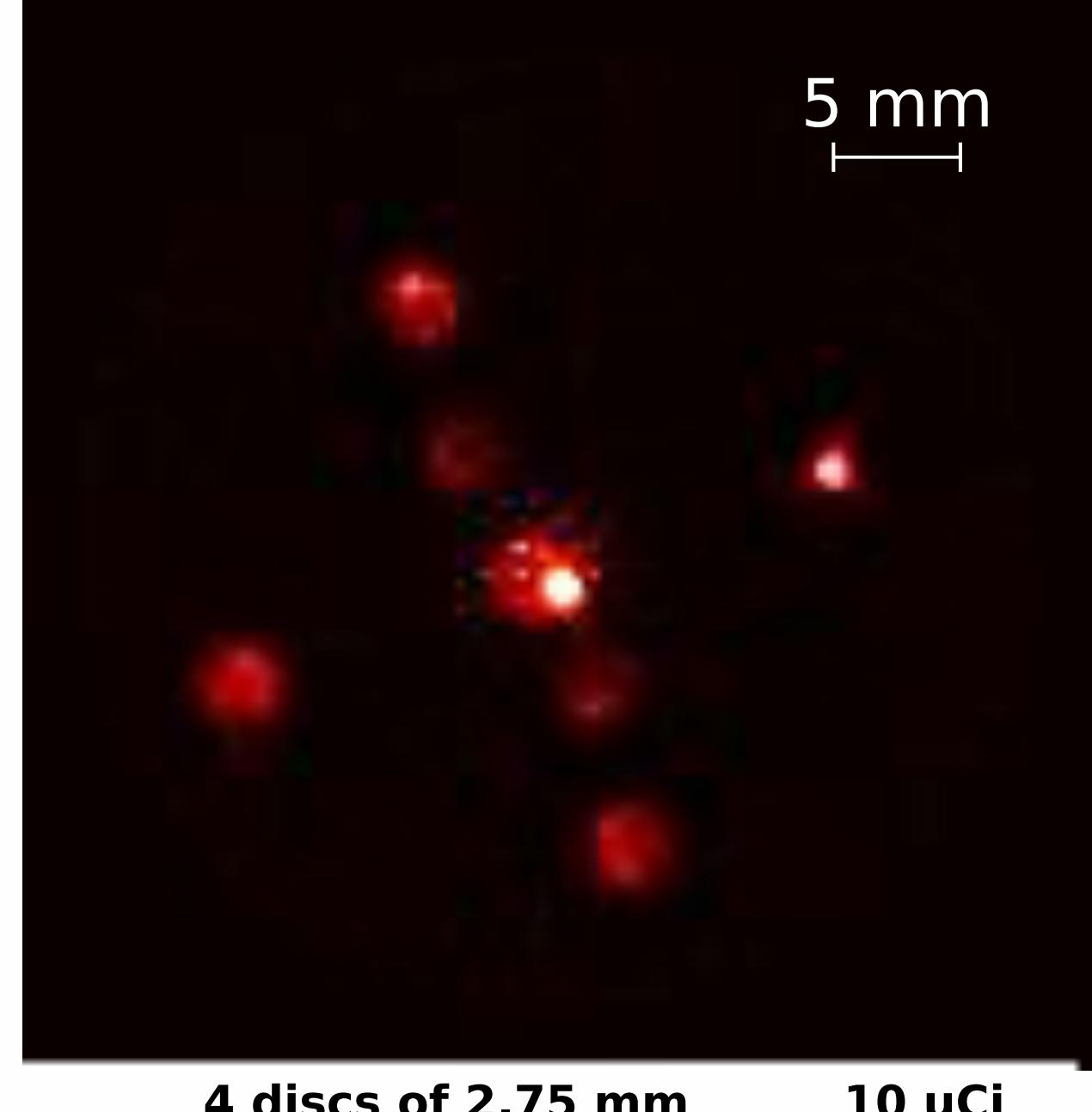


### NEMA NU 4-2008 Spatial Resolution

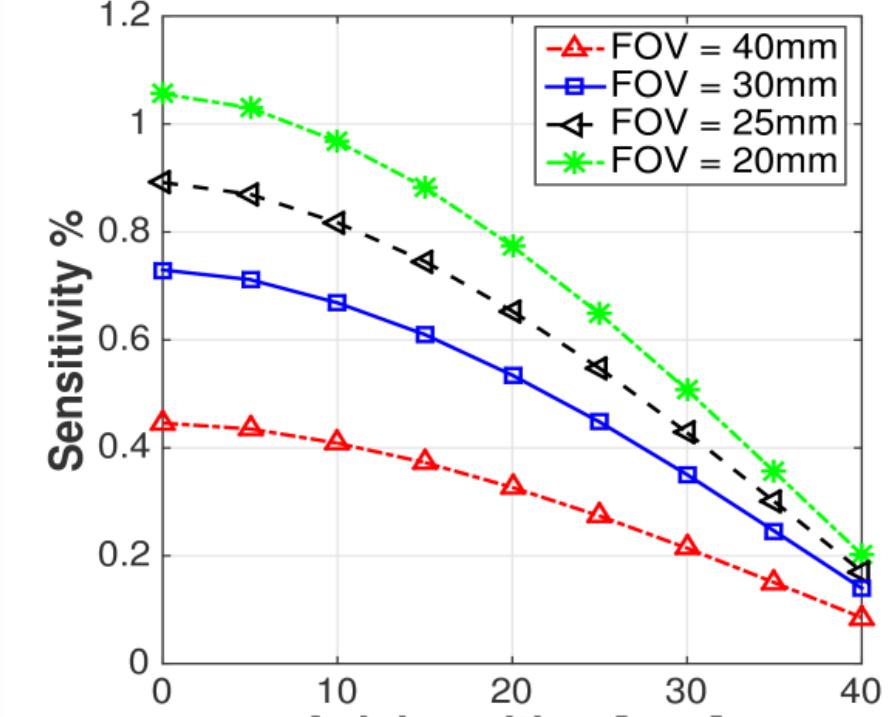
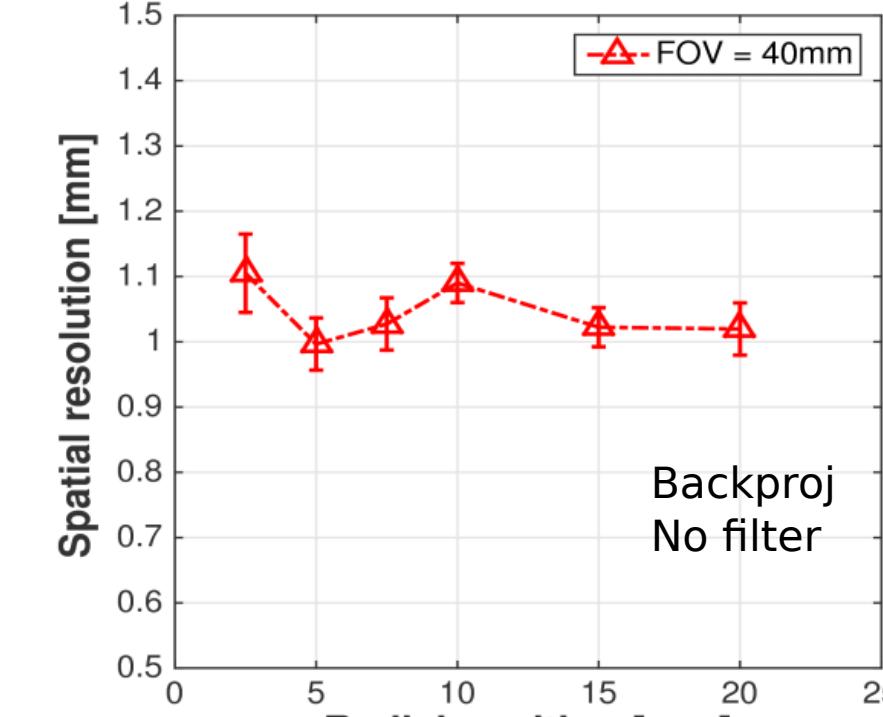
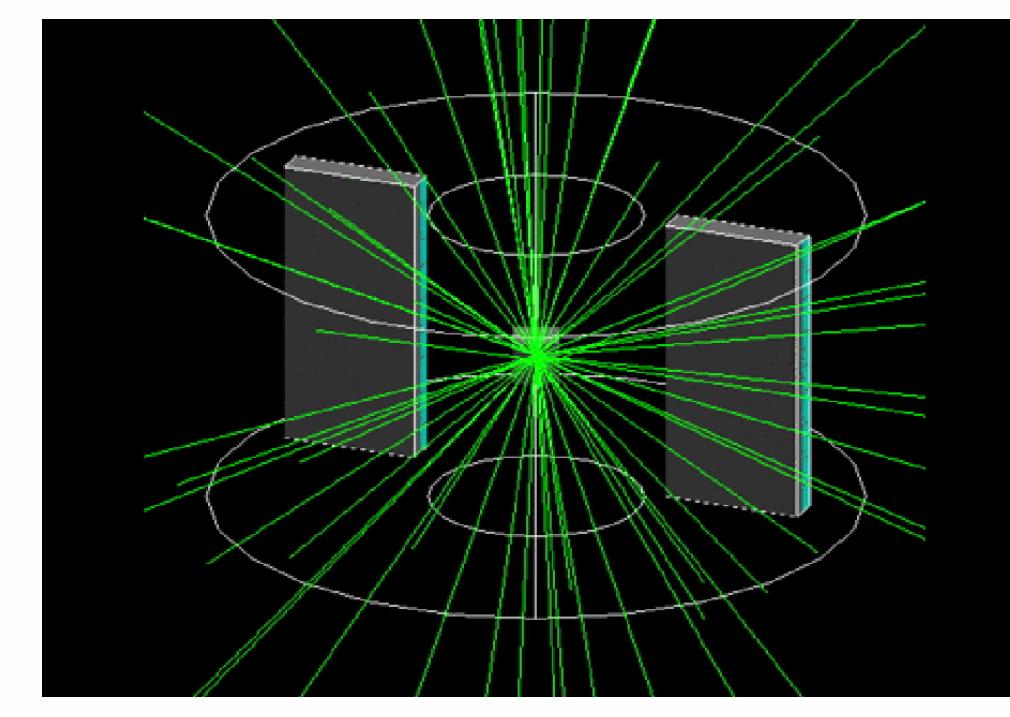
#### Position Resolution (PSF)



### Na22 Sources Mix



### Scaled up version: GATE simulated results - NEMA (50x5 + 50x5 : 1.5x1.5x20 mm LYSO crystals)



## References

- V. Arosio et al., "easyPET - an innovative concept for an affordable tomographic system", Nuclear Instruments and Methods in Physics Research Section A 845(2017) 644
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## Conclusions

### Simple and unique image acquisition method

#### Demonstrator version

- Excellent spatial resolution of around 1.1 mm FBP and uniformity over the whole FoV
  - cell identification through resistive chain – only 4 readout channels
- Scaled up version ( 50x5 + 50x5 : 1.5x1.5x20 mm LYSO crystals)**
- Low cost
  - High spatial resolution below 1 mm (FWHM) with iterative algorithms and uniformity over the whole FoV
  - Fair sensitivity of about 2% (estimated through intelligent scanning)

### There is room for Improvement:

- Intelligent scanning - only subject volume will be scanned
- Improve sensitivity
- Background reduction and contrast increase
- Scanning step smaller than crystal size
- Position resolution improvement