

Spatial Resolution in Dual Panel and Cylindrical TB-PET

Investigating the impact of TOF and DOI

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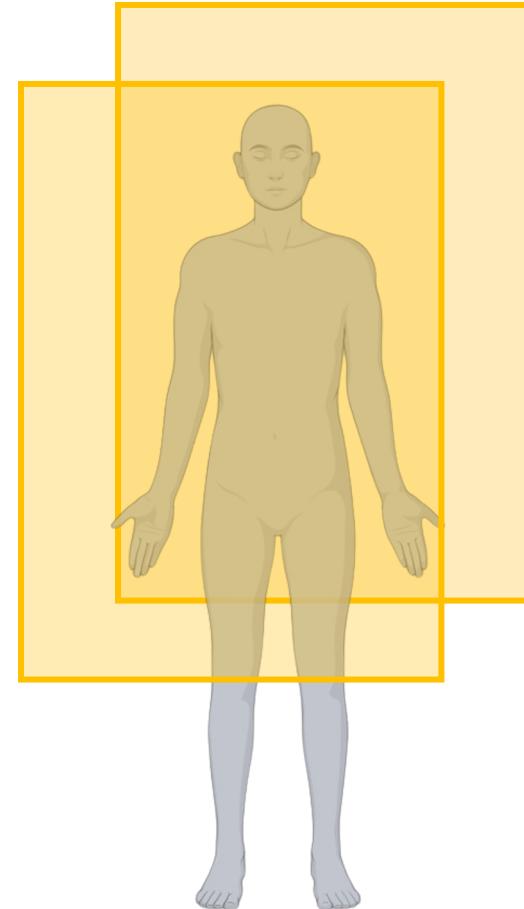


wt-pet.org

Walk-Through PET

LAFOV dual panel system
based on monolithic detectors

- **compact**
 - **cost-efficient**
 - **high-throughput**
 - **high-resolution**
- monolithic detectors
- high intrinsic resolution
 - depth of interaction



Aims of the study



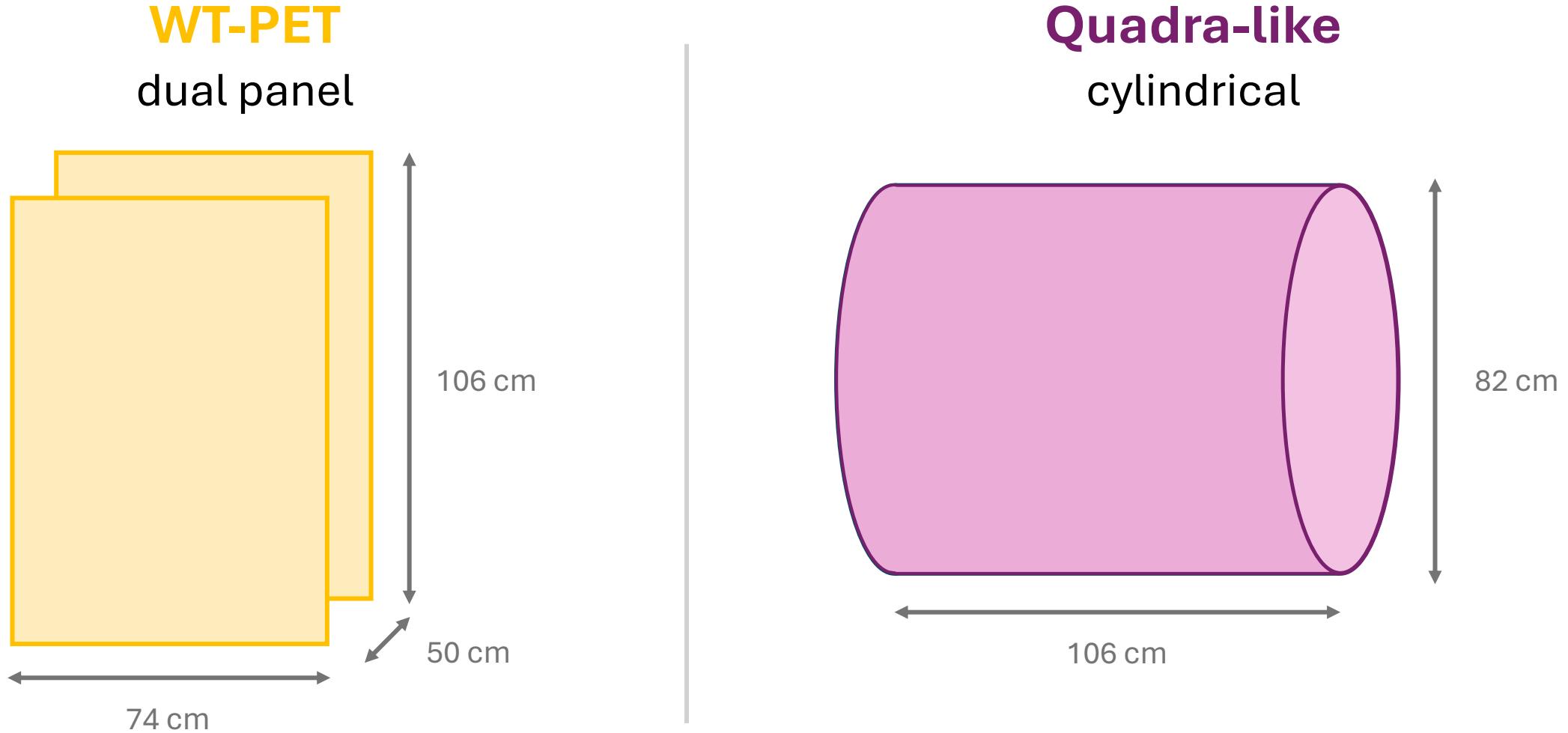
benchmark the spatial resolution of the WT-PET to a conventional pixelated cylindrical device



investigate the effect of

system geometry
depth of interaction
time of flight

System models: geometries

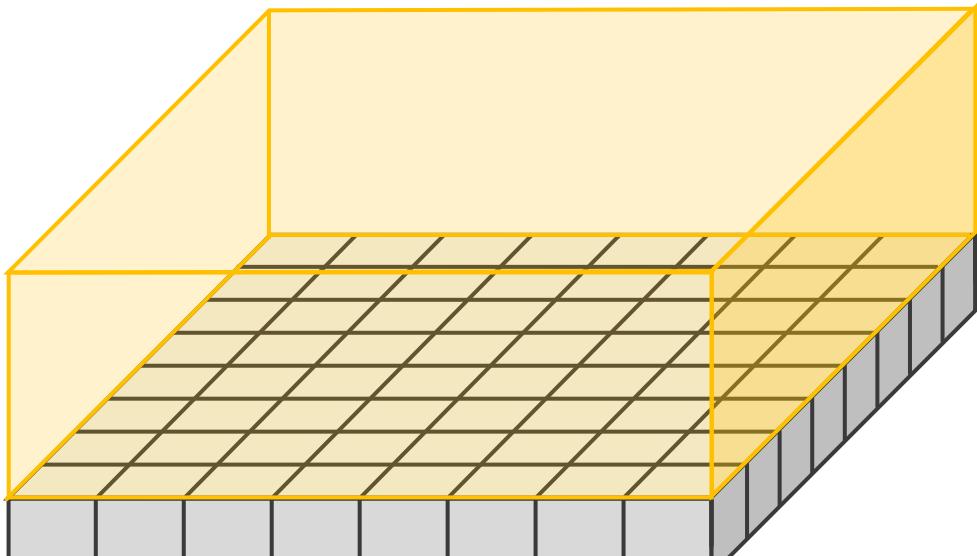


System models: detectors

WT-PET

monolithic BGO

$50 \times 50 \times 16 \text{ mm}^3$

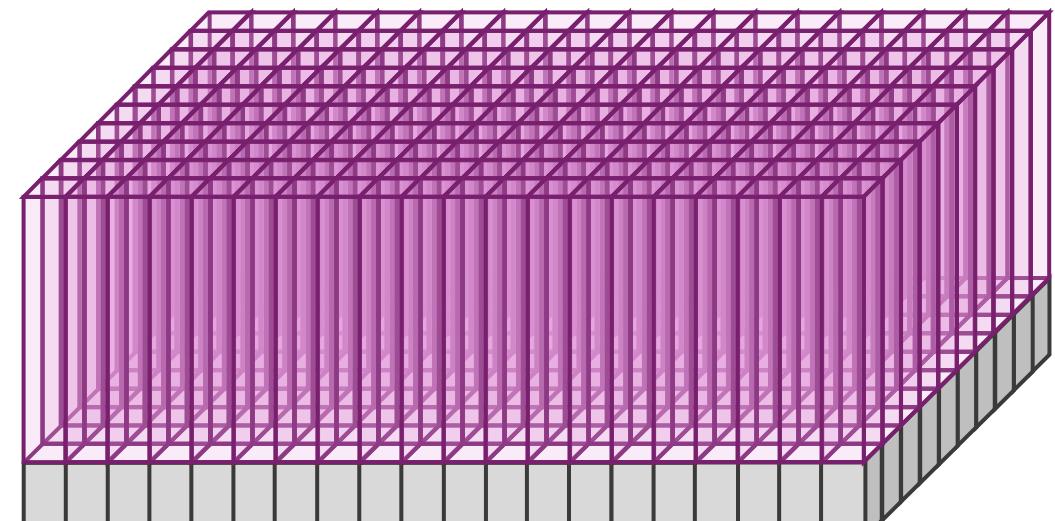


$8 \times 8 \text{ SiPMs}$

Quadra-like

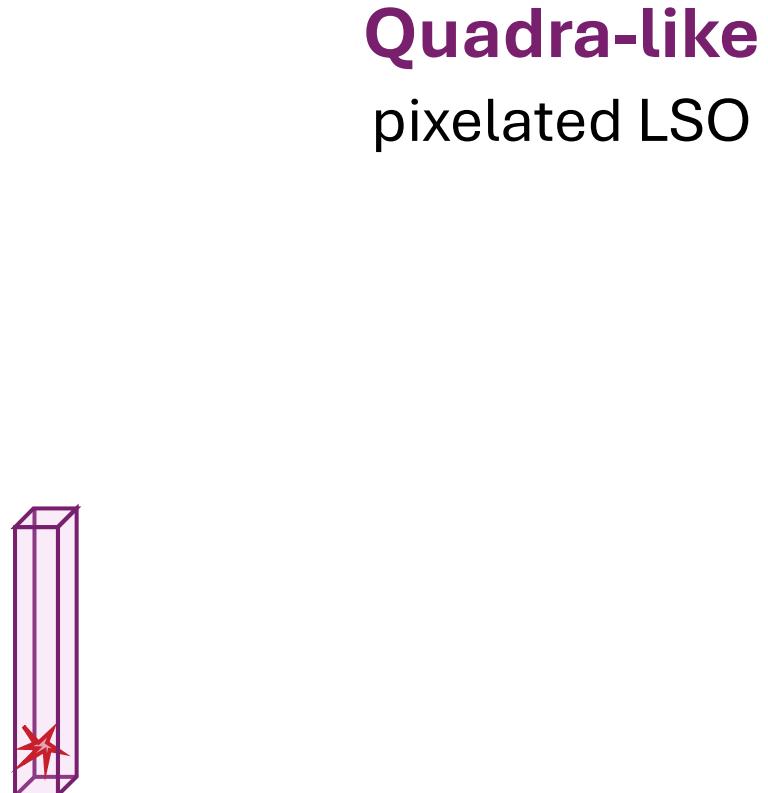
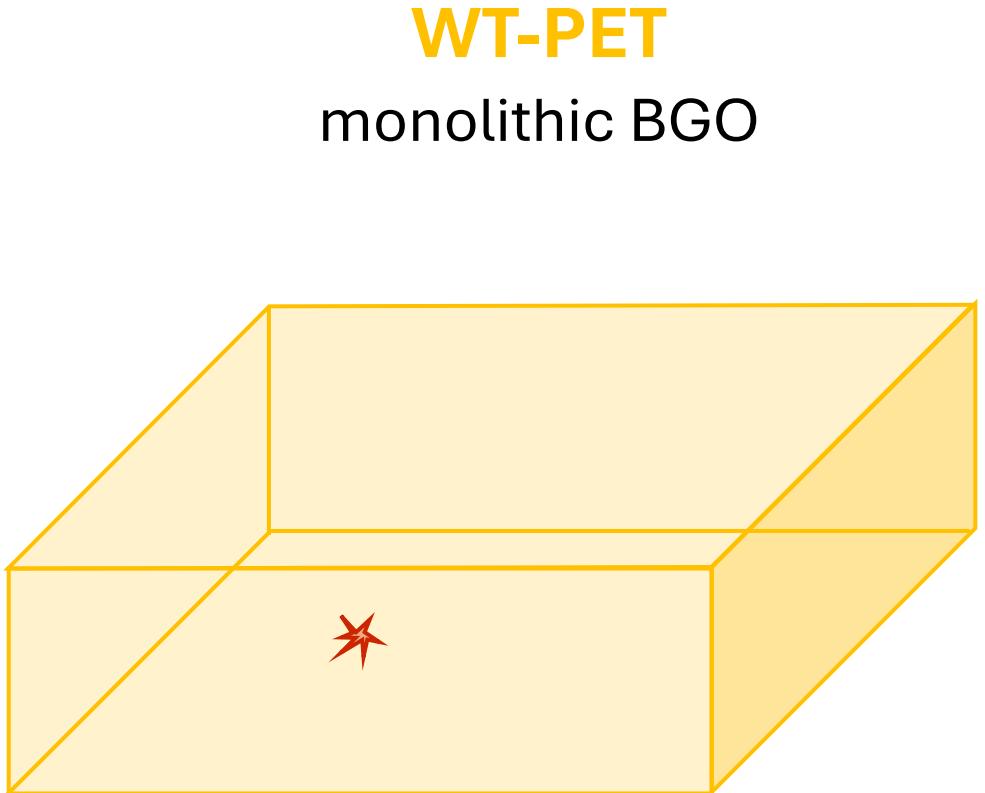
pixelated LSO

$3.2 \times 3.2 \times 20 \text{ mm}^3$

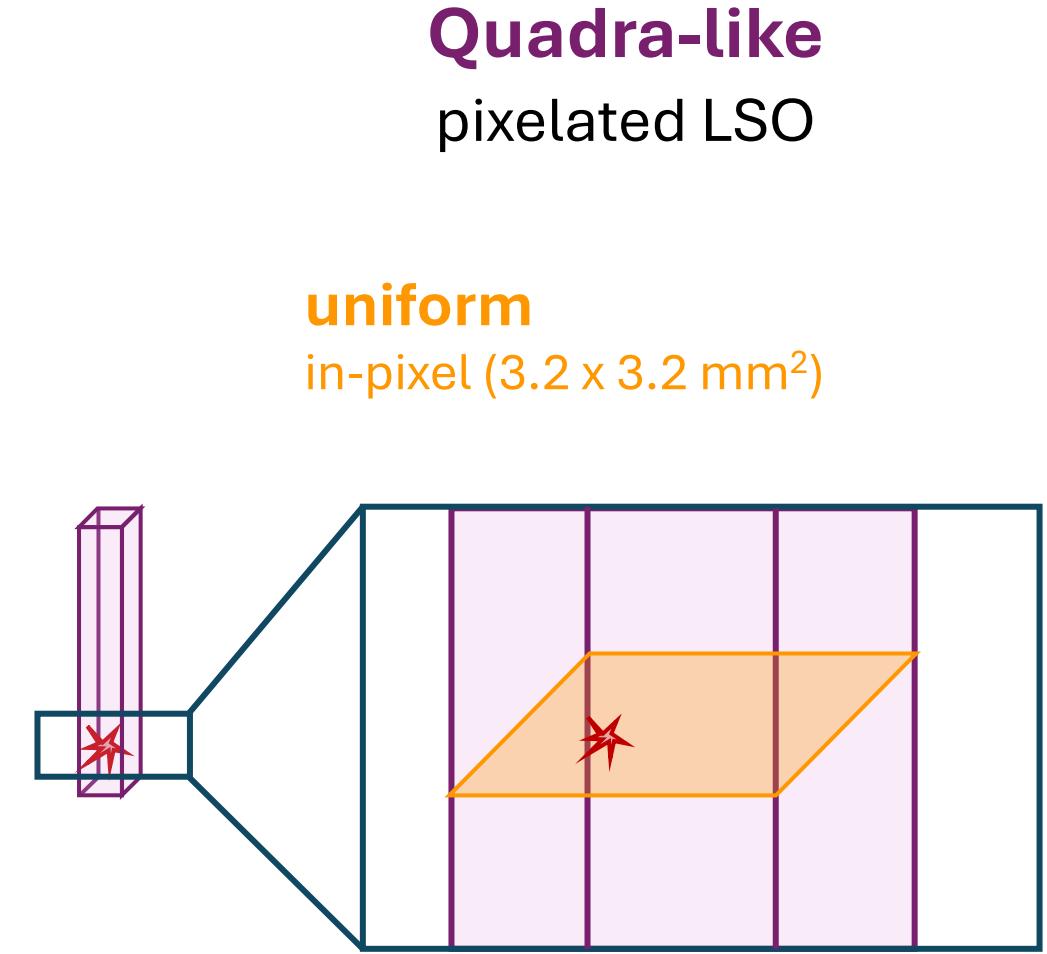
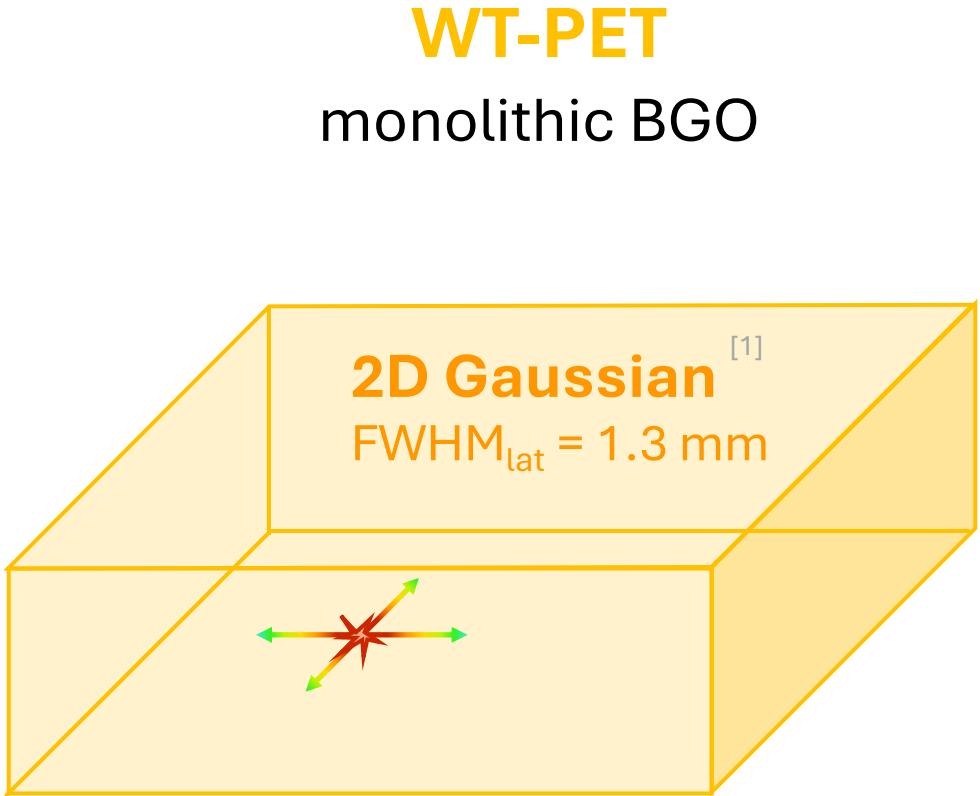


one-to-one coupling

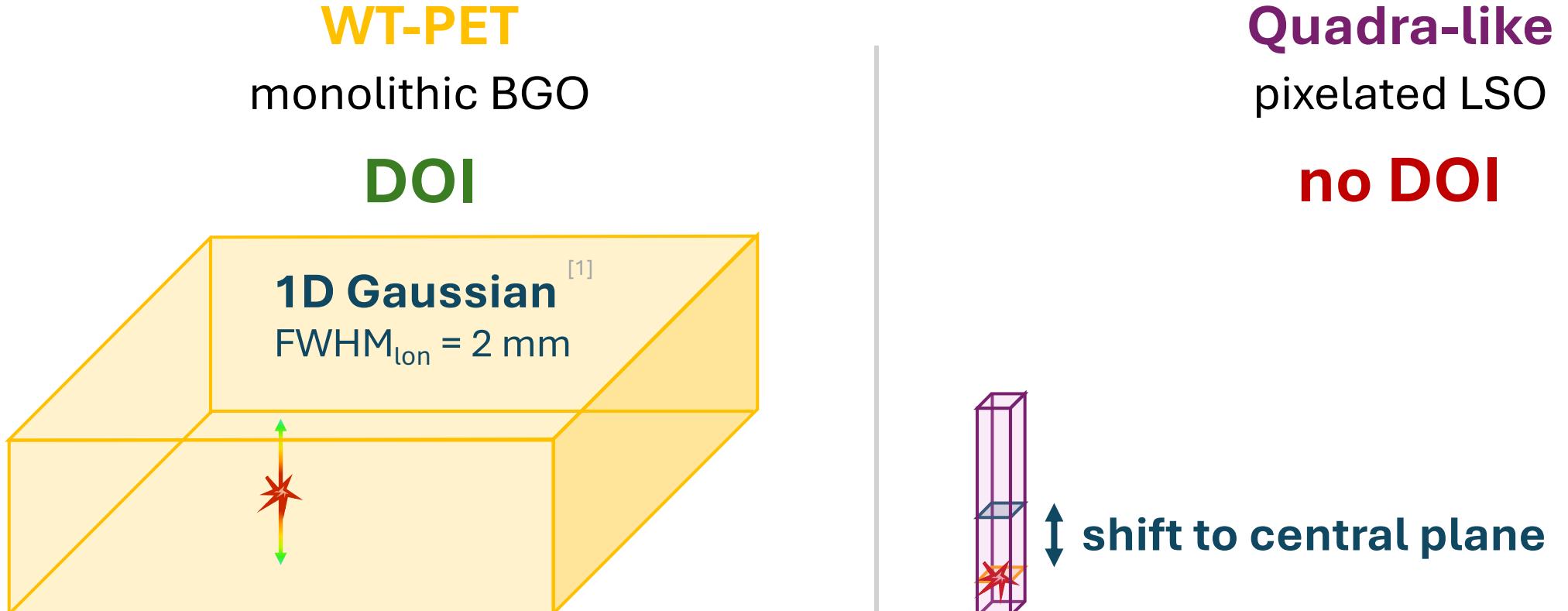
GATE simulation: exact interaction positions



Post-processing: lateral (in-plane) blurring



Post-processing: longitudinal blurring

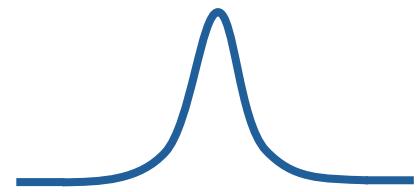


[1] P. Carra et al., "Performance of a monolithic BGO-based detector implementing a Neural Network event decoding algorithm for TB-PET applications", PSMR-TBP, 2022

Post-processing: time blurring

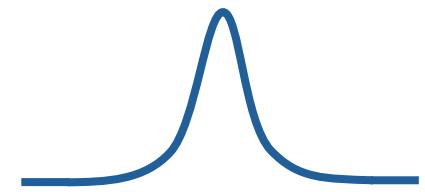
WT-PET
monolithic BGO

327 ps^[1]
49 mm



Quadra-like
pixelated LSO

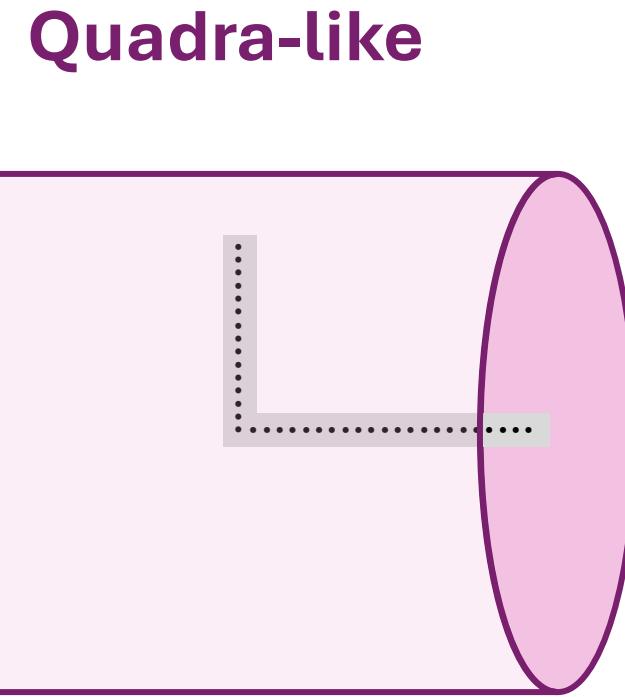
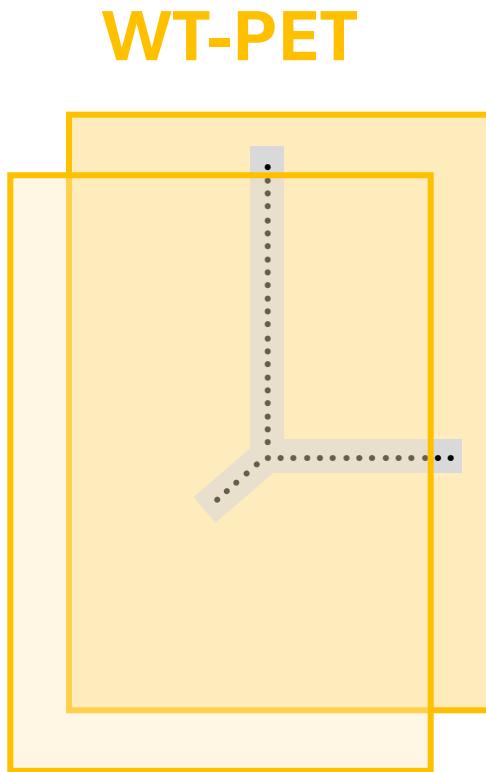
228 ps^[2]
34 mm



[1] P. Carra et al., "Performance of a monolithic BGO-based detector implementing a Neural Network event decoding algorithm for TB-PET applications", PSMR-TBP, 2022

[2] Biograph Vision Quadra – technical specifications, obtained from www.siemens-healthineers.com/nl-be/molecular-imaging/pet-ct/biograph-vision-quadra on 15/05/2023

Simulation setup

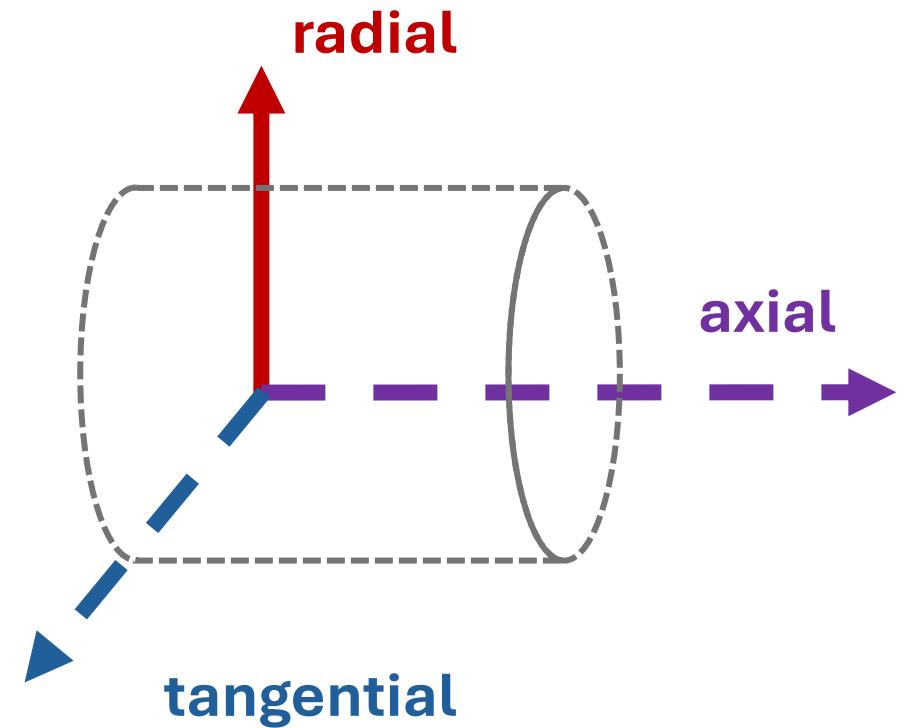
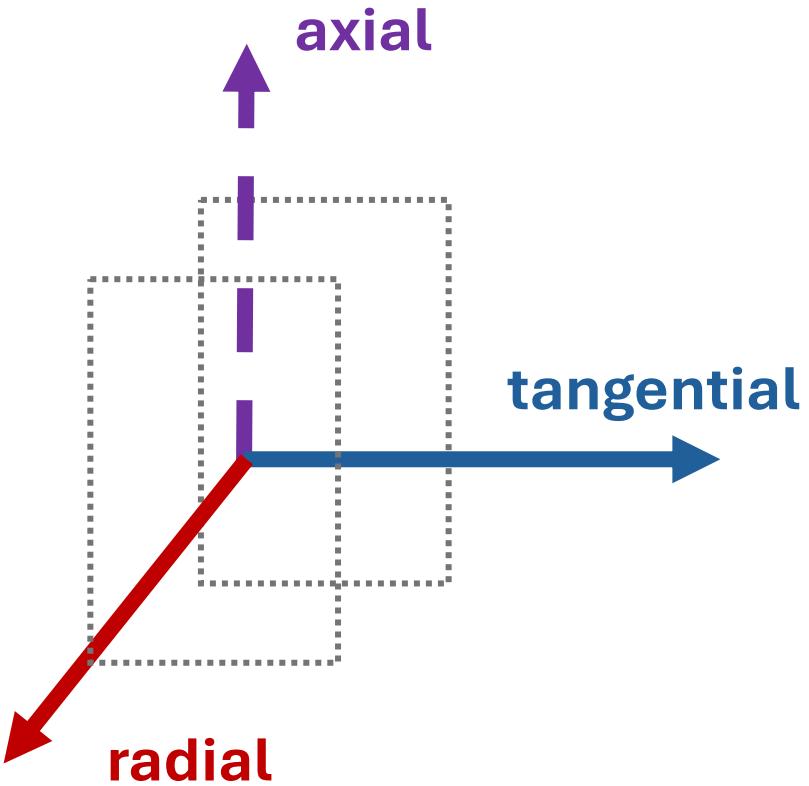


LM-MLEM \rightarrow 10,000:1 activity ratio (point source:background)

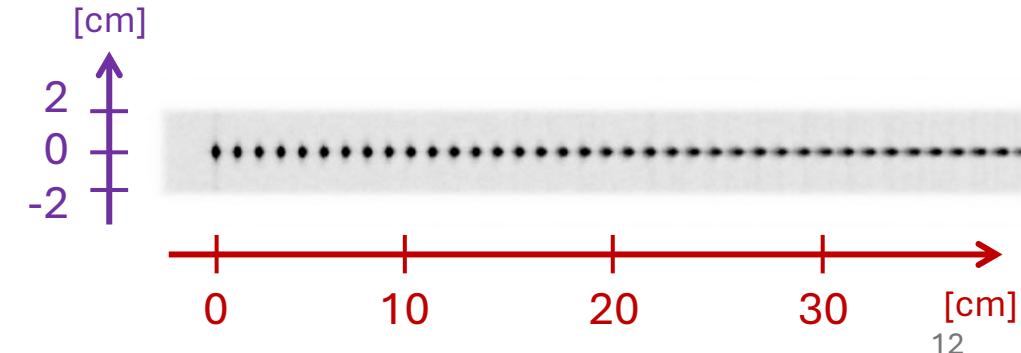
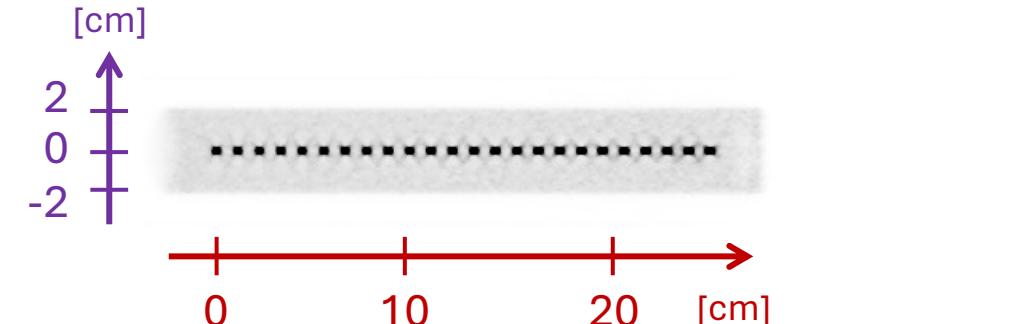
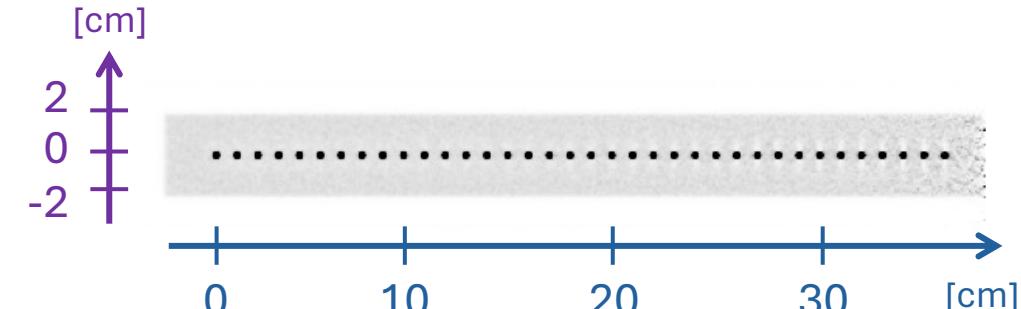
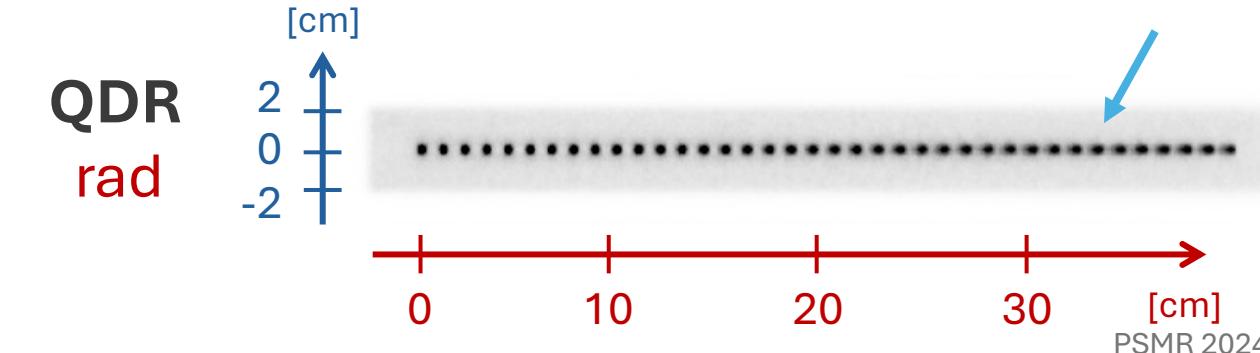
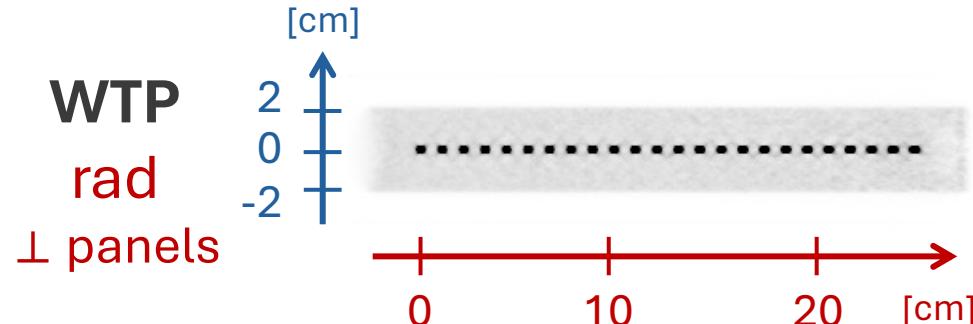
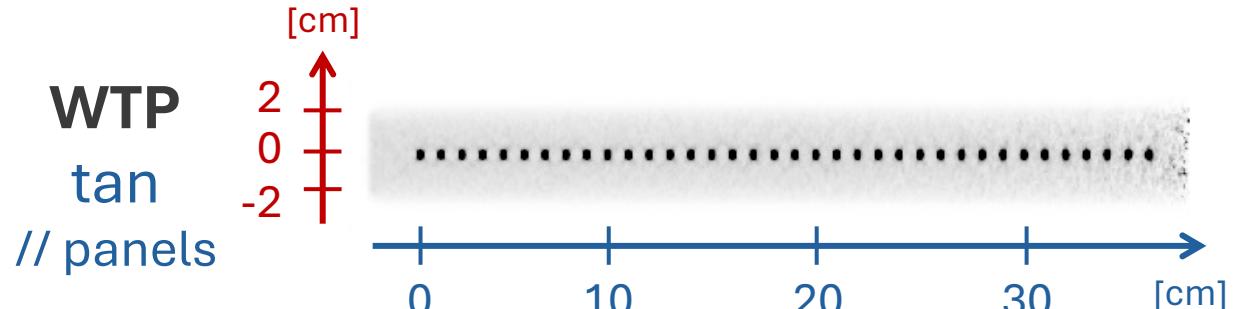
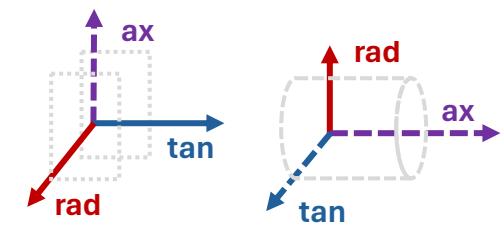


$$= \bullet + \bullet + \bullet + \dots + \square + \square + \square$$

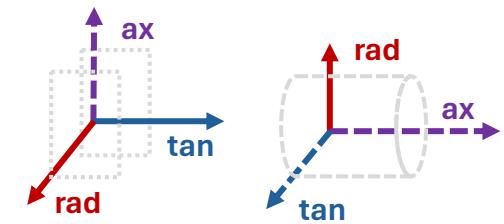
Coordinate system and nomenclature



Standard configurations: images

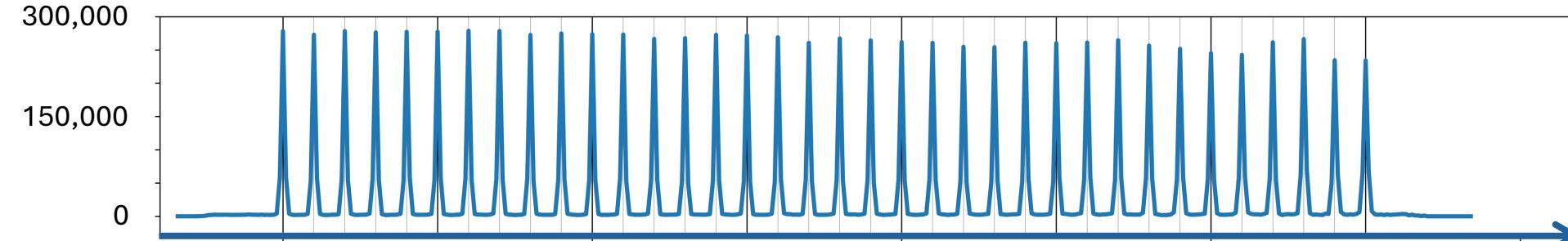


Standard configurations: line profiles



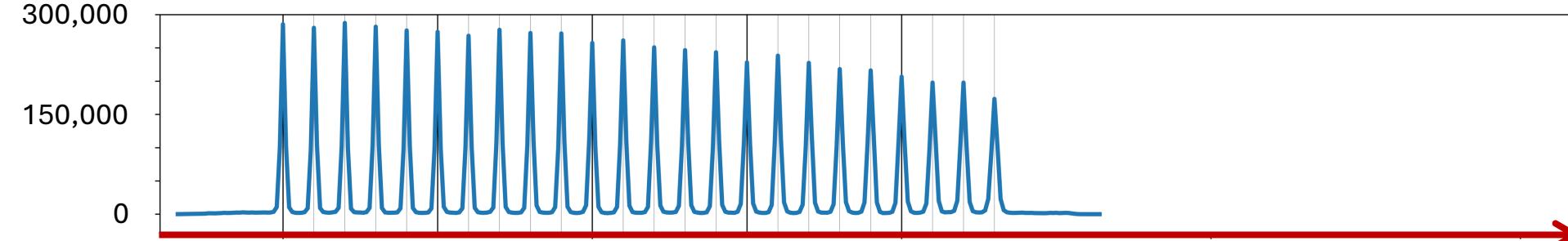
[counts/voxel]

WTP
tan



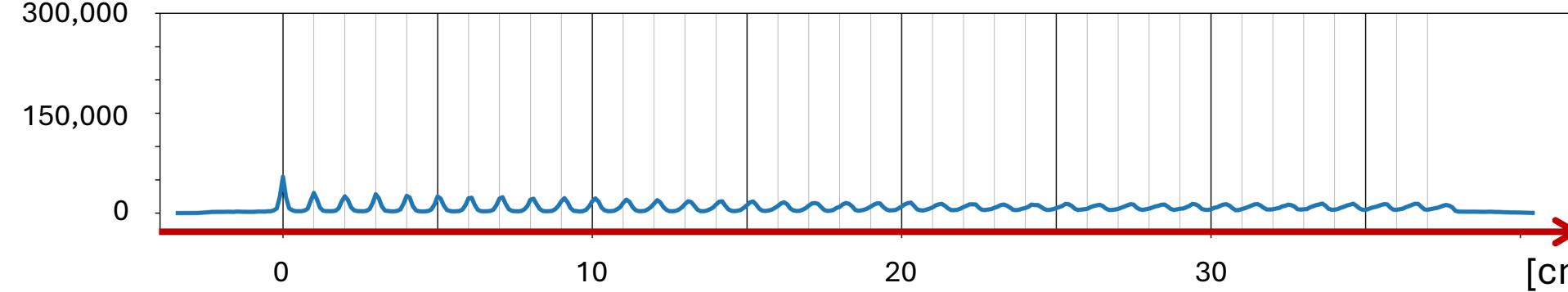
// panels

WTP
rad

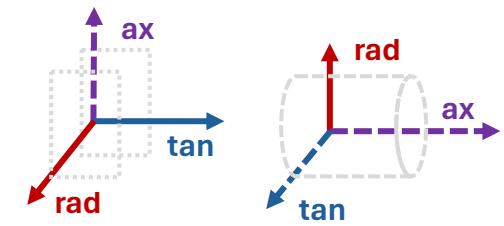


⊥ panels

QDR
rad

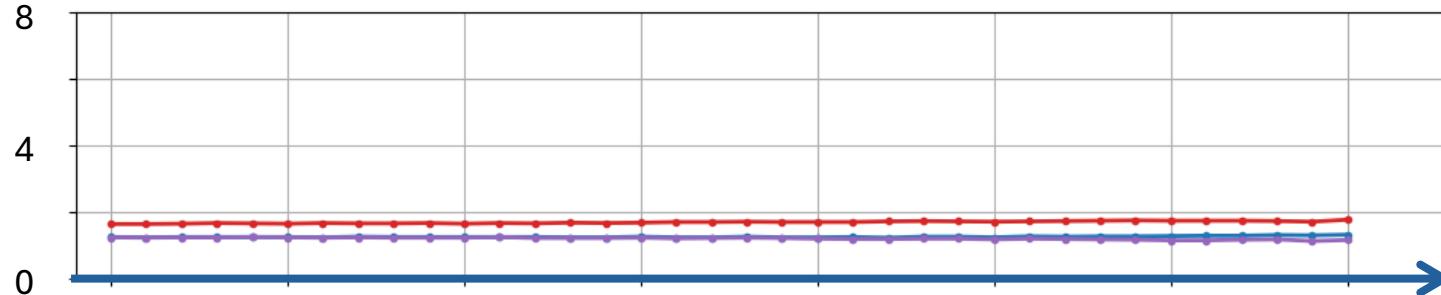


Standard configurations: FWHM

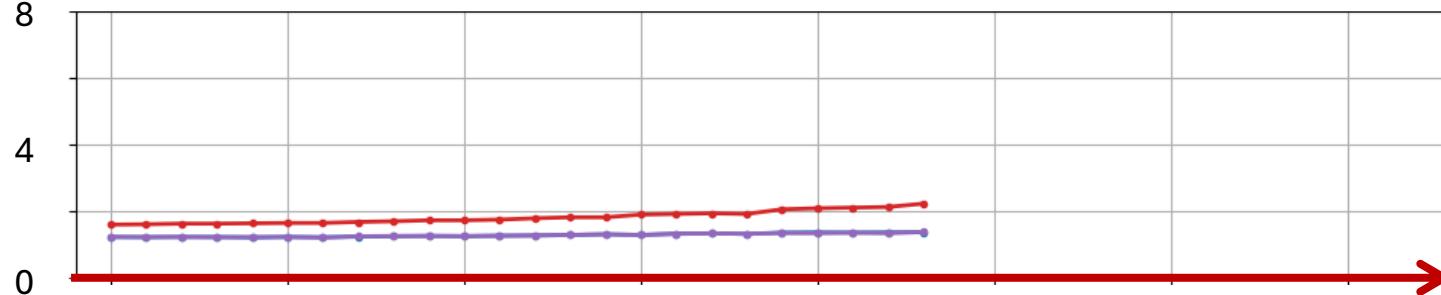


WTP
tan
// panels

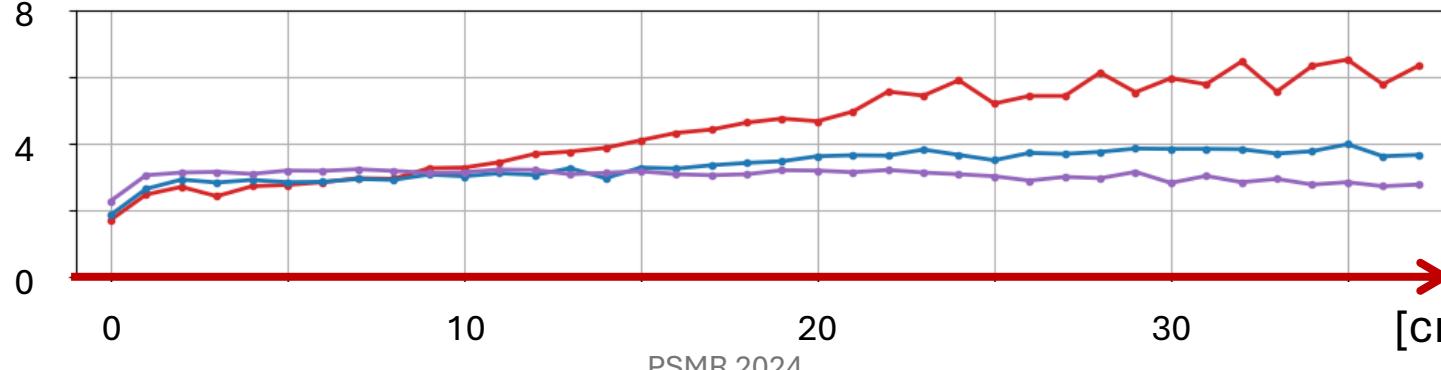
[mm]



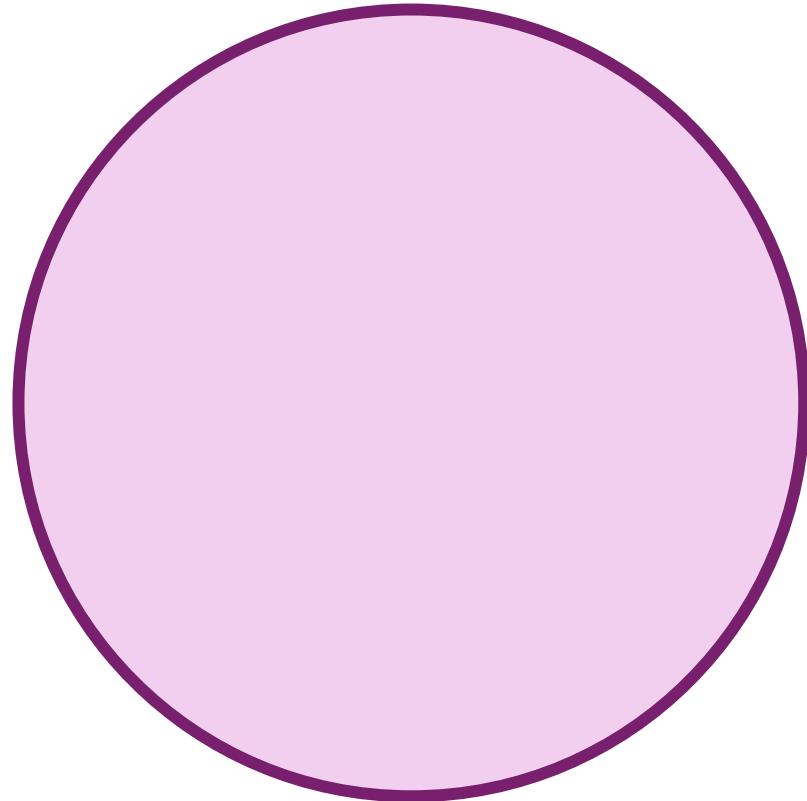
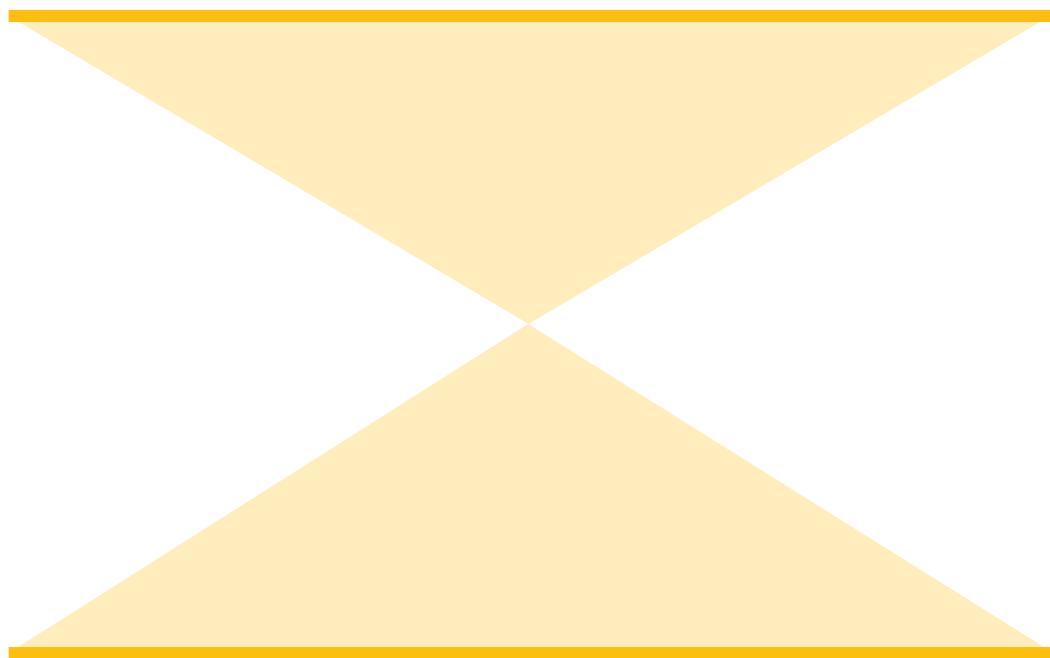
WTP
rad
⊥ panels



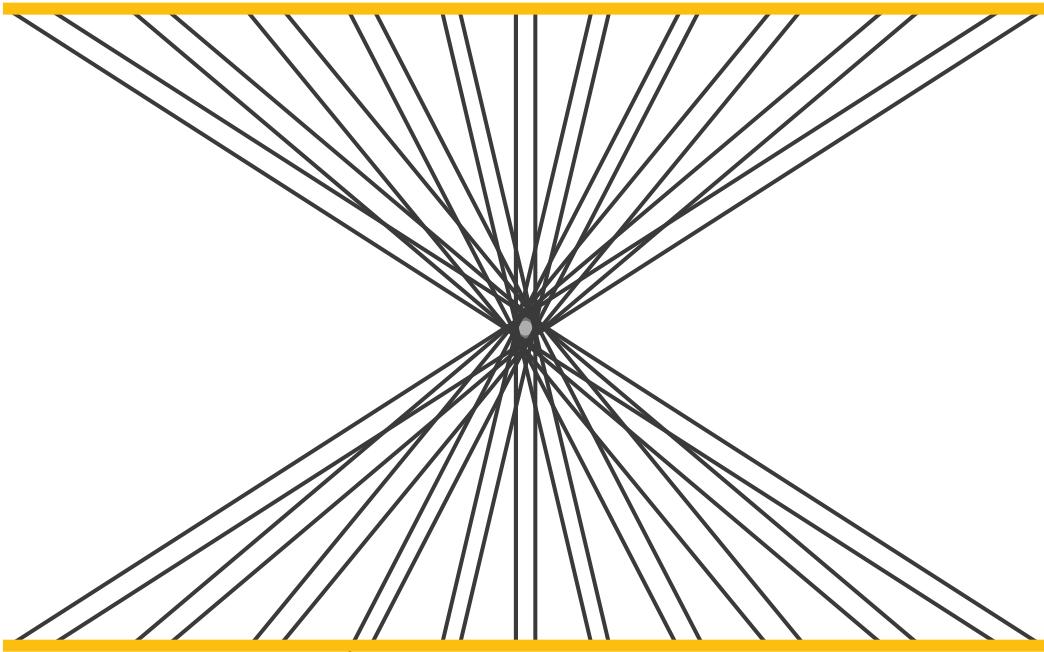
QDR
rad



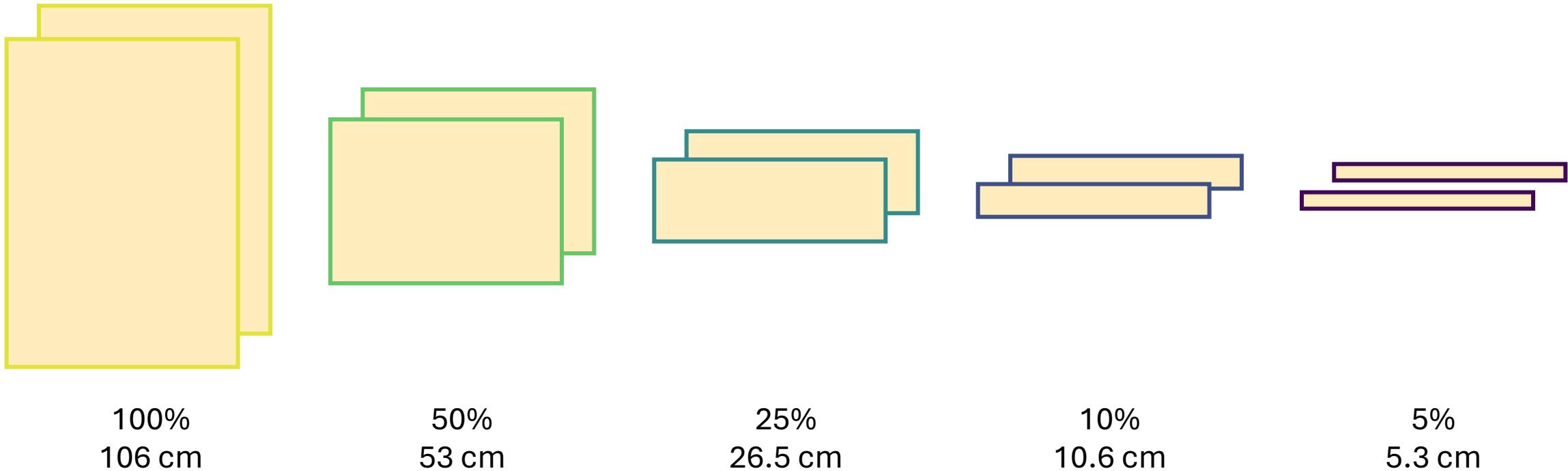
Limited angles



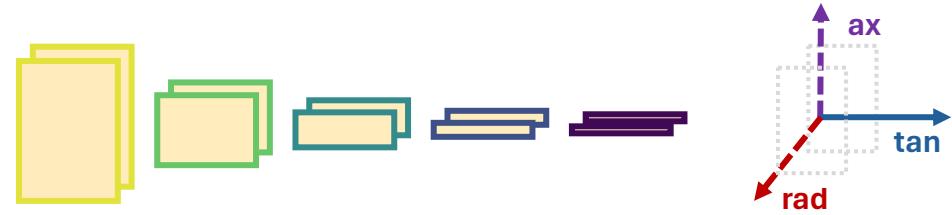
Effect of limited angles



Effect of limited angles

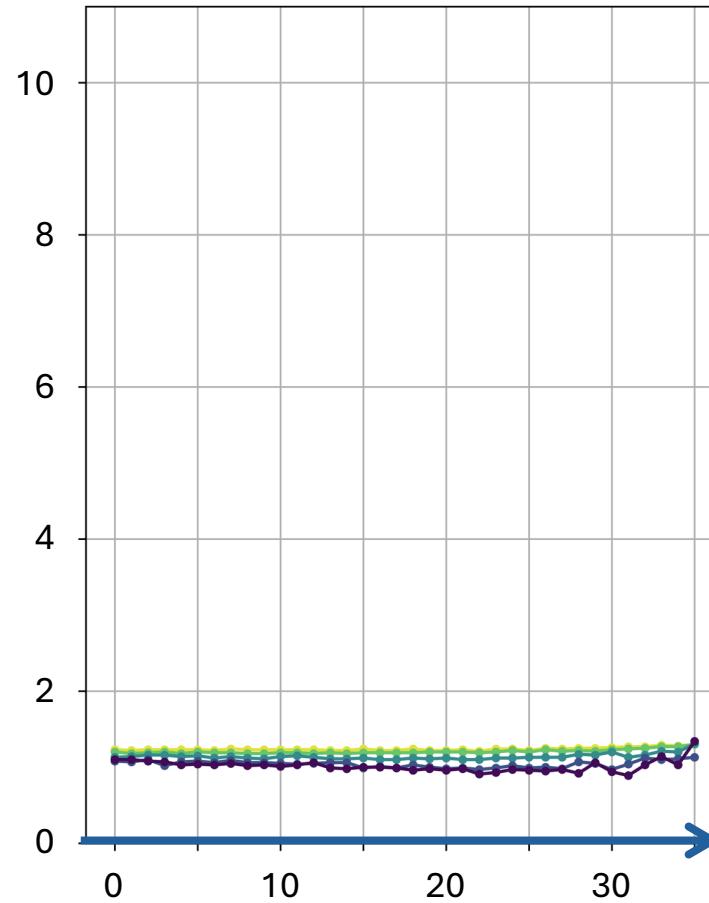


Effect of limited angles: FWHM

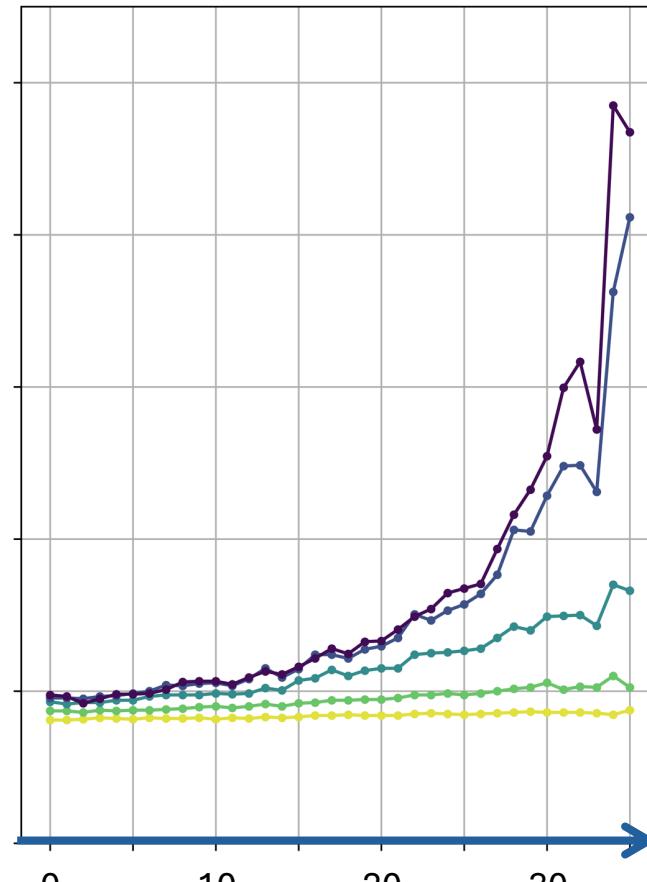


[mm]

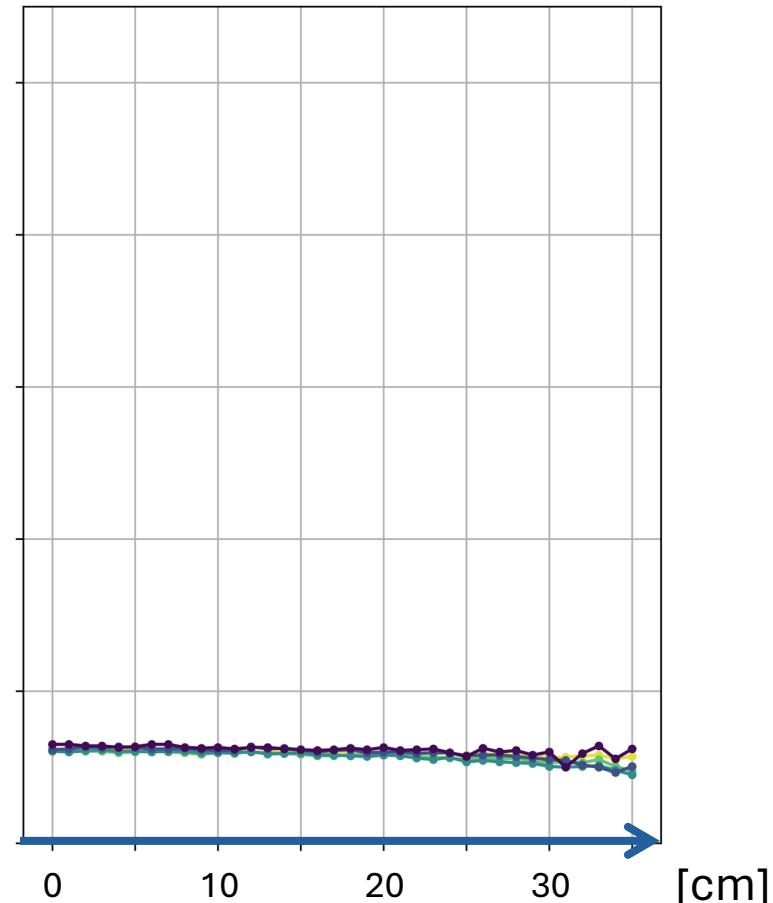
tangential



radial



axial



Aims of the study



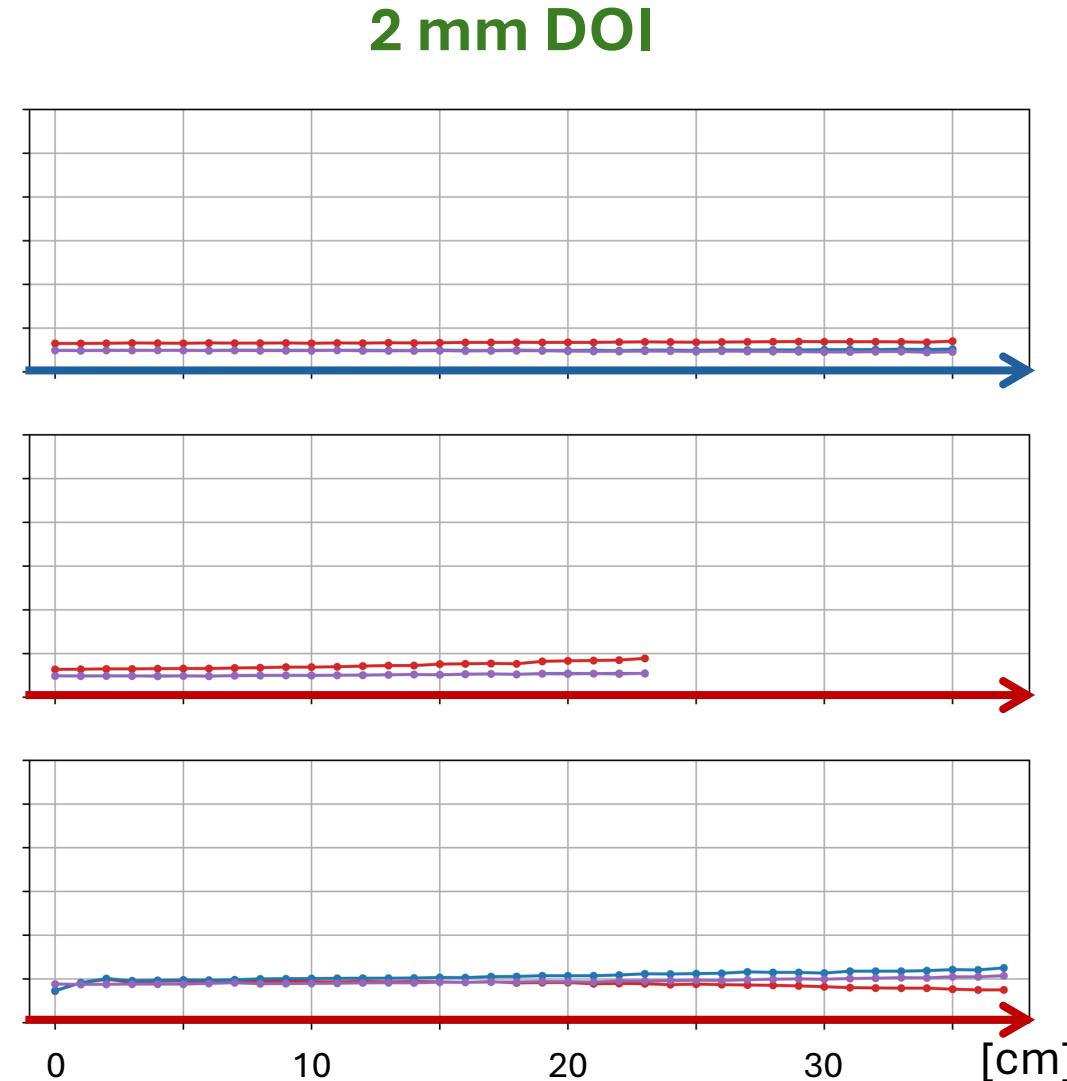
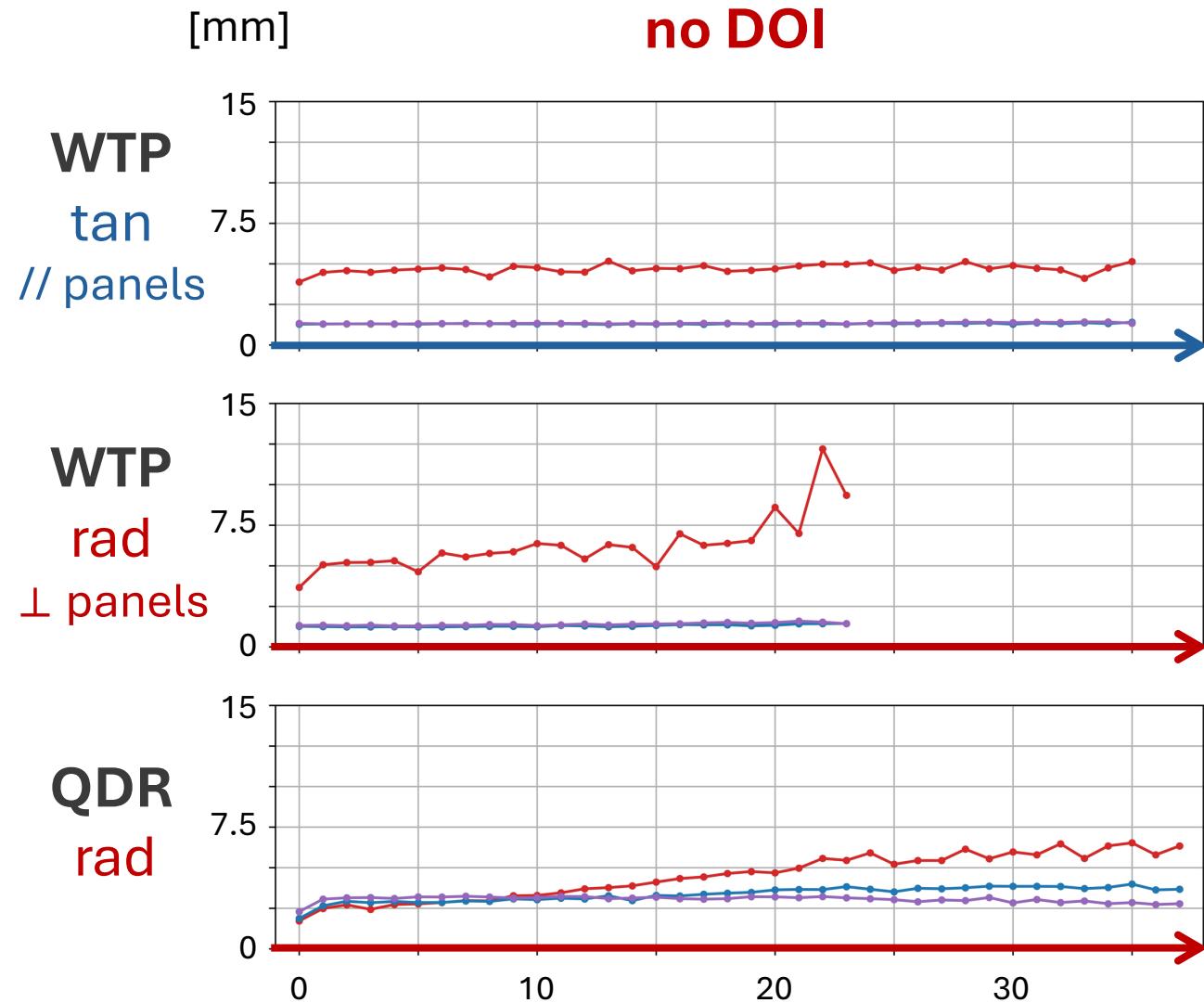
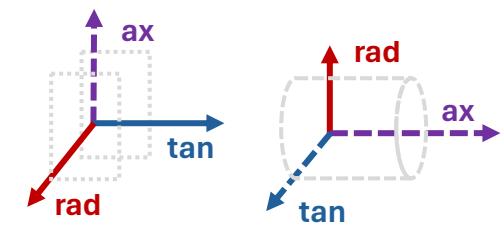
benchmark the spatial resolution of the WT-PET to a conventional pixelated cylindrical device



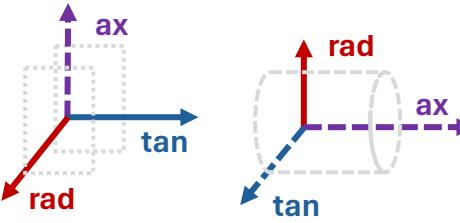
investigate the effect of

system geometry
depth of interaction
time of flight

Effect of DOI: FWHM



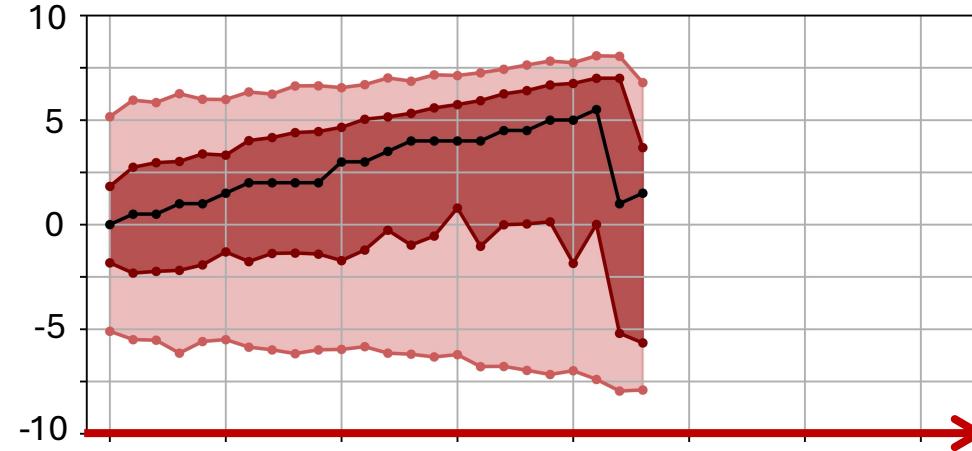
Effect of DOI: mispositioning

- maximum
 - FWHM bound
 - FWTM bound
- 

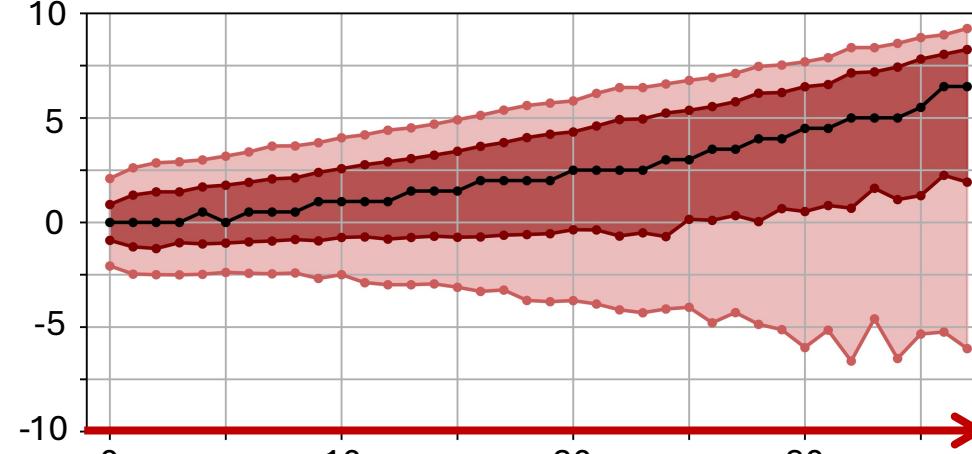
[mm]

no DOI

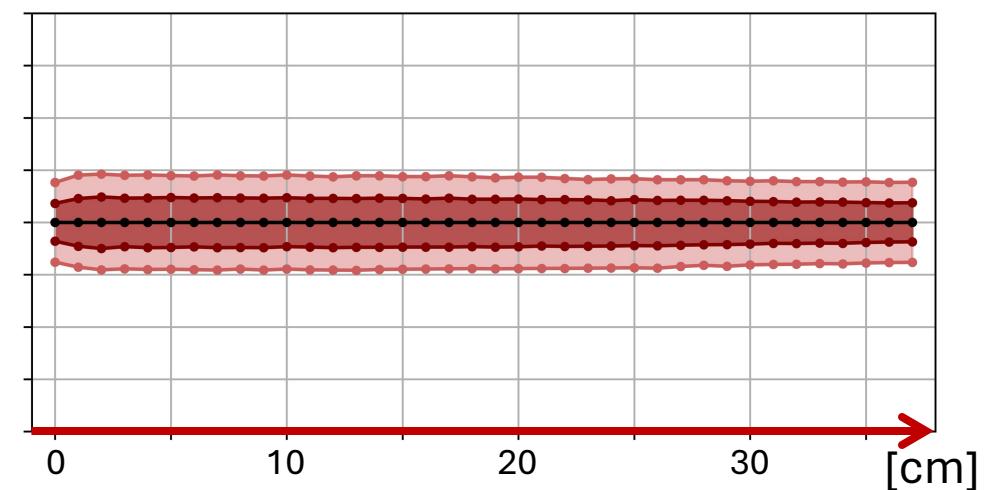
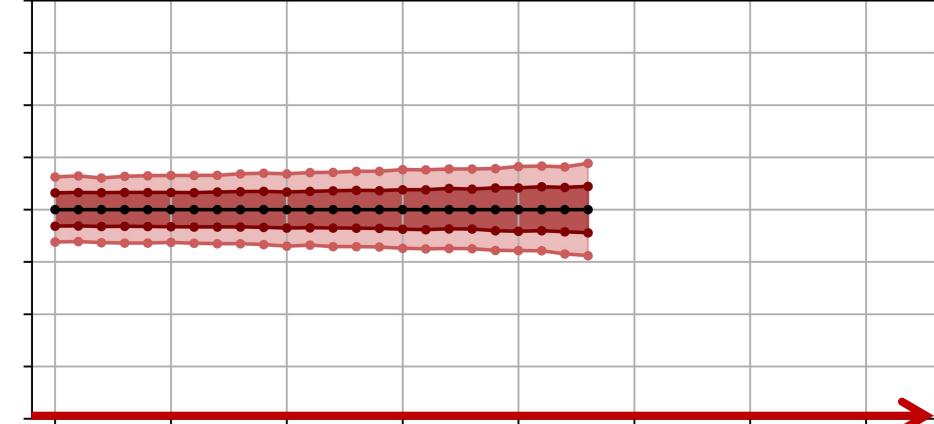
WTP
rad
 \perp panels



QDR
rad



2 mm DOI



Aims of the study



benchmark the spatial resolution of the WT-PET to a conventional pixelated cylindrical device



investigate the effect of

system geometry
depth of interaction
time of flight

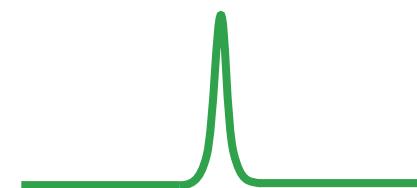
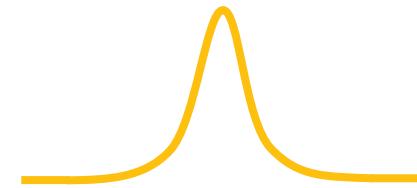
Post-processing: time blurring

WT-PET
monolithic BGO

no TOF

327 ps 49 mm

050 ps 7.5 mm

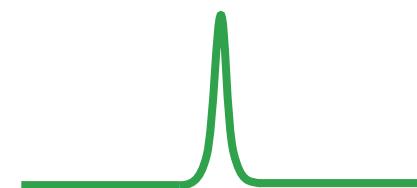
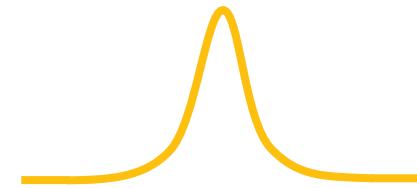


Quadra-like
pixelated LSO

no TOF

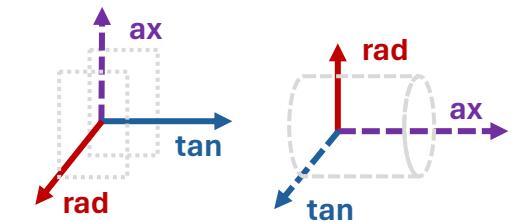
228 ps 34 mm

050 ps 7.5 mm



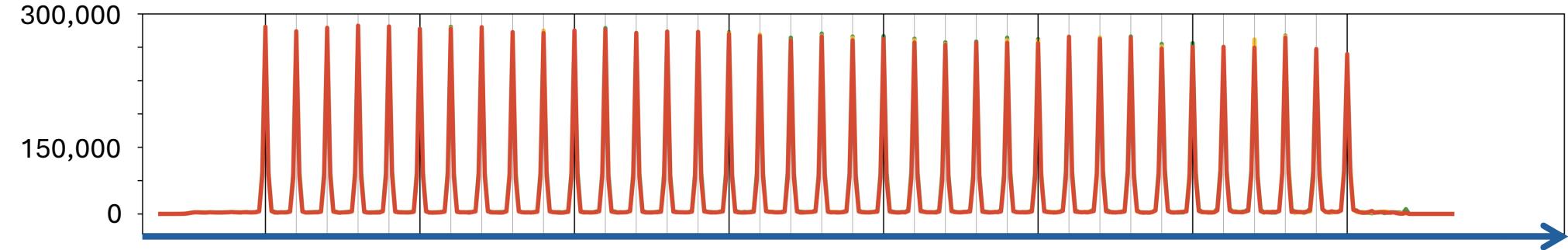
Effect of TOF: line profiles

- no TOF
- 327 ps
- 050 ps

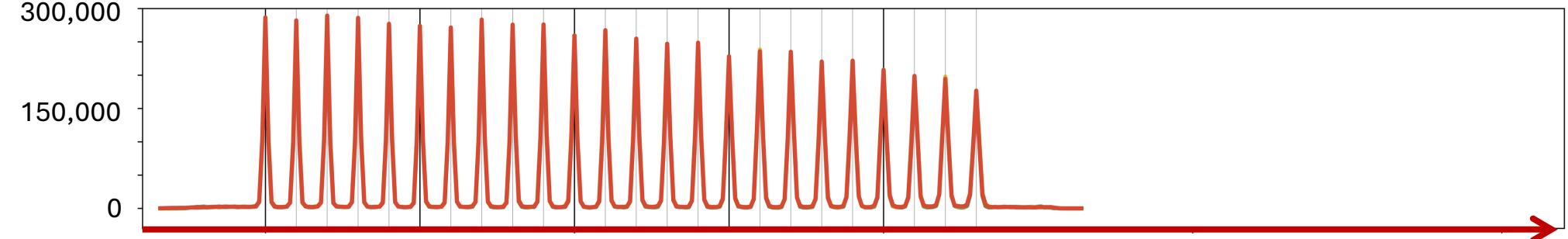


[counts/voxel]

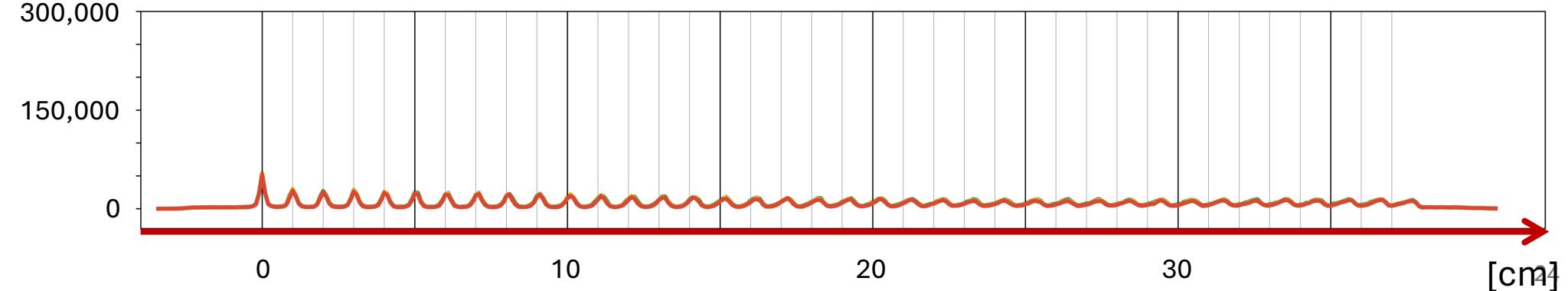
WTP
tan
// panels



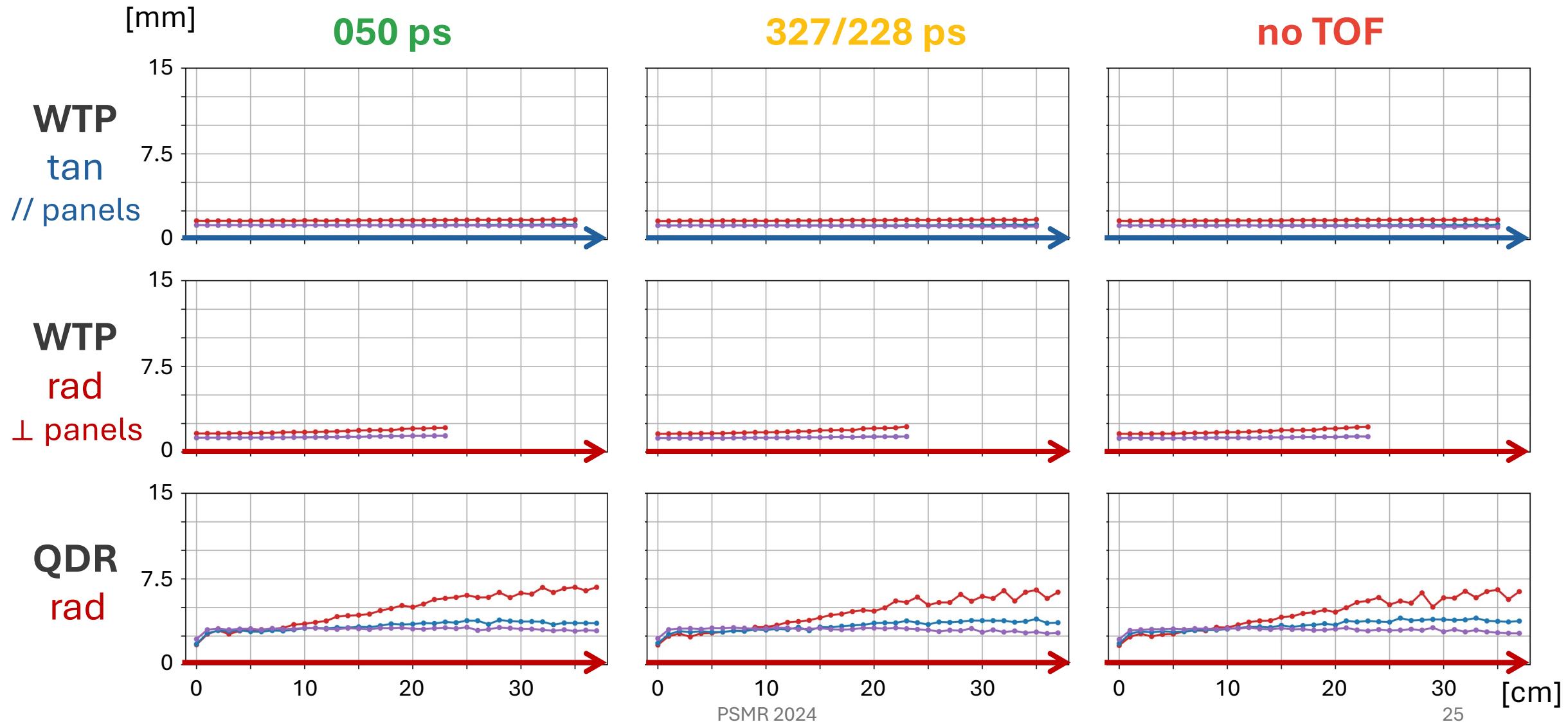
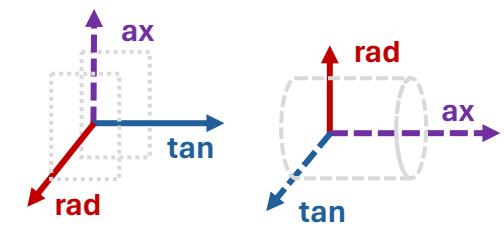
WTP
rad
⊥ panels



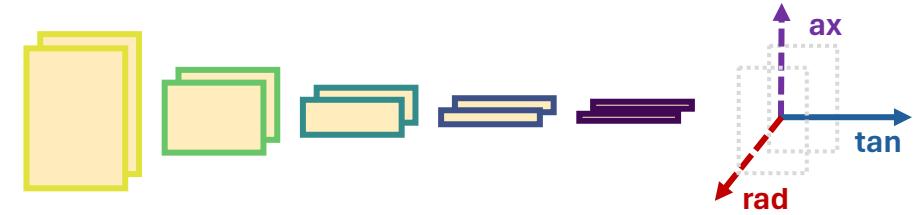
QDR
rad



Effect of TOF: FWHM

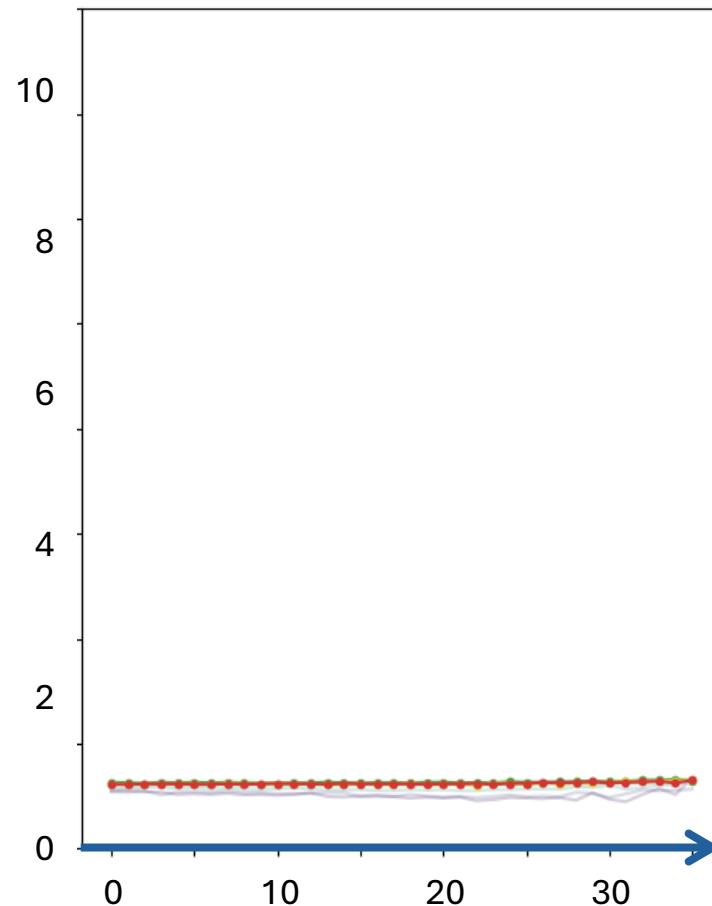


Limited angles and TOF: FWHM

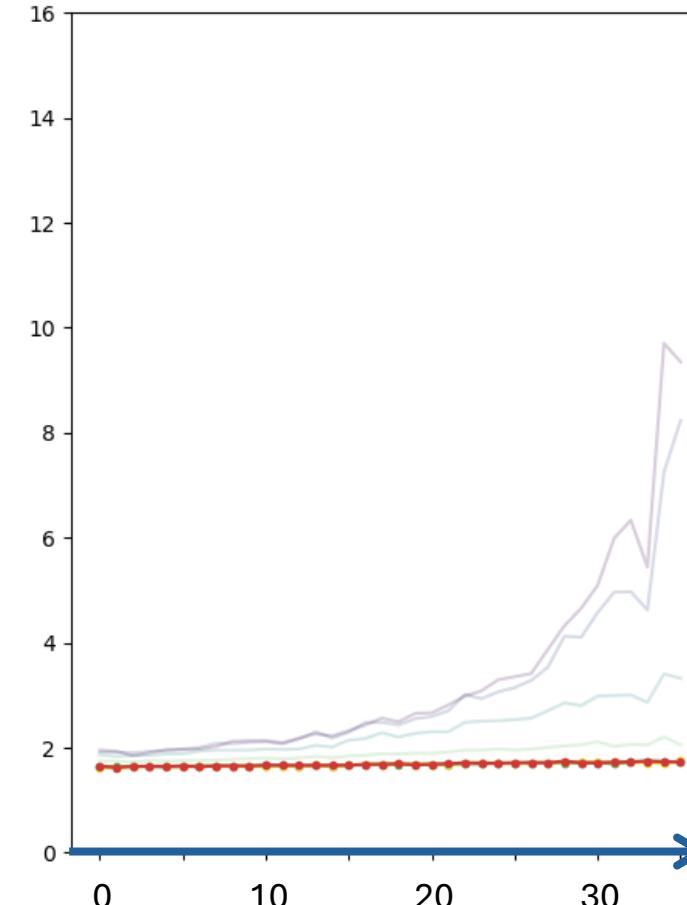


[mm]

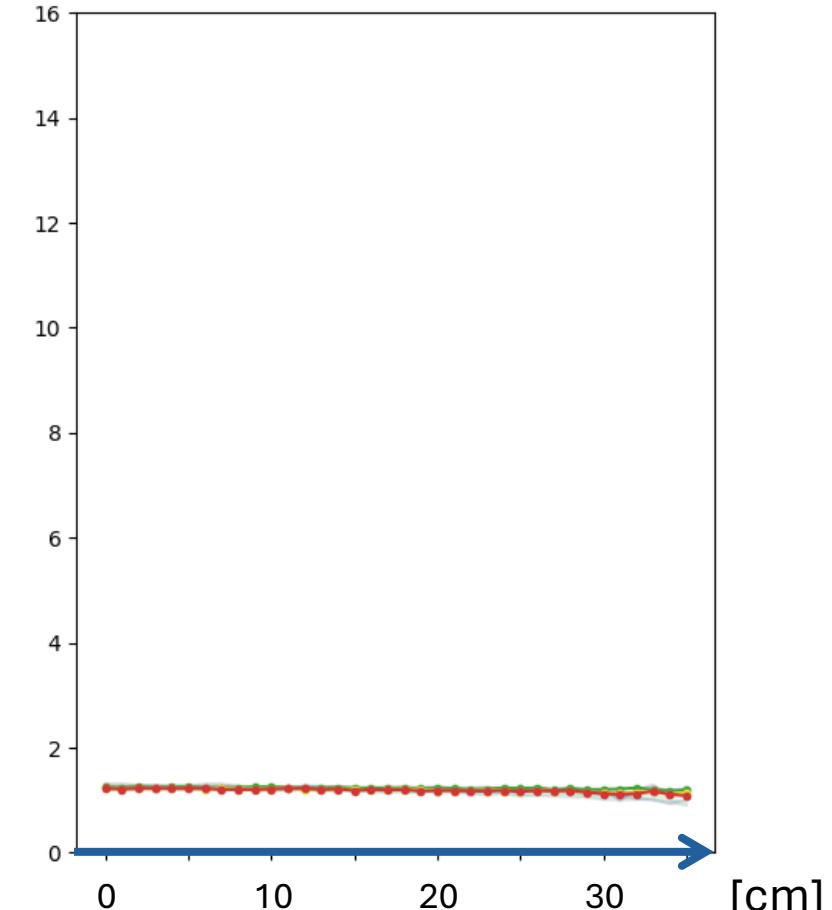
tangential



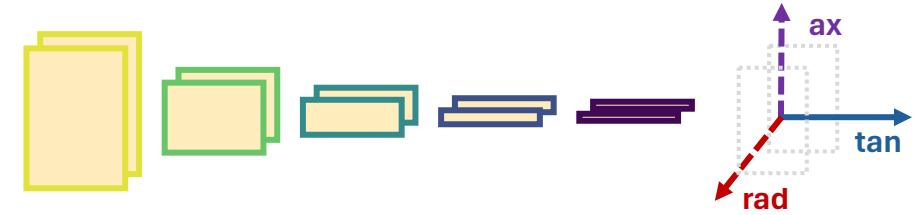
radial



axial

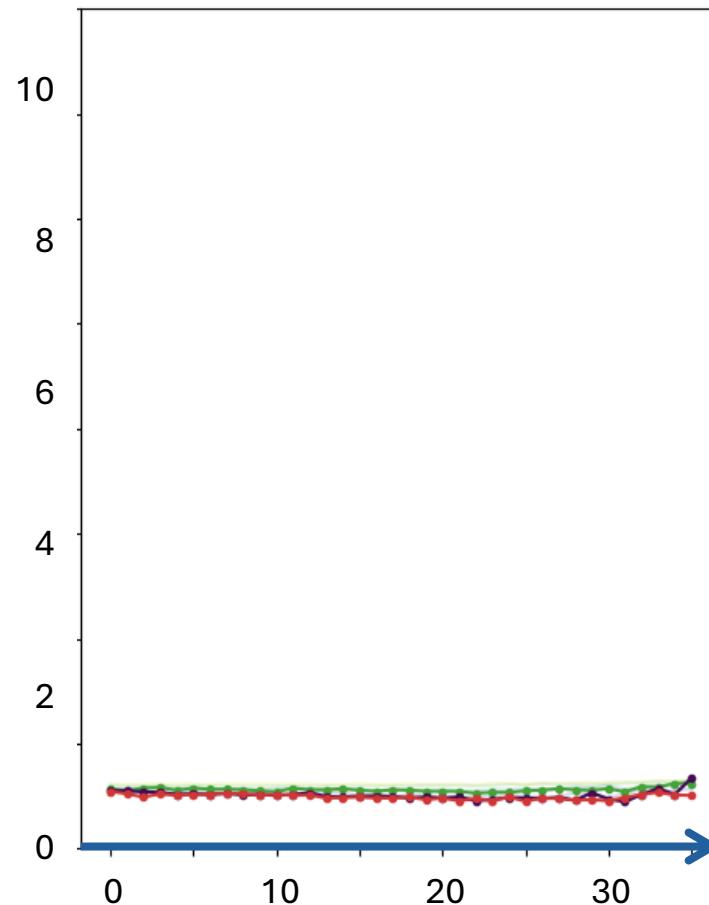


Limited angles and TOF: FWHM

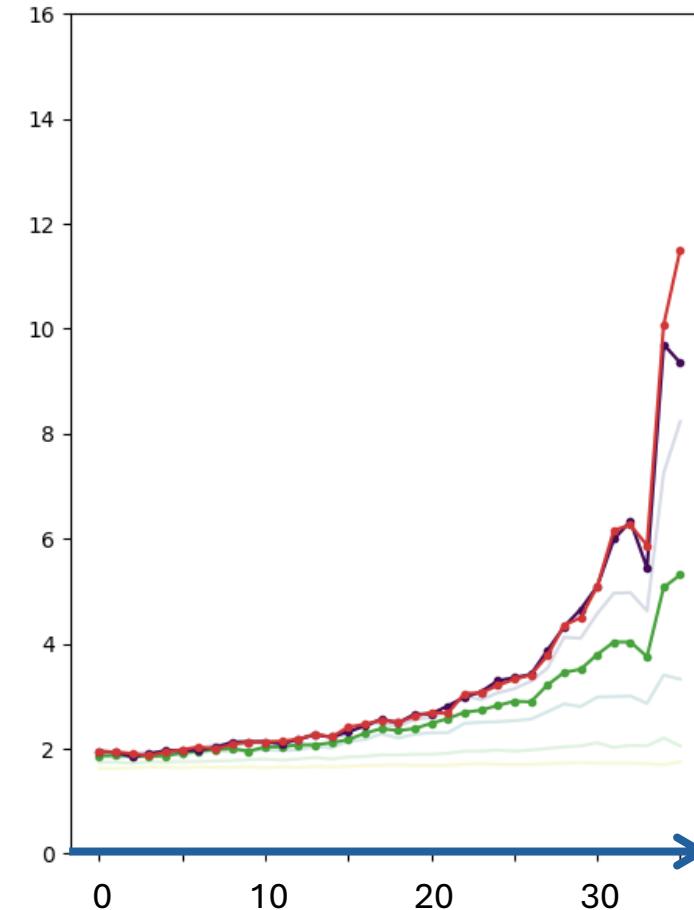


[mm]

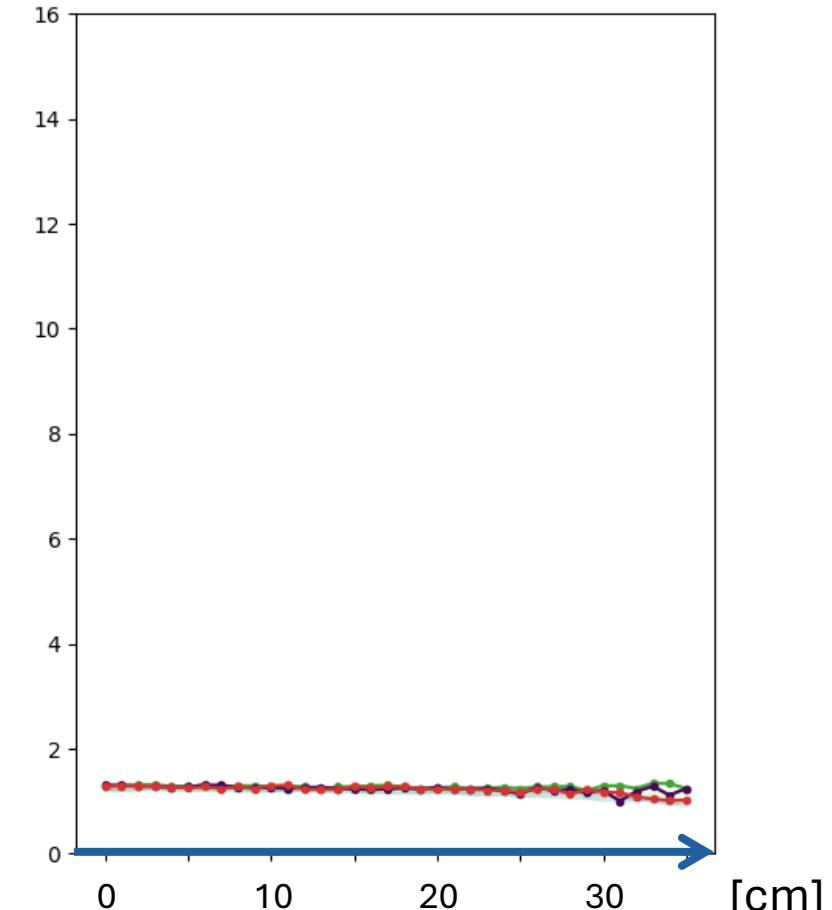
tangential



radial



axial



Conclusions of the study



WT-PET shows higher and more homogeneous resolution than pixelated cylindrical device



system geometry

cylindrical: parallax at large radial offset

depth of interaction

dual panel: parallax over full FOV + limited angle

time of flight

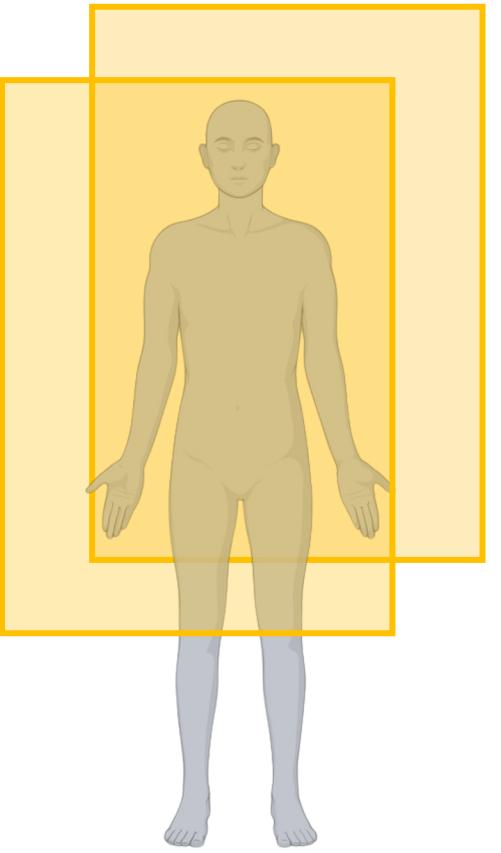
indispensable to avoid parallax effect

negligible effect (except for very high TOF)



Thanks!

WT-PET.org



This work was funded by
the special research
fund of Ghent University

System models

Parameter	WT-TB-PET	Quadra-like
Energy resolution	15 %	11 %
Energy window (keV)	434-645	455-645
TOF resolution (ps)	327	228
Dead time (ns)	370	320