



Nuclear medical imaging context

- Main tool: Positron Emission Tomography (PET)
- Injection of radioactive tracer ¹⁸F
- γ photons (LOR) detected by scintillation.
- Image quality = f(injected dose, duration)
- High time resolution (100s of ps)
- Power hungry
- Huge amount of data: not real-time

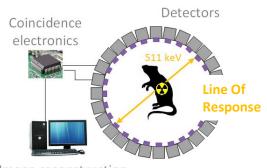


Image reconstruction

REal Time Image REconstruction for 3-y Xenon

camera

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New tool: XEMIS2 3-γ Xenon camera prototype

- Use of a (β +, γ) emitter, e.g. Scandium 44 (⁴⁴Sc)
- 3 γ photons = Additional spatial information
- Fewer disintegration needed
- Scintillator: liquid Xenon (Lxe)



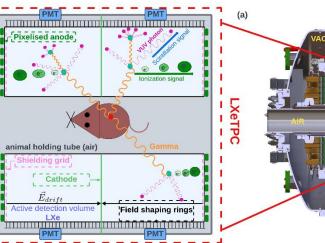
STICC

TIM

IMT Atlantique Bretagne-Pays de la Loire École Mines-Télécom

ubatech

- Localise accurately the disintegration
- Achieve real-time dynamic quantitative imaging



TOT₂ ≈ TOT₁

Measurements", Sensors 2024, 24, 5826.

тот

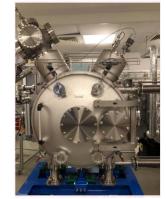
TOT

Linear up to 6 Npe

Oct.,2024, pp. 1-4

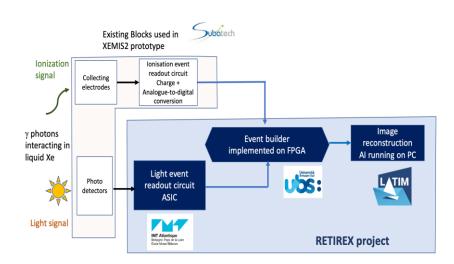
XSREMTO

(b) 64 amamatsu **PMTs**



XEMIS2 prototype

RETIREX scopes



- Need to improve photons count & arrival time
- Build event by combining ionisation and light

RAN

Design image reconstruction algorithm

New light DAC: improved UV photons count

TOT6 : t16(ns)-126(ns)

мтот

Increased linear range up to 200 Npe

MTOT₂ ≠ MTOT₄

Multi-Time-Over-Threshold (MTOT)

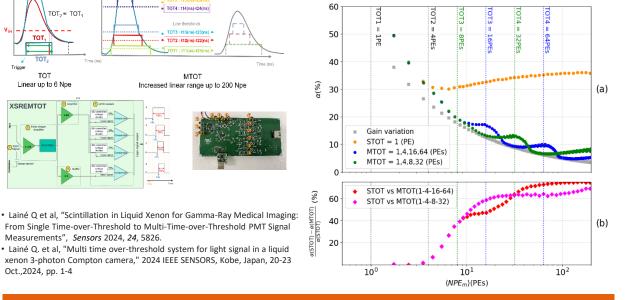
From Single Time-over-Threshold to Multi-Time-over-Threshold PMT Signal

· Lainé Q. et al, "Multi time over-threshold system for light signal in a liquid

Image reconstruction

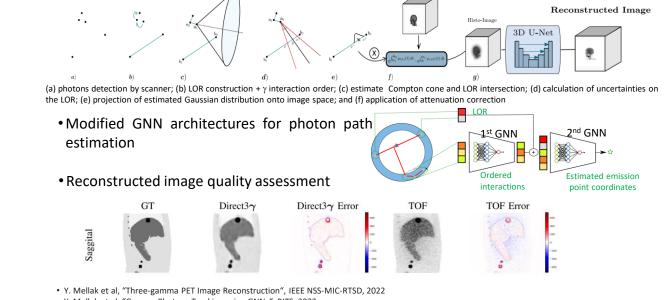
xenon 3-photon Compton camera," 2024 IEEE SENSORS, Kobe, Japan, 20-23

- Photons counts up to 200 (vs < 10 for STOT)
- 70%
 → uncertainty a in NPEs for a measured TOT Better accuracy of arrival time (+30%)



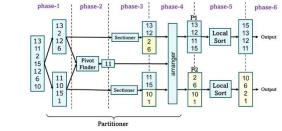
Event builder

- Direct3γ histogrammer image reconstruction flow:





Divide-and-conquer strategy



Output protocole (Payload)



- Y. Mellak et al, "Gamma Photons Tracking using GNNs", RITS, 2022
- Y. Mellak, et al. "Direct 3 {barma} PET: A Pipeline for Direct Three-gamma PET Image Reconstruction." arXiv preprint arXiv:2407.18337 (2024)

