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Recent developments & contribution to TAT of systems dedicated to α autoradiography



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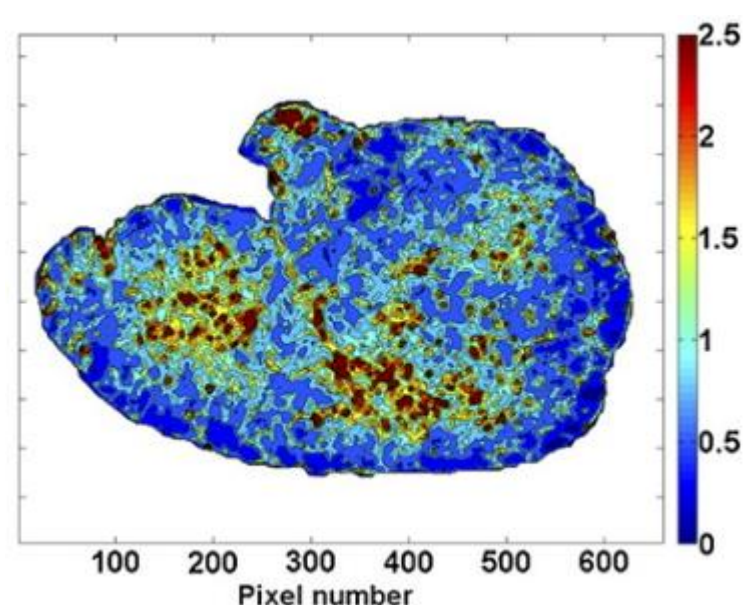
2: S.A.S. AI4R



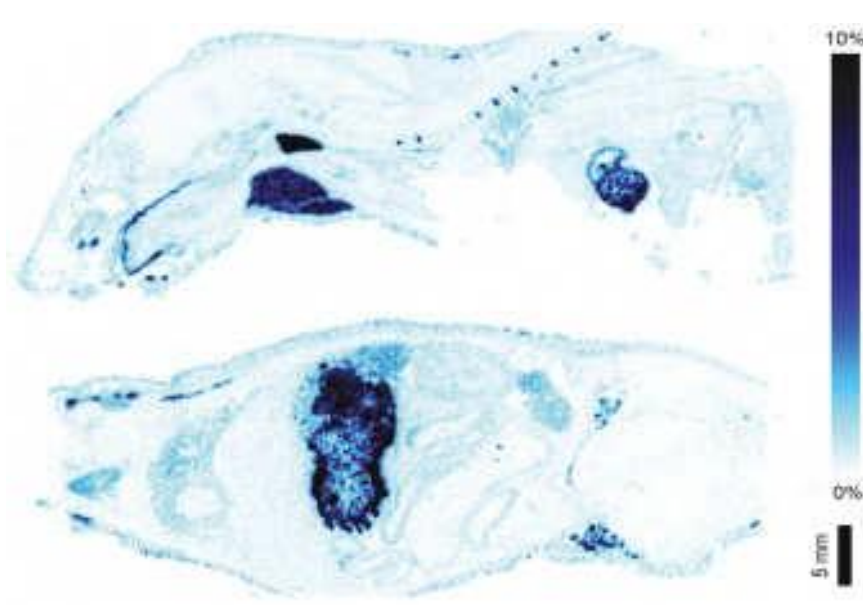
How to **identify** and **locate** the **biodistribution** of α radiopharmaceuticals when the decay chain of the emitter is generally composed of β & α and traditional imaging approaches (scintigraphy or SPECT) is not accurate enough?

With **Autoradiography**, an emission imaging technique !

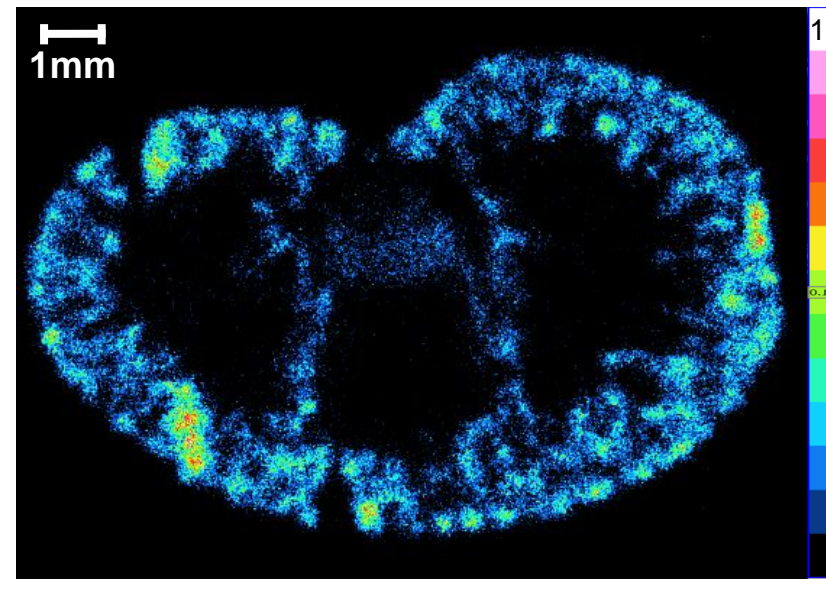
- ✓ Allows to study and locate in 2 dimensions the radioactivity emanating from a surface sample at scales until **micrometer**
- ✓ Well suited for pre-clinical TAT as it allows **understanding** and **quantifying biodistributions** in tissues at **high spatial resolution** at **low activity**
- ✓ Variety of applications : Radio-TLC, Geological Studies, Radio Toxicology...



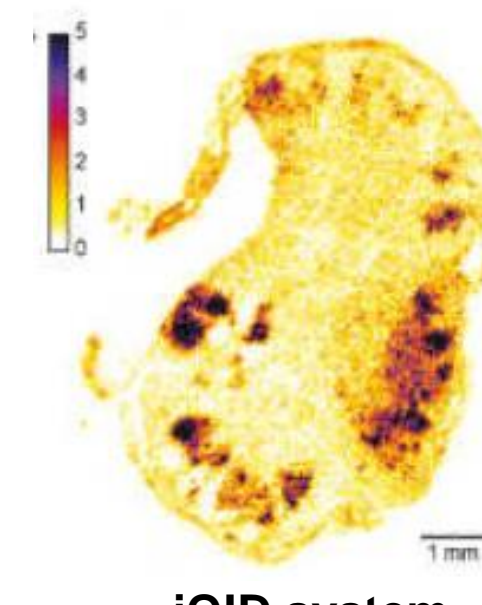
α -Camera system
²¹¹At in OVCAR-3 xenografts [1]



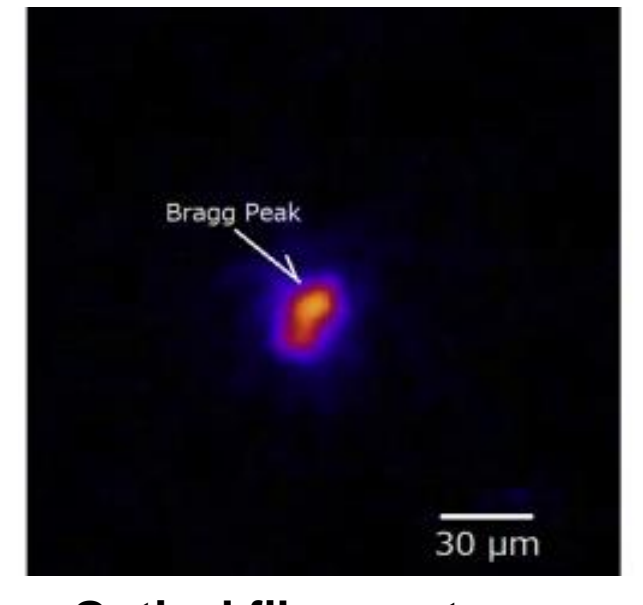
Biomolex 700 DSSD system
Mouse injected with ²¹¹At [1]



BeaQuant system
Mouse kidney labelled with ²²⁵Ac

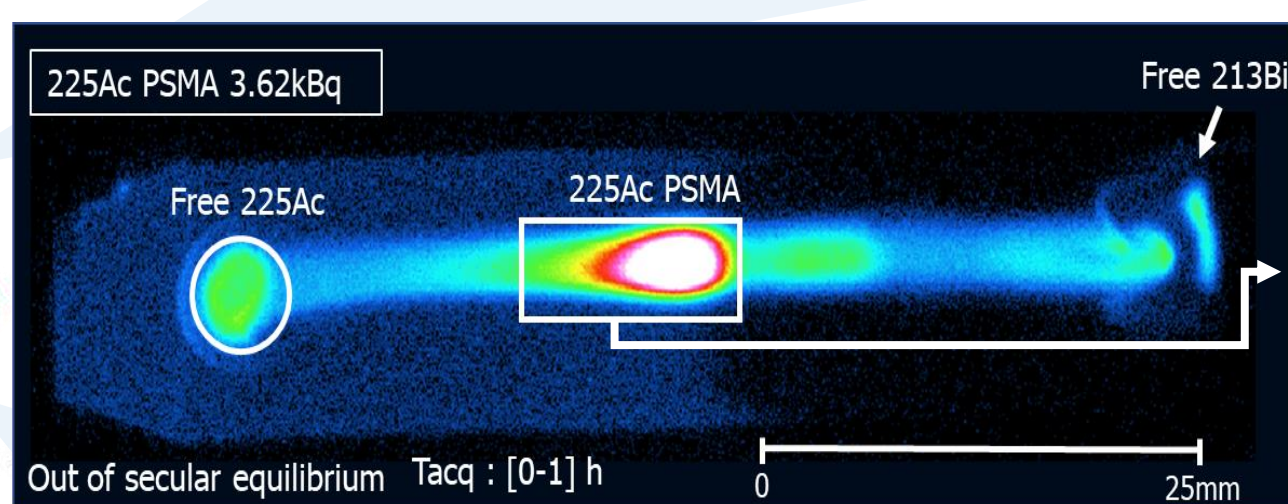


iQID system
Cryosectioned canine lymph node
labelled with ²¹¹At [2]

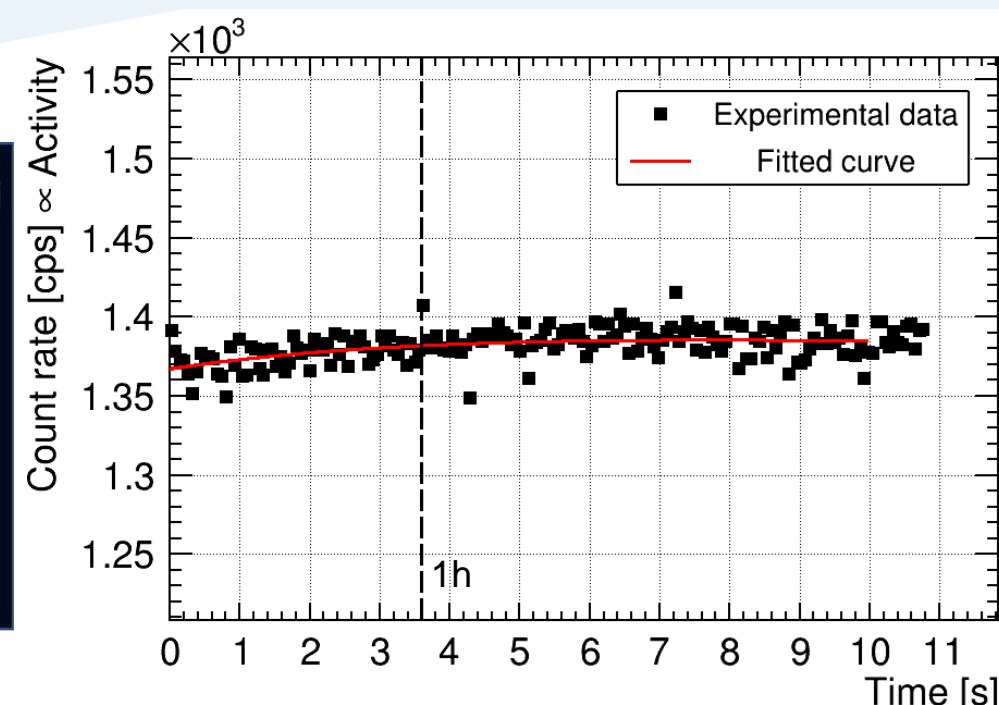


Optical fiber system
Po-218 alpha particle [3]

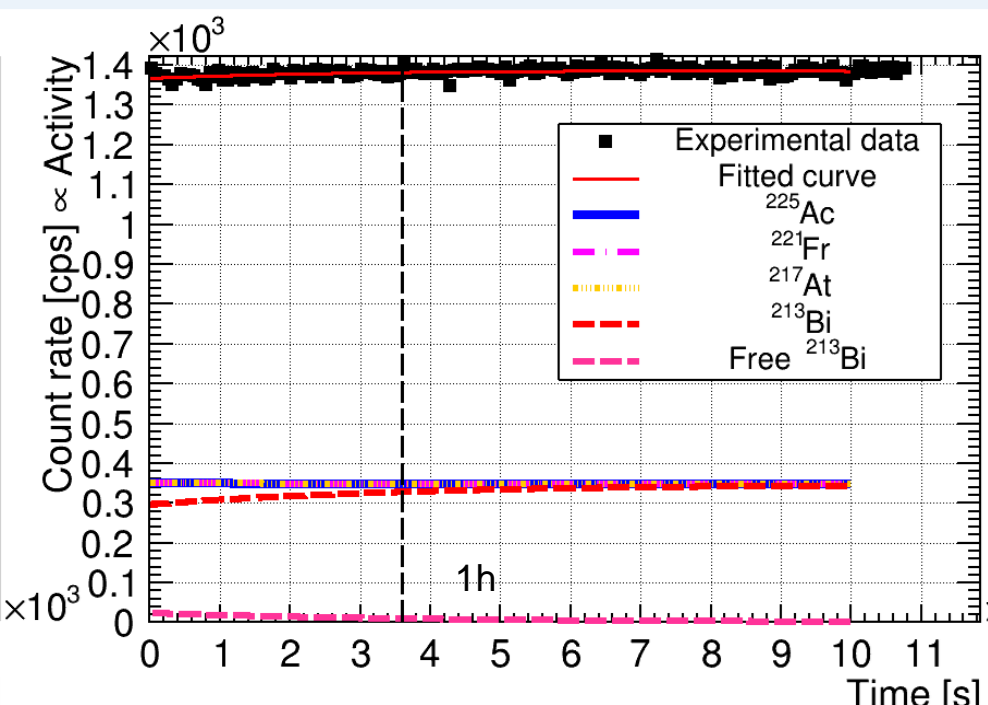
In addition to the image: It's possible to simultaneously combining autoradiography with a spectral measurement (Time or/and Kinetic energy[4]): **Spectroscopic autoradiography (SA)** → useful to discriminate the isotopes...



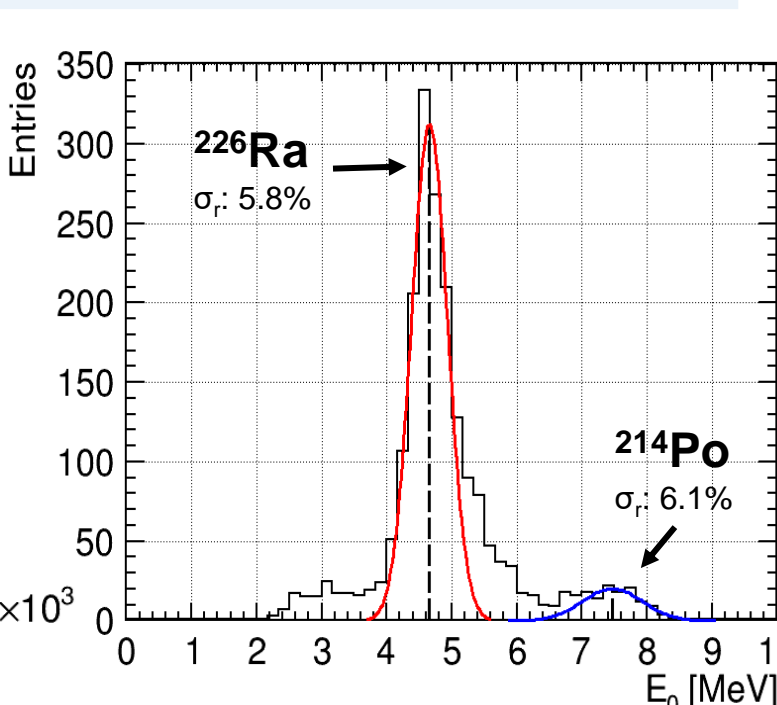
BeaQuant system
TLC with ²²⁵Ac-PSMA



Evolution of the ²²⁵Ac PSMA count
as a function of the acquisition time



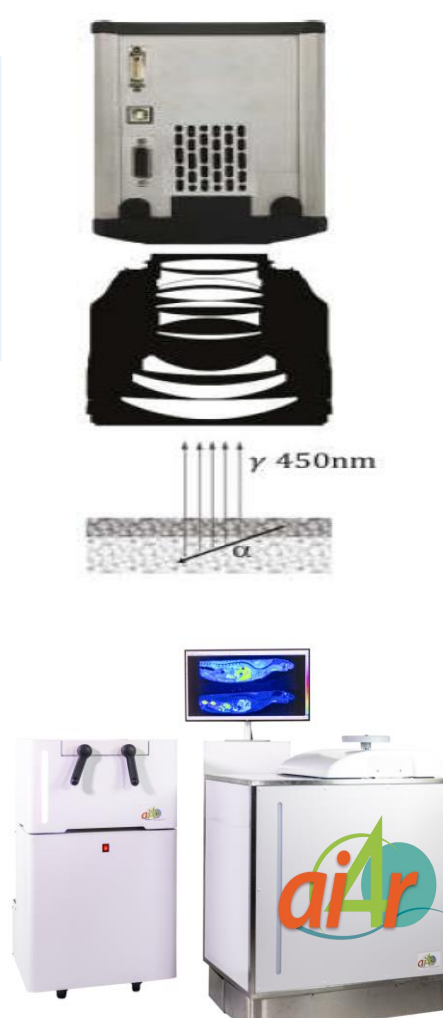
Evolution of the composition of the ROI
containing Actinium PSMA as a function
of the acquisition time



BeaQuant system
Spectrum of a ²²⁶Ra source

For α particles, **different** types of **detector technologies** make this measurement possible **But** there is often a trade-off between spatial resolution, energy, time resolution, the Field Of View and the ability to distinguish between different types of particles...

	α -Camera [1]	BeaQuant [4,5]	Biomolex [1,6]	iQID [1,2]	Optical fiber [3]
Spatial resolution [μm]	20-35	20	50	20	11-25
Quantification	YES	YES (counting mode)	YES	YES	YES?
Field Of View [cm²]	5 x 5	23 x 23	6.3 x 2.6	12.5 x 12.5	0.064 x 0.064
Real-time D.C.	YES	YES	YES	YES	YES
Technology	Solid scintillation EMCCD	Gaseous detector Micro-patterned	Semiconductor DSSD	Solid scintillation CCD/CMOS	Fiber scintillation EMCCD



Reference

- [1] M. Ljungberg, Handbook of Nuclear Medicine and Molecular Imaging for Physicists: Instrumentation and Imaging Procedures, Volume I, CRC Press, 2021.
 [2] B. W. Miller et al., "Quantitative single-particle digital autoradiography with α -particle emitters for targeted radionuclide therapy using the iQID camera" Med Phys, vol. 42, no. 7, pp. 4094–4105, 2015.
 [3] S. Yamamoto et al., « Development of an ultrahigh-resolution radiation real-time imaging system to observe trajectory of alpha particles in a scintillator », Radiation Measurements, vol. 134, p. 106368, 2020.
 [4] H. Lefeuvre et al., « Spectroscopic autoradiography of alpha particles using a parallel ionization multiplier gaseous detector », Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, vol. 1035, p. 166807, 2022.
 [5] J. Donnard et al., « The micro-pattern gas detector PIM: A multi-modality solution for novel investigations in functional imaging », Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, vol. 610, no. 1, p. 158-160, oct. 2009.
 [6] A. Örbom et al., « Characterization of a double-sided silicon strip detector autoradiography system », Medical Physics, vol. 42, no 2, p. 575-584, 2015.

Proof of concept

