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## **Recent developments & contribution to TAT of systems dedicated to $\alpha$ autoradiography**

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# Recent developments & contribution to TAT of systems dedicated to $\alpha$ autoradiography



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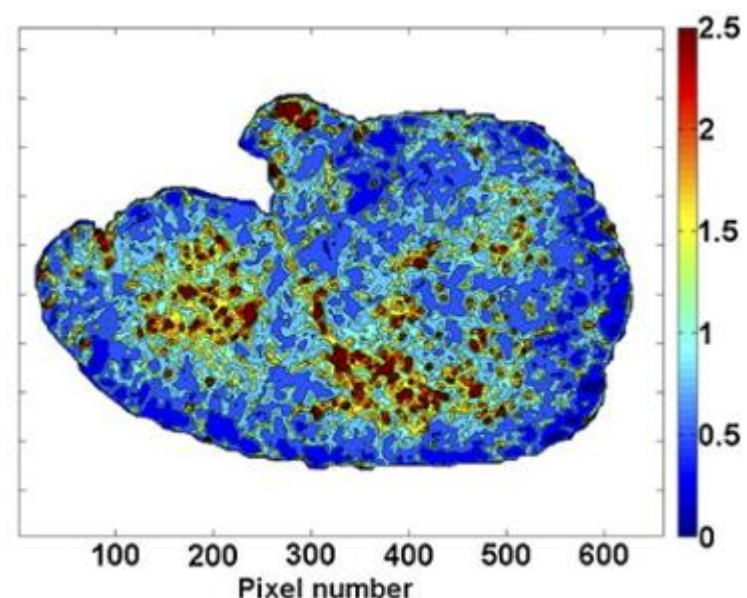
2: S.A.S. AI4R



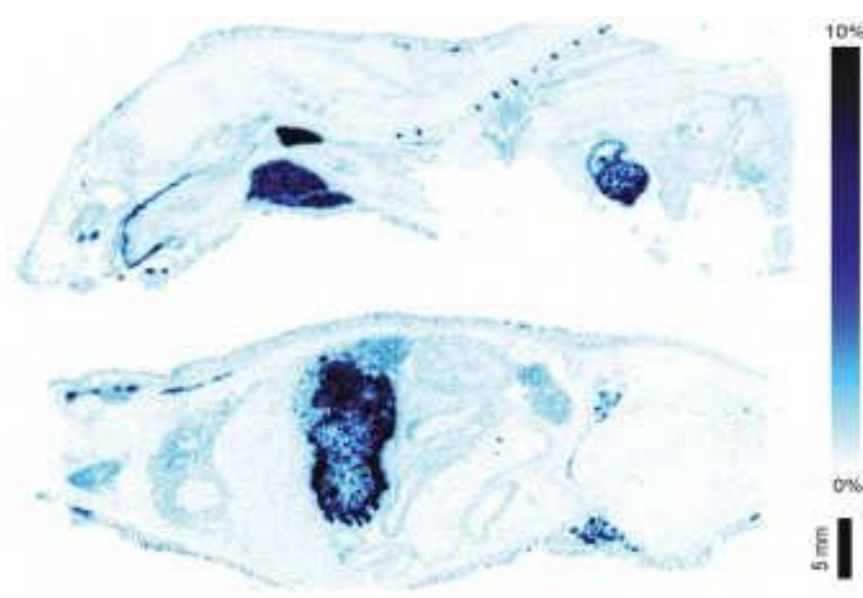
How to **identify** and **locate** the **biodistribution** of  $\alpha$  radiopharmaceuticals when the decay chain of the emitter is generally composed of  $\beta$  &  $\alpha$  and traditional imaging approaches (scintigraphy or SPECT) is not accurate enough?

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

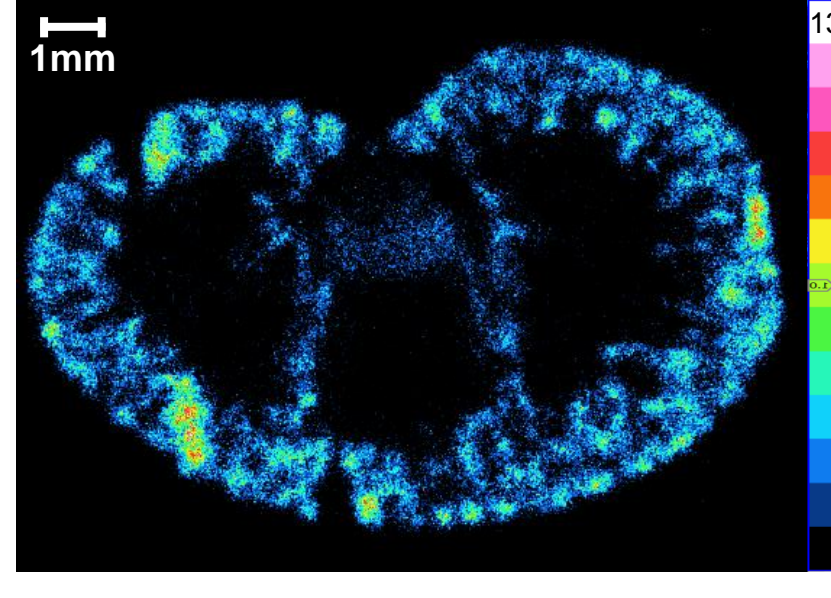
- ✓ Allows to study and locate in 2 dimensions the radioactivity emanating from a surface sample at scales until **micrometer**
- ✓ Well suited for pre-clinical TAT as it allows **understanding** and **quantifying biodistributions** in tissues at **high spatial resolution** at **low activity**
- ✓ Variety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



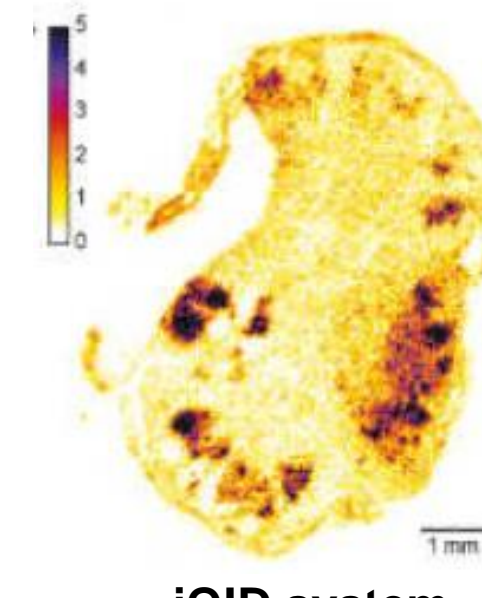
$\alpha$ -Camera system  
<sup>211</sup>At in OVCAR-3 xenografts [1]



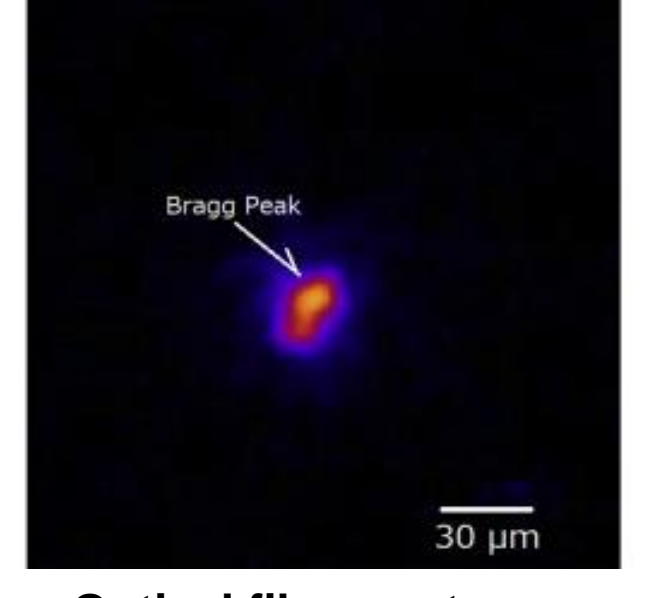
Biomolex 700 DSSD system  
Mouse injected with <sup>211</sup>At [1]



BeaQuant system  
Mouse kidney labelled with <sup>225</sup>Ac

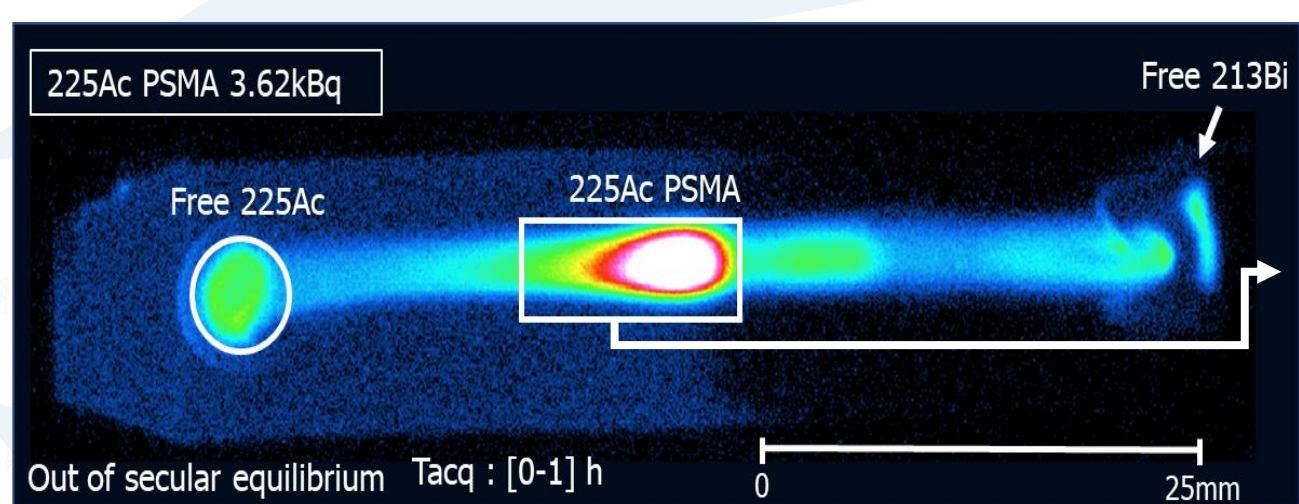


iQID system  
Cryosectioned canine lymph node  
labelled with <sup>211</sup>At [2]

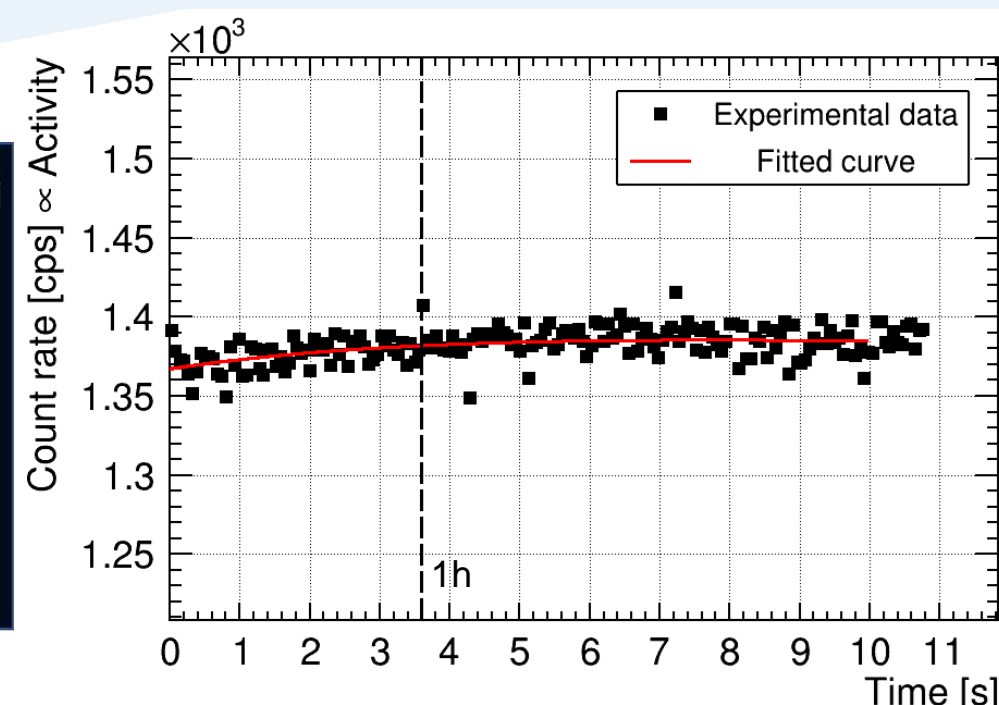


Optical fiber system  
Po-218 alpha particle [3]

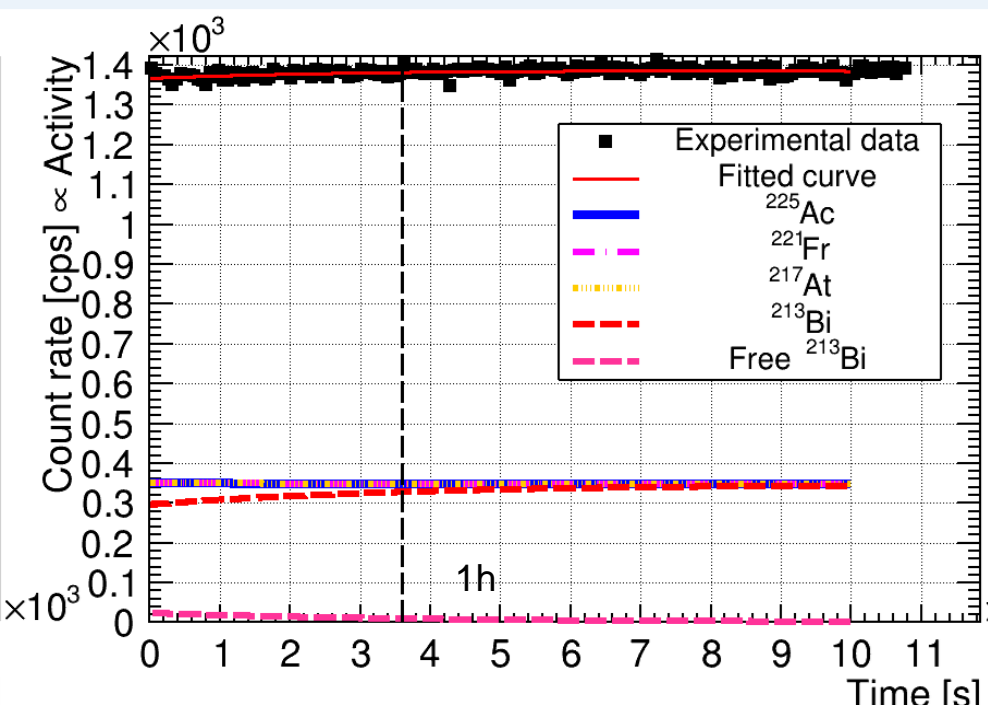
In addition to the image: It's possible to simultaneously combining autoradiography with a spectral measurement (Time or/and Kinetic energy[4]): **Spectroscopic autoradiography (SA)** → useful to discriminate the isotopes...



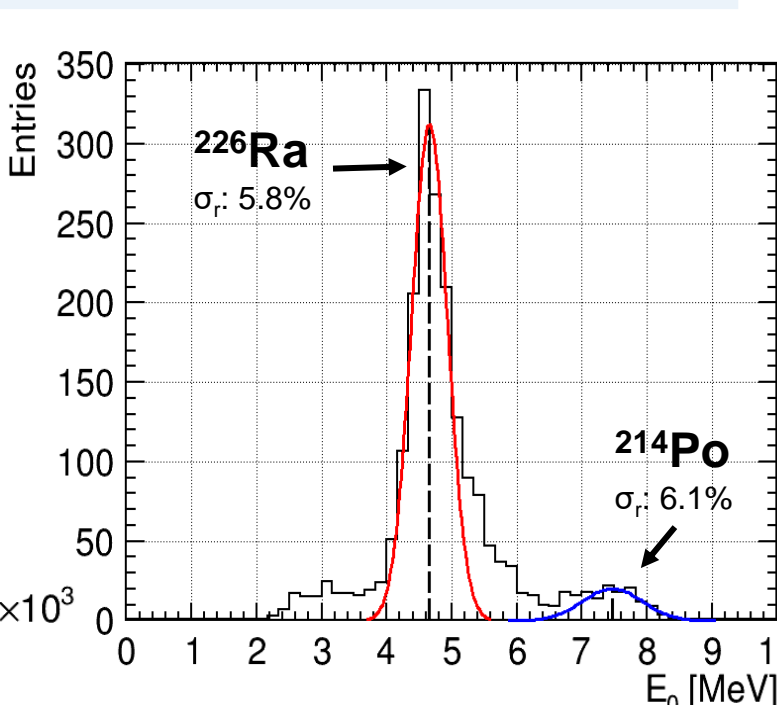
BeaQuant system  
TLC with <sup>225</sup>Ac-PSMA



Evolution of the <sup>225</sup>Ac 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 <sup>226</sup>Ra source

For  $\alpha$  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...

|   | $\alpha$ -Camera [1]         | BeaQuant [4,5]                      | Biomolex [1,6]        | iQID [1,2]                      | Optical fiber [3]            |
|---|------------------------------|-------------------------------------|-----------------------|---------------------------------|------------------------------|
| <b>Spatial resolution [<math>\mu</math>m]</b> | 20-35                        | 20                                  | 50                    | 20                              | 11-25                        |
| <b>Quantification</b>                         | YES                          | YES (counting mode)                 | YES                   | YES                             | YES?                         |
| <b>Field Of View [cm<sup>2</sup>]</b>         | 5 x 5                        | 23 x 23                             | 6.3 x 2.6             | 12.5 x 12.5                     | 0.064 x 0.064                |
| <b>Real-time D.C.</b>                         | YES                          | YES                                 | YES                   | YES                             | YES                          |
| <b>Technology</b>                             | Solid scintillation<br>EMCCD | Gaseous detector<br>Micro-patterned | Semiconductor<br>DSSD | Solid scintillation<br>CCD/CMOS | Fiber scintillation<br>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  $\alpha$ -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.  
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 [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