# MAPSSIC, a novel CMOS intra-cerebral beta+ probe for deep brain imaging in awake and freely moving rat: a Monte-Carlo study

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**Résumé**

Among the numerous methods developed to adress neuroscience research needs, the combination of pre-clinical PET with behavioral studies has been recently pointed out as a potential key breakthrough to go further in the understanding of functional processes in the brain.

Achieving such a combination is difficult. Anaesthesia or restraints inherent to micro-PET precludes its use for behavior studies. To adress this obstacle, recent approaches have been developped but remain affected by important constraints.

In that context, we have presented an original strategy using submillimetric pixelated probes

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to directly measures positrons inside the rat brain. The detection volume around the sensitive area is bounded by positron range, therefore comparable with rat brain loci sizes. Integrated electronics and wireless communication system allows fully freely-moving rats experiments. Former probes have shown promising results but have suffered from various detection limitations.
We propose here MAPSSIC, a novel beta probe project benefiting from innovative CMOS sensors to overcome these limitations. Reduced noise, high positrons sensitivity and low gamma rays detection promises relevant detection capabilities.
Monte-Carlo simulations with GATE platform have been carried out to investigate probe physical characteristics and performances on the basis of first prototypes (16×128 pixels of 30×50 $\mu m^2$ on 18 $\mu$m sensitive layer). Sensitivity to positrons and transparency to gamma rays as well as spatial detection capabilities were determined using specific 18F, 11C and 15O phantoms.
Results shows a good agreement with the expected performances required for tracers activity measurement in rats brain. In 18F studies, the mean deposited energy into pixels is 8.83 keV. Positron sensitivity is consistent with former probes (0.89 evts/(kBq/mL)) and the probe shows a good transparency to gamma rays. 90% of the detected positrons comes from less than 1.23 mm away their detection location.

**Mots-Clés:** MAPSSIC, PIXSIC, CMOS, probe, PET, rat, intracerebral, neurosciences, functional imaging, dynamic, behavior, freely, moving, awake, animal, pre, clinical, Monte, Carlo, GATE