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β imager

Application Notes

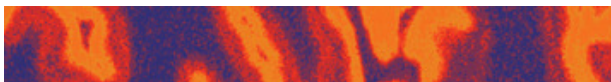
Ex vivo control of visual stimuli in rat brains by ^{18}F FDG imaging: a comparison of available techniques for tissue section imaging

Laurent Besret, Anne-Sophie Hérard (URA CEA-CNRS 2210, Orsay), Fabrice Beau (CEA-DSV, Orsay), Serge Maîtrejean (Biospace, Paris)

Goal:

In vivo imaging is rapidly developing as a direct consequence of improvements in dedicated instrumentation, superimposed upon decades of experience of *in vitro* imaging of tissues and molecular processes obtained, respectively, from histopathology and autoradiography. Examples are the strong association of *in vivo* optical microscopy with histopathology or PET/SPECT imaging with digital autoradiography. *Ex vivo* imaging of PET-labeled tissue sections after *in vivo* PET experiments is of particular interest for the precise measurement of molecular concentration or for tissue identification at high spatial resolution. While PET imaging now reaches voxel resolution in the (1-2 mm)³ range, pixel resolution in tissue sections by *ex vivo* imaging is one to two orders of magnitude better - in the (10-500 μm)² range depending on the technique used.

The present study was focussed on the increase of FDG uptake in the left colliculus of the brain after lateral visual stimulus. One goal was to evaluate the resolution and contrast performance of popular techniques available for *ex vivo* imaging of β^+ -labeled tissue sections. Tested were film, phosphor imaging, and two real-time digital imagers, the μ IMAGER™ and β IMAGER™, both products of Biospace Mesures, Paris. The comparisons were carried out on brain tissue sections for which accurate localization is of particular interest.



Material and methods:

The study was conducted on an awake Long Evans rat comfortably secured in a restrainer. The left eye was occluded with a black tape and the animal was placed facing the stimulation screen at a distance of approximately 40 cm. Five minutes after starting the visual stimulation, the animal was injected with 700 μCi of ^{18}F FDG. Following 50 minutes of unilateral visual stimulation, the animal was sacrificed, the brain was quickly removed and frozen on pre-chilled isopentane (-30°C). Adjacent coronal brain sections ($20\mu\text{m}$) were obtained on a cryomicrotome (Leica) and deposited on standard microscope slides. The slides were imaged with film (Kodak BioMax MR) and with three different imagers – a Molecular Dynamics phosphor imager and both μ IMAGER and β IMAGER from Biospace Mesures.

Approximately two hours after injection, the film and phosphor screen slides were exposed for 2.5 hours and 2 hours respectively. The other slides were sent elsewhere and were exposed overnight in the μ IMAGER and β IMAGER approximately 4 and 6 hours after injection. Allowing for decay, the following table shows the calculated fraction of the β^+ particles incident on each detector during the acquisition periods as a percent of the calculated total number of particles emitted for complete decay.

PARTICLES EMITTED DURING ACQUISITIONS				
TOTAL	FILM	PHOSPHOR	μ IMAGER	β IMAGER
100%	29%	22%	25%	9%

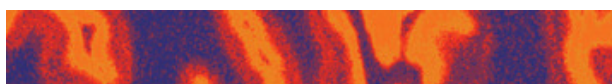
Though the μ IMAGER and β IMAGER acquisition periods were longer than the other two, they took place significantly later. Especially for the β IMAGER, where during acquisition there was in reality only one-third the exposure of the other three, achieving quality imaging presented the most difficult challenge.

Results:

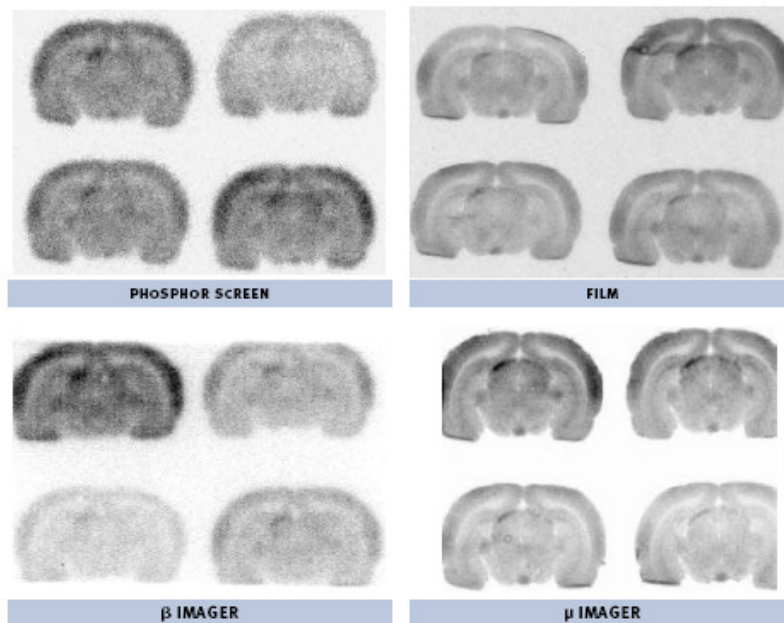
The results of the four acquisitions are presented below. Variations on a given slide are attributed to variations in the section thickness due to the cryomicrotome. The two real-time imagers both show significantly improved spatial resolution over the phosphor screen. This is expected since both the phosphor screen and photographic film are more dense and hence interact more with γ particles than do either the $3\mu\text{m}$ thick scintillation film of the μ IMAGER or the gas-filled detector of the β IMAGER. In the Biospace imagers, the cross-section for γ particles is nearly nonexistent and almost all the counts recorded are derived from β^+ particles.

In addition, in the case of the μ IMAGER, as is clearly evident below, the very thin detection medium provides resolution at a level comparable to film, while avoiding the significant background level of film, most probably originating from β^+ particles.

The count rates observed with either the μ IMAGER or the β IMAGER are similar, which suggests that they both achieve near 100% efficiency for incident β^+ particles.



Real-time solutions for molecular imaging



Conclusion: Real-time particle counting digital instruments, i.e. the μ IMAGER and the β IMAGER, are shown to be better suited for *ex vivo* imaging of β^+ -labeled molecules than are phosphor screens. Their good spatial resolution, particularly that of the μ IMAGER, allows excellent visualization of small areas of interest in the brain or other organs. Further, real-time acquisition and visualization allow rapid assessment of the experiment and avoid over- and under-exposure, as is often the case with film when activity levels are not known.



 biospace lab

10, rue Mercœur, 75011, Paris, France
t+33 (0)1 55 25 60 60/f+33 (0)1 55 25 60 61
185 Alewife Parkway #410, Cambridge, MA02138, USA
t+1 330 998 1099/f+(0)1 888 467 3196
info@biospace.eu/www.biospace.eu

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