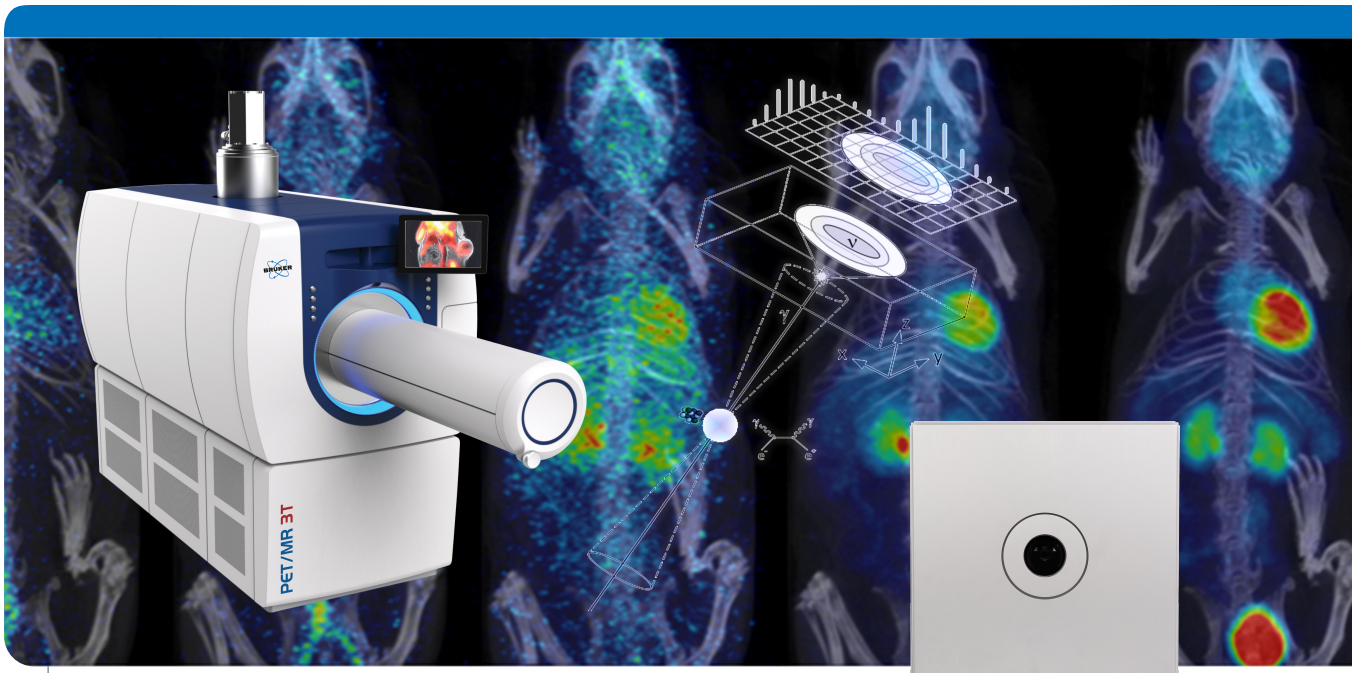


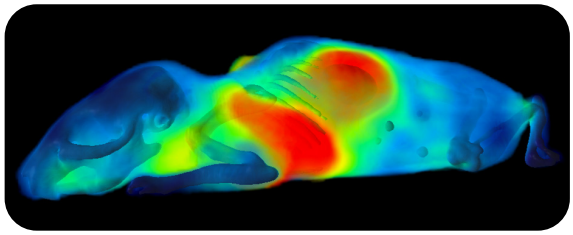
Coincidence PET

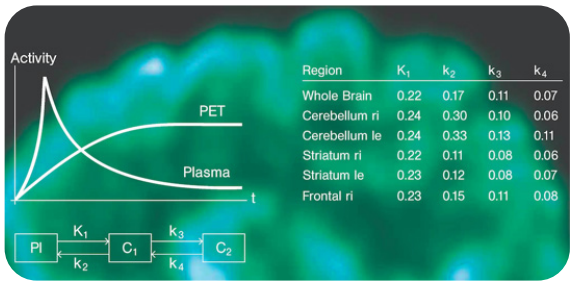
- Unlocks state-of-the-art quantification

State-of-the-art positron-emission tomography (PET) scanners capture the antiparallel photons emitted from positron annihilation as coincidences. By using coincidences there is no need for collimation to determine the line-of-response for decay events. Combined with full rings of detector blocks utilizing the latest crystals (LYSO) and detectors (silicone photomultipliers), this gives coincidence PET unparalleled sensitivity in the 10% range (and even greater). This exquisite sensitivity is a key benefit of PET, making functional imaging in humans and animals possible with true tracer doses, avoiding pharmacological effects due to the molar dose of the tracer delivered and allowing low radioactive dose for subject health in longitudinal studies.

PET image quality is a balance between scanner sensitivity, the injectable dose of the tracer and the feasible duration of imaging. With low scanner sensitivity, researchers may try to inject a greater dose of the tracer, but rapidly face pharmacological and injected volume (particularly in mice) limitations. PET relies on injection of a tracer dose, namely a dose that occupies an insignificant proportion of the target receptor/protein/enzyme. Depending on the molar activity of the tracer, the dose of unlabeled tracer compound delivered to the animal can have a pharmacological effect, either altering the animal's physiological state or displacing the labeled tracer. Either result would make your PET data unreliable and potentially unsuitable for publication.

Increasing the imaging duration is only possible for certain tracers with very slow kinetics and long half-life. Slow kinetics can even be undesirable for fully quantitative PET with tracer kinetic modeling. Kinetic modeling allows accurate quantification of receptor availability (and more). Dynamic imaging with short (< 1 min) time frames is necessary to describe fast/medium tracer kinetics, and without sufficient washout of the tracer in the total feasible in vivo imaging window, model fitting may be unsuccessful. Full quantification of receptor availability is particularly interesting for occupancy studies in pharmaceutical development. The ability to image tracers labeled with biogenic isotopes such as C-11 and N-13 using coincidence PET further supports pharmaceutical development. Labeling of investigational drugs with these isotopes typically leads to simpler, cheaper, radiolabeling and avoids altering the pharmacokinetic profile of the drug. The table below summarizes these keys advantages of coincidence PET compared to low sensitivity imaging of PET tracers using collimators and SPECT technology (sometimes referred to as "Collimated PET imaging").





	"Collimated PET"	Coincidence PET
Dynamic PET in full FOV (incl. multi-mouse)	No	Yes, (whole-body) frames < 5 s
Imaging with biogenic nuclides (O15, N13, C11, F18) (pharma. drug dev.)	Very limited	Yes, no limitations
Image quality maintained for multi-mouse imaging	No	Yes
True trace doses for receptor studies	Very limited	Yes
Minimal doses for longitudinal studies	No, sensitivity limitation	Yes
Sensitivity	< 0.5 %	5-12 %
Imaging with tracers that don't reach an equilibrium	Limited	Yes
Large FOV including blood pool for kinetic modeling	No, 12*9 mm (d*l) cylinder	Yes, up to 85*50-150 mm cylinder
Static imaging bed for combined blood sampling	Only for 12*9 mm FOV	Yes, for any organ within large FOV
Direct translation to clinical imaging	No	Yes
Uniform sub-mm resolution	Yes, in small FOV	Yes, in large FOV
Trusted quantitative images	No	Yes
Single session blocking studies (dual injection O15, N13, C11)	Very limited	Yes

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