G4 PET/X-ray

PRODUCT NOTE

Pre-clinical *in vivo* Imaging

Key Benefits:

- High performance, ultra-sensitive PET technology designed for pre-clinical imaging
- 3D PET and X-ray whole body images
- Purpose built bench-top footprint
- Fast and automatic image reconstruction
- Real-time animal monitoring
- Simple data acquisition and advanced analysis

SOFIEBIOSCIENCES

PerkinElmer is the exclusive, global provider of Sofie Pre-clinical PET platforms.

Next Generation Small Animal PET Technology

Small animal PET is an essential tool for translational research. The G4 is an uncompromising high performance solution that offers flexibility for the researcher in a compact footprint. PerkinElmer believes it should be convenient, cost-effective, and deliver high performance in an easy-to-use compact footprint.

PerkinElmer's Solution

High performance and quantitative benchtop PET imaging with intuitive workflows for seamless integration into any laboratory. G4 PET/X-ray introduces a unique, highly sensitive detection technology that enables physiologically translatable dosages in research models that are relevant to the clinic while reducing exposure.

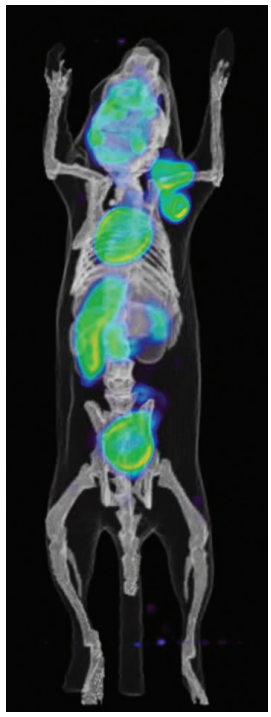

Figure 1. Visualization by [^{18}F]FDG G4 PET/X-ray of glycolytic tissues in a mouse bearing a subcutaneous tumor.

PerkinElmer®
For the Better

Compact Size

Generate 3D quantitative PET and X-ray data in record time

At only 18 inches wide and 24 inches tall, G4 is the smallest PET imaging system in the industry. G4 can be installed in any laboratory setting with minimal site planning and training to quickly get your existing staff up and running.

Figure 2. Dimensions of G4 PET/X-ray imaging system.

Technology

New generation of PET imaging

G4 breaks away from a conventional ring-based detection system by surrounding the animal with panel detectors resulting in one of the most sensitive PET systems on the market.

This sensitivity allows imaging of trace amounts of probes, which translates to 10x less dose to the animal, while maintaining beautiful image quality.

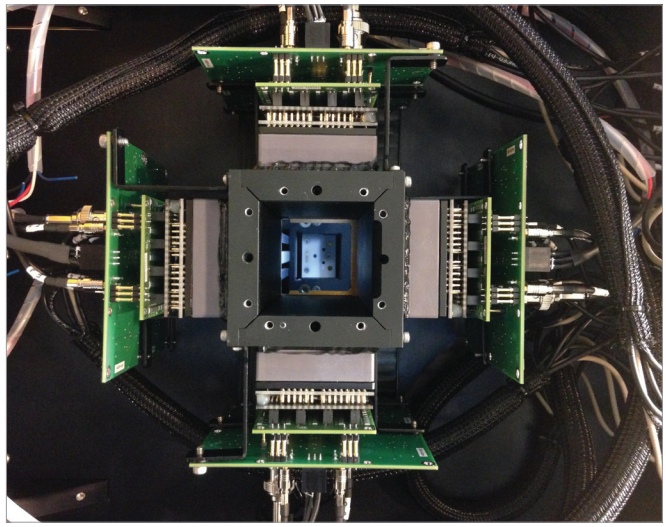

Figure 3. G4 PET/X-ray is a benchtop PET scanner dedicated to high sensitivity and high resolution imaging of small rodents. New panel based architecture breaks away from the ring of detectors. *Gu Z. et al. Phys Med Biol. 2013 Jun 7;58(11):3791-814.*

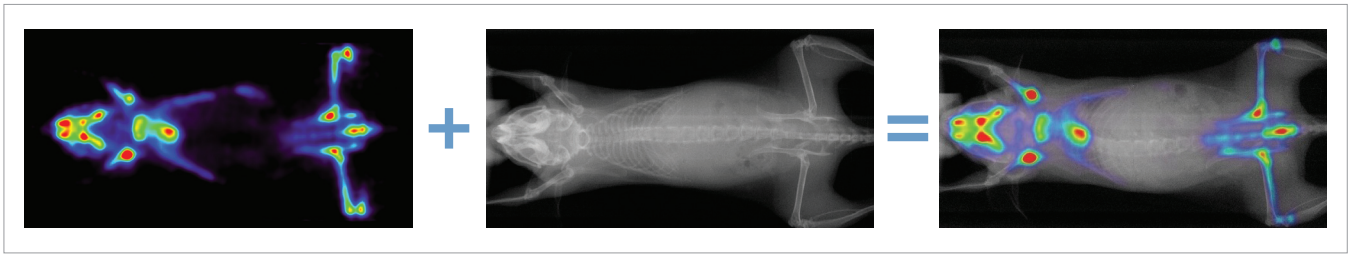

Figure 4. Integrated multi-modality imaging systems provide important information on the biological process of disease combined with an anatomical reference. Bone metabolism can be imaged using [^{18}F]NaF through the rapid incorporation of NaF into bone. Increased bone metabolism is an indicator of oncologic processes in the bone, both metastatic disease and de novo cancer. NaF PET Scan (left), X-ray, (middle), PET + X-ray (right).

G4 Workflow

Get more done with less effort

Make research studies successful day after day. Merging simplicity with performance is THE focal point of this system.

G4 is designed to maximize workflow efficiency while keeping experimental accuracy in mind. Queue up an assembly line of multiple animals in imaging chambers and docking stations to increase throughput and decrease set-up time.

Queue up animals

- Automatic anesthesia and heating
- Efficient animal prep
- Simplified workflow
- High-throughput capability

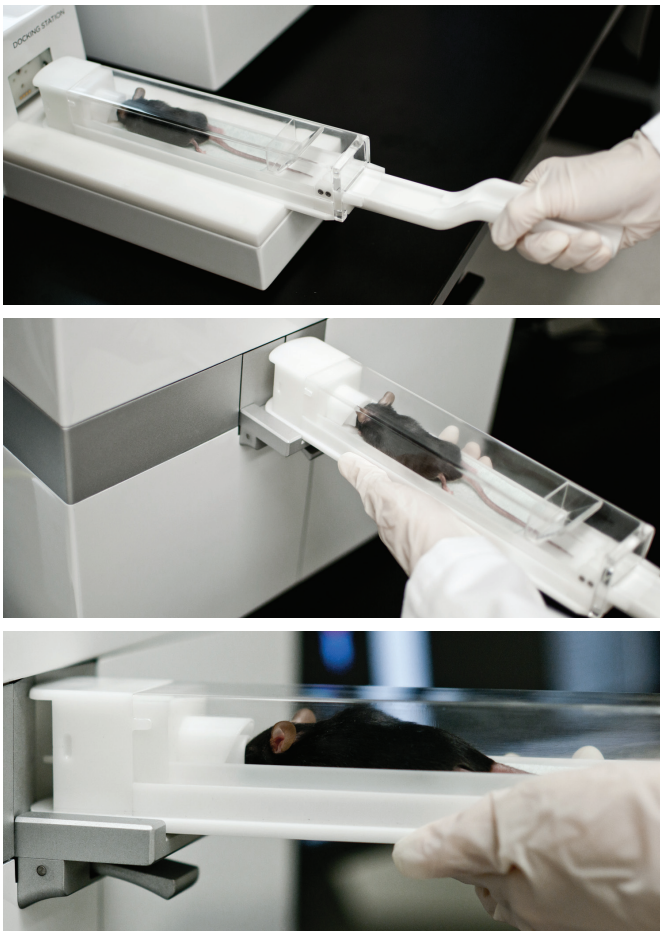

Figure 5. Seamless subject handling.

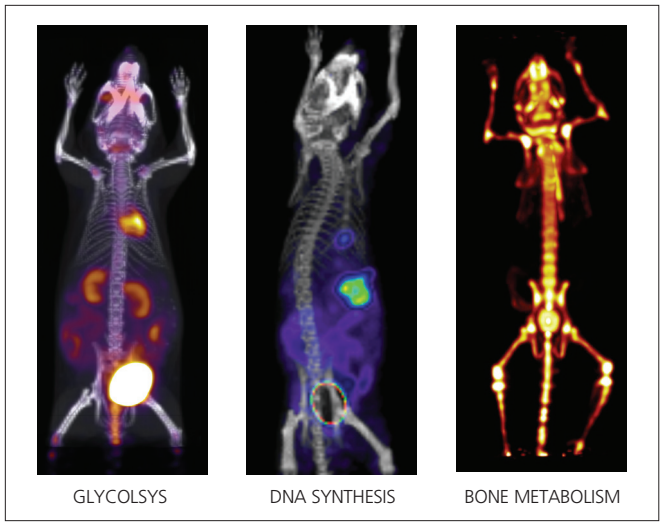

Figure 6. Simplified G4 workflow allows for a single person to image groups of animals with multiple tracers. Images from Lazari et al, Fully Automated Production of Diverse [^{18}F]-Labeled PET Tracers on the ELIXYS Multireactor Radiosynthesizer Without Hardware Modification, JNMT, 2014.

Imaging Chamber and Docking Station

Regulation of temperature and oxygen are critical to a well-executed study. These key factors can affect the physiology of your animal, and therefore your data. Simply glide the Imaging Chamber into the Docking Station to automatically deliver heat and anesthesia.

- Nose cone anesthesia and constant heating (37°C)
- Reproducible positioning of the mouse for imaging
- Pathogen barrier for environmental protection
- Provisions
  - Catheter line
  - Blood sampling lines for kinetic studies
  - Slot to hold syringe for dynamic studies
- Multi-modality connectivity for MRI, CT, SPECT

Figure 7. G4 imaging chamber and docking station.

Simple Operation, Fast Results

With only three clicks away from whole body scanning, registration, and organ analysis, G4 may be small in size, but big on performance. With its high sensitivity, spatial resolution, ease-of-use, and heavy duty computing power, beautiful PET images will be in your hands quickly with minimal effort.

Ultrafast Automatic Image Reconstruction

G4 takes advantage of an array of CPUs between gantry and workstation, enabling fast and automatic histogramming, image processing and 3D image reconstruction – all completed in only a few minutes post acquisition.

Live Link to Animal

Real-time respiratory and video monitoring

The built-in video camera provides a live-link to the animal allowing monitoring of its physiologic condition in real-time, taking the guess-work out of anesthesia management for an optimal, safe, and stable imaging environment.

Rat and Mouse Compatible

A smaller size doesn't mean a reduction in capacity. Use G4 for both your mouse and small rat studies.

G4 Software

Experience the G4 acquisition engine

Whether an experienced user or just beginning with PET imaging, G4 acquisition engine helps to generate 3D images in just a few clicks.

Built for speed, G4 acquisition engine combines the latest in computer processing power, advanced tomographic image reconstruction, and networking to quickly acquire, process, and manage image data. G4 software:

- Encourages optimized workflow through an intuitive user interface increasing study throughput.
- Optimized workflow enables simultaneous study creation, acquisition, and reconstruction.
- Reduces tedious bookkeeping and user input error through automation in software.
- Data is available in minutes.
- Robust administration tools for logging user and study activity for billing and study parameter cross checking.
- DICOM standard for output data.

Figure 8. Never before have you been able to setup a PET/x-ray system on a benchtop. What typically sits on the floor, occupies the majority of a room, and requires additional infrastructure, G4 PET/X-ray allows you to image anywhere.

Mouse Registration System

Mouse registration system is a proprietary algorithm that brings together PET images, X-ray projections, and a database of CT images from a variety of mice to produce a 3D integrated result specific to this mouse. This registration system gives the user an automatic, robust, and repeatable organ level quantification.

As a use case, there are over 3,000 PET imaging probes in development that assay a wide variety of biological questions. The mouse registration system allows for those developing PET probes to produce a quick output of biodistribution of the compound, organ by organ.

Figure 9. G4 PET/X-ray data with mouse registration systems applied to a Johns Hopkins Novel PET Test Article.

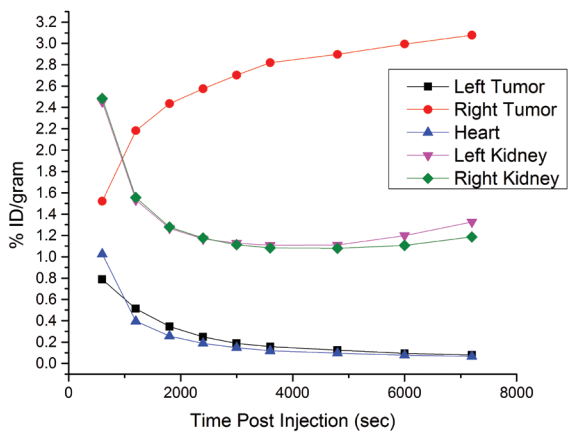

Figure 10. Time activity curve showing the amount of PET probe in left tumor, right tumor, heart, left kidney, and right kidney.

G4 Visualization and Analysis

VivoQuant™ image viewer and analysis software

VivoQuant image analysis software processes and analyzes data from multiple pre-clinical imaging modalities such as PET, MR, CT, Optical and SPECT.

- 3D Region of Interest (ROI) tool enables easy ROI segmentation of volume data sets.
- Supports multimodal and dynamic data.
- Quantification tools enables easy analysis of activity concentration and SUV calculations.
- Easy exportation of results in various image and movie format.
- Time activity curves which show a rate of change of activity in plasma and tissues over time.
- InviCRO's iPACS data management tool featuring comprehensive image storage, version control, study planning, batch image processing, and report generations is an option available to support your data management needs.

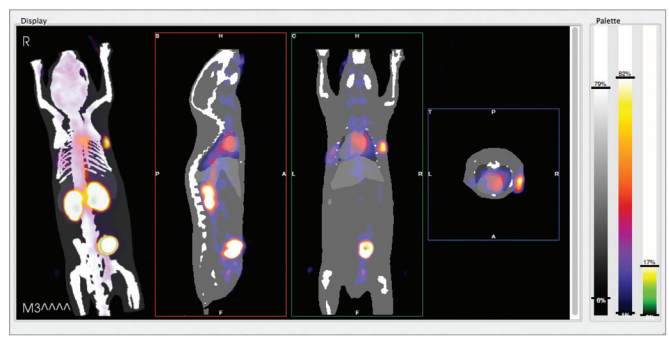

Figure 11. Visualization and analysis of G4 PET/X-ray with mouse registration system using VivoQuant software.

Applications

Oncology

[^{18}F]FDG PET is a common assay of glycolysis which represents the vast majority of clinical PET studies.

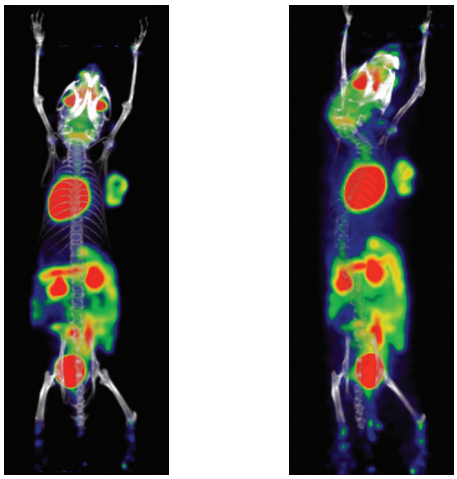

Figure 12. Image above shows a subcutaneous patient-derived glioblastoma xenograft.

CNS

Project evaluating the regulation of dopamine D2/D3 receptors in rat brain using [^{18}F]Fallypride PET.

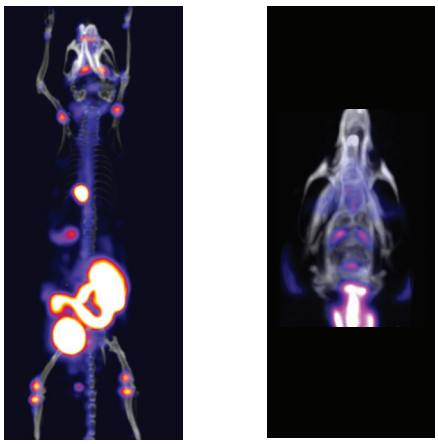

Figure 13. Balb/C mouse injected with 20 uCi [^{18}F]Fallypride, one hr post injection. Acquisition time 10 minutes (Left). Sprague-Dawley rat injected with 50 uCi [^{18}F]Fallypride, one hr post injection. Acquisition time 30 minutes (Right).

Cardiology

[^{18}F]FDG PET can provide important insights into the physiology and biology of the heart enabling researchers to explore the effects of new therapeutics

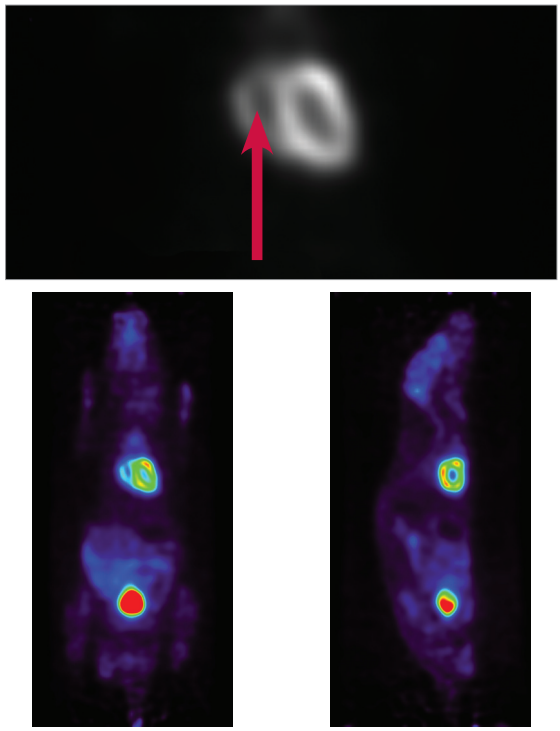

Figure 14. Non-gated [^{18}F]FDG PET study of 26 g mouse. Without cardiac monitoring, still able to resolve the elusive right ventricle (top), coronal (lower left), and sagittal (lower right).

Biodistribution

G4 is capable of performing dynamic studies to measure the kinetics of transport and metabolism. In the end, it's not just about images, but about quantitative measurements of kinetics.

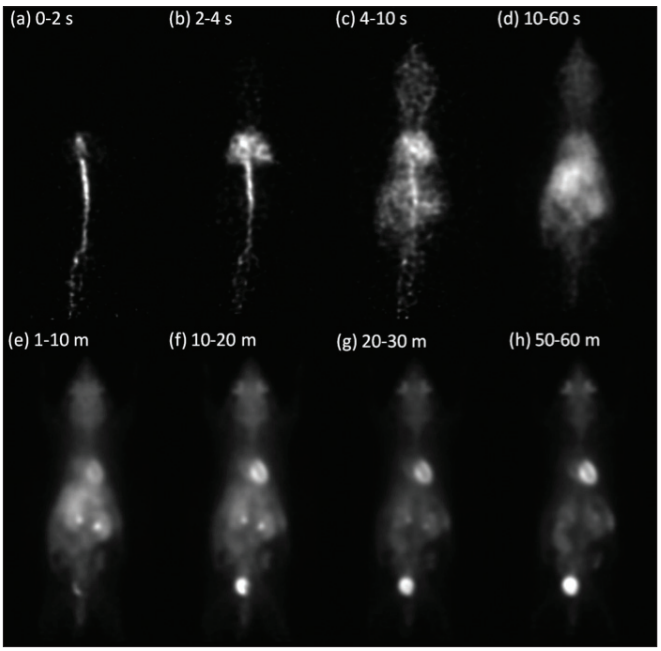

Figure 15. Selected frames from the 1 hour dynamic scan of a mouse following a tail vein injection of 43 uCi [^{18}F]FDG. Different coronal images are shown for each frame to better reveal the activity distribution for different time periods.

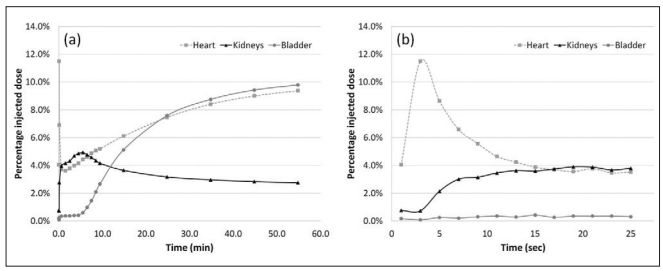

Figure 16. Time activity curves in major organs of a mouse during 1 hour dynamic [^{18}F]FDG. (a) Organ uptake for the 1 hour period. (b) A detailed graph showing the first 26 s following injection.

ImmunoPET

Antibodies are becoming central in the development of targeted therapeutics and provides a powerful class of molecular imaging probes for interrogating cell surfaces *in vivo*. Antibody imaging is a sensitive, non-invasive means for molecular characterization which can guide diagnosis, prognosis, therapy selection, and monitoring treatment in cancer. These radiolabeled antibodies, di-bodies and mini-bodies are commonly tagged with [^{64}Cu], [^{89}Zr], and [^{124}I].

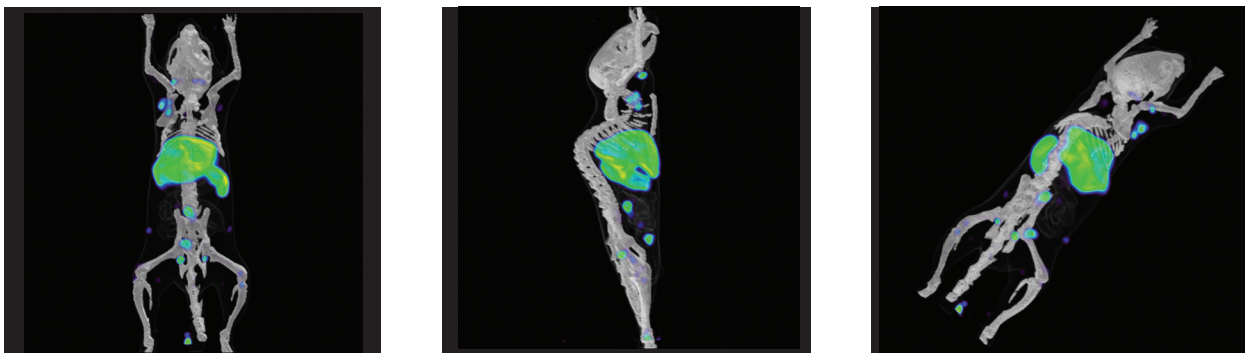

Figure 17. PET image fused with the mouse registration system showing uptake of ^{64}Cu radiolabeled minibody in liver in a healthy mouse during a 20 min scan after an uptake of four hours. The activity was 3.7 uCi in the entire mouse at the scan time.

Table 1. G4 PET/X-ray Specifications

	Engineering Specifications
Width	18″ (45.7 cm)
Depth	19″ (48.3 cm)
Height	24″ (61.0 cm)
Weight	120 lbs (54.4 kg)
Operating room temperature	65 - 75 °F (18 - 24 °C)
Operating humidity	30 - 70% non-condensing
Power requirements	2 A @ 110 V (1 A @ 220 V)

	PET Performance Specifications
Axial FO V	9.5 cm
Transaxial FO V	4.4 cm
Detector element size	1.8 mm x 1.8 mm x 7 mm
Peak absolute system sensitivity*	>14%
Reconstructed resolution at center of FO V*	1.4 mm
Average energy resolution	≤18%
Energy window range	150 - 650 keV
Total number of detector elements	4,992
Reconstruction algorithm	3D ML-EM
Weight (kg) (instrument only)	46

	X-Ray Performance Specifications
Axial FO V	9.0 cm
Transaxial FO V	4.0 cm
X-ray tube potential	35 kVp
X-ray tube current	100 uA
Exposure time	2 sec
Detector pixel array	1024 x 1000
Detector pixel size	96 um
Image pixel size	106 um
Magnification factor	1.1
	Complies with FDA regulation, 21 CFR 1020.40, for radiation safety

'For laboratory use only. This product is intended for research purposes only and not for use in humans.'

For more information, please visit www.perkinelmer.com/PETImaging

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