MILabs
Making Molecular Imaging Clear

All-in-one Imaging Platform for Preclinical Applications

VECTor*/U-PET/U-SPECT/ U-OI/U-CT

1. Introduction

MILabs B.V. (Headquarters: The Netherlands, hereinafter MILabs), which joined the Rigaku Group in August 2021, is a leading global manufacturer of preclinical imaging systems. Preclinical research, as the name suggests, is a crucial step in the drug discovery process that usually uses mice and rats in advance of clinical trials on human. In preclinical research, efficacy, safety or toxicity of the drug candidates is assessed on living (*in vivo*) small animals, while visualization of experimental results allows researchers to comprehend how a drug works in organs or the full body with the help of imaging systems. MILabs provides such imaging systems with best-in-class accuracy, sensitivity and efficiency by virtue of developing its proprietary technologies, one of which being cylindrical multi-pinholes collimators (Fig. 1).

Various imaging systems (also known as modalities) are used in preclinical research, including PET (Positron Emission Tomography), SPECT (Single Photon Emission Computed Tomography), Optical Imaging (hereinafter OI), CT (Computed Tomography)†, MRI (Magnetic Resonance Imaging), and ultrasound imaging. As each system has different functions, users usually need to install as many instruments as the number of functions they see necessary. MILabs, on the other hand, offers an all-in-one imaging platform that integrates up to four functions, meeting a variety of research needs with a single device. Exclusive features, including multimodal synergy, scalability, and convenience, are one of the reasons why MILabs' imaging platform has been chosen by universities and pharmaceutical companies around the world.

MILabs' imaging platform has a modular setup where PET, SPECT, OI or CT functionality can be delivered separately or in any combination. When performance differentiation within the individual modules is also taken into account, MILabs offers up to 30 patterns of configuration. This is worth noting because any single imaging system alone has difficulty visualizing certain tissues or substances, thus limiting its range of applications. Meanwhile, the integrated use of MILabs' all-in-one imaging platform can expand the scope of application and broaden research opportunities, providing incremental user value beyond that of either system alone and that of side-by-side usage.

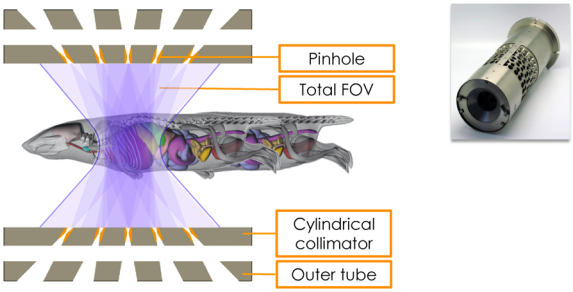

Fig. 1. MILabs' proprietary cylindrical multi-pinholes collimators technology.

* VECTor stands for **V**ersatile **E**mission **C**omputed **To**mog**r**aphy, and is the product name of an integrated PET & SPECT imaging system.

† To distinguish them from PET, SPECT, and CT used for clinical trials (human use) and diagnostic/treatment purposes, imaging systems dedicated to small animals use are sometimes referred to as micro-PET, micro-SPECT, and micro-CT.

2. Types of Imaging Functions Handled

Among the above-mentioned four functions, PET and SPECT are categorized as nuclear medical imaging techniques in which radioactive tracers are injected into small animals to take a picture inside the body and measure the behavior of drug from outside. The difference between PET and SPECT depends on the type of tracers: those used for PET emit positrons, while those for SPECT directly emit gamma rays. Nevertheless, when the positrons annihilate electrons, gamma rays are also emitted, whose signals can be captured and detected by PET. Since those gamma rays are highly permeable, the tracers detected in PET and SPECT can be used to acquire projection data and visualize the results as a picture.

MILabs' OI module enables 2D bioluminescence, fluorescence, and Cherenkov imaging, as well as 3D/4D bioluminescence and fluorescence tomographic imaging. It also features simultaneous imaging of up to 10 mice in 2D planar mode and up to 3 mice in 3D bioluminescence mode.

Last but not least, CT that applies anatomical and morphological imaging techniques is ideally suited for whole-body imaging and visualization of hard tissues such as bones and organs. Optionally, CT can be upgraded to image medium-size animals, enabling whole-body scanning of rabbits, ferrets, as well as small-sized marmosets and crab-eating macaques.

3. Feature Highlight for MILabs' All-in-one in vivo Imaging Platform

3.1 Multimodal Synergy: The combination of up to four types of imaging functions on a single platform offers unrivaled synergy capabilities

All imaging functions (PET/SPECT/OI/CT) are performed without performance compromise, and the combination offers unique synergistic imaging capabilities, thus extending preclinical applications beyond the reach of other companies' systems. These exclusive synergistic capabilities include but are not limited to simultaneous imaging of multiple PET tracers, simultaneous imaging of PET & SPECT tracers, imaging of alpha-particle(α)- or beta-particle(β)-emitting tracers, as well as CT-guided 3D optical tomography. Among them, α- or β-emitting tracers are detected by capturing the relatively high-energy gamma rays emitted almost simultaneously from the decay of radioactive nuclei. Capable of imaging not only relatively easy-to-handle β-emitting tracers but also α-emitting tracers, which have higher therapeutic efficacy, MILabs' imaging platform is likely to enhance opportunities for theranostic applications, where diagnosis and treatment are simultaneously performed using radioactive nuclei.

Typically, energies used by each type of imaging systems vary from one to another. By fully integrating four types of imaging functions, MILabs' platform manages to exploit energies from 1 eV to 1 MeV. This enables acquisition of a wide range of information on what is happening inside living animal bodies at the molecular and cellular level.

3.2 Scalability: Additional functionality, both on hardware and software, can be added after initial installation to meet different research needs

Users can start with any single imaging function module and then extend the in-line imaging platform to dual- or tri-modules as needed. The configuration can be further extended up to a quad-modules system. For example, an initially installed OI module can be flexibly expanded to OI/CT, PET/OI/CT, SPECT/OI/CT, or even PET/SPECT/OI/CT at a later date, catering to the users' research needs and budget (Fig. 2).

MILabs' CT offers the four product classes in its lineup, namely Standard, High-Resolution, Ultra-High-Resolution, and Extra-Ultra-High-Resolution. Even after initial installation, higher spatial resolution can be achieved by upgrading the CT hardware and software to a higher class. In addition, MILabs also provides other additional functionality such as elimination of certain image blurring effects in PET (such as resolution loss of some PET tracers with long positron range).

3.3 Convenience: MILabs provides user-friendly design and easy-to-use features, achieving high user satisfaction

Since certain tissues or substances cannot be visualized by a single imaging system, users must use different imaging systems separately and align two or more images so that corresponding pixels representing the same object can be fused. However, if the position of the object deviates subtly from one imaging system to another, even by only a few millimeters, the fused images will be disappointingly misaligned. MILabs'

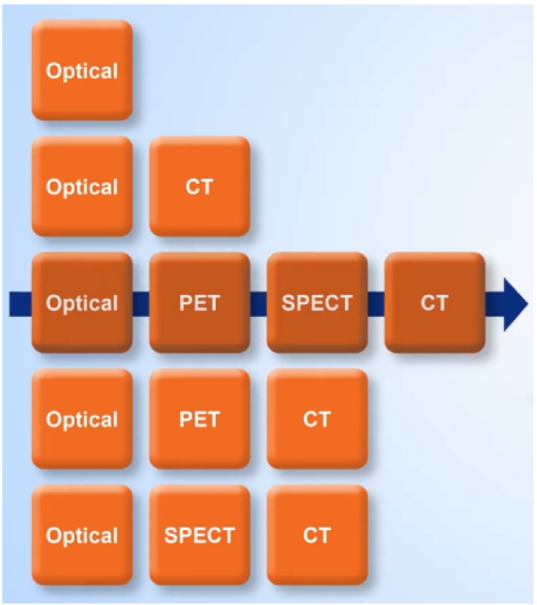

Fig. 2. Diagram showing combination patterns based on four types of imaging functions.

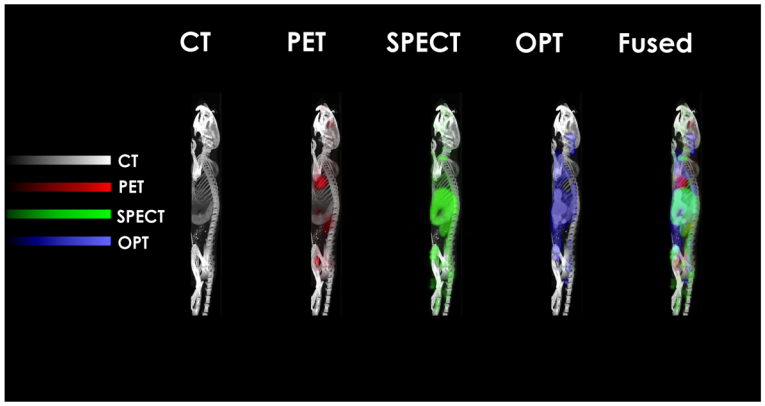

Fig. 3. Separate PET/SPECT/OI/CT images and their fused image (left).

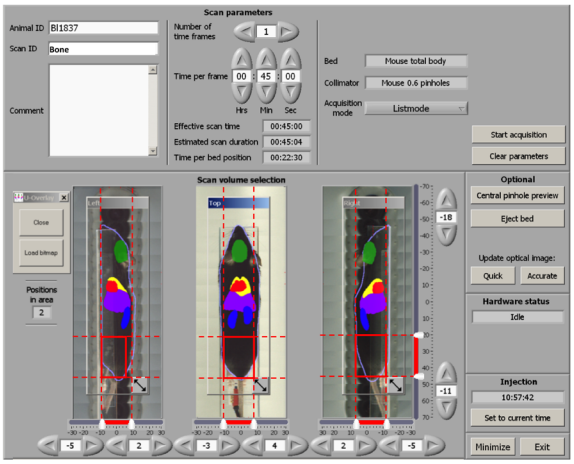

Fig. 4. The handy atlas function used to select the area of interest (right).

all-in-one imaging platform, on the other hand, enables the fused images to be acquired in a single scan, liberating users from complicated adjustment work (Fig. 3).

In addition, in preclinical research, it is important to seamlessly monitor the uptake, distribution and other disposition of drug candidates inside the body over a period of time. In this sense, otherwise missing observations that can result from side-by-side usage, even from replacing animal beds from one imaging system to another, are prevented by MILabs' all-in-one in-line platform design.

In addition, MILabs' platform is equipped with an intuitive touchscreen that can be easily operated by professors and researchers, as well as by university students who do not necessarily have advanced knowledge of system operation. An example of the user-friendly graphical user interface is an atlas of the organs that can be added to the image, to better guide users when they are selecting the scanning volume of interest (Fig. 4).

4. Conclusion

MILabs' all-in-one imaging platform is a versatile solution that meets a wide range of research needs. A number of other features—such as simplified geometric calibration, high-speed-high-resolution scanning with low dosage and space-saving design—also help optimize otherwise laborious workflow at the R&D site. In addition to best-in-class performance and robust design, comprehensive after-sales services support offered by MILabs, including remote service for system help, ensures long-term reliability and satisfaction.