Part No	Description
900100	Triumph Gantry and Base Subsystem Field-Upgradeable to Tri-modality mmpSPECT1-4, PET8, HR-CT Completely Shielded X-Y Motion Bed with Hand Controller Physiological Monitoring (cardiac, respiratory & temperature) Animal Monitoring (video camera and top-mounted monitor) Animal Handling System (heated mouse & rat beds with interconnect) Cylindrical Flood, Capillary Tube & Tungsten Wire Calibration Phantoms Pre-Plumbed Gaseous Anesthesia Supply and Waste Connections Multi-core PC workstation with Windows 7 operating system including: ▪ VivoQuant image fusion, visualization and analysis software ▪ DiCOM for image import from FLECT 400 and MRS 3016 Power Transformer with Uninterrupted Power Supply (UPS) Auto shielded according to FDA Closed X-Ray Cabinet Standard
900300	**XO-CT Subsystem** Mounted in same plane as SPECT for accurate image registration 40 Watt, 80kVp X-ray Source 6.7 megapixel, 50µm pitch CMOS Detector 118mm x 112mm FOV Variable Magnification (CT-Zoom); 1.3X - 4.5x Fluoroscopy Mode for Live Positioning CT Computer with CT Acquisition Software Cone Beam Reconstruction Software Whole-body scan times as short as 60 seconds
900410	**LabPET 4PET Subsystem with** 1536 Digital APD Detectors Phoswich LYSO/LGSO crystal configuration with one-to-one coupling tom APD 1.35 mm Spatial Resolution FBP, <1mm 3D-OSEM 37 mm Axial Field of View (FOV); user-selectable transaxial FOV 46-100 mm > 80 MBq Maximum Activity Range in NEMA NS-4 2008 mouse standard 15 cm Ring Diameter with APD-based detection Continuous-motion PET acquisition; on-board list-mode acquisition computer PET Acquisition GUI and PET Reconstruction (FBP, 2D & 3D MLEM, 3D OSEM) Patented Accelerated Method using Polar Symmetries (3D AMPS-OSEM) Installation, Calibration, Certification & Initial Training (1-2 weeks) Advanced Training (3-5 days, 2-3 months after Initial Training) 5 Year Warranty
	Total System List Price (excluding VAT)

Triumph II Trimodality System

The Triumph Platform provides an integrated, flexible and upgradeable platform to accommodate the following choices of high-performance imaging modalities: Positron Emission Tomography (PET), X-ray Computed Tomography (CT), and Single Photon Emission Computed Tomography (SPECT). The platform includes critical features for imaging flexibility, as well as advanced subject handling and monitoring. Triumph is a fully integrated molecular imaging system that provides solutions for biomedical research and drug discovery. It helps researchers easily and effectively monitor disease processes and understand the effects of new drug treatments. The same animal can be studied over time with repeated measurements.

Ancillary devices, which may be essential for performing reproducible and reliable molecular imaging studies in live animals (i.e. radiopharmaceutical injectors, vital sign monitors, Microvolumetric Blood counter, bed motion sequence, etc.), can all be controlled from a single user-friendly interface. Complex imaging protocols can be pre-programmed in advance, saving valuable scanner time for imaging. In addition, relevant information about each scan is collected during imaging and recorded in a DICOM- compatible database.

The high precision mechanical design leads to steady image acquisition even over long acquisition protocols, with positions for SPECT and CT hardware focused on identical fields of view to provide the best possible co-registration between these imaging modalities. The system allows for the mounting of 1, 2, 3
or 4 advanced digital SPECT cadmium zinc telluride (CZT) gamma cameras. Powered gull-wing doors on either side of the system allow for push button access to change collimators with ease. The gantry also provides variable Radius of Rotation for the SPECT and CT detectors (15-125 mm) to allow variable geometric magnification in both imaging modalities – allowing the full capabilities of the components of the system to contribute to the best quality images in the widest range of imaging applications. Its fully shielded cabinet for X-rays enables laboratory use without the need for additional room shielding requirements.

Animal Handling

The platform includes a precision animal positioning system that places all imaging systems on the same imaging axis and provides contoured, heated, beds for mice (25 mm) and rats (50 mm). The heated beds are warmed, which drives down variability in the physiological condition of the subjects, translating into more consistent results for longitudinal and lateral studies. The beds and heating elements are made of carbon fiber composite to minimize radiation absorption. Integrated gas and exhaust lines with mouse and rat specific nose cones allow for seamless use of gas anesthesia and waste-gas management. A complete anesthesia delivery system is available as an optional accessory. The configuration also allows for ready access to the subject for catheters and other accessory lines, without compromising radiation shielding, from optional accessory features such as the injection pump and the blood counter and withdrawal pump.

Animal Monitoring

The Triumph II platform includes an integrated physiological measurement system, enabling respiratory, cardiac, and temperature monitoring throughout imaging studies. Real-time video monitoring of the subject is enabled through an integrated CCD camera, Laser/LED illumination system, and video display mounted on the top of the system. Compatible with both Minerve and ASI-Instruments animal beds.

Computing

The ergonomic and mobile cart provides dual LCD displays with a single keyboard and mouse for a comfortable and compact solution for acquisition and analysis right next to the system. The Triumph Platform also includes a high-performance computing rack, and Uninterruptible Power Supply (UPS) protecting the system from power surges and fluctuations.

Digital MMP-SPECT™ Subsystem

The digital Multiplexed Multi-Pinhole SPECT (MMP-SPECTTM) sub-system provides high-quality pre-clinical SPECT imaging using digital solid-state Cadmium Zinc Telluride (CZT) detector technology for the direct detection of Single Photon Emissions followed by Computed Tomography reconstructions using MMP-SPECT algorithms. While this MMP-SPECT system is expandable from one to up to four imaging detectors, the basic MMP-SPECT camera includes one CZT detector, the complete set of SPECT imaging electronics, MMP-SPECT aperture plates and the acquisition and image reconstruction software required to conduct a wide range of high-performance SPECT imaging applications. With minimum 9-pinhole aperture plates, the system has the unique ability to perform both limited-angle SPECT and helical scanning SPECT in combination with user-selectable Radius of Rotation settings (“SPECT-Zoom”). This enables the MMP-SPECT system to perform both focused and whole-body imaging without traditional resolution-sensitivity trade-offs.

The system can be configured for SPECT imaging with spatial resolutions down to less than 0.5 mm and sensitivities up to 10,000 cps/MBq for a 4-head configuration. The system is field-upgradable with the first SPECT camera including the factory-provided calibration phantoms. When upgraded to a 4-detector system and equipped with 16-pinhole collimators, the MMP-SPECT is able to perform real-time stationary SPECT imaging, and whole-body imaging without rotating the detectors.

CZT Detector

Each CZT detector has an imaging area of 125 mm x 125 mm with 6,400 individual pixels providing an intrinsic detector resolution of approximately 1.5mm, the best in the industry. Moreover, the digital solid-state CZT detectors use direct conversion of gamma rays to electrical signals to provide a 4.5% FWHM energy resolution (at 140 keV) and cover an energy range of 25-250 keV. With this excellent energy resolution, CZT detectors are optimized for simultaneous multi-isotope SPECT imaging, or SPECT imaging in the presence of PET isotopes, both capabilities that are difficult to achieve using standard scintillation detectors with Photomultiplier Tubes (PMTs) detection. Because of the SPECT-Zoom, the detectors can be equipped with a universal 9-pinhole MMP-SPECT collimator suited for imaging both mice and rats. In addition, there is an optional range of user-selectable MMP-SPECT collimators, which can be delivered at any time when further optimization of performance is required for particular applications. SPECT isotopes supported include: Tc-99m, In-111, I-123, I-125, Tl-201, Lu-177, Re-186, and Re-188. Challenging simultaneous SPECT dual-isotope imaging including Tc-99m/I-123, and I-123/In-111 combinations are possible. Even more challenging simultaneous triple isotope SPECT imaging is possible with combinations including for instance, Tc-99m, I-123, and Tl-201.

X-SPECT Software with RAYguideTM-enhanced MMP-SPECT reconstruction

The SPECT software includes acquisition protocols for static, dynamic, tomographic, spiral tomographic (SpiralSPECT™), and calibration acquisition modes for a wide range of application needs. The embedded reconstruction engines provide for Filtered Back Projection (FBP), standard Ordered Subset Expectation Maximization (OSEM), and advanced HiSPECTTM multi-pinhole SPECT OSEM reconstructions. The latter image reconstruction includes RAYguide image regularization to enhance image contrast for low-dose and fast scans. This HiSPECT MMP-SPECT image reconstruction uses exclusive Iterative Reconstruction Software using maximum-likelihood approach (OSEM) with built-in calibration methods, resolution recovery and wizard-supported setup. Advanced communications and data compatibility features include DICOM import/export, Interfile import/export, and TCP/IP to networked storage solutions.

Parallel Hole Collimation for Whole-Body Pharmacokinetics and pharmacodynamics

The digital MMP-SPECT system can be equipped with so-called parallel hole collimators. These collimators provide a wide field-of-view (FOV) covering the whole body of a mouse and a large portion of a rat and are ideally suited for pharmacokinetic /pharmacodynamics studies. Imaging with a large FOV enables to trace the dynamics of a labeled drug from its site of administration throughout the body and as such, whole-body SPECT can make a great contribution to our understanding of ADME processes.
noninvasive This is one of processes where noninvasive imaging can contribute the most to our understanding. The presence of a marker - nuclear, NMR, optical - is ideally suited to trace the dynamics of a drug from its site of administration

SPECT Calibration/Quality Control Kit
The system allows for ready routine calibration, to ensure long-term repeatability for all applications. Integral to this is a set of standardized calibration phantoms that come with the system, including:

Large Square Flood Phantoms: Contains a 5” x 5” x 0.5” tank that can be filled with any liquid isotopes; One side of the square has a 4” long plastic handle that can be clicked into a specific “phantom holder” and fixed vertically onto the animal bed assembly in the Triumph gantry. It is used to acquire planer images for uniformity correction of the parallel-hole collimators; the flood image can also be acquired to evaluate the uniformity of the cameras.

Small Square Flood Phantoms Contains a 2” x 2” x 0.5” tank that can be filled with any liquid isotopes. Similar to the large phantom, it has a handle and shares the same holder for the Triumph gantry. The small fillable area can reduce required volume hence allow higher concentration. It is used to acquire planar images using pinhole collimators.

· Cylindrical Flood Phantom: A 1” wide (OD) and 5” long plexi-glass cylinder that can be filled with any liquid source. Volumetrically it mimics an average size mouse and can easily fit onto the mouse bed. It can be used to acquire flood SPECT data in order to evaluate the field of view as well as 3D reconstructed uniformity of various collimators.

Capillary tubes: A vial of 0.5 mm ID, 3” inch long glass capillaries that can be filled with any liquid source. A random combination of multiple capillaries in a soft matrix is typically used to assess fusion accuracy for the glass can be clearly identified in CT images. It can also be used to measure approximate resolution for quality control purpose.

“XO” X-ray CT Subsystem

The XO Computed Tomography (CT) sub-system provides high-quality CT images for whole body anatomical imaging suitable for either standalone imaging, or imaging in conjunction with PET or SPECT, thus enabling high-precision co-registration of functional and anatomical images. It is ideal for dual- or tri-modality, low dose, high-speed CT imaging. When used for standalone X-ray CT, the CT images can be fused with optical FLECT images imported through the DICOM communications interface. The CT system features a large area 6.7 mega pixel CMOS detector and has the flexibility to perform a wide range of acquisition protocols, including whole body imaging in less than one minute. The variable distances between the axis-of-rotation (AOR) to detector and to X-ray tube provides a CT-Zoom feature with a magnification range of 1.3x to 4.5x that allows for rapid optimization of the field of view and image resolution to accommodate different subjects and a wide range of studies.

X-ray Source

Includes an X-ray generator with a variable output of 30 to 80kVp and a maximum energy output of 40W with a 50µm focal spot size.

X-ray Detector

Consists of a large area (118.4 mm x 112 mm) CMOS direct-to-digital X-ray detector with 2368 x 2840 pixels and 50mm pitch. The detector can be operated in an un-binned mode for high resolution, or in a 2 x 2 or 4 x 4-binning mode for increased imaging speed.

Low Dose

The X-ray system deposits less than 2cGy in a subject with a length of 97 mm in continuous rotation mode. This reduced dose ensures that X-ray imaging is a minimal factor in longitudinal studies.

Imaging Performance

The CT imaging resolution ranges from <50µm voxel size for un-binned detection to 100 to 180 um (FWHM), depending on scan parameters, CT-Zoom settings and selected mode of operation, either step-and-shoot or fast continuous-rotation acquisition. The system design permits changing the field-of-view with a maximum imaging volume of 93 mm in diameter by 97 mm in the axial direction.

Protocol Flexibility

The protocols enabled by the XO system include: whole body mouse acquisition in less than one minute, user selectable step-and-shoot or continuous-rotation scan modes when using rapidly clearing contrast
agents, plus user-selectable CT-Zoom for optimizing field of view and resolution. The protocols can specify the level of binning of the detector to optimize the scan speed versus resolution trade-offs. An intelligent persistence-imaging mode allows for a live single projection view for improved subject positioning and scan definition.

Software

The CT Software includes a complete Control, Acquisition, Processing and Display package. The CT Control and Acquisition software package (Triumph XO-software) acquires persistent images for animal positioning and static planar imaging. It is used to acquire tomographic data with user-selectable CT-Zoom magnification, number of projections, frame stacking, detector binning mode. It is also used to reconstruct the CT image with user selectable voxel size, number of reconstructed voxels, and optimization for spatial resolution and soft tissue contrast. Reconstructed CT images are displayed and analyzed by the VivoQuant™ visualization and analysis software package, which takes advantage of the truly 3D nature of the data sets.

CT Calibration/Quality Control Kit

The system comes with a complete set of CT calibration phantoms to keep the system working with complete consistency of imaging performance over time. This drives down variability in longitudinal and lateral studies and improves researcher's abilities to detect the smallest differences from data set to data set. The included phantoms are:

· Tungsten wire phantom: A 50mm tungsten wire fixed in a 1"OD x 5" long cylinder. This phantom can be easily placed on a mouse bed and is used to obtain the FWHM value of a CT 3D reconstructed image.

· Cylindrical flood phantom: A 1" wide (OD) and 5" long plexi-glass cylinder that can

be filled with any liquid sources. Volumetrically it mimics an average-sized mouse and can easily fit onto the mouse bed. It is used to acquire flood CT images to evaluate CT 3D reconstructed uniformity.

“XO-HRCT” High-Resolution X-ray CT Upgrade

This optional upgrade for high-resolution in-vivo X-ray CT imaging includes prospective respiratory-gated acquisitions to avoid imaging blurring caused by the animal’s breathing cycle. Image resolution is maximized by using a X-ray source with variable focal spot (25-130µm) and an expanded geometric magnification range of 1.3x to 5.0x. the XO-HRCT achieves high spatial resolutions at low X-ray doses, expanding Triumph II applications into specimen scanning, detailed bone studies, lung morphology and (potentially) tumor angiography. Typical spatial resolutions are down to 30-35mm (14 lp/mm), among the best resolutions achievable with a low-dose X-ray CT system.

VivoQuantTM Software: Image Fusion, Visualization and Analysis

This software is the workhorse of visualization and data analysis to translate your data into publication-ready images, presentation-ready movies, and to perform quantitative analyses. The core features include:

Image Fusion

Supports the viewing and analyzing of both static and dynamic image data sets across multiple modalities (PET, SPECT, CT, MRI, and Optical FLECT; over 15 data formats DiCOM and non- DiCOM)
Multi-modal registration (automated, manual and/or through the use of imaging fiducial markers) with reorientation tool

Image Visualization

Extensive viewing features: slice view, multiple planar reconstruction (MPR), and tile view for dynamic MR data
Filtering, cropping, smoothing, and re-scaling functionality
Plotting tools for time-activity and time-signal curves, contours and histograms
Image and movie generation for all viewing functions; broad range of file formats
Includes magnification tool to generate high definition renderings for publication, presentation, posters.

Image Analysis

3D ROI segmentation via automatic, semi-automatic and manual tools with undo-redo tool
Dosimetry tool to generate 3D ROI derived input value to plug onto OLINDA EXM
MR analysis toolkit for generating T1, T2 and ADC maps
VivoScript enabling batch processing and analysis automation
Supports brain atlas packages (mouse, rat, select non-human-primates) for PET, SPECT, CT and MRI (multi-modal) data sets with selected PK modeling support

Compatibility

Supports Mac OS-X, Windows 7 and Linux (RHEL 5 or higher)
Interfaces with inviCRO's iPACS® image data management and archiving platform
LabPET™ Subsystem
The LabPET™ sub-system provides researchers with the ability to visualize and quantify biological processes in small animals with a reconstructed resolution better than 1.0 µl. LabPET is an advanced digital system, which uses Avalanche Photodiode Detectors (APDs). The system uses dual-scintillator detection units in a phoswich architecture. Pairs of LYSO/LGSO crystals provide a one-to-one coupling between scintillator and APD detectors, which in combination with the 162 mm detector ring diameter, provides enhanced intrinsic detector resolutions. The system provides a 110 mm inner bore diameter with < 1.0 mm resolution at the center of the FOV.

Architecture
Fundamental PET performance enhancements are obtained by one-to-one coupling of the phoswich scintillators to the APD detector. This unique detector eliminates detector light sharing and the need for crystal-decoding schemes found in conventional systems. This one-to-one coupling of scintillator pixels with APD results in higher spatial resolution and improved image quality. The LabPET system also has electronics based on field-programmable gate arrays (FPGA) enabling the use of massive real-time parallel processing, which results in fast data acquisitions and high countrate capabilities to handle the wide range of activities found in preclinical animal studies.

Geometry
LabPET is a flexible, expandable high performance system. LabPET consists of stacks of individual detector rings. Each ring contains 192 APD detector units and has a physical diameter of 162 mm. LabPET is available in three different configurations: LabPET 4, 8 or 12 with 37, 75 or 112 mm axial fields-of-view, respectively. The subsystem has an effective bore size of 11cm enabling imaging of a range of small animals, and an imaging transverse FOV of up to 100 mm. Reconstructed fields of view are software selectable and include 46, 60, 80 and 100 mm. The LabPET sub-

system is positioned at the front of the Triumph II gantry, allowing easy access to subjects enabling administration of fast decaying isotopes while catching fast kinetic distribution images. The LabPET is positioned directly on the same axis as the X-O CT and MMP-SPECT sub-systems. This ensures the best image co-registration, eliminating the need for complex manipulation in post-processing software or the risk of mis-registration due to the movement of the animal during the transport of the animal bed between separate scanners.

GUI and Acquisition Software

The LabPET software allows for simple and efficient workflow in designing PET imaging protocols. An intuitive graphical user interface (GUI) enables the user to capture relevant information about the acquisition as well as to specify a wide range of options for the protocols. Protocols for static, dynamic and continuous motion bed positions can be defined in seconds. The software also has the functionality to control the optional automatic infusion system, which improves imaging reproducibility and enhances quantification.

The reconstruction portion of the LabPET software uses the full flexibility of the list-mode acquisition format. Data can be reconstructed with either one time frame for a static scan or with a number of different time frames with arbitrary lengths for dynamic scans. When data has been acquired with a vital sign monitoring system, cardiac or respiratory-gated images can be reconstructed.

Patented LabPET Image Reconstruction Software

The LabPET system acquires PET data in a list-mode file format. This format allows maximum flexibility during reconstruction. With a single acquisition protocol, the software can reconstruct static, dynamic or gated volumes. The system currently offers three reconstructions algorithms: filtered back projection (2D-FBP), Maximum Likelihood Expectation Maximization (2D- and 3D-MLEM) and Ordered Subset Expectation Maximization (2D- and 3D-OSEM). The latter fast 3D reconstruction method is based on a patented Accelerated Method using Polar Symmetries (AMPS-OSEM). The MLEM and AMPS-OSEM reconstruction software includes an accurate 3D description of the physical detector response and 3D model-based attenuation and scatter correction algorithms. Both corrections require a co-registered CT image that is further segmented into air, water and bone regions.

LabPET Calibration/Quality Control Kit

This kit contains:

· **Germanium Rod Source**: The LabPET system uses a rotating Ge-68 line source to perform detector efficiency normalization, which ensures repeatability, reproducibility and improves quantitative accuracy. Specialized mounting hardware is included with the LabPET ring, and the source rotates around the ring with automated control to make normalization fast, easy and repeatable. This source is ordered and shipped separately but required.

· **Cylindrical Flood Phantom**: A 1" wide (OD) and 5" long plexi-glass cylinder that can be filled with any liquid sources. Volumetrically it mimics an average-sized mouse and can easily fit onto the mouse bed. It can be used to acquire flood PET data in order to evaluate field of view as well as 3D reconstructed uniformity.

· **Capillary Tubes:** A vial of 0.5 mm ID, 3" inch long glass capillaries that can be filled with any liquid sources. A random combination of multiple capillaries in a soft matrix is typically used to assess fusion accuracy for the glass can be clearly identified in CT images. It can also be used to measure approximate resolution for quality control purpose.

Integration with Accessories

The LabPET hardware and acquisition software works seamlessly with optional accessories, such as the automated injection pump and a Microvolumetric Blood Counter and withdrawal pump. The gantry includes 3 mounting rails for mounting one or more optional injection and/or withdrawal pumps so that the injection and/or withdrawal of tracers can be performed with a minimal delay. The gantry also provides near-bore integrated electronic coupling for automatic control of the injector pump for optimal quality measurements, also making for a clutter free work environment.

Accessory for Pharmacokinetic and Pharmacodynamic Studies

Automated Microvolumetric Blood Counter:

Quantifying Tracer Uptake Confidently

The Microvolumetric blood counter is a fully integrated and automated system for measuring the radioactivity concentration in the blood of live small animals. The system consists of a controller unit, a pumping system and a detector for measurement of beta (β+ or β-) radiation. It offers a reliable and reproducible solution for accurate radioactivity measurement in µl volumes of arterial or venous blood drawn from small animals. The tiny detection volume (3-8 µl) and programmable sampling speed enable the full blood time-activity curve to be obtained routinely from rats and mice. The counter is offered as an option with the Triumph imaging platform and paired with the LabPET™ scanner for accurate and sophisticated pharmacokinetic analysis in small animal studies. With its precise, minimal blood withdrawal, the Microvolumetric Blood Counter is considered essential for pharmacokinetic and pharmacodynamic studies.

Features include:

- High detection sensitivity with low sensitivity to γ-radiation background (<5 cps for 37 MBq/1 mCi 18F @ 10 cm)

- Automated Sampling: A minimum of 15µl of blood is required for counting and can be returned to the subject. A withdrawal speed range from 0.02 µl/min to 4.9 ml/min is supported.
- Linearity: up to 160 kBq/µl or 4.2 µCi/µl with compensation for dispersion (0.15 s-1 @ 0.5 ml/min, rat whole blood)
- Detection of the following isotopes: C-11, N-13, F-18, Cu-64, O-15, Ga-68, Rb-82, I-124, P-32.