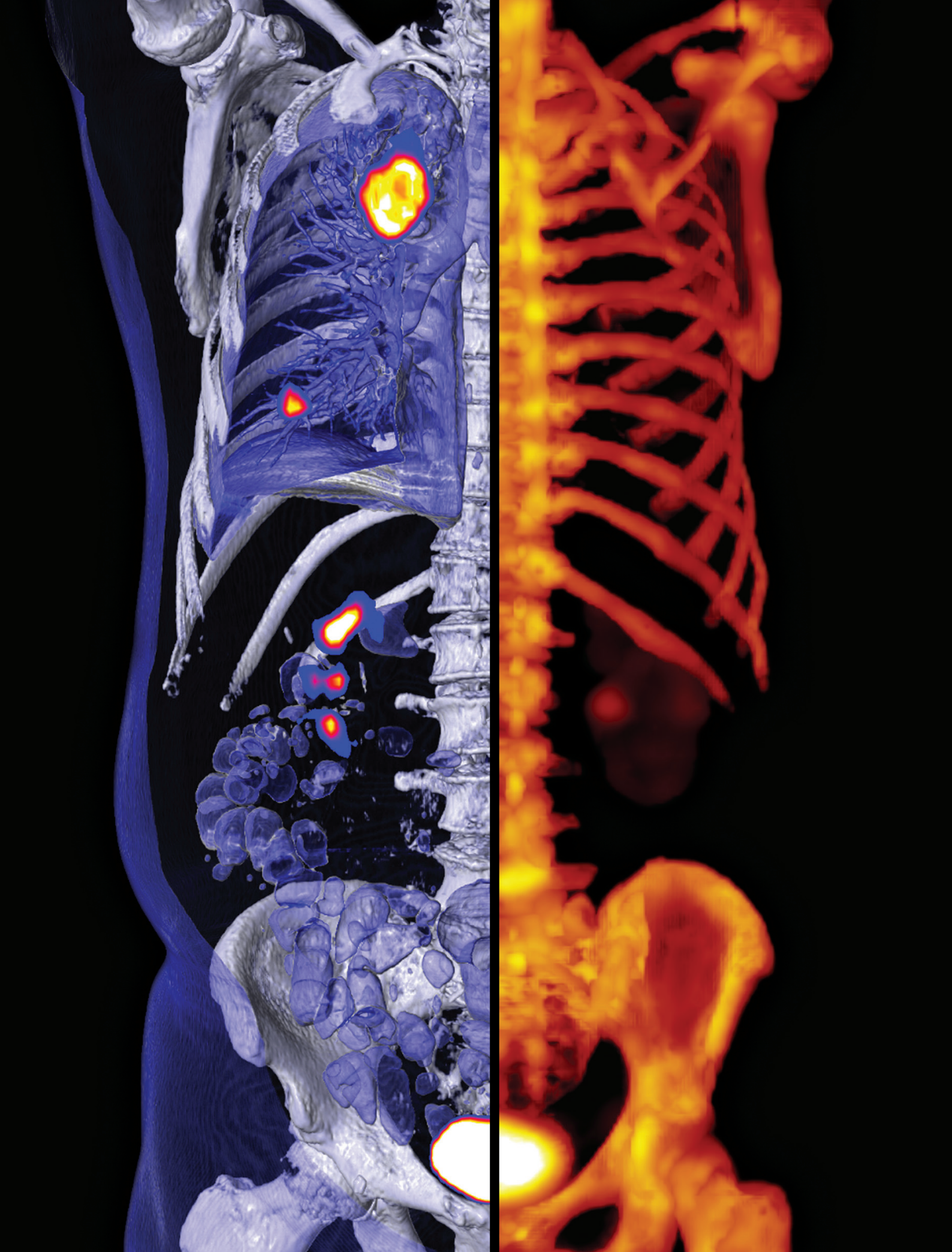

The Future of Molecular Imaging Has Arrived

Siemens has once again proved that the most distant technical horizons can be surpassed with consistent dedication to improving healthcare through the introduction of two new platforms that redefine molecular imaging. One transforms the one-size-fits-all PET/CT exam into a tailored suit; the other propels hybridized SPECT and CT beyond today's state-of-the-art technology to qualify as a whole new modality.

By Greg Freiherr

Nuclear medicine has long been a cornerstone of diagnostic imaging due to its ability to illustrate metabolic activity and provide physicians with the answers they need sooner than is possible with traditional anatomical modalities. However, in today's challenging healthcare environment, where the growing demand for higher-quality, patient-centered care is matched only by the need for definitive and timely answers, the limitations of conventional PET/CT and SPECT/CT scanners are becoming more evident.

Despite the high sensitivity of today's SPECT/CT scanners that can aid physicans in early disease detection, the modality is restricted in its ability to provide definitive and timely answers. Its limited specificity, resulting from the use of mechanically fused images, often requires the need for follow-up procedures that delay patient care and potentially increase costs. Meanwhile, the stop-and-go technology of conventional PET/CT limits a physician's ability to tailor the scanning to the needs of each patient and results in a one-size fits all approach to scanning that can lead to higher dose and unnecessary patient anxiety.

Founded on the belief that the highest technical performance is only achieved when solutions deliver clinical outcome that can help improve patient health, Siemens has been a recognized leader in medical innovation for more than 130 years. From the first electromedical devices in 1896 to the latest molecular imaging technologies, Siemens has a long history of pioneering technological achievements that help make the impossible, possible.

In what may be the most significant advance in PET in more than a decade, Siemens' new Biograph mCT Flow™ replaces the stop-and-go acquisition of conventional exams with FlowMotion™, easing the patient steadily through the gantry to boost throughput, improve uniformity for better quantification and increase patient comfort. Taking PET/CT to a new level of performance, Biograph mCT Flow eliminates the need to collect data in overlapping bed positions by continuously scanning the entire patient.

The unavoidable necessity of overlaps in stop-and-go PET is eliminated with FlowMotion, as the patient moves smoothly through the Biograph mCT Flow gantry. These time savings can be used to produce higher resolution images, as the pace of the table's continuous motion slows to allow the detector to gather more counts over demand organs and body areas. Biograph mCT Flow increases detector sensitivity edge-to-edge, boosting both the accuracy and reproducibility of quantitative values that characterize disease and health. The continuous motion helps assure patients that the scan is progressing, while efficiencies afforded by Biograph mCT Flow minimize radiation exposure.

Siemens' new Symbia Intevo™* integrates data from SPECT and CT. Leveraging this hybridized source of information, the new scanner delivers the high sensitivity commonly obtained with SPECT, the high specificity often sought in follow-up studies and, for the first time, quantification.* Together these capabilities raise this technological advancement to the status of a new modality, which Siemens has dubbed xSPECT.*

In the revolutionary xSPECT exams performed with Symbia Intevo, image quality reaches extraordinary resolution as data from the two systems are matched and processed together using algorithms that correct and localize SPECT information using CT information beyond the positional data. The exactness of this integration allows zoning and a corresponding image quality boost, as well as SPECT quantification, which is difficult to perform on conventional SPECT/CT. Fast and confident one-stop accurate results, a never-before-possible achievement that could possibly render tests, such as MR and biopsy, potentially saving time and reducing healthcare costs.

In these unique ways, Biograph mCT Flow and Symbia Intevo could not only change the practice of molecular imaging, but also alter the foundation by which disease is detected and characterized. They have the potential to replace uncertainty with certainty and streamline the processes underlying diagnosis and therapy monitoring, heralding a new age of molecular imaging and more efficient and effective patient management.

Siemens Unveils Continuous FlowMotion PET•CT

Surgeons had removed the patient's cancer and all of the thyroid tissue surrounding it. But there was a node of metabolic activity at the base of the neck, where metastatic disease would not be expected. In line with that, behind the jugular, was another, less intense node.

If a traditional whole-body PET/CT had been performed, those cancerous nodes would likely have been missed. But Dr. Kirk A. Frey, MD, PhD, director of the PET Center at the University of Michigan Hospitals in Ann Arbor, Michigan, USA, was reading images acquired with a new generation of PET•CT, one that allows physicians to increase the resolution of selected body areas without requiring more time for the exam.

"We wouldn't have been confident about either node if not for the high-resolution scan," Frey says. "It gave us the information we needed to make a confident diagnosis, and the surgeons a nice road map to remove the nodes."

The scan was acquired on Siemens' new Biograph mCT Flow, arguably the most significant advancement in PET since it was hybridized more than a decade ago. Rather than bed positions, defined by conventional stop-and-go movement of the patient table, scans with the new scanner, guided by FlowMotion, are focused according to body areas and organs as the patient moves continuously through the detector rings.

In the case performed by Frey, the patient's head and neck were scanned at a slow table speed. This allowed more counts to be gathered and high-resolution images to be produced.

"The ability to do a single acquisition, while easily dwelling over areas you want to reconstruct at higher resolution, is a big plus," he says.

The continuously moving patient table provides the foundation for software and hardware that together remedy the shortcomings of conventional, stop-and-go PET/CT. Images are higher quality; quantification more sensitive and reproducible; dose and throughput optimized; and scans more comfortable for the patient.

FlowMotion orchestrates image quality, doubling the resolution of conventional scanning for selected areas of the body and easily gating data acquisition to account for respiration as part of standard scanning protocol, making it routine.

A new quantification paradigm improves noise uniformity in all dimensions, edge-to-edge, maximizing accuracy and boosting reproducibility.

Throughput can be increased by scanning body areas at a steady, rapid pace. Alternatively, the table can be slowed to gather the necessary counts with a lower dose of radiopharmaceutical.

Patient experience is addressed as well, as the continuous motion of the table reassures patients that the scan is progressing, free from the stop-and-go bed motion that characterizes conventional PET/CT.

What makes FlowMotion unique clinically, however, is what matters most—the ability to detect, characterize and monitor disease with greater certainty than ever before.

Biograph Changes Patient Flow

Conventional PET/CT assigns rigidly sized bed positions, typically seven for an adult male. When performing a stop-and-go scan, the table moves into the first bed position and stops. It remains there, stationary for a set time, while the ring detectors record the number of photon strikes resulting from coincidence events. The table then steps to the next position, where it stops again. This process repeats until the scan is done.

Planning and scanning is limited to the fixed size of the detector and the bed positions. While technically possible in some scanners, the complexity of adjusting scan parameters in clinical stop-and-go protocols has limited its routine use. As a result, each bed or step acquisition typically lasts the same length of time and uses the same reconstruction matrix. Despite an increasingly competitive and rapidly changing healthcare environment that demands definitive and timely answers, hospitals and physicians have been confined to the limitations set by stop-and-go technology. This has resulted in

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Biograph mCT Flow

xSPECT: The Difference Between Seeing and Knowing

With the introduction of Symbia Intevo, Siemens is once again pioneering hybrid imaging. This new system weaves SPECT and CT data so tightly together that the system represents not just a new product, but a new modality.

As the world's first xSPECT* system, Symbia Intevo delivers not only the high sensitivity that the nuclear medicine community has come to expect from SPECT, but also extraordinary image quality that may allow physicians to make a diagnosis based on just this one exam. And best of all, for the first time, the SPECT data is fully quantitative.

Peter Bartenstein, MD, chairman of the Department of Nuclear Medicine, Ludwig-Maximillians-University in Munich, Germany, describes xSPECT as providing excellent spatial resolution and increasing diagnostic certainty. "Because we can better locate the lesion and get a clearer idea of the extent of the lesion, xSPECT may result in more confident interpretation," he says.

"We are in the early stages of our evaluation of quantification with xSPECT," adds Jerry Froelich, MD, director of Nuclear Medicine and Molecular Imaging at the University of Minnesota in Minneapolis. "I am excited about the possibilities."

Images generated by xSPECT, comprised of SPECT and CT data, show excellent delineation between bone and soft tissue and the lesions present within, according to Zsolt Szabo, MD, PhD, professor of Radiology at Johns Hopkins Hospital. "It is much easier to localize lesions in the bone and do lesion characterization," he says.

A Breed Apart

Despite the high sensitivity of today's SPECT/CT scanners, which permit early disease detection, the modality is restricted by its ability to provide definitive and timely answers.

While detecting virtually all cases of disease, SPECT and SPECT/CT have always been labeled as "unclear medicine." Physicians often have been forced to rely on other modalities, such as MRI, diagnostic CT, PET/CT or biopsy, to accurately characterize suspicious lesions, distinguishing inflammation, for example, from bone tumor. For this reason, SPECT/CT has been viewed as a modality that may generate as many questions as it does answers.

Symbia Intevo (short for evolution of integration) overcomes the challenges that limit conventional SPECT/CT, by providing the information that physicians need to find and differentiate disease. It does so through a new, accurate alignment method that completely integrates SPECT and CT. The resulting high-resolution xSPECT images provide physicians with the potential to not only find disease, but also to more confidently interpret images. Moreover, Symbia Intevo's unique quantitative capabilities may provide the ability to monitor and adjust treatments earlier by accurately measuring small differences.

"The quantitative aspect is of paramount importance," says Bartenstein. "Without it, you are really making an educated guess."

Symbia Intevo also has the potential to improve patient care and increase efficiency by cutting dose to the minimum needed to achieve high-quality diagnostic images—all while maximizing throughput. Its optimization of CT and SPECT data acquisition and processing affords the potential to cut dose in half and double the scan speed, thereby increasing patient well-being and throughput.

As such, Symbia Intevo is a truly revolutionary product that represents not only a technological advance, but also an entirely new modality: xSPECT.

Symbia Intevo

Building on Innovation

The Symbia Intevo xSPECT series is built upon the same roots as conventional SPECT and SPECT/CT. These roots extend back decades to the first gamma cameras, which produced planar images. These two-dimensional images indicated the presence and general location of suspicious lesions, but little more. They gave way in the 1970s to images produced using single photon emission CT scanners. These images provided substantially higher resolution based on technology that evolved from CT scanners.

The success of PET/CT led to the hybridization of SPECT and CT a decade ago. But early SPECT/CT scanners did not meet expectations. Instead, they represented mostly an advance in

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Siemens Unveils Continuous FlowMotion PET•CT

higher dose, greater patient anxiety and lower efficiency.

Siemens, a recognized leader in medical innovations for more than 130 years, has broken down these barriers with the introduction of Biograph mCT Flow with FlowMotion, the world's first continuous motion PET/CT system. Instead of fitting the patient to bed positions defined by the old way of stop-and-go, Biograph mCT Flow fits the scan to each patient with a bed that moves in a one continuous motion.

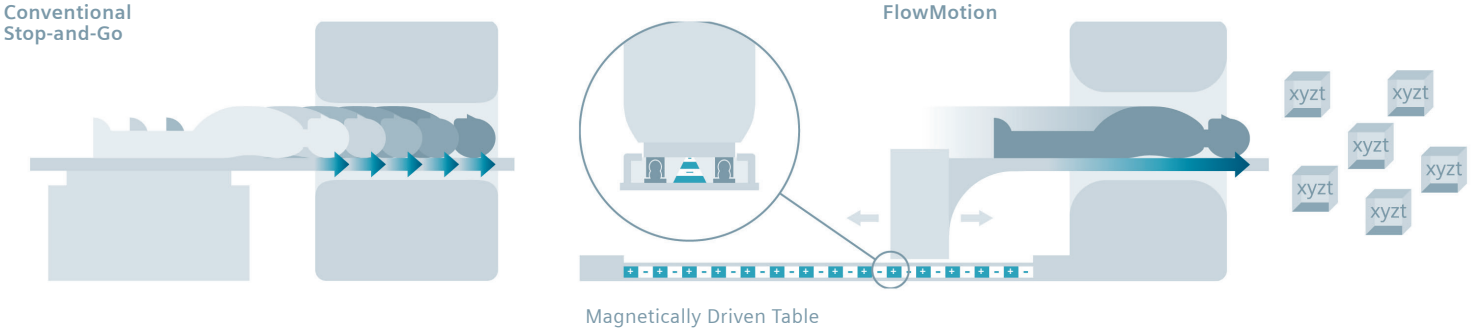
Under the automatic control of Siemens' FlowMotion, Biograph mCT Flow replaces this one-size-fits-all approach with protocols tailored for each organ. Up to four zones are assigned to a single scan. Each is customized to tailor fit organs and anatomic regions, for example, the high resolution scan of the head/neck or respiratory-gated scan of the lungs. The bed moves continuously, but its speed is adaptable throughout the scan based on the counts needed for each organ or zone.

For example, in patients suspected of lung cancer, the new standard imaging protocol may set zone 1 (the head and neck) at a slower scan speed for high resolution to look for metastatic disease in the brain and lymph nodes. Zone 2 may cover the lungs at a slower scan speed and with gating. Zone 3 over the liver may maximize counts in case of liver metastasis. Zone 4 may be covered at increased speed in lower attenuating areas like the extremities to make the best use of time. This flexibility over the different zones allows every scan to produce optimal image quality.

"In the past, we had to decide where to start gating, based on bed position, not anatomy," Frey says. "I think the ability to use anatomically defined segmentation will drive the acquisition parameters in a sensible direction and raise the opportunity for individualized scanning protocols." Gone is the need for time-consuming multiple scans in a conventional patient exam to accomplish higher contrast over a specific area. Gone, too, is the one-size-fits-all compromise that has beleaguered PET/CT since its inception.

FlowMotion Innovation

Underpinning the success of the new Biograph mCT Flow with FlowMotion is the precisely engineered table. Siemens began work on this technology with Dr. David W. Townsend PhD, a pioneer of PET/CT, more than 10 years ago, knowing this was the key to the future. The first step was the development of Siemens' SMART patient handling system (PHS). A key component of the SMART PHS is the cantilevered bed with its hardened carbon fiber, which allows zero differential deflection. This ensures that the patient remains correctly positioned from



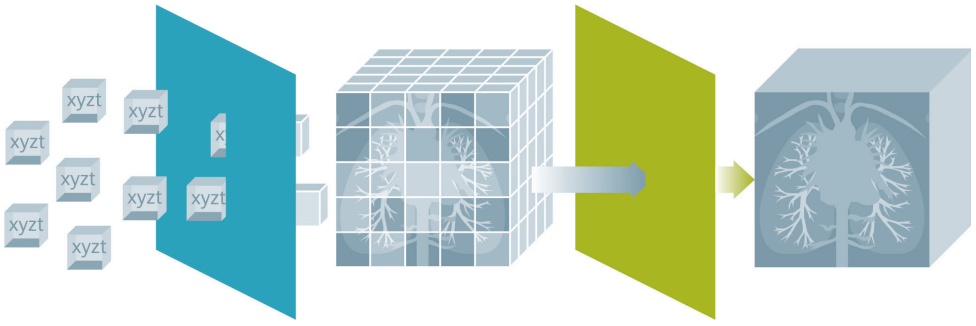
> “There are parts of the whole-body image where reconstruction on a more resolute matrix offers real advantages...”

Kirk Frey, MD, PhD
Director of the PET Center
University of Michigan Hospitals
Ann Arbor, Michigan, USA

the CT exam at the front of the gantry through the PET exam at the back, thereby preventing misregistration between the CT and PET images.
The table can travel up to 200 mm per second when positioning the patient. The magnetic drive enables precise acquisition speeds from 0.1 mm to 10 mm per second with submillimeter positioning accuracy and <0.1 percent velocity accuracy, even carrying a patient weighing 227 kg/500 lbs. This precision cannot be achieved in the belt-driven CT bed design found on conventional PET/CT scanners.
Further contributing to the engineering success of FlowMotion is the new Flow Advanced Computational System (ACS), which acquires imaging data from the scanner. Two solid-state drives, coupled to the detector array, help ensure a steady stream of data from the scanner to the ACS. These data are processed on the fly, thus resolving a shortcoming of stop-and-go scanning, which can only record as many counts as the onboard storage device will allow.
With Flow ACS, the data stream from the scanner for immediate processing without limiting signal collection. In conventional scanning, data accumulate for each bed position.
FlowMotion has another advantage as each event is time and position “stamped” to indicate where and when the data were acquired so they can be rebinned for reconstruction and normalized based on their specific line of response. This new complexity, addressed by FlowMotion, propels PET•CT to the next level of performance, allowing every detector row in the scanner to see the body as it moves continuously through the scanner field of view (FOV).

Finest Detail in Every Scan

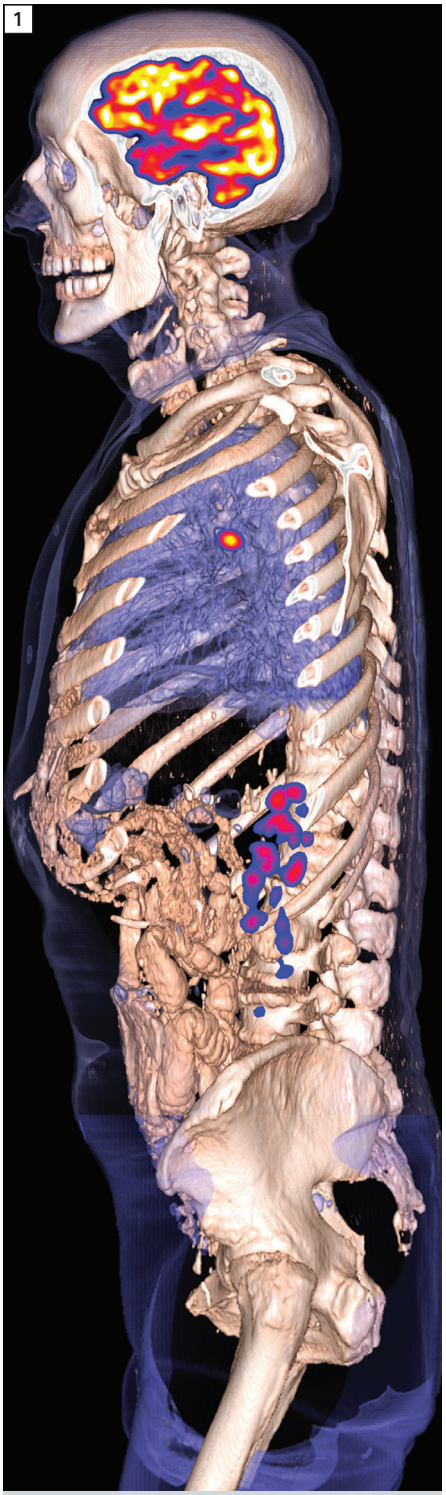
To provide an accurate diagnosis, physicians need an accurate image. However, conventional systems can lose definition toward the edge of the FOV, miss small or low-grade lesions and are subject to motion blurring, potentially compromising the image and reducing diagnostic confidence.
With FlowMotion as the guiding principle, Biograph mCT Flow provides unsurpassed image quality, which has always been the first priority at Siemens. Its OptisoHD (high-definition) detection system is designed to deliver the industry’s finest* volumetric resolution of 87 mm^3, with the industry’s best 400x400 reconstruction matrix.* Siemens’ ultraHD•PET delivers increased image quality compared to conventional PET/CT technology by combining two important



Solid-State Electronic Architecture

Dynamic Data Processing

1



1 FlowMotion supports the highest possible resolution for each organ with a high-resolution 400x400 matrix and HD•Chest for motion management. This helps achieve the finest volumetric resolution,* which, for example, is critical for white and grey matter differentiation and early lesion detection.

“FlowMotion will stimulate the development of completely different protocols. That’s what I like about the technology.”

Frank M. Bengel, MD, Director, Dept. Nuclear Medicine
Medizinische Hochschule, Hannover, Germany

innovations: HD•PET, which provides improved uniformity across the FOV; and Time of Flight (TOF), which doubles improvement in signal to noise. With the addition of z-Sharp™ technology that offers CT-isotropic resolution down to 0.28 mm at any position within the scan field, Biograph mCT Flow pushes the boundaries of spatial resolution.
Additionally, by eliminating the need for individual bed positions, Biograph mCT Flow enables examination parameters, such as speed, image resolution and motion management to be adjusted to the precise dimensions of each organ.
At the University of Michigan Hospitals, Frey and colleagues are custom-designing FlowMotion protocols based on disease populations to produce high-resolution images of specific body areas, then making up time by increasing the table speed over areas of less concern.
“There are parts of the whole-body image where reconstruction on a more resolute matrix offers real advantages,” Frey says. “Such areas might be the brain or head/neck region. Their interpretation might benefit from reconstruction on a 400x400 matrix as opposed to the typical 200 matrix for the body.”
The increased resolution possible with FlowMotion proved useful when Frey performed a PET•CT to stage a lung cancer patient. Initially diagnosed with a pulmonary mass, the patient complained of vision problems. Frey ordered a slow table time for the head. Reconstructed in a 400x400 pixel matrix, the images revealed a metabolically active lesion in the occipital cortex.
“This up-staged the patient to one with a distant metastatic deposit and further directed us in terms of the kind of lung cancer we were dealing with,” he says. “This was clearly an aggressive tumor type, raising the possibility that maybe it isn’t a typical squamous cell but rather a small cell cancer.”
Identifying distant metastatic disease in the brain confirmed that the patient was stage IV, thus highlighting the likely change from non-small cell lung cancer (NSCLC) to small cell lung cancer (SCLC). This could have an important impact on treatment strategy, because some drugs utilized for NSCLC are not effective against SCLC.
These are just a few examples of what might be achieved with Biograph mCT Flow. The flexibility of the scanner and the ease by which protocols can be designed may lead to many others.
“FlowMotion will stimulate the development of completely different protocols,” says Frank M. Bengel, MD, director of the Department of Nuclear Medicine at the Medizinische Hochschule, in Hannover, Germany. “That’s what I like about the technology.”

Unprecedented Quantification

In conventional stop-and-go scanning, where protocols are built around bed positions, data may be sampled anywhere in the FOV. Consequently, different values may be obtained depending on whether the sampling point was in the sweet spot of the FOV or near the edge of the detector. Such differences could impact clinical decisions when using quantification to assess the effect of therapy. If the sampling points are not the same before and after the start of therapy, values may erroneously indicate patient response or lack of it, directly influencing the management of the patient.
Biograph mCT Flow promises to boost both the accuracy and reproducibility of quantification. Guided by FlowMotion, protocols can be built around organs rather than bed positions, helping to ensure that values are obtained when the point being quantified is in the sweet spot of the FOV. The continuous motion of the patient table means all points of interest pass through the sweet spot of the detector’s FOV at some time during the scan. This optimizes data collection, potentially increasing reproducibility, as the measurements are known to have been gathered in exactly the same way for each scan.
Further, FlowMotion acquisition improves edge-to-edge noise uniformity compared with conventional stop-and-go. With Biograph mCT Flow, the acquisition is continuous, avoiding the loss of sensitivity that can occur when the

overlap between bed positions in conventional scanning is not sufficient. Noise uniformity is achieved throughout the FOV, all the way to the edge plane, thereby assuring the accuracy and reproducibility of standardized uptake values. Additionally, quality control algorithms built into the Biograph platform normalize data collection to help ensure the accuracy and reproducibility of acquired quantitative data, while Quanti•QC, an automatic quality check process, normalizes and precisely calibrates the scanner nightly to the right specifications. Because the calibration is performed overnight, it does not negatively impact scheduling or reduce throughput.

Optimizing Dose and Throughput

FlowMotion further improves throughput by simplifying workflow with the means to easily integrate high-resolution scans–and even respiratory gating–into a single scan.

"From what I have seen, I don't think it will be a great challenge to go from stop-and-go to FlowMotion," says Jerry Froelich, MD, director of nuclear medicine and molecular imaging at the University of Minnesota in Minneapolis, USA. "The interface makes it very straightforward, very easy to set up the protocols."

At a busy medical center performing routine clinical studies, throughput may be a paramount concern. In such cases, Biograph mCT Flow can be set to deliver standard resolution, yet cover the whole-body scan in less time than if the scan had been performed using stop-and-go. While increased throughput is important, providing minimal radiation exposure to the patient is also a critical concern. The old way of scanning by bed position exposes the patient to more CT radiation than required. This is because the area covered by a bed position may be more than is needed to cover the organ or body area being targeted. Biograph mCT Flow solves this problem by scanning only where needed, eliminating the extra CT dose caused by overscanning. Depending on the number of bed positions, this dose savings can rise to 32 percent of the overall CT dose.

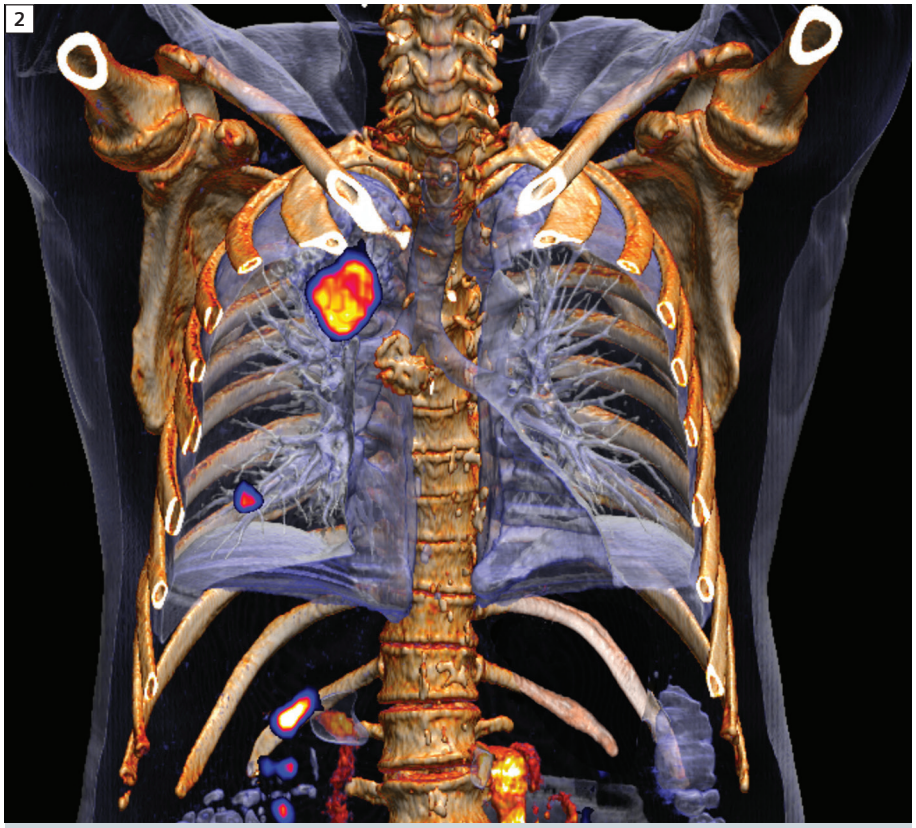
"If you do the bed-by-bed acquisition, you need CT over your entire bed position, but you may not need to look at an image extending that far," Bengel says. "Your area of interest might end right in the middle of the bed position, but you will need still to cover the whole position with CT. With FlowMotion, you can stop the CT scan where your area of interest ends."

Siemens' CARE (Combined Applications to Reduce Exposure) and iterative reconstruction software, which minimize CT radiation exposure are enhanced by Biograph mCT Flow with FlowMotion and single source dual-energy CT. Similarly the company's FAST (Fully Assisting Scanner Technologies) accelerates workflow by helping the technologist plan, scan and process the data, as Biograph's wide bore gantry measuring 78 cm in diameter bolsters patient comfort.

Because FlowMotion is so efficient at counting coincidence events, radiation dose from the radiopharmaceutical can be minimized as well. The operator can administer a lesser dose of radiopharmaceutical and acquire data over the same length of time as if a conventional scan were being done. Radiation dose from the PET tracer might be reduced by half with True V, for example, from 12 to 6 millicuries, yet the same number of counts can be acquired and, therefore, image quality maintained.

This flexibility in scanning is achieved with single-click simplicity through protocols set by the operator and executed by algorithms built into Biograph mCT Flow. Despite its sophistication, the user interface is easy to learn, Frey says. "There was some anxiety among technologists that this was going to further complicate their daily workflow, but I think that after they experienced it, they adopted the opposite opinion," he says.

In this way, FlowMotion and TrueV can boost throughput, reduce dose or find a



2 Accurate staging of lung cancer requires early detection of small lesions. Biograph mCT Flow allows for routine use of HD•Chest motion management techniques that enable delineation as well as quantification of small lesions.

Biograph mCT Flow improves patient comfort and offers the lowest possible dose.

balance between the two that satisfies the clinical demands and the patient's safety. This flexibility assures that the patient is exposed to radiation dose as low as reasonably achievable, the so-called ALARA principle, which is widely embraced by the imaging community and is becoming increasingly important to patients.
"With FlowMotion, we also get a great marketing tool because it is what the physician needs and at the same time places the lowest possible radiation burden to the patient," Bengel says.

Patient-Centric Imaging

Biograph mCT Flow supports not only higher quality imaging and reduced dose, but patient comfort. Gone are the jarring steps that can unsettle the patient and potentially prompt involuntary patient motion which, in turn, can introduce motion artifacts into the images.
Some technologists try to avoid such problems by alerting patients to upcoming steps. FlowMotion eliminates the need to do so, allowing them to concentrate on other duties, as the continuous motion of the table provides moment-to-moment feedback to the patient that the scan is progressing.
"FlowMotion may be a relief for patients, because the patient will know the machine is performing," says Koji Murakami, MD, PhD, head of the Division of Nuclear Medicine, Department of Radiology at Keio University School of Medicine in Keio, Japan.
Otherwise, with stop-and-go, the patient may feel no activity for two minutes at a time, Froelich notes. "They are lying on the table; the table doesn't move; they think nothing is happening," he says.
Likewise, when standard resolution is sufficient, table speed can be maximized over the length of the body, thereby boosting patient comfort.
"There are some patients who cannot tolerate standard scanning time and in those cases we have to decide the scanning time on what we expect the patient can manage," Murakami says. "With FlowMotion, we can vary the whole-body scanning time according to the patient."
Extended time can be a big issue for patients undergoing conventional scanning. If, following a whole-body scan, higher resolution is needed, an additional, dedicated acquisition of a single-bed position must be done. The patient must be positioned in the detector rings so the region of interest is inside their FOV. And another scan must be done, adding substantially to the overall exam time.

> "FlowMotion may be a relief for patients, because the patient will know the machine is performing..."
>
> Koji Murakami, MD, PhD
> Head of the Division of Nuclear Medicine,
> Department of Radiology
> Keio University School of Medicine, Keio, Japan

3 Biograph mCT Flow combines industry-leading volumetric PET resolution* with advanced CT capabilities for increased diagnostic confidence.

"This revolutionary technology (FlowMotion) offers a much more flexible approach..."

Jerry Froelich, MD
Director of Nuclear Medicine/Molecular Imaging
University of Minnesota, MN, USA

Engineered as a true dual-modality scanner, Biograph mCT Flow further enhances the patient experience by meeting all diagnostic requirements in a single imaging session. Comprehensive diagnostic CT and PET imaging can now be offered with one room, one team and one integrated system. Such clinical flexibility saves precious hospital space, cost and patient time while maximizing dual-modality utilization, patient experience and enabling business growth.

"We rarely obtain the necessary and achievable resolution of the brain when it is part of a whole- body acquisition," Frey says. "If we were to want to do a dedicated brain scan, it would require us to go back and re-image over that area. It would usually be a single-bed position and, if for some reason, the entire brain is not well centered, there could be difficulties with some of the anatomy being excluded (from the FOV)."

If the point being sampled is on the edge of the FOV, quantitative accuracy and image quality might be reduced with conventional technology. Not so with FlowMotion.

"This revolutionary technology (FlowMotion) offers a much more flexible approach to that kind of data collection," Froelich says.

The Future of PET•CT Has Arrived

By leveraging past advances in the Biograph mCT platform, Siemens blends the familiar with what is novel, transforming a long history of Siemens innovation in core PET•CT technologies into the foundation for this advanced and logical evolution of the modality, which is FlowMotion.

The confluence of these varied technologies and the engineering precision to take advantage of them has brought PET•CT solidly into the 21st century. It is a leap beyond stop-and-go, whose drawbacks were long accepted because there was no alternative. Now there is.

With Biograph mCT Flow, physicians are able to benefit from the finest* image resolution in every patient situation and every organ. Furthering their ability to understand disease, FlowMotion enables accurate and reproducible quantification in every dimension. In addition, simple and precise range planning eliminates over-scanning and its associated radiation exposure, while at the same time streamlining workflow. Biograph mCT Flow also incorporates proven solutions that support the usage of the lowest possible dose, all while scanning patients faster than ever before. Finally, FlowMotion's sense of continuous progress provides a more comfortable exam experience for every patient.

As result, the new Biograph mCT Flow enables physicians to make unprecedented progress in diagnosing and treating the most challenging diseases, in effect, redefining the clinical decision-making process. Overcoming the limitations of conventional PET/CT, Biograph mCT Flow is the end of stop-and-go.

* Based on competitive literature available at time of publication. Data on file.

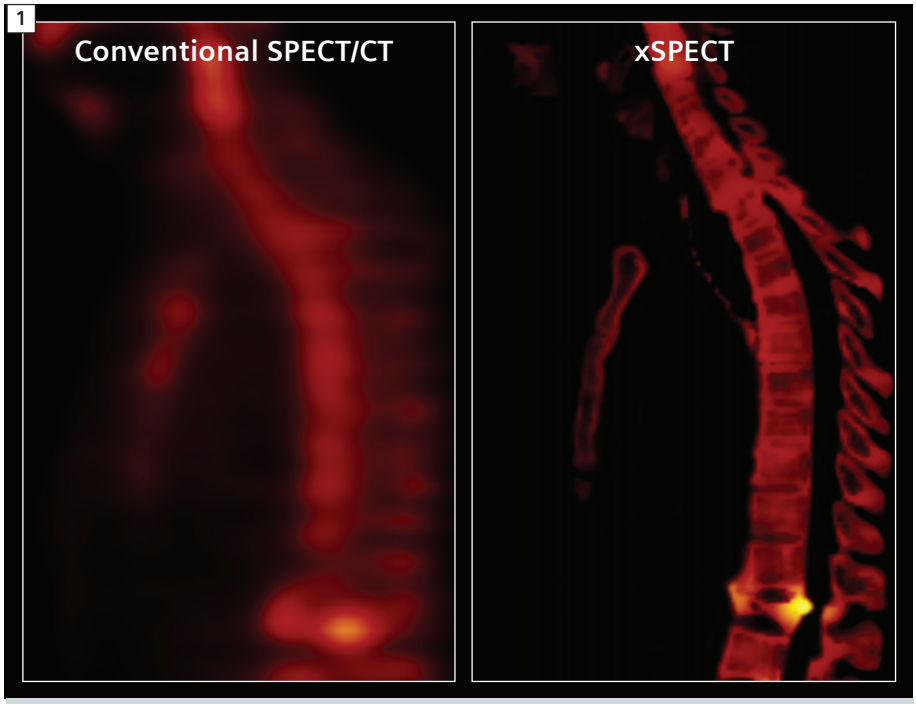
Continued from page 11

xSPECT: The Difference Between Seeing and Knowing

attenuation correction, as the CT components were incapable of delivering diagnostic information.
Siemens broke from this trend with the introduction of its Symbia T series SPECT•CT systems, which featured advanced CT components capable of delivering diagnostic information. Yet, even these did not truly integrate the two modalities.

A Change of Perspective

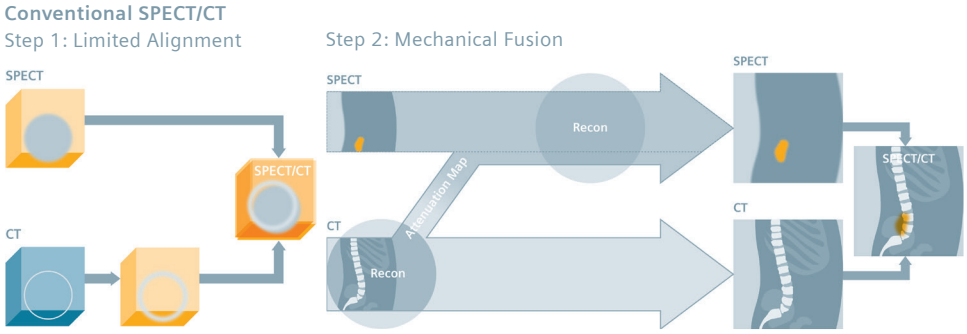
SPECT/CT has always been based on the principle of separately reconstructing images that are then mechanically fused. While this method enables basic anatomical localization of disease, the inherent misalignment of SPECT and CT prevents utilization of high-resolution CT properties during SPECT reconstruction. As a result, the physician's ability to characterize and follow disease is limited.
Precise data alignment is not possible with today's SPECT/CT scanners as the low-fidelity SPECT is always used as the starting frame of reference, forcing the degradation of CT's fine spatial resolution. The computer cannot align images that are based upon different sets of coordinates. Therefore, when reconstructing two sets of data, algorithms need to rely on a common frame of reference, defaulting to the lowest resolution, a process called "down sampling." As a result, high-resolution CT images are reduced from a 512x512 reconstruction matrix size to the lowest common denominator, typically the 128x128 matrix size of the SPECT image.
The engineering team from Siemens, understood that if SPECT and CT were to ever be truly integrated, a change of perspective is required. For over a decade SPECT has been the foundation for the reconstruction of SPECT/CT data. Perhaps therein lies the problem. If CT is known for its fine volumetric resolution, doesn't it follow that CT should be the foundation to align SPECT and CT?
As the result of more than a decade of relentless engineering, Siemens is the world's first molecular imaging company to break through this barrier, aligning SPECT and CT at the high-resolution level of the xSPECT frame of reference—powered by exclusive innovations in image acquisition and reconstruction.



1 With Symbia Intevo, physicians are now able to have more diagnostic information to aid them in differentiating cancer from other forms of disease.

xSPECT Integration

With SPECT/CT, the data from each system is acquired separately and their images are reconstructed apart from each other. The two types—SPECT and CT images—are then mechanically fused, but the data themselves are never truly merged. Consequently,the images are often viewed independent from one another and are even displayed in separate windows onscreen.
"Right now, we have to switch among the images showing CT, SPECT and fusion," Szabo says. "You really have to have a multidimensional mind because you are moving through slices of the human body and at the same time you have to think in terms of metabolic imaging."
Unlike conventional SPECT/CT, xSPECT fully integrates SPECT and CT data. Going beyond mechanical fusion,



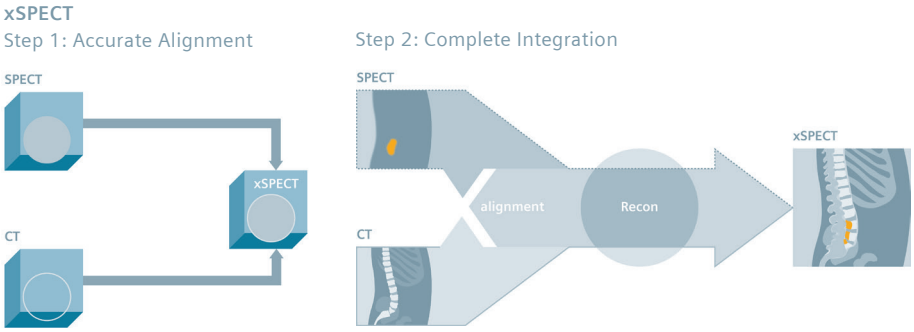
“The CT and SPECT information are truly merged [in xSPECT]to provide new information that I haven’t had before…”

Jerry Froelich, MD
Director of Nuclear Medicine and Molecular Imaging
University of Minnesota, MN, USA

Symbia Intevo uses the high-precision CT as its common frame of reference. This enables both SPECT and CT to be precisely and accurately aligned in a 256x256 high-resolution matrix size. The immediate benefit from this xSPECT alignment is a more complete and deep integration of SPECT functional information with CT’s anatomical precision. The resulting complete integration could set the standard for image quality in anatomical detail and functional clarity.
“The CT and SPECT information are truly merged [in xSPECT] to provide new information that I haven’t had before,” says Froelich.

Innovative Technologies

Underlying this precise registration of SPECT and CT data are advanced detector technologies. New, slim detectors provide improved rotational uniformity and improved energy resolution that guard against deflection during gantry rotation that can degrade tomographic resolution. A newly developed rear bed support prevents defection of the patient table, yet allows a scan length of 202 cm, longer than any conventional SPECT/CT.** This zero deflection table minimizes the use of correction models upon which conventional SPECT/CT scanners depend, models whose inability to handle non-linear deflections may result in artifacts and truncation that negatively impact image quality. Siemens’ proprietary reconstruction method, built on a conjugate-gradient iterative reconstruction algorithm, accounts for detector motion, gantry deflections, the sizes and shapes of collimator holes and the distance of the patient from the detectors.
The data from SPECT and CT acquisitions are processed using a state-of-the-art, 64-bit computer architecture, which allows high-resolution image reconstruction in a clinically acceptable time frame, thereby maintaining efficient workflow. Reconstructing the information acquired using the two modalities generates a single, high-resolution image. Details are sharp, thanks to the near perfect alignment. This allows a resolution greater than would be technically possible with the SPECT detector alone.
“Since you have a sharper image it may be easier and faster to find the lesion,” Szabo says.



See the Unseen

Conventional SPECT/CT systems may image disease, but they are poor at differentiating one disease from another or even healthy tissue from diseased. Their use may raise more questions than answers, leading physicians to order additional tests, such as MRI. This can delay treatment and increase cost.
Symbia Intevo is different. Its underlying xSPECT alignment and fundamentally improved technology have the potential to differentiate cancer from other forms of disease, even in bone, which is especially challenging for today’s conventional SPECT/CT systems.
To help in their interpretations, physicians often consider SPECT/CT exams in the context of a patient’s age, recognizing that abnormalities in the spine among older patients are typically degenerative, whereas those in the long bone are metastatic. But this is not always the case.
“You look at the spine of an older person and you see lots of abnormalities that look like degenerative change. But you can have metastatic disease in a bed of degenerative change. These are the ones that come back to bite you,” Froelich says. “We can take some of these subjective interpretations away now and make an objective interpretation because the xSPECT image contains supporting information needed to make the diagnosis.”

The key is differentiating between bone and surrounding soft tissue. This is difficult using conventional SPECT/CT, because of its poor resolution, but not Symbia Intevo, which uses high-resolution CT to provide an accurate frame of reference to precisely align SPECT and CT data. Distinctions can be drawn using a unique application context-based reconstruction.

The advanced algorithms underlying Symbia Intevo leverage attenuation coefficients to index each voxel into any of five classes: air, adipose, soft tissue, soft bone and cortical bone. These provide the basis for a patient-specific linear attenuation map that can improve the SPECT resolution and enables physicians to confidently interpret and diagnose the most challenging diseases. Being able to see that the SPECT data originate from inside the bone rather than the surrounding soft tissue allows the diagnostician to determine whether a malignancy is present. Clinical management differs significantly between the two diagnoses. And confidence in the conclusion, based on the Symbia Intevo exam alone, means additional testing might be not necessary, which means an MRI study or bone biopsy can potentially be avoided along with the added time, cost and inconvenience, not to mention, in the case of biopsy, patient discomfort.

When evaluating bone scans with xSPECT, Froelich has found cases of cancer that might have been missed if he had relied on conventional bone scans alone. "With the specificity and sensitivity from xSPECT, we may be able to characterize patients with one exam," he says. In deciding on a course of treatment, physicians must determine whether a primary tumor, for example, in the prostate or breast has metastasized, which makes a huge difference in patient management. "If there are no metastatic lesions, then the treatment is surgical; you remove the primary tumor and the patient is many times cured," Szabo says. "In the case of metastatic disease, you have to consider radiation or chemo-therapy. If the diagnosis is degenerative disease, then typically it is just prescribing pain medication if the patient suffers from pain."

Higher xSPECT image contrast and more precise lesion characterization provides physicians additional support in distinguishing between degenerative disease and cancer. This facilitates physician decision making and potentially minimizes the need for costly CT, MRI or biopsy follow-ups.

"In our practice, we want the patients to leave with an answer," Froelich says. "With xSPECT the answers are in the images themselves so I won't have to do additional studies outside of the department."

Quantify the Difference

Once the physician is able to make a confident diagnosis, a treatment plan must be defined and monitored. Inherent limitations in conventional technology have prevented SPECT/CT from producing quantitative measurements, the cornerstone of early and accurate evaluation of treatment response.

Due to their inherent misalignment of data, conventional SPECT/CT systems lack the clinical information to reliably quantify the metabolic activity. Simply put, quantitative data cannot be reliably extracted and put into the context of the conventional SPECT/CT image.

2 Symbia Intevo enables more precise lesion characterization than conventional PECT/CT bone imaging.

> "Since you have a sharper image it is expected to be easier and faster to find the lesion."
>
> Zsolt Szabo, MD, PhD
> Professor of Radiology
> Director of Nuclear Medicine/Molecular Imaging
> Johns Hopkins Hospital, Baltimore, MD, USA

Symbia Intevo* is the first system of its kind to allow easy, accurate and reproducible quantification.*

"We want to be able to monitor therapy and track what is happening to the tumor," Froelich says. "We can get the images, but the inability to quantify the data causes a lot of variability in our measurements."
Symbia Intevo provides accurate quantification by integrating SPECT counts per voxel with CT's volumetric tissue density. The precise xSPECT alignment of SPECT and CT data by Symbia Intevo makes tracer quantification possible. Accuracy and reproducibility is ensured through quality control using a precision ^{57}Co source unique to Siemens, which provides confidence that the quantitative measures are accurate and consistent over time. This combined with the most advanced reconstruction in nuclear medicine today, enables Symbia Intevo to deliver fully quantitative measurements of the region of interest. These measurements can be translated in units of Bq/ml, standard uptake values, counts per voxel and HU values.
"We have the potential to be more accurate in assessing disease severity through quantification," says Szabo. "And we will be able to quantify the response to therapy."
The improved image quality possible with xSPECT should provide very exact data sampling.

"I expect we will be able to place the cursor on the region very accurately, so we don't cross boundaries between the bone and soft tissue when we are doing the analysis," he says.
Much of Bartenstein's research has involved the quantitative assessment of radionuclide uptake as a means for planning radiation therapy. Because SPECT/CT has been incapable of such quantitative measurements, he has used PET/CT. But this could change with xSPECT. "We think that xSPECT will go beyond the classic SPECT to allow this," he says.
As experience with xSPECT increases and the knowledge grows, the understanding of values representing normal and abnormal will naturally increase. In this way, CT may do for xSPECT what it has done for PET/CT by allowing absolute quantification of metabolic data.

Adapt the Lowest Dose

In molecular imaging, physcians strive to expose patients to the lowest possible dose of radiation, while delivering diagnostic quality images. Symbia Intevo utilizes a wide range of technologies to rein in dose.
With CARE, Siemens has been highly successful integrating many innovations into its systems that significantly reduce radiation dose compared to conventional SPECT/CT systems. CARE Dose 4D™ for instance uses a patient topogram to tailor radiation dose coming from the CT to fit the size and shape of the patient. The software varies the CT tube current according to the size of the patient and the density of body regions. For example, larger patients receive more dose than smaller patients, just as the shoulders get more dose than the thorax. Tube current is further refined in real time as the scanner plots moment-to-moment attenuation of the CT beam, adjusting current according to body regions as well as different beam angles that occur as the tube rotates around the patient.
Whereas conventional SPECT/CT systems deliver only one tube voltage, typically 120 kV, Symbia Intevo offers a range from 80 to 130 kV. The lower settings permit markedly lower patient radiation exposures. A tube voltage of 80 kV for cardiac attenuation correction, for example, reduces the dose as much as 74 percent compared with a conventional exposure at 120 kV.**
By offering automated dose modulation, flexible CT protocols and unique collimator design, Symbia Intevo enables up to 74 percent** lower CT radiation and up to 26 percent** reduction in injected dose to reduce long-term patient radiation risk.

Double the Throughput

Time affects all aspects of daily imaging from patient comfort to staff productivity. Conventional SPECT/CT systems rely on manual procedures to ensure their proper function. These procedures typically run during the day, absorbing technologists' time and impeding workflow. Symbia Intevo has the potential to boost throughput through quality control procedures that run automatically overnight, generating a report for technologists to review the following morning. This Automatic Quality Control (AQC) saves up to an hour each day and ensures that Symbia Intevo is always

Symbia Intevo enables up to 74 percent** lower CT radiation and up to 26 percent** reduction in injected dose to reduce long-term patient radiation risk.

ready to scan. And because AQC does not involve the handling of the open radioactive sources, there is minimal risk of open-source spillage or exposure of technologists to radiation during quality control procedures they would otherwise have to perform on conventional SPECT/CTs.

The Symbia Intevo also automates the exchange of collimators. A single click saves technologists up to five minutes per exchange. An auto-contouring feature uses infrared sensors to optimize detector-to-patient distance during the scan, maximizing SPECT resolution while sparing technologists the need to manually position detector heads.

Scan speeds are optimized by using Siemens AUTOFORM collimators. Their proprietary design provides uniform septa wall thickness, which increases sensitivity by 26 percent, thereby accelerating scan time.

> "Once we get the word out and people see what xSPECT can do, they are going to demand it as part of their care."
>
> Jerry Froelich, MD
> Director of Nuclear Medicine and Molecular Imaging
> University of Minnesota, MN, USA

Furthermore, cardiac scans can be performed in four minutes without sacrificing image quality through the use of IQ•SPECT Ultra-fast Cardiac. **SMART**ZOOM collimators magnify the heart, quadrupling sensitivity and accelerating the scan. Advanced detector robotics onboard Symbia Intevo help ensure that the detectors precisely orbit the heart, just as the system's conjugate-gradient iterative reconstruction algorithm correlates this orbital path to the geometry of the 48,000 collimator holes to precisely map the counts in 3D space.

By combining all of Symbia Intevo's unique productivity features, institutions have the potential to realize up to 50 percent time savings and, subsequently, the potential to double patient throughput.

“Because we can much better locate the lesion and get a better idea of the extent of the lesion, xSPECT can improve diagnostic confidence.”

Peter Bartenstein, MD
Chairman, Department of Nuclear Medicine
Ludwig-Maximillians University, Munich, Germany

The Difference Between Seeing and Knowing

Despite limitations of conventional scanners, patients—particularly the families of pediatric patients—increasingly have been coming to the nuclear medicine department at the University of Minnesota asking for SPECT/CT, according to Froelich.

“They have done the research and know they can get better information with SPECT/CT,” he says. “What they don’t realize yet is that xSPECT will give them even more information.”

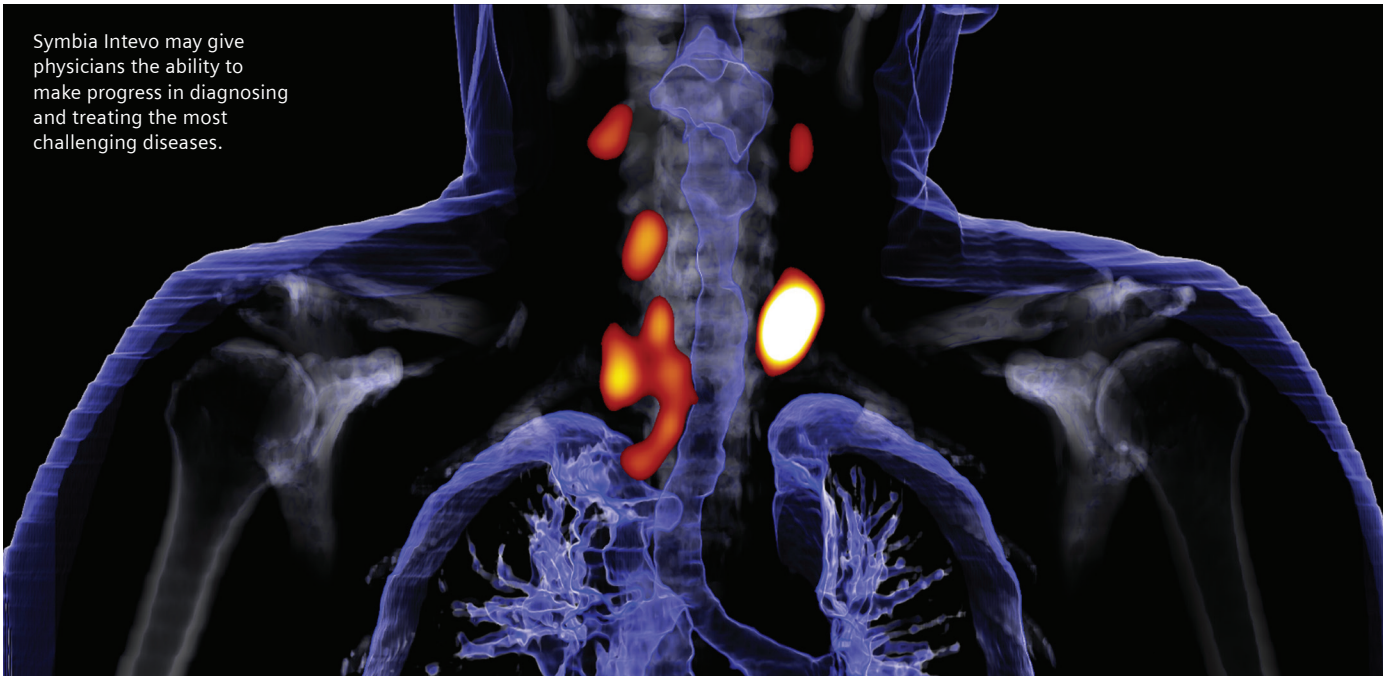
Symbia Intevo and the new modality it represents could turn into a marketing tool for the department, according to Froelich.

“Once we get the word out and people see what xSPECT can do, they are going to demand it as part of their care,” he says. Now, more than ever, with the Symbia Intevo xSPECT series, healthcare practitioners have the potential to find the abnormalities early and, more importantly, effectively characterize disease and monitor treatment response, thus setting a new standard in diagnostic imaging. Symbia Intevo, the world’s first xSPECT system makes the difference between seeing and knowing.

* xSPECT, Symbia Intevo, and xSPECT Quantification is not licensed according to Canadian law, is pending 510(k) clearance, and is not yet commercially available in Canada, the United States or in all countries worldwide. Due to regulatory reasons, its future availability cannot be guaranteed. Please contact your local Siemens organization for further details.

** Based on competitive literature available at time of publication. Data on file.

The statements by Siemens’ customers described herein are based on results that were achieved in the customer’s unique setting. Since there is no “typical” hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption) there can be no guarantee that other customers will achieve the same results.



Symbia Intevo may give physicians the ability to make progress in diagnosing and treating the most challenging diseases.