
PHILIPS
Imalytics Research Workstation
From images to
insights

Imalytics

at a glance

Standard medical workstations are very constrained and usually unsuitable for research workflows.

In order to attend the growing demand for a dedicated research workstation able to address the challenges of medical-imaging-based workflows, Philips has launched Imalytics.

Imalytics is a powerful and flexible workstation for obtaining valuable results from your medical-imaging-based research workflows. It allows you to go from images to insights in an intuitive and efficient way.

The major asset of Imalytics is its flexibility.

- All algorithms and tools can be flexibly used and combined
- Several proprietary and non-DICOM formats are supported
- Any defined Volumes of Interest can be evaluated on images from different points-in-time or modalities, or even on different patients throughout all modules
- Users have access to state-of-the-art algorithms and tools and they can even integrate their own algorithms (programmed in C++)
- It can be integrated in any DICOM network
- Results are reproducible, thanks to automated algorithms and customized workflows

Additionally, specialized modules for specific research questions can be flexibly added on demand:

VOXULUS
Accurate pharmacokinetic modeling at high computation speed

STRATOS
Intuitive 2D and 3D image-based solution for voxelized dosimetry in radionuclide therapy

CAD4D
State-of-the-art brain metabolism evaluation for FDG or Amyloid PET

MULTIVIEWER
Comprehensive longitudinal reviews at a glance

MODEL BASED SEGMENTATION
Research Framework for the fully automatic organ segmentation in multimodal images

PVC
Complete platform for importing, visualizing, processing and managing MPI data

The basic Imalytics system offers several toolboxes for registration, segmentation, processing, visualization and quantitative measurements on images, featuring:

Advanced image visualization

- image data display in orthogonal planes
- comprehensive environment for fused multimodality visualization in 2D and 3D multiparametric analysis
- configurable presentation states
- quantitative measurement tools
- multiple quantification units for all supported modalities

Automatic rigid and non-rigid co-registration

- Translation
- Rigid: translation + rotation
- Affine: translation + rotation + scaling + skewing
- BSpline: elastic registration*
- Landmark: rigid registration based on defined landmarks (anatomical or fiducial markers)

Automatic and semiautomatic segmentation tools

- manual contour drawing with linearly or Bezier interpolated curves
- thresholding
- region growing
- clustering
- hole filling
- island removal
- splitting
- PET tumor segmentation
- directional morphological operators
- logical operators (AND, OR, WITHOUT)
- computation of volume statistics for segmented objects

State-of-the-art image processing algorithms (freely combinable)

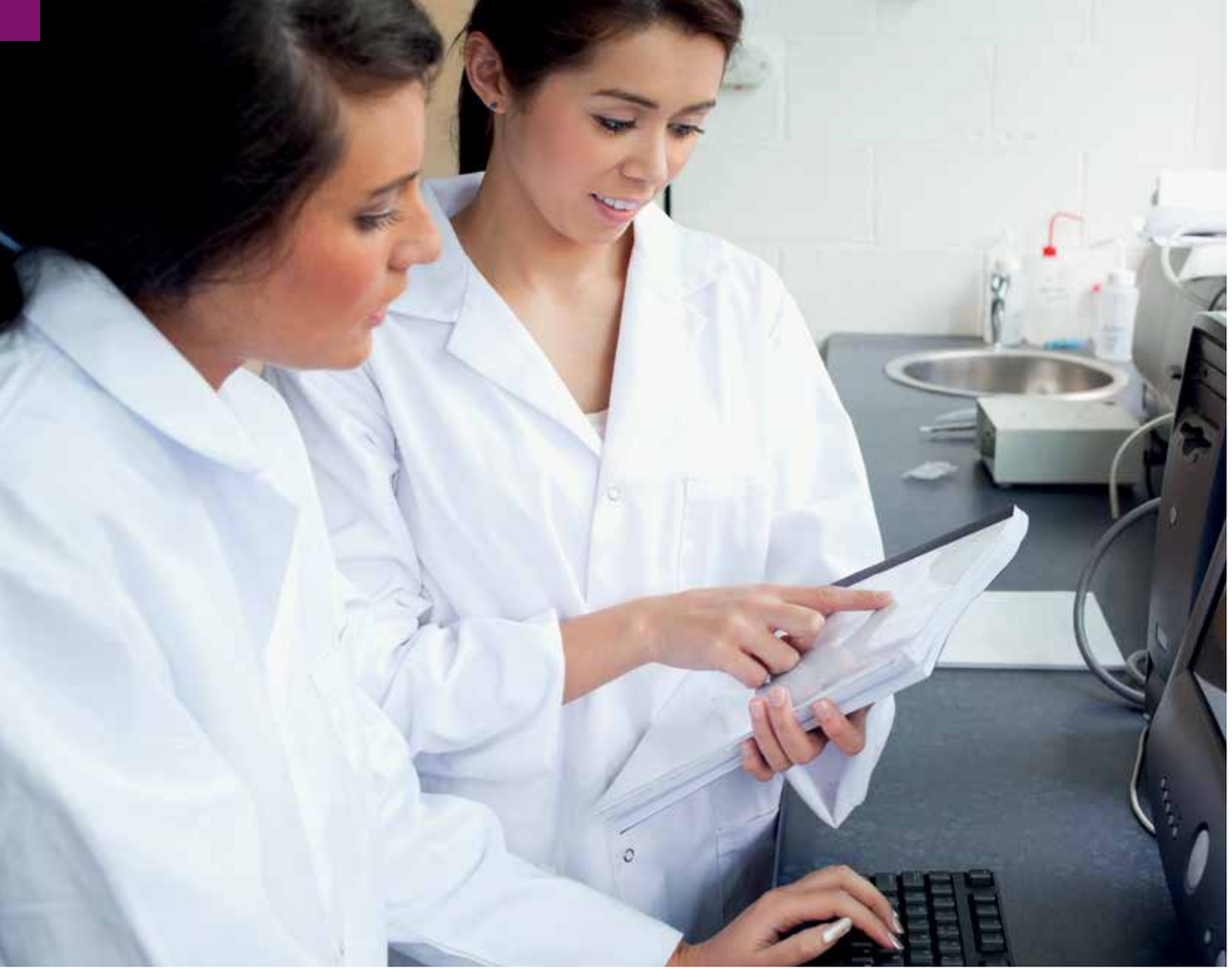
- cropping, flipping, extraction of volumes
- mathematical operations on multiple images
- filtering: smoothing, sharpening, edge detection, gradients, noise suppression, resampling, ...
- signal-to-noise ratio
- phase extraction from dynamic data
- MR bias field correction
- transform propagation
- concatenation of static images to dynamic series
- computation of dynamic features
- C++ interface for addition of your own Algorithms

* For elastic registration, Imalytics relies on *elastix*, the ultimate tool for multimodal image registration tasks. To learn more about *elastix*, please refer to: S. Klein, M. Staring, K. Murphy, M.A. Viergever, J.P.W. Pluim, “**elastix: a toolbox for intensity based medical image registration**”, *IEEE Transactions on Medical Imaging, vol. 29, no. 1, pp. 196 - 205, January 2010* or visit their website http://elastix.isi.uu.nl/

Use cases

A state-of-the-art solution for every research case

- pharmacokinetic modeling of dynamic data (Voxulus)
- oncology (metabolism, hypoxia, apoptosis, proliferation, angiogenesis)
- neurology (brain receptor density, binding potential)
- cardiology (myocardial perfusion, absolute blood flow, coronary flow reserve, viability)
- biodistribution studies of new drug candidates (Voxulus)
- dosimetry in targeted radionuclide therapy (Stratos)
- radio-iodine therapy, SIRT, radio-peptide therapy, antibody therapy
- dementia evaluation with FDG or amyloid tracer (CAD4D)
- serial analysis (MultiViewer)
- therapy follow up analysis, disease progression
- multimodal and multipara-metric data analysis
- model based segmentation (organ specific models)
- partial volume correction (PVC) translational research



Voxulus

Pharmaco-kinetic modeling

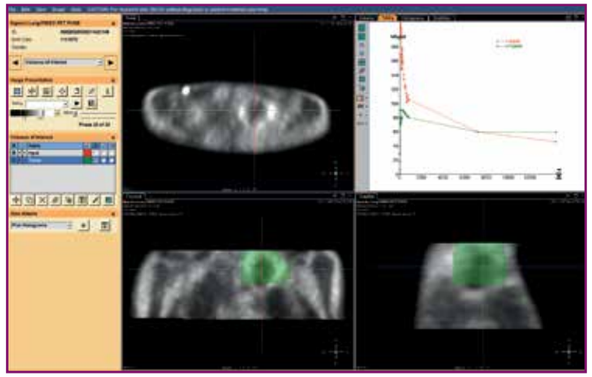
Voxulus is a pharmacokinetic modeling research software, which allows you to obtain quantitative parameters from dynamic imaging data. The available models support your research in many areas, including studies of metabolic processes, hypoxia, cell proliferation, perfusion and receptor binding studies.

Key features of Voxulus:

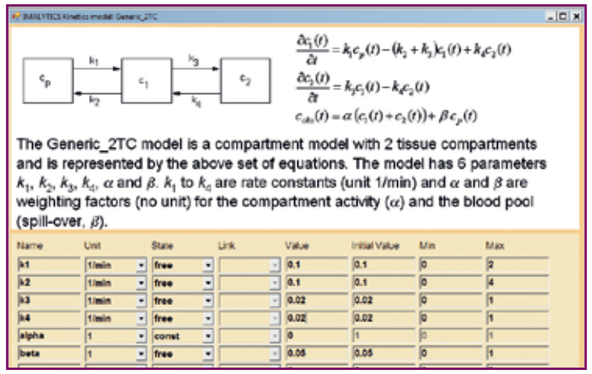
- efficient computation of parametric maps based on fully analytical mathematical solutions
- voxel-wise and regional parameter estimation
- statistical analysis of modeling results, correlation plots and histograms
- full control over model parameters setup
- flexible combination of models for input and target function
- possibility to define your own analysis protocols

Available compartment models include:

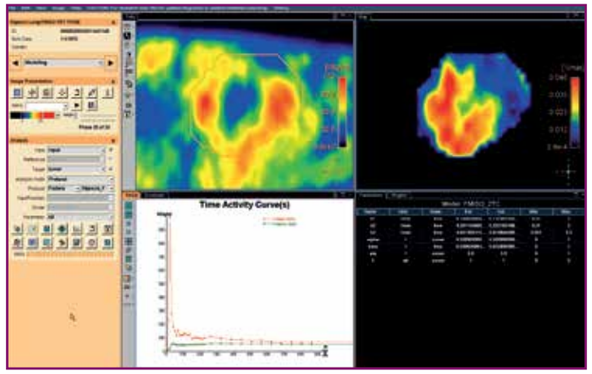
- generic 1 and 2-tissue compartment models
- blood flow models with 1 and 2-tissue compartments
- FMISO/FAZA 2 and 3-tissue compartment models
- Lammertsma and simplified Lammertsma reference tissue models
- mono-exponential ADC model



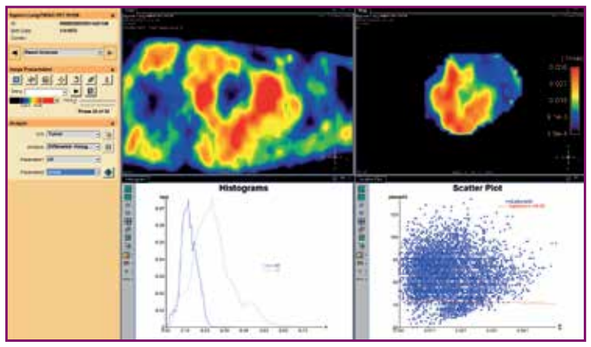
Dynamic PET data and Time-Activity-Curves for the target and input function region



Compartment model setup window



Parametric map calculated by fitting the compartment model to the data



Statistical analysis of the parameter results (scatter plot and histogram)

Publications

Image-guided PO2 probe measurements correlated with parametric images derived from 18F-fluoromisonidazole small-animal PET data in rats.
Bartlett RM, Beattie BJ, Naryanan M, Georgi JC, Chen Q, Carlin SD, Roble G, Zanzonico PB, Gonen M, O'Donoghue J, Fischer A, Humm JL.
J. Nucl. Med, Volume 53, Issue 10, October 2012, Pages 1608-1615

Pharmacokinetic analysis of hypoxia (18)F-fluoromisonidazole dynamic PET in head and neck cancer.
Wang W, Lee NY, Georgi JC, Narayanan M, Guillem J, Schöder H, Humm JL.
J. Nucl. Med, Volume 51, Issue 1, January 2010, Pages 37-45

Evaluation of a compartmental model for estimating tumor hypoxia via FMISO dynamic PET imaging.
Wang W, Georgi JC, Nehmeh SA, Narayanan M, Paulus T, Bal M, O'Donoghue J, Zanzonico PB, Schmidtlein CR, Lee NY, Humm JL.
Phys. Med. Biol, Volume 21, Issue 54, 21 May 2009, Pages 3083-3099

The quantification of dynamic FET PET imaging and correlation with the clinical outcome in patients with glioblastoma.
Thiele F, Ehmer J, Piroth MD, Eble MJ, Coenen HH, Kaiser HJ, Schaefer WM, Buell U, Boy C.
Phys. Med. Biol, Volume 54, Issue 18, 2009, Pagea 5525-5539

Evaluation of non-uniform weighting in non-linear regression for pharmacokinetic neuroreceptor modelling.
Thiele F, Buchert R.
Nucl. Med. Commun, Volume 29, Issue 2, February 2008

The simplified reference tissue model for SPECT/PET brain receptor studies. Interpretation of its parameters.
Buchert R, Thiele F.
Nuklearmedizin, Volume 47, Issue 4, 2008, Pages 167-174

Ecstasy-induced reduction of the availability of the brain serotonin transporter as revealed by [11C](+) McN5652-PET and the multi-linear reference tissue model: loss of transporters or artifact of tracer kinetic modelling?
Buchert R, Thiele F, Thomasius R, Wilke F, Petersen K, Brenner W, Mester J, Spies L, Clausen M.
J. Psychopharmacol, Volume 21, August 2007, Pages 628-634

Stratos

Dosimetry Solution

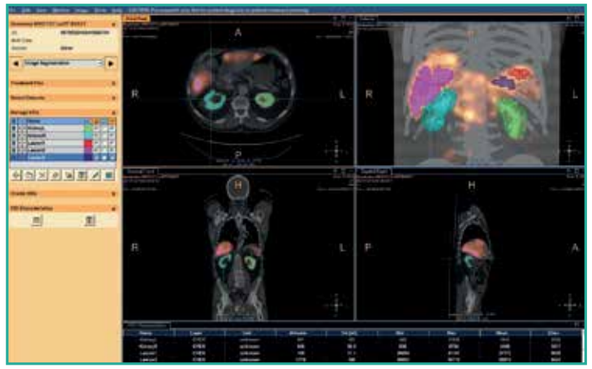
The STRATOS Dosimetry Solution is an advanced research software package for 3D voxelized dose calculation in nuclear medicine, using SPECT/CT and PET/CT data. It allows the calculation and visualization of patient-specific dose maps for targeted radionuclide therapies.

Key features of the Stratos Dosimetry Solution:

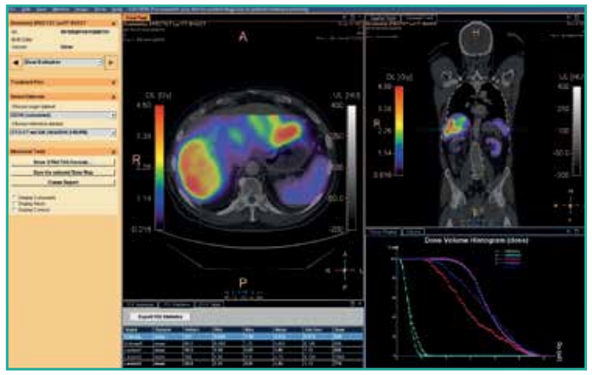
- complete workflow for multiple 3D images, including registration, segmentation and visualization
- calculation of voxel-wise residence-time maps
- calculation of voxel-wise energy-dose distributions using a Dose-Volume-Kernel approach according to MIRD pamphlet 17
- supported therapy isotopes: ^{131}I, ^{90}Y, ^{177}Lu, ^{166}Ho, ^{188}Rh, ^{32}P, ^{153}Sm (others on request)
- support for all SPECT and PET imaging isotopes, enabling both prospective as well as retrospective studies
- calculation of dose statistics and Dose-Volume-Histograms per region
- tissue density correction based on the CT scan
- HTML report with key results and images from the analysis

Additionally, you can also use planar images as input for the calculation of 3D maps in dosimetry imaging procedures. This means that you can adapt the analysis to your clinical workflow and use a combination of 3D scans and planar images, considerably shortening the overall imaging time.

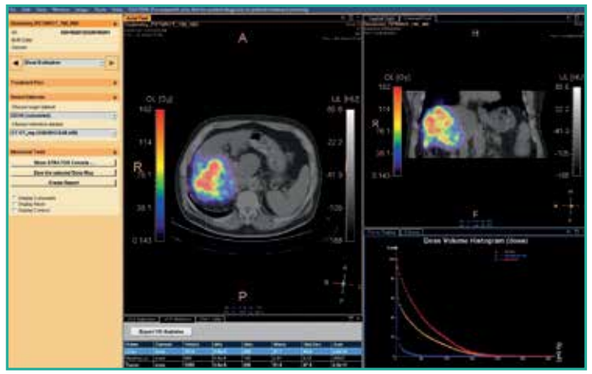
Note: STRATOS is an additional module for Imalytics sold separately



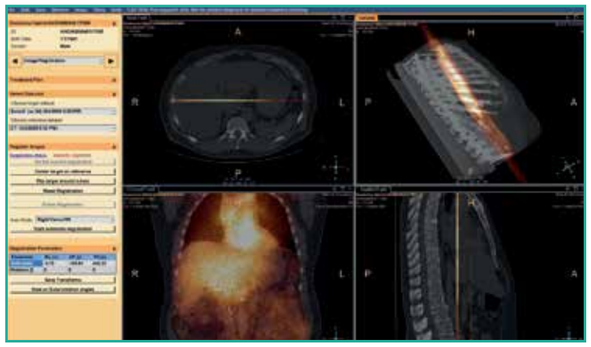
3D VOI definition on SPECT/CT images for a ^{177}Lu-DOTATOC therapy case



3D dose map fused with CT data; dose statistics and dose-volume-histogram for a ^{177}Lu-DOTATOC therapy case



3D dose map fused with CT data; dose statistics and dose-volume-histogram for a ^{90}Y SIRT case



Registration of a planar scintigraphy image to a 3D CT in Stratos+

Publications

Study-Parameter Impact in Quantitative 90-Yttrium PET Imaging for Radioembolization Treatment Monitoring and Dosimetry.
Goedicke A, Berker Y, Verburg FA, Behrendt FF, Winz O, Mottaghy FM.
Medical Imaging, Volume 32, Issue 3, March 2013, Pages 485-492

Activity quantification combining conjugate-view planar scintigraphies and SPECT/CT data for patient-specific 3-D dosimetry in radionuclide therapy.
Berker Y, Goedicke A, Kemerink GJ, Aach T, Schweizer B.
Eur. J. Nucl. Med. Mol. Imaging, Volume 38, Issue 12, December 2011, Pages 2173-2185

Dosimetry in molecular nuclear therapy.
Wierts R, de Pont CD, Brans B, Mottaghy FM, Kemerink GJ.
Methods, Volume 55, Issue 3, November 2011, Pages 196-202

Evaluation of voxel-based dosimetry for targeted radionuclide therapies in phantom studies.
Schweizer B, Schaefer A, Donsch P, Kremp S, Gouverneur E, Farmakis G, Grgic A, Bal M, Kirsch CM, Hellwig D.
Eur. J. Nucl. Med. Mol. Imaging, Volume 36, Issue 2 Supplement, September 2009, Page 428

CAD4D

Brain metabolism evaluation

CAD4D FDG

CAD4D FDG is a powerful tool for advanced and intuitive analysis of FDG-PET brain images in Research work, featuring:

- advanced non-rigid stereotactical normalization of FDG-PET brain scans
- voxel-wise statistical maps for detecting regions of statistically significant hypo and hyper-metabolism
- interactive adjustment of significance level
- stereotactic surface projection for simplified viewing
- quantitative comparison of detected patterns to databases for specific diseases*
- tools for verification and quality assurance
- overlay of FDG-PET and T1-MRI, optimized for visualization of the temporal lobe and hippocampus

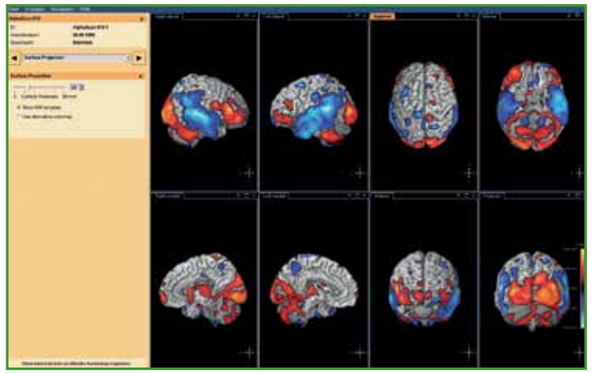
CAD4D Amyloid

The CAD4D Amyloid application allows you to easily asses and visualize the amyloid plaque levels in brain scans, featuring:

- advanced non-rigid stereotactical normalization of amyloid brain scans
- regional and voxel-wise SUV ratios relative to the mean SUV in cerebellum
- stereotactic surface projection for simplified viewing
- tools for verification and quality assurance
- overlay of amyloid PET and T1-MRI, optimized for visualization of the temporal lobe and hippocampus

* Definition of your own databases available in combination with a Premium service contract.

Voxel-wise statistical maps of glucose hypo (blue) and hyper-metabolism (red) in the brain



Surface projection of areas with hypo and hyper-metabolism on a MRI template of the brain

PET/MRI fusion view

Calculation of Amyloid SUV ratios per voxel and for relevant anatomical structures in the brain

Publications

Voxel-based classification of FDG PET in dementia using inter-scanner normalization.
Thiele F, Young S, Buchert R, Wenzel F.
NeuroImage Volume 77, 15 August 2013, Pages 62-69

B-spline-based stereotactical normalization of brain FDG PET scans in suspected neurodegenerative disease: impact on voxel-based statistical single-subject analysis.
Wenzel F, Young S, Wilke F, Apostolova I, Arlt S, Jahn H, Thiele F, Buchert R.
NeuroImage Volume 50, Issue 3, 15 April 2010, Pages 994-1003

Association between FDG uptake, CSF biomarkers and cognitive performance in patients with probable Alzheimer's disease.
Arlt S, Brassen S, Jahn H, Wilke F, Eichenlaub M, Apostolova I, Wenzel F, Thiele F, Young S, Buchert R.
Eur. J. Nucl. Med. Mol. Imaging Volume 36, Issue 7, July 2009, Pages 1090-1100

MultiViewer

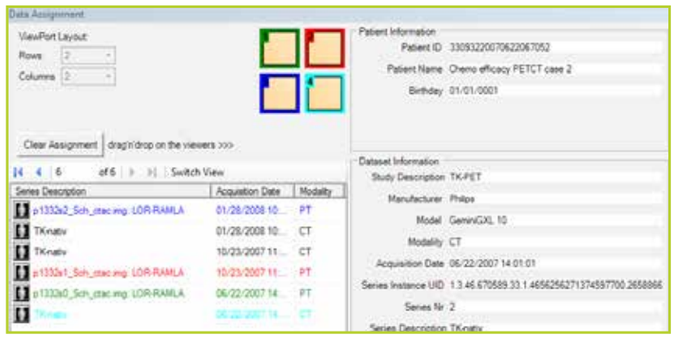
Multimodality and multi-time analysis

The MultiViewer application is a powerful research tool for simultaneous viewing and analysis of multimodality imaging data, including the handling and analysis of volumes of interest (VOIs). The data can for example be acquired at different points in time, on different modalities or using different acquisition protocols or sequences.

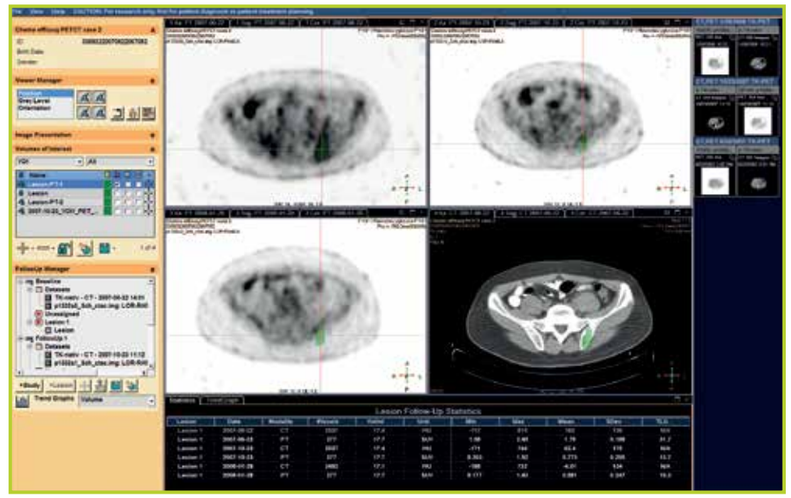
The VOIs can be edited fast and reliably and their status concerning size and biological properties can be analyzed over time. MultiViewer is therefore ideally suited for your longitudinal study tasks, like follow-up studies and early prediction of treatment response.

Key features of MultiViewer:

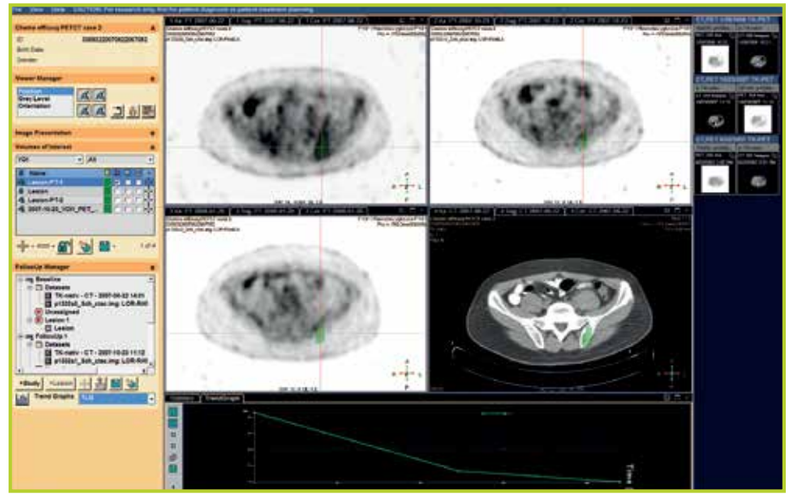
- viewing of multiple DICOM image series of different modalities for a side-by-side comparison
- linking of viewers for scrolling, zooming, panning and image presentation settings
- adjustable viewer layout
- display, delineation and tracking of VOIs on different image modalities and/or at different points in time
- a variety of VOI quantifications and statistics calculations, including size progression and volume histogram



Data manager for assigning datasets to individual viewers



Lesion statistics for a follow-up study



Total lesion glycolysis trend graph for a follow-up study

Multi-modal data evaluation for a TAVI case: CTA, native CT for calcium scoring, XperCT with LV-injection, whole heart MR

Model based segmentation

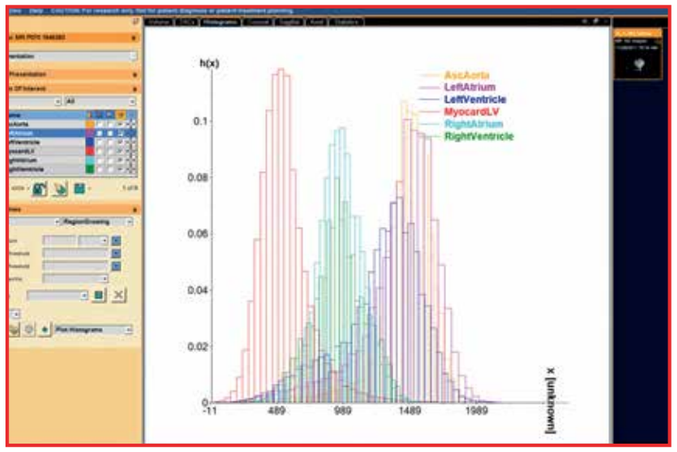
The Model Based Segmentation Framework provides you with the infrastructure for fully automatic segmentation of organs and their substructures in multi-modal images for research purpose. This is achieved by applying a generic organ model to the images of a specific case.

The segmentation is performed very efficiently, delivering quantitative and reproducible results.

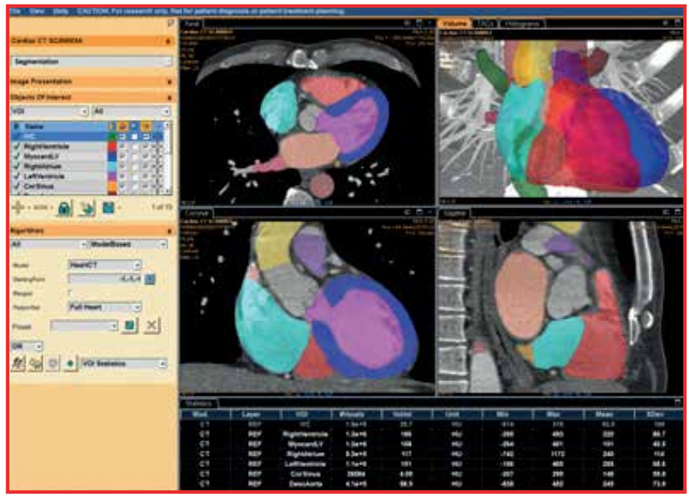
Currently available organ models:

- heart model for MRI
- heart model for CTA
- prostate model for MRI

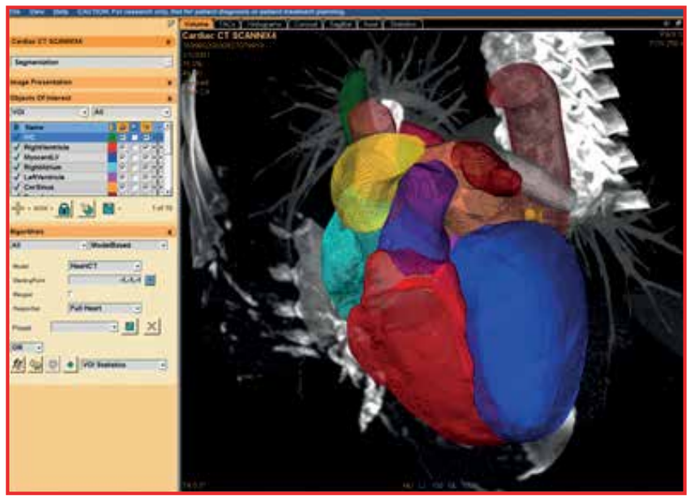
Other specific models can be developed upon customer request.



Histogram of the MRI signal distribution for the segmented anatomical substructures



Segmentation of the heart using the cardiac model for CTA



3D mesh representation of the heart segmentation on CTA data

Segmentation of the heart using the cardiac model for MRI

Publications

Automatic whole heart segmentation in static magnetic resonance image volumes.
Peters J, Ecabert O, Meyer C, Schramm H, Kneser R, Groth A, Weese J.
Med Image Comput, Volume 10, 2007

Automatic model-based segmentation of the heart in CT images.
Ecabert O, Peters J, Schramm H, Lorenz C, von Berg J, Walker MJ, Vembar M, Olszewski ME, Subramanyan K, Lavi G, Weese J.
Medical Imaging, Volume 27, Issue 9, September 2008, Pages 1189-1201

Optimizing boundary detection via Simulated Search with applications to multi-modal heart segmentation.
Peters J, Ecabert O, Meyer C, Kneser R, Weese J.
Medical Image Analysis, Volume 14, Issue 1, February 2010, Pages 70-84

Segmentation of the heart and great vessels in CT images using a model-based adaptation framework.
Ecabert O, Peters J, Walker MJ, Ivanc T, Lorenz C, von Berg J, Lessick J, Vembar M, Weese J.
Medical Image Analysis, Volume 15, Issue 6, December 2011, Pages 863-876

Partial Volume Correction

Partial Volume Correction modifies volume-of-interest statistics in order to compensate the Partial Volume Effect. It ensures the proper quantification of objects taking into account spill-over and spill-in between regions.

Following correction methods are available:

Recovery-Coefficients-Method

The Recovery Coefficients Method corrects the volume-of-interest measurement using a correction factor based on the volume. A reference table with these factors for different volumes is used and interpolated for the specific correction factor to be applied.
Different sets of recovery coefficients can be specified in a configuration file and then be selected within the application.

Geometric-Transfer-Matrix-Method

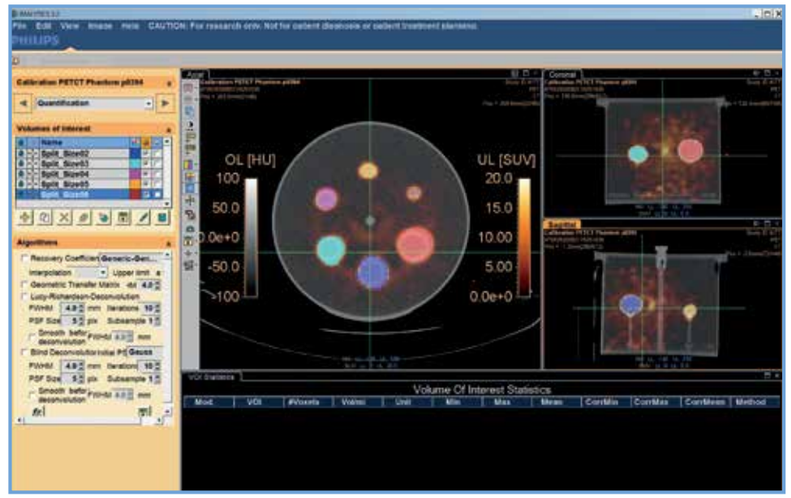
The Geometric Transfer Matrix Method calculates recovery and cross-contamination factors of volumes-of-interest in the image. These geometry-dependent transfer coefficients form a matrix representing the fraction of true activity from each volume-of-interest observed in any other volume-of-interest. This matrix can be inverted to correct for Partial Volume Effects, independent of the tracer concentrations in each volume-of-interest.

Lucy-Richardson-Deconvolution

Lucy-Richardson Deconvolution estimates a corrected image first and then evaluates the volume-of-interest on the corrected image. The corrected image is estimated in an iterative fashion starting with the acquired image. It takes into account the point-spread-function of the imaging system as well.

Blind-Deconvolution

Blind Deconvolution is an extension of the Lucy-Richardson Deconvolution where both the corrected and the point-spread-function (PSF) are estimated. The volume-of-interest is evaluated on the corrected image as for Lucy-Richardson. The corrected image and the PSF are estimated in an iterative fashion starting with the acquired image and initial PSF.



Selection of volumes-of-interest for the computation of the partial volume correction

Output table showing the corrected statistics for the selected volumes of interest

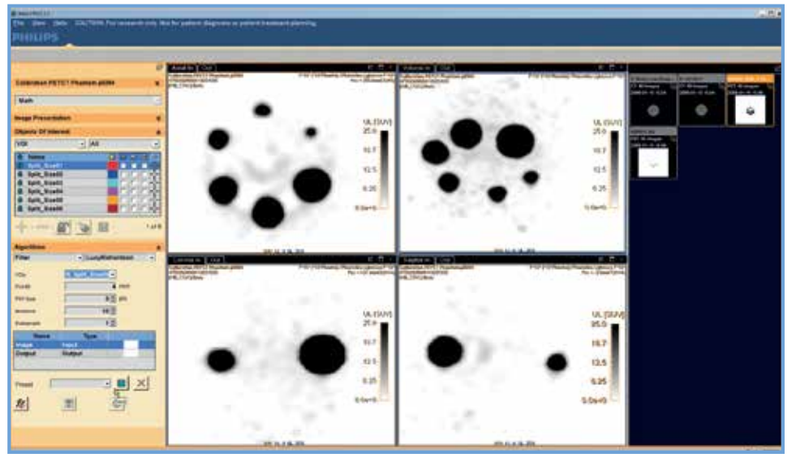


Image based partial volume correction using the Lucy-Richardson algorithm as a prerequisite for accurate lesion quantification

www.philips.com/imalytics

Caution: For data research only. Not for patient diagnosis or patient treatment planning

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