



Clinical Applications 2 Application Guide

syngo
speaking

syngo 3D
syngo Fly Through
syngo Colonography
syngo InSpace4D
syngo Vessel View

Software Version VB10

SIEMENS
medical

Dear SOMATOM user,

We would like to present you our application guide for clinical applications. To improve future versions of this application guide we would highly appreciate your questions, suggestions, and comments. The information presented in this application guide is for illustration only and is not intended to be relied upon by the reader for instruction as to the practice of medicine.

Any health care practitioner reading this information is reminded that they must use their own learning, training, and expertise in dealing with their individual patients. This material does not substitute for that duty and is not intended by Siemens Medical Solutions Inc., to be used for any purpose in that regard.

The drugs and doses mentioned herein are consistent with the approval labeling for uses and/or indications of the drug. The treating physician bears the sole responsibility for the diagnosis and treatment of patients, including drugs and doses prescribed in connection with such use. The Operating Instructions must always be strictly followed when operating the CT System. The source for the technical data is the corresponding data sheets.

The pertaining operating instructions must always be strictly followed when operating a SOMATOM scanner. The statutory source for the technical data are the corresponding data sheets. We express our sincere gratitude to the many customers who contributed valuable input. Special thanks to Daniel Rinck, Oliver Hauenstein, Christian Asbeck, Richard Beier, Lutz Gündel, Alan Bowman, Axel Barth, Christiane Bredenhoeller, Kristin Pratt and the CT-Application Team for their valuable assistance.

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Matrix

	<i>syngo</i> 3D	<i>syngo</i> VRT	<i>syngo</i> Fusion
SOMATOM Emotion	○	●	●
SOMATOM Emotion Duo	○	●	●
SOMATOM Emotion6	○	●	●
SOMATOM Sensation 10	○	●	●
SOMATOM Sensation 16	○	●	●
SOMATOM Sensation Cardiac	○	●	●

○ *Standard*

● *Option*

– *not available*

depending on the system configuration.

Please contact the local Siemens representative for further information.

<i>syngo</i> Fly Through	<i>syngo</i> Colonography	<i>syngo</i> InSpace4D	<i>syngo</i> Vessel View
●	—	●	●
●	●	●	●
●	●	●	●
●	●	●	●
●	●	●	●
●	●	●	●

User Documentation

For further information about the basic operation, please refer to the corresponding *syngo* CT Operator Manual:

***syngo* CT Operator Manual**

Volume 1:

Security Package

Basics

Preparations

Examination

HeartView CT

CARE Bolus CT

CARE Vision CT

***syngo* CT Operator Manual**

Volume 2:

syngo Patient Browser

syngo Viewing

syngo Filming

syngo 3D

***syngo* CT Operator Manual**

Volume 3:

syngo Data Set Conversion

syngo Calcium Scoring

syngo Dental CT

syngo Dynamic Evaluation

syngo Osteo CT

syngo Perfusion CT

syngo Pulmo CT

syngo Volume

***syngo* CT Operator Manual
Volume 4:**

syngo Colonography

syngo InSpace 4D

syngo LungCARE CT

***syngo* CT Operator Manual
Volume 5:**

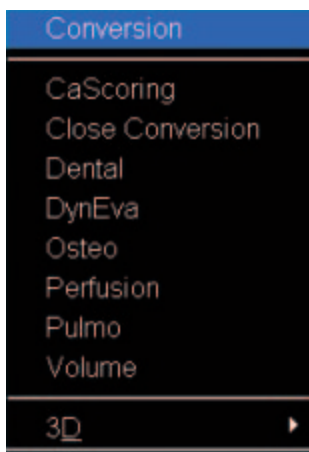
syngo Argus

syngo Vessel View

Image Converter

The **CT Application Common DICOM Adapter** provides conversion between different DICOM data sets as they may be provided by other CT vendors.

- You will find the converter in the Application menu of the PatientBrowser.



In the pop-up window you can select for which application you want to convert the images. After conversion you can load these datasets in the application of your choice.



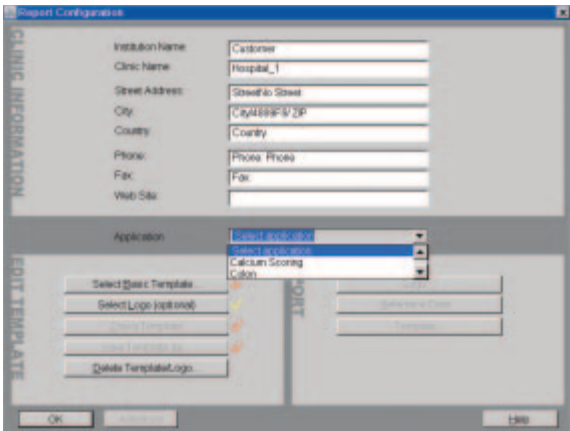
Report Template Configuration

Under Options/Configuration you will find the Report Template Configuration.

With the Report Configuration you can edit the basic information, e. g. hospital information for your report templates of the applications:

- CalciumScoring
- Colon
- LungCARE

Additionally you can insert your logo and select which reference data you want to use.



File Browser

The File Browser provides the ability to access and to manage your created files:

- Copy images and files to the CD Burn folder
- Access to all created reports and movies (AVI files)
- Access to the Offline folder
- Access to downloaded files

Open the File Browser via main menu entry Options – File Browser.

The File Browser provides special folders for our applications. Therein the created reports and movies are saved.

With an external PC connected you can access your offline data on the external PC for postprocessing.

1. Transfer files to floppy:

- Select the desired files and send them via the right mouse button menu on a floppy disk.

2. Burn on CD:

- Select the desired files and drag&drop them into the folder "Burn on CD" (or send them via the right mouse button menu to the folder "Burn on CD").
- Open the "LocalJobStatus" in the PatientBrowser and clear all entries.
- Select "Record to Offline" in the Transfer menu of the PatientBrowser.
- CD burning starts.
- Hint: CD burning of offline files is only possible in Single session.

3. Review reports and movies:

- Select the desired files and doubleclick on them.
- The corresponding program, e. g. Movie Media Player will be opened and you can review what you have saved.
- Now you can send these files to floppy or burn it on CD.

Hint

Files with the following extensions can not be started/
opened from the FileBrowser

**".bat", ".cmd", ".com", ".exe", ".reg", ".dot", ".htm",
".html", ".pl", ".vbs", ".js", ".wsf", ".wsh", ".xml"**

syngo 3D

The 3D Card offers the possibility to combine two-dimensional images to form three-dimensional views.

To do this the 3D Card provides you with the following methods:

Multi Planar Reconstruction (MPR)

interactive navigation through 3D volumes in arbitrary orientations.

- Orthogonal, oblique or double-oblique orientation.
- Easy scrolling through 3D volume data set.
- Real-time reconstruction of secondary slices.
- Additional diagnostic information, e. g. with sagittal or coronal reconstructions from axial images.
- Variable slice thickness (MPR thick, MPR) and distance with configurable default values.
- Calculation of arbitrarily curved cuts.

Maximum Intensity Projection (MIP)

angiographic display.

- Projection of pixels with highest intensity (vascular information) onto an arbitrarily oriented plane.
- Display of e. g. aneurysms, plaques, stenoses and other vascular anomalies.
- MIP thin function for projection within a small slab to focus on particular vascular structure.

Shaded Surface Display (SSD)

surface display of complex anatomies.

- 3D display of surfaces from a series of contiguous slices using a variable threshold.
- The displayed volume consist of voxels whose HU are in a range defined by two limit values, an upper and a lower threshold (= HU limits).
- Display and analyze various anatomies, e. g. from the cranium, pelvis, extremities, e. g. for the purpose of planning surgical interventions.
- The 3D objects can be tilted and rotated in real-time.

Volume Rendering Technique (VRT)

True 3D visualization of volume data.

- Projection onto an arbitrarily oriented plane.
- Density, opacity and refraction information is used to generate views that optimally meet different clinical objectives.
- Optimal display quality and differentiation of different organs through independent control of color, opacity and shading in up to 4 tissue classes.
- Predefined settings for many clinical objectives and anatomic regions are easily selected from an image gallery.
- Pre-settings can be linked to DICOM series description to automatically ensure standardized quality in clinical routine.
- Clip-planes can be used to easily scroll through the volume in VRT thin mode.
- Easy interaction with SmartSelect control (right mouse button).

Prerequisites

At least 3 and maximum of 1600 images must have been loaded to process 3D; (with more than 1600 images the series will be split up). All images must have the same x/y coordinates and FoV.

- You should close any data sets that you no longer need in order to release memory space and maintain application performance.
- CT volume data sets are best acquired with overlapping thin slice CT technique.

Workflow

Loading the Images

After loading the images into syngo 3D the following layout is displayed:

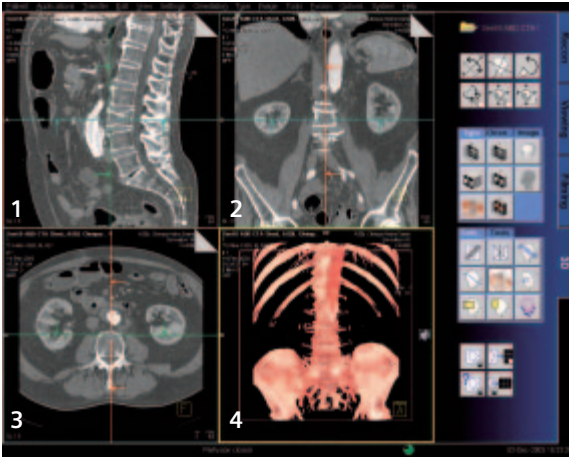


Image Representation on the 3D Card

The image area on the 3D task card is divided into four segments:

The first three segments are reference segments, the fourth segment is an output segment. In the three reference segments the images are first shown in the views that are parallel and perpendicular to the direction of scanning.

- (1) Reference segment (sagittal view)
- (2) Reference segment (coronal view)
- (3) Reference segment (transversal view)
- (4) Output segment

By turning and moving the views you can define the position and orientation of the plane that is to be used as the reference image for the reconstruction of images or series.

The reference segments are used to display different views of the volume data set, while the reference display (the view) is used as a reference for a 3D-reconstruction.

The images and series generated by various tools on the basis of the reference image are displayed in the output segment.

To find the best suitable reference image for planning reconstruction of images and series, you can freely rotate and move all three views.

The reference display (= reference image) is used as a reference for a 3D-reconstruction, while the other views are used to display different views of the volume data set.

The generated images and series are displayed in the output segment.

Defining Output Types

You can change the output type for a segment at any time, i. e., from Multi Planar Reconstruction (MPR) to Maximum Intensity Projection (MIP), to Shaded Surface Display (SSD), or to Volume Rendering Technique (VRT).

Depending on your working method, you will first generate a reference image, for example, in MPR in the desired view and then switch to MIP, SSD or VRT display.

- Click on the segment for which you want to change the out-put type.
- If you want to switch over all segments, you must select and switch over each one separately, one after the other.

Creating Series

This application gives you the ability to easily create new images or even image series, e. g. for fast display of anatomical interesting structures

- With any slice thickness (at least the reconstructed slice thickness)
- Variable distance/angle between the images
- Selectable number of images
- Selectable range of reconstruction
- Different output types

Parallel Ranges

With this option you generate series of cut images that are parallel to one another and perpendicular to the reference image for the output types MPR, MPR thick and MIP thin.

For example, for MPRs or MIP thin through a process in the lung or abdomen.

Radial Ranges

For output types MPR, MPR thick and MIP thin you generate a series of cut images arranged in a star shape.

For output types MIP, SSD and VRT you generate a series of projections and views of the volume each rotated around a defined angle. In this way, you simulate a step-by-step rotation.

For example, for colored VRT images, showing a process from different angles.

Expanded Ranges

With this option you generate images that are located in front of or behind the reference image. This option, too, is only available for output types MPR, MPR thick or MIP thin.

For example, for MPRs or MIP thin through a process in the lung or abdomen.

Curved Ranges

If you want to view sub-areas that cannot be obtained by planar, i. e., flat images, you can draw a cut line with any curvature freehand. This cut will then be shown as an image/series in the output segment.

For example, for MPRs or MIPthin from the aorta or the peripheral arteries.

Editing

A common problem in evaluating medical images is that areas relevant to an examination are hidden by other structures, especially bones. The necessary image information is contained in the volume data set but must be made visible with suitable editing steps.

1. **VOI mode:** With a Volume of Interest (VOI), you extract a volume of diagnostic interest by limiting the volume to be reconstructed to a partial volume.

You can extract a VOI (volume of interest) in one of the following ways:

- Position and differentiate a cuboid VOI (VOI Clipbox)
- Draw a freehand VOI (VOI Punch Mode)

2. **Clip planes:** Clip planes can also be used for hiding parts of the data set.

Sometimes it is useful to use only a part of the volume for projection. The sub area is defined by the two parallel intersection planes ("separation plane"). The distance between these planes is the slice thickness to be defined. For example, you can avoid cutting out interfering structures; (MIP thin, VRT thin/clip).

3. **3D Object Editor:** Easy elimination of obstructing information.
- Easy volume confinement with clip-box or variable editing slab.
 - Fast object creation with threshold operations or automatic volume growing.
 - Multiple editor objects can be displayed with differently colored SSD.
 - Complete object subtraction with dilatation and erosion functions.
 - Remaining volume dataset after object subtraction can be displayed with all 3D representations, i. e. VRT, MPR, MIP or SSD.

With the 3D Object Editor you can perform the following operations:

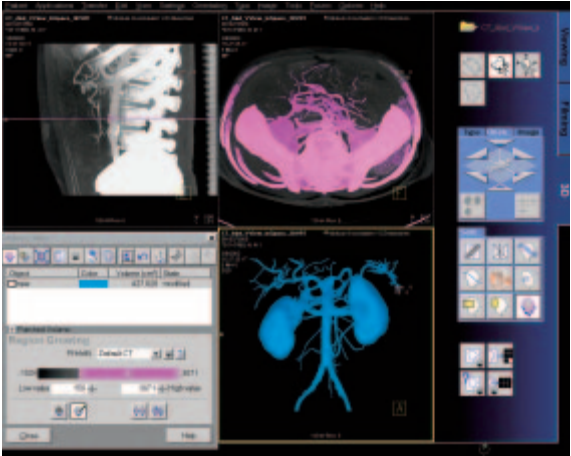
- Object generation with Region Growing
- Object management in the object list
- Object editing with Object Punching and Morphological Operations

Region Growing

Normally in the first step you will generate one or more "objects" from the volume data set originally loaded in 3D. By specifying a limited voxel value range you extract only a section of the voxels from the original data set. In this way, you generate an object in the result segment.

Instead of extracting globally from the entire volume data set you can also proceed "slice by slice" (in 3D blocks) using the **Slab Editor**.

You can also set **Seed Points** in the original data set, thus limiting the creation of an object to defined regions which are also connected to one another in the specified voxel area.



Object Punching

Like editing volume data sets in the VOI mode, you can use the 3D Editor, too. You are provided with tools for cutting out structures from an object that you have previously generated.

Using the **Slab Editor** you can define your own cutting depth.

Morphological Operations

In some cases it will not be simple to separate the structures of an object using the cutting tools. Here we recommend eroding, or shrinking, the areas of the object by a specified surface thickness until the obscuring structures are no longer contained in the object.

You can subsequently dilate, or blow up, the remaining object areas by a defined surface thickness. As a result, the irrelevant areas contained at the outset are now removed from the representation.

If you perform the same operations in reverse order, small cavities in the object will be filled.

Documentation of Results

The buttons *Copy to Film sheet* and *Save/Save As* are always available. You can always document intermediate results by these buttons.

To save images you have following possibilities:

- Storing the new series automatically during reconstruction
- The *Save* button will store the image/series with no further check
- The *Save as* button will give you the possibility to choose a name for the new the image/series before storing

Workflow for a CT Extremity Examination

• Using MPR/MPR thick

1. Load the series to MPR.
2. Manipulate the volume to evaluate anatomy:
 - a) Orientate the image volume for the best view of the anatomy.
 - b) Adjust the window as necessary.
 - c) Pan and zoom image as necessary.
3. Scroll through the volume quickly using the 3D cross-hair or dogears to gain a three-dimensional impression.
4. The minimum slice thickness of an MPR image is one voxel. But you can generate thicker slices (MPR thick) for easier evaluation.
5. Measure, annotate and document as needed.
6. Optionally, create image series using parallel, expanded or curved ranges and output them either on a film or save them to database.

• Using SSD

1. Load the series to SSD.
Hint: Do not use a series with a high resolution kernel, e. g. kernel 10 or 20 are recommended.
2. Manipulate the volume to evaluate anatomy:
 - a) Orientate the image volume for the best view of the anatomy.
 - b) Adjust the threshold as necessary.
 - c) Pan and zoom image as necessary.
 - d) To eliminate unwanted structures use VOI punching/3D Object Editor.
3. Measure, annotate and document as needed.
4. Optionally, create image series using radial ranges and output them either on a film or save them to database.

• Using VRT

1. Load the series to VRT.
2. Manipulate volume to evaluate anatomy:
 - a) Orientate the image volume for the best view of the anatomy.
 - b) To eliminate unwanted structures either activate VRT thin/clip or use VOI punching/3D Object Editor.
 - c) Select VRT preset from VRT gallery.
 - d) Adjust window, opacity, color and lighting effects as necessary.
 - e) Pan and zoom image as necessary.
3. Measure, annotate and document as needed.
4. Optionally, create image series using radial ranges for VRT; parallel, expanded or curved ranges for VRT thin/clip and output them either on a film or save them to database.

Workflow for a CT Angiography

• Using MIP/MIPthin

1. Load the series to MIP.
2. Manipulate the volume to evaluate anatomy:
 - a) Orientate the image volume for the best view of the anatomy.
 - b) To eliminate unwanted bone either activate MIP thin or use VOI punching/3D Object Editor.
 - c) Adjust the window as necessary.
 - d) Pan and zoom image as necessary.
3. Measure, annotate and document as needed.
4. Optionally, create image series using radial ranges for MIP; parallel, expanded or curved ranges for MIP thin and output them either on a film or save them to database.

• Using VRT/VRTthin/clip

1. Load the series to VRT.
2. Manipulate volume to evaluate anatomy:
 - f) Orientate the image volume for the best view of the anatomy.
 - g) To eliminate unwanted bone either activate VRT thin/clip or use VOI punching/3D Object Editor.
 - h) Select VRT preset from VRT gallery.
 - i) Adjust window, opacity, color and lighting effects as necessary.
 - j) Pan and zoom image as necessary.
3. Measure, annotate and document as needed.
4. Optionally, create image series using radial ranges for VRT; parallel, expanded or curved ranges for VRT thin/clip and output them either on a film or save them to database.

Hints in General

1. Setting Views in the Volume Data Set

Three-dimensional image processing allows you to create images in any orientations and positions within the data volume.

You can “move” through the volume and rotate it in any direction. Depending on the method you are using, various aids are available to you.

Rotating around one axes (oblique cut planes)

For oblique slices, you rotate a slice about one axis of the patient coordinate system starting from the standard view.

The orientation is displayed in the image as a combination of two orientation labels.

One of the two reference lines in the image is now dotted. The corresponding plane is therefore oblique in relation to the displayed image.

Rotating around two axis (double-oblique cut planes)

You obtain cut planes in two axes whenever you rotate one slice around two different patient coordinate axes one after the other.

The plane is then no longer perpendicular to either of the coordinate axes. The image orientation is displayed as a combination of three orientation labels.

- ⇒ The subtaskcard “Orientation” will give you always the ability to return immediately back to the beginning or to any standard view.
- ⇒ View perpendicular to reference image (*Ortho Sync*). Usually, you activate the orthogonal view to display slices along the main axis of an organ, e. g., the heart.

2. Changing /Creating VRT Presets

You will use the Volume Rendering Technique (VRT) to obtain more precise representation and separation of tissue types. To highlight certain aspects of the anatomical region, you can change the color, brightness, and transparency of different areas.

As display parameters for the VRT view, customary default settings are stored on your system in the VRT gallery.

If the default settings are not appropriate for your diagnostic problem, you can alter them individually. In that way you can emphasize the structures of interest in an optimum way.

- ⇒ Ramp and trapezoid manipulation: Ramps and trapezoids are functions which define window and rendering settings. Trapezoids can also be used to differentiate a tissue classification range (e. g. bone versus soft tissue in a CT image).
- ⇒ Change rendering settings using the table classifier trapezoids. Moving the ramp changes the window width and center. Opacity and brightness can be adjusted to optimize organ-specific settings.
- ⇒ Lighting to enhance 3D. The mouse cursor is used to define the direction of incident light.
- ⇒ VRT presets can be stored in the VRT gallery and linked to specific series description.

3. Auto Load in 3D and Postprocessing Presets

Automatic generation of parallel (MPR, MIP thin) or radial cuts (MPR, MIP, SSD, VRT) for subsequent image reading.

You can activate the *Auto load in 3D* function on the Examination Card/Auto Tasking and link it to a recon job. If the postprocessing type is chosen from the pull down menu, the reconstructed images will be loaded automatically into the 3D Card on the Navigator with the corresponding postprocessing type after the reconstruction.

On the 3D Card you have the possibility to create for Range Parallel and Radial protocols which can be linked to a special series names.

- ⇒ Select the image type
- ⇒ Select the orientation
- ⇒ Open the Range function and adapt the range settings (Image thickness, Distance between the images etc.)
- ⇒ Hit the link button
- ⇒ Save the linked preset

4. Blow-up Mode: full screen display by double-clicking in the segment for easier visualization.

syngo Fusion

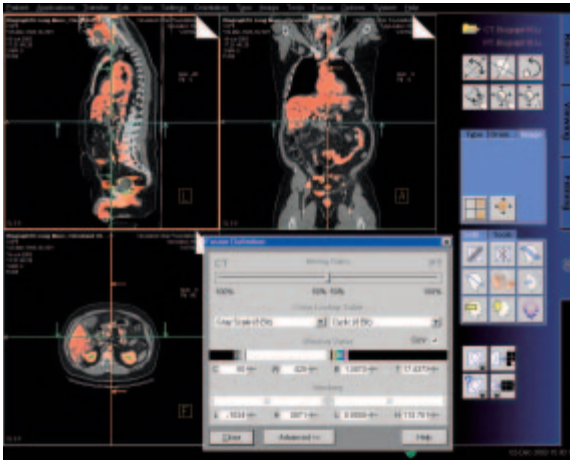
Composite display of CT, MR, NM and PET images – fast and easy for routine use.

Registration

- Quick first visual alignment with 6 degrees of freedom (3 x translation, 3 x rotation).
- Point-based high precision registration using anatomical landmarks.
- Convenient landmark editor to improve precision.
- Storage of transformation matrix with data sets after registration for later retrieval.

Visualization

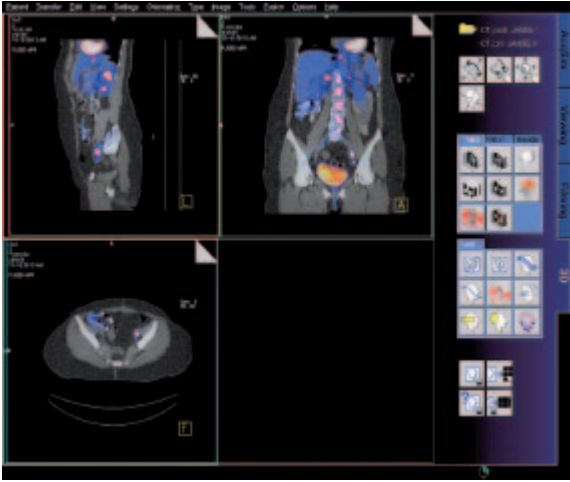
- Side-by-side MPR display of both data sets.
- Correlated pointer and correlated scrolling with dogears for follow-up studies or tumor staging.
- 2D alpha-blending in monochrome or pseudo-color with adjustable balance between the two superimposed data sets to optimize representation of both data sets.
- Storage of fused results as secondary capture images.



Tips

- Surface Matching
We recommend using Surface Matching only if you want to fuse objects that do not move, e. g. bone.
- Landmarks
We recommend using Landmarks for therapy datasets, which are scanned with markers.
- Resample Data
Is used to scroll simultaneously through the datasets and send them to other workstations.
- Masking
This function is used for a better display of either CT or PET images. With the sliders you can decide which dataset should be displayed more.
- With the SmartSelect menu you can rotate the images fast and easy.
- It is possible to measure distances in the fused datasets.

syngo Fusion



syngo Fly Through

syngo Fly Through is a Virtual CT Endoscopy Software integrated into the syngo 3D functionality. It offers the possibility to render endoluminal views of structures such as the airways and vessels from volume data sets.

Virtual CT Endoscopy simulates diagnostic conventional endoscopic procedures e. g. bronchoscopy and colonoscopy, that are usually uncomfortable and more invasive to the patient.

Key Features

- Add-on advanced 3D functionality (Fly icon) integrated in the existing, familiar 3D taskcard.
- One-click access to perspective endoscopic rendering at a point of interest.
- Both Shaded Surface Display (SSD) and Volume Rendering Technique (VRT) can be used.
- Volume Rendering Technique* (VRT) presets can be stored in the VRT* gallery and linked to specific examination protocol or series description.
- Endoscopic viewing parameters e. g. the viewing angle, depth and the viewing distance from the endoscope can be defined and linked to a data set.
- Manual or Automatic endoscopic navigation.
- Fly path planning creates and saves a flight path in the volume data set. This offers the possibility to play back an endoscopic evaluation and to create a series of endoscopic snapshots that can be saved on the database.

* syngo VRT is optionally available

Prerequisites

This software works with CT, MR and conventional Angiographic data sets.

CTA data set with good vessel enhancement for virtual angioscopy.

Volume data set acquired with overlapping thin slice CT technique.

The Basics for CT Virtual Endoscopy

SSD and VRT* Presets for Endoscopic Renderings

In order to create endoluminal displays with CT data sets, we need to differentiate the structures of interest from the rest of the anatomy. This can be achieved with either positive or negative contrast enhancement.

In principle, there are few objects/media which are suitable for endoscopic renderings:

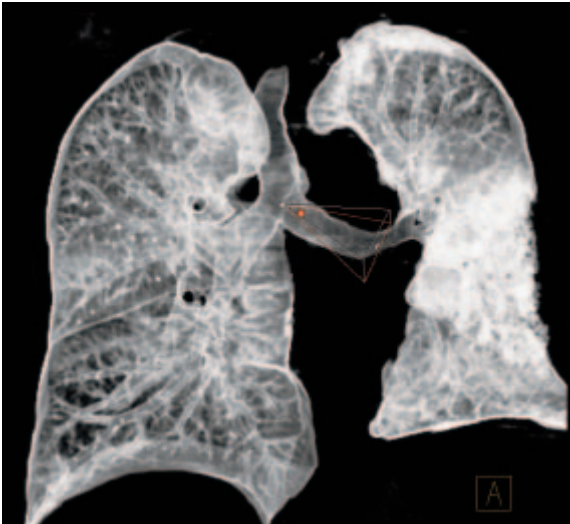
- Gas, e. g. air or carbon dioxide
- Fluid, e. g. water, Iodine-based intravenous/ infusion media or Barium-based oral and rectal contrast agents
- Bone
- Metal, e. g. stents

* *syngo VRT is optionally available*

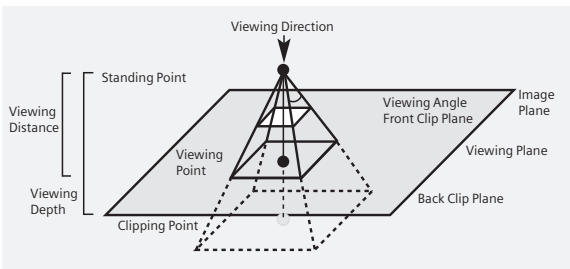
syngo Fly Through

Endoscopic Viewing Parameters/Fly Cone Settings

In general, the shape of a pyramidal cone can be used to represent visualization of an endoscopic volume. The boundaries and the viewing perspective of the endoscopic volume are defined by adjusting the shape and size of this cone.



Cone setting for flying through the airways.



Cone Graphic and Definition

syngo Fly Through

- Standing Point
 - The cone rotates around the viewing point.
- Viewing Point
 - The complete cone moves.
- Clipping Point
 - The cone rotates around the standing point.
- Viewing Angle
 - Is changed by moving one of the sides of the angle.
- Viewing Distance
 - The distance from the Standing to the Viewing Point.
- Viewing Depth
 - Moving the Front/Back Clip Plane changes the viewing depth.
- Front Clip Plane
 - To remove foreground-obscuring tissue.
The position of the front clip plane will always be between standing and viewing point.
- Back Clip Plane
 - To remove tissue at the back of the volume.
The position of the back clip plane will always be behind viewing point.

Patient Preparation

Bony and cartilaginous structures such as the central airway and bronchial tree, the osteomeatal system of the Paranasal Sinuses are inherently filled with air and therefore ideal for performing Virtual CT Endoscopy. No special preparations are required.

For CT endoscopic evaluation of the vessel (virtual CT angiography), a good CTA data set with good vessel enhancement is required.

In the case of CT colonography, adequate preparation in bowel cleaning must be done prior to the CT exam. The bowel can be delineated with air, carbon dioxide, water or iodine/barium suspension.

Workflow

Load the images in 3D.

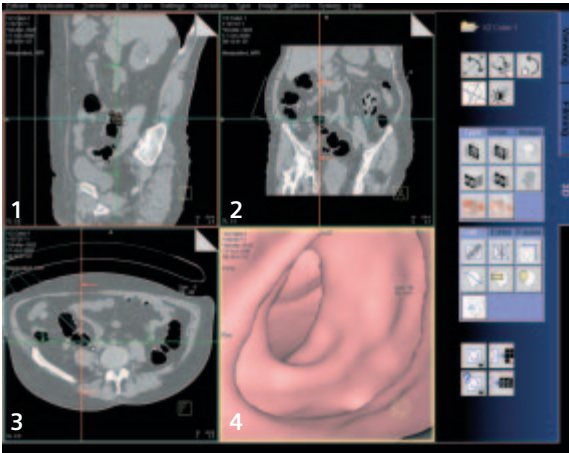
The following standard layout is displayed:

Segment 1: Sagittal view

Segment 2: Coronal view

Segment 3: Transversal view

Segment 4: Fly segment with perspective SSD as default



Scroll through the MPR images until you reach an image where you would like to start the CT endoscopic evaluation.

syngo Fly Through

Position the Reference lines at that point of interest e. g. in the trachea.

Click the Fly Through icon to activate the endoscopic display in the fourth segment.

The default endoscopic display has the same orientation (viewing direction) as the last selected image segment in which you placed the point of interest and invoked the *syngo* Fly Through option.

Change the endoscopic display by adjusting the SSD threshold or change to VRT* display.

Link the new settings to data set for future evaluation. Define the Cone settings (endoscopic viewing parameters) and link the cone settings to data set for future application.

Start the endoscopic navigation by using:

- Manual method
- Auto-navigation
- Path creation

Create flight path through the data set and save the path for future playback.

Click the "Save Image" button before navigating the endoscopic projection along the path.

A series of endoscopic snapshots will be created and saved automatically on the database.

These images can be documented on hardcopy or loaded to Viewer for cine display of the endoscopic movie.

* *syngo* VRT is optionally available

Navigation of the Endoscopic Volume

- *Manual Navigation*

Click with the right mouse button in the Fly segment to activate the SmartSelect menu.

The following controls are available:

- auto-navigation
- push/pull
- rotate around viewing point
- rotate view

Adjust the viewing direction and select push/pull.

Click and hold the left mouse button.

Move the mouse up or down to navigate through the endoscopic volume manually.

- *Auto Navigation*

Adjust the initial viewing direction.

Activate the SmartSelect menu

Select the function auto-navigation.

Click and hold with the left mouse button. Give the mouse a small upward push and then hold it steady.

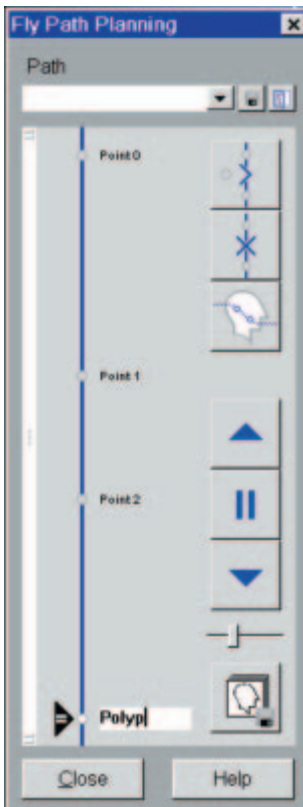
The software will automatically detect the centerline and navigate through the endoscopic volume without any user intervention.

To stop or change the direction of the navigation, release the mouse and adjust the viewing direction accordingly before proceeding further.

syngo Fly Through

Fly Path Planning

Open the Fly Path Planning.



Create a path by inserting path points in the volume during navigation.

The relevant settings (viewing direction, viewing angle etc.) are stored along the path.

After defining and storing a path it is possible to play back the entire navigation along the path as a movie or to jump straight to the section of the endoscopic volume predefined by the path points.

Note: Only one path can be saved with each data set. To define another flight path through the same volume, the existing path will be overwritten and deleted.

syngo Colonography

This is a promising application, dedicated to visualize and assist the physician with the evaluation of lesions in the colon. This study is not only non-invasive, but a much more comfortable method for the patient.

Key Features

- Very small lesions can be visualized
- Loading of two datasets for comparison
- After loading the images, the evaluation starts automatically at the rectum position
- Lesion visualization in MPRs and virtual endoscopy
- Switching between single and side by side view
- Automatic endoscopic navigation
- Fly back offers a view from the opposite side
- Recording of a movie at any time
- Easy and flexible reporting of the evaluated lesions

Prerequisites

1. A comprehensive study consists of four sections:
Preparation, examination in supine & prone positioning, and postprocessing.

- Patient preparation

Important for good results in a *syngo* Colonography evaluation adequate preparation in bowel cleansing must be done. The patient has to start with a diet and bowel cleansing two days prior to the examination like for a conventional Colonoscopy.

- Patient examination

The bowel can be delineated with air, or, if desired, with carbon dioxide. Inflate the colon to the patient's maximum tolerance.

To decrease colon spasm, e. g. Buscopan™ or Glucagon™ can be given IV.

Usually, a prone and supine examination is done to differentiate between polyps and stool within the colon. The second scan can be performed with lower dose, e. g. 30 to 50 mAs.

For your *syngo* Colonography evaluation, you can use one or two series of the same study or different studies of the same patient. The images must fulfill the following conditions:

- Only load original, axial CT images of the same patient acquired without gantry tilt.

Scan Protocols

Use the CT Colonography protocol. We recommend using a tube voltage of at least 120 kV.

You will find the CT Colonography scan protocols under body region "Abdomen".

1. SOMATOM Emotion Duo

Supine	CTColonography
<i>kV</i>	130
<i>Effective mAs</i>	50
<i>Slice collimation</i>	2.5 mm
<i>Slice width</i>	3.0 mm
<i>Feed/Rotation</i>	10.0 mm
<i>Rotation time</i>	1.0 sec.
<i>Kernel</i>	B41s
<i>Increment</i>	1.5 mm
<i>CTDI_{Vol}</i>	5.39 mGy

Prone	CTColonography
<i>kV</i>	130
<i>Effective mAs</i>	30
<i>Slice collimation</i>	3.0 mm
<i>Slice width</i>	3.0 mm
<i>Feed/Rotation</i>	10.0 mm
<i>Rotation time</i>	1.0 sec.
<i>Kernel</i>	B41s
<i>Increment</i>	1.5 mm
<i>CTDI_{Vol}</i>	3.23 mGy

syngo Colonography

Supine	CTColonography08s
<i>kV</i>	130
<i>Effective mAs</i>	50
<i>Slice collimation</i>	2.5 mm
<i>Slice width</i>	3.0 mm
<i>Feed/Rotation</i>	10.0 mm
<i>Rotation time</i>	0.8 sec.
<i>Kernel</i>	B41s
<i>Increment</i>	1.5 mm
<i>CTDI_{vol}</i>	5.39 mGy

Prone	CTColonography08s
<i>kV</i>	130
<i>Effective mAs</i>	30
<i>Slice collimation</i>	2.5 mm
<i>Slice width</i>	3.0 mm
<i>Feed/Rotation</i>	10.0 mm
<i>Rotation time</i>	0.8 sec.
<i>Kernel</i>	B41s
<i>Increment</i>	1.5 mm
<i>CTDI_{vol}</i>	3.23 mGy

2. SOMATOM Emotion 6

Supine	CTColonography
<i>kV</i>	130
<i>Effective mAs</i>	50
<i>Slice collimation</i>	1.0 mm
<i>Slice width</i>	1.25 mm
<i>Feed/Rotation</i>	10.8 mm
<i>Rotation time</i>	0.8 sec.
<i>Kernel</i>	B41s
<i>Increment</i>	0.8 mm
<i>CTDI_{Vol}</i>	6.6 mGy

Prone	CTColonography
<i>kV</i>	130
<i>Effective mAs</i>	30
<i>Slice collimation</i>	1.0 mm
<i>Slice width</i>	1.25 mm
<i>Feed/Rotation</i>	10.8 mm
<i>Rotation time</i>	0.8 sec.
<i>Kernel</i>	B41s
<i>Increment</i>	0.8 mm
<i>CTDI_{Vol}</i>	3.96 mGy

syngo Colonography

Supine	CTColonography06s
<i>kV</i>	130
<i>Effective mAs</i>	50
<i>Slice collimation</i>	1.0 mm
<i>Slice width</i>	1.25 mm
<i>Feed/Rotation</i>	10.8 mm
<i>Rotation time</i>	0.6 sec.
<i>Kernel</i>	B41s
<i>Increment</i>	0.8 mm
<i>CTDI_{vol}</i>	6.6 mGy

Prone	CTColonography06s
<i>kV</i>	130
<i>Effective mAs</i>	30
<i>Slice collimation</i>	1.0 mm
<i>Slice width</i>	1.25 mm
<i>Feed/Rotation</i>	10.8 mm
<i>Rotation time</i>	0.6 sec.
<i>Kernel</i>	B41s
<i>Increment</i>	0.8 mm
<i>CTDI_{vol}</i>	3.96 mGy

3. SOMATOM Sensation 10

Supine	CTColonography
<i>kV</i>	120
<i>Effective mAs</i>	50
<i>Slice collimation</i>	0.75 mm
<i>Slice width</i>	1.0 mm
<i>Feed/Rotation</i>	11.2 mm
<i>Rotation time</i>	0.5 sec.
<i>Kernel</i>	B30f
<i>Increment</i>	0.7 mm
<i>CTDI_{Vol}</i>	4.1 mGy

Prone	CTColonography
<i>kV</i>	120
<i>Effective mAs</i>	30
<i>Slice collimation</i>	0.75 mm
<i>Slice width</i>	1.0 mm
<i>Feed/Rotation</i>	11.2 mm
<i>Rotation time</i>	0.5 sec.
<i>Kernel</i>	B30f
<i>Increment</i>	0.7 mm
<i>CTDI_{Vol}</i>	2.46 mGy

4. SOMATOM Sensation 16

Supine	CTColonography
<i>kV</i>	120
<i>Effective mAs</i>	50
<i>Slice collimation</i>	0.75 mm
<i>Slice width</i>	1.0 mm
<i>Feed/Rotation</i>	18.0 mm
<i>Rotation time</i>	0.5 sec.
<i>Kernel</i>	B30f
<i>Increment</i>	0.7 mm
<i>CTDI_{Vol}</i>	3.9 mGy

Prone	CTColonography
<i>kV</i>	120
<i>Effective mAs</i>	30
<i>Slice collimation</i>	0.75 mm
<i>Slice width</i>	1.0 mm
<i>Feed/Rotation</i>	18.0 mm
<i>Rotation time</i>	0.5 sec.
<i>Kernel</i>	B30f
<i>Increment</i>	0.7 mm
<i>CTDI_{Vol}</i>	2.3 mGy

5. SOMATOM Sensation Cardiac

Supine	CTColonography
<i>kV</i>	120
<i>Effective mAs</i>	50
<i>Slice collimation</i>	0.75 mm
<i>Slice width</i>	1.0 mm
<i>Feed/Rotation</i>	18.0 mm
<i>Rotation time</i>	0.5 sec.
<i>Kernel</i>	B30f
<i>Increment</i>	0.7 mm
<i>CTDI_{Vol}</i>	3.9 mGy

Prone	CTColonography
<i>kV</i>	120
<i>Effective mAs</i>	30
<i>Slice collimation</i>	0.75 mm
<i>Slice width</i>	1.0 mm
<i>Feed/Rotation</i>	18.0 mm
<i>Rotation time</i>	0.5 sec.
<i>Kernel</i>	B30f
<i>Increment</i>	0.7 mm
<i>CTDI_{Vol}</i>	2.3 mGy

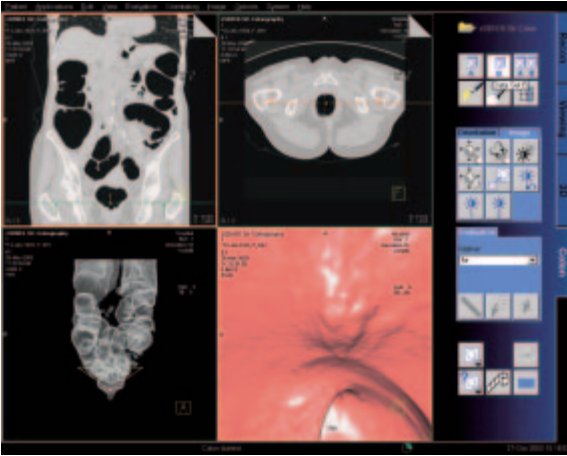
Workflow

Layout of the Taskcard

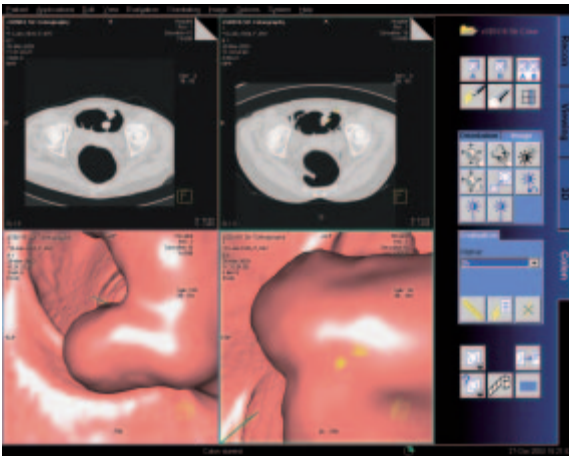
After loading the series into *syngo* Colonography a 4-segment layout is displayed.

- Upper left segment:
Scroll View using MPR for fast and easy navigation through the colon. As default, a coronal view is displayed. Markers can be set for further evaluation and documentation.
- Upper right segment:
Scroll View using MPR for fast and easy navigation through the colon. As default, a transversal view is displayed. Markers can be set for further evaluation and documentation.
- Lower left segment:
Global View showing a three-dimensional unobscured, overall view of the whole colon in a double-contrast display. This segment provides an overview with markers, the current position of the virtual endoscope and its field of view, and the path traveled in the Endo View Segment.
- Lower right segment:
Endo View looks like an original endoscopic view, using perspective SSD (pSSD). With the auto navigation a flight with the virtual endoscope along an automatically calculated path is started.

syngo Colonography



User interface of syngo Colonography



Supine and prone position in "Side by Side" view.

Visualization and Evaluation

Two alternative workflows are possible:

- First identify and mark all the suspected lesions in the entire data set during the first pass navigation. As a second step you can do the individual close-up evaluation of the pre-marked lesions.
- Immediately evaluate each suspicious lesion as soon as it is visualized during the first navigation.

Identification and Marking of Lesions

- Load one or two series of the same patient into *syngo* Colonography. The images are always displayed in the same orientation. The system will automatically find the starting point at the lowest position in the rectum.
- Select the desired dataset (A or B) or use the side by side view for comparison.
- Scroll through the dataset with the slabs of the two Scroll Views.
- Set the virtual endoscope to the required start point.
- Fly with the virtual endoscope forward and backward through the volume to identify lesions. The Global view provides an overview of the current position and the path traveled.
- Set lesion markers in the Endo View or in the Scroll View segments. The markers always get the extension of the corresponding dataset, e. g. 1a.
- Set a bookmark to save all segments with all parameters, i. e., position, zoom/pan, orientation temporarily.

Close-up Inspection of Lesions

- Turn the virtual endoscope to look exactly at the lesion of interest.
- Activate Fly Around and rotate the volume displayed around the centered marker to view the lesion from all sides.
- Fly backward to get a view on the lesion from the opposite direction.
- Change to Side by Side View to differentiate between polyps and fecal matter.
- Switch between endo and combined mode to display the surrounding tissue.

Measurements of Lesions

- Select a marker from the marker list, all segments will be updated to the position of the marker.
- Select a Scroll View segment where the lesion is best visible.

- Activate Blow-up mode.
- Click on the Distance button on the Evaluation subtask card and draw a distance line.
- With the "Goto image" button you can easily jump to the image with the corresponding distance measurement.

Documentation and Reporting

- In the Endo View Segment, you can record a movie of your virtual flight through the colon at any time.
- As soon as distance lines are measured, they are documented in the Colonography Lesion Details dialog. You can add comments to each entry.
- You can include up to four images for each lesion in your report. Select the image you require and copy it to the report. The copied image is also saved in the local database.
- During the evaluation, specific details such as the location, quality, and size of each lesion can be entered into the Colonography lesion details dialog.

syngo Colonography

Lesion Details

Marker
1a

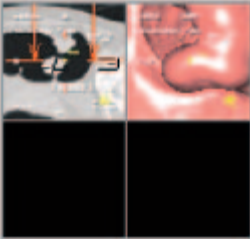
Location
None

Quality
Indeterminate
Polyp
Indeterminate

Size [cm]
1: 1.71

Comment

Images in Report



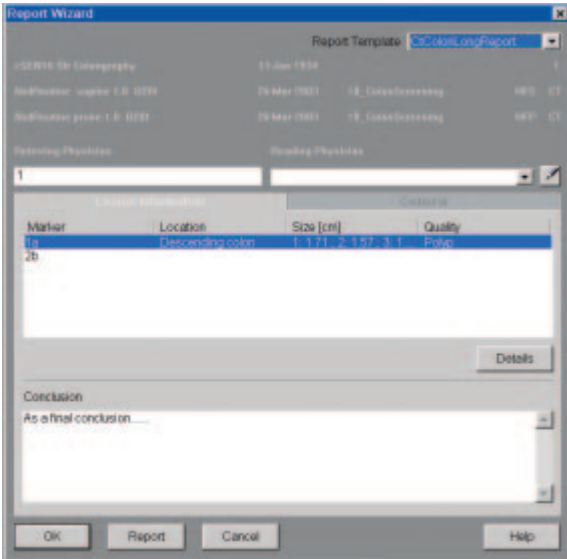
OK Cancel

syngo Colonography

The *Report Wizard* provides a brief table of the evaluated lesions.

The user can enter any additional observed abnormalities and the conclusion as well.

- The Report template is configurable.
- It is possible to print the report or to export the report in several formats, e. g. PDF-, HTML- or RTF-Format.



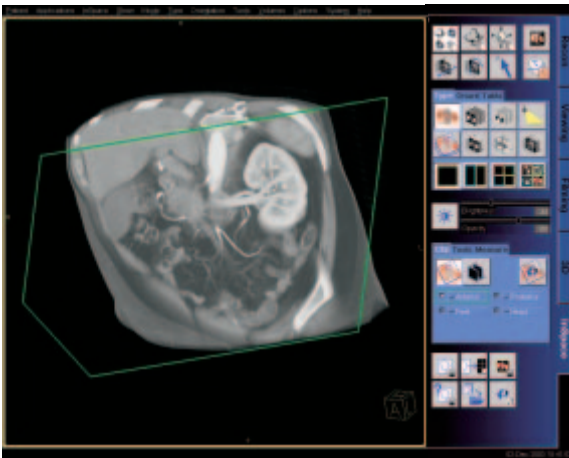
Ending an Evaluation

- After ending the Colonography Evaluation the “Save report” dialog appears. For identification of the created report the user can enter a comment.

InSpace4D

syngo InSpace is an interactive volume viewer tailored for modern volume scanners.

InSpace4D is the real-time volume rendering application of *syngo* offering excellent image quality and interactive performance even with your largest datasets. The primary focus of InSpace is to melt very rapidly through a complete 3D image volume using a clip plane or image slab to reveal the desired anatomy. This is analogous to 2D-cine mode, but much faster, and with freely controllable double-oblique orientation within the whole 3D volume.



Key Features

- Genuinely real-time 3D
- VRT, MIP, MiniIP, MPR
- Clip plane and image slab melt-through
- Excellent image quality
- Support for very large volumes
- 3D measurements
- Documentation, including AVI digital movies

Basics

InSpace provides two different working modes: Expert or Beginner mode. You can select and change more parameters in Expert mode. This mode is recommended for experienced users only.

You can use the optional VolumePro Graphics accelerator card to provide exceptional image quality and provide support for very large volumes at maximum interactive performance. The InSpace/Settings/Quality menu allows you to activate and deactivate VolumePro mode (only available in Expert mode).



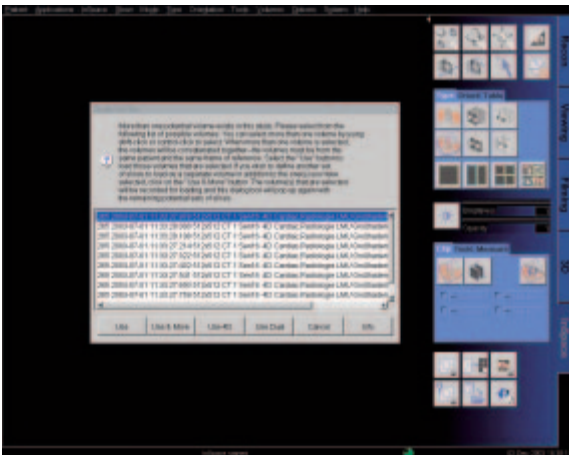
Prerequisites

Loading of Images

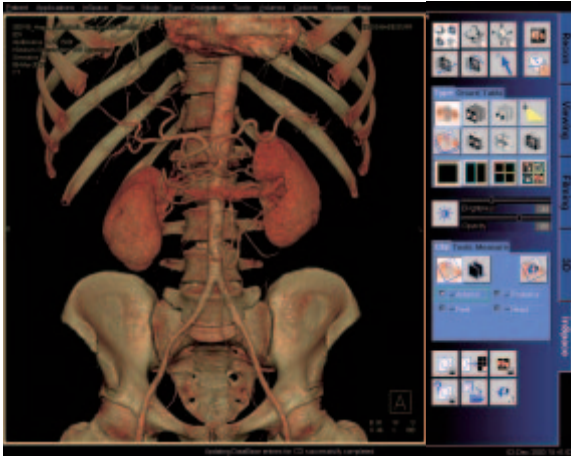
- Only load CT and MR images.
- You can load three data sets.
Recommended: Load no more than two data sets at the same time.
- A cardiac study containing multiple series can be loaded for 4D viewing.
- You should close any data set that you no longer need in order to release memory space and maintain application performance.
- CT volume data sets are best acquired with overlapping thin slice CT technique.

If the data you have selected contain several volumes for display, the Study Purifier dialog box opens. You have the option to:

- Select a single data set, or
- Merge two or more data sets to form a volume, or
- Display two or more data sets as separate volumes.
- Select exactly two volumes from the same patient with the same parameters to merge them to one volume.
- Select multiple time-sequence volumes from the list to view them in motion.



Layout of Screen



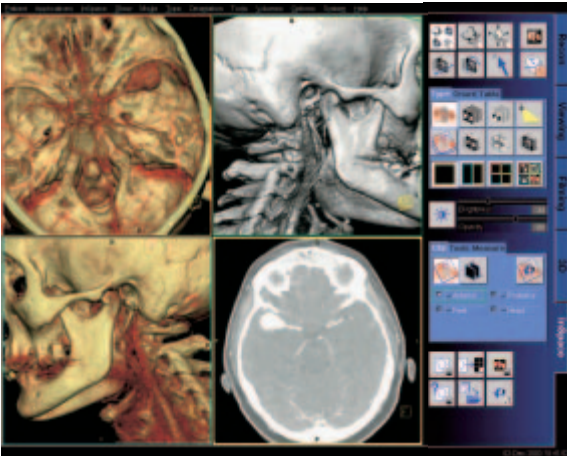
The image area is used for 3D VRT, MIP, MinIP or MPR image display in one, two or four segments. Whenever you change image parameters, the modifications are displayed in real time.

The taskcard control area consists of:

- Mode buttons
The six mouse mode buttons on the left are used for image control. The two buttons on the right are used for High Quality and Hide All Graphics.
- Upper stack of subtask cards
These subtask cards are used to set rendering mode, screen layout and the Advanced Lighting function. This button is only available with the optional VolumePro graphics accelerator. Also two subtask cards used for orientation and tissue classification.
- Button "Load Modality Preset" and Sliders for Brightness and Opacity. These sliders set the overall opacity/brightness of the image. If multiple ramps and/or trapezoids are present, all will be adjusted together.
- Lower stack of subtask cards.
Contains the settings for clip planes, tools and measurements.

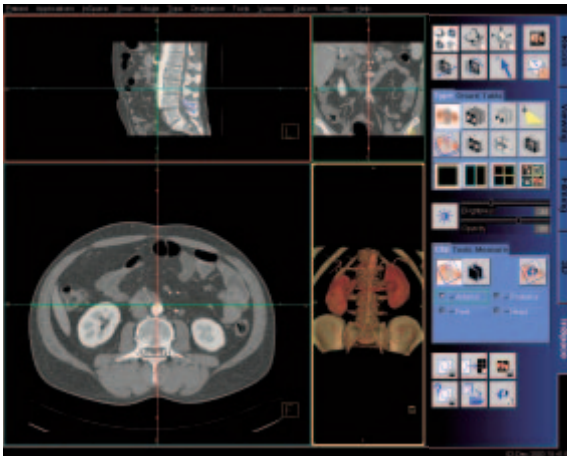
syngo InSpace4D

- Input/output buttons
These buttons are used to save or film result images, and to close the current series.
- Image segment area layouts
Four different layouts of the image area are provided:
 - Single View Mode
 - Two View Mode
 - Four View Mode
 - MPR View Mode



The layout can be modified:

- Blow-up any segment to full-screen by double click.
To bring display back to original layout, double click left mouse again.
- Drag segment boundaries or intersection in 2- or 4-view layouts.
- Reset layout by clicking again on the depressed layout icon.



Startup Configuration

A default startup layout can be configured, or the startup layout can be linked to a series description so that the layout is applied automatically for all such series:

- To make a Default startup bookmark for the selected series create the screen layout and image settings that you need, then select main menu InSpace/Save Series Bookmark as...:
 - check the “Bookmark” box,
 - press “Make Default”,
 - press “Save&Close”, or,
- To make a startup bookmark that is linked with a specific **Series Description**, load a relevant series, create the screen layout and image settings that you need, then in InSpace/Save Modality Preset:
 - check the “Bookmark” box,
 - select “Linking – Link Current”
“Linking – Preset Link” displays all available links for the specific series.
 - press “OK”.

Workflow

In general, syngo InSpace display, evaluation and documentation tools can be used in any workflow sequence. For an interactive 3D diagnosis using double-oblique “3D melt-through” a typical workflow would involve the following steps:

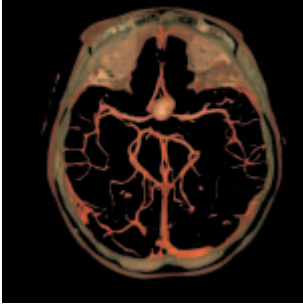
- Load series into a (default) MPR layout
- To view axial dataset, scroll through the axial MPR segment using left mouse button push-pull (double click segment if you want it full screen).
Tip: press the “Quality” button to ensure maximum image quality.
- Select 1 x 1 layout to show the 3D View.
Tip: release Quality button for maximum interactive performance.
- To evaluate soft tissue, select VRT rendering mode, or a soft tissue preset, and add a single clip-plane. Adjust window settings using middle mouse button, and also the “opacity” if necessary. Adjust clip-plane position and orientation to “melt through” and reveal desired anatomy.
- To evaluate vessels, select a MIP preset and add a pair of clip planes using “Slab Mode”, or simply select “slab-MIP” rendering. Adjust window settings as needed using middle mouse button. Adjust slab position, thickness and orientation to see only the required vessels.
- Manipulate the volume by pan, zoom and rotation using mouse mode icons at top of task-card.
- At any time during the interaction you may use tools to make annotated measurements, edit the data, and document to film sheet, disk-file image such as JPEG or AVI digital movie in MPEG4 format.

Extended Workflow Techniques

Other techniques that you may find useful, some of which are available only in “Expert” mode, include: Volume manipulation, windowing, presets.

Rapid diagnosis is supported by series-linked bookmarks that anatomically select optimal parameter settings, rendering mode, and even the screen layout for each exam protocol and by comprehensive tool-set of measurement and editing functions. In addition to conventional image reporting in DICOM format, jpeg, tiff images and MPEG4 movies of real-time interaction can be easily created.

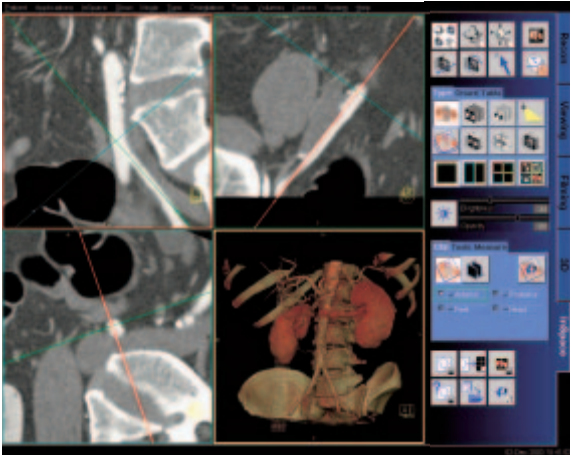
- Use modality presets to select different rendering settings, including color VRT.
- Ramp and trapezoid manipulation: Ramps and trapezoids are functions which define window and rendering settings. Trapezoids can also be used to differentiate a tissue classification range (e. g. soft tissue versus bone in a CT image).
- Change rendering settings using the table classifier trapezoids. Moving the ramp changes the window width and center. Opacity and brightness can be adjusted to optimize organ-specific settings. With the right mouse button options related to ramps and trapezoids are available.
- Lighting to enhance 3D. The lighting direction arrow is used to define the direction of incident light.
- As well as the individual mouse mode icons, all volume and clip-plane manipulation can be accomplished without mode change using the “manipulate all objects” icon.
- In this mode, Pan and Zoom can be performed even when a clip-plane is present by using the middle mouse button while pressing the Shift key.



MPR Mode

- *Double oblique MPR*

The MPR View Mode divides the image area into three orthogonal reference images with the 3D view in the fourth segment. Adjust the reference line center position and orientation to create double-oblique views.



Editing the Volume

- *Cropping*

This editing method is to crop the entire volume (box edit). Cropping limits you to three orthogonal directions.

- *VOI punching*
ROIs can be used to remove more complex shapes from the volume. ROIs can be drawn around the wanted (keep inside) or around the unwanted (keep outside) region. Drawing several ROIs before punching saves time.
- *Clip planes*
Clip planes can also be used for hiding parts of the dataset. The number of clip planes available depends on the selected mode:
 - Beginner mode: one
 - Expert mode with VolumePro: four
 - Expert mode without VolumePro: six

Hint

The ROI punch can be applied to the whole volume, or to only the parts visible when using clips or slabs. This is useful for editing bone in complex regions.

Measurement and Evaluation

- We recommend performing measurements on MPR planes. For 2D measurements, always use clip planes oriented parallel to the screen.
- Measure by placing a grid over the image, and moving its center and orientation as required.
- Measure distances and angles using the measurement feature on the Tools subtask card.

Documentation to Film and Database

- Images can be documented to the virtual film sheet, or a Postscript printer.
- Images can be saved to the DICOM patient database, or can be exported to disk file in JPEG, BMP, TIF, PNG formats.

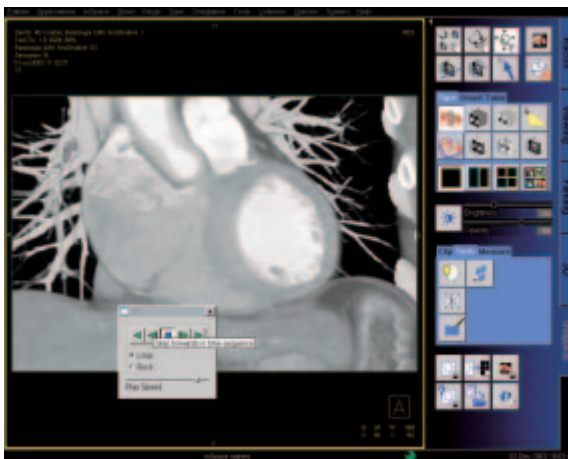
- *Digital movies*

You can generate digital movies, using various compressed AVI formats, such as MPEG 4. You can then replay movies on other computers or send them from there via the Internet or Intranet, to discuss findings with other specialists, for example.

- *Output ranges*

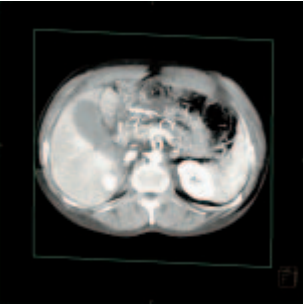
The Ranges function provides a simple way of creating a radial range series from 3D images. You can then send these series to the screen, output them on film or as a movie, or store them to the patient database.

syngo InSpace4D



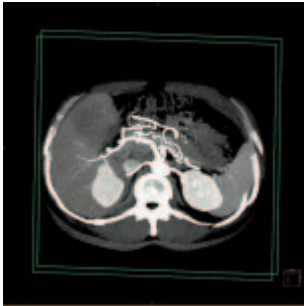
Case Examples

Soft Tissue Evaluation using Clipped VRT



1. Load series
2. Select soft tissue preset, adjust windowing as needed.
3. Enable a single clip-plane.
4. Manipulate volume to evaluate anatomy:
 - a) Orientate the clip-plane and image volume for the best view of the anatomy.
 - b) Push-pull the clip plane through the volume.
 - c) Adjust window and opacity as necessary.
 - d) Pan and zoom image as necessary.
 - e) To eliminate unwanted bone either activate clip planes or use VOI punching.
5. Measure, annotate and document as needed.

Examination of Vascular Trees, using Slab MIP



1. Load series.
2. Select slab-MIP rendering.
3. Select MIP preset, or adjust window.
4. Manipulate volume to evaluate anatomy:
 - a) Orientate the slab and image volume for the best view of the anatomy.
 - b) Push-pull the slab through the volume.
 - c) Adjust window and opacity as necessary.
 - d) Pan and zoom image as necessary.
 - e) To eliminate unwanted bone either activate clip planes or use VOI punching.
5. Measure, annotate and document as needed.
6. Optionally, create image series using radial ranges and output them either on film, local database, or as digital movie.

Vessel Analysis Using Color VRT



1. Load series.
2. Select color VRT preset.
3. Manipulate volume to evaluate anatomy:
 - a) Orientate the image volume for the best view of the anatomy.
 - b) Use clip planes to hide unwanted anatomy.
 - c) Adjust window, opacity, color and lighting effects as necessary.
 - d) Pan and zoom image as necessary.
 - e) To eliminate unwanted bone either activate clip planes or use VOI punching.
4. Use lighting for optimum 3D display (in VolumePro mode only).
5. Either select a default preset that has lighting or define your own lighting effects and set the incident light direction (usually from the front).
Lighting options and recommendations:
 - a) Shading: 80
 - b) Surface Enhancement: 20
 - c) Diffuse: 70
 - d) Highlights: 80
 - e) Shininess: 20
6. Measure, annotate and document as needed.
7. Optionally, create image series using radial ranges and output them either as a film, database, or digital movie.

You can also perform oblique MPR assessment of vessels as follows:

1. Align a single clip plane so that it cuts the vessel in the same direction as the required MPR.
2. Select Align MPR view from the Orient subtask card.
3. If necessary, also adjust MPR positions and perform measurements.

Examination of the Colon



1. Load series.
2. Select the caudo-cranial view.
3. Select double-contrast colon VRT preset.
4. The table parameters are based on a single trapezoid with the following properties:
 - a) Very narrow trapezoid.
 - b) Trapezoid positioned on the Hounsfield scale in the region of air.
 - c) Reduced opacity (opacity approx. 25).
5. To eliminate surrounding soft tissue punch out VOI. It is important to select a high punch value (around 500).
6. Manipulate volume to evaluate anatomy:
 - a) Orientate the image volume for the best view of the anatomy.
 - b) Adjust window and opacity as necessary.
 - c) Pan and zoom image as necessary.
 - d) Use a clip plane to hide parts of the colon if necessary.
7. Measure, annotate and document as needed.

syngo Vessel View

syngo Vessel View is a dedicated tool for 3D visualization and analysis of vascular structures in MR and CT data sets.

In addition to vessel analysis, this option is also useful for pre-surgical evaluation, which requires direct measurements in a 3D-volume data set.

Key Features

- 3D visualization with MPRs, MIPs, and Volume Rendering.
- VRT presets shared with the common gallery available with the *syngo* VRT option on the 3D Card.
- 3D editing with clip planes or VOI punching.
- Semi-automatic segmentation of complete vessel trees & intuitive path planning.
- Manual path planning along the vessel & manual vessel segmentation with the Tube Mode.
- Vessel Navigator which creates a Ribbon MPR for close-up evaluation of the vessel.
- Display up to 3 flags at the normal and minimum diameters or cross-sectional areas of the vessel.
- Automatic calculation of the stenotic ratio in percent.
- Straight & curved distance measurements directly in the Vessel Navigator or in the VRT segment.

- Angle measurements directly in the volume segment.
- Automatic contour detection and area calculation of the vessel lumen orthogonal to the centerline path.
- The quantification results are summarized in output tables (Reports) that can be documented as hardcopy or stored together with the corresponding images in the database.
- Setting of Annotation Texts either along the path in the VRT segment or anywhere in the 3D volume in the MPR segments to identify anatomically important coordinates.

Prerequisites

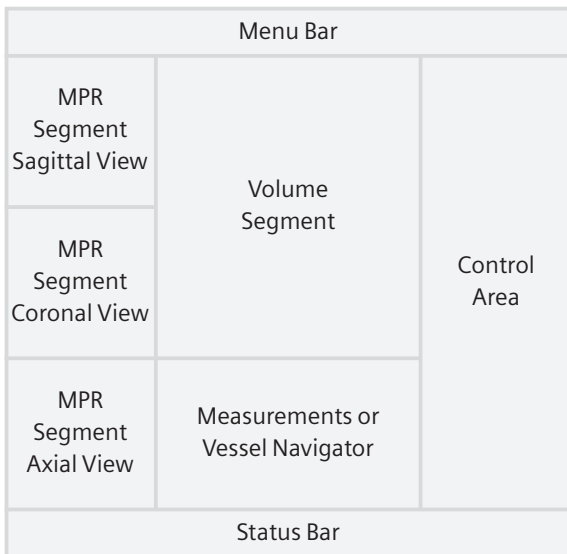
Volume data set with good opacification for vascular analysis, with overlapping thin slice and a soft kernel reconstruction is recommended.

To ensure optimal enhancement after the contrast medium injection a Test Bolus or Bolus Tracking using CARE Bolus (optional) should be used. For the coronary vessels and the large thoracic vessels, best results can be achieved with ECG-synchronized scanning using the Heart View CT (optional).

Workflow

1. Loading the Images

After loading the images into *syngo* Vessel View the following layout is displayed:



MPR Segments

The three small segments on the left are referred to as MPR Segments although these segments may also display thinMIP and thickMPR. These segments contain manipulator lines, as in the 3D Card, which allow the user to rotate and translate image planes. 2D measurements are also possible on these segments.

Volume Segment

This segment displays the complete volume data set either in VRT or MIP representation.

Hint: VRT presets are shared with the common gallery available with the VRT option on the 3D Card. Since Vessel View applies a different volume rendering algorithm that provides no “shaded” display like the 3D Card, it may be helpful to create and save your specific Vessel View VRT settings.

A green arrow, the so-called Focus Pointer indicates the current position in the volume, e.g. for creation of annotation texts. The Focus Pointer also indicates the intersection point of the three MPR segments.

The orientation cube in the lower right corner may be used to quickly change the orientation of the volume data set. Single click on one side of the cube will set the orientation of the volume to that side. Double click anywhere on the cube will set the orientation and the zoom factor of the volume back to their default values.

Vessel Navigator

The Vessel Navigator shows a longitudinal cut along the centerline of the vessel. An area curve of the vessel’s cross-sectional area is displayed as a graphical overlay on the Vessel Navigator image.

The user can move along the vessel and rotate the Vessel Navigator image about the vessel axis. The Focus Pointer (known from the Volume Segment) is represented by a green vertical line.

When moving the Focus Pointer, the three MPR Segments are synchronized to the position of the Focus Pointer.

2. Visualization

This step is used to get an initial impression of the dataset and – if necessary – remove structures, which hide the view on the structures of interest.

To get an initial impression of the dataset, the user may view it in VRT or MIP representation in the Volume Segment or page through the dataset in the MPR Segments.

Working with the VRT/MIP representation in the Volume Segment the user may typically

- Apply a VRT preset from the VRT Gallery.
- Create his own VRT preset.
- Change the W/C setting with the middle mouse button.
- Freely rotate the volume.
- Click on the Orientation Cube to quickly set the orientation to desired standard views.
- Blow up the Volume Segment to full screen size.

Working with the MPR Segments the user may typically

- Page through the axial, sagittal and coronal views.
- Change the views to any oblique/double oblique view.
- Change the W/C setting with the middle mouse button.
- Blow up one MPR Segment to go to the Volume Segment.

Working with the Vessel Navigator the user may typically

- Change W/C setting with the middle-mouse button.
- Change the Ribbon Viewer width (if less than the full vessel width or not enough surroundings are shown).
- Zoom/Pan to display the region of interest.
- Display curves of either the cross-sectional area of the vessel or a combination of the minimum, maximum and equivalent diameters along the vessel's centerline.
- Measure straight distances perpendicular to the vessel (e. g. diameter of the vessel).

syngo Vessel View

- Measure curved distances along the vessel's centerline.
- Rotate the Ribbon MPR step by step or in cine mode.
- Change the display to thinMIP.

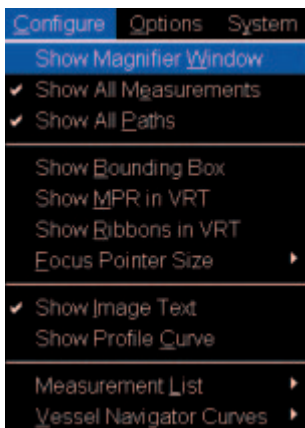
To remove unwanted structures the user may

- Punch out unwanted structures.
- Apply clip planes.

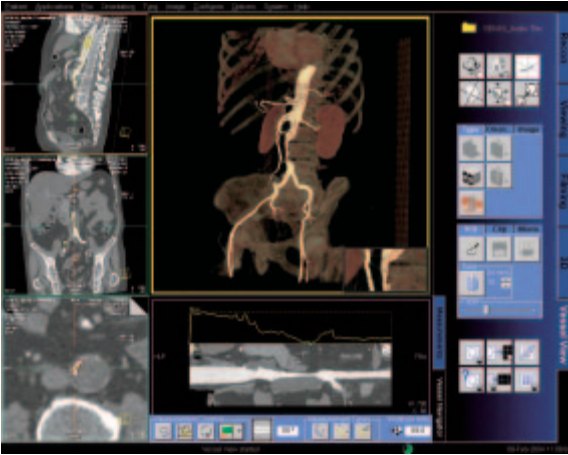
3. Segmentation

In this step, the user places certain seed points in order to identify the vessel of interest and define paths along its centerline. These paths can be the result of a semi-automatic or fully manual segmentation procedure.

- Select “Configure – Show Magnifier Window” from the main menu to set the seed points easier, mainly on small vessels.



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a) Semi-Auto Segmentation

With the Semi-Auto Segmentation all path points are automatically set by the application.

Segmentation steps:

Step 1: Choose a vascular area

(aorta, carotids, coronaries or other).

Step 2: Set one or more seed points.

There are two different types of seed points:

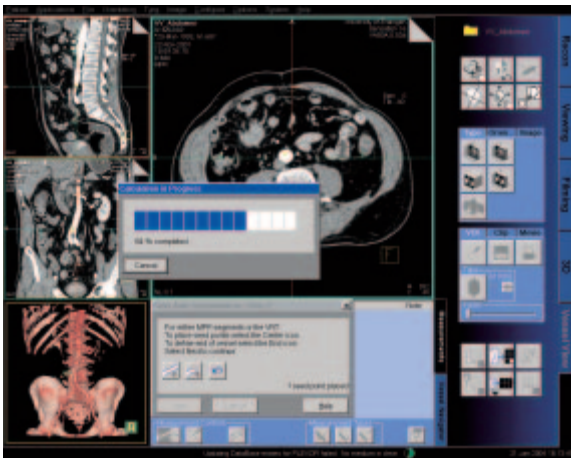
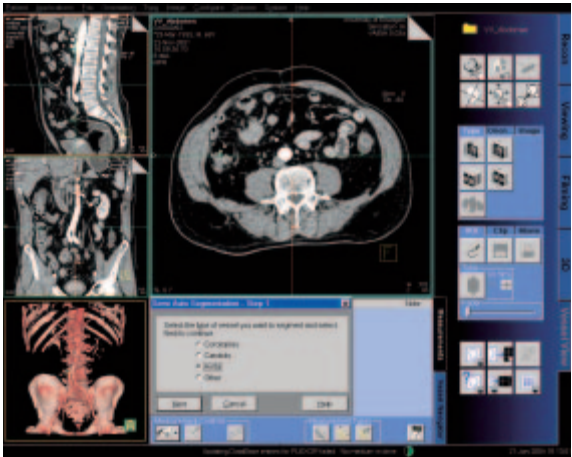
Inner points – e. g. one click for the complete aorta

End points – e. g. prevents the segmentation to run from carotids into aortic arch.

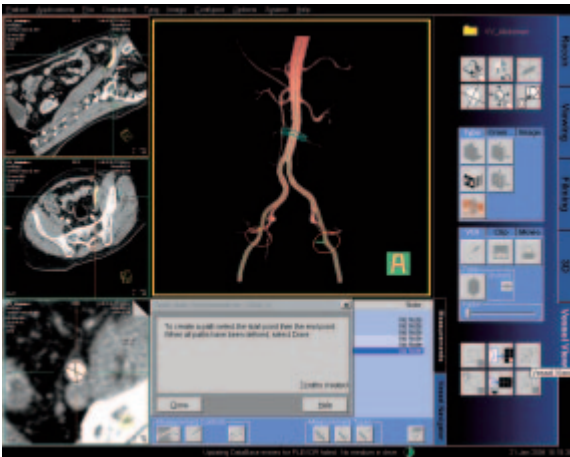
Step 3: Adjust sensitivity (threshold for segmentation).

Step 4: Define paths along the branches of the vessel tree by performing two clicks into the VRT image for each path. You may define as many paths as necessary.

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The user only has to:

- Position one or more seed points anywhere in the vessel of interest via the left mouse button.
- Position individual seed points in the most suitable image segment (Volume or MPR segment).
- Position an end point where vessel branches run into other vessels, if necessary.
- In many cases, e. g. the aorta, only one seed point is necessary to trace the whole vascular tree.
- Adjust the threshold to remove bone or any other unwanted structures. The segmentation algorithm automatically finds the vessel limits and determines the whole vessel tree.
- As a last step, plan as many paths as wanted in the Volume segment.

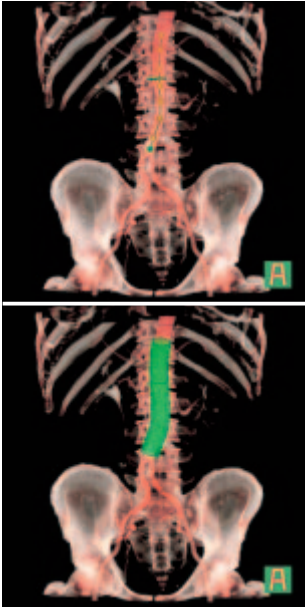
b) Manual mode

With the manual mode all path points have to be set by the user.

- Position path points at the beginning of a vessel. Wherever the vessel changes its course and at the end of the vessel.
- Position the individual path points in the most suitable image segment. (Volume or MPR segment).
- For the identification of branched vessels, position a path point where the branches join.

Depending on the number as well as accuracy used in positioning the path points, the paths represents the actual course of the blood vessel.

Manual mode does not isolate the vessel tree from the surrounding tissue and bones. For this purpose Tube Mode may be used.



Path Modification

After segmentation has been completed, each path is given a unique name. You may modify the path name, e. g. to an anatomical name and add an explanatory note to each path.

To improve the visibility of paths the translucent mode is automatically switched on after segmentation.

You can modify the course of a path in the Volume or the MPR Segment by using the Edit entry in the context sensitive menu (right mouse button).

4. Measurement Analysis

Flags

Flags are special area measurements. There are usually two or three flags associated with each path, but they can also be turned off completely. The user can move them in the Vessel Navigator and move them to healthy (one or two flags, called "Normal A" and "Normal B") and stenotic (the flag called "Minimum") parts of the vessel.

When their contours (on the Vessel Orthogonal MPR) are accepted their values are displayed in the Measurement List. Accepted area measurements and flags are shown as (planar) contours in the Volume Segment. They have the same color as their MPR counterpart.

Stenosis Ratio Values

Each path has a variable number of "Stenotic Ratio" values displaying the ratio of the "Minimum" flag to the average of the "Normal A" flag and the "Normal B" flag (if available).

Which parts of the flags are used for this ratio – area, minimum diameter, maximum diameter and/or equivalent diameter, is determined globally in the configuration dialog.

The value that is displayed is actually 100% minus the ratio (following the NASCET criteria), resulting in a perfectly healthy vessel being assigned a 0% stenosis and a totally obstructed vessel being assigned a 100% stenosis.

These values only appear in the list after the flags' contours are accepted (= validated). The names are automatically created, incrementing a number at the end. The name can then be changed by the user.

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Navigation along a path

After creating a path the MPR Segments are automatically set to the *Vessel Orthogonal Orientation*. This means that the previously “standard” axial view will now be a view orthogonal to the center line of the vessel; the previous “standard” coronal and sagittal views are now views tangential to the center line of the vessel.

The user has the ability to switch back to the *Patient Orthogonal Orientation*. This means that the MPR Segments remain in the true orthogonal orientations (axial, sagittal, coronal view) as the user scrolls along the path.

The user can set the MPR Segments individually to display the current view in MPR, MIP, thickMPR or thinMIP representation.

Using the Focus Pointer the user can move along the path and follow the Vessel Orthogonal MPR Segments.

Tube

Tube is a clipping tool, which creates a cylindrical volume following the centerline of the selected vessel. The radius of the tube can be selected by the user. Tube provides a quick way to either keep the tube volume (= the volume around the vessel) and remove the surrounding structures, or to remove the tube volume and keep the surrounding structures.

Usually this only makes sense after a manual path creation, because the segmentation does a more precise job in separating vessel from surrounding tissue.

Fader

“Removed” parts of the volume are not really deleted from the data set. Instead, they are hidden by the Fader. With the Fader, you may modify the transparency of the “removed” volume.

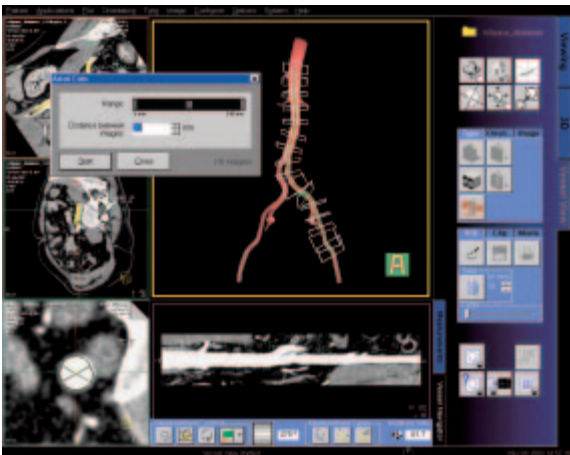
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Axial Cuts

This button is only enabled (ungrayed) when a path is selected.

- The FoV of the axial MPR image represents the FoV of the resulting "Axial Cuts" range: Zoom/pan the path orthogonal MPR image to the best view, then select button "Axial Cuts" in the control area.
- You can specify the begin and end of the range (in mm).
- You can enter a distance between the cuts. The system calculates the resulting number of slices (images).
- While this dialog is open, the VRT shows the location of the cuts as squares.
- Pressing "Cancel" hides the dialog and the squares in the VRT segment.
- Pressing "Start" saves the images to the database.



Performing measurements

The user can

- Measure straight distances in MPR and VRT views and on the Vessel Navigator (VN)
- Measure curved distances in VRT view and on the VN
- Perform automatic measurements of the vessel's cross-sectional area. After semi-automatic segmentation, a colored vessel contour is displayed on the vessel-orthogonal MPR view. The user can accept this contour as official contour.
- Draw and evaluate free-hand ROIs
- Modify existing contours
- Measure angles
- Measure volume

You can hide measurements and show them again with the menu option Configuration Show/Show All Measurements.

5. Documentation of Results

The buttons *Save to Database* and *Copy to Filmsheet* are always available. The user can always document intermediate results by these two buttons.

Hint: Save to Database and Copy to Film Sheet is always applied to the currently selected segment. Make sure that the correct segment is selected.

Save Session and Load Session

Use the menu option File/Save Session to save intermediate results of a Vessel View session. Restore the session by first loading the patient images to Vessel View and then selecting File/Load Session.

Do not delete the series VVIEW_NONIMAGE_SERIES until you have fully completed the evaluation of your patient. This series contains non-image data which is required by the Load/Session function to restore a previously interrupted session.

Create report

The Report button creates several output tables of the measurement results. These tables are automatically stored to the database and can be sent to the film sheet.

Graphical documentation of measurements

The Measurement List displays all measurements created in this session. Selecting an entry of this list will display the VRT- and MPR images associated with this measurement. The user can then apply the buttons *Save to Database* and *Copy to Filmsheet* to the relevant segments.

AVI-File of Volume Segment and Vessel Navigator image

The user can generate an avi-file of the Volume Segment or the Vessel Navigator image rotating around the vessel axis depending on which segment is currently selected.

Case Examples

Workflow for an Aortic Aneurysm Case

Visualization

Use VRT settings and window settings for good visualization of the aortic and iliac arteries.

Adjust the VRT view by using presets from the VRT Gallery. You can fine-tune the settings by adjusting the trapezoids in the definition card.

If necessary, remove unwanted volume structures by using the Clip Plane or the VOI Punch function.

Hint: “Removed” parts of the volume are not really deleted from the data set. Instead, they are hidden by the Fader. With the Fader you can modify the transparency of the “removed” volume parts.

Semi-Automatic Segmentation

Activate the semi-automatic segmentation mode.

Place inner seed points into the aorta. In many cases, one seed point is sufficient. Place the seed points either in the MPR segments or in the VRT segment.

As soon as the user presses the “Next” button, an automatic segmentation will be performed and keep mainly the aortic lumen. After segmentation, the translucent mode is automatically switched on.

Define paths along the aorta or other vessel branches by two clicks for each path.

Editing & Merging Paths

Following segmentation of the aorta, the resultant paths are shown as a list on the Measurement Card.

You can edit the paths by repositioning the path points along the path into the center of the vessel lumen.

You can also merge paths by selecting two paths from the Measurement Card at a time and clicking the “Merge” button.

Measurements

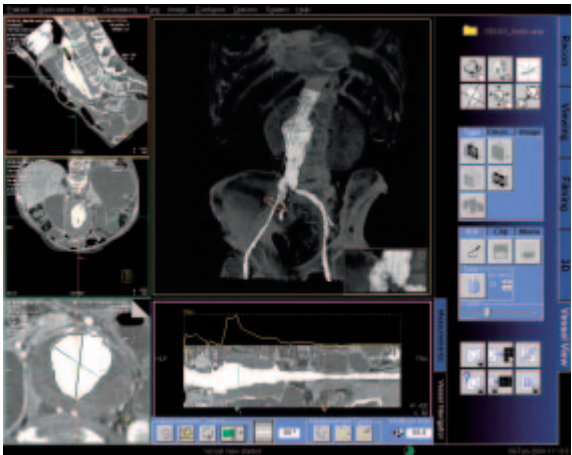
Select the path of interest on the Measurements Card.

Move the Focus Pointer, e. g. by dragging the green vertical line in the Vessel Navigator.

The 3 MPR segments are now displayed orthogonal to the path. These images will be updated as you change the position of the Focus Pointer.

The following measurements can be performed:

1. Curved Distance directly in the Vessel Navigator e. g. origins of the renal arteries to neck of the aneurysm.
2. Curved Distance in the central long axis of the aneurysm between the upper and lower necks of the aneurysm.
3. Straight Distance for maximum diameter of the aneurysm or any of the aortic branches, i. e. the iliac arteries.
4. Automatic contouring and area calculation of the lumen of the aneurysm or the aortic branches, i. e. the iliac arteries.
5. Angle Measurement



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Workflow for a Coronary CTA Case, e. g. LM and LAD

Visualization

Use VRT settings and window settings for good visualization of the Left Main (LM) and the Left Anterior Descending Artery (LAD).

Adjust the VRT view by using presets from the VRT Gallery. You can fine-tune the settings by adjusting the trapezoids in the definition card.

If necessary, remove unwanted volume structures by using the Clip Plane or the VO Punch function.

Hint: “Removed” parts of the volume are not really deleted from the data set. Instead, they are hidden by the Fader. With the Fader you can modify the transparency of the “removed” volume parts.

Change all MPR segments to 5 mm thin MIP for better visualization of the coronary arteries.

Semi-Automatic Segmentation

Activate the semi-automatic segmentation mode.

Place two end points into the ascending aorta, one above and one below the bifurcation of the coronary arteries.

Hint: If you place the seed points in the MPR segments, you do not need to isolate the heart in the VRT segment. But make sure you switch the MPR segments from 5 mm thin MIP back to standard MPR prior to placing the seed points as seed points cannot be placed on thin MIP or MIP images.

As soon as the user presses the “Next” button, an automatic segmentation will be performed and keep mainly the coronary tree and part of the ascending aorta. After segmentation, the translucent mode is automatically switched on.

Define paths along the coronaries by two clicks for each path.

Editing & Merging Paths

Following segmentation of the aorta, the resultant paths are shown as a list on the Measurement Card.

You can edit the paths by repositioning the path points along the path into the center of the vessel lumen.

You can also merge paths by selecting two paths from the Measurement Card at a time and clicking the "Merge" button.

Measurements

Select the Vessel Navigator for close-up evaluation of the coronary artery.

A Ribbon/Longitudinal MPR along the path is displayed.

Zoom up the MPR display to the region of interest e. g. a stenosis in the vessel.

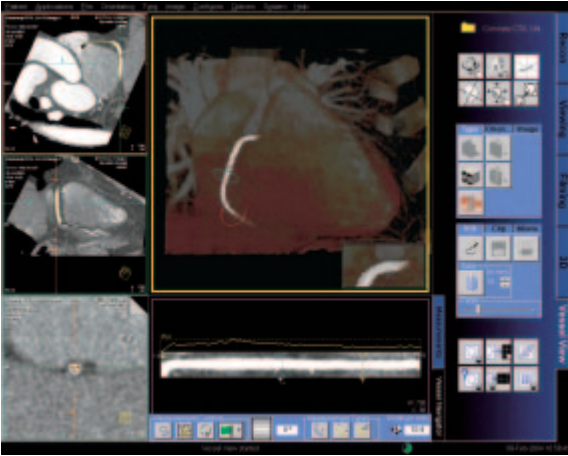
You can rotate the MPR plane by using the Movie function. Choose a plane that demonstrates the tightest stenosis.

You can move the Focus Pointer along the vessel by dragging the green vertical line in the Vessel Navigator.

The following measurements can be performed:

1. On the Vessel Navigator, vessel diameters at the stenosis as well as proximal and distal to the stenosis by placing straight distance measurements.
2. On the Vessel Navigator, length of the stenosis along the vessel center line by measuring the curved distance between the proximal and distal positions of the narrowing.
3. On MPR views, luminal areas at the stenosis (narrowest part of the vessel), proximal and distal to the stenosis by using the automatic contouring and area calculation functions.

For a more accurate evaluation, it is essential to repeat the measurements from a second plane, at 90° to the first plane. This is essential in assessing a lesion with non-concentric narrowing.



Workflow for a Carotid Stenosis Case

Visualization

Use VRT settings and window settings for good visualization of the carotids.

Adjust the VRT view by using presets from the VRT Gallery. You can fine-tune the settings by adjusting the trapezoids in the definition card.

If necessary, remove unwanted volume structures by using the Clip Plane or the VO Punch function.

Hint: "Removed" parts of the volume are not really deleted from the data set. Instead, they are hidden by the Fader. With the Fader you can modify the transparency of the "removed" volume parts.

Semi-Automatic Segmentation

Activate the semi-automatic segmentation mode.

Place inner seed points into the carotid of interest. In many cases, one seed point is sufficient. Place the seed points either in the MPR segments or in the VRT segment.

As soon as the user presses the "Next" button, an automatic segmentation will be performed and keep mainly the aortic lumen. After segmentation, the translucent mode is automatically switched on.

Define paths along the carotid by two clicks for each path.

Editing & Merging Paths

Following segmentation of the aorta, the resultant paths are shown as a list on the Measurement Card.

You can edit the paths by repositioning the path points along the path into the center of the vessel lumen.

You can also merge paths by selecting two paths from the Measurement Card at a time and clicking the "Merge" button.

Measurements

Select the Vessel Navigator for close-up evaluation of the carotids.

A Ribbon/Longitudinal MPR along the path is displayed.

Zoom up the MPR display to the region of interest e. g. a stenosis in the vessel.

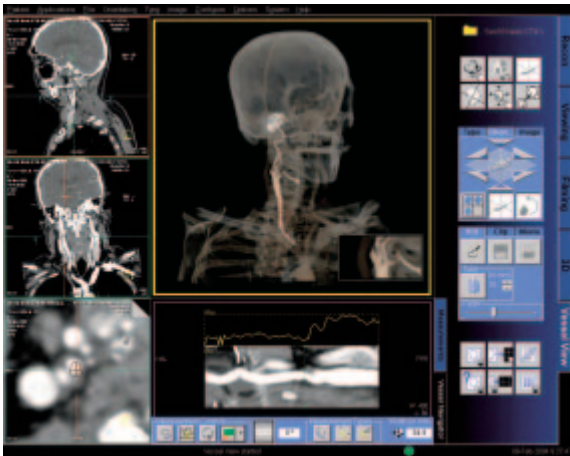
You can rotate the MPR plane by using the Movie function. Choose a plane that demonstrates the tightest stenosis.

You can move the Focus Pointer along the vessel by dragging on the green vertical line in the Vessel Navigator.

The following measurements can be performed:

1. On the Vessel Navigator, vessel diameters at the stenosis as well as proximal and distal to the stenosis by placing Straight Distance measurements.
2. On the Vessel Navigator, length of the stenosis along the vessel center line by measuring the curved distance between the proximal and distal positions of the narrowing.
3. On MPR views, luminal areas at the stenosis (narrowest part of the vessel), proximal and distal to the stenosis by using the automatic contouring and area calculation functions.

syngo Vessel View



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