SIEMENS

Algorithm Validation ToolKit
AVT2EXT

[redacted] **SCR-CMIV**

Measurement Variability Tool
User Manual
R1.0

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CMIV

SCR-CMIV

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Signature:	.....	Signature:	.....

History

Document History

Version/ Status	Date of Issue	Author	Change and Reason of Change / Change Request/CHARM

History of released Versions

Version	Release date	Product Version

Table of Contents

1 Introduction

Validity of this Document

This document is only valid for the Measurement Variability Tool Application revision 556.

Safekeeping of User Documentation

Always store User Documentation in an easily accessible location in the vicinity of the system.

Conventions Used in This User Manual

The following conventions are used in this *User Manual*:

- A command followed by the > sign indicates that the command has subcommands. For example, Filter > Gaussian.
- The names of workflow functions, pages, browsers, menus, buttons, and dialog boxes appear in bold type. For example:
  - On the **Patient** menu, click **Export**, and then click **OK**.
- Buttons are represented pictorially in procedures, as appropriate.
- **Names and Parameters:** All parameters and images shown in this document are examples. Only the parameters displayed by the application are valid. Configuration-dependent designations, such as names of drives, network nodes, and databases used in this document, are usually not the same as the designations to be found on a particular installation of the application.

2 Getting Started

Application Startup

Before you start the MVT application, make sure that the following requirements are met.

- Installation of Java 6 SDK preferably jdk1.6.0_10 or later

  NOTE: AVT/XIP does not appear to be compatible with 64bit installations of Java. Download the 32bit version and be sure you also set your JAVA_HOME variable to point to the 32bit version if you have more than one version of Java installed.
- R Statistical Package preferably R 2.8.0
- Graphics card supporting OpenGL 2.0 with hardware shaders
- Minimum 1280x1024 pixel display
- 256MB graphics memory required (512MB preferred)
- DB2 Express C 9.7 from http://www-01.ibm.com/software/data/db2/express/ (version 9.5 or later may work).

If your OS is Windows XP, please change to Windows Classic theme.

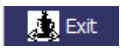
Start up MVT

1. Click the **AVT** startup icon to start the XIP Host;
2. In the AD tab-card, enter the query criteria;
3. Click **Search AD**;
4. Check the checkbox in front of the (many) selected **series** in the queried results;
5. Check the **AIM plus SEG** box above the **Retrieve** button;
6. Click **Retrieve**;
7. After all the files have been listed in the left pane of window, click "**MVT**" to open the **MVT** application;

-or-

1. Click the **AVT** startup icon to start the main programmer;
2. Click "**C:**" in the upper right corner of **AVT** interface to load annotations from the local folder;
3. After all the files have been listed in the left pane of window, click "**MVT**" to open the **MVT** application.

Application Exit

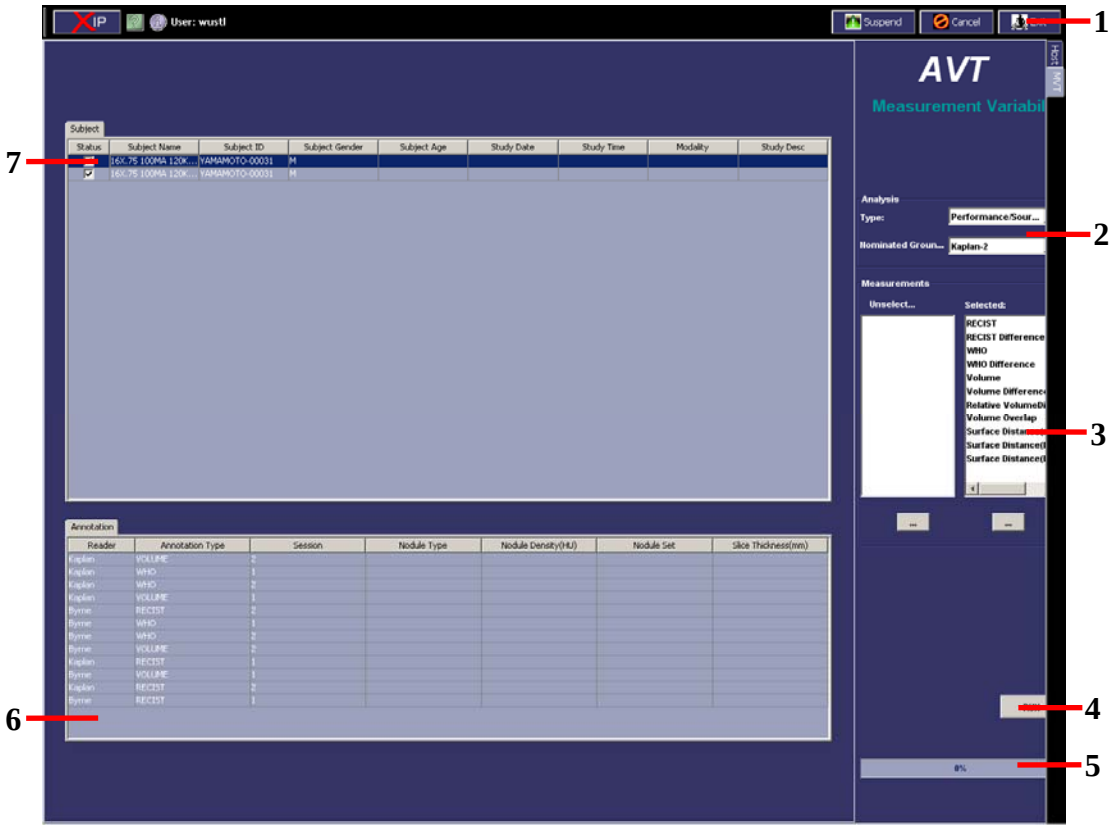
Exit the MVT application by clicking the 

button at the upper right corner of the screen.

3 User Interface

The AVT application provides the following startup interface.

Figure 1: Startup user interface



Legend No.	Area on the interface	Description
1	Menu bar	Horizontal area at the top of the screen
2	Analysis type selection panel	Panel on the top-right area.
3	Measurements selection panel	Panel in the middle of the right side.
4	RUN button	Main control button that invokes computation.
5	Status bar	Horizontal area at the bottom-right of the screen with computation status.

6	Annotation list	Bottom area of the main body with annotation information, such as “Reader” ”Annotation Type” ”Session”, etc.
7	Subject list	Top area of the main body. Available subject items will show here.

The AVT application provides the following analysis interface.

Figure 2: Analysis user interface

Legend No.	Area on the interface	Description
1	Menu bar	Horizontal area at the top of the screen
2	Statistics control area	Top area on the right side.
3	Outlier control area	Middle area on the right side.
4	Plotting control area	Bottom area on the right side.
5	Control buttons	Buttons showing their functions.

6	Status bar	Horizontal area at the bottom of the right side with computation status.
7	Image area	Large area at the bottom-left of the screen to show MPR images.
8	Subtask cards	Middle area on the left side with “Statistics” ”Outlier” and” Plotting” tabs.
9	Computation Results list	Top area on the left side with computation results.

Shortcut Keys

The MVT application provides the following keyboard shortcuts to perform the basic operations as shown in the following table

Standard key	**Function**
Up Arrow	Move the active item one row up in the same column
Down Arrow	Move the active item one row down in the same column
Left Arrow	Move the active item one column left in the same row
Right Arrow	Move the active item one column right in the same row

Mouse Events

The application can use the following mouse button associations.

Mouse Event	**Location**	**Function**
Left-Click	pane	Select the active pane
Right-Click	pane	Select the active pane
Left-Drag	Image center	Move the image
Right-Drag	Image	Adjust the window size and window level
Left-Drag	Image boundary	Zoom in/out

System bar

The system bar provides commands for loading and system command

	Return to XIP host interface
	Display the XIP help content in command window
	Display XIP information (version, developer, contact)
	Suspend the current application processing that is in progress
	Cancel the current application processing that is in progress
	Exit the MVT application

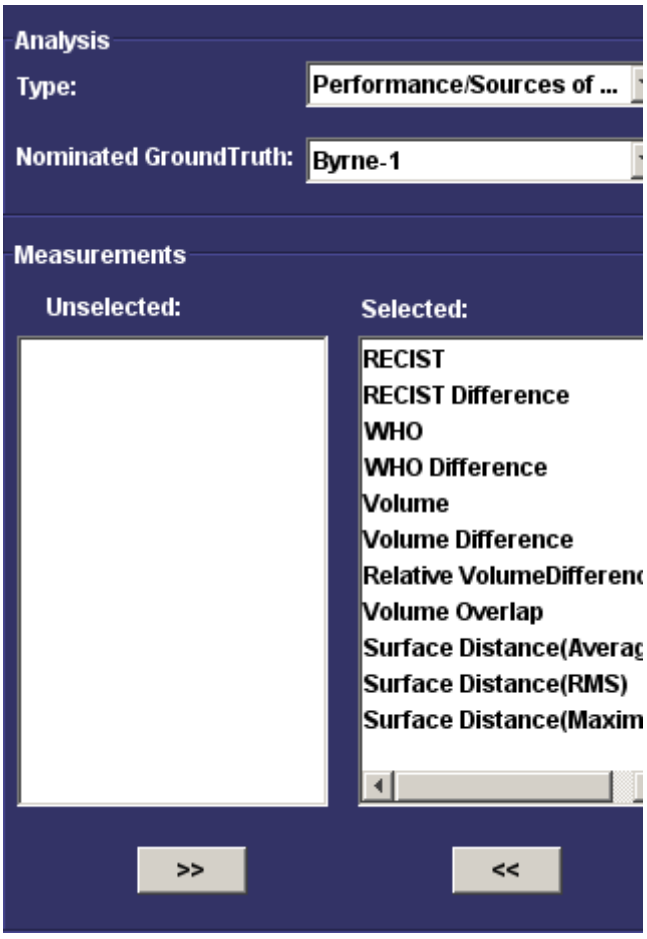
4 Functions Overview

4.1 Start-up

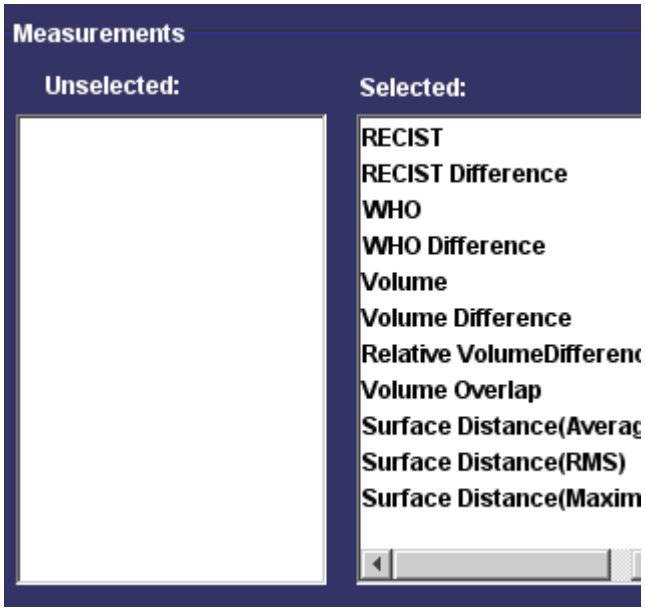
4.1.1 Analysis type and measurements selection

The MVT provides following panels to set analysis type and measurements.

Figure 3: Analysis type and measurements selection panel



Item	Description
	Available analysis types include: ○ Reader Variability; ○ Performance/Source of Variation (default)

	○ For **Performance/Source of Variation,** you need to set a nominal ground truth, by selecting one "reader" as the "oracle" who supposedly knows the truth. ○ For **Reader Variability**, this setting is unavailable.
	Available measurements include: ○ RECIST ○ RECIST Difference ○ WHO ○ WHO Difference ○ Volume ○ Volume Difference ○ Relative Volume Difference ○ Surface Distance (Average) ○ Surface Distance (RMS) ○ Surface Distance (Maximum) ○ Volume Overlap
<<	Remove the selected measurement from the "Selected" item lists
>>	Add the selected measurement to the "Selected" item lists

Tips:

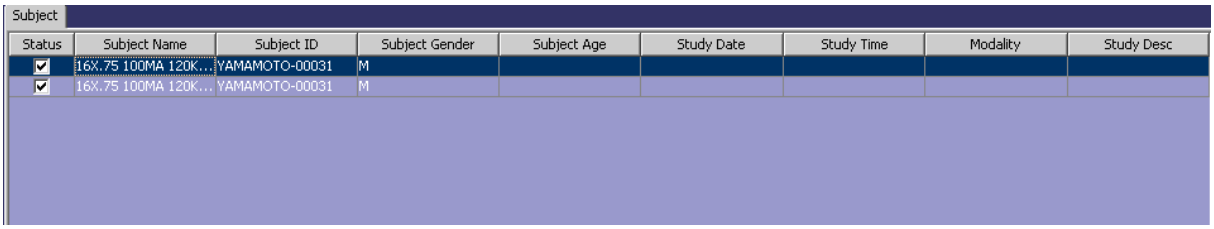
- *If you select more than one comparison to add or remove, clicking the button will only move one of them, but repeated clicking will move the rest of them.*
- *There is no restriction to the number of readers supported or the number of times the reader annotates the same image.*

4.1.2 Subject[1] list

MVT provides the following subject list in startup window.

Figure 4: Subject list

[1] The definition of "subject" depends on the experiment. For the sample data supplied, each physical tumor is a different subject, which appears in one or more series, each of which is read by one or more readers, each reading it one or more times.



Tips:

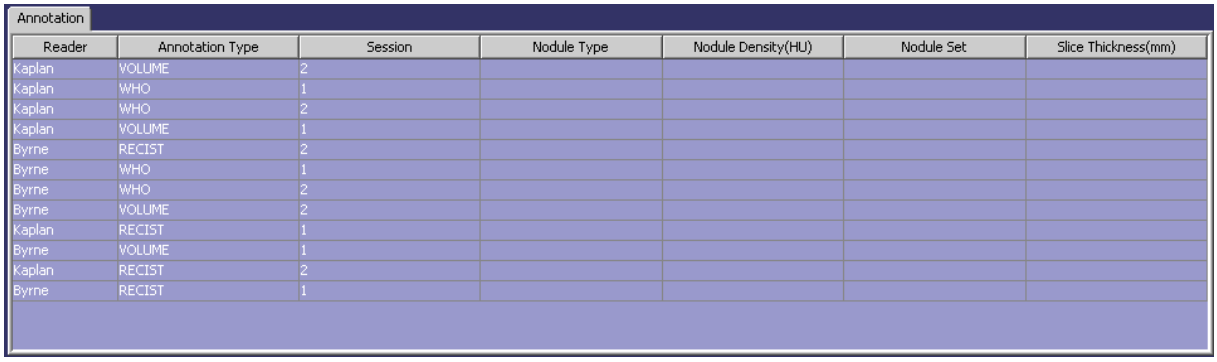
- *By default, all items are selected. You can uncheck corresponding boxes to exclude unnecessary cases.*
- *Click one of the items, its annotation information will be shown in "Annotation list".(See blow)*

4.1.3 Annotation list

- Click one of the items in "Subject list", its annotation information will be shown in "Annotation list".

MVT provides the following "Annotation list" with annotation information including: reader, annotation type, session, nodule type, nodule density (HU), nodule set and slice thickness.

Figure 5: Annotation list



4.2 Analysis

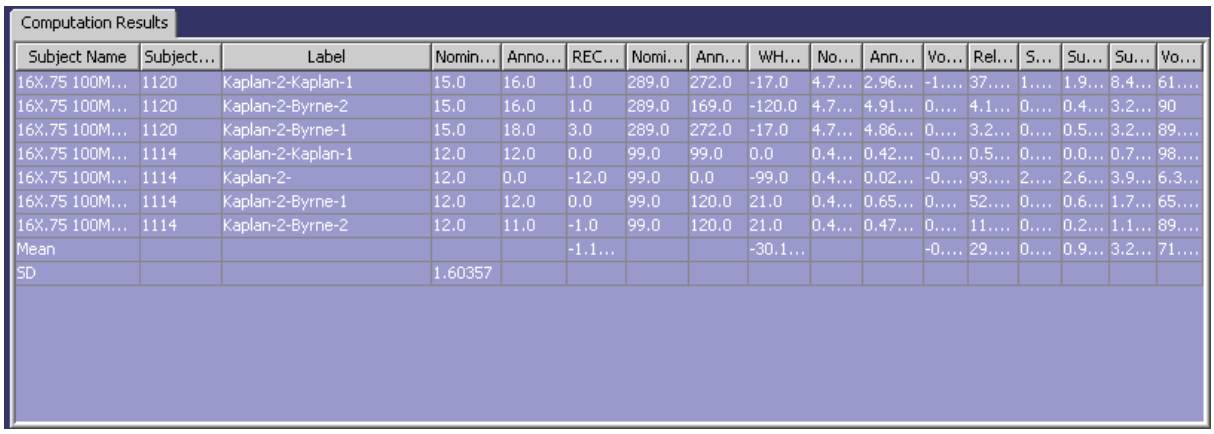
Control Buttons

Item	Description
BACK	Back to startup window.
RUN	Run statistics analysis and outlier analysis.
PLOT	Plot statistical charts.

Computation results list

- After clicking **RUN** button in startup window, the UI is changed to analysis window. Computation results will be shown in Computation results list.
- After clicking **RUN** button, statistical analysis results of **Mean** and **SD** will also be shown in Computation results list

Figure 6: Computation results list

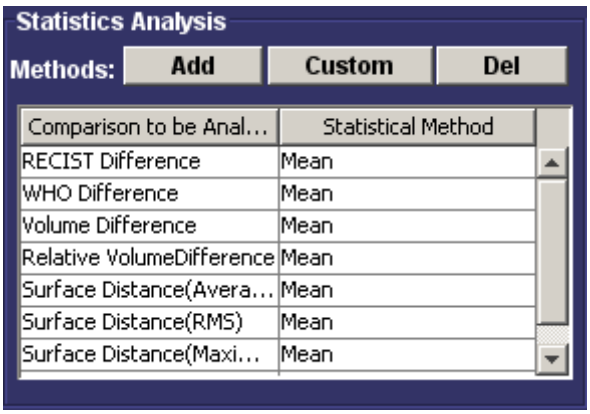


Subject Name	Subject...	Label	Nomin...	Anno...	REC...	Nomi...	Ann...	WH...	No...	Ann...	Vo...	Rel...	S...	Su...	Su...	Vo...
16X.75 100M...	1120	Kaplan-2-Kaplan-1	15.0	16.0	1.0	289.0	272.0	-17.0	4.7...	2.96...	-1....	37....	1....	1.9...	8.4...	61....
16X.75 100M...	1120	Kaplan-2-Byrne-2	15.0	16.0	1.0	289.0	169.0	-120.0	4.7...	4.91...	0....	4.1...	0....	0.4...	3.2...	90
16X.75 100M...	1120	Kaplan-2-Byrne-1	15.0	18.0	3.0	289.0	272.0	-17.0	4.7...	4.86...	0....	3.2...	0....	0.5...	3.2...	89....
16X.75 100M...	1114	Kaplan-2-Kaplan-1	12.0	12.0	0.0	99.0	99.0	0.0	0.4...	0.42...	-0....	0.5...	0....	0.0...	0.7...	98....
16X.75 100M...	1114	Kaplan-2-	12.0	0.0	-12.0	99.0	0.0	-99.0	0.4...	0.02...	-0....	93....	2....	2.6...	3.9...	6.3...
16X.75 100M...	1114	Kaplan-2-Byrne-1	12.0	12.0	0.0	99.0	120.0	21.0	0.4...	0.65...	0....	52....	0....	0.6...	1.7...	65....
16X.75 100M...	1114	Kaplan-2-Byrne-2	12.0	11.0	-1.0	99.0	120.0	21.0	0.4...	0.47...	0....	11....	0....	0.2...	1.1...	89....
Mean					-1.1...			-30.1...			-0....	29....	0....	0.9...	3.2...	71....
SD			1.60357													

If you had chosen Reader Variability instead of Performance/Sources of Variation as the analysis method, the Results window would contain two tabs, for inter-reader and intra-reader results. All of the analysis methods in the remainder of this manual are applied to whichever result table is visible when they are executed.

4.2.1 Statistics analysis

Figure 7: Statistics analysis panel



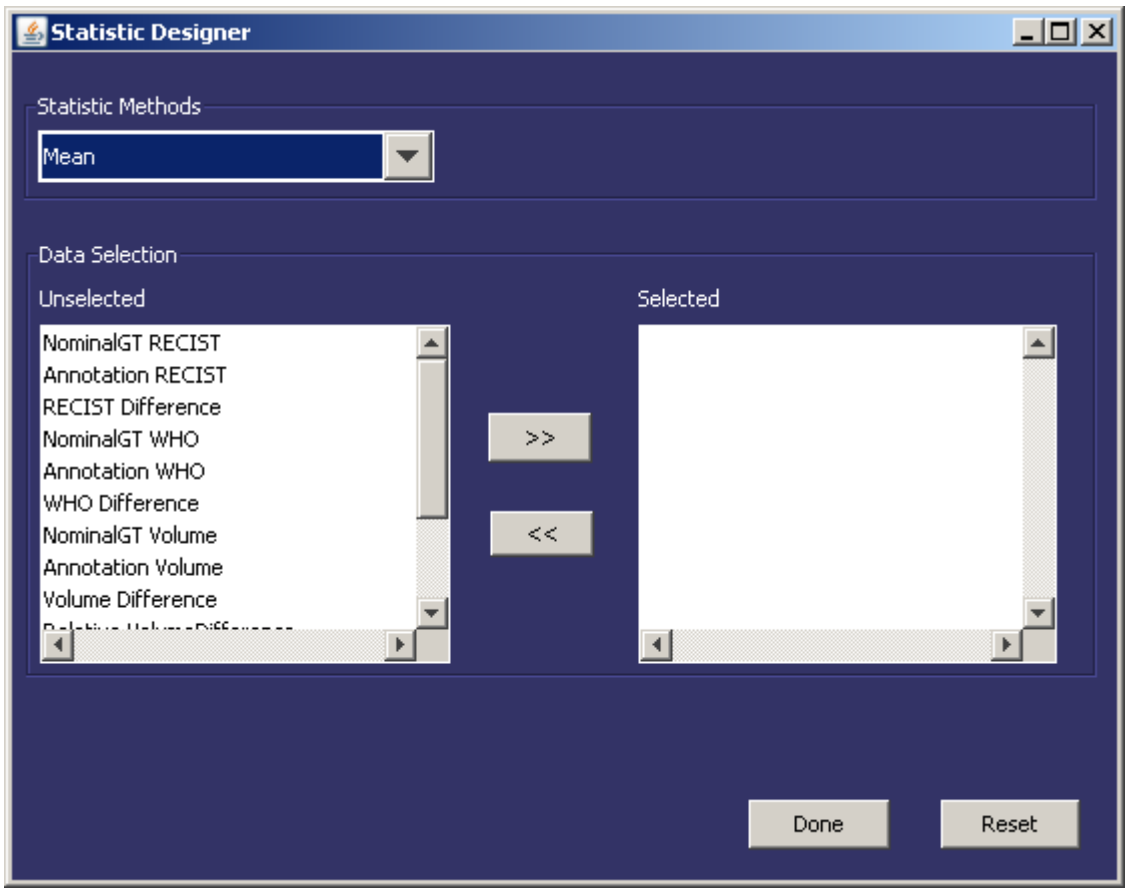
Item	Description
Add	Open **Statistic Designer** dialog box to add a statistical method. See also "**Statistic Designer".**
Custom	Open **Script Designer** dialog box to design a customized method. See also "**Script Designer**".

Del	Delete a selected statistical method in the list.

Statistic Designer

- Click **Add** in "Statistics Analysis", "Statistic Designer" dialog is opened

Figure 8: Statistic designer dialog



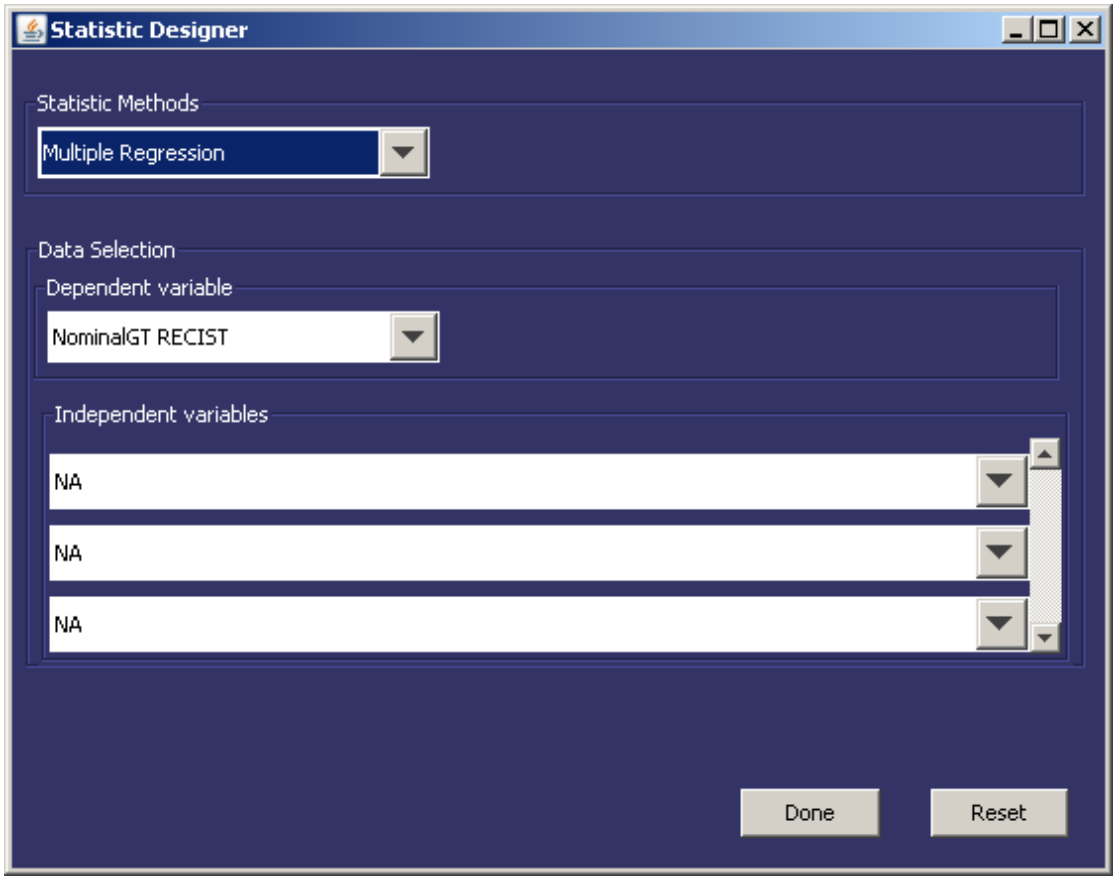
Item	Description
	Select a statistical method from the pull-down list. Choices are: mean, standard deviation, multiple regression and N-way ANOVA.
	Available measurements to be analyzed for mean and standard deviation include(Other cases see “Multiple Regression Analysis” and “N-way ANOVA Analysis”): ○ NominalGT RECIST ○ Annotation RECIST ○ RECIST Difference ○ NominalGT WHO ○ Annotation WHO

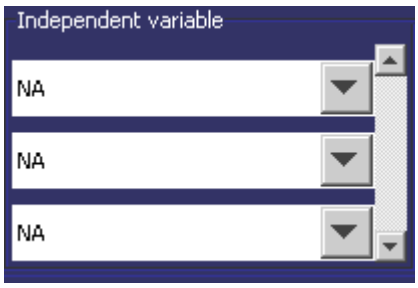
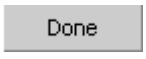
	○ WHO Difference ○ NominalGT Volume ○ Annotation Volume ○ Volume Difference ○ Relative Volume Difference ○ Surface Distance (Average) ○ Surface Distance (RMS) ○ Surface Distance (Maximum) ○ Volume Overlap
>>	Add one measurement to the selected list.
<<	Remove one selected measurement from the selected list
Done	Complete setting and add the method to the "Methods" list
Reset	Reset the statistic method settings
✕	Close the dialog

Multiple Regression Analysis

- Select Statistic Methods --> **Multiple Regression**

Figure 9: Multiple regression statistics analysis

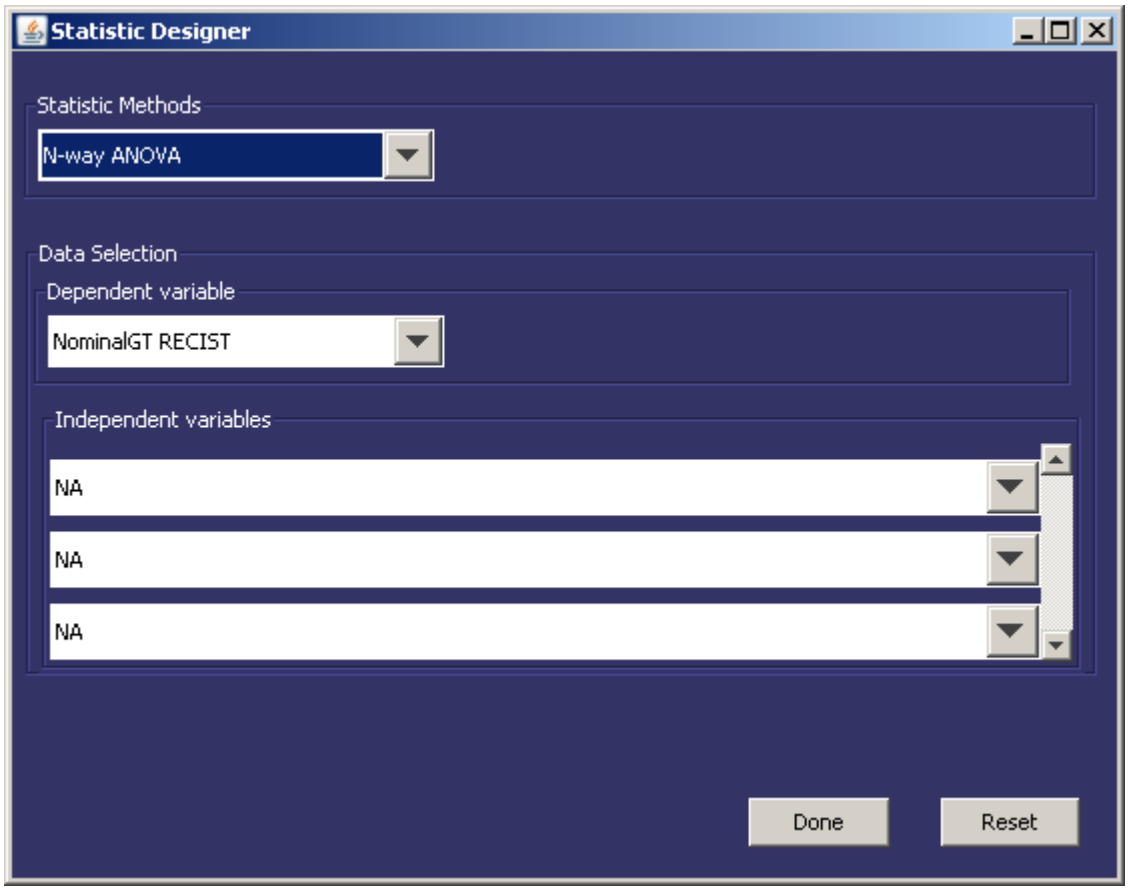


Item	Description
	Select Statistic Methods to "Multiple Regression"
	Select a dependent variable from the pull-down list. Available dependent variables include: ○ NominalGT RECIST ○ Annotation RECIST ○ RECIST Difference ○ NominalGT WHO ○ Annotation WHO ○ WHO Difference ○ NominalGT Volume ○ Annotation Volume ○ Volume Difference ○ Relative Volume Difference ○ Surface Distance (Average) ○ Surface Distance (RMS) ○ Surface Distance (Maximum) ○ Volume Overlap
	Select independent variables from the pull-down list provided. Available independent variables include: ○ Gender ○ Exposure ○ Pitch ○ Collimation ○ Reconstruction kernel ○ Slice Thickness
	Complete setting and add the method to the "Methods" list
	Reset the statistic method settings
	Close the dialog

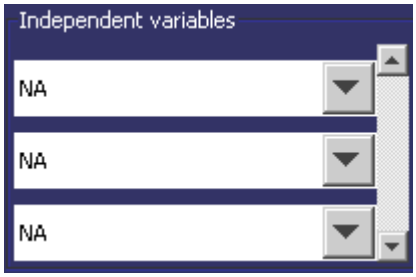
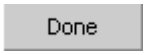
N-Way ANOVA Analysis

- Select Statistic Methods --> **N-way ANOVA**

Figure 10: N-way ANOVA statistics analysis



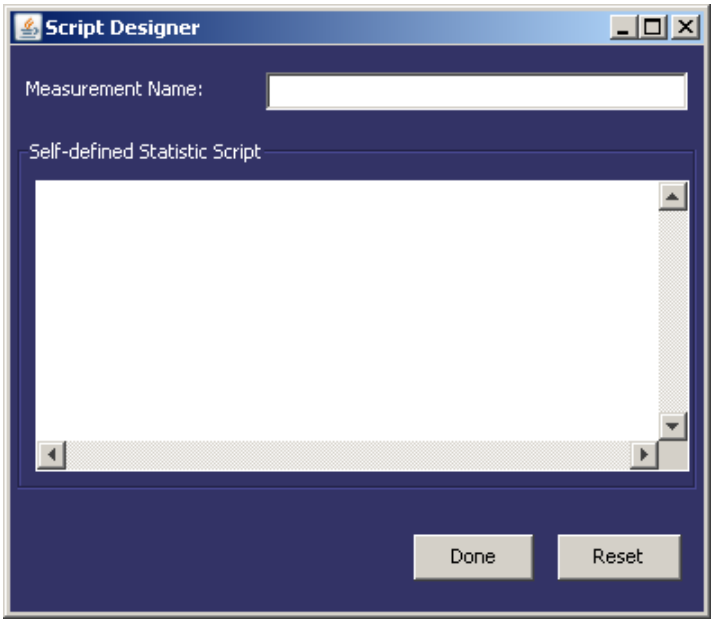
Item	Description
	Select Statistic Methods to "N-way ANOVA"
	Select a dependent variable from the pull-down list. Available dependent variables include: o NominalGT RECIST o Annotation RECIST o RECIST Difference o NominalGT WHO o Annotation WHO o WHO Difference o NominalGT Volume o Annotation Volume o Volume Difference o Relative Volume Difference o Surface Distance (Average) o Surface Distance (RMS) o Surface Distance (Maximum) o Volume Overlap

	Select independent variables from the pull-down list provided. Available independent variables include: ○ NominalGT RECIST ○ Annotation RECIST ○ RECIST Difference ○ NominalGT WHO ○ Annotation WHO ○ WHO Difference ○ NominalGT Volume ○ Annotation Volume ○ Volume Difference ○ Relative Volume Difference ○ Surface Distance (Average) ○ Surface Distance (RMS) ○ Surface Distance (Maximum) ○ Volume Overlap
	Complete setting and add the method to the "Methods" list
	Reset the statistic method settings
	Close the dialog

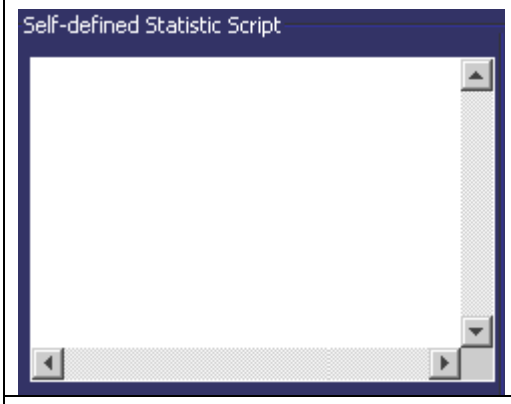
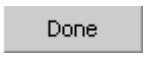
Script Designer

- Click **Custom** "Statistics Analysis" ,"Script Designer" dialog is opened

Figure 11: Script Designer



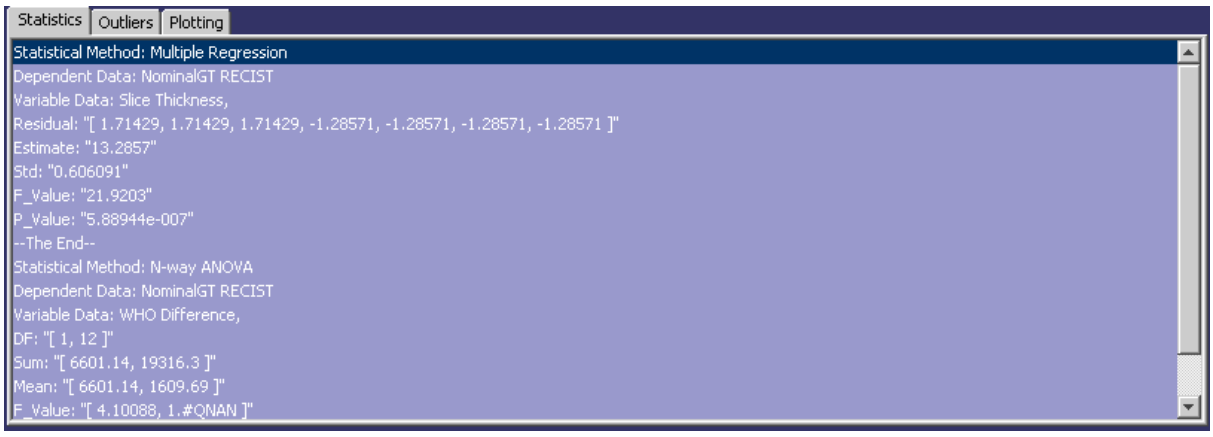
Item	Description

	Define a method name
	Input the R script
	Finish the input and add the script to the Methods list
	Clear the inputs
	Close the dialog

Statistics Tab

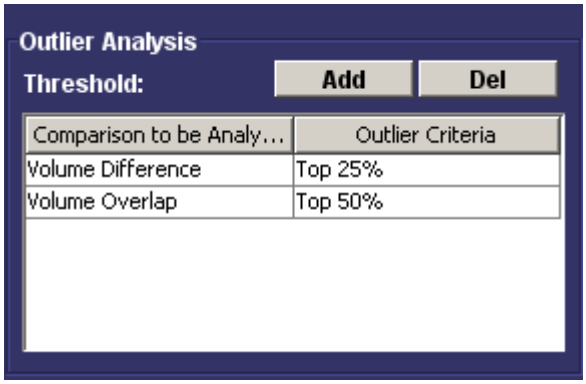
- After clicking **RUN** button, statistical results of **Multiple Regression** and **N-way ANOVA** will show in Statistics Tab.

Figure 12: Statistics tab



4.2.2 Outlier analysis

Figure 13: Outlier analysis area

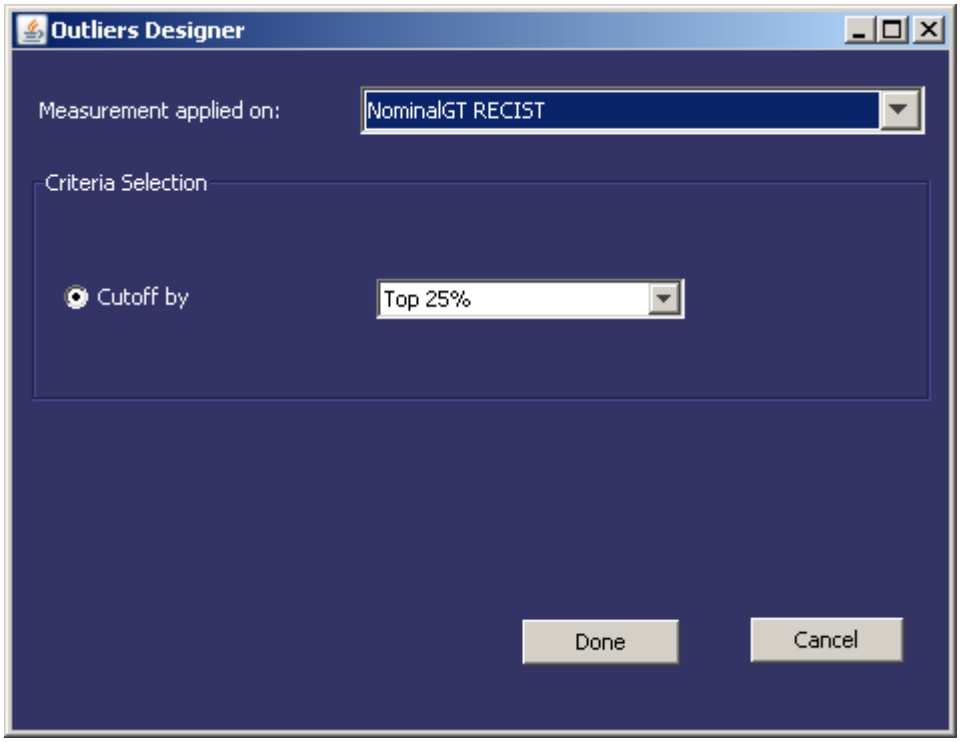


Item	Description
Add	Open **Outlier Designer** dialog to add an outlier identification method. See also “**Outlier Designer**”.
Del	Delete a selected outlier identification method in the list

Outlier Designer

- Click **Add** in "Outlier Analysis”, "Outlier Designer" dialog is opened

Figure 14: Outlier designer



Item	Description

Item	Description
	Select one measurement from the list box. The available measurements are listed as follows: o NominalGT RECIST o Annotation RECIST o RECIST Difference o NominalGT WHO o Annotation WHO o WHO Difference o NominalGT Volume o Annotation Volume o Volume Difference o Relative Volume Difference o Surface Distance (Average) o Surface Distance (RMS) o Surface Distance (Maximum) o Volume Overlap
	Select the numerical cut-off, chosen from o Top 25% o Top 50% o Bottom 25% o Bottom 50%
	Save the changes and add to the Criteria list
	Discard the change and close dialog
	Close the dialog

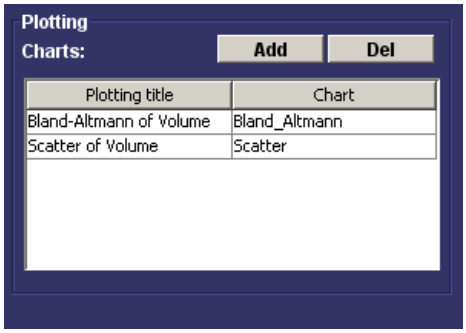
Outlier Tab

- After clicking **RUN** button, the outlier analysis results will show in the "Outliers" tab.

Figure 15: Outlier Tab

4.2.3 Statistical plotting

Figure 16: Plotting control area

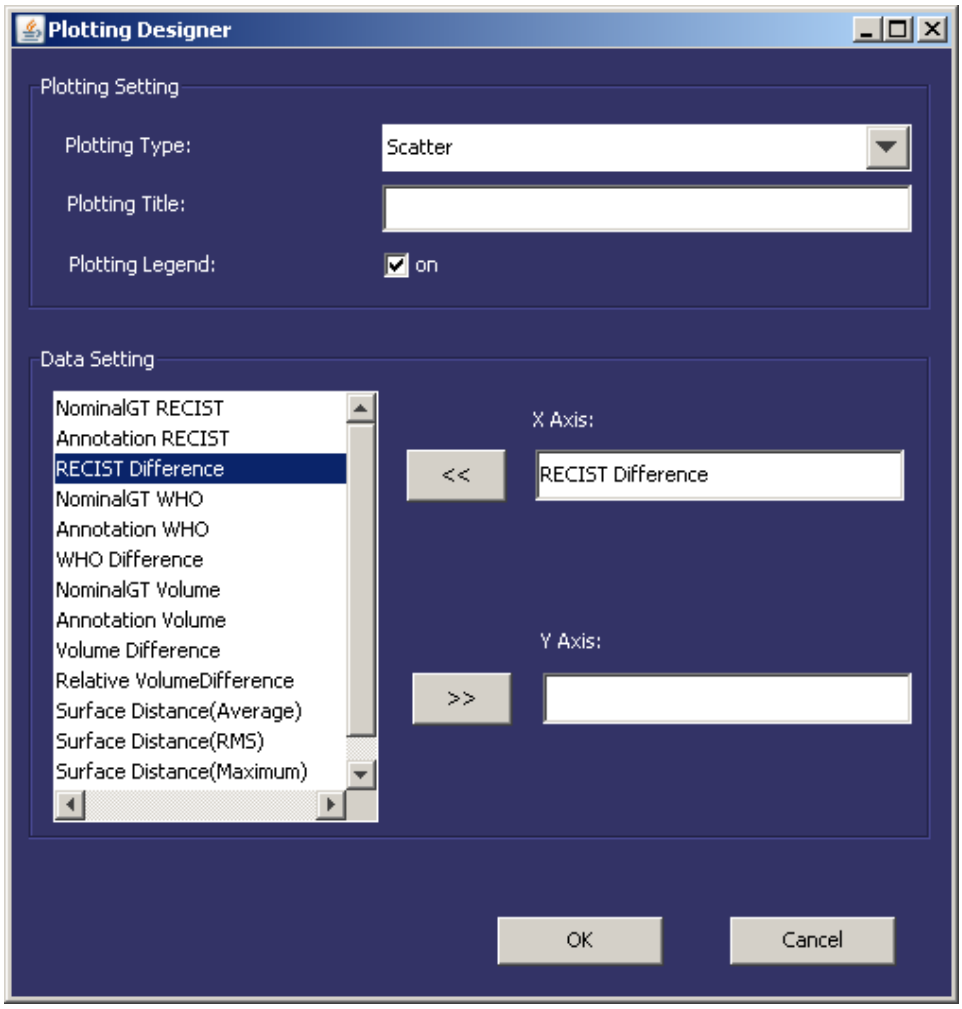


Item	Description
Add	Open **Plotting Designer** dialog box to add a plotting chart. See also “**Plotting Designer**”.
Del	Delete a selected plotting chart

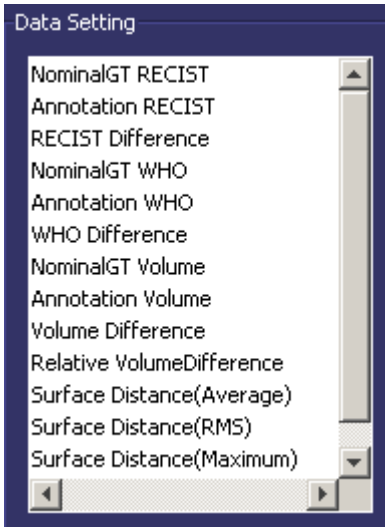
Plotting Designer

- Click **Add** in "Plotting"; "Plotting Designer" dialog is opened.

Figure 17: Plotting designer



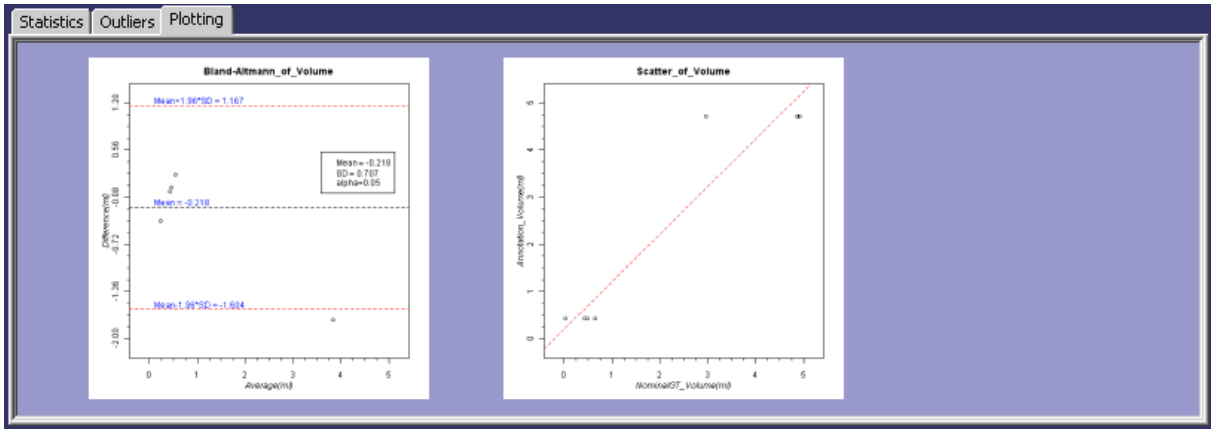
Item	Description
	Select plotting type from the pull-down list Available Plotting Types include: o Scatter plot o Bland-Altmann plot o Histogram
	Input the title of the chart
	Add/remove the legend to the chart

	Available data items include: ○ NominalGT RECIST ○ Annotation RECIST ○ RECIST Difference ○ NominalGT WHO ○ Annotation WHO ○ WHO Difference ○ NominalGT Volume ○ Annotation Volume ○ Volume Difference ○ Relative Volume Difference ○ Surface Distance (Average) ○ Surface Distance (RMS) ○ Surface Distance (Maximum) ○ Volume Overlap
>>	Select a data item. For **Scatter** plot, select measures for X-Axis and Y-Axis. For **Bland-Altmann** plot**,** select "First Method" and "Second Method". For **Histogram** plot, select independent variable for X-axis.
<<	Remove a measure before replacing it
OK	Save the change and close dialog
Cancel	Discard the change and close dialog
✕	Close the dialog

Plotting Tab

- Click **PLOT** button, the charts will show in the "Plotting" tab.

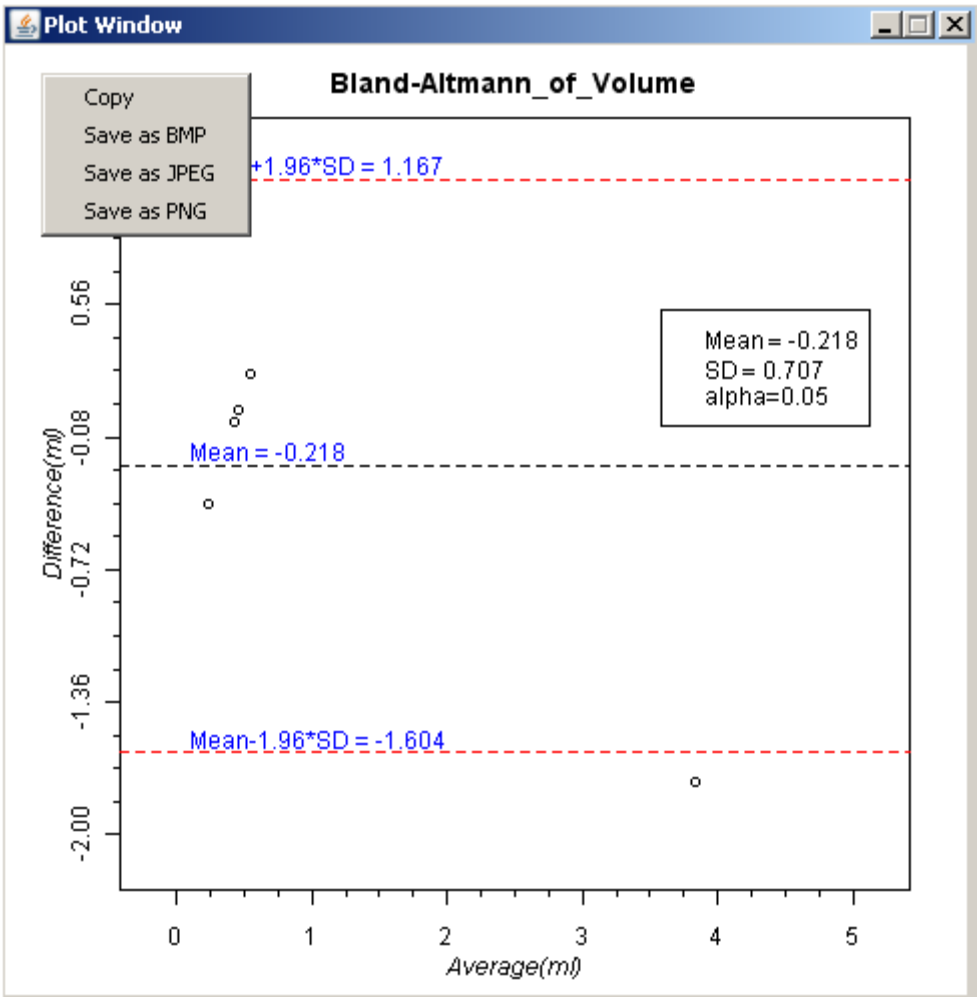
Figure 18: Plotting tab



Tips:

- *The vertical scroll bar would be helpful to look through more than three charts.*
  - *Due to a bug, the scroll bar may not appear until you click on the **Statistics** or **Outliers** tab and then click the **Plotting** tab.*
- *Double-clicking one of the charts will enlarge it to full-sized in a pop-up window.(See Figure 19)*
- *Right-click in the pop-up window to show a pop-up menu. (See Figure 19)*
  - *"Copy" to copy the chart to clipboard*
  - *"Save as BMP" to export the chart in .bmp format*
  - *"Save as JPEG" to export the chart in .jpg format*
  - *"Save as PNG" to export the chart in .png format*

Figure 19: Full-sized plotting chart



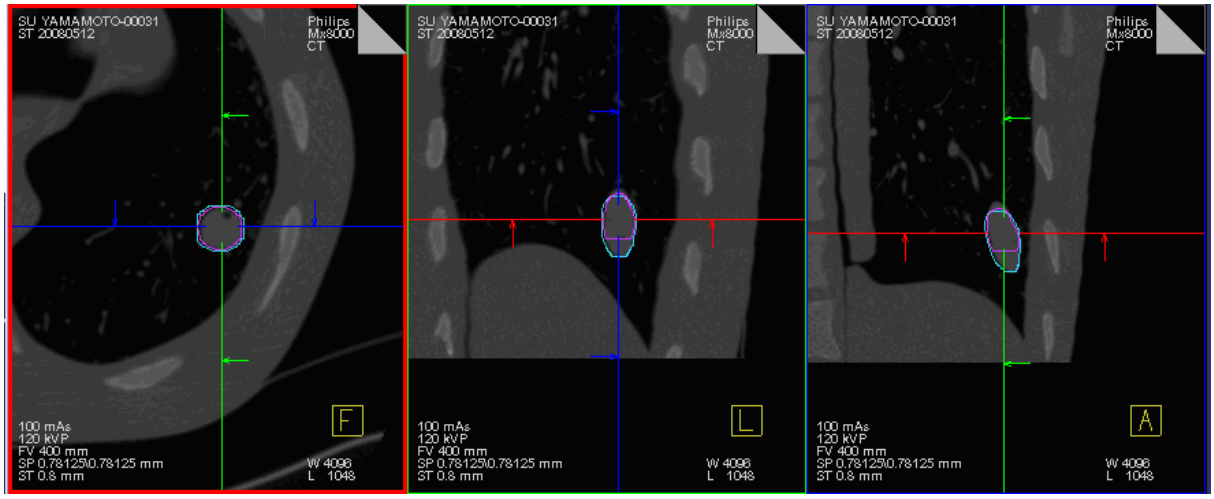
4.2.4 Drilling down

- Double click one of the rows in the "Computation Results" list; the 3D-MPR window will display the image and contours associated with the selected row in axial, coronal and sagittal views.

Tips:

- *The blue overlay presents nominal ground truth and red overlay presents annotation.*
- *You can*
  - *Set cross-hairs on tumor in red pane to inspect it.*
  - *Pan and zoom in all three panes to inspect the contours.*
  - *Click the dog-ear control in the left pane to navigate through the contours on different slices.*

Figure 20: 3D-MPR images



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