iTFlow Manual

内容

Overview

System Requirement

Requirement	Minimum Requirement	Recommended Requirements
OS	Windows 10 64-bit	Windows 10 64-bit
Network	-	-
Display	1920x1080 Resolution	1920x1080 Resolution or higher
Processor	Intel Core i5	Intel Core i7 9700K
Video Card	nVidia Dedicated GPU	nVidia Dedicated GPU
System RAM	16 GB	32 GB or higher
Video RAM	1GB	4 GB or higher

Requirement for the Operators

This system is intended to be used by medical doctors or radiologists who has trained to use the system. Please use this software only for the intended purpose.

Indication for use

Module: Dicom Browser

Browse and filter database

Import and export of 4D Flow MR Images in Dicom Format.

Module: iTFlow

Color-coded flow display with semi-automatic contour detection, synchronization and forwarding

- Graphical Display of flow rate and flow velocity.
- Background correction options
- Automatic calculations include volumes, velocities, regurgitant fraction

Abbreviations and Conventions

References to buttons or icons and modules are written in italic.

If the selection of a menu or function, requires multiple clicks, it will be notated as follows: E.g. Configuration > Contours > Rounded SAX Endocardial Contours (which explains how to get to the selection of using rounded contours for the automatic contour detection)

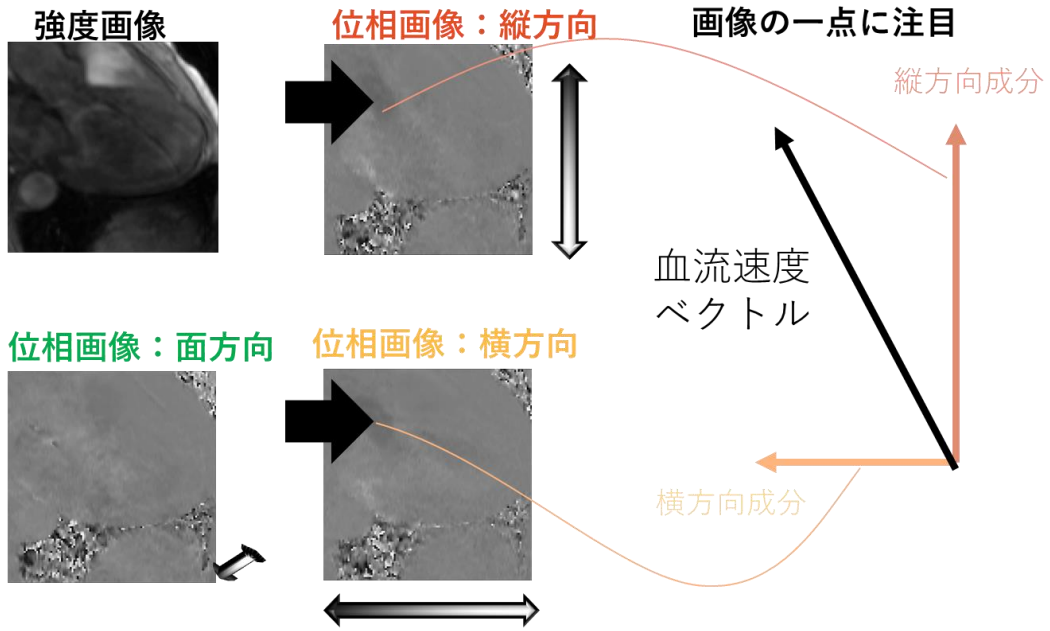
Tooltips, names of menus and icons are written the same as in the interface, e.g. the button for the Short axis 3D volume module is described as Short3D

CMR Cardiovascular imaging
PC Phase Contrast
ROI Region of Interest
LV left ventricle
LA left atrium
RV right ventricle
RA right atrium

Getting started

Principle of flow analysis using MRI

Phase contrast image data and magnitude image data can be obtained by the phase contrast method. The phase contrast image is represent blood flow velocity in the gradient magnetic field direction. It is possible to analyze the blood flow velocity as a vector with components in three directions by acquiring phase images in three axes.



Process

Mask Segmentation

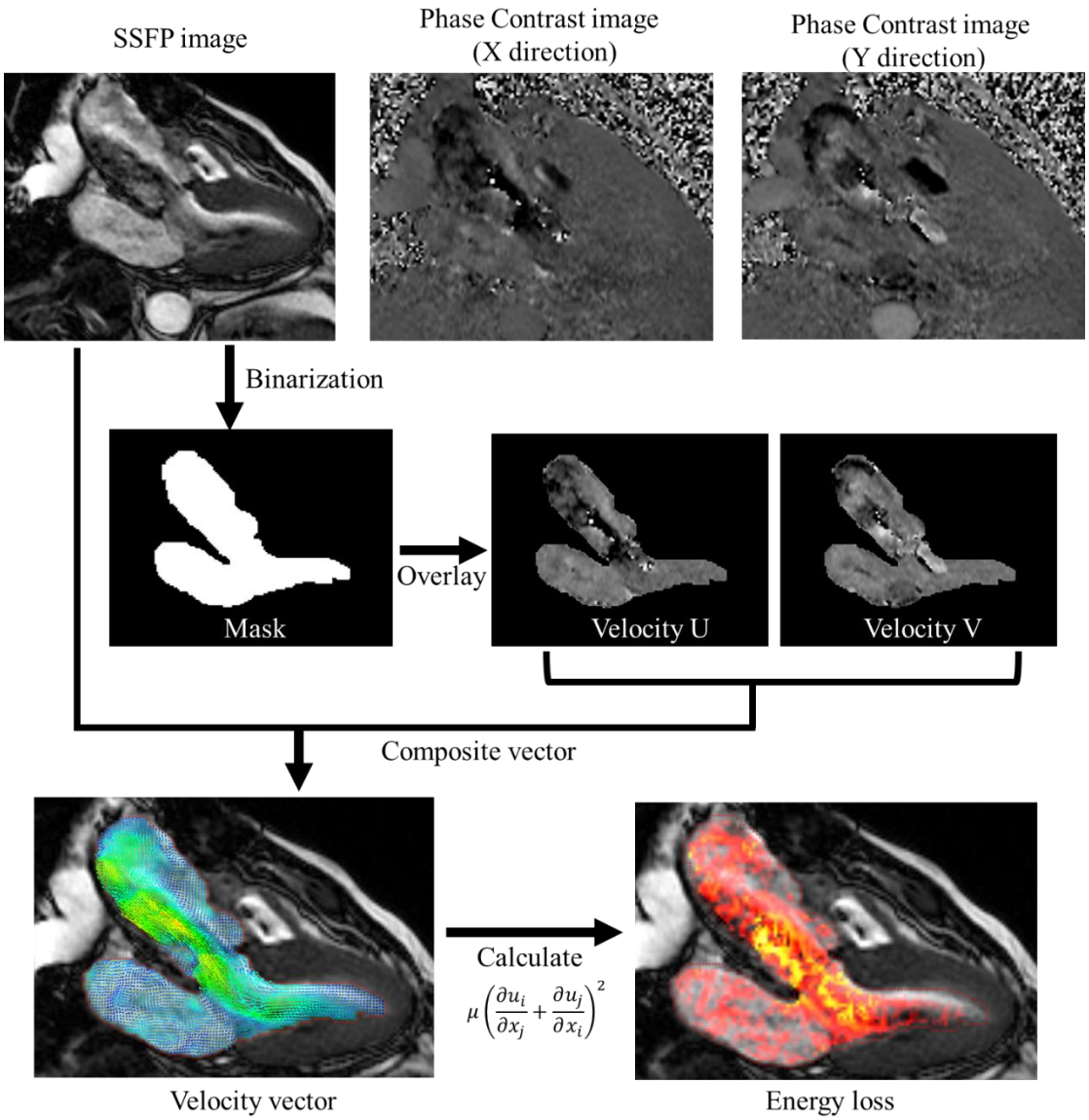
Segmentation of the target vessels or ventricle is necessary for analysis. Mask image is overlayed on the phase image to define the region for analysis.

Velocity vector visualization

It is possible to visualize the blood flow velocity as a vector by composing the three-axis phase image.

Hemodynamic parameter calculation

Blood flow rate, flow energy loss, wall shear stress, oscillatory shear index can be calculated from blood flow vector field.



Data Acquisition

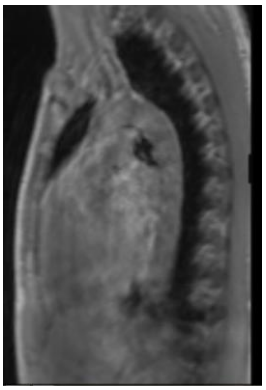
Data used in flow analysis

PC images, magnitude image, cine images are used for analysis.

PC Image（x, y z direction）

These images contain velocity information of blood flow. It is essential for flow analysis.

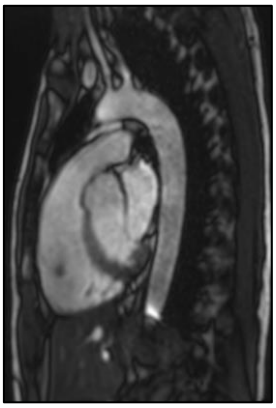
Magnitude Image



Magnitude image is required with pc image. It is used for registration with PC image and CINE image.

CINE Image

High-contrast image such as True FISP, SSFP. It is used for segmentation.



Data requirement

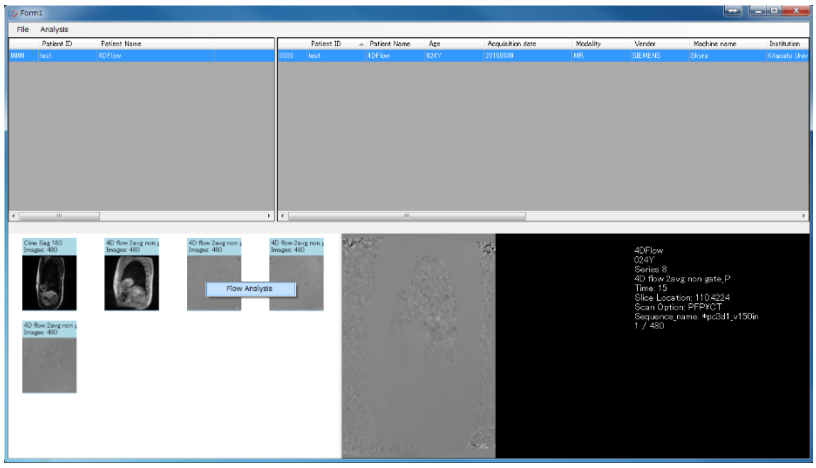
Series		
PC(3 axis)	Required	These data series must be included for flow analysis
Magnitude	Preferred	This series can be used for registration.
Cine	preferred	Using cine image enables tracking of heart beat.

Vessels that receive less effect of movement with heartbeat such as abdominal aorta can be segmented from PC image. → See ***

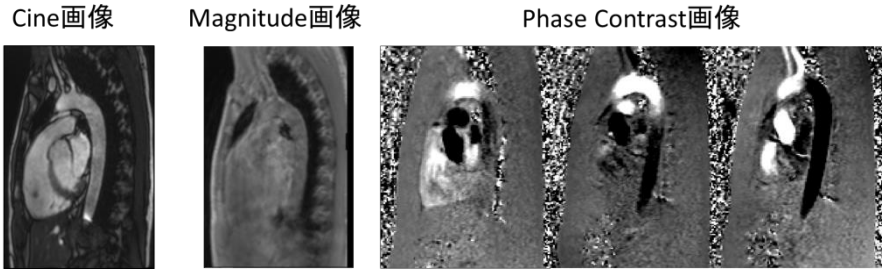
Launching the software

Launch from DICOM Browser

Click on Cardio Flow Station shortcut on the desktop to launch DICOM Browser. Multiple series for analysis can be selected by clicking with Ctrl key, then click “Flow Aanlysis” from right click menu to start 4D Flow analysis.

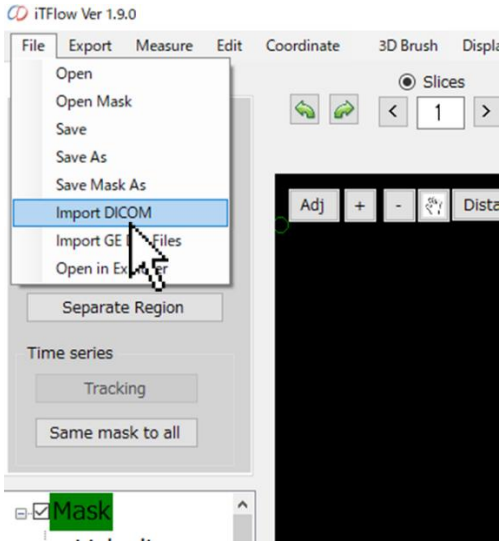


X, Y, Z PC image, images are necessary for analysis. Cine images. In addition to these series, importing Cine image makes the segmentation easier.

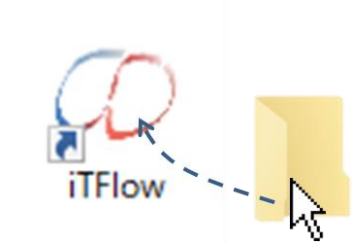


Launch iTFlow stand alone.

Click on iTFlow shortcut on the desktop and click File-> Import DICOM from menu to import dicom.



Dicom series can be easily imported by drag & drop the dicom folder on the desktop icon.



Importing Series Selection

The imported series are automatically discriminated. If the selection of the PC-X, Y,Z was wrong, it can be selected manually.

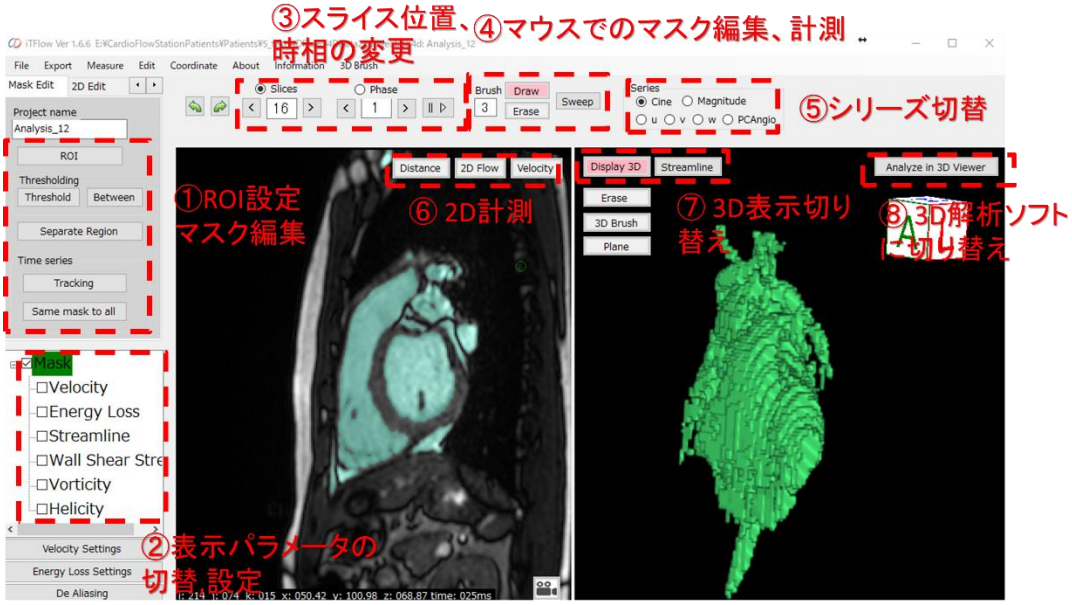
Data save and load

Click on File->Save as in the menu to save the project file and the progress. Project files are contained from 5 files below. To move the project files, move the five files to same directory.
メニューの **File→Save as** をクリックするとプロジェクトとして作業中のデータを保存できます。プロジェクトは下記の 5 つのファイルから構成されています。データを移動させる場合は５つまとめて移動させてください。

*.prj4d　：File used to import to the software. Relative file path of other four files are written.下記のファイルをまとめているファイル
*_Cine.matg：Cine image data　Cine 画像が保存されているファイル
*_Magnitude.matg: Magnitude image　Magnitude 画像が保存されているファイル
*_Mask.matm：　Mask image data. This file can be imported or exported alone.マスク情報が保存されているファイル
*_Velocity.matv：phase contrast image data. 位相画像が保存されているファイル

Project file can be loaded from File -> Open in the menu.

2D Segmentation window



① **Segmentation control field**

Mask are semi-automatically generated using these functions.

② **Displaying switch**

③ **Slice and Phase control**

Click to change the slice or phase. Checking radio button, slice or phase can bechanged using mouse wheel. Cine play is available from Play/Stop button

④ **Mouse functions**

Mask Draw/Erase

Mask Erase

Distance Measurement

Angle Measurement

Velocity Measurement

⑤ **Displaying Series**

⑥ **3D Display switch**

⑦ **Opening 3D Viewer**

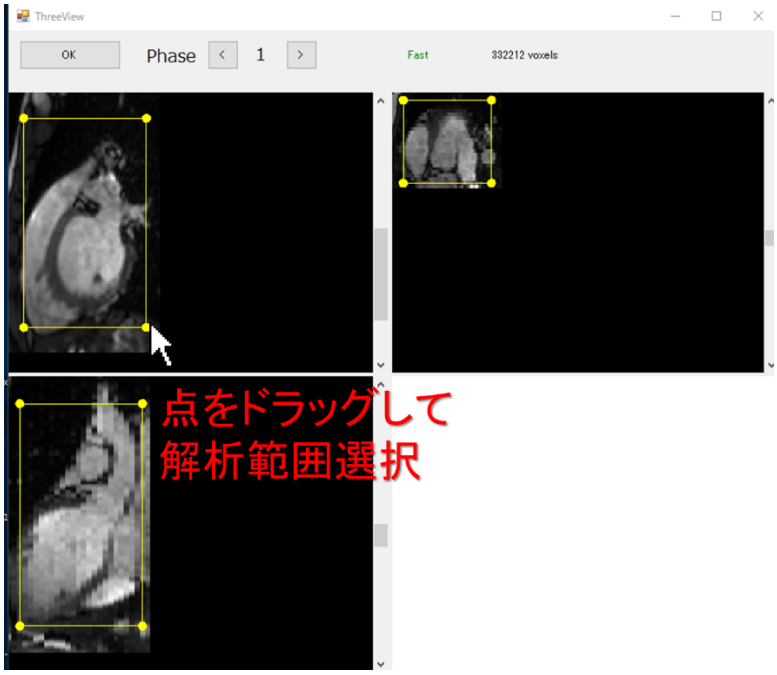
Mouse buttons function

Right button	Level change
Middle button	pan
wheel	Slice / Phase change

Ctrl+wheel	Zoom in out

ROI

You can set region of interest to save system memory and processing time.

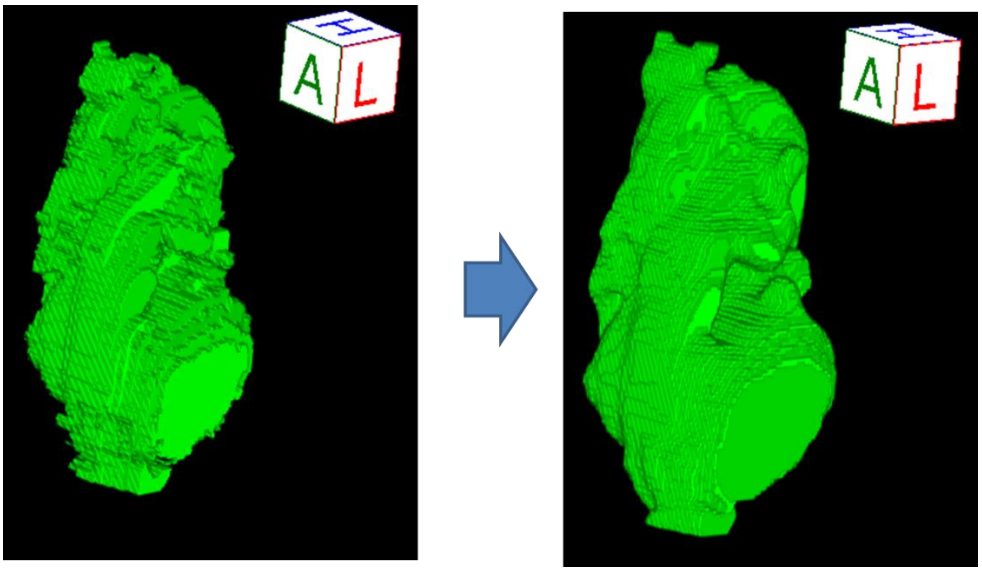


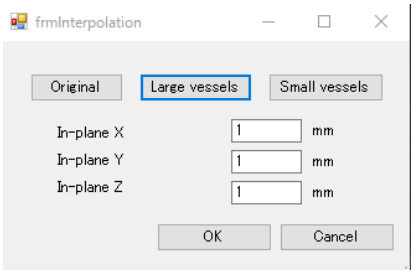
This function is not necessary when the software processing speed does not have problem.

Interpolation of Cine and Mask spatial resolution

Clicking Edit -> Interpolation in the menu, spatial resolution of Cine image and Mask image can be changed. This function is useful to achieve smoother surface of the vessel and enables accurate calculation of WSS.

Interpolation should be performed after setting ROI because it consumes large memory.

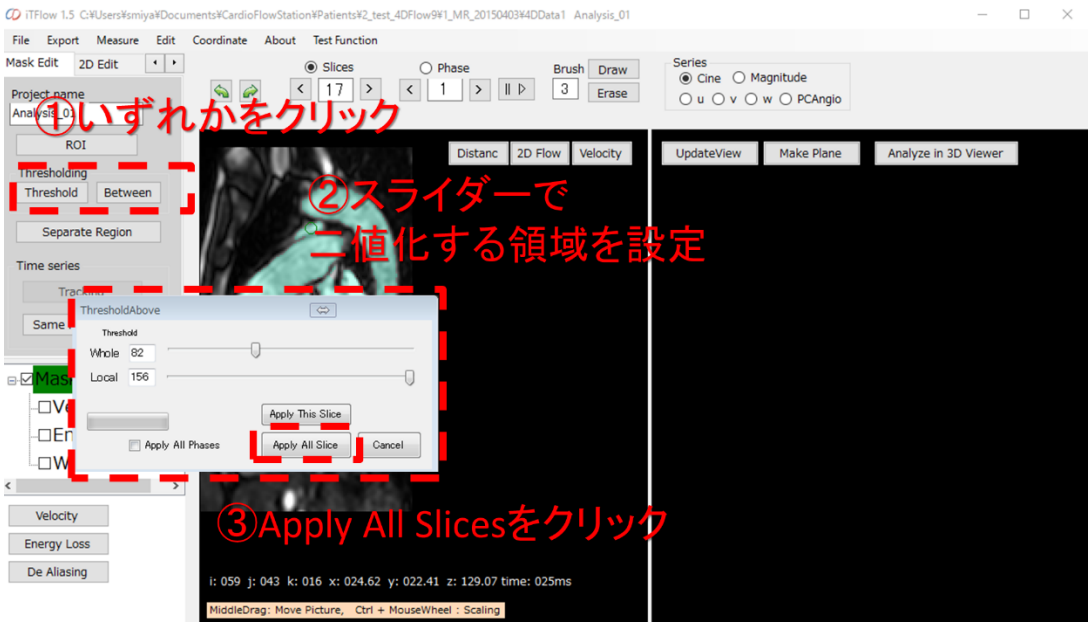




It is strongly recommended to set ROI before using interpolation, because interpolation uses high amount of memory.

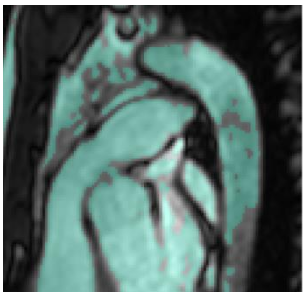
Segmentation

Thresholding

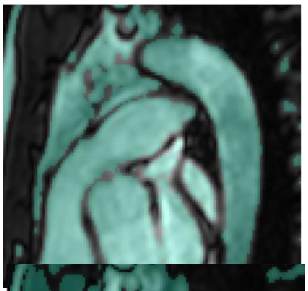


Threshol

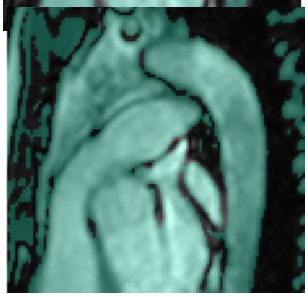
Use bar to change the threshold value. The threshold value is important because it affect the time to segment in the following step and the accuracy of the analysis.



Poor: near-wall region is not segmented enough.



Good

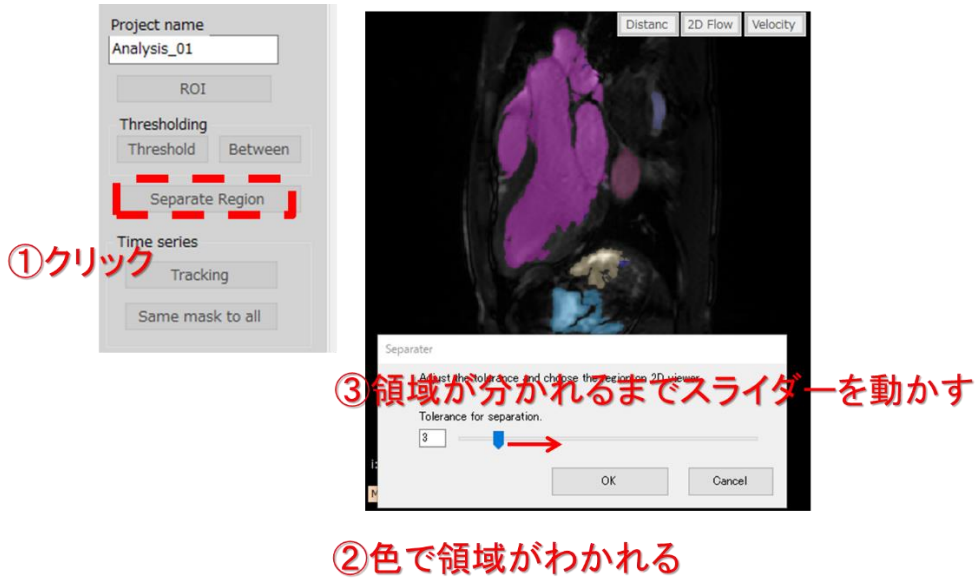


Poor: LV and PA are connected. It takes a lot of time to separate in the following process.

Separate

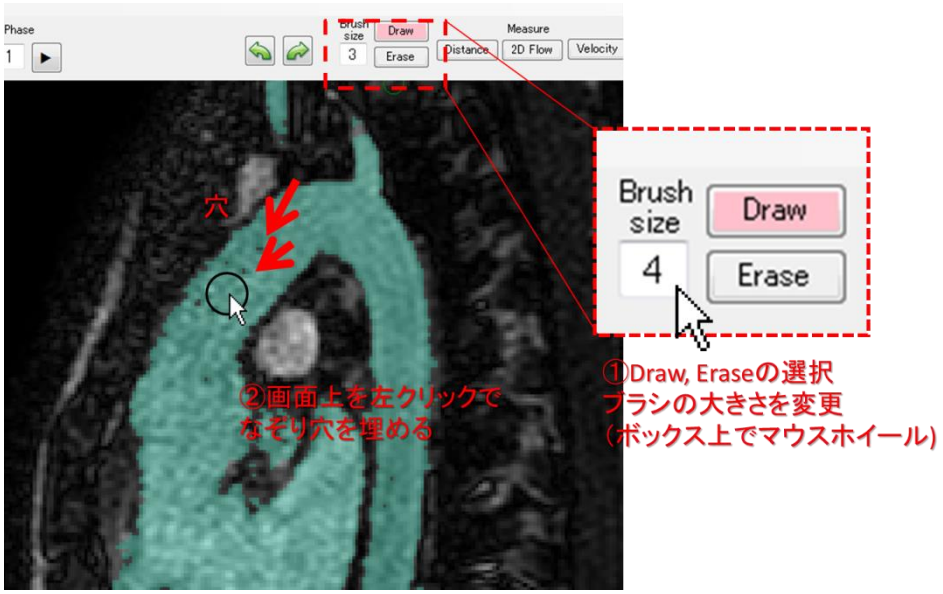
Click Separate button and the Separate window popups. Push Separate button several times in the separate window to separate the region

Select all the region by clicking from 2D View and push Apply button to delete unselected region.



Manual segmenetation

Mask can be modified manually using brush and eraser.



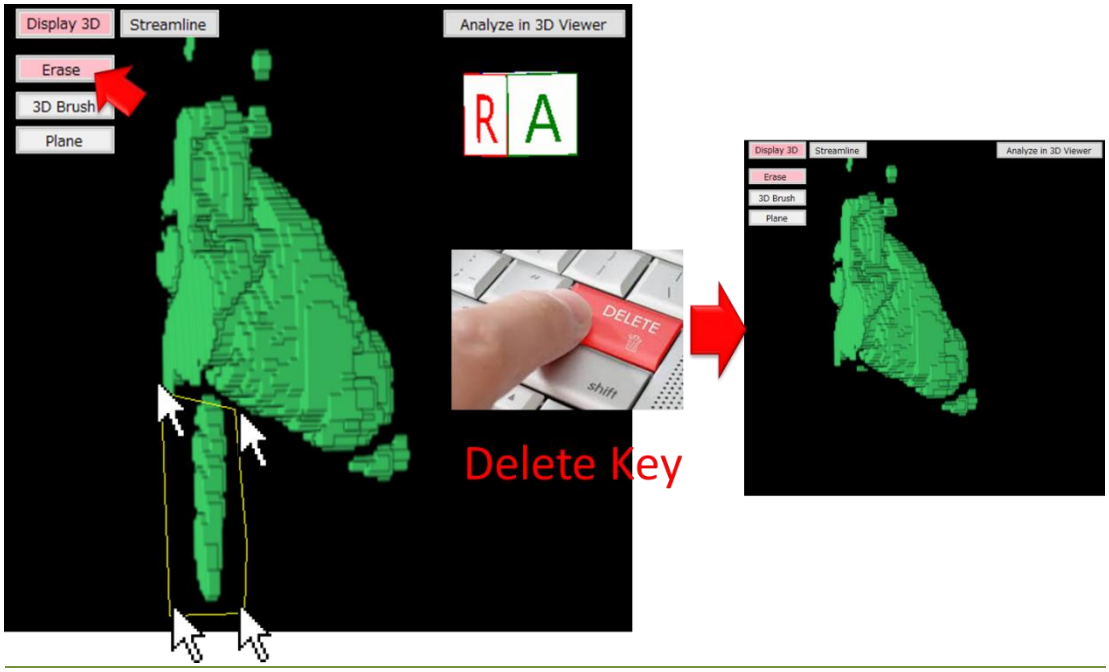
Draw/Erase. Left click to draw mask. Shift + left click to Erase the mask.

Brush Size: brush size can be changed using mouse wheel when the cursol is on the text box.

Brush size can be changed by Shift + Mouse wheel on 2D View.

3D Mask modification

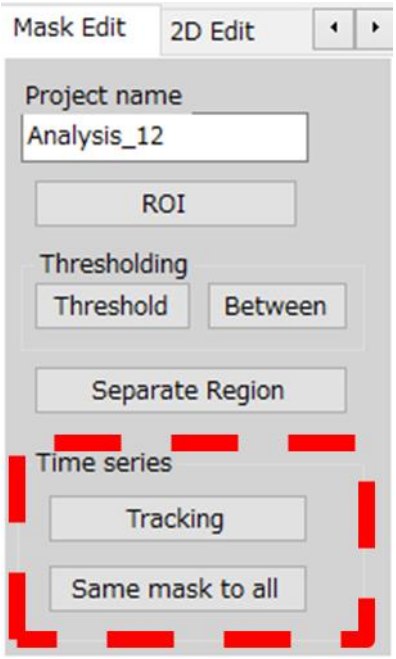
Click Erase button on 3D View. Clicking 3D View to make polygone and push delete key to erase.



3D Viewer Moue controll

Mouse right butotn	rotate
Mouse midd;le button	Pan
Mouse wheel	Zoom

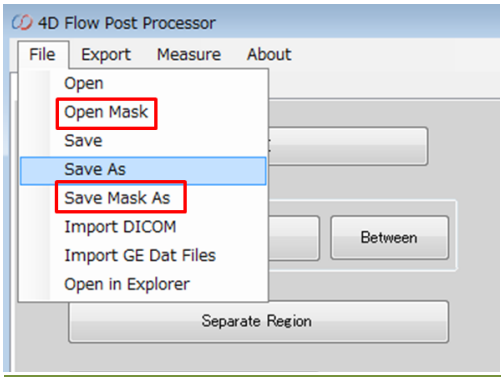
Auto(this phase) または Auto(all phase)で自動二値化



Tracking：Based on displaying phase, the mask of all phases are automatically generated using tracking algorithm.

Same mask to all: The mask of the displaying phase is copied to all other phases. This function is suitable for the vessel whose movement with heart beat is small.

Mask save

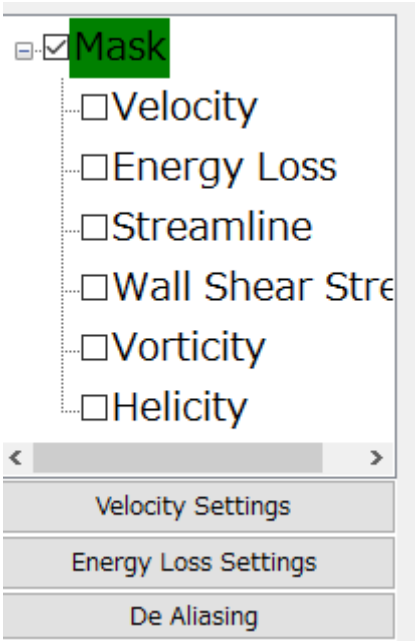


Save mask As:　mask can be saved to *.matm file

Open Mask:

This function is useful when saving mask separately such as LV mask Aorta mask and RV mask.

Flow visualization in 2D View



Vector

Velocity vector can be switched. The density of the vectors, size of the vectors and the color range can be changed from the setting.

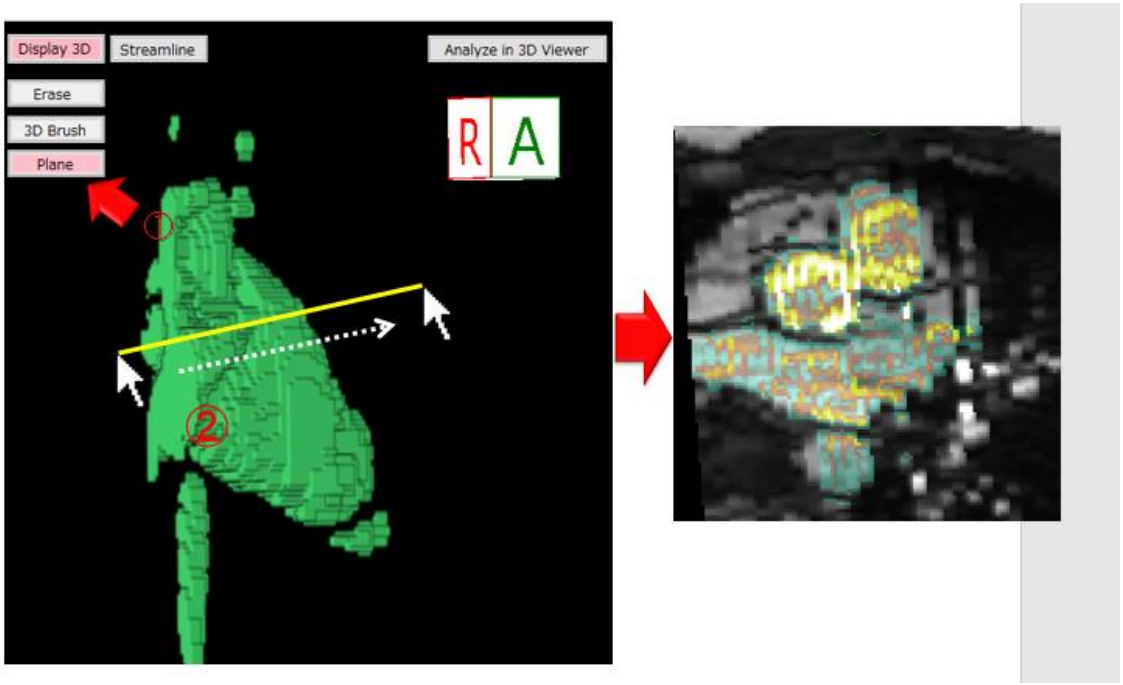
Energy loss

Energy loss display can be switched. Color scale can be changed from the setting.

Clicking **Measure – Energy Loss** to export the energy loss in the cardiac cycle.

Plane Reconstruction

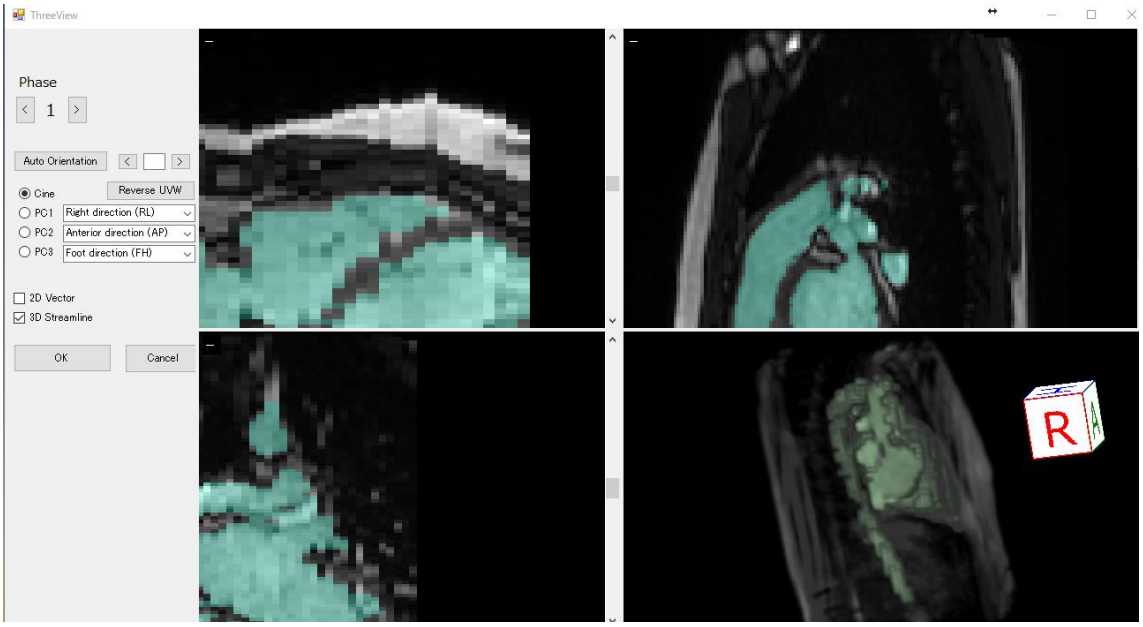
2D View plane can be reconstructed from 3D view



Velocity orientation correction

This procedure have to be performed after finishing the mask segmentation in all phase.
Click **Edit -Orientation Velocity** to Open orientation correction window.

Please use this function after finishing making mask of all phases.



Push **Auto Orientation** button and the orientation automatically corrected. If the vector direction is opposite, Push **Reverse UVW button**.

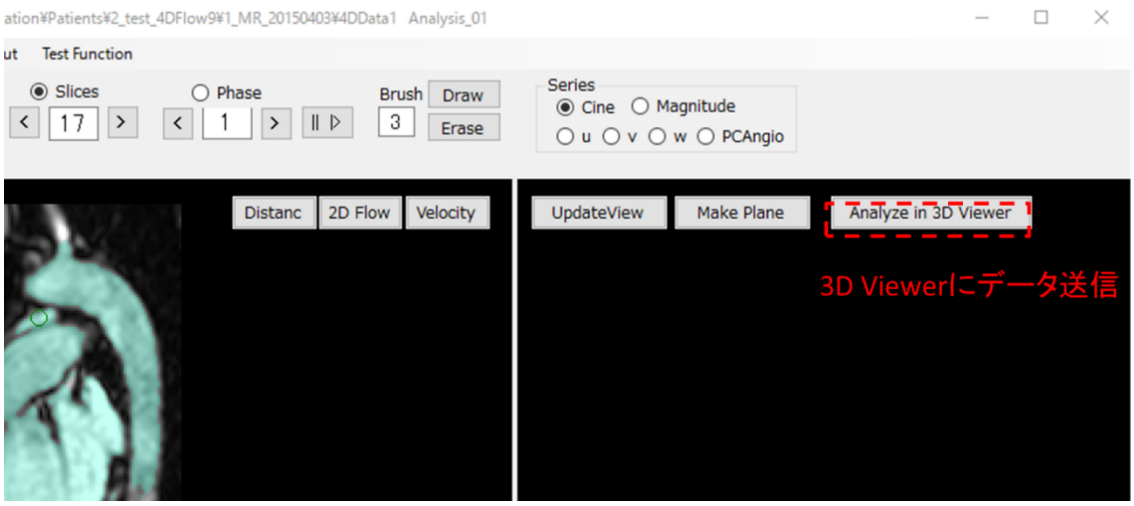
Orientation can be manually set. Push "<" button and ">" button to change the orientation pattern.

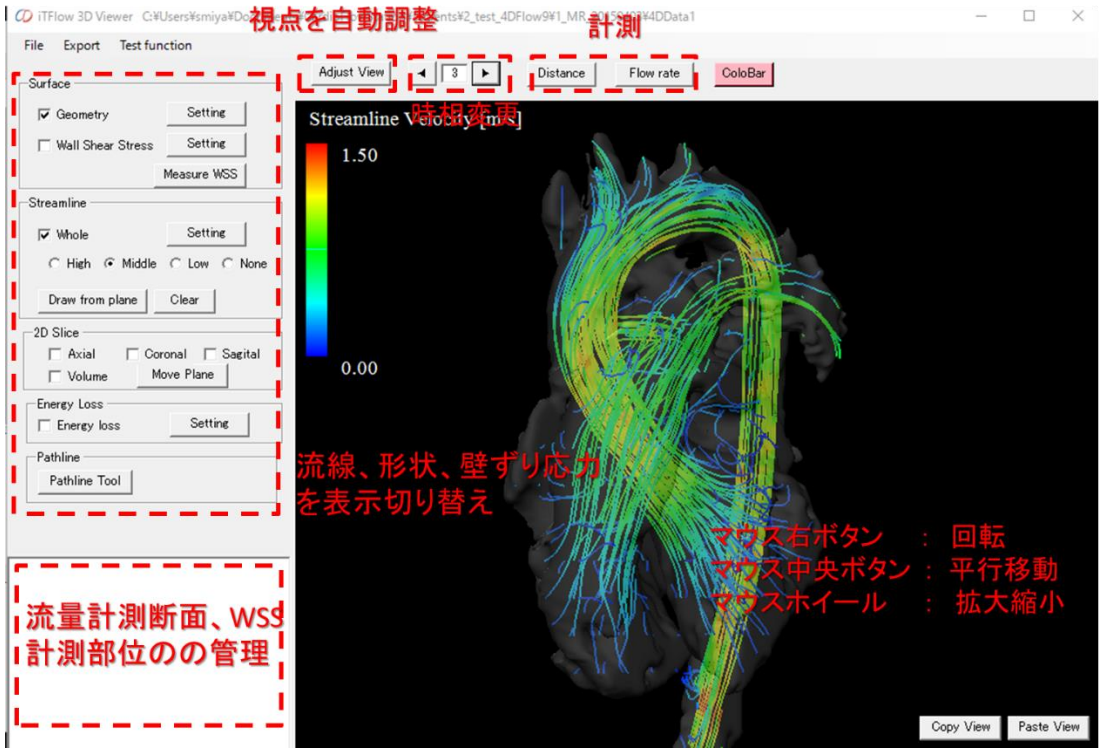
Auto orientation function is specification of PC image three axis combination based on streamline length. It is designed for vessel, and sometimes does not work corrector when segmenting heart. Please check whether the vector direction is correct after using auto orientation function.

3D visualization / quantification

3D Viewer will open by clicking **Analysis in 3D Viewer** button.

In this window, streamline, WSS, OSI, EL and vorticity are visualized in 3D. Flow rate and WSS can be quantified.





View control

Mouse Right button	Tilt
Mouse Middle Button	Pan
Mouse Wheel	Zoom in/ out

Adjust View Button	Reset Pan and Zoom

Streamline

Streamline display can be switched by checkbox. The number of lines, color range and line width can be modified from the setting button.

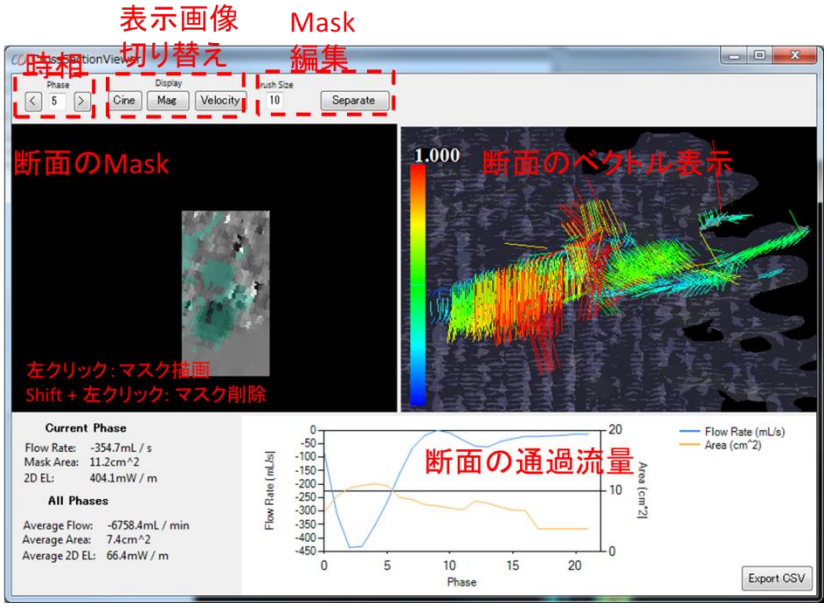
WSS

Color scale can be changed from the seting button. WSS quantification window will be opened by clicking measure WSS button. Click on the view to select the region.

Shift + click to limit the region.

Flow rate

After clicking Flow Rate button, flow rate can be calculated by mouse left button dragging to make cross section in 3D View.



Mask edit in cross section view

Left mouse button	Draw
Shift + Mouse Left button	Erase
Shift + Mouse Wheel	Change brush size

Pathline

Pathlines are the trajectories that individual fluid particles follow. These can be thought of as "recording" the path of a fluid element in the flow over a certain period. The direction the path takes will be determined by the streamlines of the fluid at each moment in time.

Particle emission

Push **Pathline Plane** button

Drag mouse left button on the screen to make cross section.

Push OK button on the pathline window.