

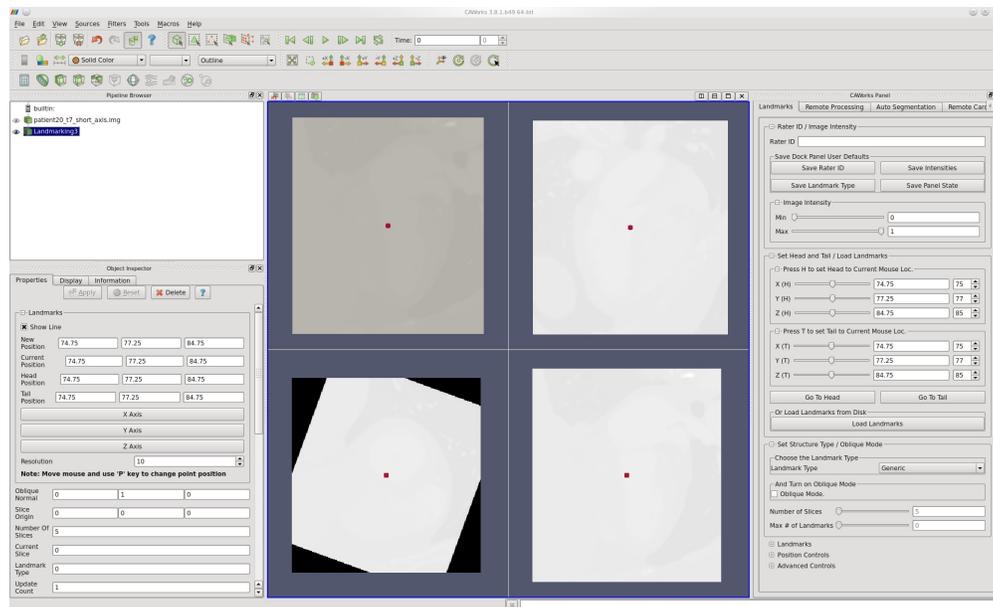
# CAWorks Cardiac Remote Processing

The Remote Cardiac Processing Panel in CAWorks provides volume-based matching of a single template and target cardiac image. In addition to the original intensity images, the processing pipeline requires left ventricle segmentation masks and landmark files for both the template and target. Both the volume and mask files must be Analyze (\*.img, \*.hdr) files, although CAWorks is compatible with many more file types and can be used to convert images to this file type. The template and target landmark files will be generated using CAWorks' Landmark filter (landmark files use the \*.lmk file type).

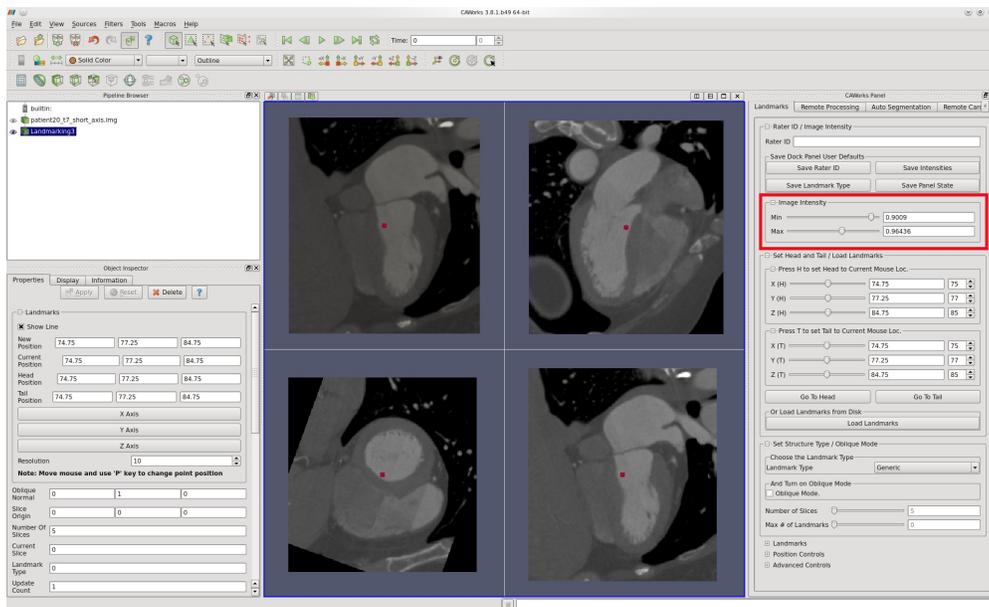
The cardiac processing pipeline resamples the target to the template resolution, performs rigid matching of the target to template with global scaling, then performs [LDDMM](#). The process will calculate the determinants of the jacobian for both the forward and reverse transformation as well as the momentum of the transformation. It is assumed that the template has no odd-valued dimensions, as LDDMM will not run properly if any of the image dimensions are not divisible by 2.

## I. Landmarking

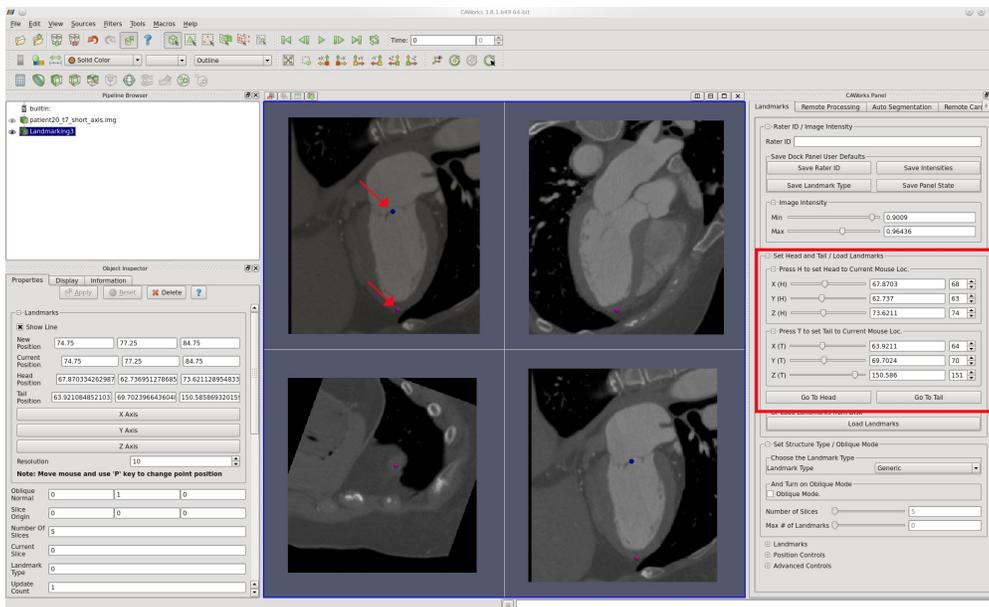
1. In CAWorks, open the template volume (intensity) file.
2. Open the landmarking filter under the Filters menu using Filters > Alphabetical > Landmarking. This will open axial, sagittal, and coronal views of the image in the viewer and the Landmarks tab in the CAWorks Panel.



3. Adjusting the Min and Max values in the Image Intensity menu may improve contrast and clarity for some images.

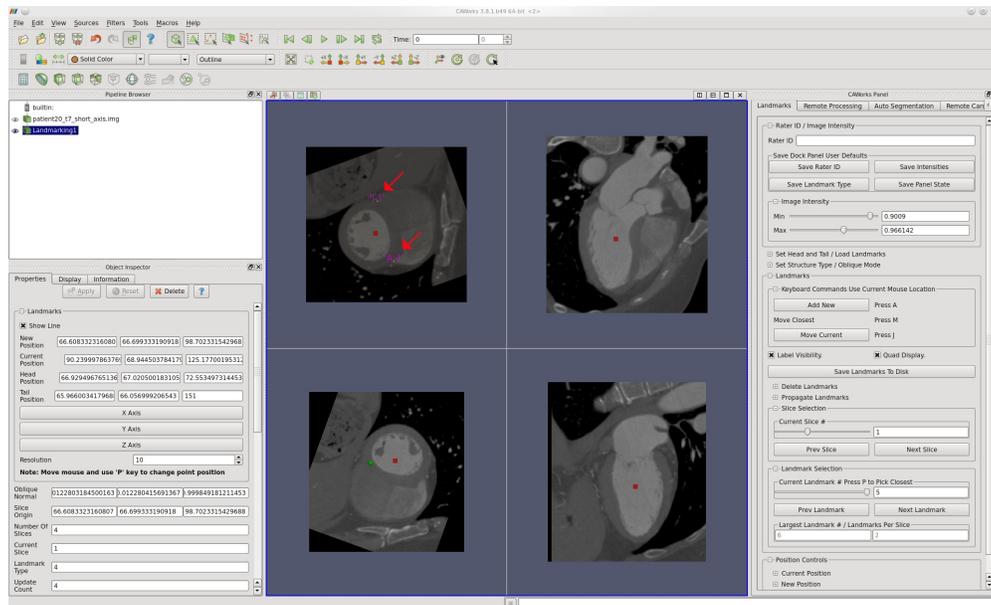


- The first set of landmarks to place are the head and the tail. These will delineate the long axis of the left ventricle, with the head being placed at the center of the mitral valve and the tail being placed at the apex of the heart. The head and tail location can be set using the Set Head and Tail / Load Landmarks menu of the Landmarks tab, or by mousing over the correct location on any of the four views and typing “h” for head or “t” for tail. The head landmark will appear in blue and the tail in pink.



- After setting the head and tail, set the Landmark Type to “Heart” in the drop down menu and then check the box for Oblique Mode under the Set Structure Type / Oblique Mode menu in the Landmarks tab.
- When Oblique Mode is selected, the image is reoriented so that the four oblique landmarks can be placed. Each of these landmarks is placed at the insertion points on two slices defined normal to the long axis of the heart, in between the head and the tail. Landmarks will be added

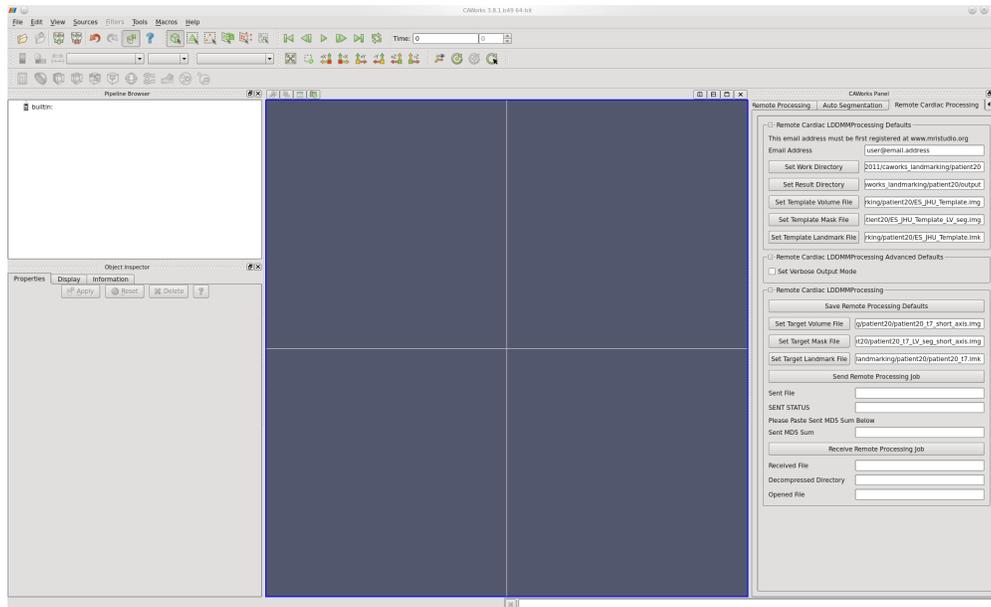
at the cursor location by typing “a” and can be moved afterwards to a new cursor location by pressing “m”; landmarks will appear as small yellow dots with pink labels. The currently selected landmark will be marked with a larger green dot. Place the first oblique landmark at the anterior insertion point and the second landmark at the inferior insertion point.



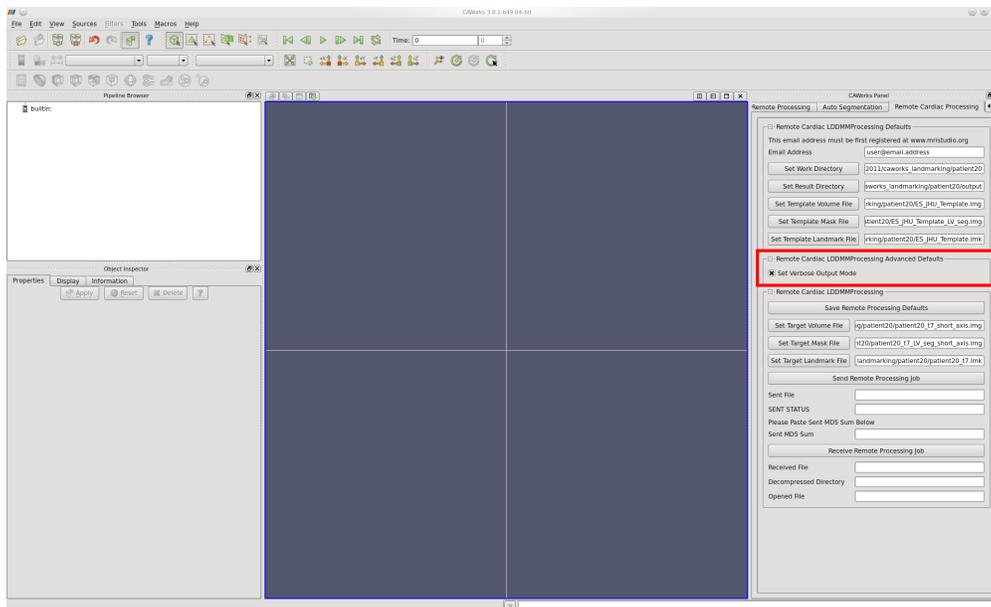
7. After setting the first two oblique landmarks, press the “Next Slice” button under the Slice Selection menu of the Landmarks tab. CAWorks will automatically propagate the locations of the landmarks on the previous slice to this slice. Do not add additional landmarks but move the cursor to the correct location and type “m” to move these landmarks.
8. Press the “Save Landmarks To Disk” button to save the current landmark locations. Then repeat the landmarking process for the target volume (intensity) image.

## II. Using the Remote Cardiac Processing Panel

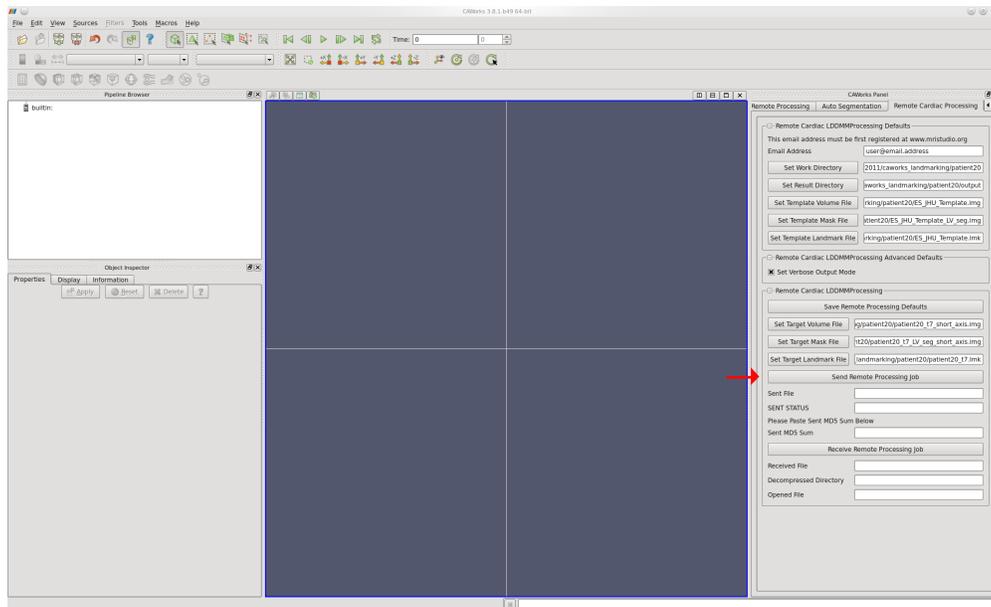
1. To use the CAWorks Remote Cardiac Processing Panel, you must first [register an email address](#) at the MRI Studio website. Updates on the status of the remote process will be sent to this email address.
2. Under the Remote Cardiac Processing tab in the CAWorks Panel, enter the email address and designate the locations of the work directory and desired result directory, as well as the locations of the intensity volume, segmentation mask, and landmark files for both the template and target.



3. In the Remote Cardiac LDDMM Processing Advanced Defaults menu of the Remote Cardiac Processing tab, there is an option to set Verbose Output Mode. The default output mode provides the deformed target and template files, the rigid transformation matrix, the determinants of the Jacobian for the transformation (for both template-to-target and target-to-template), and the LDDMM momentum. The verbose output mode also provides all output files from LDDMM in addition to the normal output files, but the received data is much larger.



4. Press the “Send Remote Processing Job” button in the Remote Cardiac Processing tab to send the job for remote processing. You will receive emails when processing begins on this job and when it completes.



5. When processing is complete, copy the MD5 Sum from the notification email into the space next to "Sent MD5 Sum" in the Remote Cardiac Processing tab, make sure the designated result directory is correct, and press the "Receive Remote Processing Job". The results of the cardiac remote processing can now be accessed in the result directory.