



Stitching data in Avizo

Some preliminary notes:

These instructions are for stitching two overlapping data sets together. If you have more than 2 data sets to stitch together, I'd recommend doing one set at a time, and saving in between: Stitch A to B, save as A+B, stitch the completed A+B set to C, save as A+B+C, etc. This significantly decreases the likelihood of Avizo crashing.

I would also recommend continuing to save/archive the original data files, not just the stitched data sets.

I describe several different techniques here. Feel free to try things and view the results to see if they are appropriate to your needs.

1) Open the first two data sets you will be stitching together.

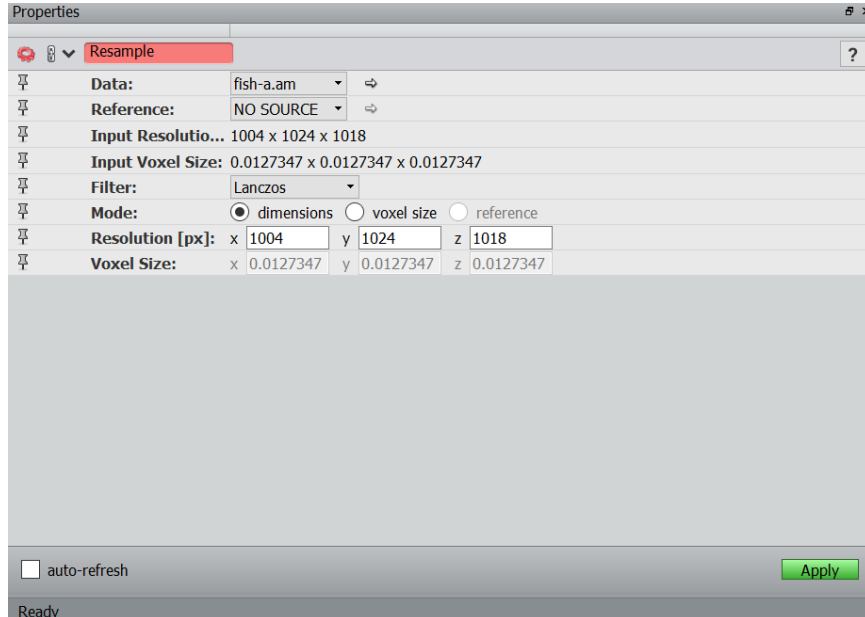
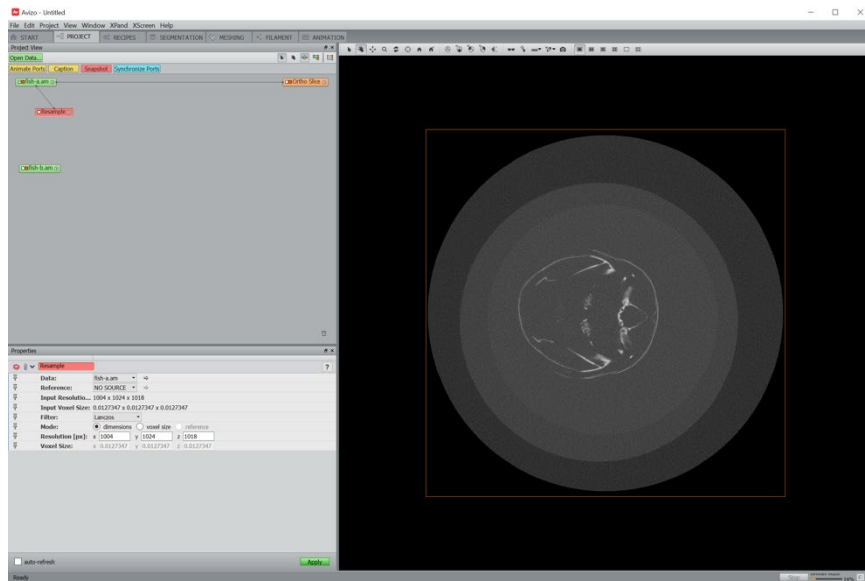
If you have more than two scans that will need to be stitched, you can start from either end, or the middle. It doesn't really make a difference which end you start from, as long as the two scans you're starting with are contiguous.

2) Downsample the data sets (optional).

This may or may not be needed, depending on what size of file you can handle. The B46 computer can handle files up to about 20GB in size. If the respective file sizes of all the files to be stitched add up to more than that, I recommend downsampling at this point. Downsampling early rather than later will also make all of the later processing steps go faster.

The end result of downsampling is that you will be decreasing the resolution of the data to be stitched together. Many data sets taken in the BRC CT facility are large enough that I'd recommend downsampling, so as to prevent very slow computing times and increased likelihood of the software crashing. Skip to step 3 if you are sure you don't want to downsample. If you are downsampling, you will want to do it for all of your data sets.

Right click on the first green object in the project view that you want to downsample, and select "Resample".



Set the resolution to your desired dimensions. You can do so by changing either the voxel size in mm or the pixel dimensions. I'd recommend keeping the same aspect ratio that you currently have (typically 1:1:1), by, for example, halving the resolution/doubling the voxel size.

Click Apply. A green object ending with .resample will show up in the project view tab. Click on it, then click File->Save Data As. For now, it's fine to save it as an Avizo data file (.am), or you can save it in DICOM or TIFF format.

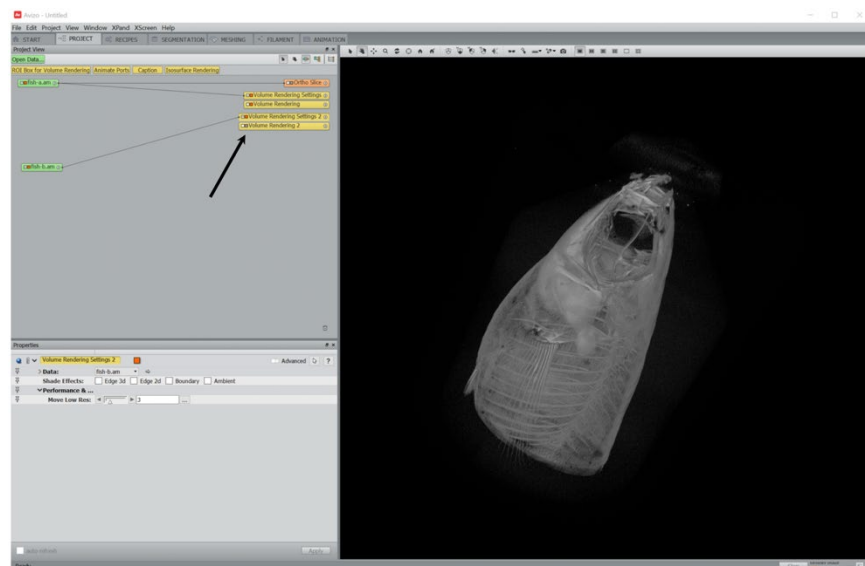
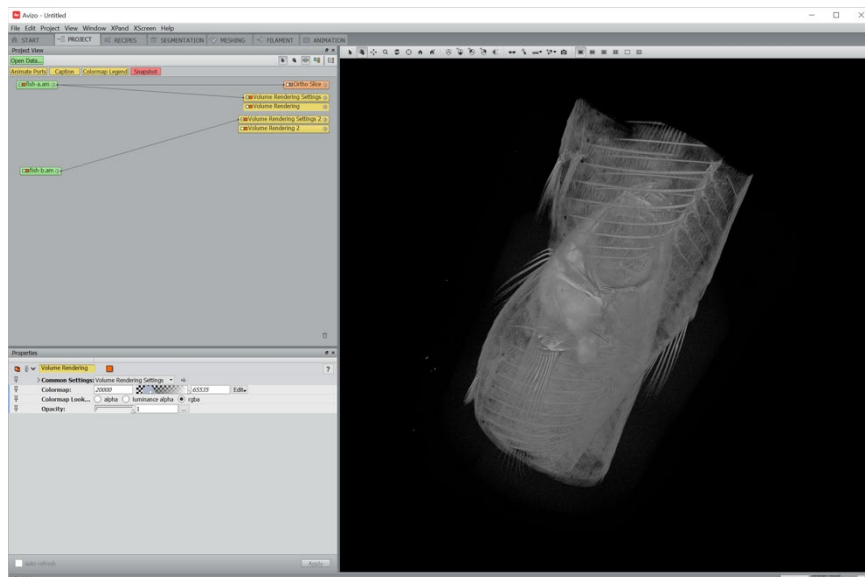
Do this for each data set to be stitched.

Once you have resampled, you don't need to keep the original data in the Project View. You may take all green objects associated with the original, un-downsampled data sets and drag them to the trash can.

3) Coarse Alignment of Data sets

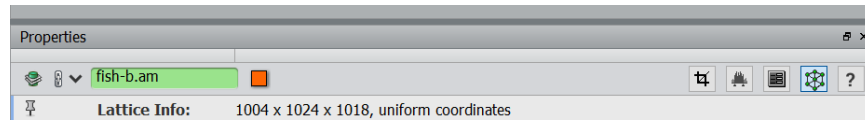
When a data set is visible in Avizo, it's located in what, for lack of a better term, is an actual, if virtual, space in the window. The first thing we are going to do is to take the loaded datasets and arrange them so that they are relatively close to their actual aligned positions. This will help with the fine alignment later.

Attach a Volume Rendering object to the first two of your data sets, but turn off the visualization of one of them for now by clicking the orange box in the yellow Volume Rendering object, because the two probably overlap completely and it'll be difficult to see what you're doing.

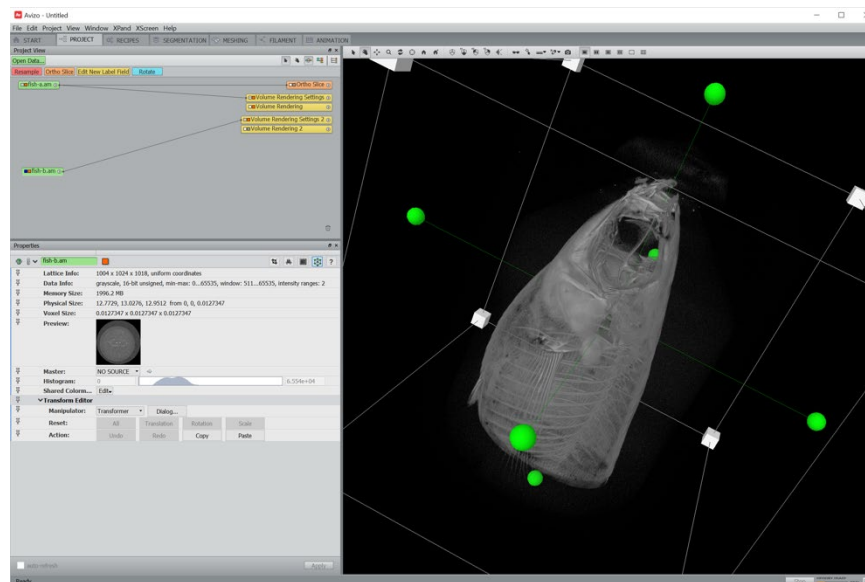


Make any adjustments to the volume rendering settings that you need to make the area of interest clearly visible.

Click on the green data object that you are visualizing right now. In the Properties window, select the Transform Editor icon—it's the green-cornered wireframe box highlighted in blue in the screenshot below.

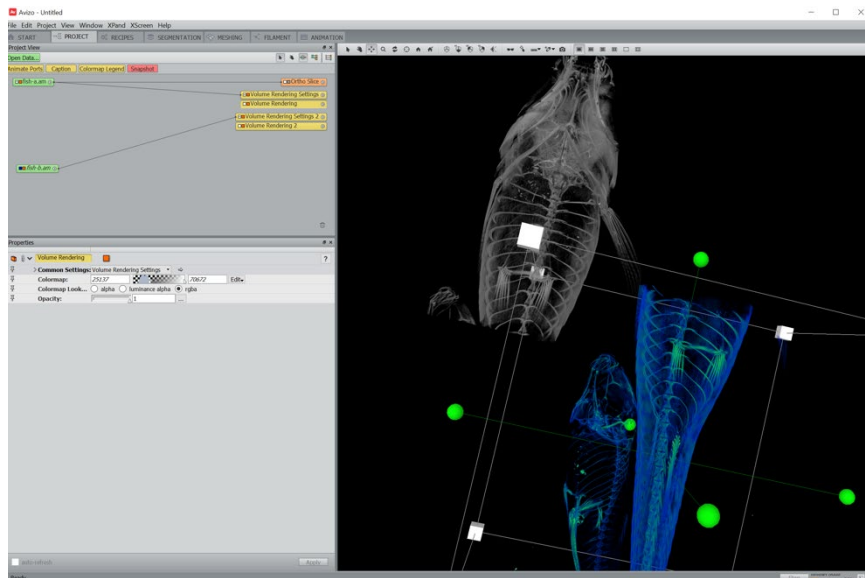


This will toggle the transforming wireframe box, shown below. With the cursor selected, you can now move this dataset relative to the second dataset. There is also a Transform Editor that appears lower in the Properties window, which allows you to change the visual style of the transformation box, permits you to rotate and resize the dataset, etc.

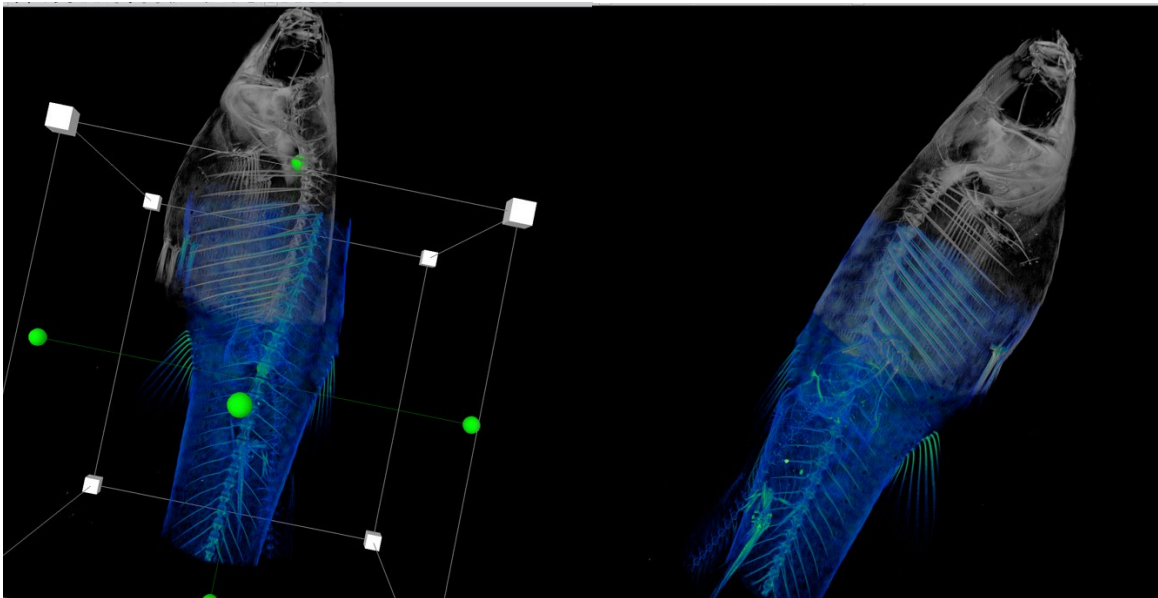


Using the cursor, click and drag the scan, so that the next data set will not overlap when made visible. Any mistakes can be undone by clicking the Reset button in the Transform Editor menu.

Display the volume rendering for the second data set, making any adjustments needed to make it show clearly. I find it helpful to use a different colormap for each data set, as seen below.



Now use the Transform Editor to get the two parts of the scan roughly aligned. For scans performed in the BRC, there should be a good amount of overlap between scans with planned stitching. On the left, you can see a slightly misaligned set of scans—note the small fin to the left and the spine. On the right, the alignment is very close.



Toggle the Transform Editor off when you're done with the coarse alignment.

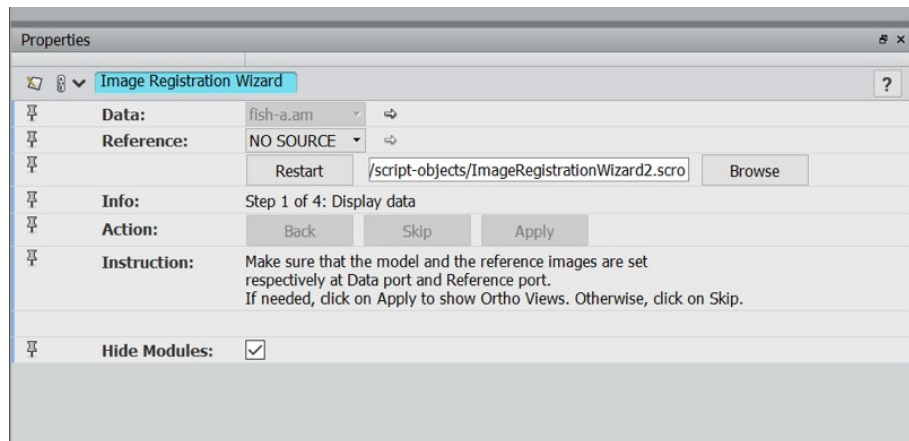
4) Image Registration

To get the two parts more carefully aligned, you can do a fine alignment automatically, using Avizo's Image Registration Wizard, or manually, using the Transform Editor while visualizing the data in 2D and/or 3D. I find that the automatic alignment is not very reliable, but I'll outline both methods below in case the automatic alignment is useful for your workflow.

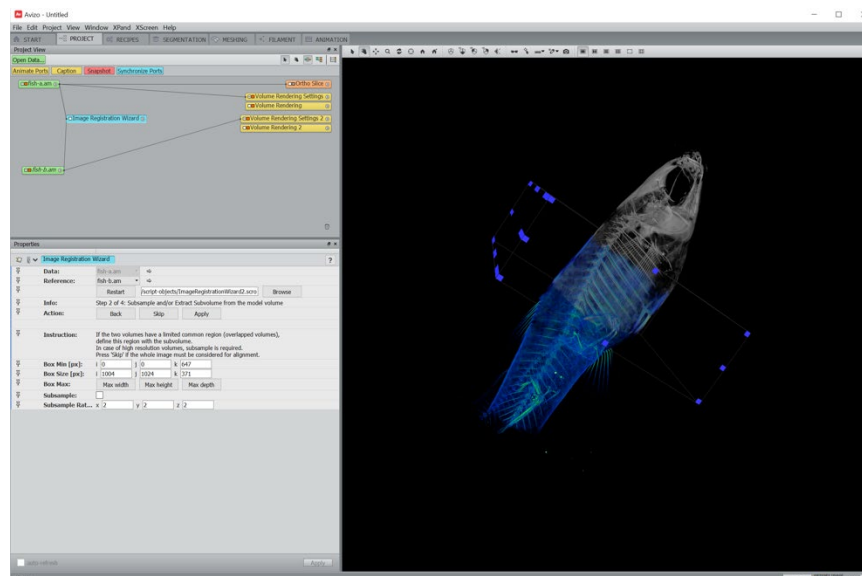
Option A: Automated Image Registration

Right click on one of the green data objects you want to stitch and choose the Image Registration Wizard. Click on the blue Image Registration Wizard object to display its information in the Properties window.

Using the drop-down menu, set the Reference to the second data set. Make sure that you can see both volume renderings, or choose an Ortho View if you prefer. Click Next, or Skip if you are already viewing both data sets.



Step 2/3: Using the cursor, drag the corners of the box that has appeared until the box encloses the part of the first scan (the one selected as "Data") that overlaps the second. I prefer to be a little bit generous with my selection of this region; the larger the volume you select, the longer it will take the software to register the images, but there's a decreased likelihood of making a mistake that prevents the registration from being successful. Click Apply when the volume has been selected. Do the same thing for Step 3, selecting the region where the reference dataset overlaps with the first.



The Image Registration Wizard gives several choices in how it performs the registration. The defaults are a reasonable place to start. Click Apply. The registration will take a few moments. If you are satisfied with the registration, skip to the next step.

Option B: Aligning Manually

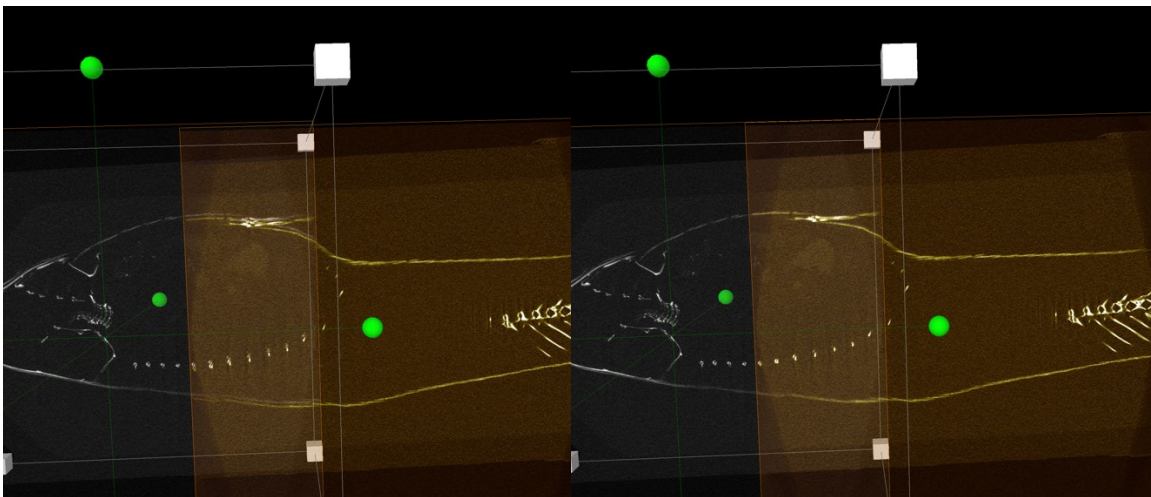
To align the scans manually, use the transform editor to carefully align the images.

A few tips on manual alignment:

- I find that looking at slices in Ortho Slice (2D visualization) is more accurate than volumetric visualization. Find a feature visible on both scans and use it as a registration mark.

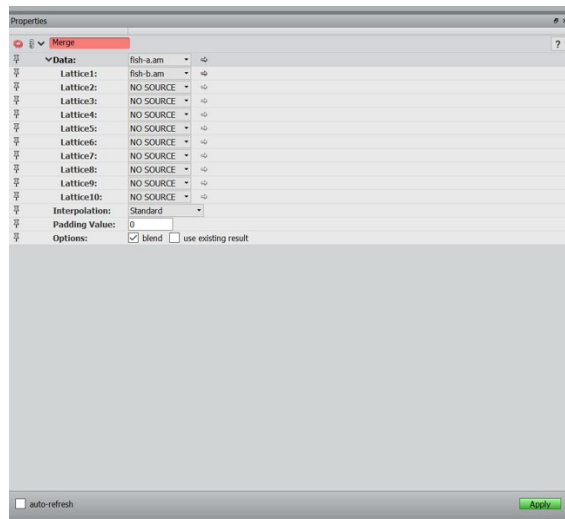
- If you are looking at two datasets viewed with Ortho Slice, they will not be transparent by default, which makes it hard to line things up. To make both slices semitransparent, click on Alpha under Transparency in the Ortho Slice properties window.

- Try looking at the Ortho Slice images in xy , yz , and zx to confirm alignment. You may want to go through an additional iteration after going through it once. In the images below you can see the same segment in Ortho view before (left) and after (right) manual fine alignment. The image on the left was aligned in 3D, but in 2D the slight misalignment is clearer.



5) Merge registered images

Right click on the first green data object and select Merge. Click on the Merge object to display its options in the Properties window.



Using the drop-down lists, set the first dataset to “Data” and the second to “Lattice1” (note: these designations seem to be arbitrary; they don’t need to go in any particular direction but you do need to start at one end if stitching together more than 2 datasets.) The choices at the bottom allow you to favor one scan over another or to fully blend the two datasets. Click Apply.

-Note: On some CT scans, the data quality is poorer on the very edges of the scanned cylinder. We typically arrange scans with sufficient overlap that these areas can be cropped out and still give you well-stitched data. Before performing the merge, you can crop your two data sets to remove these areas by clicking on the green data object and clicking the crop button in the Properties window. I recommend not cropping your data until this point, though, so that you have more points of registration to work with during the alignment phase of the workflow.

Once the merging process is complete, a data object labeled “Merged-[filename]” will appear. Save this before doing anything to it; if Avizo crashes you will lose the merged data set if you haven’t saved it. If you’re going to be doing more stitching to this file, saving it in Avizo’s file format (.am) is faster than exporting it as a DICOM or TIFF.

Check the data for any registration errors. If you have another set of scans to add, repeat these steps, starting with the merged file and the next file to be added.

