10 steps to taking x-ray images with your Shad-o-Box camera

1. ***Install the hardware and software***. Plug in the frame grabber and load the frame grabber software and the ShadoCam software on your PC. Connect the data cable between the frame grabber and the camera. Connect the power supply to the camera and plug it in.

    Hint: Follow the installation instructions in the frame grabber manual. Make sure you install the complete frame grabber software, not just the Windows drivers. If you are using the PXD1000 frame grabber, allow it to modify your Autoexec.bat file.

2. ***Run ShadoCam***. Take a moment to familiarize yourself with the menus and the on-line help system (see Help Menu).

3. ***Check the preferences*** dialog (Acquisition→Preferences) to make sure ShadoCam is set up for the correct camera and frame grabber model. Read the on-line help file for more information on preference settings.

    Hint: Set the Default Frame Exposure to 400, 1000 or 2000 ms. If you use a long frame exposure, you may want to reduce the "Number of frames to average for Calibration Images" setting in order to speed up the calibration process.

4. ***Load the pixel map*** that was supplied with your camera (Calibration→Pixel Map→Read a new pixel map from file). The pixel map is usually shipped on the same CD as this file and should have a filename like *Sxxxx_Pixel Map* where *xxxx* is the serial number of your Shad-o-Box camera.

5. ***Set the exposure time*** (Acquisition→Frame Exposure). This is the number of milliseconds that the detector will integrate x-rays for every frame (also the reciprocal of the frame rate).

6. ***Acquire an offset image*** (Calibration→Offset Image→Acquire a new offset image from the camera). Make sure the x-rays are turned off when you do this! The offset image will be used by ShadoCam to correct for small pixel-to-pixel variations in the dark signal from the detector. You can minimize the offset image window to make sure you don't accidentally delete or overwrite it.

    Hint: Set the lookup table limits to 0-100. The offset image should look uniformly dark gray with some faint vertical striping and a few black or white columns, as well as some black rows or columns for a standard grade detector.

    If you set your acquisition preferences to "Always acquire images into ACTIVE window" be sure to open a new image window before proceeding, so you don't overwrite the offset image. Use the same precaution when acquiring the gain image (see step 8).

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7. ***Check your signal level***. Place the object that you want to image between the camera and the x-ray source and turn on the x-rays. Use the continuous mode (Acquisition→Continuous) to monitor the images from the camera. Adjust the kV and mA settings of your source and the ShadoCam lookup table (LUT Control) to optimize the image. Note the average z-value of the image either by selecting a region-of-interest (ROI) and checking the image histogram (Edit→Statistics), or simply by moving the mouse cursor across the image.

   Hint: For dense objects the average z-value may only be a few hundred counts. An average z-value between 1000 and 2000 will give optimum results. Avoid z-values above 3000, except in areas that are nearly transparent or directly exposed to the beam.

8. ***Acquire a gain image***. Remove the object and turn on the x-rays. Adjust the mA settings (and if necessary the kV) to achieve the same average z-value as in the previous step (use continuous acquisition to check the images). When you're close, tell ShadoCam to acquire a new gain image (Calibration→Gain Image→Acquire a new gain image from the camera). The gain image will be used to correct for signal variations across the detector. You can minimize the gain image window to make sure you don't accidentally delete or overwrite it.

   Hint: The gain correction works best if the gain image contains similar signal levels as your final image. Avoid saturating the gain image, which can lead to unexpected non-uniformity in your final image.

   At this point you can save your calibration files (Calibration→Save Calibration) for future use. However, you may want to frequently renew the offset image since the camera offsets can change with time and temperature. You may want to take a new gain image if your imaging conditions (source-detector distance, signal levels etc.) change.

9. ***Check the calibration***. Leave the x-rays on and take an image (Acquisition→ Single Image). Adjust the lookup table. The image should be uniformly gray except for small, random variations from the x-rays.

   Hint: You can use the image statistics function (Edit→Statistics) to check your calibration. A well-corrected flat-field image should have a standard deviation that is at most only a few percent of the mean signal value.

10. ***Capture an image***. Place your object back into the beam and restore the original settings from step 7. Acquire an image (Acquisition→Single Image). Congratulations! You're done!

   Hint: Try averaging (Acquisition→Multiple Images) to get a smoother-looking image if there is a lot of graininess in your image.