XLI-CT Learning by doing program

On the ASCI open XLI-CT, Fiji and create the folder (within /data/imbl/workshop/output) where your output will go

1)*Absorption* dataset (standard set-up) :

- On Experimental parameters tab select *Absorption* folder as input directory
    - In the *Frames, Darks* and *Flats* boxes enter "tomo\d+.tif", "dark\d+.tif", "flat\d+.tif" (note that \d+ stands for a sequence on digits and \w+ for a sequence of letters)
    - Enter pixel size:10, Energy 10, Angle step 0.2
    - In the output section
        - Switch on sinograms
        - click the *Files* radio button
        - select the output directory
        - enter output file prefixes for slices, sinograms and output parameters (the last is a text file so choose something like "params.txt")
- on the second tab tick *Dark* and *Flat* options only. The flat option should be set to *Average all flats*
- On the CT reconstruction tab
    - select reconstruction method (either will do)
    - Select Centre of rotation method "error"
    - check *Output Mu*
- Press *Process* to run the job

Things to try:

- Look at an output slice (try slice 100 of thereabouts)
- Switch the sinograms on and look at a sinograms in Fiji - try numbers 000 and number 100 – why do they look different?
- Switch off dark and flat correction – look at output slice number 100 now (try rescaling image in Fiji – the data is in there somewhere!)
- Leaving them switched off try switching on *Region normalization* with the values X1=2, Y1=2, X2=5 ,Y2=250 – does that improve matters? Do you know why?

2) *Ring* dataset:

What can cause ring artifacts? Noise (in flats), CCD defects/nonlinearity

- On Experimental parameters tab select *Ring* folder as input directory
- Otherwise set up as for *Absorption*
- Click *Process* to run job and look at output slice and a sinogram – what do you see (half-rings in slice, vertical lines in sinogram hopefully)
- Switch on *Ring artifact removal* and enter *Filter size* of 51 (must be odd number)

- Experiment with varying filter from, say 3 to 91 – discuss results

3) *Zingers* dataset

What causes zingers? – look at input image

- On Experimental parameters tab select *Zingers* folder as input directory
- Otherwise set up as for *Absorption* (switch ring filter off)
- Click *Process* to run job and look at output slice (choose slice no 97 and 100) – what kind of artifacts do you see? (bad rings on some slices, linear artefacts on many slices)
- Try using *Ring artifact removal* to get rid of rings (but linear artifacts remain)
- Switch off *Ring artifact removal* and use Zingers filter with *Filter size* 9 and *threshold* 1.2 and try again
- Try running jobs with smaller values of the *threshold* (perhaps 1.1, 1.05)
- Try playing with the *Filter* size too

5) *Phase_Contrast* dataset

- On Experimental parameters tab select *Phase_Contrast* folder as input directory
- Otherwise set up as for *Absorption*
- Run job and examine slice
- Switch on *TIE-hom phase-extraction* with *R-prime* = 100000 and *delta/beta* = 400
- Run job and examine slice
- Have a look at the effect of making *delta/beta* significantly larger or smaller

4) *Noisy* (abosprtion) dataset

- On Experimental parameters tab select *Noisy* folder as input directory (this is absorption only data)
- Otherwise set up as for *Absorption*
- Run job and examine slice
- Switch on *Ring artifact removal* and enter *Filter size* of 13 (must be odd number)
- Run job and examine slice

6) *Noisy_phase_contrast* dataset

- On Experimental parameters tab select Noisy_*Phase_Contrast* folder as input directory
- Otherwise set up as for *Absorption*
- Run job and examine slice
- Switch on *Ring artifact removal* and enter *Filter size* of 51,
- Run job and examine slice
- Switch on *TIE-hom phase-extraction* with *R-prime* = 100000 and *delta/beta* = 400
- Run job and examine slice

7) Scaling data to 8 bit tiff

Brief outline of what number formats are –

Default output is **floating point tiff (32 bit),** but often **unsigned 8-bit tiff** (integer 0-255 range of greys) is a handy format for input to rendering or analysis software – we can scale our output to this format choosing a sensible dynamic range.

- Look at your latest reconstructed slice in Fiji and get a feel for the image intensity values as you run mouse over image
- On CT reconstruction tab Switch on *Rescale reconstructed slices*
- Select *Manual* and enter *Min* = 0.0 and *Max* = 2.0
- Select *8-bit unsigned int* from drop-down list
- Process to run job
- Experiment with effect of changing *Min* and *Max*

8) Other artifacts (e.g. operator error) –

- on CT reconstruction tab switch Centre of rotation method to manual and try a value a little different to the correct value zero (e.g 5 or -10) and examine results
- Setting the centre of rotation back to zero, on Experimental parameters tab change angle step by a little (0.19, 0.21) and a lot (0.5) and compare results
- Have a look at the results of both a wrong centre of rotation and a (slightly) wrong angle step

9) XLI CT Workflow on the command line

Look in the console tab of the XLI CT Workflow to find parameters for last reconstruction.

The command to run the simplest reconstruction of the absorption data we did at the start (see ….workshop/input/Scripts):

```
Mylogin:> opt/x-tract/bin/XLICTWorkflowMPI --indir
/data/imbl/workshop/input/Absorption --outdir
/data/imbl/workshop/output/Mayo/Absorption --proj "tomo\d+.tif" --
darks "dark\d+.tif" --flats "flat\d+.tif" --dark_correction 1 --
flat_correction 1 --angle_step 0.2 --energy 10 --recon_method 1 --
pixel_size 10 --recon_out_mu 1  --cor_method 2 --file_prefix_ctrecon
"slice.tif"
```