EXD HME MicroCT Data Acquisition, Processing and Data Request Overview

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Executive Summary

This document is a short summary of the steps required for MicroCT evaluation of a specimen. This includes data acquisition through image analysis, for the EXD HME program [1]. Expected outputs for each stage are provided. Data shall be shipped to LLNL as described herein.

Data Acquisition

Data acquisition procedure is outlined in [2]. Data acquisition should be preceded daily by acquisition of the following full-panel uncollimated system calibration files for each system configuration to be used in scanning:

- Dark current detector output (*drk* file), with the source off.
- Light current detector output (*lit* file), with the source on at experiment-nominal kV and mA values.
- Mid current detector output (*mid* file), with the source on at nominal kV value and 2/3 of experiment-nominal mA values.

Acquisition with LLNL's DRCT software generates the following slit-collimated files:

- Gain-corrected radiographs for each view (**.sdt* and *.spr*)
- A *RawMode* folder with pre-gain correction detector output (**R*.sdt* and *.spr*), where *R* indicates a radiograph that has not had gain correction applied.
- Following the test plan for data collection, this is done for 3 system configurations:
  - 160kV 2-slit with AlCu filters (Exp1)
  - 100kV 2-slit with Al filter (Exp2)
  - 160kV 1-slit with AlCu filters (Exp1_Open)

Image Reconstruction

Image reconstruction is to be performed using Livermore Tomography Tools v1.3 (32b), using script files generated from a template provided by LLNL [3].

These script files:

- Perform bad pixel correction
- Generate attenuation radiographs (*attenRad*.sdt* and *.spr*)
- Generate cropped attenuation radiographs (*attenRad*.sdt* and *.spr*)
- Generate sinograms (*sinos*.sdt* and *.spr*)
- Apply ring removal (if specified) and polynomial beam hardening compensation (for the 100 kV configuration)
- Generate reconstructed images (*recobj*.sdt* and *.spr*, *rz*.sdt* and *.spr*)

During the reconstruction, LTT will generate a subfolder for each operation performed on the data, saving files into that subfolder. An example set of folders for a script that does bad pixel correction, generates attenuation radiographs, crops the radiographs, generates sinograms, performs polynomial beam hardening compensation, and then performs filtered backprojection reconstruction is presented below in Figure 1.
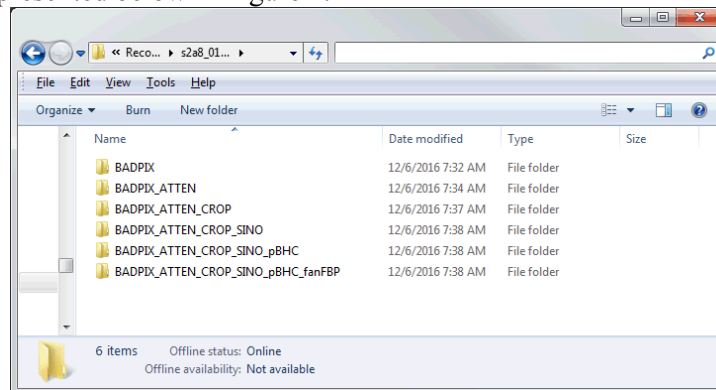

Figure 1: Example Reconstruction directory layout for a script performing the steps as described above. For a script with ring removal before pBHC, an additional folder would appear in the list.

For an acquired scan, the set of reconstructed images should include:
- 11 slices each in the upper and lower slits for two-slit experiments (*recobj*.sdt* and *.spr*)
- 11 slices in the slit region for open experiments (*recobj*.sdt* and *.spr*)
- Full-bottle reconstructions of the specimen for open experiments (*rz*.sdt* and *.spr*)

Data Reduction
LLNL is interested in the output of MicroCT Analysis v2.0, rev6 [4], which processes reconstructed images and pulls copper strip quality assurance data from gain-corrected images. The executable will generate image segmentation files as well as summary Excel spreadsheets (**_characterization.xls* and *CuStrip_*.xls*)

Please report any errors encountered when running these executables to:
Isaac Seetho (seetho3@llnl.gov).

Additional Records
In addition to the acquired and reconstructed image files, LLNL is interested in an acquisition notes sheet per scan processed, following the format provided in Appendix A, and a data shipping Traveler document following the format provided in Appendix B.

Requested Items to be Sent to LLNL (per specimen scanned)

Provided below is a list of files to send to LLNL for specimens scanned under DHS EXD. Files sent by disk shall be accompanied by a traveler document (see Appendix B) providing a complete inventory of disk contents. Disks shipments to LLNL shall also be accompanied by email notification to Steve Cocoles (cocoles1@llnl.gov) and Harry Martz (martz2@llnl.gov) with tracking information.

Send by Disk (to: Steve Cocoles, L-154, Lawrence Livermore National Laboratory, 7000 East Ave., Livermore, CA 94550):

- Files for each system configuration used (Exp1, Exp2, Exp1-Open)
    - Pre-acquisition system calibration files (*drk*, *mid*, *lit*)
    - Raw and gain-corrected DRCT output files (**R*.sdt* and **.sdt*)
    - Attenuation radiographs (*attenRad*.sdt*)
    - Sinograms (*sinos*.sdt*)
    - Reconstructed images (*recobj*.sdt*, *rz*.sdt*)
    - Bad pixel files (*bdpix.txt*)
    - Beam hardening compensation files used (**_ISA_BHC_Coeffs.txt*)
    - All parameter files (**.sct*) generated during data processing
    - Reconstruction scripts used
- MicroCT Analysis GUI output folders (for both specimen/reference image segmentation and for copper strip segmentation)

Send by Email (to: Isaac Seetho and Jeff Kallman at: seetho3@llnl.gov, kallman1@llnl.gov):
- MicroCT Analysis GUI output summary spreadsheets
- Acquisition and reconstruction notes sheet

References

1. William D. Brown, *TP83-MicroCT Data Acquisition, Reconstruction and Analysis Using the ISA MicroCT System*, LLNL-TR-649192, Lawrence Livermore National Laboratory, January 30, 2014.
2. Cary Pincus, Steven Benson, *MicroCT Data Acquisition Checklist*, LLNL-TR-XXXX, Lawrence Livermore National Laboratory, December 30, 2013.
3. William D. Brown, *Computed Tomography Reconstruction Checklist for Data Acquired on the ISA MicroCT System*, LLNL-TR-649121, Lawrence Livermore National Laboratory, January 23, 2014.
4. I. Seetho, W. Brown, J. Kallman, H. Martz, W. White, *MicroCT: Automated Analysis of CT Reconstructed Data of Home Made Explosive Materials Using the Matlab MicroCT Analysis GUI*, LLNL-TR-503291 rev 1, Lawrence Livermore National Laboratory, December 2016.

Appendix A: MicroCT Acquisition and Reconstruction Notes

Provided below is a sample acquisition and reconstruction notes sheet. Each field should be filled out for each specimen scan performed.

KVP and Filter Set:
```
    1.  2-slit, Low Energy, 100 kvp, Aluminum 1.943mm
    2.  2-slit, High Energy, 160 kvp, Aluminum 1.943mm, Copper 1.905mm
    3.  1-slit, High Energy, 160 kvp, Aluminum 1.943mm, Copper 1.905mm
```

Reference Standards:
```
Teflon Cylinder, 0.5" O.D. (outer diameter)
Water in 5 mL 0.5" O.D. test tube
Delrin Cylinder, 0.5" O.D.
Graphite Cylinder, 0.5" O.D.
Magnesium Cylinder, 0.5" O.D.
Aluminum Cylinder, 0.5" O.D.
```

HME Containers:
```
50 mL 1" O.D. Polypropylene digestive vessel with green cap.
```

Reconstruction Parameters:
```
SOD=1098.43 mm
SDD=1406.48 mm
ODD=308.05 mm
PXcenter=1009
PZcenter=663
Calibration Folders = C:\MCT\Calib_140916\Cal
HME Code = Z1C4
Batch Code = N/A
Specimen ID Code = 141003_Z1C4_1
Prepared By = Smith
Preparation Date = 141002
Prescan Net Weight = 68.03
Prescan Volume = 62.99
Prescan Density = 1.08
Postscan Net Weight = 68.03
Postscan Volume = 62.99
Postscan Density = 1.08
Additional Notes: *ROR development MCT specimen #1
```

Appendix B: Data Shipment Traveler Document

Data Tracking Receipt

From:		Date:	

Table of Contents

Compound Name:	

Additional Comments: (Total # of Drives Sent, # of CD/DVDs sent, etc…)	

Shipped By:		Date Shipped:	
UPS Tracking #		Delivery Date:	
Received By:		Date Received:	