



MOCUPY-Version0

USER GUIDE

**HEPSCT Reconstruction software
(stand-alone version)**

2022.09

Introduction to software development



- Stand-alone version of HEPSCCT: MOCUPY is a offline data tomographic reconstruction software, using CUDA for GPU hardware acceleration to achieve fast reconstruction, which contains modules such as Image import, Preprocessing, Phase retrieval (to be integrated) and Reconstruction. So as to meet the needs of users for "massive" X-ray CT data processing.
- This software provide several image reconstruction algorithms for tomography, such as FBP, Grid and EM. It only takes several seconds for tomographic datasets with image size of 2k*2k to reconstruct based on the grid algorithm. In the future, according to the continuous development of experimental technology we will successively develop new data analysis modules based on deep learning method to support the synchrotron radiation users' experiments.

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0. Installation



1. Installation Requirements:

The software of MOCUPY is based on CUDA Libraries, which requires Turing/Ampere cores or newer NVIDIA graphics/computing cards(<https://www.techpowerup.com/gpu-specs/?mfgr=NVIDIA&sort=name>). In addition, in order to achieve higher reconstruction speed, please use the NVMe SSD (such as WD:SN770/SN570、KBG40ZNS) to read and write data.

The recommended computer graphics card performance (or higher) is as follows :

No.	Computer Performance			Data size	Total Time
	Graphics Card	Hard Disc	Memory		
1	NVIDIA GeForce RTX 3060 laptop (6GB)	WD_SN570	16 GB	2k*2k*1441p (11.3GB)	49s
2	NVIDIA GeForce RTX 3090 (24GB)	Samsung 980 Pro	200 GB	2k*2k*1441p (11.3GB)	35s
3	NVIDIA GeForce RTX 3090 (24GB)	Samsung 980 Pro	200 GB	5k*4k*1441p (56.2GB)	6mins 54s
4	NVIDIA GeForce RTX 3090 (24GB)	Samsung 980 Pro	200 GB	5k*4k*5120p (200GB)	11mins 34s

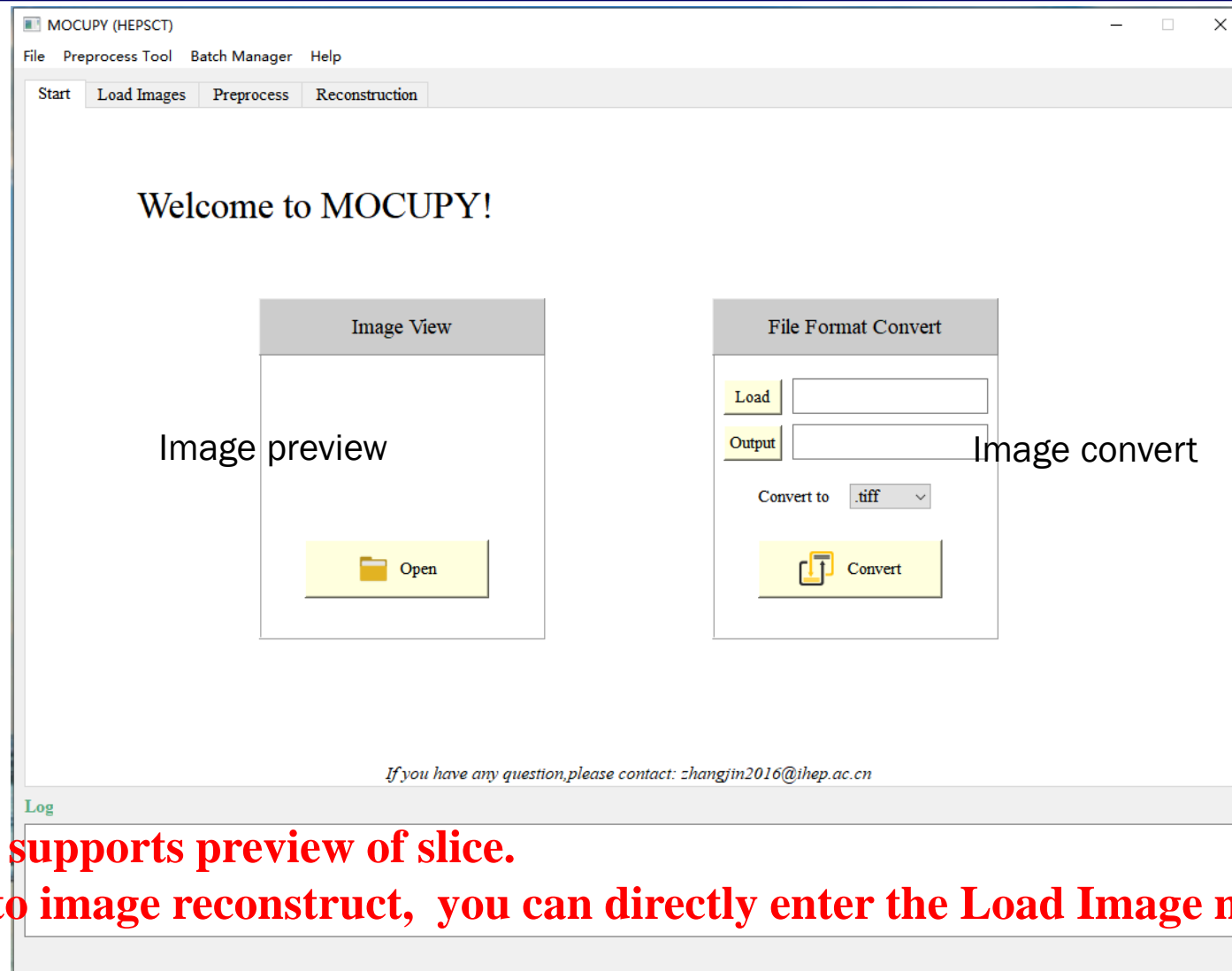
2. How to run the software :

Find the file named **startCTRecon.bat** in the folder and double clicked.

1. Image preview module



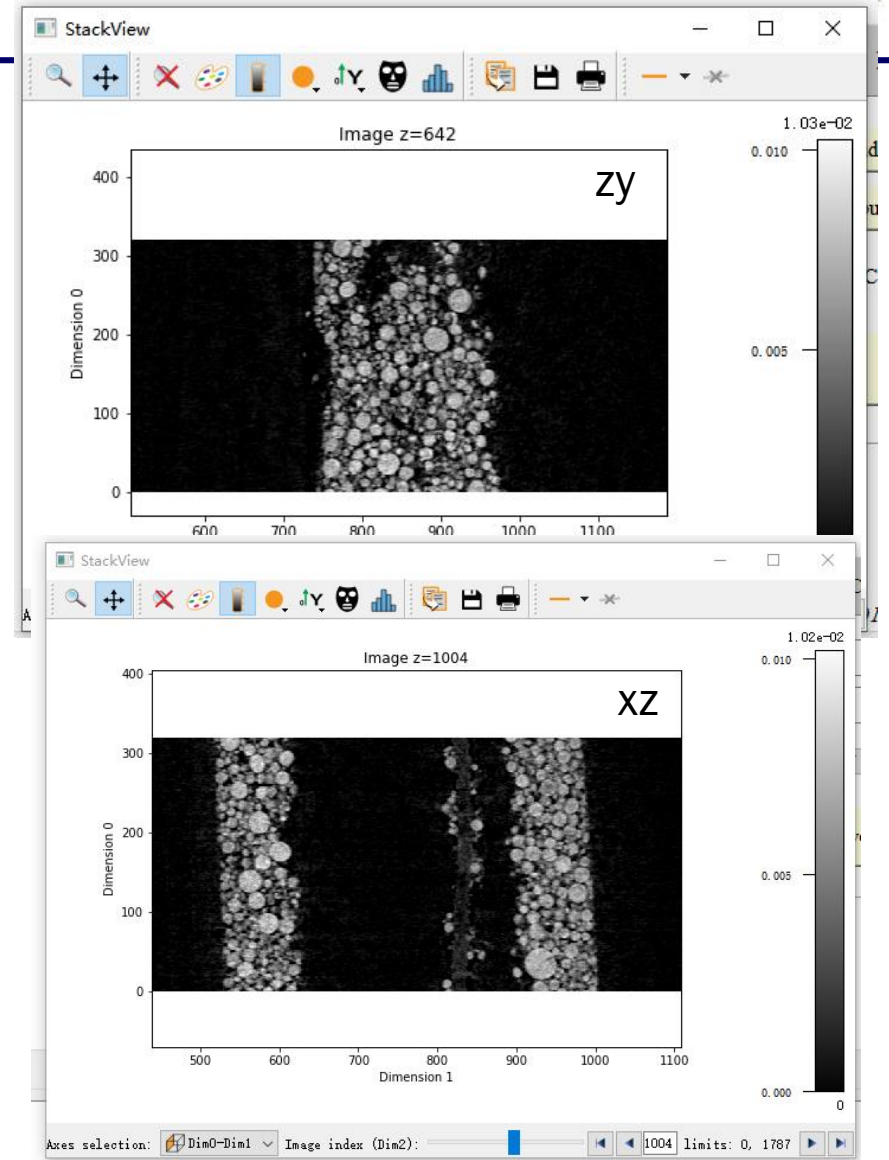
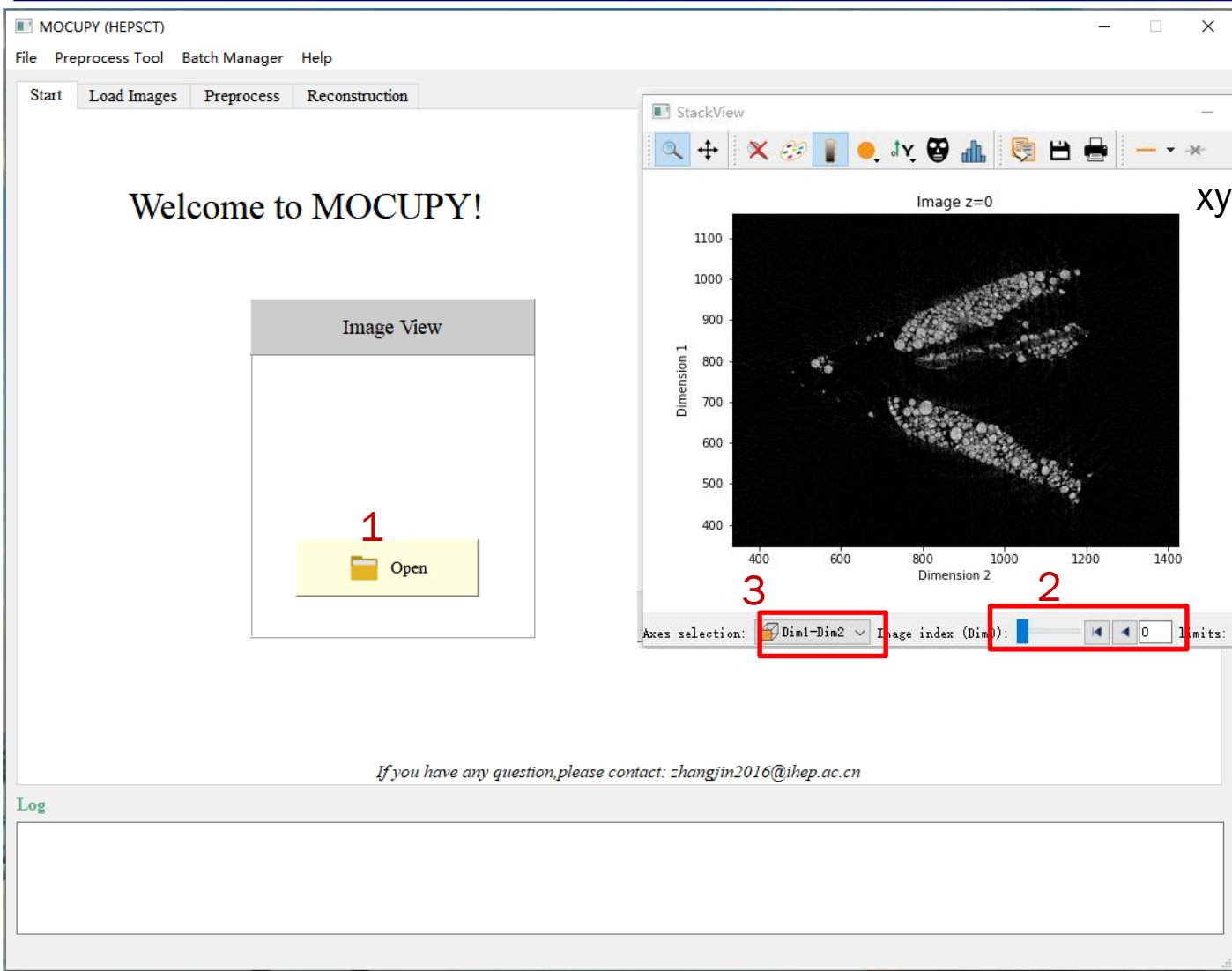
Start module: includes the functions of preview, export and format convert of images.



This module supports preview of slice.

If you want to image reconstruct, you can directly enter the Load Image module.

1. Image preview module



1. Click open button to select files; 2. Preview different slice; 3. Different dimension for slice display



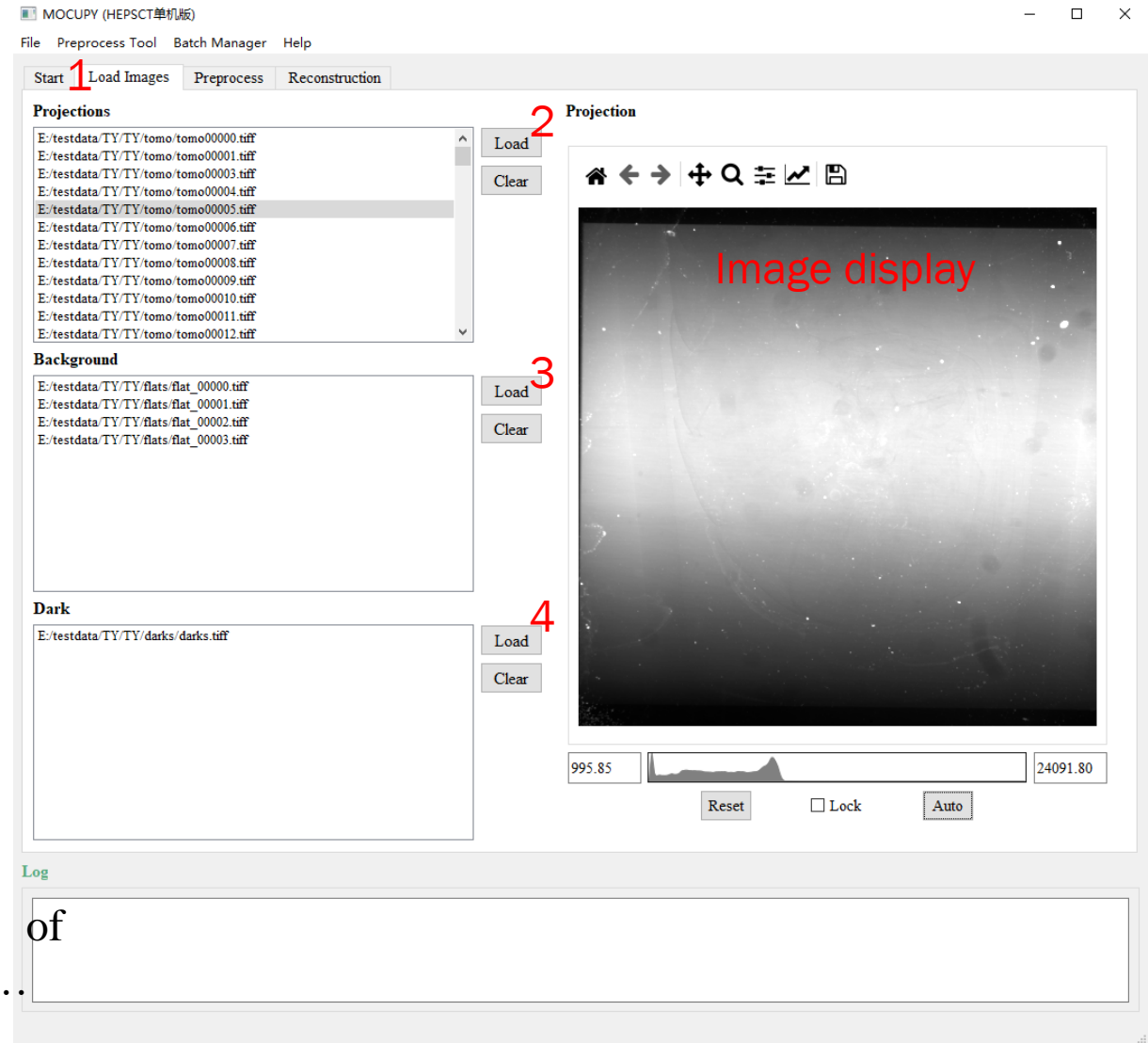
The Process of CT data reconstruction

1. Load Image



Load Images module: mainly contains image import, display and histogram adjustment

1. Click Load Image button to switch the image import tab;
2. Click and select projection images;
3. Click and select flat(background) images;
4. Click and select dark images.



Note : The data is loaded by the numerical order of the images' name. For example: 0001、0002、0003.....

2. Image Preprocess

Preprocess module : contains denoise, background correct, negative value remove, ROI select, line profile preview.



1. Chose the algorithm of denoise;
2. background correct ;
3. negative value remove ;
4. ROI select of reconstruction: checked, click and drag the left mouse button in the image display area to select. After confirming the selection, click **Set ROI**. The red dashed line in the figure is the reconstruction area. **Note: If you want to reconstruct the entire image, skip this step.**
5. Check. Click and drag the left mouse button in the image display area. Select the area where there is no sample to normalize background. If confirmed, click **Set BgROI** (note: the selection of this area cannot exceed 300*300. If the sample filled all the area, this step can be skipped;)
6. Manual Update
7. Auto Update: If checked, the image display area will auto update.

The screenshot shows the MOCUPY (HEPSCT单机版) software interface. The main window is titled "MOCUPY (HEPSCT单机版)" and has a menu bar with "File", "Preprocess Tool", "Batch Manager", and "Help". The interface is divided into several sections:

- Start**: Includes "Load Images", "Preprocess", and "Reconstruction" tabs.
- Denoise**: A dropdown menu set to "Median" (labeled 1).
- CT Parameters Setting**: Includes checkboxes for "Minus Log" (labeled 2) and "Neg Cutoff" (labeled 3).
- Preview**: A slider for "Projections" (labeled 5) and a "Manual Update" button (labeled 4).
- ROI**: Includes checkboxes for "Recon ROI Selection" (labeled 6) and "Background Region Selection" (labeled 7). It features "Set ROI" and "Set BgROI" buttons, with the ROI value [15, 2029, 843, 703] and BgROI value [51, 45, 1862, 67] displayed.
- Profile**: A line graph showing a profile of the image. The y-axis ranges from 0.00 to 0.20, and the x-axis ranges from 0 to 2000. A blue vertical line is positioned at x=643.
- Projection**: A large image display area (labeled "the image display area") showing a grayscale image of a human torso. A red dashed line indicates the reconstruction area. Below the image are "Reset", "Lock", and "Auto" buttons.
- Log**: A log display area at the bottom showing two warning messages: "2022-09-14 16:21:00,369 - [WARNING] [15, 2029, 843, 703]" and "2022-09-14 16:21:33,123 - [WARNING] [51, 45, 1862, 67]".

The line profile preview of dash line(green).

Log display

3.Reconstruction

Parameters Setting

1. **Reconstruction algorithm:** FBP、 grid (fast) 、 em;
2. Iteration number, default 20;
3. Batch size: related to computer performance, default 64;
4. Starting Angle: according to actual data collection, default 0;
5. stop Angle: according to the actual data acquisition, default 180;
6. The value is calculated from the number of projections loaded and the input of 4 and 5. **Note: You need to check that Step Size is correct before reconstruction.**
7. If checked, the reconstruct area will be masked, and the value outside the circle will be set zero;
8. If checked, the negative value will be removed after reconstruction;
9. If checked, ring artifacts will be removed.

The screenshot shows the MOCUPY (HEPSCT单机版) software interface. The main window is titled "MOCUPY (HEPSCT单机版)" and has a menu bar with "File", "Preprocess Tool", "Batch Manager", and "Help". The interface is divided into several sections:

- CT Parameters Setting:** This section contains various input fields and checkboxes. The "Algorithm" is set to "grid" (marked with a red 1). "Iteration Num" is 20 (marked with a red 2). "Batch Size" is 64 (marked with a red 3). "Angle Start" is 0 (marked with a red 4) and "Angle End" is 180 (marked with a red 5). "Step Size" is 0.125 (marked with a red 6). Checkboxes for "Circle Clip" (marked with a red 7), "Neg Cutoff" (marked with a red 8), and "Ring Artifacts Removal" (marked with a red 9) are all checked.
- Axis:** This section has a slider for "Slice" at 1023 and "Axis" at 1097.8. There are "Guess Axis", "Set Axis1", and "Set Axis2" buttons, along with "Auto Update" and "Manual Update" options.
- Output Path:** A text field for the output path is present, with a red annotation "The output path of results" pointing to it.
- Reconstruction Controls:** "Reconstruct" and "stop" buttons are visible.
- Reconstruction Progress Monitoring:** A progress bar at the bottom shows the reconstruction status.
- Log:** A log window at the bottom displays system messages, including timestamps and information about preprocessing and reconstruction times.

On the right side of the interface, there is a "Slice" window showing a 3D visualization of a slice of a specimen, with navigation and zoom controls above it.

3.Reconstruction

Axis correct:

1. Adjust different slice;
2. Adjust the Axis;
3. Click, and the axis can be calculated by algorithm. If the calculation is not accurate, you can manually adjust by dragging 2 or clicking +/- in 4.
4. If the sample the axis values is different greatly between upper and lower, you can drag 1 to select the upper and lower slice, and adjust 2 to calculate a **optimal axis value**. Then click 5, Set Axis1 and Axis2. **If there is little difference between the upper and lower slice, you can skip this step directly.**
5. After setting Axis1 and Axis2, check 6 to lock the rotation axis. When you preview the results, the value of axis will be calculated according to the Axis1 and Axis2 Settings;
6. Click 7 to select the saved folder (**Note: the folder name does not recognize Chinese characters**).
7. When all parameters are set correctly, click 8 to start reconstruction.
8. If you want to quit, click 9 to stop.

MOCUPY (HEPSCT单机版)

File Preprocess Tool Batch Manager Help

Start Load Images Preprocess Reconstruction

Slice

CT Parameters Setting

Algorithm Iteration Num Batch Size

Angle Start Angle End Step Size

Circle Clip Neg Cutoff Ring Artifacts Removal

Axis **Axis correct**

Slice Lock Axis

Axis

Auto Update

Output Path

Reconstruct Status

Log

```
2022-09-15 14:07:29,128 - [INFO] Back ground region preprocess time: 0.0
2022-09-15 14:07:29,130 - [INFO] Batch index:
2022-09-15 14:07:29,165 - [INFO] Read time: 0.03387928009033203
2022-09-15 14:07:29,183 - [INFO] Preprocess time: 0.016954660415649414
2022-09-15 14:07:29,208 - [INFO] Reconstruction time: 0.023936033248901367
2022-09-15 14:07:29,217 - [INFO] Postprocess time: 0.006981611251831056
```

4. Common problems



- MOCUPY is a fast CT reconstruction software for GPU acceleration based on CUDA. Therefore, the graphics card needs to support CUDA. When the graphics card does not support CUDA acceleration, the software may fail to run.
 - If the CT data missing too much angles or the sample is out of the projection field of view, Guess axis may not calculate accurately. You can manually adjust the Axis value.
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