

SCANCO Micro-CT Scanner:

User Policy & Guidelines

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In order to promote the effective operation of the scanner, it is essential for all users to follow the policy and guidelines for the device. Otherwise, the system will promptly become very disorganized and the data disk will fill up. If this occurs, it will be difficult for users to retrieve and manage their data, and there will be no space available for recording the data of new measurements /scans.

Overview of guidelines:

- 1- Pre-scanning
 - a. Plan how analysis will be performed once scans are made.
 - b. Fill out contact sheet.
 - c. Sort and name samples.
 - d. Enter names into database.
 - e. Fill out log sheet, update it regularly and enter into logbook.
- 2- Scanning
 - a. Perform calibration if necessary
 - b. Perform scans
- 3- Post Scanning
 - a. Perform preprocessing (reconstruct images with new angles and contouring)
 - b. Backup all RSQs
 - c. Delete ISQ files
 - d. Perform analysis
 - e. Backup project

1.0 Pre-Scanning

There are a number of activities that must be completed prior to performing scanning. Such activities include the following:

- Most importantly, PLAN! Before any scanning is performed, you MUST determine your purpose for scanning and plan how analysis will be performed. Also, it is not acceptable to use maximum resolution, integration time, frame averaging as it is unnecessary, time consuming and thus, prevents others from using the scanner.
- Set up your project directory
- Create a project information sheet for the logbook
- Register specimens in the database

1.1 Plan

Before any scanning is performed, you MUST determine your purpose for scanning and plan how analysis will be performed. If this is not done, and

scans are made, then the data from those scans unnecessarily takes up space on the measurement disk for a long time. If the disk fills up with such data, NO ONE will be able to scan, as there will be no more room left for recording new data on the disk. Planning how you intend to analyze will require some thought, and some discussion with your project supervisor about the UCT system, and its capabilities. However, if done adequately, it will make yours and others projects run much more smoothly.

1.2 Set-up Project Directory

When starting a new project, an appropriate directory should be made. Your project directory should be created under your supervisor, and should be given a relevant heading. In your directory, the following subdirectories should be created: COM, DOC, DOC.IMG.2D, DOC.IMG.3D, MODELS and LOG. These directories will eventually hold all of your project files and information. The following flow chart demonstrates the directory system.

**** Note: CAPITALS should be used for ALL directory names!!!****

**** Note: ALWAYS use underscores _ and not dashes – or spaces in directory names. ****

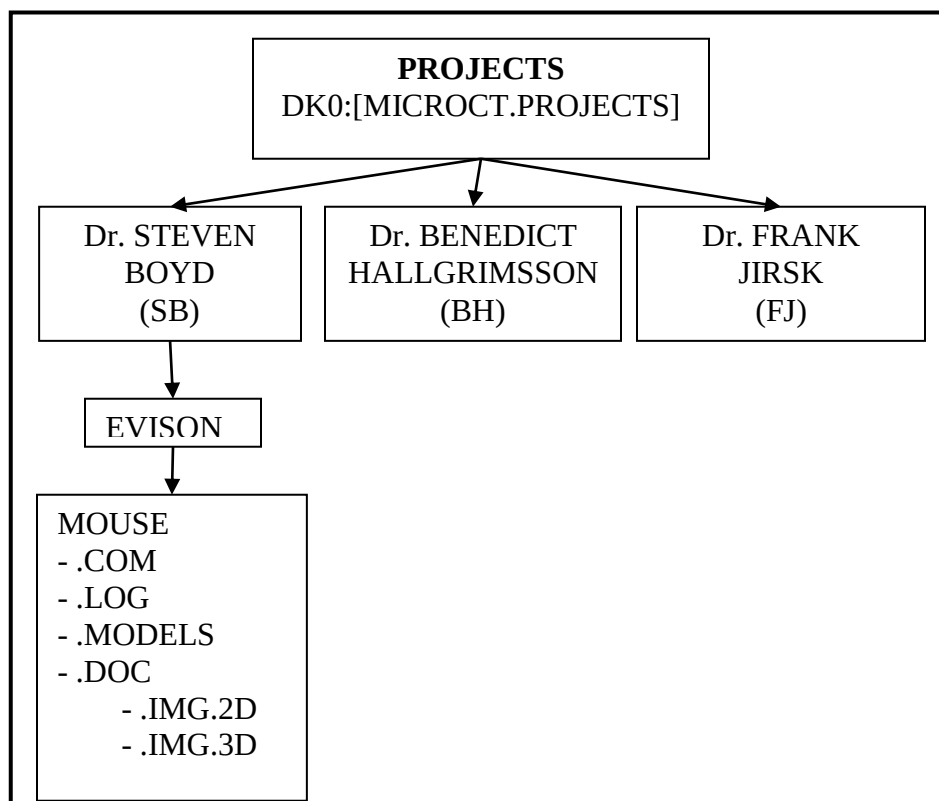


Figure 1: System Directories Flowchart

- To get to your lab's directory type:
 - `$ cd DK0:[MICROCT.PROJECTS.SB]`

(where you would replace SB with your supervisor's initials ie. Dr. Steven Boyd = SB, Dr. Benedict Hallgrimsson = BH...etc.)

- Once in your supervisor's directory, to create a directory for your project, type the following but replace EVISON and MOUSE with relevant headings for your project:
 - `$ create/directory [.EVISON.MOUSE]`
- Within your directory, to create the COM, DOC, DOC.IMG.2D, DOC.IMG.3D, MODELS and LOG subdirectories, type the following (and repeat for all directories):
 - `$ create/directory [.EVISON.MOUSE.COM]`
- Type `cd 'PROJECT DIRECTORY NAME'`, to change into your new project directory.
 - `$ cd DK0:[MICROCT.PROJECTS.SB.EVISON.MOUSE]`

1.3 Create a Project Information Sheet (Log Sheet)

When commencing a new project and before any samples are scanned, you must begin a project information sheet for your project. This enables you and others, who may later be involved in your project, to keep track of your scan data, as it goes through processing, analysis and archiving stages.

- Obtain a project log sheet from the UCT log book. ** If you take the last one, please obtain more (email Steve Boyd skboyd@ucalgary.ca or make photocopies of the last blank one)
- Write the project name.
- Sort your samples, so they can easily be named in the next step.
- **Name** the samples. **A proper naming scheme should be applied to the naming of all specimens, denoted by the following points:
 - Your lab initials should appear first, using capital letters (ie. SB_).
 - Next should be your project name, also using capitals (ie. SB_EVI^SON_MOUSE).
 - Then, identify the type of specimen (ie. SB_EVI^SON_MOUSE_Femur). * NOTE: it is ok to use lower case here*
 - Finally, indicate the number of the specimen (ie. SB_EVI^SON_MOUSE_Femur_01). You may also want to include other characteristics about the specimen, 'R' for Right, or 'L' for left (ie. SB_EVI^SON_MOUSE_Femur_R01).
 - Keep names as short as possible and try to create names for your project that are the same number of characters. Moreover, remember to use CAPS for your lab initials and project name!

- Write the project name at the top of your log sheet, and then only list the part of the name that does not include the project name on the log project sheet.

An example log sheet can be seen in the blue binder found in the UCT lab.

1.4 Register Samples in Database

Before any samples are scanned, all specimen names must be registered in the database. Each sample must now have been given an appropriate, descriptive name and must now be assigned a **sample** number. Once the user begins scanning, the **measurement** numbers of all scans must be recorded given their importance in further processing, analysis and archiving procedures. There are places on the logsheet where these numbers should be recorded for each specimen.

- To register samples, click on the uct_samples tool which is seen in Figure 2.
- Carefully type the name of your first sample (using the proper cases)
- Save
- Click New
- Carefully type in the name of your second sample
- Save
- Click New
- Repeat until all samples are entered into the database.

The screenshot shows the 'SCANCO μCT-Samples V1.1' application window. It features a menu bar with 'File' and a main content area with several labeled input fields. The 'Name' field is highlighted with a blue border and contains the text 'SB_EVISON_Mouse_Femur_R01'. Below the input fields are four buttons: 'Find...', 'Find Next', 'New', and 'Save'.

Figure 2: UCT_SAMPLE naming

1.5 Sample Preparation

The last step before scanning can be performed is sample preparation. Sample preparation consists of sorting samples and preparing a suitable sample holder to secure the samples during scanning. Most specimens must be contained within a sample holder during scanning. It is essential that a sample remains fixed throughout the measurement because any movement will result in poor images. Holders vary, depending on the specimen shape and size, but generally, they are made of foam, and are cut to fit in the vial in which the samples are to be scanned. The holders often have slots or cavities in which the samples are positioned. Examples of holders are shown below.

Figure 3: Sample Holders

2.0 Scanning

2.1 Weekly Maintenance

If you are scanning on a Monday, ensure that the weekly calibration scan has been performed. If no calibration has been completed, please follow the instructions in these guidelines to complete the calibration. If you need assistance, speak to Wei, the lab technician. *Note: if this task is not completed, your results will be affected.

The scanner must be calibrated weekly. To perform the calibration, complete the following steps:

1. Verify on the weekly calibration status sheet, whether the weekly calibration has been performed or not.
2. Load the calibration device seen in Figure 4 into the scanner. Notice that the device should be loaded with the "top" facing up.

**Note: More detail instructions for steps 2 and 3 are given in section 2.3 of these guidelines.

3. Open the UCT TOMOGRAPHY tool and select the appropriate control file (1,2 or 3) for the corresponding number on the calibration device.
4. Start the scan (using batch measurement and exit the tool).
5. The calibration should take no more than 1 hour.
6. Fill out the calibration status sheet, marking that the weekly calibration has been performed.

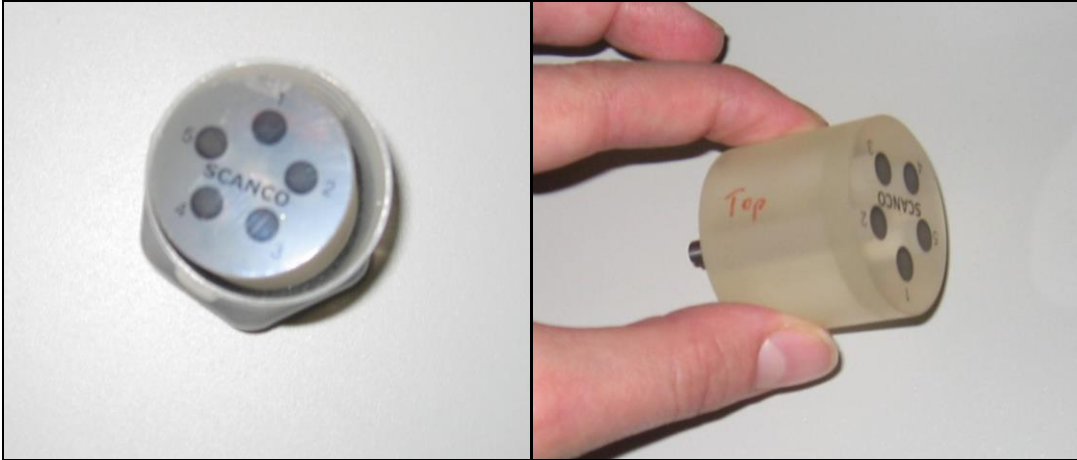


Figure 4: Calibration Device

Now you can start scanning!!! Yay!

Figure 5: UCT Main Toolbar

(From left to right: UCT_SAMPLES, UCT_TOMOGRAPHY, UCT_EVALUATION, UCT_THREEDEE, UCT_BACKUP, UCT_TOOLS, EXIT)

2.2 Define a Control File

Before actually starting a measurement, you must create a control file that contains the scanner settings you desire for scanning your specimens. The control file includes the following options:

- Diameter of the cylinder (mm) – This should be set to the size of the vial that you are using for your scan
- Resolution: High / Medium/ Normal – This should be set as low as possible, but high enough to meet your needs. Usually medium resolution yields very nice scans.
- Isotropic: usually yes
- Energy (kVp)
- Current (μ A)
- Integration Time (ms) – The higher the integration time, the longer the scan will take. *NOTE: Max out integration time before using frame averaging.
- Frame averaging – Avoid using unless highest integration time scans are not of sufficient resolution.

Do not scan everything on the best possible settings, as it will take up a lot of data space, and TIME (i.e. the scanner will be blocked up). Perhaps, do 1 or 2 test scans on lowest/medium setting to see if the resulting images meet your needs. Keep in mind that if you scan at very high resolution, your data files will be very large, unmanageable and difficult to process.

2.3 Start the Measurement

!! Before starting measurements, be sure that enough disk space is available!
To do so, type "DISKS" in a terminal, which will display the current disk availability.

To begin scanning, complete the following tasks:

- Start the UCT_TOMOGRAPHY tool
- Select the first sample in the database
- Select the control file that you have defined for your project and make a scout view (write down the position range of the scout view, for each specimen, on the log sheet under scout view. The positions for the specimen can often be reused for later measurements.)
- In the scout view, set the reference line to define where the scan should begin and end.
- Record on the project sheet the number of slices you are scanning and the estimated scan time.
- Click on Batch Measurement
- Click on 'Others' if there are more specimens in the holder to scan and select the next sample in the database. If you are only scanning one specimen, then skip to the last bullet.
- Repeat this procedure for every sample you have in your holder.
- The batch measurement jobs (ie. Scanning) will start as soon as you exit the UCT_TOMOGRAPHY tool. ** You must EXIT the tool by clicking in the top left corner and exiting. DO NOT press Start Scan. You MUST exit!**

3.0 Post Scanning

3.1 Reconstruction Angles

Subsequent to scanning, the project data can be processed at which point the data can be analyzed.

To reconstruct your images, with a new angle, the following steps must be performed.

- Get offset angle with the uct_evaluation tool.
- In a terminal type (**NOTE: you must be in the directory when your RSQ file is located for this to work):
 \$ define uct_reconstruction_offset 75.0
 \$ uct_reconstruction
 ...give RSQ With full path name
- Record angle (ie. 75.0) in log sheet.

3.2 Backup / Archiving

Several archiving steps must also be performed, concurrently to the processing and analysis steps (this is critical for maintaining space on the measurement disk for scanning).

Note: RSQ (also RAW) – raw projection data
 ISQ (also IMA) – reconstructed data (from RSQ)
 AIM (IMA) – extracted 3D image of area of interest (from ISQ)
 GOBJ (IMA) – contour/mask (for focused post processing). ROI.

Processing and Archiving of scanned data must be done promptly after scanning.

Processing of data should begin promptly after scanning is performed. When reconstruction angles are defined for all measurements, the images can be reconstructed with their new angles. The main reason for reconstructing images is to orient them in a suitable/desirable direction and to ultimately save space on the measurement disk. Once the images are reconstructed with new angles (ie. all reconstruction jobs are complete), the RSQ data on the measurement disk **MUST be backed up immediately.**

Archiving is often referred to as 'backup,' and therefore the tool used to archive is the `uct_backup` tool, which is on the `uct_toolbar` shown in Figure 4. Archiving is when data is moved from the measurement disk to a tape, for a permanent archive of the data. Archiving data is an essential part of project procedures. There is limited space on the measurement disk and thus, all data (especially RAW data, aka. RSQ data) must be archived as soon as possible after scanning is complete to allow space for recording new data onto the measurement disk. Moreover, once all analysis is performed and a project is complete, the entire project should be archived.

It is also important to know at what stage of the measurement/analysis process one can archive RAW data and IMA data. RAW files can be archived as soon as slices have been fully reconstructed, but image files can only be archived when all evaluation has been executed and files such as (AIM, GOBJ, GFILT) have been created.

****General Policy:** RSQ data is backed up, as well as AIMs and GOBJs, which are made from ISQs. ISQ data is deleted. If needed in an emergency, ISQ data can be recovered from the backed up RSQs.**

3.3 Archiving Using the UCT_backup Tool

The `uct_backup` tool method is a really simple, interactive method, but is only practical when you have a few files to archive. The following explains how to perform this method:

- First, put a tape in the tape device. The tape name should correspond with the type of files you are archiving; if you are archiving RAW files

(ie. RSQ files), use a RAW tape (eg. SBR001 or SBI001 which stands for Steve Boyd RAW or IMA respectively, and tape number 1).

- At your computer, log on and open the uct_backup tool by clicking on the 'disk' picture on the uCT icon bar.
- Under the heading '**Disk Information**'-> **Tape** you must click on either **Mount** or **Initialize** (see Figure).

****IMPORTANT:** If the tape is **NOT** a brand new tape, **DO NOT** initialize it!!! Initializing will erase all the data already on the tape. **

- If the tape is new, click on initialize and when a small window pops up, write in the name of the tape (eg: **SBR001**), press ok and then click on **Mount** to mount the tape. If the tape has already been initialized, then just press **Mount**.



Figure 6: Disk Information section of uct backup tool window, where one can mount, dismount or initialize a tape.

- Once the tape is mounted, in the section '**Data Management**' and under **Measurement**, select the measurement from which you wish to archive files. Next, under **Selected Measurement**, indicate whether you want to archive raw data or image data by activating the option button beside the RAW or IMA. Raw data is only .RSQ files whereas image data is everything except .RSQ files (ie. .ISQ, .AIM, .GOBJ, .GFILT).

RAW	IMA
RSQ	ISQ, AIM, GOBJ, filtered files

Table 1 – Data Categories

Data Management

Measurement:

52: SB_BOTOX_Rab_Fem_CIR_L03	52: 2-FEB-2005 16:20	949 Slices MR +
59: SB_BOTOX_Rab_Fem_CoR_C02	55: 4-FEB-2005 16:37	724 Slices MR +
64: SB_BOTOX_Rab_Fem_CoL_C03	60: 8-FEB-2005 20:10	733 Slices MR +
69: SB_BOTOX_Rab_Fem_CoR_C04	67: 9-FEB-2005 16:45	733 Slices MR +
70: SB_BOTOX_Rab_Fem_CIL_L10	68: 9-FEB-2005 18:07	841 Slices MR +
72: SB_BOTOX_Rab_Fem_CIL_L02	70: 11-FEB-2005 16:34	841 Slices MR +
73: SB_BOTOX_Rab_Fem_CIL_L03	71: 11-FEB-2005 18:04	831 Slices MR +
74: SB_MACNEIL_OARAB_RISE_01	72: 3-FEB-2005 11:26	771 Slices CU
75: SB_MACNEIL_OARABBIT_RISE_01	73: 14-FEB-2005 11:58	946 Slices CU
77: SB_MISC_Juvenile_Mouse_B16M	81: 14-FEB-2005 15:26	1901 Slices MR + o

* = aborted o = archived + = evaluated

Select Old Measurement ... Update List

Selected Measurement:

☐ RAW

☒ IMA

Move To:

Figure 7: Data Management section of the uct_backup tool window, where one selects a measurement to archive and indicates the types of files to archive. The Move To, Tape and Start buttons are shown.

- To start the archive process, make sure the **Move To** and the **Tape** options are selected and then, press **Start**. A window will appear asking whether you are sure you want to execute the move/copy command; click on **Yes**, if you are sure.
 - Move** – this command is used for moving data from the measurement disk to a tape.

- **Copy** – this command is used for restoring data from a tape to the measurement disk.
- Once the process has started, you can **MINIMIZE** the uct_backup tool and the window will open automatically when the data has been written to tape. ****WARNING:** If you restore the window before the data is archived the window will not be refreshed and has a tendency to freeze and/or crash.



Figure 8: Entire uct_backup tool window with confirmation message that appears when one clicks on the start button.

- You will know that the archive is finished when the uct backup window pops up again. When the window appears, click on **Dismount**, retrieve the tape from the machine.
- To verify whether or not the archive worked, open the uct_backup tool again and select the measurement you archived. In the **Selected Measurement** window, the data should appear with TP0 in front of it, if it was properly archived.

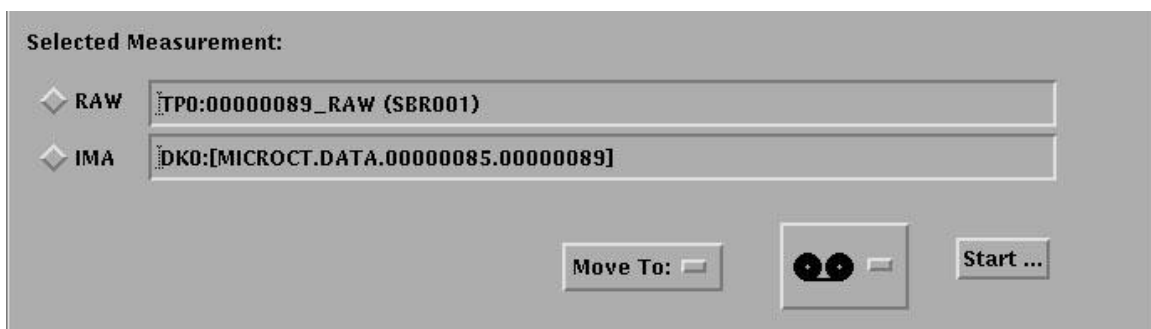


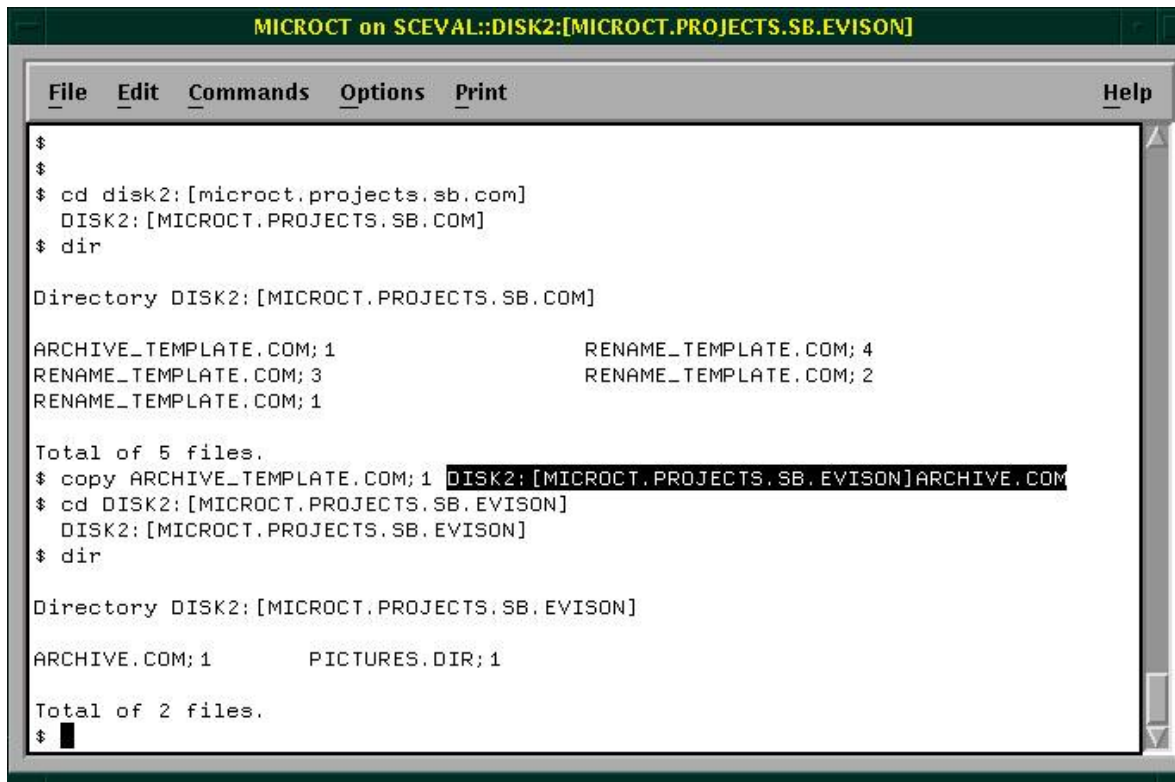
Figure 9: Selected Measurement window showing the data location at TP0. This indicates that the measurement 00000089_RAW was properly written to tape SBR001.

3.4 Archiving Using a Text File

This method is also fairly simple, and is useful for archiving a lot of data concurrently. The following is an explanation of this method:

The idea is to write a command file with all the data files you want archived and then run it.

- To begin, copy an old archive.com file from your labs com directory by typing the following:
 - `COPY old_archive_pathname new_archive_pathname`
- Write the script, first open up Notepad, save your file as archive, in your project's com directory.
- Next, open up archive.com located in PROJECTS.SB.COM directory. The file that appears will be one that was previously used for archiving, and to save you time, you can copy parts of the old archive file and paste them into the new archive file in your project directory.



```
MICROCT on SCEVAL::DISK2:[MICROCT.PROJECTS.SB.EVISON]
File Edit Commands Options Print Help
$
$
$ cd disk2:[microct.projects.sb.com]
  DISK2:[MICROCT.PROJECTS.SB.COM]
$ dir

Directory DISK2:[MICROCT.PROJECTS.SB.COM]

ARCHIVE_TEMPLATE.COM;1          RENAME_TEMPLATE.COM;4
RENAME_TEMPLATE.COM;3          RENAME_TEMPLATE.COM;2
RENAME_TEMPLATE.COM;1

Total of 5 files.
$ copy ARCHIVE_TEMPLATE.COM;1 DISK2:[MICROCT.PROJECTS.SB.EVISON]ARCHIVE.COM
$ cd DISK2:[MICROCT.PROJECTS.SB.EVISON]
  DISK2:[MICROCT.PROJECTS.SB.EVISON]
$ dir

Directory DISK2:[MICROCT.PROJECTS.SB.EVISON]

ARCHIVE.COM;1          PICTURES.DIR;1

Total of 2 files.
$
```

Figure 10: VMS terminal showing how to copy an old archive file.

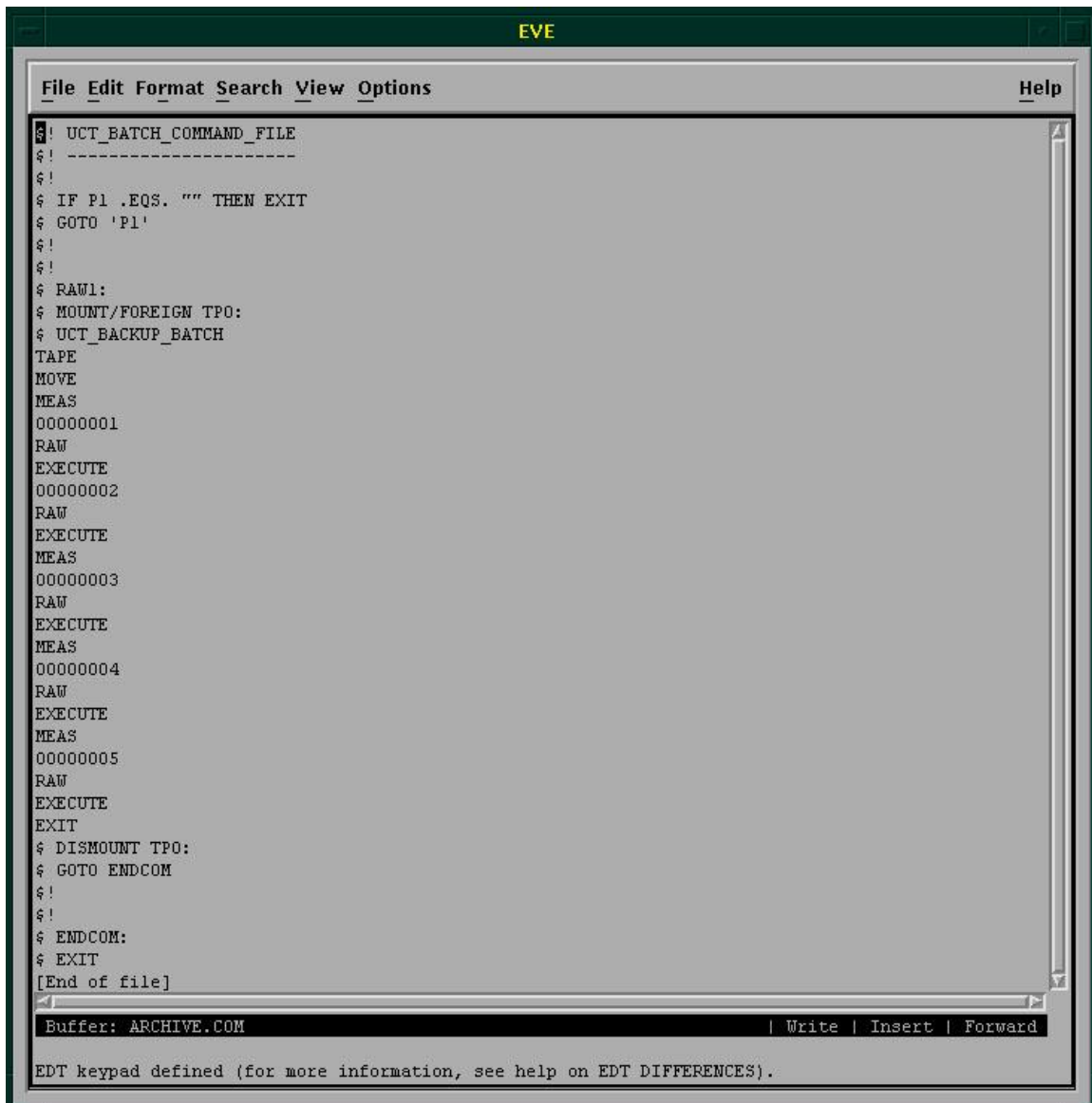


Figure 11: Eve text file called ARCHIVE.COM, displaying archive file for backing up RAW data.

The following lists many important things about the above archive file and what should be in your archive file:

- 1) Lines 1-7 use the goto command to jump to the section of the archive file to be backed up (section is indicated by the parameter P1).
- 2) Line 8: RAW1 is the parameter P1 that will be entered in the command line to start the archive process.
- 3) Lines 9-12 mount the tape. The two words **TAPE** and **MOVE** indicate that you are moving data to the tape. Archiving is

- characterized by these words and they must be included in the order shown.
- 4) Lines 13-16 are the four lines of script required for each measurement number. Only one thing needs to be changed and that is all the numbers, they should be changed to reflect the measurement numbers you wish to archive. **IMPORTANT:** use MEASUREMENT numbers and **NOT** sample numbers.
 - 5) Lines 32-34 dismount the tape and goto the endcom command.
 - 6) Finally, lines 37-38 is the endcom command, which exits the com file.

When you have modified the file as directed, **save the file.**

Insert a tape in the COMPAQ tape device. The tape name should correspond to the types of files you archive (ie. if you are archiving RAW files, use a RAW tape).

To start the process, log on and in a VMS terminal, go to your project's com directory. Use the command line `@archive_file_name P1`, where the file name is your archive file name and P1 is a parameter, which corresponds to RAW1 or the heading corresponding to line 8 in Figure 9. As an example, one could type the following:

```
@archive RAW1 (See Figure 10).
```

To check the status of your archive, check the queue. When archiving is complete, retrieve the tape from the tape machine.

NOTE: If the tape fills up during archiving, the following error message will appear:

```
resume operation on volume 02
```

If this occurs, type no, remove the tape from the machine and move the little clip on the tape sideways (so that a little orange strip appears) to write lock the tape, so it can no longer be written to. Put the tape in its box.

Retrieve a new tape, write the new name on it (numbered consecutively ie. SBR002), put it in the tape machine, open the pxt backup tool and initialize the tape (as was described previously). Verify which measurements have been archived on the previous tape and start the archiving process again for the remaining measurements. ****NOTE:** Edit your archive file, so that you now have a new P1 paramter (eg. RAW2) command for the measurements that remain to be archived.

For IMA data archiving, the process is the same, except all references to RAW should be replaced with IMA. In addition, an IMA tape should be used instead of the RAW tape. Copy the RAW part within your archive file (Lines 8-28 in Figure 8). Set the cursor at the beginning of the duplicated section, then go to the drop down menu; Edit → Replace and type Raw under 'Old

String' and IMA under 'New String.' Activate the All option and press Ok. (See Figure 11)

One last note, it is crucial that you record, in the appropriate column on your project log sheet, what tape your data was archived to. This is important so that if you ever need to retrieve data, you will know where it can be found.



Figure 12: Replace command

4.0 General

4.1 Online Access Via Internet

The system is accessible online for users. The link is

<http://sceval.ucalgary.ca/~microct>

The user name is Microct (case sensitive) and the password can be obtained from Dr. Steve Boyd. Online access can be very useful for tracking scans, processing data and analysis.