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**OAK RIDGE
NATIONAL
LABORATORY**

MARTIN MARIETTA

**HEAT-FLUX GAGE
THERMOPHOSPHOR SYSTEM**

**Software/Hardware Guide
Version 1.1**

K. W. Tobin

August 1991

**MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY**

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HEAT-FLUX GAGE THERMOPHOSPHOR SYSTEM

Software/Hardware Guide Version 1.1

K. W. Tobin

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ABSTRACT

This document describes the installation, hardware requirements, and application of the Heat-Flux Gage (Version 1.0) software package developed by the Oak Ridge National Laboratory, Applied Technology Division. The developed software is a single component of a thermographic phosphor-based temperature and heat-flux measurement system. The heat-flux transducer was developed by EG&G Energy Measurements Systems and consists of a 1- by 1-in. polymethylpentene sheet coated on the front and back with a repeating thermographic phosphor pattern. The phosphor chosen for this application is gadolinium oxysulphide doped with terbium. This compound has a sensitive temperature response from 10 to 65.6°C (50–150°F) for the 415- and 490-nm spectral emission lines.

1. INTRODUCTION

The Heat-Flux Gage software package, Version 1.0, has been designed by the Oak Ridge National Laboratory, Applied Technology Division (ORNL/ATD) for use with the two-dimensional heat-flux gage, which was concurrently developed by EG&G Energy Measurement Systems, Santa Barbara, California.

The heat-flux gage consists of a 25- μm thick, 1- by 1-in. sheet of polymethylpentene (PMP). A gadolinium oxysulphide thermographic phosphor doped with terbium ($\text{Gd}_2\text{O}_2\text{S:Tb}$) has been deposited on the front and back surface of the PMP in a regular triangular array. When viewed through the surface, the front and back phosphor coatings correspond to unit rectangular regions (see Fig. 1) that the software utilizes to extract the two-dimensional temperature and heat flux.

Fig. 1. Geometry associated with the $\text{Gd}_2\text{O}_2\text{S:Tb}$ heat-flux gage.

The temperature information on the front and back surfaces is obtained by the ratio of the 415- and 490-nm spectral lines of the phosphor emission when illuminated with a steady-state ultraviolet light source. Since a ratio is incorporated to generate the required temperature information, the following nomenclature will be used throughout this document:

NUMERATOR	- numerator image of the ratio, $n(x,y)$
NUMERATOR BACKGROUND	- numerator background (no ultraviolet source), $n_b(x,y)$
DENOMINATOR	- denominator image of the ratio, $d(x,y)$
DENOMINATOR BACKGROUND	- denominator background image of the ratio, $d_b(x,y)$

The ratio image data are calibrated to temperature by the following relationship,

$$T(x,y) = f \left[\frac{n(x,y) - n_b(x,y)}{d(x,y) - d_b(x,y)} \right] = f [r(x,y)] , \quad (1)$$

where $r(x,y)$ is the corrected image ratio and $f[r(x,y)]$ has been shown to be the linear function,

$$T(x,y) = f [r(x,y)] = T_h - (T_h - T_l) \left(\frac{r - r_l}{r_h - r_l} \right) , \quad (2)$$

for the $\text{Gd}_2\text{O}_2\text{S:Tb}$ compound over the temperature range from 16 to 65.6°C (59–150°F).^{1,2} The constants, T_h , T_l , r_h , and r_l , are calibration constants for the phosphor compound.

The calibrated amplitude-based ratio is used to generate the temperature of the associated surface. The surface heat flux estimate is then made by application of Fourier's law of conduction,³

$$q''(x,y,z) = -k \nabla T(x,y,z) , \quad (3)$$

where $q''(x,y,z)$ is the heat flux, k is the thermoconductivity of the material, and $T(x,y,z)$ is the temperature. For the current application it is assumed that the PMP is sufficiently thin to make the approximation that the heat flux, q'' , can be expressed as,

$$q''(x,y) = -k \frac{\Delta T(x,y)}{\Delta z} , \quad (4)$$

or, for the gage design shown in Fig. 1,

$$q''(x,y) = -k \frac{T(x,y)_{\text{front}} - T(x,y)_{\text{back}}}{\Delta z_{\text{PMP}}} , \quad (5)$$

where $T(x,y)_{front}$ and $T(x,y)_{back}$ are the surface temperatures at unit cell (x,y) on the front and back of the gage, respectively, and Δz_{PMP} is the thickness of the PMP material.

The heat flux is determined in the code by combining Eqs.(2) and (5) to give,

$$q''(x,y) = -\frac{k}{\Delta z_{PMP}} (T_h - T_l) \left(\frac{r_{back}(x,y) - r_{front}(x,y)}{r_h - r_l} \right) . \quad (6)$$

The heat-flux gage will be mounted on a fixed surface in a wind tunnel, as shown in Fig. 2, and viewed with an intensified CCD video camera. The ultraviolet illumination source is required to be steady state for this application because of constraints of the imaging hardware, which require operation at standard RS-170 video rates (30 frames/s).

Fig. 2. Schematic representation of the heat-flux measurement system utilizing the DT-2861 image processing hardware.

The camera will image the gage surface through a quartz window on the wind tunnel and through one of the two narrow-band optical filters (i.e., 415 nm or 490 nm). Currently, development, these filters must be positioned by hand. The imaged information is exported by the camera in analog RS-170 video format where it is subsequently digitized by a DT-2861 Data TranslationTM image processing board mounted in an 80386 or 80286 computer system. The captured and processed images are displayed on an RGB monitor for viewing and verification of the experiment setup. The resultant temperature and heat-flux data are also displayed and stored in a data file for postprocessing and analysis.

2. SYSTEM REQUIREMENTS

2.1 HARDWARE

The heat-flux gage system was developed for operation on an 80386 or 80286 computer with or without a math co-processor, using DOS 3.2 or higher. The program works in conjunction with a DT-2861 Data TranslationTM image processing module. The DT-2861 is a full-sized plug-in card that requires a 16-bit AT-style slot. The processed images are displayed on a standard color monitor that has the following four inputs:

Red (video in)
Green (video in)
Blue (video in)
External Sync

These video lines are located on the BNC ribbon cable, which must be purchased with the DT-2861 card. The following hardware and software defines the prototype heat-flux gage system:

Data Translation:

DT-2861	- 60-Hz frame grabber
EP197	- coaxial cable assembly
IDRV61.SYS	- software driver
ISCLLIB.LIB	- SP0215 C-binding library support
ISDEFS.H	- SP0215 definition file
ISERRS.H	- SP0215 error definition file

Microsoft:

MS-DOS	- version 3.2 (or higher)
C-compiler	- version 5.0 (or higher)

Computer:

80286 or 80386 system
80287 or 80387 co-processor (optional)

2.1 SOFTWARE

The software control program was developed using the Microsoft C-compiler (version 5.1) and the Vitamin-C screen I/O library (version 3.1a), along with the SP0215 library associated with the image processing hardware. The following lists the source code files and sizes developed to implement the heat-flux gage algorithm:

HEAT	720	- <i>make file for compilation of the code</i>
HEAT.IMG	262656	- <i>default image screen</i>
HEAT.PTH	22	- <i>start-up data path information</i>
HEAT.H	10909	- <i>definition (header) file for the C code</i>
HEAT.C	739	- <i>main control module source code</i>
HEATMENU.C	13173	- <i>menu definition source code</i>
HEATMISC.C	9628	- <i>miscellaneous custom program tools</i>
HEATFILE.C	12475	- <i>disk I/O etc. source code</i>
HEATSLCT.C	3929	- <i>DT-2861 buffer select etc. source code</i>
HEATPROC.C	25246	- <i>algorithm implementation source code</i>
HEATCOLR.C	7449	- <i>false color, zoom/pan control, etc.</i>
HEATCONT.C	3012	- <i>contrast enhancement, etc.</i>

An example set of system output files resulting from a test run is given here.

DEMO.GRD	235	- <i>grid coordinate data</i>
DEMO.SUM	1261	- <i>full run summary</i>
DEMO.DAT	513	- <i>short run summary</i>
DEMO.CON	106	- <i>configuration/calibration constants</i>
DEMO.001	262656	- <i>numerator background image</i>
DEMO.002	262656	- <i>numerator fluorescence image</i>
DEMO.003	262656	- <i>denominator background image</i>
DEMO.004	262656	- <i>denominator fluorescence image</i>

The executable run file is as follows:

HEAT.EXE	176646
----------	--------

When the directory is selected where the executable file resides, the program is started by typing the following:

```
C:\> HEAT
```

If the DT-2861 is properly installed, the program will load normally with the following screen message and begin at the main system menu.

```
*****
      Initializing DT2861 hardware ...
*****
```

If the DT-2861 is improperly installed or malfunctioning, then the program will automatically exit back to the DOS prompt at this point with the error message,

```
*****
      Missing or bad DT-2861 imaging hardware.
*****
```

3. MENU SYSTEM

3.1 MAIN MENU

When the program has been successfully loaded, the main control menu will be displayed on the computer monitor as shown in Screen 1.

Screen 1. Main menu.

The main menu contains all necessary information to enable capturing, saving, retrieving, processing, and calibrating image data. The **FILES** menu invokes a submenu that allows data disk I/O access and default path definitions. The **SELECT** menu also invokes a submenu that allows selection of required data buffers for storing and processing fluorescence image data. The **PROCESS** menu and submenu allow processing of the captured data, grid geometry definitions, and access to the system calibration tools. For the current version of the heat-flux software, the **COLOR** and **CONTRAST** menu options will be of little additional use. Their current capabilities and future purpose will be described later in this document.

3.1.1 Controlling the Menu

The menu system has been designed to allow easy access to any portion of the program such as modifying the configuration, loading and saving data, or processing image data. The menu is controlled by the UP, DOWN, RIGHT, and LEFT arrow keys on the computer key pad. A highlighted menu item is selected by pressing the ENTER key. When the ENTER key is pressed, either a submenu will be invoked, the user will be prompted for input, or an operation will be performed on the image data. When a submenu or menu option has been invoked the user can always back up one level or terminate an option by using the ESC key.

3.1.2 Message Line

At the bottom left corner of the menu screen a message line is continually displayed that contains a short definition of the current menu option. (e.g., Screen 1 displays "Save and retrieve files to/from disk.") This message is continually updated as the menu selector box traverses the screen. When a calculation is being performed on the image data, the message line will display information about the current process. When the process is complete, the message line will resume its previous function.

3.1.3 Status Box

The status box in the lower right corner of the display (see Screen 1) is continually updated to reflect the current state of the program. The status box parameters are defined as follows:

Path: current I/O path for the storage of images, grid coordinates, process results, and system configuration data.

Image: displays the name of the most current image file read from the disk path. If no file has been retrieved from the disk, a *no file* status will be displayed.

Grid: name of the most current grid coordinate file read from the current path. If no grid has been selected or a new grid has been defined during the current session, a *no file* status will be displayed.

Configuration: name of the configuration file read from the current path. If no configuration has been selected, a *no file* status will be displayed.

Display: name of the image buffer which is currently being displayed on the RGB monitor (e.g., NUMERATOR, RATIO, HEAT-FLUX, etc.). When the program is initially started, the NUMERATOR image (initially blank) is displayed.

Input LUT (look-up table): defines the A/D input gain for the DT-2861 system. The standard (DEFAULT) table is linear. This table can be modified by using the CONTRAST option on the main menu but *this tool has not been fully developed to date*.

Output LUT (look-up table): defines the RGB color mapping on the RGB display device. This tool is accessed using the COLOR menu option. While *this tool has not been fully developed to date*, its use will not adversely affect the processing of image data.

3.1.4 Function Keys - F1, F2, F3

Currently, three function keys are defined to allow easier access to some of the frequently used menu options. The definitions of these keys are permanently displayed in the lower right-hand corner of the screen. The F1 key toggles through the resultant image(s) display on the RGB monitor. When a data set has been processed, the ratio, temperature, and heat flux can be chosen for display. The F2 key will turn on the camera and allow the

collection of data into the current active buffer (as displayed in the status box). The F3 key will invoke the process routine for the image data set, the result of which is the ratio, temperature, and heat-flux distribution on the gage surface. All of these function keys reduce the number of key strokes necessary to execute the indicated command. All of the commands executed by a function key are otherwise accessed through the menu system.

3.2 FILES MENU

The FILES menu options are shown in Screen 2. This submenu allows for a change in default data path, image storage and retrieval, grid coordinate storage and retrieval, and system configuration storage and retrieval.

HEAT-FLUX GAUGE - Ver. 1.0 (ORNL/ATD)	
FILES	SELECT PROCESS COLOR CONTRAST EXIT
Set Path	
Save Image	
Retrieve Image	
Save Grid	
Retrieve Grid	
Save Configuration	
Retrieve Configuration	
<div> <div>Status Box</div> <div> Path: c:\ Image: no file Grid: no file Configuration: no file Display: Numerator Input LUT: DEFAULT Output LUT: MONO </div> </div>	
Set path for data storage/retrieval. <div>F1(disp) F2(cam) F3(proc)</div>	

Screen 2. Files menu.

3.2.1 Set Path

The *Set Path* option (see Screen 3) allows the user to define the data storage area for the computer I/O. All image data, grid coordinate data, and configuration data will be written to this directory. Also, when the process function is invoked, the user will be prompted for a file name under which to store the long and abbreviated data summary. This data will also be located in the current path. If the user wishes to utilize several subdirectories for storing program data, the *Set Path* option can be modified at any time during the program execution. When the program exits, the current path will be the default start path the next time the program is executed.

HEAT-FLUX GAUGE - Ver. 1.0 (ORNL/ATD)

FILES SELECT PROCESS COLOR CONTRAST EXIT

Set Path

Save Image

Retrieve Image

Save Grid

Retrieve Grid

Save Configuration

Retrieve Configuration

SET PATH FOR SUBDIRECTORY

Path: d:\imaging\qflux\data

Status Box

Path: c:\

Image: no file

Grid: no file

Configuration: no file

Display: Numerator

Input LUT: DEFAULT

Output LUT: MONO

For example: C:\

F1(disp) F2(cam) F3(proc)

Screen 3. Files menu showing the Set Path option.

3.2.2 Save/Retrieve Image

The Save/Retrieve Image option is shown on Screen 4. The four data buffers—NUMERATOR, NUMERATOR BACKGROUND, DENOMINATOR, and DENOMINATOR BACKGROUND—must be maintained on disk if the data are to be reanalyzed at a later time (e.g., if a modified calibration is to be employed, etc.). When the user is prompted for a file name (see Screen 4) four files will be created sharing this name.

<file name>.001	- numerator background image
<file name>.002	- numerator fluorescence image
<file name>.003	- denominator background image
<file name>.004	- denominator fluorescence image

It is important to note that only **one** name (no file type) should be entered. This method of naming a data set ensures that data from separate runs are kept together for future reference.

3.2.3 Save/Retrieve Grid

The Save/Retrieve Grid option is shown on Screen 5. The image grid is a set of coordinates defined by the user under the PROCESS/Define Grid submenu option. The grid file contains the (x,y) coordinates of the heat-flux unit cell for future use by the program. This option allows several runs to occur without redefining the gage geometry and unit cell location. The current hardware (DT-2861) employed to process the gage data has no built-in morphological processes or functions; thus, automatic detection of the unit cell location is a manual task for the user. When a grid has been manually defined, it can be stored and recalled for use at a later date as long as the experiment geometry remains constant. If the

geometry changes, a new grid must be manually generated. The filetype *.GRD is automatically appended to the user defined file name.

HEAT-FLUX GAUGE - Ver. 1.0 (ORNL/ATD)

FILES SELECT PROCESS COLOR CONTRAST EXIT

Set Path

Save Image

Retrieve Image

Save Grid

Retrieve Grid

Save Configuration

Retrieve Configur

RETRIEVE IMAGE

Image file name:

us Box
ing\qflux\data\
e

no file

Display: Numerator

Input LUT: DEFAULT

Output LUT: MONO

Enter the file name (no extension)

F1(dis) F2(cam) F3(proc)

Screen 4. Files menu showing the Save/Retrieve Image option.

HEAT-FLUX GAUGE - Ver. 1.0 (ORNL/ATD)

FILES SELECT PROCESS COLOR CONTRAST EXIT

Set Path

Save Image

Retrieve Image

Save Grid

Retrieve Grid

Save Configuration

Retrieve Configur

RETRIEVE A GRID

Image file name:

us Box
ing\qflux\data\
e

no file

Display: Numerator

Input LUT: DEFAULT

Output LUT: MONO

Enter the file name (no extension)

F1(dis) F2(cam) F3(proc)

Screen 5. Files menu showing the Save/Retrieve Grid option.

3.2.4 Save/Retrieve Configuration

The Save/Retrieve Configuration option is shown on Screen 6. The system configuration file contains the current calibration data for the thermographic phosphor being used. These items include the phosphor ratio levels, r_h , r_l ; high and low temperature limits, T_h , T_l , on the calibration; thermal conductivity of the PMP, k ; and the PMP thickness, Δz_{PMP} . These data are updated under the PROCESS/Calibrate submenu. There is also information related to the dimensions and geometry of the heat-flux gage itself. These data are updated under the PROCESS/Set Rectangle submenu. The filetype *.CFG is automatically appended to the user defined file name. Several sets of configuration can be independently applied to a given set of image data if desired.

```

HEAT-FLUX GAUGE - Ver. 1.0 (ORNL/ATD)
FILES  SELECT  PROCESS  COLOR  CONTRAST  EXIT

Set Path
Save Image
Retrieve Image
Save Grid
Retrieve Grid
Save Configuration
Retrieve Configu

RETRIEVE CONFIGURATION
File name: us Box
           ing\qflux\data\ e
           no file
Display: Numerator
Input LUT: DEFAULT
Output LUT: MONO

Enter the file name (no extension)          F1(dis) F2(cam) F3(proc)

```

Screen 6. Files menu showing the Save/Retrieve Configuration option.

3.3 SELECT MENU

The SELECT menu, shown on Screen 7, allows for input of image data to the DT-2861 frame buffer system. The image buffers must be filed with the proper phosphor fluorescence information before the PROCESS menu or F3(proc) key can be used. There are two ways to load data into the image buffers. Data can be loaded from the computer disk drive as described above, or it can be captured from the intensified video device.

3.3.1 Display image buffer

The Display Numerator/Denominator/... options on the SELECT submenu are used to update the RGB display to the selected image and to set the active buffer status (shown in the status box). An active buffer is the only DT-2861 memory location that will be accessed when the video source is activated. Therefore, to load the NUMERATOR data buffer with

the properly filtered (e.g., 415 nm) fluorescence data, the Display Numerator option must be selected on the submenu prior to activating the video device. The same is true for all subsequent image buffers.

HEAT-FLUX GAUGE - Ver. 1.0 (ORNL/ATD)
FILES SELECT PROCESS COLOR CONTRAST EXIT

Display Numerator
Display Num. Background
Display Denominator
Display Den. Background

Camera (F2)

Ratio Data (F1)
Temperature Data (F1)
Heat-Flux Data (F1)

Status Box
Path: d:\imaging\qflux\data\
Image: no file
Grid: no file
Configuration: no file
Display: Numerator
Input LUT: DEFAULT
Output LUT: MONO

Set numerator image to active display.
F1(dis) F2(cam) F3(proc)

Screen 7. Select menu options.

3.3.2 Camera (F2)

The Camera option activates the video device and allows the data buffer to be filled with the appropriate image data. The same result is achieved if the F2 key is depressed. When activated, the system sets the synchronization (sync) source to external thus allowing the camera to run free until another key hit is registered. This allows for image pass through (live image play) and inspection while the experiment is being set up. Note that when a single data buffer is filled, no more adjustments to the experiment geometry should be made. Even slight movement of the experiment components can throw off the predefined grid coordinates and image correlations, thus requiring a complete new configuration. When a key hit is registered, the system is set back to internal sync drive and the camera can be turned off or removed from the system input.

3.3.3 Ratio/Temperature/Heat-Flux Data (F1)

The Ratio/Temperature/Heat-Flux Data options allow selection of these image buffers for redisplay when the data has been processed. The F1 key can be used to step through these buffers from any location in the menu system. The Ratio Data buffer displays the numerical calculation per unit cell of the emission ratio on the front and back side of the heat-flux gage. The Temperature Data buffer displays the corresponding calculated temperatures at each unit cell location [based on Eq.(2)], and the Heat-Flux Data buffer shows the corresponding heat-flux estimate [based on Eq.(6)].

3.4 PROCESS MENU

The PROCESS menu, shown in Screen 8, performs all program processing and calibration tasks. It should be invoked only after the data buffers (SELECT menu options, etc.) have been properly loaded.

```

HEAT-FLUX GAUGE - Ver. 1.0 (ORNL/ATD)
FILES  SELECT  PROCESS  COLOR  CONTRAST  EXIT

Process Data (F3)
Set Rectangle
Define Grid
Calibrate

Status Box
Path: d:\imaging\qflux\data\
Image: no file
Grid: no file
Configuration: no file
Display: Numerator
Input LUT: DEFAULT
Output LUT: MONO

Process data (image) buffers.          F1(dis) F2(cam) F3(proc)

```

Screen 8. PROCESS data menu option.

3.4.1 Process Data (F3)

The Process Data option performs the point-wise calculation of temperature and surface heat flux on the basis of Eqs.(2) and (6). To perform this process, it is assumed that the NUMERATOR data buffers contain the 415-nm spectral information, while the DENOMINATOR buffers contain the 490-nm spectral information. The user should ensure that this requirement is met. There is no programmatic verification. When the data has been processed, the results are displayed on the RGB monitor and can be accessed through the SELECT menu or by using the F1 function key. Also, the user will be prompted for a file name under which to save a disk version summary and data listing (*.SUM and *.DAT). The data files will be located in the directory specified by the current path (as displayed in the Status Box). Screen 9 shows an example summary file (*.SUM), which can be accessed after leaving the HEAT.EXE program.

The first line of the summary file shows the current program version. The next four lines show the status of the system when the data was generated (i.e., the current path and the list of image, grid, and calibration files that were being used). The next five lines contain the current calibration parameters that were contained in the configuration file. The remaining data are a list of (x,y) coordinates, ratio, temperature, and heat-flux data. The *.DAT file contains the (x,y) coordinate data, the temperature data, and the heat-flux data,

respectively. This file has been generated to allow easy access to code data by second party graphing and data analysis software packages. The summary and data output files are stored in ASCII format and can be edited or viewed with any commercial text editor.

```

HEAT-FLUX GAUGE - Ver. 1.0 (ORNL/ATD)

Data Path:          d:\imaging\qflux\data\
Image File Name:    demo0
Grid File Name:     demo0
Calibration File Name: demo0

Calibration Parameters:
High Ratio = 0.700, Low Ratio = 0.100
High Temp. = 130.0 °C, Low Temp. = 50.0 °C
Gauge Thermal Conductivity = 0.00170 W/cm°C
Gauge Thickness = 0.00030 cm

Number of grid rows and columns:  4  4

Data: (x, y, front ratio, back ratio, front temp, back temp., heat flux)
106 114 0.5455 0.4474 70.61 83.68 74.11
106 174 0.4608 0.4167 81.90 87.78 33.33
106 230 0.4468 0.4423 83.76 84.36 3.40
102 290 0.4583 0.5806 82.22 65.91 -92.41
178 114 0.5072 0.3774 75.70 93.02 98.14
178 170 0.4605 0.3590 81.93 95.47 76.73
178 230 0.3980 0.3611 90.27 95.19 27.84
178 290 0.4206 0.4154 87.26 87.95 3.91
250 114 0.4932 0.3617 77.58 95.11 99.32
250 174 0.4151 0.3590 87.99 95.47 42.40
250 238 0.4000 0.4103 90.00 88.63 -7.75
250 290 0.4128 0.3810 88.29 92.54 24.10
322 114 0.5636 0.3725 68.18 93.66 144.38
322 170 0.5000 0.3235 76.67 100.20 133.33
322 234 0.4368 0.3600 85.10 95.33 58.01
322 290 0.4731 0.3667 80.25 94.44 80.43

```

Screen 9. Example output file (*.SUM) generated using the Process Data function.

3.4.2 Set Rectangle

The Set Rectangle option configures the heat-flux gage for the current experiment geometry. This option must be used when initially configuring the system. The resultant measurement data are maintained in the configuration file when the Store Configuration option is selected (FILES menu).

When activated, a window will open on the computer screen querying the user for a data window size with the following message:

No. of Pixels, (current = $n \times n$):

The value of n defines the rectangular region that will be used to collect pixel (or image) information from the data buffers.

Next, a cursor will be displayed on the RGB monitor over the active buffer. This cursor is repositioned by using the UP, DOWN, RIGHT, and LEFT arrow keys on the computer key pad. Concurrently, a window will open on the computer display that gives the following commands:

*Set upper left of rectangle,
Set upper left of rectangle below,
Set upper left of rectangle to right,
Set lower triangle of main rectangle,
Set upper triangle of main rectangle.*

The locations prompted by the system are shown schematically in Fig. 3. When the data has been properly entered, the following message is displayed:

Remember to update the current configuration file!

This reminds the user to update the current system configuration file (or to create one) so that the measurements can be recalled for later use. Note that the size of the rectangle displayed on the RGB monitor (schematically shown in Fig. 3) will reflect the value, n , entered by the user.

Fig. 3. Representation of the gage geometry and software cursor locations used with the *Set Rectangle* and *Define Grid* commands.

3.4.3 Define Grid

The Define Grid option allows the user to set the (x,y) coordinate array for the heat-flux gage. An array definition must be in place to process the image data buffers. When activated, the following message will be displayed on the computer screen:

*Press <ENTER> to introduce new grid point,
Press <ESC> to quit ...*

The cursor will be displayed on the RGB monitor and controlled by the keypad cursor keys, as described previously. When the first point is set, the following message is displayed:

Move Cursor to point n of N

where n is the n th point entered out of a total of N allowable points. For the current version, the total allowable points has been set to $N = 100$.

The array must be rectangular (i.e., there must be $n \times m$ points defined for the sorting routines to work properly). Although the points can be entered in any order, they cannot be edited, and they cannot be triangular in distribution. If a bad data point is marked by the user, the option must be terminated and restarted to correct. When the points have been entered, the data should be saved in a grid file (*.GRD) through the FILES menu option.

3.4.4 Calibrate

The calibration data for the heat-flux gage system is measured and modified through the PROCESS/Calibrate submenu. Screen 10 shows the submenu display. The calibration procedure is mostly manual and depends on the user to generate the indicated parameters. The Point-Cal. option allows the imaging system to obtain the fluorescence data necessary to generate the required parameters.

3.4.4.1 Parameter entry

The parameters necessary to operate the heat-flux gage system were shown previously in Eqs.(2) and (5), which describe the temperature and heat-flux calculation. The Calibration submenu requires the following input:

<i>Ratio(high)</i>	-	r_h
<i>(low)</i>	-	r_l
<i>Temp(high)</i>	-	T_h
<i>(low)</i>	-	T_l
<i>Cond(k)</i>	-	k
<i>Delta</i>	-	Δz_{PMP}

These values are obtained by measuring the ratio data at known temperature values (e.g., thermocouples mounted on a $Gd_2O_3:S:Tb$ coated gage).

HEAT-FLUX GAUGE - Ver. 1.0 (ORNL/ATD)						
FILES	SELECT	PROCESS	COLOR	CONTRAST	EXIT	
		Process Data (F3)				
		Set Rectangle				
Ratio(high) (low) Temp(high) (low) Cond(k) Delta Point-Cal.						
<div style="border: 1px solid black; padding: 5px; float: right; width: 250px;"> Status Box Path: d:\imaging\qflux\data\ Image: no file Grid: no file Configuration: no file Display: Numerator Input LUT: DEFAULT Output LUT: MONO </div>						
Enter high ratio cutoff point.				F1(dis) F2(cam) F3(proc)		

Screen 10. Calibrate submenu accessed through the PROCESS/Calibrate option.

3.4.4.2 Point-Cal.

The Point-Cal. option is activated to enable the system to measure the ratio values at known temperatures. When the Point-Cal. option is activated the following message is displayed:

Set/Reset data ROI (Y/N) ? ...

The data ROI is a region of interest (ROI) that the user defines on the displayed data buffer from which to obtain fluorescence data. The Set/Reset message appears each time the option is used so that the same region of an image can be accessed for data analysis as the image buffers are modified (i.e., for different temperature levels). When an ROI has been set and the ENTER key pressed, the system goes to the separate data buffers and calculates the background-corrected ratio in that region. The user must manually note the data and the thermocouple temperature for later determination of the curve-fit parameters, r_l , r_h , T_l , and T_h .

3.5 COLOR MENU

The COLOR menu option, shown on Screen 11, is not applicable to the temperature and heat-flux calculations for the current version of the program because of hardware limitations of the DT-2861 image processing device.

HEAT-FLUX GAUGE - Ver. 1.0 (ORNL/ATD)					
FILES	SELECT	PROCESS	COLOR	CONTRAST	EXIT
			Zoom/Pan Zoom/Pan Reset Monoochrome Color bars Color band		
			Status Box Path: d:\imaging\qflux\data\ Image: no file Grid: no file Configuration: no file Display: Numerator Input LUT: DEFAULT Output LUT: MONO		
Zoom pan and scroll the active display.			F1(dis) F2(cam) F3(proc)		

Screen 11. Color menu option.

3.6 CONTRAST MENU

The CONTRAST menu option, shown on Screen 12, is not applicable to the temperature and heat-flux calculations for the current version of the program because of hardware limitations of the DT-2861 image processing device.

HEAT-FLUX GAUGE - Ver. 1.0 (ORNL/ATD)					
FILES	SELECT	PROCESS	COLOR	CONTRAST	EXIT
			Linear Histogram Modified LUT Default LUT		
			Status Box Path: d:\imaging\qflux\data\ Image: no file Grid: no file Configuration: no file Display: Numerator Input LUT: DEFAULT Output LUT: MONO		
Linear contrast stretch & modify input LUT.			F1(dis) F2(cam) F3(proc)		

Screen 12. Contrast menu option.

3.7 PROGRAM EXIT

The EXIT option on the main menu will allow the user to properly exit the software package. Screen 13 shows the exit window from which the user must verify his or her intent. The exit option can also be reached by pressing the ESC key anywhere in the main menu. If the user is several menus deep, repeated use of the ESC key will display the exit option.

When the program is exited, all data buffers and all grid and calibration definitions will be deleted from the DT-2861 memory. Therefore, the user must save all required data by stepping through the FILES menu option prior to exiting the program back to DOS (Screen 14).

HEAT-FLUX GAUGE - Ver.	
EXIT to DOS (y/n)?	
<div> <div>Status Box</div> <div> Path: d:\imaging\qflux\data\ Image: no file Grid: no file Configuration: no file Display: Numerator Input LUT: DEFAULT Output LUT: MONO </div> </div>	
Exit and return to DOS.	F1(dis) F2(cam) F3(proc)

Screen 13. User is prompted to verify exit.

HEAT-FLUX GAUGE - Ver. 1.0 (ORNL/ATD) OAK RIDGE NATIONAL LABORATORY Applied Technology Division Developed by: K. W. Tobin & J. K. Jordan P.O. Box 2003 Bldg. K-1220, MS-7280 Oak Ridge, TN 37831-7280 D:\IMAGING\QFLUX>
--

Screen 14. Program exited and back to DOS.

4. TUTORIAL

This section will briefly outline the steps required to capture and process florescent emission data from the $\text{Gd}_2\text{O}_2\text{S:Tb}$ phosphor-based heat-flux gage using the HEAT.EXE software package described herein.

STEP I Load the program by entering the command `c:\...\>HEAT`

STEP II Choose the FILES/Set Path option and set the desired path for data storage and retrieval.

STEP III Select the SELECT menu.

Select the Display Numerator option.
 Install the 415-nm narrow-band filter.
 Turn on the ultraviolet light source.
 Press the Camera (or F2) option.
 While image is live, align the system, adjust the aperture, etc.
 Press <ENTER> key when done with alignment
 (Note: At this point no further realignment of the experiment hardware should be made.)

Select the Display Numerator Background option.
 Turn off the ultraviolet light source.
 Press the Camera (or F2) option.
 Press the <ENTER> key when done.

Select the Display Denominator option.
 Install the 490-nm narrow-band filter.
 Turn on the ultraviolet light source.
 Press the Camera (or F2) option.
 Press the <ENTER> key when done.

Select the Display Denominator Background option.
 Turn off the ultraviolet light source.
 Press the Camera (or F2) option.
 Press the <ENTER> key when done.

Select the Display Numerator option.
 (Note: This need only be done while the system is being set up on the first pass for the Set Rectangle and Define Grid commands in STEP IV.)

STEP IV Select the PROCESS menu.

Select the Set Rectangle option and follow the instructions.

Select the Define Grid option and set the grid coordinates.

Select the Calibrate option if modification of the parameters is necessary.

STEP V Select the FILES menu.
(Note: Recall that when the program is exited all data will be lost; therefore, updates to the image data buffers and the grid and configuration should be made often.)

Select the Save Image option and enter a file name.

Select the Save Grid option and enter a file name.

Select the Save Config option and enter a file name.

STEP VI Select the PROCESS/Process Data (or F3) option. Enter a file name for the summary (*.SUM) and data (*.DAT) file when finished.

STEP VII To generate new temperature data, do the following:

Repeat STEP III above when the experiment is at a new steady-state temperature.

(Note: The image backgrounds (i.e., when the ultraviolet light source is off) will not vary with temperature; therefore, the image backgrounds do not need to be collected at every temperature point.)

Go to the FILES menu and save the new image data, if desired.

(Note: When the program is terminated, all data are lost unless previously saved to the current path from the FILES menu.)

STEP VIII EXIT the program when finished. Be sure to turn off the camera and ultraviolet light source. When the program is restarted at a later date for data collection, the STEP II procedures can be followed after the grid and configuration files have been loaded. Note that if the experiment geometry has changed even slightly, the entire procedure must be repeated.

REFERENCES

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2. Tobin, K. W., et al., *Evaluation of Thermographic Phosphor Technology for Aerodynamic Model Testing*, ORNL/ATD-40, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tennessee, August 1990.
3. Incropera, F. P., and D. P. Dewitt, *Fundamentals of Heat Transfer*, John Wiley & Sons, New York, 1981, p.36.

APPENDIX - SOFTWARE LISTING

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float TemperatureCalc(float r)	A-35
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int print_summary(void)	A-35
COUNT mSetRectangle(VCMENU *mnuptr)	A-36
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int arrange(int xy[][2], int npts, int maxrows, int *mrows int ncols)	A-38
int mark_grid(int image_number, int mark_row, int mark_col, int type)	A-39
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```

/*-----
PROGRAM : HEAT.H

DATE : 14 December 1990

PROGRAMMER : K. W. Tobin P.O. Box 2003
             J. K. Jordan Bldg. K-1220, MS-7280
             Applied Technology Division Oak Ridge, TN 37831
             Oak Ridge National Laboratory

COMMENTS: This is the header control file for the heat-flux gauge
          routine, HEAT.EXE. The method of heat-flux estimation is
          based on obtaining the ratio of a thermographic phosphor
          emission from two narrow-bands in the spectrum. This is
          achieved for a particular gauge material with phosphor on
          two sides and a known thermal conductivity in between. When
          the temperature is determined on both sides of the gauge,
          heat-flux is derived using  $q'' = -k \text{ grad } T(x,y)$ .

          The measurement system consists of an 80286-based computer
          system which incorporates a Data Translation(TM) DT-2861
          image processing board. The hardware board is capable of
          digitizing and storing 16 images of 512x512 pixelsize,
          by 8-bit deep resolution.

          The software incorporated to develop this application
          follows:

              Microsoft C-Compiler ver. 5.1
              Vitamin-C Menu Software ver. 3.1a
              DT-IRIS SP0215 for the DT-2861

-----*/

/* Include files for Data Translation, Vitamin-C, and Microsoft C5.1. */

#include <iserrs.h> /* <-- DT2861 control files. */
#include <isdefs.h>

#include <vcstdio.h> /* <-- Vitamin-C control file. */

#include <string.h> /* <-- Microsoft C5.1 control files. */
#include <dos.h>
#include <math.h>

/* Global definitions for Data Translation associated hardware (DT2861). */

#define ON 1 /* <-- For controlling display, cursor, etc. */
#define OFF 0

#define ROW 512 /* <-- Maximum row/column and grey scale. */
#define COL 512
#define GREY 256

#define OVLY_ROW 32
#define OVLY_COL 32
#define OVLY_HEIGHT 400
#define OVLY_WIDTH 352

#define GRID_POINT 100 /* <-- Grid constants. */
#define ROW_SELECT 0
#define COL_SELECT 1
#define NUM_SELECT 0
#define DEN_SELECT 1

```



```

#define POINTS 5      /* Number of pixels to avg. about cursor (PxP array). */
#define TOPROW 0.55   /* Offsets for gathering data relative to grid. */
#define TOPCOL 0.24   /* TOP... refers to top phosphor, */
#define BOTROW 0.25   /* BOT... refers to bottom phosphor. */
#define BOTCOL 0.50   /* (these are system defaults) */

#define SYNC_EXT 1     /* <-- internal/external sync control */
#define SYNC_INT 0

#define MONO_LUT 0     /* <-- output look-up-table definitions */
#define COLOR_LUT 2

#define DEFAULT_LUT 0  /* <-- input look-up-table definitions */
#define MODIFIED_LUT 2

#define DTUP 72        /* <-- for controlling the cursor */
#define DTDOWN 80
#define DTRIGHT 77
#define DTLEFT 75
#define DTCR 13
#define DTPgUP 73
#define DTPgDN 81
#define DTESC 27
#define DTRKEY 'R'
#define DTGKEY 'G'
#define DTBKEY 'B'

#define TOTAL_IMAGES 7 /* <-- number of defined selectable buffers */
#define DATA_IMAGES 4 /* <-- number of data images */

#define NUMERATOR 0     /* <-- image buffers */
#define NUMERATOR_BACK 1
#define DENOMINATOR 2
#define DENOMINATOR_BACK 3

#define RATIO 4
#define TEMPERATURE 5
#define HEAT_FLUX 6

#define NUMERATOR_CORR 7
#define DENOMINATOR_CORR 8

#define GRAPHIC_BUF 9   /* <-- scratch buffers */
#define OVLY_BUF 10

/* Global definitions for DOS system */

#define SUCCESS 0        /* <-- Subroutine test parameter. */
#define FAILURE 1

#define PATHSTRLEN 28
#define FILENAMLEN 9

#define TITLE "HEAT-FLUX GAUGE - Ver. 1.0 (ORNL/ATD)"
#define PATH "c:\""
#define NONE_IMAGE "heat.img"
#define STARTFILE "no file"

/* Base units for current configuration */
#define TUNIT "°C"      /* <-- temperature */
#define DTTUNIT "deg C" /* <-- (for DT2861 display) */
#define XUNIT "cm"      /* <-- distance */
#define KUNIT "W/cm°C"  /* <-- thermal conductivity */
#define DTKUNIT "W/cm C" /* <-- (for DT2861 display) */
#define QUNIT "W/cm²"   /* <-- heat flux */
#define DTQUNIT "W/cm2" /* <-- (for DT2861 display) */

```

```

/*----- MACROS -----*/

#define FILE_EXISTS(f) (access(f,0)==0)

/*----- PROTOTYPES -----*/

/*----- HEAT.C ----- */
/* Main control routine. Tests for proper configuration of the hardware
   and calls the menu control routine.
*/

    void main();

/*----- HEATMISC.C -----*/
/* Miscellaneous functions which are used for initializing and ending program
   operations, displaying messages, controlling cursors, etc. These functions
   are called by many program modules.
*/

    int dt_init( void );
    void dt_end( void );
    void message_box( char *msg );
    void message_box_np( char *msg );
    void StatusBox_func( void );
    void update_status_box( void );
    int caution( void );
    int dt_cursor( int *ptr_grey, int *ptr_row, int *ptr_col, int row_sensitivity, int
col_sensitivity);
    int F1_handler( COUNT key_code, VCPROKEY *ksp );
    int F2_handler( COUNT key_code, VCPROKEY *ksp );
    int F3_handler( COUNT key_code, VCPROKEY *ksp );

/*----- HEATMENU.C -----*/
/* Main menu module from which all submenu or function calls are made.
   This routine also defines the screen (computer display) colors. An
   attempt has been made to render the menus suitable for either color
   or monochrome displays.
*/

    void heatmenu( void );
    COUNT mQuit( VCMENU *mnuptr );
    int Quit( void );
    int GetYN( void );
    COUNT set_colors( void );

/*----- HEATFILE.C -----*/
/* Functions for disk file operations such as retrieving and saving data
   to and from the indicated drive path.
*/

    COUNT mPath( VCMENU *mnuptr );
    COUNT mSave( VCMENU *mnuptr );
    COUNT mRetrieve( VCMENU *mnuptr );
    COUNT mSaveGrid( VCMENU *mnuptr );
    COUNT mRetrieveGrid( VCMENU *mnuptr );
    COUNT mSaveConfig( VCMENU *mnuptr );
    COUNT mRetrieveConfig( VCMENU *mnuptr );
    int load_buffer( char *filespec, int BufferNumber );
    int save_buffer( char *filespec, int BufferNumber );
    int retrieve_file( char *filename, int BufferNumber );
    int get_file_name_guts( char *title, char *prompt, char *filename, char *defaultname );
    char *add_run_ext( char *buf, int runnum );

```

```

/*----- HEATSLCT.C -----*/
/* Controls the display and capture of image data. Data is captured to
   the appropriate image buffers from an RS-170 video source, and can then
   be selected by the user(from the menu) for display on the RGB interlaced
   output device.
*/

COUNT mNumerator( VCMENU *mnuptr );
COUNT mNumeratorBack( VCMENU *mnuptr );
COUNT mDenominator( VCMENU *mnuptr );
COUNT mDenominatorBack( VCMENU *mnuptr );
COUNT mCamera( VCMENU *mnuptr );
COUNT mRatio( VCMENU *mnuptr );
COUNT mTemperature( VCMENU *mnuptr );
COUNT mHeatFlux( VCMENU *mnuptr );
void switch_display( int image_number );
int turn_camera_on( void );
int capture_image( void );

/*----- HEATPROC.C -----*/
/* Process routines for evaluating data buffers to estimate 2-D temperature
   and heat-flux values.
*/

COUNT mProcess( VCMENU *mnuptr );
float TemperatureCalc( float r );
float HeatFluxCalc( float T_top, float T_bot );
int print_summary( void );
COUNT mSetRectangle( VCMENU *mnuptr );
COUNT mDefineGrid( VCMENU *mnuptr );
int arrange( int xy[][2], int npts, int maxrows, int *mrows, int *ncols );
int mark_grid( int image_number, int mark_row, int mark_col, int type );
int draw_square( int image_number, int square_row, int square_col );
int mark_display( int image_number, int mark_row, int mark_col, char *title_msg,
                  char *mark_msg );

COUNT mEnterRatioHigh( VCMENU *mnuptr );
COUNT mEnterRatioLow( VCMENU *mnuptr );
COUNT mEnterTempHigh( VCMENU *mnuptr );
COUNT mEnterTempLow( VCMENU *mnuptr );
COUNT mEnterk( VCMENU *mnuptr );
COUNT mEnterx( VCMENU *mnuptr );
void mCalibrateTemp( void );

/*----- HEATCOLR.C -----*/
/* Utility functions for producing false-color output of the displayed data
   using the DT-2861 output look-up-tables (LUT's). Also allows for zoom,
   pan, and scroll of the displayed data.
*/

COUNT mZoomPan( VCMENU *mnuptr );
COUNT mZoomPanReset( VCMENU *mnuptr );
COUNT mMonochrome( VCMENU *mnuptr );
COUNT mColorBar( VCMENU *mnuptr );
COUNT mColorBand( VCMENU *mnuptr );
void load_color( void );

/*----- HEATCONT.C -----*/
/* Functions contained here allow for modification and control of the input
   LUT's. Both a linear mapping and a statistical mapping (based on histo-
   gram equalization) are included. Once these mappings are defined they can
   be enabled or disabled at any time.
*/

COUNT mContrastLinear( VCMENU *mnuptr );
COUNT mContrastEqual( VCMENU *mnuptr );
COUNT mSelectModLUT( VCMENU *mnuptr );
COUNT mSelectDefLUT( VCMENU *mnuptr );

```

```

/*----- WINDOW VARIABLES -----*/

COUNT StatusBoxWindow;          /* program status information */

/*----- GLOBAL VARIABLES -----*/

char Path[PATHSTRLEN+1];          /* <-- display environment */
char FileName[FILENAMLEN], CalName[FILENAMLEN],
    GridName[FILENAMLEN];
char BufferName[TOTAL_IMAGES][15];
char ILUTName[7][10], OLUName[7][10];

int ActiveBuffer;                 /* <-- DT2861 environment */
int ActiveILUT, ActiveOLUT;
int red_lut[GREY], green_lut[GREY], blue_lut[GREY];

int GridPoints, GridRow, GridCol; /* <-- process environment */
int grid[GRID_POINT][2];         /* ( [1][2] = num/den select ) */
int top_grey[GRID_POINT][2],
    bot_grey[GRID_POINT][2];
float top_ratio[GRID_POINT],
    bot_ratio[GRID_POINT];
float top_temperature[GRID_POINT],
    bot_temperature[GRID_POINT];
float heat_flux[GRID_POINT];

int grid_points;                 /* <-- grid variables for data collection */
float grid_toprow, grid_topcol;
float grid_botrow, grid_botcol;

float T_high, T_low;             /* temperature extremes, <-- calibration data */
float r_high, r_low;             /* ratio extremes, */
float k_cond, delta_x;           /* thermalconductivity & gauge thickness. */

```

```

/*-----
PROGRAM : HEAT.C
DATE    : 14 December 1990
PROGRAMMER : K. W. Tobin

J. K. Jordan
Applied Technology Division
Oak Ridge National Laboratory

ROUTINES :

void main()
-----*/

#include "heat.h"

void main()
{
    if( dt_init()==SUCCESS )
    {
        vcstart(CLRSCRN);
        heatmenu();
        vcend(CLOSE);

        dt_end();
    }
    else
    {
        printf("\n*****");
        printf("\a\n\nMissing or bad DT-2861 imaging hardware.\n");
        printf("\n*****\n\n");
    }
}

```

```

/*-----
PROGRAM : HEATMENU.C

DATE : 14 December 1990

PROGRAMMER : K. W. Tobin

J. K. Jordan
Applied Technology Division
Oak Ridge National Laboratory

ROUTINES :

void heatmenu( void )
COUNT mQuit( VCMENU *mnuPtr )
int Quit( void )
int GetYN( void )
COUNT set_colors( void )

-----*/

#include "heat.h"

void heatmenu()
{
int i,j,k;
int window_stat;
VCMENU *menunew();
VCMENU *menu_main,
      *menu_files,
      *menu_select,
      *menu_process,
      *menu_color,
      *menu_contrast,
      *menu_calibrate;

/* SET UP SCREEN MENU CONTROL USING VITAMIN-C ROUTINES . . . */

vcstart(SAVESCRN);
set_colors();
erase();

window_stat=wxopen(24,0,24,79,NULL,ACTIVE,0,0);
/*window_stat=wxopen(24,0,24,79,NULL,ACTIVE,1,80,3,32);*/

xatsay(0, 54, "F1(disp) F2(cam) F3(proc)", vc.black+(vc.bg*vc.white));
setswdo(window_stat);

statlin(0,0);

addvcstyle("STDHORIZ",HORIZONTAL|TITLECENTER,-1,
          vc.white+(vc.bg*vc.blue),
          vc.black+(vc.bg*vc.white),
          vc.cyan+vc.bold+(vc.bg*vc.blue),
          vc.cyan+(vc.bg*vc.blue),
          0 );
addvcstyle("STDVERT",VERTICAL|TITLECENTER,-1,
          vc.blue+(vc.bg*vc.cyan),
          vc.black+(vc.bg*vc.brown),
          vc.blue+vc.bold+(vc.bg*vc.cyan),
          vc.blue+(vc.bg*vc.cyan),
          0 );

menu_main=menunew(0, 0, TITLE, "NO HELP", "STDHORIZ");

menu_files=menunew(2,1,NULL,"NO HELP","STDVERT");
menu_select=menunew(2,8,NULL,"NO HELP","STDVERT");
menu_process=menunew(2,15,NULL,"NO HELP","STDVERT");
menu_color=menunew(2,22,NULL,"NO HELP","STDVERT");

```

```

menu_contrast=menunew(2,29,NULL,"NO HELP","STDVERT");
menu_calibrate=menunew(6, 0, NULL, "NO HELP", "STDHORIZ");

/* BEGIN PROGRAM . . . */

/* MAIN menu items . . . */

menuxitem(menu_main,"FILES",NULL,0,NULLFUNC,(TEXT *)menu_files,
    "Save and retrieve files to/from disk.", "NO HELP",MENU);
menuxitem(menu_main,"SELECT",NULL,0,NULLFUNC,(TEXT *)menu_select,
    "Select display buffer/video control.", "NO HELP",MENU);
menuxitem(menu_main,"PROCESS",NULL,0,NULLFUNC,(TEXT *)menu_process,
    "Process data buffers.", "NO HELP",MENU);
menuxitem(menu_main,"COLOR",NULL,0,NULLFUNC,(TEXT *)menu_color,
    "False color options for display.", "NO HELP",MENU);
menuxitem(menu_main,"CONTRAST",NULL,0,NULLFUNC,(TEXT *)menu_contrast,
    "Contrast enhancement of monochrome data.",
    "NO HELP",MENU);
menuxitem(menu_main,"EXIT",NULL,0,mQuit,NULL,
    "Exit and return to DOS.", "NO HELP",ESCAPE);

/* FILES menu items . . . */

menuxitem(menu_files,"Set Path",NULL,0,mPath,NULL,
    "Set path for data storage/retrieval.", "NO HELP",
    ESCAPE);

menuitem(menu_files,"",NULLFUNC,NULL,"",BLANKITEM);

menuxitem(menu_files,"Save Image",NULL,0,mSave,NULL,
    "Save current data set to disk.", "NO HELP",
    ESCAPE);
menuxitem(menu_files,"Retrieve Image",NULL,0,mRetrieve,NULL,
    "Retrieve a data set from the disk.",
    "NO HELP",ESCAPE);

menuitem(menu_files,"",NULLFUNC,NULL,"",BLANKITEM);

menuxitem(menu_files,"Save Grid",NULL,0,mSaveGrid,NULL,
    "Save current grid pattern to a disk.",
    "NO HELP",ESCAPE);
menuxitem(menu_files,"Retrieve Grid",NULL,0,mRetrieveGrid,NULL,
    "Retrieve grid pattern from disk.",
    "NO HELP",ESCAPE);

menuitem(menu_files,"",NULLFUNC,NULL,"",BLANKITEM);

menuxitem(menu_files,"Save Configuration",NULL,0,mSaveConfig,NULL,
    "Save current calibration to disk.",
    "NO HELP",ESCAPE);
menuxitem(menu_files,"Retrieve Configuration",NULL,0,mRetrieveConfig,NULL,
    "Retrieve calibration from disk.",
    "NO HELP",ESCAPE);

/* SELECT menu items . . . */

menuxitem(menu_select,"Display Numerator",NULL,0,mNumerator,NULL,
    "Set numerator image to active display.",
    "NO HELP",ESCAPE);
menuxitem(menu_select,"Display Num. Background",NULL,0,mNumeratorBack,NULL,
    "Set numerator background image to active display.",
    "NO HELP",ESCAPE);
menuxitem(menu_select,"Display Denominator",NULL,0,mDenominator,NULL,
    "Set denominator image to active display.",
    "NO HELP",ESCAPE);

```

```

menuxitem(menu_select,"Display Den. Background",NULL,0,mDenominatorBack,NULL,
          "Set denominator background to active display.",
          "NO HELP",ESCAPE);

menuitem(menu_select,"",NULLFUNC,NULL,"",BLANKITEM);

menuxitem(menu_select,"Camera (F2)",NULL,0,mCamera,NULL,
          "Acquire image to active buffer (current Input LUT).",
          "NO HELP",ESCAPE);

menuitem(menu_select,"",NULLFUNC,NULL,"",BLANKITEM);

menuxitem(menu_select,"Ratio Data( F1)",NULL,0,mRatio,NULL,
          "Display phosphor ratio data.",
          "NO HELP",ESCAPE);

menuxitem(menu_select,"Temperature Data (F1)",NULL,0,mTemperature,NULL,
          "Display phosphor temperature data.",
          "NO HELP",ESCAPE);

menuxitem(menu_select,"Heat-Flux Data (F1)",NULL,0,mHeatFlux,NULL,
          "Display heat-flux data.",
          "NO HELP",ESCAPE);

/* PROCESS menu items . . . */

menuxitem(menu_process,"Process Data (F3)",NULL,0,mProcess,NULL,
          "Process data (image) buffers.",
          "NO HELP",ESCAPE);

menuitem(menu_process,"",NULLFUNC,NULL,"",BLANKITEM);

menuxitem(menu_process,"Set Rectangle",NULL,0,mSetRectangle,NULL,
          "Enable cursor for definition of rectangle dim.",
          "NO HELP",ESCAPE);

menuxitem(menu_process,"Define Grid",NULL,0,mDefineGrid,NULL,
          "Enable cursor for definition of grid pattern.",
          "NO HELP",ESCAPE);

menuitem(menu_process,"",NULLFUNC,NULL,"",BLANKITEM);

menuxitem(menu_process,"Calibrate",NULL,0,NULLFUNC,(TEXT *)menu_calibrate,
          "Activate menu for calibration.",
          "NO HELP",MENU);

/* CALIBRATE menu items . . . */

menuxitem(menu_calibrate,"Ratio(high)",NULL,0,mEnterRatioHigh,NULL,
          "Enter high ratio cutoff point.",
          "NO HELP",ESCAPE);

menuxitem(menu_calibrate,"(low)",NULL,0,mEnterRatioLow,NULL,
          "Enter low ratio cutoff point.",
          "NO HELP",ESCAPE);

menuxitem(menu_calibrate,"Temp(high)",NULL,0,mEnterTempHigh,NULL,
          "Enter high temperature cutoff point.",
          "NO HELP",ESCAPE);

menuxitem(menu_calibrate,"(low)",NULL,0,mEnterTempLow,NULL,
          "Enter low temperature cutoff point.",
          "NO HELP",ESCAPE);

menuxitem(menu_calibrate,"Cond(k)",NULL,0,mEnterk,NULL,
          "Enter gauge thermal conductivity.",
          "NO HELP",ESCAPE);

menuxitem(menu_calibrate,"Delta",NULL,0,mEnterx,NULL,
          "Enter gauge thickness.",
          "NO HELP",ESCAPE);

```



```

menuxitem(menu_calibrate,"Point-Cal.",NULL,0, mCalibrateTemp ,NULL,
          "Enable point-calibration mode.",
          "NO HELP",ESCAPE);

/* COLOR menu items . . . */

menuxitem(menu_color,"Zoom/Pan",NULL,0,mZoomPan,NULL,
          "Zoom pan and scroll the active display.",
          "NO HELP",ESCAPE);
menuxitem(menu_color,"Zoom/Pan Reset",NULL,0,mZoomPanReset,NULL,
          "Reset the zoom pan and scroll display.",
          "NO HELP",ESCAPE);

menuitem(menu_color,"",NULLFUNC,NULL,"",BLANKITEM);

menuxitem(menu_color,"Monochrome",NULL,0,mMonochrome,NULL,
          "Set display to monochrome.",
          "NO HELP",ESCAPE);
menuxitem(menu_color,"Color bars",NULL,0,mColorBar,NULL,
          "Activate red/green/blue contour bars.",
          "NO HELP",ESCAPE);
menuxitem(menu_color,"Color band",NULL,0,mColorBand,NULL,
          "Activate continuous color band.",
          "NO HELP",ESCAPE);

/* CONTRAST menu items . . . */

menuxitem(menu_contrast,"Linear",NULL,0,mContrastLinear,NULL,
          "Linear contrast stretch & modify input LUT.",
          "NO HELP",ESCAPE);
menuxitem(menu_contrast,"Histogram",NULL,0,mContrastEqual,NULL,
          "Histogram equalization & modify input LUT.",
          "NO HELP",ESCAPE);

menuitem(menu_contrast,"",NULLFUNC,NULL,"",BLANKITEM);

menuxitem(menu_contrast,"Modified LUT",NULL,0,mSelectModLUT,NULL,
          "Select modified input LUT for CAMERA capture.",
          "NO HELP",ESCAPE);
menuxitem(menu_contrast,"Default LUT",NULL,0,mSelectDefLUT,NULL,
          "Reset input LUT to default.",
          "NO HELP",ESCAPE);

/* setup for function key handling */
setkeyfunc(vcprokey);

/* setup the F1 key as a display switcher */
addprokey(F1, F1_handler, NULL);

/* setup the F2 key to invoke the camera function */
addprokey(F2, F2_handler, NULL);

/* setup the F3 key to invoke the processor function */
addprokey(F3, F3_handler, NULL);

/* display status box */
StatusBox_func();

/* Activate main menu screen . . . */
do
{
    vcmenu( menu_main );
} while( Quit() != SUCCESS );

} /* End of colormenu() */

```

```

/*-----*/
/* When QUIT is selected from the menu, "mQuit()" is called which simply
   returns the value RETURN to "vcmenu()", signaling a exit to DOS. When
   "vcmenu()" returns, function "colormenu()" calls "Quit()" to verify.
   If Mr. User has a change of heart, "colormenu()" calls "vcmenu()" again.
*/

```

```

COUNT mQuit( VCMENU *mnuptr)
{
    return RETURN;
}

```

```

/*-----*/
/* does he really want to quit or was this an accident? */
/* Quit() is called from main to verify he actually wants to quit */

```

```

int Quit()
{
    int wtemp;
    char c;
    int RetCode;

    wtemp=wxopen(2,23,6,47,"",ACTIVE|BORDER|BD2,0,0,5,32);
    if( wtemp == -1 )
        terror("Unable to open QuitWindow. Aborting");
    erase();
    xatsay(1,3,"EXIT to DOS (y/n)?",vc.dflt);

    if( (c=GetYN()) == ESC )
        c='N';

    if( c=='y' || c=='Y' )
        RetCode=SUCCESS;
    else
        RetCode=FAILURE;

    wclose(wtemp);
    return RetCode;
}

```

```

/*-----*/
int GetYN( void ) /* wait for y,Y,n,N or ESC */
{
    int c='.';

    while( c=='.' )
    {
        c=getone();
        if( c!='y' && c!='Y' && c!='n' && c!='N' && c!=ESC )
        {
            c='.';
            bell();
        }
    }
    return(c);
}

```

```

/*-----*/
COUNT set_colors()
{
    /* Color Set 0 */
    wtable[0].bd_t = vc.brown;
    wtable[0].bg_t = vc.brown+vc.bold;
    wtable[0].say_t = vc.brown+vc.bold;
    wtable[0].nget_t = vc.brown;
    wtable[0].get_t = vc.red+vc.bold;
    wtable[0].tit_t = vc.white+vc.bold;
}

```

```

/* Color Set 1 */
wtable[1].bd_t = vc.black+(vc.bg*vc.white);
wtable[1].bg_t = vc.brown+vc.bold+(vc.bg*vc.blue);
wtable[1].say_t = vc.brown+vc.bold+(vc.bg*vc.blue);
wtable[1].nget_t = vc.white+vc.bold+(vc.bg*vc.blue);
wtable[1].get_t = vc.black+(vc.bg*vc.white);
wtable[1].tit_t = vc.black+(vc.bg*vc.white);

/* Color Set 2 */
wtable[2].bd_t = vc.cyan+vc.bold+(vc.bg*vc.blue);
wtable[2].bg_t = vc.cyan+vc.bold+(vc.bg*vc.blue);
wtable[2].say_t = vc.cyan+vc.bold+(vc.bg*vc.blue);
wtable[2].nget_t = vc.white+vc.bold+(vc.bg*vc.blue);
wtable[2].get_t = vc.black+(vc.bg*vc.white);
wtable[2].tit_t = vc.white+vc.bold+(vc.bg*vc.blue);

/* Color Set 3 */
wtable[3].bd_t = vc.white+vc.bold+(vc.bg*vc.red);
wtable[3].bg_t = vc.red+(vc.bg*vc.white);
wtable[3].say_t = vc.black+(vc.bg*vc.white);
wtable[3].nget_t = vc.black+(vc.bg*vc.white);
wtable[3].get_t = vc.white+vc.bold;
wtable[3].tit_t = vc.brown+vc.bold+(vc.bg*vc.red);

/* Color Set 4 */
wtable[4].bd_t = vc.brown+vc.bold+(vc.bg*vc.blue);
wtable[4].bg_t = vc.blue+(vc.bg*vc.cyan);
wtable[4].say_t = vc.blue+(vc.bg*vc.cyan);
wtable[4].nget_t = vc.black+(vc.bg*vc.cyan);
wtable[4].get_t = vc.white+vc.bold;
wtable[4].tit_t = vc.blue+(vc.bg*vc.cyan);

/* Color Set 5 */
wtable[5].bd_t = vc.white+vc.bold+(vc.bg*vc.red);
wtable[5].bg_t = vc.white+vc.bold+(vc.bg*vc.red);
wtable[5].say_t = vc.white+vc.bold+(vc.bg*vc.red);
wtable[5].nget_t = vc.brown+vc.bold+(vc.bg*vc.red);
wtable[5].get_t = vc.brown+vc.bold;
wtable[5].tit_t = vc.white+vc.bold+(vc.bg*vc.red);

/* Color Set 6 */
wtable[6].bd_t = vc.red+(vc.bg*vc.brown);
wtable[6].bg_t = vc.brown+vc.bold+(vc.bg*vc.brown);
wtable[6].say_t = vc.brown+vc.bold+(vc.bg*vc.brown);
wtable[6].nget_t = vc.white+vc.bold+(vc.bg*vc.brown);
wtable[6].get_t = vc.green+vc.bold;
wtable[6].tit_t = vc.brown+vc.bold+(vc.bg*vc.brown);

/* Color Set 7 */
wtable[7].bd_t = vc.brown+vc.bold+(vc.bg*vc.brown);
wtable[7].bg_t = vc.black+(vc.bg*vc.green);
wtable[7].say_t = vc.black+(vc.bg*vc.green);
wtable[7].nget_t = vc.white+vc.bold+(vc.bg*vc.green);
wtable[7].get_t = vc.brown+vc.bold;
wtable[7].tit_t = vc.black+(vc.bg*vc.brown);

/* Color Set 8 */
wtable[8].bd_t = vc.brown+vc.bold+(vc.bg*vc.white);
wtable[8].bg_t = vc.white+vc.bold+(vc.bg*vc.magenta);
wtable[8].say_t = vc.white+vc.bold+(vc.bg*vc.magenta);
wtable[8].nget_t = vc.brown+vc.bold+(vc.bg*vc.magenta);
wtable[8].get_t = vc.brown+vc.bold;
wtable[8].tit_t = vc.magenta+(vc.bg*vc.white);

```

```
/* Color Set 9 */  
wtable[9].bd_t = vc.white+vc.bold+(vc.bg*vc.cyan);  
wtable[9].bg_t = vc.white+(vc.bg*vc.blue);  
wtable[9].say_t = vc.white+(vc.bg*vc.blue);  
wtable[9].nget_t = vc.white+vc.bold+(vc.bg*vc.blue);  
wtable[9].get_t = vc.white;  
wtable[9].tit_t = vc.white+vc.bold+(vc.bg*vc.cyan);  
}
```

```

/*-----
PROGRAM : HEATMISC.C

DATE : 14 December 1990

PROGRAMMER : K. W. Tobin

J. K. Jordan
Applied Technology Division
Oak Ridge National Laboratory

ROUTINES :

void dt_end( void )
int dt_init( void )
void message_box( char *msg )
void message_box_np( char *msg )
void StatusBox_func( void )
void update_status_box( void )
int caution( void )
int dt_cursor( int *ptr_grey, int *ptr_row, int *ptr_col, int row_sensitivity, int
               col_sensitivity )
int F1_handler( COUNT key_code, VCPROKEY *ksp )
int F2_handler( COUNT key_code, VCPROKEY *ksp )
int F3_handler( COUNT key_code, VCPROKEY *ksp )

-----*/

#include "heat.h"

/*-----*/
void dt_end( void )
{
    /* Function closes the channel to the DT-IRIS device driver etc. */
    IS_END();

    printf("\n\n          %s\n", TITLE );
    printf("          OAK RIDGE NATIONAL LABORATORY\n");
    printf("          Applied Technology Division\n\n");
    printf("          Developed by: K. W. Tobin & J. K. Jordan\n");
    printf("          P.O. Box 2003\n");
    printf("          Bldg. K-1220, MS-7280\n");
    printf("          Oak Ridge, TN 37831-7280\n\n\n");

    return;
}

/*-----*/
int dt_init( void )
{
    int returncode=SUCCESS;
    int status;
    int i;
    FILE *in;

    /* Function opens a channel to the DT-IRIS device driver. The device
       is then interrogated for configuration etc. */

    if( IS_INITIALIZE() != ISE_NORMAL ) returncode=FAILURE;
    else
    {
        printf("\n\n*****");
        printf("\n          Initializing DT2861 hardware ...");
        printf("\n*****\n\n");
    }
}

```

```

if( (in = fopen( "HEAT.PTH", "r" )) != NULL )
{
    fscanf( in, "%s", Path );          /* <-- path from file */
    fclose( in );
}
else strcpy( Path, PATH );           /* <-- default path */

for( i=0; i<TOTAL_IMAGES; i++ ) IS_FRAME_CLEAR( i );

/* <-- restore color-bar image */
if( IS_RESTORE( OVLY_BUF, 0, 0, NONE_IMAGE ) != ISE_NORMAL )
    returncode=FAILURE;

IS_DISPLAY(ON);

IS_SET_ACTIVE_REGION( 0, 0, ROW, COL );

ActiveBuffer=NUMERATOR;              /* <-- initial settings */
ActiveILUT=DEFAULT_LUT;
ActiveOLUT=MONO_LUT;

sprintf( BufferName[0], "Numerator" );
sprintf( BufferName[1], "Num. Back." );
sprintf( BufferName[2], "Denominator" );
sprintf( BufferName[3], "Den. Back." );
sprintf( BufferName[4], "Ratio" );
sprintf( BufferName[5], "Temperature" );
sprintf( BufferName[6], "Heat-Flux" );

sprintf( ILUTName[0], "DEFAULT");
sprintf( ILUTName[2], "MODIFIED");

sprintf( OLUTName[0], "MONO");
sprintf( OLUTName[2], "COLOR");

strcpy( FileName, STARTFILE );
strcpy( CalName, STARTFILE );
strcpy( GridName, STARTFILE );

grid_points=POINTS;                 /* <-- default grid dimensions */
grid_toprow=TOPROW;
grid_topcol=TOPCOL;
grid_botrow=BOTROW;
grid_botcol=BOTCOL;

T_high=130.0;                        /* <-- default calibration */
T_low=50.0;
r_high=0.7;
r_low=0.1;
k_cond=1.0;
delta_x=1.0;

load_color();

}

return returncode;
}

```

```

/*-----*/
/* Open a window and display a message */
/* Prompt and wait for a keypress, then return */

void message_box( char *msg )
{
    int width, start, wtemp;
    static char prompt[]="Press any key to continue...";

```

```

int pwidth = strlen(prompt);
int mwidth = strlen(msg);

/*
width = mwidth;
if( width < pwidth )
    width = pwidth;
width += 7;
*/
width = max(mwidth, pwidth) + 7;
start = (80 - width) / 2;

wtemp = wxxopen(6, start, 12, start + width, "", ACTIVE | BORDER | BD2, 0, 0, 5, 32);
if( wtemp == -1 )
    terror("Unable to open message_box. Aborting");
erase();

atsay(1, (width - mwidth) / 2, msg);
atsay(3, (width - pwidth) / 2, prompt);

getone();
wclose(wtemp);
}

/*-----*/
/* open a window and display a message */
/* wait for a keypress (no prompt), then return */

void message_box_np( char *msg )
{
    int width, start, wtemp;

    width = strlen(msg) + 7;
    start = (80 - width) / 2;

    wtemp = wxxopen(6, start, 10, start + width, "", ACTIVE | BORDER | BD2, 0, 0, 5, 32);
    if( wtemp == -1 )
        terror("Unable to open message_box. Aborting");
    erase();
    atsay(1, 4, msg);
    getone();
    wclose(wtemp);
}

/*-----*/
void StatusBox_func( void )
{
    StatusBoxWindow = wxxopen(12, 41, 20, 79, "Status Box", ACTIVE | BORDER | BD2, 0, 0, 2, 32);
    if( StatusBoxWindow == -1 )
        terror("Unable to open StatusBox. Aborting");
    update_status_box();

    return;
}

/*-----*/
void update_status_box( void )
{
    char buffer[80];
    int co = -1; /* column offset */
    int pcolor, dcolor;
    int currentwindow;

    if( (currentwindow = wselect(StatusBoxWindow)) == -1 )
        terror("Unable to select StatusBoxWindow. Aborting");

```

```

woff();
erase();
pcolor=vc.cyan+vc.bold+(vc.bg*vc.blue);
dcolor=vc.cyan+(vc.bg*vc.blue);

atsay(0,3,"Path: ");
sprintf(buffer,"%s",Path);
atsay(0,10,buffer);

atsay(1,3,"Image: ");
sprintf(buffer,"%s",FileName);
atsay(1,11,buffer);

atsay(2,3,"Grid: ");
sprintf(buffer,"%s",GridName);
atsay(2,10,buffer);

atsay(3,3,"Configuration: ");
sprintf(buffer,"%s",CalName);
atsay(3,19,buffer);

atsay(4,3,"Display: ");
sprintf(buffer,"%s",BufferName[ActiveBuffer]);
atsay(4,13,buffer);

atsay(5,3,"Input LUT: ");
sprintf(buffer,"%s",ILUTName[ActiveILUT]);
atsay(5,16,buffer);

atsay(6,3,"Output LUT: ");
sprintf(buffer,"%s",OLUTName[ActiveOLUT]);
atsay(6,16,buffer);

won();

if( wselect(currentwindow)==-1 )
    terror("Unable to select currentwindow. Aborting");

return;
}

/*-----*/

int caution( void )
{
    int i;
    int window;
    char yn='N';

    window=wxopen(15,0,23,40,NULL,ACTIVE+CENTER,1,40);
    atsay(1,3,"CAUTION - This function will delete");
    atsay(2,3,"          the current buffer data");
    atsay(3,3,"          for this option.");
    atsay(5,3,"          Continue (Y/N) ? ...   ");
    atget(5,37,&yn,"A");
    readgets();
    wclose(window);
    if( yn == 'N' ) return(FAILURE); else return(SUCCESS);
}

/*-----*/
/* dt_cursor - The cursor function uses the DT2861 library calls to turn
on the cursor in the active buffer and return its position
and grey scale after user relocation. The arguments are:
grey - pointer to the cursor grey value, row - pointer to the cursor row,
col - pointer to the cursor column, row_sensitivity - number of pixels to skip
upon key stroke, col_sensitivity - number of pixels to skip upon key stroke.
*/

```



```

int dt_cursor(int *ptr_grey, int *ptr_row, int *ptr_col, int row_sensitivity, int col_sensitivity)
{
    int i,j,c;
    int window;
    char sentence[70];
    int cursor_row,
        cursor_col;
    int pixel_val;
    int returnval=SUCCESS;

    cursor_row=*ptr_row;
    cursor_col=*ptr_col;

    empty(sentence,70);

    window=wxopen(20,0,23,40,NULL,ACTIVE+CENTER,2,65);

    IS_SET_CURSOR_POSITION(cursor_row,cursor_col);
    IS_CURSOR(ON);

    atsay(0,0," Move cursor with arrow keys . . . ");

    while( (c=getch()) != DTCR )
    {
        if( c == 0 ) c=getch();

        if( c==DTESE )
        {
            IS_CURSOR(OFF);
            wclose(window);
            return( FAILURE );
        }

        if( c==DTUP ) cursor_row=cursor_row-row_sensitivity;
        if( c==DTDOWN ) cursor_row=cursor_row+row_sensitivity;
        if( c==DTRIGHT ) cursor_col=cursor_col+col_sensitivity;
        if( c==DTLEFT ) cursor_col=cursor_col-col_sensitivity;

        if( cursor_col>COL-1 ) cursor_col=cursor_col-col_sensitivity;
        if( cursor_col<0 ) cursor_col=cursor_col+col_sensitivity;
        if( cursor_row>ROW-1 ) cursor_row=cursor_row-row_sensitivity;
        if( cursor_row<0 ) cursor_row=cursor_row+row_sensitivity;

        IS_SET_CURSOR_POSITION(cursor_row,cursor_col);
        IS_GET_PIXEL(ActiveBuffer,cursor_row,cursor_col,1,&pixel_val);

        sprintf(sentence," Coordinate = (%3d,%3d)      ",
                    cursor_row,cursor_col);
        atsay(1,0,sentence);

        sprintf(sentence," Value = %3d      ", pixel_val);
        atsay(2,0,sentence);

    }

    IS_CURSOR(OFF);
    wclose(window);

    *ptr_grey=pixel_val;
    *ptr_row=cursor_row;
    *ptr_col=cursor_col;

    return( SUCCESS );
}

```

```
/*-----*/
int F1_handler( COUNT key_code, VCPROKEY *ksp )
{
    ActiveBuffer++;
    if( (ActiveBuffer > HEAT_FLUX) || (ActiveBuffer < RATIO) )
        ActiveBuffer=RATIO;
    switch_display(ActiveBuffer);
    update_status_box();
    return(0);
}

/*-----*/
int F2_handler( COUNT key_code, VCPROKEY *ksp )
{
    mCamera();
    return(0);
}

/*-----*/
int F3_handler( COUNT key_code, VCPROKEY *ksp )
{
    mProcess();
    return(0);
}
```

```

/*-----
PROGRAM : HEATFILE.C

DATE : 12 December 1989

PROGRAMMER : K. W. Tobin

J. K. Jordan
Applied Technology Division
Oak Ridge National Laboratory

ROUTINES :

COUNT mPath( VCMENU *mnuptr )
COUNT mSave( VCMENU *mnuptr )
COUNT mRetrieve( VCMENU *mnuptr )
COUNT mSaveGrid( VCMENU *mnuptr )
COUNT mRetrieveGrid( VCMENU *mnuptr )
COUNT mSaveConfig( VCMENU *mnuptr )
COUNT mRetrieveConfig( VCMENU *mnuptr )
int load_buffer( char *filespec, int BufferNumber )
int save_buffer( char *filespec, int BufferNumber )
int retrieve_file( char *filename, int BufferNumber )
int get_file_name_guts( char *title, char *prompt, char *filename, char *defaultname )
char *add_run_ext( char *buf, int runnum )

-----*/

#include "heat.h"

/*-----*/
COUNT mPath( VCMENU *mnuptr )
{
    COUNT wtemp;
    FILE *tempfileptr, *out;
    char buffer[80];
    char filespec(PATHSTRLEN+FILENAMLEN+4);
    char temppath[PATHSTRLEN], *pch;
    int ret, i;

    empty(temppath,PATHSTRLEN);
    for( i=0; Path[i]; i++ )
        temppath[i]=Path[i];

    wtemp=wxopen(6,18,10,58,"",ACTIVE|BORDER|BD2|CURSOR,0,0,5,32);
    if( wtemp == -1 )
        terror("Unable to open SetPathWindow. Aborting");
    xatsay(0,6,"SET PATH FOR SUBDIRECTORY",vc.dflt);
    xatsay(2,2,"Path:",vc.dflt);
    xxatgetc(vcdgt, wtemp, 2, 8, temppath, "xxxxxxxxxxxxxxxxxxxxxxxx",
        NULLFUNC, "For example: C:\\", "", vc.white+(vc.bg*vc.red), vc.white+(vc.bg*vc.red),
        DEFAULT, STRING+FLDBLANK, NULL, NULLFUNC, NULLFUNC);
    ret=readgets();
    wclose(wtemp);

    if( ret != vkey.abort )
    {
        /* remove trailing chars at the first blank found, insure \ char */
        if( (pch=strchr(temppath,' ')) != NULL )
            *pch='\0';
        pch = strchr( temppath, '\0' );
        if( *(--pch) != '\\' )
            strcat( temppath, "\\");

        /* check to see if path exists by trying to open a temporary file */
        strcpy( filespec, temppath );
        strcat( filespec, "JUNK.TMP" );
        if( (tempfileptr=fopen(filespec,"w"))==NULL )
        {
            bell();
            sprintf(buffer,"Path: [%s] does not exist",temppath);

```

```

        message_box(buffer);
    }
    else
    {
        /* if temp file opens OK, path is verified, save it */
        strcpy(Path,temp_path);

        /* clean up temporary stuff */
        if( fclose(tempfileptr) )
            error("Unable to close temp file in mSSPath()");
        if( remove( filespec ) )
            error("Unable to delete temp file in mSSPath()");
    }

    out = fopen( "HEAT.PTH", "w" );
    fprintf( out, "%s", Path );
    fclose( out );

}

update_status_box();

return(0);
}

/*-----*/
COUNT mSave( VCMENU *mnuptr )
{
    char tempfile[FILENAMELEN], temp_ext[FILENAMELEN];
    char filespec[FILENAMELEN+PATHSTRLEN+3];
    int i;
    int ret=SUCCESS;

    /* GET FILENAME FOR IMAGE */
    if( (get_file_name_guts("STORE AN IMAGE","File name:",tempfile,NULL))==SUCCESS )
    {
        strcpy(fileName,tempfile);
        update_status_box();

        for( i=0; i<DATA_IMAGES; i++)
        {
            strcpy(temp_ext,tempfile);
            add_run_ext(temp_ext,i+1);
            strcpy(filespec,Path);
            strcat(filespec,temp_ext);
            ret=save_buffer( filespec, i );
        }

    }

    if( ret != SUCCESS )
        message_box("ERROR in storing image");

    return(0);
}

/*-----*/
COUNT mRetrieve( VCMENU *mnuptr )
{
    char tempfile[FILENAMELEN], temp_ext[FILENAMELEN];
    char filespec[FILENAMELEN+PATHSTRLEN+3];
    int i;

    ActiveBuffer=NUMERATOR;
    switch_display( ActiveBuffer);
    update_status_box();

    if( (get_file_name_guts("RETRIEVE IMAGE","Image file name:",tempfile,NULL))==SUCCESS )
    {
        strcpy(fileName,tempfile);
        update_status_box();
    }
}

```

```

        for( i=0; i<DATA_IMAGES; i++)
        {
            strcpy(temp_ext,tempfile);
            add_run_ext(temp_ext,i+1);
            strcpy(filespec,Path);
            strcat(filespec,temp_ext);
            retrieve_file( filespec, i );
        }

    return(0);
}

/*-----*/
int retrieve_file( char *filename, int BufferNumber )
{
    char buffer[80];
    int ret;
    int returncode=SUCCESS;

    if( FILE_EXISTS(filename) )
    {
        ret=load_buffer( filename, BufferNumber );
    }
    else
    {
        bell();
        sprintf(buffer, "Image file %s does not exist", filename);
        message_box(buffer);
        returncode = FAILURE;
    }

    return returncode;
}

/*-----*/
int load_buffer( char *filespec, int BufferNumber )
{
    int returncode=SUCCESS;
    int status;

    /* LOAD BUFFER FROM filespec */
    /* IF ERROR, SET returncode=FAILURE */

    if( IS_RESTORE(BufferNumber,0,0,filespec) != ISE_NORMAL ) returncode=FAILURE;

    return returncode;
}

/*-----*/
int save_buffer( char *filespec, int BufferNumber )
{
    int returncode=SUCCESS;

    /* SAVE BUFFER TO filespec */
    /* IF ERROR, SET returncode=FAILURE */

    if( IS_SAVE(BufferNumber,0,1,0,filespec) != ISE_NORMAL ) returncode=FAILURE;

    return returncode;
}

/*-----*/
int get_file_name_guts( char *title, char *prompt, char *filename, char *defaultname )
{
    COUNT wtemp;
    int width, start, twidth, pwidth, tcol, pcol, gcol;

```

```

int returncode=SUCCESS;
int ret;

twidth=strlen(title);
pwidth=strlen(prompt)+2+FILENAMLEN-1;
width=max(twidth,pwidth) + 7;
tcol=(58-18-twidth)/2;
pcol=(58-18-pwidth)/2;
gcol=pcol+strlen(prompt)+2;

empty(filename,FILENAMLEN);

/* copy defaultname into filename */
if( defaultname )
{
    char *tptr, *fptr;

    for( fptr=defaultname,tptr=filename; *fptr; fptr++,tptr++ )
        *tptr=*fptr;
    /* *tptr='\0'; */
}

wtemp=wxopen(12,18,16,58,"",ACTIVE|BORDER|BD2|CURSOR,0,0,5,32);
/*wtemp=wxopen(15,18,19,58,"",ACTIVE|BORDER|BD2|CURSOR,0,0,5,32);*/
if( wtemp == -1 )
    error("Unable to open get_file_name window. Aborting");

atsay(0,tcol,title);
atsay(2,pcol,prompt);
xatgetc(2, gcol, filename, "xxxxxxx", NULLFUNC,
        "Enter the file name (no extension)", "", vc.white+(vc.bg*vc.red),
        vc.white+(vc.bg*vc.red), DEFAULT, STRING, NULL);
ret=readgets();
wclose(wtemp);

trim(filename);
if( ret==vckey.abort || filename[0]=='\0' )
{
    bell();
    returncode=FAILURE;
}

return returncode;
}

/*-----*/
/* Add an extension to a filename consisting of the run number expressed
   as 3 decimal chars. 'buf' points to a character array containing a
   file name (with or without an existing extension). If extension exists,
   it will be replaced. Returns NULL if problem, else pointer to the filename.
*/
char *add_run_ext( char *buf, int runnum )
{
    char *p;
    char ext[4];

    if( runnum<0 || runnum>999 ) /* make sure run# is within limits */
        return NULL;
    if( sprintf(ext, "%03u", runnum) != 3 )
        return NULL;

    if( (p = strchr( buf, '.' )) )
    {
        if( (p-buf) > 8 ) /* do not exceed max filename size */
            return NULL;
        strcpy( ++p, ext ); /* '.' is found, replace extension */
    }
    else

```

```

    {
        if( strlen( buf ) > 8 ) /* do not exceeded max filename size */
            return NULL;
        strcat( buf, "." ); /* '.' is not found, add extension */
        strcat( buf, ext );
    }

    return buf;
}

/*-----*/
COUNT mSaveGrid( VCMENU *mnuptr )
{
    char tempfile[FILENAMLEN];
    char filespec[FILENAMLEN+PATHSTRLEN+3];
    int ret=SUCCESS;
    int i;
    FILE *out;

    /* GET FILENAME FOR IMAGE */
    if( (get_file_name_guts("STORE A GRID","File name:",tempfile,NULL))==SUCCESS )
    {
        /* add path and extension to filename */
        strcpy(filespec,Path);
        strcat(filespec,tempfile);
        strcat(filespec,".grd");

        strcpy(GridName,tempfile);
        update_status_box();

        /* SAVE GRID */
        out = fopen( filespec, "w" );

        fprintf( out, "%d\n", GridPoints );
        fprintf( out, "%d\n", GridRow );
        fprintf( out, "%d\n", GridCol );

        for( i=0; i<GridPoints; i++ )
            fprintf( out, "%d %d\n", grid[i][ROW_SELECT], grid[i][COL_SELECT] );

        fclose( out );
    }

    if( ret != SUCCESS )
        message_box("ERROR in storing grid data");

    return(0);
}

/*-----*/
COUNT mRetrieveGrid( VCMENU *mnuptr )
{
    char buffer[40];
    char tempfile[FILENAMLEN];
    char filespec[FILENAMLEN+PATHSTRLEN+3];
    int i;
    FILE *in;

    ActiveBuffer=NUMERATOR;
    switch_display( ActiveBuffer);
    update_status_box();

    if( (get_file_name_guts("RETRIEVE A GRID","Image file name:",tempfile,NULL))==SUCCESS )
    {
        /* add path and extension to filename */
        strcpy(filespec,Path);
        strcat(filespec,tempfile);
        strcat(filespec,".grd");
    }

```

```

if( (in = fopen( filespec, "r" )) != NULL )
{
    strcpy(GridName,tempfile);
    update_status_box();

    IS_FRAME_COPY( ActiveBuffer, GRAPHIC_BUF );    /* Copy active frame for
                                                    graphic overlay. */

    switch_display( GRAPHIC_BUF );

    fscanf( in, "%d", &GridPoints );
    fscanf( in, "%d", &GridRow );
    fscanf( in, "%d", &GridCol );

    for( i=0; i<GridPoints; i++ )
    {
        fscanf( in, "%d %d", &grid[i][ROW_SELECT], &grid[i][COL_SELECT] );
        mark_grid( GRAPHIC_BUF, grid[i][ROW_SELECT], grid[i][COL_SELECT], 0
);
    }

    fclose( in );
    sprintf( buffer, "See display for grid pattern (%s) ...",tempfile );
    message_box( buffer );
    switch_display( ActiveBuffer );

} else
{
    sprintf( buffer, "Grid file %s does not exist",tempfile );
    message_box( buffer );
}

}

return(0);
}

/*-----*/
COUNT mSaveConfig( VCMENU *mnuptr )
{
    char tempfile[FILENAMLEN];
    char filespec[FILENAMLEN+PATHSTRLEN+3];
    int ret=SUCCESS;
    int i;
    FILE *out;

    /* GET FILENAME FOR DATA */
    if( (get_file_name_guts("STORE CONFIGURATION","File name:",tempfile,NULL))==SUCCESS )
    {
        /* add path and extension to filename */
        strcpy(filespec,Path);
        strcat(filespec,tempfile);
        strcat(filespec,".con");

        strcpy(CalName,tempfile);
        update_status_box();

        /* SAVE CALIBRATION */
        out = fopen( filespec, "w" );

        /* save calibration parameters */
        fprintf( out, "%f\n", T_high );
        fprintf( out, "%f\n", T_low );
        fprintf( out, "%f\n", r_high );
        fprintf( out, "%f\n", r_low );
        fprintf( out, "%f\n", k_cond );
        fprintf( out, "%f\n", delta_x );

        /* save grid triangle dimension */
        fprintf( out, "%d\n", grid_points );
        fprintf( out, "%f\n", grid_toprow );
        fprintf( out, "%f\n", grid_topcol );

```



```

        fprintf( out, "%f\n", grid_botrow );
        fprintf( out, "%f\n", grid_botcol );

        /* save current path */

        fclose( out );
    }

    if( ret != SUCCESS )
        message_box("ERROR in storing calibration data");

    return(0);

}

/*-----*/
COUNT mRetrieveConfig( VCMENU *mnuPtr )
{
    char buffer[40];
    char tempfile[FILENAMELEN];
    char filespec[FILENAMELEN+PATHSTRLEN+3];
    int i;
    FILE *in;

    if( (get_file_name_guts("RETRIEVE CONFIGURATION","File name:",tempfile,NULL))==SUCCESS )
    {
        /* add path and extension to filename */
        strcpy(filespec,Path);
        strcat(filespec,tempfile);
        strcat(filespec,".con");

        if( (in = fopen( filespec, "r" )) != NULL )
        {
            strcpy(CalName,tempfile);
            update_status_box();

            /* retrieve calibration parameters */
            fscanf( in, "%f", &T_high );
            fscanf( in, "%f", &T_low );
            fscanf( in, "%f", &r_high );
            fscanf( in, "%f", &r_low );
            fscanf( in, "%f", &k_cond );
            fscanf( in, "%f", &delta_x );

            /* retrieve grid triangle dimension */
            fscanf( in, "%d", &grid_points );
            fscanf( in, "%f", &grid_toprow );
            fscanf( in, "%f", &grid_topcol );
            fscanf( in, "%f", &grid_botrow );
            fscanf( in, "%f", &grid_botcol );

            /* retrieve current path */

            fclose( in );

        } else

        {
            sprintf( buffer, "Calibration file %s does not exist",tempfile );
            message_box( buffer );
        }

    }

    return(0);
}

```

```

/*-----
PROGRAM : HEATSLCT.C
DATE : 144 December 1990
PROGRAMMER : K. W. Tobin
J. K. Jordan
Applied Technology Division
Oak Ridge National Laboratory

ROUTINES :

COUNT mNumerator( VCMENU *mnuptr );
COUNT mNumeratorBack( VCMENU *mnuptr );
COUNT mDenominator( VCMENU *mnuptr );
COUNT mDenominatorBack( VCMENU *mnuptr );
COUNT mRatio( VCMENU *mnuptr );
COUNT mTemperature( VCMENU *mnuptr );
COUNT mHeatFlux( VCMENU *mnuptr );
COUNT mCamera( VCMENU *mnuptr );
void switch_display( int image_number );
int turn_camera_on( void );
int capture_image( void );

-----*/

#include "heat.h"

/*-----*/
COUNT mNumerator( VCMENU *mnuptr )
{
    ActiveBuffer=NUMERATOR;
    switch_display( ActiveBuffer );
    update_status_box();
    return(0);
}

/*-----*/
COUNT mNumeratorBack( VCMENU *mnuptr )
{
    ActiveBuffer=NUMERATOR_BACK;
    switch_display( ActiveBuffer );
    update_status_box();
    return(0);
}

/*-----*/
COUNT mDenominator( VCMENU *mnuptr )
{
    ActiveBuffer=DENOMINATOR;
    switch_display( ActiveBuffer );
    update_status_box();
    return(0);
}

/*-----*/
COUNT mDenominatorBack( VCMENU *mnuptr )
{
    ActiveBuffer=DENOMINATOR_BACK;
    switch_display( ActiveBuffer );
    update_status_box();
    return(0);
}

/*-----*/
COUNT mRatio( VCMENU *mnuptr )
{
    ActiveBuffer=RATIO;
    switch_display( ActiveBuffer );

```

```

    update_status_box();
    return(0);
}

/*-----*/
COUNT mTemperature( VCMENU *mnuptr )
{
    ActiveBuffer=TEMPERATURE;
    switch_display( ActiveBuffer );
    update_status_box();
    return(0);
}

/*-----*/
COUNT mHeatFlux( VCMENU *mnuptr )
{
    ActiveBuffer=HEAT_FLUX;
    switch_display( ActiveBuffer );
    update_status_box();
    return(0);
}

/*-----*/
COUNT mCamera( VCMENU *mnuptr )
{
    int ret=SUCCESS;

    if( ActiveBuffer > DENOMINATOR_BACK )
    {
        message_box( "Camera not available for current display." );
        return(0);
    }

    if( caution()==SUCCESS )
    {
        /* TURN ON CAMERA */
        ret = turn_camera_on();

        if( ret==SUCCESS )
        {
            message_box_np("Press any key to capture image");
            /* WHEN KEY IS PRESSED, CAPTURE IMAGE */
            ret = capture_image();
        }

        if( ret != SUCCESS )
            message_box("ERROR in capturing image");
    }

    return(0);
}

/*-----*/
void switch_display( int image_number )
{
    IS_SELECT_INPUT_FRAME( image_number );
    IS_SELECT_OUTPUT_FRAME( image_number );
}

/*-----*/
int turn_camera_on( void )
{
    int returncode=SUCCESS;

    /* TURN CAMERA ON, IF ERROR, SET returncode=FAILURE */

    if( IS_SET_SYNC_SOURCE(SYNC_EXT) != ISE_NORMAL ) returncode=FAILURE;
    if( returncode == SUCCESS )

```

```

        if( IS_PASSTHRU() != ISE_NORMAL ) returncode=FAILURE;

    return returncode;
}

/*-----*/
int capture_image( void )
{
    int returncode=SUCCESS;

    /* CAPTURE IMAGE HERE, IF ERROR, SET returncode=FAILURE */

    IS_FREEZE_FRAME();
    IS_ACQUIRE(ActiveBuffer,8);      /* <-- 8 frames averaged. */
    IS_SET_SYNC_SOURCE(SYNC_INT);

    return returncode;
}

```

```

/*-----
PROGRAM : HEATPROC.C

DATE : 19 December 1990

PROGRAMMER : K. W. Tobin

J. K. Jordan
Applied Technology Division
Oak Ridge National Laboratory

ROUTINES :

COUNT mProcess( VCMENU *mnuptr )
float TemperatureCalc( float r )
float HeatFluxCalc( float T_top, float T_bot )
int print_summary( void )
COUNT mSetRectangle( VCMENU *mnuptr )
COUNT mDefineGrid( VCMENU *mnuptr )
int arrange( int xy[][2], int npts, int maxrows, int *mrows, int *ncols )
int mark_grid( int image_number, int mark_row, int mark_col, int type )
int draw_square( int image_number, int square_row, int square_col )
int mark_display( int image_number, int mark_row, int mark_col, char *title_msg,
char *mark_msg )

COUNT mEnterRatioHigh( VCMENU *mnuptr )
COUNT mEnterRatioLow( VCMENU *mnuptr )
COUNT mEnterTempHigh( VCMENU *mnuptr )
COUNT mEnterTempLow( VCMENU *mnuptr )
COUNT mEnterk( VCMENU *mnuptr )
COUNT mEnterx( VCMENU *mnuptr )
void mCalibrateTemp( void )

-----*/

#include "heat.h"

/*-----*/
COUNT mProcess( VCMENU *mnuptr )
{
char title_buffer[80], msg_buffer[40];
int i,j,k;
int pixel;
int toprow,topcol;
int botrow,botcol;
int topoffrow,topoffcol;
int botoffrow,botoffcol;
float topsum,botsum;

/* Remove image backgrounds.*/

IS_DISPLAY( OFF );
IS_SUBTRACT( NUMERATOR, NUMERATOR_BACK, NUMERATOR_CORR );
IS_SUBTRACT( DENOMINATOR, DENOMINATOR_BACK, DENOMINATOR_CORR );
IS_DISPLAY( ON );

/* Copy numerator frame for graphic overlay. */
IS_FRAME_COPY( NUMERATOR, GRAPHIC_BUF );
switch_display( GRAPHIC_BUF );

/* GRAB GRID DATA FROM CORRECTED IMAGES. */

if( GridPoints > GRID_POINT ) GridPoints=1;
for( k=0; k<GridPoints-GridCol; k++)
{
if( (k+1)%GridCol == 0 ) continue;

topsum=0.0;
botsum=0.0;

/* Calculated offset in units of pixels. */

```

```

topoffrow=grid_toprow*(grid[k+GridCol][ROW_SELECT]-grid[k][ROW_SELECT]);
topoffcol=grid_topcol*(grid[k+1][COL_SELECT]-grid[k][COL_SELECT]);

botoffrow=grid_botrow*(grid[k+GridCol][ROW_SELECT]-grid[k][ROW_SELECT]);
botoffcol=grid_botcol*(grid[k+1][COL_SELECT]-grid[k][COL_SELECT]);

/* Offset pixel coordinates for each phosphor cell. */
toprow=grid[k][ROW_SELECT]+topoffrow;
topcol=grid[k][COL_SELECT]+topoffcol;

botrow=grid[k][ROW_SELECT]+botoffrow;
botcol=grid[k][COL_SELECT]+botoffcol;

/* Mark image at offset location for visual verification. */
draw_square( GRAPHIC_BUF, toprow, topcol );
draw_square( GRAPHIC_BUF, botrow, botcol );

/* Grab pixel data from PxP area for numerator phosphor. */
for( i=0; i<grid_points; i++ )
{
    for( j=0; j<grid_points; j++ )
    {
        IS_GET_PIXEL( NUMERATOR_CORR, toprow-grid_points/2+i,
                                topcol-grid_points/2+j,    1,
&top_grey[k][NUM_SELECT] );
        topsum+=top_grey[k][NUM_SELECT];
        IS_GET_PIXEL( NUMERATOR_CORR, botrow-grid_points/2+i,
                                botcol-grid_points/2+j,    1,
&bot_grey[k][NUM_SELECT] );
        botsum+=bot_grey[k][NUM_SELECT];
    }
    top_grey[k][NUM_SELECT]=(int)(topsum/(grid_points*grid_points));
    bot_grey[k][NUM_SELECT]=(int)(botsum/(grid_points*grid_points));

    topsum=0.0;
    botsum=0.0;

/* Grab pixel data from PxP area for denominator phosphor. */
for( i=0; i<grid_points; i++ )
{
    for( j=0; j<grid_points; j++ )
    {
        IS_GET_PIXEL( DENOMINATOR_CORR, toprow-grid_points/2+i,
                                topcol-grid_points/2+j,    1,
&top_grey[k][DEN_SELECT] );
        topsum+=top_grey[k][DEN_SELECT];
        IS_GET_PIXEL( DENOMINATOR_CORR, botrow-grid_points/2+i,
                                botcol-grid_points/2+j,    1,
&bot_grey[k][DEN_SELECT] );
        botsum+=bot_grey[k][DEN_SELECT];
    }
    top_grey[k][DEN_SELECT]=(int)(topsum/(grid_points*grid_points));
    bot_grey[k][DEN_SELECT]=(int)(botsum/(grid_points*grid_points));

    if( top_grey[k][DEN_SELECT] > 0 )
    {
        top_ratio[k]=(float)top_grey[k][NUM_SELECT]/(float)top_grey[k][DEN_SELECT];
        top_temperature[k]=TemperatureCalc( top_ratio[k] );
    } else
    {
        top_ratio[k]=0.0;
        top_temperature[k]=0.0;
    }
}

```

```

        if( bot_grey[k][DEN_SELECT] > 0 )
        {
            bot_ratio[k]=(float)bot_grey[k][NUM_SELECT]/(float)bot_grey[k][DEN_SELECT];
            bot_temperature[k]=TemperatureCalc( bot_ratio[k] );
        } else
        {
            bot_ratio[k]=0.0;
            bot_temperature[k]=0.0;
        }

        heat_flux[k]=HeatFluxCalc( top_temperature[k], bot_temperature[k] );
    }

/* DISPLAY RATIO DATA ON IMAGE BUFFER */

IS_FRAME_COPY( NUMERATOR, RATIO );
ActiveBuffer=RATIO;
switch_display( ActiveBuffer );
update_status_box();

sprintf( title_buffer, "PHOSPHOR RATIO DATA (front/back)" );
for( k=0; k<GridPoints-GridCol; k++ )
{
    if( (k+1)%GridCol == 0 ) continue;

    sprintf( msg_buffer, "%3.2f", top_ratio[k] );
    mark_display( ActiveBuffer, grid[k][ROW_SELECT], grid[k][COL_SELECT], title_buffer,
        msg_buffer );

    sprintf( msg_buffer, "%3.2f", bot_ratio[k] );
    mark_display( ActiveBuffer, grid[k][ROW_SELECT]+17, grid[k][COL_SELECT]+5, title_buffer,
        msg_buffer );
}

/* DISPLAY TEMPERATURE DATA ON IMAGE BUFFER */

IS_FRAME_COPY( NUMERATOR, TEMPERATURE );
ActiveBuffer=TEMPERATURE;
switch_display( ActiveBuffer );
update_status_box();

sprintf( title_buffer, "PHOSPHOR TEMPERATURE DATA (%s)", DTTUNIT );
for( k=0; k<GridPoints-GridCol; k++ )
{
    if( (k+1)%GridCol == 0 ) continue;

    sprintf( msg_buffer, "%4.1f", top_temperature[k] );
    mark_display( ActiveBuffer, grid[k][ROW_SELECT], grid[k][COL_SELECT], title_buffer,
        msg_buffer );

    sprintf( msg_buffer, "%4.1f", bot_temperature[k] );
    mark_display( ActiveBuffer, grid[k][ROW_SELECT]+17, grid[k][COL_SELECT]+5, title_buffer,
        msg_buffer );
}

/* DISPLAY HEAT FLUX DATA ON IMAGE BUFFER */

IS_FRAME_COPY( NUMERATOR, HEAT_FLUX );
ActiveBuffer=HEAT_FLUX;
switch_display( ActiveBuffer );
update_status_box();

sprintf( title_buffer, "PHOSPHOR HEAT FLUX DATA (%s)", DTQUNIT );
for( k=0; k<GridPoints-GridCol; k++ )
{
    if( (k+1)%GridCol == 0 ) continue;

```

```

        sprintf( msg_buffer, "%.1f", heat_flux[k] );
        mark_display( ActiveBuffer, grid[k][ROW_SELECT], grid[k][COL_SELECT], title_buffer,
                      msg_buffer );
    }

    print_summary();
}

/*-----*/
float TemperatureCalc( float r )
{
    float T;
    T = T_high-(T_high-T_low)*(r-r_low)/(r_high-r_low);
    if( r<r_low ) T = T_high;
    if( r>r_high ) T = T_low;
    return( T );
}

/*-----*/
float HeatFluxCalc( float T_top, float T_bot )
{
    float qflux;
    qflux = -k_cond*(T_top-T_bot)/delta_x;
    return( qflux );
}

/*-----*/
int print_summary( void )
{
    char tempfile[FILENAMLEN];
    char filespec[FILENAMLEN+PATHSTRLEN+3],
          filespec2[FILENAMLEN+PATHSTRLEN+3];
    int ret=SUCCESS;
    int k;
    FILE *out, *out2;

    /* GET FILENAME FOR DATA */
    if( (get_file_name_guts("STORE RESULT SUMMARY","File name:",tempfile,NULL))==SUCCESS )
    {
        /* add path and extension to filename */

        /* the *.sum file contains the total run information including the ratio data,
           temperatures, heatflux, and file configuration.
           the *.dat file contains the (x,y) pixel location, temperature,
           and heatflux data. The format is amenable to use with surface plot
           routines.
        */

        strcpy(filespec,Path);          strcpy(filespec2,Path);
        strcat(filespec,tempfile);      strcat(filespec2,tempfile);
        strcat(filespec,".sum");        strcat(filespec2,".dat");

        /* SAVE DATA */
        out = fopen( filespec, "w" );    out2 = fopen( filespec2, "w" );

        fprintf( out, "%s\n\n", TITLE );
        fprintf( out, "Data Path:          %s\n", Path );
        fprintf( out, "Image File Name:         %s\n", FileName );
        fprintf( out, "Grid File Name:          %s\n", GridName );
        fprintf( out, "Calibration File Name: %s\n\n", CalName );

        fprintf( out, "Calibration Parameters:\n" );
        fprintf( out, "High Ratio = %4.3f, Low Ratio = %4.3f\n", r_high, r_low );
        fprintf( out, "High Temp. = %4.1f %s, Low Temp. = %4.1f %s\n", T_high, TUNIT, T_low,
TUNIT );
        fprintf( out, "Gauge Thermal Conductivity = %7.5f %s\n", k_cond, KUNIT );
        fprintf( out, "Gauge Thickness = %6.5f %s\n\n", delta_x, XUNIT );

        fprintf( out, "Number of grid rows and columns: %3d %3d\n", GridRow-1, GridCol-1);
    }
}

```



```

fprintf( out, "Data: (x, y, front ratio, back ratio, front temp, back temp., heat
flux)\n" );
for( k=0; k<GridPoints-GridCol; k++)
{
    if( (k+1)%GridCol == 0 ) continue;
    fprintf( out, "%3d %3d %5.4f %5.4f %5.2f %5.2f %6.2f\n", grid[k][0],
grid[k][1],top_ratio[k],bot_ratio[k],top_temperature[k],bot_temperature[k],
heat_flux[k] );
    fprintf( out2, "%3d %3d %5.2f %5.2f %6.2f\n", grid[k][0], grid[k][1],
top_temperature[k], bot_temperature[k], heat_flux[k] );
}
fclose( out );
fclose( out2 );
}

if( ret != SUCCESS )
    message_box("ERROR in storing process data");

return(0);
}

/*-----*/
COUNT mSetRectangle( VCMENU *mnuPtr )
{
    double n;
    int wtemp;
    int ret;
    int gry;
    int subrow,subcol;
    char buffer[50];
    char yn='N';

    float row_top, col_left;
    float row_separation, col_separation;

    /* Set data array size... */

    /* Initialize screen value to current value */
    n=grid_points;

    /* Open window for entry of array data */
    wtemp=wxopen(6,18,10,60,"",ACTIVE|BORDER|BD2|CURSOR,0,0,5,32);
    if( wtemp == -1 )
        terror("Unable to open window: mSetRectangle. Aborting");
    sprintf( buffer, "No. of pixels, (current = %d x %d):", grid_points, grid_points );
    xatsay(2,4,buffer,vc.dflt);
    atgetc(2,38,(TEXT *)&n,"##",DEFAULT,REAL+FLDBLANK,NULL);
    xatsay(0,11,"SET PIXEL ARRAY SIZE",vc.dflt);
    ret=readgets();

    if( n>2*POINTS )
    {
        sprintf( buffer, "The array size must be less than %2d x %2d", 2*POINTS,
2*POINTS );
        message_box( buffer );
    } else
        grid_points=(int)n;

    wclose(wtemp);

    /* Set rectangle coordinates... */

    IS_FRAME_COPY( ActiveBuffer, GRAPHIC_BUF );
    switch_display( GRAPHIC_BUF );

    /* Open window for entry of grid data */
    wtemp=wxopen(6,18,15,60,"",ACTIVE|BORDER|BD2|CURSOR,0,0,5,32);
    if( wtemp == -1 )

```

```

        terror("Unable to open window: mSetRectangle. Aborting");
xatsay(0,11,"SET RECTANGLE COORDINATES",vc.dflt);

```

```

subrow=ROW/2;
subcol=COL/2;

```

```

xatsay(2,3,"Set upper left of rectangle",vc.dflt);
dt_cursor( &gry, &subrow, &subcol, 2, 2 );
row_top=subrow;
col_left=subcol;
mark_grid( GRAPHIC_BUF, subrow, subcol, 0 );

```

```

xatsay(3,3,"Set upper left of rectangle below",vc.dflt);
dt_cursor( &gry, &subrow, &subcol, 2, 2 );
row_separation=subrow-row_top;
mark_grid( GRAPHIC_BUF, subrow, subcol, 0 );

```

```

xatsay(4,3,"Set upper left of rectangle to right",vc.dflt);
dt_cursor( &gry, &subrow, &subcol, 2, 2 );
col_separation=subcol-col_left;
mark_grid( GRAPHIC_BUF, subrow, subcol, 0 );

```

```

xatsay(5,3,"Set lower triangle of main rectangle",vc.dflt);
dt_cursor( &gry, &subrow, &subcol, 2, 2 );
grid_toprow=(subrow-row_top)/row_separation;
grid_topcol=(subcol-col_left)/col_separation;
draw_square( GRAPHIC_BUF, subrow, subcol );

```

```

xatsay(6,3,"Set upper triangle of main rectangle.",vc.dflt);
dt_cursor( &gry, &subrow, &subcol, 2, 2 );
grid_botrow=(subrow-row_top)/row_separation;
grid_botcol=(subcol-col_left)/col_separation;
draw_square( GRAPHIC_BUF, subrow, subcol );

```

```

wclose(wtemp);

```

```

message_box( "Remember to update the current configuration file!");
switch_display( ActiveBuffer );
return(0);
}

```

```

/*-----*/

```

```

COUNT mDefineGrid( VCMENU *mnuptr )

```

```

{
int window;
int i,j,k,l;
int grid_row=50, /* Initialized to place first cursor. */
    grid_col=50;
int maxrows = 25; /* Used by arrange() for sort routine. */
char sentence[70];

```

```

ActiveBuffer=NUMERATOR;
switch_display( ActiveBuffer);
update_status_box();

```

```

window=wxopen(8,10,14,60,NULL,ACTIVE+CENTER+CURSOR,1,40,5,32);
atsay(1,1,"Press <ENTER> to introduce new grid point,");
atsay(2,1,"Press <ESC> to quit ...");

```

```

IS_FRAME_COPY( ActiveBuffer, GRAPHIC_BUF ); /* Copy active frame for graphic overlay. */
switch_display( GRAPHIC_BUF );

```

```

GridPoints=GRID_POINT;

```

```

for( k=0; k<GRID_POINT; k++)
{
    sprintf( sentence, "Move cursor to point %3d of %3d", k+1, GRID_POINT );
    atsay(4,1,sentence);
}

```

```

        if( dt_cursor(&l,&grid_row,&grid_col,4,4) == FAILURE ) break;

        grid[k][ROW_SELECT]=grid_row;
        grid[k][COL_SELECT]=grid_col;
        GridPoints=k+1;

        mark_grid( GRAPHIC_BUF, grid_row, grid_col, 0 );
    }

    switch_display( ActiveBuffer );      /* Return display to active buffer. */

    wclose(window);

    /* Sort grid data and determine number of rows & columns. */

    arrange( grid, GridPoints, maxrows, &GridRow, &GridCol );

    return(0);
}

/*-----*/
/*
Function arrange(): given a list of coordinate pairs in arbitrary order,
arrange them logically into a 2-d grid, determine the number of rows
and columns, and sort the list by row and column.

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input:
    xy[][2]: the list of coordinates. xy[][0] is the x (row) and
              xy[][1] is the y (column)
    npts: the number of coordinate pairs in the list
    maxrows: the maximum number of rows possible, used to determine
              the minimum possible row height

output:
    mrows: pointer to an integer for returning the number of rows
    ncols: pointer to an integer for returning the number of columns

return value:
    SUCCESS if successful
    FAILURE if unable to determine the grid
*/

int arrange( int xy[][2], int npts, int maxrows, int *mrows, int *ncols )
{
    int min_delta_row;      /* minimum possible row height */
    int temp, i, j, k, l;
    int errorflag=SUCCESS;

    /* sort list by x (first element, row) */
    for( i=0; i<npts; i++ )
        for( j=i+1; j<npts; j++ )
            if( xy[i][0] > xy[j][0] )
                for( k=0; k<2; k++ ) /* swap both row and col */
                {
                    temp = xy[j][k];
                    xy[j][k] = xy[i][k];
                    xy[i][k] = temp;
                }

    /* after sorting, determine row breaks */
    min_delta_row = (xy[npts-1][0]-xy[0][0])/maxrows;

    /* locate the 1st column break */
    *ncols=0;
    for( i=0; i<npts; i++ )
    {
        if( abs( xy[i+1][0] - xy[i][0] ) > min_delta_row )
        {
            *ncols=i+1;
            break;
        }
    }
}

```

```

    )
    *mrows=npts/(*ncols);

    /* verify all additional row breaks */
    for( j=1; j < *mrows; j++ )
    {
        for( i=0; i < *ncols-1; i++ )
            if( abs(xy[j*(*ncols)+i+1][0]-xy[j*(*ncols)+i][0]) > min_delta_row )
            {
                errorflag=FAILURE;
                break;
            }

        if( errorflag )
            break;
        if( j < *mrows-1 ) /* do not check end of last row */
            if( abs(xy[j*(*ncols)+i+1][0]-xy[j*(*ncols)+i][0]) < min_delta_row )
            {
                errorflag=FAILURE;
                break;
            }
    }

    /* now, sort each row by columns */
    if( !errorflag )
        for( j=0; j < *mrows; j++ )
            for( i=0; i < *ncols; i++ )
                for( l=i+1; l < *ncols; l++ )
                    if( xy[j*(*ncols)+i][1] > xy[j*(*ncols)+l][1] )
                        for( k=0; k<2; k++ )
                        {
                            temp = xy[j*(*ncols)+l][k];
                            xy[j*(*ncols)+l][k] = xy[j*(*ncols)+i][k];
                            xy[j*(*ncols)+i][k] = temp;
                        }

    return( errorflag );
}

/*-----*/

int mark_grid( int image_number, int mark_row, int mark_col, int type )
{
    int i;
    int disp_info[10];
    char sentence[10];

    IS_SET_MODE(0);

    IS_SET_CHARACTER_SIZE(1);
    IS_SET_FOREGROUND(GREY-2);
    IS_SET_BACKGROUND(0);

    IS_SET_GRAPHIC_POSITION(mark_row-5,mark_col-2);
    if( type == 0 )
    {
        sprintf(sentence,"+");
    } else sprintf(sentence,"o");
    for( i=0; i<10; i++) disp_info[i]=(int)sentence[i];
    IS_DRAW_TEXT(image_number,strlen(sentence),disp_info);

    return(0);
}

/*-----*/
/* draw_square() - Function draws a square on the image buffer encompassing
the processed area of each phosphor coated region.
*/

```

```

int draw_square( int image_number, int square_row, int square_col )
{
    int point_count=4;
    int point_array[4][2];

    point_array[0][0]=square_row + 0;      point_array[0][1]=square_col + grid_points;
    point_array[1][0]=square_row + grid_points; point_array[1][1]=square_col + grid_points;
    point_array[2][0]=square_row + grid_points; point_array[2][1]=square_col + 0;
    point_array[3][0]=square_row;           point_array[3][1]=square_col;

    IS_SET_MODE(0);
    IS_SET_FOREGROUND(GREY-2);
    IS_SET_BACKGROUND(0);

    IS_SET_GRAPHIC_POSITION( square_row, square_col );
    IS_DRAW_LINES( image_number, point_count, point_array );
}

/*-----*/
/* mark_display() - Function will write msg0 to the top line of the RGB
   display, msg1 will be written at coordinate (mark_row,mark_col).
*/

int mark_display( int image_number, int mark_row, int mark_col, char *title_msg,
                  char *mark_msg )
{
    int i;
    int disp_info[40];
    char sentence[40];

    IS_SET_MODE(0);

    IS_SET_CHARACTER_SIZE(1);
    IS_SET_FOREGROUND(GREY-2);
    IS_SET_BACKGROUND(0);

    IS_SET_GRAPHIC_POSITION(30,50);
    sprintf( sentence, title_msg );
    for( i=0; i<40; i++) disp_info[i]=(int)sentence[i];
    IS_DRAW_TEXT(image_number,strlen(sentence),disp_info);

    IS_SET_GRAPHIC_POSITION(mark_row-5,mark_col-2);
    sprintf( sentence, mark_msg );
    for( i=0; i<40; i++) disp_info[i]=(int)sentence[i];
    IS_DRAW_TEXT(image_number,strlen(sentence),disp_info);

    return(0);
}

/*-----*/
/* The following routines are called from the main menu to enter
   calibration data into the program. This data can be updated or saved
   using the "Calibration Save/Retrieve" command under the Files menu.
*/

COUNT mEnterRatioHigh( VCMENU *mnuptr )
{
    double n;
    int wtemp;
    int ret;
    char buffer[40];

    /* Initialize screen value to current value */
    n=r_high;

    /* Open window for entry of data */
    wtemp=wxopen(6,18,10,58,"",ACTIVE|BORDER|BD2|CURSOR,0,0,5,32);
    if( wtemp == -1 )

```

```

        terror("Unable to open window: mEnterRatioHigh. Aborting");
xatsay(2,4,"New high ratio value:",vc.dflt);
atgetc(2,30,(TEXT *)&n,"###.###",DEFAULT,REAL+FLDBLANK,NULL);
xatsay(0,11,"SET HIGH RATIO",vc.dflt);
ret=readgets();
wclose(wtemp);

    r_high=n;

    return(0);
}

/*-----*/

COUNT mEnterRatioLow( VCMENU *mnuptr )
{
    double n;
    int wtemp;
    int ret;
    char buffer[40];

    /* Initialize screen value to current value */
    n=r_low;

    /* Open window for entry of data */
    wtemp=wxopen(6,18,10,58,"",ACTIVE|BORDER|BD2|CURSOR,0,0,5,32);
    if( wtemp == -1 )
        terror("Unable to open window: mEnterRatioLow. Aborting");
    xatsay(2,4,"New low ratio value:",vc.dflt);
    atgetc(2,30,(TEXT *)&n,"###.###",DEFAULT,REAL+FLDBLANK,NULL);
    xatsay(0,11,"SET LOW RATIO",vc.dflt);
    ret=readgets();
    wclose(wtemp);

    if( n>r_high )
    {
        sprintf( buffer, "The low ratio must be less than %6.4f.", r_high );
        message_box( buffer );
    } else
        r_low=n;

    return(0);
}

/*-----*/

COUNT mEnterTempHigh( VCMENU *mnuptr )
{
    double n;
    int wtemp;
    int ret;
    char buffer[40];

    /* Initialize screen value to current value */
    n=T_high;

    /* Open window for entry of data */
    wtemp=wxopen(6,18,10,58,"",ACTIVE|BORDER|BD2|CURSOR,0,0,5,32);
    if( wtemp == -1 )
        terror("Unable to open window: mEnterTempHigh. Aborting");
    sprintf( buffer, "High temp. value (%s):", TUNIT );
    xatsay(2,4,buffer,vc.dflt);
    atgetc(2,30,(TEXT *)&n,"###.###",DEFAULT,REAL+FLDBLANK,NULL);
    xatsay(0,11,"SET HIGH TEMPERATURE",vc.dflt);
    ret=readgets();
    wclose(wtemp);

    T_high=n;

    return(0);
}

```

```

/*-----*/
COUNT mEnterTempLow( VCMENU *mnuptr )
{
    double n;
    int wtemp;
    int ret;
    char buffer[50];

    /* Initialize screen value to current value */
    n=T_low;

    /* Open window for entry of data */
    wtemp=wxwpen(6,18,10,58,"",ACTIVE|BORDER|BD2|CURSOR,0,0,5,32);
    if( wtemp == -1 )
        terror("Unable to open window: mEnterTempLow. Aborting");
    sprintf( buffer, "Low temp. value (%s):", TUNIT );
    xatsay(2,4,buffer,vc.dflt);
    atgetc(2,30,(TEXT *)&n,"###.##",DEFAULT,REAL+FLDBLANK,NULL);
    xatsay(0,11,"SET LOW TEMPERATURE",vc.dflt);
    ret=readgets();
    wclose(wtemp);

    if( n>T_high )
    {
        sprintf( buffer, "The low temp must be less than %5.2f.", T_high );
        message_box( buffer );
    } else
        T_low=n;

    return(0);
}
/*-----*/

COUNT mEnterk( VCMENU *mnuptr )
{
    double n;
    int wtemp;
    int ret;
    char buffer[40];

    /* Initialize screen value to current value */
    n=k_cond;

    /* Open window for entry of data */
    wtemp=wxwopen(6,18,10,58,"",ACTIVE|BORDER|BD2|CURSOR,0,0,5,32);
    if( wtemp == -1 )
        terror("Unable to open window: mEnterk. Aborting");
    sprintf( buffer, "Thermal cond. (%s):", KUNIT );
    xatsay(2,4,buffer,vc.dflt);
    atgetc(2,30,(TEXT *)&n,"###.####",DEFAULT,REAL+FLDBLANK,NULL);
    xatsay(0,11,"SET THERMAL CONDUCTIVITY",vc.dflt);
    ret=readgets();
    wclose(wtemp);

    k_cond=n;

    return(0);
}
/*-----*/

COUNT mEnterx( VCMENU *mnuptr )
{
    double n;
    int wtemp;
    int ret;
    char buffer[40];

    /* Initialize screen value to current value */
    n=delta_x;

```

```

/* Open window for entry of data */
wtemp=wxopen(6,18,10,58,"",ACTIVE|BORDER|BD2|CURSOR,0,0,5,32);
if( wtemp == -1 )
    terror("Unable to open window: mEnterx. Aborting");
sprintf( buffer, "Gauge thickness (%s):", XUNIT );
xatsay(2,4,buffer,vc.dflt);
atgetc(2,30,(TEXT *)&n,"###.###",DEFAULT,REAL+FLDBLANK,NULL);
xatsay(0,11,"SET GAUGE THICKNESS",vc.dflt);
ret=readgets();
wclose(wtemp);

delta_x=n;

return(0);
}

/*-----*/

int subrow=32,subcolo=32,
    subrow,subcol,
    subheight=400,subwidth=352;

void mCalibrateTemp( void )
{
    int i,j,k,gry;
    int window;
    char sentence[70];
    long image;
    float rawnum,rawden,fnum,fden,fratio,fTemperature;
    char yn='N';

    window=wxopen(15,0,18,40,NULL,ACTIVE+CENTER,1,40);
    atsay(1,3,"Set/Reset data ROI (Y/N) ? ... ");
    atget(1,37,&yn,"A");
    readgets();
    wclose(window);
    if( (yn == 'Y') || (yn == 'y') )
    {
        subrow=ROW/2;
        subcolo=COL/2;
        dt_cursor( &gry, &subrow, &subcolo, 2, 16 );
        subrow=subrow;
        subcol=subcolo;
        dt_cursor( &gry, &subrow, &subcol, 2, 16 );
        subheight=subrow-subrow;
        subwidth=subcol-subcolo;
    }

    if( (subheight == 0) || (subwidth == 0) )
    {
        message_box( "Invalid range on data ROI" );
        return;
    } else
        IS_SET_ACTIVE_REGION(subrow,subcolo,subheight,subwidth);

    /* Remove image backgrounds. */
    IS_DISPLAY( OFF );
    IS_SUBTRACT( NUMERATOR, NUMERATOR_BACK, NUMERATOR_CORR );
    IS_SUBTRACT( DENOMINATOR, DENOMINATOR_BACK, DENOMINATOR_CORR );
    IS_DISPLAY( ON );

    /* Extract ratio information to determine camera response */

    IS_SUMMATION( NUMERATOR, &image );
    rawnum=(float)image/((float)subheight*(float)subwidth);

    IS_SUMMATION( DENOMINATOR, &image );
    rawden=(float)image/((float)subheight*(float)subwidth);

```



```

IS_SUMMATION( NUMERATOR_CORR, &image );
fnum=(float)image/((float)subheight*(float)subwidth);

IS_SUMMATION( DENOMINATOR_CORR, &image );
fden=(float)image/((float)subheight*(float)subwidth);
if( fden == 0 ) fden=1.0;

fratio=fnum/fden;
fTemperature=T_high-(T_high-T_low)*(fratio-r_low)/(r_high-r_low);

window=wxopen(15,0,23,45,NULL,ACTIVE+CENTER,2,65);

empty(sentence,70);
sprintf(sentence," POINT CALIBRATION DATA:" );
atsay(1,0,sentence);

empty(sentence,70);
sprintf(sentence," Ratio = %5.4f  Temperature = %4.1f %s", fratio, fTemperature, TUNIT );
atsay(2,0,sentence);

empty(sentence,70);
sprintf(sentence," Raw num = %4.1f  Raw den = %4.1f", rawnum, rawden );
atsay(3,0,sentence);

empty(sentence,70);
sprintf(sentence," Corr num = %4.1f  Corr den = %4.1f", fnum, fden );
atsay(4,0,sentence);

empty(sentence,70);
sprintf(sentence," TEMPERATURE ESTIMATE BASED ON:" );
atsay(6,0,sentence);

empty(sentence,70);
sprintf(sentence," Ratio(low) = %5.4f  Ratio(high) = %5.4f", r_low, r_high );
atsay(7,0,sentence);

empty(sentence,70);
sprintf(sentence," Temp(low) = %4.1f %s  Temp(high) = %4.1f %s", T_low, TUNIT, T_high, TUNIT );
atsay(8,0,sentence);

getch();
wclose(window);

IS_SET_ACTIVE_REGION( 0, 0, ROW, COL );
}

```

```

/*-----
PROGRAM : HEATCOLR.C

DATE : 14 December 1990

PROGRAMMER : K. W. Tobin

J. K. Jordan
Applied Technology Division
Oak Ridge National Laboratory

ROUTINES :

COUNT mZoomPan( VCMENU *mnuptr )
COUNT mZoomPanReset( VCMENU *mnuptr )
COUNT mMonochrome( VCMENU *mnuptr )
COUNT mColorBar( VCMENU *mnuptr )
COUNT mColorBand( VCMENU *mnuptr )
void load_color( void )

-----*/

#include "heat.h"

/*-----*/
COUNT mZoomPanReset( VCMENU *mnuptr )
{
    IS_ZOOM_AND_PAN( ActiveBuffer, 1, 0, 0);
    return(0);
}

/*-----*/
COUNT mZoomPan( VCMENU *mnuptr )
{
    int window;
    char sentence[70];

    int cursor_row=0,
        cursor_col=0,
        zoom=1,
        c;

    empty(sentence,70);

    window=wxopen(19,0,23,45,NULL,ACTIVE+CENTER,0,0);

    atsay(0,0," Zoom with PgUP and PgDN keys, ");
    atsay(1,0," Pan/scroll with arrow keys ... ");

    while( (c=getch()) != DTCR )
    {
        if( c == 0 ) c=getch();

        if( c==DTUP ) cursor_row=cursor_row+4;
        if( c==DTDOWN ) cursor_row=cursor_row-4;
        if( c==DTRIGHT ) cursor_col=cursor_col+4;
        if( c==DTLEFT ) cursor_col=cursor_col-4;

        if( c==DTPgUP ) zoom=zoom*2;
        if( c==DTPgDN ) zoom=zoom/2;

        if( cursor_col>COL-1 ) cursor_col=0;
        if( cursor_col<0 ) cursor_col=COL-1;
        if( cursor_row>ROW-1 ) cursor_row=0;
        if( cursor_row<0 ) cursor_row=ROW-1;

        if( zoom>8 ) zoom=8;
        if( zoom<1 ) zoom=1;

        IS_ZOOM_AND_PAN(ActiveBuffer,zoom,cursor_row,cursor_col);
    }
}

```

```

        sprintf(sentence," Coordinate = (%3d,%3d)      ",
                    cursor_row,cursor_col);
        atsay(3,0,sentence);

        sprintf(sentence," Zoom      = %3d      ",zoom);
        atsay(4,0,sentence);
    }

    wclose(window);

    return(0);
}

/*-----*/
COUNT mMonochrome( VCMENU *mnuptr )
{
    ActiveOLUT=MONO_LUT;
    IS_SELECT_OLUT(ActiveOLUT);
    update_status_box();
    return(0);
}

/*-----*/
#define COLOR 5

int rgb_lut[COLOR][GREY];

COUNT mColorBar( VCMENU *mnuptr )
{
    int i,j,c,color;
    static int mid[COLOR]={0,192,128,64,0},delta[COLOR]={0,10,10,10,0};
    static int high[COLOR]={0,202,138,74,0},low[COLOR]={GREY-1,182,118,54,0};
    int window;
    char sentence[70];

    IS_SET_ACTIVE_REGION( OVLY_ROW, OVLY_COL, OVLY_HEIGHT, OVLY_WIDTH );
    IS_COPY_REGION( ActiveBuffer, OVLY_BUF, OVLY_ROW, OVLY_COL );
    switch_display( OVLY_BUF );

    ActiveOLUT=COLOR_LUT;
    update_status_box();

    empty(sentence,70);

    window=wxopen(19,0,23,45,NULL,ACTIVE+CENTER,2,65);

    atsay(0,0," Select [R]ed, [G]reen, [B]lue color bar");
    atsay(1,0," UP/DOWN arrow keys to shift color bar");
    atsay(2,0," RIGHT/LEFT arrow keys to broaden color bar");
    atsay(3,0," ENTER key to select color scheme");

    color=DTRKEY;

    while( (c=getch()) != DTCR )
    {
        if( c == 0 ) c=getch();

        c=toupper(c);

        if( c==DTRKEY ) color=1;
        if( c==DTGKEY ) color=2;
        if( c==DTBKEY ) color=3;

        if( c==DTUP ) mid[color]=mid[color]+2;
        if( c==DTDOWN ) mid[color]=mid[color]-2;
        if( c==DTRIGHT ) delta[color]=delta[color]+1;    /* <<< 2 -> 1 >>> */
        if( c==DTLEFT ) delta[color]=delta[color]-1;

        if( delta[color]<1 ) delta[color]=1;    /* <<< 2 -> 1 >>> */
    }

```

```

        if( delta[color]>(low[color-1]-high[color+1])/2-1 )
            delta[color]=(low[color-1]-high[color+1])/2-1;

        if( mid[color]+delta[color]>low[color-1] ) mid[color]=mid[color]-2;
        if( mid[color]-delta[color]<high[color+1] ) mid[color]=mid[color]+2;

        high[color]=mid[color]+delta[color];
        low[color]=mid[color]-delta[color];

        for( i=0; i<GREY; i++) { rgb_lut[1][i]=i;

rgb_lut[2][i]=i;
rgb_lut[3][i]=i; }

        for( i=low[1]; i<high[1]; i++) { rgb_lut[1][i]=GREY-1;

            rgb_lut[2][i]=0;
            rgb_lut[3][i]=0;

        }

        for( i=low[2]; i<high[2]; i++) { rgb_lut[2][i]=GREY-1;

            rgb_lut[1][i]=0;
            rgb_lut[3][i]=0;

        }

        for( i=low[3]; i<high[3]; i++) { rgb_lut[3][i]=GREY-1;

            rgb_lut[2][i]=0;
            rgb_lut[1][i]=0;

        }

        IS_LOAD_OLUT(ActiveOLUT,rgb_lut[1],rgb_lut[2],rgb_lut[3]);
        IS_SELECT_OLUT(ActiveOLUT);
    }

    wclose(window);

    IS_SET_ACTIVE_REGION( 0, 0, ROW, COL );
    switch_display( ActiveBuffer );

    return(0);
}

/*-----*/
int red[GREY],green[GREY],blue[GREY];

COUNT mColorBand( VCMENU *mnuptr )
{
    int i,j,c;
    static int mid=128,delta=20;
    int high,low;
    int window;
    char sentence[70];

    ActiveOLUT=COLOR_LUT;
    update_status_box();

    IS_SET_ACTIVE_REGION( OVLY_ROW, OVLY_COL, OVLY_HEIGHT, OVLY_WIDTH );
    IS_COPY_REGION( ActiveBuffer, OVLY_BUF, OVLY_ROW, OVLY_COL );
    switch_display( OVLY_BUF );

    empty(sentence,70);

```

```

window=wxopen(20,0,23,45,NULL,ACTIVE+CENTER,2,65);

atsay(0,0," UP/DOWN arrow keys to shift color band");
atsay(1,0," RIGHT/LEFT arrow keys to broaden color band");
atsay(2,0," ENTER key to select color scheme");

    while( (c=getch()) != DTCR )
    {
        if( c == 0 ) c=getch();

        if( c==DTUP ) mid=mid+2;
        if( c==DTDOWN ) mid=mid-2;
        if( c==DTRIGHT ) delta=delta+2;
        if( c==DTLEFT ) delta=delta-2;

        if( delta<2 ) delta=2;
        if( delta>(GREY/2)-1 ) delta=(GREY/2)-1;

        if( mid+delta>GREY-1 ) mid=mid-2;
        if( mid-delta<0 ) mid=mid+2;

        high=mid+delta;
        low=mid-delta;

        for( i=0; i<low; i++) { red[i]=i; green[i]=i; blue[i]=i; }
        for( i=high; i<GREY; i++) { red[i]=i; green[i]=i; blue[i]=i; }
        for( i=low; i<high; i++)
        {
            red[i]=red_lut[(int)(GREY*((float)i-low)/(float)(high-low))];
            green[i]=green_lut[(int)(GREY*((float)i-low)/(float)(high-low))];
            blue[i]=blue_lut[(int)(GREY*((float)i-low)/(float)(high-low))];
        }

        IS_LOAD_OLUT(ActiveOLUT,red,green,blue);
        IS_SELECT_OLUT(ActiveOLUT);
    }

wclose(window);

IS_SET_ACTIVE_REGION( 0, 0, ROW, COL );
switch_display( ActiveBuffer );

return(0);
}

/*-----*/
void load_color( void )
{
    int i,j;

    for( i=0, j=3; i<37; i++, j+=7 )    /* build standard RGB lookup tables */
    {
        red_lut[i] = 3;
        green_lut[i] = 3;
        blue_lut[i] = j;
    }

    for( i=37, j=10; i<73; i++, j+=7 )
    {
        red_lut[i] = 3;
        green_lut[i] = j;
        blue_lut[i] = 255;
    }

    for( i=73, j=248; i<109; i++, j-=7 )
    {
        red_lut[i] = 3;
        green_lut[i] = 255;
    }

```

```
        blue_lut[i] = j;
    }

    for( i=109, j=10; i<145; i++, j+=7 )
    {
        red_lut[i] = j;
        green_lut[i] = 255;
        blue_lut[i] = 3;
    }

    for( i=145, j=248; i<181; i++, j-=7 )
    {
        red_lut[i] = 255;
        green_lut[i] = j;
        blue_lut[i] = 3;
    }

    for( i=181, j=10; i<217; i++, j+=7 )
    {
        red_lut[i] = 255;
        green_lut[i] = 3;
        blue_lut[i] = j;
    }

    for( i=217, j=10; i<253; i++, j+=7 )
    {
        red_lut[i] = 255;
        green_lut[i] = j;
        blue_lut[i] = 255;
    }

    for( i=253; i<256; i++ )
    {
        red_lut[i] = 255;
        green_lut[i] = 255;
        blue_lut[i] = 255;
    }
}
```

```

/*-----
PROGRAM : HEATCONT.C

DATE : 14 December 1990

PROGRAMMER : K. W. Tobin

J. K. Jordan
Applied Technology Division
Oak Ridge National Laboratory

ROUTINES :

COUNT mContrastLinear( VCMENU *mnuptr )
COUNT mContrastEqual( VCMENU *mnuptr )
COUNT mSelectModLUT( VCMENU *mnuptr )
COUNT mSelectDefLUT( VCMENU *mnuptr )

-----*/

#include "heat.h"

/*-----*/
COUNT mContrastLinear( VCMENU *mnuptr )
{
    int input_lut[GREY];
    int i;
    int i_low,i_high,i_hold;
    int row,col;
    COUNT wtemp;

    wtemp=wxopen(6,18,12,58,"",ACTIVE|BORDER|BD2,0,0,5,32);
    if( wtemp == -1 )
        terror("Unable to open Window. Aborting");
    xatsay(1,6,"Define HIGH grey scale",vc.dflt);
    xatsay(2,6,"value with cursor . . .",vc.dflt);
    xatsay(4,6,"(Press ENTER to select.)",vc.dflt);

    row=255;
    col=255;
    dt_cursor(&i_high,&row,&col,2,2);

    xatsay(1,6,"Define LOW grey scale ",vc.dflt);

    row=255;
    col=255;
    dt_cursor(&i_low,&row,&col,2,2);

    wclose(wtemp);

    /*Check range on i_high and i_low and adjust */
    if( i_high < i_low )
    {
        i_hold=i_high;
        i_high=i_low;
        i_low=i_hold;
    }
    if( i_high == i_low ) i_high=i_high+1;

    /*Load input_lut array with scaled data */
    for( i=0; i<GREY; i++)
    {
        input_lut[i]=(GREY-1)*((float)(i-i_low)/((float)(i_high-i_low)));
        if( i>i_high ) input_lut[i]=GREY-1;
        if( i<i_low ) input_lut[i]=0;
    }

    IS_LOAD_ILUT( MODIFIED_LUT, input_lut );
}

```

```

IS_PERFORM_FEEDBACK( ActiveBuffer, MODIFIED_LUT, ActiveBuffer );

return(0);
}

/*-----*/
long pdf[GREY];
float cdf[GREY];

COUNT mContrastEqual( VCMENU *mnuptr )
{
    int input_lut[GREY];
    int i,j;
    float sum,den;

    /* Load pdf vector */
    IS_HISTOGRAM( ActiveBuffer, pdf );

    pdf[0]=0;
    sum=0.0;
    den=(float)ROW*(float)COL;

    /* Sum number of pdf pixels */
    /* (This also works) */
    /* den=0.0;
       for( i=0; i<GREY; i++)
           den+=(float)pdf[i];
    */

    /* Calculate cdf vectors */
    for( i=0; i<GREY; i++)
    {
        sum+=(float)pdf[i];
        cdf[i]=sum/den;
    }

    /* Calculate lut vector. */
    for( i=0; i<GREY; i++)
    {
        input_lut[i]=(GREY-1)*cdf[i];
    }

    IS_LOAD_ILUT( MODIFIED_LUT, input_lut );

    IS_PERFORM_FEEDBACK( ActiveBuffer, MODIFIED_LUT, ActiveBuffer );

    return(0);
}

/*-----*/
COUNT mSelectModLUT( VCMENU *mnuptr )
{
    ActiveILUT=MODIFIED_LUT;
    IS_SELECT_ILUT( ActiveILUT );
    update_status_box();
    return(0);
}

/*-----*/
COUNT mSelectDefLUT( VCMENU *mnuptr )
{
    ActiveILUT=DEFAULT_LUT;
    IS_SELECT_ILUT( ActiveILUT );
    update_status_box();
    return(0);
}

```


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