

# ***Data Visualization***

## ***EPICS Extensions IDL Tools***

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# ***Introduction***

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- **Written in IDL/ezcaIDL to view real-time / post scan data**
- **Packaged data browsers with complete mouse driven user interface**
- **IDL interactive graphics and analysis tools**
- **High quality interactive graphic Itools (IDL 6.X)**
- **Packaged tools support license free IDLVM 6.0**
- **Platforms: Unix , Win2000/XP, Linux**
- **Object methods for easy post scan data array extraction and manipulation**



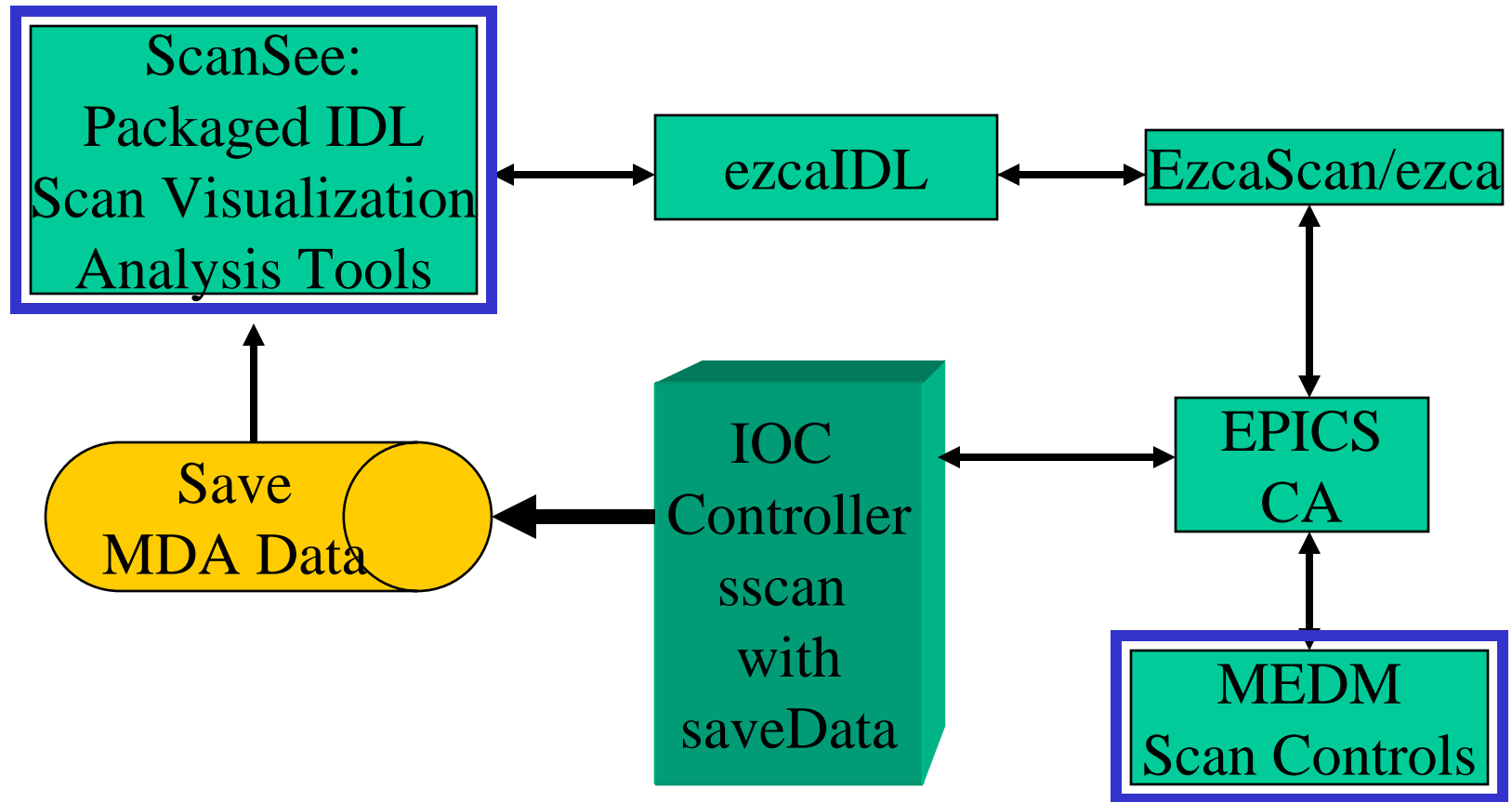
# Outline

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- **Overview**
- **System and setup requirement**
- **ScanSee program user interface**
- **Sharable visualization subprograms**
- **Scan object methods and examples**
- **EzcalDL setup and examples**



# Scan Visualization Architecture



# Overview

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- **Scan Visualization Tools**
  - *scanSee* – 85 detectors, 1D/2D/3D scan (read MDA)
  - *catcher* – 15 detectors, 1D/2D scan (save/read 1D/2D files)
- **HDF Visualization Tools**
  - *hdfb* – HDF4 1D/2D/3D browser
  - *h5b* – HDF5 1D/2D/3D browser
- **Common/sharable Visual/Analysis Tools** [http://www.aps.anl.gov/~cha/idl\\_html/list.html](http://www.aps.anl.gov/~cha/idl_html/list.html)
  - *plot1d*, *ez\_fit*, *overlay\_1d*
  - *plot2d\_image*, *plot2d*, *image2d*, *view3D\_2D*
  - *calibration\_factor*, *scan2d\_roi*, *multiroi\_pick*
  - *panimage*, *scan2d\_overlay*, *wd\_readascii*



# ***Input Forms***

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- **XDR catcher 1D/2D file**
- **MDA 1D/2D/3D scan data**
- **Nexus/HDF release 4 1D/2D/3D data**
- **Nexus/HDF release 5 1D/2D/3D data**
- **Arrays data**
- **Fix format ASCII data**



# ***Output Forms***

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- **1D/2D graphic output**
- **1D/2D ASCII report data**
- **Graphic output: TIFF / PNG / PICT / PS**
- **1D/2D ROI statistics reports**
- **Flexible 3D to 2D, 2D to 1D sliced output**



# System Requirement

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- **EPICS extensions built: ezca, EzcaScan, ezcalDL, idl**
  - *Scripts and executables installed under*  
*/usr/local/epics/extensions/bin/solaris-sparc for 3.14.X*
  - *IDL programs installed under*  
*/usr/local/epics/extensions/idllib for 3.14.X*
- **IDL 6.0 and IDLVM 6.0 installed**
- **IOC sscan record properly configured by medm**





# *Unix Setup Requirement*

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- Set EPICS\_EXTENSIONS  
setenv EPICS\_EXTENSION /usr/local/epics/extensions
- Access EPICS 3.14.X  
setenv EPICS\_HOST\_ARCH solaris-sparc  
set path=( /usr/local/epics/extensions/bin/solaris-sparc \$path)



# ***Packaged Unix Scripts for IDL Visualization Tools***

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- **scanSee** – MDA viewer with real-time scanning
- **sscan** – post scan viewer for MDA files
- **catcher** – real-time scanning with data saving
- **viewer** – post scan viewer for data catcher
- **hdfb** – data browser for HDF4/Nexus files
- **h5b** – data browser for HDF5/Nexus files
- **img** – Tiff/Jpeg/Png/Ascii/Xdr image processor
- **idlvm** – run IDLVM 6.0 with any IDL 6.0 saved programs



# IDLVM 6.0

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- **No license required for IDL 6.0 saved program**
- **Document:** <http://www.aps.anl.gov/~cha/idlvm60.html>
- **IDL 6.0 \*.sav files:**
  - *catcher.sav* – for catcher
  - *viewer.sav* – for viewer without CA
  - *sscan.sav* – for scanSee R3.4 and later
  - *SB2.sav* – for MDA reader without CA
  - *hdfb.sav* – for HDF version 4
  - *h5b.sav* – for HDF version 5
  - *Img.sav* – image processor
- **Unix script methods:**
  - idlvm <pname>***  
where <pname> can be any of the above name without ‘.sav’
- **Ittools & data calibration not available in IDLVM 6.0**



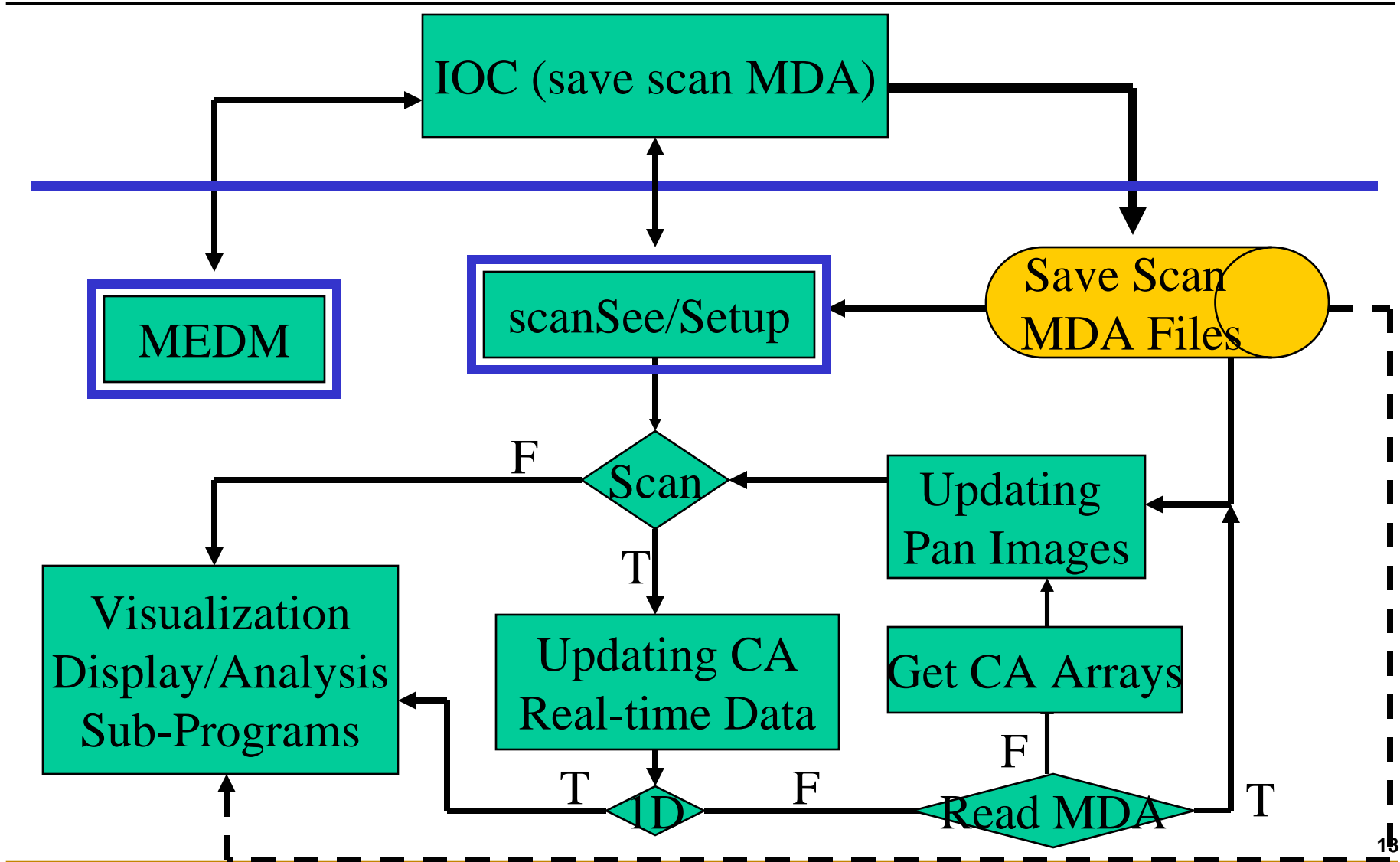
# Unix Access Methods

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- **IDLVM version** (recommend unless calibration is desired)  
*idlvm sscan* (scanSee.R3.4 and later)  
*idlvm catcher*
- **Runtime version**  
*scanSee*  
*catcher*
- **Developer Version** (ITTOOLS available)  
*scanSee -D*  
*catcher -D*



# scanSee Flow Diagram



# ***Files Used by scanSee***

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- **MDA scan files automatically saved by IOC**
- **Restart Configuration file: DC.config**
- **Saved output files:**
  - ASCII/\*.txt - 1D/2D data files
  - TIFF/\*.tiff - TIFF image files
  - PNG/\*.png - PNG image files
  - PICT/\*.pict - MAC image files
  - ROI/\*.roi, \*.rpt - various ROI files
  - idl.ps, plot2d.ps ... - saved various PS plot, report files



# ***Features Access Restriction***

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- **ITTOOLS**
  - Developer version only
  - License free ITTOOLS
    - *'readascii.sav'* (IDLVM 6.1)  
Idlvm readascii
- **1D/2D Calibration features**
  - Developer and Runtime versions



# ***Invocation Problem***

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- **Problem of startup scanSee**
  - *Due to MDA file not found in configuration file*
  - *Wrong type or bad file picked*
- **Resolve Invocation Problem**
  - *Method 1*
    - Use File->Open to pick a new file
  - *Method 2*
    - Remove the 'DC.config' before run **scanSee**



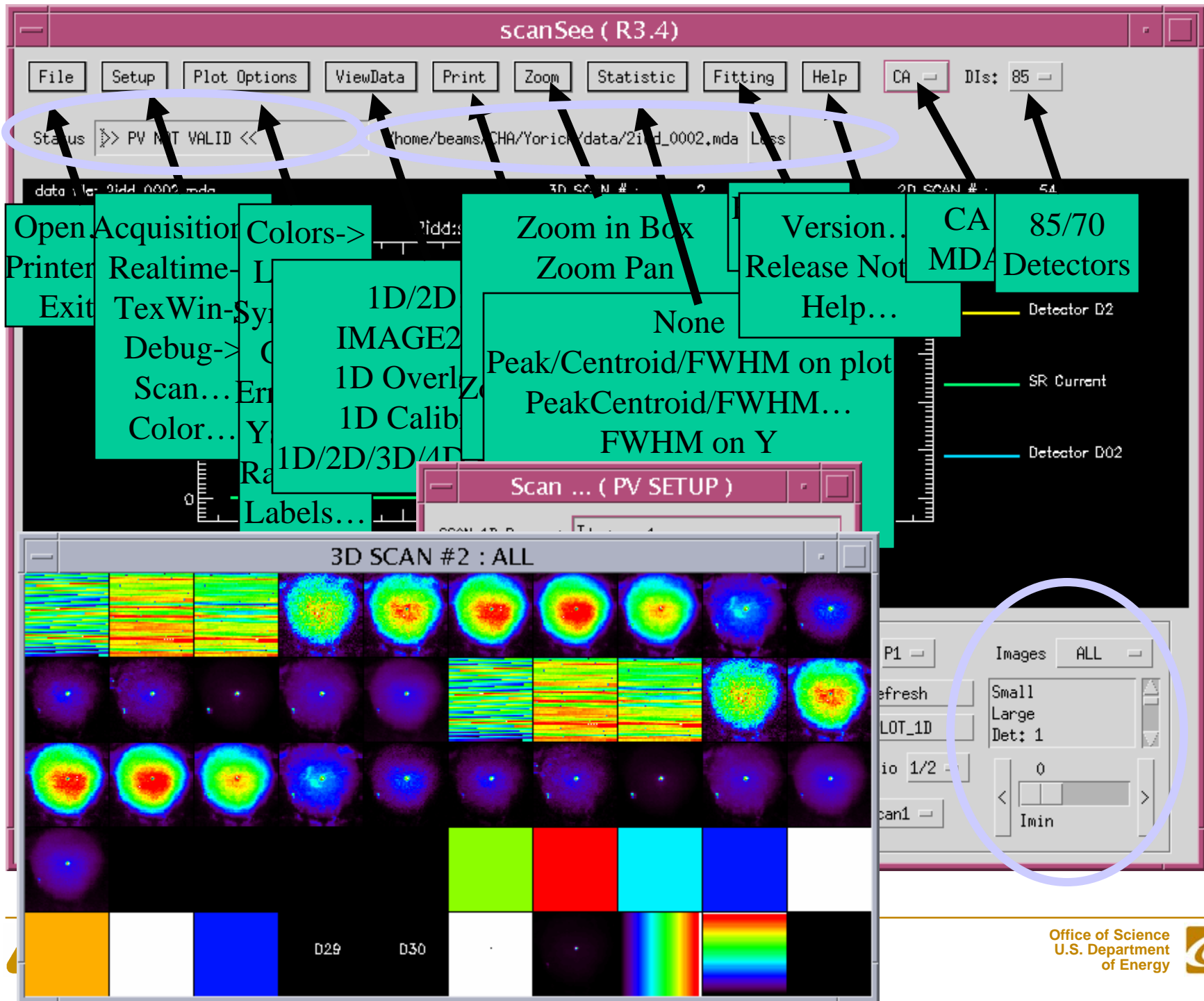


# General Widget Interfaces

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- **Click LMB** - selection of menu/button/cursor/slider/list
- **Text field** - text entry must be ended with CR
- **Button...** - a pop up window/subprogram associated with it
- **Multiple list selection**
  - *Ctrl+LMB* – add/delete item to selection list
  - *Shift+LMB* – select all items between current and last click
- **ROI Mouse buttons**
  - *LMB* – pick/drag ROI
  - *MMB* – resize ROI
  - *RMB* – accept ROI





# ScanSee Features

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- Use file DC.config for easy restart
- Flexible MDA file selection dialog
- User settable monitor of 1D/2D scan record
- Display near real-time 1D and 2D scanning data
- Flexible 1D display in detectors, line texture, plot ranges and labels, zoom, FWHM, easy fitting, etc
- Image data analysis, ROI statistics, calibrations
- Easy access 1D/2D/3D post scan data and pass to appropriate subprograms
- Easy ASCII/TIFF/PNG/PICT/ROI/PS output



**VIEW 1D ...**

File Seq #: 2    First    Next    Prev    Last    Done

Scan Data from : 2idd\_0002.mda

Print Plot    Modify Plot    ASCII View    ASCII Print

1D Data Column Format: E18,8

1D Scan # [ 1 - 54 ]: 54    ▶    →    ←    ◀    54

*ViewData->1D/2D...*

**Plot Labels ...**

Scan #: 54

Title : 2idd:scan1 @ y(54)=-834.30000

X Label: PM500\_X (micron)

**2idd\_0002.mda.tmp**

```

; SCAN Record Name: 2idd:scan1
;
; PLOT SPECIFICATIONS
;
; Title:      2idd:scan1 @ y(54)=-834.30000
; X Label:    PM500_X (micron)
; Y Label:
; Saved in:   /home/oxygen/CHA/Yorick/data/2idd_0002.mda
; Time Stamp: Apr 11, 2004 10:45:55.323498687
; Comment:
; Type:       Line
; Y Scale:    Linear
; Errbars:    Off
; Realtime:   itime=      1,  dtime=      0.200000
; Plot Vs Position Array #      1
;
; SCAN Data:
;
; I      2idd:m33.VAL S:SRcurrentAI 2idd:scaler1_cts1.C 2idd:scaler1_cts1.B 2id
; (Desc) PM500_X          SR Current
; (Units) micron          mA
; 0      -639.20000      101.90868      240776.00      404918.
; 1      -638.90000      101.90780      240825.00      405028.
; 2      -638.60000      101.89173      240848.00      405302.

```

ViewData->  
IMAGE2D..

The screenshot shows a software window titled `/home/beams/CHA/Yorick/data/2idd_0002.mda`. The menu bar includes `File`, `Color`, `Help`, `Log Off`, `View as TV`, `Pixel By User`, `Plot vs Values`, and `Done`. A green box highlights the `File` menu, with arrows pointing to `Save Image for AIM` and `Save as PNG`. A dialog box titled `Set New 2D Scan Ranges` is open, asking for confirmation to set new ranges. The dialog shows the following values:

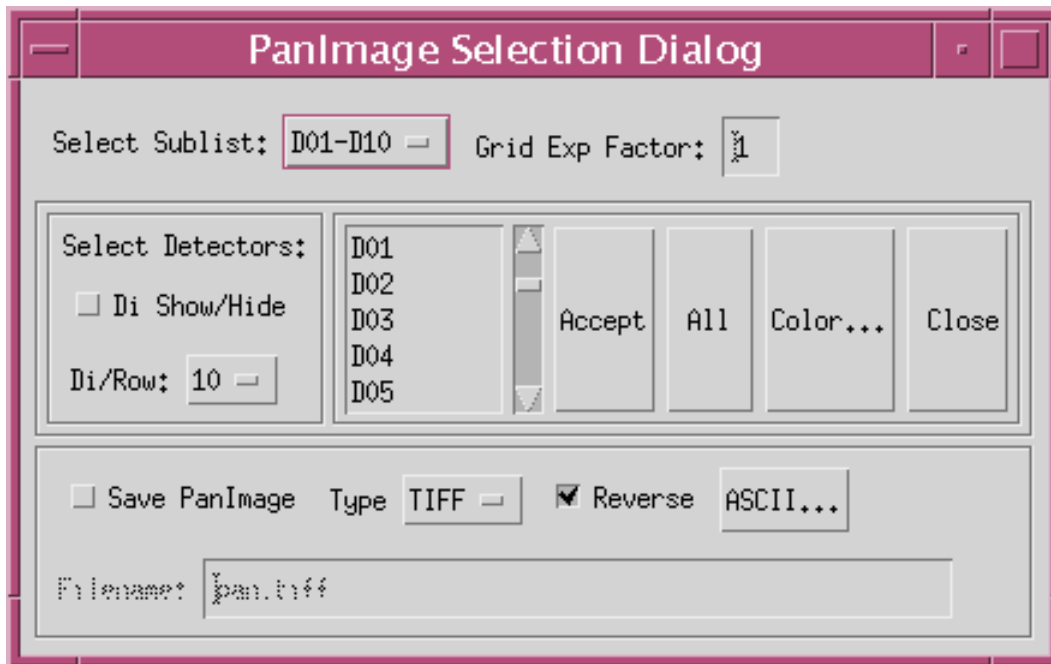
- Xmin: 2idd:scan1.P1SP=-639.20000
- Xmax: 2idd:scan1.P1EP=-623.30000
- Ymin: 2idd:scan2.P1SP=-850.20000
- Ymax: 2idd:scan2.P1EP=-834.30000

The dialog has `Yes` and `No` buttons. A blue circle highlights the `Yes` button. Below the dialog, a table of data is visible:

(xvalues)				
-639.20000				
-638.90000				
-638.60000				
-638.30000	3	57.000000	51.000000	55.000000
-638.00000	4	76.000000	65.000000	69.000000
-637.70000	5	66.000000	54.000000	81.000000
-637.40000	6	57.000000	61.000000	64.000000
-637.10000	7	71.000000	62.000000	101.00000
-636.80000	8	87.000000	91.000000	84.000000
-636.50000	9	73.000000	98.000000	89.000000
-636.20000	10	85.000000	85.000000	88.000000
-635.90000	11	88.000000	87.000000	102.00000
-635.60000	12	89.000000	111.00000	92.000000
-635.30000	13	82.000000	107.00000	136.00000
-635.00000	14	99.000000	89.000000	106.00000
-634.70000	15	51.000000	76.000000	98.000000
-634.40000	16	74.000000	93.000000	117.00000

A blue circle highlights the `Imin` label on the left side of the table. On the right side of the interface, there are input fields for `-623.30000` and `-834.30000`, and a `2D-ROI` button. A blue circle highlights these fields and the `2D-ROI` button. An arrow points from the `2D-ROI` button to the `Set New 2D Scan Ranges` dialog box.



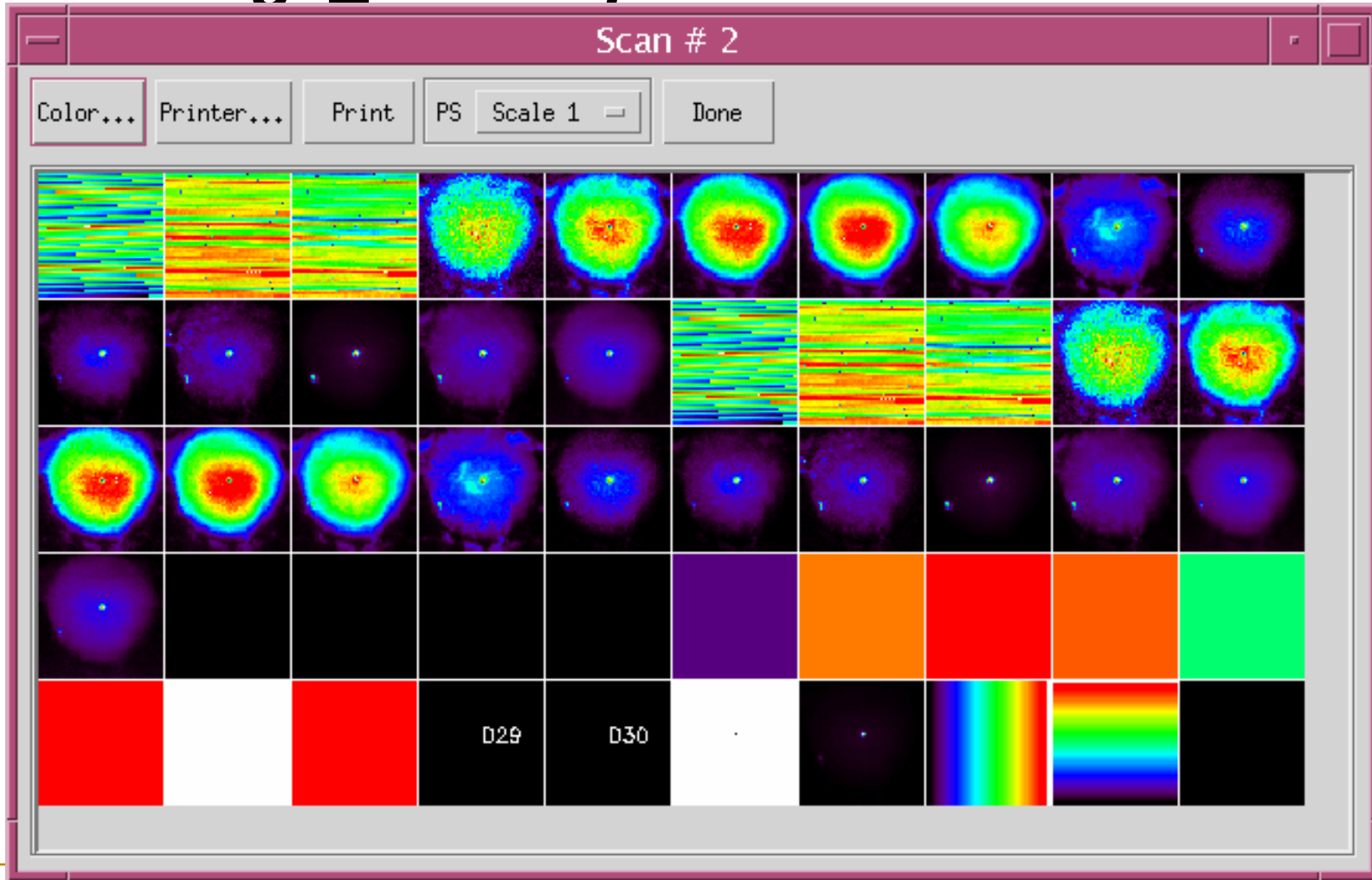


## *PanImage\_sel Features*

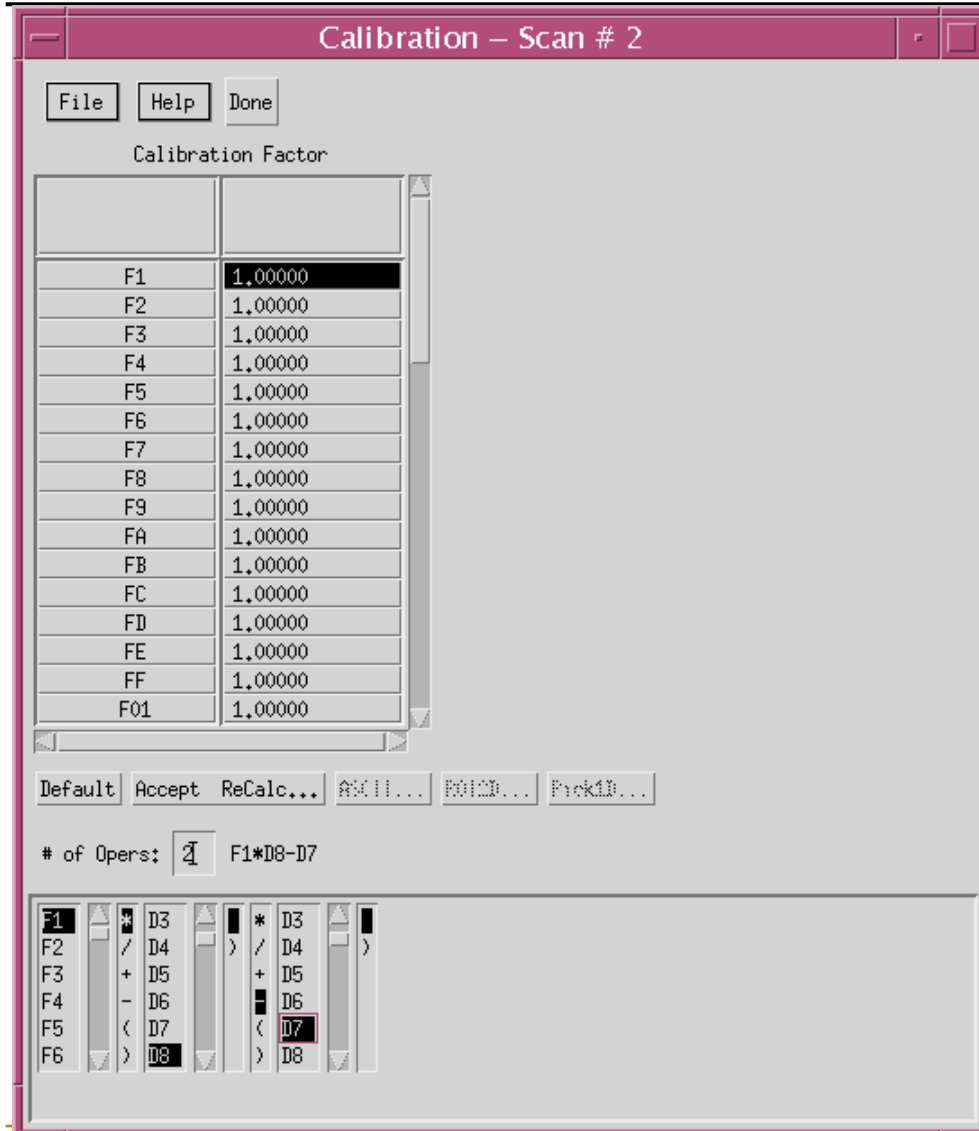
- **Panimage Select sub-list: D01-D10,D11-D20,...**
- **Multiple detectors selection list, default All**
- **Grid factor, default 1 (60x60)**
- **Show/Hide detector names**
- **Detectors per row, default 10**
- **Accept, All, Color table dialog**
- **Easy TIFF, PNG, PICT, ASCII panimage generation**



# PanImage\_sel Output



## 2D Calibration\_factor Features

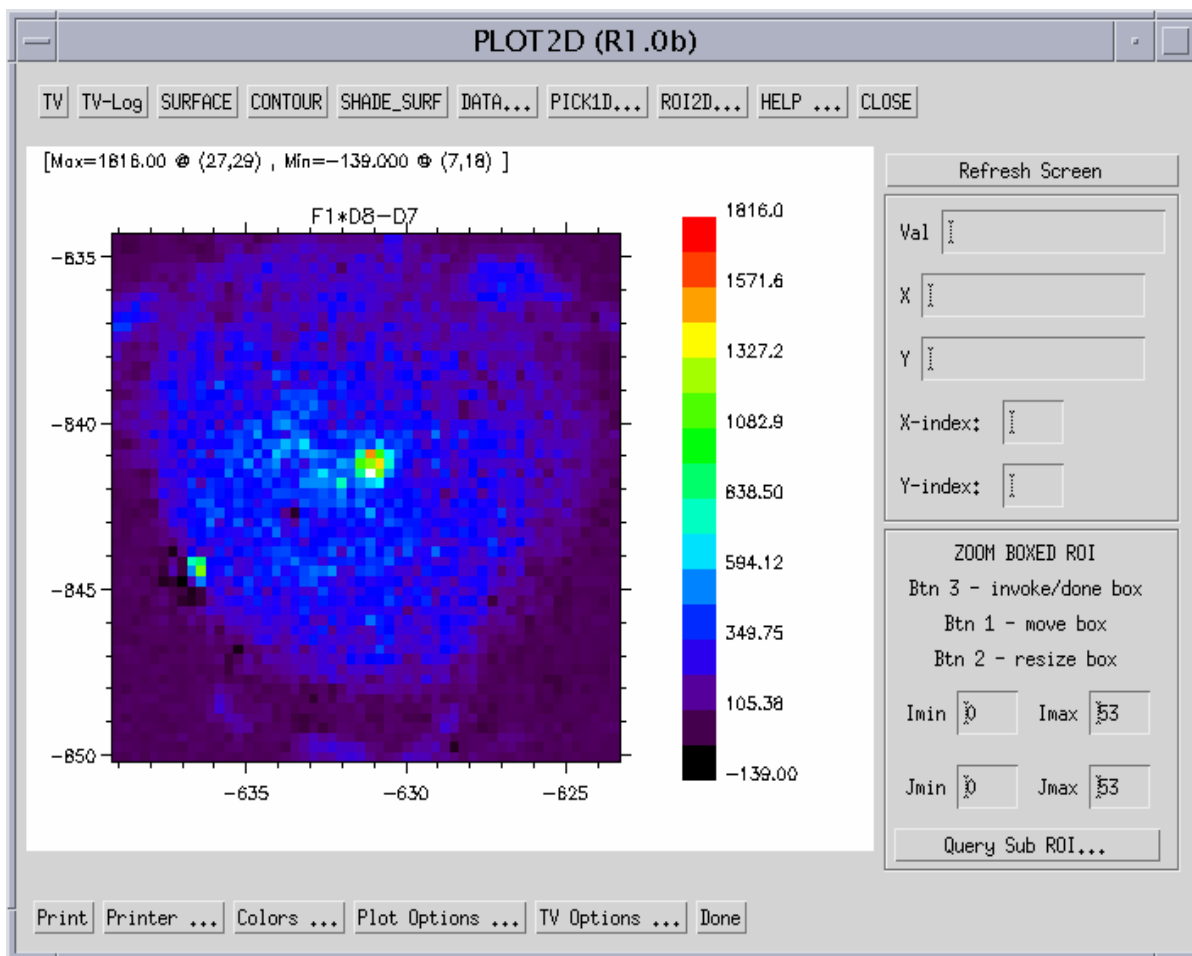


- Calibration\_factor table freely modifiable
- File menu allows save/load factor file
- User settable # of terms, math operations, detectors, resultant calibration function displayed
- Accept & ReCalc, ASCII, ROI2D, Pick1D sub-programs





# 2D Calibra Result



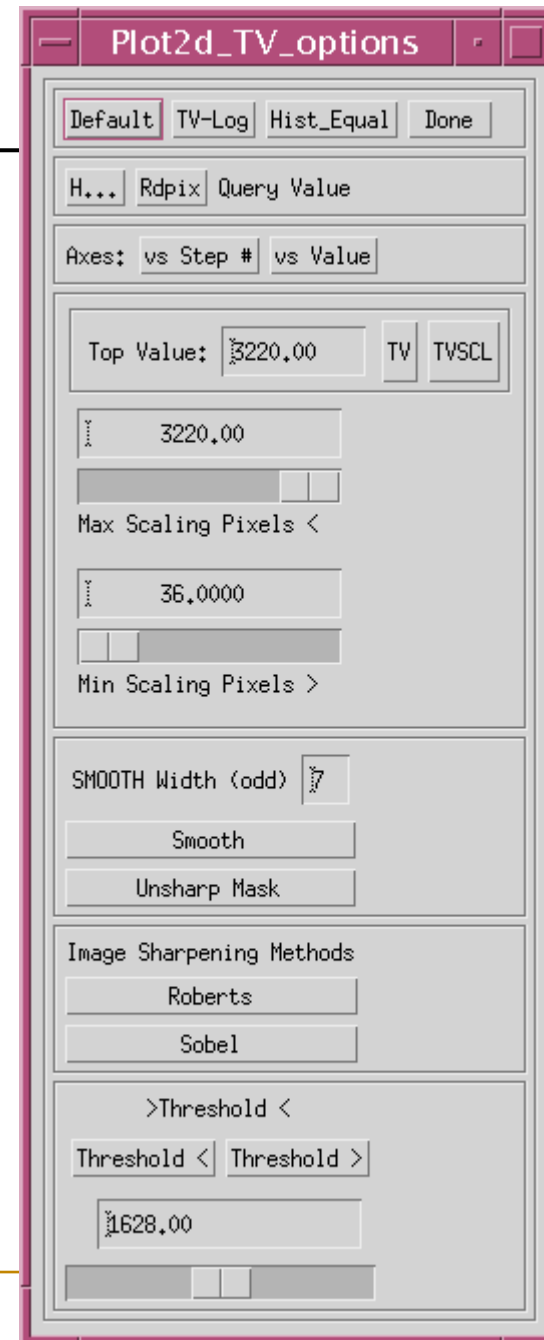
## Plot2d Features

- Support TV, Surface, Contour, Shade\_Surface
- Access of ROI, Pick1D, ASCII data sub-programs
- TV image mouse query and sub-region query
- Dialog for various plot area configurations
- Dialog for various TV manipulation features: sharp, smooth, hist\_equal,

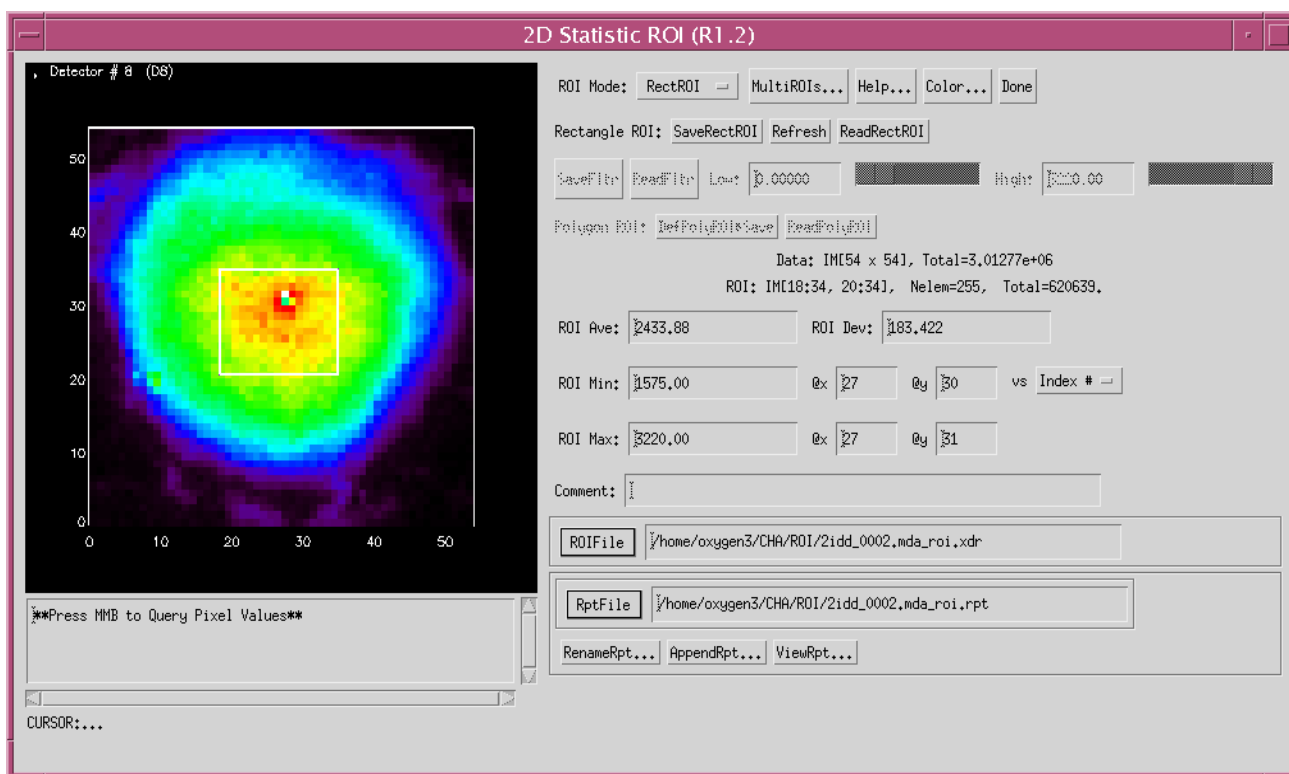


# Plot2d\_TV Options

- TV-log, TV, TVSCL
- Image query mode
- Hist\_Equal
- Max/min filter value
- Smooth/Unsharp Mask
- Roberts/Sobel Sharpping
- Threshold



# Scan2d\_roi



## ROI Features

- Rect/Filter/Polygon/Multi mode of ROI
- Various controls of different ROI mode
- Mouse query / modify ROI
- Display statistic summary results
- User Settable ROI define and report filename
- Dialogs save, display, manage ROI reports



# MultiROI\_pick subprogram

MULTIROI\_PICK R1.1

/home/beams/CHA/Yorick/data/2idd\_0002.mda

Offset Val: 0.00000 Charsize: 1.00000

Report generated at: Fri Jul 16 10:04:40 2004

REGION OF INTEREST : 2

MINIMUM: 1179.00 I=45 J=26

MAXIMUM: 2497.00 I=18 J=32

TOTAL: 539974.

AVERAGE: 2177.31

VARIANCE: 21228.7

DEVIATION: 145.701

OFFSET: 0.00000

N\_ELEMENTS: 248

N	I	J	IM(I,J)-Offset
0	25	16	1969.00
1	26	16	2050.00
2	22	17	2102.00
3	23	17	2024.00
4	24	17	2033.00

ROI # : 1  
2  
3  
4

Save As... Print Clear 0

ROIs TIFF : 2idd\_0002.mda\_roi.pick.tiff

Done



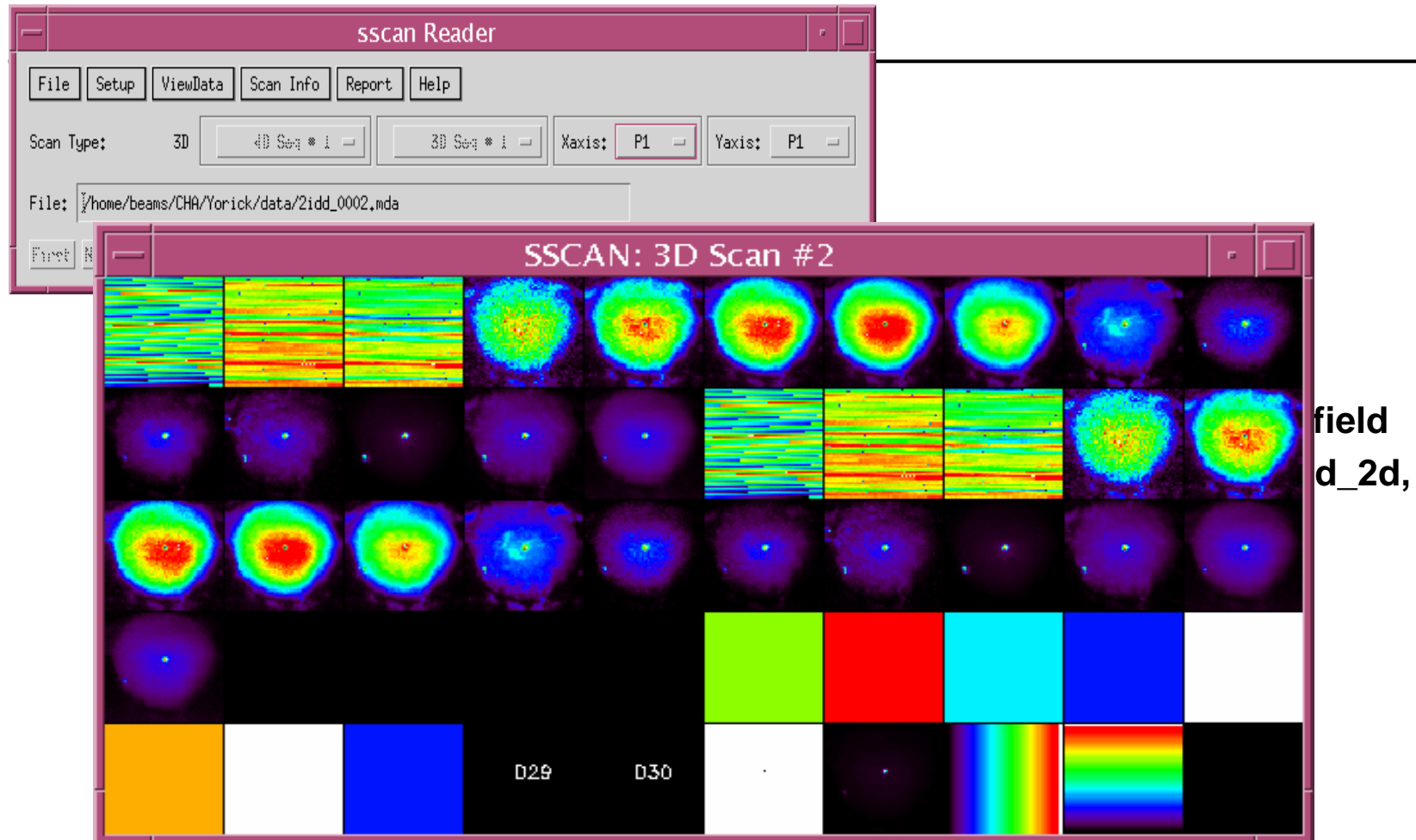
# ***Multi\_ROI Features***

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- **Flexible Add/delete/modify ROIs**
- **Free hand drawing of polygon ROIs**
- **Display one/all statistic of ROIs**
- **Save/load multi ROIs to/from a file**
- **Manipulate/generate multi ROIs statistic report**
- **Save ROIs as a TIFF/PNG/PICT file**
- **Image query**

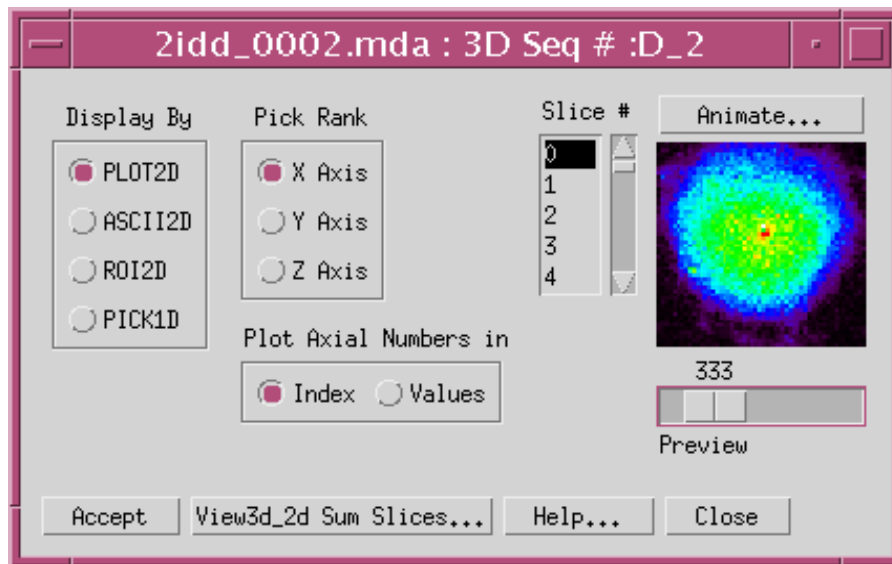


# ViewData->SSCAN (1D/2D/3D/4D)...



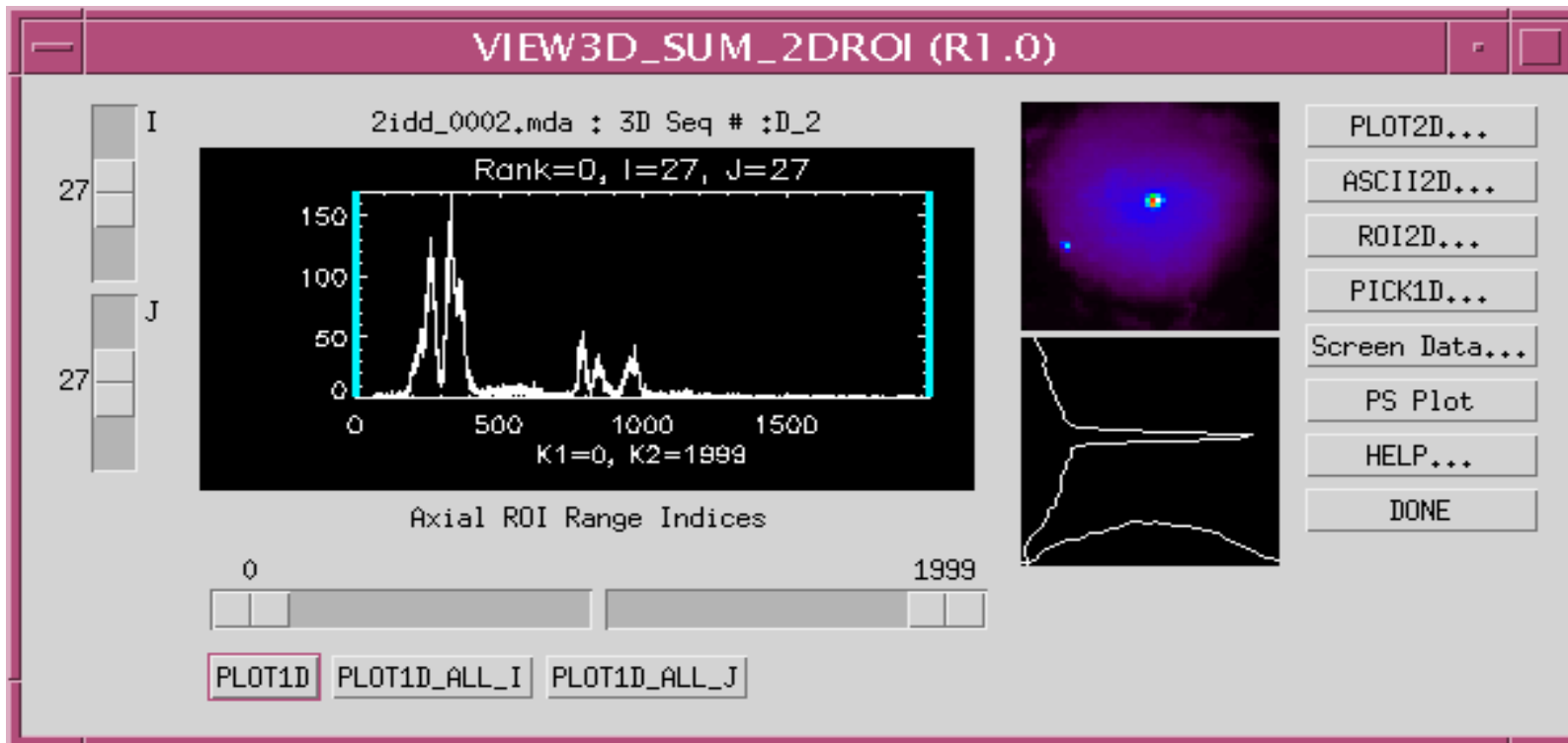
# View3d\_2d Slicer

# Features



- Plot2d/Ascii2d/ROI2d/Pick1d subprogram selection
- Flexible axial rank selection for 2D slicer
- Flexible 2D image animator or preview slider
- 2D image slice # selection
- View3d\_2d Sum ROI subprogram





### *View3d\_Sum\_2DROI Features*

- **Slider controls for I,J, axial range K1,K2**
- **Spectrum plot at I,J with K1,K2 marked as blue lines**
- **Option of PLOT1D, PLOT1D\_ALL\_I, PLOT1D\_ALL\_J spectrum**
- **Image of sum of 2D values bound by K1,K2**
- **Plot of cross image line values at I,J**
- **Option of Plot2d/Ascii2d/Roi2d/Pick1d/Data/PS plot**





CALIBRA\_PICK1D\_2idd\_0002.mda : 3D Seq # :D\_16X\_Slice.slc0\_19

Help... Format: {G12.8} Plot-Rows... Plot-Columns... Fitting... Close

	Col127	Col128	Col129
Row0	1111,00	1190,00	1344,00
Row1	1313,00	1412,00	2017,00
Row2	2233,00	2532,00	3151,00
Row3	3285,00	3909,00	4862,00
Row4	5700,00	5882,00	6585,00
Row5	7558,00	7450,00	7677,00
Row6	8674,00	8316,00	8738,00
Row7	9655,00	9533,00	9777,00
Row8	10631,0	10397,0	10619,0
Row9	11304,0	11473,0	11836,0

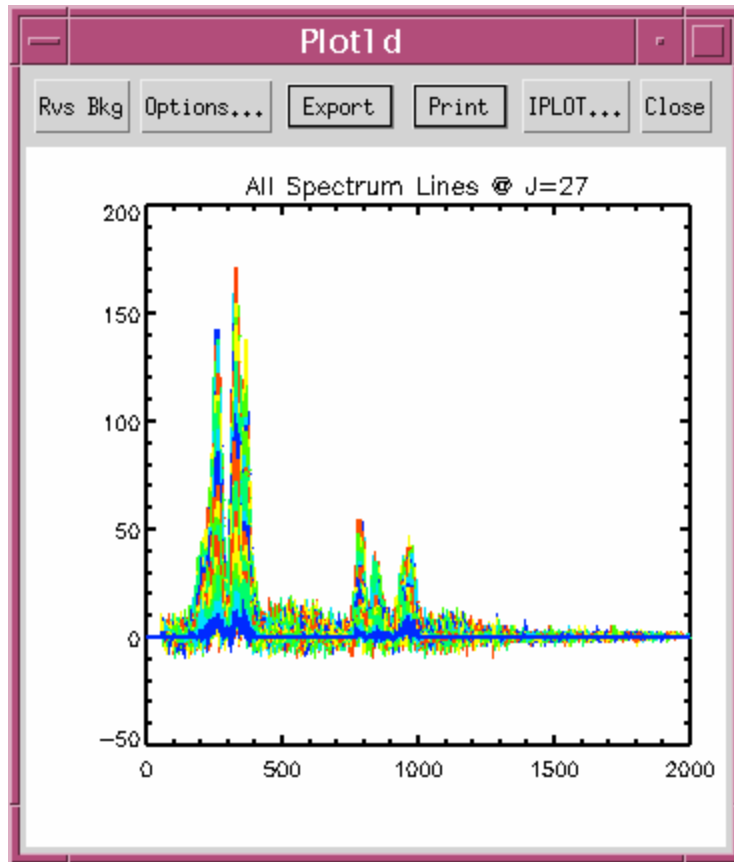
## Calibra\_pick1d Dialog

### *Pick1D Features*

- Table display of 2D image value with format control
- Column/Row selection pops up plot1d program
- Plot all columns/rows with plot1d subprogram
- Access ez\_fit subprogram with image array



# Plot All I-spectrum



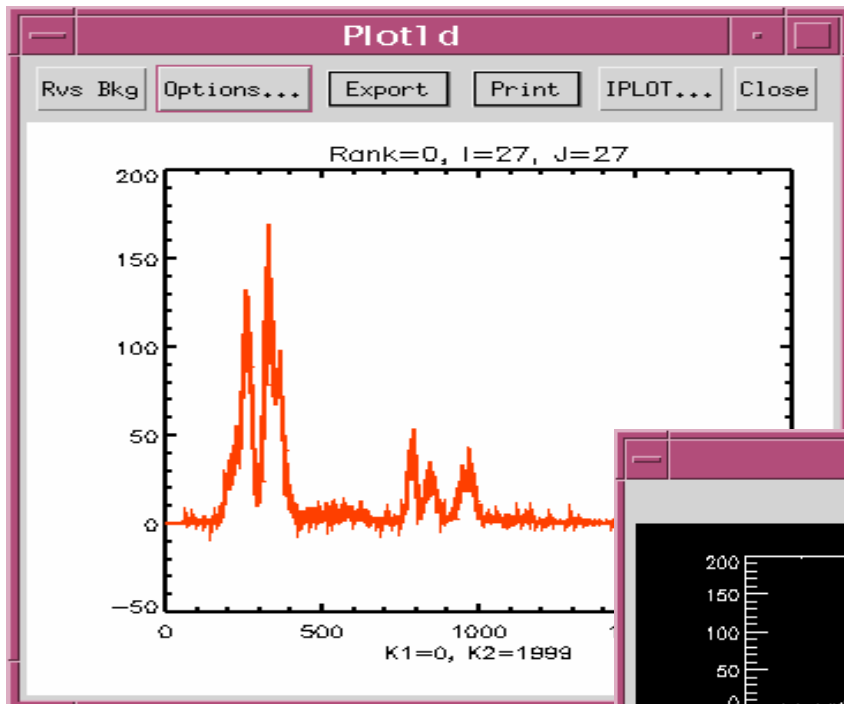
## Plot1d Features

- Plot region resize with window size
- Export ASCII, TIFF, PNG, PICT, PS file generation
- Access of IPLLOT of IDL 6.0 Itools (developer version)
- Multiple lines plot program support scattering data
- Options... Dialog for various line plot configurations, legend, statistic, fitting, FWHM,etc



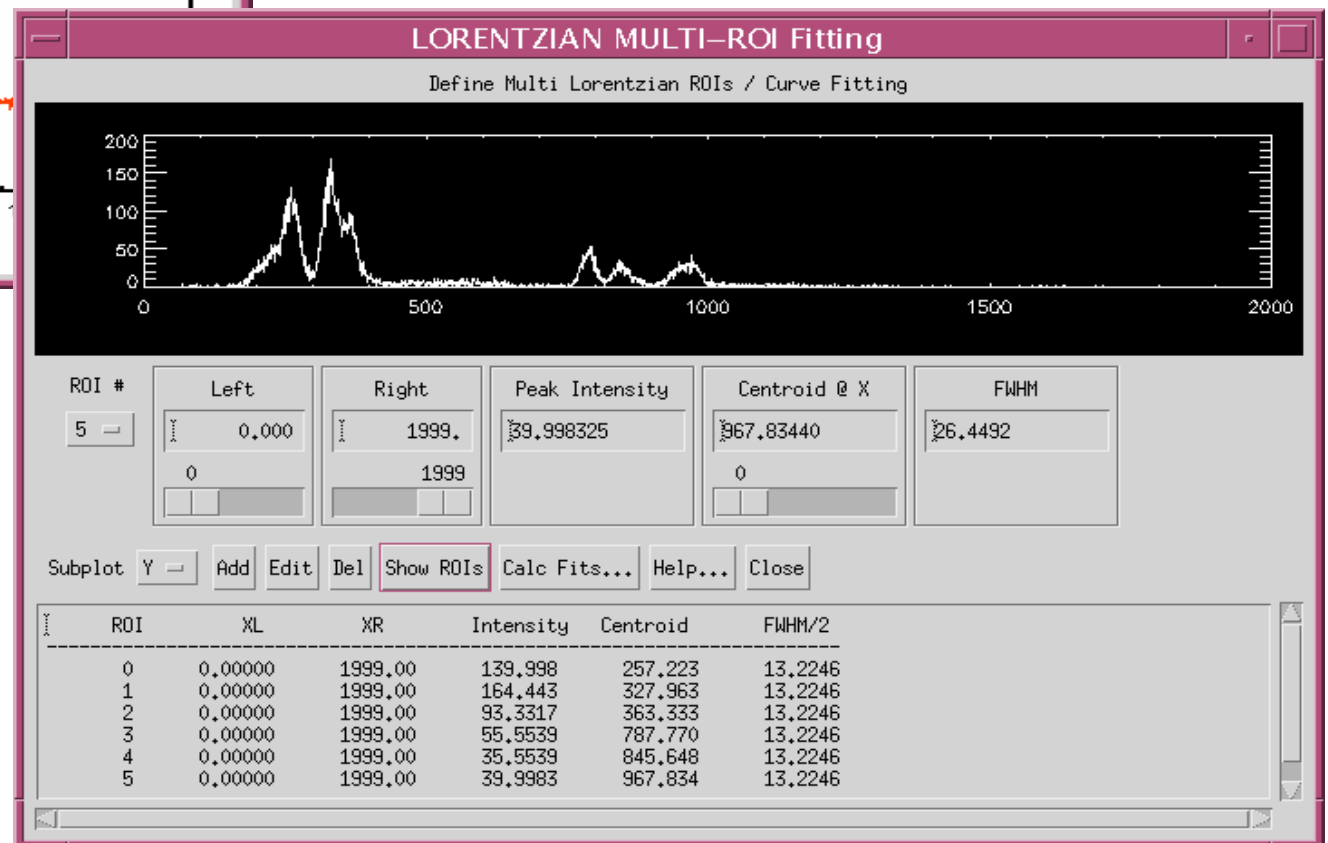
# EZ\_FIT Dialog

The image displays the EZ\_FIT (R1.6) software interface with several overlapping dialog boxes. The main window has a menu bar with 'File', 'GetData', 'Curve Fit', 'Multi Fit', 'Help', and 'Close'. Below the menu is a text field for '1D XLR File: fitting.bin'. Overlaid on this are three dialog boxes: 'EZ\_FIT 2D Image' (showing a heatmap), 'COMFIT' (partially visible), and 'POLY\_FIT' (showing a plot and fit parameters). The 'POLY\_FIT' dialog includes a plot titled 'Least-Square POLY\_FIT' with a y-axis from  $-5.0 \times 10^3$  to  $2.5 \times 10^4$  and an x-axis from 0 to 60. Below the plot, the fit equation is shown as  $Y = A0 + A1 * X^1 + A2 * X^2 + A3 * X^3 + A4 * X^4$  with the following parameters:  $A0=655.91234$ ,  $A1=1194.1731$ ,  $A2=-4.9051098$ ,  $A3=-0.70550848$ ,  $A4=0.0069784901$ , and  $SIGMA=782.50614$ . The 'GOODNESS OF FIT' is 745.39918. The user name is 'cha'.

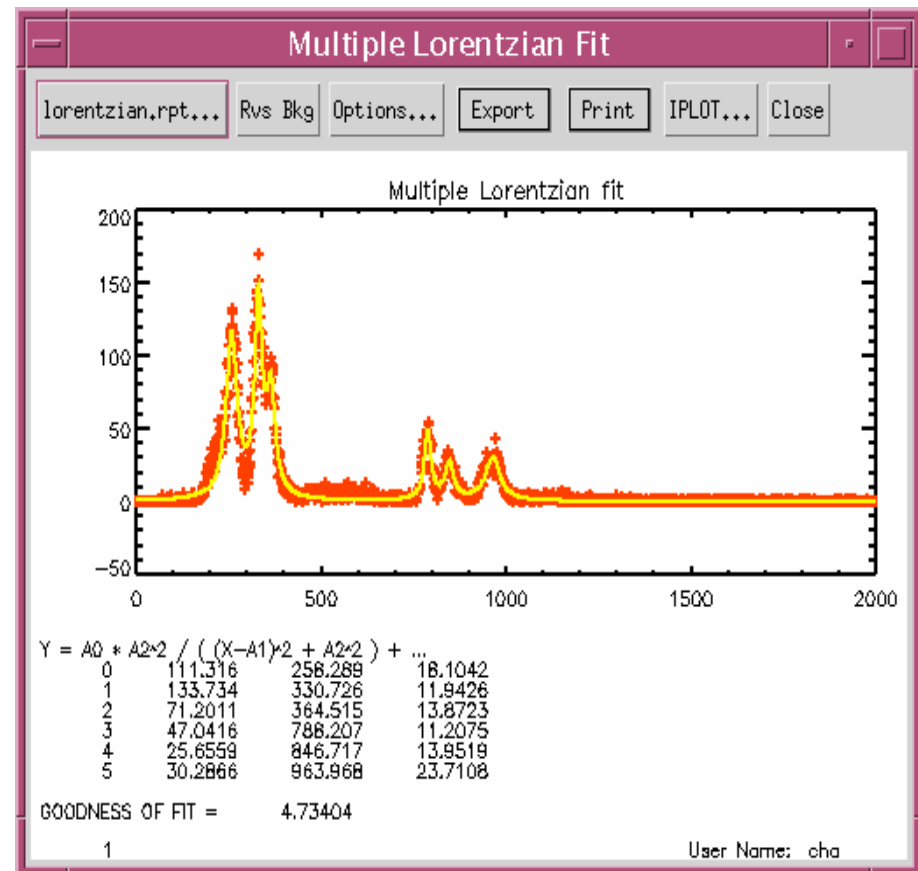
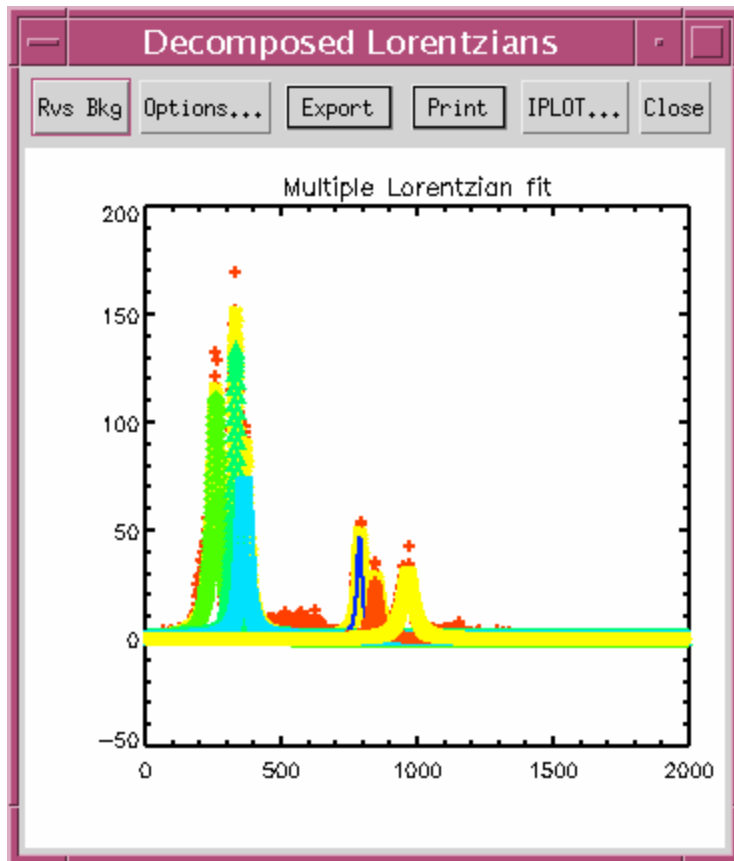


Options...->FITTING...  
Muti Fit->LORENTZIAN

- Click First Peak
- Click Add Btn
- Click Next Peak
- Click Show ROIs
- Click Calc Fits...



# Calc Fits...



# idlvm readascii

WD\_READASCII

File: /home/oxygen/CHA/ASCII/2idd\_0002.mda.im08 ASCII... 2D - Close

Y Axis Line #: 53 Data Start Li  
X Axis Column #: 0 Data Start Co

Accept Transpose PLOT1D... PLOT2D...

	0	
0	66.0000	73.00
1	75.0000	73.00
2	76.0000	72.00
3	57.0000	51.00
4	76.0000	65.00
5	66.0000	54.00

PLOT2D (R1.0b)

TV TV-Log SURFACE CONTOUR SHADE\_SURF DATA... PICK1D... ROI2D... HELP ... CLOSE ITOOLS

[Max=3220.00 @ (27,31) , Min=36.0000 @ (48,3) ]

Refresh Screen

Val:   
X:   
Y:   
X-index:   
Y-index:

ZOOM BOXED ROI  
Btn 3 - invoke/done box  
Btn 1 - move box  
Btn 2 - resize box  
Imin:  Imax:   
Jmin:  Jmax:   
Query Sub ROI...

Print Printer ... Colors ... Plot Options ... TV Options ... Done

# Use Sharable Programs

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- **IDL Developer License Required**
- **Common Visualization Tools Sharable by Any Other IDL Program**
  - *Plot1d, plot2d, image2d, view3d\_2d, panimage,...*
- **IDL Startup Setup**
  - setenv IDL\_STARTUP /usr/local/epics/extensions/idllib/viewer\_startup.pro

- **Example**

**idl**

```
IDL> loadct, 39
```

```
IDL> da = dist(100)
```

```
IDL> plot2d,da
```

```
IDL> plot1d,da
```



# Scan Object Files

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- **Scan Object files with methods:**
  - sscan\_\_define.pro (access MDA data)
  - scan2d\_\_define.pro (access catcher 2D image file)
  - scan1d\_\_define.pro (access catcher 1D file)
- **Object Access Setup :**  
setenv IDL\_STARTUP /usr/local/epics/extensions/idllib/viewer\_startup.pro





# *Sscan Object Examples*

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- **Referring**

[http://www.aps.anl.gov/~cha/idl\\_html/sscan\\_ObjectRef.html](http://www.aps.anl.gov/~cha/idl_html/sscan_ObjectRef.html)

- **Examples:**

idl

```
IDL> file='/home/beams/CHA/Yorick/data/2ixm_0020.mda'
```

```
IDL> V = obj_new('sscan',file=file)
```

```
IDL> V->image2d ; use object method
```

```
IDL> V->view3d_2d ; use object method
```

```
IDL> V->read,da1d=da1d,da2d=da2d,da3d=da3d,...
```

```
IDL> view3d_2d,da3d ; call sharable program
```

```
IDL> image2d,da2d ; call sharable program
```



# Catcher: Scan1d Object Examples

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- **Referring:**

[http://www.aps.anl.gov/~cha/idl\\_html/scan1d\\_ObjectRef.html](http://www.aps.anl.gov/~cha/idl_html/scan1d_ObjectRef.html)

- **Examples:**

idl

```
IDL> file='/home/beams/CHA/Yorick/data/junk2')
```

```
IDL> .run scan1d__define
```

```
IDL> V = obj_new('scan1d',file=file)
```

```
IDL> V->read,10,pa=pa,da=da,/plot; read scan #10 in pa and  
; da array also plot da
```

```
IDL> V->plot,10,iy='4,5' ; read scan # 10 and plot  
; detector 4 & 5 only
```

```
IDL> plot1d,da ; call sharable program
```



# Catcher: Scan2d Object Examples

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- Referring:

[http://www.aps.anl.gov/~cha/idl\\_html/scan2d\\_ObjectRef.html](http://www.aps.anl.gov/~cha/idl_html/scan2d_ObjectRef.html)

- Examples:

**idl**

```
IDL> file='/home/beams/CHA/Yorick/data/junk2.image')
```

```
IDL> V = obj_new('scan2d',file=file)
```

```
IDL> V->print ; summary of image file
```

```
IDL> v->panimage,2 ; access the 2nd scan
```

```
IDL> v->images,2,im,def ; extract all images in 2nd scan
```

```
IDL> image2d,im,id_def=def ; use image2d to view 2nd scan  
; images
```



# HDF4: NX Object Examples

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- **Referring:**

[http://www.aps.anl.gov/~cha/idl\\_html/NX\\_ObjectRef.html](http://www.aps.anl.gov/~cha/idl_html/NX_ObjectRef.html)

- **Examples:**

idl

```
IDL> file='/home/beams/CHA/Yorick/data/2xfm_0020.nexus')
```

```
IDL> .run NX__define
```

```
IDL> v = obj_new('NX',file=file)
```

```
IDL> v->print ; dialog show file info, find num SDS
```

```
IDL> for i=0,309 do begin v->sds,i,da,name=na & help,da,out=t & print,na,i,t & end  
; get all SDS data name and array info
```

```
IDL> retail
```

```
IDL> v->sds,131,da,name=na ; read the 131th set of SDS
```

```
IDL> view3d_2d,da ; pass 3D array to view3d_2d program
```

```
IDL> v->sds,96,da,name=na ; read the 96th set of SDS
```

```
IDL> plot2d,da ; pass 2D array to plot2d program
```

```
IDL> hdfb ; call hdfb program
```



# Access ezcaIDL functions

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- **Reference Documents:**

<http://www.aps.anl.gov/~cha/catcher/ezcaIDLRef.html>

- **Unix Setup Requirement:**

```
source /usr/local/epics/extensions/bin/solsris-sparc/ezcaidl_setup  
( LD_LIBRARY_PATH, EZCA_IDL_SHARE, IDL_STARTUP)
```

- **Examples:**

**Idl -32**

```
IDL> r = caGetArray('cha:scan1.D1DA',data,max=11)           ; get 11 data points  
  
IDL> plot1D,data                                           ; plot data array  
IDL> x = ['chademoai1', 'chademoai2']                     ; set x to two PVs  
IDL> r = caGetArray(x, y) & print,y                       ; get &print values  
IDL> newy = y+1. & r = caPutArray(x, newy)                 ; add & put values
```



# *Where to Get More Information*

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- <http://www.aps.anl.gov/aod/bcda/dataVis/index.php>

