

fbanal Users Manual

**Owen Saxton
Stanford Linear Accelerator Center
September 2002**

1. Introduction

The main function of the fbanal (feedback analysis) program is to minimize the effects of the beam polarization on the beam intensity and position. This is achieved by measuring the differences in intensity, x-position and y-position caused by the beam polarization, and using these to apply corrections to the hardware generating the polarization. In the case of the beam intensity, the current is read using one of several toroids along the beam line, and the computed correction is applied via a Pockels cell located in the path of the source laser light. For beam position, one of several BPMs is used to obtain the x- and y-positions, and the correction is applied to a piezo-electrically driven tilt mirror, also located in the source laser light path.

A second function of fbanal is to stabilize the phases of the raw BPM signals read out in the ESA data stream. The simplified method used to convert the raw data to beam position values requires that the phases be close to zero, but they tend to drift slowly with time. By measuring the actual phase, a correction voltage is derived that is applied to a phase adjustment module in the BPM readout electronics.

A third function is to calculate several quantities that are supplied upon request to other programs. In particular the daqctrl program uses these to raise alarms whenever certain error conditions, such as the absence of data from the ASSET stream, are encountered.

A fourth function is to make various diagnostic displays which help ensure the correct operation of the experiment. These displays include such things as counts and rates of the various possible event types, the polarization statistics, and the current state of the feedback values being applied to the beam source.

2. Running fbanal

Fbanal is an example of an ESA analysis program. As such, it requires several files to be present in the current working directory in order to function correctly, and must also have write access to this directory. These files, amongst other things, specify the hardware configuration, the source of the input data, the associated display program and parameters for it, and various startup options. In addition, fbanal requires its own special parameter file containing the many options used for its analysis. The display program associated with fbanal is fbdisp, and it is capable of generating many specialized displays as well as the standard ones. It also contains many menu items for changing the configuration parameters used by fbanal.

2.1. Files used by fbanal

2.1.1. Database file (anal-sdb.dat)

This is the primary file read by any analysis program, and contains the names of the “camac” configuration file(s), the logging types file, and the setup file. The first two items are standard and generally not changed by the user except under special circumstances. The setup file needs to be configured specially for fbanal. While the database file name defaults to anal-sdb.dat, a different one may be specified by invoking fbanal with the -s option.

2.1.2. Setup file

The setup file contains most of the standard configuration information. It includes the name of the companion display program (fbdisp), specifications for the input data streams (whether there are one or two, and where the data is to be obtained: from a file or from a network server distributing the real-time data), specifications for network messaging, as well as several other options. It is common for this file to be named anal-setup.dat, but it can have any name at all since this is specified in the database file. Different setup files might be used to specify different numbers of data streams, and different sources for the data.

The general contents of a setup file are described in ESA documentation. However there are a couple of items of special interest to fbanal. The first is the “netname” parameter that identifies the program to other entities on the network. For the production instance of fbanal it should be specified as follows:

```
netname=fbanal;
```

This allows other programs (e.g. daqctrl) to connect to fbanal. More importantly, it also indicates to fbanal that it is the production instance and causes it to become feedback master upon startup and take control of the source voltages, setting them to its previously saved values.

For other instances of fbanal, the netname parameter should be set to something other than “fbanal”, or omitted entirely. The outcome of having two instances of fbanal, both acting as feedback master, is somewhat unpredictable.

A second item, essential to running any instance of fbanal, is the gbufsize parameter that specifies the size (in

bytes) of a buffer (the general purpose buffer) used for sharing data between fbanal and fbdisp. The size of this buffer tends to increase with each new release of fbanal; currently about a megabyte is needed. This parameter is specified as follows:

```
gbufsize=1000000;
```

2.1.3. Parameter file (fbparm.dat)

The parameter file is particular to fbanal and is read during program initialization to do detailed configuration. If it is missing, the parameters are set to default values (mostly zero), and would have to be set manually using menu items. The file may also be read or written manually at any time using a menu item. Parameter files with arbitrary names may also be read and written, as a way to save different sets of parameter values. In the usual production mode of fbanal, the parameter file is written whenever new source feedback values are applied, and at program exit, thus ensuring that the program can be restarted without causing any change in the configuration.

The format of a parameter file is very simple. For each parameter being specified there is a line consisting of a keyword identifying the parameter, followed by either one of two values, depending on the parameter. The keyword and values are separated by spaces, and no punctuation is present. Blank lines are ignored. Comment lines are not allowed, since comments are not preserved when saving a parameter file. Some typical lines from a parameter file are the following:

```
ifbstate compute
ifbrleng 400
ifbgain 1
ifbsrc tor1b
tor1alim 4000 55000
tor1blim 4000 55000
tor1ag24c 0 0.000295
```

Parameter values are usually changed by using the Feedback menu, described in section 3.5. Sometimes it is useful to edit a parameter file directly; in this case the Feedback Parameters display (see section 4.1) can be used to determine the association between keywords and descriptions of parameters.

2.2. Files used by fbdisp

2.2.1. Display definition file (disp.dat)

The display definition file contains a line for each display generated by fbdisp and made available via the list created by the "Displays" button on the main window (see figure 2.1). The order of the displays in this file determines the order in the display list. In addition to the displays particular to fbdisp, there are a number of useful diagnostic displays that are available to all display programs. Each display is associated with a window in the window definitions file, and there may be several displays using the same window.

2.2.2. Window definition file (wind.dat)

The window definition file contains a line for each display window to be used, and causes each to be created (but not actually drawn) during program initialization. The definition of each window includes its dimensions, along with attributes such as whether it has a scroll bar and which buttons are available along the bottom. Only one instance of each window exists so that if a number of displays shares the same window, only one of them can be displayed at a time.

2.2.3. Help information file (help.dat)

The help information file is designed to provide help on as many topics as desired, and is specific to fbanal/fbdisp.

2.3. Starting and stopping fbanal

To run the production version of fbanal, you need to be logged on as esaexp on esasun3. The run directory is ~esaexp/fbanal/run/sunos/. Hence, after logging on, you do:

```
> cd fbanal/run/sunos
> fbanal
```

This runs fbanal in the standard mode of receiving data from both data streams (ASSET and ESA). To make other choices, use the -s option:

```
> fbanal -s ast-sdb.dat      reads the ASSET stream only
> fbanal -s esa-sdb.dat     reads the ESA stream only
```

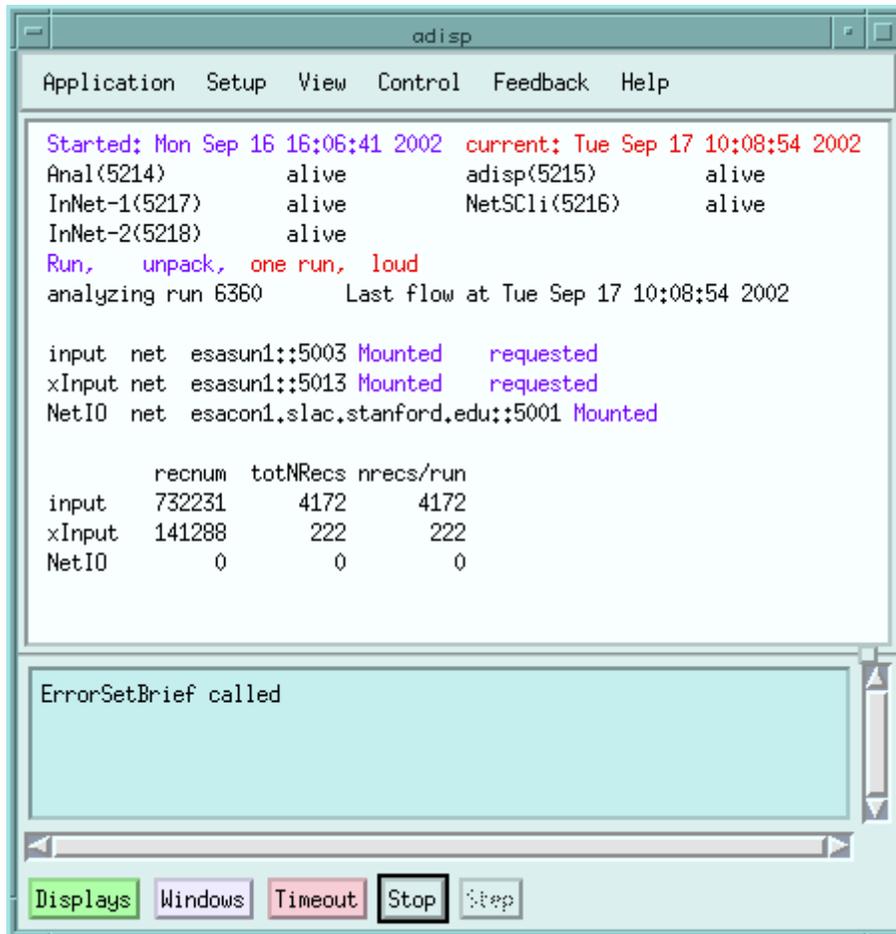


Figure 2.1 The main window of fbdisp

To use a different display program, e.g. a new version, use the `-gui` option:

```
> fbanal -gui fbdisp_new
```

After starting, fbanal sends about 40 lines of messages to the terminal, then the main window of fbdisp appears (see figure 2.1). Data should already be flowing (assuming that a run is in progress), and this is indicated by the counts at the bottom of the top pane being incremented. If data is not flowing, check that the second button from the right (at the bottom of the window) is labelled "Stop". If it is labelled "Run" instead, click on it to start the data flowing.

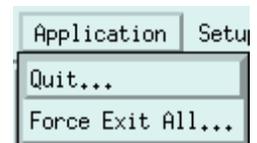
To stop fbanal, use the Application menu as described in section 3.1.

3. Menus

The menus used by fbdisp are shown (see figure 2.1) along the top of the main window. All are a standard part of any analysis/display program except for the Feedback menu.

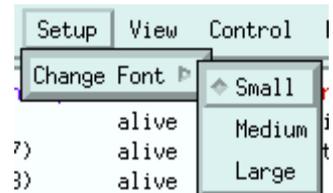
3.1. Application menu

The Application menu is used for exiting fbanal. Under normal circumstances, the “Quit” item suffices to terminate everything. It simply causes fbdisp to terminate, which in turn causes fbanal and its other sub-processes to terminate. The “Force Exit All” menu item explicitly causes all processes associated with fbanal to terminate, and is therefore somewhat more robust.



3.2. Setup menu

The Setup menu contains only the “Change Font” item, which allows the size of the font used in the scrolling message pane of the main window to be set to either small, medium or large.



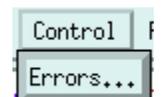
3.3. View menu

The View menu contains only the “Widget Tree” item, which produces a listing of the complete widget tree of the fbdisp program.

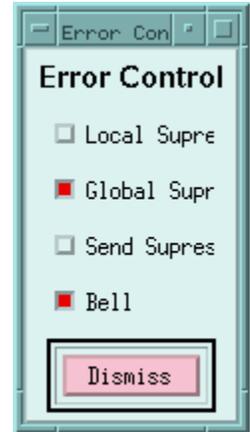


3.4. Control menu

The Control menu used by fbdisp contains only the “Errors” item, though for a general display program several other items would also be available.

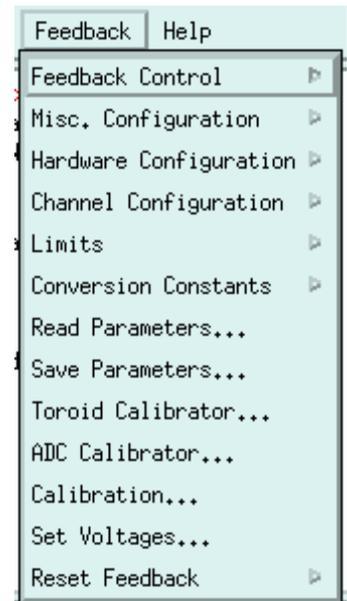


The Errors item brings up a dialog box that allows some options for error message display to be set. The “Local Supress” check box causes repeats of error messages of the same kind generated by fbdisp to be suppressed. “Global Supress” causes repeated messages generated by fbanal to be suppressed. “Send Supress” causes the sending of messages from fbanal for display in the message area of the fbdisp main window to be suppressed. “Bell” enables the sounding of the bell whenever an error message is displayed in the fbdisp message area.



3.5. Feedback menu

The Feedback menu contains the many items used to configure and control fbanal, grouped in large part into sub-menus. Most of the items operate by changing the value of a parameter in memory. There are also items to save and read these parameters to and from a disk file. Other items cause various actions such as setting source or calibrator voltages, or carrying out a calibration.



3.5.1. Feedback Control

The Feedback Control item produces a sub-menu used to select which feedback systems to control, intensity and position (and double), or stokes and phase.



Selecting the Intens/Posn item produces a dialog box containing several items, divided into three sections.

The Intensity and Position sections control the intensity and position feedbacks respectively, and contain four items each. "State" is a pop-up used to select the state of the feedback: off, compute or feedback. For the intensity feedback, a fourth option, calibrate, is available but should never be selected; it is used internally during calibration runs. "Run Length" sets the number of event pairs in a feedback mini-run. "Gain" sets the gain of the feedback loop. "Source" is a pop-up that selects which device's data is used for the feedback calculation.

The Double section controls the so-called double feedback which attempts to reduce the correction applied by the intensity feedback to zero. It accomplishes this by adjusting the voltages on the CP and PS pockels cells over a relatively long time scale. This section contains the "State" and "Gain" items just as in the other sections. "Run Leng Fctr" sets the number of intensity feedback mini-runs used in making a single double feedback correction.

The "Apply" button is used to actually store the values set in the items above.

Section	Item	Value
Intensity:	State	feedback
	Run Length	800
	Gain	1
	Source	tor1a
Double:	State	feedback
	Run Leng Fctr	30
	Gain	0.5
Position:	State	compute
	Run Length	10000
	Gain	0.25
	Source	bpm1

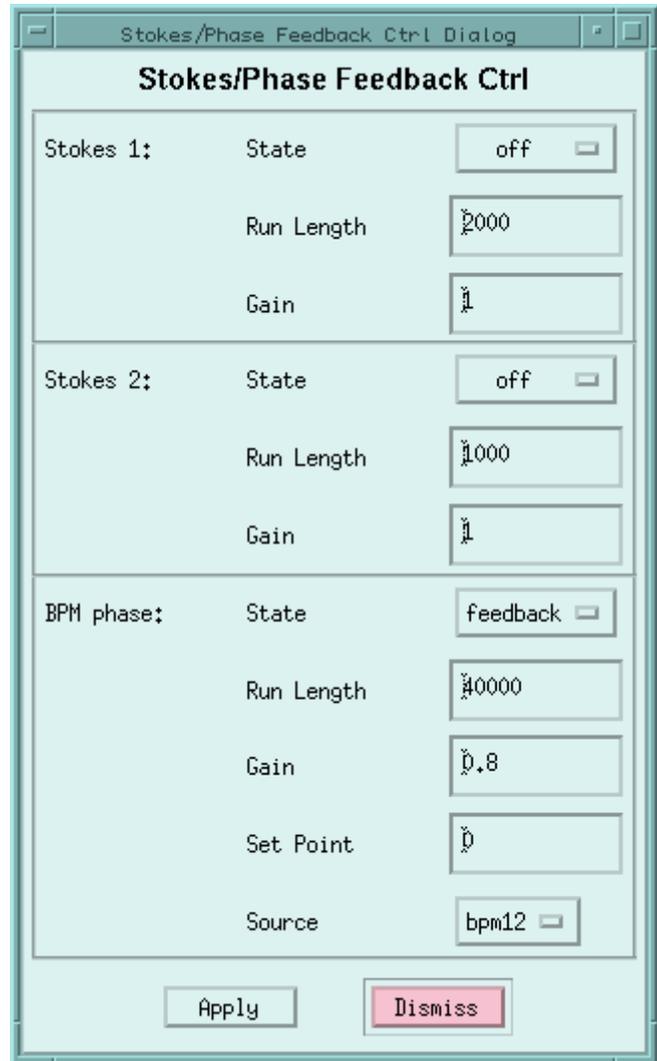
Buttons: Apply, Dismiss

Selecting the Stokes/Phase item produces another dialog box, also divided into three sections, which control the two stokes feedbacks (not currently used) operating on the CP and PS pockels cells, and the BPM phase feedback.

All sections contain the “State” pop-up which is used to set the state of the corresponding feedback: off, compute or feedback. “Run Length” is also present in all sections. For the BPM phase it is the number of events used to compute the phase correction; for the stokes feedbacks it is the number of event pairs in each feedback mini-run. “Gain” sets the loop gain for each feedback.

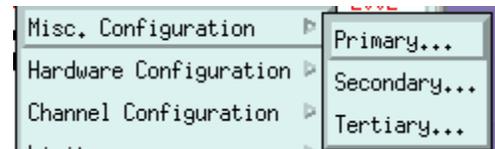
The BPM phase section also contains two other items. “Set Point” is the desired phase (usually zero), in degrees. “Source” is a pop-up which selects which BPM is to have its phase kept as close as possible to the set point.

The “Apply” button is used to actually store the values set in the items above.



3.5.2. Miscellaneous Configuration

The Miscellaneous Configuration item brings up a sub-menu containing three groupings of options labelled Primary, Secondary and Tertiary, based roughly on their overall importance. These options all act globally, rather than just for a particular feedback.



The Primary item brings up the Primary Configuration dialog box containing the most important global options.

The “Feedback master” pop-up determines the degree of control that fbanal has. For the production version, this is normally set to “full”, allowing the feedback states to be set to “feedback” and source voltages to be set manually. It also causes the source voltages to be set from the saved values, and all parameter values to be saved whenever new values are calculated via a feedback and when the program exits. The other values disallow any feedback state to be set to “feedback” and disable the automatic saving of parameter values. The “mini” value allows source voltages to be set manually.

The “Feedback active” check box allows all feedbacks to be temporarily disabled and re-enabled.

The “Ignore processing state” check box allows fbanal to ignore the run processing state sent by the daqcntrl program. Normally fbanal stops all feedback processing, including accumulating statistics, when a run is not in progress.

The “Individual data errors” check box allows fbanal to process an event’s data for any device for which it is error-free. The normal mode is to not process an event at all if any of its data has an error.

The “Perform difftrig cut” check box causes an event pair to be rejected if the trigger times for its component events differ from each other.

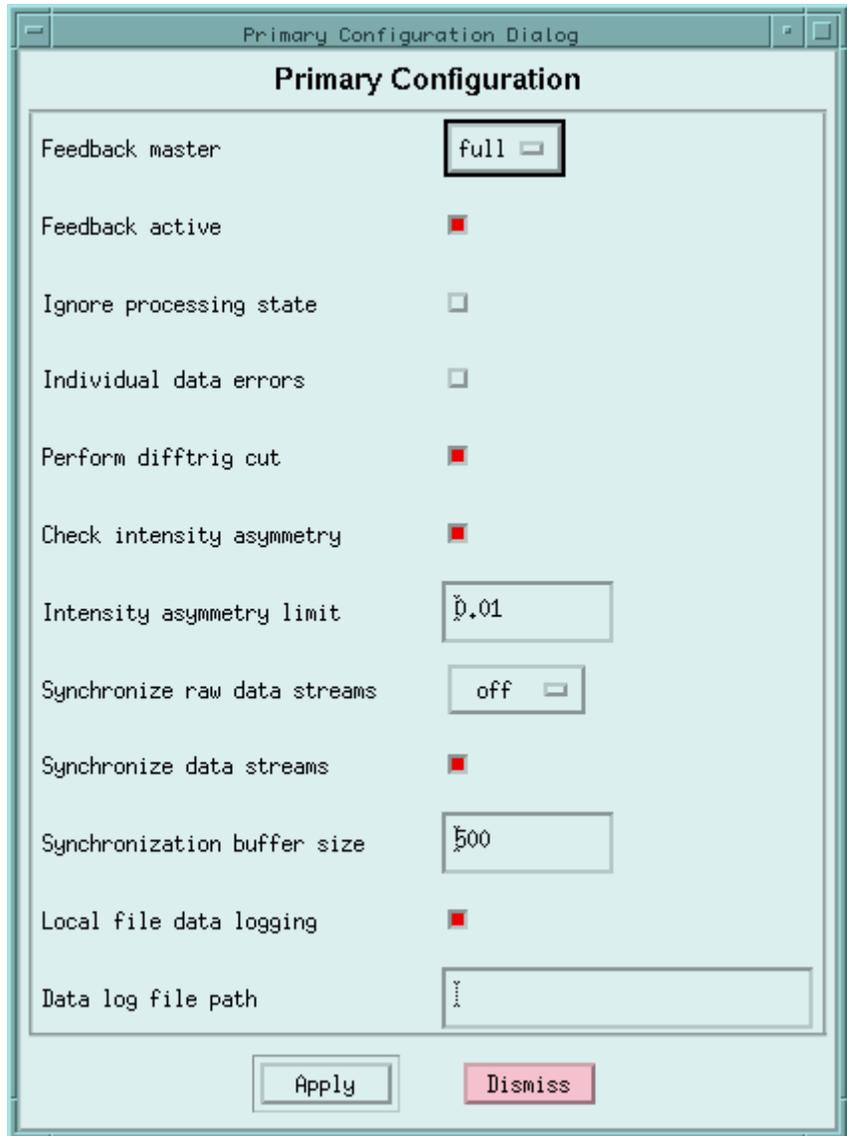
The “Check intensity asymmetry” check box causes an event pair to be rejected if its intensity asymmetry exceeds the limit set by the “Intensity asymmetry limit” item.

The “Synchronize raw data streams” pop-up allows fbanal to synchronize the two data streams on PMON beam crossing number before the data is seen by the main analysis code. This option is needed for processing data from files, but should not be used for real-time data. Two options (besides “off”) are available: “noloss” ensures that all the data is kept, so there can be events on one stream not matched on the other; “full” causes unmatched events to be discarded.

The “Synchronize data streams” check box allows fbanal to synchronize the two data streams on PMON beam crossing number, using the main analysis code. When enabled, unmatched events are not processed. Because the real-time ASSET data stream lags the ESA stream by a few tens of events, buffering is needed to store temporarily unmatched events. The size of this buffer (in event pairs) is set by the “Synchronization buffer size” item.

The “Local file data logging” check box enables the logging to a local file of the data generated at the end of each active feedback mini-run, in addition to the logging to the ASSET stream. This file is named fbrun-nnnnnnnn, where “nnnnnnnn” is the decimal representation of the internal time when the file was created. Normally the file is created in the current working directory; the “Data log file path” item allows an alternative directory to be selected.

The “Apply” button is used to actually store the values set in the items above.



The Secondary item of the Miscellaneous Configuration sub-menu brings up the Secondary Configuration dialog box, containing a second group of global options.

The “ASSET polarization source” pop-up selects which device, “pmon” or “ioreg”, is to be used for obtaining the beam polarization at ASSET. Normally, the PMON data is used.

The “ESA polarization source” pop-up selects which PMON, “vpmon” (VME) or “pmon” (CAMAC), is to be used for obtaining the polarization data in ESA. Normally the VME PMON data is used.

The “Use witness pulse for data” check box allows witness pulses to be used for beam data. Normally they are not.

The “Use witness pulse for poln” check box allows witness pulses to be used for polarization data. Normally they are not.

The “Use no-beam pulse for poln” check box allows no-beam pulses to be used for polarization data. Normally they are not.

The “Minimum no. pedestals required” item determines the number of pedestal (no-beam) events needed before the running pedestal value is considered valid, and the event data can be considered valid. The cannot exceed the maximum number of pedestals used.

The “Maximum no. pedestals used” item determines the maximum number of pedestal events to be used in calculating the running pedestal value. It cannot exceed 100.

The “Maxm. no. current values used” item determines the maximum number of events with valid beam current data to be used in calculating the running beam current values, one for each toroid. It cannot exceed 100.

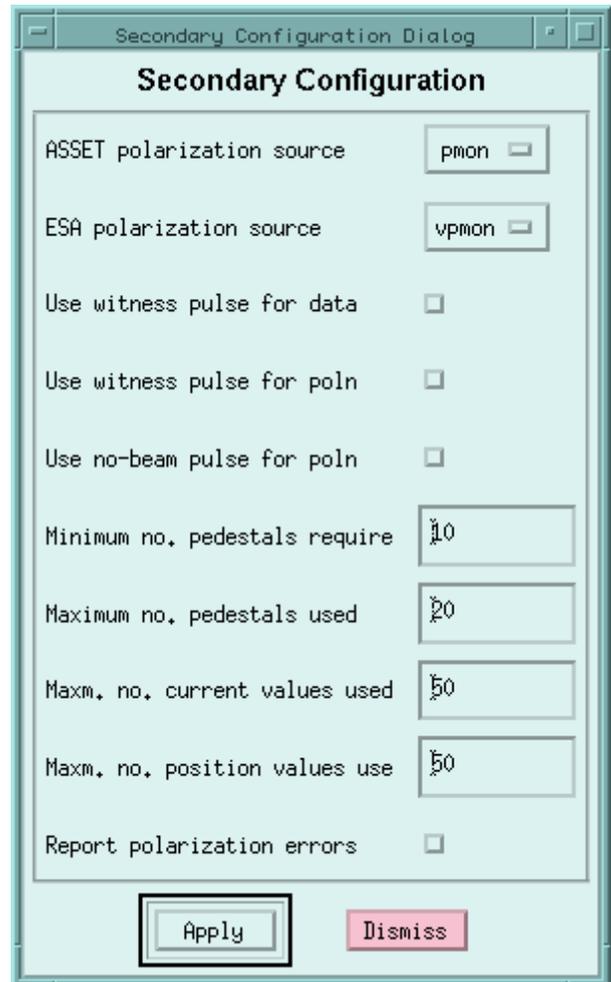
The “Maxm. no. position values used” item determines the maximum number of events with valid beam position data to be used in calculating the running beam position values, one set for each BPM. It cannot exceed 100.

The “Report polarization errors” check box, when enabled, causes errors in beam polarization to be reported to the terminal. The most common such error is the PMON beam crossing number being non-consecutive, due to missed events.

The “Apply” button is used to actually store the values set in the items above.

The Tertiary item of the Miscellaneous Configuration sub-menu brings up the Tertiary Configuration dialog box, containing a third set of global options.

“DAC setting tolerance” and “DAC setting noise” together specify how close a read voltage must be to the set value, during a calibration, in order to be considered as settled on that value. The tolerance is a multiplier of the DAC voltage, while the noise is a constant term.



“DAC setting timeout” sets the maximum time (in seconds) to wait for the read value of a DAC used in a calibration to approach the set value, within the tolerance described above.

“Toroid calibrator wait time” specifies the time to wait (in seconds), after setting a toroid calibrator value, before reading the induced toroid values during a calibration.

The “Voltage check enabled” check box causes the read source voltages to be compared with the set values at regular intervals, set by the “Voltage check interval” item.

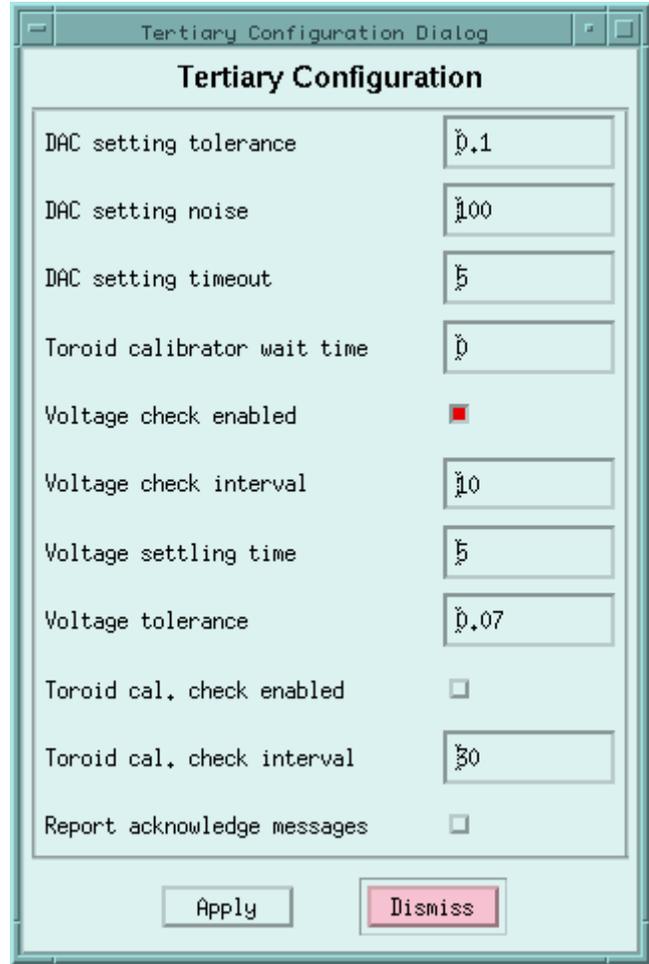
“Voltage settling time” specifies the time (in seconds) to wait after any source voltage is set, before any checking is done.

The “Voltage tolerance” item specifies the maximum deviation allowed of the read value of a normalized source voltage from its set value, before an attempt is made to reset it. Such a normalized voltage ranges from -10 to 10 volts, and is the actual voltage output from the DAC before any amplification to reach the value seen by the source device.

The “Toroid cal. check enabled” check box causes the toroid calibrators to be read at regular intervals and compared with their set values. The read interval is set by the “Toroid cal. check interval” item.

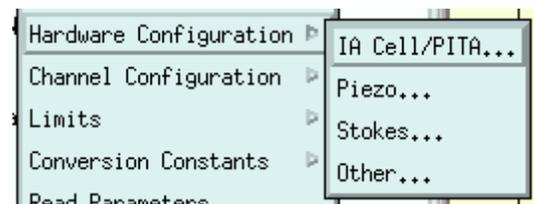
The “Report acknowledge messages” check box enables the display of a message on the terminal whenever an acknowledgement of a network message is received.

The “Apply” button is used to actually store the values set in the items above.



3.5.3. Hardware Configuration

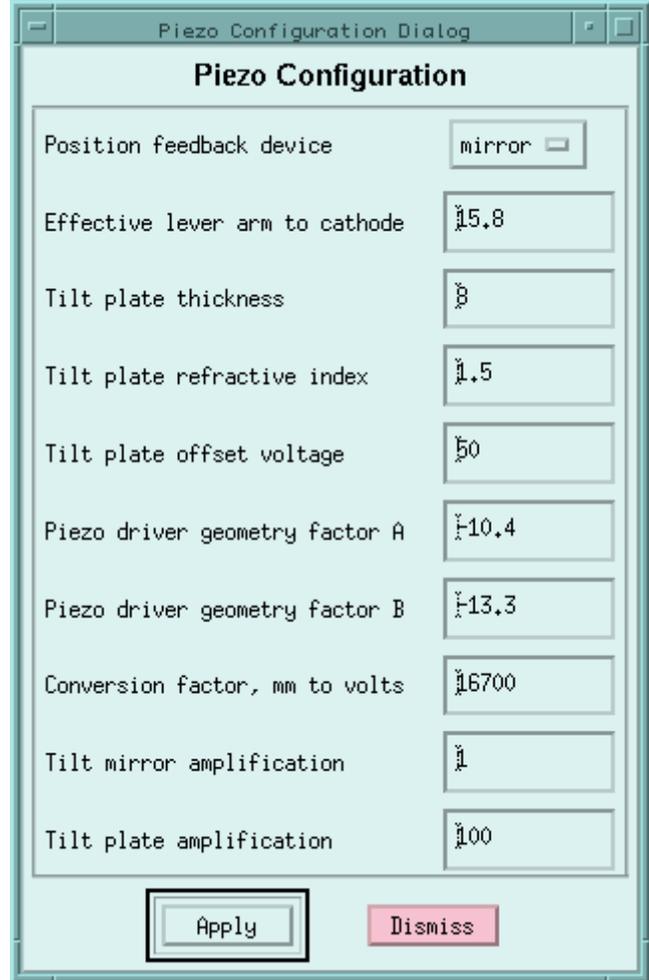
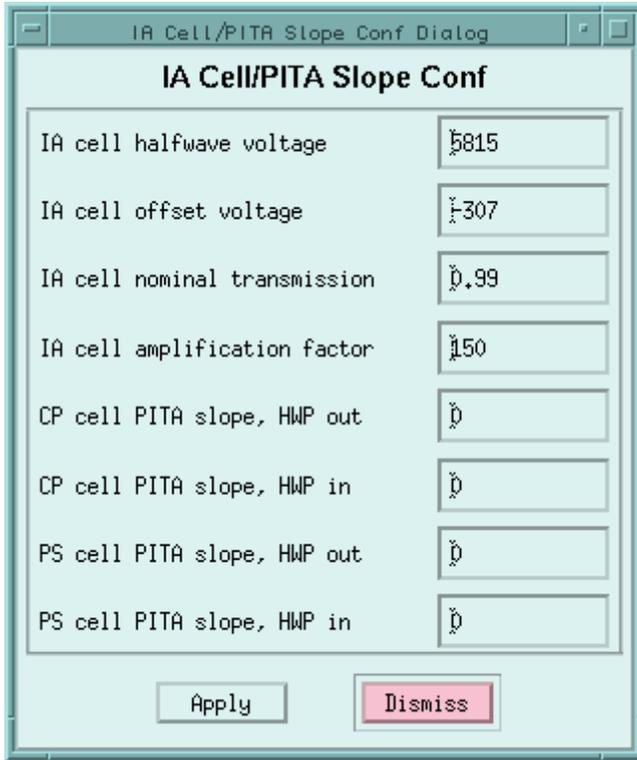
The Hardware Configuration item is used to set parameters describing the installed hardware implementing the feedbacks. As such, the values are expected to be changed rarely, if at all, and then only by experts. This item displays a sub-menu to select the section of hardware to be configured.



The IA Cell/PITA sub-menu item produces the IA Cell/PITA Slope Configuration dialog box, used to configure the IA cell device which compensates for beam intensity asymmetries induced by the beam polarization.

“IA cell halfwave voltage”, “IA cell offset voltage” and “IA cell nominal transmission” are all parameters used in calculating the feedback to be applied to the IA cell.

“IA cell amplification factor” is the gain of the amplifier that converts the DAC voltage (in the range -10 to



10) to the actual voltage used by the IA cell.

“CP cell PITA slope, HWP out” and “PS cell PITA slope, HWP out” are parameters used in calculating the double feedback to be applied to the CP and PS cells when the wall half-wave plate is out.

“CP cell PITA slope, HWP in” and “PS cell PITA slope, HWP in” are the values of these parameters to be used when the wall half-wave plate is in.

The “Apply” button is used to actually store the values set in the items above.

The Piezo sub-menu item produces the Piezo Configuration dialog box which configures the tilt mirror and tilt plate devices, driven by piezo-electric crystals. These are used to compensate for position asymmetries induced by the beam polarization.

“Position feedback device” is a pop-up to select which device, tilt mirror or tilt plate, is being used for the feedback.

“Effective lever arm to cathode” is used only by the tilt mirror.

“Tilt plate thickness”, “Tilt plate refractive index “ and Tilt plate offset voltage” are used only by the tilt plate.

“Piezo driver geometry factor A”, “Piezo driver geometry factor B” and “Conversion factor, mm to volts” are used by both piezo devices.

“Tilt mirror amplification” is the gain of the amplifier used to convert a DAC voltage to the actual voltage

used by the tilt mirror.

“Tilt plate amplification” is the gain of the amplifier used to convert a DAC voltage to the actual voltage used by the tilt plate.

The “Apply” button is used to actually store the values set in the items above.

The Stokes sub-menu item brings up the Stokes Configuration dialog box which sets parameters describing the CP and PS pockels cells. These are used to produce the main polarization of the electron beam and are manipulated by the stokes 1 and stokes 2 feedbacks respectively.

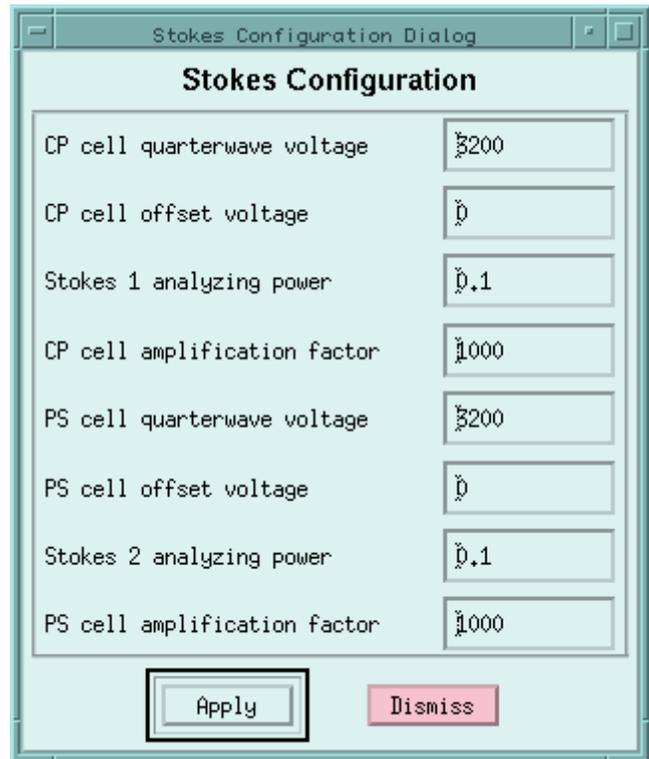
“CP cell quarterwave voltage”, “CP cell offset voltage” and “Stokes 1 analyzing power” are used for the stokes 1 feedback.

“CP cell amplification factor” is the gain of the amplifier used to convert a DAC voltage to the actual voltage used by the CP cell.

“PS cell quarterwave voltage”, “PS cell offset voltage” and “Stokes 2 analyzing power” are used for the stokes 2 feedback.

“PS cell amplification factor” is the gain of the amplifier used to convert a DAC voltage to the actual voltage used by the PS cell.

The “Apply” button is used to actually store the values set in the items above.



The Other sub-menu item brings up the Other HW Configuration dialog box which sets parameters describing various other hardware in the system.

“Phase voltage constant term”, “Phase voltage linear coeff” and “Phase voltage quadratic coeff” are the coefficients used to convert a BPM phase correction (in radians) to the DAC voltage that drives the phase adjustment hardware.

“CID VSAM to DAC voltage slope” and “CID VSAM to DAC voltage offset” are the coefficients used to convert a CID VSAM value to its corresponding DAC voltage.

“ESA VSAM to DAC voltage slope” and “ESA VSAM to DAC voltage offset” are the coefficients used to convert an ESA VSAM value to its corresponding DAC voltage.

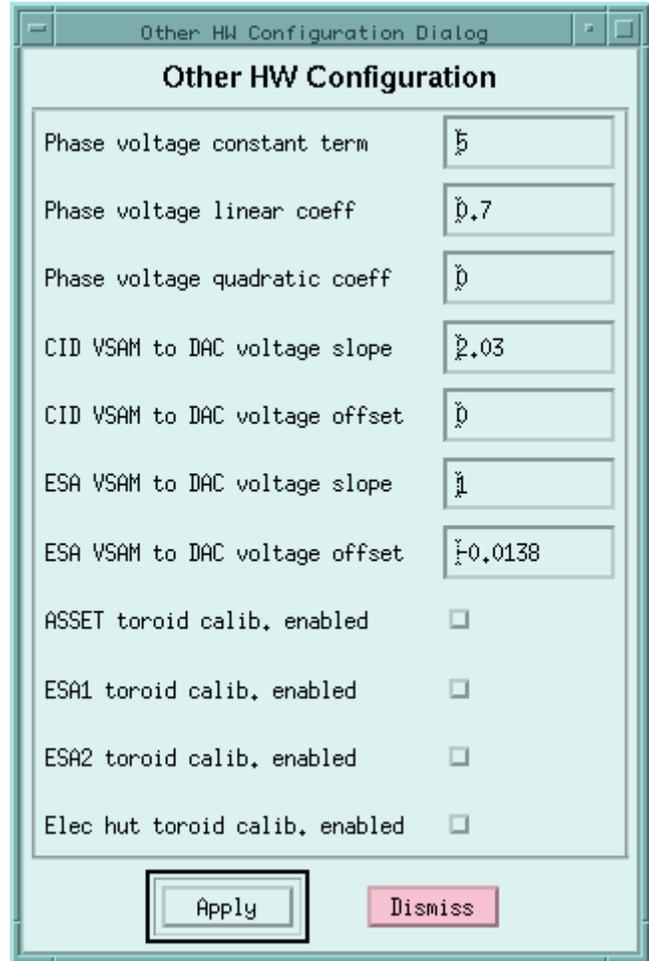
The “ASSET toroid calib. enabled” check box is used to indicate whether the toroid calibrator is present in the ASSET VME crate.

The “ESA1 toroid calib. enabled” check box is used to indicate whether the first toroid calibrator is present in the ESA VME crate.

The “ESA2 toroid calib. enabled” check box is used to indicate whether the second toroid calibrator is present in the ESA VME crate.

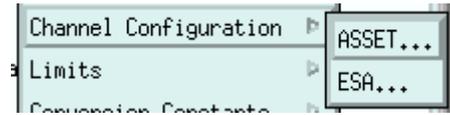
The “Elec hut toroid calib. enabled” check box is used to indicate whether the toroid calibrator is present in the electronics hut VME crate.

The “Apply” button is used to actually store the values set in the items above.



3.5.4. Channel Configuration

The Channel Configuration menu item is used to specify the ADC channels used by each of the devices that measure beam-related quantities. As for hardware configuration, these parameters are expected to be changed only rarely. It brings up a sub-menu to select either the devices at ASSET or those in ESA. Within either of these groups, the channel numbers start at 0 for the first ADC, 7 for the second one, etc. Channels numbered $7n+6$ are not assigned to any device since they contain overall data for the corresponding ADC.



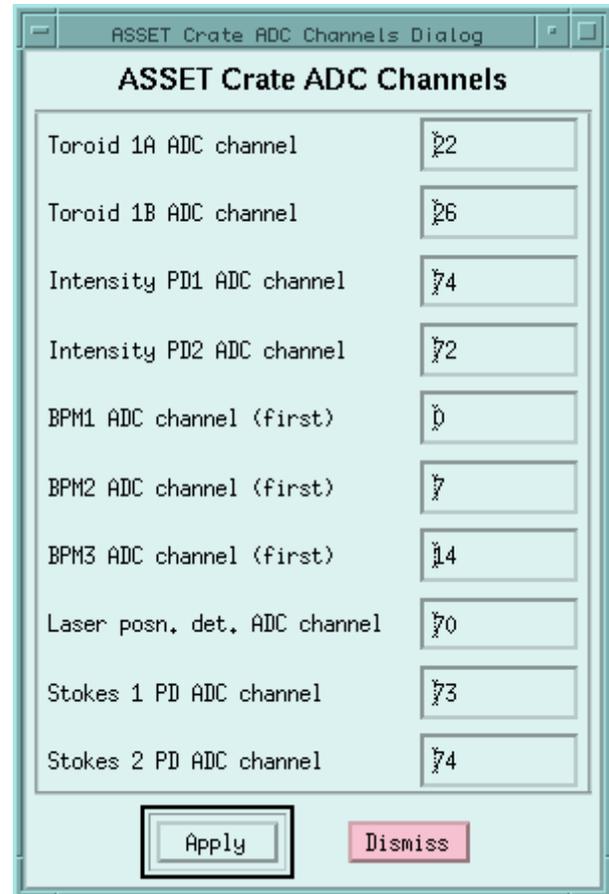
The ASSET sub-menu item produces the ASSET Crate ADC Channels dialog box, listing all the devices attached to the ASSET VME crate.

The toroids (1A and 1B) take one channel each, as do the Intensity and Stokes photo-diodes.

The BPMs (1, 2 and 3) take 6 channels each, and they are assigned in the order real X, imag X, real Y, imag Y, real Q and imag Q.

The laser position detector takes 3 ADC channels.

The "Apply" button is used to actually store the values set in the items above.



The ESA sub-menu item brings up the ESA Crate ADC Channels dialog box listing all the devices attached to the ESA VME crate.

The toroids (2A, 2B, 3A and 3B) take one ADC channel each.

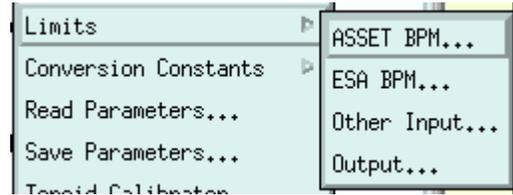
The BPMs (12, 24, 28, 31, 32, 41 and 42) take 6 channels each, and they are assigned in the order real X, imag X, real Y, imag Y, real Q and imag Q.

The “Apply” button is used to actually store the values set in the items above.



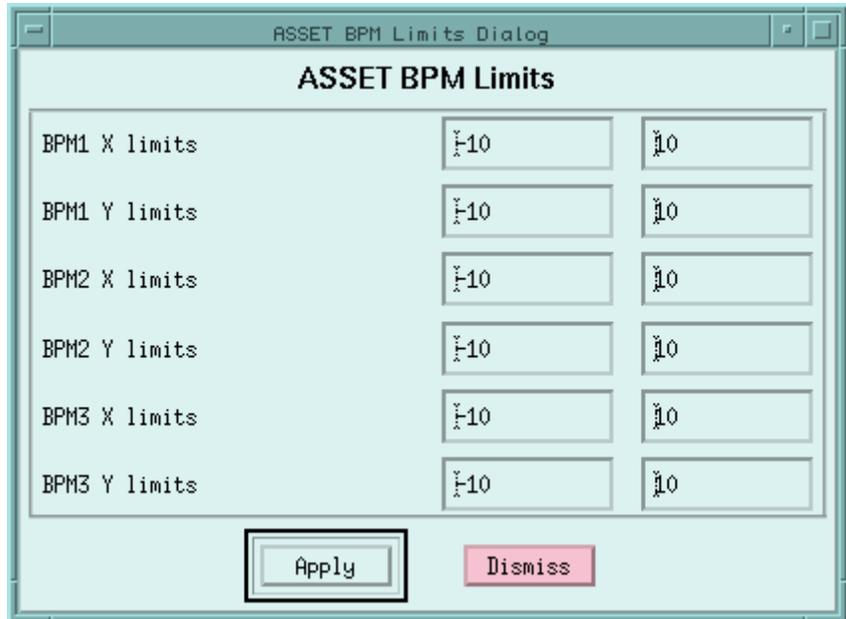
3.5.5. Limits

The Limits menu item is used for setting the various limits imposed on both input and output values. It brings up a sub-menu which divides the limits into four groups.



The ASSET BPM sub-menu item brings up the ASSET BPM limits dialog box. This allows lower and upper limits to be set on the computed X and Y values for each of the ASSET BPMs (1, 2 and 3). If a quantity is out of bounds, it is flagged with an error.

The "Apply" button is used to actually store the values set in the items above.



The ESA BPM sub-menu item brings up the ESA BPM limits dialog box. This allows lower and upper limits to be set on the computed X and Y values for each of the A-line and Alcove (ESA) BPMs (12, 24, 28, 31, 32, 41 and 42). If a quantity is out of bounds, it is flagged with an error.

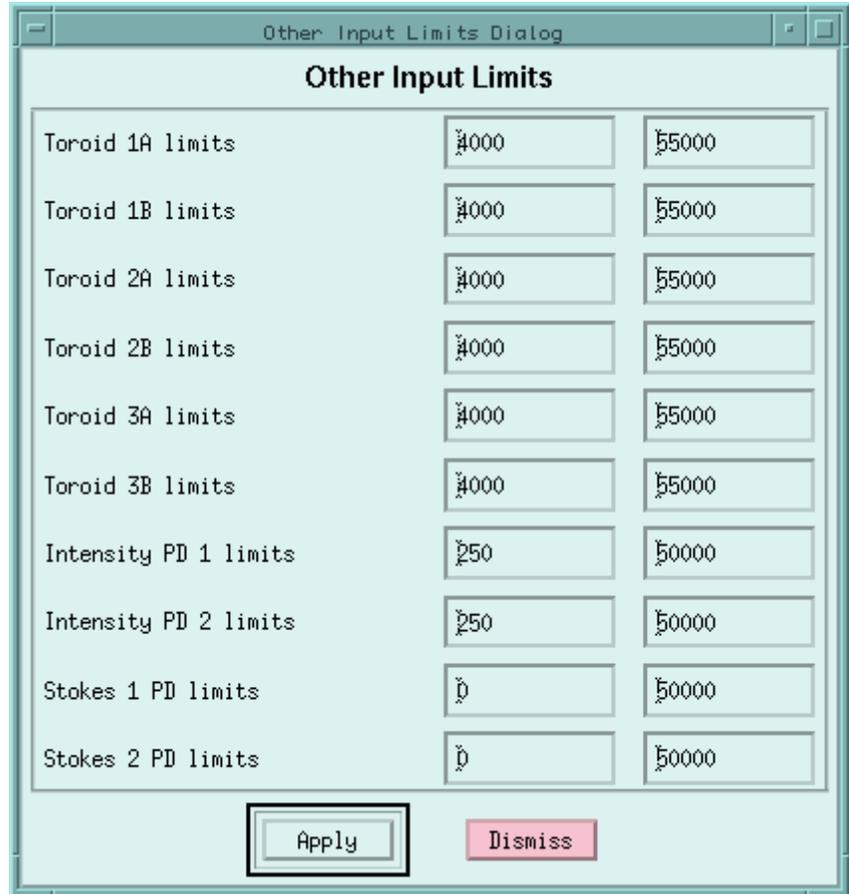
The “Apply” button is used to actually store the values set in the items above.

BPM	X limits	Y limits
BPM12	-200	800
BPM12	-2	2
BPM24	-900	100
BPM24	-2	2
BPM28	-10	10
BPM28	-10	10
BPM31	-2	2
BPM31	-2	2
BPM32	-2	2
BPM32	-2	2
BPM41	-10	10
BPM41	-10	10
BPM42	-10	10
BPM42	-10	10

Buttons: Apply, Dismiss

The Other Input sub-menu item produces the Other Input Limits dialog box. This allows lower and upper limits to be set on the raw ADC values for all the toroids (1A, 1B, 2A, 2B, 3A and 3B), the two intensity photo-diodes, and the two stokes photo-diodes.

The “Apply” button is used to actually store the values set in the items above.



The Output sub-menu item brings up the Output Limits dialog box. This sets lower and upper limits on various output values generated by fbanal. For the most part these are voltages used to control the beam source, and these are not currently implemented. These are the IA cell left and right voltages, the piezo control voltages A, B and C, in left and right versions and the CP and PS left and right voltages.

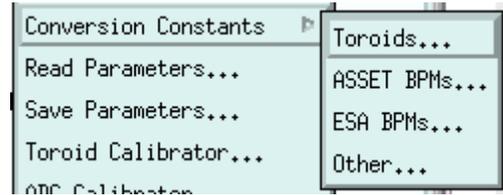
The remaining limits are placed on the induced X and Y position asymmetries, and cause the generated value to be held at the limit, if it were to be exceeded.

The "Apply" button is used to actually store the values set in the items above.

Output Limits		
IA cell left V limits	0	1000
IA cell right V limits	0	1000
Posn. feedback X asymm. limits	-0.0008	0.0008
Posn. feedback Y asymm. limits	-0.0008	0.0008
Piezo control A left V limits	0	0
Piezo control A right V limits	0	0
Piezo control B left V limits	0	0
Piezo control B right V limits	0	0
Piezo control C left V limits	0	0
Piezo control C right V limits	0	0
CP cell left V limits	0	0
CP cell right V limits	0	0
PS cell left V limits	0	0
PS cell right V limits	0	0

3.5.6. Conversion Constants

The Conversion Constants menu item allows the multitude of conversion constants used by the program to be set. It brings up a sub-menu allowing the selection of the particular group of constants to be set.



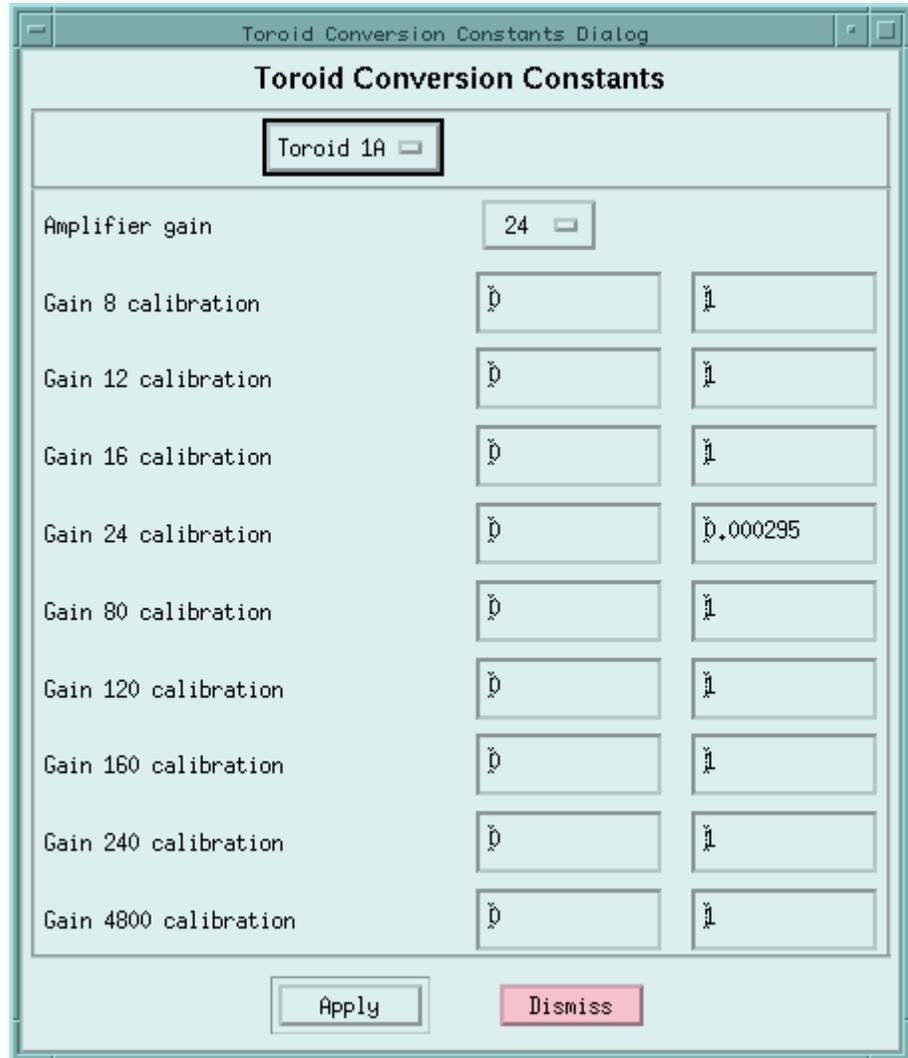
The Toroids sub-menu item produces the Toroid Conversion Constants dialog box. This allows the constants used in converting a raw toroid ADC value to a beam current (in units of $1e11$ electrons/bunch) to be set.

The top pop-up menu selects which toroid (1A, 1B, 2A, 2B, 3A or 3B) to set constants for.

The “Amplifier gain” pop-up sets which gain is being used on the input amplifier for the toroid.

The remaining items specify, for each of the possible amplifier gains, the constant and slope to be used in converting an ADC value to a beam current.

The “Apply” button is used to actually store the values set in the items above.



The ASSET BPMs sub-menu item brings up the ASSET BPM Conv Constants dialog box. This allows the constants used for converting raw ASSET BPM ADC values to position and charge values to be set.

The top pop-up menu selects which BPM (1, 2 or 3) to set constants for. The first seven constants (“X relative calibration”, “Y relative calibration”, “Q relative calibration”, “X conversion factor”, “X offset”, “Y conversion factor” and “Y offset”) apply when the BPM is being run in free oscillator mode. The next four constants (“Toroid X conversion factor”, “Toroid Y conversion factor”, “Toroid partner” and “Use imaginary part”) apply when the BPM is being run in locked oscillator mode (the usual).

“Rotation angle” is the angle by which the computed X and Y asymmetries, considered as a vector, are to be rotated when calculating the correction to be applied.

The ESA BPMs sub-menu item brings up the ESA BPM Conv Constants dialog box. This is identical to the one for the ASSET BPMs, except that the top pop-up menu shows all possible ESA BPMs (12, 24, 28, 31, 32, 41 or 42) instead of the ASSET ones. Also the “Toroid partner” pop-up shows only ESA toroids instead of ASSET ones.

The “Apply” button is used to actually store the values set in the items above.

Parameter	Value
BPM	BPM1
X relative calibration	0
Y relative calibration	0
Q relative calibration	0
X conversion factor	0
X offset	0
Y conversion factor	0
Y offset	0
Tord X conversion factor	0.1377
Tord Y conversion factor	0.06042
Toroid partner	tor1b
Use imaginary part	<input type="checkbox"/>
Rotation angle	0

The Other sub-menu item brings up the Other Conversion Constants dialog box, which allows various other constants and options to be set.

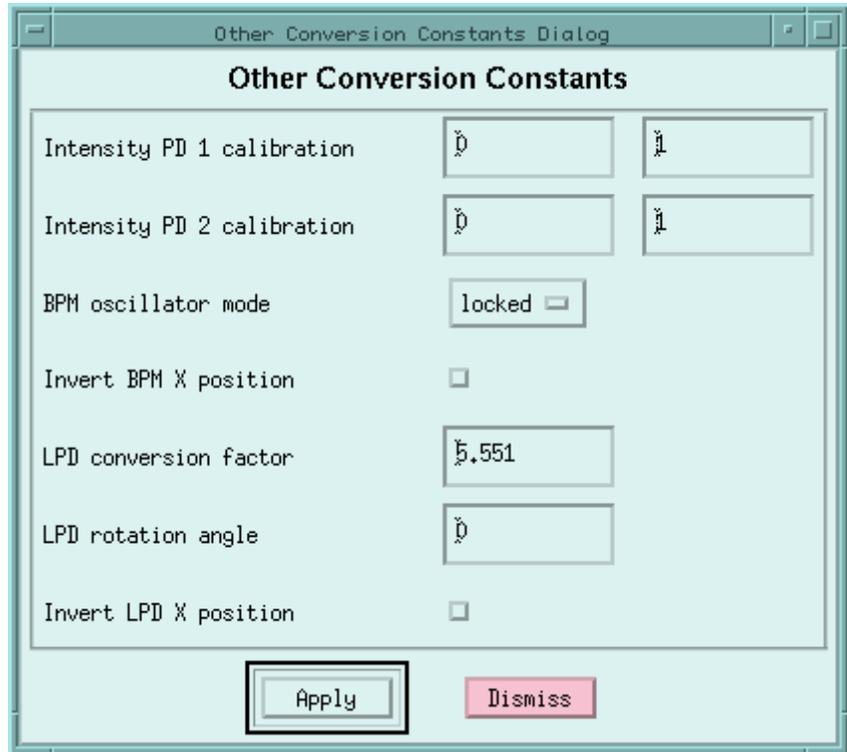
The “Intensity PD calibration” items are the constant terms and slopes used to convert raw ADC values to beam currents for the two intensity photo-diodes.

The “BPM oscillator mode” pop-up allows the mode (locked or free) of all BPM oscillators to be set.

The “Invert BPM X position” check box causes the value of all BPM X asymmetries to be negated when calculating position feedback corrections.

“LPD conversion factor” is used in obtaining the beam position from the raw LPD (laser position detector) ADC values. “LPD rotation angle” and “Invert LPD position” are used in calculating position feedback corrections from LPD values.

The “Apply” button is used to actually store the values set in the items above.

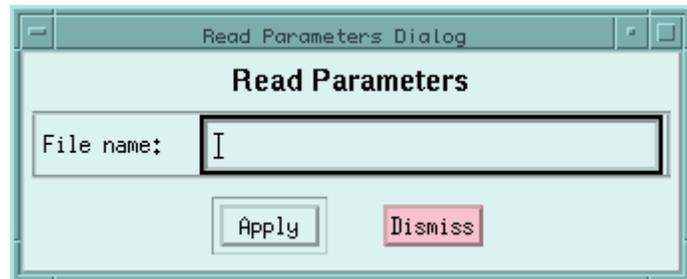


3.5.7. Reading & Saving Parameters

The Read Parameters and Save Parameters menu items bring up a simple dialog box into which the name of the parameter file to be read or written can be entered. This name is limited to 64 characters and can be an absolute or relative path name. If the name is left blank, the default file, fbparm.dat in the current working directory, is used. When a parameter file is read, only those parameters that are specified in the file have their values changed in the program; the others are left untouched.

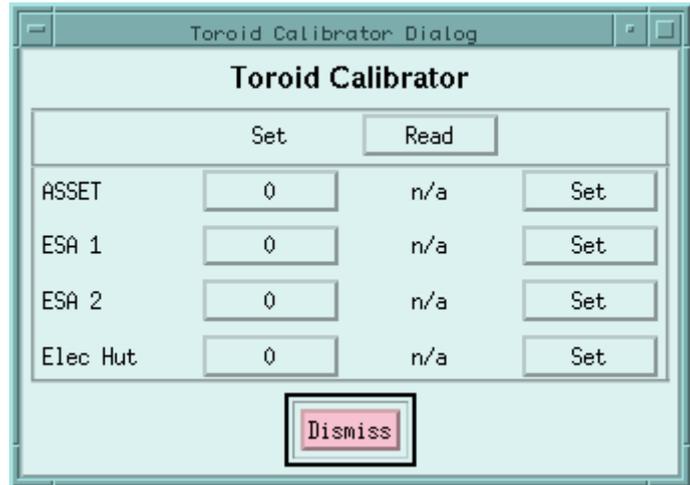
When a parameter file is written, all parameter values in the program are put into the file.

The “Apply” button causes the reading or saving to take place.



3.5.8. Toroid Calibrator

The Toroid Calibrator menu item brings up a dialog box which allows toroid calibrator voltages to be set and displayed. Each calibrator in the system is listed with a button for entering the value to be set, the read value and a button for actually setting the value. The “Read” button at the top causes all the calibrator voltages to be read and displayed. Only calibrators that have been enabled in the “Other HW Configuration” dialog box (see section 3.5.3) can have their voltage set or read.



3.5.9. ADC Calibrator

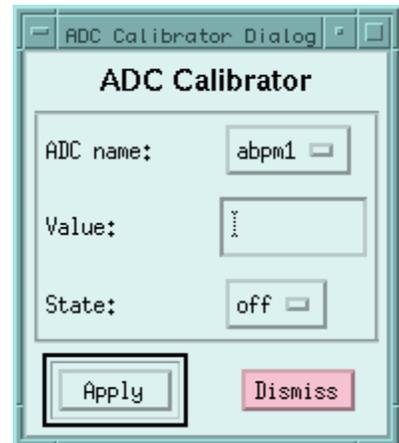
The ADC Calibrator menu item brings up a dialog box that enables the calibrator voltage on any ADC to be set.

The “ADC name” item selects which ADC to use.

The “Value” item sets the value to set in the calibrator.

The “State” item selects whether the calibrator is to be turned on or off. No calibrator should be left in the “on” state during a normal data run.

The “Apply” button causes the voltage and state to be actually set.



3.5.10. Calibration

The Calibration menu item brings up a dialog box which allows the various calibrations to be controlled.

The pop-up at the top selects the calibration.

The “Run length” item sets the number of events per data point.

The “No. data points” item sets the number of data points.

The “Starting voltage” item sets the voltage for the first data point.

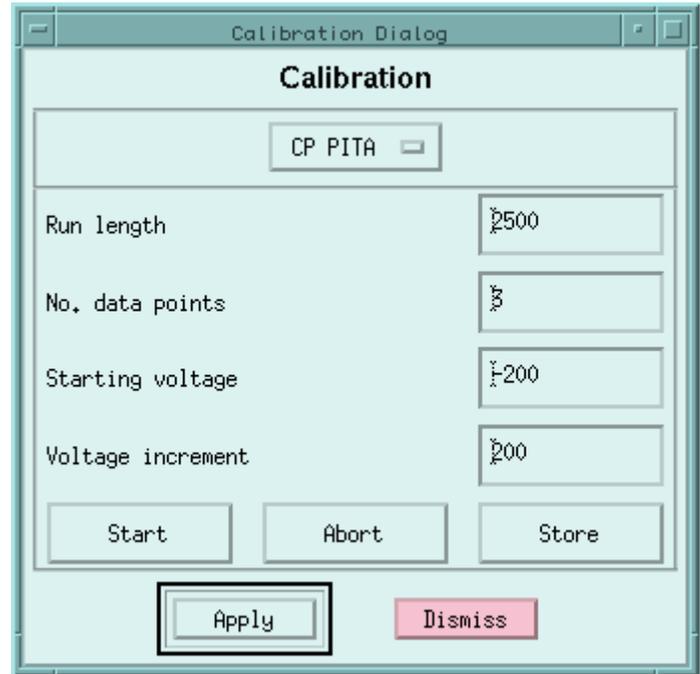
The “Voltage increment” item sets the voltage change for each subsequent point.

The “Start” button starts the calibration.

The “Abort” button aborts the calibration, if necessary.

The “Store” buttons stores the quantities derived from the calibration after it has completed.

The “Apply” button is used to actually store any of the values changed by the above text box items.

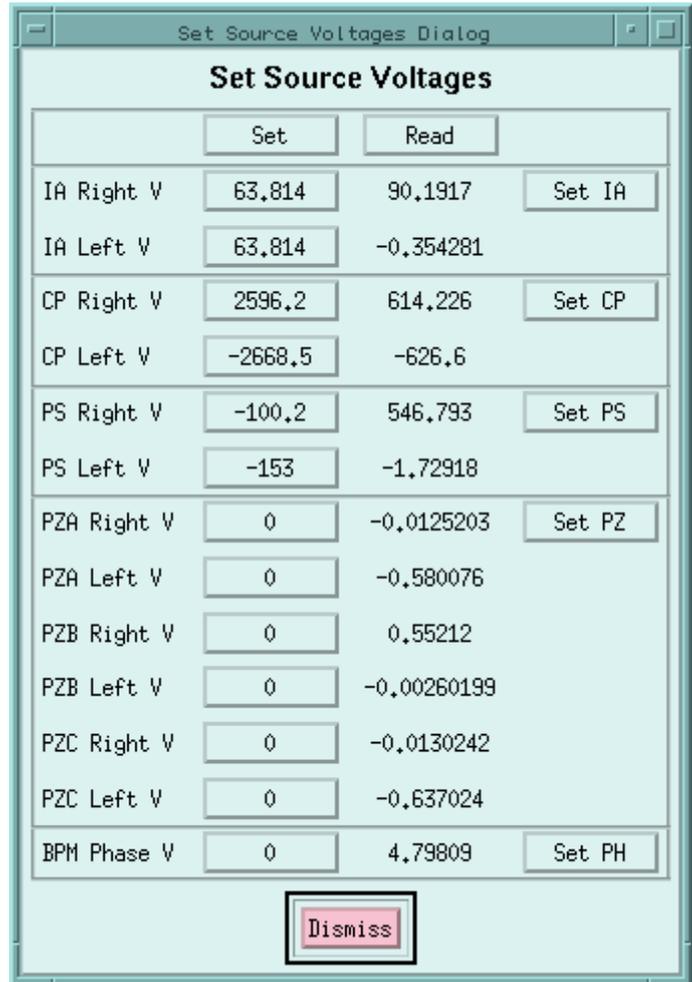


3.5.11. Set Voltages

The Set Voltages menu item produces a dialog box that enables source voltages to be set and displayed. Usually these voltages are set under the control of the various feedbacks, but sometimes it is necessary to set some of them manually. All possible voltages are listed, and they are arranged into groups that are set together.

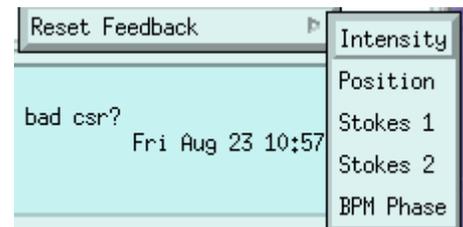
For each voltage there is a button that allows the new set value to be entered, and a display of the current read back value. If a voltage has not been read within the last 10 seconds, it is displayed as "n/a". Each group of voltages has a button to actually set all the voltages in the group.

The "Set" button at the top causes the displayed set values to be refreshed from the stored ones, and is necessary because the set values may be changing because of feedback. The "Read" button at the top updates the displayed values with the latest ones read from the data stream.



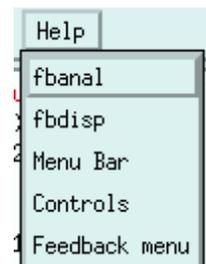
3.5.12. Reset Feedback

The Reset Feedback menu item brings up a sub-menu which selects the feedback to be reset. Resetting a feedback first allows the current mini-run to complete; then the output voltages are set to nominal values, the induced asymmetries are set to zero, and the mini-run number is set to zero.



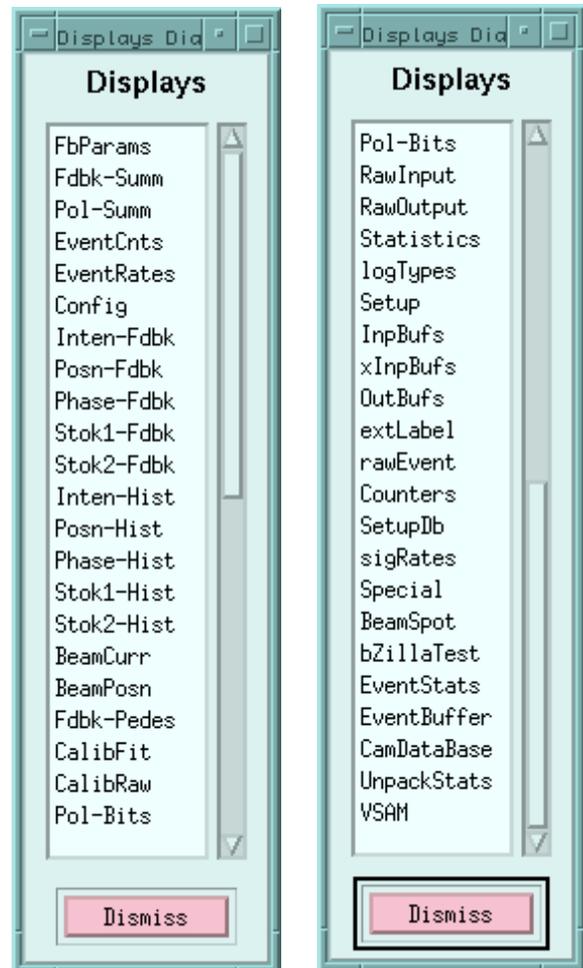
3.6. Help menu

The Help menu is used to display help information about various aspects of fbanal. It contains a list of topics, each of which displays a scrolling window of information about that topic.



4. Displays

The displays produced by fbdisp are accessed via the “Displays” button at the bottom of the main window (see figure 2.1). Pressing this button brings up a scrolling list box showing all available displays. Shown are two views of this box scrolled to show the first and second halves respectively of the display list. The first half contains displays particular to fbdisp, and these are described in the following sections. The second half contains displays common to all display programs and will not be discussed further here.



All displays can be set to update periodically. Double-clicking on a display brings up a dialog box that allows the update interval to be set via a slider, and the periodic update to be started or stopped.



4.1. Feedback Parameters (FbParams) display

The Feedback Parameters display is a scrolling window showing the values of all the parameters used by fbanal. Each item has a long descriptive name, a short name and one or two values. The short name is the name by which the parameter is designated in a parameter file. Parameters without short names cannot be read from or saved to a parameter file. In general, only limits have two values.

The parameters are grouped into the following sections:
 Miscellaneous, Feedback Control, Hardware Configuration, Computed Values, Output Value Limits, ADC Channels, Input Value Limits, Toroid Conversion Constants, BPM Conversion Constants, Calibration Run Constants and Toroid Calibrator Control.

The screenshot shows a window titled "Params" with a sub-header "FbParams". Below the sub-header is a yellow bar labeled "Feedback Parameters". The main content is a table with three columns: "Description", "Name", and "Value". The table is divided into sections by dashed lines. The "Miscellaneous" section includes parameters like "Feedback master", "Feedback active", "Processing state", "Ignore processing state", "Calibration state", and "Calibration type". Other sections include "Asset polarization source", "Beam polarization source", "Use witness pulse for data", "Use witness pulse for poln", "Use no-beam pulse for poln", "Individual data errors", "Perform difftrig cut", "Check intensity asymmetry", "Intensity asymmetry limit", "Synchronize raw data streams", "Synchronize data streams", and "Synchronization buffer size".

Description	Name	Value
Miscellaneous		
Feedback master		off
Feedback active		on
Processing state		off
Ignore processing state	ignrproc	off
Calibration state		off
Calibration type		none
Asset polarization source	apolsrc	pmon
Beam polarization source	bpolsrc	vpmom
Use witness pulse for data	wpfordata	off
Use witness pulse for poln	wpforpoln	off
Use no-beam pulse for poln	nbforpoln	off
Individual data errors	indiverr	off
Perform difftrig cut	diftrgcut	on
Check intensity asymmetry	checkiasy	on
Intensity asymmetry limit	iasylimit	0.01
Synchronize raw data streams	synchrawd	off
Synchronize data streams	synchdata	on
Synchronization buffer size	sybufsize	500
Minimum no. pedestals required	minpedread	10

At the bottom of the window, there are four buttons: "Print", "Mode", "Update", and "Dismiss".

4.2. Feedback Summary (Fdbk-Summ) display

The Feedback Summary display is a scrolling window giving a brief overall summary, followed by a summary of each feedback.

The overall summary shows the number of events and the times of the first and last events separated into the two streams, ASSET and ESA.

The summaries for each feedback show the state, the mini-run length, the source of the data, the current beam asymmetry, the induced beam asymmetry, and the set voltages.

The screenshot shows a window titled "Fdbk-Summ" with a yellow header "Feedback Summary". The data is organized into several sections:

	ASSET	ESA
Number of events	6175	448733
Time of first event	17-Sep-2002 16:20:33	17-Sep-2002 15:18:30
Time of last event	17-Sep-2002 16:21:23	17-Sep-2002 16:21:24

Intensity Feedback

State: compute Run length: 400 Data source: tor1b
Time of last completed mini-run:
Beam asymmetry: 0 Induc asymmetry: 0
Left voltage set: 0.000 Right voltage set: 0.000

Position Feedback

State: compute Run length: 20000 Data source: bpm3
Time of last completed run:
Beam asymmetry X: 0 Ind. asymmetry X: 0
Beam asymmetry Y: 0 Ind. asymmetry Y: 0
Left voltage A set: 0.000 Right voltage A set: 0.000
Left voltage B set: 0.000 Right voltage B set: 0.000
Left voltage C set: 0.000 Right voltage C set: 0.000

BPM Phase Feedback

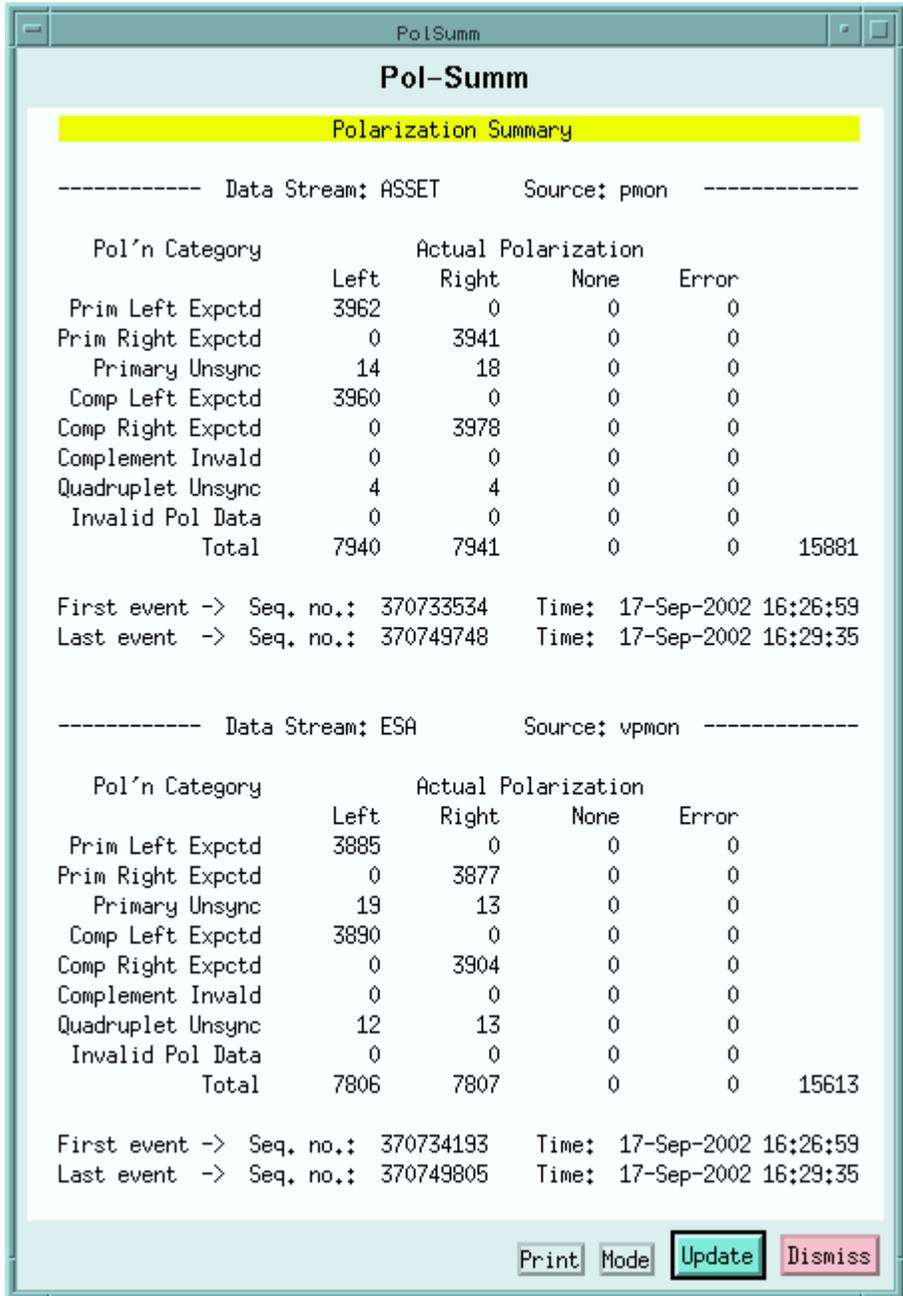
State: compute Run length: 200
Time of last completed run:
BPM phase: 0 Induc BPM phase: 0
Phase voltage set: 0.000

At the bottom right of the window are four buttons: Print, Mode, Update, and Dismiss.

4.3. Polarization Summary (Pol-Summ) display

The Polarization Summary display shows statistics for the polarization analysis. It has two sections, one for each data stream. The heading for each shows which device is supplying the polarization data. The end of each section shows the PMON sequence numbers and times of the first and last events covered by the display.

The middle part of each section shows the events distributed in columns according to the four possible polarization values, and in rows by various normal and error categories plus a total. The "Prim Left Expctd" and "Prim Right Expctd" rows count events that fall in the first half of a quadruplet and are expected to have the designated polarization. The "Primary Unsync" row counts primary events for which the polarization cannot yet be predicted. The "Comp Left Expctd" and "Comp Right Expctd" rows count events that fall in the second half of a quadruplet and are expected to have the indicated polarization. The "Complement Invald" row counts events for which the polarization is not the complement of the corresponding primary event. The "Quadruplet Unsync" row counts events for which the quadruplet synchronization has not yet been established. The "Invalid Pol Data" row counts events for which the polarization data packet has bad status or checksum.



The display data may be cleared by using the "Mode" button at the bottom of the display.

4.4. Event Counts (EventCnts) display

The Event Counts display shows event statistics divided various ways.

In the first two sections there are four columns separating the events by data stream (ASSET or ESA) and by timeslot (phase) within each stream.

In the first section, the rows divide the events according to beam trigger type.

In the second section, the rows divide the data events according to various conditions, most of which represent errors.

“Invalid data” means that the data from one or more devices was missing or out of range, and that the individual data errors option is not in effect. “Bad polarization” means that one of the several possible polarization errors occurred. “No polarization data” should never happen. “Unpaired” means that the event’s complementary polarization partner was missing or had invalid data. “Failed difftrig cut” means that an event and its polarization partner had different trigger times, and the cut was in effect. “Failed asymmetry cut” means that the intensity asymmetry of a pair exceeded the maximum allowed value, and the cut was in effect. “Unsynchronized” means that a pair from one data stream was not matched by a pair with the same PMON sequence number from the other stream. “Processed” means that the event was actually processed. The values in the “Total data” line should equal the sums of all the beam trigger types (usually only “Standard Beam”) contributing to data.

In the third section are shown the statistics for raw data synchronization. No splitting by phase is available at this point in the processing, so there are only two columns. The “Paired raw” line counts the events that were paired via PMON sequence number with an event in the other data stream (so both numbers should be the same). The “Individual raw” line counts events that were not paired, but processed anyway. The “Dropped raw” line counts events that were dropped because of being unpaired. The sums of the first two lines should equal the totals of the first section.

The last two lines of the display show the times of the first and last events in each atream covered by the display. The display values may be cleared by using the “Mode” button at the bottom.

Description	ASSET		ESA	
	Phase0	Phase1	Phase0	Phase1
Standard Beam	0	0	16003	10757
NoBeam	0	0	134	0
Witness Beam	0	27081	0	0
NoBeam	0	135	0	0
Total	0	27216	16137	10757
Total (both phases)		27216		26894
Invalid data	0	0	0	0
Bad polarization	0	0	15	9
No polarization data	0	0	0	0
Unpaired	0	0	1	0
Failed difftrig cut	0	0	8126	2620
Failed asymmetry cut	0	0	0	0
Unsynchronized	0	0	0	0
Processed	0	0	7860	8128
Total data	0	0	16002	10757
Total (both phases)		0		26759
Paired raw		68		68
Individual raw		27148		26826
Dropped raw		0		0
Time of first event:	17-Sep-2002 16:26:59		17-Sep-2002 16:26:59	
Time of last event:	17-Sep-2002 16:31:27		17-Sep-2002 16:31:27	

4.5. Event Rates (EventRates) display

The Event Rates display shows event rates divided into various categories, along with totals, and the time of the last event. Rates are calculated by counting the number of events occurring during the last 10 seconds.

The columns divide the events according to the data stream and timeslot (phase) within each stream. The rows further divide the events according to the beam trigger type.

Description	ASSET		ESA	
	Phase0	Phase1	Phase0	Phase1
Standard Beam	0.0	0.0	58.7	39.4
NoBeam	0.0	0.0	0.5	0.0
Witness Beam	0.0	100.3	0.0	0.0
NoBeam	0.0	0.5	0.0	0.0
Total	0.0	100.8	59.2	39.4
Total (both phases)		100.8		98.6

Time of last event: 17-Sep-2002 16:32:34 17-Sep-2002 16:32:34

4.6. Source Configuration (Config) display

The Source Configuration display shows the state of the various adjustable source components, along with the voltages set at the source.

Source Configuration 17-Sep-2002 16:33:12

Insertable Optics

Diode Laser Combiner	IN
Wall Bench Half-Wave Plate	OUT
Helicity Filter	OUT
Gun Bench Half-Wave Plate	OUT
Cathode Pickoff	OUT
Asymmetry Inverter	+2I
Spare Insertable	BOTH

Voltages

IA Cell	R: 85.4153	L: -0.330069
CP Cell	R: 619.801	L: -641.623
PS Cell	R: 652.589	L: -2.09707
Piezo A	R: -0.0112692	L: -0.628134
Piezo B	R: 0.579812	L: -0.00227373
Piezo C	R: -0.0115795	L: -0.64452

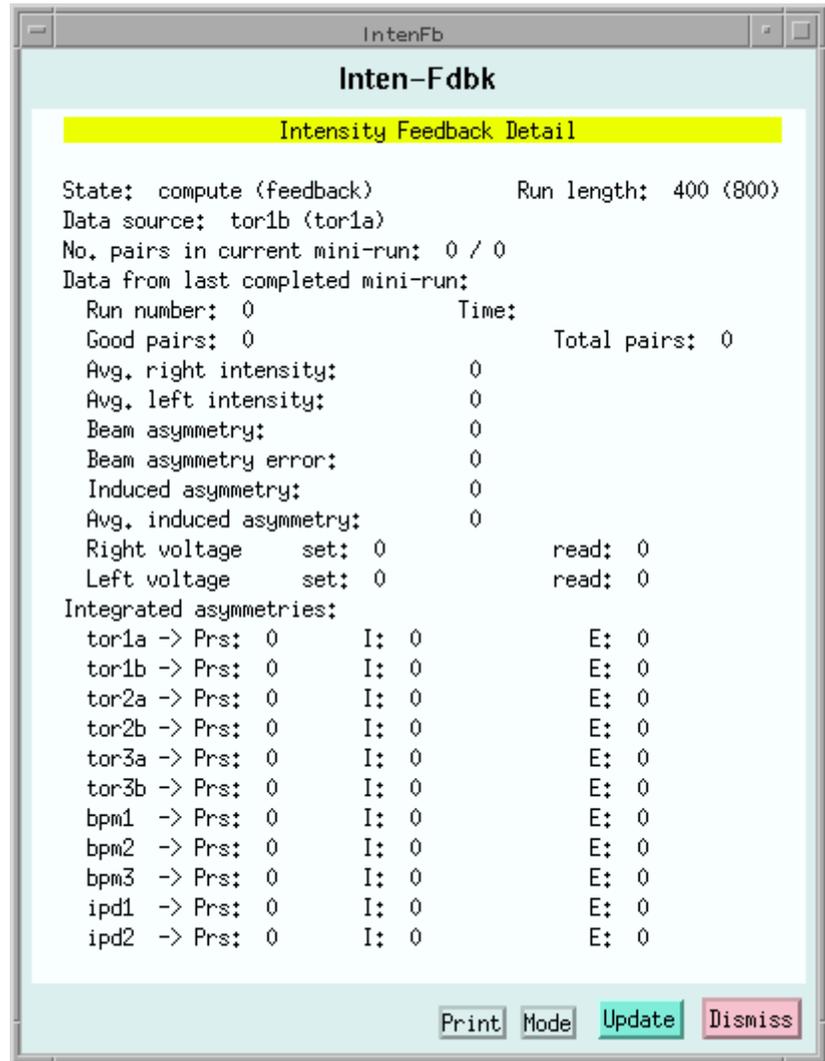
4.7. Intensity Feedback (Inten-Fdbk) display

The Intensity Feedback display shows detailed information about the intensity feedback.

The first three lines show what state (off, compute or feedback) the feedback is in, the number of pairs in a mini-run, which device's data is being used for the feedback, and the progress of the current mini-run. Each value in parentheses shows what the current value will change to at the beginning of the next mini-run.

The next section of the display shows the data from the last completed mini-run, and is largely self-explanatory. The induced asymmetry is the accumulated asymmetry needed to generate the source correction that reduces the measured asymmetry to zero. The average induced asymmetry is the induced asymmetry averaged over all mini-runs.

The last section of the display shows the average intensity asymmetry and its error (calculated as the RMS error divided by the square root of the number of pairs), along with the number of pairs used, for each device in the system that measures beam current. The numbers in this section may be zeroed by using the "Mode" button at the bottom of the display.



4.8. Position Feedback (Posn-Fdbk) display

The Position Feedback display shows detailed information about the position feedback.

The first three lines show the state (off, compute or feedback) of the feedback, the mini-run length (in pairs), the device whose data is being used for the feedback, the device (tilt mirror or tilt plate) used to implement the feedback, and the progress of the current mini-run. Values in parentheses are those that will apply at the beginning of the next mini-run.

The next section summarizes the data from the last completed mini-run, and is largely self-explanatory. The induced asymmetry is the accumulated asymmetry needed to drive the source correction device to the point where the instantaneous asymmetry is zero.

The last section shows averaged X and Y position asymmetries and their errors (calculated as the RMS error divided by the square root of the number of pairs), along with the number of pairs used, for every device in the system being used to measure beam position. These values may be cleared by using the "Mode" button at the bottom of the display.

The screenshot shows a window titled "Posn-Fdbk" with a yellow header "Position Feedback Detail". The display contains the following text:

```

State: compute (compute)          Run length: 20000 (10000)
Data source: bpm3 (bpm1)         Output devc: mirror (mirror)
No. pairs in current mini-run: 0 / 0
Data from last completed mini-run:
Run number: 0                    Time:
Good pairs: 0                    Total pairs: 0
Avg. right posn.      X: 0      Y: 0
Avg. left posn.      X: 0      Y: 0
Beam asymmetry       X: 0      Y: 0
Beam asymm. error    X: 0      Y: 0
Induced asymmetry    X: 0      Y: 0
Right voltage A      set: 0     read: 0
Left voltage A       set: 0     read: 0
Right voltage B      set: 0     read: 0
Left voltage B       set: 0     read: 0
Right voltage C      set: 0     read: 0
Left voltage C       set: 0     read: 0
Integrated asymmetries:
bpm1  -> Prs: 0      X: 0      E: 0
      Y: 0      E: 0
bpm2  -> Prs: 0      X: 0      E: 0
      Y: 0      E: 0
bpm3  -> Prs: 0      X: 0      E: 0
      Y: 0      E: 0
bpm12 -> Prs: 0      X: 0      E: 0
      Y: 0      E: 0
bpm24 -> Prs: 0      X: 0      E: 0
      Y: 0      E: 0
bpm28 -> Prs: 0      X: 0      E: 0
      Y: 0      E: 0
bpm31 -> Prs: 0      X: 0      E: 0
      Y: 0      E: 0
bpm32 -> Prs: 0      X: 0      E: 0
      Y: 0      E: 0
bpm41 -> Prs: 0      X: 0      E: 0
      Y: 0      E: 0
bpm42 -> Prs: 0      X: 0      E: 0
      Y: 0      E: 0
lpd   -> Prs: 0      X: 0      E: 0
      Y: 0      E: 0

```

At the bottom of the window, there are four buttons: "Print", "Mode", "Update", and "Dismiss".

4.9. BPM Phase Feedback (Phase-Fdbk) display

The BPM Phase Feedback display shows details about the BPM phase feedback.

The first four lines show the state (off, compute or feedback) of the feedback, the mini-run length (in events), the BPM whose data is being used for the feedback, the desired set point (in degrees), and the progress of the current mini-run. Values in parentheses are those that will apply at the beginning of the next mini-run.

The second section shows summary data from the last completed mini-run, and is largely self-explanatory. The induced phase is the accumulated phase needed to maintain the correction to the phase adjustment hardware that brings the instantaneous phase to the set point.

The third section shows average phase values and their RMS errors, along with the number of events used, for each BPM (i.e. those in the A-line and Alcove areas) affected by the phase feedback. These values may be cleared by using the “Mode” button at the bottom of the display.



4.10. Stokes 1 Feedback (Stok1-Fdbk) display

The Stokes 1 Feedback display shows detailed information about the stokes 1 feedback.

The first line shows the state (off, compute or feedback) of the feedback, and the mini-run length (in pairs). Values in parentheses are those that will apply at the beginning of the next mini-run.

The next section shows summary data from the last completed mini-run, and is largely self-explanatory.

The last section shows the average asymmetry, its error, and the number of pairs used for the stokes 1 photo-diode data. The values may be cleared by using the "Mode" button at the bottom of the display.



4.11. Stokes 2 Feedback (Stok2-Fdbk) display

The Stokes 2 Feedback display shows detailed information about the stokes 2 feedback.

The first line shows the state (off, compute or feedback) of the feedback, and the mini-run length (in pairs). Values in parentheses are those that will apply at the beginning of the next mini-run.

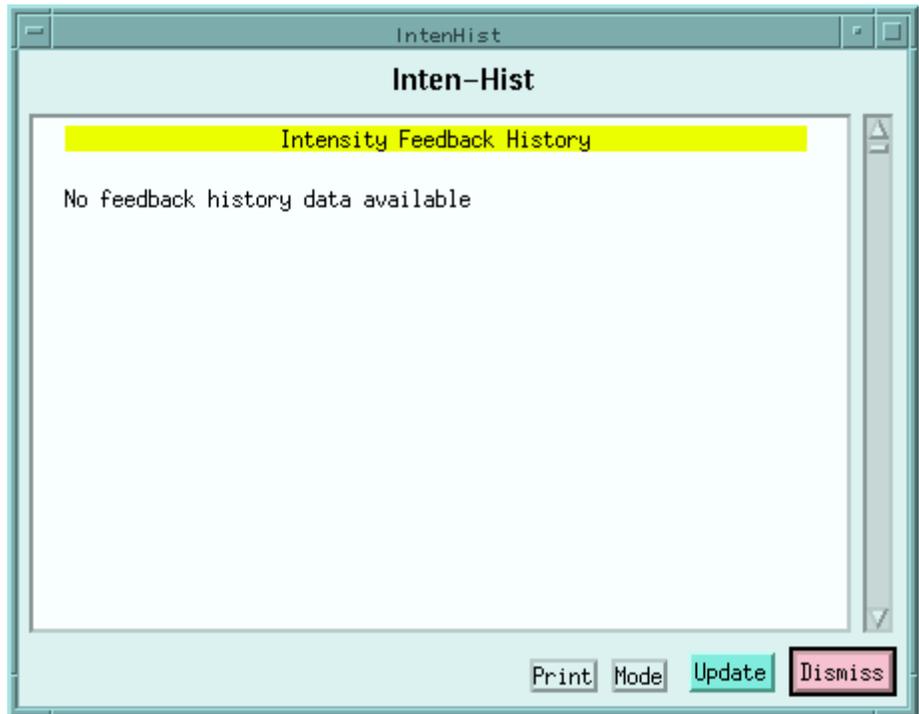
The next section shows summary data from the last completed mini-run, and is largely self-explanatory.

The last section shows the average asymmetry, its error, and the number of pairs used for the stokes 2 photo-diode data. The values may be cleared by using the "Mode" button at the bottom of the display.



4.12. Intensity Feedback History (Inten-Hist) display

The Intensity Feedback History display shows a summary of up to the last 3000 intensity feedback mini-runs, starting with the latest. For each mini-run are shown the run number, the completion time, the asymmetry and the asymmetry error.



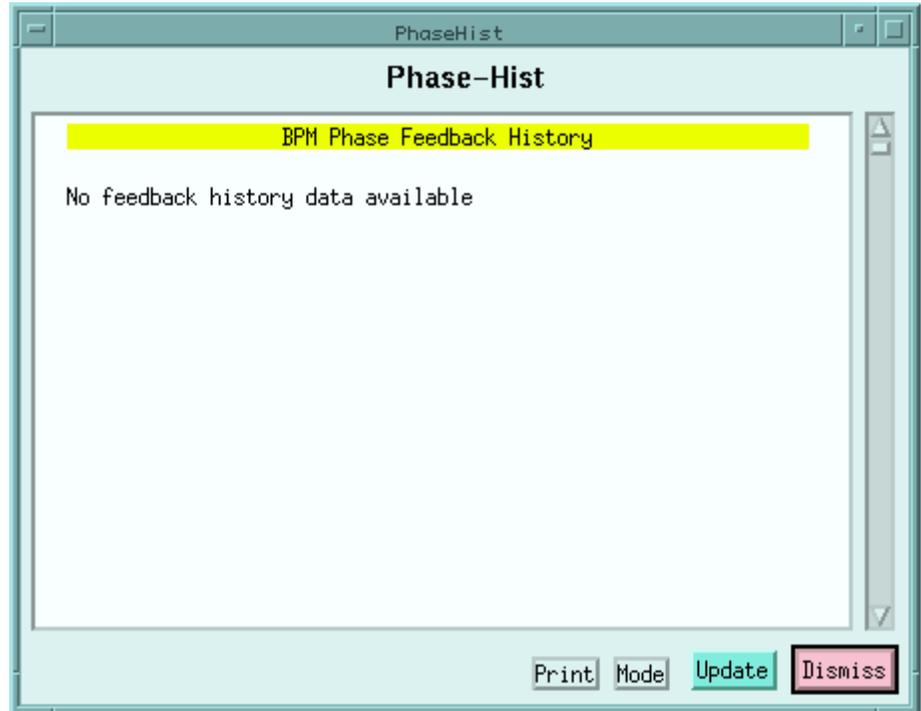
4.13. Position Feedback History (Posn-Hist) display

The Position Feedback History display shows a summary of up to the last 1000 position feedback mini-runs, starting with the latest. For each mini-run are shown the run number, the completion time, the X and Y asymmetries and their corresponding errors.



4.14. BPM Phase Feedback History (Phase-Hist) display

The BPM Phase Feedback History display shows a summary of up to the last 500 BPM phase feedback mini-runs, starting with the latest. For each mini-run are shown the run number, the completion time, the average phase and the phase RMS error.



4.15. Stokes 1 Feedback History (Stok1-Hist) display

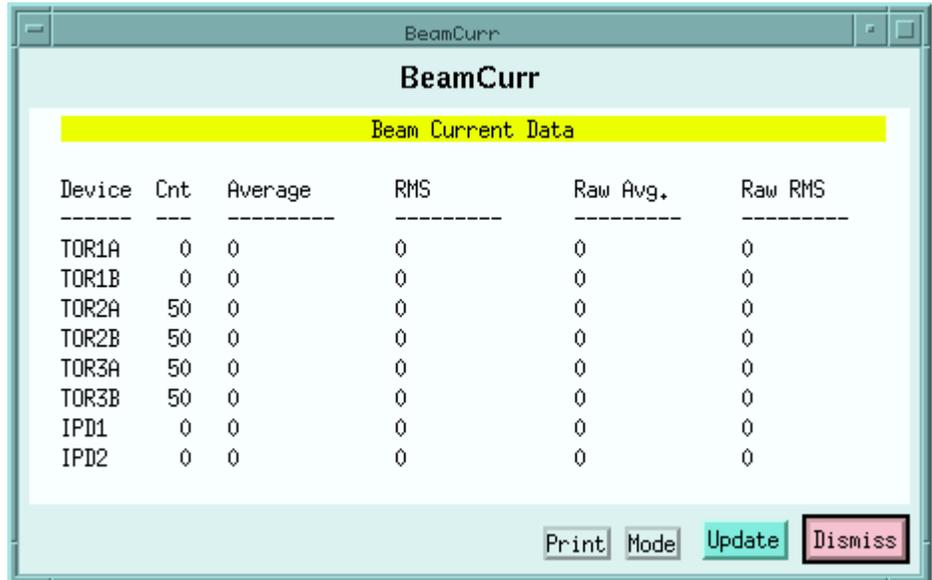
This display is very similar to the Intensity Feedback History display, except that the maximum number of mini-runs is 500.

4.16. Stokes 2 Feedback History (Stok2-Hist) display

This display is very similar to the Intensity Feedback History display, except that the maximum number of mini-runs is 500.

4.17. Beam Current (BeamCurr) display

The Beam Current display shows the beam current and its RMS error, for each beam current measuring device in the system. The values are computed as a running average over the last several valid events, with the number of events used also being shown. The averaged raw ADC values and their RMS errors are also shown.



The screenshot shows a window titled "BeamCurr" with a yellow header bar "Beam Current Data". Below the header is a table with six columns: Device, Cnt, Average, RMS, Raw Avg., and Raw RMS. The table lists data for devices TOR1A, TOR1B, TOR2A, TOR2B, TOR3A, TOR3B, IPD1, and IPD2. At the bottom of the window are four buttons: Print, Mode, Update, and Dismiss.

Device	Cnt	Average	RMS	Raw Avg.	Raw RMS
TOR1A	0	0	0	0	0
TOR1B	0	0	0	0	0
TOR2A	50	0	0	0	0
TOR2B	50	0	0	0	0
TOR3A	50	0	0	0	0
TOR3B	50	0	0	0	0
IPD1	0	0	0	0	0
IPD2	0	0	0	0	0

4.18. Beam Position (BeamPosn) display

The Beam Position display shows the average value and phase (in degrees), along with their RMS errors, for each section (X, Y and Q) of each BPM in the system. The values are running averages over the last several valid events, and the number of events used for each BPM is also shown.

BPM Position Data						
Device	Count	Comp	Avg. Value	Value RMS	Avg. Phase	Phase RMS
BPM1	0	X	0	0	0	0
		Y	0	0	0	0
		Q	0	0	0	0
BPM2	0	X	0	0	0	0
		Y	0	0	0	0
		Q	0	0	0	0
BPM3	0	X	0	0	0	0
		Y	0	0	0	0
		Q	0	0	0	0
BPM12	0	X	0	0	0	0
		Y	0	0	0	0
		Q	0	0	0	0
BPM24	0	X	0	0	0	0
		Y	0	0	0	0
		Q	0	0	0	0
BPM28	0	X	0	0	0	0
		Y	0	0	0	0
		Q	0	0	0	0
BPM31	0	X	0	0	0	0
		Y	0	0	0	0
		Q	0	0	0	0
BPM32	0	X	0	0	0	0
		Y	0	0	0	0
		Q	0	0	0	0
BPM41	0	X	0	0	0	0
		Y	0	0	0	0
		Q	0	0	0	0
BPM42	0	X	0	0	0	0
		Y	0	0	0	0
		Q	0	0	0	0

4.19. Pedestals (Fdbk-Pedes) display

The Pedestals display shows the averaged pedestal values and their RMS errors for each ADC channel in the system. Two pedestals are kept for each channel, one for each timeslot (phase). The values are computed as running averages using the last several no-beam events, and the number of data values in each average is also shown.

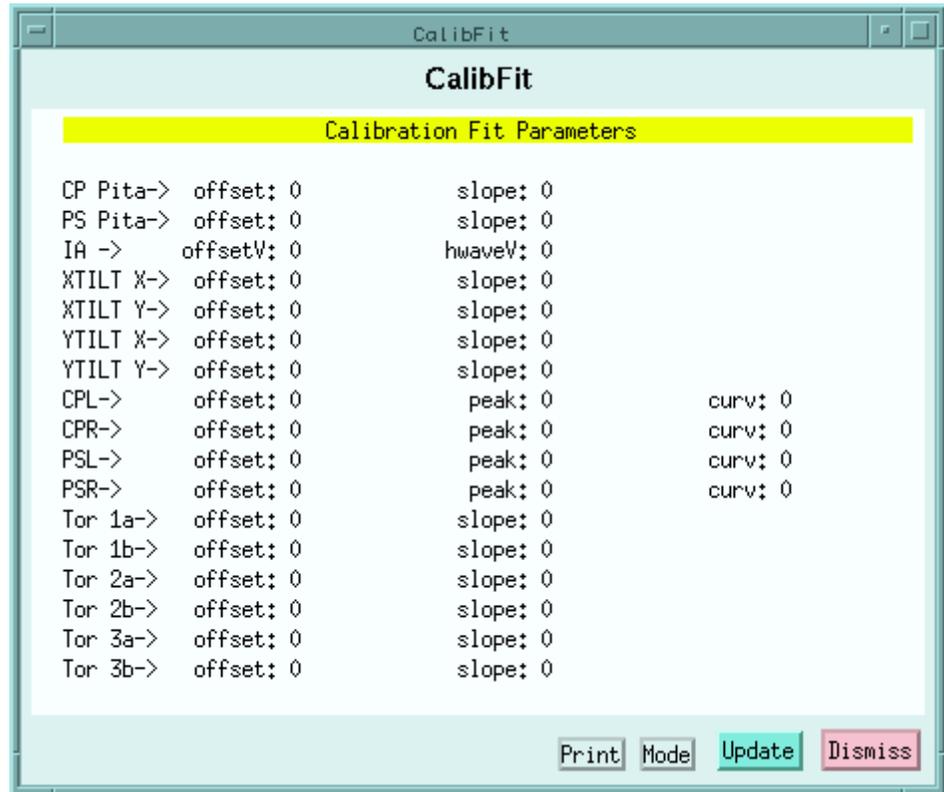
The screenshot shows a window titled "Fdbk-Pedes" with a sub-header "Pedestal Data". The table below represents the data shown in the window. The columns are organized into two main sections: "Phase 0" and "Phase 1". Each section has three sub-columns: "Cnt", "Average", and "RMS". The rows list various devices, including TOR (TOR1A, TOR1B, TOR2A, TOR2B, TOR3A, TOR3B) and BPM (BPM1 X1, BPM1 X2, BPM1 Y1, BPM1 Y2, BPM1 Q1, BPM1 Q2, BPM2 X1, BPM2 X2, BPM2 Y1, BPM2 Y2, BPM2 Q1, BPM2 Q2, BPM3 X1, BPM3 X2, BPM3 Y1, BPM3 Y2, BPM3 Q1, BPM3 Q2, BPM12 X1, BPM12 X2, BPM12 Y1).

Device	Phase 0			Phase 1		
	Cnt	Average	RMS	Cnt	Average	RMS
TOR1A	0	0	0	0	0	0
TOR1B	0	0	0	0	0	0
TOR2A	20	-314.166	4.78475	0	0	0
TOR2B	20	-143.294	7.64407	0	0	0
TOR3A	20	148.241	5.07231	0	0	0
TOR3B	20	12.1156	5.13867	0	0	0
BPM1 X1	0	0	0	0	0	0
BPM1 X2	0	0	0	0	0	0
BPM1 Y1	0	0	0	0	0	0
BPM1 Y2	0	0	0	0	0	0
BPM1 Q1	0	0	0	0	0	0
BPM1 Q2	0	0	0	0	0	0
BPM2 X1	0	0	0	0	0	0
BPM2 X2	0	0	0	0	0	0
BPM2 Y1	0	0	0	0	0	0
BPM2 Y2	0	0	0	0	0	0
BPM2 Q1	0	0	0	0	0	0
BPM2 Q2	0	0	0	0	0	0
BPM3 X1	0	0	0	0	0	0
BPM3 X2	0	0	0	0	0	0
BPM3 Y1	0	0	0	0	0	0
BPM3 Y2	0	0	0	0	0	0
BPM3 Q1	0	0	0	0	0	0
BPM3 Q2	0	0	0	0	0	0
BPM12 X1	20	488.312	18.4325	0	0	0
BPM12 X2	20	1091.05	3.16677	0	0	0
BPM12 Y1	20	-330.6	3.88487	0	0	0

At the bottom of the window, there are four buttons: "Print", "Mode", "Update", and "Dismiss".

4.20. Fitted Calibration Data (CalibFit) display

The Fitted Calibration Data display shows the fitted calibration constants for each type of calibration, derived from the data taken during the last calibration run.



4.21. Raw Calibration Data (CalibRaw) display

The Raw Calibration Data display shows the raw data (averaged over the run) from the last calibration run (if any) for each possible type of calibration. For each calibration there will be multiple lines of values, one for each voltage set point used.

