Statement of Work

Introduction

The US Geological Survey (USGS), Central Geologic Hazards Team (CGHT) has a requirement to replace the existing graphical user interface (GUI) and associated software supporting seismic waveform data quality control (QC) analysis. The USGS currently uses an application called "xyz" that allows an analyst to manipulate time series data to support QC processing. A typical use of xyz is to examine a subset of channels (e.g., BH* and LH*) from one station for a period of 10-14 days and to zoom in for a closer look at features that appear to be problematic. However, xyz is also used to examine all channels from one station or to compare subsets of channels among stations.

Two key behaviors of xyz that must be preserved are the concepts of panels and sequencing. Panels are an implementation of the idea that certain seismic channels may be associated and that channels associated in this way can be quickly moved on and off of the screen together. Typically one or more panels will be displayed concurrently, but panels can be added or subtracted through a set of analyst controls. Note that how channels are associated into panels may change depending on analyst input when a new set of channels are loaded. The second behavior allows the analyst to display a sequence of panels one at a time through a "next" control (e.g., BHZ & LHZ -> BHN & LHN -> BHE & LHE).

In addition to channel and zoom control, different functions, such as spectral transformations, polarization analysis, etc., can be applied to the waveform data. In xyz, these have been implemented as pop-up windows. In addition to existing functionality, the QC GUI is required to integrate several new data types including problem reports from an Automated QC subsystem, state-of-health data, and earthquake synthetics and to produce reports with illustrations derived from the displays. Of course, the QC GUI must also be designed to maximize the efficiency of the analyst by minimizing the number of physical actions that are required to perform tasks.

QC GUI Functional Requirements

1. Inputs - the QC GUI shall accept the following inputs
   a. Equally sampled timeseries in miniSEED
      i. Add-on option: support for an "in the clear" format (i.e., time series samples in single precision IEEE floating point binary).
   b. Unequally sampled timeseries of parameters in XML, for example:
      i. Output from the auto QC operations
      ii. SOH information, e.g.
         1. Internal voltage
         2. Latency
      iii. Earthquake information
      iv. Picks

Who design XMLs

c. Two different XML formats are envisioned to support the display of the unequally sampled timeseries. In particular the auto QC and earthquake information are an example of a format with one sample per message. Latency information is an example of a format with many samples per message. The USGS will supply details on the XML format(s) at a later date.

d. Metadata in dataless SEED format. + RESP format.

e. Data access

   i. Equally sampled timeseries will be imported via a socket-based protocol to be specified.

   ii. Unequally sampled timeseries will be imported via a socket-based protocol to be specified

   iii. Metadata will be read from local files

   iv. Add-on: Import of miniSEED data from local files

+ later

CWB.

2. Outputs – the QC GUI shall provide the following outputs

   a. Selected timeseries in miniSEED (for evenly sampled data) and XML (for unevenly sampled data) +

   b. Selected non-timeseries data in an "in the clear" format (e.g., spectra). Again, "in the clear" implies time or frequency domain samples in single precision IEEE floating point. + ASCII Clarification

   c. Panel or pop-window images in a standard graphics format (e.g., jpeg, gif, png)

   d. Updated/Revised QC reports in html

      i. Ability to include examples (bit map images)

   e. Updated flow control information via an API to a database (i.e., QC flow control to prevent un-QCed data from going to the archive). The API call will be provided. later

   f. Updated metadata information in resp format or a report noting modifications — Ability to reread the resp

3. GUI characteristics

   a. Start-up – On start-up, the GUI will:

      i. Read an optional user configuration file

         1. The configuration file provides control of stations and channels to be displayed, time span, trace ordering, and sequencing

      ii. Accept user input on the stations/channels/timespan to load

         1. Command-line specification shall override the configuration file

         2. The application shall support the use of wildcards in the specification of station/channels

      iii. Minimal start-up specification is station name and start time, with the following defaults:

         a. Display all channels for specified station(s)

         b. Display a timespan of 1 day

Display time span relate to earthquake

Any combination of files/DIRS

Catalog-Driven loading.

            c. Display Z,N,E (or Z, 1, 2 or alphabetical if no Z), grouped by station and sample rate (from low to high)
        iv. Load optional reports (auto QC, earthquake information) for specified stations and time span
    b. Display & processing
        i. Display behavior – (see figure 1 for conceptual illustration)
            1. The GUI will generate a root window that typically fills the entire screen.
            2. The root window consists of left or right subwindow (user configurable) for the display of optional autoQC and earthquake information and a top/bottom subwindow (user configurable) for the display of control buttons

SNCL

            3. The remainder of the root window consists of subwindows for the display of the traces
            4. Each channel (except for overlaid traces) will be displayed in its own subwindow. No subwindow will overlap with other subwindows when the y-scale is expanded (i.e., the trace will clip).

panel

            5. The GUI will support the ability to display multiple traces in the same subwindow in order to overlay traces (e.g., data-synthetic comparisons.
            6. The GUI will allow the interrogation of the display to return time and amplitude values based on the selection of one or two points. In the case of a two-point selection, the GUI will return the difference in the time and amplitude values at the selection points.

In each panel;

            7. Trace labels will include SNCL (station-network-channel-location codes), start time, duration, sampling rate
        ii. Auto QC/Event files
            1. Upon loading the optional autoQC/event files that match the station/channel/timeperiods, the GUI will generate a separate subwindow (configurable to appear on the left or right side of the display)
            2. Auto QC information
                a. The panel will display QC "issues", with individual "instances". An example of the QC issue might be "flatlined trace" and an instance would be a start time and duration of the specific issue. E.g.

Issue 1
- Instance 1
- Instance 2

Issue 2
- Instance 1

Issue 3
- Instance 1

Instance 2
Instance 3

b. The GUI will display issues in priority order. The priority will be determined by the "criticality" of the issue as specified in each auto QC message. The prioritization algorithm will be supplied by the USGS

c. User actions
    i. Clicking on an "issue" will cause the GUI will display the affected channels and highlight all instances
    ii. Clicking on an "instance" will cause the GUI to zoom in to display the time period of interest
    iii. The GUI will allow trace control so that the display of the issues and instances will either take place on all traces specified in the autoQC report (i.e., they will be displayed if the are not currently) or only on the currently displayed traces ?

XML who would place it.

Show on the current frame or create another frame.

works with ~~all~~ even scrolled unscrolled panels

3. Event information display

a. The event pane will contain a list of "known" events.

    Known events
        Region – Mag
        Region – Mag
        Region – Mag

b. Events for which synthetics exist will be identified through some means such as color, bold type, etc.

c. Channel-specific event information (as provided in the XML file), such as analyst picks and predicted arrival times shall be displayed on the specified traces.

d. User actions:
    i. Clicking on "known events" and the GUI will display the affected channels and highlight all events
    ii. Clicking on an event and the GUI will zoom in to display the time period of interest (in this case, perhaps starting at the origin time and extending some fixed interval of time).
    iii. The GUI will allow trace control so that the display of the events will either take place on all traces specified in the event information or only on the loaded traces

iii. x, y axis control – the GUI will require the following capabilities for control of the x and y axes (in the discussions below, the x-axis will be associated with time and the y axis with amplitude)

1. Default behavior:
    a. Independent (absolute) amplitude scaling of each channel (i.e., maximum displayed amplitudes of each channel map to channel window limits)
    b. Absolute time alignment of the traces
2. Supported options
    a. Relative amplitude (normalized) scaling between channels (i.e., maximum displayed amplitudes of all channels map to all channel window limits)
    b. Ability to apply an offset to overlaid traces for separation
    c. Ability to remove the mean of individual timeseries
    d. Relative time alignment of the traces (alignment starting from the first sample of all channels without regard to absolute time)
    e. Ability to flip polarity of a timeseries (i.e., multiply amplitudes by –1)
    f. Ability to expand/contract the y-scale on individual channels

duplication

(optional) Relative time by clicking on individual traces

new

C) xhair

EM

iv. Trace control (individual subwindows within the viewing area)

panel frame

1. Default
    a. Step through each station/network/channel/location (SNCL) in a single waveform ~~window~~ panel in the ~~root~~ ~~window~~ frame (i.e., display one channel at a time in sequence)
2. Supported Alternatives
    a. Step through each station/network channel with similar channels from different sensors overlaid in one waveform window in the root window. (ie. different location codes but same channel in each window)
    b. Same as above but not overlaid (i.e., a separate sub-window for each channel), but multiple related waveforms displayed in the root window.
3. Once displayed, the GUI should allow re-selecting subsets of data for redisplay – maybe by highlighting existing channel names.
4. Once displayed, the GUI should allow traces to be ordered (moved up or down in the list)

OK

v. View reports

1. The GUI must provide a means to view and update the QC report for the current station/channel/time period (i.e., either the auto or the manually updated QC report)

vi. Zoom
   1. Using a pointing device, the user shall be able to select a section of timeseries to be "zoomed" in a fast and convenient manner (e.g., a box select).
   2. The GUI must support multiple levels of zooming (up to 10).
   3. The GUI must be able to step back through previous zoom levels as well as support returning to the original or full display.
   4. Must be fast and convenient (i.e., minimal user input, very fast response)

vii. Pop-up windows- As part of the GUI, the output of certain activities or requests for information may be displayed as pop-up windows.
   1. Pop-up windows that display the results of certain actions require
      a. User-control of the x,y axes
      b. User labeling of the axes and title
   2. Pop-up windows are required for:
      a. Spectra
      b. Processed traces (filtered, deconvolved, etc.)
      c. Polarization analysis
      d. Instrument response
      e. Data-synthetic comparisons that require filtering
      f. Correlation functions
      g. ~~Metadata viewing and editing~~
      h. ~~QC report viewing and editing~~
      i. Add-on: Ability to view the ~~full~~ SEED header for a selected point
      j. Add-on: Ability to generate maps (option to be supported in the future)

or optionally

Main Frame Not popup

optional

fixed ~~Seed~~ miniseed header

viii. Actions
   1. General: Using a pointing device, the user will have ability to select one or more traces and a time span to perform one or more of the following operations (e.g., filtering and cross-correlation). The output from these operations is expected to be displayed in a pop-up window
   2. Fourier domain processing
      a. Provide the option of select from a pre-set collection of filters (to be specified later), the ability to select high and low corners, or to select no filtering operation
      b. Provide an option to allow/disallow spectral smoothing (spectral smoothing algorithm to be supplied by the USGS), with the default action of smoothing.

XYZ has it.

c. Provide an option to allow/disallow instrument deconvolution, with the default action of deconvolution.

always remove instrument

Seis tool does it.

d. Provide an option for convolving responses from a pre-set selection of generic instrument responses (to be specified later)

e. Provide optional pop-up window of the resulting spectra

   i. Add-on: Ability to display baseline spectra for selected channels. Baseline spectra will be provided in external XML files.

f. Provide optional pop-up window of the resulting timeseries

3. Rotation

   a. Provide for 3-D rotation, with the rotation of the horizontal traces the default, with user-specification of the angles of rotation. The rotation is computed from the orientation of the sensors as specified in the channel metadata.
   b. Provide a pre-set option to rotate the 3 components into the ray frame
   c. Provide a pre-set option to rotate the horizontals into the great-circle path
   d. Provide a pre-set option to rotate an STS-2 in U,V,W components
   e. Add-on option: Either as part of this option or as a separate tool, allow the user to specify a window on one of the traces and then minimize the energy in that window by a grid search over arrival azimuth.

Phase picking

4. Polarization

   a. Allow user to select a time window
   b. Display polarization plots for selected timeseries

5. Cross-correlation/Auto-correlation

   a. Allow user to select a time window
   b. Allow user to select an optional taper to be applied
   c. Display the resulting correlation function
   d. Display window should show peak amplitude and lag time
   e. Correlation can be applied to any two timeseries (including state-of-health timeseries)

ix. Save output – The GUI will allow the user to save output in multiple formats at different points in the operation

   1. Allow user control of file names and location for saving
   2. Selected traces should be saved as miniSEED or XML depending on whether the timeseries is evenly sampled or not.

            3. Spectra should be saved in XML or an "in the clear" format
            4. Images should be saved in a standard graphics format (e.g.,jpeg, gif, png).
    c. Metadata
        i. Ability to view channel metadata

Gone

        ii. Ability to edit selected metadata including items such as sensitivity of different stages, poles, zeros, orientation, depth, etc.
    d. Closeout
        i. Generate updated QC report
        ii. Update flow control
4. Other
    a. The main components of the software shall be open source
    b. The GUI shall run on the following platforms
        i. Solaris
        ii. Linux
        iii. OS X
    c. Flexibility to work on multiple screen types

Technical Specifications

1. Primary display operation should be no slower than the current implementation:
    a. Currently, it takes the xyz program approximately 10-12 seconds to display 10 days of "in the clear" data consisting of three 40sps channels and three 1sps channels
2. Limits (designed to accommodate regular QC usage)
    a. The GUI must be able to display at least 1200 timeseries segments
    b. The GUI must be able to display at least 30 days of timeseries (our QC analysts regularly look at 20 days of station data for stations with two broadband sensors).
    c. The GUI must be able to display at least 16 channels concurrently in each panel.(The intent here is to compare several data streams.)
    d. The GUI must be able to display at least 12-16 panels of data. (This requirement is a bit above the usual number that analysts currently use.)

<u>Task Description</u>

1. Finalize Functional and Technical Requirements:
   Working with USGS personnel in Golden and Albuquerque, the contractor will develop a final documented set of requirements. Implementation of the GUI will not begin until the COR has signed off on the Requirements document.

Lind.

2. Implement QC GUI;
   Implementation of the GUI will follow the schedule set forth in the Milestones section.

<u>Milestones: all dates relative to contract signing.</u>

1. Planning
    a. Finalize specifications: within 1 month
        i. USGS will provide relevant formats and protocols

    b. Design review: within 2 months
    c. GUI mockup review: within 3 months
2. Implementation
    a. USGS will deliver relevant test data sets: 3 months
    b. First progress review: 6 months
    c. Second progress review: 8 months
    d. Prototype demonstrated: 10 months
    e. Final version delivered: end of contract
3. Evaluation: end of contract
        i. Review documentation
        ii. Test software
            1. Test data set provided by USGS

Property Rights

The contractor is aware that the DOI will own the intellectual property rights to any software developed on its behalf to the maximum extent practical. Generally, FAR 52.227-14, Rights in Data-General, and its alternates will be used in the contract.

As part of this development, source code for the current USGS QC program, "xyz", will be provided to the vendor.

Figures

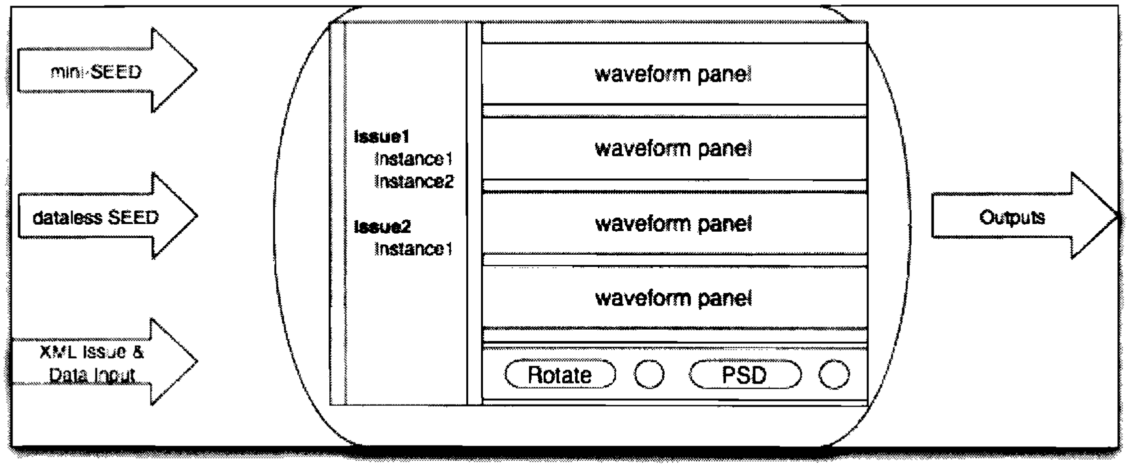
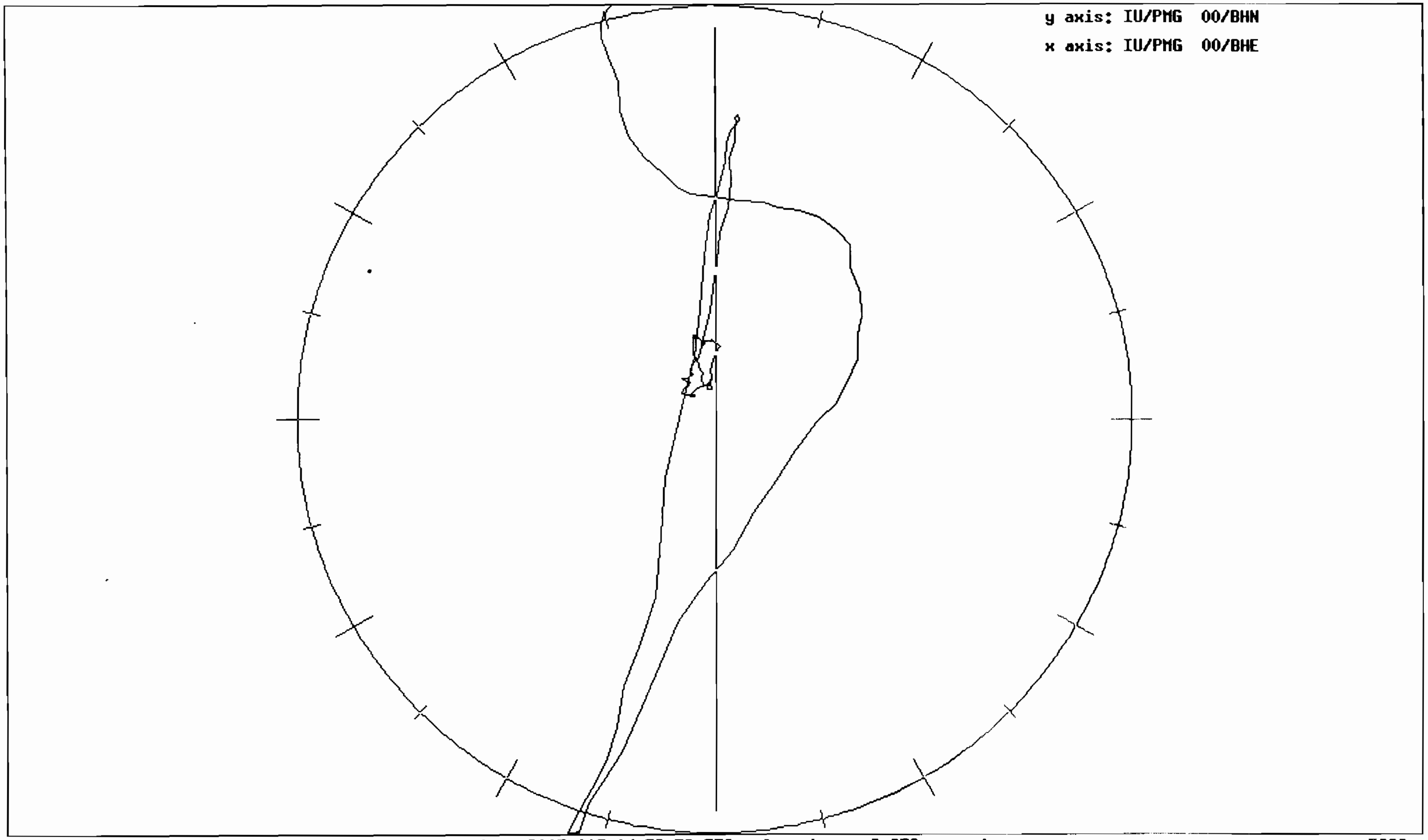


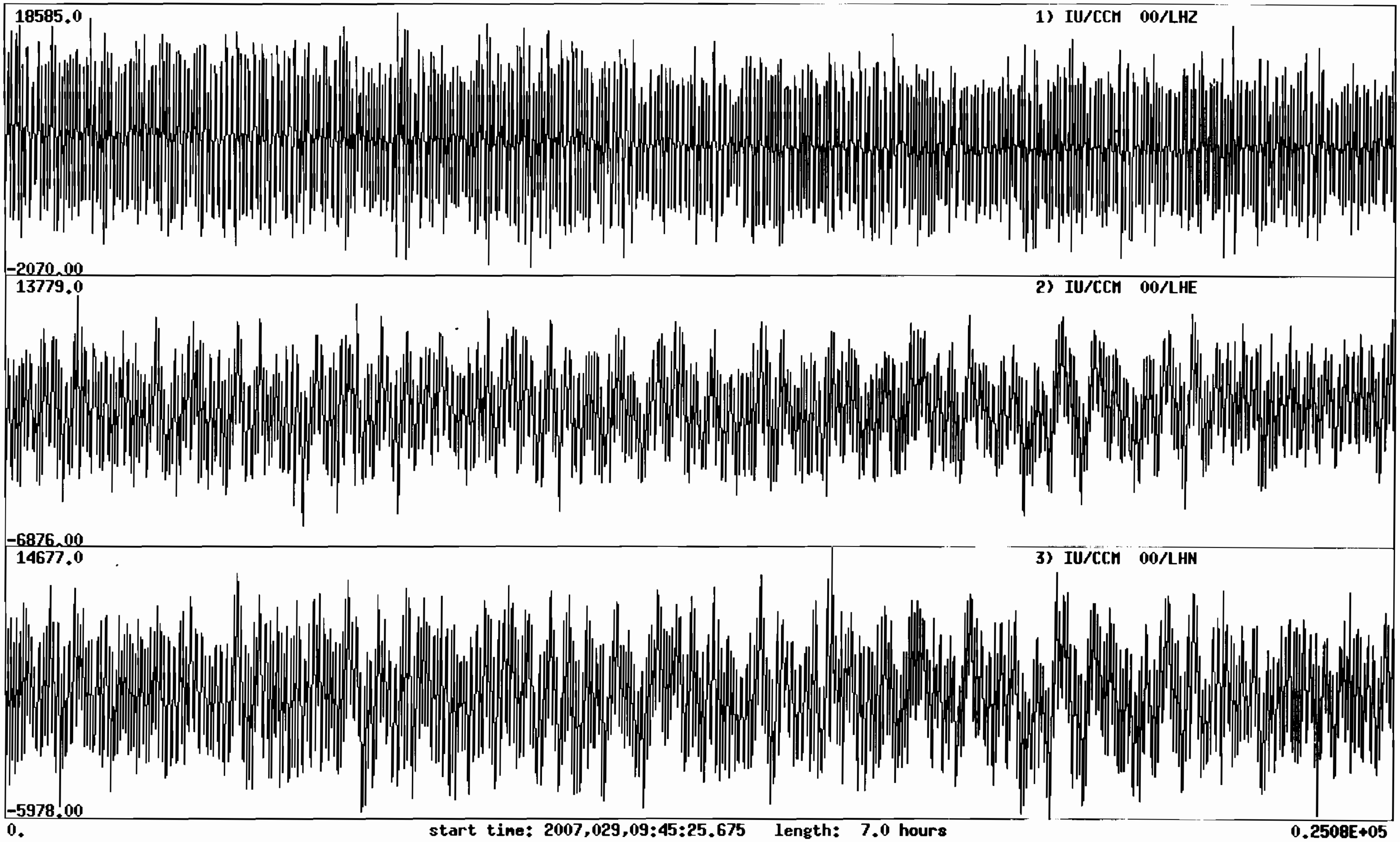
Figure 1 This mock-up gives a visual image to the suggested form of the GUI display. The buttons designated "Rotate" and "PSD" represent a method to request actions.



-4897. start time: 2007,013,04:32:58.352 length: 6.238 seconds 5929.

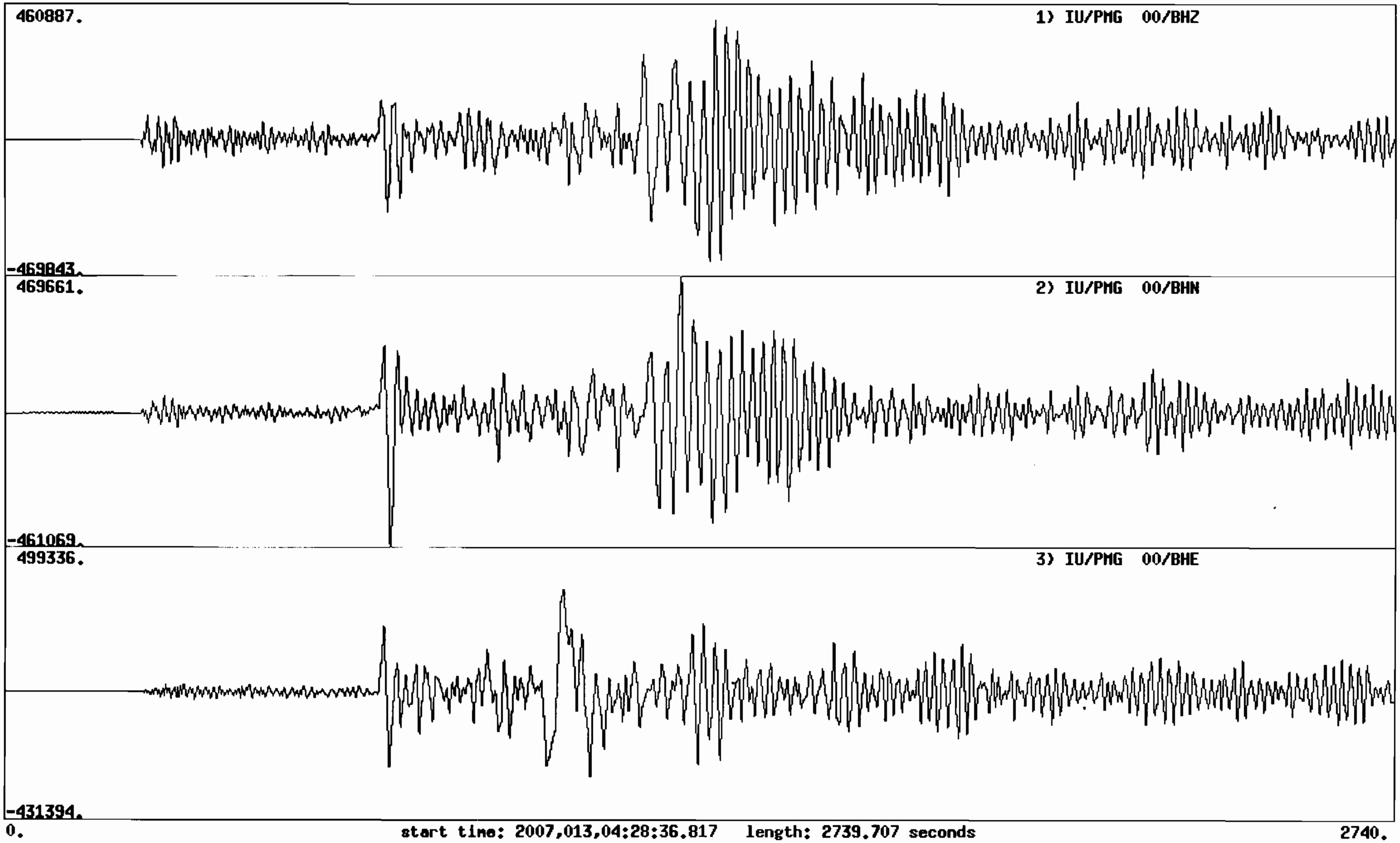
reference line: 0.0 degrees 180.0 degrees
reference line: 0.0 degrees 180.0 degrees
GFS file: data_IU_PMG_00185.gfs

A) 1 deg B) 5 deg C) 30 deg	A) -1 deg B) -5 deg C) -30 deg	enter angle	hardcopy
return			



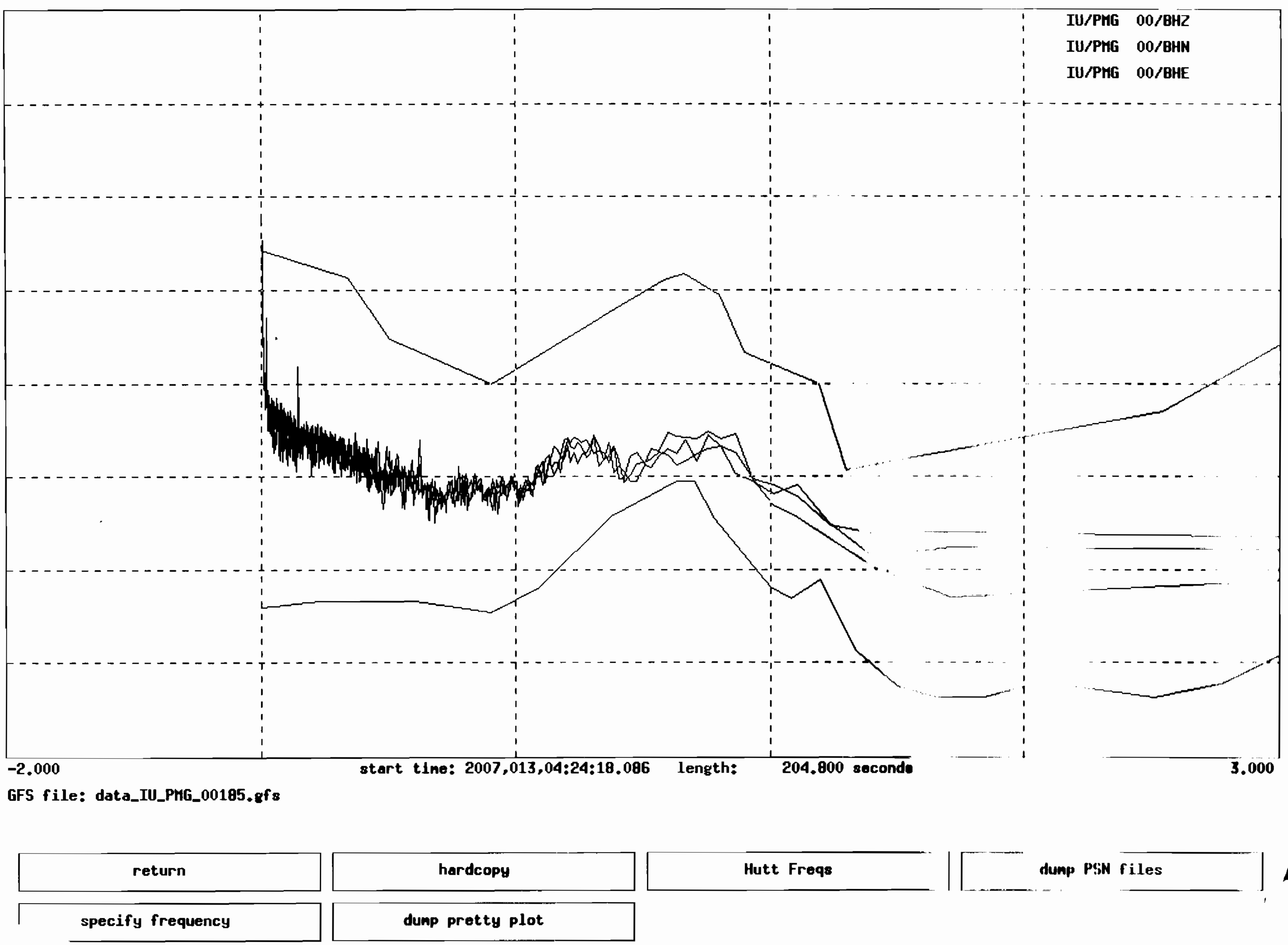
dumping to gfs file: 83) IU ,CCM ,LHE
dumping to gfs file: 257) IU ,CCM ,LHN
GFS file: tele.gfs

PLT: A) plot B) sel C) ovr	DMP: A) SAC B) GFS C) ASCII	A) hardcopy B) pretty plot	SCL: A) auto B) com C) xhair
A) next+plot B) next C) back	quit	A) offset B) ttpick C) delpick	A) PPM B) PSD C) RESP
TOG: A) phases B) color C) mean	PHS: A) + B) - C) EQ ID	FLTR: A) lp B) bp C) dyo	LIM: A) xlim B) ylim



station: IU/PMG channels: 00/VHE 00/VHN 00/VHZ 00/VE1 00/VMN 10/VMZ 10/VME 00/VMZ 00/VME 10/VMN 00/VK1 10/BHN 10/BHE 10/BHZ 00/BHE 00/BHZ 00/B
specify panels to plot: 7 8 9
GFS file: data_IU_PMG_00185.gfs

PLT: A) plot B) sel C) ovr	DMP: A) SAC B) GFS C) ASCII	A) hardcopy B) pretty plot	SCL: A) auto B) com C) xhair
A) next+plot B) next C) back	quit	A) offset B) ttpick C) delpick	A) PPM B) PSD C) RESP
TOG: A) phases B) color C) mean	PHS: A) + B) - C) EQ ID	FLTR: A) lp B) bp C) dyo	LIM: A) xlim B) ylim



IU/PMG 00/BHZ
IU/PMG 00/BHN
IU/PMG 00/BHE
-2.000
start time: 2007,013,04:24:18.086 length: 204.800 seconds
3.000
GFS file: data_IU_PMG_00185.gfs
return
hardcopy
Hutt Freqs
dump PSN files
specify frequency
dump pretty plot