Exceptional service in the national interest

SAND2016-3608PE

Sandia National Laboratories

USER INTERFACE STORYBOARDS

Measures Signal Features

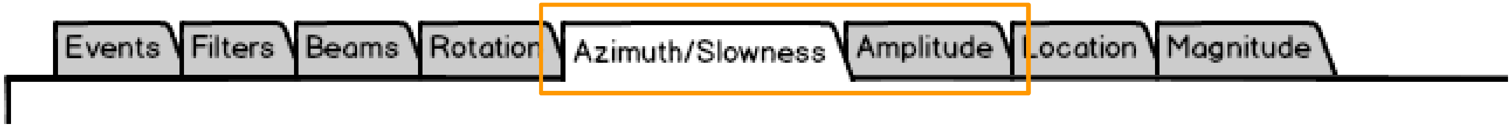
Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

Brief Description

This use case describes how the Analyst measures signal features on waveform data. The Analyst measures the same signal features as are measured in pipeline processing (see ‘System Measures Signal Features’ UC), but the Analyst has the option to select the input parameters rather than the predefined parameters used during pipeline processing.

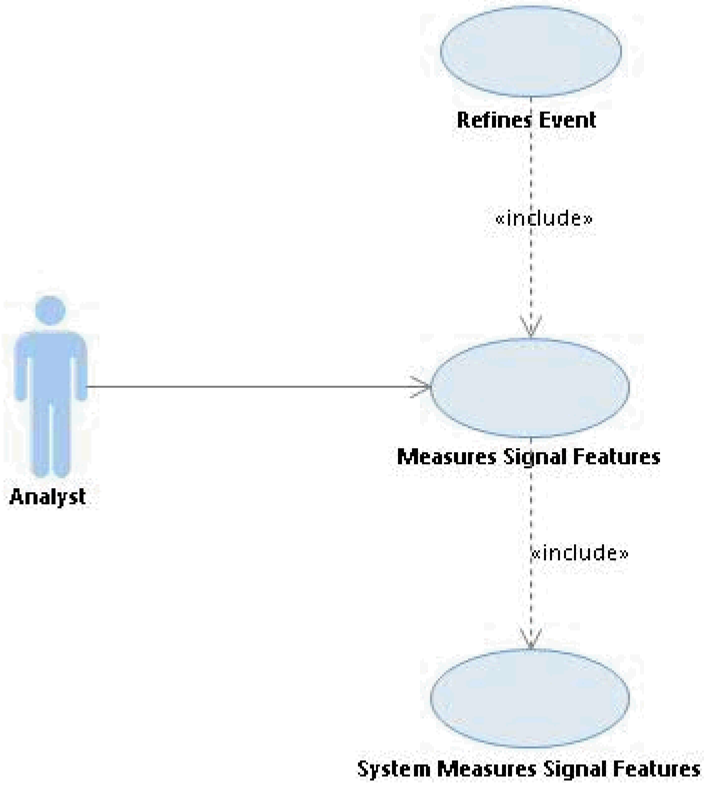
Overview

- The Analyst accesses the displays represented by these storyboards by opening the Analyst workspace (Analyzes Events UC), selecting data for analysis (Selects Data for Analysis UC), and selecting an event to refine (Refines Event UC).
- Alternatively, the Analyst can measure signal features outside the context of a specific event, for example when scanning (see Scans Waveforms and Unassociated Detections UIS).

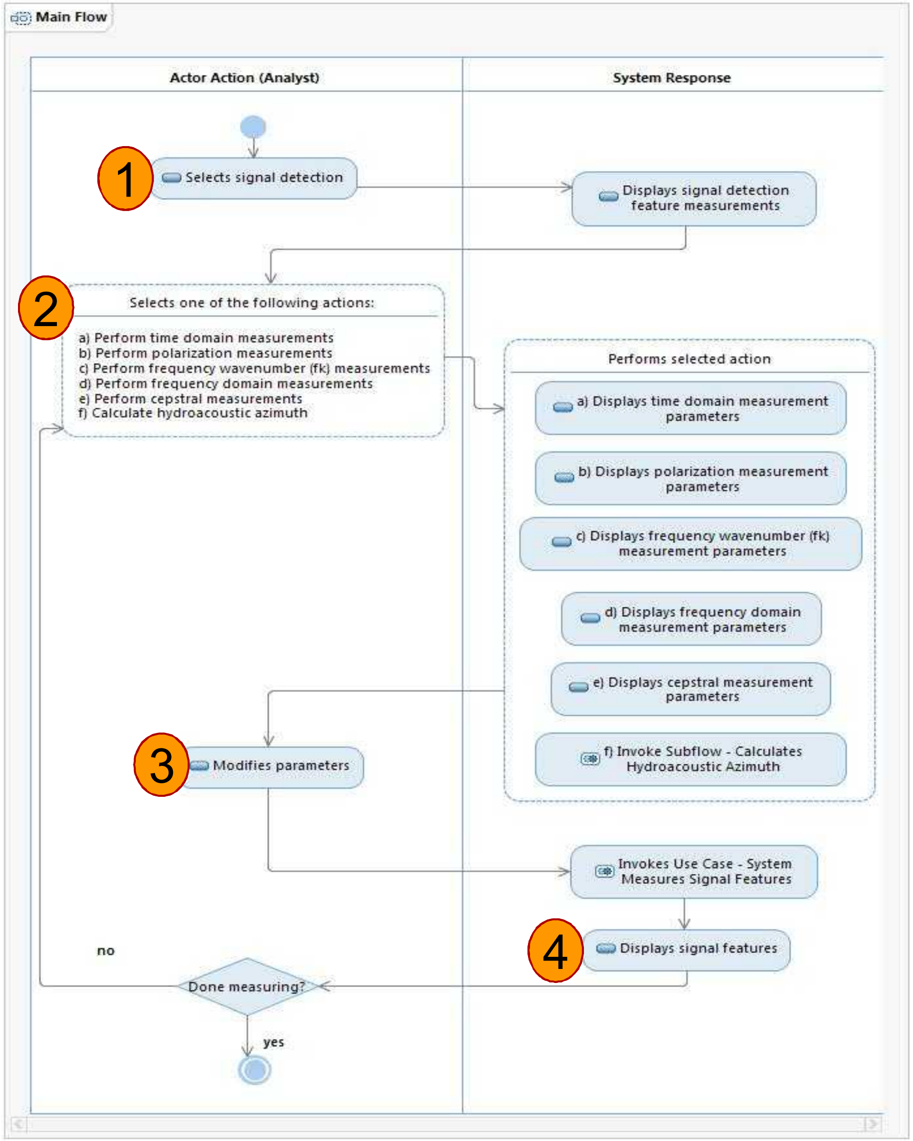

Events
Filters
Beams
Rotation
Azimuth/Slowness
Amplitude
Location
Magnitude

- Azimuth/slowness signal features are measured via the Azimuth/Slowness tab in the Analyst Workspace
- Amplitude signal features are measured via the Amplitude tab

Measures Signal Features: Use Case

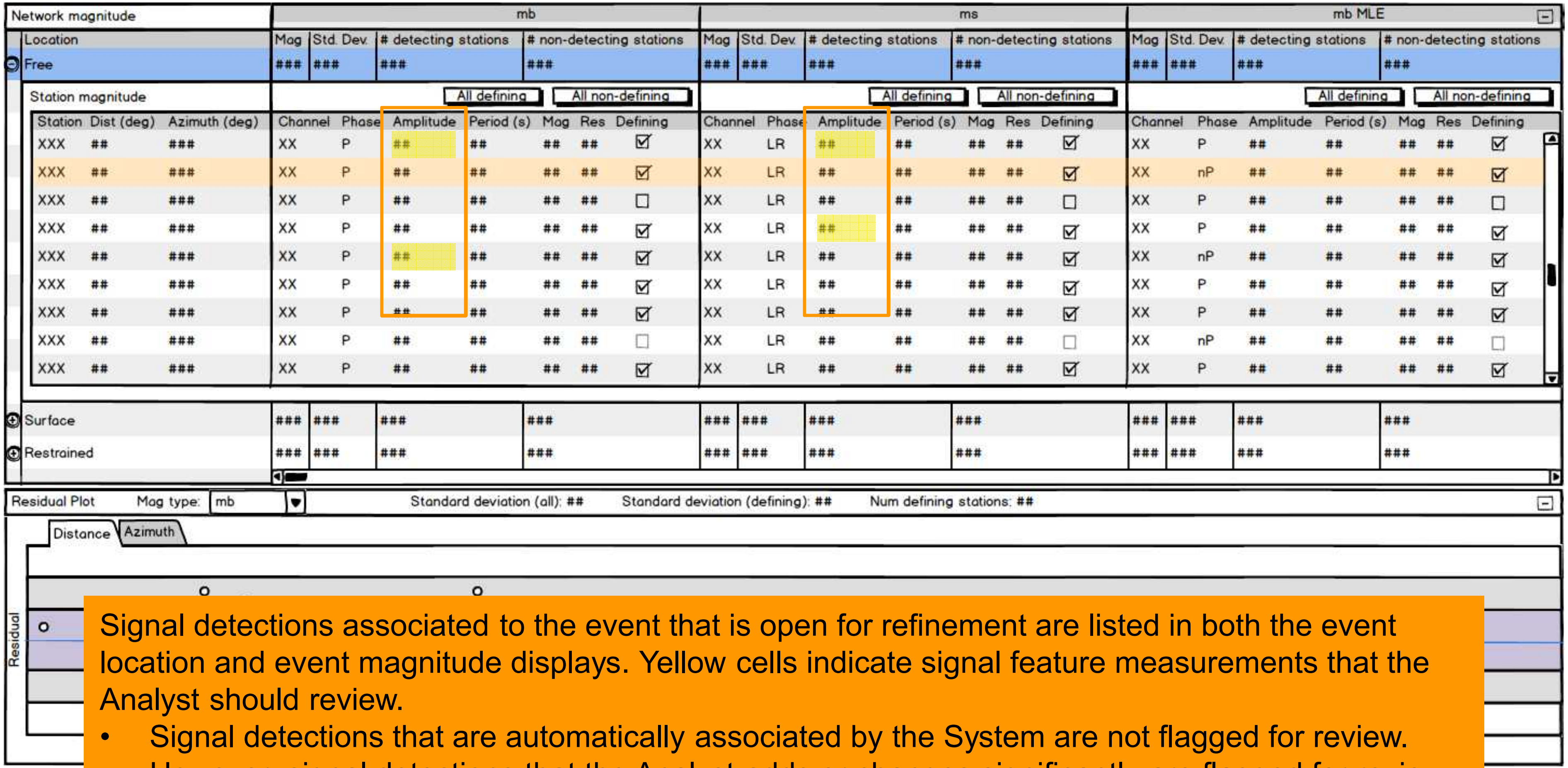

Refines Event
«include»
Analyst
Measures Signal Features
«include»
System Measures Signal Features

Main Flow


Main Flow
Actor Action (Analyst)
System Response
1
Selects signal detection
Displays signal detection feature measurements
2
Selects one of the following actions:
a) Perform time domain measurements
b) Perform polarization measurements
c) Perform frequency wavenumber (fk) measurements
d) Perform frequency domain measurements
e) Perform cepstral measurements
f) Calculate hydroacoustic azimuth
Performs selected action
a) Displays time domain measurement parameters
b) Displays polarization measurement parameters
c) Displays frequency wavenumber (fk) measurement parameters
d) Displays frequency domain measurement parameters
e) Displays cepstral measurement parameters
f) Invoke Subflow - Calculates Hydroacoustic Azimuth
3
Modifies parameters
Invokes Use Case - System Measures Signal Features
4
Displays signal features
no
Done measuring?
yes

1) Selects signal detection
2) Selects one of the following actions:
   a. Perform time domain measurements
   b. Perform polarization measurements
   c. Perform frequency wavenumber (fk) measurements
   d. Perform frequency domain measurements
   e. Perform cepstral measurements
   f. Calculate hydroacoustic azimuth (subflow)
3) Modifies parameters
4) Displays signal features

1) Selects signal detection



Network magnitude	mb				ms				mb MLE			
Location	Mag	Std. Dev.	# detecting stations	# non-detecting stations	Mag	Std. Dev.	# detecting stations	# non-detecting stations	Mag	Std. Dev.	# detecting stations	# non-detecting stations
Free	###	###	###	###	###	###	###	###	###	###	###	###
Surface	###	###	###	###	###	###	###	###	###	###	###	###
Restrained	###	###	###	###	###	###	###	###	###	###	###	###

Station magnitude

All defining | All non-defining (mb) · All defining | All non-defining (ms) · All defining | All non-defining (mb MLE)

Station	Dist (deg)	Azimuth (deg)	Channel	Phase	Amplitude	Period (s)	Mag	Res	Defining	Channel	Phase	Amplitude	Period (s)	Mag	Res	Defining	Channel	Phase	Amplitude	Period (s)	Mag	Res	Defining
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	nP	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☐	XX	LR	##	##	##	##	☐	XX	P	##	##	##	##	☐
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	nP	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☐	XX	LR	##	##	##	##	☐	XX	nP	##	##	##	##	☐
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑

Residual Plot Mag type: mb Standard deviation (all): ## Standard deviation (defining): ## Num defining stations: ##

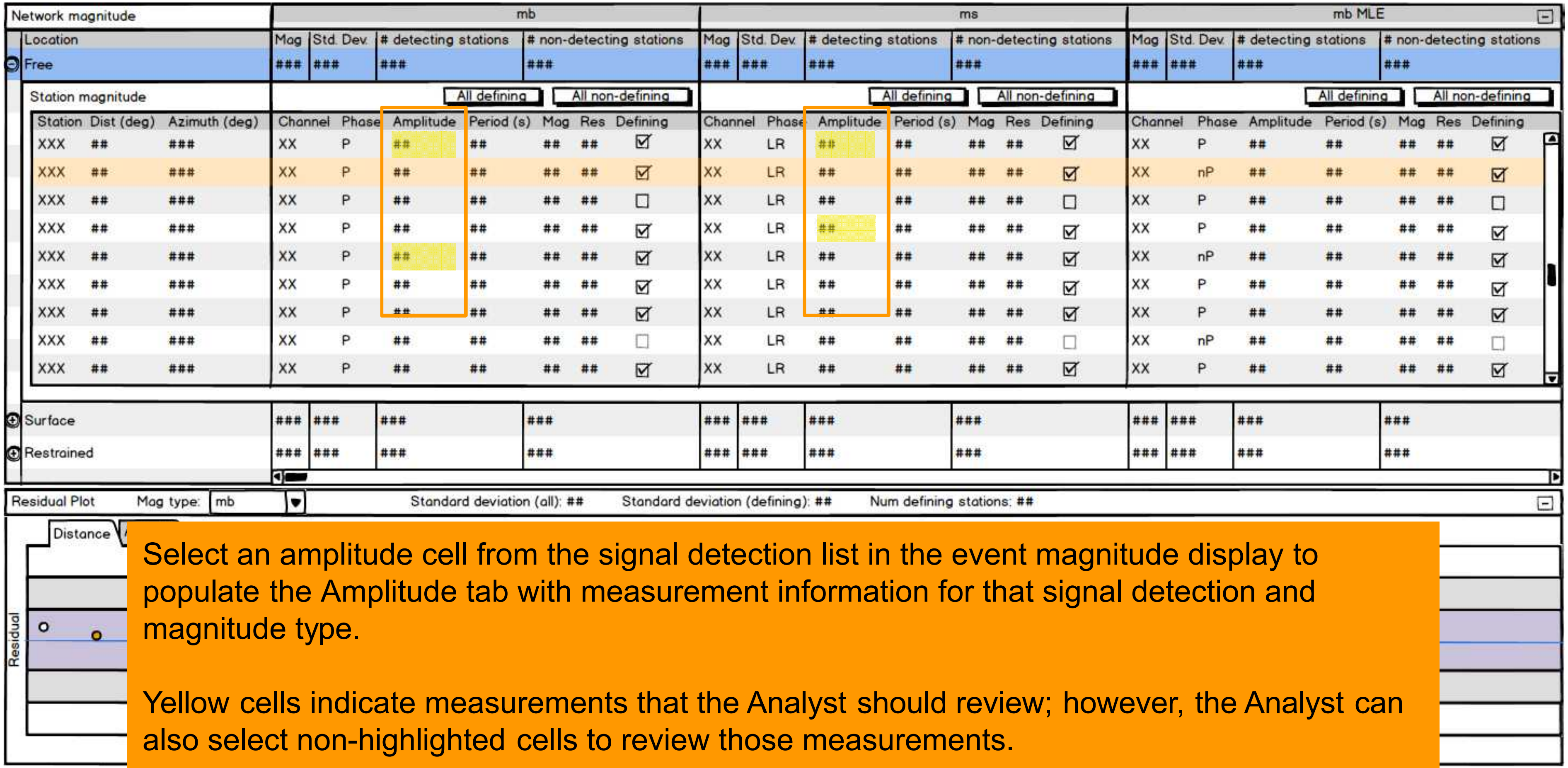
Signal detections associated to the event that is open for refinement are listed in both the event location and event magnitude displays. Yellow cells indicate signal feature measurements that the Analyst should review.

- Signal detections that are automatically associated by the System are not flagged for review. However, signal detections that the Analyst adds or changes significantly are flagged for review.
- Yellow highlighted cells are a warning only. They do not prevent the Analyst from saving the event or marking it as complete.

Amplitude

PERFORM TIME AND FREQUENCY DOMAIN MEASUREMENTS

2a, d) Time and frequency domain: Amplitude



Network magnitude	mb				ms				mb MLE			
Location	Mag	Std. Dev.	# detecting stations	# non-detecting stations	Mag	Std. Dev.	# detecting stations	# non-detecting stations	Mag	Std. Dev.	# detecting stations	# non-detecting stations
Free	###	###	###	###	###	###	###	###	###	###	###	###
Surface	###	###	###	###	###	###	###	###	###	###	###	###
Restrained	###	###	###	###	###	###	###	###	###	###	###	###

Station magnitude

All defining | All non-defining (mb) — All defining | All non-defining (ms) — All defining | All non-defining (mb MLE)

Station	Dist (deg)	Azimuth (deg)	Channel	Phase	Amplitude	Period (s)	Mag	Res	Defining	Channel	Phase	Amplitude	Period (s)	Mag	Res	Defining	Channel	Phase	Amplitude	Period (s)	Mag	Res	Defining
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	nP	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☐	XX	LR	##	##	##	##	☐	XX	P	##	##	##	##	☐
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	nP	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☐	XX	LR	##	##	##	##	☐	XX	nP	##	##	##	##	☐
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑

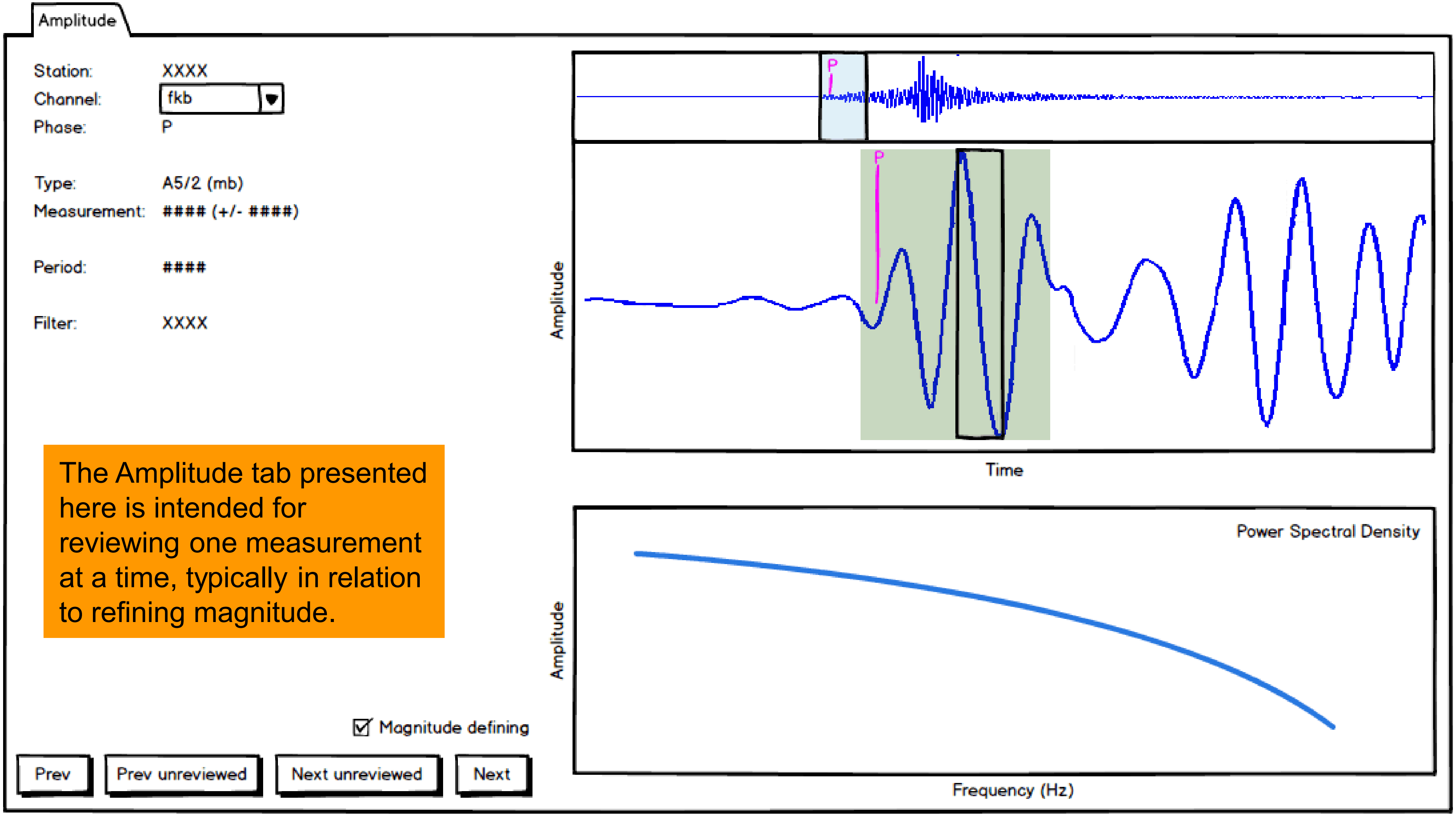
Residual Plot Mag type: mb ▾ Standard deviation (all): ## Standard deviation (defining): ## Num defining stations: ##

Select an amplitude cell from the signal detection list in the event magnitude display to populate the Amplitude tab with measurement information for that signal detection and magnitude type.

Yellow cells indicate measurements that the Analyst should review; however, the Analyst can also select non-highlighted cells to review those measurements.

See Refines Event Magnitude UIS for more information about the event magnitude display.

2a, d) Time and frequency domain: Amplitude



Station: XXXX
Channel: fkb
Phase: P

Type: A5/2 (mb)
Measurement: #### (+/- ####)

Period: ####

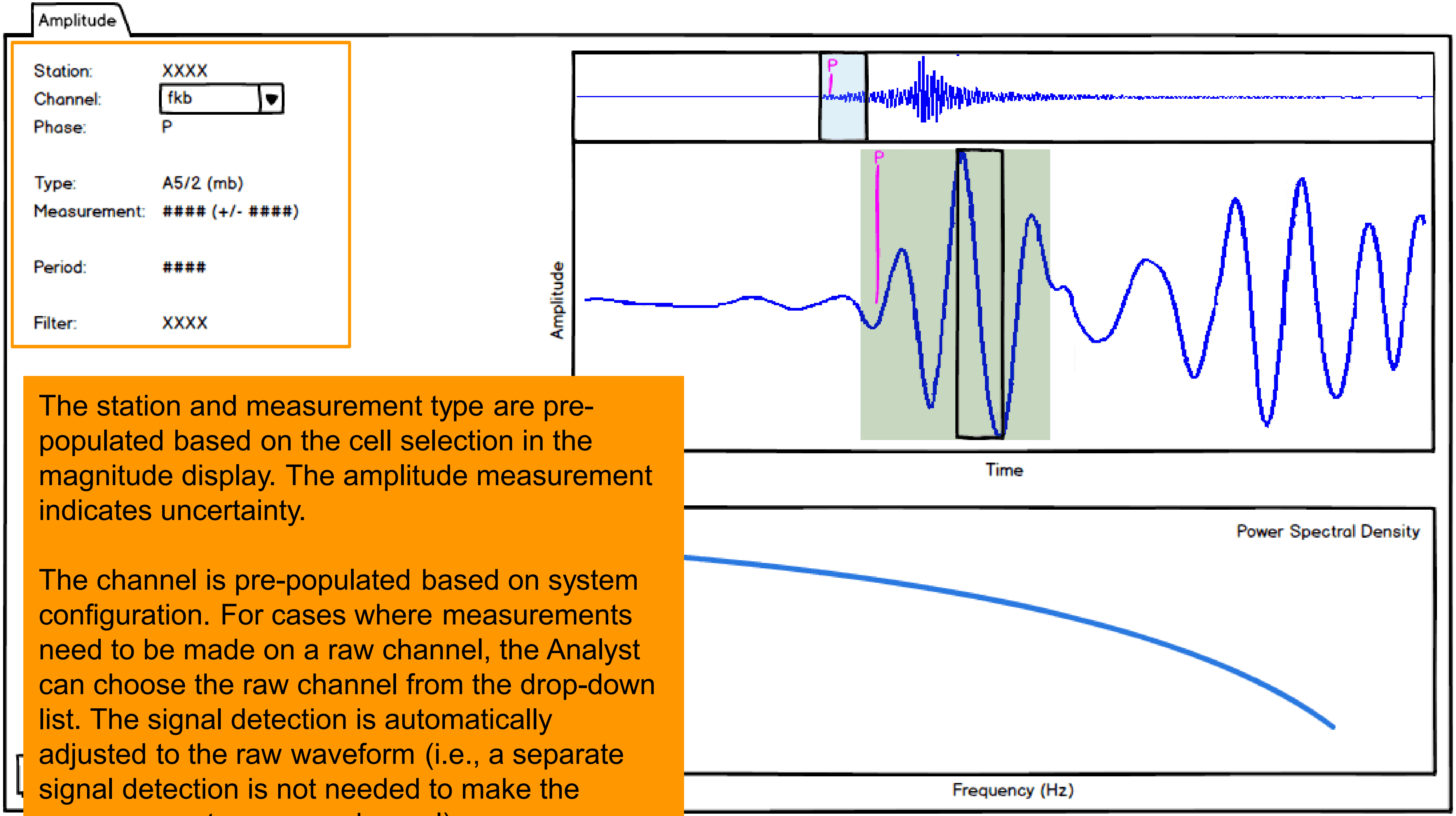
Filter: XXXX

☑ Magnitude defining

Amplitude
P
P
Amplitude
Time
Power Spectral Density
Amplitude
Frequency (Hz)
Prev
Prev unreviewed
Next unreviewed
Next

The Amplitude tab presented here is intended for reviewing one measurement at a time, typically in relation to refining magnitude.

2a, d) Time and frequency domain: Amplitude



Station: XXXX
Channel: fkb
Phase: P

Type: A5/2 (mb)
Measurement: #### (+/- ####)

Period: ####

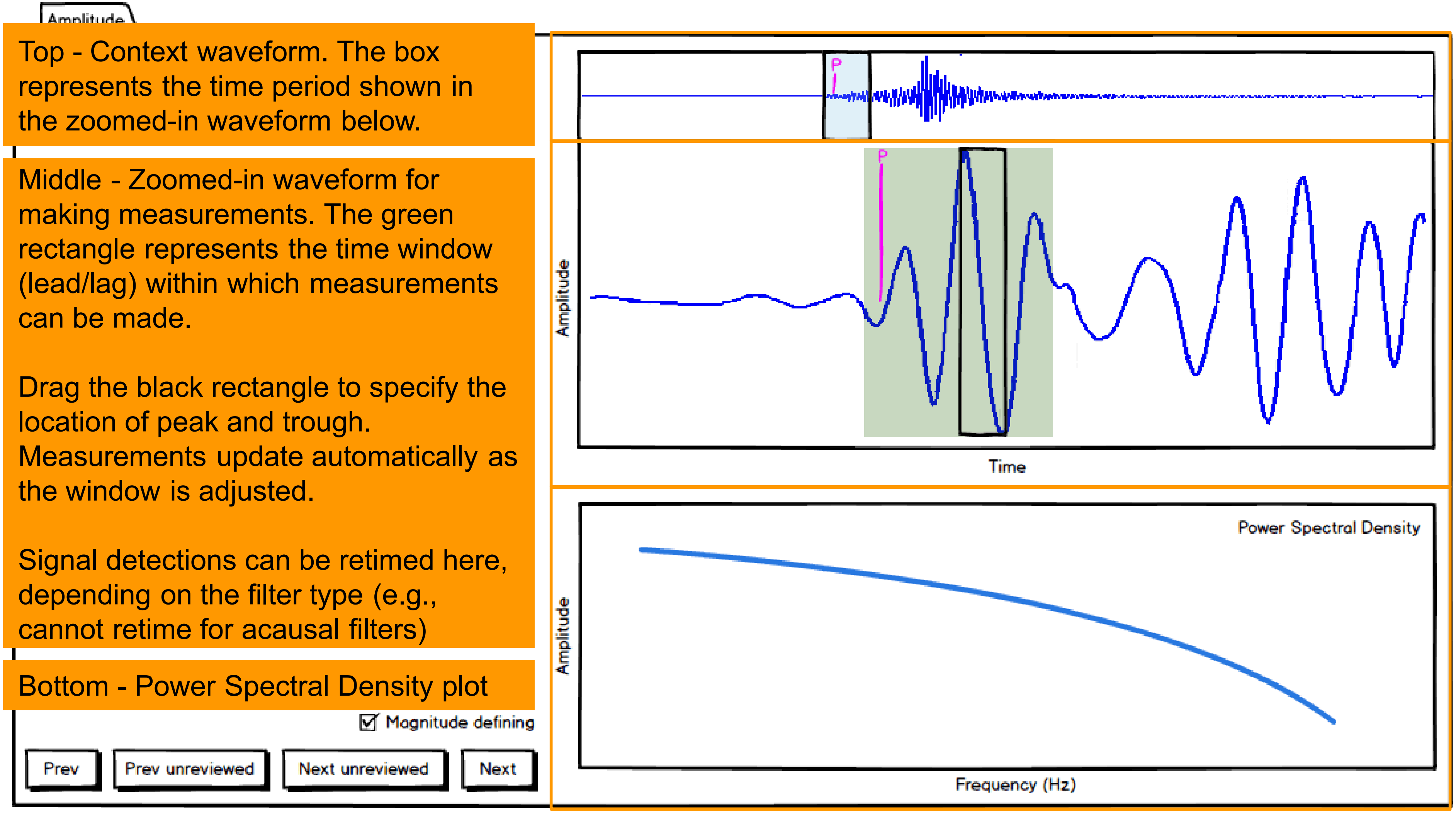
Filter: XXXX

The station and measurement type are pre-populated based on the cell selection in the magnitude display. The amplitude measurement indicates uncertainty.

The channel is pre-populated based on system configuration. For cases where measurements need to be made on a raw channel, the Analyst can choose the raw channel from the drop-down list. The signal detection is automatically adjusted to the raw waveform (i.e., a separate signal detection is not needed to make the measurement on a raw channel).

3) Modifies parameters

Amplitude measurements are shown in both the time and frequency domains.


Amplitude
P
P
Amplitude
Time
Power Spectral Density
Amplitude
Frequency (Hz)
☑ Magnitude defining
Prev
Prev unreviewed
Next unreviewed
Next

Top - Context waveform. The box represents the time period shown in the zoomed-in waveform below.

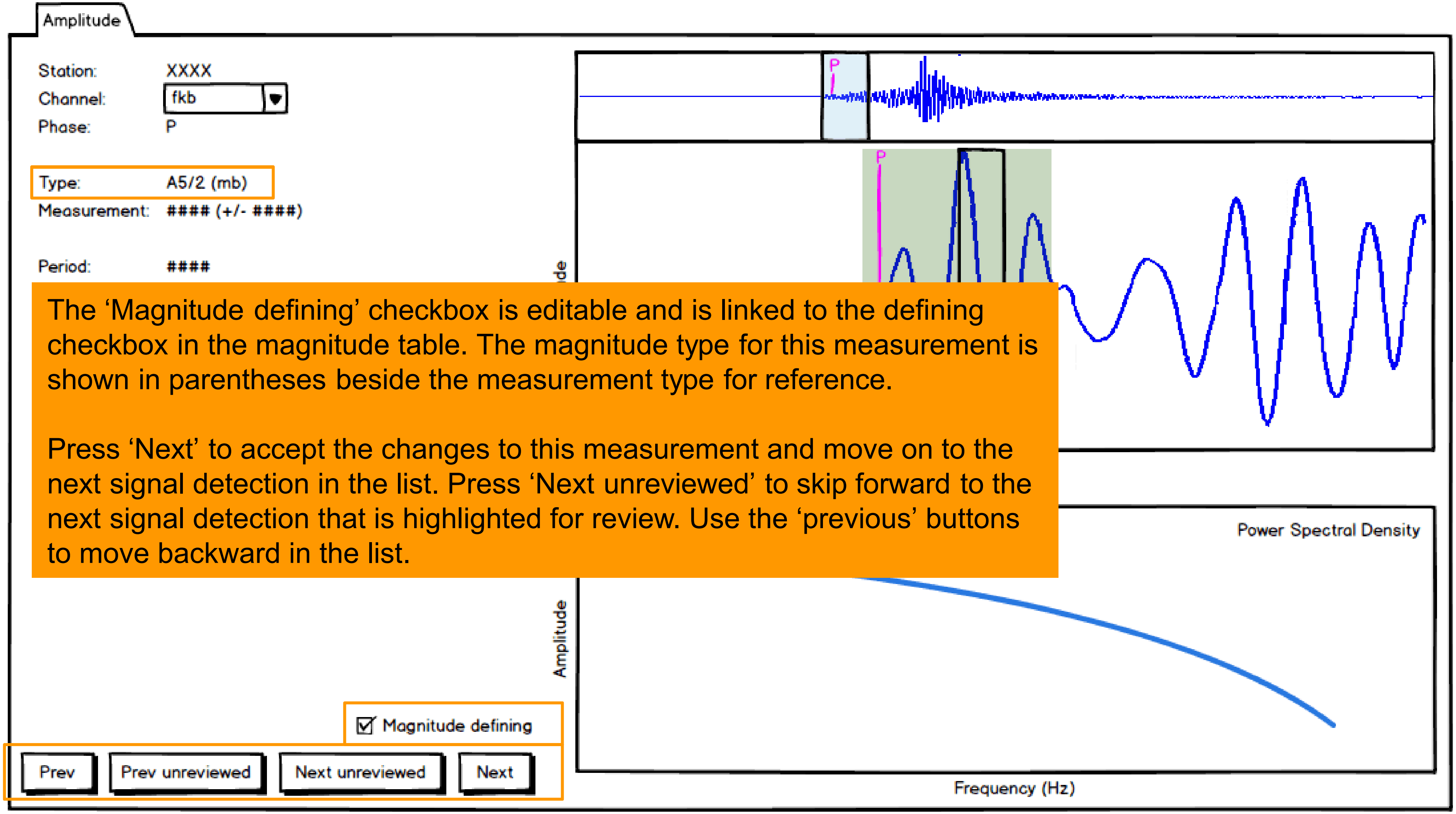
Middle - Zoomed-in waveform for making measurements. The green rectangle represents the time window (lead/lag) within which measurements can be made.

Drag the black rectangle to specify the location of peak and trough. Measurements update automatically as the window is adjusted.

Signal detections can be retimed here, depending on the filter type (e.g., cannot retime for acausal filters)

Bottom - Power Spectral Density plot

4) Displays updated signal features



Station: XXXX
Channel: fkb
Phase: P

Type: A5/2 (mb)
Measurement: #### (+/- ####)

Period: ####

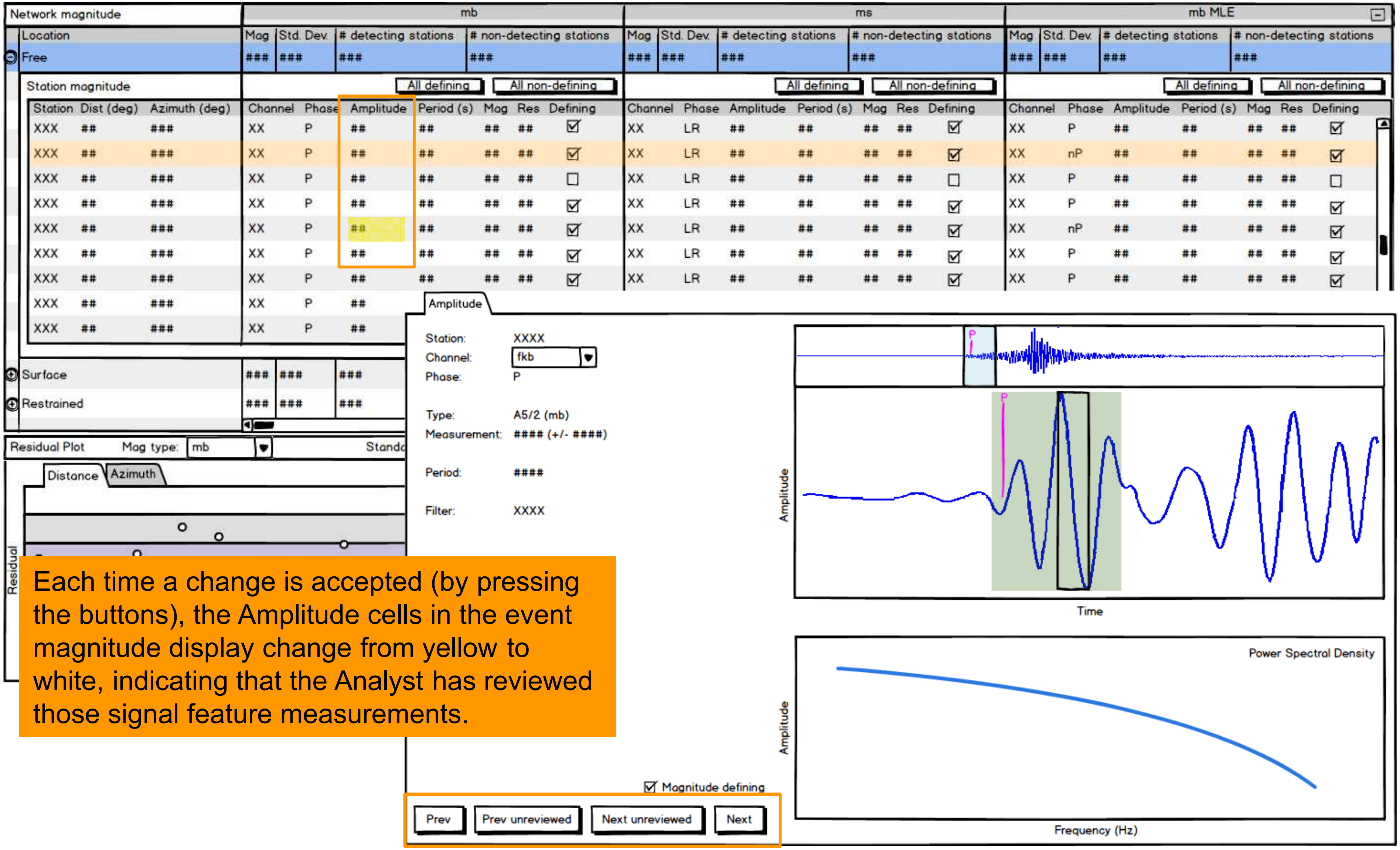
☑ Magnitude defining

Amplitude
P
P
Amplitude
Power Spectral Density
Frequency (Hz)
Prev
Prev unreviewed
Next unreviewed
Next

The ‘Magnitude defining’ checkbox is editable and is linked to the defining checkbox in the magnitude table. The magnitude type for this measurement is shown in parentheses beside the measurement type for reference.

Press ‘Next’ to accept the changes to this measurement and move on to the next signal detection in the list. Press ‘Next unreviewed’ to skip forward to the next signal detection that is highlighted for review. Use the ‘previous’ buttons to move backward in the list.

4) Displays updated signal features



Network magnitude	mb				ms				mb MLE			
Location	Mag	Std. Dev	# detecting stations	# non-detecting stations	Mag	Std. Dev	# detecting stations	# non-detecting stations	Mag	Std. Dev	# detecting stations	# non-detecting stations
Free	###	###	###	###	###	###	###	###	###	###	###	###
Surface	###	###	###									
Restrained	###	###	###									

Station magnitude

Station	Dist (deg)	Azimuth (deg)	Channel	Phase	Amplitude	Period (s)	Mag	Res	Defining	Channel	Phase	Amplitude	Period (s)	Mag	Res	Defining	Channel	Phase	Amplitude	Period (s)	Mag	Res	Defining
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	nP	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☐	XX	LR	##	##	##	##	☐	XX	P	##	##	##	##	☐
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	nP	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑
XXX	##	###	XX	P	##	##	##	##	☑	XX	LR	##	##	##	##	☑	XX	P	##	##	##	##	☑
XXX	##	###	XX	P	##																		
XXX	##	###	XX	P	##																		

Residual Plot Mag type: mb

Amplitude

Station: XXXX
Channel: fkb
Phase: P

Type: A5/2 (mb)
Measurement: #### (+/- ####)

Period: ####

Filter: XXXX

☑ Magnitude defining

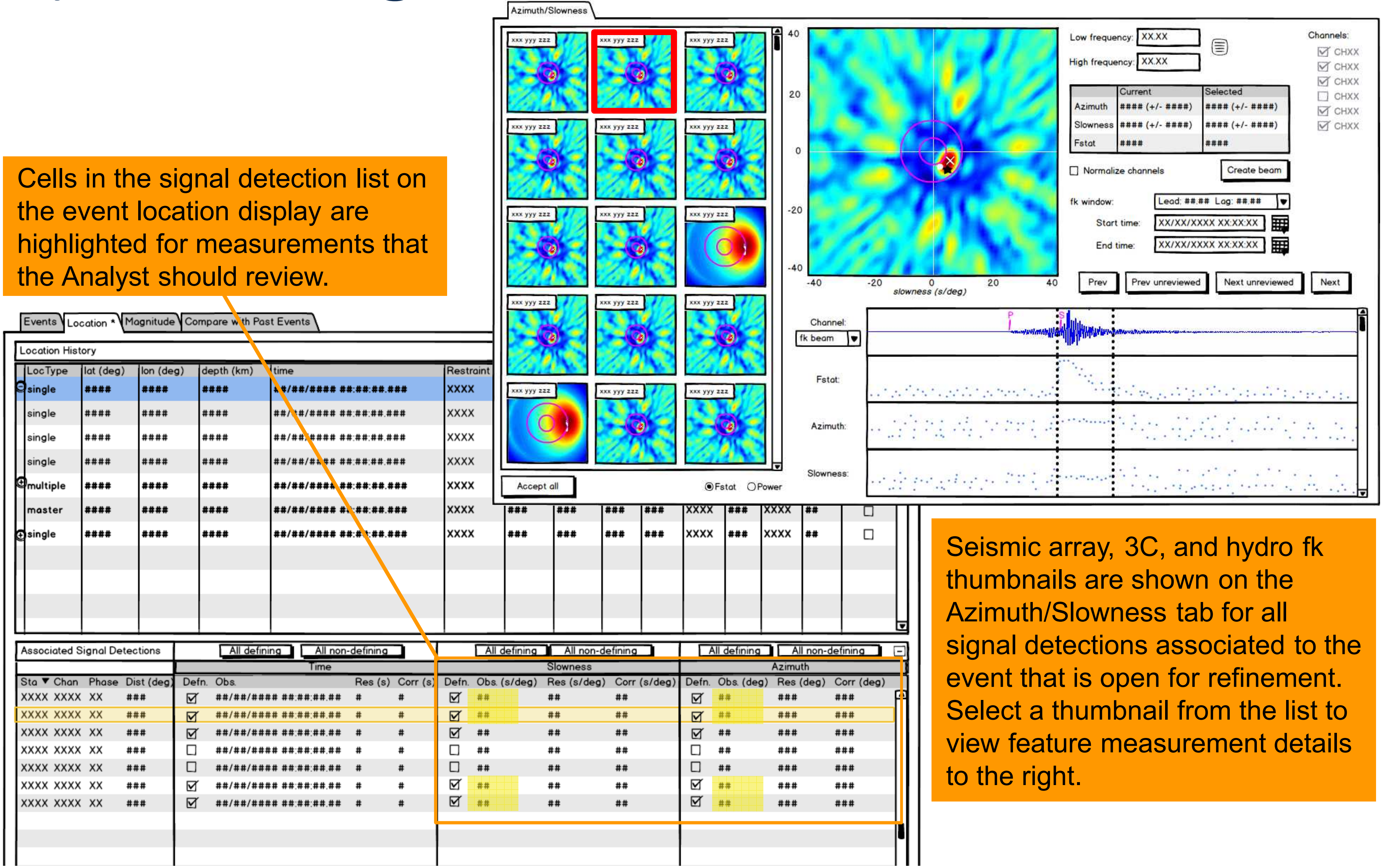
All defining
All non-defining
Stando
Distance
Azimuth
Residual
P
Amplitude
Time
Power Spectral Density
Amplitude
Frequency (Hz)
Prev
Prev unreviewed
Next unreviewed
Next

Each time a change is accepted (by pressing the buttons), the Amplitude cells in the event magnitude display change from yellow to white, indicating that the Analyst has reviewed those signal feature measurements.

Azimuth/Slowness

PERFORM FREQUENCY WAVENUMBER MEASUREMENTS

1) Selects signal detection


Azimuth/Slowness
xxx yyy zzz
40
20
0
-20
-40
slowness (s/deg)
Accept all
Channel:
fk beam
Fstat:
Azimuth:
Slowness:
P
S
Events
Location *
Magnitude
Compare with Past Events
All defining
All non-defining
Create beam
Prev
Prev unreviewed
Next unreviewed
Next

Cells in the signal detection list on the event location display are highlighted for measurements that the Analyst should review.

● Fstat ○ Power

Low frequency: XX.XX

High frequency: XX.XX

	Current	Selected
Azimuth	#### (+/- ####)	#### (+/- ####)
Slowness	#### (+/- ####)	#### (+/- ####)
Fstat	####	####

☐ Normalize channels

fk window: Lead: ##.## Lag: ##.##

Start time: XX/XX/XXXX XX:XX:XX

End time: XX/XX/XXXX XX:XX:XX

Channels:
☑ CHXX
☑ CHXX
☑ CHXX
☐ CHXX
☑ CHXX
☑ CHXX

Location History

LocType	lat (deg)	lon (deg)	depth (km)	time	Restraint									
single	####	####	####	##/##/#### ##:##:##.###	XXXX									
single	####	####	####	##/##/#### ##:##:##.###	XXXX									
single	####	####	####	##/##/#### ##:##:##.###	XXXX									
single	####	####	####	##/##/#### ##:##:##.###	XXXX									
multiple	####	####	####	##/##/#### ##:##:##.###	XXXX									
master	####	####	####	##/##/#### ##:##:##.###	XXXX	###	###	###	###	XXXX	###	XXXX	##	☐
single	####	####	####	##/##/#### ##:##:##.###	XXXX	###	###	###	###	XXXX	###	XXXX	##	☐

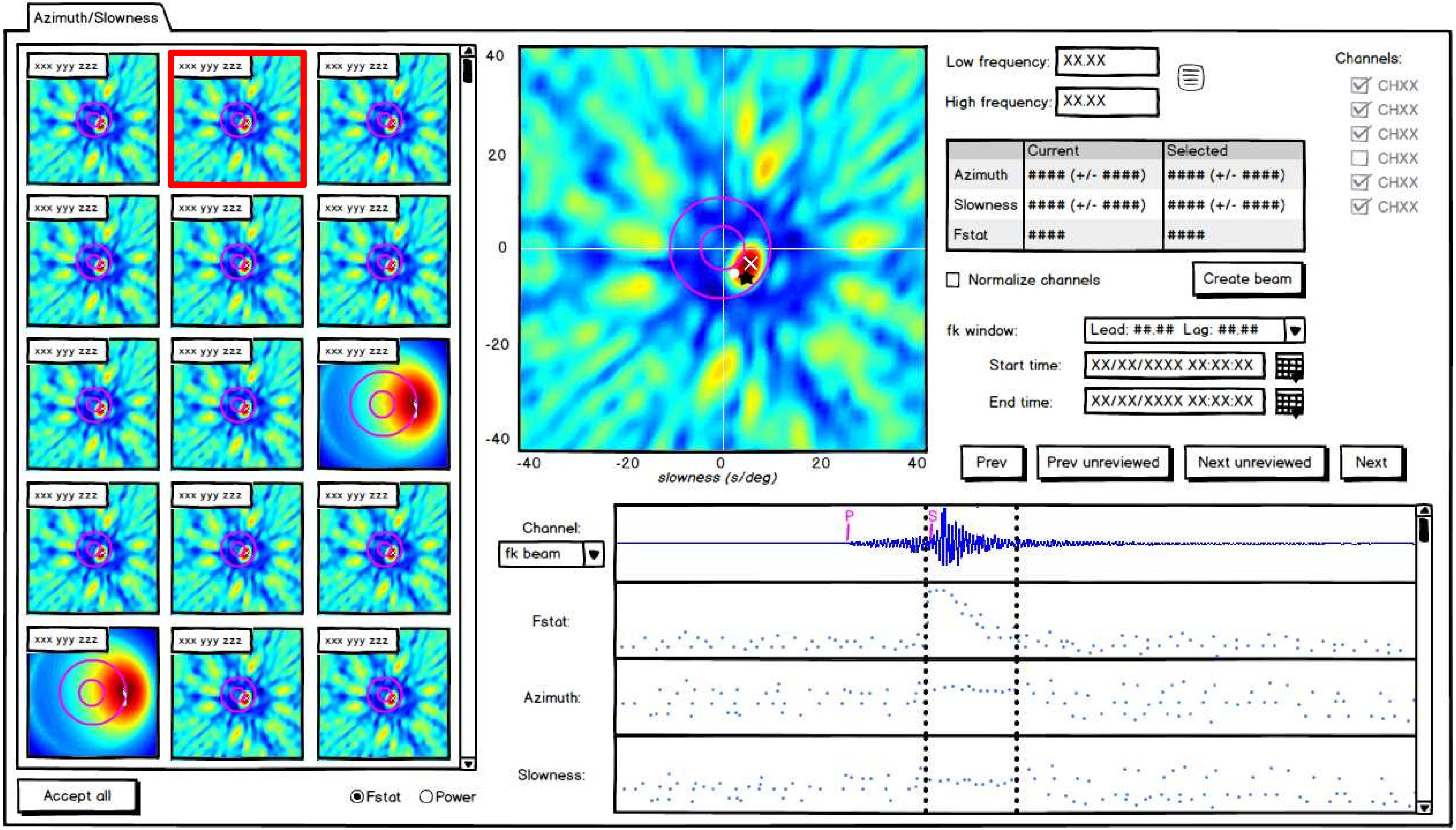
Associated Signal Detections

				Time				Slowness				Azimuth			
Sta ▼	Chan	Phase	Dist (deg)	Defn.	Obs.	Res (s)	Corr (s)	Defn.	Obs. (s/deg)	Res (s/deg)	Corr (s/deg)	Defn.	Obs. (deg)	Res (deg)	Corr (deg)
XXXX	XXXX	XX	###	☑	##/##/#### ##:##:##.##	#	#	☑	##	##	##	☑	##	###	###
XXXX	XXXX	XX	###	☑	##/##/#### ##:##:##.##	#	#	☑	##	##	##	☑	##	###	###
XXXX	XXXX	XX	###	☑	##/##/#### ##:##:##.##	#	#	☑	##	##	##	☑	##	###	###
XXXX	XXXX	XX	###	☐	##/##/#### ##:##:##.##	#	#	☐	##	##	##	☐	##	###	###
XXXX	XXXX	XX	###	☐	##/##/#### ##:##:##.##	#	#	☐	##	##	##	☐	##	###	###
XXXX	XXXX	XX	###	☑	##/##/#### ##:##:##.##	#	#	☑	##	##	##	☑	##	###	###
XXXX	XXXX	XX	###	☑	##/##/#### ##:##:##.##	#	#	☑	##	##	##	☑	##	###	###

Seismic array, 3C, and hydro fk thumbnails are shown on the Azimuth/Slowness tab for all signal detections associated to the event that is open for refinement. Select a thumbnail from the list to view feature measurement details to the right.

2c) fk Measurements: Array fk selected

② c) Displays frequency wavenumber (fk) measurement parameters


Azimuth/Slowness
xxx yyy zzz
40
20
0
-20
-40
slowness (s/deg)
Create beam
Prev
Prev unreviewed
Next unreviewed
Next
P
S
Fstat:
Azimuth:
Slowness:
Accept all

Low frequency: XX.XX

High frequency: XX.XX

	Current	Selected
Azimuth	#### (+/- ####)	#### (+/- ####)
Slowness	#### (+/- ####)	#### (+/- ####)
Fstat	####	####

☐ Normalize channels

fk window: Lead: ##.## Lag: ##.##

Start time: XX/XX/XXXX XX:XX:XX

End time: XX/XX/XXXX XX:XX:XX

Channels:
- ☑ CHXX
- ☑ CHXX
- ☑ CHXX
- ☐ CHXX
- ☑ CHXX
- ☑ CHXX

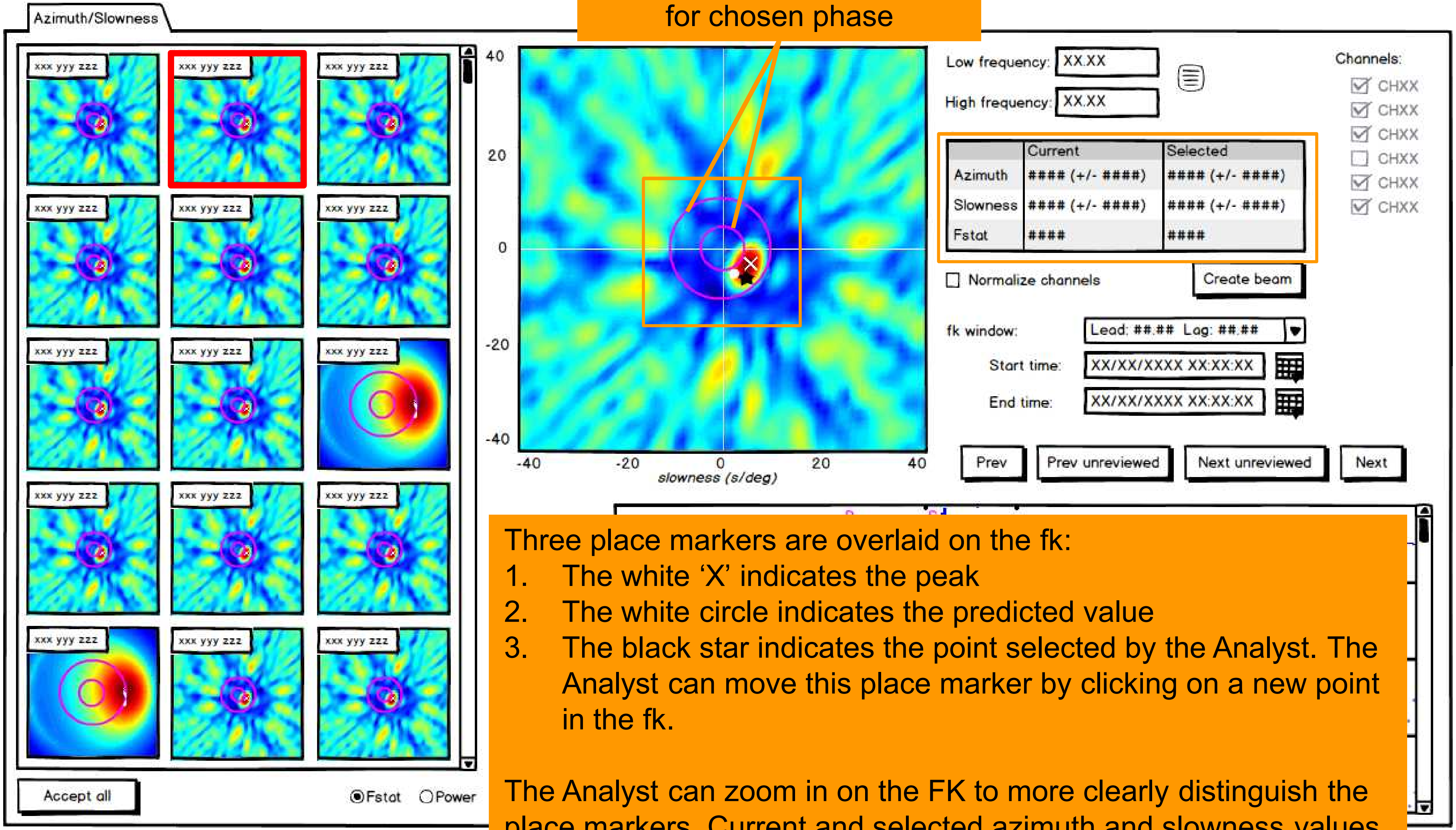
Channel: fk beam

● Fstat ○ Power

3) Modify parameters

② c) Displays frequency wavenumber (fk) measurement parameters

Acceptable slowness range for chosen phase


Azimuth/Slowness
xxx yyy zzz
40
20
0
-20
-40
-40
-20
0
20
40
slowness (s/deg)
Create beam
Prev
Prev unreviewed
Next unreviewed
Next
Accept all

Low frequency: XX.XX

High frequency: XX.XX

	Current	Selected
Azimuth	#### (+/- ####)	#### (+/- ####)
Slowness	#### (+/- ####)	#### (+/- ####)
Fstat	####	####

Channels:
- ☑ CHXX
- ☑ CHXX
- ☑ CHXX
- ☐ CHXX
- ☑ CHXX
- ☑ CHXX

☐ Normalize channels

fk window: Lead: ##.## Lag: ##.##

Start time: XX/XX/XXXX XX:XX:XX

End time: XX/XX/XXXX XX:XX:XX

● Fstat ○ Power

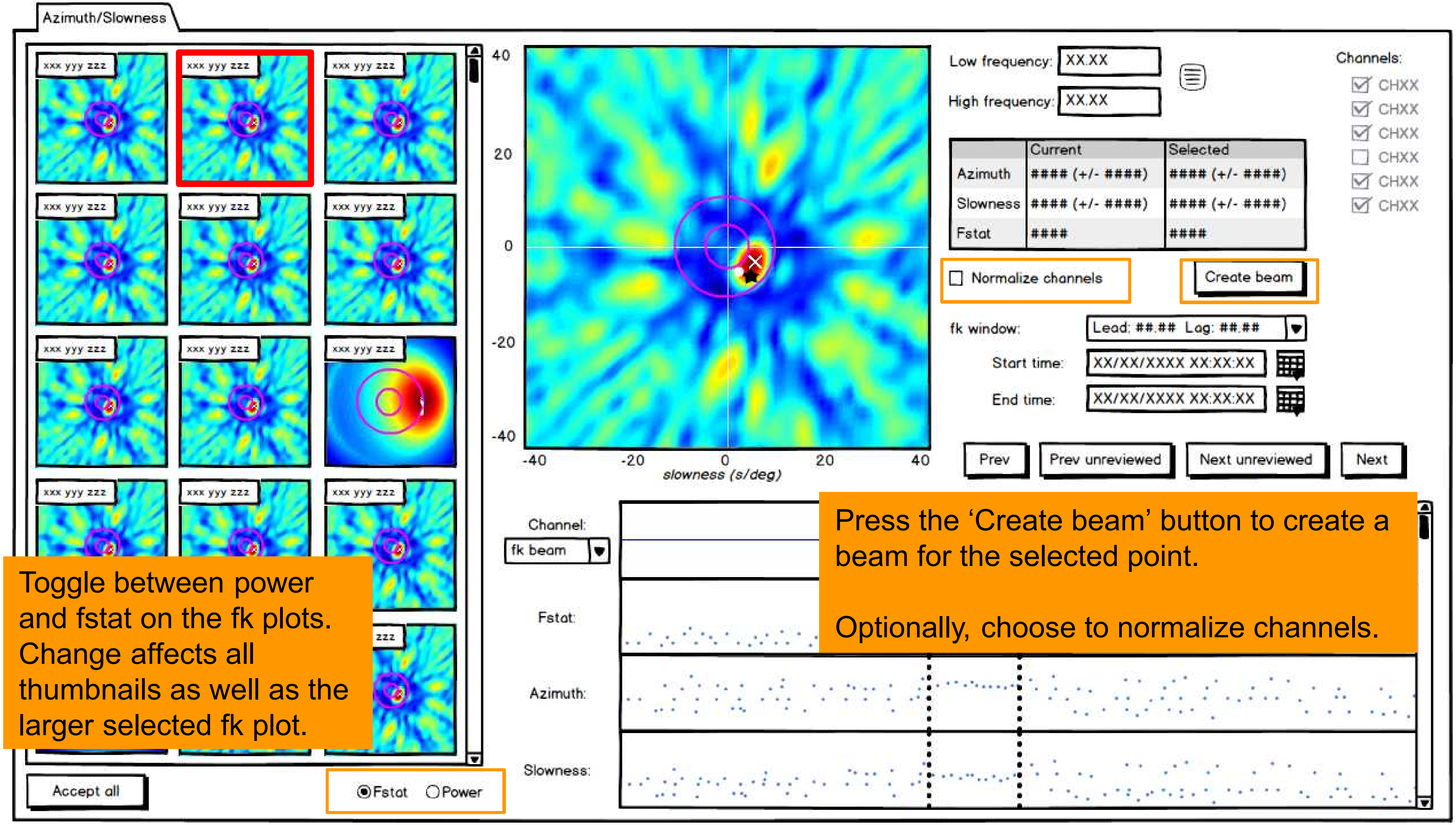
Three place markers are overlaid on the fk:

1. The white ‘X’ indicates the peak
2. The white circle indicates the predicted value
3. The black star indicates the point selected by the Analyst. The Analyst can move this place marker by clicking on a new point in the fk.

The Analyst can zoom in on the FK to more clearly distinguish the place markers. Current and selected azimuth and slowness values, along with their uncertainties, are also displayed in the table.

3) Modify parameters

② c) Displays frequency wavenumber (fk) measurement parameters


Azimuth/Slowness
xxx yyy zzz
40
20
0
-20
-40
-40
-20
0
20
40
slowness (s/deg)
Create beam
Prev
Prev unreviewed
Next unreviewed
Next
Fstat:
Azimuth:
Slowness:
Accept all

Low frequency: XX.XX

High frequency: XX.XX

	Current	Selected
Azimuth	#### (+/- ####)	#### (+/- ####)
Slowness	#### (+/- ####)	#### (+/- ####)
Fstat	####	####

Channels:
- ☑ CHXX
- ☑ CHXX
- ☑ CHXX
- ☐ CHXX
- ☑ CHXX
- ☑ CHXX

☐ Normalize channels

fk window: Lead: ##.## Lag: ##.##

Start time: XX/XX/XXXX XX:XX:XX

End time: XX/XX/XXXX XX:XX:XX

Channel: fk beam

● Fstat ○ Power

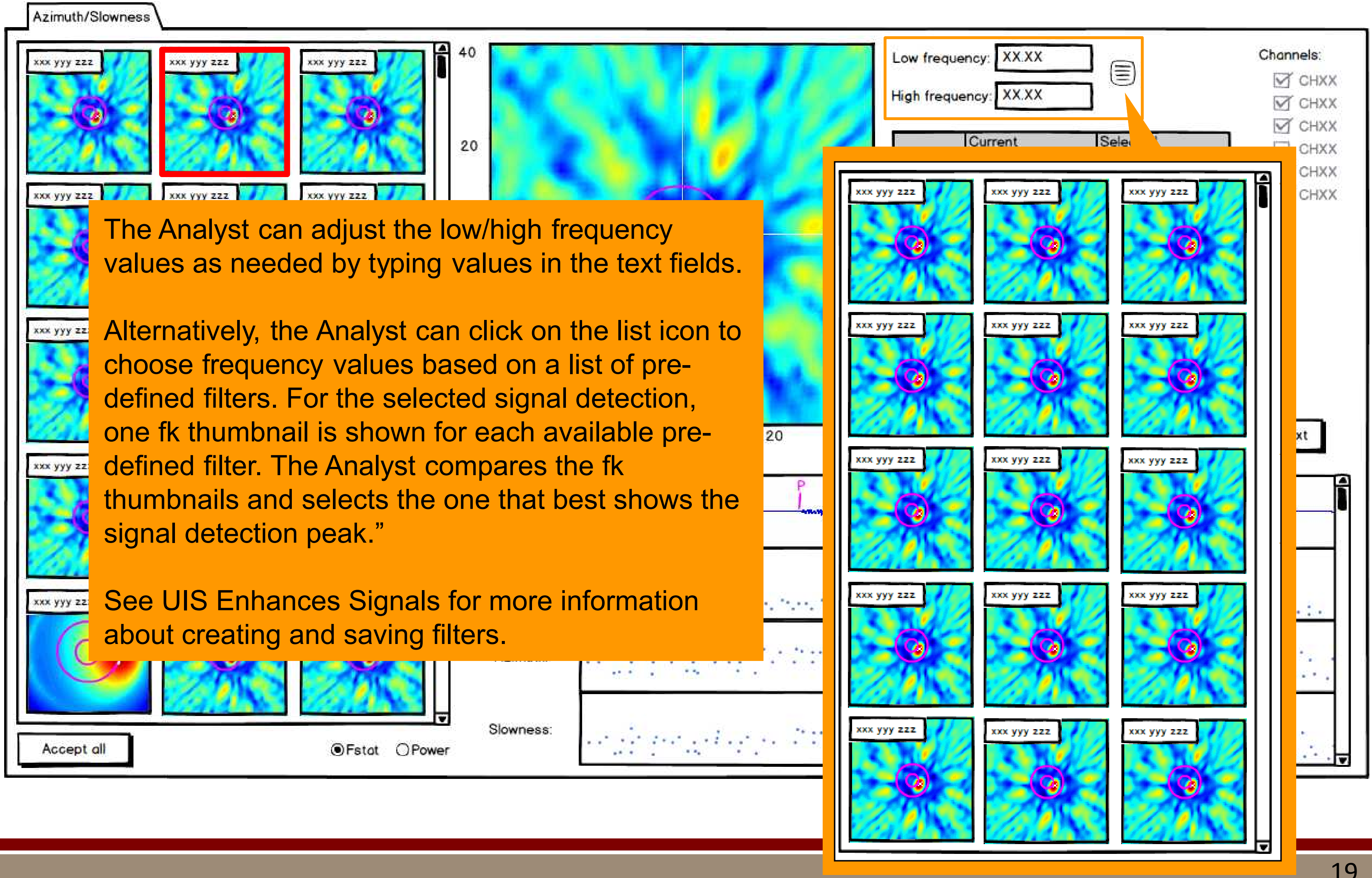
Toggle between power and fstat on the fk plots. Change affects all thumbnails as well as the larger selected fk plot.

Press the ‘Create beam’ button to create a beam for the selected point.

Optionally, choose to normalize channels.

3) Modify parameters

2 c) Displays frequency wavenumber (fk) measurement parameters


Azimuth/Slowness
xxx yyy zzz
40
20
Current
Selec
Channels:
☑ CHXX
☑ CHXX
☑ CHXX
☐ CHXX
CHXX
CHXX
xt
P
Slowness:
Accept all

Low frequency: XX.XX

High frequency: XX.XX

● Fstat ○ Power

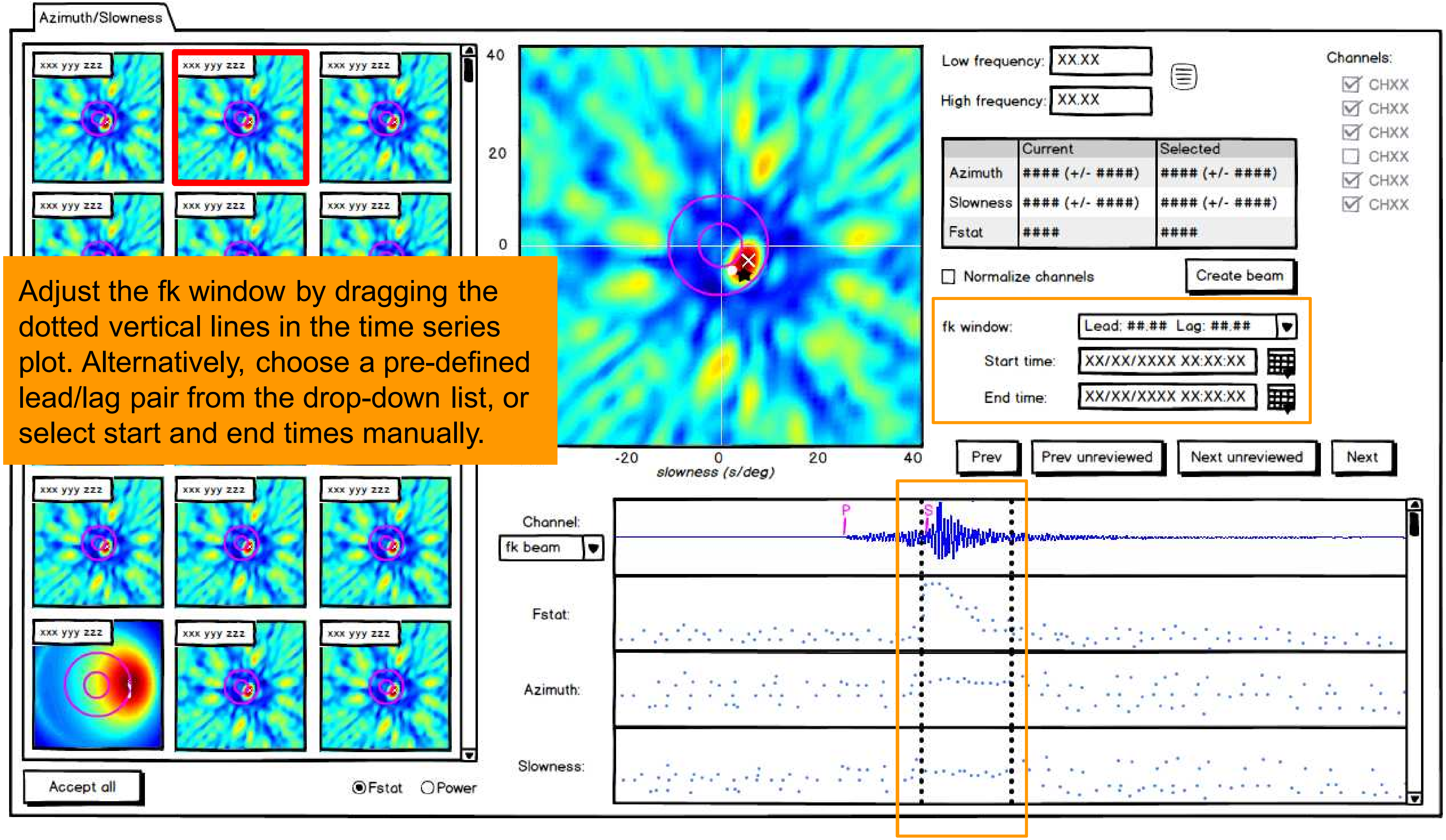
The Analyst can adjust the low/high frequency values as needed by typing values in the text fields.

Alternatively, the Analyst can click on the list icon to choose frequency values based on a list of pre-defined filters. For the selected signal detection, one fk thumbnail is shown for each available pre-defined filter. The Analyst compares the fk thumbnails and selects the one that best shows the signal detection peak.”

See UIS Enhances Signals for more information about creating and saving filters.

3) Modify parameters

② c) Displays frequency wavenumber (fk) measurement parameters


Azimuth/Slowness
xxx yyy zzz
40
20
0
-20
0
20
40
slowness (s/deg)
P
S
Create beam
Prev
Prev unreviewed
Next unreviewed
Next
Accept all

Low frequency: XX.XX

High frequency: XX.XX

	Current	Selected
Azimuth	#### (+/- ####)	#### (+/- ####)
Slowness	#### (+/- ####)	#### (+/- ####)
Fstat	####	####

☐ Normalize channels

Channels:
- ☑ CHXX
- ☑ CHXX
- ☑ CHXX
- ☐ CHXX
- ☑ CHXX
- ☑ CHXX

fk window: Lead: ##.## Lag: ##.##

Start time: XX/XX/XXXX XX:XX:XX

End time: XX/XX/XXXX XX:XX:XX

Channel: fk beam

Fstat:

Azimuth:

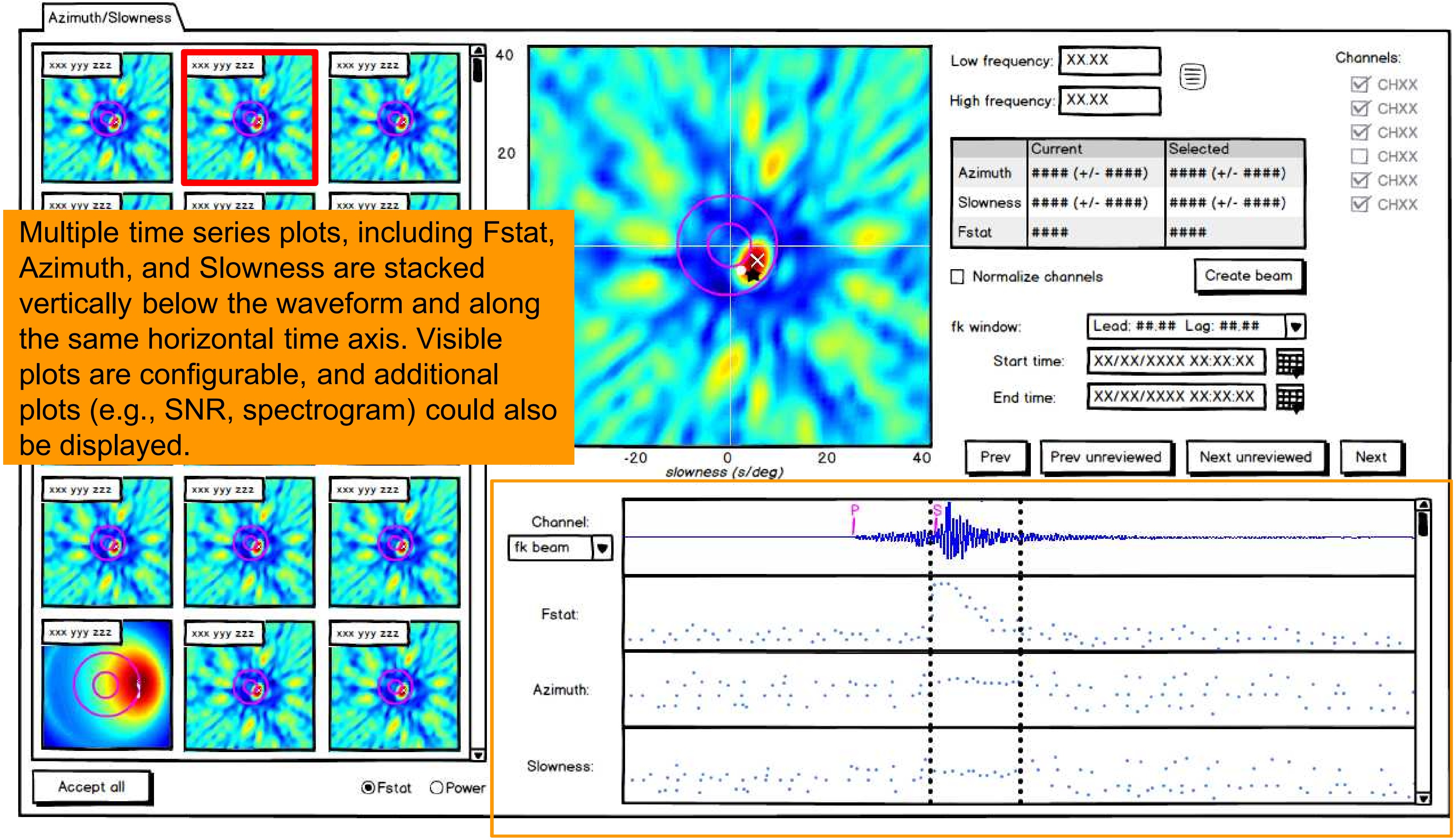
Slowness:

● Fstat ○ Power

Adjust the fk window by dragging the dotted vertical lines in the time series plot. Alternatively, choose a pre-defined lead/lag pair from the drop-down list, or select start and end times manually.

3) Modify parameters

② c) Displays frequency wavenumber (fk) measurement parameters


Azimuth/Slowness
xxx yyy zzz
40
20
-20
0
20
40
slowness (s/deg)
P
S
Accept all
Create beam
Prev
Prev unreviewed
Next unreviewed
Next

Low frequency: XX.XX

High frequency: XX.XX

	Current	Selected
Azimuth	#### (+/- ####)	#### (+/- ####)
Slowness	#### (+/- ####)	#### (+/- ####)
Fstat	####	####

☐ Normalize channels

fk window: Lead: ##.## Lag: ##.##

Start time: XX/XX/XXXX XX:XX:XX

End time: XX/XX/XXXX XX:XX:XX

Channels:
- ☑ CHXX
- ☑ CHXX
- ☑ CHXX
- ☐ CHXX
- ☑ CHXX
- ☑ CHXX

● Fstat ○ Power

Channel: fk beam

Fstat:

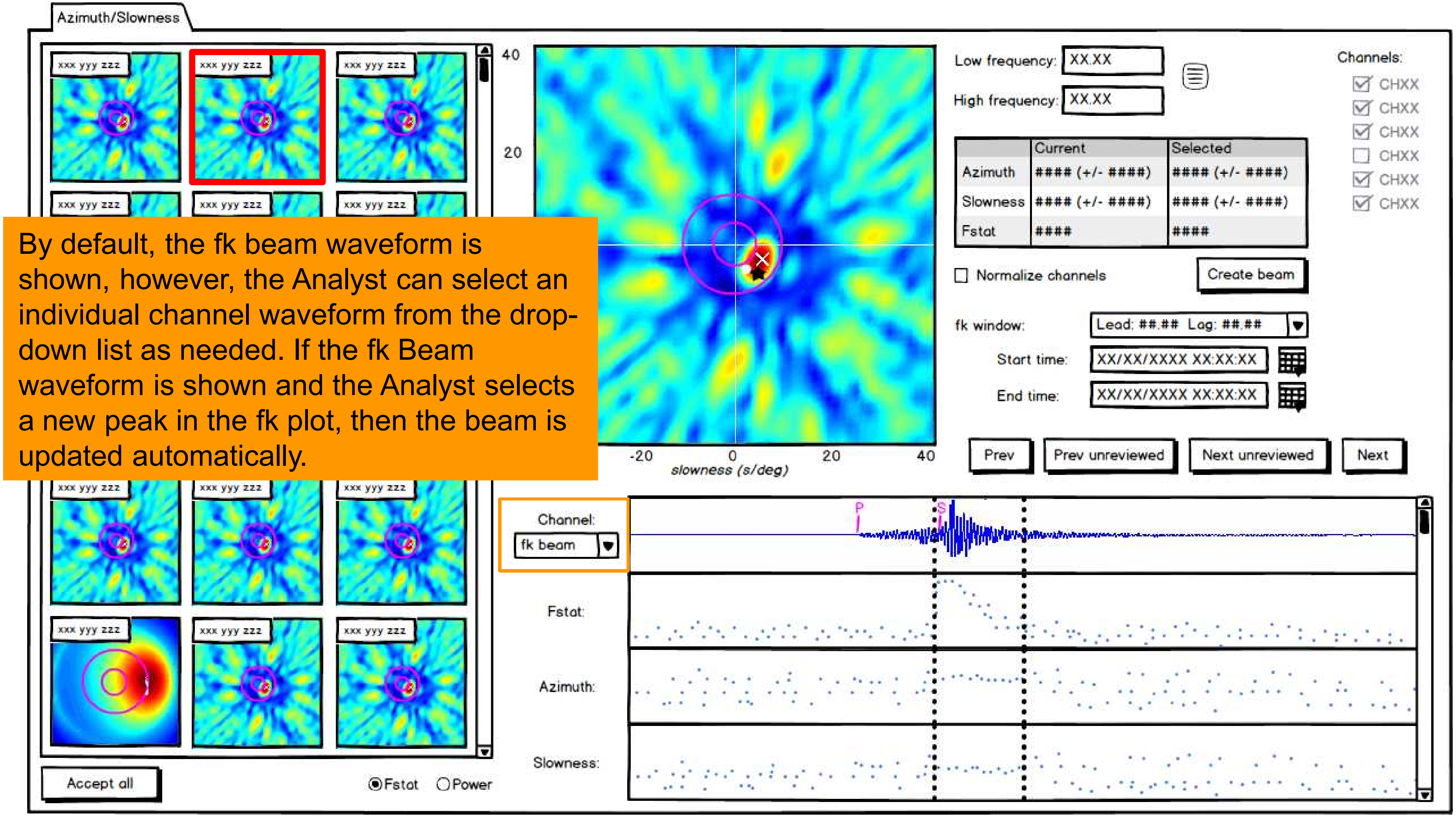
Azimuth:

Slowness:

Multiple time series plots, including Fstat, Azimuth, and Slowness are stacked vertically below the waveform and along the same horizontal time axis. Visible plots are configurable, and additional plots (e.g., SNR, spectrogram) could also be displayed.

3) Modify parameters

② c) Displays frequency wavenumber (fk) measurement parameters


Azimuth/Slowness
xxx yyy zzz
40
20
-20
0
20
40
slowness (s/deg)
P
S
Fstat
Azimuth
Slowness
Create beam
Prev
Prev unreviewed
Next unreviewed
Next
Accept all

Low frequency: XX.XX

High frequency: XX.XX

	Current	Selected
Azimuth	#### (+/- ####)	#### (+/- ####)
Slowness	#### (+/- ####)	#### (+/- ####)
Fstat	####	####

☐ Normalize channels

fk window: Lead: ##.## Lag: ##.##

Start time: XX/XX/XXXX XX:XX:XX

End time: XX/XX/XXXX XX:XX:XX

Channels:
- ☑ CHXX
- ☑ CHXX
- ☑ CHXX
- ☐ CHXX
- ☑ CHXX
- ☑ CHXX

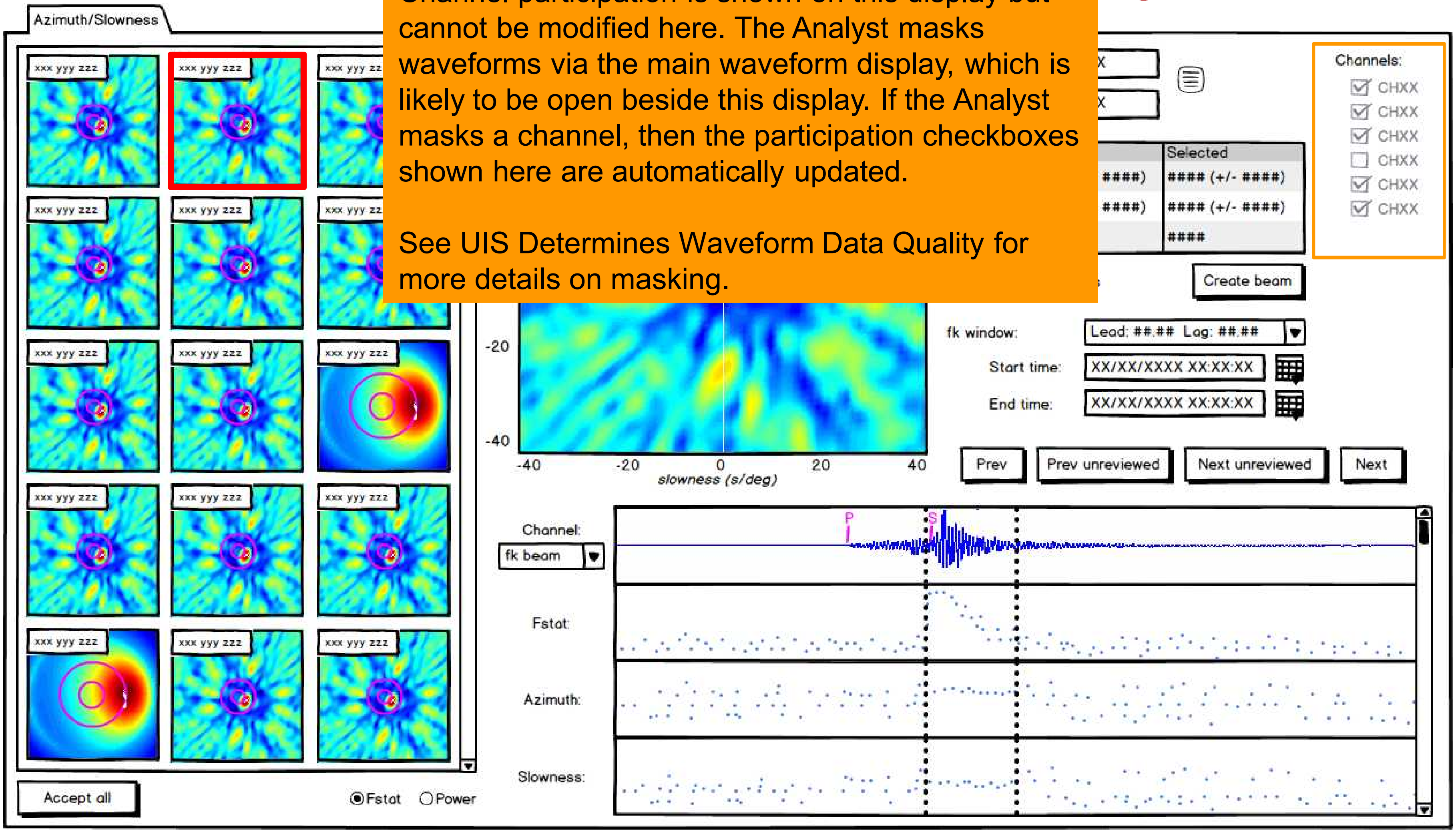
Channel: fk beam

● Fstat ○ Power

By default, the fk beam waveform is shown, however, the Analyst can select an individual channel waveform from the drop-down list as needed. If the fk Beam waveform is shown and the Analyst selects a new peak in the fk plot, then the beam is updated automatically.

3) Modify parameters

② c) Displays frequency wavenumber (fk) measurement parameters


Azimuth/Slowness
xxx yyy zzz
-20
-40
-40
-20
0
20
40
slowness (s/deg)
Create beam
Prev
Prev unreviewed
Next unreviewed
Next
Fstat:
Azimuth:
Slowness:
P
S
Accept all
● Fstat ○ Power

Channels:
☑ CHXX
☑ CHXX
☑ CHXX
☐ CHXX
☑ CHXX
☑ CHXX

	Selected
####)	#### (+/- ####)
####)	#### (+/- ####)
	####

fk window: Lead: ##.## Lag: ##.##

Start time: XX/XX/XXXX XX:XX:XX

End time: XX/XX/XXXX XX:XX:XX

Channel: fk beam

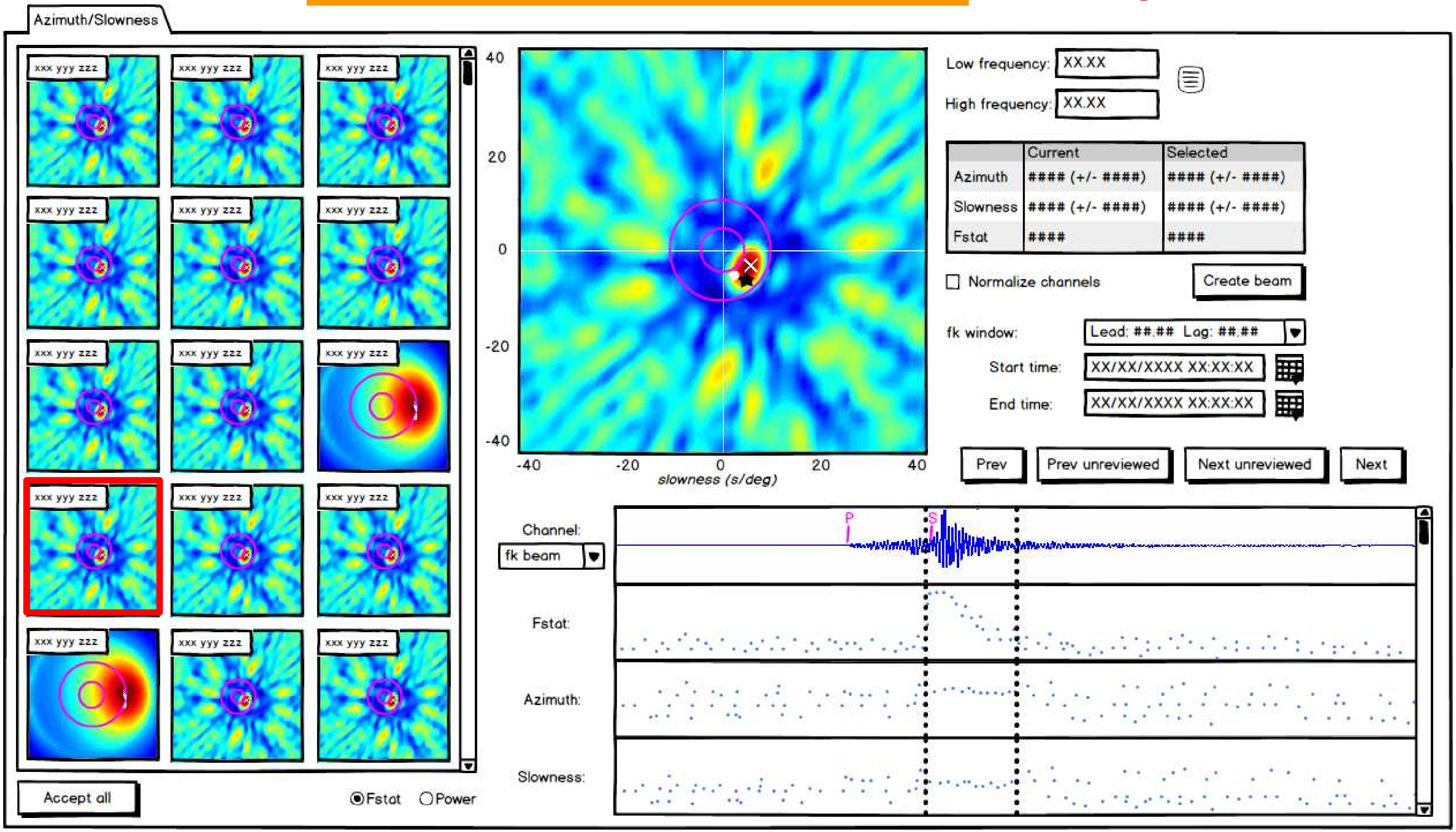
Channel participation is shown on this display but cannot be modified here. The Analyst masks waveforms via the main waveform display, which is likely to be open beside this display. If the Analyst masks a channel, then the participation checkboxes shown here are automatically updated.

See UIS Determines Waveform Data Quality for more details on masking.

fk measurements: Hydro fk selected

The same information is shown for a Hydro fk

② c) Displays frequency wavenumber (fk) measurement parameters


Azimuth/Slowness
xxx yyy zzz
40
20
0
-20
-40
-40
-20
0
20
40
slowness (s/deg)
Create beam
Prev
Prev unreviewed
Next unreviewed
Next
P
S
Fstat:
Azimuth:
Slowness:
Accept all

Low frequency: XX.XX

High frequency: XX.XX

	Current	Selected
Azimuth	#### (+/- ####)	#### (+/- ####)
Slowness	#### (+/- ####)	#### (+/- ####)
Fstat	####	####

☐ Normalize channels

fk window: Lead: ##.## Lag: ##.##

Start time: XX/XX/XXXX XX:XX:XX

End time: XX/XX/XXXX XX:XX:XX

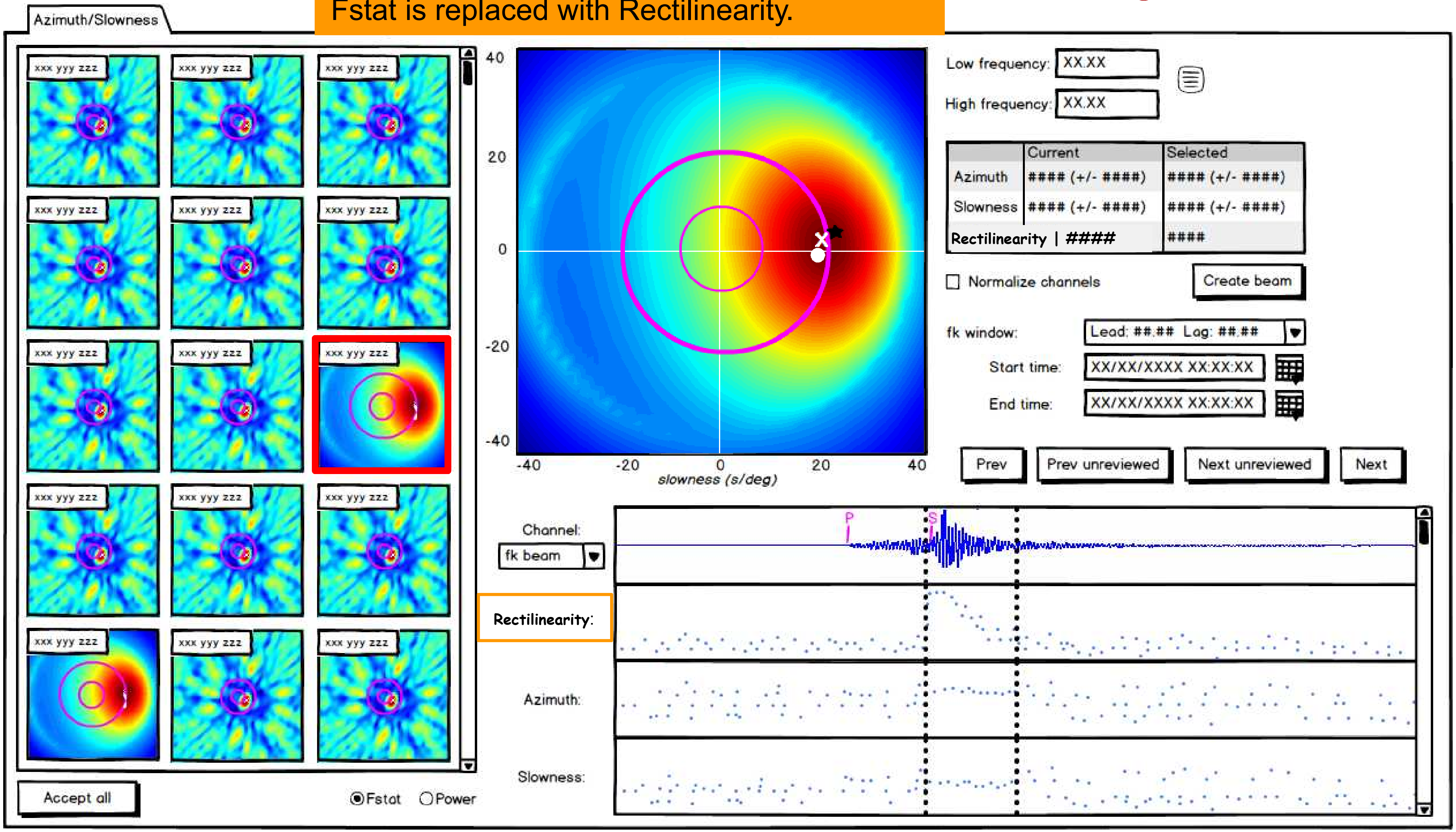
Channel: fk beam

● Fstat ○ Power

fk measurements: 3C fk selected

The same information is shown for a 3C fk.
Fstat is replaced with Rectilinearity.

② c) Displays frequency wavenumber (fk) measurement parameters


Azimuth/Slowness
xxx yyy zzz
40
20
0
-20
-40
-40
-20
0
20
40
slowness (s/deg)
P
S
Create beam
Prev
Prev unreviewed
Next unreviewed
Next
Accept all

Low frequency: XX.XX

High frequency: XX.XX

	Current	Selected
Azimuth	#### (+/- ####)	#### (+/- ####)
Slowness	#### (+/- ####)	#### (+/- ####)
Rectilinearity	**####**	####

☐ Normalize channels

fk window: Lead: ##.## Lag: ##.##

Start time: XX/XX/XXXX XX:XX:XX

End time: XX/XX/XXXX XX:XX:XX

Channel: fk beam

Rectilinearity:

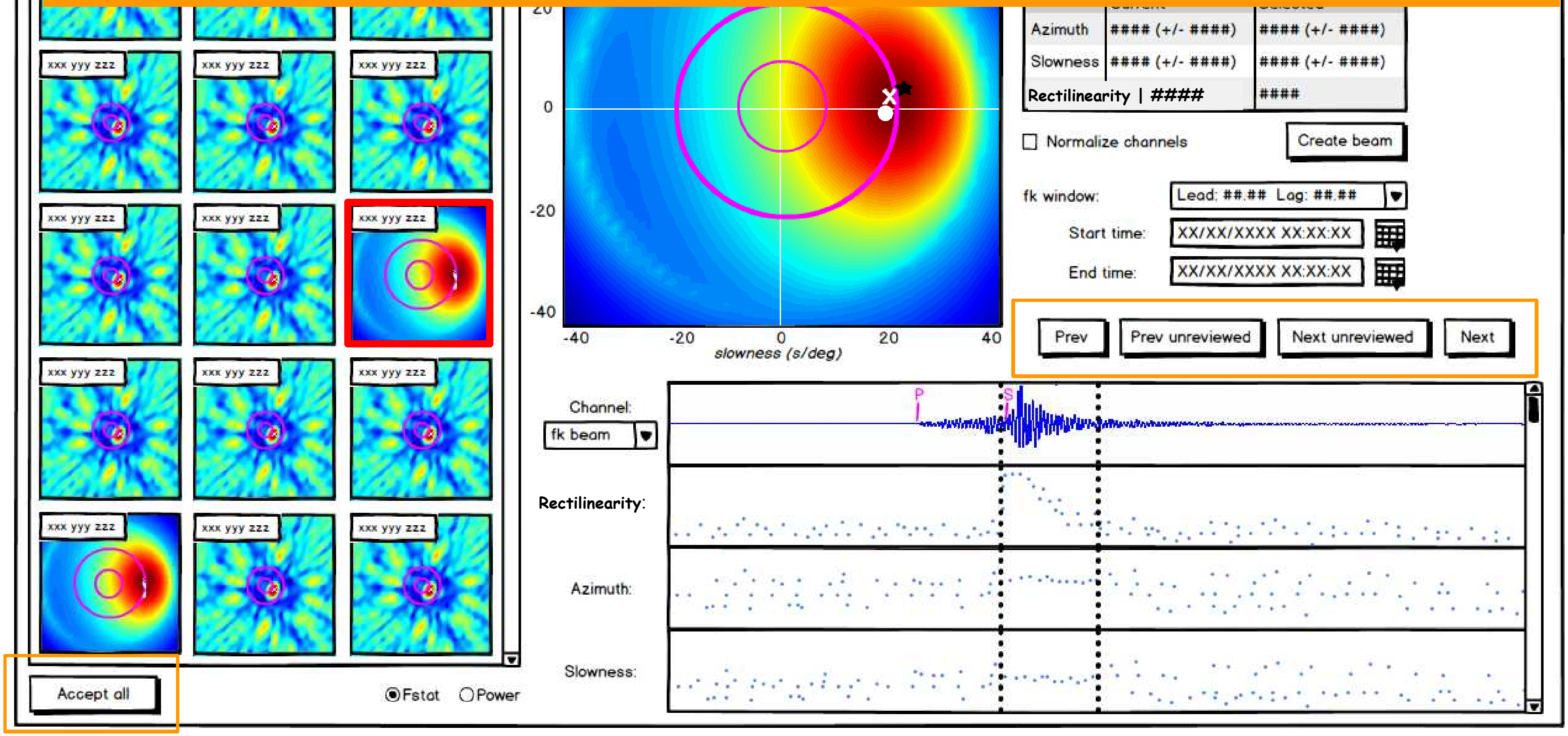
Azimuth:

Slowness:

● Fstat ○ Power

4) Displays updated signal features

Press ‘Next’ to accept the changes to this measurement and move on to the next signal detection in the list. Press ‘Next unreviewed’ to skip forward to the next signal detection that is highlighted for review. Use the ‘previous’ buttons to move backward in the list. Alternatively, press “Accept all” to accept all of the measurements in the list. The Azimuth and Slowness columns in the event location display change from yellow to white as each measurement is accepted, indicating that the Analyst has reviewed them.



Azimuth	#### (+/- ####)	#### (+/- ####)
Slowness	#### (+/- ####)	#### (+/- ####)
Rectilinearity	####	####

☐ Normalize channels

Create beam

fk window: Lead: ##.## Lag: ##.##

Start time: XX/XX/XXXX XX:XX:XX

End time: XX/XX/XXXX XX:XX:XX

Prev | Prev unreviewed | Next unreviewed | Next

Channel: fk beam

Rectilinearity:

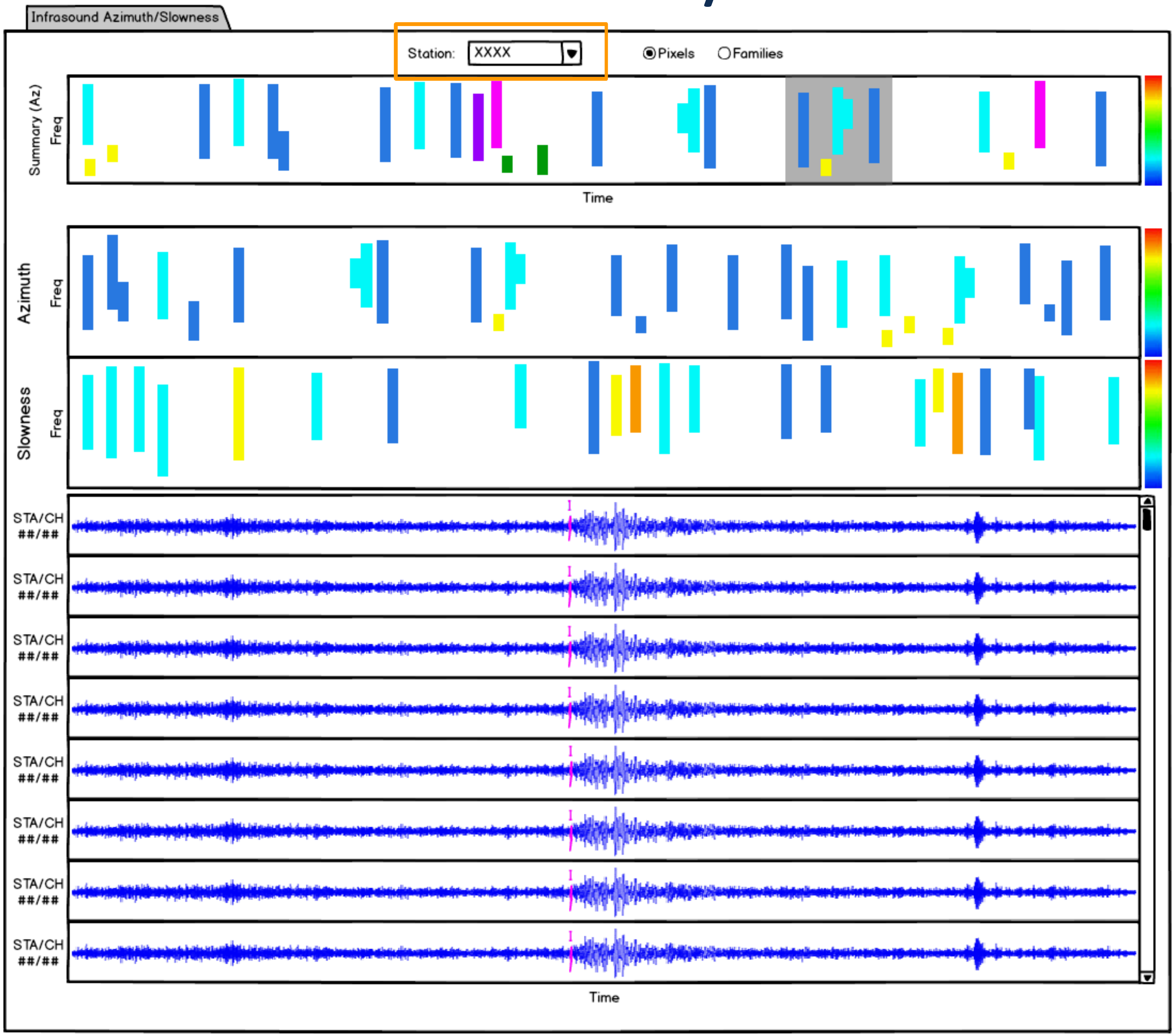
Azimuth:

Slowness:

Accept all

● Fstat ○ Power

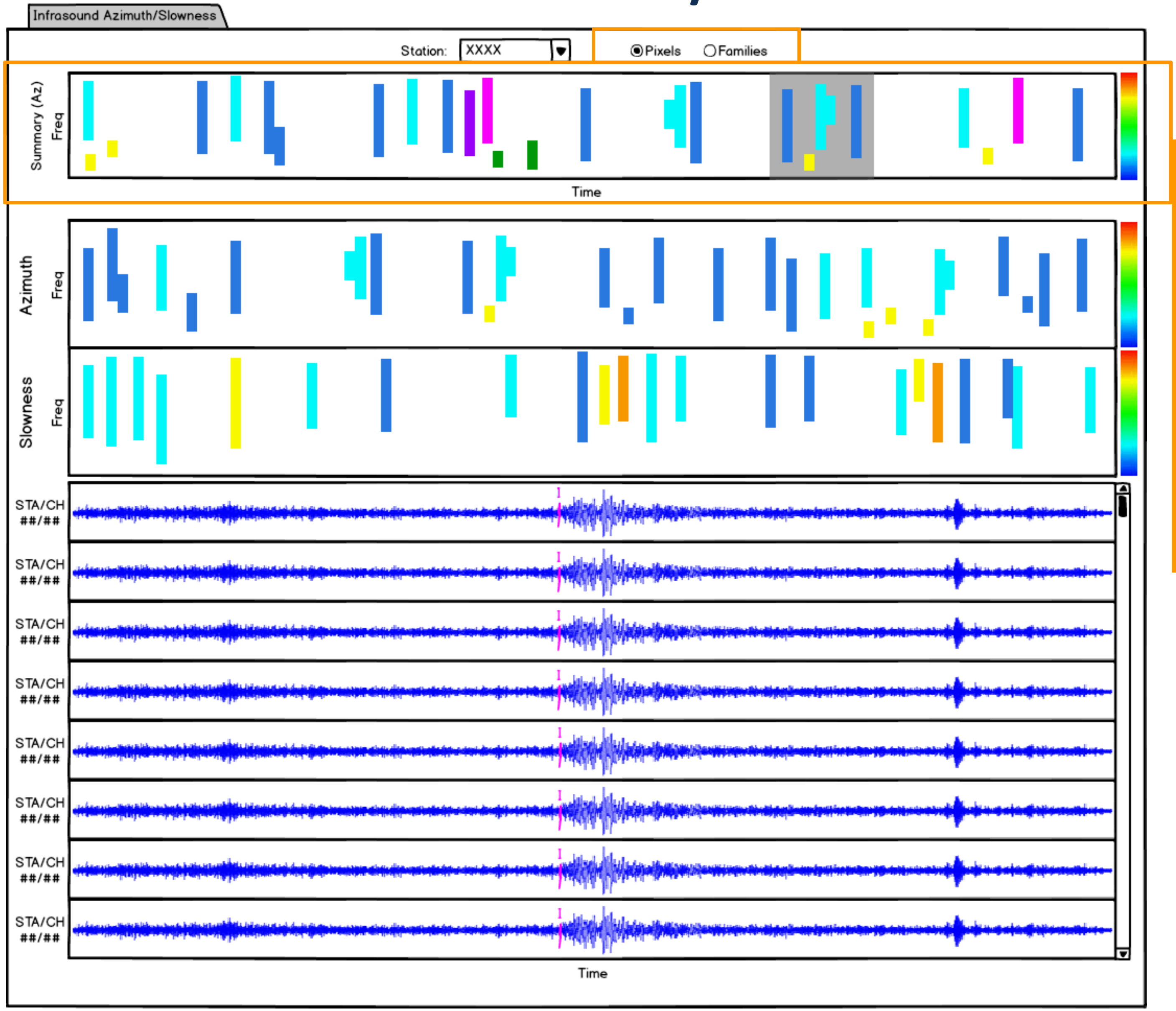
Infrasound azimuth/slowness


Infrasound Azimuth/Slowness
Station: XXXX
● Pixels
○ Families
Summary (Az)
Freq
Time
Azimuth
Freq
Slowness
Freq
STA/CH
##/##
Time

Additional infrasound azimuth/slowness information (i.e. PMCC) can be viewed on a separate display for a single selected station.

The Analyst can select an infrasound station from the drop down list here or via the main waveform display.

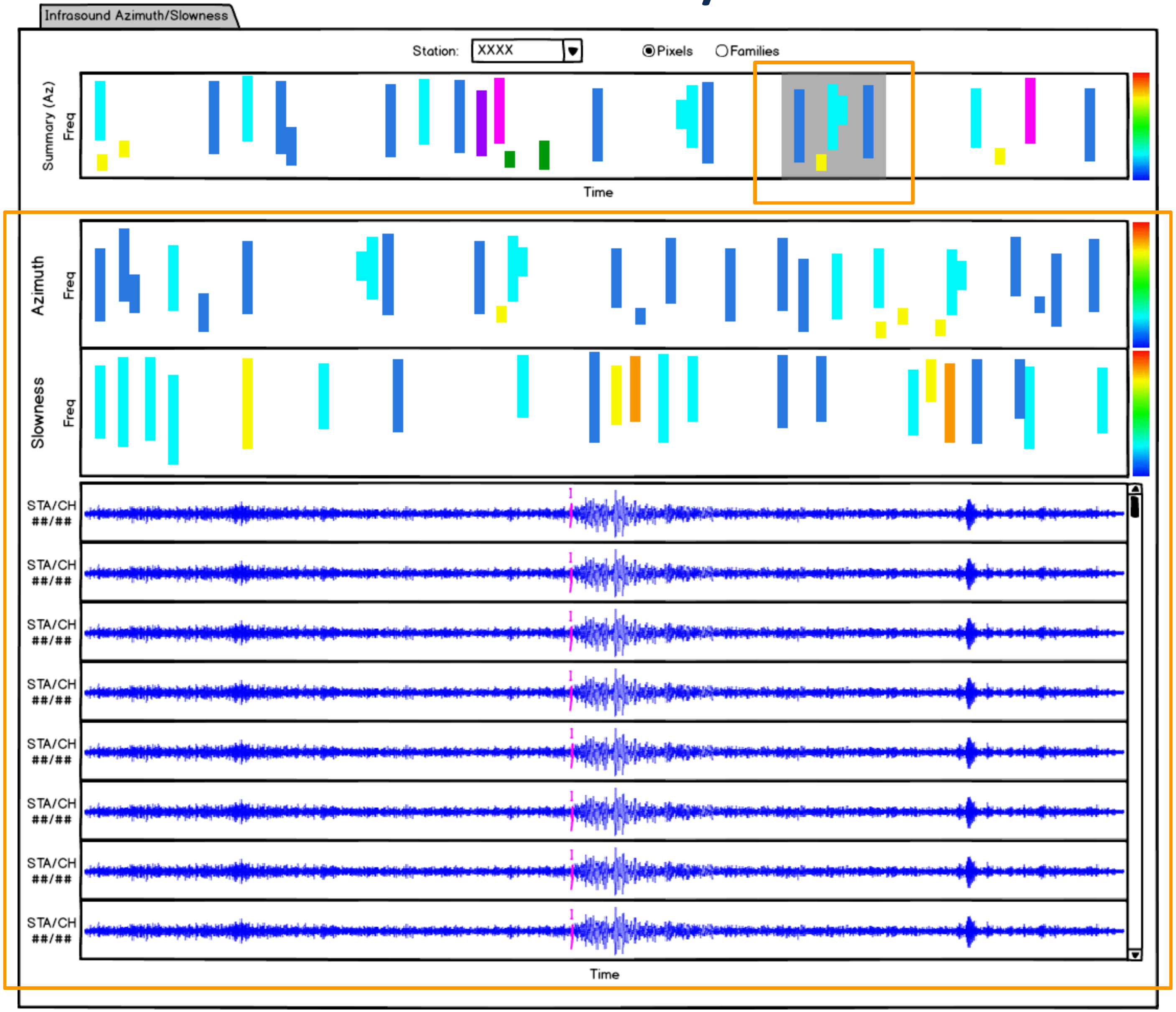
Infrasound azimuth/slowness


Infrasound Azimuth/Slowness
Station:
XXXX
● Pixels
○ Families
Summary (Az)
Freq
Time
Azimuth
Freq
Slowness
Freq
STA/CH
##/##
Time

A summary plot at the top of the display shows azimuth information over time. The Analyst can zoom in/out to adjust the time range.

The display can be configured to show individual pixels or pixel families.

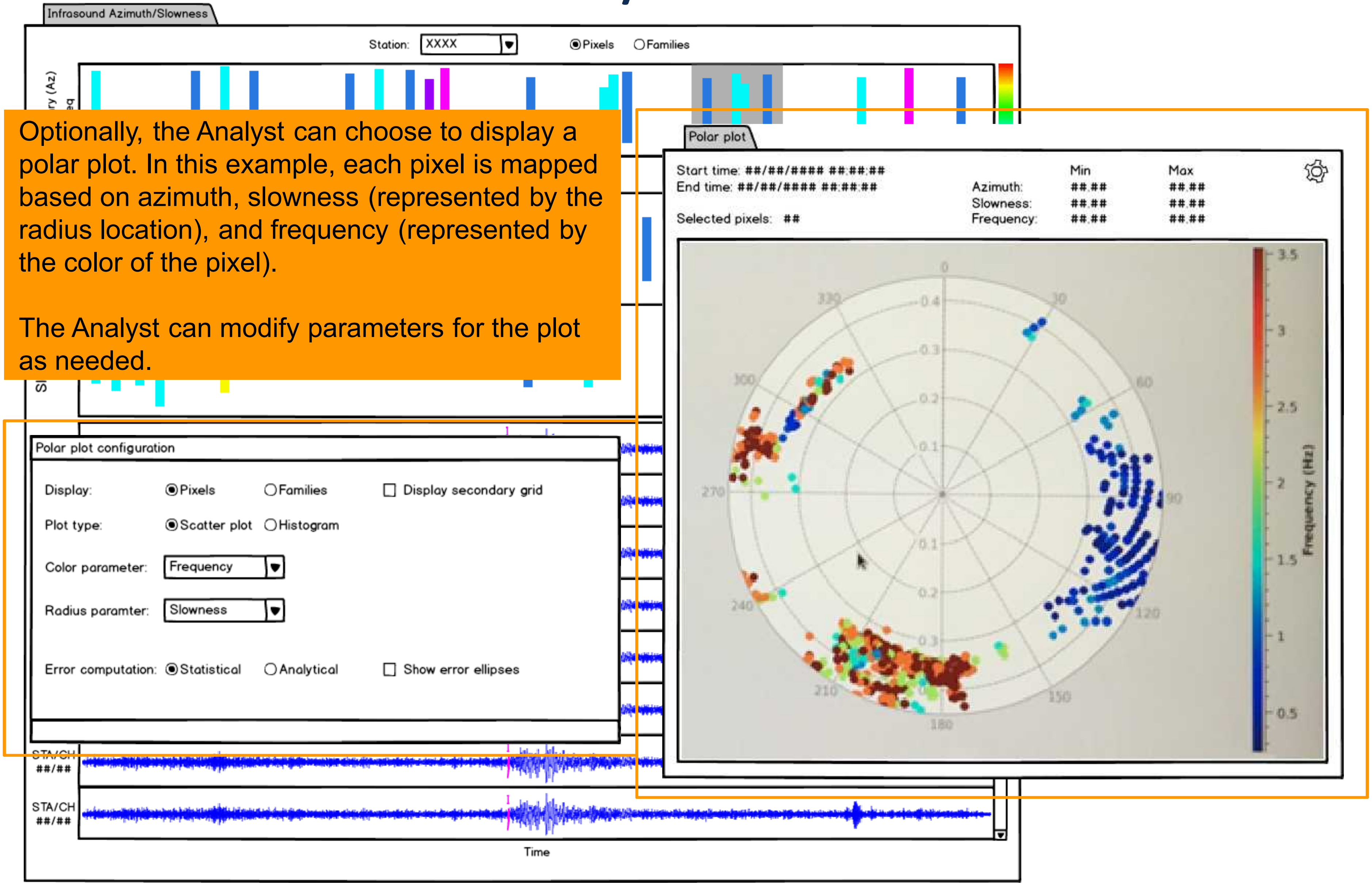
Infrasound azimuth/slowness


Infrasound Azimuth/Slowness
Station: XXXX
● Pixels
○ Families
Summary (Az)
Freq
Time
Azimuth
Freq
Slowness
Freq
STA/CH ##/##
STA/CH ##/##
STA/CH ##/##
STA/CH ##/##
STA/CH ##/##
STA/CH ##/##
STA/CH ##/##
STA/CH ##/##
Time

The Analyst selects a smaller time window in the summary plot to see additional detail in the remaining plots. Azimuth, slowness, and the individual channel waveforms are stacked vertically over the same “zoomed in” time range.

The Analyst can add new detections or modify existing ones (e.g., retime, associate/ unassociate) via these channel waveforms or via the main waveform display. Changes are automatically synchronized between the two displays.

Infrasound azimuth/slowness



Optionally, the Analyst can choose to display a polar plot. In this example, each pixel is mapped based on azimuth, slowness (represented by the radius location), and frequency (represented by the color of the pixel).

The Analyst can modify parameters for the plot as needed.

Infrasound Azimuth/Slowness

Station: XXXX

● Pixels ○ Families

Polar plot

Start time: ##/##/#### ##:##:##

End time: ##/##/#### ##:##:##

Selected pixels: ##

	Min	Max
Azimuth:	##.##	##.##
Slowness:	##.##	##.##
Frequency:	##.##	##.##

Polar plot configuration

Display: ● Pixels ○ Families ☐ Display secondary grid

Plot type: ● Scatter plot ○ Histogram

Color parameter: Frequency

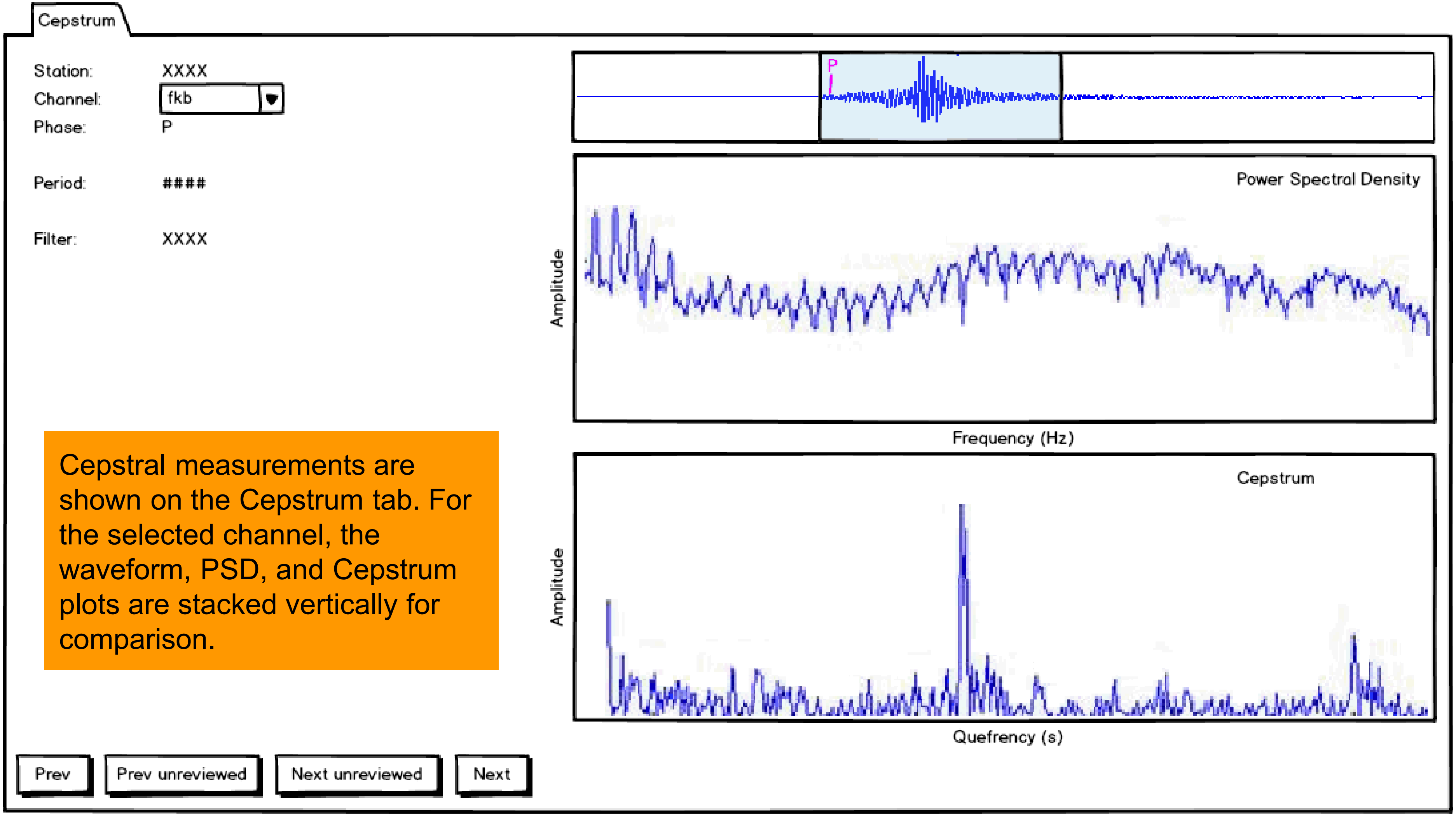
Radius paramter: Slowness

Error computation: ● Statistical ○ Analytical ☐ Show error ellipses

0
30
60
90
120
150
180
210
240
270
300
330
0.1
0.2
0.3
0.4
3.5
3
2.5
2
1.5
1
0.5
Frequency (Hz)
STA/CH
##/##
STA/CH
##/##
Time

PERFORM CEPSTRAL MEASUREMENTS

2e) Perform cepstral measurements


Cepstrum
P
Power Spectral Density
Amplitude
Frequency (Hz)
Cepstrum
Amplitude
Quefrency (s)
Prev
Prev unreviewed
Next unreviewed
Next

Station: XXXX
Channel: fkb
Phase: P

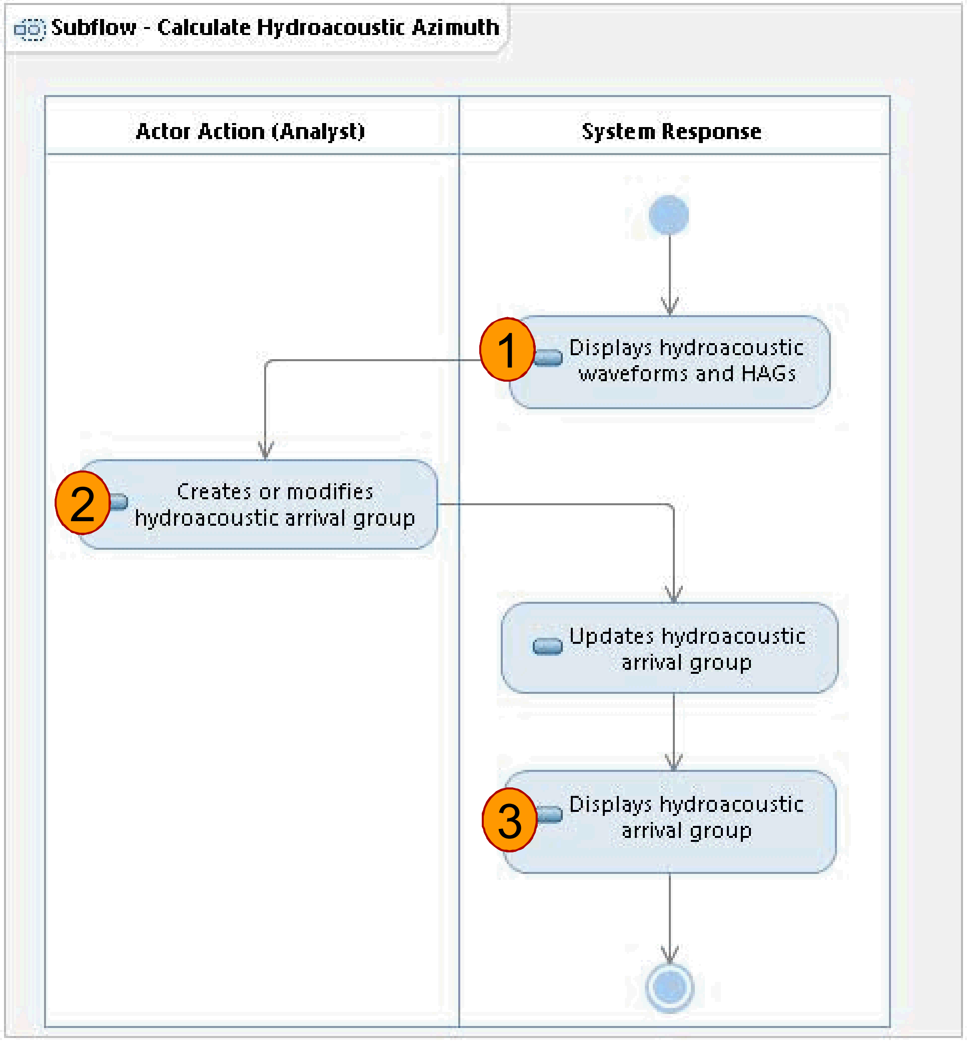
Period: ####

Filter: XXXX

Cepstral measurements are shown on the Cepstrum tab. For the selected channel, the waveform, PSD, and Cepstrum plots are stacked vertically for comparison.

HYDROACOUSTIC AZIMUTH

2f) Subflow: Calculate Hydroacoustic Azimuth


Subflow - Calculate Hydroacoustic Azimuth
Actor Action (Analyst)
System Response
1
Displays hydroacoustic waveforms and HAGs
2
Creates or modifies hydroacoustic arrival group
Updates hydroacoustic arrival group
3
Displays hydroacoustic arrival group

1) Displays hydroacoustic waveforms and HAGs
2) Creates or modifies hydroacoustic arrival group
3) Displays updated hydroacoustic arrival group

Hydroacoustic azimuth

- See open issue, this is TBD

Notes

- Timing uncertainties for signal detections are viewed/modified via the main waveform display. See UIS Detects Signals.

Open Issues

- Need to finalize infrasound/PMCC details. What did we get right in slides 27-30, what is missing? (CR1993)
- Need to address hydroacoustic arrival groups (CR1994)
  - We would like to see how HAGs are created/modified/viewed today. What is needed in the modernized system?
  - How would a HAG display differ from the hydro fk shown on Slide 24? Are both useful?
- We would like to see how cepstral measurements are currently being used by analysts. What measurement is being made? Can the Analyst accept/modify the measurement?