`traceview`: A New Replacement for `dbpick`

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dbpick

- Oldest and most used software module in Antelope
- First version written in 1989 based on a prior version written mainly in FORTRAN using SUN's proprietary OpenLook window graphics
- `dbpick` developed almost entirely in C on a SUN4-SPARCSTATION using the then new X-windows graphics middleware
- Designed for a single CPU, single threaded 20 Mhz processor using 64 Mbytes of RAM and no graphics acceleration
- Based on ASCII representations of CSS2.7 database tables
- Pre-`datascope`
- Pre-Antelope parameter files
- Design was driven by seismic analyst suggestions and testing

`dbpick` – requirements

- Support for normal seismic analyst operations (not necessarily research)
- CSS database as source
- Highest performance given slow CPU, single CPU, small RAM, slow graphics
- User interaction to support seismic analyst suggestions and input
- Make the program as self contained as possible so that it could be used by Universities (no external Relational Database Management System)

`dbpick` – design

- Database access using home brewed software library
- X-windows application
- Avoided any graphics middleware
- Developed concept of waveform pixilation in time
- Database `wfdisc` and `arrival` tables read and saved internally at startup. Waveforms accessed as necessary. Static `arrival` saved view but edits pushed out to table. Static `wfdisc` view.
- GUI largely designed from seismic analyst suggestions and input

`dbpick` – subsequent development

- Conversion to Datascope (early 90s)
- Conversion to CSS3.0 (early 90s)
- Integration with `dbloc2` (mid 90s)
  - Command type-in interface
  - `tcl/tk` based command message passing
- Addition of event-oriented processing (mid 90s)
- Attempt to support dynamic database queries (2011)

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`dbpick` – The Good

- Stable and mature waveform viewing and arrival editing program
- Probably the highest performance program for viewing waveforms
- Operates equally well on large and small databases
- Does not require any pre-processing
- Operates directly off of databases without the need for external Relational Database Management Systems
- Highly efficient analyst review interactions
- Provides generalized command mechanism through typein interface

dbpick – The Bad

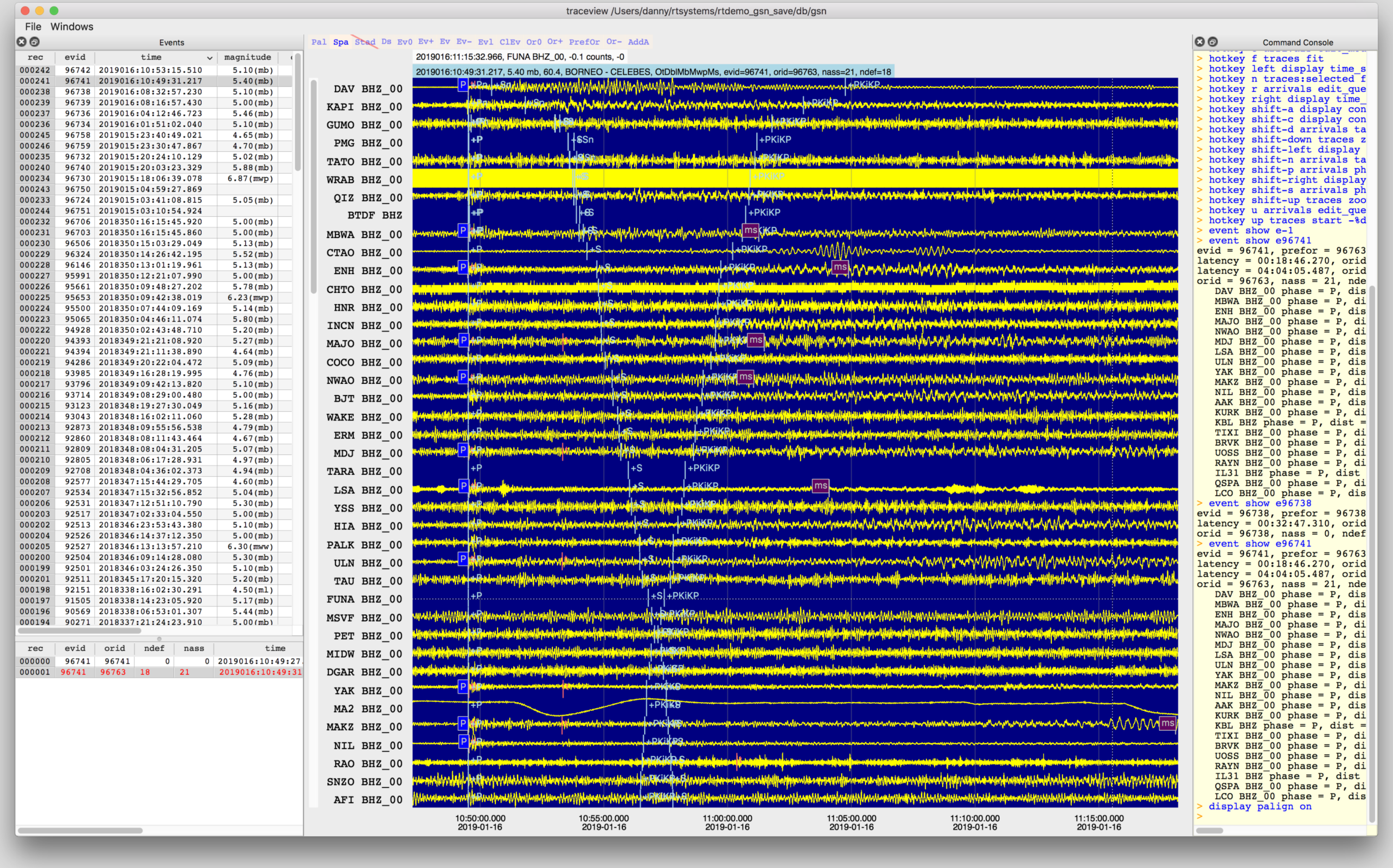
- Depends on X-windows
- Outdated software development style (written 30 years ago in C with very little middleware or infrastructure support)
- Does not adhere to Antelope configuration standards (no parameter files)
- Limited user configuration
- Written as a monolithic application that is not reusable in other programs
- Has become difficult to modify and maintain
- Limited in its ability to support research
- Not a suitable platform for further development

`dbpick` – The Ugly

- Synchronization with dynamically changing databases
- Proper functioning with dynamically changing databases
- Can be unreliable when multiple users and/or processes are modifying the same database

traceview

- Newly developed software meant to be a complete replacement for dbpick
- Development started June 2018
- In the 5.9 Antelope release, both dbpick and traceview applications
- Also, in the 5.9 Antelope release, BQTraceview C++ class library and appropriate python extensions



2019016:11:15:32.966, FUNA BHZ_00, -0.1 counts, -0

2019016:10:49:31.217, 5.40 mb, 60.4, BORNEO - CELEBES, OtDblMbMwpMs, evid=96741, orid=96763, nass=21, ndef=18

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000241	96741	2019016:10:49:31.217	5.40(mb)
000238	96738	2019016:08:32:57.230	5.10(mb)
000239	96739	2019016:08:16:57.430	5.00(mb)
000237	96736	2019016:04:12:46.723	5.46(mb)
000236	96734	2019016:01:51:02.040	5.10(mb)
000245	96758	2019015:23:40:49.021	4.65(mb)
000246	96759	2019015:23:30:47.867	4.70(mb)
000235	96732	2019015:20:24:10.129	5.02(mb)
000240	96740	2019015:20:03:23.329	5.88(mb)
000234	96730	2019015:18:06:39.078	6.87(mwp)
000243	96750	2019015:04:59:27.869	
000233	96724	2019015:03:41:08.815	5.05(mb)
000244	96751	2019015:03:10:54.924	
000232	96706	2018350:16:15:45.920	5.00(mb)
000231	96703	2018350:16:15:45.860	5.00(mb)
000230	96506	2018350:15:03:29.049	5.13(mb)
000229	96324	2018350:14:26:42.195	5.52(mb)
000228	96146	2018350:13:01:19.961	5.13(mb)
000227	95991	2018350:12:21:07.990	5.00(mb)
000226	95661	2018350:09:48:27.202	5.78(mb)
000225	95653	2018350:09:42:38.019	6.23(mwp)
000224	95500	2018350:07:44:09.169	5.14(mb)
000223	95065	2018350:04:46:11.074	5.80(mb)
000222	94928	2018350:02:43:48.710	5.20(mb)
000220	94393	2018349:21:21:08.920	5.27(mb)
000221	94394	2018349:21:11:38.890	4.64(mb)
000219	94286	2018349:20:22:04.472	5.09(mb)
000218	93985	2018349:16:28:19.995	4.76(mb)
000217	93796	2018349:09:42:13.820	5.10(mb)
000216	93714	2018349:08:29:00.480	5.00(mb)
000215	93123	2018348:19:27:30.049	5.16(mb)
000214	93043	2018348:16:02:11.060	5.28(mb)
000213	92873	2018348:09:55:56.538	4.79(mb)
000212	92860	2018348:08:11:43.464	4.67(mb)
000211	92809	2018348:08:04:31.205	5.07(mb)
000210	92805	2018348:06:17:28.931	4.97(mb)
000209	92708	2018348:04:36:02.373	4.94(mb)
000208	92577	2018347:15:44:29.705	4.60(mb)
000207	92534	2018347:15:32:56.852	5.04(mb)
000206	92531	2018347:12:51:10.790	5.30(mb)
000203	92517	2018347:02:33:04.550	5.00(mb)
000202	92513	2018346:23:53:43.380	5.10(mb)
000204	92526	2018346:14:37:12.350	5.00(mb)
000205	92527	2018346:13:13:57.210	6.30(mww)
000200	92504	2018346:09:14:28.080	5.30(mb)
000199	92501	2018346:03:24:26.350	5.10(mb)
000201	92511	2018345:17:20:15.320	5.20(mb)
000198	92151	2018338:16:02:30.291	4.50(ml)
000197	91505	2018338:14:23:05.920	5.17(mb)
000196	90569	2018338:06:53:01.307	5.44(mb)
000194	90271	2018337:21:24:23.910	5.00(mb)

rec	evid	orid	ndef	nass	time
000000	96741	96741	0	0	2019016:10:49:27
000001	96741	96763	18	21	2019016:10:49:31

```
> hotkey f traces fit
> hotkey left display time_s
> hotkey n traces:selected f
> hotkey r arrivals edit_que
> hotkey right display time_
> hotkey shift-a display con
> hotkey shift-c display con
> hotkey shift-d arrivals ta
> hotkey shift-down traces z
> hotkey shift-left display
> hotkey shift-n arrivals ta
> hotkey shift-p arrivals ph
> hotkey shift-right display
> hotkey shift-s arrivals ph
> hotkey shift-up traces zoo
> hotkey u arrivals edit_que
> hotkey up traces start -%d
> event show e-1
> event show e96741
evid = 96741, prefor = 96763
latency = 00:18:46.270, orid
latency = 04:04:05.487, orid
orid = 96763, nass = 21, nde
   DAV BHZ_00 phase = P, dis
   MBWA BHZ_00 phase = P, di
   ENH BHZ_00 phase = P, dis
   MAJO BHZ_00 phase = P, di
   NWAO BHZ_00 phase = P, di
   MDJ BHZ_00 phase = P, dis
   LSA BHZ_00 phase = P, dis
   ULN BHZ_00 phase = P, dis
   YAK BHZ_00 phase = P, dis
   MAKZ BHZ_00 phase = P, di
   NIL BHZ_00 phase = P, dis
   AAK BHZ_00 phase = P, dis
   KURK BHZ_00 phase = P, di
   KBL BHZ phase = P, dist =
   TIXI BHZ_00 phase = P, di
   BRVK BHZ_00 phase = P, di
   UOSS BHZ_00 phase = P, di
   RAYN BHZ_00 phase = P, di
   IL31 BHZ phase = P, dist
   QSPA BHZ_00 phase = P, di
   LCO BHZ_00 phase = P, dis
> event show e96738
evid = 96738, prefor = 96738
latency = 00:32:47.310, orid
orid = 96738, nass = 0, ndef
> event show e96741
evid = 96741, prefor = 96763
latency = 00:18:46.270, orid
latency = 04:04:05.487, orid
orid = 96763, nass = 21, nde
   DAV BHZ_00 phase = P, dis
   MBWA BHZ_00 phase = P, di
   ENH BHZ_00 phase = P, dis
   MAJO BHZ_00 phase = P, di
   NWAO BHZ_00 phase = P, di
   MDJ BHZ_00 phase = P, dis
   LSA BHZ_00 phase = P, dis
   ULN BHZ_00 phase = P, dis
   YAK BHZ_00 phase = P, dis
   MAKZ BHZ_00 phase = P, di
   NIL BHZ_00 phase = P, dis
   AAK BHZ_00 phase = P, dis
   KURK BHZ_00 phase = P, di
   KBL BHZ phase = P, dist =
   TIXI BHZ_00 phase = P, di
   BRVK BHZ_00 phase = P, di
   UOSS BHZ_00 phase = P, di
   RAYN BHZ_00 phase = P, di
   IL31 BHZ phase = P, dist
   QSPA BHZ_00 phase = P, di
   LCO BHZ_00 phase = P, dis
> display palign on
>
```

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traceview – Development Requirements

- Preserve the good features of dbpick
  - High performance
  - Highly scalable
  - No pre-processing
  - Direct database access
  - Efficient analyst GUI
  - Generalized command interface
- Preserve the dbpick GUI
- Use modern software development methodologies
- Make compatible with Antelope configuration standards
- Develop as reusable software modules
- Avoid dependence on X-windows
- Provide an easily extendable platform for developing future capabilities
- Provide access through python
- Eliminate datascope vulnerabilities

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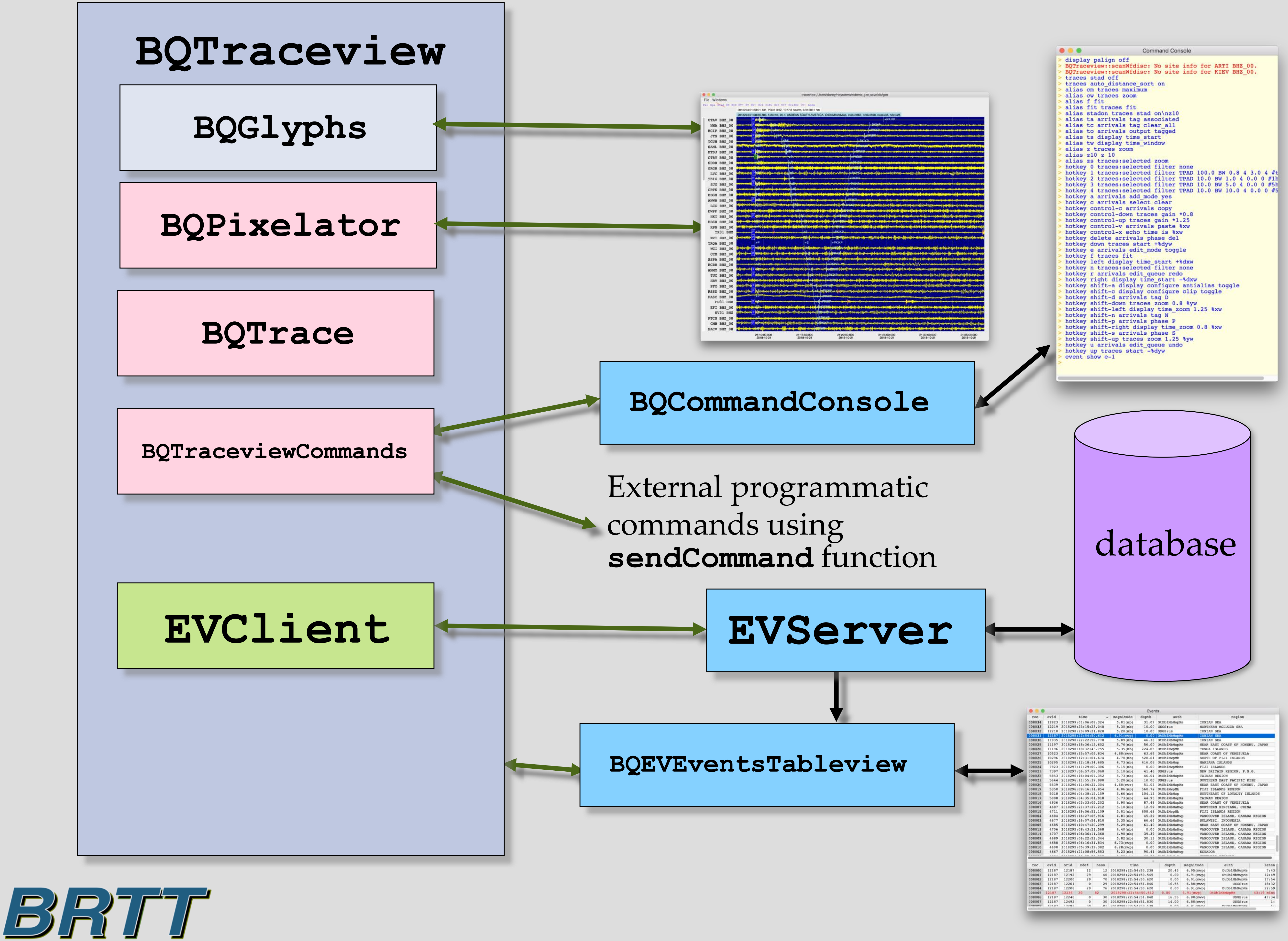
traceview – Development Strategy

- Emulate dbpick GUI as much as reasonable
- Develop as one or more reusable and extendable C++ classes
- Use Qt as the underlying graphics middleware
- Develop as a BQPlot compatible viewport item
- Use other BQPlot classes to implement glyph displays and interaction
- Use Antelope configuration standards
- Provide a high level of user configuration
- Develop appropriate python wrappers
- Adopt waveform time pixelation methodology developed in dbpick
- Develop generalized command methods as used in dbpick
- Develop separate class to support a user type-in interface
- Use EVServer and EVClient classes to provide safe database interactions

traceview – Basic Design

- New C++ class, BQTraceview, developed as a BQPlot viewport item using the Qt graphics middleware
- BQTraceview objects highly configurable through Antelope standard parameter file objects
- Helper C++ classes developed, including BQPixelator to implement high performance dbpick-style time pixelation, BQTrace to implement single waveform display and interaction and BQTraceviewCommands to implement generic command interface for BQTraceview
- New BQCommandConsole class developed to provide a user command type-in interface
- python wrappers for BQTraceview and BQCommandConsole
- BQTraceview creates internal EVClient object for connection with external EVServer object



BQTraceview

BQGlyphs

BQPixelator

BQTrace

BQTraceviewCommands

EVClient

BQCommandConsole

External programmatic commands using **sendCommand** function

EVServer

database

BQEVEventsTableview

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Command Console

```
> display palign off
> BQTraceview::scanWfdisc: No site info for ARTI BHZ_00.
> BQTraceview::scanWfdisc: No site info for KIEV BHZ_00.
> traces stad off
> traces auto_distance_sort on
> alias cm traces maximum
> alias cw traces zoom
> alias f fit
> alias fit traces fit
> alias stadon traces stad on\nz10
> alias ta arrivals tag associated
> alias tc arrivals tag clear_all
> alias to arrivals output tagged
> alias ts display time_start
> alias tw display time_window
> alias z traces zoom
> alias z10 z 10
> alias zs traces:selected zoom
> hotkey 0 traces:selected filter none
> hotkey 1 traces:selected filter TPAD 100.0 BW 0.8 4 3.0 4 #t
> hotkey 2 traces:selected filter TPAD 10.0 BW 1.0 4 0.0 0 #1h
> hotkey 3 traces:selected filter TPAD 10.0 BW 5.0 4 0.0 0 #5h
> hotkey 4 traces:selected filter TPAD 10.0 BW 10.0 4 0.0 0 #5
> hotkey a arrivals add_mode yes
> hotkey c arrivals select clear
> hotkey control-c arrivals copy
> hotkey control-down traces gain *0.8
> hotkey control-up traces gain *1.25
> hotkey control-v arrivals paste %xw
> hotkey control-x echo time is %xw
> hotkey delete arrivals phase del
> hotkey down traces start +%dyw
> hotkey e arrivals edit_mode toggle
> hotkey f traces fit
> hotkey left display time_start +%dxw
> hotkey n traces:selected filter none
> hotkey r arrivals edit_queue redo
> hotkey right display time_start -%dxw
> hotkey shift-a display configure antialias toggle
> hotkey shift-c display configure clip toggle
> hotkey shift-d arrivals tag D
> hotkey shift-down traces zoom 0.8 %yw
> hotkey shift-left display time_zoom 1.25 %xw
> hotkey shift-n arrivals tag N
> hotkey shift-p arrivals phase P
> hotkey shift-right display time_zoom 0.8 %xw
> hotkey shift-s arrivals phase S
> hotkey shift-up traces zoom 1.25 %yw
> hotkey u arrivals edit_queue undo
> hotkey up traces start -%dyw
> event show e-1
>
```

Events

rec	evid	time	magnitude	depth	auth	region
000034	12823	2018299:01:06:08.324	5.01(mb)	31.07	OtDblMbMwpMs	IONIAN SEA
000033	12219	2018298:23:15:23.040	5.30(mb)	10.00	USGS:us	NORTHERN MOLUCCA SEA
000032	12210	2018298:23:09:21.820	5.20(mb)	10.00	USGS:us	IONIAN SEA
000031	12187	2018298:22:54:50.612	6.91(mwp)	0.00	OtDblMbMwpMs	IONIAN SEA
000030	11935	2018298:22:22:59.770	5.09(mb)	46.36	OtDblMbMwpMs	IONIAN SEA
000029	11197	2018298:18:36:12.602	5.76(mb)	56.00	OtDblMbMwpMs	NEAR EAST COAST OF HONSHU, JAPAN
000028	11196	2018298:18:32:43.755	5.35(mb)	224.05	OtDblMwpMb	TONGA ISLANDS
000027	10523	2018298:15:57:05.834	4.80(mww)	63.68	OtDblMbMwpMs	NEAR COAST OF VENEZUELA
000026	10296	2018298:12:31:01.674	4.70(mb)	528.61	OtDblMwpMb	SOUTH OF FIJI ISLANDS
000025	10295	2018298:12:18:34.685	4.73(mb)	416.08	OtDblMbMwp	MARIANA ISLANDS
000024	7923	2018297:11:29:00.306	5.15(mb)	0.00	OtDblMwpMbMs	FIJI ISLANDS
000023	7397	2018297:06:57:09.060	5.10(mb)	41.46	USGS:us	NEW BRITAIN REGION, P.N.G.
000022	5853	2018296:16:04:07.352	5.73(mb)	46.04	OtDblMbMwpMs	TAIWAN REGION
000021	5644	2018296:11:55:37.980	5.20(mb)	10.00	USGS:us	SOUTHERN EAST PACIFIC RISE
000020	5539	2018296:11:06:22.304	4.60(mwr)	51.03	OtDblMbMwpMs	NEAR EAST COAST OF HONSHU, JAPAN
000019	5350	2018296:09:16:31.854	4.06(mb)	560.72	OtDblMwpMb	FIJI ISLANDS REGION
000018	5018	2018296:04:38:15.159	5.66(mb)	104.13	OtDblMbMwp	SOUTHEAST OF LOYALTY ISLANDS
000017	5008	2018296:04:35:01.918	5.73(mb)	44.95	OtDblMbMwpMs	TAIWAN REGION
000016	4936	2018296:03:33:05.202	4.90(mb)	87.48	OtDblMbMwpMs	NEAR COAST OF VENEZUELA
000007	4687	2018295:21:37:27.212	5.10(mb)	12.59	OtDblMbMsMwp	NORTHERN XINJIANG, CHINA
000015	4711	2018295:19:06:52.109	5.01(mb)	608.68	OtDblMwpMb	FIJI ISLANDS REGION
000004	4684	2018295:16:27:05.916	4.81(mb)	45.29	OtDblMbMsMwp	VANCOUVER ISLAND, CANADA REGION
000003	4677	2018295:16:07:54.810	5.35(mb)	66.64	OtDblMbMsMwp	SULAWESI, INDONESIA
000005	4685	2018295:10:47:20.299	5.29(mb)	61.40	OtDblMbMsMwp	NEAR EAST COAST OF HONSHU, JAPAN
000013	4706	2018295:08:43:21.568	4.40(mb)	0.00	OtDblMbMsMwp	VANCOUVER ISLAND, CANADA REGION
000014	4707	2018295:06:36:11.360	4.90(mb)	39.39	OtDblMbMsMwp	VANCOUVER ISLAND, CANADA REGION
000009	4689	2018295:06:22:52.344	5.82(mb)	30.13	OtDblMbMsMwp	VANCOUVER ISLAND, CANADA REGION
000008	4688	2018295:06:16:31.834	6.73(mwp)	0.00	OtDblMbMsMwp	VANCOUVER ISLAND, CANADA REGION
000010	4690	2018295:05:39:39.382	6.28(mwp)	0.00	OtDblMbMsMwp	VANCOUVER ISLAND, CANADA REGION
000002	4667	2018294:21:08:56.583	5.23(mb)	90.41	OtDblMbMsMwp	ECUADOR

rec	evid	orid	ndef	nass	time	depth	magnitude	auth	laten
000000	12187	12187	12	12	2018298:22:54:53.238	20.43	6.95(mwp)	OtDblMbMwpMs	7:43
000001	12187	12192	29	40	2018298:22:54:50.545	0.00	6.91(mwp)	OtDblMbMwpMs	12:49
000002	12187	12200	29	70	2018298:22:54:50.620	0.00	6.91(mwp)	OtDblMbMwpMs	17:54
000003	12187	12201	0	29	2018298:22:54:51.840	16.55	6.80(mww)	USGS:us	18:32
000004	12187	12206	29	76	2018298:22:54:50.620	0.00	6.91(mwp)	OtDblMbMwpMs	22:59
000005	12187	12236	30	82	2018298:22:54:50.612	0.00	6.91(mwp)	OtDblMbMwpMs	43:19 minu
000006	12187	12240	0	30	2018298:22:54:51.840	16.55	6.80(mww)	USGS:us	47:34
000007	12187	12492	0	30	2018298:22:54:51.830	14.00	6.80(mww)	USGS:us	1:

"Event View" specialized server-client interface into Datascope databases

- Two new object oriented c++ classes were introduced in Antelope 5.7 – **`EVServer`** and **`EVClient`** (see man EV(3)).
- These event view classes provide a server-client implementation of database access operations specific to the various seismic event tables in the `css` schema.

NAME

EV - BRTT utility for earthquake event view formation

SYNOPSIS

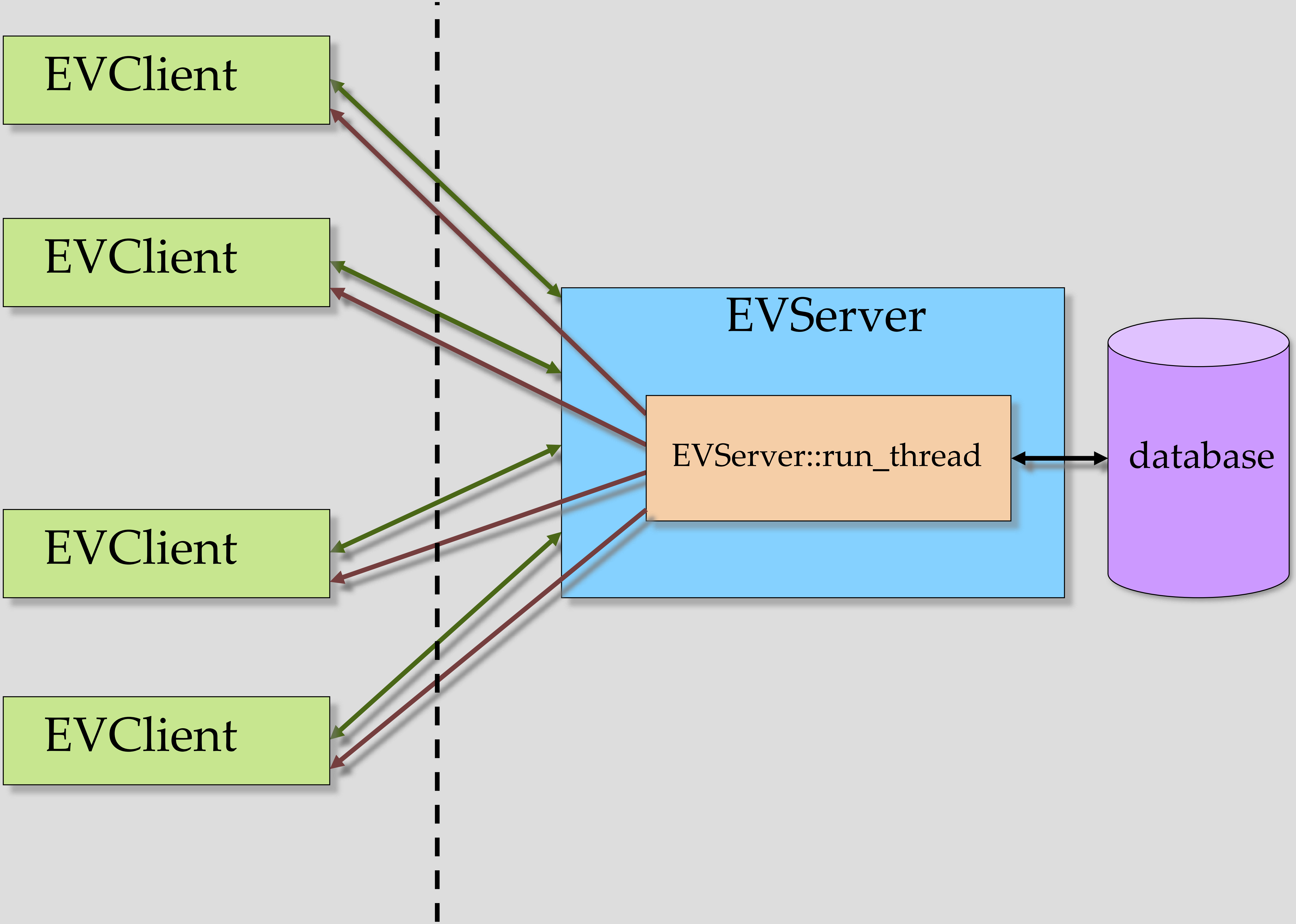
```
-lbrttutil

#include "EV.h"
```

DESCRIPTION

There are two fundamental classes, **EVServer** and **EVClient**, that implement complete views of earthquake event information from underlying databases. They are intended to be dynamic in response to changing databases. Information from events, origins, origin errors, associations, arrivals, detections, stations, magnitudes and moment tensors are joined in a set of views that can be returned through a set of specialized structures.

The underlying database is monitored and the views are made by a single **EVServer** object. The views are refreshed automatically by **EVServer** objects whenever any of the database file modification times have changed. **EVServer** makes all of the joins though calls to **dbmatches(3)** only, without using the various other Datascope view generation routines, such as **dbjoin(3)**. Most Datascope view generation routines cannot track dynamic changes in the underlying database. By only using **dbmatches(3)**, which is designed to track certain changes in the underlying database, **EVServer** objects can track changes in the database and recompute the various view structures as required. All calls to **dbmatches(3)**, **dbget(3)** or **dbgetv(3)** made by **EVServer** objects trap error returns, which could be caused by changes in the database during **EVServer** processing. When **dbget(3)**, **dbgetv(3)** or **dbmatches(3)** return errors, the **EVServer** object will automatically close the database, reopen it, free all **dbmatches(3)** hooks, and reform the various views. This will also happen automatically whenever the database files shrink in size.


EVClient
EVClient
EVClient
EVClient
EVServer
EVServer::run_thread
database

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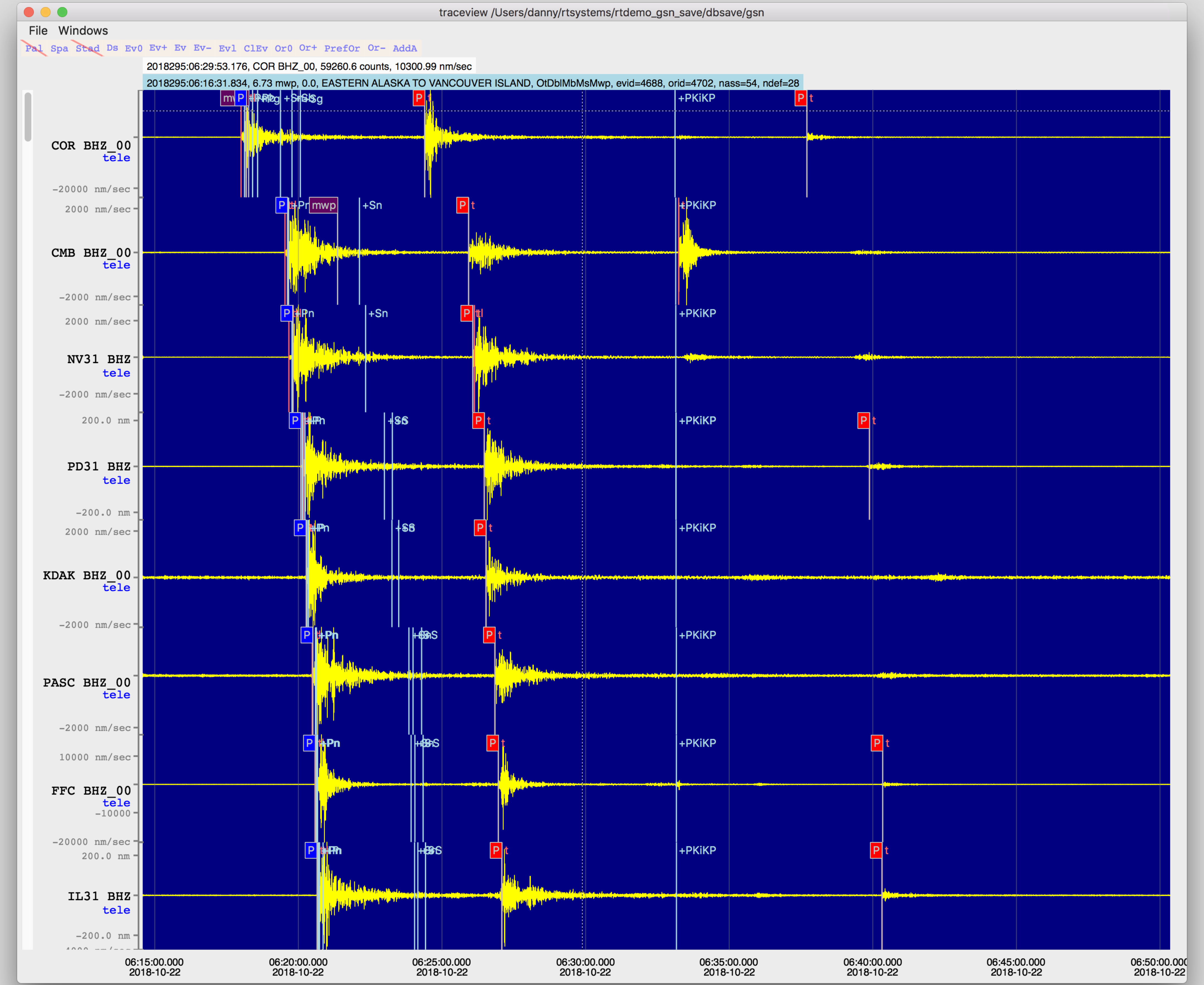
- `EVServer` objects launch a thread, `EVServer::run_thread`, to interact with the database. This thread is the only thread that interacts with the database.
- The primary responsibility of `EVServer::run_thread` is to keep an up to date internal set of structures that contain all of the information from the database, including copies of the database records, all linked together to form earthquake event oriented views.
- None of the internal structures contain database pointers or other references back to the database. In this way the internal structures are complete and self consistent snapshots of the database at the time when the structures were made.

- **`EVClient` objects can request copies of the internal structures that `EVServer` objects maintain.**
- **`EVClient` objects can register callback functions with their `EVServer`. `EVServer::run_thread` will execute these callbacks whenever any of the internal structures have changed.**
- **All `EVClient` acquired event view structures are complete and self consistent snapshots of the database at the time when the structures were made.**
- **`EVClient` objects never try to reference the database directly.**

EVServer changes to support traceview

- Serve `wfdisc` rows
- Serve unassociated `arrival` rows
- Serve unassociated `detection` rows
- Serve unassociated `site` rows
- Provide generic equivalents to `dbput`, `dbnextid` and `dbadd`
- Provide generic equivalents to `dbsubset` and `dbmatches`



traceview /Users/danny/rtsystems/rtdemo_gsn_save/dbsave/gsn

2018295:06:29:53.176, COR BHZ_00, 59260.6 counts, 10300.99 nm/sec

2018295:06:16:31.834, 6.73 mwp, 0.0, EASTERN ALASKA TO VANCOUVER ISLAND, OtDblMbMsMwp, evid=4688, orid=4702, nass=54, ndef=28

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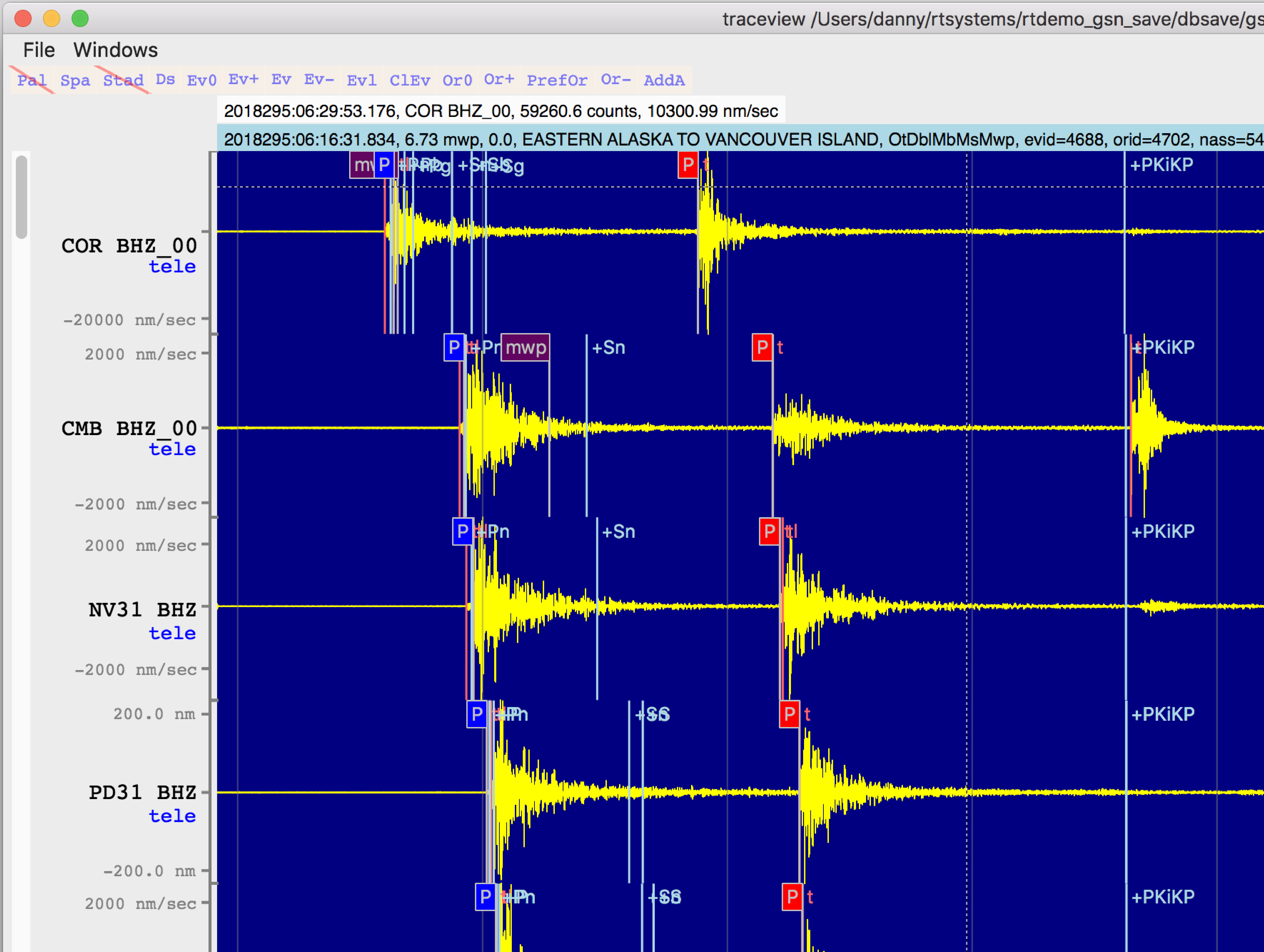
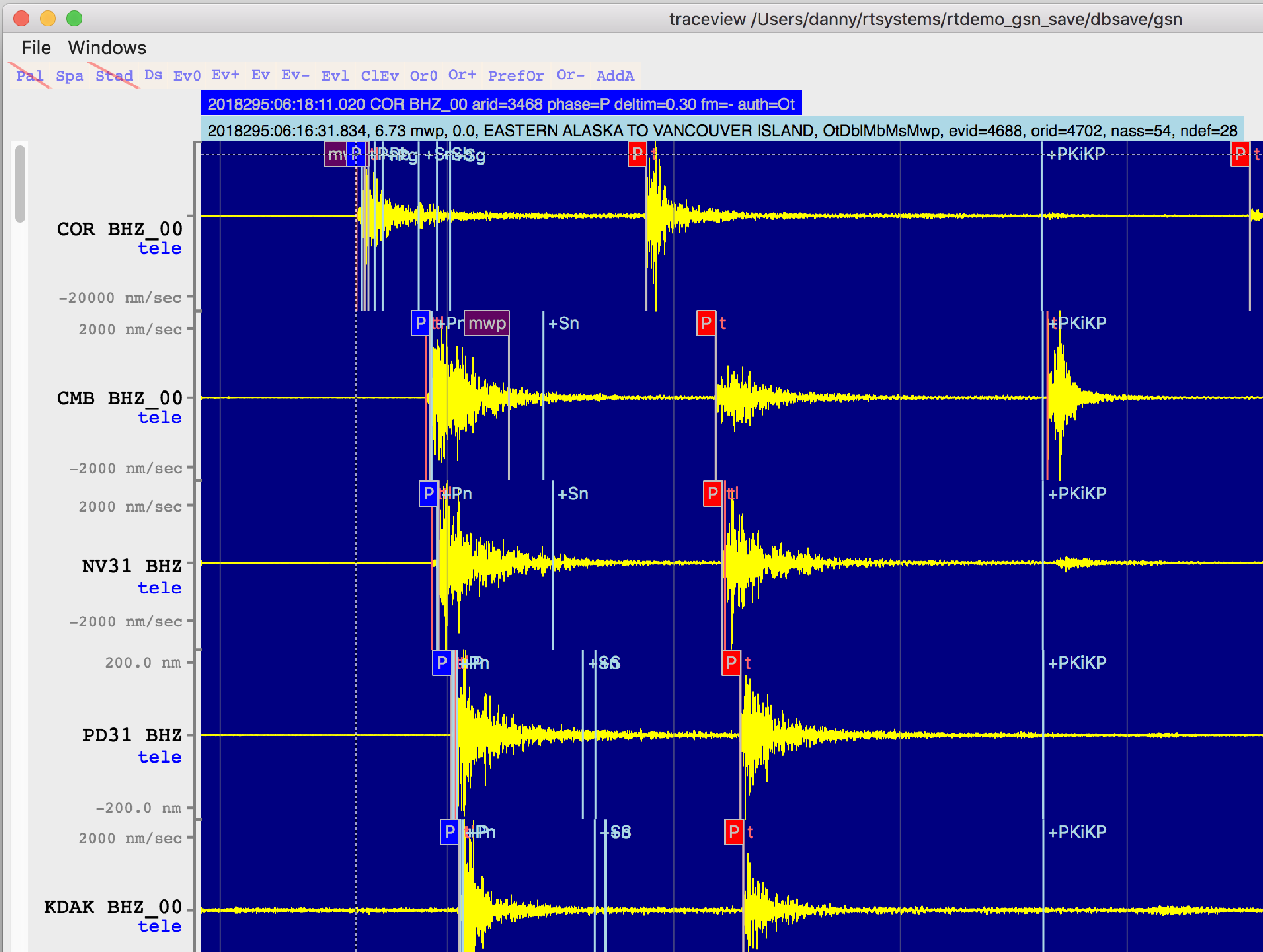


2018295:06:29:53.176, COR BHZ_00, 59260.6 counts, 10300.99 nm/sec

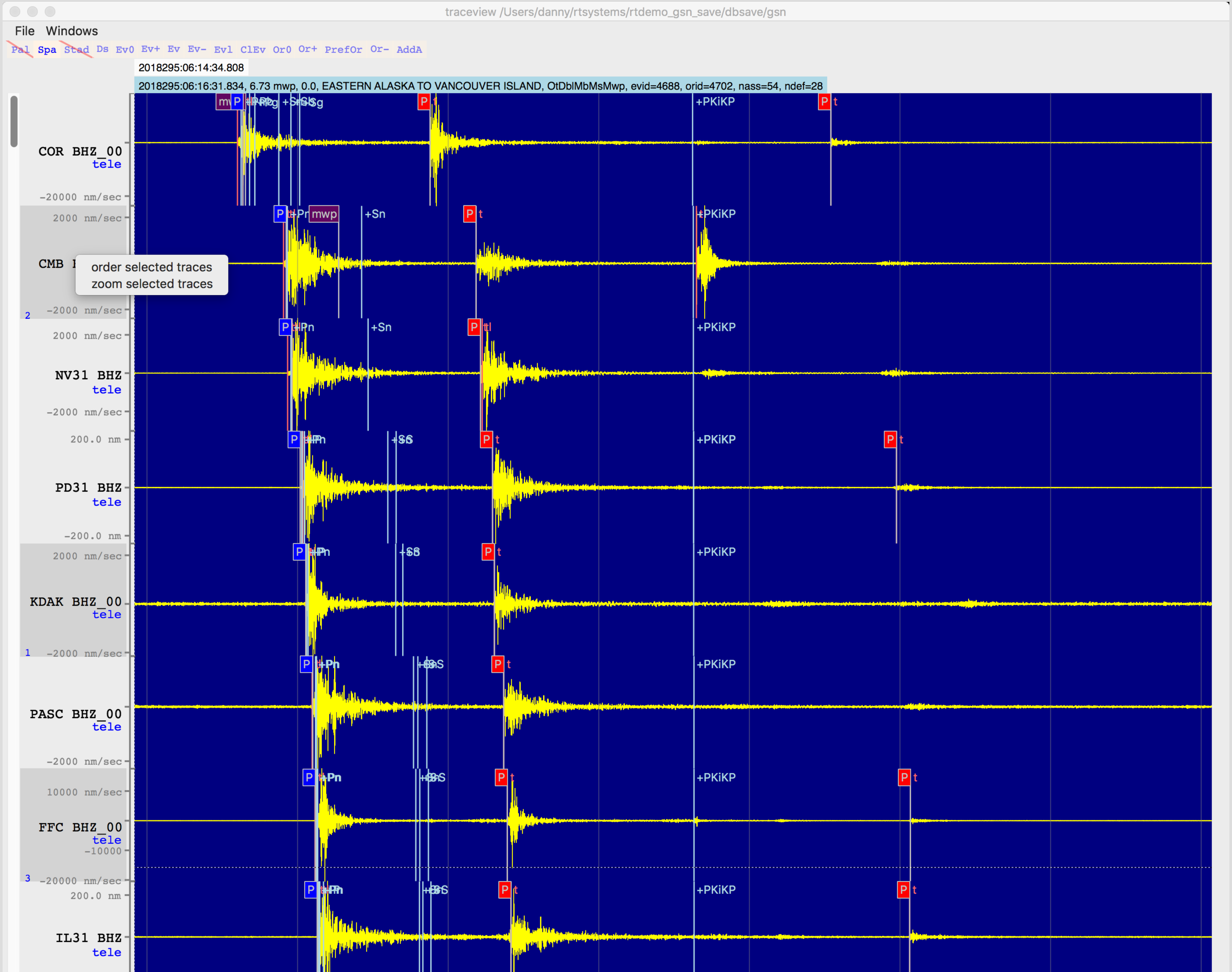
2018295:06:16:31.834, 6.73 mwp, 0.0, EASTERN ALASKA TO VANCOUVER ISLAND, OtDblMbMsMwp, evid=4688, orid=4702, nass=54



traceview /Users/danny/rtsystems/rtdemo_gsn_save/dbsave/gsn

2018295:06:18:11.020 COR BHZ_00 arid=3468 phase=P deltim=0.30 fm=- auth=Ot

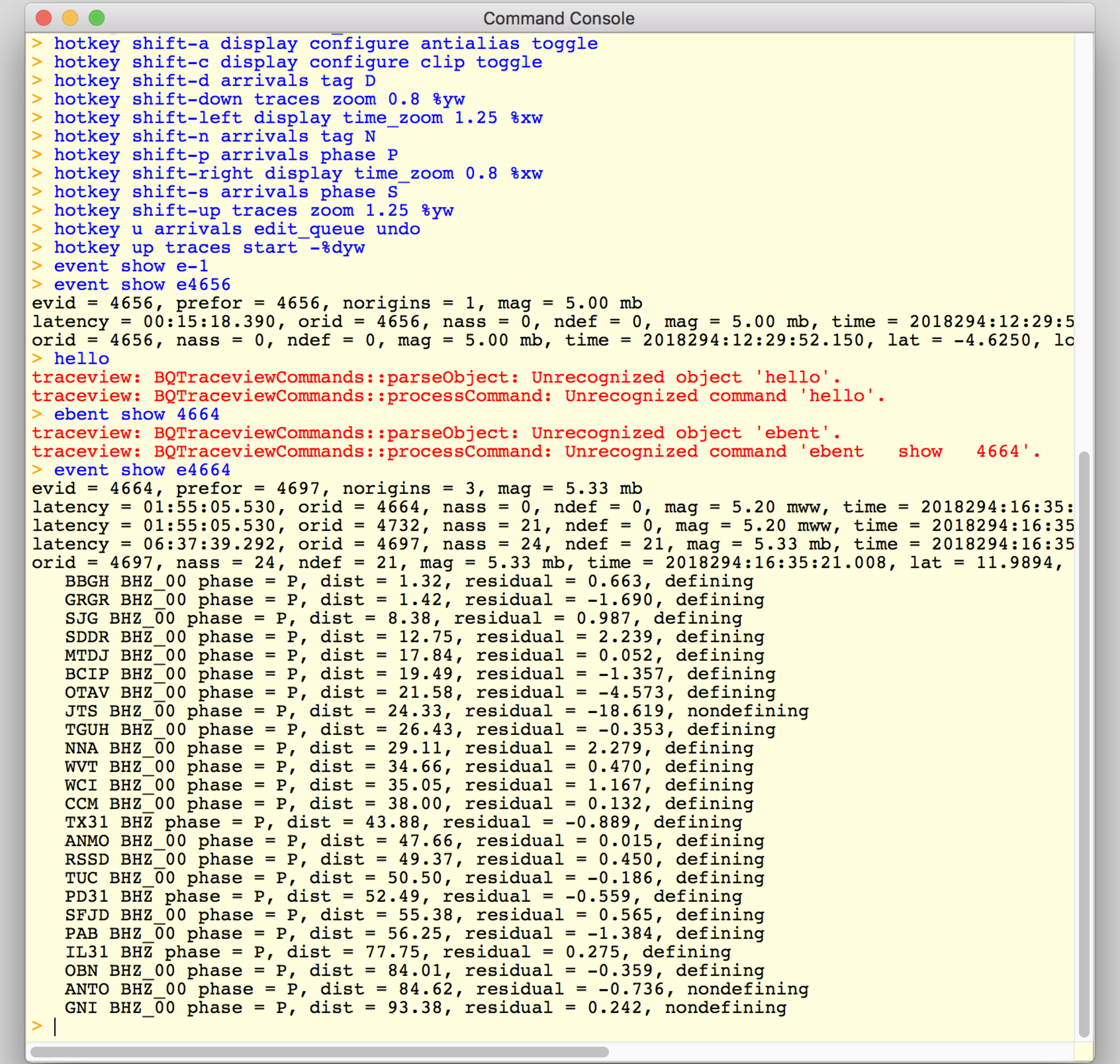
2018295:06:16:31.834, 6.73 mwp, 0.0, EASTERN ALASKA TO VANCOUVER ISLAND, OtDblMbMsMwp, evid=4688, orid=4702, nass=54, ndef=28



traceview /Users/danny/rtsystems/rtdemo_gsn_save/dbsave/gsn

2018295:06:14:34.808

2018295:06:16:31.834, 6.73 mwp, 0.0, EASTERN ALASKA TO VANCOUVER ISLAND, OtDblMbMsMwp, evid=4688, orid=4702, nass=54, ndef=28



```
> hotkey shift-a display configure antialias toggle
> hotkey shift-c display configure clip toggle
> hotkey shift-d arrivals tag D
> hotkey shift-down traces zoom 0.8 %yw
> hotkey shift-left display time_zoom 1.25 %xw
> hotkey shift-n arrivals tag N
> hotkey shift-p arrivals phase P
> hotkey shift-right display time_zoom 0.8 %xw
> hotkey shift-s arrivals phase S
> hotkey shift-up traces zoom 1.25 %yw
> hotkey u arrivals edit_queue undo
> hotkey up traces start -%dyw
> event show e-1
> event show e4656
evid = 4656, prefor = 4656, norigins = 1, mag = 5.00 mb
latency = 00:15:18.390, orid = 4656, nass = 0, ndef = 0, mag = 5.00 mb, time = 2018294:12:29:5
orid = 4656, nass = 0, ndef = 0, mag = 5.00 mb, time = 2018294:12:29:52.150, lat = -4.6250, lo
> hello
traceview: BQTraceviewCommands::parseObject: Unrecognized object 'hello'.
traceview: BQTraceviewCommands::processCommand: Unrecognized command 'hello'.
> ebent show 4664
traceview: BQTraceviewCommands::parseObject: Unrecognized object 'ebent'.
traceview: BQTraceviewCommands::processCommand: Unrecognized command 'ebent   show   4664'.
> event show e4664
evid = 4664, prefor = 4697, norigins = 3, mag = 5.33 mb
latency = 01:55:05.530, orid = 4664, nass = 0, ndef = 0, mag = 5.20 mww, time = 2018294:16:35:
latency = 01:55:05.530, orid = 4732, nass = 21, ndef = 0, mag = 5.20 mww, time = 2018294:16:35
latency = 06:37:39.292, orid = 4697, nass = 24, ndef = 21, mag = 5.33 mb, time = 2018294:16:35
orid = 4697, nass = 24, ndef = 21, mag = 5.33 mb, time = 2018294:16:35:21.008, lat = 11.9894,
   BBGH BHZ_00 phase = P, dist = 1.32, residual = 0.663, defining
   GRGR BHZ_00 phase = P, dist = 1.42, residual = -1.690, defining
   SJG BHZ_00 phase = P, dist = 8.38, residual = 0.987, defining
   SDDR BHZ_00 phase = P, dist = 12.75, residual = 2.239, defining
   MTDJ BHZ_00 phase = P, dist = 17.84, residual = 0.052, defining
   BCIP BHZ_00 phase = P, dist = 19.49, residual = -1.357, defining
   OTAV BHZ_00 phase = P, dist = 21.58, residual = -4.573, defining
   JTS BHZ_00 phase = P, dist = 24.33, residual = -18.619, nondefining
   TGUH BHZ_00 phase = P, dist = 26.43, residual = -0.353, defining
   NNA BHZ_00 phase = P, dist = 29.11, residual = 2.279, defining
   WVT BHZ_00 phase = P, dist = 34.66, residual = 0.470, defining
   WCI BHZ_00 phase = P, dist = 35.05, residual = 1.167, defining
   CCM BHZ_00 phase = P, dist = 38.00, residual = 0.132, defining
   TX31 BHZ phase = P, dist = 43.88, residual = -0.889, defining
   ANMO BHZ_00 phase = P, dist = 47.66, residual = 0.015, defining
   RSSD BHZ_00 phase = P, dist = 49.37, residual = 0.450, defining
   TUC BHZ_00 phase = P, dist = 50.50, residual = -0.186, defining
   PD31 BHZ phase = P, dist = 52.49, residual = -0.559, defining
   SFJD BHZ_00 phase = P, dist = 55.38, residual = 0.565, defining
   PAB BHZ_00 phase = P, dist = 56.25, residual = -1.384, defining
   IL31 BHZ phase = P, dist = 77.75, residual = 0.275, defining
   OBN BHZ_00 phase = P, dist = 84.01, residual = -0.359, defining
   ANTO BHZ_00 phase = P, dist = 84.62, residual = -0.736, nondefining
   GNI BHZ_00 phase = P, dist = 93.38, residual = 0.242, nondefining
> |
```

BRTT

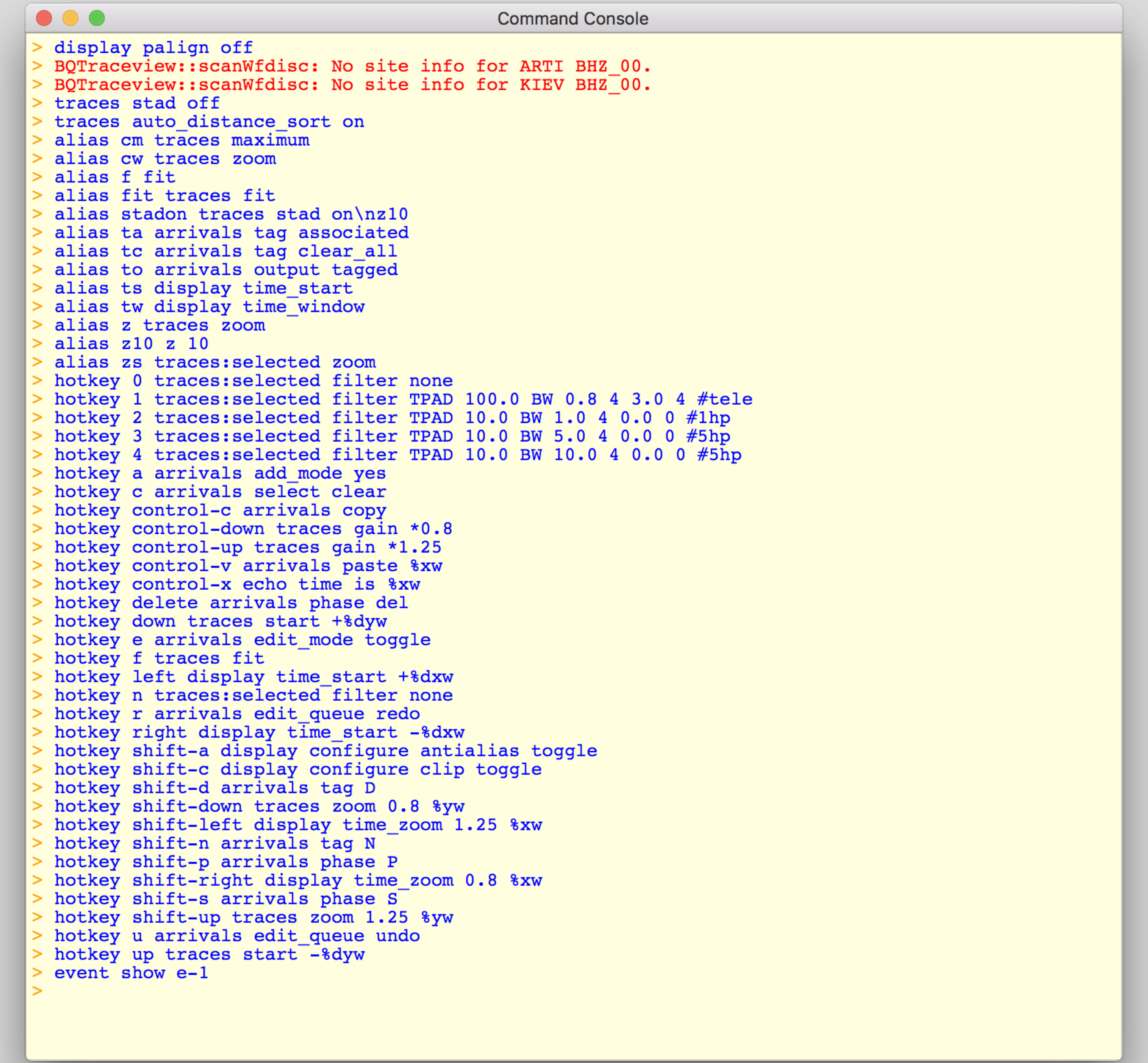
`traceview` – Command Processing

- Most `BQTraceview` object run time display configuration and editing functions are specified through a command processing interface
- Commands can be sent to `BQTraceview` objects at run time either through a type-in interface or programmatically
- A new class, `BQCommandConsole`, was developed to provide a generalized user command type-in interface
  - all commands are stored in an internal command history queue
  - history substitutions using the up and down arrows keys
  - in-line command editing
  - command history queue can be dumped to an external file
  - commands can be read from an external file and executed as if typed
  - The typed-in commands, normal command output and command error output are displayed in different colors

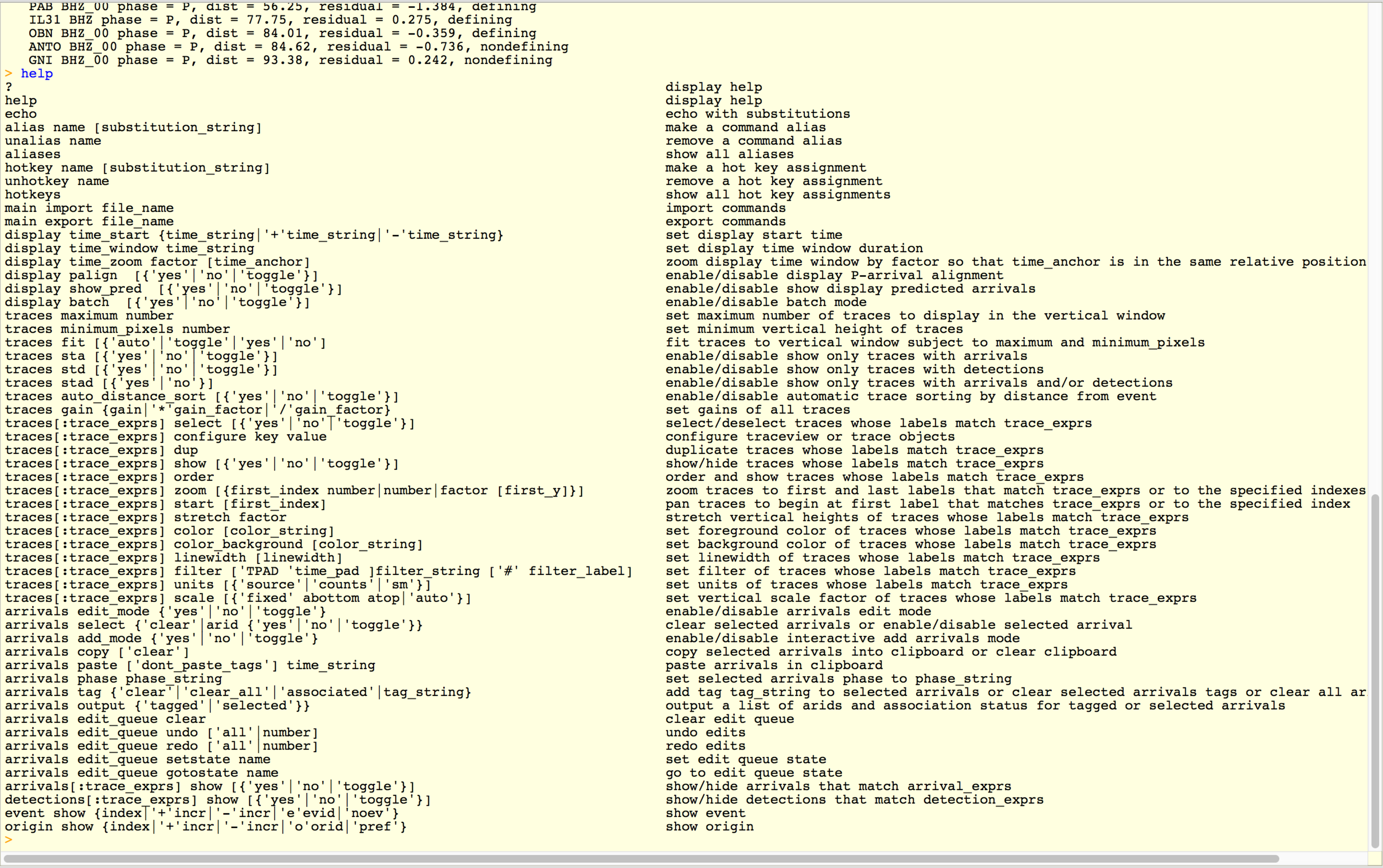
BRTT

traceview – Command Processing

- BQTraceview object commands are processed by a helper class, BQTraceviewCommands
  - commands can be aliased
  - commands support simple variable substitution
  - keyboard shortcuts (hotkeys) can be defined
- A BQTraceview object can be linked, through its BQTraceviewCommands helper object, to a BQCommandConsole object providing a user type-in interface
- Also, remote commands can be sent to a BQTraceview object, through its BQTraceviewCommands helper object, and these commands can be optionally echoed in any linked BQCommandConsole object.



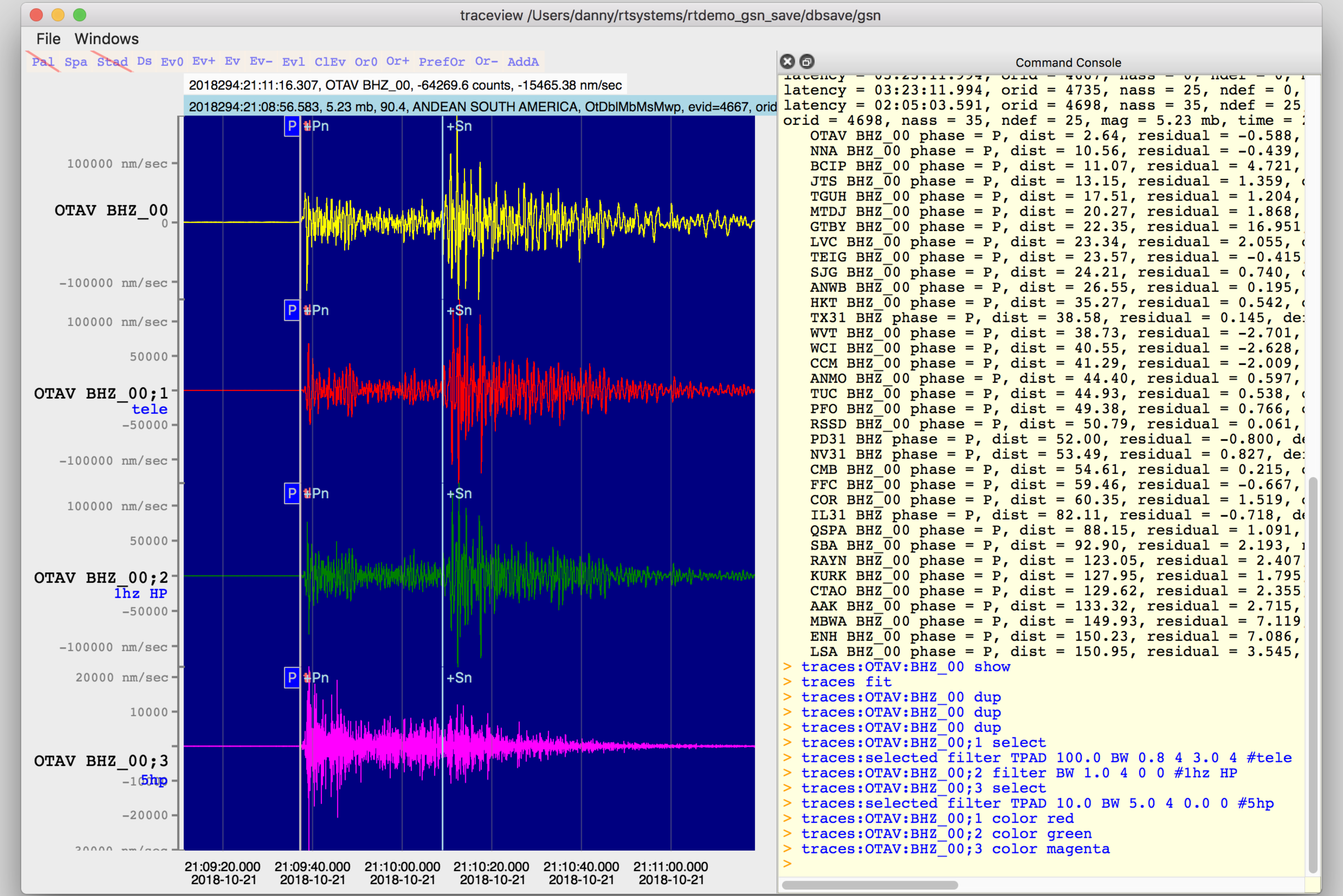
```
> display palign off
> BQTraceview::scanWfdisc: No site info for ARTI BHZ_00.
> BQTraceview::scanWfdisc: No site info for KIEV BHZ_00.
> traces stad off
> traces auto_distance_sort on
> alias cm traces maximum
> alias cw traces zoom
> alias f fit
> alias fit traces fit
> alias stadon traces stad on\nz10
> alias ta arrivals tag associated
> alias tc arrivals tag clear_all
> alias to arrivals output tagged
> alias ts display time_start
> alias tw display time_window
> alias z traces zoom
> alias z10 z 10
> alias zs traces:selected zoom
> hotkey 0 traces:selected filter none
> hotkey 1 traces:selected filter TPAD 100.0 BW 0.8 4 3.0 4 #tele
> hotkey 2 traces:selected filter TPAD 10.0 BW 1.0 4 0.0 0 #1hp
> hotkey 3 traces:selected filter TPAD 10.0 BW 5.0 4 0.0 0 #5hp
> hotkey 4 traces:selected filter TPAD 10.0 BW 10.0 4 0.0 0 #5hp
> hotkey a arrivals add_mode yes
> hotkey c arrivals select clear
> hotkey control-c arrivals copy
> hotkey control-down traces gain *0.8
> hotkey control-up traces gain *1.25
> hotkey control-v arrivals paste %xw
> hotkey control-x echo time is %xw
> hotkey delete arrivals phase del
> hotkey down traces start +%dyw
> hotkey e arrivals edit_mode toggle
> hotkey f traces fit
> hotkey left display time_start +%dxw
> hotkey n traces:selected filter none
> hotkey r arrivals edit_queue redo
> hotkey right display time_start -%dxw
> hotkey shift-a display configure antialias toggle
> hotkey shift-c display configure clip toggle
> hotkey shift-d arrivals tag D
> hotkey shift-down traces zoom 0.8 %yw
> hotkey shift-left display time_zoom 1.25 %xw
> hotkey shift-n arrivals tag N
> hotkey shift-p arrivals phase P
> hotkey shift-right display time_zoom 0.8 %xw
> hotkey shift-s arrivals phase S
> hotkey shift-up traces zoom 1.25 %yw
> hotkey u arrivals edit_queue undo
> hotkey up traces start -%dyw
> event show e-1
>
```



```
   PAB BHZ_00 phase = P, dist = 56.25, residual = -1.384, defining
   IL31 BHZ phase = P, dist = 77.75, residual = 0.275, defining
   OBN BHZ_00 phase = P, dist = 84.01, residual = -0.359, defining
   ANTO BHZ_00 phase = P, dist = 84.62, residual = -0.736, nondefining
   GNI BHZ_00 phase = P, dist = 93.38, residual = 0.242, nondefining
> help
?                                                                                 display help
help                                                                              display help
echo                                                                              echo with substitutions
alias name [substitution_string]                                                  make a command alias
unalias name                                                                      remove a command alias
aliases                                                                           show all aliases
hotkey name [substitution_string]                                                 make a hot key assignment
unhotkey name                                                                     remove a hot key assignment
hotkeys                                                                           show all hot key assignments
main import file_name                                                             import commands
main export file_name                                                             export commands
display time_start {time_string|'+'time_string|'-'time_string}                    set display start time
display time_window time_string                                                   set display time window duration
display time_zoom factor [time_anchor]                                            zoom display time window by factor so that time_anchor is in the same relative position
display palign  [{'yes'|'no'|'toggle'}]                                           enable/disable display P-arrival alignment
display show_pred  [{'yes'|'no'|'toggle'}]                                        enable/disable show display predicted arrivals
display batch  [{'yes'|'no'|'toggle'}]                                            enable/disable batch mode
traces maximum number                                                             set maximum number of traces to display in the vertical window
traces minimum_pixels number                                                      set minimum vertical height of traces
traces fit [{'auto'|'toggle'|'yes'|'no']                                          fit traces to vertical window subject to maximum and minimum_pixels
traces sta [{'yes'|'no'|'toggle'}]                                                enable/disable show only traces with arrivals
traces std [{'yes'|'no'|'toggle'}]                                                enable/disable show only traces with detections
traces stad [{'yes'|'no'}]                                                        enable/disable show only traces with arrivals and/or detections
traces auto_distance_sort [{'yes'|'no'|'toggle'}]                                 enable/disable automatic trace sorting by distance from event
traces gain {gain|'*'gain_factor|'/'gain_factor}                                  set gains of all traces
traces[:trace_exprs] select [{'yes'|'no'|'toggle'}]                               select/deselect traces whose labels match trace_exprs
traces[:trace_exprs] configure key value                                          configure traceview or trace objects
traces[:trace_exprs] dup                                                          duplicate traces whose labels match trace_exprs
traces[:trace_exprs] show [{'yes'|'no'|'toggle'}]                                 show/hide traces whose labels match trace_exprs
traces[:trace_exprs] order                                                        order and show traces whose labels match trace_exprs
traces[:trace_exprs] zoom [{first_index number|number|factor [first_y]}]          zoom traces to first and last labels that match trace_exprs or to the specified indexes
traces[:trace_exprs] start [first_index]                                          pan traces to begin at first label that matches trace_exprs or to the specified index
traces[:trace_exprs] stretch factor                                               stretch vertical heights of traces whose labels match trace_exprs
traces[:trace_exprs] color [color_string]                                         set foreground color of traces whose labels match trace_exprs
traces[:trace_exprs] color_background [color_string]                              set background color of traces whose labels match trace_exprs
traces[:trace_exprs] linewidth [linewidth]                                        set linewidth of traces whose labels match trace_exprs
traces[:trace_exprs] filter ['TPAD 'time_pad ]filter_string ['#' filter_label]    set filter of traces whose labels match trace_exprs
traces[:trace_exprs] units [{'source'|'counts'|'sm'}]                             set units of traces whose labels match trace_exprs
traces[:trace_exprs] scale [{'fixed' abottom atop|'auto'}]                        set vertical scale factor of traces whose labels match trace_exprs
arrivals edit_mode {'yes'|'no'|'toggle'}                                          enable/disable arrivals edit mode
arrivals select {'clear'|arid {'yes'|'no'|'toggle'}}                              clear selected arrivals or enable/disable selected arrival
arrivals add_mode {'yes'|'no'|'toggle'}                                           enable/disable interactive add arrivals mode
arrivals copy ['clear']                                                           copy selected arrivals into clipboard or clear clipboard
arrivals paste ['dont_paste_tags'] time_string                                    paste arrivals in clipboard
arrivals phase phase_string                                                       set selected arrivals phase to phase_string
arrivals tag {'clear'|'clear_all'|'associated'|tag_string}                        add tag tag_string to selected arrivals or clear selected arrivals tags or clear all ar
arrivals output {'tagged'|'selected'}}                                            output a list of arids and association status for tagged or selected arrivals
arrivals edit_queue clear                                                         clear edit queue
arrivals edit_queue undo ['all'|number]                                           undo edits
arrivals edit_queue redo ['all'|number]                                           redo edits
arrivals edit_queue setstate name                                                 set edit queue state
arrivals edit_queue gotostate name                                                go to edit queue state
arrivals[:trace_exprs] show [{'yes'|'no'|'toggle'}]                               show/hide arrivals that match arrival_exprs
detections[:trace_exprs] show [{'yes'|'no'|'toggle'}]                             show/hide detections that match detection_exprs
event show {index|'+'incr|'-'incr|'e'evid|'noev'}                                 show event
origin show {index|'+'incr|'-'incr|'o'orid|'pref'}                                show origin
>
```

`traceview` – Trace Expressions and Duplication

- The commands involving **`traces`** objects can contain an optional **`trace_exprs`** string which defines a subset of all traces
- When the **`trace_exprs`** string is specified, actions apply only to those traces that match the expressions
- Traces can be duplicated – duplicated traces are indicated by a ***`;<copy_number>`*** appended to the channel code



2018294:21:11:16.307, OTAV BHZ_00, -64269.6 counts, -15465.38 nm/sec

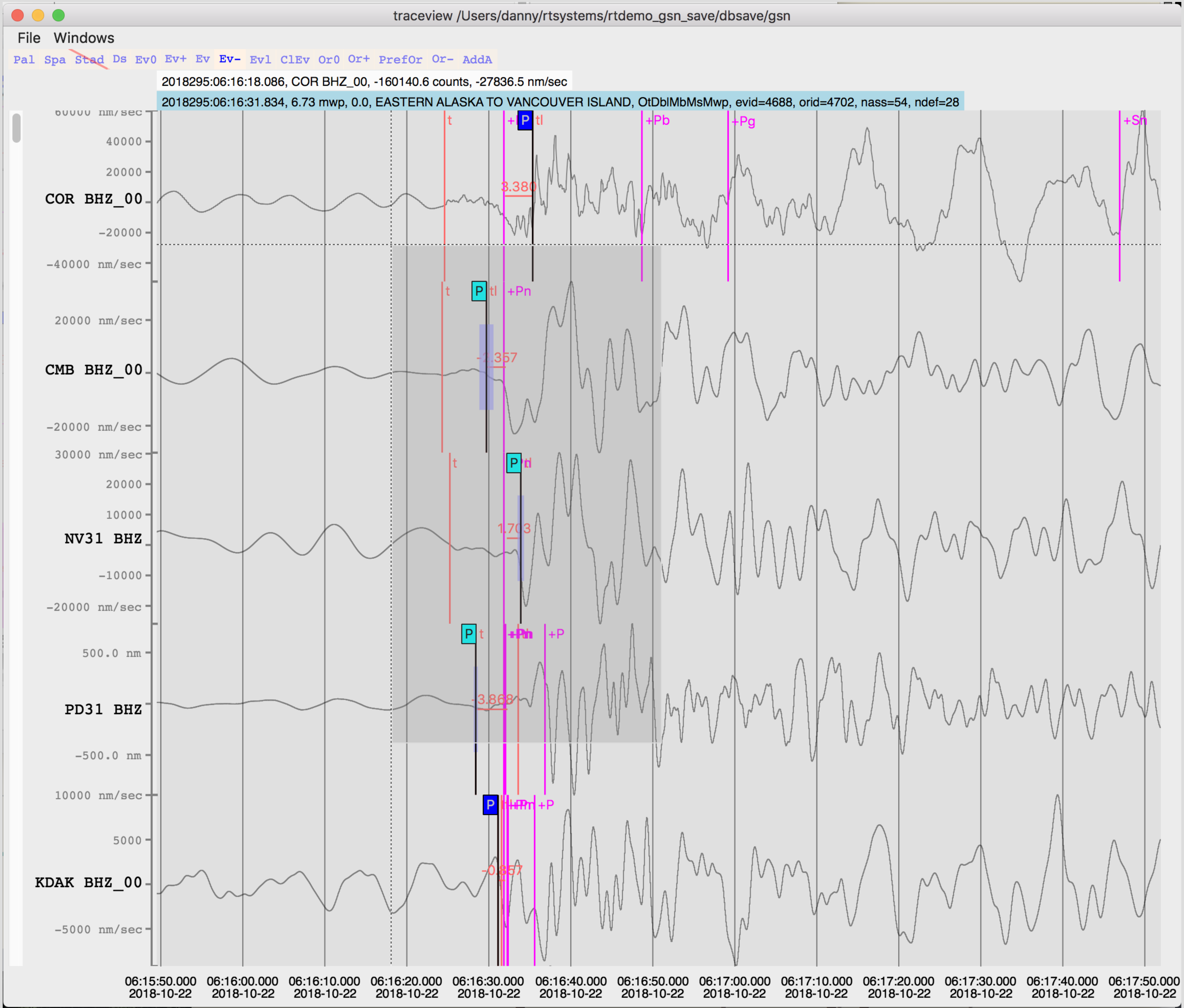
2018294:21:08:56.583, 5.23 mb, 90.4, ANDEAN SOUTH AMERICA, OtDblMbMsMwp, evid=4667, orid

```
latency = 03:23:11.994, orid = 4667, nass = 0, ndef = 0,
latency = 03:23:11.994, orid = 4735, nass = 25, ndef = 0,
latency = 02:05:03.591, orid = 4698, nass = 35, ndef = 25
orid = 4698, nass = 35, ndef = 25, mag = 5.23 mb, time =
   OTAV BHZ_00 phase = P, dist = 2.64, residual = -0.588,
   NNA BHZ_00 phase = P, dist = 10.56, residual = -0.439,
   BCIP BHZ_00 phase = P, dist = 11.07, residual = 4.721,
   JTS BHZ_00 phase = P, dist = 13.15, residual = 1.359,
   TGUH BHZ_00 phase = P, dist = 17.51, residual = 1.204,
   MTDJ BHZ_00 phase = P, dist = 20.27, residual = 1.868,
   GTBY BHZ_00 phase = P, dist = 22.35, residual = 16.951
   LVC BHZ_00 phase = P, dist = 23.34, residual = 2.055,
   TEIG BHZ_00 phase = P, dist = 23.57, residual = -0.415
   SJG BHZ_00 phase = P, dist = 24.21, residual = 0.740,
   ANWB BHZ_00 phase = P, dist = 26.55, residual = 0.195,
   HKT BHZ_00 phase = P, dist = 35.27, residual = 0.542,
   TX31 BHZ phase = P, dist = 38.58, residual = 0.145, de
   WVT BHZ_00 phase = P, dist = 38.73, residual = -2.701,
   WCI BHZ_00 phase = P, dist = 40.55, residual = -2.628,
   CCM BHZ_00 phase = P, dist = 41.29, residual = -2.009,
   ANMO BHZ_00 phase = P, dist = 44.40, residual = 0.597,
   TUC BHZ_00 phase = P, dist = 44.93, residual = 0.538,
   PFO BHZ_00 phase = P, dist = 49.38, residual = 0.766,
   RSSD BHZ_00 phase = P, dist = 50.79, residual = 0.061,
   PD31 BHZ phase = P, dist = 52.00, residual = -0.800, de
   NV31 BHZ phase = P, dist = 53.49, residual = 0.827, de
   CMB BHZ_00 phase = P, dist = 54.61, residual = 0.215,
   FFC BHZ_00 phase = P, dist = 59.46, residual = -0.667,
   COR BHZ_00 phase = P, dist = 60.35, residual = 1.519,
   IL31 BHZ phase = P, dist = 82.11, residual = -0.718, de
   QSPA BHZ_00 phase = P, dist = 88.15, residual = 1.091,
   SBA BHZ_00 phase = P, dist = 92.90, residual = 2.193,
   RAYN BHZ_00 phase = P, dist = 123.05, residual = 2.407
   KURK BHZ_00 phase = P, dist = 127.95, residual = 1.795
   CTAO BHZ_00 phase = P, dist = 129.62, residual = 2.355
   AAK BHZ_00 phase = P, dist = 133.32, residual = 2.715,
   MBWA BHZ_00 phase = P, dist = 149.93, residual = 7.119
   ENH BHZ_00 phase = P, dist = 150.23, residual = 7.086,
   LSA BHZ_00 phase = P, dist = 150.95, residual = 3.545,
> traces:OTAV:BHZ_00 show
> traces fit
> traces:OTAV:BHZ_00 dup
> traces:OTAV:BHZ_00 dup
> traces:OTAV:BHZ_00 dup
> traces:OTAV:BHZ_00;1 select
> traces:selected filter TPAD 100.0 BW 0.8 4 3.0 4 #tele
> traces:OTAV:BHZ_00;2 filter BW 1.0 4 0 0 #1hz HP
> traces:OTAV:BHZ_00;3 select
> traces:selected filter TPAD 10.0 BW 5.0 4 0.0 0 #5hp
> traces:OTAV:BHZ_00;1 color red
> traces:OTAV:BHZ_00;2 color green
> traces:OTAV:BHZ_00;3 color magenta
>
```

BRTT

`traceview` – Arrival Editing

- When arrivals need to be edited or added, the `BQTraceview` object must be put into a special edit mode using the command `arrivals edit_mode on`
- When a `BQTraceview` object is in edit mode:
  - the display changes its background and foreground colors
  - a new mouse interaction is enabled to select groups of arrivals
  - when arrivals are selected, the time uncertainty and residuals are displayed
  - selected arrivals can have their times and time uncertainties edited interactively
  - selected arrivals can have their phases edited or can be marked as deleted interactively through a user defined popup menu
  - selected arrivals can be tagged as being defining or non-defining in a subsequent re-location
  - selected arrivals can be copied into a clipboard and pasted as a group as new arrivals at a different time
  - an arrival editing history is kept and edits can be undone and redone



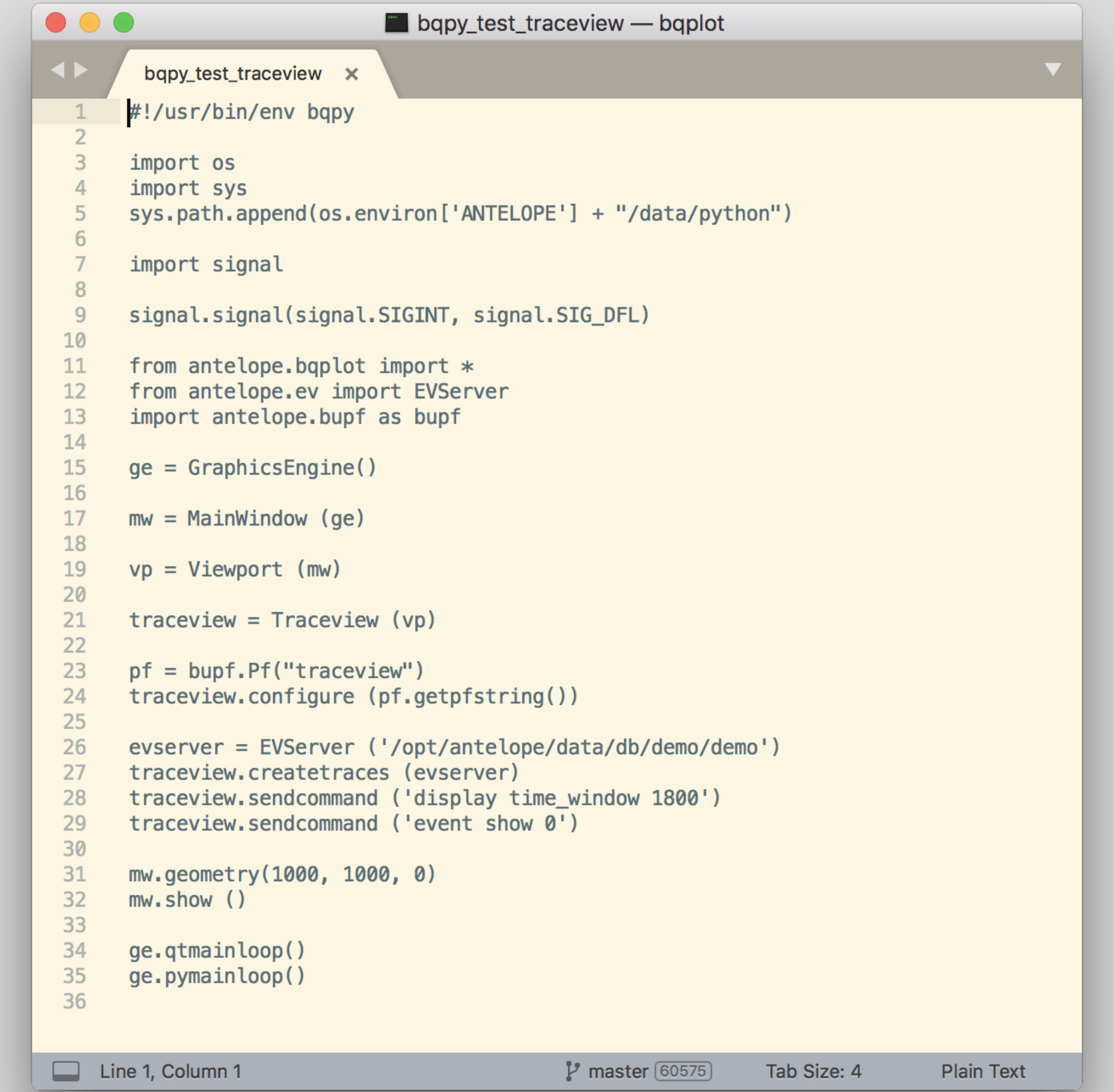
traceview /Users/danny/rtsystems/rtdemo_gsn_save/dbsave/gsn

2018295:06:16:18.086, COR BHZ_00, -160140.6 counts, -27836.5 nm/sec

2018295:06:16:31.834, 6.73 mwp, 0.0, EASTERN ALASKA TO VANCOUVER ISLAND, OtDblMbMsMwp, evid=4688, orid=4702, nass=54, ndef=28

`traceview` – Configuration and Python

- All configuration done through standard Antelope parameter file
- `python` extensions for both `BQTraceview` and `BQCommandConsole` classes



```
#!/usr/bin/env bqpy

import os
import sys
sys.path.append(os.environ['ANTELOPE'] + "/data/python")

import signal

signal.signal(signal.SIGINT, signal.SIG_DFL)

from antelope.bqplot import *
from antelope.ev import EVServer
import antelope.bupf as bupf

ge = GraphicsEngine()

mw = MainWindow (ge)

vp = Viewport (mw)

traceview = Traceview (vp)

pf = bupf.Pf("traceview")
traceview.configure (pf.getpfstring())

evserver = EVServer ('/opt/antelope/data/db/demo/demo')
traceview.createtraces (evserver)
traceview.sendcommand ('display time_window 1800')
traceview.sendcommand ('event show 0')

mw.geometry(1000, 1000, 0)
mw.show ()

ge.qtmainloop()
ge.pymainloop()

```

`traceview` – New Stuff

- C++ class definitions allow easy reuse
- Qt based graphics
- `EVServer` based database access
- New command console class supporting command editing
- More systematic command syntax
- Ability to apply commands to specific traces
- Ability to duplicate traces
- Ability to save and replay commands
- User defined command aliases
- User defined command hot keys
- Arrival edit mode
- Ability to select and edit multiple arrivals
- Ability to tag arrivals
- Ability to copy and paste arrivals
- Ability to undo and redo arrival edits
- User defined editing menus
- Use of standard Antelope parameter files for configuration
- `python` interface

`traceview` – Still To Do

- Magnify windows
- Arrival amplitude and period editing
- Ability to connect to different data sources (multiple databases, ORB, Trace databases, etc.)
- Different trace displays (spectragram, etc.)
- Ability to overlay traces