

# *Antelope* sensor calibration

June, 2008

Antelope User Group Meeting  
Skamania Lodge, WA



# Objectives

- Initial version written to support USArray/TA
- Q330 dataloggers, STS2, CMG3T and Trillium broadband sensors
- Design software so it could be expanded to work with other dataloggers and sensors

## Q330 sensor calibration capabilities

- High resolution DAC with precise timing
- A variety of waveforms including step function, sine, random telegraph, white noise, red noise (white noise produces best results over entire frequency band)
- Ability to monitor DAC output simultaneously with sensor output
- Special data “markers” inserted into output data stream that clearly identify calibrations regardless of the command source

# Sensor calibration strategy using Antelope and Q330 dataloggers

- Q330 calibration command can be done either using the Antelope **dlcmd** mechanism, or any other extra-Antelope mechanism, such as **willard**
- As the calibration sequence runs on the Q330, special data markers are generated and inserted into the waveform data stream.
- **q3302orb** looks for these calibration data markers and generates special database ORB packets, using the new **dlcalwf** relation, for each data channel that contains calibration waveforms (either sensor or monitor)
- The calibration waveforms and the **dlcalwf** relation ORB packets flow through the Antelope real-time system and eventually are stored in one or more archive databases.
- Post analysis is accomplished with the new **dbc calibrate** program which reads all of its input and writes all of its output from/to archive databases
- Calibration results can be displayed and hard copy Postscript can be generated by the new **displayscal** script
- Note the decoupling of command, capture and analysis functions

dlmon

File Views Windows

TA 109C TA 113A TA 120A TA 124A TA 328A TA 428A TA 526A TA A06A TA A13A TA A15A TA A17A TA B08A TA B10A TA B11A TA B14A TA C07A TA C11A TA D06A TA D07A TA D08A TA D12A TA G07A TA G10A TA G12A TA H10A

TA J14A TA L22A TA O21A TA P10A TA P18A TA P21A TA Q19A

TA 125A TA 126A TA 127A TA 214A TA 216A TA 217A TA 218A

TA 427A TA 527A TA 528A TA 626A TA 627A TA 628A TA A05A

TA C06A TA C08A TA C09A TA C10A TA C12B TA C13A TA C14A

TA E10A TA E11A TA E12A TA E13A TA E14A TA E15A TA E16A

TA G08A TA G09A TA G11A TA G13A TA G14A TA G15A TA G16A

TA I14A TA I15A TA I16A TA I17A TA I18A TA J08A TA J09A

TA K19A TA K20A TA L10A TA L11A TA L12A TA L13A TA L14A TA L15A TA L16A TA L17A TA L18A TA L19A TA L20A TA L21A TA M10A TA M11A TA M12A TA M13A TA M14A TA M15A TA M16A TA M17A TA M18A TA M19A TA M20A

TA M21A TA M22A TA MSTX TA N10A TA N11A TA N12A TA N13A TA N14A TA N15A TA N16A TA N17A TA N18A TA N19A TA N20A TA N21A TA N22A TA O10A TA O11A TA O12A TA O13A TA O15A TA O16A TA O17A TA O18A TA O19A

TA O20A TA P11A TA P12A TA P13A TA P14A TA P15A TA P16A TA P17A TA P19A TA P20A TA Q10A TA Q11A TA Q12A TA Q13A TA Q14A TA Q15A TA Q16A TA Q18A TA Q20A TA Q21A TA Q22A TA R10A TA R11A TA R12A TA R13A

TA R14A TA R15A TA R16A TA R17A TA R18A TA R20A TA R21A TA S10A TA S11A TA S12A TA S13A TA S14A TA S17A TA S18A TA S19A TA S21A TA T11A TA T12A TA T13A TA T14A TA T15A TA T16A TA T17A TA T18A TA T19A

TA T22A TA U10A TA U11A TA U12A TA U13A TA U14A TA U15A TA U16A TA U17A TA U18A TA U19A TA U20A TA V11A TA V12A TA V14A TA V15A TA V17A TA V18A TA V19A TA V20A TA V22A TA V23A TA W12A TA W13A TA W14A

TA W15A TA W16A TA W17A TA W18A TA W19A TA W20A TA W21A TA W22A TA W23A TA W24A TA W25A TA X14A TA X15A TA X16A TA X17A TA X18A TA X19A TA X20A TA X21A TA X23A TA X24A TA X25A TA X26A TA X27A TA Y12C

TA Y13A TA Y14A TA Y15A TA Y16A TA Y17A TA Y18A TA Y19A TA Y20A TA Y21A TA Y22A TA Y23A TA Y24A TA Y25A TA Y26A TA Y27A TA Z13A TA Z14A TA Z15A TA Z16A TA Z17A TA Z18A TA Z19A TA Z20A TA Z21A

dlmon: TA\_Y22D logs

Freeze Unfreeze Channels... Massrecenter... Calibrate... Debug... Start Stop DcIrg Antcrg Done

```

2008134 13:44:44,084: tadatav9: TA_Y22D: DEBUG: q330_read_data: read cmd=DT_DATA, seq=29369, nbytes=288, nlack=17, chan
2008134 13:44:44,084: tadatav9: TA_Y22D: DEBUG: q330_read_data: pushing seq=29369
2008134 13:44:44,084: tadatav9: TA_Y22D: DEBUG: q330_read_data: popped seq=29369
2008134 13:44:44,084: tadatav9: TA_Y22D: DEBUG: q330_read_data: read cmd=DT_DATA, seq=29370, nbytes=340, nlack=18, chan
2008134 13:44:44,084: tadatav9: TA_Y22D: DEBUG: q330_read_data: pushing seq=29370
2008134 13:44:44,084: tadatav9: TA_Y22D: DEBUG: q330_read_data: popped seq=29370
2008134 13:44:44,640: tadatav9: TA_Y22D: DEBUG: q330_read_data: read cmd=DT_DATA, seq=29371, nbytes=284, nlack=19, chan
2008134 13:44:44,640: tadatav9: TA_Y22D: DEBUG: q330_read_data: pushing seq=29371
2008134 13:44:44,640: tadatav9: TA_Y22D: DEBUG: q330_read_data: popped seq=29371
2008134 13:44:48,649: tadatav9: TA_Y22D: DEBUG: q330_read_data: read cmd=D
2008134 13:44:48,649: tadatav9: TA_Y22D: DEBUG: q330_read_data: pushing seq=29372
2008134 13:44:48,649: tadatav9: TA_Y22D: DEBUG: q330_read_data: popped seq=29372
2008134 13:44:52,658: tadatav9: TA_Y22D: DEBUG: q330_read_data: ETIM: time
2008134 13:44:53,098: tadatav9: TA_Y22D: Setting debug_data to 0...
2008134 13:44:53,098: tadatav9: TA_Y22D: Setting debug_udp to 0...
2008134 13:44:53,282: tadatav9: TA_Y22D: Processing user command set debug_
2008134 13:44:53,282: tadatav9: TA_Y22D: Processing user command set debug_
2008134 13:44:53,284: tadatav9: TA_Y22D: Processing user command set debug_
2008134 13:44:53,287: tadatav9: TA_Y22D: Processing user command set debug_
2008134 13:44:53,287: tadatav9: TA_Y22D: Setting debug_ack to 0...

```

Massrecenter TA\_Y2

Execute Stop calibration Done

time	2008134:20:00:00
duration	5400
settling time	600
trailer time	1200
waveform	white
period	
amplitude	1
sensors	
monitor channels	0x2

Mac OS X desktop environment showing a window titled "dlmon" with a grid of test points (TA 109C to TA 113A) and a "Massrecenter TA\_Y22" dialog box. The dialog box contains the following fields:

- Execute:  Stop calibration  Done
- time: 2008134:20:00:00
- duration: 5400
- settling time: 600
- trailer time: 1200
- waveform: white
- period:
- amplitude: 1
- sensors:
- monitor channels: 0x2

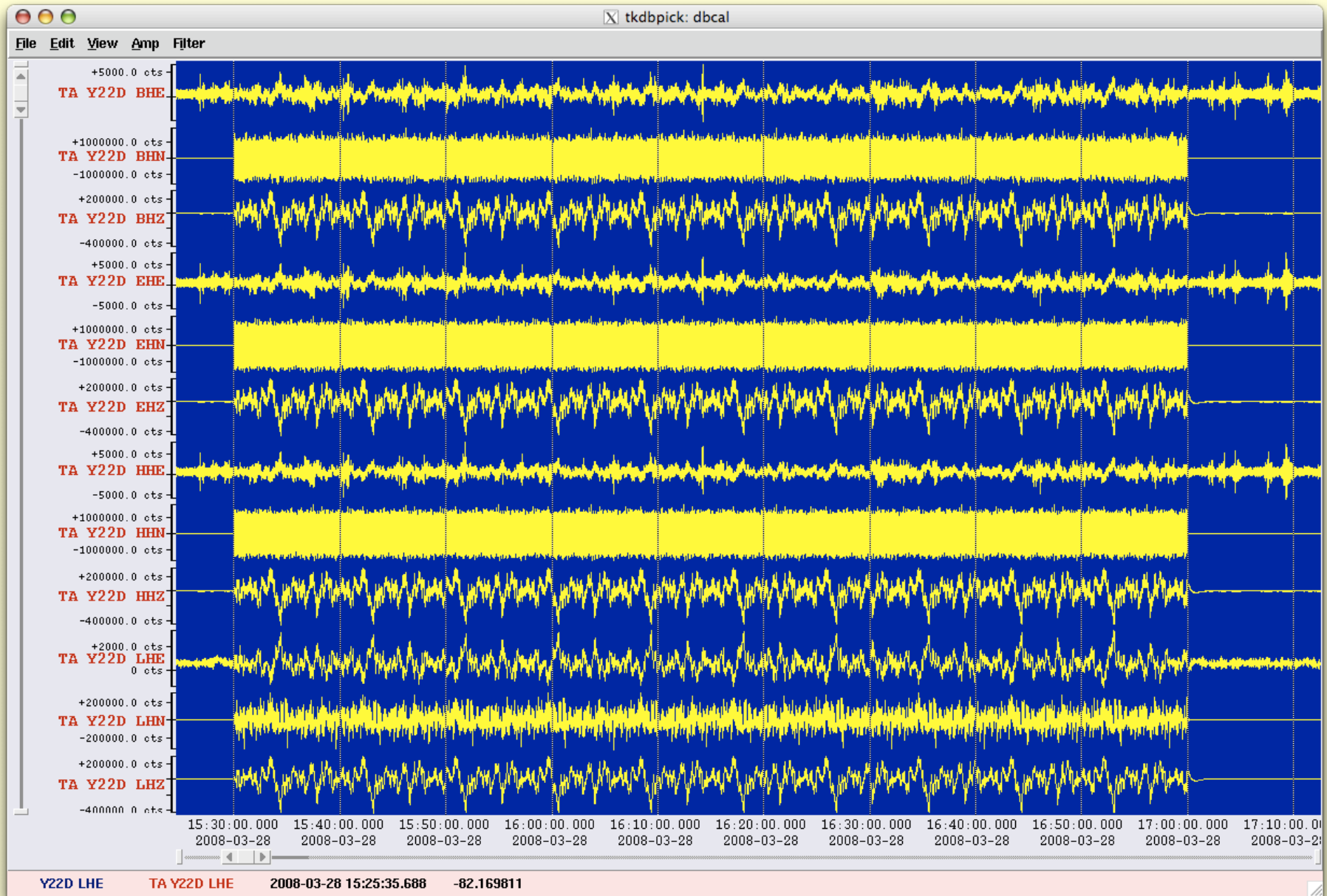
Below the dialog box is a log window titled "dlmon: TA\_Y22D logs" with the following content:

```

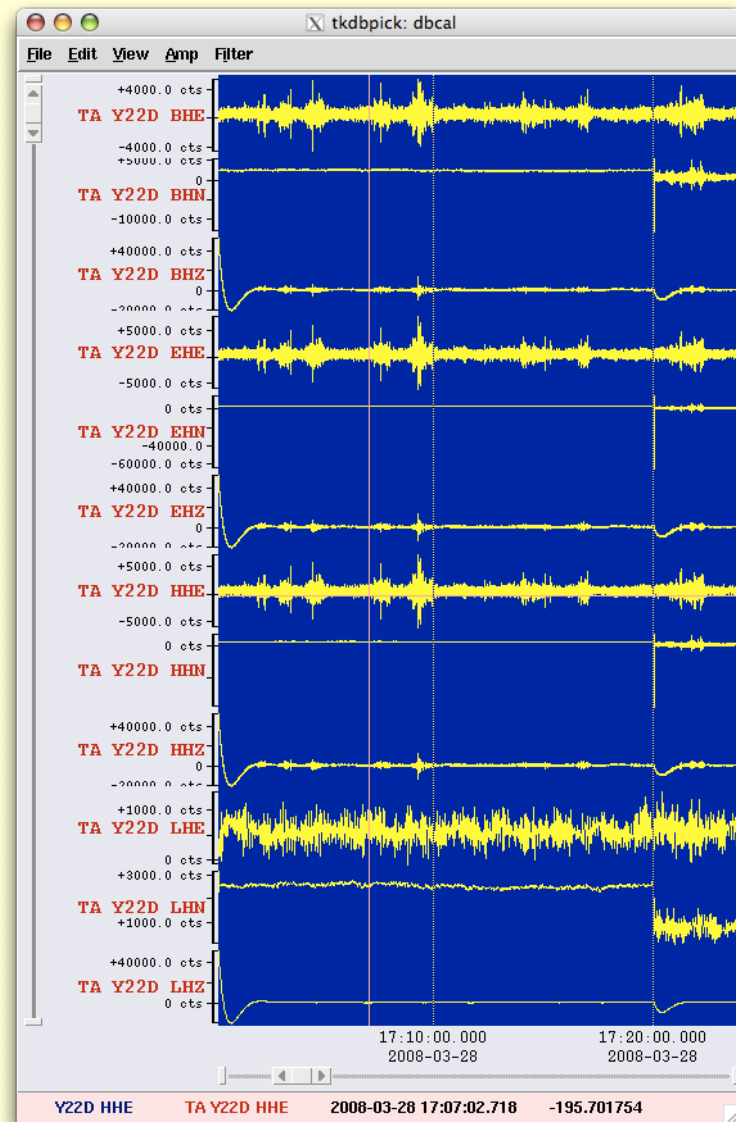
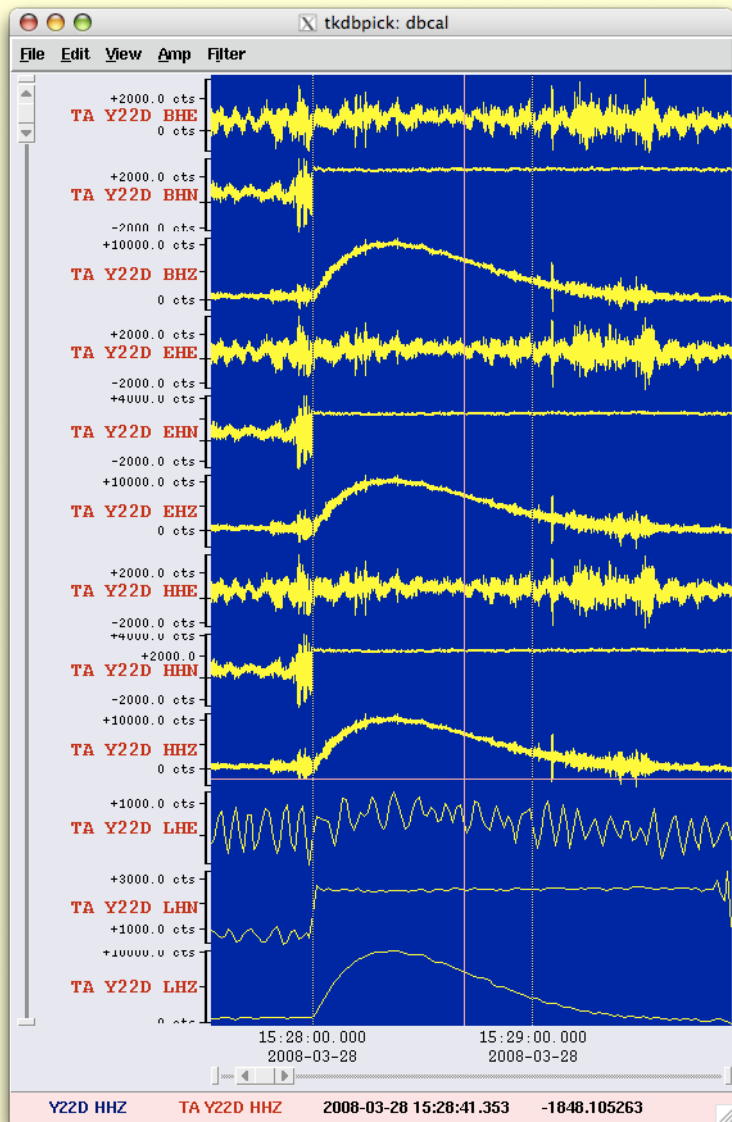
Freeze Unfreeze Channels... Massrecenter... Calibrate... Debug... Start Stop Dcfig Antcfig Done
2008134 13:44:53.282: tadatav9: TA_Y22D: Processing user command set debug_control 0
2008134 13:44:53.282: tadatav9: TA_Y22D: Setting debug_control to 0...
2008134 13:44:53.284: tadatav9: TA_Y22D: Processing user command set debug_udp 0
2008134 13:44:53.284: tadatav9: TA_Y22D: Setting debug_udp to 0...
2008134 13:44:53.287: tadatav9: TA_Y22D: Processing user command set debug_ack 0
2008134 13:44:53.287: tadatav9: TA_Y22D: Setting debug_ack to 0...
2008134 13:50:59.460: tadatav9: TA_Y22D: Processing user command set debug_ack 0
2008134 13:50:59.460: tadatav9: TA_Y22D: Setting debug_ack to 0...
2008134 13:50:59.463: tadatav9: TA_Y22D: Processing user command calibrate -time 2008134:20:00:00 -duration 5400 -settling_time 600 -trailer_time 1200 -waveform white -amplitude 1 -monitor_chan
2008134 13:50:59.463: tadatav9: TA_Y22D: Sending calibration cmd with following params:
2008134 13:50:59.463: tadatav9: TA_Y22D:   starting_time = 264024000 (2008134:20:00:00)
2008134 13:50:59.463: tadatav9: TA_Y22D:   waveform = 0x0002 (white)
2008134 13:50:59.463: tadatav9: TA_Y22D:   amplitude = 1 (2.500V)
2008134 13:50:59.463: tadatav9: TA_Y22D:   duration = 5400 (sec)
2008134 13:50:59.463: tadatav9: TA_Y22D:   settling_time = 600 (sec)
2008134 13:50:59.463: tadatav9: TA_Y22D:   calibration_bitmap = 0x003F (AB)
2008134 13:50:59.463: tadatav9: TA_Y22D:   trailer_time = 1200 (sec)
2008134 13:50:59.463: tadatav9: TA_Y22D:   sensor_control_bitmap = 0x0088
2008134 13:50:59.463: tadatav9: TA_Y22D:   monitor_channel_bitmap = 0x0002
2008134 13:50:59.464: tadatav9: TA_Y22D:   frequency_divider = 1 (1.000Hz)
2008134 13:50:59.464: tadatav9: TA_Y22D:   coupling = RESISTIVE
2008134 13:51:00.624: tadatav9: TA_Y22D: Processing user command start
2008134 13:51:00.626: tadatav9: TA_Y22D: Processing user command start
  
```

0	snet	fsta	fchan	loc	time	model	ssidnt	dlcalseq	dlcaltype	dlcalerr	dlcalinput	dlcalchanbm	phchan	samprate	dlcalamp	dlcalfreq	dlcalsettle	dlcaltrailer
TA	TCHZ	LHZ			11/13/2007 (317) 17:00:55.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:00:55	white	ok	s	0x3F	0	1.0000000	5.0000000	1.0000	100.0000	100.0000
TA	TCHZ	LHN			11/13/2007 (317) 17:00:55.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:00:55	white	ok	d	0x3F	1	1.0000000	5.0000000	1.0000	100.0000	100.0000
TA	TCHZ	LHE			11/13/2007 (317) 17:00:55.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:00:55	white	ok	s	0x3F	2	1.0000000	5.0000000	1.0000	100.0000	100.0000
TA	TCHZ	BHZ			11/13/2007 (317) 17:00:55.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:00:55	white	ok	s	0x3F	0	40.0000000	5.0000000	1.0000	100.0000	100.0000
TA	TCHZ	BHN			11/13/2007 (317) 17:00:55.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:00:55	white	ok	d	0x3F	1	40.0000000	5.0000000	1.0000	100.0000	100.0000
TA	TCHZ	BHE			11/13/2007 (317) 17:00:55.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:00:55	white	ok	s	0x3F	2	40.0000000	5.0000000	1.0000	100.0000	100.0000
TA	TCHZ	HHZ			11/13/2007 (317) 17:00:55.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:00:55	white	ok	s	0x3F	0	100.0000000	5.0000000	1.0000	100.0000	100.0000
TA	TCHZ	HHN			11/13/2007 (317) 17:00:55.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:00:55	white	ok	d	0x3F	1	100.0000000	5.0000000	1.0000	100.0000	100.0000
TA	TCHZ	HHE			11/13/2007 (317) 17:00:55.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:00:55	white	ok	s	0x3F	2	100.0000000	5.0000000	1.0000	100.0000	100.0000
TA	TCHZ	LHZ			11/13/2007 (317) 17:40:00.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:40:00	white	ok	s	0x3F	0	1.0000000	2.5000000	1.0000	300.0000	300.0000
TA	TCHZ	LHN			11/13/2007 (317) 17:40:00.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:40:00	white	ok	d	0x3F	1	1.0000000	2.5000000	1.0000	300.0000	300.0000
TA	TCHZ	LHE			11/13/2007 (317) 17:40:00.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:40:00	white	ok	s	0x3F	2	1.0000000	2.5000000	1.0000	300.0000	300.0000
TA	TCHZ	BHZ			11/13/2007 (317) 17:40:00.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:40:00	white	ok	s	0x3F	0	40.0000000	2.5000000	1.0000	300.0000	300.0000
TA	TCHZ	BHN			11/13/2007 (317) 17:40:00.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:40:00	white	ok	d	0x3F	1	40.0000000	2.5000000	1.0000	300.0000	300.0000
TA	TCHZ	BHE			11/13/2007 (317) 17:40:00.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:40:00	white	ok	s	0x3F	2	40.0000000	2.5000000	1.0000	300.0000	300.0000
TA	TCHZ	HHZ			11/13/2007 (317) 17:40:00.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:40:00	white	ok	s	0x3F	0	100.0000000	2.5000000	1.0000	300.0000	300.0000
TA	TCHZ	HHN			11/13/2007 (317) 17:40:00.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:40:00	white	ok	d	0x3F	1	100.0000000	2.5000000	1.0000	300.0000	300.0000
TA	TCHZ	HHE			11/13/2007 (317) 17:40:00.00000	q330	0100000EA996551D	TA_TCHZ-2007317:17:40:00	white	ok	s	0x3F	2	100.0000000	2.5000000	1.0000	300.0000	300.0000
TA	TCHZ	LHZ			11/14/2007 (318) 21:12:34.00000	q330	0100000EA996551D	TA_TCHZ-2007318:21:12:34	step	ok	s	0x3F	0	1.0000000	2.5000000	1.0000	100.0000	100.0000
TA	TCHZ	LHN			11/14/2007 (318) 21:12:34.00000	q330	0100000EA996551D	TA_TCHZ-2007318:21:12:34	step	ok	d	0x3F	1	1.0000000	2.5000000	1.0000	100.0000	100.0000
TA	TCHZ	LHE			11/14/2007 (318) 21:12:34.00000	q330	0100000EA996551D	TA_TCHZ-2007318:21:12:34	step	ok	s	0x3F	2	1.0000000	2.5000000	1.0000	100.0000	100.0000
TA	TCHZ	BHZ			11/14/2007 (318) 21:12:34.00000	q330	0100000EA996551D	TA_TCHZ-2007318:21:12:34	step	ok	s	0x3F	0	40.0000000	2.5000000	1.0000	100.0000	100.0000
TA	TCHZ	BHN			11/14/2007 (318) 21:12:34.00000	q330	0100000EA996551D	TA_TCHZ-2007318:21:12:34	step	ok	d	0x3F	1	40.0000000	2.5000000	1.0000	100.0000	100.0000
TA	TCHZ	BHE			11/14/2007 (318) 21:12:34.00000	q330	0100000EA996551D	TA_TCHZ-2007318:21:12:34	step	ok	s	0x3F	2	40.0000000	2.5000000	1.0000	100.0000	100.0000
TA	TCHZ	HHZ			11/14/2007 (318) 21:12:34.00000	q330	0100000EA996551D	TA_TCHZ-2007318:21:12:34	step	ok	s	0x3F	0	100.0000000	2.5000000	1.0000	100.0000	100.0000

- **q3302orb** automatically generates special database ORB packets, using the new **dlcalwlf** relation, for each data channel that contains calibration waveforms (either sensor or monitor)
- The calibration waveforms and the **dlcalwlf** relation ORB packets flow through the Antelope real-time system and eventually are stored in one or more archive databases.
- The **dlcalwlf** rows act as markers in the archive database to identify calibration waveforms and their associated parameters







## Sensor calibration analysis using **dbcalibrate**

- **dbcalibrate** operates strictly by computing smoothed spectral ratios in amplitude and phase, including statistics, between pairs of waveforms that can span different time periods, stations and channels
- An estimate of sensor response (as seen through the calibration circuitry and mechanics) can be obtained by ratioing a recorded sensor calibration output and a direct loopback signal from the datalogger calibration signal DAC back through the datalogger ADC (Q330 monitor channel)
- Spectral comparisons of like calibration output signals across different time period and/or different stations and/or different channels can also be computed to produce spectra of changes (should be flat and zero phase if there are no changes)
- Noise to calibration signal spectral power ratios can also be generated to determine valid comparison spectra frequency ranges
- Note that **dbcalibrate** can only compare two recorded waveforms and not a recorded waveform with an internally generated theoretical waveform

## Sensor calibration analysis using **dbcalibrate**

- **dbcalibrate** produces its output spectra only as frequency, amplitude, phase, amplitude error, phase error tables - no pole and zero fitting or “post spectra” smoothing are performed
- Spectral ratios are computed by dividing the cross correlation spectrum between the numerator (subject) and denominator (reference) waveforms by the autocorrelation spectrum of the denominator waveform
- Spectral smoothing and statistics determination are computed through accumulations of the frequency domain cross correlation matrix elements from a set of tapered moving time windows through the waveform data
- In order to reduce the size of the resulting response functions (1000 sec to 100 hz response would produce a spectrum with 200,000 points) and to provide many short time windows for the higher frequencies vs. fewer longer time windows for the lower frequencies, we do the analysis in multiple frequency bands
- Try **man dbcalibrate** for more detailed information

# Example run of **dbcalibrate**

```
2615 ruper% dbcalibrate -v -outrecno \  
    -dlcalwf_sifter 'fchan =~ /EH./ && (fchan == "EHZ" || dlcalinput == "d")' \  
    -out dbcal dbcal TA_Y22D-2008088:15:30:00  
  
dbcalibrate: Processing calibration sequence TA_Y22D-2008088:15:30:00  
dbcalibrate: for q330 sn 0100000A27B8E96F at 3/28/2008 15:30:00.000:  
dbcalibrate:          type = white  
dbcalibrate:          duration = 5400.0000 Seconds  
dbcalibrate:          disposition = ok  
dbcalibrate:          channel bitmap = 0x7  
dbcalibrate:          amplitude = 2.5000 Volts  
dbcalibrate:          frequency = 1.0000  
dbcalibrate:          settle time = 120.0000 Seconds  
dbcalibrate:          trailer time = 1200.0000 Seconds  
dbcalibrate:          found 1 sensors attached to datalogger:  
dbcalibrate:          A -> sts2_g3:30716  
dbcalibrate:          type=V, drive=c, active=yes, calgen=0.0300238cm/V, cal2rsp=1, sngen=1500V/cm/s, calper=1.000  
dbcalibrate:          found 2 channels in this sequence:  
dbcalibrate:          TA_Y22D_EHN -> Y22D:EHN, sensor=sts2_g3:30716, nomresp=yes, input=d, phchan=1, samprate=200.0  
dbcalibrate:          TA_Y22D_EHZ -> Y22D:EHZ, sensor=sts2_g3:30716, nomresp=yes, input=s, phchan=0, samprate=200.0  
dbcalibrate:          found 1 samplerate groups in this sequence:  
dbcalibrate:          for samplerate 200.0, found 1 channels to process:  
dbcalibrate:          reference trace at TA_Y22D_EHN -> Y22D:EHN, data samples ok  
dbcalibrate:          TA_Y22D_EHZ -> Y22D:EHZ, timing ok, time window ok, data samples ok  
dbcalibrate: specdiv: Total process window of 6430.000 seconds starting at 2008088:15:29:30.000:  
dbcalibrate: specdiv: Processing 4 frequency bands to produce 1150 frequency points:  
dbcalibrate: specdiv: For band 0, Processing 1 windows of 10485.760 seconds with fmax=100.000 and df=0.000095
```

**BRTT**

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- **dbcalibrate** disposes its output into a new database relation **sensorcal** and a set of ASCII response files
- Response files include the spectral ratio itself, a nominal response and amplitude and phase differences (errors?) between the ratio and the nominal response
- Also computed as an absolute gain term that is used to infer the effective sensor generator constant, although it is unclear how this relates to the true sensor generator constant

0	sta	chan	rsta	rchan	tstart	tend	time	rtime	dlcalseq	dlcalseqr	dlcalttype	ptype	pnoise
	Y22D	EHZ	Y22D	EHN	3/28/2008 (088) 15:29:30.00000	3/28/2008 (088) 17:16:39.44000	3/28/2008 (088) 15:30:00.00000	3/28/2008 (088) 15:30:00.00000	TA_Y22D-2008088:15:30:00	TA_Y22D-2008088:15:30:00	white	ratio	no
	Y22D	EHZ	Y22D	EHZ	3/29/2008 (089) 1:59:30.00000	3/29/2008 (089) 3:30:29.84000	3/29/2008 (089) 2:00:00.00000	3/28/2008 (088) 15:30:00.00000	TA_Y22D-2008088:15:30:00	TA_Y22D-2008088:15:30:00	white	power	yes
	Y22D	EHE	Y22D	EHN	3/28/2008 (088) 15:29:30.00000	3/28/2008 (088) 17:16:39.44000	3/28/2008 (088) 15:30:00.00000	3/28/2008 (088) 15:30:00.00000	TA_Y22D-2008088:15:30:00	TA_Y22D-2008088:15:30:00	white	ratio	no
	Y22D	EHE	Y22D	EHE	3/29/2008 (089) 1:59:30.00000	3/29/2008 (089) 3:30:29.84000	3/29/2008 (089) 2:00:00.00000	3/28/2008 (088) 15:30:00.00000	TA_Y22D-2008088:15:30:00	TA_Y22D-2008088:15:30:00	white	power	yes
	Y22D	EHZ	Y22D	EHE	3/28/2008 (088) 19:59:30.00000	3/28/2008 (088) 21:46:39.44000	3/28/2008 (088) 20:00:00.00000	3/28/2008 (088) 20:00:00.00000	TA_Y22D-2008088:20:00:00	TA_Y22D-2008088:20:00:00	white	ratio	no
	Y22D	EHZ	Y22D	EHZ	3/29/2008 (089) 1:59:30.00000	3/29/2008 (089) 3:30:29.84000	3/29/2008 (089) 2:00:00.00000	3/28/2008 (088) 20:00:00.00000	TA_Y22D-2008088:20:00:00	TA_Y22D-2008088:20:00:00	white	power	yes
	Y22D	EHN	Y22D	EHE	3/28/2008 (088) 19:59:30.00000	3/28/2008 (088) 21:46:39.44000	3/28/2008 (088) 20:00:00.00000	3/28/2008 (088) 20:00:00.00000	TA_Y22D-2008088:20:00:00	TA_Y22D-2008088:20:00:00	white	ratio	no
	Y22D	EHN	Y22D	EHN	3/29/2008 (089) 1:59:30.00000	3/29/2008 (089) 3:30:29.84000	3/29/2008 (089) 2:00:00.00000	3/28/2008 (088) 20:00:00.00000	TA_Y22D-2008088:20:00:00	TA_Y22D-2008088:20:00:00	white	power	yes
	Y22D	EHZ	Y22D	EHZ	3/28/2008 (088) 19:59:30.00000	3/28/2008 (088) 21:46:39.44000	3/28/2008 (088) 20:00:00.00000	3/28/2008 (088) 15:30:00.00000	TA_Y22D-2008088:20:00:00	TA_Y22D-2008088:15:30:00	white	ratio	no
	TETH	EHZ	TETH	EHN	3/28/2008 (088) 15:29:30.00000	3/28/2008 (088) 17:16:39.44000	3/28/2008 (088) 15:30:00.00000	3/28/2008 (088) 15:30:00.00000	TA_TETH-2008088:15:30:00	TA_TETH-2008088:15:30:00	white	ratio	no
	TETH	EHZ	TETH	EHZ	3/29/2008 (089) 1:59:30.00000	3/29/2008 (089) 3:30:29.84000	3/29/2008 (089) 2:00:00.00000	3/28/2008 (088) 15:30:00.00000	TA_TETH-2008088:15:30:00	TA_TETH-2008088:15:30:00	white	power	yes
	TETH	EHE	TETH	EHN	3/28/2008 (088) 15:29:30.00000	3/28/2008 (088) 17:16:39.44000	3/28/2008 (088) 15:30:00.00000	3/28/2008 (088) 15:30:00.00000	TA_TETH-2008088:15:30:00	TA_TETH-2008088:15:30:00	white	ratio	no
	TETH	EHE	TETH	EHE	3/29/2008 (089) 1:59:30.00000	3/29/2008 (089) 3:30:29.84000	3/29/2008 (089) 2:00:00.00000	3/28/2008 (088) 15:30:00.00000	TA_TETH-2008088:15:30:00	TA_TETH-2008088:15:30:00	white	power	yes
	TETH	EHZ	TETH	EHE	3/28/2008 (088) 19:59:30.00000	3/28/2008 (088) 21:46:39.44000	3/28/2008 (088) 20:00:00.00000	3/28/2008 (088) 20:00:00.00000	TA_TETH-2008088:20:00:00	TA_TETH-2008088:20:00:00	white	ratio	no
	TETH	EHZ	TETH	EHZ	3/29/2008 (089) 1:59:30.00000	3/29/2008 (089) 3:30:29.84000	3/29/2008 (089) 2:00:00.00000	3/28/2008 (088) 20:00:00.00000	TA_TETH-2008088:20:00:00	TA_TETH-2008088:20:00:00	white	power	yes
	TETH	EHN	TETH	EHE	3/28/2008 (088) 19:59:30.00000	3/28/2008 (088) 21:46:39.44000	3/28/2008 (088) 20:00:00.00000	3/28/2008 (088) 20:00:00.00000	TA_TETH-2008088:20:00:00	TA_TETH-2008088:20:00:00	white	ratio	no
	TETH	EHN	TETH	EHN	3/29/2008 (089) 1:59:30.00000	3/29/2008 (089) 3:30:29.84000	3/29/2008 (089) 2:00:00.00000	3/28/2008 (088) 20:00:00.00000	TA_TETH-2008088:20:00:00	TA_TETH-2008088:20:00:00	white	power	yes
	TETH	EHZ	TETH	EHZ	3/28/2008 (088) 19:59:30.00000	3/28/2008 (088) 21:46:39.44000	3/28/2008 (088) 20:00:00.00000	3/28/2008 (088) 15:30:00.00000	TA_TETH-2008088:20:00:00	TA_TETH-2008088:15:30:00	white	ratio	no
	N16A	EHZ	N16A	EHN	3/28/2008 (088) 18:59:30.00000	3/28/2008 (088) 20:46:39.44000	3/28/2008 (088) 19:00:00.00000	3/28/2008 (088) 19:00:00.00000	TA_N16A-2008088:19:00:00	TA_N16A-2008088:19:00:00	white	ratio	no
	N16A	EHZ	N16A	EHZ	3/29/2008 (089) 1:59:30.00000	3/29/2008 (089) 3:30:29.84000	3/29/2008 (089) 2:00:00.00000	3/28/2008 (088) 19:00:00.00000	TA_N16A-2008088:19:00:00	TA_N16A-2008088:19:00:00	white	power	yes
	N16A	EHE	N16A	EHN	3/28/2008 (088) 18:59:30.00000	3/28/2008 (088) 20:46:39.44000	3/28/2008 (088) 19:00:00.00000	3/28/2008 (088) 19:00:00.00000	TA_N16A-2008088:19:00:00	TA_N16A-2008088:19:00:00	white	ratio	no
	N16A	EHE	N16A	EHE	3/29/2008 (089) 1:59:30.00000	3/29/2008 (089) 3:30:29.84000	3/29/2008 (089) 2:00:00.00000	3/28/2008 (088) 19:00:00.00000	TA_N16A-2008088:19:00:00	TA_N16A-2008088:19:00:00	white	power	yes

```

2628 ruper% more white_Y22D_EHZ_08088153000
##
## TA_Y22D-2008088:15:30:00 white sta=Y22D chan=EHZ time= 3/28/2008 15:30:00.000 duration=5400.000 sec
## Compared to:
## TA_Y22D-2008088:15:30:00 white sta=Y22D chan=EHN time= 3/28/2008 15:30:00.000 duration=5400.000 sec
##
## response analysis parameters:
#   {bands}[0]{fmax} = 0.02
#   {bands}[0]{fmin} = 0.000001
#   {bands}[0]{nwindows} = 1
#   {bands}[0]{overlap_percent} = 0.0
#   {bands}[0]{taper_percent} = 0.0
#   {bands}[1]{fmax} = 1.0
#   {bands}[1]{fmin} = 0.0025
...
#   {tlag} = 1000.0
#   {tlead} = 30.0
##
##Frequency(hz)      Amplitude      Phase(deg)    AmpUncertHigh  AmpUncertLow  PhaseUncertHigh  PhaseUncertLow
##
measured 1 complete-white fap2 danny/dbcalibrate
1150

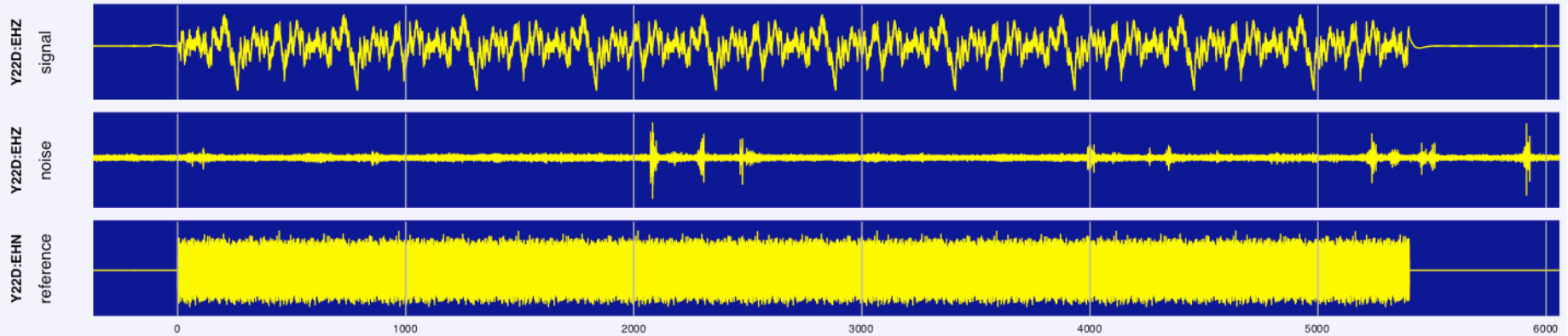
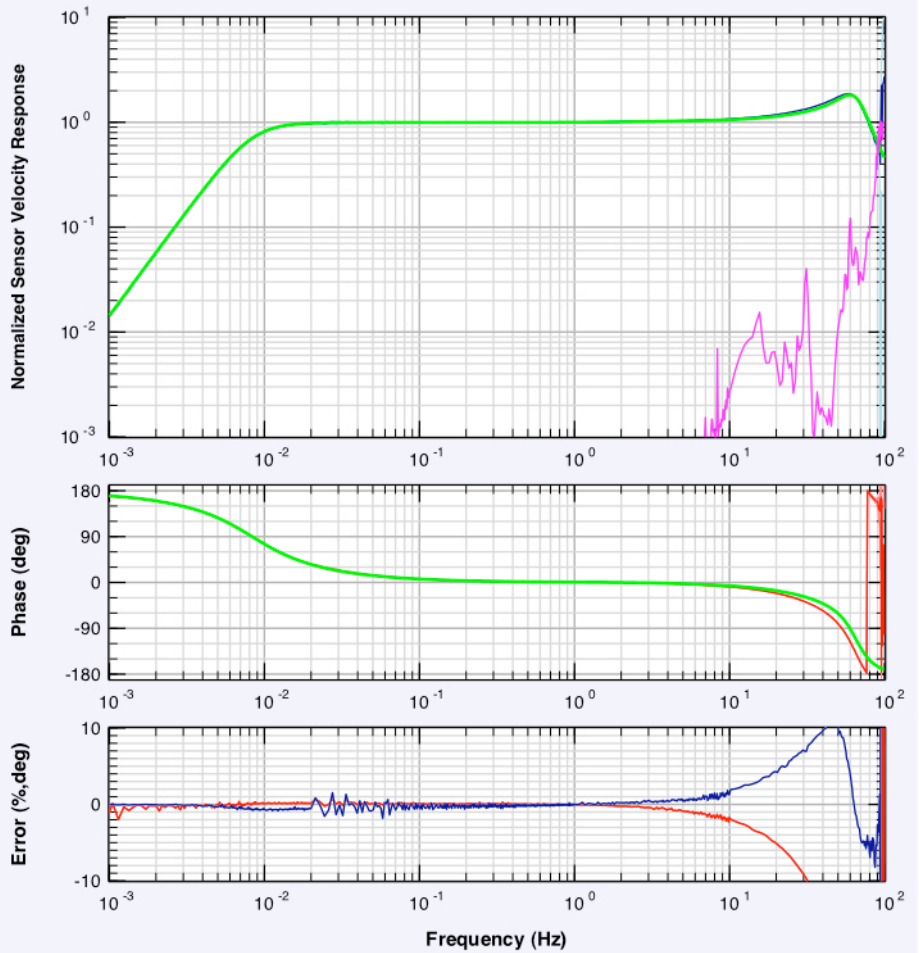
```

# White noise sensor calibration processing results

Processed by dbcabrtdanny.redgarden at 2008134:12:49:37.095

Channel: <b>TA_Y22D_EHZ</b>	Time: <b>2008088:15:30:00.000</b>	Sequence: <b>TA_Y22D-2008088:15:30:00</b>		
Dlmodel: <b>q330</b>	Dlserial: <b>0100000A27B8E96F</b>	Snmodel: <b>sts2_g3</b>	Snsrial: <b>30716</b>	
Noise Channel: <b>TA_Y22D_EHZ</b>	Noise Time: <b>2008089:02:00:00.000</b>	Noise Sequence: <b>TA_Y22D-2008088:15:30:00</b>		
Noise Dlmodel: <b>q330</b>	Noise Dlserial: <b>0100000A27B8E96F</b>	Noise Snmodel: <b>sts2_g3</b>	Noise Snsrial: <b>30716</b>	
Ref Channel: <b>TA_Y22D_EHN</b>	Ref Time: <b>2008088:15:30:00.000</b>	Ref Sequence: <b>TA_Y22D-2008088:15:30:00</b>		
Ref Dlmodel: <b>q330</b>	Ref Dlserial: <b>0100000A27B8E96F</b>	Ref Snmodel: <b>sts2_g3</b>	Ref Snsrial: <b>30716</b>	
Cal mode: <b>mon</b>	Cal Waveform: <b>white</b>	Cal Duration: <b>1:30 hours</b>	Samplerate: <b>200</b>	Cal Amplitude: <b>2.500 V</b>
Cal processing: <b>ratio</b>	Cal Settle Time: <b>2:00 minutes</b>	Cal Trailer Time: <b>20:00 minutes</b>		

Sngen: <b>1517.30 V/m/s</b>	Nominal Sngen: <b>1500.00 V/m/s</b>	Norm Freq: <b>1.000 Hz</b>	Noise Relative To: <b>TA_Y22D-2008088:15:30:00</b>
<b>Processing Parameters:</b>			
{bands}0{fmax} = 0.02	{bands}2{nwindows} = 0		
{bands}0{fmin} = 0.000001	{bands}2{overlap_percent} = 50.0		
{bands}0{nwindows} = 1	{bands}2{taper_percent} = 50.0		
{bands}0{overlap_percent} = 0.0	{bands}3{fmax} = 200.0		
{bands}0{taper_percent} = 0.0	{bands}3{fmin} = 1.00		
{bands}1{fmax} = 1.0	{bands}3{nwindows} = 0		
{bands}1{fmin} = 0.0025	{bands}3{overlap_percent} = 50.0		
{bands}1{nwindows} = 0	{bands}3{taper_percent} = 50.0		
{bands}1{overlap_percent} = 50.0	{lag} = 1000.0		
{bands}1{taper_percent} = 25.0	{lead} = 30.0		
{bands}2{fmax} = 10.0			
{bands}2{fmin} = 0.05			

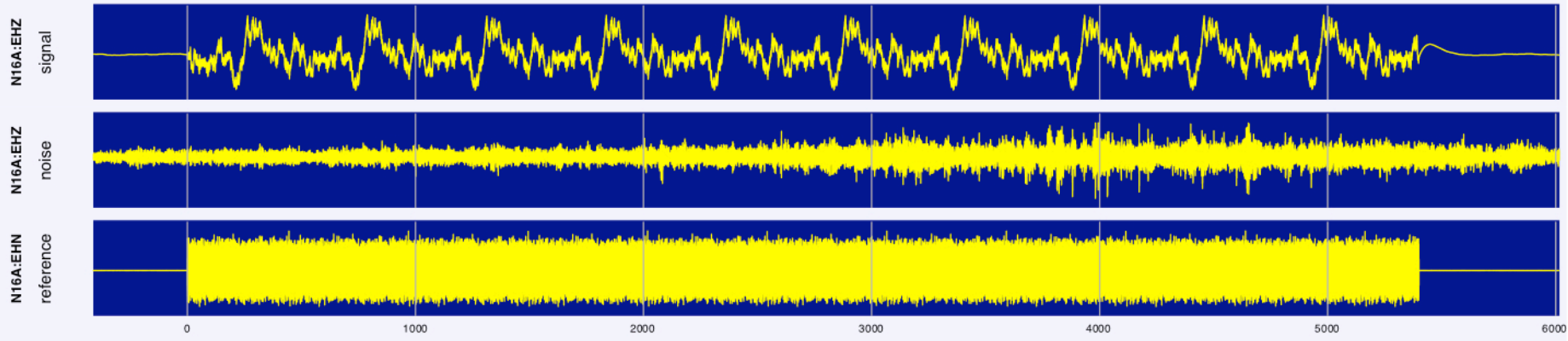
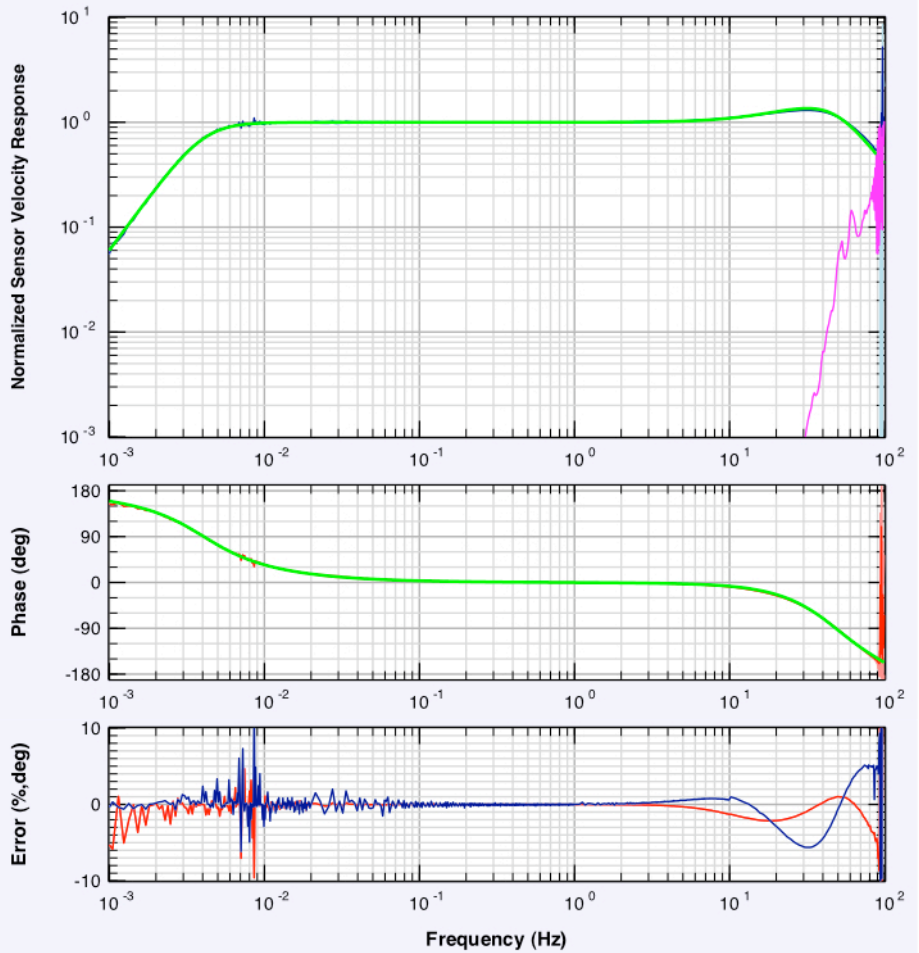


# White noise sensor calibration processing results

Processed by dbcalbrt:danny.redgarden at 2008134:12:51:30.613

Channel: <b>TA_N16A_EHZ</b>	Time: <b>2008088:19:00:00.000</b>	Sequence: <b>TA_N16A-2008088:19:00:00</b>		
Dlmodel: <b>q330</b>	Dlserial: <b>010000044D889446</b>	Snmodel: <b>trillium_240</b>	Snsrial: <b>252</b>	
Noise Channel: <b>TA_N16A_EHZ</b>	Noise Time: <b>2008089:02:00:00.000</b>	Noise Sequence: <b>TA_N16A-2008088:19:00:00</b>		
Noise Dlmodel: <b>q330</b>	Noise Dlserial: <b>010000044D889446</b>	Noise Snmodel: <b>trillium_240</b>	Noise Snsrial: <b>252</b>	
Ref Channel: <b>TA_N16A_EHN</b>	Ref Time: <b>2008088:19:00:00.000</b>	Ref Sequence: <b>TA_N16A-2008088:19:00:00</b>		
Ref Dlmodel: <b>q330</b>	Ref Dlserial: <b>010000044D889446</b>	Ref Snmodel: <b>trillium_240</b>	Ref Snsrial: <b>252</b>	
Cal mode: <b>mon</b>	Cal Waveform: <b>white</b>	Cal Duration: <b>1:30 hours</b>	Samplerate: <b>200</b>	Cal Amplitude: <b>0.312 V</b>
Cal processing: <b>ratio</b>	Cal Settle Time: <b>20:00 minutes</b>	Cal Trailer Time: <b>20:00 minutes</b>		

Sngen: <b>1500.70 V/m/s</b>	Nominal Sngen: <b>1500.00 V/m/s</b>	Norm Freq: <b>1.000 Hz</b>	Noise Relative To: <b>TA_N16A-2008088:19:00:00</b>
Processing Parameters:			
{bands}0{fmax} = 0.02		{bands}2{nwindows} = 0	
{bands}0{fmin} = 0.000001		{bands}2{overlap_percent} = 50.0	
{bands}0{nwindows} = 1		{bands}2{taper_percent} = 50.0	
{bands}0{overlap_percent} = 0.0		{bands}3{fmax} = 200.0	
{bands}0{taper_percent} = 0.0		{bands}3{fmin} = 1.00	
{bands}1{fmax} = 1.0		{bands}3{nwindows} = 0	
{bands}1{fmin} = 0.0025		{bands}3{overlap_percent} = 50.0	
{bands}1{nwindows} = 0		{bands}3{taper_percent} = 50.0	
{bands}1{overlap_percent} = 50.0		{lag} = 1000.0	
{bands}1{taper_percent} = 25.0		{lead} = 30.0	
{bands}2{fmax} = 10.0			
{bands}2{fmin} = 0.05			



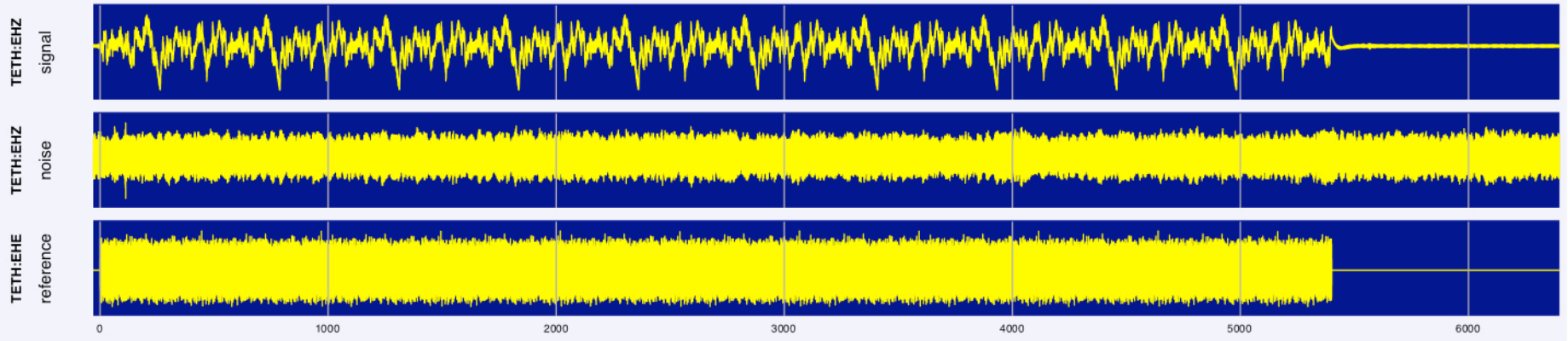
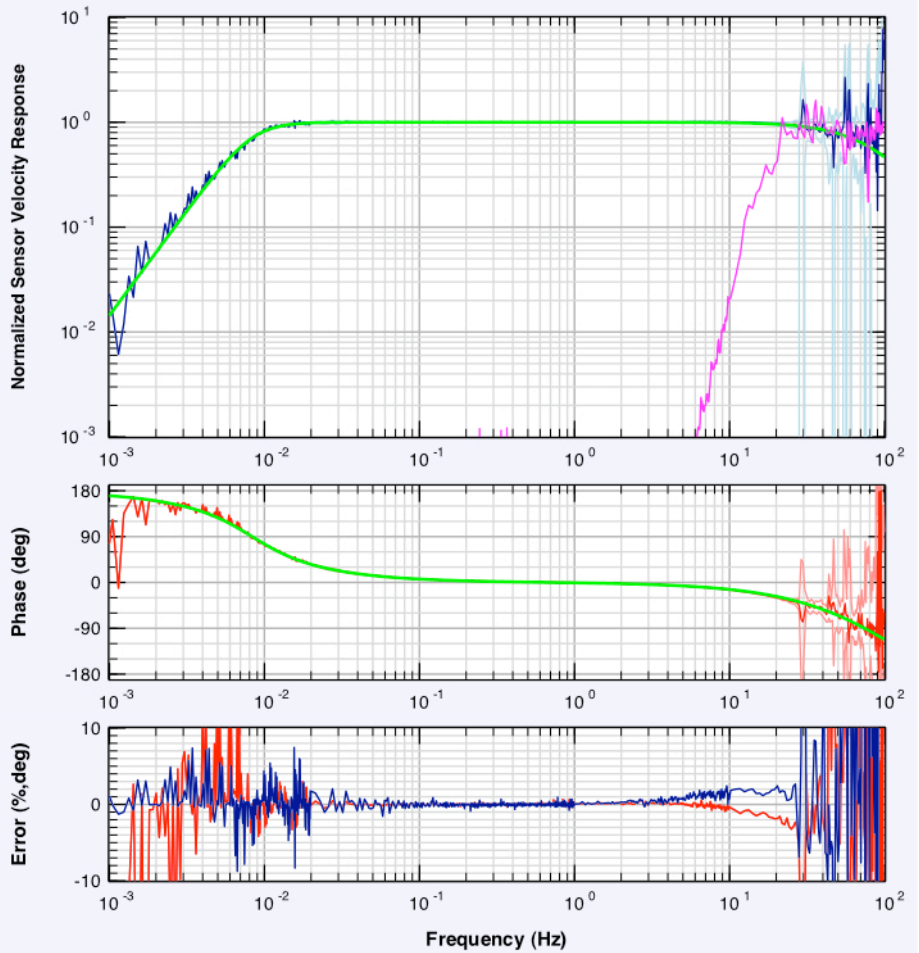


# White noise sensor calibration processing results

Processed by dbcalbrt:danny.redgarden at 2008134:12:50:59.008

Channel: <b>TA_TETH_EHZ</b>	Time: <b>2008088:20:00:00.000</b>	Sequence: <b>TA_TETH-2008088:20:00:00</b>		
Dlmodel: <b>q330</b>	Dlserial: <b>0100000EBDCFB1B8</b>	Snmodel: <b>cmg3t</b>	Snsrserial: <b>0001</b>	
Noise Channel: <b>TA_TETH_EHZ</b>	Noise Time: <b>2008089:02:00:00.000</b>	Noise Sequence: <b>TA_TETH-2008088:20:00:00</b>		
Noise Dlmodel: <b>q330</b>	Noise Dlserial: <b>0100000EBDCFB1B8</b>	Noise Snmodel: <b>cmg3t</b>	Noise Snsrserial: <b>0001</b>	
Ref Channel: <b>TA_TETH_EHE</b>	Ref Time: <b>2008088:20:00:00.000</b>	Ref Sequence: <b>TA_TETH-2008088:20:00:00</b>		
Ref Dlmodel: <b>q330</b>	Ref Dlserial: <b>0100000EBDCFB1B8</b>	Ref Snmodel: <b>cmg3t</b>	Ref Snsrserial: <b>0001</b>	
Cal mode: <b>mon</b>	Cal Waveform: <b>white</b>	Cal Duration: <b>1:30 hours</b>	Samplerate: <b>200</b>	Cal Amplitude: <b>2.500 V</b>
Cal processing: <b>ratio</b>	Cal Settle Time: <b>10:00 minutes</b>	Cal Trailer Time: <b>20:00 minutes</b>		

Sngen: <b>1501.90 V/m/s</b>	Nominal Sngen: <b>1500.00 V/m/s</b>	Norm Freq: <b>1.000 Hz</b>	Noise Relative To: <b>TA_TETH-2008088:20:00:00</b>
Processing Parameters:			
{bands}0{fmax} = 0.02	{bands}2{nwindows} = 0		
{bands}0{fmin} = 0.000001	{bands}2{overlap_percent} = 50.0		
{bands}0{nwindows} = 1	{bands}2{taper_percent} = 50.0		
{bands}0{overlap_percent} = 0.0	{bands}3{fmax} = 200.0		
{bands}0{taper_percent} = 0.0	{bands}3{fmin} = 1.00		
{bands}1{fmax} = 1.0	{bands}3{nwindows} = 0		
{bands}1{fmin} = 0.0025	{bands}3{overlap_percent} = 50.0		
{bands}1{nwindows} = 0	{bands}3{taper_percent} = 50.0		
{bands}1{overlap_percent} = 50.0	{bands}3{fmax} = 200.0		
{bands}1{taper_percent} = 25.0	{bands}3{fmin} = 1.00		
{bands}2{fmax} = 10.0	{lag} = 1000.0		
{bands}2{fmin} = 0.05	{lead} = 30.0		



# White noise sensor calibration processing results

Processed by dbcalbrt:danny.redgarden at 2008134:12:50:26.979

Channel: <b>TA_Y22D_EHZ</b>	Time: <b>2008088:20:00:00.000</b>	Sequence: <b>TA_Y22D-2008088:20:00:00</b>		
Dlmodel: <b>q330</b>	Dlserial: <b>0100000A27B8E96F</b>	Snmodel: <b>sts2_g3</b>	Snsrial: <b>30716</b>	
Noise Channel: <b>TA_Y22D_EHZ</b>	Noise Time: <b>2008089:02:00:00.000</b>	Noise Sequence: <b>TA_Y22D-2008088:15:30:00</b>		
Noise Dlmodel: <b>q330</b>	Noise Dlserial: <b>0100000A27B8E96F</b>	Noise Snmodel: <b>sts2_g3</b>	Noise Snsrial: <b>30716</b>	
Ref Channel: <b>TA_Y22D_EHZ</b>	Ref Time: <b>2008088:15:30:00.000</b>	Ref Sequence: <b>TA_Y22D-2008088:15:30:00</b>		
Ref Dlmodel: <b>q330</b>	Ref Dlserial: <b>0100000A27B8E96F</b>	Ref Snmodel: <b>sts2_g3</b>	Ref Snsrial: <b>30716</b>	
Cal mode: <b>cmp</b>	Cal Waveform: <b>white</b>	Cal Duration: <b>1:30 hours</b>	Samplerate: <b>200</b>	Cal Amplitude: <b>2.500 V</b>
Cal processing: <b>ratio</b>	Cal Settle Time: <b>10:00 minutes</b>	Cal Trailer Time: <b>20:00 minutes</b>		

Amp Ratio: <b>0.997160</b>	Norm Freq: <b>1.000 Hz</b>	Noise Relative To: <b>TA_Y22D-2008088:15:30:00</b>
-------------------------------	-------------------------------	---

**Processing Parameters:**

```

{bands}0{fmax} = 0.02
{bands}0{fmin} = 0.000001
{bands}0{nrwindows} = 1
{bands}0{overlap_percent} = 0.0
{bands}0{taper_percent} = 0.0
{bands}1{fmax} = 1.0
{bands}1{fmin} = 0.0025
{bands}1{nrwindows} = 0
{bands}1{overlap_percent} = 50.0
{bands}1{taper_percent} = 25.0
{bands}2{fmax} = 10.0
{bands}2{fmin} = 0.05
{bands}2{nrwindows} = 0
{bands}2{overlap_percent} = 50.0
{bands}3{fmax} = 200.0
{bands}3{fmin} = 1.00
{bands}3{nrwindows} = 0
{bands}3{overlap_percent} = 50.0
{lag} = 1000.0
{lead} = 30.0
    
```

