

A decorative graphic on the left side of the slide consisting of white lines and circles on a blue gradient background, resembling a circuit board or a stylized tree structure.

# STATION ACCEPTANCE

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# STATION ACCEPTANCE – WHAT IS IT? WHY HAVE IT?

- Concluding phase of station deployment
- “Acceptance” – confirms fitness for the purpose(s) of the installation
- Why have a station acceptance phase?
  - Verification of functions and performance
  - Check metadata, esp. gains, acquisition parameters
  - Closure for field team – really being done with the installation.
  - Closure for contractor – potential contingent payments
  - Verification step for funding agency or customer



# STATION ACCEPTANCE VS. STATION QUALITY ASSESSMENT

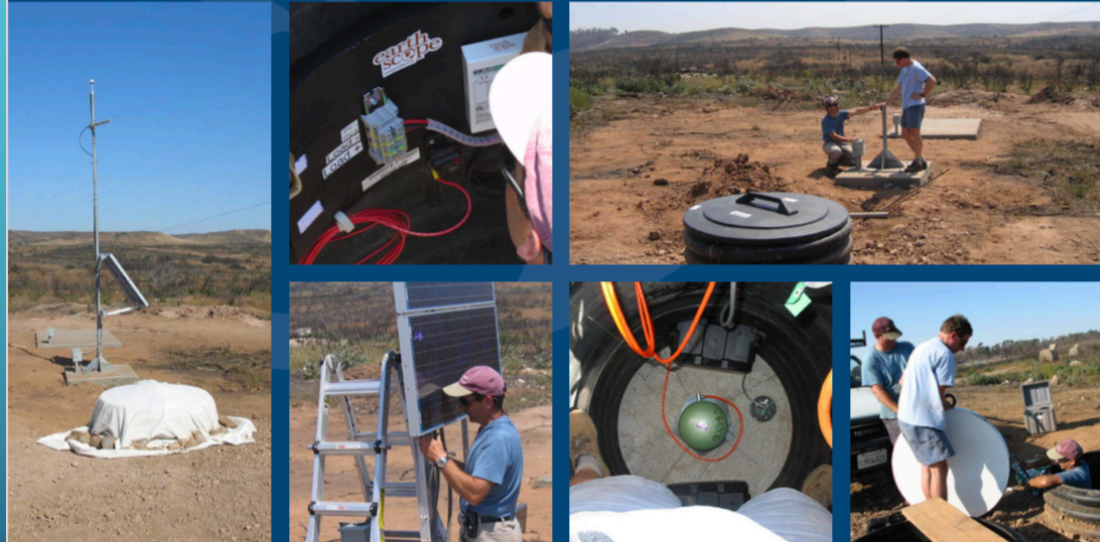
- Station quality: how good or bad is the data?
  - PQLX noise psd's: Grade "A", "B", "C", ....
- Station acceptance: How bad can data be and still accept the station for use.
  - Where is the bottom of the "C-"

Example, integrated station design and acceptance for large-scale broadband deployment.



# The Design and Implementation of EarthScope's USArray Transportable Array

in the Conterminous United States and Southern Canada



R.W. Busby, R.L. Woodward, K.A. Hafner, F.L. Vernon, A.F. Frassetto

# DRAFT

Updated 6/1/2018



# MEASURES OF FITNESS

- Consider purpose of the site
- Urban strong motion (accelerometer) sites – will it record ground motions of engineering significance?
  - Example: Felt ground accelerations are  $\sim 1 \text{ cm/s/s}$ . To record with 20:1 SNR, background is  $1/20$  of  $1 \text{ cm/s/s}$ , or  $\sim 0.07 \text{ cm/s/s}$  RMS.
- EEW: timeliness of data delivery and capability with strong ground motions
- Regional network: SNR for earthquake detection and magnitude
  - Spurious triggers a minor factor
  - Completeness more important than strict timeliness.
- Customer input important here – to get levels, standards, clarify expectations,

## 2. Station Acceptance Functional Requirements

Heuristic rationale for technical details in the station functional requirements section are provided in an appendix to this procedure.

### 2.1. EEW system seismic station functional requirements:

- 2.1.1. Station **location** is known **within 100 meters**.
- 2.1.2. Station data accurate in **time within 0.01 seconds**.
- 2.1.3. Known **calibration** information relate recordings **to absolute ground motion**.
- 2.1.4. Sensor response is flat in the band 0.3 to 15 Hz to approximately recover sensor output in native ground motion units with a single scaling factor per channel.
- 2.1.5. **Data promptness** (from ground motion impulse to data delivery for ShakeAlert) **<3.5 s 98%** of the time. Delays after data delivery and before availability to ShakeAlert are not included in data promptness.
- 2.1.6. **Data gaps and out-of-order deliveries in real-time data shall be considered late for ShakeAlert purposes**, and charged against the promptness criteria for the actual time in the gap or out-of-order sequence plus the effective station unavailability time during recovery of station real-time filter stream.
- 2.1.7. **Station rms noise shall not exceed 0.070 cm/sec<sup>2</sup> in the 0.3-15 Hz band for more than 1 minute per hour averaged over one week.**
- 2.1.8. **Incidence of offsets, spikes, boxcars, and glitches with peaks of 0.34 cm/sec<sup>2</sup> in the band 0.3-15 Hz and durations of 0.03 s shall not exceed 20 per hour.**
- 2.1.9. **Internet-aware station components are** secured to protect the station itself and the ShakeAlert system from intrusion or compromise.
- 2.1.10. Process of station acceptance is recognized by EEW Central and documented.

EEW Station Assessment Procedure

Version 9

January 9, 2018

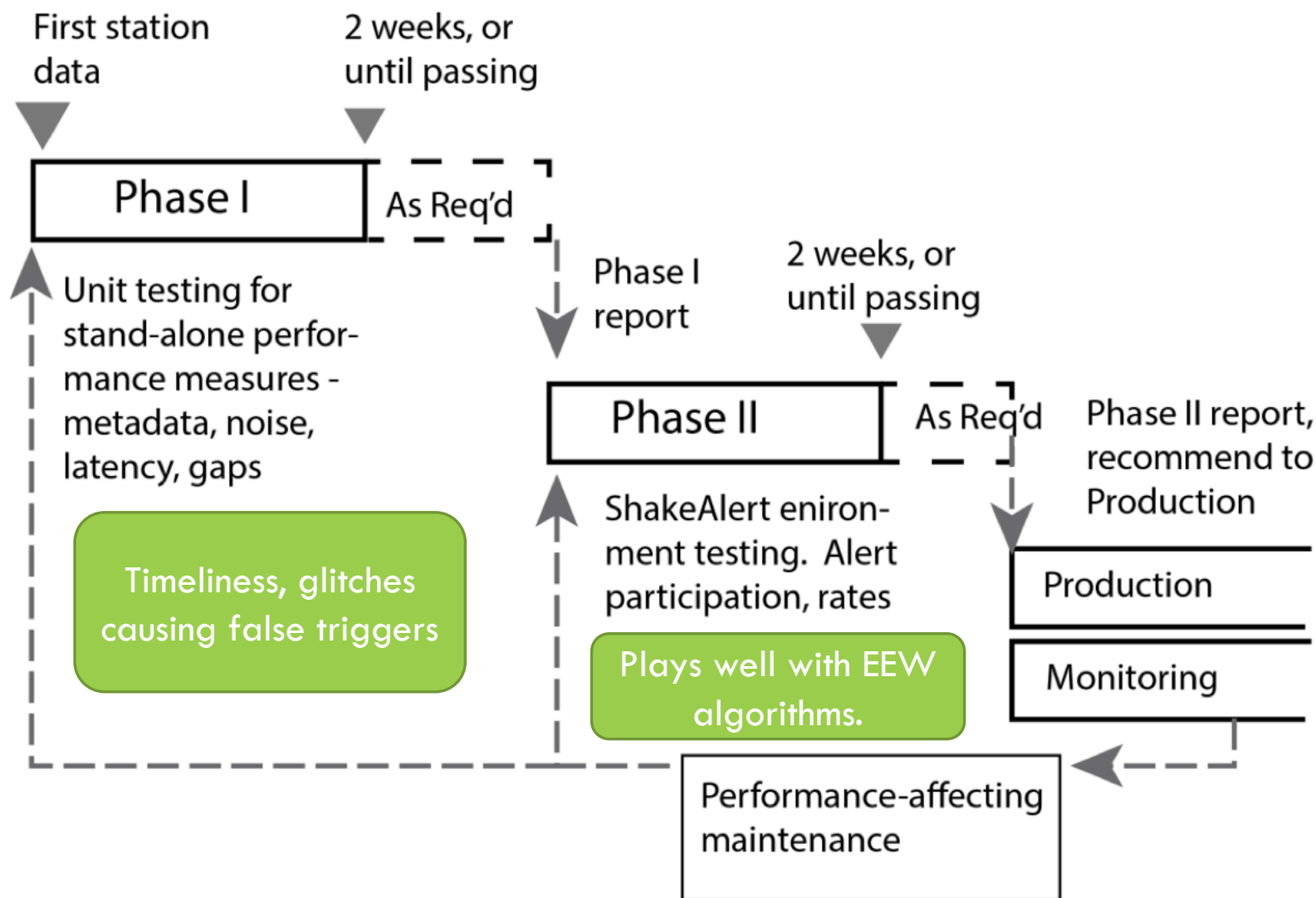
Really, we want it in 1 s.



# Station Acceptance Process

## Two Phases

- Unit and stand-alone tests
- Integration testing – plays nice with others



# eew\_stationreport Request

Notes: Duration are in hours, negative values will make the starttime the endtime. Max is +/- 700hrs.  
center e.g.: IRIS, NCEDC, SCEDC.

[eew\\_stationreport github page with details on what's calculated](#)

[sniffwave\\_tally github page with details](#)

[View the queue.](#)

[See what's currently cooking.](#)

[See what's been cooked.](#)

[Page with completed reports](#)

Station (e.g. ALKI)

POR

Network (e.g. UW)

CI

Data Center (e.g. IRIS)

SCEDC

Institution ID; valid: MENLO, UCB, PNSN, SCSN, (blank)

SCSN

Starttime (yyyy-mm-dd hh:mm:ss)

2019-11-01 00:00:00

Duration in hours (float). Negative values are valid

48

Email

gbiasi@usgs.gov

Submit

## Interfaces for Station Acceptance Tests

Network name (ex.: CI, UW, NC)

CI

Site name (ex.: RHC2, LUMI, BPRB)

POR

Location code (ex.: -- or 01)

--

Operator code (SCSN, NCSN, or PNSN)

SCSN

Email Address

gbiasi@usgs.gov

Submit

Reset Form

**Note 1: The seismic data analysis is done on the 100 Hz data channels**

Note 2: I will add a "Validate station" button to check for the data

NCSN example for [BK.PETY.00](#)

SCSN example for [CI.RHC2.--](#)

PNSN example for [UO.DRAN.--](#)

Gorilla

PIPSQUEAK



Station report for EEW certification: CI.POR

2019-11-01T00:00:00 - 2019-11-03T00:00:00 UTC

Generated: 2019-11-03T19:12 PT for gbiasi@usgs.gov [Link to PDF](#)

Site Information

Station Institution Lat. (deg N) Lon. (deg E) Elev. (m) Start Date  
CI.POR SCSN 36.10368 -119.00343 198.0 2018-10-04T17:00:00

Sensor(s)

Channel Sample rate Sensor		
BHE.--	40.0	MBB-2,Velocity Transducer,METROZET
BHN.--	40.0	MBB-2,Velocity Transducer,METROZET
BHZ.--	40.0	MBB-2,Velocity Transducer,METROZET
HHE.--	100.0	MBB-2,Velocity Transducer,METROZET
HHN.--	100.0	MBB-2,Velocity Transducer,METROZET
HHZ.--	100.0	MBB-2,Velocity Transducer,METROZET
HNE.--	100.0	EPISENSOR ES-T,Accelerometer,KINEMETRICS
HNE.2C	200.0	EPISENSOR ES-T,Accelerometer,KINEMETRICS
HNN.--	100.0	EPISENSOR ES-T,Accelerometer,KINEMETRICS
HNN.2C	200.0	EPISENSOR ES-T,Accelerometer,KINEMETRICS
HNZ.--	100.0	EPISENSOR ES-T,Accelerometer,KINEMETRICS
HNZ.2C	200.0	EPISENSOR ES-T,Accelerometer,KINEMETRICS

Time quality

Pct. data w acceptable Clock locking/quality	Pct. data w acceptable Clock drift/phase
no information	no information

Data Promptness Metrics

Collected from earthworm WAVE\_RING using sniffwave\_tally

Channel	Sniffed measurement period	% with acceptable latency (<3.5s)	% data without gaps, including gap penalty	Total combined data completeness (green = >90%)	Number of gaps per hour (<1)
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PIPSQUEAK Report

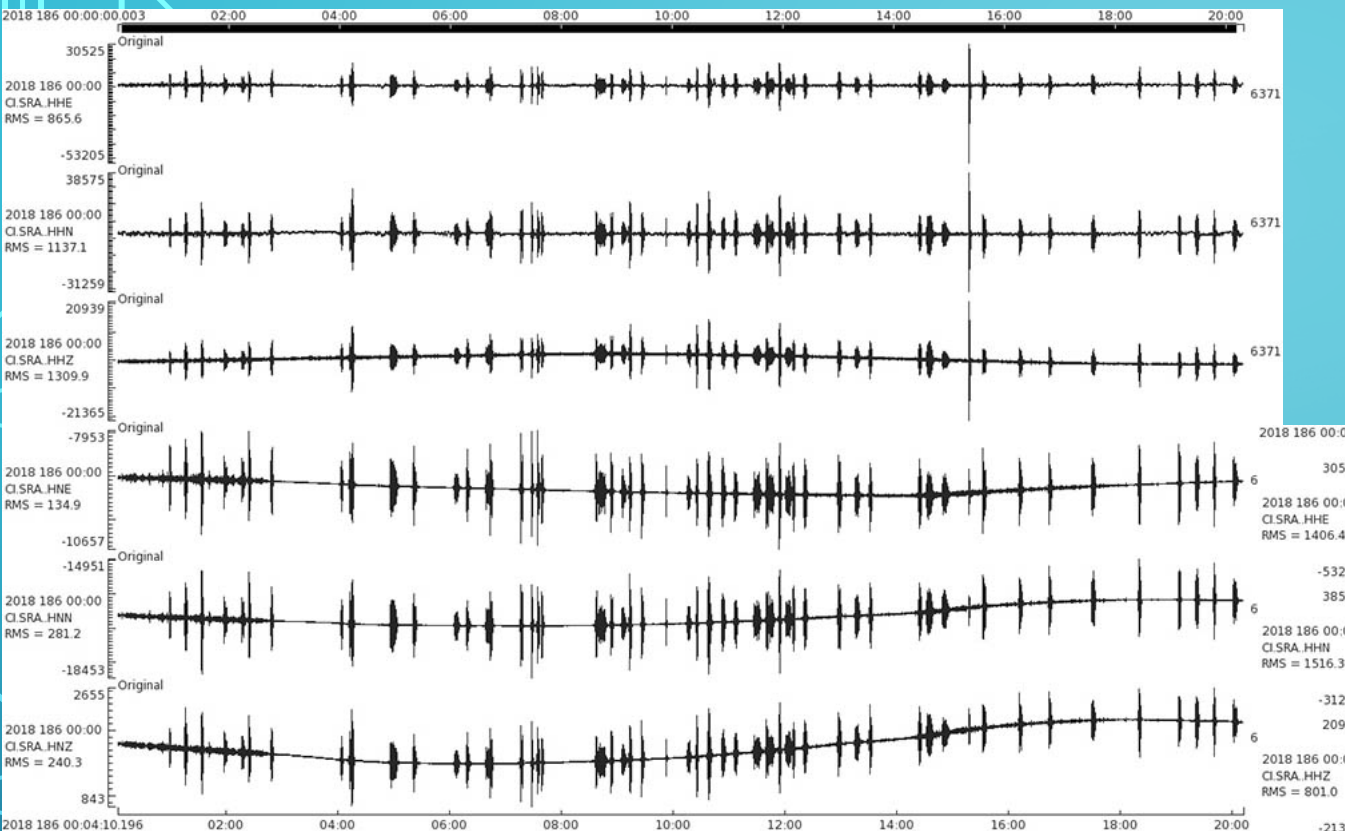
2019-10-31T17:01:00 -				
CI.POR.--.HHE 2019-11-02T16:50:59 (1 day, 23:45:24)	99.928	100.0	99.928	0.0
2019-10-31T17:01:00 -				
CI.POR.--.HHN 2019-11-02T16:50:59 (1 day, 23:45:24)	99.928	100.0	99.928	0.0
2019-10-31T17:01:00 -				
CI.POR.--.HHZ 2019-11-02T16:50:59 (1 day, 23:45:24)	99.928	100.0	99.928	0.0
2019-10-31T17:01:00 -				
CI.POR.--.HNE 2019-11-02T16:50:59 (1 day, 23:45:25)	99.928	100.0	99.928	0.0
2019-10-31T17:01:00 -				
CI.POR.--.HNN 2019-11-02T16:50:59 (1 day, 23:45:25)	99.928	100.0	99.928	0.0
2019-10-31T17:01:00 -				
CI.POR.--.HNZ 2019-11-02T16:50:59 (1 day, 23:45:24)	99.928	100.0	99.928	0.0

Data Quality Metrics

Measurement period: 2019-11-01T00:00:00 - 2019-11-03T00:00:00 (2 days, 0:00:00)

Channel	Number of noise glitches per hour >0.34 cm/s^2 (<1)	RMS exceeding 0.07cm/s^2 in s per hour (<60)
CI.POR.--.BHE	0.02083	0.20625
CI.POR.--.BHN	0.02083	0.20573
CI.POR.--.BHZ	0.0	0.0
CI.POR.--.HHE	0.04167	0.32083
CI.POR.--.HHN	0.02083	0.32167
CI.POR.--.HHZ	0.0	0.0
CI.POR.--.HNE	0.10417	0.80438
CI.POR.--.HNN	0.08333	0.7375
CI.POR.--.HNZ	0.0	0.0

Reference: [Station Acceptance Policy Document](#)



20 hours, station Cl:SRA  
Looks terrible  
Station Assessment? glitches okay,  
noise amplitude, okay  
RMS elevated, but okay. Passes.

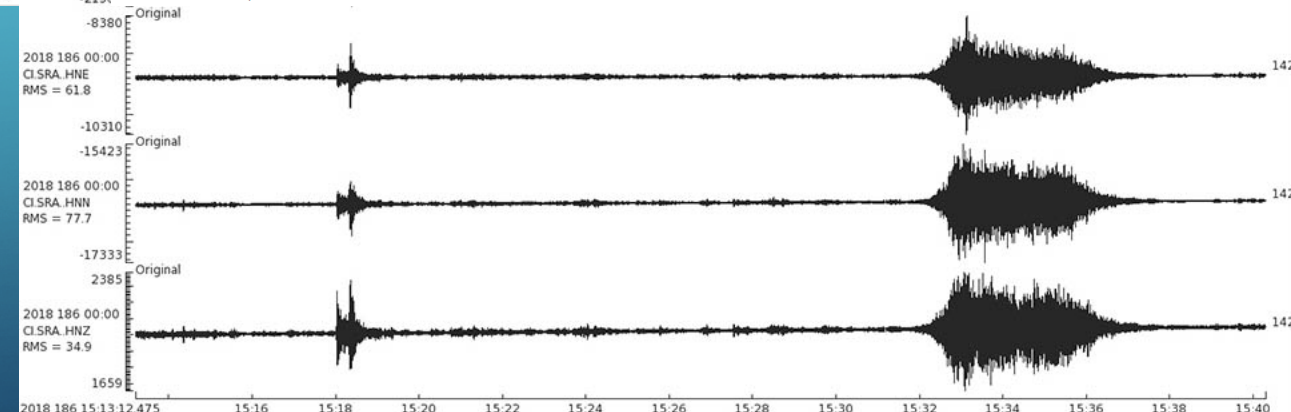
## Data Quality Metrics

Measurement period: 2018-09-01T00:00:00 - 2018-09-04T00:00:00 (3 days, 0:00:00)

Channel	Number of noise glitches per hour >0.34 cm/s <sup>2</sup> (<1)	RMS exceeding 0.07cm/s <sup>2</sup> in s per hour (<60)
Cl:SRA.--.BHE	0.0	0.0
Cl:SRA.--.BHN	0.0	2.36215
Cl:SRA.--.BHZ	0.0	0.0
Cl:SRA.--.HHE	0.0	6.47069
Cl:SRA.--.HHN	0.0	32.34569
Cl:SRA.--.HHZ	0.0	1.84139
Cl:SRA.--.HNE	0.0	10.82014
Cl:SRA.--.HNN	0.0	34.72889
Cl:SRA.--.HNZ	0.0	2.47361

Reference: [Station Acceptance Policy Document](#)

© 2018, PNSN





# STATION QUALITY – MONITORING STATIONS FOR ESSENTIAL PERFORMANCE

- Need to measure qualities of importance to the project.
- Wanted: measure how algorithms (picking, detection, EEW) actually see or respond the data

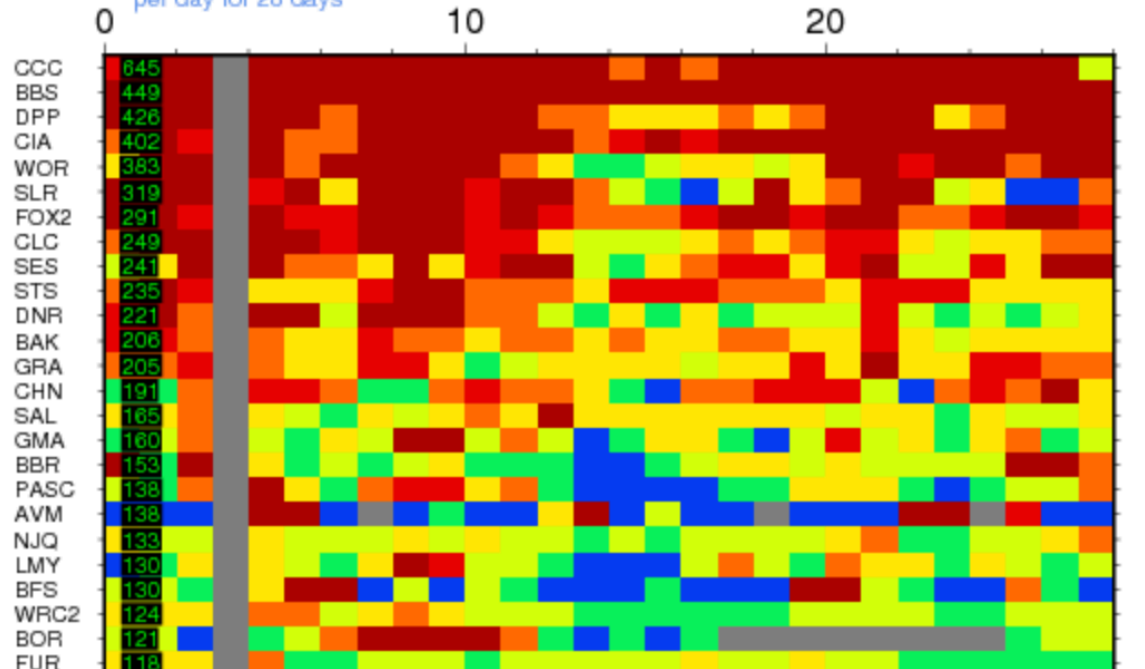
# STATION QUALITY, AUTOMATED ASSESSMENT

Wanted: measure how algorithms actually see the data

Below: EEW Epic algorithm triggers/day. (full network at right)

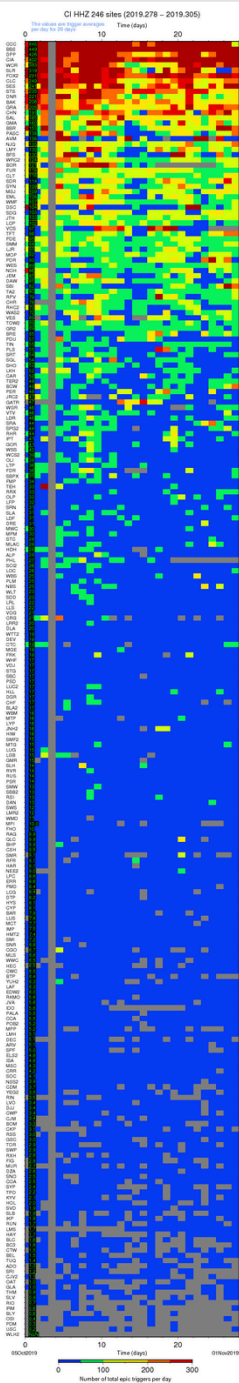
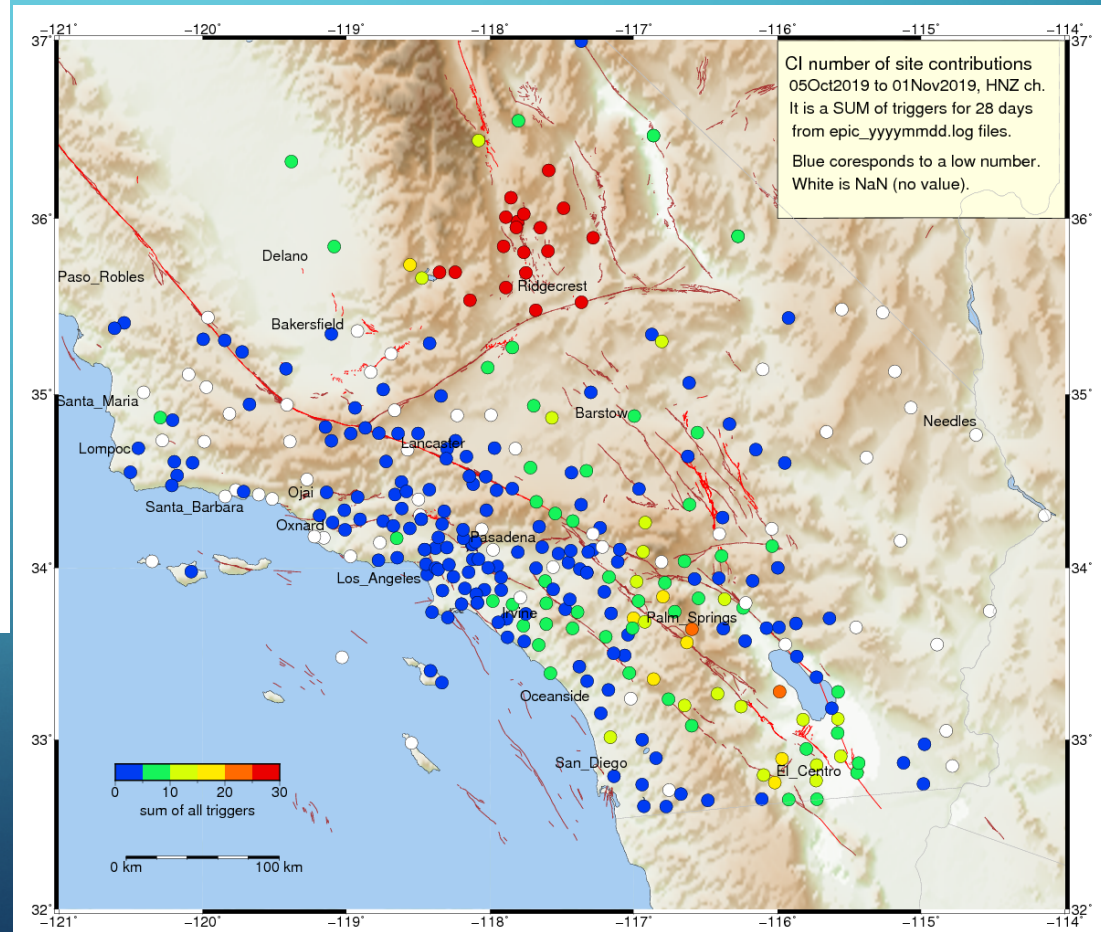
CI HHZ 246 sites (2019.278 – 2019.305)

The values are trigger averages  
per day for 28 days



Station QC, mining AQMS  
and EEW log files

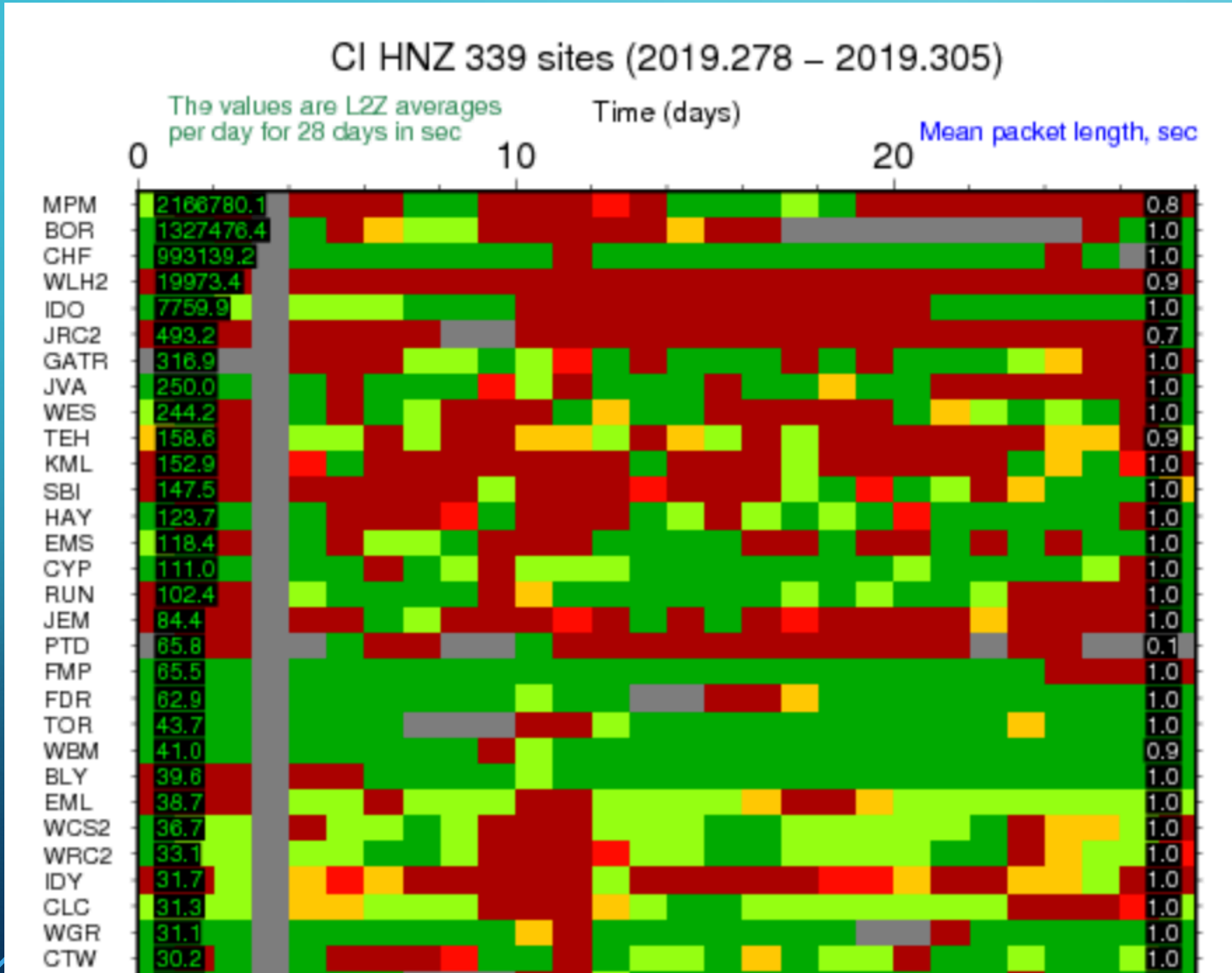
Map view of station contributions to located  
earthquakes. Map helps evaluate high trigger counts.





# STATION QUALITY, AUTOMATED ASSESSMENT

Measure qualities of importance to the project: latency



Latency requirement is unique to EEW

Monitor latency to all stations.

Available:

- L1Z: pure transport latency
- A latency as reported by the EEW algorithm (Epic)

Chronically late? call for telemetry improvement

crust.caltech.edu/~igor/QC/20

## Index of /~igor/QC/20191005

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<a href="#">US/</a>	2019-11-02 11:59	-
<a href="#">UW/</a>	2019-11-02 11:59	-

# EEW CHECKS IMPLEMENTED ON ALL EEW STATIONS

EEW QC measures for  
all network stations in  
EEW

Directory of measured  
qualities.  
HHZ and HNZ  
AQMS and EEW triggers  
Sorted views for situation  
awareness  
Maps

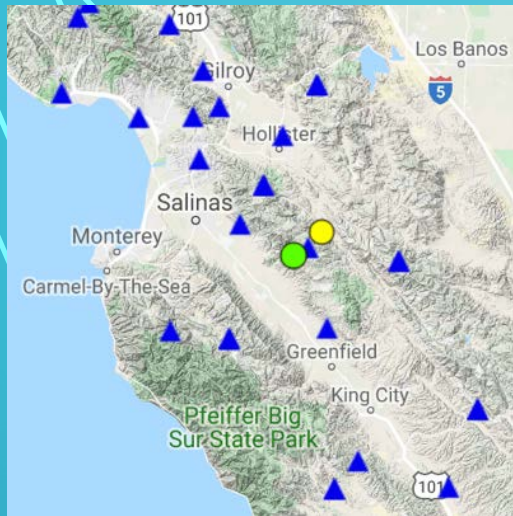
Post-event Message Text - Google | Inbox (81) - shakealerteew@gmail.com | eewreport.pnsn.or

crust.caltech.edu/~igor/QC/20191005/CI/

## Index of /~igor/QC/20191005/CI

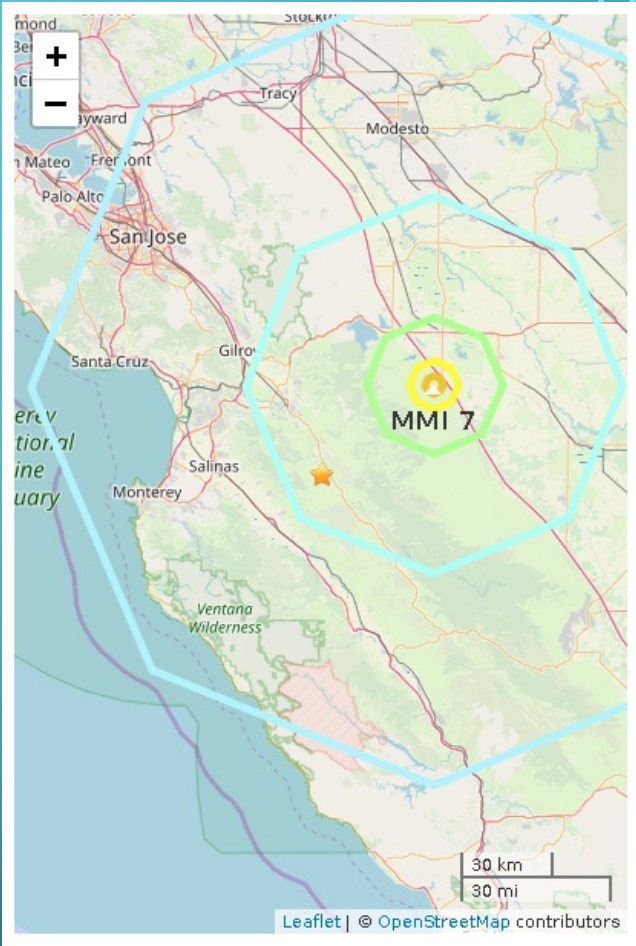
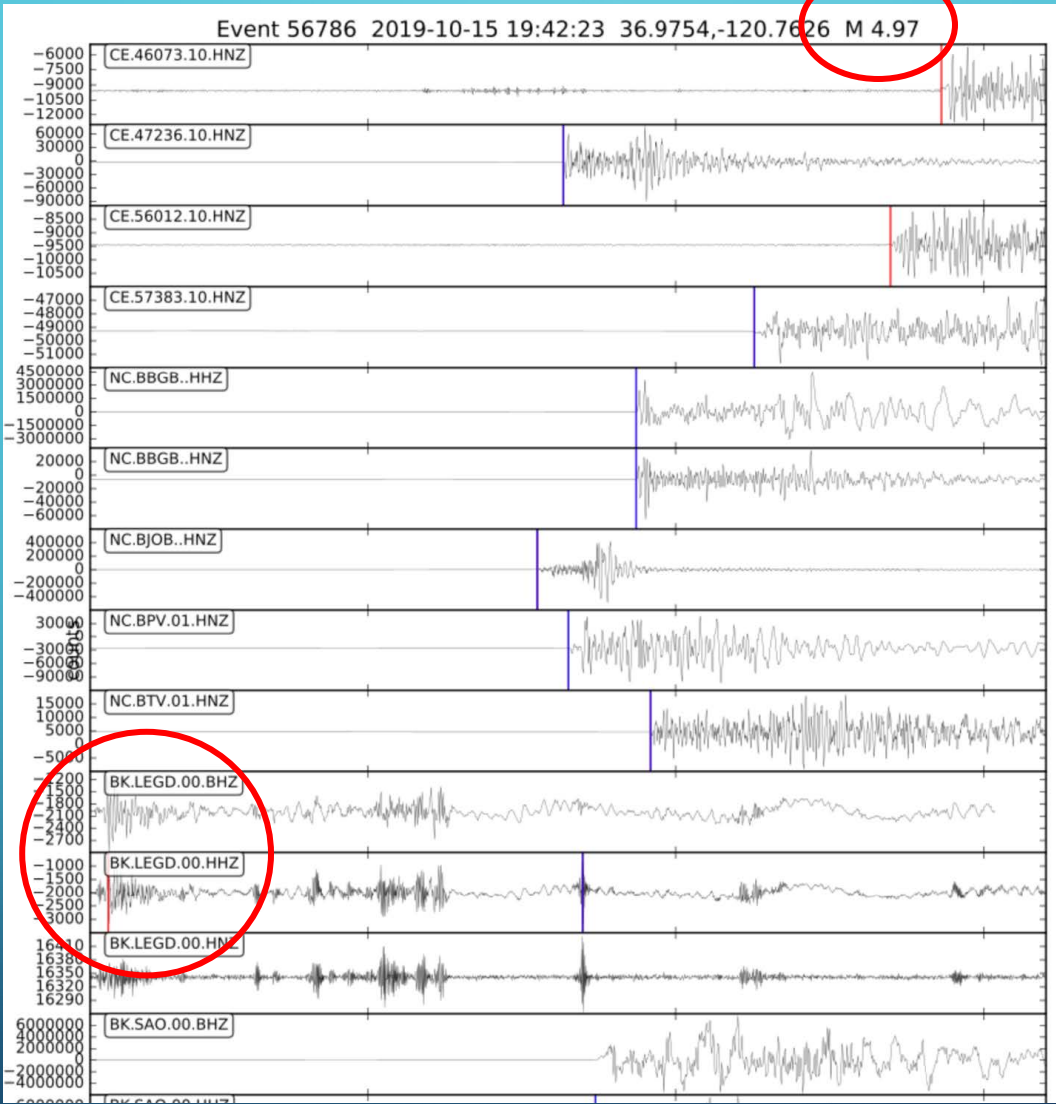
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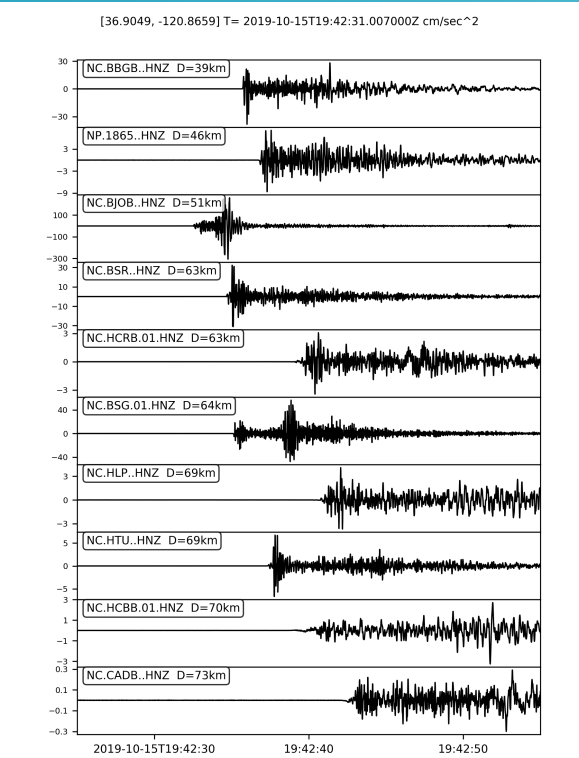


# Cautionary tale about the power of a bad trigger

## 2019-10-15 19:42 Los Piños event.



Location, magnitude >50 km off – alerted wrong area  
Magnitude briefly in range to issue wireless alert.

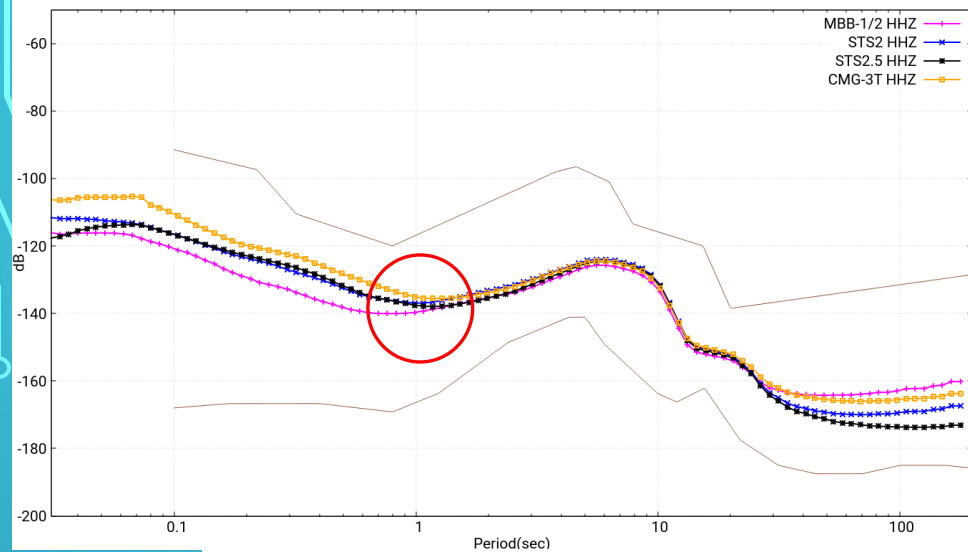


# STATION REPAIR AND RETURN TO SERVICE

- Station acceptance informs duties after station maintenance.
- EEW customer needs: amplitude, latency, noise level, glitch counts
- Regression testing
  - Retest if maintenance alters required qualities.
  - How much? proportional to the repair; we only look at long data slices to check on site noise; this doesn't change with maintenance



Comparison of PSDs for all SCSN MBB-1/2, STS-2, STS-2.5, CMG-3T sensors for 2017

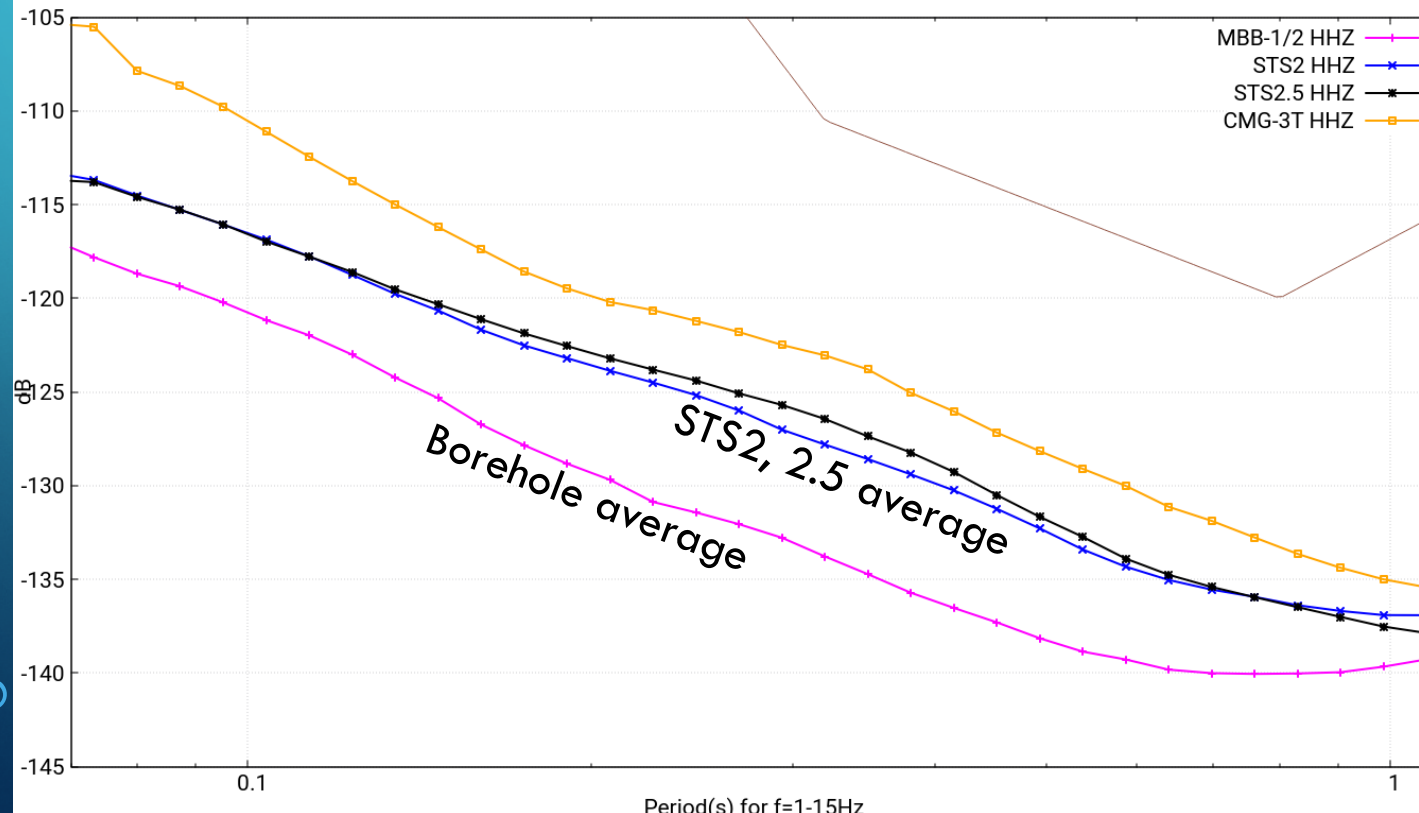


## FIXING A NOISY STATION: Maybe a shallow borehole sensor

~2 m borehole sensor can reduce effects of site noise

Advantage at frequencies  $>1$  Hz  $\sim 6$  db ( $\sim 4\times$ )

Comparison of PSDs for all MBB-1/2, STS-2, STS-2.5, CMG-3T sensors for 2017



Ensemble average, shallow borehole sensors in SCSN

# REALITY CHECK

- Rerunning acceptance tests on installed/grandfathered stations has its perils.
- Procedure can be tedious. AVOID unnecessary details. Each entry costs time and energy. Avoid parameters that cannot be automated. Example: clock locked at least 2x/day?
- Some site problems can be fixed
  - Shallow borehole sensors
  - Reduce wind exposure



# SUMMARY

- Station acceptance procedures improve uniformity
- Station acceptance procedures clarify expectations – performance minimums
- Siting
  - Do a noise survey if you have the time and money
  - Siting difficulty means we may have to live with compromises
- Shallow borehole sensors are more available now, and may help with some noise problems

# CI custom SMS interface, short field report

## INPUT:

(to a suitable URL)



## OUTPUT:

(to your message app)

### CI.BOM

[CWB] Last 5 min stats:

CI.BOM has 33 channels of data

[ping averaged] 3/3 from cs-  
import1: 29.6ms

[IP] 10.7.4.10

[plume] Seismic channels with  
latencies:

BOM.HHE.CI. 0.30s

BOM.HHN.CI. 0.30s

BOM.HHZ.CI. 0.30s

BOM.HNE.CI. 0.30s

BOM.HNN.CI. 0.30s

BOM.HNZ.CI. 0.30s

[sensor,ZNE] STS-2.5 \_A  
[-26, 22, -12]

[voltage, temp] 12.75, 30C

[clock quality] 100 good

[UTC time] 2019/04/04 20:52:37

[PST time] 2019/04/04 13:52:37

\* Please do not reply \*