ARMONIA Project: Transfrontier Strategy in the Management of Earthquakes

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ARMONIA Project

The ARMONIA project aims to tighten collaboration between the civil protection institutions for the risk prevention. Through the use of innovative methodologies, it develops a trans-frontier strategy in the management of natural disasters. On the cross border area natural disasters, as strong earthquakes, causes damages and loss of life in different countries. The development of common protocols allows joint planning and implementation of harmonize actions to accelerate and facilitate the rescue operations. Partners will develop an innovative seismic monitoring system extended also to the strategic buildings that will provide critical information, in the cross-border area, crucial for a rapid and focused interventions at the occurrence of earthquake.

Partners of the project are: Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Università degli Studi di Udine, Università degli Studi di Trieste (SeisRaM Working Group), Regione Autonoma Friuli Venezia Giulia - Protezione civile della Regione, Regione del Veneto - Direzione Protezione Civile e Polizia Locale, Zentralanstalt fur Meteorologie und Geodynamik (ZAMG), Universitat Innsbruck. Associated Partners are: Presidenza del Consiglio dei Ministri - Dipartimento della Protezione Civile, Agenzia per la Protezione Civile - Provincia autonoma di Bolzano, Ufficio Geologia e Prove Materiali - Provincia autonoma di Bolzano

Within the WP4 of ARMONIA project, SeisRaM group with collegues of ZAMG, are testing different seismic instrumentations installed in August in Umbria Civil Defence Building in Foligno. The main goal is the improvement and the integration of existing network to enhance the effectiveness in a trasnational prospective, in order to obtain the required quality of the data together with the maximum distribution of the instruments in the territory. The deployment of new instrumentation in near field and in sentinel buildings provides to high level of efficiency adding important information in case of emergency.

Stations

Station Name	Producer	Model	Type
RABD6	Raspberry Pi	1D	MEM
FOPC	Kinemetrics	Basalt	Accelerometer
SARA	Sara	Acebox	Accelerometer
A49F	MOHO	Suricat	MEM
LUSA	Kinemetrics	ETNA-2	Accelerometer
LUNI	Lunitec	Triton	MEM
STN01	Nanometrics	TitanSMA	Accelerometer
TEST	Guralp	Fortis	Accelerometer

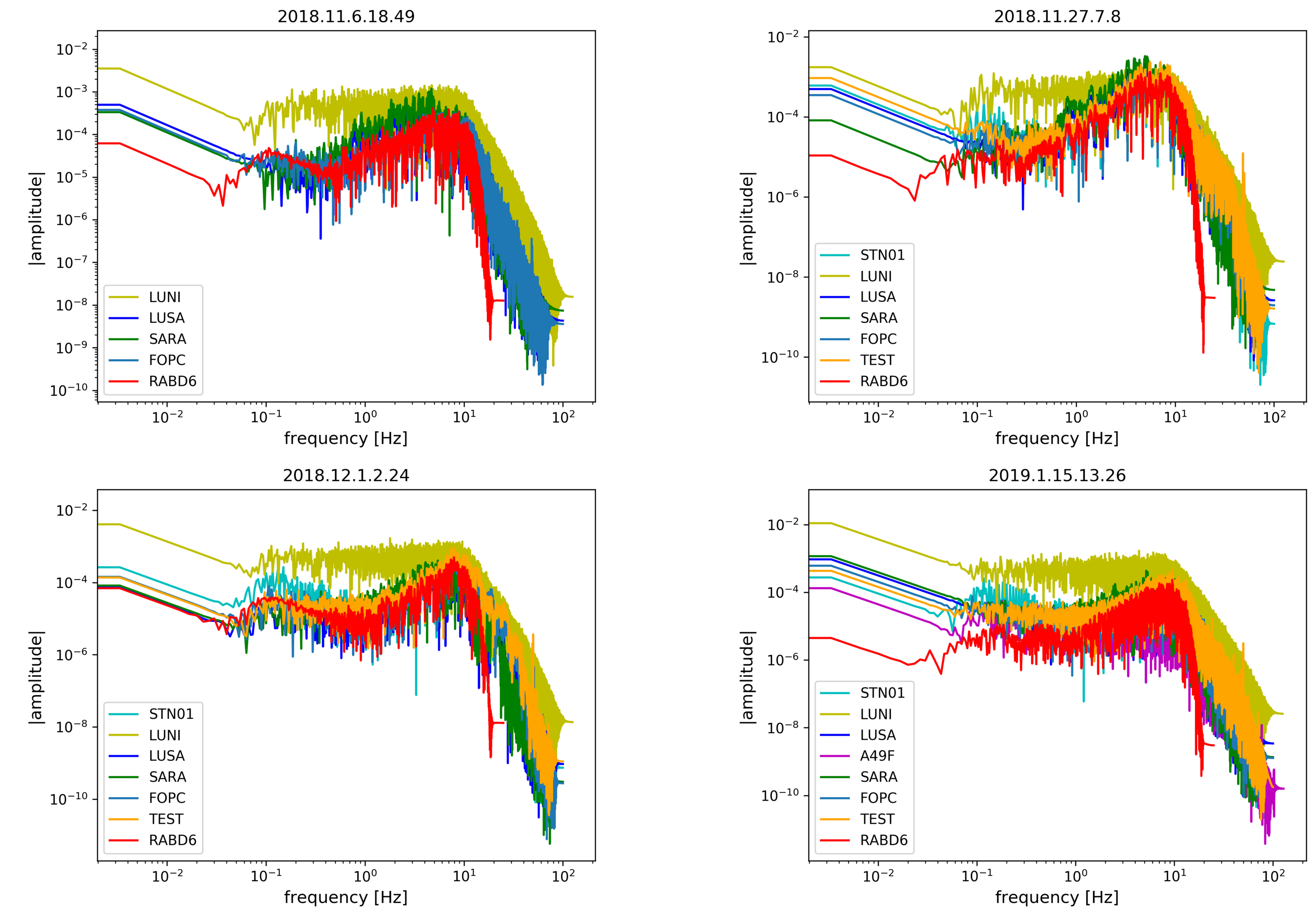
Earthquakes

Events that are detected by National Institute of Geophysics and Volcanology (INGV) are selected for the analysis. Recursive STA/LTA (Trnkoczy, A. 2012, Withers, M. et al. 1998) method is used for the earthquake detection. Green and red colors indicate the detection and no detection, respectively. Correlations are done by using FOPC as a reference. FOPC managed to detect all the earthquakes.

Date	Ml	Depth (km)	Distance (km)	RABD6	SARA			A49F			LUSA			LUNI			STN01			TEST		
				Z	E	N	Z	E	N	Z	E	N	Z	E	N	Z	E	N	Z	E	N	Z
2018.11.6.18.49	3.4	10	77	0.68	0.28	0.95	0.95				0.23	0.97	0.24	0.47	0.51	0.37						
2018.11.11.15.15	2.7	8	28	0.61	0.17	0.95	0.93				0.15	0.97	0.18	0.18	0.23	0.18						
2018.11.13.3.39	2.6	22	46	0.63	0.23	0.89	0.85				0.21	0.92	0.26	0.08	0.07	0.07						
2018.11.15.1.1	3.0	11	70	0.65	0.24	0.95	0.93				0.22	0.96	0.24	0.19	0.22	0.16	0.97	0.97	0.94	0.98	0.99	0.96
2018.11.16.1.20	2.5	16	46	0.67	0.34	0.89	0.87				0.02	0.03	0.05	0.09	0.08	0.07	0.95	0.88	0.88	0.95	0.93	0.89
2018.11.23.18.33	2.6	13	65	0.73	0.31	0.93	0.9				0.28	0.95	0.29	0.18	0.14	0.12	0.97	0.96	0.93	0.97	0.97	0.94
2018.11.24.8.34	3.0	11	42	0.7	0.25	0.94	0.92				0.21	0.96	0.24	0.29	0.28	0.16	0.99	0.98	0.94	0.98	0.98	0.95
2018.11.25.11.28	2.6	10	48	0.7	0.18	0.91	0.89				0.16	0.94	0.18	0.07	0.11	0.06	0.94	0.94	0.93	0.94	0.96	0.93
2018.11.25.23.43	2.6	12	73	0.54	0.16	0.85	0.67				0.18	0.9	0.17	0.07	0.06	0.06	0.8	0.8	0.7	0.83	0.89	0.71
2018.11.26.0.37	2.9	17	72	0.66	0.17	0.93	0.84				0.17	0.94	0.19	0.07	0.11	0.07	0.91	0.89	0.82	0.94	0.96	0.86
2018.11.26.19.19	2.9	10	39	0.68	0.29	0.95	0.93				0.28	0.97	0.25	0.29	0.39	0.28	0.99	0.99	0.97	0.98	0.99	0.96
2018.11.27.7.8	2.7	8	8	0.76	0.31	0.96	0.96				0.3	0.97	0.29	0.87	0.87	0.79	1	1	0.98	0.99	0.99	0.98
2018.12.1.2.24	2.6	10	32	0.85	0.31	0.96	0.95				0.32	0.97	0.38	0.29	0.4	0.46	0.98	0.98	0.98	0.97	0.99	0.97
2018.12.1.19.8	3.1	14	36	0.75	0.22	0.95	0.93				0.21	0.96	0.22	0.46	0.49	0.39	0.99	0.99	0.97	0.99	0.99	0.99
2018.12.4.8.35	2.5	10	41	0.73	0.34	0.94	0.91				0.3	0.96	0.34	0.15	0.23	0.15	0.96	0.95	0.94	0.96	0.97	0.94
2018.12.21.17.49	3.6	10	76	0.67	0.18	0.95	0.96	0.12	0.1	0.07				0.27	0.23	0.17	0.99	0.98	0.97	0.99	0.99	0.97
2018.12.22.11.26	2.7	9	76	0.56	0.18	0.89	0.86	0.06	0.06	0.05	0.17	0.92	0.15	0.06	0.08	0.07	0.92	0.88	0.88	0.94	0.94	0.9
2019.1.5.23.29	2.8	12	32	0.7	0.25	0.94	0.95	0.25	0.27	0.15	0.24	0.95	0.27	0.53	0.58	0.46	0.99	0.99	0.98	0.99	0.99	0.97
2019.1.13.20.28	2.5	14	70	0.62	0.13	0.82	0.77	0.06	0.05	0.05	0.14	0.88	0.14	0.07	0.07	0.06	0.76	0.65	0.71	0.86	0.87	0.82
2019.1.14.23.2	4.3	21	158	0.74	0.13	0.97	0.98	0.3	0.4	0.2	0.12	0.97	0.14	0.6	0.67	0.56	1	1	0.99	0.99	0.99	0.99
2019.1.15.12.20	2.6	10	23	0.68	0.34	0.93	0.94	0.21	0.26	0.16	0.35	0.94	0.34	0.48	0.48	0.38	0.99	0.99	0.98	0.98	0.98	0.97
2019.1.15.13.26	2.6	9	44	0.71	0.17	0.93	0.91	0.07	0.07	0.07	0.17	0.95	0.17	0.17	0.21	0.18	0.97	0.97	0.95	0.98	0.98	0.93

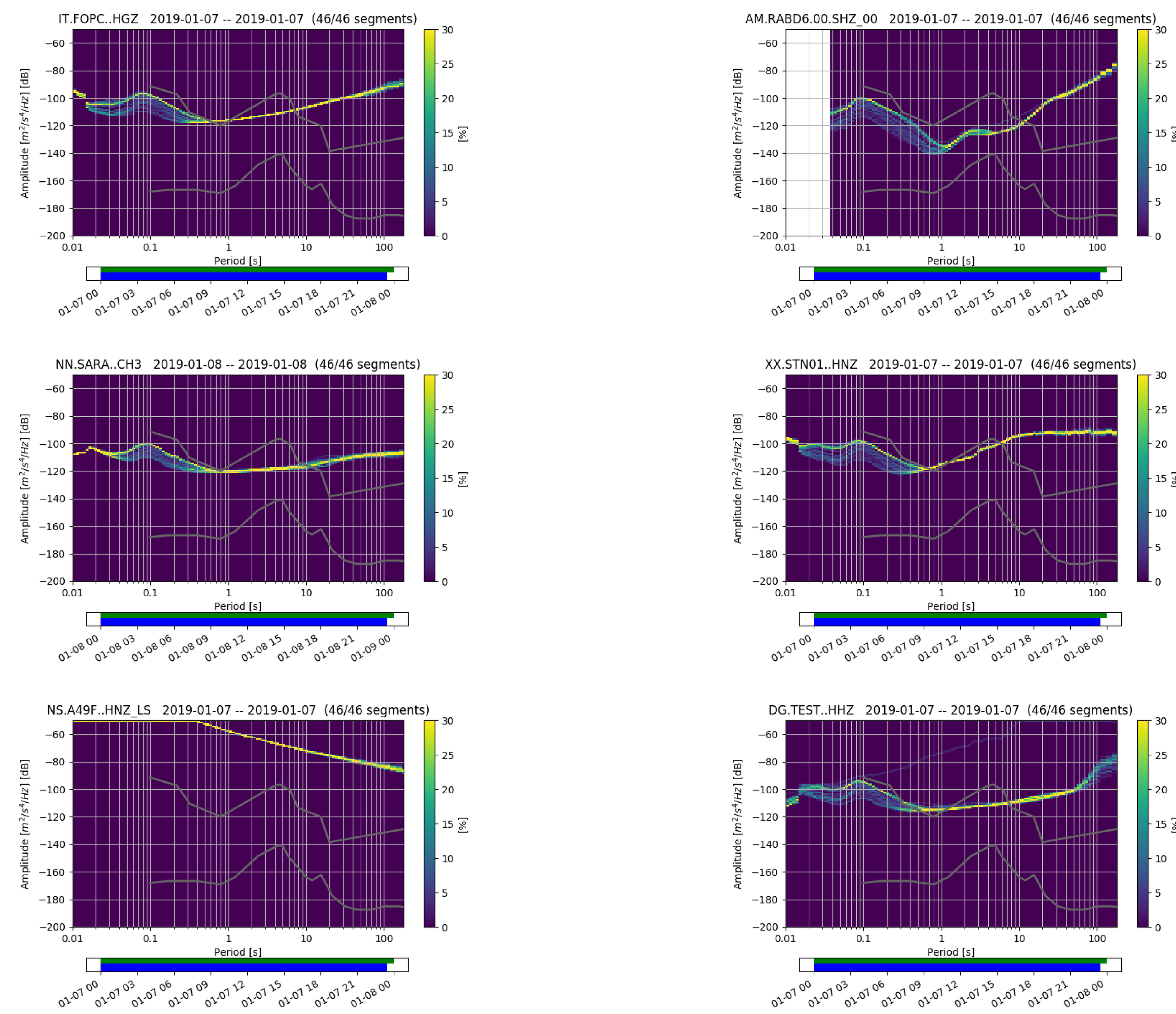
Frequency Contents

Frequency content of an earthquake is a vital information for seismological studies. We calculated the frequency content of each sensor for each earthquake.



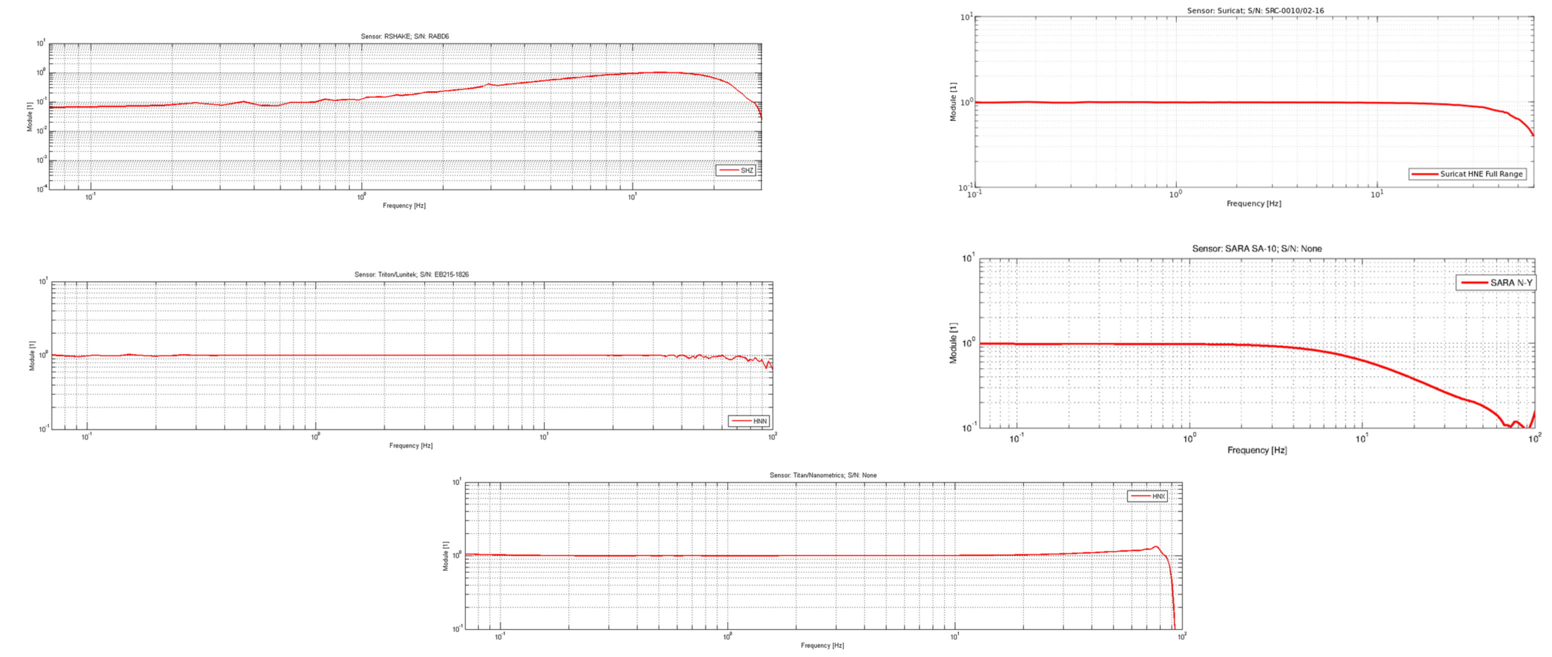
PPSD

Probabilistic power spectral densities are calculated by using the routine of McNamara, Daniel E. and Buland, Raymond P. 2004. PPSD are calculated for the 6 stations.



Shake Table

5 sensors have been tested with a white noise using the shaking table that has vertical and horizontal laser beam vibrometer with 200 nm of resolution (Di Bartolomeo et al 2005) designed by OGS.

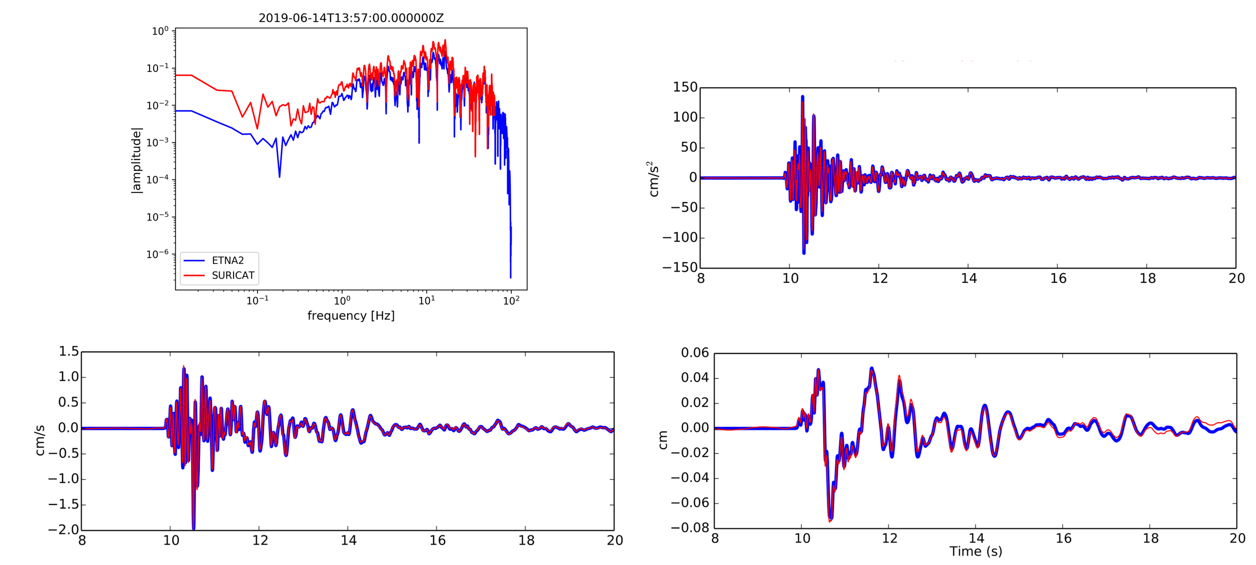


ETNA2 vs. SURICAT

Further investigation has been done for Suricat seismometers by using data from another test site. ETNA2 and SURICAT stations are located in a test site in Tolmezzo, NE Italy. Information about the earthquake and the information retrieved from ETNA2 and SURICAT devices can be seen in the Figure below.

Station: TOLM (ETNA-2) - Z
Station: TOL1 (SURICAT) - Z
Event: Tolmezzo - 14/06/2019 13:57:24 UTC - Ml = 4.06 - Ep. dist = 1.916 km
BUTTERWORTH FILTER: 0.3 Hz - 50.0 Hz - 4 poles
Correlation Coefficient between ETNA-2 and SURICAT is: 0.97

PGA	PGV	PGD
135.43	1.96	0.07
127.03	1.96	0.07



Conclusions

- SURICAT and LUNITEC need earthquakes with bigger magnitudes to record the event and to capture the features of the earthquake. The reason for this effect is that these stations are MEM devices whereas the rest are force balance seismometers.
- RASPBERRY PI and SARA are the only low cost devices that detect all the earthquakes with a nice correlation.
- SARA has a filter on 8 Hz which is visible at Shake Table analysis.
- Almost all stations have a flat region on FFT in between 0.08 Hz to 10 Hz. Maximum amplitudes on FFT are read in similar frequency band.