

# QC in Slovenia

European Antelope User Group Meeting 2018

*Procedures and tools for data quality and seismic network operation control in Slovenia*

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Ljubljana, Slovenia

# Typical seismic station



SUPPORT EQUIPMNET  
-communication units  
-power supply  
-local seismic data storage  
-...

UPS >20h

SEISMIC EQUIPMNET  
-acquisition unit  
-seismometer  
-accelerometer

UPS >9 days



# data centre : 2 x YES



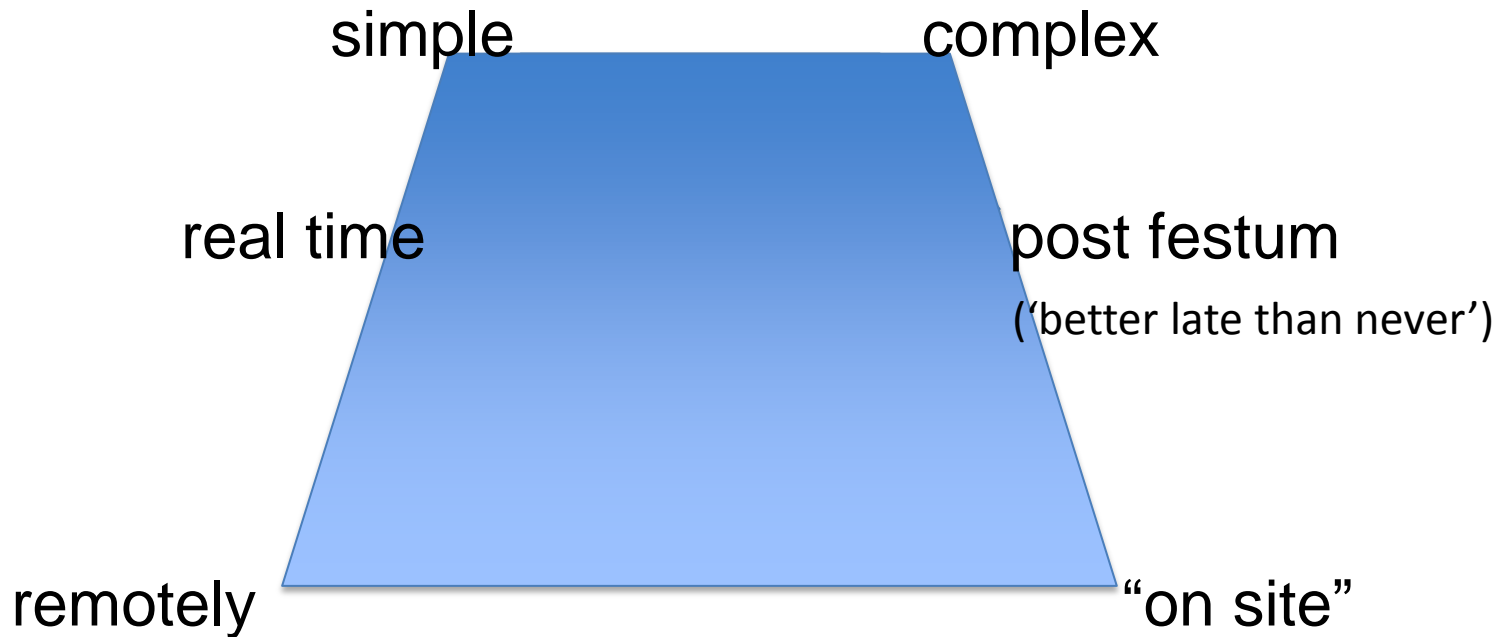
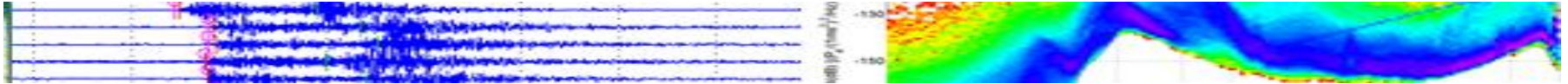
SEISMIC DATA IS COMING

{ YES  
NO

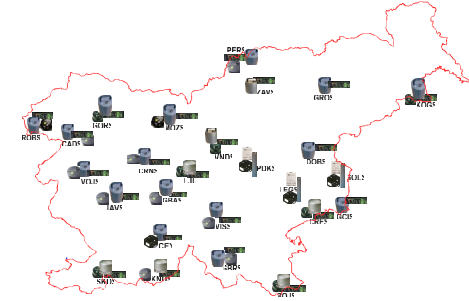
THEY ARE RELIABLE

{ YES  
NO

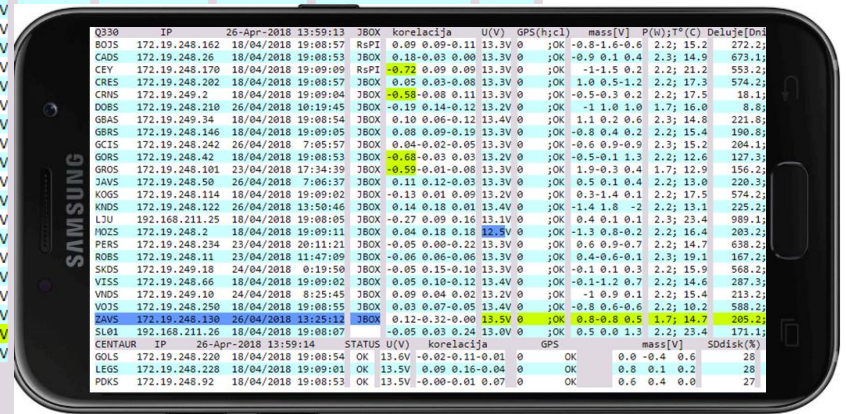
# procedures and tools



# simple SOH monitor

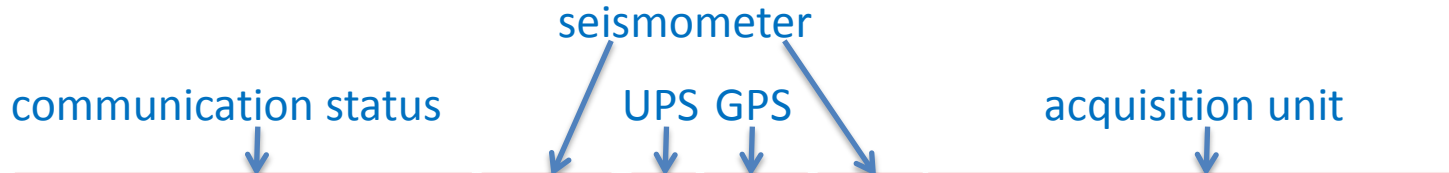


Q330	IP	26-Apr-2018	13:59:13	JBOX	korelacija	U(V)	GPS(h;cl)	mass[V]	P(W);T°(C)	Deluje[Dni(Q;B)]	disk(%)	opozorila
BOJS	172.19.248.162	18/04/2018	19:08:57	RsPI	0.09 0.09-0.11	13.3V	0 ;OK	-0.8-1.6-0.6	2.2; 15.2	272.2;272.2	50.1	
CADS	172.19.248.26	18/04/2018	19:08:53	JBOX	0.18-0.03 0.00	13.3V	0 ;OK	-0.9 0.1 0.4	2.3; 14.9	673.1;87.2	94.9	
CEY	172.19.248.170	18/04/2018	19:09:09	RsPI	-0.72 0.09 0.09	13.3V	0 ;OK	-1-1.5 0.2	2.2; 21.2	553.2;67.1	94.9	
CRÉS	172.19.248.202	18/04/2018	19:08:57	JBOX	0.05 0.03-0.08	13.3V	0 ;OK	1.0 0.5-1.2	2.2; 17.3	574.2;87.2	94.9	
CRNS	172.19.249.2	18/04/2018	19:09:04	JBOX	-0.58 -0.08 0.11	13.3V	0 ;OK	-0.5-0.3 0.2	2.2; 17.5	18.1;87.2	95	
DOBS	172.19.248.210	26/04/2018	10:19:45	JBOX	-0.19 0.14-0.12	13.2V						
GBAS	172.19.249.34	18/04/2018	19:08:54	JBOX	0.10 0.06-0.12	13.4V						
GBRS	172.19.248.146	18/04/2018	19:09:05	JBOX	0.08 0.09-0.19	13.3V						
GCIS	172.19.248.242	26/04/2018	7:05:57	JBOX	0.04-0.02-0.05	13.3V						
GORS	172.19.248.42	18/04/2018	19:08:53	JBOX	-0.68 -0.03 0.03	13.2V						
GROS	172.19.248.101	23/04/2018	17:34:39	JBOX	-0.59 -0.01-0.08	13.3V						
JAVS	172.19.248.50	26/04/2018	7:06:37	JBOX	0.11 0.12-0.03	13.3V						
KOGS	172.19.248.114	18/04/2018	19:09:02	JBOX	-0.13 0.01 0.09	13.2V						
KNDS	172.19.248.122	26/04/2018	13:50:46	JBOX	0.14 0.18 0.01	13.4V						
LJU	192.168.211.25	18/04/2018	19:08:05	JBOX	-0.27 0.09 0.16	13.1V						
MOZS	172.19.248.2	18/04/2018	19:09:11	JBOX	0.04 0.18 0.18	12.5V						
PERS	172.19.248.234	23/04/2018	20:11:21	JBOX	-0.05 0.00-0.22	13.3V						
ROBS	172.19.248.11	23/04/2018	11:47:09	JBOX	-0.06 0.06-0.06	13.3V						
SKDS	172.19.249.18	24/04/2018	0:19:50	JBOX	-0.05 0.15-0.10	13.3V						
VISS	172.19.248.66	18/04/2018	19:09:02	JBOX	0.05 0.10-0.12	13.4V						
VNDS	172.19.249.10	24/04/2018	8:25:45	JBOX	0.09 0.04 0.02	13.2V						
VOJS	172.19.248.250	18/04/2018	19:08:55	JBOX	0.03 0.07-0.05	13.4V						
ZAVS	172.19.248.130	26/04/2018	13:25:12	JBOX	0.12-0.32-0.00	13.5V						
SL01	192.168.211.26	18/04/2018	19:08:07		-0.05 0.03 0.24	13.0V						
CENTAUR	IP	26-Apr-2018	13:59:14	STATUS	U(V)	korelacija						
GOLS	172.19.248.220	18/04/2018	19:08:54	OK	13.6V	-0.02-0.11-0.01						
LEGS	172.19.248.228	18/04/2018	19:09:01	OK	13.5V	0.09 0.16-0.04						
PDKS	172.19.248.92	18/04/2018	19:08:53	OK	13.5V	-0.00-0.01 0.07						





# simple SOH monitor



Q330	IP	28-Dec-2017	09:59:13	JBOX	korelacija	U (V)	GPS (h;cl)	mass [V]	P (W); T° (C)	Deluje [Dni (Q;B)]	disk (%)	opozorila
BOJS	172.19.248.162	22/12/2017	6:31:55	RsPI	0.05-0.01-0.03	13.3V	0	:OK	0.5 0.0-0.8	2.3; 16.4	133.1;133.1	31.8
CADS	172.19.248.26	22/12/2017	6:31:55	JBOX	0.05 0.17 0.09	13.4V	0	:OK	-0.2 0.4 0.8	2.2; 13.5	553.9;454.2	94.0
CEY	172.19.248.170	22/12/2017	6:31:55	RsPI	0.03 0.05-0.09	13.3V	0	:OK	-0.8-0.8-0.1	2.2; 16.5	434.1;434.1	88.9
CRFS	172.19.248.202	22/12/2017	6:31:55	JBOX	0.01 0.02 0.00	13.3V	0	:OK	-0.1-0.5 0.5	2.2; 14.9	455.0;454.2	94.9
CRNS	172.19.249.2	22/12/2017	6:31:55	JBOX	-0.02-0.04 0.04	13.2V	0	:OK	0.5 1.1-1.5	2.2; 14.4	569.0;454.2	94.9
DOBS	172.19.248.210	27/12/2017	8:27:13	JBOX	-0.11 0.05-0.13	13.3V	0	:OK	-0.6 0.9 0.7	1.7; 16.0	75.0;75.0	8.19
GBAS	172.19.249.34	22/12/2017	6:31:55	JBOX	0.23 0.01-0.07	13.4V	0	:OK	0.5 0.1 0.5	2.5; 13.4	102.7;272.1	74.5
GBRS	172.19.248.146	22/12/2017	6:31:55	JBOX	0.21 0.11 0.04	13.3V	0	:OK	-0.6-0.1 0.4	2.2; 13.9	71.6;72.0	11.9
GCIS	172.19.248.242	28/12/2017	8:05:14	JBOX	-0.01 0.03 0.02	13.3V	0	:OK	-0.7 0.1-0.4	2.3; 15.2	84.9;85.0	14.5
GORS	172.19.248.42	22/12/2017	6:31:55	JBOX	-0.07-0.02 0.02	13.1V	0	:OK	-0.7 0.8 0.1	2.1; 12.7	8.1;454.1	94.9
GROS	172.19.248.101	23/12/2017	16:03:44	JBOX	-0.16-0.09 0.01	13.3V	0	:OK	1.9 0.2 0.7	1.7; 11.7	37.0;71.1	8.46
JAVS	172.19.248.50	27/12/2017	21:59:20	JBOX	0.25 0.14 0.06	13.3V	0	:OK	0.2 0.1 0.4	2.2; 11.4	101.1;454.1	90.5
KOGS	172.19.248.114	22/12/2017	6:31:55	JBOX	0.03 0.07-0.04	13.2V	0	:OK	1.2-0.7-0.3	2.2; 16.5	455.0;454.2	94.9
KNDS	172.19.248.122	28/12/2017	8:05:27	JBOX	0.05 0.17 0.16	12.3V	0	:OK	0.8-0.7 1.0	2.1; 12.4	106.0;454.1	94.9
LJU	192.168.211.25	22/12/2017	6:31:55	JBOX	-0.12 0.17 0.05	13.1V	0	:OK	1.2 0.1 1.1	2.2; 18.7	869.9;454.1	94.9
MOZS	172.19.248.2	22/12/2017	6:31:55	JBOX	0.01 0.25 0.20	13.1V	0	:OK	0.5 0.1 0.1	2.2; 12.8	84.1;84.1	94.9
PEBS	172.19.248.234	22/12/2017	6:32:07	JBOX	-0.01 0.02-0.09	13.4V	0	:OK	0.4 0.5-0.6	2.2; 14.7	509.9;445.0	83.3
ROBS	172.19.248.11	22/12/2017	6:31:55	JBOX	0.27 0.05-0.11	13.2V	0	:OK	0.7-0.6-0.9	2.3; 13.9	48.0;48.0	7.88
SKDS	172.19.249.18	28/12/2017	7:19:46	JBOX	0.06 0.04-0.05	13.3V	0	:OK	-1.6-0.9 0.0	2.2; 13.7	449.1;449.1	94.9
VISS	172.19.248.66	22/12/2017	6:31:55	JBOX	0.06-0.03-0.06	13.4V	0	:OK	0.4-1.2 0.8	2.2; 13.3	168.1;454.1	94.9
VNDS	172.19.249.10	27/12/2017	17:55:17	JBOX	0.22-0.01 0.02	13.2V	0	:OK	-1.1 0.4 0.3	2.1; 13.9	94.1;139.0	22.5
VOJS	172.19.248.250	22/12/2017	6:31:55	JBOX	0.16 0.04 0.02	13.3V	0	:OK	-0.6 0.5-0.5	2.2; 10.2	469.0;454.1	75.9
ZAVS	172.19.248.130	28/12/2017	8:06:41	JBOX	0.08-0.02-0.01	13.4V	0	:OK	0.9-0.8 0.5	1.7; 11.9	86.2;90.0	9.57
SL01	192.168.211.26	22/12/2017	6:31:55	JBOX	0.08-0.03 0.15	13.1V	0	:OK	1.2 0.1 0.5	2.2; 18.7	51.9;51.9	44.4
CENTAUR	IP	28-Dec-2017	09:59:14	STATUS	U (V)	korelacija	GPS	mass [V]	SDdisk (%)	JBOX		
GOLS	172.19.248.220	28/12/2017	7:44:52	OK	13.6V	-0.14-0.03 0.04	0	0.0 -0.4 0.6	0	RsPI		
LEGS	172.19.248.228	22/12/2017	6:31:55	OK	13.5V	-0.05 0.14-0.02	0	0.8 0.1 0.2	0	RsPI		
PKDS	172.19.248.92	22/12/2017	6:31:55	OK	13.5V	-0.06-0.04 0.03	0	0.6 0.4 0.0	0	RsPI		

UPS q330:11.951 V od:2017/12/27 19:23

# Example: 3 events

communication breakdown between the central and acquisition unit

Q330	IP	28-Dec-2017	09:59:13	JBOX	korelacija	U (V)	GPS (h;cl)	mass[V]	P(W);T° (C)	Deluje[Dni(Q;B)]	disk(%)	opozorila
BOJS	172.19.248.162	22/12/2017	6:31:55	RsPI	0.05-0.01 0.03	13.3V	0	;OK 0.3 0.0-0.6	2.3; 16.4	153.1;153.1	31.6	
CHDS	172.19.248.26	22/12/2017	6:31:55	JBOX	0.05 0.17 0.09	13.4V	0	;OK -0.2 0.4 0.8	2.2; 13.5	553.9;454.2	94.0	
CEY	172.19.248.170	22/12/2017	6:31:55	RsPI	0.03 0.05-0.09	13.3V	0	;OK -0.8-0.8-0.1	2.2; 16.5	434.1;434.1	88.9	
CEES	172.19.248.202	22/12/2017	6:31:55	JBOX	0.01 0.02 0.00	13.3V	0	;OK -0.1-0.5 0.5	2.2; 14.9	455.0;454.2	94.9	
CESE	172.19.248.202	22/12/2017	6:31:55	JBOX	-0.02-0.04 0.04	13.2V	0	;OK 0.5 1.1-1.5	2.2; 14.4	569.0;454.2	94.9	
DOBS	172.19.248.210	27/12/2017	8:27:13	JBOX	-0.11 0.05-0.13	13.3V	0	;OK -0.6 0.9 0.7	1.7; 16.0	75.0;75.0	8.19	
GBRS	172.19.248.166	22/12/2017	6:31:55	JBOX	0.23 0.01-0.07	13.4V	0	;OK 0.5 0.1 0.5	2.5; 13.4	102.7;272.1	74.5	
GBRS	172.19.248.146	22/12/2017	6:31:55	JBOX	0.21 0.11 0.04	13.3V	0	;OK -0.6-0.1 0.4	2.2; 13.9	71.6;72.0	11.9	
GCLIS	172.19.248.242	28/12/2017	8:05:14	JBOX	-0.01 0.03 0.02	13.3V	0	;OK -0.7 0.1-0.4	2.3; 15.2	84.9;85.0	14.5	
GORS	172.19.248.42	22/12/2017	6:31:55	JBOX	-0.07-0.02 0.02	13.1V	0	;OK -0.7 0.8 0.1	2.1; 12.7	8.1;454.1	94.9	
GROS	172.19.248.101	23/12/2017	16:03:44	JBOX	-0.16-0.09 0.01	13.3V	0	;OK 1.9 0.2 0.7	1.7; 11.7	37.0;71.1	8.46	
JAVS	172.19.248.50	27/12/2017	21:59:20	JBOX	0.25 0.14 0.06	13.3V	0	;OK 0.2 0.1 0.4	2.2; 11.4	101.1;454.1	90.5	
KOGS	172.19.248.114	22/12/2017	6:31:55	JBOX	0.03 0.07-0.04	13.3V	0	;OK 1.2-0.7-0.3	2.2; 16.5	455.0;454.2	94.9	
KNDS	172.19.248.122	28/12/2017	8:05:27	JBOX	0.05 0.17 0.11	12.3V	0	;OK 0.8-0.7 1.0	2.1; 12.4	106.0;454.1	94.9	UPS g330:11.951 V 2017/12/27 19:23
LJU	192.168.211.25	22/12/2017	6:31:55	JBOX	-0.12 0.17 0.05	13.1V	0	;OK 1.2 0.1 1.1	2.2; 18.7	869.9;454.1	94.9	
MOBS	172.19.248.202	22/12/2017	6:31:55	JBOX	0.01 0.25 0.20	16.1V	0	;OK 0.5 0.1 0.1	2.2; 12.8	84.1;84.1	94.9	
PEBS	172.19.248.234	22/12/2017	6:32:07	JBOX	0.01 0.02-0.09	13.4V	0	;OK 0.4 0.5-0.6	2.2; 14.7	509.9;445.0	83.3	
ROBS	172.19.248.111	22/12/2017	6:31:55	JBOX	0.27 0.05-0.11	13.2V	0	;OK 0.7-0.6-0.9	2.3; 13.9	48.0;48.0	7.88	
SKPS	172.19.249.18	28/12/2017	7:19:46	JBOX	0.06 0.04-0.05	13.3V	0	;OK -1.6-0.9 0.0	2.2; 13.7	449.1;449.1	94.9	
VIS	172.19.248.66	22/12/2017	6:31:55	JBOX	0.06-0.03-0.06	13.4V	0	;OK 0.4-1.2 0.8	2.2; 13.3	168.1;454.1	94.9	
VND	172.19.249.10	27/12/2017	17:55:17	JBOX	0.22-0.01 0.02	13.2V	0	;OK -1.1 0.4 0.3	2.1; 13.9	94.1;139.0	22.5	
VOJS	172.19.248.250	22/12/2017	6:31:55	JBOX	0.16 0.04 0.02	13.3V	0	;OK -0.6 0.5-0.5	2.2; 10.2	469.0;454.1	75.9	
ZAVS	172.19.248.130	28/12/2017	8:06:41	JBOX	0.08-0.02-0.01	13.4V	0	;OK 0.9-0.8 0.5	1.7; 11.9	86.2;90.0	9.57	
SLO	192.168.211.26	22/12/2017	6:31:55	JBOX	0.08-0.03 0.15	13.1V	0	;OK 1.2 0.1 0.5	2.2; 18.7	51.9;51.9	44.4	
CEN/AUR	IP	28-Dec-2017	09:59:14	STATUS	U (V)	korelacija	GPS	mass[V]	SDdisk(%)	JBOX		
GOL	172.19.248.220	28/12/2017	7:44:52	OK	13.6V	-0.14-0.03 0.04	0	OK 0.0 -0.4 0.6	0	RsPI		
LEG	172.19.248.228	22/12/2017	6:31:55	OK	13.5V	-0.05 0.14-0.02	0	OK 0.8 0.1 0.2	0	RsPI		
PKS	172.19.248.92	22/12/2017	6:31:55	OK	13.5V	-0.06-0.04 0.03	0	OK 0.6 0.4 0.0	0	RsPI		

communication breakdown between the central and seismic stations

no 230VAC power



# simple SOH monitor

Seismic Network of the Republic of Slovenia

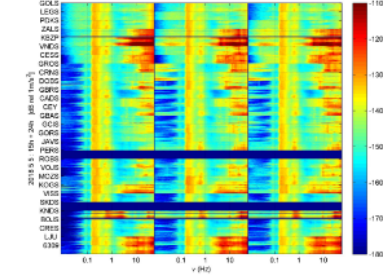
temporary and other locations

accelerograph

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0938      EP      84*may-2018 17:14:19 amon bazalacija u|v| G3|d|c|l|      nact|v|      #|l|t|c|l|      naluja|ml|l|ml|      dist|l|l|      opozovita
0939 172.18.248.162 84/85/2018 8:18:25 merr 8.85 8.85+8.1 13.5v 0 100 8.8 8.8 8.5 2.2; 15.8 282.4230.4 51.4
0940 172.18.248.216 84/85/2018 8:20:14 amon 8.88 8.82+8.88 13.5v 0 100 8.8 8.8 8.5 2.2; 15.8 483.2477.9 84.8
0941 172.18.248.178 84/85/2018 16:50:59 merr 8.81 8.81+8.8 13.5v 0 100 8.8 8.8 8.5 2.2; 21.7 528.4570.2 84.8
0942 172.18.248.282 84/85/2018 20:48:48 amon 8.88 8.81+8.88 13.5v 0 100 8.8 8.8 8.5 2.2; 18.3 584.4577.5 84.8
0943 172.18.248.218 84/85/2018 8:21:48 amon 8.88 8.81+8.8 13.5v 0 100 8.8 8.8 8.5 2.2; 18.3 282.4577.5 84.8
0944 172.18.248.218 84/85/2018 8:18:55 amon 8.87 8.81+8.8 13.5v 0 100 8.8 8.8 8.5 2.2; 18.3 18.8122.8 21.4
0945 172.18.248.14 84/85/2018 20:16:15 amon 8.19 8.19+8.18 13.4v 0 100 8.8 8.2 8.4 2.3; 15.8 282.4577.4 84.8
0946 172.18.248.42 84/85/2018 8:18:25 amon 8.87 8.81+8.8 13.5v 0 100 8.8 8.8 8.5 2.2; 18.4 281.3248.9 32.4
0947 172.18.248.242 84/85/2018 7:06:49 amon 8.88 8.81+8.8 13.4v 0 100 8.4 8.8 8.8 2.3; 14.8 214.3248.3 34.5
0948 172.18.248.42 84/85/2018 7:24:23 amon 8.85 8.81+8.8 13.5v 0 100 8.8 8.8 8.5 2.2; 18.4 157.4577.9 84.8
0949 172.18.248.181 84/85/2018 13:04:13 amon 8.22 8.22+8.8 13.5v 0 100 2.4 8.3 8.5 1.7; 14.1 144.3248.4 23.1
0950 172.18.248.42 84/85/2018 8:18:25 amon 8.85 8.81+8.8 13.5v 0 100 8.8 8.8 8.5 2.2; 18.4 281.4577.5 84.8
0951 172.18.248.114 84/85/2018 8:28:24 amon 8.18 8.82 8.81 13.2v 0 100 8.8 8.5 8.2 2.2; 18.4 584.857.4 85
0952 172.18.248.122 84/85/2018 17:11:24 amon 8.28 8.83 8.82 13.4v 0 100 8.5 1.8 8.8 2.2; 14.1 285.857.9 84.8
0953 182.188.211.25 84/85/2018 8:57:32 amon 8.88 8.84 8.8 13.5v 0 100 8.8 8.1 8.1 2.2; 24.8 888.2187.9 84.8
0954 172.18.248.2 84/85/2018 15:18:37 amon 8.17 8.18 8.16 13.0v 0 100 8.3 8.8 8.2 2.2; 17.4 213.4213.4 84.8
0955 172.18.248.228 84/85/2018 12:04:57 amon 8.88 8.88 8.88 13.5v 0 100 8.8 8.8 8.8 2.2; 16.9 483.4577.8 84.8
0956 172.18.248.11 84/85/2018 8:28:11 amon 8.85 8.81+8.8 13.2v 0 100 8.8 8.8 8.8 2.3; 18.8 177.8177.3 28.7
0957 172.18.248.11 84/85/2018 8:28:11 amon 8.88 8.88 8.88 13.5v 0 100 8.8 8.8 8.8 2.2; 16.9 285.4577.5 84.8
0958 172.18.248.44 84/85/2018 8:28:23 amon 8.84 8.84+8.8 13.4v 0 100 8.8 8.1 8.7 2.2; 15.7 287.4577.9 84.8
0959 172.18.248.18 84/85/2018 12:22:15 amon 8.16 8.84 8.8 13.2v 0 100 8.8 8.8 8.1 2.2; 14.2 283.3248.3 84.2
0960 172.18.248.258 84/85/2018 15:15:18 amon 8.85 8.85+8.8 13.4v 0 100 8.8 8.8 8.5 2.2; 15.4 588.3187.8 84.8
0961 172.18.248.138 84/85/2018 15:08:28 amon 8.88 8.82+8.8 13.5v 0 100 8.8 8.8 8.5 1.7; 15.8 215.3248.3 28.2
0962 182.188.211.24 84/85/2018 8:57:34 amon 8.88 8.81+8.8 13.5v 0 100 8.8 8.8 8.8 2.2; 24.1 181.3181.2 34.8
0963 172.18.248.228 84/85/2018 12:04:57 am 13.5v 8.88 8.88+8.85 8 00 8.8 8.1 8.2 31 amon
0964 172.18.248.82 84/85/2018 12:04:57 am 13.5v 8.82 8.83 8.81 8 00 8.8 8.4 8.8 38 merr
```

```
0938      EP      84*may-2018 17:14:19 amon bazalacija G3      nact|v|      #|l|t|c|l|      naluja|ml|l|ml|      dist|l|l|      opozovita
0939 172.18.248.178 84/85/2018 16:50:59 merr 8.81 8.81+8.8 13.5v 0 100 8.8 8.8 8.5 2.2; 21.7 528.4570.2 84.8
0940 172.18.248.42 84/85/2018 8:18:25 amon 8.87 8.81+8.8 13.5v 0 100 8.8 8.8 8.5 2.2; 18.4 281.3248.9 32.4
0941 172.18.248.218 84/85/2018 8:21:48 amon 8.88 8.81+8.8 13.5v 0 100 8.8 8.8 8.5 2.2; 18.3 282.4577.5 84.8
0942 172.18.248.11 84/85/2018 8:28:11 amon 8.85 8.81+8.8 13.2v 0 100 8.8 8.8 8.8 2.3; 18.8 177.8177.3 28.7
0943 172.18.248.11 84/85/2018 8:28:11 amon 8.88 8.88 8.88 13.5v 0 100 8.8 8.8 8.8 2.2; 16.9 285.4577.5 84.8
0944 172.18.248.44 84/85/2018 8:28:23 amon 8.84 8.84+8.8 13.4v 0 100 8.8 8.1 8.7 2.2; 15.7 287.4577.9 84.8
0945 172.18.248.18 84/85/2018 12:22:15 amon 8.16 8.84 8.8 13.2v 0 100 8.8 8.8 8.1 2.2; 14.2 283.3248.3 84.2
0946 172.18.248.258 84/85/2018 15:15:18 amon 8.85 8.85+8.8 13.4v 0 100 8.8 8.8 8.5 2.2; 15.4 588.3187.8 84.8
0947 172.18.248.138 84/85/2018 15:08:28 amon 8.88 8.82+8.8 13.5v 0 100 8.8 8.8 8.5 1.7; 15.8 215.3248.3 28.2
0948 182.188.211.24 84/85/2018 8:57:34 amon 8.88 8.81+8.8 13.5v 0 100 8.8 8.8 8.8 2.2; 24.1 181.3181.2 34.8
0949 172.18.248.228 84/85/2018 12:04:57 am 13.5v 8.88 8.88+8.85 8 00 8.8 8.1 8.2 31 amon
0950 172.18.248.82 84/85/2018 12:04:57 am 13.5v 8.82 8.83 8.81 8 00 8.8 8.4 8.8 38 merr
```

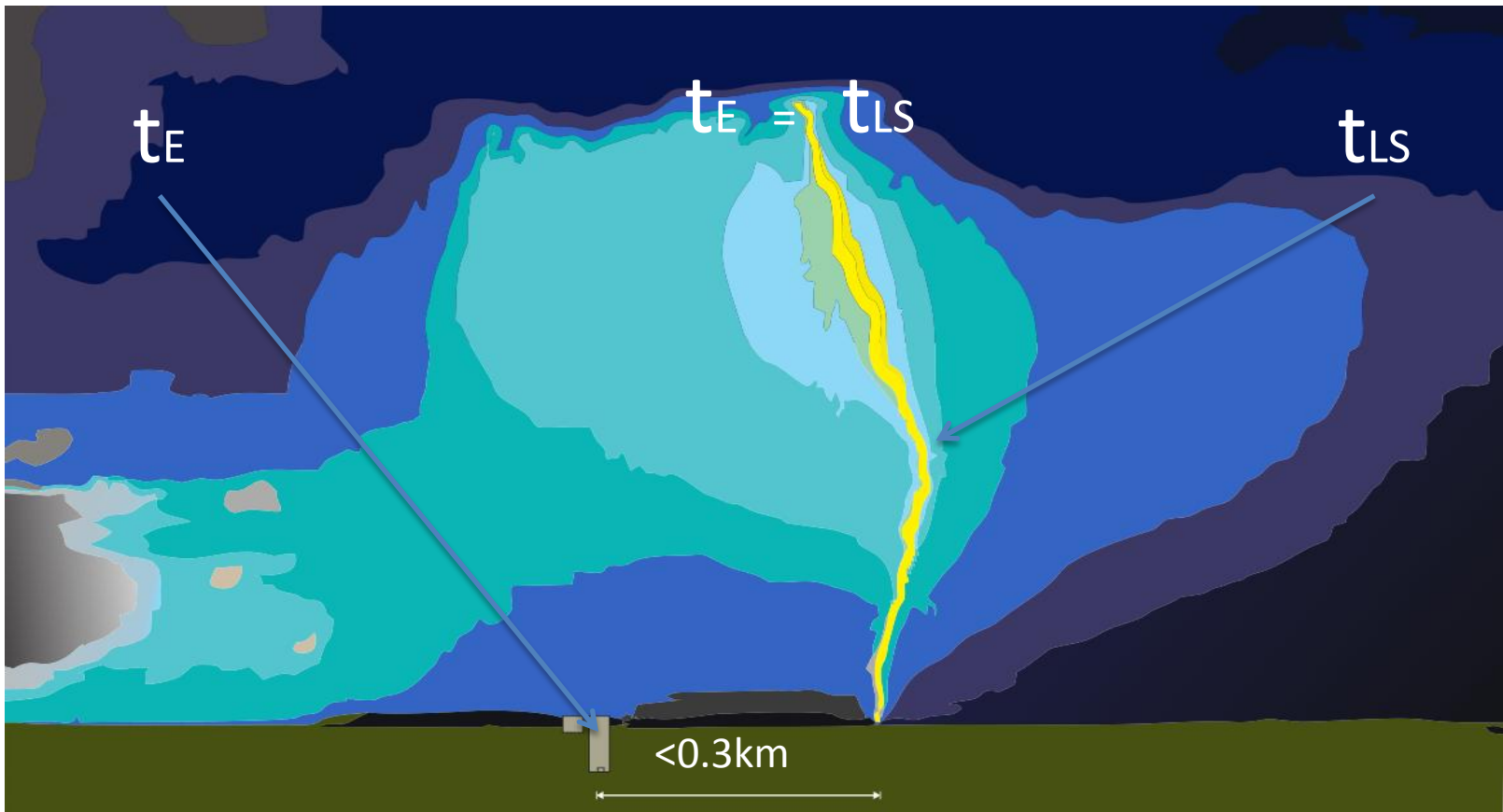
```
podatki stve iz Golovca
stve nazvo 84*may-2018 12:21:35 G3      u|v|      #|l|t|c|l|      naluja|ml|l|ml|      dist|l|l|      opozovita
0938 18245 84*may-2018 8:41:48 00 L 11.4 28.7 48 8
0939 18111 84*may-2018 8:41:48 00 8 13.4 28.7 48 8
0940 18114 84*may-2018 8:41:12 00 8 13.4 21.2 48 8
0941 18118 84*may-2018 8:41:12 00 8 13.4 18.2 48 8
0942 18120 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0943 18122 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0944 18124 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0945 18126 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0946 18128 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0947 18130 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0948 18132 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0949 18134 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0950 18136 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0951 18138 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0952 18140 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0953 18142 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0954 18144 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0955 18146 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0956 18148 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0957 18150 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0958 18152 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0959 18154 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0960 18156 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0961 18158 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0962 18160 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0963 18162 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0964 18164 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0965 18166 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0966 18168 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0967 18170 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0968 18172 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0969 18174 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0970 18176 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0971 18178 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0972 18180 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0973 18182 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0974 18184 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0975 18186 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0976 18188 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0977 18190 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0978 18192 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0979 18194 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0980 18196 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0981 18198 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0982 18200 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0983 18202 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0984 18204 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0985 18206 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0986 18208 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0987 18210 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0988 18212 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0989 18214 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0990 18216 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0991 18218 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0992 18220 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0993 18222 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0994 18224 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0995 18226 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0996 18228 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0997 18230 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0998 18232 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
0999 18234 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
1000 18236 84*may-2018 8:41:12 00 8 13.4 22.2 48 8
```



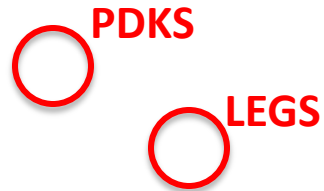
# EXAMPLE: lightning strike

Event:

- equipment failure
- communication failure



# EXAMPLE: lightning strike



# lightning strikes (LEGS) : 2017-06-25

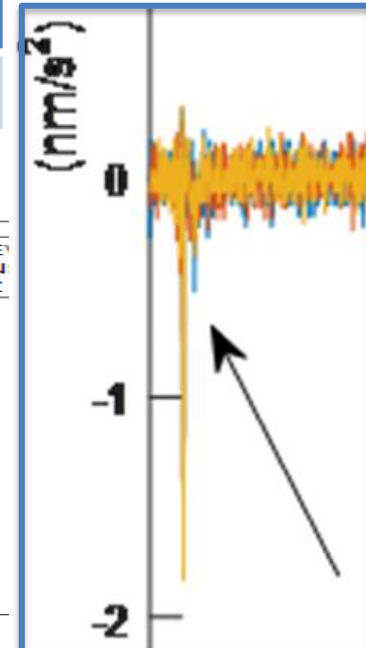
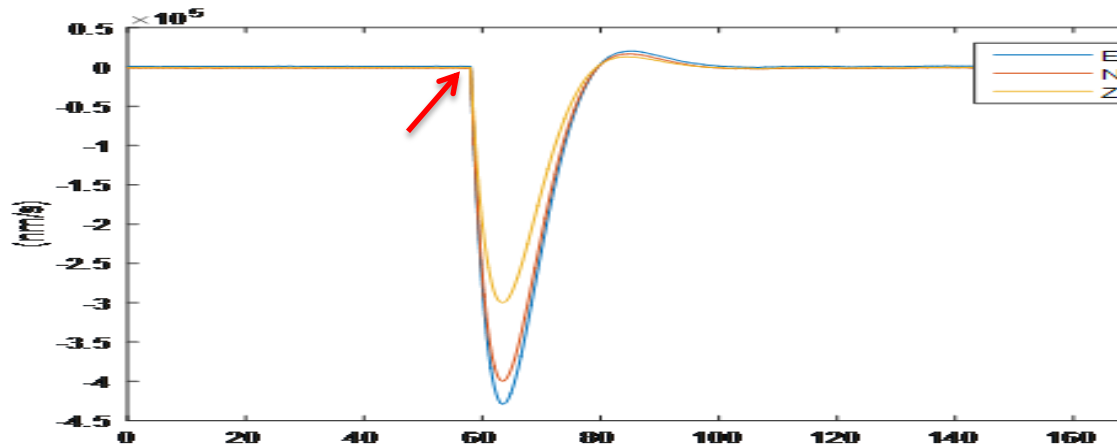
Time (UTC)	Distance	Description
11:41	0.14 km	modem failure
16:38	0.26 km	GPS antenna failure



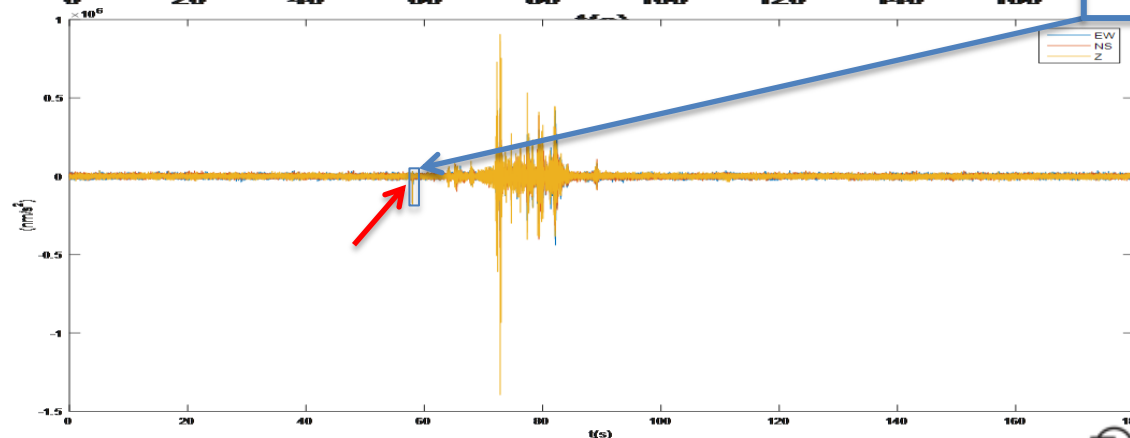
# lightning strike (PDKS) : 2017-09-16

Time (UTC)	Distance	Description
18:17:58,0	5 km	pulse (seismometer)

SEISMOMETER



ACCELEROMETER



after such an event, the relay remains open



ARSO POTRESI

# Correlation coefficients

(measure linear dependence between components)

Q330	IP	28-Dec-2017	09:59:13	JBOX	korelacija	U (V)	GPS (h;cl)	masa[V]	P(W);T° (C)	Deluje[Dni(Q;B)]	disk(%)	c
BOJS	172.19.248.162	22/12/2017	6:31:55	RsPI	0.05-0.02-0.03	13.3V	0 ;OK	0.3 0.0-0.6	2.3; 16.4	153.1;153.1	31.6	
CADS	172.19.248.26	22/12/2017	6:31:55	JBOX	0.05 0.17 0.09	13.4V	0 ;OK	-0.2 0.4 0.8	2.2; 13.5	553.9;454.2	94.0	
CEY	172.19.248.170	22/12/2017	6:31:55	RsPI	0.03 0.05-0.09	13.3V	0 ;OK	-0.8-0.8-0.1	2.2; 16.5	434.1;434.1	88.9	

CMG-40TB & LIGHTENING



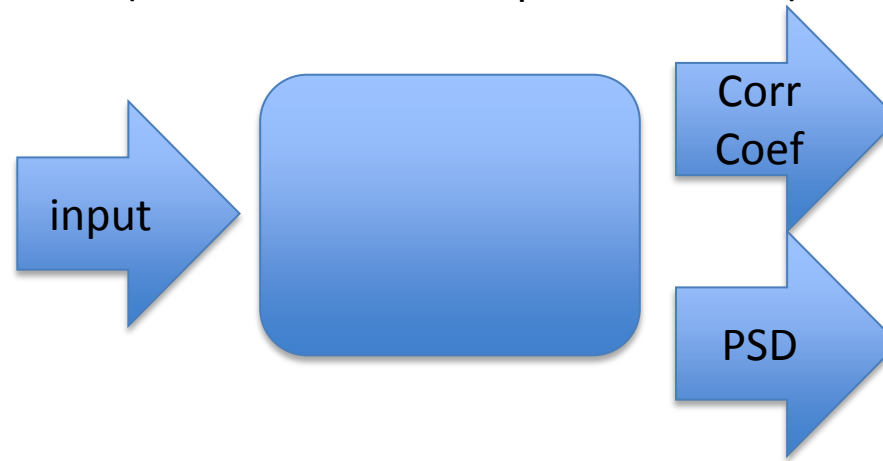
Q730 CONNECTOR





# CorrCoeff & PSD

(calculated for each previous hour)



## *Inputs:*

- **seismic data** with a length of one hour

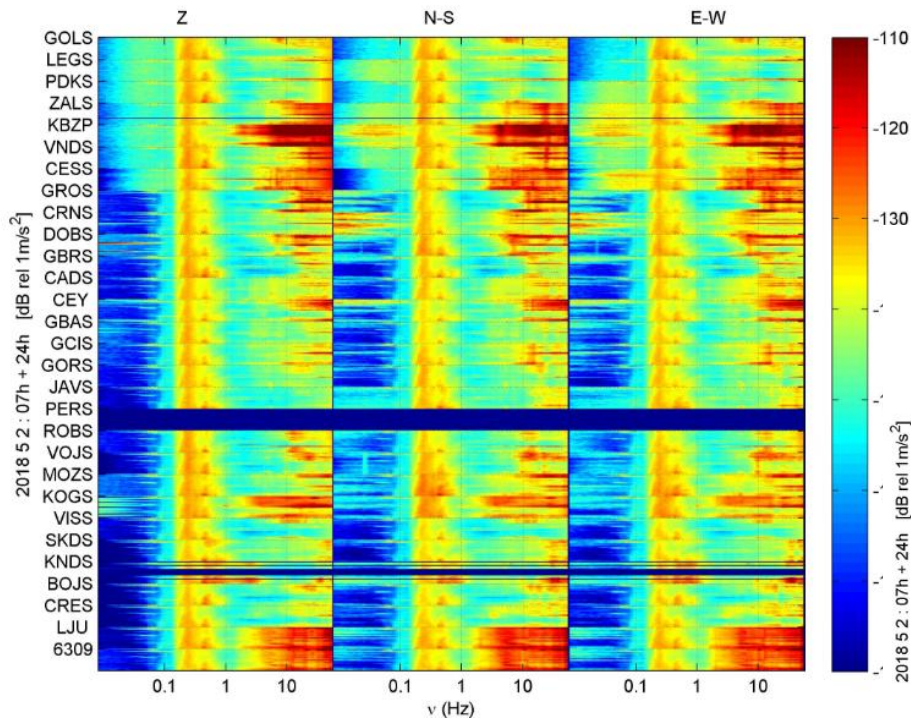
## *Outputs:*

- **Correlation Coefficients** (CorrCoef) are calculated between EW, NS and Z components of seismometer
- **Power Spectral Density estimates** (PSD) are calculated for all seismic inputs (Seismometer, accelerometer)

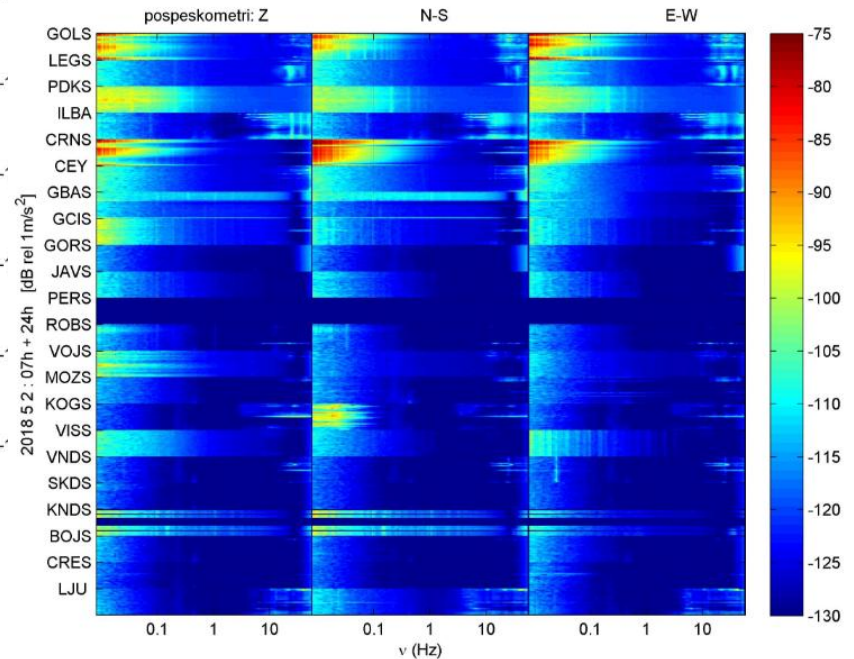
# PSD

(last 24 hours - simple SOH monitor)

## SEISMOMETER



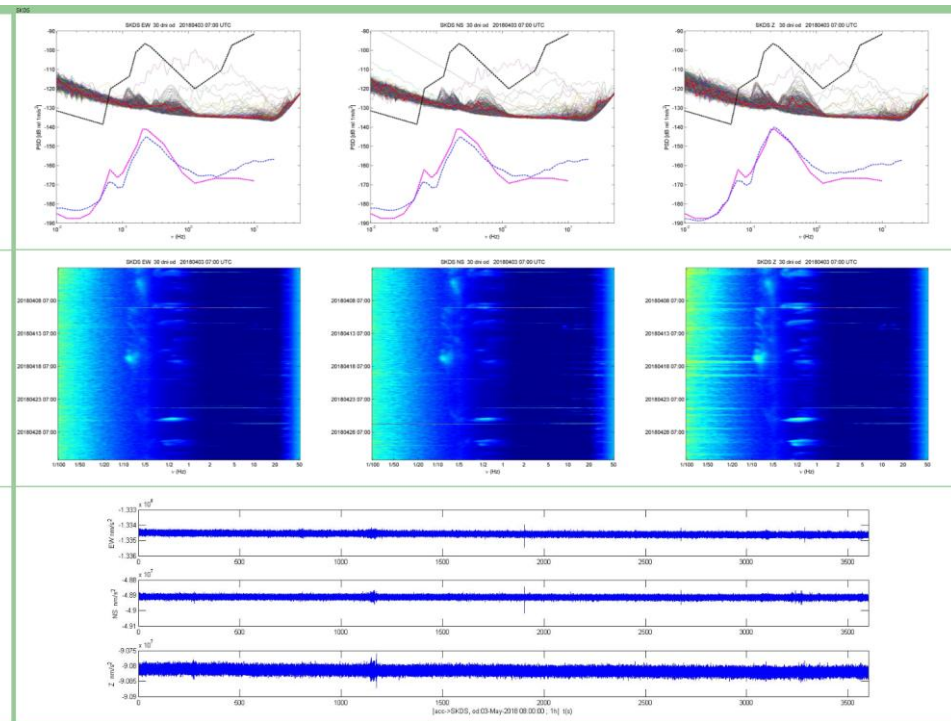
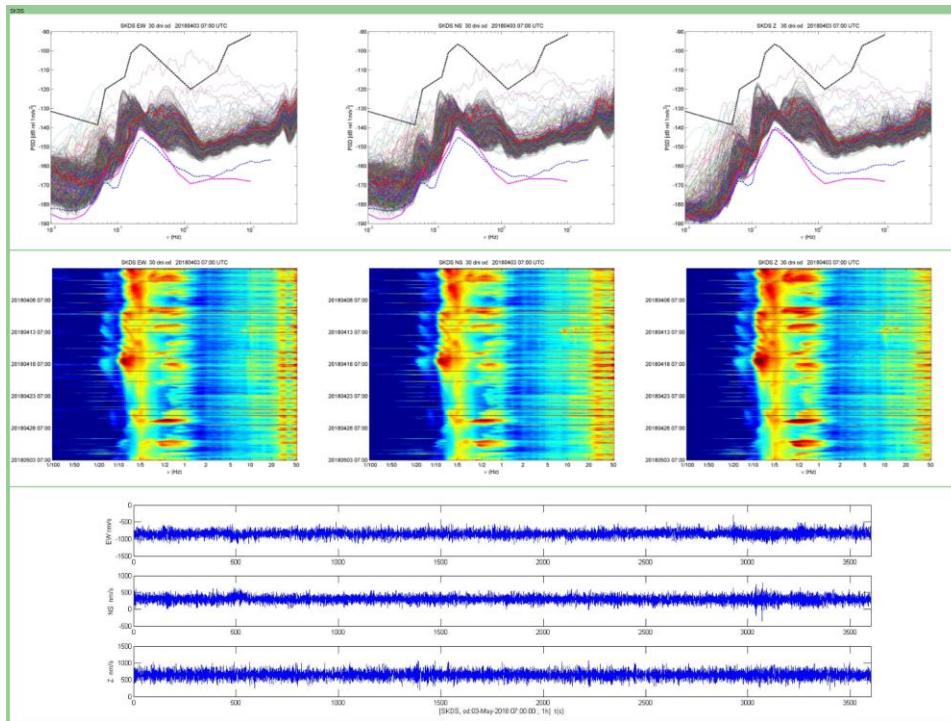
## ACCELEROMETER



# PSD monitor – last 30 days

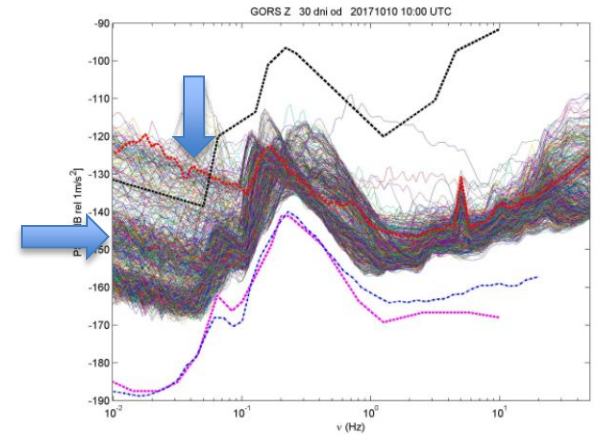
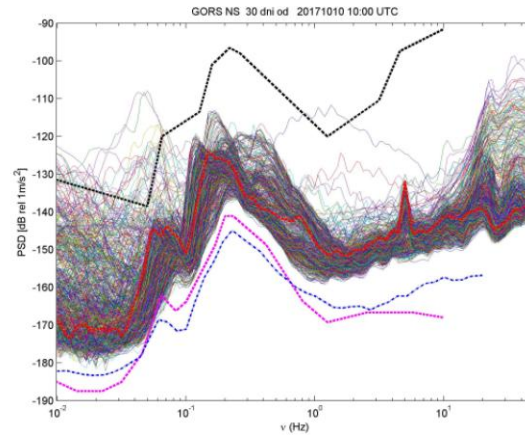
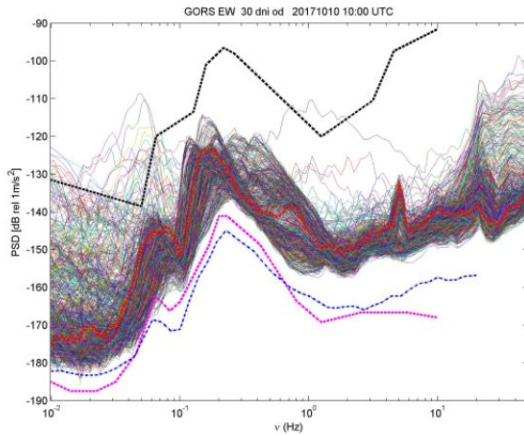
## SEISMOMETER

## ACCELEROMETER

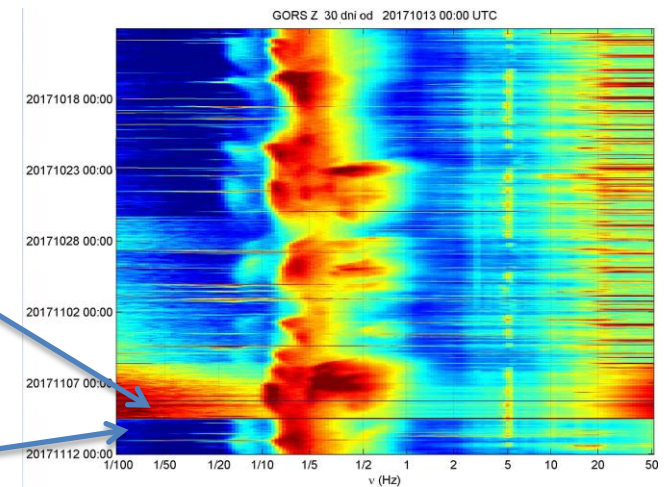


# PSD monitor- We Liked

to detect (atypical) errors



CMG-3T seismometers: an abnormally increased instrumental noise at one component

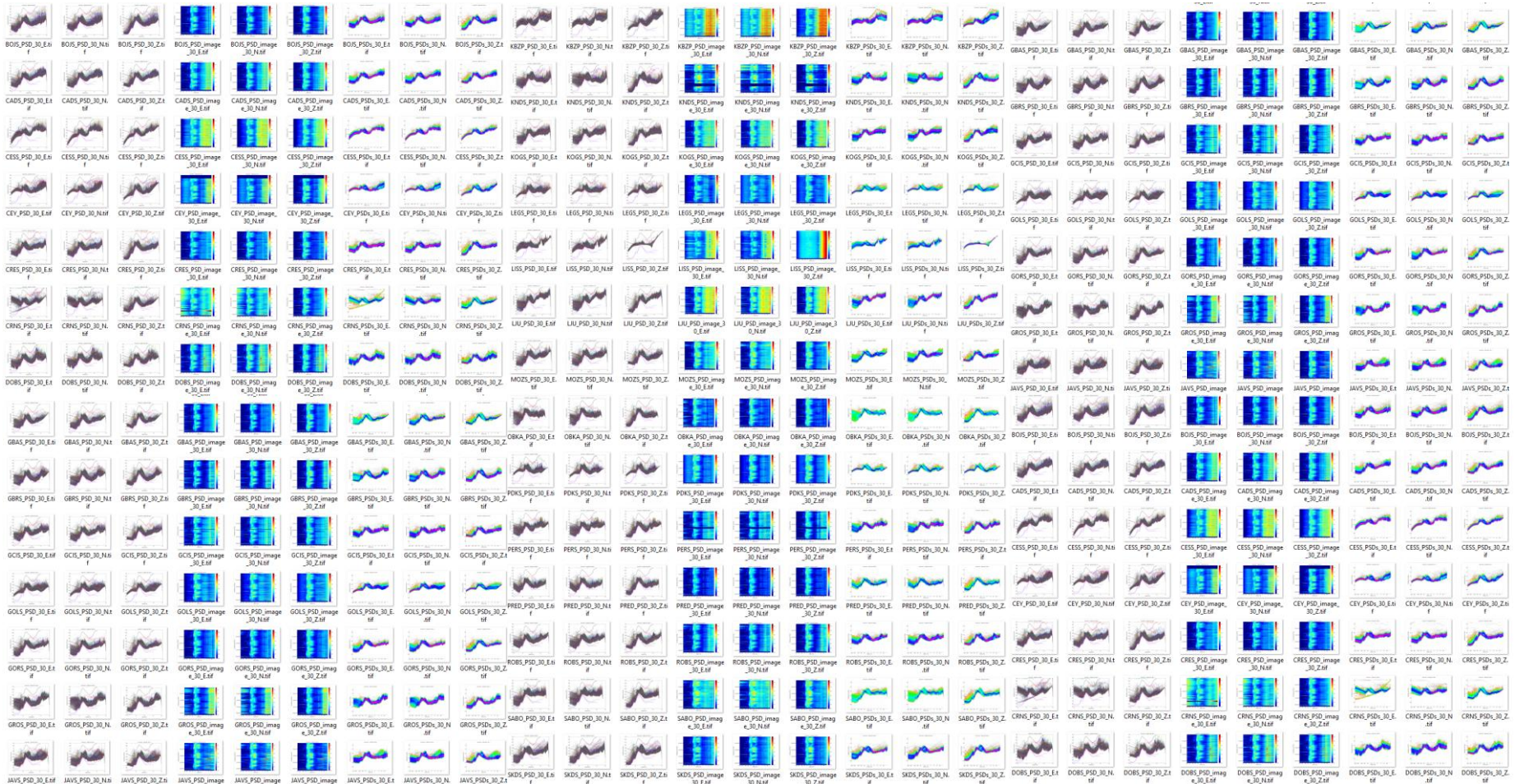


Solution (often but not always): lock / unlock



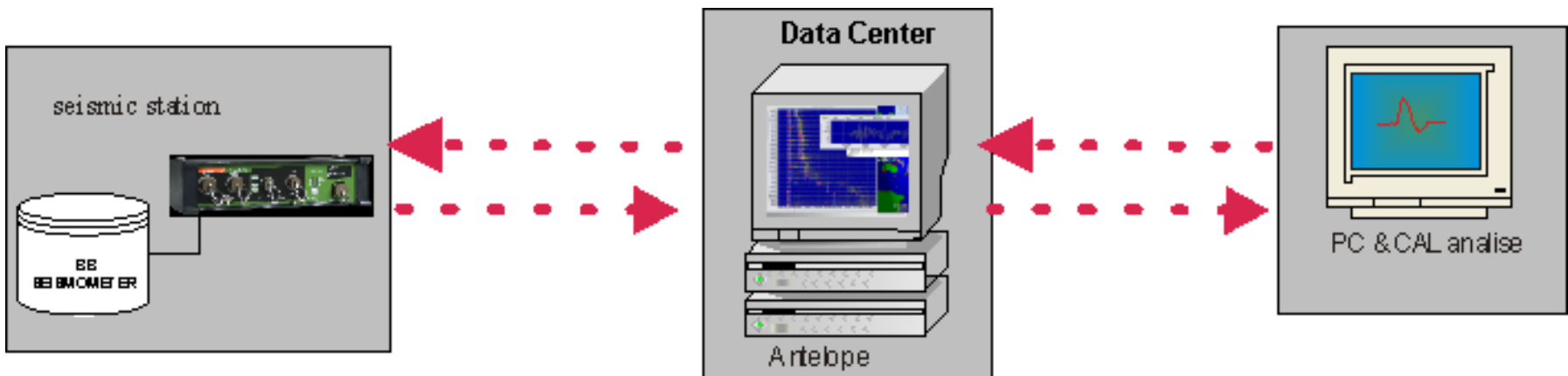
# PSD monitor- We Disliked

minor errors can be overlooked



# USE OF TEST (calibration) SIGNALS

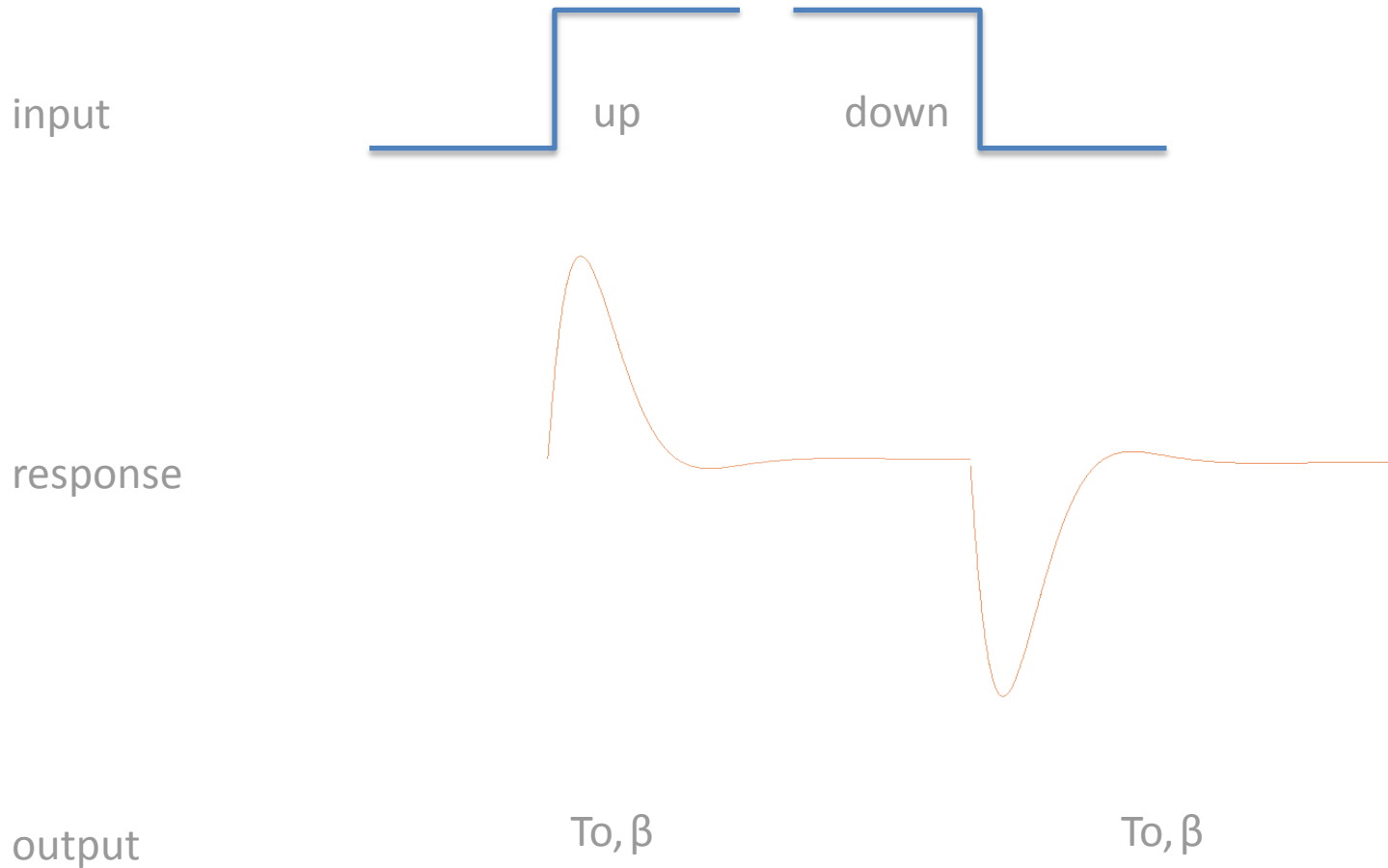
built into the acquisition units



The start of the process is on demand,  
everything else is done by automation,  
including the analysis of the response



# TEST SIGNAL - STEP



# STEP- We Liked

we can detect errors in the Host Box (STS-2)

## "OK Host Box"

U:	↑	To[s]:	119.7	;	β:	0.7098	;
U:	↓	To[s]:	119.7	;	β:	0.7103	;
V:	↑	To[s]:	120.6	;	β:	0.7085	;
V:	↓	To[s]:	120.7	;	β:	0.7085	;
W:	↑	To[s]:	120.6	;	β:	0.7084	;
W:	↓	To[s]:	120.7	;	β:	0.7086	;

## "defective Host Box"

U:	↑	To[s]:	114.5	;	β:	0.6745	;
U:	↓	To[s]:	119.9	;	β:	0.7123	;
V:	↑	To[s]:	119.5	;	β:	0.7113	;
V:	↓	To[s]:	119.8	;	β:	0.7113	;
W:	↑	To[s]:	119.2	;	β:	0.7045	;
W:	↓	To[s]:	120.6	;	β:	0.7116	;

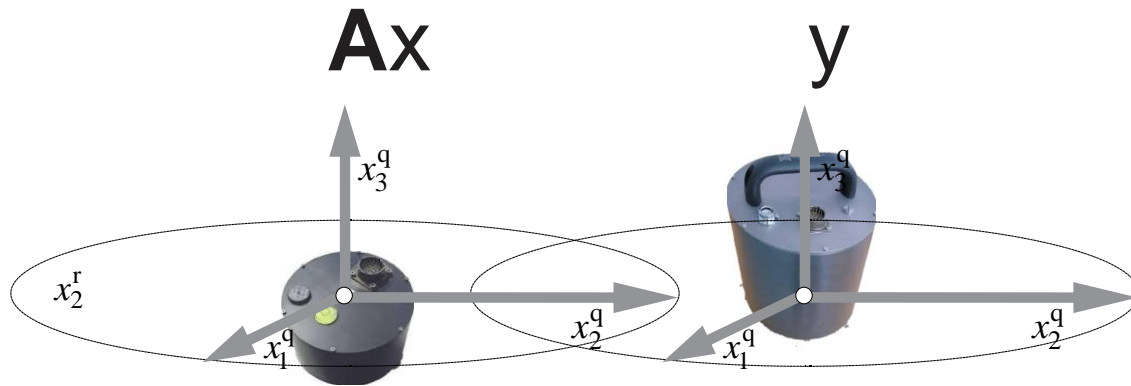
-the problem is humidity

-3/5 defective HOST BOX were identified

# STEP- We Disliked

- some critical errors can be overlooked (e.g. cable failure)
- there are no seismic data at the time of the test

# quality control of seismometer and accelerometer



**A** - the transformation matrix that maps the detection of accelerometer into the space of seismometer detection

Estimated parameters from the transformation matrix **A**:

- amplitude correction factors
- orientation misalignment
- ...

# QC example: STS-2, EpiSensor

regional earthquakes

SKDS

Date	amplitude correction			$\alpha$
	EW	NS	Z	
2016-08-24	0.99	0.99	0.99	-0.3°
2016-10-26	0.99	0.99	0.99	-0.3°
2016-10-30	0.99	0.99	0.99	-0.3°
2017-01-18	0.99	0.99	0.99	-0.3°



# QC example: STS-2, EpiSensor

regional earthquakes

BOJS

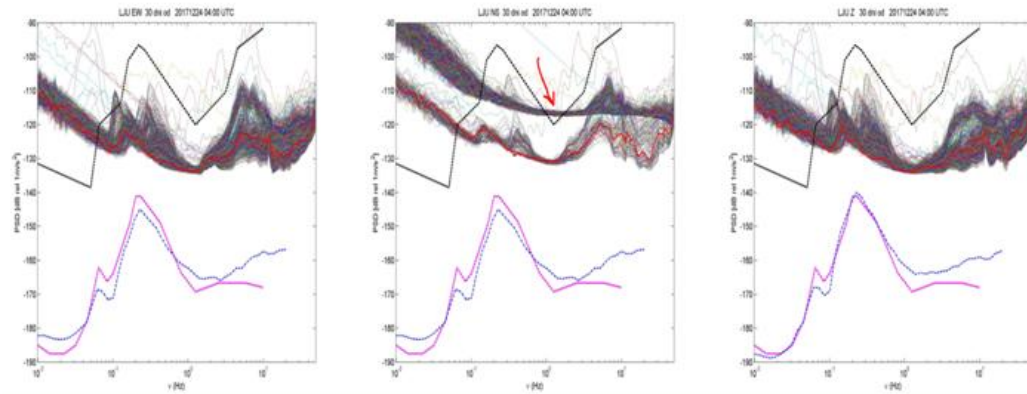
Date	amplitude correction			$\alpha$
	EW	NS	Z	
2016-08-24	0.98	0.99	0.99	3.0°
2016-10-26	<b>0.57</b>	0.98	0.99	<del>5.1°</del>
2016-10-30	0.98	0.99	0.99	<b>11.4°</b>
2017-01-18	0.98	0.99	0.99	-1.6°





# QC example: STS-2, EpiSensor (LJU)

## local earthquake - conditional suitable

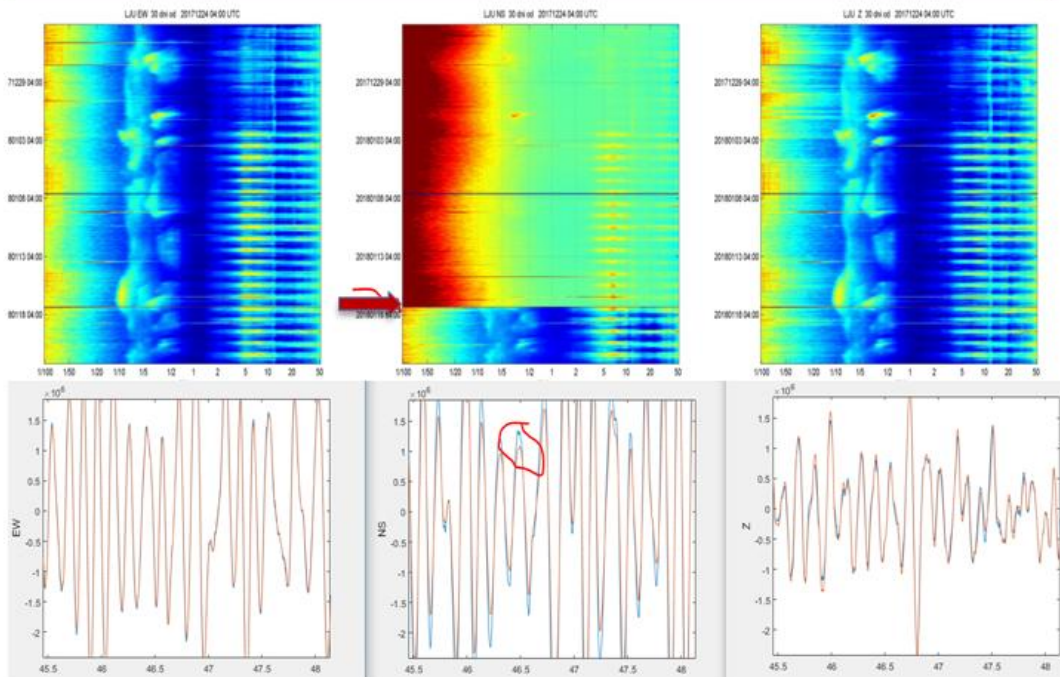


Date	$M_w$	LJU amplitude correction			$\alpha$
		EW	NS	Z	
2018-01-17	3.5	1.00	1.25	1.00	$0.3^\circ$

NS component of EpiSensor:

- must be multiplied by 1.25
- PSD was unusual high.

Action: off/on the accelerometer



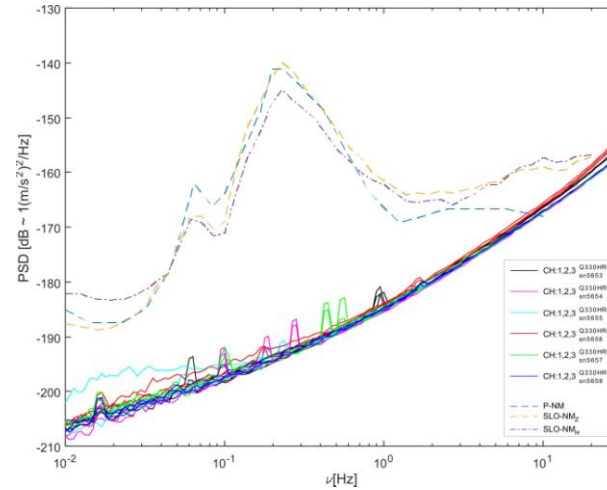
## QC - We Liked

- a large number of seismic stations data can be processed precisely in a relatively short time

## QC - We Disliked

- a strong seismic signal is needed

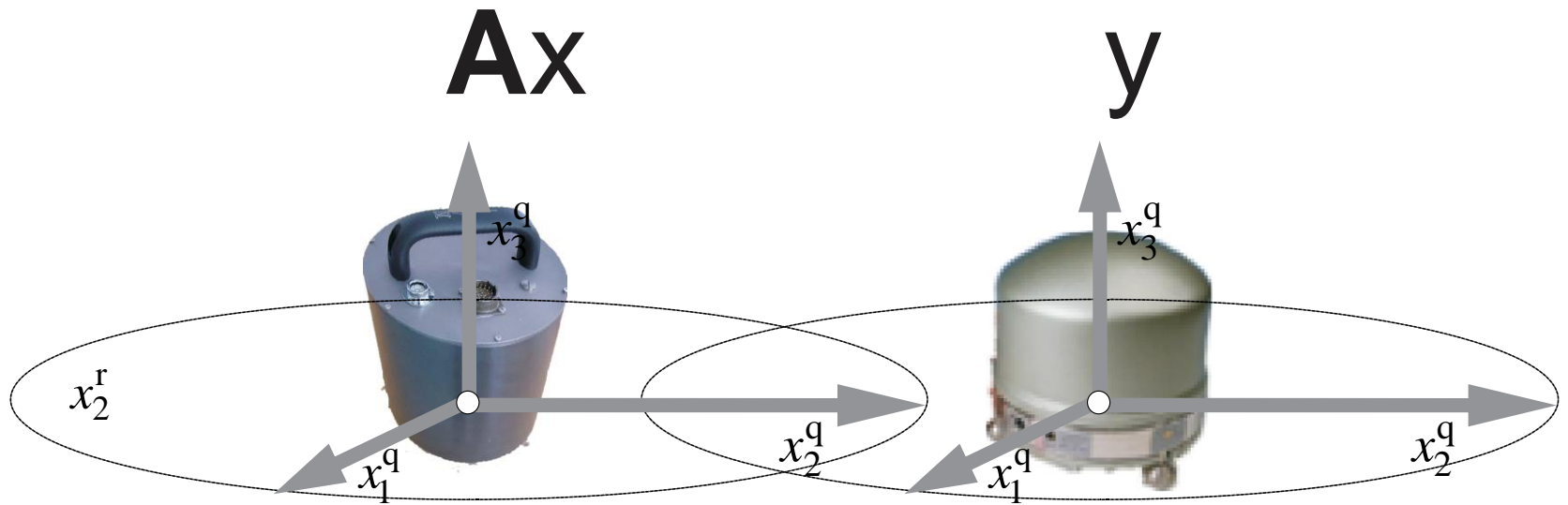
# control of new/'from repair' systems



individual approach

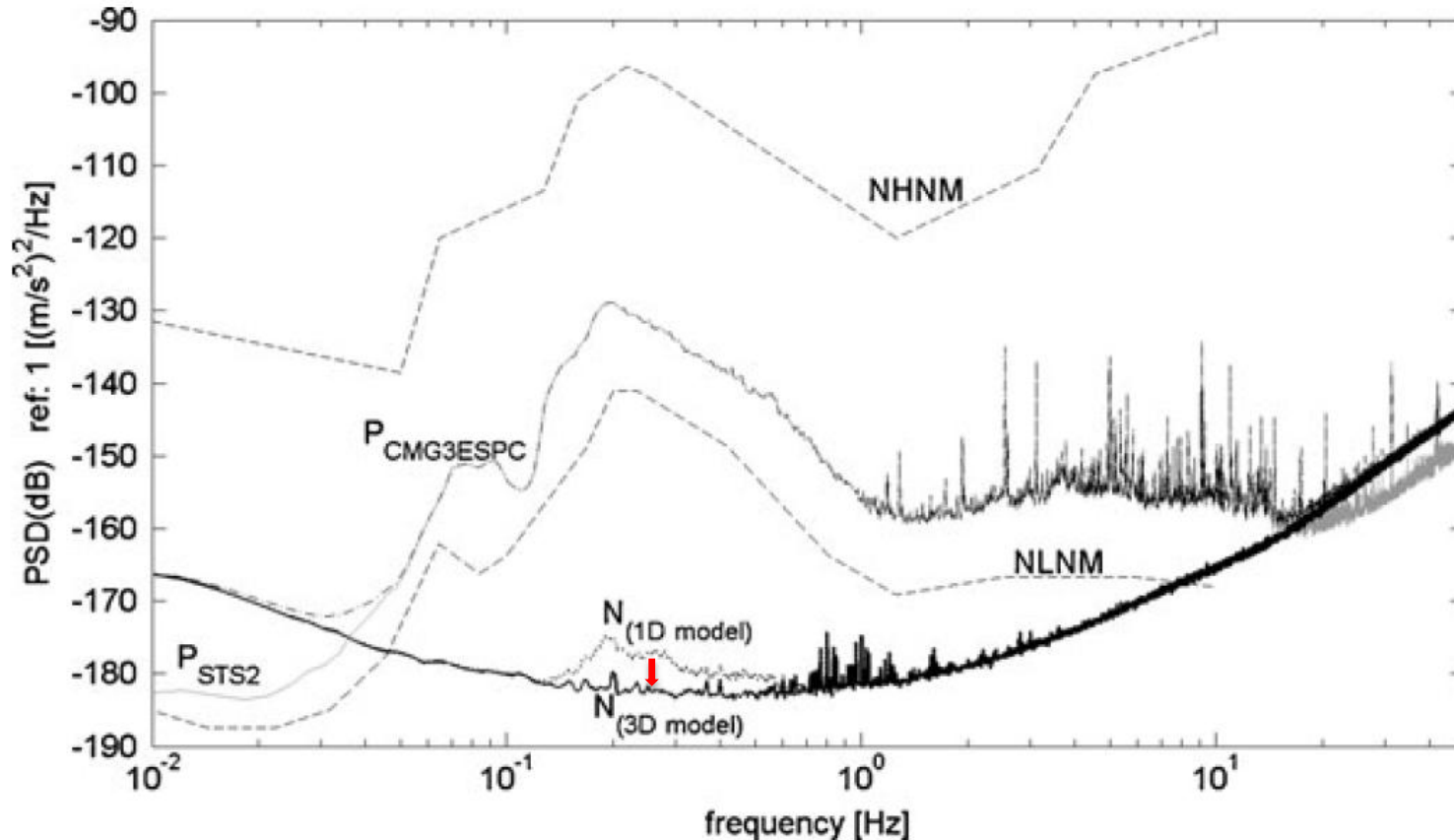


# control of new/'from repair' seismometer



Tasič, Runovc: the development and analysis of 3D transformation matrices for two seismometers; Journal of seismology, (DOI: DOI: 10.1007/s10950-014-9429-0)

# control of new/'from repair' seismometer



Tasič, Runovc: Seismometer self-noise estimation using a single reference instrument, Journal of seismology, (DOI: 10.1007/s10950-012-9355-y)

# 2 x STS-2 seismometer

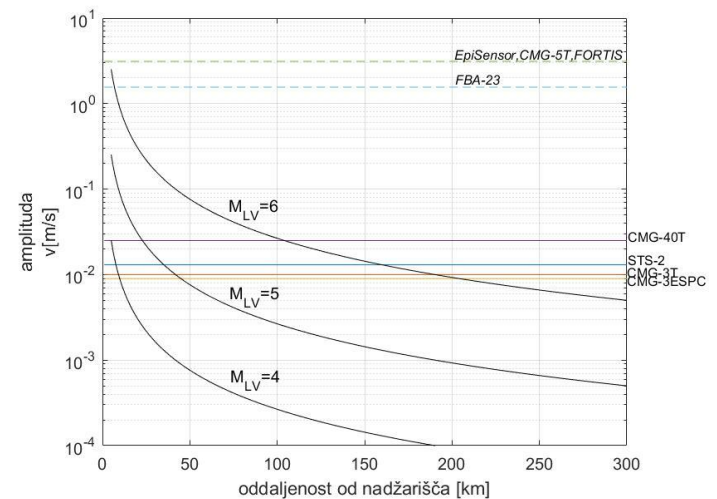
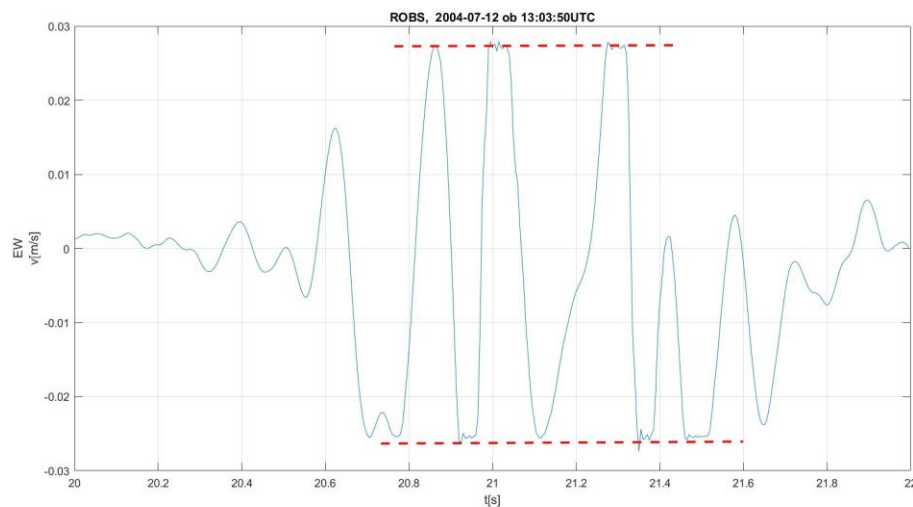
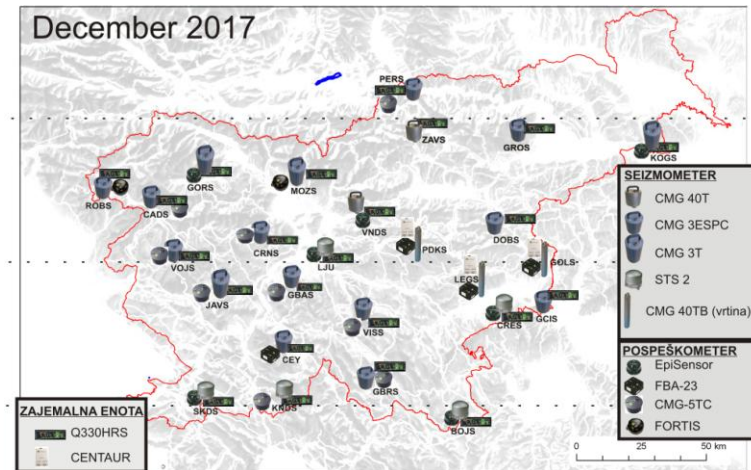
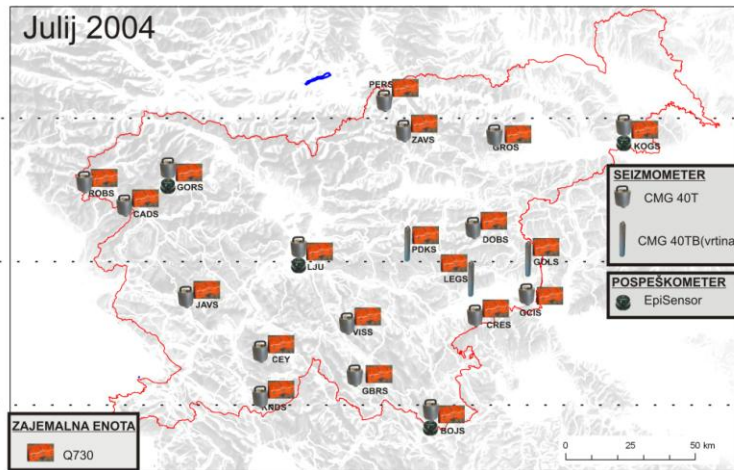
$$\mathbf{A}_{qr} = \begin{bmatrix} 1.00849 & 0.00134 & -0.00021 \\ -0.00171 & 1.01109 & 0.00068 \\ -0.00038 & -0.00049 & 1.00938 \end{bmatrix}; \mathbf{A}_{rq}^{-1} = \begin{bmatrix} 1.00849 & 0.00134 & -0.00021 \\ -0.00171 & 1.01109 & 0.00068 \\ -0.00038 & -0.00049 & 1.00938 \end{bmatrix}$$
$$\mathbf{I} = \begin{bmatrix} 1.00000 & 0.00000 & 0.00000 \\ 0.00000 & 1.00000 & 0.00000 \\ 0.00000 & 0.00000 & 1.00000 \end{bmatrix}; \mathbf{K}_G = \begin{bmatrix} 1.00000 & -0.00037 & -0.00059 \\ 0.00000 & -1.00000 & -0.00019 \\ 0.00000 & 0.00000 & -1.00000 \end{bmatrix}$$

Matrices  $\mathbf{A}_{qr}$ ,  $inv(\mathbf{A}_{rq})$ ,  $\mathbf{I}$  and  $\mathbf{K}_G$  in the  $[i,j,k]$  orientation, calculated for a pair of two STS-2 seismometers

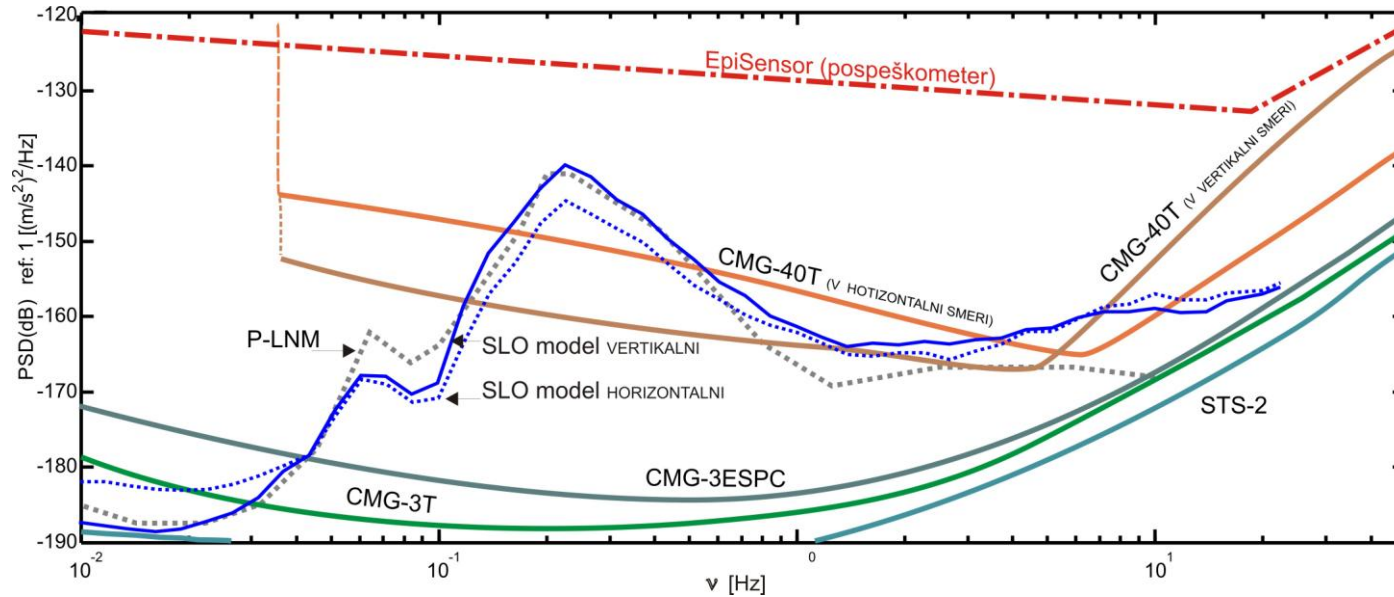
Tasič, Runovc: Determination of a seismometer's generator constant, azimuth and orthogonality in three-dimensional space using a reference seismometer, Journal of seismology, (DOI: 10.1007/s10950-012-9355-y)



# Improvements - Seismic Network of the Republic of Slovenia



# Improvements - Seismic Network of the Republic of Slovenia



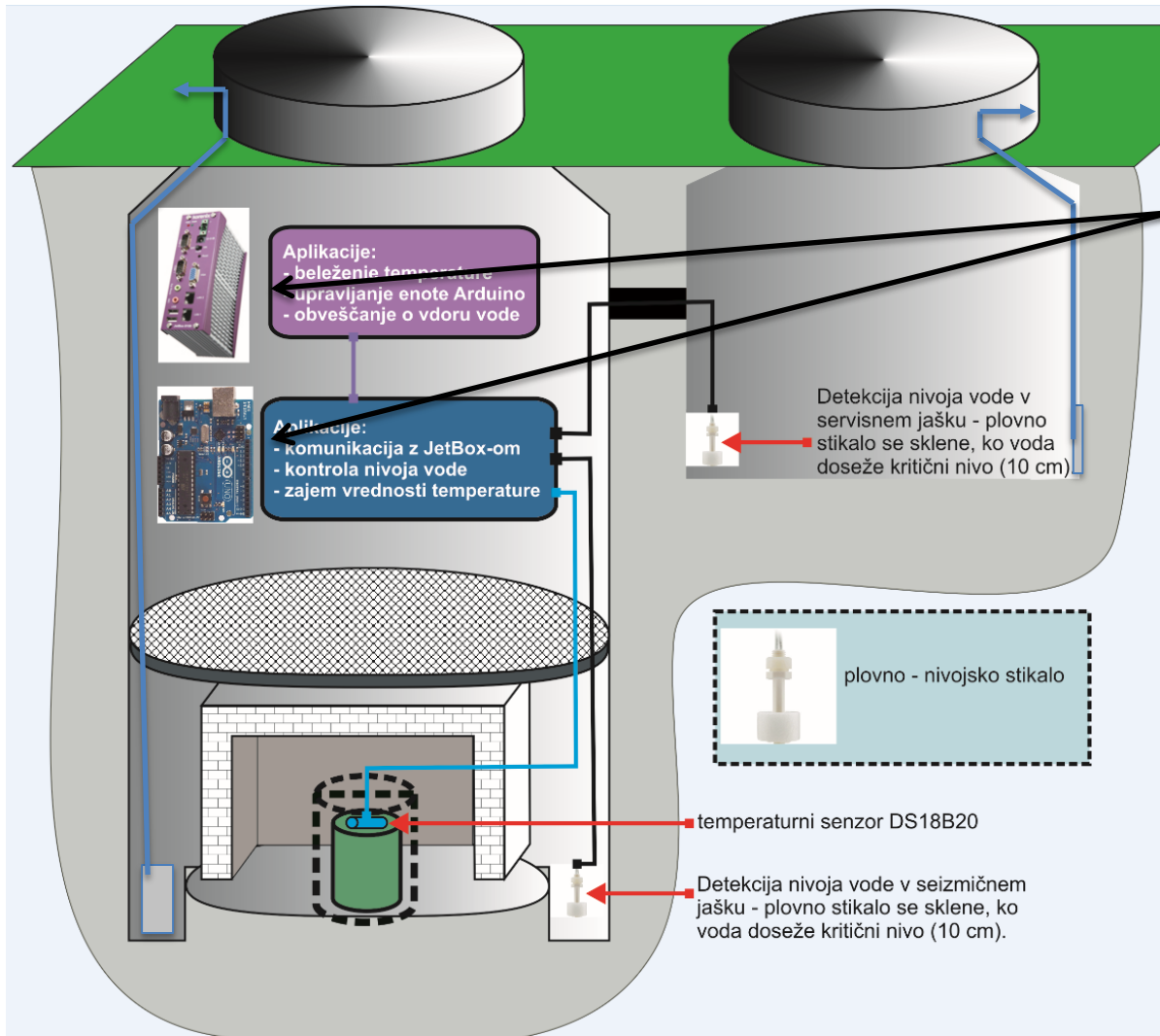
seismometer	max. amplitude
CMG-40T	2,5 cm/s
STS-2	1,3 cm/s
CMG-3T	1,1 cm/s
CMG-3ESPC	0,9 cm/s



# waterproof



# waterproof

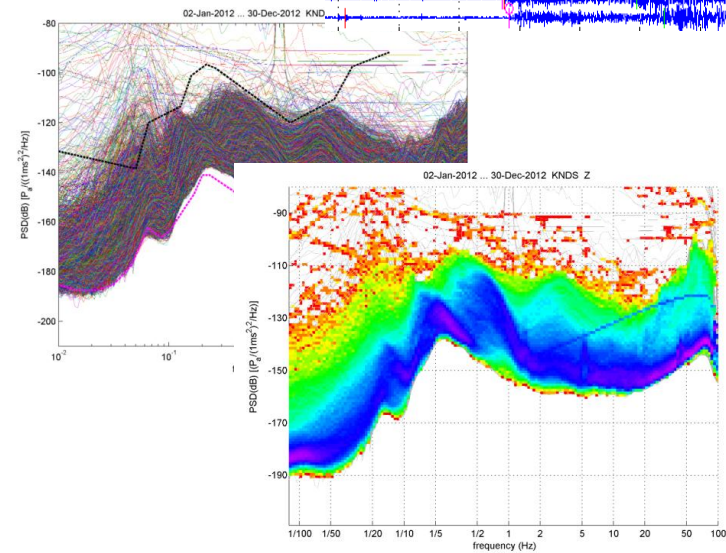
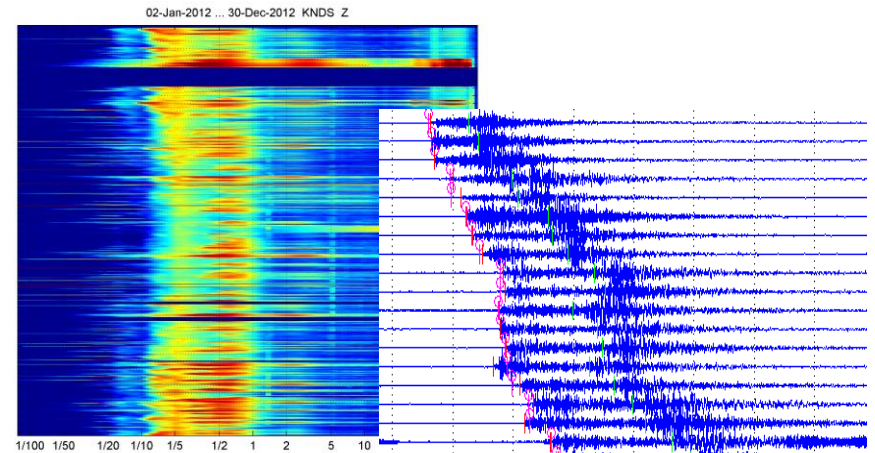
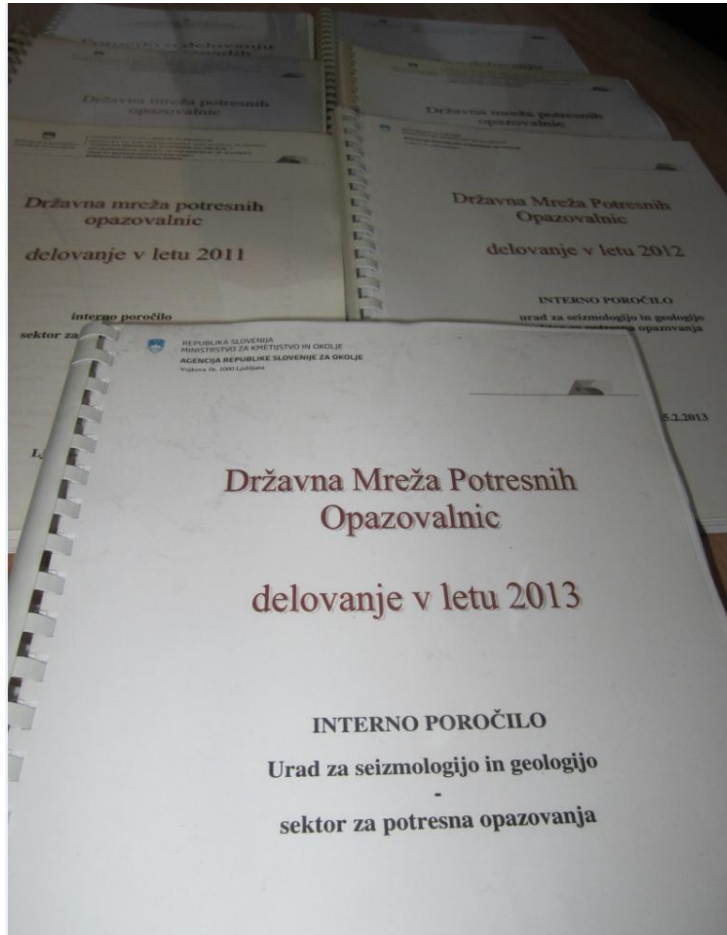


- additional archive backup
- modem control
- water-level control
- temperature monitoring
- ...



# ANNUAL ANALYSIS

(in the end of the year)



...of course there are many more small tasks....

thank you