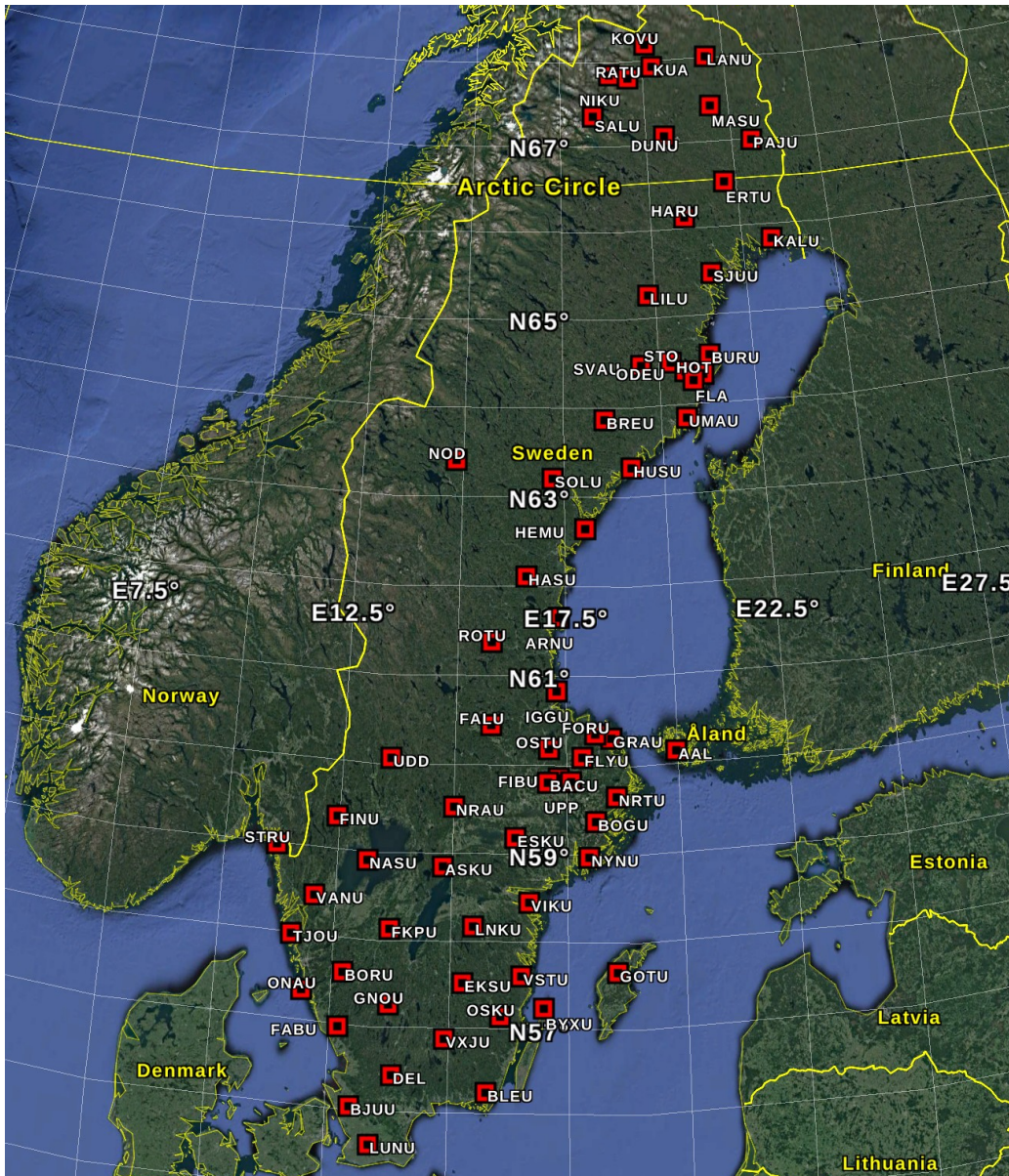


The Swedish National Seismic Network

Michael Roth, Björn Lund and the SNSN Team
Uppsala University, Sweden



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aal	AAL	2002	Åland	kou	KOUV	2011	Kortovare
arn	ARNU	2000	Hudiksvall	kur	KUA	1998	Kurravaara
ask	ASKU	2002	Askersund	lan	LANU	2004	Lannavaara
bac	BACU	2001	Vittinge	lil	LILU	2000	Jörn
bjv	BJUU	2008	Bjuv	lnk	LNKU	2002	Linköping
ble	BLEU	2002	Karlskrona	lun	LUNU	2008	Lund
bog	BOGU	2019	Bogesund	mas	MASU	2003	Masugnsbyn
bor	BORU	2006	Borås	nas	NASU	2006	Värmlandsnäs
bre	BREU	2000	Bjurholm	nik	NIKU	2003	Nikkaluokta
bur	BURU	2000	Skellefteå	nor	NOD	1998	Norderåsen
byx	BYXU	2002	Öland	nra	NRAU	2002	Nora
del	DEL	1969	Delary	nrt	NRTU	2002	Norrtälje
dun	DUNU	2003	Gällivare	nyn	NYNU	2002	Nynäshamn
eks	EKSU	2002	Eksjö	ode	ODEU	2012	Burträsk
ert	ERTU	2004	Lansjärv	ona	ONAU	2010	Onsala
esk	ESKU	2002	Eskilstuna	osk	OSKU	2002	Oskarshamn
fab	FABU	2006	Falkenberg	ost	OSTU	2001	Horsskog
fal	FALU	2002	Falun	paj	PAJU	2004	Pajala
fib	FIBU	2009	Fiby	rat	RATU	2011	Ratekjokk
fin	FINU	2005	Årjäng	rot	ROTU	2000	Edsbyn
fkp	FKPU	2006	Falköping	sal	SALU	2003	Saltoluokta
fla	FLA	2012	Flarken	sjv	SJUU	2000	Luleå
fly	FLYU	2002	Österbybruk	sol	SOLU	2000	Sollefteå
for	FORU	2005	Forsmark	sto	STOU	2012	Storbäcken
gno	GNOU	2006	Gnosjö	str	STRU	2006	Strömstad
got	GOTU	2002	Gotland	sva	SVAU	2000	Svanaliden
gra	GRAU	2001	Öregrund	tjo	TJOU	2006	Tjörn
har	HARU	2006	Harads	udd	UDD	1966	Uddeholm
has	HASU	2000	Hassela	uma	UMAU	2002	Umeå
hem	HEMU	2000	Härnösand	up1	UPP	1904	Uppsala
hot	HOT	2015	Hotjärn	van	VANU	2006	Vänernsberg
hus	HUSU	2000	Örnsköldsvik	vik	VIKU	2002	Vikbolandet
igg	IGGU	2000	Gävle	vst	VSTU	2002	Västervik
kal	KALU	2006	Kalix	vxj	VXJU	2001	Växjö

68 stations (May 2020)





SNSN

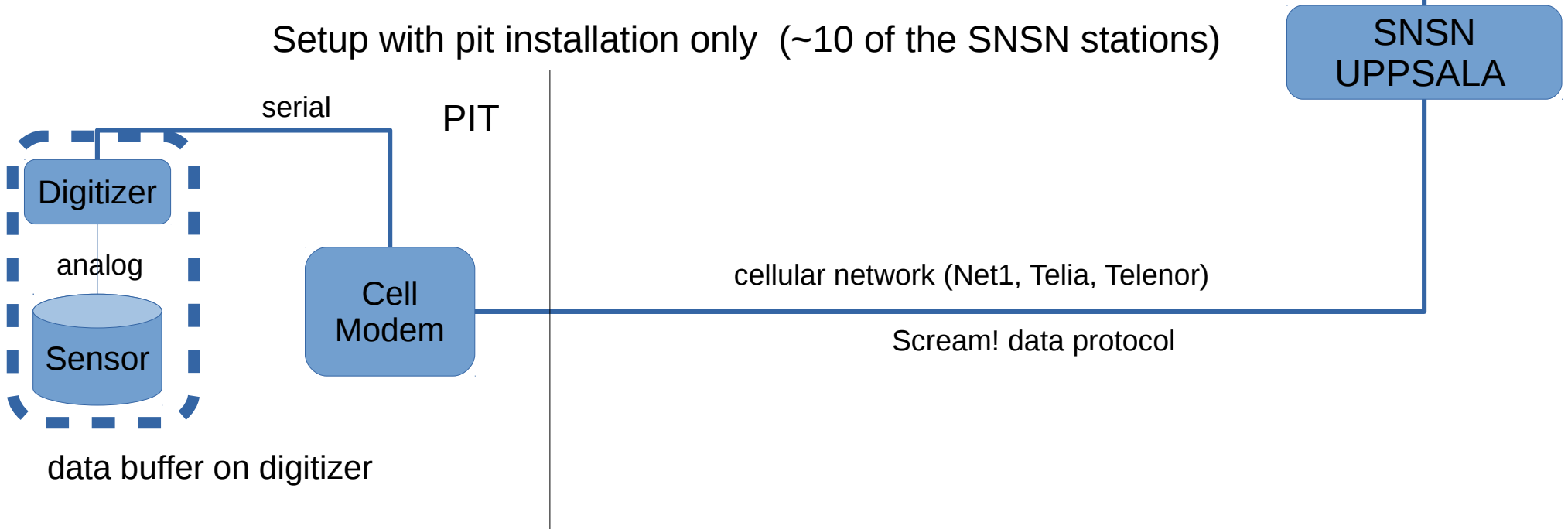
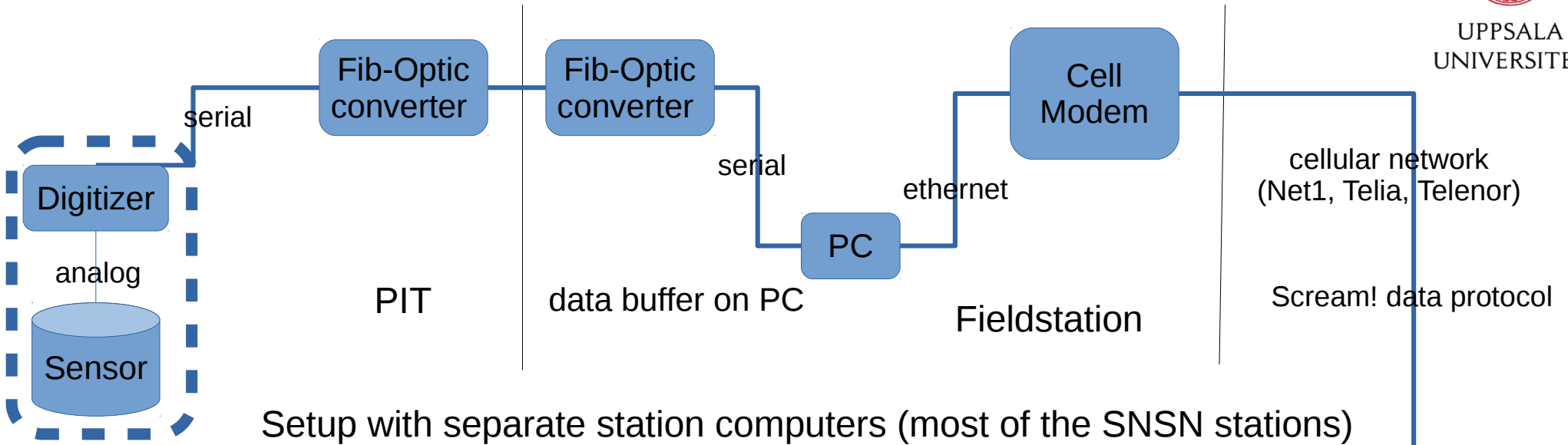
- 68 permanent broadband stations
- Extend South-North:
N55.6 – N68.2 (Lund - Kortovare)
- Extend West-East:
E11.2 – E 23.4 (Strömstad – Kalix)
- continuous data 100 sps
- communication via cell network
- remote maintenance and SOH monitoring
- independent remote power control of all station components
- 10 stations (LANU, SJUU, BREU, NOD, AAL, UPP, NRAU, STRU, VIKU, DEL) are forwarded in realtime to ORFEUS
- additional ~30 stations are forwarded in realtime to Finland, Denmark and Norway
- SNSN receives realtime data from about 50 stations in neighbouring countries



SNSN station setups



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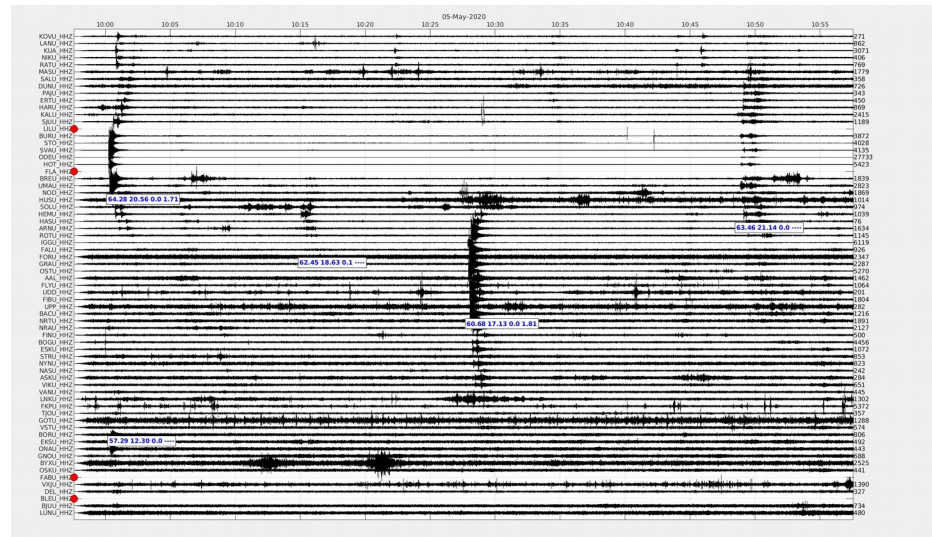
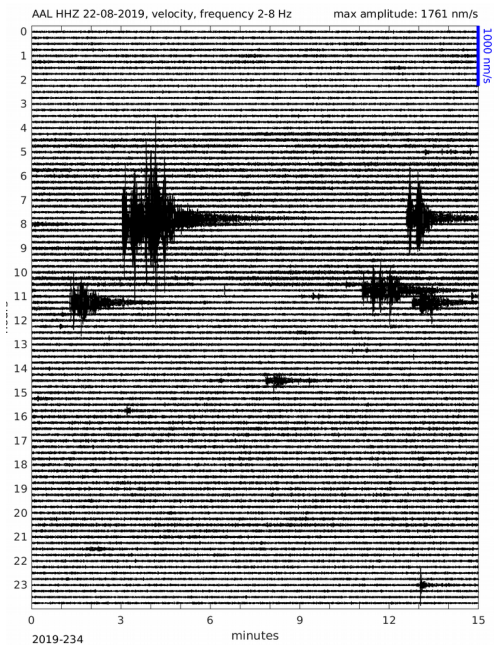
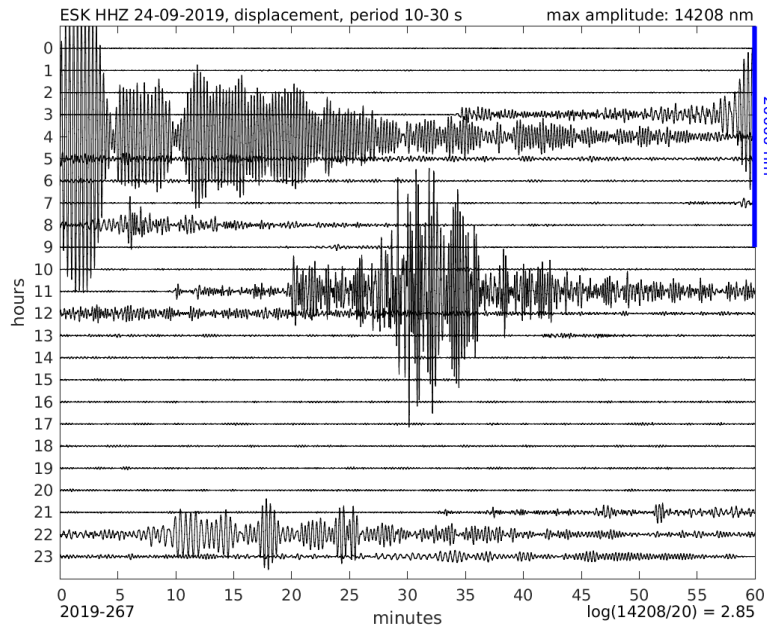
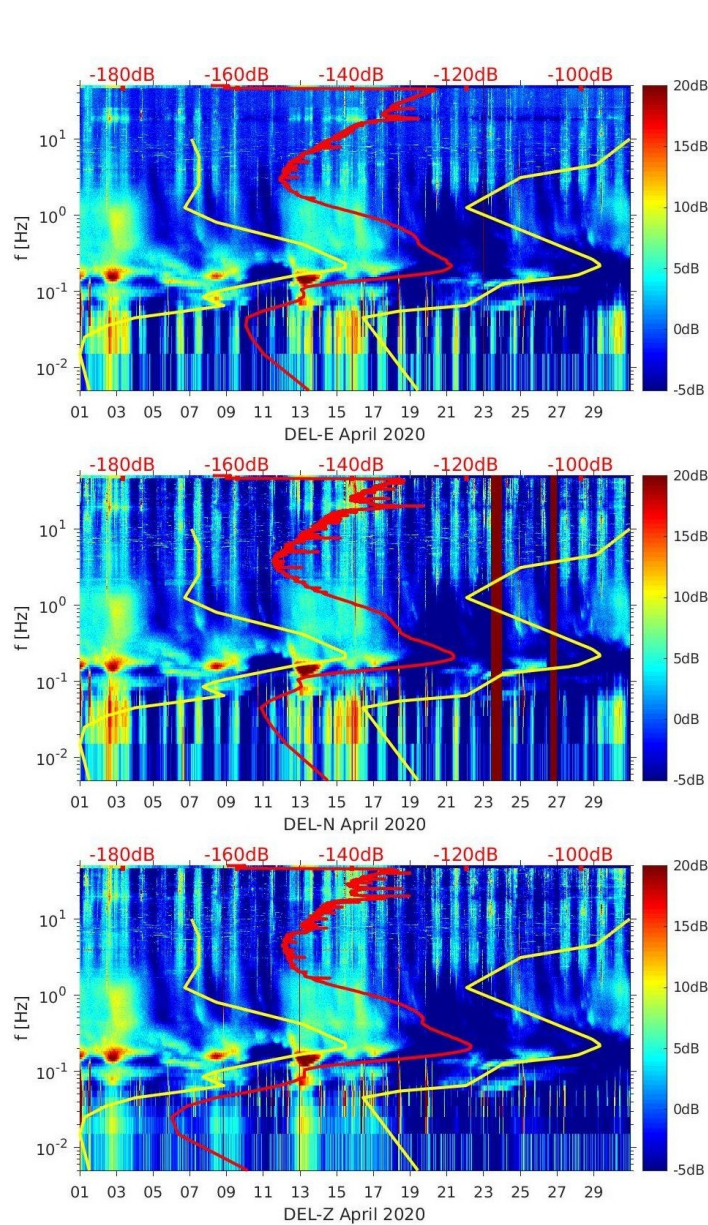
SNSN
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- Continuous State-of-health monitoring (monthly PSD overviews)
- Instrument-corrected SP and LP helicorder plots for vertical channels of all SNSN stations
- SP and LP overview plots for the entire network



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Examples:



current plots and overviews at <http://www.snsn.se/mro/>

Simplified Data Flow and Processing Flow



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DATA FLOW

4GByte/day

SNSN stations

GSM (Scream!
protocol)

SNSN

ORFEUS
+
Cooperating institutes

External stations

Internet, (seedlink)

PROCESSING FLOW

SIL/MSIL

Automatic bulletin

SNSN stations

MSdet

Automatic bulletin

Analyst review

External stations

Seiscomp
Earthworm

Automatic bulletins and alert messages



Automatic processing at SNSN

SIL/MSIL:

SIL system was put in operation 1990 and was designed to work in a network with narrow bandwidth and to work on segmented waveform data. Part of the processing takes place at the station computer. MSIL is a further developed SIL version that runs centralized and performs all processing at the SNSN data centre on the incoming data streams. SIL/MSIL only utilize SNSN stations

Seiscomp3 and Earthworm:

We have implemented Seiscomp3 as well as Earthworm for regional and local monitoring. Both systems are running independently on different hardware and are providing automatic bulletins and alert messages in near-realtime. Both systems are using SNSN data and data from stations of the neighbouring countries. Solutions are consistent for more than 90% of detected events.

MSdet:

This waveform backpropagation and stacking algorithm was developed by F. Wagner (Wagner et al, 2017, GJI, 209, 1866-1877) and it was recently implemented and adapted for SNSN. It is somewhat computational demanding (3 hours to process 1 day of data), but it is very sensitive and picks up also very small explosions and events not seen by the other systems.

Monitoring and visualization of automatic processing

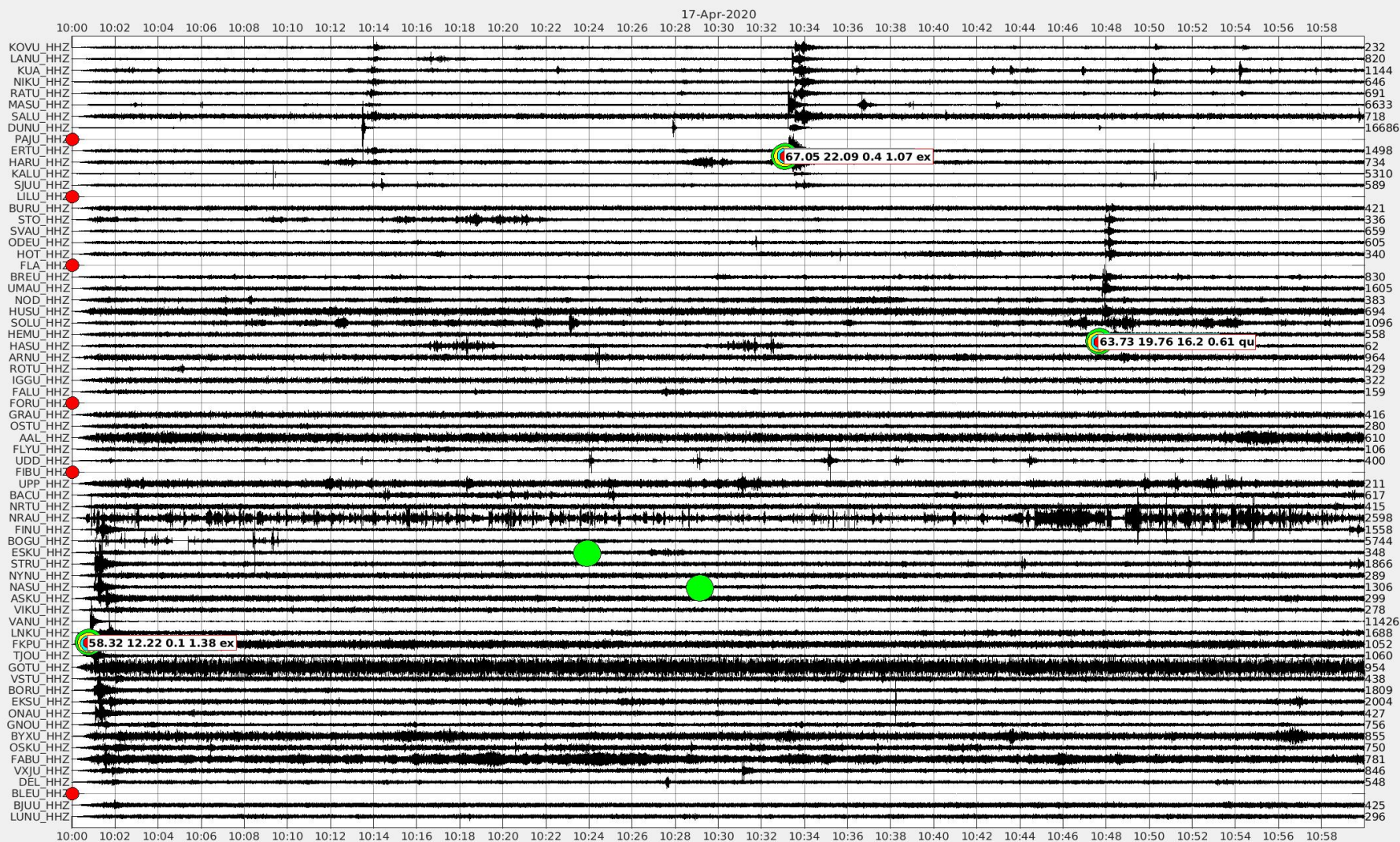


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- hourly short-period plots (2-20Hz) of all vertical SNSN channels
- event location marker at origin time and event latitude
(green: SIL/MSIL, yellow: Seiscomp, cyan: earthworm, red: analyst-reviewed)

17.04.2020 10:00-11:00

69 deg



Monitoring and visualization of automatic processing

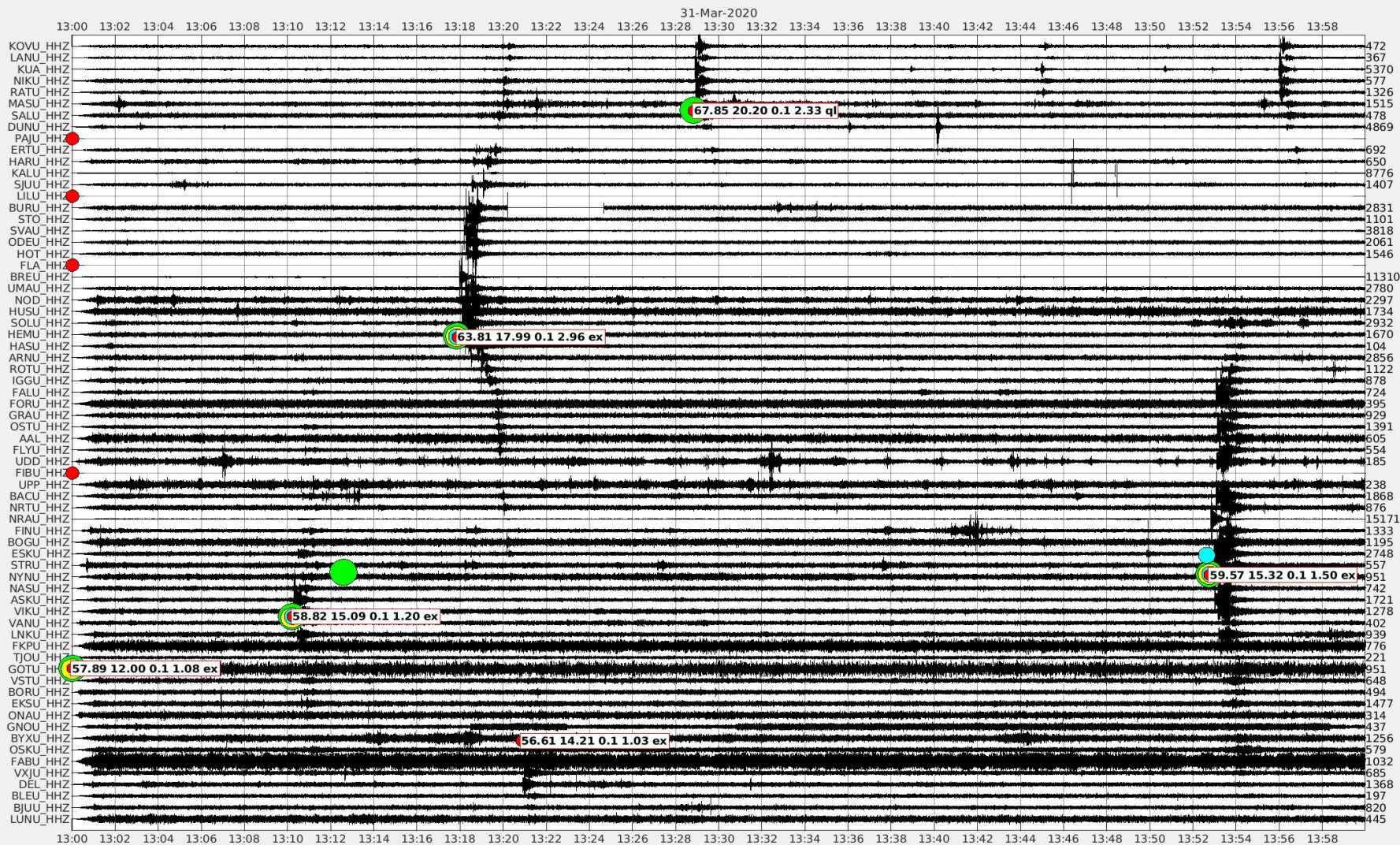


UPPSALA
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- hourly short-period plots (2-20Hz) of all vertical SNSN channels
- event location marker at origin time and event latitude
(green: SIL/MSIL, yellow: Seiscomp, cyan: earthworm, red: analyst-reviewed)

31.03.2020 13:00-14:00

69 deg



55 deg

Interactive map with automatic and analyst-reviewed events



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Circles: Analyst reviewed
red: earthquakes
bright yellow: mining-induced
green: blasts
yellow: not classified events
abroad Sweden

Additional layers with

- known mines and quarries
- SNSN station network
- known faults
- SIL automatic locations
- Seiscomp automatic locations

