

# SCDetect: Near real-time computationally efficient waveform cross-correlation based earthquake detection during intense earthquake sequences

**Daniel Armbruster**, Maria Mesimeri, Philipp Kästli, Tobias Diehl, Frédéric Massin, and Stefan Wiemer

Swiss Seismological Service, ETH Zurich, Zurich, Switzerland

[daniel.armbruster@sed.ethz.ch](mailto:daniel.armbruster@sed.ethz.ch)

[maria.mesimeri@sed.ethz.ch](mailto:maria.mesimeri@sed.ethz.ch)

Both *real time* and *playback* waveform cross correlation, fully integrated into SeisComP architecture

- **Earthquake Detection:**

Stream based, Gap Interpolation, Resampling, Filtering, Pearson Correlation Coefficient, Determination of local maxima

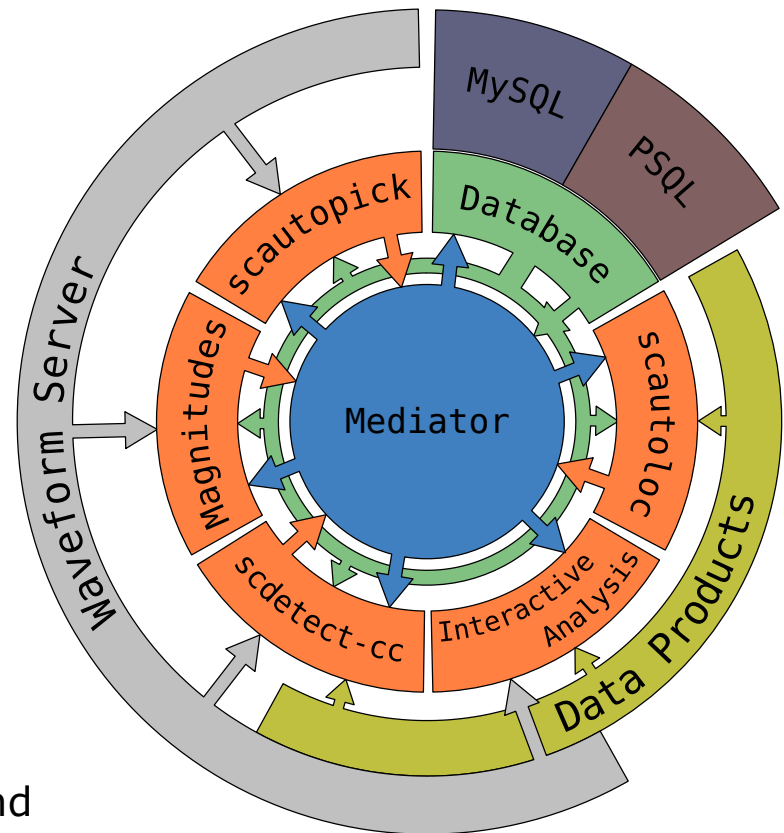
- **Phase Association:**

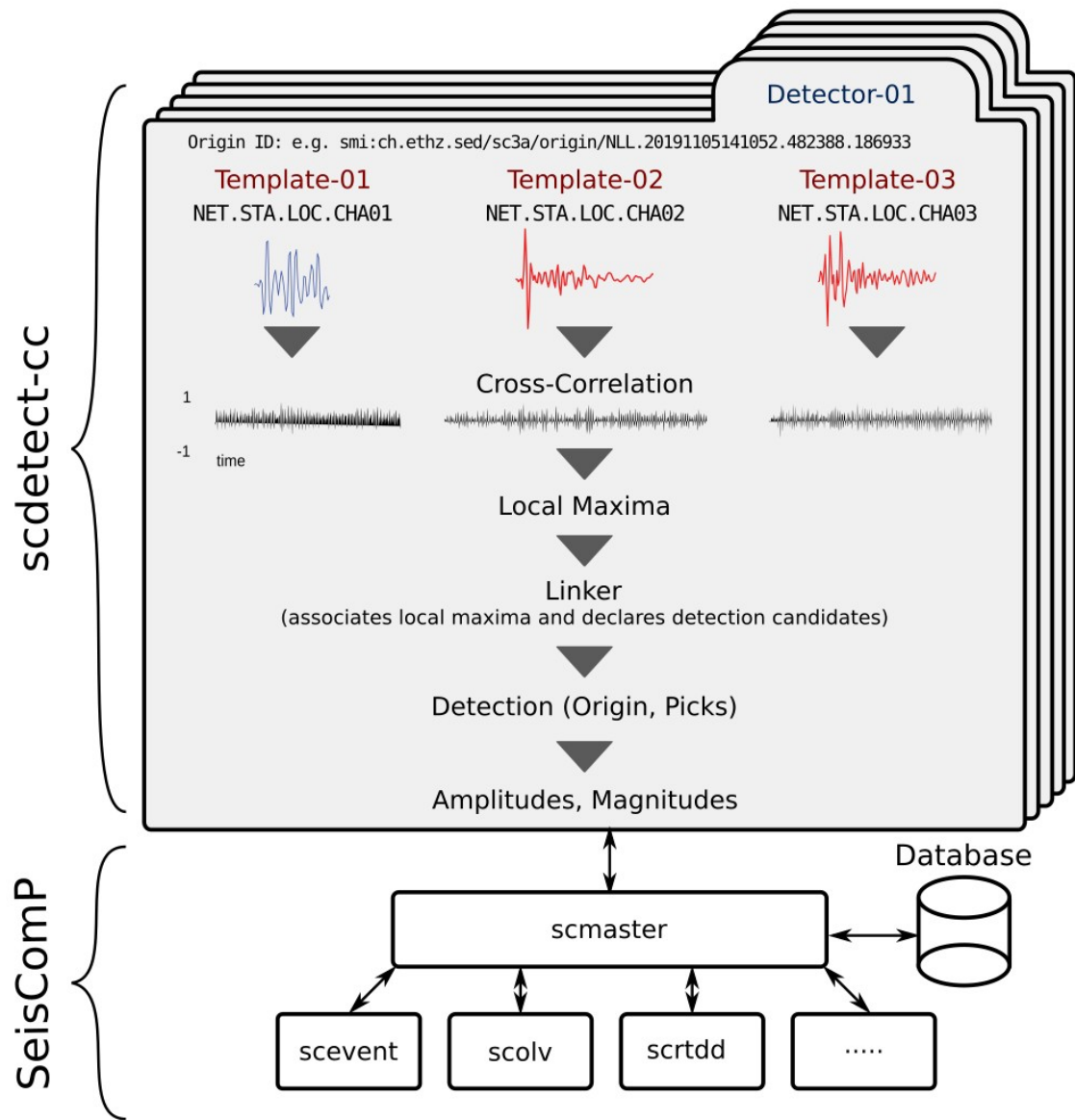
Matrix approach based on template event arrival times & Arrival offset threshold

- **Amplitude & Magnitude Calculation:**

***MRelative***: Ratio between template waveform and detection (e.g. Peng et al., 2009)

***MLx***: Template-family based amplitude-magnitude regression approach (Herrmann et al., 2019)





# Exemplary Application

Activities

scmm@localhost/production

File Plugins Help

Enable console log

Type	Sender	Destination
notifier_m...	sevent	EVENT
notifier_m...	scdetect-cc	AMPLITUDE
notifier_m...	scdetect-cc	LOCATION
notifier_m...	scdetect-cc	AMPLITUDE
notifier_m...	scdetect-cc	LOCATION
notifier_m...	sevent	EVENT
notifier_m...	sevent	EVENT
notifier_m...	scdetect-cc	AMPLITUDE

Name	Type[-1]	Destination[-1]
MASTER	DatabasePr...	31B5005A
scoutopick	notifier_m...	AMPLITUDE
scdetect-cc	notifier_m...	AMPLITUDE
sevent	notifier_m...	EVENT

Messages Clients Statistics Settings


Options View Help

Summary Events (55/55)

## 2022-05-13 08:20:13 UTC

### 25 seconds ago

#### Switzerland



Type

Value

+/-

M

-

-

MLv

-

-

MRelative

-0.1

-

Mw(mB)

-

-

mB

-

-

mb

-

-

Latitude:

46.32 °N

Longitude:

7.36 °E

Depth:

6 km

scsvs@localhost/production

File Edit View Settings Help

Previous event Next event

Preferred

Current

### 2022-05-13 08:12:15

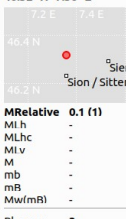
8m and 23s ago

#### M 0.1

#### Switzerland

#### Depth 5.42 km

#### 46.32°N 7.36°E



MRelative

0.1 (1)

Mh

-

MLhc

-

MLv

-

M

-

mb

-

Mw(mB)

-

Phases: 3

RMS Res.: 0.5

Event ID: gzf2022jly

Agency ID: SED

-

automatic

Location

Magnitudes

Event

Events (55/55)

OT (UTC)	M	MType	Phases	RMS (s)	Lat (°)	Lon (°)	Depth	Stat	Agency	Region	ID	CCC
2022-05-13 08:20:13.88	-0.1	MRelative	3	0.53	46.32 N	7.36 E	5.52 km	A	SED	Switzerland	gzf2022jlylgc	0.465677
2022-05-13 08:18:22.68	0.1	MRelative	3	0.59	46.32 N	7.37 E	4.79 km	A	SED	Switzerland	gzf2022jlyigo	0.412013
2022-05-13 08:17:26.05	0.1	MRelative	3	0.54	46.32 N	7.36 E	5.52 km	A	SED	Switzerland	gzf2022jlyivw	0.458510
2022-05-13 08:16:45.72	0.0	MRelative	3	0.58	46.32 N	7.36 E	5.30 km	A	SED	Switzerland	gzf2022jlyisl	0.422400
2022-05-13 08:16:33.23	-0.0	MRelative	3	0.49	46.32 N	7.36 E	5.52 km	A	SED	Switzerland	gzf2022jlyhaz	0.513352
2022-05-13 08:16:06.88	0.2	MRelative	3	0.55	46.32 N	7.36 E	5.30 km	A	SED	Switzerland	gzf2022jlyhrw	0.453982
2022-05-13 08:15:55.00	0.4	MRelative	3	0.52	46.32 N	7.36 E	5.42 km	A	SED	Switzerland	gzf2022jlyhnl	0.475420
2022-05-13 08:15:19.23	-0.2	MRelative	3	0.56	46.32 N	7.36 E	5.30 km	A	SED	Switzerland	gzf2022jlyhab	0.440608
2022-05-13 08:15:13.49	-0.0	MRelative	3	0.57	46.32 N	7.36 E	5.30 km	A	SED	Switzerland	gzf2022jlygby	0.432125
2022-05-13 08:14:50.18	0.0	MRelative	3	0.58	46.32 N	7.37 E	5.35 km	A	SED	Switzerland	gzf2022jlyjns	0.417039
2022-05-13 08:14:35.16	-0.1	MRelative	3	0.54	46.32 N	7.36 E	4.37 km	A	SED	Switzerland	gzf2022jlyjgl	0.460850
2022-05-13 08:14:27.18	-0.1	MRelative	3	0.56	46.32 N	7.36 E	5.52 km	A	SED	Switzerland	gzf2022jlyggq	0.443384
2022-05-13 08:14:19.38	0.5	MRelative	3	0.51	46.33 N	7.35 E	4.32 km	A	SED	Switzerland	gzf2022jlyjds	0.492948
2022-05-13 08:14:13.54	0.0	MRelative	3	0.50	46.32 N	7.37 E	4.79 km	A	SED	Switzerland	gzf2022jlygbo	0.497137
2022-05-13 08:14:06.22	0.6	MRelative	3	0.45	46.32 N	7.36 E	4.37 km	A	SED	Switzerland	gzf2022jlyjfy	0.552486
2022-05-13 08:13:57.21	0.1	MRelative	3	0.57	46.33 N	7.36 E	3.91 km	A	SED	Switzerland	gzf2022jlyjvl	0.433381
2022-05-13 08:13:47.76	0.1	MRelative	3	0.57	46.32 N	7.36 E	5.30 km	A	SED	Switzerland	gzf2022jlyfrx	0.431100
2022-05-13 08:13:33.71	-0.2	MRelative	3	0.55	46.33 N	7.35 E	5.47 km	A	SED	Switzerland	gzf2022jlyfmp	0.454255
2022-05-13 08:13:21.15	0.2	MRelative	3	0.52	46.32 N	7.36 E	5.30 km	A	SED	Switzerland	gzf2022jlyjfr	0.479361
2022-05-13 08:13:15.27	0.3	MRelative	3	0.55	46.32 N	7.36 E	5.42 km	A	SED	Switzerland	gzf2022jlyjfm	0.450817
2022-05-13 08:12:47.19	-0.1	MRelative	3	0.50	46.32 N	7.37 E	5.35 km	A	SED	Switzerland	gzf2022jlyjevi	0.503345
2022-05-13 08:12:41.68	-0.1	MRelative	3	0.55	46.32 N	7.36 E	5.52 km	A	SED	Switzerland	gzf2022jlyjetg	0.453341
2022-05-13 08:12:15.53	0.1	MRelative	3	0.54	46.32 N	7.36 E	5.42 km	A	SED	Switzerland	gzf2022jlyejl	0.462357

Clear list

Last days: 1

Read

From: 2022/05/03 08:13:02

To: 2022/05/13 08:13:02

Read

☒ Hide other/fake events

☐ Show only own events

☐ Show only latest/preferred origin per agency

☐ Hide events

outside

- custom -

...

region

A new origin arrived at 2022-05-13 10:20:29 (localtime)

scrttv@localhost/production

File Interaction Help

Enabled Disabled

RAW2 8D HHZ

amax: 4.01644e-06

mean: 8.98557e-13

SAYF2 CH HGZ

amax: 0.00309285

mean: -7.0152e-11

STSW2 CH HGZ

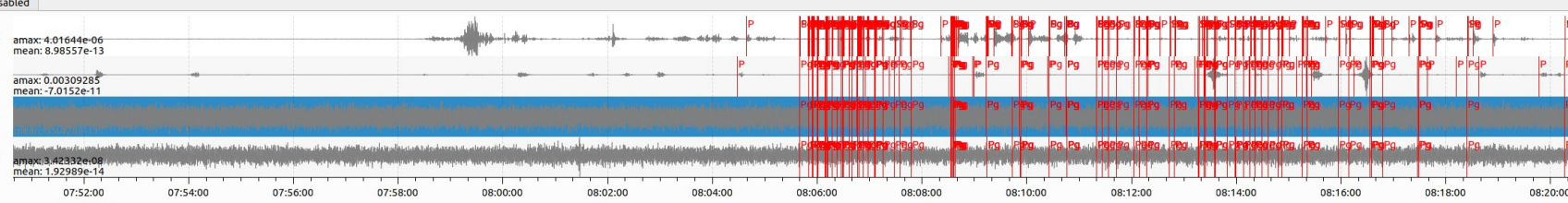
amax: 3.42332e-08

mean: 1.92989e-14

SENIN CH HHZ

amax: 3.42332e-08

mean: 1.92989e-14



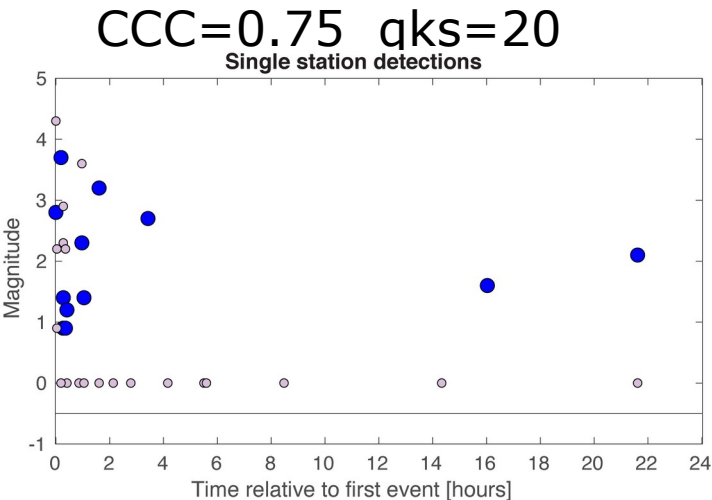
Filter ON: RMHP(2)>>TAPER(5)>>BW\_BP(3,1.5,15)

An origin arrived at 2022-05-13 10:20:29 (localtime)

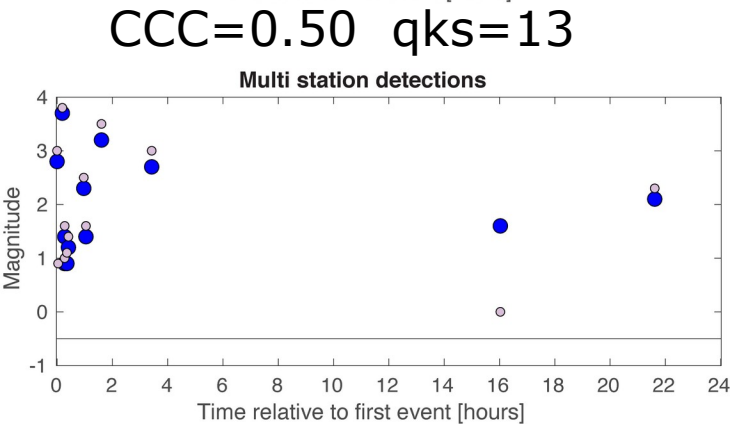
Konstanz, 2019  
Cataloged (24 hrs): **13**

● Cataloged  
● *scdetect-cc*

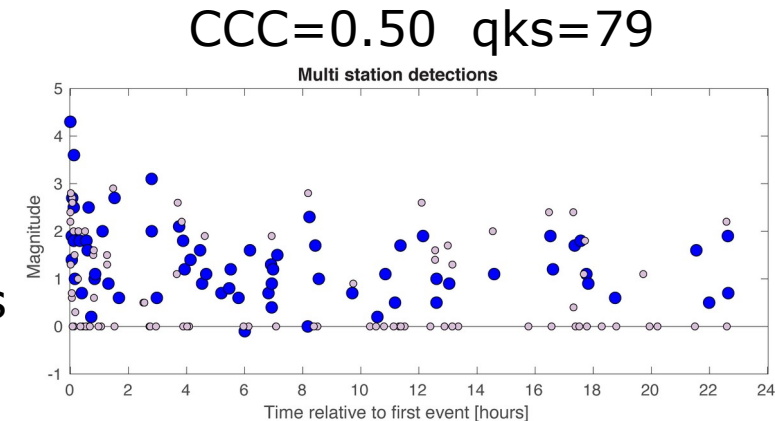
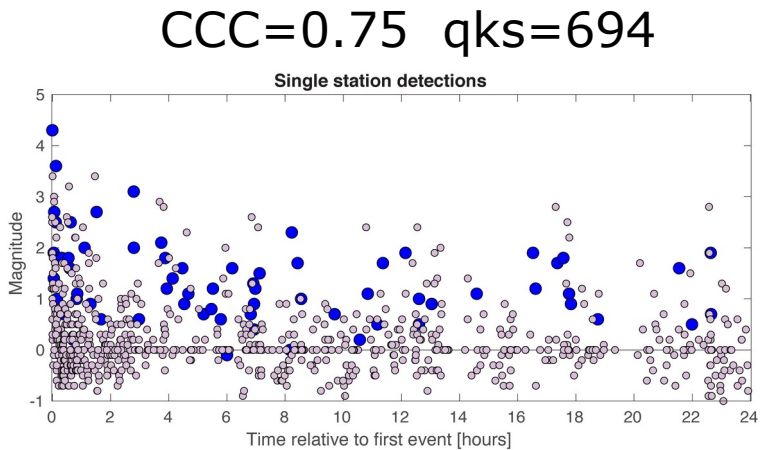
Elm, 2020  
Cataloged (24 hrs): **69**



1 station  
3 channels  
8/16 Detectors  
24/48 Templates



4 stations  
12 channels  
8/16 Detectors  
6/192 Templates





# Code and Documentation

swiss-seismological-service / **scdetect** Public

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[master](#)
8 branches
 1 tag

**damb** DOC: Document earthquake detection

.github/workflows	CICD: Install libboost-timer-dev
doc	DOC: Document earthquake detection
src	MAINT: Create notifiers for StationM
.clang-format	CICD MAINT: Update .clang-format
.gitignore	Initial commit
.readthedocs.yaml	DOC: Prepare docs for RTD
CMakeLists.txt	MAINT: Add CMakeLists.txt file
LICENSE	Initial commit
README.md	DOC: Fix readthedocs badge link

README.md

## SCDetect - Computationally efficient earthquake detection

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SCDetect

stable

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### CONFIGURATION

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- Template configuration
- Bindings configuration details
- Template family configuration

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- Architecture
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## About

SCDetect is a [SeisComp](#) package. With the extension module [scdetect-cc](#) it implements both real-time and classical offline earthquake detection based on waveform cross-correlation, also called matched filtering or template matching. Again, the underlying cross-correlation algorithm is based on computing the [Pearson Correlation Coefficient](#).

The module allows both single-stream and multi-stream earthquake detection.

In case the detection parameters exceed the configured thresholds, [scdetect-cc](#) declares a new origin.

Besides, magnitudes may be estimated based on multiple magnitude estimation methods (i.e. regression, amplitude ratios).

## Installation

Instructions for compiling and the installation of the software can be found on the [SCDetect project page](#).

## Cite

If you intend to use SCDetect please cite as:

Armbruster, D., Mesimeri, M., Kästli, P., Diehl, T., Massin, F., and Wiemer, S. (2022)  
 SCDetect: Near real-time computationally efficient waveform cross-correlation based earthquake detection during intense earthquake sequences  
 EGU General Assembly 2022, Vienna, Austria, 23–27 May 2022, EGU22-12443

## Code and Documentation



<https://github.com/swiss-seismological-service/scdetect>

<https://scdetect.readthedocs.io>

