# The Friuli Venezia Giulia accelerometric network RAF and its integration with the RAN.

Giovanni Costa

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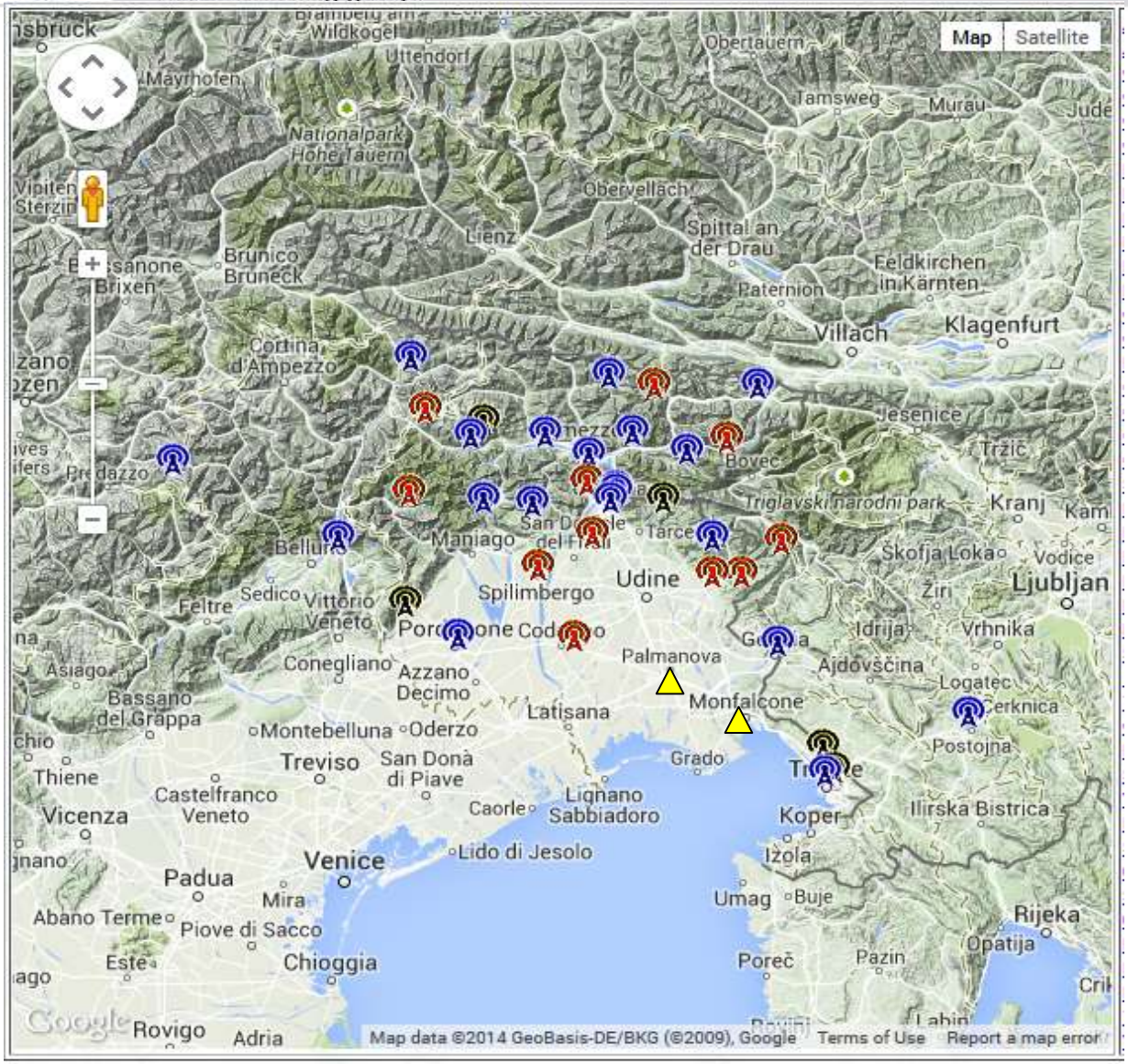
*University of Trieste, Italy;*

SeisRaM
*Seismological Researcher and Monitoring group*

*Giovanni Costa, Piero Falconer, Lorenzo Furlan, Antonella Gallo, Lara Tiberi, Blaž Vičič, Giuliana Zoppé*

# Antelope User Group meeting
## Rome, Maj 18-20, 2016






1993 - 2000

2000 -


2011 - PROTEZIONE CIVILE NAZIONALE

Friuli Venezia Giulia Accelerometric Network (RAF)

National Accelerometric Network (RAN)

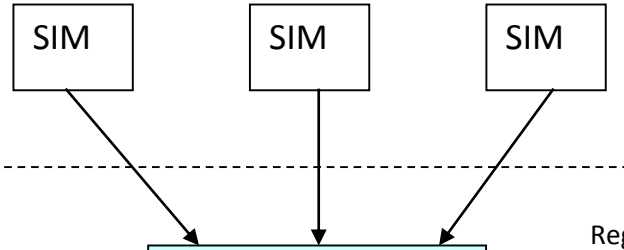
Stations of NE Italy Broadband Network (NI)

**The RAN is of the Dipartimento della Protezione Civile, Presidenza del Consiglio dei Ministri, Roma**

**The VINO and TRI stations are managed in collaboration with OGS. TRI is a MedNet station. The NE Italy BB Network is managed in collaboration with the Istituto Nazionale di Ocenografia e di Geofisica Sperimentale - OGS, Trieste**

trasmissione dati GPRS

Stazioni



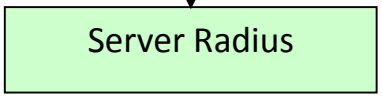

Private APN

Registrazione della SIM
accesso alla rete GPRS
tramite APN dedicato

Telecom

CDN

Autenticazione della SIM
associazione IP statico




DPC

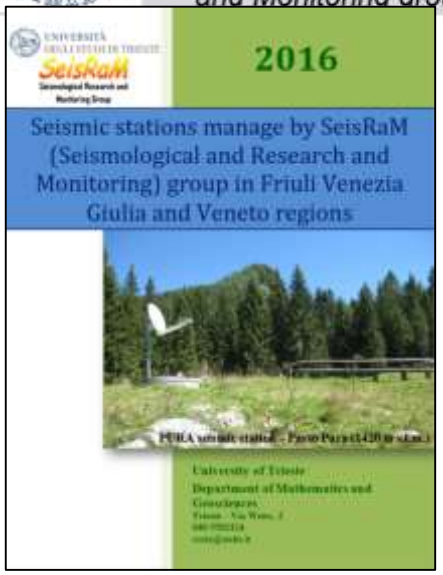
SeisRaM
Seismological Researcher and Monitoring group

# Antelope User Group meeting
## Rome, Maj 18-20, 2016

AUG Antelope Users Group








## Stazione di Gemona - DE

| Codice | Latitudine | Longitudine | Quota slm (m) |
|---|---|---|---|
| GEDE | 46.254 | 13.124 | 180 |

*Estratto CTRN*

*Veduta satellite*

SENSORE: Kinemetrics EpiSensor.

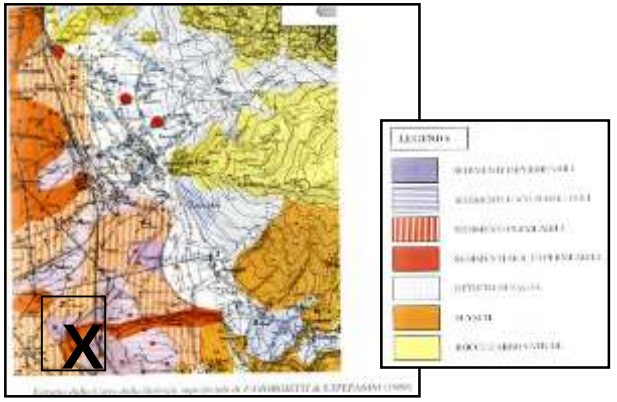
SISTEMA DI ACQUISIZIONE: Kinemetrics Etna.

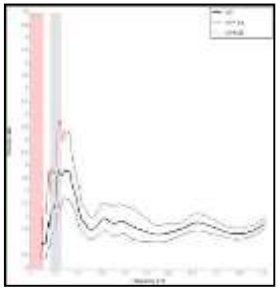
COLLEGAMENTO: modem GSM, modalità dial-up.

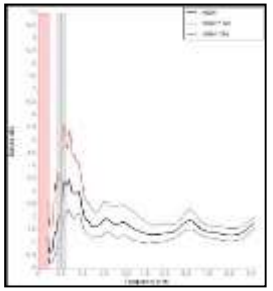
GEOLOGIA: nel bacino sedimentario.

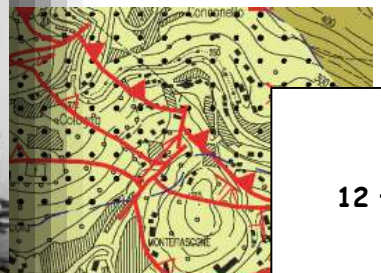
TOPOGRAFIA: pianura.

**Note.** La stazione è operativa nella configurazione attuale dall'inverno 1999/2000, a poca distanza dall'installazione precedente, codice GETM, attiva dal 1994 al 1999. È installata sul basamento preesistente di una piccola costruzione.

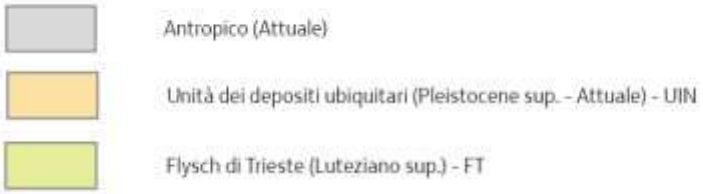


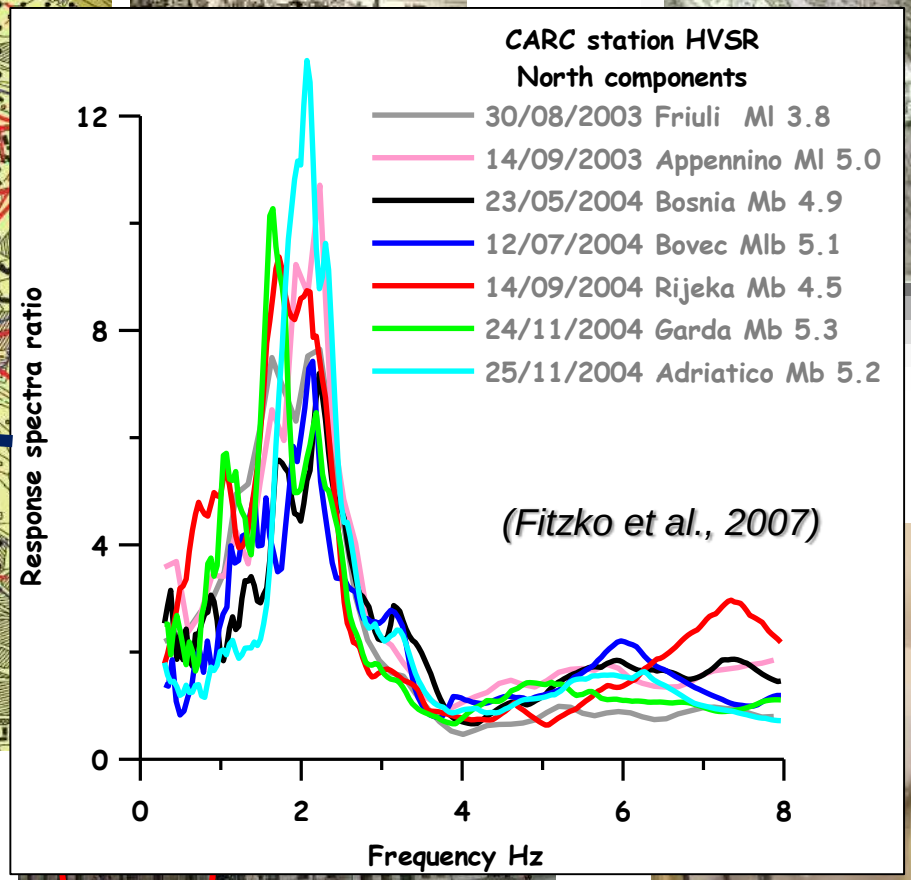



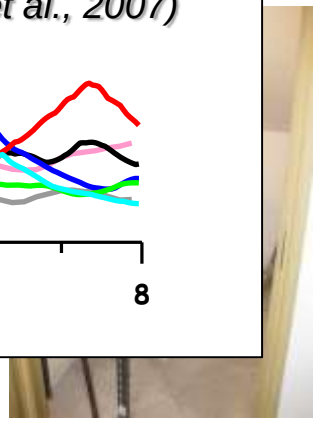




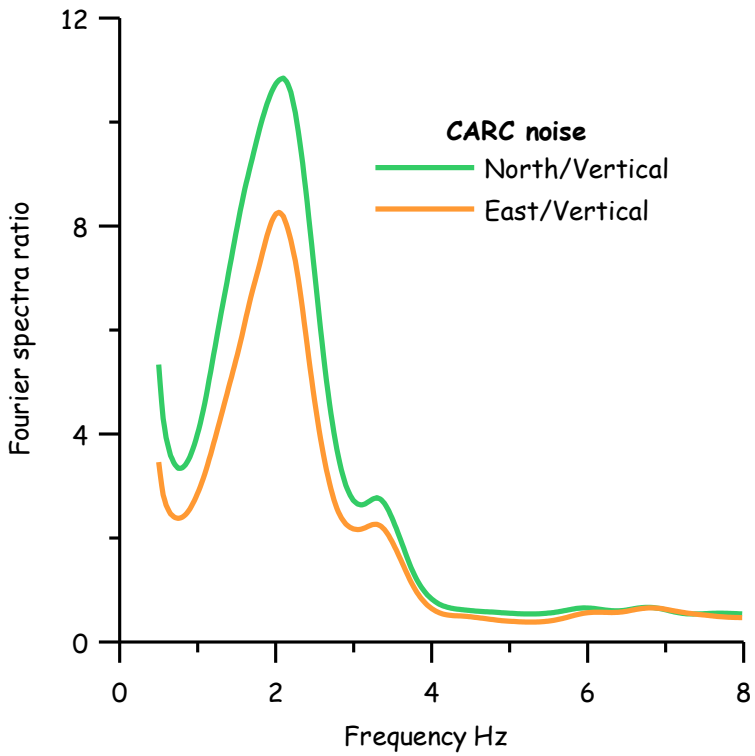

(Cucchi et al., 2013)

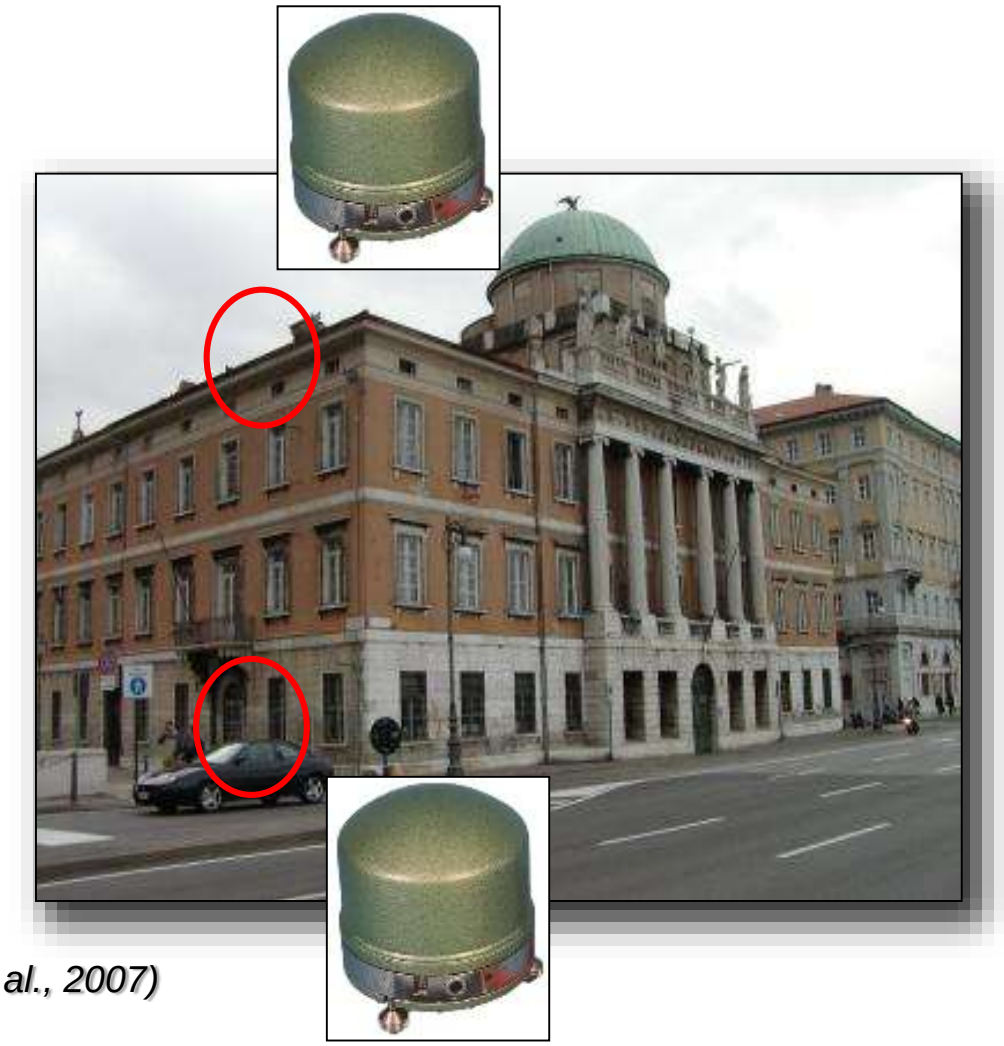


# Stazione CARC - Borgo Teresiano - Trieste

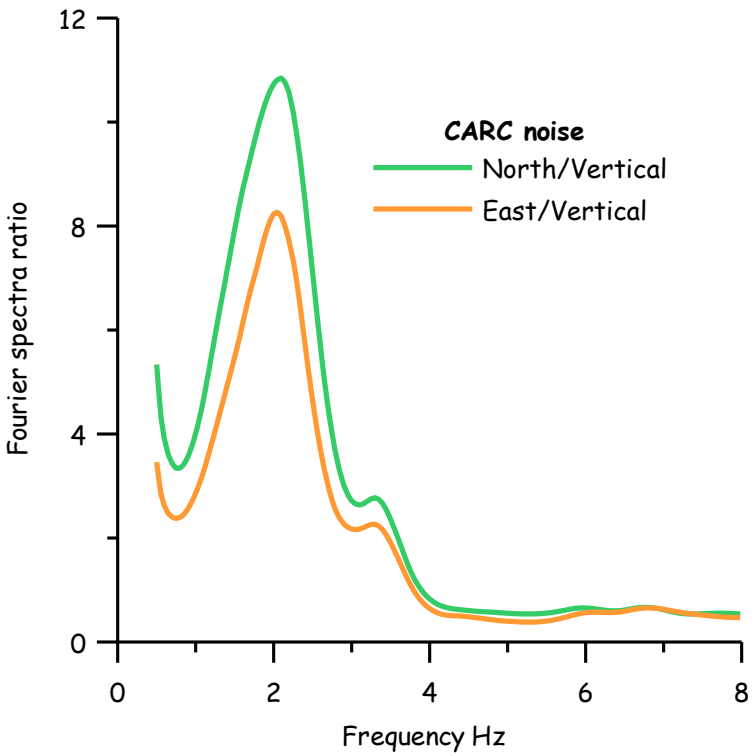


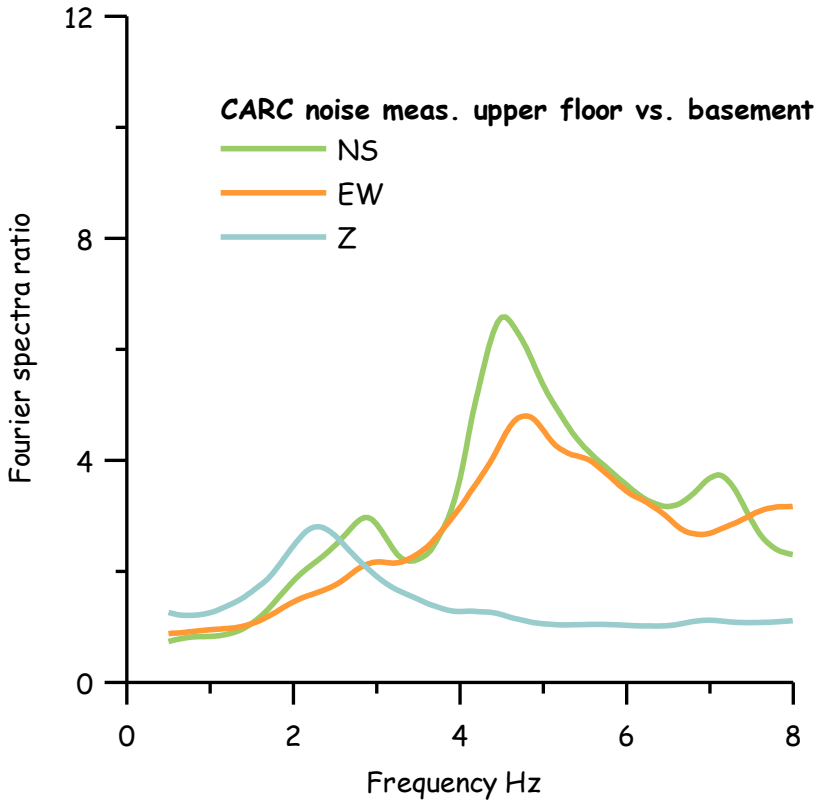



*(Fitzko et al., 2007)*

# Stazione CARC - Borgo Teresiano - Trieste

*(Fitzko et al., 2007)*

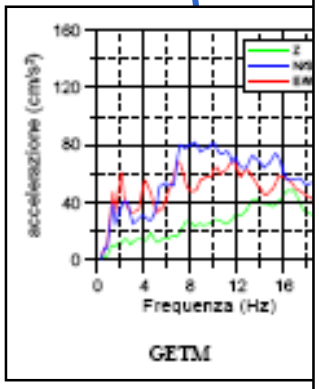


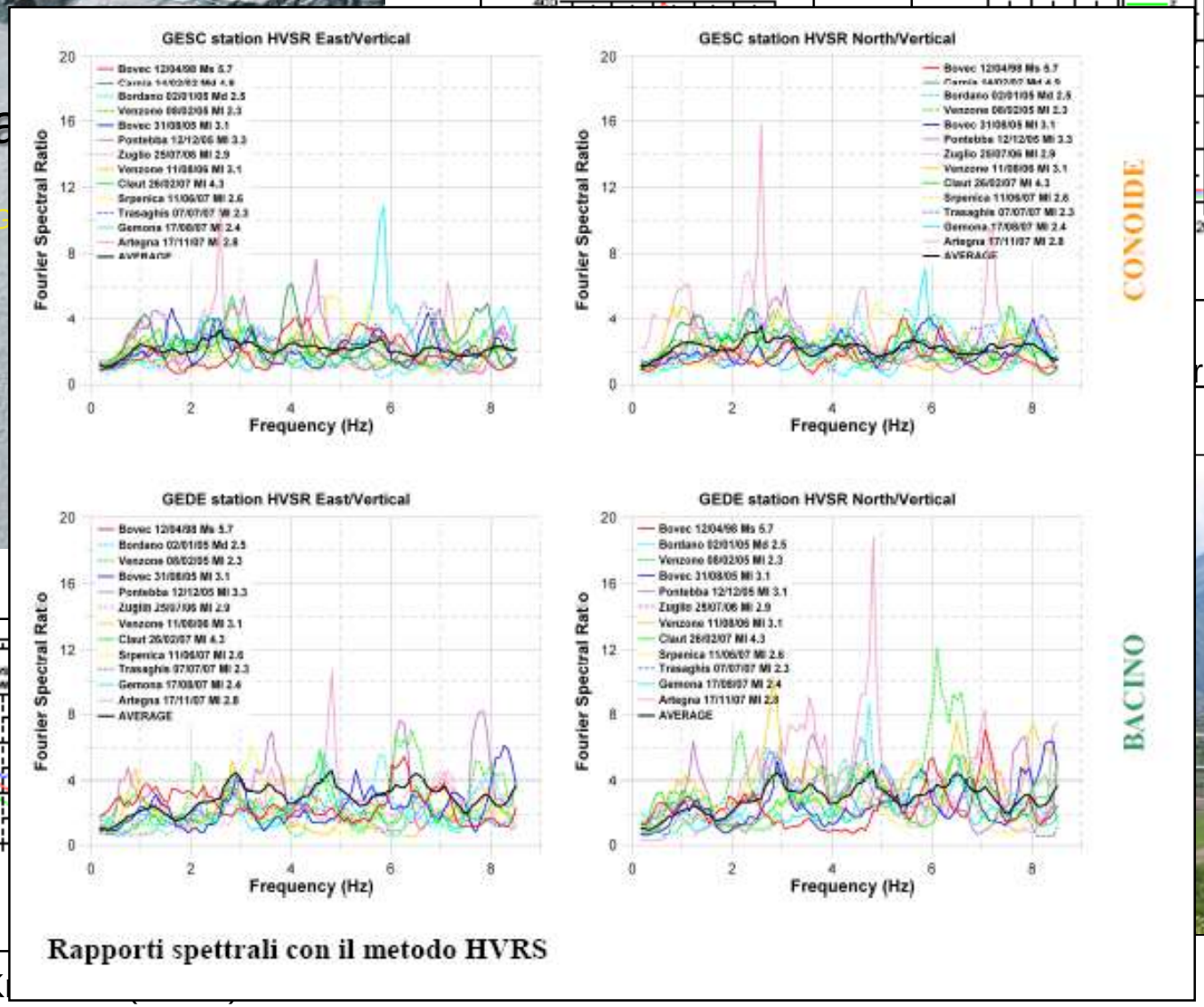




# Stazione CARC - Borgo Teresiano - Trieste

Gemona

GETM



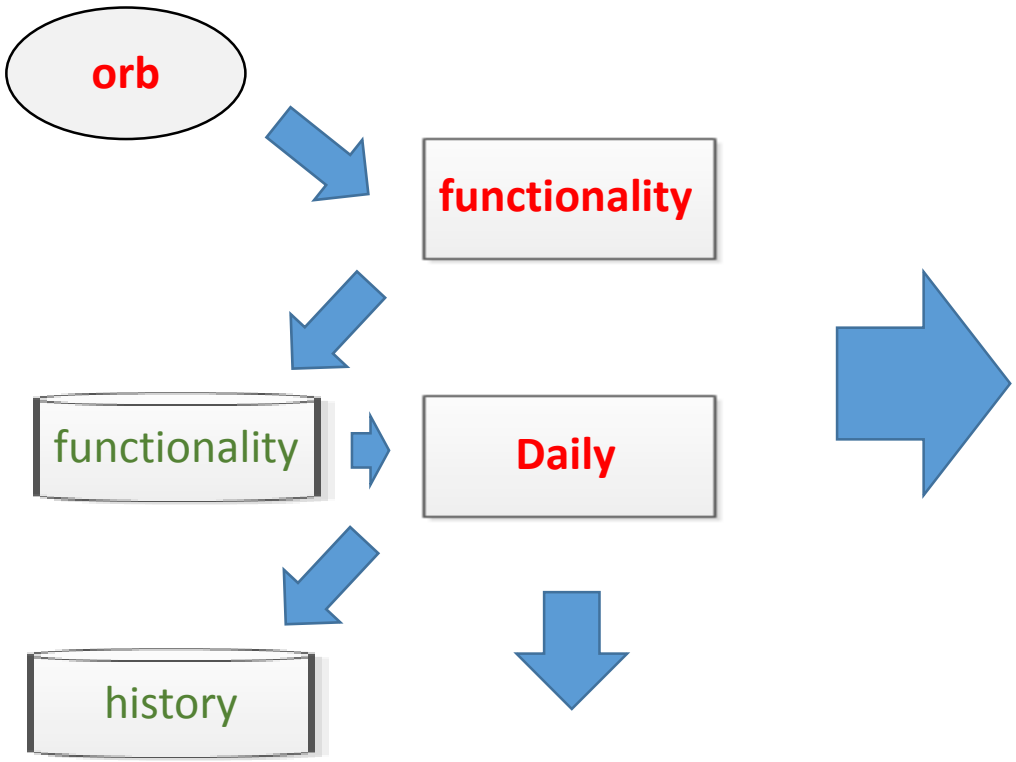

Rapporti spettrali con il metodo HVRS

risposta

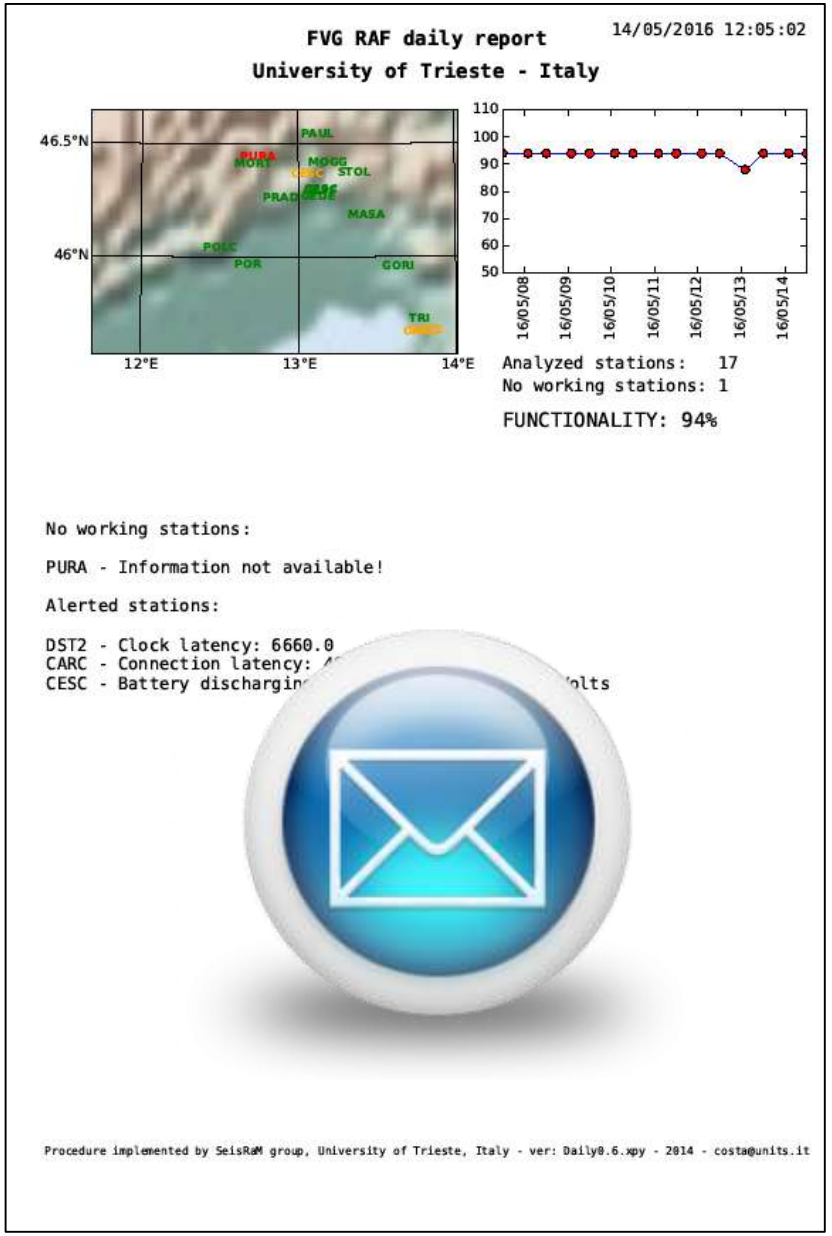

Evento Bovec – K
spettri di risposta (damping 5%)

Alpine Space
Interreg III B

# Daily report



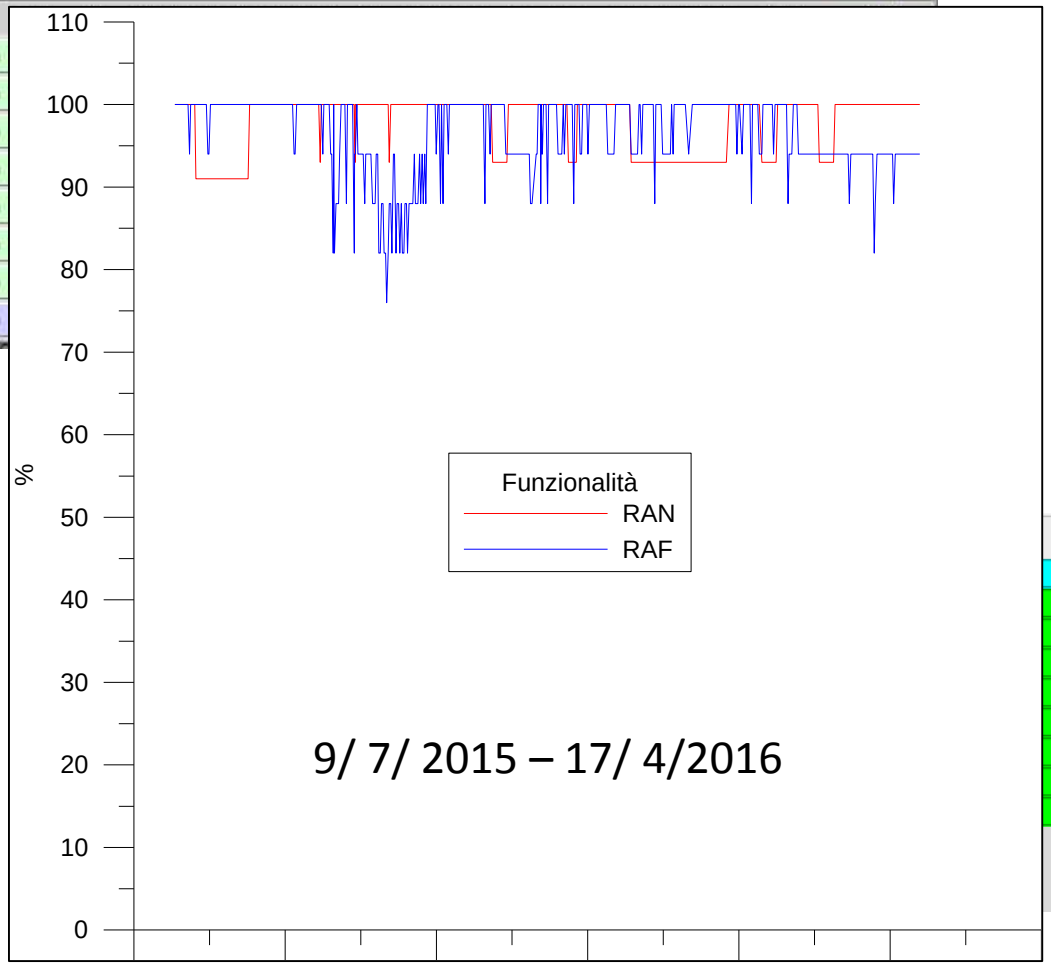

Funzionalita_RF20160514.xml



dlmon

File Views Windows

| dlname | com | modem | lcom | ctm |
|---|---|---|---|---|
| CESC | dis | <-m_CESC | blk | 00h |
| GEDE | dis | <-m_GEDE | blk | 00h |
| GESC | dis | ->raf_in_V674 | blk | 00h |
| MASA | dis | <-m_MASA | blk | 00h |
| PAUL | dis | <-m_PAUL | blk | 00h |
| POR | dis | <-m_POR | blk | 01h |
| PRAD | dis | <-m_PRAD | blk | 00h |
| STOL | blk | ->raf_in_V674 | blk | 02h |




| reset delay | #reset | SIM s/n |
|---|---|---|
| 12407:54:26 | 0 | CCID:89390100000626169534 |
| 12407:53:56 | 0 | CCID:89390100001200546501 |
| 12407:53:55 | 0 | CCID:89390100001211720111 |
| 12407:53:49 | 0 | CCID:89390100000969040540 |
| 12407:54:27 | 0 | CCID:89390100001200546477 |
| 12404:34:57 | 0 | CCID:89390100001200546196 |
| 12407:54:28 | 0 | CCID:89390100001200546162 |
| 12407:53:55 | 0 | CCID:89390100001200546089 |

Last update: 2016/04/18 14:13:11.338


# CE$^3$RN

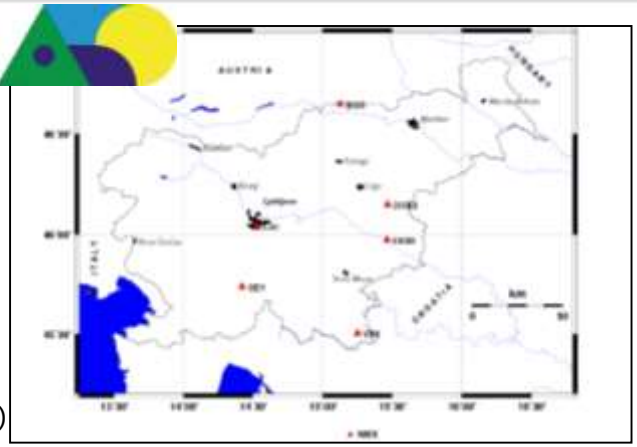
Central and Eastern European Earthquake Research Network

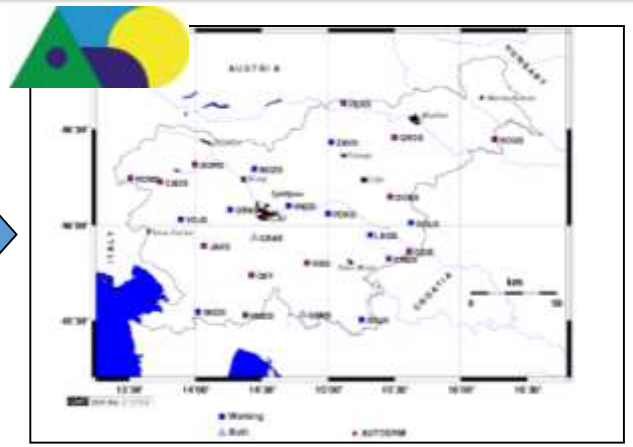
SeisRaM
Seismological Researcher and Monitoring group

# Antelope User Group meeting
## Rome, Maj 18-20, 2016

AUG Antelope Users Group


Živčić, (Susans, 2007)





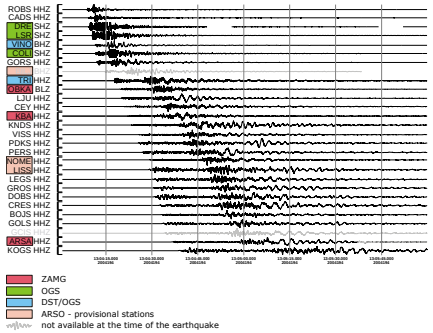

THE INTERREG IIIA PROJECTs

"TRANS-NATIONAL SEISMOLOGICAL NETWORK IN THE SOUTH-EASTERN ALPS"

FASTLINK

HAREIA
Historical And Recent Earthquakes in Italy and Austria

*Trans-National Seismological Networks in the South-Eastern Alps*
-
CE3RN


# *Trans-National Seismological DATABASE*

# *2003-2016*

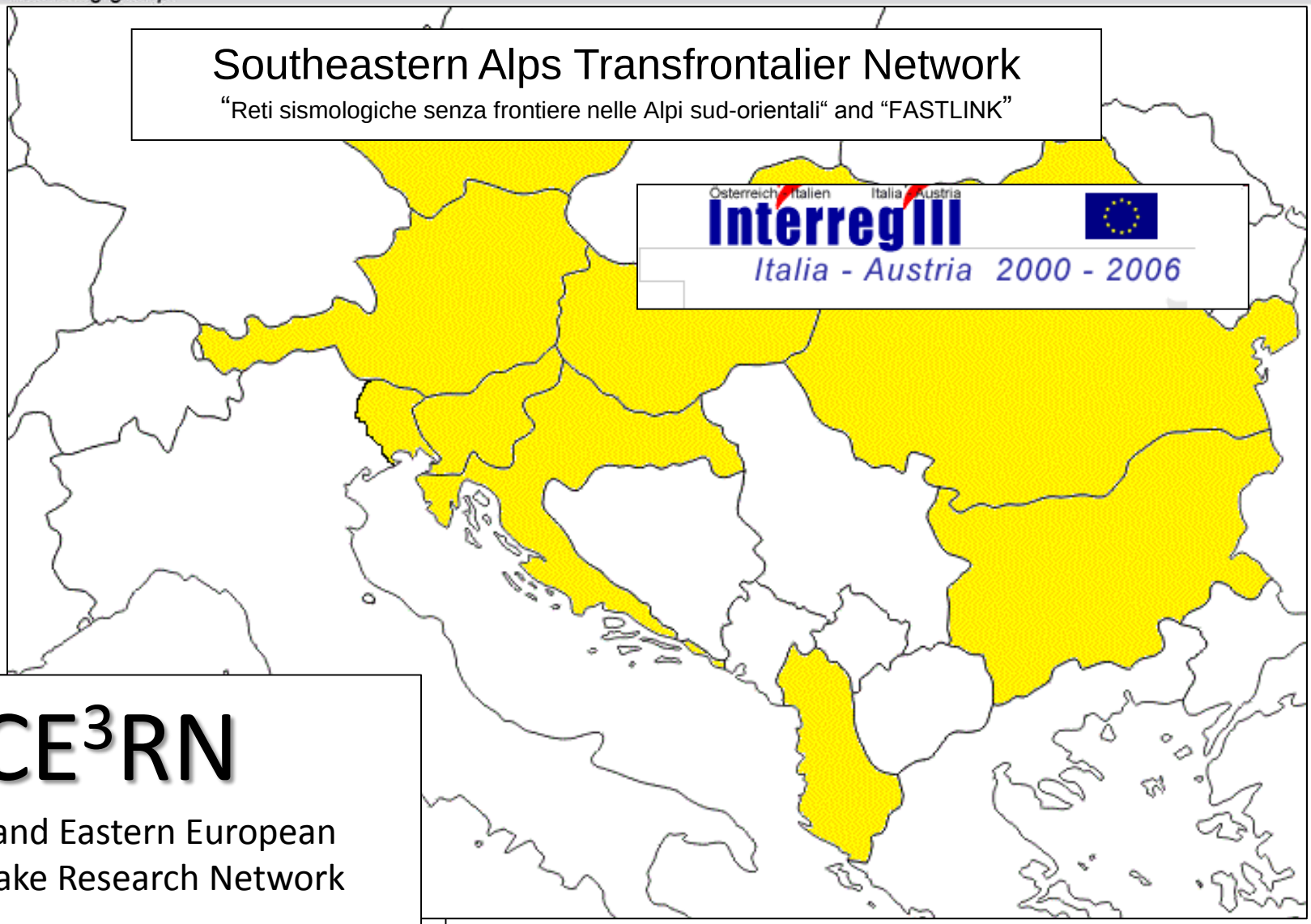
SeisRaM

2008

## Southeastern Alps Transfrontalier Network

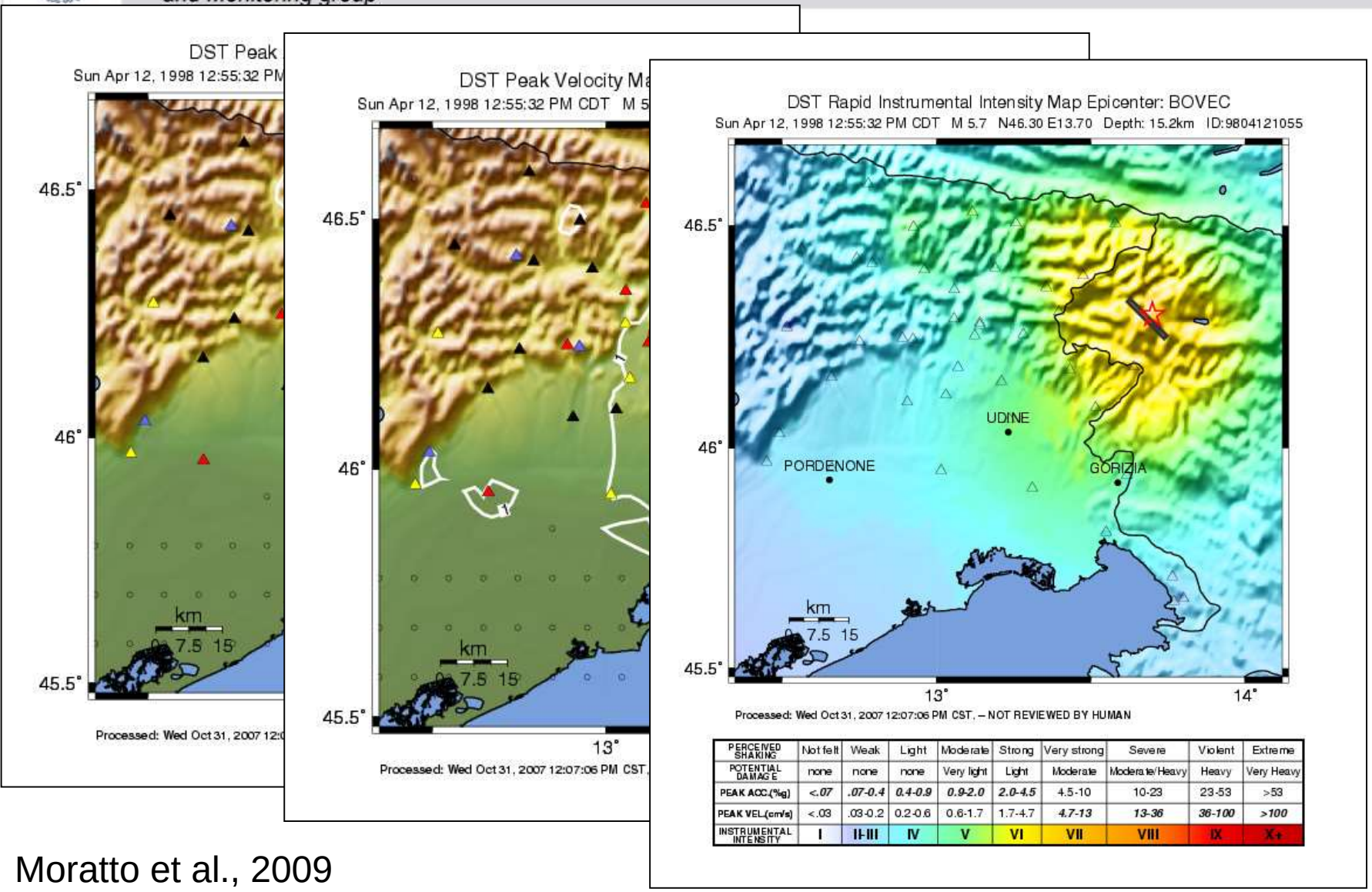
"Reti sismologiche senza frontiere nelle Alpi sud-orientali" and "FASTLINK"

Österreich Italien Italia Austria
Interreg III
Italia - Austria 2000 - 2006



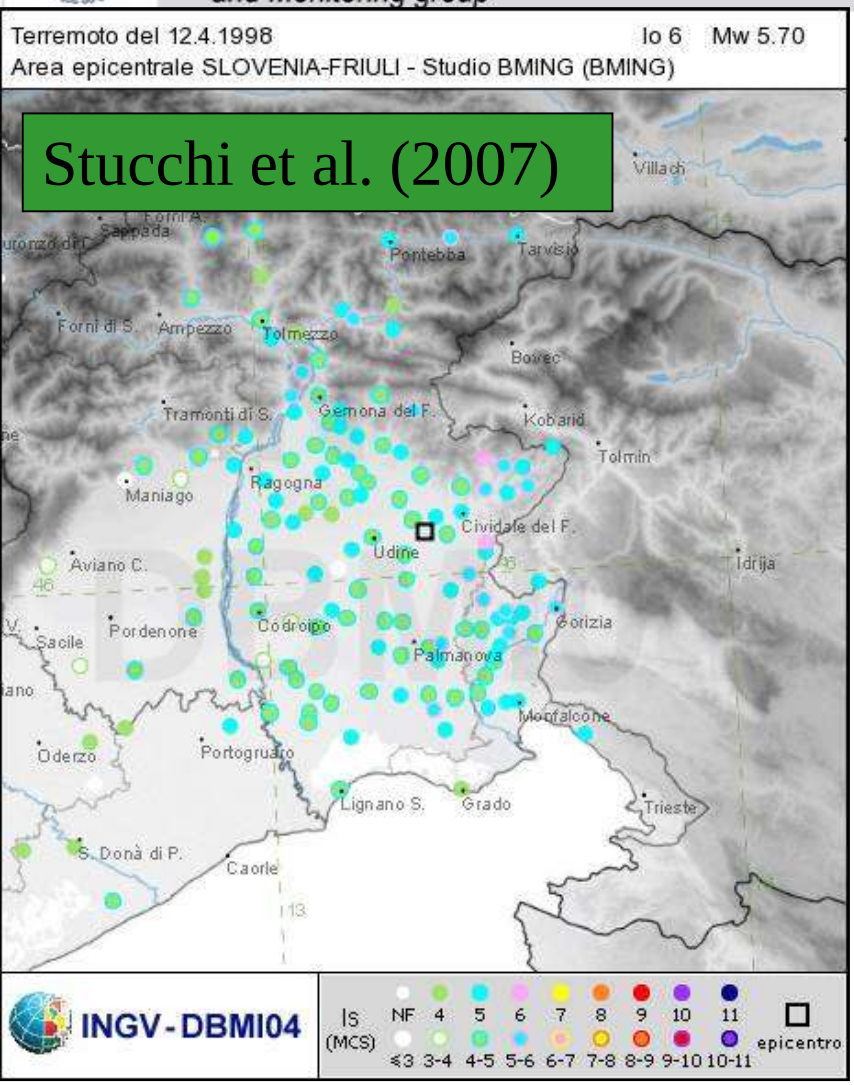
# CE³RN

Central and Eastern European Earthquake Research Network



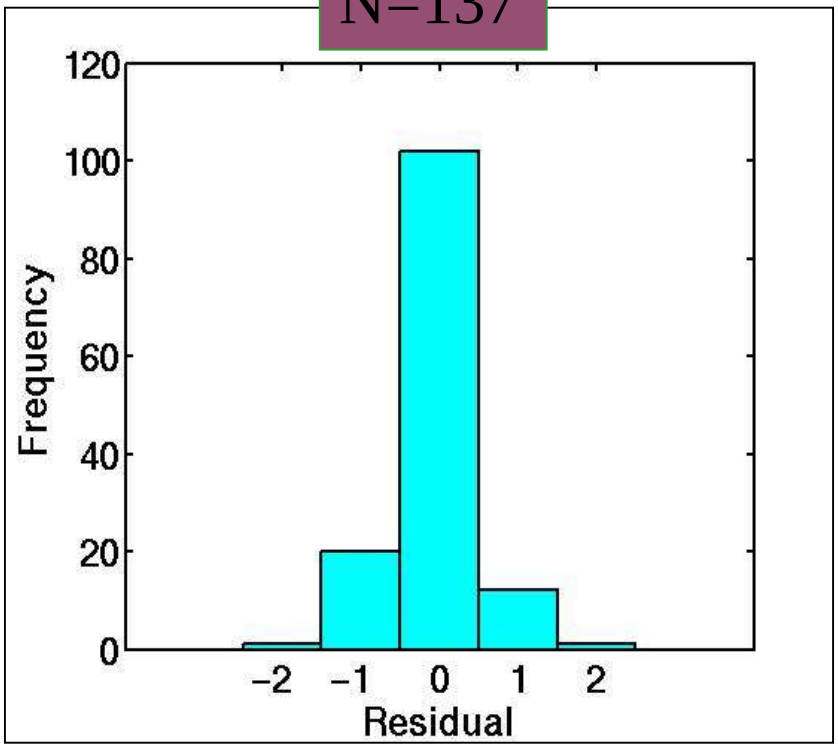

| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | <.07 | .07-0.4 | 0.4-0.9 | 0.9-2.0 | 2.0-4.5 | 4.5-10 | 10-23 | 23-53 | >53 |
| PEAK VEL.(cm/s) | <.03 | .03-0.2 | 0.2-0.6 | 0.6-1.7 | 1.7-4.7 | 4.7-13 | 13-36 | 36-100 | >100 |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

Moratto et al., 2009




$$Misfit = \frac{\sum_{i=1}^{N} |I_{COM} - I_{OBS}|}{N} = 0.264$$

N=137




Moratto et al., 2009

# RAN

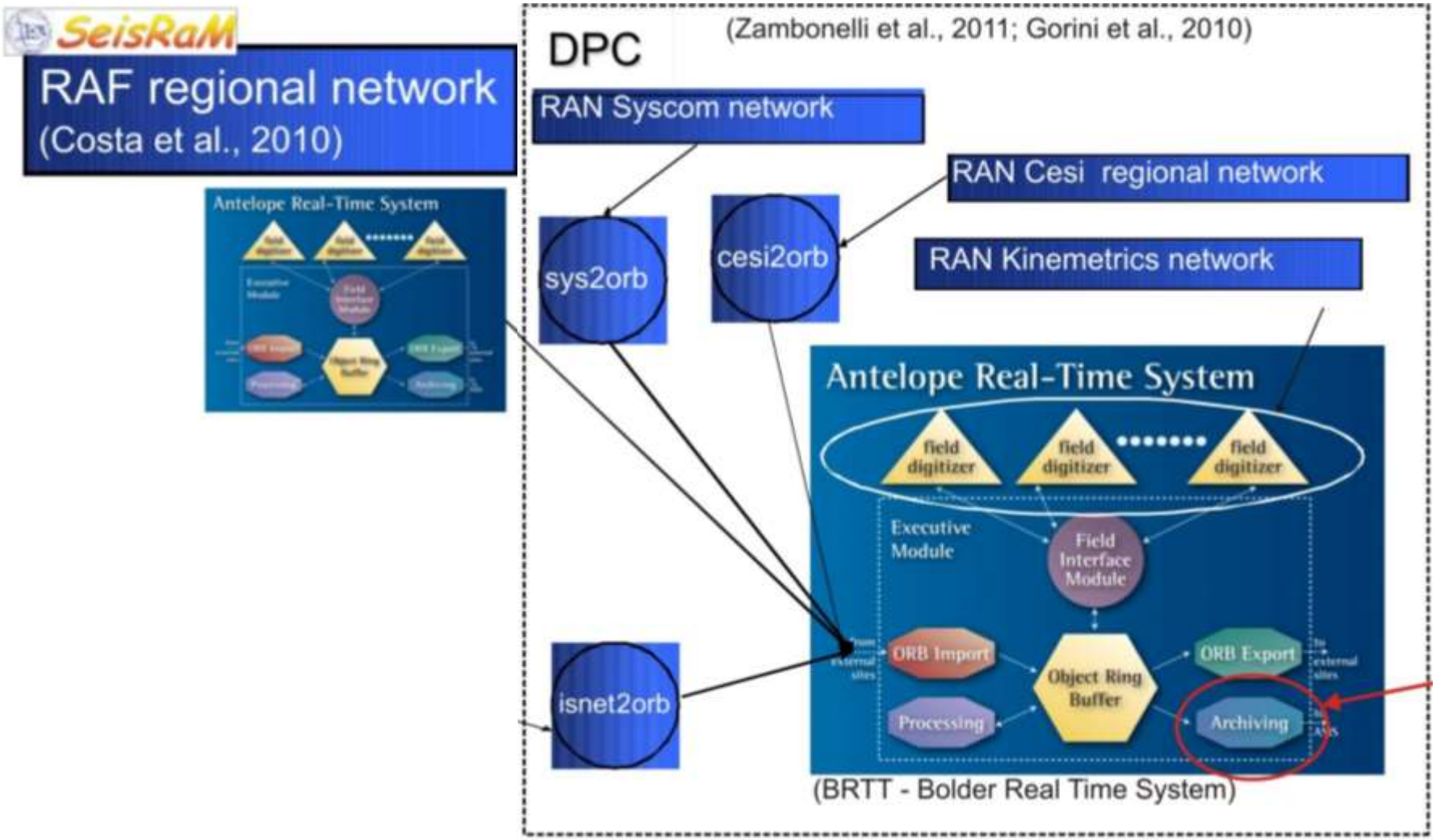
# RAF

Friuli Venezia Giulia
Accelerometric Network – RAF

SeisRaM

- RAN - Syscom
- RAN - Kinemetrics
- RAN - CESI
- RAF
- ISNet

# Real-time system



# Fast strong motion data analysis

A fast seismic data analysis is essential to provide useful information to Authorities which make decisions immediately after a strong earthquake occurrence. During a strong earthquake, the modern accelerometers are the only instruments which can provide near source high-quality data that are important both for scientific (e.g. a better understanding of the source characteristic) and for civil protection purposes (e.g. a rapid provision of information on ground motion parameters to Authorities).

Automatic and fast techniques have been developed by the University of Trieste for the automatic real-time strong motion data analysis. These techniques have tested at University of Trieste using the VBB and strong-motion data of the Central and Eastern European Earthquake Research Network (CE3RN). Starting from 2012 this technique has been installed and optimized in the data acquisition centre of the National Department of Civil Protection of Italy (DPC) in Rome to process the near real-time data of the National Accelerometric Network (RAN).

# Fast strong motion data analysis

The developed procedure estimates in real time the seismic moment, moment magnitude and corner frequency of events recorded by a network comprising broad-band, velocimeter and accelerometer sensors.

Engineering and damage parameters

*PGA, PGV, PGD, PSA, duration, Arias, Housner, RMSA, intensity of zero crossing, Saragoni index, damage factor, etc*.

are also obtained in near real-time, archived and sent by e-mail to the Civil Defence Authorities.

The procedure produces reliable results even for small-magnitude events (≈ 2).

# Alert (python)

origin
stamag
wfmeas

wfmax

alertmeas

DSTalev
DSTalert
places
snetsta
origin

*green: new tables*

DmG.sms

SMS

Alert


10/05/2016 05:26:01 ORID: 340278 EVID: 340278

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

**Earthquake AUTOMATIC REPORT**

**Dipartimento della Protezione Civile - Rome - Italy**
**Rete Accelerometrica Nazionale**
**RAN**

**WARNING:**
**These information are preliminary**
**and may be revised when more data are available.**

Event: CENTRAL ITALY
Origin time: 2016/05/10 03:25:12
Latitude: 42.900 Longitude: 12.784
Depth: 20 km
Magnitude Ml: 2.7
Hostname: aspendpc5
nass: 5
PGA max:
Min distance:

**Nearest cities:**
Terni

12°E 13°E 14°E
43°N 43°
42°
TRE FOPC FOC GNU LSS

| sta | net | stype | dist | | | | |
|---|---|---|---|---|---|---|---|
| TRE | IT | A | 2 | | (N) | 7.2e-02 | (N) |
| FOPC | IT | A | 5 | | (Z) | 1.2e-02 | (E) |
| FOC | IT | A | 9 | | (E) | 4.6e-02 | (N) |
| GNU | IT | A | 11 | | (E) | 7.9e-03 | (E) |
| LSS | IT | A | 21 | | (N) | 2.6e-03 | (E) |

Procedure implemented by SeisRaM group, University of Trieste, Italy, under the agreement with DPC - Alert_3.03 - 2016

# dbmw (fortran90)

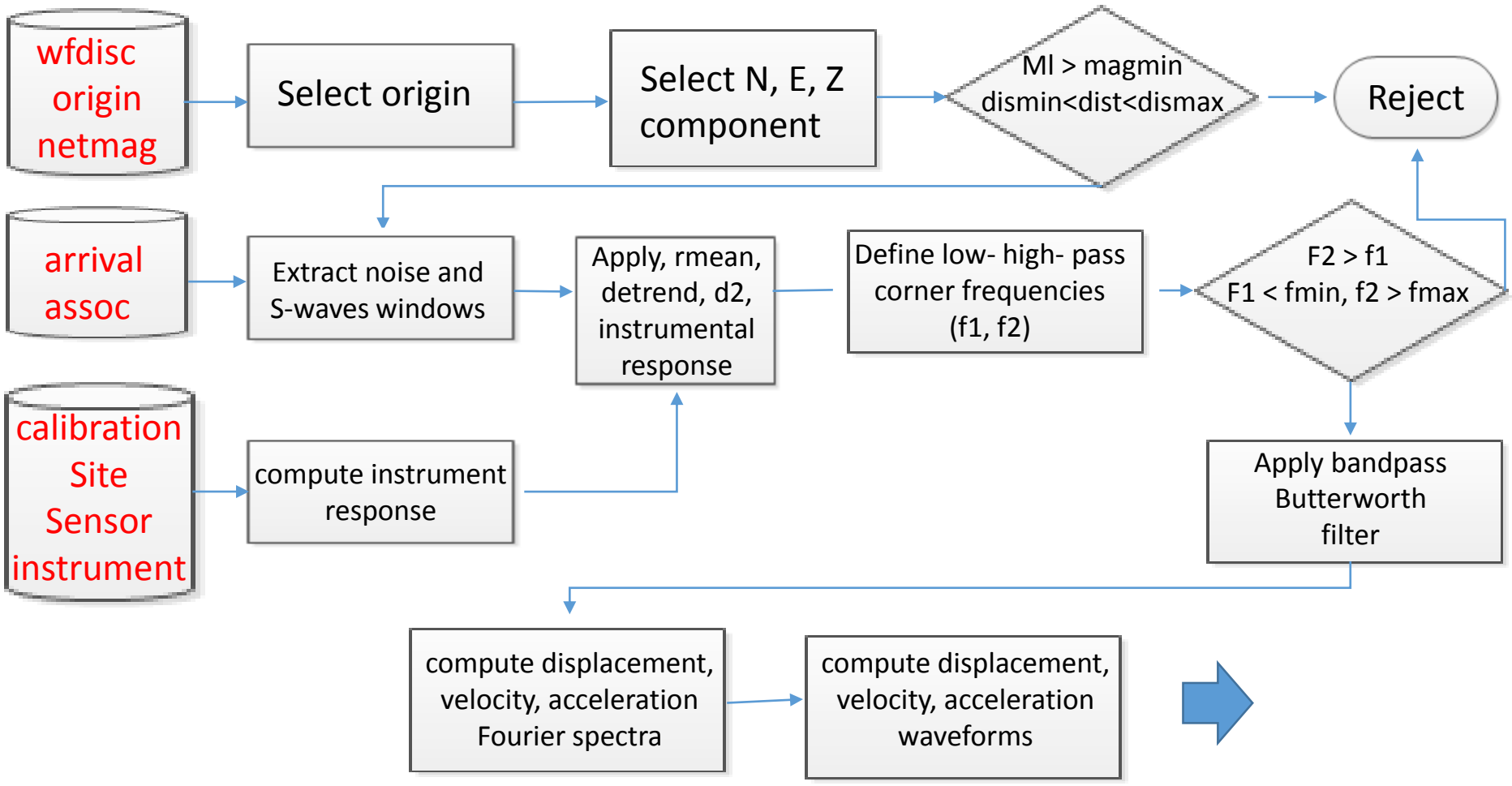
**Signal pre-processing**

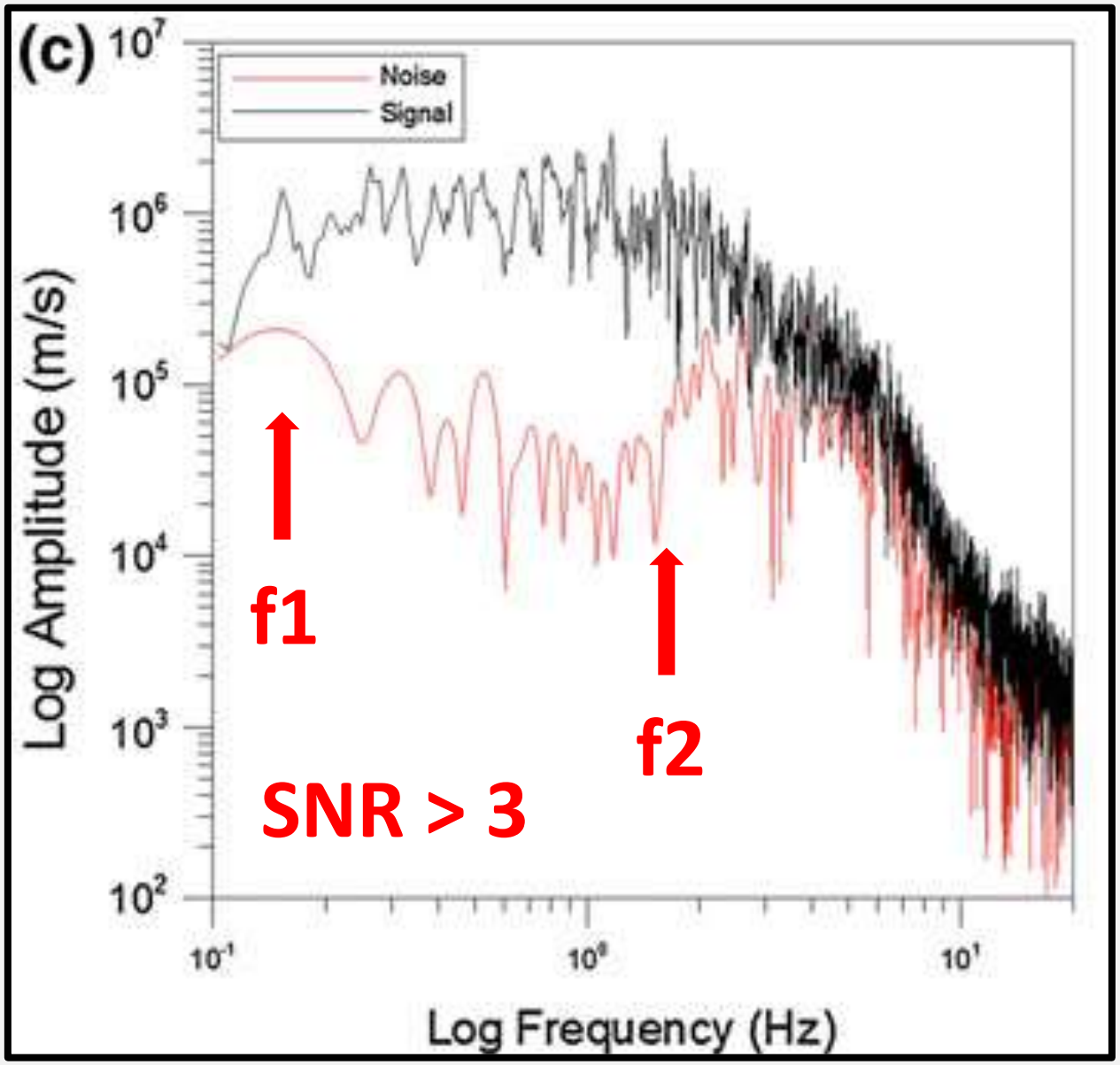
**Seismic Moment, $f_0$, stress drop, Mw computation**

**Response spectra and Ground Motion Parameters**

# dbmw (fortran90)

# Signal pre-processing




(c)
Noise
Signal
Log Amplitude (m/s)
Log Frequency (Hz)
f1
f2
SNR > 3

$$A(f) = D(f)E(f)G(R)$$

$$D(f) = \frac{M_0}{4\pi k\rho v^3}\left[1+\left(\frac{f}{f_0}\right)^2\right]^{-1}$$

Brune source model

$$E(f) = e^{-\left(\frac{\pi f T}{Q(f)}\right)}$$

$$Q(f) = 80\, f^{1.1}$$

(Consoli and Rovelli, 1981)

$$G(R) = \frac{1}{R}$$

($R_{max}$ =70km)

ANDREWS METHOD (1986)

$$SV2 = \int_{f_{inf}}^{f_{sup}} V^2(f)df$$

$$SD2 = \int_{f_{inf}}^{f_{sup}} D^2(f)df$$

$$\Omega^2 = 4SD2^{3/2}SV2^{-1/2}$$

$$f_0 = 1/2\pi\sqrt{SD2SV2}$$

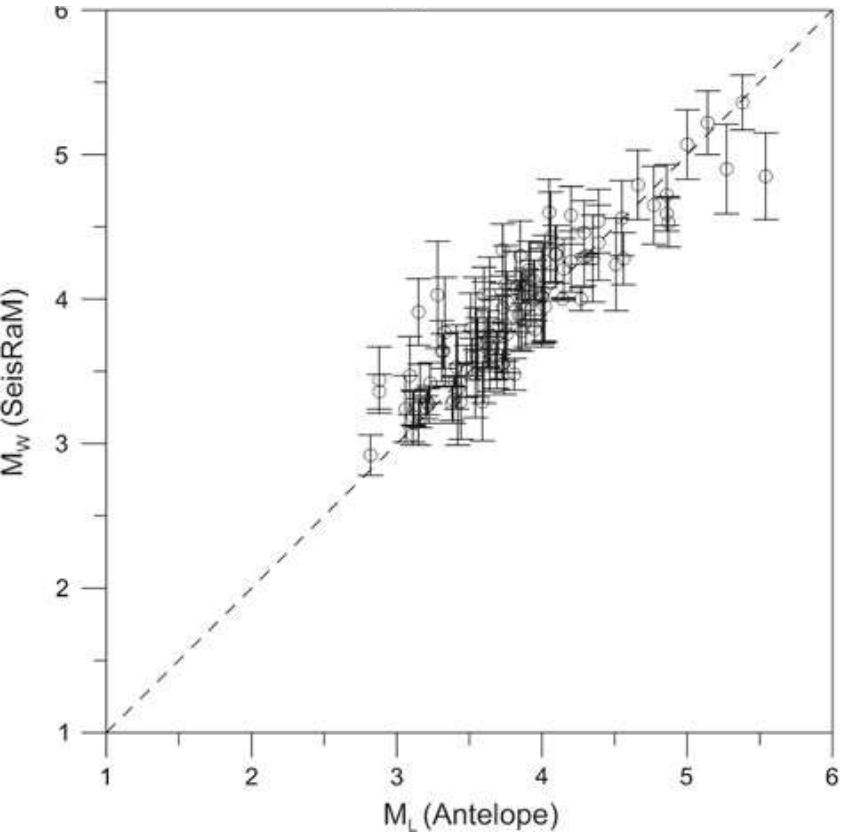
$$M_0 = 4\pi\rho v^3\Omega k$$

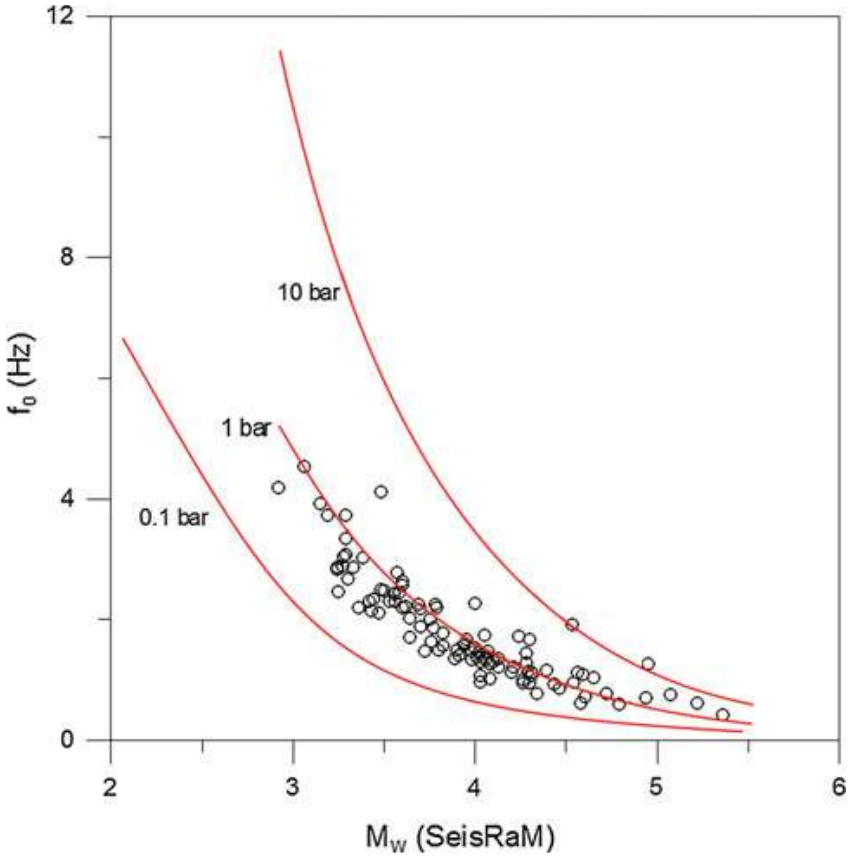
KANAMORI (1979)

$$M_W = \frac{2}{3}\log(M_0) - 6.1$$

Gallo et al., 2014

# SEISMIC MOMENT AND MOMENT MAGNITUDE COMPUTATION




Gallo et al., 2014

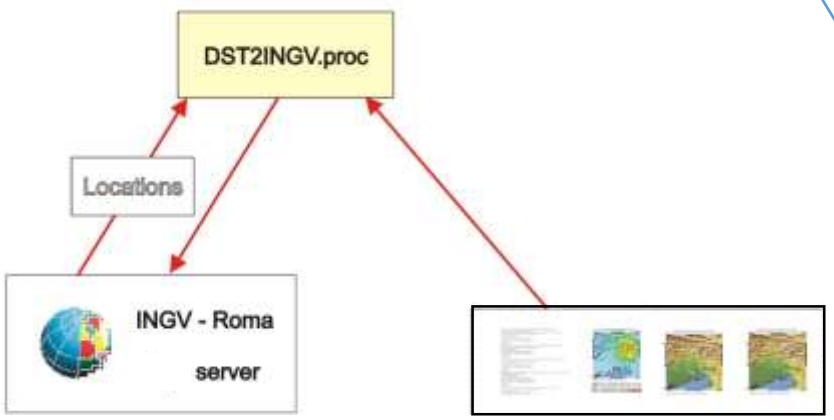
# dbmw (fortran90)

## Response spectra and Ground Motion Parameters

compute response spectra (2, 5, 10, 20 %)

Compute PGA, PGV, PGD, PSA03, PGA10, PGA30, duration

Compute RMSA, Intensity of zero crossing, Saragoni index, damage factor




wfparam
wfdamage

# new dbmw (C)

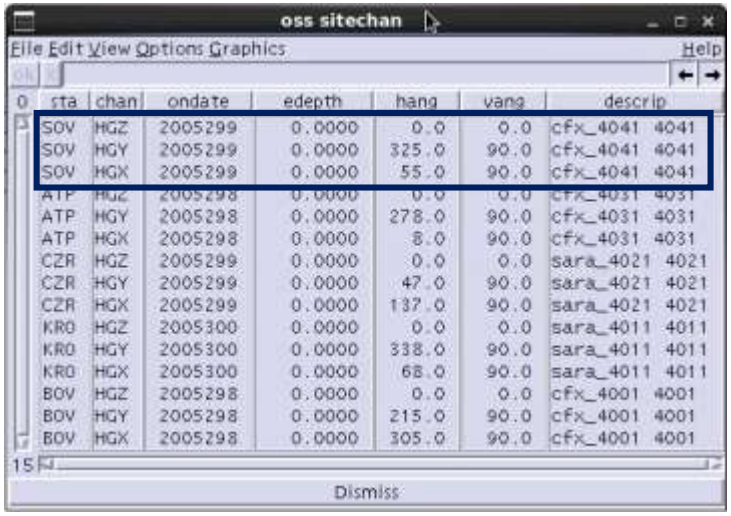
**Fortran90**

~~orb2wf~~

**C**

**orb2wf**

Select N, E, Z components From "chan"




| | sta | chan | ondate | edepth | hang | vang | descrip | |
|---|---|---|---|---|---|---|---|---|
| | SOV | HGZ | 2005299 | 0.0000 | 0.0 | 0.0 | cfx_4041 | 4041 |
| | SOV | HGY | 2005299 | 0.0000 | 325.0 | 90.0 | cfx_4041 | 4041 |
| | SOV | HGX | 2005299 | 0.0000 | 55.0 | 90.0 | cfx_4041 | 4041 |
| | ATP | HGZ | 2005298 | 0.0000 | 0.0 | 0.0 | cfx_4031 | 4031 |
| | ATP | HGY | 2005298 | 0.0000 | 278.0 | 90.0 | cfx_4031 | 4031 |
| | ATP | HGX | 2005298 | 0.0000 | 8.0 | 90.0 | cfx_4031 | 4031 |
| | CZR | HGZ | 2005299 | 0.0000 | 0.0 | 0.0 | sara_4021 | 4021 |
| | CZR | HGY | 2005299 | 0.0000 | 47.0 | 90.0 | sara_4021 | 4021 |
| | CZR | HGX | 2005299 | 0.0000 | 137.0 | 90.0 | sara_4021 | 4021 |
| | KRO | HGZ | 2005300 | 0.0000 | 0.0 | 0.0 | sara_4011 | 4011 |
| | KRO | HGY | 2005300 | 0.0000 | 338.0 | 90.0 | sara_4011 | 4011 |
| | KRO | HGX | 2005300 | 0.0000 | 68.0 | 90.0 | sara_4011 | 4011 |
| | BOV | HGZ | 2005298 | 0.0000 | 0.0 | 0.0 | cfx_4001 | 4001 |
| | BOV | HGY | 2005298 | 0.0000 | 215.0 | 90.0 | cfx_4001 | 4001 |
| | BOV | HGX | 2005298 | 0.0000 | 305.0 | 90.0 | cfx_4001 | 4001 |

Rotate components to N and E

Energy computation

# SPT

origin
site
Geosite
Spetpar
wfparam
wfdamage
netmw

SPT (python)

SPTmap.gmt

*green: new tables*

*future development: python*

22/04/2014 13:07:07 ORID: 22386715 EVID: 22153020

SeisRaM

## Earthquake AUTOMATIC REPORT

**University of Trieste - Italy**
**SeisRaM group**
**data from CE3RN (ARSO, OGS, UniTS, ZAMG)**

**WARNING:**
**These information are preliminary**
**and may be revised when more data are available.**

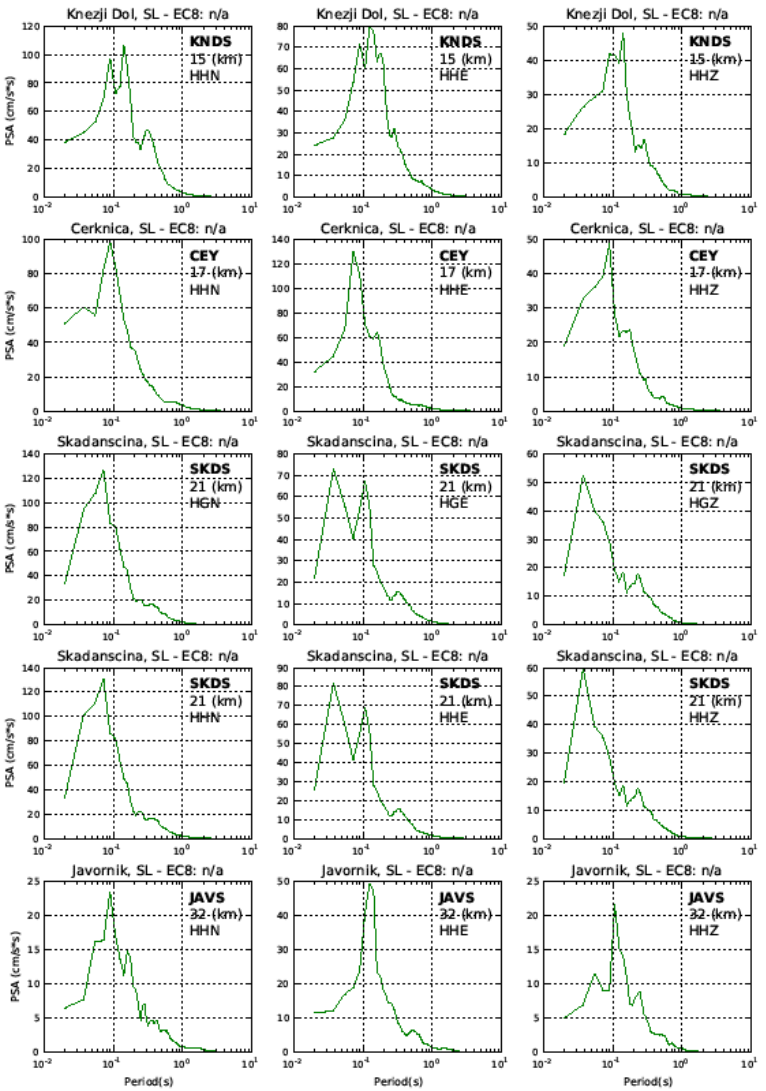
Event: KNEZAK
Origin time: 2014/04/22 08:58:27
Latitude: 45.633 Longitude: 14.258
Magnitude Ml: 4.7
AGENCY: UniTS

Seismic Moment: 2.67e+16 Nm
Mw: 4.5
AGENCY: UniTS

Records analyzed by procedure: 153
Selected limits: max distance=150. km min PGA= 0.1 cm/s*s
min PGA to show response spectra= 0.1 cm/s*s
Records inside the selected limits: 150 response spectra inside the limits: 150

Nearest station: KNDS distance: 15.23 km
HHN - PGA=37.72 cm/s*s, PGV=0.82 cm/s
Max recorded PGA: 47.72 cm/s*s Station: CEY Cerknica, SL
HHN - distance=17.31 km, PGV=0.75 cm/s

Procedure implemented by SeisRaM group, University of Trieste, Italy - ver: SPT_1.25 - 2014 - costa@units.it



SeisRaM

**Event: KNEZAK - Origin time: 2014/04/22 08:58:27 Lat:45.633 Lon:14.258 Ml = 4.7 Agency: UniTS**
**Seismic moment: 2.670e+16 Nm - Mw = 4.5 Agency: UniTS**

| sta | chan | dista | filter | PGA | EPA | PGV | PGD | PSA03 | PSA10 | PSA30 | EC8 | location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | km | Hz | cm/s*s | cm/s*s | cm/s | cm | cm/s*s | cm/s*s | cm/s*s | | |
| KNDS | HHN | 15 | 0.1-50.0 | 37.72 | 18.21 | 0.82 | 0.05 | 46.81 | 3.25 | 0.34 | na | Knezji Dol, SL |
| KNDS | HHE | 15 | 0.1-50.0 | 23.92 | 13.69 | 0.69 | 0.06 | 27.62 | 3.59 | 0.28 | na | Knezji Dol, SL |
| KNDS | HHZ | 15 | 0.1-50.0 | 17.14 | 6.61 | 0.33 | 0.02 | 15.04 | 0.78 | 0.11 | na | Knezji Dol, SL |
| CEY | HHN | 17 | 0.1-50.0 | 47.72 | 10.45 | 0.75 | 0.05 | 17.87 | 3.40 | 0.32 | na | Cerknica, SL |
| CEY | HHE | 17 | 0.1-50.0 | 30.33 | 9.38 | 0.70 | 0.04 | 11.35 | 1.94 | 0.22 | na | Cerknica, SL |
| CEY | HHZ | 17 | 0.1-50.0 | 17.83 | 4.48 | 0.27 | 0.02 | 9.18 | 0.86 | 0.12 | na | Cerknica, SL |
| SKDS | HGN | 21 | 0.1-50.0 | 30.76 | 9.61 | 0.62 | 0.04 | 15.55 | 2.15 | 0.20 | na | Skadanscina, SL |
| SKDS | HGE | 21 | 0.1-50.0 | 19.71 | 7.32 | 0.44 | 0.03 | 14.50 | 1.60 | 0.14 | na | Skadanscina, SL |
| SKDS | HGZ | 21 | 0.1-50.0 | 13.09 | 4.50 | 0.27 | 0.02 | 10.94 | 0.76 | 0.10 | na | Skadanscina, SL |
| SKDS | HHN | 21 | 0.2-50.0 | 30.33 | 9.88 | 0.65 | 0.03 | 15.58 | 2.16 | 0.22 | na | Skadanscina, SL |
| SKDS | HHE | 21 | 0.2-50.0 | 21.62 | 7.46 | 0.43 | 0.02 | 14.51 | 1.65 | 0.16 | na | Skadanscina, SL |
| SKDS | HHZ | 21 | 0.1-50.0 | 13.35 | 4.49 | 0.27 | 0.02 | 10.97 | 0.77 | 0.10 | na | Skadanscina, SL |
| JAVS | HHN | 33 | 0.1-50.0 | 6.13 | 2.86 | 0.14 | 0.02 | 4.66 | 0.80 | 0.15 | na | Javornik, SL |
| JAVS | HHE | 33 | 0.1-50.0 | 11.36 | 6.15 | 0.31 | 0.03 | 10.40 | 1.63 | 0.20 | na | Javornik, SL |
| JAVS | HHZ | 33 | 0.1-50.0 | 4.70 | 2.64 | 0.12 | | 5.09 | | | | |
| DST2 | HHN | 36 | 0.1-47.0 | 7.46 | 4.97 | 0.27 | 0.02 | 9.90 | | | | |
| DST2 | HHE | 36 | 0.1-46.4 | 9.09 | 4.13 | 0.20 | 0.01 | 8.00 | | | | |
| DST2 | HHZ | 36 | 0.1-47.8 | 4.49 | 2.65 | 0.12 | | 5.70 | | | | |
| GBAS | HHN | 37 | 0.1-50.0 | 3.23 | 1.26 | 0.07 | | 2.35 | | | | |
| GBAS | HHE | 37 | 0.1-50.0 | 3.71 | 1.43 | 0.07 | | 3.31 | | | | |
| GBAS | HHZ | 37 | 0.1-50.0 | 2.43 | 0.96 | 0.06 | | 1.56 | | | | |
| TRI | HHN | 39 | 0.1-47.3 | 12.38 | 1.97 | 0.15 | | 2.33 | | | | |
| TRI | HHE | 39 | 0.1-45.6 | 13.66 | 3.60 | 0.19 | | 4.30 | | | | |
| TRI | HHZ | 39 | 0.1-47.5 | 31.18 | 4.24 | 0.34 | | 5.12 | | | | |
| GBRS | HHN | 45 | 0.1-50.0 | 11.89 | 3.11 | 0.20 | | 2.86 | | | | |
| GBRS | HHE | 45 | 0.1-50.0 | 15.31 | 3.81 | 0.25 | | 4.30 | | | | |
| GBRS | HHZ | 45 | 0.1-50.0 | 4.42 | 1.12 | 0.07 | | 1.75 | | | | |
| VISS | HHN | 49 | 0.1-50.0 | 3.78 | 2.32 | 0.13 | 0.01 | 4.22 | | | | |
| VISS | HHE | 49 | 0.1-50.0 | 3.68 | 2.00 | 0.10 | | 2.71 | | | | |

dista = epicentral distance
filter = automatic band pass butterworth filter
EC8 = site classification (Eurocode from ITACA)
PGA,PGV,PGD = p
EPA = effective g
PSA03,PSA10,PSA

SeisRaM

**Event: KNEZAK - Origin time: 2014/04/22 08:58:27 Lat:45.633 Lon:14.258 Ml = 4.7 Agency: UniTS**
**Seismic moment: 2.670e+16 Nm - Mw = 4.5 Agency: UniTS**

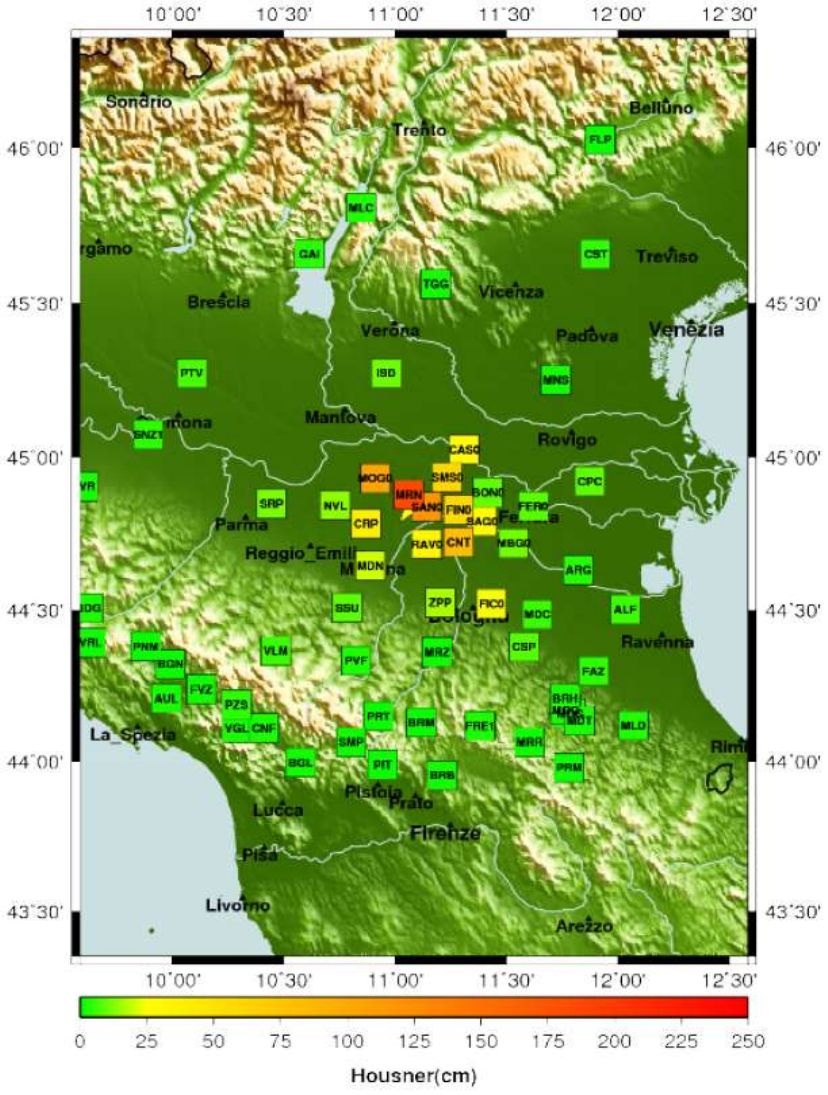
| sta | chan | dista | filter | Td | PGV/PGA | RMSA | v0 | Pd | Id | Housner | Arias | EC8 | location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | km | Hz | s | s | cm/s*s | 1/s | cm*s | cm/s | cm | cm/s | | |
| KNDS | HHN | 15 | 0.1-50.0 | 3.10 | 0.02 | 7.03 | 225.53 | | 4.94 | 2.68 | 0.24 | na | Knezji Dol, SL |
| KNDS | HHE | 15 | 0.1-50.0 | 4.30 | 0.03 | 5.05 | 175.84 | | 6.60 | 2.29 | 0.18 | na | Knezji Dol, SL |
| KNDS | HHZ | 15 | 0.1-50.0 | 5.82 | 0.02 | 2.45 | 170.08 | | 6.25 | 0.99 | 0.06 | na | Knezji Dol, SL |
| CEY | HHN | 17 | 0.1-50.0 | 4.67 | 0.02 | 5.93 | 320.00 | | 4.63 | 1.90 | 0.26 | na | Cerknica, SL |
| CEY | HHE | 17 | 0.1-50.0 | 5.78 | 0.02 | 5.24 | 252.25 | | 7.43 | 1.91 | 0.25 | na | Cerknica, SL |
| CEY | HHZ | 17 | 0.1-50.0 | 8.03 | 0.02 | 2.52 | 218.18 | | 10.70 | 0.76 | 0.08 | na | Cerknica, SL |
| SKDS | HGN | 21 | 0.1-50.0 | 4.37 | 0.02 | 7.04 | 415.12 | | 11.42 | 1.90 | 0.35 | na | Skadanscina, SL |
| SKDS | HGE | 21 | 0.1-50.0 | 5.63 | 0.02 | 4.20 | 311.98 | | 11.49 | 1.33 | 0.16 | na | Skadanscina, SL |
| SKDS | HGZ | 21 | 0.1-50.0 | 8.31 | 0.02 | 2.76 | 250.66 | | 18.01 | 0.80 | 0.10 | na | Skadanscina, SL |
| SKDS | HHN | 21 | 0.2-50.0 | 4.58 | 0.02 | 7.24 | 399.34 | | 12.21 | 1.91 | 0.38 | na | Skadanscina, SL |
| SKDS | HHE | 21 | 0.2-50.0 | 5.59 | 0.02 | 4.52 | 316.35 | | 12.42 | 1.29 | 0.18 | na | Skadanscina, SL |
| SKDS | HHZ | 21 | 0.1-50.0 | 8.01 | 0.02 | 2.91 | 255.56 | | 19.07 | 0.80 | 0.11 | na | Skadanscina, SL |
| JAVS | HHN | 33 | 0.1-50.0 | 14.61 | 0.02 | 0.85 | 92.16 | | 12.71 | 0.56 | 0.02 | na | Javornik, SL |
| JAVS | HHE | 33 | 0.1-50.0 | 6.92 | 0.03 | 1.93 | 163.75 | | 7.22 | 0.97 | 0.04 | na | Javornik, SL |
| JAVS | HHZ | 33 | 0.1-50.0 | 13.39 | 0.03 | 0.71 | 105.49 | | 11.55 | 0.39 | 0.01 | na | Javornik, SL |
| DST2 | HHN | 36 | 0.1-47.0 | 14.76 | 0.04 | 1.37 | 111.59 | | 13.69 | 0.90 | 0.04 | A | DST-Trieste_station |
| DST2 | HHE | 36 | 0.1-46.4 | 17.05 | 0.02 | 1.31 | 101.23 | | 15.93 | 0.59 | 0.05 | A | DST-Trieste_station |
| DST2 | HHZ | 36 | 0.1-47.8 | 18.82 | 0.03 | 0.89 | 116.84 | | 27.43 | 0.42 | 0.02 | A | DST-Trieste_station |
| GBAS | HHN | 37 | 0.1-50.0 | 17.75 | 0.02 | 0.61 | 99.07 | | 30.41 | 0.21 | 0.01 | na | Gornja Brezovica, SL |
| GBAS | HHE | 37 | 0.1-50.0 | 16.73 | 0.02 | 0.61 | 102.00 | | 25.26 | 0.22 | 0.01 | na | Gornja Brezovica, SL |
| GBAS | HHZ | 37 | 0.1-50.0 | 17.07 | 0.02 | 0.46 | 110.28 | | 24.66 | 0.20 | | na | Gornja Brezovica, SL |
| TRI | HHN | 39 | 0.1-47.3 | 21.71 | 0.01 | 1.69 | 101.70 | | 33.98 | 0.41 | 0.10 | A | TRI-Trieste_station |
| TRI | HHE | 39 | 0.1-45.6 | 22.66 | 0.01 | 2.58 | 90.25 | | 57.66 | 0.53 | 0.24 | A | TRI-Trieste_station |
| TRI | HHZ | 39 | 0.1-47.5 | 25.99 | 0.01 | 9.15 | 179.03 | | 207.24 | 0.84 | 3.49 | A | TRI-Trieste_station |
| GBRS | HHN | 45 | 0.1-50.0 | 16.55 | 0.02 | 2.27 | 86.01 | | 35.58 | 0.61 | 0.14 | na | Gornja Briga, SL |
| GBRS | HHE | 45 | 0.1-50.0 | 15.47 | 0.02 | 2.88 | 87.82 | | 33.79 | 0.68 | 0.21 | na | Gornja Briga, SL |
| GBRS | HHZ | 45 | 0.1-50.0 | 18.57 | 0.02 | 0.85 | 106.62 | | 43.55 | 0.25 | 0.02 | na | Gornja Briga, SL |
| VISS | HHN | 49 | 0.1-50.0 | 12.92 | 0.03 | 0.74 | 116.91 | | 14.44 | 0.45 | 0.01 | na | Visnje, SL |
| VISS | HHE | 49 | 0.1-50.0 | 13.73 | 0.03 | 0.67 | 103.20 | | 17.68 | 0.31 | | na | Visnje, SL |

dista = epicentral distance
filter = automatic band pass butterworth filter
Td = duration (Trifunac and Bardy, 1975)
PGA,PGV = peak ground acceleration and velocity
RMSA = root mean square acceleration
v0 = intensity of zero crossing
Pd = Saragoni index
Id = damage factor
Housner = Housner spectral intensity
Arias = Arias intensity
EC8 = site classification (Eurocode8 from ITACA)

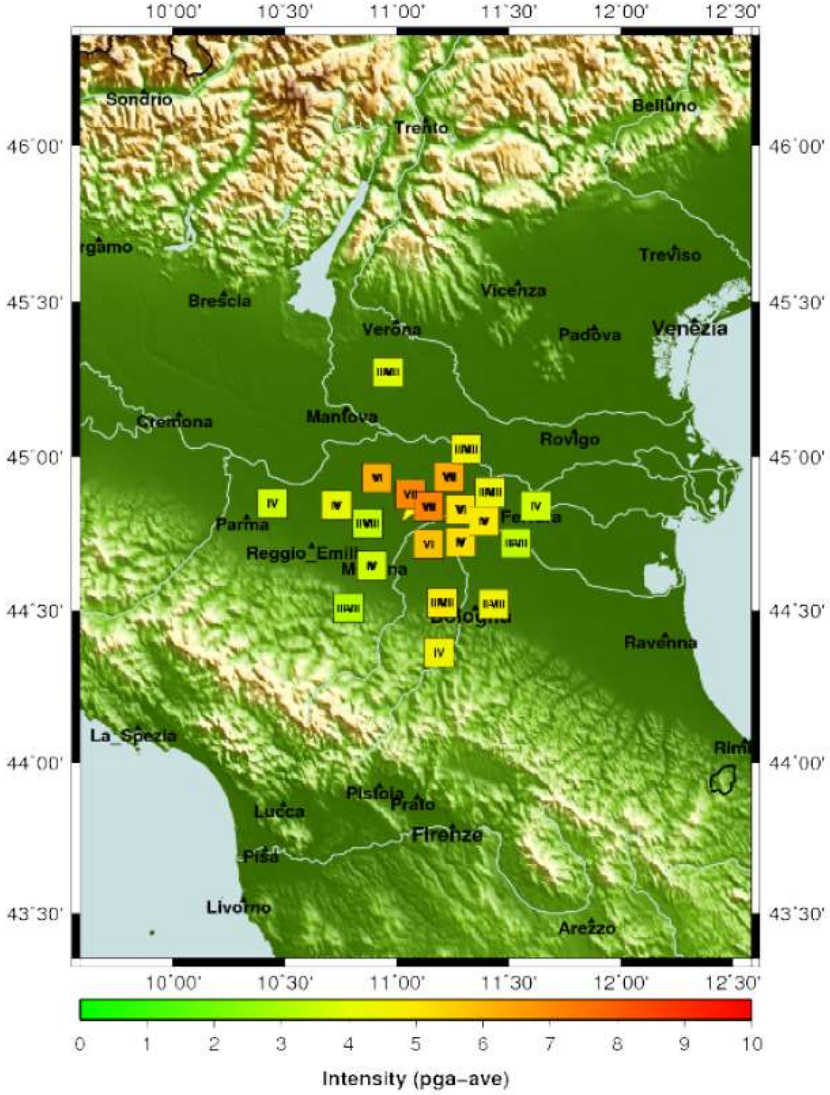
# Antelope User Group meeting
## Rome, Maj 18-20, 2016



2012/05/29 07:00:03 MI:5.8 NORTHERN_ITALY




2012/05/29 07:00:03 MI:5.8 NORTHERN_ITALY



**Event: NORTHERN - Origin time: 2012/05/29 07:00:03 Lat:44.851 Lon:11.086 Ml = 5.8 Agency: INGV**
**Seismic moment: 1.130e+18 Nm - Mw = 5.8 Agency: UniTS**

| sta | chan | dista km | filter Hz | PGA cm/s*s | EPA cm/s*s | PGV cm/s | PGD cm | PSA03 cm/s*s | PSA10 cm/s*s | PSA30 cm/s*s | EC8 | location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MRN | HGN | 4 | 0.1-50.0 | 296.92 | 267.39 | 50.05 | 16.75 | 711.99 | 344.55 | 156.01 | C | Mirandola |
| MRN | HGE | 4 | 0.1-50.0 | 251.19 | 214.60 | 24.34 | 8.70 | 588.27 | 174.41 | 72.37 | C | Mirandola |
| MRN | HGZ | 4 | 0.1-50.0 | 895.78 | 239.98 | 21.64 | 5.86 | 381.48 | 87.98 | 25.17 | C | Mirandola |
| SAN0 | HGN | 4 | 0.1-50.0 | 238.52 | 201.78 | 31.15 | 10.91 | 531.88 | 198.90 | 122.31 | na | San_Felice_sul_Panaro |
| SAN0 | HGE | 4 | 0.1-50.0 | 152.70 | 148.42 | 23.65 | 6.08 | 388.62 | 208.71 | 81.58 | na | San_Felice_sul_Panaro |
| SAN0 | HGZ | 4 | 0.1-50.0 | 327.18 | 134.34 | 9.81 | 3.55 | 295.86 | 42.63 | 20.32 | na | San_Felice_sul_Panaro |
| SMS0 | HGN | 15 | 0.1-50.0 | 187.27 | 141.93 | 13.04 | 4.48 | 337.50 | 168.40 | 36.21 | na | San_Martino_Spino |
| SMS0 | HGE | 15 | 0.1-50.0 | 177.15 | 238.06 | 15.51 | 4.11 | 606.28 | 137.93 | 28.43 | na | San_Martino_Spino |
| SMS0 | HGZ | 15 | 0.1-50.0 | 122.37 | 52.29 | 3.08 | 0.97 | 106.20 | 17.54 | 7.95 | na | San_Martino_Spino |
| RAV0 | HGN | 16 | 0.1-50.0 | 94.78 | 73.04 | 9.59 | 3.78 | 248.98 | 138.27 | 20.17 | na | Ravarino |
| RAV0 | HGE | 16 | 0.1-50.0 | 57.84 | 42.25 | 5.55 | 1.32 | 185.47 | 74.58 | 8.96 | na | Ravarino |
| RAV0 | HGZ | 16 | 0.1-50.0 | 64.19 | 27.69 | 1.65 | 1.35 | 92. | | | | |
| FIN0 | HGN | 16 | 0.1-50.0 | 247.46 | 195.48 | 15.89 | 3.00 | 585. | | | | |
| FIN0 | HGE | 16 | 0.1-50.0 | 212.39 | 178.21 | 14.65 | 3.01 | 366. | | | | |
| FIN0 | HGZ | 16 | 0.1-50.0 | 208.85 | 54.58 | 3.17 | 0.87 | 119. | | | | |
| MOG0 | HGN | 16 | 0.1-50.0 | 161.37 | 175.17 | 20.21 | 5.77 | 461. | | | | |
| MOG0 | HGE | 16 | 0.1-50.0 | 252.91 | 227.59 | 25.65 | 2.92 | 578. | | | | |
| MOG0 | HGZ | 16 | 0.1-50.0 | 125.22 | 89.73 | 4.27 | 1.43 | 248. | | | | |
| CRP | HGN | 19 | 0.1-50.0 | 172.60 | 109.54 | 7.27 | 1.96 | 193. | | | | |
| CRP | HGE | 19 | 0.1-50.0 | 128.17 | 86.17 | 8.94 | 2.11 | 192. | | | | |
| CRP | HGZ | 19 | 0.1-50.0 | 85.82 | 42.72 | 2.26 | 0.77 | 76. | | | | |
| CNT | HGN | 21 | 0.1-50.0 | 301.71 | 245.93 | 14.63 | 2.55 | 1011. | | | | |
| CNT | HGE | 21 | 0.1-50.0 | 215.22 | 259.72 | 17.15 | 3.38 | 781. | | | | |
| CNT | HGZ | 21 | 0.1-50.0 | 67.00 | 55.26 | 2.68 | 0.50 | 280. | | | | |
| SAG0 | HGN | 25 | 0.1-50.0 | 66.74 | 62.56 | 6.09 | 2.15 | 177. | | | | |
| SAG0 | HGE | 25 | 0.1-50.0 | 84.09 | 86.95 | 7.10 | 1.45 | 291. | | | | |
| SAG0 | HGZ | 25 | 0.1-50.0 | 67.09 | 35.01 | 1.94 | 0.56 | 75. | | | | |
| CAS0 | HGN | 26 | 0.1-50.0 | 42.08 | 40.79 | 7.50 | 3.50 | 113. | | | | |
| CAS0 | HGE | 26 | 0.1-50.0 | 71.49 | 69.43 | 6.16 | 2.74 | 172. | | | | |

dista = epicentral distance
filter = automatic band pass butterworth filter
EC8 = site classification (Eurocode from ITACA)
PGA,PGV,P
EPA = effe
PSA03,PSA

**Event: NORTHERN - Origin time: 2012/05/29 07:00:03 Lat:44.851 Lon:11.086 Ml = 5.8 Agency: INGV**
**Seismic moment: 1.130e+18 Nm - Mw = 5.8 Agency: UniTS**

| sta | chan | dista km | filter Hz | Td s | PGV/PGA s | RMSA cm/s*s | v0 1/s | Pd cm*s | Id cm/s | Housner cm | Arias cm/s | EC8 | location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MRN | HGN | 4 | 0.1-50.0 | 6.98 | 0.17 | 103.65 | 108.02 | 0.01 | 5.05 | 186.41 | 128.07 | C | Mirandola |
| MRN | HGE | 4 | 0.1-50.0 | 7.54 | 0.10 | 77.17 | 115.84 | | 7.35 | 101.21 | 71.95 | C | Mirandola |
| MRN | HGZ | 4 | 0.1-50.0 | 5.22 | 0.02 | 187.28 | 304.31 | | 9.46 | 49.74 | 293.44 | C | Mirandola |
| SAN0 | HGN | 4 | 0.1-50.0 | 6.55 | 0.13 | 69.39 | 76.95 | | 4.24 | 119.18 | 50.50 | na | San_Felice_sul_Panaro |
| SAN0 | HGE | 4 | 0.1-50.0 | 6.62 | 0.15 | 52.14 | 71.20 | | 4.98 | 80.70 | 28.79 | na | San_Felice_sul_Panaro |
| SAN0 | HGZ | 4 | 0.1-50.0 | 4.44 | 0.03 | 76.86 | 232.21 | | 8.72 | 29.86 | 41.13 | na | San_Felice_sul_Panaro |
| SMS0 | HGN | 15 | 0.1-50.0 | 8.76 | 0.07 | 46.51 | 82.01 | | 7.76 | 60.31 | 38.32 | na | San_Martino_Spino |
| SMS0 | HGE | 15 | 0.1-50.0 | 6.12 | 0.09 | 66.42 | 93.86 | | 9.83 | 60.38 | 43.26 | na | San_Martino_Spino |
| SMS0 | HGZ | 15 | 0.1-50.0 | 6.70 | 0.03 | 33.49 | 173.56 | | 19.94 | 12.12 | 12.02 | na | San_Martino_Spino |
| RAV0 | HGN | 16 | 0.1-50.0 | 13.40 | 0.10 | 17.39 | 38.05 | | 4.46 | 34.32 | 6.49 | na | Ravarino |
| RAV0 | HGE | 16 | 0.1-50.0 | 13.13 | 0.10 | 11.66 | 42.50 | | 5.56 | 21.83 | 2.86 | na | Ravarino |
| RAV0 | HGZ | 16 | 0.1-50.0 | 9.21 | 0.03 | 12.37 | 88.10 | | 13.30 | 6.52 | 2.25 | na | Ravarino |
| FIN0 | HGN | 16 | 0.1-50.0 | 9.14 | 0.06 | 41.24 | 61.45 | | 3.96 | 52.00 | 24.91 | na | Finale_Emilia |
| FIN0 | HGE | 16 | 0.1-50.0 | 9.03 | 0.07 | 43.83 | 63.90 | | 5.58 | 57.50 | 27.78 | na | Finale_Emilia |
| FIN0 | HGZ | 16 | 0.1-50.0 | 5.59 | 0.02 | 58.03 | 146.69 | | 28.47 | 14.94 | 30.14 | na | Finale_Emilia |
| MOG0 | HGN | 16 | 0.1-50.0 | 6.52 | 0.13 | 59.12 | 63.96 | | 6.99 | 102.93 | 36.49 | na | Moglia |
| MOG0 | HGE | 16 | 0.1-50.0 | 7.18 | 0.10 | 66.03 | 59.71 | 0.01 | 4.83 | 95.01 | 50.16 | na | Moglia |
| MOG0 | HGZ | 16 | 0.1-50.0 | 9.13 | 0.03 | 31.66 | 83.42 | | 17.13 | 22.43 | 14.66 | na | Moglia |
| CRP | HGN | 19 | 0.1-50.0 | 12.99 | 0.04 | 30.50 | 49.02 | | 9.64 | 32.63 | 19.36 | na | Carpi |
| CRP | HGE | 19 | 0.1-50.0 | 12.85 | 0.07 | 27.14 | 54.01 | | 8.26 | 38.53 | 15.15 | na | Carpi |
| CRP | HGZ | 19 | 0.1-50.0 | 10.61 | 0.03 | 20.22 | 80.68 | | 22.38 | 11.62 | 6.94 | na | Carpi |
| CNT | HGN | 21 | 0.1-50.0 | 5.76 | 0.05 | 65.78 | 96.79 | | 5.65 | 55.61 | 39.94 | na | Cento |
| CNT | HGE | 21 | 0.1-50.0 | 4.20 | 0.08 | 79.24 | 138.10 | | 7.15 | 82.42 | 42.22 | na | Cento |
| CNT | HGZ | 21 | 0.1-50.0 | 8.98 | 0.04 | 17.86 | 83.85 | | 15.97 | 9.60 | 4.59 | na | Cento |
| SAG0 | HGN | 25 | 0.1-50.0 | 17.43 | 0.09 | 13.91 | 35.97 | | 8.29 | 27.31 | 5.40 | na | Sant_Agostino |
| SAG0 | HGE | 25 | 0.1-50.0 | 16.61 | 0.08 | 17.95 | 36.80 | | 8.96 | 27.53 | 8.57 | na | Sant_Agostino |
| SAG0 | HGZ | 25 | 0.1-50.0 | 10.65 | 0.03 | 13.29 | 75.40 | | 14.43 | 7.08 | 3.81 | na | Sant_Agostino |
| CAS0 | HGN | 26 | 0.1-50.0 | 18.53 | 0.18 | 13.32 | 23.58 | | 10.42 | 27.93 | 5.27 | na | Castelnassa |
| CAS0 | HGE | 26 | 0.1-50.0 | 17.80 | 0.09 | 16.35 | 26.00 | 0.01 | 10.82 | 26.81 | 7.62 | na | Castelnassa |

dista = epicentral distance
filter = automatic band pass butterworth filter
Td = duration (Trifunac and Bardy, 1975)
PGA,PGV = peak ground acceleration and velocity
RMSA = root mean square acceleration
v0 = intensity of zero crossing
Pd = Saragoni index
Id = damage factor
Housner = Housner spectral intensity
Arias = Arias intensity
EC8 = site classification (Eurocode8 from ITACA)

03/04/2014 12:05:11 ORID: 618 EVID: 389

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

**Earthquake AUTOMATIC REPORT**

**Dipartimento della Protezione Civile - Rome - Italy**
**Rete Accelerometrica Nazionale**
**RAN**

**WARNING:**
**These information are preliminary**
**and may be revised when more data are available.**

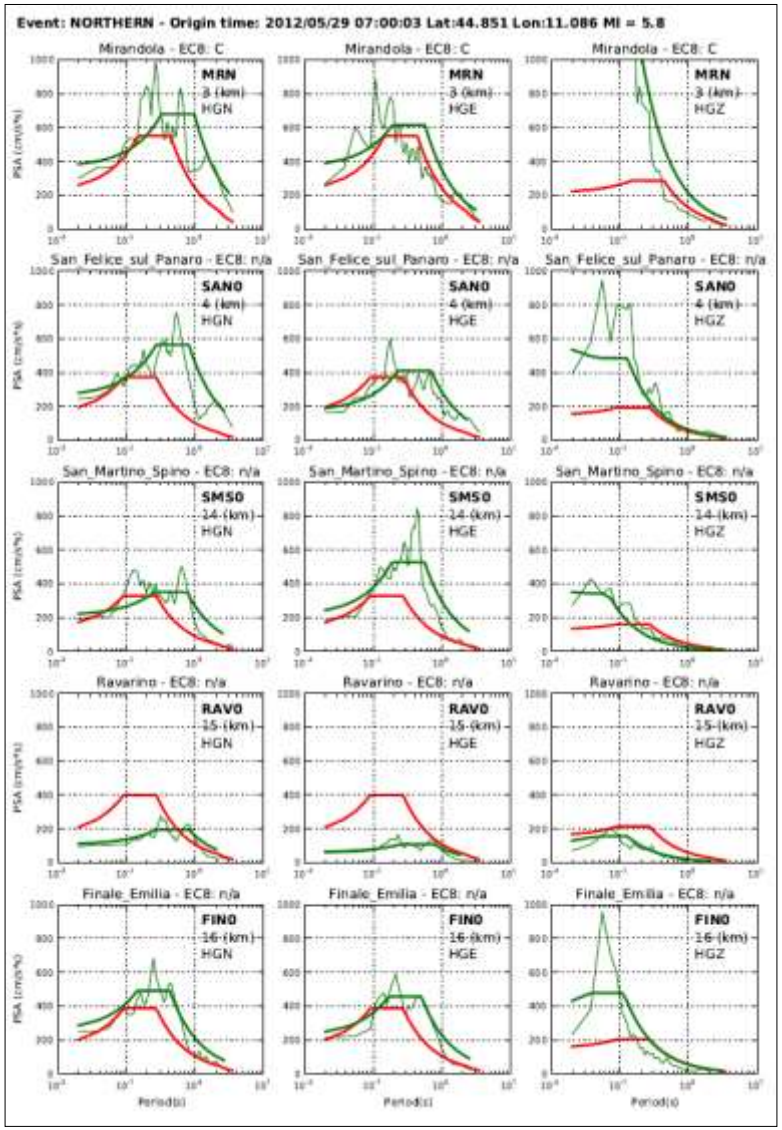
Event: NORTHERN_ITALY
Origin time: 2012/05/29 07:00:03
Latitude: 44.851 Longitude: 11.086
Magnitude Ml: 5.8
AGENCY: INGV

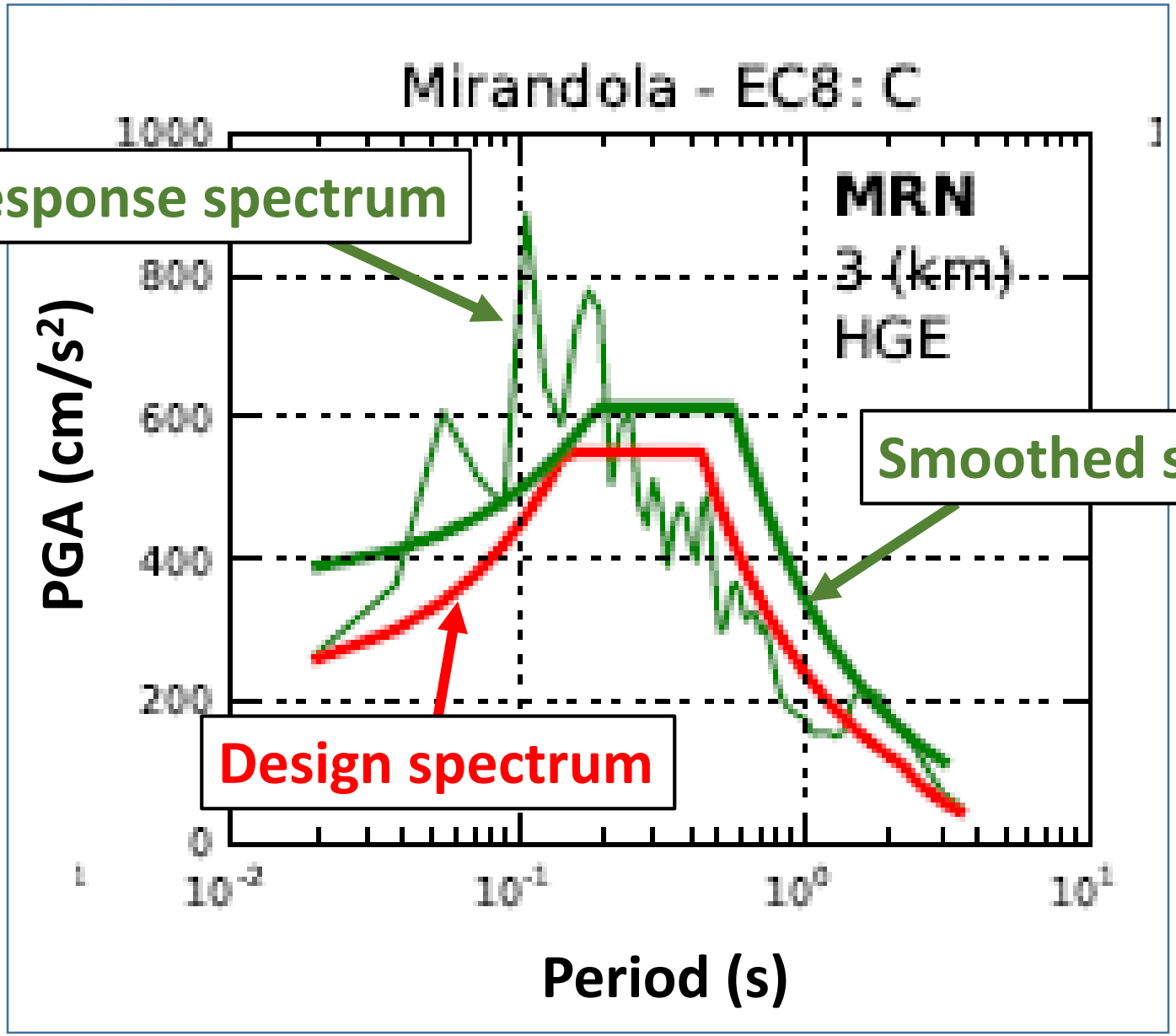
Seismic Moment: 1.13e+18 Nm
Mw: 5.8
AGENCY: UniTS

Records analyzed by procedure: 197
Selected limits: max distance=150. km min PGA= 0.1 cm/s*s
min PGA to show response spectra= 0.1 cm/s*s
Records inside the selected limits: 185 response spectra inside the limits: 185

Nearest station: MRN distance: 3.81 km
HGZ - PGA=895.78 cm/s*s, PGV=21.64 cm/s

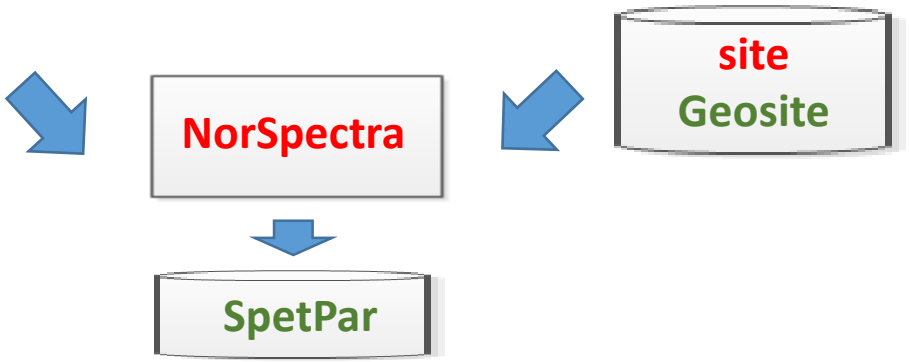
Procedure implemented by SeisRaM group, University of Trieste, Italy - ver: SPT_1.24 - 2014 - costa@units.it




Mirandola - EC8: C
Response spectrum
MRN
3 (km)
HGE
Smoothed spectrum
Design spectrum
PGA (cm/s²)
Period (s)
1000
800
600
400
200
0
10⁻²
10⁻¹
10⁰
10¹

# NorSpectra (python)

```
TR=30 R=30 TR=50 TR=72 TR=101 TR=140 TR=201 TR=475 TR=975 TR=2475
ID LON LAT ag Fo TC
 * ag Fo TC
 * ag Fo TC
 * ag Fo TC
 * ag Fo TC
 * ag Fo TC
 * ag Fo TC
 * ag Fo TC
 * ag Fo TC
 *
13111 6.5448 45.134 0.263 2.50 0.18 0.340 2.51 0.21 0.394 2.55 0.22 0.469 2.49 0.24 0.545 2.50 0.24 0.640 2.49 0.25 0.943 2.44 0.27 1.267 2.42 0.27 1.767 2.43 0.29
13333 6.5506 45.085 0.264 2.49 0.18 0.341 2.51 0.21 0.395 2.55 0.22 0.469 2.49 0.24 0.543 2.50 0.24 0.636 2.50 0.25 0.935 2.44 0.27 1.254 2.42 0.28 1.751 2.44 0.29
13555 6.5564 45.035 0.264 2.50 0.18 0.340 2.51 0.20 0.393 2.55 0.22 0.466 2.50 0.24 0.540 2.51 0.24 0.630 2.51 0.25 0.923 2.45 0.27 1.237 2.43 0.28 1.729 2.44 0.29
13777 6.5621 44.985 0.263 2.50 0.18 0.338 2.52 0.20 0.391 2.55 0.22 0.462 2.51 0.24 0.535 2.51 0.24 0.621 2.52 0.25 0.909 2.46 0.27 1.217 2.44 0.28 1.703 2.44 0.29
12890 6.6096 45.188 0.284 2.46 0.19 0.364 2.51 0.21 0.431 2.50 0.22 0.509 2.48 0.24 0.585 2.50 0.24 0.695 2.47 0.25 1.006 2.44 0.27 1.338 2.43 0.27 1.844 2.44 0.29
13112 6.6153 45.139 0.286 2.46 0.19 0.366 2.51 0.21 0.433 2.50 0.22 0.511 2.48 0.24 0.586 2.50 0.25 0.695 2.47 0.25 1.005 2.45 0.27 1.336 2.43 0.27 1.841 2.44 0.29
13334 6.621 45.089 0.288 2.46 0.19 0.367 2.51 0.21 0.434 2.50 0.22 0.511 2.49 0.24 0.586 2.51 0.25 0.694 2.48 0.25 1.001 2.45 0.27 1.332 2.43 0.27 1.835 2.44 0.29
13556 6.6268 45.039 0.288 2.46 0.19 0.367 2.51 0.21 0.433 2.51 0.22 0.510 2.49 0.24 0.584 2.51 0.25 0.691 2.48 0.25 0.996 2.45 0.27 1.325 2.44 0.28 1.828 2.44 0.29
13778 6.6325 44.989 0.288 2.46 0.19 0.366 2.52 0.21 0.430 2.51 0.22 0.507 2.50 0.24 0.580 2.51 0.25 0.686 2.49 0.25 0.989 2.45 0.27 1.318 2.44 0.28 1.819 2.44 0.29
14000 6.6383 44.939 0.286 2.47 0.19 0.363 2.52 0.21 0.426 2.52 0.22 0.502 2.50 0.24 0.576 2.52 0.24 0.679 2.49 0.25 0.981 2.45 0.27 1.307 2.44 0.28 1.807 2.44 0.29
14222 6.6439 44.889 0.284 2.47 0.19 0.360 2.53 0.21 0.421 2.53 0.22 0.497 2.50 0.24 0.570 2.52 0.24 0.671 2.50 0.25 0.970 2.45 0.27 1.294 2.44 0.28 1.792 2.44 0.29
12891 6.6803 45.192 0.306 2.43 0.20 0.389 2.50 0.21 0.467 2.47 0.23 0.544 2.49 0.23 0.625 2.50 0.25 0.736 2.47 0.26 1.049 2.46 0.27 1.374 2.46 0.28 1.875 2.46 0.29
10228 6.6826 45.794 0.283 2.42 0.20 0.364 2.46 0.22 0.430 2.46 0.24 0.505 2.44 0.25 0.577 2.48 0.26 0.679 2.48 0.26 0.992 2.43 0.27 1.335 2.38 0.28 1.924 2.30 0.30
13113 6.686 45.143 0.309 2.43 0.20 0.391 2.51 0.21 0.470 2.47 0.23 0.546 2.49 0.23 0.627 2.50 0.25 0.737 2.48 0.26 1.048 2.46 0.27 1.373 2.46 0.28 1.873 2.46 0.29
```




dpc Spetpar

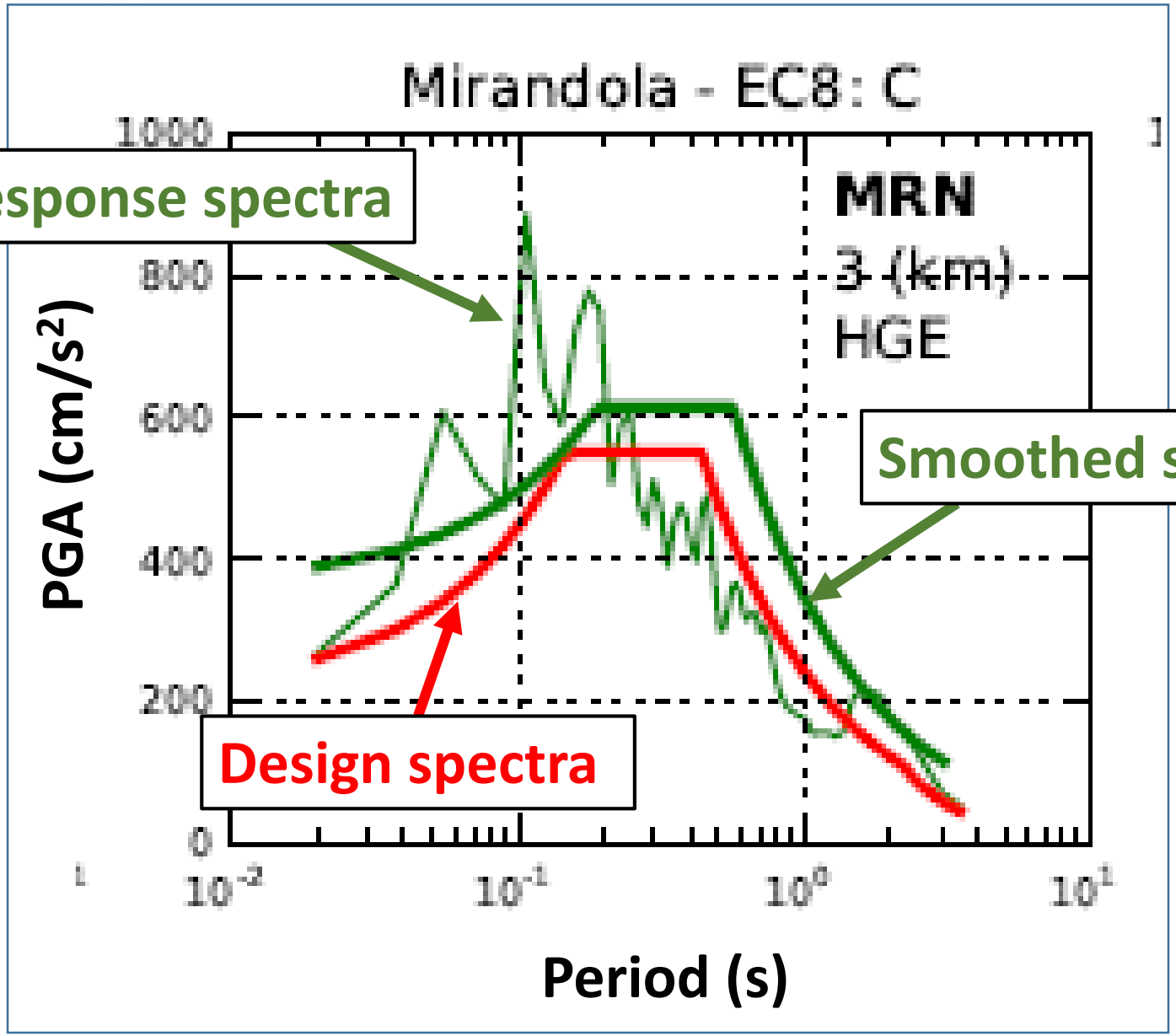
File Edit View Options Graphics Help

ok X

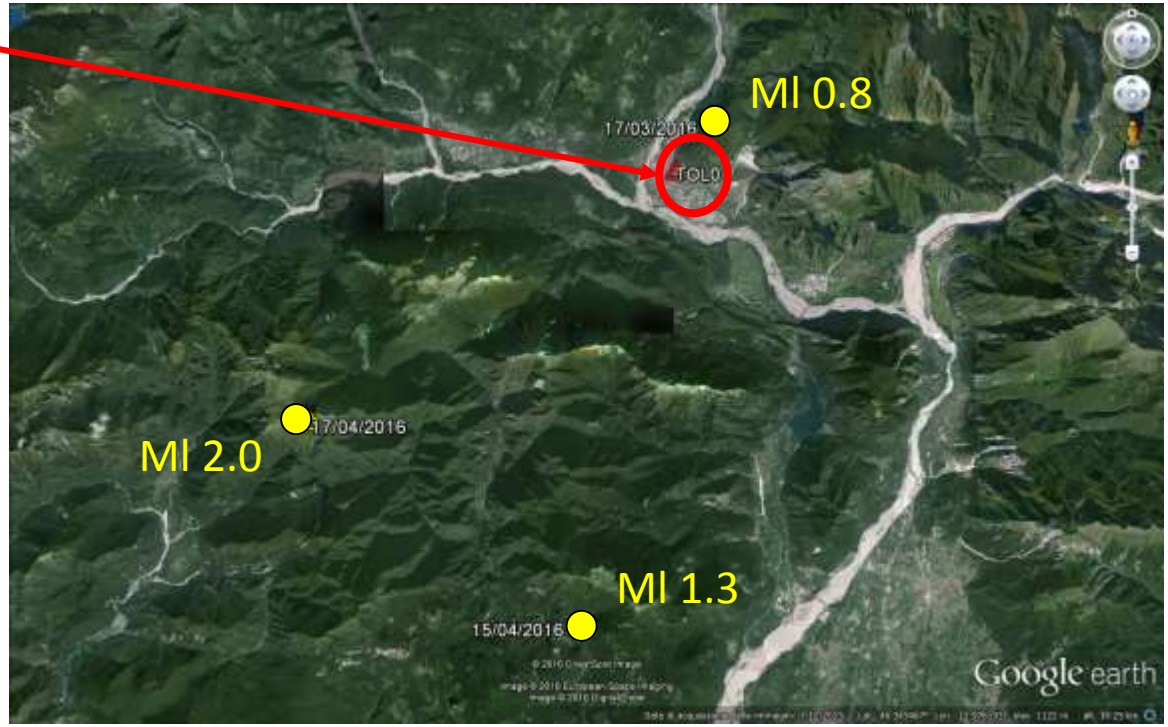
| 0 | sta | RType | RTval | ag | Fo | TC | ID | Rlat | Rlon | Rdelta | auth |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ACR | T | 30 | 0.713 | 2.290 | 0.280 | 39006 | 39.4970 | 16.4040 | 2.268 | Spetpar |
| | ACR | T | 50 | 0.947 | 2.280 | 0.300 | 39006 | 39.4970 | 16.4040 | 2.268 | Spetpar |
| | ACR | T | 72 | 1.141 | 2.290 | 0.320 | 39006 | 39.4970 | 16.4040 | 2.268 | Spetpar |
| | ACR | T | 101 | 1.356 | 2.320 | 0.330 | 39006 | 39.4970 | 16.4040 | 2.268 | Spetpar |
| | ACR | T | 140 | 1.588 | 2.350 | 0.330 | 39006 | 39.4970 | 16.4040 | 2.268 | Spetpar |
| | ACR | T | 201 | 1.881 | 2.380 | 0.350 | 39006 | 39.4970 | 16.4040 | 2.268 | Spetpar |
| | ACR | T | 475 | 2.735 | 2.430 | 0.370 | 39006 | 39.4970 | 16.4040 | 2.268 | Spetpar |
| | ACR | T | 975 | 3.654 | 2.480 | 0.400 | 39006 | 39.4970 | 16.4040 | 2.268 | Spetpar |
| | ACR | T | 2475 | 5.144 | 2.520 | 0.450 | 39006 | 39.4970 | 16.4040 | 2.268 | Spetpar |
| | AGR | T | 30 | 0.194 | 2.520 | 0.200 | 48731 | 37.3350 | 13.6160 | 2.969 | Spetpar |
| | AGR | T | 50 | 0.254 | 2.480 | 0.220 | 48731 | 37.3350 | 13.6160 | 2.969 | Spetpar |

5121

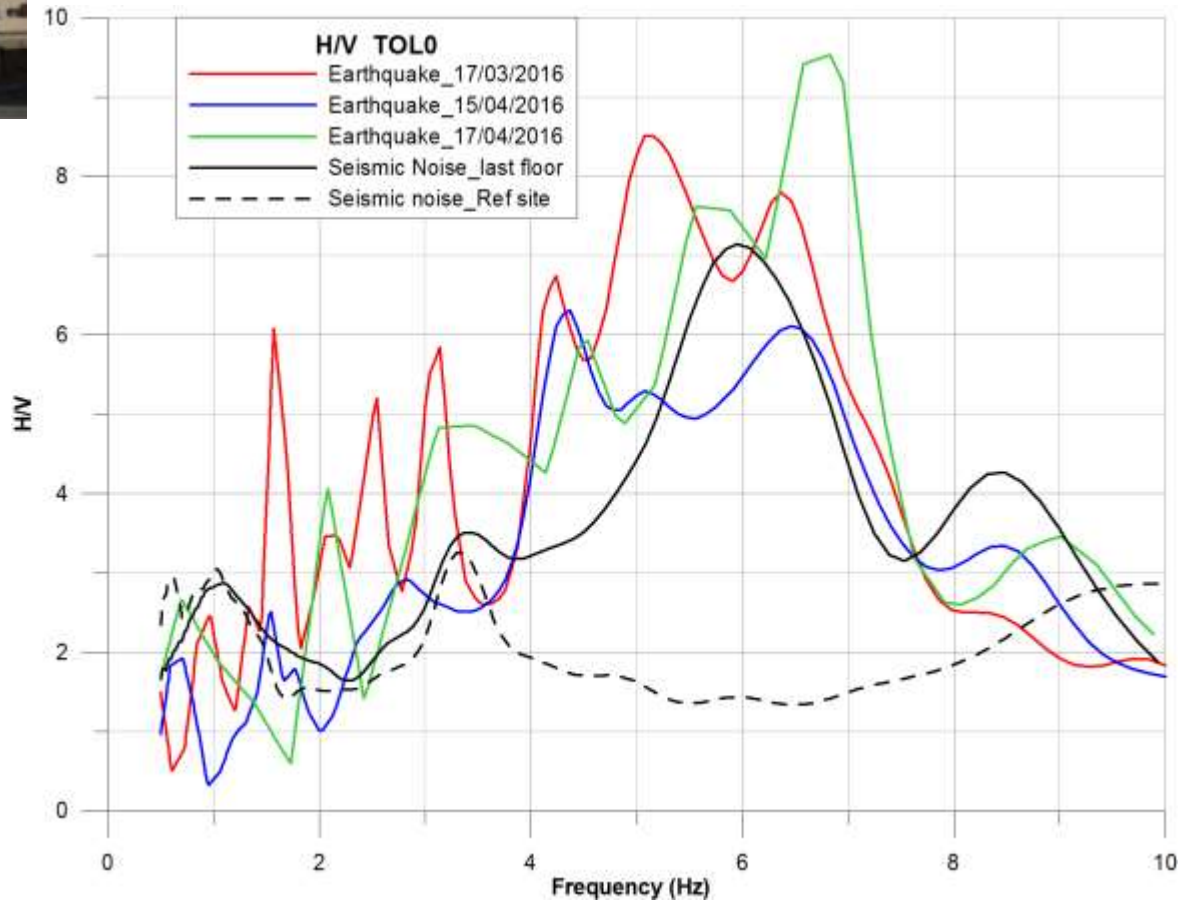
Dismiss


Mirandola - EC8: C
MRN
3 (km)
HGE
Response spectra
Smoothed spectra
Design spectra
PGA (cm/s²)
Period (s)
1000
800
600
400
200
0
10⁻²
10⁻¹
10⁰
10¹

# Tolmezzo


Ml 0.8
17/03/2016
TOLO
17/04/2016
Ml 2.0
Ml 1.3
15/04/2016
Google earth

# Tolmezzo


H/V TOL0
Earthquake_17/03/2016
Earthquake_15/04/2016
Earthquake_17/04/2016
Seismic Noise_last floor
Seismic noise_Ref site
H/V
Frequency (Hz)
0
2
4
6
8
10

SeisRaM
*Seismological Researcher and Monitoring group*

*Giovanni Costa, Piero Falconer, Lorenzo Furlan, Antonella Gallo, Lara Tiberi, Blaž Vičič, Giuliana Zoppé*

# Thank you for your attention.

http://rtweb.units.it.