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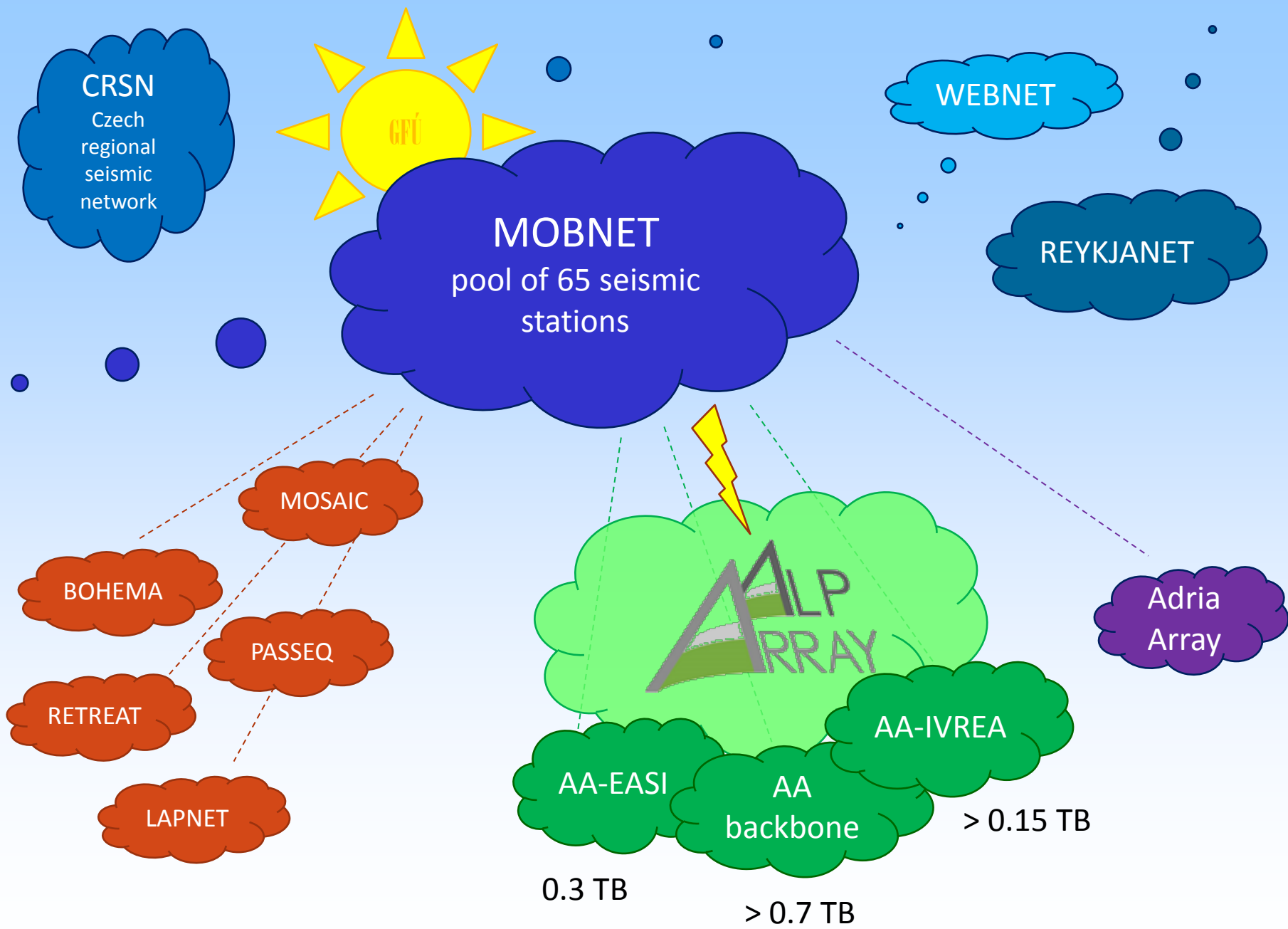
# Data quality control and application of a new arrival-time picker

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H. Žlebčíková, V. Babuška and AlpArray WG



INSTITUTE OF GEOPHYSICS  
OF THE CZECH ACADEMY OF SCIENCES

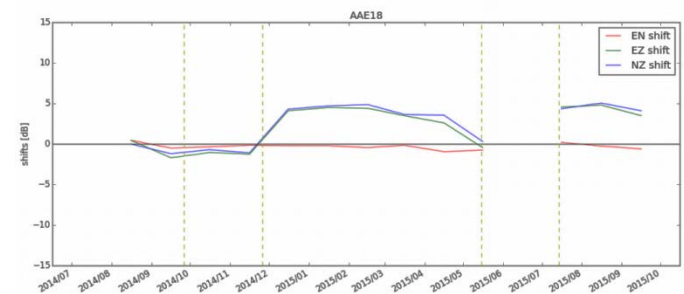
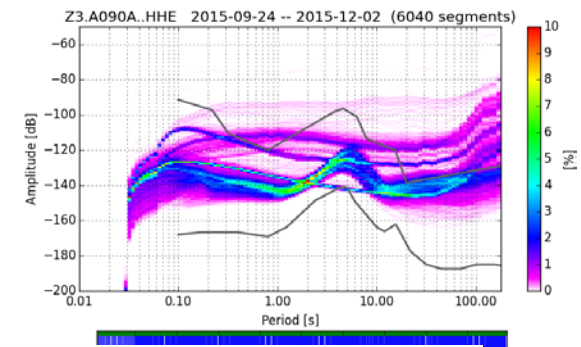
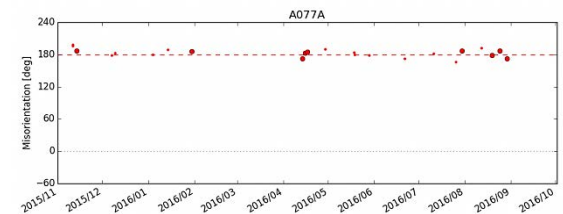
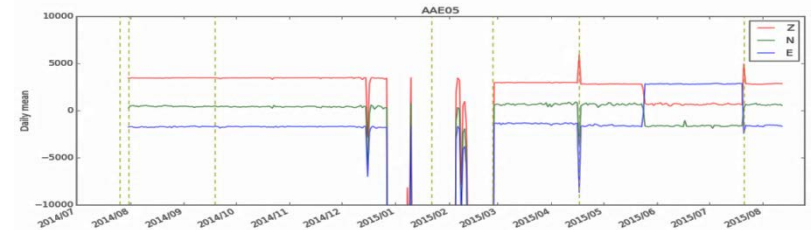
Prague, Dec 5, 2018

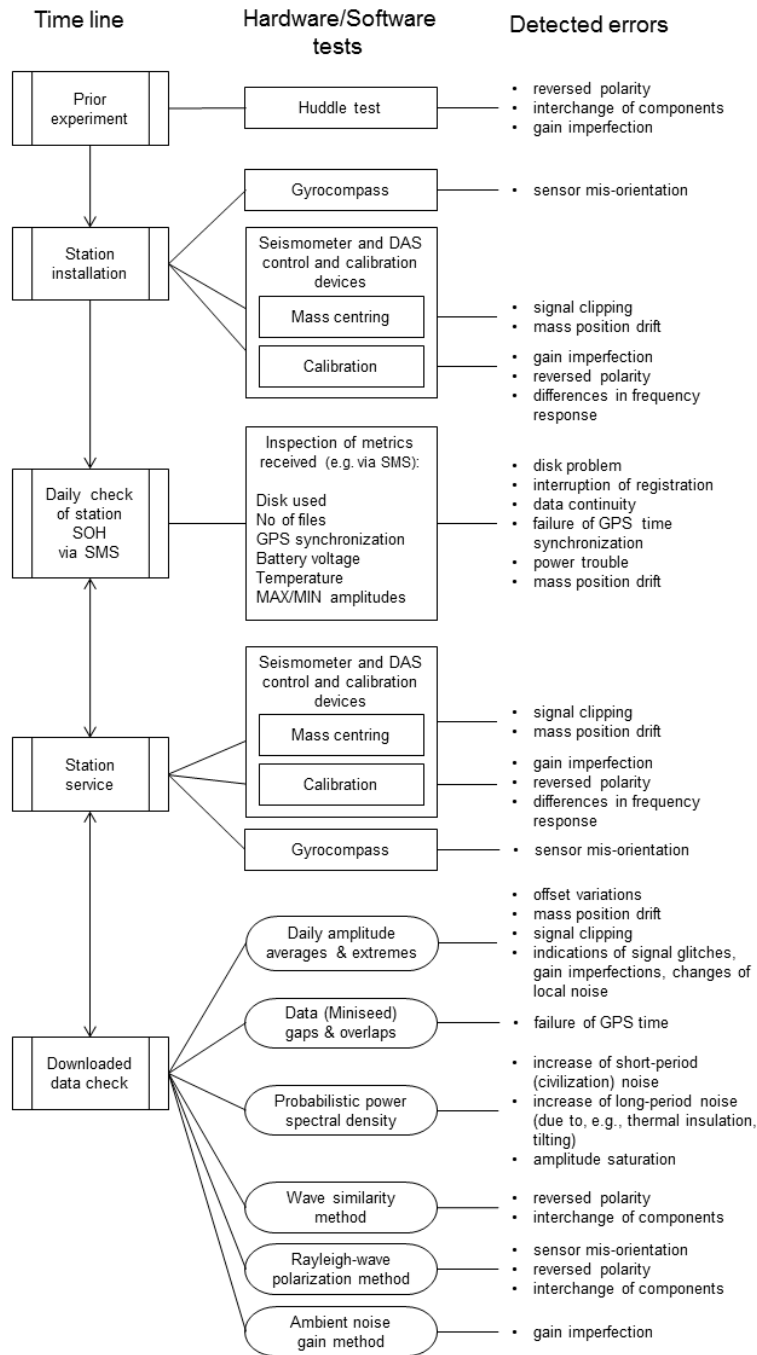


# Double check of data quality



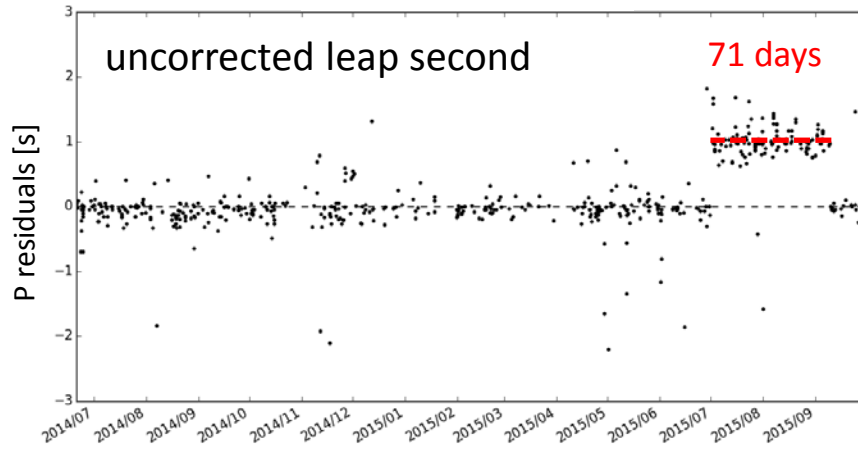
- Timing issues
- Noise in signals
- Sensor orientation
- Reversed or interchanged components
- Drift of sensor mass position
- Gain imperfection
- Glitches in signal
- Metadata



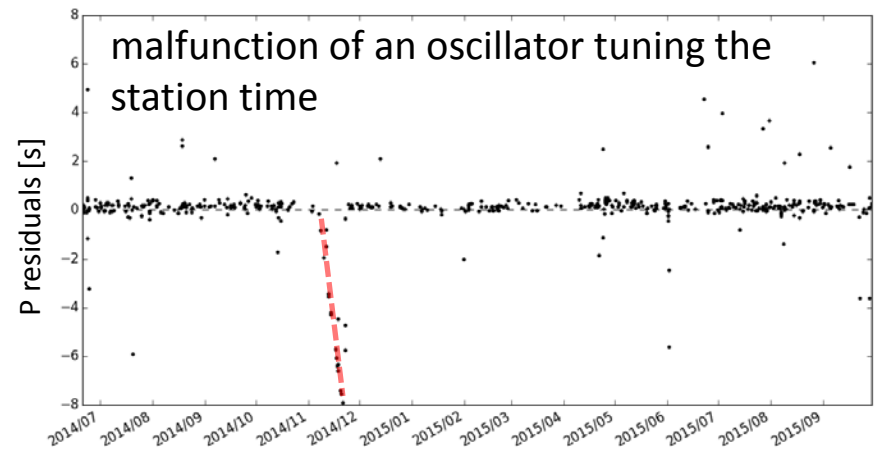


# Time instabilities - examples

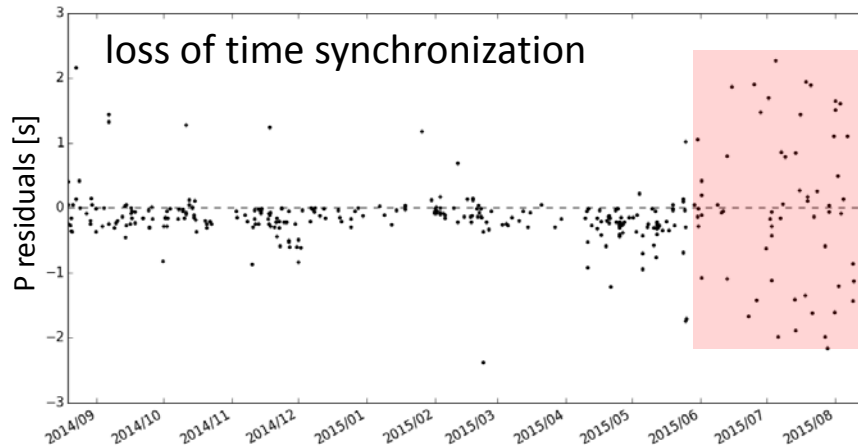
TH.HKWD..HHZ



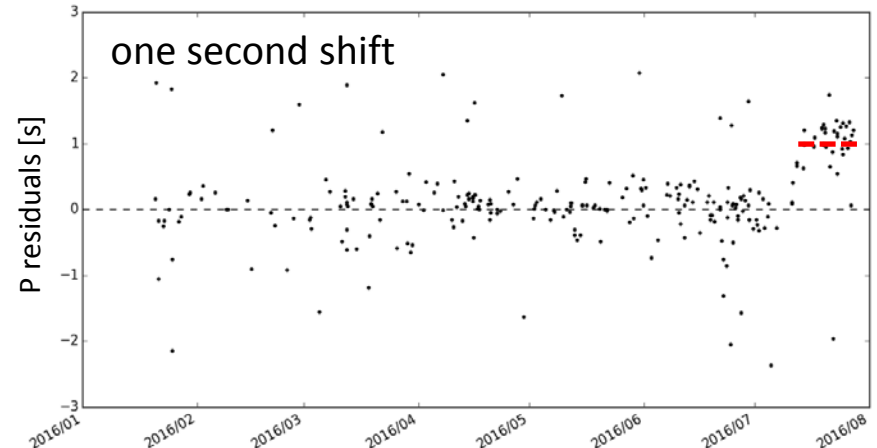
BW.MGGB..EHZ



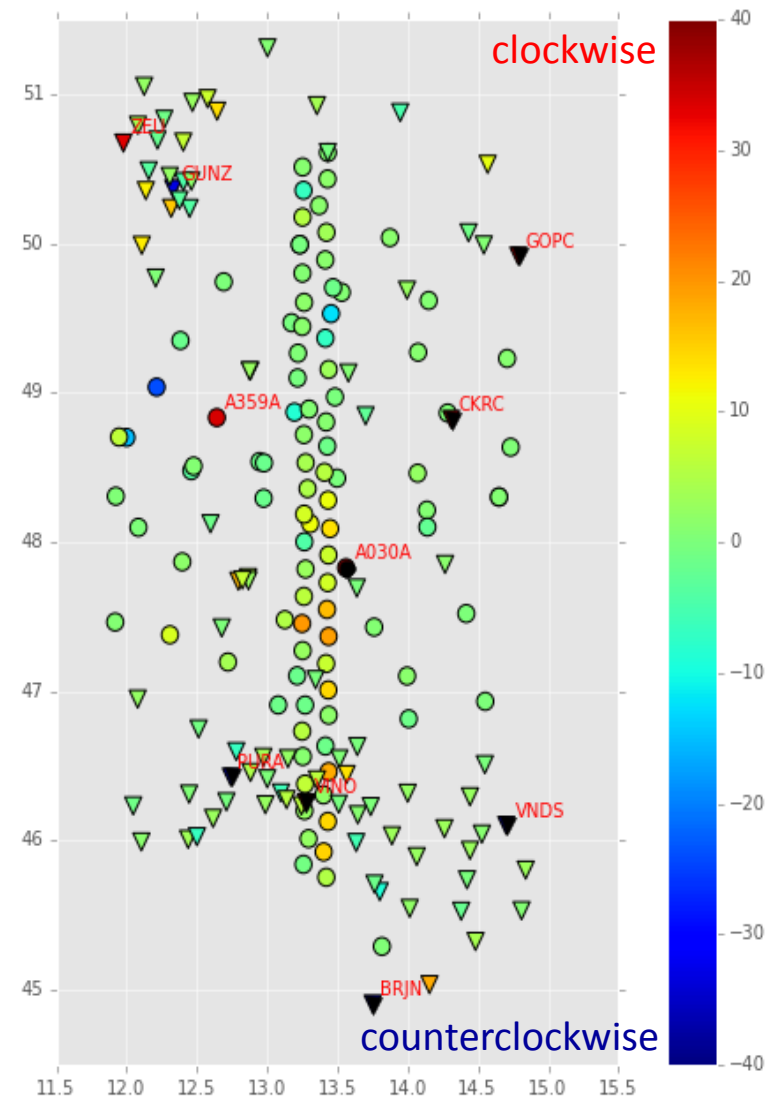
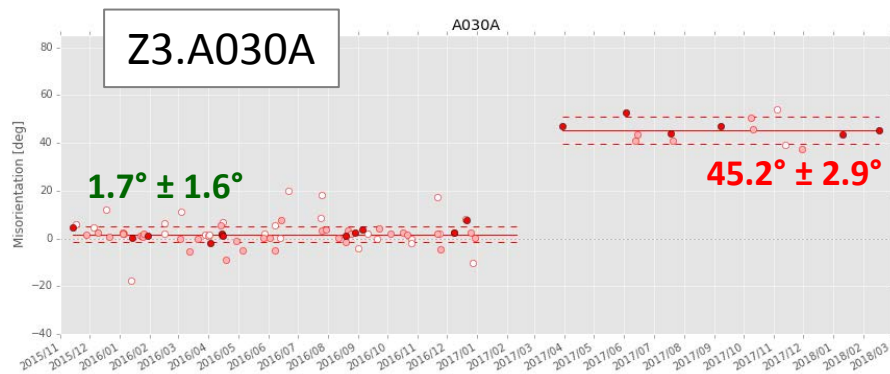
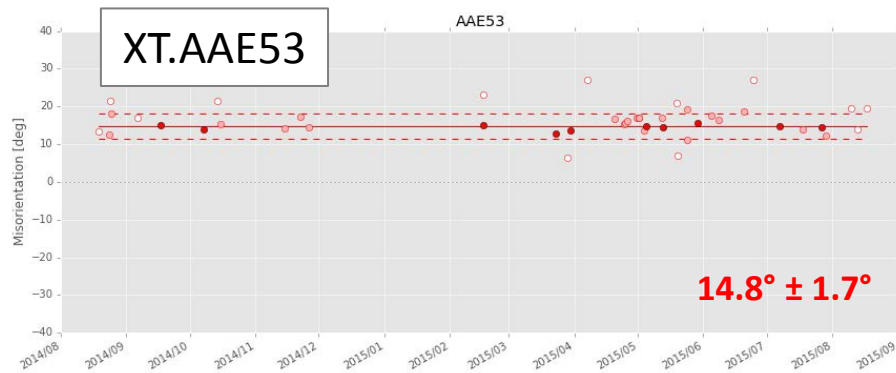
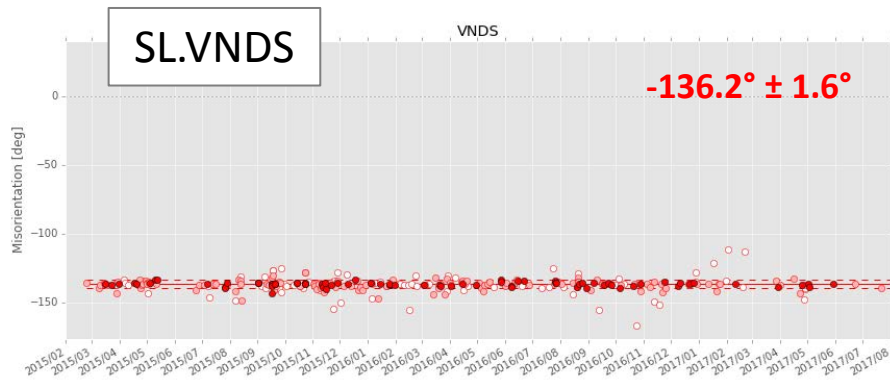
XT.AAE21..HHZ



Z3.A147A.00.HHZ



# Sensor mis-orientations



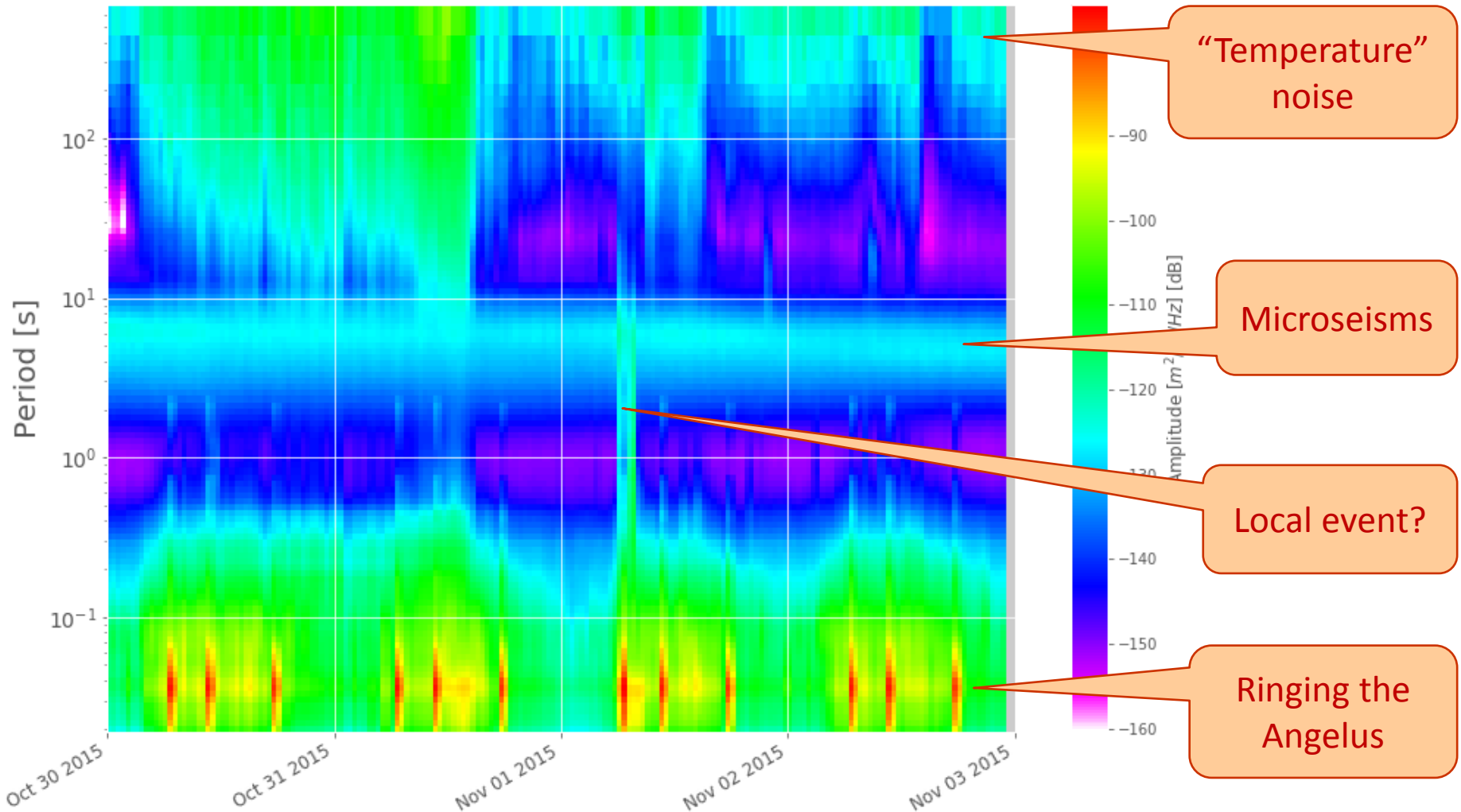
Mis-orientations colored from **blue** ( $-40^\circ$ ) to **red** ( $+40^\circ$ ), larger deviations are in **black**. Stations with their mis-orientations exceeding  $30^\circ$  are named. Triangles mark permanent stations, circles temporary ones.

# Signal spectrogram

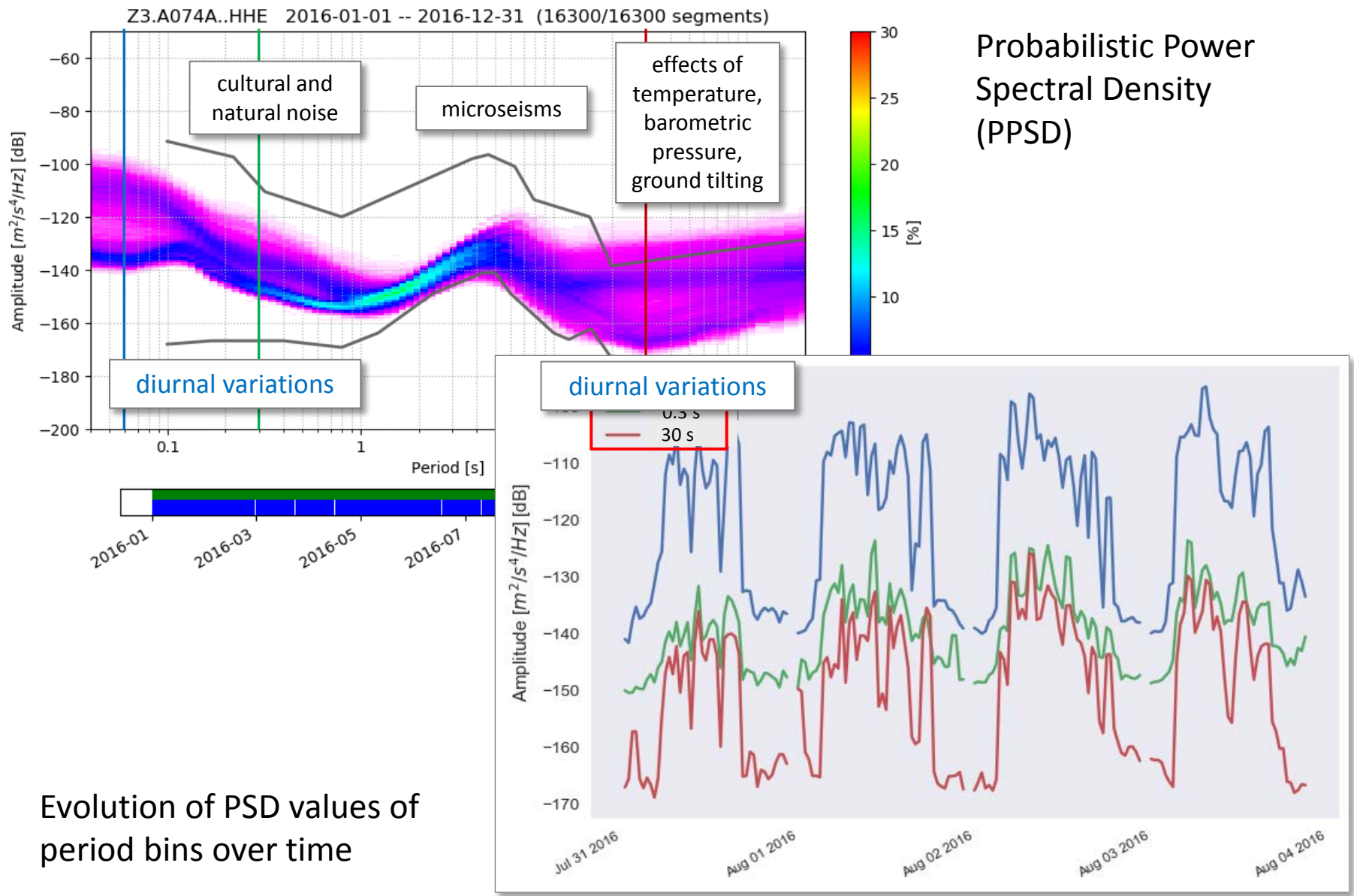
Staré Sedliště,  
church of St  
Procopius and  
Ulrich



Z3.A071A..HHE



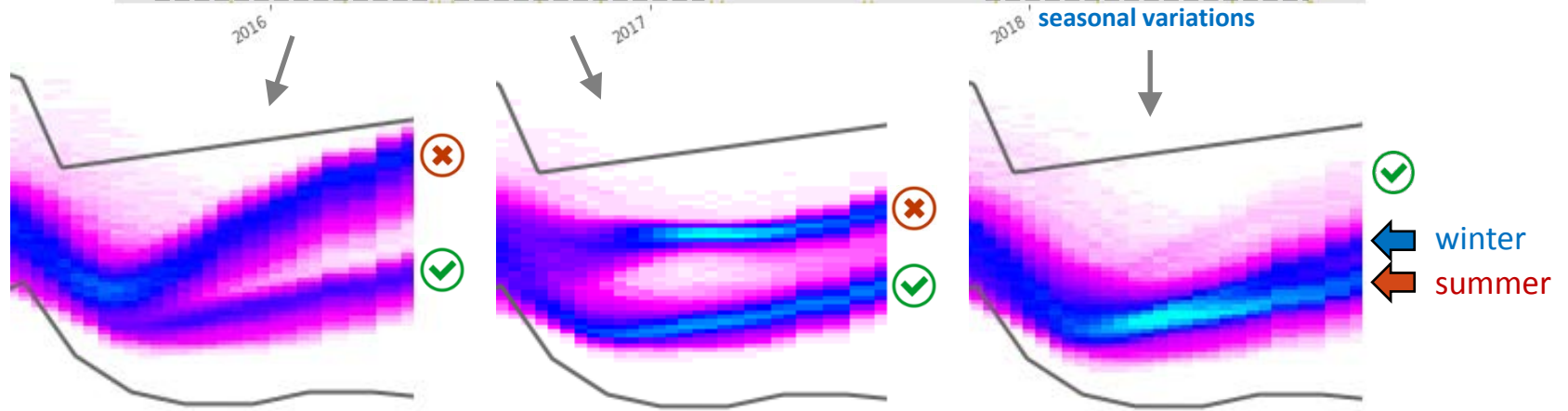
# Diurnal variations





# Effect of sensor insulation

Z3.A081A..HHZ



PPSD – long-period sections 13-200 s

# EIDAWS WFCatalog waveform metadata webservice

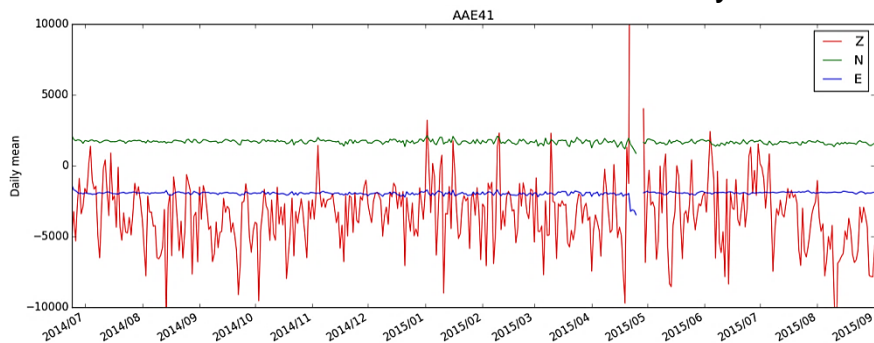
- provides detailed information on the contents of waveform data including quality control parameters

## Applications:

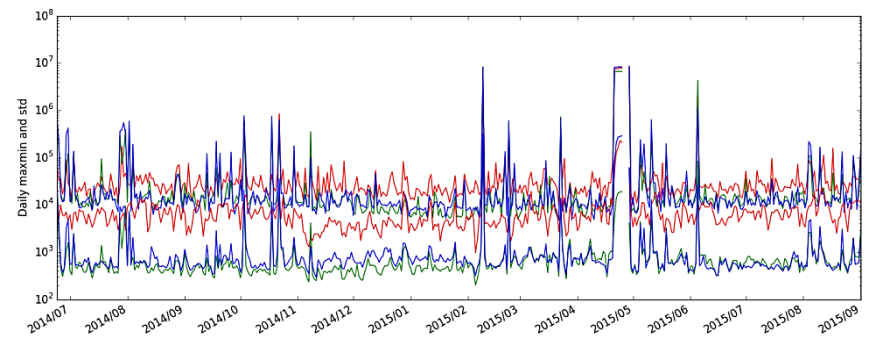
- check of **correct names of channels** and **components** in station metadata
- help in determination of which signal data are **available to download** from EIDA
- metrics showing station **state of health**

XT.AAE41

daily means



daily max-min and std



# TimePicker 2017

- Fully automatic picker of teleseismic P arrivals
- Method based on (two-step) **signal correlations**
- **Relative picks** of extremes (peaks) are recomputed to absolute picks by signal comparison to a reference signal
- **Error estimates** determined by levels of SNRs and signal similarities
- Platform: ObsPy/Python
  
- First implementation: AlpArray-EASI project, area with 235 broadband and short-period stations, ~1800 events

# Fully automatic P-arrival time picker



list of  
teleseismic  
events



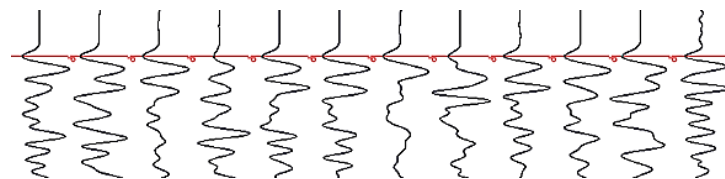
station  
metadata



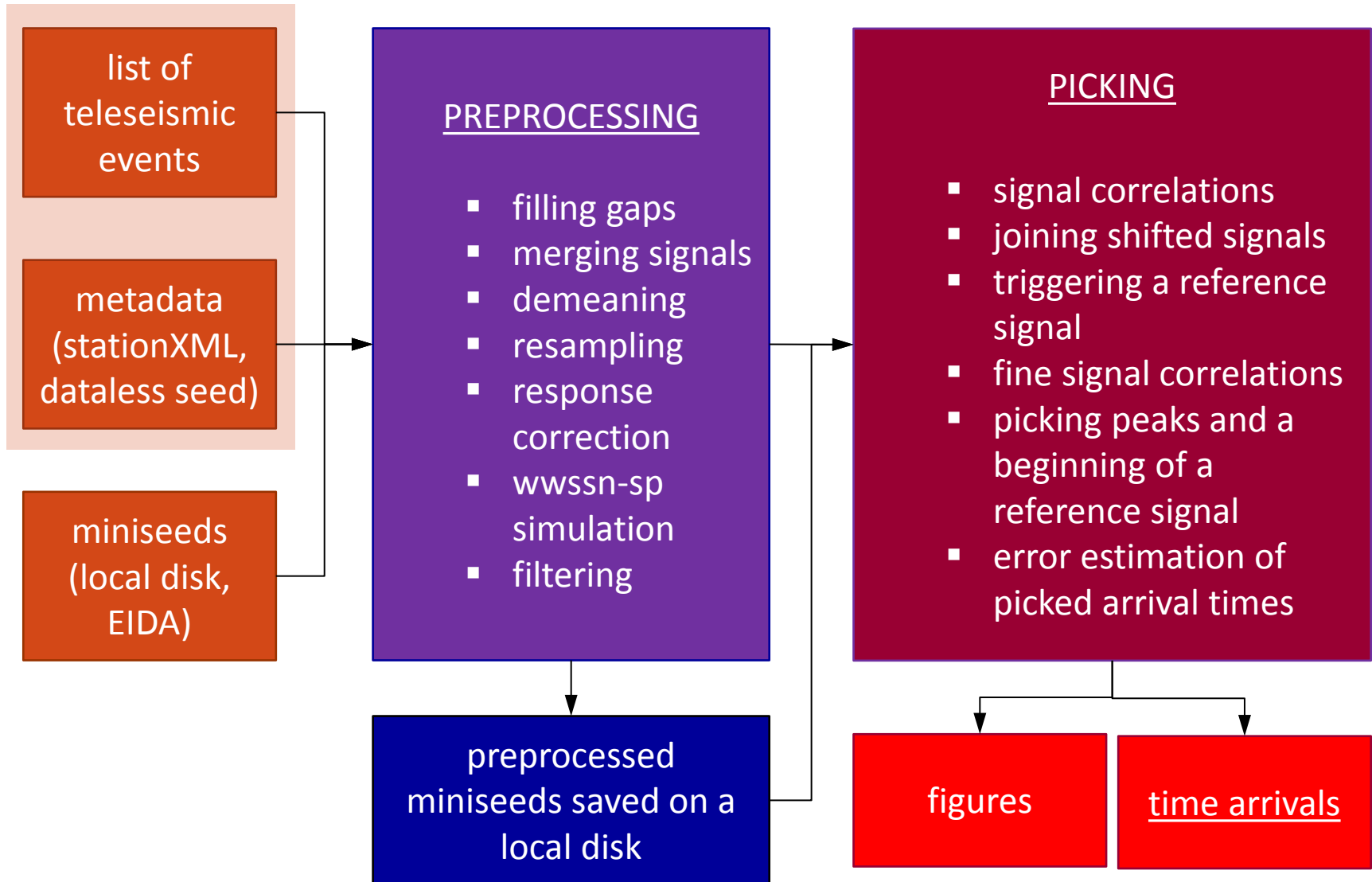
seismic  
signals  
(mseconds)



arrival-  
time  
picker

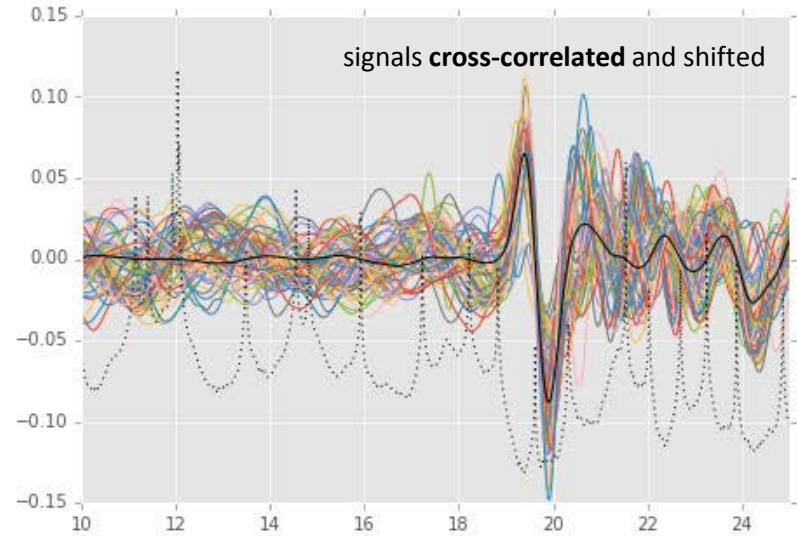
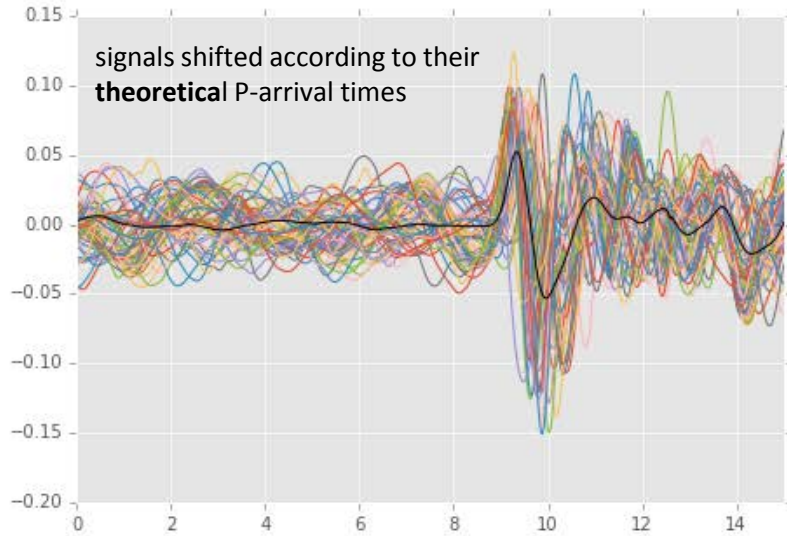


# TimePicker flowchart

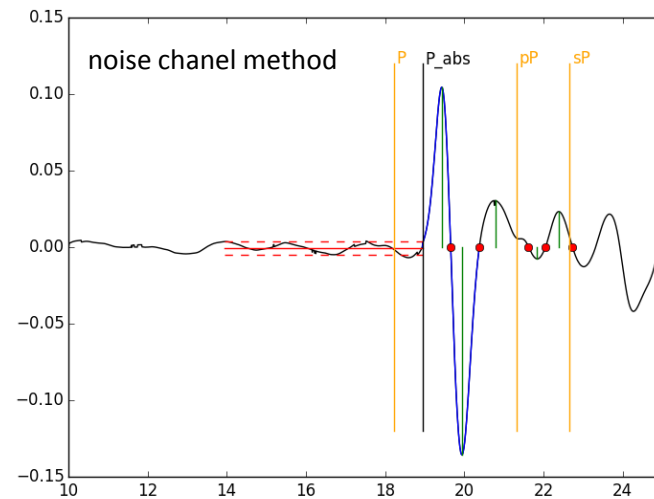
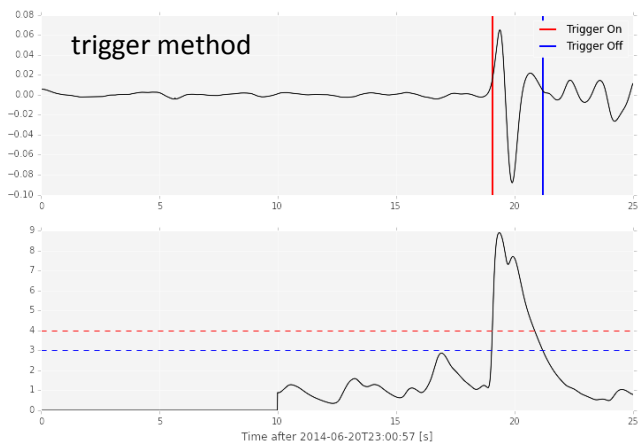


# Reference signal

## Summation of correlated signals

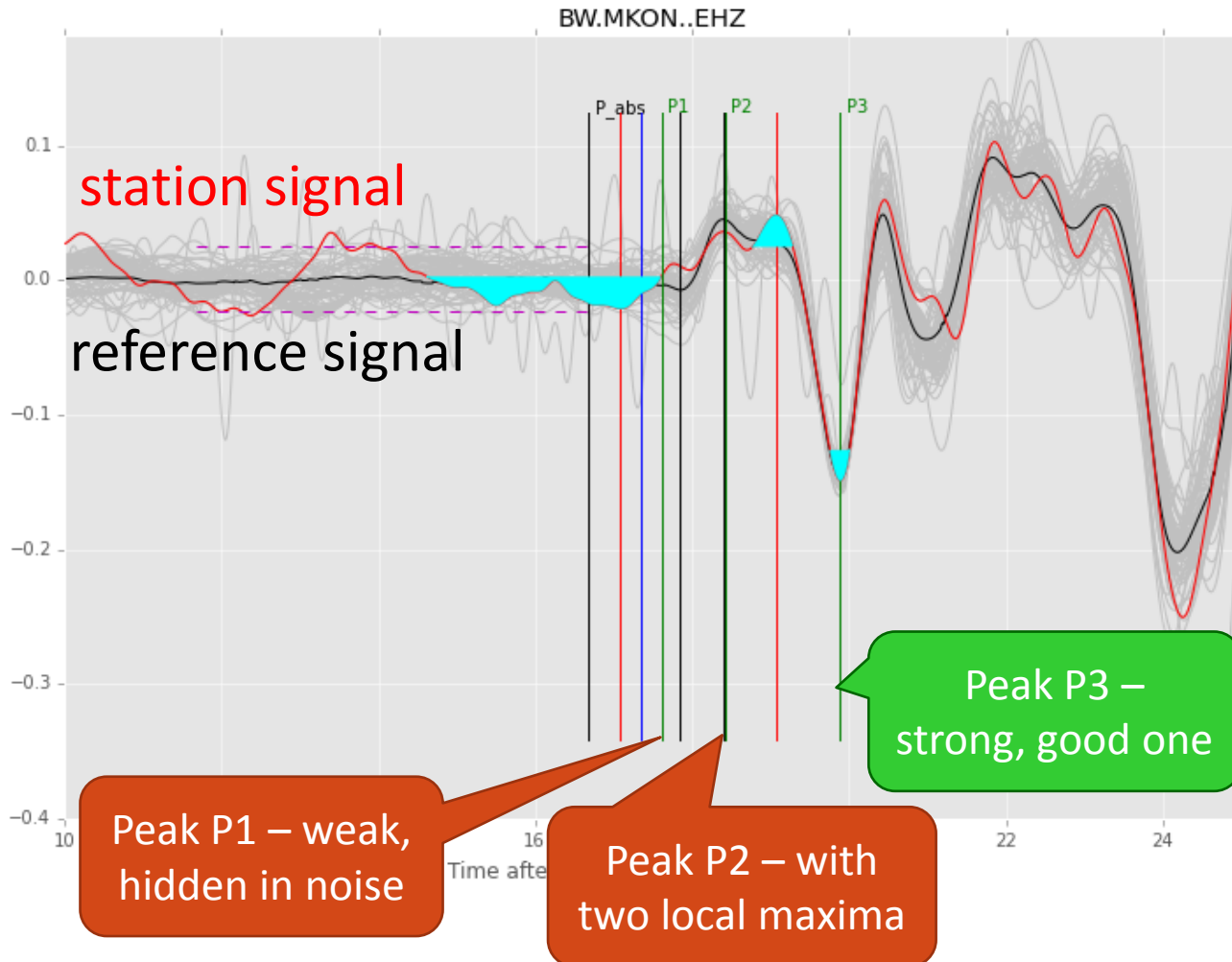


## Picking a beginning of the reference signal



# Picking peak times and error estimates

Main principle: relative time of a peak as close to a wave beginning as possible but with high SNR



For each station:

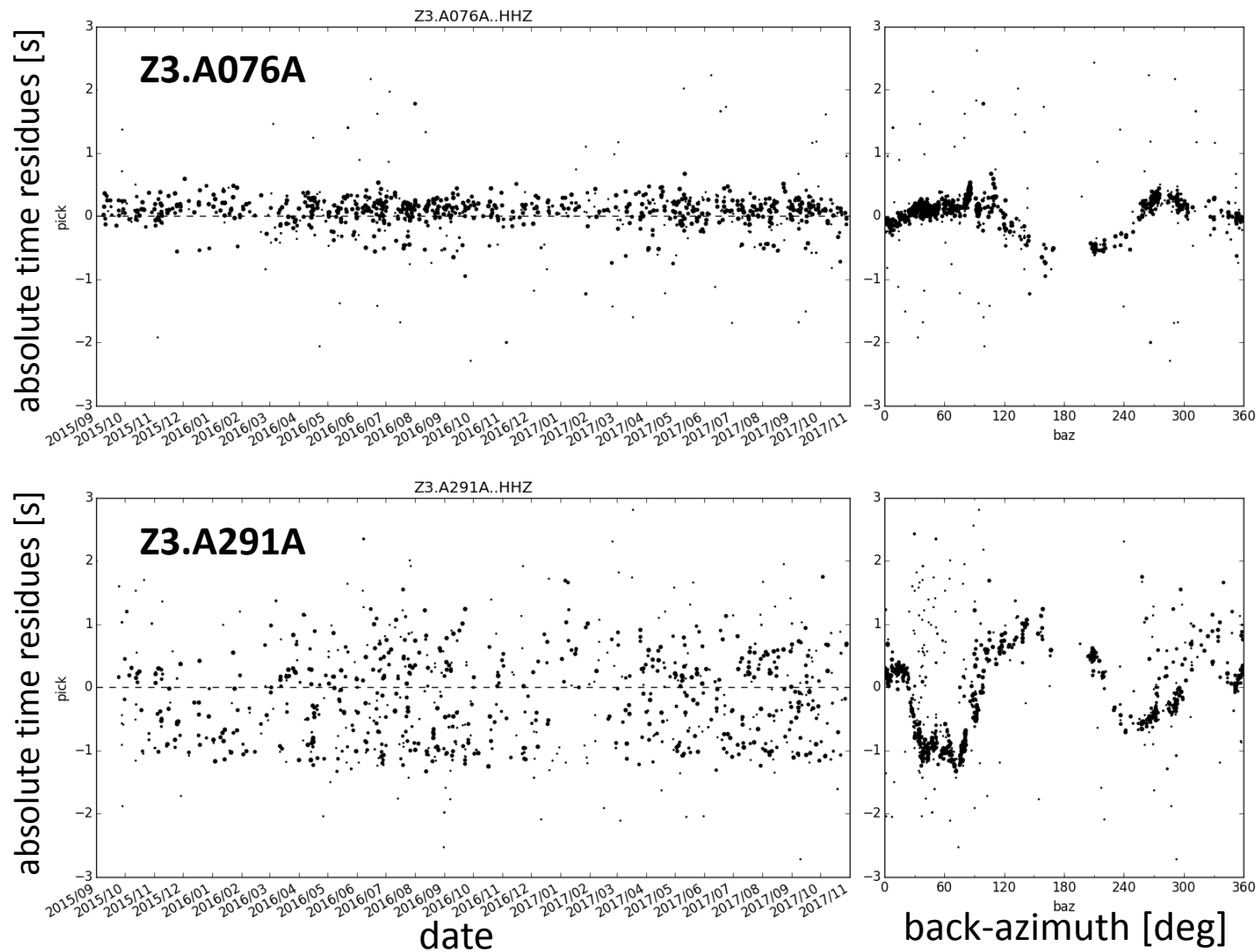
- max/min pick
- global correlation pick
- local correlation pick

Time of a final pick is a combination of these three picks.

Error estimate:

- SNR
- similarity of the signal to the reference signal
- distance between the peak and the P-arrival time  $P_{abs}$ .

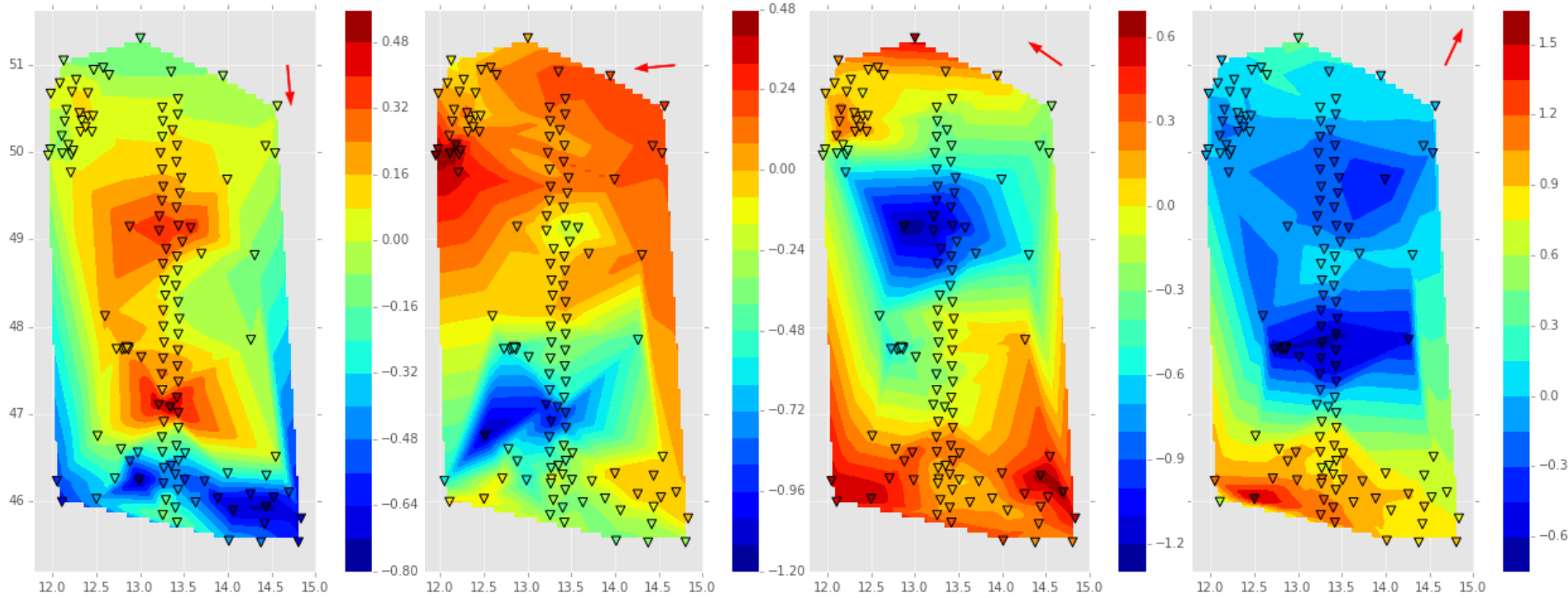
# First application of the code - AlpArray-EASI





# AlpArray-EASI: P residues

(preliminary!)





# Conclusions

- Modules of ObsPy/Python together with easy connection to integrated data archives (EIDA, IRIS) clear the way for **fully automated procedures** for seismic data analysis
- **Quality check** of input data (events, station metadata, signals) is **necessary** during all steps of automatic procedures
- The hardware control in-situ and the ex-post software data checking represent the **double check** of data quality. We have developed both **special control devices** for seismometers and GAIA DAS, and **methods and software codes** to identify and correct problems in data, e.g., imperfectly set gains, interchange of components and polarity reversals, sensor mis-orientations, insufficient sensor mass centring, and time issues)
- New code TimePicker 2017 is a fully automated software for picking teleseismic P-arrivals. The picking method is based on **signal cross-correlations** and it is supplemented by automatic **error estimates** of determined P-time arrivals.