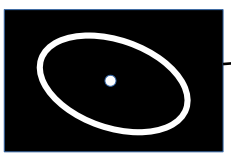
# Smooth picking procedure

Function for picking the phase velocity curve from the zero crossings of the frequency-domain representation of the stacked cross correlation.

The picking procedure is based on drawing an ellipse around each zero crossings and assigning a weight according to the distance from the center of the zero crossing to the ellipse boundary. The weights are then stacked in the phase-velocity - frequency plot and a smoothed version of the zero- crossing branches is obtained. This procedure reduces the influence of spurious zero crossings due to data noise, makes it easier to identify the well constrained parts of the phase-velocity curve and to obtain a smooth dispersion curve. A reference dispersion curve must be given to guide the algorithm in finding the correct phase-velocity branch to start the picking, because parallel branches are subject to a 2 pi ambiguity.

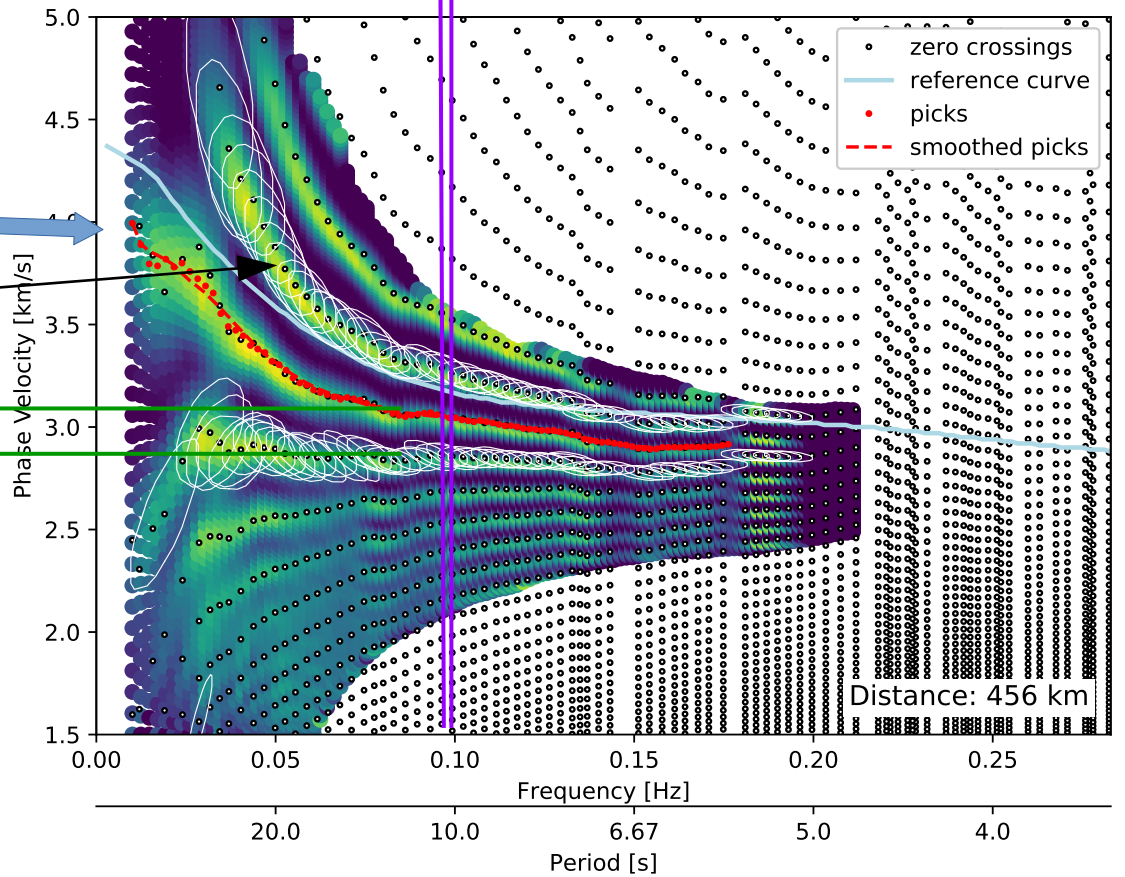


Around each zero crossing, an ellipse is drawn with an intensity value of 1 at the center and 0 and the boundary (white lines in plot, only for two branches the ellipses are shown in the plot, but they are drawn around every zero crossing). The contribution of adjacent ellipsis are summed and give the colored intensity map. This is similar to a kernel density estimate (KDE) with elliptical kernels. The picks are taken where the intensity is maximized. The shape and size of the ellipses can be influenced by the parameters explained below (**filt_width** and **filt_height**).

Picking starts at the low frequency end, close to the reference curve, if the branches are well separated.

One cycle jump. “Distance” between cycles along y-axis (phase velocity) depends on frequency, velocity and interstation distance.

“Distance” between two zero crossings along the x-axis (frequency) depends on frequency, velocity and interstation distance.




**Arguments of the noise.get_smooth_pv function**

get_smooth_pv(frequencies, corr_spectrum, interstation_distance, ref_curve, freqmin=0.0, freqmax=99.0, min_vel=1.0, max_vel=5.0, filt_width=7, filt_height=0.8, pick_threshold=2, horizontal_polarization=False, smooth_spectrum=False, plotting=False)

**frequencies**: array giving the frequency value of the cross correlation
**corr_spectrum**: array giving the values of the cross correlation
**interstation_distance**: distance between the stations (in km)
**ref_curve**: reference curve to guide the picking procedure (light blue curve in plot above)
**freqmin**: minimum frequency taken into account
**freqmax**: maximum frequency taken into account
**min_vel**: minimum velocity taken into account (1.0 km/s in plot above)
**max_vel**: maximum velocity taken into account (5.0 km/s in plot above)
**filt_width**: size of the ellipses in x-direction in units of typical distance between two adjacent zero crossings. Recommended values 3-9
**filt_height**: size of the ellipses in y-direction in units of typical cycle jump distance. Recommended values 0.5 – 1.0
**pick_threshold:** only picks where the intensity of the maximum is larger than pick_threshold times the minimum amplitude above and below are taken.
**horizontal_polarization**: should be set to True if working with TT or RR correlations. In this case, an additional factor is taken into account (see Kästle et al. 2016)
**smooth_spectrum**: smooth the spectrum before extracting the zero crossings, this can give better picks.
plotting: if True, a test plot like the one shown above is created.