

## FEATURES

- Automated operation
- Fast results
- Graphic output

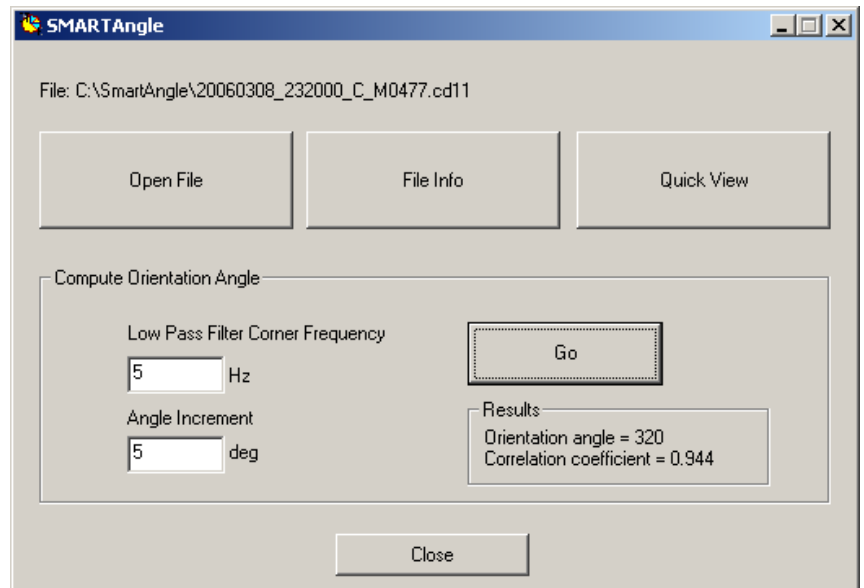
**SMARTAngle** is an automated program package to calculate the orientation of the horizontal components of a borehole seismometer by cross correlation with data recorded simultaneously from a surface seismometer.

The calculation is very fast and consists of computing the correlation coefficients between a rotated horizontal component of the surface seismometer and a horizontal component of the borehole seismometer, both low-pass filtered. The surface seismometer is assumed to be located as close as possible to the wellhead.

**SMARTAngle** can read **CD1.1** formatted files as written by the SMART-24R® recorder, or can import files in **32-bit SUDS** and in **miniSEED** formats.

Tests have showed that, depending on the borehole seismometer installation depth, the method can give an accuracy of at least 5 degrees.

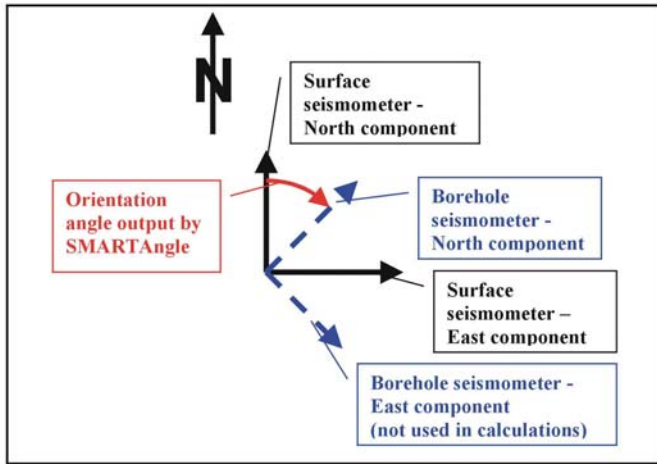
## SMARTAngle Automated Borehole Seismometer Orientation Calculator



# SMARTAngle INPUT AND OUTPUT

A special cable between the digitizer, the borehole and surface seismometers has to be made according to the following connections (see Figure below):

Channel 1 of recorder ↔ Borehole seismometer - North Component  
 Channel 2 of recorder ↔ Surface seismometer - North Component  
 Channel 3 of recorder ↔ Surface seismometer - East Component



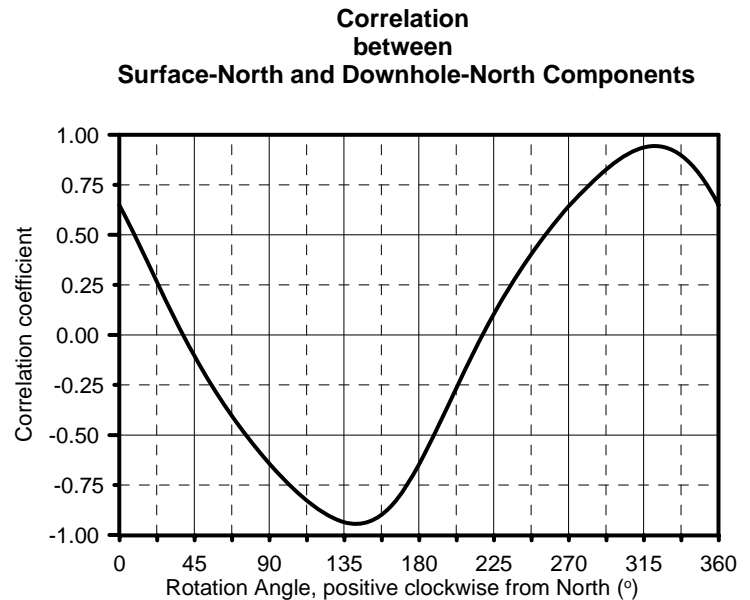
The surface instrument has to be properly leveled and aligned relative to the North direction (see Figure above).

While data are being recorded, it is recommended to minimize artificial noise in the vicinity of the seismometer location. Data should be recorded in parallel from the two sensors for **at least 1 minute duration**, at a **sample rate of 50 Hz** or above.

The recorded file(s) should be first transferred to a computer (e.g. downloaded by FTP from the **SMART-24®** recorder) and then opened with the SMARTAngle program. The user can inspect the file using the Quick Look option. To start processing, press Go. Files where the surface data look too different from the borehole data should be ignored.

SMARTAngle filters the data with a 4-pole band-pass filter between 0.05 Hz and the high frequency specified by the user. The **default value is 5 Hz**. The angle increment is a measure of the accuracy of the determination. The **default value is 5 degrees**.

SMARTAngle automatically finds the rotation angle corresponding to the maximum correlation between the surface and the borehole components (with the accuracy of the increment angle above). This is **the angle by which the Borehole seismometer - North component is rotated clockwise from geographic North**. The rotation angle and the corresponding maximum correlation coefficient value are output in the Results panel of the dialog window, as well as graphically (see Figure below).



**Downhole-North orientation corresponds to maximum correlation**

Orientation angle = 320  
 Correlation coefficient = 0.944

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**SMARTAngle** Graphic Output

It is also recommended to repeat the measurements several times to check the results for consistency.