Starstim EEG monitoring during tDCS stimulation

Neuroelectrics White Paper WP201307

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In this short white paper we show that EEG signals can be recorded concurrent with tDCS stimulation with *Starstim* using *PISTIM* electrodes. We also show that electrodes used for stimulation can be used for PRE and POST stimulation comparisons.

Neuroelectrics *PISTIM* ("Pi") electrodes[1] rely on optimal electrochemistry for efficient, low noise current transfer. In particular, they are superior to sponge electrodes in terms of induced electrical noise. See our wiki for more information.

The first figures in the following pages display raw detrended data, spectrograms and the Power Spectral Density functions of EEG signals from O1 and O2 positions recorded with tDCS stimulation ON and OFF sessions. In all cases, 1 mA stimulation currents were delivered through electrodes F3 (cathodal) and F4 (anodal).

We recall here that Starstim can measure EEG from all electrodes with stimulation OFF, and from electrodes not used for stimulation during stimulation. *PISTIM* electrodes (gelled Ag/AgCl 3.14 cm^2 electrodes) were used both for stimulation channels and EEG recording channels with CMS/DRL electrodes placed in the left mastoid. All signals show a clear peak at 10 Hz corresponding to the alpha waves of the subject, who remained with eyes closed during the whole protocol. Signals are filtered for display from 1 to 45 Hz.

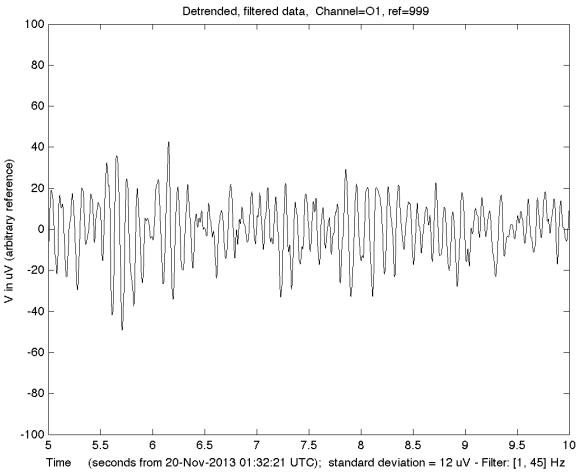
Comparisons between tDCS stimulation ON and OFF show that the quality of EEG signals at O1 and O2 during tDCS stimulation using "Pi" electrodes is very good and unaffected by the current injected through the stimulation electrodes. We note, however, that some low frequency artifacts may be present in electrodes very close to the stimulation electrodes, and that stimulation is typically electrically noisier during the first minutes of a session, while conduction channels are established and impedance stabilizes.

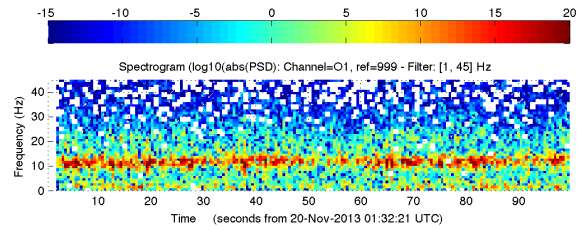
In the last figures we show the spectrograms from the stimulation electrodes (F3 and F4) before and after a stimulation session and see that although there is some leftover noise from electrochemical dynamics returning to zero current equilibrium during the first minute, it decays rapidly.

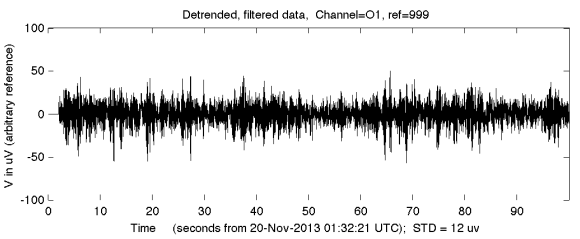
[1] The term *Pi* comes from the 1 cm radius of these electrodes, which thus provide a π cm^2 (3.14 cm^2) gel contact area with the skin. The gel used is *SIGNAGEL Electrode Gel* by Parker Labs.

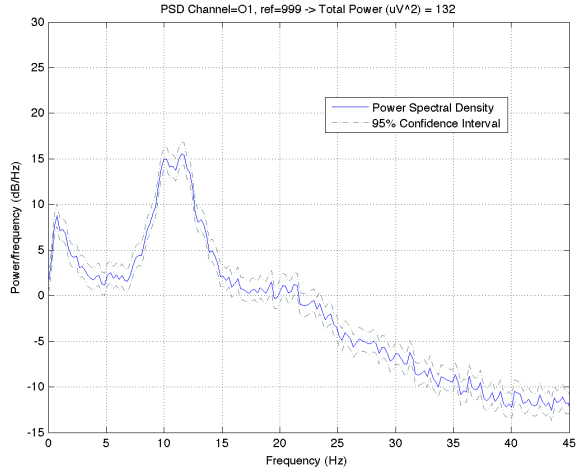
O1 Channel

STIM OFF

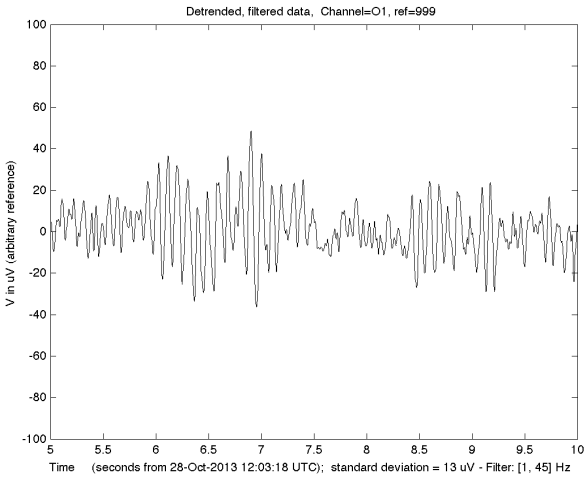


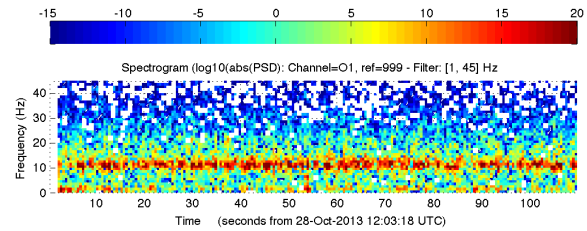


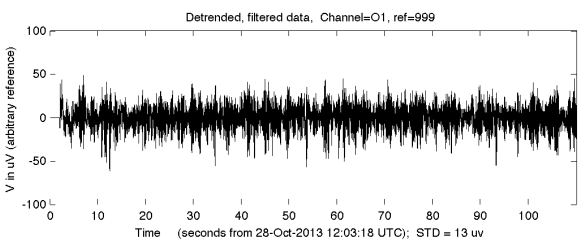


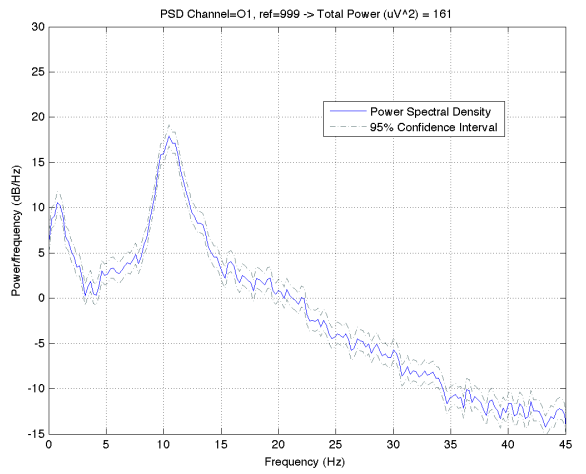


STIM ON



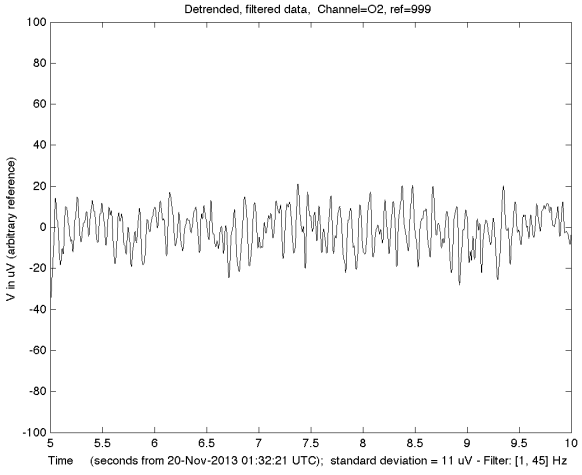


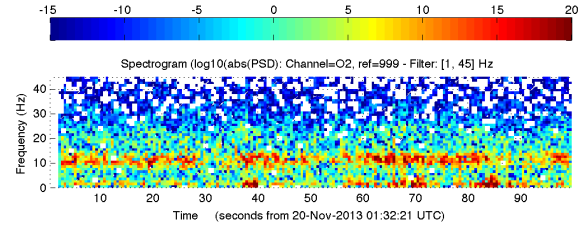


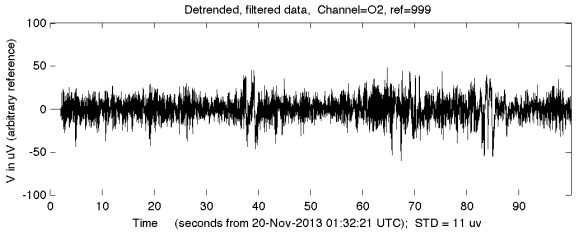


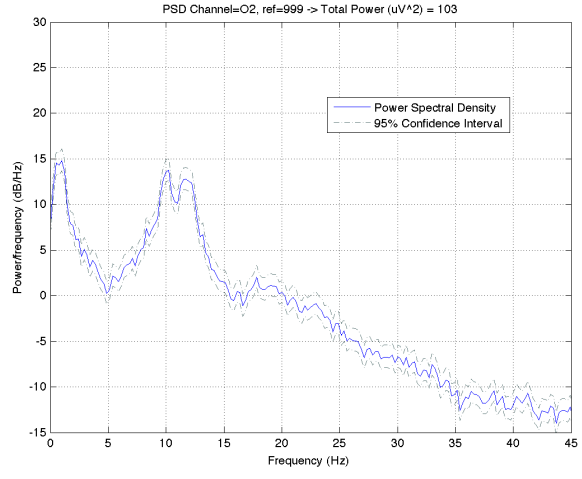
O2 Channel

STIM OFF

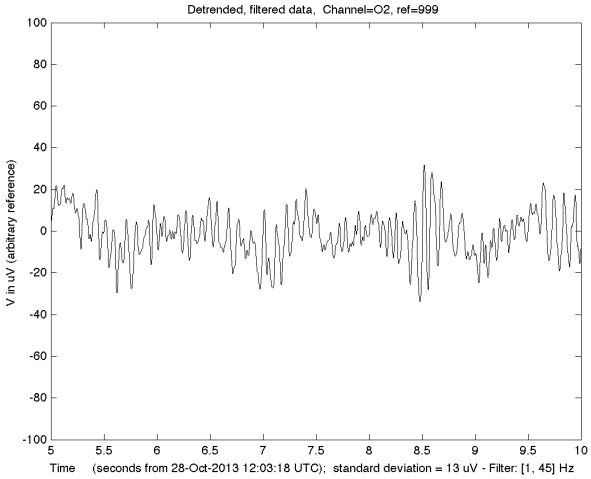


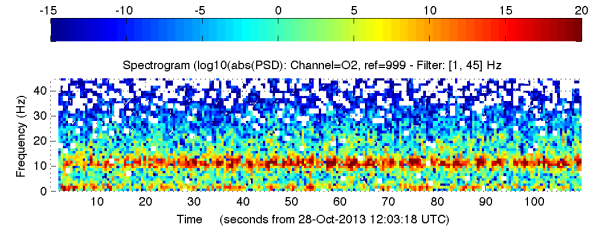


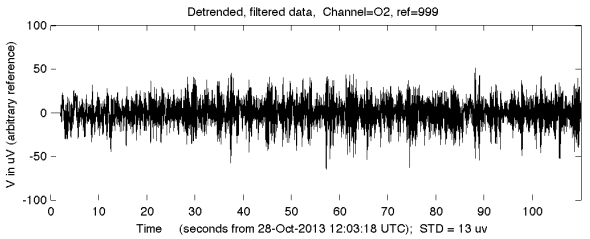


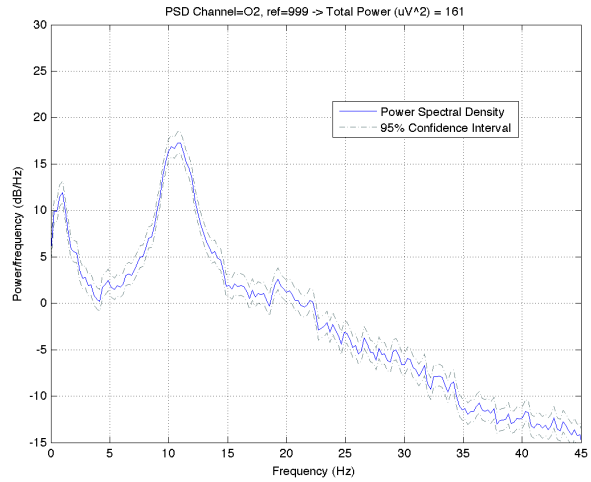


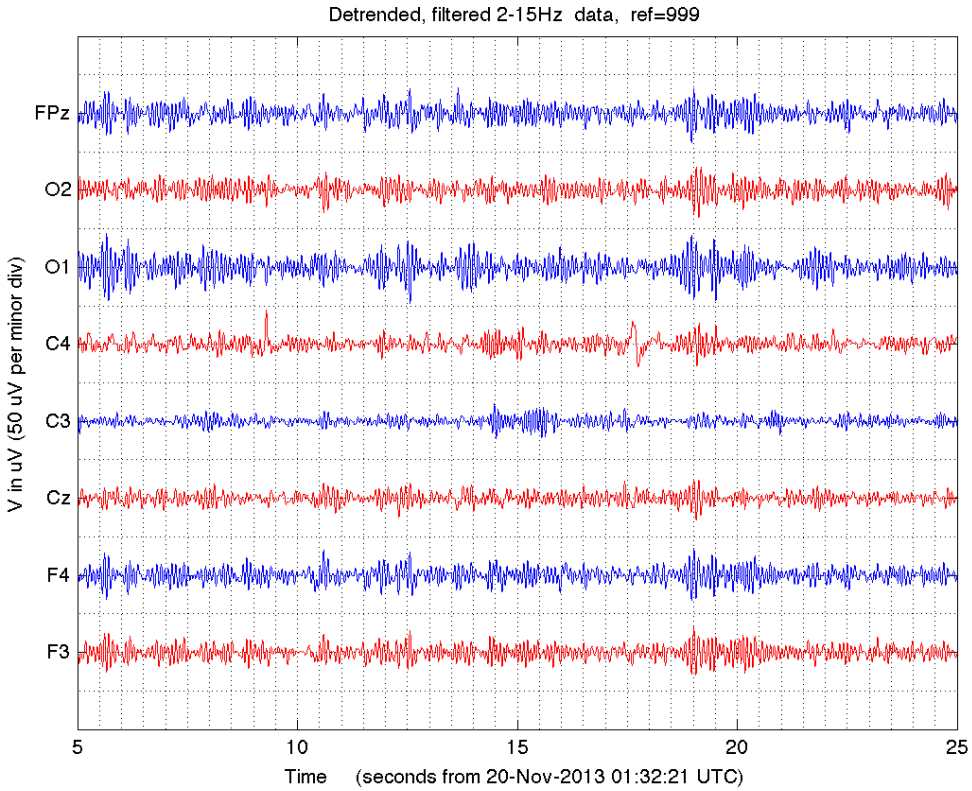
STIM ON

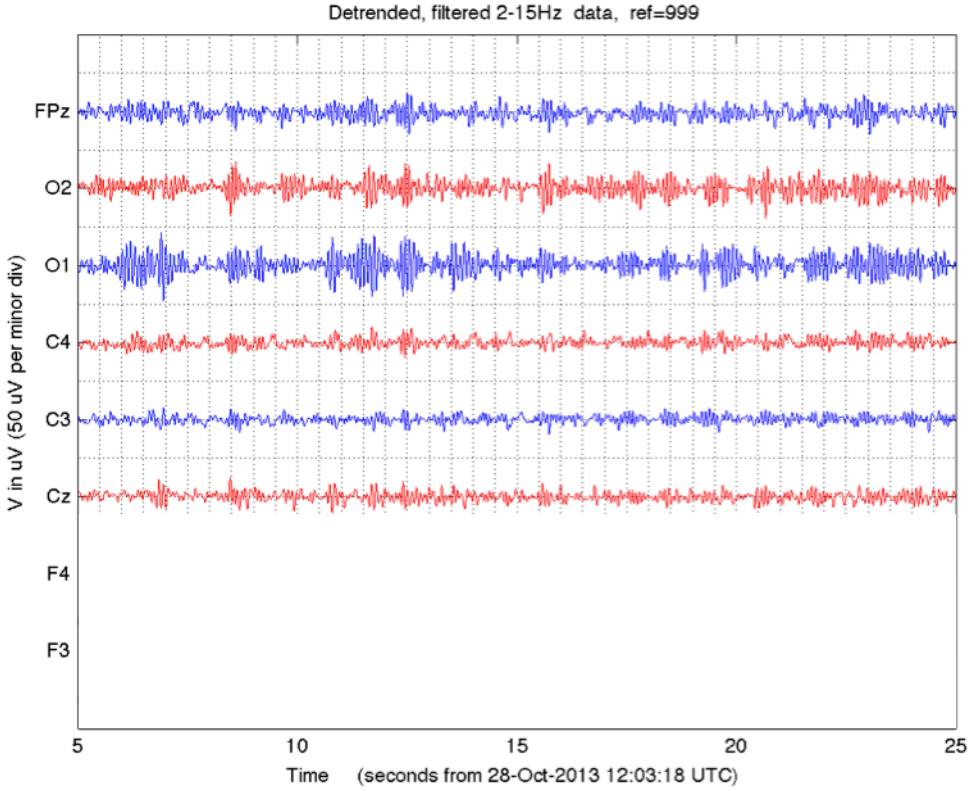




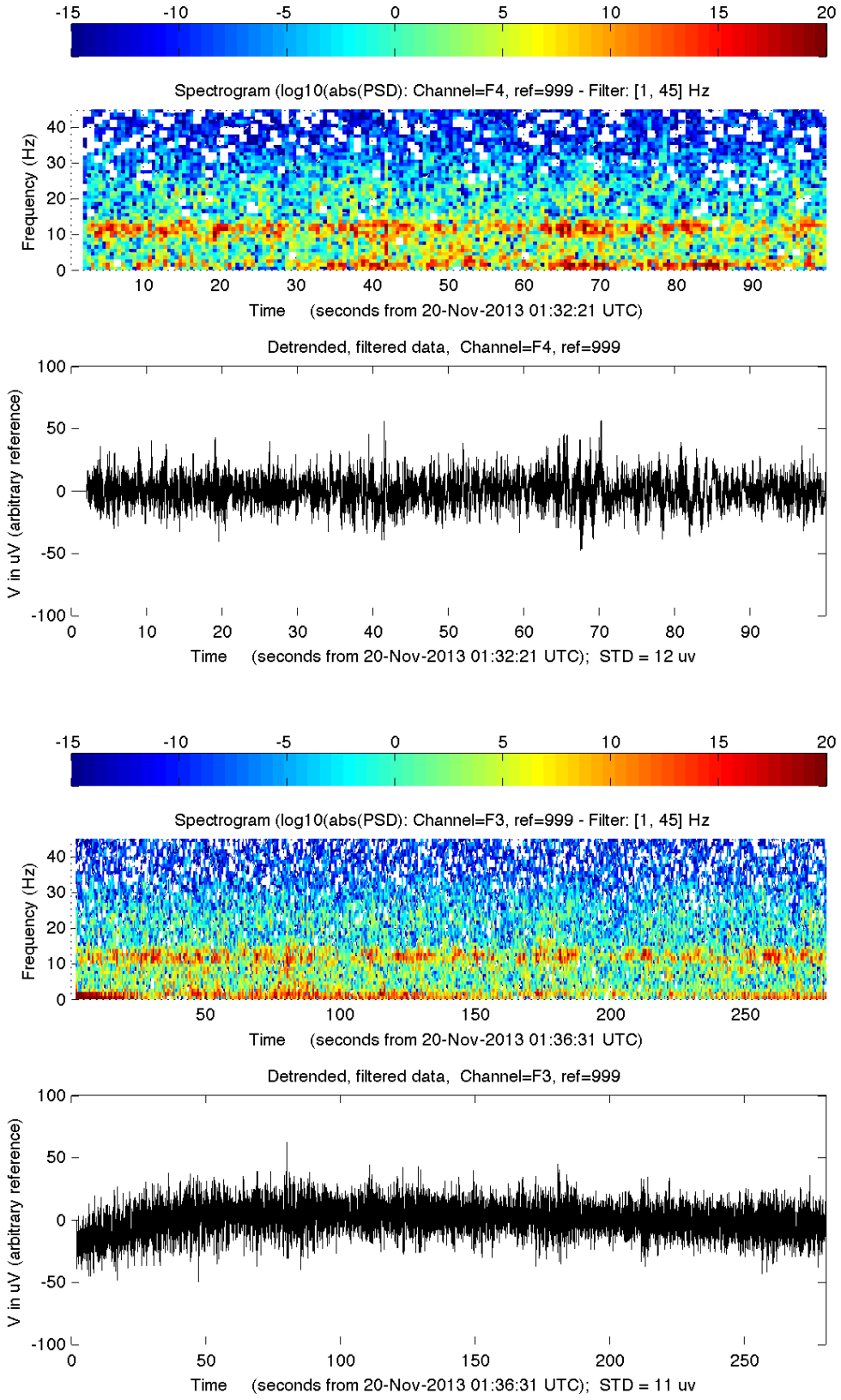




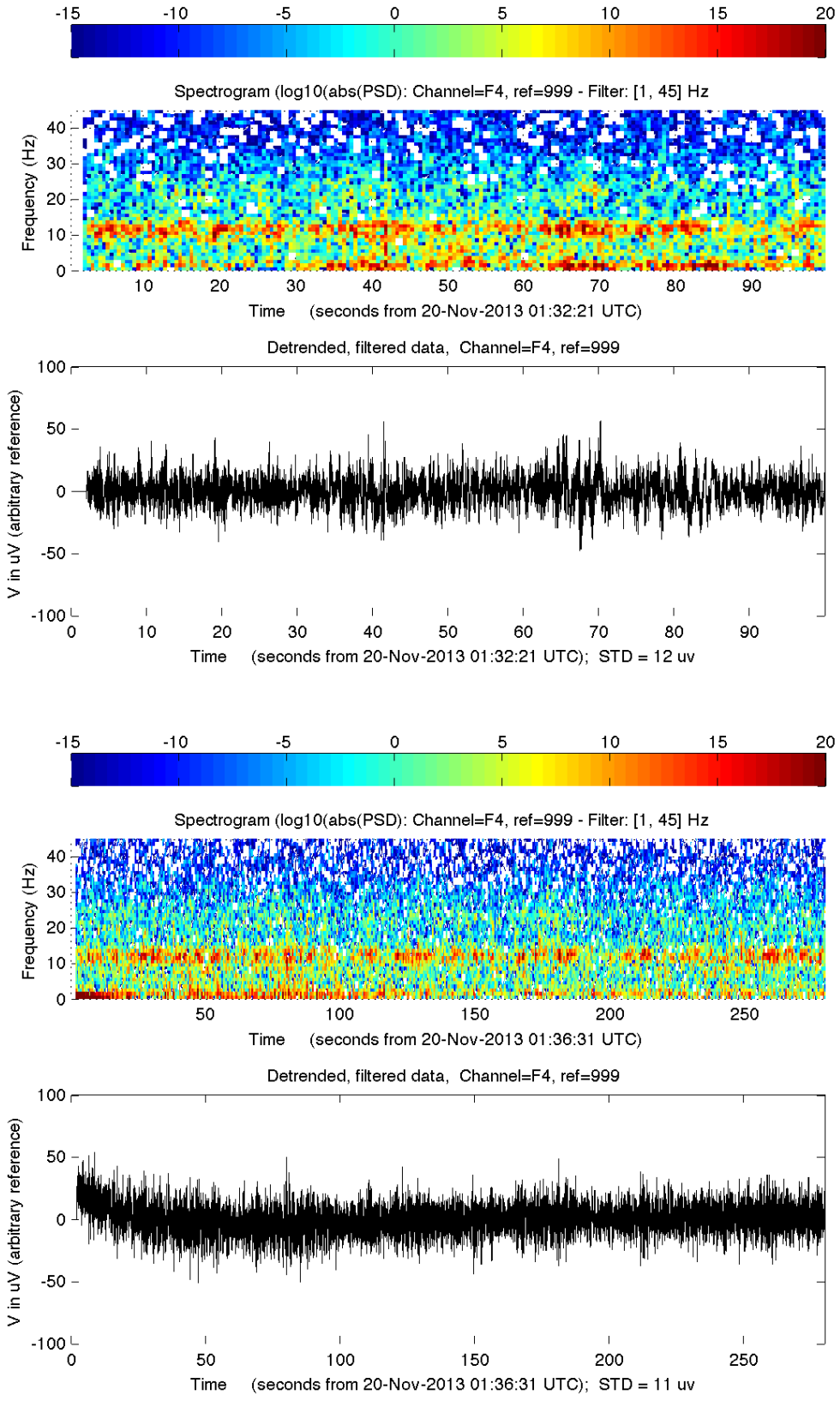




EEG data collected with stimulation OFF (top) and ON (bottom) with 2-15 Hz filtering. Reference is a global average (F3 and F4 electrodes used for stimulation).



EEG data collected with stimulation OFF from the stimulation electrode F3 (cathode) before (top) and after (bottom) stimulation. Some low frequency noise is apparent after stimulation during the first 50s.



EEG data collected with stimulation OFF from the stimulation electrode F4 (anode) before (top) and after (bottom) stimulation. Some low frequency noise is apparent after stimulation during the first 50s.