

Introduction

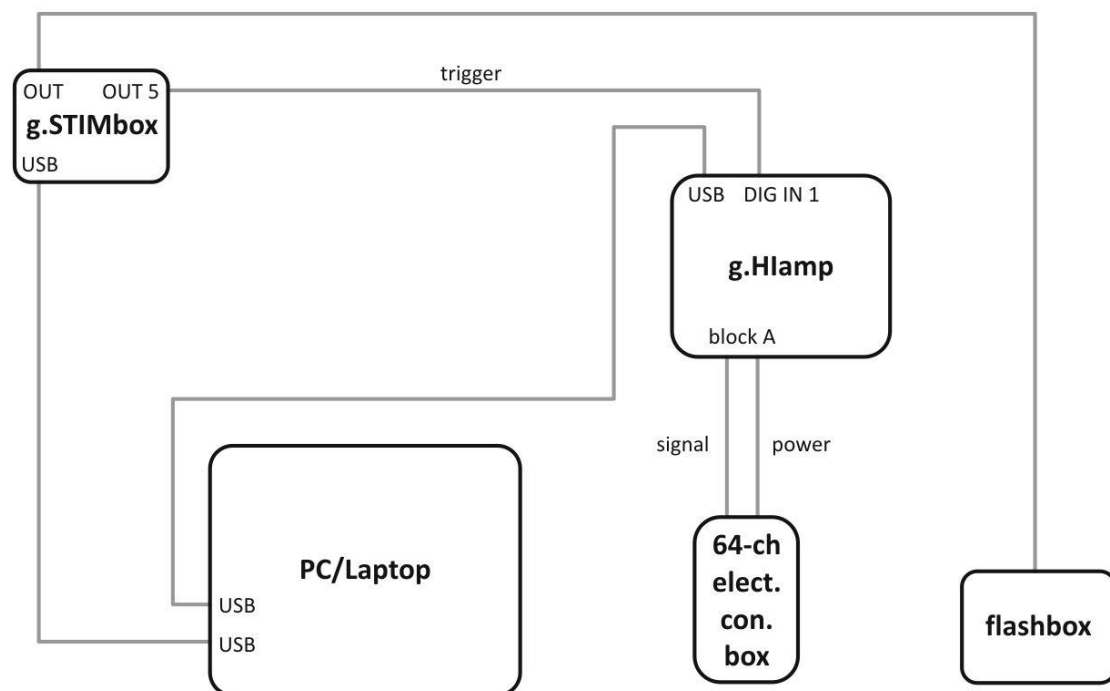
This document describes a simple visual evoked potential (VEP) experiment using g.Hlamp. The experiment is designed to be used as a user training or demonstration session and can be performed in less than one hour. 64 EEG channels are recorded with a standard g.GAMMAcap² and active g.LADYbird electrodes. An 8-LED flash box driven by g.STIMbox serves as the visual stimulator. Data are recorded with g.Recorder and data analysis is performed with g.BSanalyze.

Needed Equipment

- g.GAMMAcap² with 64 active electrodes (g.GAMMAgel and syringe)
- 64-channel active electrode connector box for g.Hlamp (with cables)
- g.Hlamp equipped with 64 or more channels (with power supply and USB cable)
- Trigger cable for g.Hlamp (1 Cinch connector to DIG In 1)
- g.STIMbox
- LED-flash box for g.STIMbox
- g.Recorder for g.Hlamp
- g.BSanalyze with EEG-toolbox
- EP-Master Software for g.STIMbox (comes with g.STIMbox)
- Setup file for g.Hlamp: `VEP_64ch_setup.xml` (included in the VEP-package, needs to be modified for your amplifier, please see note on next page)
- Montage file for g.BSanalyze: `64chVEPmontage.mat` (included in the VEP-package)

Step 1: System Setup

Place the equipment on a large table and plug all components together. If possible choose a place with low electrostatic charges and low electromagnetic interference.



System setup: Components and connections

Step 2: System Test

Before mounting the electrode cap perform a complete system check as follows: Turn on g.Hlamp and start g.Recorder. Change to the administrator mode and load the setup file `VEP_64ch_setup.xml`.

Note: The configuration file included in the VEP package was initially created for the device serial number HA-2011.09.06 and needs to be modified when used with a g.Hlamp with a different serial number. The file `VEP_64ch_setup.xml` can be opened with “Notepad” or with an other editor. Use the “Replace” function of the editor to change the serial number from HA-2011.09.06 to the serial number of your device. Make sure that all entries in the file are replaced by using the “Replace all” option. Save the file and load it in g.Recorder. In case of any troubles, please contact g.tec to provide an appropriate setup file for your g.Hlamp.

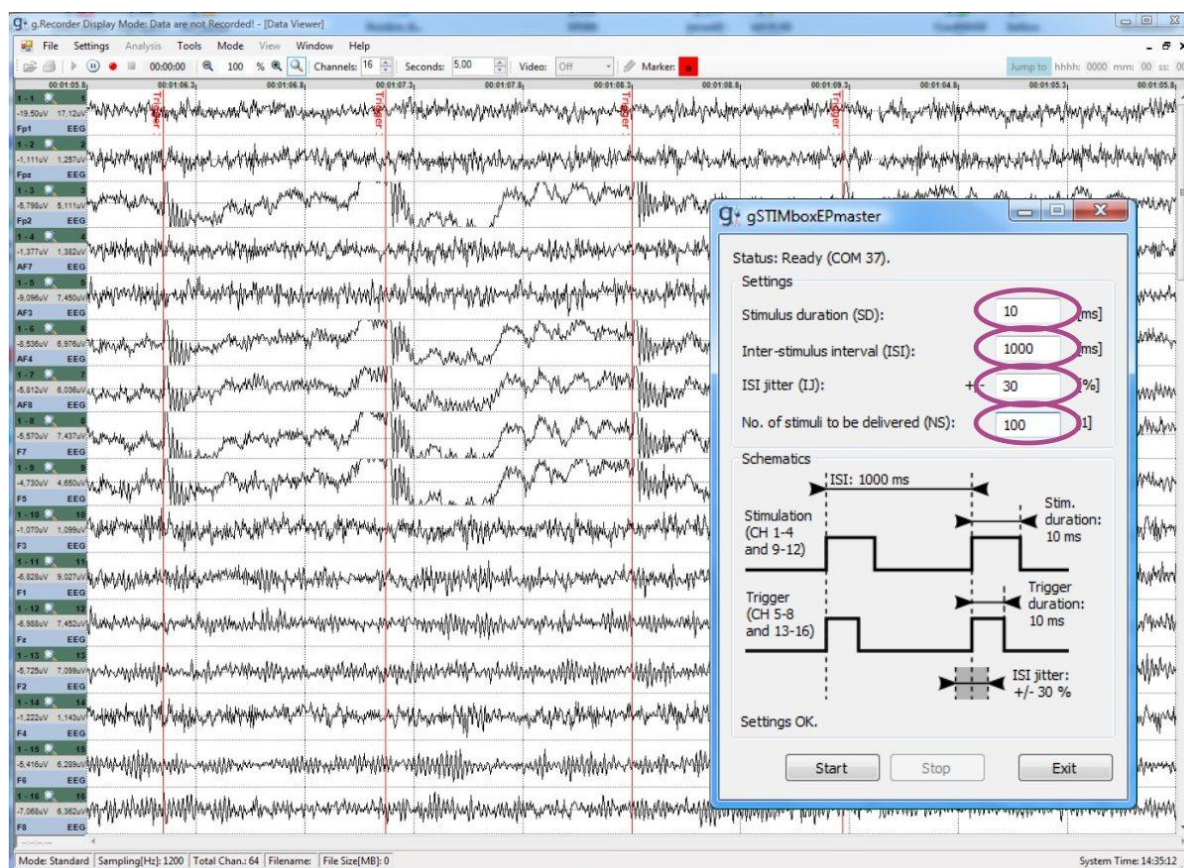
The following settings will be set for g.Hlamp:

- 64 channels selected for acquisition
- Sampling Frequency: 1200 Hz
- Bandpass 0.5 – 100 Hz set for all channels
- Notch (50 Hz) set for all channels (change to 60 Hz if necessary!)
- All channels use a common reference (channel 64)
- All channels are type “EEG” and the scope standard scaling is set to $\pm 50 \mu\text{V}$
- All channels have assigned electrode position names (Fp1, Fpz, Fp2, A1, A2)

Start the display mode and check if the data visualization works. Then start the EP-Master software `gSTIMunitEPmaster.exe`. With the driver for g.STIMbox installed and the g.STIMbox connected to the computer the application will detect the device and the used COM-port automatically after a few seconds. Make sure that the following parameters are set:

- Stimulus duration (SD) = 10 ms
- Inter-stimulus interval (ISI) = 1000 ms
- ISI jitter (IJ) = $\pm 30 \%$
- No. of stimuli to be delivered (NS) = 100

Make sure that the trigger cable connects output 5 of the g.STIMbox to DIG IN 1 of the g.Hlamp. Then start the EP-Master software and check if the LED-flash box works. In g.Recorder (the data visualization is still running) you should see a trigger marker for each flash delivered by the flash box. Now the system test is finished and we are ready to mount the electrodes and start the recording.



Parameters for g.STIMboxEPmaster and trigger markers in g.Recorder

Step 3: Subject instructions, electrode montage and impedance check

Before putting on the cap make sure that the subject is seated comfortably and the electrode connector box (connected to block “A”) is placed safely in front of or behind the subject avoiding tension of the electrode cables. The flash box should be placed in front of the subject in a distance of approx. 30 – 40 cm from the eyes with the LEDs facing exactly towards the subject’s eyes.

NOTE: As we are using flashing light stimulation, subjects who had experienced epileptic seizures in the past SHOULD NOT participate in the experiment. Flickering light may elicit seizures in epileptic patients!

A careful introduction of the experimental procedure to the subject is mandatory for professional scientists. Explain all details to the subject and ask if there are any remaining questions before starting.

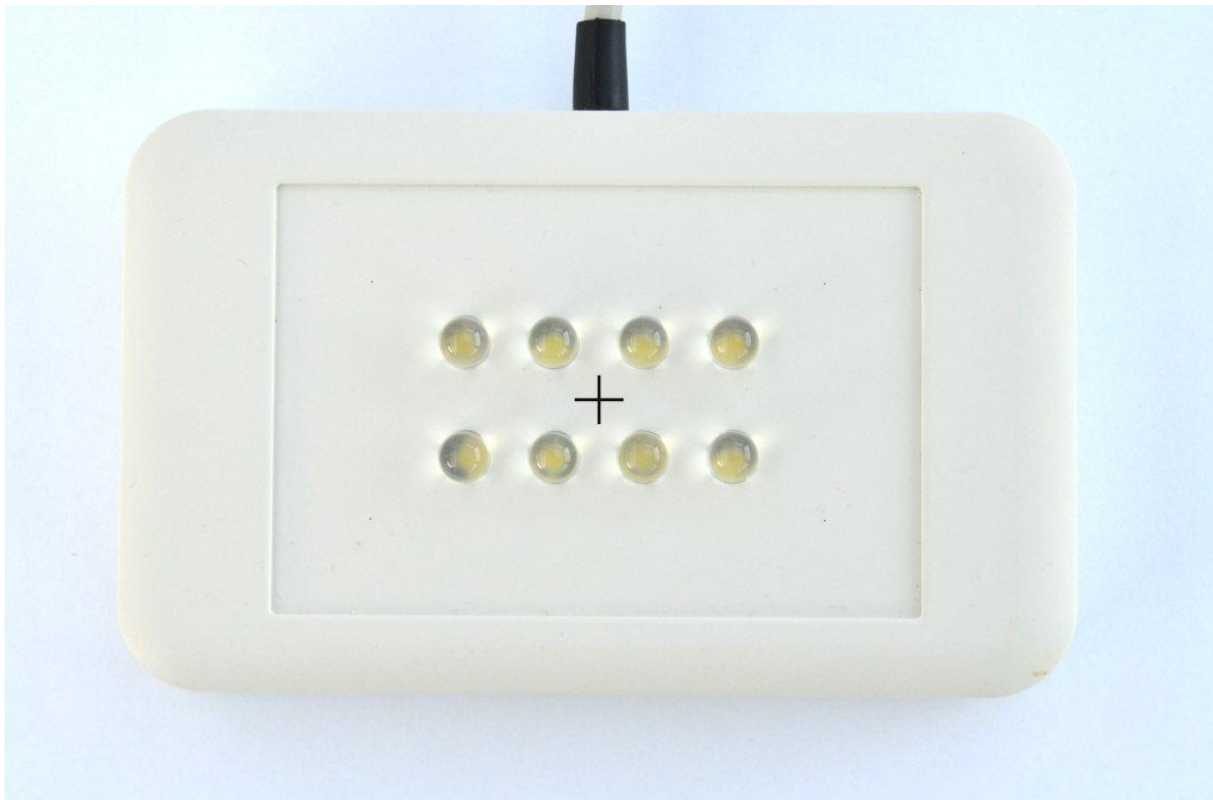
Put on the cap and place it correctly with position Cz showing the same distance to the nasion and to the inion. First attach the two earlobe electrodes (A1, A2) with a drip of gel. Then carefully fill the ground electrode (yellow) with gel using a syringe with a plastic tip. Make sure that an area of at least 1 cm² of skin is properly wetted with gel before filling up the electrode. Continue with electrode 1 (Fp1) which is the ‘Z’ electrode (black color, this electrode is required to be used on channel 1 to enable impedance measurement with active electrodes! The ‘Z’ electrode provides a normal signal as all the other electrodes do. Impedance measurement is possible for all channels except for channel 1 and for the ground electrode).

The next step is a visual data inspection. Start the display in g.Recorder and wait until all channels calm down. Scroll through all channels and watch out for suspicious channels with significant drift or noise. Then instruct the subject to perform the following actions:

- “blink your eyes” -> eye-blink artefacts occur with high amplitudes in the frontal channels -> OK
- “clench your teeth” -> muscle artefacts on all channels -> OK
- “close your eyes and relax” -> alpha oscillations will appear for most subjects, largest amplitudes in occipital channels -> OK

Now the instruction for the VEP recoding follows:

- The session will last less than 2 minutes and it can be stopped at any time for any reason.
- During the session the subject should sit still in a relaxed position. All muscles of the neck and the face should be fully relaxed.
- The subject should look at the central point in between the LEDs on the flash box and keep this point fixated for the whole session.
- Eye-blinks should be avoided or reduced as far as possible during the recording session.



8-LED flash box, the subject should fixate the point in the middle of the box

Step 4: Data recording

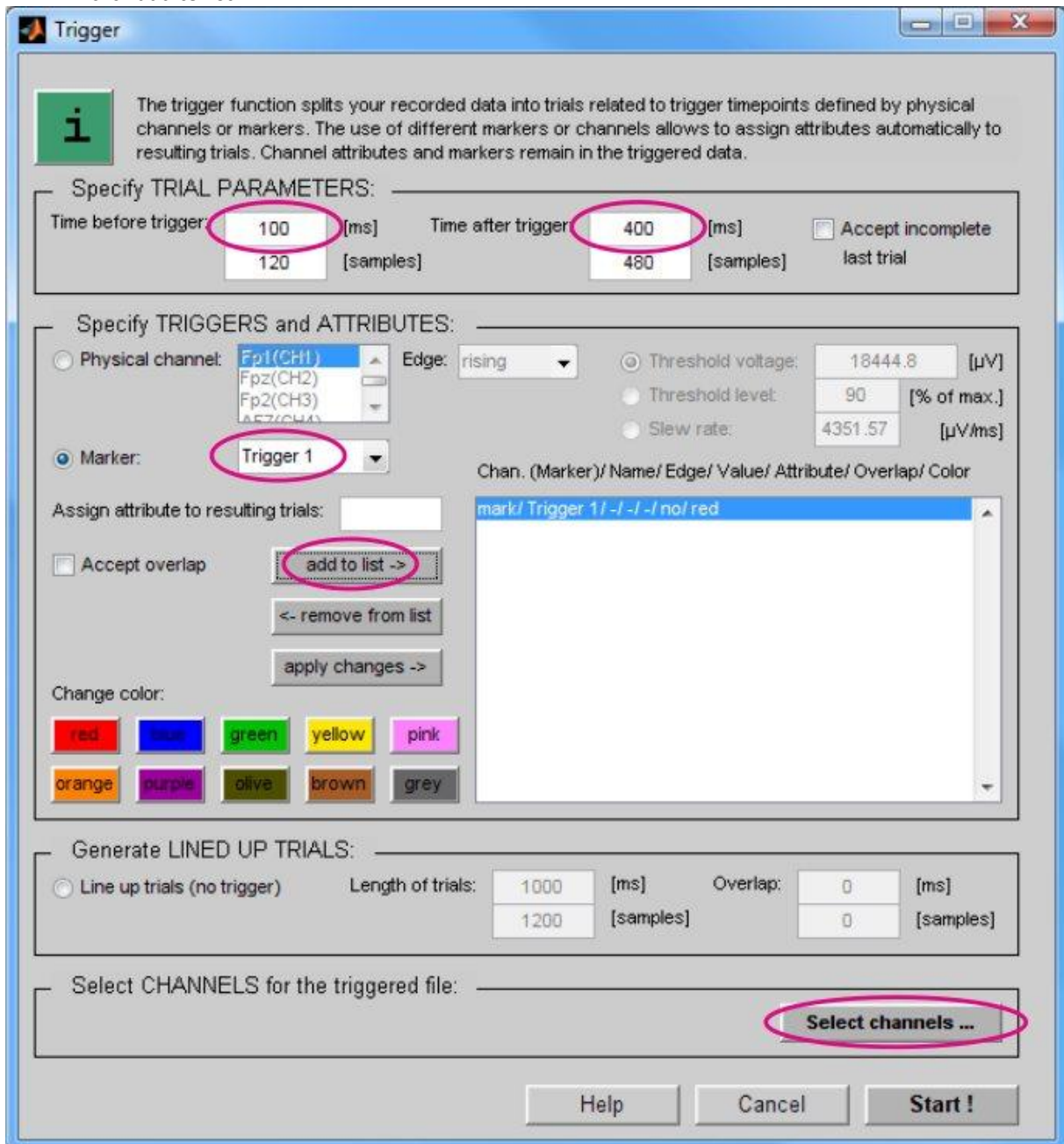
Start the data viewing mode in g.Recorder and press the “record” button to specify the path and file name. Then start the recording and wait a few seconds until all channels have calm down and appear stable. Make sure that the subject is ready and looking at the flash box. Now press the “Start” button in the g.STIMboxEPmaster application to start the stimulation. Observe the subject and the raw signals during the session to guarantee high quality data. The stimulation automatically stops after the preselected number of flashes (100).

Step 5: Data analysis

Start g.BSanalyze and load the recorded data file. If no dataset is available you can also open the file:
gtec\VEP\VEPexampleDATASET.hdf5

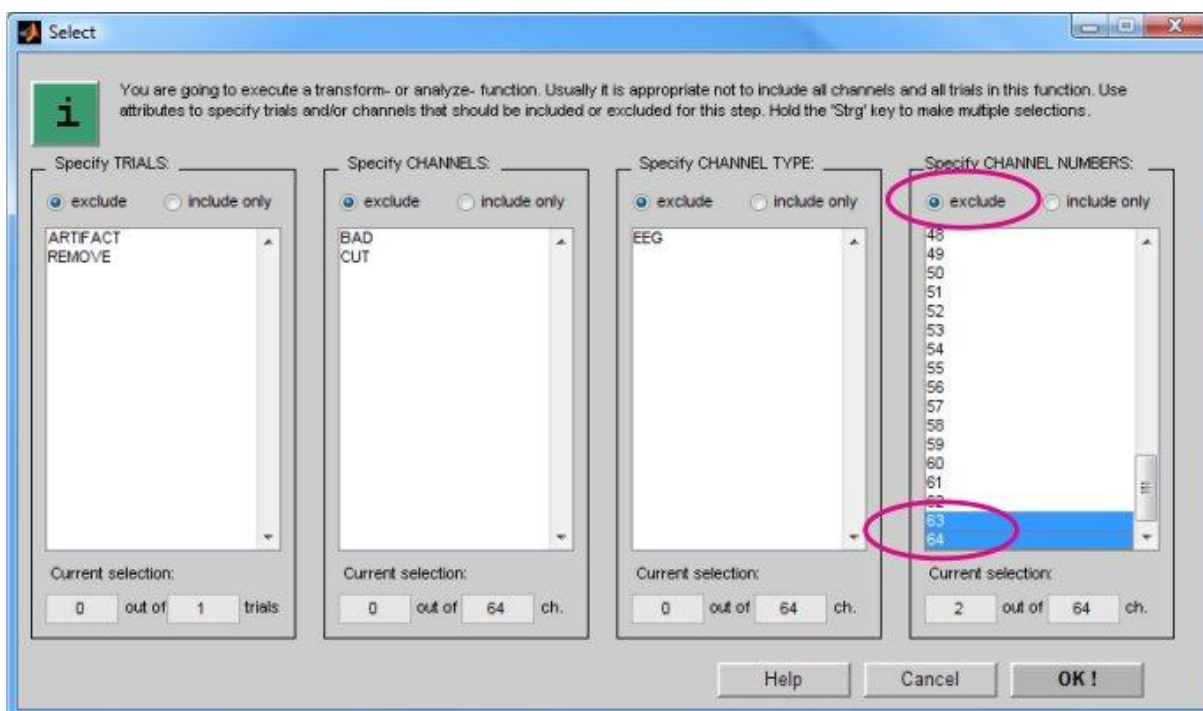
Open the **Trigger** dialog in the **Transform** menu and set the following parameters:

- Time before trigger: 100 ms
- Time after trigger: 400 ms
- Specify **TRIGGER**, select **Marker** and choose Trigger 1 from the list
- click **add to list->**



Specify parameters in the "Trigger" dialog

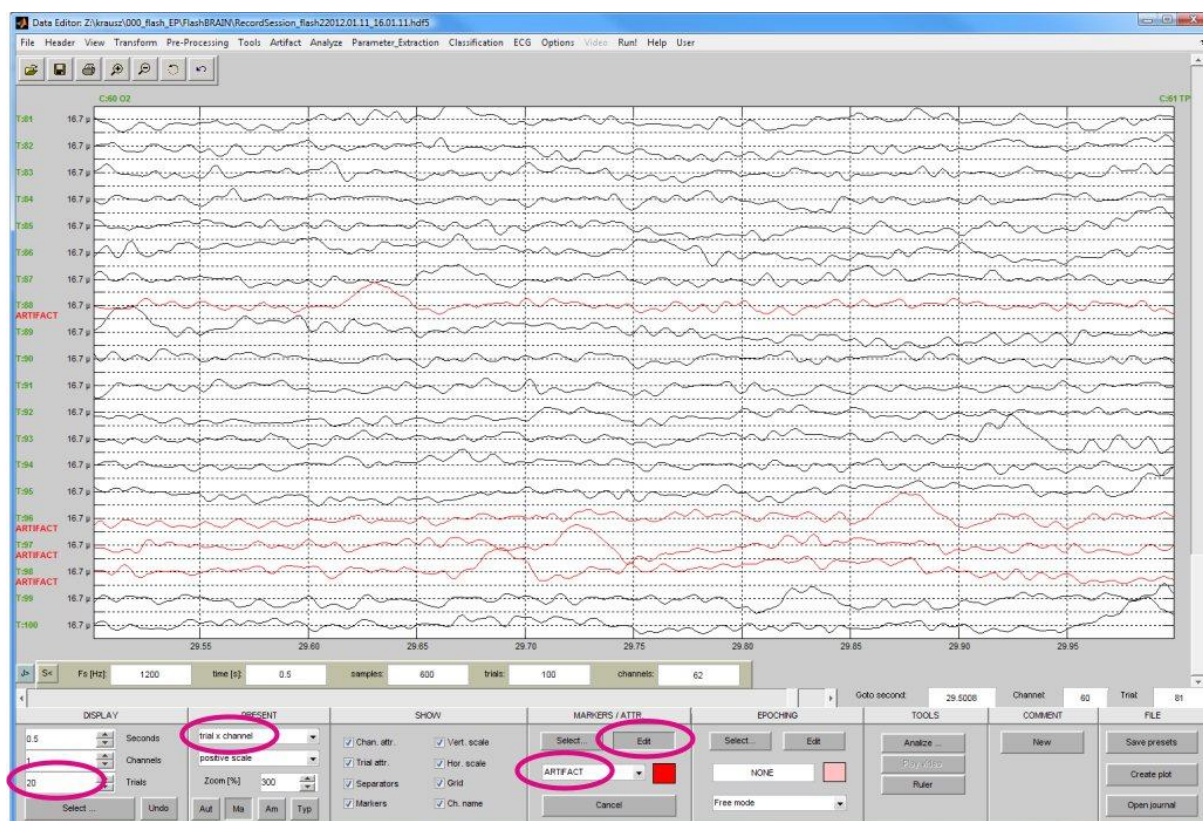
- **Select CHANNELS** for the triggered file, press **Select channels**
- in the **Select** dialog choose **exclude** and mark channels 63 and 64 (Reference A1 and A2), then press **OK!**



Select channel 63 and 64 (A1, A2) to be excluded from the triggered data file

Press **Start !** in the Trigger dialog. Now you will get a triggered data file containing 100 trials and 62 channels.

For artefact rejection change to the **trial x channel** presentation mode, show 20 trials on the screen and press the **Edit** button in the **MARKERS/ATTR.** section. Now you can scroll through the trials and channels and mark artefact-trials by clicking on the signal trace (the trace turns into red). Large eye-blink artefacts can be found easily in the fronto-polar channels (Fp1/Fp2), muscle artefacts may appear in various channels. When finished, press the **Edit** button again.



Mark trials with large artefacts: The attribute "ARTIFACT" will be assigned to marked trials

Now open the **Average** dialog in the **Analyze** menu. Specify the baseline correction parameters (reference interval 50 ms – 100 ms) and the smoothing parameters (Smoothing: average, Window: 16 samples; Horizontal averaging: factor = 4).

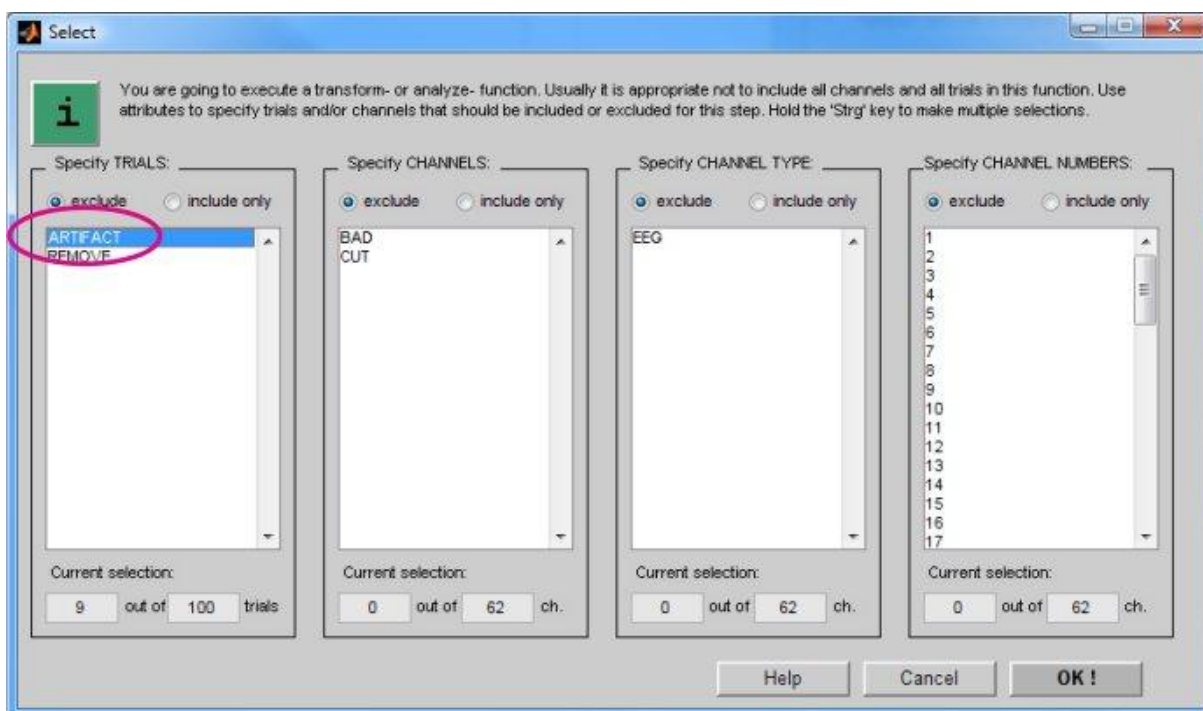
The screenshot shows the 'Average' dialog box with the following settings highlighted by red circles:

- Baseline correction:**
 - ☒ Baseline correction
 - Reference interval: 50 [ms] to 100 [ms]
 - Correct for reference interval from 60 [samples] to 120 [samples]
- Averaging options:**
 - ☒ Compute simple average
 - ☒ Nothing else
 - ☐ Add standard deviation time course
 - ☐ Compute borders for: +/- 1 standard deviation
 - ☐ Compute signal-to-noise ratio
 - ☐ Compute split-half averages
 - ☒ Compute simple average and split-half correlation
 - ☐ Compute separate split-half averages and correlation
 - ☐ Compute separate average of the first 50 trials and compare to ...
 - ☐ Compute separate averages for odd and even trials
- Smoothing / Downsampling:**
 - ☒ Smoothing: average
 - Window: 16 [samples]
 - ☒ Horizontal averaging: Factor: 4
- Select TRIALS and CHANNELS:**
 - Select trials / chan.** (button)
- Result procedure:**
 - ☒ Show with Result2D
 - ☐ Show with Result3D
 - ☐ Save results
 - Automatic treemaker is: enabled
 - Filename: enter filename

Buttons at the bottom: Help, Cancel, Start

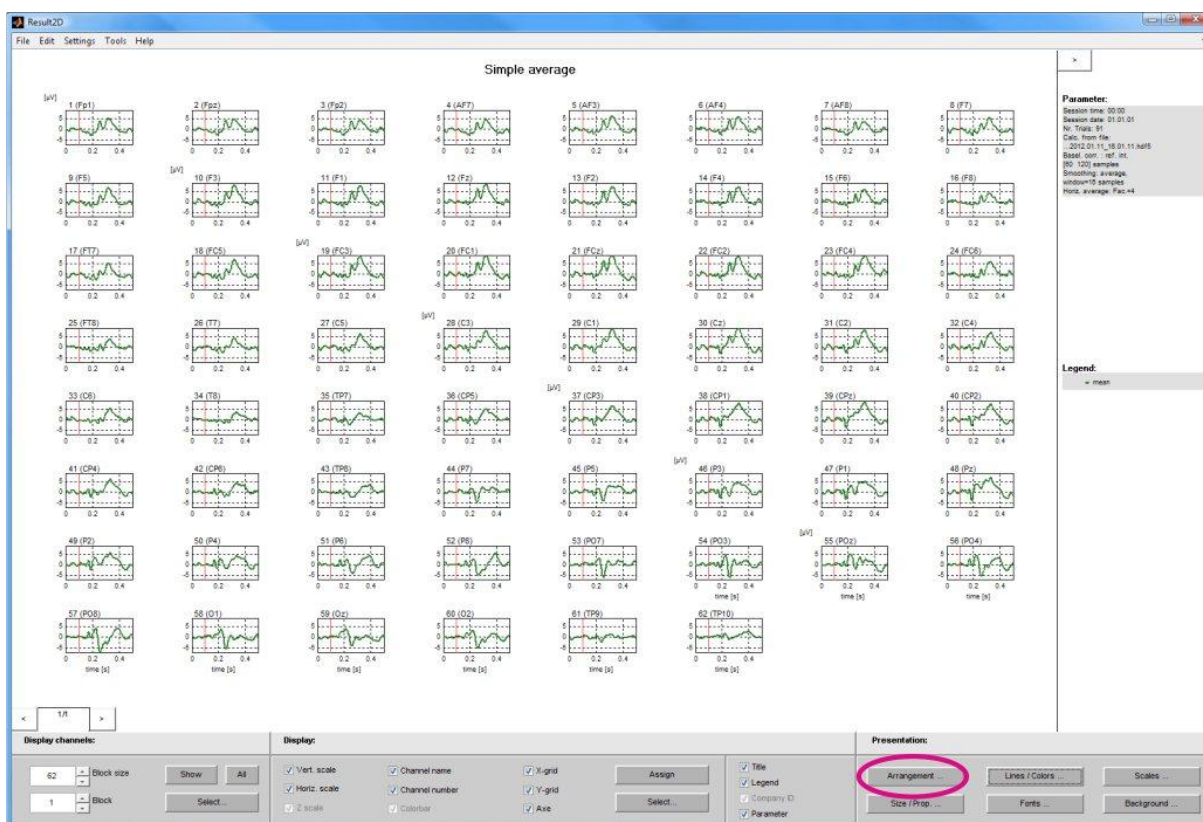
Specify baseline and smoothing parameters in the "Average" dialog

Then select the trials to be involved in the analysis by excluding **ARTIFACT**-trials.



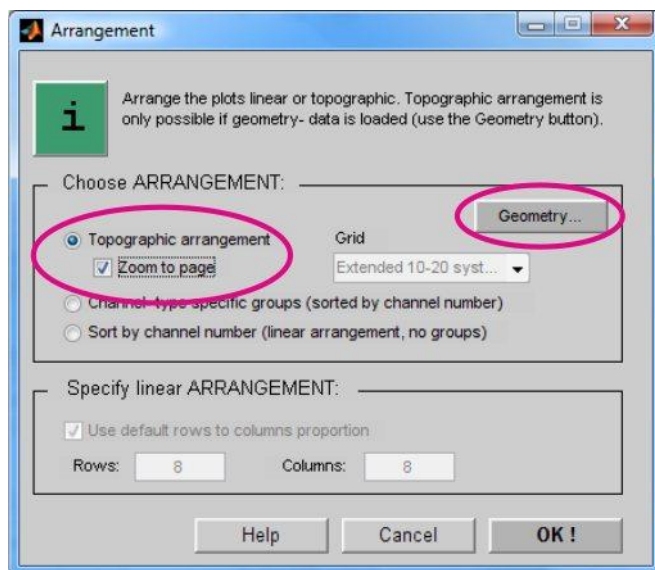
Select **ARTIFACT**-trials to be excluded from the averaging

Press **Start** to compute the results. The results will be shown in the **Result2D** viewing window.



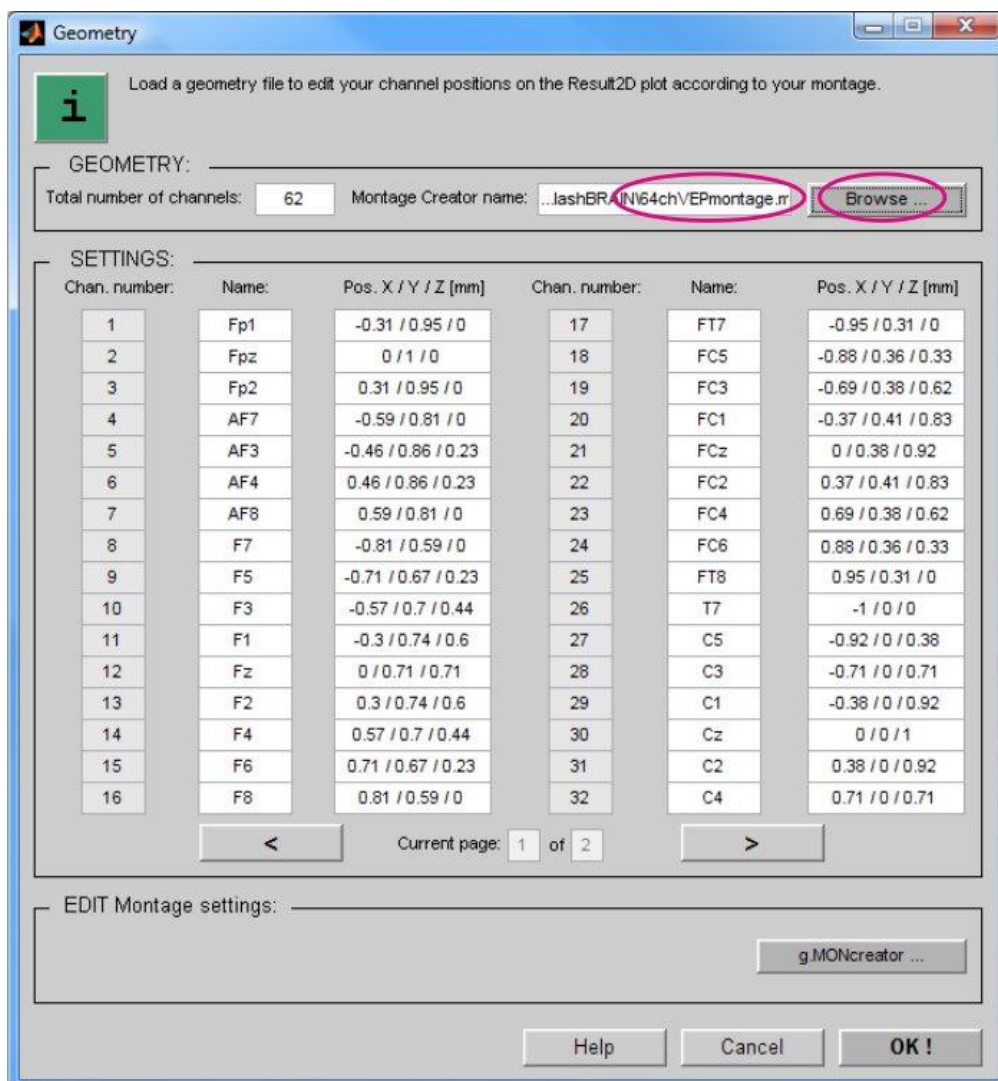
The VEP results for all 62 channels are displayed in a linear arrangement in the "Result2D" window

The result plots are displayed in a linear arrangement. To get a topographic arrangement click the **Arrangement** button, select **Topographic arrangement** and **Zoom to page**.



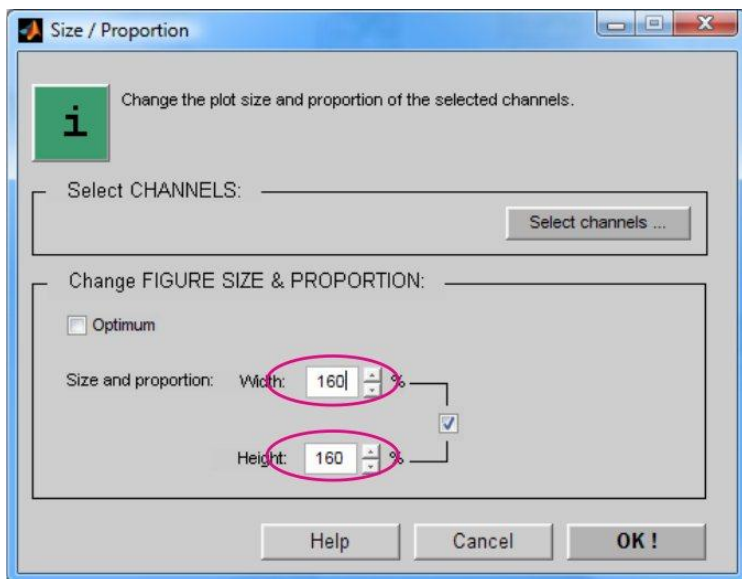
Change the arrangement of the result plots

Then press the **Geometry** button and load the following geometry file: gtec\VEP\64chVEPmontage.mat



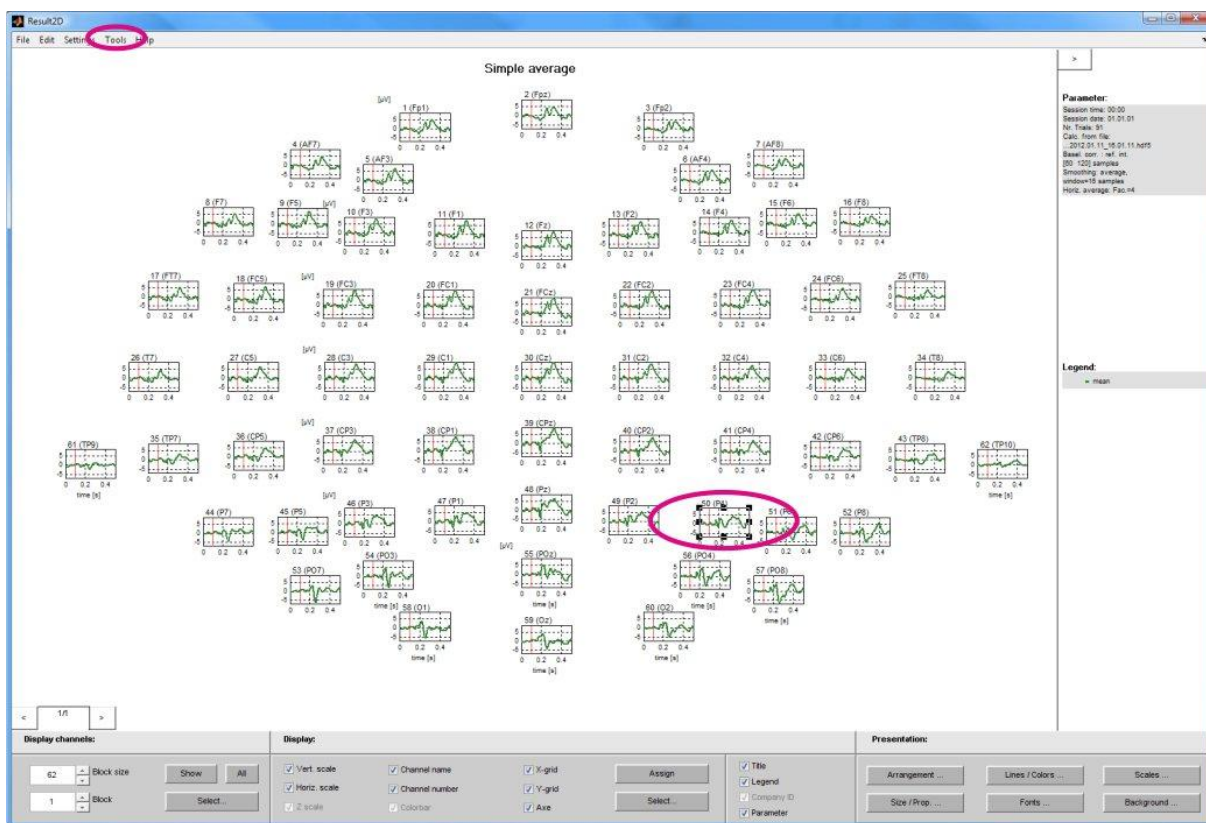
Press the "Browse..." button and load the geometry file

Now the results are displayed in a topographic arrangement but the single plots are a little bit too small. Press the **Size/Prop.** button and set the zoom factor to 160 %.



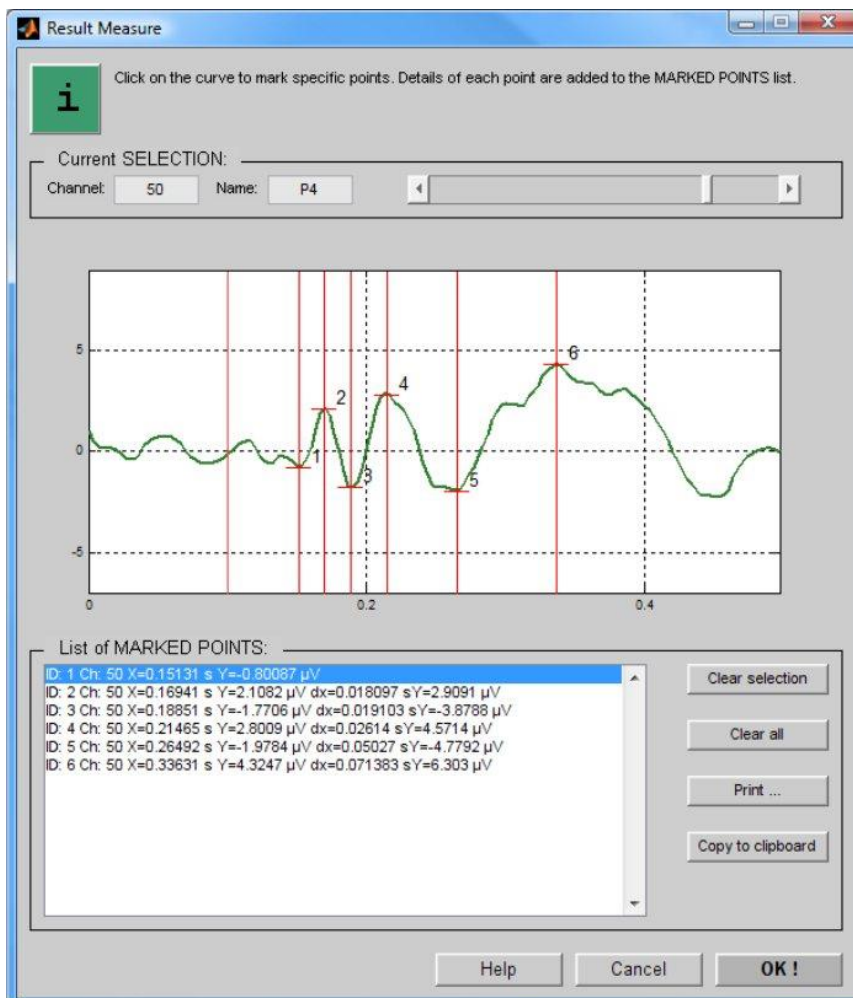
Set the zoom to 160 %

Depending on your screen size you should see the results in proper size now.



Correct topographic arrangement of the result plots; Select a channel to open the plot in the "Result measure" tool

To investigate a single channel click on the plot outline to mark the desired channel. Then open the **Result measure** window in the **Tools** menu. By clicking the result trace you can measure the amplitude and latency of identified components of the evoked potential.



The "Result measure" tool allows to measure amplitudes and latencies of identified VEP components

Visual evoked potentials never look absolutely identical for different subjects but for most subjects you will be able to identify the main components of a "typical" VEP in some of the recorded channels.

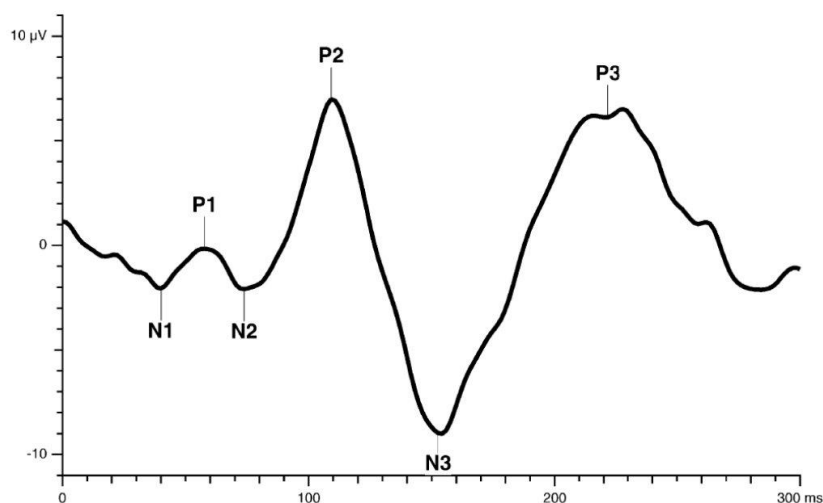


Figure 4. A normal flash VEP.

A typical flash VEP wave shape reported in literature (Visual evoked potential standard, Odom et. al. 2004)

Step 6: Cap cleaning

Clean the cap immediately after use!

- Disconnect the electrode connector box from the signal cable and from the power supply cable. The cap remains connected to the electrode driver box for cleaning!
- Securely protect the electrode driver box from water during the cleaning procedure.
- Soak the cap in warm water with a little bit of soap or shampoo for two minutes (not longer!). Use a smooth toothbrush to remove the gel from the electrodes under water. Clean the inner side and the outer side of the electrodes.
- Finally rinse the cap with warm water and make sure that no gel remains in the holes of the electrodes.
- Use one towel from the inner side of the cap and one from the outer side to remove the water, at least put the cap on a polystyrene head for drying.
- Never pack or store a wet cap!



64-channel g.GAMMAcap² for g.Hlamp with active electrode connector box

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