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GUGER  
TECHNOLOGIES

g.<sup>®</sup> GAMMAsys  
ACTIVE ELECTRODE SYSTEM

## Comparison of Active versus Passive Electrodes

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# 1 Introduction to g.GAMMAsys

g.GAMMAsys is g.tec's newest high-end and high-performance active electrode system for non-invasive electrophysiological derivations. The system allows the acquisition of biosignal channels such as EEG (Electroencephalogram), EOG (Electrooculogram), EMG (Electromyogram) and ECG (Electrocardiogram) using g.tec's genuine active electrodes. The system is designed for use with biosignal amplifiers with monopolar (unipolar) or bipolar (differential) inputs.

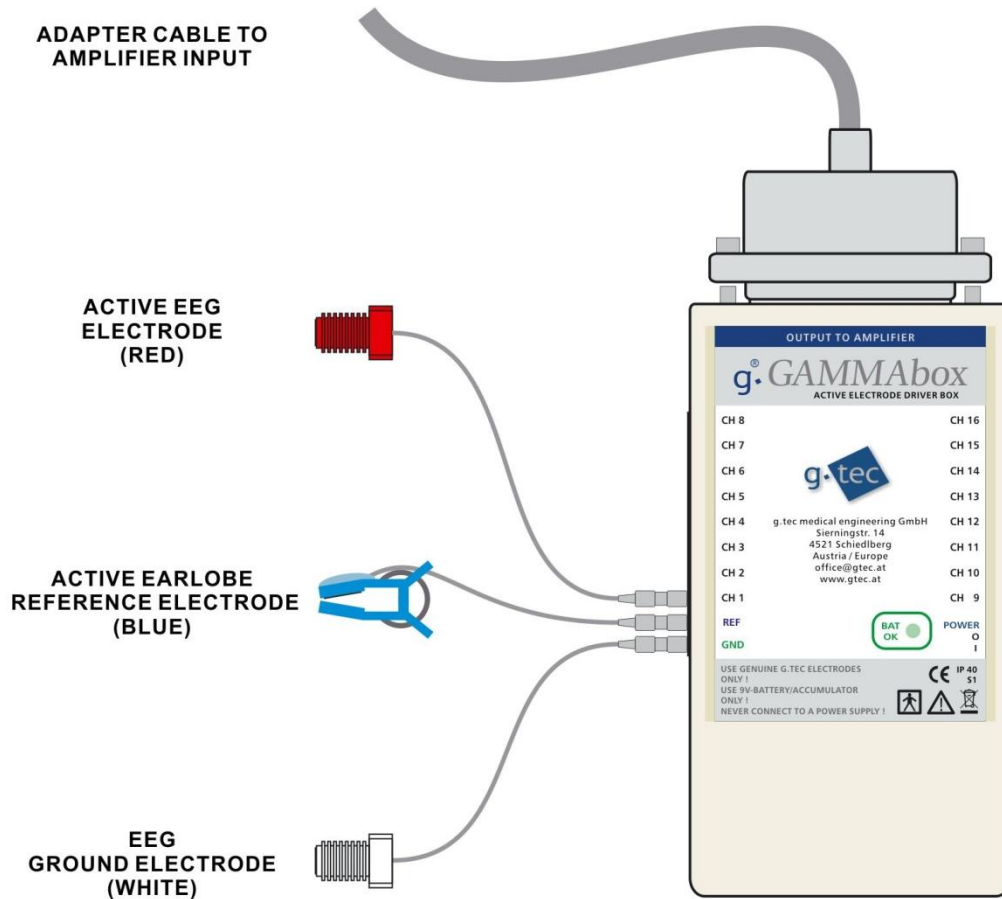
The system avoids or reduces artifacts and signal noise resulting from high impedance between the electrode(s) and the skin (e.g. 50/60 Hz coupling, artifacts caused by electrode or cable movements, distorted signals or background noise). The purpose of the document is to compare active and passive electrodes.



***g.GAMMAbox with active electrodes***

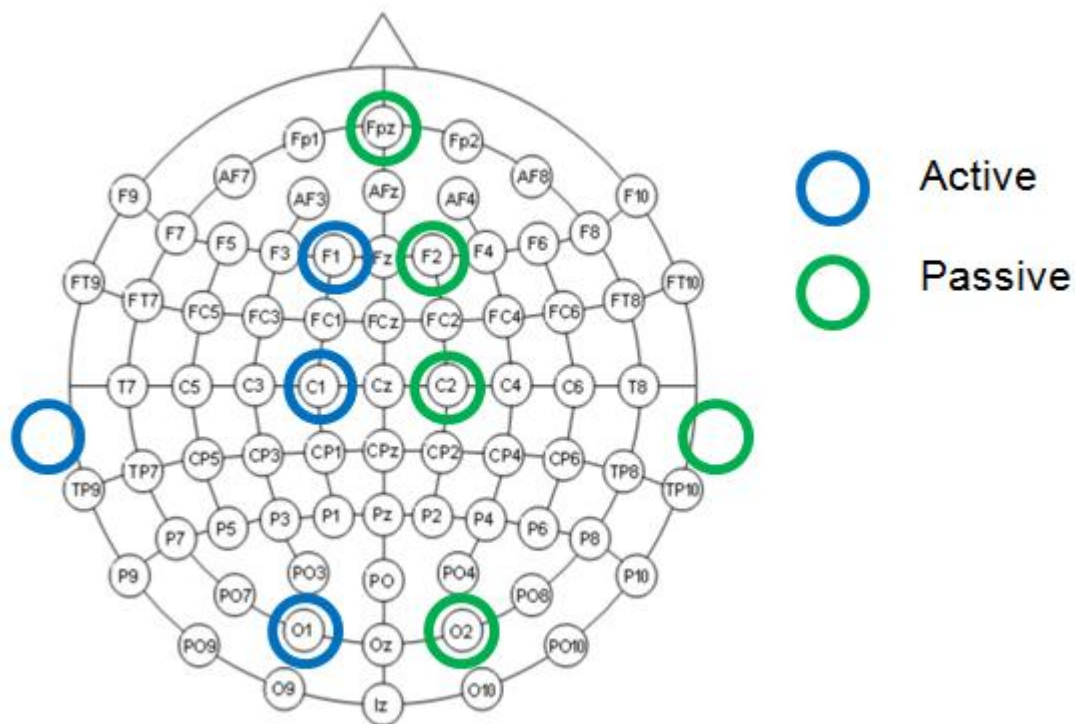
## 2 Comparison

Active electrodes have an amplification unit in the active EEG electrode (red) and active earlobe reference electrode (blue). The EEG ground electrode (white) is a passive electrode and acts as ground potential for the amplifier.



***g.GAMMAbox connection scheme***

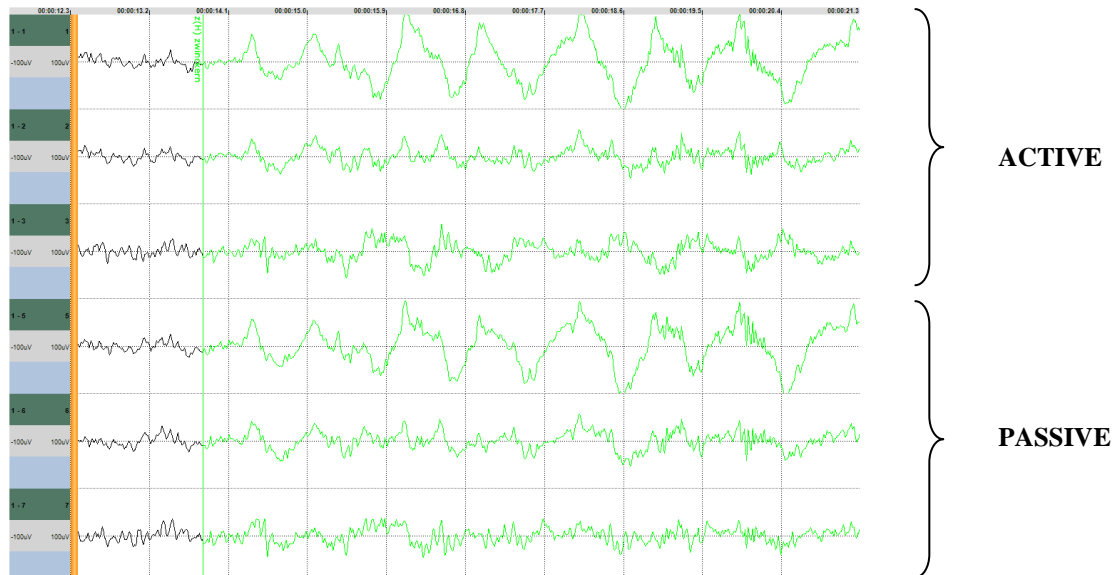
The compare active and passive electrodes active electrodes were mounted on positions F1 (channel 1), C1 (channel 2), O1 (channel 3) with g.GAMMAgel (no abrasion) and passive electrodes were mounted on positions F2 (channel 4), C2 (channel 5) and O2 (channel 6) with abrasive gel. Active and passive electrodes are located next to each other to allow a better comparison. The ground electrode was located on position Fpz. The active electrodes were referenced against the right ear. The passive electrodes are referenced against the left ear. Five conditions were compared: (i) eye movements, (ii) biting, (iii) cable artefacts, (iv) active head movements by the person himself and (v) passive head movements done by a second person.



*Electrode positions for comparison*

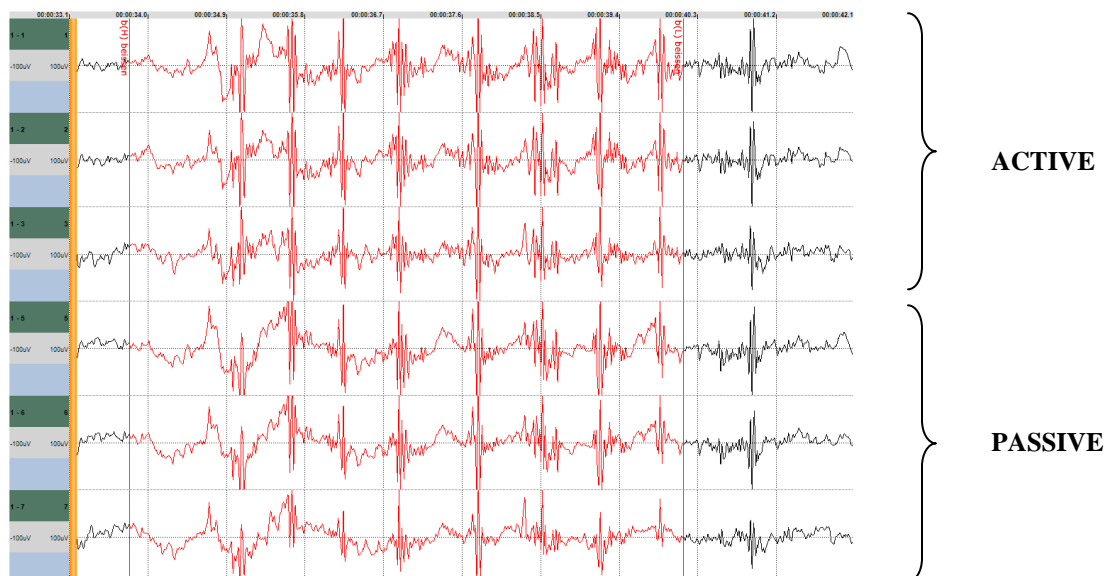
## EYE MOVEMENTS

The channels closer to the eyes (1 and 4) show higher EOG artefacts than central and occipital channels. Both passive and active electrodes show a similar EOG contamination which is also clear because both pick up the same source signal.



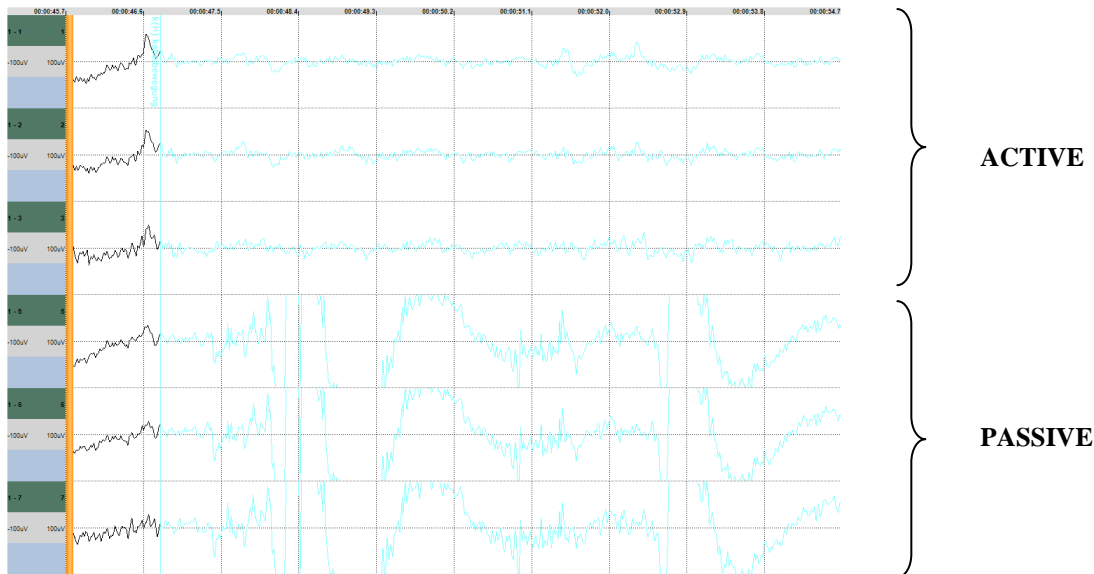
## BITING

Biting produces EMG contamination almost equally on all channels and there is no difference between active and passive electrodes because both pick up the same source signal.



## CABLE ARTEFACTS

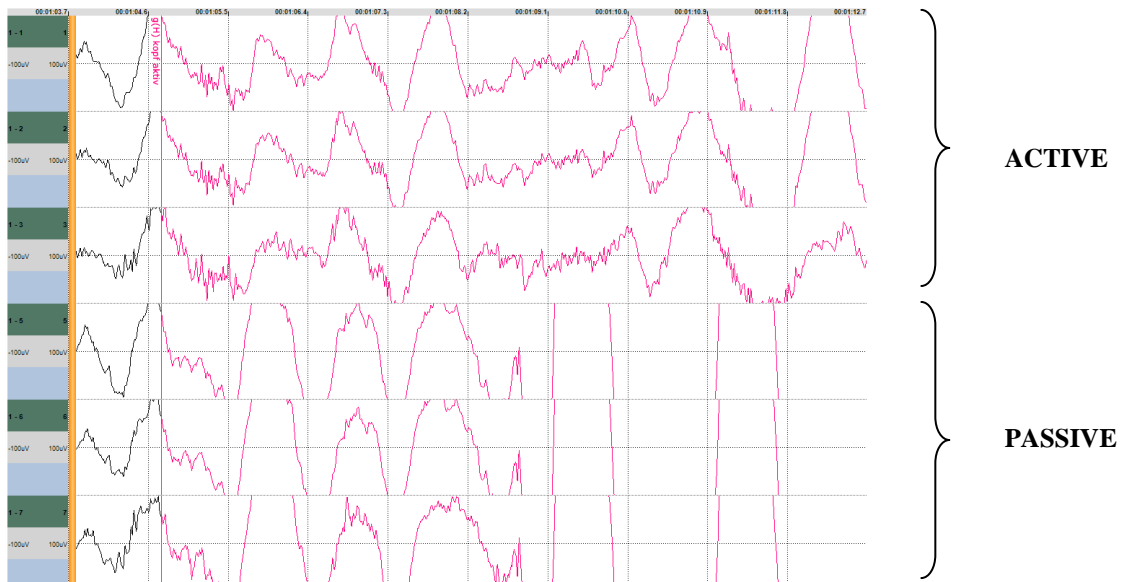
Cable artefacts are produced by touching or shaking the cables. The active electrodes are almost unaffected while the passive electrodes show large movement artefacts.



## ACTIVE HEAD MOVEMENTS

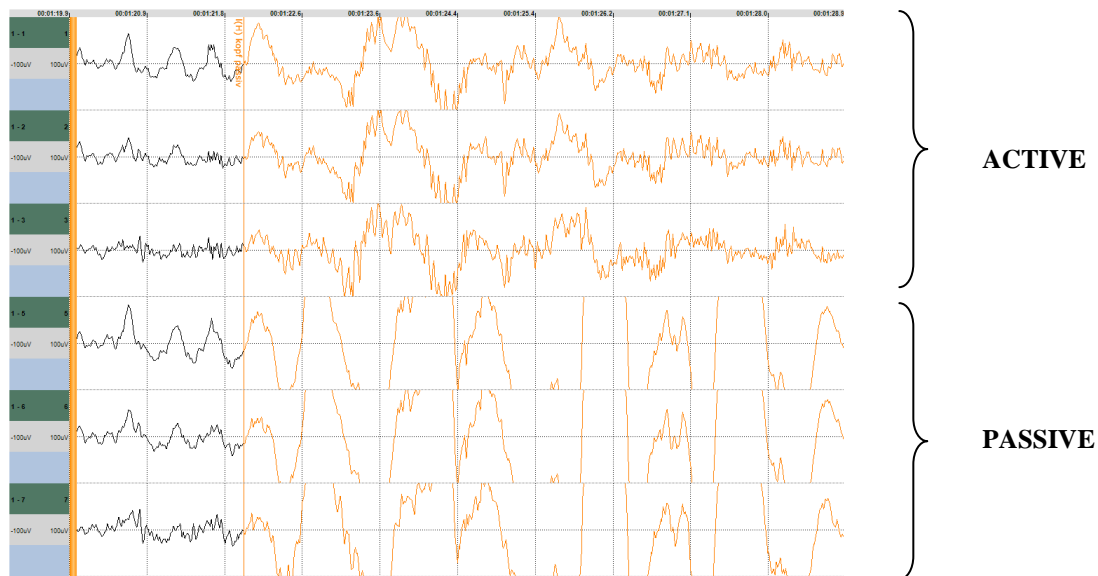
Active head movements produce fewer artefacts with active electrodes compared to passive ones.

Artefacts for both electrodes can occur because of skin-electrode movements. Passive electrodes are mostly affected by the cable movements initiated by the head movements.



## PASSIVE HEAD MOVEMENTS

Passive head movements have lower accelerations than active head movements and therefore the artefacts are smaller and mostly visible with passive electrodes.





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