

# Non-invasive detection of fast ripples in low-noise EEG recordings

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**Rational:** Ripples (80-250 Hz) and fast ripples (FRs, 250-500 Hz) are characterized by poor signal-to-noise ratio (SNR), which reduces their visibility in non-invasive recordings. While ripples could be observed in scalp EEG, FR detection has been restricted only to invasive recordings. We report here on FRs detection in the scalp EEG of epilepsy patients, recorded with low-noise technology.

**Methods:** One hour scalp EEG was recorded in two patients with focal epilepsy exhibiting interictal spikes and one non-epileptic patient. We used a custom-made low-noise 8-channel amplifier, with noise level 2.3 nV/ $\sqrt{\text{Hz}}$ . Electrodes were placed on both hemispheres with impedances below 2 k $\Omega$ . Segments of artifact-free bipolar traces, filtered in the FR band, were selected for analysis. FR rates were obtained semi-automatically by combining entropy based amplitude threshold computation and single event visual validation.

**Results:** For patient 1 (spikes on left side), FR rates averaged across channels were 0.495/min on the left and 0.046/min the right side. For patient 2 (spikes predominantly on the right side), rates were 1.365/min on the left and 1.262/min the right side. For patient 3 (absence of spikes), rates were 0.057/min. The mean FR peak-to-peak amplitude was  $3.23 \pm 2.79 \mu\text{V}$ . The amplitude threshold was  $0.51 \pm 0.08 \mu\text{V}$  across all channels.

**Discussion:** FRs in scalp EEG could be detected using optimized low-noise technology. FRs were more frequent in the more epileptogenic regions and may therefore represent epileptic activity. The opportunity to access FRs non-invasively represents a critical step towards the non-invasive investigation of fast neural dynamics.