Crash and recovery of the potential in a toroidal plasma column, as observed by generalized conditional sampling

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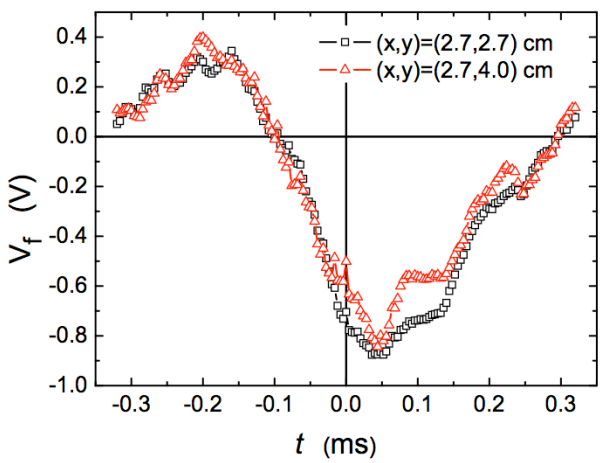
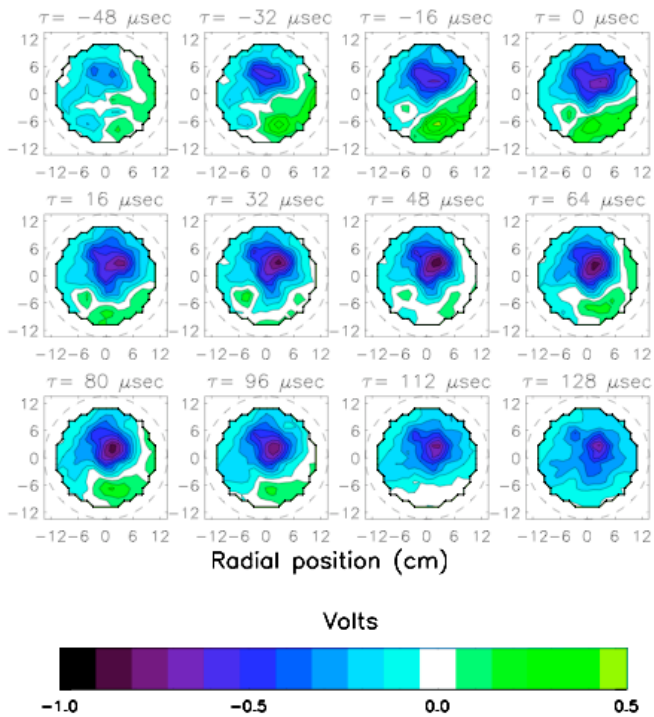
Abstract

Conditional sampling methods are generalized by applying a matched-filter on the reference signal. This generalized method is illustrated by data obtained in a magnetized toroidal plasma without rotational transform. By proper choice of the filter characteristics we can observe a rapid ``crash'' in the electrostatic plasma potential in the entire plasma column. The crash is then followed by a slower recovery phase. The results are noticeably different from those found by using a more traditional conditional analysis of the same data. The significant difference between the two results indicate that generalizations of the conditional sampling method can give new insights. Conditionally obtained local power spectra demonstrate an enhancement in the amplitude of the fluctuations preceding the potential crash. The analysis is illustrated also by using a synthetic dataset.



The figure shows the time evolution of the conditionally averaged potential [1,2] as detected at two positions close to the center of the column. The positions are marked on the insert on the figure. We note rapid drop in the potential followed by a slower recovery phase. By using a conditional wavelet transform we find that the local maximum of the potential enhancement around -0.2 ms is accompanied by a local enhancement of the fluctuation power. The period around the local minimum potential has a reduced fluctuation power, which then increases to its unperturbed level for late times. It might be speculated that the enhanced fluctuations mediate an enhanced transport that give rise to the observed events [3].



The full space variation of the conditionally averaged potential is shown for selected times. A conditional average performed without a matched filter will show smaller scale structures that propagate in the azimuthal direction [2]. This propagation is absent when we analyze signals obtained by using the matched filter on the reference signal. Also we find the time variation of the resulting potential to be slower here. We analyzed also the distribution of events over time, obtaining evidence for a distribution being reasonable well represented by a Poisson distribution. Since a Poisson distribution applies for statistically independent events, we may argue that a viable model for the observed phenomena assumes that crashes appear independently, with equal probability in any given time interval of given length. The sole constraint seems to be that crashes should have marginal temporal overlap, at most.

References

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