Excess estimation in On/Off measurements including single-event variables

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What is this contribution about?

This contribution describes a new method for estimating the signal rate in On/Off measurements, which not only has the advantage of avoiding the need for fixed signal-extraction cuts, but it also improves the precision of the signal estimation. We call this novel method Bayesian Analysis including Single-event Likelihoods `BASiL`.

Why is it interesting?

Wouldn't it be nice to keep all recorded events from your experiments and be able at the same time to increase the precision of the signal estimation? We are used to think that this is impossible and that in order to increase the Signal to Noise Ratio (SNR) we must select events based on signal extraction cuts. With our new novel method this is not anymore true!

What have we done?

When estimating the signal rate from an On/Off measurement, we fully exploit in the Bayesian framework the information on how single-events variables distribute for a signal or a background population and replace fixed signal extraction cuts with a statistical weighting of the events. By doing so, we avoid cutting data according to some (or a combination of) variable to suppress the background, which inevitably discards a part of the signal.

What is the result?

The new method, while yielding results consistent with the standard data analysis method, it improves the precision of the signal estimation.