

1 Technical details of signal processing

1.1 Offset removal

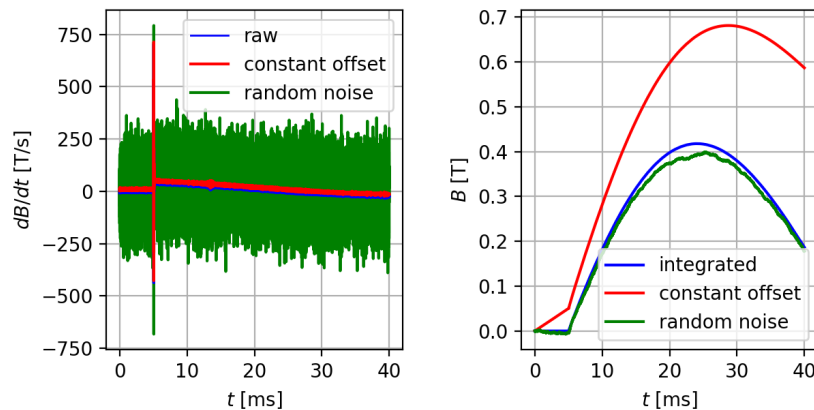


Figure 1: Time traces of dB/dt and integrated B in GOLEM discharge #31150, demonstrating the offset impact on the integrated data quality.

Magnetic measurements via electromagnetic induction are quite simple to set up, but their disadvantage lies in the need to integrate the signal. This involves many problems, the most basic of which is handling the *offset*. An offset is a non-physical addition to a signal, created by noise in the electronics, parasitic voltages, cross-talk between the diagnostics and many other influences. Figure 1 demonstrates the impact an offset can have on data integration. In blue, the real, physical dB/dt and B are plotted. In red, a small constant offset was added to the entire raw signal. In green, a normal-distributed noise with a zero mean was added to the raw signal. One observes the effect that this has on the integrated signal, in particular the *drift* in the red case.

In this assignment, offsets are more than likely to appear on the U_l , U_{B_t} and U_{RC} signals. The simplest method to remove them is to average the first few hundred/thousands of samples (may vary depending on oscilloscope trigger settings) and subtract this average from the signal prior to its integration. This method will fail if the offset is time-dependent, but in that case removing it is a whole new problem which cannot be addressed within the time frame of this assignment.

1.2 Signal processing, averaging and error propagation

The signal processing workflow is shown in figure 2. After the red-marked quantities are calculated, they are averaged over the quasi-stationary part of the discharge (see figure ??) and their error is taken as the standard deviation within the same time window. The electron temperature T_e and the energy confinement time τ_E are then calculated from these mean values and their uncertainties are estimated using the standard error propagation tools. This means that we neglect the errors contained in the calibration constants, the chamber current I_{ch} and the offset removal.

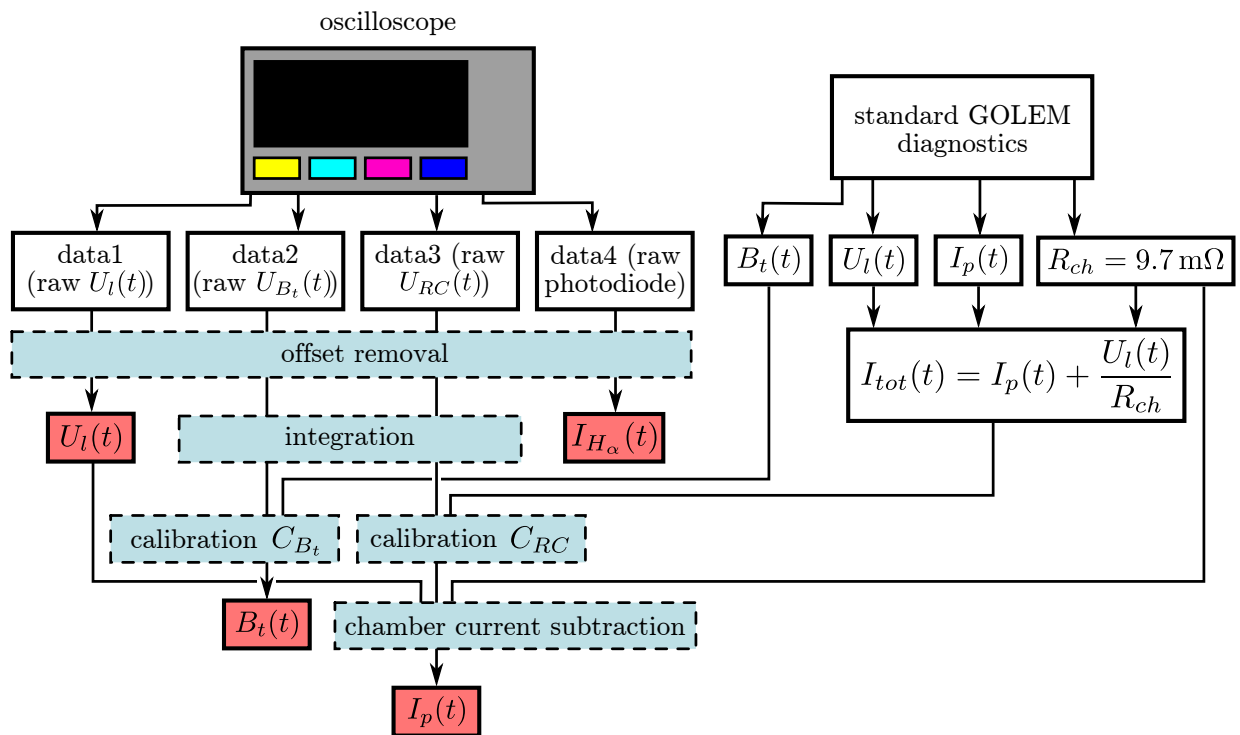


Figure 2: Flow chart of the signal processing procedure.