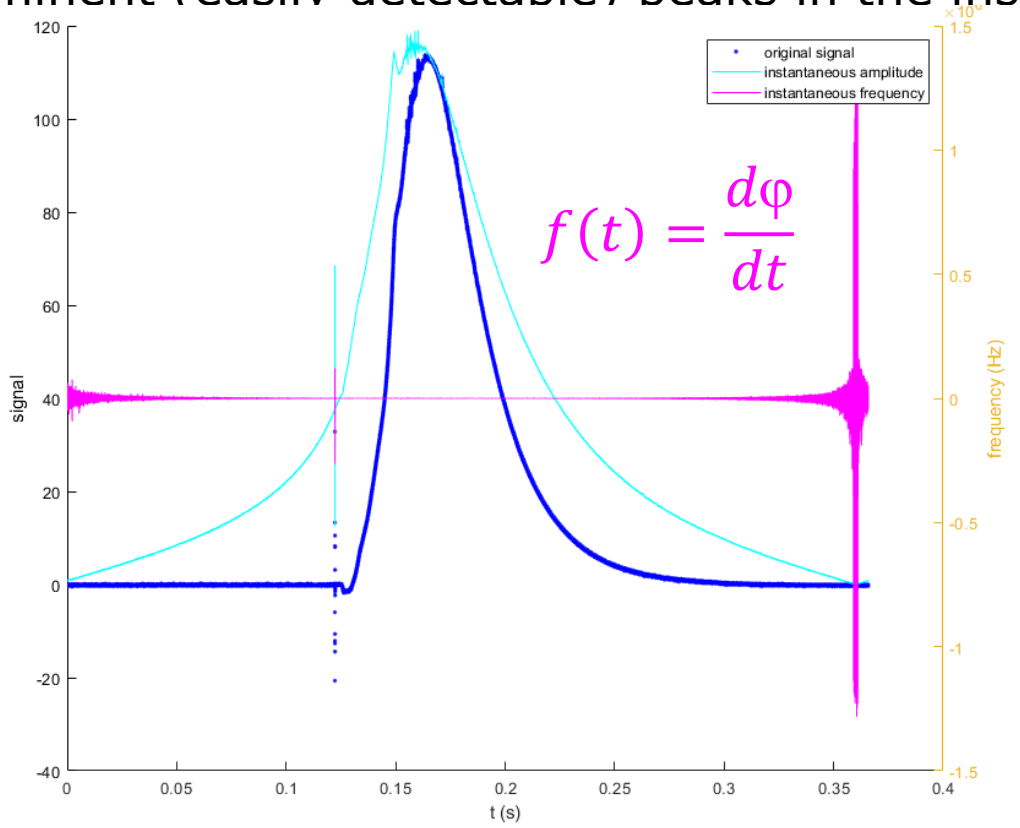
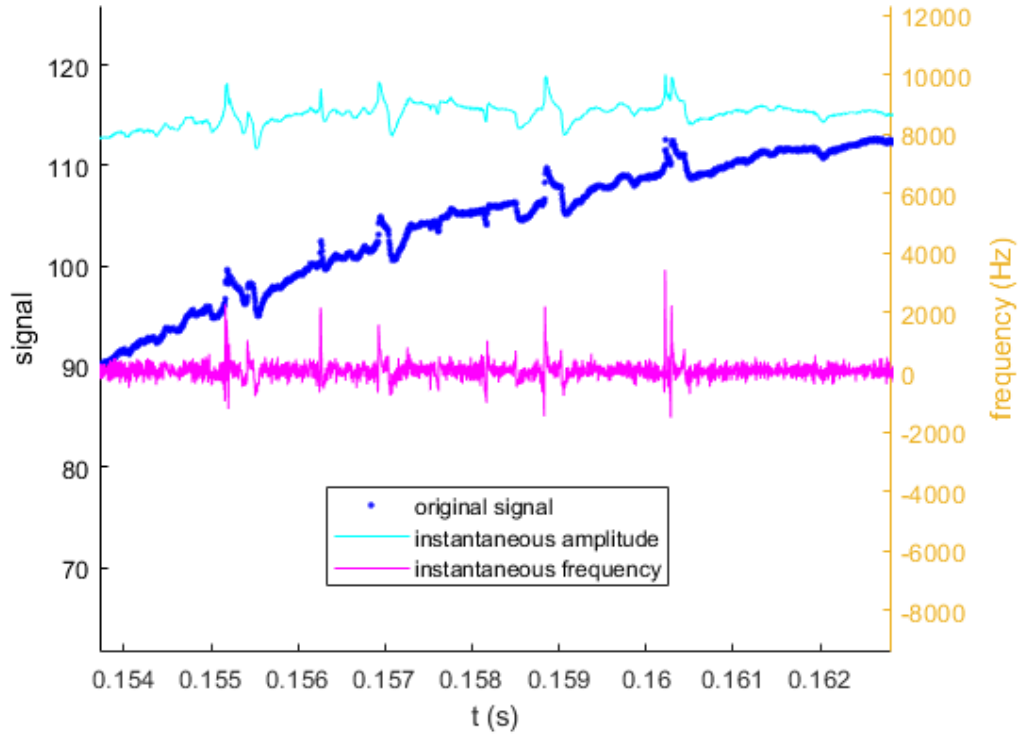
Time-frequency analysis with Hilbert transform

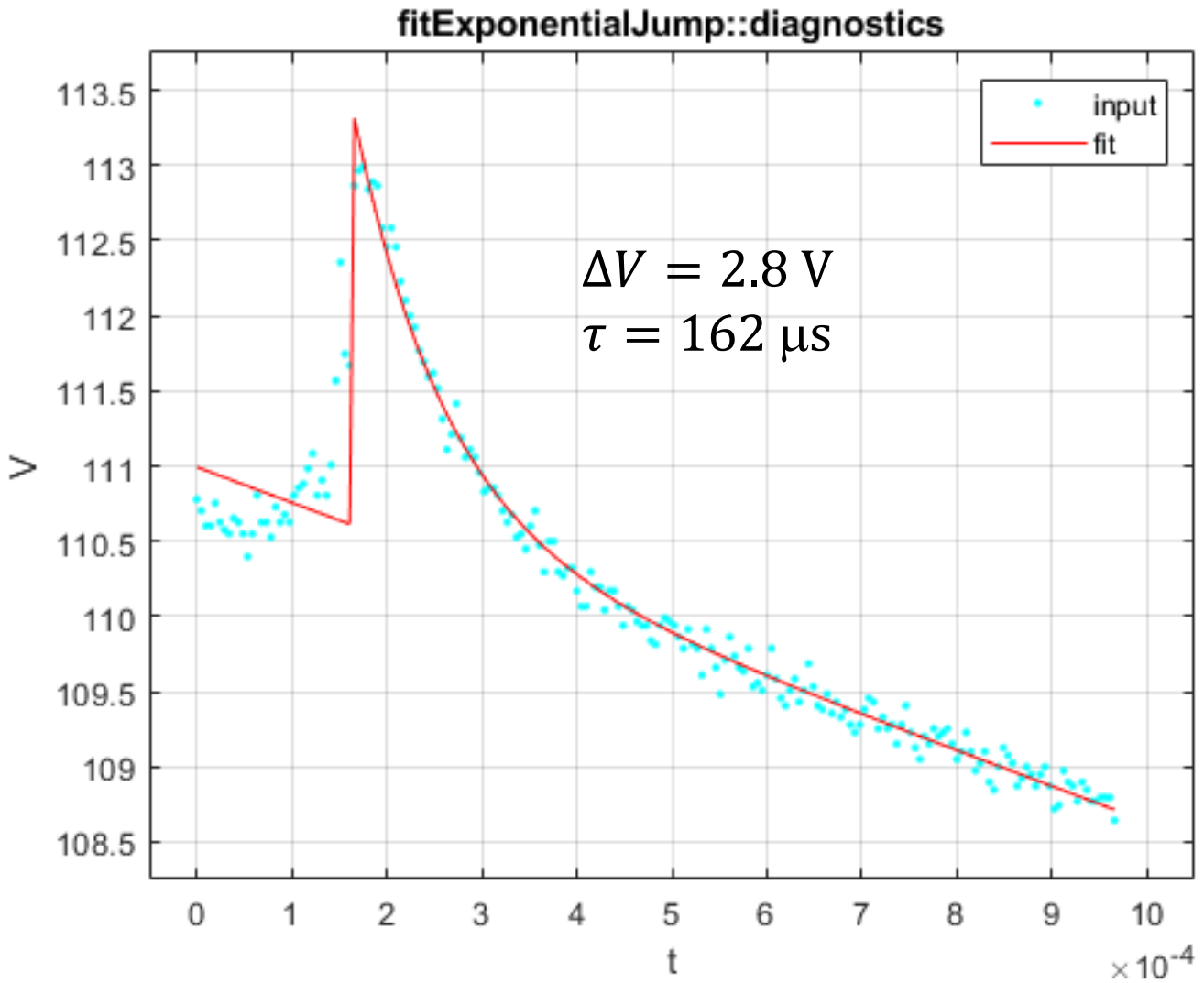
- Analytic representation of a signal V(t) via Hilbert transform $H(u) = \frac{1}{\pi}\int_{-\infty}^{\infty}\frac{V(t)}{t-u}dt$
- Matlab function A(t)+iφ(t) = hilbert(V(t)) gives amplitude demodulation for an ideal, single-component signal
- Prominent (easily detectable) peaks in the instantaneous frequency seem to match largest voltage spi





Automated spike feature analysis

- Most (but not all) largest spikes match a linear + step + exponential decay model
- Good results from a fully automated 6-parameter best-fit with a combination of heuristic initial guess + monte carlo + levenberg-marquardt optimization (5-10 s per spike)



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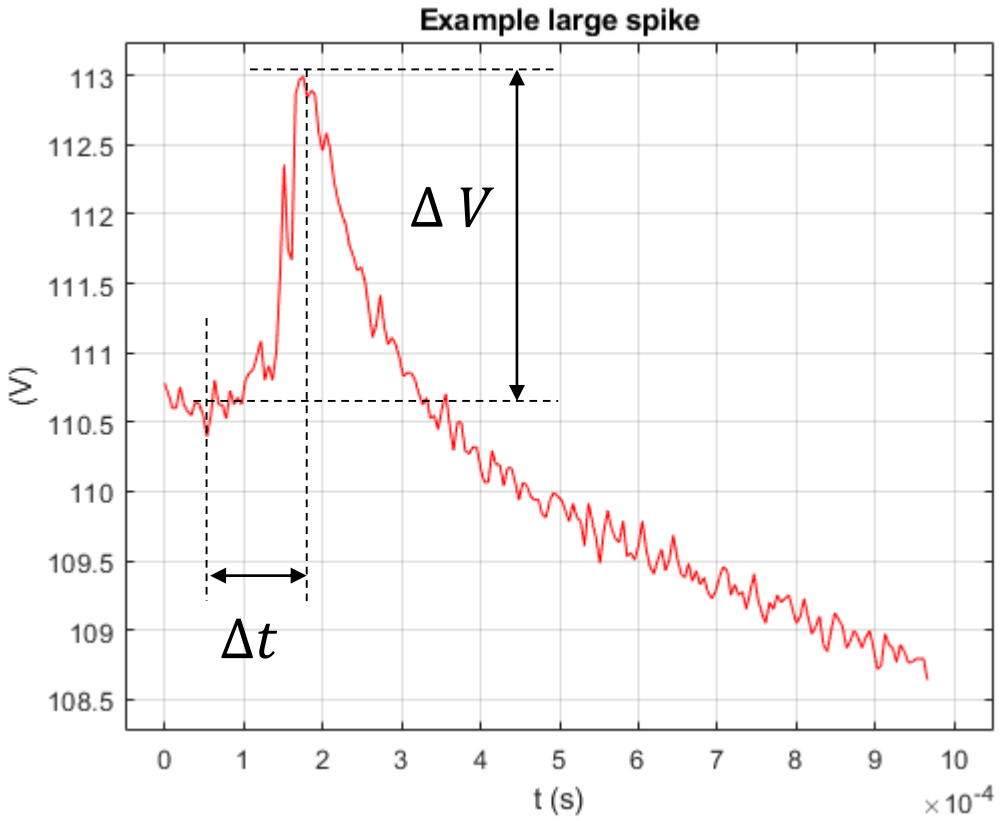
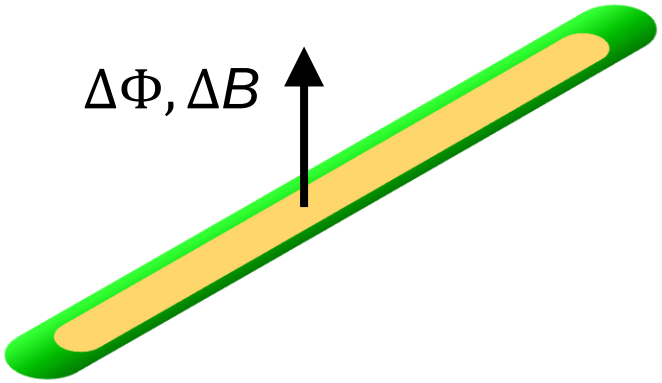
Physical interpretation of spikes

- Naïf attempt to interpret the meaning of a flux jump experienced by a whole half-coil:





Avg area of 1 turn:
$A_t \approx 10\ \text{m} \times 0.1\ \text{m}$
$N_t = 56\ turns$

$$\Delta\Phi = \int V dt \approx \frac{1}{2}\Delta V \Delta t$$

$$\Delta B = \frac{\Delta\Phi}{N_t A_t} \approx 3\ \mu T$$