MBHA001 – Update on simulations

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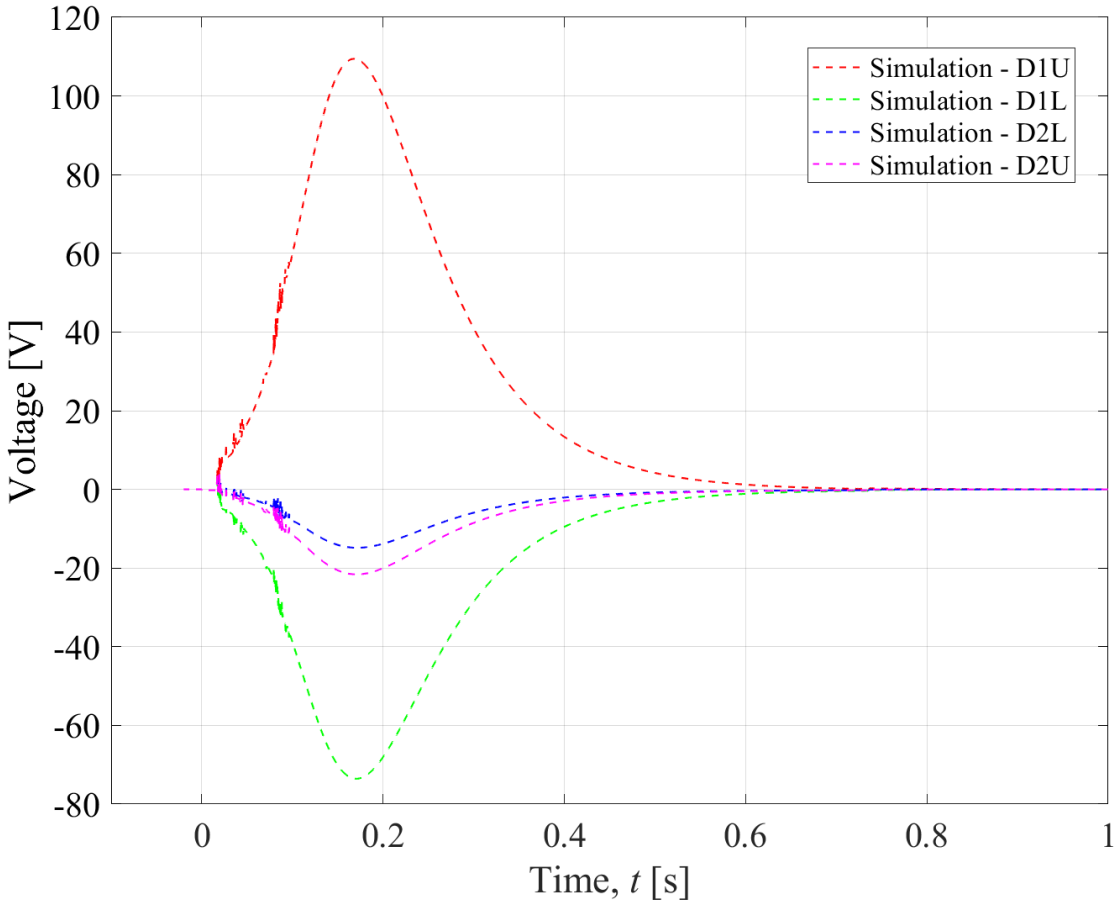
Observations about the “voltage bump”

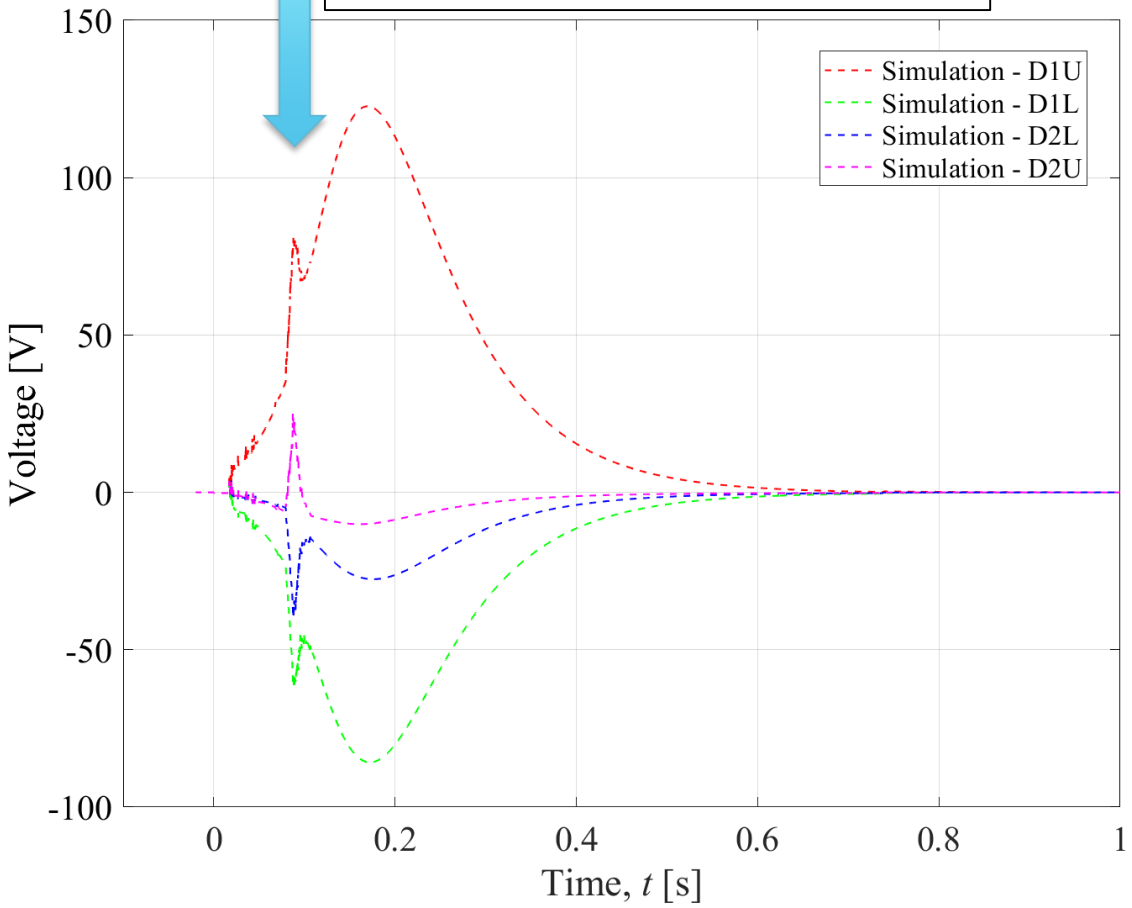
- Working assumption: The voltage bump (aka wiggle) occurs when IL of one or more coils is quenched, and the IL of one or more coils is not quenched
- It’s misleading to say “when the quench propagates from OL to IL”, because it implies heat diffusion is the main mechanism to quench
- However, coupling loss in the IL is of similar magnitude with respect to the OL-IL heat diffusion
- **OL is quenched by QH, IL is quenched by a combination of OL-IL heat diffusion and coupling loss**
- Hence, the voltage bump could be due to different coupling loss in the coils (effective transverse resistivity)

- In the tests when we delayed either D1 or D2 QHs, the magnet current change was shifted by about 10 ms due to the slower coil resistance growth
- If the IL is quenched mostly by coupling loss, we’d expect a delay of about 10 ms on the voltage bump, in both tests [disclaimer: I arrived at this conclusion after looking at the test results]

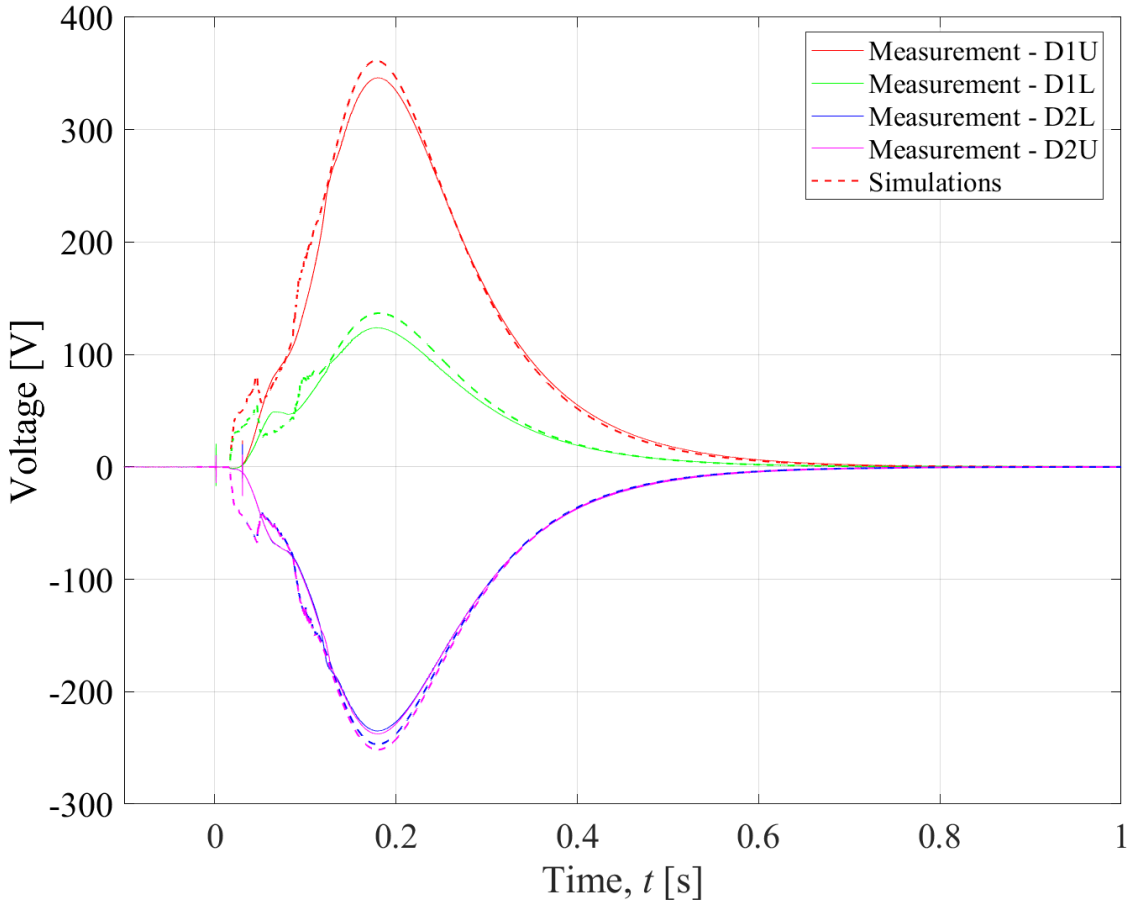
Simulation with higher effective resistivity for D1L and D2L

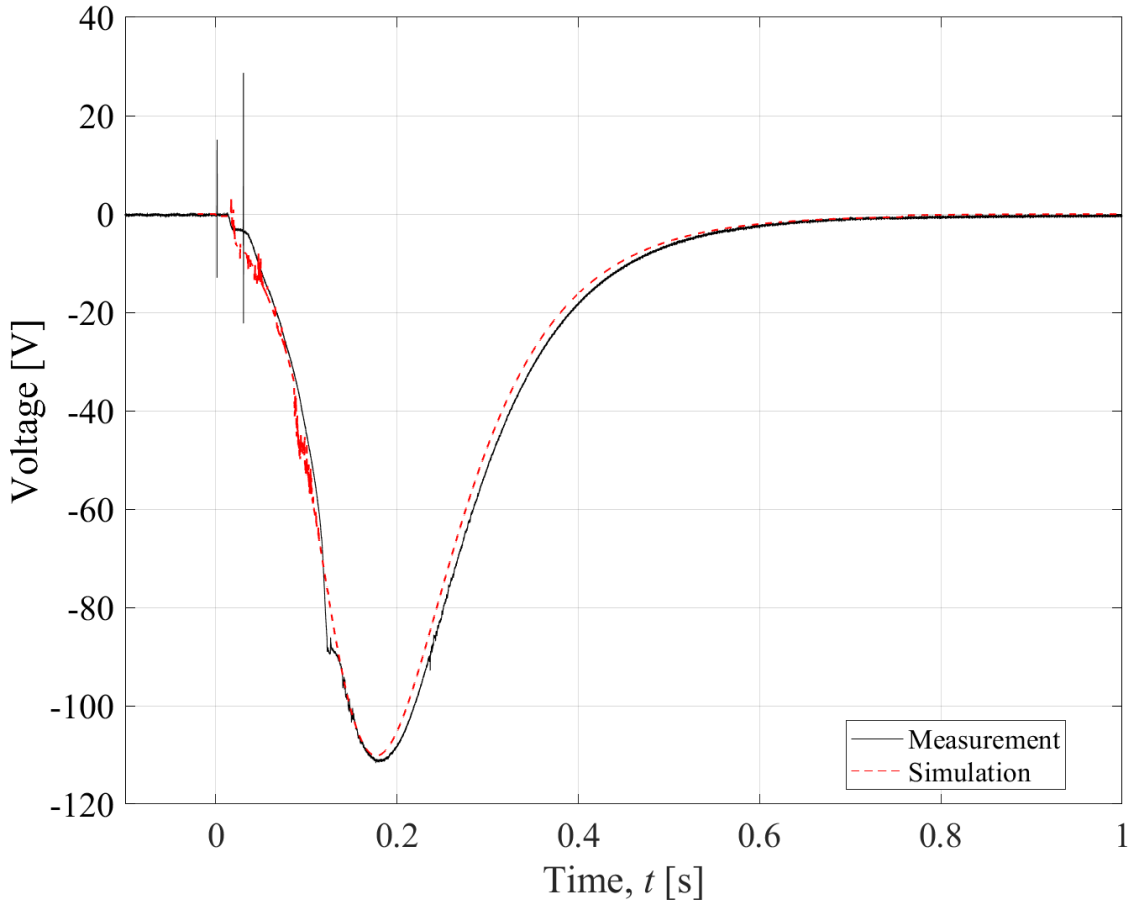


IL of D1L and D2L quench with a delay with respect to IL of D1U and D2U

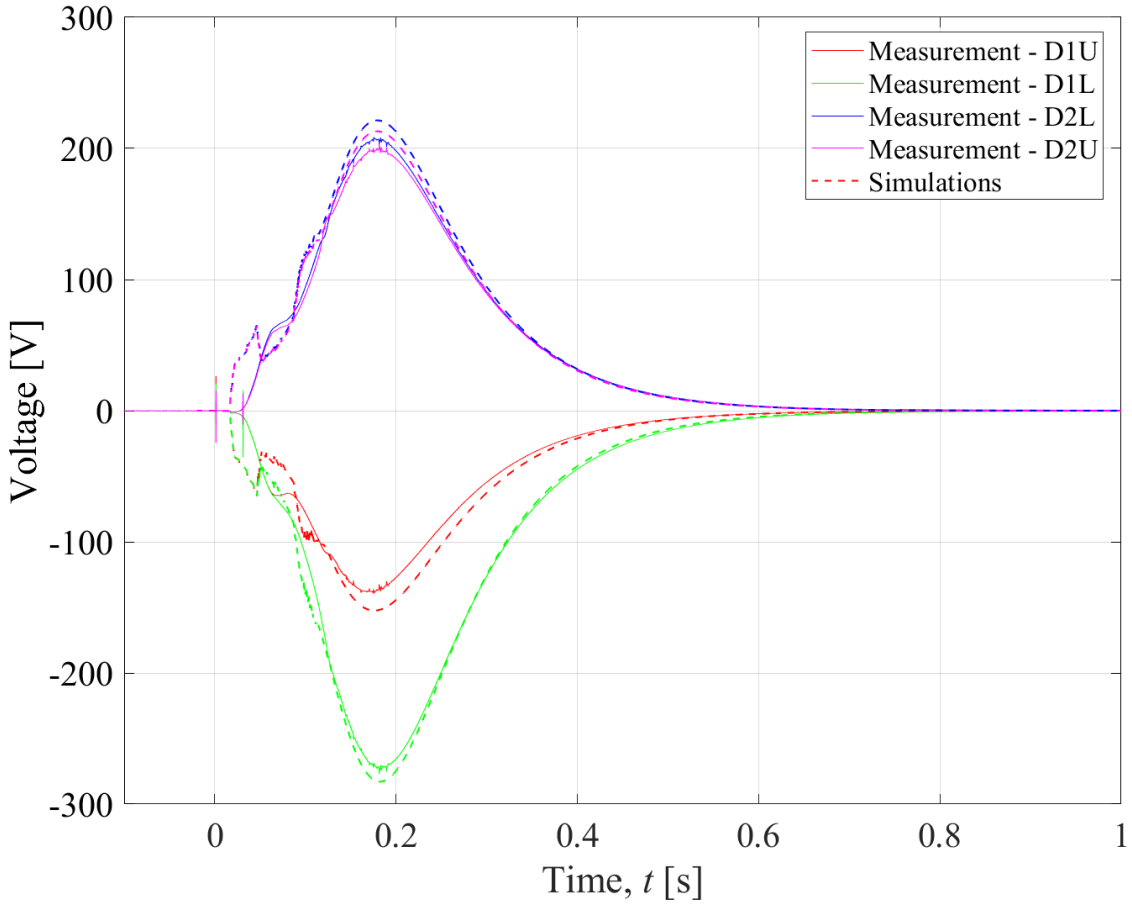


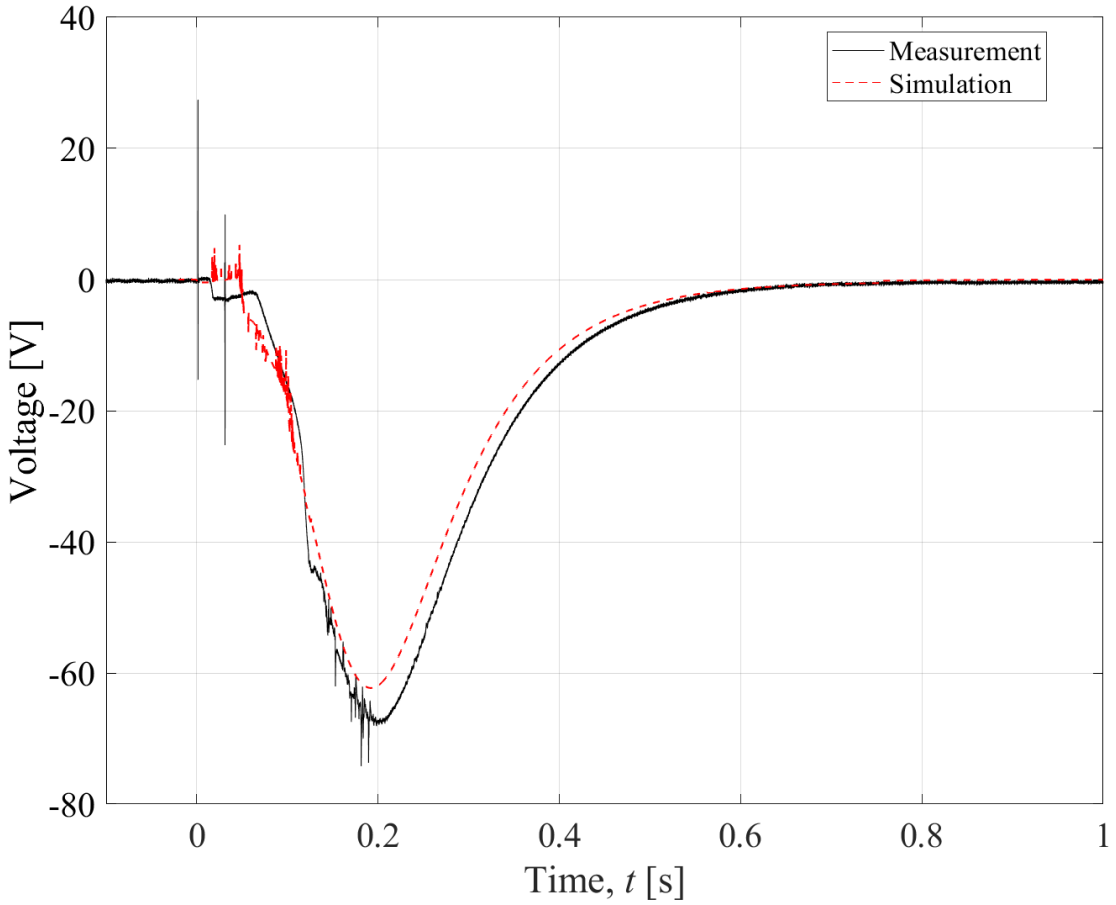
Meas cpr Sim – 9 kA, D2U-QHs and D2L-QHs delayed by 30 ms



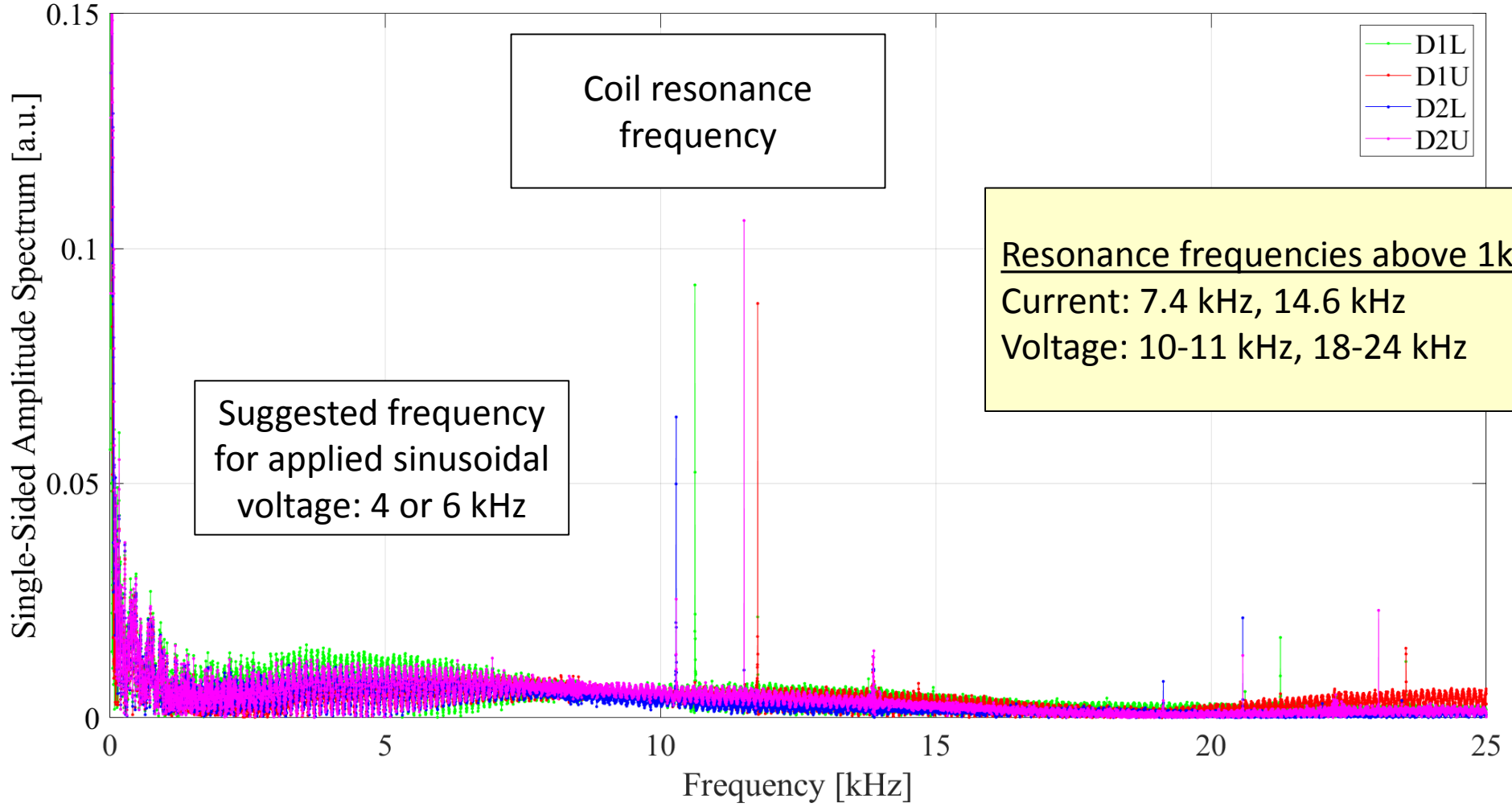


Meas cpr Sim – 9 kA, D1U-QHs and D1L-QHs delayed by 30 ms

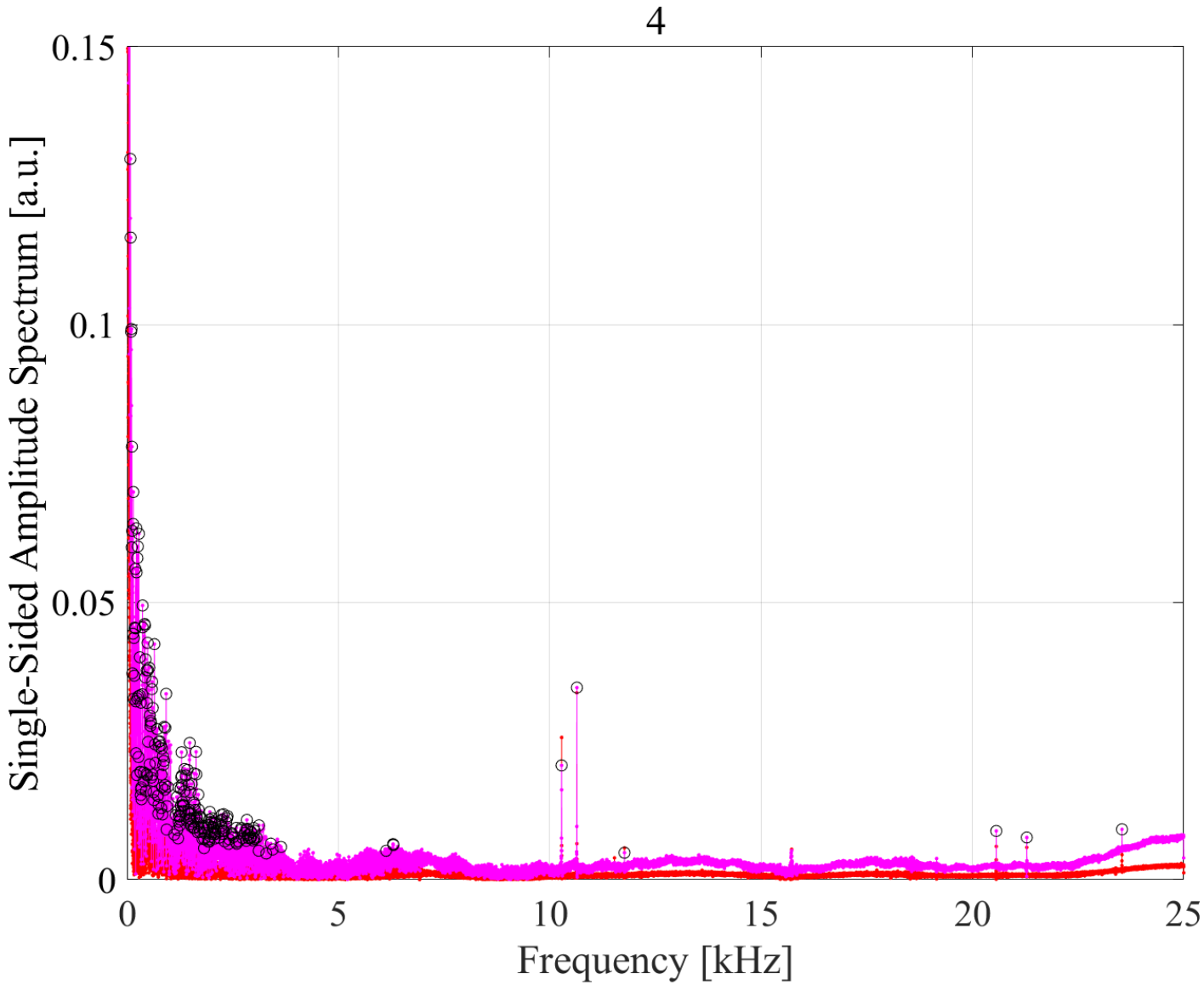




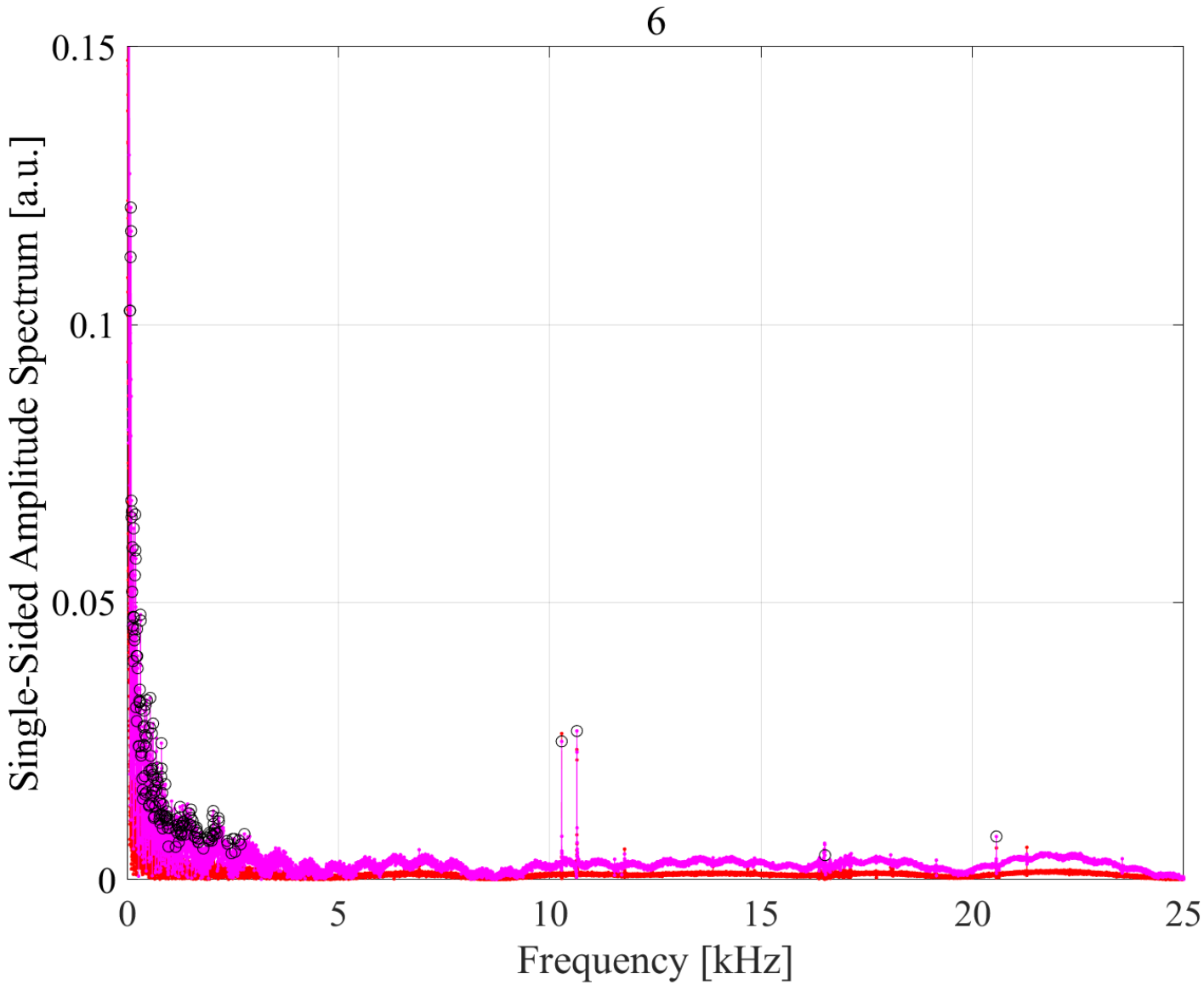
FFT of each coil voltage – 9 kA – QH of D1U delayed



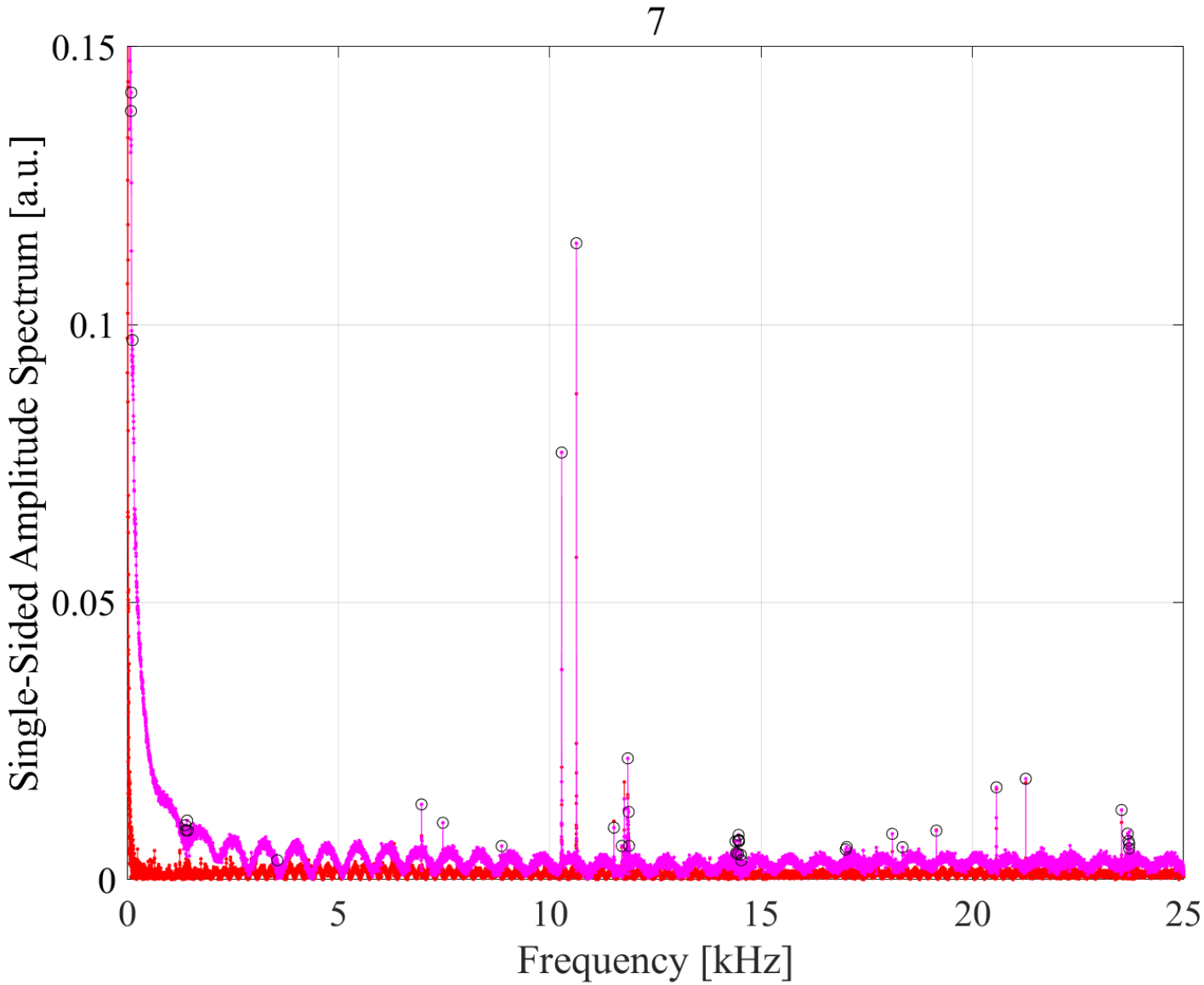
FFT of D1L+D2L – 9 kA – 2019



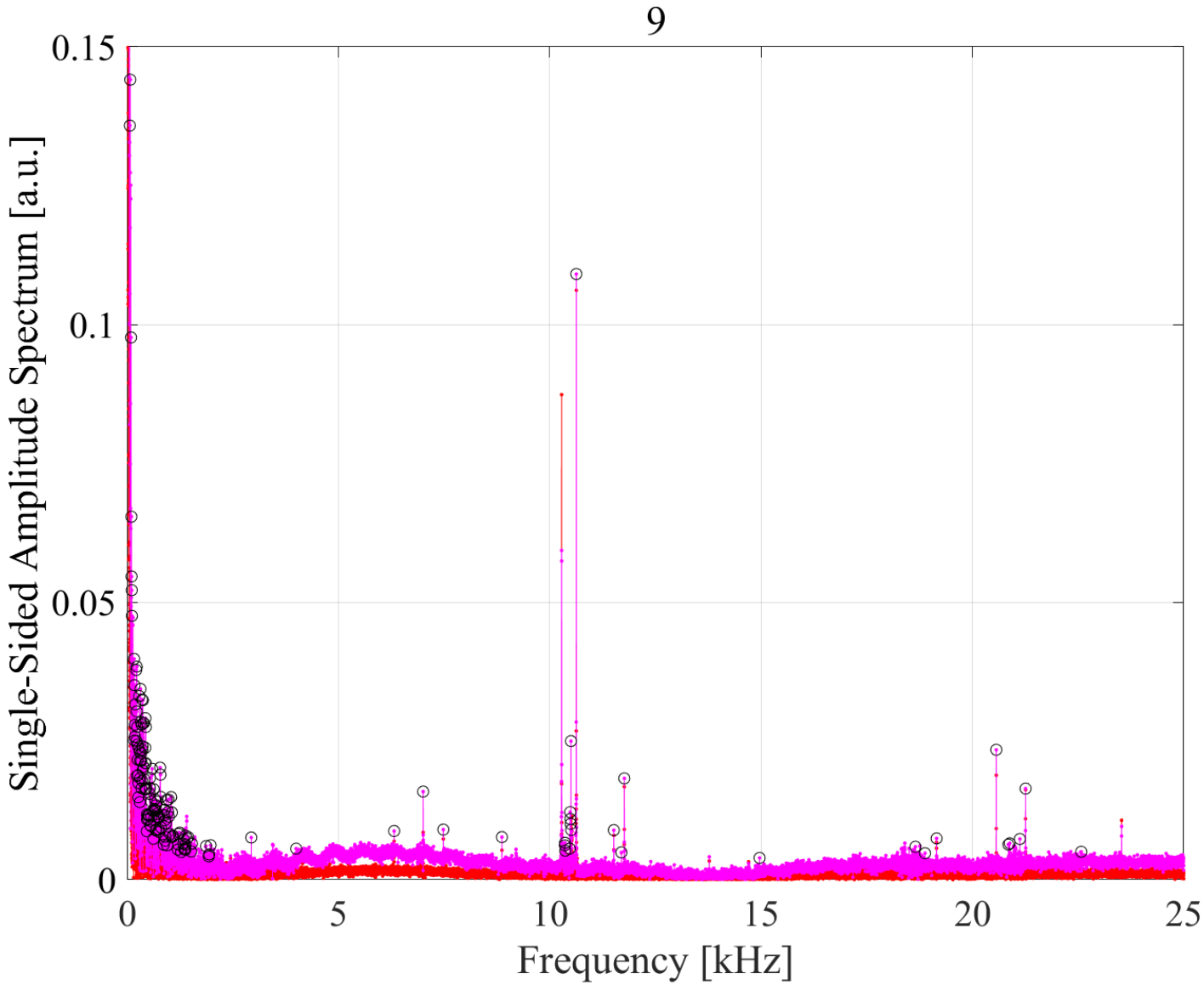
FFT of D1L+D2L – 8.5 kA – 2019



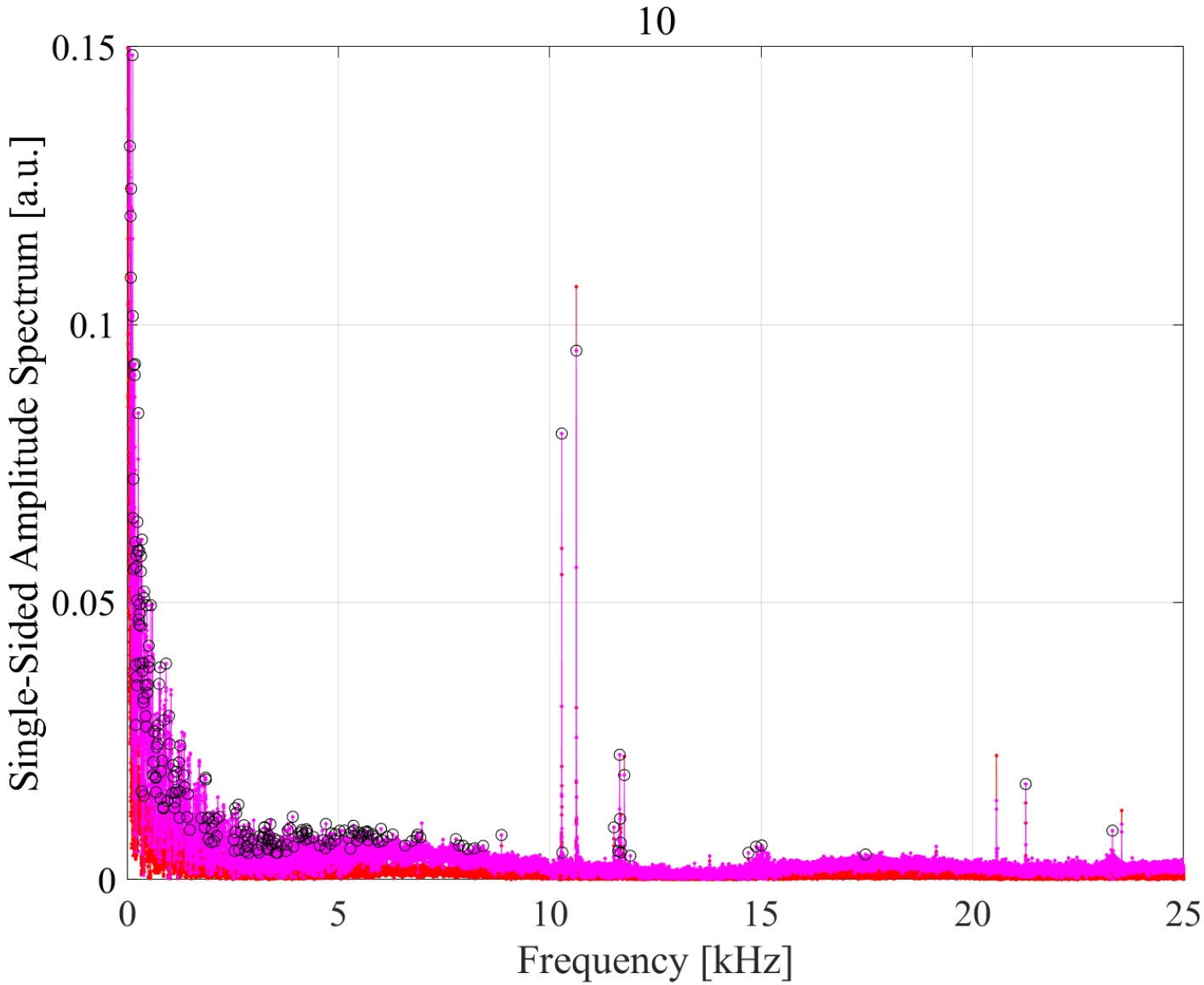
FFT of D1L+D2L – 7.1 kA



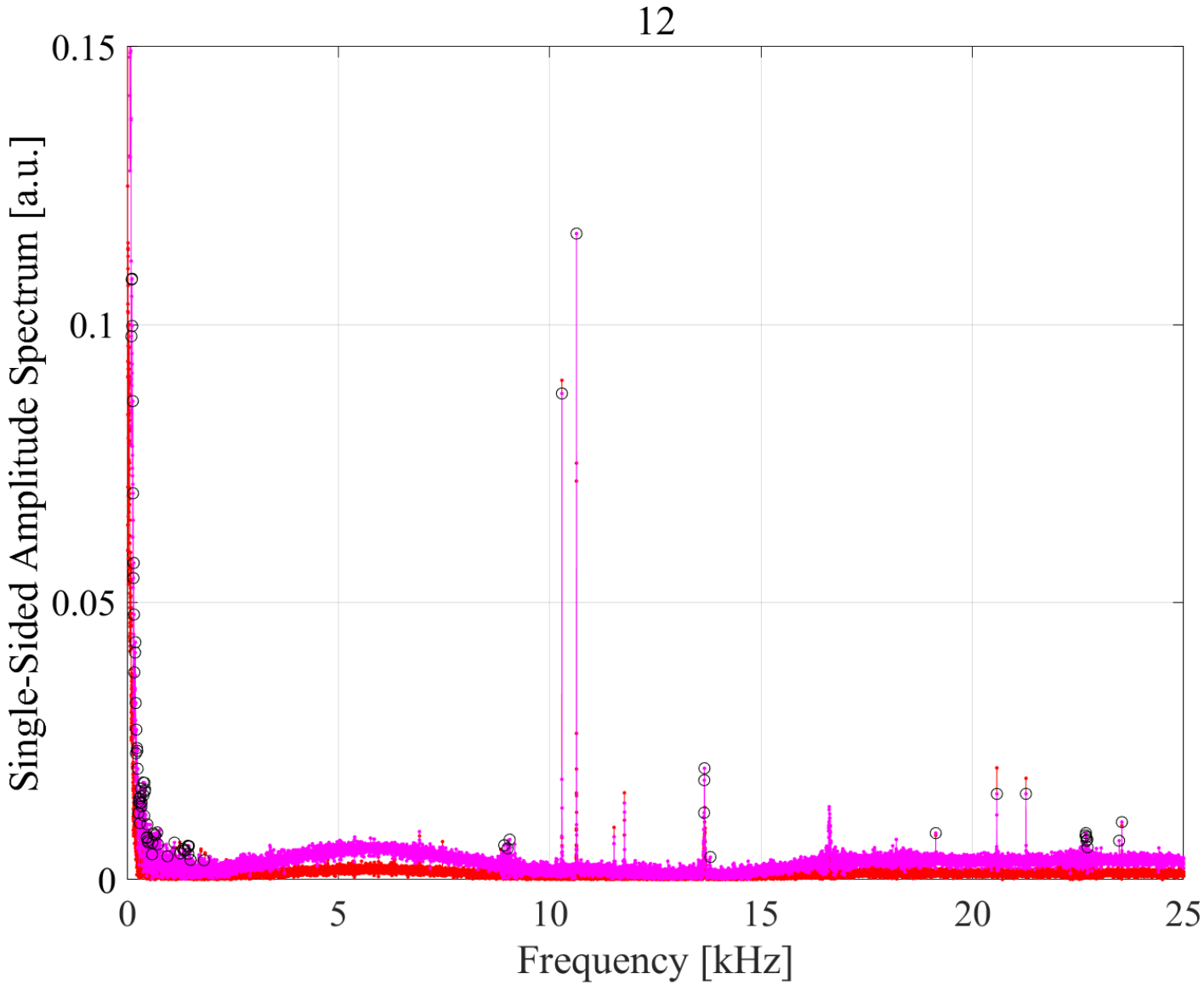
FFT of D1L+D2L – 9 kA



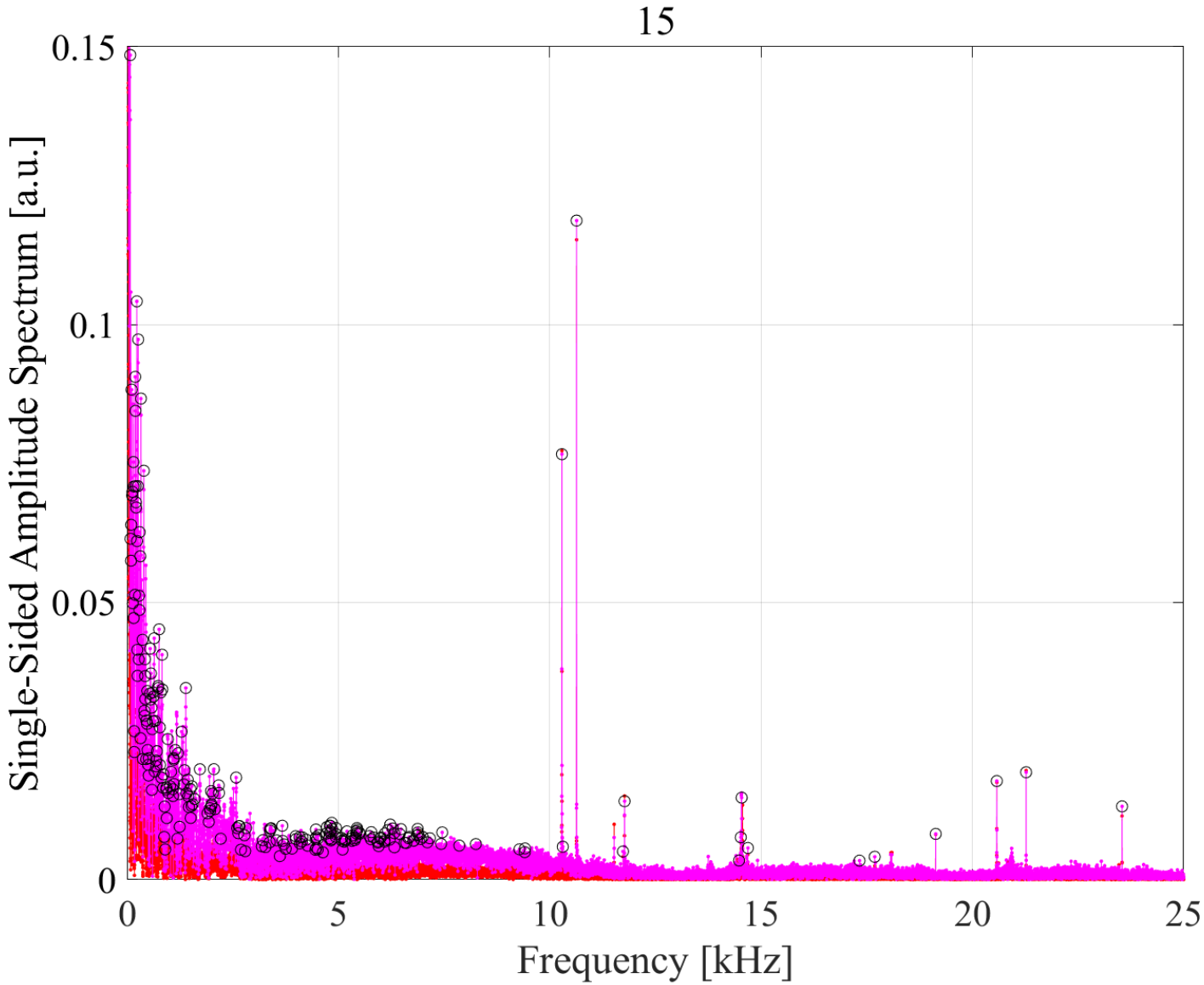
FFT of D1L+D2L – 9 kA



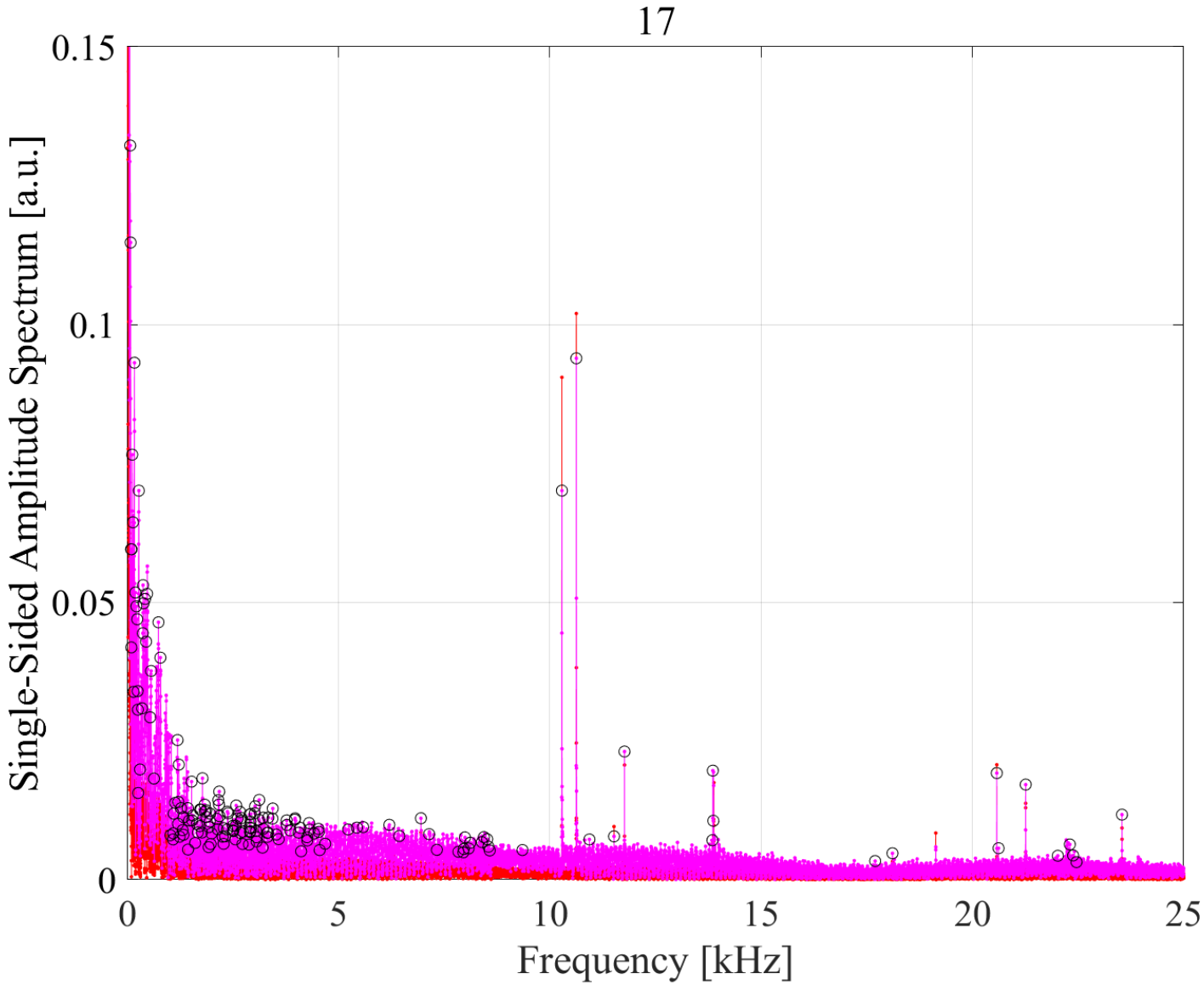
FFT of D1L+D2L – 11.85 kA



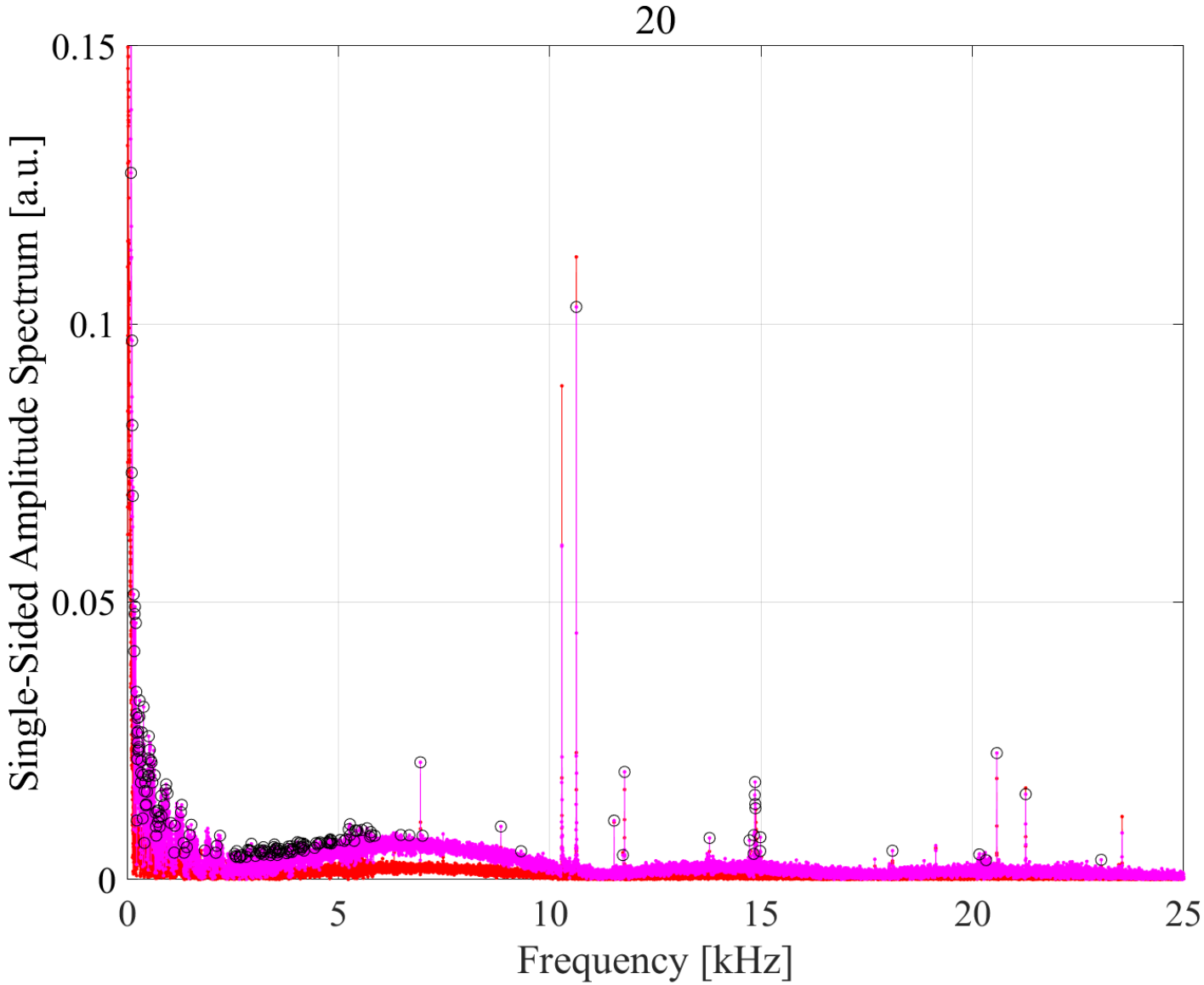
FFT of D1L+D2L – 9 kA



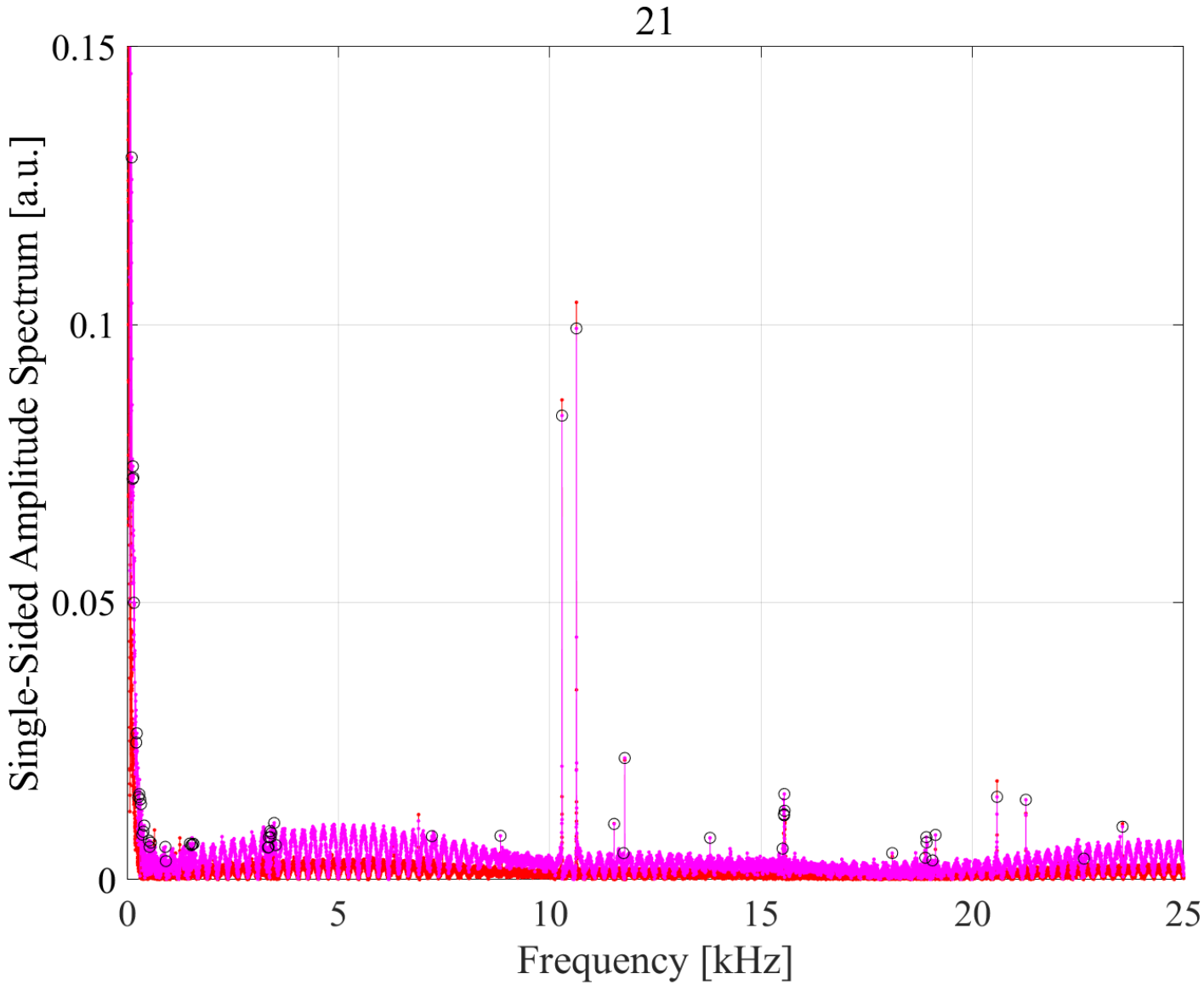
FFT of D1L+D2L – 9 kA – QH of D1U delayed



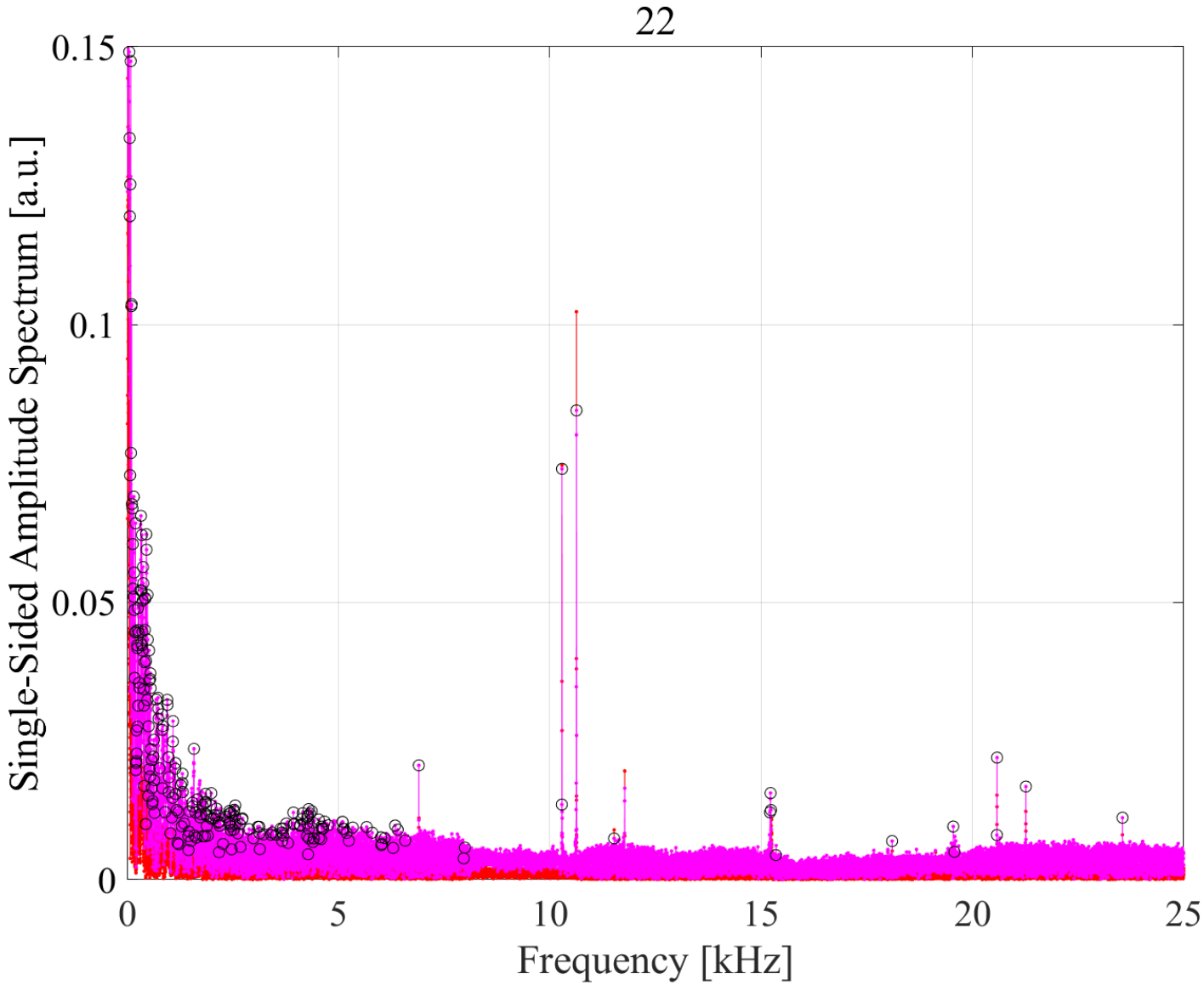
FFT of D1L+D2L – 10.5 kA



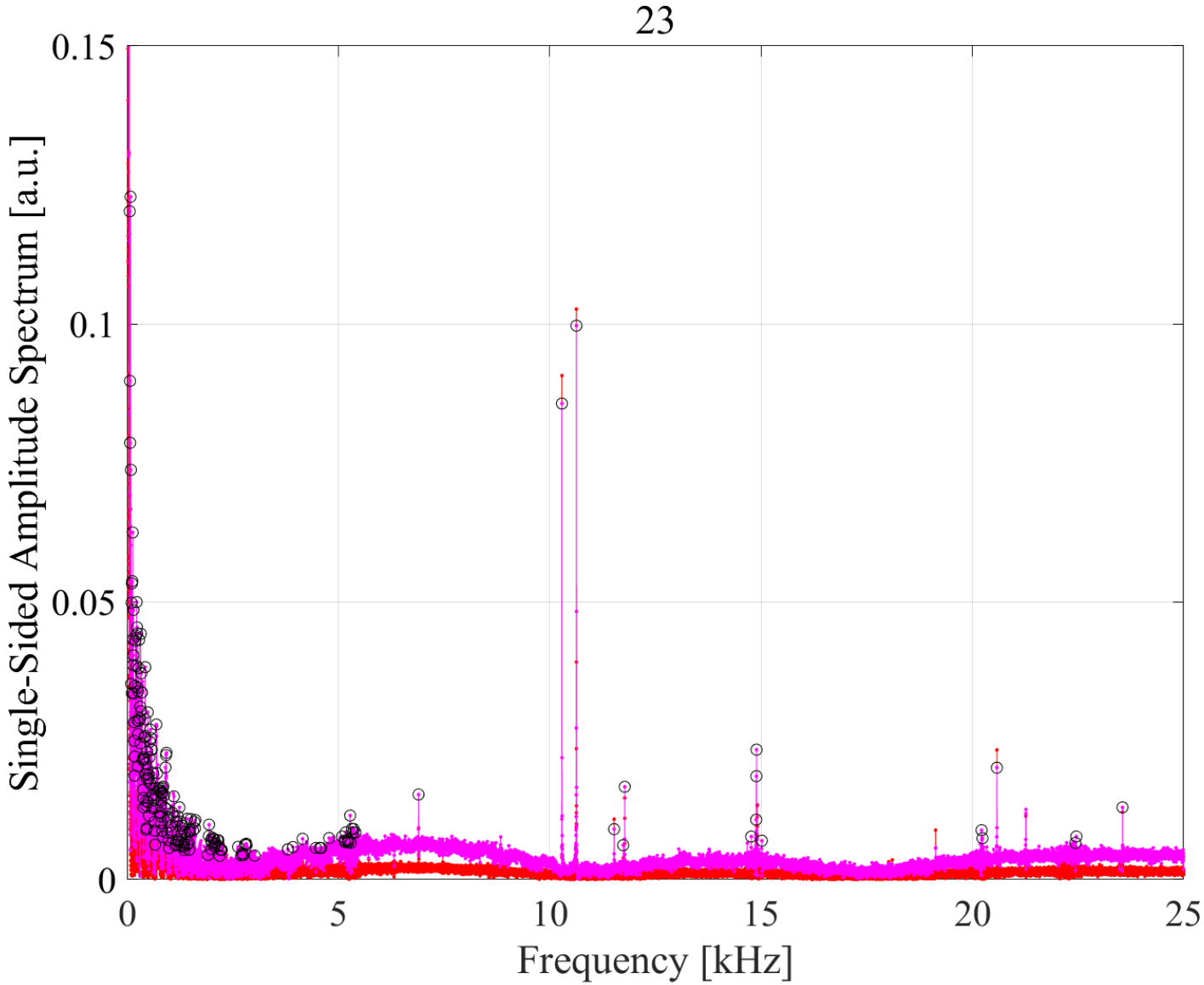
FFT of D1L+D2L – 11.85 kA – QH of D1U delayed



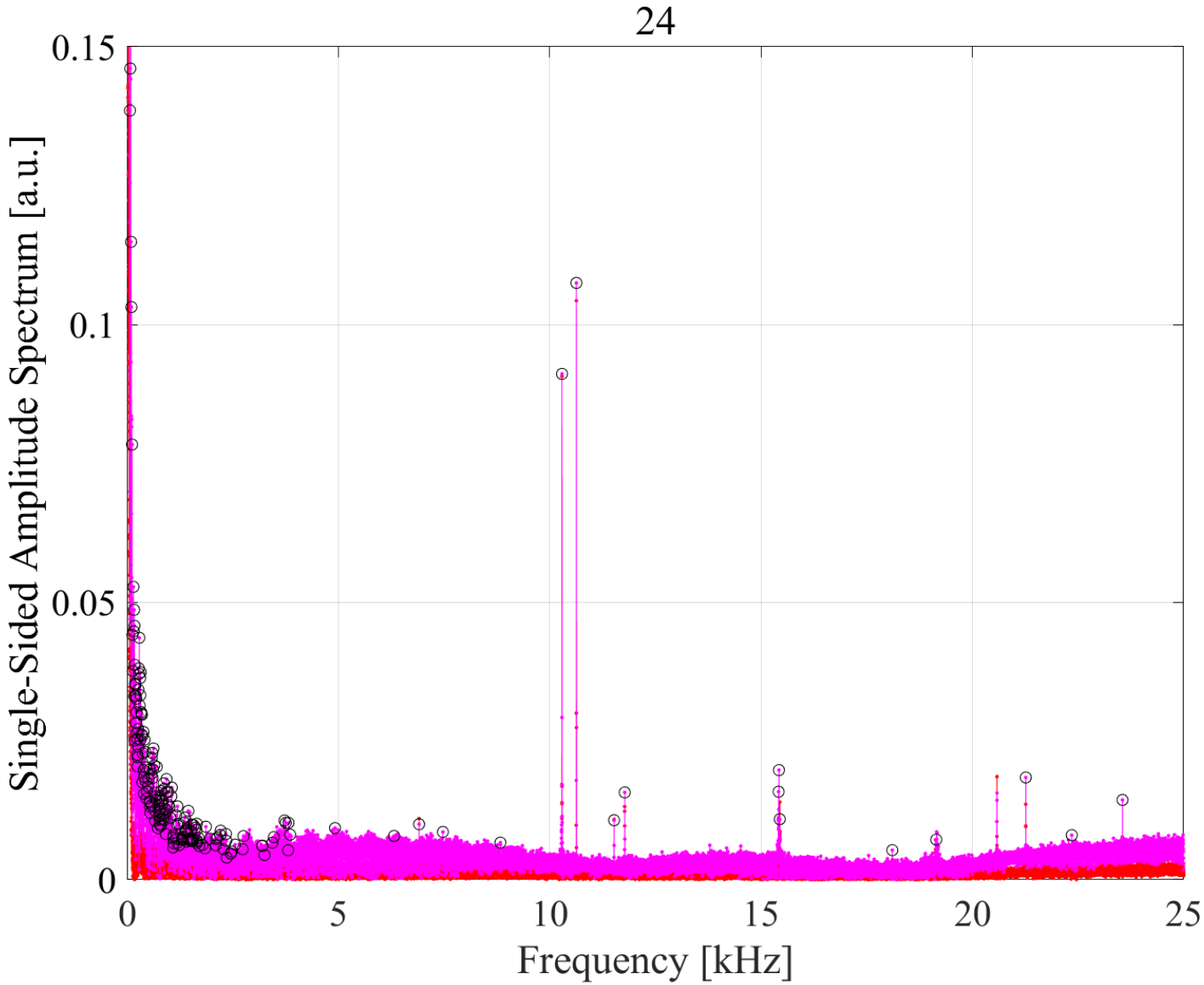
FFT of D1L+D2L – 9 kA – QH of D1U+D1L delayed



FFT of D1L+D2L – 9 kA – after 11.85 kA cycle

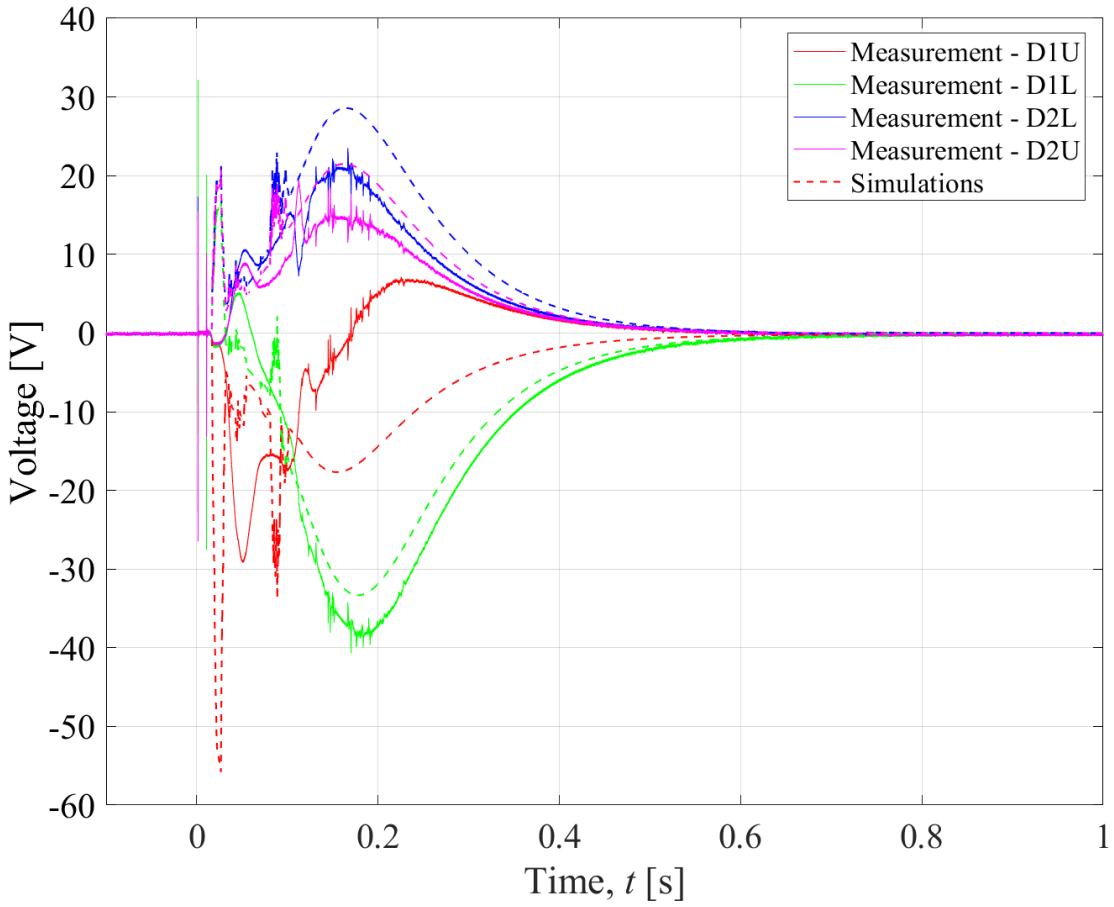


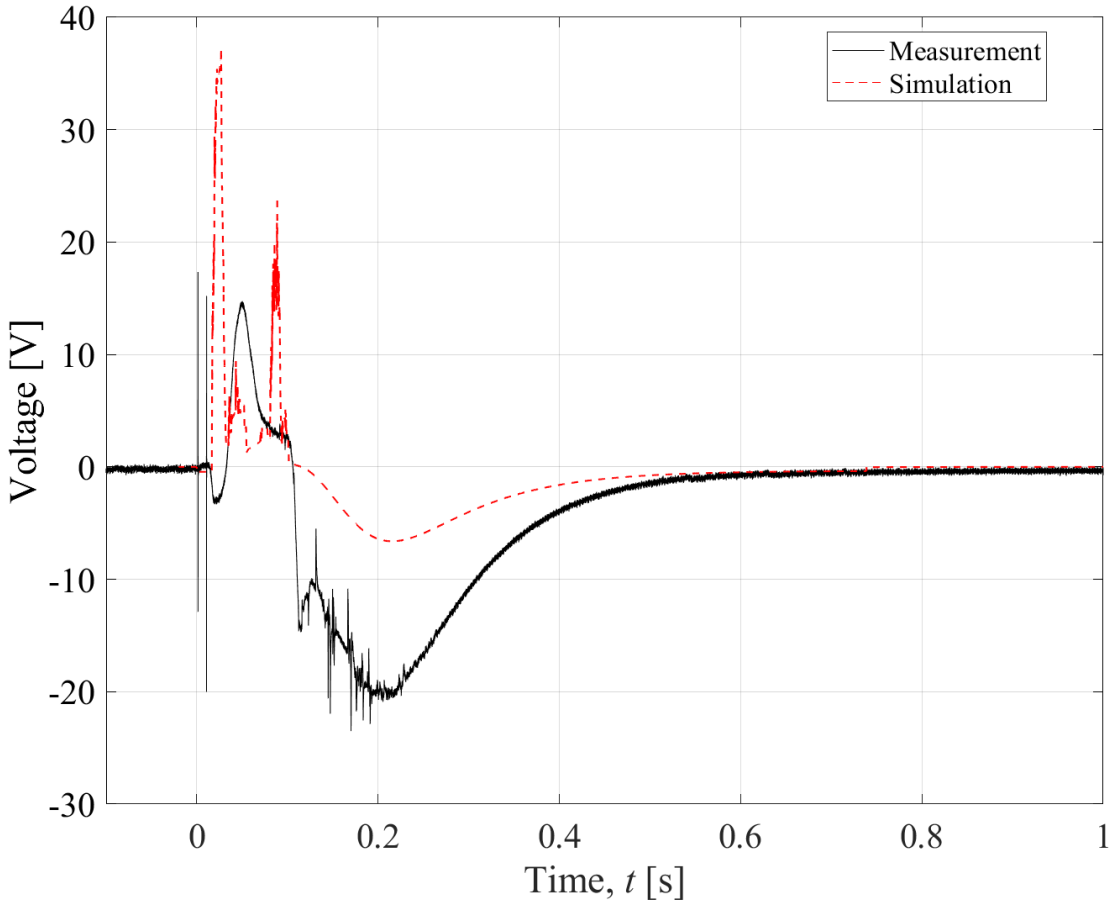
FFT of D1L+D2L – 9 kA – QH of D2U+D2L delayed



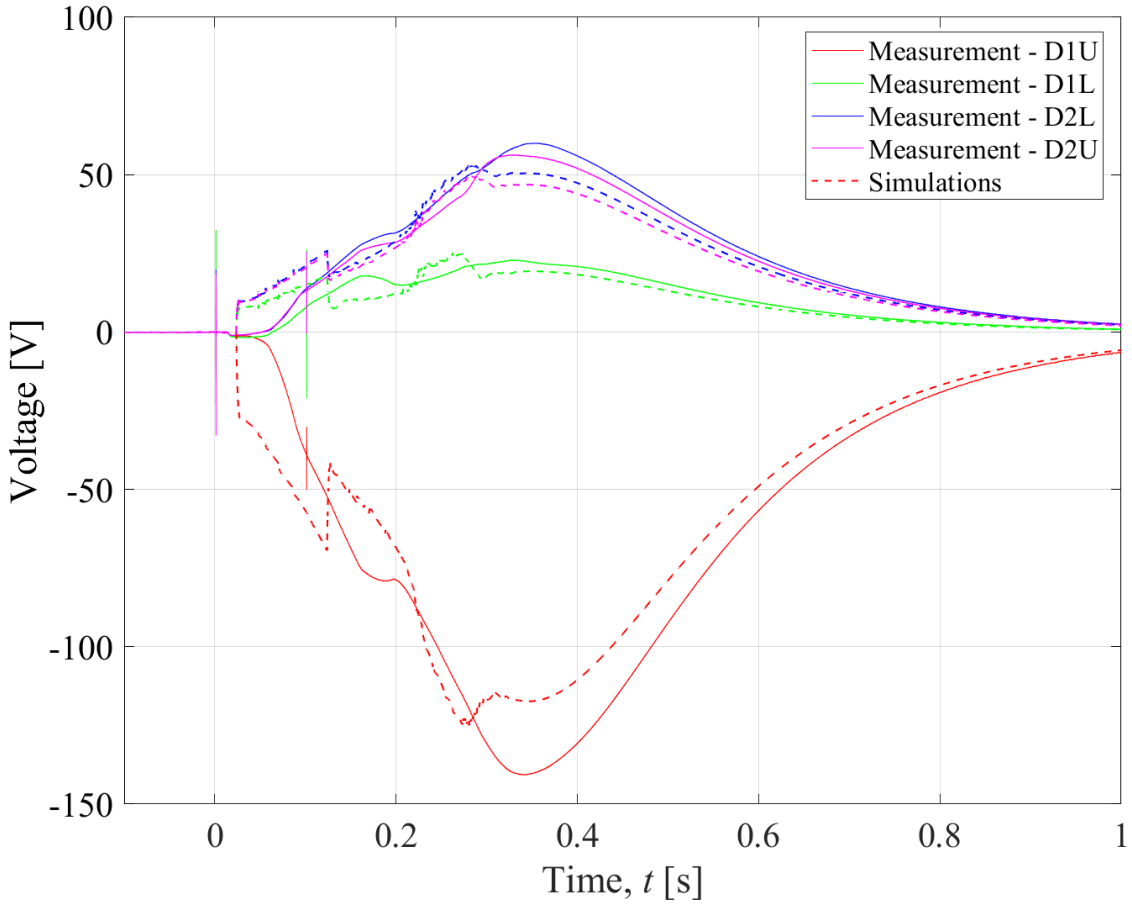
Annex

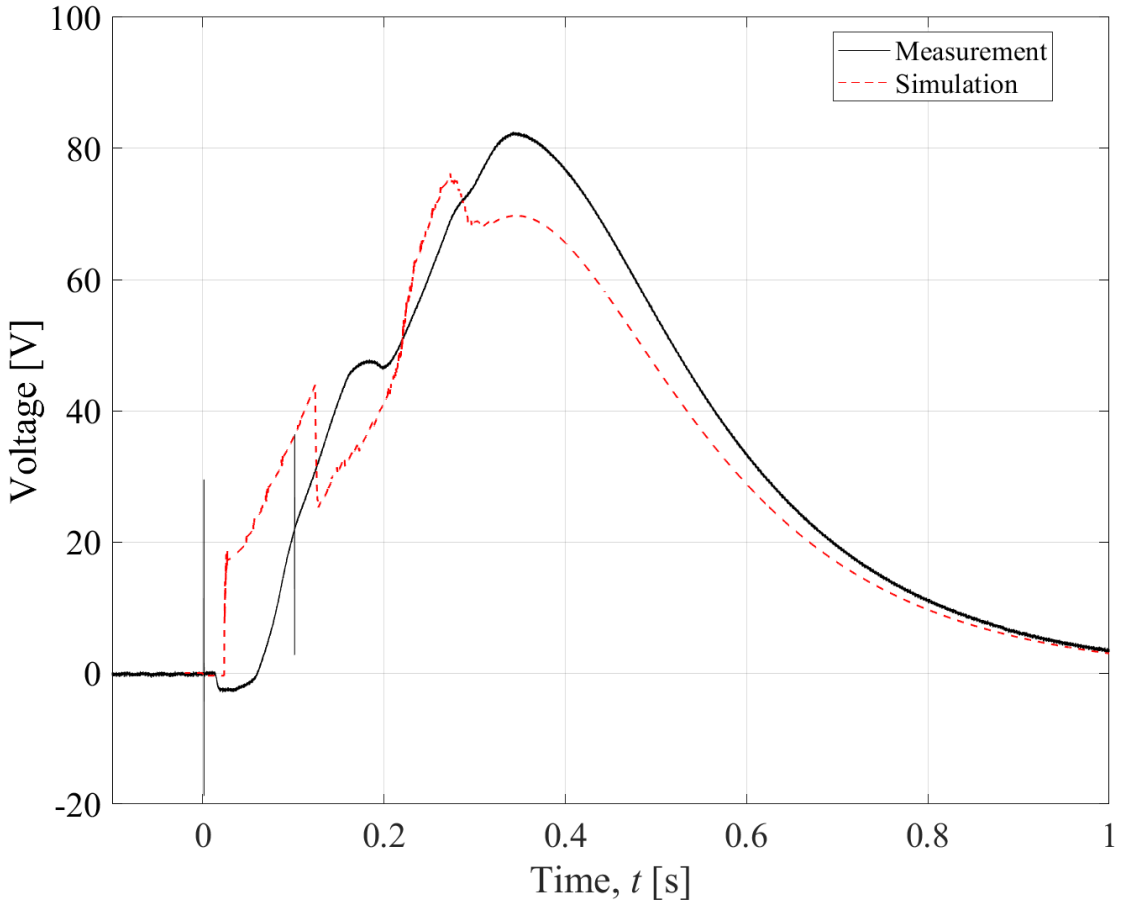
Meas cpr Sim – 9 kA, D1U-QHs delayed by 10 ms





Meas cpr Sim – 6 kA, D1U-QHs delayed by 100 ms





Proposed test #2 – 9 kA, D1L-QHs delayed by 10 ms