Attempt to measure field change during MQXFA17 ‘spike’ event.

19Sep2024

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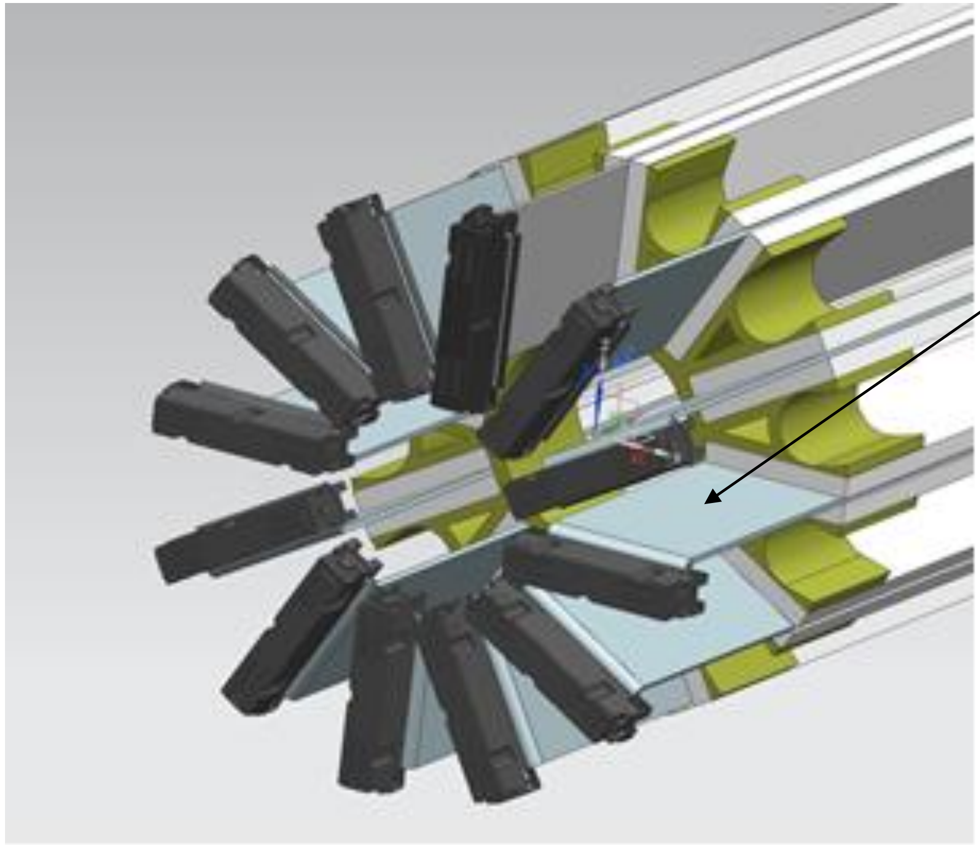
The full-length 'Theta Quench Antennas' (TQA) were switched from DQBuck with amplifiers to UnBucked (UB) configuration in May2024



TQA are 12 radial, full-length PCB-like, antennas having dipole and quadrupole bucking

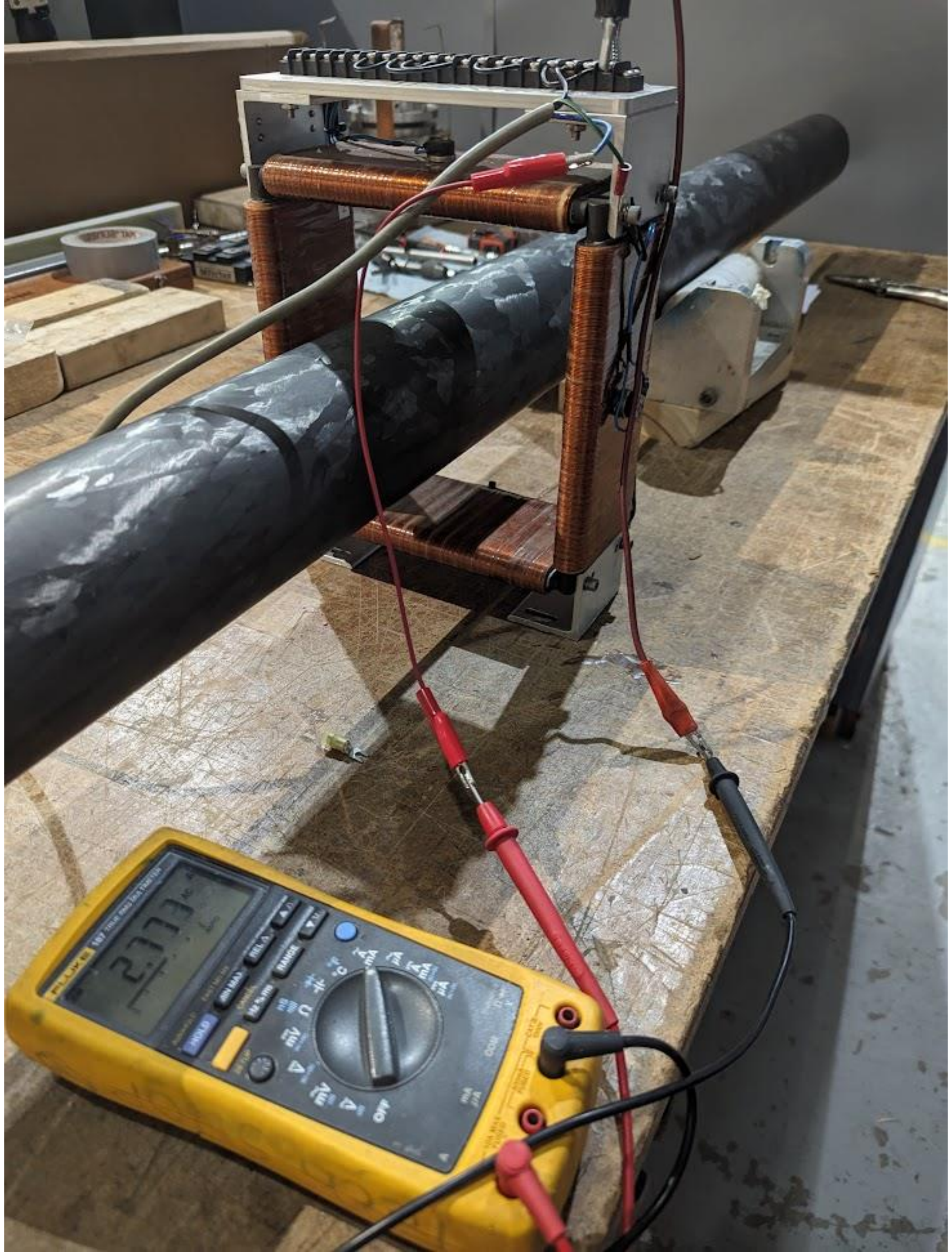
These were re-configured to be 'UnBucked' in order to have sensitivity to dipole and quadrupole field changes

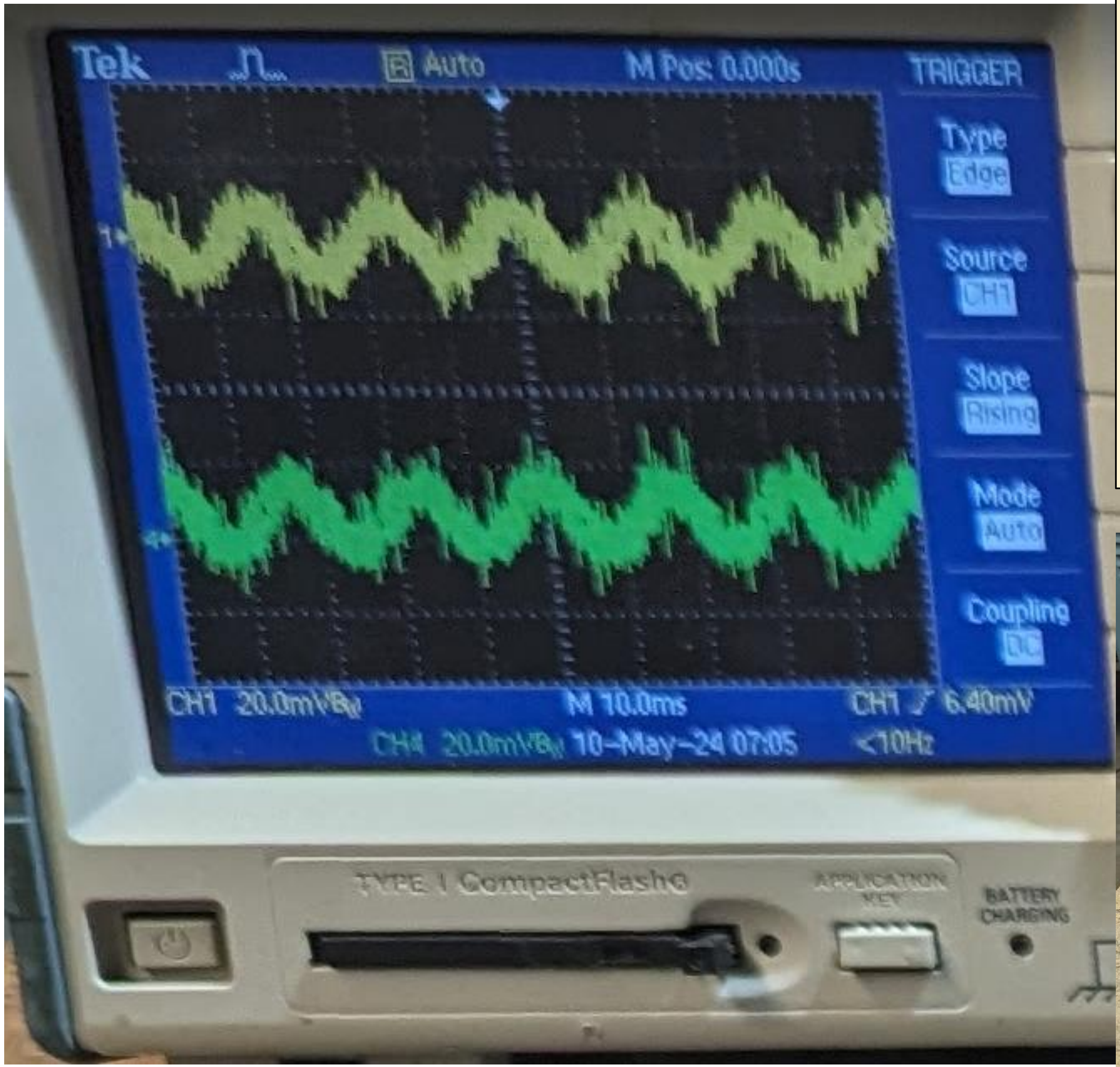
Thanks to the BNL technical team for their great support doing this work!

The UB TQA were tested with short (90mm), dipole magnet cycled with 60Hz current.

The field from the magnet was measured to be ~ 8mT, magnetic length ~ 0.23m

➔ TQA sees ~1.85 mTm integrated field change.

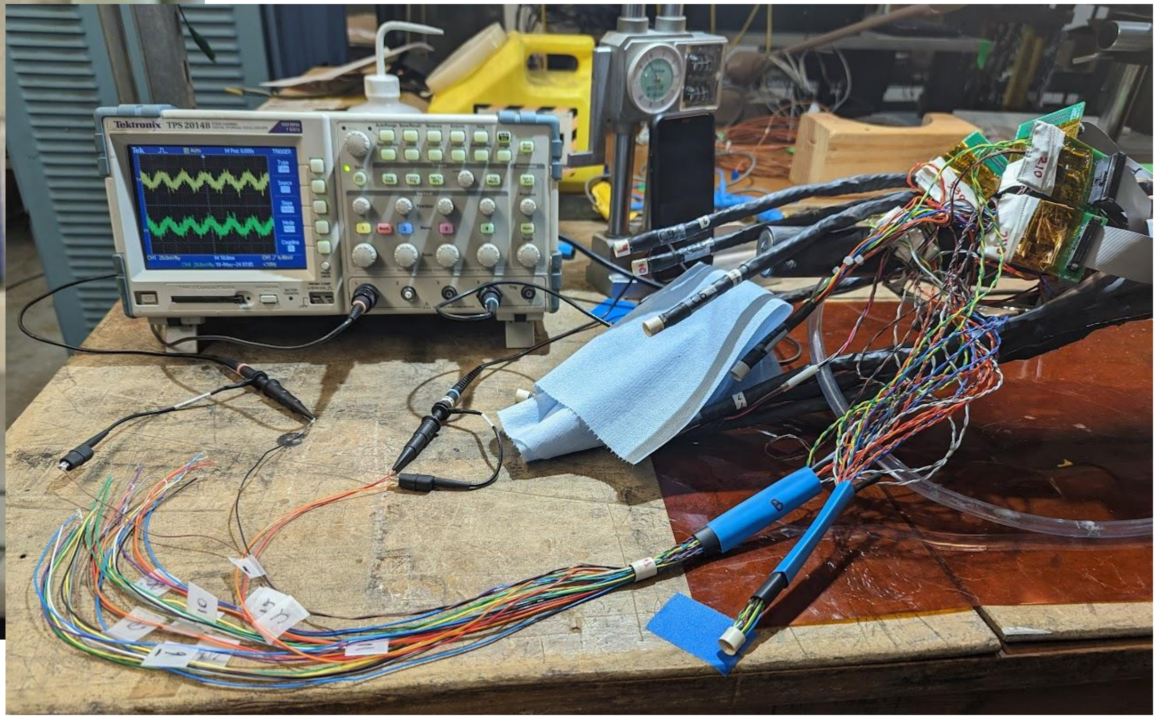


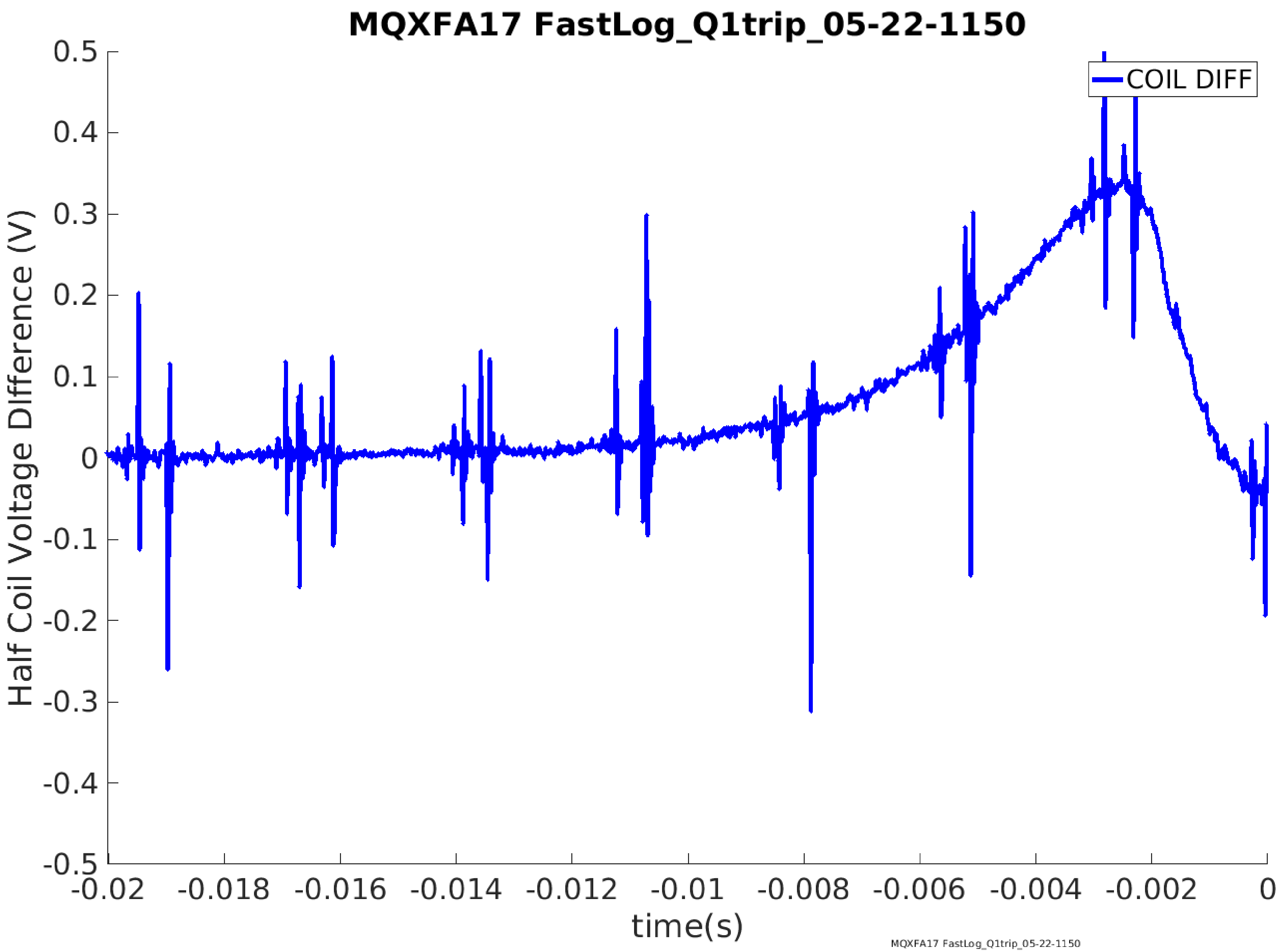


Scope signal on TQA is ~15mV P-P for the AC 1.85 mTm field change of the small dipole.➔ measured integrated voltage signal from scope is ~4e-5 Vs.

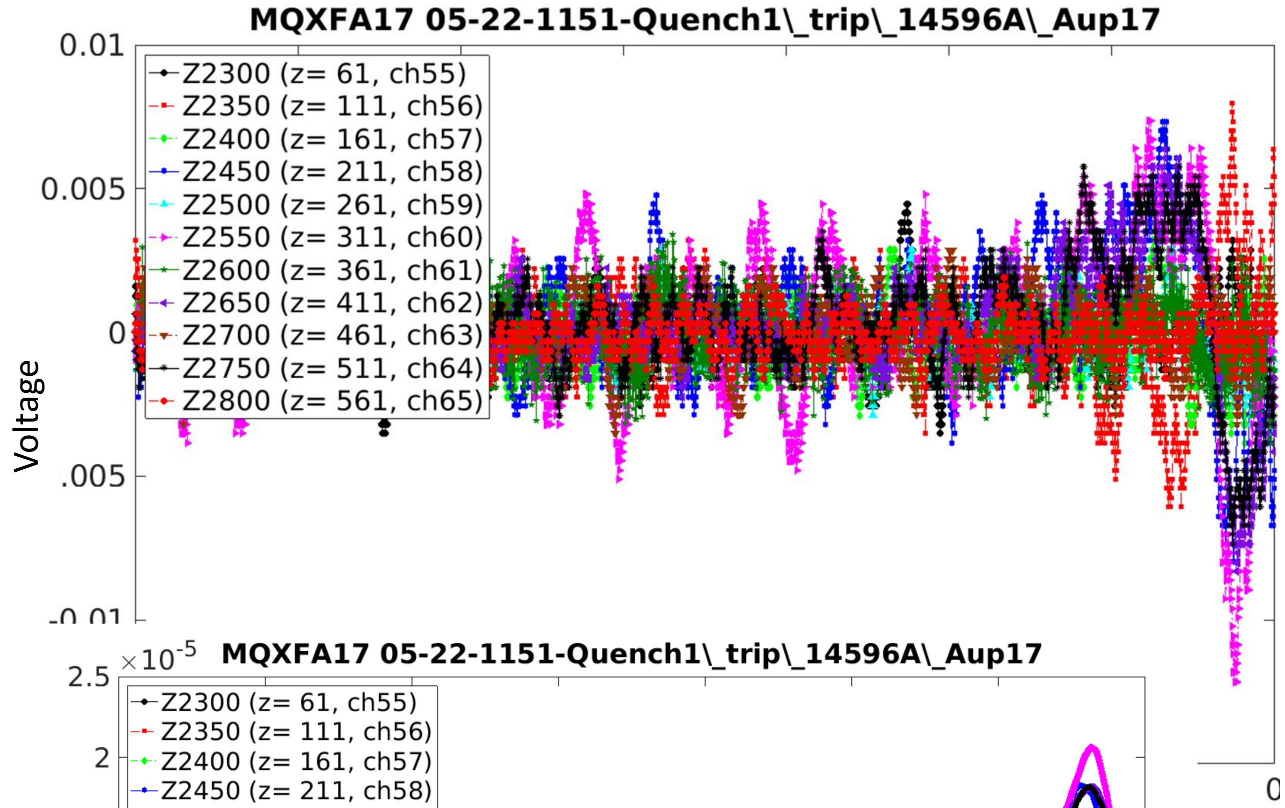
To compare with what is expected from TQA, the UB quench antenna has sensitivity of about 0.015 m^2, so 1.85 mTm integrated field change should give about 3e-5 Vs signal on the quench antenna.

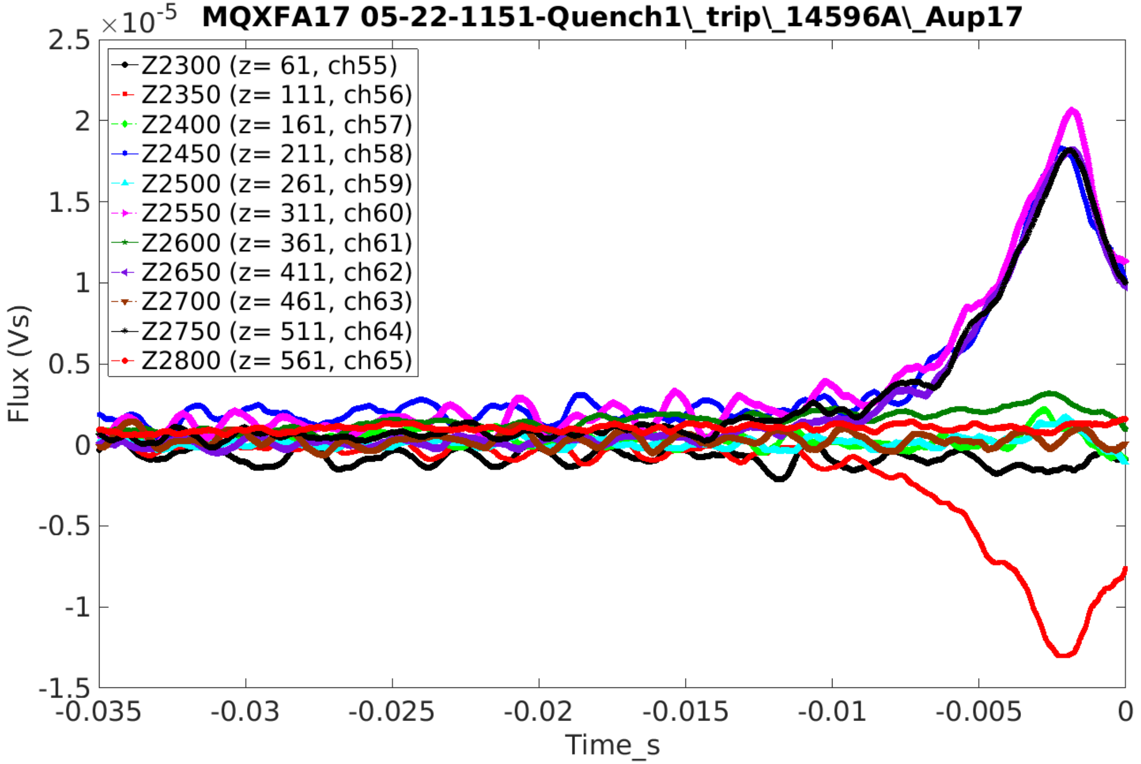
➔ Agrees roughly with expected

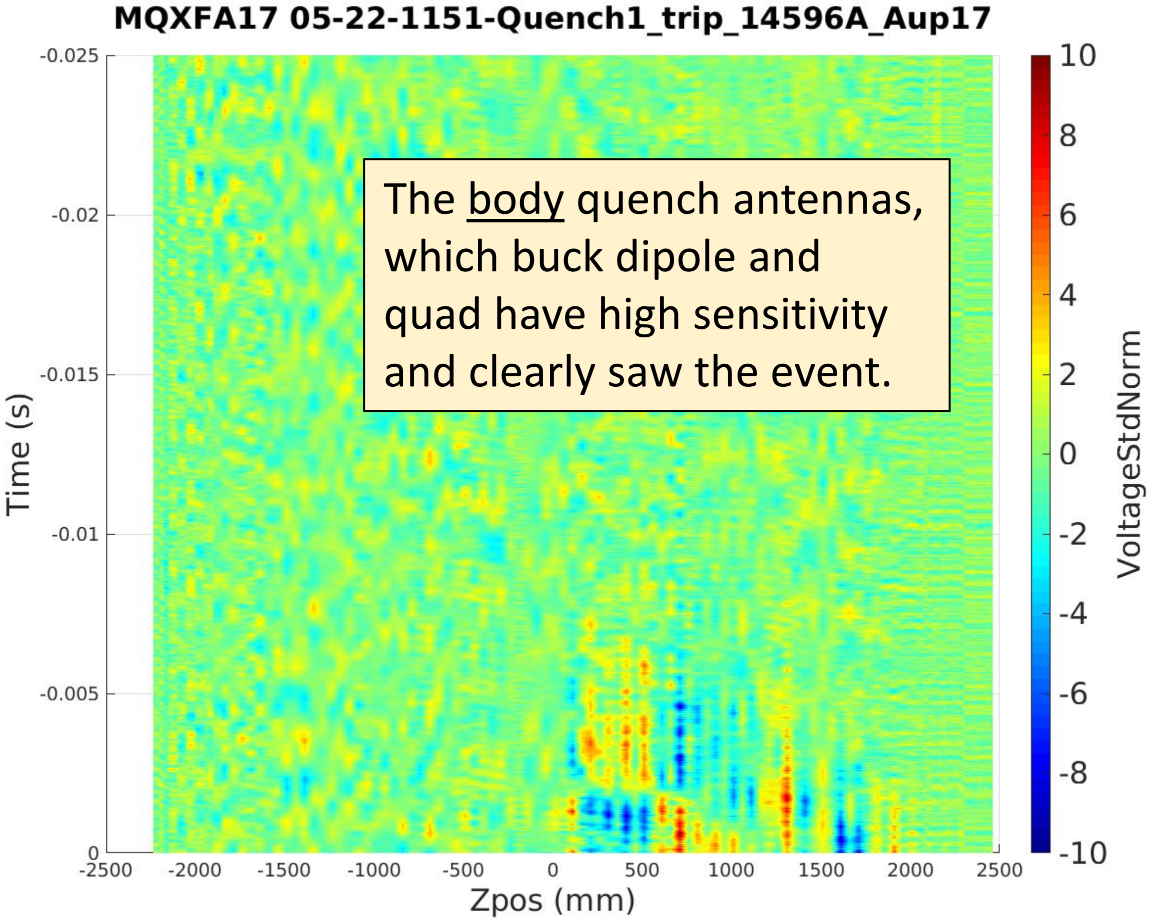



MQXFA17 FastLog_Q1trip_05-22-1150
COIL DIFF
Half Coil Voltage DIfference (V)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.02
-0.018
-0.016
-0.014
-0.012
-0.01
-0.008
-0.006
-0.004
-0.002
0
time(s)
MQXFA17 FastLog_Q1trip_05-22-1150

MQXFA17 first trip/quench had a ‘current spike’ event.

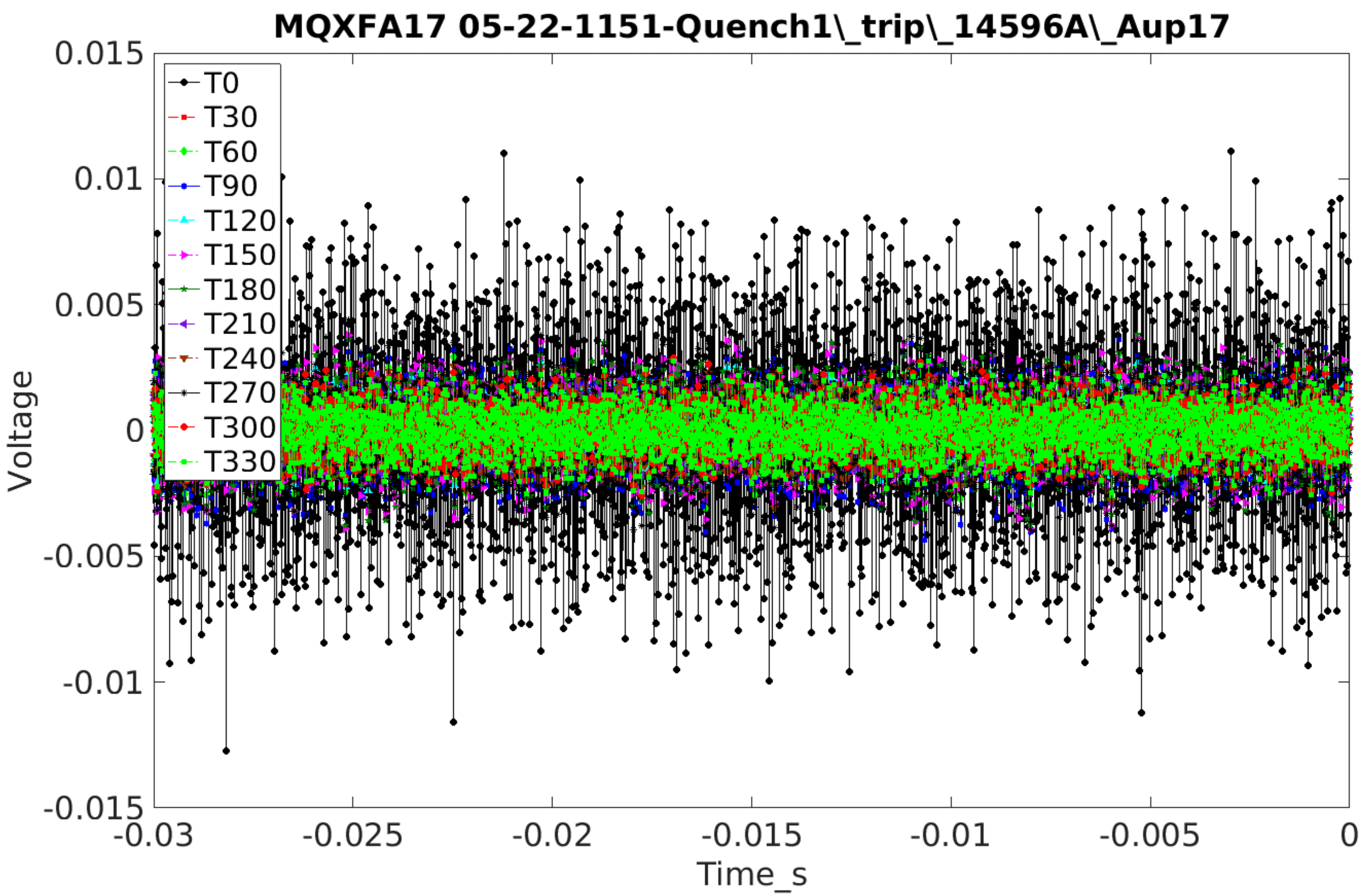




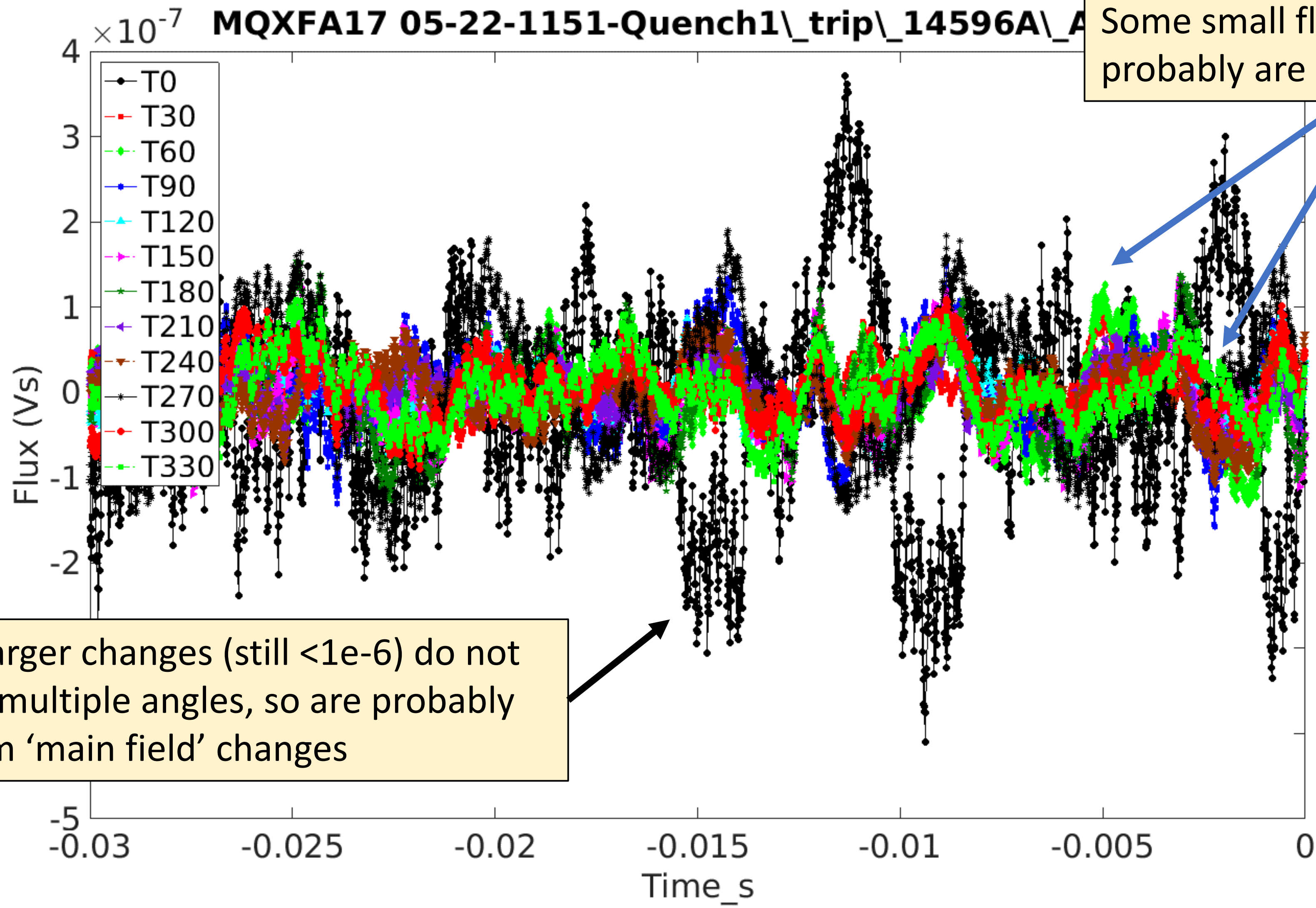


The body quench antennas, which buck dipole and quad have high sensitivity and clearly saw the event.

Voltage signals on TQA during spike event

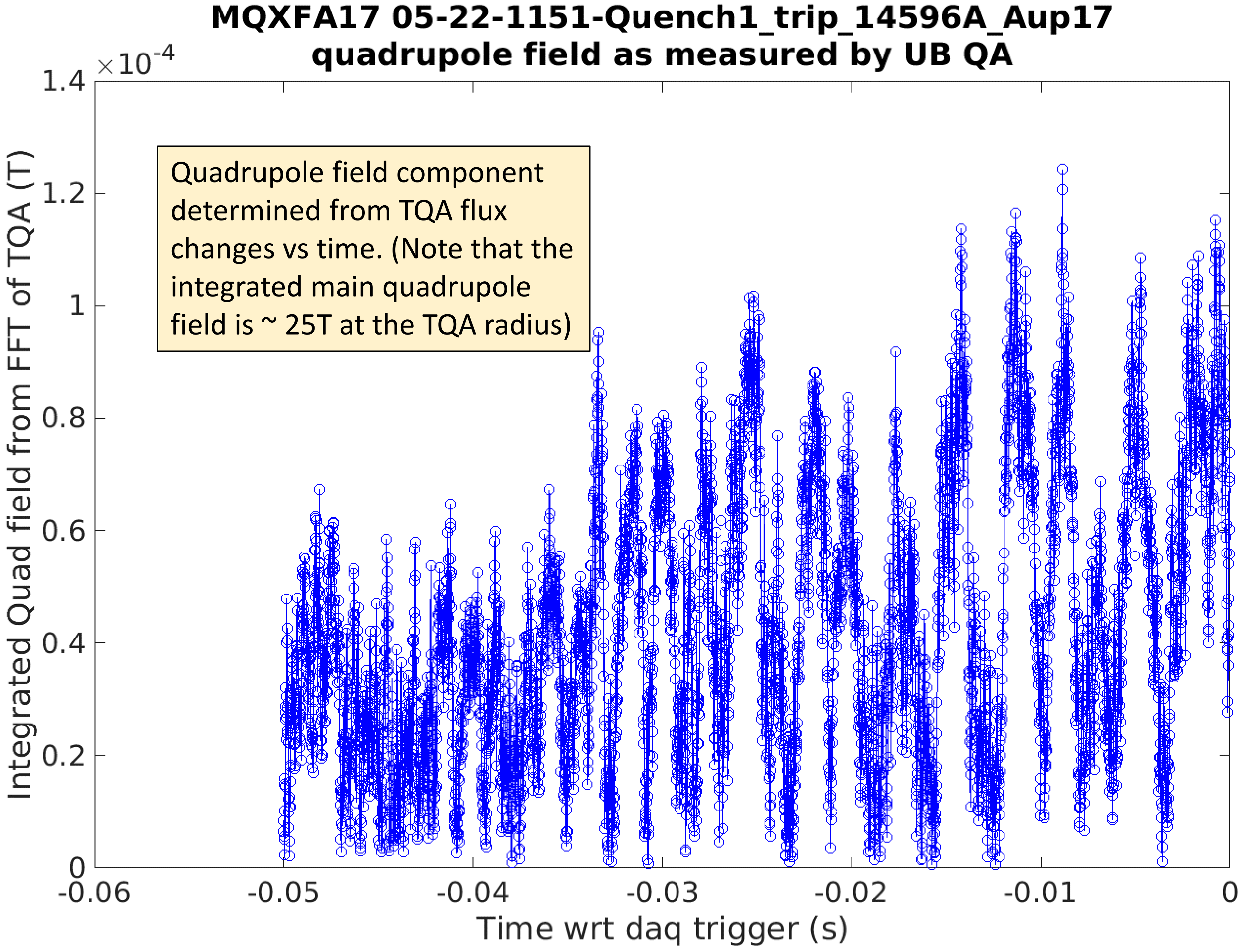


TQA flux signals do not seem to see anything at the level above 1e-6 Vs

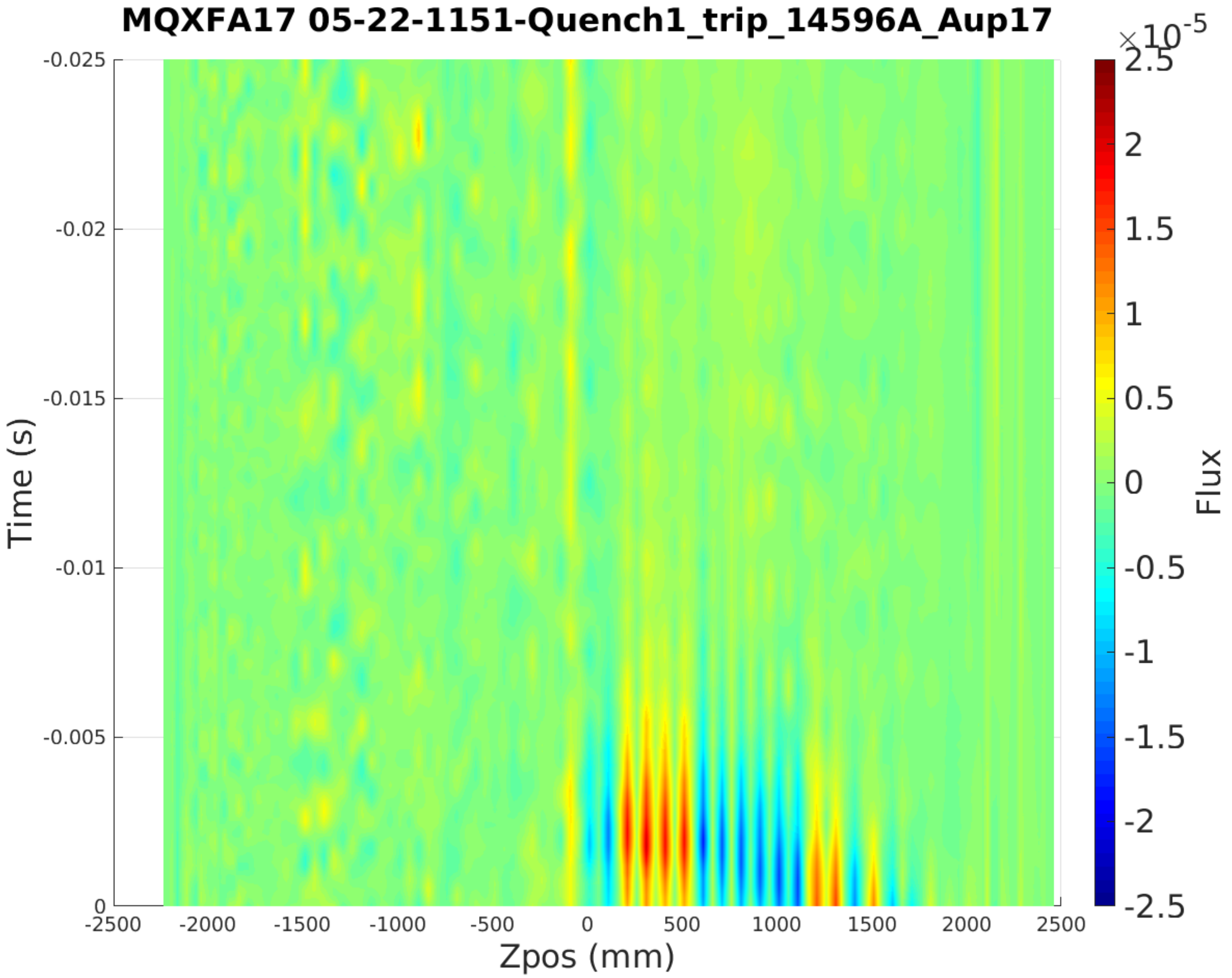


Some small flux changes probably are being seen here

These larger changes (still <1e-6) do not involve multiple angles, so are probably not from 'main field' changes



MQXFA17 05-22-1151-Quench1_trip_14596A_Aup17
quadrupole field as measured by UB QA
×10^-4
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Integrated Quad field from FFT of TQA (T)
-0.06
-0.05
-0.04
-0.03
-0.02
-0.01
0
Time wrt daq trigger (s)
Quadrupole field component determined from TQA flux changes vs time. (Note that the integrated main quadrupole field is ~ 25T at the TQA radius)



Perhaps in terms of integral field, flux changes are cancelling axially (?)

Summary/Conclusion:

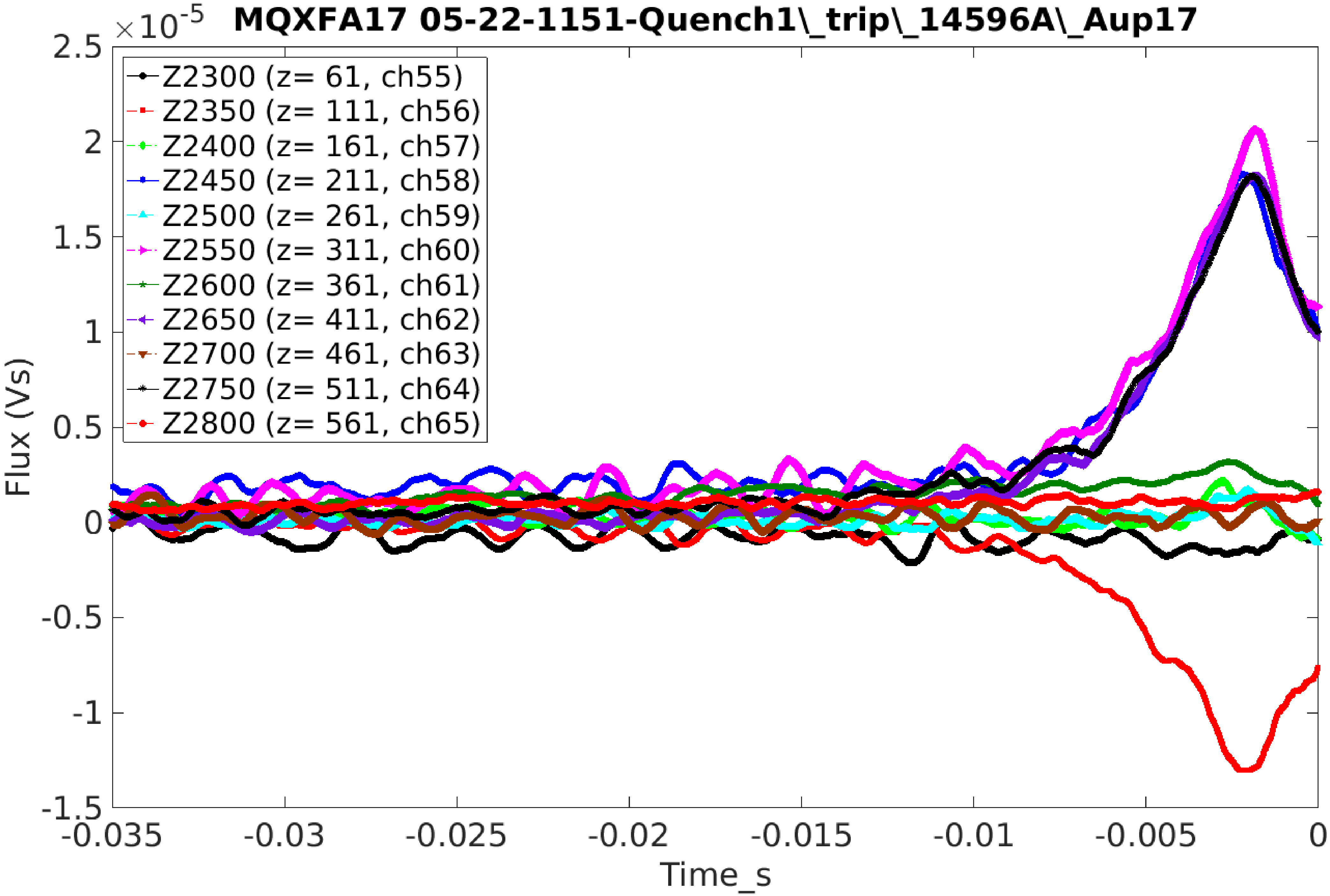
The azimuthal full-length quench antennas (Theta Quench Antennas (TQA)) were reconfigured to be sensitive to dipole and quadrupole fields.

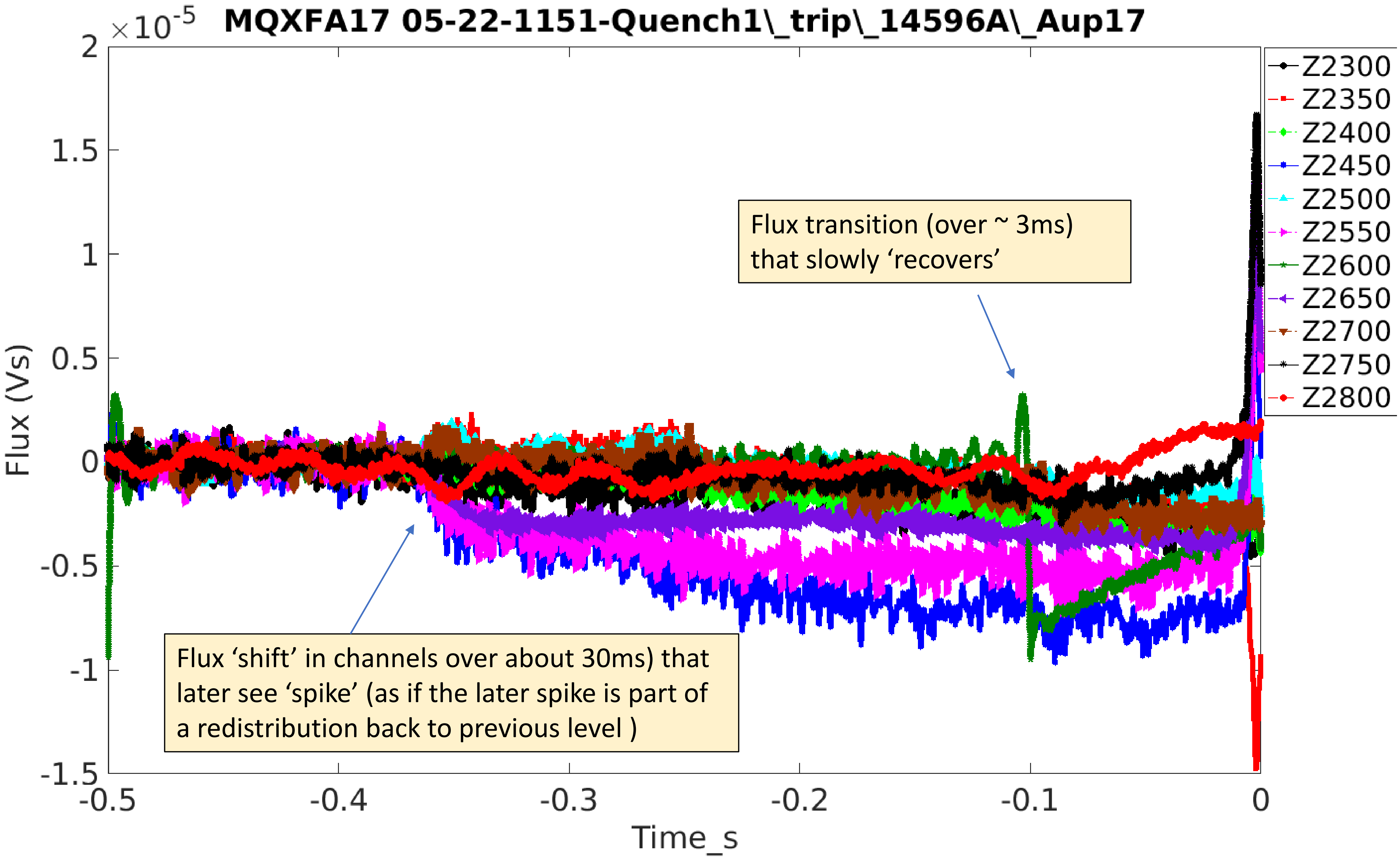
The reconfigured TQA were tested with a small AC magnetic field to assess their sensitivity – they could clearly see integrated field changes on the order of 1.85e-3 Tm, resulting in TQA signals of about 5e-5 Vs.

TQA signals during quench show < 1e-6 Vs flux change during the quench with a 'spike event', and so no large change in field seemed to accompany this event.

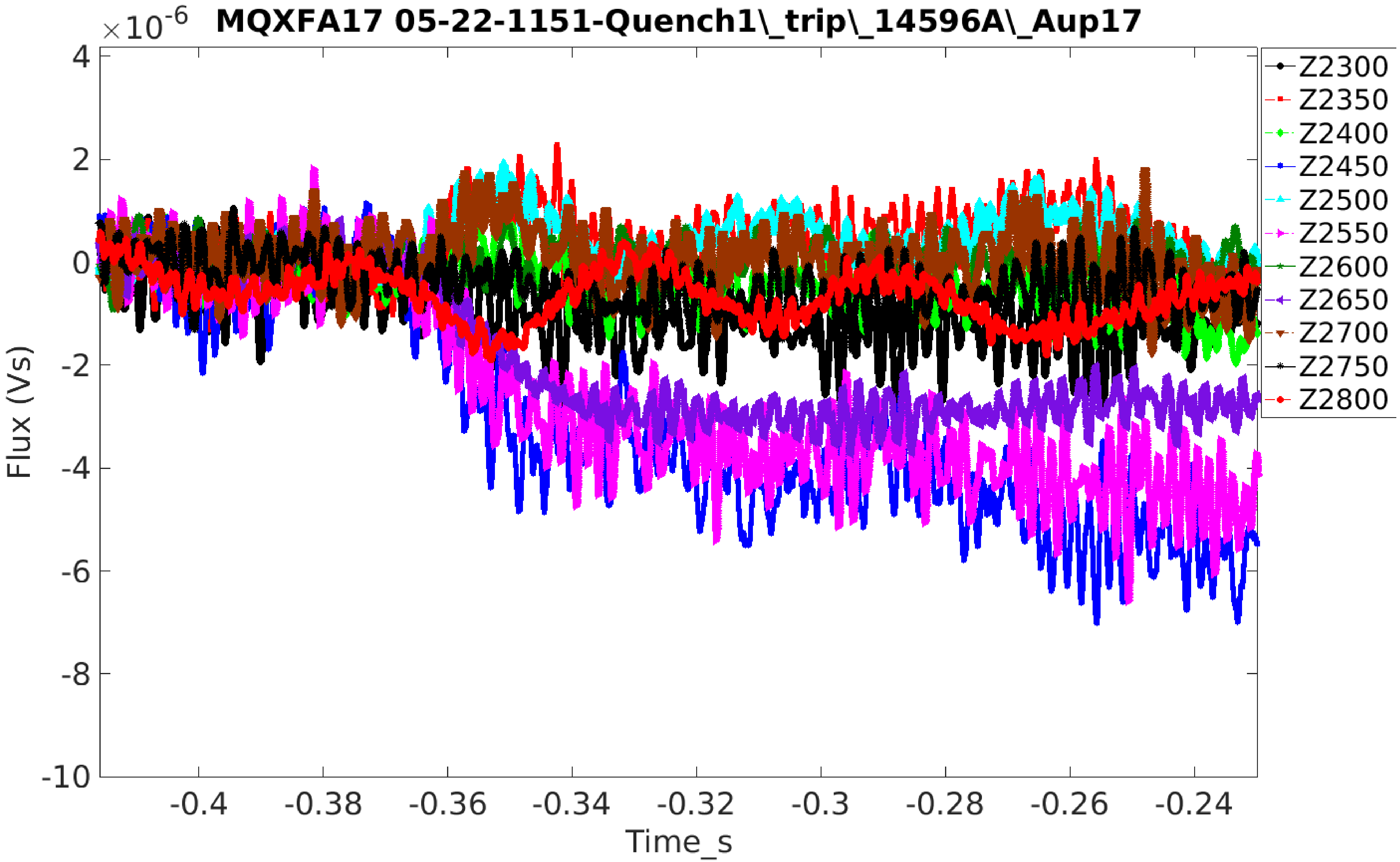
The integrated quadrupole field changes during the spike event were measured to be < 2.5e-4 T, compared to the main field integral of ~25 T, which would be a **negligible perturbation to the field**.

Additional slides➔

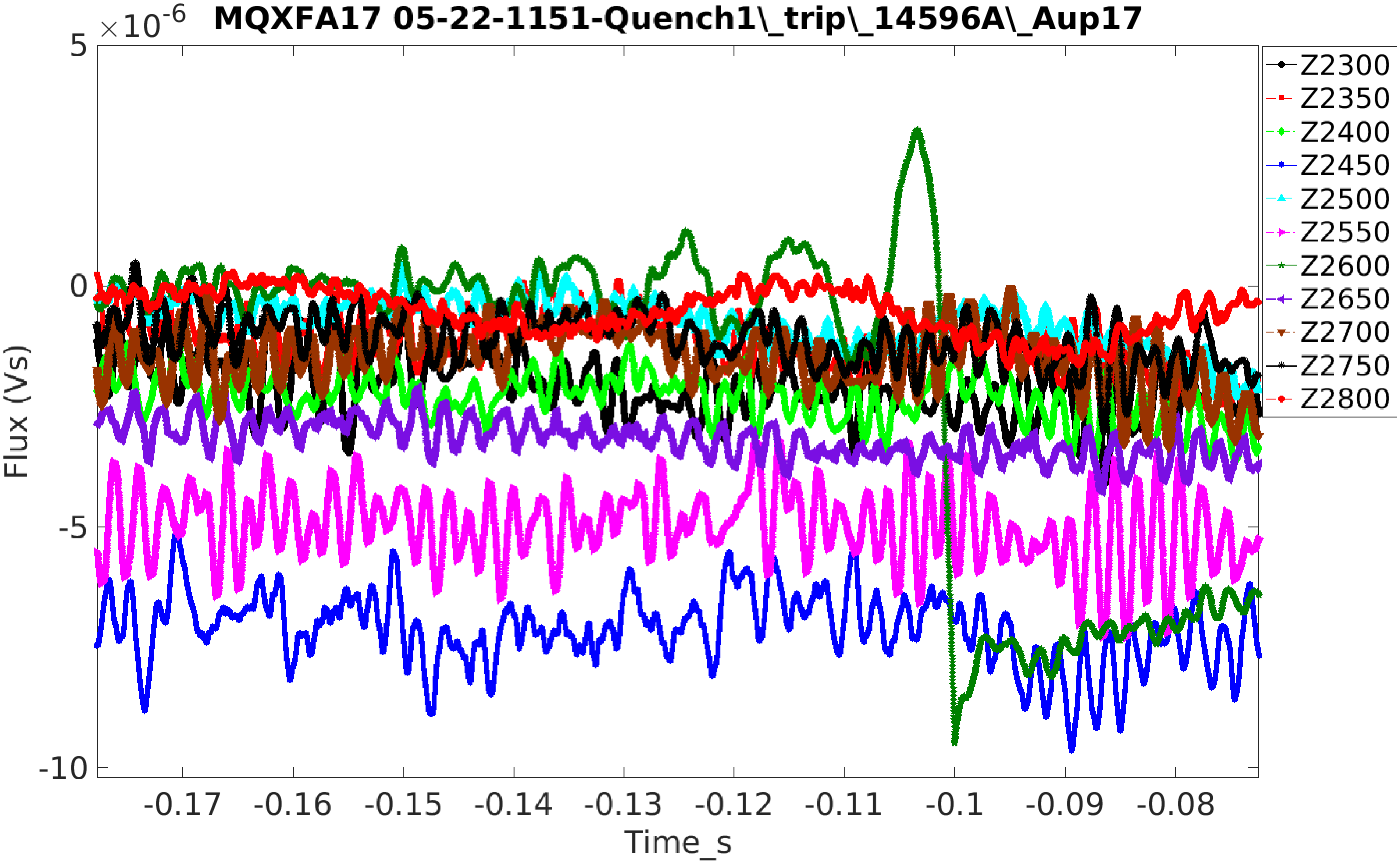

MQXFA17 05-22-1151-Quench1_trip_14596A_Aup17
×10^-5
Flux (Vs)
Time_s
Z2300 (z= 61, ch55)
Z2350 (z= 111, ch56)
Z2400 (z= 161, ch57)
Z2450 (z= 211, ch58)
Z2500 (z= 261, ch59)
Z2550 (z= 311, ch60)
Z2600 (z= 361, ch61)
Z2650 (z= 411, ch62)
Z2700 (z= 461, ch63)
Z2750 (z= 511, ch64)
Z2800 (z= 561, ch65)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-0.035
-0.03
-0.025
-0.02
-0.015
-0.01
-0.005
0



MQXFA17 05-22-1151-Quench1_trip_14596A_Aup17
×10^-5
2
1.5
1
0.5
0
-0.5
-1
-1.5
Flux (Vs)
-0.5
-0.4
-0.3
-0.2
-0.1
0
Time_s
Z2300
Z2350
Z2400
Z2450
Z2500
Z2550
Z2600
Z2650
Z2700
Z2750
Z2800
Flux transition (over ~ 3ms) that slowly 'recovers'
Flux 'shift' in channels over about 30ms) that later see 'spike' (as if the later spike is part of a redistribution back to previous level)



MQXFA17 05-22-1151-Quench1_trip_14596A_Aup17
×10^-6
4
2
0
-2
-4
-6
-8
-10
Flux (Vs)
-0.4
-0.38
-0.36
-0.34
-0.32
-0.3
-0.28
-0.26
-0.24
Time_s
Z2300
Z2350
Z2400
Z2450
Z2500
Z2550
Z2600
Z2650
Z2700
Z2750
Z2800



MQXFA17 05-22-1151-Quench1_trip_14596A_Aup17
×10^-6
5
0
-5
-10
Flux (Vs)
-0.17
-0.16
-0.15
-0.14
-0.13
-0.12
-0.11
-0.1
-0.09
-0.08
Time_s
Z2300
Z2350
Z2400
Z2450
Z2500
Z2550
Z2600
Z2650
Z2700
Z2750
Z2800