

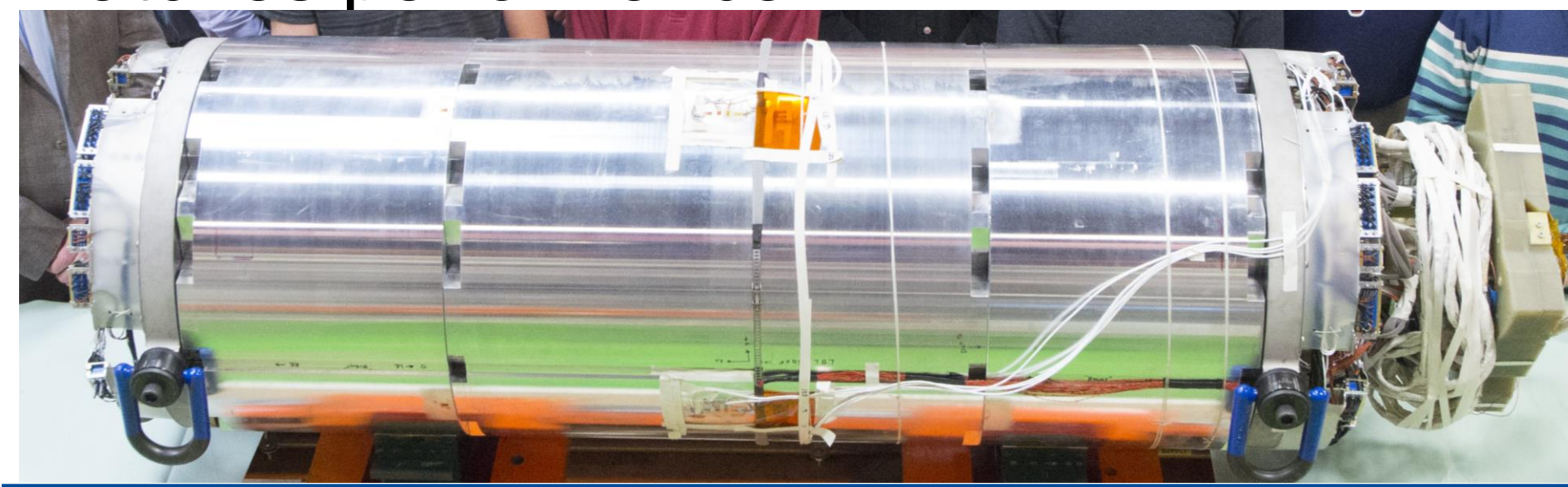
Quench Location in the LARP MQXFS1 prototype

T. Strauss (FNAL), G. Ambrosio (FNAL), G. Chlachidze (FNAL), P. Ferracin (CERN), G. Sabbi (LBNL),
S. Stoynev (FNAL), M. Martchevskii (LBNL)

Mon-Af-Po1.01-04

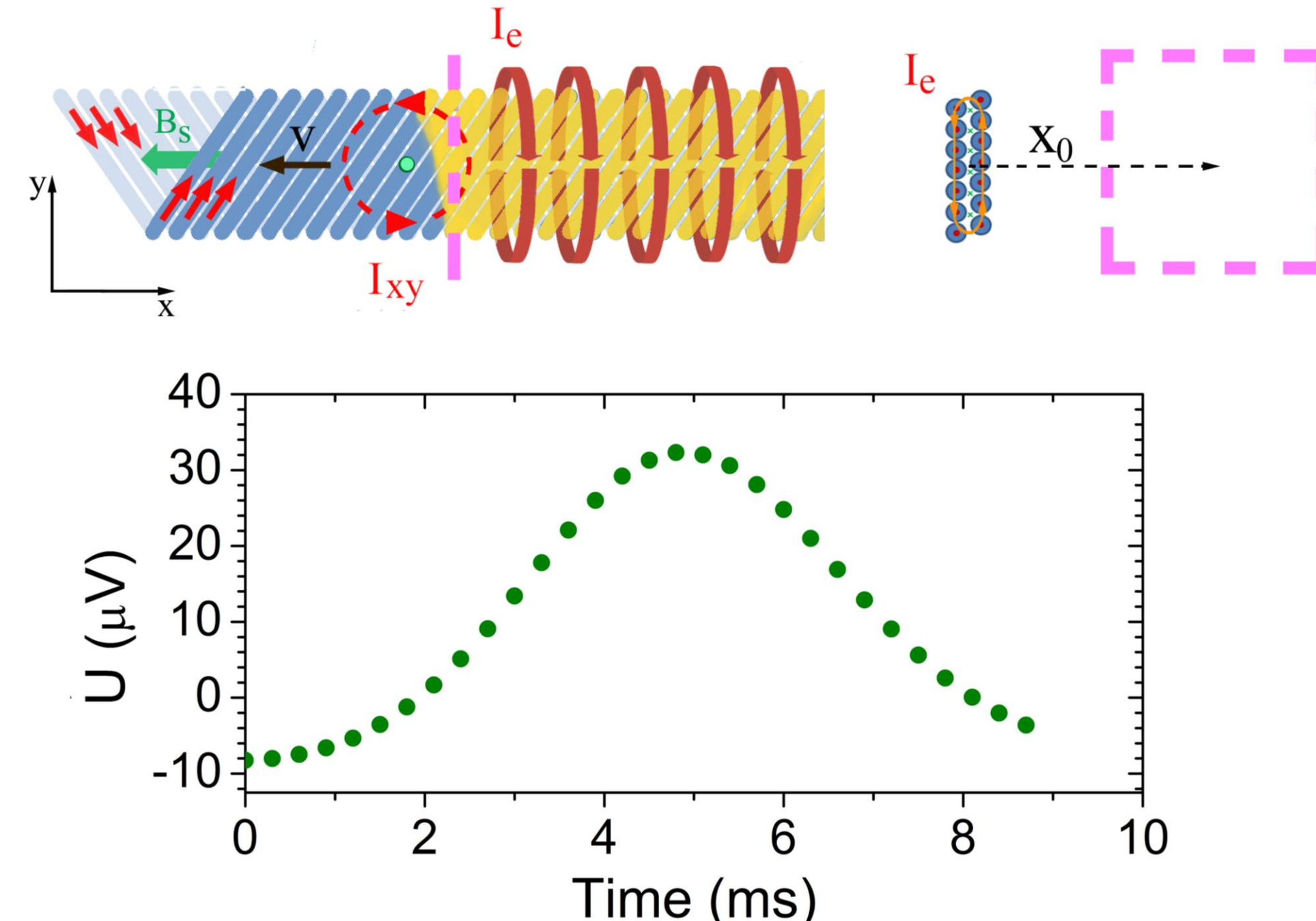
The MQXFS1 magnet

The LARP collaboration and CERN have developed the MQXF series Nb₃Sn quadrupoles (150 mm aperture, 12 T) for the LHC luminosity upgrade. Among others, several short prototypes with a magnetic length of 1 m was built. An extensive testing campaign at FNAL for MQXFS1, the first prototype, was conducted to ensure it matches performance.



The Quench Antenna

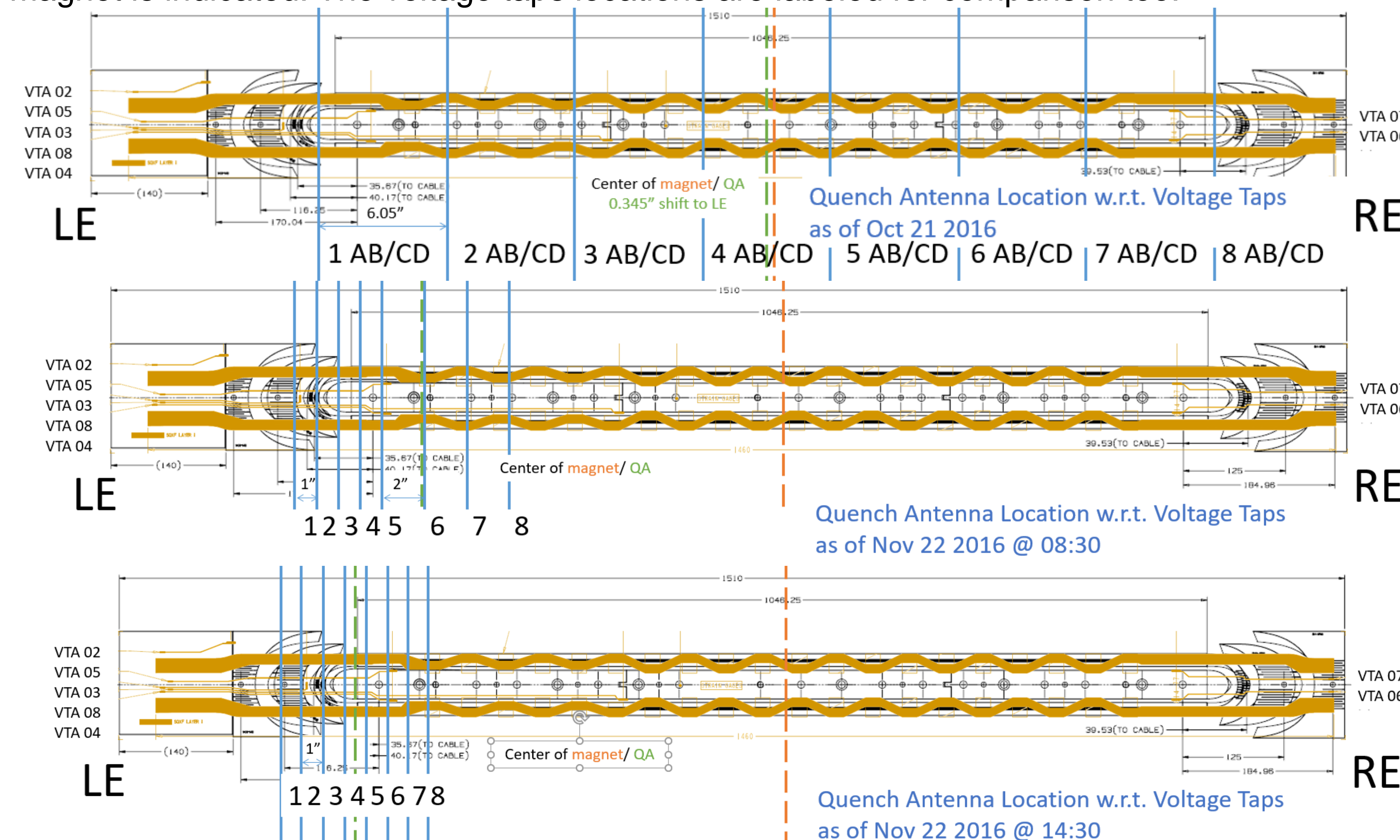
A sketch showing quench propagation in a Rutherford cable. The normal zone expands to the right causing “leakage” of the solenoidal field from the cable interior, as well as current redistribution near the normal zone boundary. Both effects can be simulated as a set of current loops building up along the cable length. When quench front passes along the antenna pickup coil (shown in dashed pink line) an inductive signal is generated.



In green dots we show the transient inductive voltage calculated for a 25x25 mm-sized rectangular pickup loop placed at $x_0=55$ mm from the quenching cable.

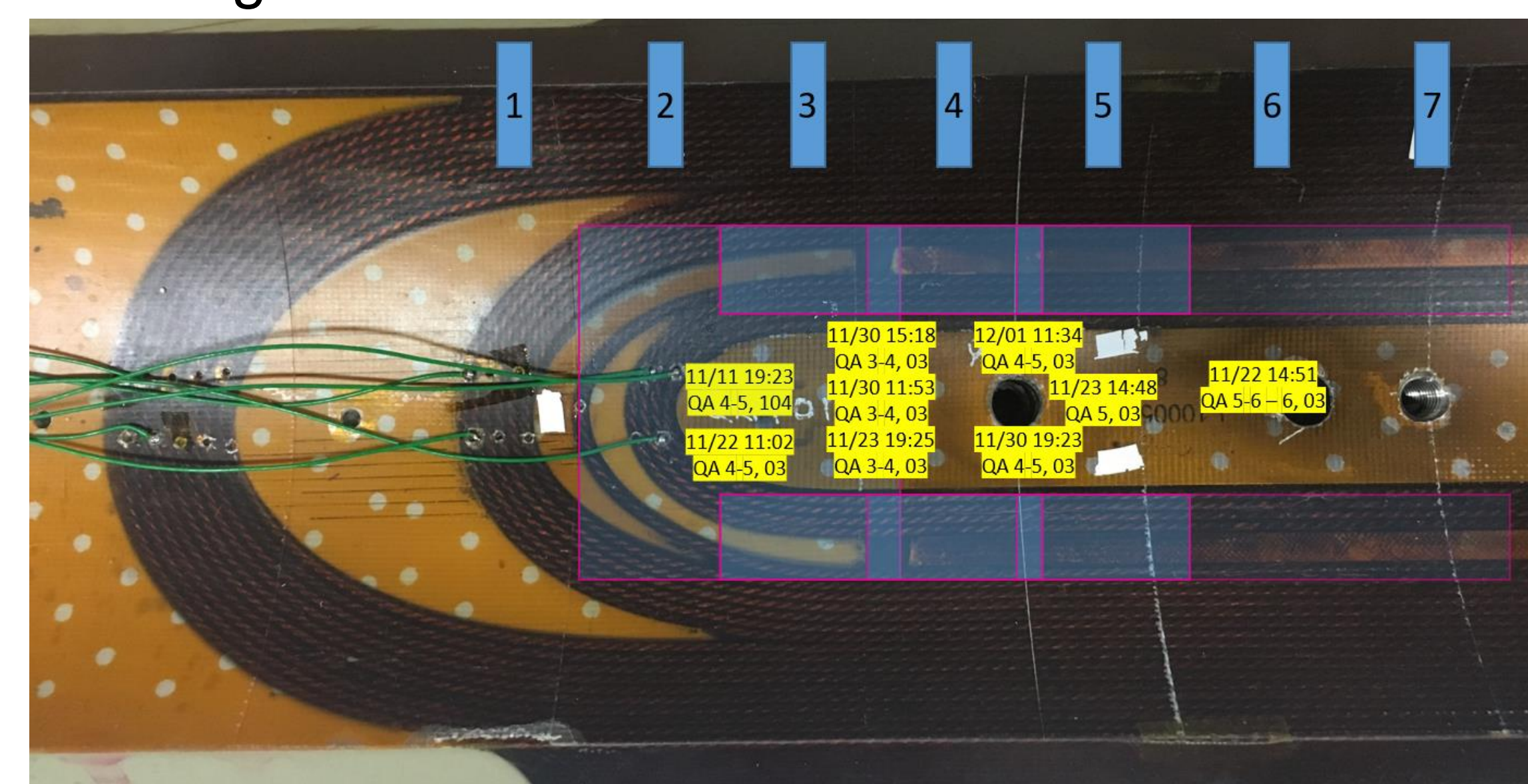
Quench Antenna Configurations

A schematic of the quench antenna positioning. The segments are represented by full lines, overlaid with the mechanical assembly drawing to indicated the position of each segment along the z-axis. For the top and bottom plate the antenna segments are labeled and lead end (LE) and return end (RE) of the magnet is indicated. The voltage taps locations are labeled for comparison too.

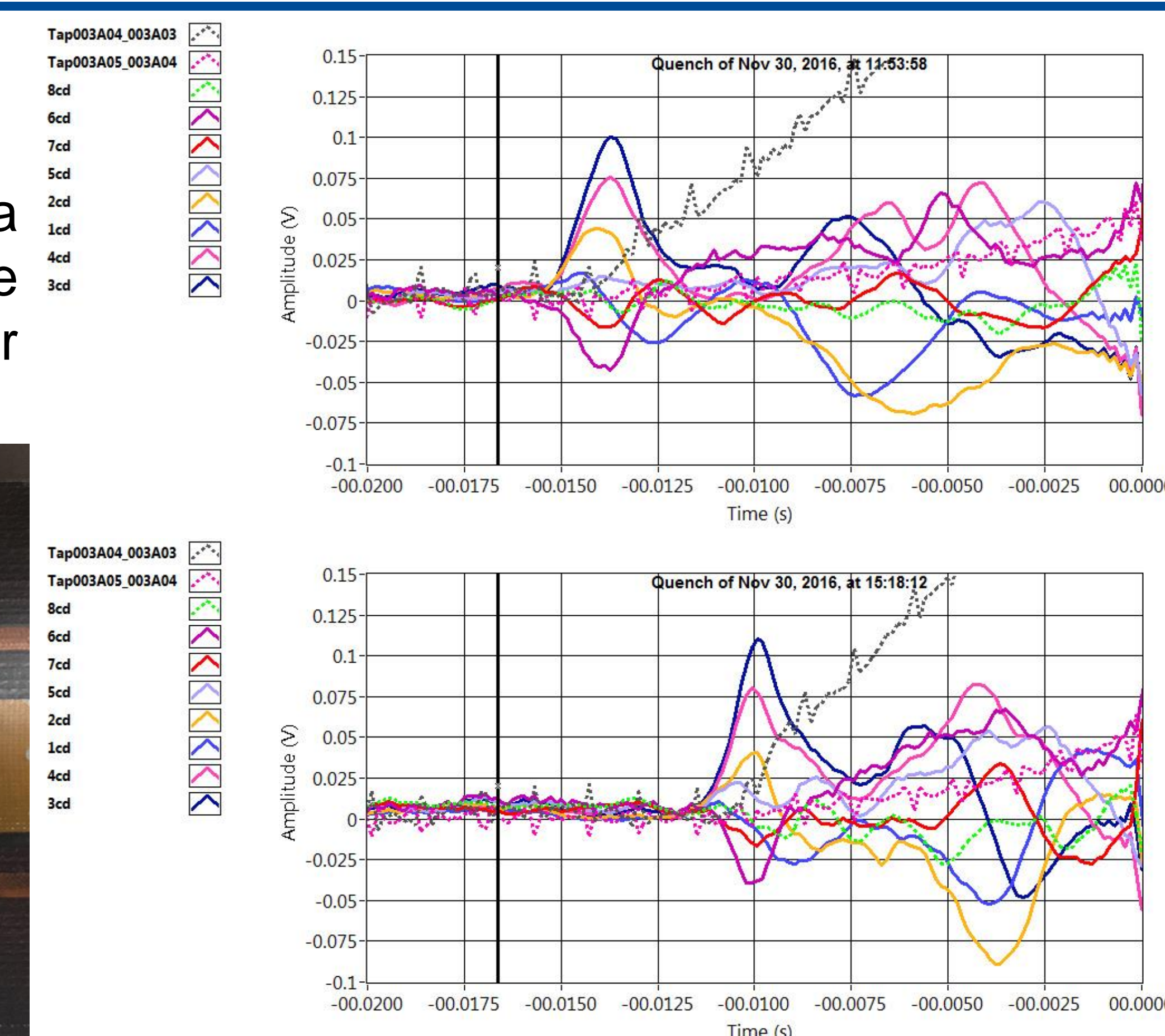


The Quench Locations

Data from the voltage taps and quench antenna stacked on top of an image of a MQXF coil. The overlap indicated quench origin near the pole spacer to wedge transition.



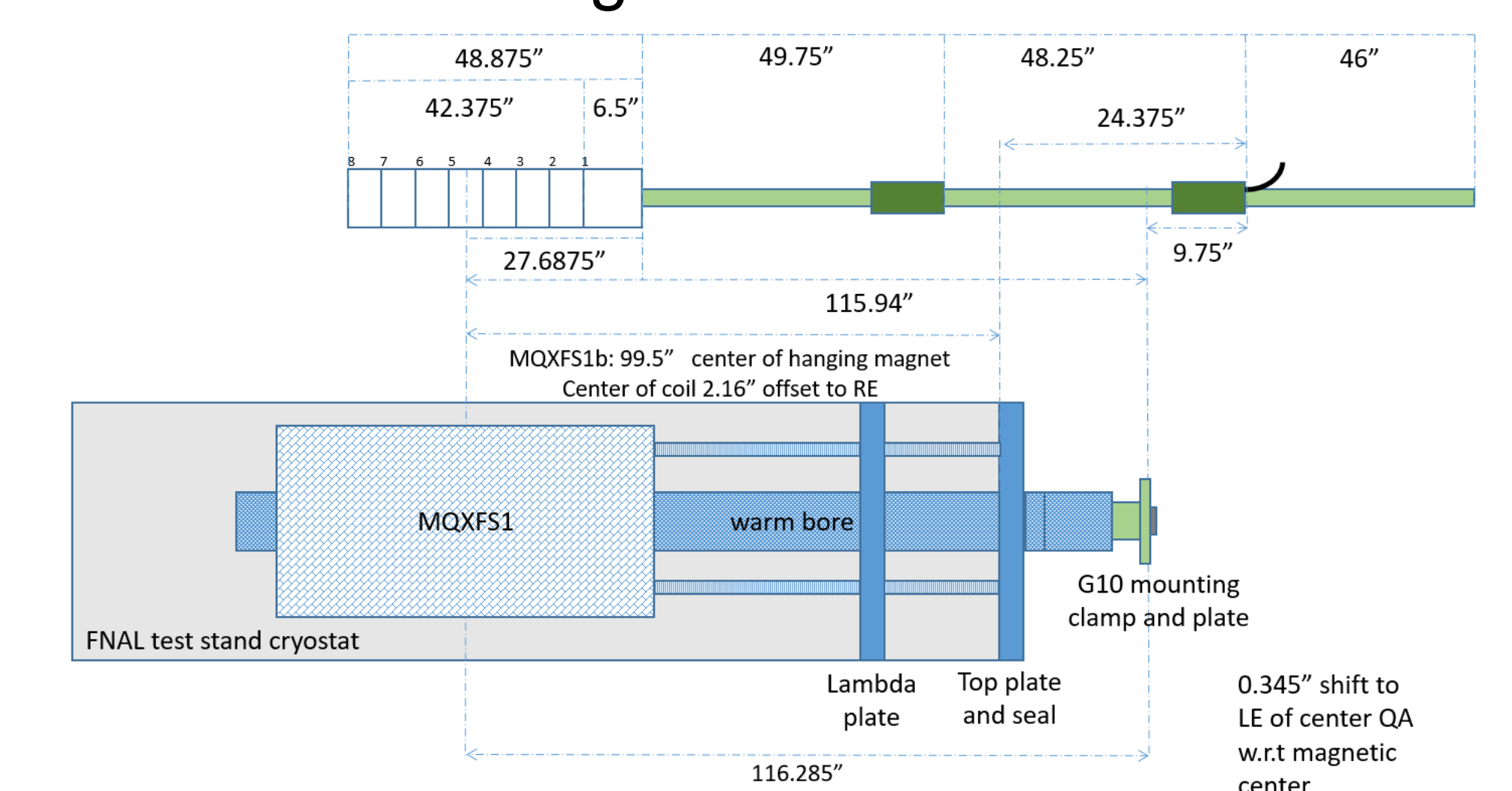
Overlay of the quench location



Two examples of quench data sets

Centering the antenna

Assembled with 6 inch spacers for an antenna length of 107.1 cm the antenna ensures full length coverage of the MQXF-S magnet straight section (100.2 cm), with a small overlap to the coil ends. The quench antenna is centered to the mechanical center of the magnet.



Antenna Segment Rotation

To further localize the quench origin, we tried to rotate the quench antenna 45 degrees, such that the dipole-bucks coil segment face parting plane (mid plane) between coils the instead of the pole; further analysis to study the effect is needed.

