Towards a Better Quench Instrumentation

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Introduction

Superconducting magnets, which are an integral part of modern accelerators, suffer from quenches which occur when local environmental fluctuations cause a temporary loss in superconductivity.

The increased resistance causes a change in the local current which we can detect using arrays of small windings, called quench antennas. They have voltages induced in them when the local magnetic flux changes. By knowing which antennas show voltage spikes, we can locate the start of the quench.

Methodology

The key realization was that we could use less data channels if we had redundant quench antennas. By wiring particular ones in series, we could develop a kind of digital "encoding" for each original quench antenna channel.

Analysis

Given the variety of ways in which quenches evolve, it is tricky to determine a numerical figure of merit for the start of the quench. Thus, as a proxy, we looked at the ability of our scheme to reconstruct the original quench antenna data. We normalized both the original and decoded data relative to it's highest peak and then compared them.

Conclusion

By using redundant sets of quench antennas wired in series, we can use less data channels to achieve a similar resolution to a normal quench antenna arrangement that may require 4, or 5 times, less data ingestion channels.

Future research should focused on implementing this scheme practically and understanding its limitations. In particular, a better numerical figure of merit to understand the viability of various configurations is important to consider.

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