

Performance and Lifetime Improvements of Pulsed Magnets

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The National High Magnetic Field Laboratory at Los Alamos develops and operates seven capacitor-driven pulsed magnets to deliver very high pulsed magnetic fields for users. In recent years, the facility has made significant advances in magnet development to expand capacity and increase the productivity of these capacitor-driven magnet systems, supporting the growing needs of the user community.

Four cells of 65T workhorse magnets have served as the primary capacitor-driven systems, providing users with pulsed magnetic fields up to 65 tesla and pulse lengths of about 80 ms. Recently developed 75 T duplex and 60 T mid-pulse magnets now offer users access to pulsed magnetic fields with higher amplitudes and longer pulse durations. These magnets employ a new design that incorporates liquid-nitrogen cooling channels between component coils, significantly reducing the cooling time between pulses. In addition, an advanced mechanical design, combined with the use of improved yet more cost-effective CuCrZr magnet wire, has markedly increased the lifespan of these magnets. All of the design advancements developed for the 75-T duplex and 60-T mid-pulse magnets have recently been implemented in the existing 65-T workhorse magnets, significantly improving their performance and productivity.

These enhancements have led to a substantial increase in magnet productivity. In 2024, the 65-T magnets delivered approximately 3,500 pulses at or above 60 T, while the 75-T duplex magnet provided about 450 full-field pulses for uses.

Facilities and instrumentation used: Pulsed Field Facility – Los Alamos National Laboratory

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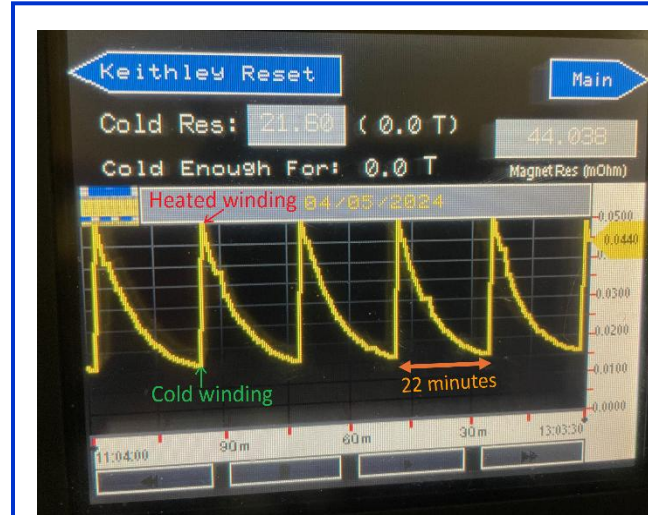


Figure 1. Monitor display of the magnet resistance curve during operation of a 65-T magnet. The magnet resistance (which reflects the winding temperature) increases sharply immediately after each full-field pulse and then gradually returns to the baseline (cold) level. The cooling time between full-field shots is approximately 22 minutes.

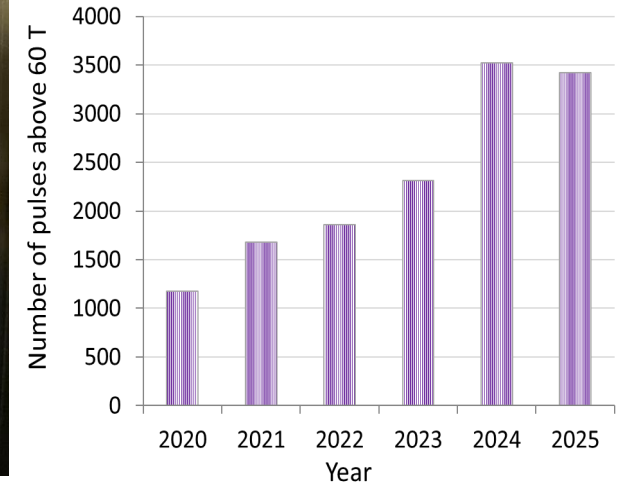


Figure 2. Number of pulses exceeding 60 T delivered by the 65-T magnets in recent years. The improved cooling time and extended magnet lifespan achieved with the new magnet design and conductor introduced in 2024 resulted in a 50% increase in the number of pulses, reaching the full operational capacity of about 3,500 full-field pulses per year.