# Smart non-linear transport technique expands the frontier of superconductor research

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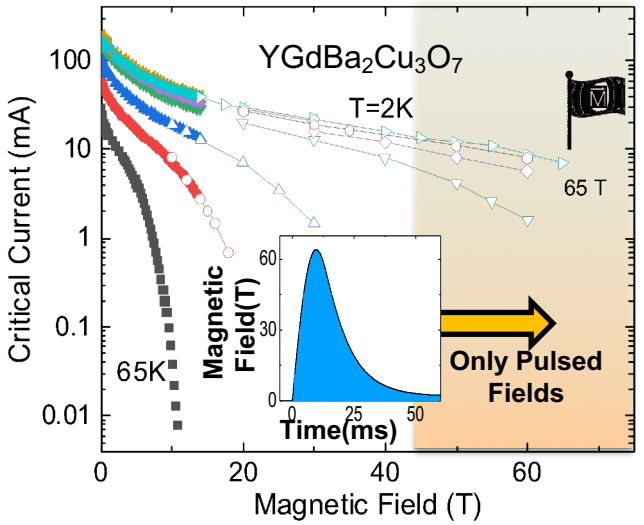
MagLab scientists developed a smart technique for rapidly measuring non-linear transport in pulsed magnetic fields, measurements that have unveiled new physics for fast-moving magnetic vortices. This new technique has attracted users from research groups in the USA, Europe, and Japan to study critical currents in cuprates, iron-based, and new nickel-based superconductors in magnetic fields up to 65T. Non-linear transport is also an important probe to study charge-density-wave systems and topological materials.

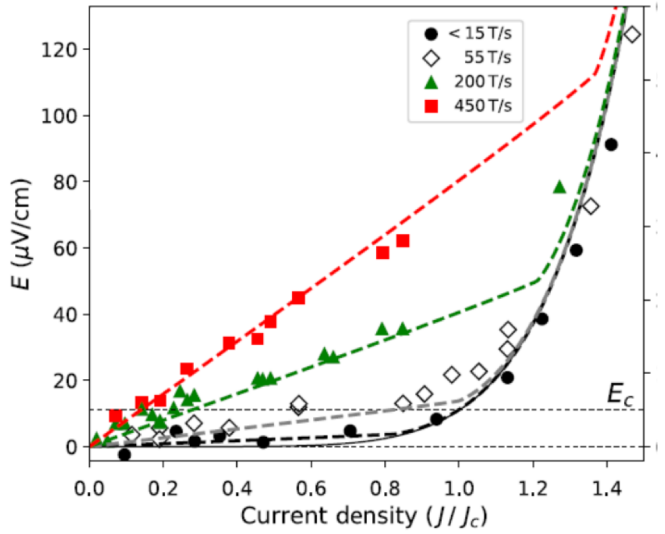
In superconductors, measurements of non-linear electrical transport is necessary to determine their current-carrying properties. However, during these measurements, *sudden changes in sample voltage can destroy the sample. Thus, until now, transport experiments of superconductors in pulsed magnetic fields have been limited to very low currents.*

*To solve this problem, MagLab scientists developed a new technique using Field Programmable Gate Arrays that vary the current in response to changing sample voltage in less than 10 nanoseconds*, allowing several non-destructive current-voltage curves to be measured in a single 50msec-long magnetic field pulse.

*These measurements of critical current up to 65T unveiled novel dynamic vortex responses as a consequence of the fast-changing pulsed magnetic fields.*




Measuring non-linear electric field – current density (*E-J*) curves in pulsed magnetic fields to 65T allowed researchers to determine critical current densities ($J_c$) at record high magnetic fields.




The data revealed new vortex physics from the E-J curves measured in rapidly-changing magnetic fields. The collaboration developed a model that quantitatively describes the curves with no free parameters.

**Facility used:** Pulsed field facility 65T magnets.

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