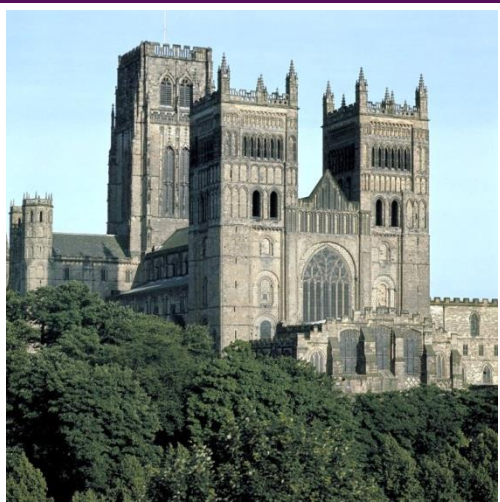


Analysis of Raw V-I data to extract I_C



Centre for Materials Physics

Superconductivity Group

www.durham.ac.uk/cmp



Durham
University

Presentation by

Prof. Damian Hampshire and Dr. Mark Raine

Critical current measurements on short samples in high magnetic fields

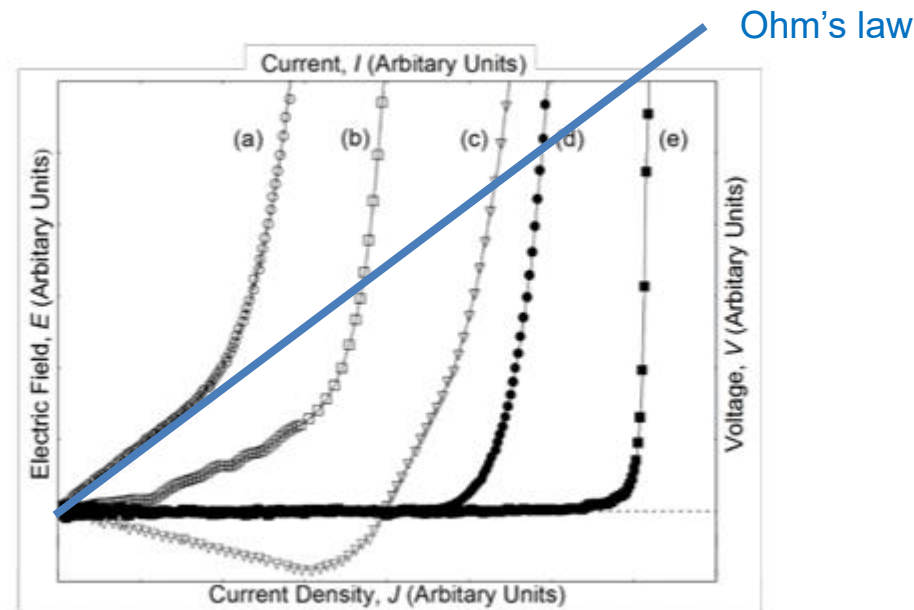
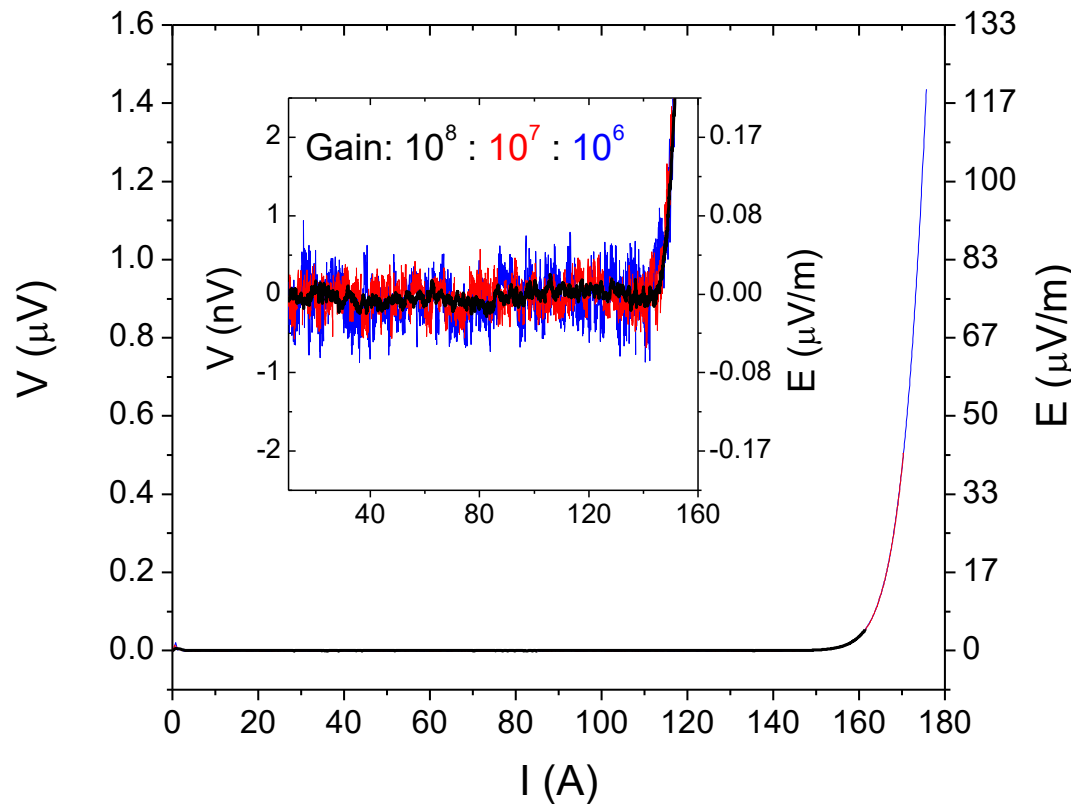


Fig 1: Five E - I traces found when measuring different superconductors. Trace (a) shows resistive behaviour from origin because the sample measured was short. Alternatively, such artefacts can appear if there are thermal voltages across the sample, or across the amplifier terminals. We can remove this resistive behaviour by simply subtracting the line obeying Ohm's law shown in blue. This will give us the required E - I trace with zero resistance.

M J Raine, S A Keys and D. P. Hampshire [Characterisation of the Transport Critical Current Density for Conductor Applications](#) Handbook of Superconductivity. Publisher: Taylor and Francis (2021)

Critical current density in high magnetic fields



$T = 4.2 \text{ K}, B = 7 \text{ T}$

$V_{\text{theory}} \sim 54 \text{ pV}$

After the baseline subtraction, the data should show the text-book behaviour shown above. State of the art measurements are about a factor of 3 above the fundamental theoretical limit given from taking account of the quantisation of charge and calculating the Johnson noise.

Extracting critical current (I_c) or critical current density (J_c) values.

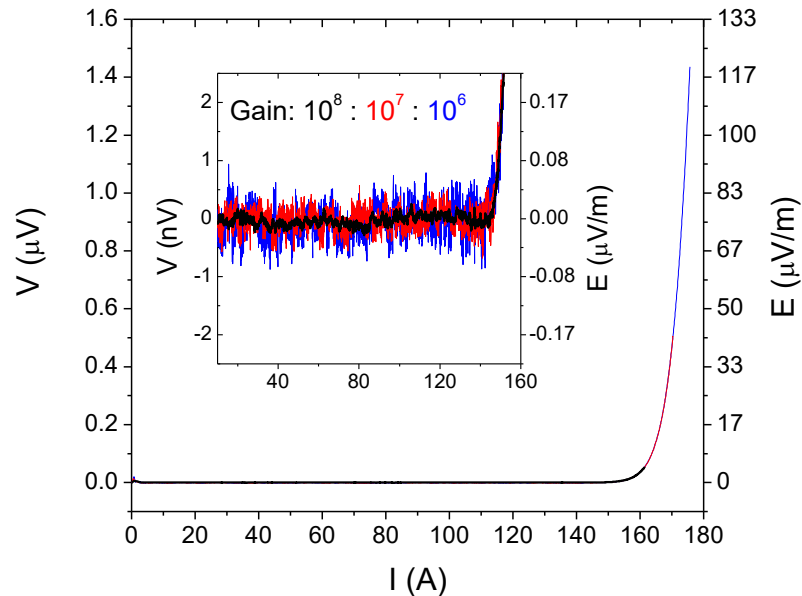


Fig 1: $E - I$ characteristics generated for an HTS tape measured at 4.2 K and 7 T. The $E - I$ data can be parameterised using the power law with E_c fixed at $100 \mu V.m^{-1}$, and I_c and n as free parameters

The data can be described by:

$$E = E_c \left(\frac{I}{I_c} \right)^n$$

where E_c is the small (and arbitrary) electric field used to define the critical current (I_c). It is usually taken to be $100 \mu V.m^{-1}$. The index of transition, n , is a fitting parameter that characterises the 'sharpness of the transition' and I_c gives how much supercurrent the tape can carry at the electric field criterion.