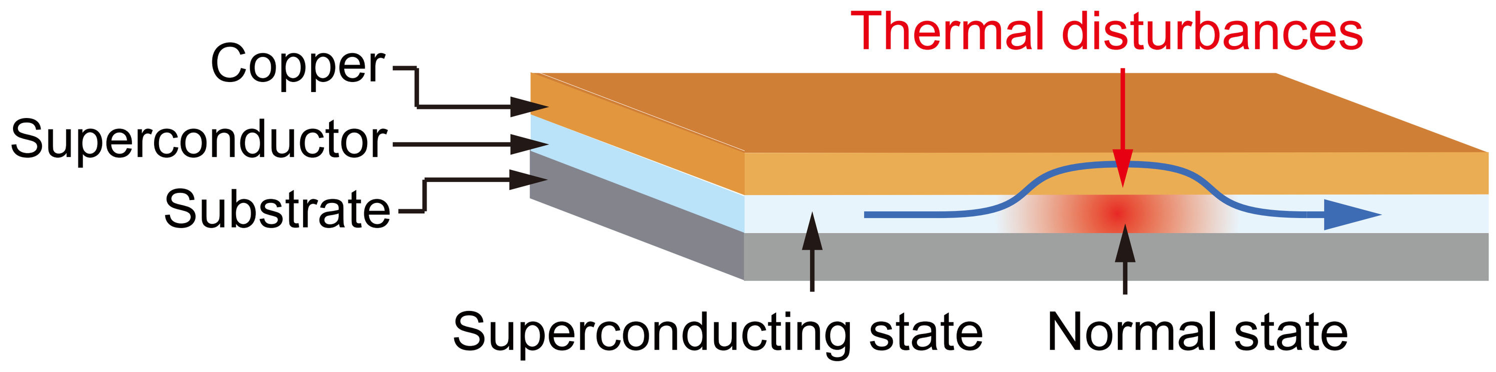
Quench Behaviors of Coated Conductors Subject to Transient and Localized Thermal Disturbances

Amemiya Group, Kyoto University

1. What is quench?



- **Quench**

  "The process which occurs when any part of a magnet goes from the superconducting to the normal resistive state.
  Because normal-state resistivities and current densities are both high, intense local heating will ensue, taking the quench point and surrounding region to temperatures far above critical."

- **Risk**

  "The local temperature rise may be sufficient to char the insulation or even melt the conductor."

  (M. N. Wilson, Superconducting Magnets)

2. Example of thermal disturbance

- **Beam loss**

  By some reasons, a particle beam deviates from its orbit and hits a magnet in an accelerator.

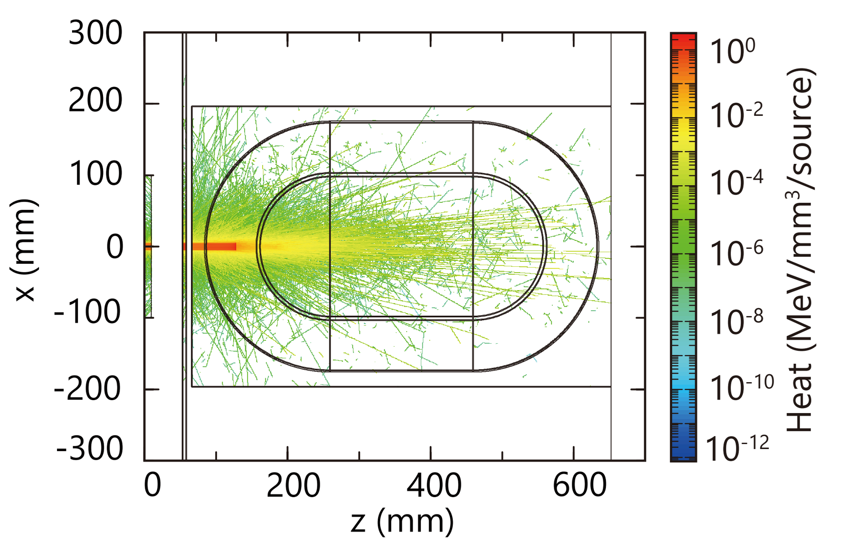
  Transient and localized thermal disturbances

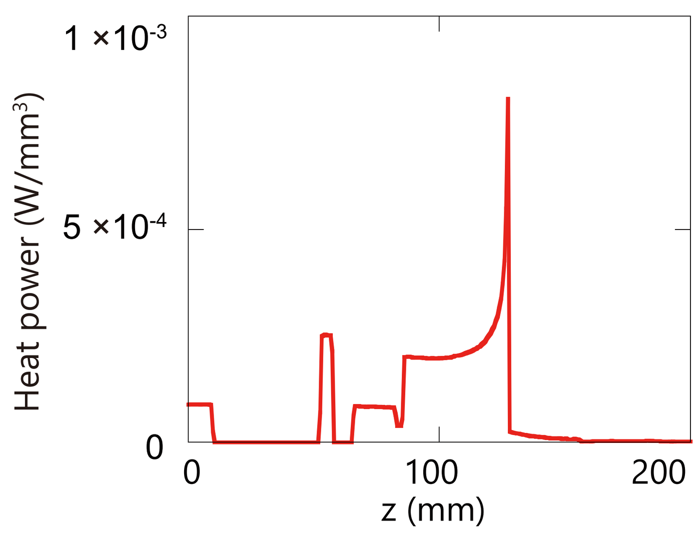
  ➡ **Risk of Quench**

- **Simulation by PHITS**

  "Particle and Heavy Ion Transport code System" code developed at JAEA

  - Source : C
  - Number : 2 × 10^9 pps
  - Energy : 430 MeV
  - Radius : 5 mm





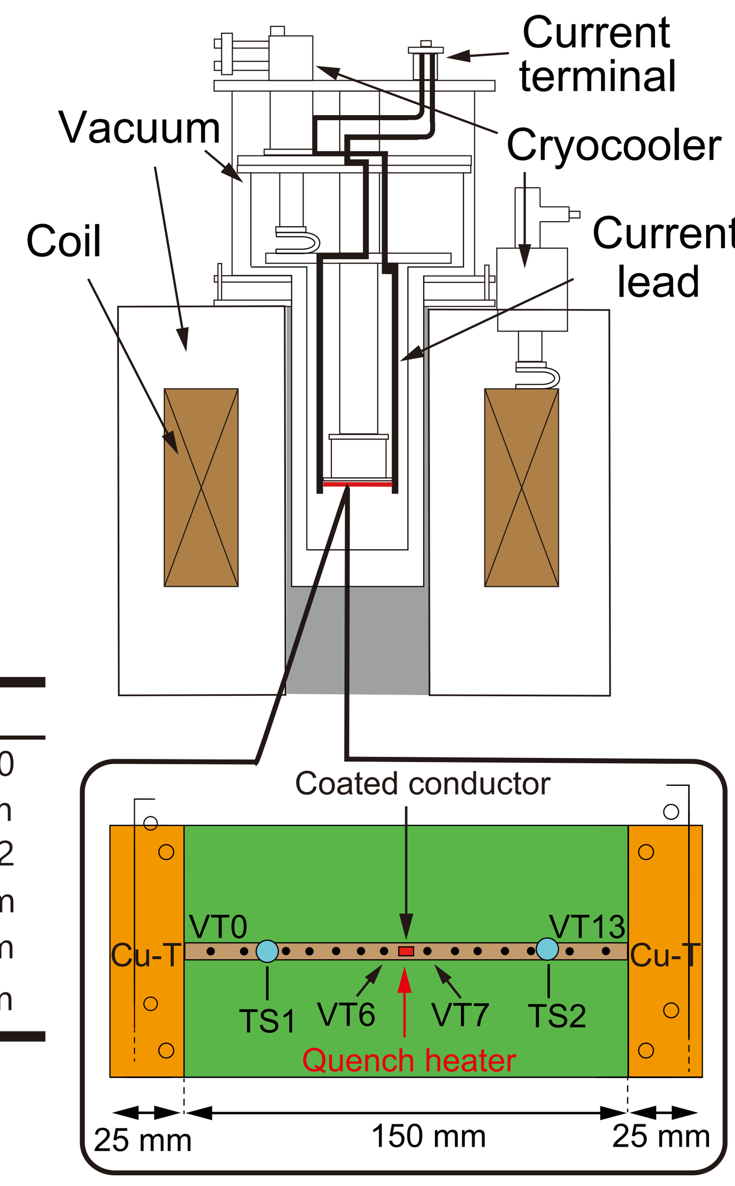
3. Quench experiment of short sample

- **Conditions**

  T = 15 - 50 K

  B = up to 5 T

  I = up to 500 A



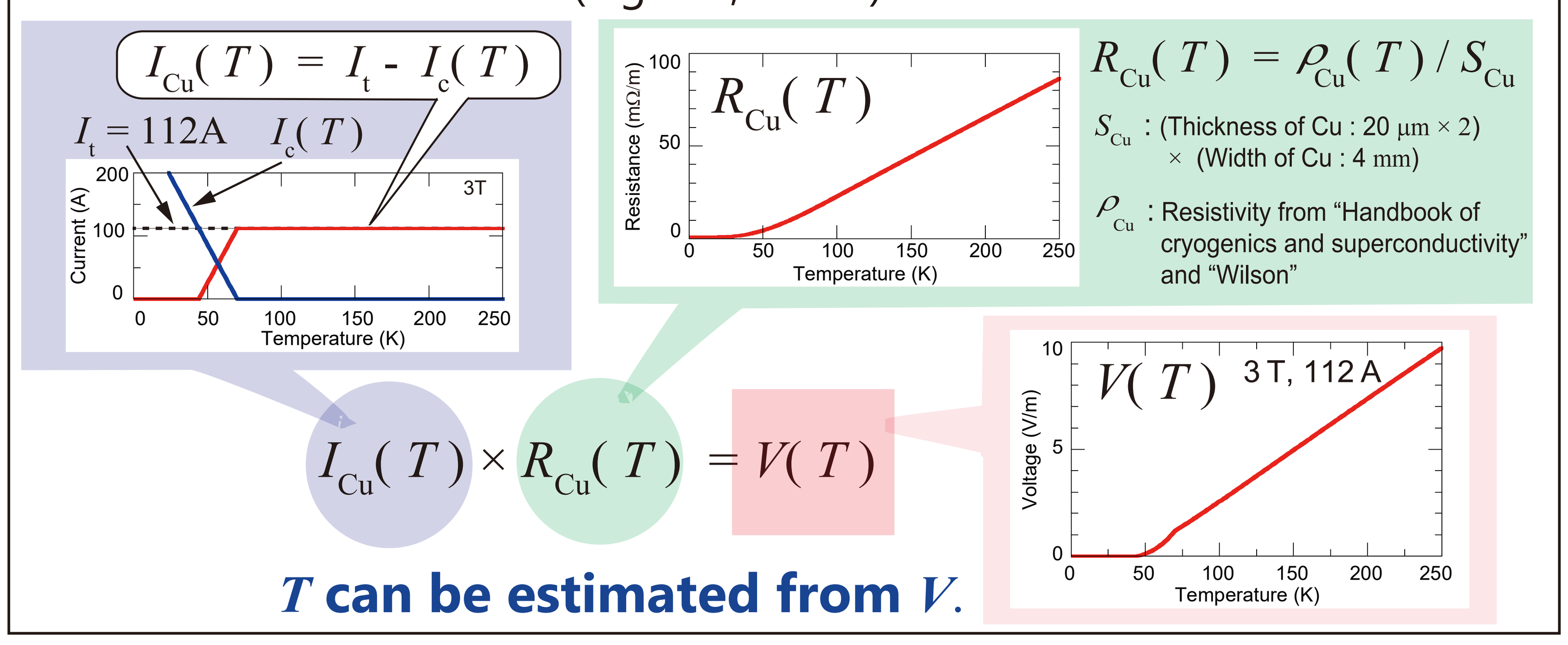
- **Sample Information**

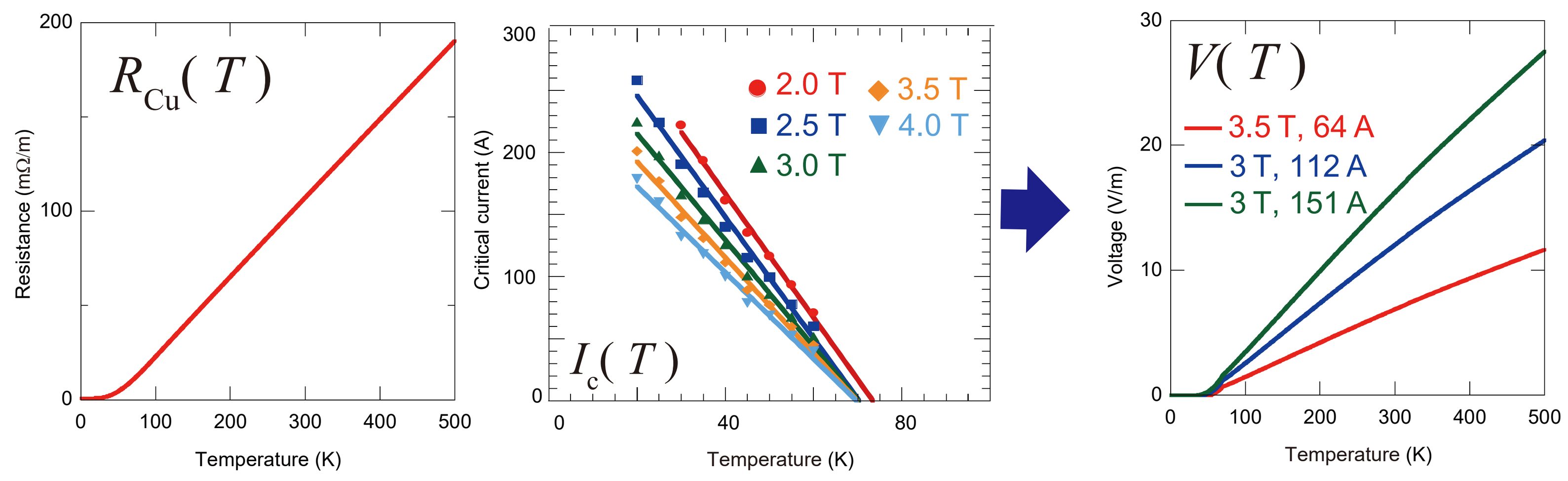
Specifications of sample	
Type	SCS4050
Width of sample	4 mm
Thickness of Cu	20 µm × 2
Thickness of HTS	~1 µm
Thickness of Ag	~3.8 µm
Thickness of substrate	50 µm

VT : voltage tap
TS : temperature sensor
Cu-T : copper terminal

4. Hot-spot temperature estimation

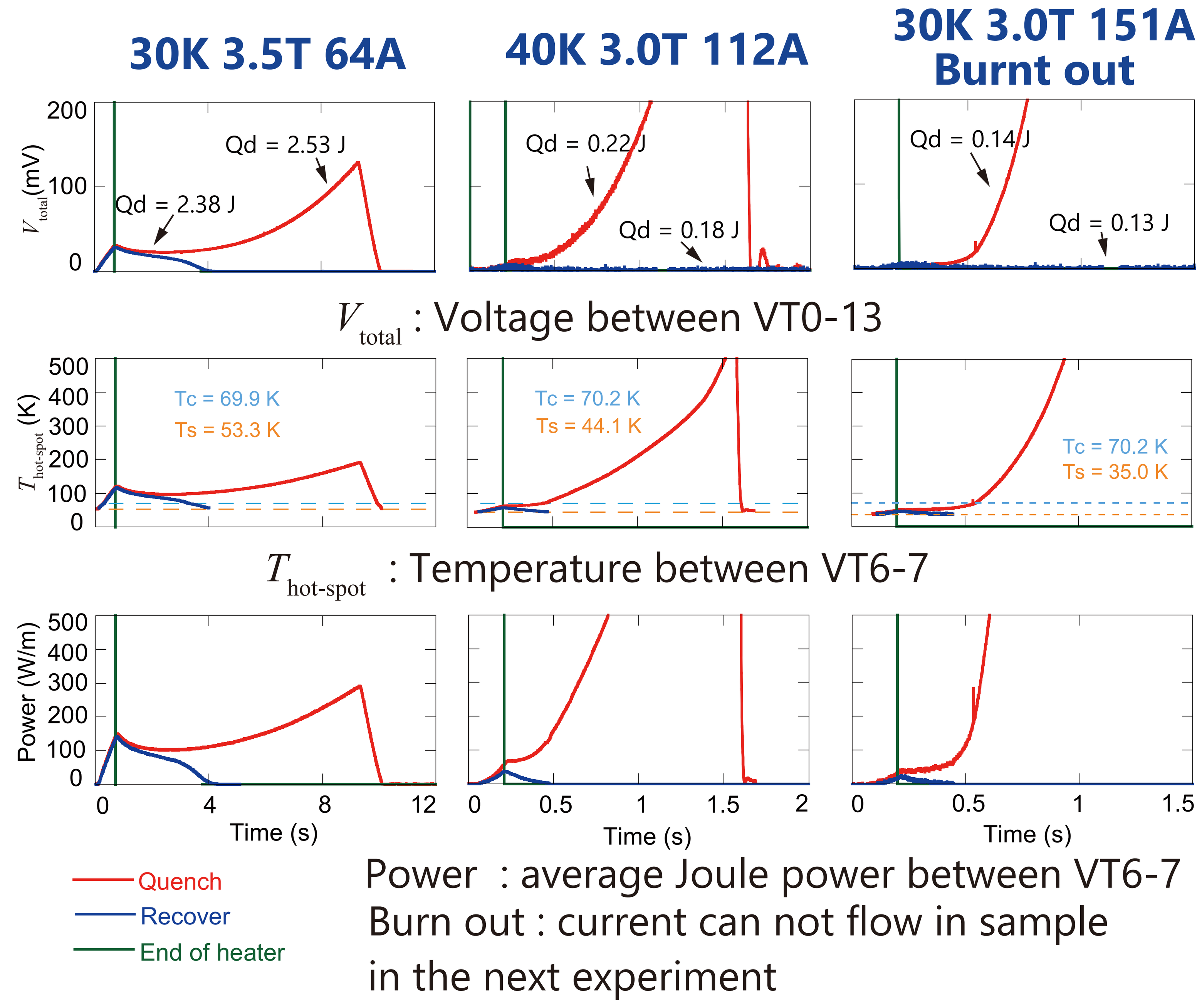
How to derive V-T relation (e.g. 3 T, 112 A)





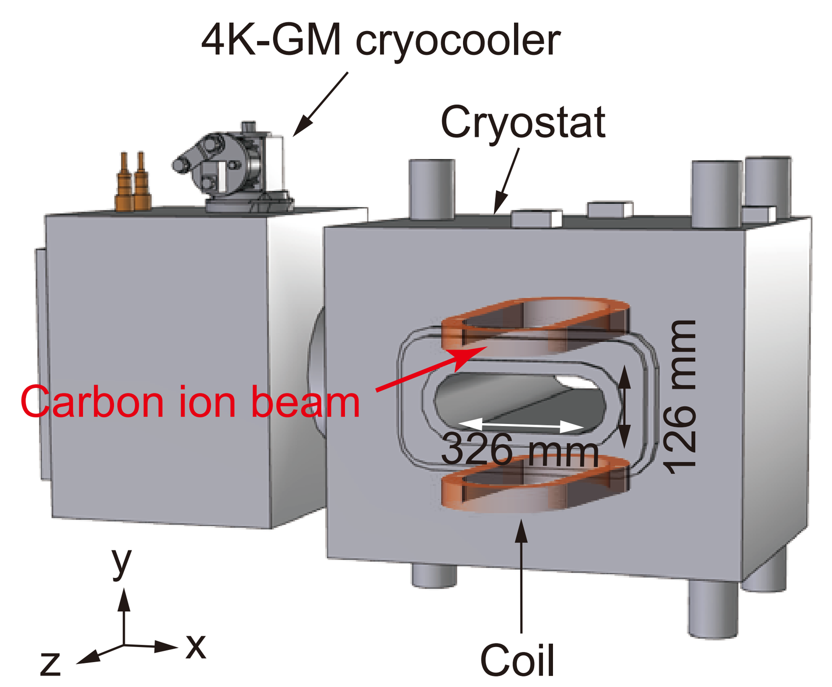
With calculated V-T relation, we can estimate $T_{hot\text{-}spot}$ from $V_{hot\text{-}spot}$ in section 5.

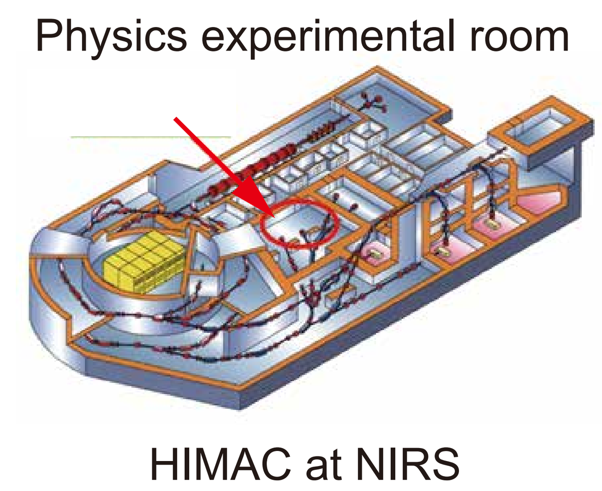
5. Voltage, temperature, Joule heating



Power : average Joule power between VT6-7
Burn out : current can not flow in sample in the next experiment

6. Beam injection test at HIMAC





Particle	C^{6+}
Beam energy	430 MeV/u
Magnetic rigidity	6.62 Tm
Orbit radius @ 2.5 T	2.7 m