Investigation and Implementation of an Active Stabilisation Scheme for Superconducting Transition Edge Sensors

Philipp Bauer

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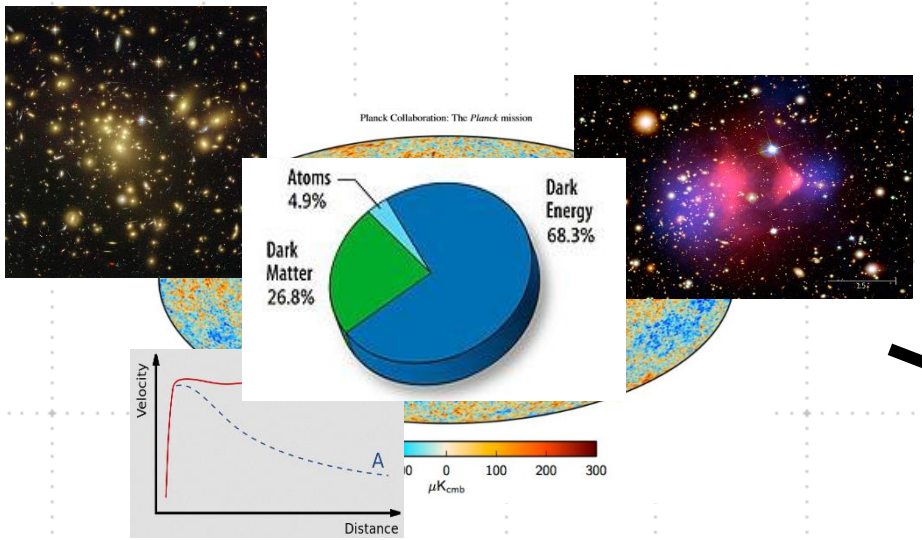
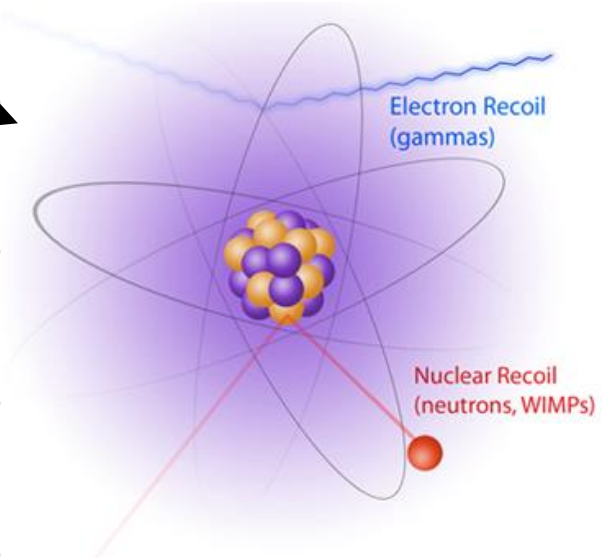
Direct Dark Matter Search





CRESST – Cryogenic Rare Event Search with **Superconducting Thermometers**

Thermometer based readout of deposited energies

Small deposited energies ~ 10keV and rates ~0.01 /kg /day

CRESST

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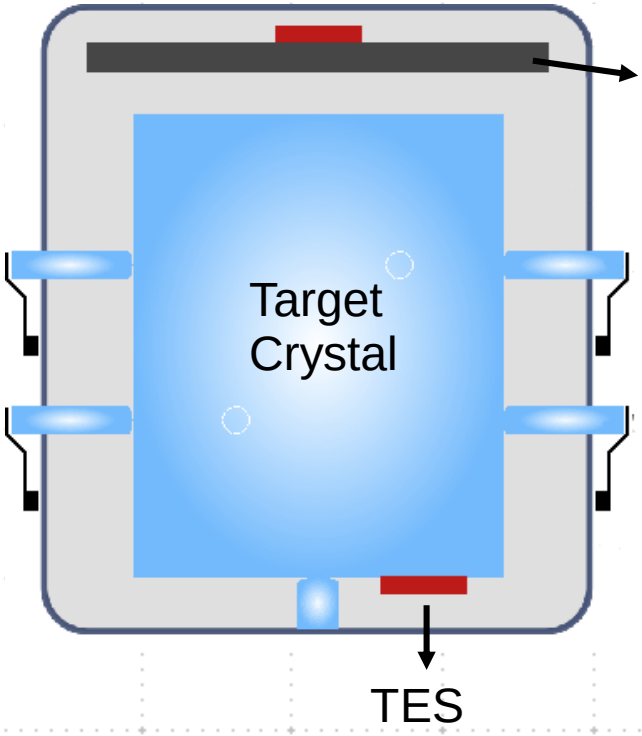

CRESST

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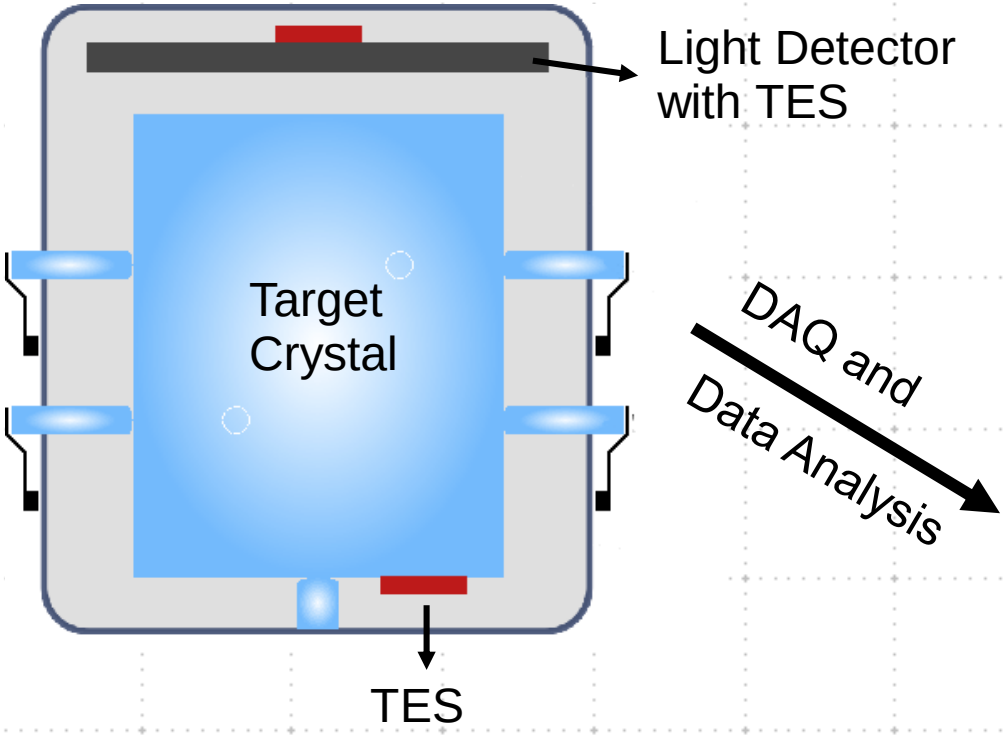

CRESST

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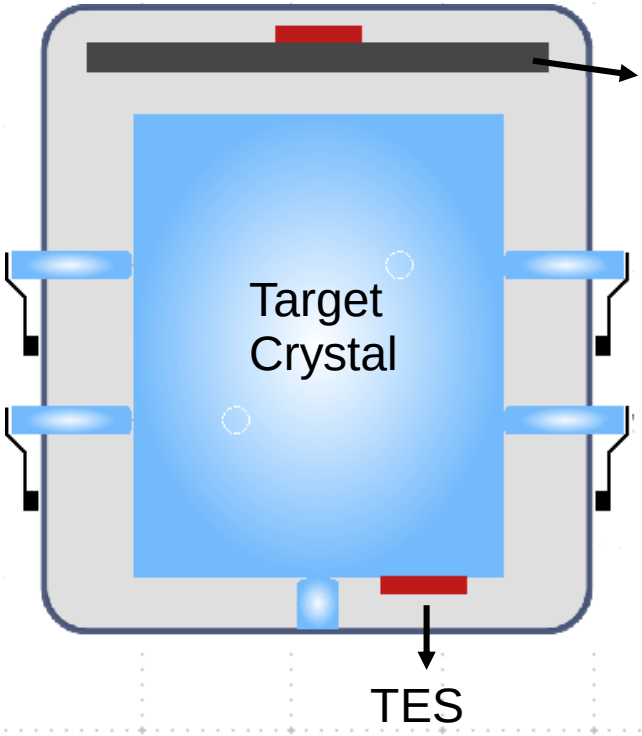
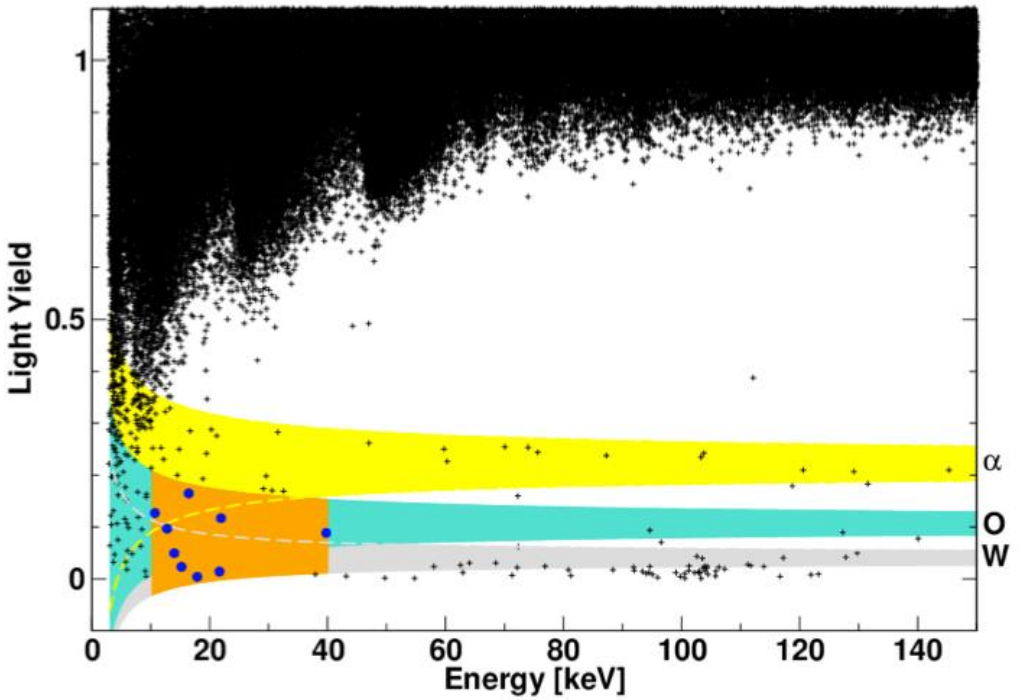


DAQ and Data Analysis



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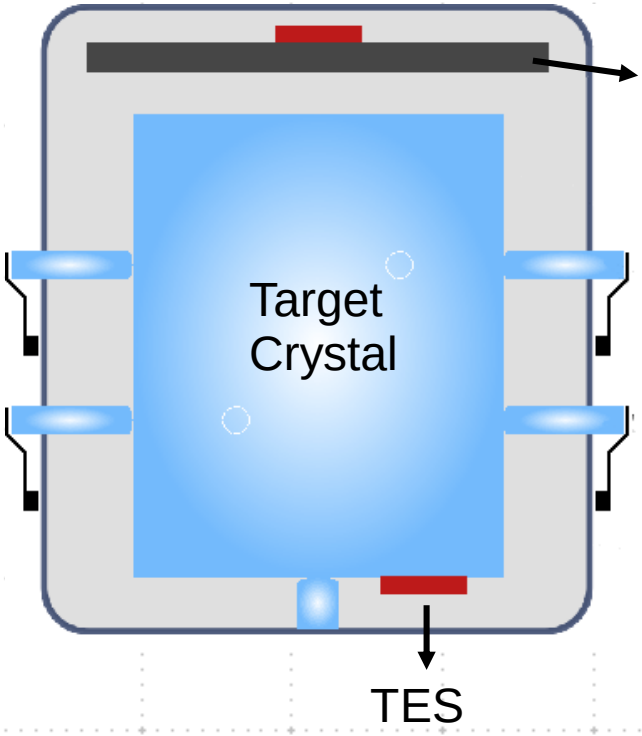

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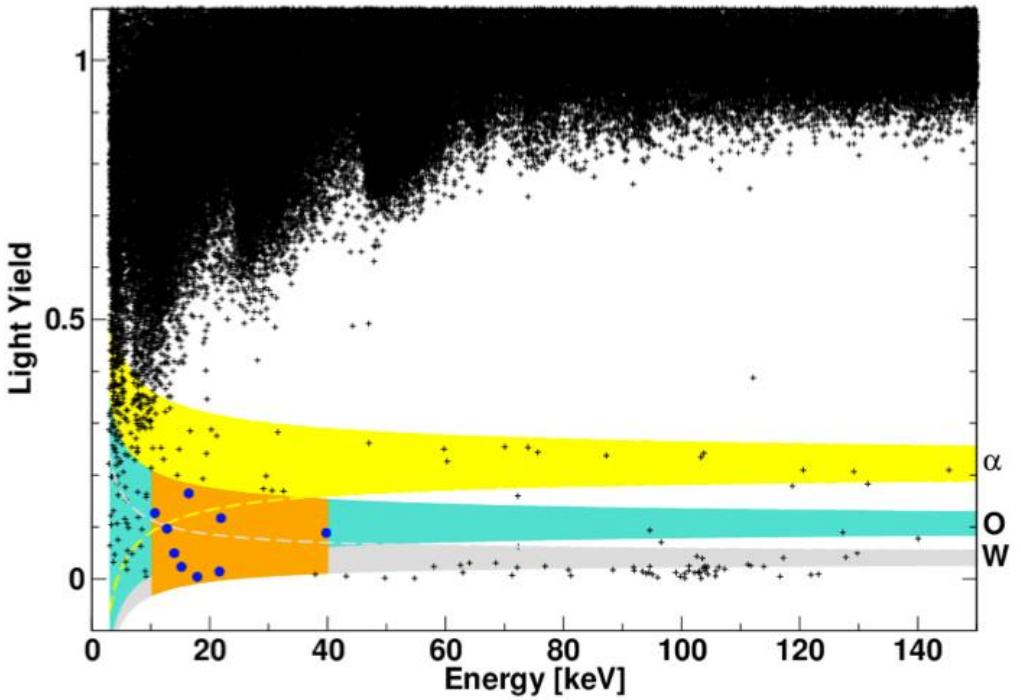

Energy resolution is very important!

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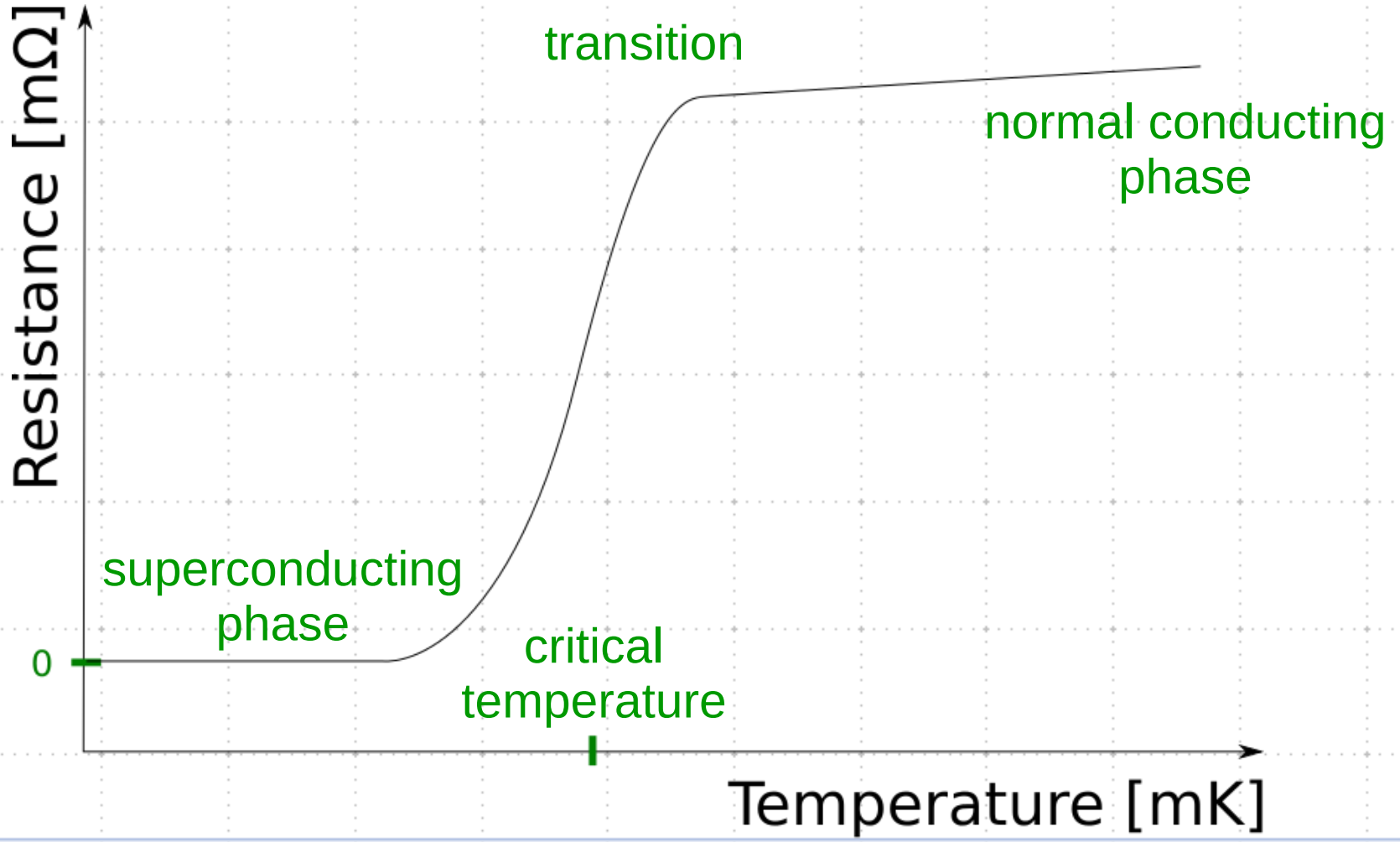
Transition Edge Sensors

Working Principle



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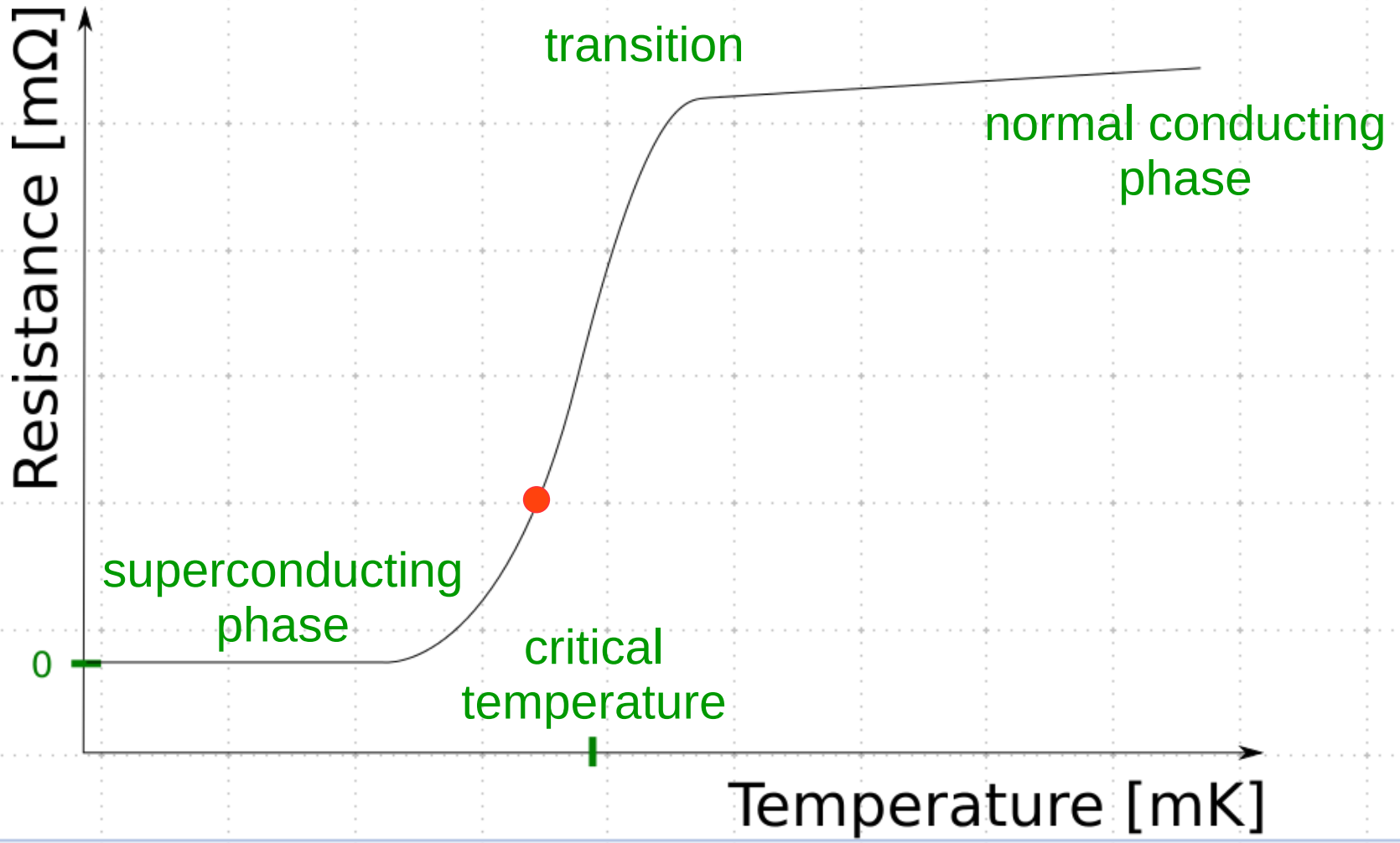

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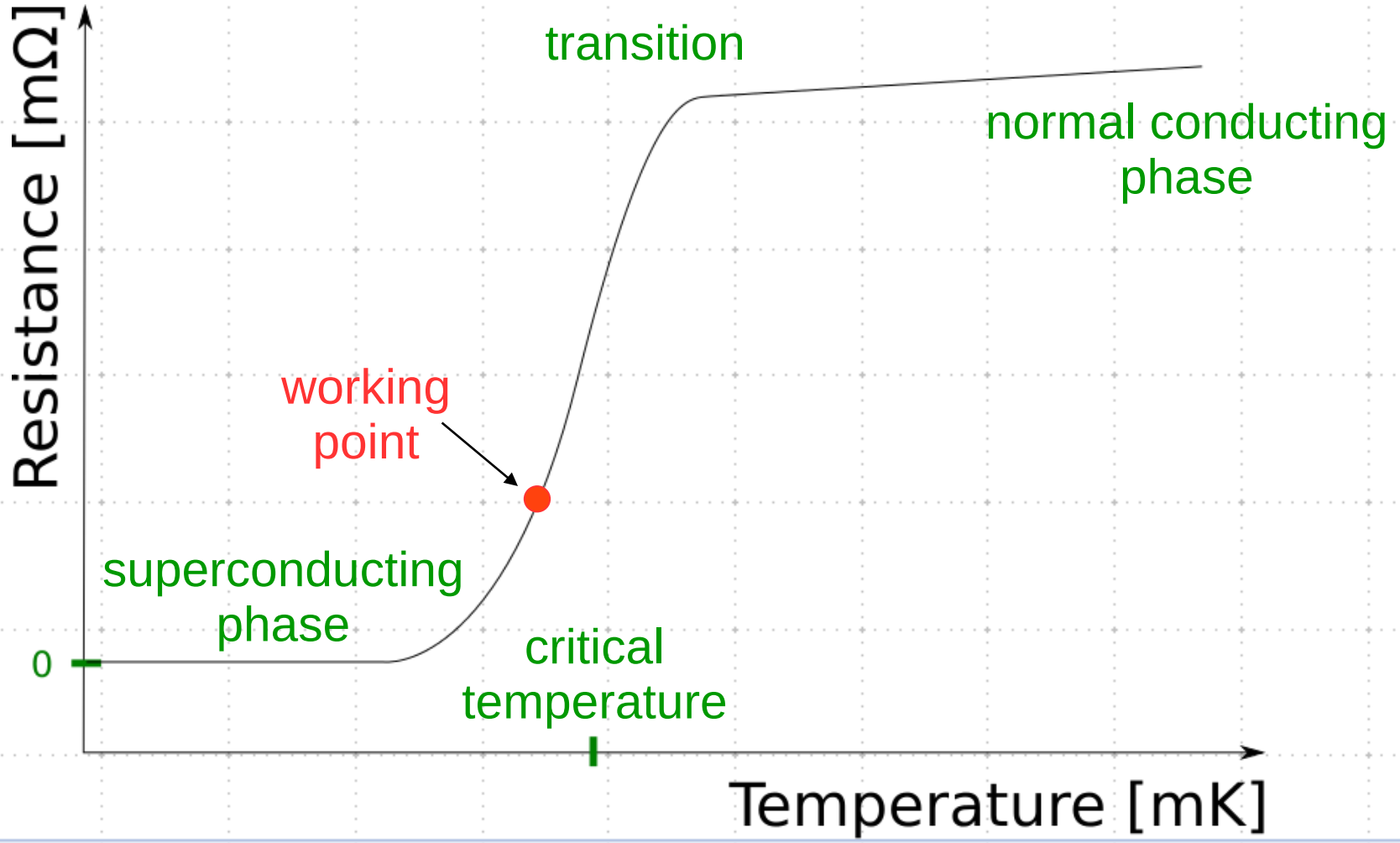

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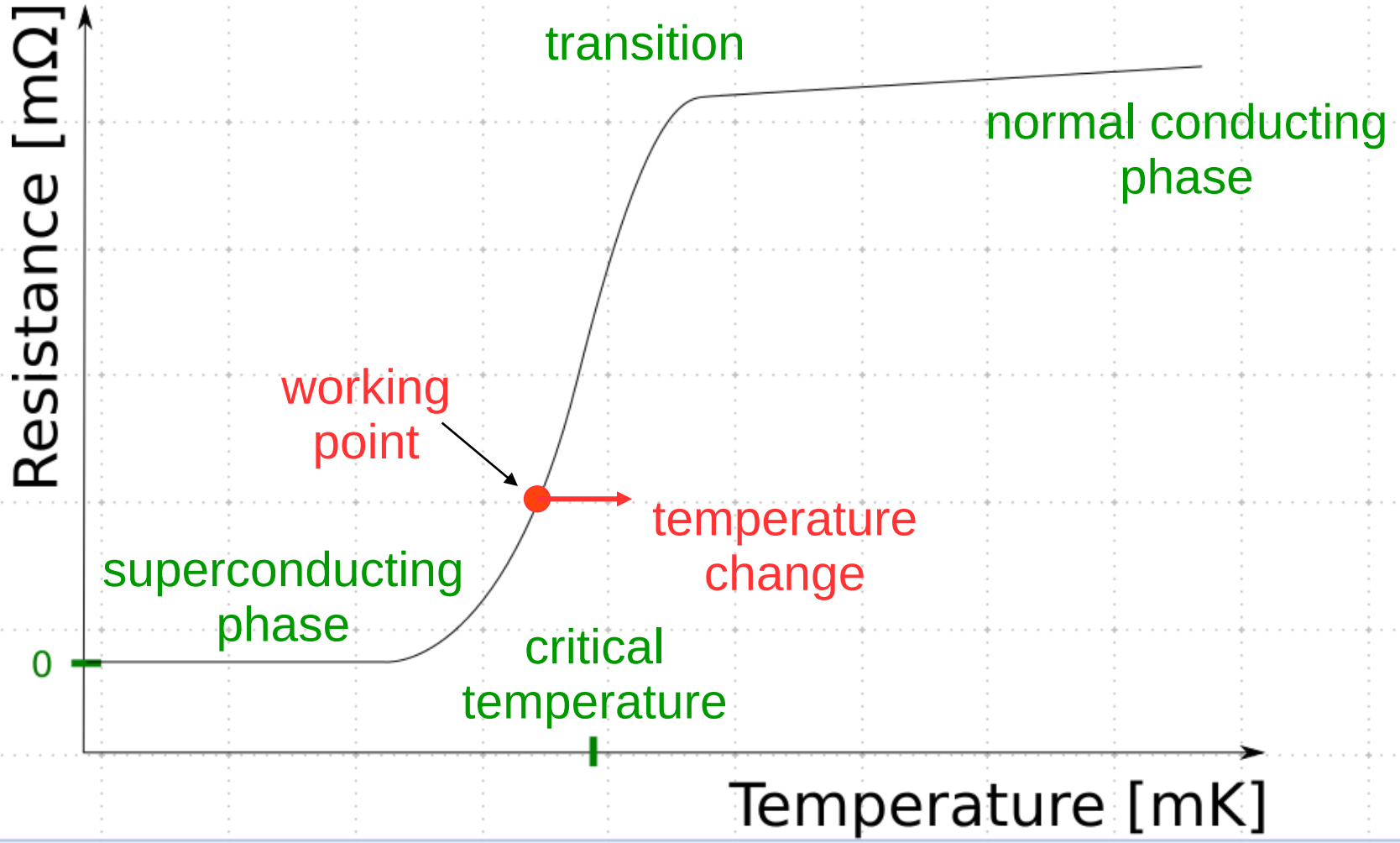

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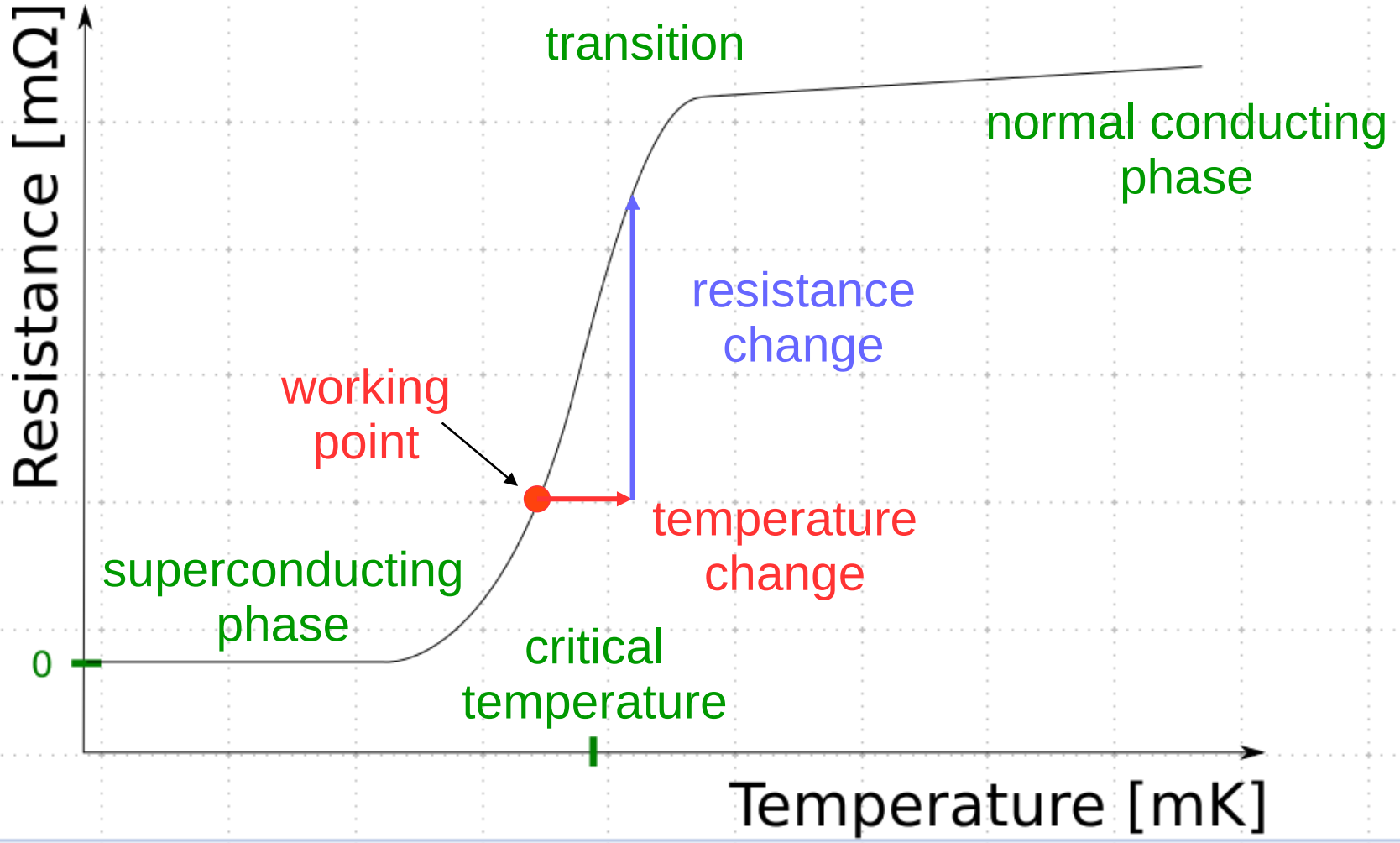

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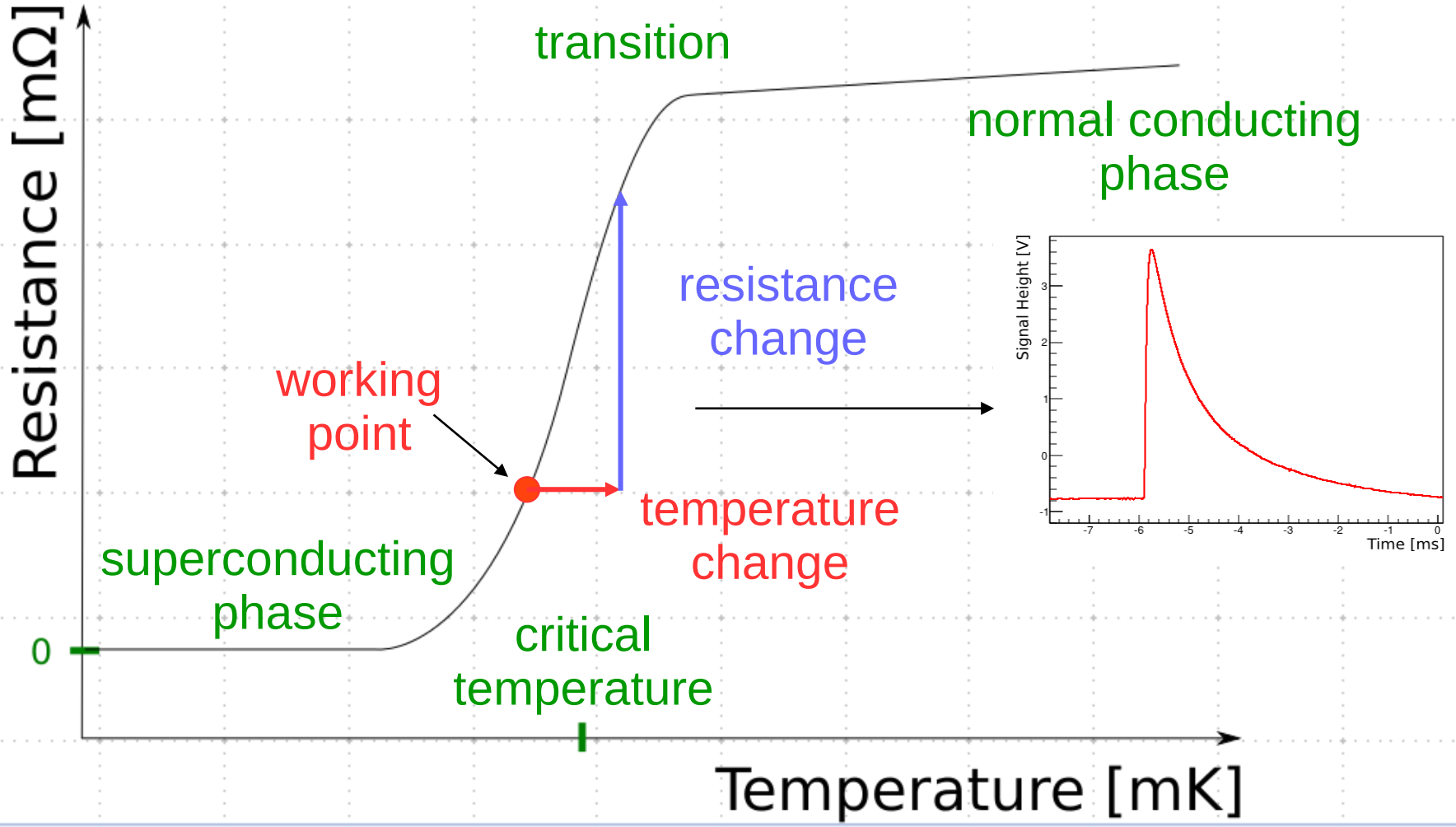

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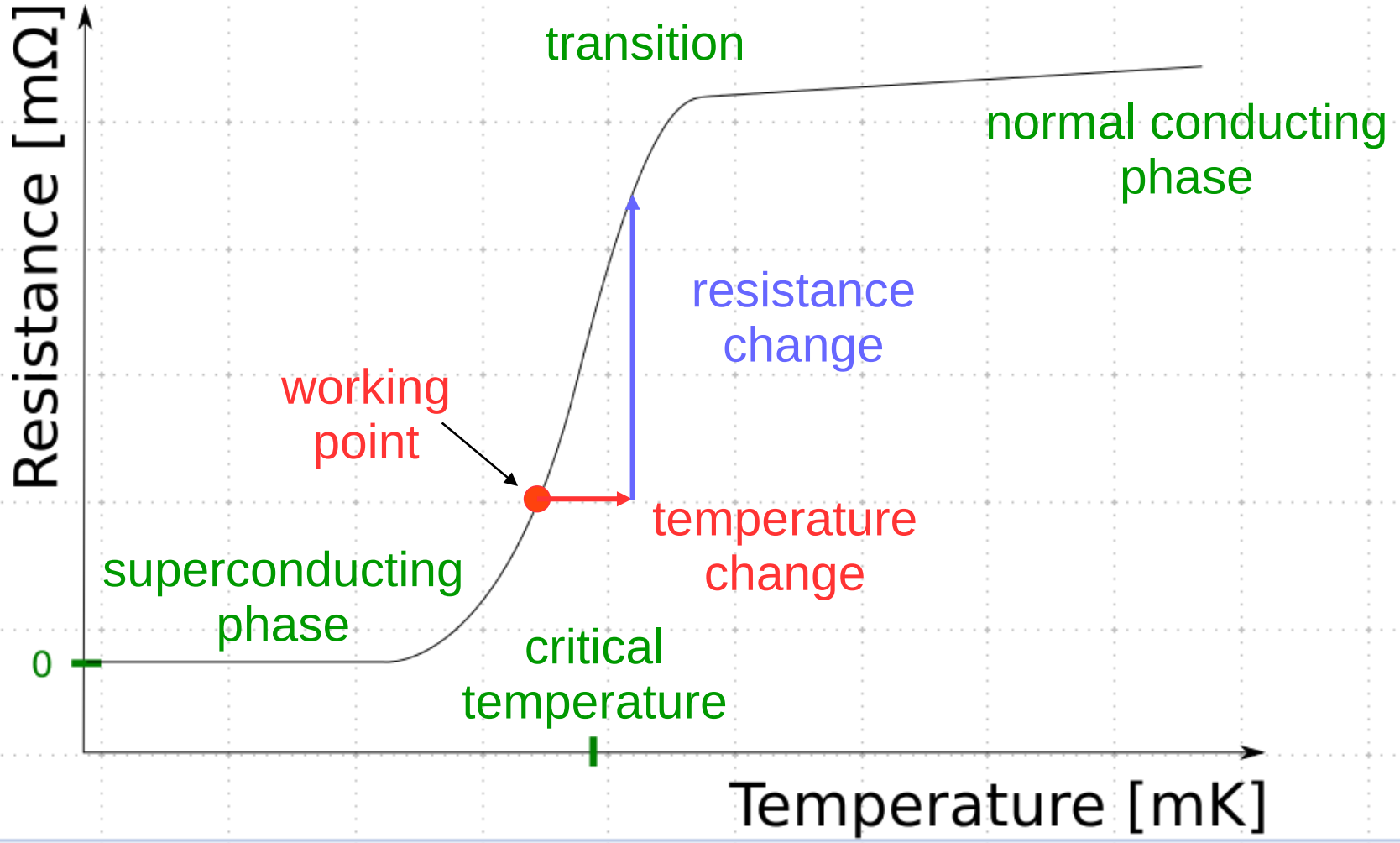

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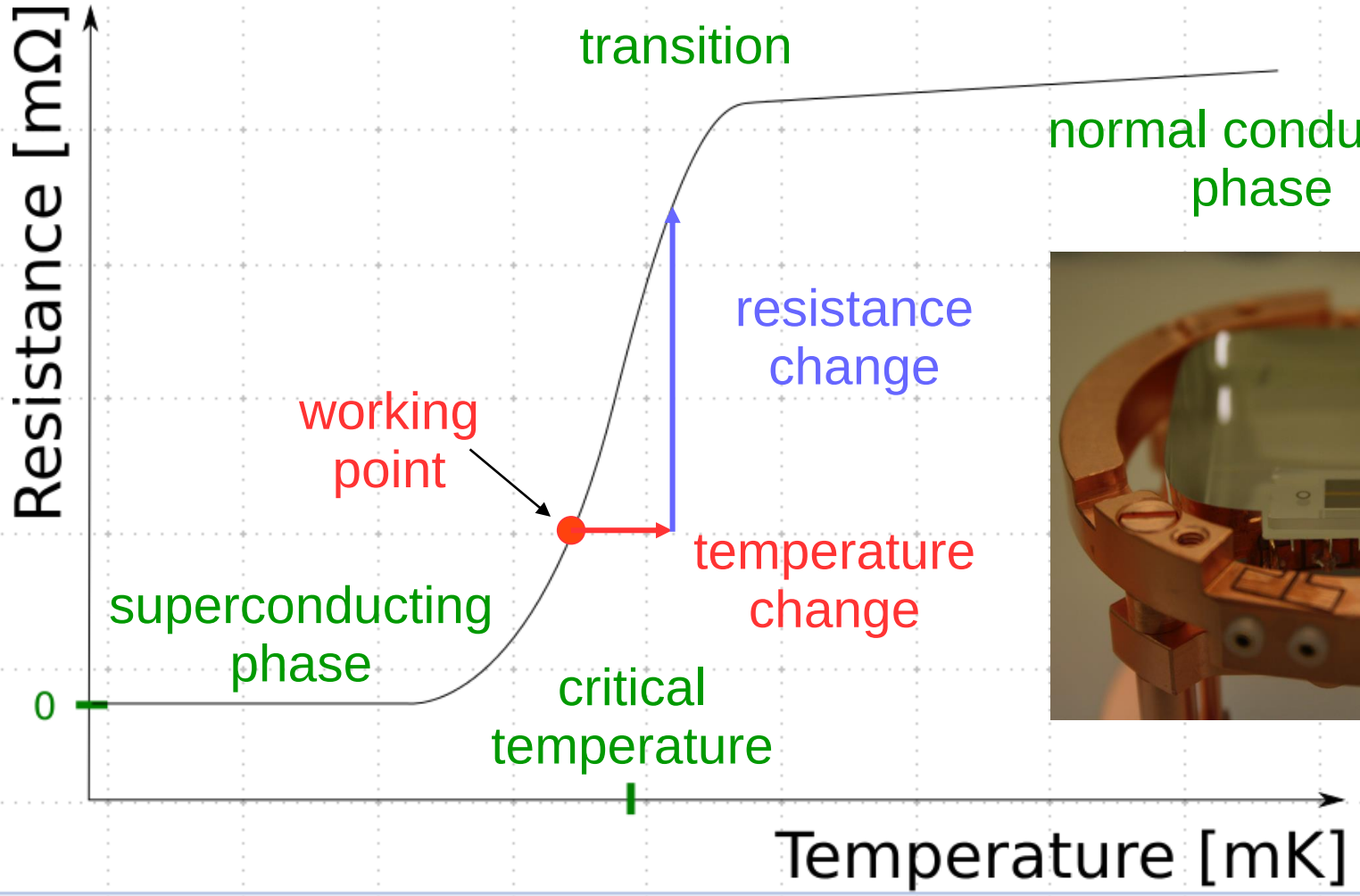

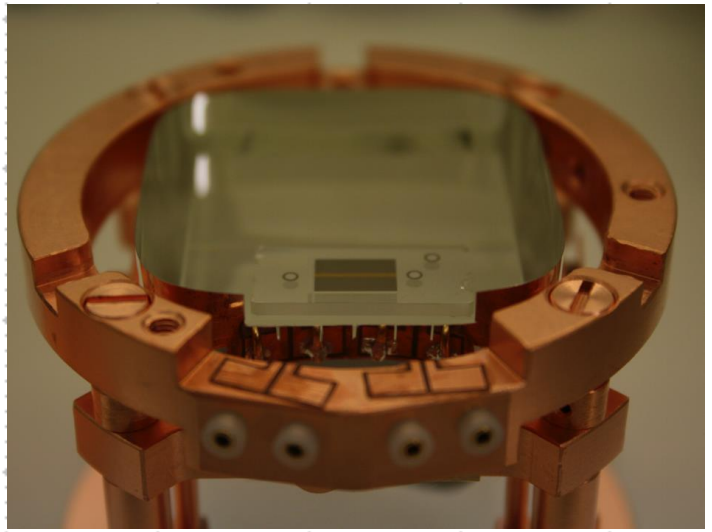

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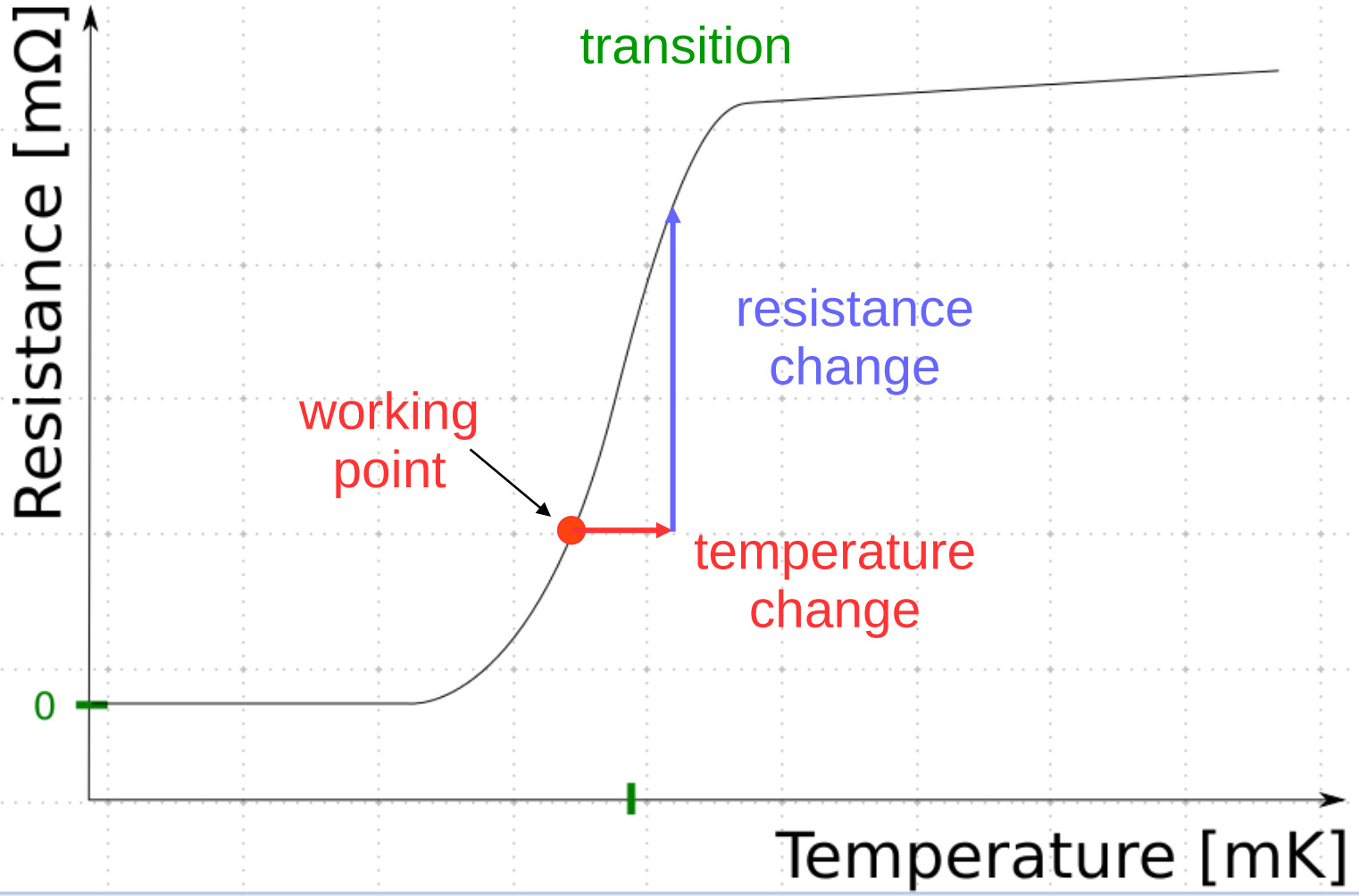
Control Pulse Stabilisation



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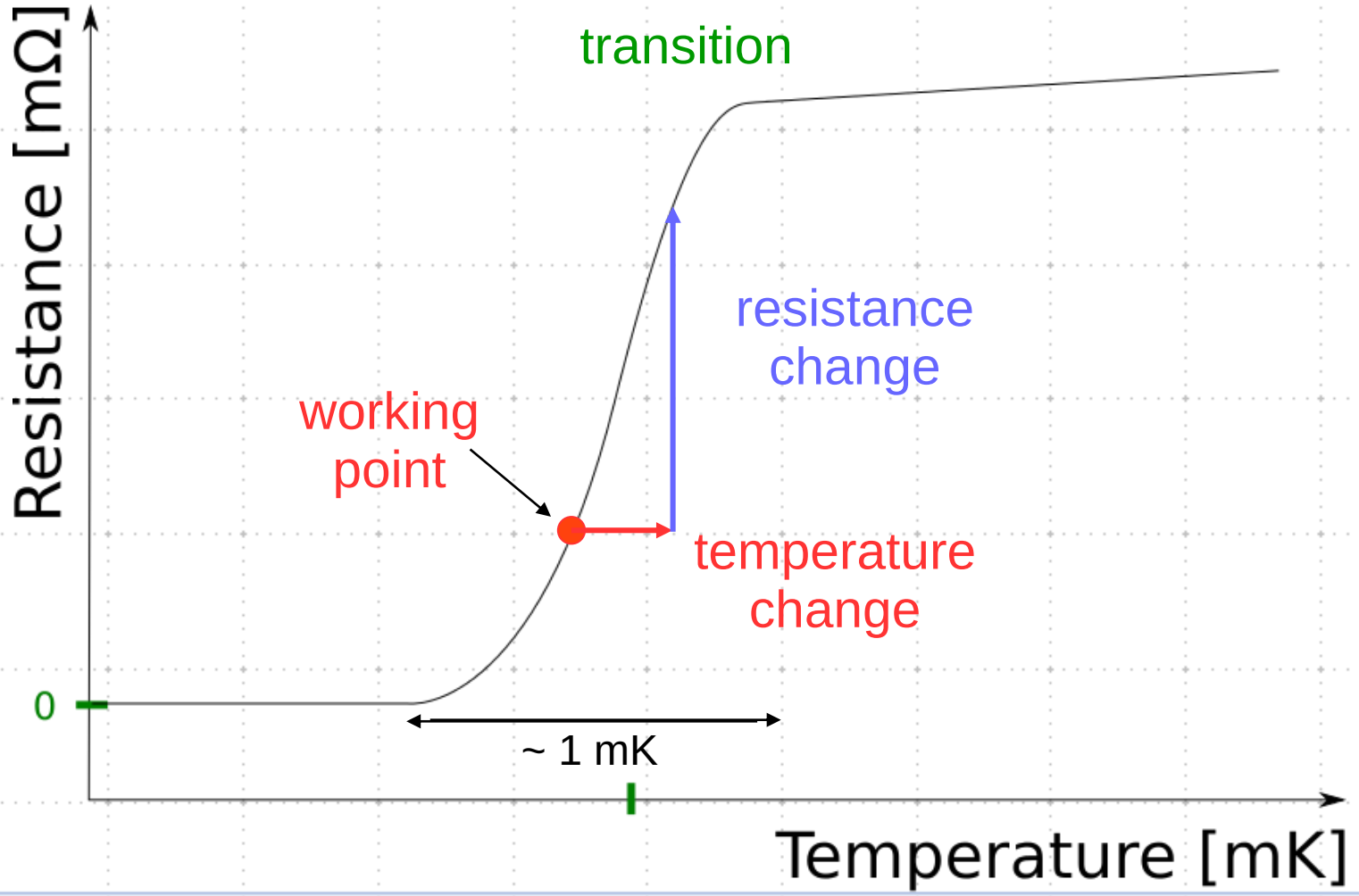

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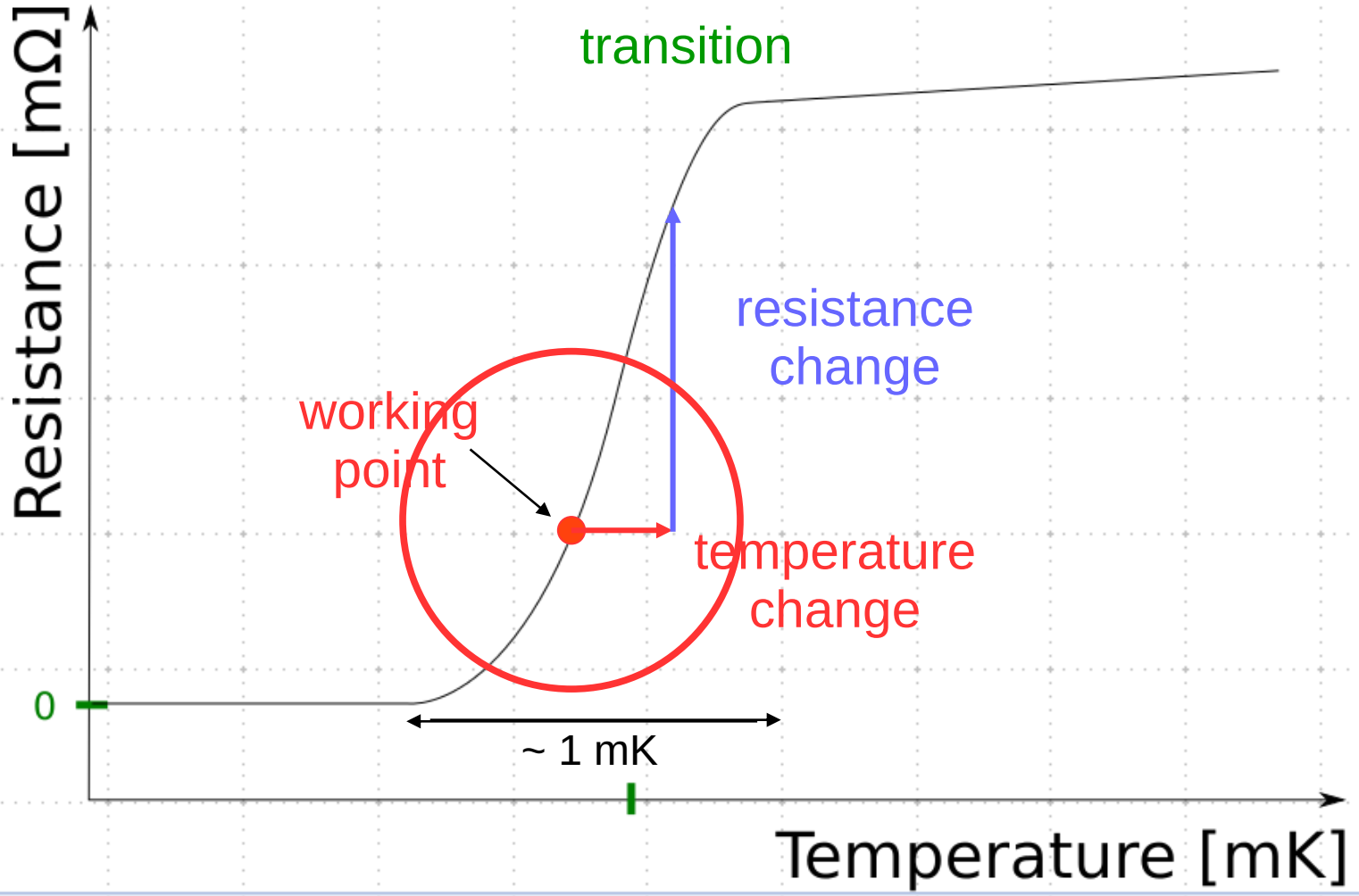

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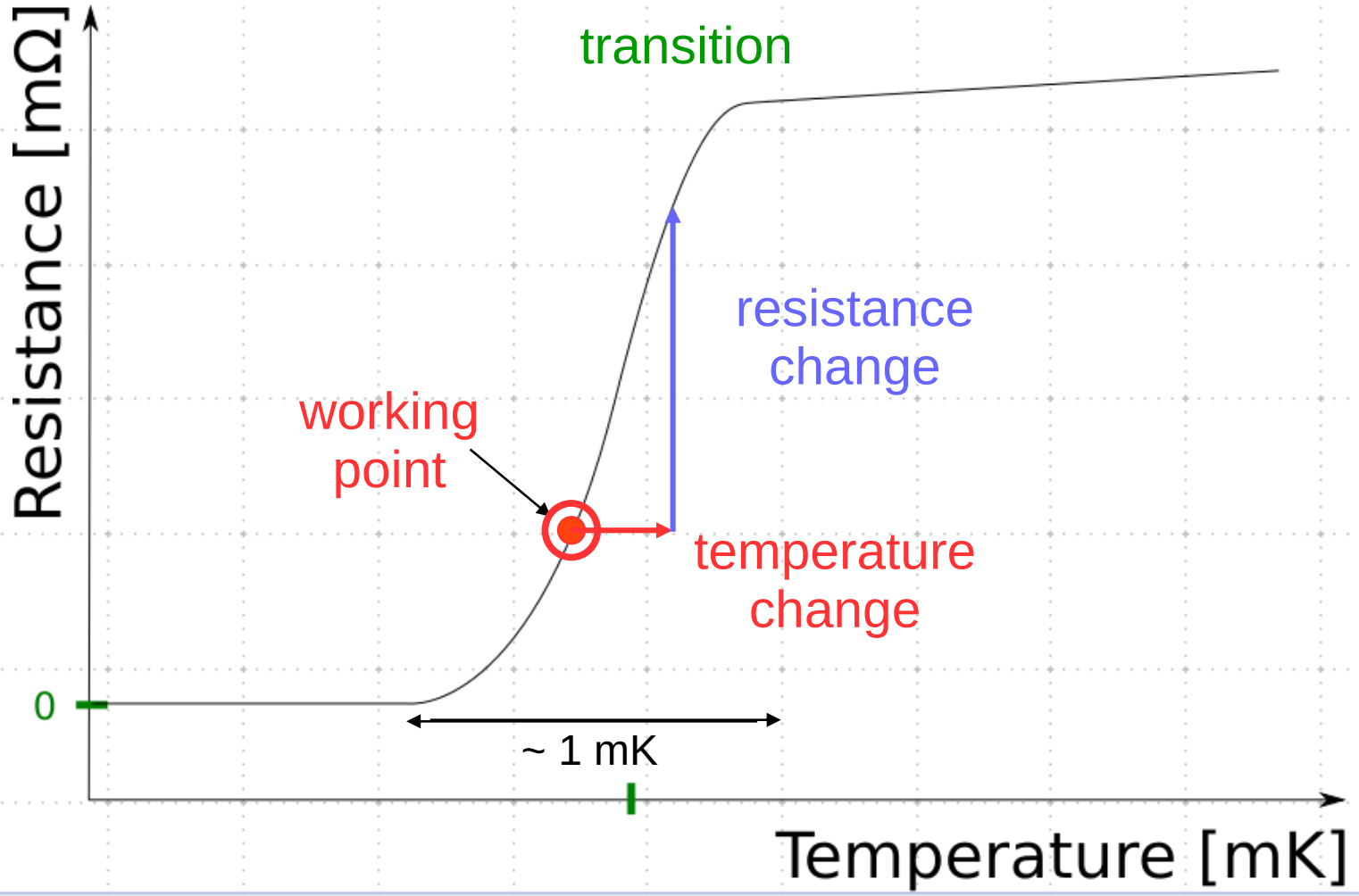

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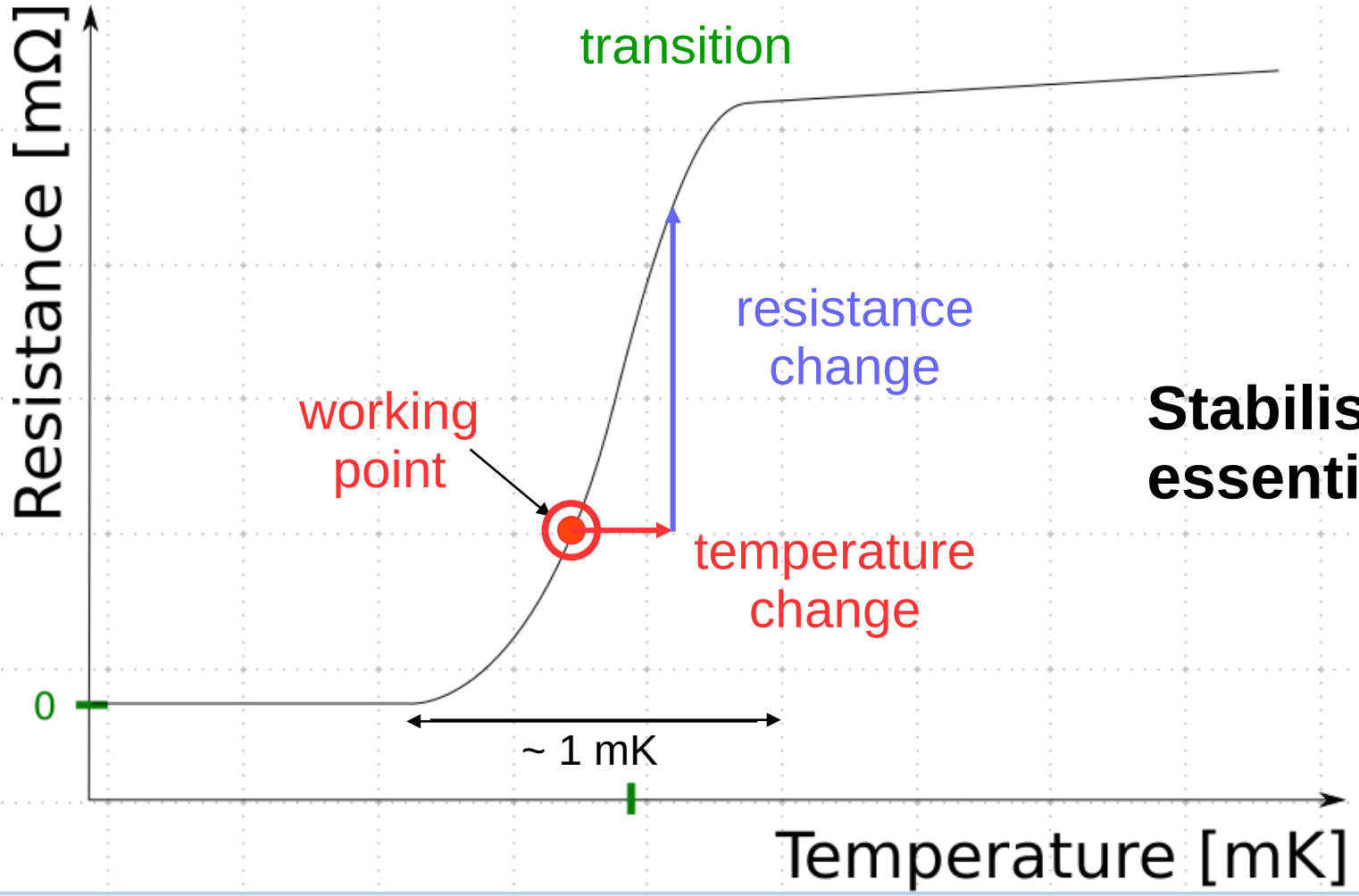

Stabilisation essential!

Control Pulse Stabilisation

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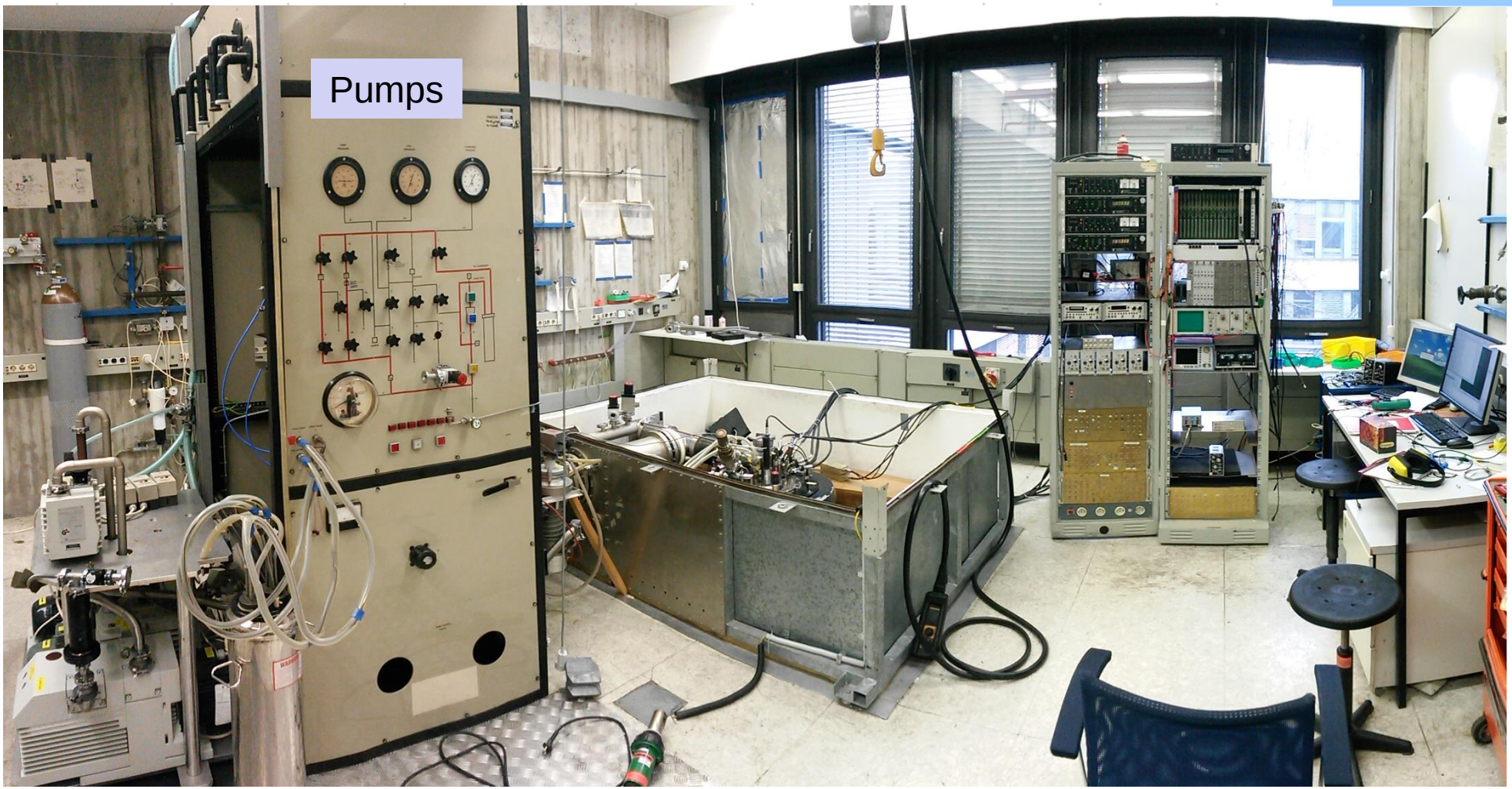

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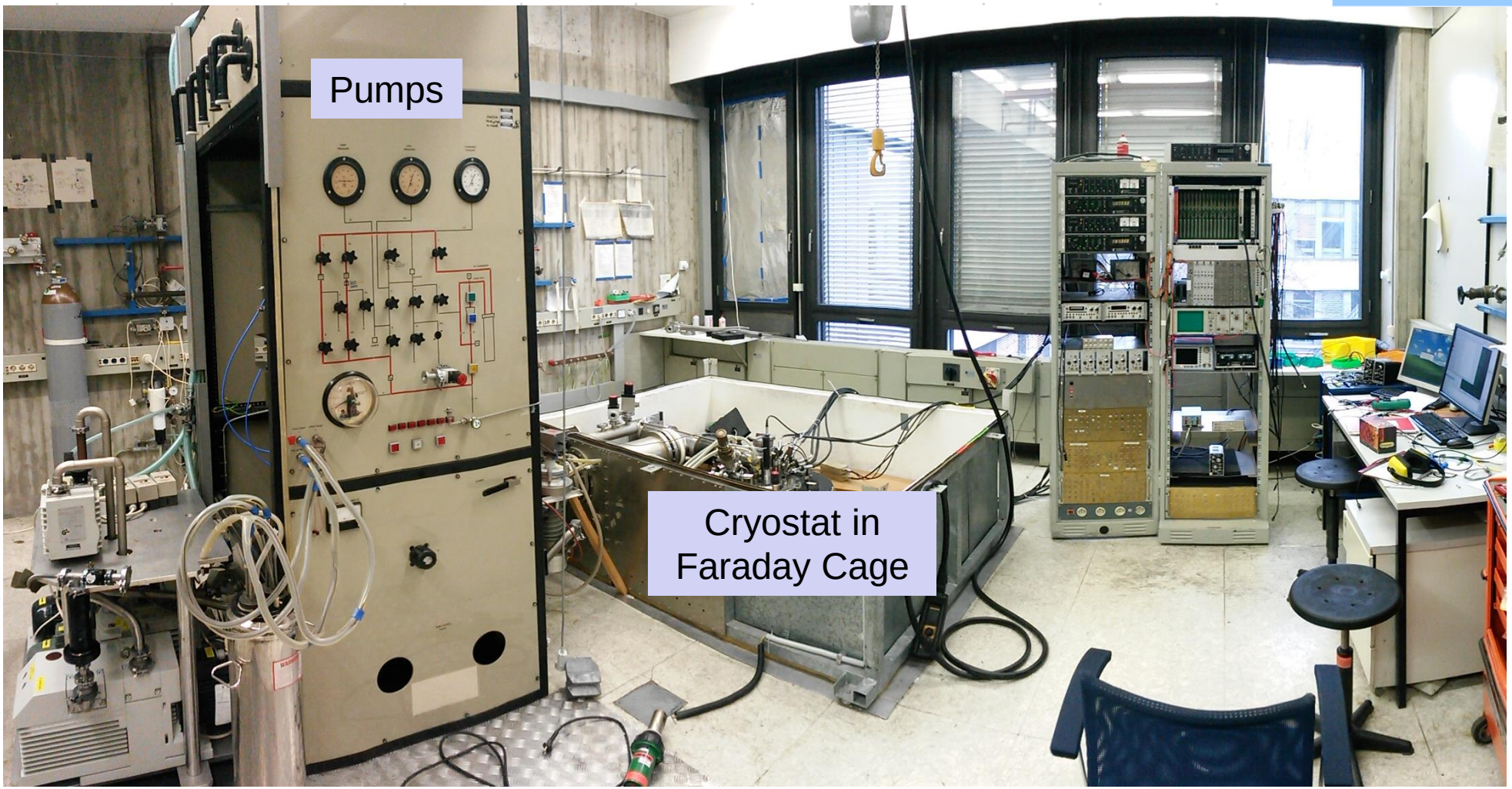

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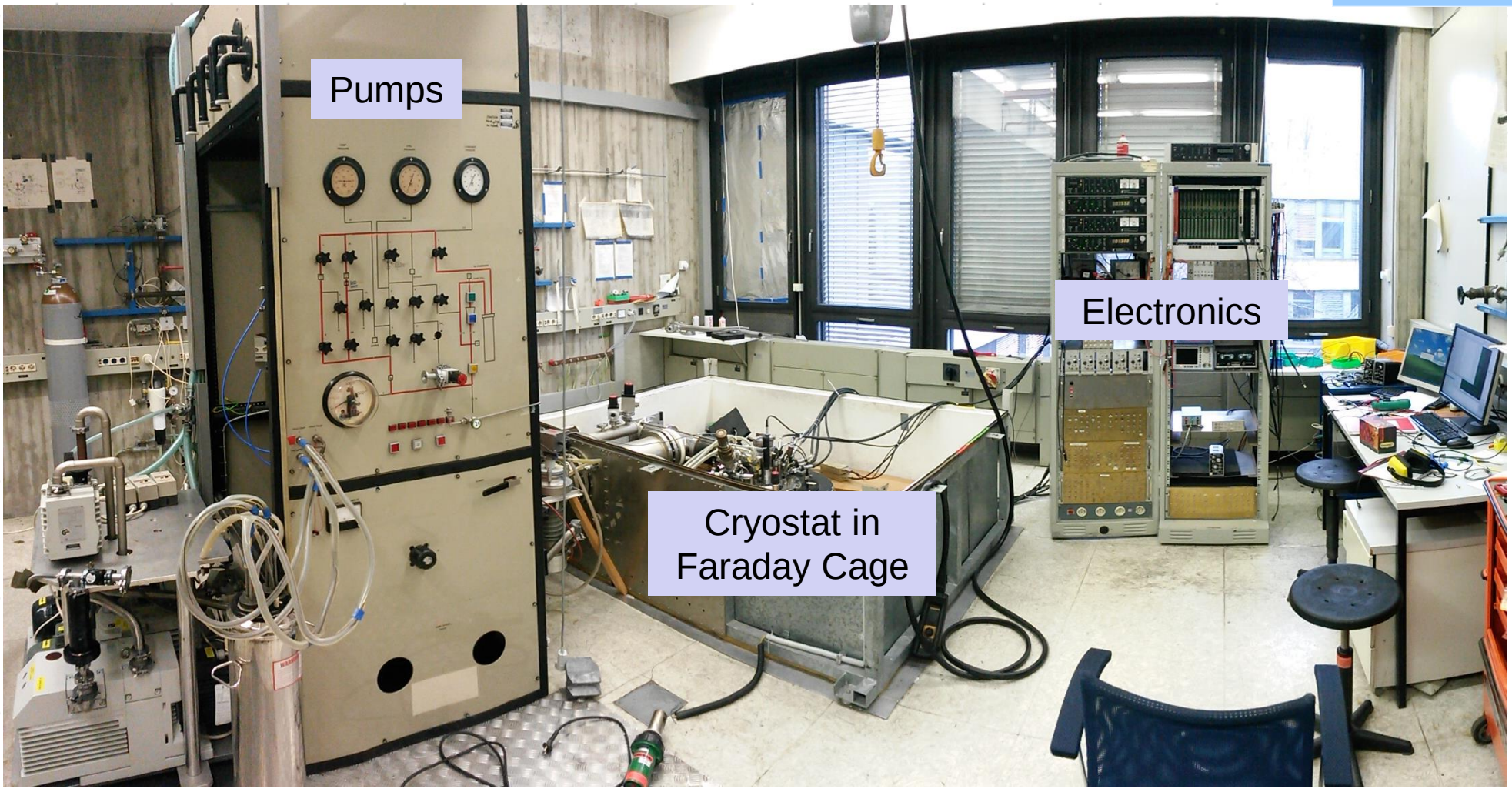

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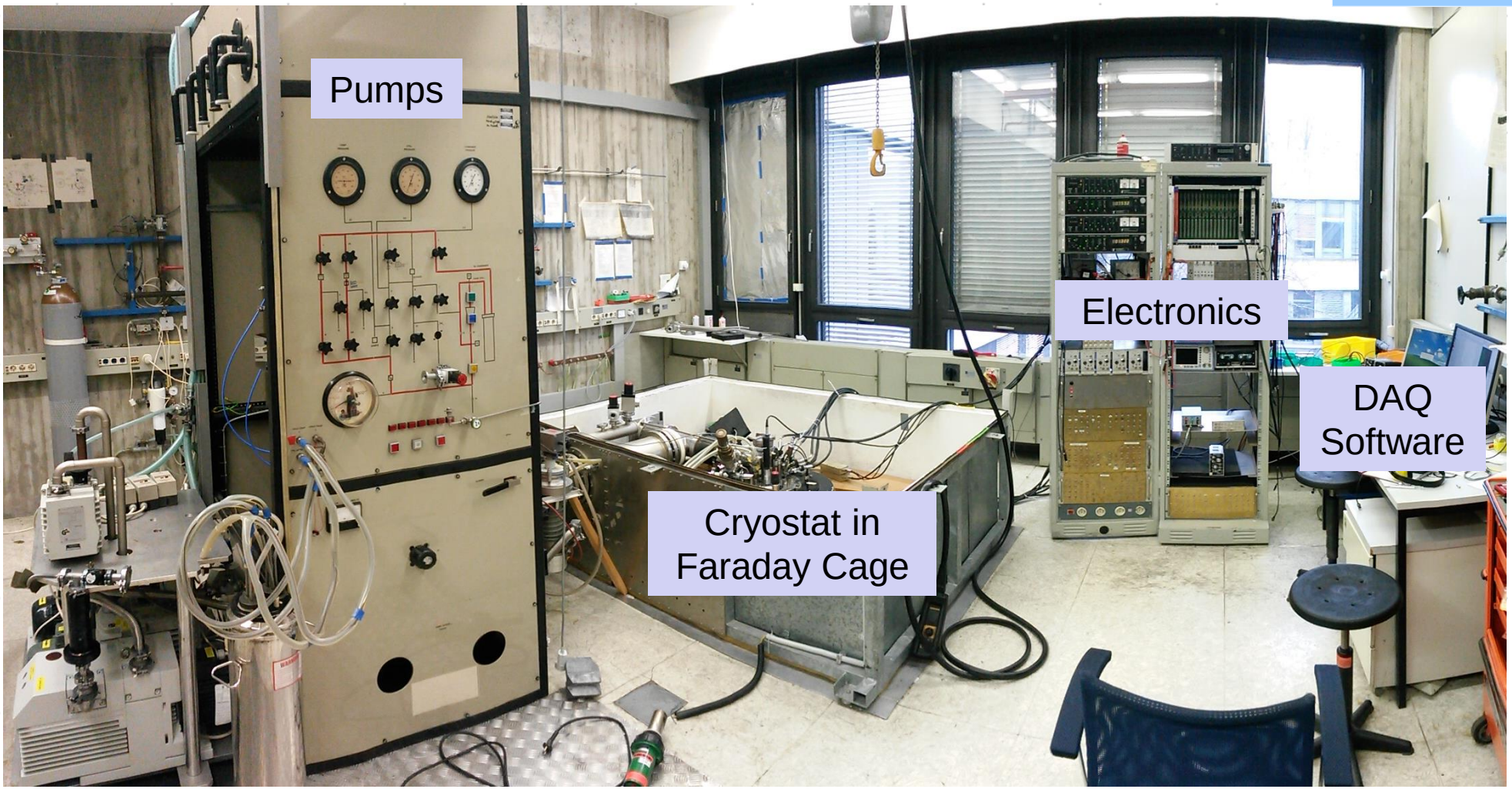

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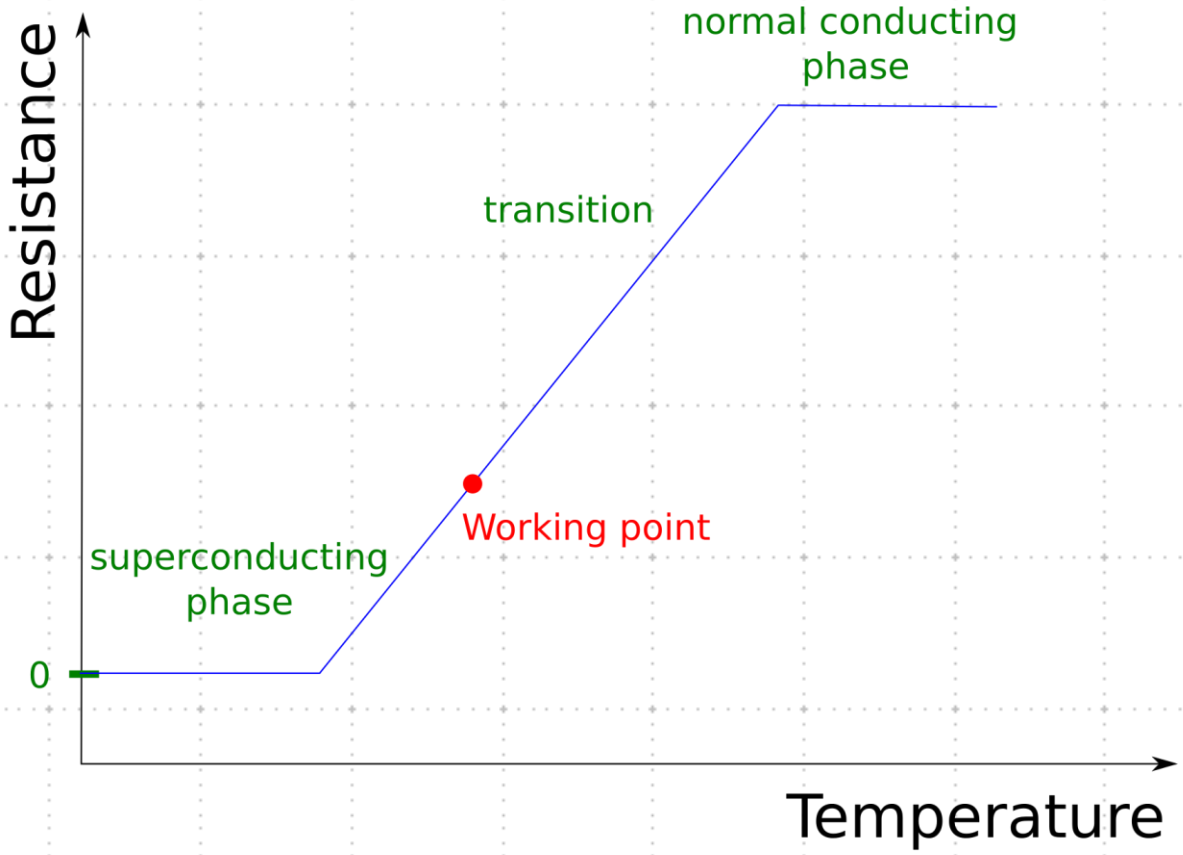

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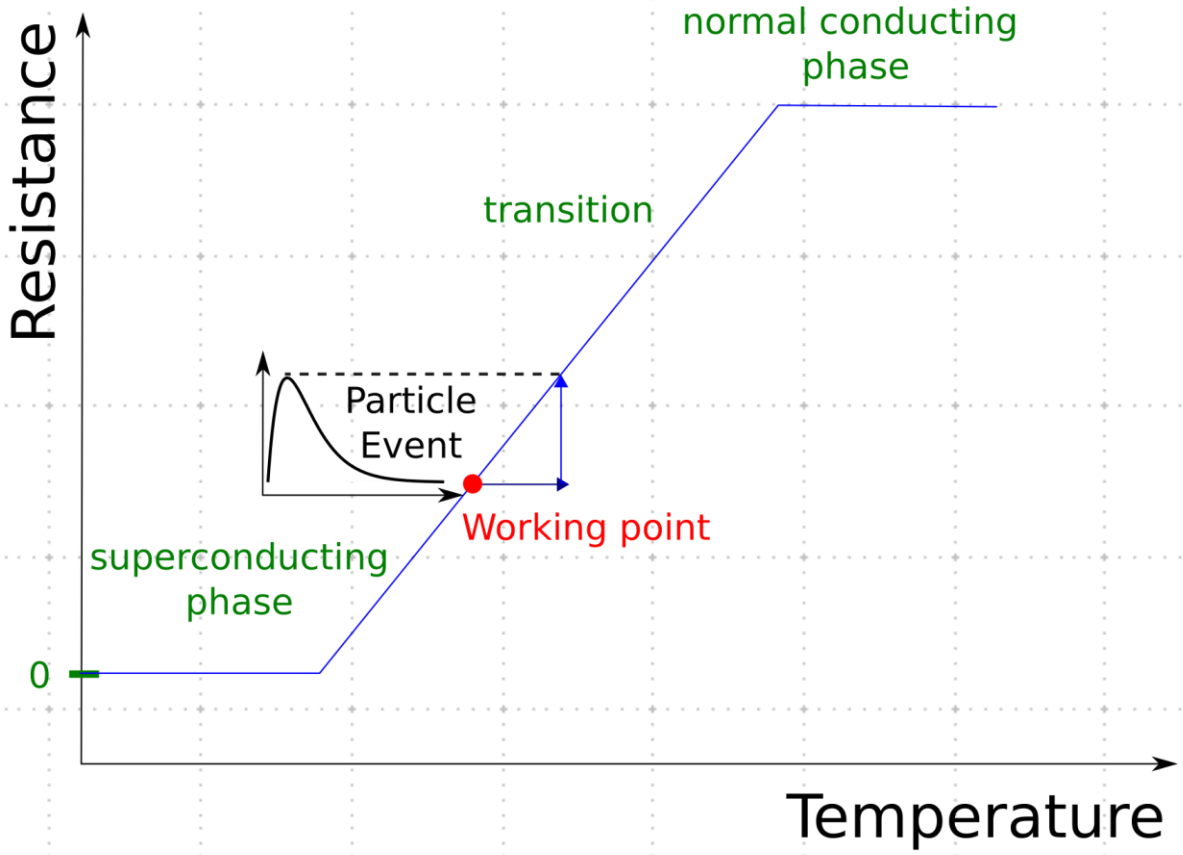

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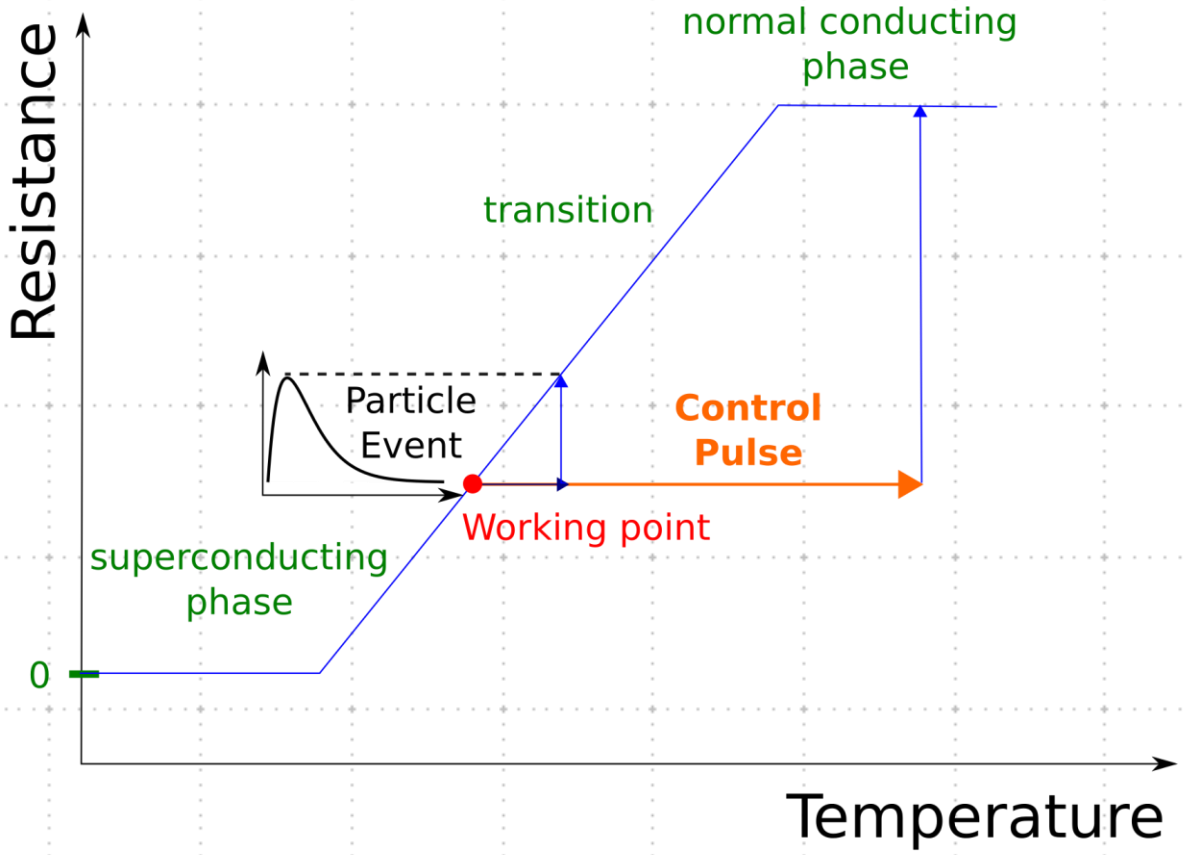

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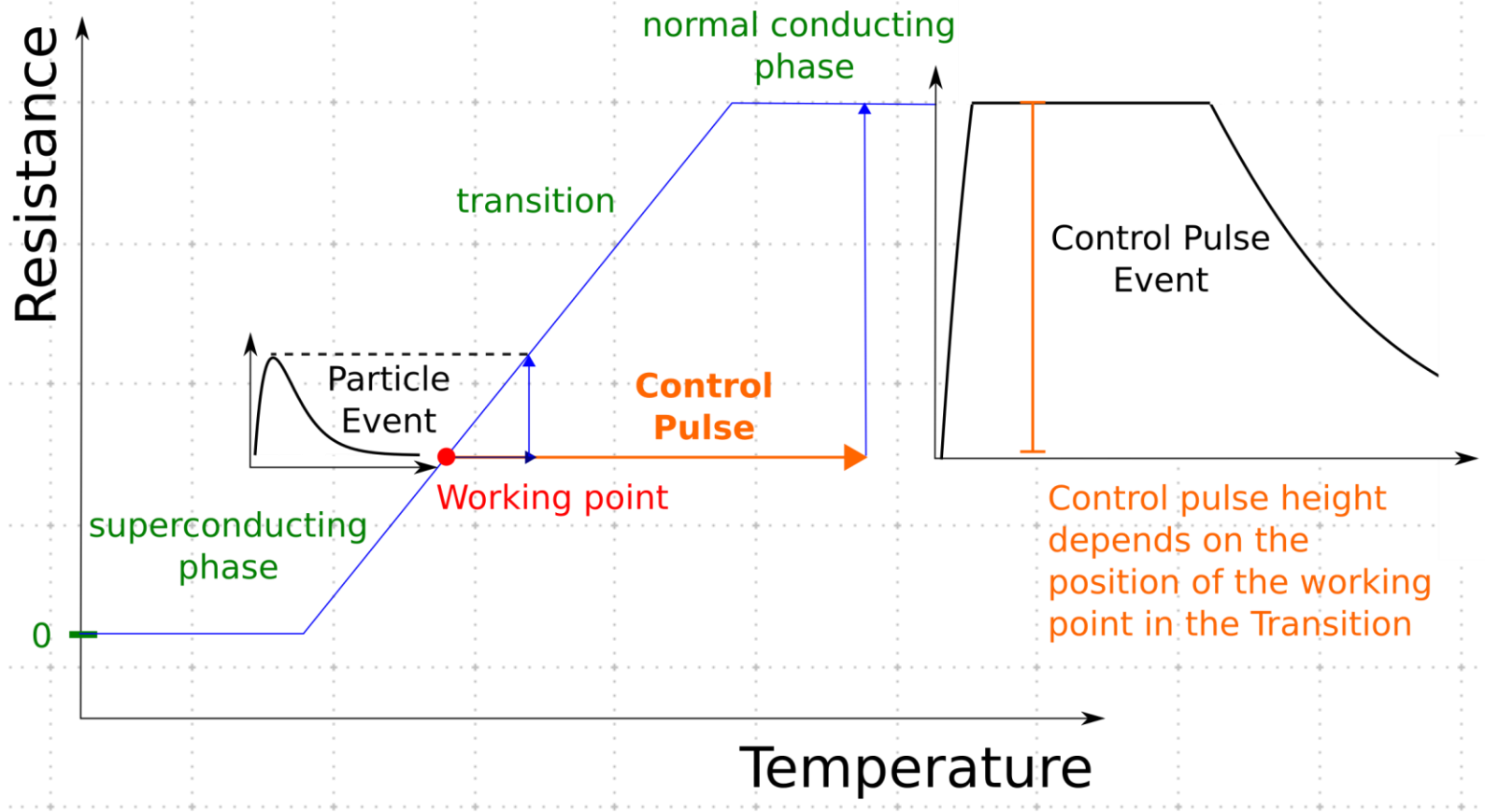

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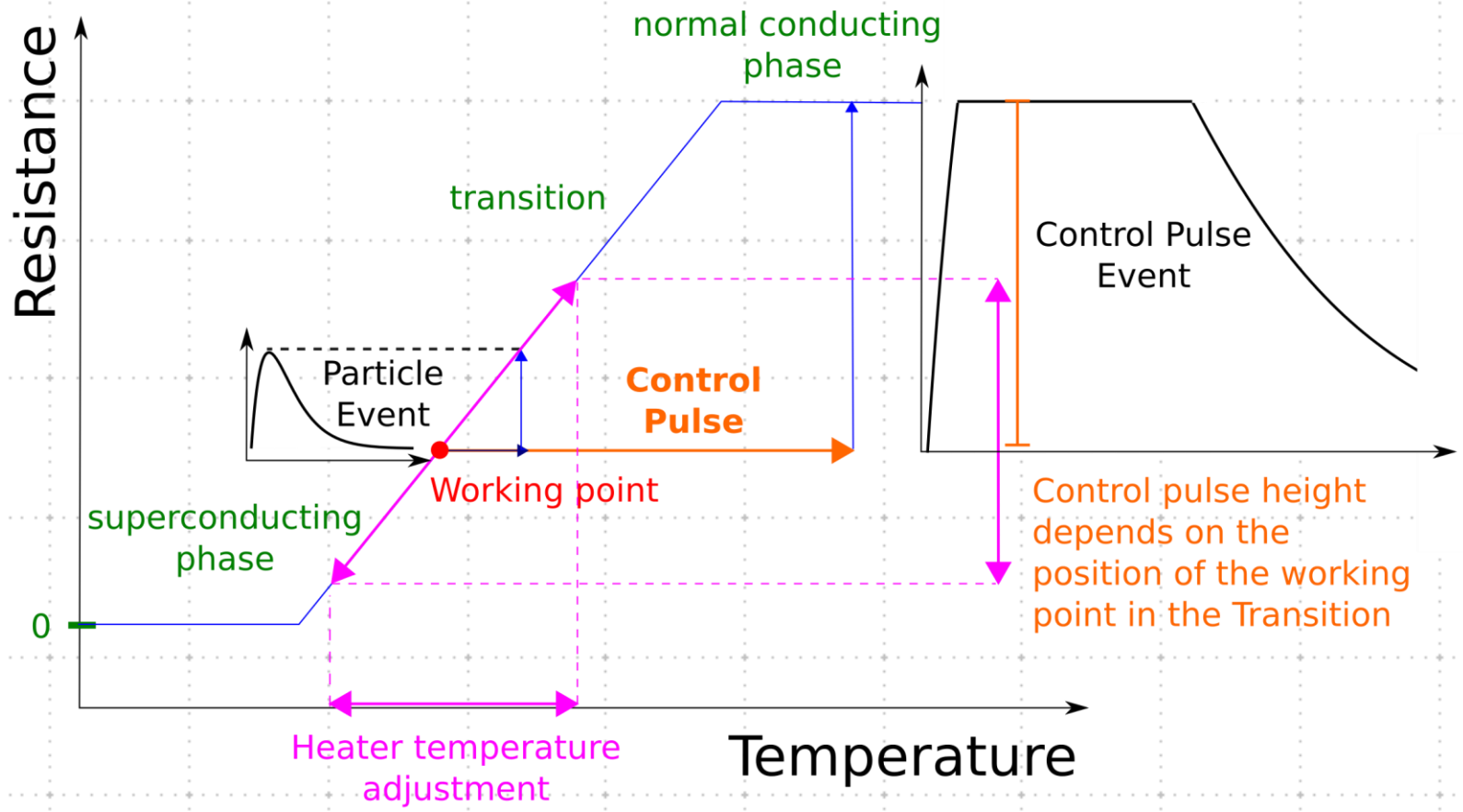

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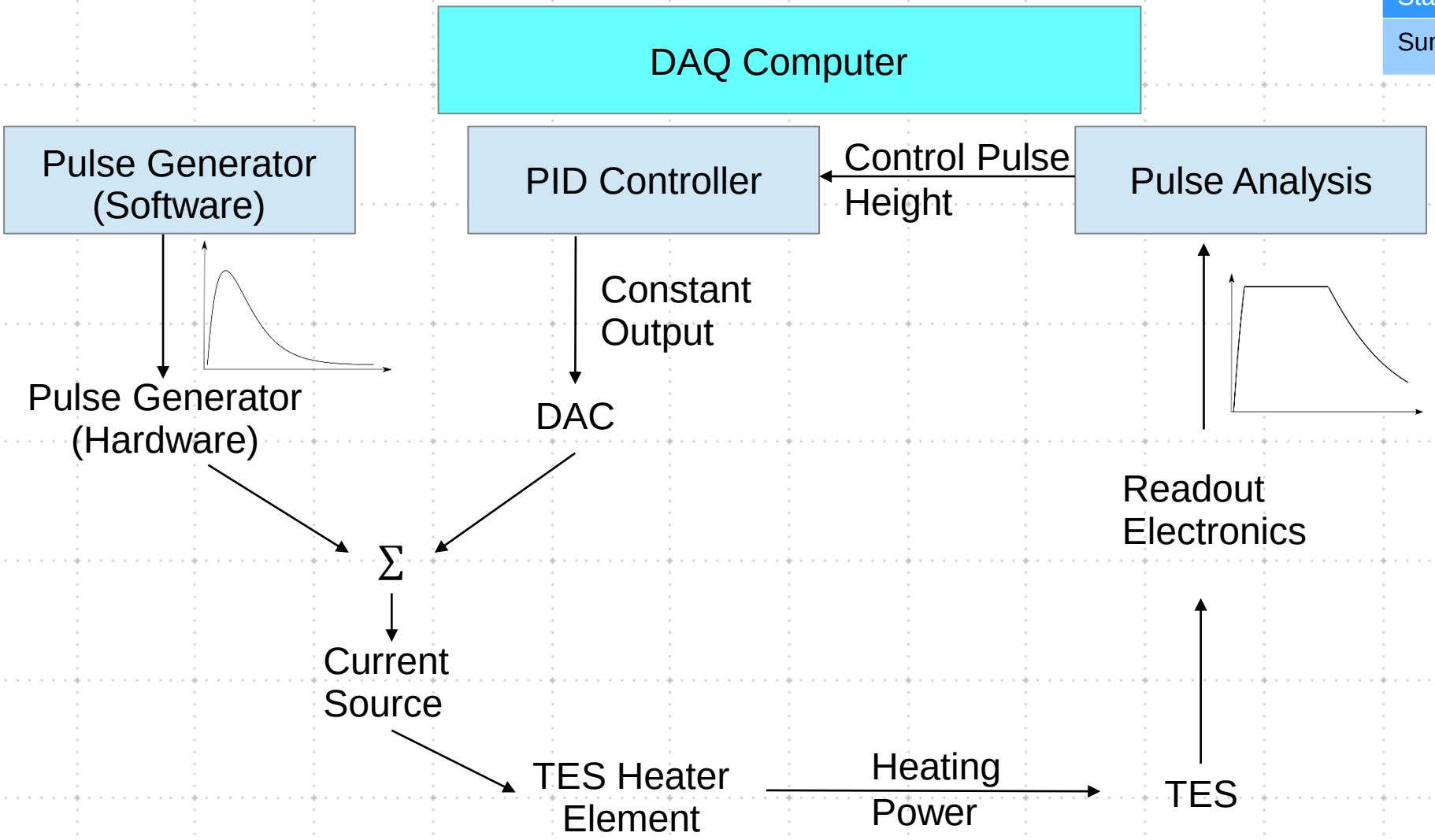

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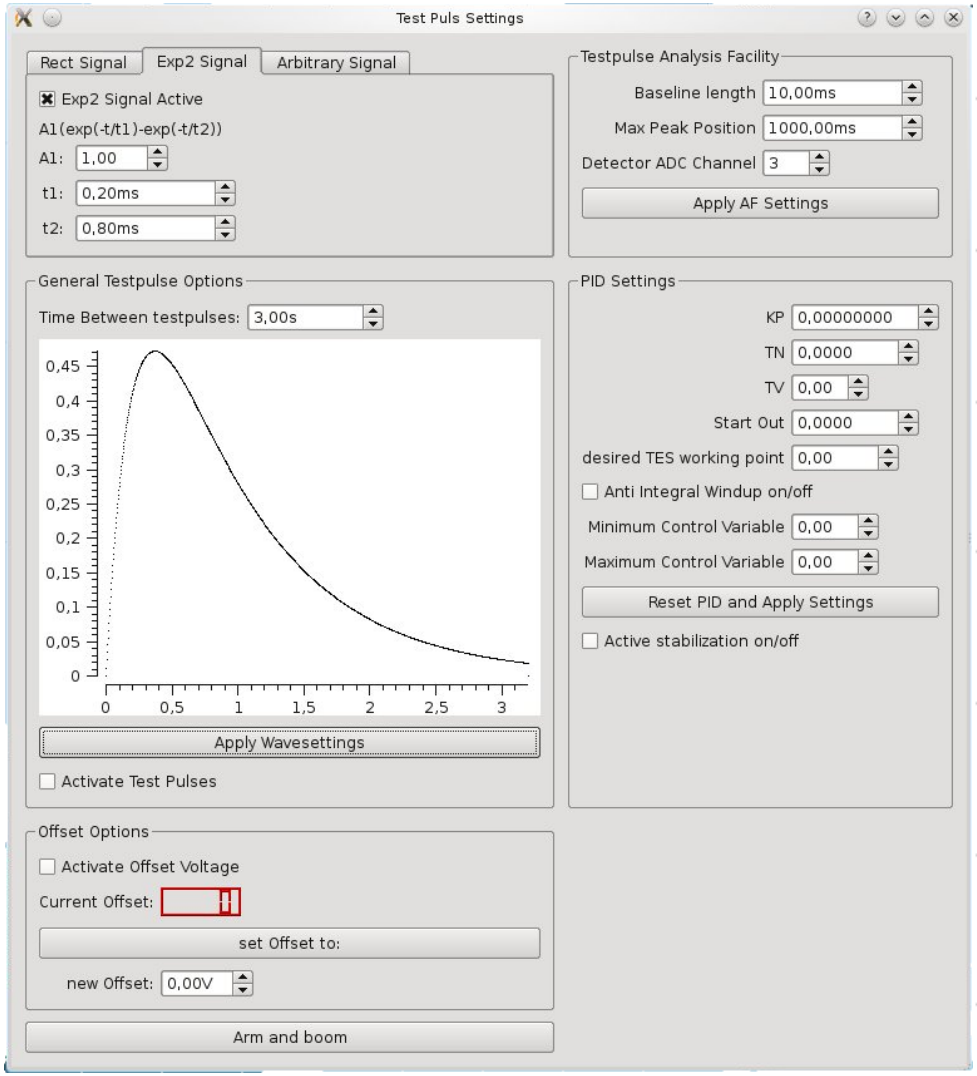

General Requirement

Flexible and easy to use

Input Parameters

Control Pulse Settings

Control Pulse Preview and Control Pulse Rate

Manual Voltage Offset Controls

Control Pulse Analysis Options

Controller Parameters

Control Pulse Stabilisation

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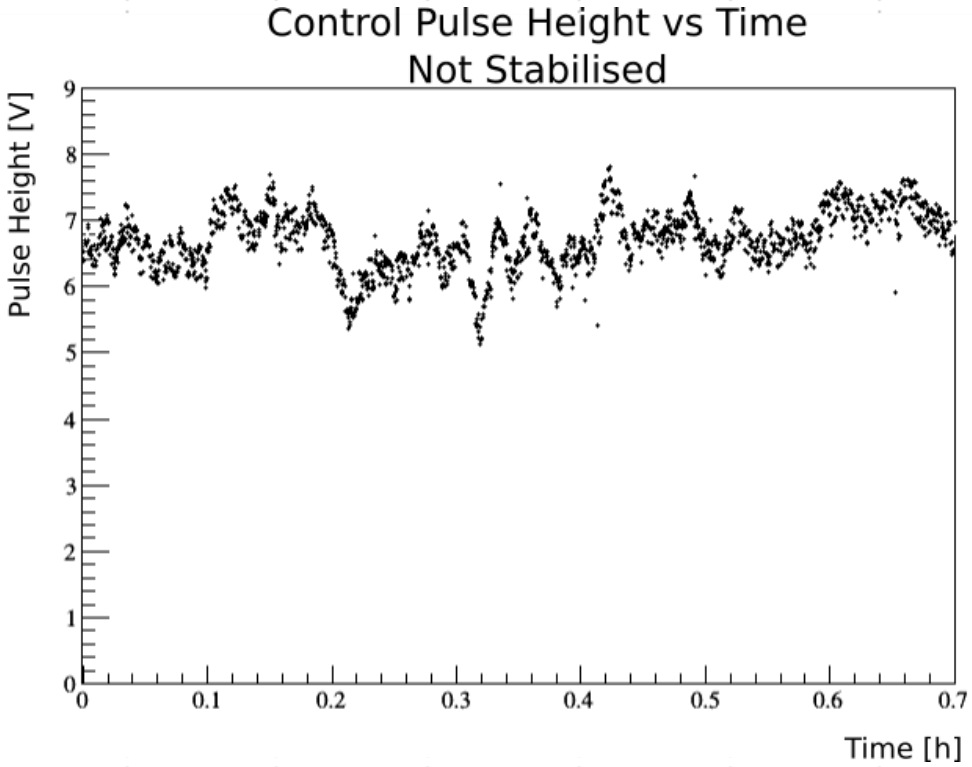

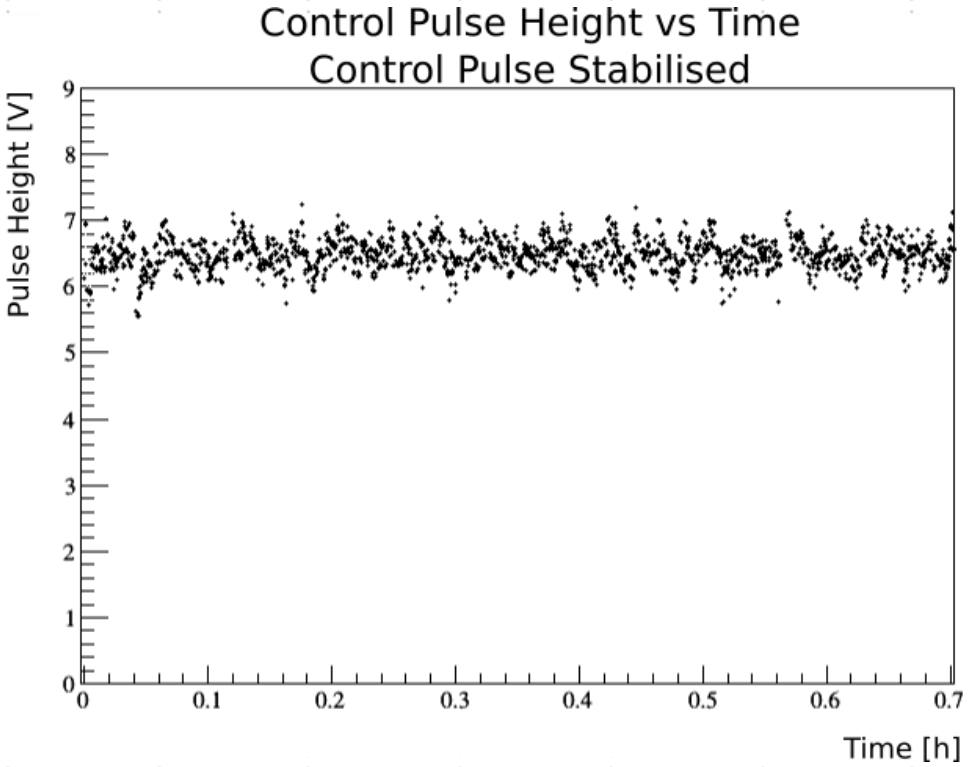

Additional Programs

Introduction
Active TES Stabilisation
Summary

Motivation

- Characterisation of TES → Add new possibilities due to the new hardware

- Determination of parameters for the stabilisation

- Test a features that could be useful in future CRESST runs with many detectors

Transition Recorder

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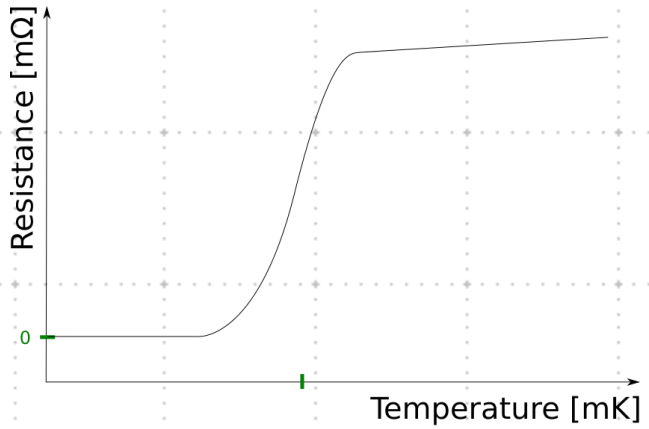

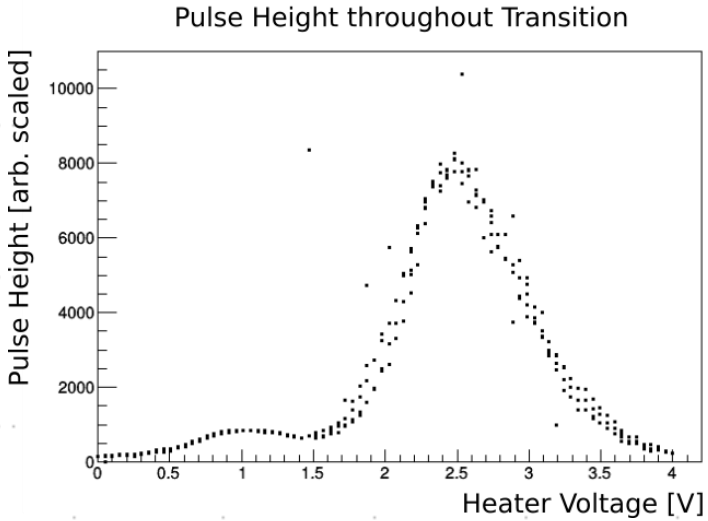

Transition Recorder records the TES transition in different ways.

Application:

Characterisation of the TES
- Transition width
- Critical temperature
- Linearity

Determination of the controller parameters

Determination of the Working Point

Introduction
Active TES Stabilisation
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Working Point Finder

Problem

- Find the right heating power **and**

- find the ideal readout current, which has a heating power of its own!

=> **Two** parameters have to be varied! Very time consuming if done manually as in CRESST.

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Working Point Finder

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Solution

Automatically vary those two parameters and record a quantity that indicates the “quality” of the working point.

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Solution

Automatically vary those two parameters and record a quantity that indicates the “quality” of the working point.

Chosen quantities

Pulse Height + Signal to Noise of different heater pulses

Working Point Finder

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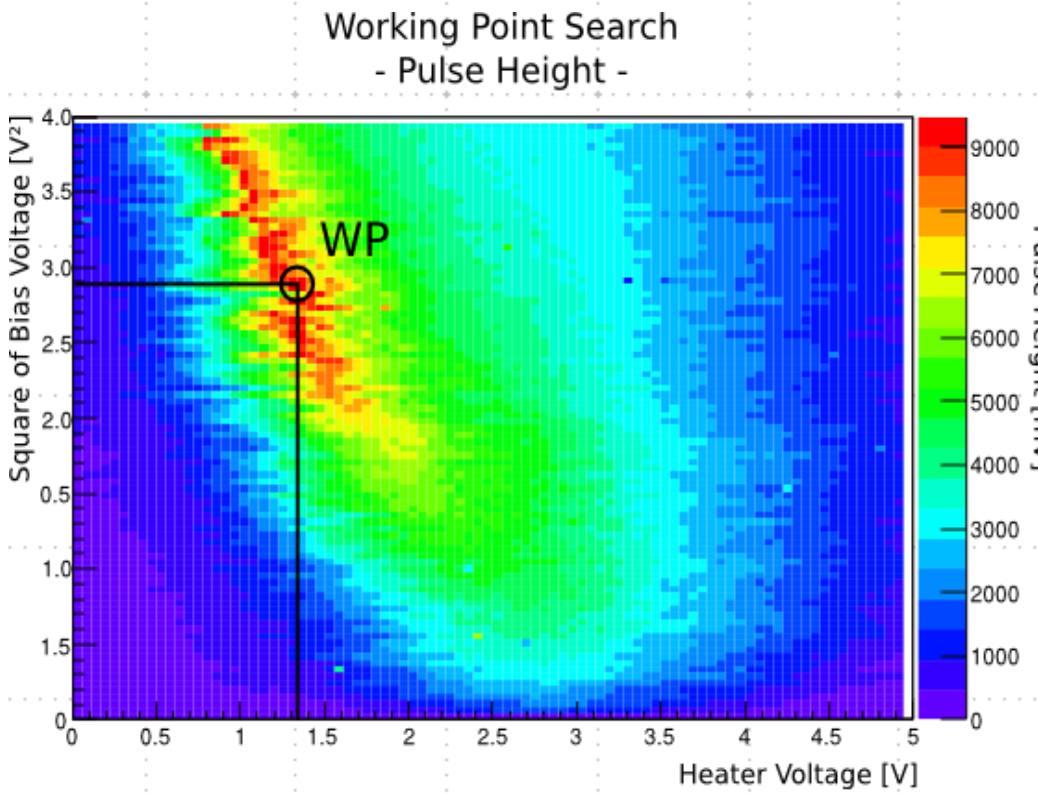

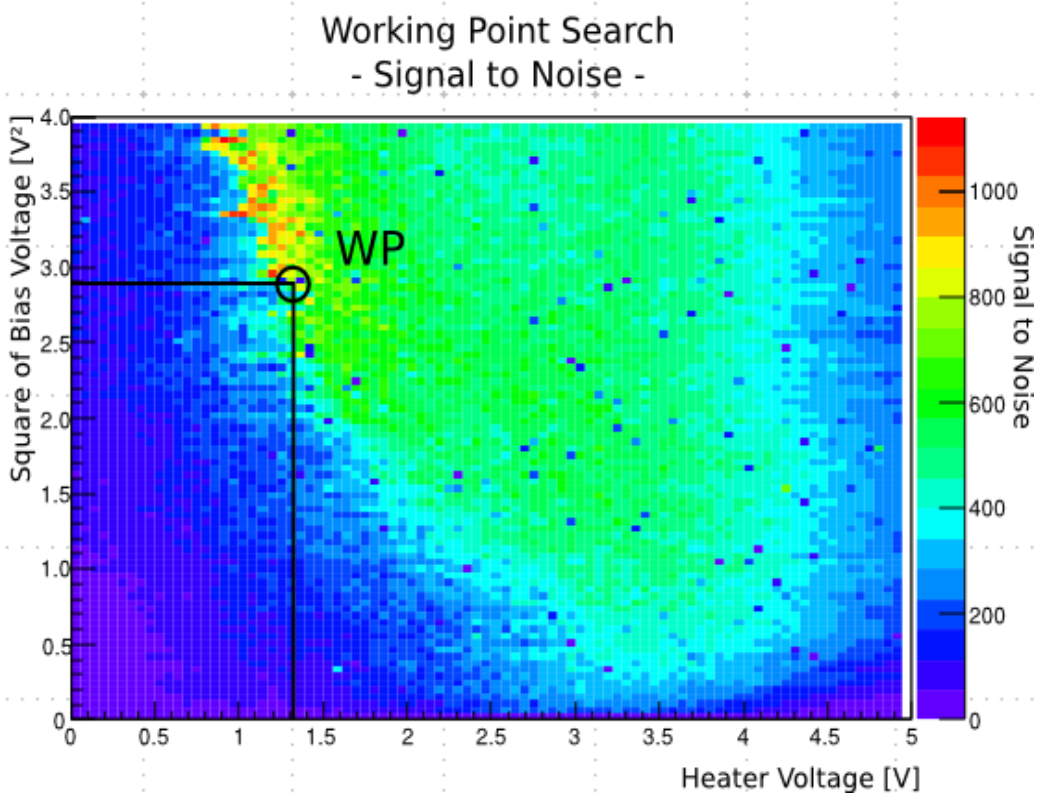

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Summary

- CRESST uses Transition Edge Sensors

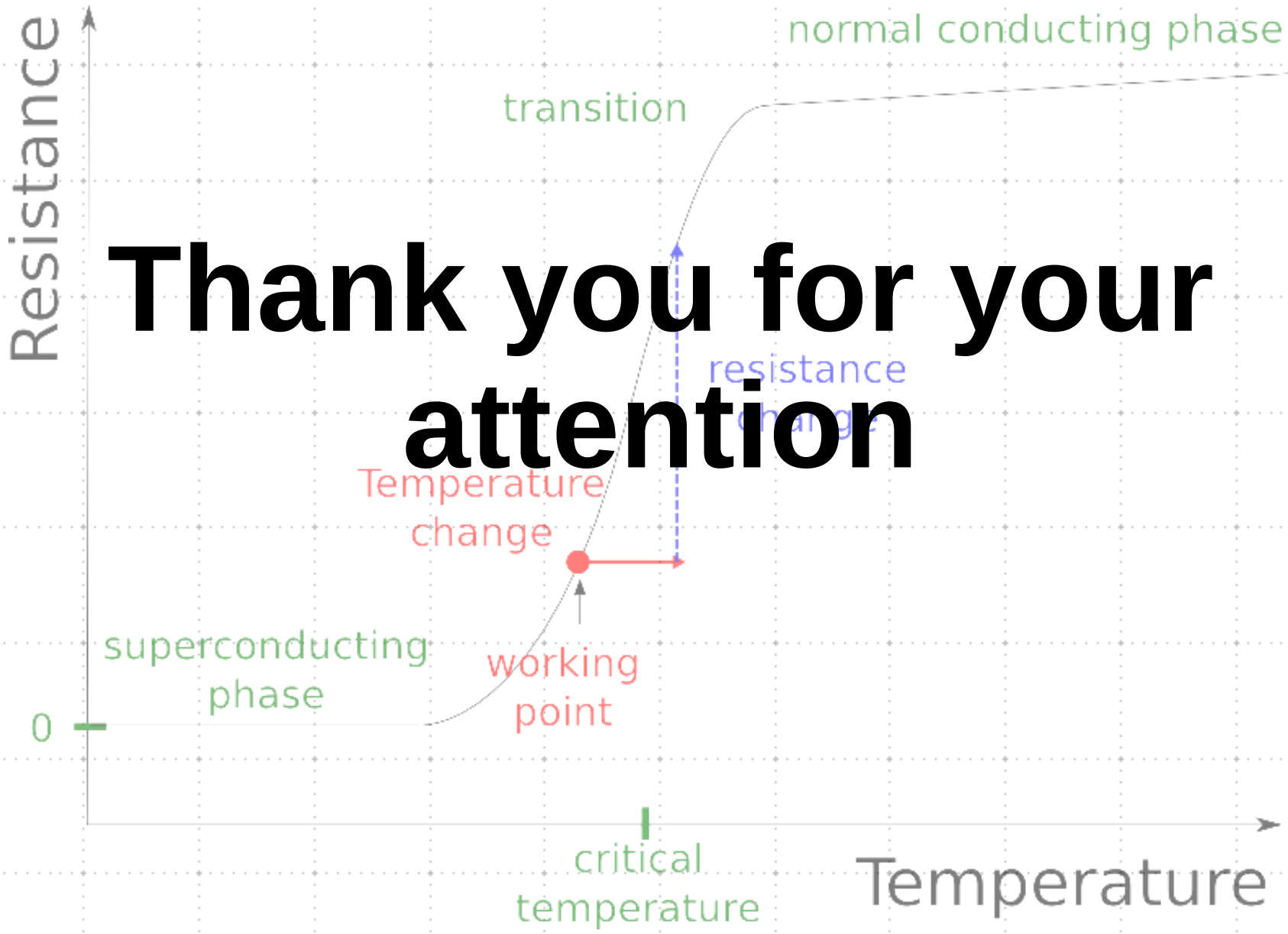
- Transition Edge Sensors are based on superconducting thin films and require a stabilisation

→ **Heater Pulse** based stabilisation implemented at a cryostat at the TU Munich
=> CRESST like test conditions

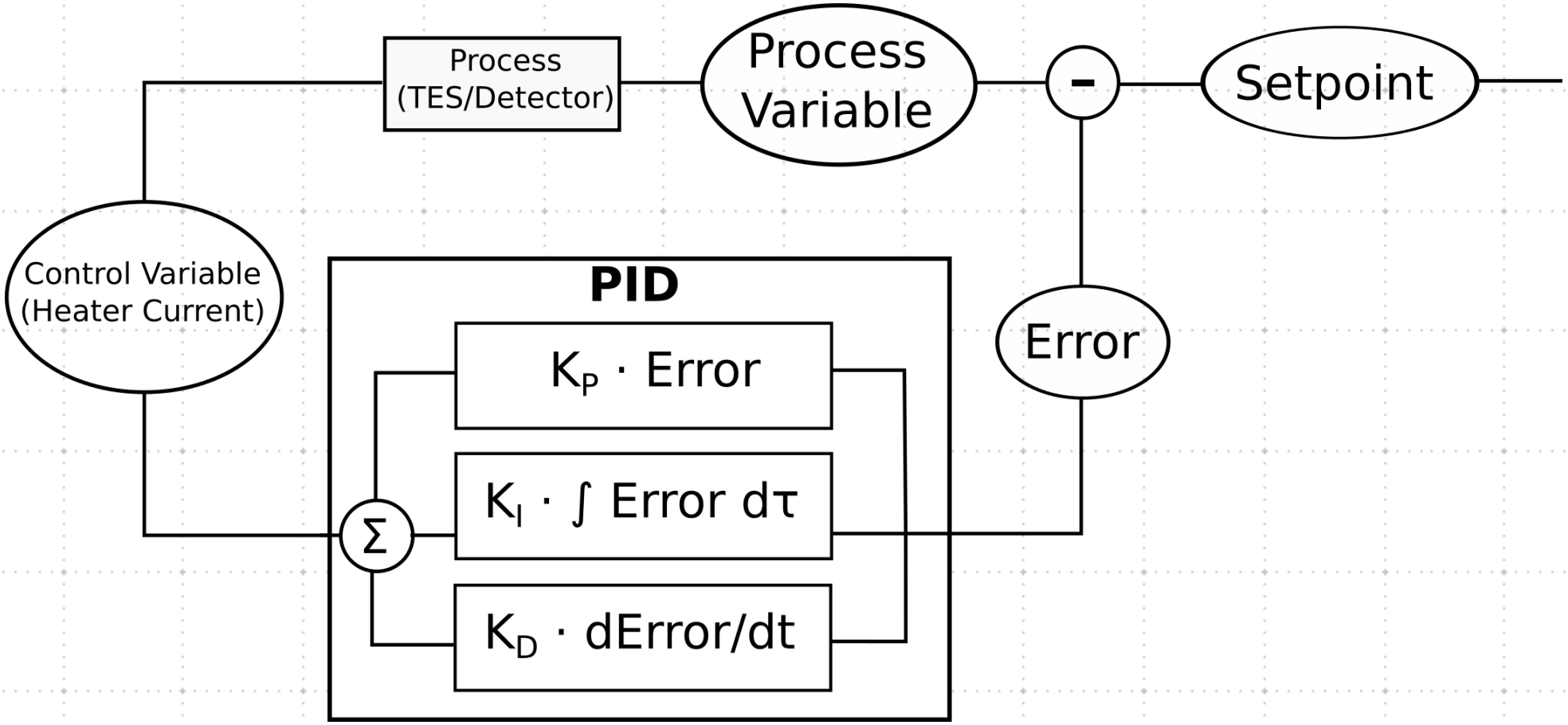
→ Supplementary software **(Transition Recorder, Working Point Finder)** developed

→ Functionality and performance were demonstrated in test measurements

Thank you for your attention



PID Basics


Process
(TES/Detector)
Process
Variable
-
Setpoint
Control Variable
(Heater Current)
PID
Error
$K_P \cdot$ Error
$K_I \cdot \int$ Error dτ
$K_D \cdot$ dError/dt
Σ