



CONSIGLIO NAZIONALE DELLE RICERCHE



Dual detector for simultaneous time and energy measurements with superconductive detectors

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Overview

- Introduction to the Superconducting Tunnel Junction (STJ)
- Introduction to the Dual Detector
- Dual Detector used
- Measurement setup
- Results
- Model
- Conclusion and future work



Introducing the STJ

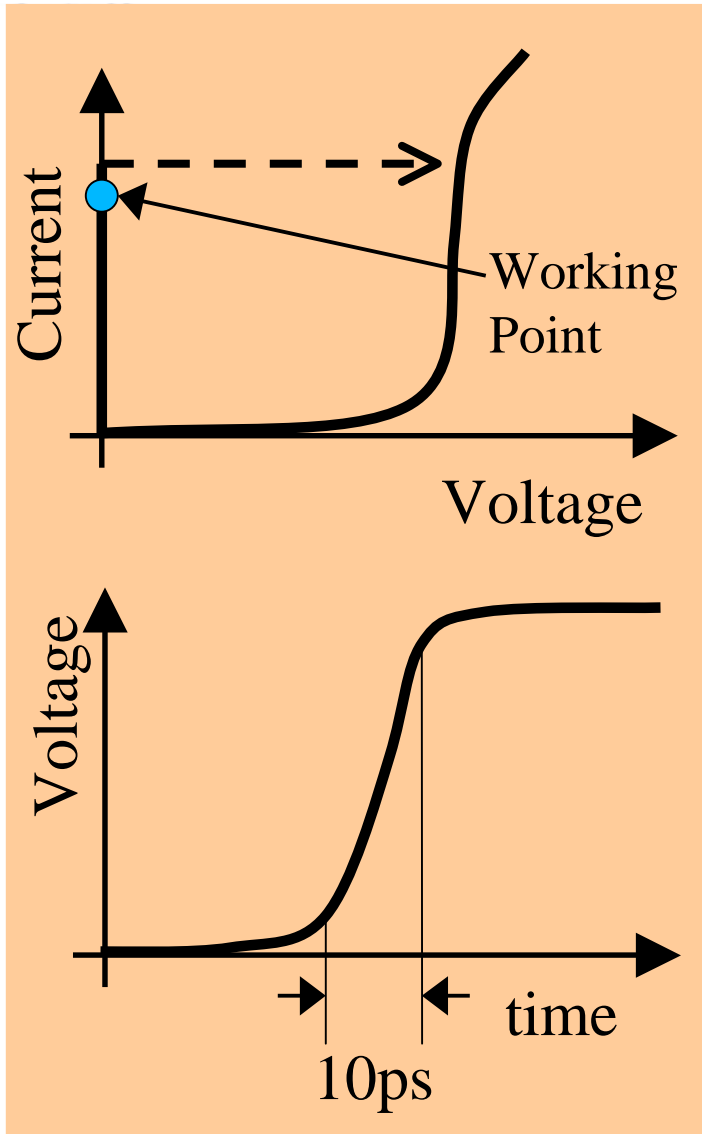
Operating principle:

- **X-ray is absorbed in STJ ($t=0$)**
- **Creates a high-energy phonon bubble (few ps)**
- **Phonons creates quasiparticles & low energy phonons (≤ 1 ns)**
- **Quasiparticles tunnel across tunneling barrier (≤ 10 μ s)**

The number of quasiparticles is proportional to the energy of the X-ray.

The time of arrival is measured when the quasiparticles start to tunnel.

The Time Measurement



Place a Josephson Tunnel Junction (JTJ) close to the STJ.

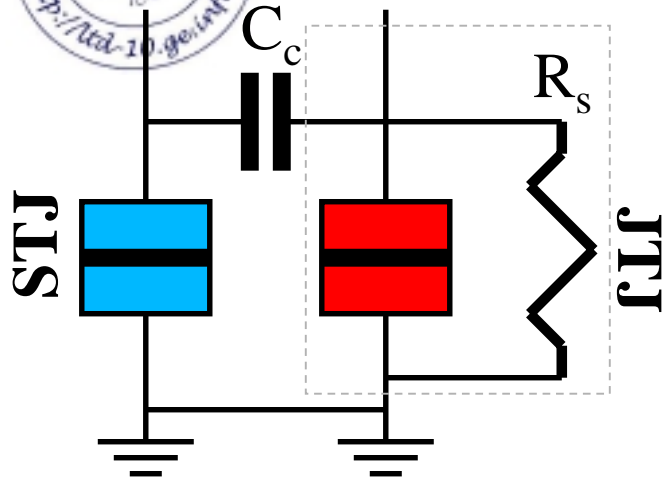
Surplus current from the X-ray impact makes the JTJ switch.

JTJ has low amount of spurious switches, high internal bandwidth, and rapid switch (ps).

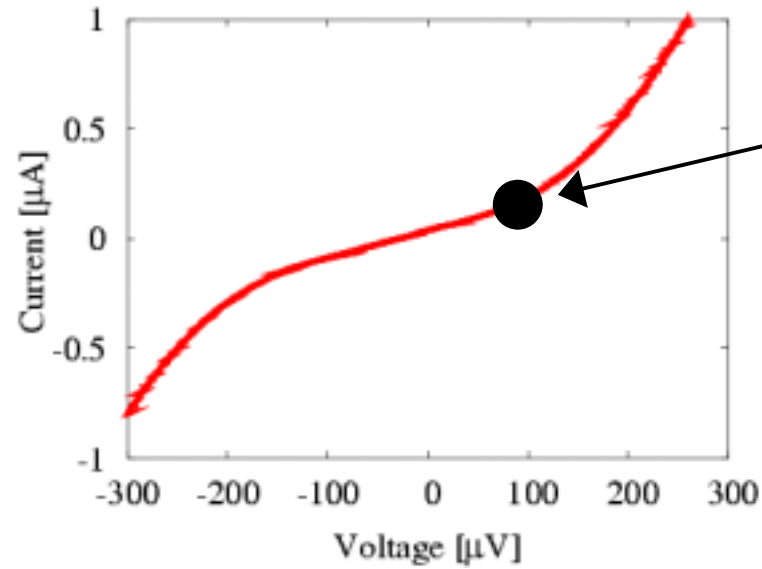
Splits the energy (STJ) and time (JTJ) signal



Our Dual Detector

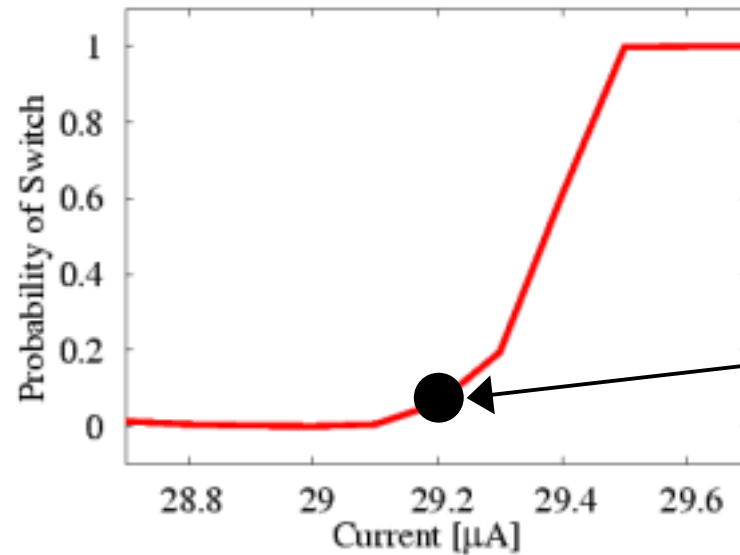


$C_c = 680 \text{ pF}$
 $T = 312 \text{ mK}$



Working point

Al/AlO_x/Al
 $C_{STJ}: 150 \text{ pF}$

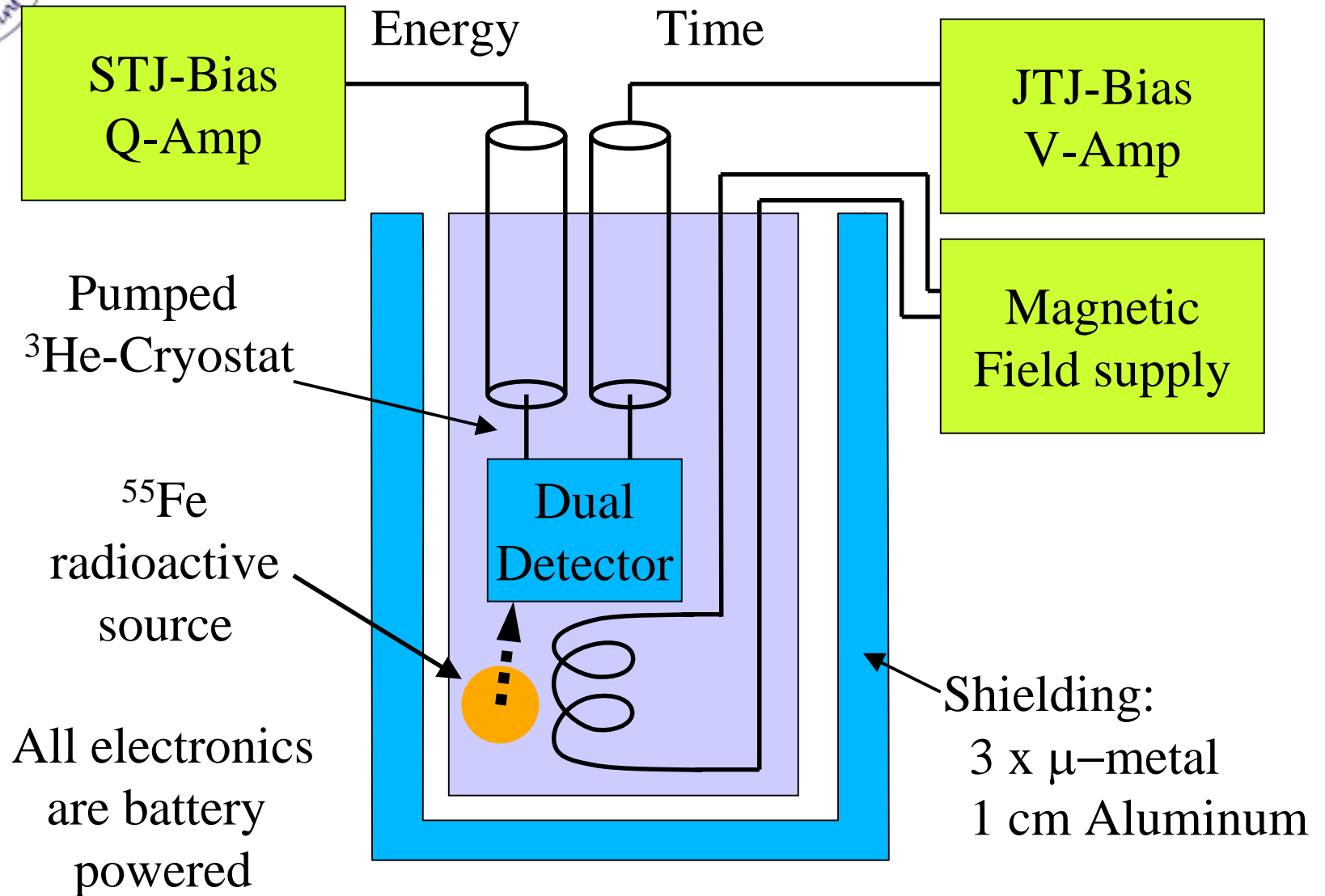


Nb/AlO_x/Nb
 $C_{JTJ}: 66 \text{ pF}$

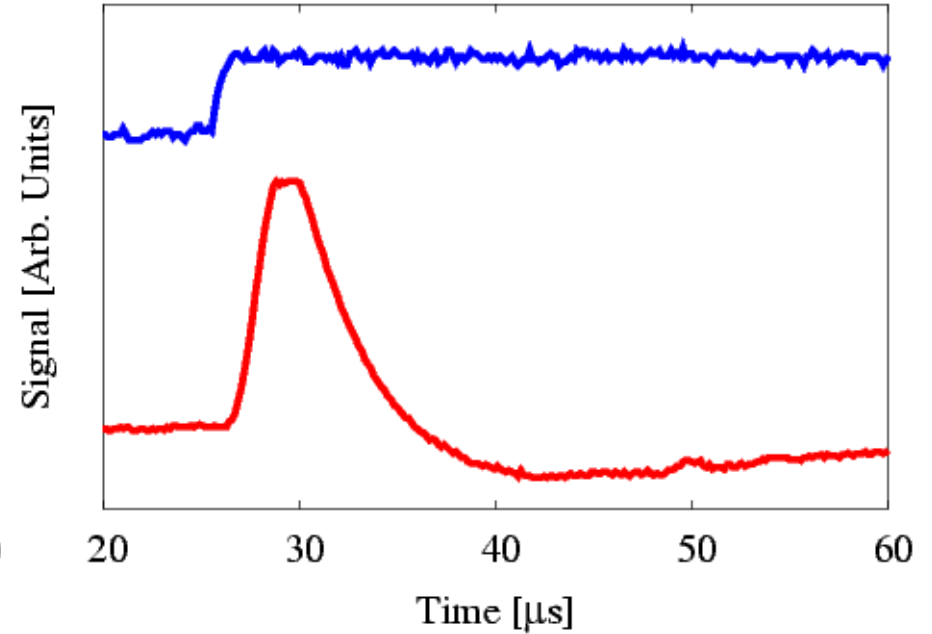
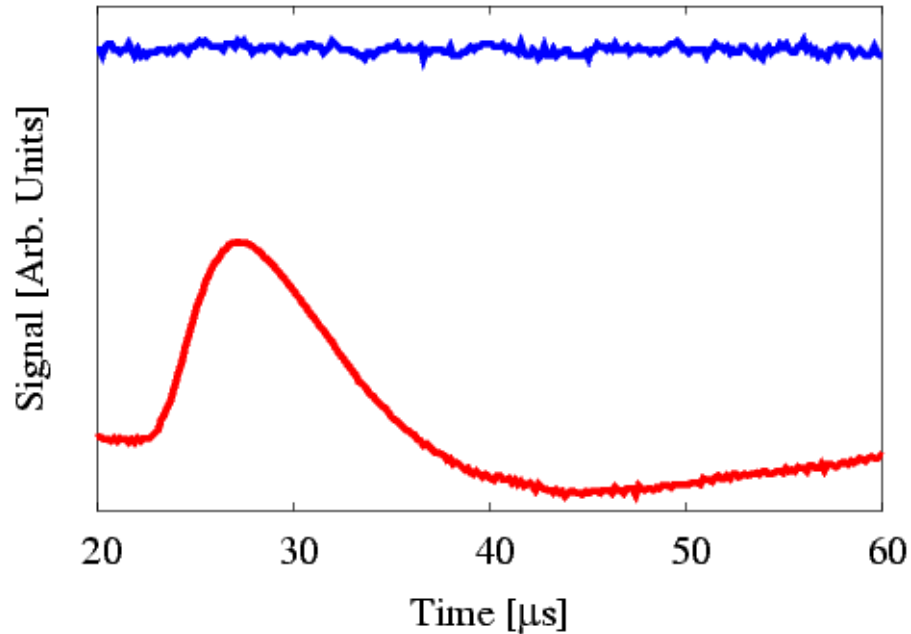
Working point



Measurement Setup



Simultaneous Energy & Time Measurement

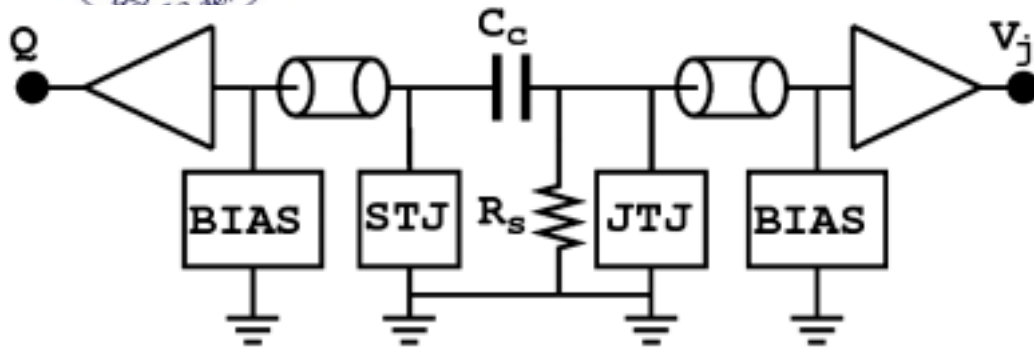


X-ray only.
Energy resolution: 300 eV

**Simultaneous energy
and time measurement.**
Time resolution: 50 ns



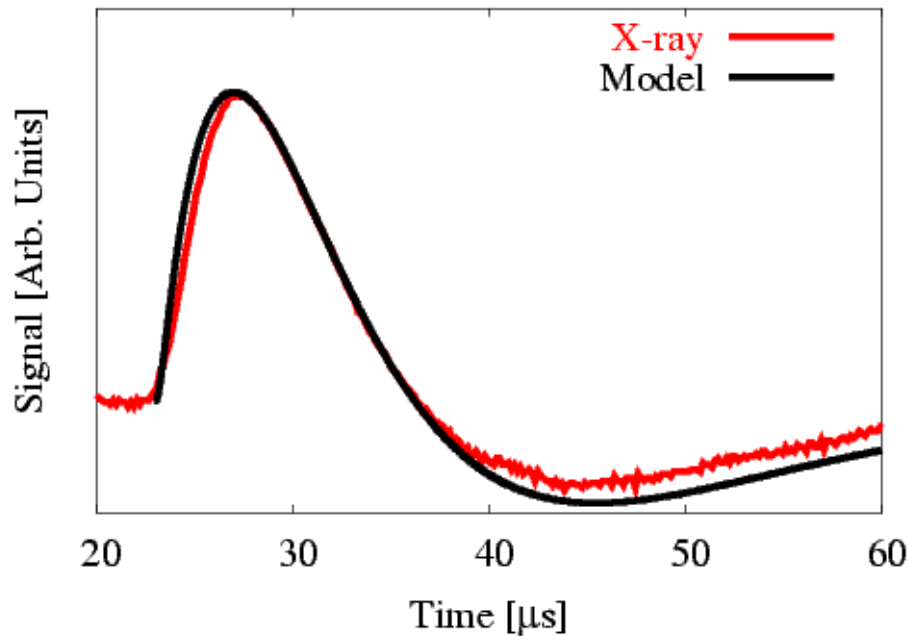
The Dual Detector Model



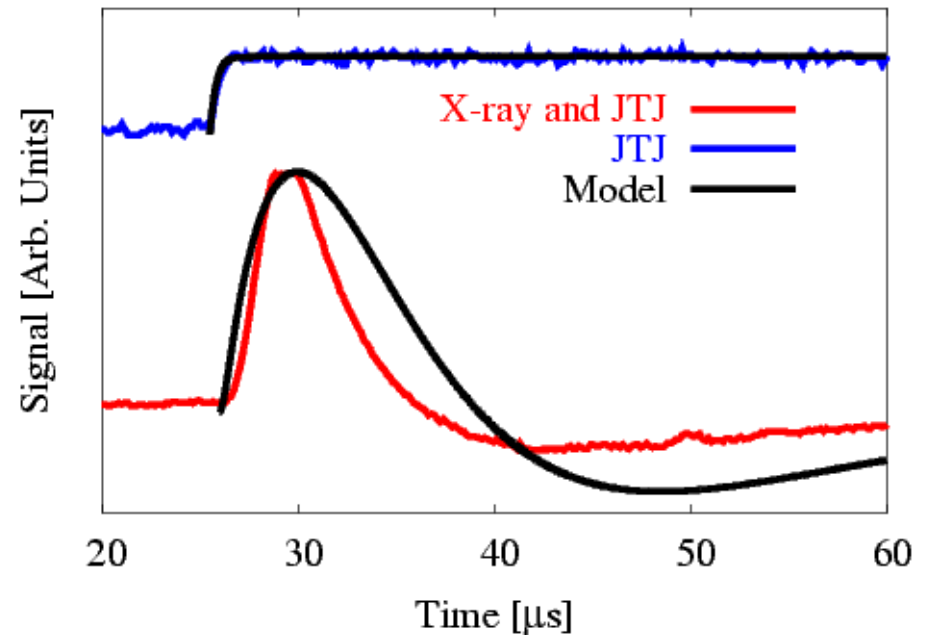
STJ-model: Modified Van Duzer and Turner for non-equilibrium case.

JTJ-model: Resistively shunted junction model.

X-ray only used for calibration



Model agrees with coincidence



Conclusion & Future Research

- **Simultaneous energy and time measurement has been accomplished**
300 eV
50 ns
resolutions obtained.
- **A good model of the dual detector has been constructed, and numerical simulations agrees well with data.**
- **Using the model we plan to investigate other possible dual detector configurations to improve energy and time resolution.**