



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

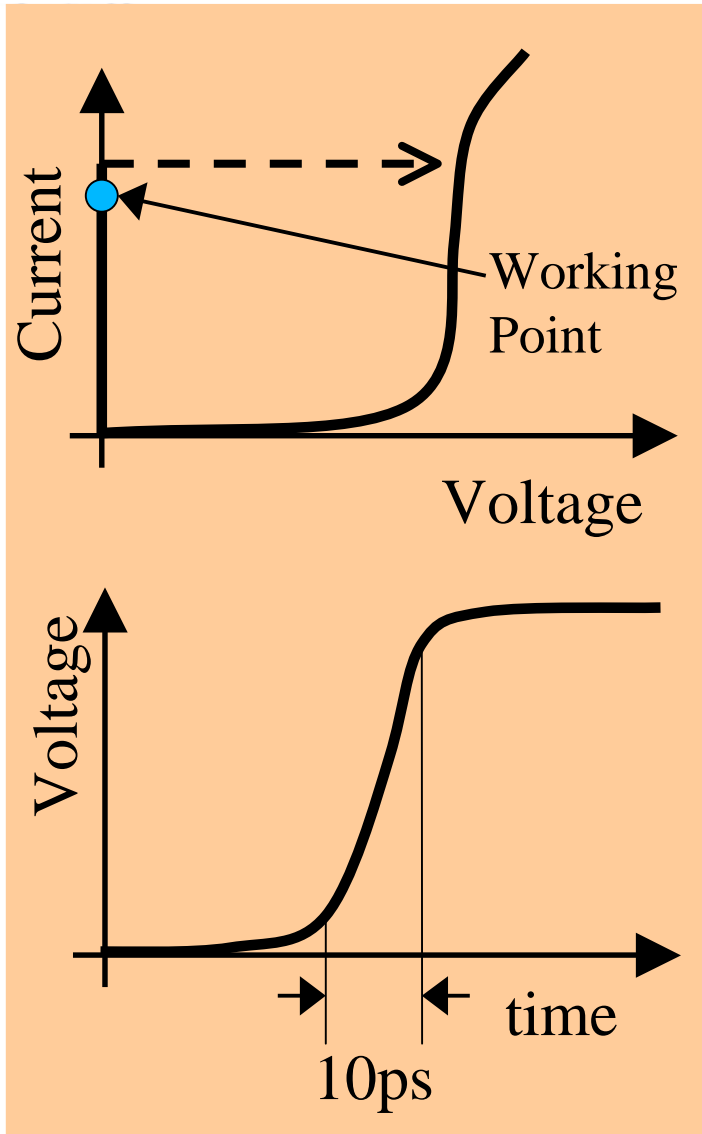
## Operating principle:

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

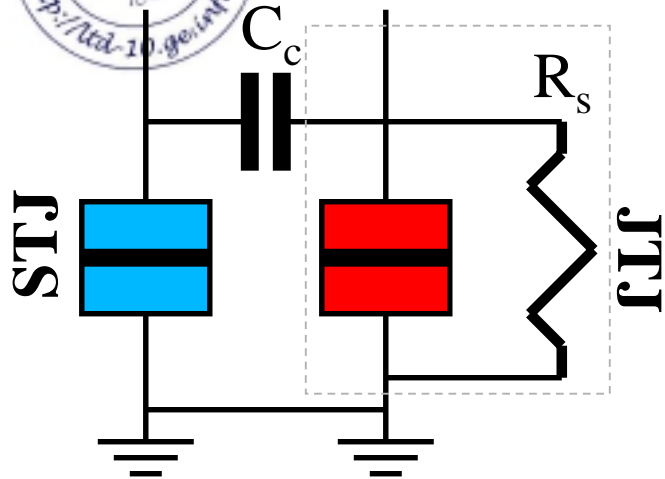
**Surplus current from the X-ray impact makes the JTJ switch.**

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

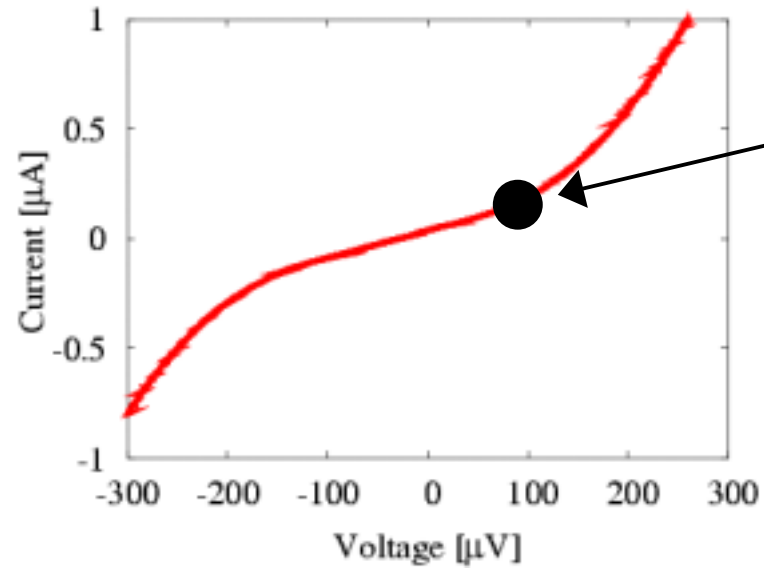
**Splits the energy (STJ) and time (JTJ) signal**



# Our Dual Detector

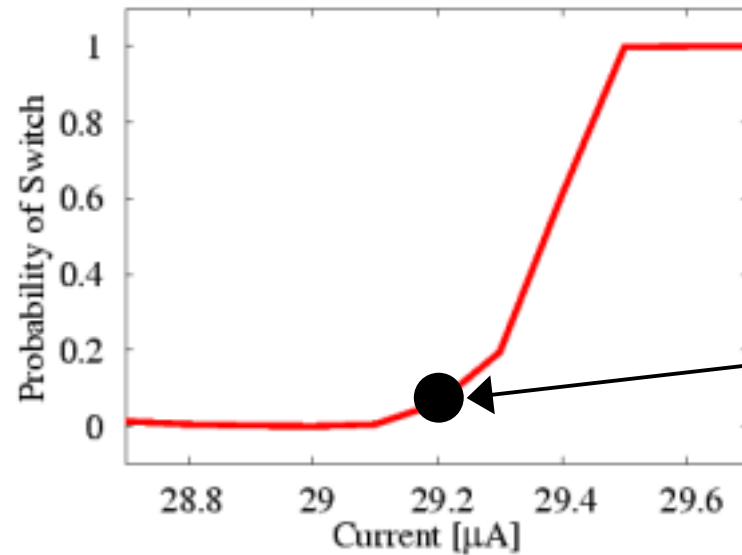


$C_c = 680 \text{ pF}$   
 $T = 312 \text{ mK}$



Working point

Al/AlO<sub>x</sub>/Al  
 $C_{STJ}: 150 \text{ pF}$

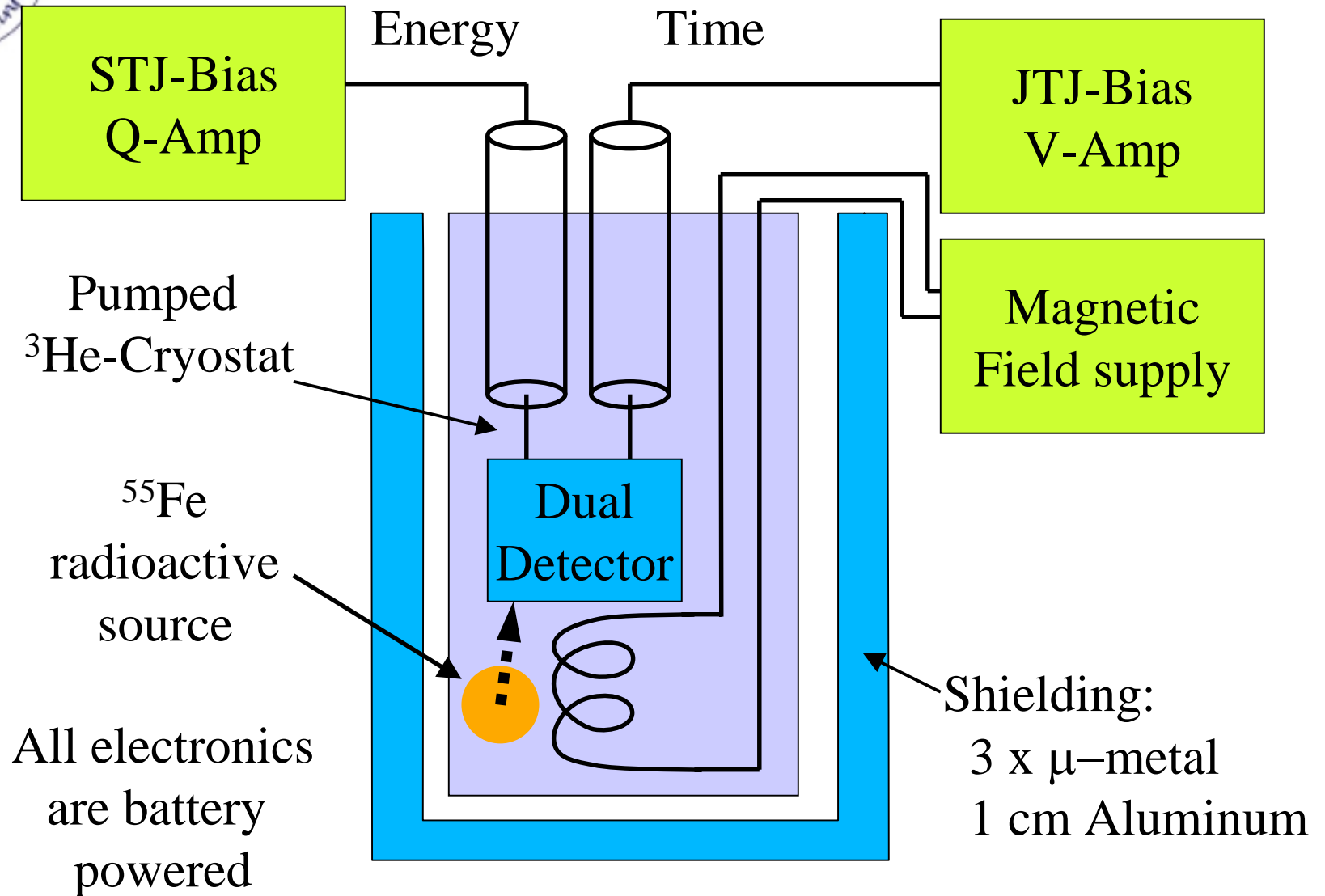


Nb/AlO<sub>x</sub>/Nb  
 $C_{J TJ}: 66 \text{ pF}$

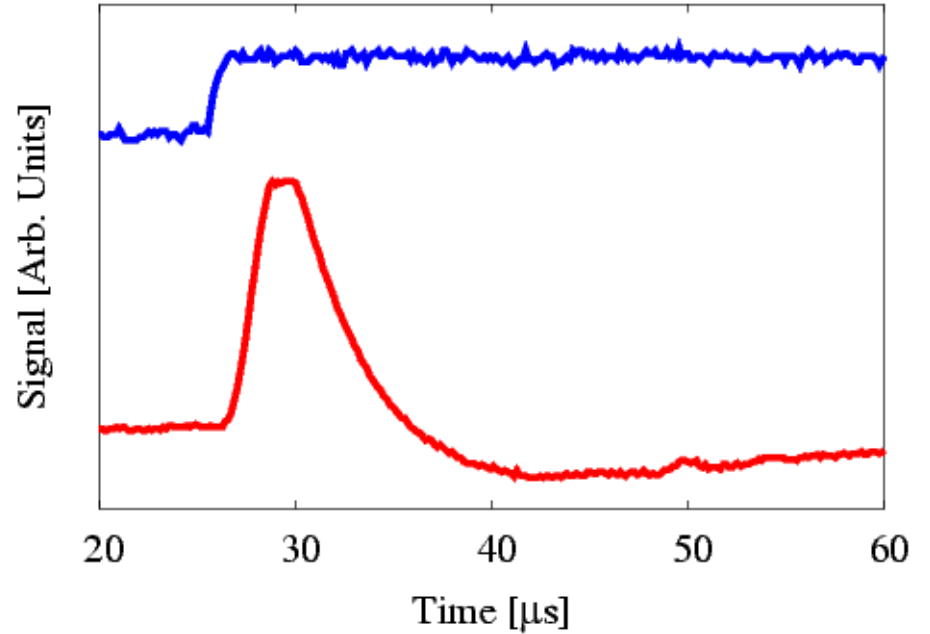
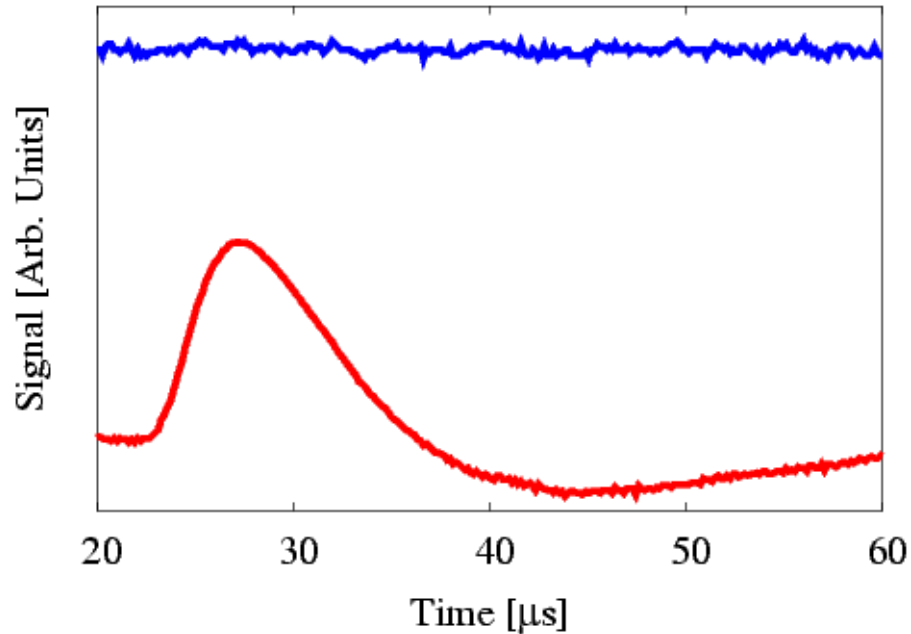
Working point



# Measurement Setup



# Simultaneous Energy & Time Measurement

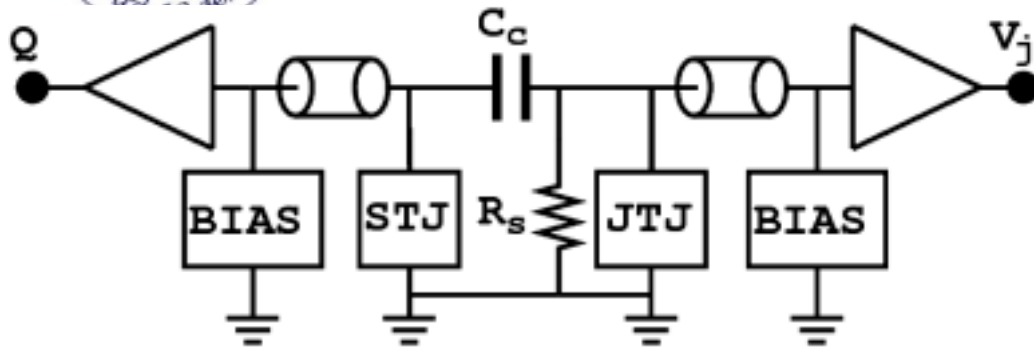


**X-ray only.**  
**Energy resolution: 300 eV**

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



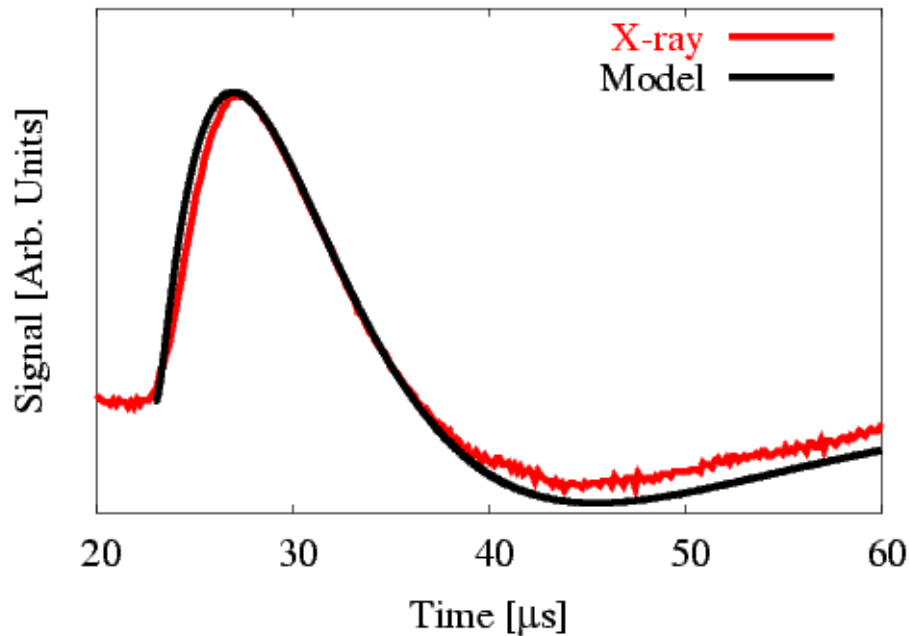
# The Dual Detector Model



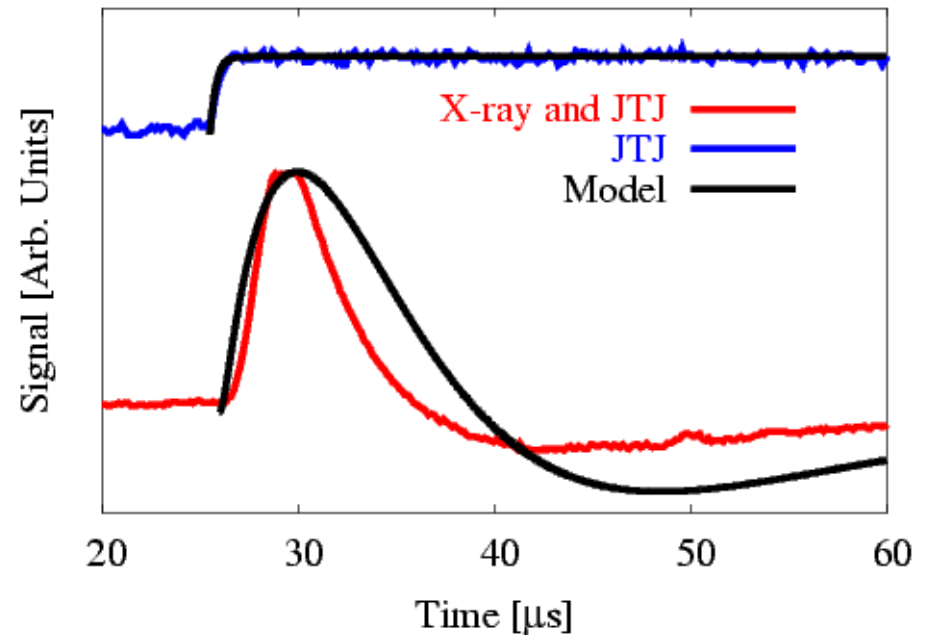
**STJ-model: Modified Van Duzer and Turner for non-equilibrium case.**

**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.**