

A very fast recap about...

...TESs development @INRiM for PTOLEMY project

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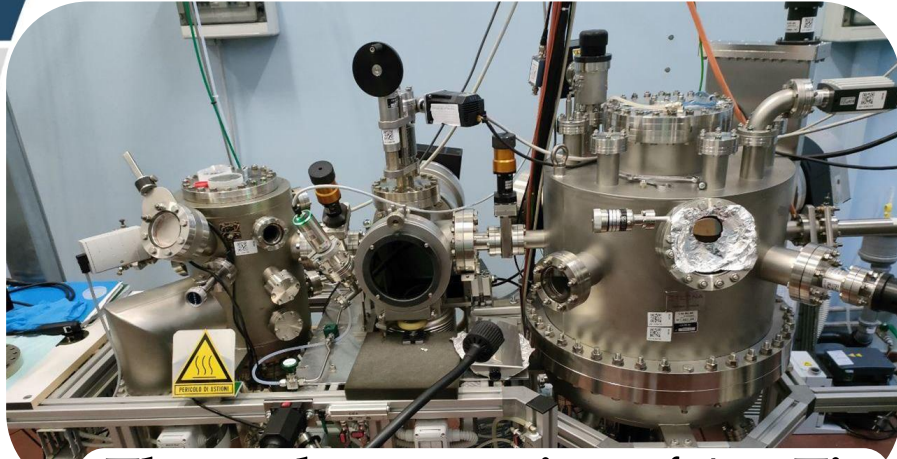
PhD student

Federico Malnati

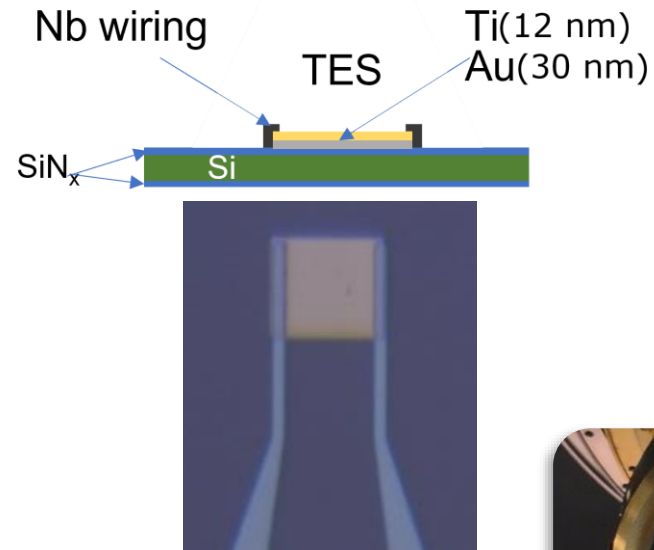


PhD student

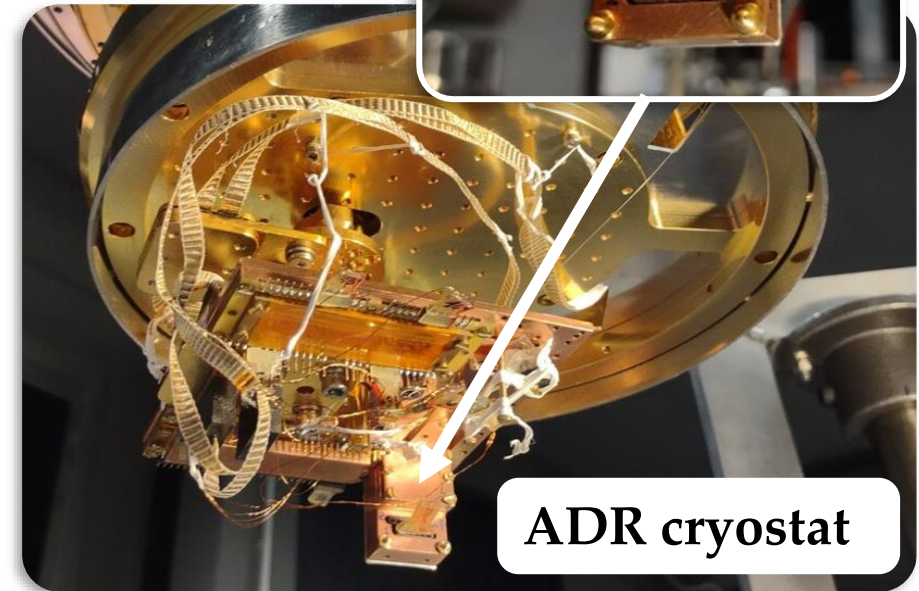
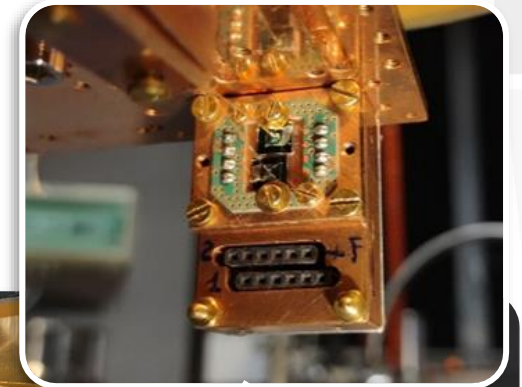
Fabrication



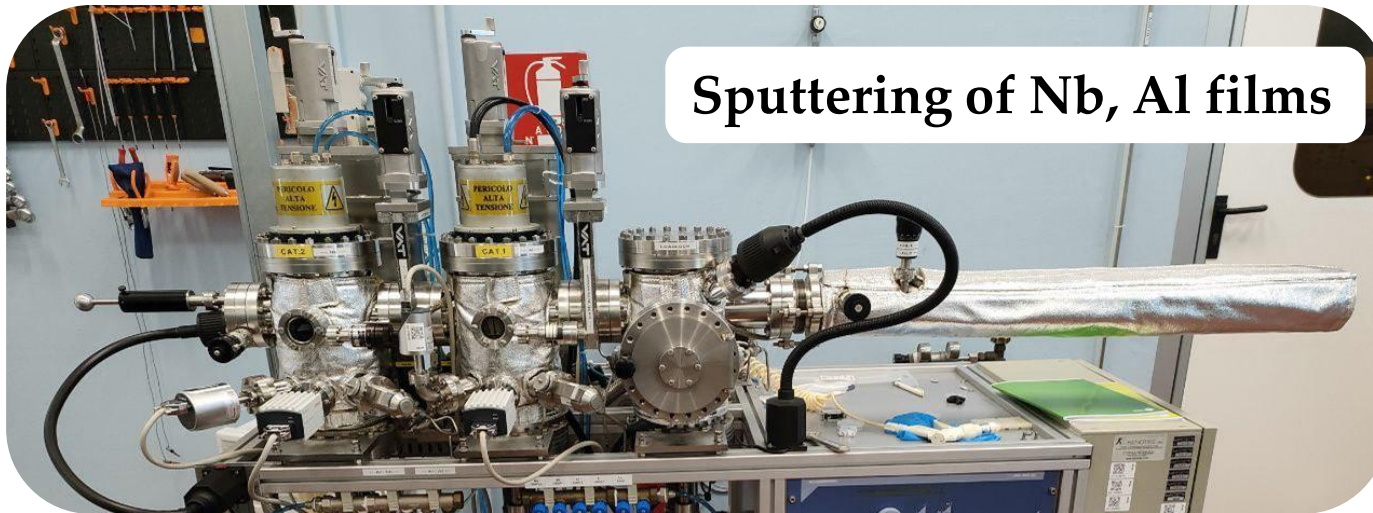
Thermal evaporation of Au ,Ti.
Depositions in rapid sequence.



Characterization



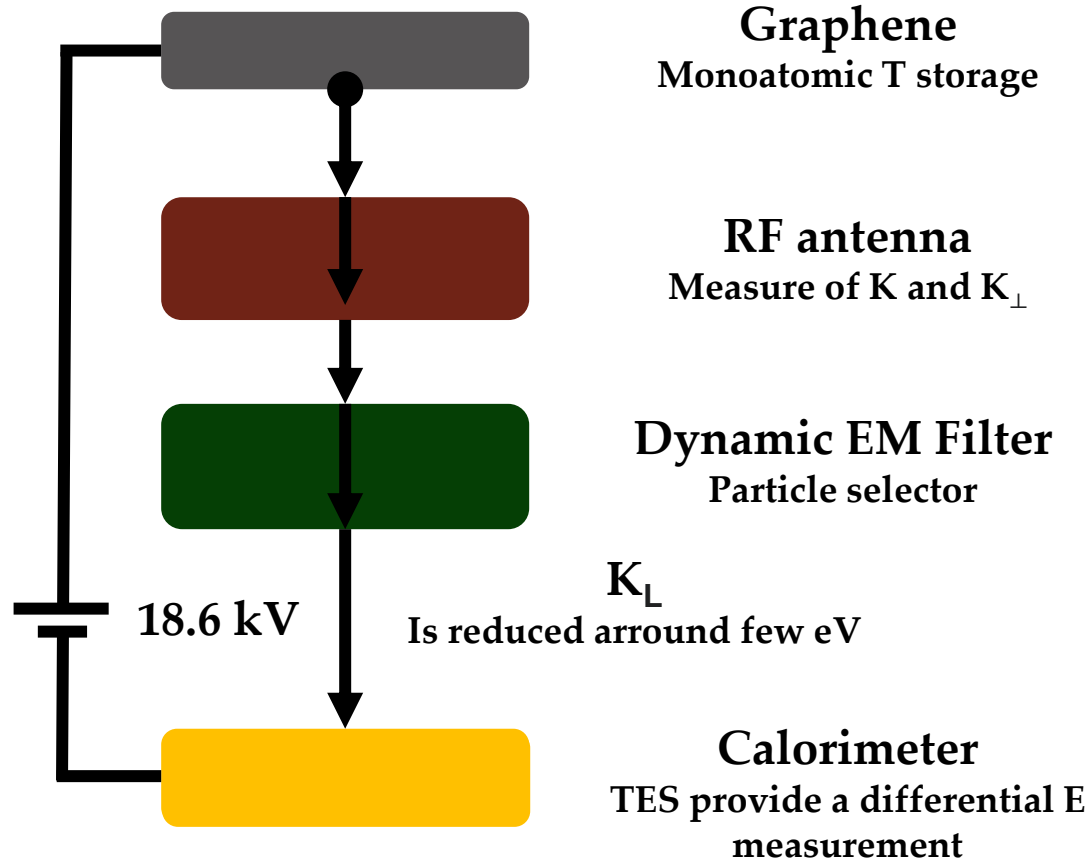
ADR cryostat



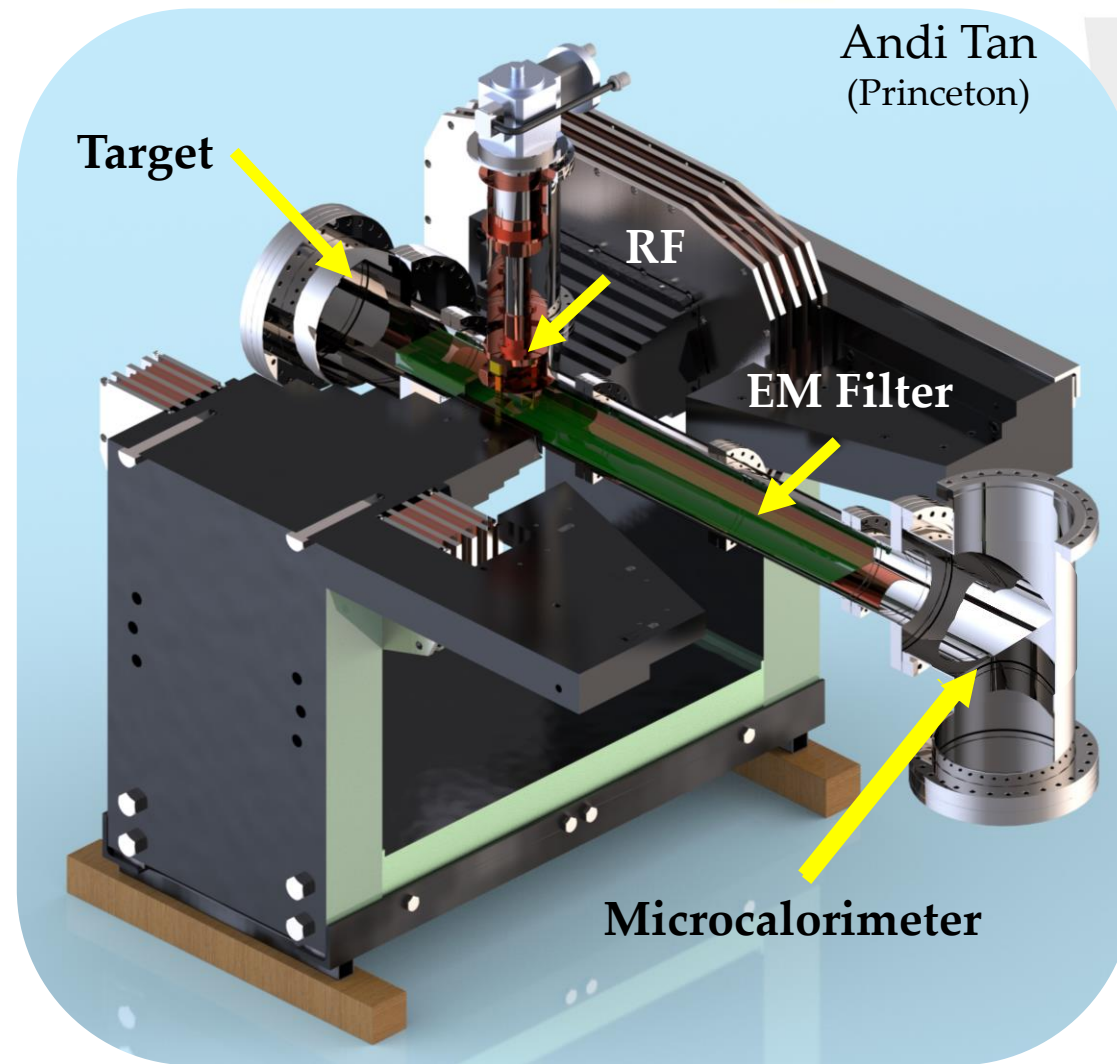
Sputtering of Nb, Al films

INRiM role in PTOLEMY

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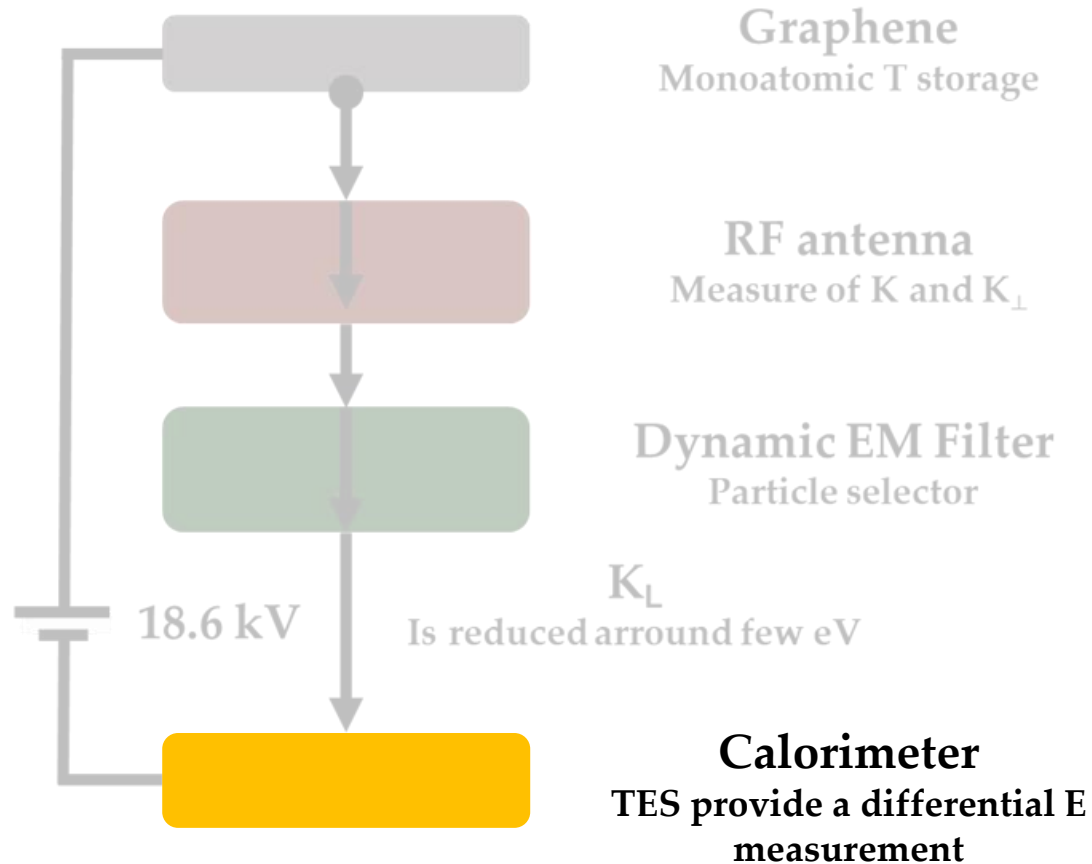
Goal $\Rightarrow \Delta E_e = 50 \text{ meV @ } 10 \text{ eV}$



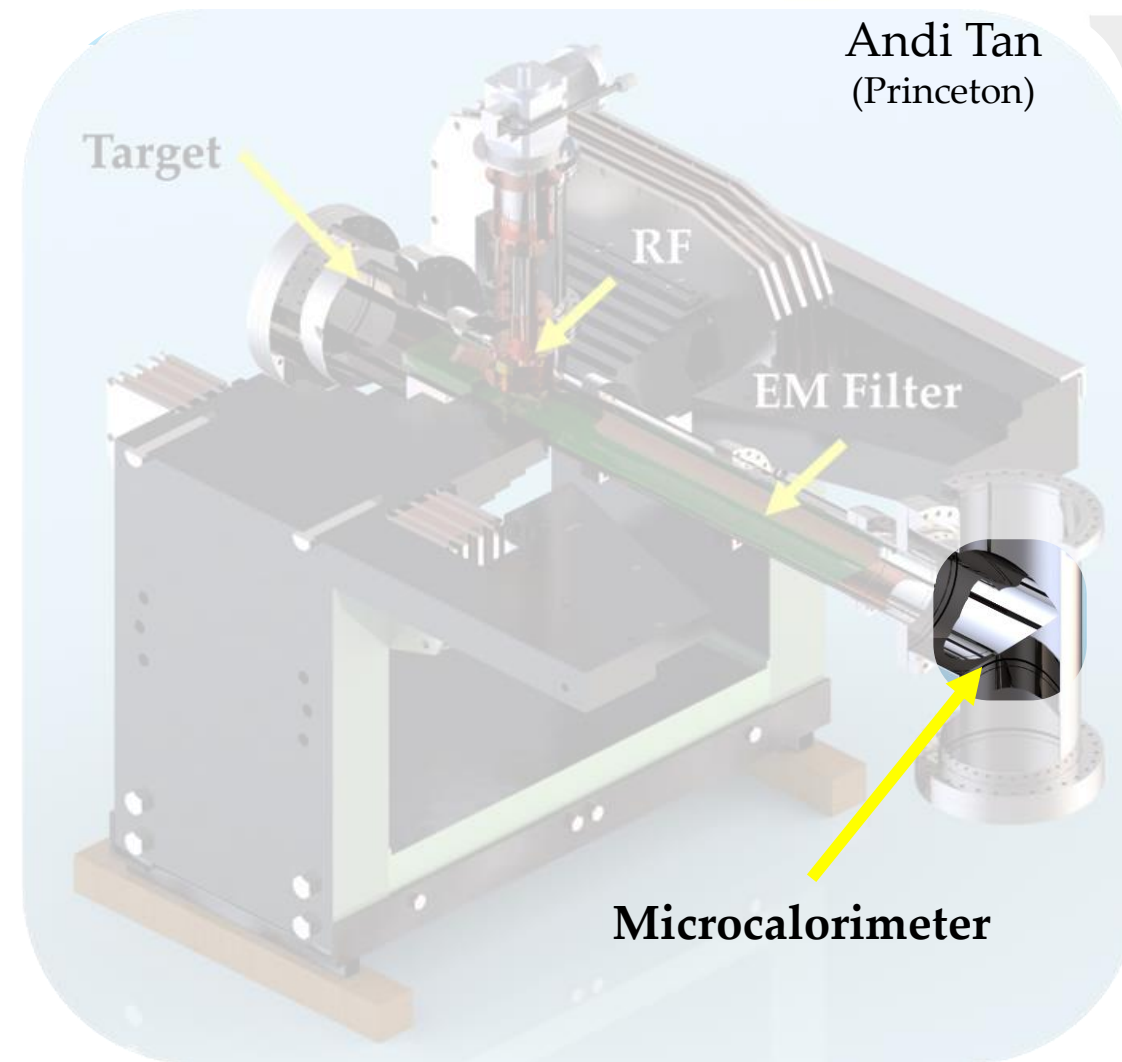
Andi Tan
(Princeton)

INRiM role in PTOLEMY

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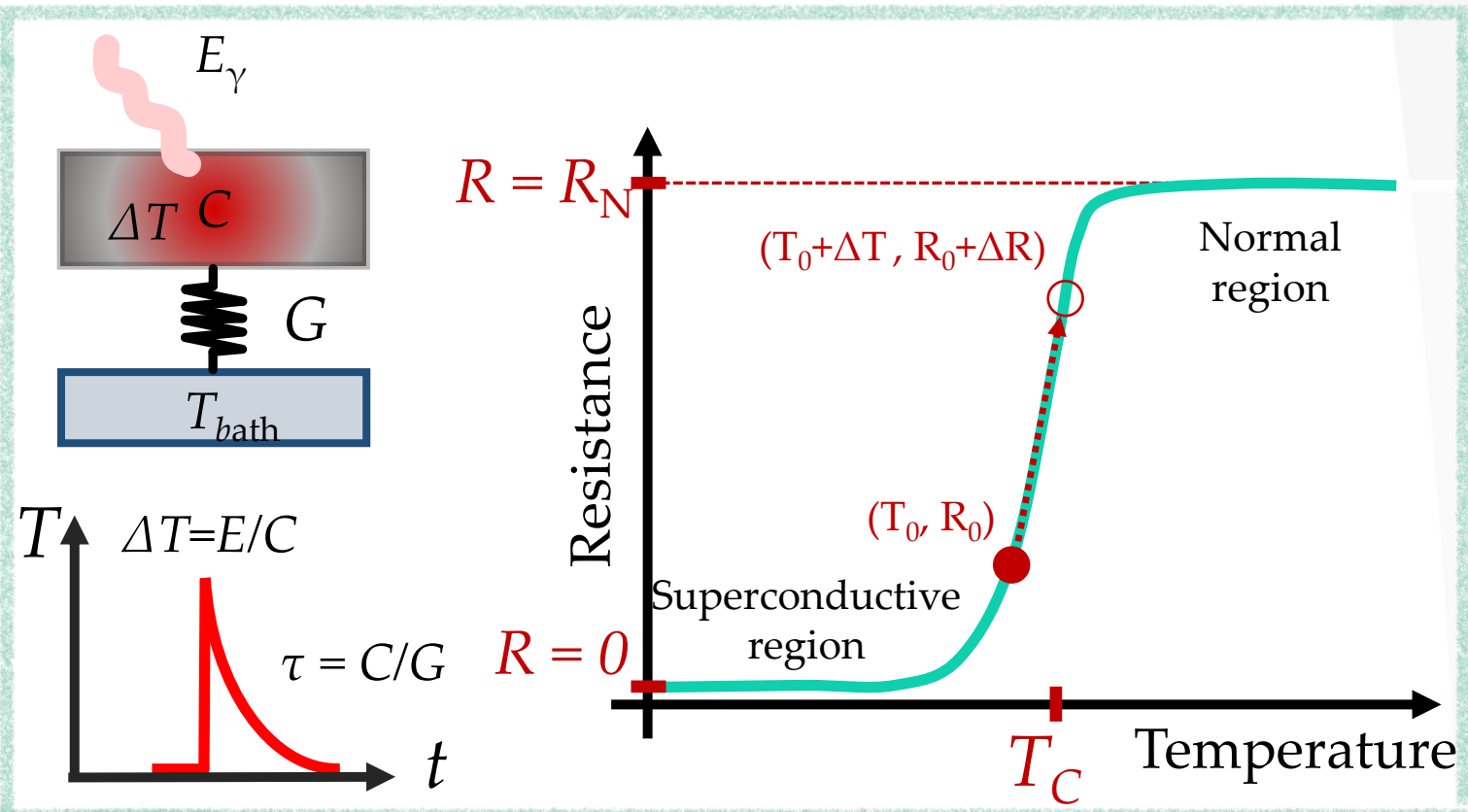
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Transition-Edge Sensors

- TES: detector that exploit the strongly temperature-dependent resistance of the superconducting phase transition occurring at critical temperature T_c

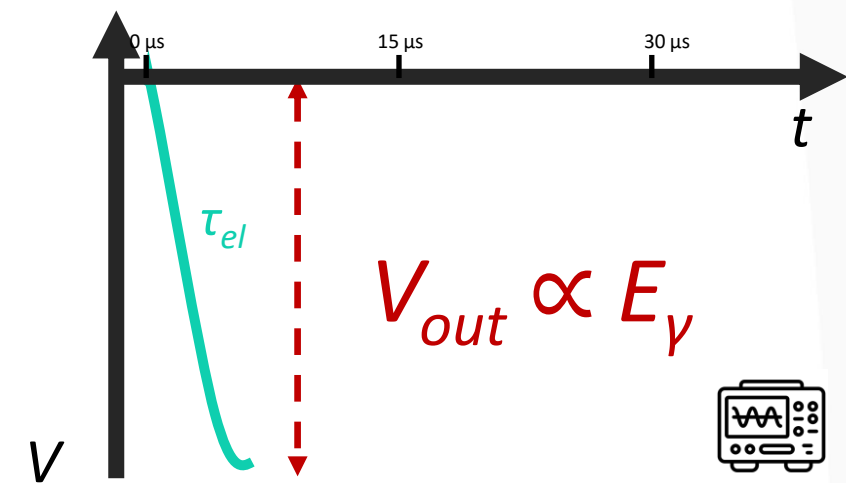
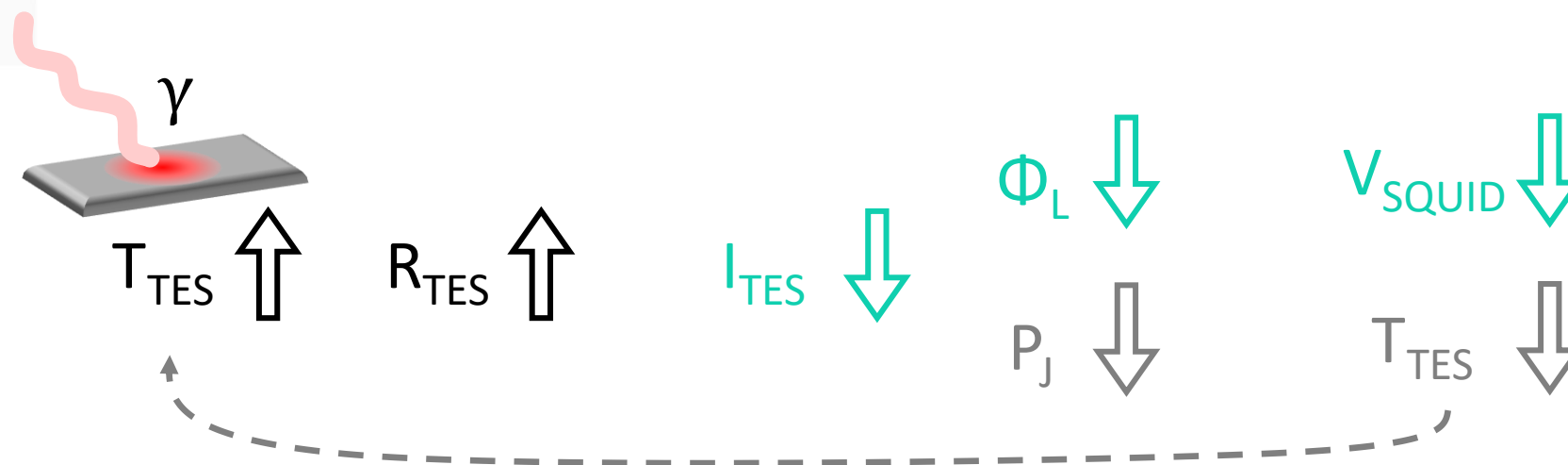
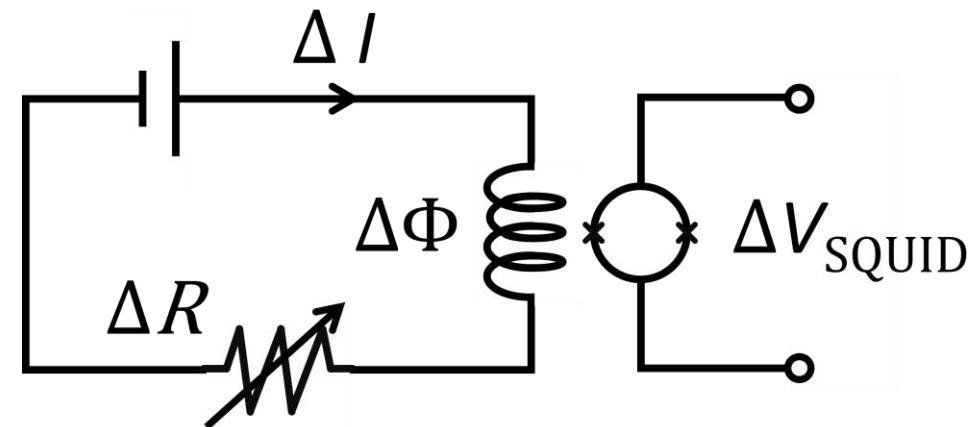


- ✓ Efficiency 98%
Fukuda et al. (2011)
- ✓ ΔE 0.067 eV
Hattori et al. (2022)
- ✓ PNR >50
Xu et al. (2024)
- ✓ Dark count $< 10^{-3}$ Hz
Manenti et al. (2015)



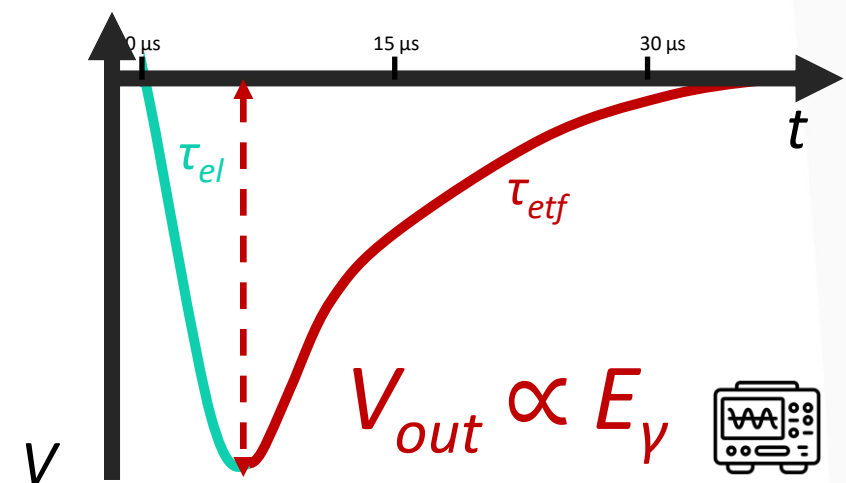
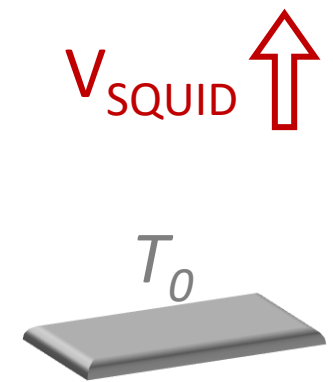
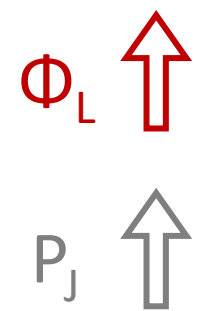
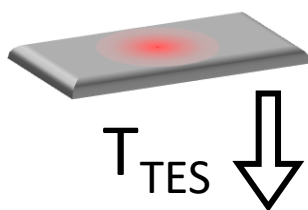
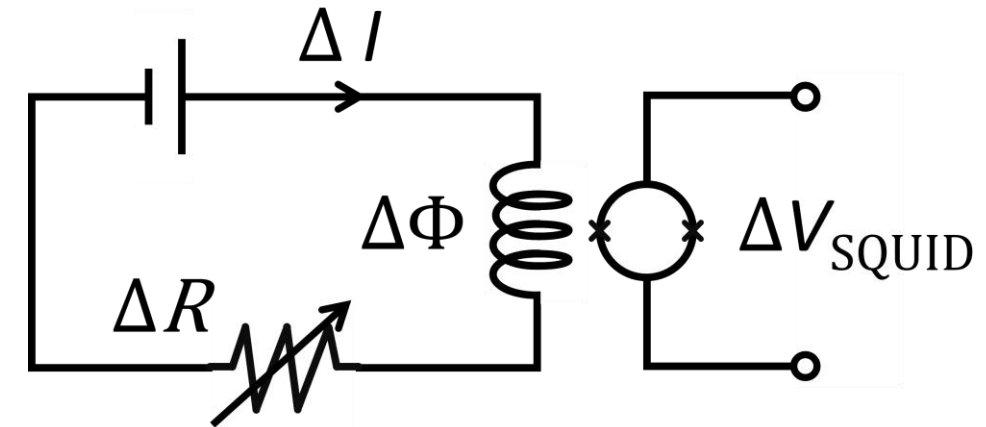
TES working principle

Electrothermal Feedback (*Irwin, 1995*)

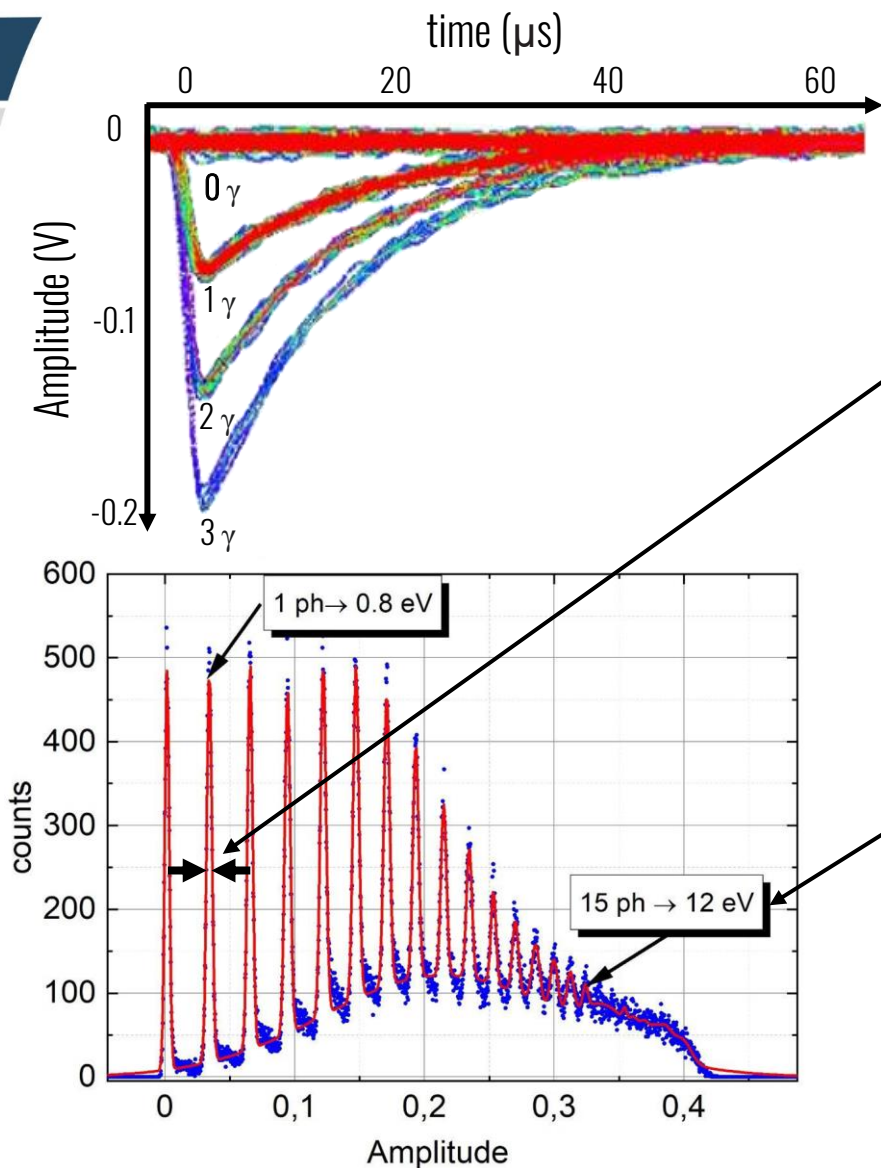


TES working principle

Electrothermal Feedback (*Irwin, 1995*)



Some Figures of Merit



Energy resolution:

$$\Delta E_{FWHM} \approx 7 \sqrt{k_B E_{sat} T_c \sqrt{(1 + 2\beta)(1 + M^2)}} \\ \propto \sqrt{k^{-1} A T_c^3} \quad \underbrace{\hspace{10em}}_{\approx 10}$$

Saturation energy:

$$E_{sat} \approx \frac{CT_c}{\alpha} \propto A T_c^2$$

Best result @INRIM $\Rightarrow \Delta E_e = 48 \text{ meV @1540 nm}$
 $(20 \times 20) \mu\text{m}^2$

...future steps about electrons detection using TESs