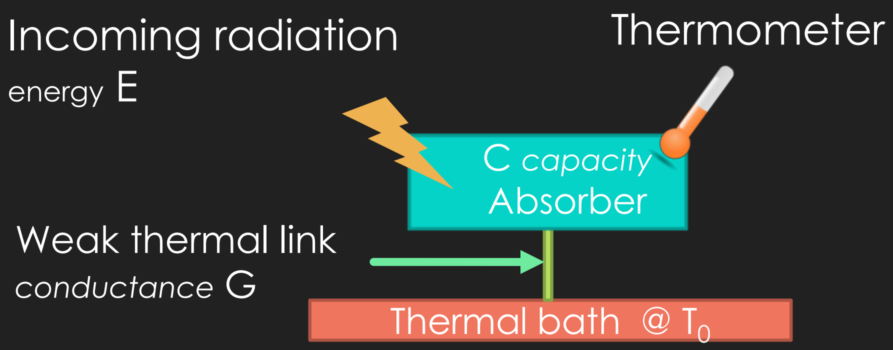
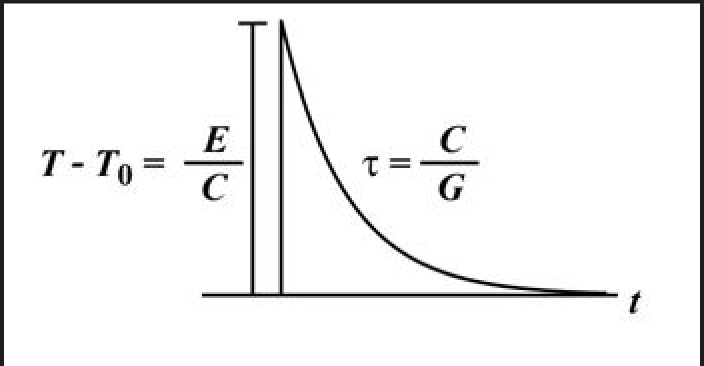
TES development for low-energy events detection at UNIGE

Michele Biasotti

Università di Genova & INFN sez. Genova

μ-calorimetric detector:
working principle

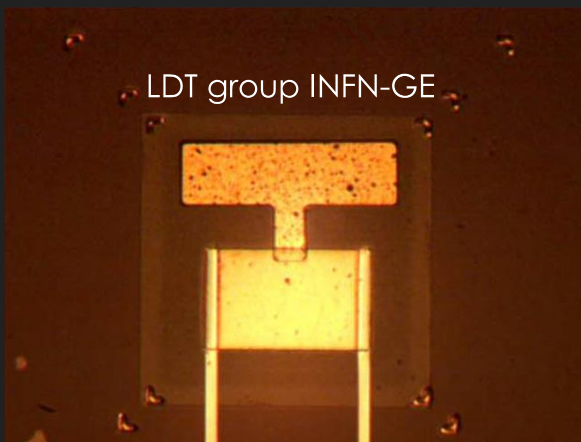


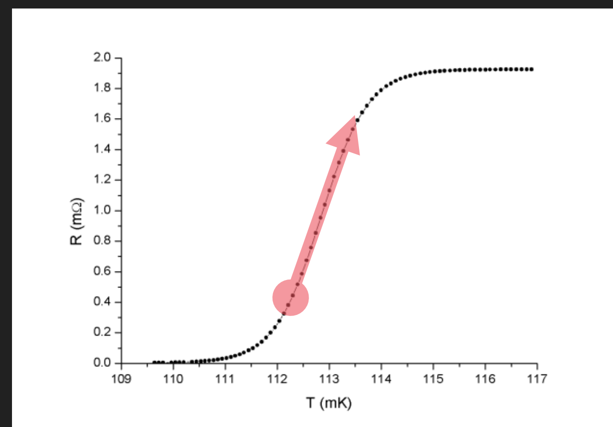


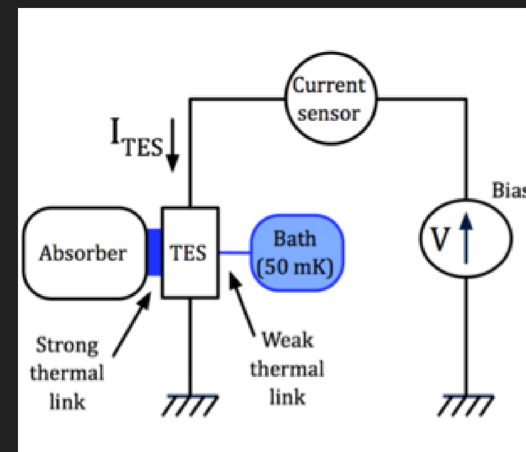
Intrinsic resolution limit:

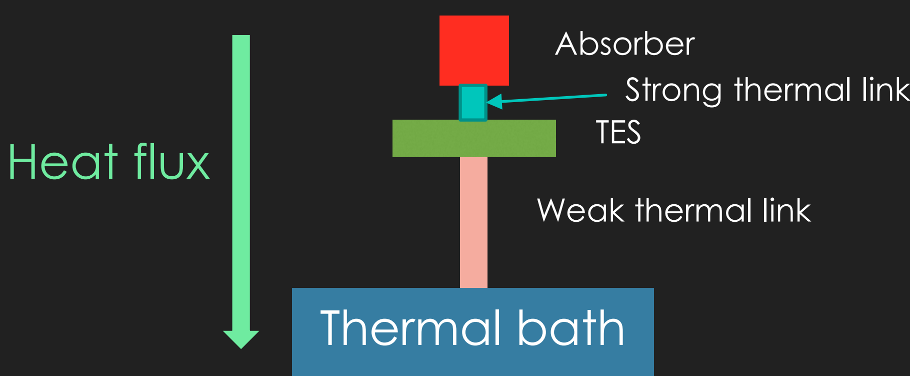
$$\sigma_E \geq \sqrt{4kT^2C}$$

Transition Edge Sensor (TES)









Constant voltage bias
Current readout

$$P_J = \frac{V^2}{R}$$

To have negative electrothermal feedback

Materials critical temperature

$$\sigma_E \propto T^{\frac{3}{2}}$$

- *Low work temperature →* **Low transition temperature**

$$\sigma_E \propto V^{\frac{1}{2}}$$

- *Low thermal capacity →* **small dimensions**

metal		T_c (K)
Aluminum	Al	1.75
Molybdenum	Mo	0.92
Titanium	Ti	0.4
Iridium	Ir	0.12

Materials critical temperature

$$\sigma_E \propto T^{\frac{3}{2}}$$

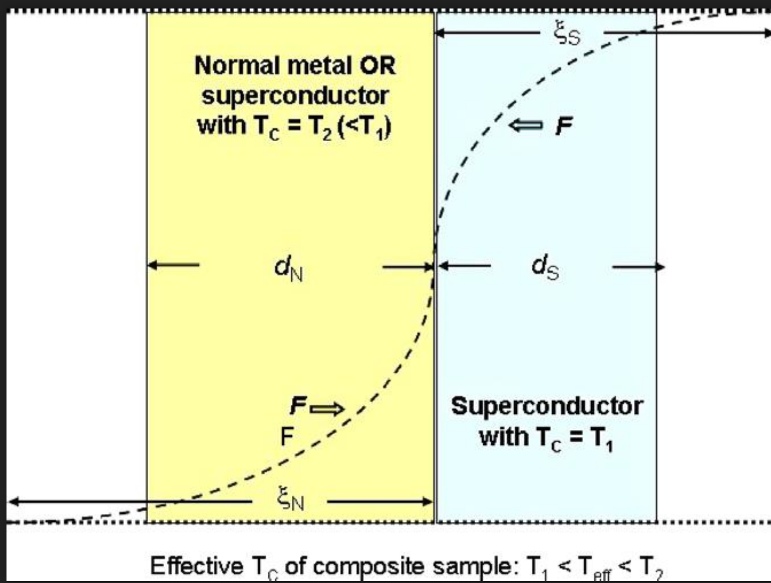
- *Low work temperature →* **Low transition temperature**

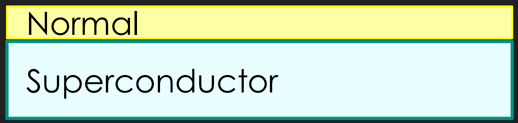
$$\sigma_E \propto V^{\frac{1}{2}}$$

- *Low thermal capacity →* **small dimensions**

metal		T_c (K)
Aluminum	Al	1.75
Molybdenum	Mo	0.92
Titanium	Ti	0.4
Iridium	Ir	0.12

Proximity effect



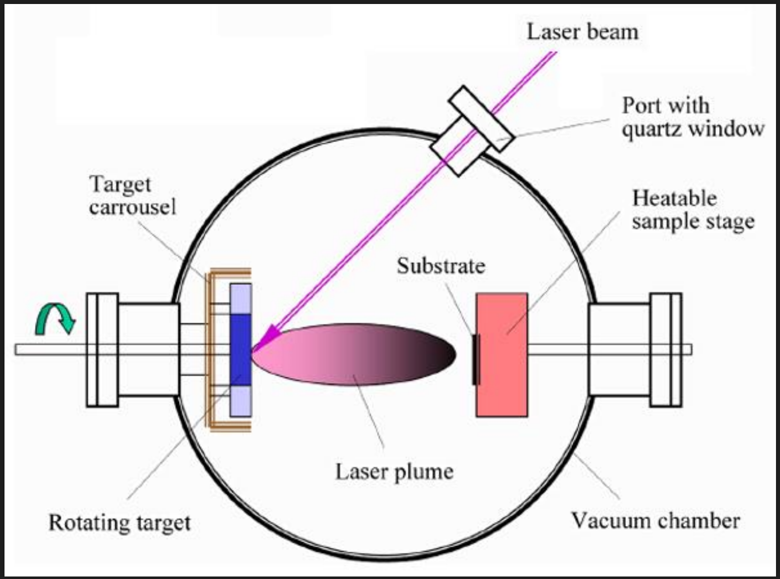


- The behavior of thin bilayer film is like a single metal
- The T_C is «averaged» between the two metals

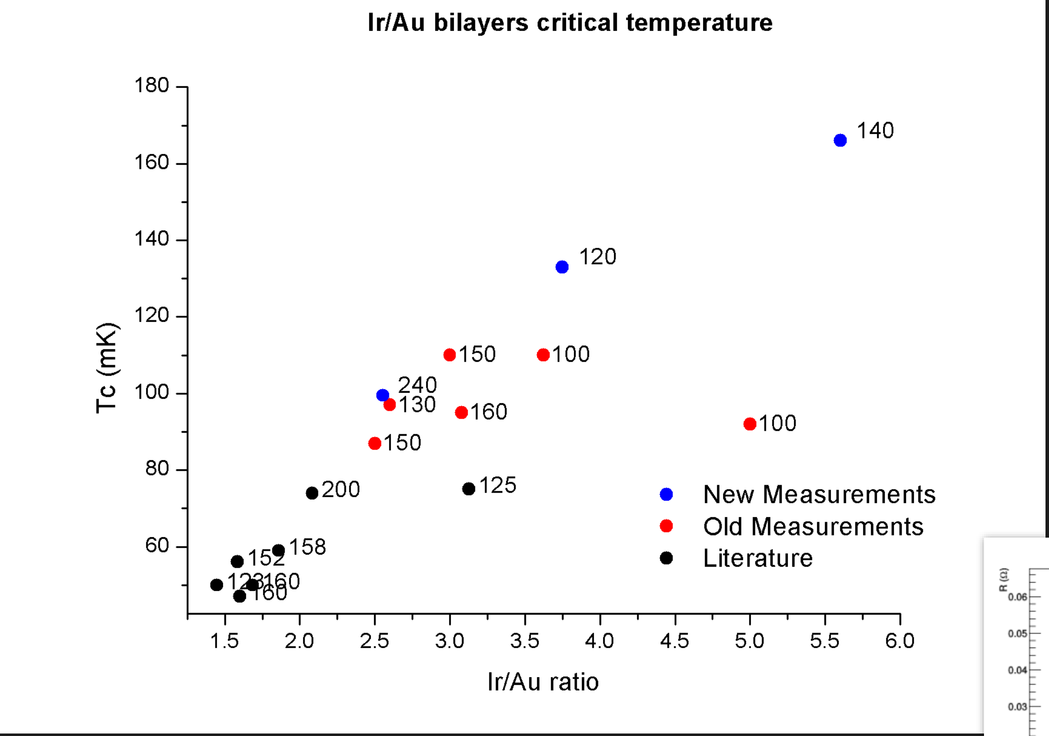
⬇

- Working temperature less than 0.1 K

Ir growth by PLD



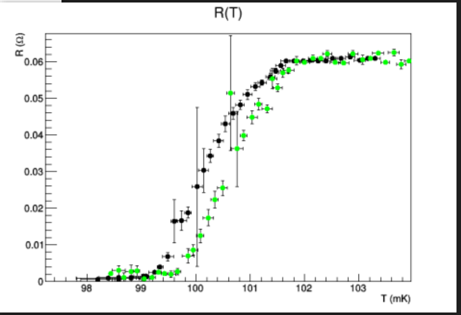
Ir:Au bilayers T_c



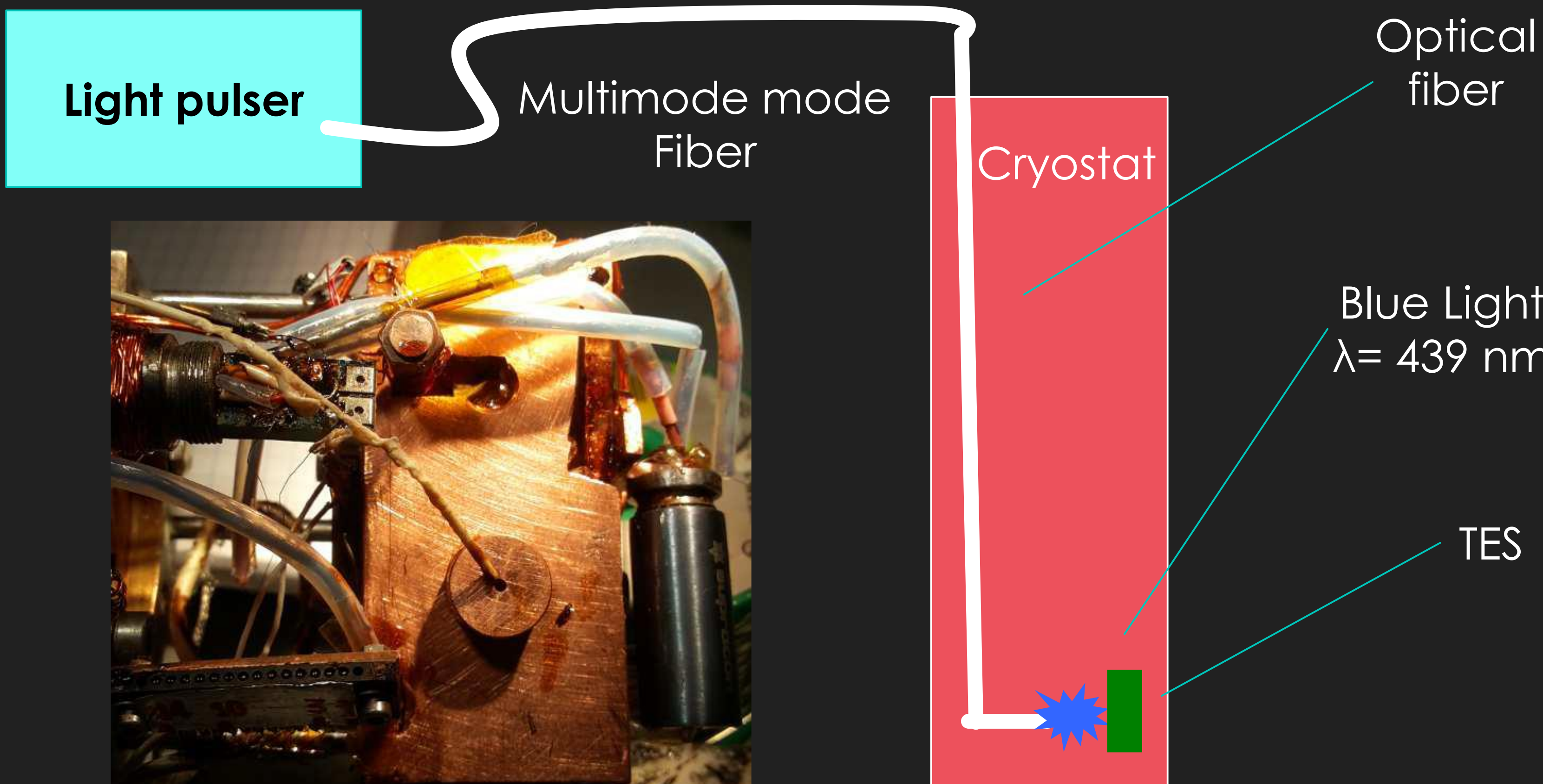
Journal of Applied Physics, 76, 4262

We studied Ir:Au critical temperature as function of Ir/Au ratio and Ir thickness

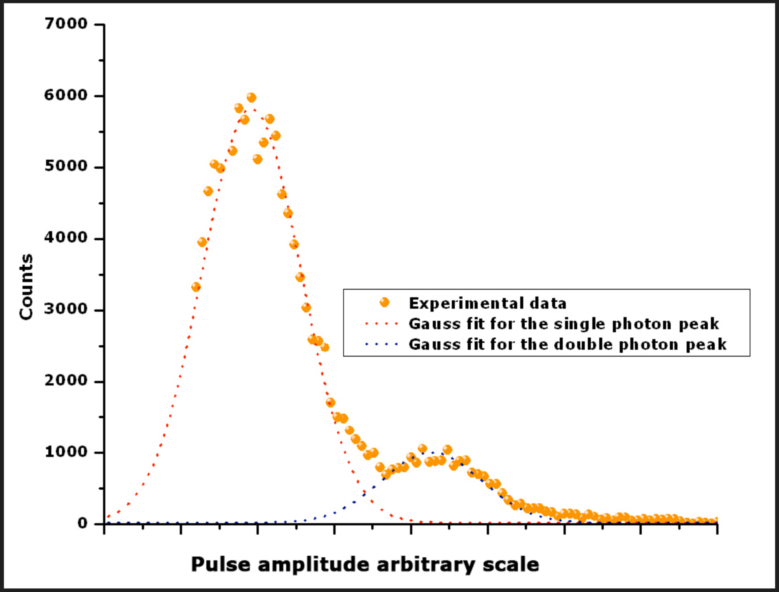
There is also a dependence to Ir absolute thickness

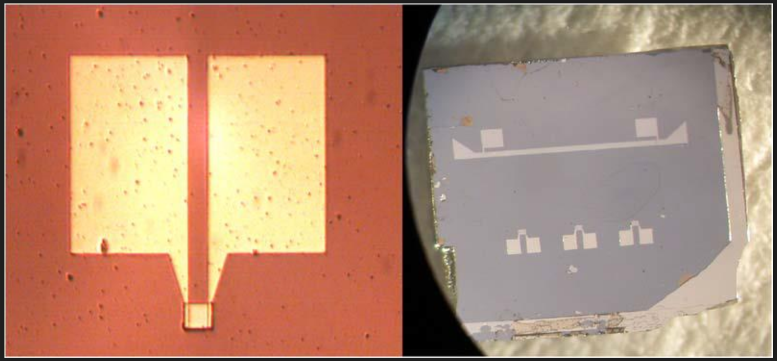


Characterization setup with blue light



TES with single photon resolution
(in the past)

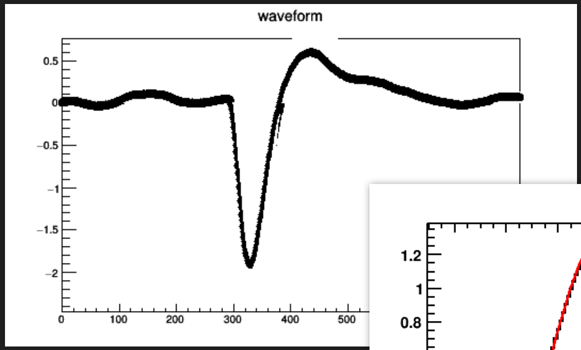




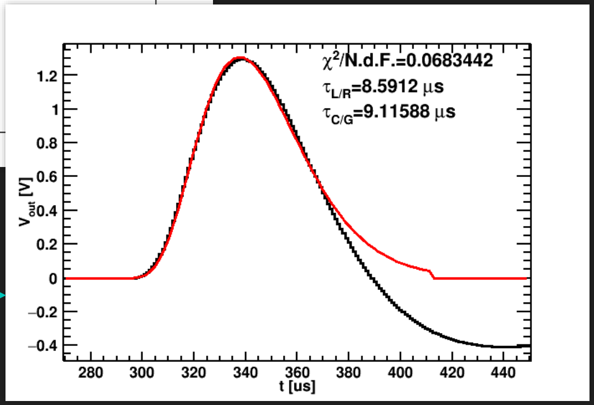
J. Low. Temp. Phys. 151: 234–238

New TES for low energy event
Tested with blue light

total area 25×25 μm²



Pulse example

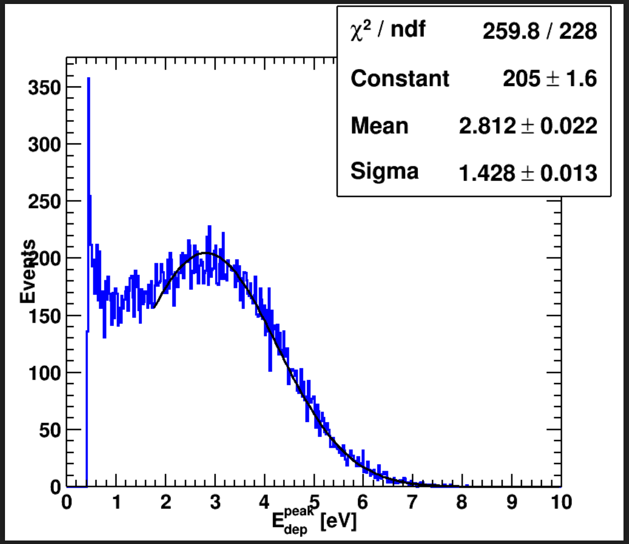


Average Pulse

Pulse detected on laser trigger
Average photons per pulse << 1

New TES for low energy event
Tested with blue light

total area 25×25 μm^2



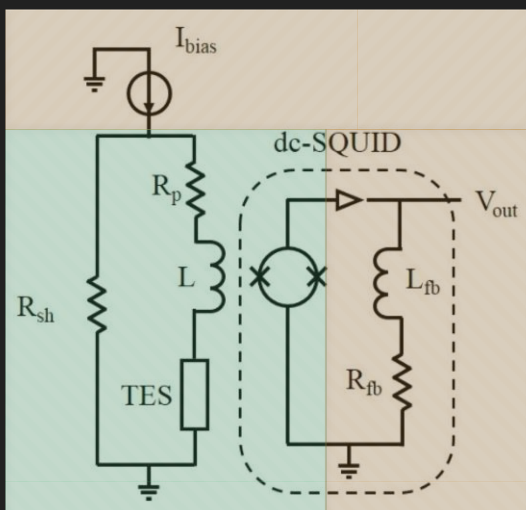
Pulse detected on laser trigger
Average photon per pulse << 1

Limited resolution probably due to photon absorption on wiring

Conclusions

- TES detector with single photon resolution already produced in the past
- Restarted the development of Ir:Au TES with single photon resolution
- A new device has been produced. Energy resolution has to be improved

Elementary TES readout



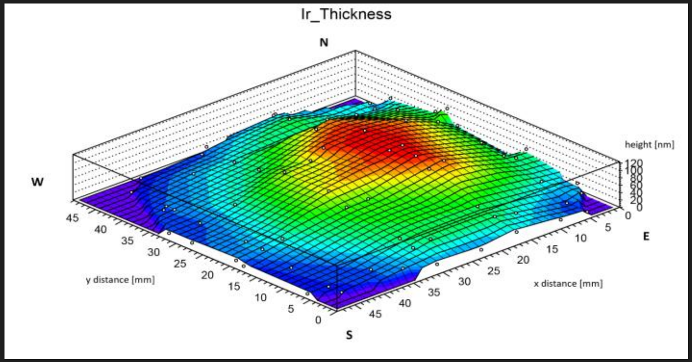
Cold Electronic

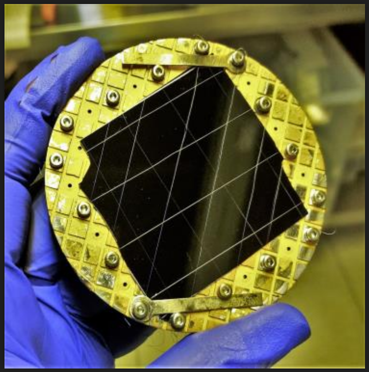
- TES
- SQuID Sensor

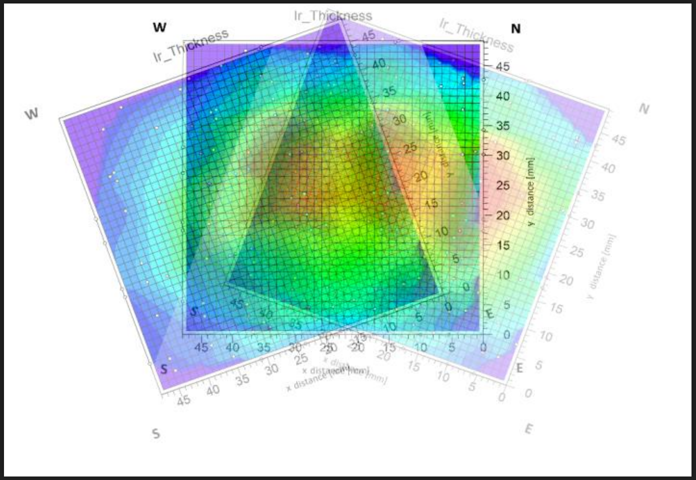
Warm Electronic

- SQuID control electronic
- ADC/DAQ

PLD calibration
To control Ir thickness







We have been calibrated our system to have an high control of Ir thickness