Status of the TESSERACT Low Voltage HPGe detector

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on behalf of the TESSERACT collaboration

GDR DI2I, 18 Juin 2026

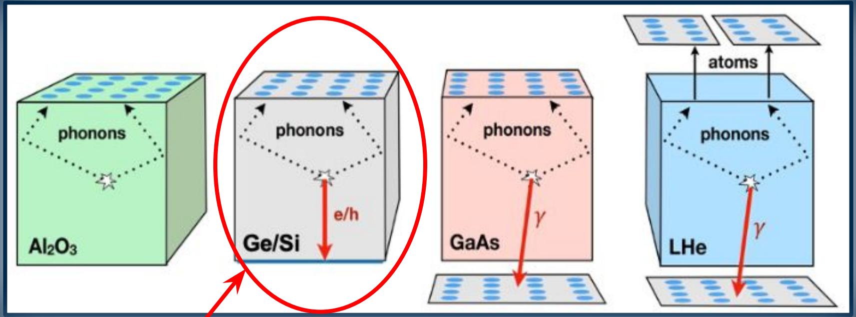
1. working principle
2. current status and performances
3. planning and next milestones

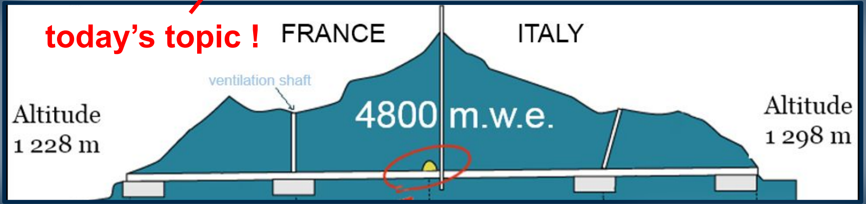
1. Introduction

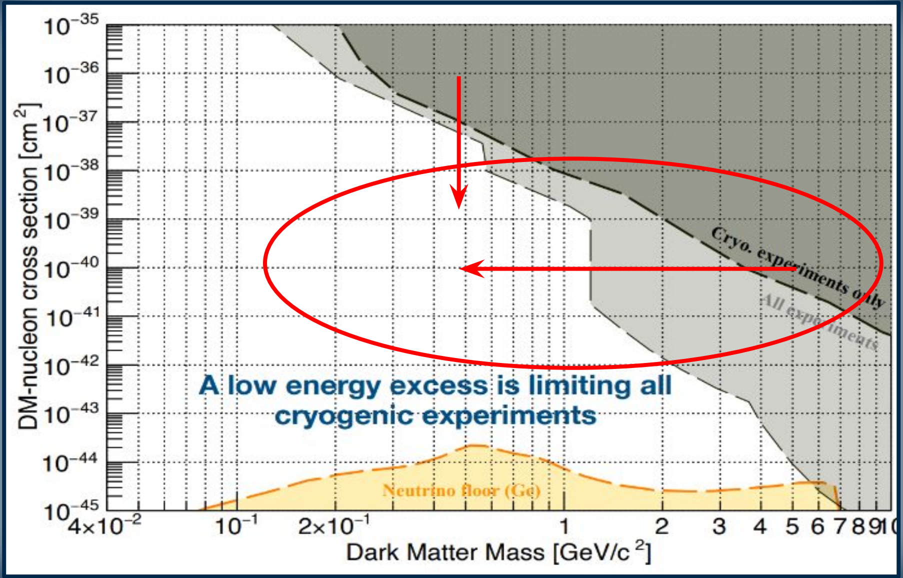
The TESSERACT collaboration

Transition-**E**dge **S**ensor with **S**ub-**e**v **R**esolution **A**nd **C**ryogenics **T**argets

Collaboration between **FRANCE / USA / SUISSE**
80 members dans **12 laboratoires**

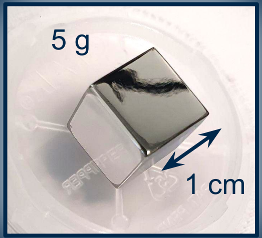


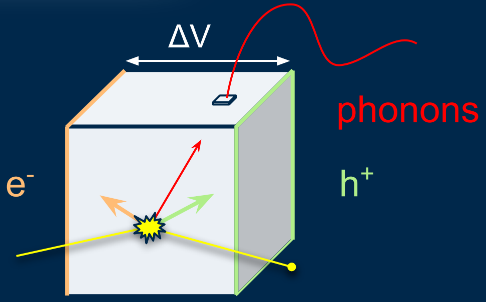


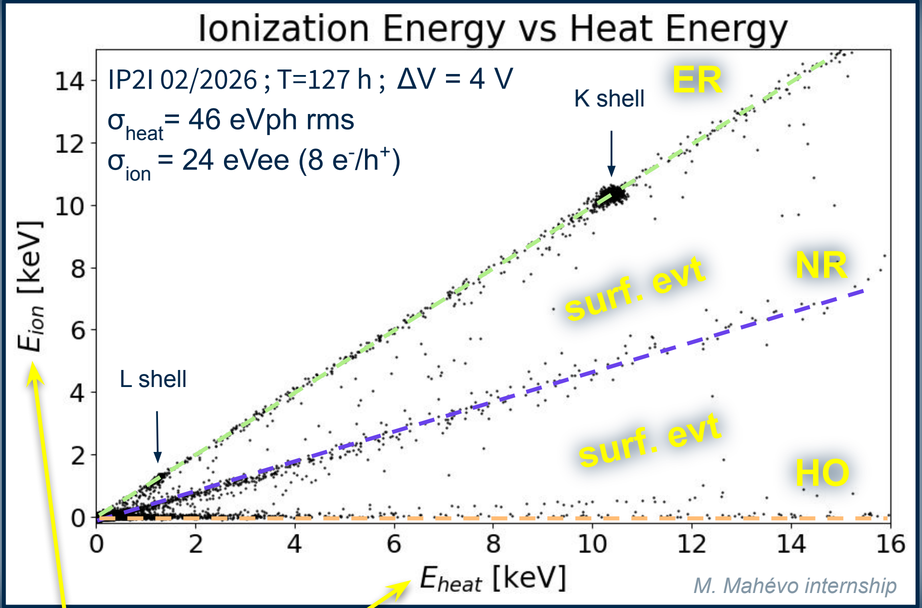


goal 100 meV/c^2 - 1 GeV/c^2

Working principle







NR dark matter, neutrinos, neutrons
ER photons (+ charged particles)

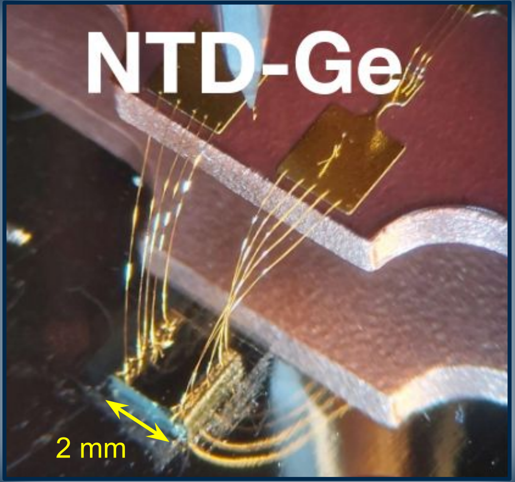
+ HO non-ionizing events

E_{ion} and E_{heat} measured simultaneously over time

need automatic pulse detection and energy estimator

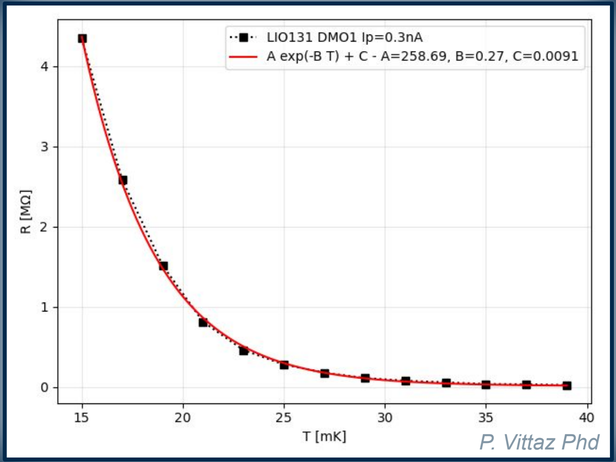
The phonon channel

the sensor itself



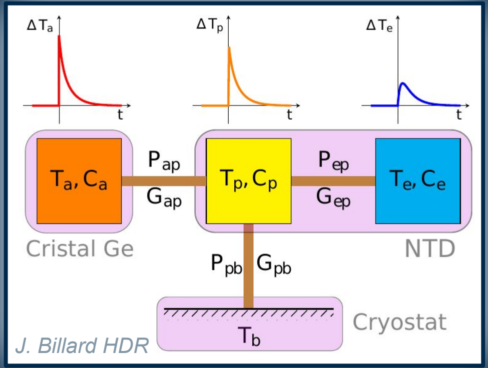
Neutron Transmutation Doped Ge

response to temperature



exponential thermistor

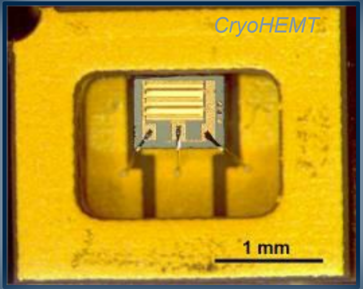
thermal model and pulses



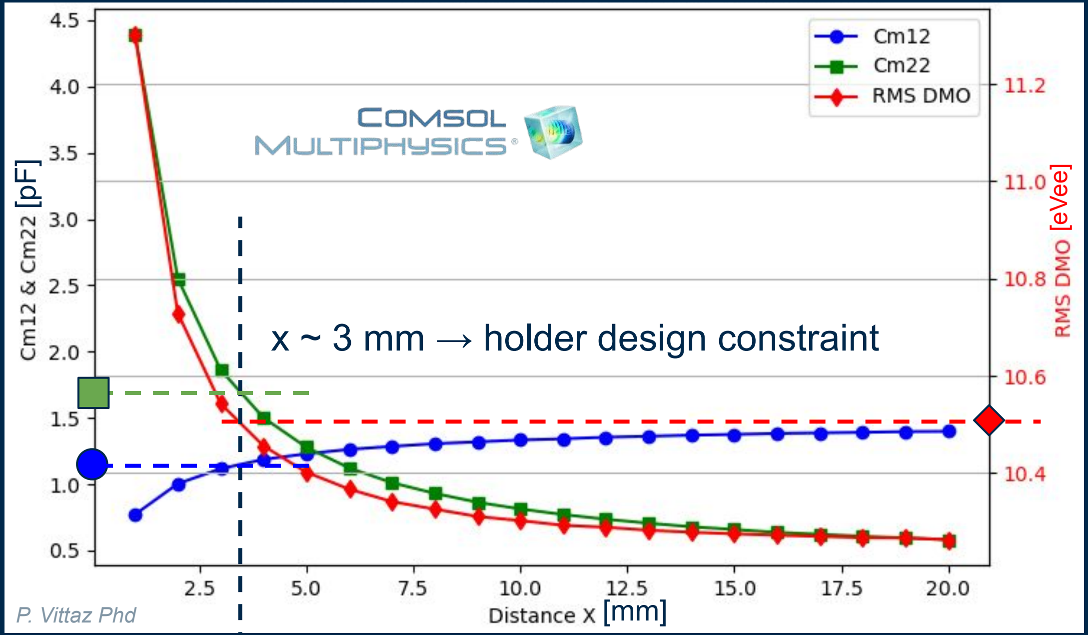
$\Delta T \sim \mu K$

$\sigma_{heat} \sim 10 - 50$ eVph

The ionization channel



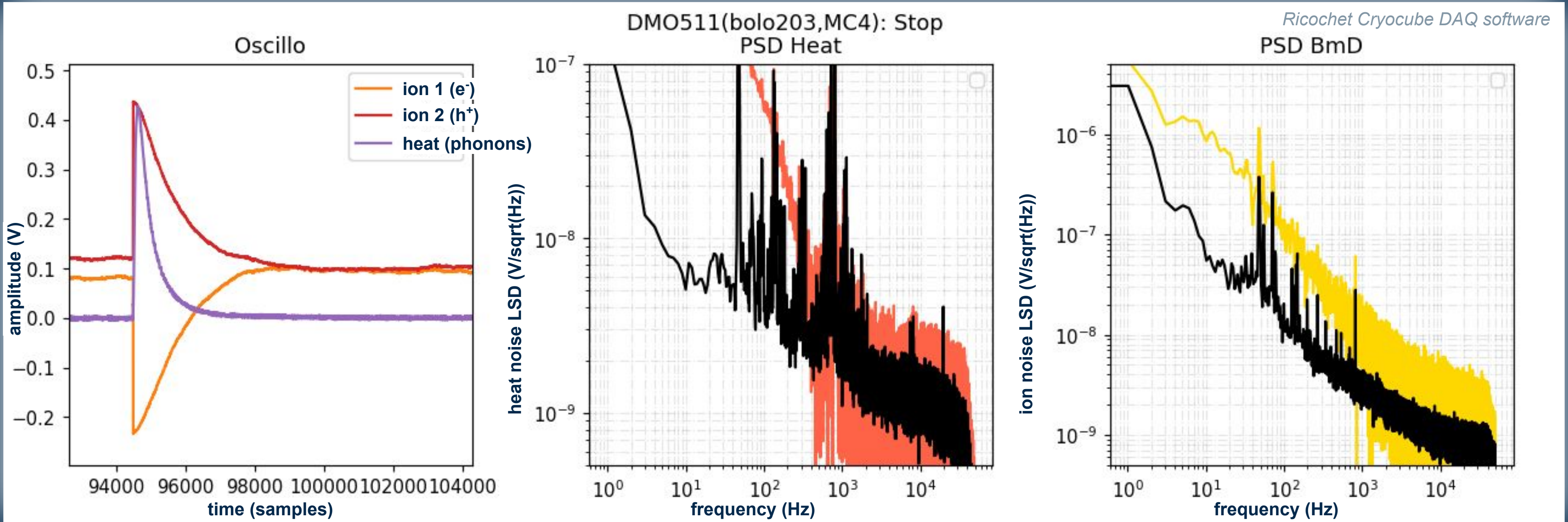
High Electron Mobility Transistor
CryoHEMT - C2N



- C_{det} ~ 1-2 pF ; $C_{parasitic}$ ~ 1-2 pF
- σ_{RMS} ~ 10.5 eV

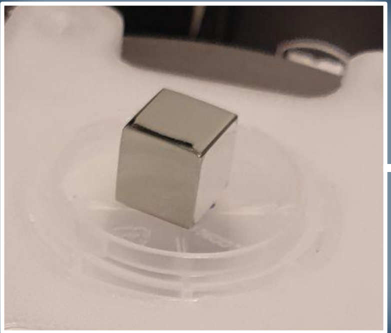
best resolution achievable ~ 10 eVee

Experimental data



2. Current status & performances

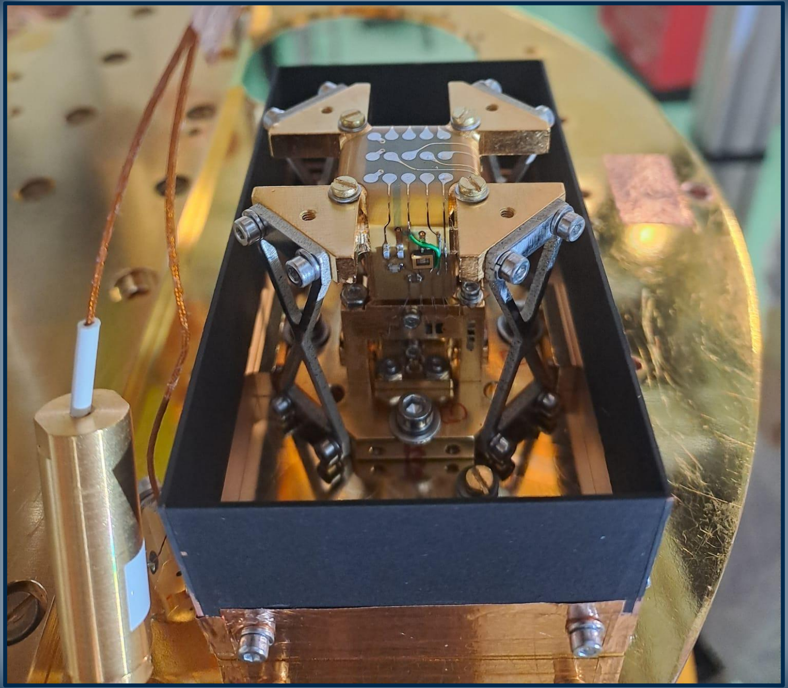
Detector integration at Lyon

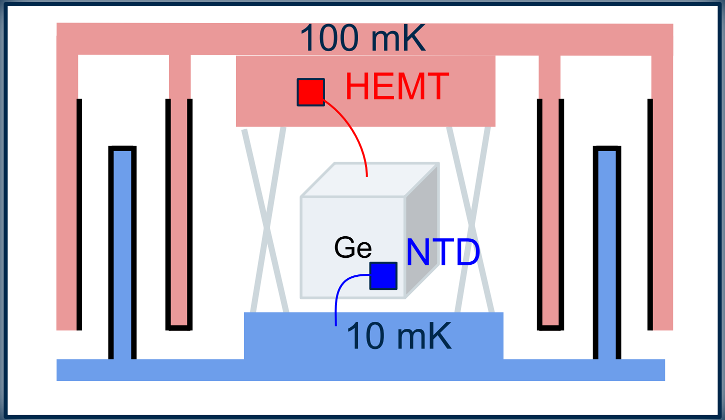


HPGe crystal from MIRION
electrodes from IJCLAB / INL NanoLyon

fully integrated detector with readout

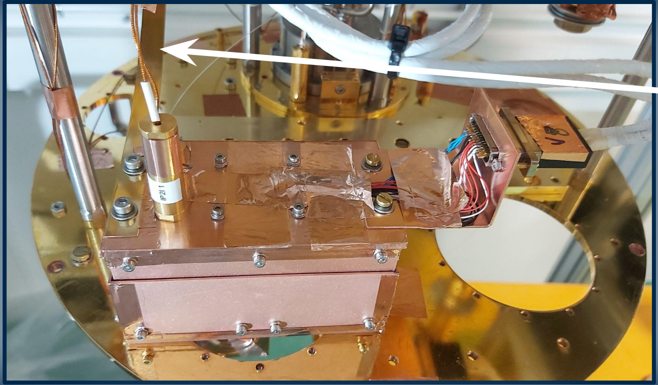
Managing IR radiation with two T stages



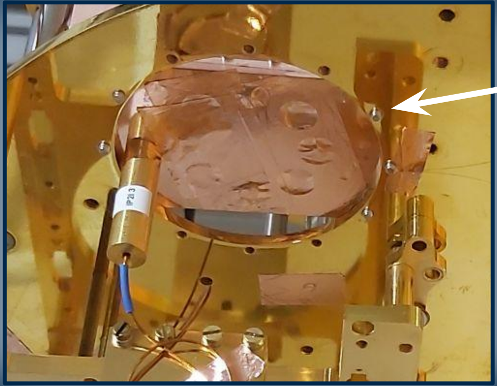


design issue HEMT induces ~ pW on the crystal

Current thermal performances



CP connection using 0.3 mm gold plated CuC2 straps



MXC connection using M3 screws + belleville washers

12 uW dissipated by the 2 HEMTs
75 nW seen on the 10 mK side

P. Vittaz Phd

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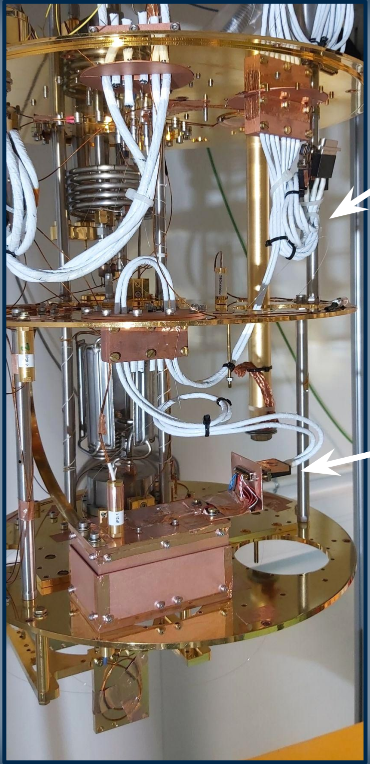
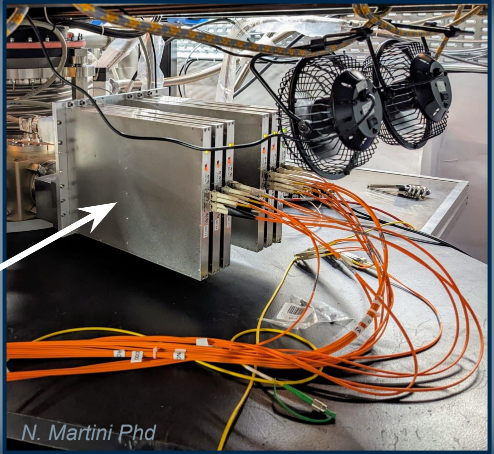
Readout and DAQ



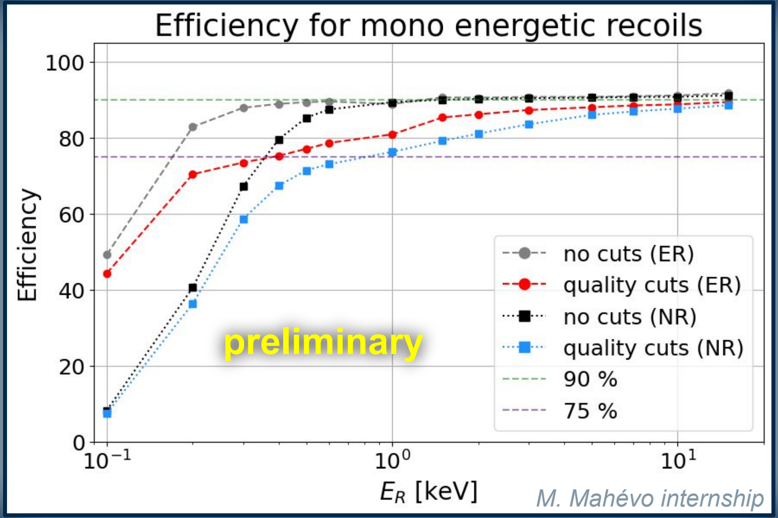
pico coaxial cable harness made by AXON
CuNi leads, stainless steel shielding

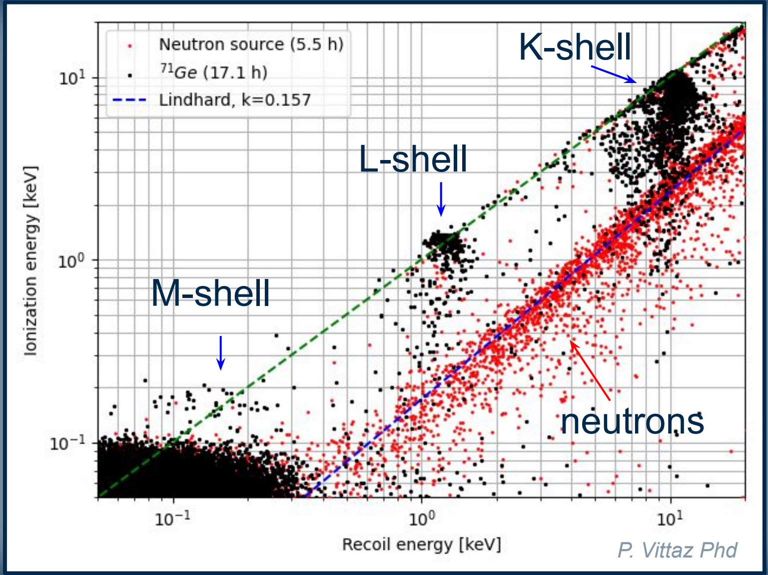
micro D 25 pins
+ custom interface

RICOCHET "boloboxes"
Cyrille Guérin talk



Detector performances





detection efficiency estimate for ER and NR

preliminary DM limit expected mid-July

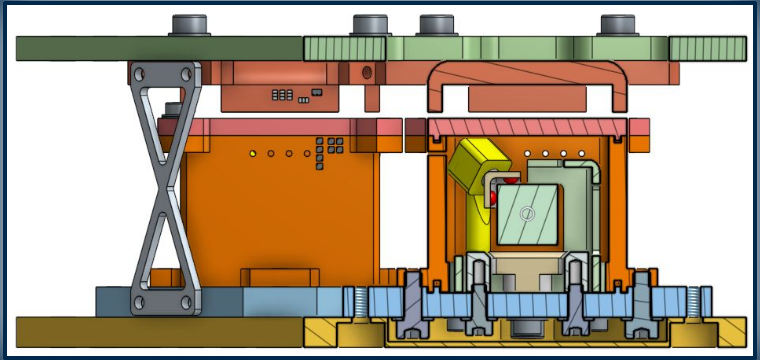
	PT on	PT off
heat (eVph)	32.8	21.6
ion (eVee)	22.9	24.7

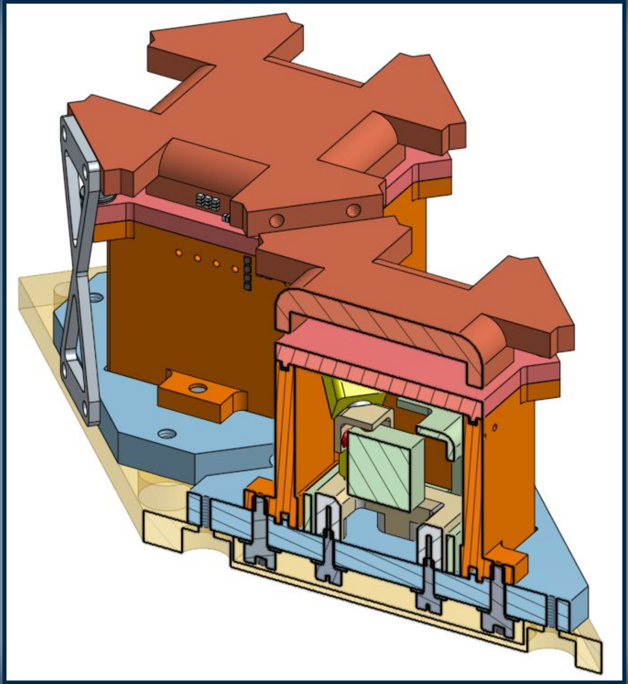
~~Future~~ Today’s development

The LV design for Modane

Take-away from this first phase

- shielding against IR at 10 mK is best
- holder is too bulky
- IR paint is (too) radioactive
- thermal straps needs to be improved
- closer the HEMT, better the ion resolution
- current thermal strategy (100/10 mK) is good enough



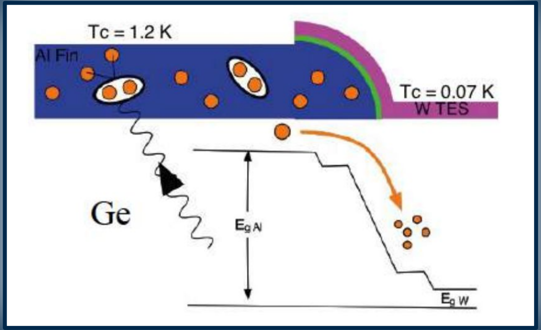


cryo. validation expected end 2026

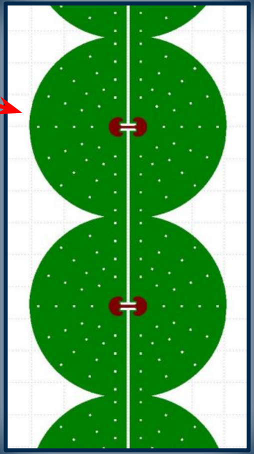
same mechanics, two phonons sensors LV-NTD, LV-TES

The (future) phonon channel

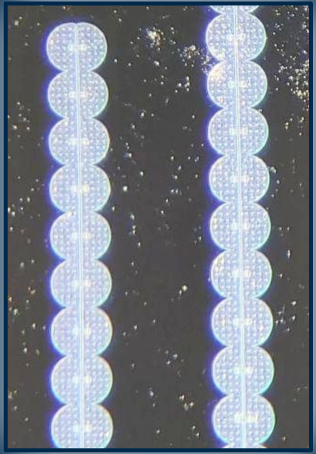
Quasiparticle-Trap-Assisted Electrothermal Feedback Transition Edge Sensors → QET-TES



Jeffrey Jyh-Chung Yen
osti 1352050



Doug Pinckney
2505.16092



athermal phonons

world leading resolution !

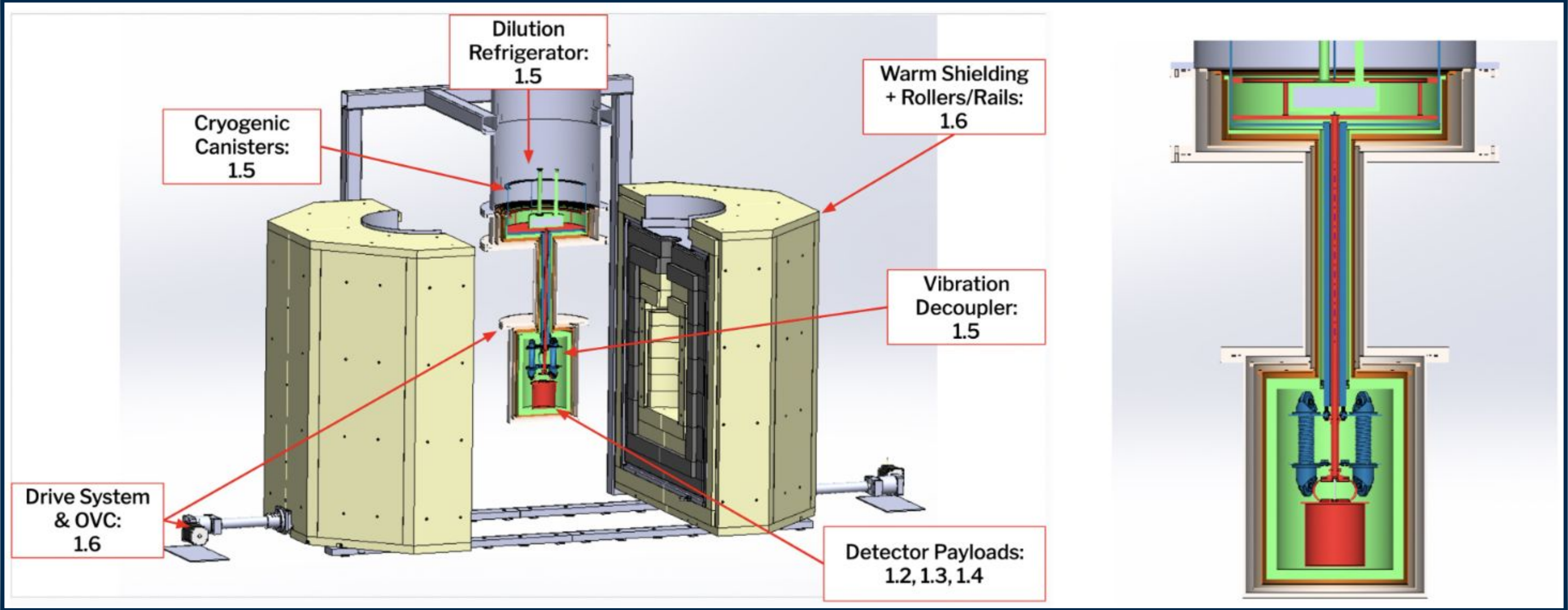
m = 0.2 g (Si) Tc ≤ 50 mK
σ_{phonon} = 361.5 ± 0.4 meV

TESSERACT collab.
2503.03683

~ 100 meV achievable on gram scale detector

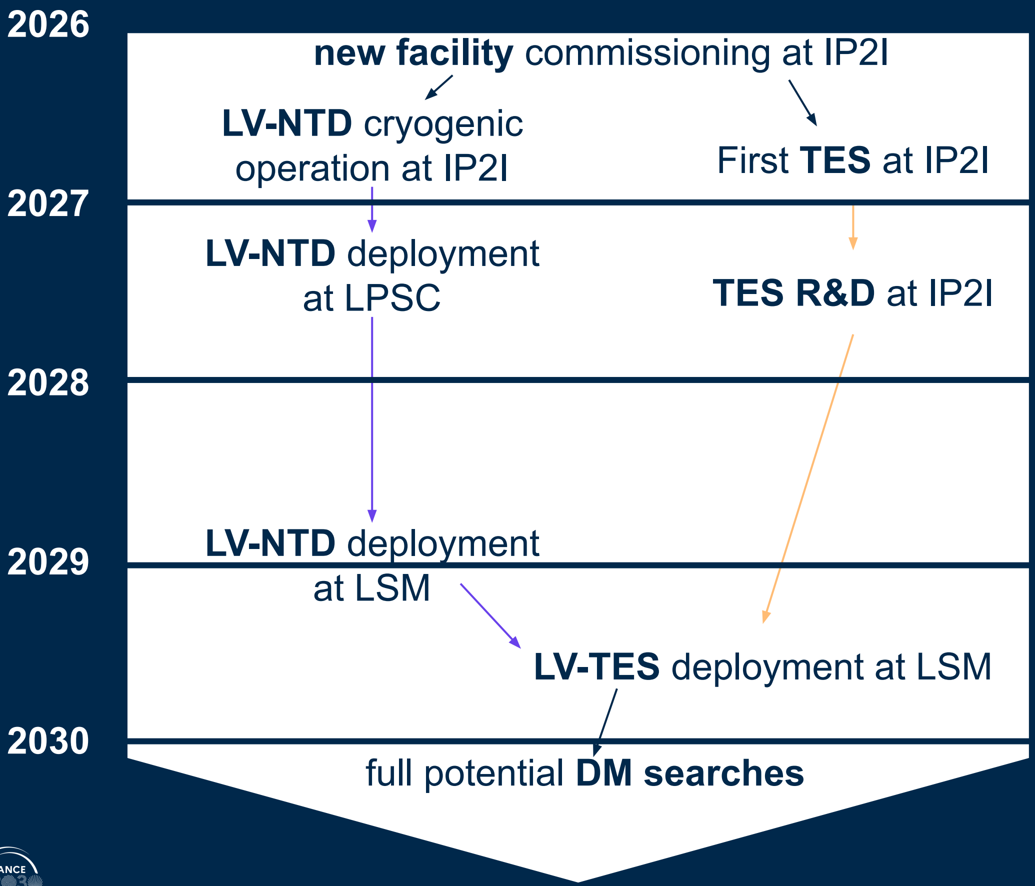
next challenge QET-TES with HEMT ionisation readout

Ultra-low background setup



+ material radioactivity screening, electro magnetic filtering

Planning and next milestones



cryogenics
=
teamwork

research team, students, post-doc,
technical staff, administrative staff, …