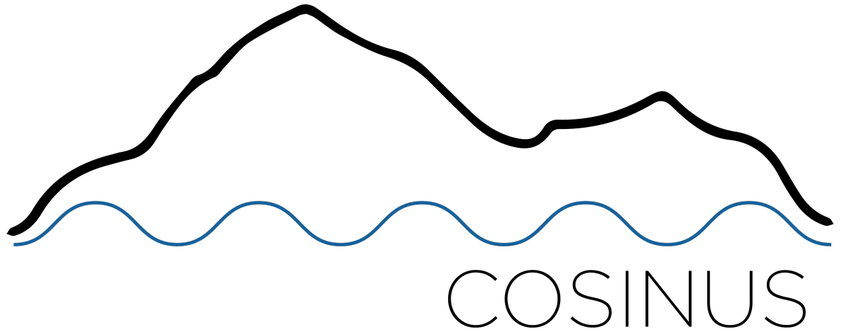
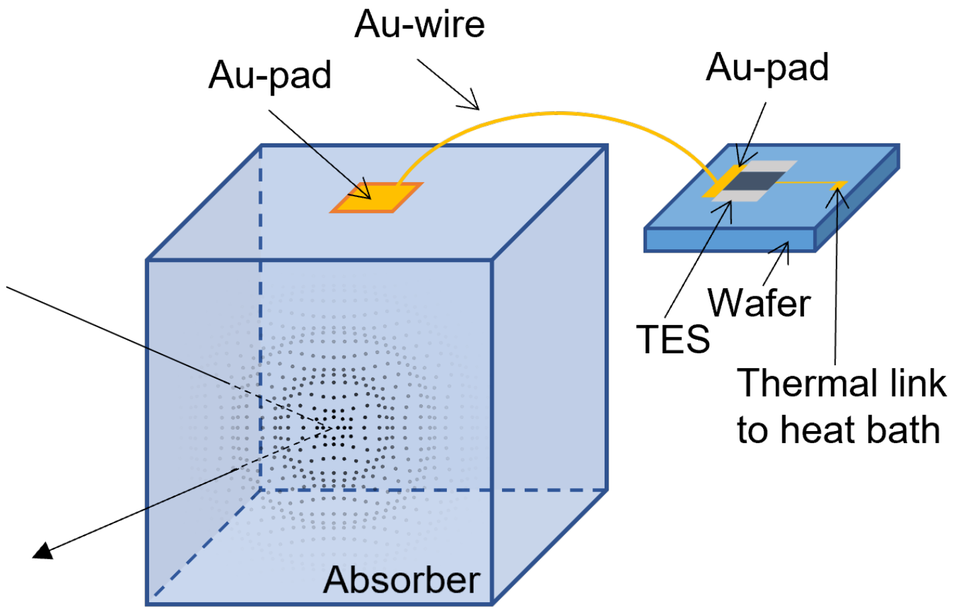


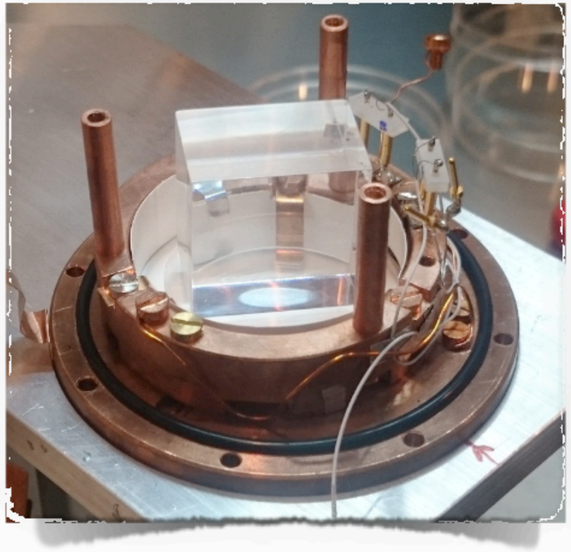
COSINUS & Friends: Search for dark matter with cryogenic detectors

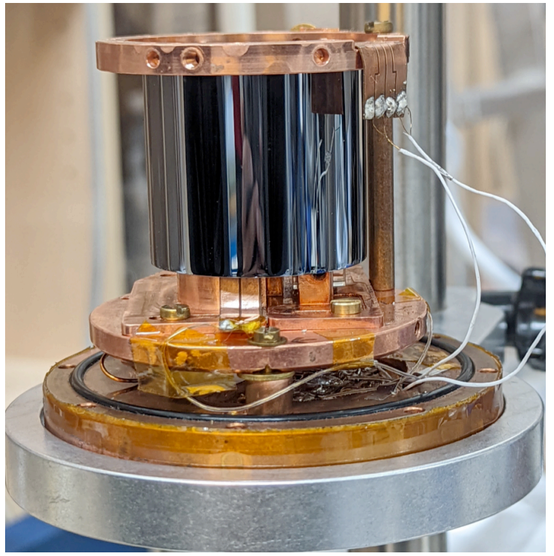
www.gssi.it

The COSINUS Experiment

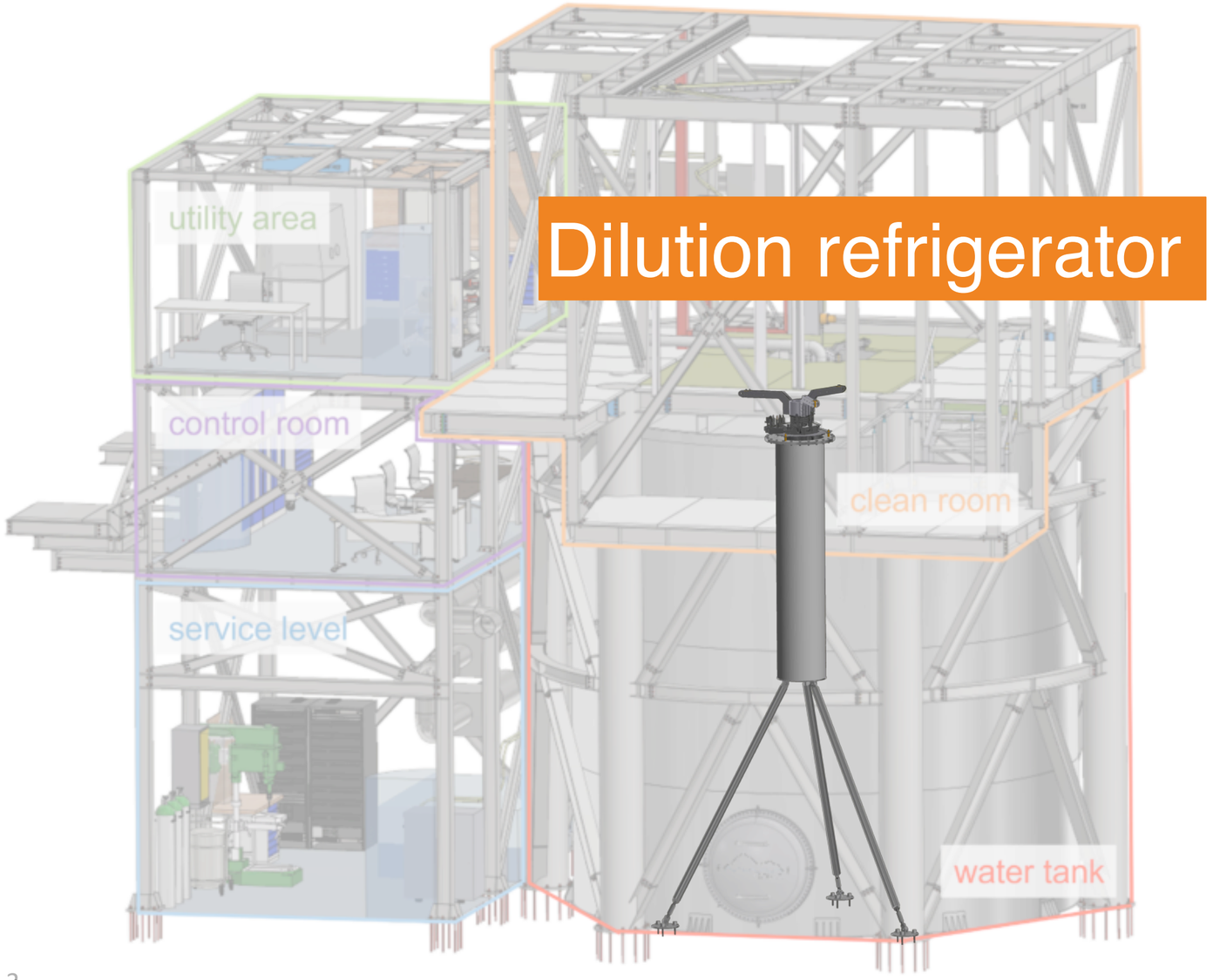


- Goal: a model independent test of the DAMA/LIBRA experiment
  - NaI target material - same as D/L
  - Same location, LNGS Hall B
- NaI as a cryogenic calorimeter
  - First ever
  - **Event by event particle Discrimination**





Experimental Setup



Dilution refrigerator

COSINUS - Hall B

COSINUS: GSSI-LNGS-UnivAQ

Gianni Profeta

Professor

Alessandro Filipponi

Professor

UNIVERSITÀ DEGLI STUDI DE L'AQUILA

GRAN SASSO SCIENCE INSTITUTE

Matthew Stukel

Scientist at Snolab

Camilla Petrucci

Post-doc

Cesare Tresca (CNR researcher)
Paolo Settembri (PhD student)

Natalia Di Marco

Professor

Lorenzo Pagnanini

Professor

Stefano Pirro

Researcher

Andrei Puiu

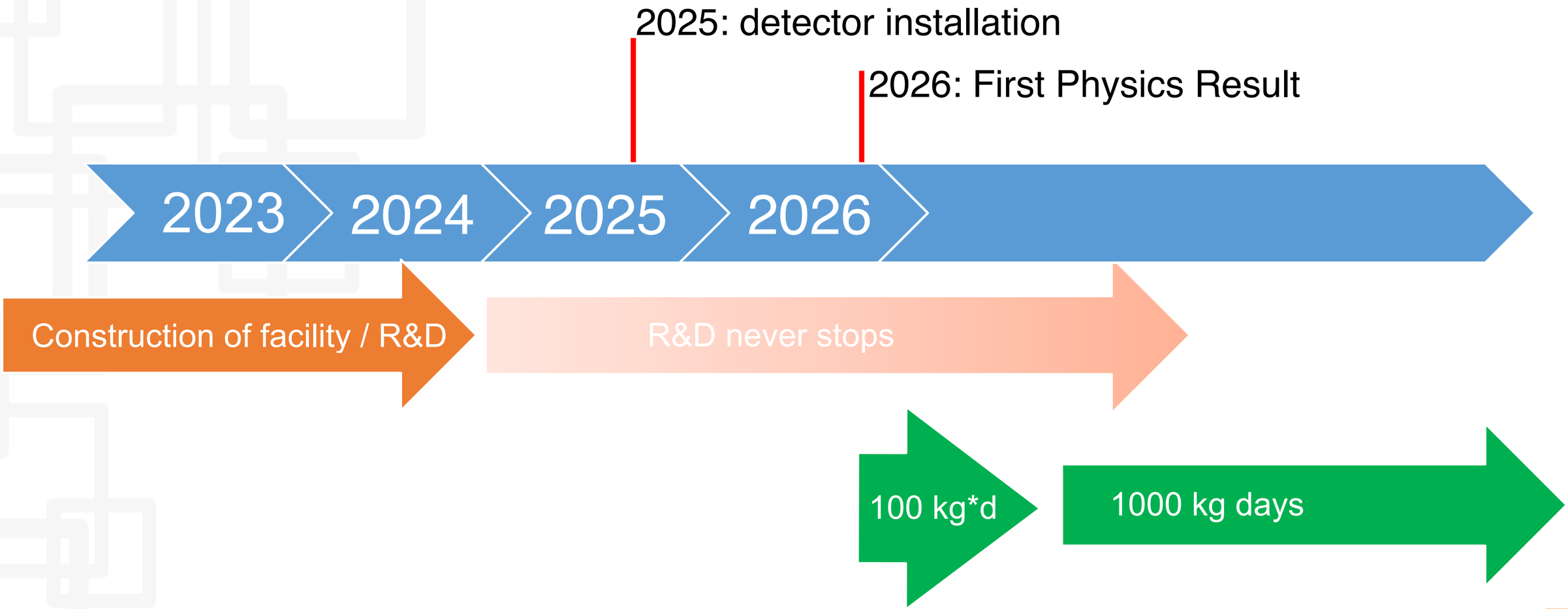
Researcher

INFN Laboratori Nazionali del Gran Sasso

Francesco Ferella (Post-doc)

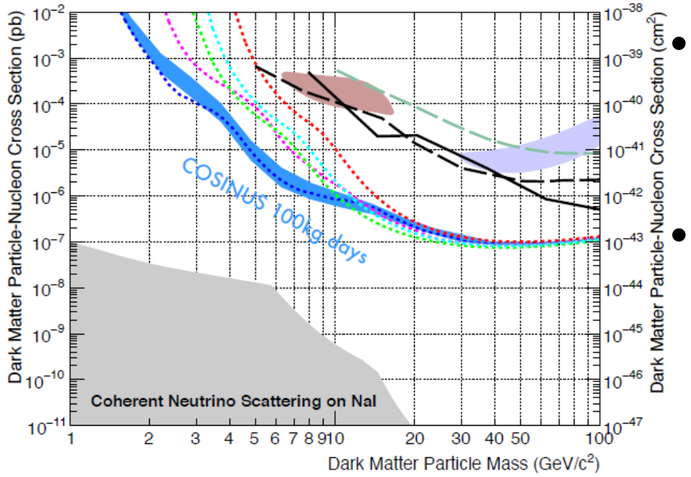
GSSI

COSINUS timeline and activities



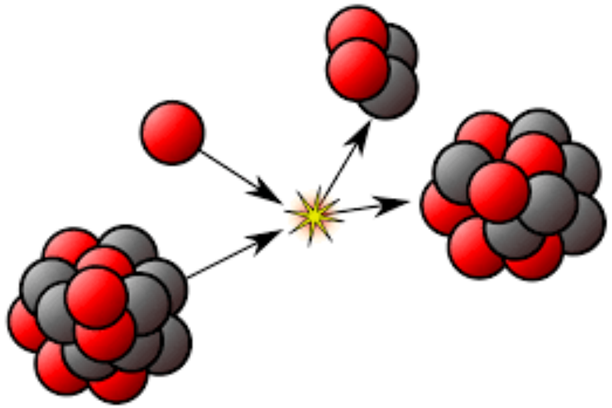
COSINUS study fields

Particle Physics



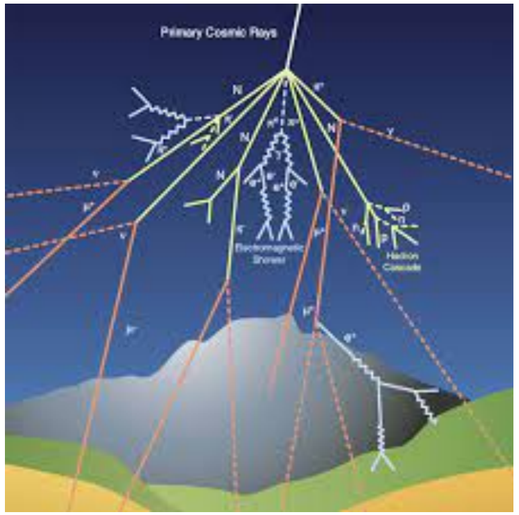
- Verification of the DAMA/LIBRA result
- Search for low mass dark matter using the Migdal effect in COSINUS

Nuclear Physics



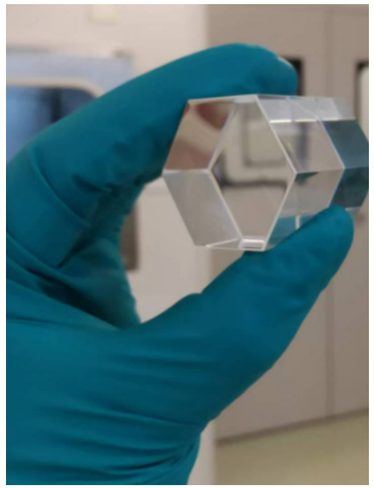
- Cosmogenic activation of the COSINUS NaI Crystals
- Measurements of rare-isotopes in NaI
  - I-129, Na-22

Astrophysics



- Cosmogenic, radiogenic and ambient background modelling
- Water Cherenkov detector setup

Cryogenic detectors R&D



- Crystal coating technique R&D
- NaI with NTD sensors: Threshold and Energy Resolution
- Commissioning of the COSINUS cryostat

Highlights

- COSINUS will investigate the unique DAMA/LIBRA dark matter result
- Hands on experience with cutting-edge cryogenic detectors
- COSINUS is in a very exciting time in it’s development
  - A Ph.D. student would get to see a complete experimental life-cycle
  - From setup to final results
- COSINUS offers many projects in a wide-range of fields
- Come visit our poster if you have any questions

DAREDEVIL
DARk mattEr DEVices for Low energy detection

DAREDEVIL local team

Gianni Profeta - Professor
Alfredo Ferella - Professor
Alessandra Continenza - Professor
Atul Prajapati - Post-doc
Paolo Settembri - PhD
Andrea Melchiorre - PhD

UNIVERSITÀ DEGLI STUDI DE L'AQUILA

Natalia Di Marco - Professor
Giovanni Benato - Professor
Camilla Petrucci - Post-doc
Cecilia Olivieri - PhD
A. Shaikina - PhD

GRAN SASSO SCIENCE INSTITUTE

Cesare Tresca - Researcher

Consiglio Nazionale delle Ricerche

SPIN

INRiM ISTITUTO NAZIONALE DI RICERCA METROL

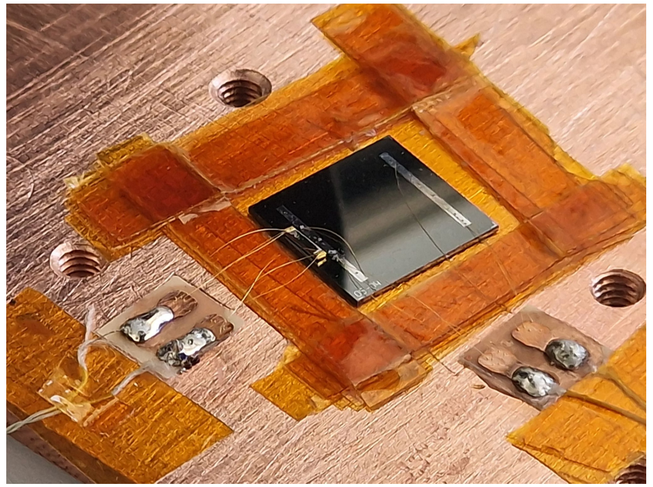
Mauro Rajteri- Researcher
Eugenio Monticone . Researcher

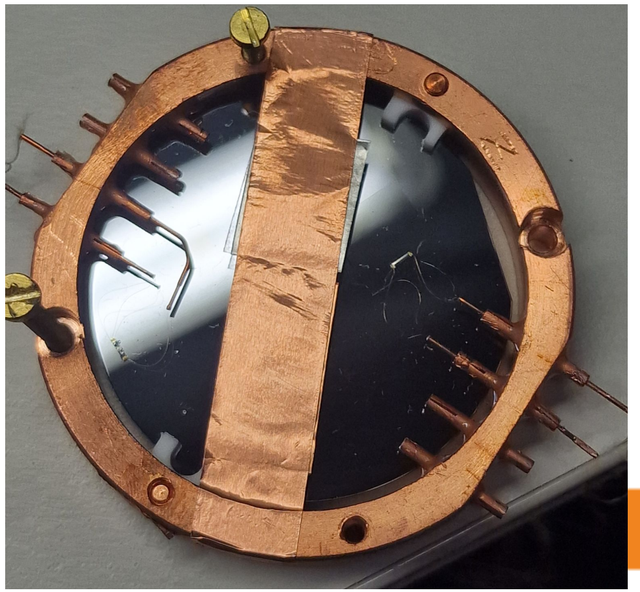
INFN Laboratori Nazionali del Gran Sasso

Andrei Puiu - Researcher
Dounia Helis - Tecnologist

DAREDEVIL goal

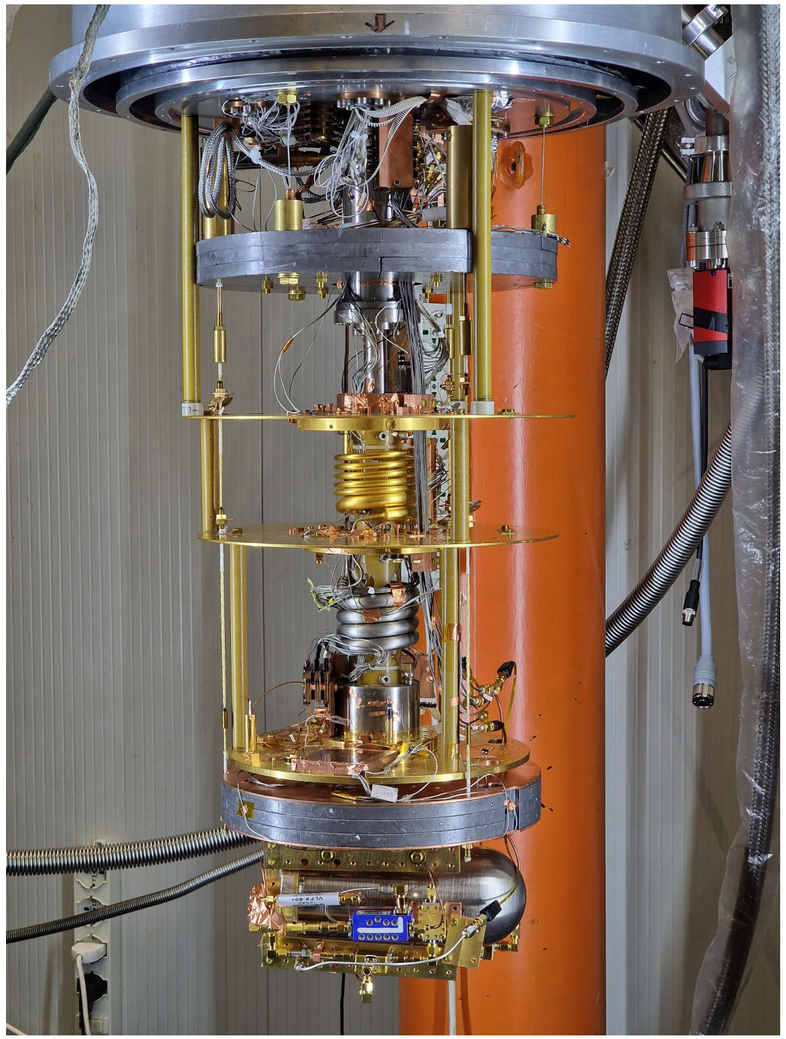
- sub-GeV DM mass candidate
- Innovative detection technique at 10 mK
- Novel crystal targets, Dirac crystals, Weyl crystals, special semiconductors
- Gallium Arsenide as DM target
- +NTL effect





DAREDEVIL Thesis opportunities

- Low Temperature Detector development with cutting edge techniques i.e. TES, SQUID, NTD for very low threshold
- Data analysis tuned for LTD signals processing -> high performance filtering techniques
- Simulations: DM models and interaction in unique target material.



Scintillation Properties of GaAs at Cryogenic Temperatures for Low-Threshold Detectors

A. Melchiorre [1,2,a], D. L. Helis [1,a], A. Puiu [1,a], G. Benato [3,1], P. Carniti [4], I. Colantoni [5,6], A. Continenza [2], N. Di Marco[3,1], A. Ferella [2,1], C. Ferrari [3,1], F. Giannessi [2], C. Gotti [4], E. Monticone [8], E. Olivieri [7], L. Pagnanini [3,1], G. Pessina [4], C. Petrucci [3,1], S. Pirro [1], A. Prajapati [1,2], G. Profeta [2], M. Rajteri [8], P. Settembri [2], A. Shaikina [3,1], C. Tresca [9], D. Trotta [4]

[1]INFN – Laboratori Nazionali del Gran Sasso, Assergi, I-67100 L'Aquila, Italy
[2]Dipartimento di Scienze Fisiche e Chimiche, Università degli Studi dell'Aquila, I-67100 L'Aquila, Italy
[3]Gran Sasso Science Institute, I-67100 L'Aquila, Italy
[4]INFN and Università degli studi di Milano-Bicocca, I-20126 Milano, Italy
[5]Consiglio Nazionale delle Ricerche, Istituto di Nanotecnologia, c/o Dip. Fisica, Sapienza Università di Roma, 00185, Rome, Italy
[6]INFN, Sezione di Roma, P.le Aldo Moro 2, 00185, Rome, Italy
[7]Université Paris-Saclay, CNRS/IN2P3, IJCLab, 91405 Orsay, France
[8]Istituto Nazionale di Ricerca Metrologica Torino, I-10135 Torino, Italy
[9]CNR-SPIN, Università degli studi dell'Aquila, I-67100 L'Aquila, Italy

the date of receipt and acceptance should be inserted later

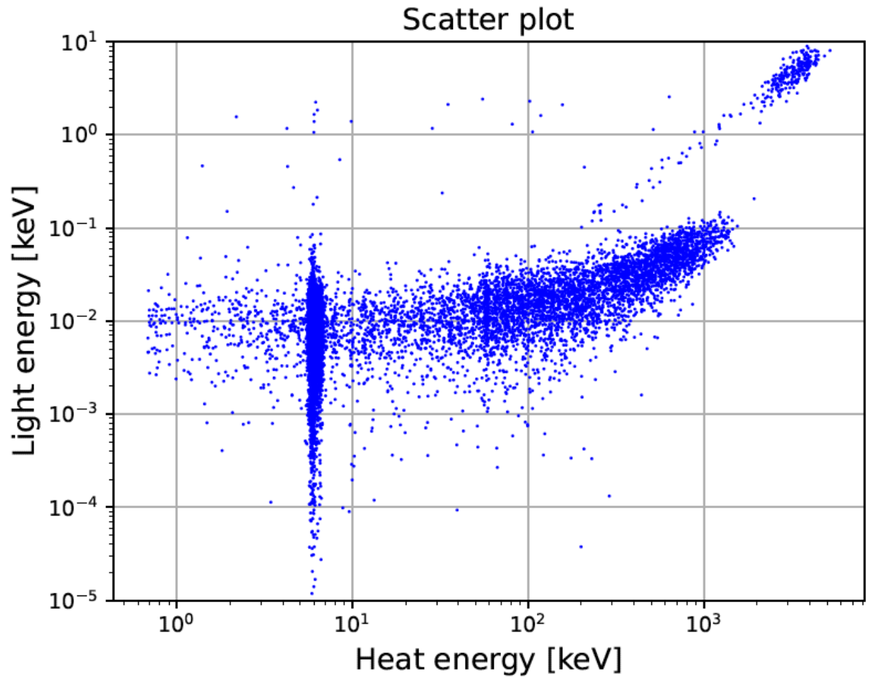
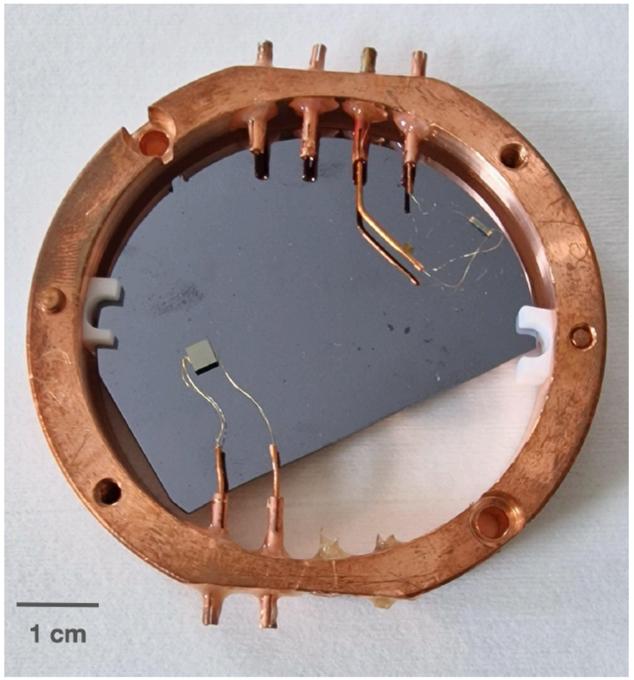
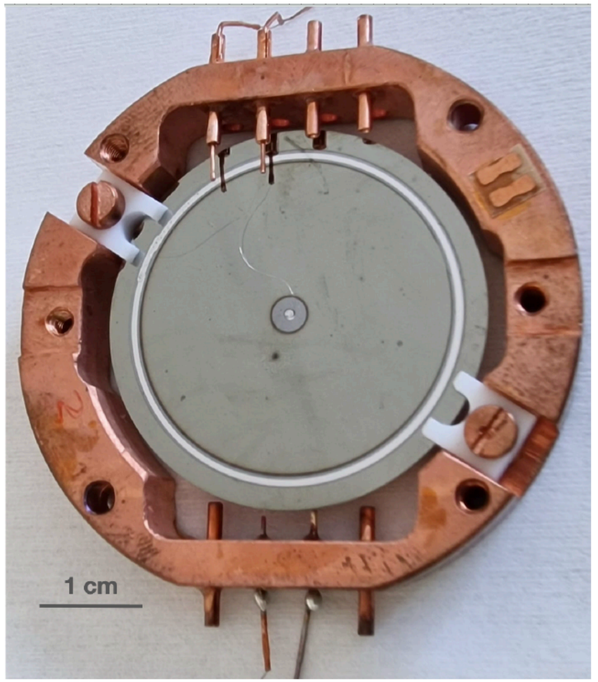


Fig. 4 Scatter plot of "light" vs "heat", highlighting the different $\beta\gamma$, and α families.





GaAs Detector performance summary

Mass	4.3	g
Density	5.32	g/cm^3
Diameter	5.08	cm
NTD response	490	$\mu V/MeV$
Baseline resolution (RMS)	121 ± 2	eV
Peak σ at 5.9 keV	140 ± 8	eV

Table 1 Summary of the performance of GaAs detector operated as a low-temperature calorimeter.