Development of low-temperature detectors for RESNOVA and OPOSSUM
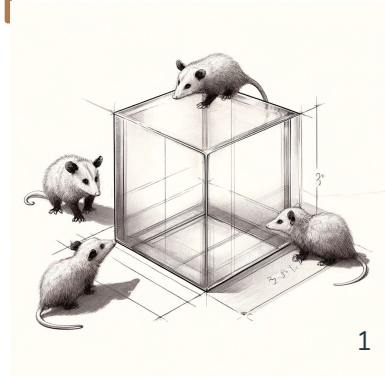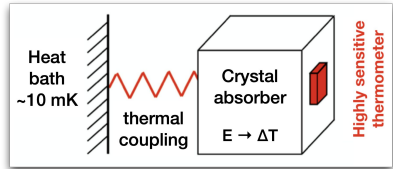
RES-NOVA: A revolutionary archaeological Pb observatory for astrophysical neutrino sources

Detection channel
Coherent neutrino–nucleus scattering

Technology
Cryogenic detectors

Target material
$PbWO_4$ from archaeological-Pb

ν_x

$E_\nu \sim 10$ MeV

ν_x

Nuclear recoil
$E_R \sim 1$ keV

Heat bath ~10 mK

thermal coupling

Crystal absorber
$E \rightarrow \Delta T$
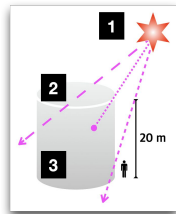
Highly sensitive thermometer
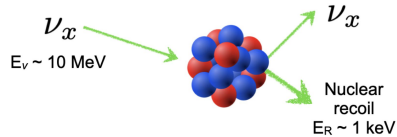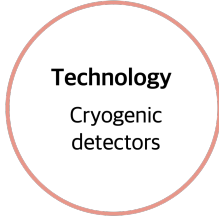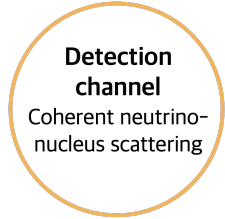
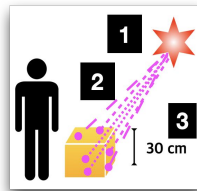**Archaeo-Pb cryogenic detector**

$$\sigma_{CE\nu NS} \propto N^2$$

cross-section

Neutron number

High radiopurity: < 1 mBq/kg

x10⁴ better than commercial low-background Pb

Status quo:

1. detection of ~1/6 SN flux
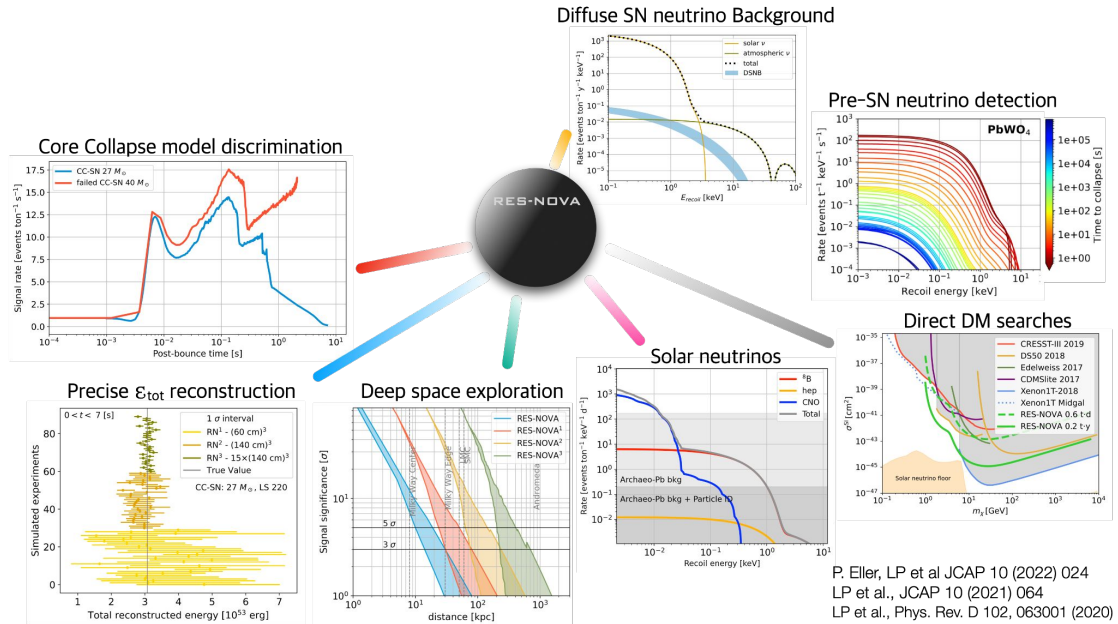2. small cross-section
3. large volume detectors

20 m

Opportunities:

1. detection of full SN ν flux
2. highest cross-section
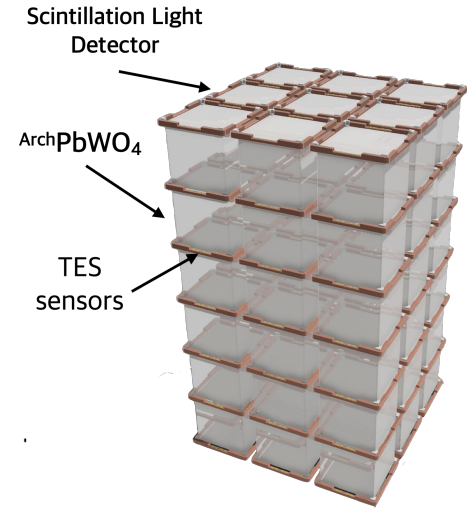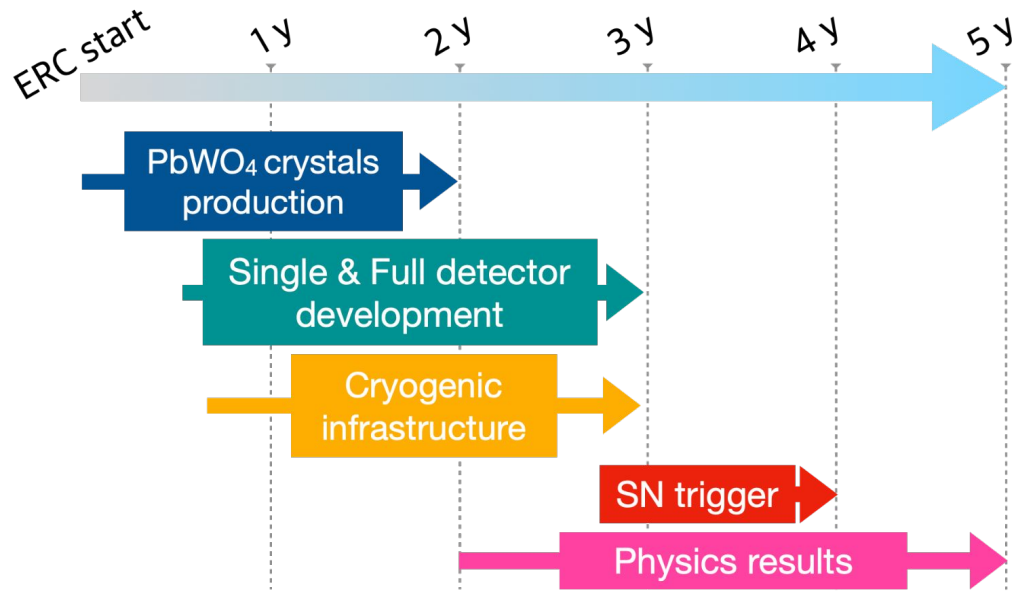3. cm-scale ν telescope

30 cm

~200 ev./m3

Research and Activity opportunities at LNGS

- Detector R&D
- Crystal test and TES development
- Radiopurity and material characterization
- RES-NOVA prototype test
- Electronics and DAQ test

Core Collapse model discrimination

Diffuse SN neutrino Background

Pre-SN neutrino detection

Precise ε_{tot} reconstruction

Deep space exploration

Solar neutrinos

Direct DM searches

P. Eller, LP et al JCAP 10 (2022) 024
LP et al., JCAP 10 (2021) 064
LP et al., Phys. Rev. D 102, 063001 (2020)

RES-NOVA plan

ERC start | 1 y | 2 y | 3 y | 4 y | 5 y

PbWO$_4$ crystals production

Single & Full detector development

Cryogenic infrastructure

SN trigger

Physics results

Scintillation Light Detector

^{Arch}PbWO$_4$

TES sensors

Survey of 90% Galactic SNe

OPOSSUM

Optimal **P**article identification **O**f **S**ingle **S**ite events with **U**nderground **M**KIDs detectors

electron creation

Elimination of all background events in the search for the **Zero Neutrinos Double Beta Decay.**
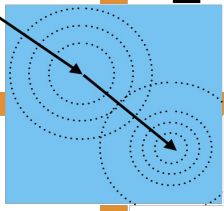
Event **topology reconstruction** in low temperature calorimeters.

MKIDs

NTD

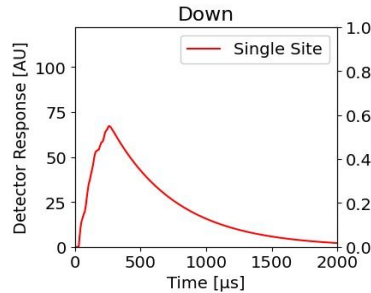For the **first** truly **background free** ton-scale experiment in the next 10 years.
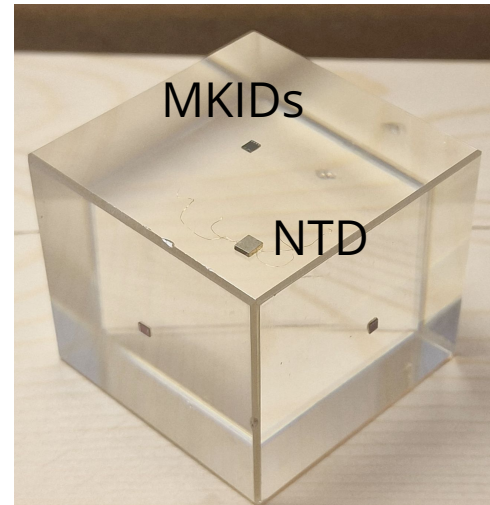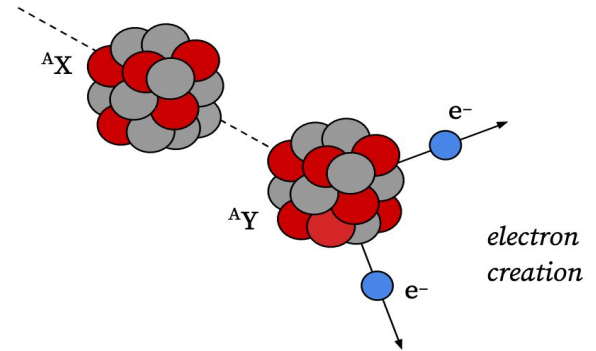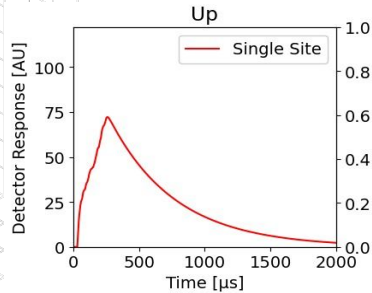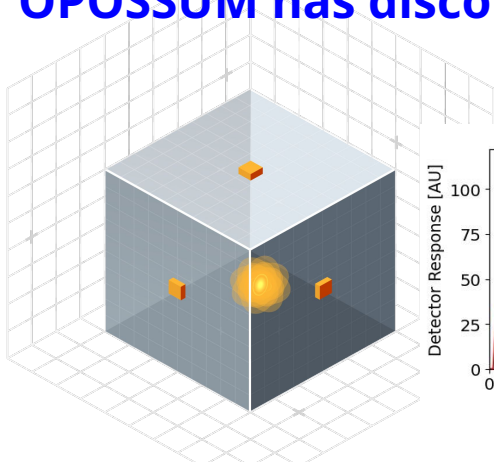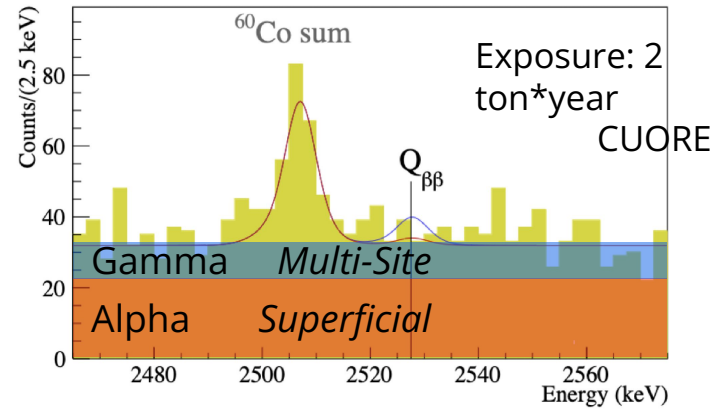
OPOSSUM identifies the 0vBB events

OPOSSUM will positively identify the Single Site Events

Background reduction of two orders of magnitude
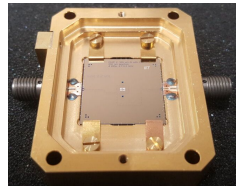
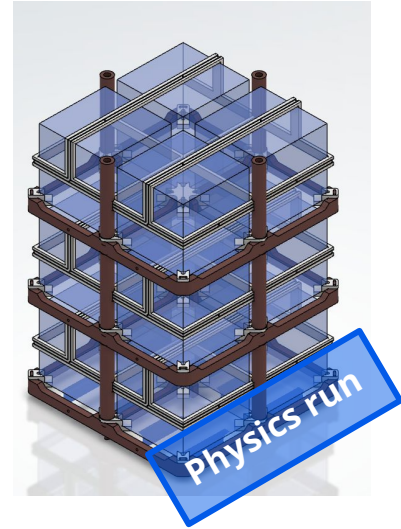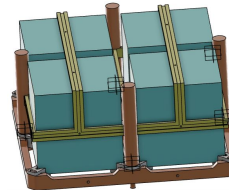**OPOSSUM has discovery potential!**

OPOSSUM's PLAN

RF and cryo setup

MKID
Deposition
on TeO$_2$

4x**TeO$_2$**
+
MKID's

Physics run

DR setup

5x5x5 cm^3 TeO$_2$ with MKIDs

Data analysis and background model

MKIDs design on TeO$_2$

12 TeO$_2$ array with MKIDs: 10 kg*y

1st year   2nd year   3rd year   4th year   5th year

Thank you for you attention

contacts:

RES-NOVA :

website https://res-nova.unimib.it/

- **LUCA PATTAVINA** luca.pattavina@unimib.it
- **GIOVANNI BENATO** giovanni.benato@gssi.it
- **LORENZO PAGNANINI** lorenzo.pagnanini@gssi.it
- **ANDREI PUIU** andrei.puiu@lngs.infn.it

OPOSSUM :

- **ANDREI PUIU** andrei.puiu@lngs.infn.it

LE-8: Cryogenics sensors for astroparticle physics

Andrei Puiu (INFN - LNGS)

Andrea Melchiorre