

# CUPID: a next-generation cryogenic $0\nu\beta\beta$ experiment

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Francesca Pucci  
for the CUPID collaboration

# CUPID

# The CUPID collaboration



## CUORE

experience in operating cryogenic ton-scale detector array of macro-calorimeters for years



## CUPID-0 and CUPID-Mo

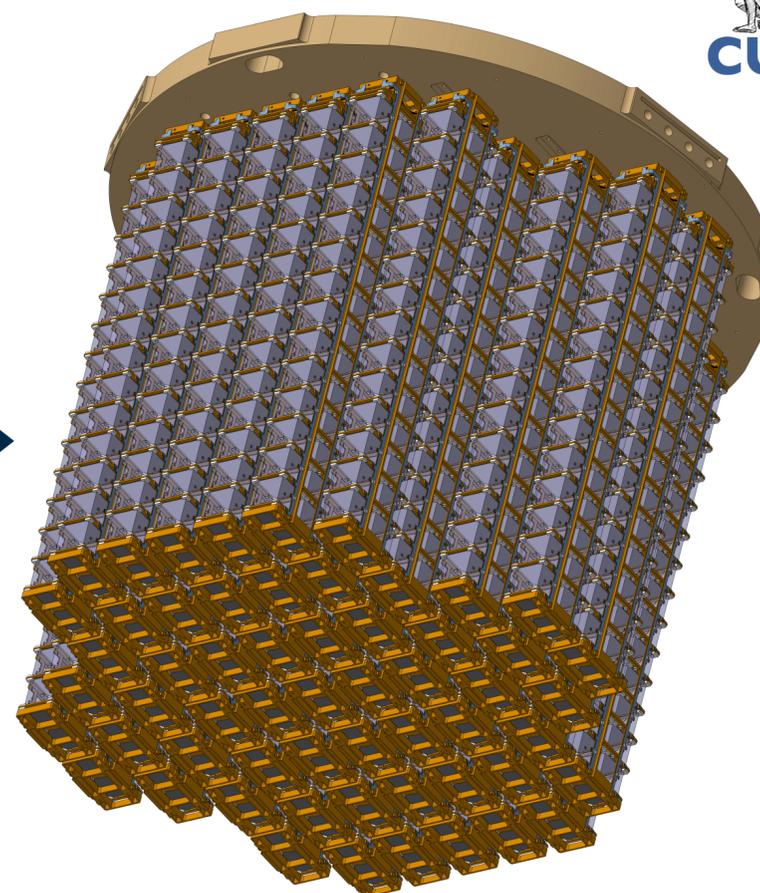
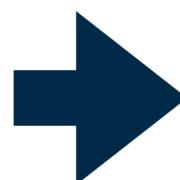
experience in operating cryogenic macro-calorimeters with particle identification technology



> 150 scientist over >30 institutions worldwide  
(Italy, US, France, China, Ukraine, Russia, Spain)



**CUORE**  
 19 towers  
 988 TeO<sub>2</sub>  
 50x50x50 mm<sup>3</sup>  
 $Q_{\beta\beta} = 2528$  keV  
 Operated as  
 calorimeters @ 10mK  
 In operation @LNGS  
 since 2016



**CUPID**  
 57 towers  
 1596 Li<sub>2</sub><sup>100</sup>MoO<sub>4</sub> (LMO)  
 45x45x45 mm<sup>3</sup> +  
 1710 Ge Light Detectors (LD)  
 $Q_{\beta\beta} = 3034$  keV  
 Operated as **scintillating**  
 calorimeters @ 10mK  
 In operation @LNGS starting  
 from 2030

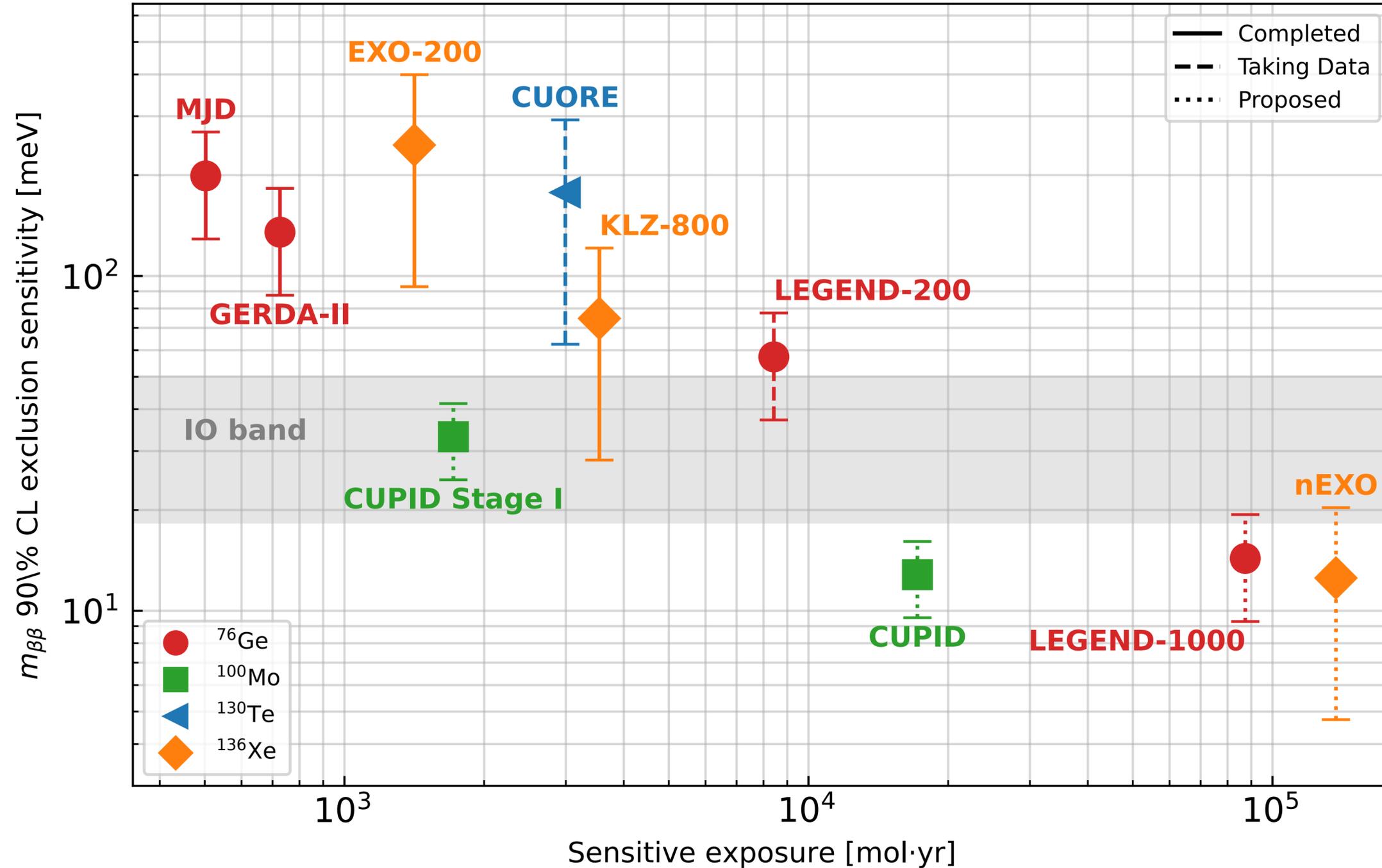
## CUORE best limits

- <sup>130</sup>Te half life:  $T_{1/2} > 3.8 \times 10^{25}$  yr
- $m\beta\beta < 70-240$  meV

Arxiv 2404.04453

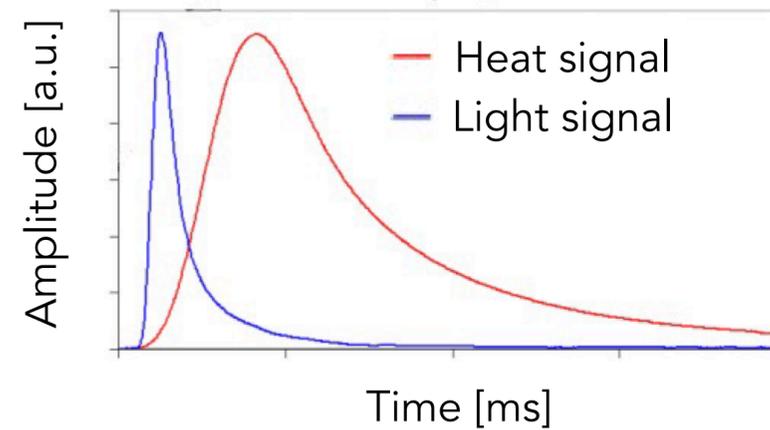
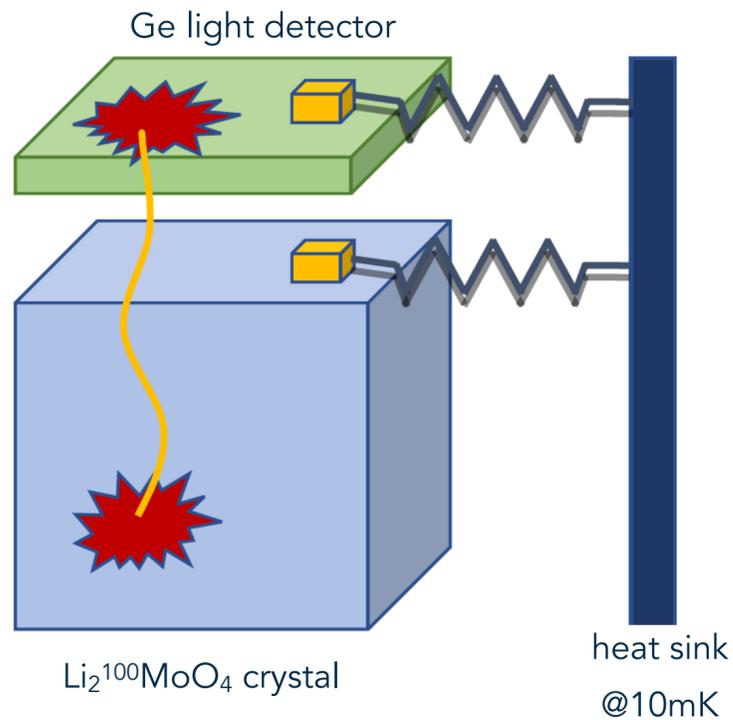
## CUPID projections

- <sup>100</sup>Mo half life:  $T_{1/2} > 1.0 \times 10^{27}$  yr
- $m\beta\beta < 12-21$  meV



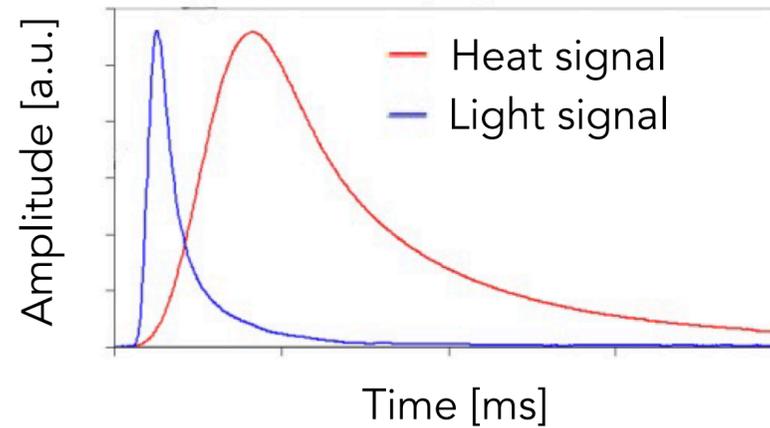
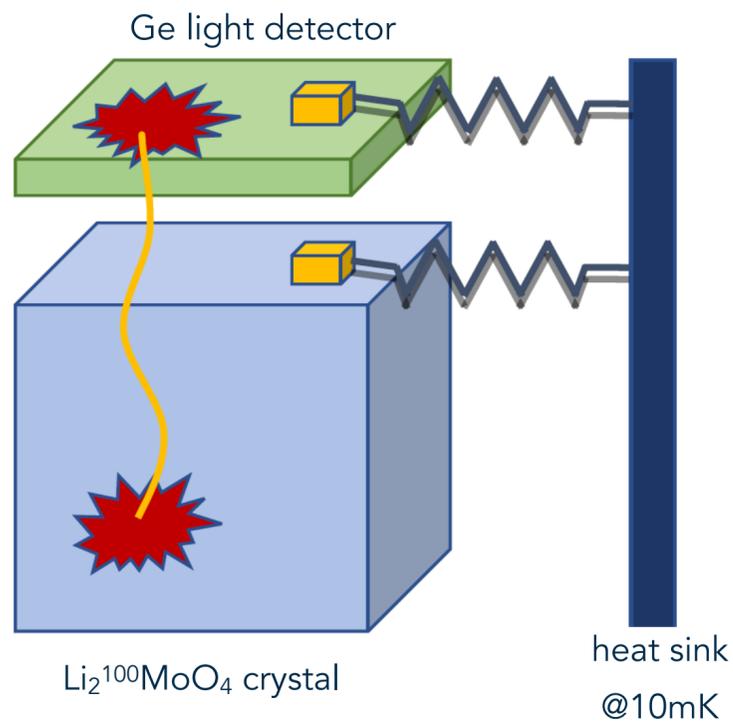
## Dual readout:

- Phonon signal → NTD glued on the LMO crystal
- Light signal → NTD glued on the Ge LD

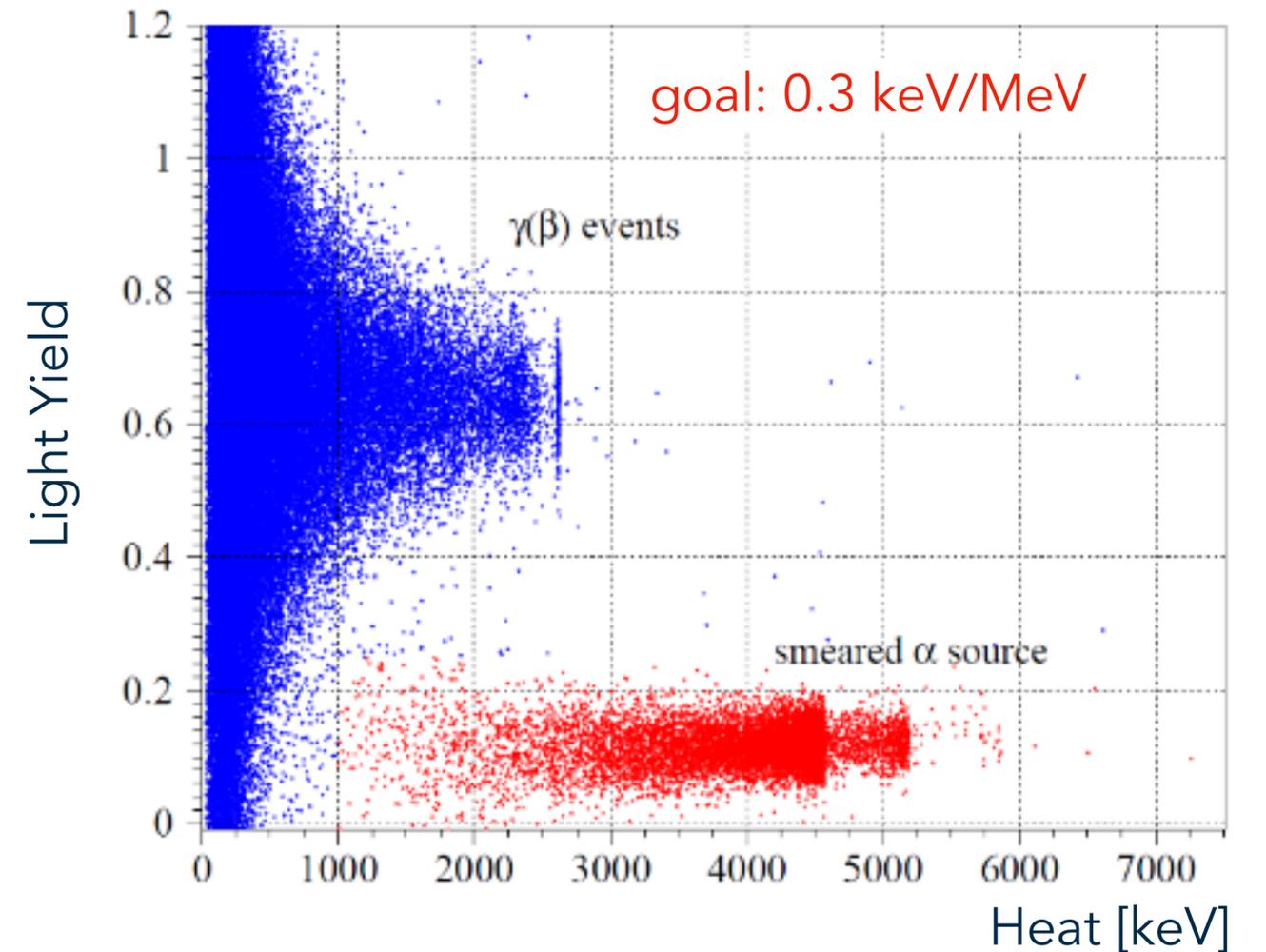


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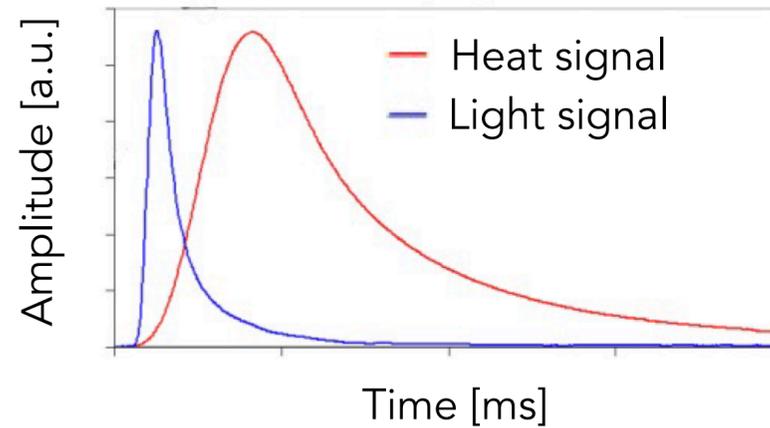
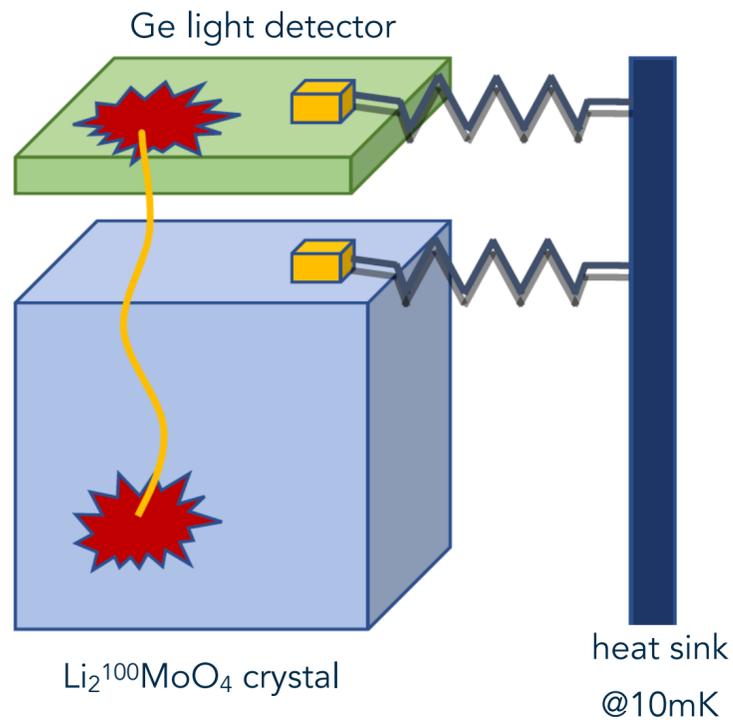


Rejection of  $\alpha$ -particles (heat + light)  
different amount of scintillation light emitted



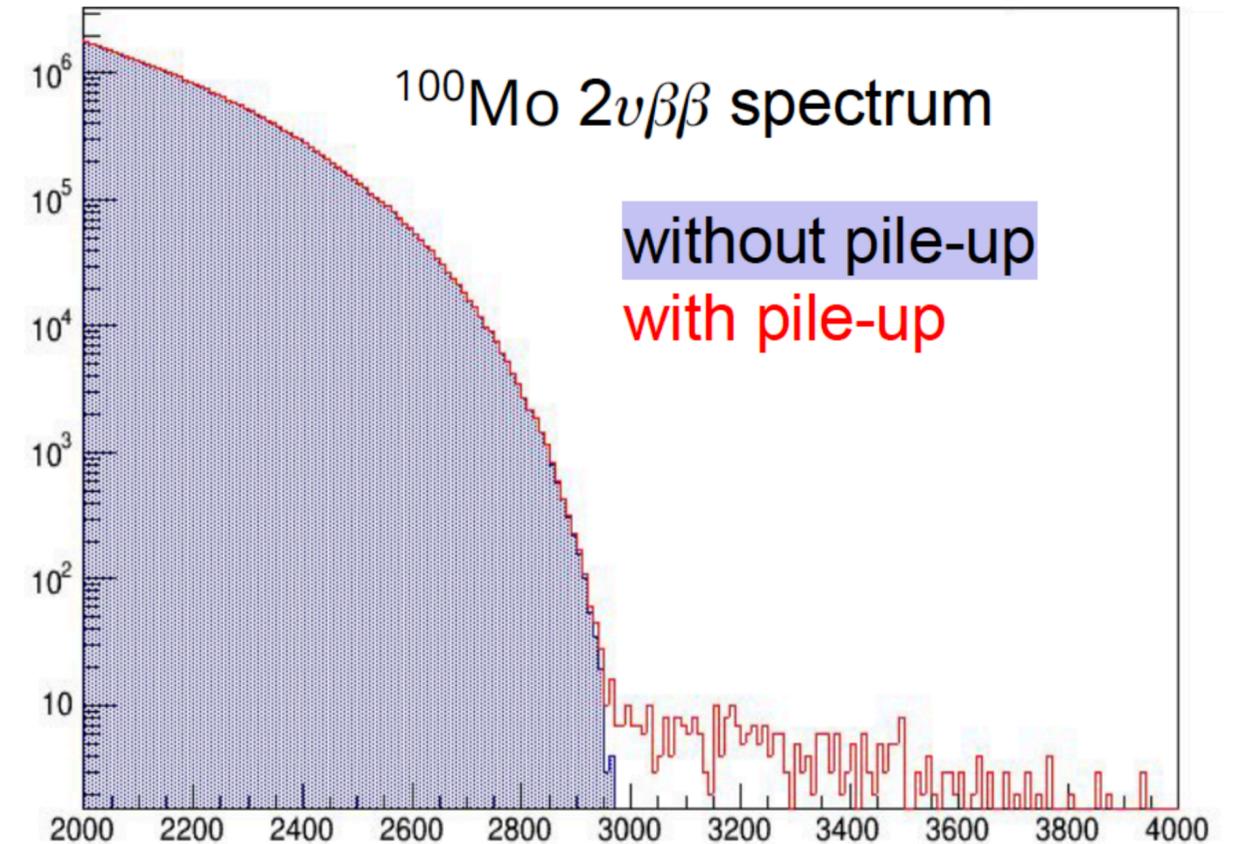
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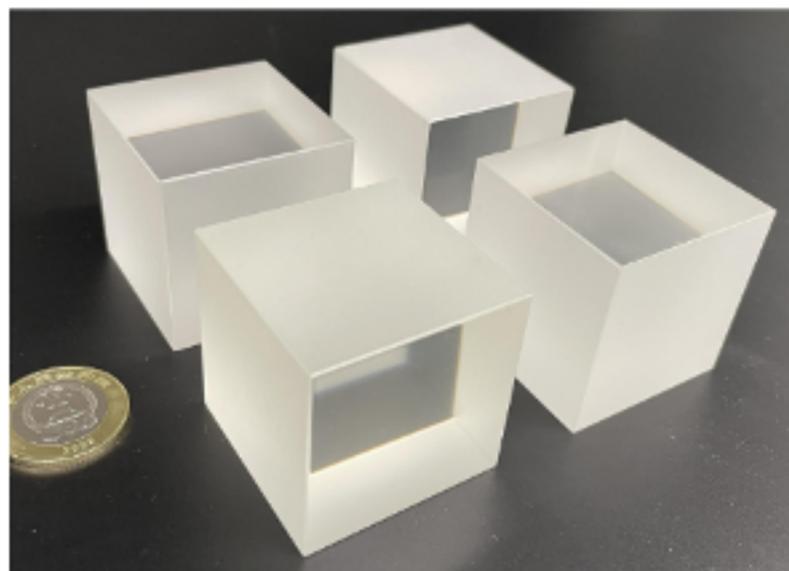
**Rejection of  $\alpha$ -particles (heat + light)**  
 different amount of scintillation light emitted

**Rejection of  $^{100}\text{Mo } 2\nu\beta\beta$  pile-up (light only)**  
 deploying LD faster pulses rise time (few ms)



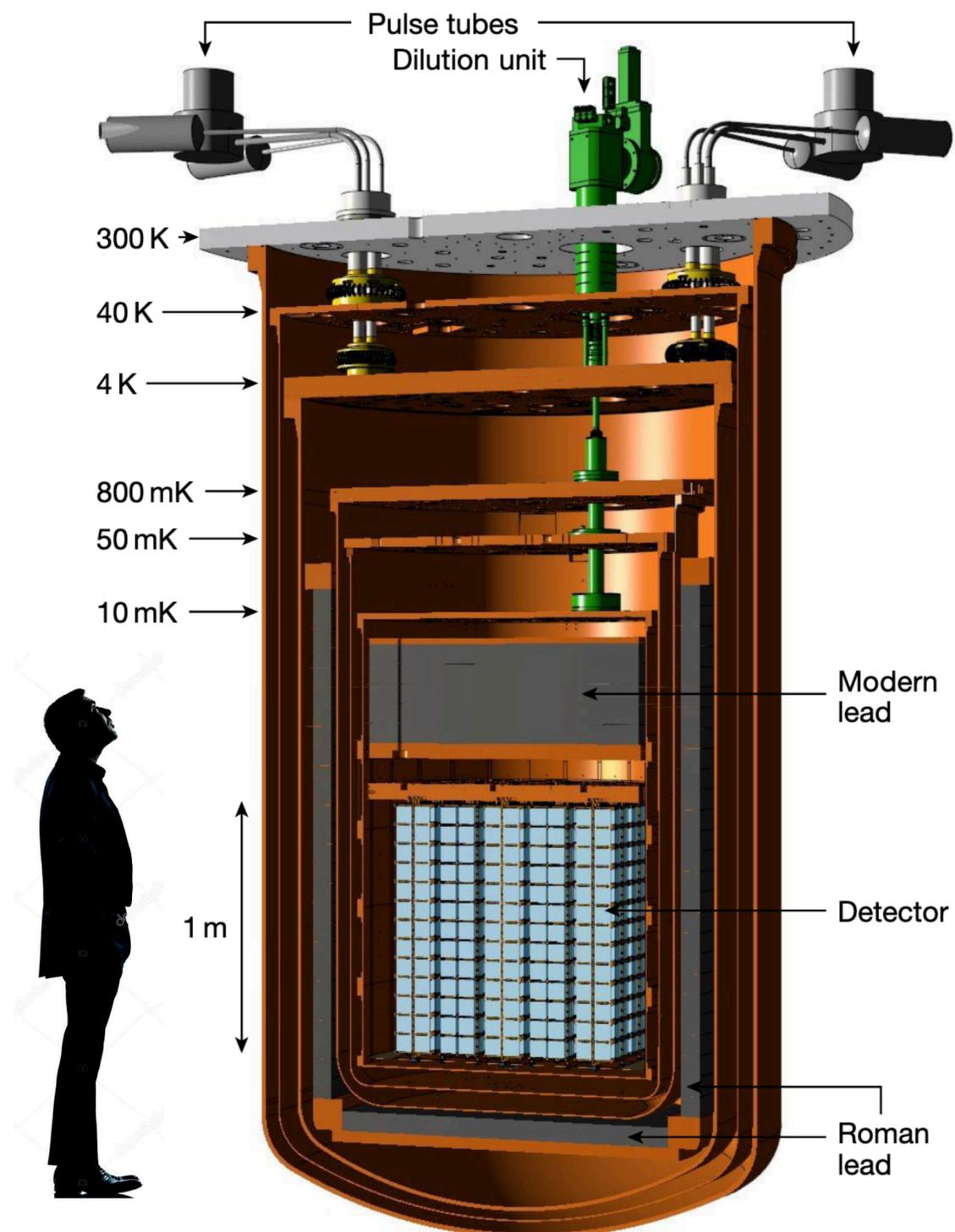
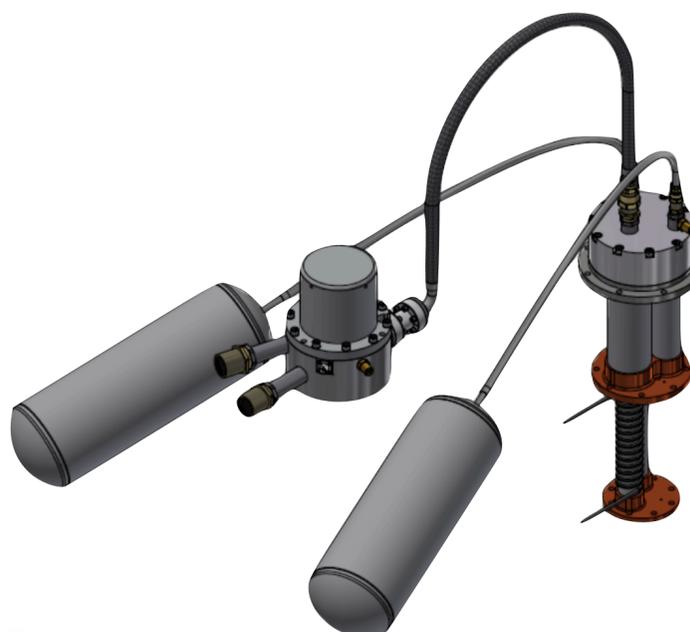
## Detector is the major change:

- change isotope ( $^{100}\text{Mo}$ )
- enriched crystals
- light detectors
- mechanical assembly
- x3 more wires



## Cryostat maintenance and upgrade:

- new wiring
- new pulse tubes
- enhanced vibration abatement strategy
- improvement of active noise cancellation algorithm

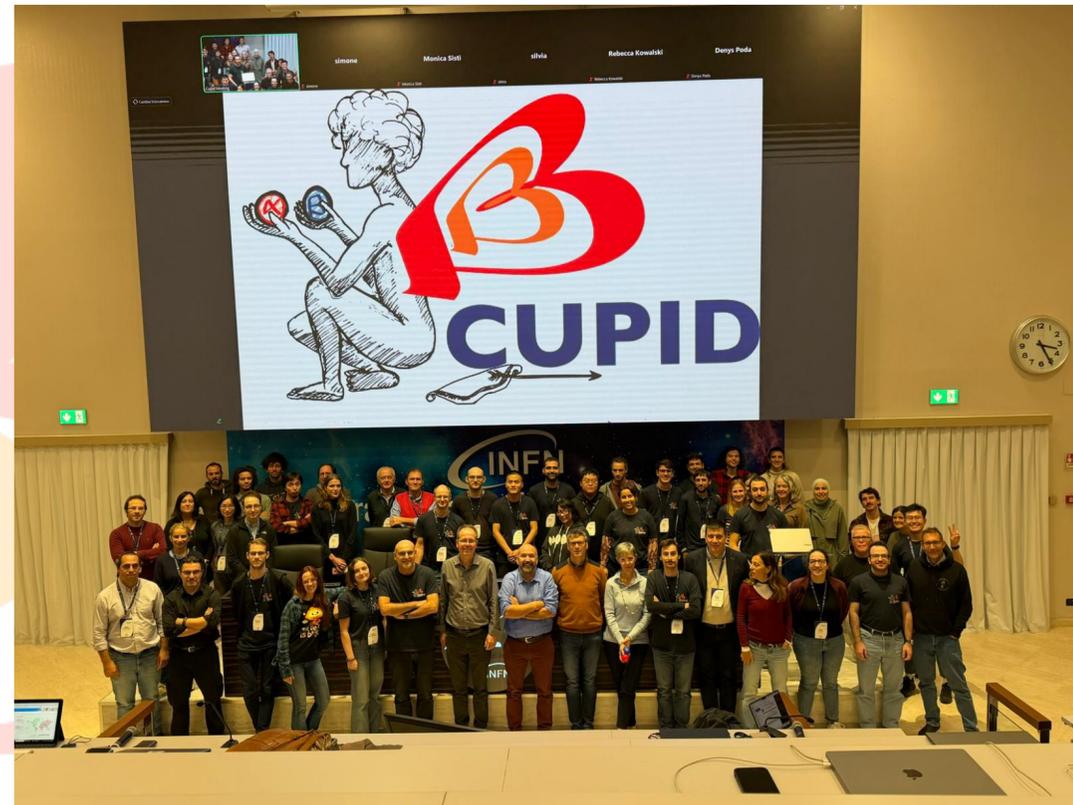


## Detector-related:

- **Experimental measurements** of  $\text{Li}_2\text{MoO}_4$  crystals for contamination assessment and performance evaluation [work mostly done in underground R&D facilities in Hall C]
- Light detector **characterisation and optimisations** (testing temperature sensors such as NTD and Neganov-Luke amplification) [work mostly done in underground R&D facility in Hall A]
- **Cryogenic technology** R&Ds (thermal switch, material conductance studies, etc...) [work mostly done in above-ground R&D facility in HdM]

## Software-related:

- Background studies and projections
- **Neural network** analyses for pile-up rejection
- **Software development** for the new experiment (DAQ, data handling and processing, slow monitoring, etc...)



Thank you for your attention



CUPID

