DELight

UNIVERSITÄT HEIDELBERG
ZUKUNFT SEIT 1386

DELight: a Direct search Experiment for Light dark matter

Lea Burmeister on behalf of the DELight Collaboration

Dark Matter and Neutrinos School 2025, Paris

The DELight Collaboration

- 3 institutes from Baden-Württemberg, Germany
- Upcoming experiment for light dark matter searches

universität freiburg

Karlsruher Institut für Technologie

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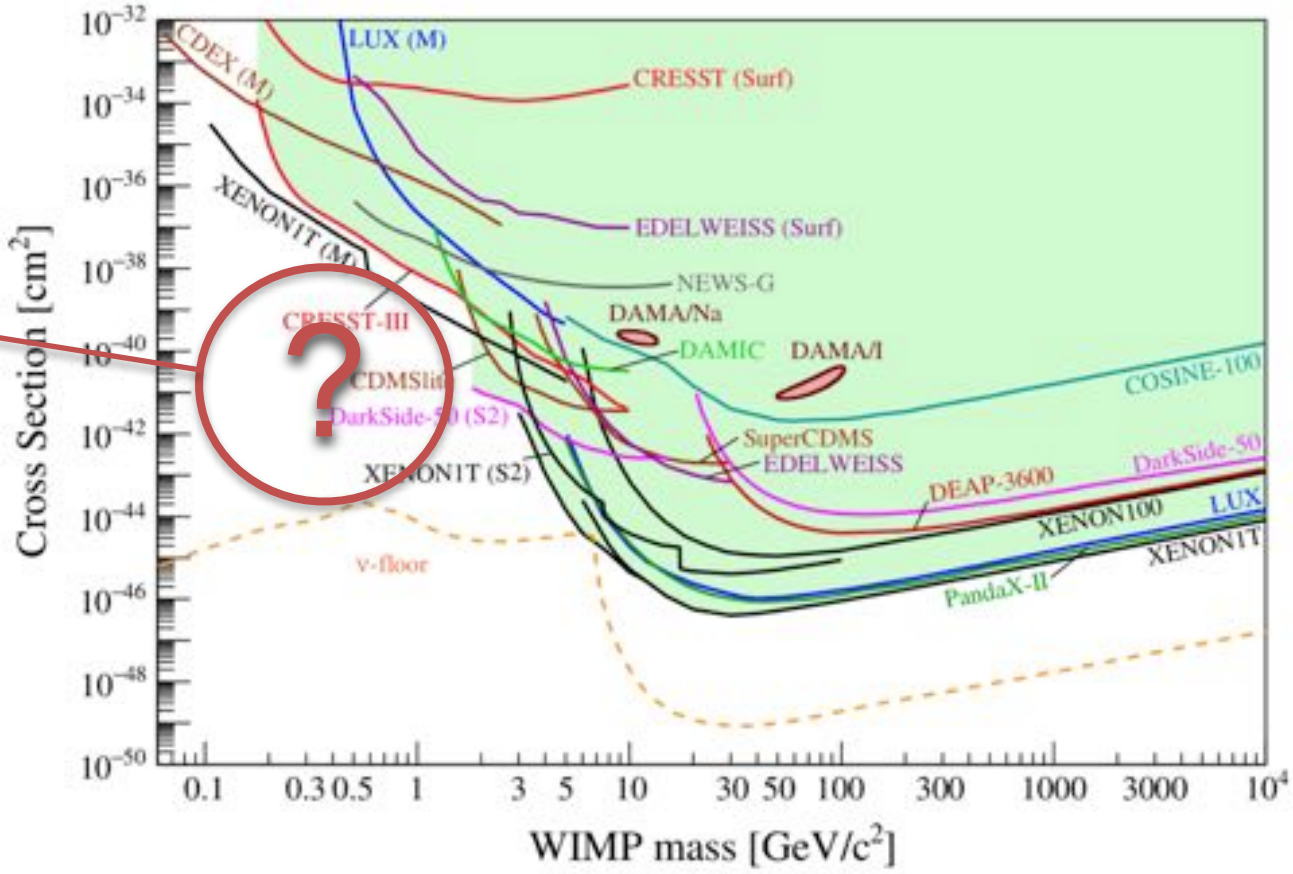
Light Dark Matter

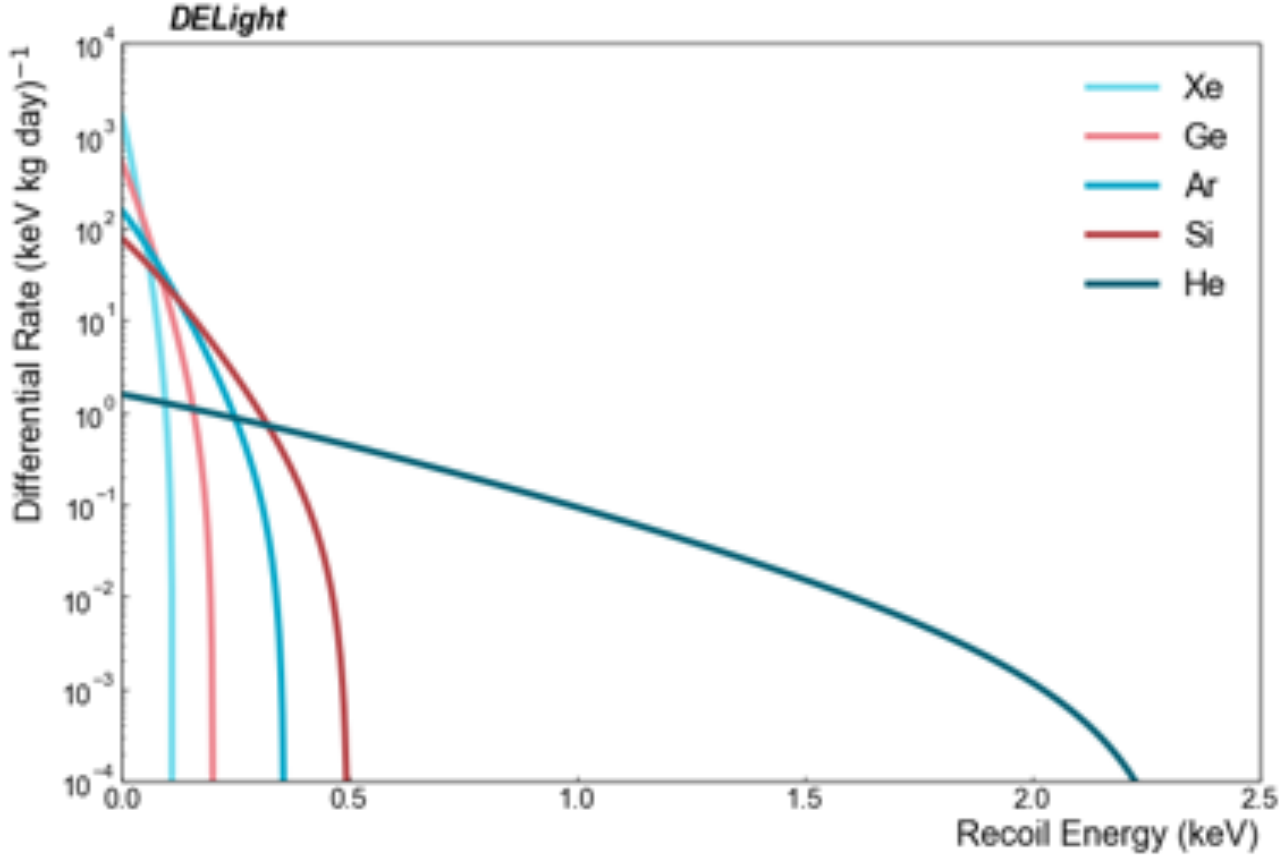
Low mass parameter space is largely unexplored!



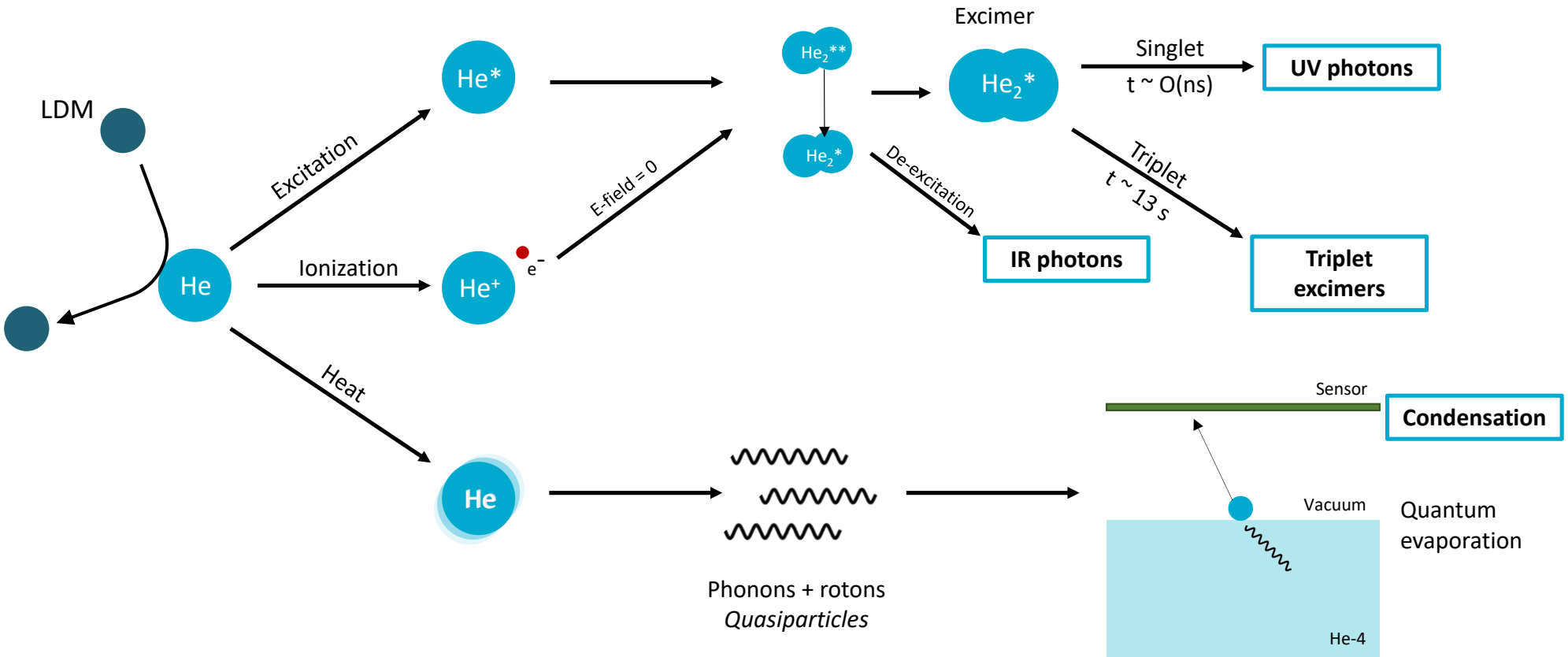
Picture: J. Billard et al.

Superfluid Helium-4

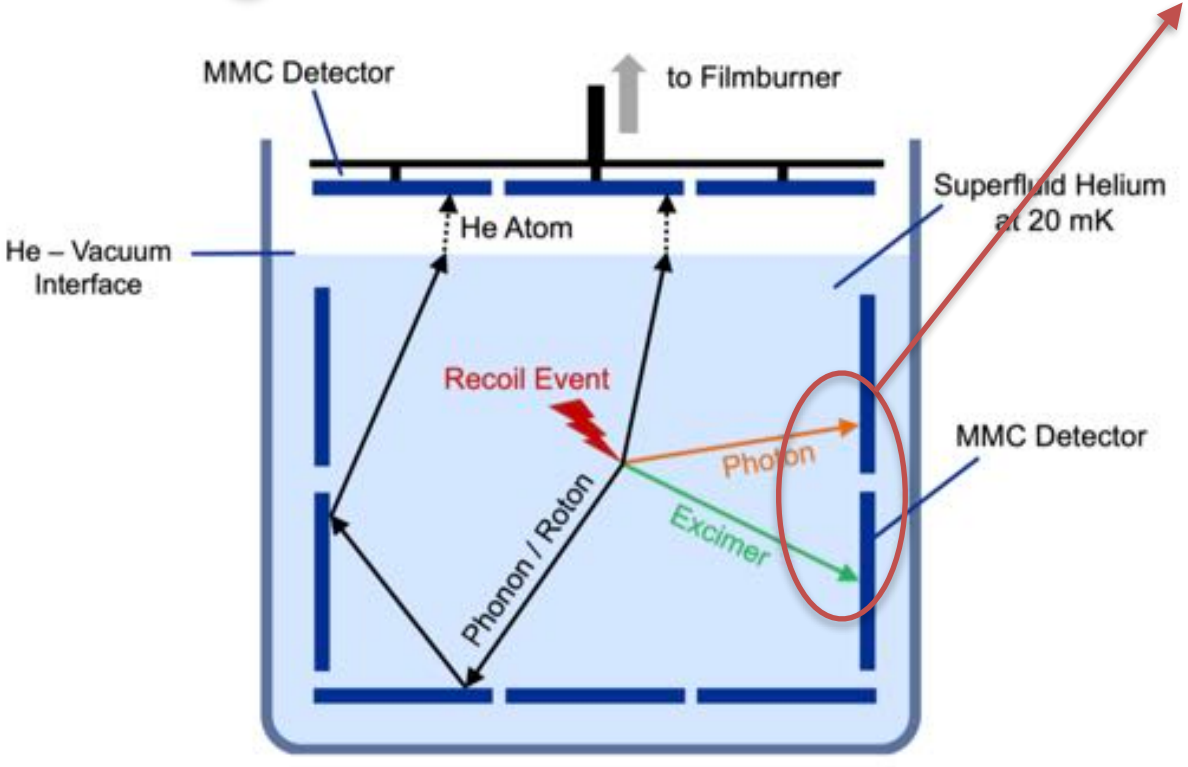
- Excellent choice as a target
  - Low nuclear mass
  - Inexpensive
  - Scalable
  - ER/NR discrimination
  - Self-cleaning:
    - Other atomic species freeze-out



DELight detection principle

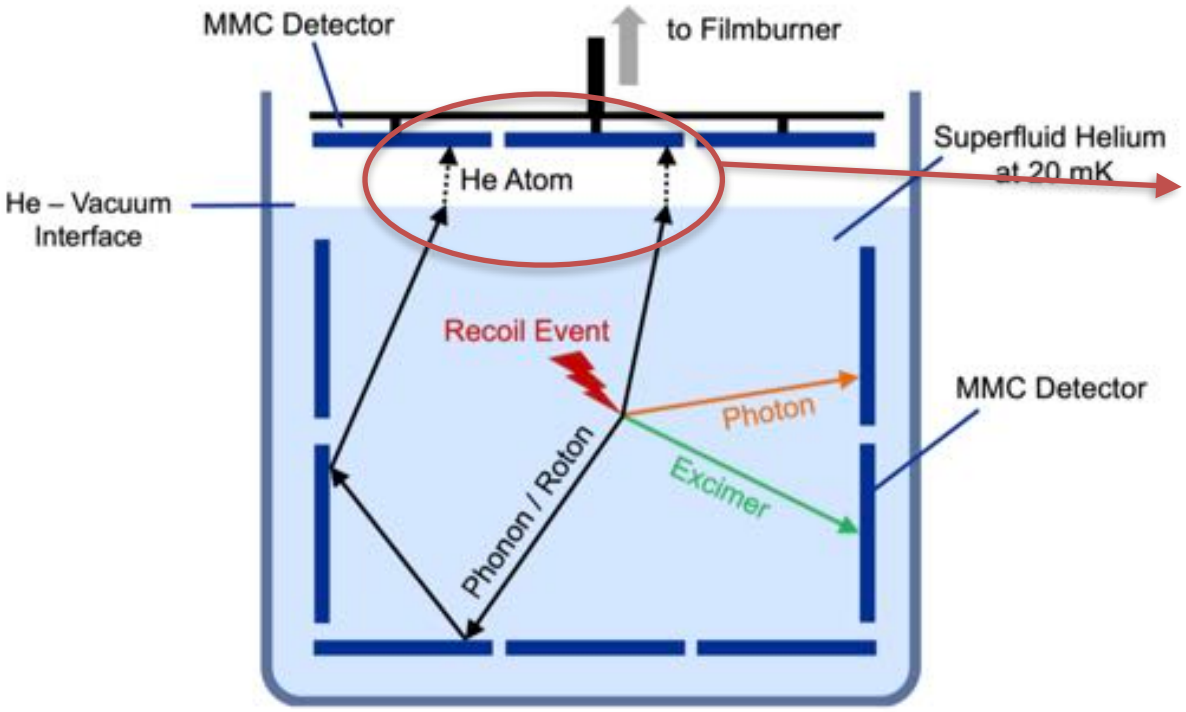


DELight detector

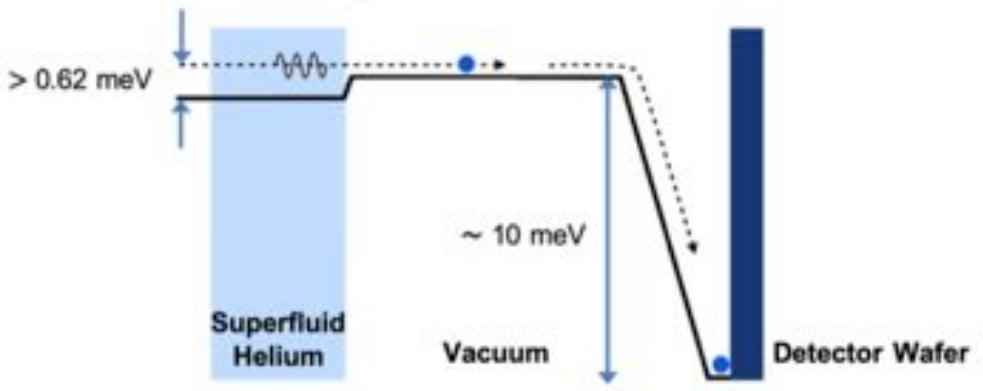


- Prompt signals from photons
- Delayed arrival time for triplet excimers

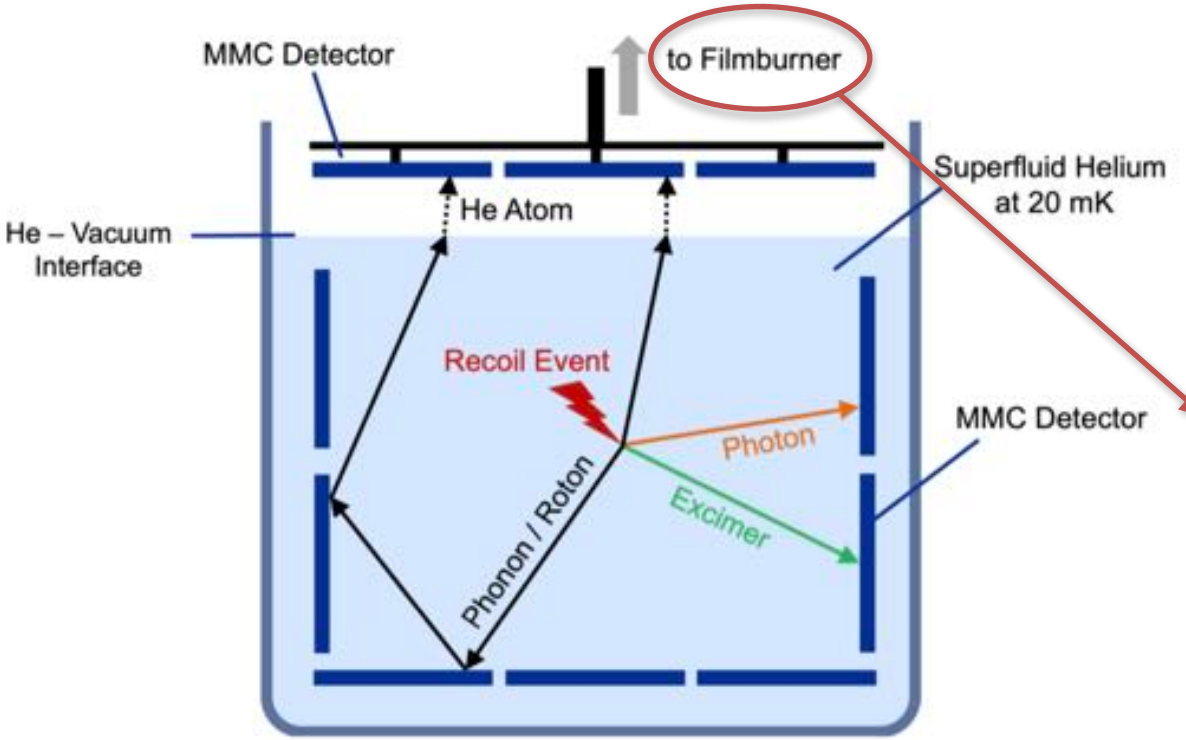
DELight detector



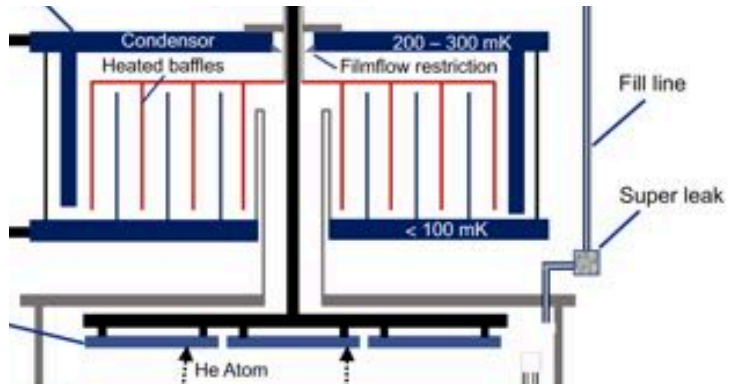
- Prompt signals from photons
- Delayed arrival time for triplet excimers
- Quasiparticles evaporates He atom (quantum evaporation)
  - Absorbed onto wafer



DELight detector



- Prompt signals from photons
- Delayed arrival time for triplet excimers
- Quasiparticles evaporates He atom (quantum evaporation)
  - Absorbed onto wafer
- Wafer must be kept free from He



Magnetic MicroCalorimeters (MMCs)

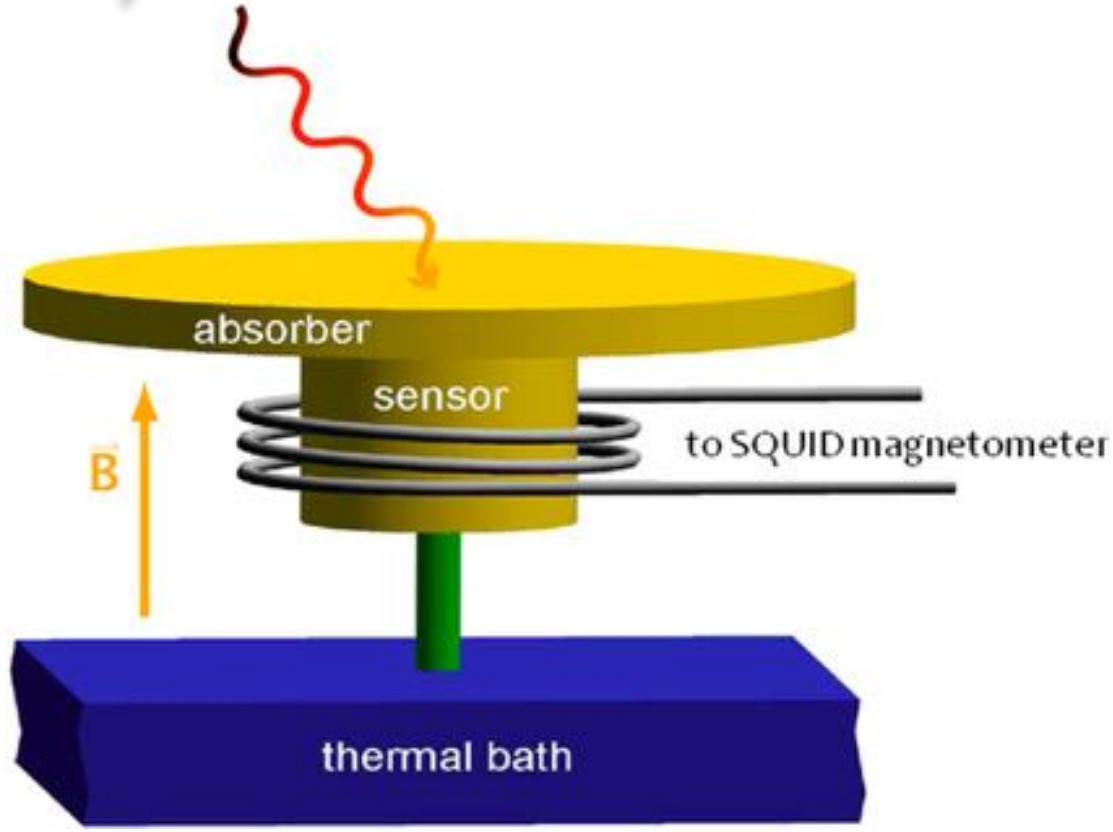
- Operated below 100 mK
- Deposition of energy

↓

Rise in temperature of sensor

↓

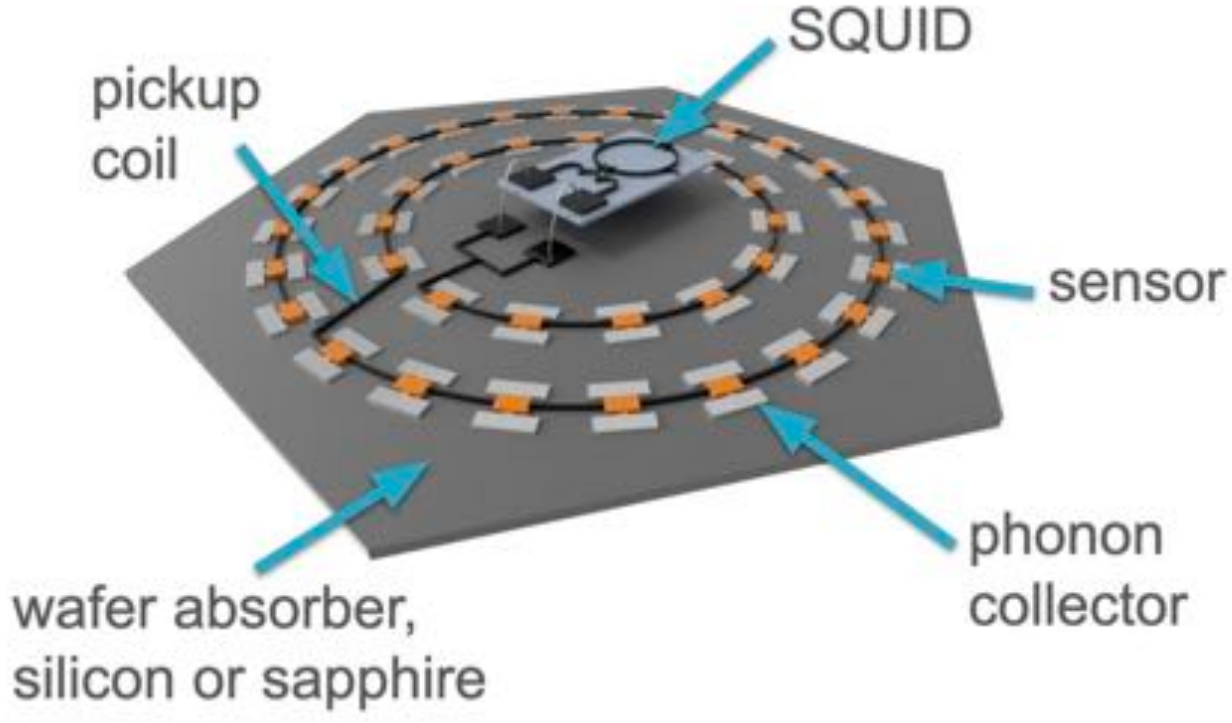
Change of magnetic flux



Picture: D. Hengstler et al.

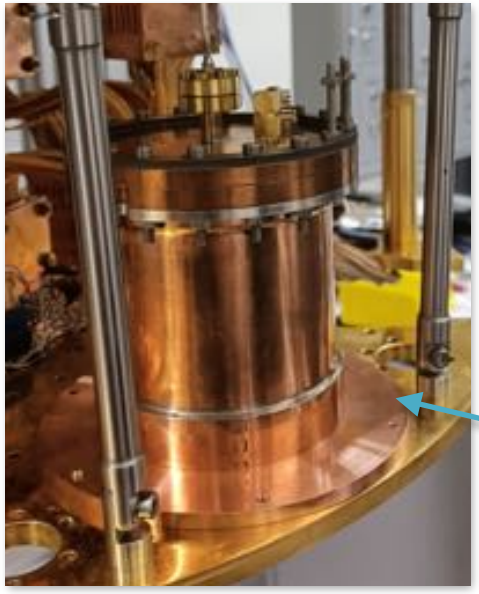
Large-area cryogenic microcalorimeters (LAMCALs)

- Particle generates athermal phonons in absorber
- Reach phonon collector: Breaks cooper pairs
- Diffuse to sensor: Release energy and rise temperature of sensor



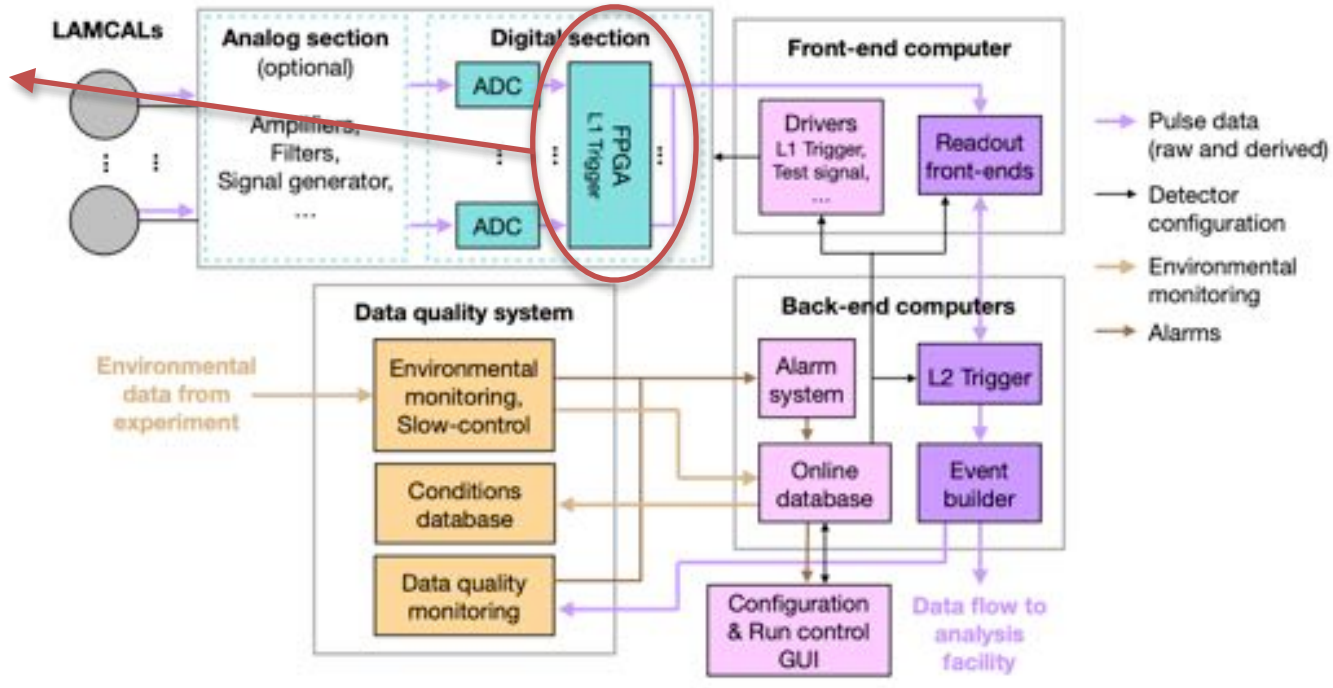
„DELight Demonstrator“

- Helium cell at UHD
  - MMC testing
  - Background modelling
  - DAQ
  - …and much more



DAQ and trigger system for DELight

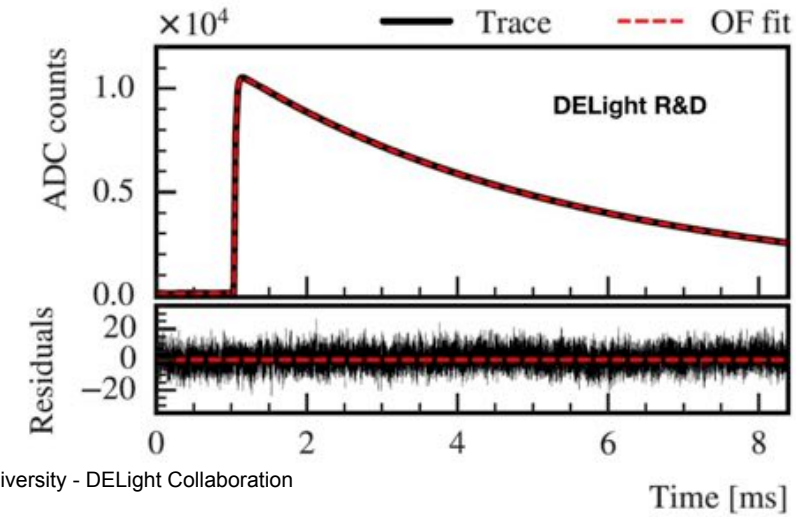
- Level-1 (L1) trigger will run on a FPGA
  - FIR filter

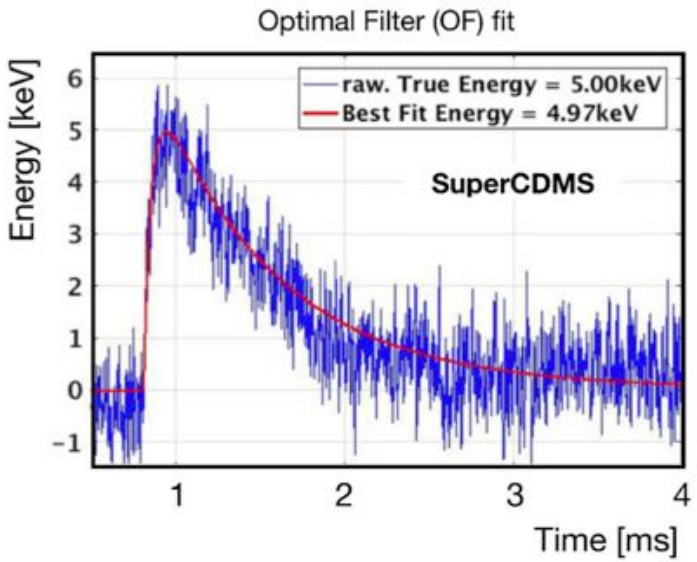


DAQ and trigger system for DELight

- Level-1 (L1) trigger will run on a FPGA
  - FIR filter ⟶ Optimal filter: $S(\nu) = a \cdot A(\nu) + n(\nu)$

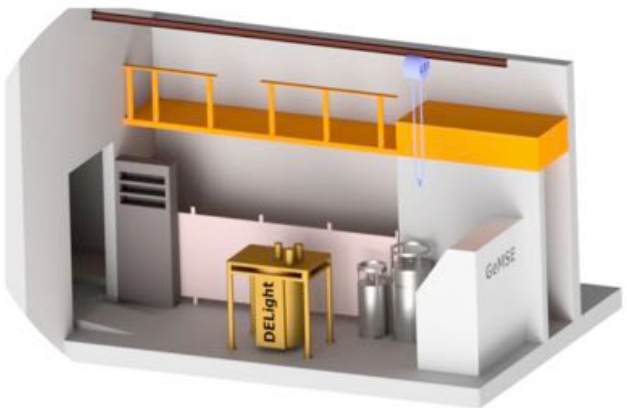
Received signal — Template — Noise

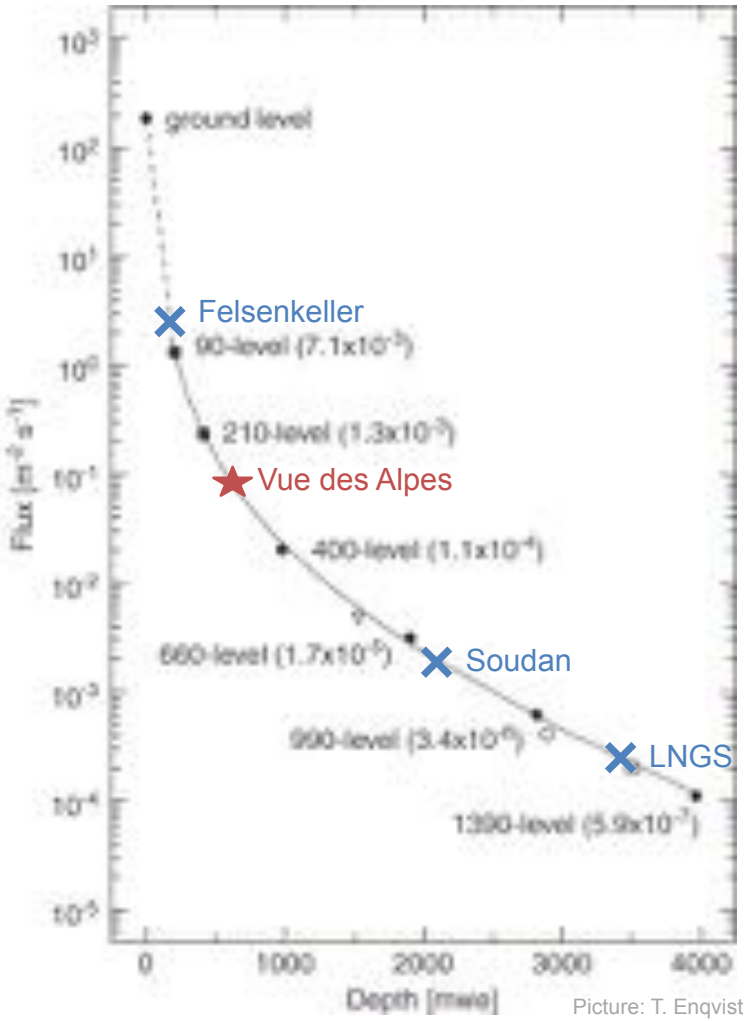




Vue-des-Alpes Underground Lab

- Shallow underground lab in Switzerland
  - 230m rock overburden (620m.w.e.)
- Hosts γ-spectrometer GeMSE
  - Operated by the University of Freiburg





Picture: T. Enqvist et al.

Outlook

- Phase I/II
  - Shallow lab at VdA
  - 10L helium target
  - Threshold of 20eV
- Long range plan
  - Underground lab
  - Larger helium target
  - Threshold of <10eV
  - …stay tuned!