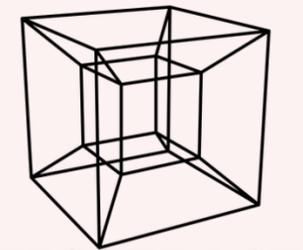




Universität
Zürich^{UZH}



TESSERACT

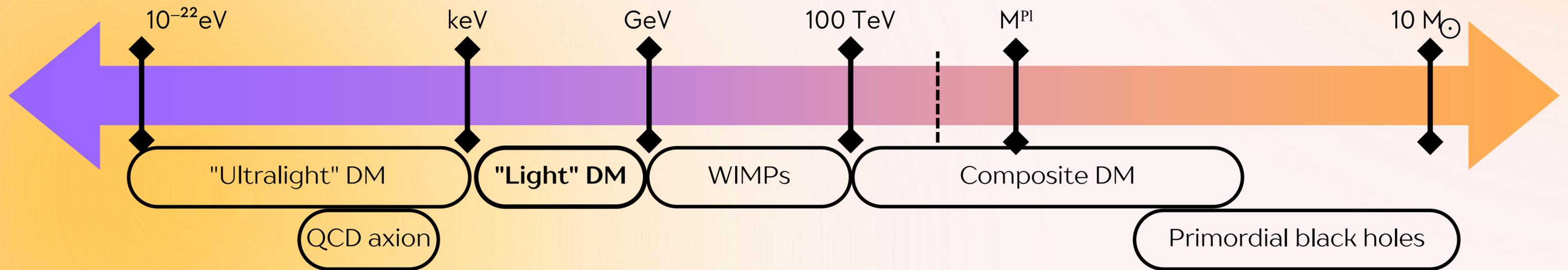
Search for light dark matter :

TESSERACT Experiment

Presented by Leslie Juigne

Introduction

Dark matter candidates



Wide range candidates and masses

Different Detection Approches

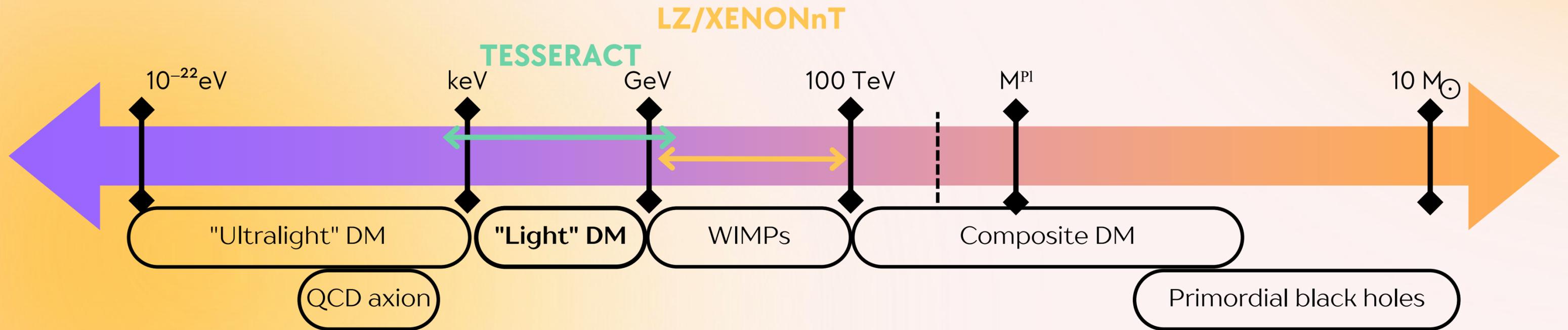
Detection methods can be Direct or Indirect or "Producing"

Direct detection of light dark matter

Masses between keV and GeV

Introduction

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Wide range candidates and masses

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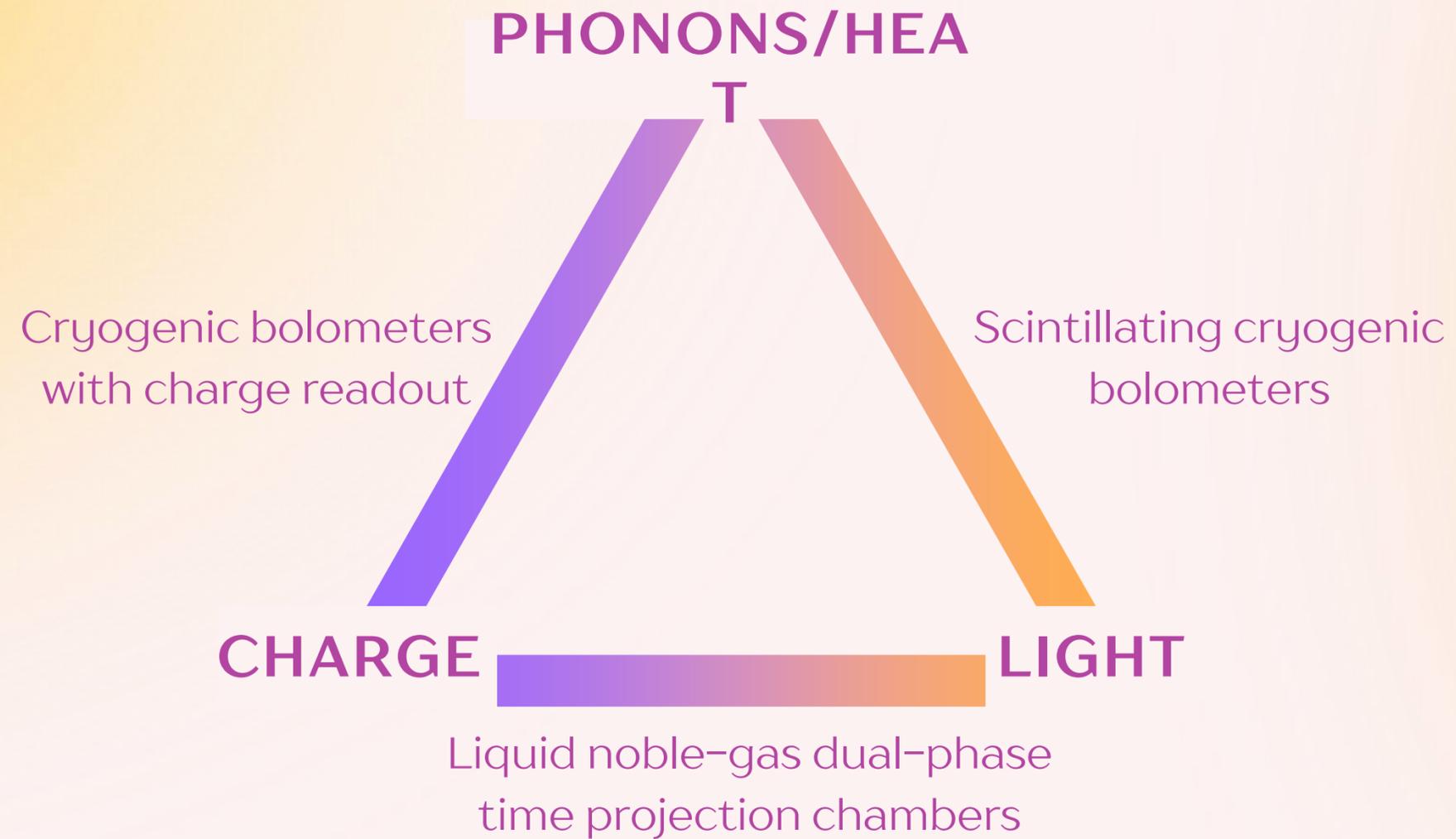
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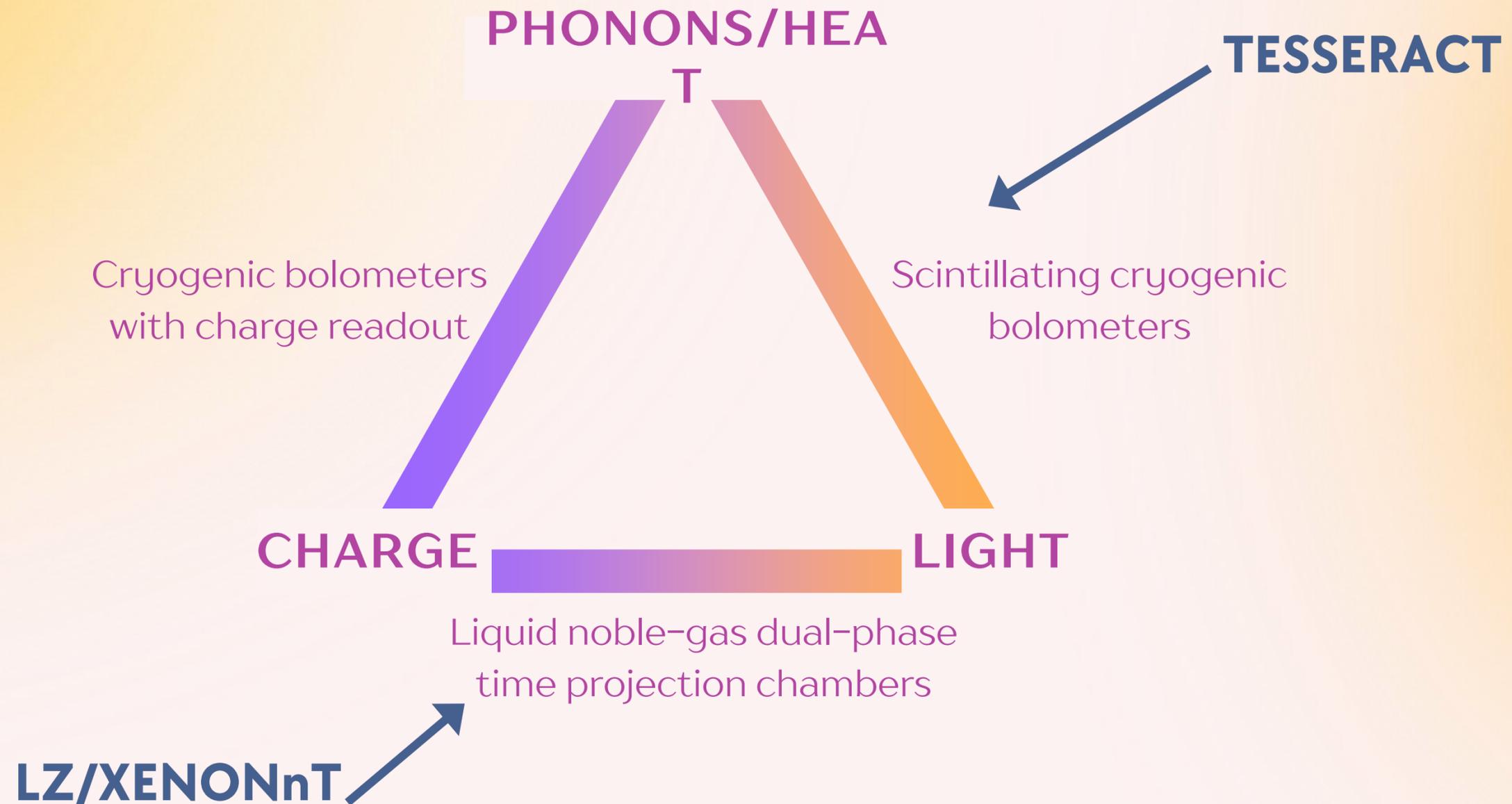
Introduction

Dark matter direct detection

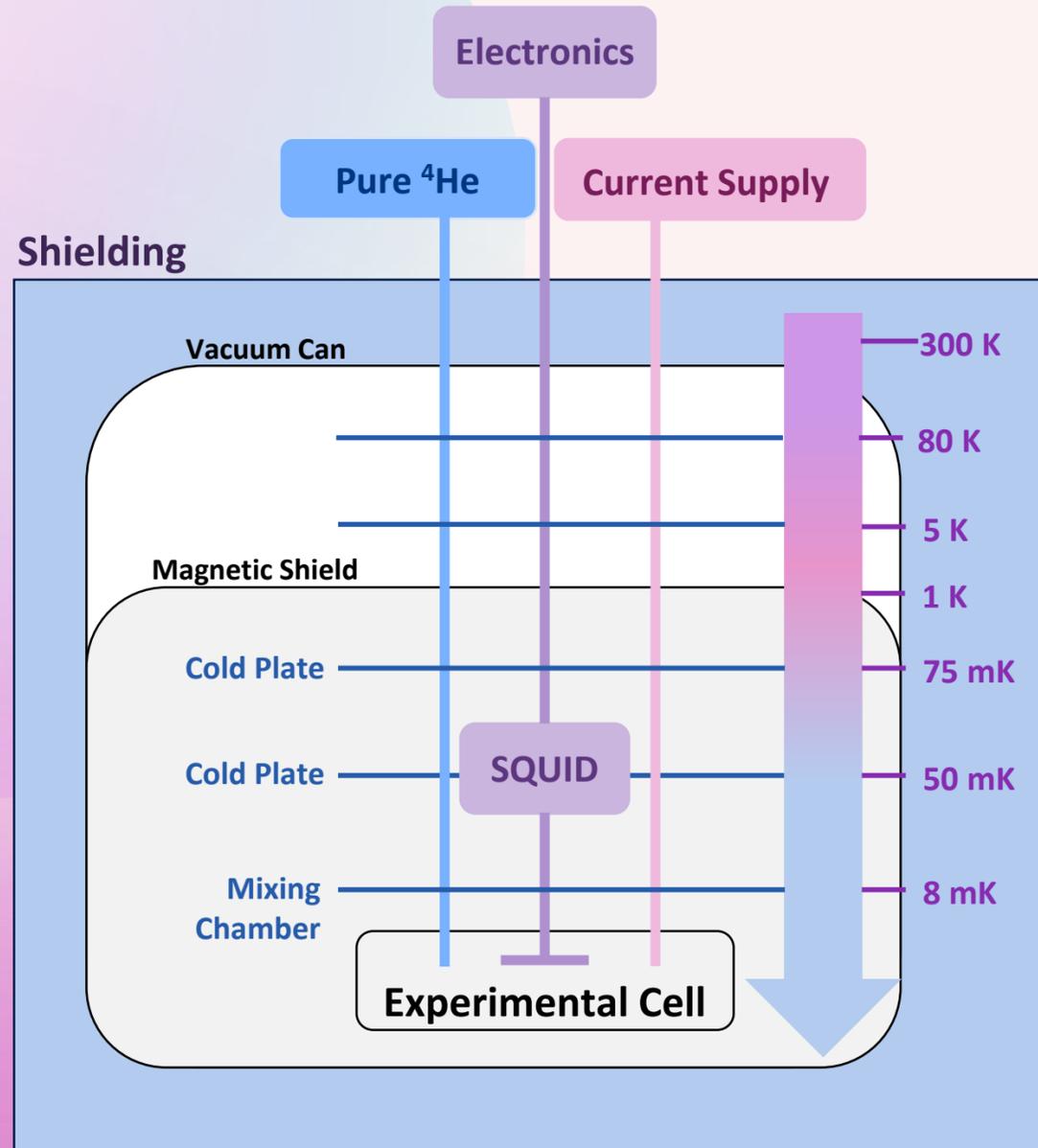


Introduction

Dark matter direct detection



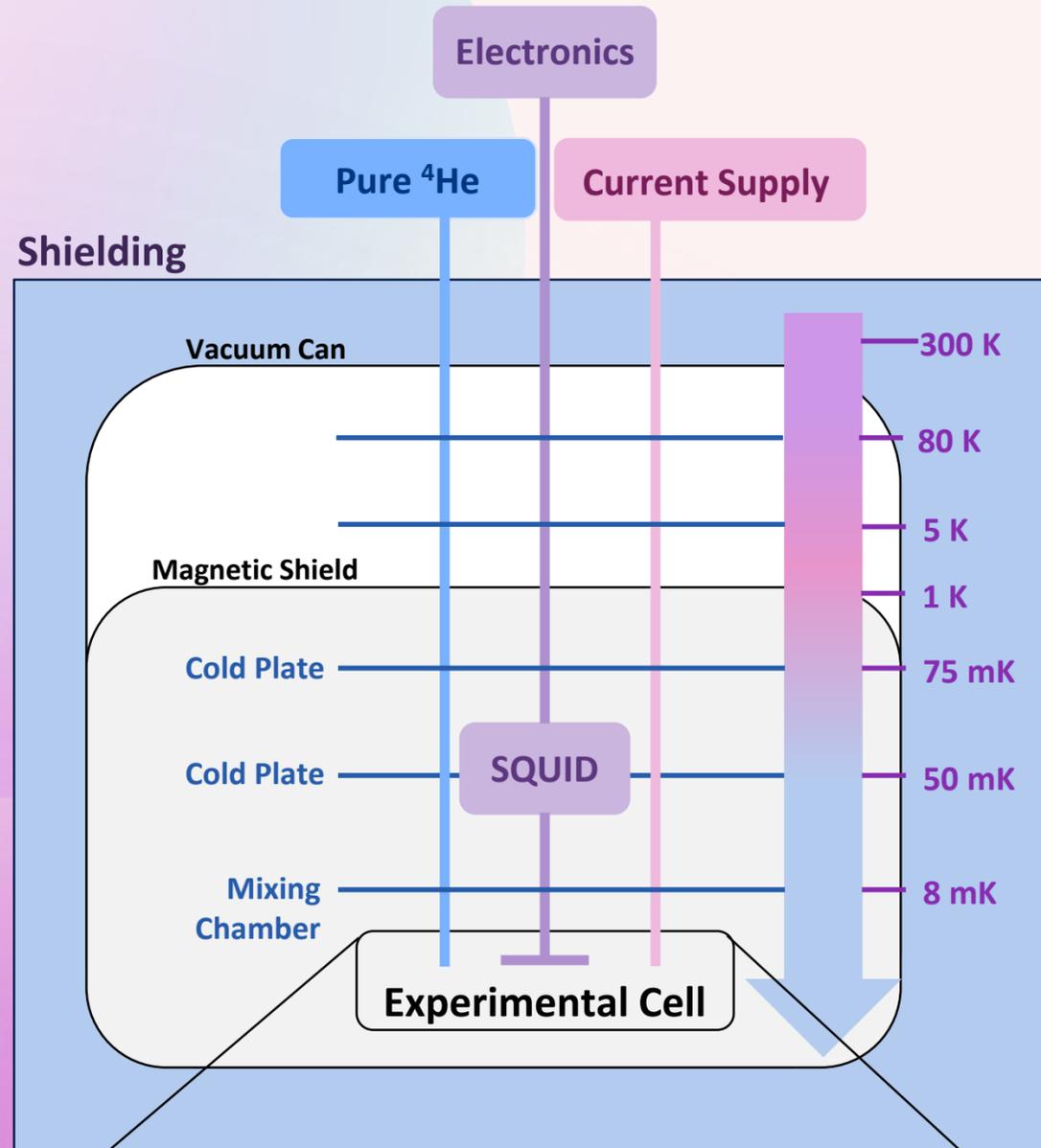
TESSERACT Experiment



Dilution Fridge

- Cools down to **mK temperatures**
- Experimental Cell : 3 different targets
- TES (Transition Edge Sensor) on top of the cell

TESSERACT Experiment

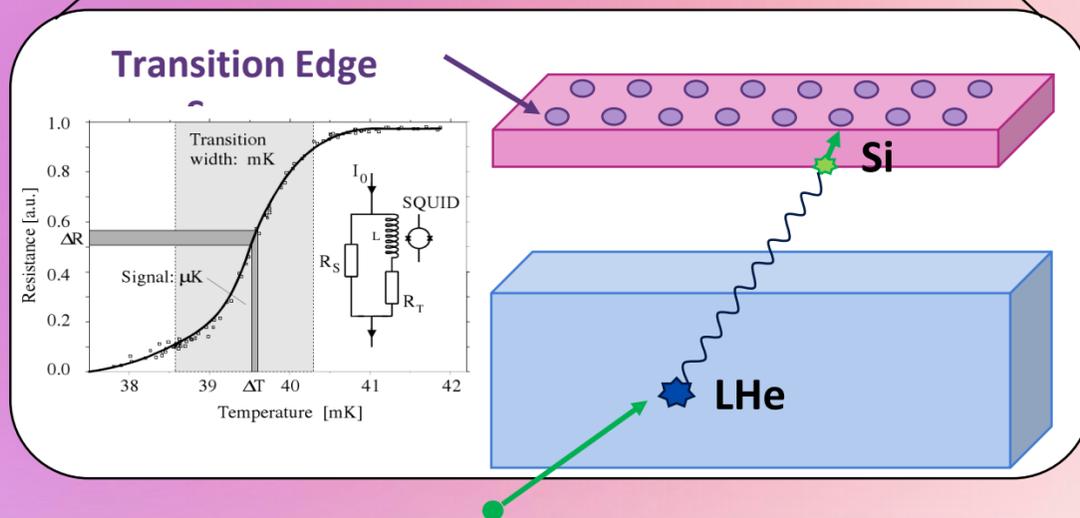


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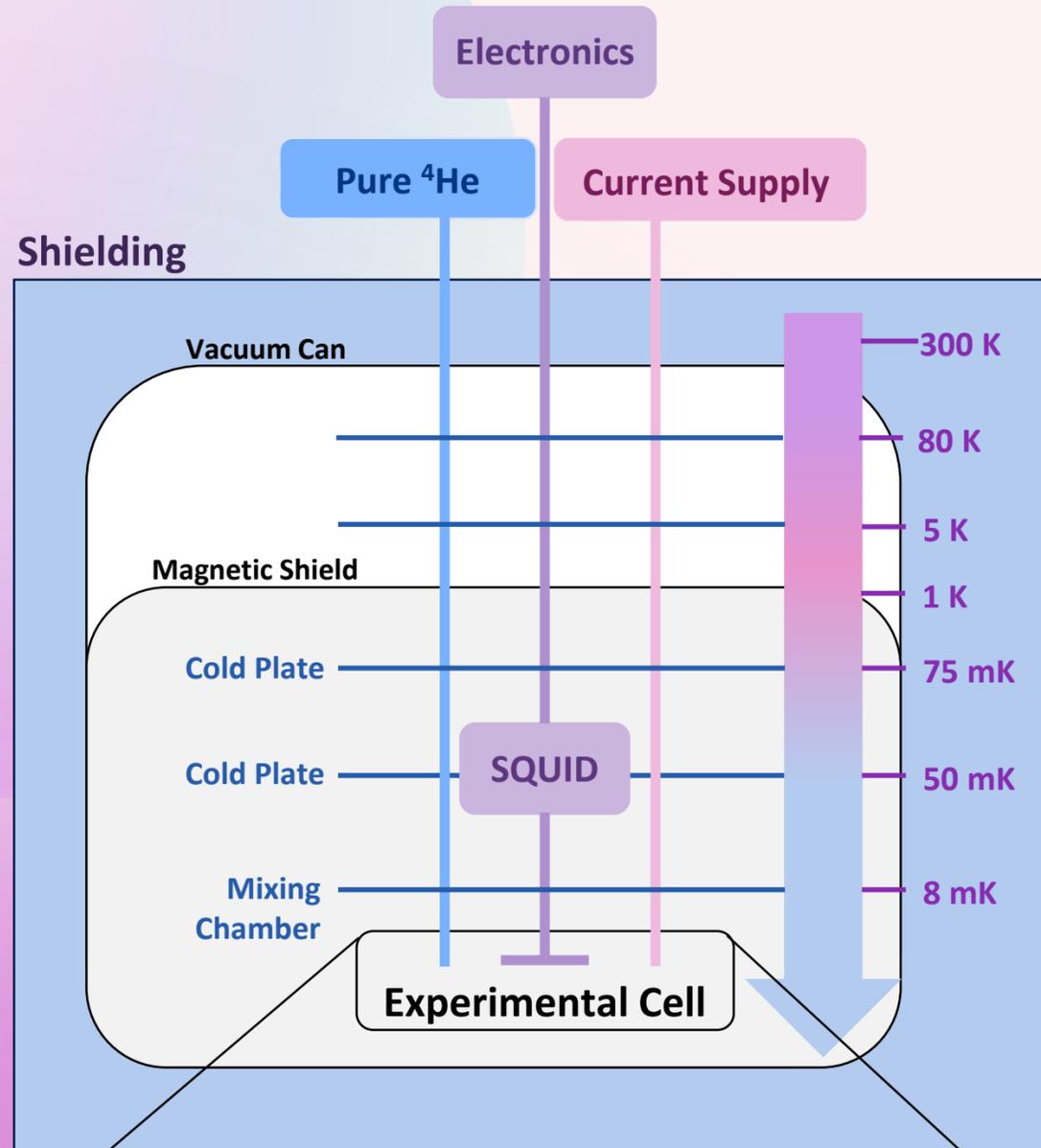
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Low Background

- Modane Underground Laboratory (**LSM**) at **1600m underground**
- Multiple layers shielding (Plastic, Stainless Steel, Pb and Cu)



TESSERACT Experiment



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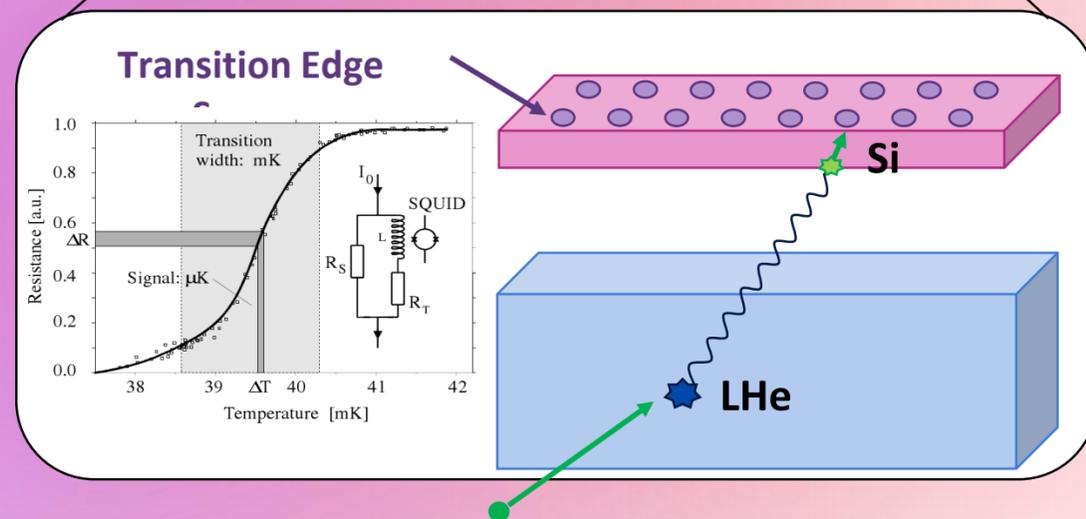
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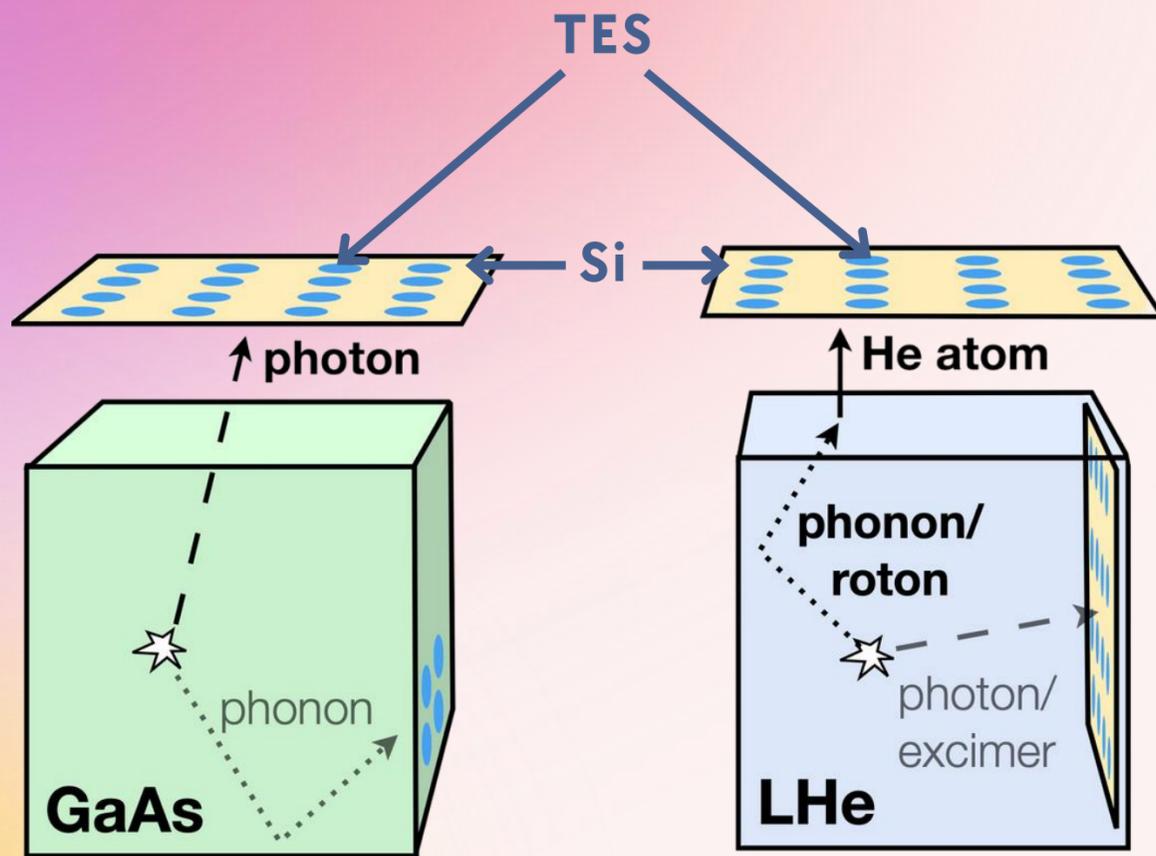
Multi-Target Approach

- Background **Identification & Discrimination**
- Different **sensitivities** for different types of **DM interactions**



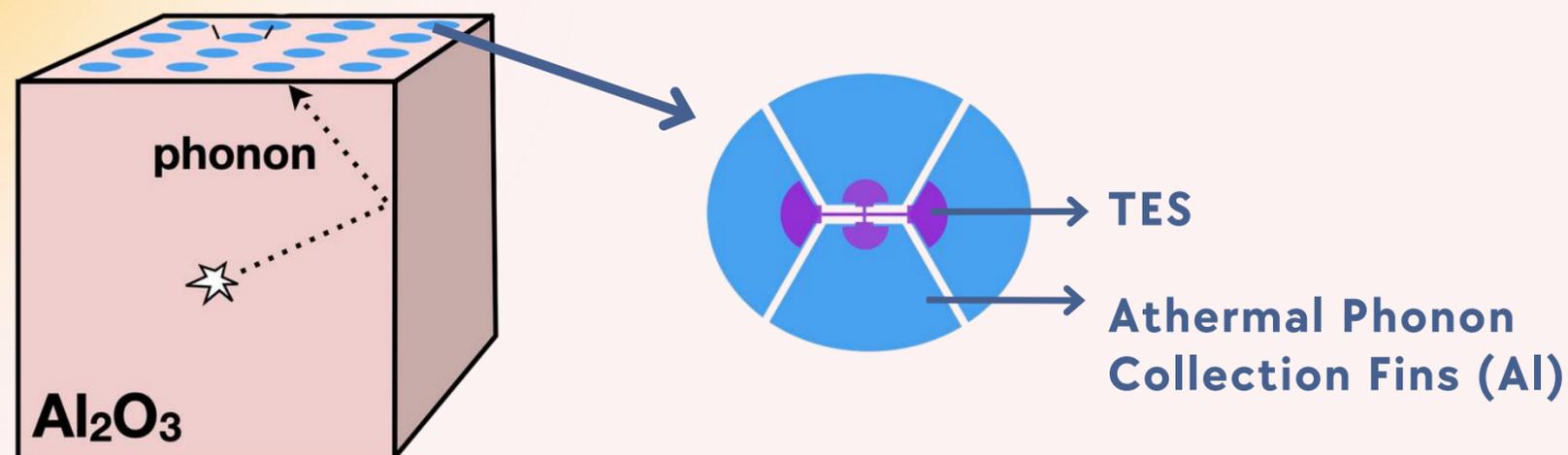
TESSERACT Experiment

Multi-targets Approach



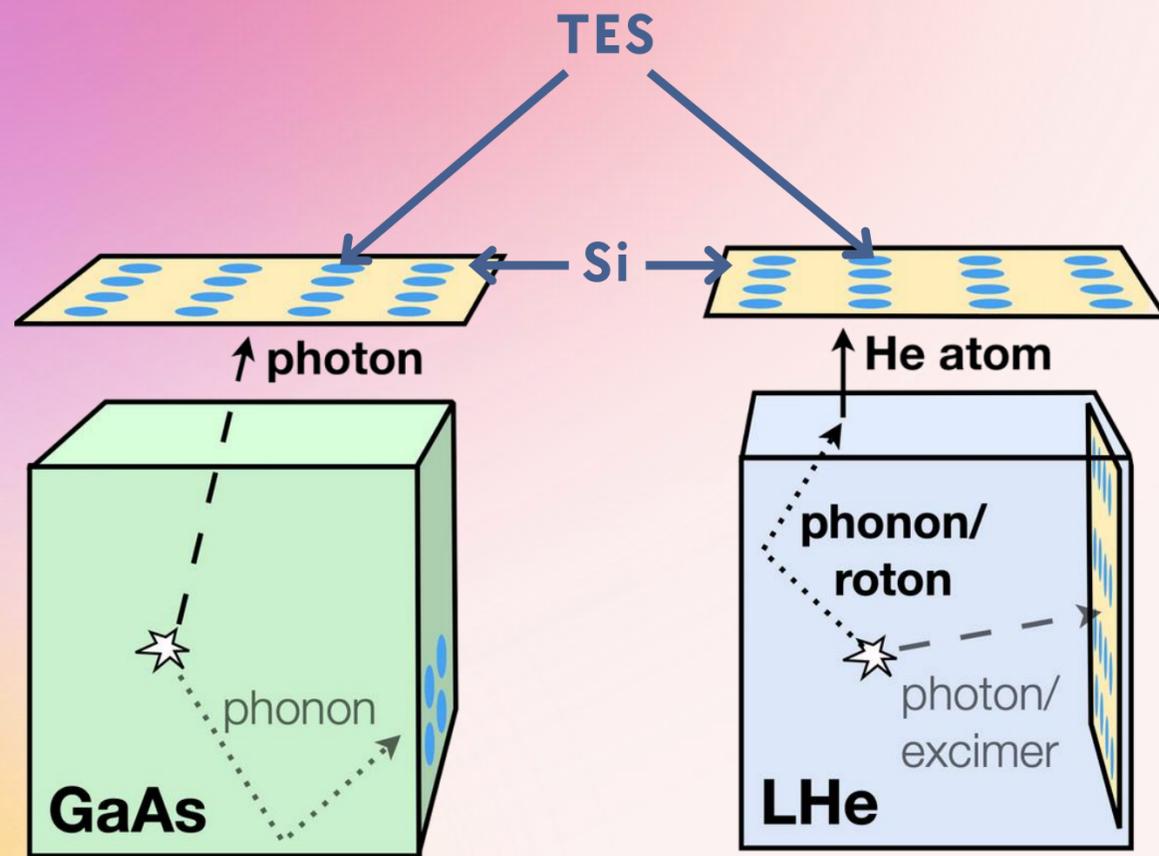
Gallium Arsenide (GaAs)

- **Cryogenic scintillator** in the IR (930nm)
- High light output : ~ **100photons/keV**
- Produces **photons** and **phonons**



TESSERACT Experiment

Multi-targets Approach

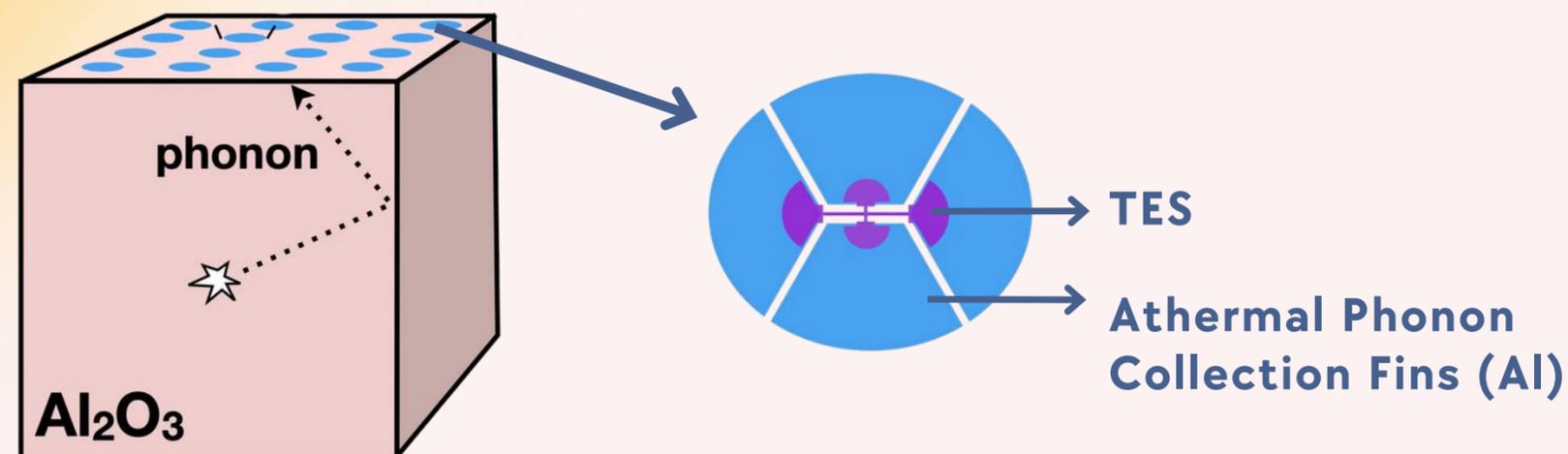


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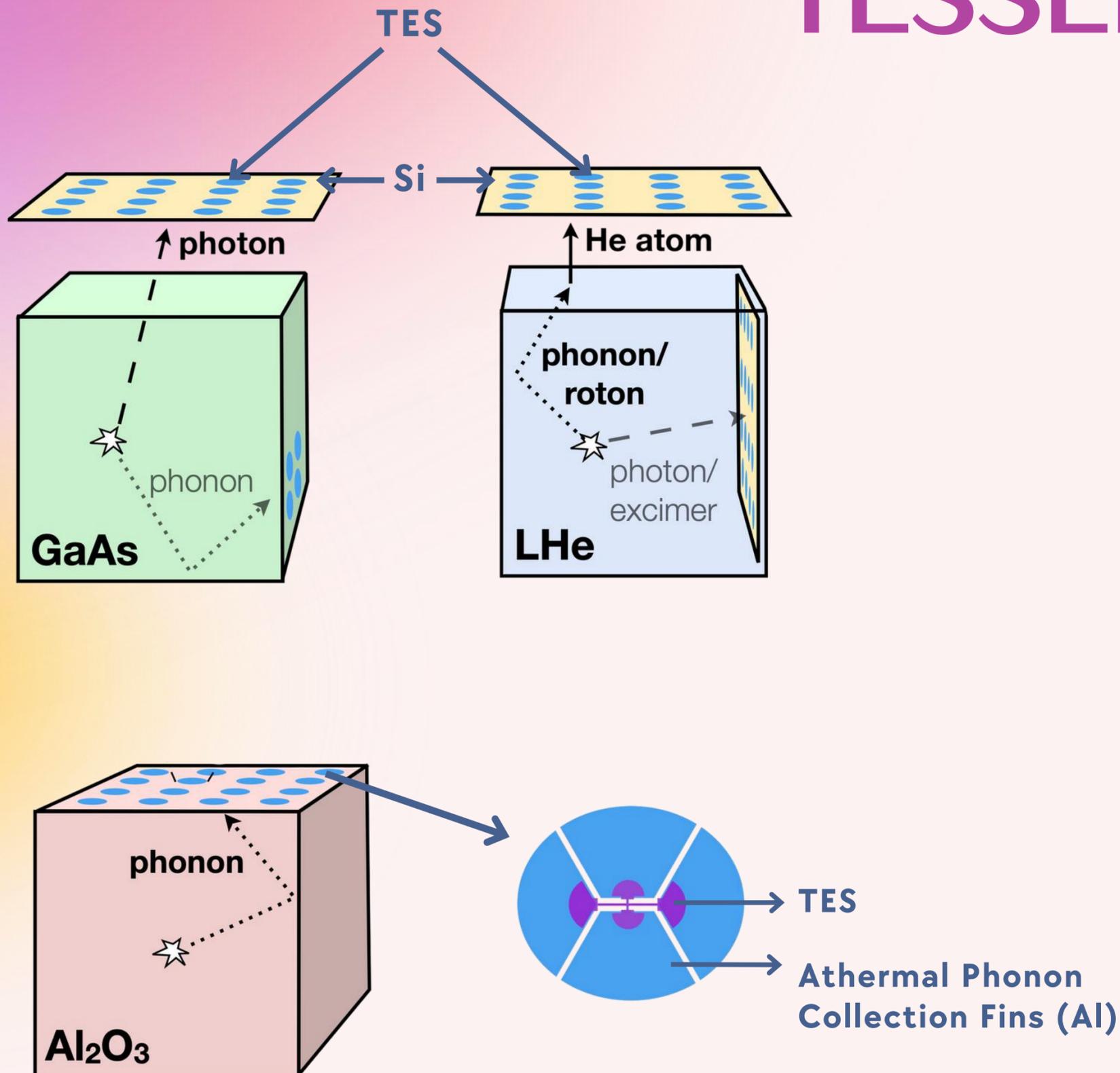
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- **Athermal Phonon** Production
- Phonon Band Structure: Extraction of **almost maximum kinetic energy** during scattering events.
- Low-Z Material: **good sensitivity for NR**



TESSERACT Experiment

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Superfluid Helium

- **Low noise** in mK temperatures
- **Unique signals channels**
- First target to be implemented

Superfluid Helium – Signal Channels

Signal Channels

- Can be **easily discriminated**
- Photon and phonons signal productions

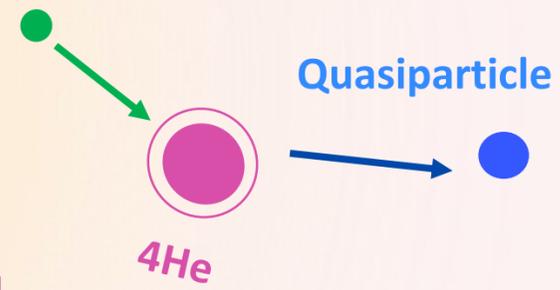
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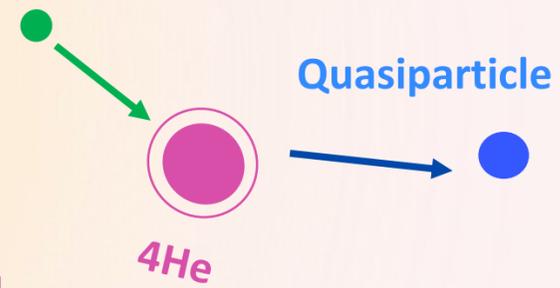
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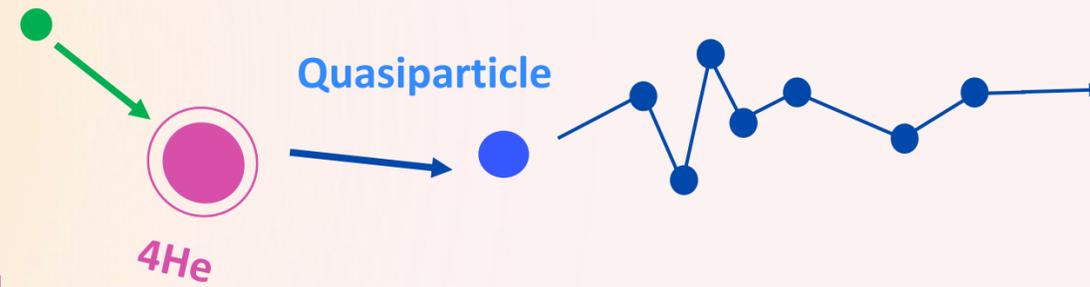
Quantum Evaporation

- **Quasiparticle** produced after interaction

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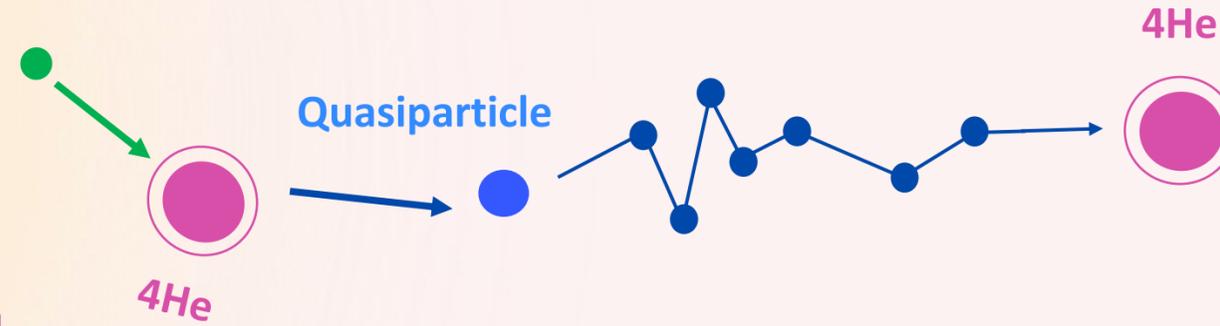
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- **Quasiparticle** produced after interaction
- Release of a **4He** at the liquid surface

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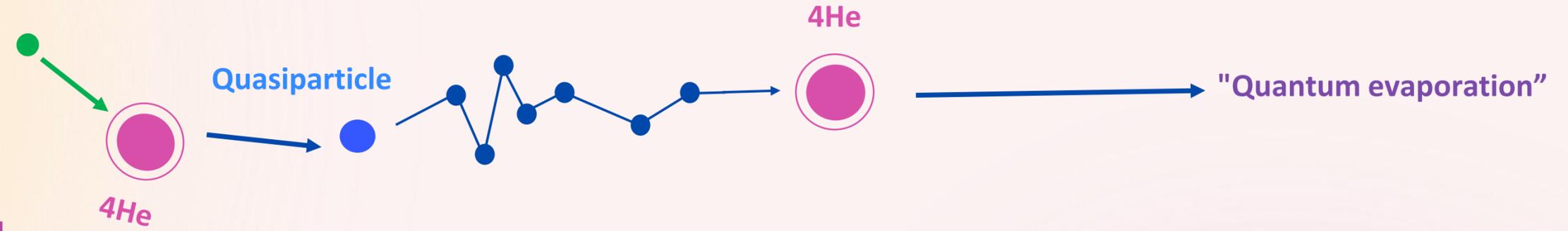
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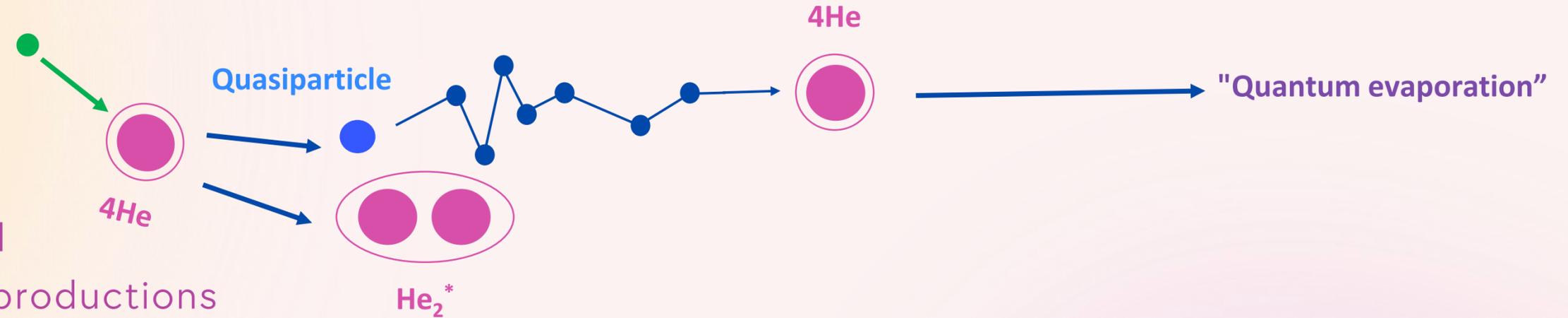
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- **0.62 eV threshold**

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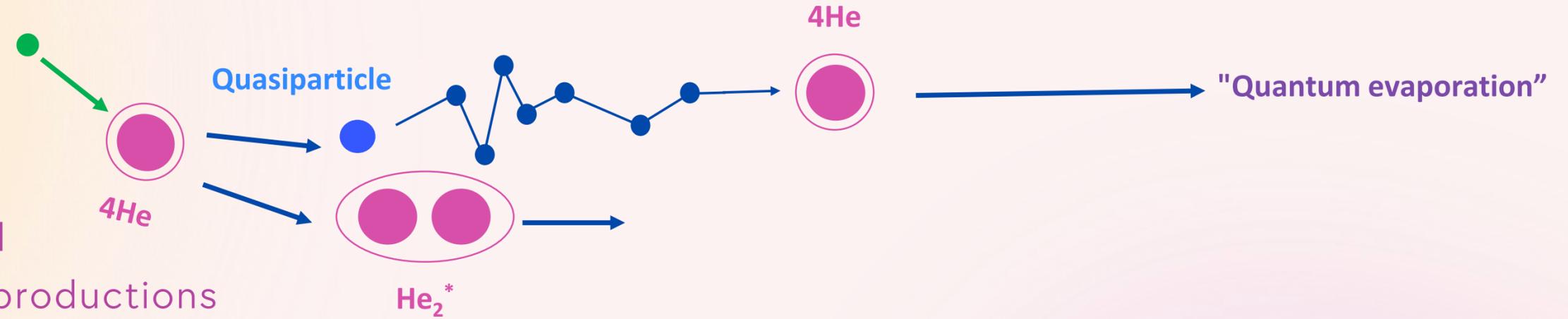
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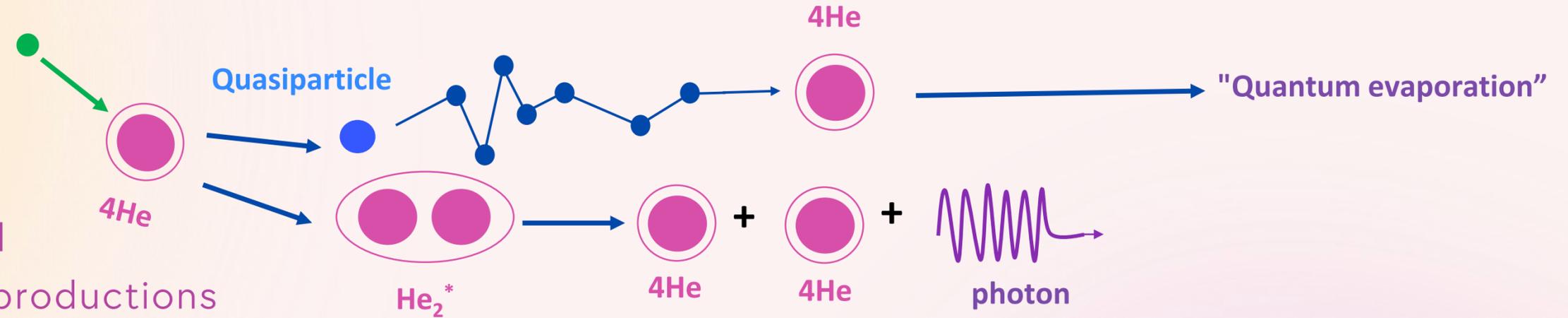
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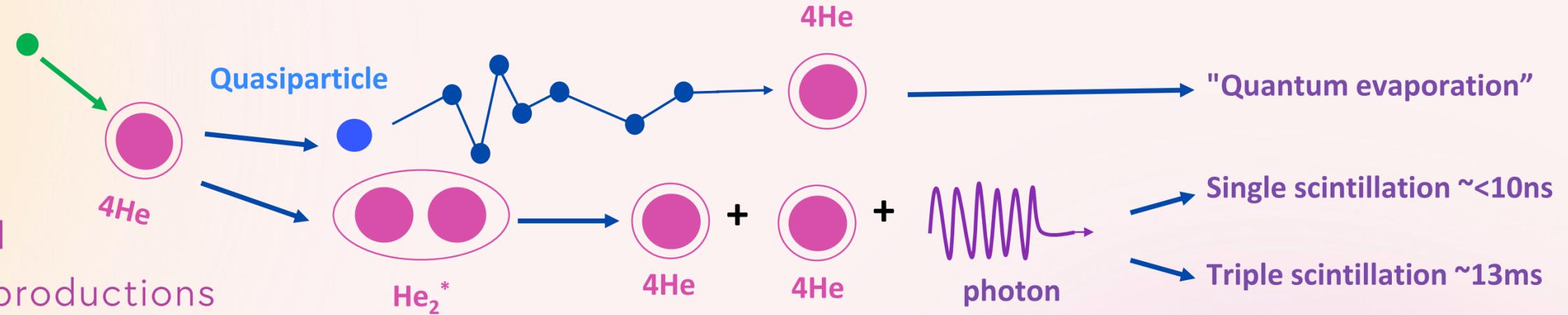
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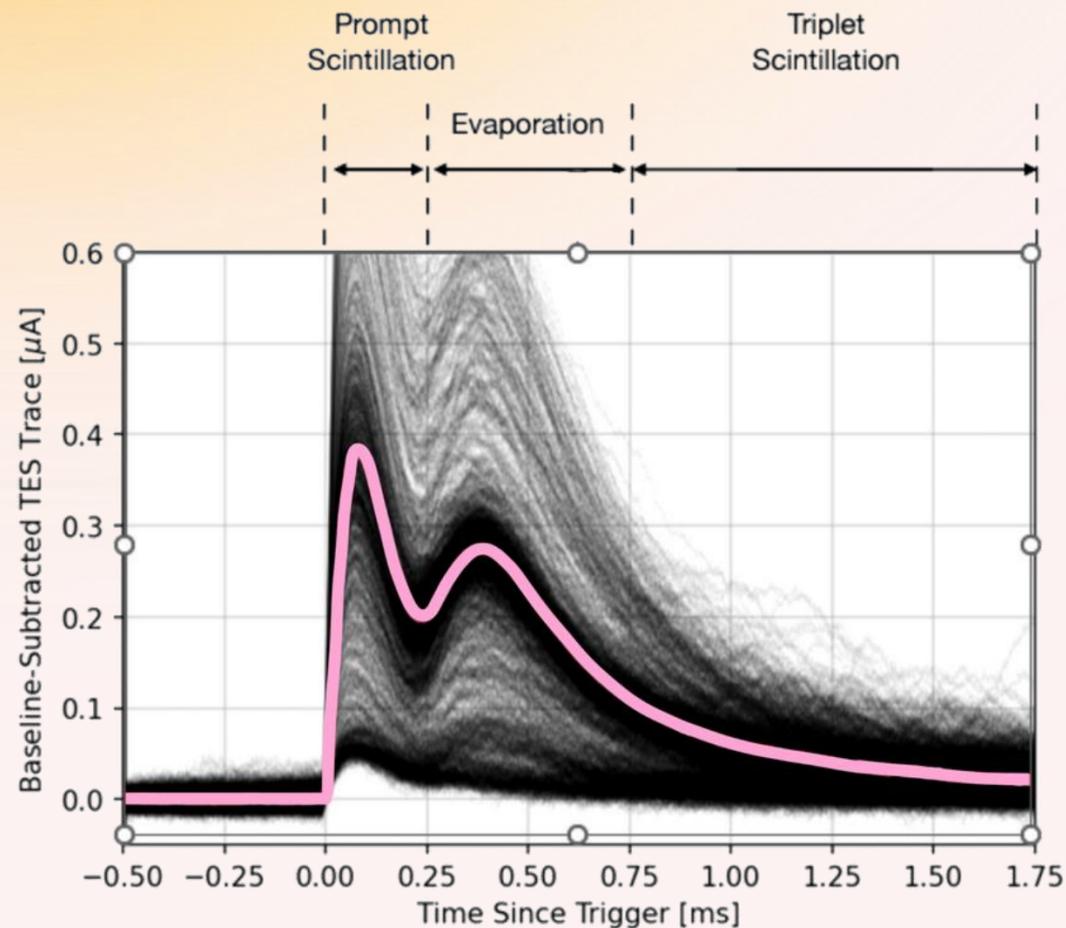
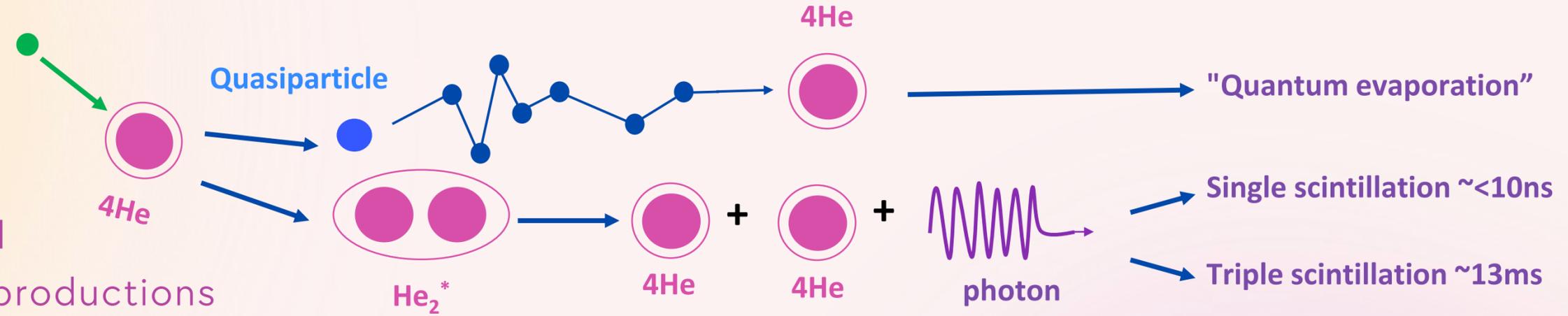
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- **Short-lived singlet state**: emit 15.5 eV VUV photon
- **Long-lived triplet state**: decay at recoil site or propagate and de-excite at surfaces

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4He waveforms from the calibration source ^{55}Fe

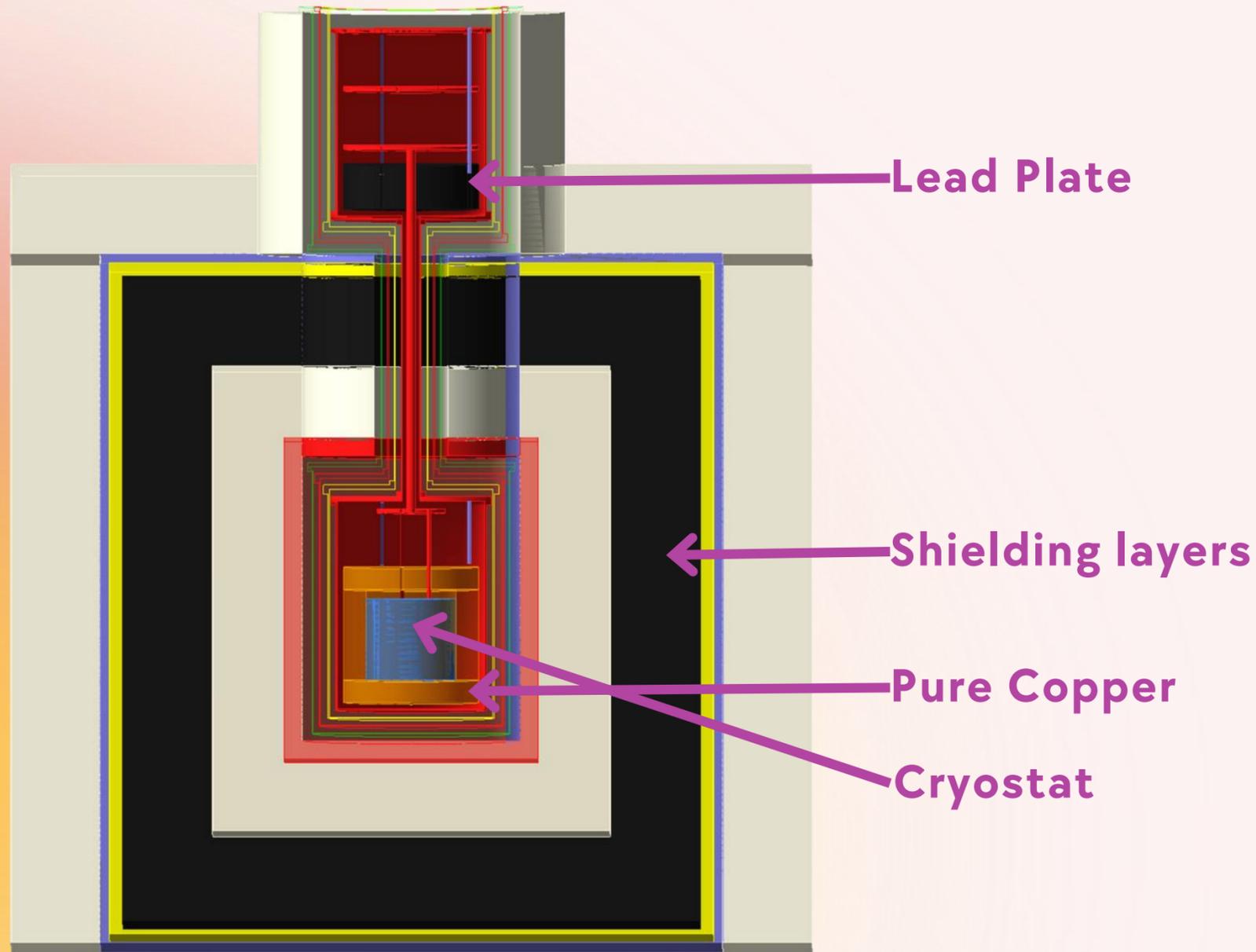
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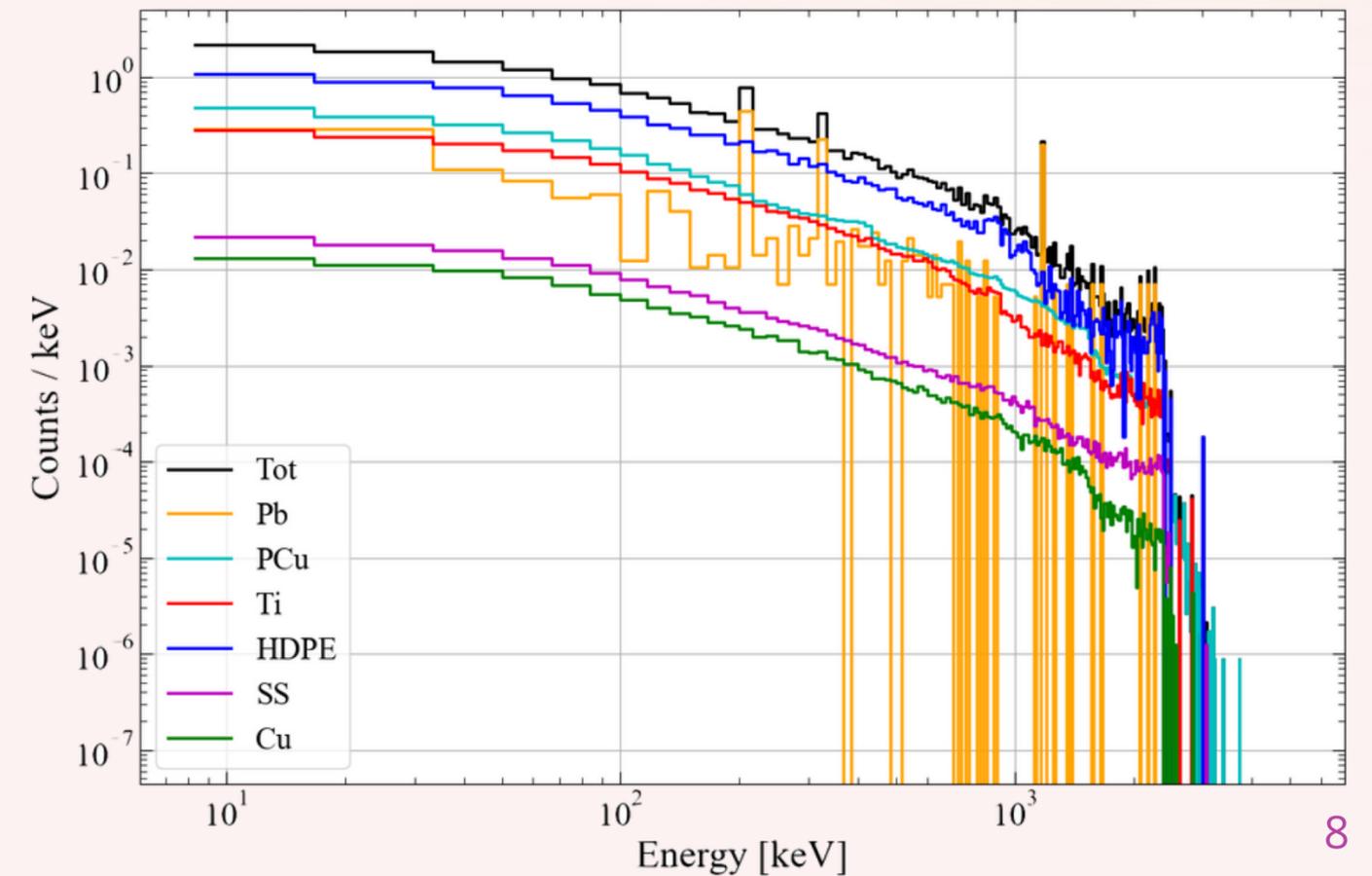
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Background modeling

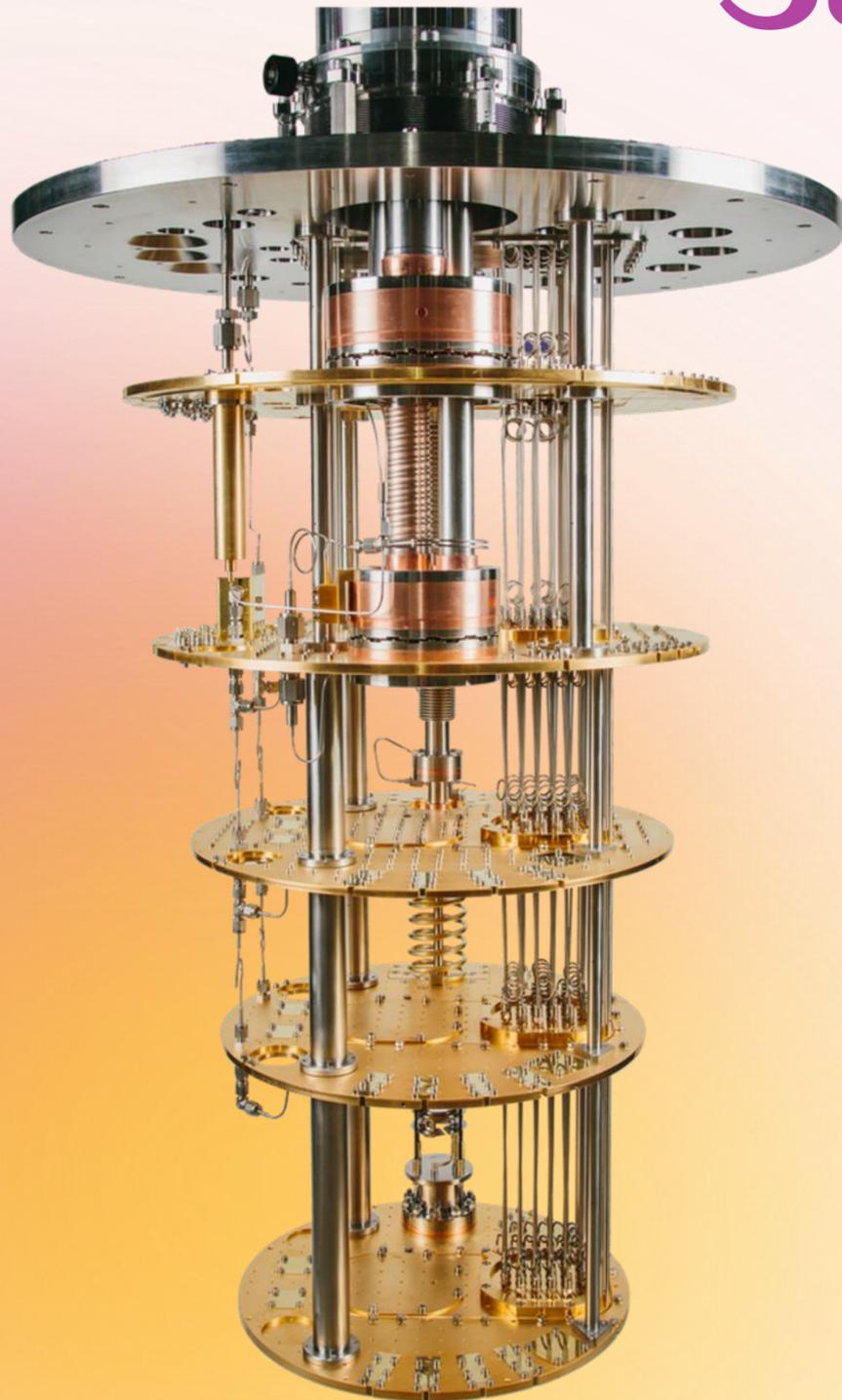


Background Simulations

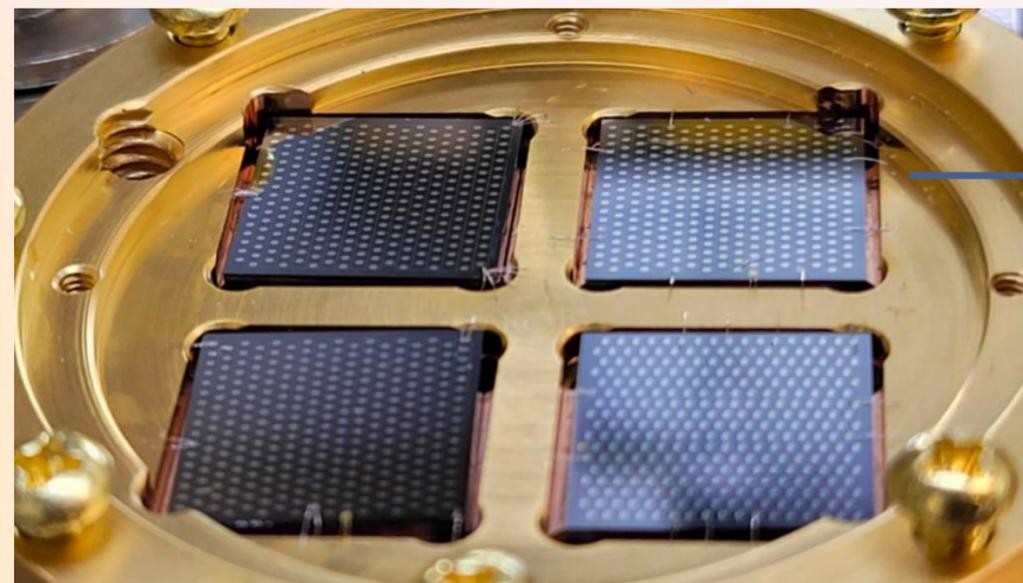
- 1st phase : Optimisation of the shielding
- 2nd phase : Full detector modeling, estimation of its performances



Sapphire Quantum Sensors



- **Building + Characterisation** of the sensors
- **Resolution** and photon **collection efficiency**
- NR/ER **discrimination**
- Creation and test of the **procedure** for the TESSERACT Experiment at the LSM



Prototype of a TESSERACT detector operated at LBNL

**Thank you for
your attention!**

References

Lin, Tongyan. (2019). Dark matter models and direct detection. 009. 10.22323/1.333.0009.

Background modeling

Optimisation of the shielding geometry

