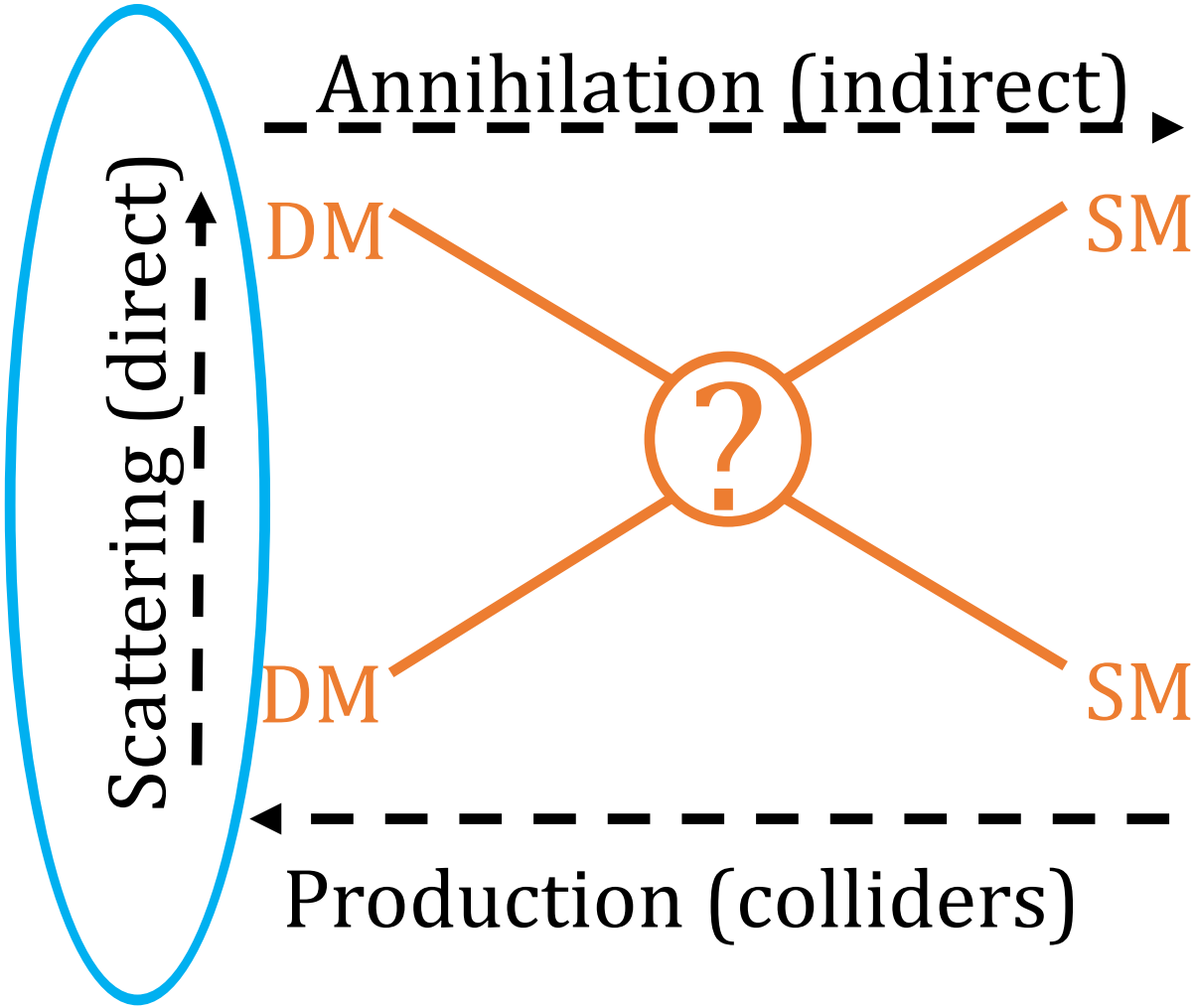
Dark matter searches

Road Map for Particle Physics in Austria Meeting,
Vienna, June 10, 2024

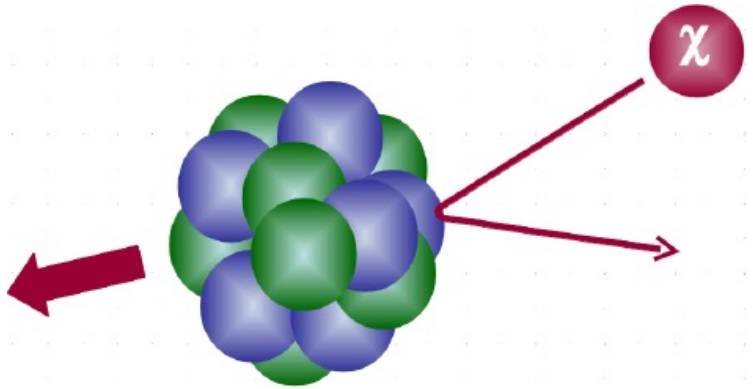
Florian Reindl
HEPHY & TU Wien

Direct dark matter detection



If not stated otherwise, explicitly:

DM-nucleus scattering



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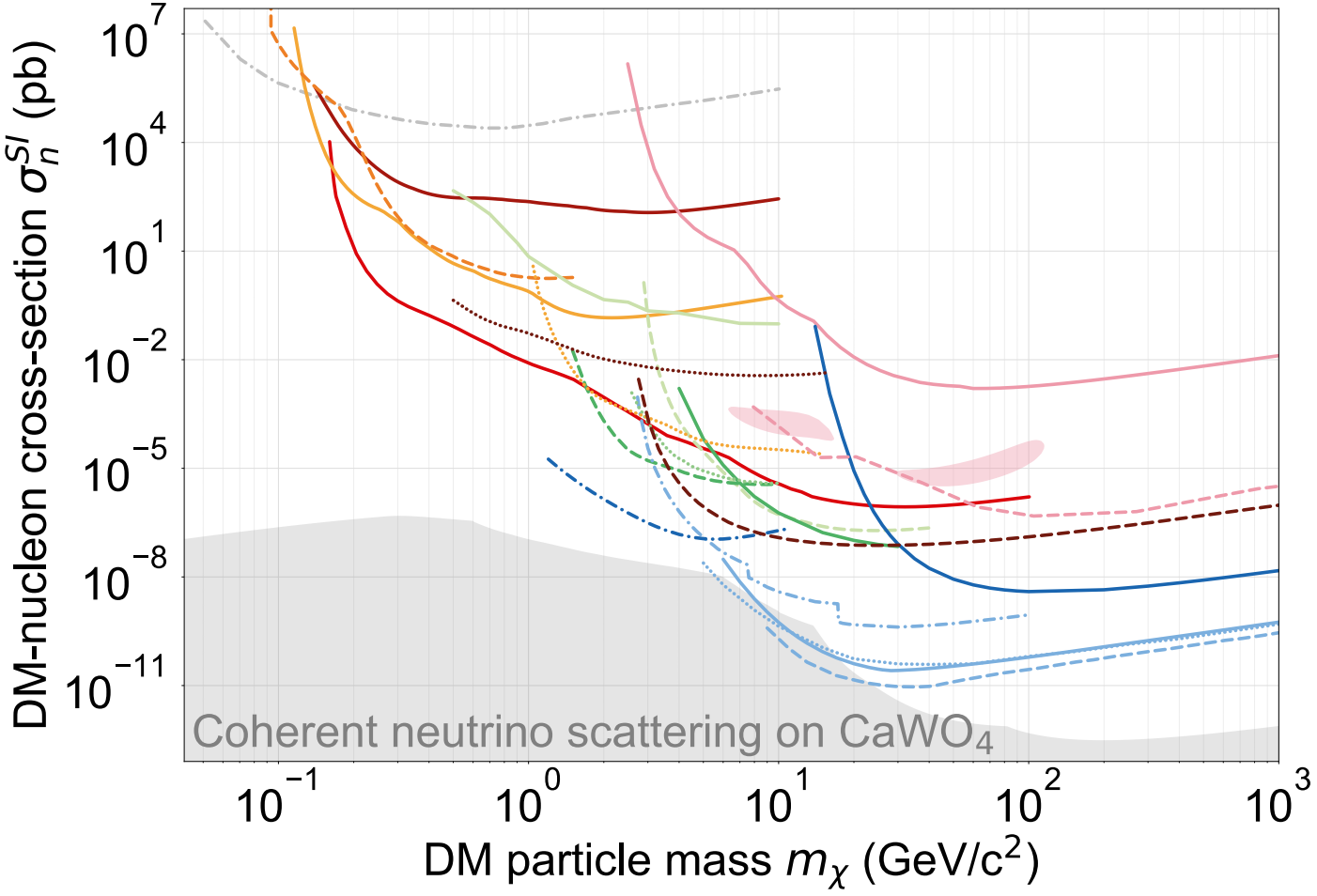

Cryogenic Detectors:
- CRESST-III $CaWO_4$ 2019
- CRESST-III Si 2023
- CRESST-surf Al_2O_3 2017
- SuperCDMS-CPD Si 2020
- SuperCDMS Ge 2014
- CDMSLite Ge 2019
- EDELWEISS-III Ge 2016
- EDELWEISS-surf Ge 2019
- COSINUS NaI 2023

Other technologies:
- DEAP-3600 LAr 2019
- PandaX-4T LXe 2021
- LUX-ZEPLIN LXe 2023
- XENONnT LXe 2023
- XENON1T S2 LXe 2019
- DarkSide-50 S2 LAr 2023
- CDEX-10 Ge 2018
- DAMIC Si 2020
- NEWS-G Ne 2018
- PICO-60 C_3F_8 2019
- Collar H 2018
- COSINE-100 NaI 2021
- DAMA/LIBRA 3σ NaI 2009

Plot: M. Kaznacheeva, K. Schäffner, Scintillating low-temperature calorimeters for direct dark matter search, to be published

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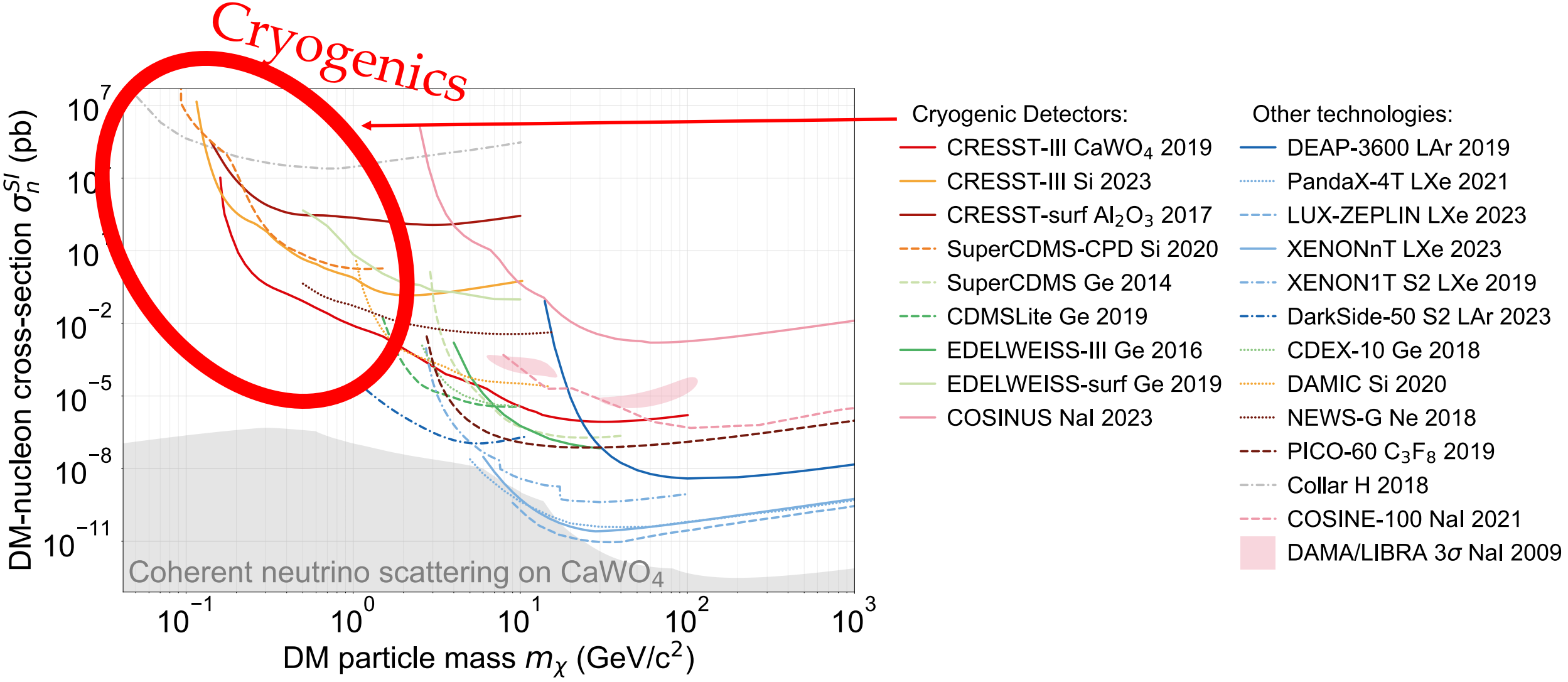

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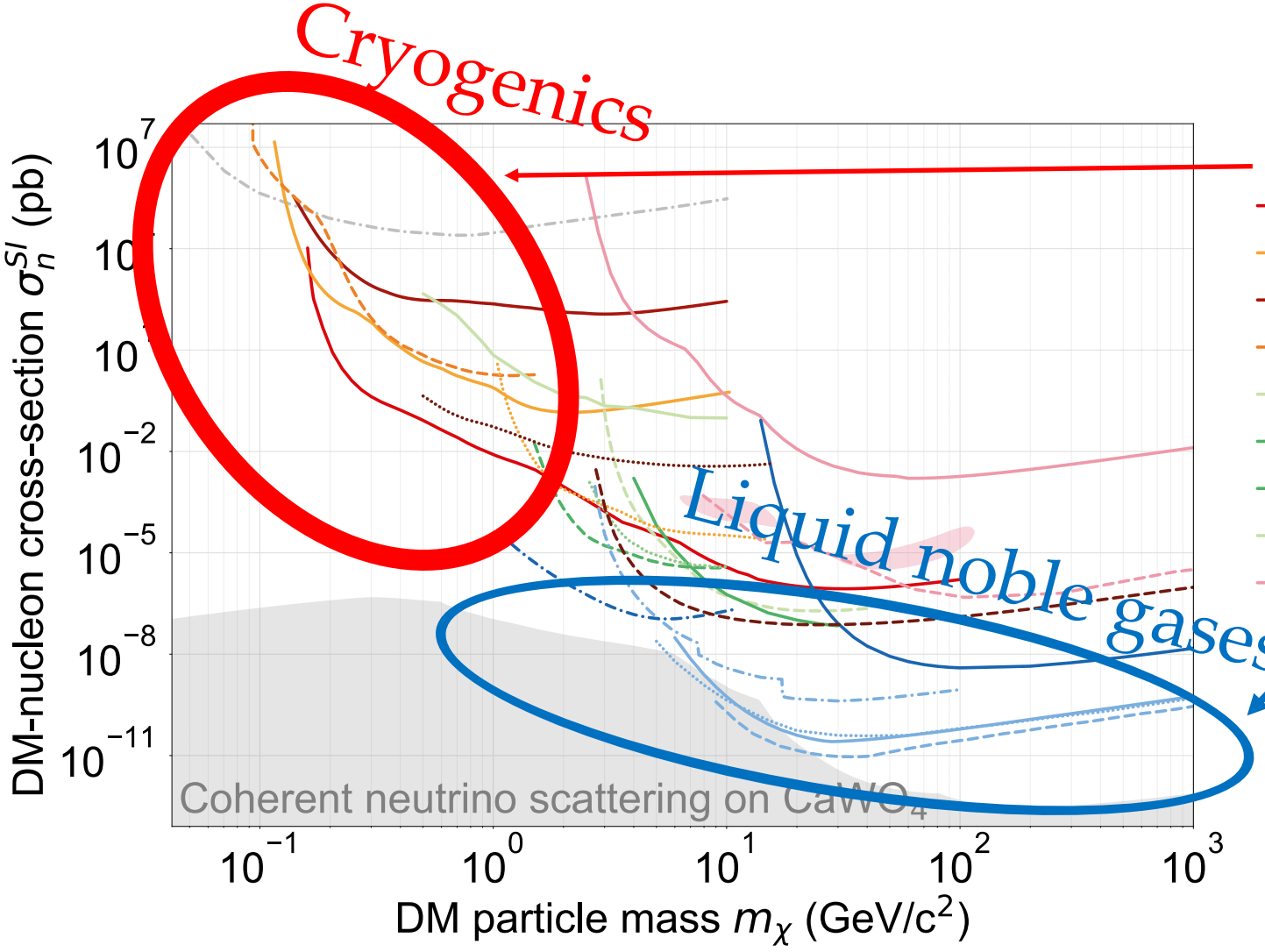

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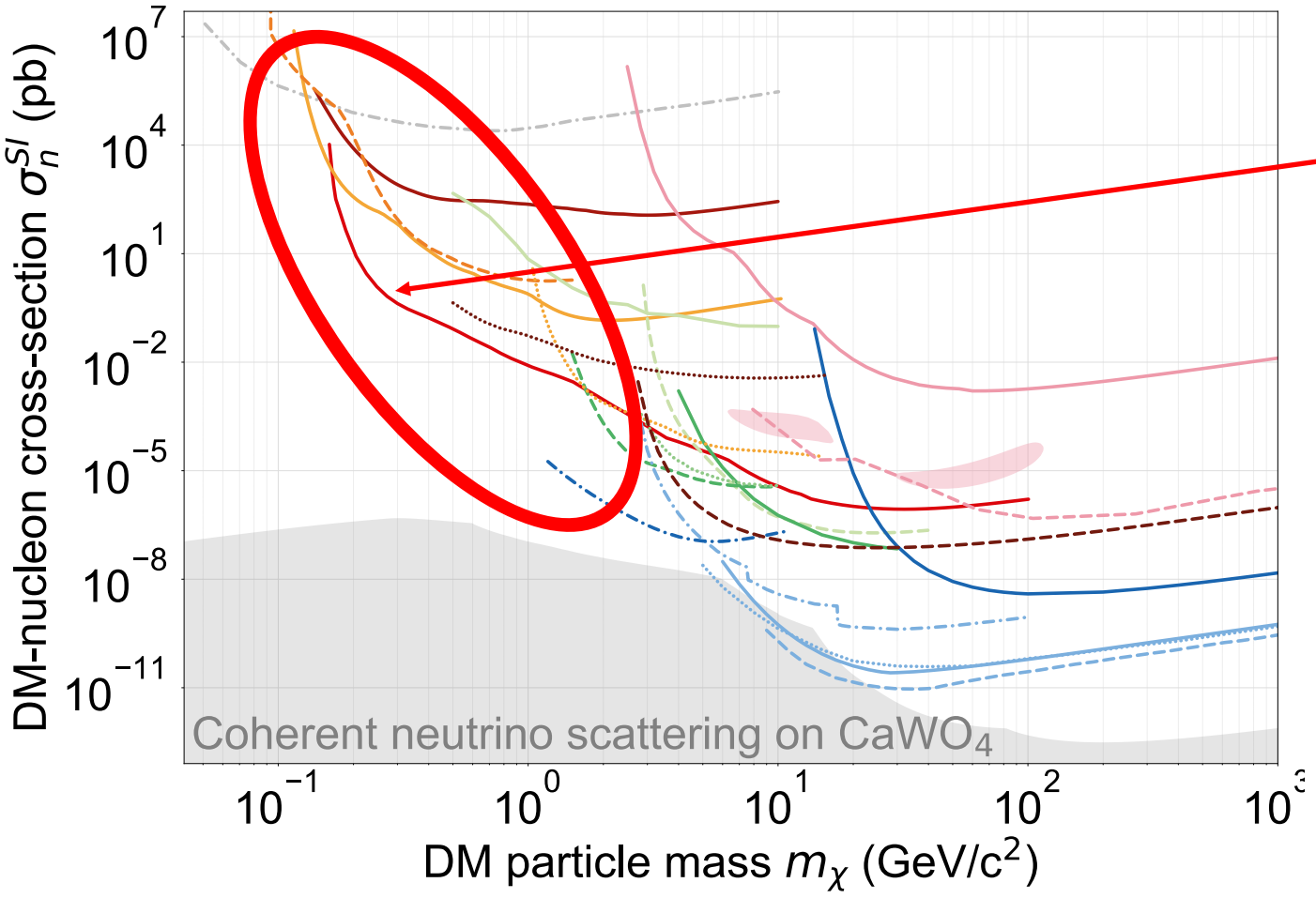

CRESST

Search for light dark matter with low-threshold cryogenic detectors

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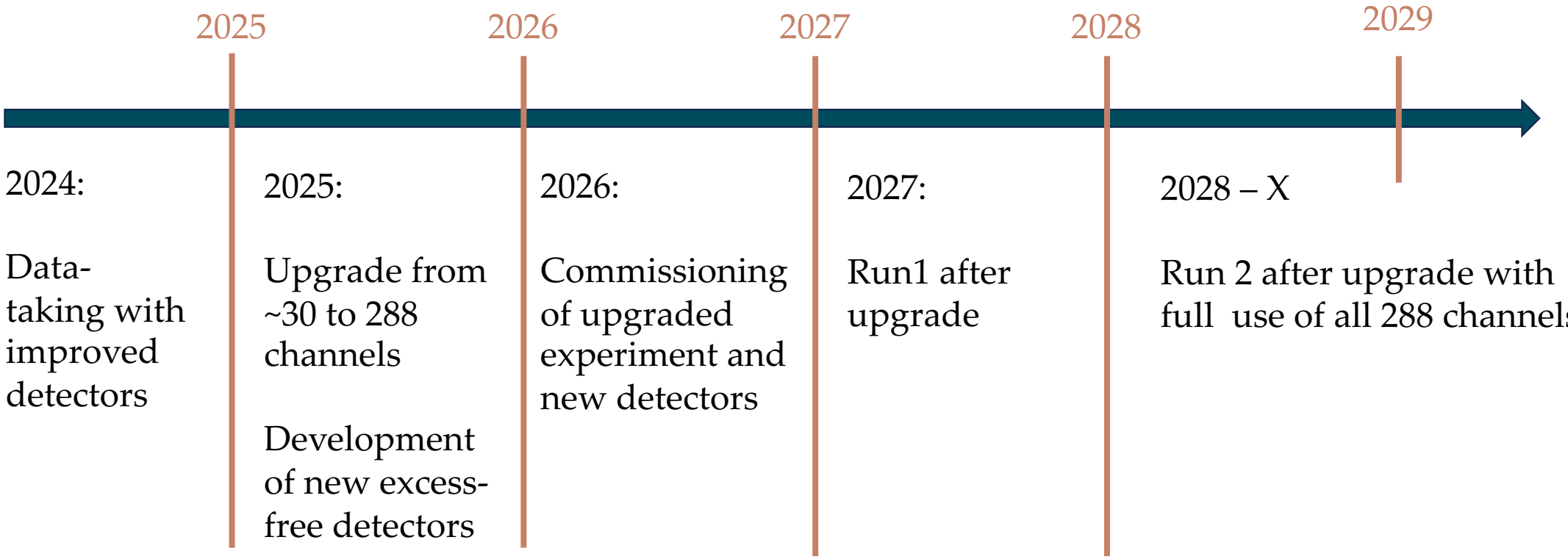
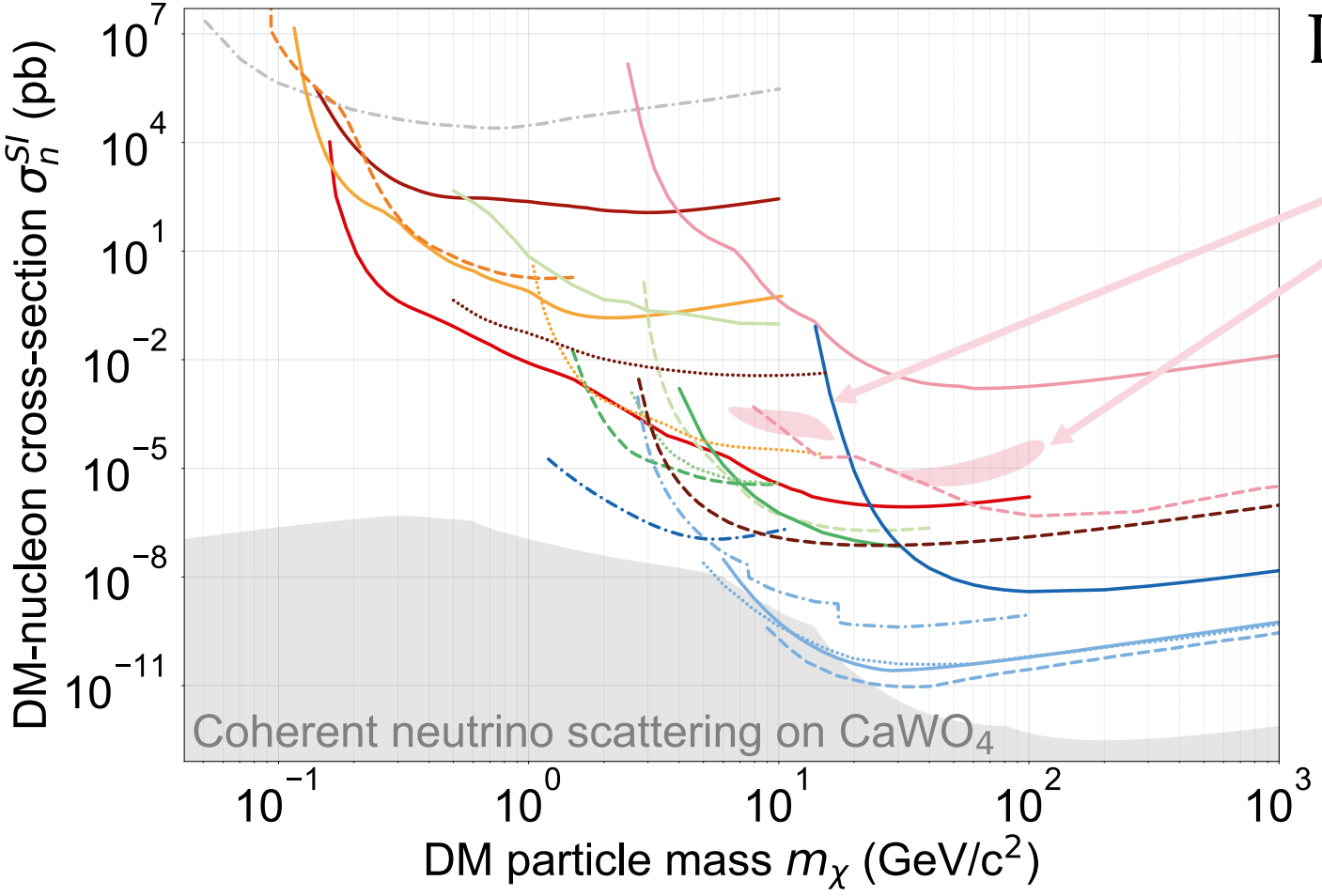
Since 1996, now in Stage CRESST-III



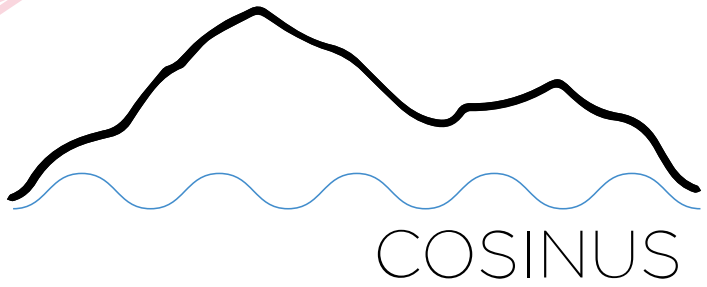
Main challenges:

1. Low-energy excess: requires detector R&D
2. Detector mass production and operation: requires new fabrication standards, new methods of operation …

2. Direct Detection and COSINUS



DAMA: strong DM claim (13.7σ)



Clarify the DAMA claim in a model-independent way using a same-material (NaI) cryogenic detector

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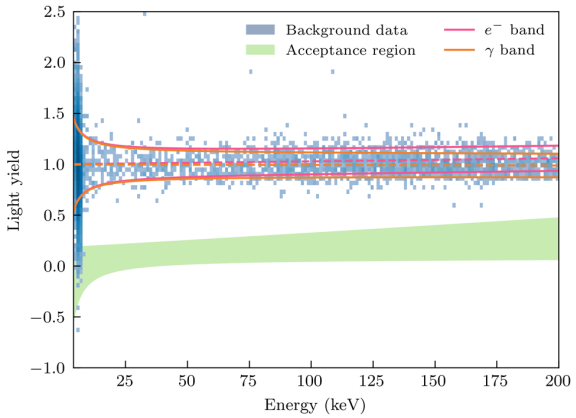
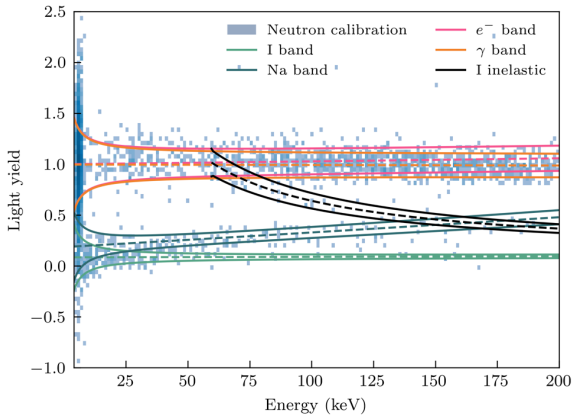
COSINUS

R&D phase: 2016-2020
Construction: 2021-2023





2025 2026 2027 2028 2029

2024:

Cabling and muon veto

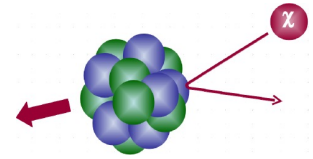
2025:

Data taking 100 kg days

2026-28:

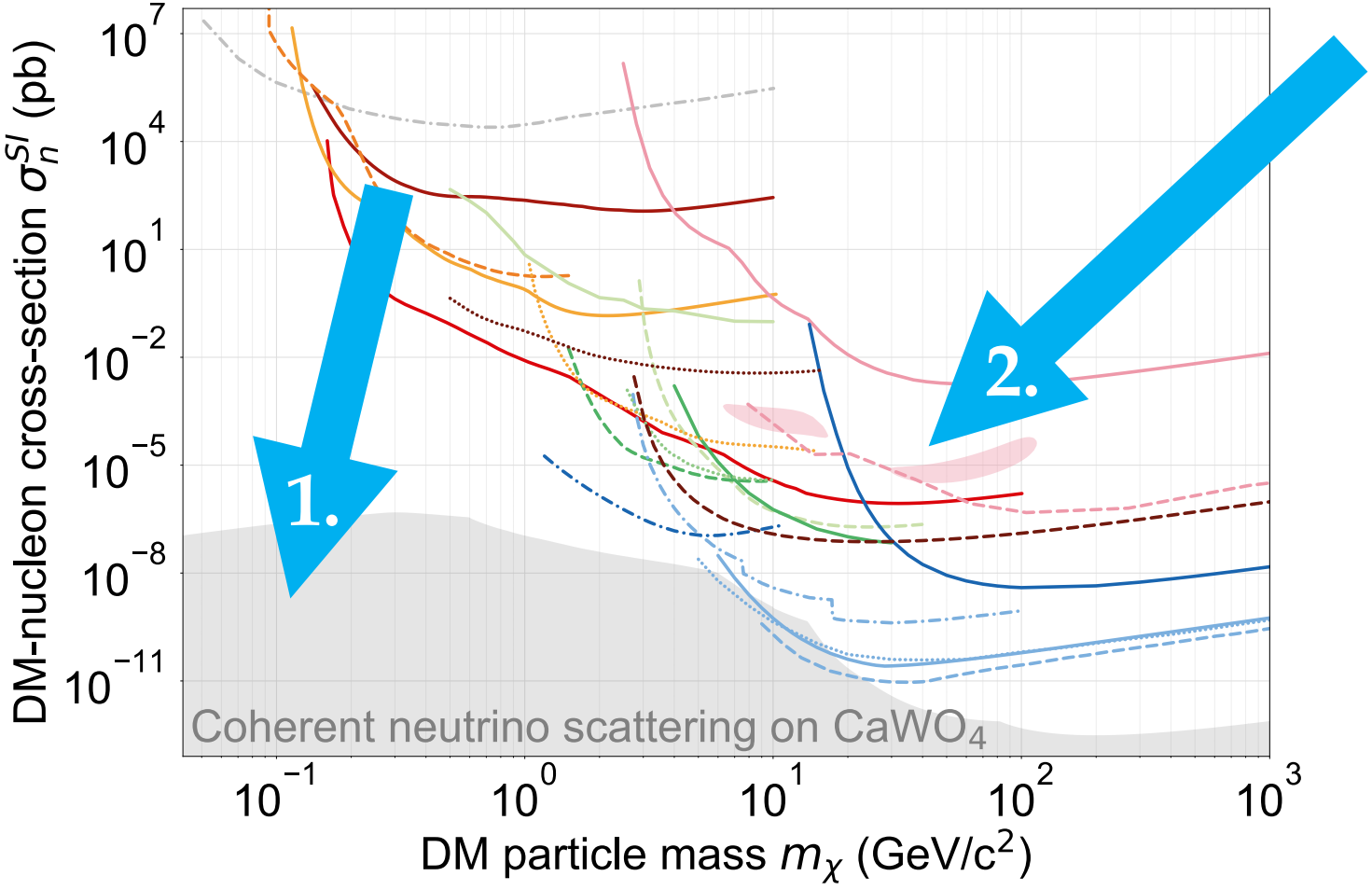
Data-taking 1000 kg days for final model-independent cross-check of nuclear recoil origin of DAMA/LIBRA

3. Goals



Main goals

1. CRESST: go to the neutrino fog for sub-GeV DM masses
2. COSINUS: clarify DAMA/LIBRA DM claim



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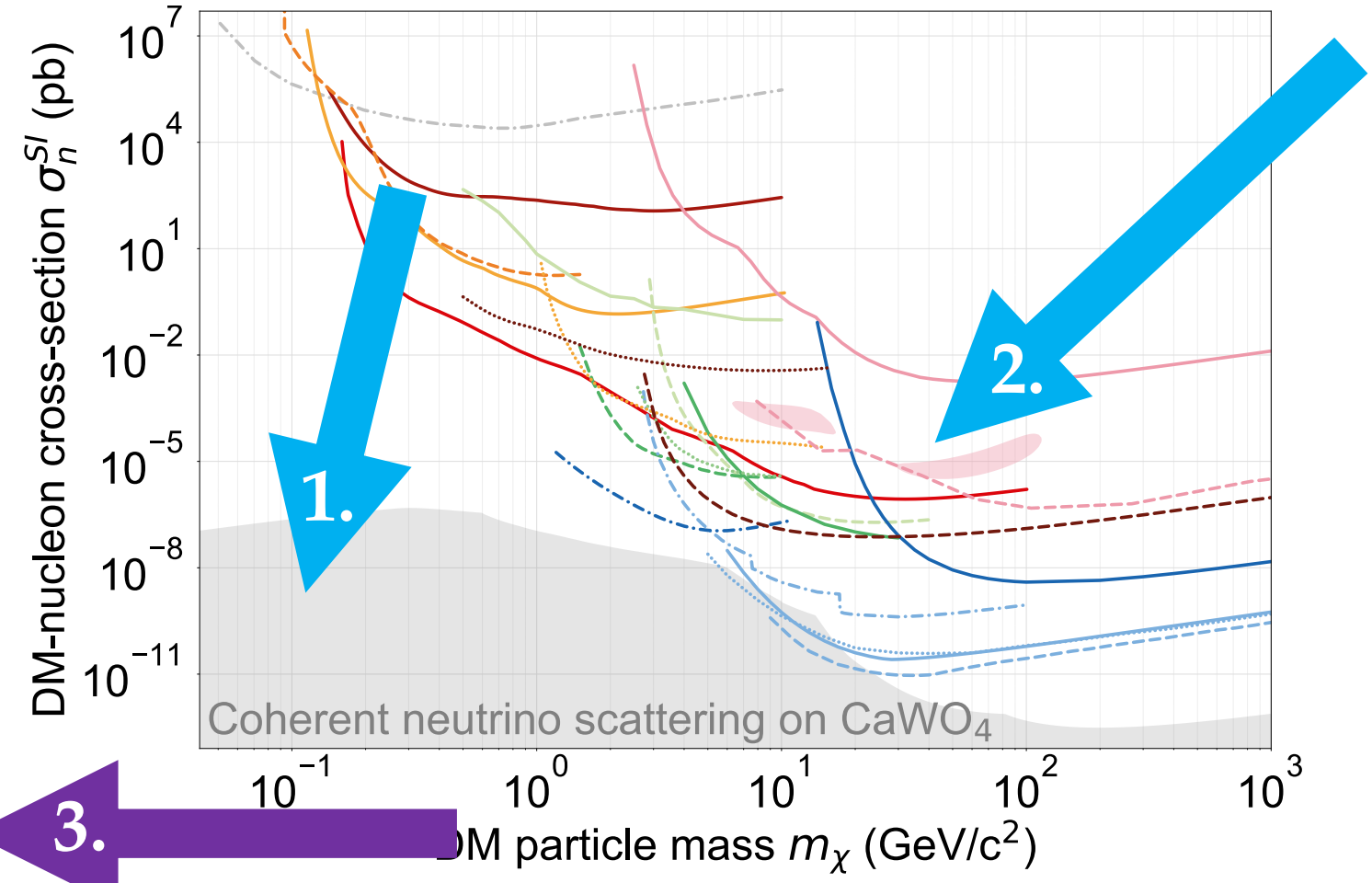

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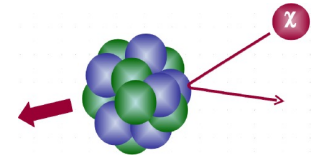

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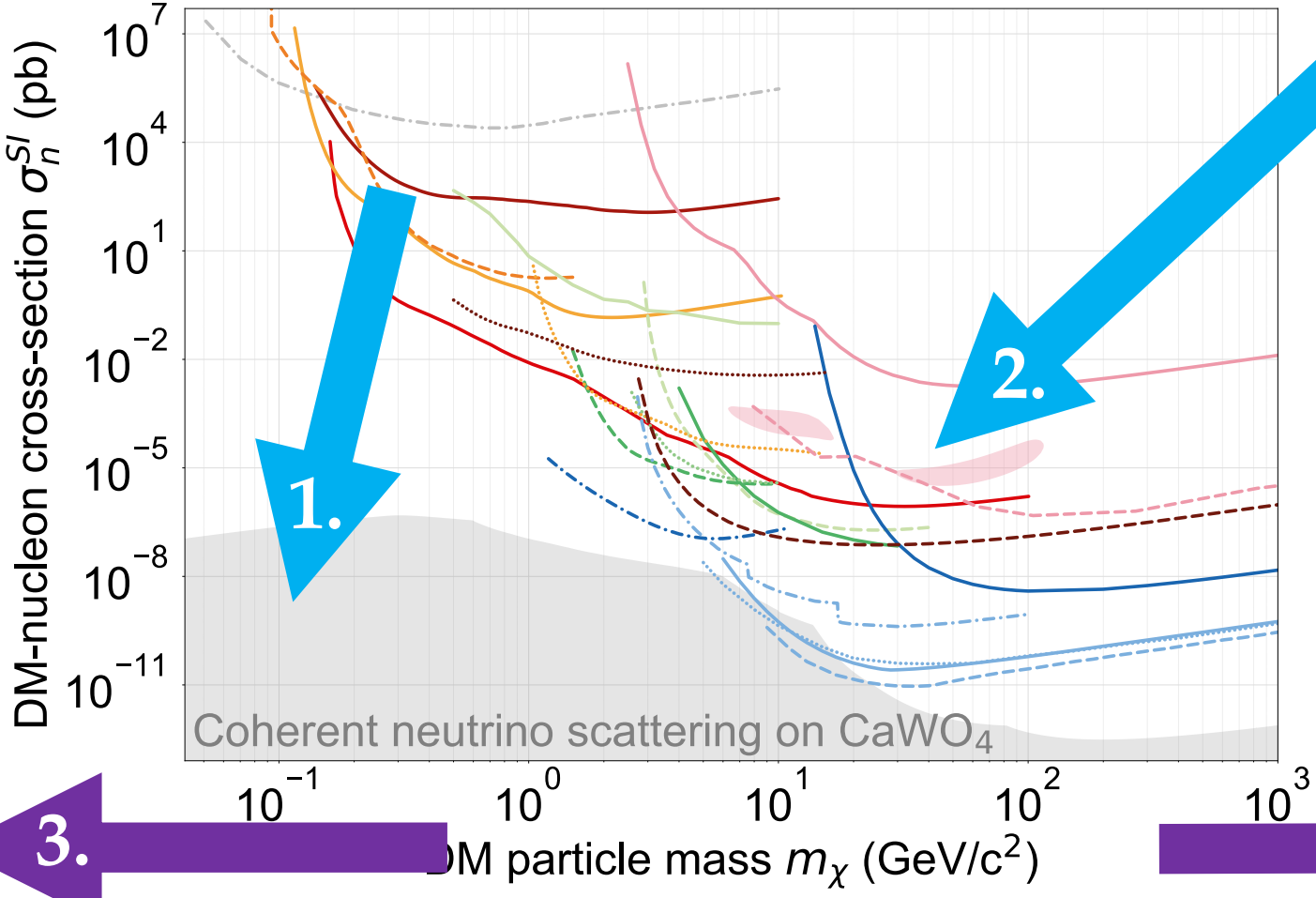
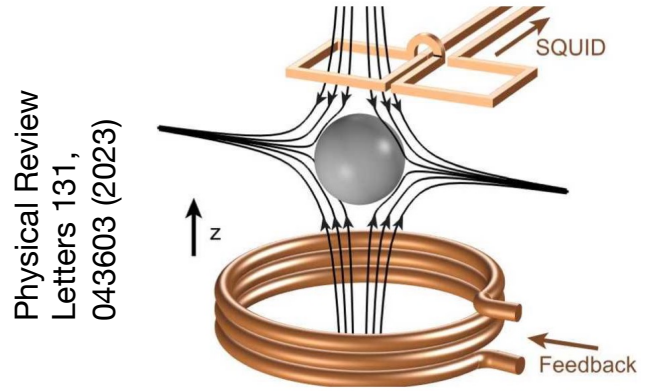
4. DM search with gravitation only?





Physical Review Letters 131, 043603 (2023)

3.

4.

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A try of a summary

- Next ~5 years: clear physics program for CRESST and COSINUS
- Synergies with NUCLEUS (talk Holger Kluck)
- Synergies with quantum computing (qubits)?
- Big contribution to COSINUS which has the most modern underground, low-background cryogenic facility
- Ideas to expand research portfolio and for times >5 years
- Phonon technology is far from the ultimate (quantization) limit
- Low thresholds and high exposure necessarily require to move to large arrays of cryogenic detectors

What do we need in terms of facilities

HEPHY/TUW group: analysis, MC simulations and DAQ electronics

BUT: we have no possibility to test and/or fabricate sensors

@PSK (new location of HEPHY)

The first step is to have our own cryolab to

- develop novel TES readouts: modulating bias, multiplexing, …
- exploit synergies with quantum sensing
- build up hardware expertise


Thank you!