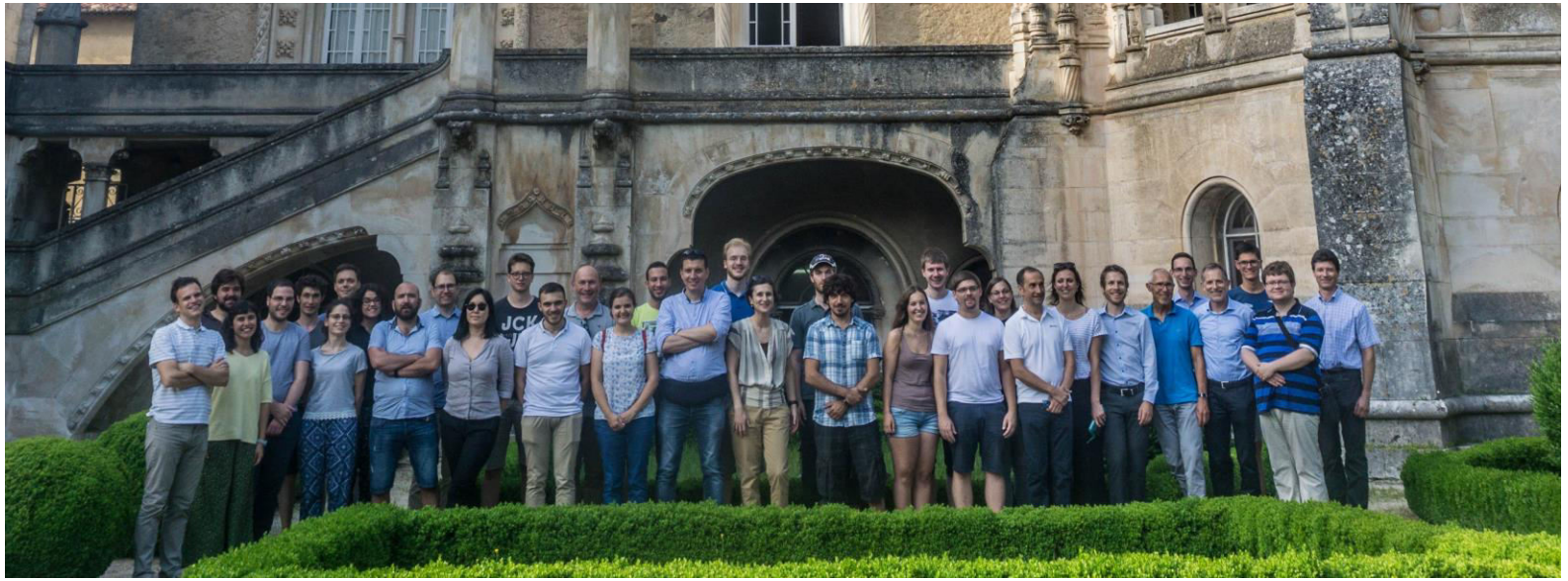
Direct dark matter search with the CRESST-III experiment



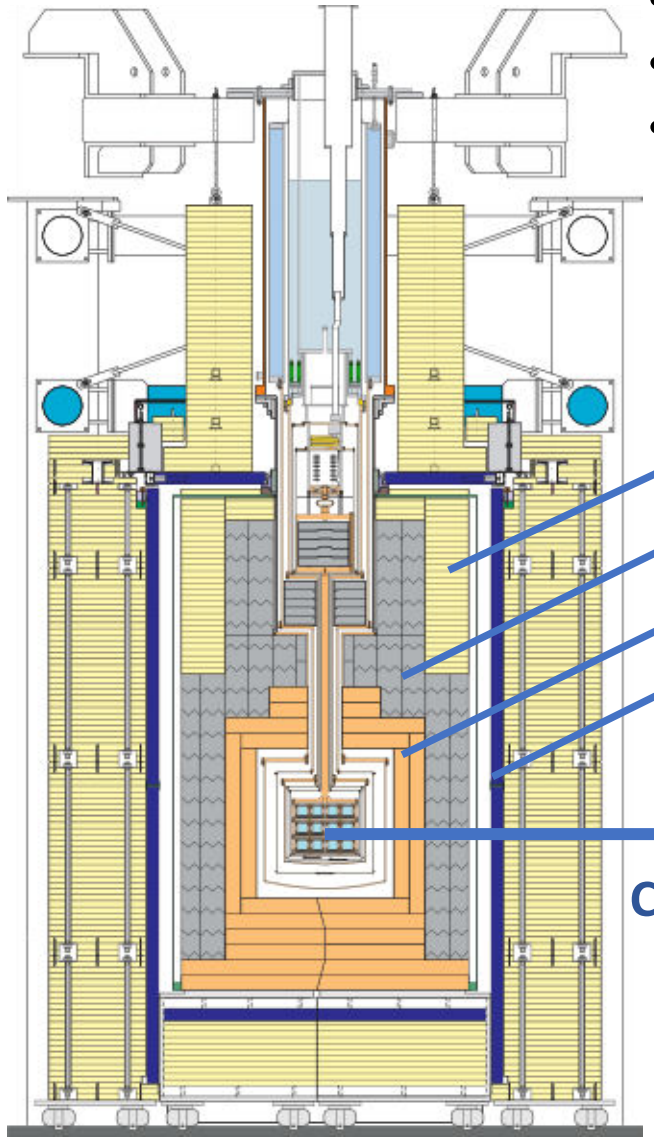
Valentyna Mokina

HEPHY OEAW

for the CRESST collaboration

Cryogenic Rare Event Search with Superconducting Thermometers

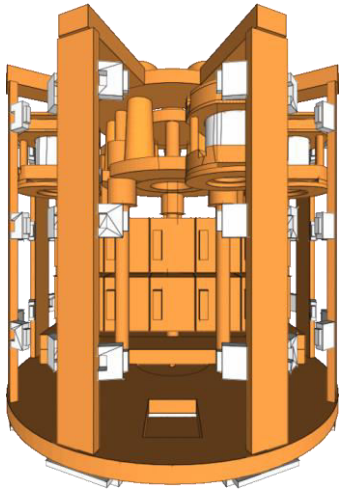
CRESST located at LNGS (Laboratori Nazionali del Gran Sasso) in Italy

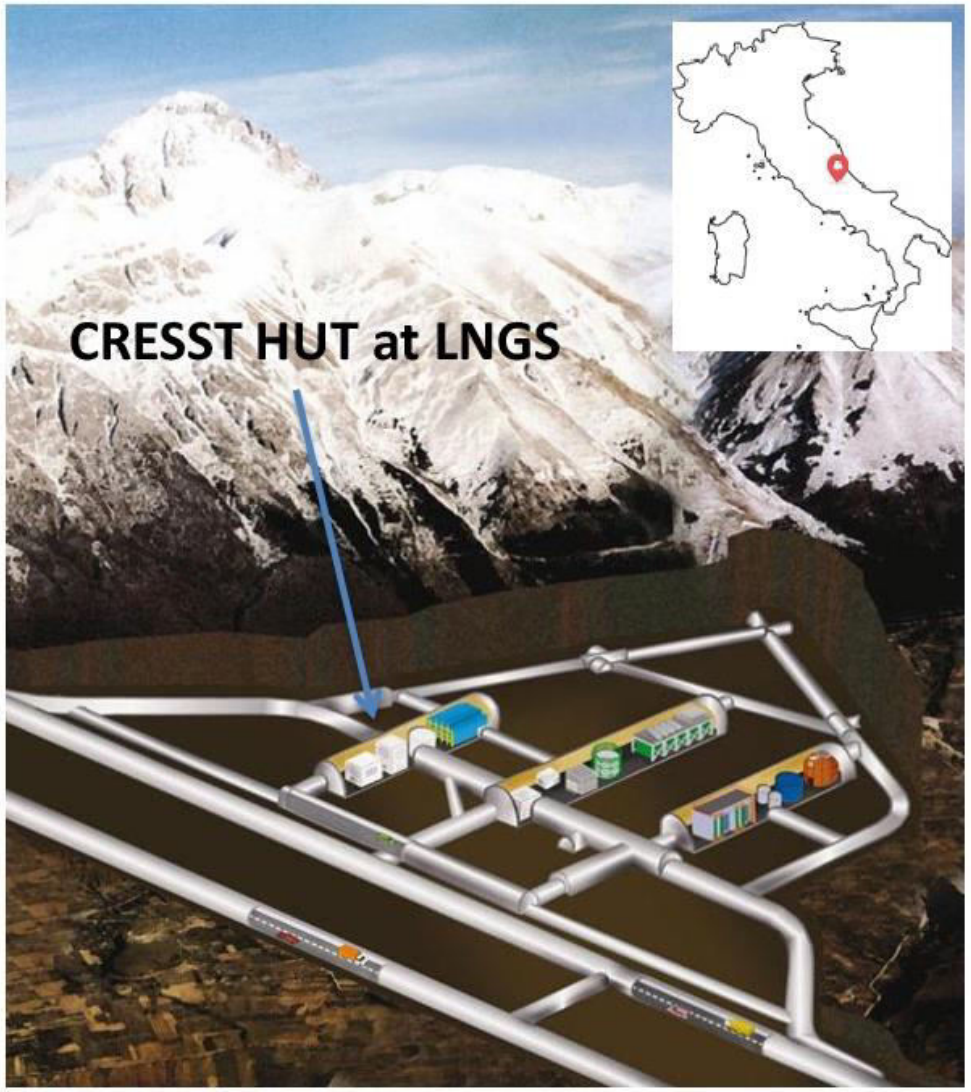


- Cryogenic scintillating calorimeter
- Target material is $CaWO_4$
- Read out channels: phonon and scintillation light

Shielding:
- polyethylene;
- lead;
- copper;
- muon veto system.

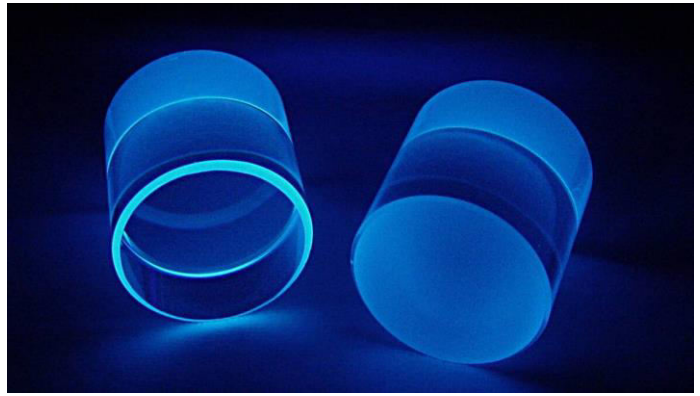
CRESST-III Phase 1

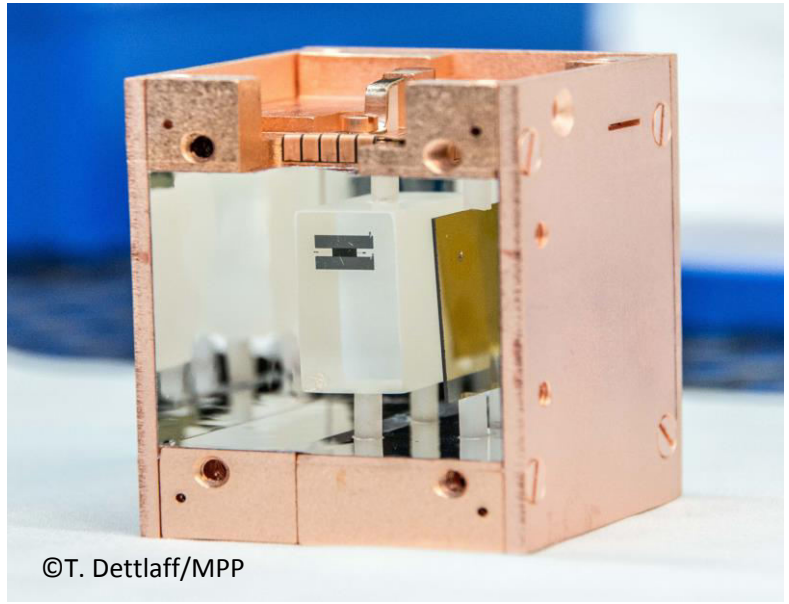




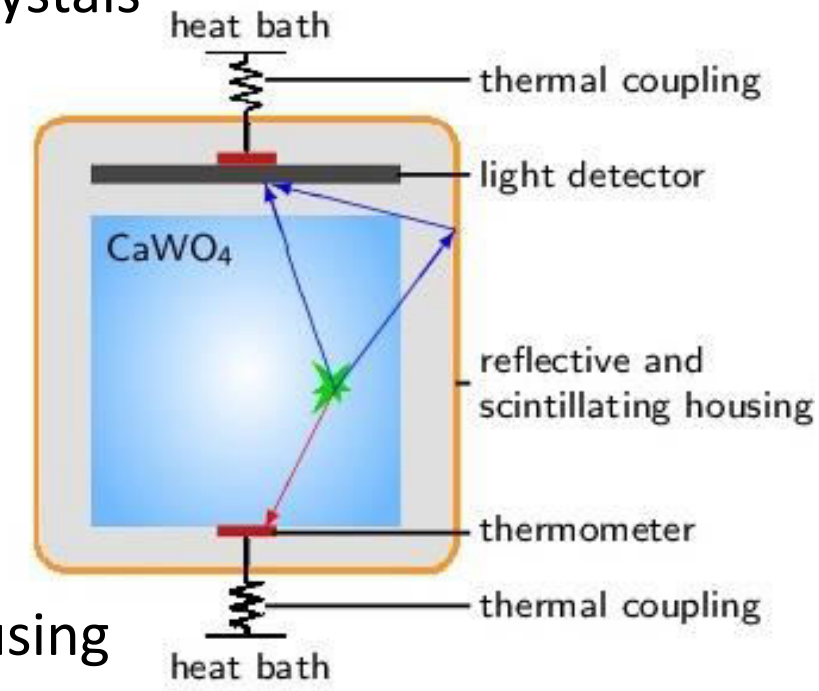
The CRESST experiment

Direct detection of dark matter particles via their scattering off target nuclei





- target material: $CaWO_4$ single crystals
- particle interaction
  - → heat (phonon) signal
    read-out with thermometer
  - → light signal
    read-out with light detector



- reflective and scintillating housing

Target crystals operated as cryogenic calorimeters (~15mK)

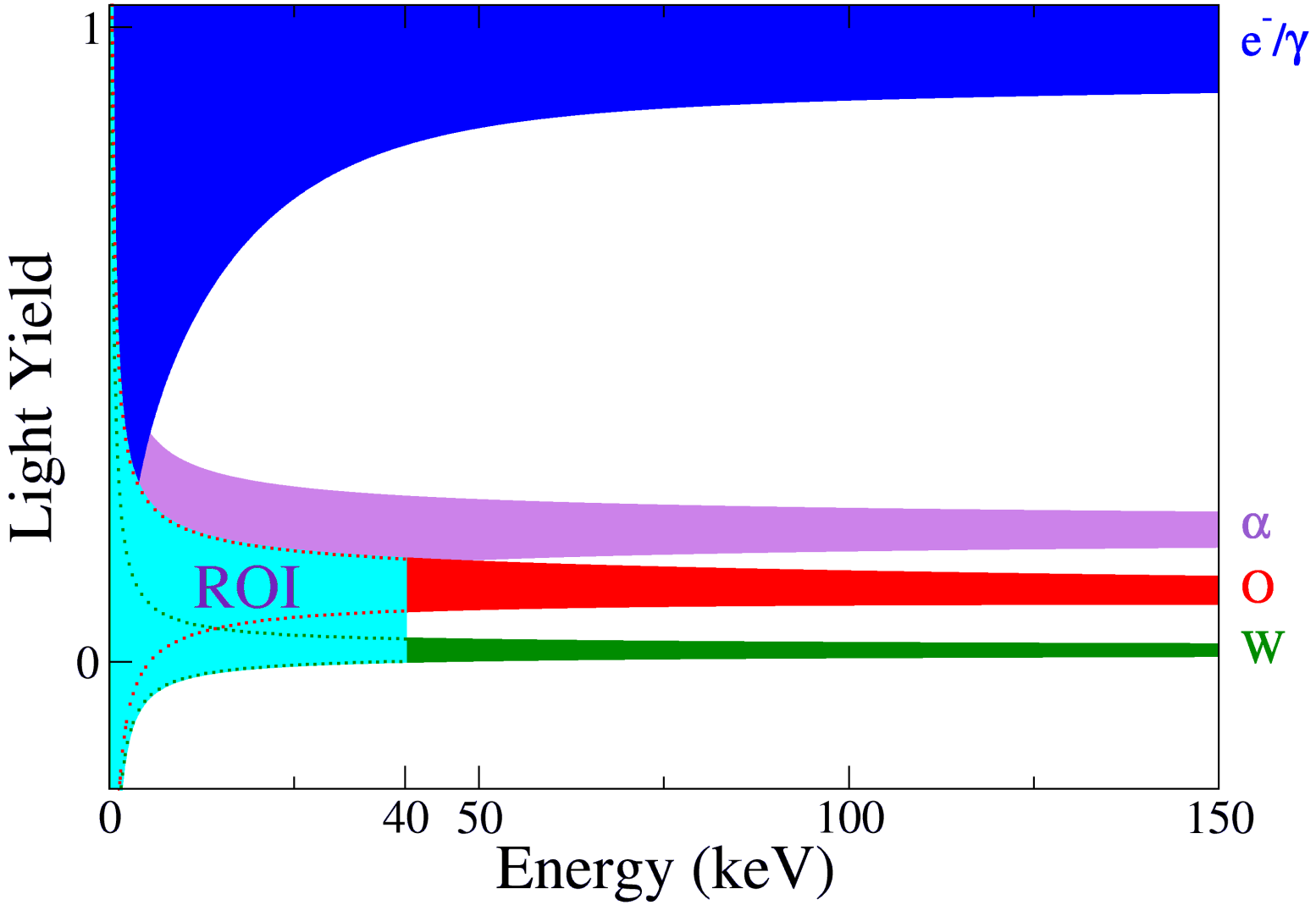
Event discrimination

Light Yield= $\frac{\text{Light signal}}{\text{Phonon signal}}$

Characteristic of the event type

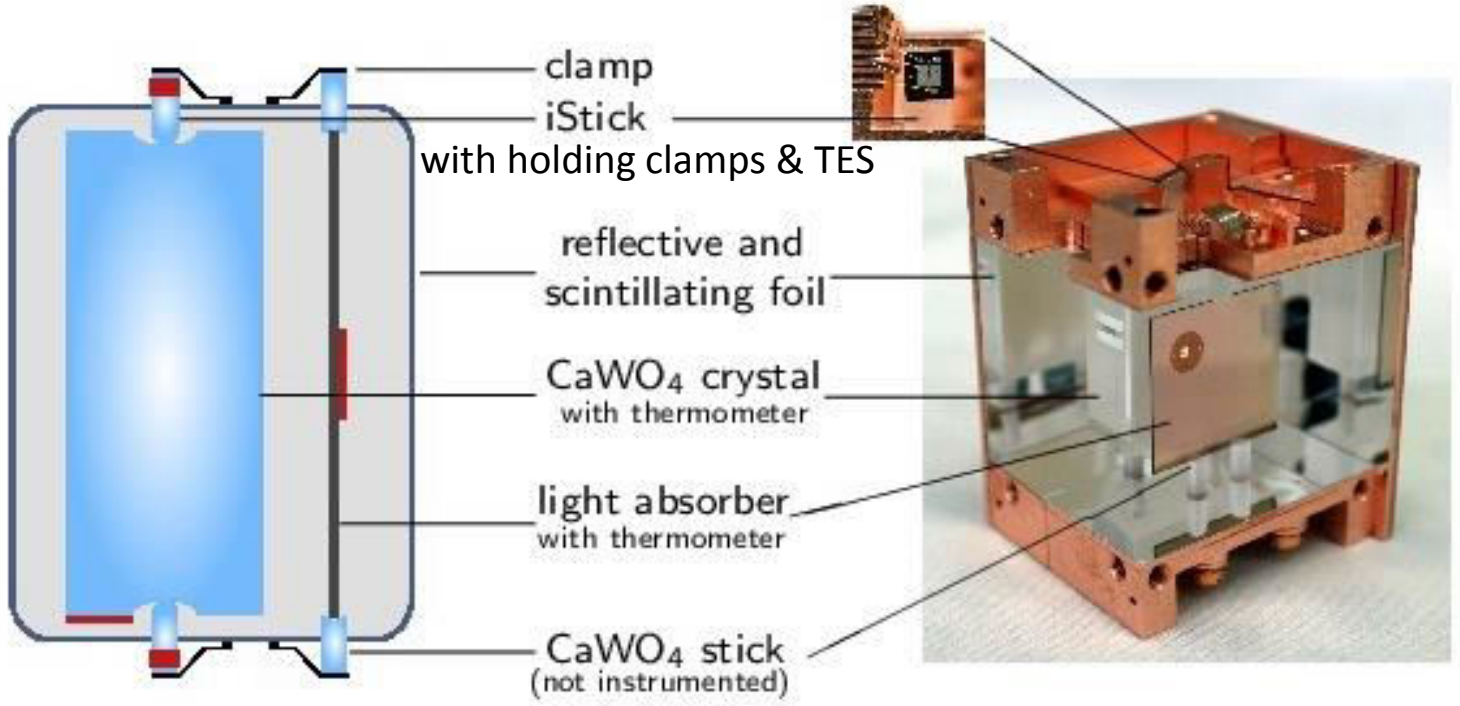
Excellent discrimination between potential signal events (**nuclear recoils**) and dominant radioactive background (**electron recoils**)

ROI: region of interest for dark matter search



CRESST-III Phase 1 low-threshold detectors

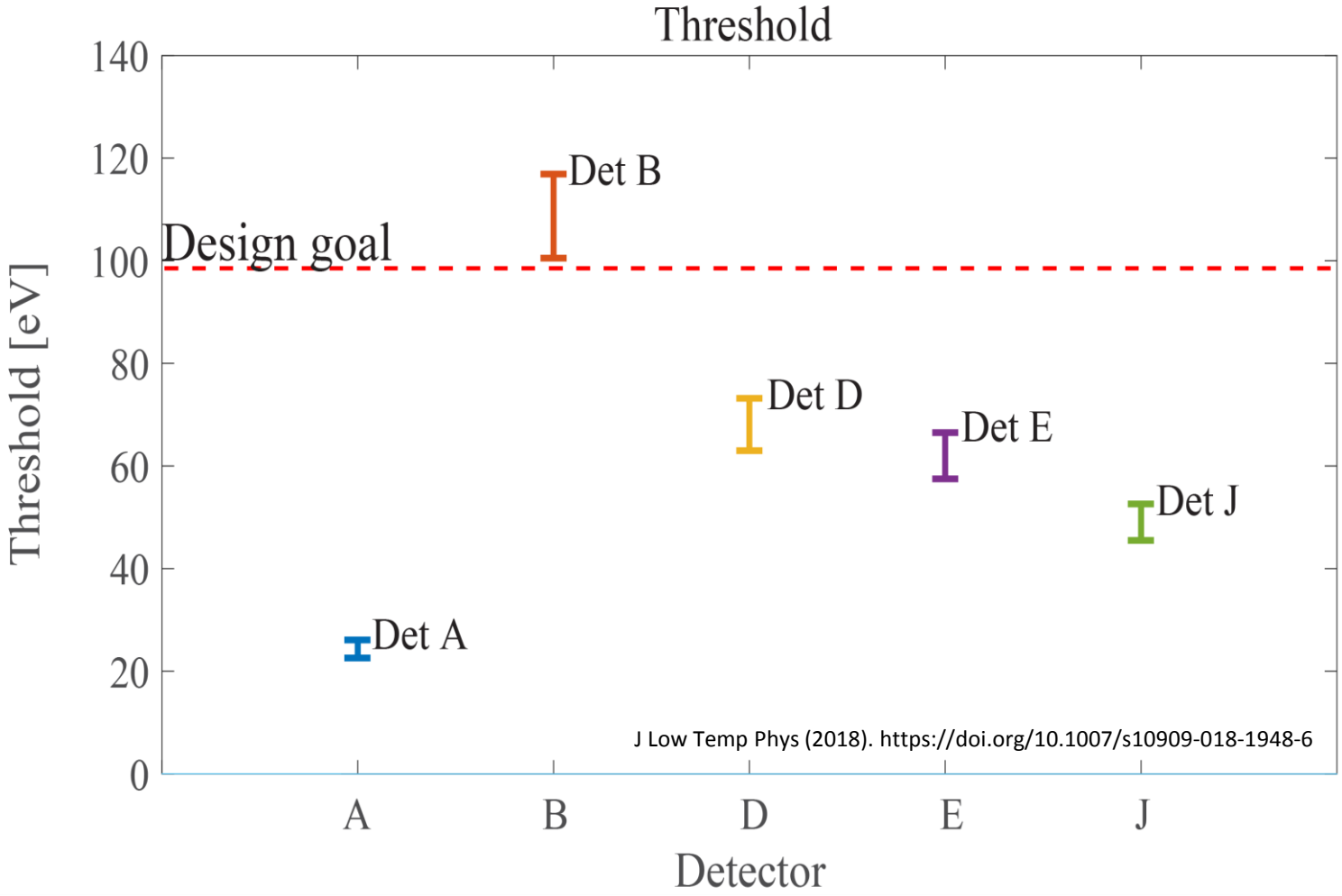
- Cuboid crystals of (20×20×10)mm^3 (**≈24g**) ╳ 10 modules
- Design goal: **100 eV threshold**
- Fully scintillating housing (holding with $CaWO_4$ sticks)
- Instrumented sticks (iSticks) for holding main crystal (veto for events happening in sticks)



Data taking from July 2016 to January 2018

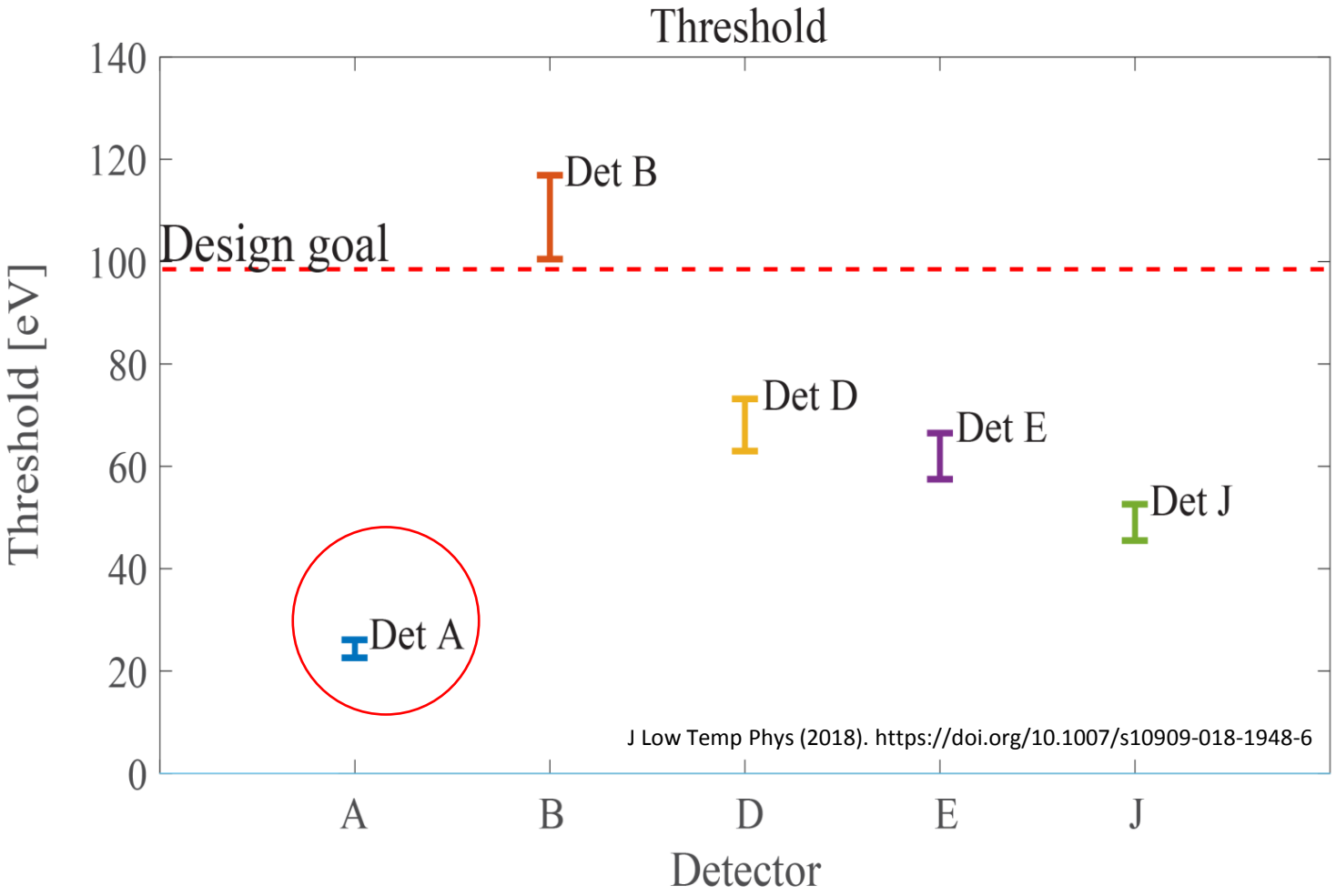
Optimum thresholds

5 detectors reach/exceed the CRESST-III design goal - threshold < 100eV



Optimum thresholds: Detector Module A

Detector A ⟶ the lowest threshold! New benchmark point in low mass dark matter search.



Data taking period: 10/2016 – 01/2018

Non-blind data (dynamically growing):
20% randomly selected

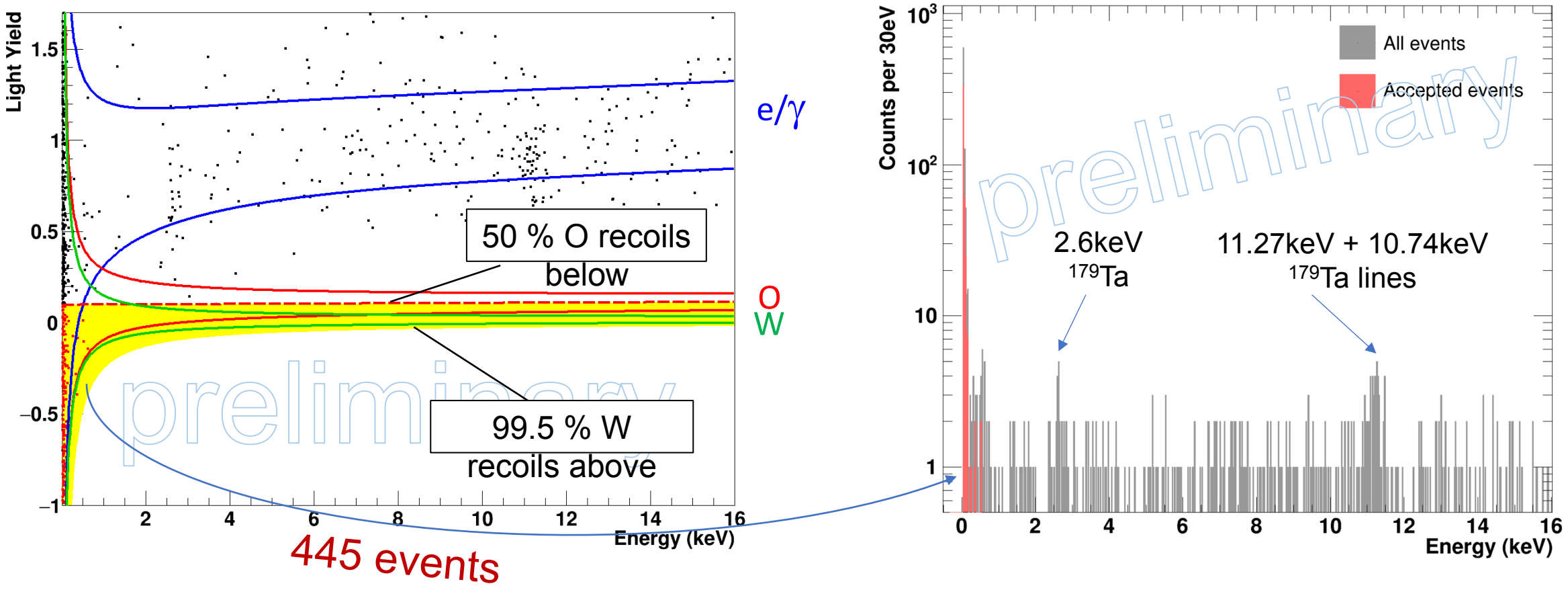
Target crystal mass: 23.6g

Gross exposure (before cuts): 5.7 kg days

Nuclear recoil threshold: 30.1 eV

Dark matter data

Acceptance region fixed before unblinding



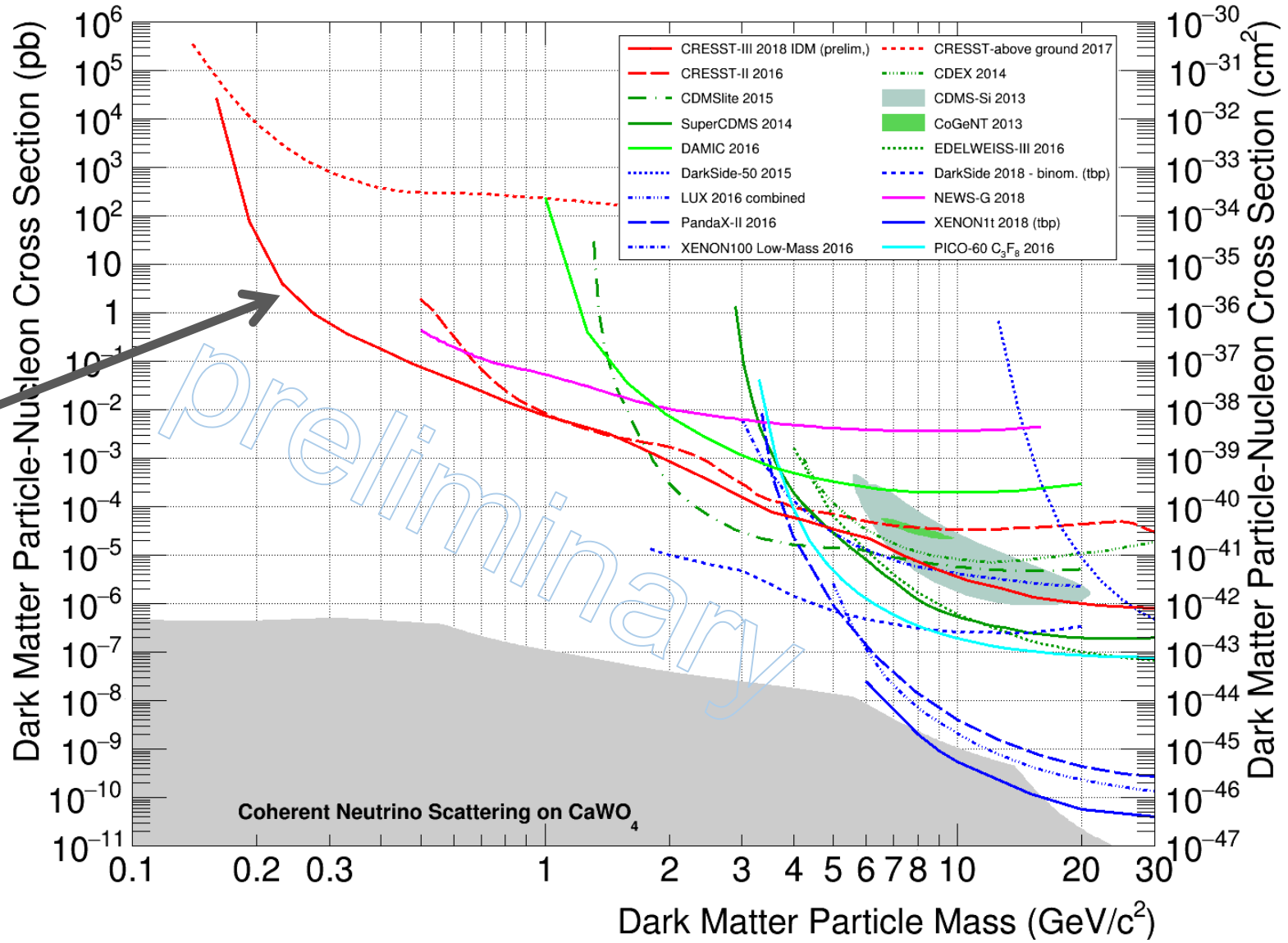
Analysis optimized for very low energies: 30eV → 16keV

(preliminary) Result

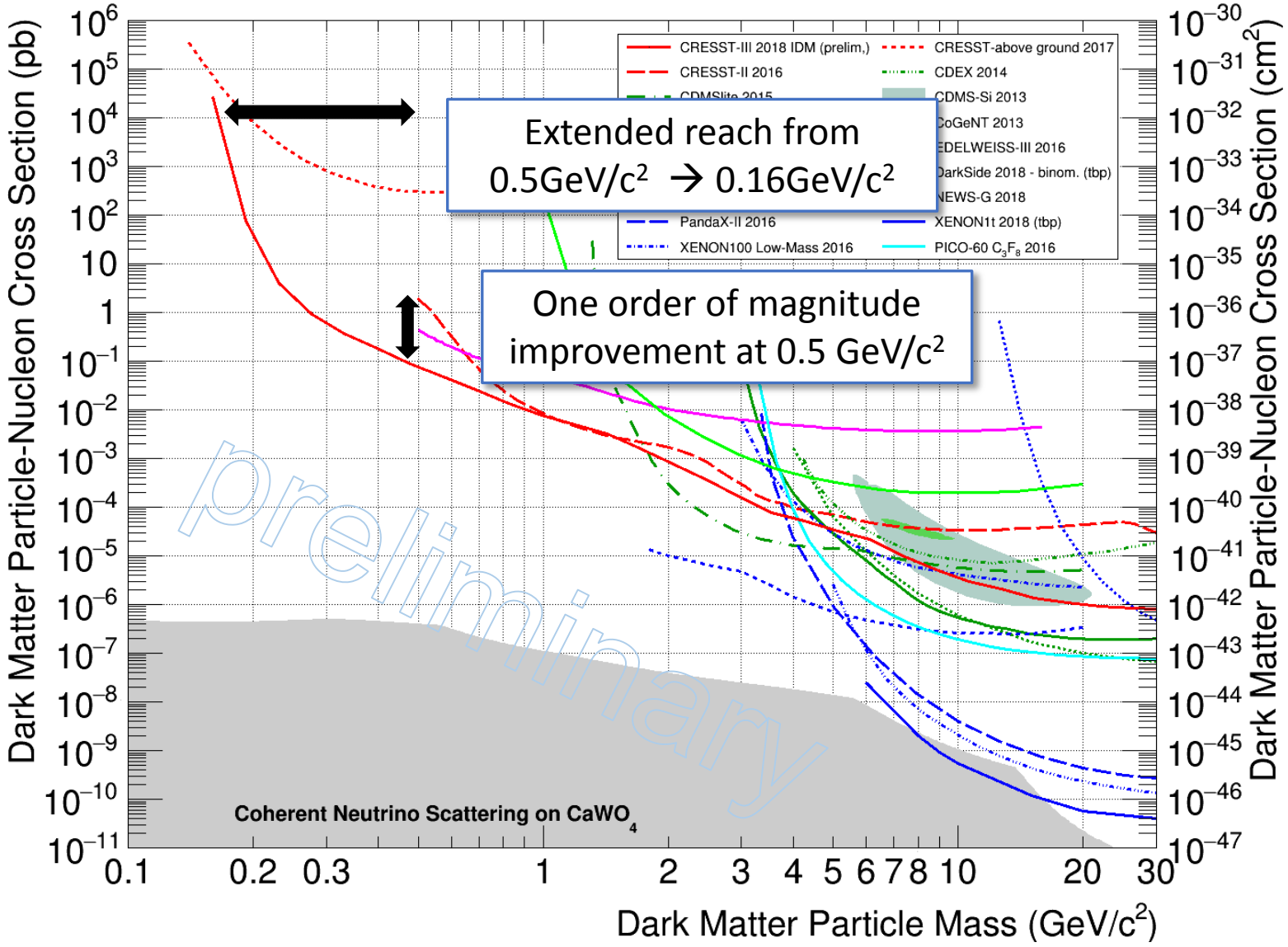
Energy spectrum of accepted events

Yellin 1D optimum interval method

Energy spectrum expected for DM



(preliminary) Result



Conclusions

First CRESST-III run 07/2016 - 02/2018

Unprecedented low nuclear recoil thresholds of 30eV

Leading sensitivity over one order of magnitude: 160MeV/c^2 → 1.8GeV/c^2

0.4GeV/c^2

LUX Migdal

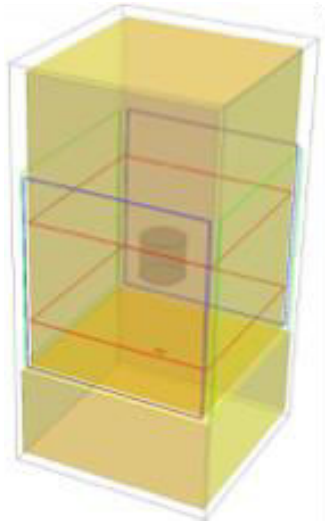
CRESST-III Phase 1 new run: Just starting

Key innovation

Upgraded detector modules with dedicated hardware changes to understand backgrounds

New feature

Active magnetic field compensation with three air coils for x,y & z-axes



Waiting for dark matter