Direct Dark Matter Search with CRESST-III
Status & Perspective

TECHNISCHE UNIVERSITÄT MÜNCHEN

29th Rencontres de Blois

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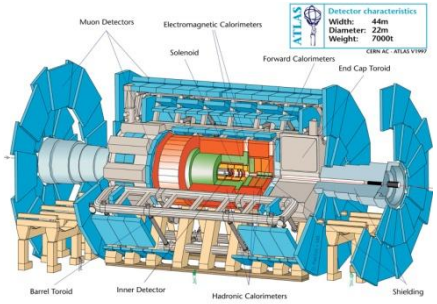
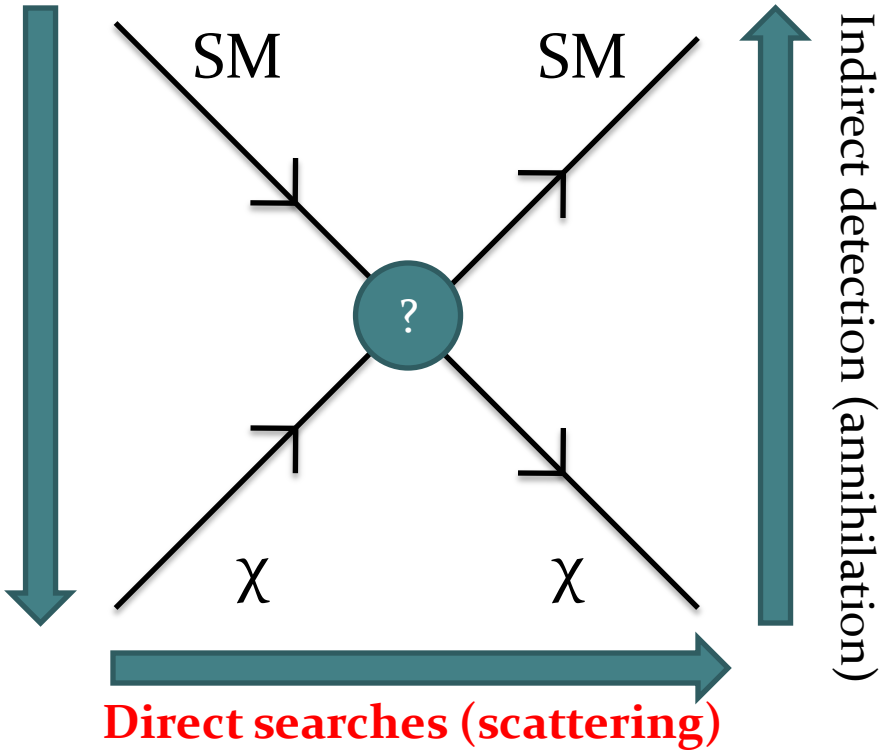
Outline

- Introduction
- The CRESST experiment going to low mass DM search
- CRESST-III detectors explained
- Performance of CRESST-III
- Conclusions and perspective

Dark matter phenomenology





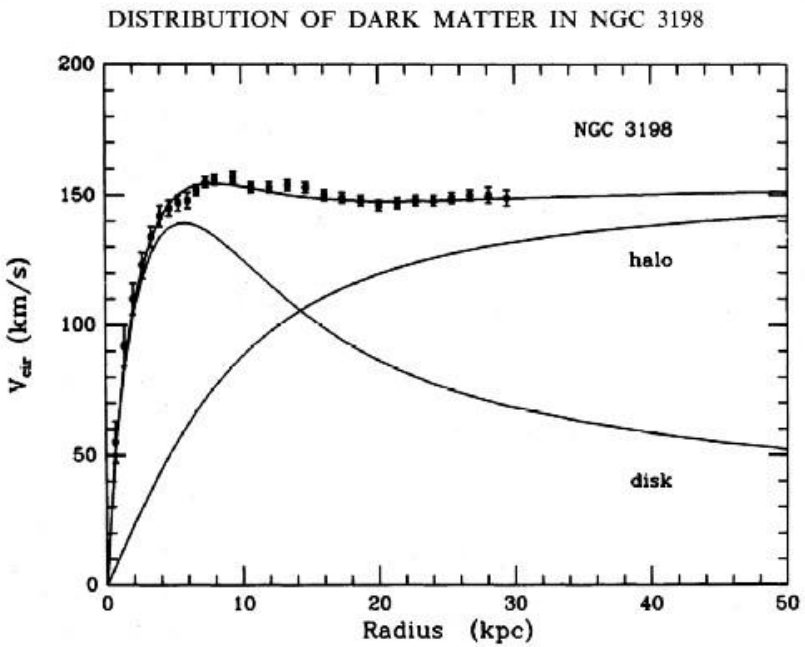
CRESST experiment

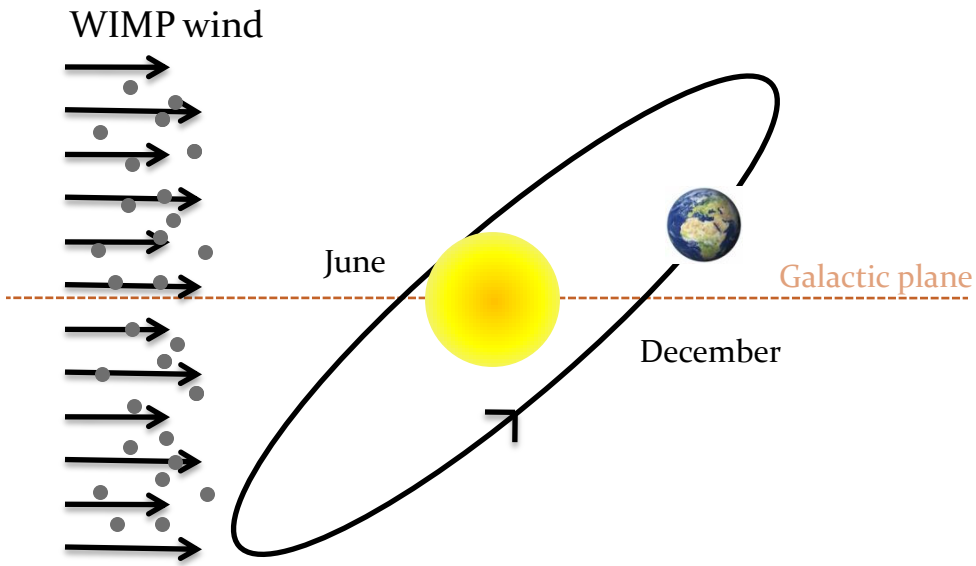
Cryogenic Rare Event Search
with Superconducting Thermometers

Standard assumptions

Standard assumptions

- Maxwellian velocity distribution
- asymptotic velocity of 220 km/s
- galactic escape velocity of 544 km/s
- local dark matter density of 0.3 GeV/cm^3

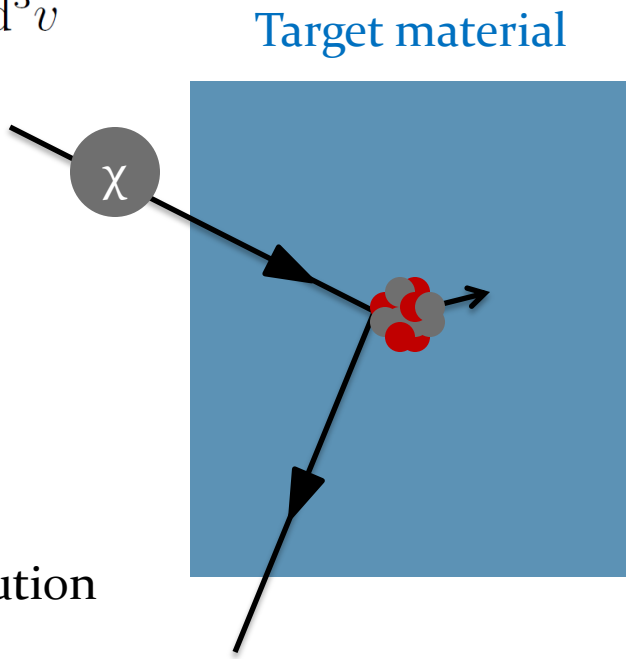




Experimental signature

The signature of dark matter in a direct detection experiment consists of a recoil spectrum of single scattering events.

$$\frac{dR}{dE}(E,t) = \frac{\rho_0}{2\mu_A^2 \cdot m_\chi} \cdot \sigma_0 \cdot A^2 \cdot F^2 \int_{v_{min}}^{v_{esc}} \frac{f(\mathbf{v},t)}{v}\, \mathrm{d}^3 v$$



- ρ_0 : local DM density
- σ_0 : cross section
- m_χ : DM particle mass
- μ_A : reduced mass
- A : atomic number
- F : nucleus form factor
- $\int_{v_{min}}^{v_{esc}} \frac{f(\mathbf{v},t)}{v}\, \mathrm{d}^3 v$ Integral of the velocity distribution
- v_{min} : minimal velocity to produce a recoil above threshold

Experimental signature

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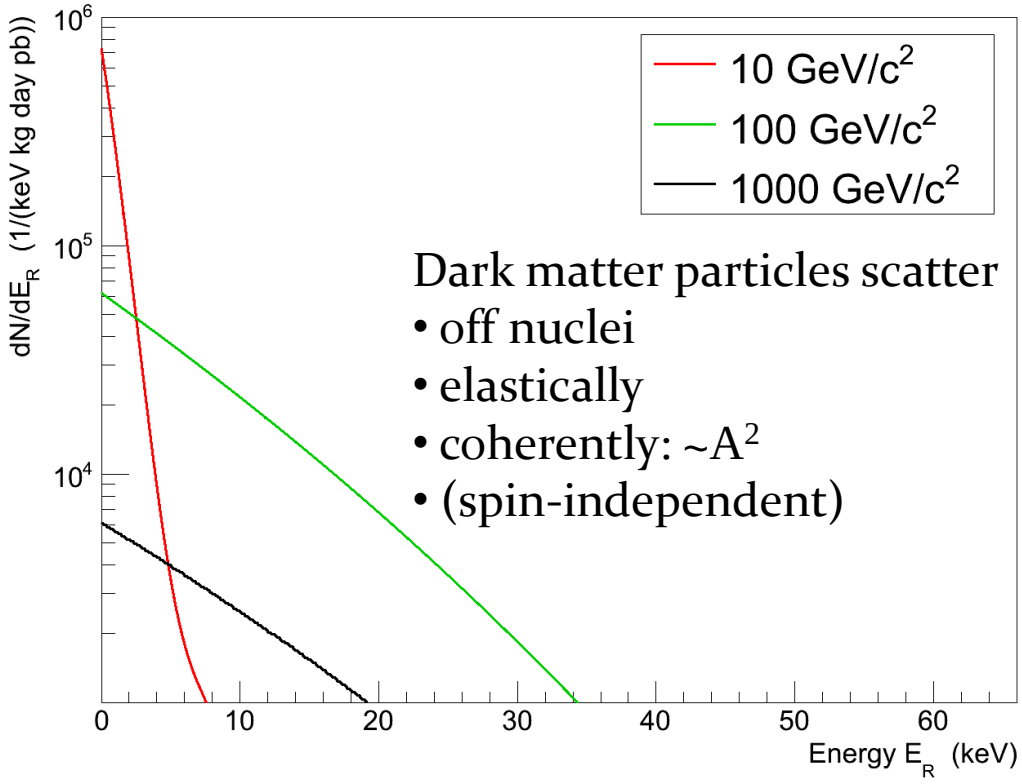
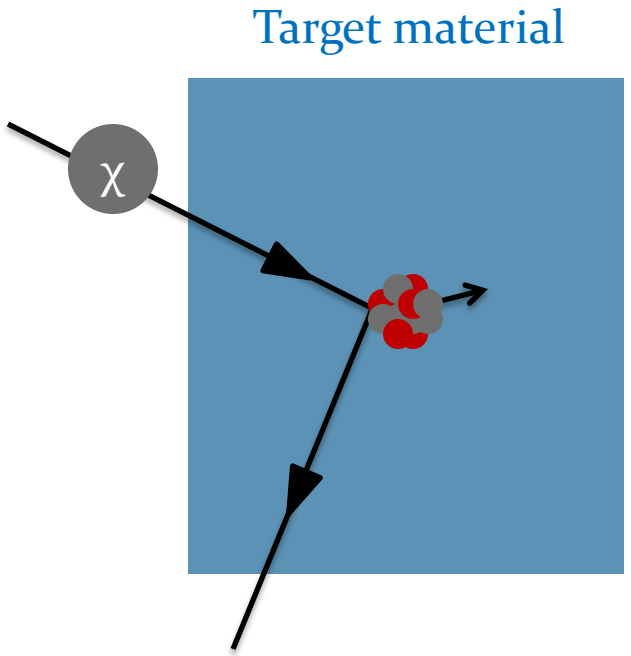
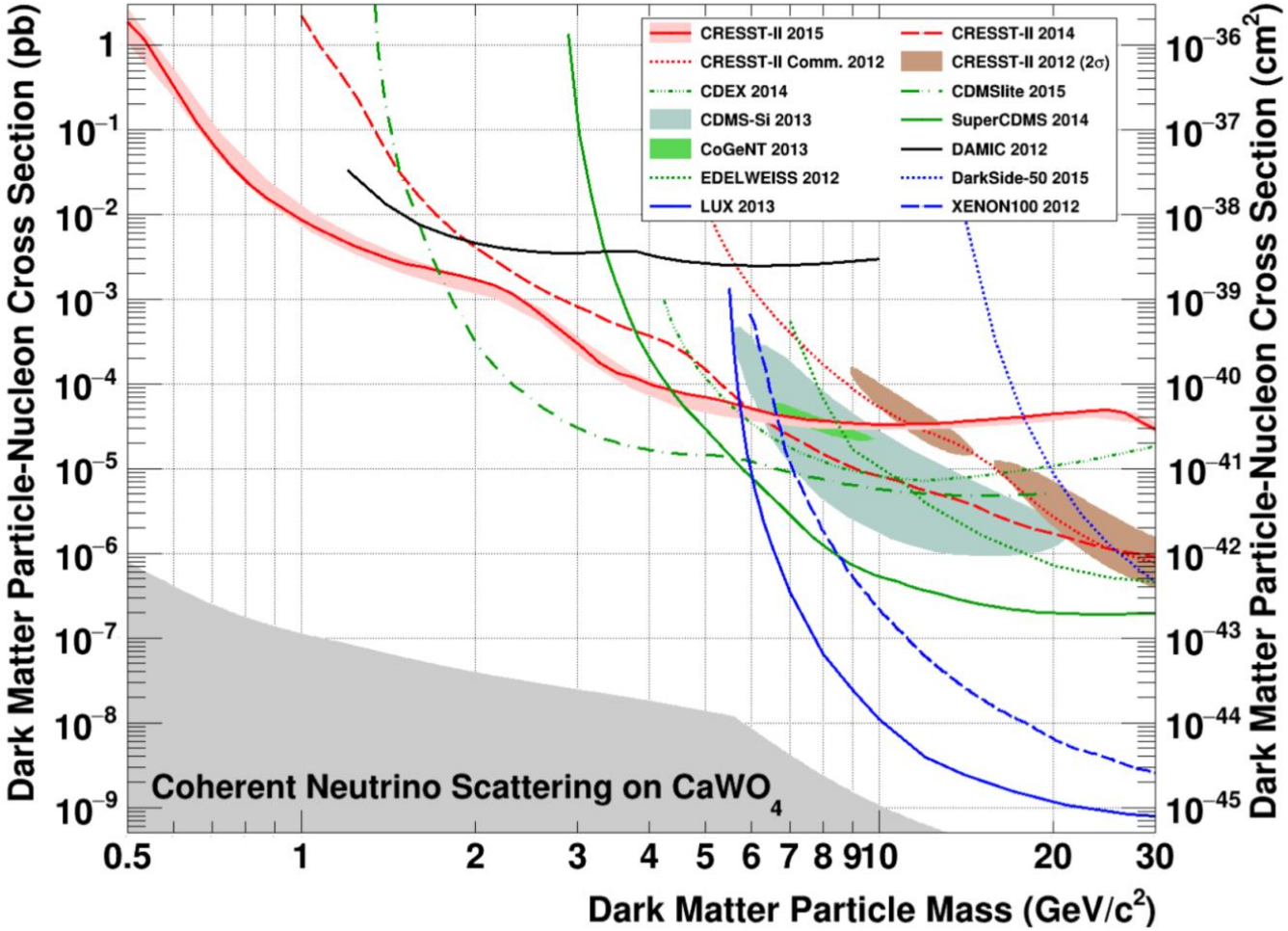


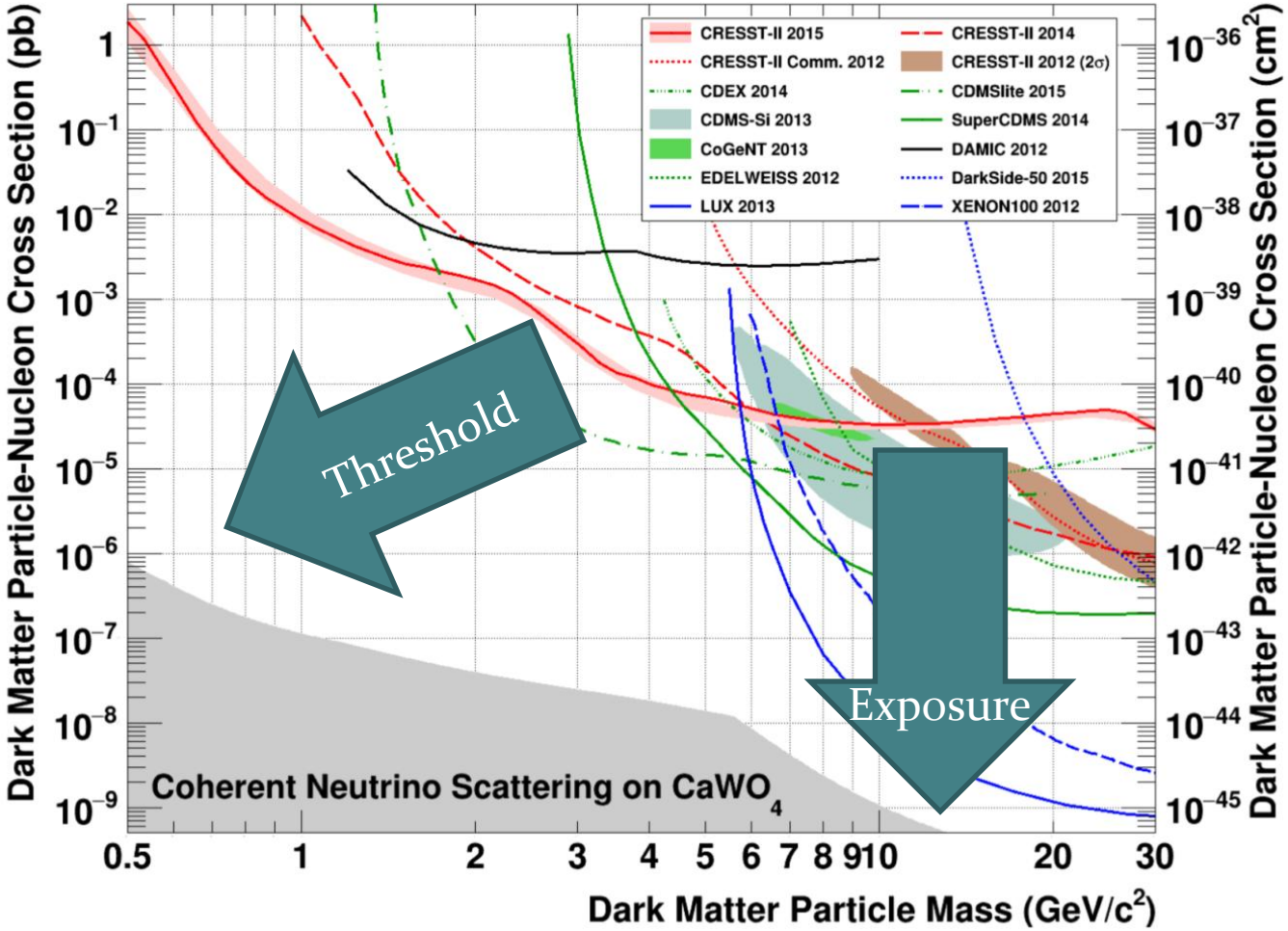


Experimental result comparison



G. Angloher et al.: *Results on light dark matter particles with a low-threshold CRESST-II detector* (2016)
EUR PHYS J C Volume 76, Number 1 (2016)

Experimental result comparison



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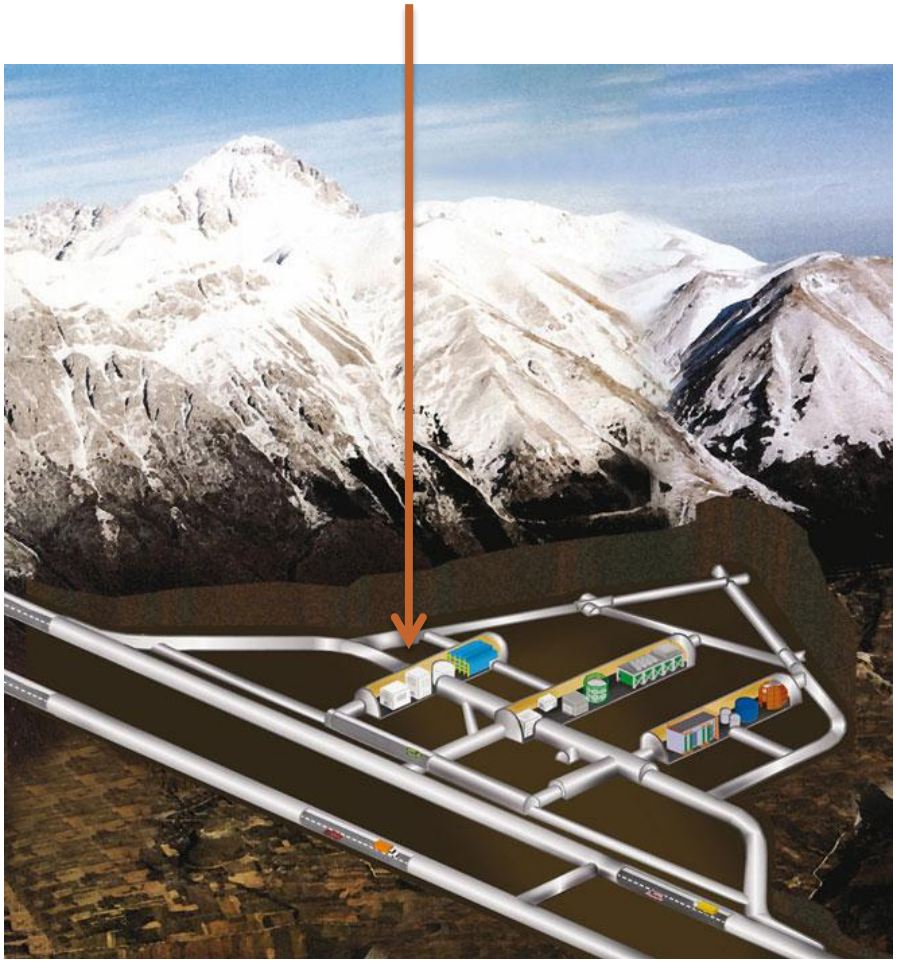
The CRESST experiment

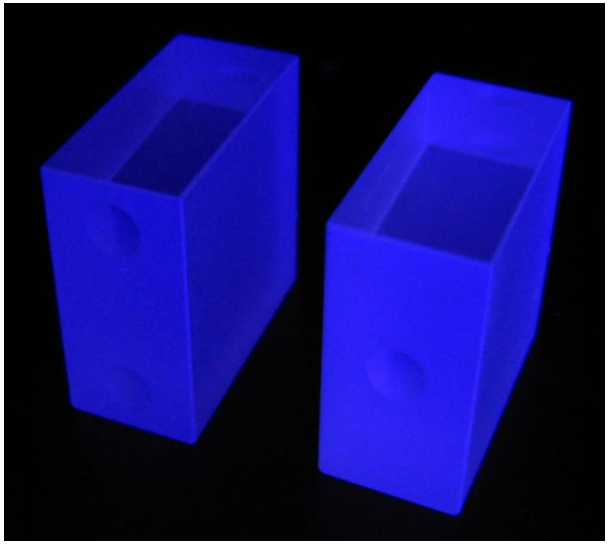
CRESST is located at LNGS (Laboratori Nazionali del Gran Sasso) in Italy

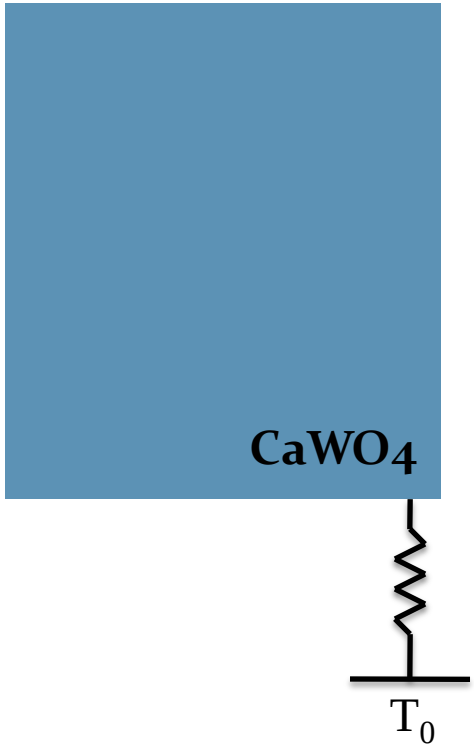


CRESST-III detectors

Scintillating 24 g $CaWO_4$ crystals as target

- Cryogenic detector $T_0 \approx 10mK$





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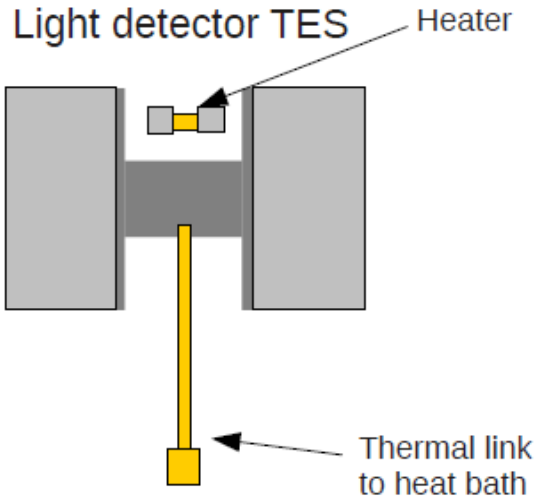

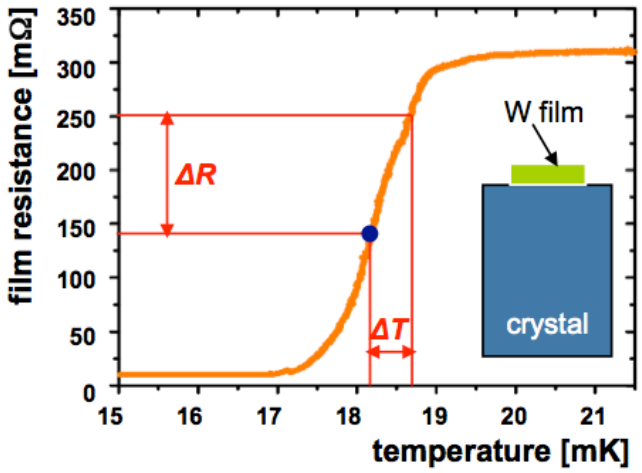

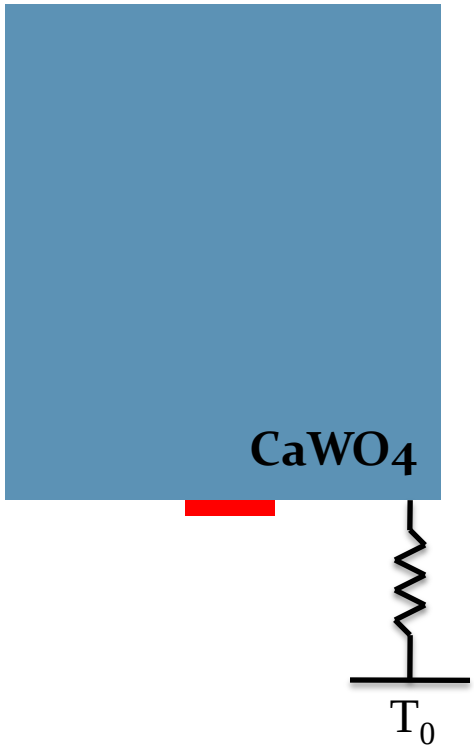

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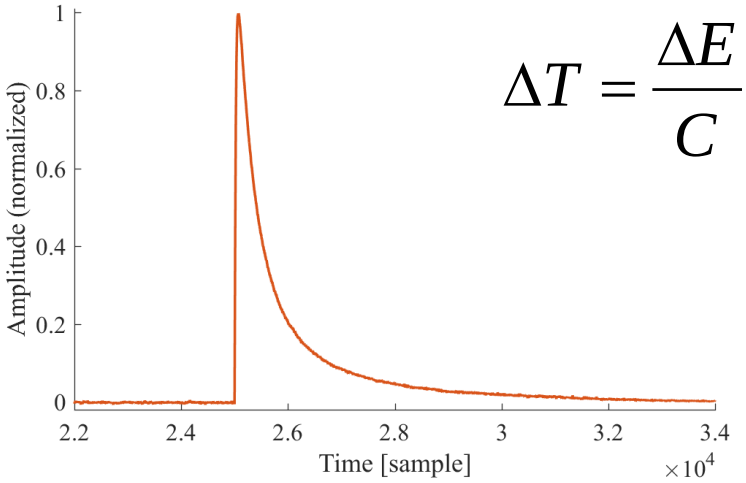
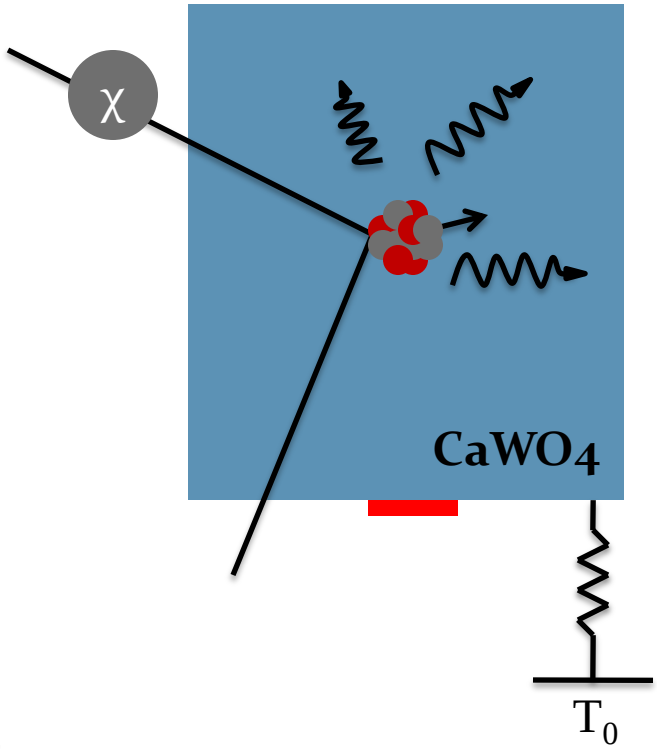


$$\Delta T = \frac{\Delta E}{C} \cdot e^{\frac{G}{C}t}$$



- Small fraction of energy into scintillation light

CRESST-III detectors

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Light detector SOS

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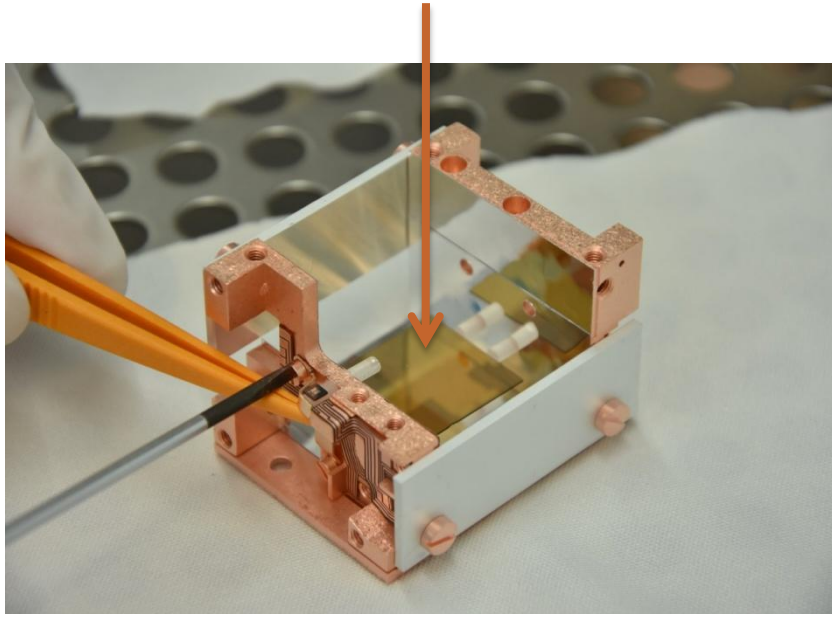

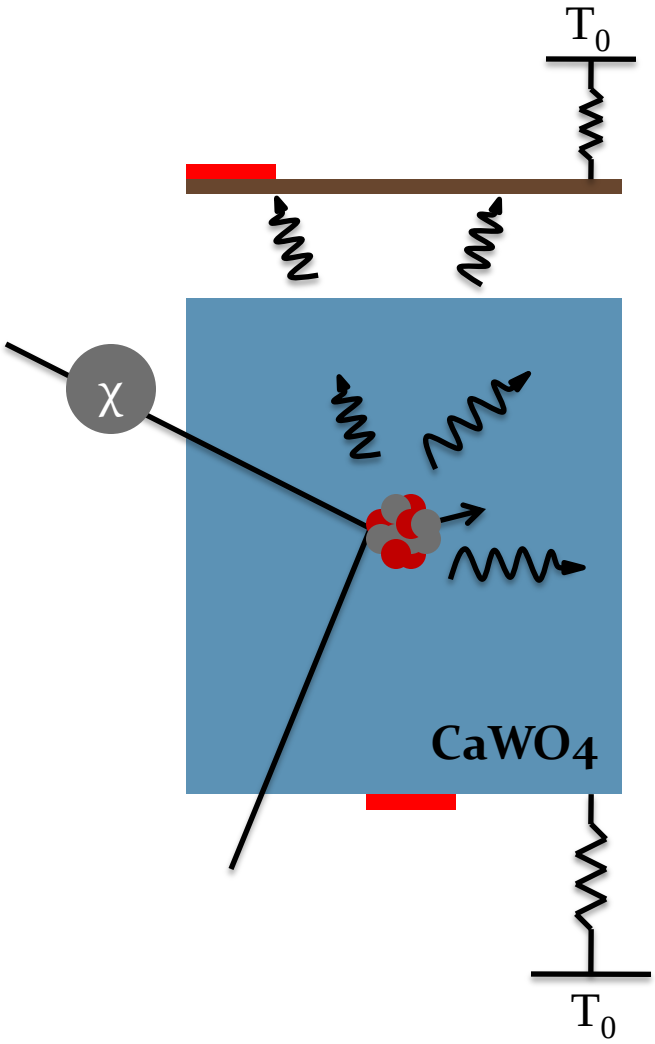

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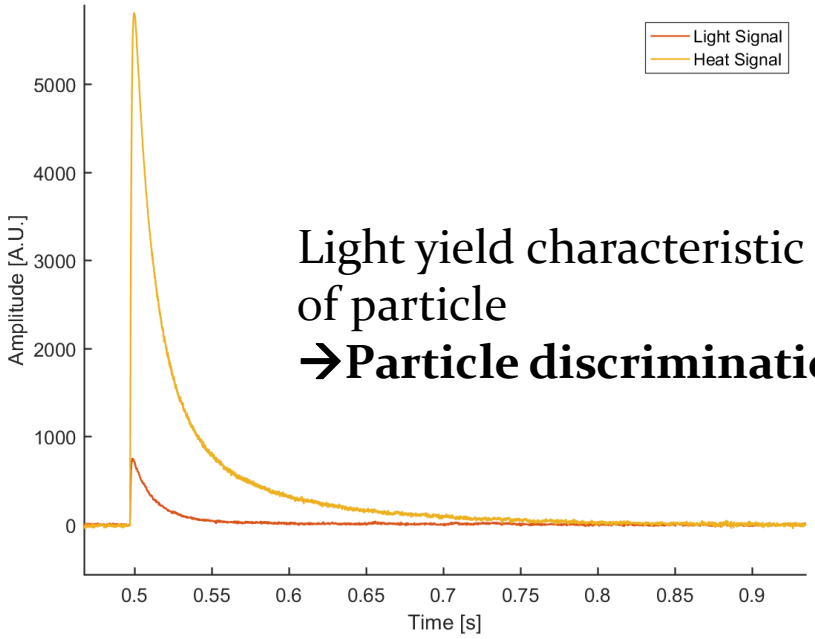
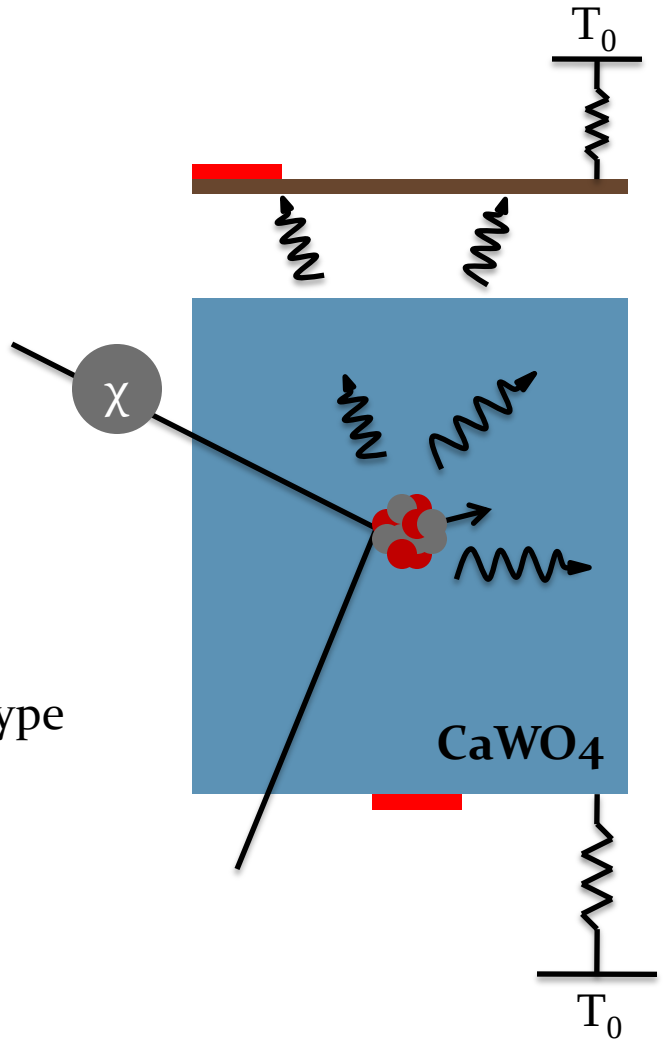


Light yield characteristic of the type of particle

→**Particle discrimination**



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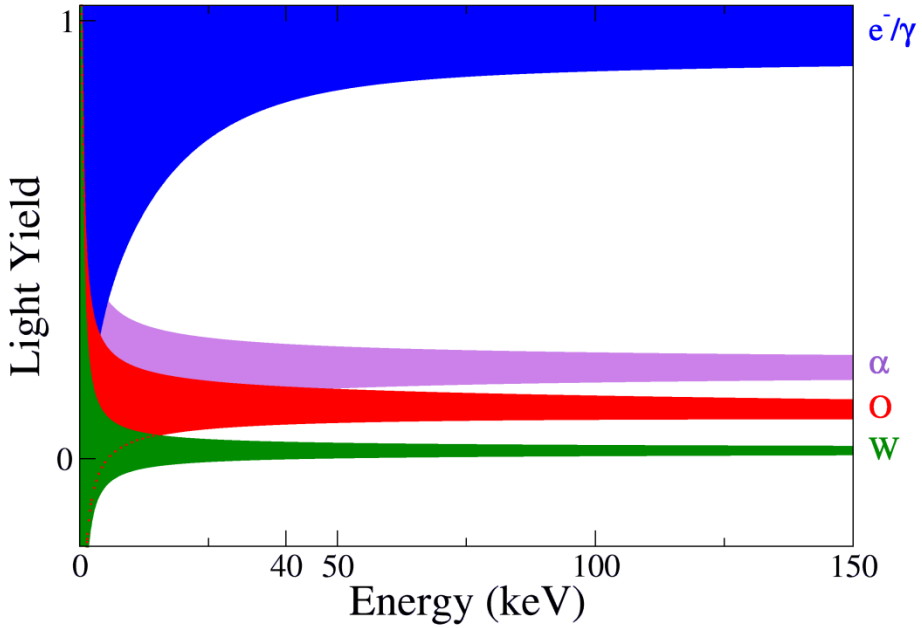

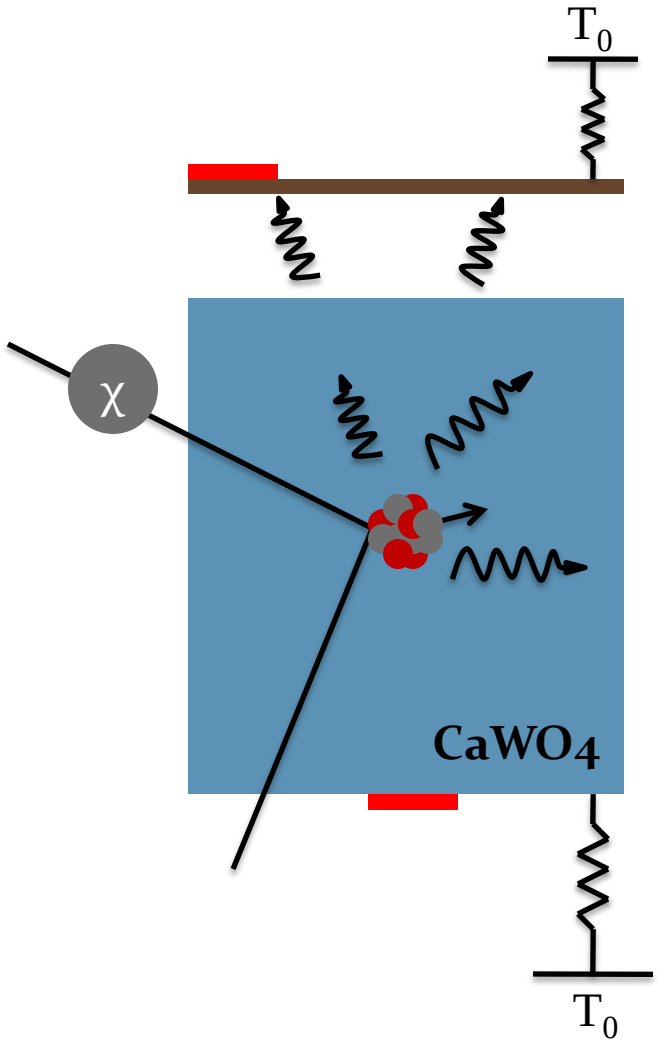

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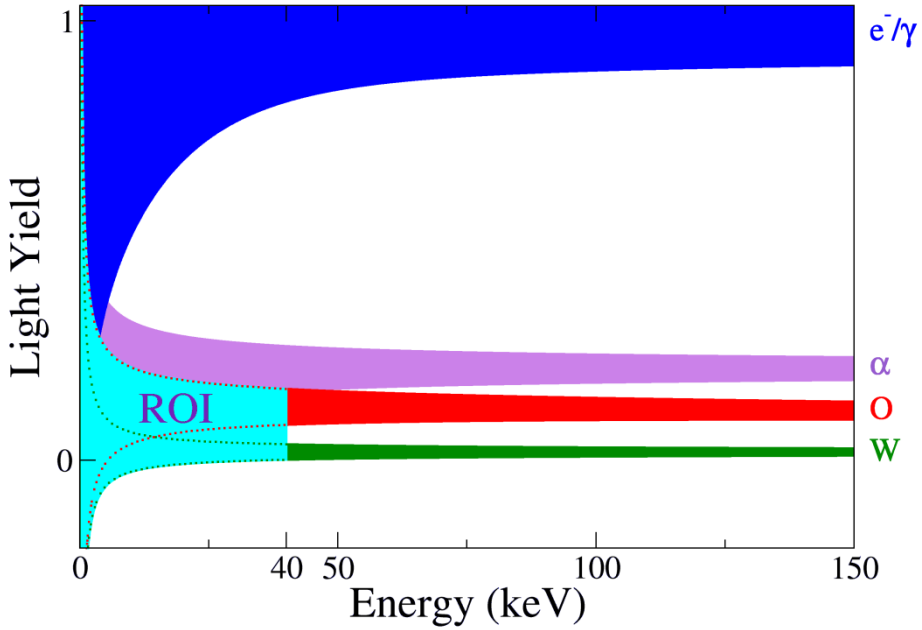

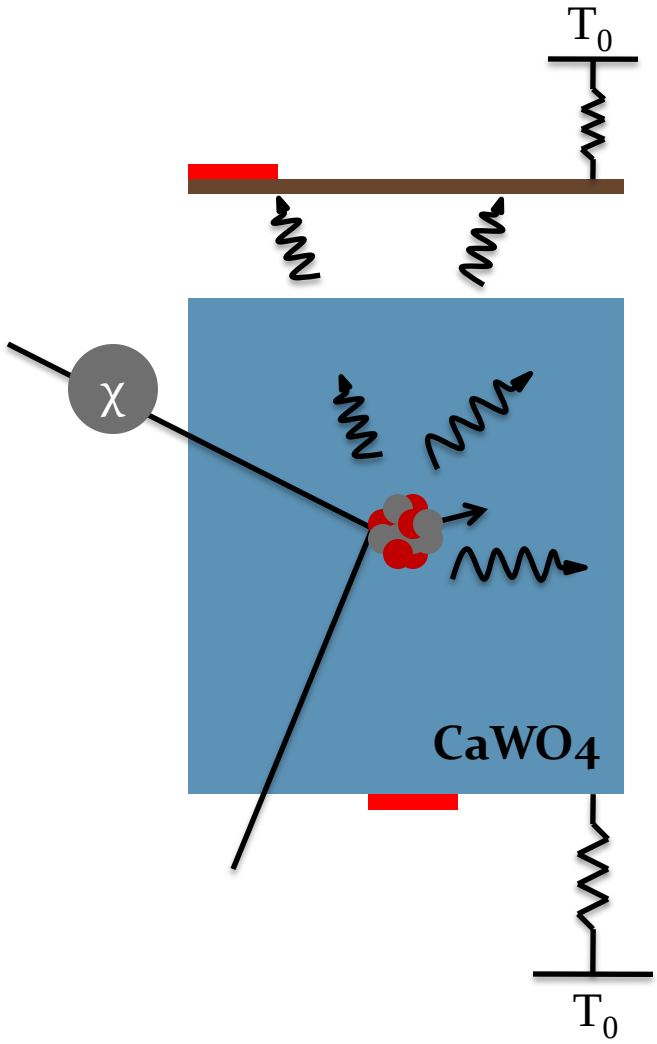

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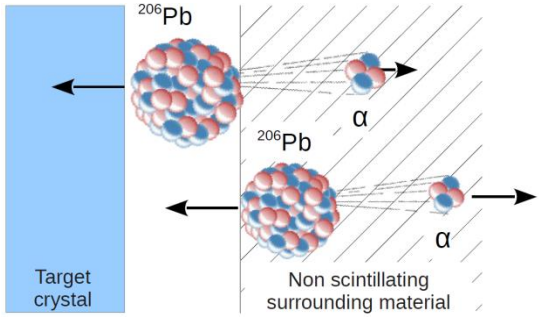
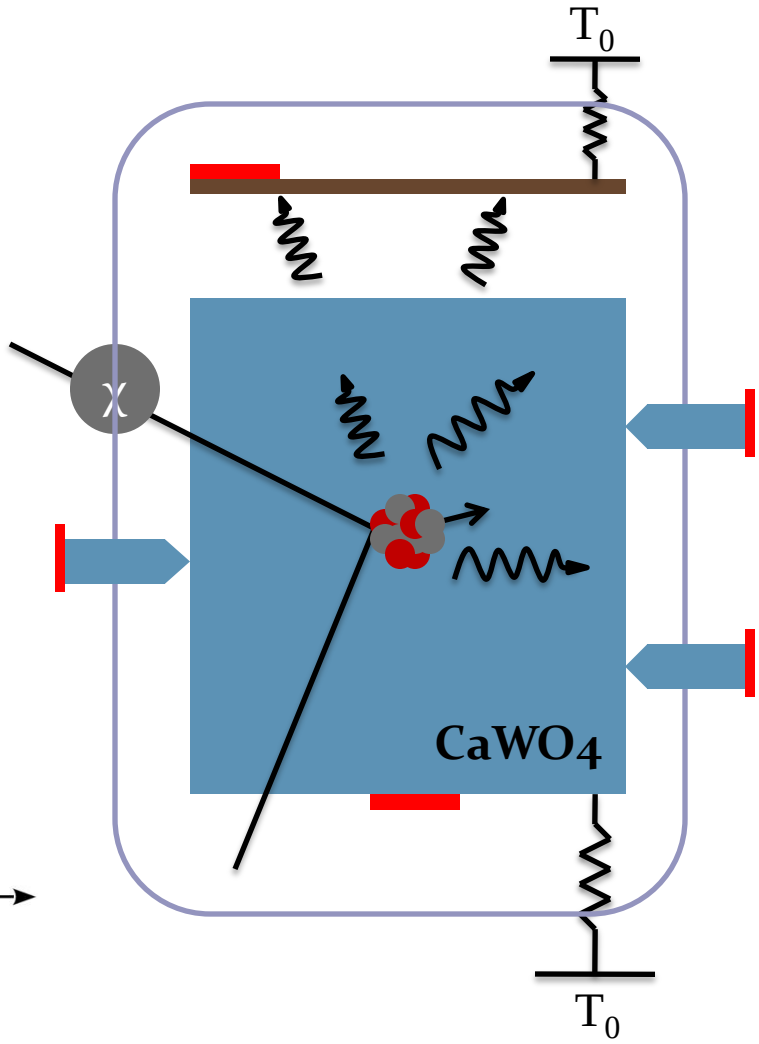
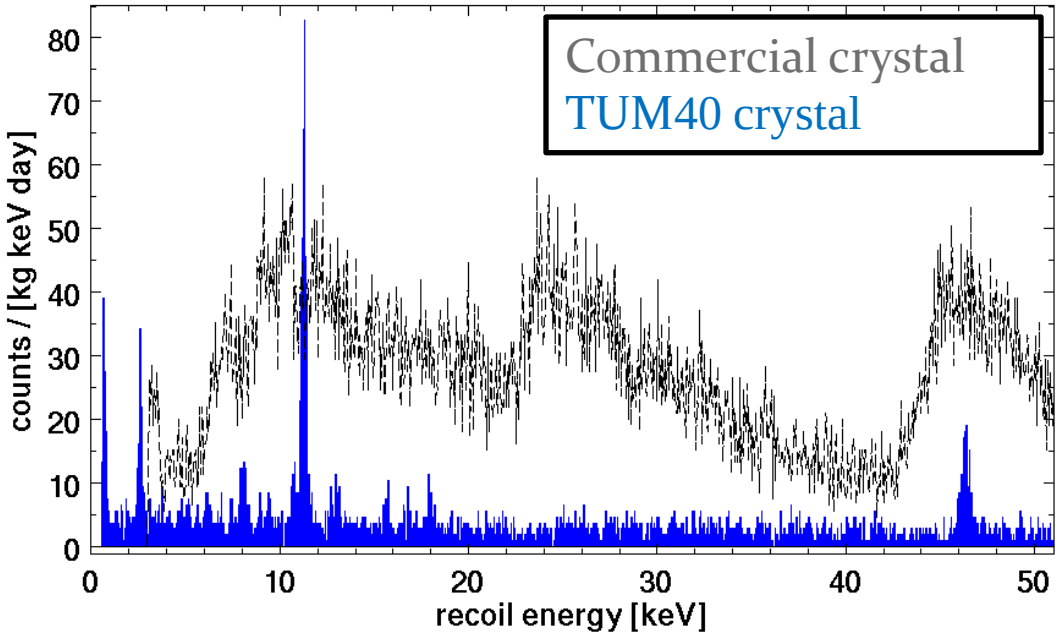
Instrumented holding system
- $CaWO_4$ stick instrumented with W-TES

Housing
- Reflecting foil
- Fully scintillating





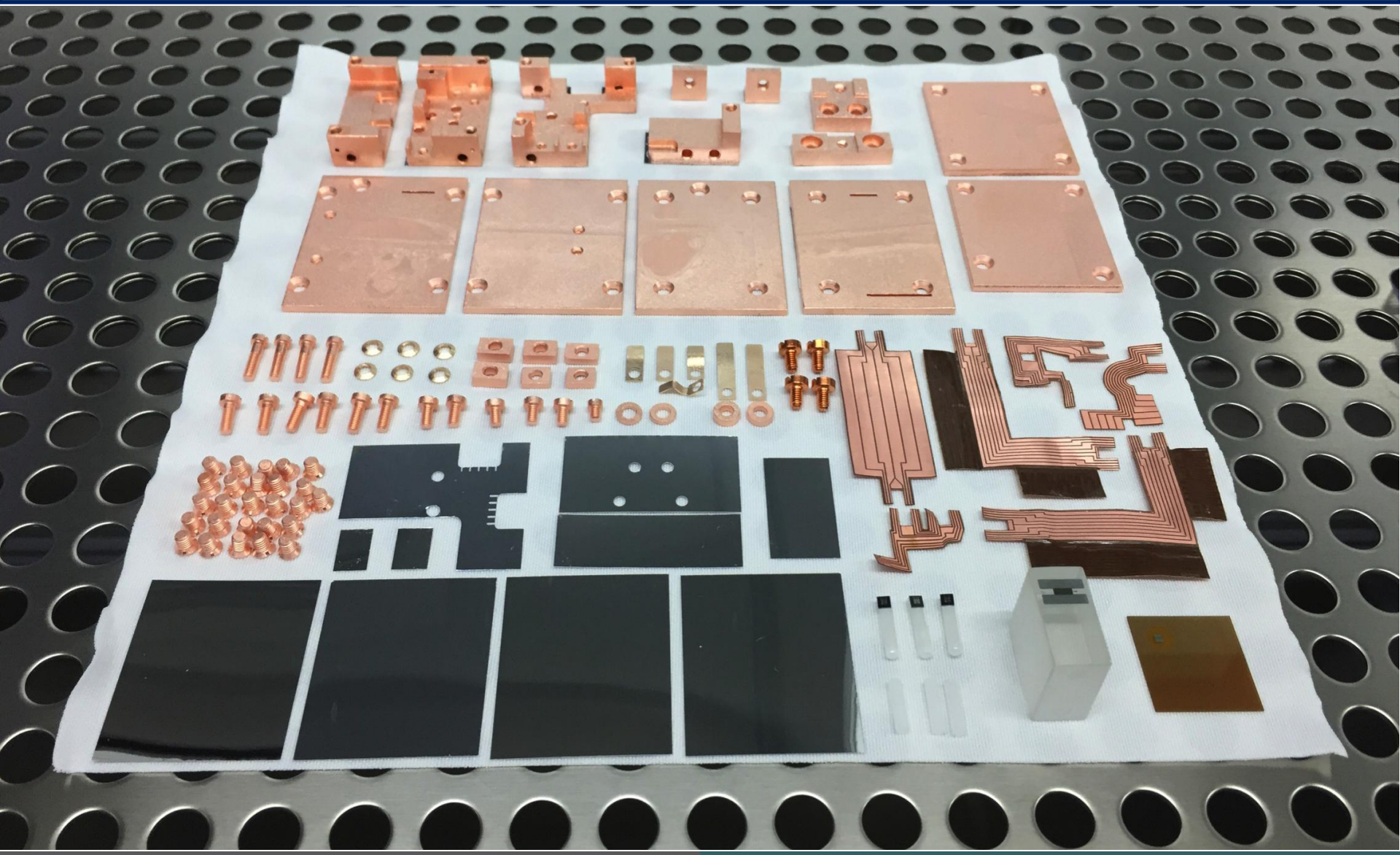
CRESST-III $CaWO_4$ crystals



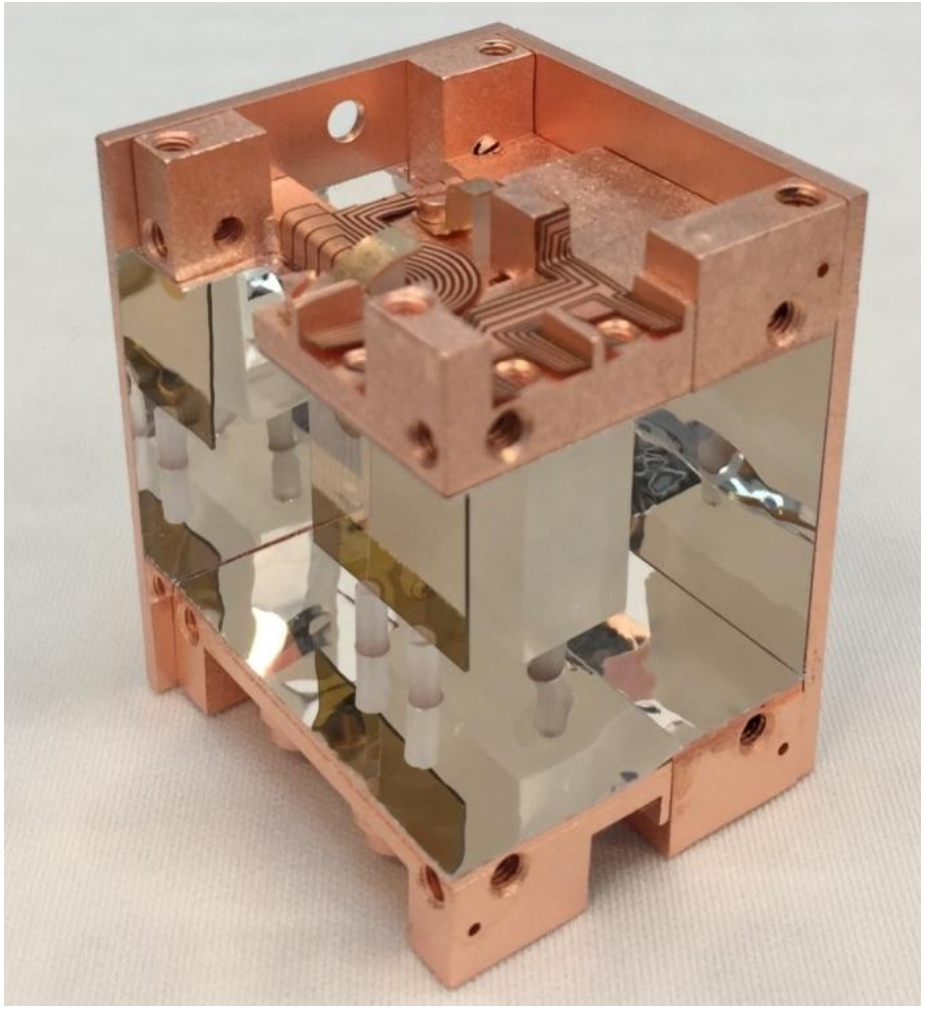
production at TU Munich
Unprecedented radiopurity

Average rate:
~3.5 counts /[kg keV day]

dx.doi.org/10.1088/1475-7516/2015/06/030



CRESST-III Status



CRESST-III phase 1 ongoing

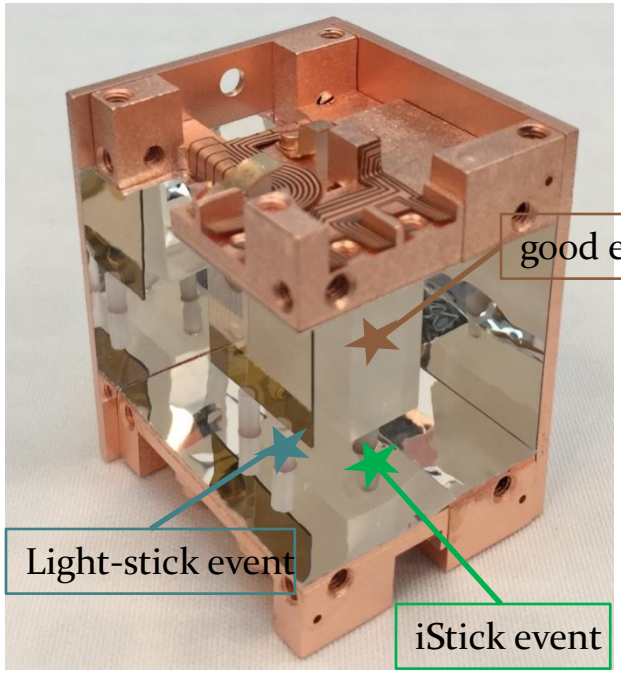
1 year measurement
50 kg*day total exposure

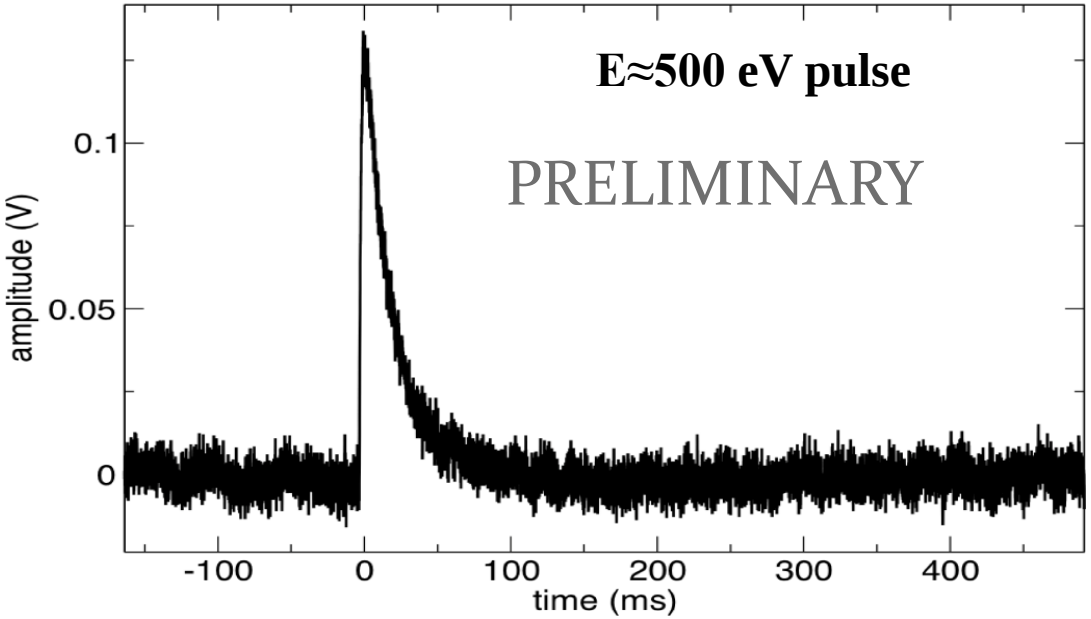
Design goal is 100 eV threshold

- May 2016: 10 CRESST-III modules installed
- Oct 2016: extensive γ-calibration
- Since November 2016: background data taking
- April 2017: extensive n-calibration

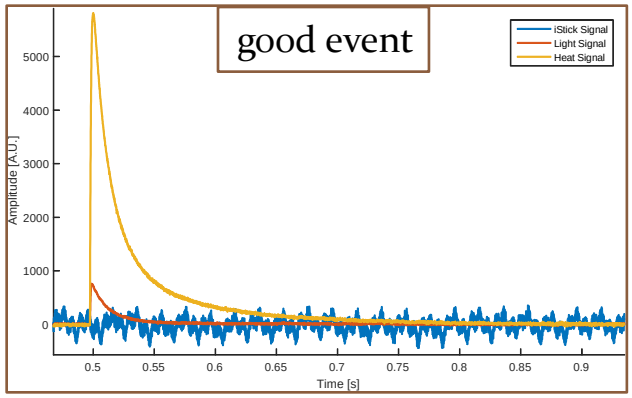
First publication planned for TAUP2017

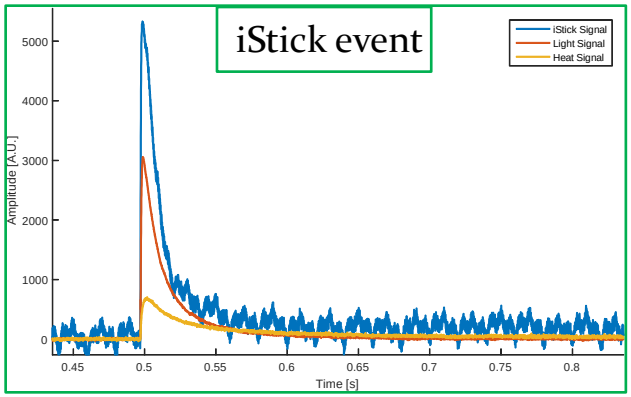
CRESST-III detector performance

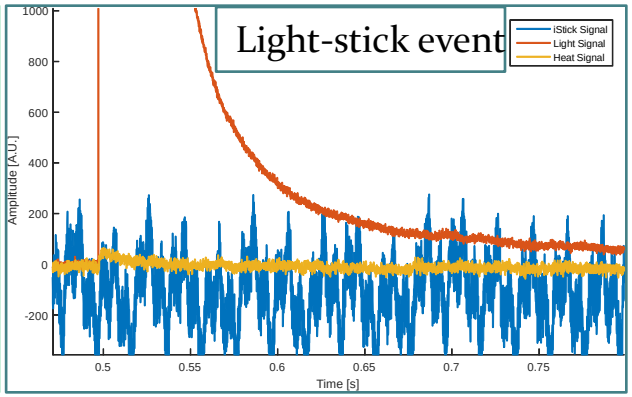




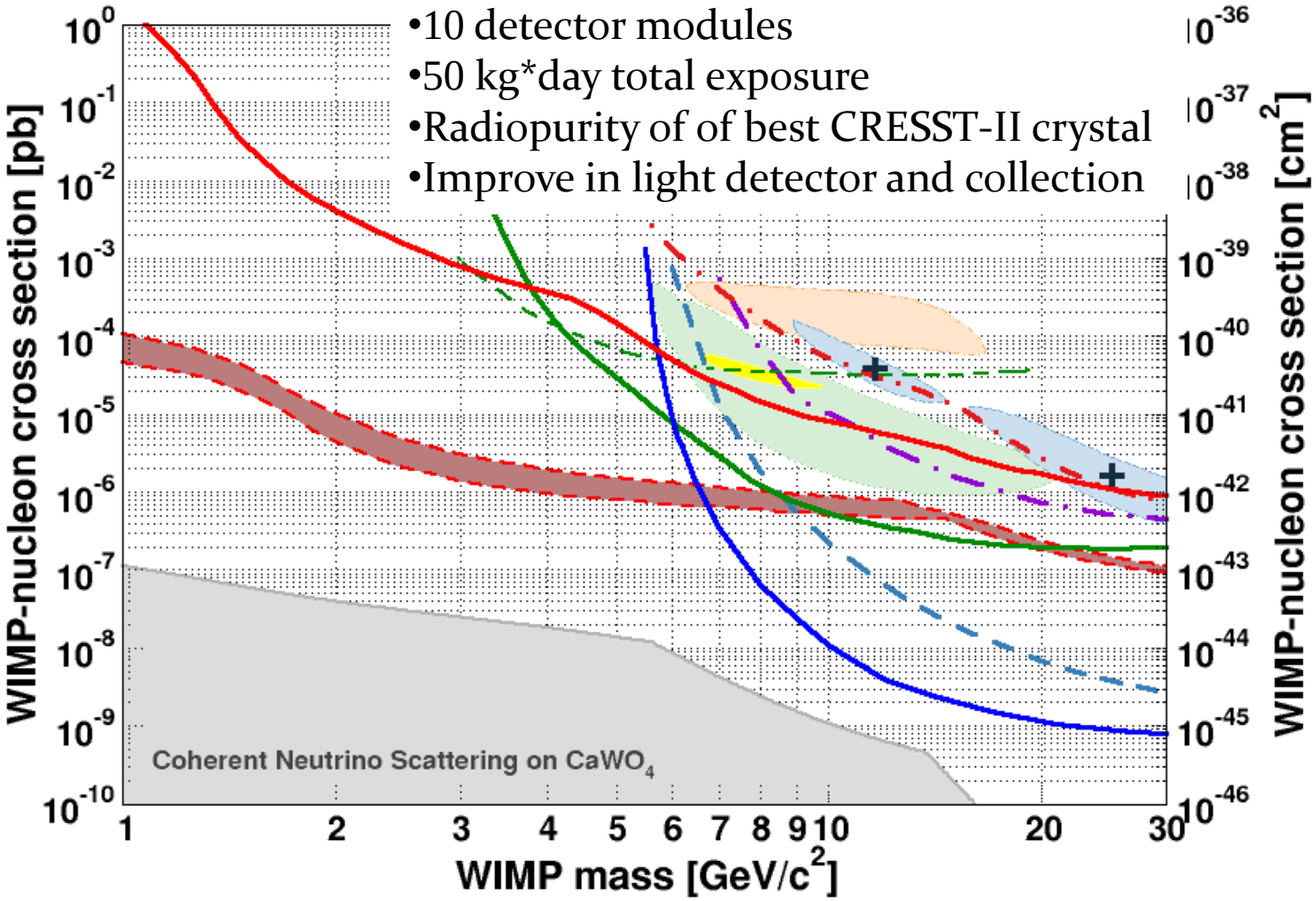
Pulse origin is defined by the ratio of the 3 channels read-out







CRESST-III Phase 1 projection



Conclusions

❖ **CRESST has an outstanding potential to explore the low-mass regime <3GeV/c^2**

CRESST-III technology :

- ✓Precise measurement of nuclear recoils at small energies
- ✓Threshold of <100eV reached with CRESST-III detectors
- ✓Reject holder-related events
- ✓TUM crystals of improved quality

❖ **First data publication planned for summer 2017**

Stay tuned!