CRESST to EURECA – Progress with cryogenic dark matter searches

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Dark matter - Evidence

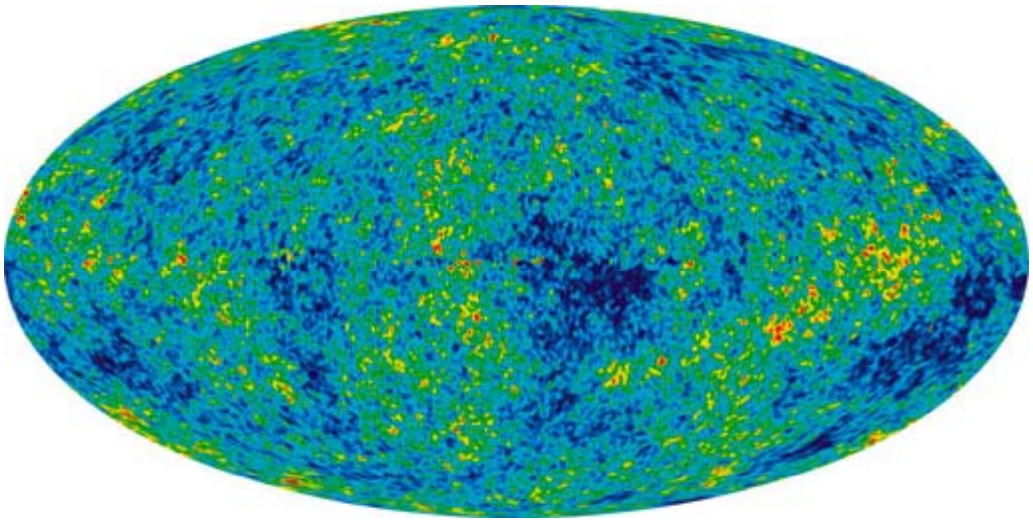
- **CMBR**

  WMAP + HST:

  Ω=1.02±0.02

  Ω_M=0.27±0.04

  Ω_b=0.044±0.004



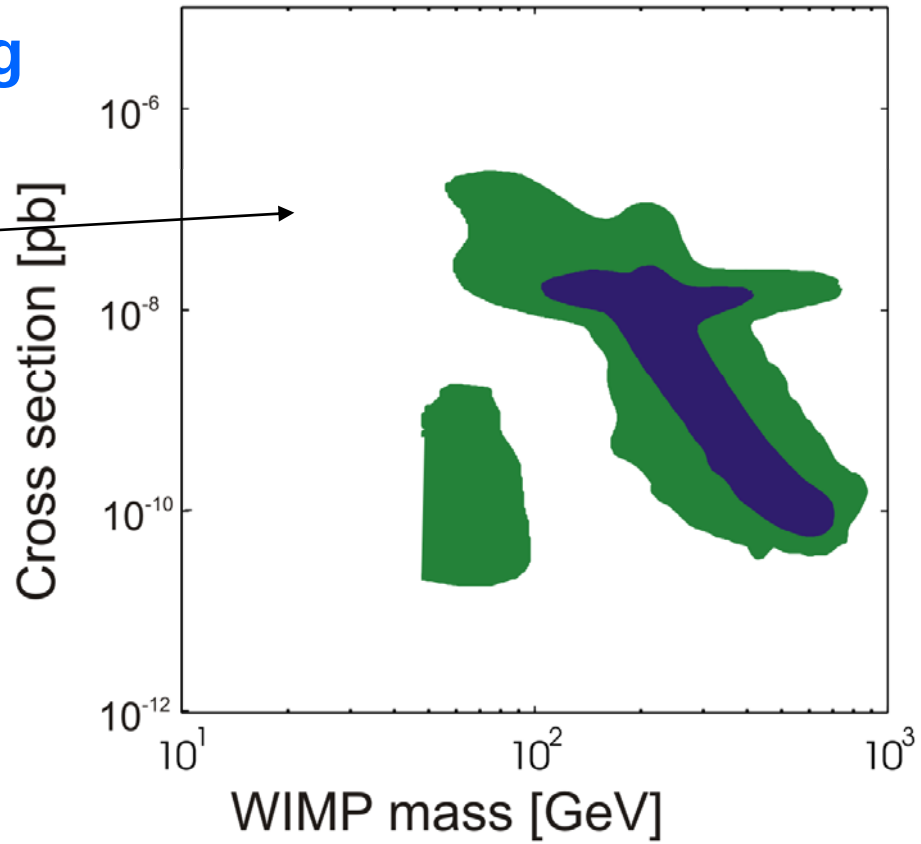
- **Galactic dark matter**

  Rotation curves of spiral galaxies

  Galaxy velocities within clusters

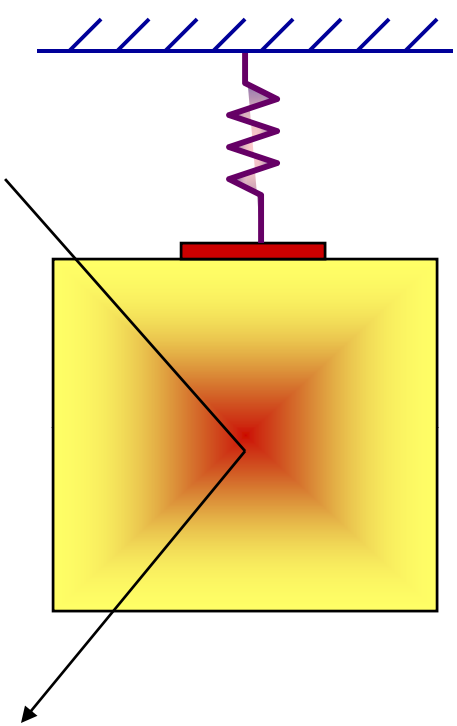
Dark matter - candidates

- Neutrinos
- Axions
- Gravitinos, axinos
- WIMPs - Weakly Interacting Massive Particles
  - Supersymmetric neutralinos
  - Kaluza Klein particles
- Alternative gravity
  - MOND - TeVeS



Ruiz de Austri, Trotta & Roszkowski

CRESST – Detectors

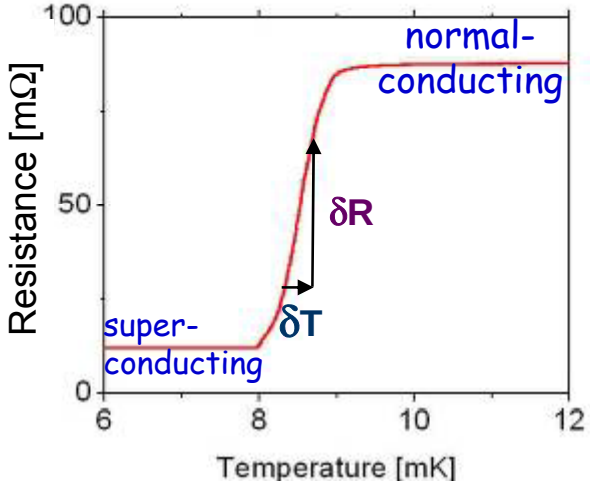


heat bath

thermal link

thermometer
(W-film)

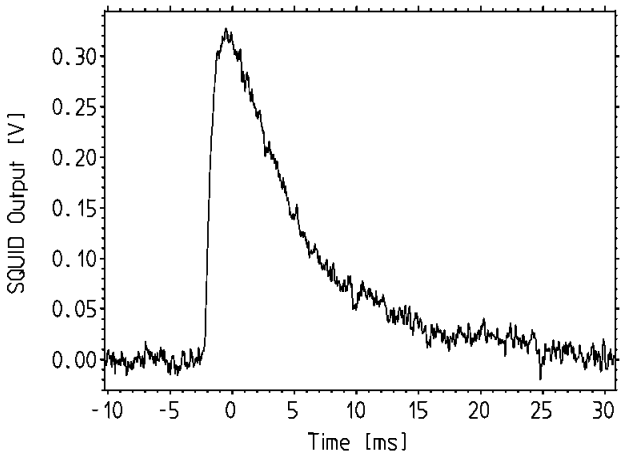
absorber
crystal



Width of transition: ~1mK
Signals: few μ K
Stablity: ~ μ K

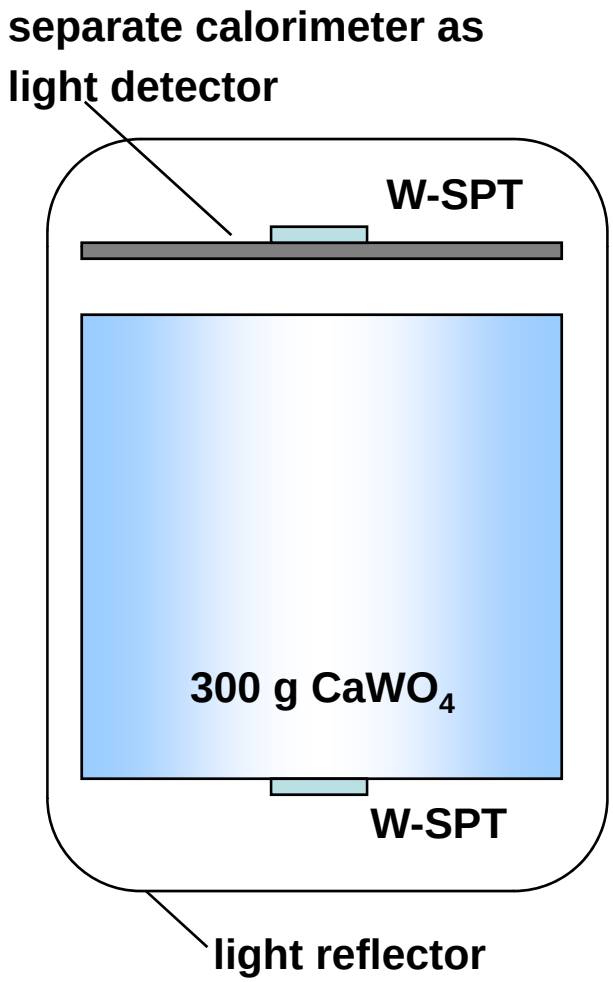
Particle interaction in absorber
creates a temperature rise in
thermometer which is proportional
to energy deposition in absorber

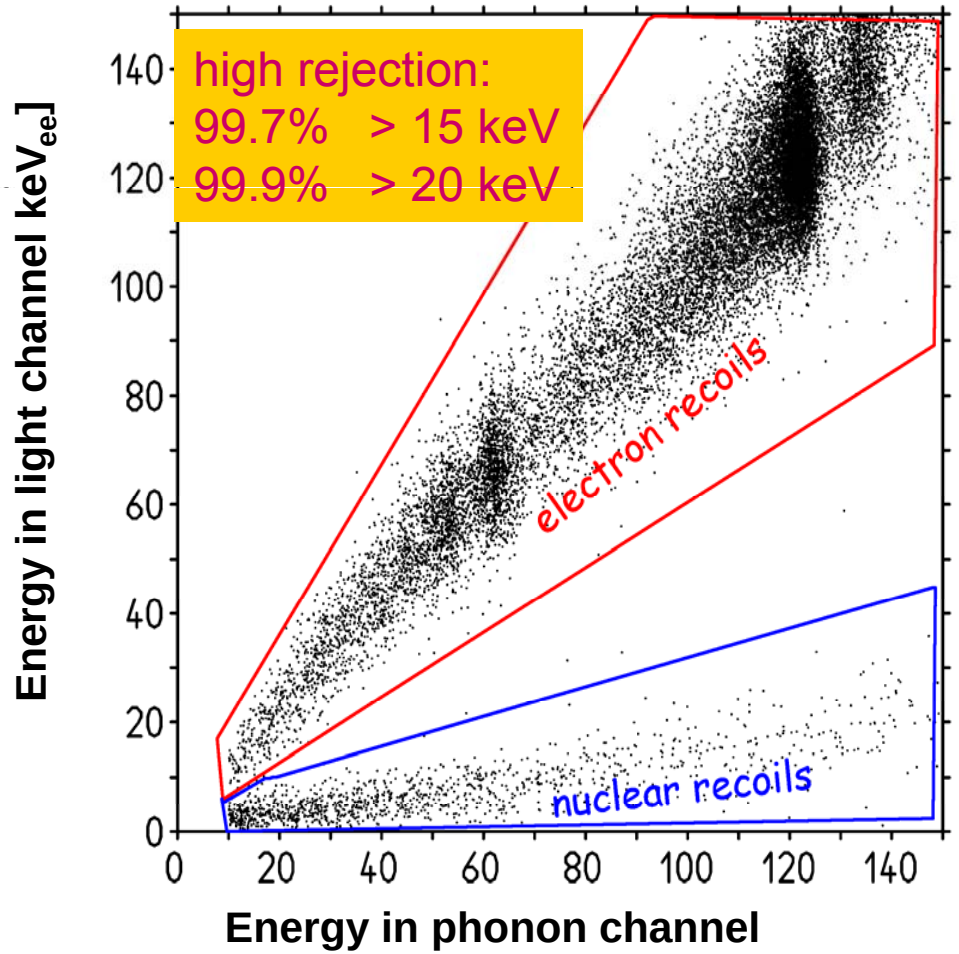
Temperature pulse (~6keV)



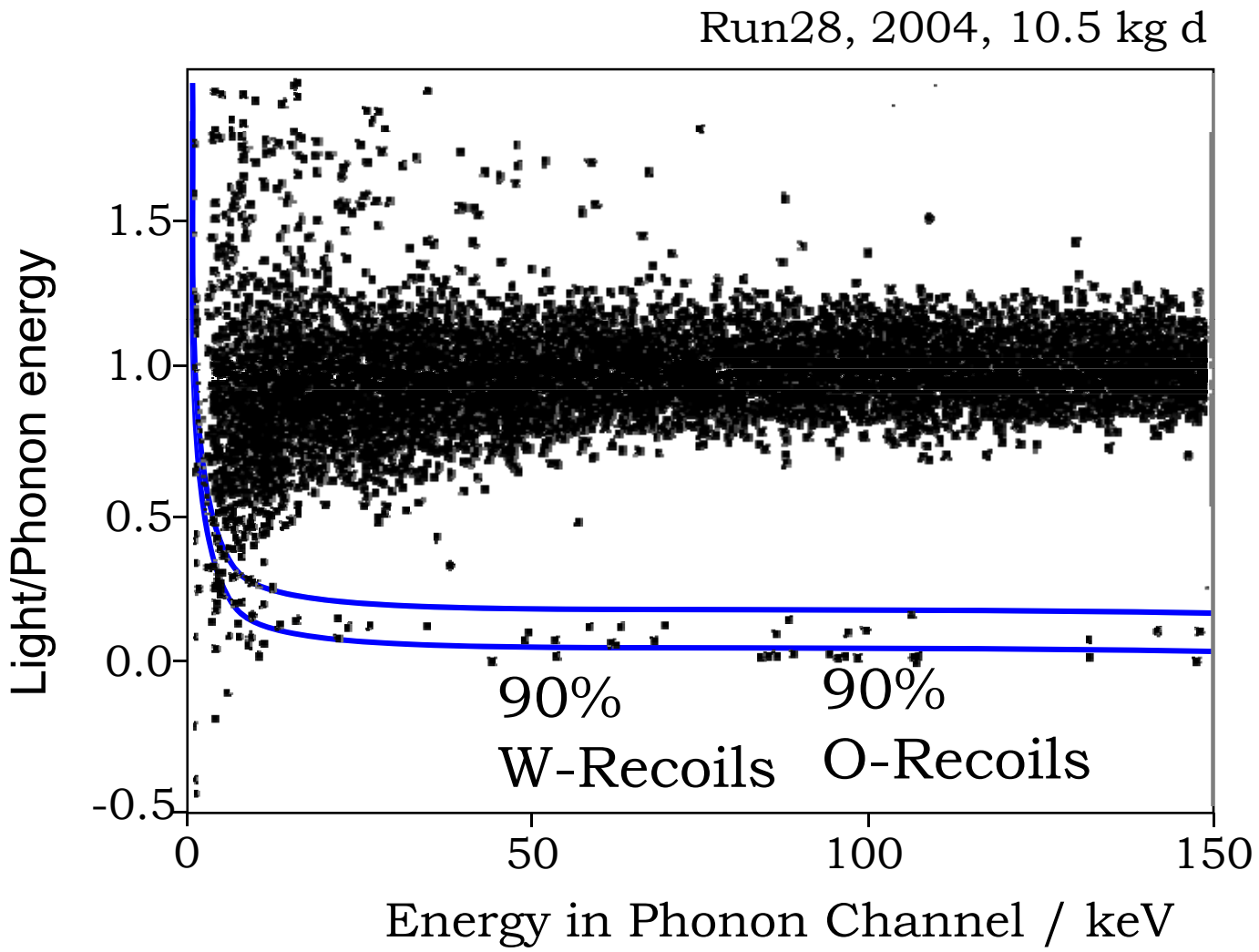
Phonon – Scintillation

Discrimination of nuclear recoils from radioactive backgrounds (electron recoils) by simultaneous measurement of phonons and scintillation light

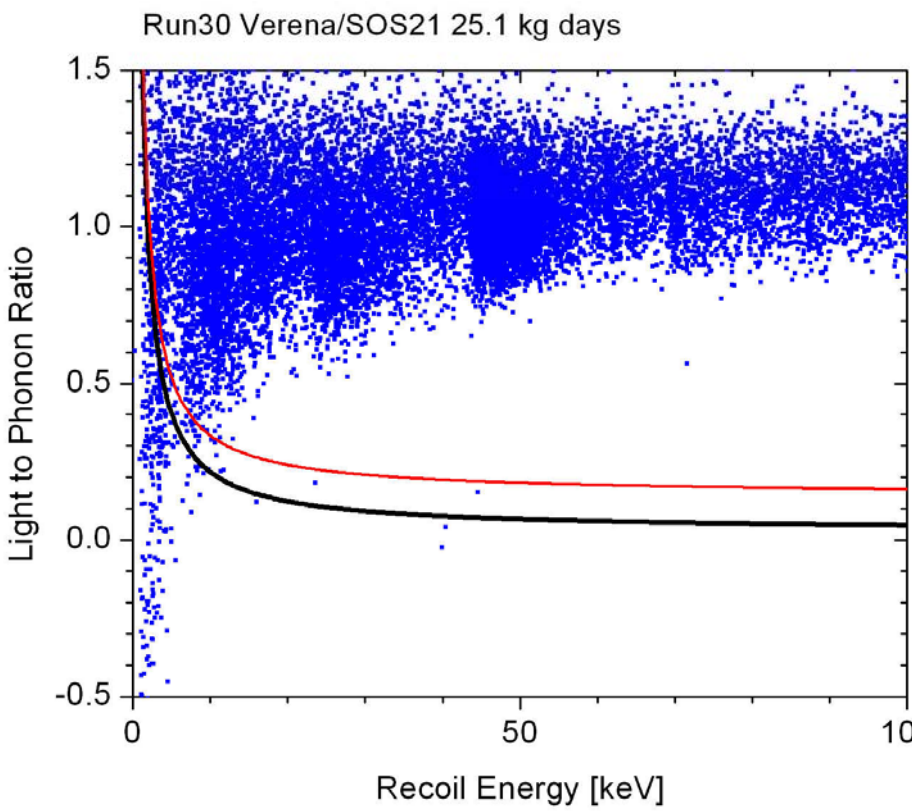


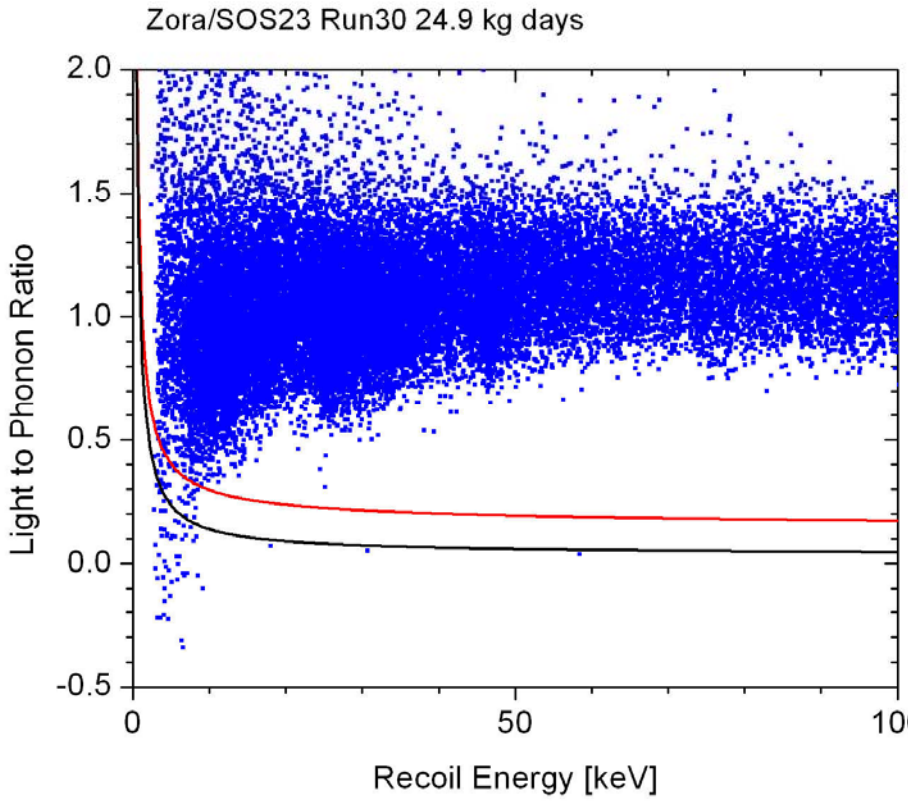


CRESST II – Results 2004



CRESST – Results 2007

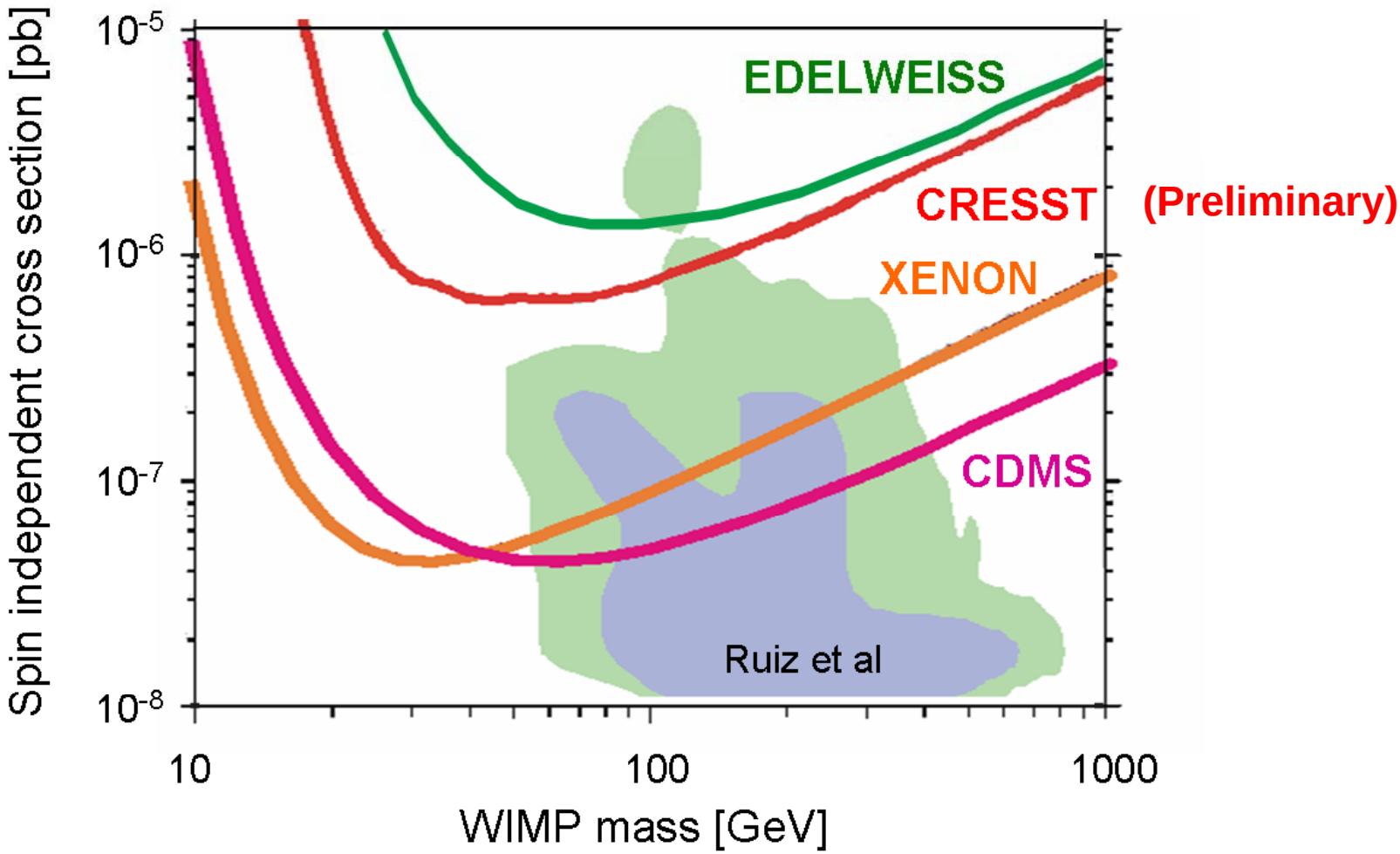




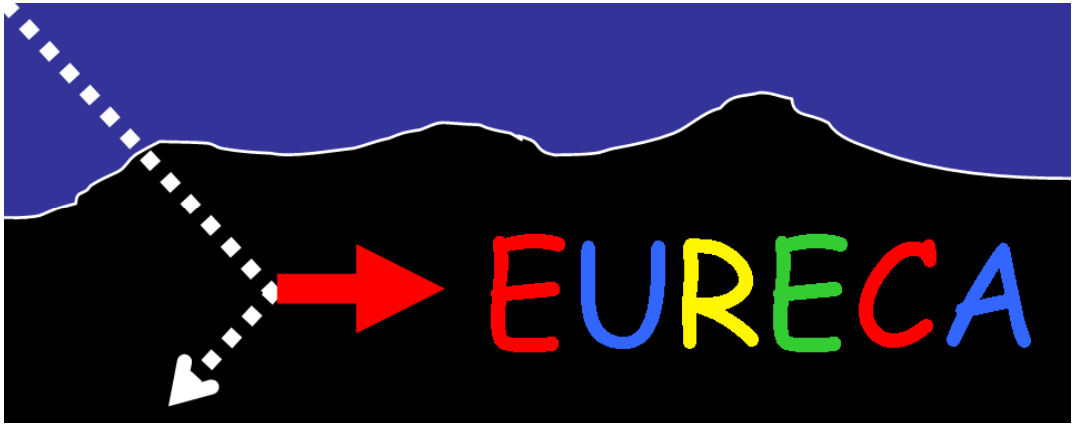
Next step – install and run 17 detector modules

CRESST / EDELWEISS – Results

Upper Limit for Spin-independent WIMP Nucleon Cross section for cryogenic detector experiments



(Preliminary)



European Underground Rare Event Calorimeter Array

- Search to $\sigma \sim 10^{-10}$pb (~1 event/tonne/year)
- CRESST and EDELWEISS, with additional groups joining.
- Target: Ge, $CaWO_4$, $ZnWO_4$…. (A dependence)
- Mass: above 100 kg towards 1 tonne
- Modane Laboratory

EURECA challenges

Detectors

- Large volume – 1000kg
- Multiple target materials – Ge + scintillators
- Radiopurity
- Maintain background discrimination

Cryostat

- Cool ~1000kg to ~10mK
- Allow easy removal / insertion of detectors

Readout

- 1000+ channels

Radiation shielding

- Neutrons

EURECA Collaboration

CRESST + EDELWEISS + ROSEBUD + …

United Kingdom

- Oxford (H Kraus, coordinator)

Germany

- MPI für Physik, Munich
- Technische Universität München
- Universität Tübingen
- Universität Karlsruhe
- Forschungszentrum Karlsruhe

Russia

- DNLP Dubna

Ukraine

- INR Kiev

France

- CEA/DAPNIA Saclay
- CEA/DRECAM Saclay
- CNRS/CRTBT Grenoble
- CNRS/CSNSM Orsay
- CNRS/IPNL Lyon
- CNRS/IAP Paris

Spain

- Zaragoza

CERN

APP UK 2008

Astroparticle Physics in the UK & Ireland

www.physics.ox.ac.uk/app2008

IOP Institute of Physics
Astroparticle Physics Group

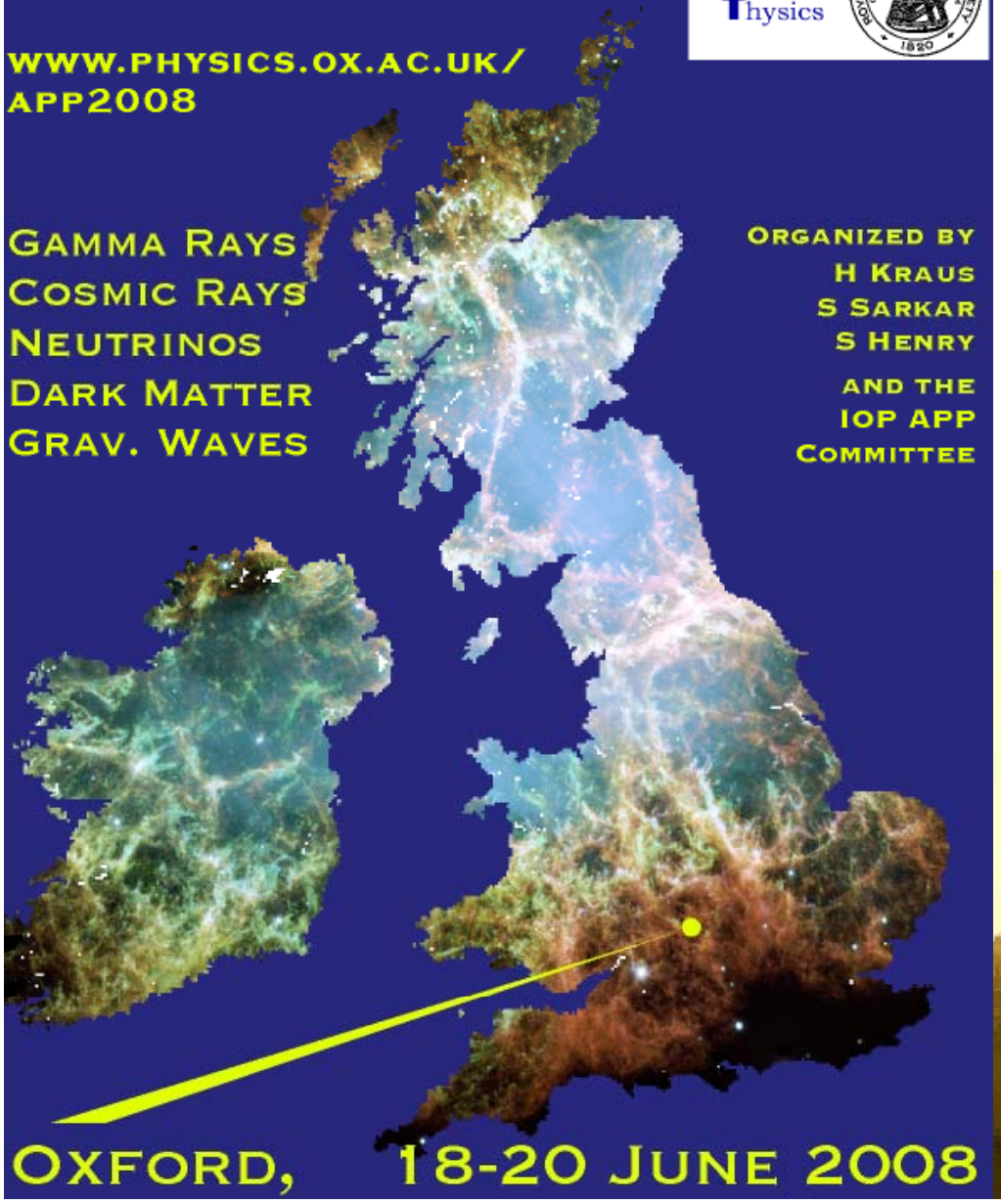
Science & Technology Facilities Council

Oxford Physics

Royal Astronomical Society 1820

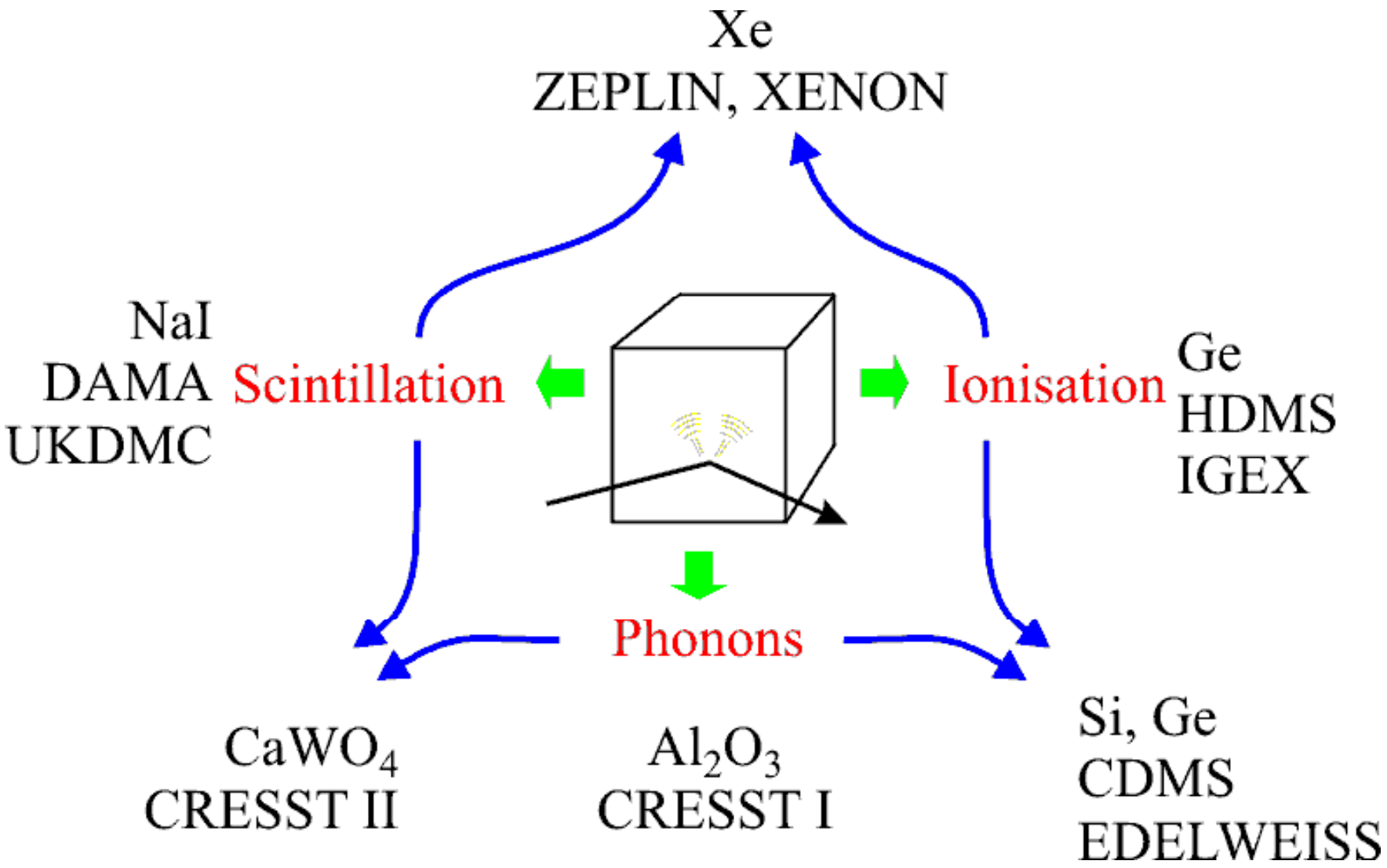
Gamma Rays
Cosmic Rays
Neutrinos
Dark Matter
Grav. Waves

Organized by
H Kraus
S Sarkar
S Henry
and the
IOP APP
Committee

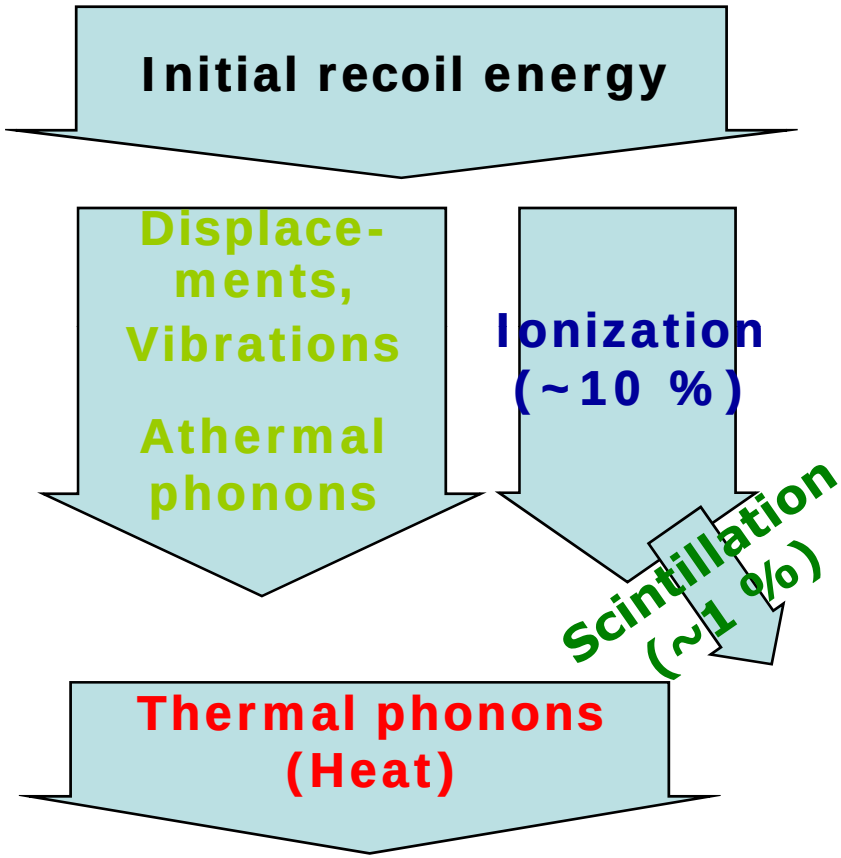


Oxford, 18-20 June 2008

Dark matter detection



Why use cryodetectors?



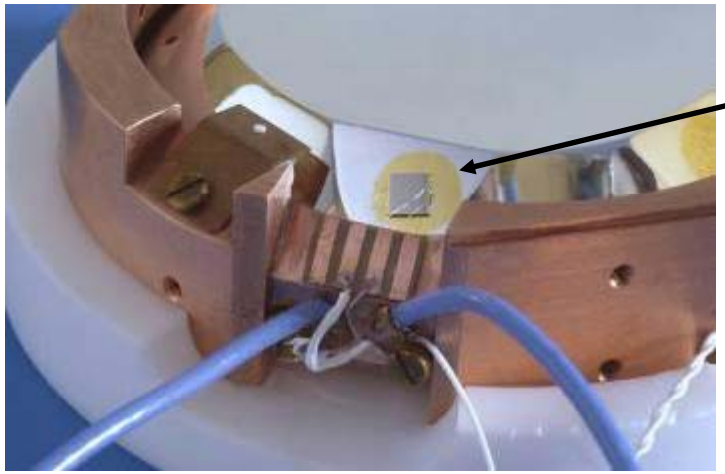
Energy to extract electron in PM tube: ~300eV

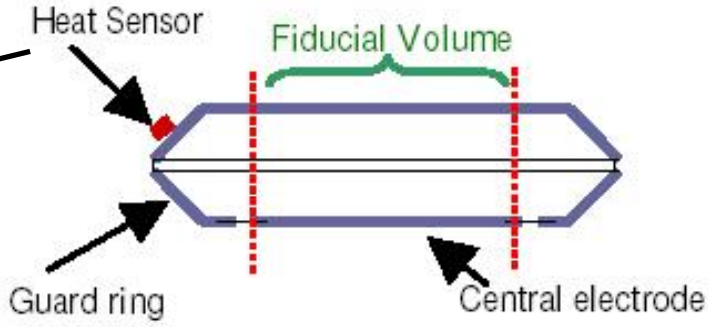
Energy to ionize gas molecule: ~30eV

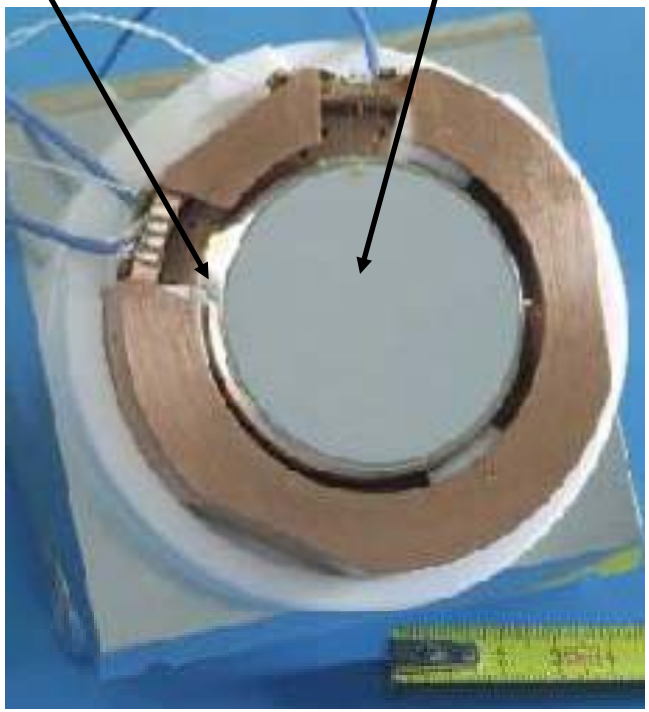
Energy to produce electronhole pair: 3.6eV

Energy to break superconducting electron pair: ~meV !

EDELWEISS – Detectors







Target:

Cyl. Ge crystal, 320 g

Ø 70 mm, h = 20 mm

Phonon - signal:

NTD-Ge (~ 20 mK)

Ionisation - signal:

Inner disc / outer guard ring