

Rencontres de Moriond EW 2008

CRESST

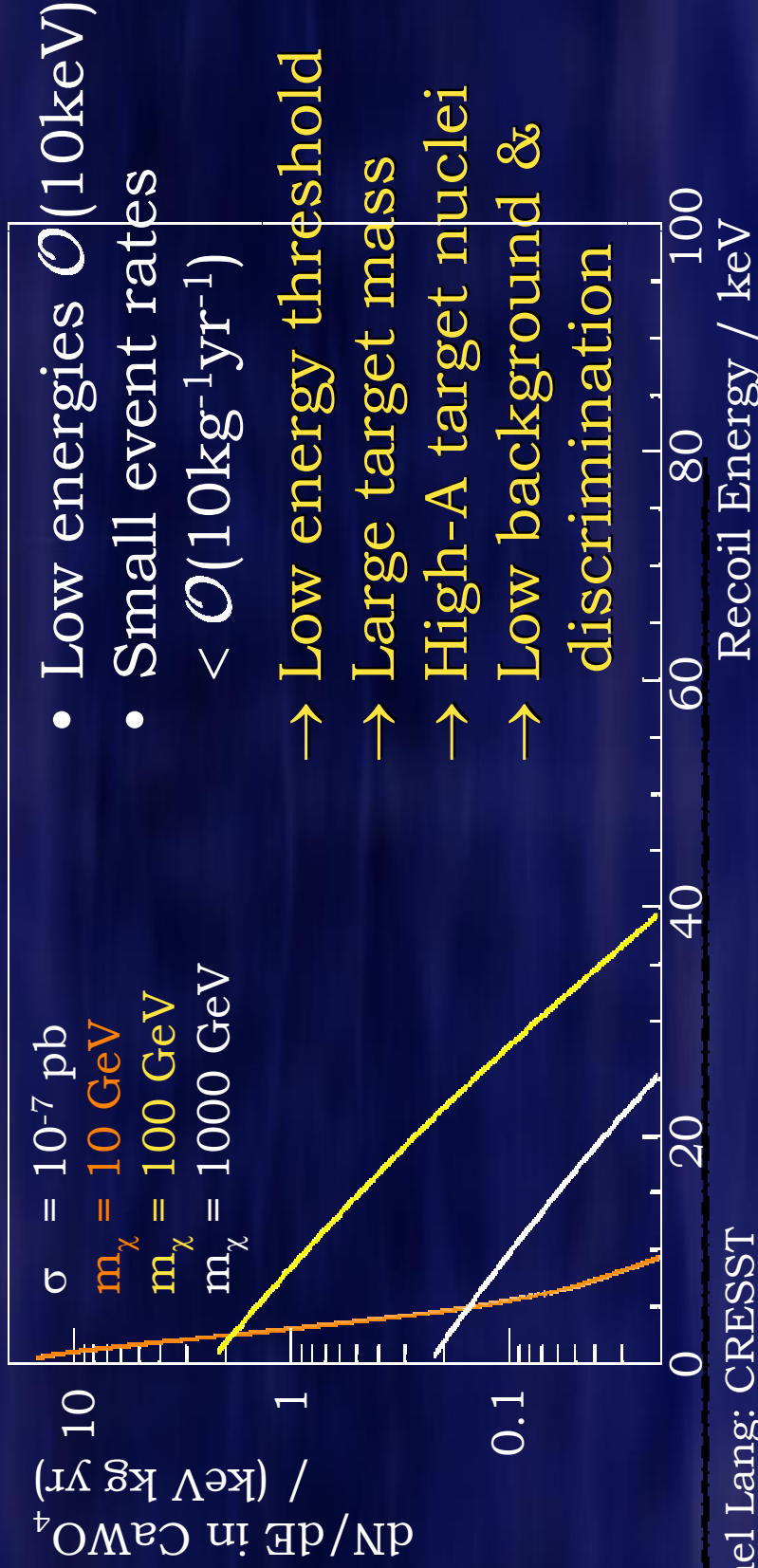
Cryogenic Rare Event Search
with Superconducting Thermometers

Rafael Lang (MPI) for the CRESST collaboration
La Thuile, March 7th, 2008

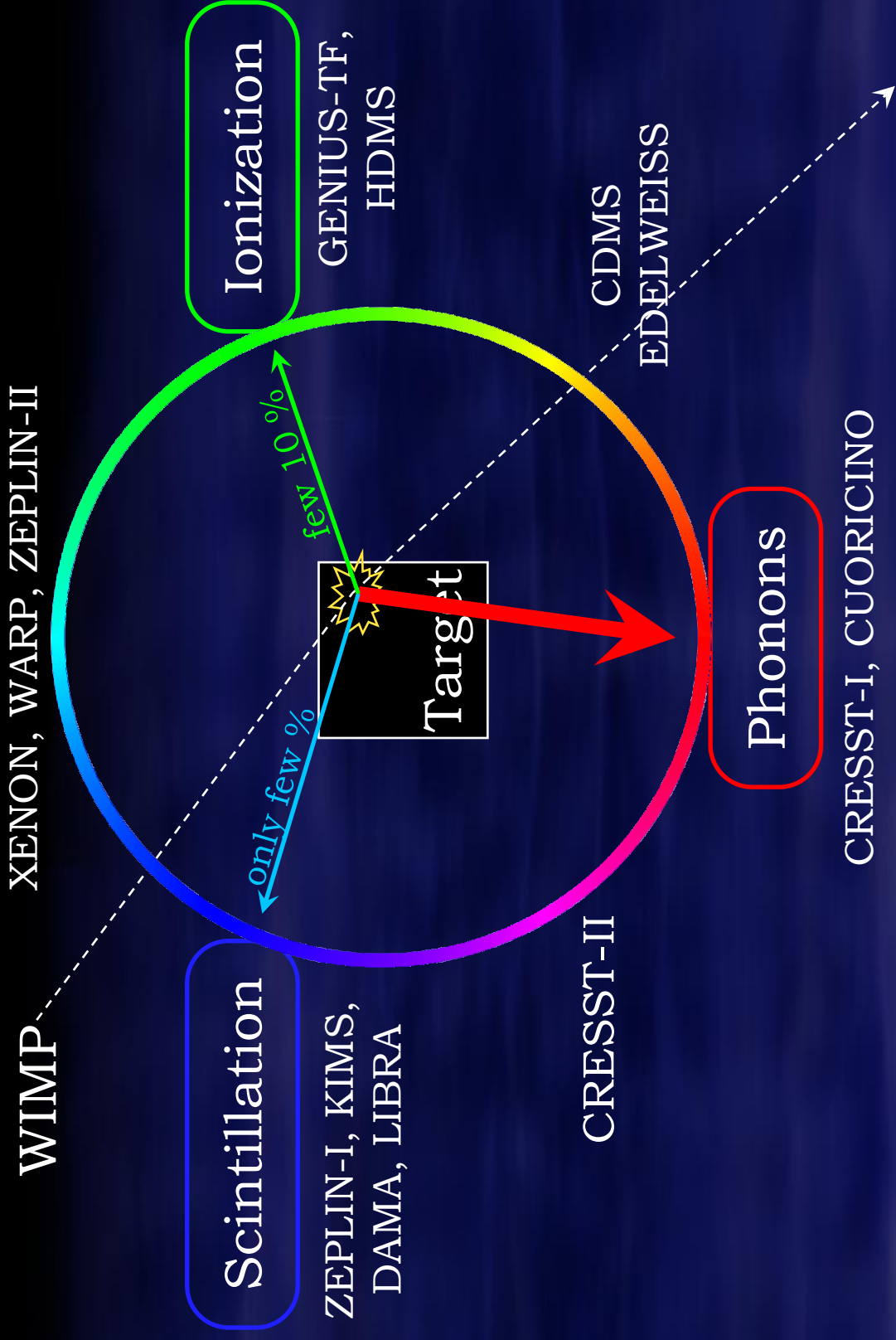
CRESST is a collaboration of the Max-Planck-Institut
für Physik, University of Oxford, Technische
Universität München and Universität Tübingen,
hosted by the Laboratori Nazionali del Gran Sasso

Expected WIMP Spectrum

- Isothermal halo, local density $\rho_\chi \sim 0.3 \text{ GeV}/\text{cm}^3$
- $V_{\text{earth}} \sim 240 \text{ km/s}$
- Coherent scattering $\sigma \propto A^2$
- Helm form factor

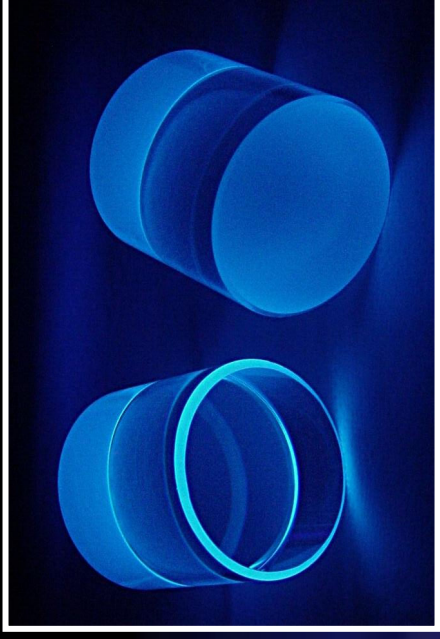


Particle Detection Channels

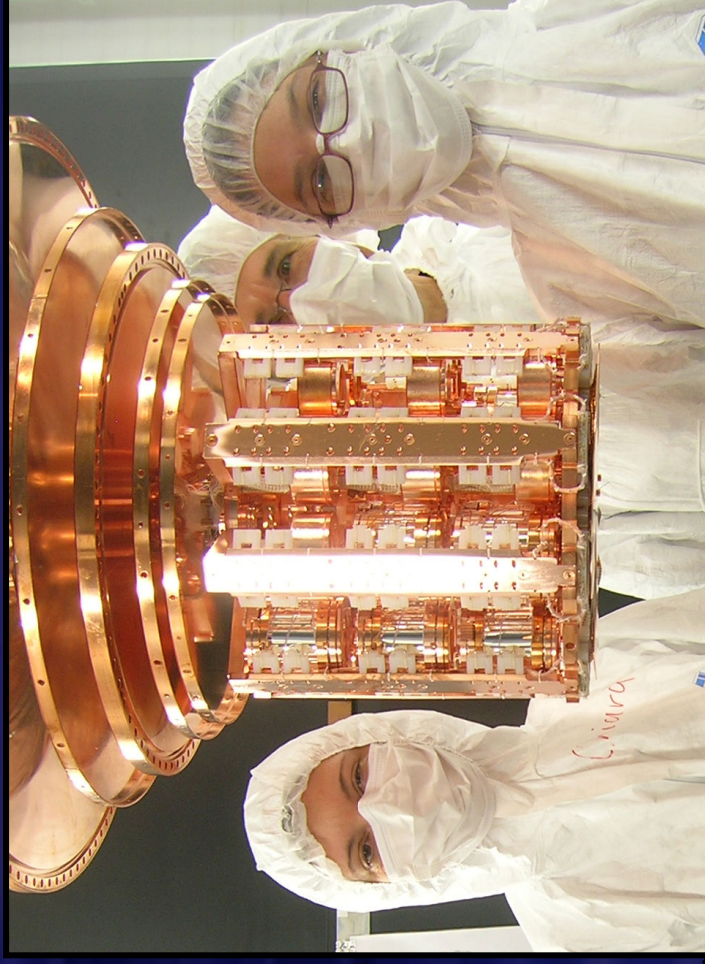


Target Materials in CRESST

- Tungsten in CaWO_4 ($A=184$)
- Modular structure: up to 33 modules easily scaleable
- 10 kg target mass multi-target possible (W, Ca, O, Mo, Zn, ...)

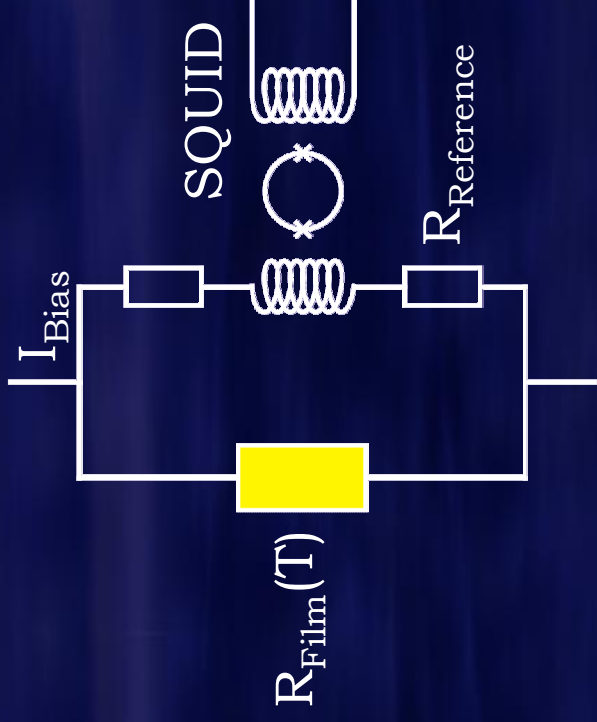
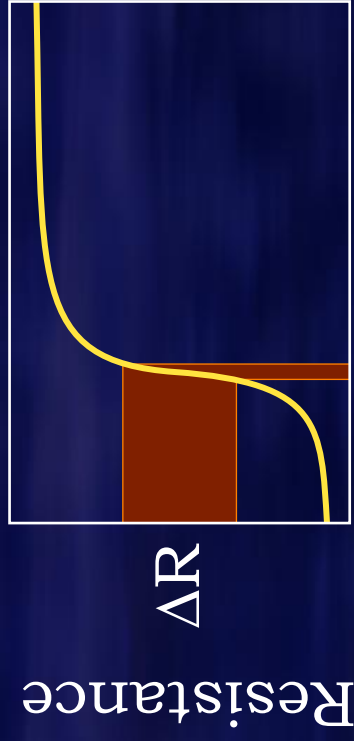


CaWO_4 ,
 $h=40\text{mm}$
 $\varnothing=40\text{mm}$
 $m=300\text{g}$



Detecting Low Energies

- Measure phonons
- $^3\text{He}/^4\text{He}$ dilution cryostat for $T \approx 10 \text{ mK}$ ($c \propto T^3$)
- Phase transition thermometer, stabilization $\mathcal{O}(\mu\text{K})$

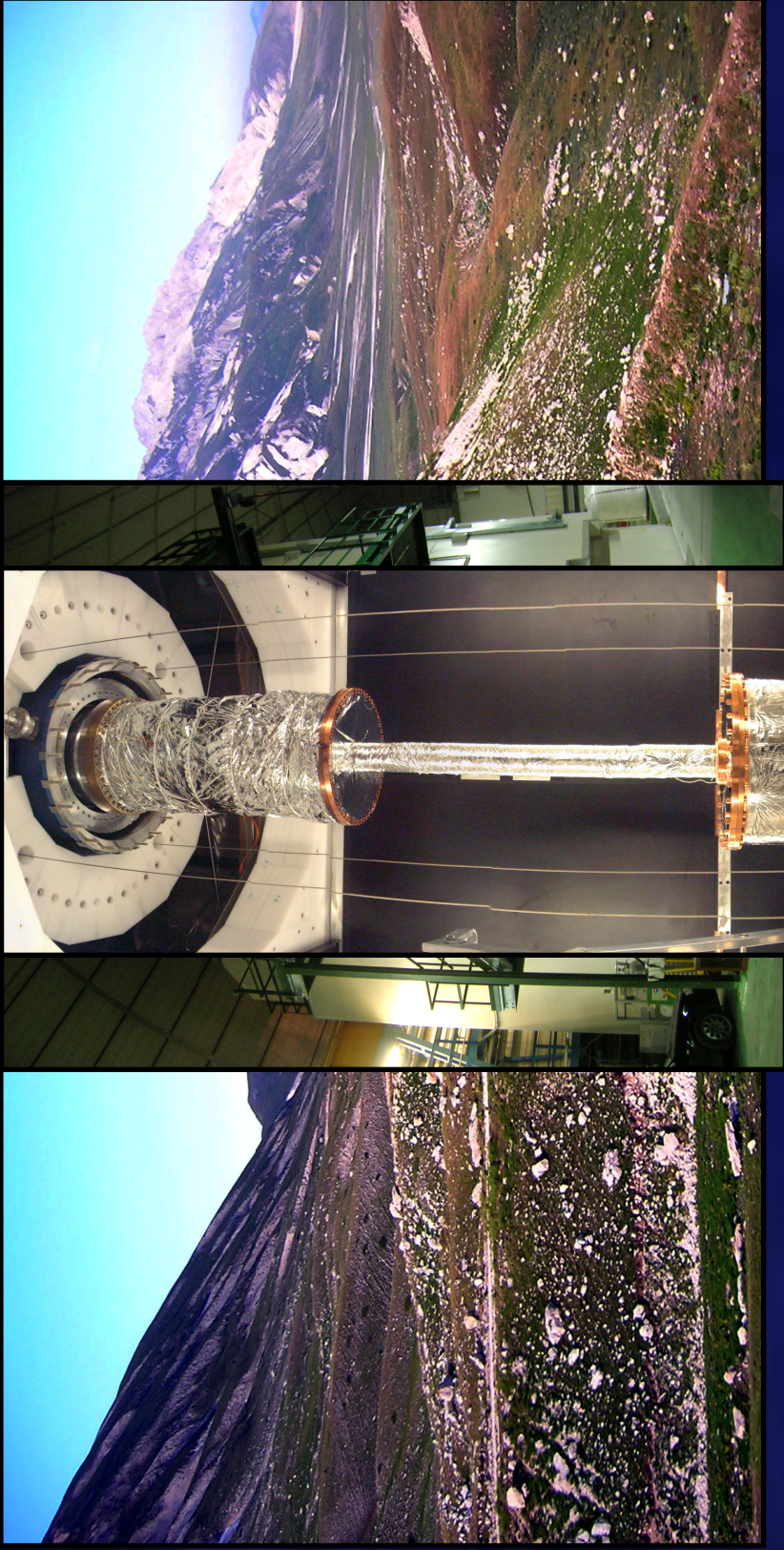


- SQUID-based amplification
- $E_{\text{threshold}} < 1 \text{ keV}$
noise FWHM 300eV



Background Shielding

- Go to underground laboratory:



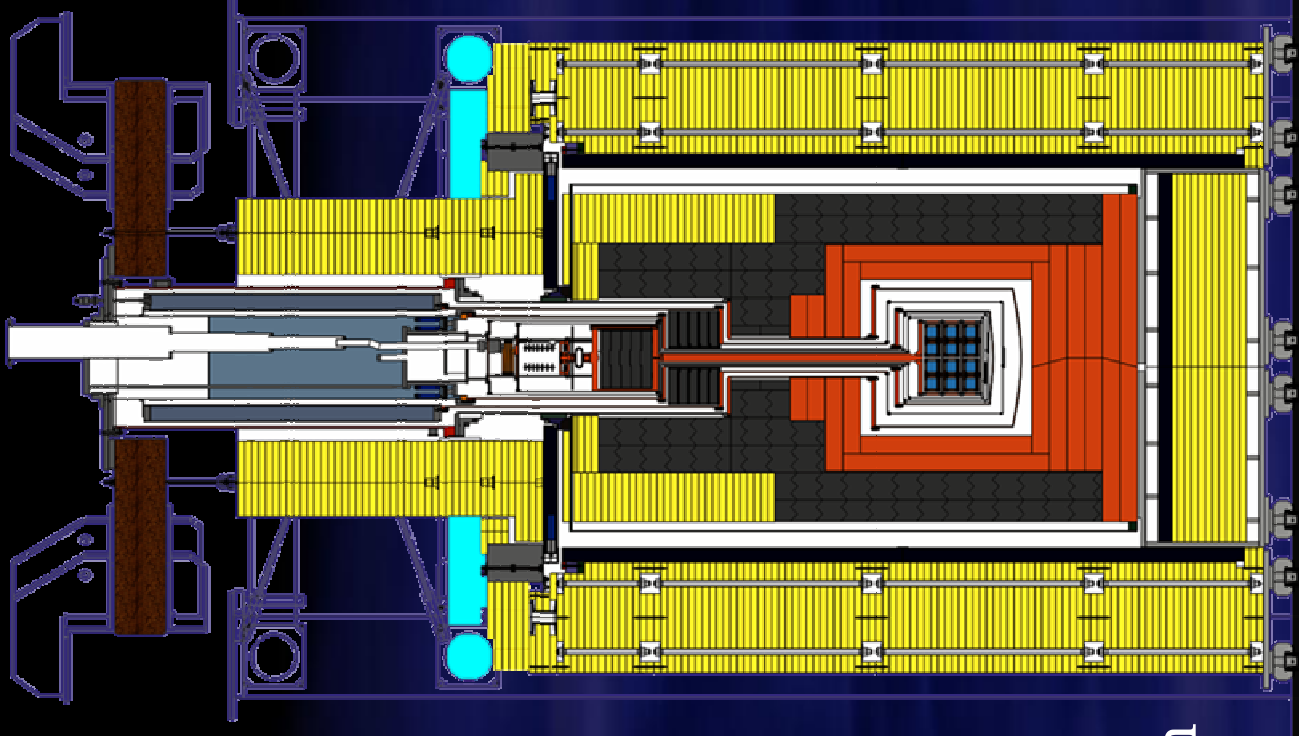
Gran Sasso underground laboratory
below 1400m of rock (~3500m water equivalent)

Passive Shielding

- Go to underground laboratory
- Muon-veto
- 45 cm PE (12 tons)
- Radon box
- 20 cm lead (24 tons)
- 14 cm copper (10 tons)
- Use only radio-pure materials

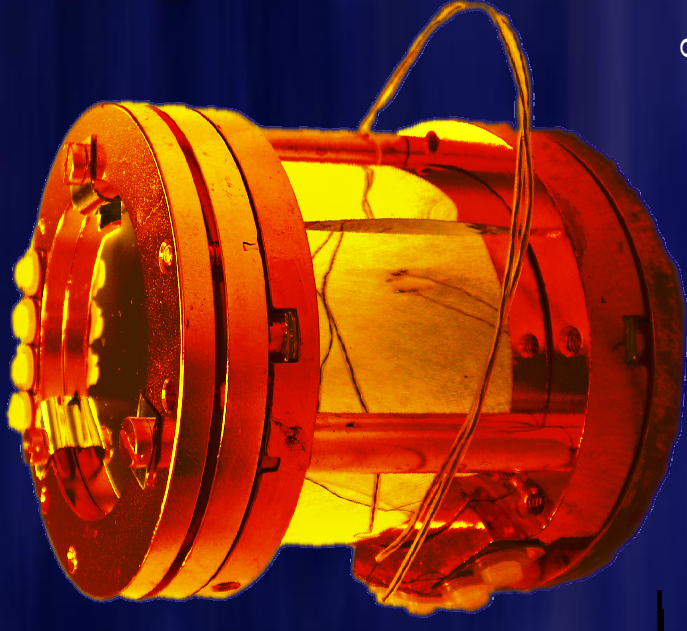
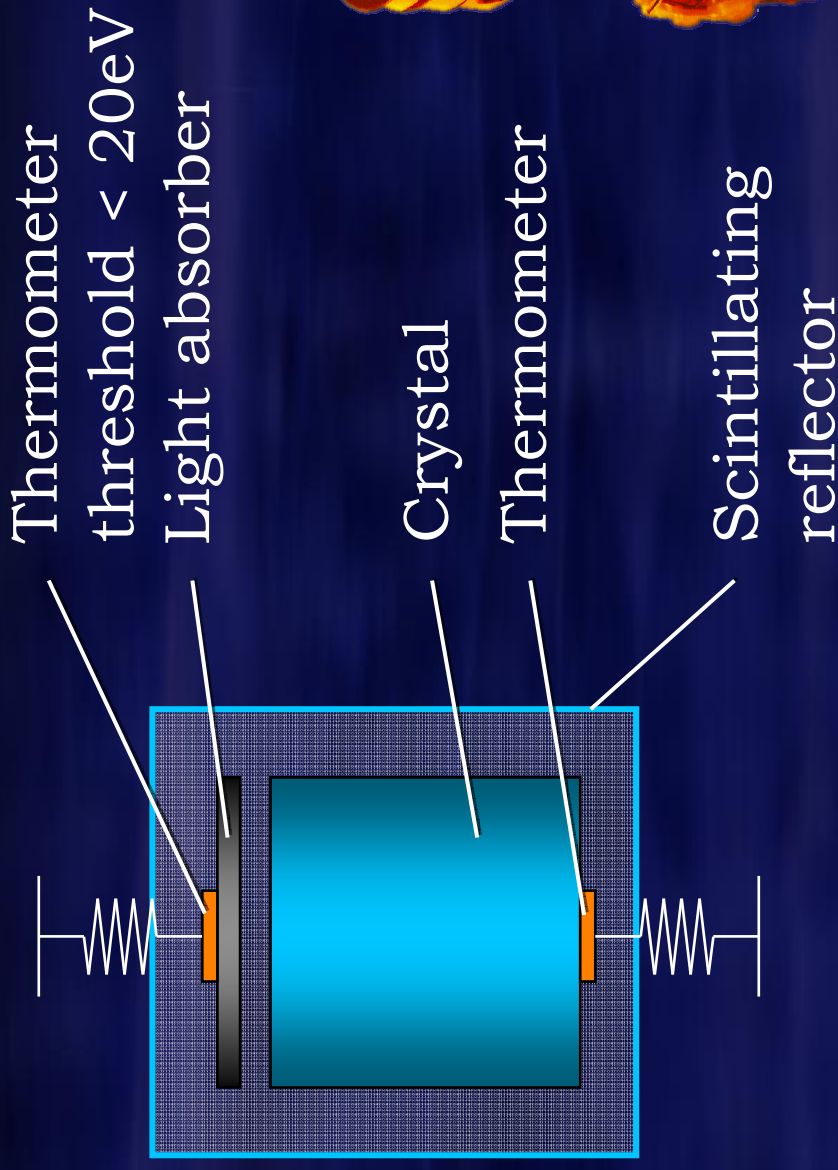
Good is not good enough!

$\mathcal{O}(1000 \text{ events/kg/day})$ still remain



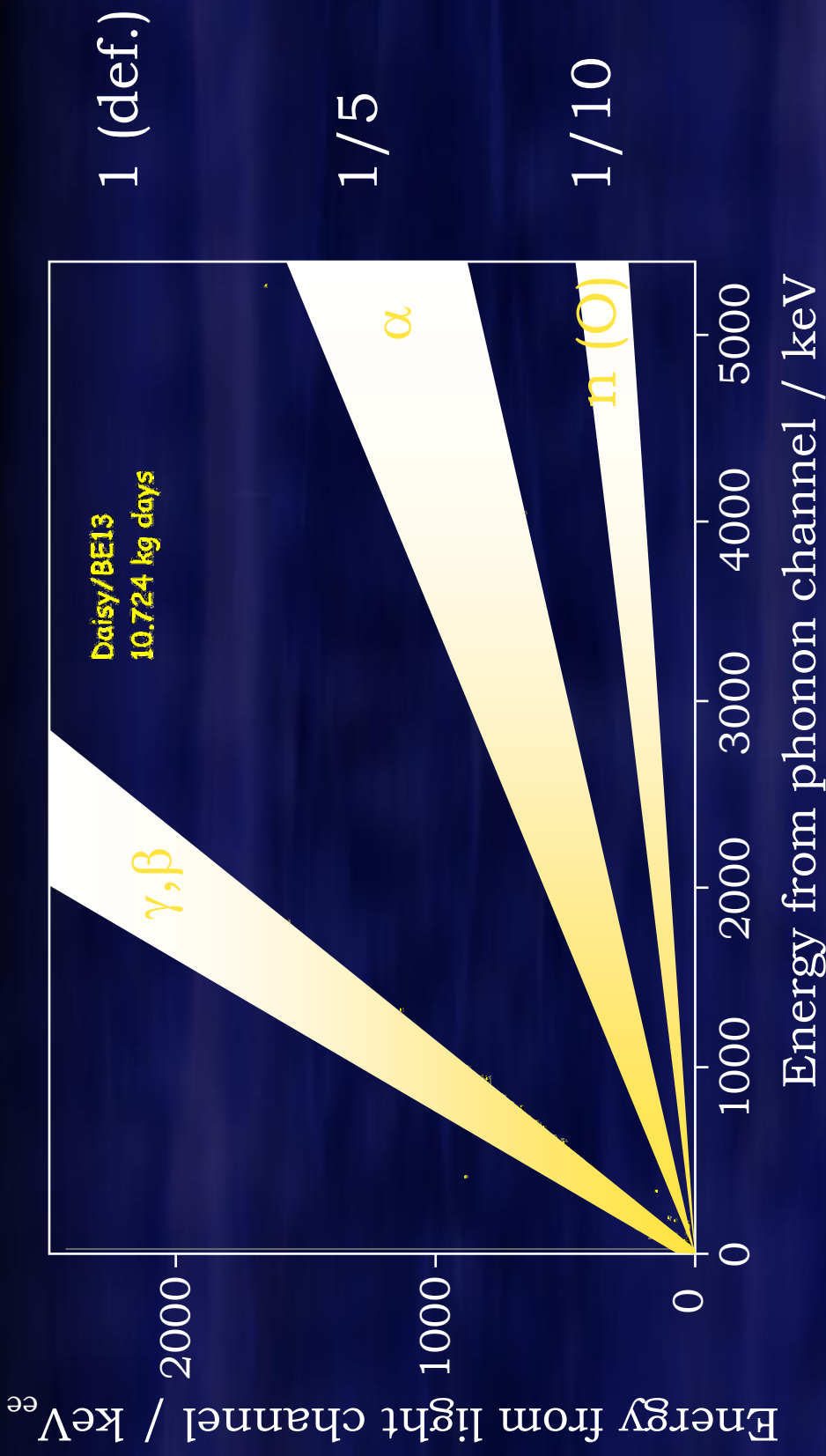
Active Background Discrimination

Use scintillating crystals



Signal Regions

Event-by-event discrimination



Lab Measurements (Room Temp.)



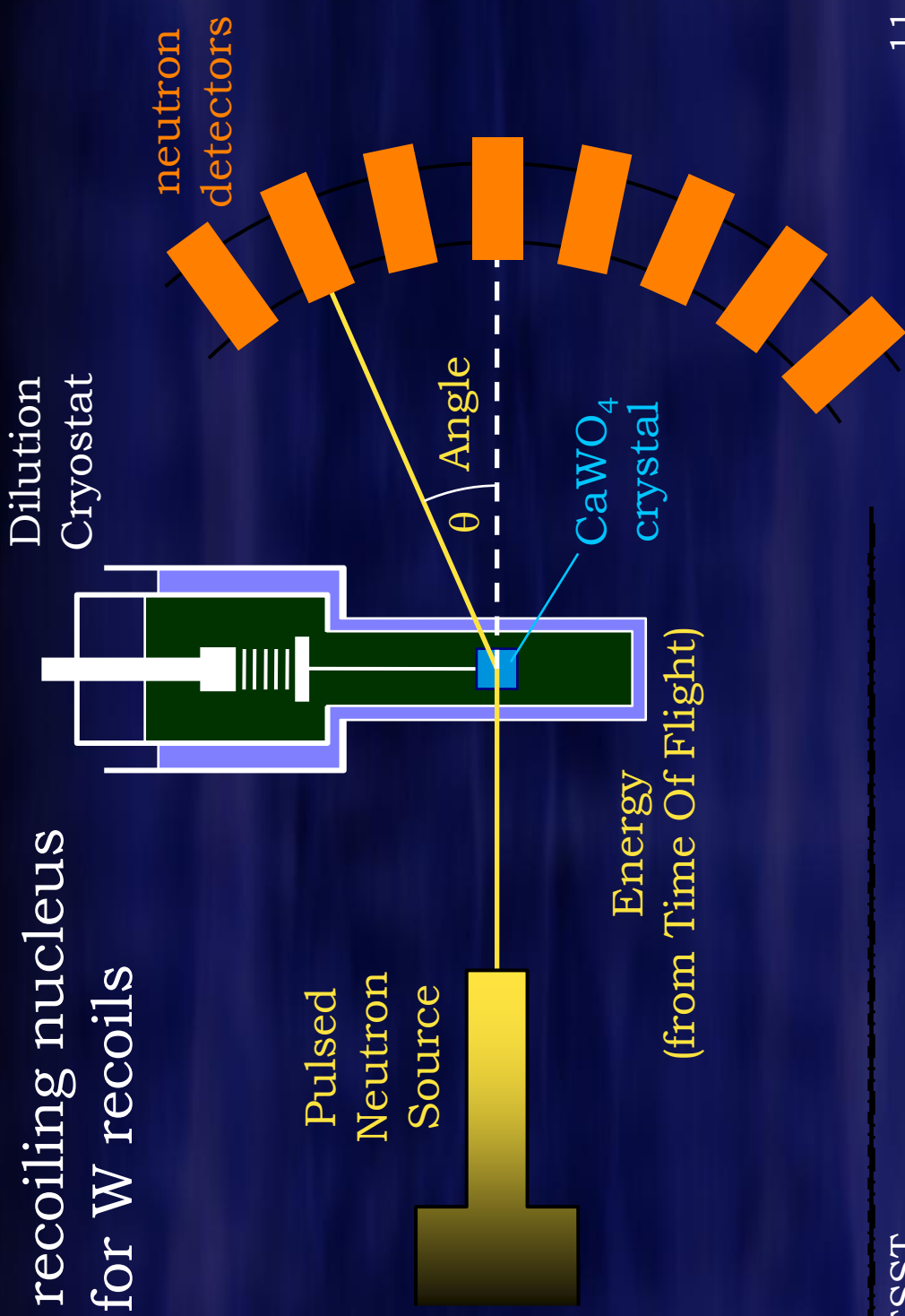
Lab Measurements at mK

Setup for cryogenic measurement:

Know kinematics

→ know recoiling nucleus

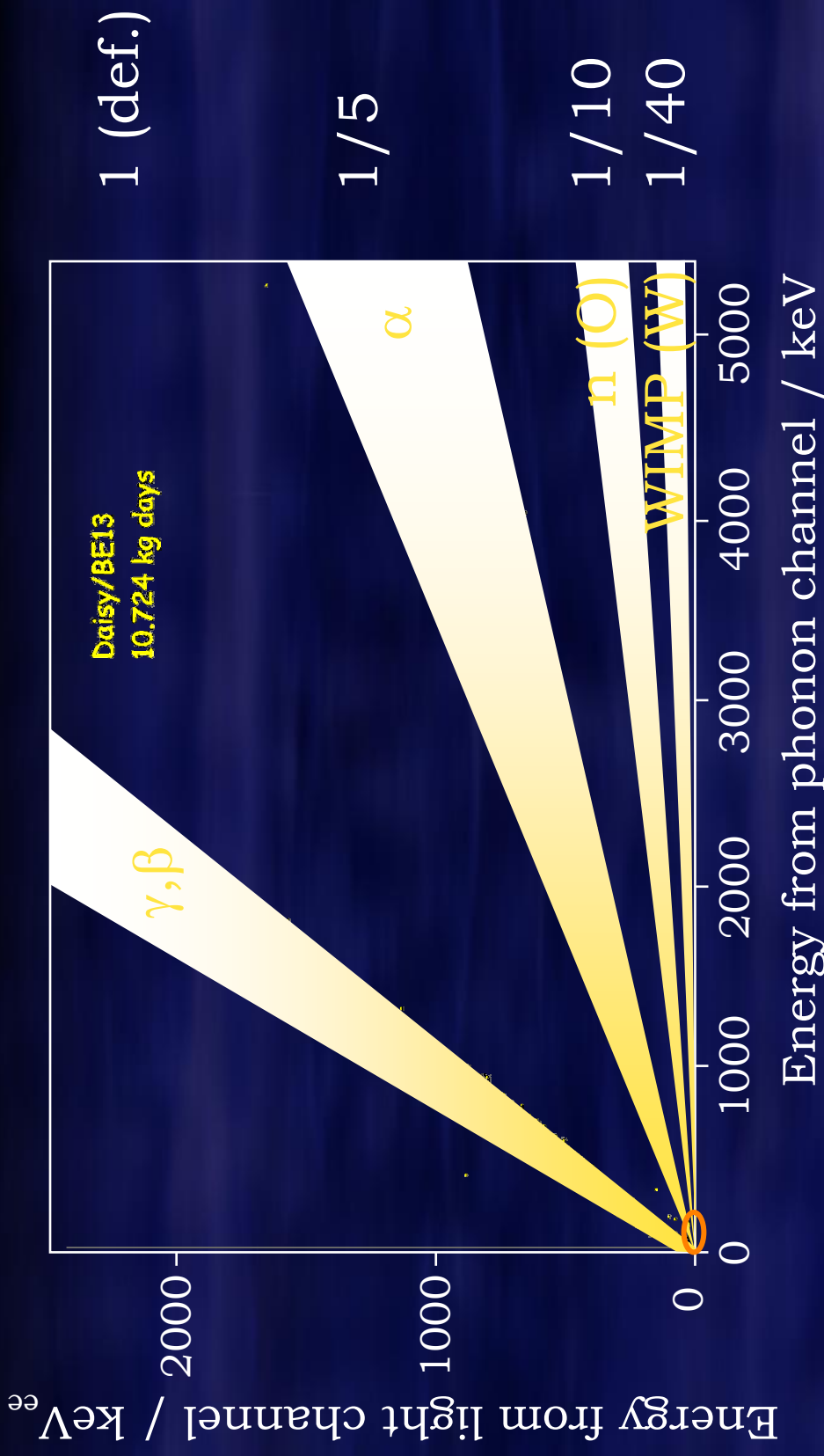
→ slope for W recoils



Signal Regions

Discrimination between Neutron and WIMPs!

Slope

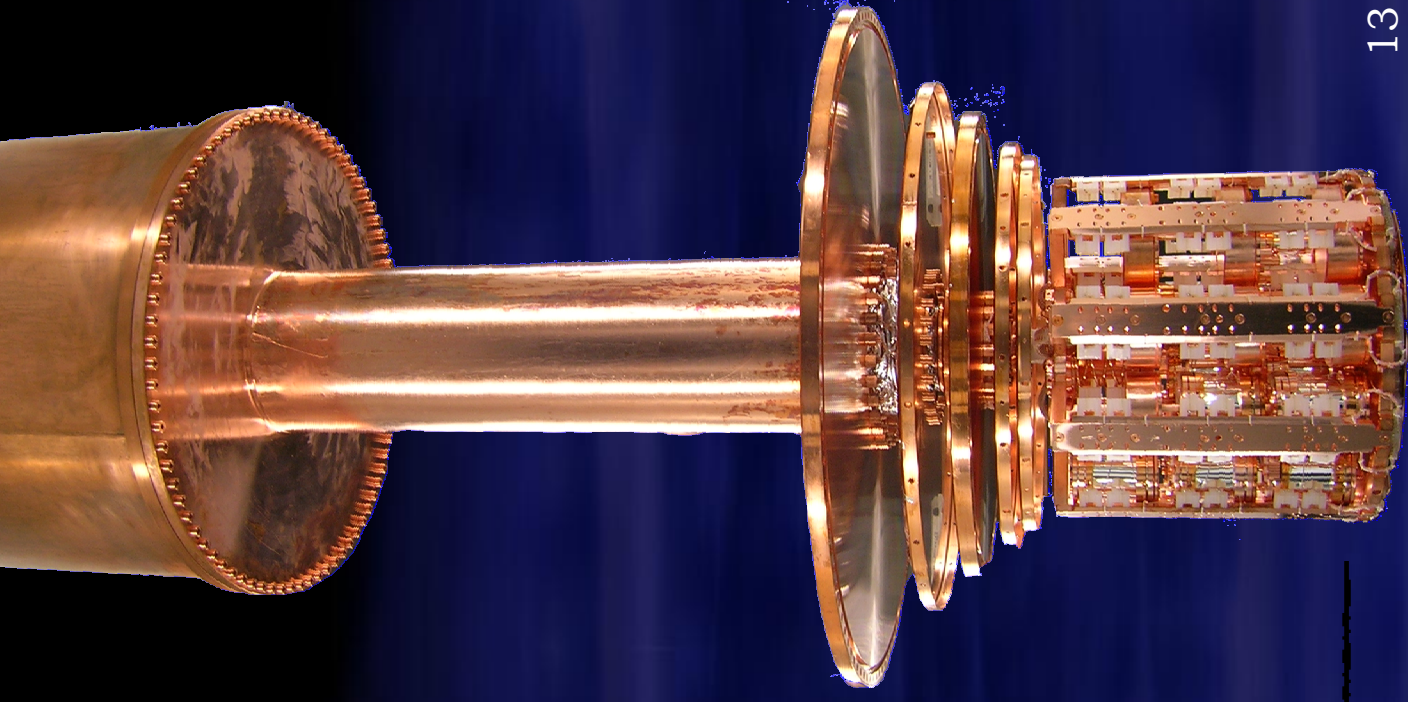


Data Taking 2007

After major upgrade

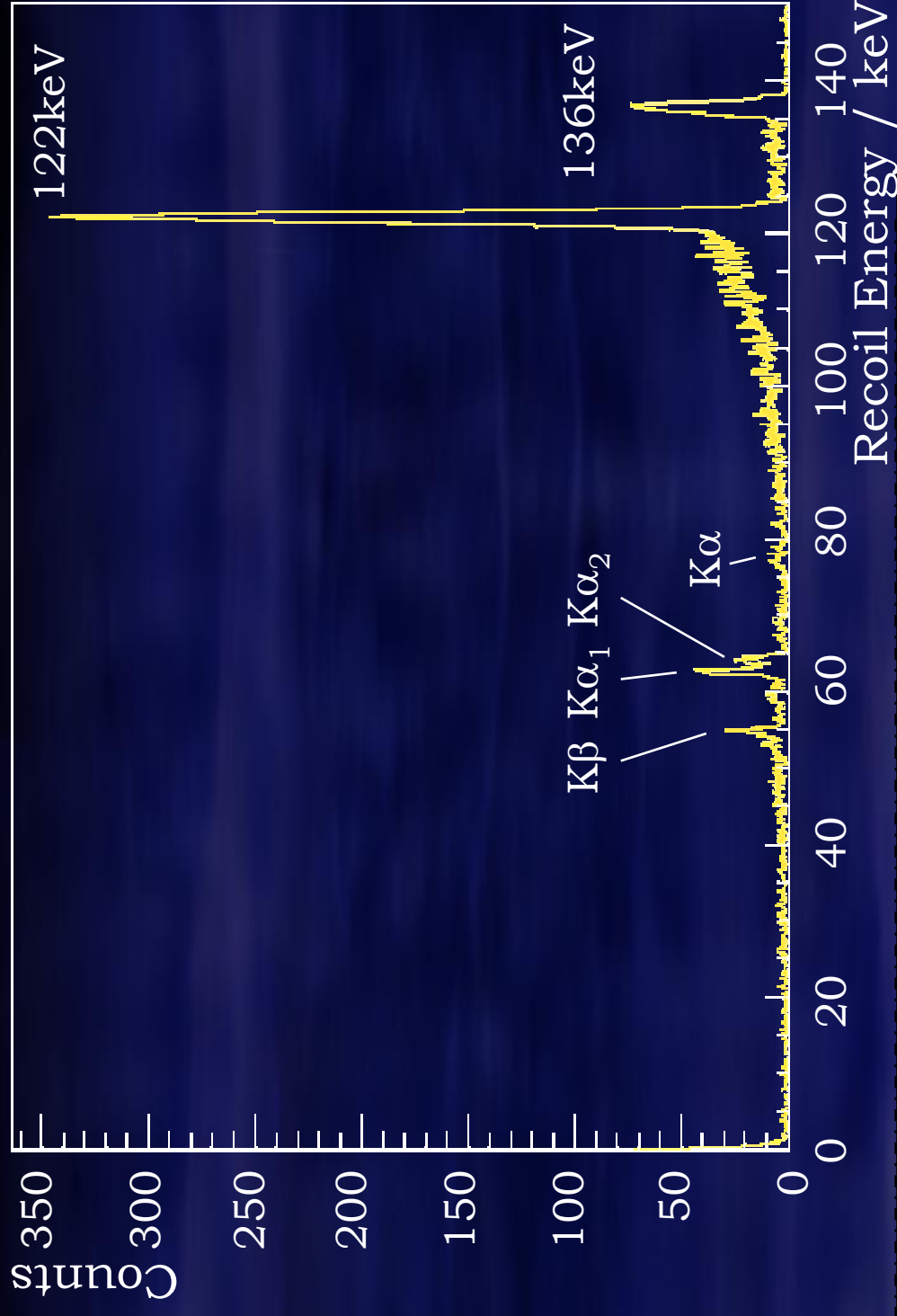
(new detectors, support structure, 66 channel SQUID system, DAQ, neutron shielding, muon veto, ...)

- 9 modules placed
- cryostat cooled down
- commissioning “Run 29”
- **Dark Matter “Run 30”**
with 2 modules
- ^{57}Co -calibrations
- Neutron-calibration



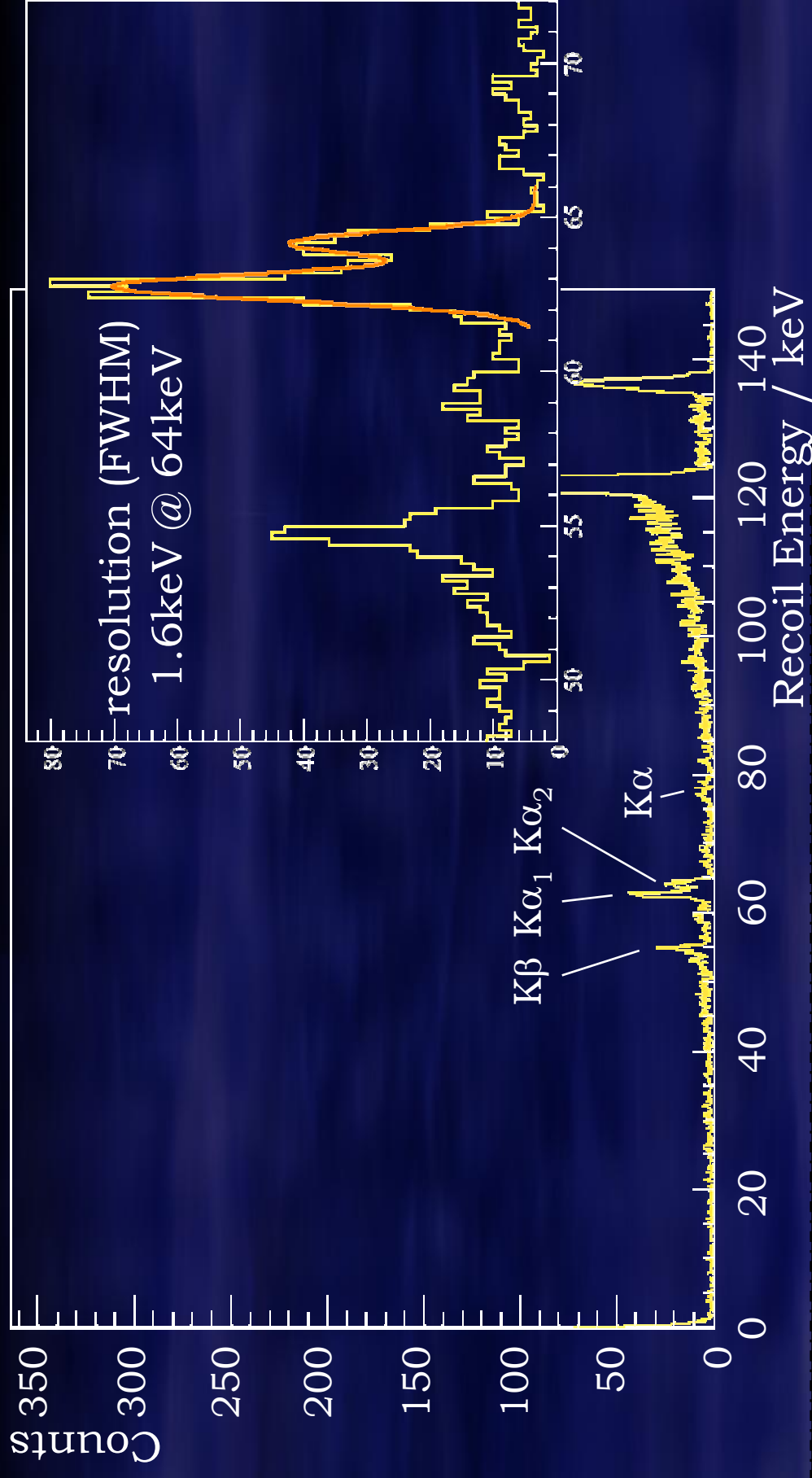
A Spectrum...

^{57}Co -Calibration of Phonon-Detector Verena

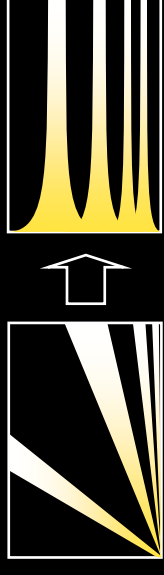


A Spectrum...

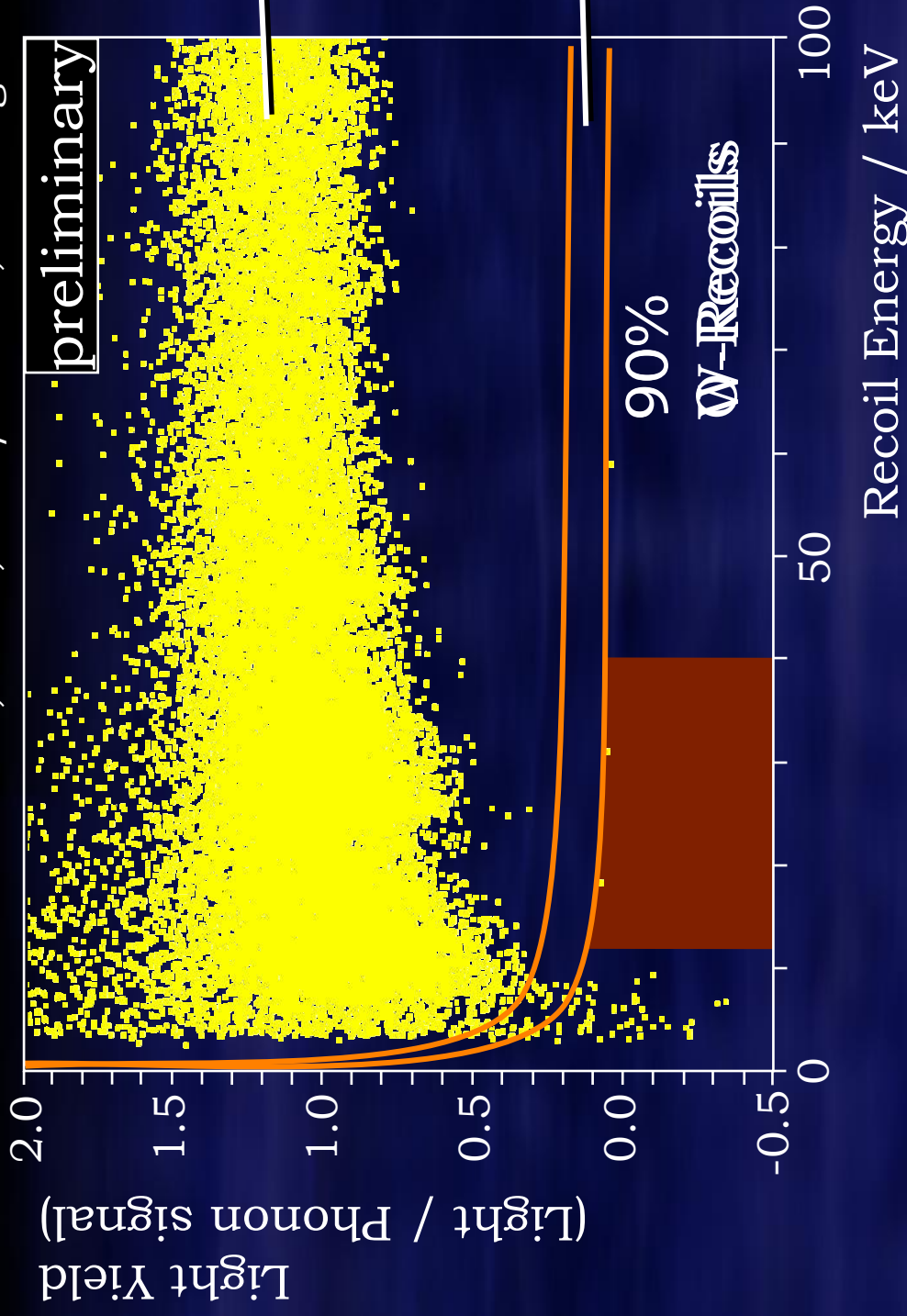
^{57}Co -Calibration of Phonon-Detector Verena



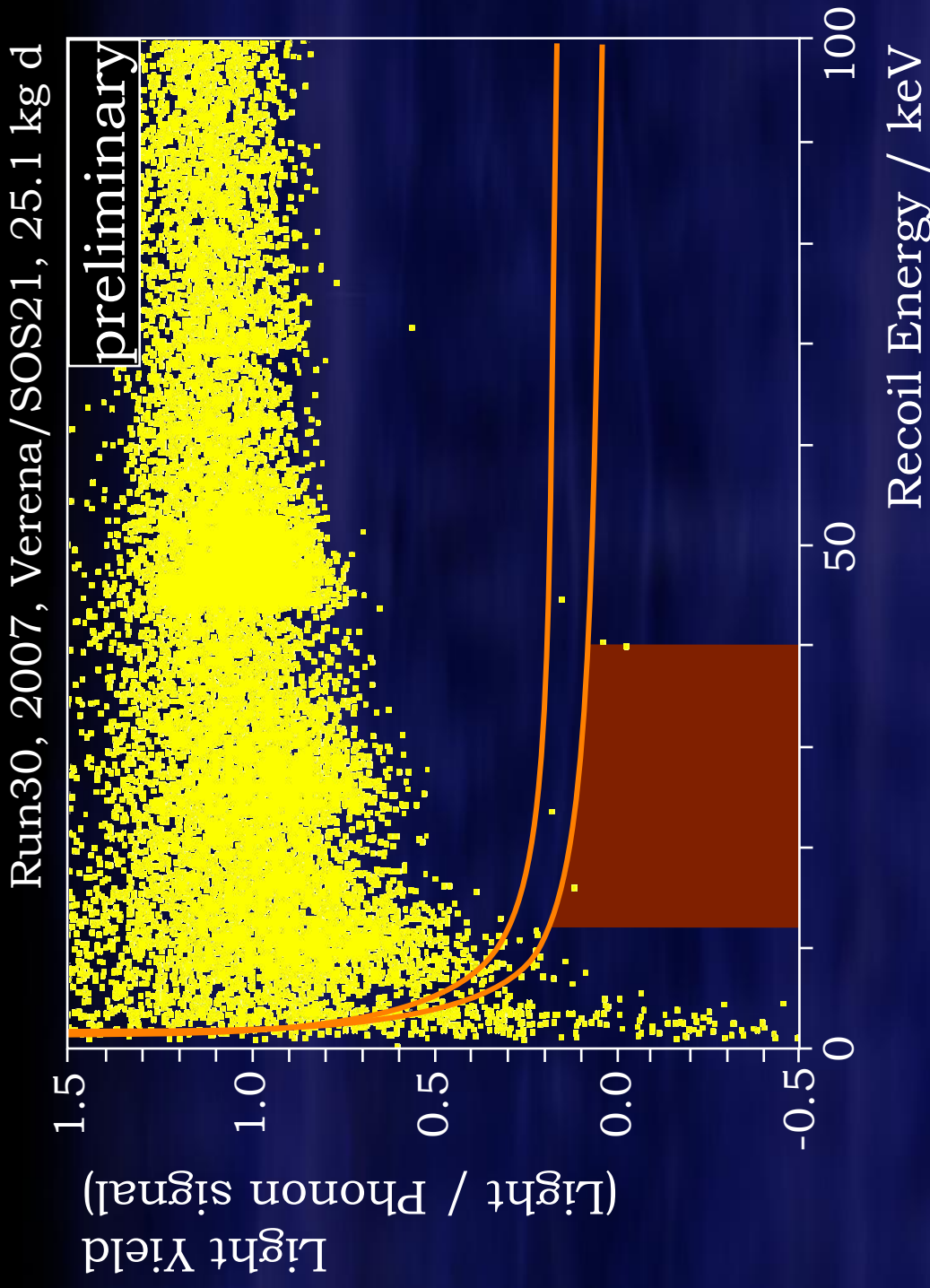
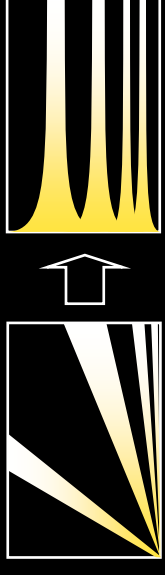
Acceptance Region



Run30, 2007, Zora/SOS23, 24.9 kg d



Acceptance Region



Limits...

