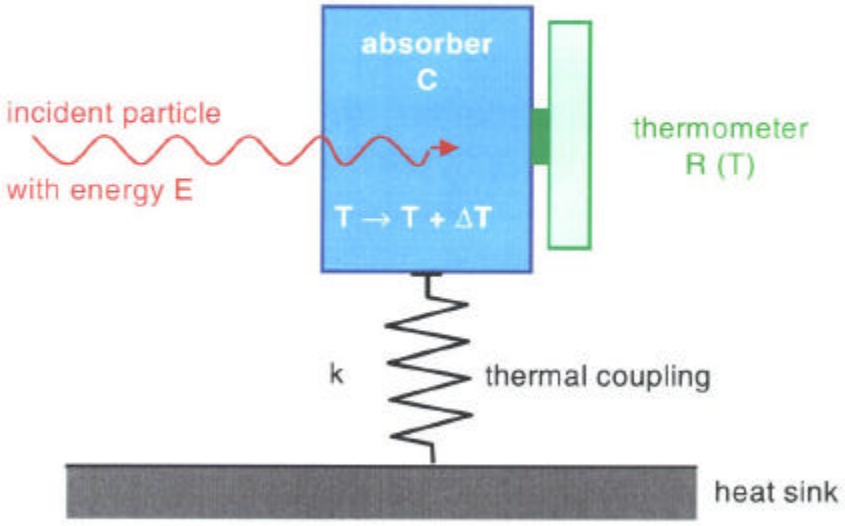
P. Egelhof

Calometric Low-Temperature Detectors for Superheavy Element Research

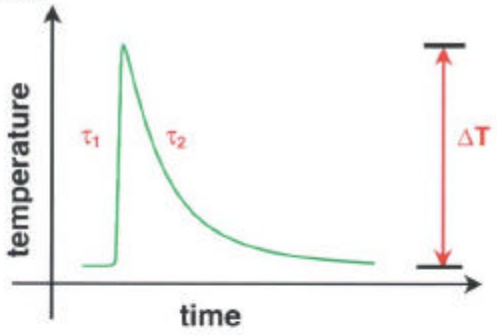
Discussion Contribution

Detection Principle and Properties of Calorimetric Low-Temperature Detectors

detection principle:



thermal signal:



amplitude:	$\Delta T = E/C$	(C = c • m = heat capacity)
rise time:	$\tau_1 \geq \tau_{therm}$	(≈ 1 – 10 µsec)
fall time:	$\tau_2 = C/k$	(≈ 100 µsec – 1 msec)

Detector Performance

- systematical investigations for:

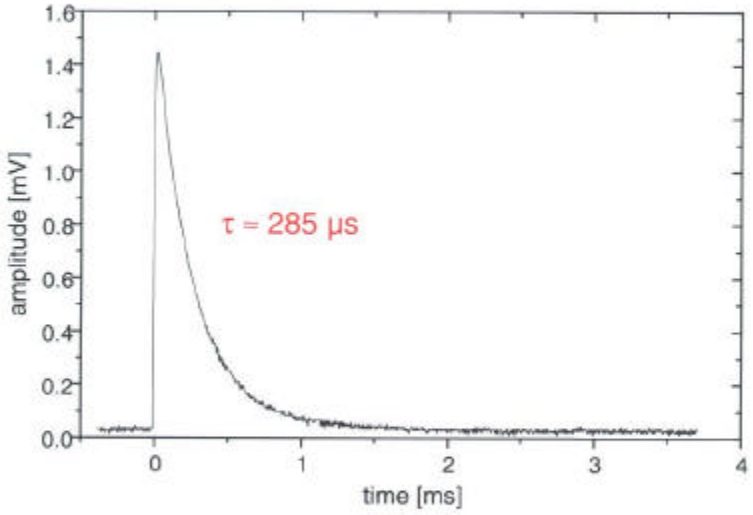
  many ion species: ^{20}Ne, ^{40}Ar, ^{58}Ni, ^{136}Xe, ^{209}Bi, ^{238}U
  large energy range: 3.6 – 360 MeV/u

- energy resolution: $\Delta E/E = 1.6 - 1.9 \cdot 10^{-3}$

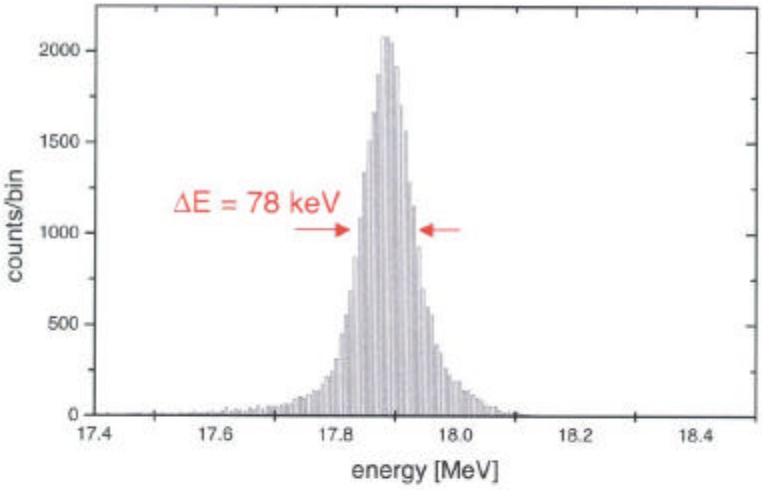
  independent of: detector type (sensitivity)
  detector volume (heat capacity)

Detector Performance

preamplifier signal: ^{238}U, E = 17.8 MeV ≙ 0.07 MeV/u



energy spectrum: ^{238}U, E = 17.8 MeV ≙ 0.07 MeV/u

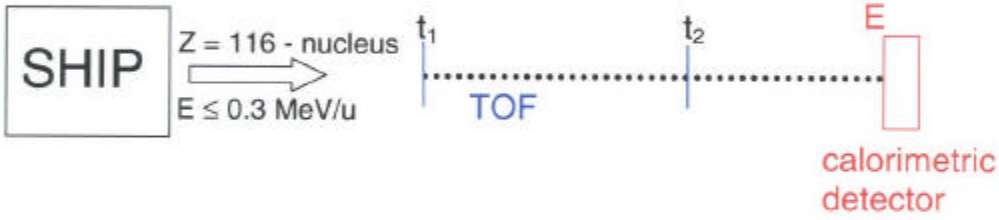


relative energy resolution: $\Delta E/E = 4.4 \cdot 10^{-3}$

Identification of Superheavy Elements

for $Z \geq 112$: decay chains do not feed a known α-chain

$\Rightarrow$ mass identification of the superheavy nucleus required



$$\left(\frac{\Delta m}{m}\right)^2 = 2\left(\frac{\Delta v}{v}\right)^2 + \left(\frac{\Delta E}{E}\right)^2$$

ultrathin ^{12}C-foils + channelplates

$$\frac{\Delta v}{v} \leq 1 \cdot 10^{-3}$$

(energy straggling in ^{12}C-foils negligible!)

calorimetric detector:

$$\frac{\Delta E}{E} \approx 2-3 \cdot 10^{-3}$$

(semiconductor detector: $\Delta E/E \geq 5 \cdot 10^{-2}$)

$$\frac{\Delta m}{m} \leq 3 \cdot 10^{-3}$$

for m = 300 $\Rightarrow \Delta m \leq 1$ amu

Design for a Detector Array

detector-layout:

96 pixels with F = 5 x 5 mm^2 each

active area:	3 x 8 cm^2
position resolution:	5 mm
α-resolution:	$\Delta E \leq 30$ keV
mass resolution:	$\Delta E/E \leq 3 \times 10^{-3} \Rightarrow \Delta m \leq 1$ amu
rate capability:	$\geq 300\ sec^{-1}$/pixel

design for a 10 pixel prototype detector: