Transition-edge-sensor microcalorimeters for mass spectrometric identification of neutral molecules


¹RIKEN, ²NIST, ³JAEA, ⁴TMU, ⁵Rikkyo Univ., ⁶Tohoku Univ., ⁷Lund Univ., ⁸JAXA

Abstract

To explore the quantum collision dynamics of the stored molecular ions by the merging experiments with a beam of the neutral atoms, we are developing a new technique of mass spectrometry for the neutral molecular fragments from the collisions using an array of TES microcalorimeters at a brand-new cryogenic electrostatic ion storage ring in RIKEN.

TES is operated at the superconducting critical temperature of less than 100 mK with radiation shield windows in front of the TES sensors (for each cooling stages) to avoid infrared background from heat radiation. Unlike x-rays, the low energy molecules (~10 keV) easily stop at these radiation shields even for 100-nm-thick aluminum sheet. One of key issue towards this application is how to operate TES system against the radiation background although our storage ring is at 4 K. We just started the study at RIKEN from this spring.

1. RICE-ring — Cryogenic electrostatic ion storage ring

2. Why cryogenic detector?

Why not Si detector?

- Range of 10 keV H on Silicon
- Stopping simulation

Why not MCP?

- Range is only ~ 130 nm even for 10 keV hydrogen
- Energy resolution is not enough

3. Setup with TES microcalorimeter

4. Radiation shield — X-ray vs. molecule

5. Shield effect @ 50 mK

6. Mesh at 50 mK (and 3 K) window