

# Development of a Dielectric Microcalorimeter with Quantum Ferroelectric Materials

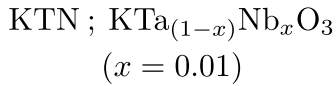
S. Yoshimoto<sup>1</sup>, K. Maehata<sup>1</sup>, N. Iyomoto<sup>1</sup>, K. Mitsuda<sup>2</sup>, N. Yamasaki<sup>2</sup>

1; Applied Quantum Physics and Nuclear Engineering, Kyushu University

2; Japan Aerospace Exploration Agency

## DIELECTRIC MICROCALORIMETER

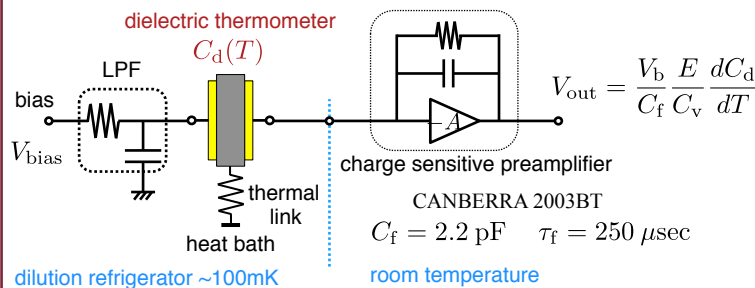
- “quantum ferroelectrics” dielectric constant has temperature dependence at cryogenic temperature



- use for thermometer and absorber
- several type of operating method are suggested
- has not demonstrated

energy absorption

- change in  $T$
- change in  $C_d$
- change in  $Q$
- change in  $v_{out}$

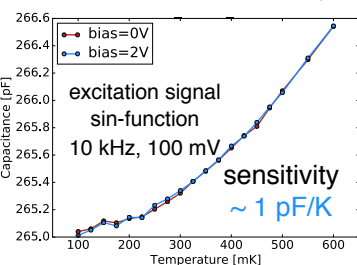
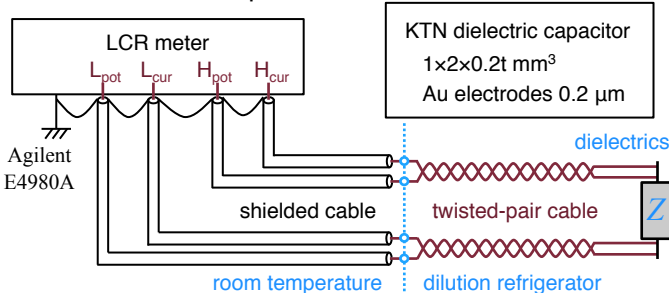


- read out by using charge sensitive preamplifier
  - simple electrical circuit
- appropriate to the multi-pixelated
  - without Joule heating and Johnson noise

**PURPOSE** demonstration of DMC using quantum ferroelectrics

## KTN THERMOSENSOR

- temperature dependence of electric capacity
- based on 4 terminal pair method
- high-potential or low-potential (same phase) side of voltage and current are coupled



peak at a temperature of 22 K corresponds to  $T_c$  of the quantum ferroelectric

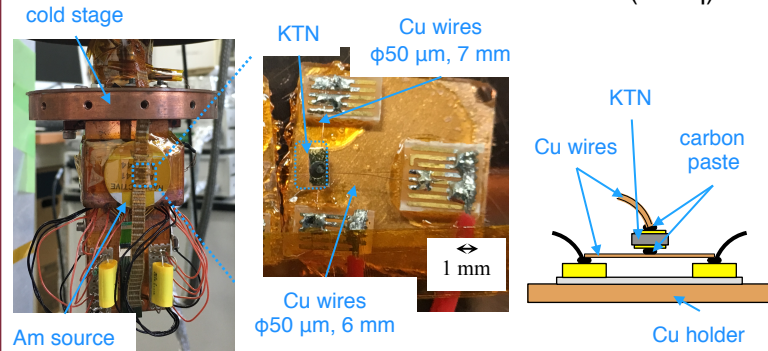
pulse height of 7 mV is estimated @  $E = 5.5 \text{ MeV}$   $V_{bias} = 1 \text{ V}$

available for the thermosensor of microcalorimeter

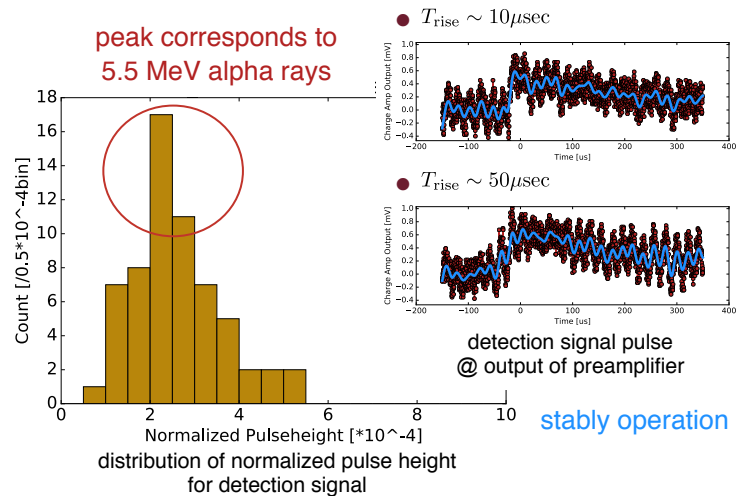
## DMC OPERATION

DMC with KTN dielectrics

- glued by conductive carbon paste
- connected by Cu wires ( $\phi 50 \mu\text{m}$ )
- operated at 100 mK using dilution refrigerator
- applied various bias voltage (-10 ~ +10 V)
- irradiated 5.5 MeV alpha ray emitted from Am source (1 kBq)



photograph and schematic diagram of prototype of DMC



- several forms of signal pulse caused by variability in incident position
- low count rate due to poor signal-to-noise ratio

**SUCCEED** to demonstrate DMC to obtain pulse height distribution for the first time

## FUTURE WORK

- improve signal-to-noise ratio
- make signal pulse height larger
    - reduction of thermosensor volume
  - make noise smaller
    - alternative method for readout
    - cooling preamplifier