



Microscopic Observation of Operating Ir/Au-TES Microcalorimeter by Low Temperature Scanning Synchrotron Microscopy

Yuichi Kunieda,^a Daiji Fukuda,^b Hiroyuki Takahashi,^c Masashi Ohno,^a Masaharu Nakazawa,^a Masataka Ohkubo,^b Fuminori Hirayama,^b Masaki Koike,^b

*^aDepartment of Quantum Engineering and Systems and Science,
The University of Tokyo, Japan*

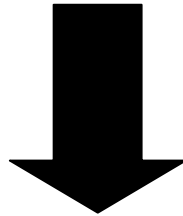
*^bNational Institute of Advanced Industrial Science and
Technology (AIST), Japan*

*^cResearch into Artifacts, Center for Engineering (RACE), The
University of Tokyo, Japan*



Our goal

Development of Ir/Au bilayer TES for microanalysis and astronomical applications.



Energy Resolution (a few eV for 5.9keV)

Count rate (1kcps)

Pixel Array (10×10)



Why is Ir/Au-TES used ?

Long-term stability of device

→ Ir,Au:chemical stability

Sufficient thermal conductivity in TES

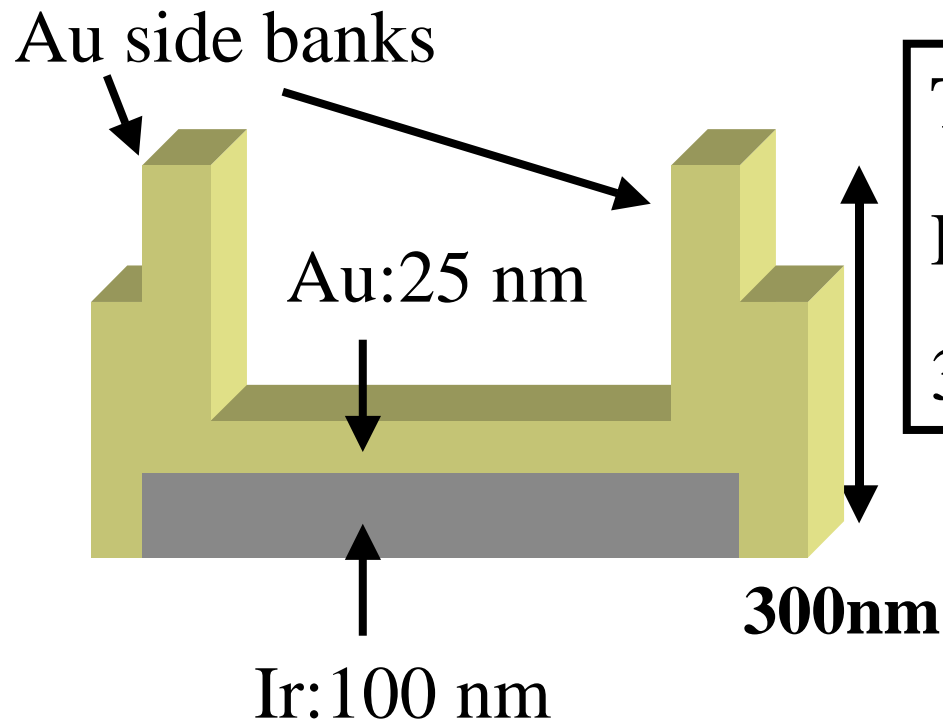
Ir-TES

→ Phase separation (S/N) by poor thermal conductivity of Ir

→ ΔE limited by nonuniformity of signal shape

Au:High thermal conductivity

A fabricated Ir/Au-TES



TES $200 \times 200 \mu\text{m}^2$
Ir: 100 nm, Au: 25 nm
300 nm Au side banks

$T_c = 110 \text{ mK}$ $R_n = 0.15 \ \Omega$ $\alpha = d \log R / d \log T \sim 300$

are obtained by R-T curve



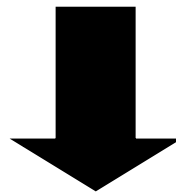
Purpose of this research

Inside of operating TES

→ Phase separation exists or not ?

Complicated intermediate states

a low temperature scanning synchrotron microscopy
(LTSSM) technique

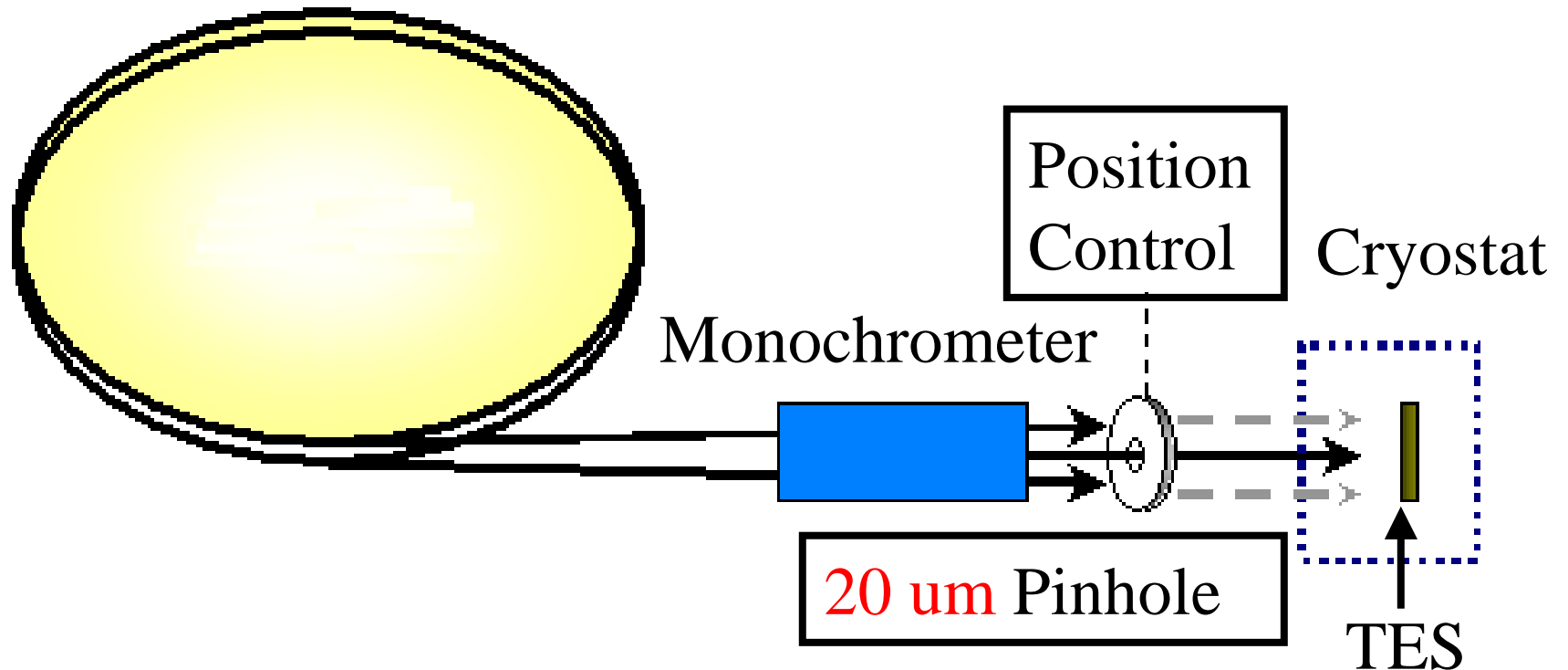


Microscopic observation of actually operating
TES signal response in terms of bias condition.

Experiment

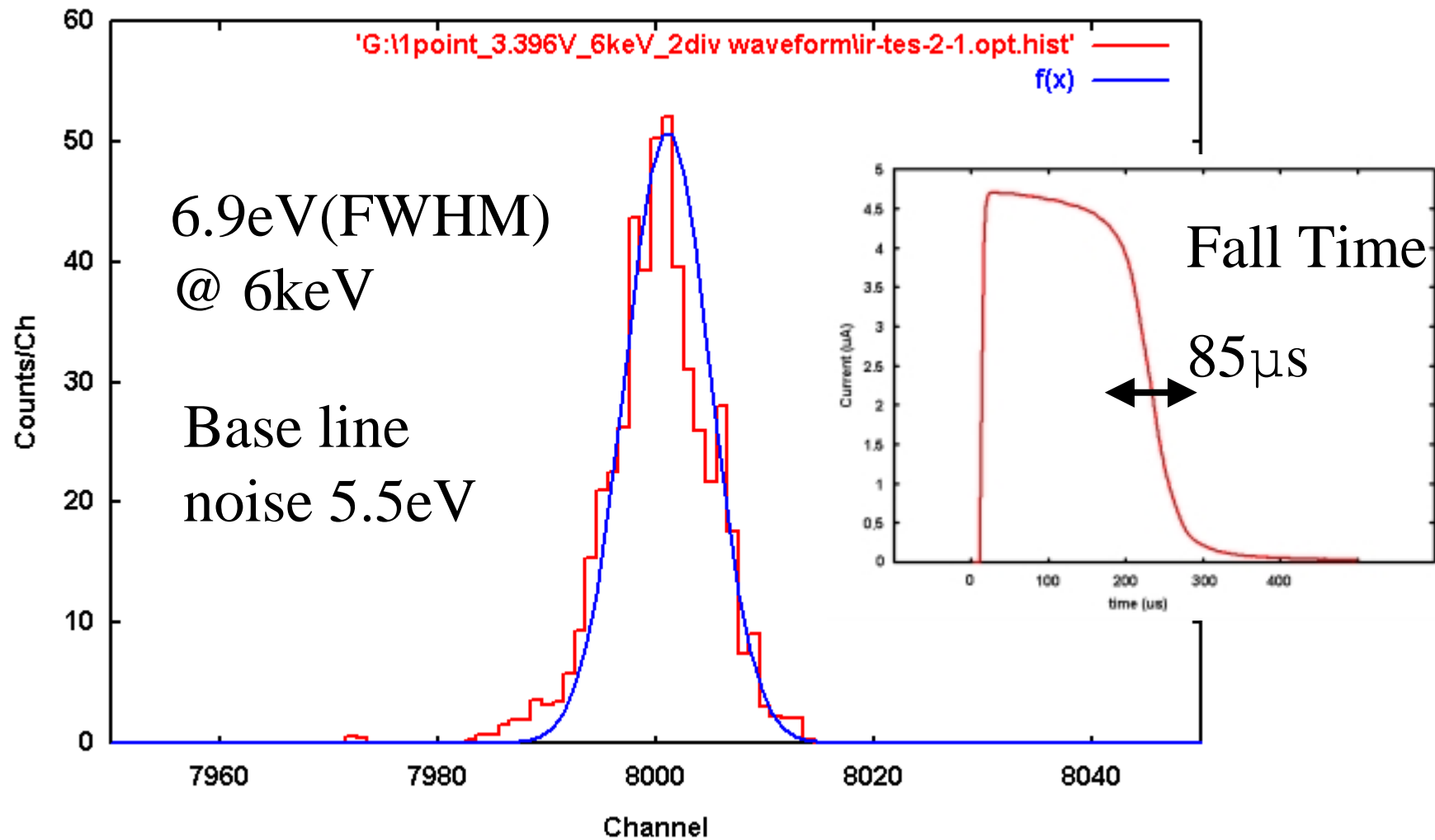
Synchrotron Radiation

Energy : **6keV**



Two-dimensional signal response profiles were obtained.

Performance of the device



Analysis of data

Joule Power

$$P_{Joule} = \frac{2\beta}{1+\beta} V \int \Delta I dt,$$

β : Bias parameter

$$= (R-R_s)/(R+R_s)$$

R : Resistance of TES

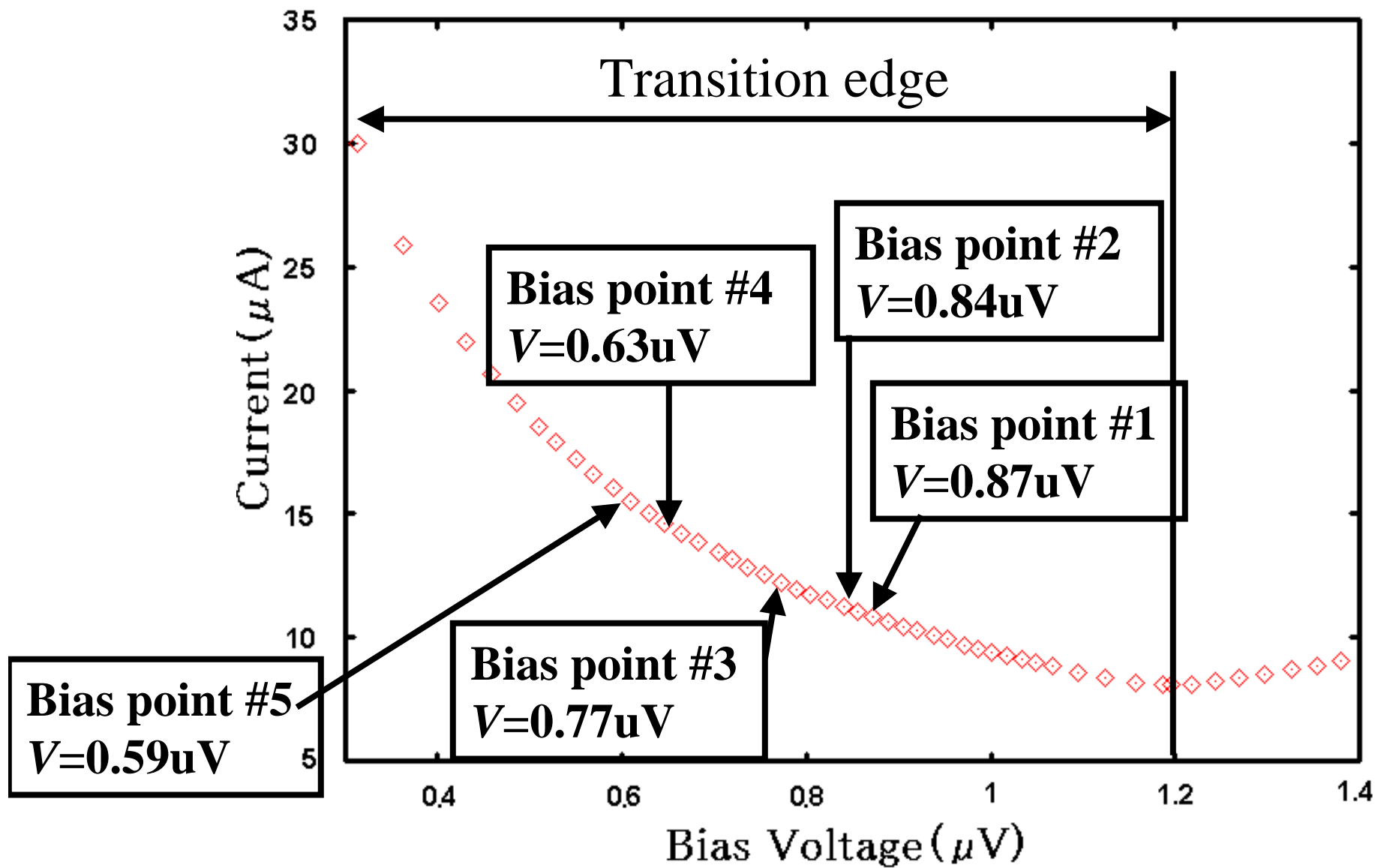
R_s : Shunt resistance

V : Bias voltage

ΔI : The change of current

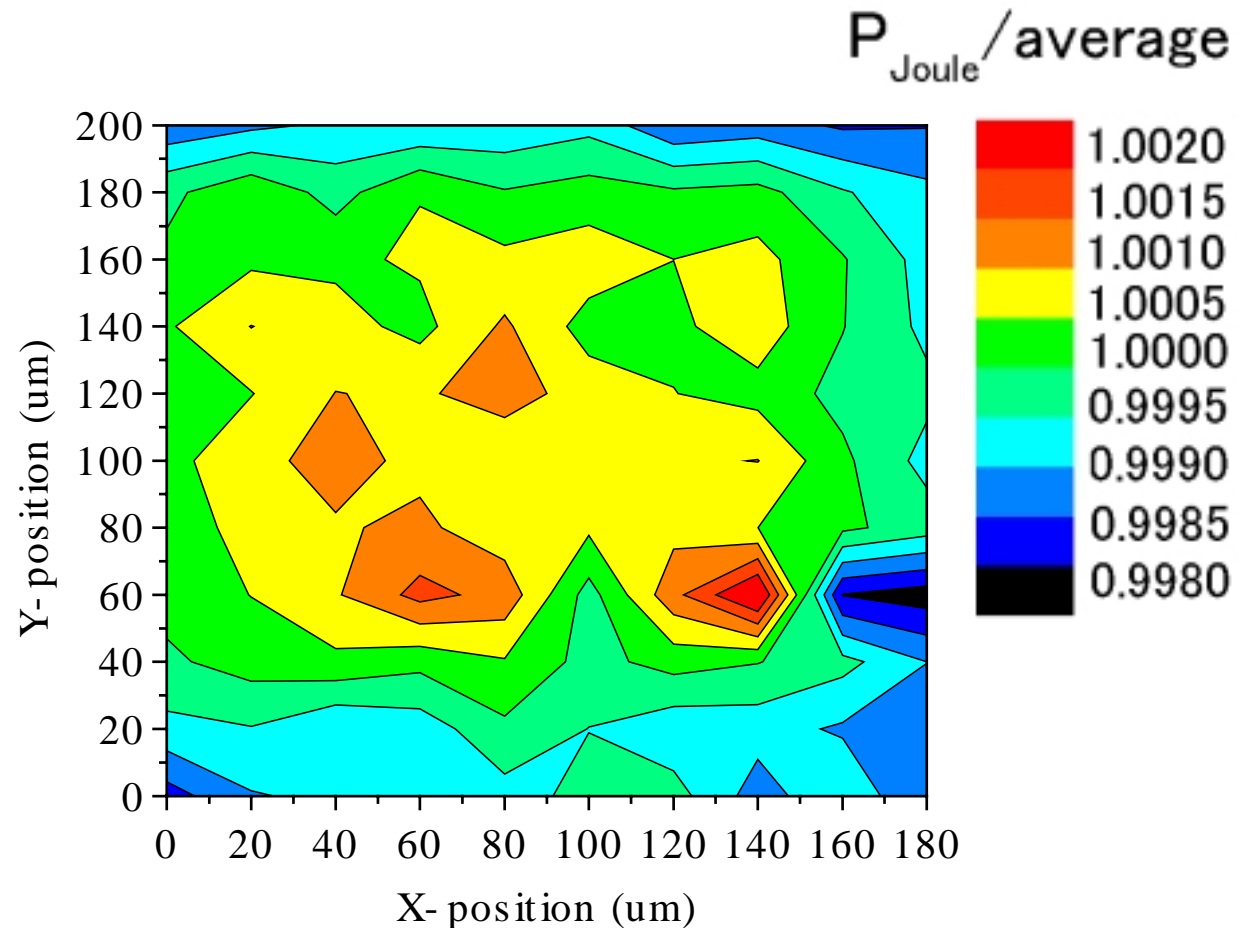
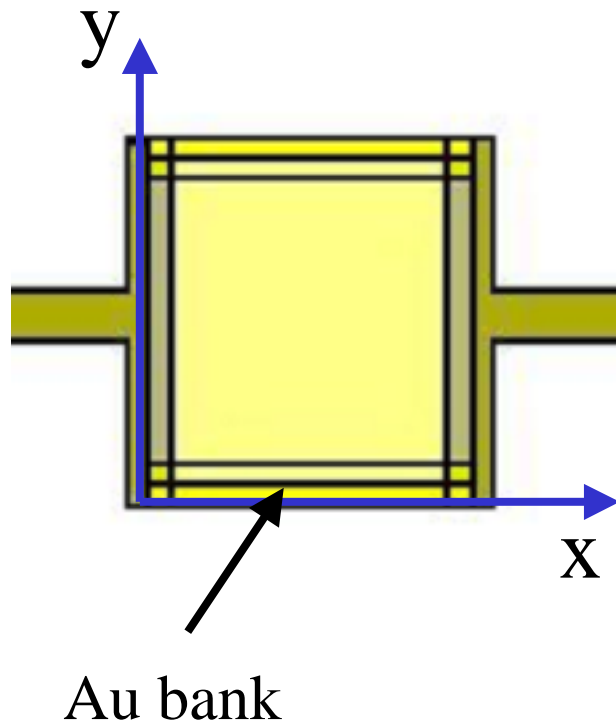
Spatial distributions of signal responses for individual positions are obtained at several bias voltage

Bias point



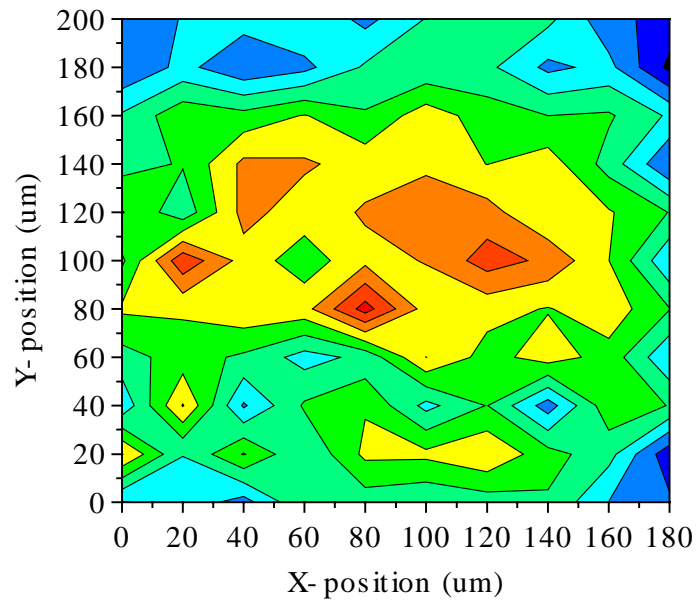
The result of two-dimensional scanning profile

Bias #1

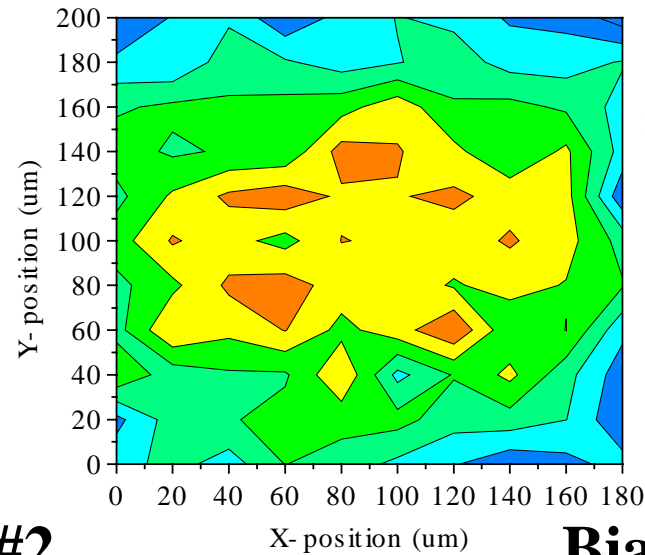


The variation of signal responses (about 5 to 6 eV)

The results of other bias points

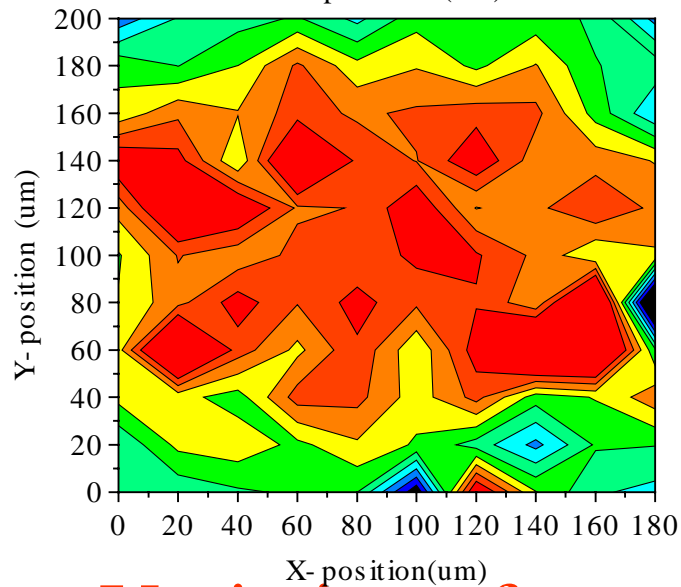
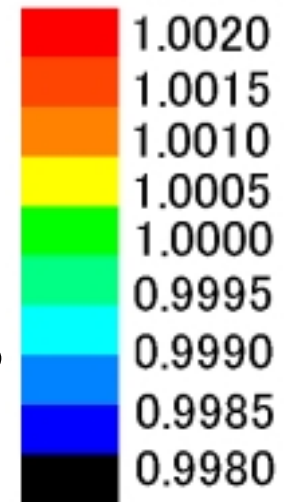


Bias #2

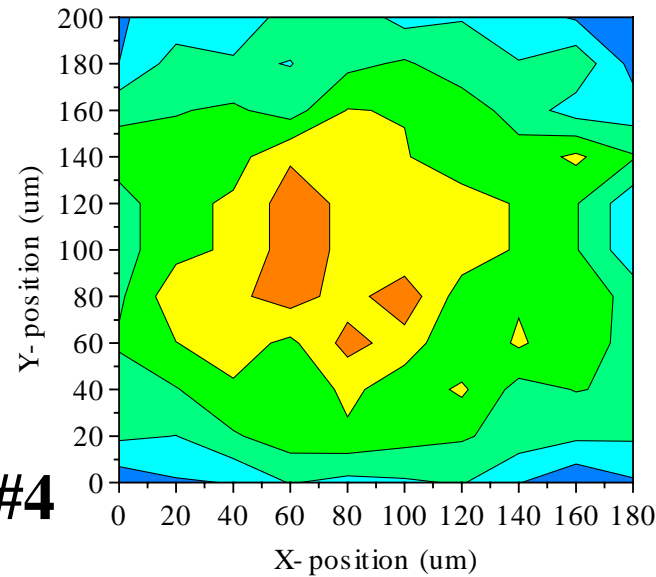


Bias #3

$P_{\text{Joule}}/\text{average}$



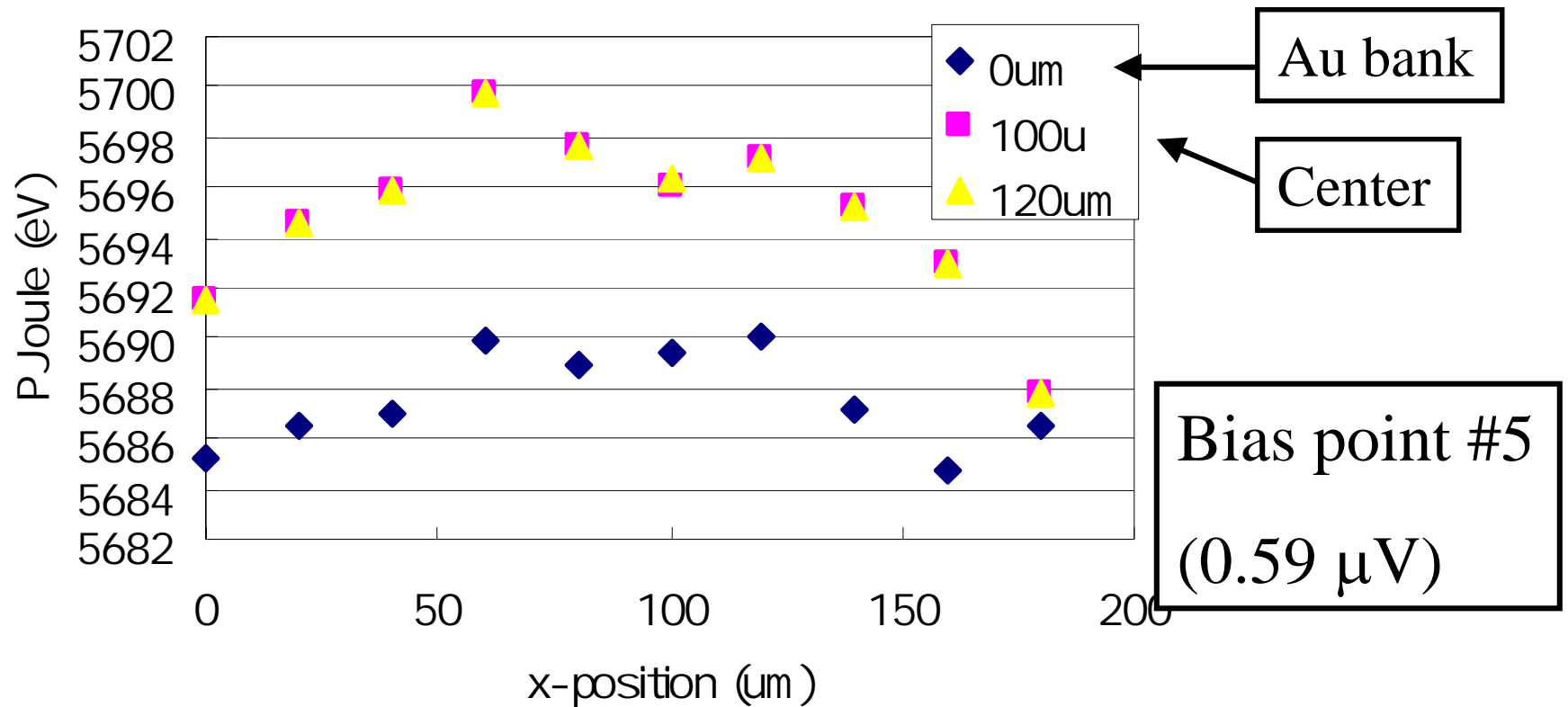
Bias #4



Bias #5

Variation of responses change with bias voltage

The result of one-dimensional scanning profile



Bank responses are ~ 10 eV less than the average



Conclusion

□ Microscopic observation of operating an Ir/Au-
TES microcalorimeter by using LTSSM technique.

X-ray signal responses vary slightly at each
position in TES, and change with bias voltage.

□ Bank responses are smaller than that of TES. →

Reduction of bank responses

ex) large effective area of TES, narrow bank width