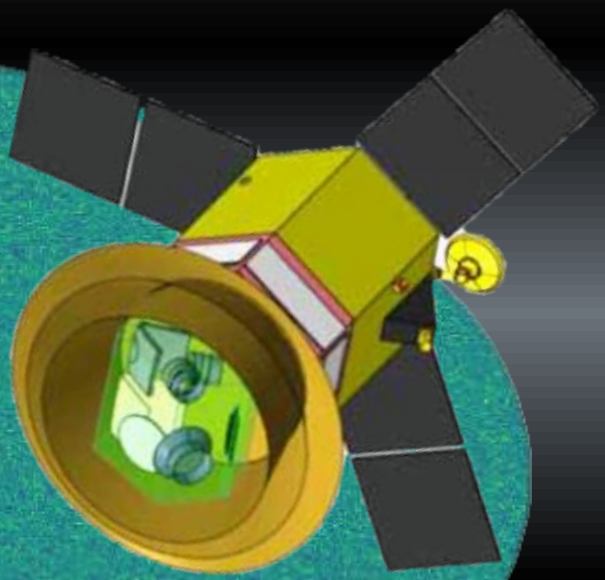
Development of superconducting detectors



Yuto Minami

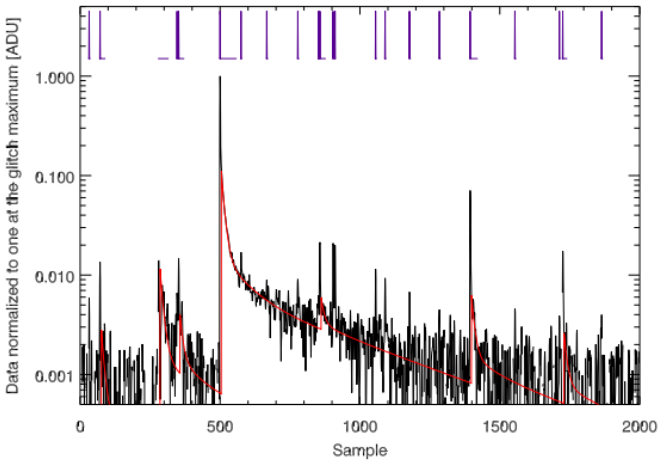
B01 and
公募研究「宇宙初期の加速膨張を検証可能にする革新的な超伝導検出器の開発」１８Ｈ０４３６１
Why does the Universe accelerate?-Exhaustive study and challenge for the future, MAR2019

A problem in space (Sun-Earth Lagrange point 2)

Satellite-borne missions concern cosmic-ray effects unlike the grand-based CMB experiments

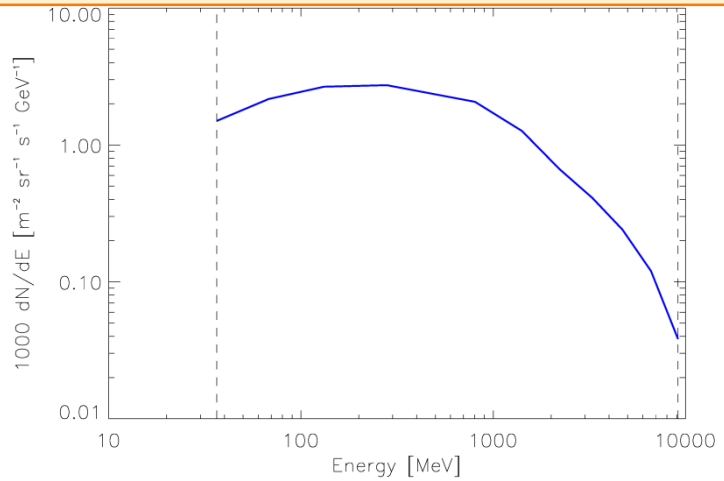
Experience from Planck

- They lost some amount of data because of cosmic-ray hits on their detectors
  - Glitch signals in the timestream of detector read-out
- Planck group estimated the glitch is created from ballistic phonons and thermal diffusion from the deposited energy by a cosmic-ray



Glitch event and fitted templates

arXiv:1101.2048v2 [astro-ph.CO]

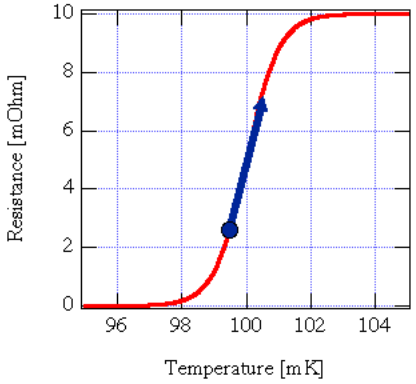


Proton flux at L2

arXiv:1403.6592 [astro-ph.IM]

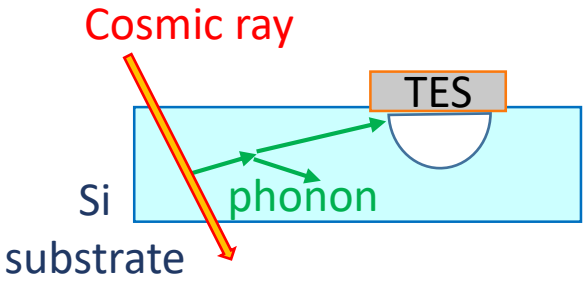
How to block ballistic phonons?

TES bolometers are used in the LiteBIRD satellite



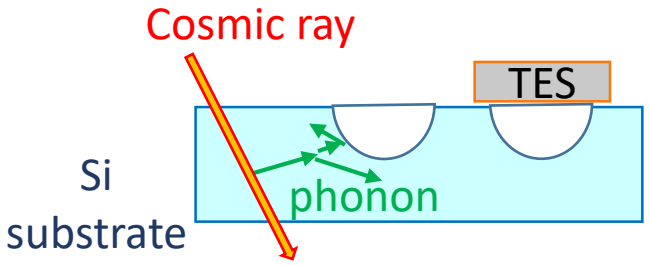
http://web.mit.edu/figueroagroup/ucal/ucal_tes/

- TES(Transition Edge Sensor)
- Sensitive detector which utilize a transition edge Works in ~100 mK environment

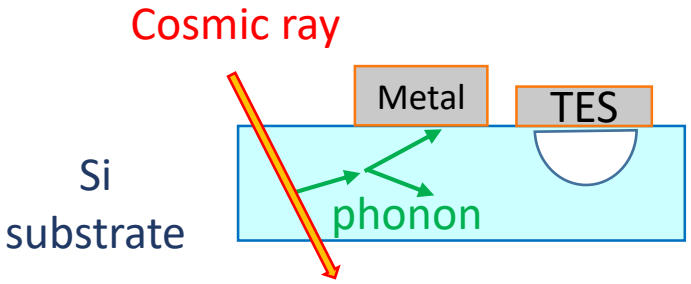


Our idea to reduce ballistic phonon propagation

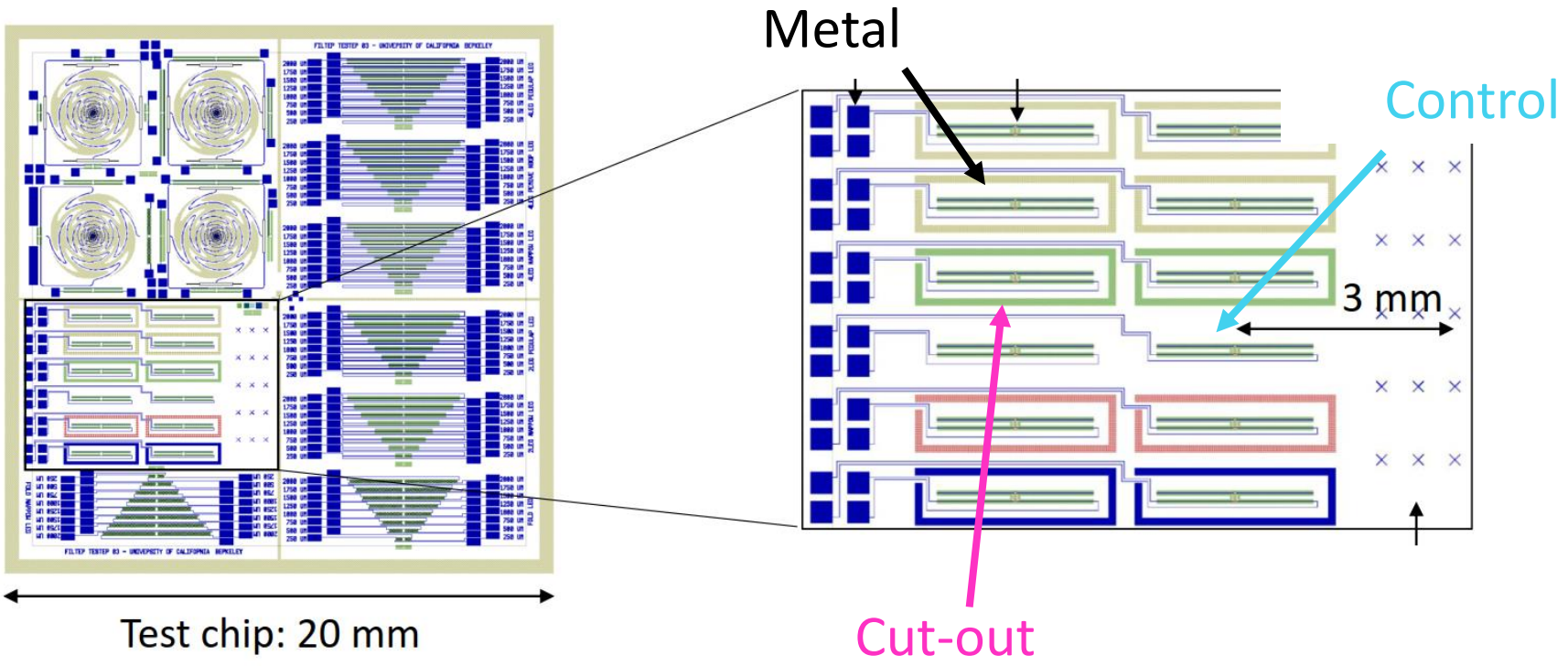
- Cut out in a Si substrate

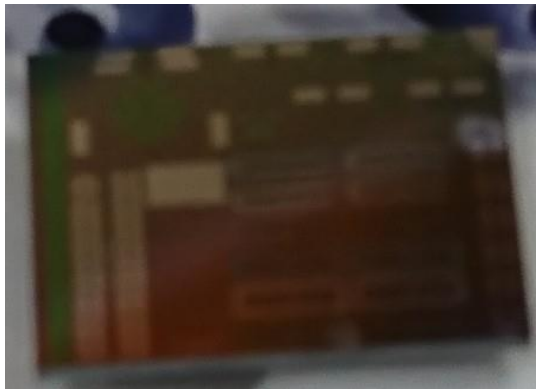


- Absorb by adding a metal



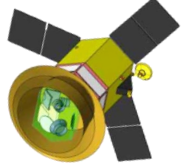
Test Chip: Developed in Berkeley



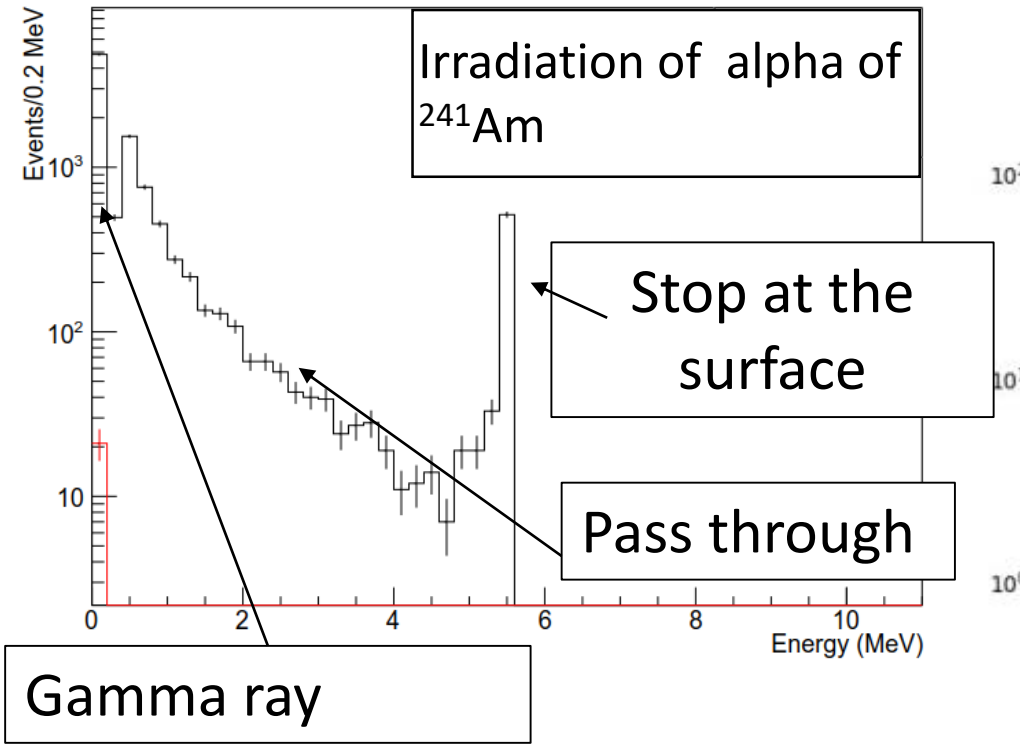


- Berkeley Lab member developed a test chip
- We are making an irradiation tests to see the performance of these ideas

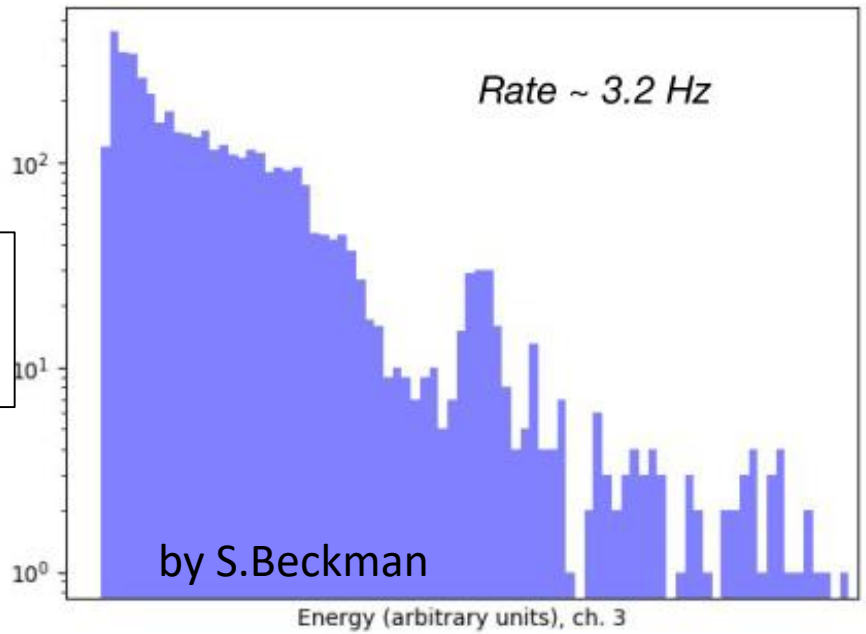
Results in Berkeley lab test



Simulation with Geant4



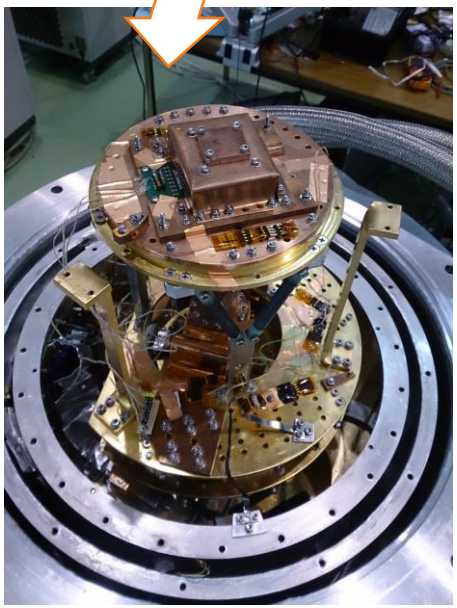
Data

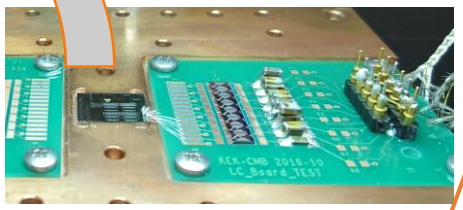


- Absolute value of TES read-out is not calibrated
- Relative shape of energy deposit is consistent with a simulation of ^{241}Am irradiation

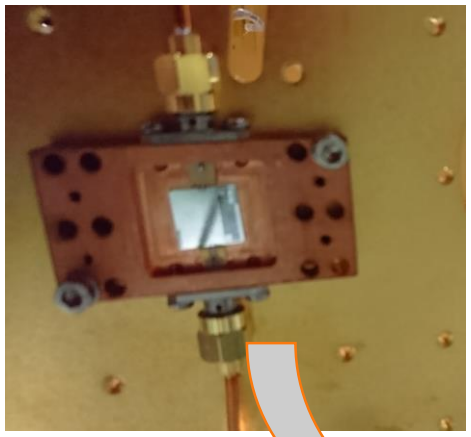
  Next step: Collimation of irradiation points and the evaluation of phonon propagation

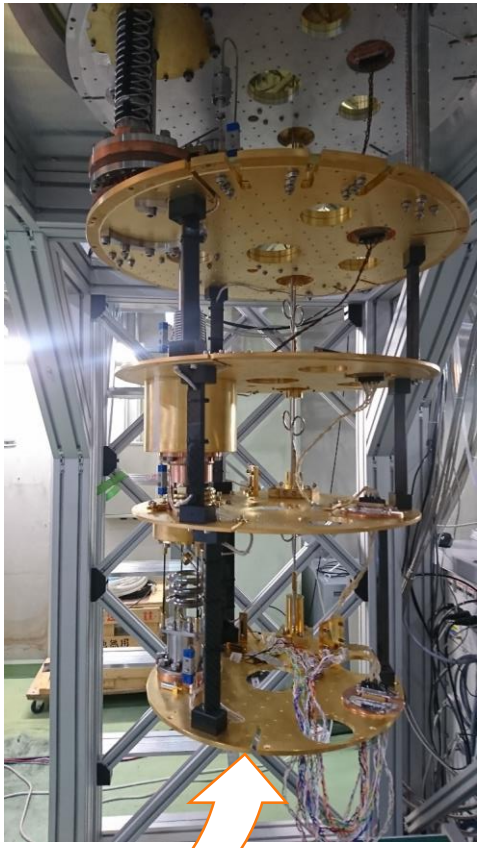
In KEK : Irradiation tests with two types of detectors are made





TES bolometer @ 250 mK



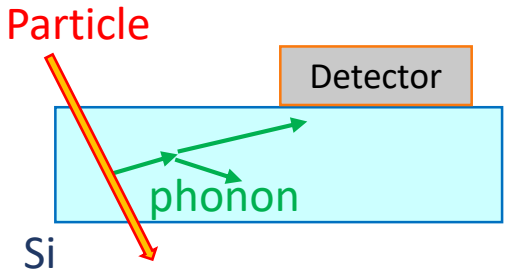


KIDs @ 100 mK

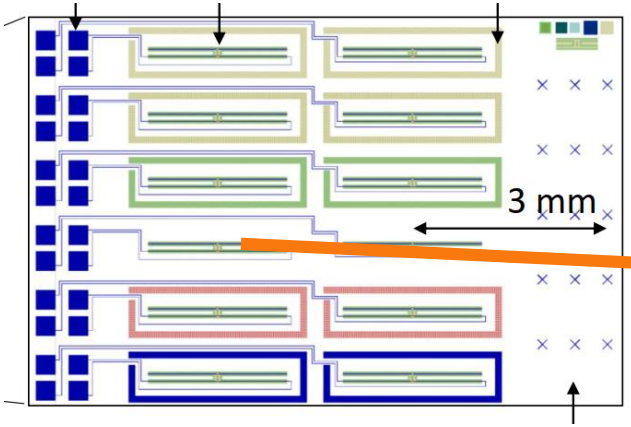
First data of irradiation tests in KEK

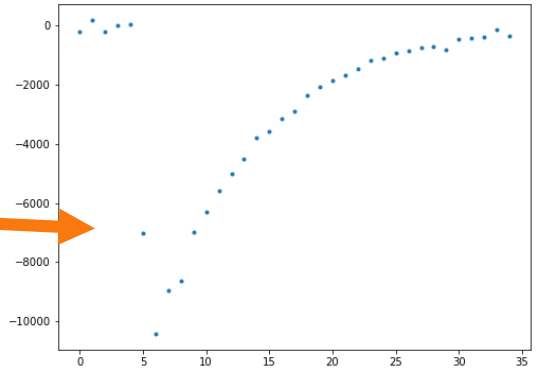
Irradiate α from ^{241}Am

We see nice pulses of particles

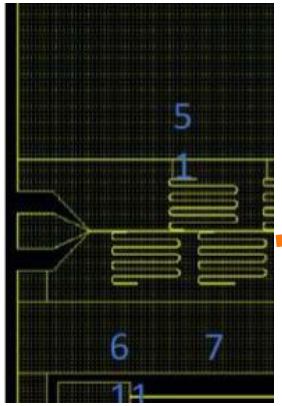


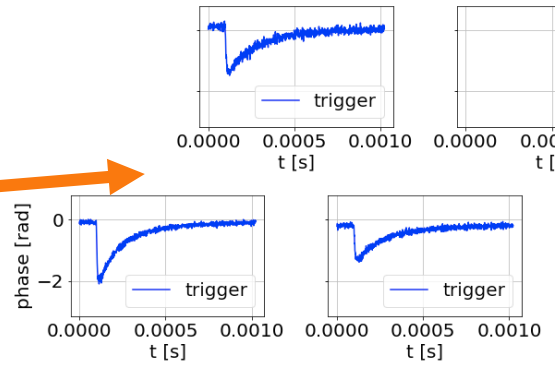
TES test chip



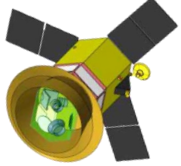


Aluminium KID





Summary



- We prepared a test chip of TES bloomer with new ideas
- Results of irradiation test at Berkeley lab shows consistent behaviour to my simulation

- In KEK, we have two ways to see the effects of particles
  - TES and KID
- At the first test at KEK, we see nice signal of particles with both TES and KIDs