



AC-LGAD and EICROC activities by EIC-JAPAN

Satoshi Yano

Hiroshima University SKCM²

eRD112 meeting

09/26/2023



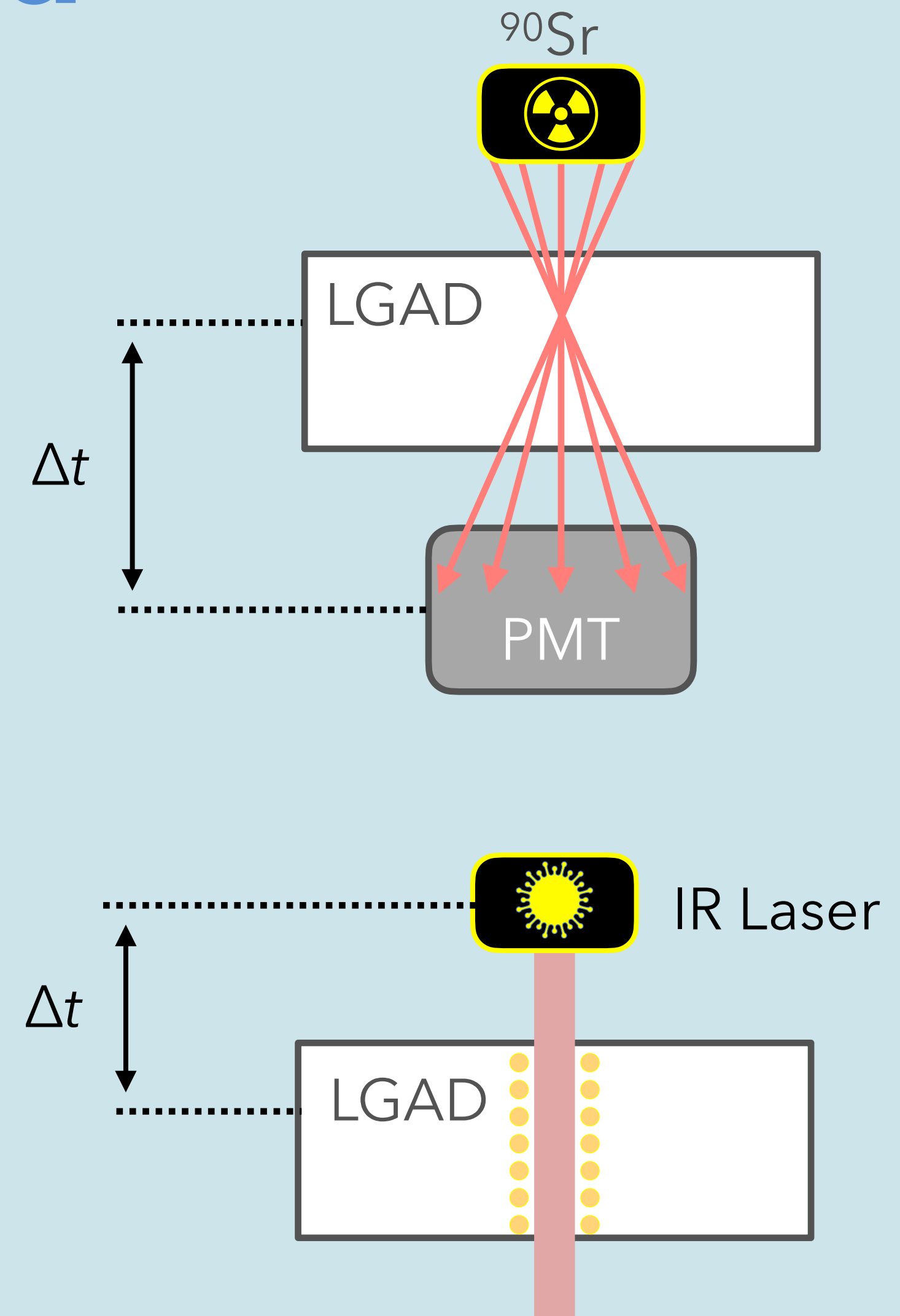
Strategy of the EIC-Japan Collaboration for ePIC-TOF

- EIC-Japan member in ePIC-TOF
 - Hiroshima University & Shinshu University: sensor, sensor-ASIC integration, module assembly
 - RIKEN & Nara Woman University: module assembly
 - University of Tokyo: streaming readout
- The sensor and ASIC R&D lab is being built at Hiroshima University
 - It is almost ready to start the R&D with the radiation source (^{90}Sr)
 - We will receive EICROC0 this week
- Coming activities
 - Oct 2023: EICROC0 R&D (without AC-LGAD) & AC-LGAD R&D
 - Nov 2023: EICROC0 + AC-LGAD R&D

AC-LGAD R&D activity

AC-LGAD R&D method

- Radiation source (^{90}Sr $O(1)$ MeV)
 - Pros: realistic S/N, easy setup, control temperature
 - Cons: worse timing resolution due to the path length fluctuation
- IR laser
 - Pros: control injection position, easy setup
 - Cons: not realistic S/N due to lack of Landau fluctuation (better timing resolution), not accessible under the readout metal
- Beam ($O(1-100)$ GeV/c)
 - Pros: realistic S/N, control inject position with additional telescopes
 - Cons: not easy setup

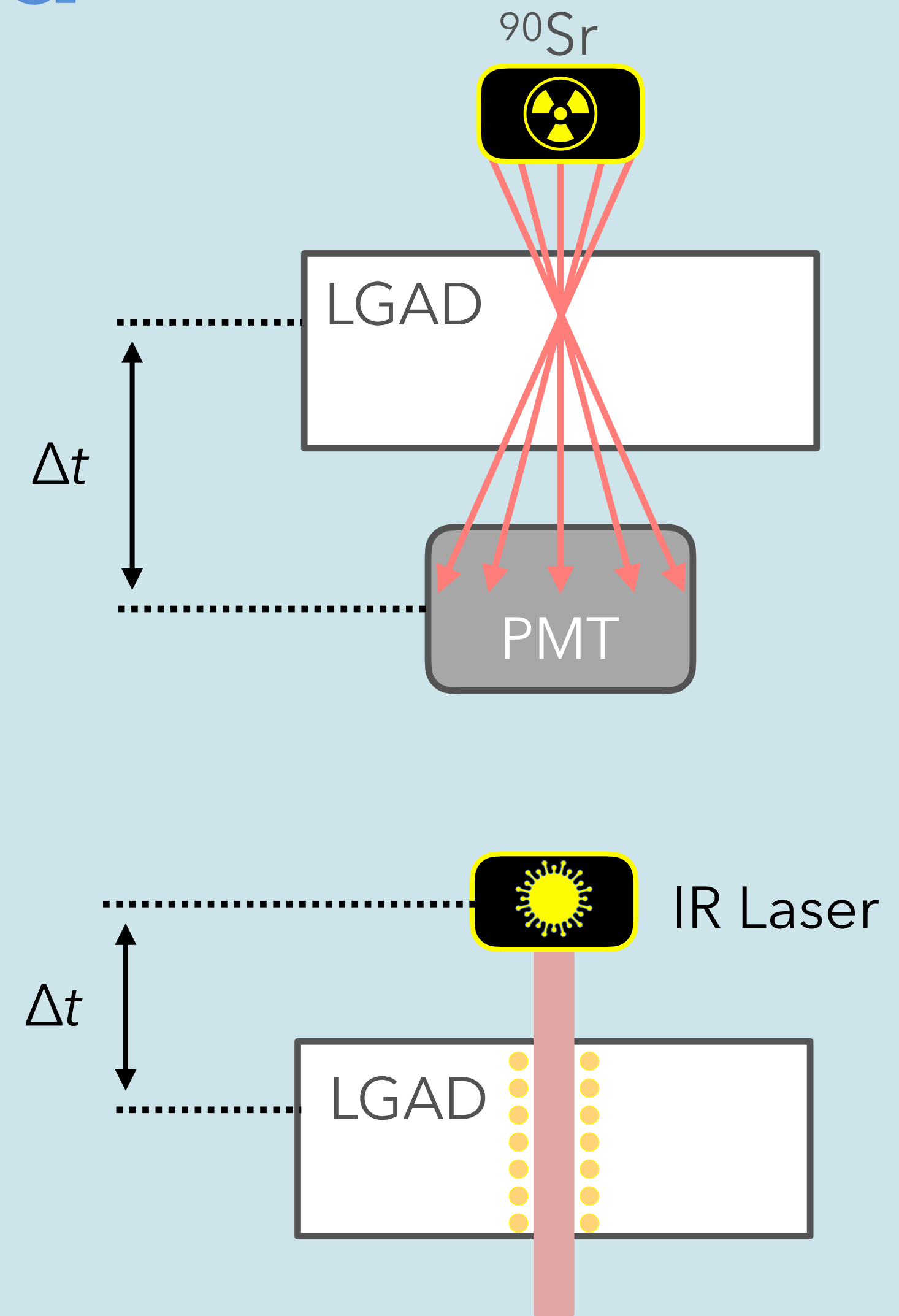


AC-LGAD R&D method

- Radiation source (^{90}Sr $O(1)$ MeV)
 - Pros: realistic S/N, easy setup, control temperature
 - Cons: worse timing resolution due to the path length fluctuation

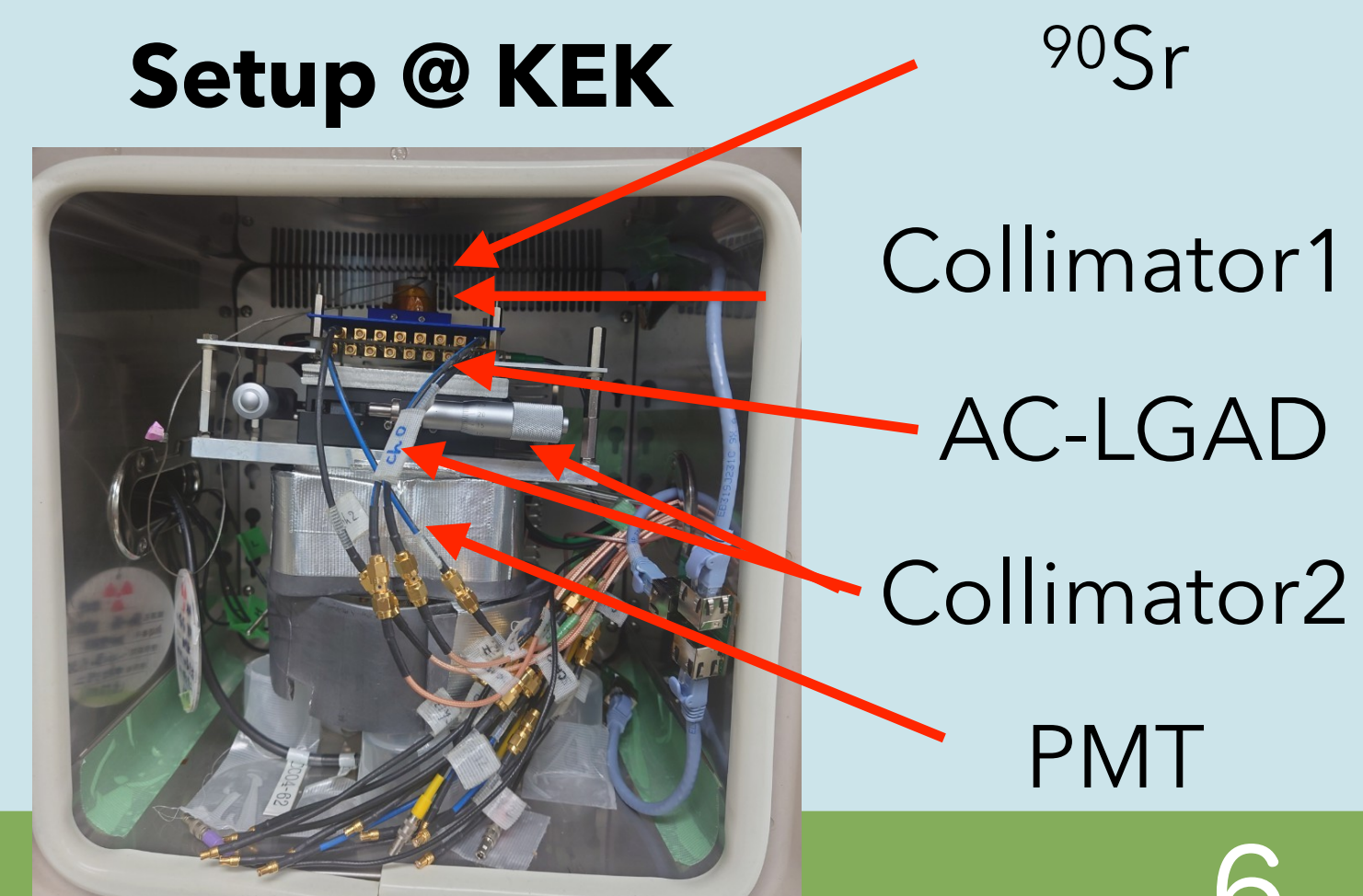
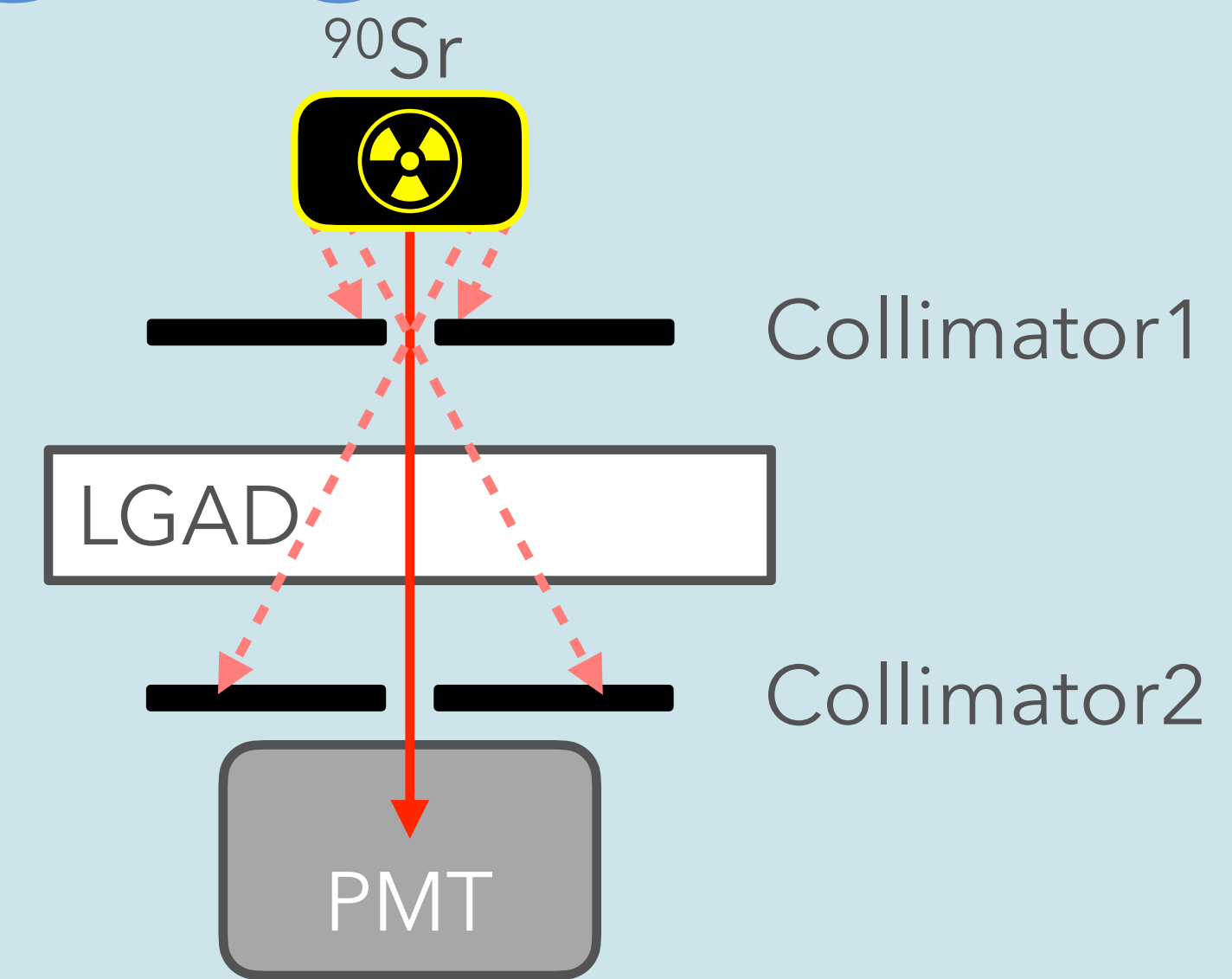
@ Hiroshima University

- IR laser
 - Pros: control injection position, easy setup
 - Cons: not realistic S/N due to lack of Landau fluctuation (better timing resolution), not accessible under the readout metal
- Beam ($O(1-100)$ GeV/c)
 - Pros: realistic S/N, control inject position with additional telescopes
 - Cons: not easy setup



Planning setup with ^{90}Sr @ HU

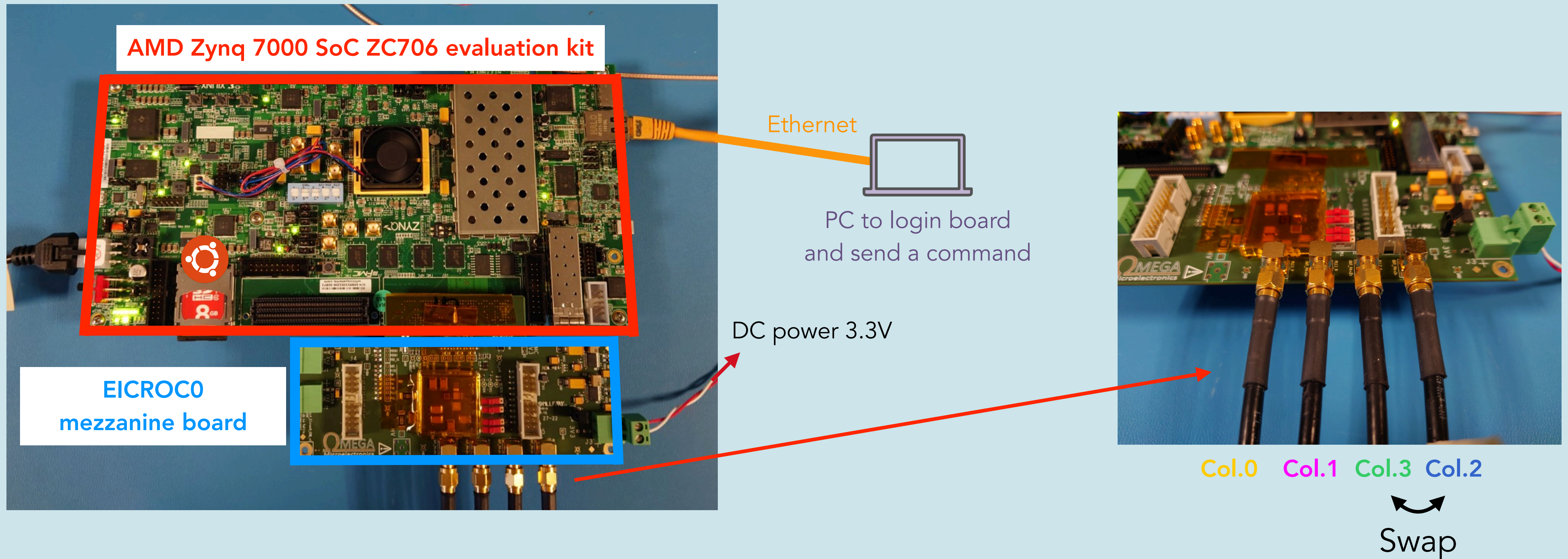
- The test bench setup with a radiation source is being built at HU
 - By using collimators, the path length fluctuation can be controlled
 - By changing the collimator configuration, some positioning resolution $O(1)$ mm can be expected to be achieved
 - High cycle test with realistic S/N can be realized (speed up the R&D)
 - The setup can be put inside a constant temperature bath due to its compact design
- We have checked to see if using collimators would help control the path length @ KEK
 - Thanks to the kind cooperation of Koji Nakamura, we could check the performance effect of collimators @ KEK
 - $\sigma_{\text{timing}} = 40 \text{ ps} \rightarrow < 30 \text{ ps}$ with 20um HPK sensor + KEK original amp board (analysis in progress)
- The GENT4 simulation study is ongoing by an undergraduate student to find the best collimator setup and check path length fluctuation @ HU



EICROC R&D activity

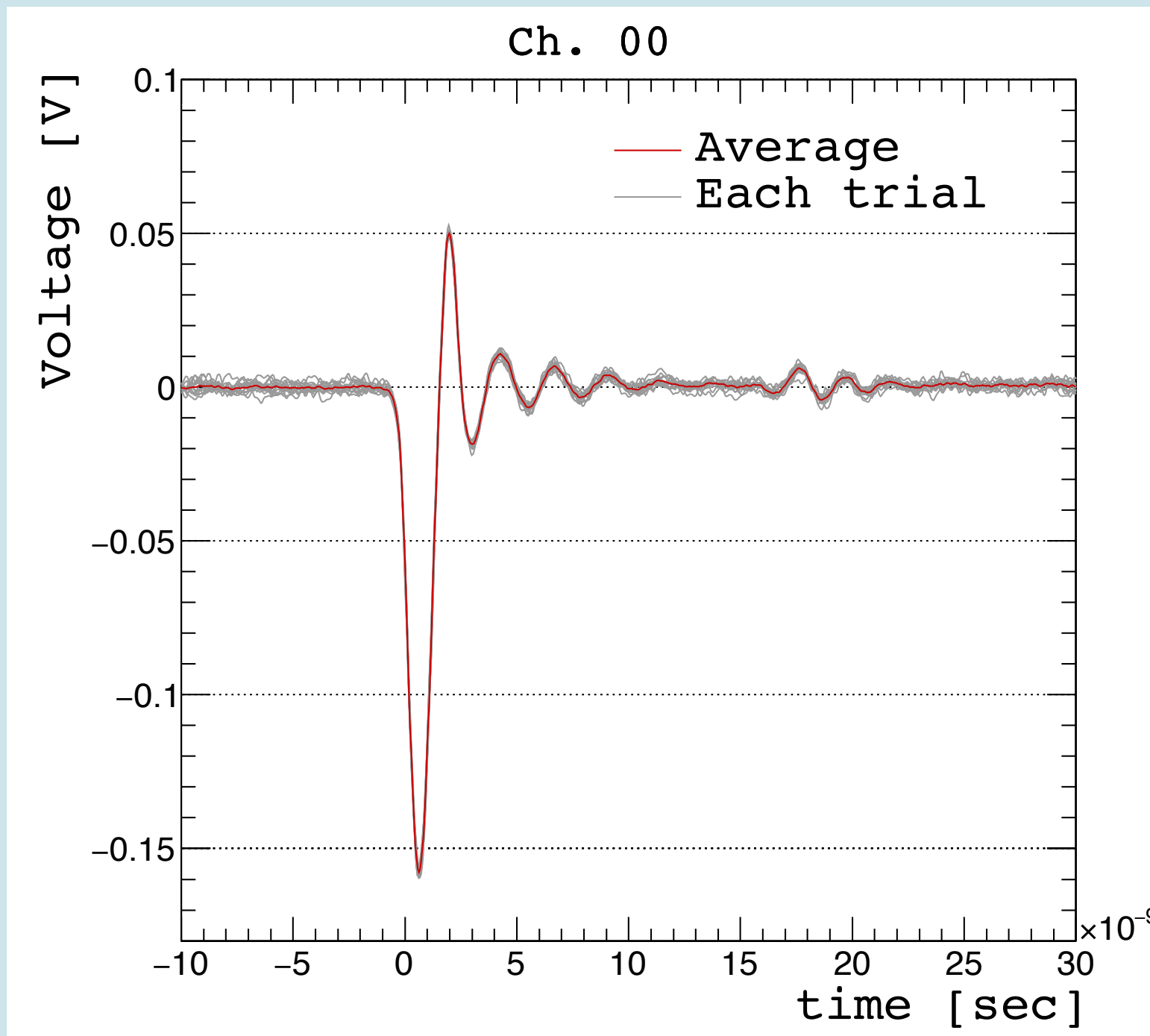
Activity for EICROC R&D @ BNL

- EIC-Japan team stayed at BNL for about 2 weeks to join the R&D of the EICROC0
- EICROC0 is characterized by injecting charges

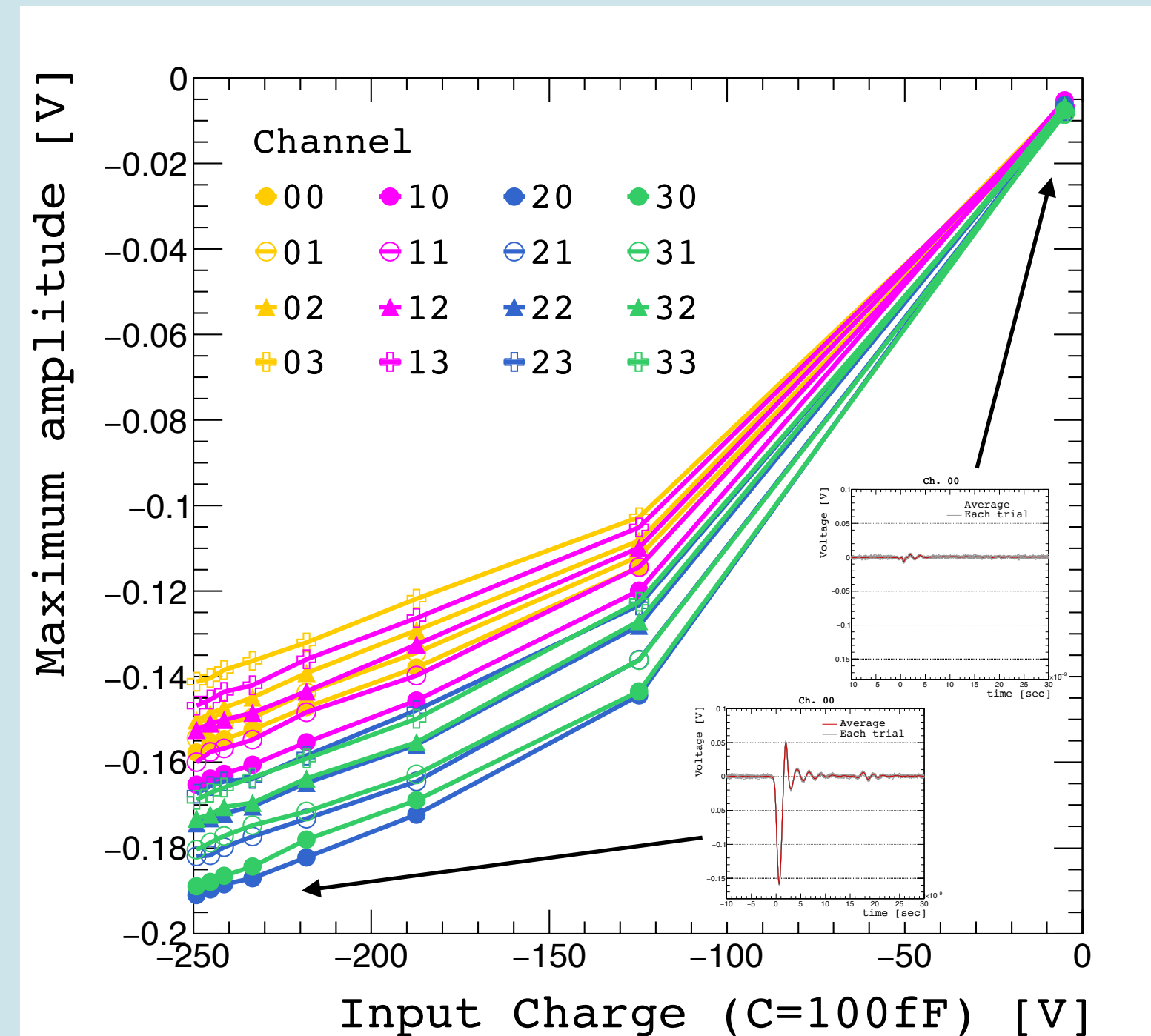


A quick look at the results of the campaign

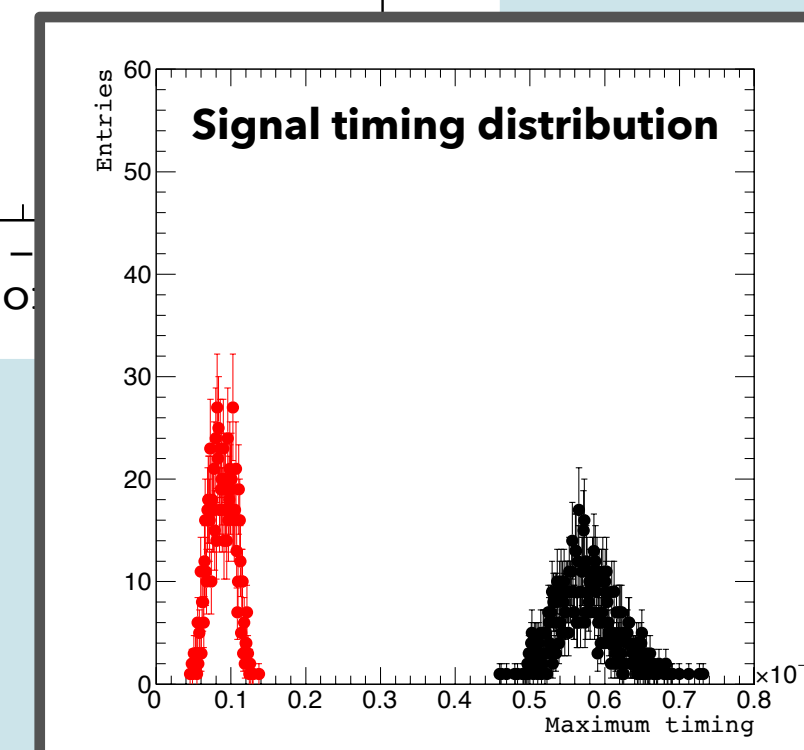
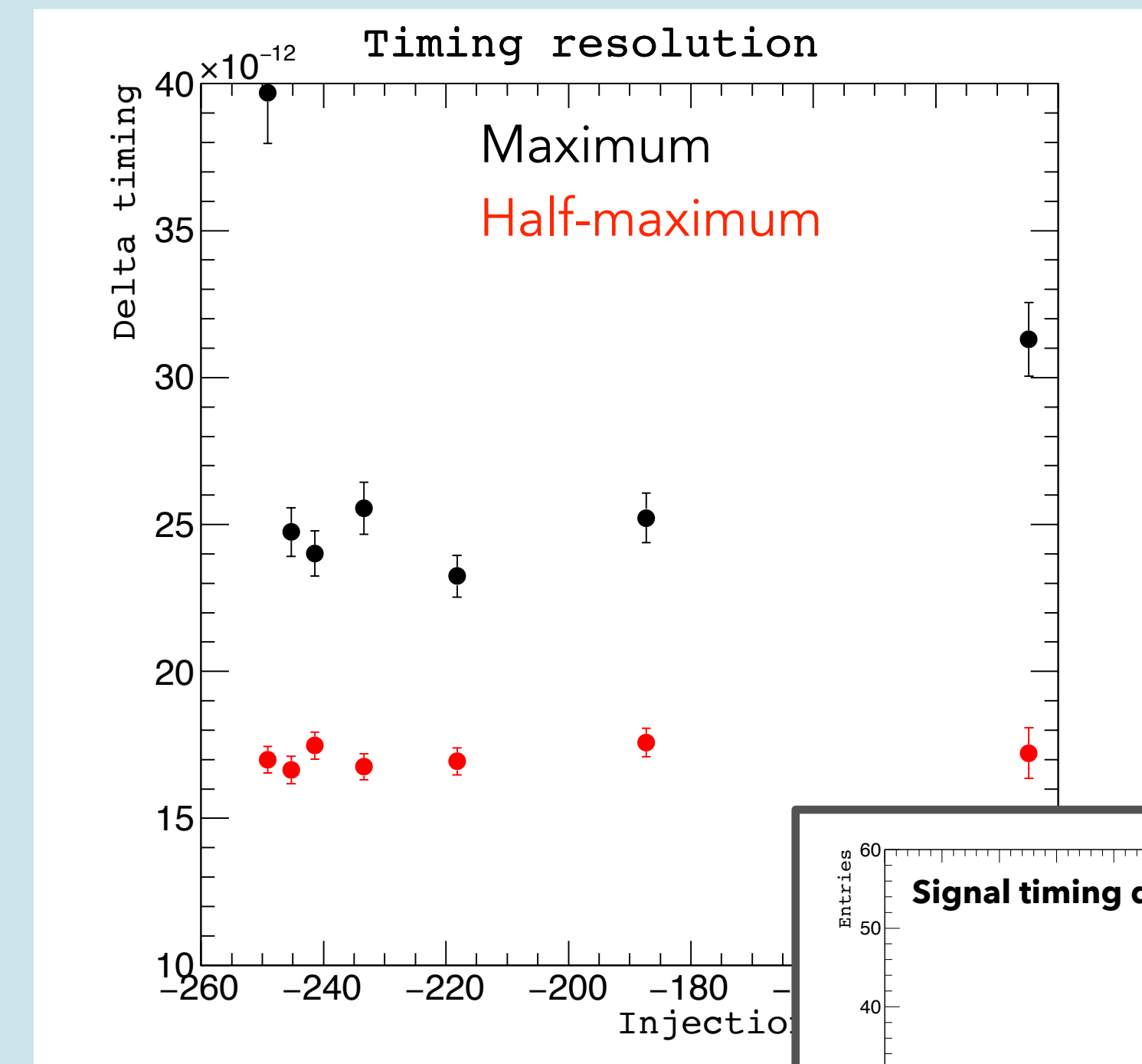
Waveform



Signal size v.s. injected charge



Signal timing fluctuation v.s. injected charge

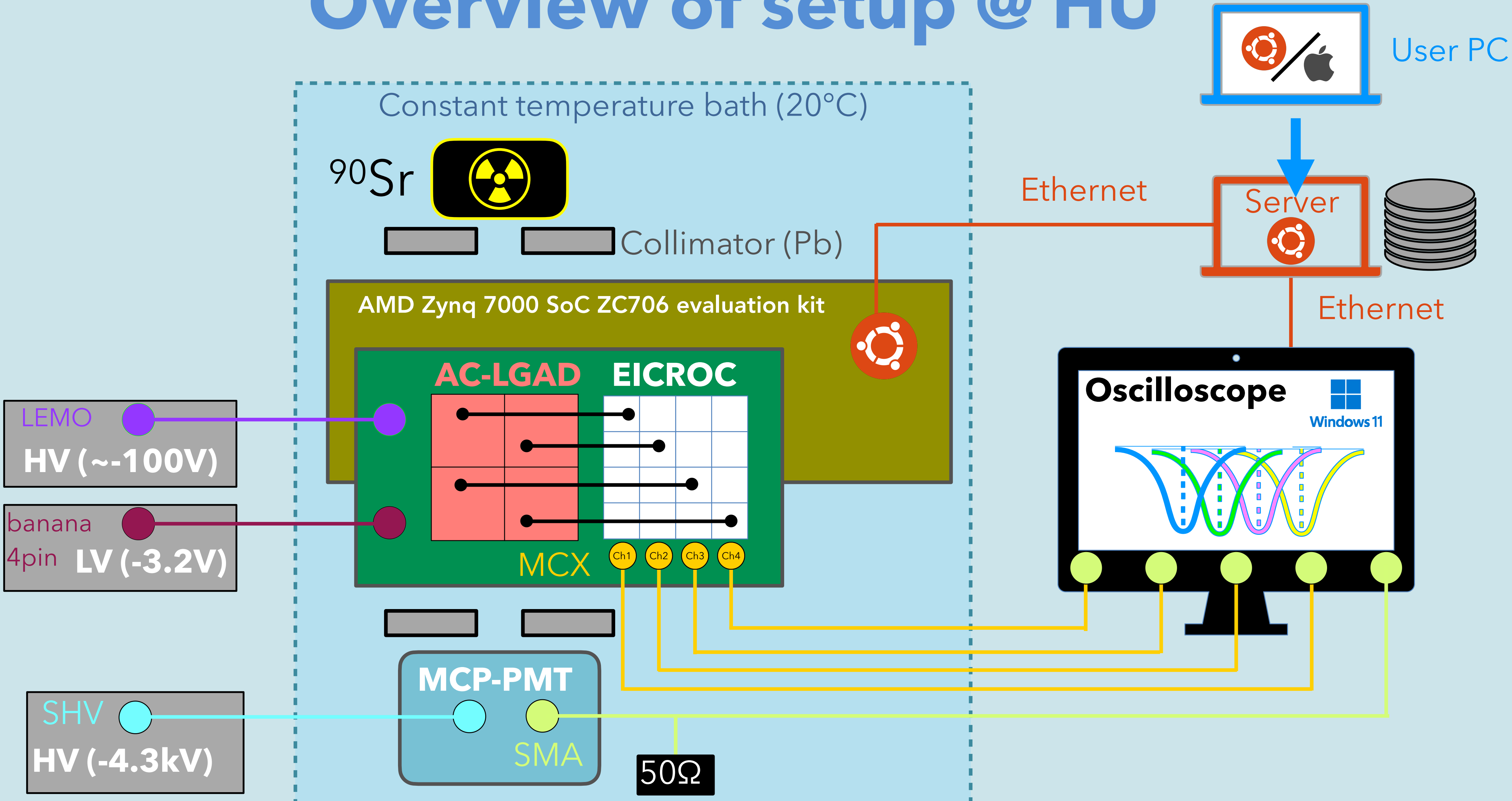


- We succeeded in reading amplified analog signal with changing injection charge in each channel (16ch)
- The fluctuation of maximum and 50% maximum signal arrival timings are obtained ($\sigma \sim 17\text{ps}$)
- The EICROC0 will be brought to Japan this week by hand

Summary and next step

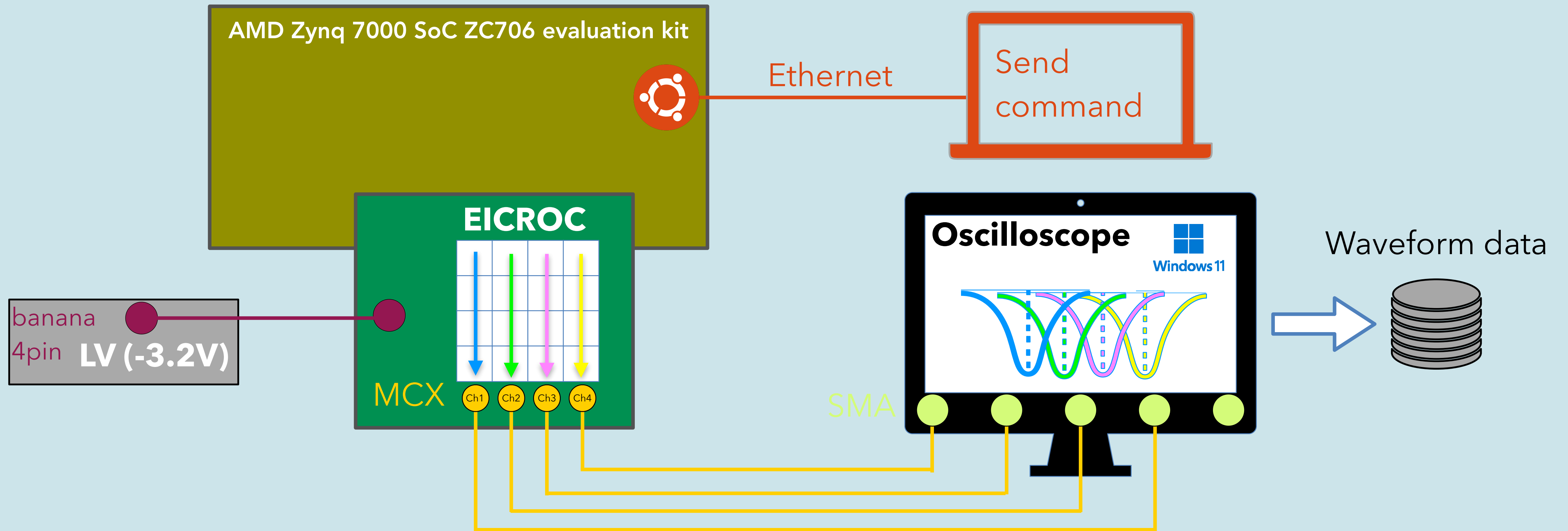
- We have already started the AC-LGAD R&D
 - The KEK setup for the R&D with a radiation source was used special thanks to K. Nakamura's kind cooperation
 - The setup with collimators worked to control the path length
- We have already started the EICROC0 R&D
 - The BNL team worked with the EIC-Japan on the EICROC0 R&D with injecting charge
 - We had very significant progress for both teams
- We are going to receive the EICROC0 this week from BNL
 - We can start R&D activities at HU
 - The same EICROC0 R&D will be demonstrated at HU as was done at BNL
 - After the test, AC-LGAD with EICROC0 will be performed
 - Wire bonding will be performed at KEK by K. Nakamura with his kind cooperation

Overview of setup @ HU



Backup

RICROC0 test setup (same as BNL)



Planning setup with ^{90}Sr @ HU

