

ePIC-ZDC development

- Crystal calorimeter RARiS test
- 2025 development in Japan

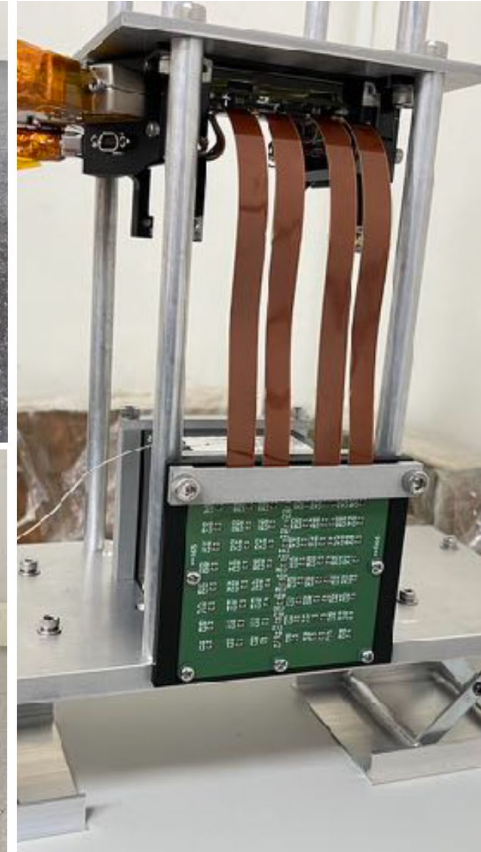
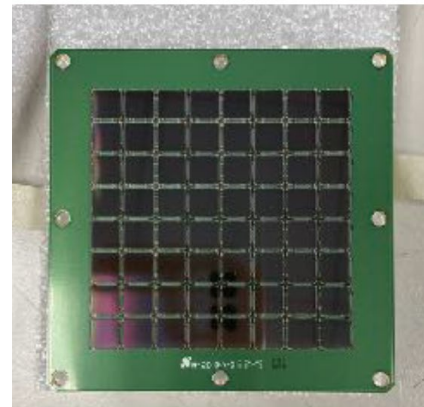
RBRC exp. group meeting

2025/4/15

Yuji Goto (RIKEN)

Crystal calorimeter RARiS test

- First prototype LYSO+SiPM
- LYSO crystal
 - 8 x 8 array of 7.1mm x 7.1mm x 88.3mm ($8X_0$)
 - Manufactured by Taiwan Applied Crystal
 - ESR (enhanced specular reflector) layer
- SiPM
 - MICROFC-60035
 - 7mm x 7mm photosensitive surface
 - 18,980 microcells
- Readout board
 - 2 CITIROC 1A (2 x 32 channels)
 - Separate voltage adjustment
 - Self-triggered



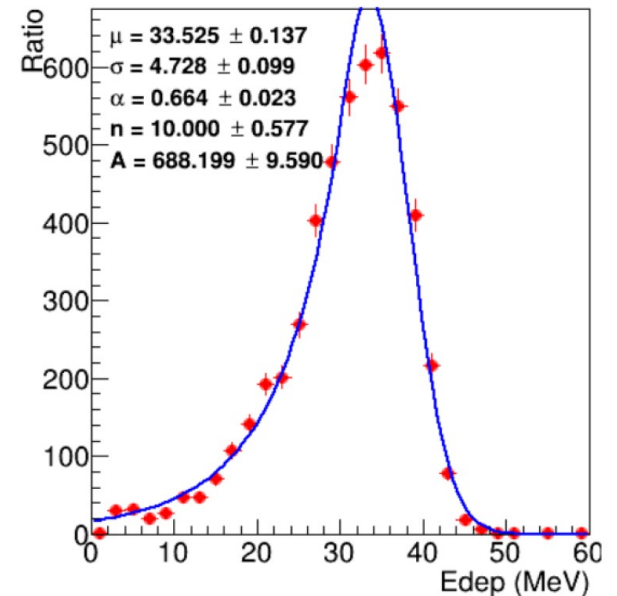
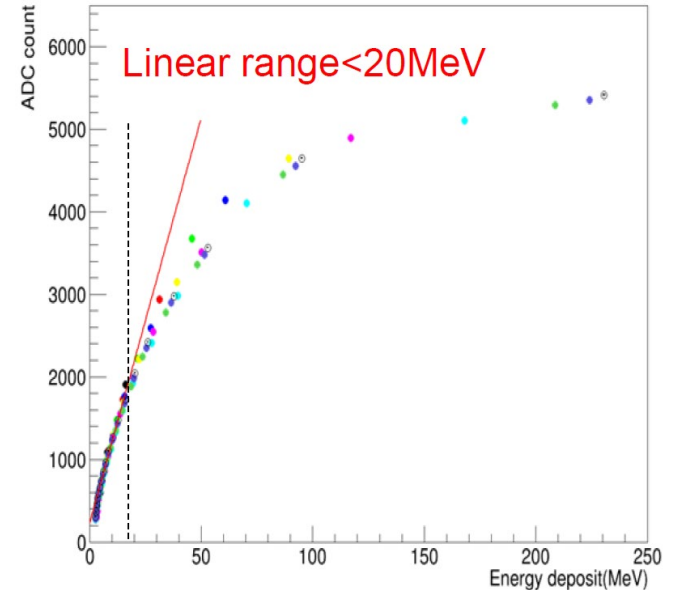
Crystal calorimeter RARiS test

- First RARiS (ELPH) test beam
 - 2024/2/15 – 21
 - 47MeV – 823MeV positron beam
 - SiPM HV scan, beam energy scan, detector rotation, etc.



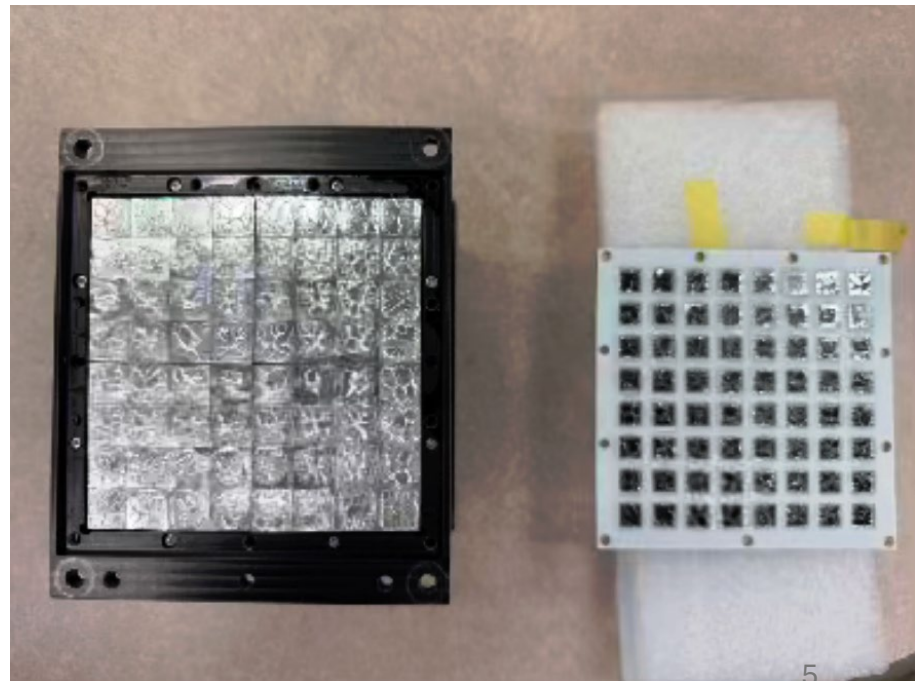
Crystal calorimeter RARiS test

- First test beam results
- Most data in the region where SiPM cells are saturated
 - Focus on the very low-energy deposit part of the data for a preliminary energy resolution study
- Energy deposit to 5 x 5 towers for the 47MeV beam
 - Width of the energy distribution 14%
 - After subtracting beam energy spread of the beam, energy resolution 11%



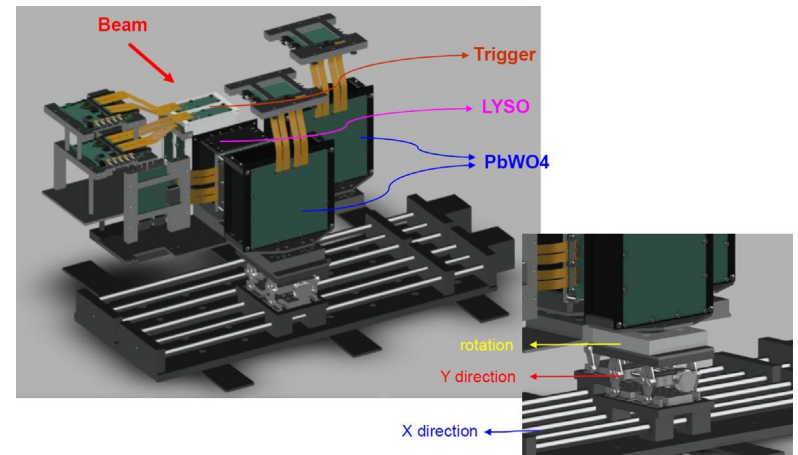
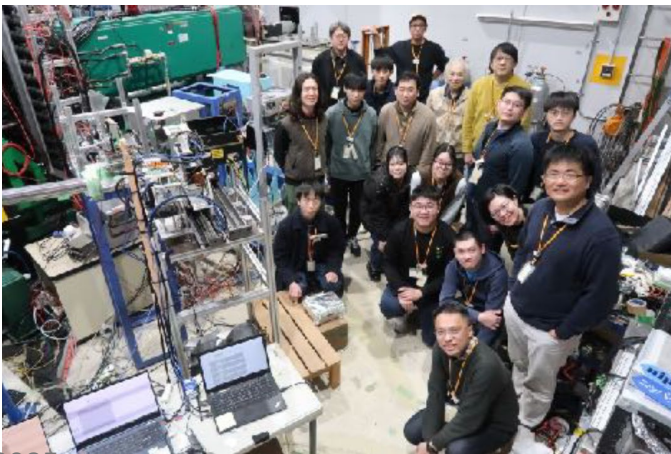
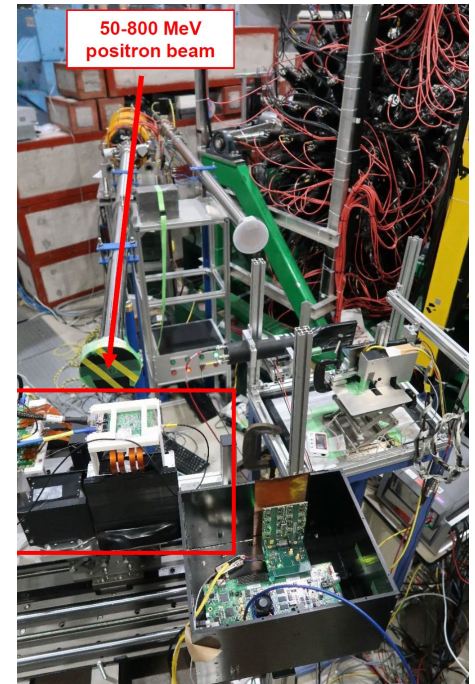
Crystal calorimeter RARiS test

- Second prototypes
 - PWO + SiPM
 - 6 x 6 array of 20.5mm x 20.5mm x 53.4mm ($6X_0$)
 - ESR reflection layer
 - LYSO + APD
 - 8 x 8 array of 10mm x 10mm x 66mm ($6X_0$)
 - ESR reflection layer
 - Trigger hodoscope
 - 2mm x 2mm x 8cm
 - (32 ch X & 32ch Y) x 2



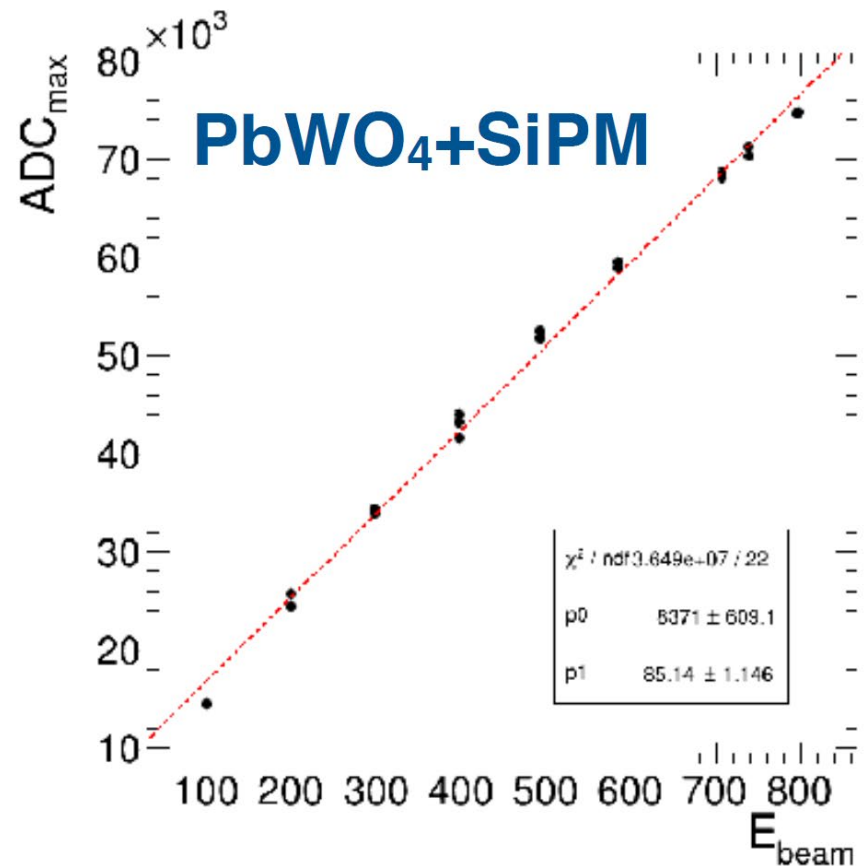
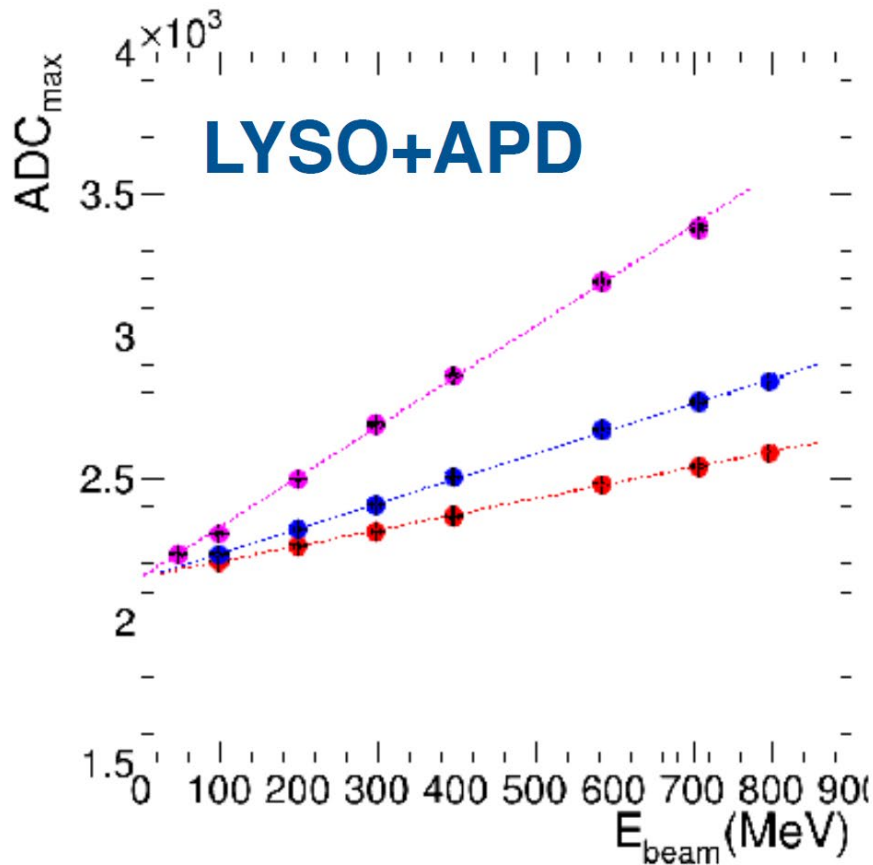
Crystal calorimeter RARiS test

- Second test beam
 - 2025/2/17 – 20
 - 47MeV – 823MeV positron beam
- Participants
 - NCU: Chia-Ming Kuo, Po-Ju Lin, Yu-Siang Xiao, Chia Sheng Chu, Shao-Yang Lu
 - Academia Sinica: Kai-yu Cheng, Chia-Yu Hsieh
 - RIKEN: Yuji Goto
 - Univ. of Tsukuba: Tatsuya Chujo, Jonghan Park, Yuto Nishida, Yuto Hama, Hikaru Kano
 - Tsukuba Univ. of Technology: Motoi Inaba, Shingo Sakai
 - Shinshu Univ.: Kentaro Kawade, Kentaro Motohashi
 - Nihon Univ.: Toshi-Aki Shibata
 - Nara Women's Univ.: Mai Takamura, Koyuki Iwatsuki



Crystal calorimeter RARiS test

- Second test beam very preliminary results
 - Linear responses observed in the initial analysis
 - Energy resolution analysis still problematic and under investigation



2025 development and beyond in Japan

- Crystal calorimeter
 - Cooperation with Taiwan group
 - Description of Pre-TDR and TDR
 - Prototype made in Japan
 - LYSO+APD or PWO+SiPM?
 - H2GCROC/CALOROC development
 - FoCal-H SiPM+H2GCROC?
- W-Si layer
 - Cooperation for Si-Pad detector with ALICE-FoCal-E
 - Radiation tolerance test of Si-Pad sensor at RIKEN RANS
 - Prototype construction and test (with HGCROC?)
- AstroPix
 - Cooperation with Korean ePIC-BIC group and Hiroshima Univ. AMEGO-X group
 - Contact ANL ePIC-BIC group and KIT/NASA
 - Purchase test modules for testing
- DAQ system for chain test and test beam
 - EASIROC?
- Simulation calculation
 - Reconstruction of Λ particle decay (W-Si layer)
 - Detection of low-energy photons (crystal calorimeter)
 - Absorber layer of hadron calorimeter (Fe or Pb)
- Hadron calorimeter
 - Cooperation with US groups (UC Riverside, Kansas Univ.)

Backup Slides

Crystal calorimeter RARiS test

- Next steps (in Taiwan)
 - Complete the data analysis from the second test beam
 - Compare the performance of LYSO crystals from different producers
 - Develop a new prototype of the LYSO calorimeter using 20mm x 20mm x 66mm crystals
 - Improve understanding of APD operation
 - Explore various ASICs
 - Design the readout board to closely resemble the final system
 - Design the trigger system to enable combined test with other subdetectors
 - Develop a laser monitoring system in collaboration with a laser group in Taiwan
 - Design the cooling system and mechanical structure