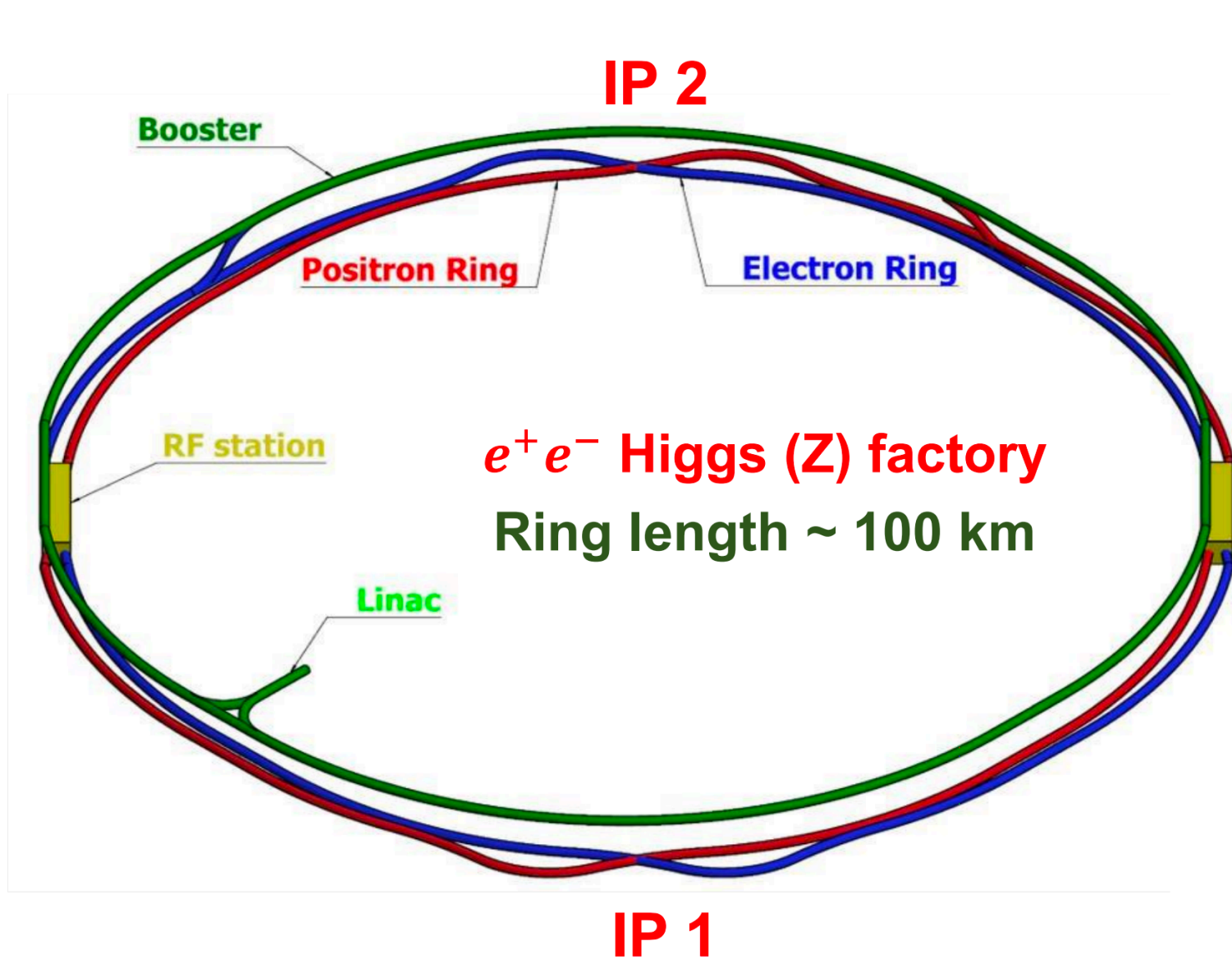


Study of residual artificial neural network for particle identification in the CEPC high-granularity calorimeter prototype

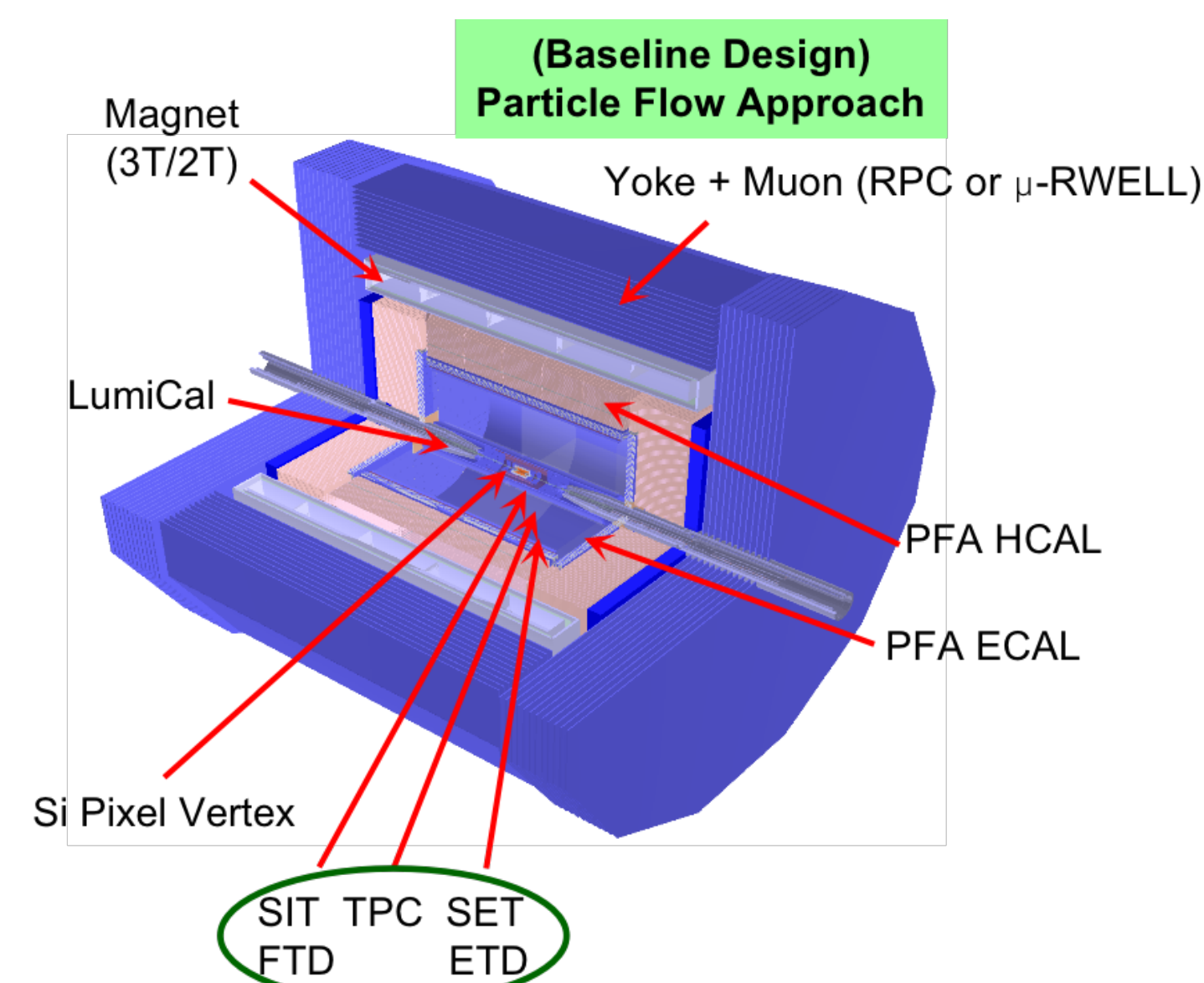
Siyuan Song, SJTU,
CEPC Calorimeter Group

Circular Electron Positron Collider (CEPC)

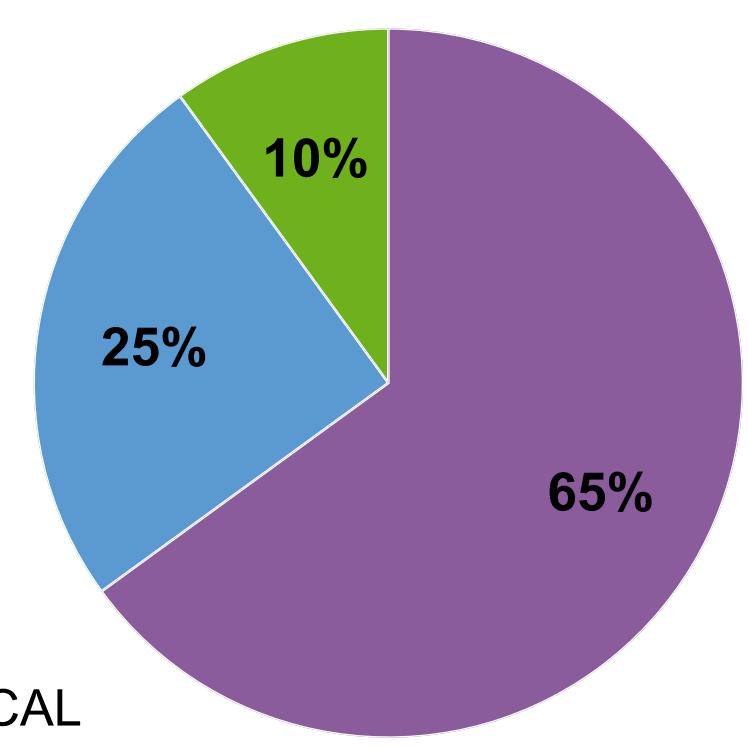
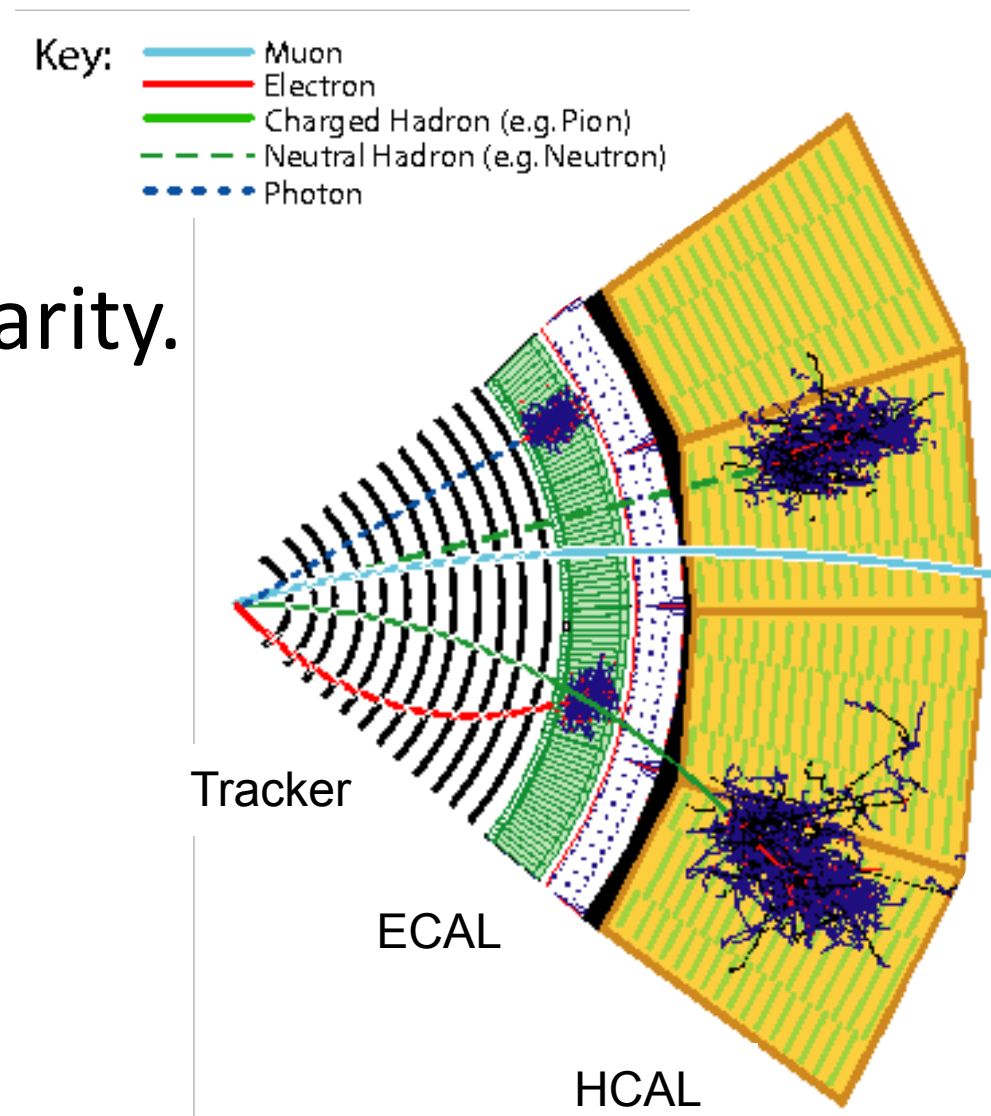
- A future e^+e^- collider with a perimeter of around 100 km in China.
- To precisely measure the property of W/Z/Higgs and to deeply investigate the origin of the mass and the physics beyond the Standard Model.



CEPC accelerator and detector



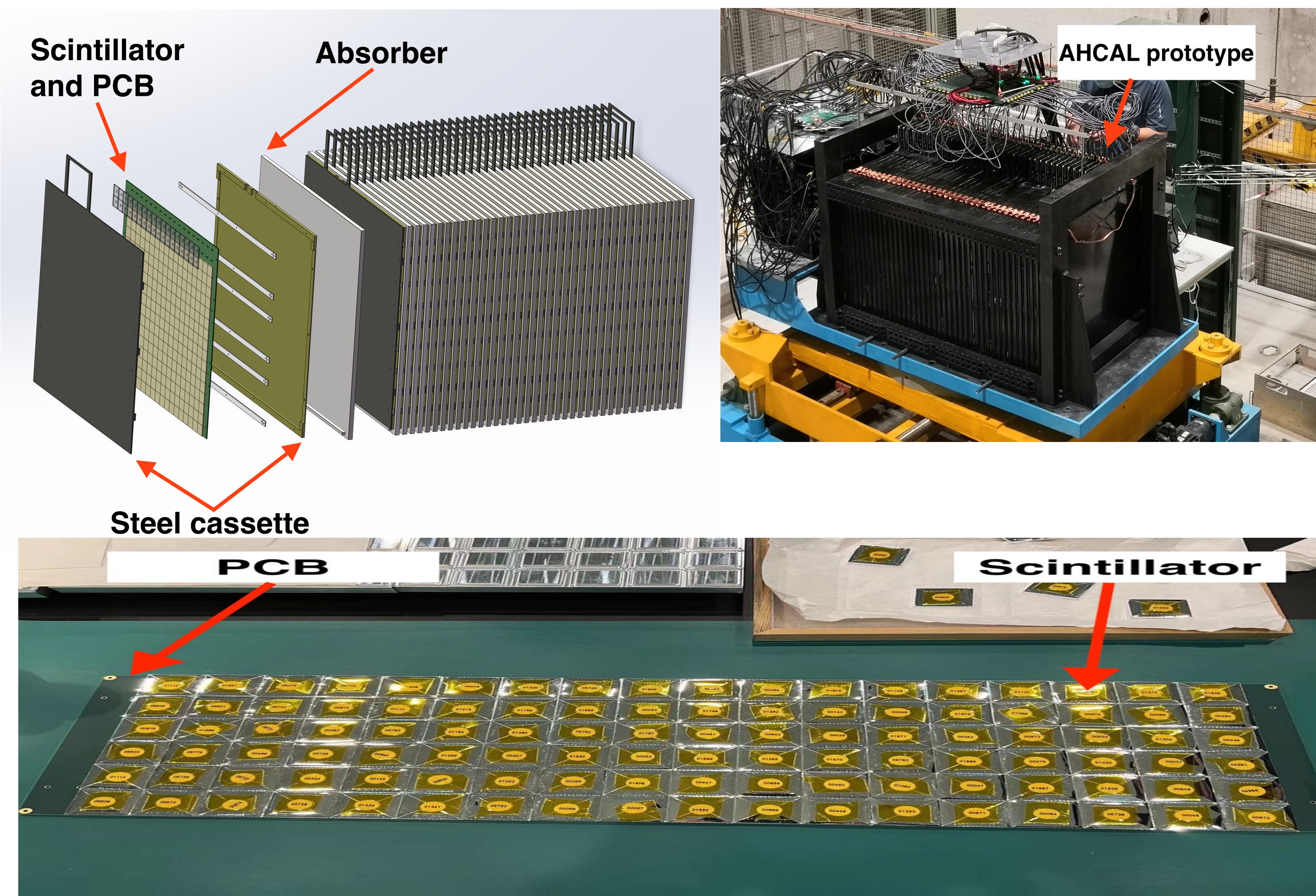
- The baseline detector incorporates the **Particle Flow Algorithm**.
- Energy of particles in a jet is detected by the most suitable sub-detector.
- With 4% Boson Mass Resolution (BMR).
- PFA-Calorimeter featuring with high granularity.



PFA concept

CEPC Analog Hadronic Calorimeter (CEPC AHCAL) Prototype

- Plastic scintillator + SiPM + Fe absorber.
- 40 sampling layers with a size of around $72 \times 72 \times 120 \text{ cm}^3$ and with around 5 nuclear interaction lengths in the longitudinal direction.
- Sensitive cells (SiPM-on-Tile) with a size of $4 \times 4 \times 0.3 \text{ cm}^3$, arranged in an array of $18 \times 18 \times 40$.
- Key part of PFA detector of CEPC experiment and with an energy resolution of $60\% \sqrt{E} \oplus 3\%$.

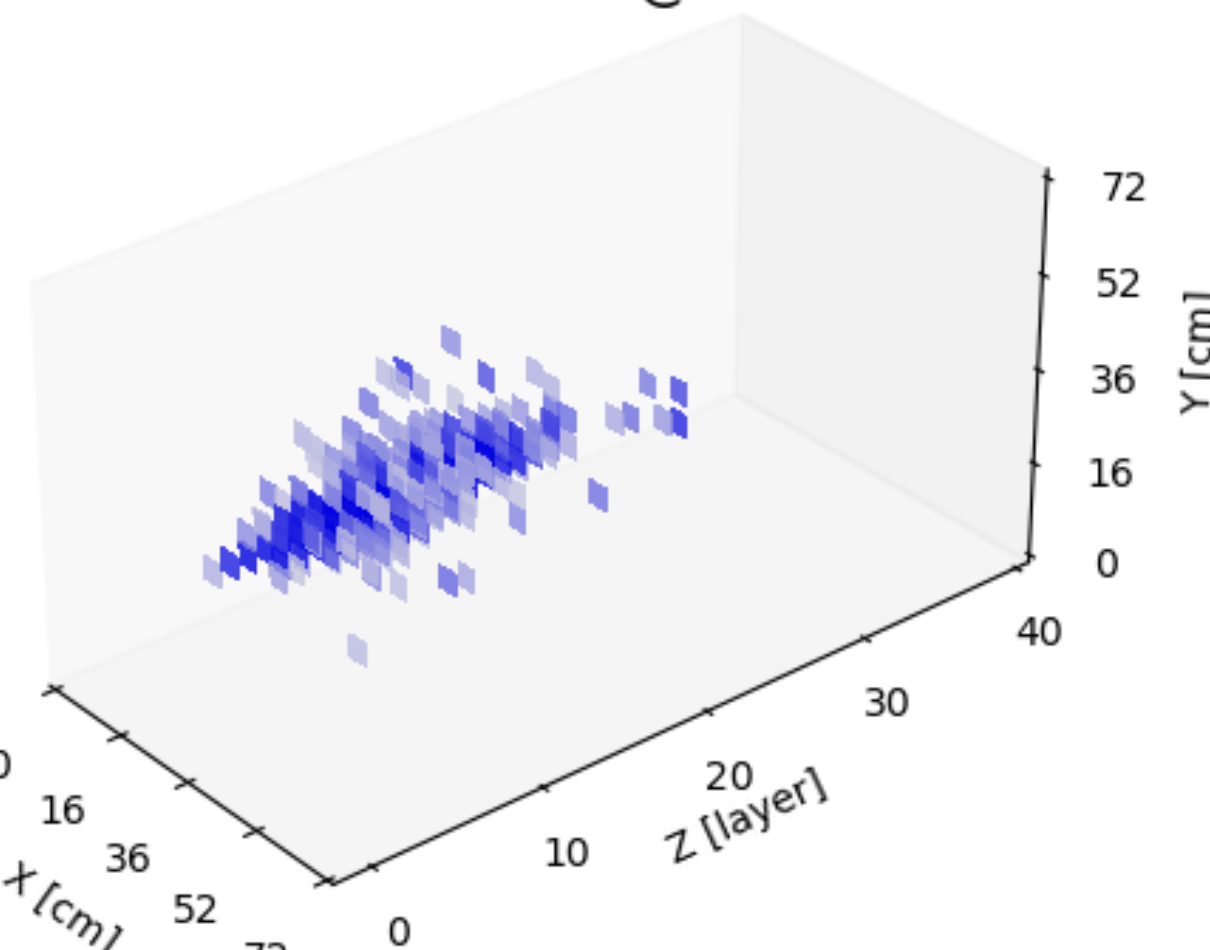


CEPC AHCAL Prototype

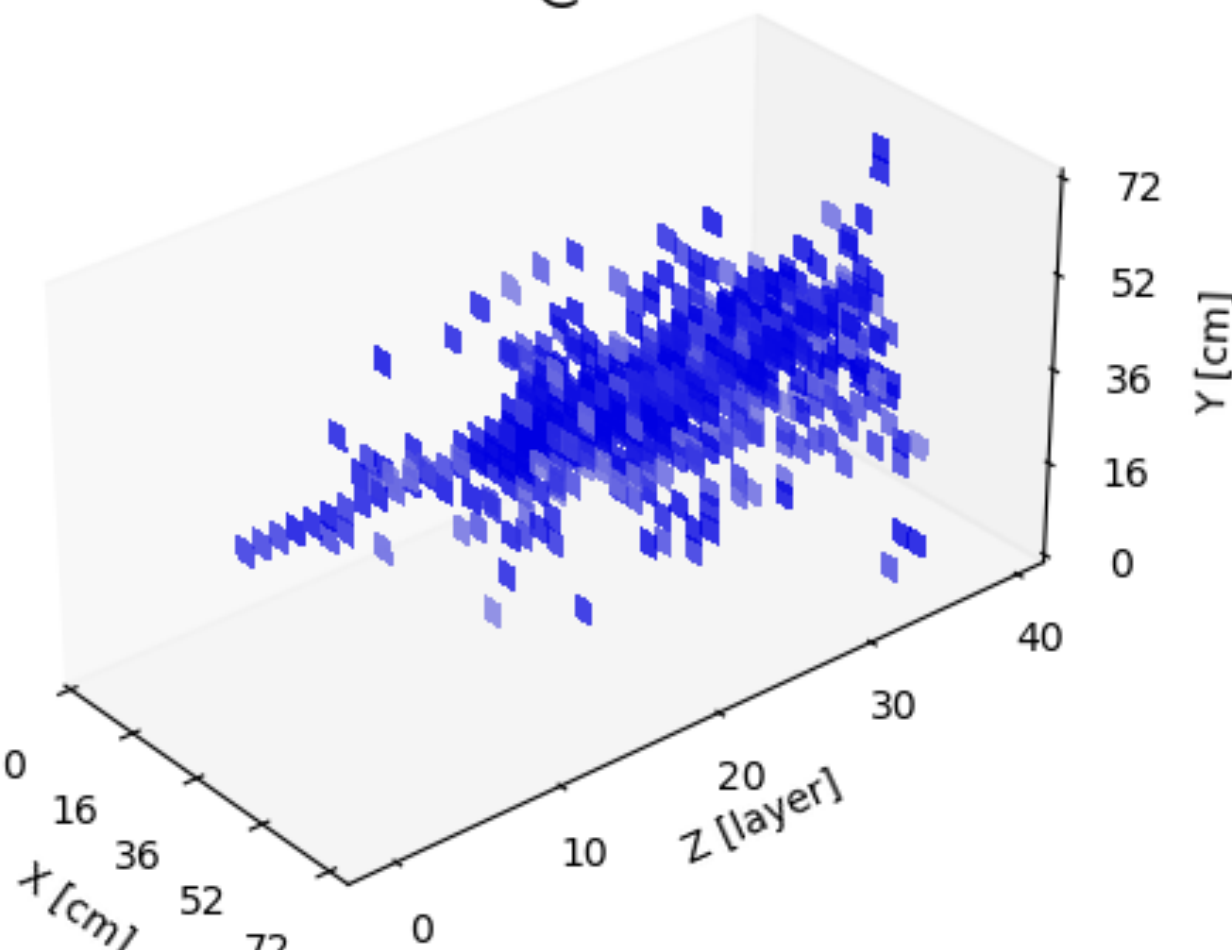
Motivation

- Developing machine-learning-based particle identification methods in PFA-oriented calorimeters and further improving the performance of detectors.
- Classifying electron events and pion events:** A serious beam contamination issue is faced during the beam test for the AHCAL prototype.

CEPC AHCAL
Electron Simulation @100GeV



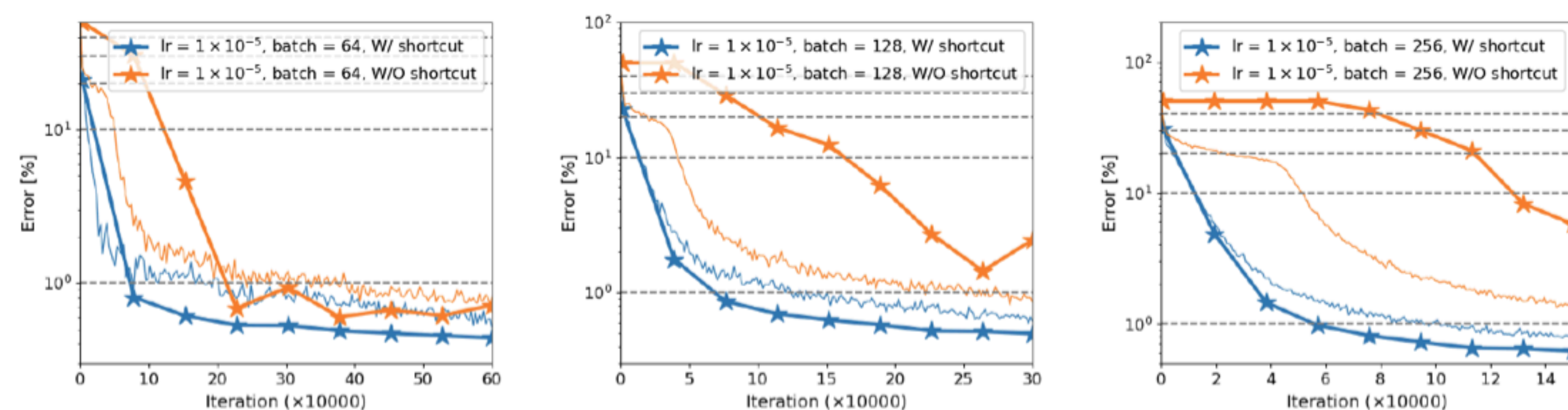
CEPC AHCAL
Pion Simulation @100GeV



Electron event and Pion event simulation events in AHCAL prototype

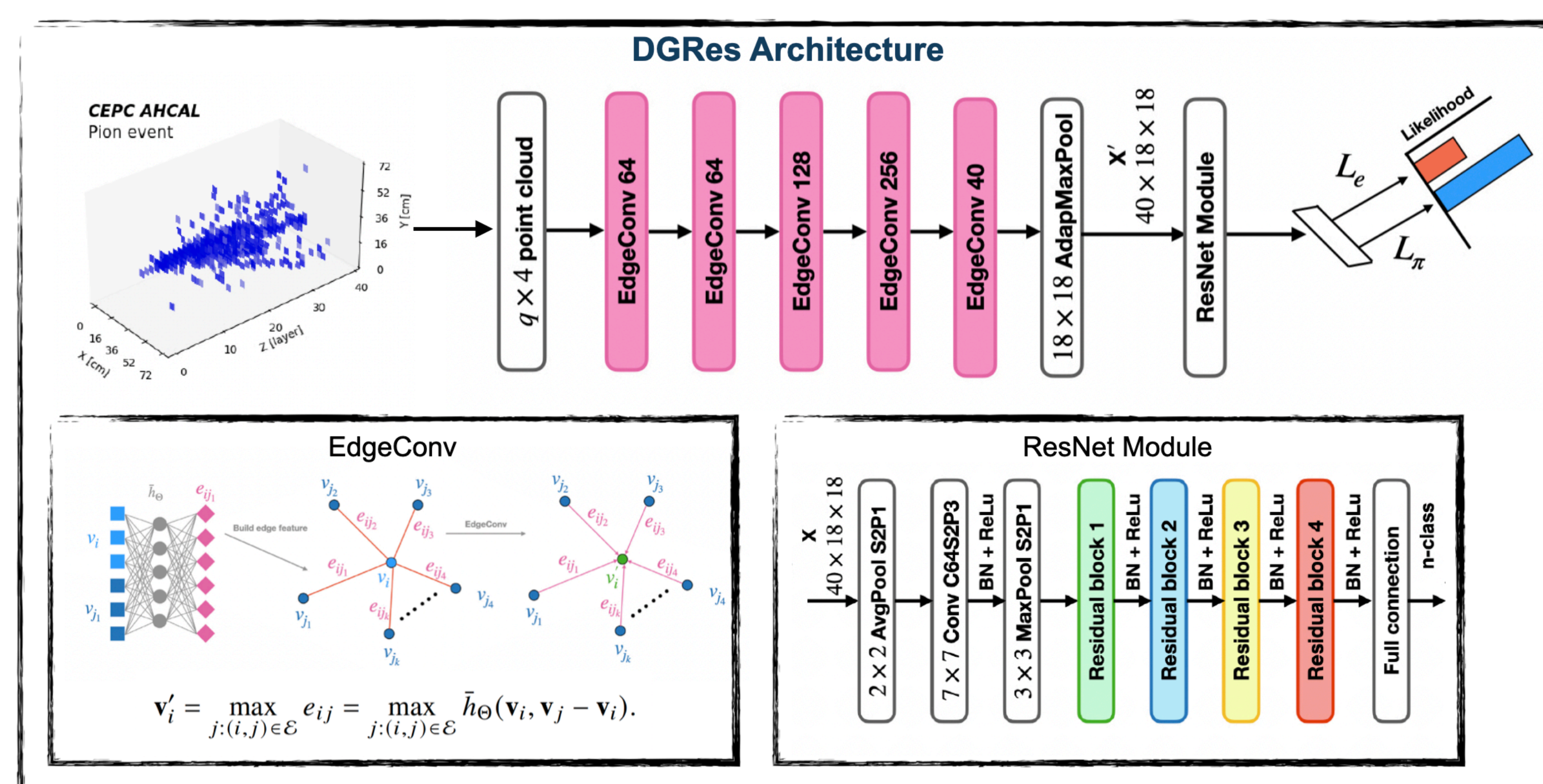
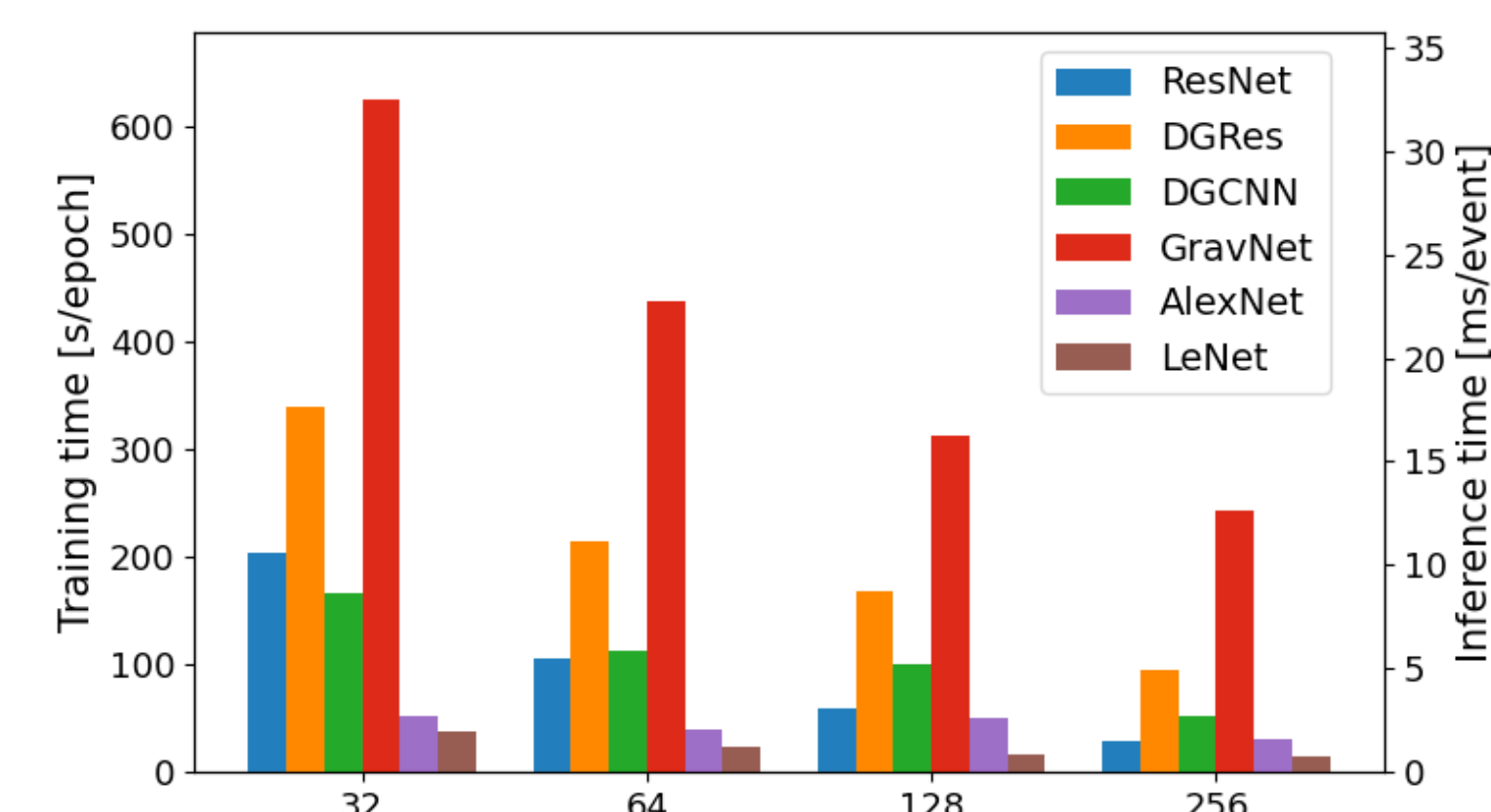
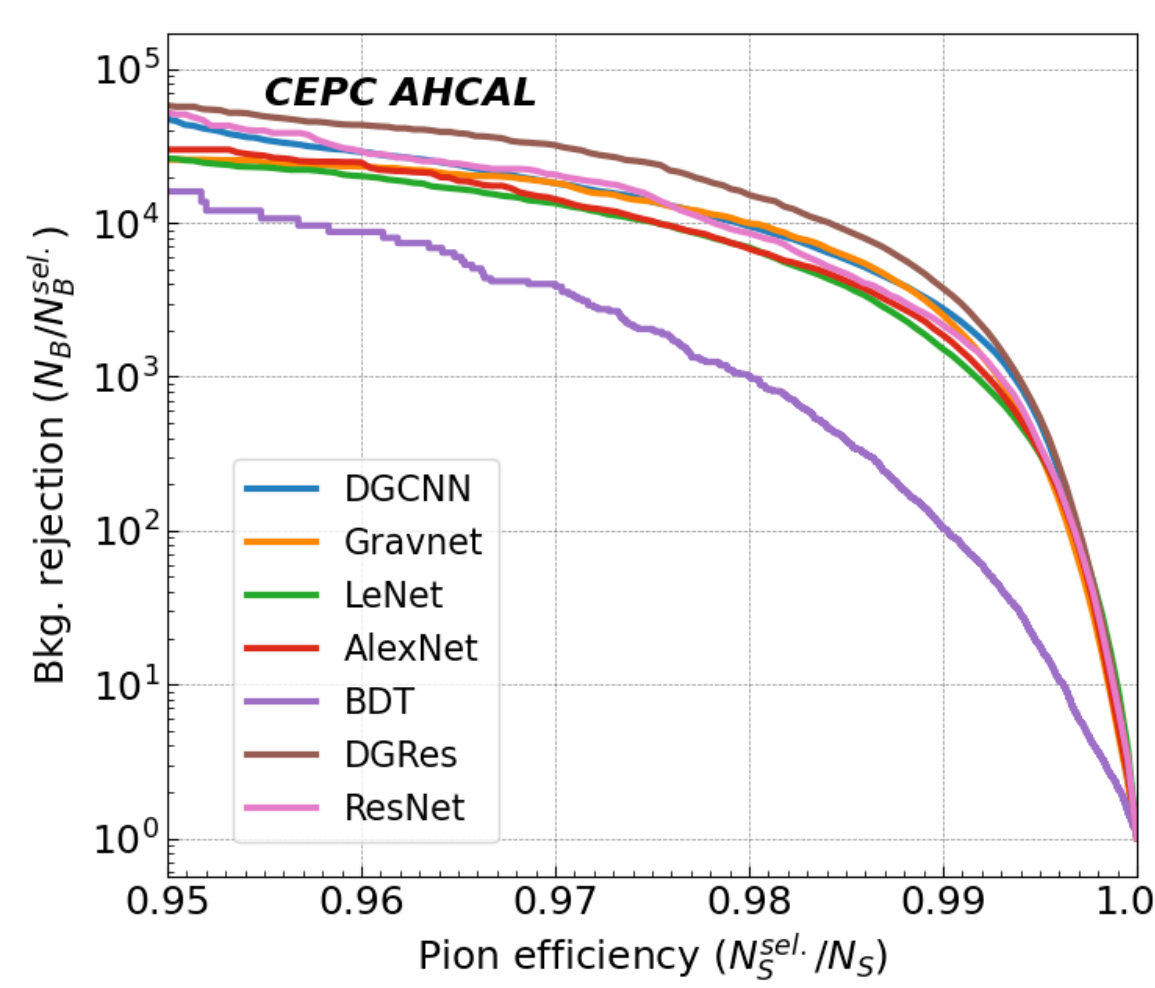
Impacts of the Residual Connections

- ResNet invites connections makes data bypass several layers.
- Validating the shortcut connection leads to a faster decrease in both training and validation errors and enhance the robustness of the network, in a reduction of the validation error by a factor of 2-3.



Dynamic Graph Residual Networks (DGRes)

- Incorporating the advantage of ResNet and the EdgeConv block.
- Grand application prospects in detractors with any geometry and better performance compared with several state-of-the-art algorithms.



Journal of Instrumentation, 2024, 19(04): P04033.