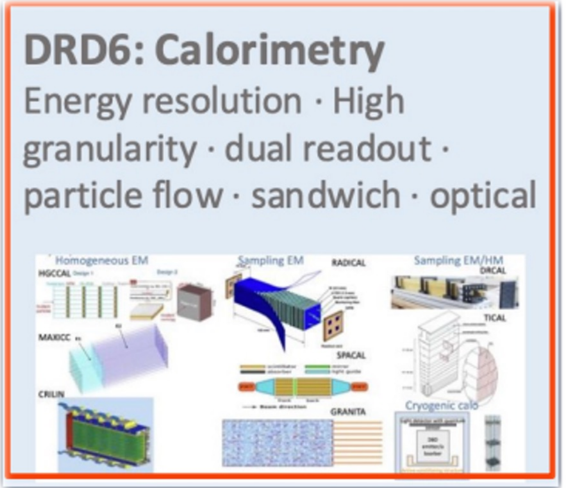
First-Year PhD Progress Report

Xin Xia
Supervisor: Roman Poeschl
Committee: Emi KOU, Dirk ZERWAS
7/24/25

Individual information

- 1st year PhD
- Funded by CALO5D project
- 36-month scholarship
- DRD6 group & ILC group



Irène Joliot-Curie
Laboratoire de Physique des 2 Infinis

Now
24 juillet 2025

Start point
12 novembre 2024

PhD defense
novembre 2027

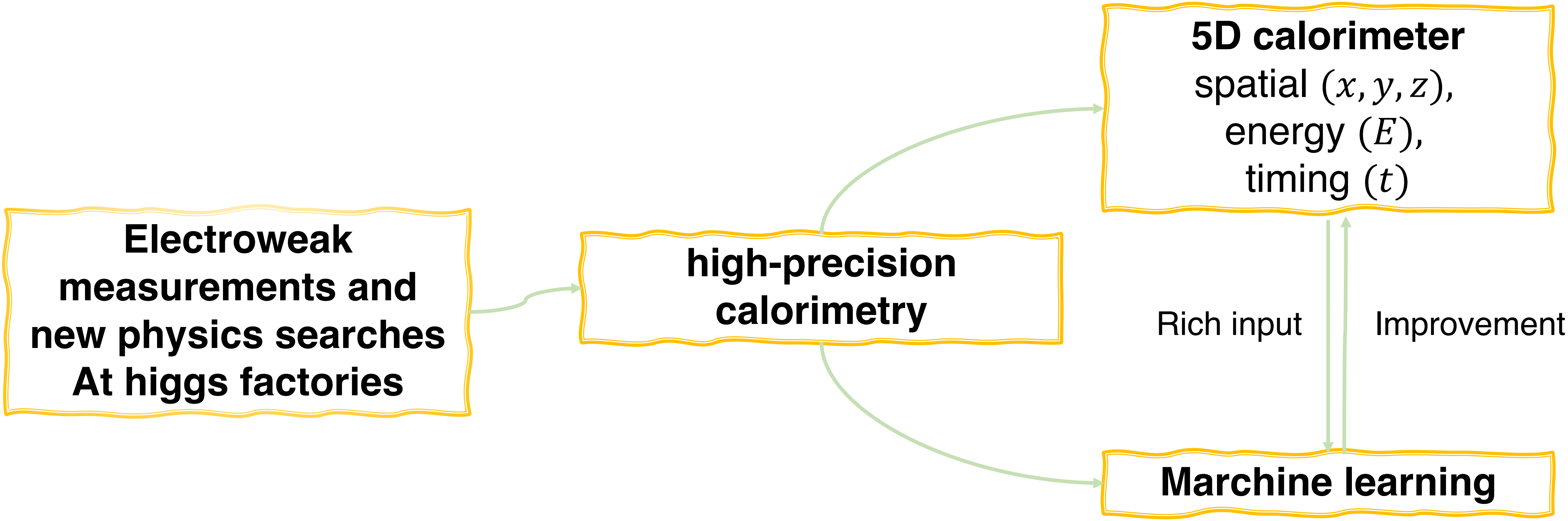
Outlines

Research: Towards 5D Calorimetry for future Higgs factories

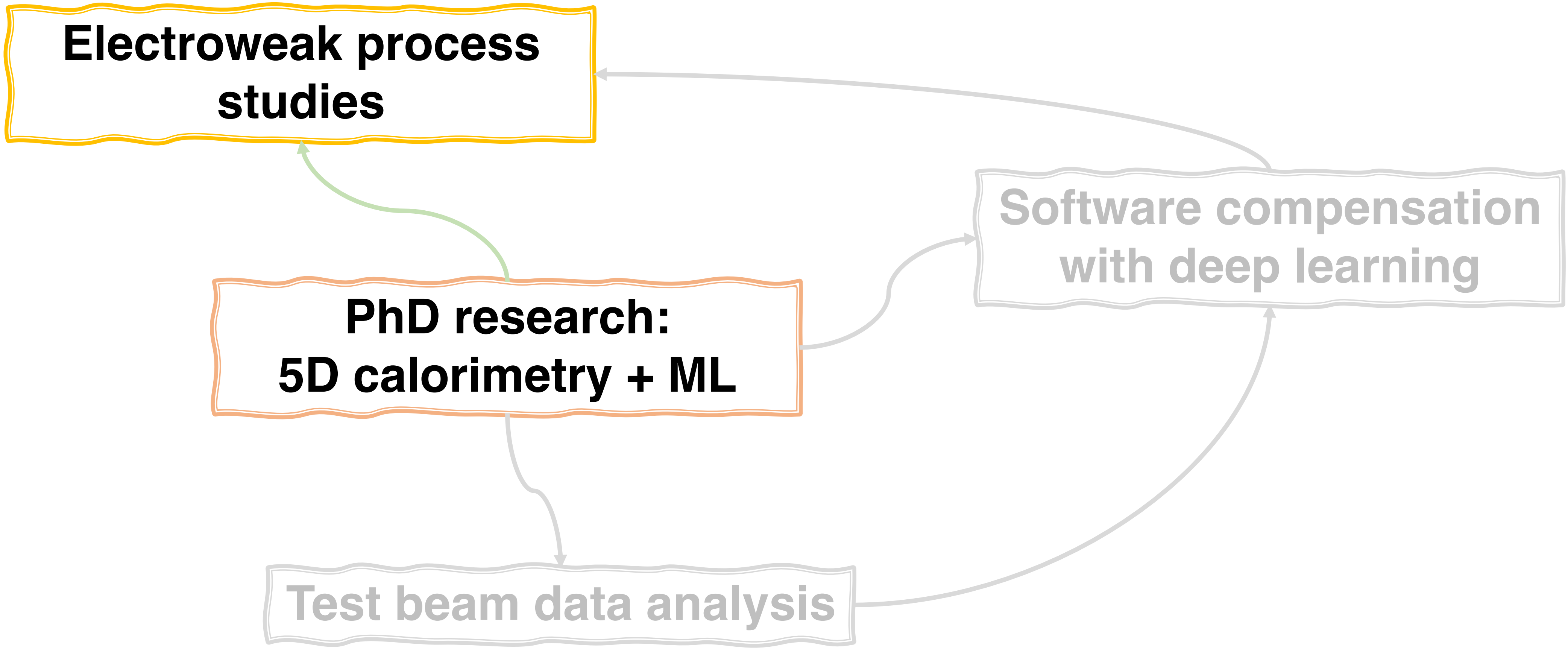
- Electroweak Measurements
- Energy reconstruction with Deep learning
- *Beam Test experiment (hardware)*

Training courses

Introduction



Outlines


Electroweak process studies
Software compensation with deep learning
PhD research:
5D calorimetry + ML
Test beam data analysis

[1]: DOI: 10.1016/0550-3213(87)90685-7

Motivation:

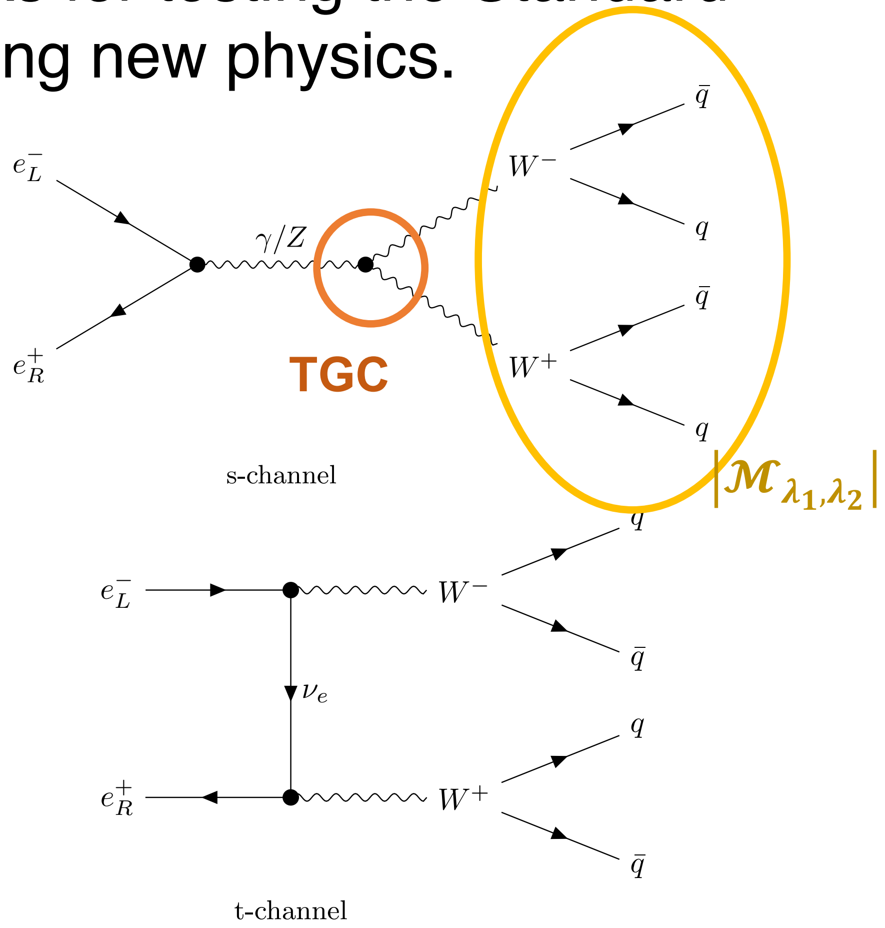
- Electroweak process serves as precision benchmarks for testing the Standard Model, constraining anomalous couplings, and probing new physics.

Process: $e^+e^- \rightarrow W^+W^- \rightarrow 4q$ (@ 250 GeV)

- the best channel for Five-fold cross section[1]:

$$\frac{d\sigma}{d\Theta\ dcos\theta\ d\phi\ dcos\bar{\theta} d\bar{\phi}} = \sum_{\lambda_1,\lambda_2} \left|\mathcal{M}_{\lambda_1,\lambda_2}\right| \cdot f$$

  - Sensitive to TGC, CP, polarization, etc
- Give assess to all helicity amplitudes
- Never been examined, the potential is unknown
- First step of the fully hadronic final state of $t\bar{t}$



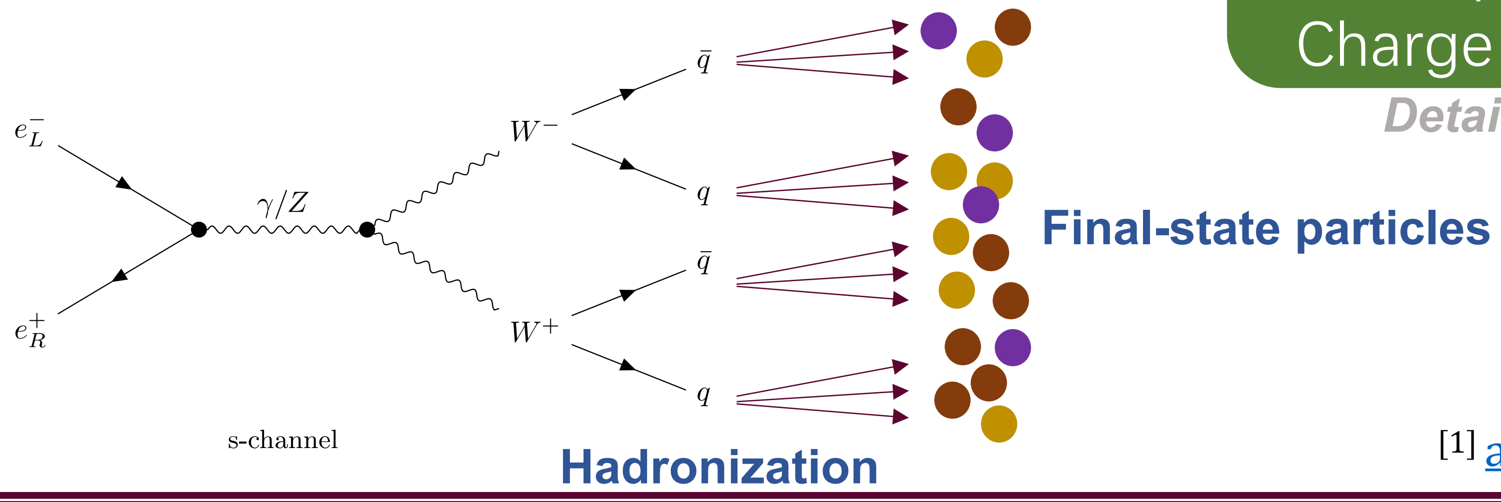
Work Flow

Simulation and Reconstruction Flow: based on ILC software framework

MCTruth → PandoraPFA[1] reconstruction → Half-Reco → Jet & boson reconstruction → Full-Reco

- MCTruth → MCParticles
- Half-Reco → PFOS + RecoMCTruthLink
- Full-Reco → PFOS + Jet clustering + Jet pairing + Charge distinguish

Details are in backup.

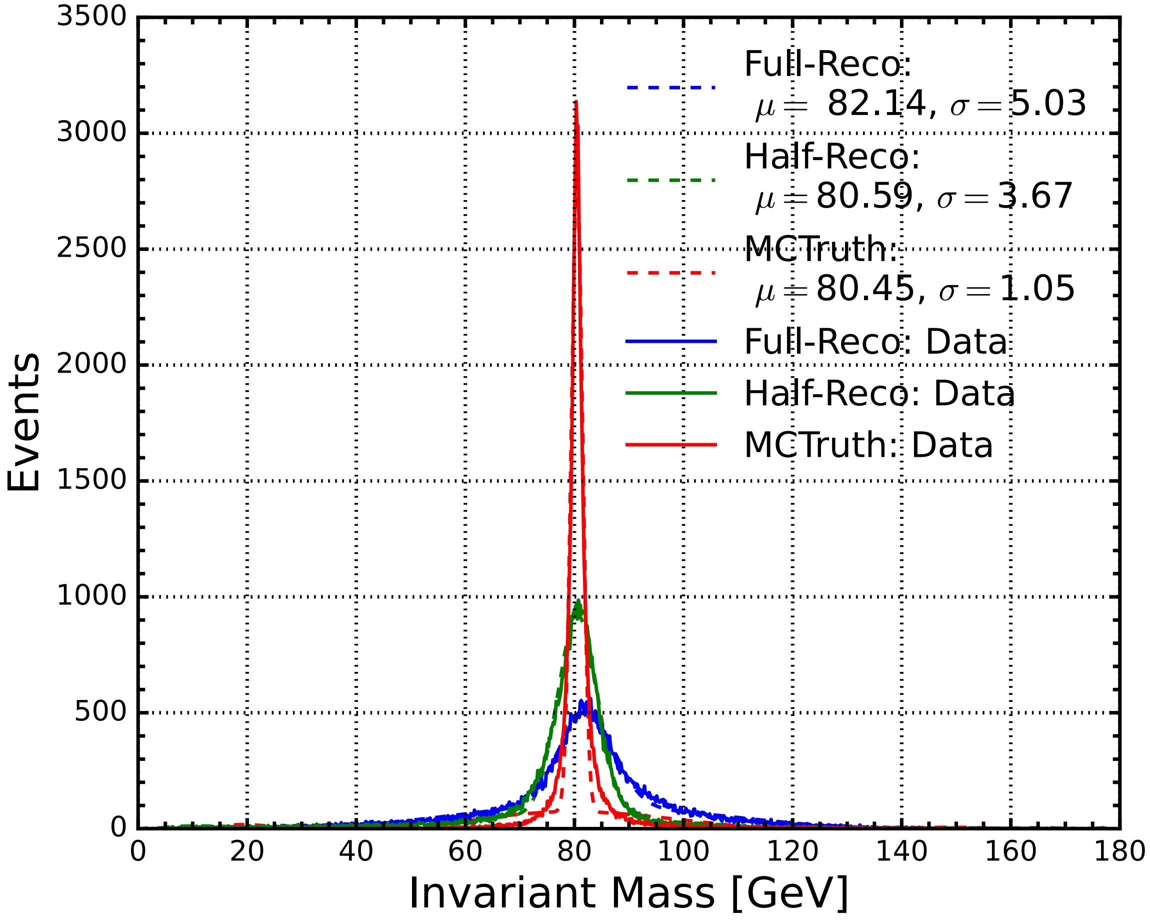


[1] arXiv:0907.3577 & P17

W boson Mass

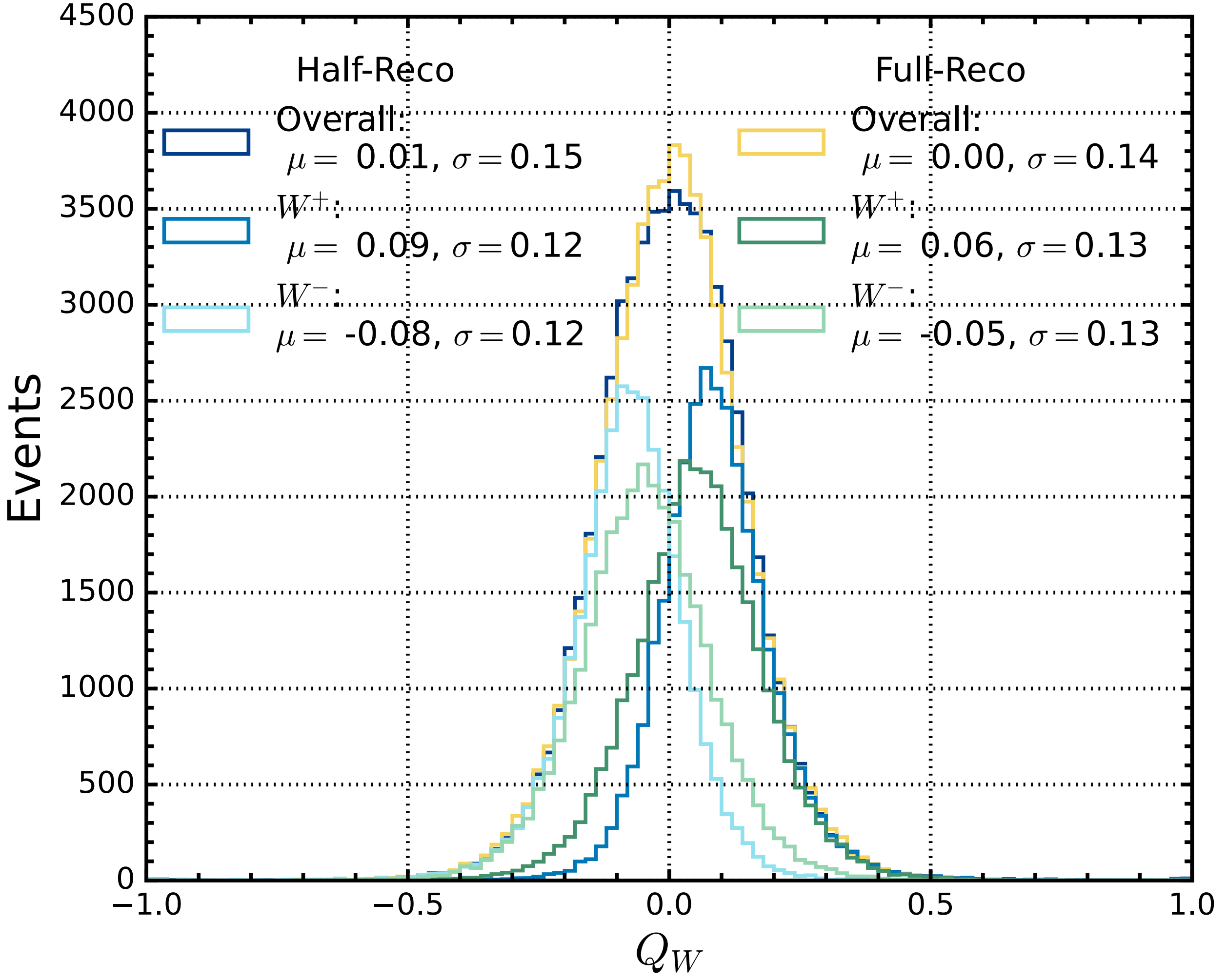
Mass of W boson

- $m_W = 82.14 \pm 5.03\ [GeV]$
  - Fit function: Chebyshev-gaussian function
  - Not optimize to measure the mass



W boson Charge

- For each jet:
  - $Q(\kappa) = \sum_{i \in J} P_i^{\kappa} Q_i / \sum_{i \in J} P_i^{\kappa}$
    - $\kappa = 0.25$
    - P_i : PFO momentum
    - Q_i: PFO charge
    - Q: Jet charge
- For W boson:
  - $Q_W = Q_{J1} + Q_{J2}$

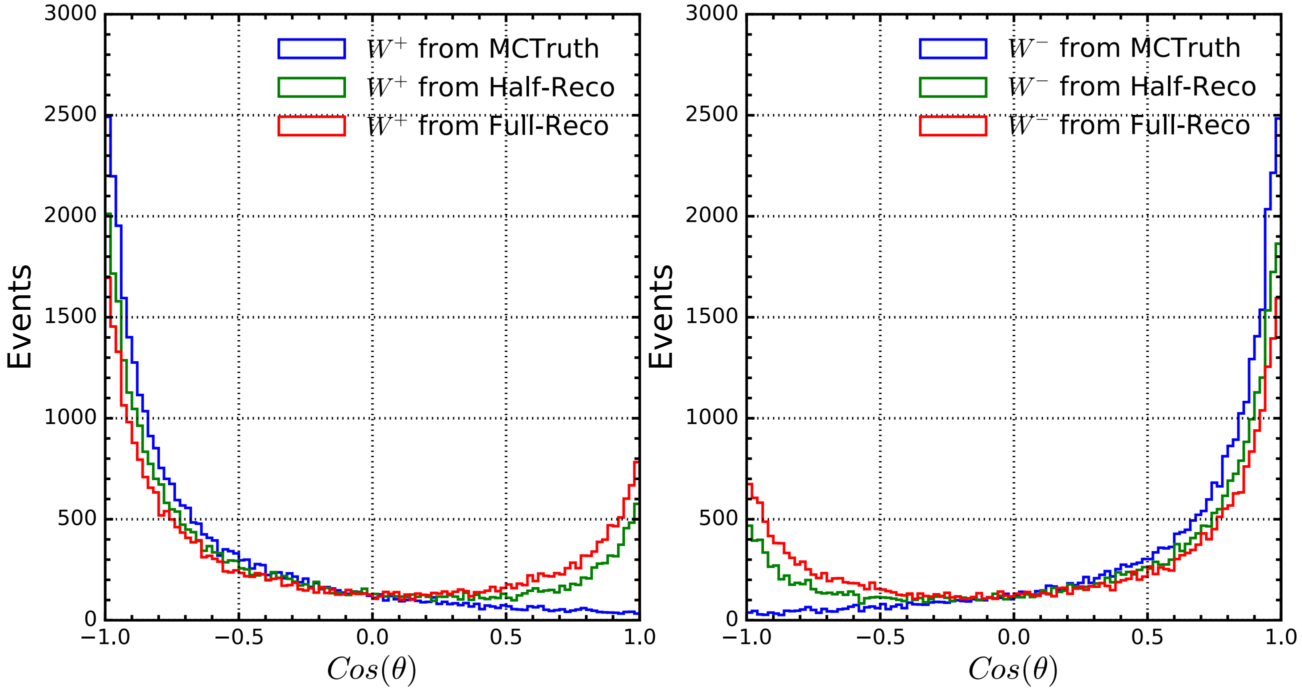


Angular distribution

Electroweak process

- Charge identification:
  - If $Q_W > 0$, this W boson is W^+.
  - If $Q_W < 0$, this W boson is W^-.

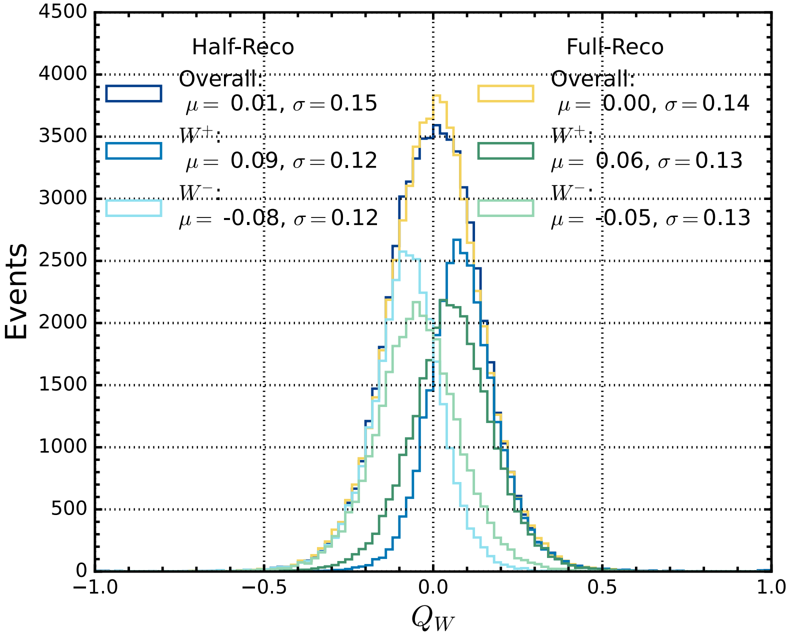
- From MCTruth to Full-Reco, more and more events migrate.
- Can be corrected by Binomial law
  - As was done in 2-fermions analysis

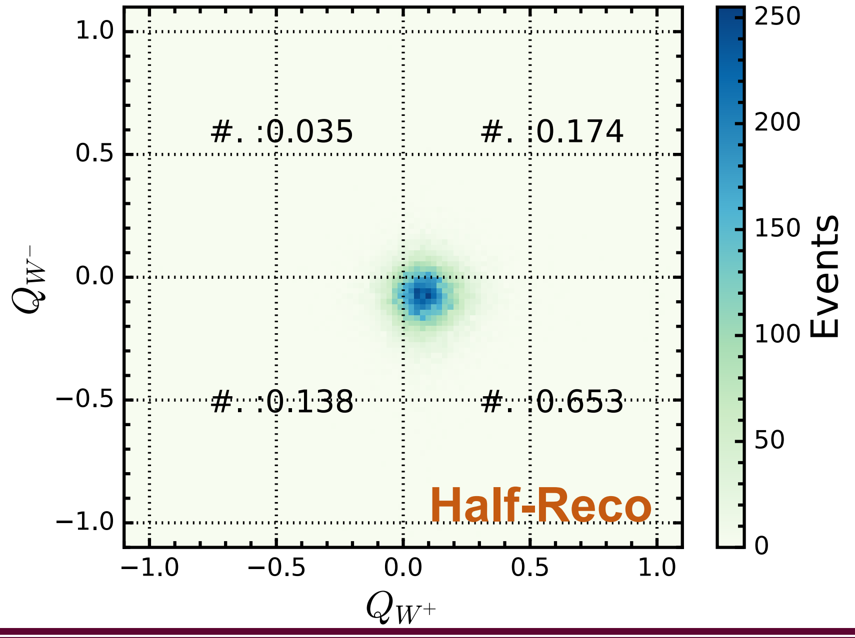


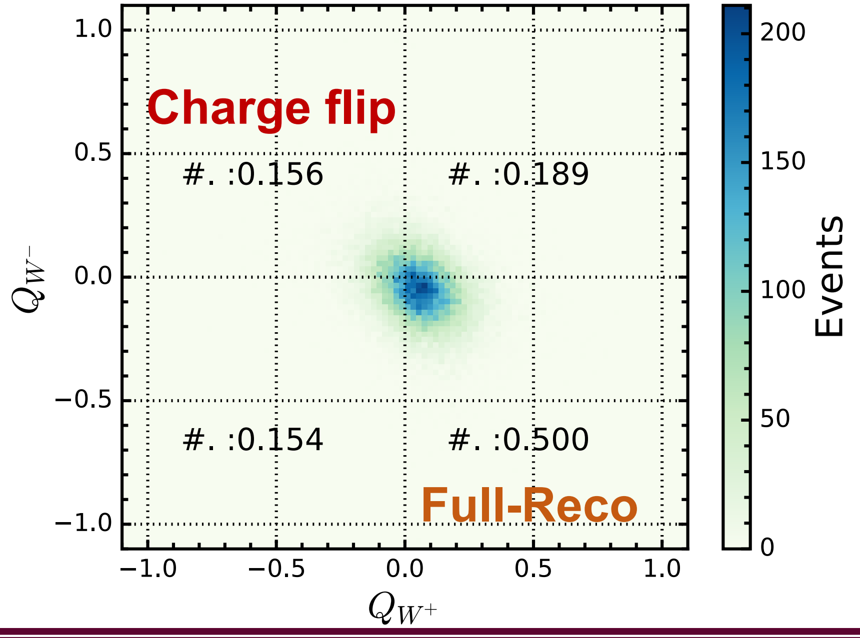
W boson Charge

From the correlation plot of Q_{W^+}/ Q_{W^-},

- Not independent between full-reco Q_{W^+}/ Q_{W^-}
  - Anti-correlation, $\rho_{X,Y} = \frac{E[(X-\mu_X)(Y-\mu_Y)]}{\sigma_X \sigma_Y}$ = -0.314
  - Jet clustering algorithm
- $p_{Q_{W^+}} > p_{Q_{W^-}}$

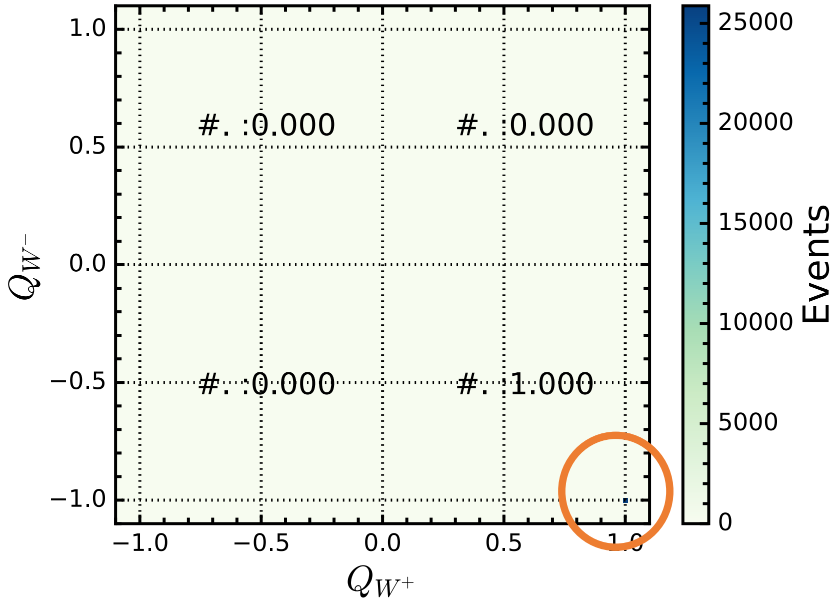


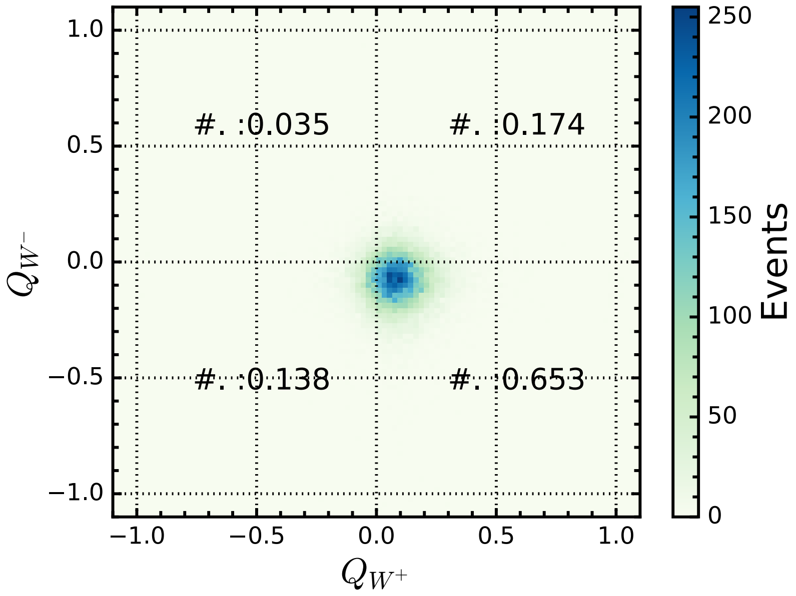


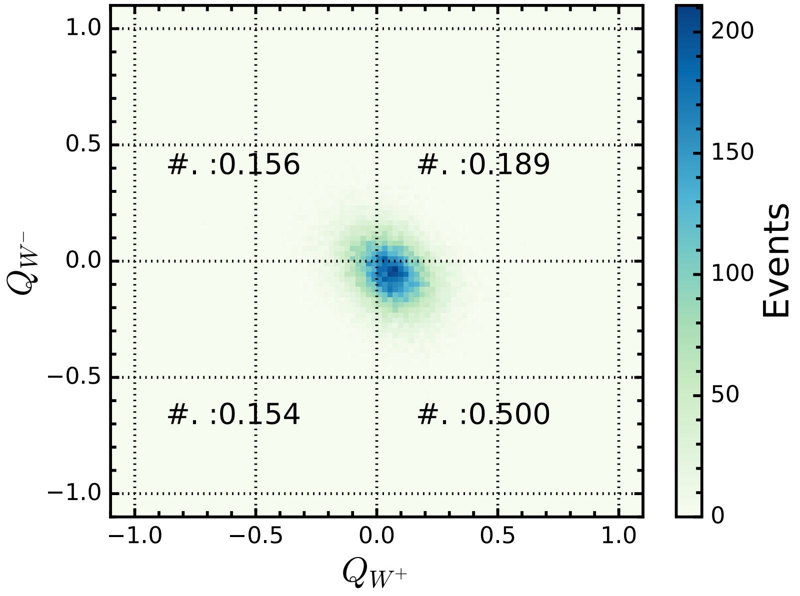


W boson Charge

MC Truth	Half-Reco	Full-Reco
Uncorrelated $p_{Q_{W^+}} = p_{Q_{W^-}}$	Uncorrelated $p_{Q_{W^+}} > p_{Q_{W^-}}$	Correlated $p_{Q_{W^+}} > p_{Q_{W^-}}$







Summary & Plans

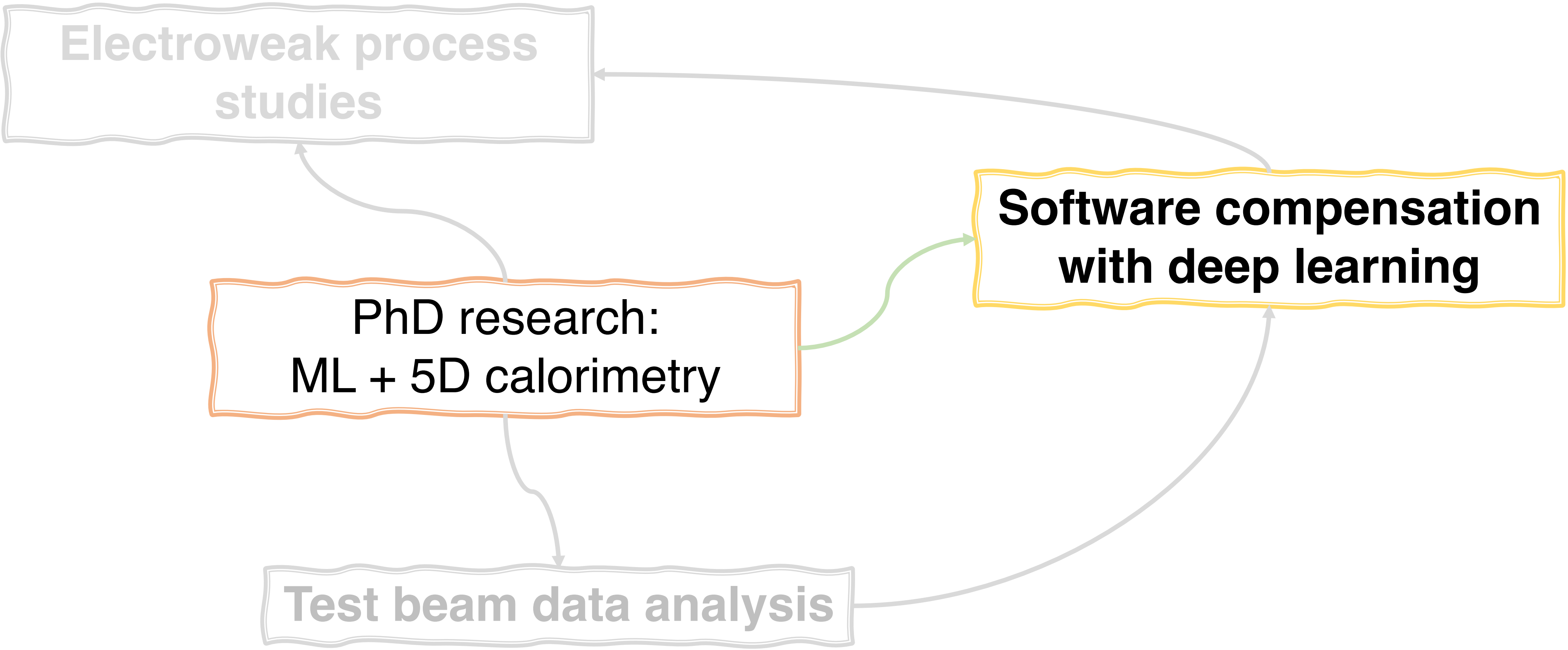
Summary:

- Developed a solid understanding of W^+/W^- reconstruction in the fully hadronic channel $e^+e^- \rightarrow W^+W^- \rightarrow 4q$ (@ 250 GeV).
- Studied and implemented the charge-weighted PFOs to measure the W charge.
- Identified a key limitation: jet clustering algorithms significantly affect charge reconstruction

Plans:

- Try other jet clustering algorithms, to assess their impact on W charge reconstruction performance.
- Explore decay-level information, including individual track charges and angular correlations.
- Develop machine learning approaches (e.g., BDTs or deep neural networks) to:
  - Refine W/jet charge determination
  - Reduce misassignments from jet clustering
- Aim to perform a full five-fold differential cross section measurement, using the reconstructed angular variables to access W helicity amplitudes and probe Triple Gauge Couplings.

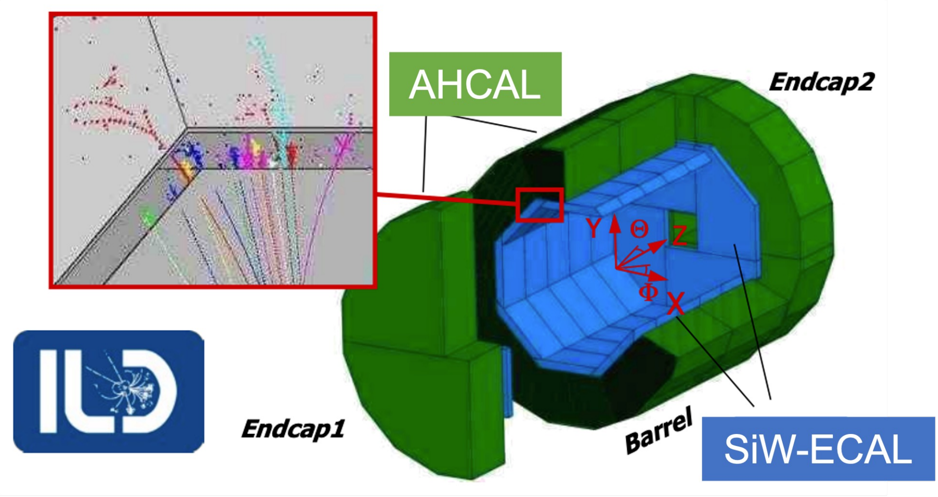
Outlines

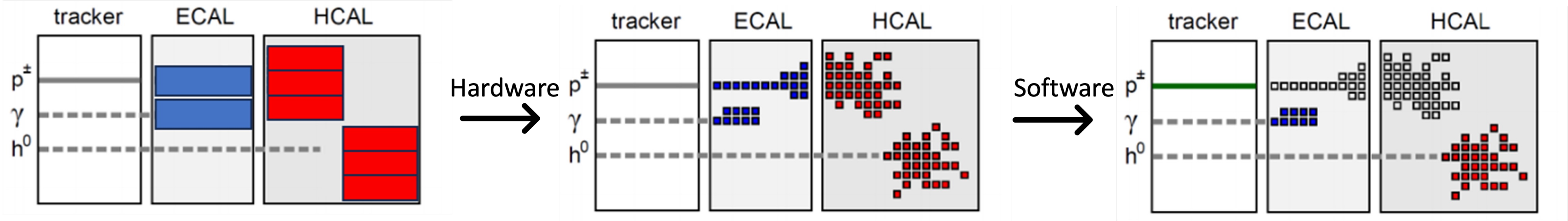


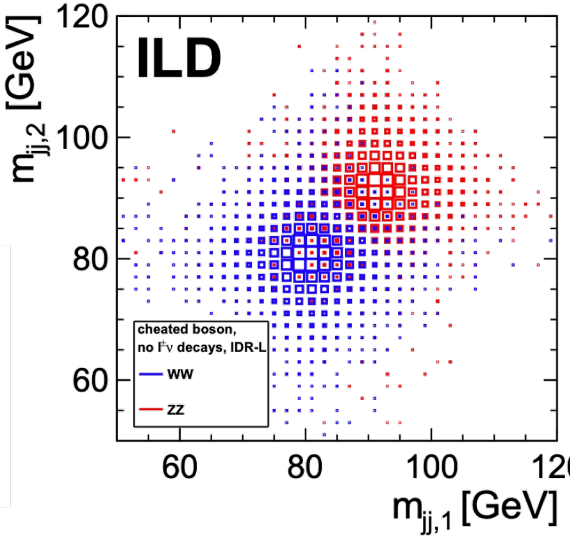
Electroweak process studies
Software compensation with deep learning
PhD research:
ML + 5D calorimetry
Test beam data analysis

Motivation | *Software compensation*

- High-precision energy measurements is essential for $W/H/Z$ studies
- Target: Jet energy resolution < $30\%/\sqrt{E}$
- A major option: Particle Flow Algorithm (PFA) + PFA-oriented detector system
  - PFA: $E_{jet} = E_{tracker} + E_{ECAL} + E_{HCAL}$
  - High granularity calorimeter (imaging):
    - SiW-ECAL + AHCAL
- $E_{ECAL} + E_{HCAL}$ as part of PFA & intrinsic performance of calorimeter

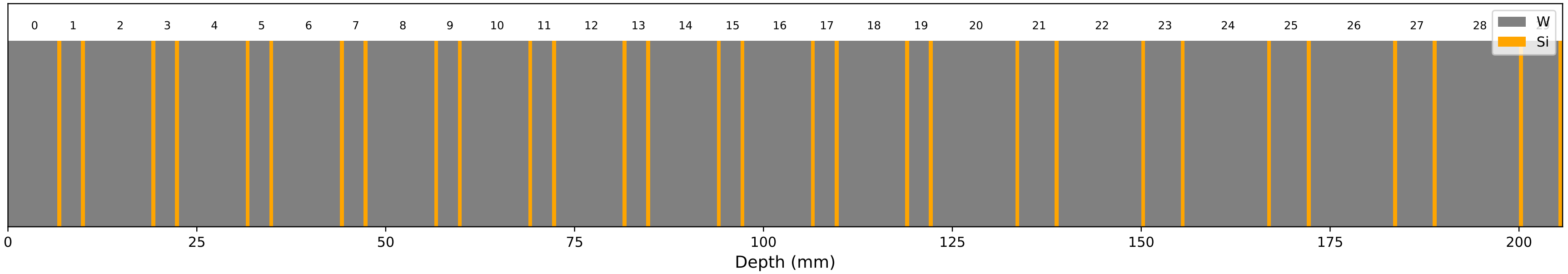






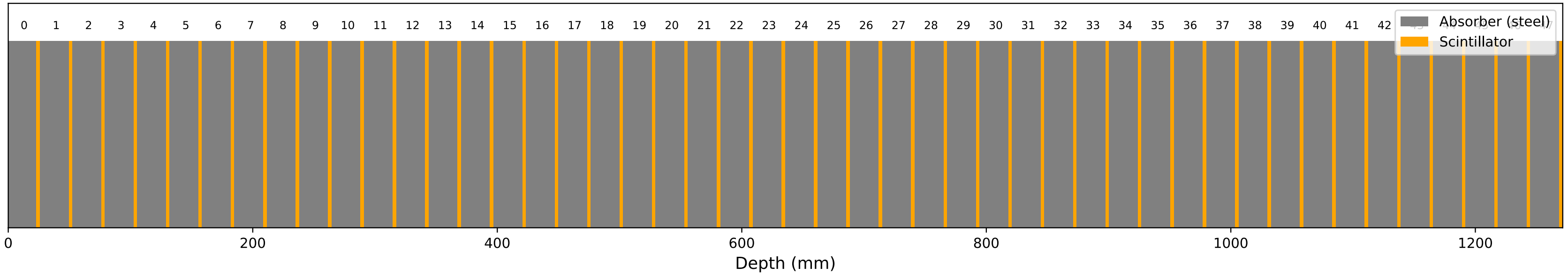
Detector introduction:

- Configuration: shown in table; Energy resolution of hadron < 60%/ $\sqrt{E}$
- Different response for electro-magnetic/hadronic shower, degrade energy measurement



SiW-ECAL

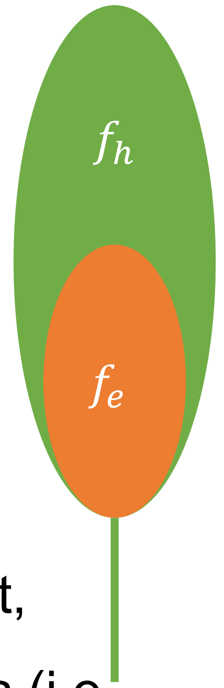
AHCAL



	#. Layers	Length	Cell size	Active material	Absorber	Type
SiW-ECAL	30 in 20 cm	~ $1\lambda_I$	0.5×0.5 cm^2	Silicon	Tungsten	Non-Compensating
AHCAL	48 in 1 m	~ $5\lambda_I$	3×3 cm^2	Scintillator	Steel	Non-Compensating

SC Algorithm

Software Compensation Algorithm:



- For a hadron in a non-compensating calorimeter
  - Have electromagnetic components (e) and hadronic components (h), e/h >1
    - $\pi = f_{em} \cdot e + (1 - f_{em}) \cdot h$
    - $E_{rec} = \frac{e}{\pi} \cdot E_{dep} = \frac{e}{f_{em} \cdot e + (1 - f_{em}) \cdot h} \cdot E_{dep} = \frac{e/h}{1 + f_{em}(e/h - 1)} \cdot E_{dep}$
      - e/h: a constant value which depends on calorimeter
      - f_{em}: generated by π^0 in hadronic shower, fluctuates strongly from event to event, Measured as the ratio of the energy deposited by electronmagnetic components (i.e., photons and $e^{\pm}$ from $\pi^0 \to \gamma\gamma$ decays) to the total deposited energy.

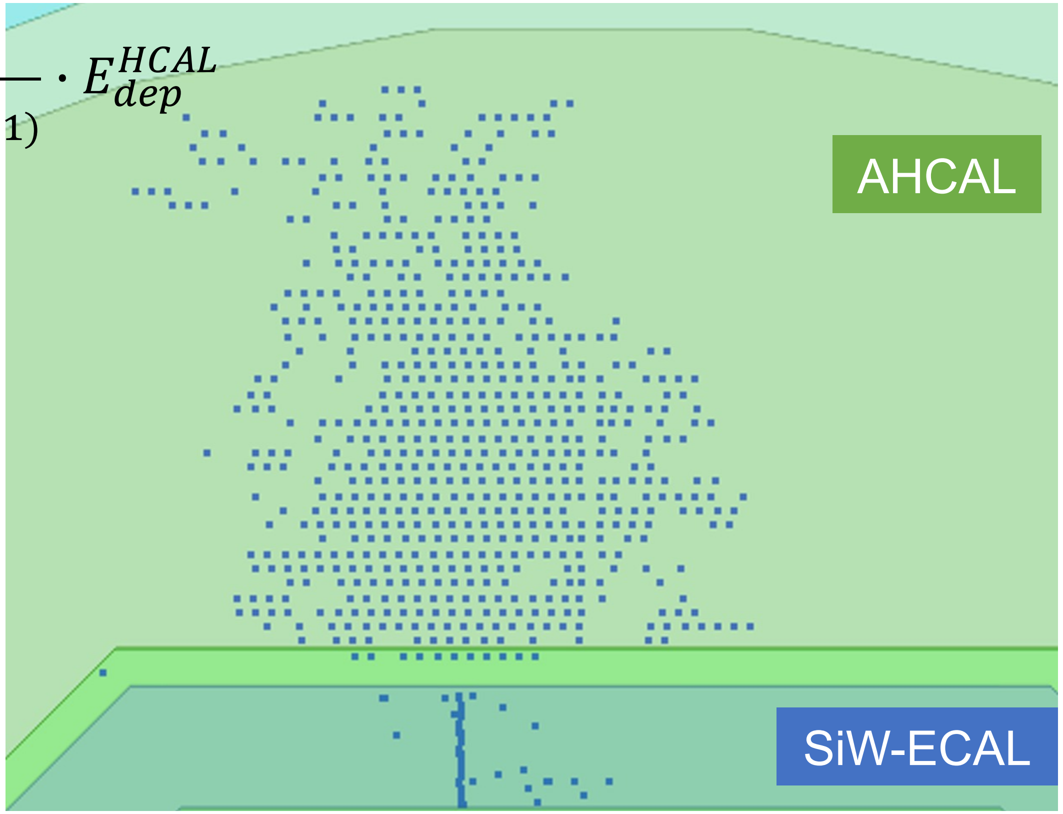
$$f_{em} = \frac{\sum_i^{em} e_i}{\sum_i^{all} e_i} \ (em\ is\ \gamma, e^{\pm}, \pi^0)$$

Software Compensation Algorithm :

- In my case, a hadron in a system (SiW-ECAL + AHCAL):

- $$E_{rec} = \frac{\left(\frac{e}{h}\right)^{ECAL}}{1 + f_{em}^{ECAL} \cdot \left(\left(\frac{e}{h}\right)^{ECAL} - 1\right)} \cdot E_{dep}^{ECAL} + \frac{\left(\frac{e}{h}\right)^{HCAL}}{1 + f_{em}^{HCAL} \cdot \left(\left(\frac{e}{h}\right)^{HCAL} - 1\right)} \cdot E_{dep}^{HCAL}$$

- f_{em}^{ECAL}
- f_{em}^{HCAL}

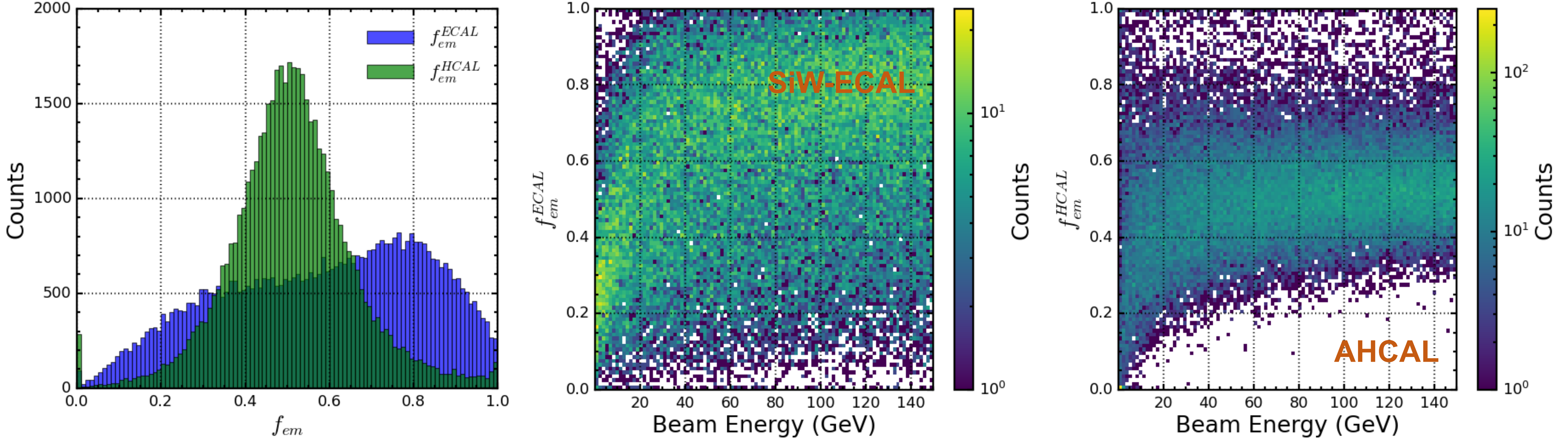


f_{em} behaviour

Software compensation

	(x, y, z)	E	t
EM component	Narrow, compact, shorter	Higher density	Prompt
Hadronic component	Broader, longer	Lower, spread out	Delayed components

- f_{em} fluctuates strongly from event to event
- How to determine f_{em} event-by-event basis?
  - Dual-readout techniques
  - Rich input from imaging calorimeter + Marchine Learning (Pytorch + CNN)



Work flow

Software compensation

Identify targets: f_{em} → Simulation Reconstruction → Data preparation & pre-analysis → Training → Results: f_{em}

Simulation Reconstruction

Platform	:	NAF Desy
Tool	:	dd4hep
Geometry	:	ILD
Particle	:	π^+ (QGSP_BERT)
Energy range	:	0 – 150 GeV
Data set	:	1 million
Output	:	.slcio

Data preparation & pre-analysis

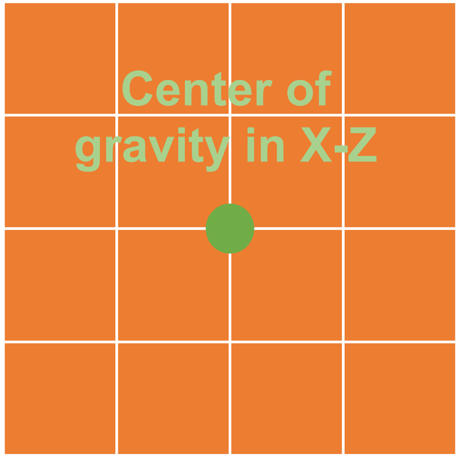
Platform	:	Openstack
Output	:	.root file

Training

Platform	:	Ruche (UPSaclay)
Frame	:	Pytorch
Model	:	Dual-branch 3D CNN
Output	:	.pth

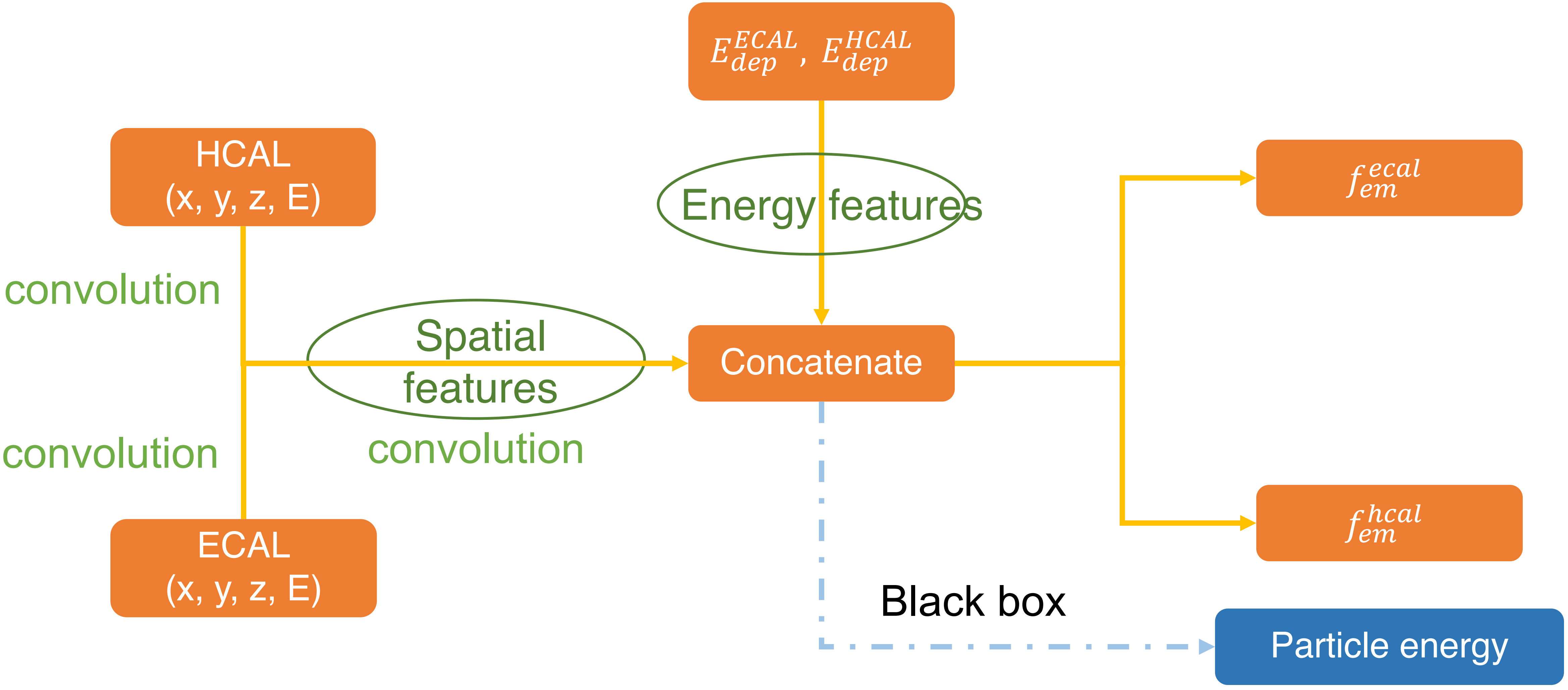
Challenges

- **Environment Setup**
  - Issue: PyTorch GPU training requires CUDA; incompatible versions cause installation conflicts
  - Solution: Try multiple versions to match system & PyTorch
- **Input Shape & Model Design**
  - Issue:
    - Voxel input per event extremely large (~100M channels)
    - Total dataset size too big for disk/memory; I/O very slow
  - Solution:
    - Center voxel grid using shower COG to reduce input size



- **Data Handling & Shuffling**
  - Issue:
    - 1M events (1k energies × 1k events); train/val/test split should reflect full spectrum, not block by energy
    - random access in .h5 is slow
    - Full shuffling causes OOM
  - Solution:
    - Use pre-chunked .h5 shards, mimic shuffle while avoiding OOM

Software compensation

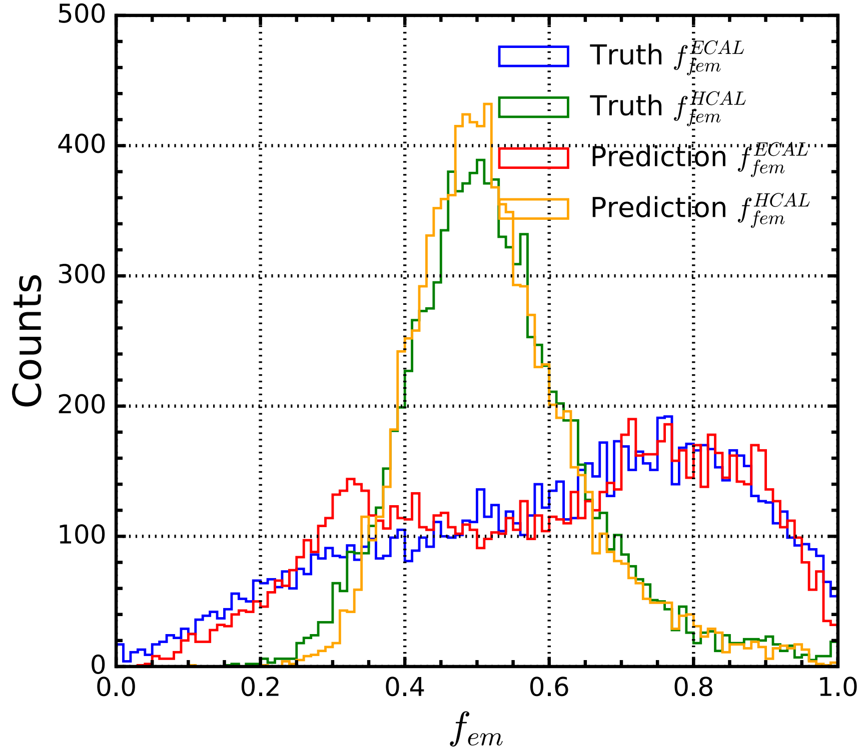


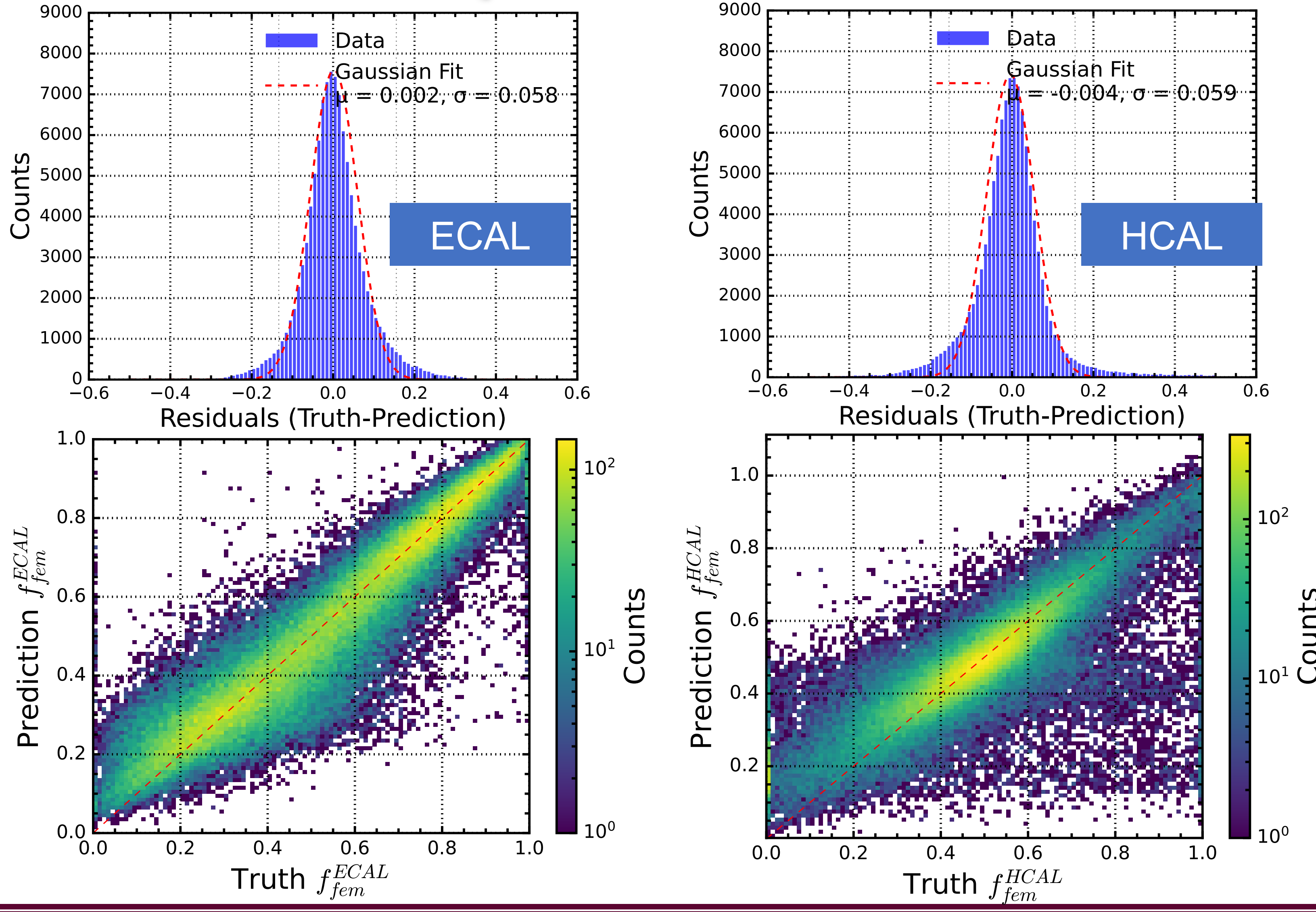
Results - f_{em}

Software compensation

Results for f_{em}^{ECAL} and f_{em}^{HCAL} :

- Shows good consistency between truth and prediction





Summary & Plans

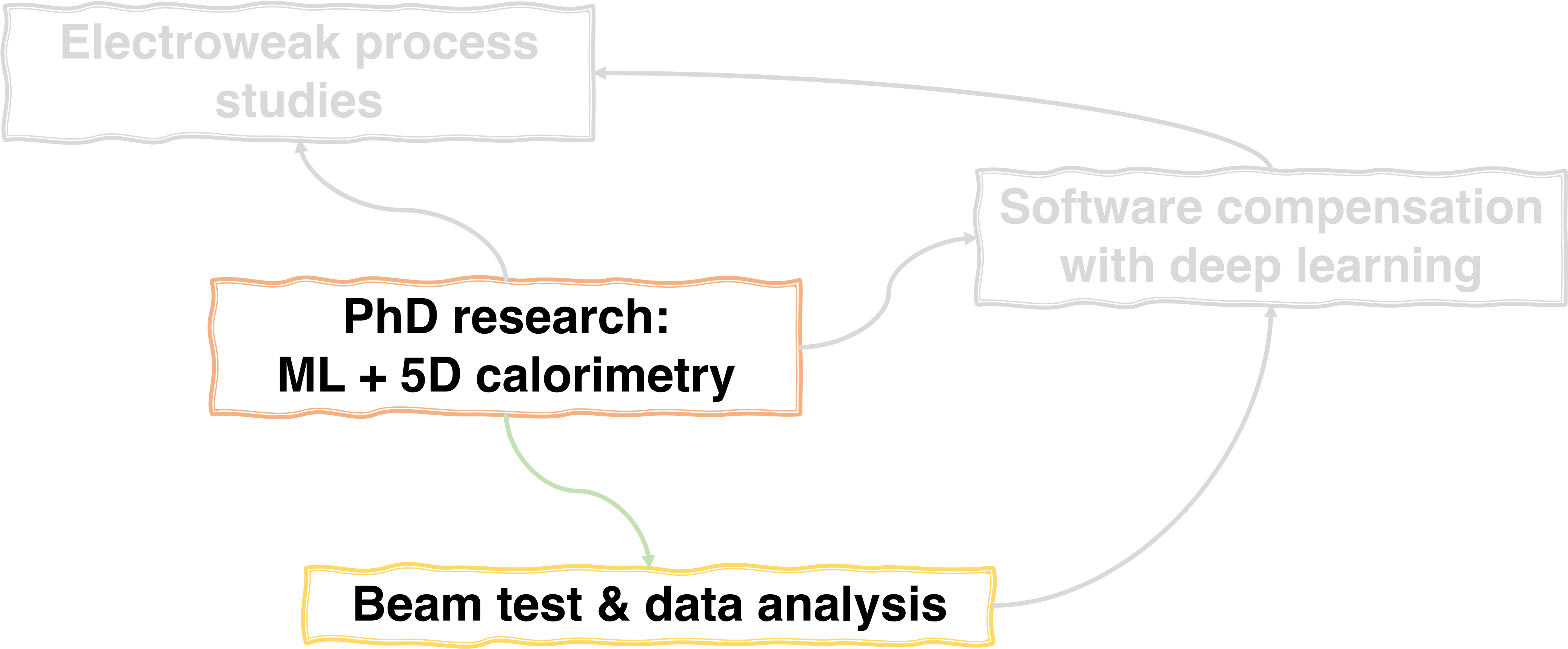
Summary:

- Full ML-based compensation chain established
- f_{em} (ECAL & HCAL) regression model shows accurate predictions

Plans:

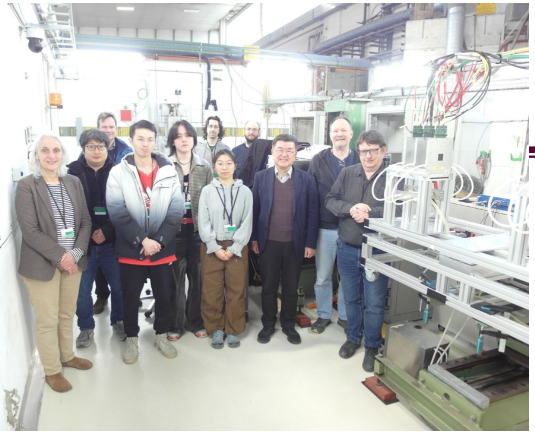
- Determine the energy resolution based on fem (first-step results in back-up)
- Expolit timing information to enhance performance
- *Test alternative physics lists for better hadronic modeling*
- *Explore other advanced architectures: GNNs, Transformers, etc.*

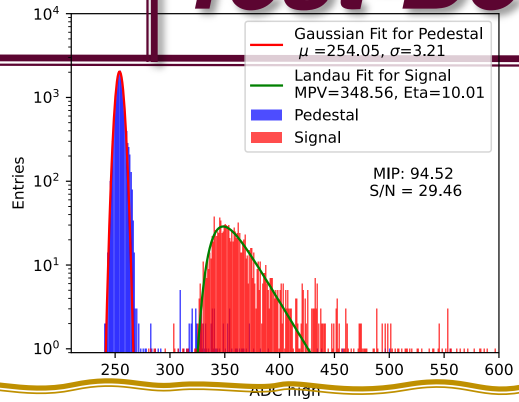
Outlines


Electroweak process studies
Software compensation with deep learning
PhD research:
ML + 5D calorimetry
Beam test & data analysis

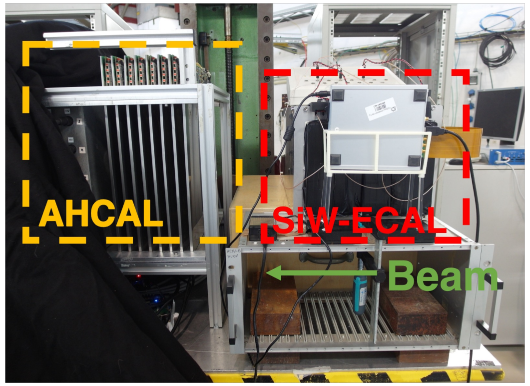
My work

Test-Beam





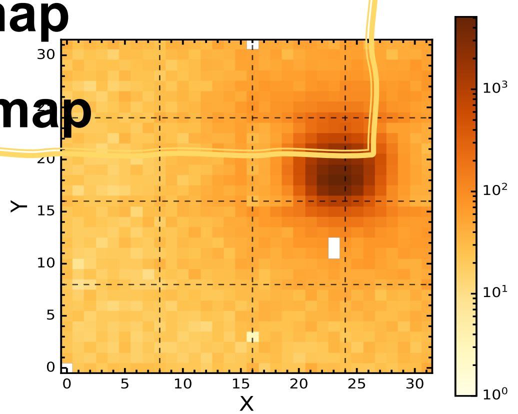
Beam test experiment



My work

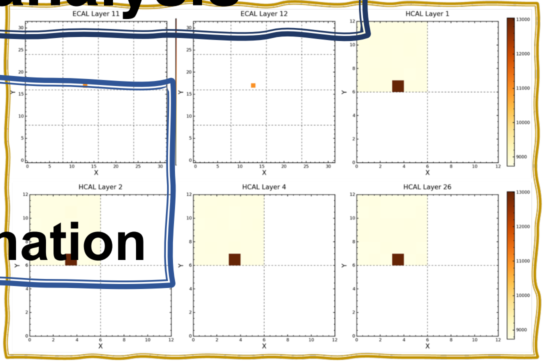
ECAL alone analysis

- S/N ratio
- Pedestal map
- Hit map
- MIP map



ECAL+HCAL analysis

- Bunch crossing ID match
- Event display for ECAL+HCAL combination



Beam test & data analysis

The result was presented on DRD Calo 2025 Collaboration Meeting

14:05 → 14:15 **DESY2025-03 Signal and Noise studies**

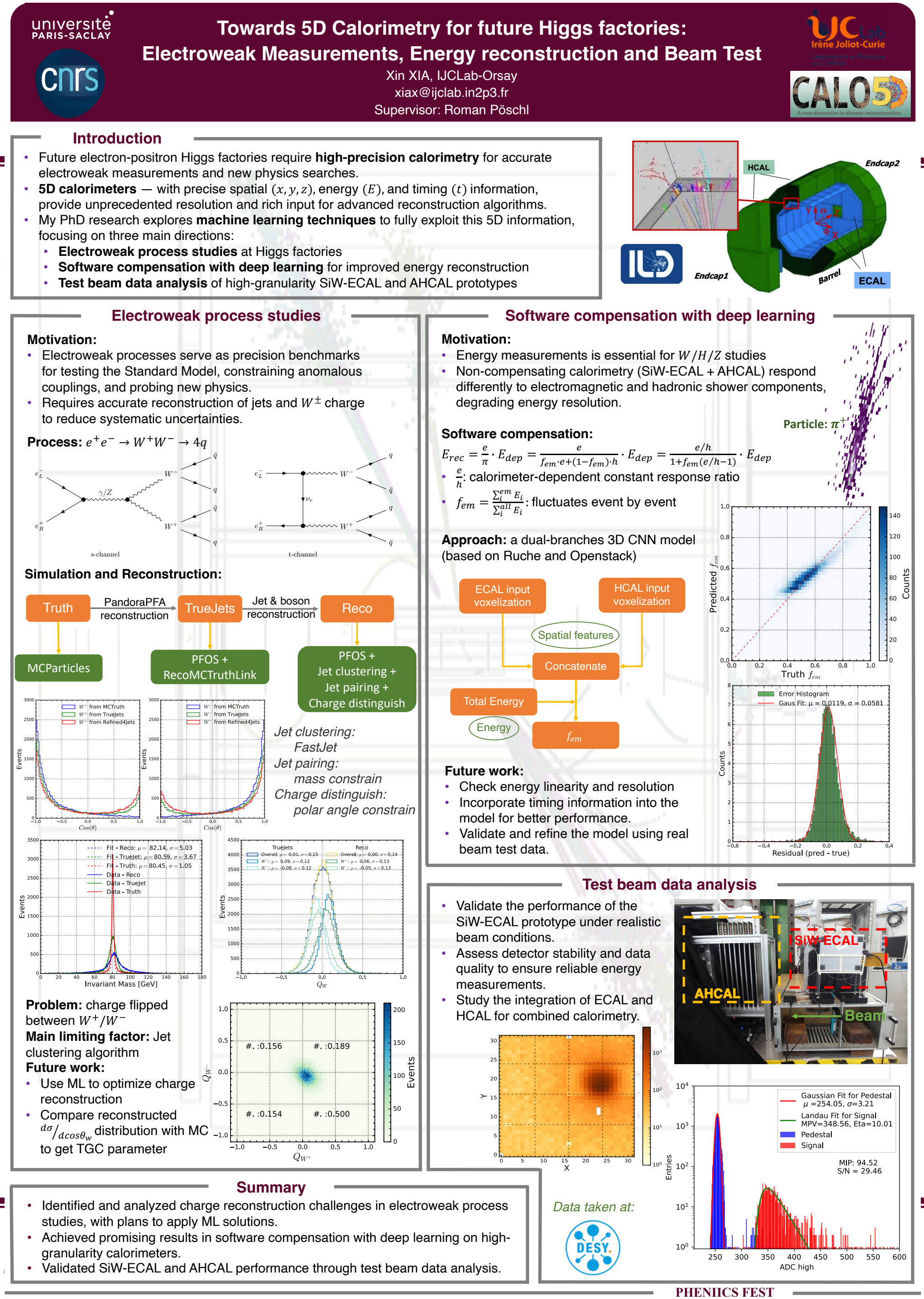
报告人: Xin Xia, Xin Xia (Université Paris-Saclay (FR))

Beamtest_results.pdf

Training courses

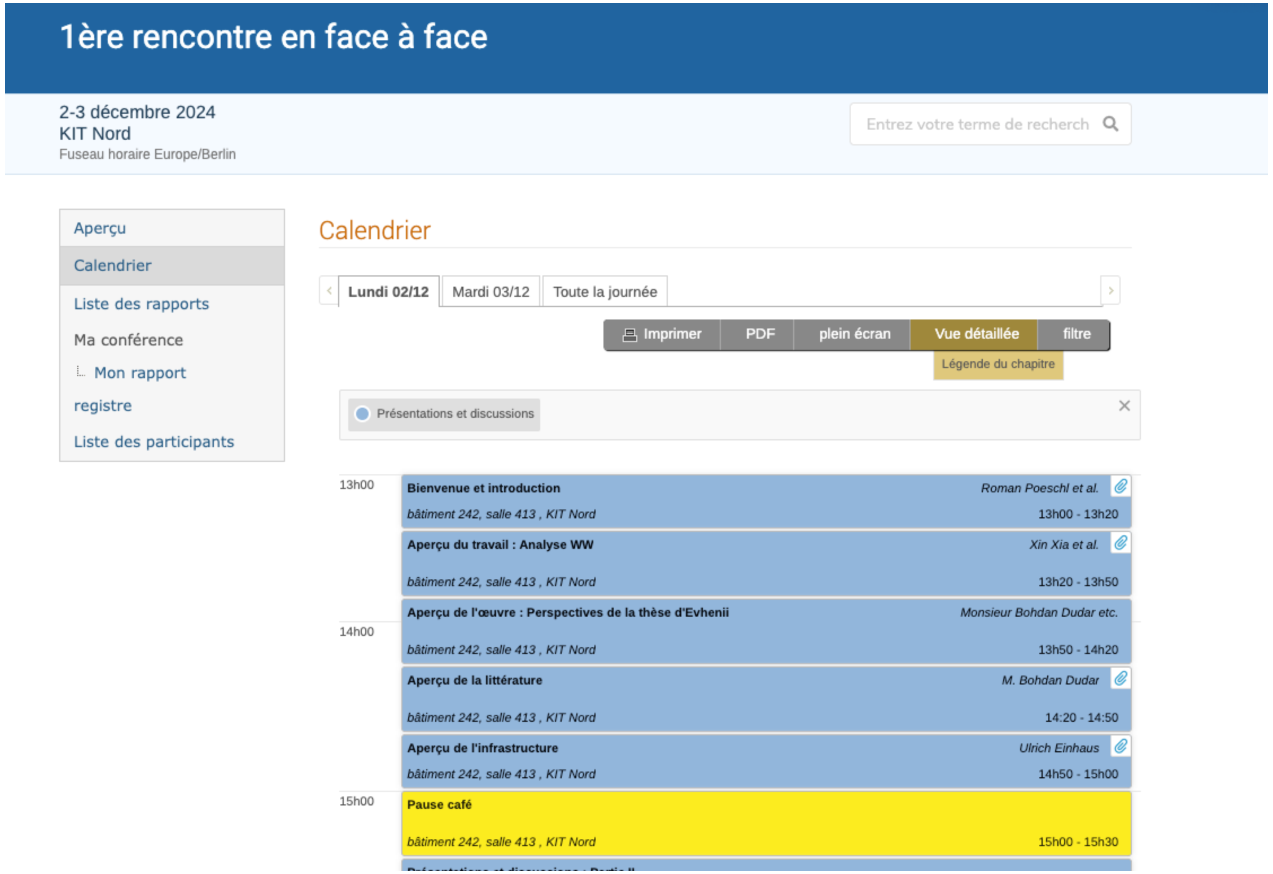
Category	Courses	Points
Reinforcing scientific culture	Understanding basic principles of particle accelerators	5
Methods, tools, techniques and concepts for conducting doctoral research	Paris-Saclay Computing Center Howto	1
	The training for new users of the Mesocenter	1
Communication skills	French course A1	6
Prepare professional future	the 10th edition of the Workshop Perspectives	2
Sustainable development	Enjeux de la transition écologique (SPOC)	1
Research ethics and scientific integrity	MOOC Ethique de la recherche et intégrité scientifique	1
Leading a professional team	Veiller à la qualité de vie au travail	1
In total		**18 / 25**

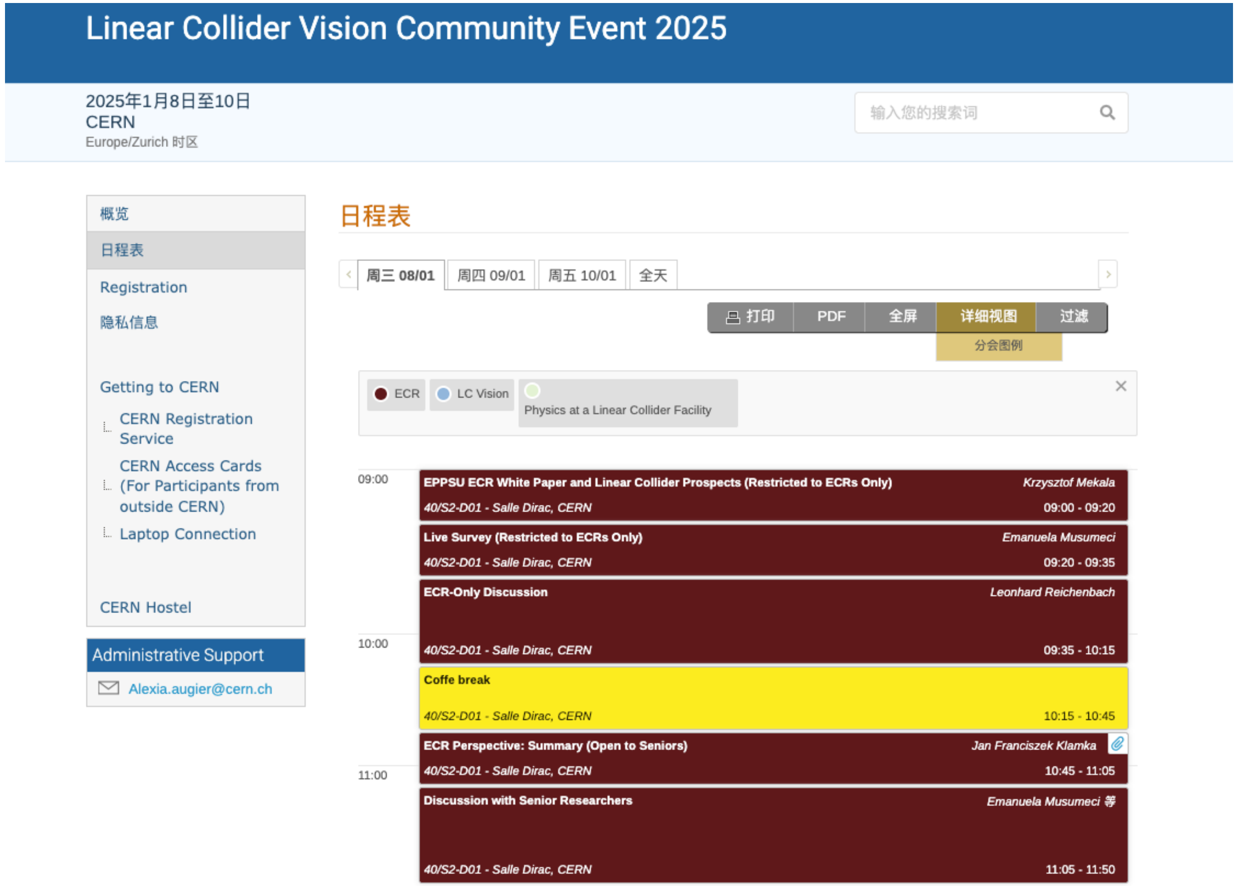
PhD Fest



Towards 5D Calorimetry for future Higgs factories:
Electroweak Measurements, Energy reconstruction and Beam Test
Xin XIA, IJCLab-Orsay
xiax@ijclab.in2p3.fr
Supervisor: Roman Pöschl
Introduction
Future electron-positron Higgs factories require high-precision calorimetry for accurate electroweak measurements and new physics searches.
5D calorimeters — with precise spatial (x, y, z), energy (E), and timing (t) information, provide unprecedented resolution and rich input for advanced reconstruction algorithms.
My PhD research explores machine learning techniques to fully exploit this 5D information, focusing on three main directions:
Electroweak process studies at Higgs factories
Software compensation with deep learning for improved energy reconstruction
Test beam data analysis of high-granularity SiW-ECAL and AHCAL prototypes
HCAL
Endcap2
Endcap1
Barrel
ECAL
Electroweak process studies
Motivation:
Electroweak processes serve as precision benchmarks for testing the Standard Model, constraining anomalous couplings, and probing new physics.
Requires accurate reconstruction of jets and $W^{\pm}$ charge to reduce systematic uncertainties.
Process: $e^+e^- \to W^+W^- \to 4q$
s-channel
t-channel
Simulation and Reconstruction:
Truth
PandoraPFA reconstruction
TrueJets
Jet & boson reconstruction
Reco
MCParticles
PFOS + RecoMCTruthLink
PFOS + Jet clustering + Jet pairing + Charge distinguish
Jet clustering: FastJet
Jet pairing: mass constrain
Charge distinguish: polar angle constrain
Invariant Mass [GeV]
Problem: charge flipped between W^+/W^-
Main limiting factor: Jet clustering algorithm
Future work:
Use ML to optimize charge reconstruction
Compare reconstructed $d\sigma/dcos\theta_w$ distribution with MC to get TGC parameter
Software compensation with deep learning
Motivation:
Energy measurements is essential for W/H/Z studies
Non-compensating calorimetry (SiW-ECAL + AHCAL) respond differently to electromagnetic and hadronic shower components, degrading energy resolution.
Particle: π^+
Software compensation:
$E_{rec} = \frac{e}{\pi} \cdot E_{dep} = \frac{e}{f_{em} \cdot e + (1-f_{em}) \cdot h} \cdot E_{dep} = \frac{e/h}{1+f_{em}(e/h-1)} \cdot E_{dep}$
$\frac{e}{h}$: calorimeter-dependent constant response ratio
$f_{em} = \frac{\sum_i^{em} E_i}{\sum_i^{all} E_i}$: fluctuates event by event
Approach: a dual-branches 3D CNN model (based on Ruche and Openstack)
ECAL input voxelization
HCAL input voxelization
Spatial features
Concatenate
Total Energy
Energy
f_{em}
Predicted f_{em}
Truth f_{em}
Counts
Error Histogram
Gaus Fit: μ = 0.0119, σ = 0.0581
Residual (pred - true)
Future work:
Check energy linearity and resolution
Incorporate timing information into the model for better performance.
Validate and refine the model using real beam test data.
Test beam data analysis
Validate the performance of the SiW-ECAL prototype under realistic beam conditions.
Assess detector stability and data quality to ensure reliable energy measurements.
Study the integration of ECAL and HCAL for combined calorimetry.
SiW-ECAL
AHCAL
Beam
Gaussian Fit for Pedestal
Landau Fit for Signal
Pedestal
Signal
MIP: 94.52
S/N = 29.46
ADC high
Entries
Data taken at:
DESY.
Summary
Identified and analyzed charge reconstruction challenges in electroweak process studies, with plans to apply ML solutions.
Achieved promising results in software compensation with deep learning on high-granularity calorimeters.
Validated SiW-ECAL and AHCAL performance through test beam data analysis.
PHENIICS FEST

Meetings


1ère rencontre en face à face
2-3 décembre 2024
KIT Nord
Fuseau horaire Europe/Berlin
Entrez votre terme de recherch
Aperçu
Calendrier
Liste des rapports
Ma conférence
Mon rapport
registre
Liste des participants
Calendrier
Lundi 02/12
Mardi 03/12
Toute la journée
Imprimer
PDF
plein écran
Vue détaillée
filtre
Légende du chapitre
Présentations et discussions
13h00
Bienvenue et introduction
Roman Poeschl et al.
bâtiment 242, salle 413 , KIT Nord
13h00 - 13h20
Aperçu du travail : Analyse WW
Xin Xia et al.
bâtiment 242, salle 413 , KIT Nord
13h20 - 13h50
Aperçu de l'œuvre : Perspectives de la thèse d'Evhenii
Monsieur Bohdan Dudar etc.
14h00
bâtiment 242, salle 413 , KIT Nord
13h50 - 14h20
Aperçu de la littérature
M. Bohdan Dudar
bâtiment 242, salle 413 , KIT Nord
14:20 - 14:50
Aperçu de l'infrastructure
Ulrich Einhaus
bâtiment 242, salle 413 , KIT Nord
14h50 - 15h00
15h00
Pause café
bâtiment 242, salle 413 , KIT Nord
15h00 - 15h30


Linear Collider Vision Community Event 2025
2025年1月8日至10日
CERN
Europe/Zurich 时区
输入您的搜索词
概览
日程表
Registration
隐私信息
Getting to CERN
CERN Registration Service
CERN Access Cards (For Participants from outside CERN)
Laptop Connection
CERN Hostel
Administrative Support
Alexia.augier@cern.ch
日程表
周三 08/01
周四 09/01
周五 10/01
全天
打印
PDF
全屏
详细视图
过滤
分会图例
ECR
LC Vision
Physics at a Linear Collider Facility
09:00
EPPSU ECR White Paper and Linear Collider Prospects (Restricted to ECRs Only)
Krzysztof Mekala
40/S2-D01 - Salle Dirac, CERN
09:00 - 09:20
Live Survey (Restricted to ECRs Only)
Emanuela Musumeci
40/S2-D01 - Salle Dirac, CERN
09:20 - 09:35
ECR-Only Discussion
Leonhard Reichenbach
10:00
40/S2-D01 - Salle Dirac, CERN
09:35 - 10:15
Coffe break
40/S2-D01 - Salle Dirac, CERN
10:15 - 10:45
ECR Perspective: Summary (Open to Seniors)
Jan Franciszek Klamka
40/S2-D01 - Salle Dirac, CERN
10:45 - 11:05
11:00
Discussion with Senior Researchers
Emanuela Musumeci 等
40/S2-D01 - Salle Dirac, CERN
11:05 - 11:50

Merci beaucoup!

Backup

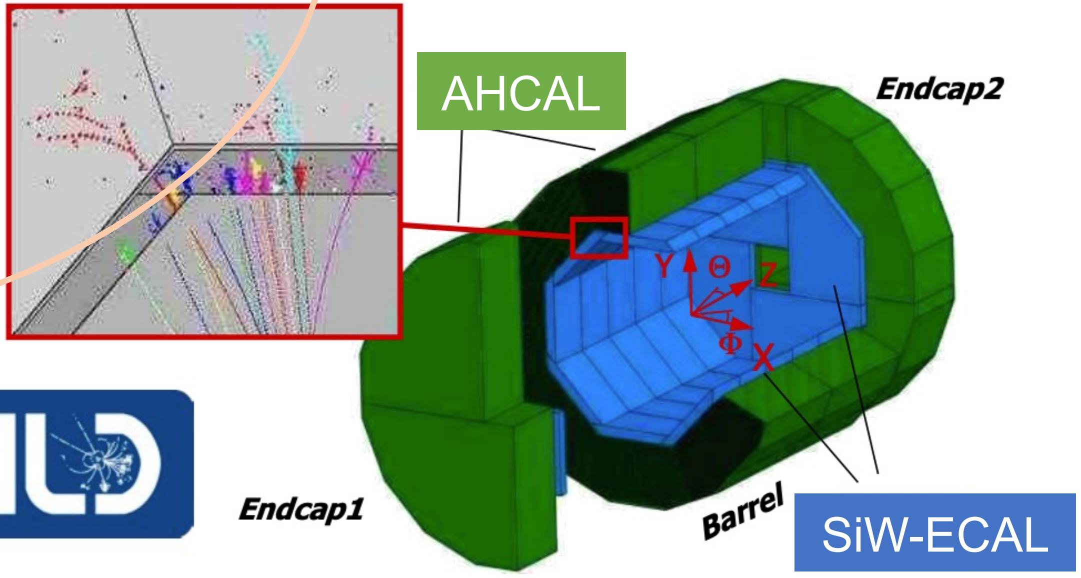
Introduction

Electroweak process studies

PhD research: ML + 5D calorimetry

Software compensation with deep learning

Beam-test experiment



Jet clustering → FastJet algorithm

Jet pairing → $|(Jet_i + Jet_j)$.Mass-80.4$|$ +$|(Jet_k + Jet_l)$.Mass-80.4$|$

$W1 = Jet_i + Jet_j$, $W2 = Jet_k + Jet_l$

Charge distinguish →

$$\sqrt{(\theta_{W_1} - \theta_{W_+})^2 + (\varphi_{W_1} - \varphi_{W_+})^2} + \sqrt{(\theta_{W_2} - \theta_{W_-})^2 + (\varphi_{W_2} - \varphi_{W_-})^2} < \sqrt{(\theta_{W_1} - \theta_{W_-})^2 + (\varphi_{W_1} - \varphi_{W_-})^2} + \sqrt{(\theta_{W_2} - \theta_{W_+})^2 + (\varphi_{W_2} - \varphi_{W_+})^2)},$$

W1 is W^+, *W2* is W^-

Electroweak process studies

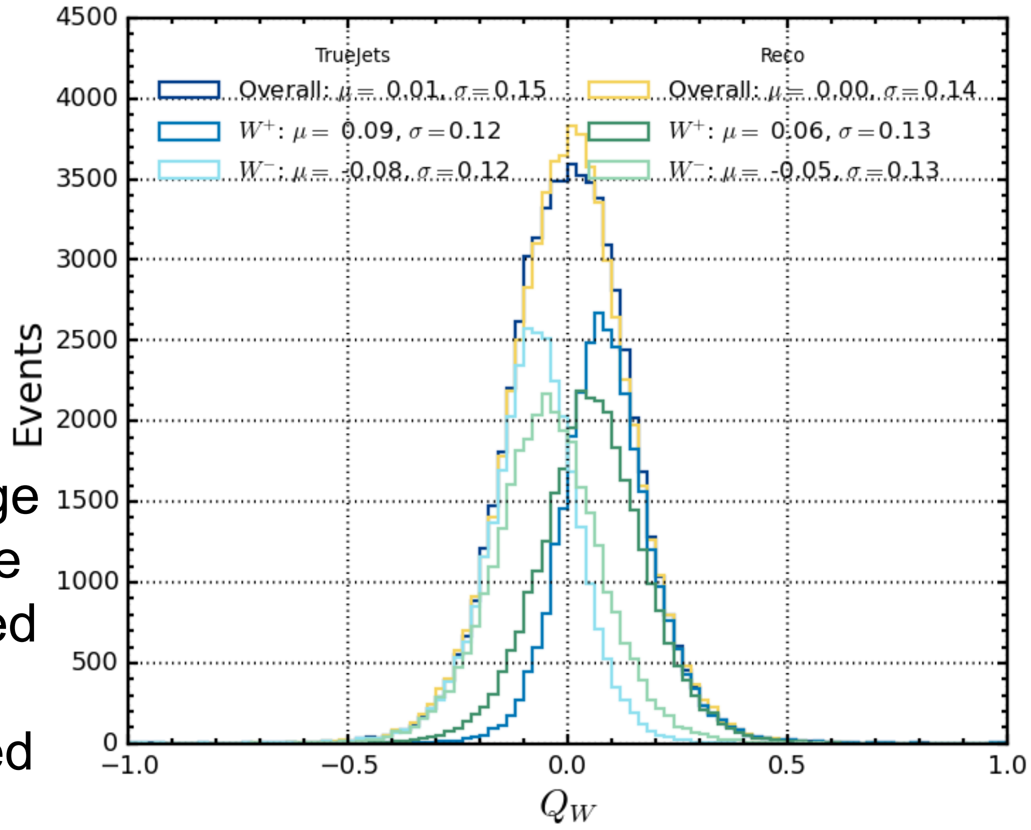
p,q method to quantify the charge identification power.

- $N_{acc} = N \cdot p^2 + N \cdot q^2$
- $N_{rej} = 2 \cdot N \cdot p \cdot q$
- $p + q = 1$
- $N_{acc} + N_{rej} = N$

Here the:

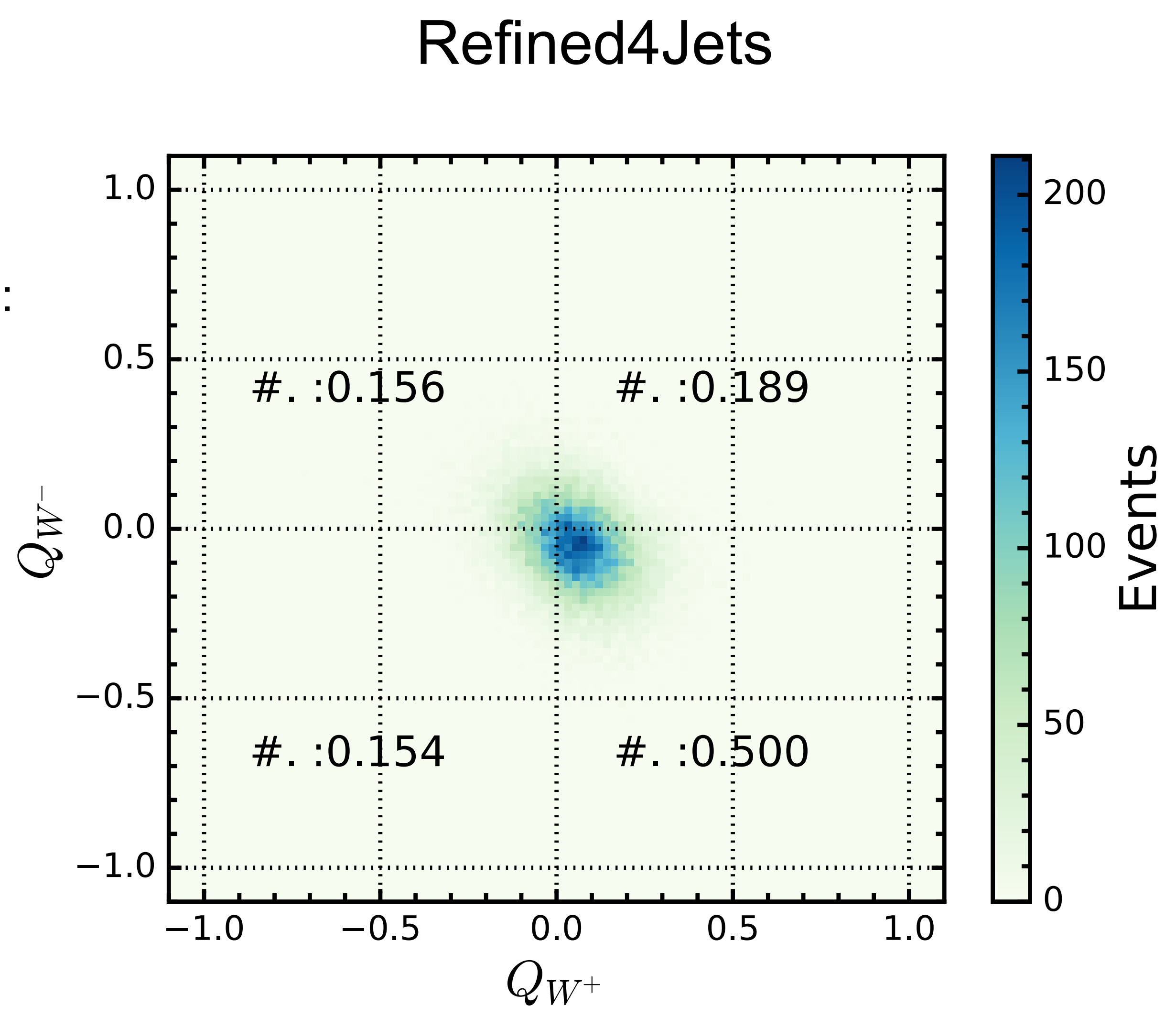
- N : total number of events
- p : probability of correctly identifying the generated W charge
- q : probability of wrongly identifying the generated W charge
- $N \cdot p^2$: number of events that both W^+ and W^- are identified
- correctly
- $N \cdot q^2$: number of events that both W^+ and W^- are identified
- wrongly
- $2 \cdot N \cdot p \cdot q$: one is identified correctly, one is identified wrongly

So p = 0.5 + 0.5$\cdot \sqrt{2 \cdot \frac{N_{acc}}{N} - 1}$



Electroweak process studies

- For the W^+ identified by MCtruth information, fill their reconstructed charge in x axis
- For the W^- identified by MCtruth information, fill their reconstructed charge in y axis
- From the right plot, We can observe that:
  - Anti-correlation, lots of events are charge-flipped, :
  - Ratio of (Q_{W^+}< 0 and Q_{W^-} > 0): 0.156, these events are charge flipped.
    - q^2 = 0.156, q = 0.395
  - Ratio of (Q_{W^+}< 0 and Q_{W^-} > 0): 0.500, these events are what we wanted.
    - p^2 = 0.500, p = 0.707
  - Very clear that $p + q \neq 1$
- Probabilities of correctly identifying the generated W^+ /W^- charge are not equal.
  - p_{W^+} = 0.689
  - p_{W^-} = 0.654
  - Bias = (N_{W^+} - N_{W^-})/ $\sqrt{(N_{W^+} - N_{W^-})}$= 5.3$\sigma$



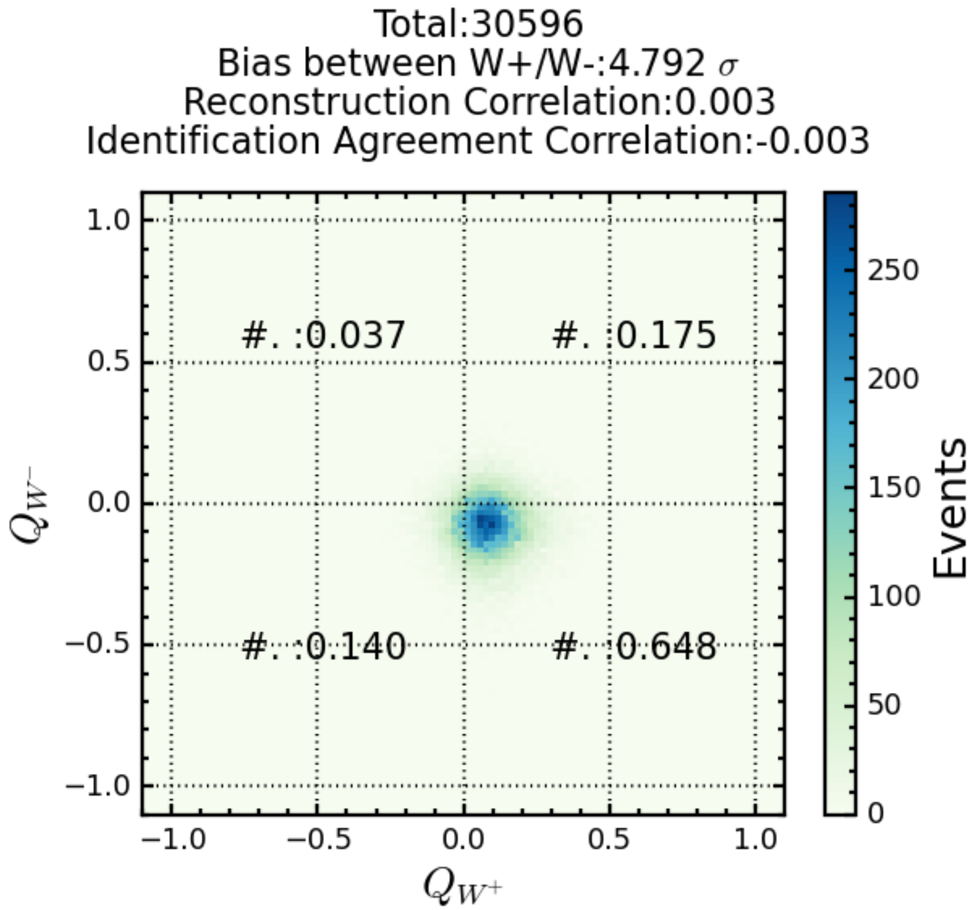
Electroweak process studies

From the right plot, We can observe that:

- p-q method works :
  - Ratio of (Q_{W^+} < 0 and Q_{W^-} > 0): 0.037, these events are charge flipped.
    - q^2 = 0.037, q = 0.192
  - Ratio of (Q_{W^+} < 0 and Q_{W^-} < 0): 0.648, these events are what we wanted.
    - p^2 = 0.648, p = 0.805
  - $p + q \approx 1$

- Probabilities of correctly identifying the generated W^+ / W^- charge are not equal.
  - p_{W^+} = 0.823
  - p_{W^-} = 0.788
  - Bais = (N_{W^+} - N_{W^-})/ $\sqrt{(N_{W^+} - N_{W^-})}$ = 4.8σ

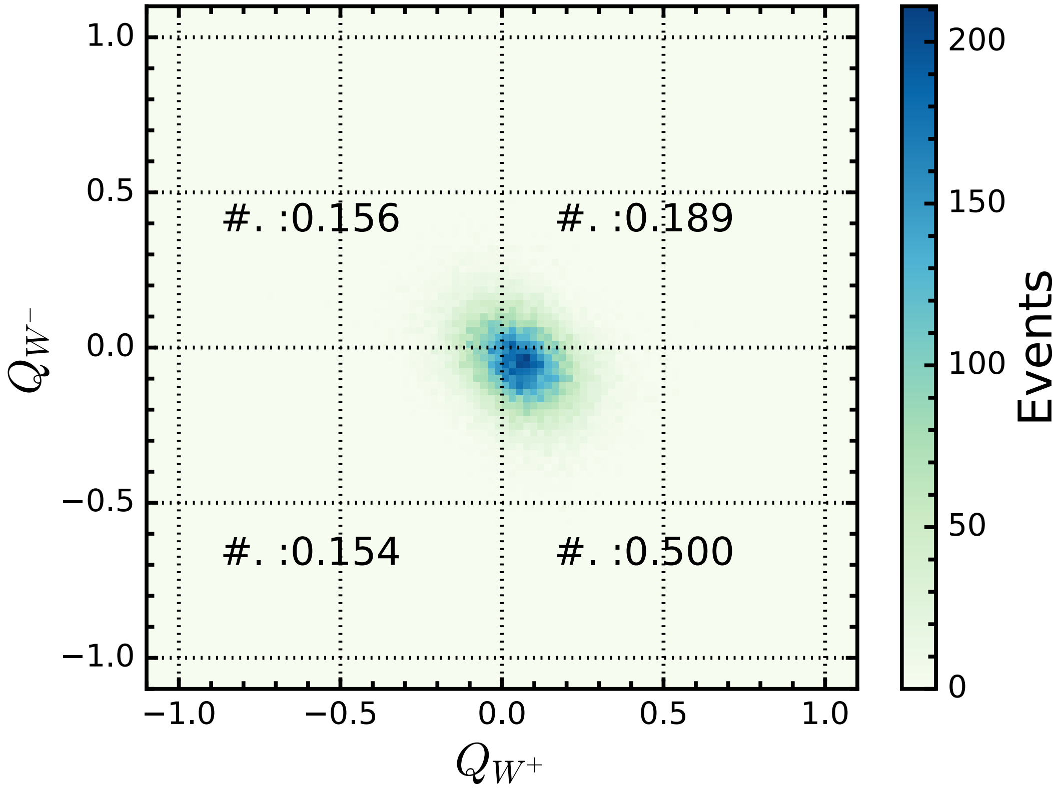
TrueJets



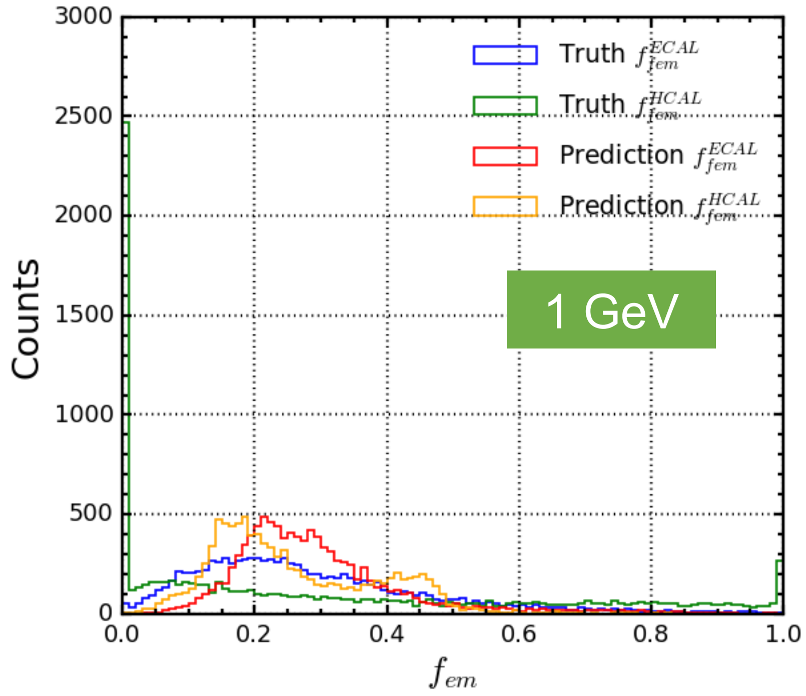
Electroweak process studies

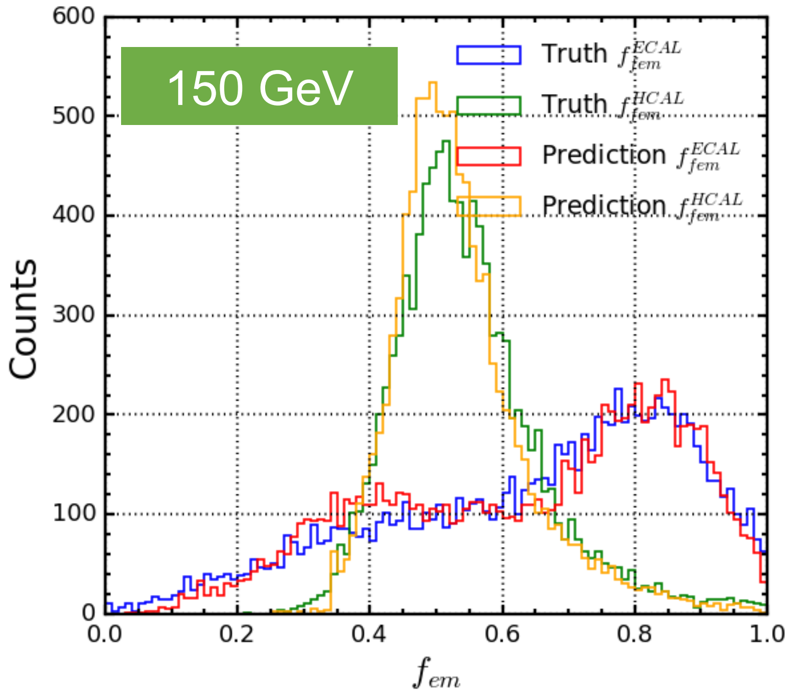
The reason of anti-correlation:

- Jet clustering algorithm
  - The reconstructed of W^+ and W^- are not independent.
  - If W^+ loses a charged PFO, W^- will gain a charged PFO. And vice versa
- If one of PFO^+ in W^+ is classified into W^-
  - $W^+ \rightarrow W^-$, $W^- \rightarrow W^+$
- If one of PFO^- in W^- is classified into W^+
  - $W^+ \rightarrow W^-$, $W^- \rightarrow W^+$
- If one of PFO^- in W^+ is classified into W^-
  - $W^+ \rightarrow W^+$, $W^- \rightarrow W^-$
- If one of PFO^+ in W^- is classified into W^+
  - $W^+ \rightarrow W^+$, $W^- \rightarrow W^-$
- $\rho_{X,Y} = \frac{E[(X-\mu_X)(Y-\mu_Y)]}{\sigma_X \sigma_Y}$ = -0.314

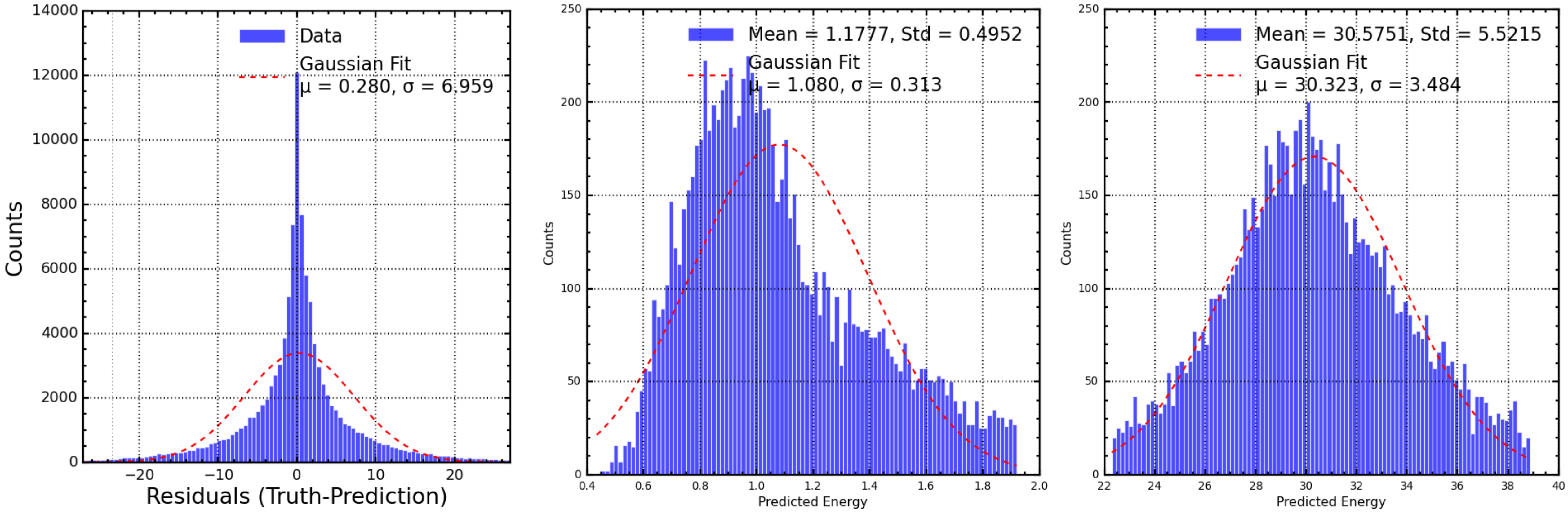


Results - f_{em} | *Software compensation*





Software compensation

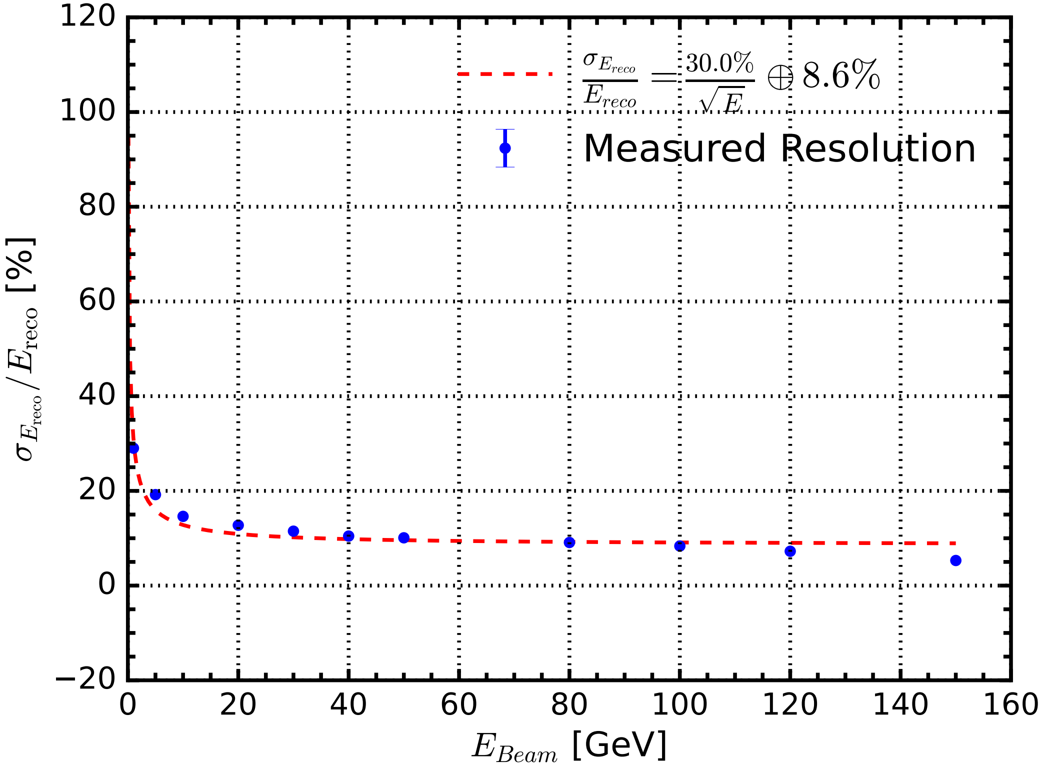


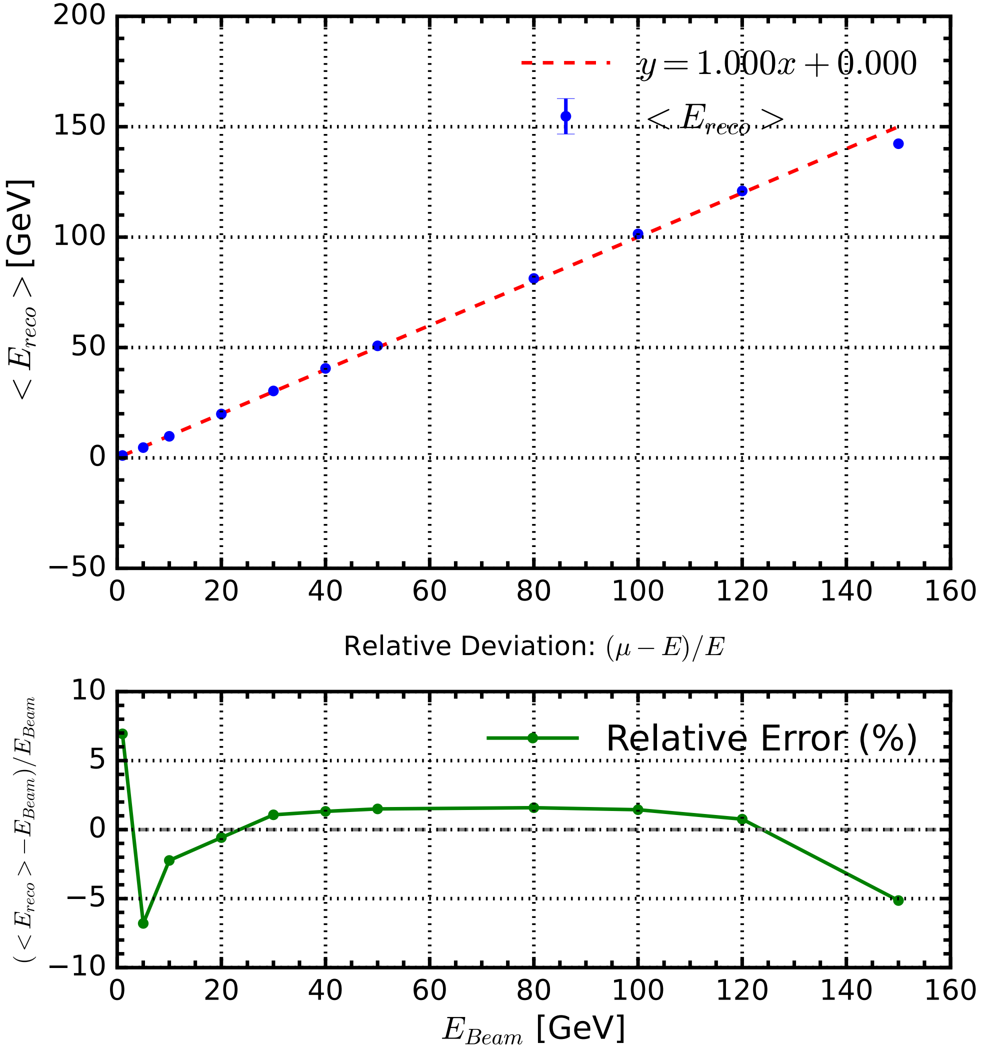
Results - Energy

Software compensation

Results for particle energy:

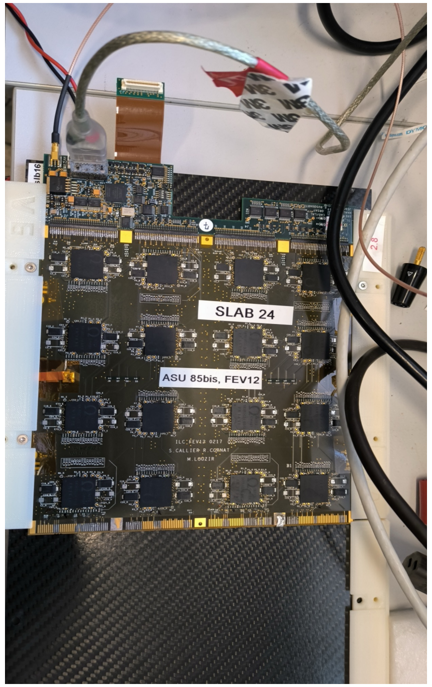
- Energy resolution: S = 30.0% $\sqrt{GeV}$; C = 8.6%
- Energy linearity: in 7 %

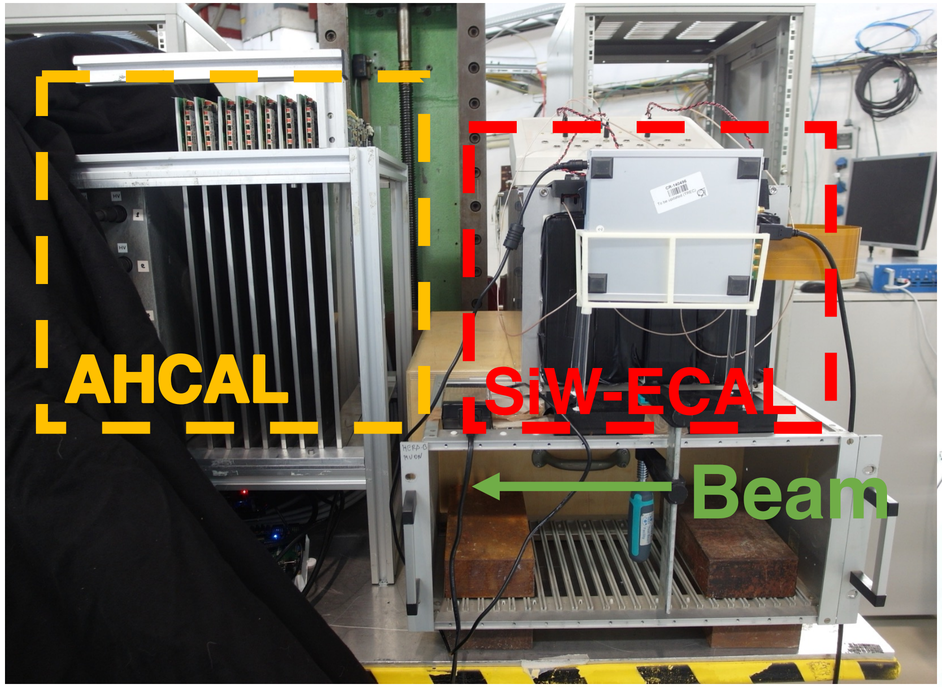


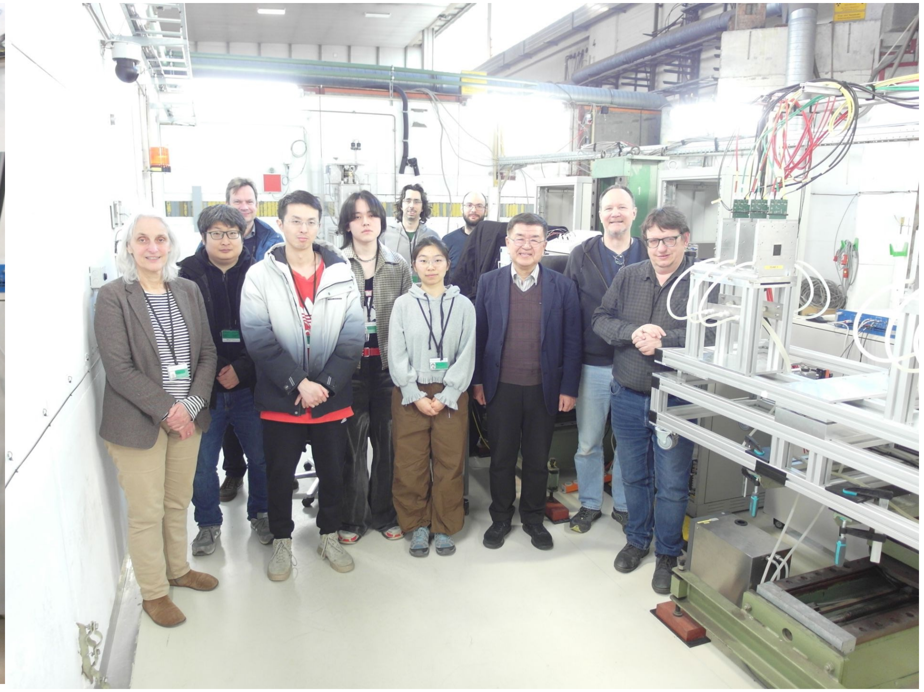


Beam test at DESY:

- Take part in the beam-test experiment from 02/03/2025 to 10/03/2025
- Prototype: SiW-ECAL and AHCAL







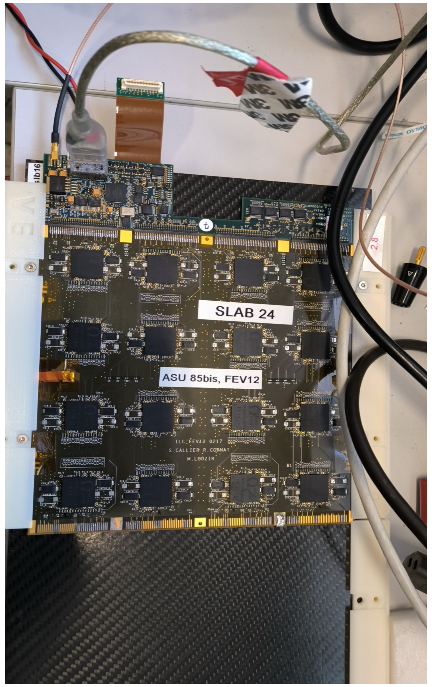
Beam test & data analysis

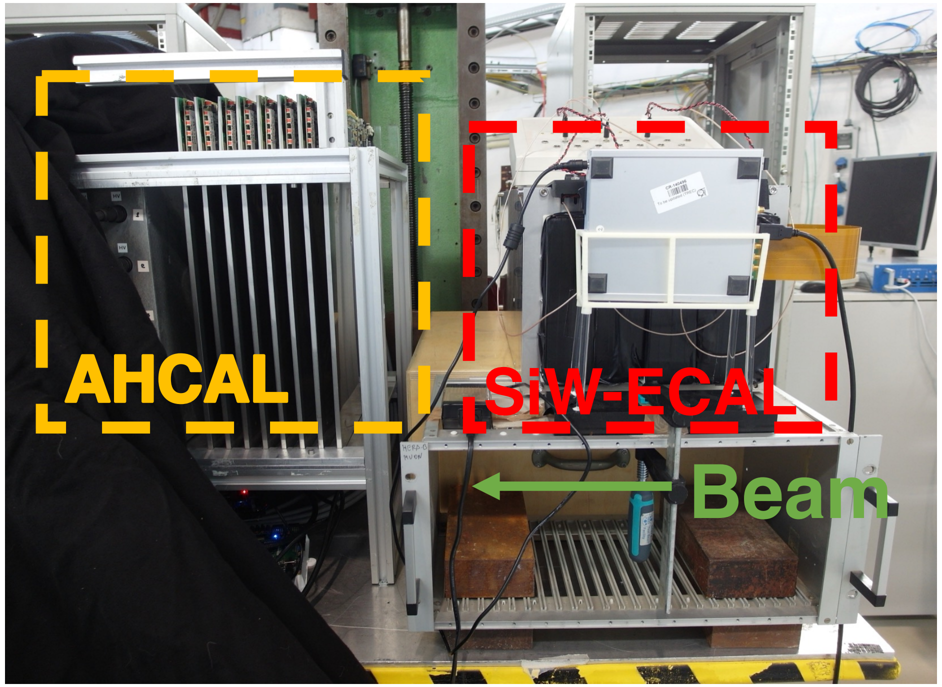
ECAL geometry

- 3 layers
  - 1 chip on board, 2 produced recently
  - 16 SKIROC chips
  - 32×32 cells: $5.5 \times 5.5\ mm^2$
  - No absorbers

Data Taking

- ECAL:Mar 4th - Mar 6th
  - Configuration and calibration
  - Position scan
- ECAL+HCAL: Mar 7th – Mar 8th
  - Configuration and calibration
  - Position scan
  - TDC test

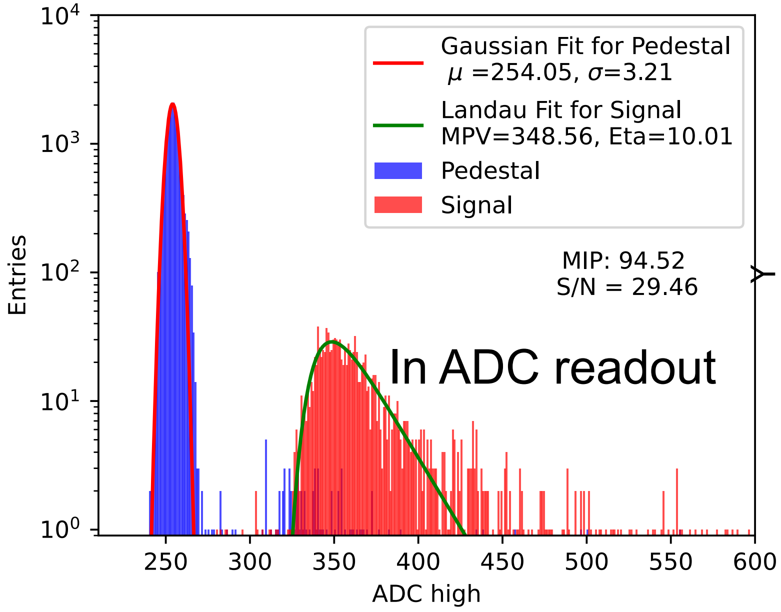


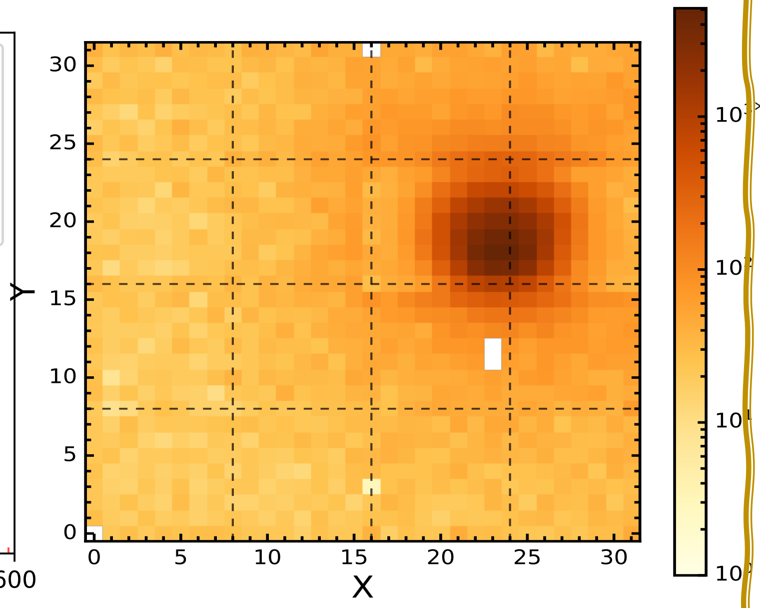


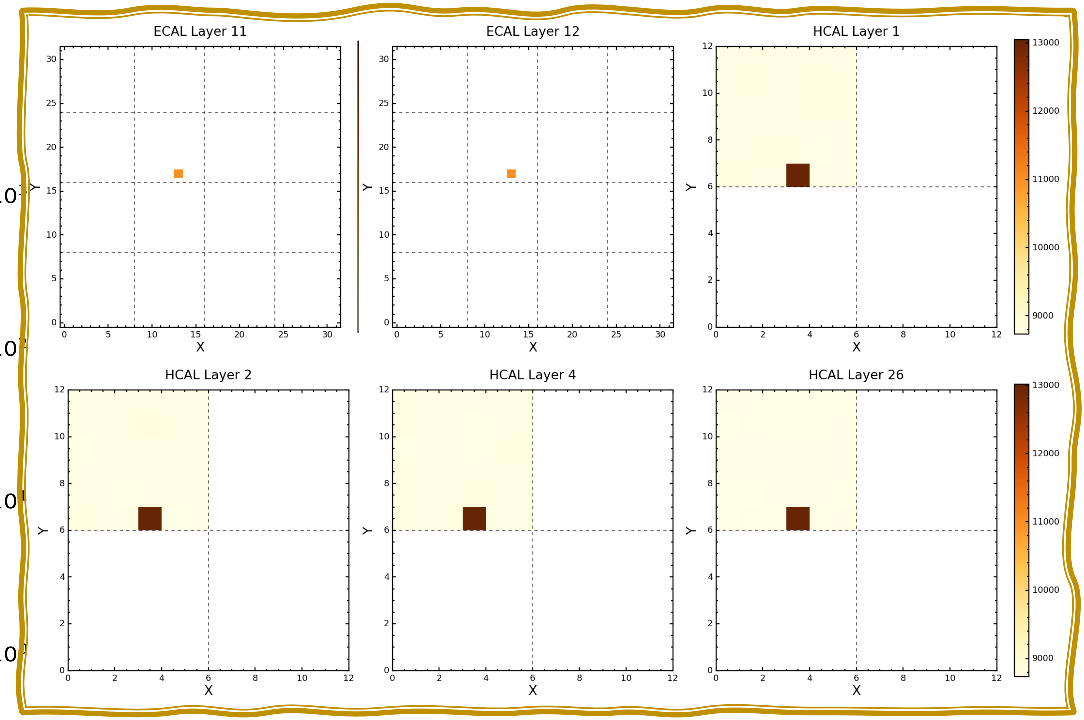
data analysis

ECAL response & ECAL-HCAL matching

- Validate the performance of the SiW-ECAL prototype under realistic beam conditions.
- Assess detector stability and data quality to ensure reliable energy measurements.
- Study the integration of ECAL and HCAL for combined calorimetry.

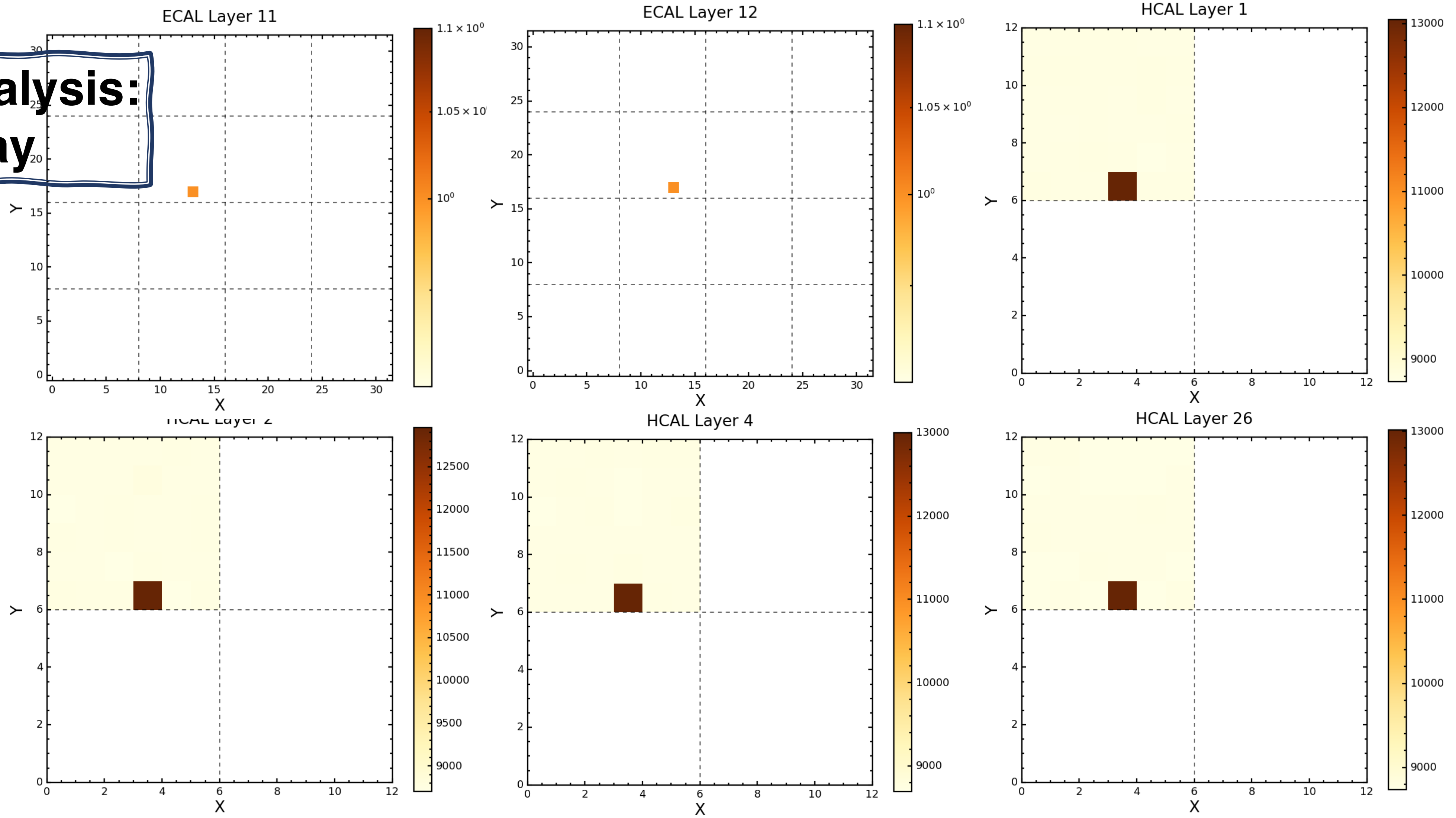






Beam test & data analysis

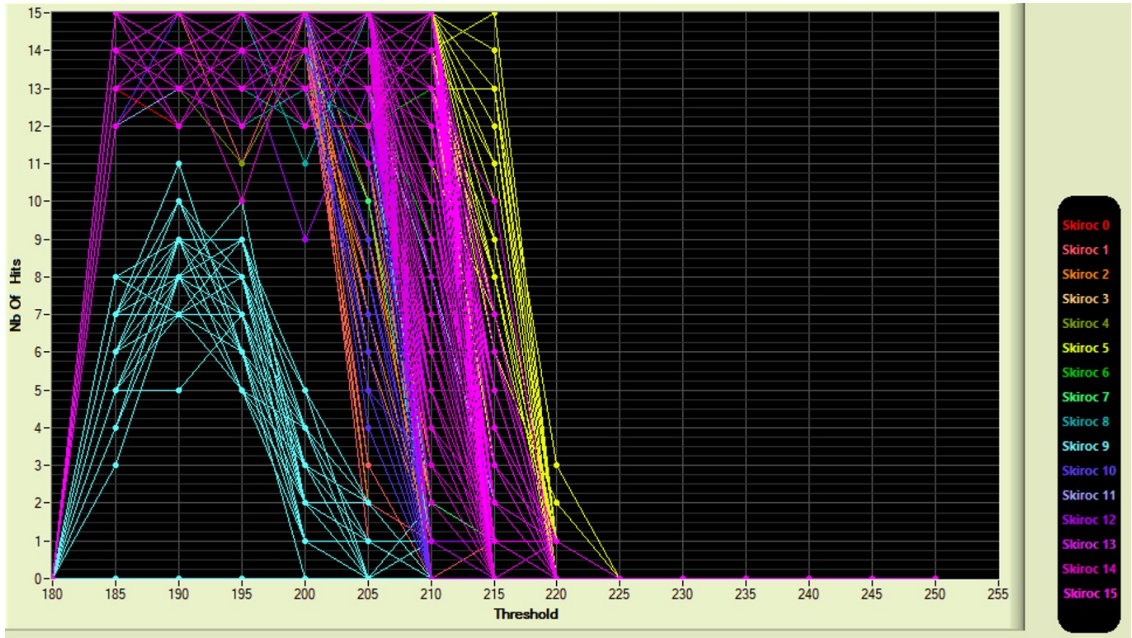
ECAL+HCAL analysis:
Event display



Beam test & data analysis

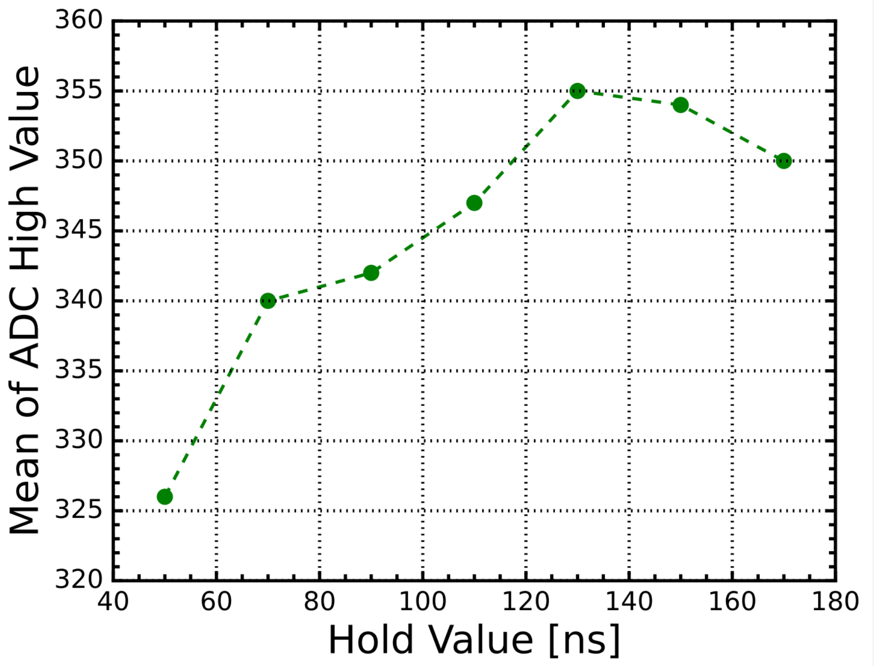
Threshold scan

- Scanning was processed separately for each channel without signal
- A threshold of **230 ADC** was applied during the beam test, with exceptions for certain chips in specific runs.



Hold value scan

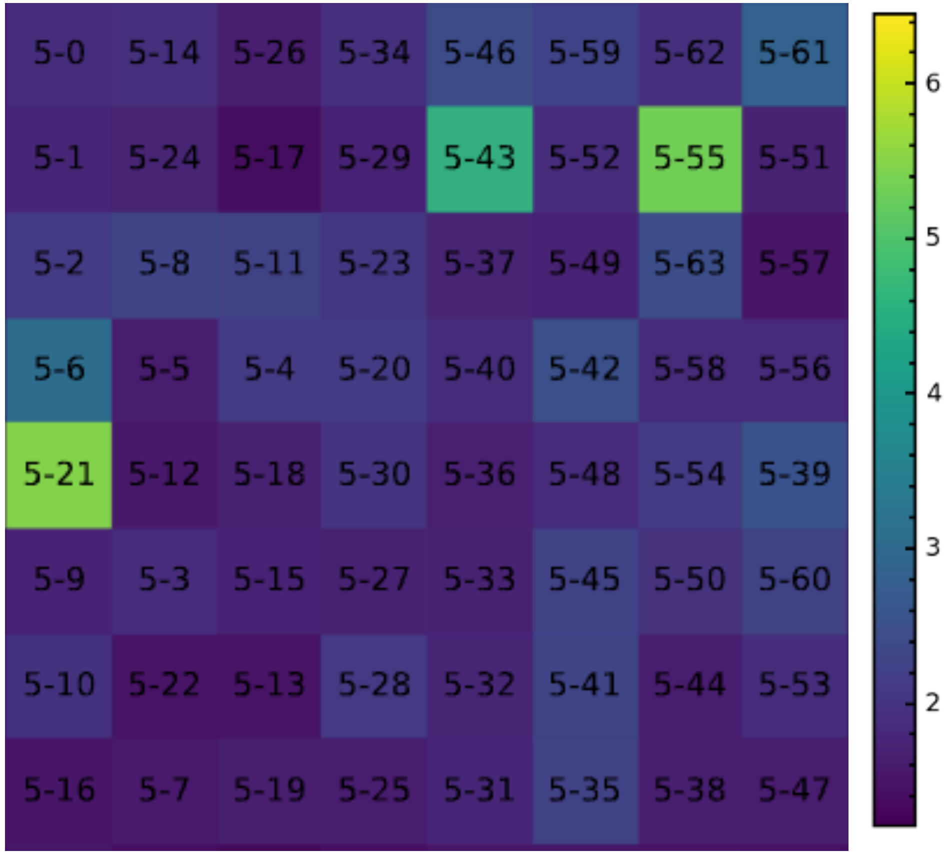
- Hold value was scanned with beam on
- The hold value was set up as **130 DAC**(1 DAC is approximately 1 ns)

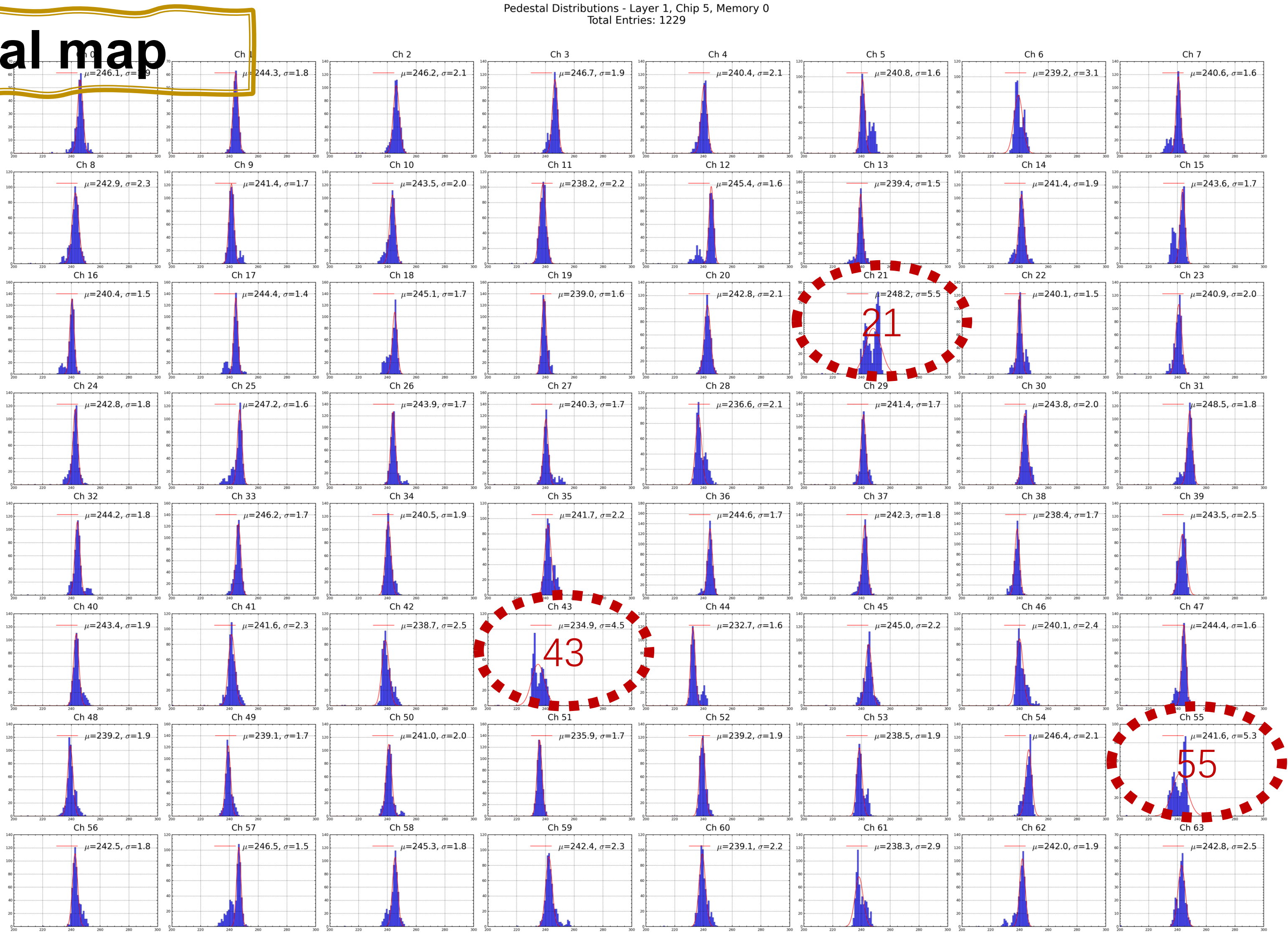


Beam test & data analysis

ECAL alone analysis: Pedestal map

Special in Layer 1, chip 5, memory 0

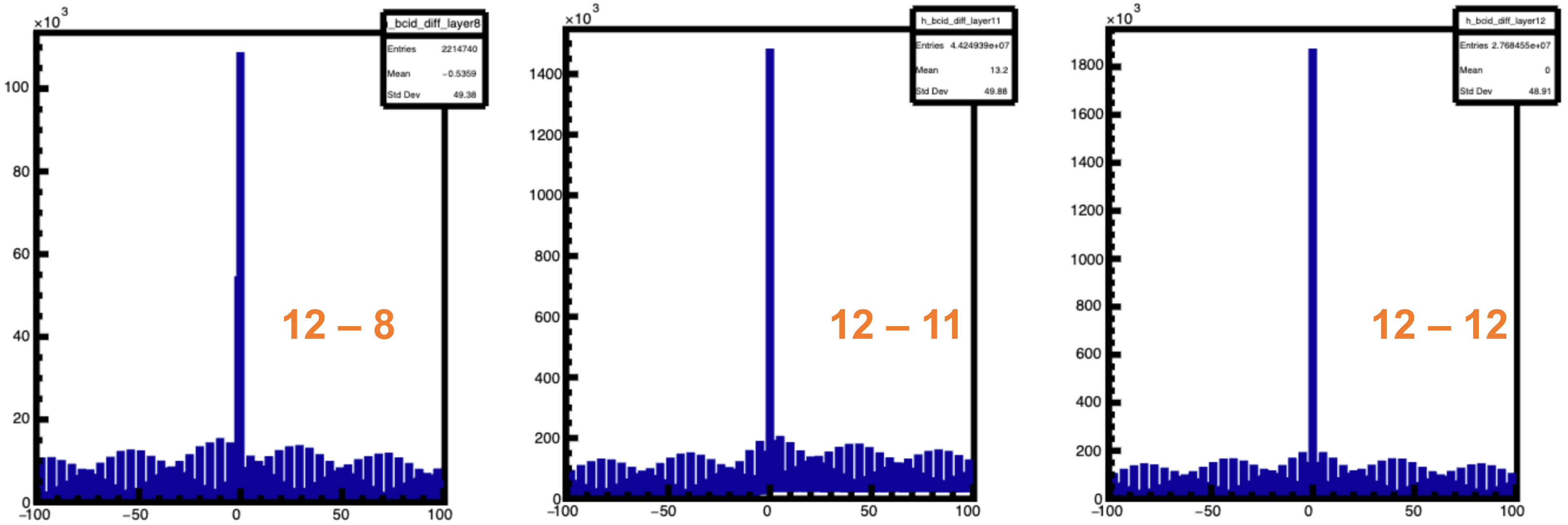


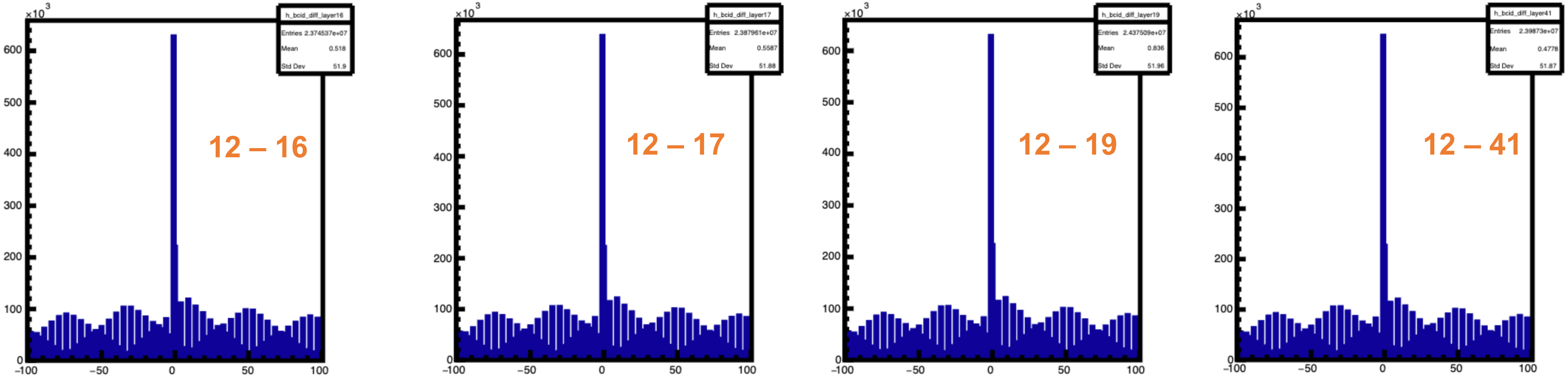


Beam test & data analysis

ECAL+HCAL analysis: Bunch crossing ID match

Layer:
- 0-14: ECAL
- 15-54: HCAL



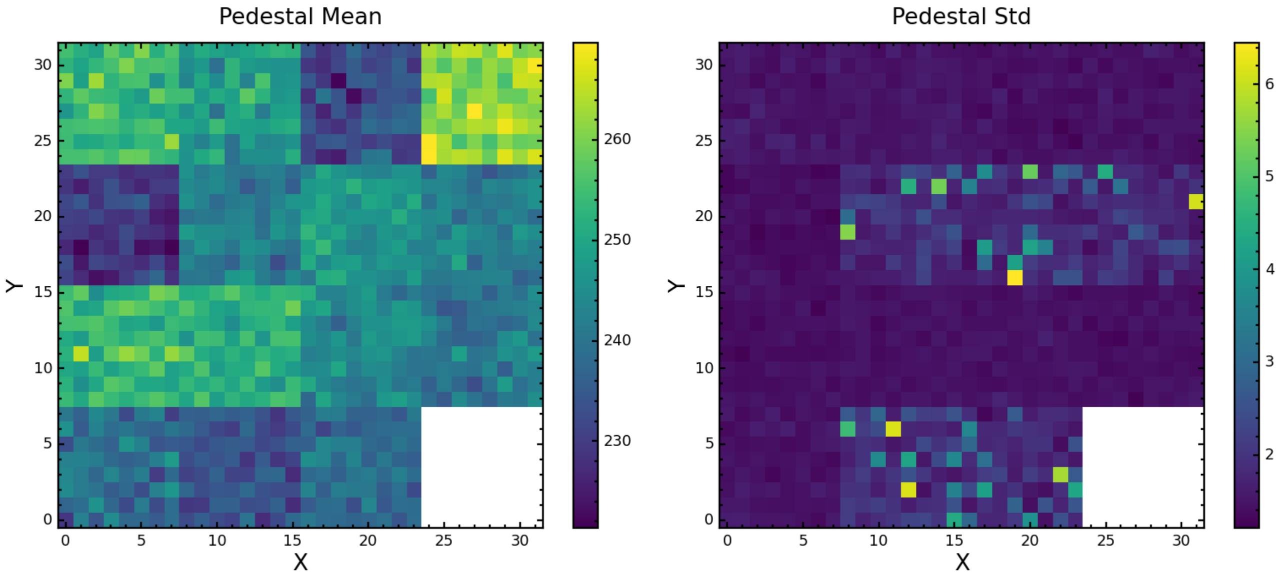


Beam test & data analysis

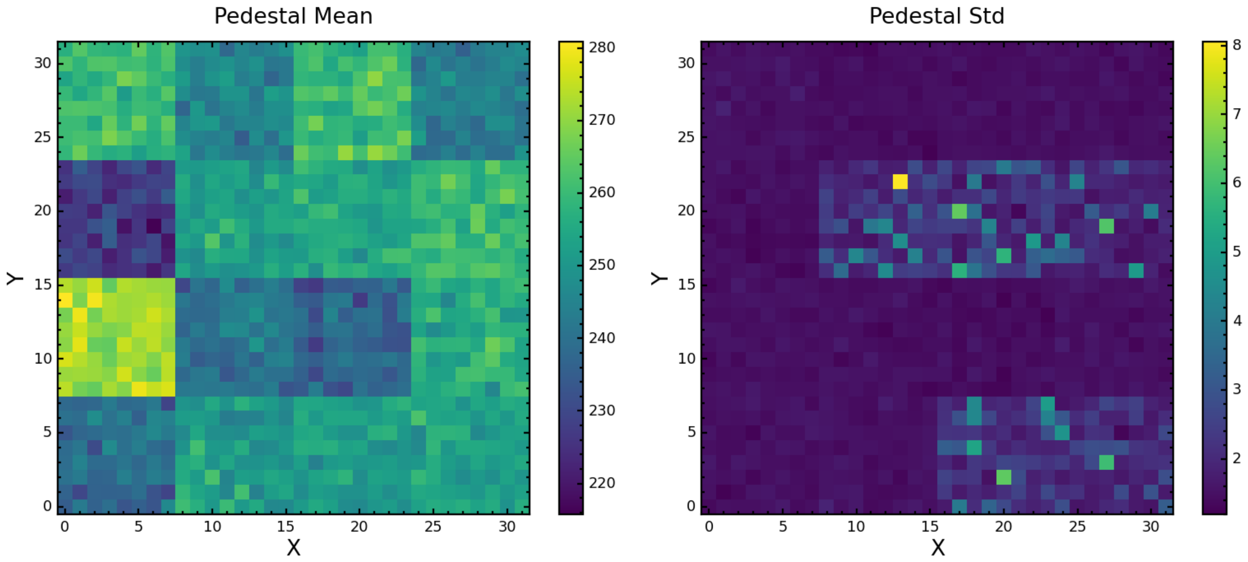
ECAL alone analysis: Pedestal map

- In each chip, the pedestals are relatively consistent.
- But in some chips, the pedestal sigma is higher than 4 because of two peaks.
- Need further check.

ASU 1



ASU 2



Beam test & data analysis

ECAL alone analysis: MIP map