中国科学技术大学
University of Science and Technology of China

Single hadrons → two-particle separation → jets and BMR

Plastic and glass with one common PFA baseline

Plastic: 0.5 MIP • Glass: 0.5 / 0.1 / 0.0818 MIP

Hongbin Diao

12 November 2026

Single hadrons: samples and frozen calibration

中国科学技术大学
University of Science and Technology of China

Frozen setting	Plastic	Glass
HCAL threshold	0.5 MIP	0.5 / 0.1 / 0.0818125 MIP
Barrel layers / sensitive thickness	43 layers / 3 mm	48 layers / 10 mm
HCAL Cc / Cn	75.948869 / 83.171391	4.000000 / 4.000000
PFA residual scale a	1.326199	0.400000

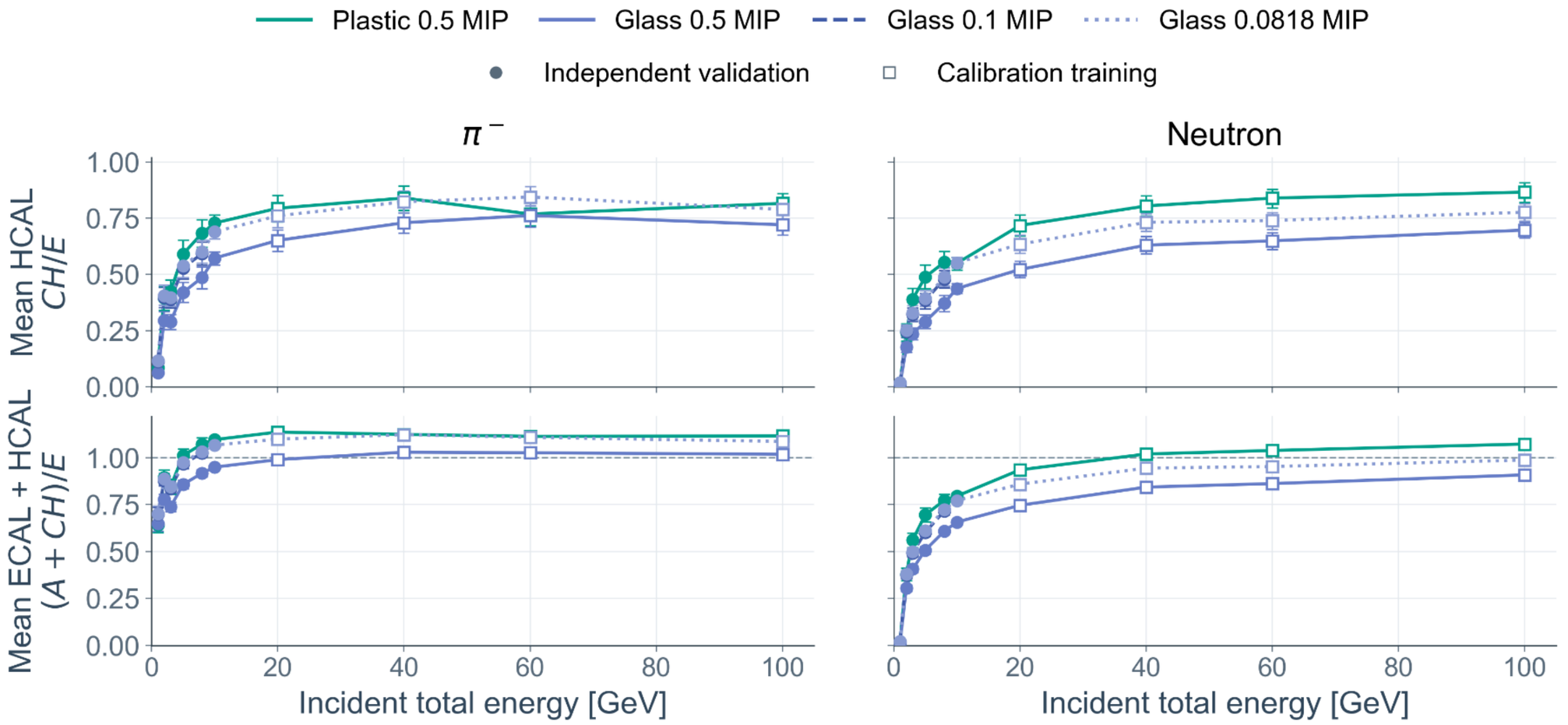
Energy response

H: HCAL signal; A: calibrated ECAL energy
HCAL: CH/E
Calorimeter (offline): (A + CH)/E
Full detector, 3 T; E = incident total energy

Samples

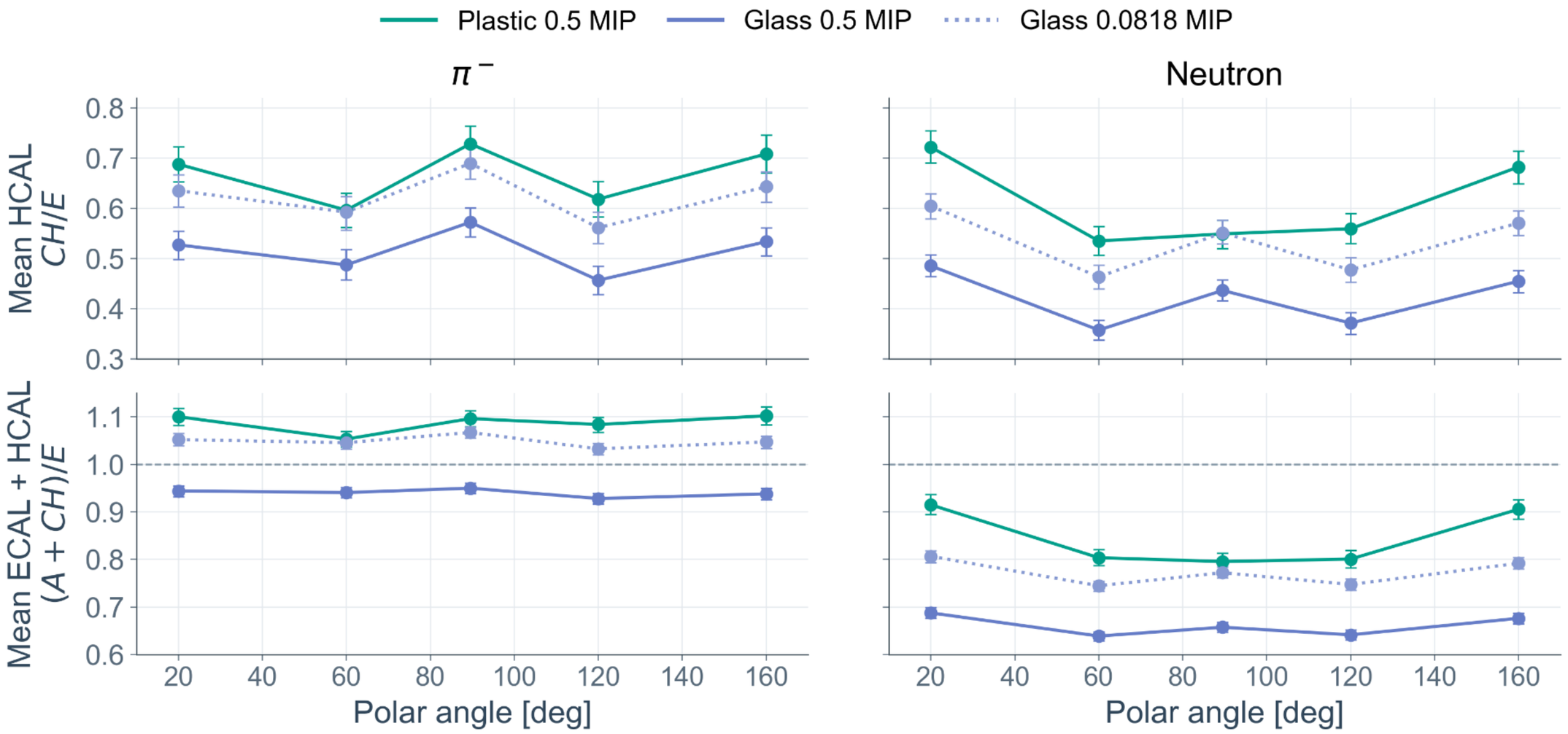
1–8 GeV: 200/point; θ = 89.5°
10 GeV: 600/point; five angles
20–100 GeV: 200/point

Single hadrons: calorimeter response versus energy

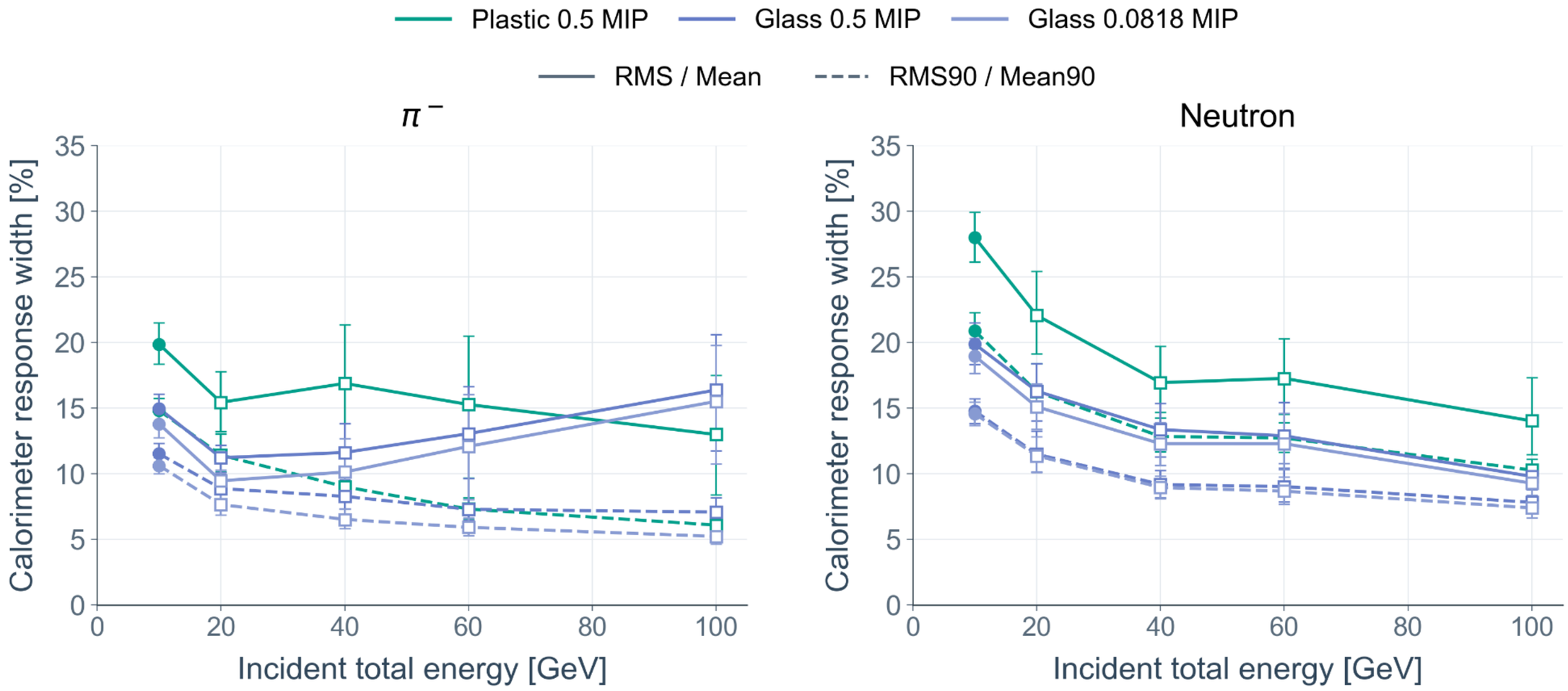


Lower glass thresholds retain more HCAL signal; the low-energy neutron response remains small.

Single hadrons: angular response at 10 GeV



Single hadrons: calorimeter response width



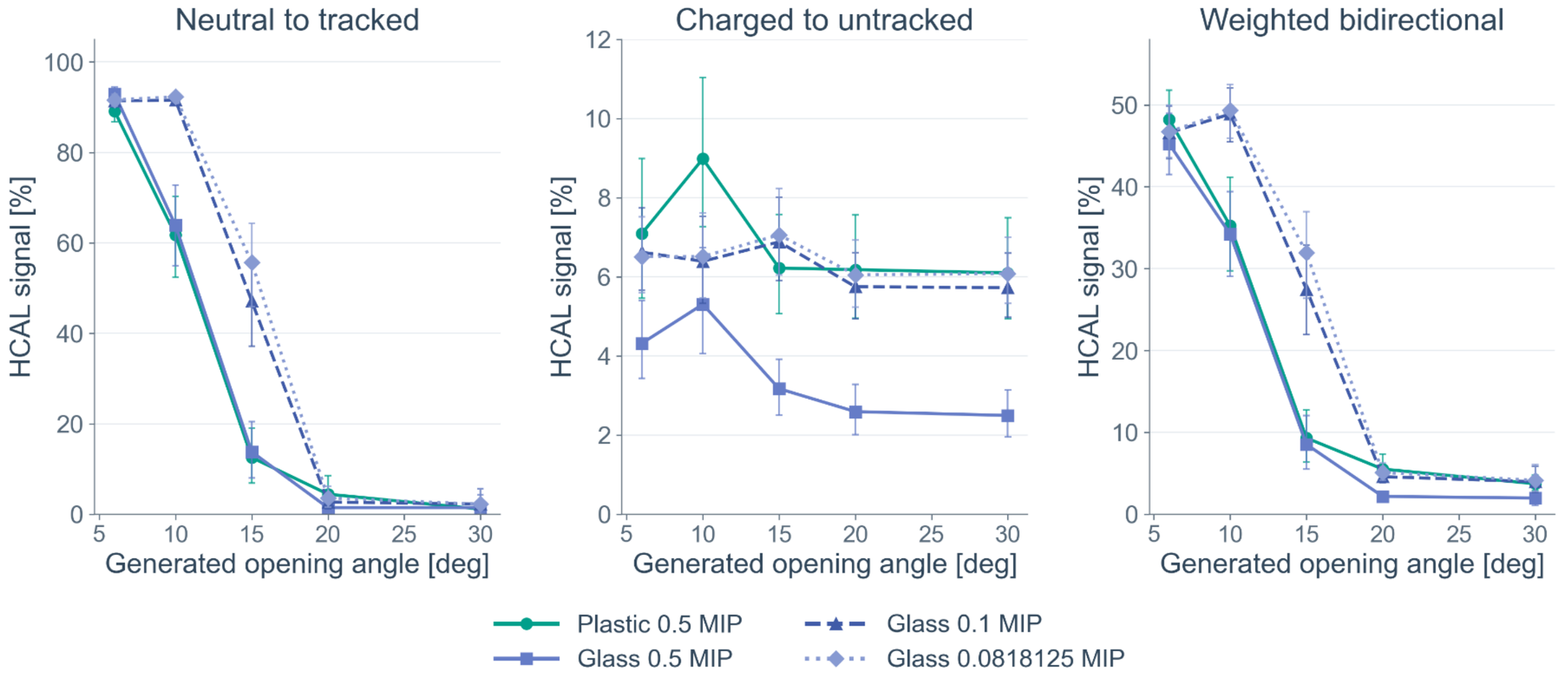
Two-particle separation: sample and metrics

π^- + n, 20 GeV + 20 GeV

6°, 10°, 15°, 20°, 30°
100 events / angle / material
Full detector, 3 T; θ = 89.5°

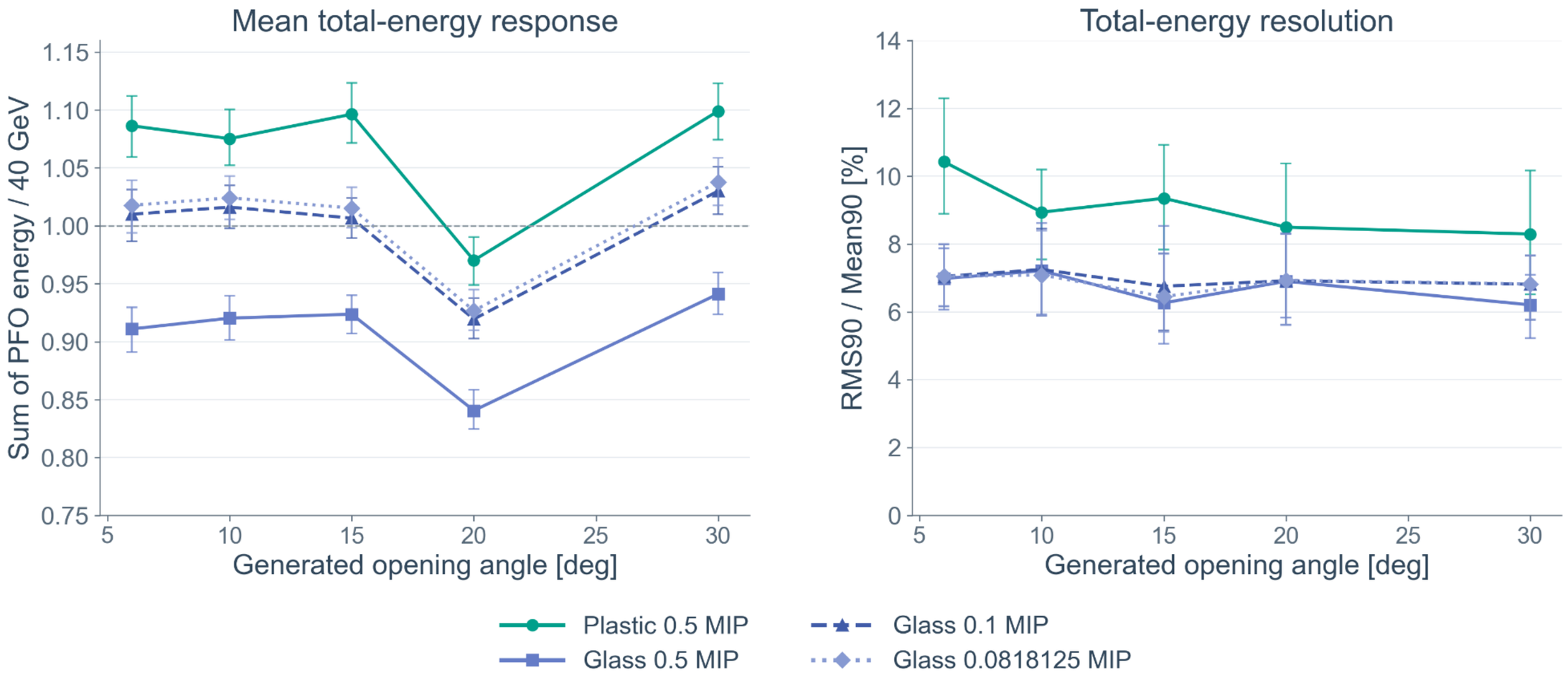
Quantity	Definition
N → tracked	Neutral raw HCAL signal in tracked objects / all neutral signal
C → untracked	Charged raw HCAL signal in untracked objects / all charged signal

Two-particle separation: both error directions



A lower threshold increases signal retention but can worsen near-neighbour assignment.

Two-particle separation: total PFA response



Jets: common sample and evaluation

University of Science and Technology of China

$\nu\bar{\nu}H, H \rightarrow gg$

175 events

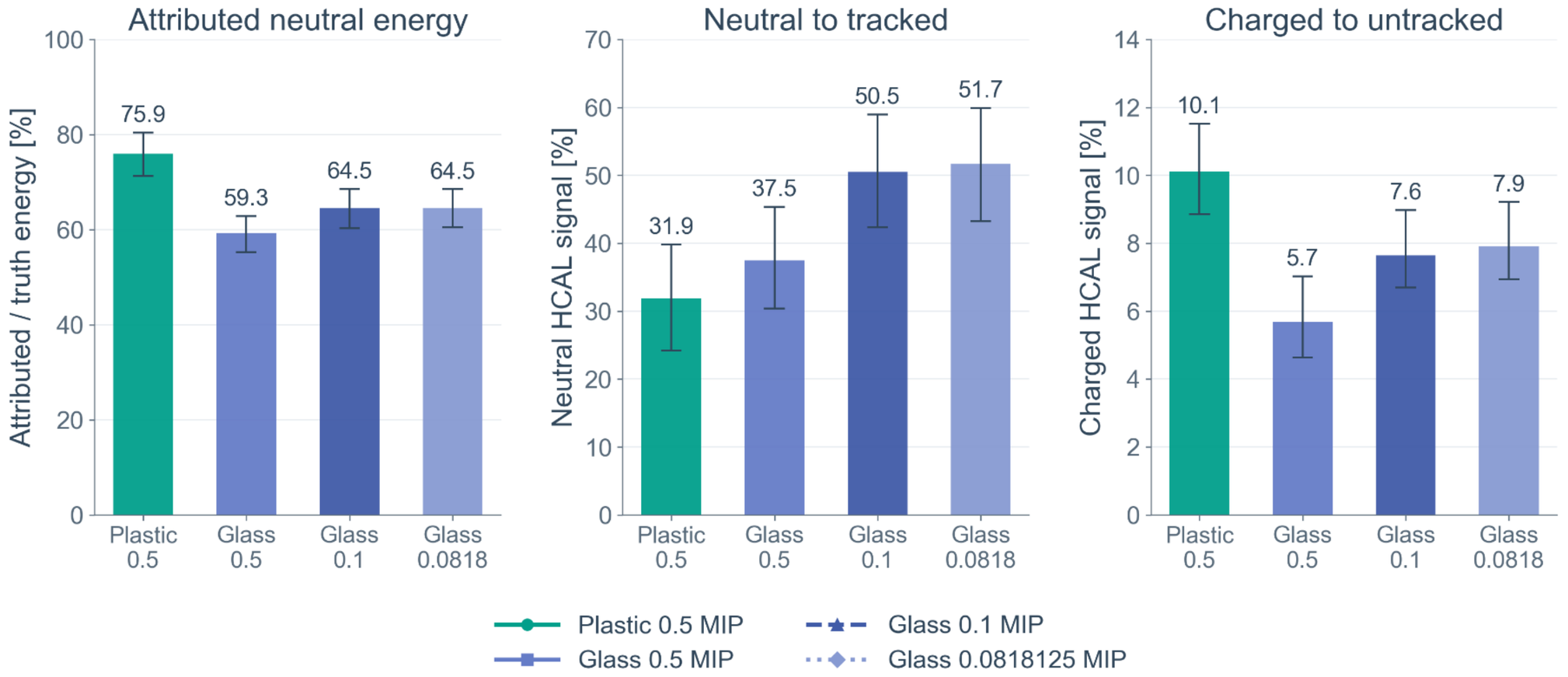
Jet energy resolution

r = Erec / Etruth
JER90 = RMS90(r) / Mean90(r)

Common PFA baseline

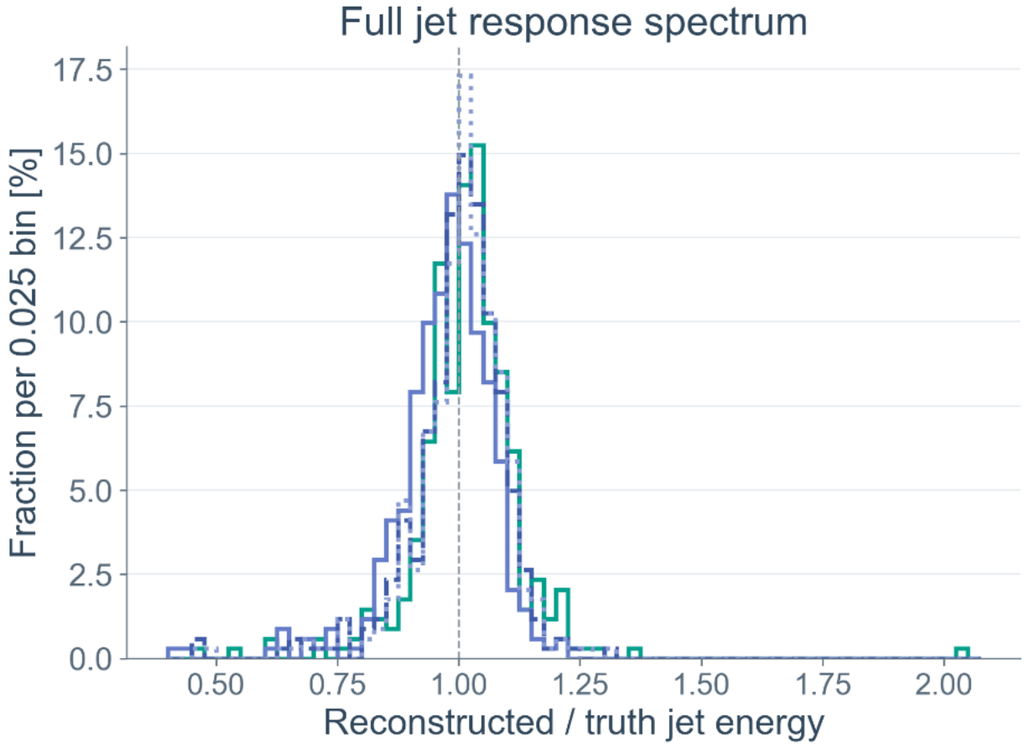
Distance-based clustering
Material-specific Cc, Cn and a (p. 2)

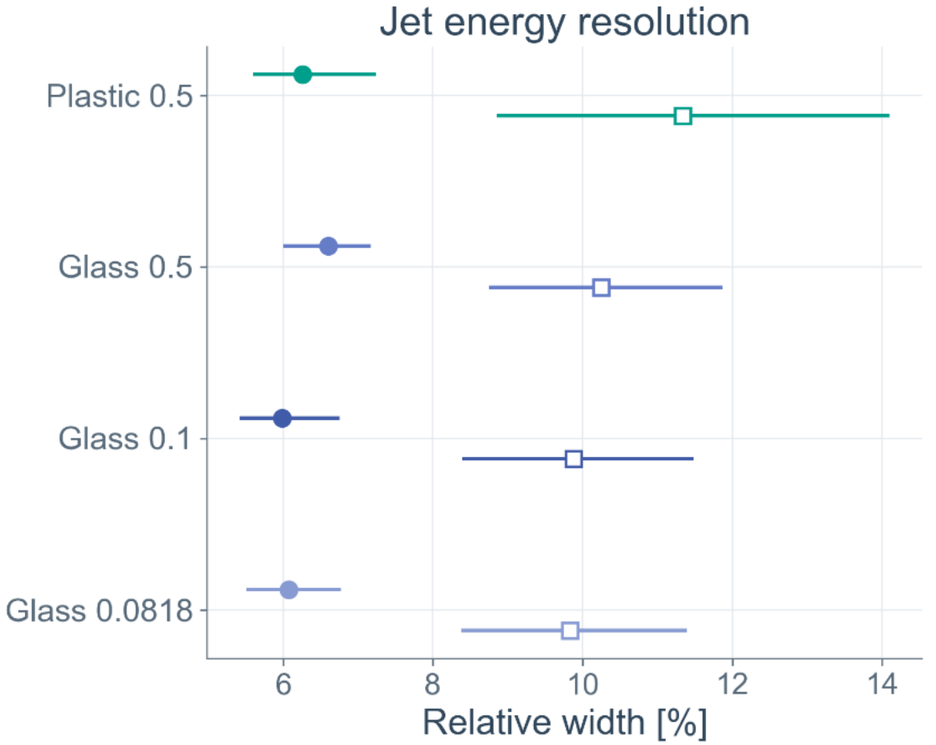
Jets: neutral energy and signal assignment



Lower glass thresholds increase attributed neutral energy and neutral-to-track assignment.

Jets: response and energy resolution





Plastic 0.5 MIP
Glass 0.5 MIP
Glass 0.1 MIP
Glass 0.0818125 MIP
RMS90 / Mean90
RMS / Mean

Glass 0.1 MIP gives a lower JER90 than 0.5 MIP in this sample, despite more assignment errors.

Jets: numerical comparison of the four settings

Metric	Plastic 0.5 MIP	Glass 0.5 MIP	Glass 0.1 MIP	Glass 0.0818 MIP
Neutral-hadron recovery (%)	57.01	49.20	39.77	37.24
Bidirectional error (%)	14.10	11.38	15.26	15.67
Mean jet response	1.0181 ± 0.0060	0.9724 ± 0.0054	1.0006 ± 0.0055	1.0039 ± 0.0054
JER90 (%)	6.256 ± 0.429	6.607 ± 0.295	5.990 ± 0.356	6.079 ± 0.321
Full RMS / Mean (%)	11.33 ± 1.39	10.25 ± 0.80	9.88 ± 0.79	9.83 ± 0.77

Mjj and BMR: the observable used here

Reconstructed dijet mass

$$Mjj^2 = (E_1 + E_2)^2 - |p_1 + p_2|^2$$

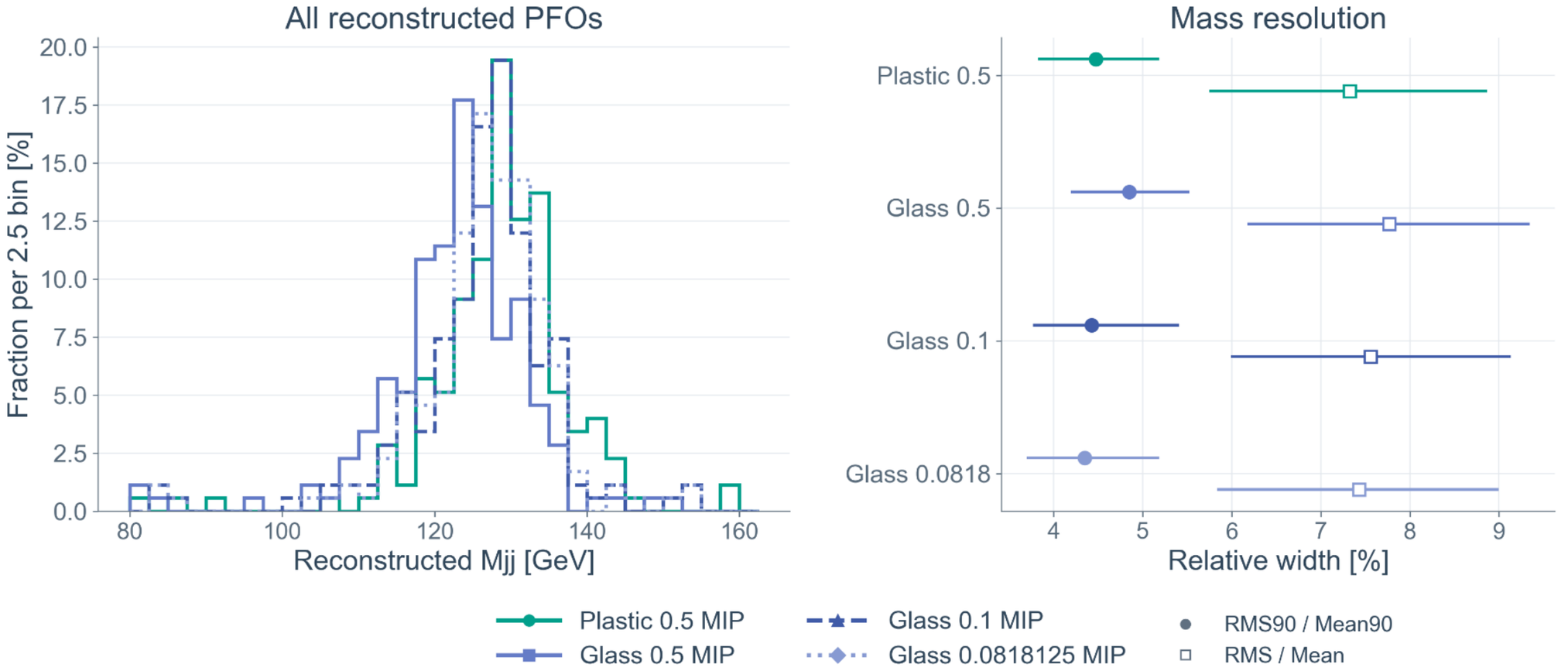
The two exclusive jets contain all final PFOs.

BMR90

$$BMR90 = RMS90(Mjj) / Mean90(Mjj)$$

Narrowest 90% of the reconstructed Mjj spectrum across all 175 events.

Mjj spectrum and mass resolution



BMR90 (%): 4.471 ± 0.343 | 4.847 ± 0.348 | 4.427 ± 0.418 | 4.349 ± 0.381

Ideal neutral-hadron reconstruction

中国科学技术大学
University of Science and Technology of China

Offline truth replacement · 200 events · three historical configurations

Ideal N replaces the reconstructed neutral-hadron component with generator four-momenta.

	JER90 (%)		BMR90 (%)	
Configuration	**Baseline**	**Ideal N**	**Baseline**	**Ideal N**
Plastic 0.5 MIP	6.40 ± 0.42	5.20 ± 0.36	4.47 ± 0.30	3.73 ± 0.32
Glass 0.5 MIP	6.50 ± 0.34	4.81 ± 0.28	4.63 ± 0.35	3.10 ± 0.28
Glass 0.0818 MIP	6.39 ± 0.34	5.07 ± 0.33	4.56 ± 0.40	3.17 ± 0.29

Conclusions

中国科学技术大学
University of Science and Technology of China

Single hadrons	Isolated neutron recovery: 11–52.5% at 1 GeV, 93.0–98.0% at 40–100 GeV.
Two-particle separation	Lower glass thresholds retain soft hits that can link nearby showers and route neutron hits to the charged PFO.
Jets and mass	JER90 ≈ 6.0–6.6%; BMR90 ≈ 4.35–4.85%.