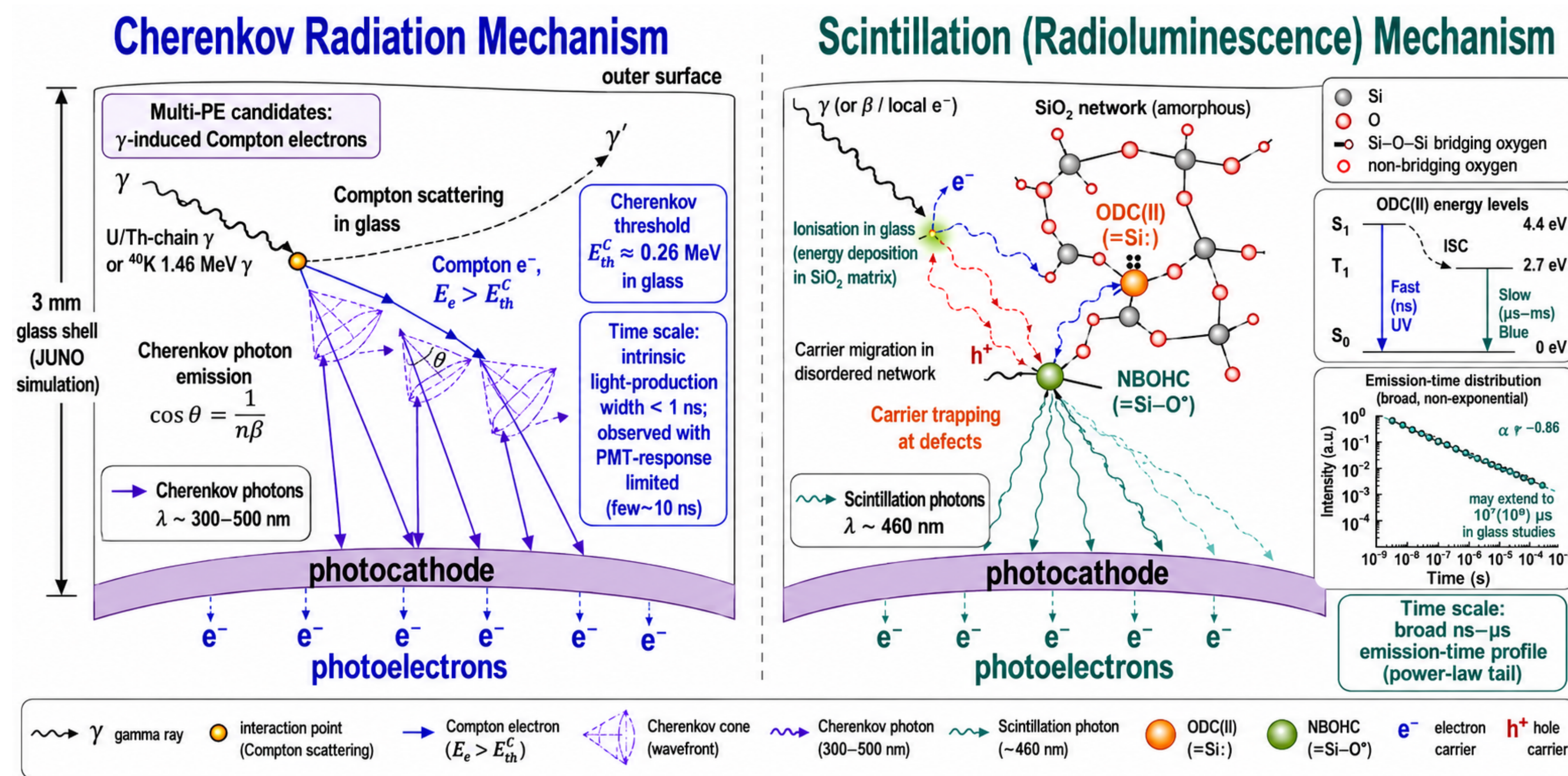


## Physical Origin

JUNO's large PMT coverage makes rare PMT-glass light emission relevant for event reconstruction.

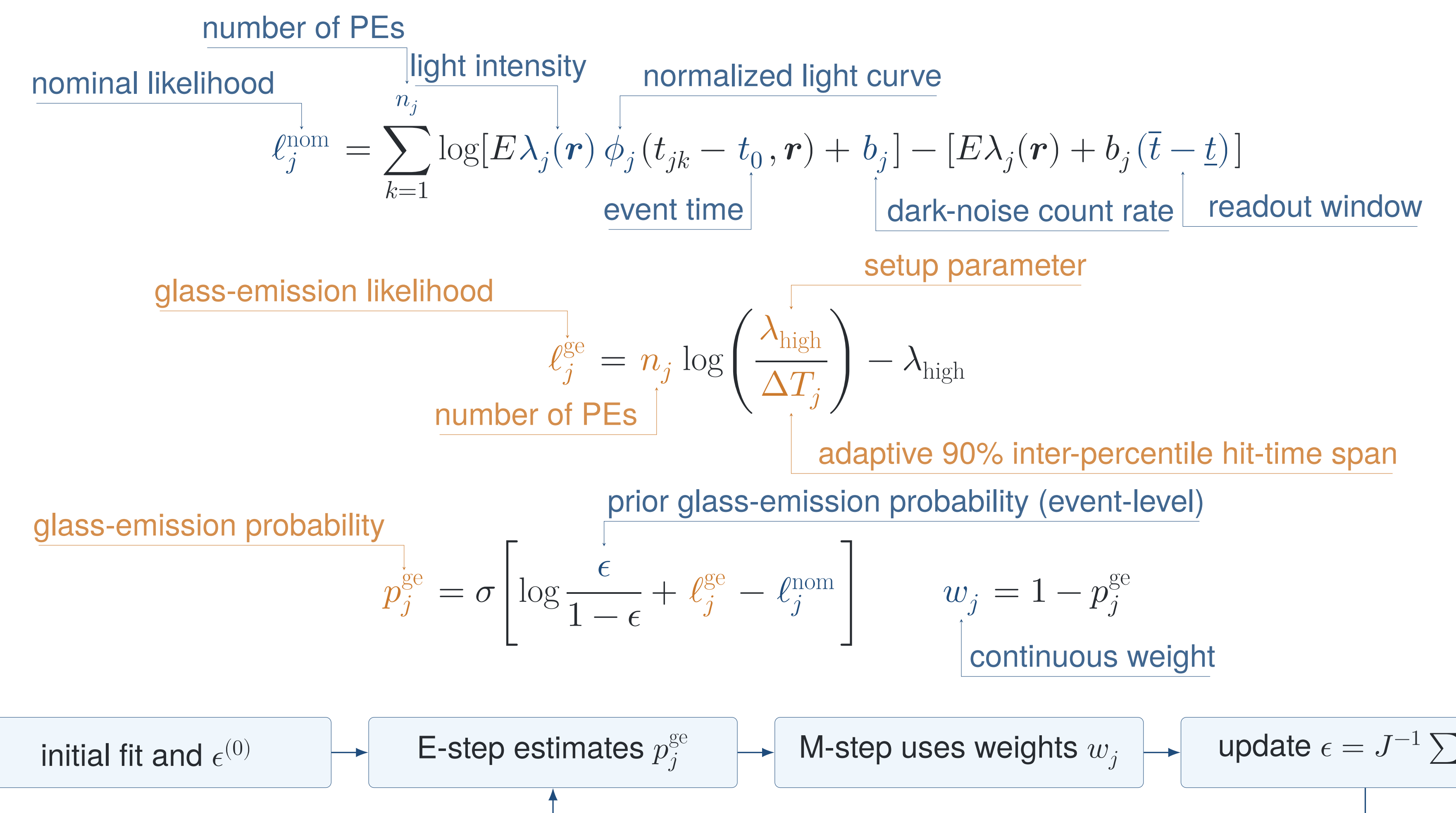


Cherenkov-like light is compact, while radioluminescence is broad in time.

Glass-emission candidates are localized on individual channels rather than correlated with the fitted event vertex.

## Expectation-Maximization-Based Channel Weighting

An expectation-maximization (EM) procedure estimates the glass-emission probability for each PMT channel.



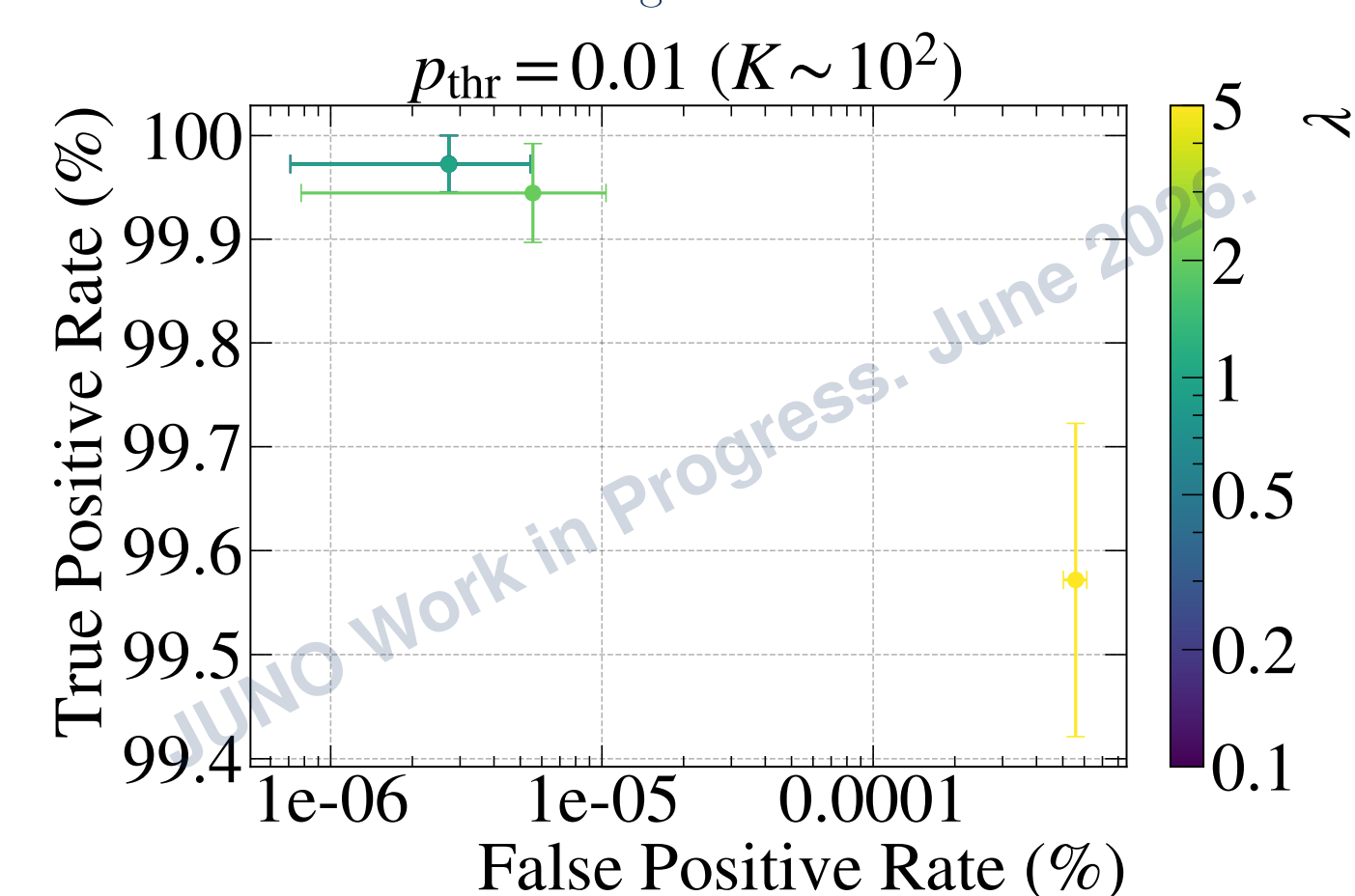
**Output:** channels are down-weighted continuously rather than rejected.

## Toy Monte Carlo Performance Check

Toy Monte Carlo quantifies false-positive (FP) control and true-positive (TP) efficiency under simplified conditions.

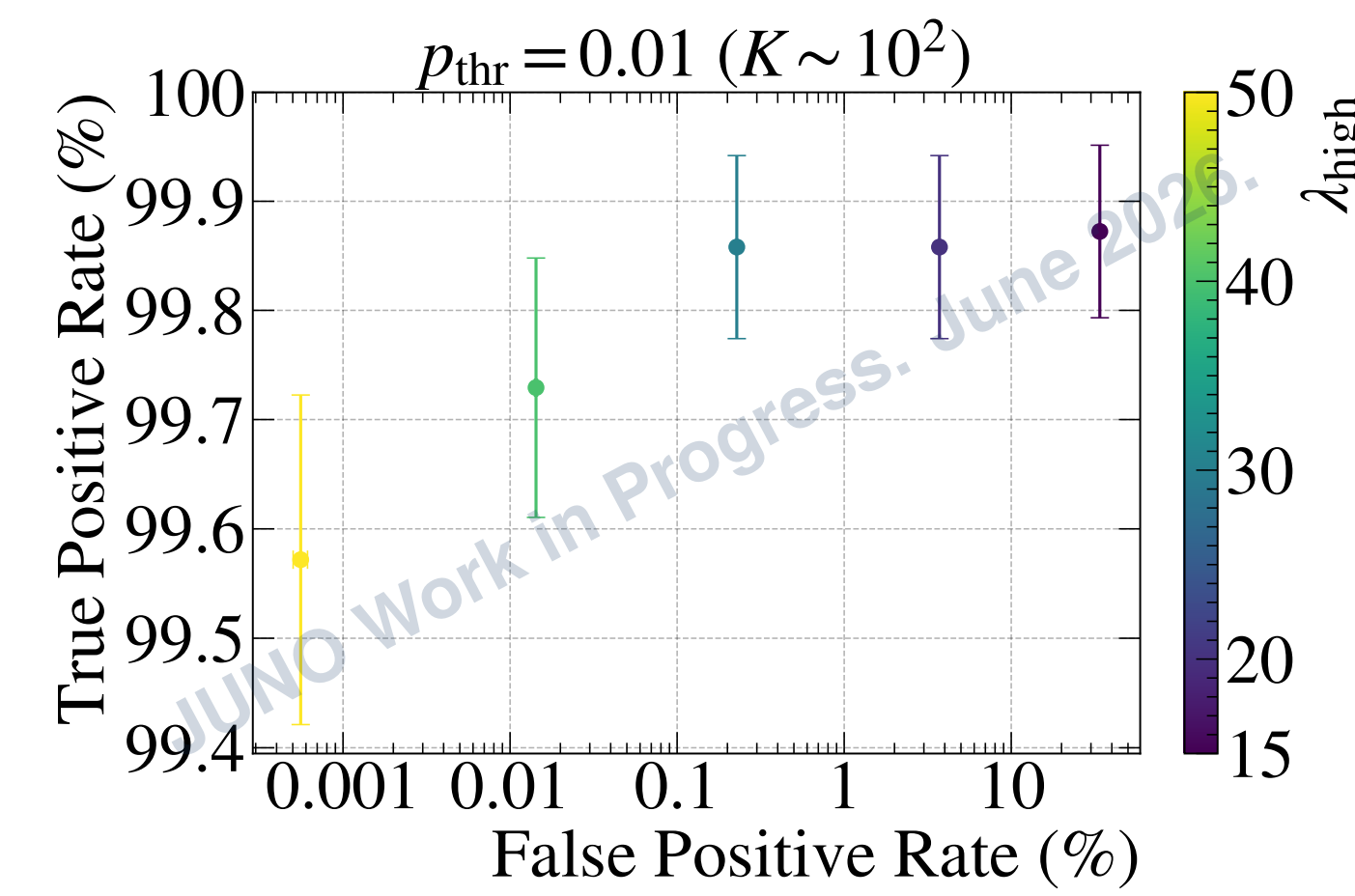
### scan over signal PE count

$$\lambda_{\text{high}} = 50$$



### scan over glass-emission intensity

$$\lambda = 5.0$$



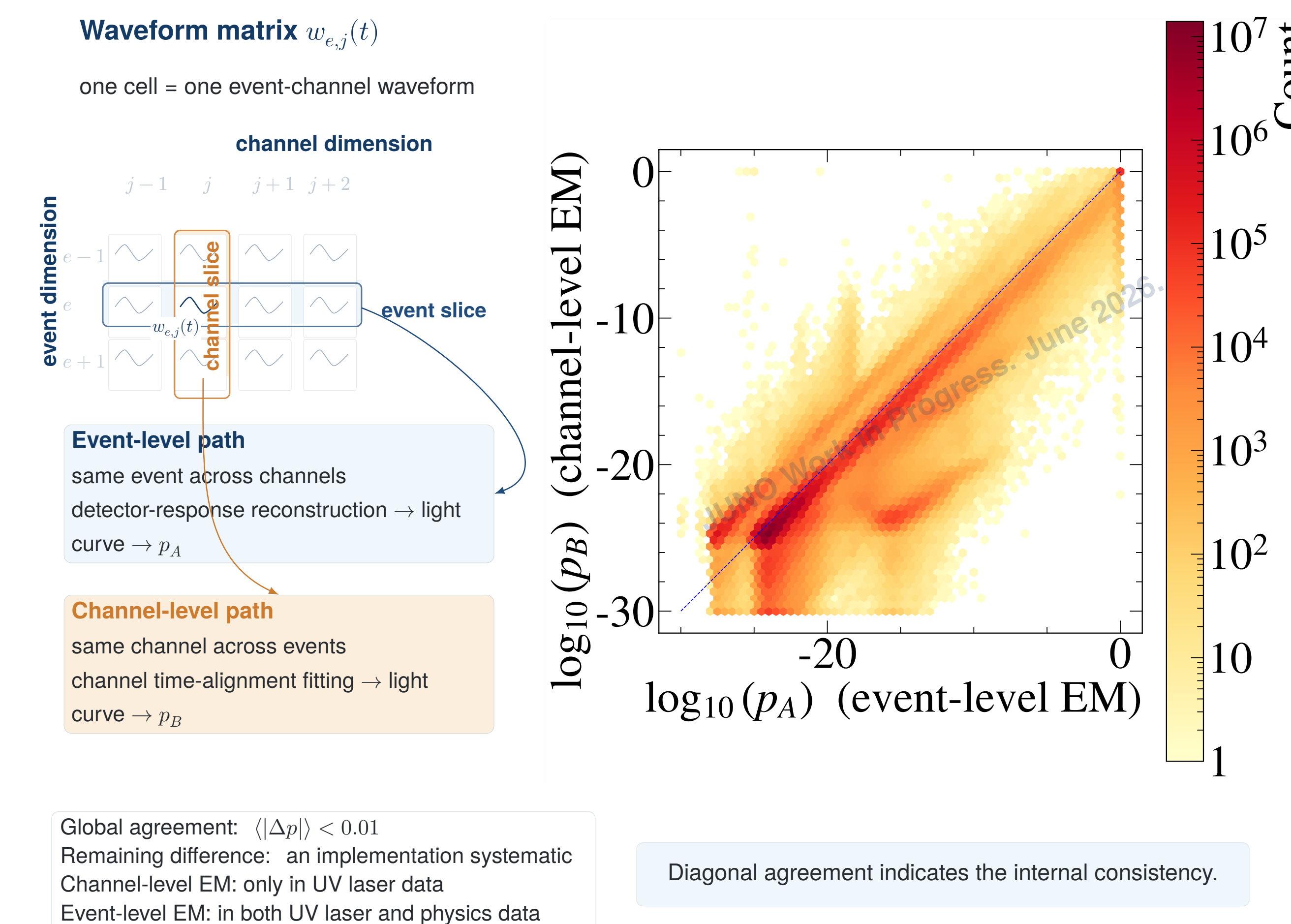
Only the classification threshold  $p_{\text{thr}} = 0.01$  panels are shown. The distributions at the typical Bayes factor thresholds  $p_{\text{thr}} = 0.5$  and  $0.9$  are similar to those at  $0.01$ .

Adverse simplified case	FP rate	TP rate
$\lambda = 0.1, \lambda_{\text{high}} = 50$	$(2.7^{+2.7}_{-2.0}) \times 10^{-8}$	$(99.97^{+0.03}_{-0.03})\%$
$\lambda = 5.0, \lambda_{\text{high}} = 50$	$(5.6^{+0.6}_{-0.6}) \times 10^{-6}$	$(99.57^{+0.15}_{-0.15})\%$

Even in the most adverse simplified configuration, FP stays at  $(5.6^{+0.6}_{-0.6}) \times 10^{-6}$  while TP remains  $(99.57^{+0.15}_{-0.15})\%$ .

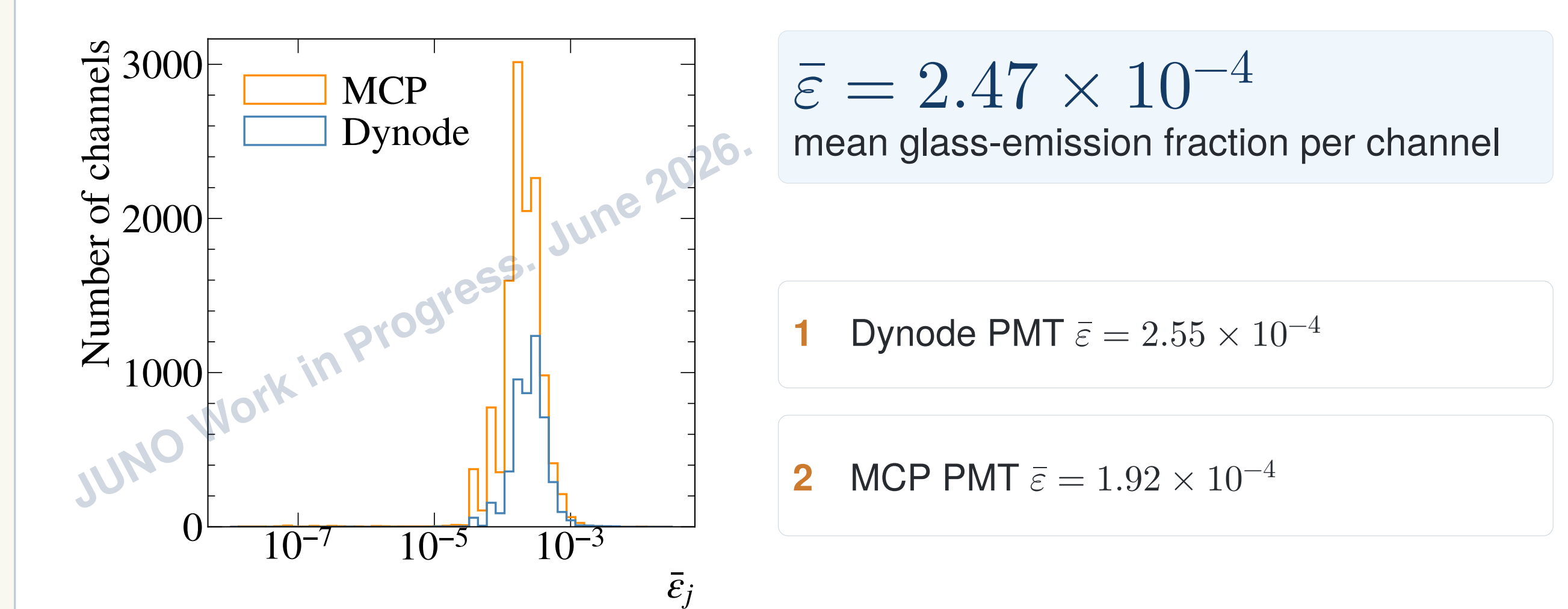
## Data-Driven Consistency Check

Since real data contain no true labels, we compare two complementary implementations using ultraviolet (UV) laser calibration data.



Diagonal agreement indicates the internal consistency.

## Glass-Emission Rate Depends on PMT Type



$$\bar{\epsilon} = 2.47 \times 10^{-4}$$

mean glass-emission fraction per channel

- Dynode PMT  $\bar{\epsilon} = 2.55 \times 10^{-4}$
- MCP PMT  $\bar{\epsilon} = 1.92 \times 10^{-4}$

## Channel Independence

Independent-channel occurrence is tested using  $p_j^{\text{ge}} > 0.01$  candidates.

Quantity	Path A	Path B
Glass-emission flags	123 291	109 981
$\bar{\text{Var}}(N_e)$	5.36	4.33
Overdispersion $\phi$	1.138	<b>1.030</b>

$\phi$  is the overdispersion relative to independent Bernoulli trials. Path B is only 3% above the independent-Bernoulli expectation. Pairwise Fisher tests find no broad population of coupled PMTs.