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### Hyper-Kamiokande Photosensors

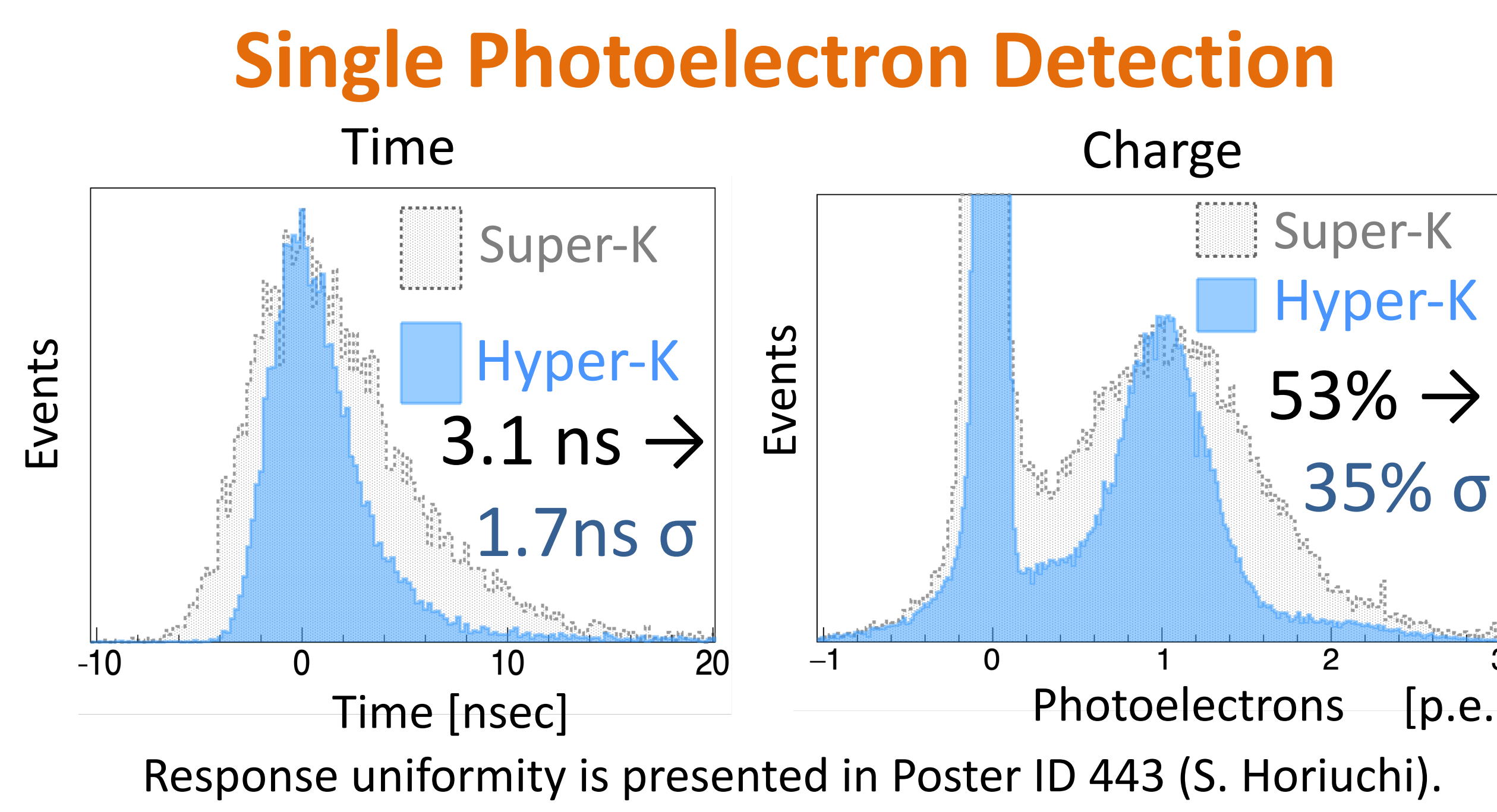
**Super-Kamiokande (Super-K)** since 1996  
22.5 (50) kton

**Super-K PMT (Photomultiplier tube)**  
Established in Super-K  
Hamamatsu R3600  
+2kV,  $10^7$  gain  
Venetian blind

Inner detector  
50 cm  $\Phi$  PMTs  $\times$  11,129  
Outer detector  
20 cm  $\Phi$  PMTs  $\times$  1,885

Missing dynodes & drift ambiguity  
→ less collection efficiency & charge tail & worse time response

**Hyper-K PMT**  
*High Quantum Efficiency*  
Hamamatsu R12860  
+2kV,  $10^7$  gain  
Box & Line  
Box  
High collection efficiency (CE)  
Uniform path  
→ High charge & time resolutions



### Hyper-Kamiokande (Hyper-K) Detector

Installation in 2027

260k ton of ultrapure water

20000 50-cm PMTs

3600 Outer Detector Photosensors  
Wavelength shifting plate + 8-cm PMT (Hamamatsu R14374)

800 Multi-PMTs (50 cm mPMTs)  
19 of 8-cm PMTs and electronics

Cover for Chain-Implosion prevention (Acrylic + Stainless Steel)

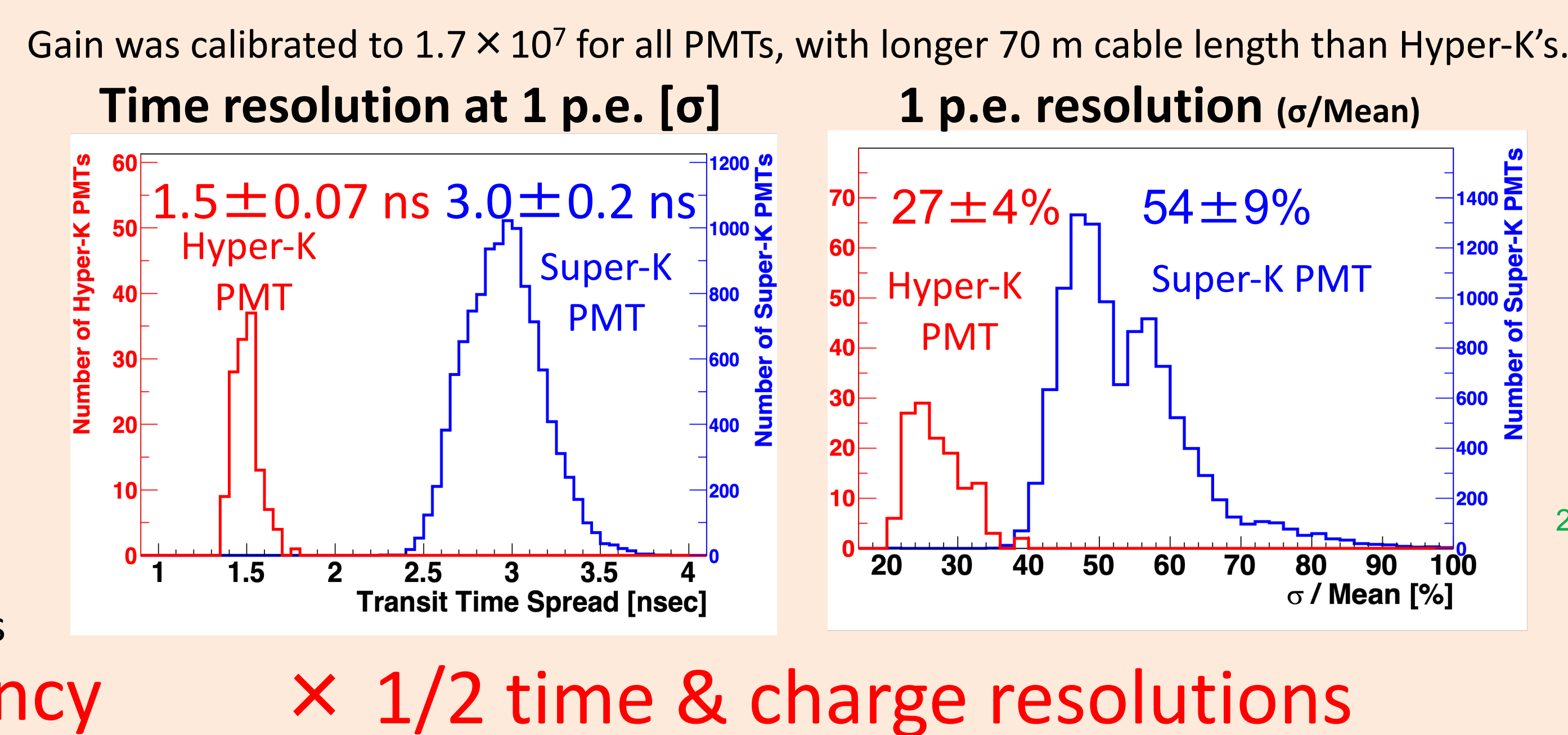
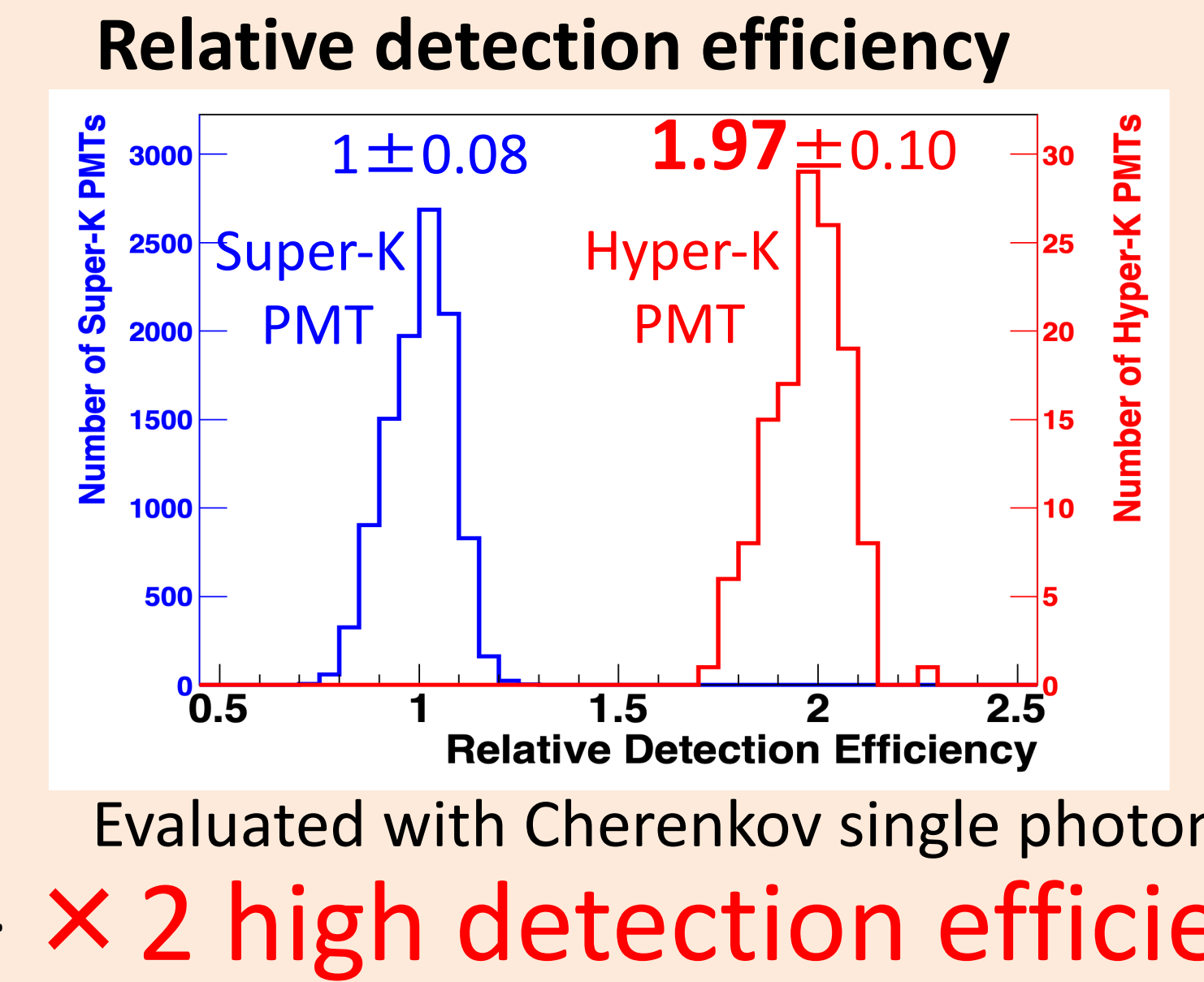
$\times$  8 Fiducial mass of Super-K

### Improved Performance of the 50-cm Hyper-Kamiokande PMT

#### Performance Validation in Water

Installed 136 HK PMTs in Super-K (2018) surrounded by many Super-K PMTs

Evaluated performance of each HK PMT compared with many Super-K PMTs in 2019.



#### Deep-Water Tolerance

- Bulb shape optimization
- Waterproofing improved
- Glass thickness control

$\times$  2 high-pressure resistance (1.25 MPa max)

### Preparation for Hyper-Kamiokande

#### Quality Assurance

- Individual control by manufacturer
- Bulb thickness scan
  - Hydrostatic test (0.85 MPa) → No rejected PMTs so far
  - 1-week rate monitor

Quality was monitored in 2021-2026.

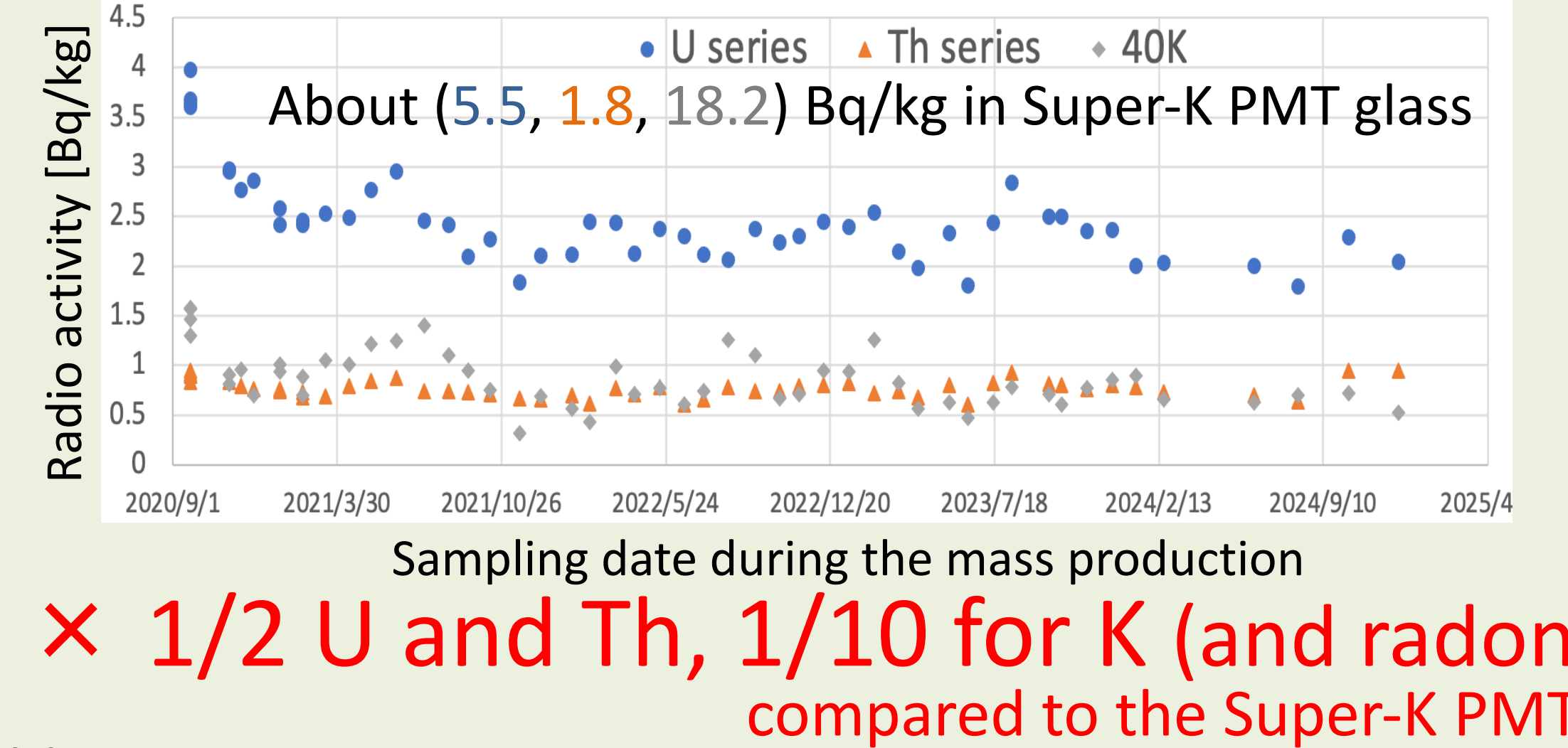
Signal Check

Visual Inspection

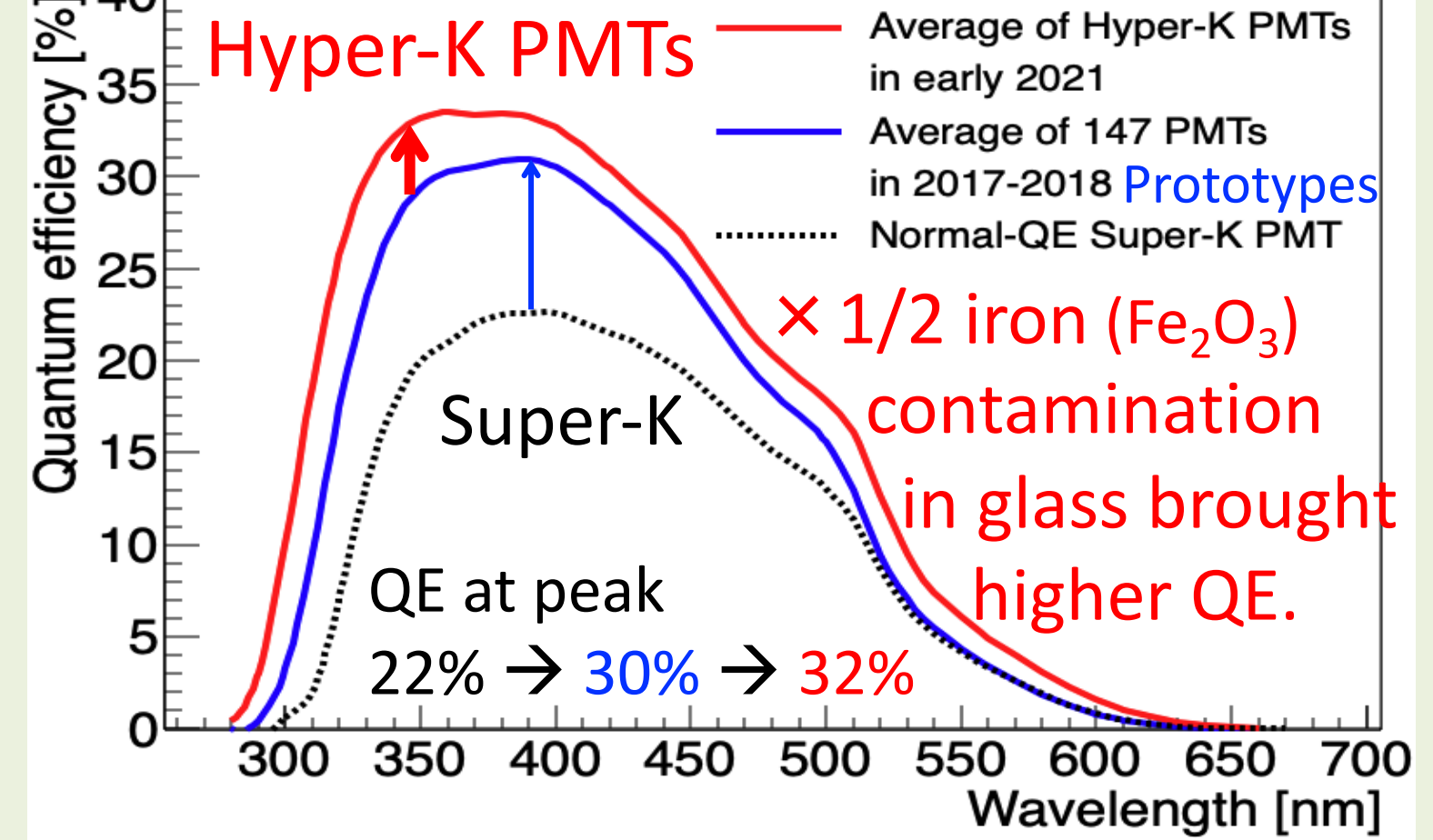
#### Mass Test for Stability Monitoring



#### Glass sampling to monitor the Radio purity and Transparency



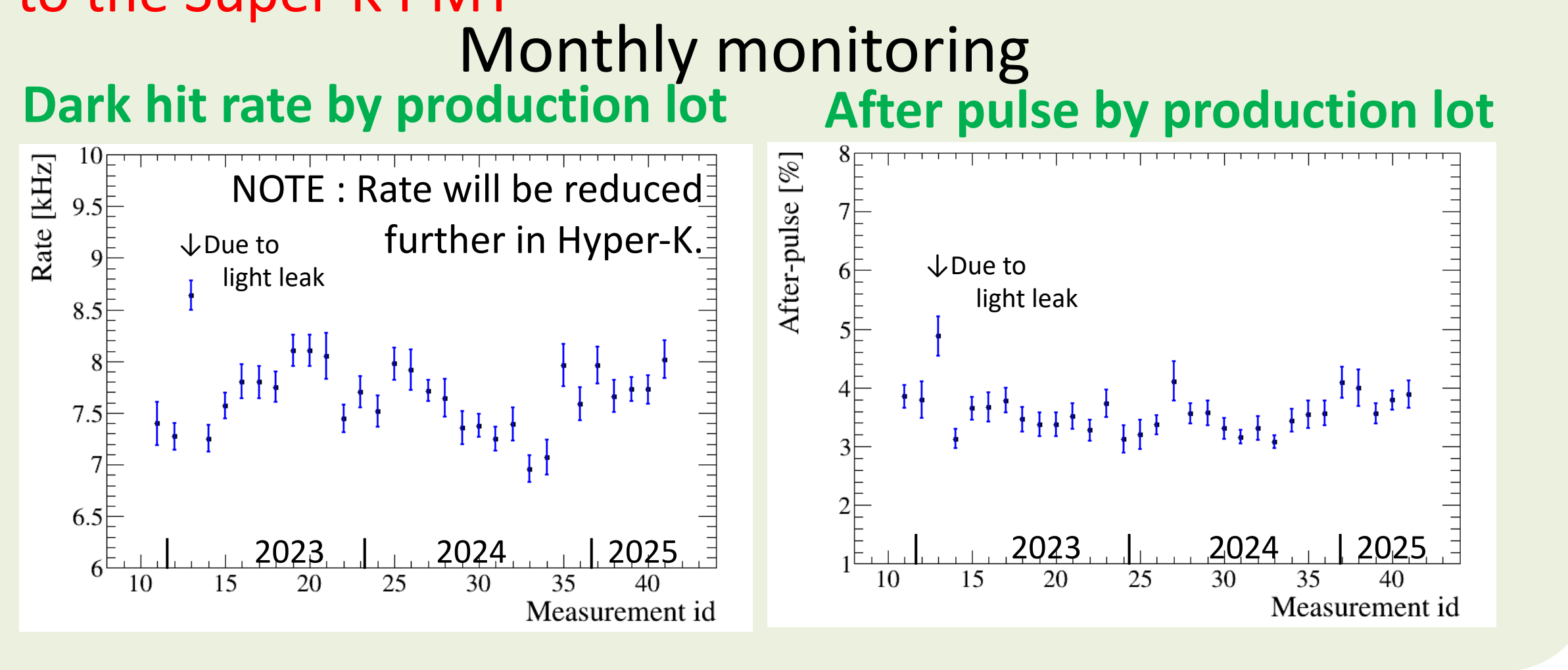
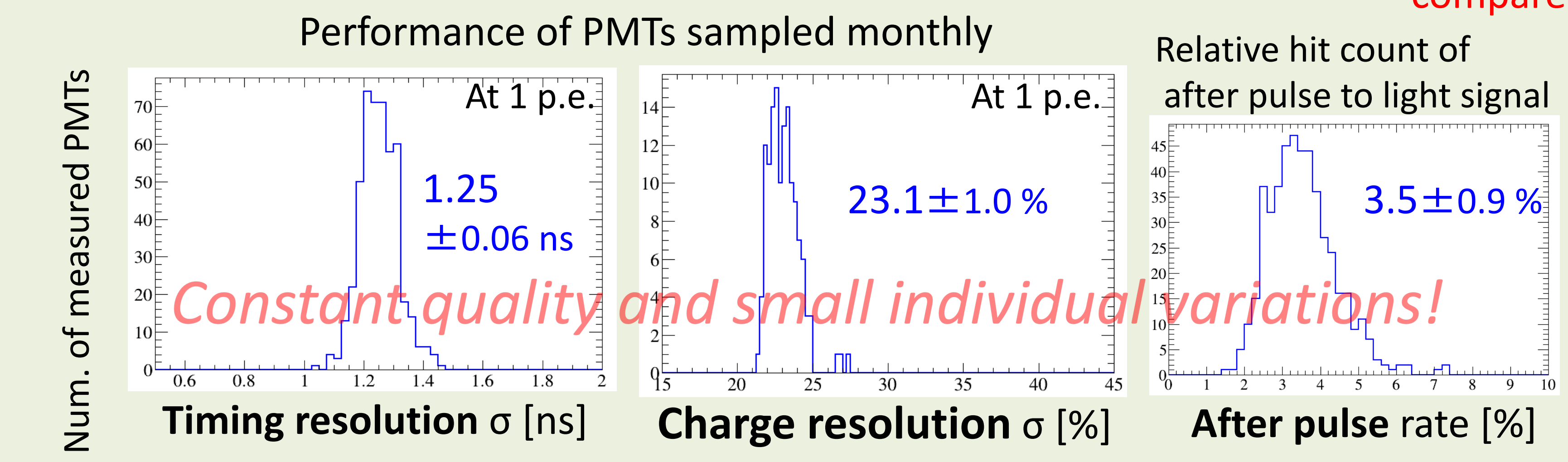
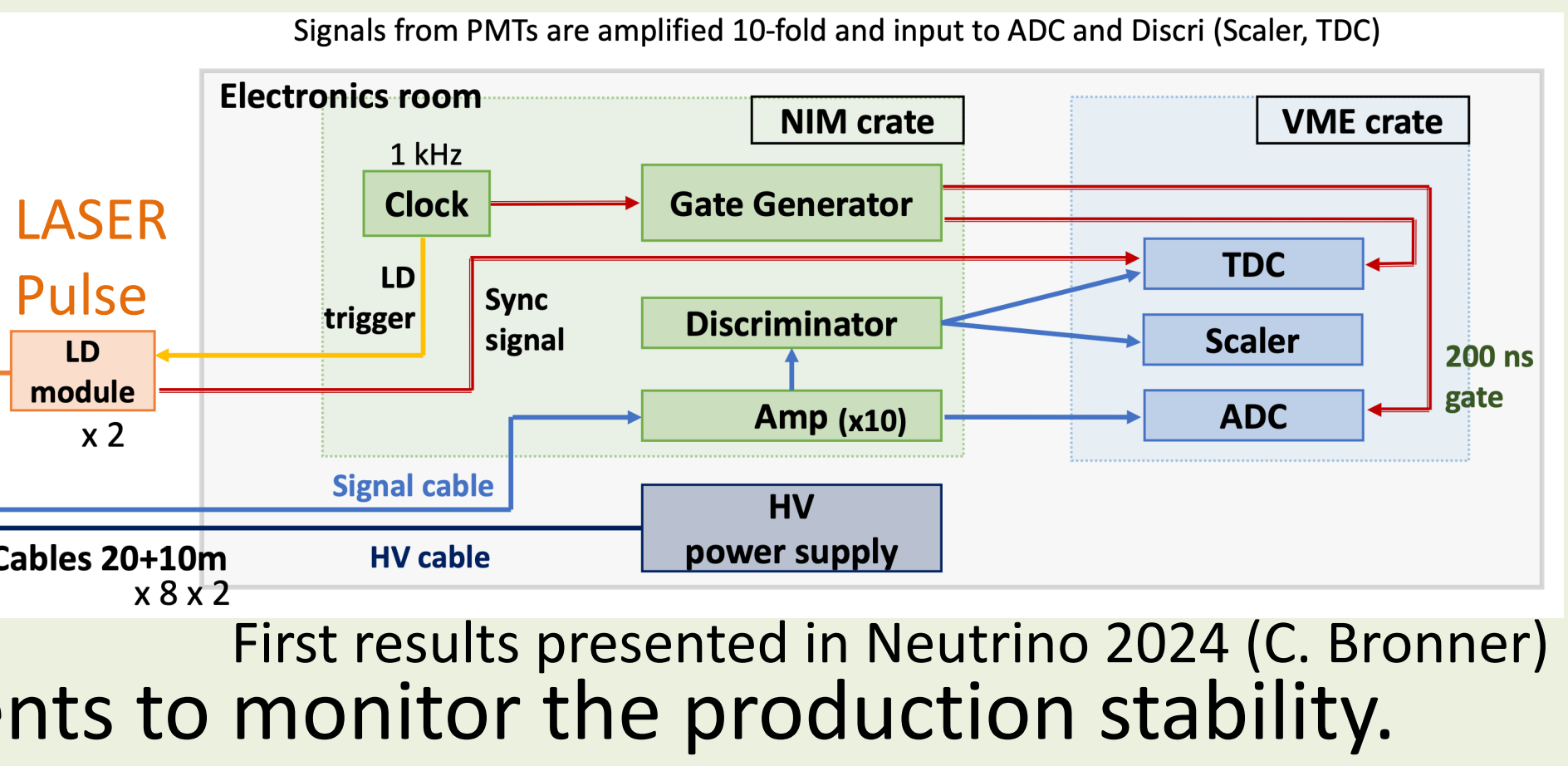
#### Quantum Efficiency Spectra



#### Performance Evaluation

8 PMTs  $\times$  2 cold rooms with light sources

Monthly replacements to monitor the production stability.



### Status

- New 50 cm PMTs were developed with significantly improved performance.
- All 20k PMTs purchased, covers are in production for the start of Hyper-K operation in 2028.

### Outlook

- Cover assembly on the PMTs and their installation in Hyper-K are planned in 2027.
- Functionality checks of all PMTs before and after installation will be conducted.