Experimental measurements

✦ MODEL INDEPENDENT MEASUREMENTS

global efficiency $\alpha = f * \eta * \epsilon = \frac{n}{N_0}$

where

f - light source intensity

η - quantum efficiency

ϵ - collection efficiency

where

n - number of events with signal above pedestal's 5σ

N_0 - total number of triggers

✦ MODEL DEPENDENT MEASUREMENTS

➤ **Disentangle different efficiencies η and ϵ**

using Pavel's model that describes SPE spectum

Experimental measurements

$$\alpha = f * \eta * \epsilon$$

f - light source intensity

- our light source (laser) characteristic. It is specific to experimental setup. In our case it is a fraction of photons that pass through ND filter system.
  We assume it is stable and constant for all our measurements.

η - quantum efficiency

- PMT photocathode characteristic, probability of the photoelectron emission. Extractable within model framework: Average number of photoelectrons (model parameter μ) is a convolution of quantum efficiency with light source intensity (which assumed constant).

ϵ - collection efficiency

- PMT dynodes characteristic, efficiency of the electron multiplier section. Extractable within model framework: fraction of events with signal over pedestal's 5σ per one photoelecton emitted (require the "knowledge" of **single photoelectron** signal shape).

α - global efficiency

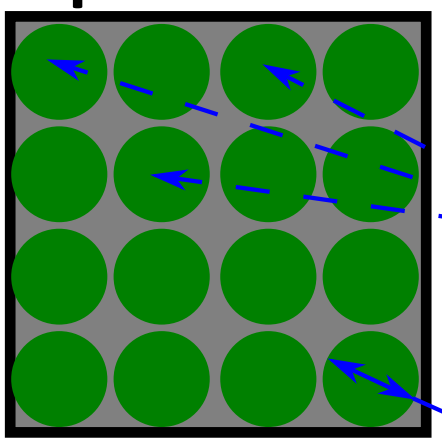
- "final" and most important criteria that is the convolution of all eficiencies. Extractable model independently.

MAPMTs sampling

TWO PAIRS of MAPMTs were chosen for H12700 and H8500 comparison with similar gains reported by Hamamatsu

H8500	H12700
CA7717: 3.43	ZA0175: 3.40
CA7740: 2.49	ZA0176: 2.68

1 pixel

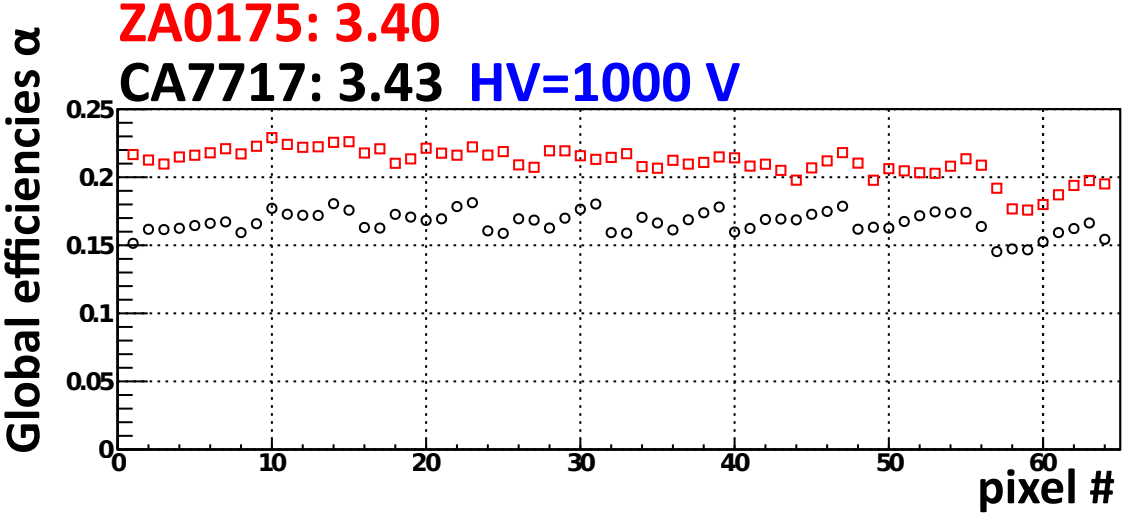


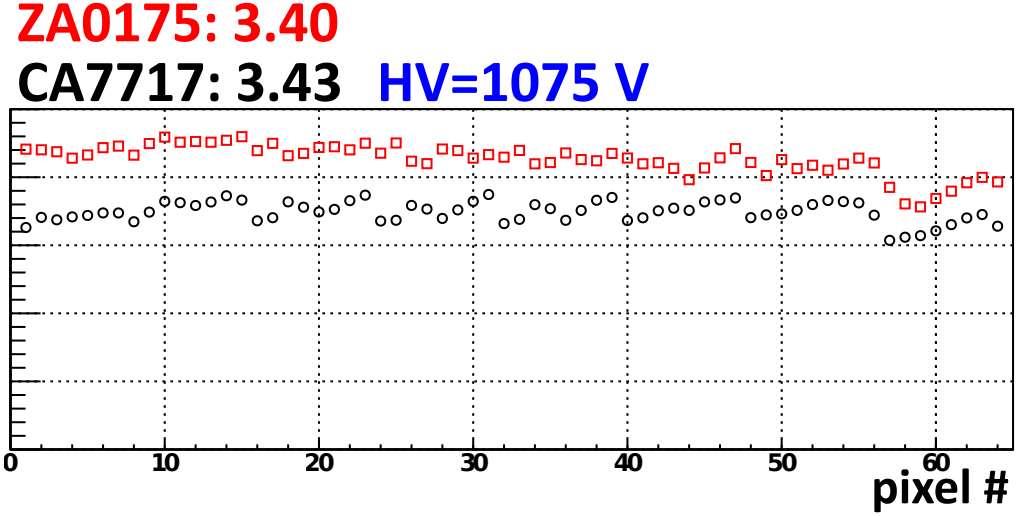
For each pixel the data were collected with 16 different beam positions over pixel to achieve uniform illumination of the MAPMT's pixels

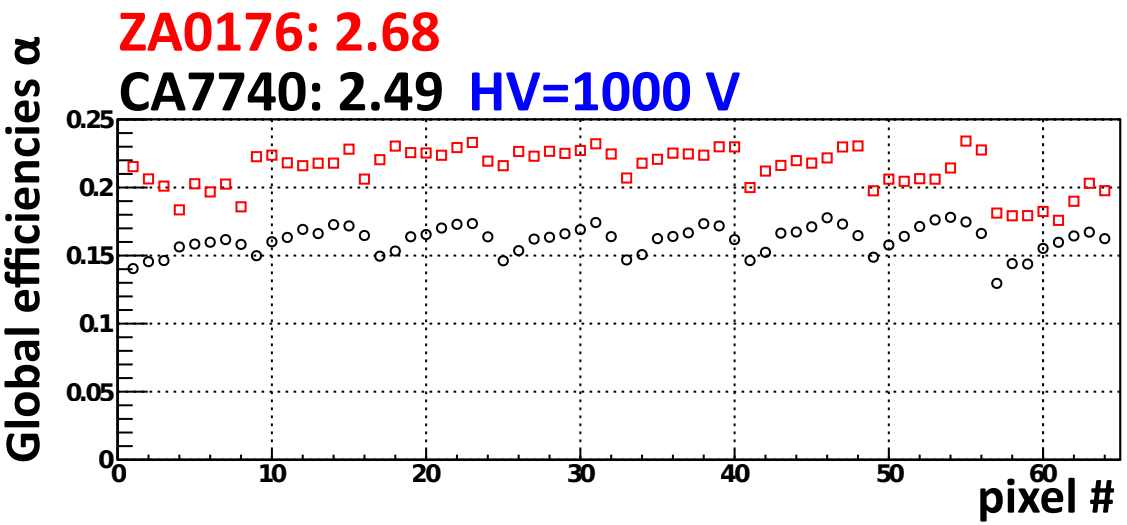
16 beam positions over pixel

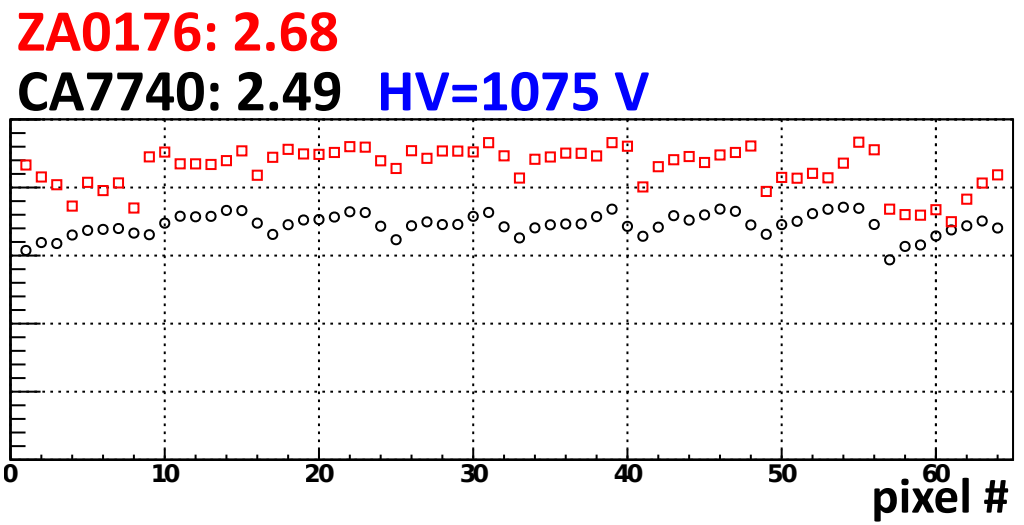
~1 mm beam size spot

Global efficiencies α

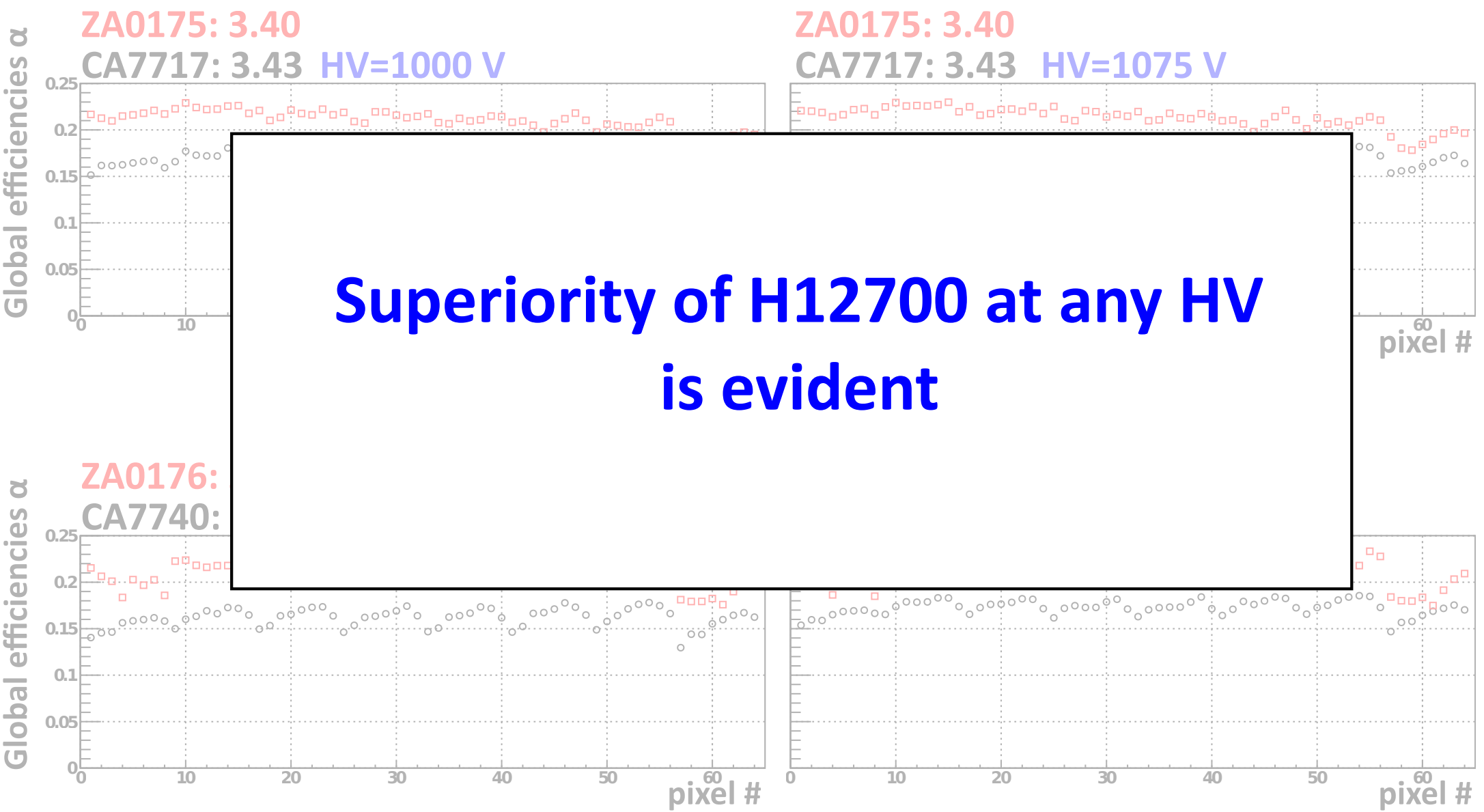








Global efficiencies α



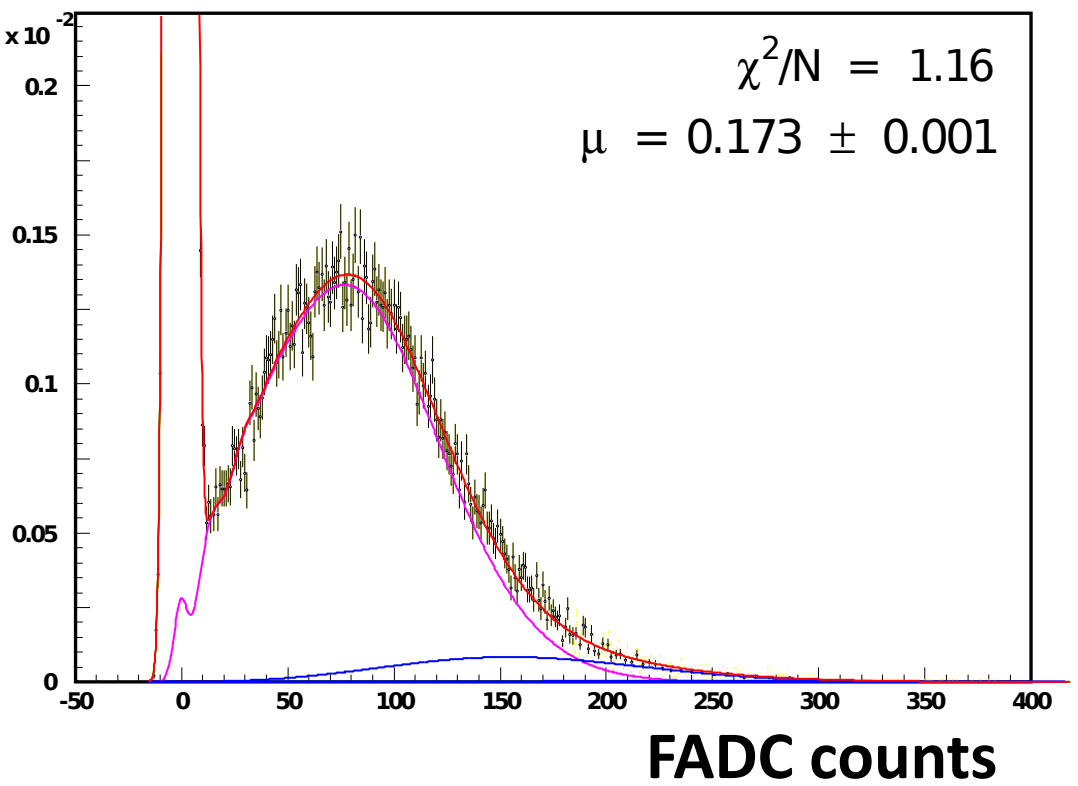
Superiority of H12700 at any HV is evident

Pavel's SPE fit model

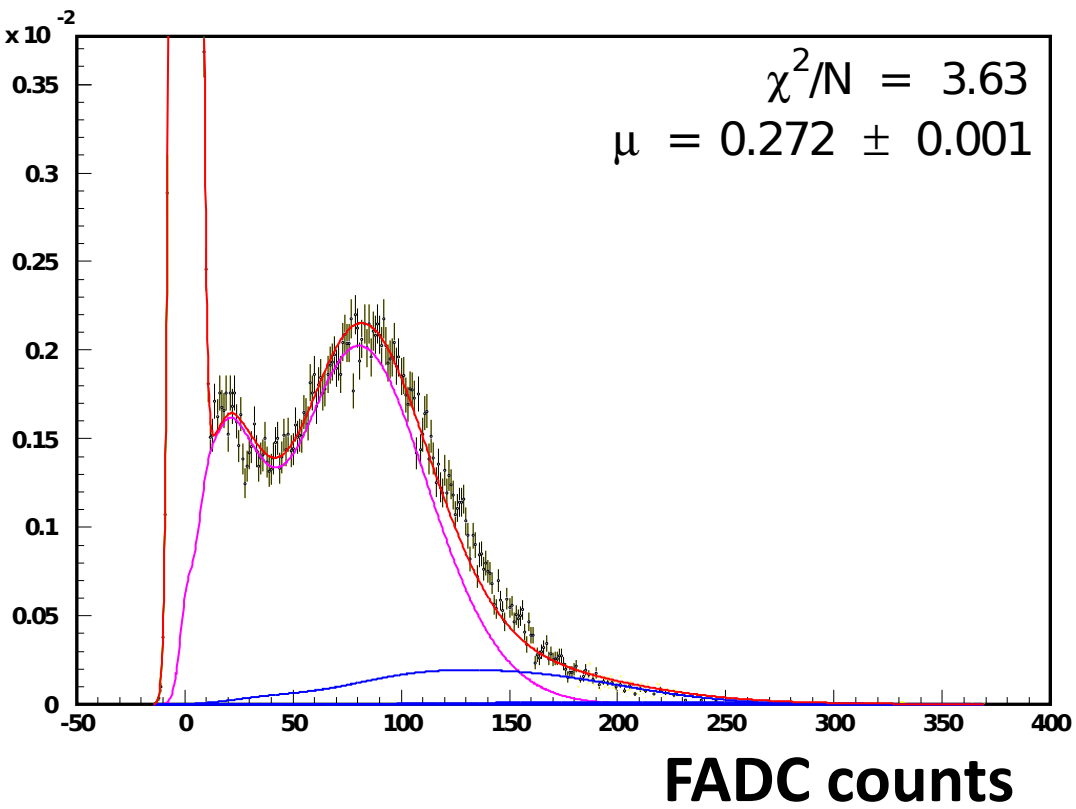
Within model framework SPE fit allows extraction of the:

- ➤ Gain
- ➤ Collection efficiency
- ➤ Average number of photoelectrons μ (related to quantum efficiency)

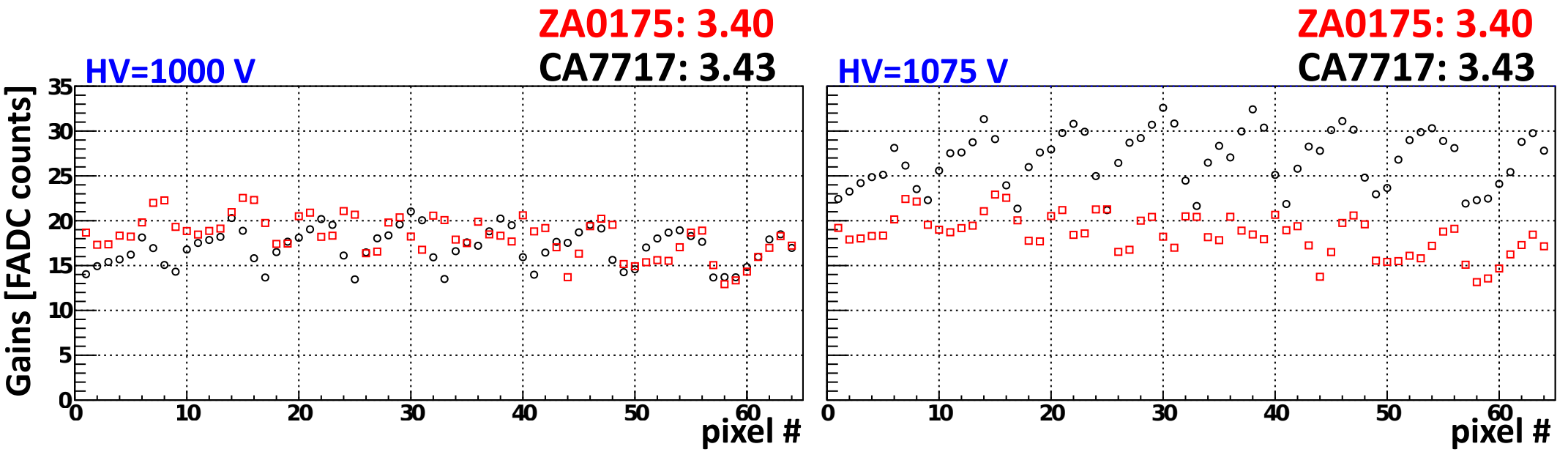
H8500

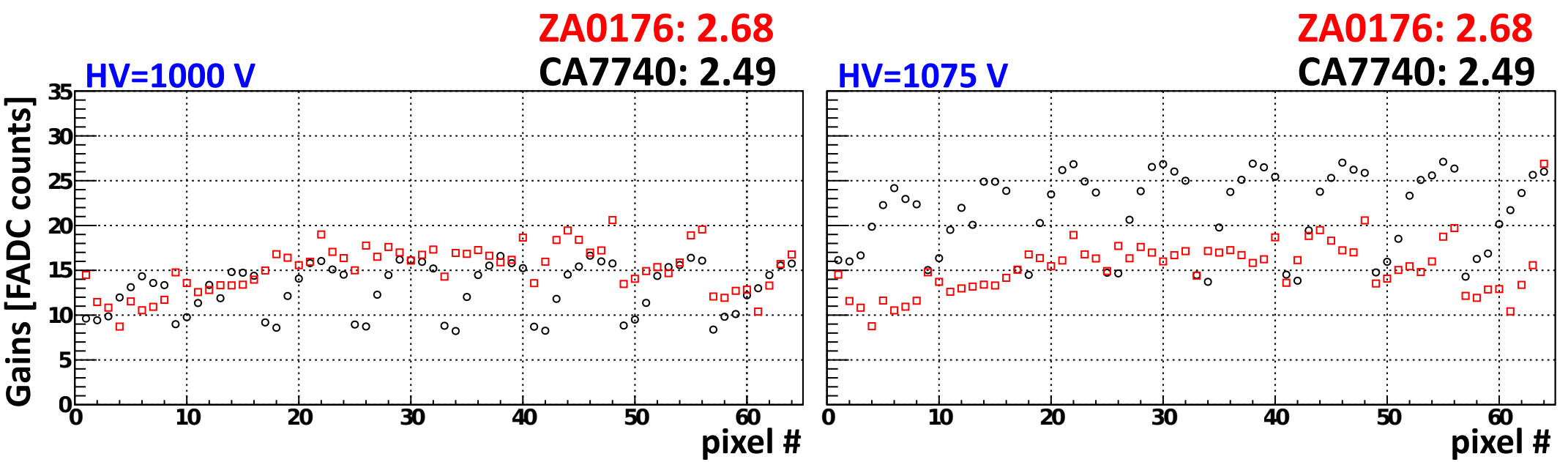


H12700

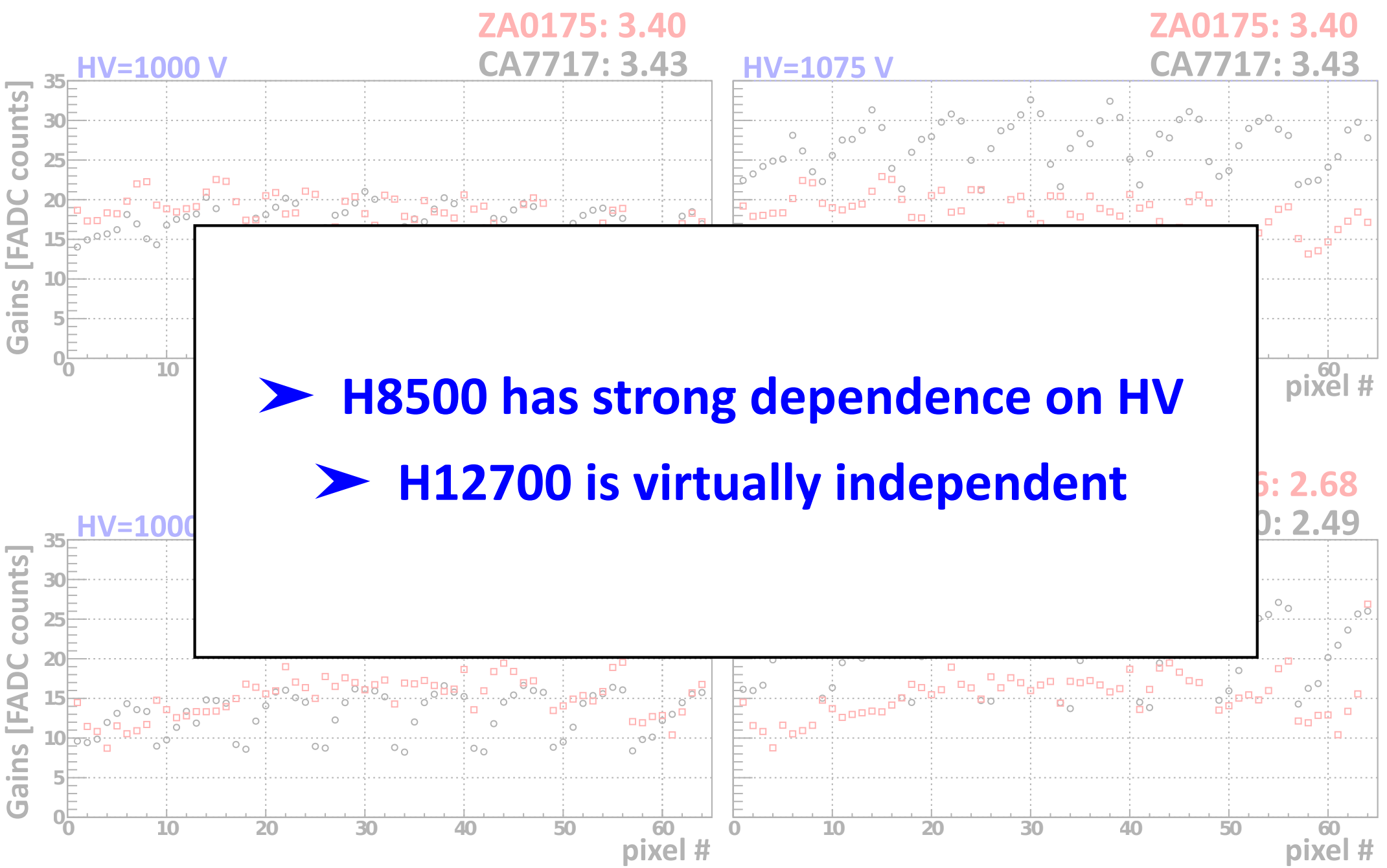


Gain Extraction

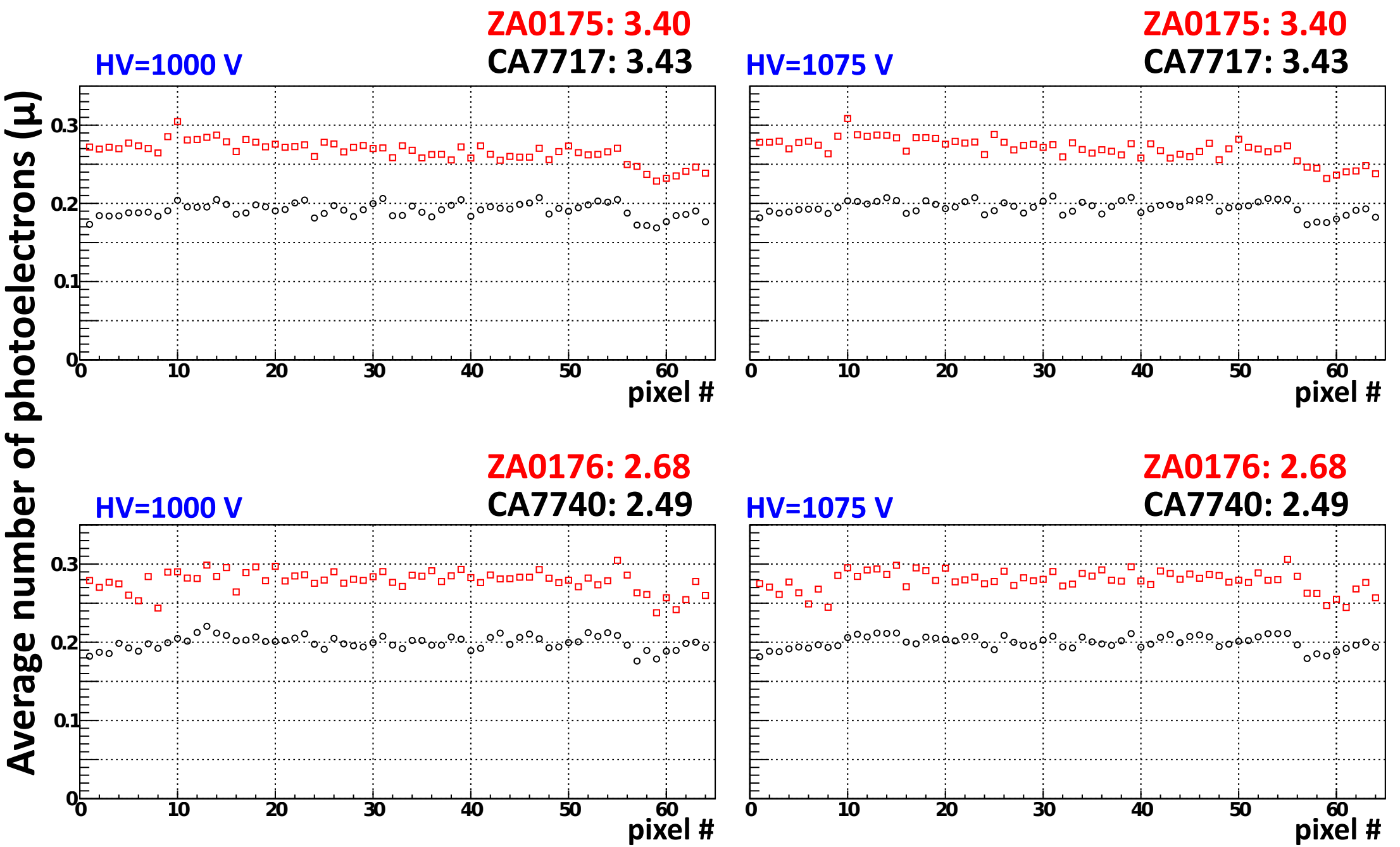




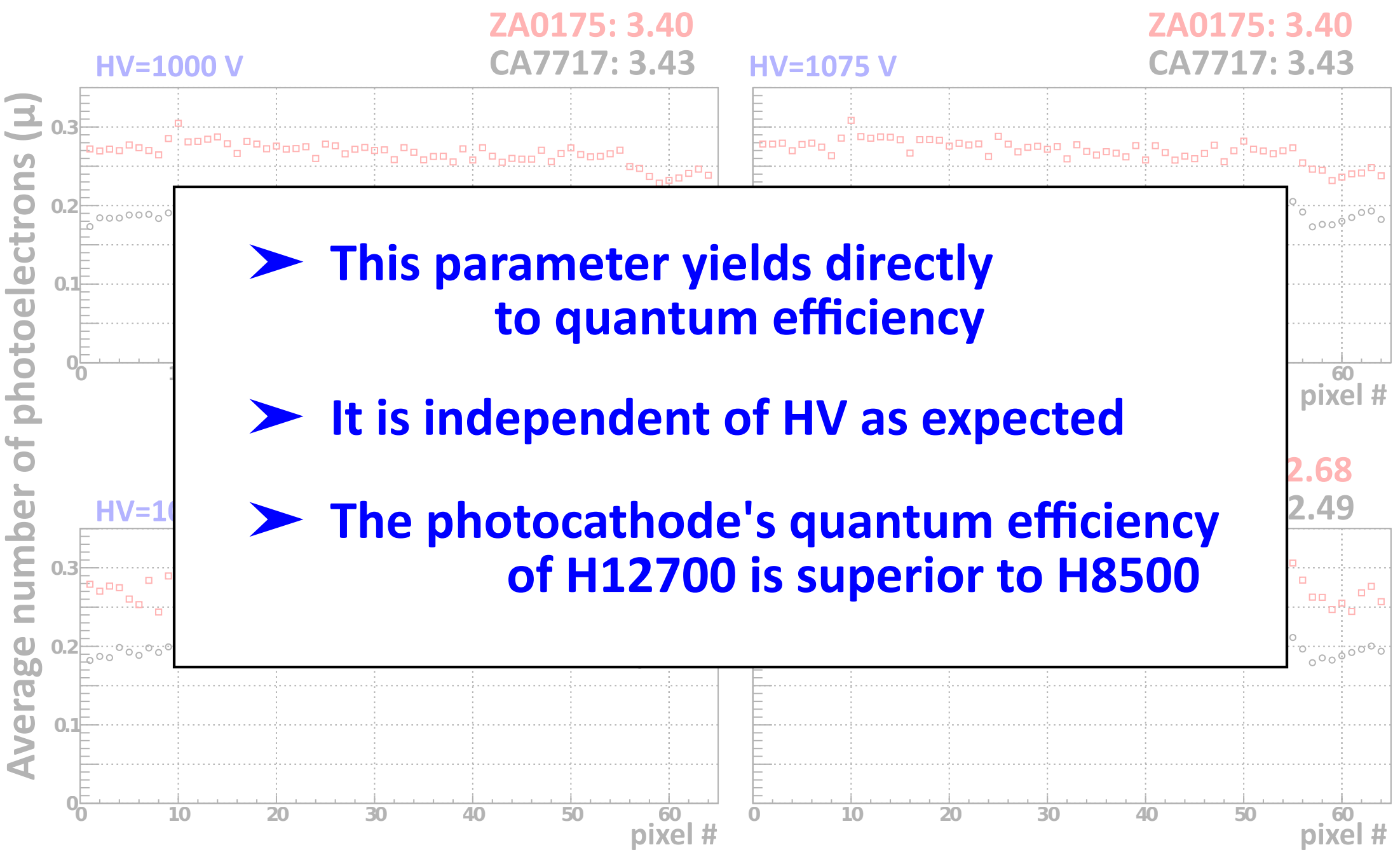
Gain Extraction



Average number of photoelectrons (μ)



Average number of photoelectrons (μ)

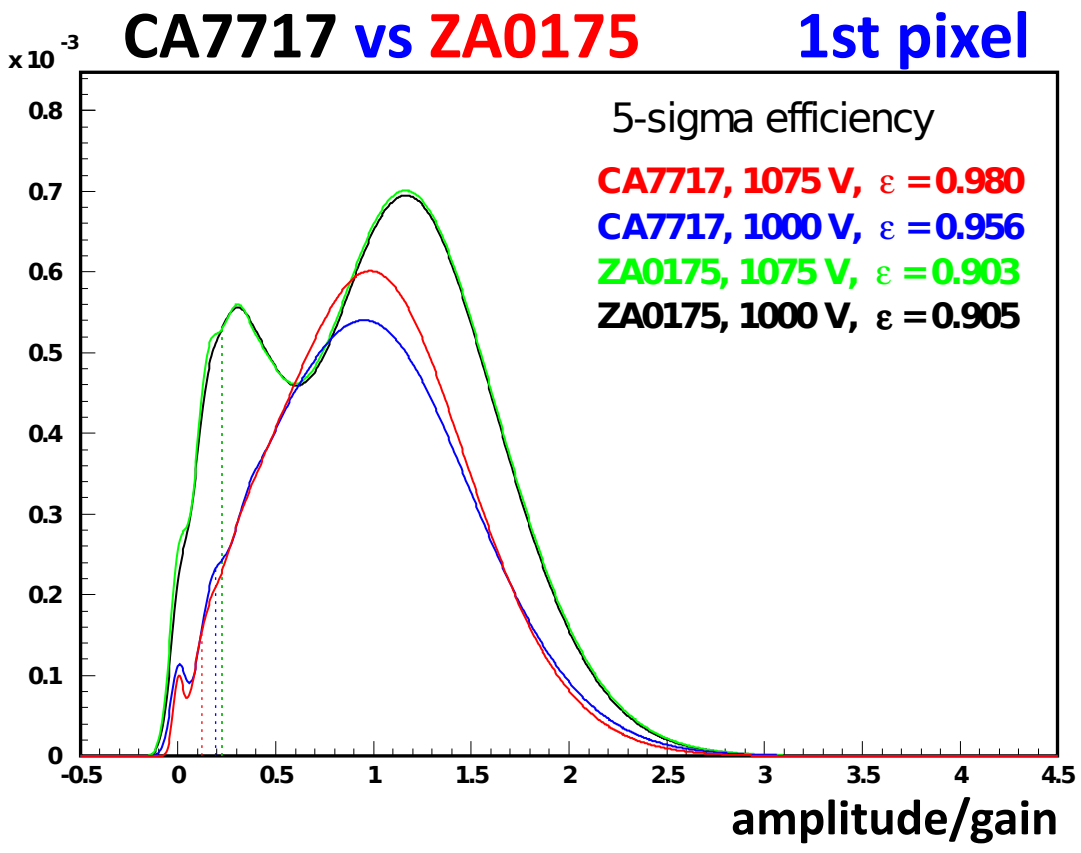


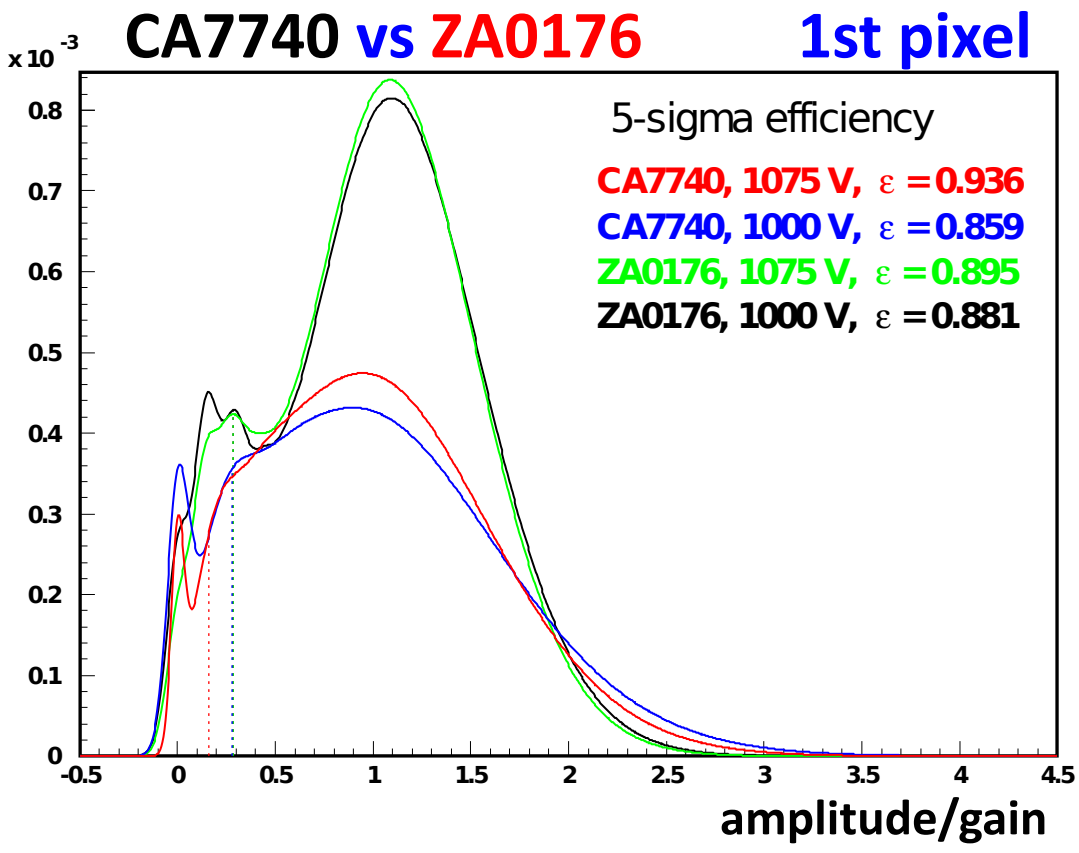
- This parameter yields directly to quantum efficiency
- It is independent of HV as expected
- The photocathode's quantum efficiency of H12700 is superior to H8500

Collection Efficiency

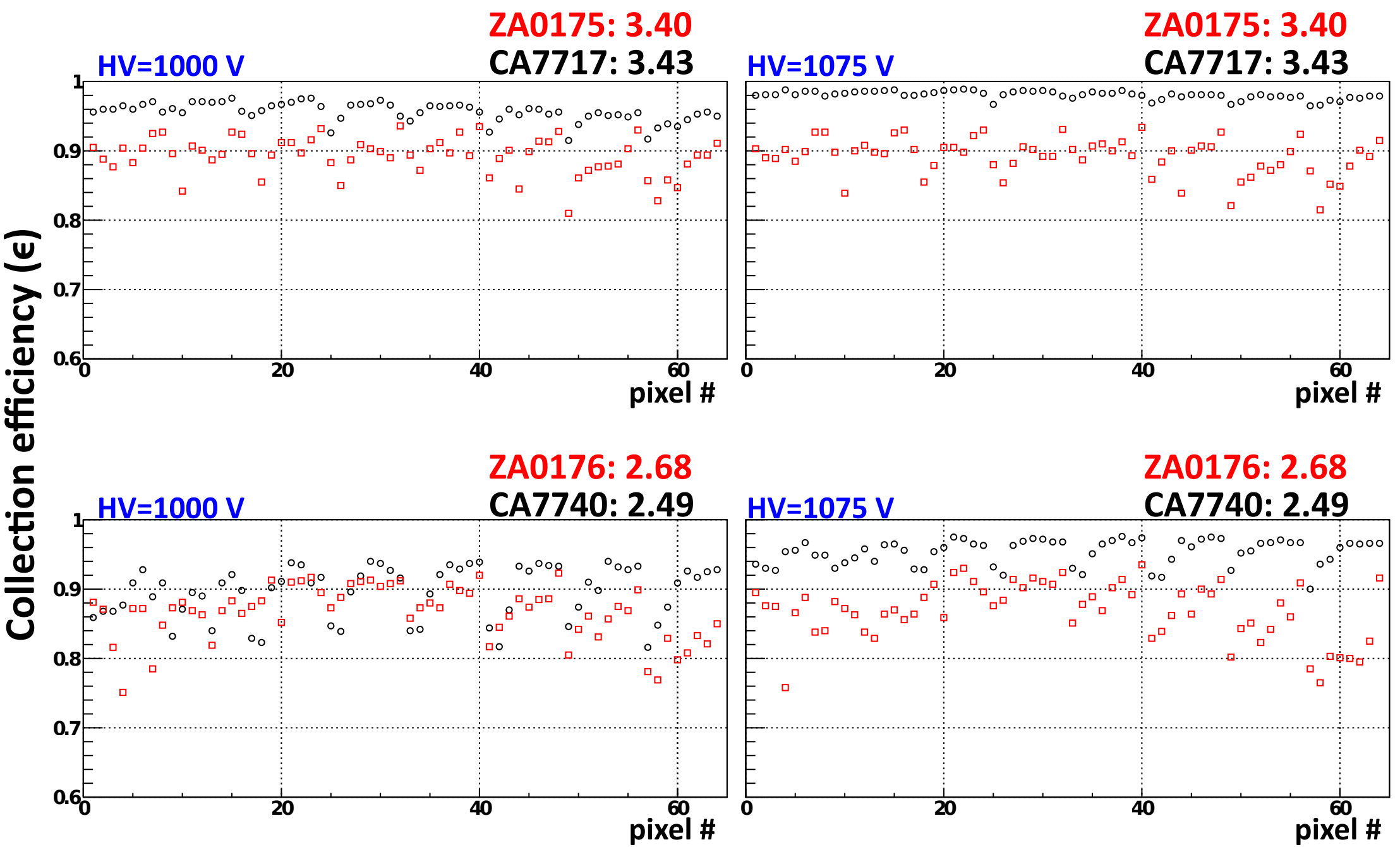
- Collection Efficiency characterizes the electron multiplier mechanism.
- This efficiency can be calculated numerically within the model framework.

The shape of SPE signal extracted from fit model is shown for different MAPMT at different HV

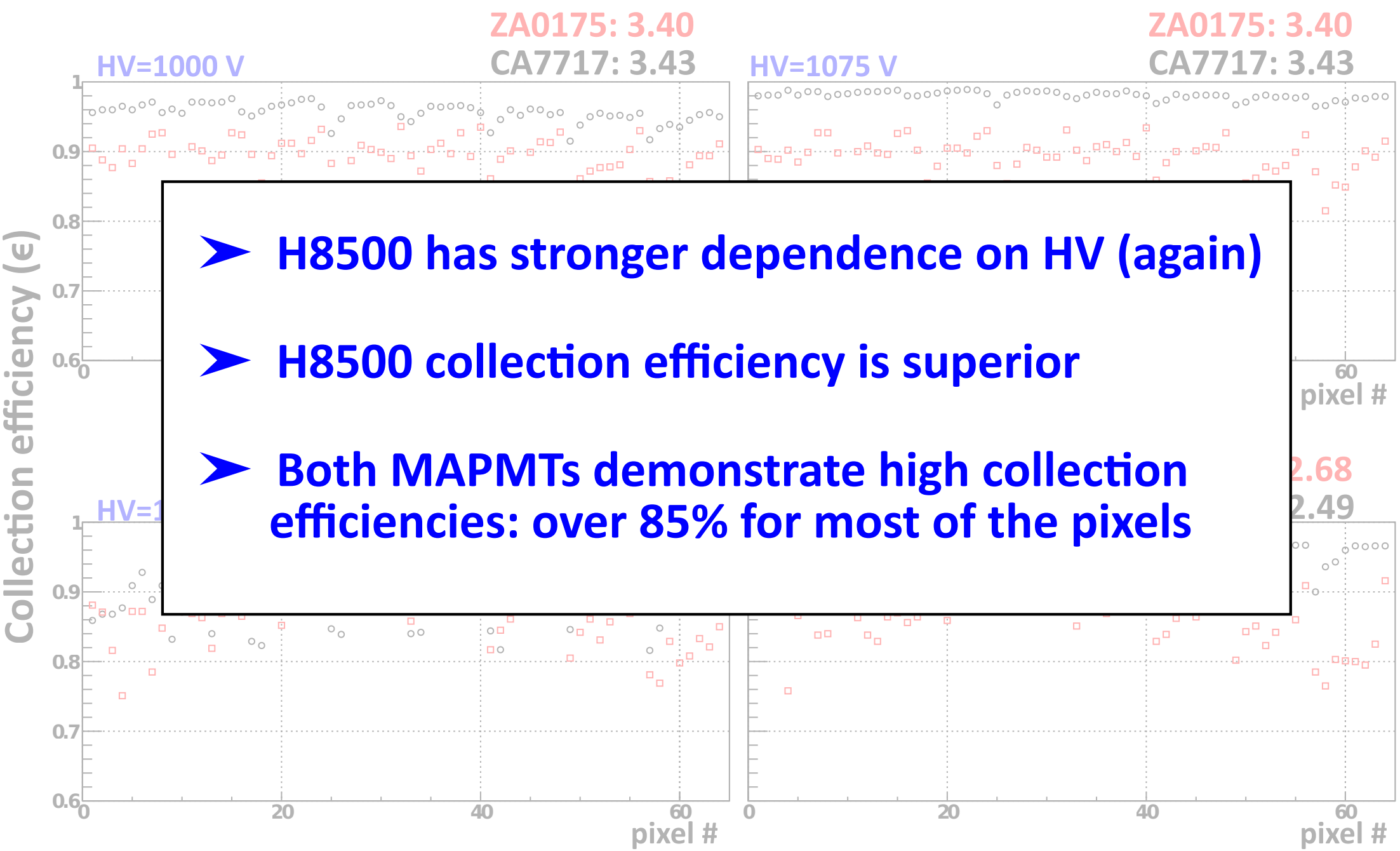




Collection Efficiency



Collection Efficiency



- H8500 has stronger dependence on HV (again)
- H8500 collection efficiency is superior
- Both MAPMTs demonstrate high collection efficiencies: over 85% for most of the pixels

CONCLUSION

WITHIN THE MODEL FRAMEWORK:

quantum efficiency is superior for H12700

collection efficiency is superior for H8500

$$\eta * \epsilon$$

MODEL INDEPENDENTLY:

H12700 is SUPERIOR

due to the DECISIVELY HIGHER QUANTUM EFFICIENCY