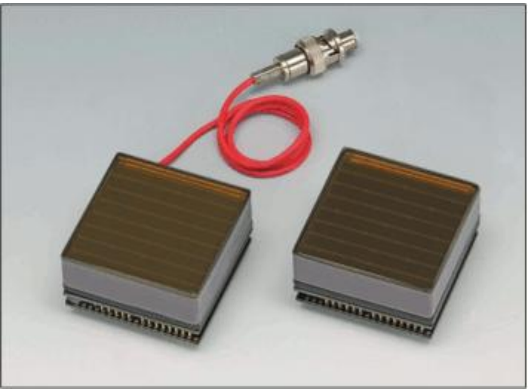
# Test of Multi-Anode PMTs fro the RICH

**Main goal of the tests:**

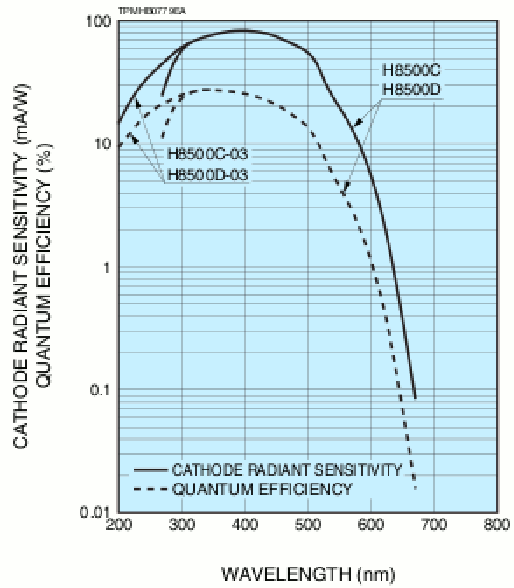
**- characterization of the MA-PMT using a laser beam**
**pixel-to-pixel uniformity**
**uniformity within 1 pixel**

**- study single photoelectron response of MA-PMTs**

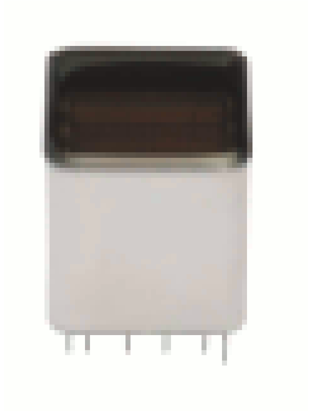
# Multi-Anode PMT



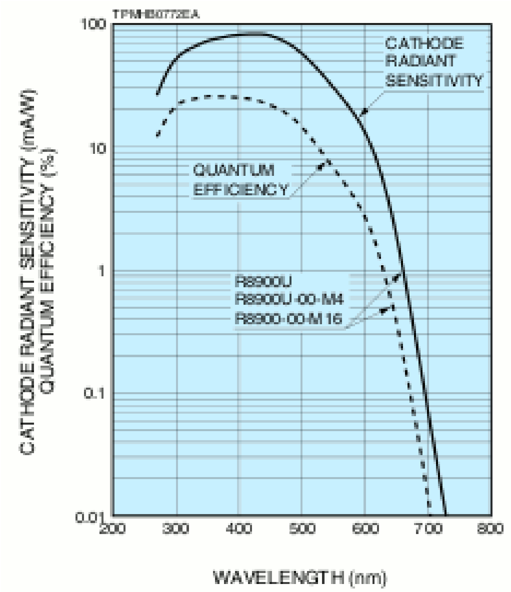
| | H8500C | H8500C-03 |
|---|---|---|
| window | borosilicate glass | UV glass |
| range | 300-650 nm | 185-650 nm |
| peak | 400 nm | |
| total area | 49x49 | |
| N. pixel | 8x8 | |
| pixel area | 5.2x5.2 | |
| packing frac. | 89% | |
| gain | 1.5 10^6 | |




**R8900-00-M15**
**R8900-100-M16**



| | R8900-00-M16 | R8900-100-M16 |
|---|---|---|
| window | borosilicate glass | |
| range | 300-650 nm | 300-650 nm |
| peak | 420 nm | 350 nm |
| total area | 26.2x26.2 | |
| N. pixel | 4x4 | |
| pixel area | ~5.8x5.8 | |
| packing frac. | 80% | |
| gain | 10^6 | |

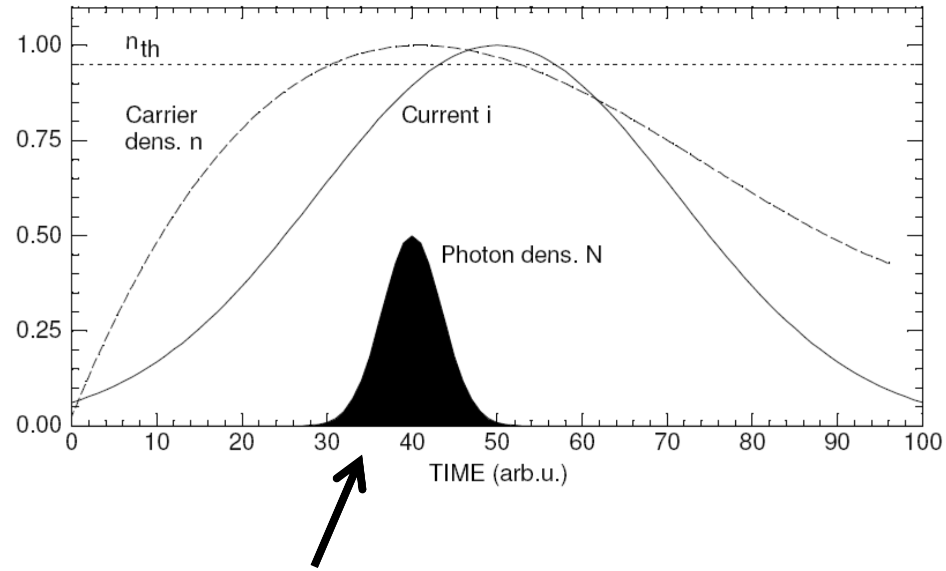


# Laser

**two Picosecond Injection Lasers**

| | |
|---|---|
| blue | λ=407.2 nm |
| red | λ=635.6 nm |

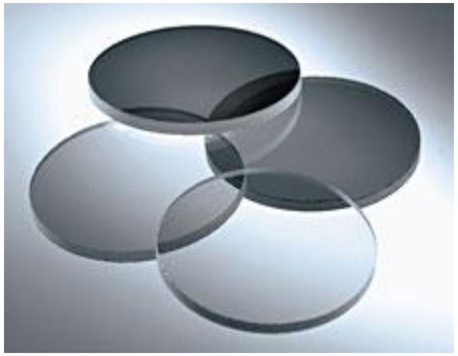
| | |
|---|---|
| pulse rate | 0÷1MHz |
| adjustable intensity | ~20-60% |
| beam collimation | 1 mm |




light pulse
FWHM ~ 30-50ps

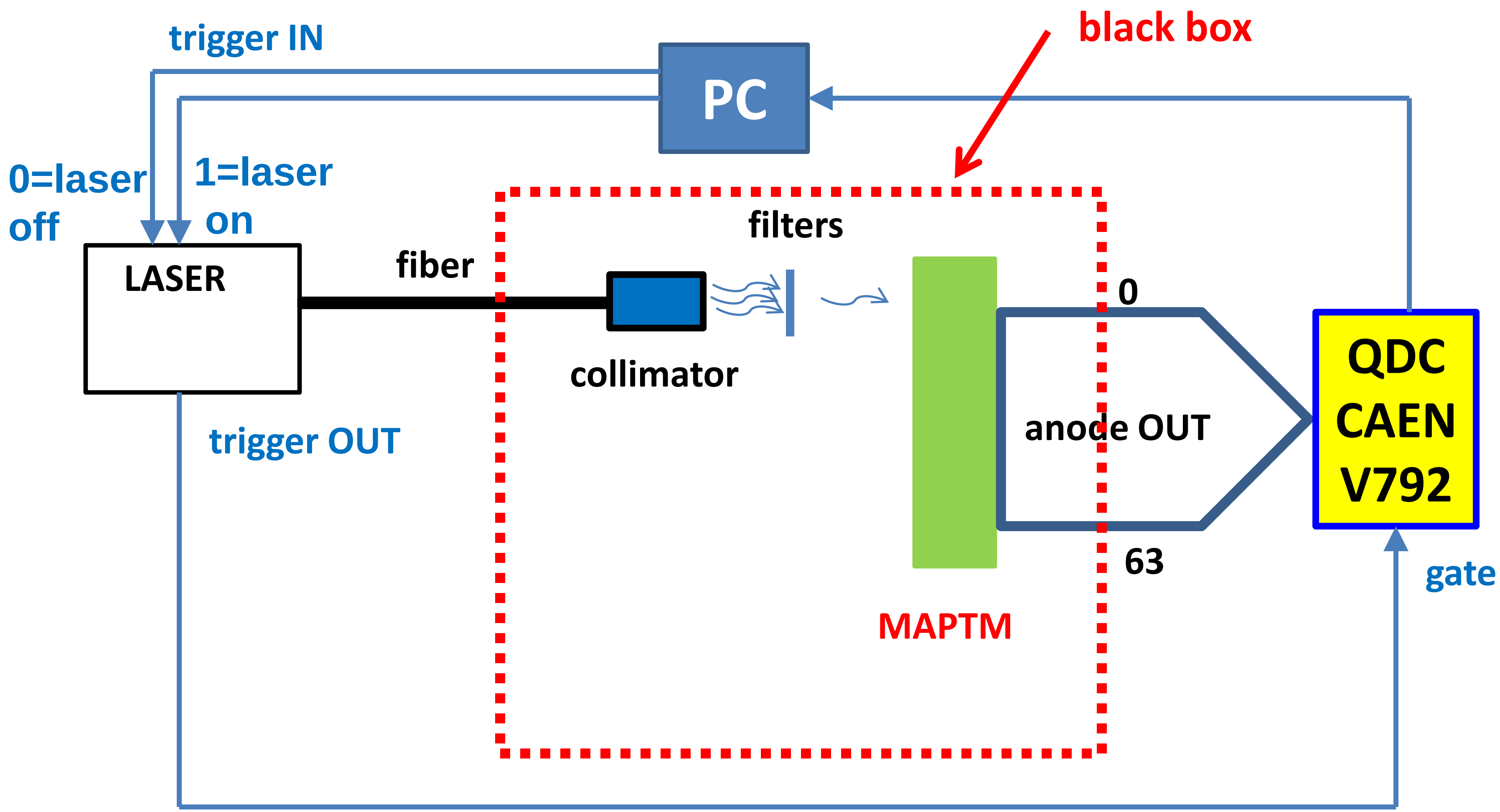
**UV-VIS Neutral Density filters**

λ=200-700 nm



| optical density | transmission |
|---|---|
| 0.5 | 32% |
| 1.0 | 10% |
| 2.0 | 1.0% |
| 3.0 | 0.1% |

# Test setup

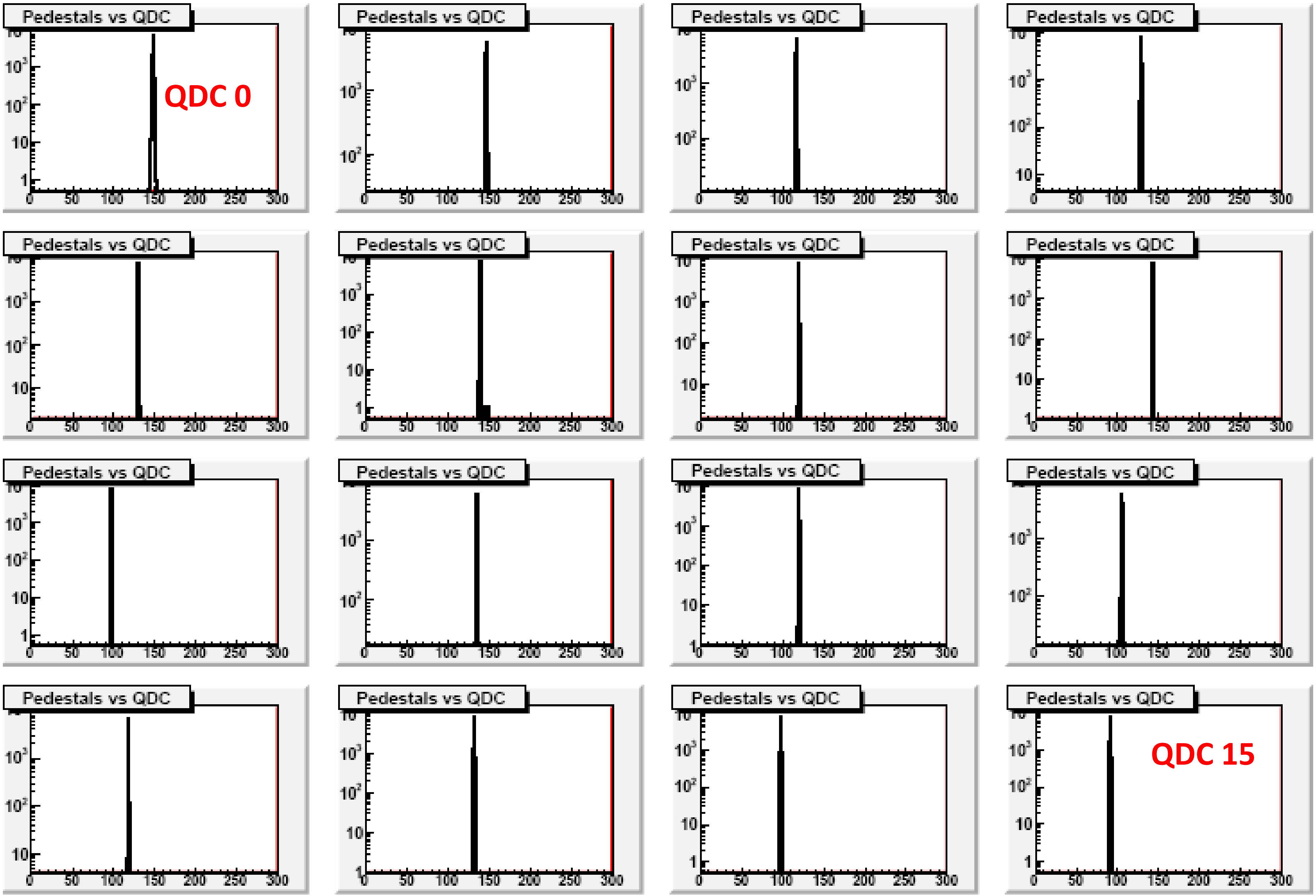



**The fiber head can be remotely moved in (x,y) to scan the PMT surface**
**DAQ rate is driven by the PC (MAX ~5 kHz, but can be varied)**

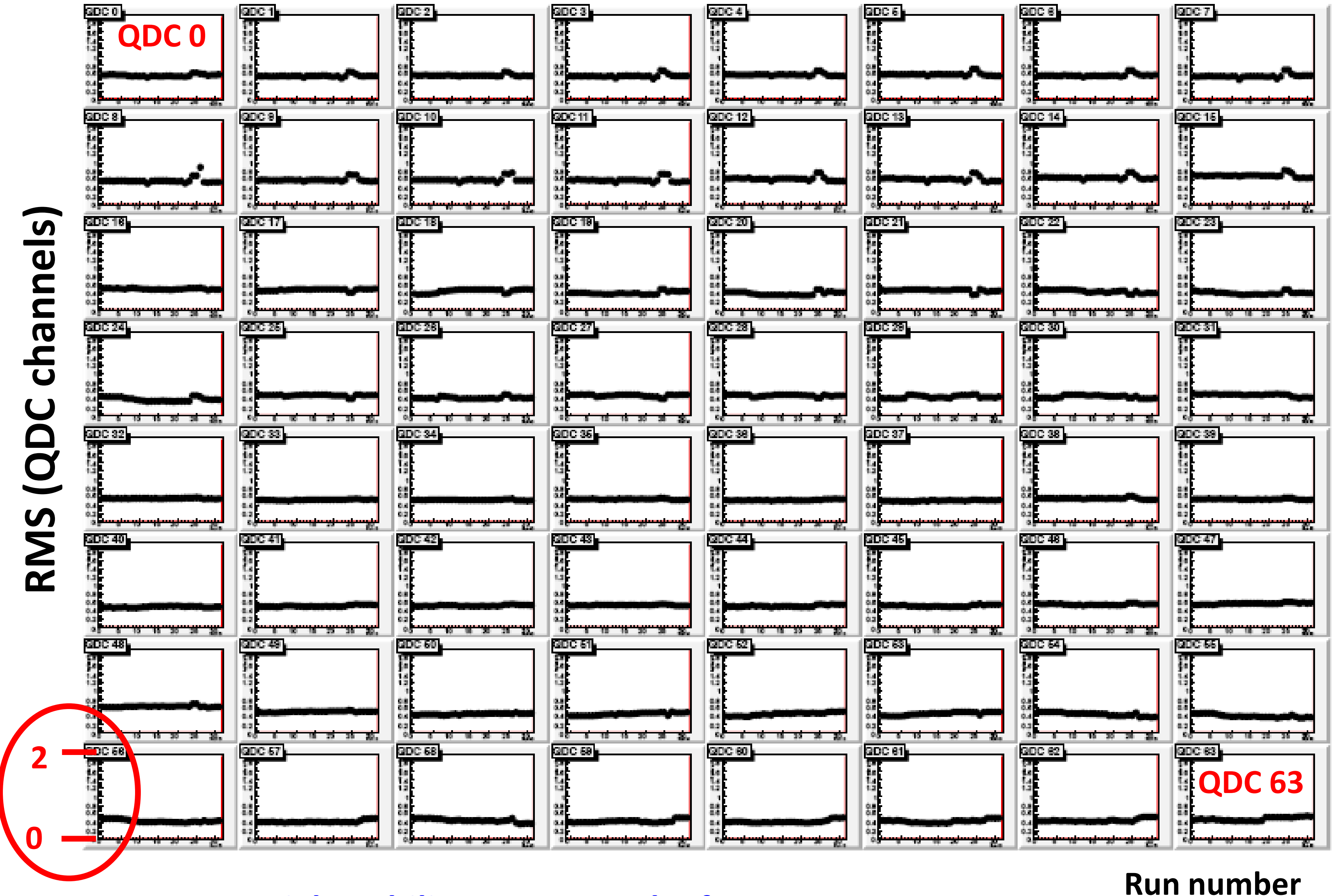
*Thanks to M. Hock, R. Montgomery (Glasgow)*


electronics
black box
laser
controller
motor
controller
The first ENVISAT check-up
of the Earth

# Pedestal measurements

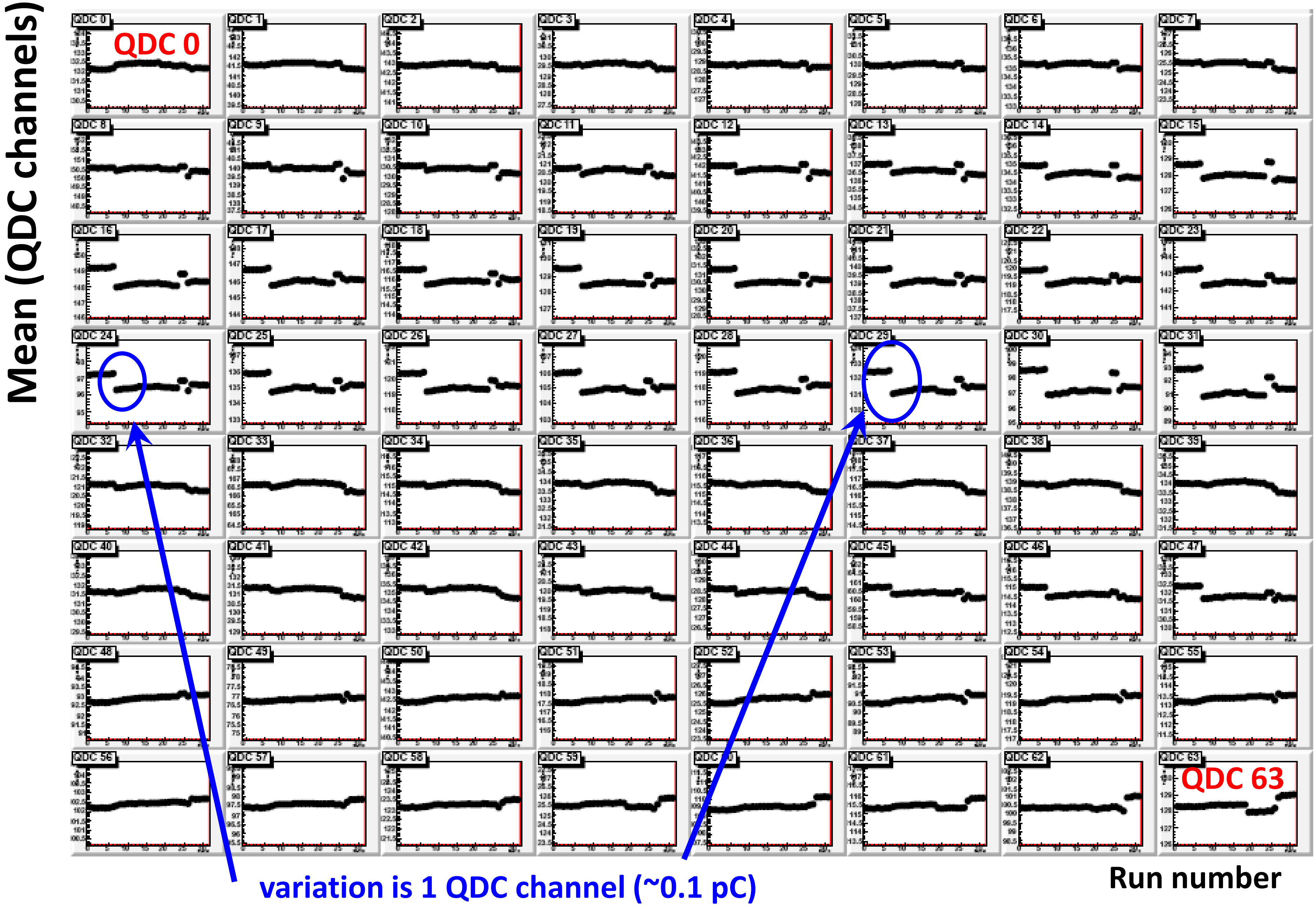


# Pedestal measurements: stability




High stability over a week of measurements

# Pedestal measurements: stability

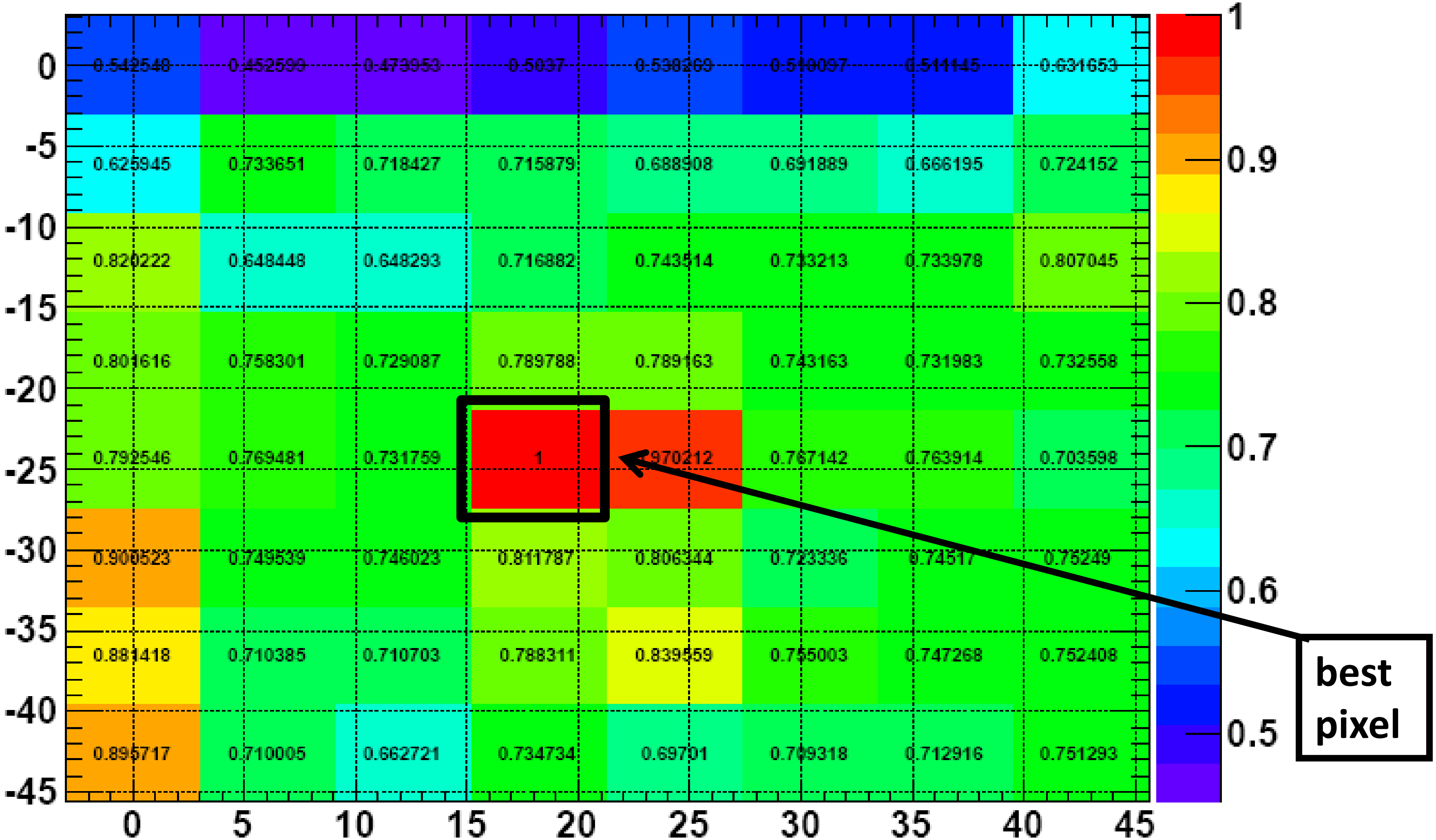


# First PMT scan

red laser, intensity 50%     HV=-800V

scan step 6.08 mm

gain relative to the best pixel




The gain map roughly matches the data sheets from Hamamatsu

Up to factor ~2 pixel-to-pixel variation

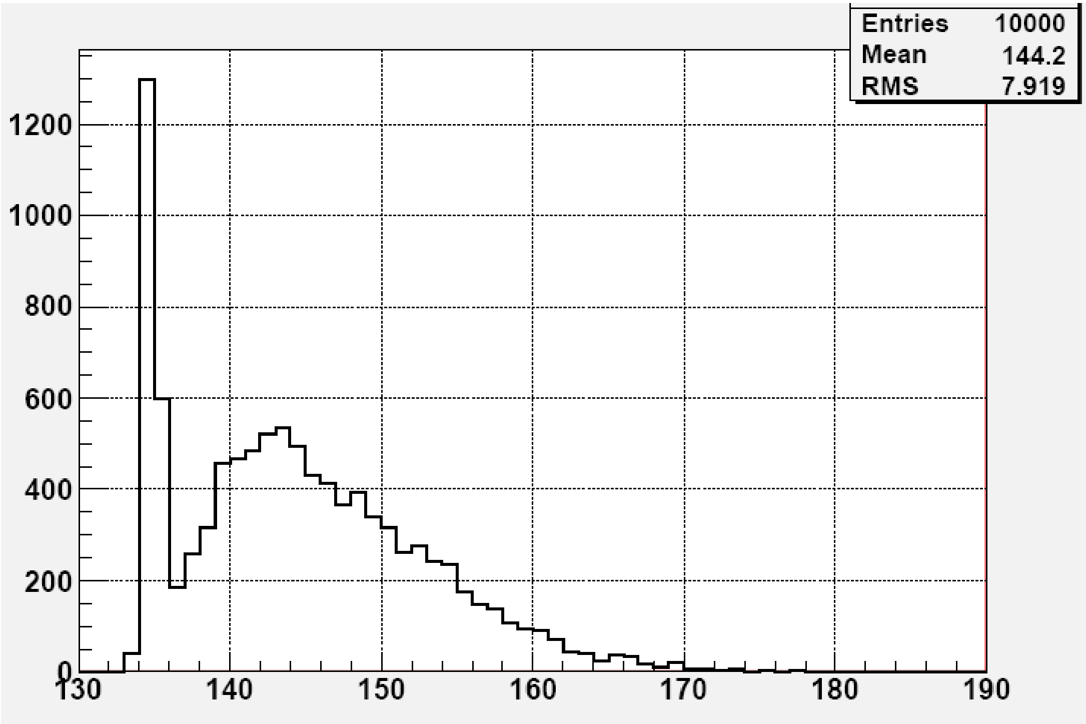
# Single p.e. measurements

**Laser conditions:**

- blue light
- tune (intensity) 25%
- 4 filters with OD=6.5, transmission~3 $10^{-7}$
- fixed position, illumination of best pixel

**DAQ rate 100Hz**

**Measurements vs HV**



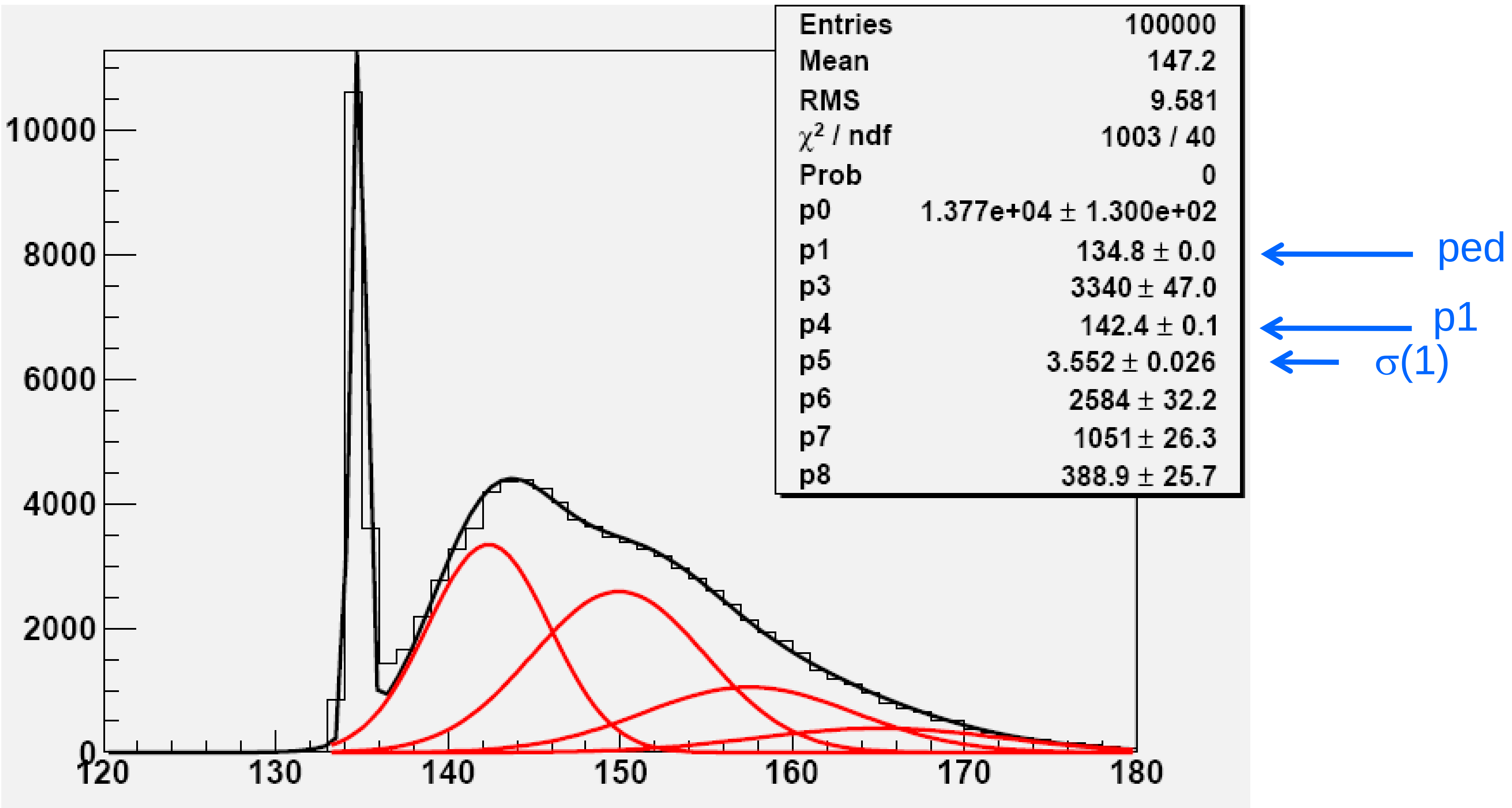
# HV = 1125 V

**Fit with pedestal (gaussian) plus contributions up to 4 p.e (gaussians)**

**$\sigma(ped) = 0.4$**

**$p(n) = ped + n(peak(1) - ped)$**

**$\sigma(n) = \sqrt{n}\,\sigma(1)$**



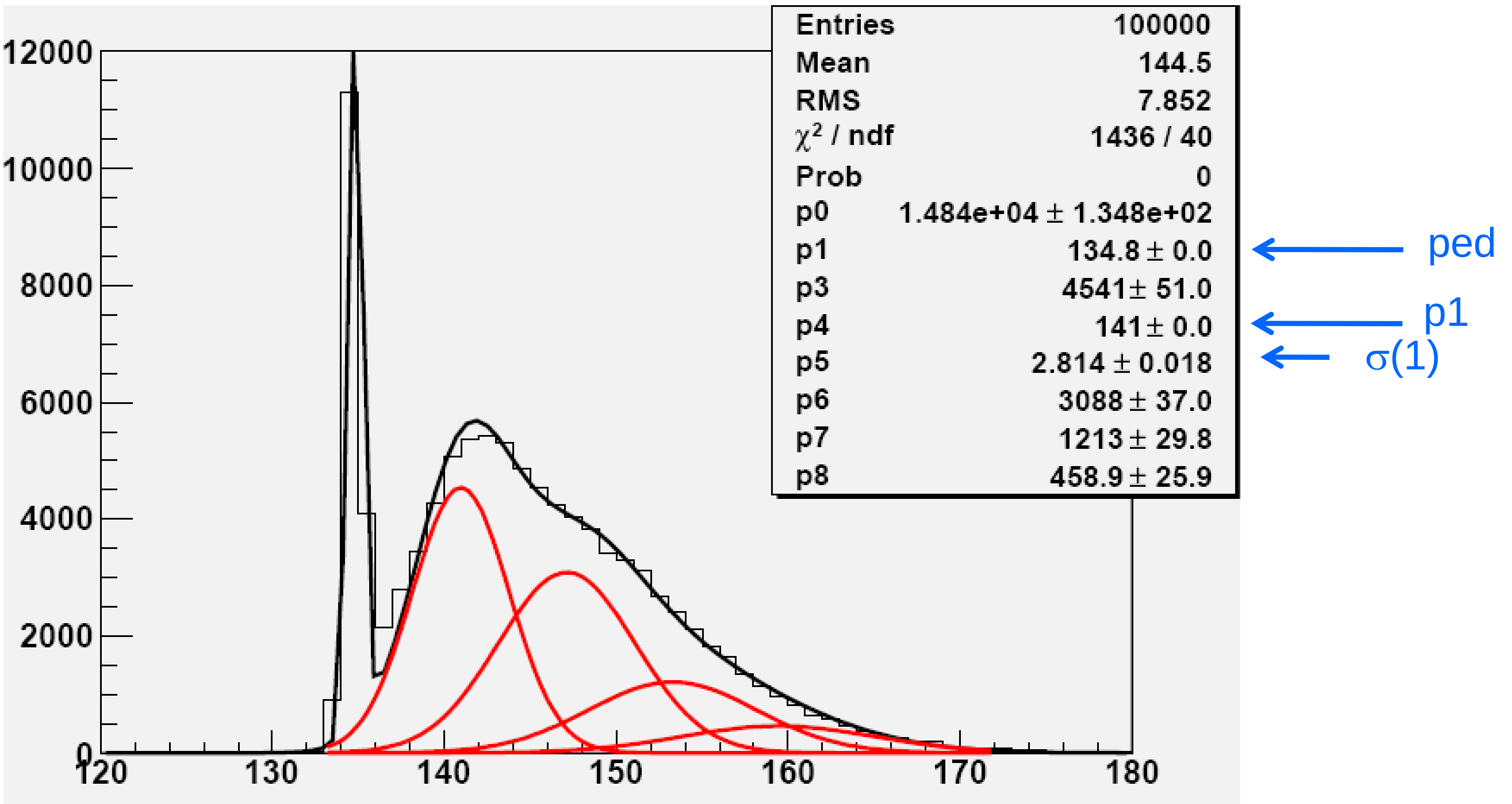
# HV = 1075 V

**Fit with pedestal (gaussian) plus contributions up to 4 p.e (gaussians)**

**σ(ped) = 0.4**

**p(n) = ped + n(peak(1) – ped)**

**σ(n) = √n σ(1)**



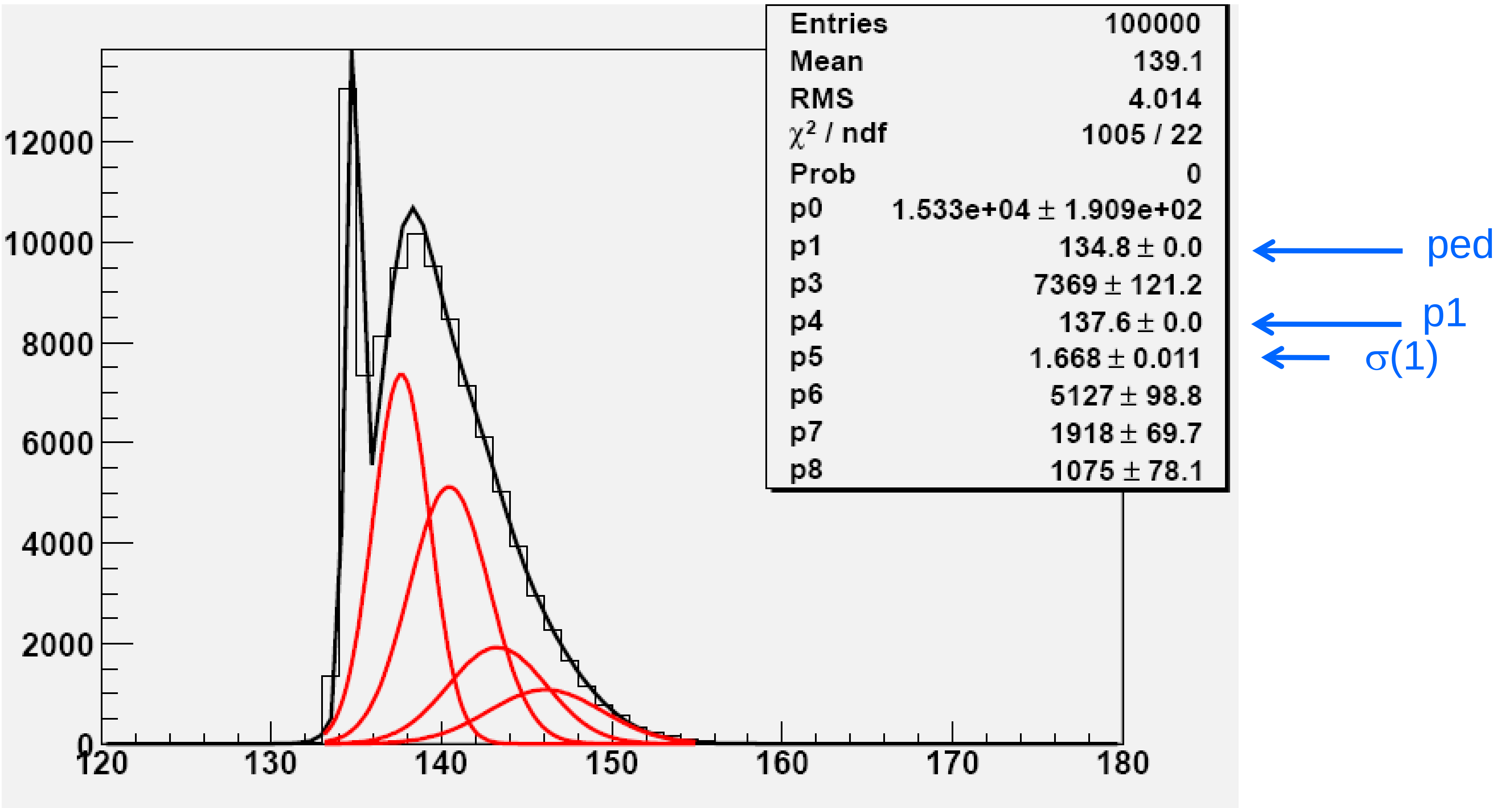
# HV = 950 V

**Fit with pedestal (gaussian) plus contributions up to 4 p.e (gaussians)**

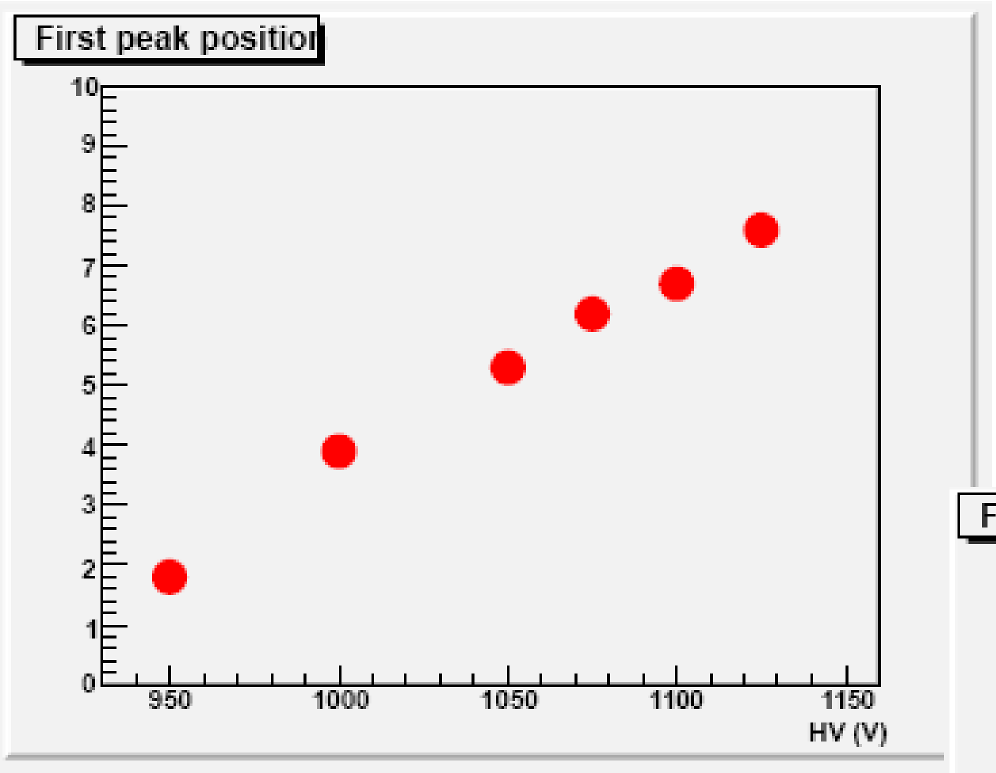
**$\sigma(ped) = 0.4$**

**$p(n) = ped + n(peak(1) - ped)$**

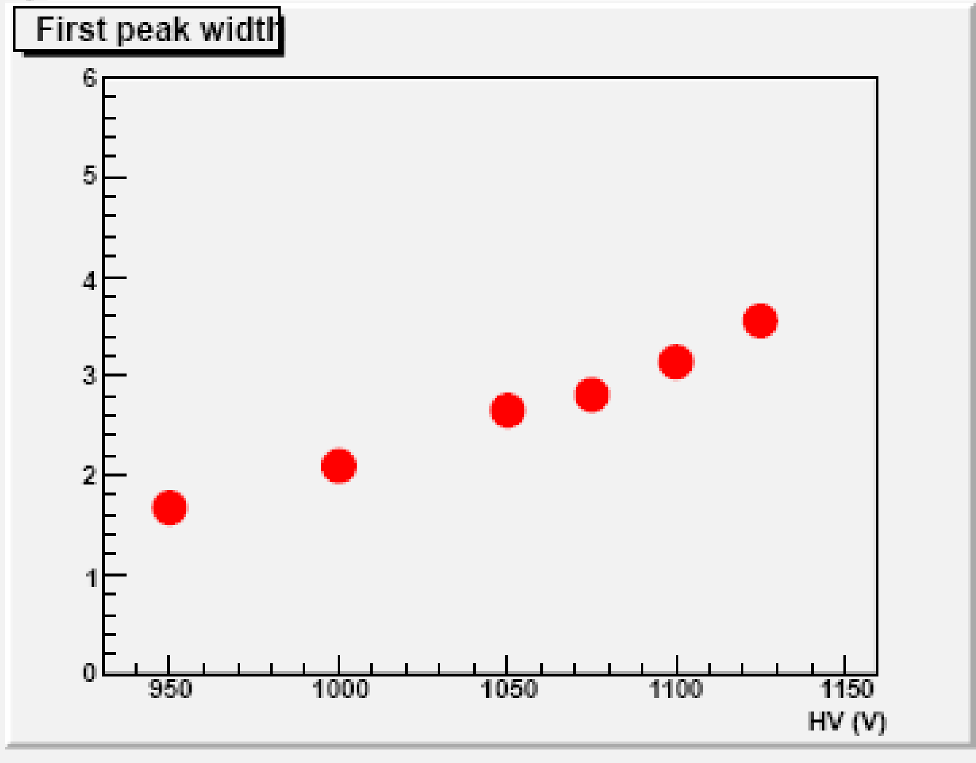
**$\sigma(n) = \sqrt{n}\,\sigma(1)$**



# Single p.e. vs HV




**error bars inside the points**




**From datasheet:**

**log G = a V + b**

**a~0.004**

# Photon flux calculation

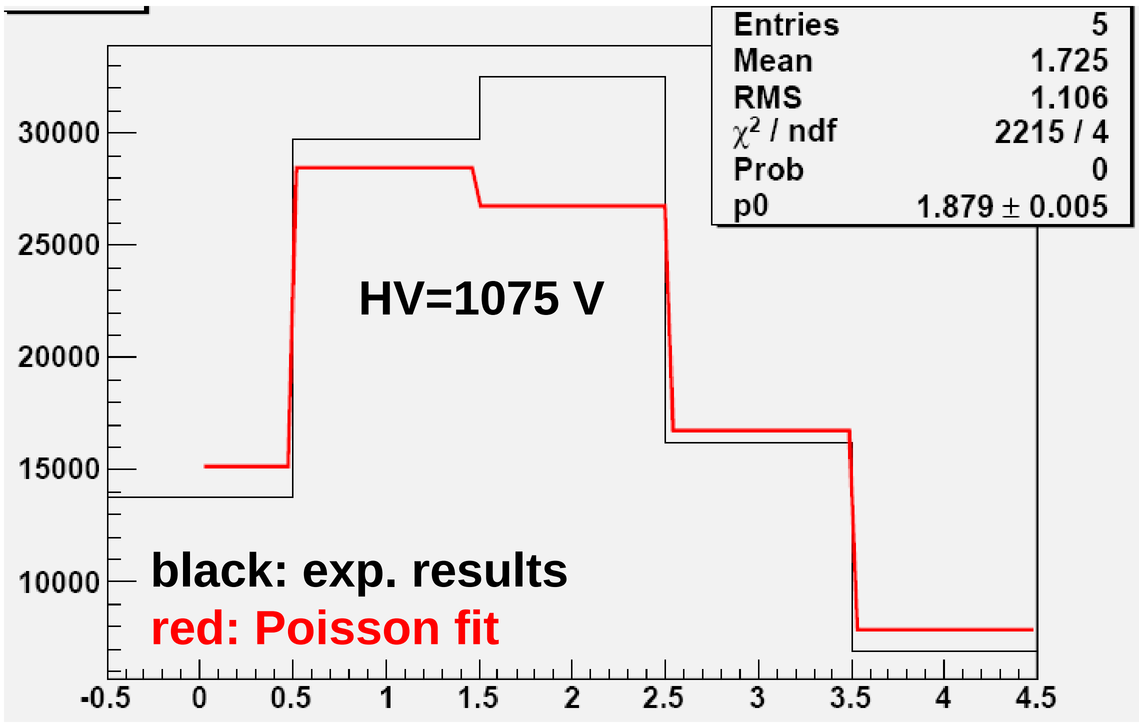
**The number of incident photons can be calculated using the Poisson distribution**

**Probability of having k p.e. with m incident photons:** $$P_m(k) = \frac{m^k e^{-m}}{k!}$$

**The distribution of the number of event with 0,1,2,... p.e. is fitted with the Poisson distribution leaving m as free parameter**

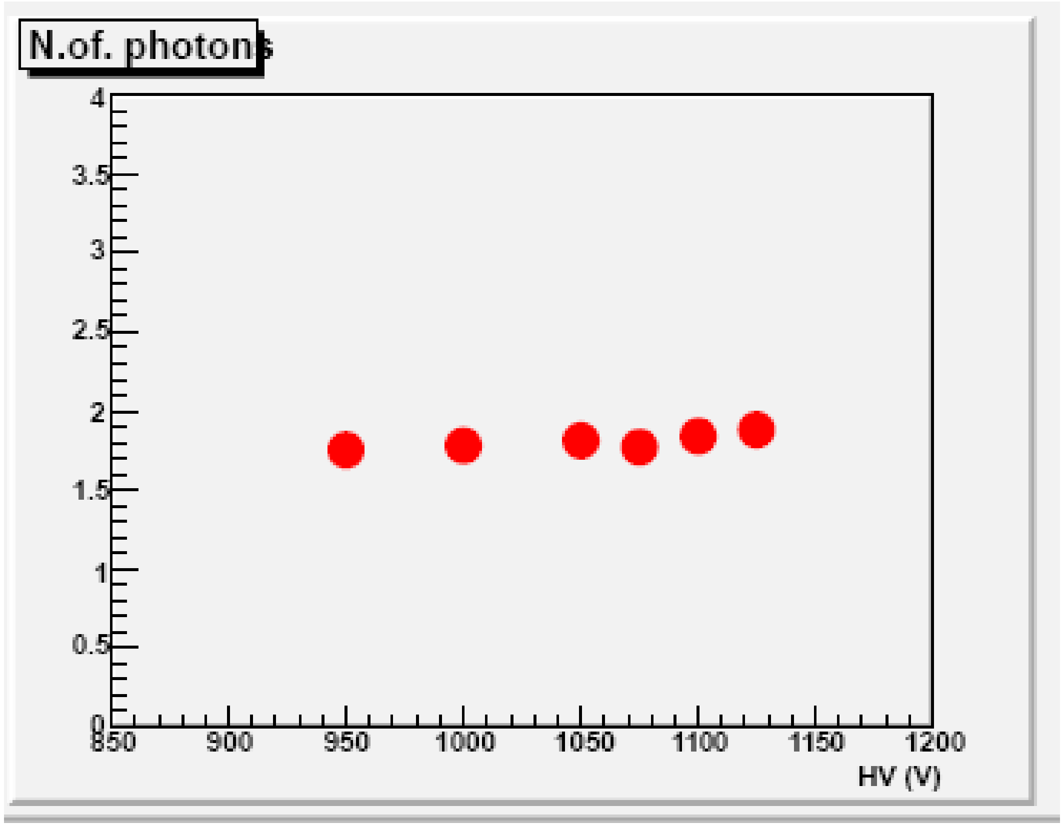
**m=1.88 ± 0.01**

**m must be (roughly) independent from the HV**




**better errors calculation needed**

# Number of incident photons




**<m> ≈ 1.8**

**small dependence from HV**

# Conclusion

- **We have a set-up for testing Multi-anode PMT with laser light**

- **Using standard CAEN electronics, the system is very stable, with very low noise**

- **A statistical procedure to study single photoelectron measurement has been established**

- **First results show that we are able to see the single photoelectron peak with Hamamatsu H8500 PMTs**

- **Good results using the best pixel, now we have to look at average pixel**

- **Next step we'll be study of Hamamatsu R8900**