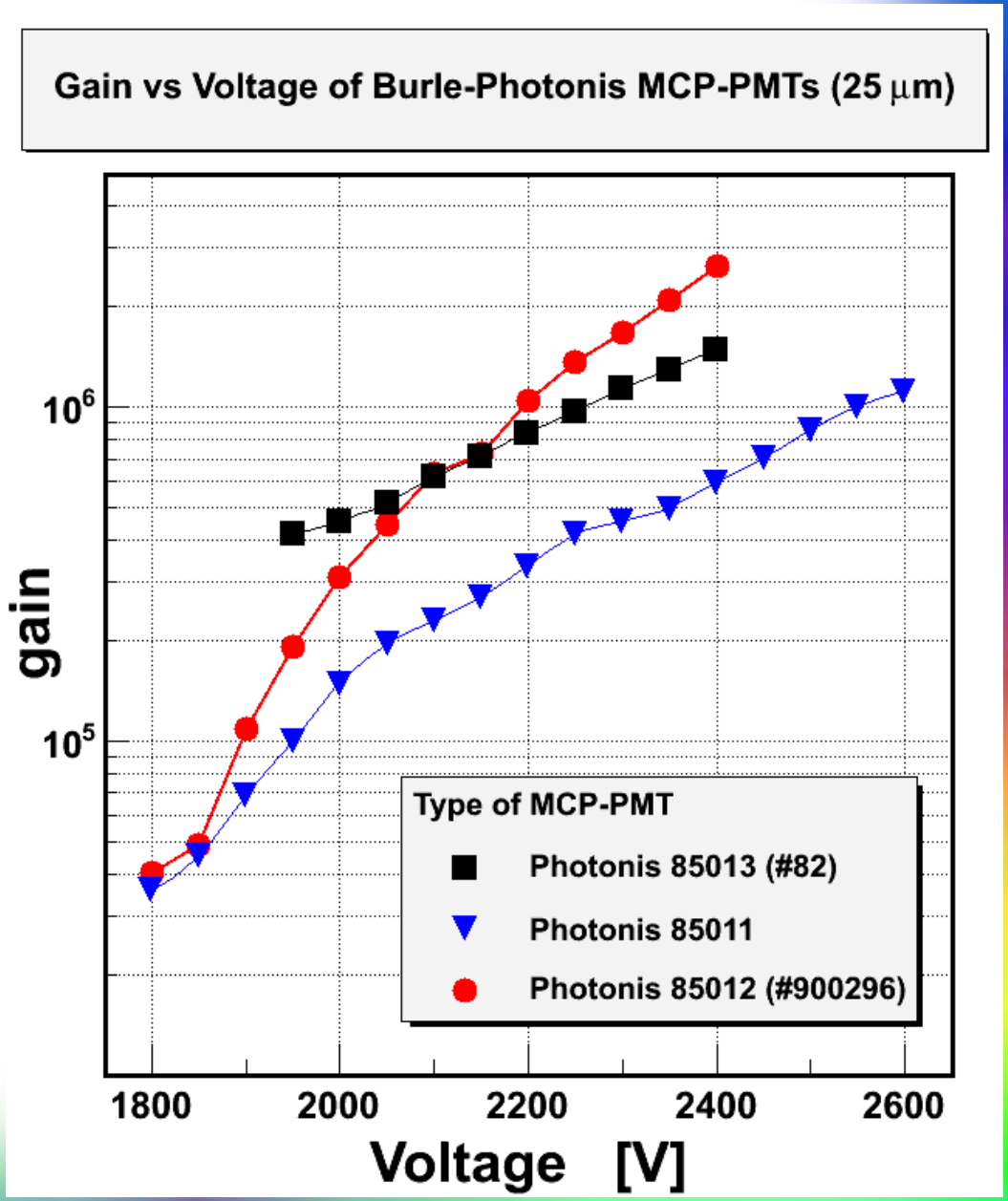
Progress in Erlangen

A. Lehmann, A. Britting, W. Eyrich, S. Reinicke, F. Uhlig
Universität Erlangen-Nürnberg

- Burle-Photonis MCP-PMTs
  - comparison of 85011, 85013, 85012
- Lifetime measurements
  - Burle-Photonis 85012
- Preparations for SiPM measurements

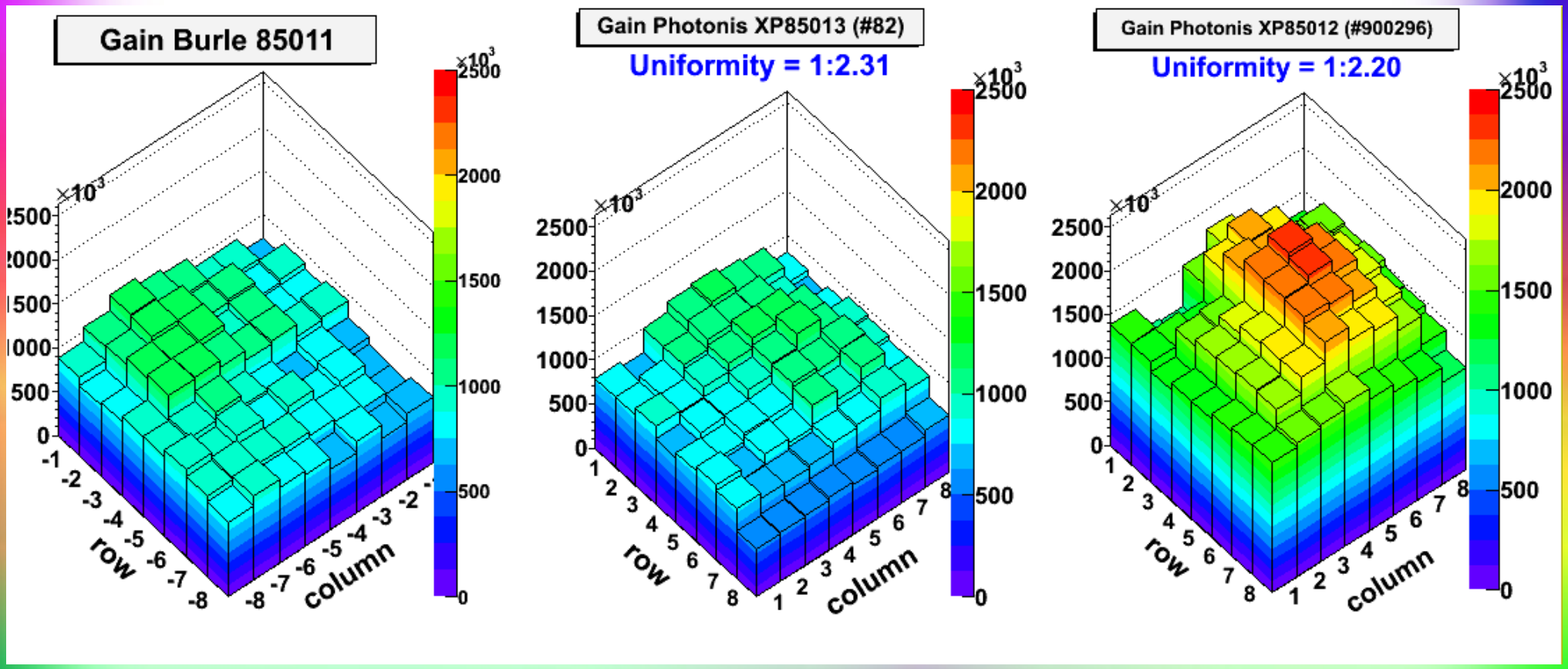
Gain of Burle-Photonis MCPs (25 um)

- 85011
  - geom. efficiency: 52%
- 85013
  - geom. efficiency: 81%
- 85012
  - geom. Efficiency: 81%
  - better vacuum
- active area for all
  - 51x51 cm^2
  - 8x8 pixels
- Best gain for 85012 :
  > 2•10^6



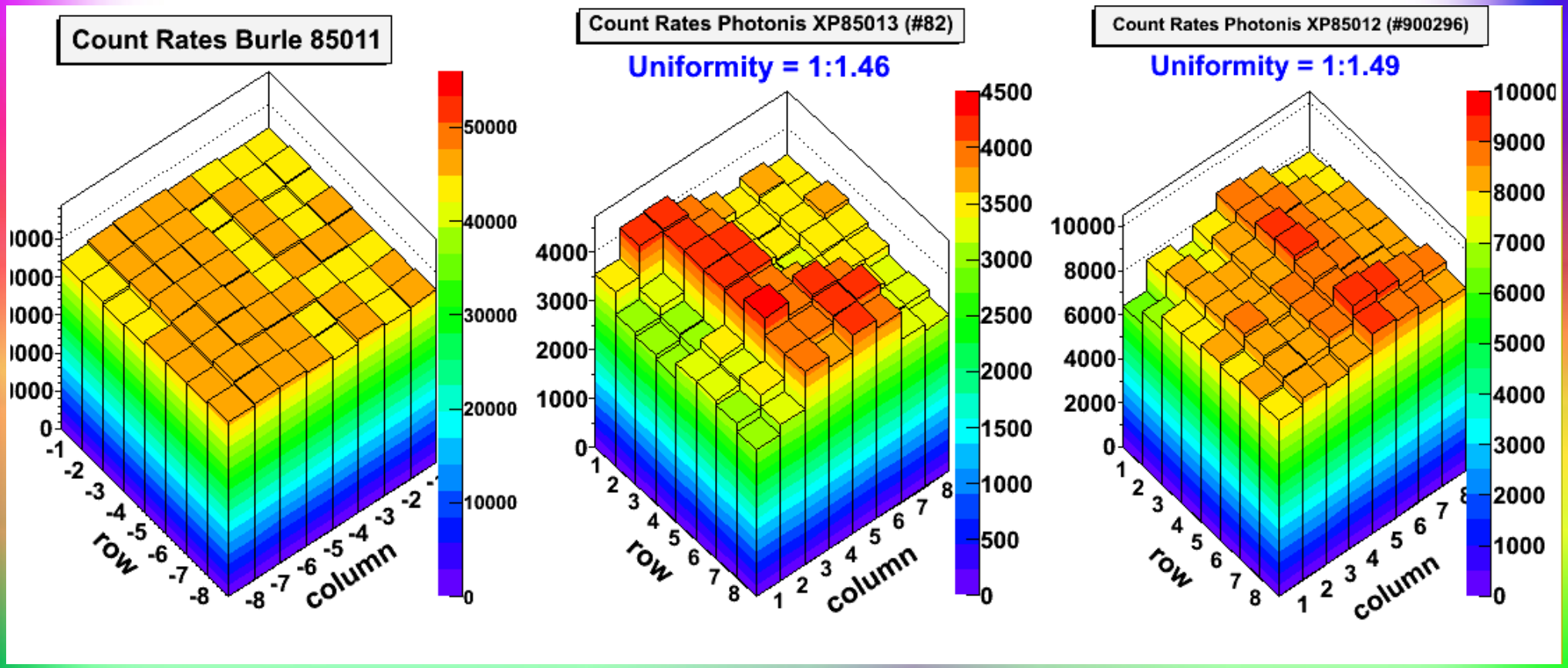
Gain of Burle-Photonis 25 µm MCP-PMT

- **factor 2 gain variations** between pixels
- no significant difference between the three MCP types

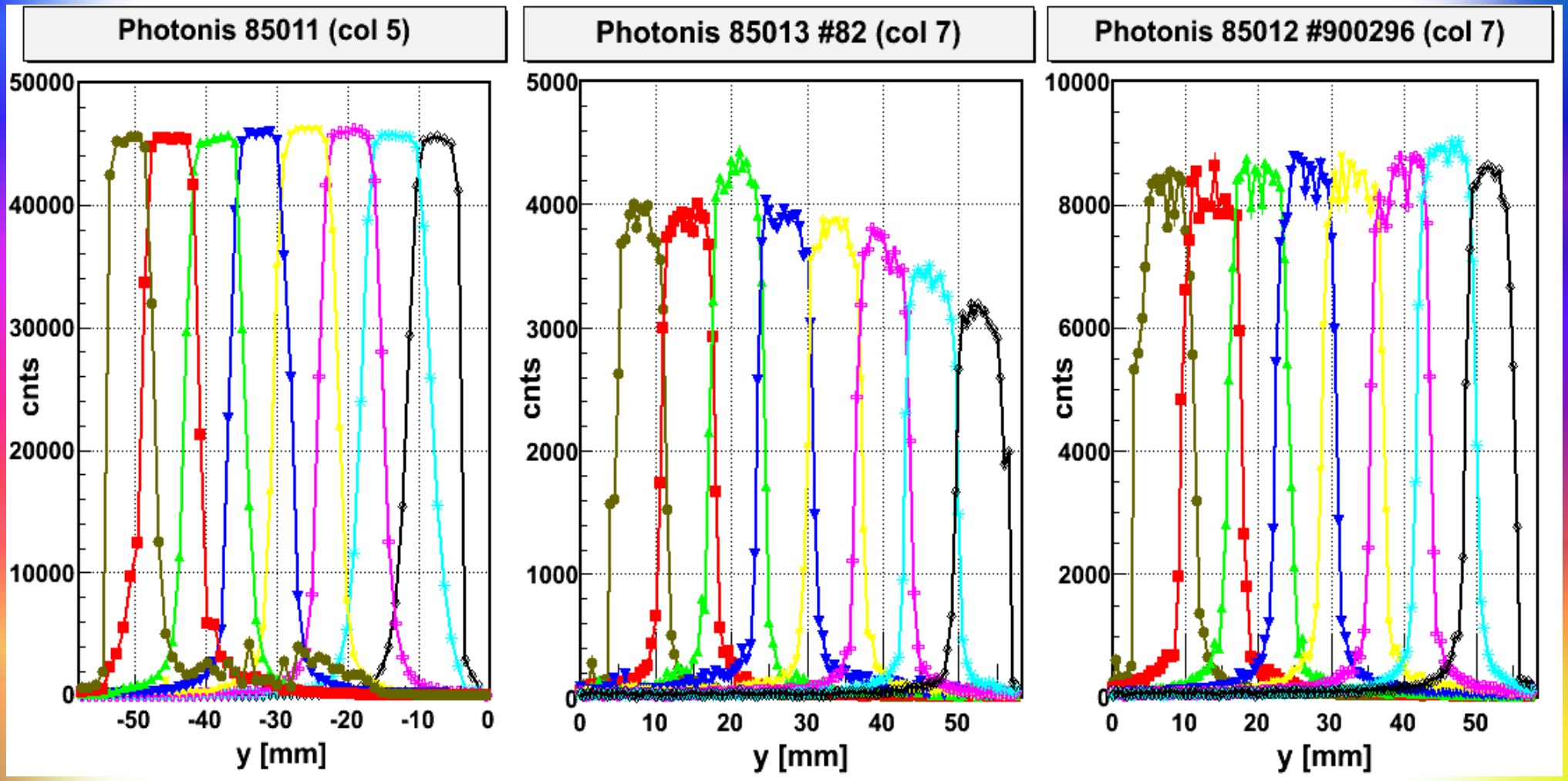


Homogeneity of Photonis 25 µm MCPs

- fairly homogeneous count rates with **factor 1.5 variations** between pixels
- old 85011 appears somewhat more homogeneous than others

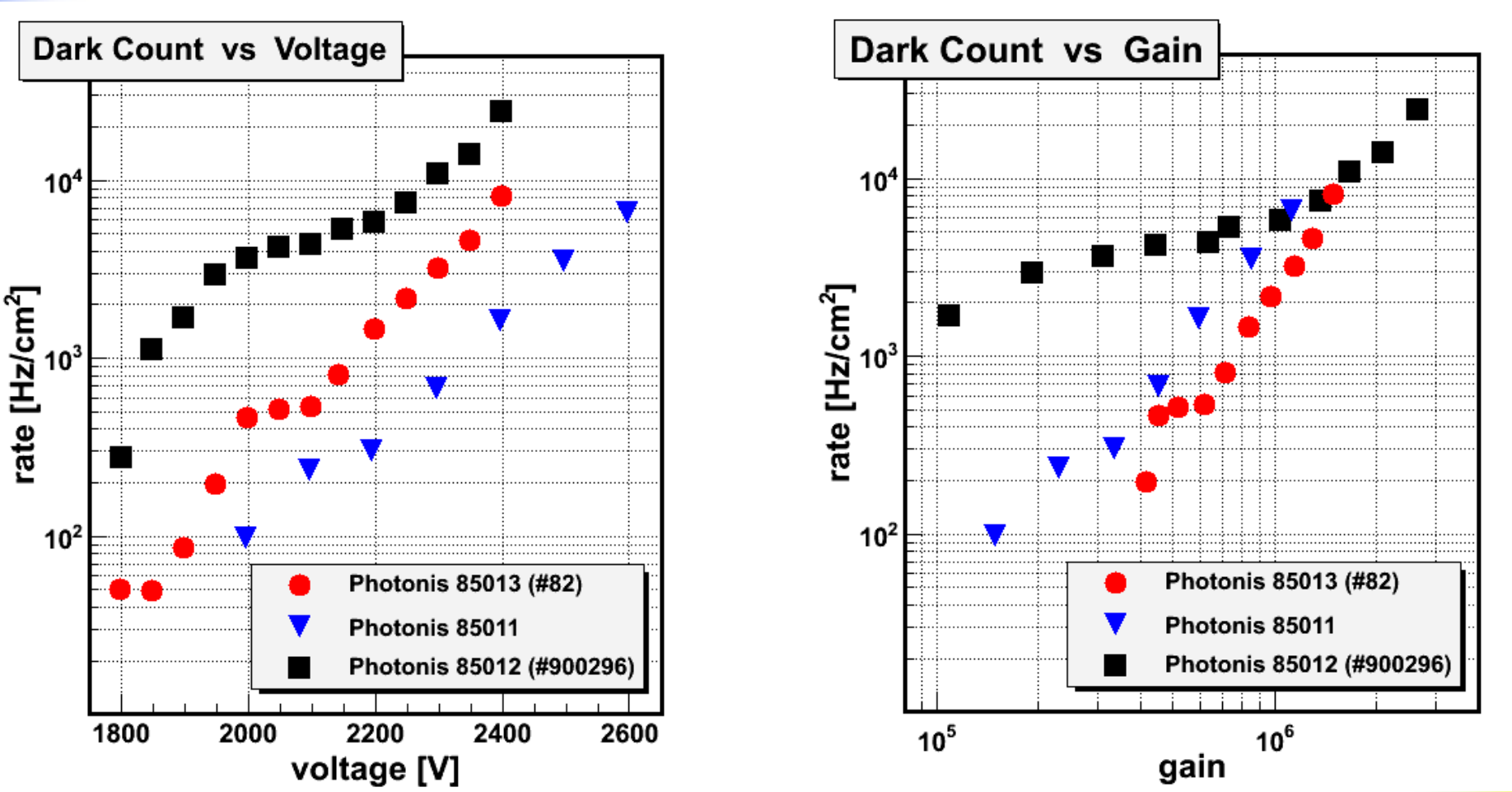


Crosstalk of Photonis 25 µm MCP-PMTs



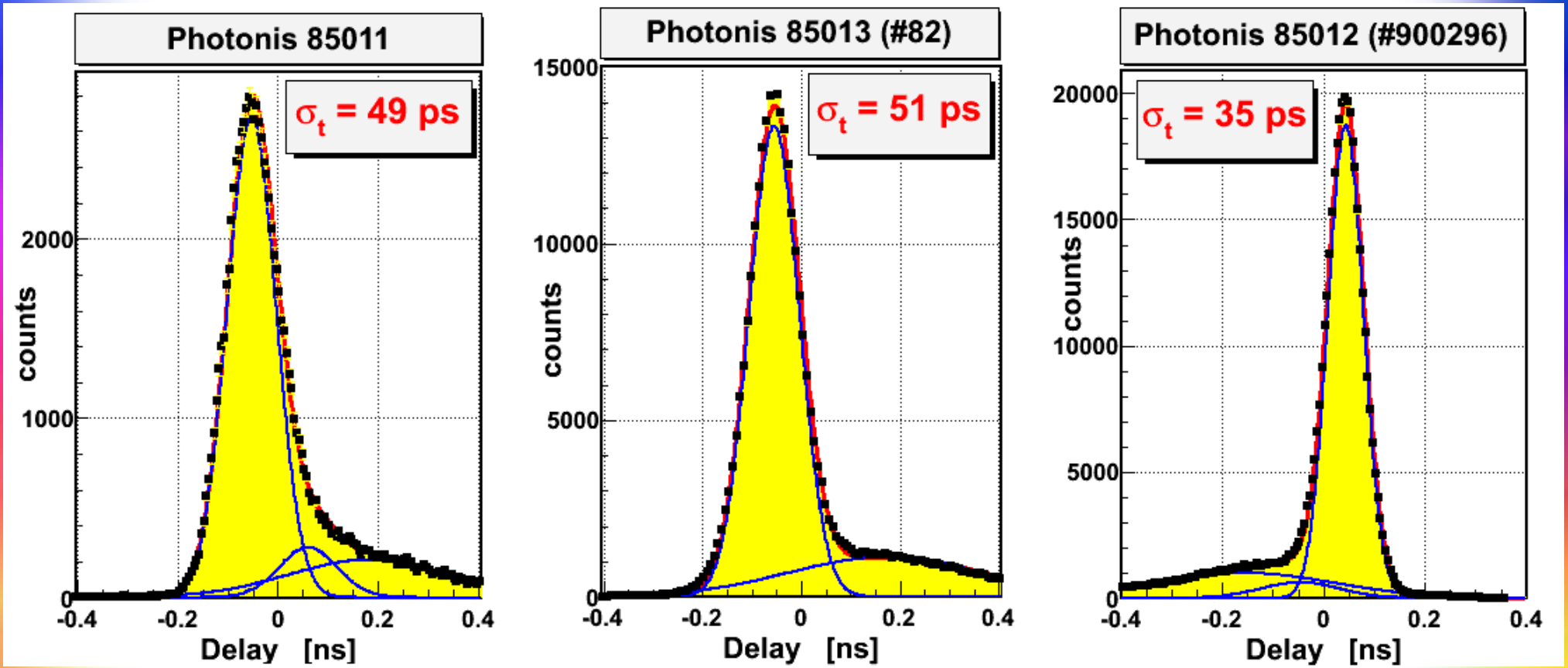
- **Crosstalk between pixels rather similar** in all three MCP-PMTs
- Pixel separation seems somewhat worse in 85012 as in 85013

Darkcount of Photonis 25 µm MCP-PMTs



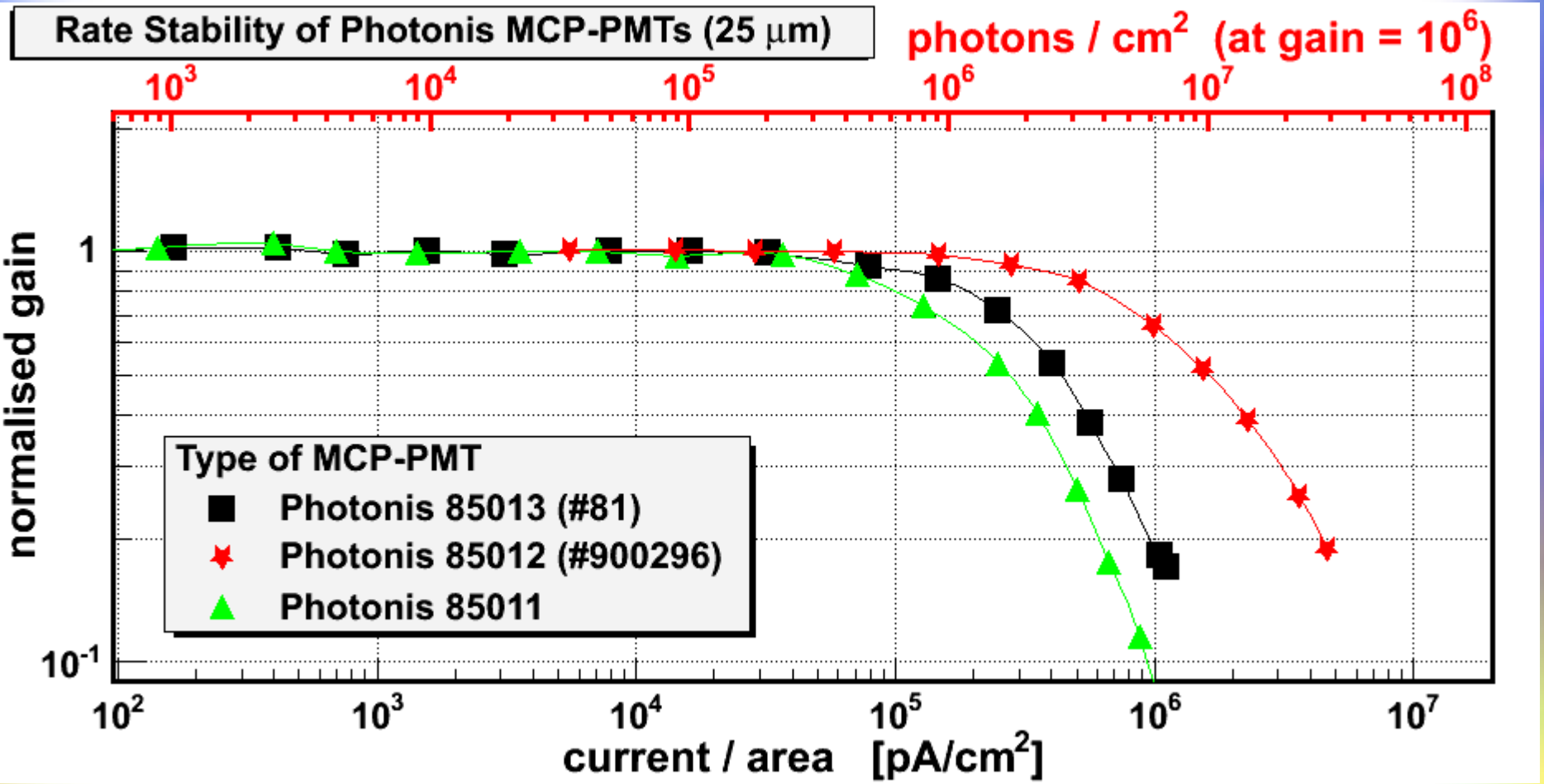
- **Darkcount rate** (gain 10^6; thresh. 50 mV; ampl. x200): **~5 kHz/cm^2**
- Unknown reason for different slope of 85012 → needs another test

Photonis Single Photon Time Resolution



- **single photon time resolution of ~50 ps for 85011 and 85013**
  - Philips Scientific 705 discriminator and Ortec FTA820 amplifier (x200)
- **time resolution of 85012 is significantly better !?**

Rate Stability of Photonis MCP-PMTs

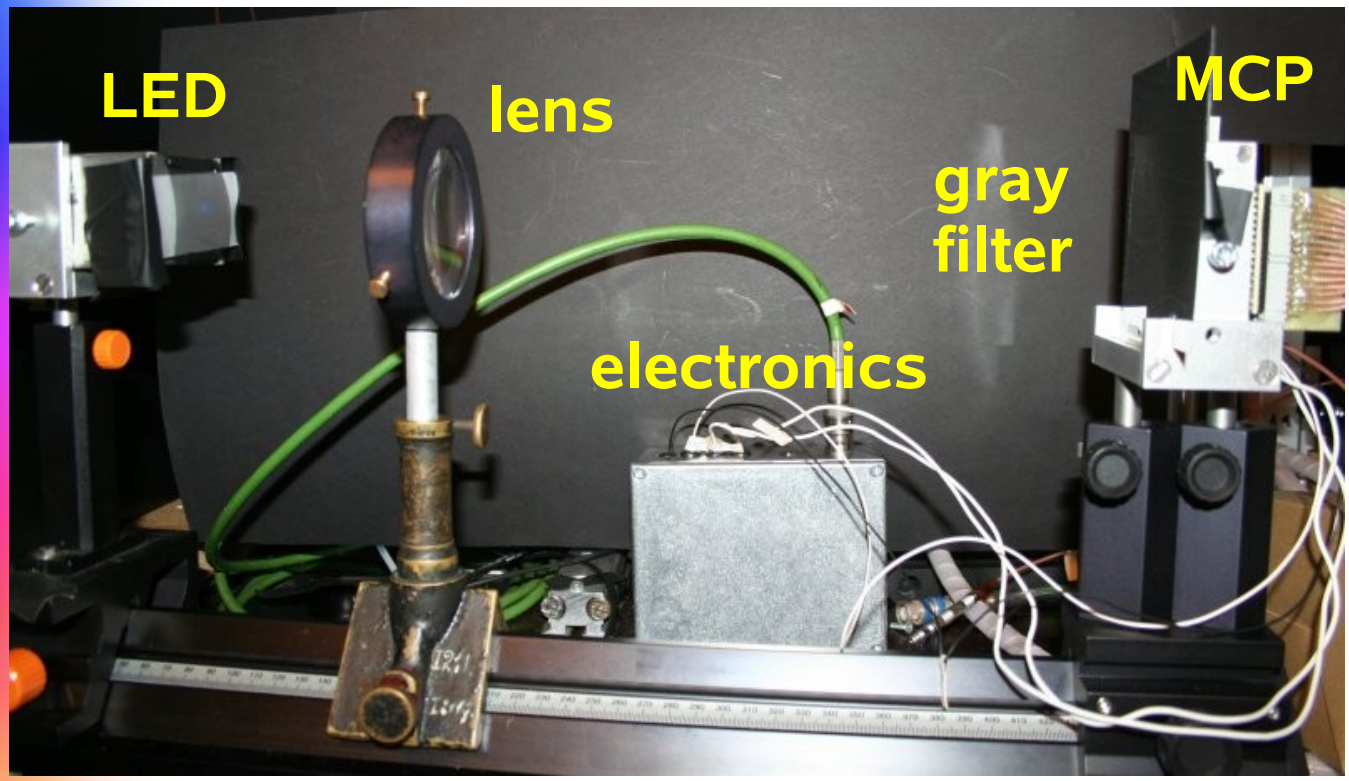


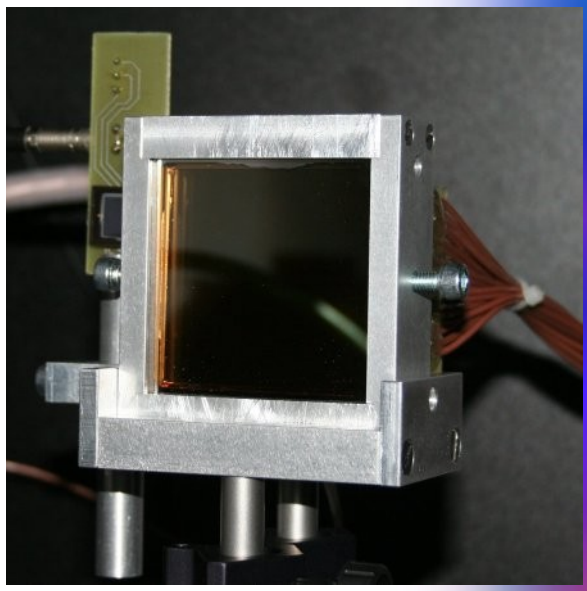
- rate stability of investigated Photonis MCP-PMT types differs
- 85012 stable up to >1 MHz/cm^2 s. ph. → okay for barrel DIRC

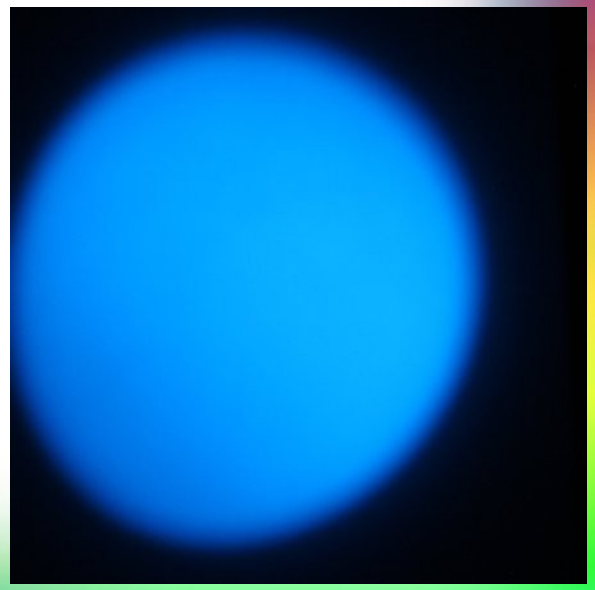
How to Measure MCP Lifetime

- Permanent illumination
  - 460 nm LED at 272 kHz rate attenuated to single photon level
  - ~0.4 photo electrons (ph.e.) per pixel → ~3.5 mC/cm^2/day
- Permanent monitoring
  - record MCP pulse heights at highly prescaled rate using CAMAC DAQ (3 pixels and MCP-out for Photonis XP85012)
  - measure LED light intensity using the current of a photo diode
- [Ir]regular quantum efficiency (QE) measurements
  - 300 – 800 nm wavelength band with 1 nm monochromator resolution
  - measure current of calibrated reference diode [Hamamatsu]
  - measure current of shorted (MCPs and anode) MCP-PMT
- Analysis
  - QE calculated from current ratio of MCP-PMT and reference diode
  - gain and number of ph.e. extracted from pulse height spectra

Setup

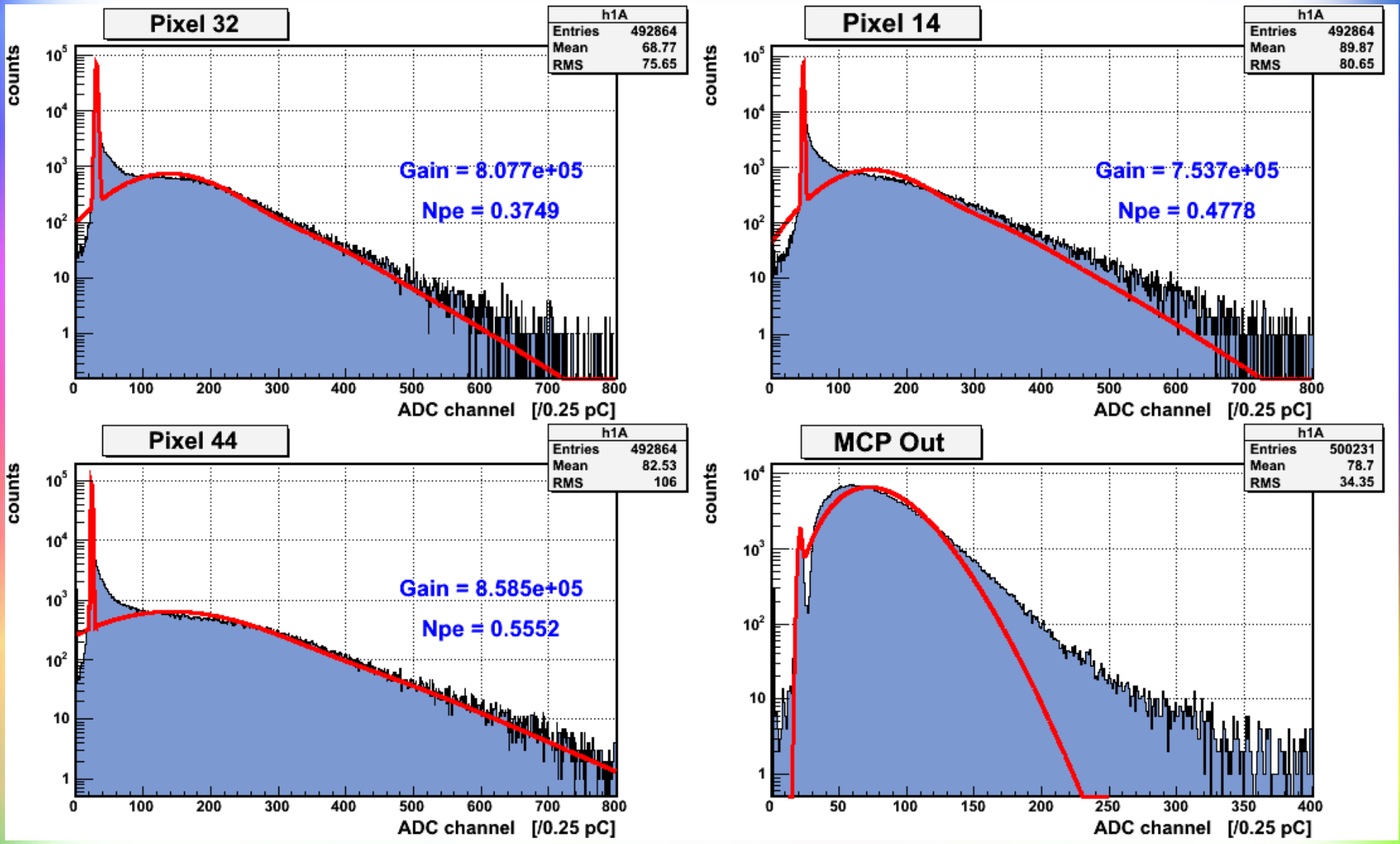






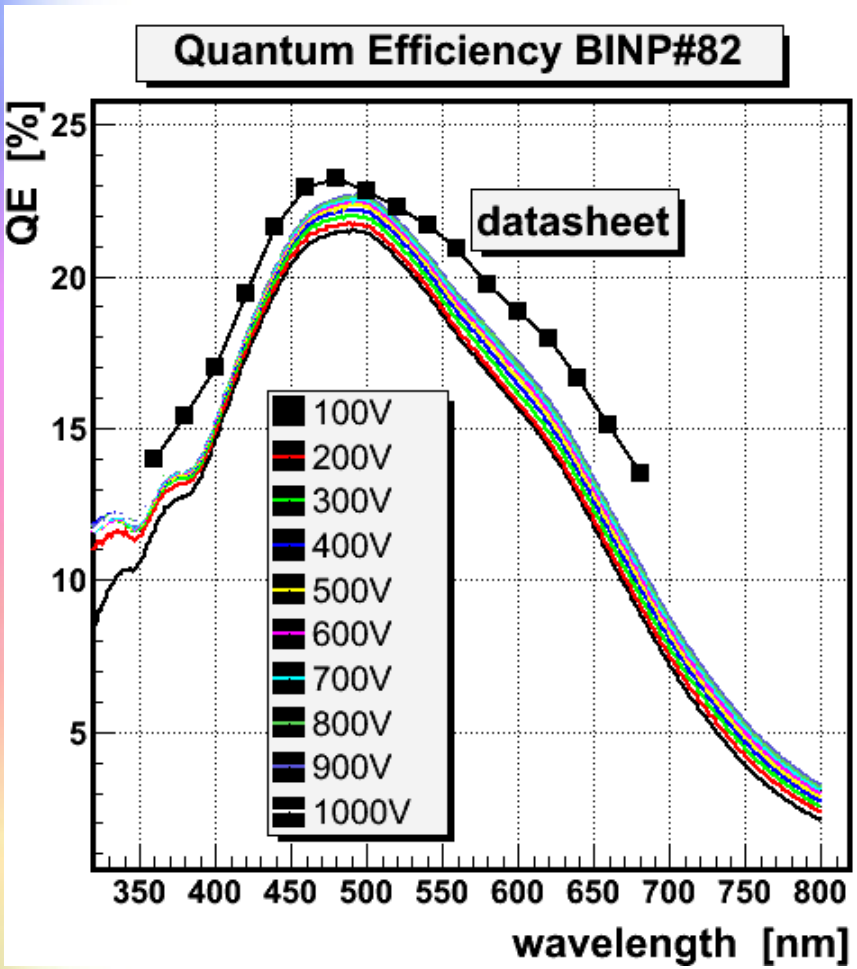
- solid and reproducible setup
- lens creates ~parallel light from LED spot
- rather homogeneous illumination of whole MCP (see the blue area of light)

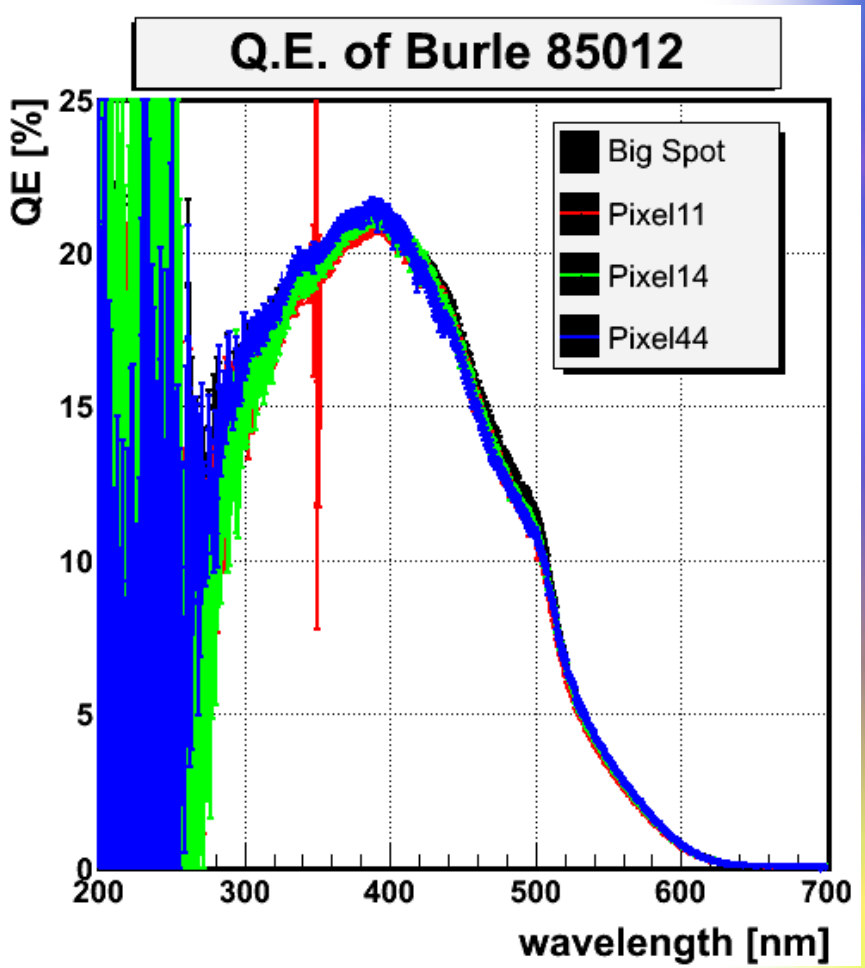
Pulse Heights of Photonis XP85012



- Gain: ~8•10^5 per pixel; Npe: ~0.4 per pixel [~4 at MCP-out ??]

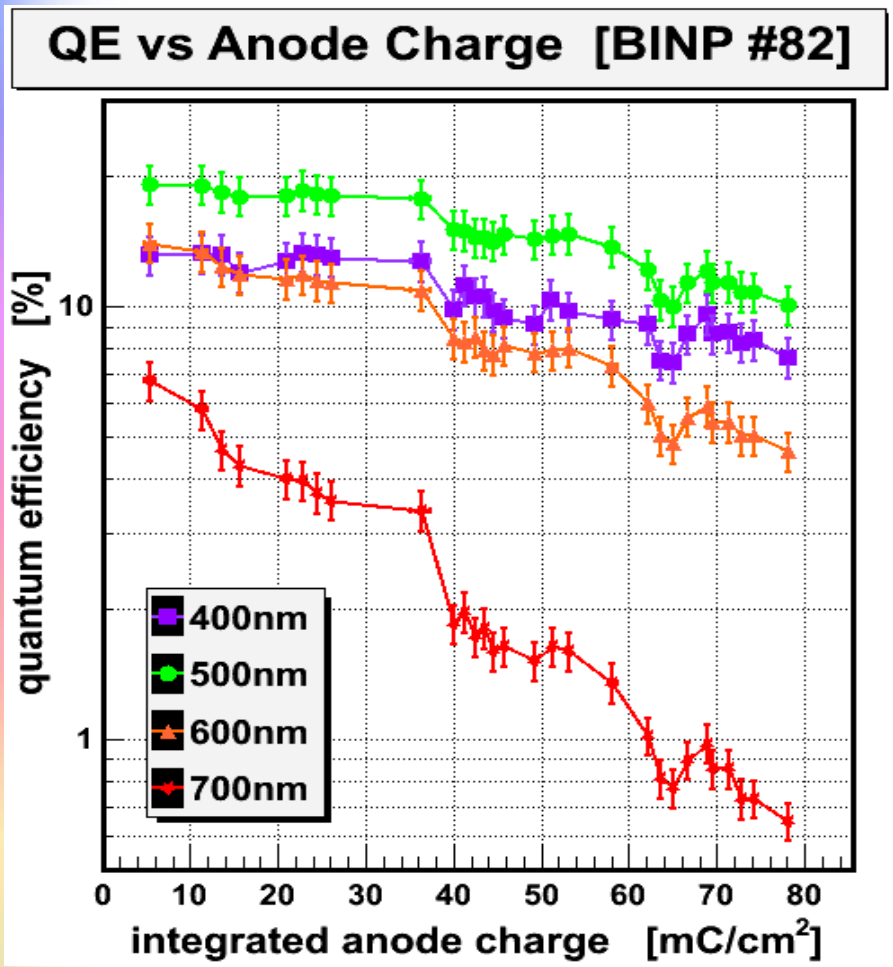
Quantum Efficiency before Illumination

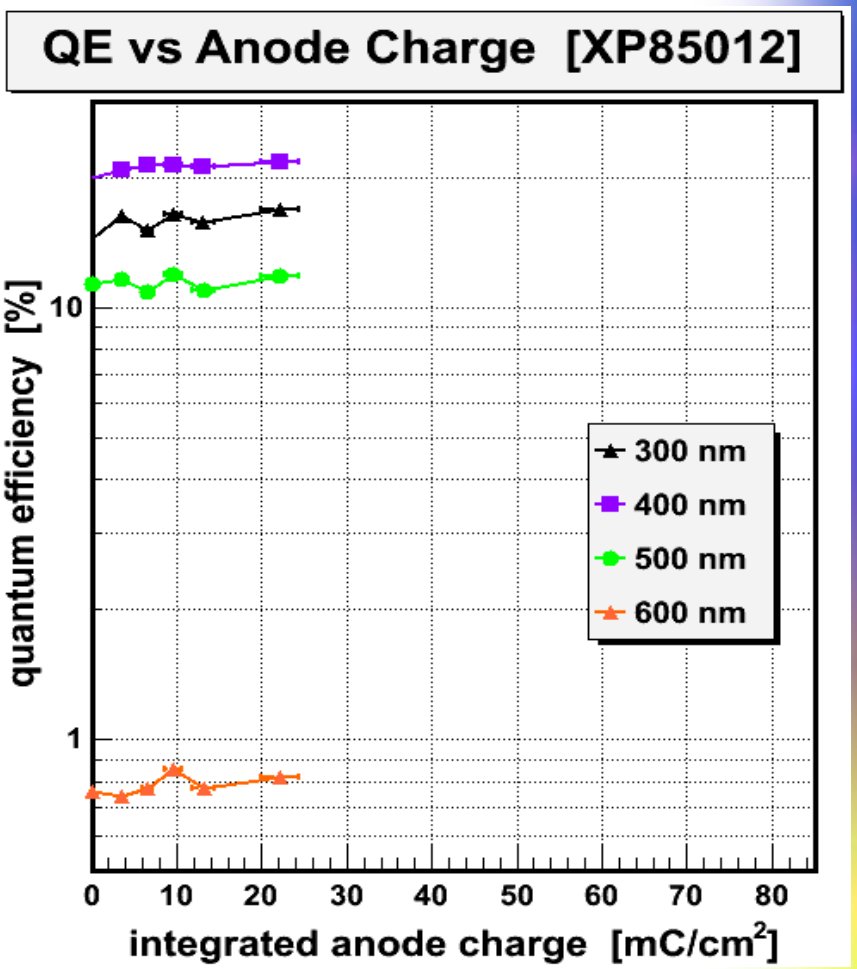




- Maximum QE at 480 nm (BINP) and 380 nm (Photonis)
- QE does not depend on illumination position and voltage PC-MCP

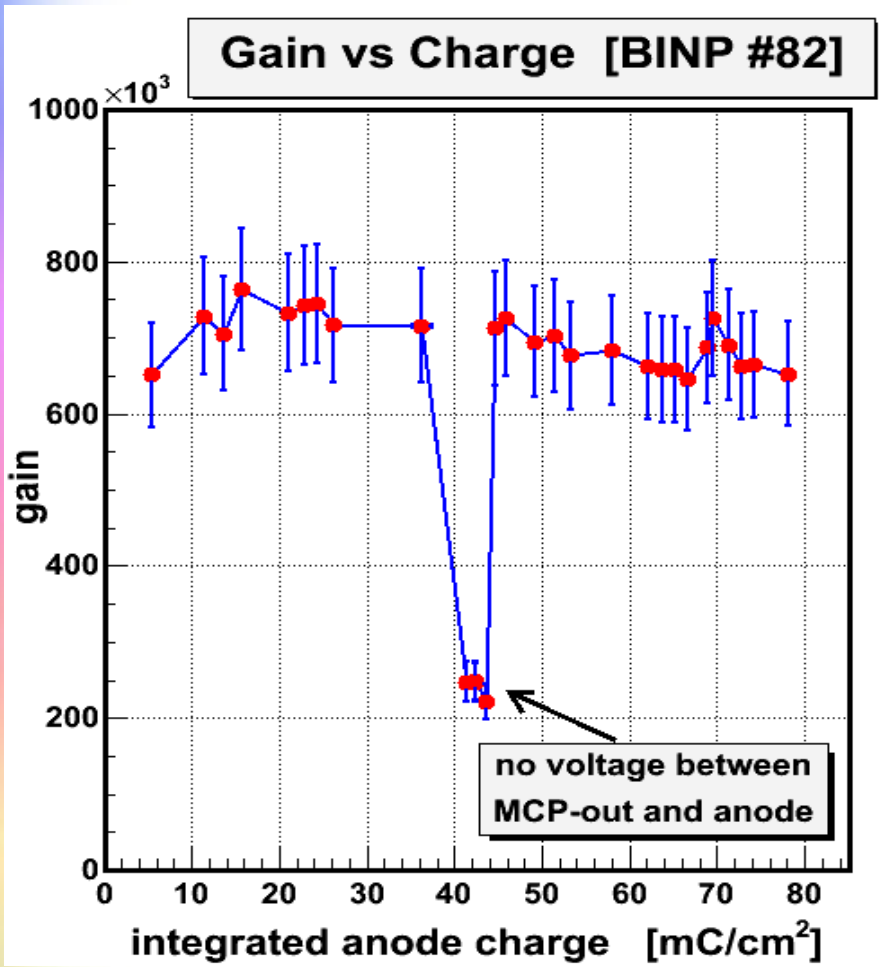
QE after Illumination

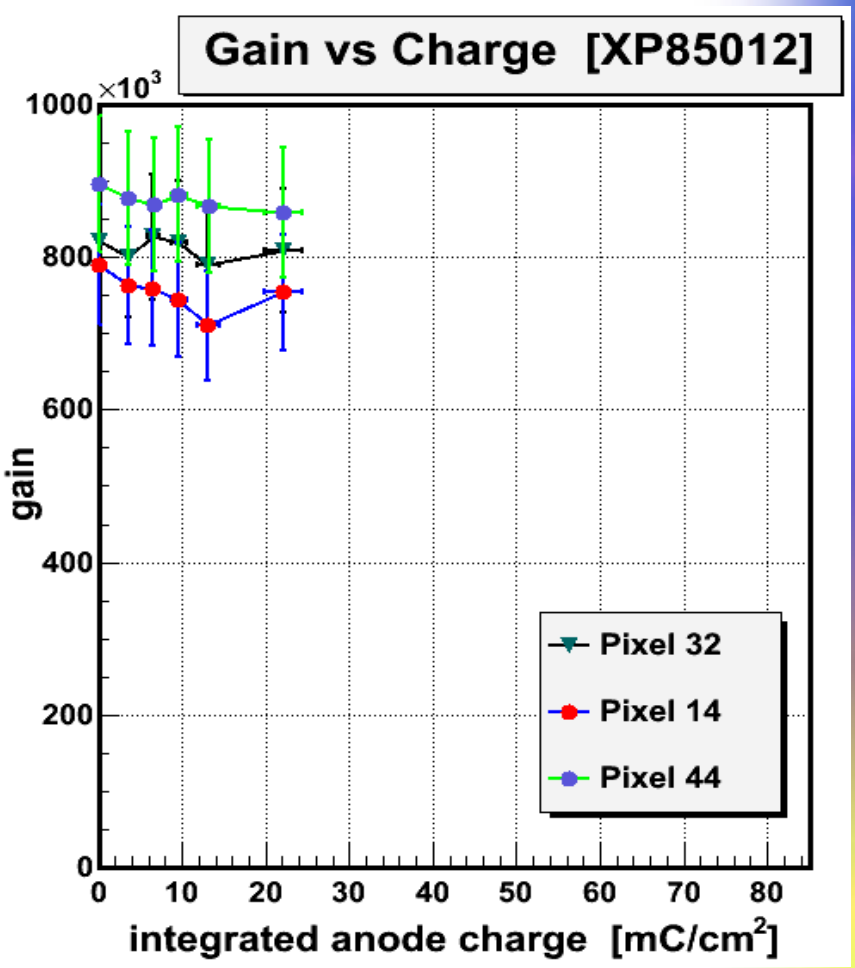




- BINP #82: **decrease of QE depends upon wavelength**
- XP85012: maybe slight increase of QE (consistent with Photonis)

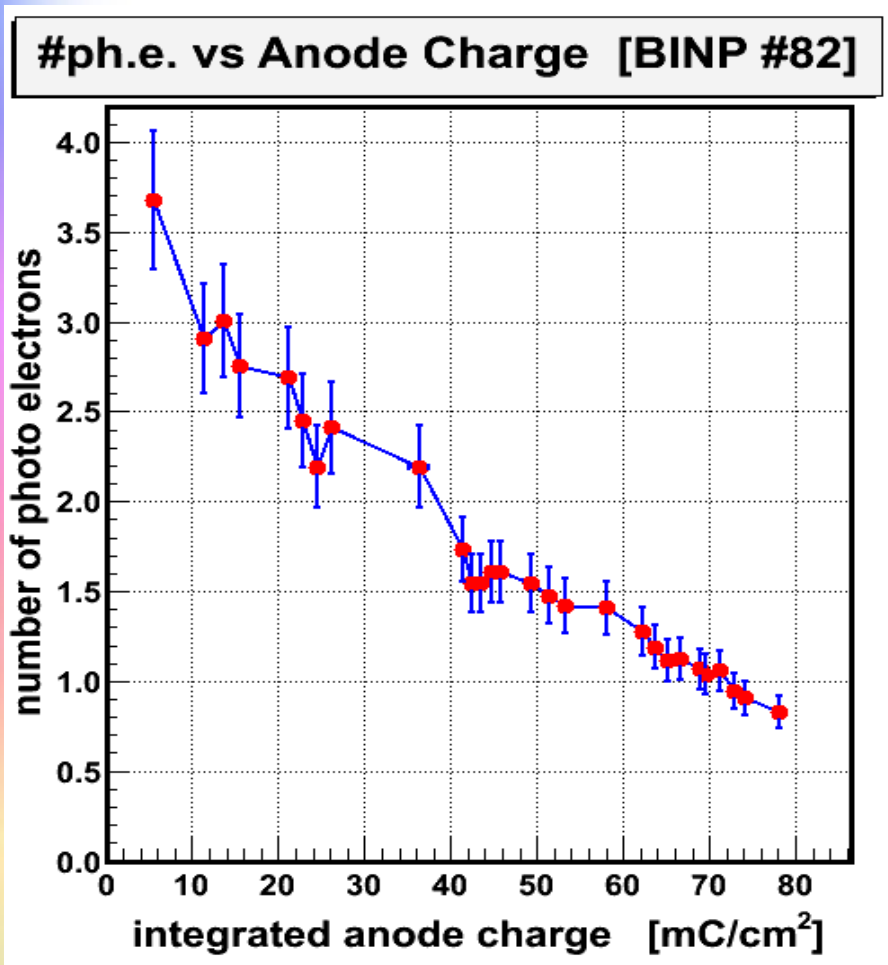
Gain after Illumination

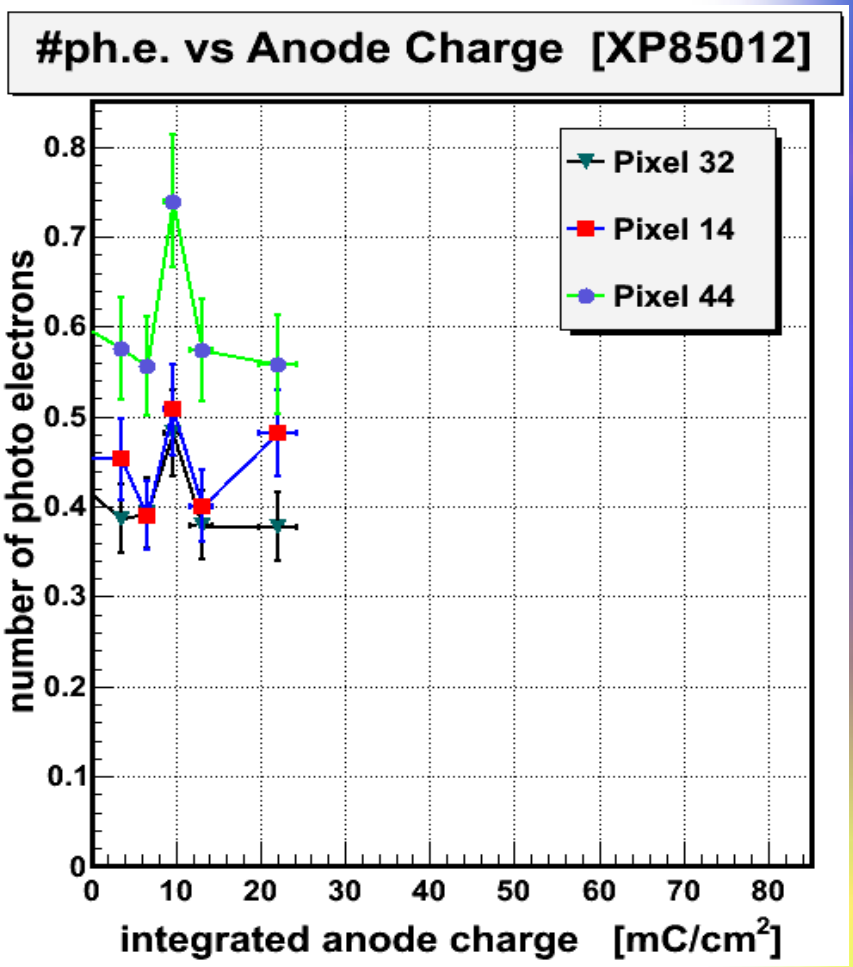




- **No change in gain** for both BINP #82 and Photonis XP85012

Photo Electrons after Illumination



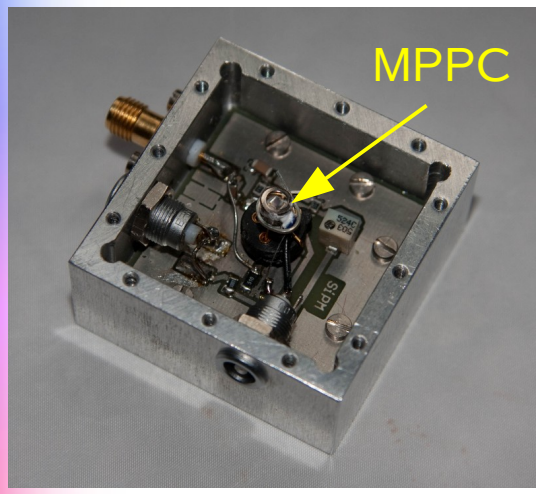


- after 80 mC/cm^2 **number of ph.e. drop by factor 3-4** in BINP MCP
- after 25 mC/cm^2 **no change in number of ph.e.** in XP85012

SiPMs available in Erlangen

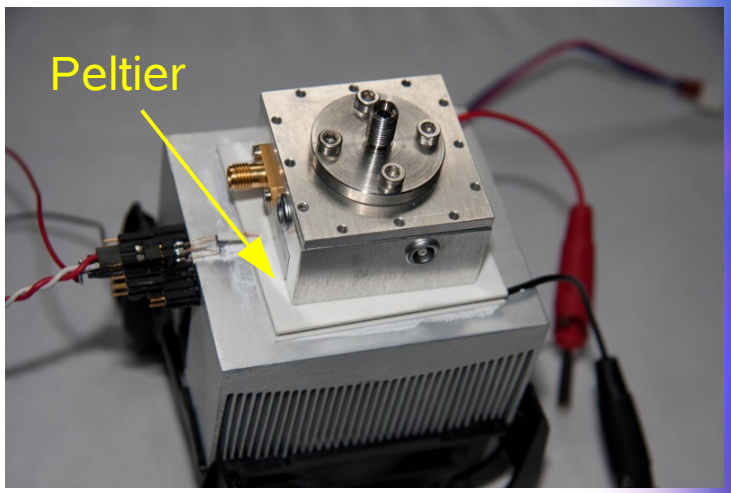
- SensL SPM
  - SPMMini (only test module)
    - 1x1 mm^2 with Peltier-Cooling
  - SPMArray
    - active area 12x12 mm^2 with 4x4 channels
      (3x3 mm^2 SiPMs with 35 µm microcells)
- Hamamatsu MPPC
  - S10362-11-025U; S10362-11-050U; S10362-11-100U
    - 1x1 mm^2 MPPCs with 25, 50 and 100 µm microcells
  - S10985-025C; S10985-050C
    - active area 6x6 mm^2 with 2x2 channels
      (3x3 mm^2 MPPCs with 25 and 50 µm microcells)

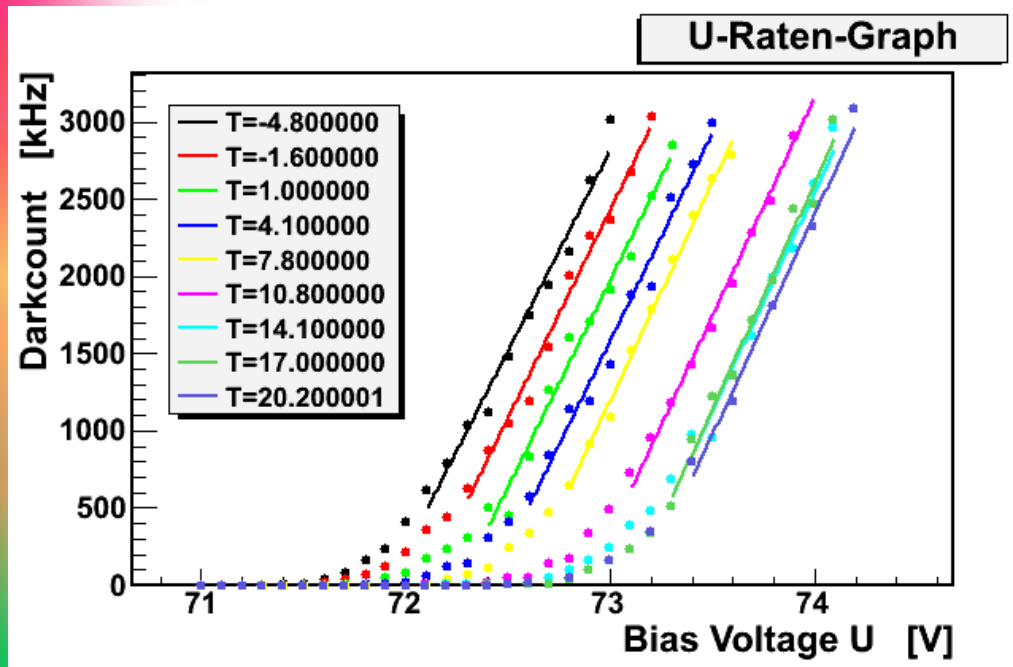
First Measurements with Cooled MPPC

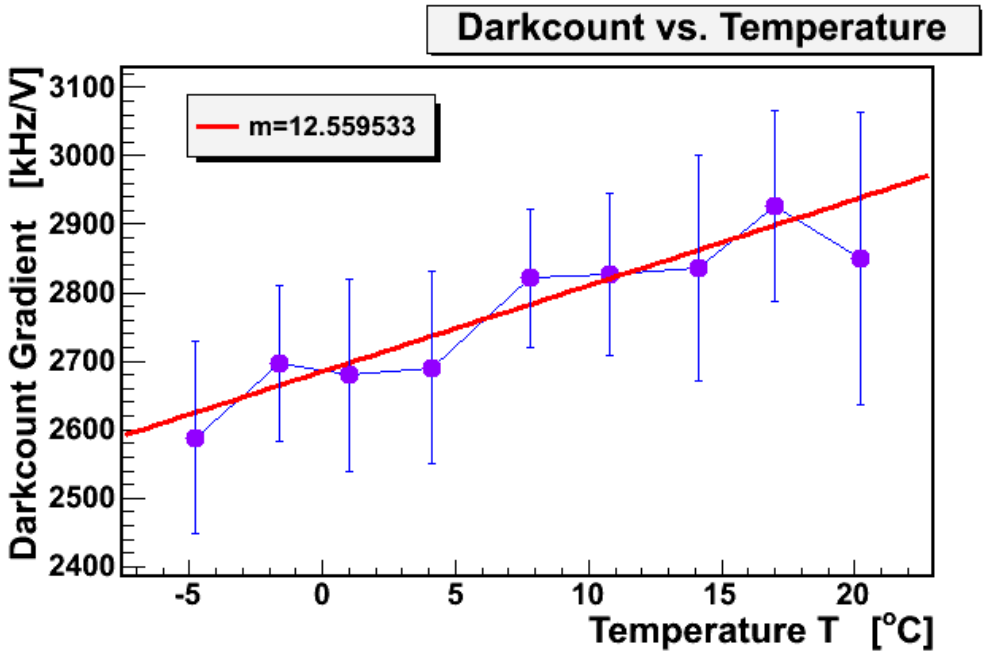


[Hamamatsu MPPC S10362-11-050U]

Cooled with 5x5 cm^2 Peltier element at air → probably not very efficient

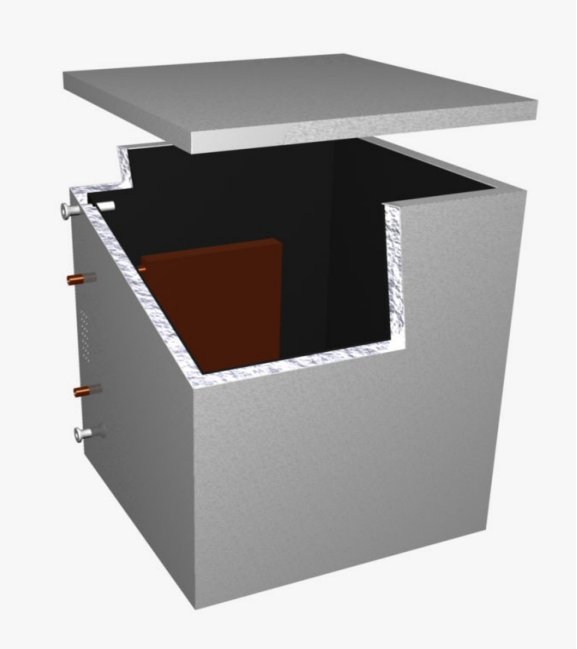






Construction of a Cooling Box

- Size: ~60x60x60 cm^3
  - large enough for XY-scans of multi-pixel SiPMs
  - vacuum insulated panels
  - cooling medium: dry gas



- Thermostat ministat 230-cc
  - temperature: **-40 ... 200 °C**
  - temp. constancy: 0.02 K
  - sucking and forcing pump
  - cooling power:
    - 0.38 kW @ 0 °C
    - 0.05 kW @ -40 °C
  - external temperature control

Summary and Outlook

- New Photonis XP85012 (with better vacuum) shows better performance than his precursors
- Lifetime measurements started for XP85012
- Preparations for performance measurements of SiPMs
  - several candidates available
    - large area sensors from SensL and Hamamatsu
    - Zecotek 8x8 pixel [~2.5x2.5 cm^2] ?
  - currently building a cooling box