

# The characterisation of the multianode photomultiplier tubes for the RICH-1 upgrade project at COMPASS\*

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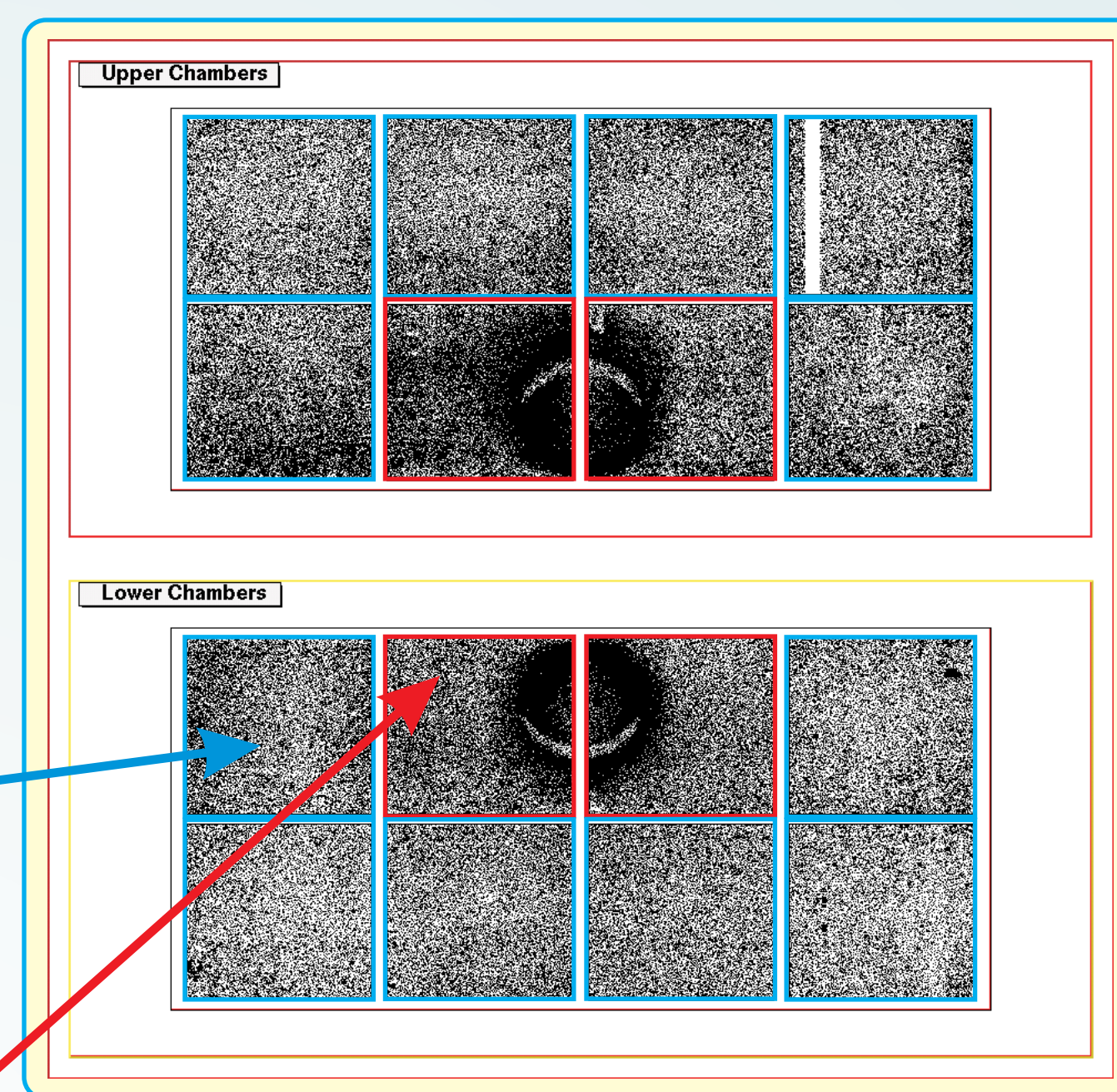
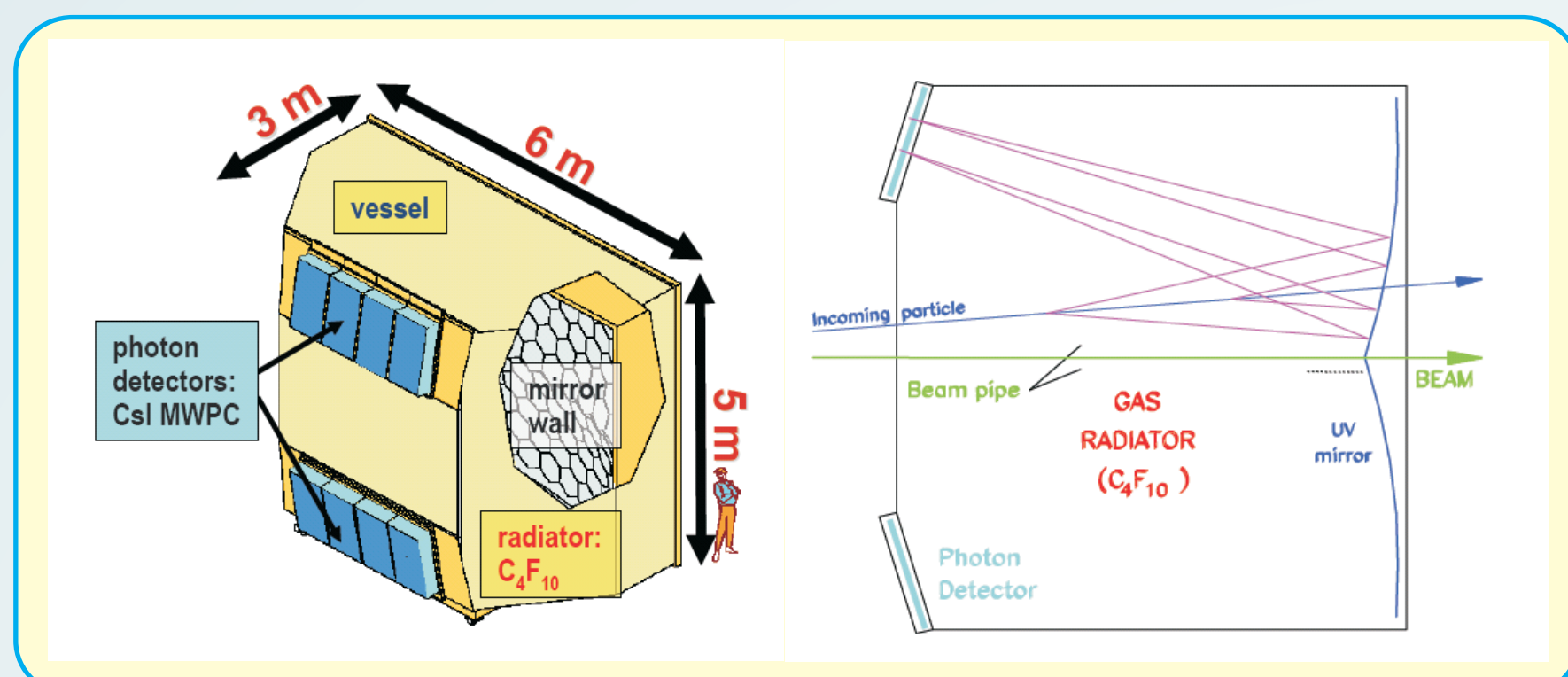


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\* - supported by BMB+F

## RICH upgrade motivation & concept

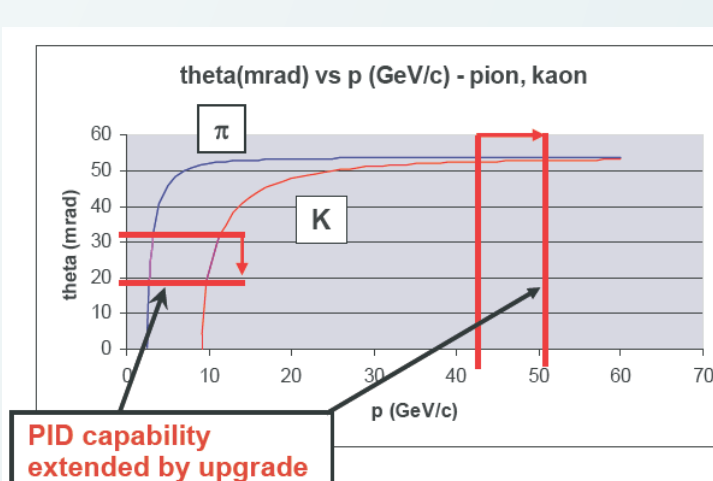
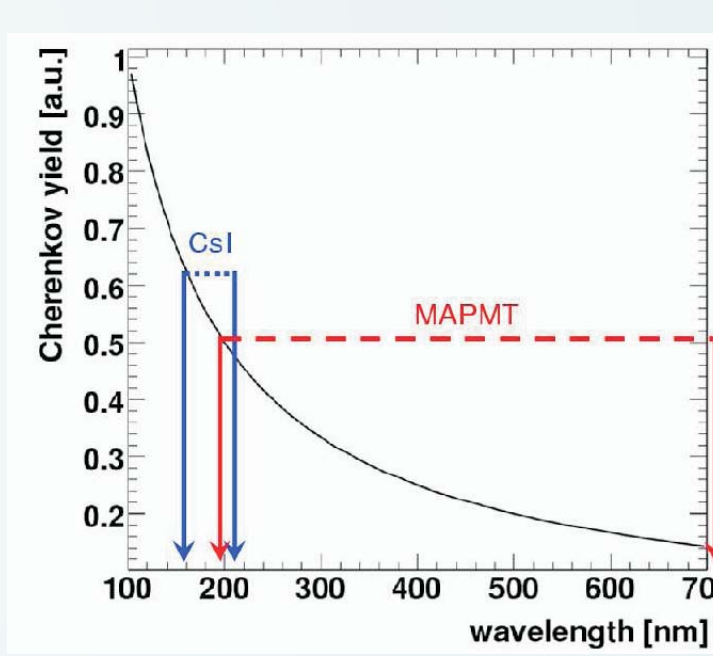
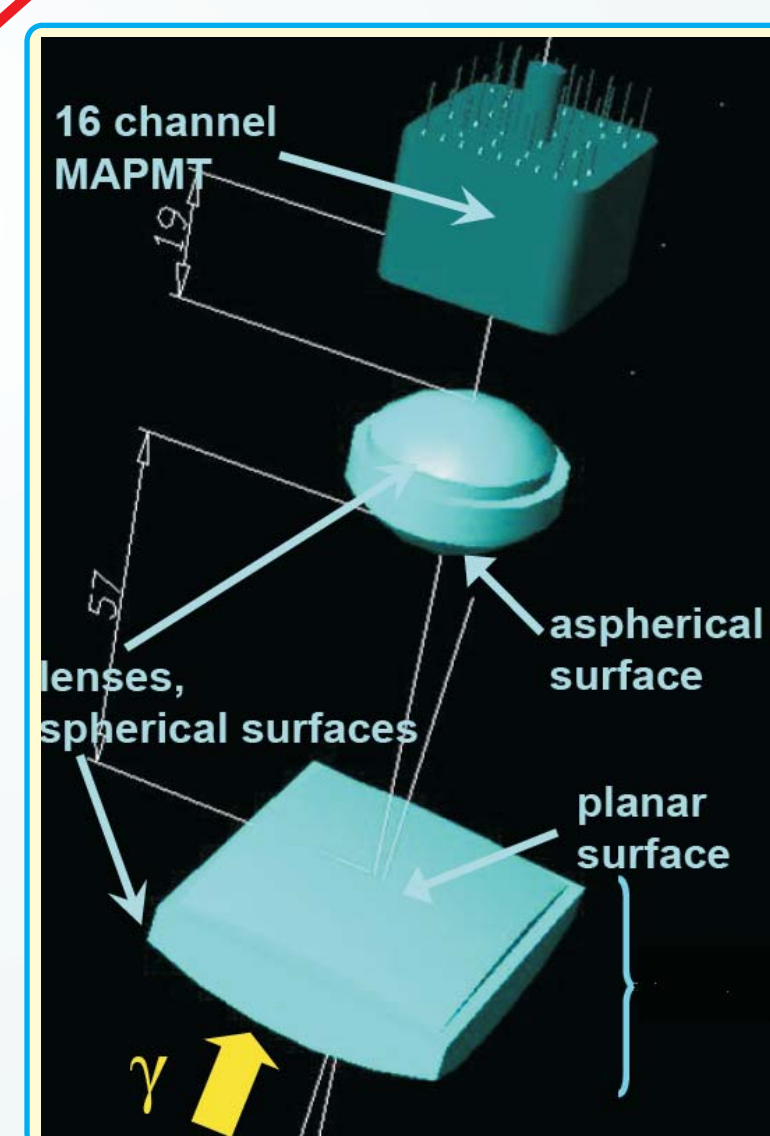


### COMPASS RICH

- ▶ Radiator : C<sub>4</sub>F<sub>10</sub>
- ▶ Mirrorsurface : 20m<sup>2</sup>
- ▶ Photodetection : CsI photocathode plus MWPC
- ▶ Detector channel : 83.000
- ▶ Readout : Gassiplex-chip / ~4μs deadtime

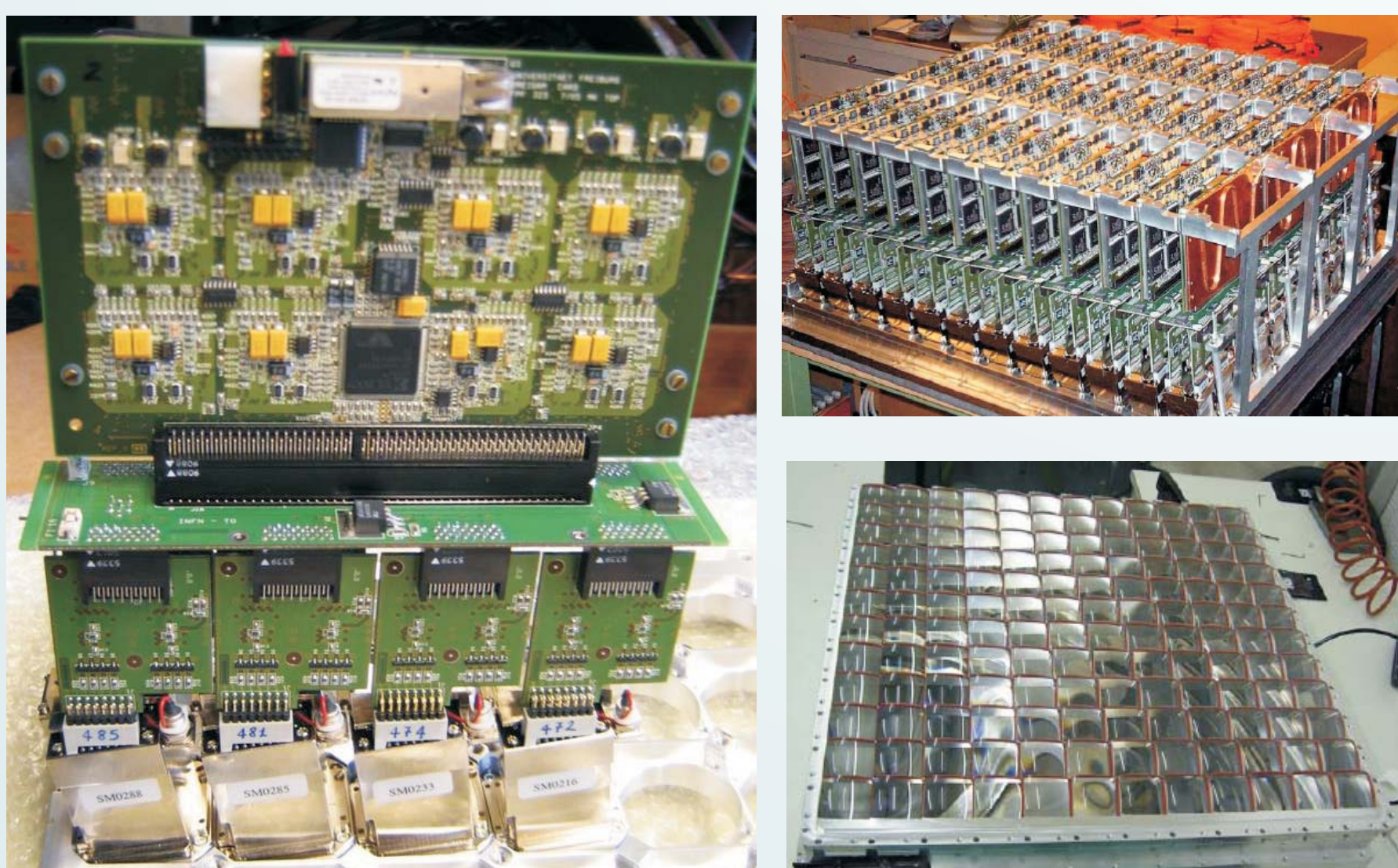
### COMPASS RICH 2006 Upgrade

- ▶ four inner region quadrants
- ▶ beam intensity 40 MHz → 100 MHz
- ▶ trigger rate 20 KHz → 100 KHz
- ▶ 576 multianode photomultiplier tubes (MAPMT)
- ▶ "Fused silica" - lenses forming optical telescopes
- ▶ readout via MAD-chip & deadtimefree F1 TDC

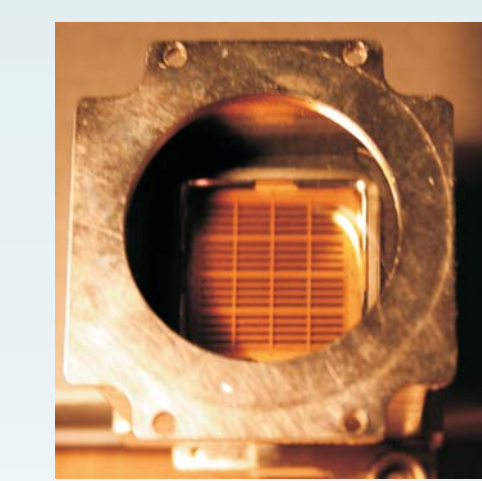


### Objectives / Prospects

- ▶  $\sigma_{ph} = 2.4$  mrad (before 1.4 mrad)
- ▶  $N_{ph} / ring \sim 40$  (before 14)
- ▶  $\sigma_{ring} \sim 0.4$  mrad (before 0.6 mrad)
- ▶  $2\sigma \pi / K$  separation @  $p \sim 50$  GeV/c (before 43 GeV/c)
- ▶ PID efficiency > 95%

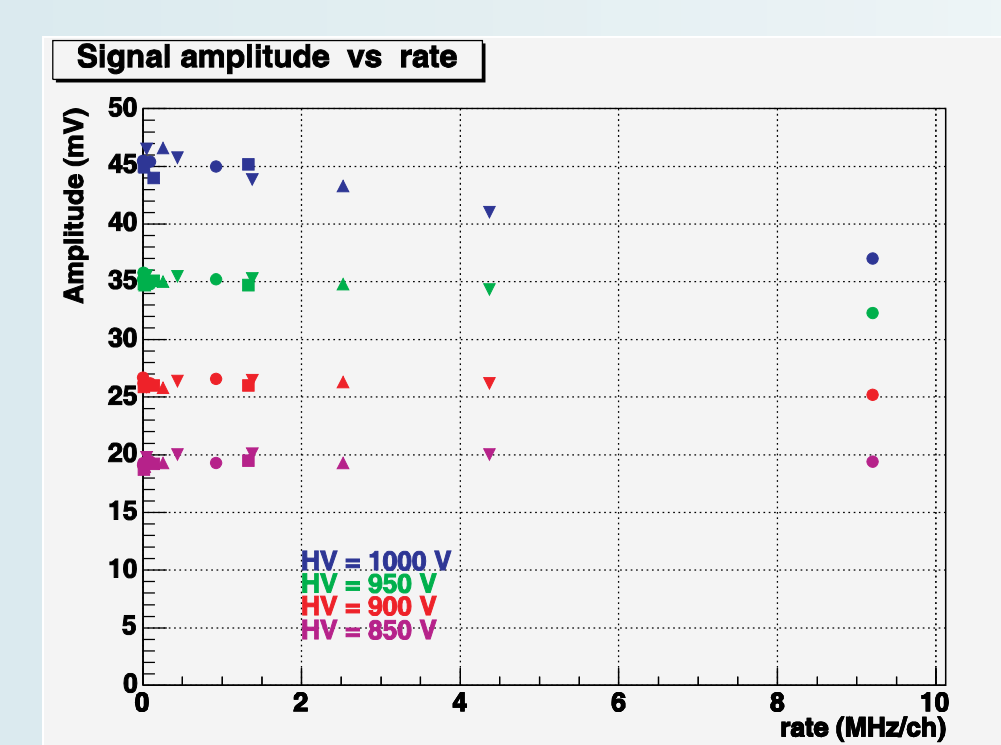


## Multianode Photomultiplier tube



### Hamamatsu R7600-03-M16

- ▶ photocathode with 16 independent channel
- ▶ 12 stage dynodestructure
- ▶ Photocathode : 4x4 matrix with 4x4mm<sup>2</sup> pixel
- ▶ Pixelgap 0.5 mm
- ▶ Darkcurrent : < 2nA
- ▶ Crosstalk : < 5% in adjacent channel
- ▶ Uniformity : ~ 20%
- ▶ Ratecapability : 6 Mhz single photon
- ▶ Gain : 6\*10<sup>6</sup> @ 850V
- ▶ spectral sensitivity : 200nm to 750nm



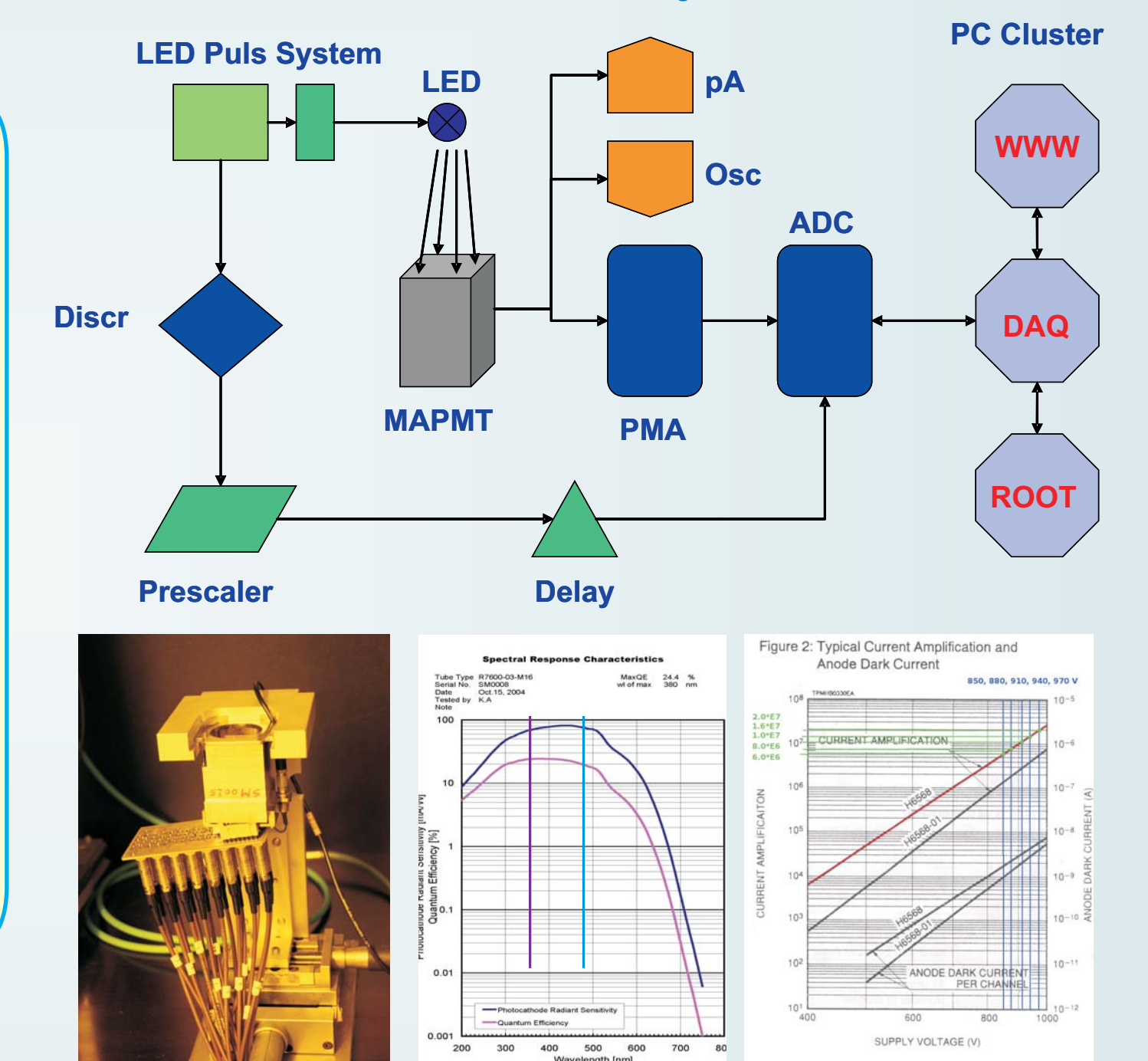
## Fully automated testsetup

### 2h measurement of each MAPMT

- ▶ visual inspection of cathode surface
- ▶ measurement of dc of all channel
- ▶ recording of ADC spectra at five different high voltage values (850V / 880V / 910V / 940V / 970V) and two different wavelength values (360 nm / 480nm)
- ▶ Digital oscilloscope recording of all channel

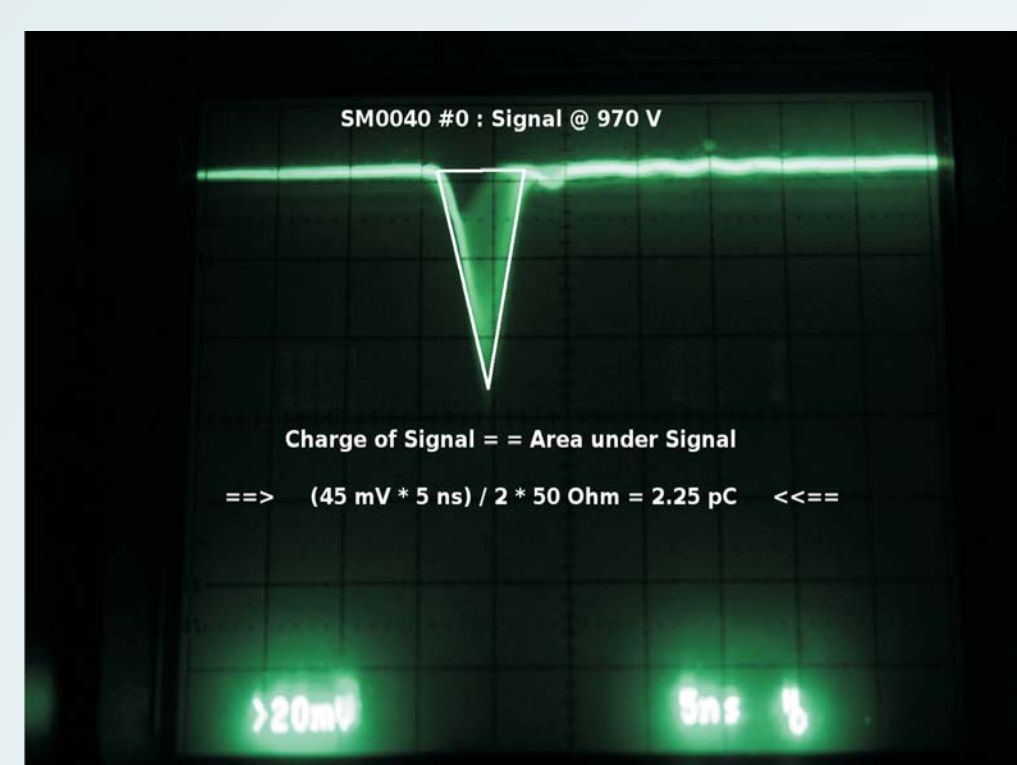
### Data analysis

- ▶ Uniformity / rel. QE. / Gain
- ▶ High voltage as function of charge
- ▶ Web based "Ruby on Rails" database to provide all important parameters

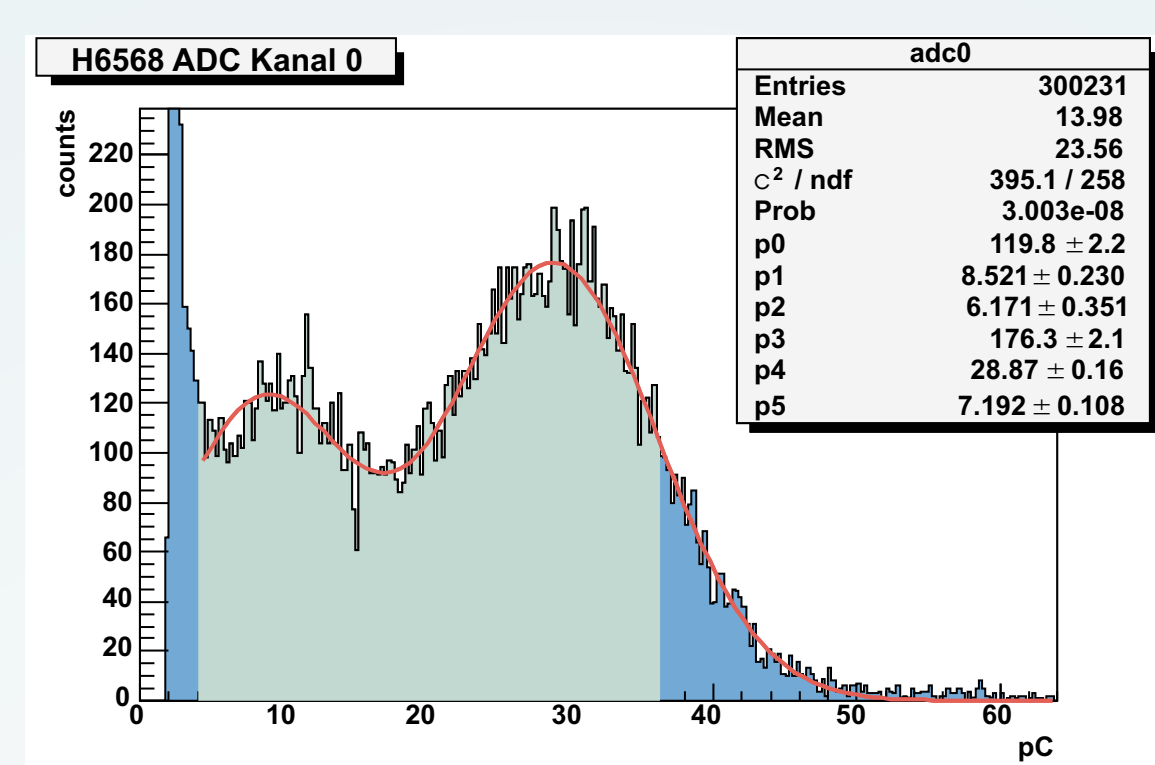


!!! Challenge : characterisation of 600 MAPMTs in terms of all requested parameters !!!

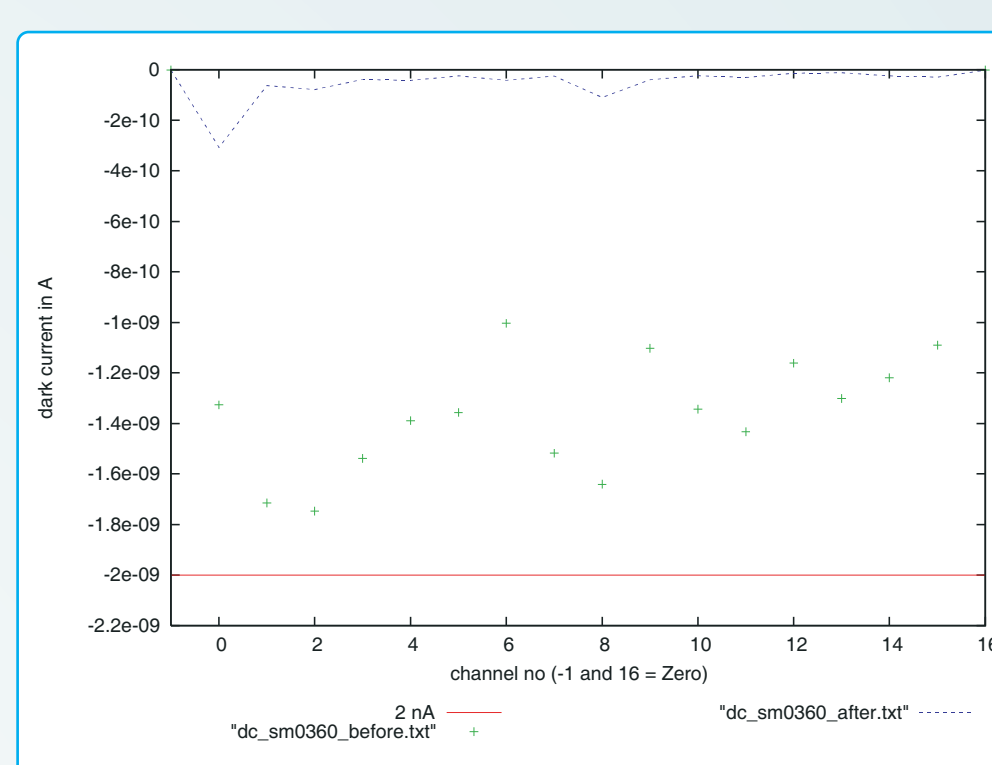
## Characterisation & best operating point



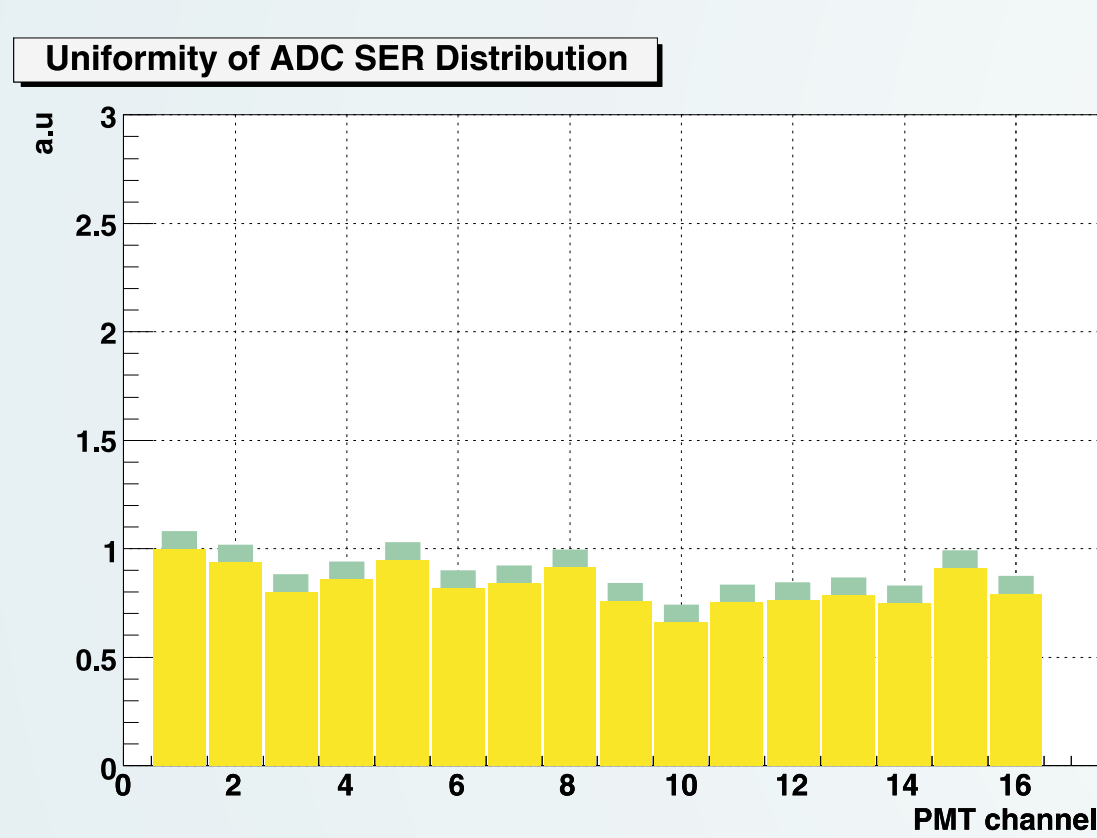
Scope analysis



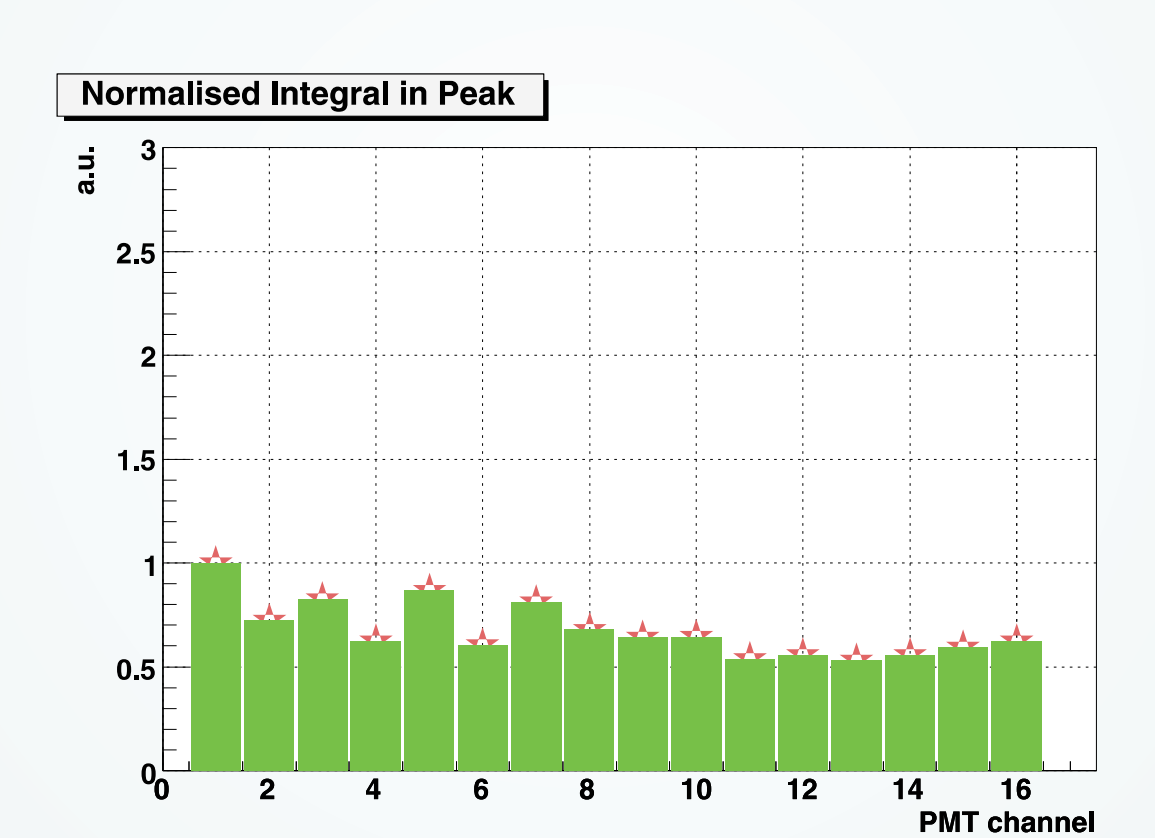
Single photon spectrum



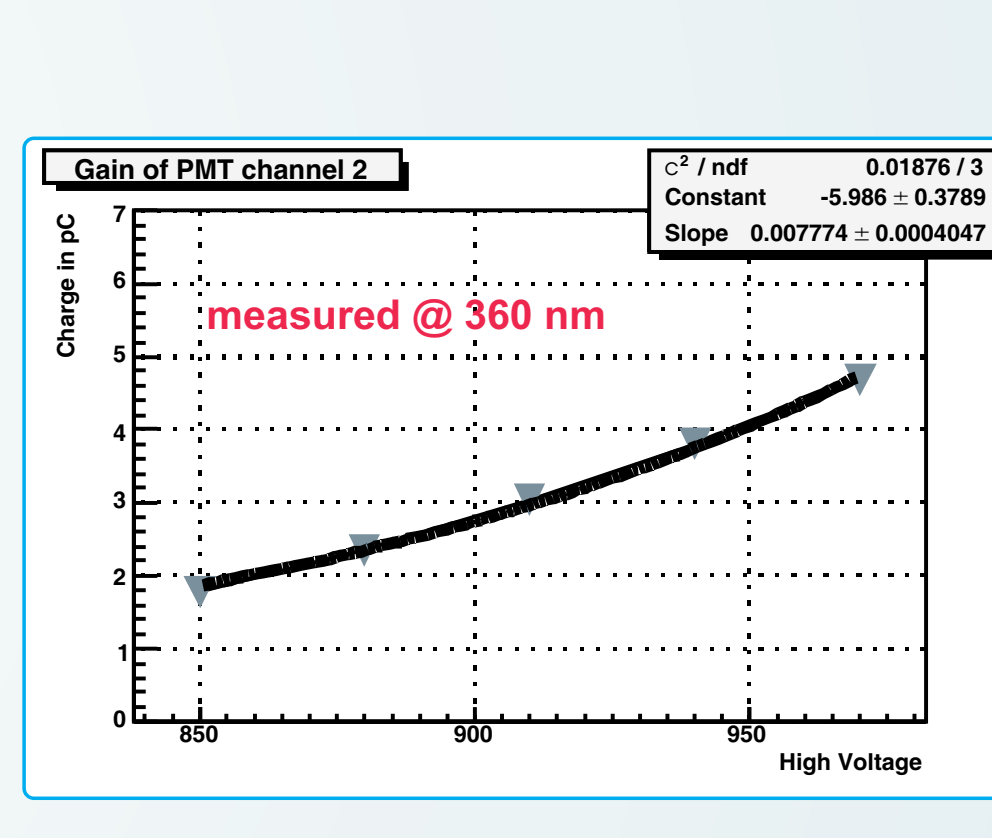
Dark current



Uniformity of amplitude

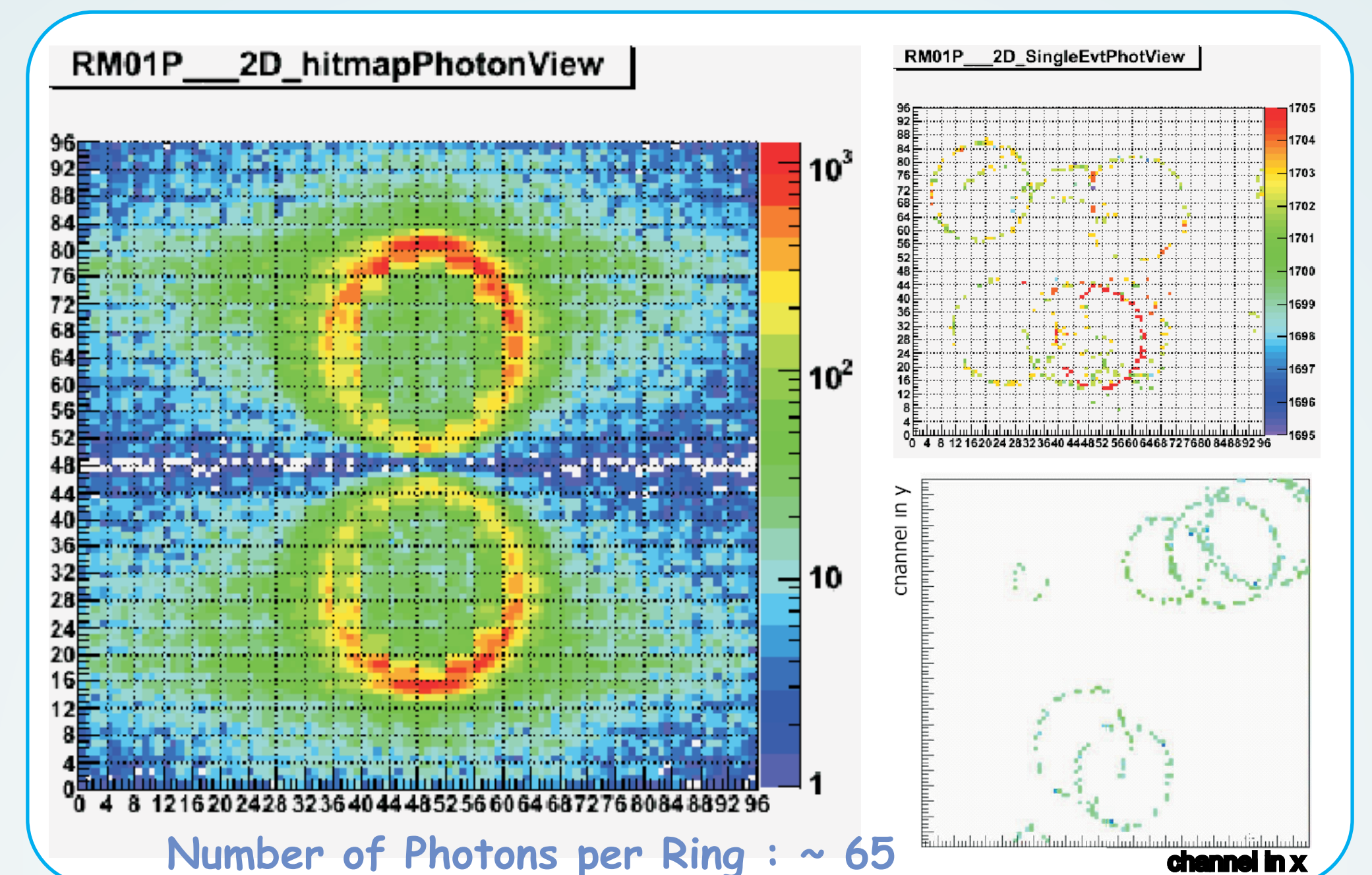


Relative quantum efficiency

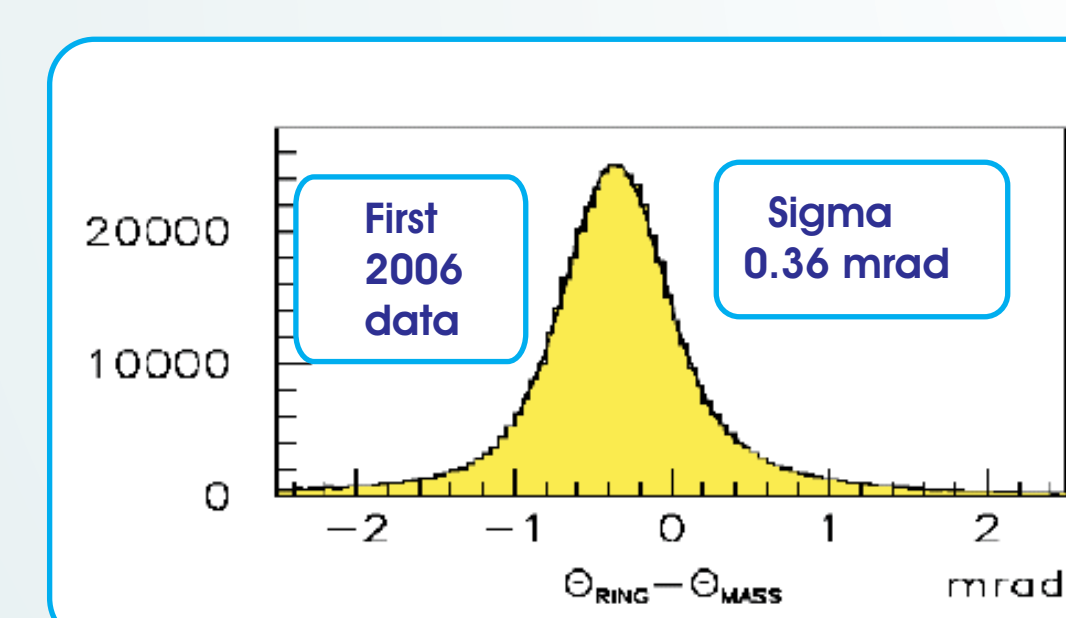


amplification ≡ gain

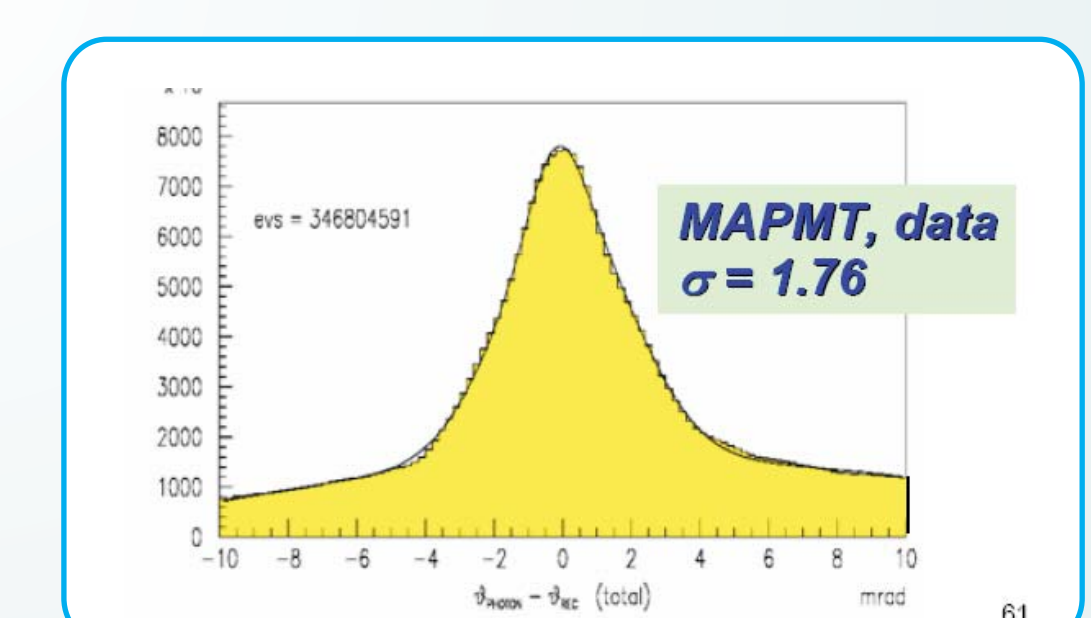
## First results



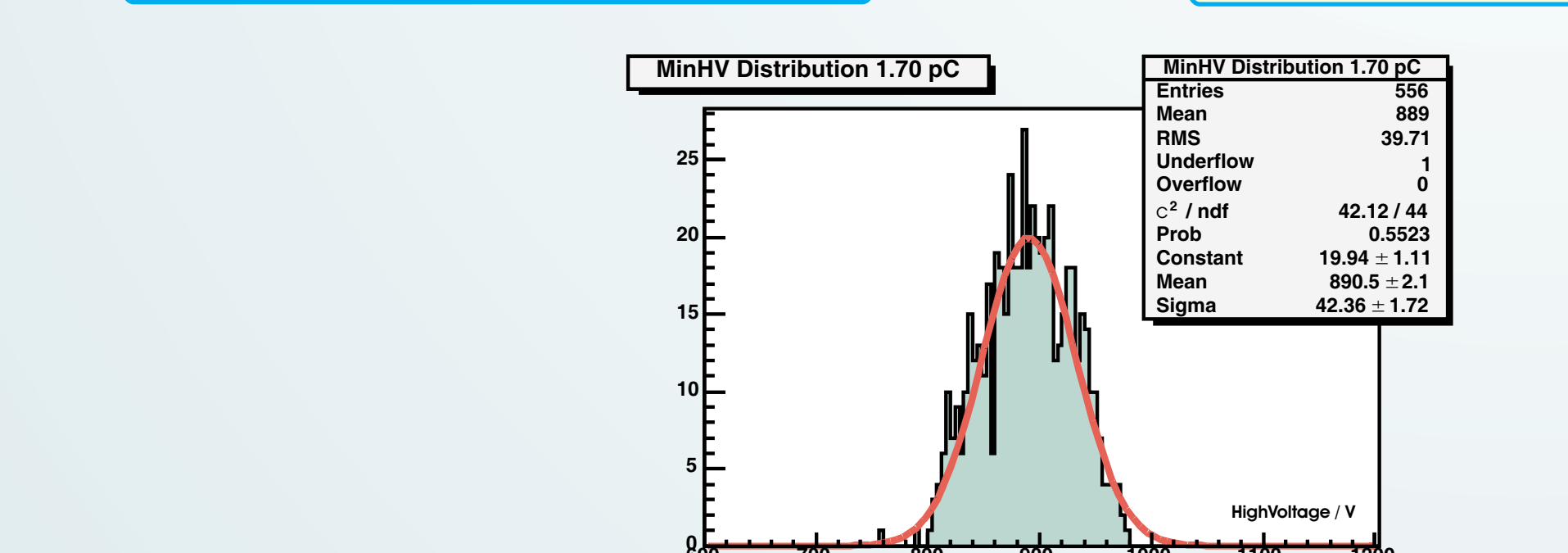
Number of Photons per Ring : ~ 65



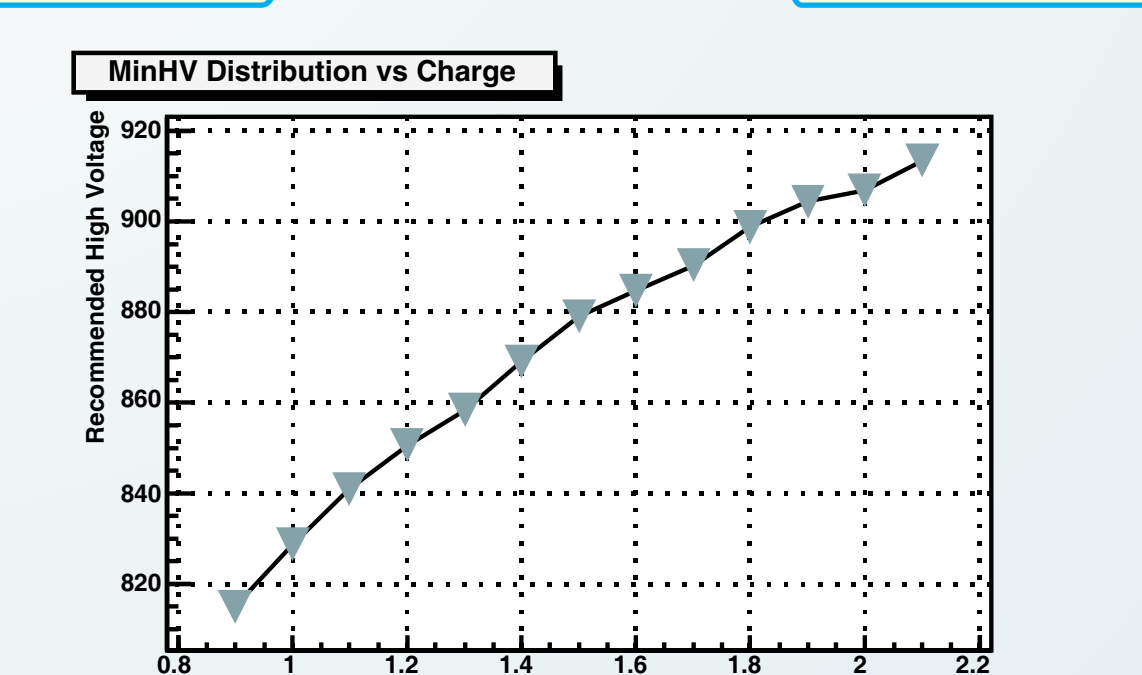
Ring resolution  $\sigma_{ring}$



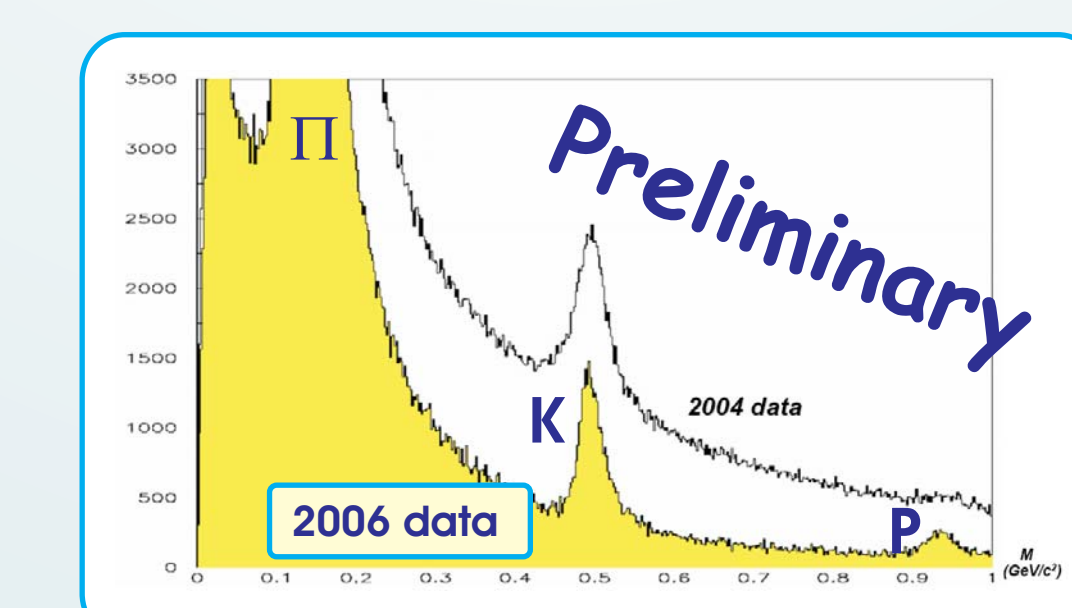
Photon resolution  $\sigma_{photon}$



High voltage distribution of all PMTs @ 1.7 pC



High voltage as function of charge



Preliminary