# Study of photocathode aging in MCP PMT

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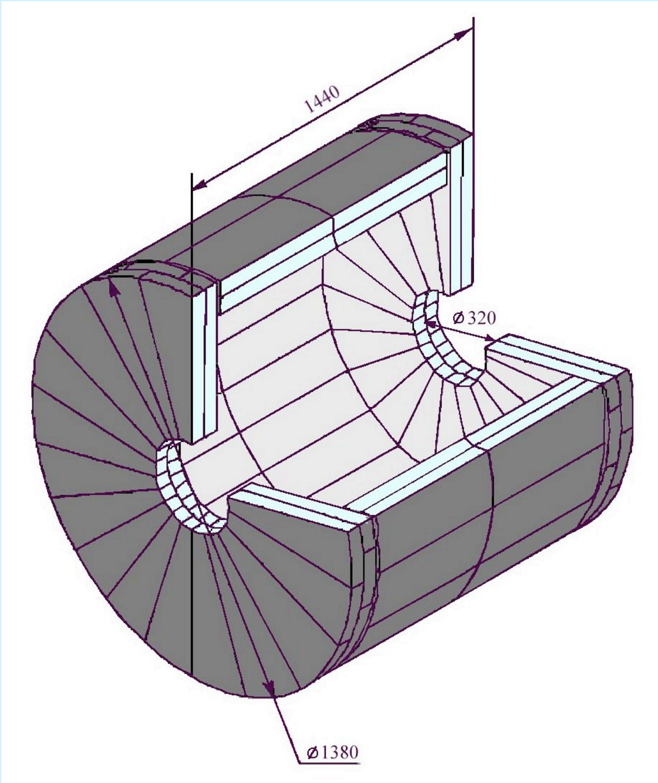
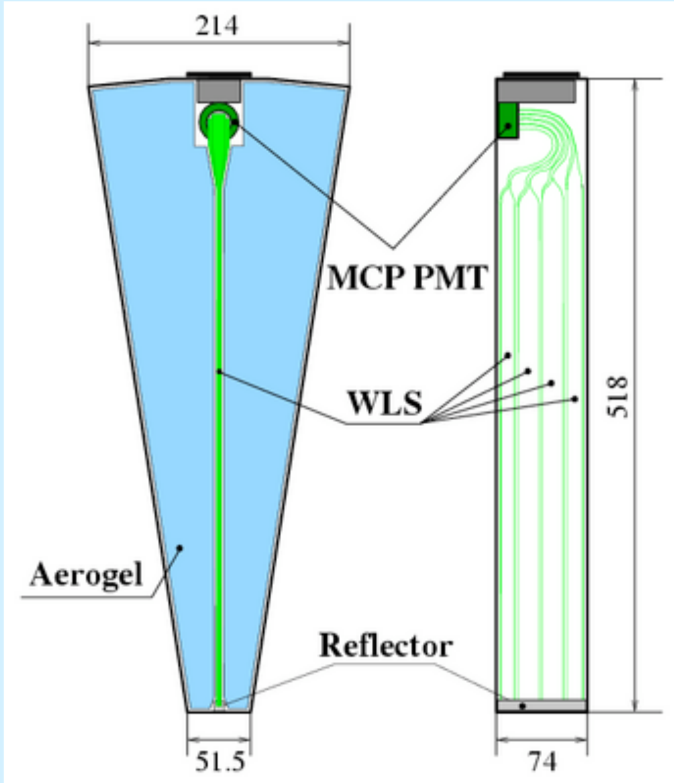
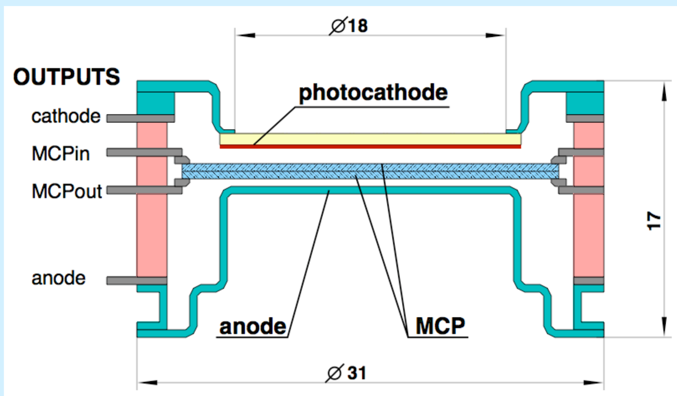
## ASHIPH counters of the KEDR detector



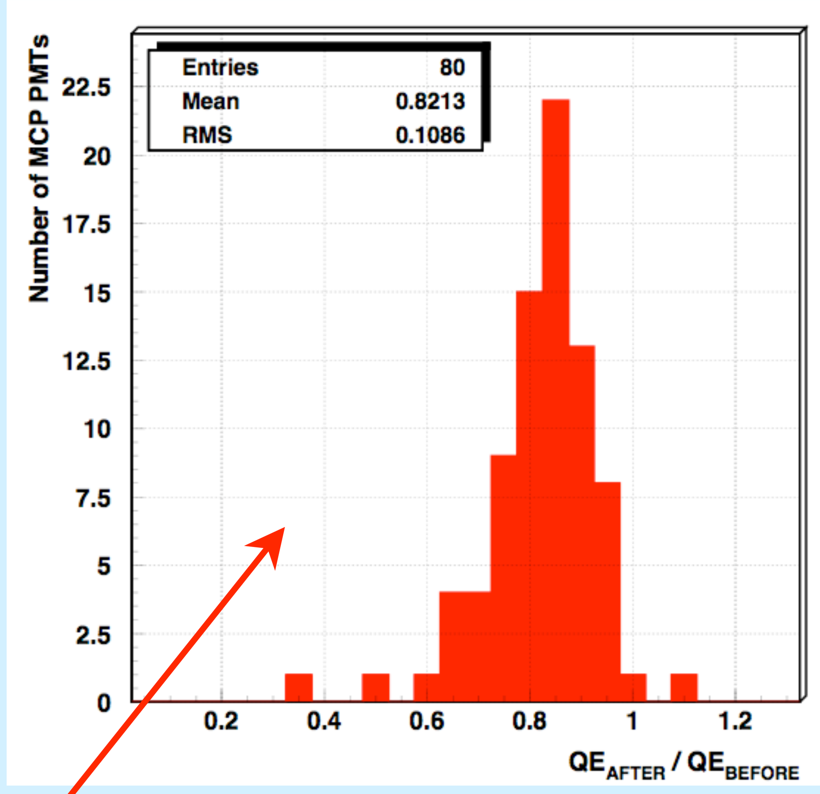



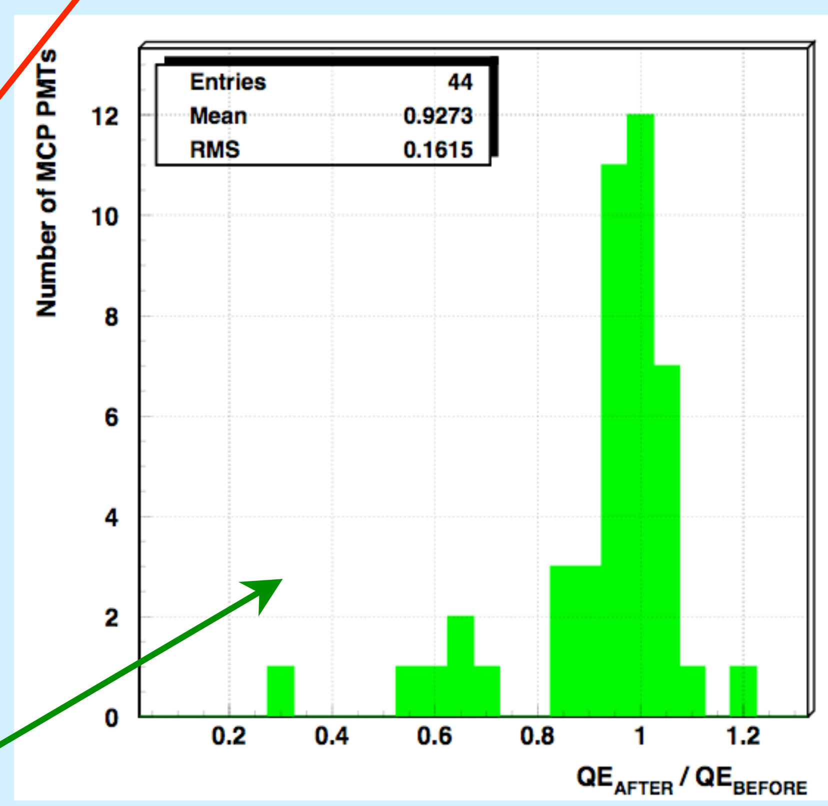

- π/K separation from 0.6 to 1.5 GeV/c
- 160 counters arranged in two layers
- aerogel radiator with n=1.05 (1000 liters)
- Wave Length Shifters for light collection ($\lambda_{emission} \approx$ 500nm)
- MCP PMT with multialkali photocathode ∅18mm ($\lambda_{max.QE} \approx$ 500nm)




## MCP PMT degradation in the KEDR

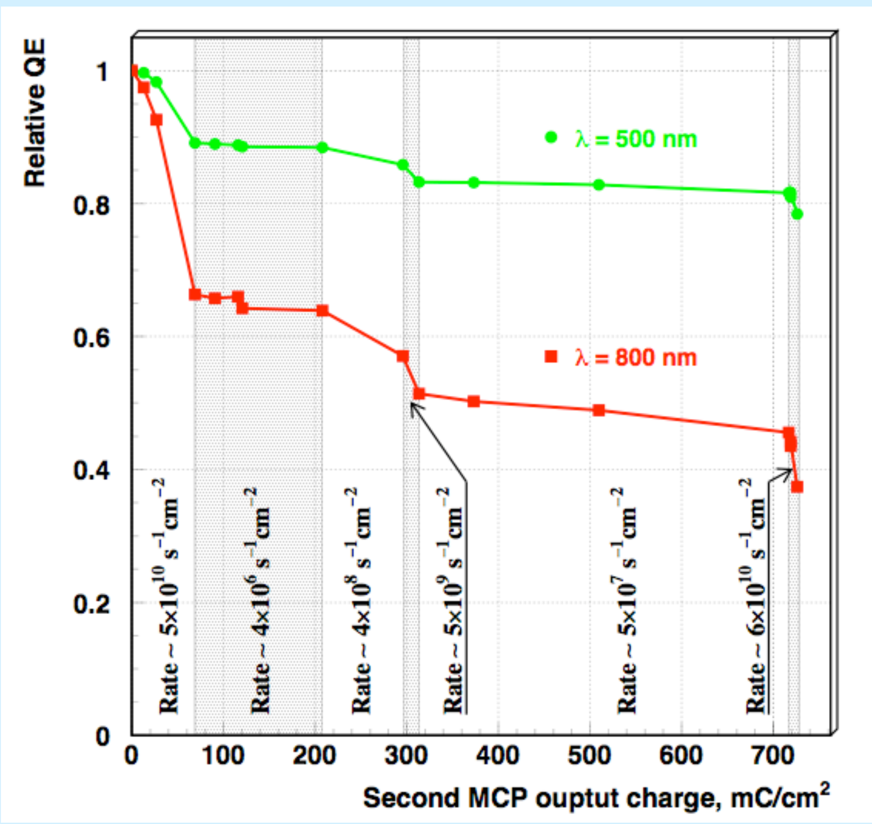
- 80 ASHIPH counters worked in the KEDR from 2003 to 2011
- working conditions:
  - ✓ gain ~3·10$^5$
  - ✓ counting rate $10^3 \div 10^4$ s$^{-1}$cm$^{-2}$
  - ✓ accumulated anode charge ~10÷100 mC/cm$^2$
- QE$_{\lambda=500nm}$ decreased by **18%** on average
- significant QE change is observed for PMTs which **did not work** in KEDR (spare and rejected PMTs)

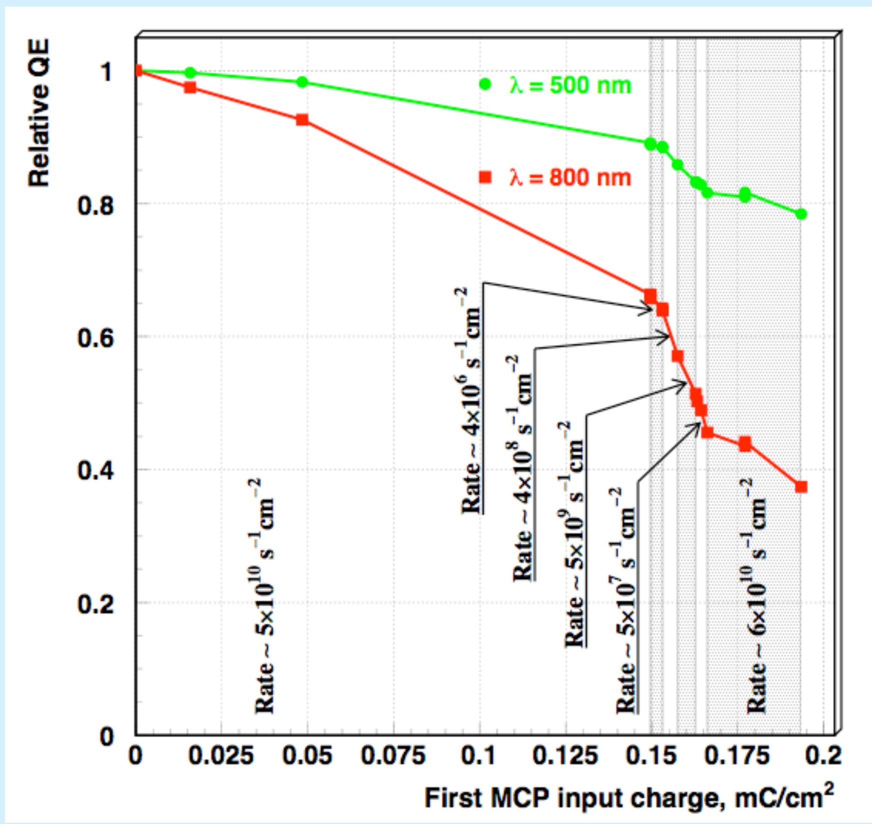


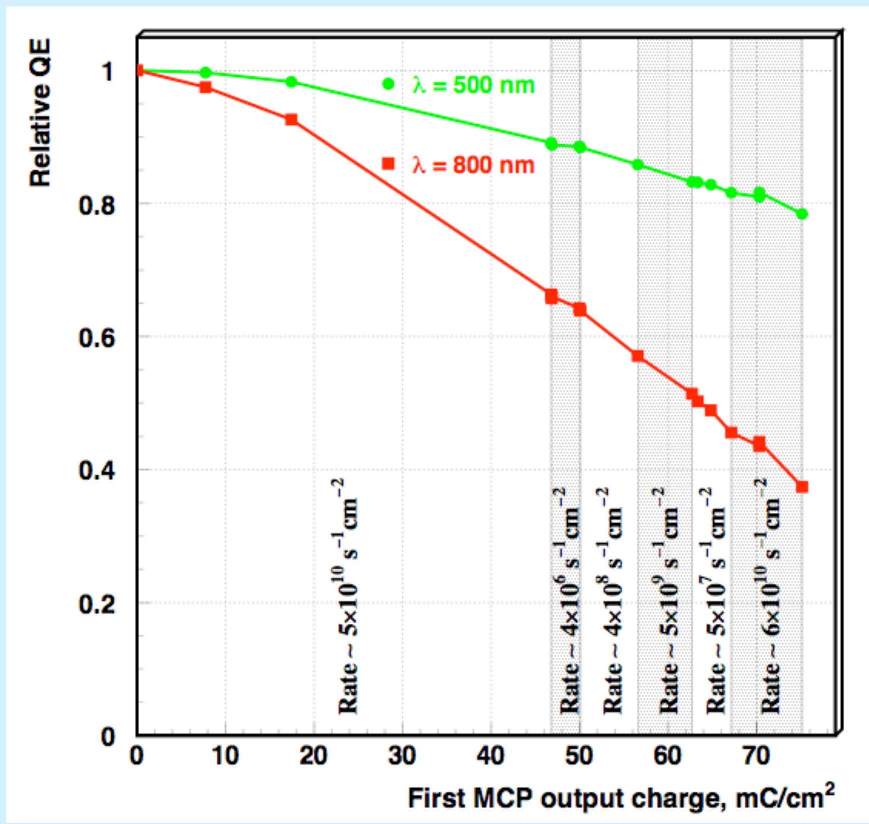




## Photocathode aging at high counting rates

The photocathode aging of one MCP PMT sample was measured at different photon counting rates from ~10$^6$ to ~10$^{10}$ s$^{-1}$cm$^{-2}$.



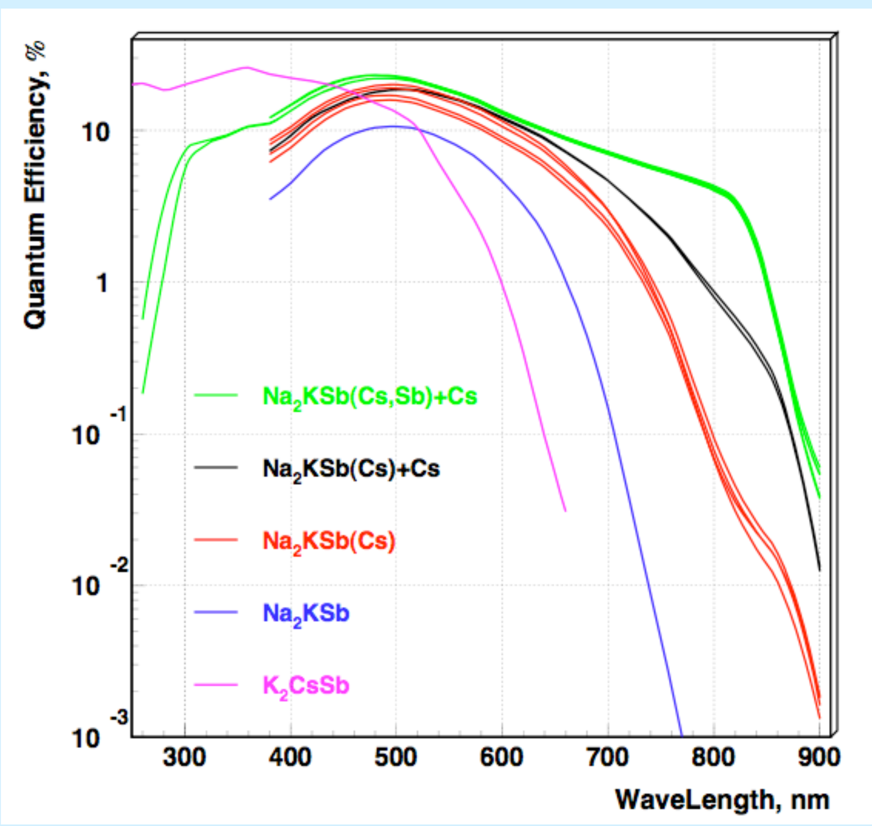



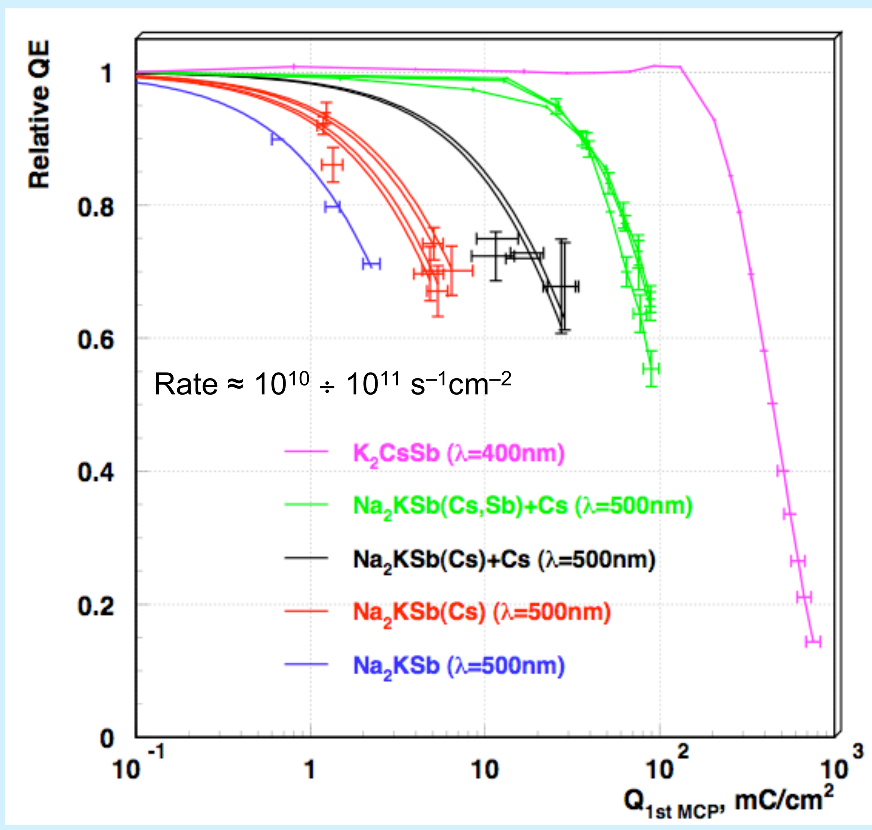

At such a high photon counting rates the QE degradation is proportional neither to the accumulated <u>anode</u> charge (left figure) nor to the accumulated <u>input</u> charge (central figure) but it is proportional to the charge extracted from the <u>first</u> (nearest to the photocathode) MCP (right figure).

## Comparison of different photocathodes

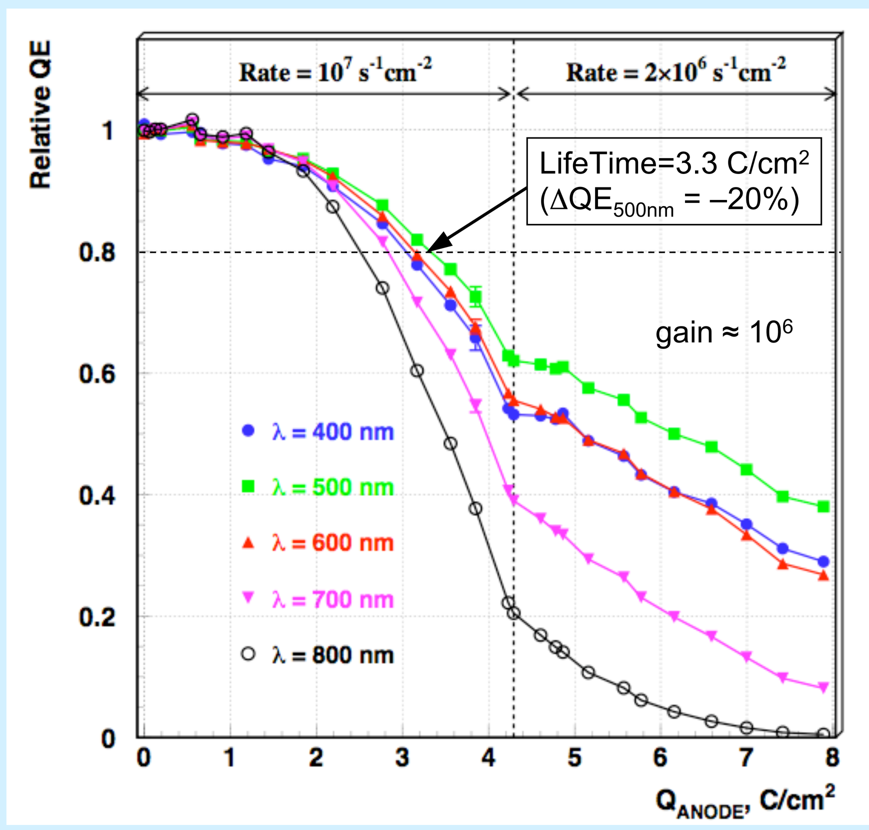
The MCP PMTs with bialkali ($Na_2KSb$ and $K_2CsSb$) and different types of multialkali photocathodes were produced and tested.




High concentration of cesium in multialkali photocathode results in higher infrared sensetivity as well as in higher thermoemission current.




The photocathodes treated with vapors of Cs (and Sb) degrade much slower than others. The higher concentration of Cs the slower aging.




The lifetime of $Na_2KSb(Cs,Sb)$+Cs multialkali photocathode was measured at the photon counting rate of 10$^7$ s$^{-1}$cm$^{-2}$ (2·10$^6$ s$^{-1}$cm$^{-2}$).