Position-Sensitive Gaseous Photomultipliers: Research and Applications

We would like to present our new work - a book

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Its main focus is on new designs, technological aspects
and physics of operation of positon- sensitive photomultipliers,
so it fits well this working group

Let me first present my co-author Tom Francke

We met at CERN in 1986, where he worked on photosensitive substances and later on various RICH designs. Then we continue to collaborate in Sweden, where he lead the XCouter company, developing micropattern detectors for medical application

General notes:

The book summarizes the experience of many groups in developments of photocathodes and position sensitive multipliers

Why are these detectors unique, why they deserved to be described in a dedicated book?

The main advantage is-a large sensitive area, since there are no constrains on the window size.

(Vacuum detectors max. diameter is 20 inch for PM and for MCP 8x8 inch2)

They are also position -sensitive

(let me remind you that gaseous detectors were the first electronic position-sensitive detectors

(PMT were not position-sensitive and MCP and multianode PMTs appeared latter)

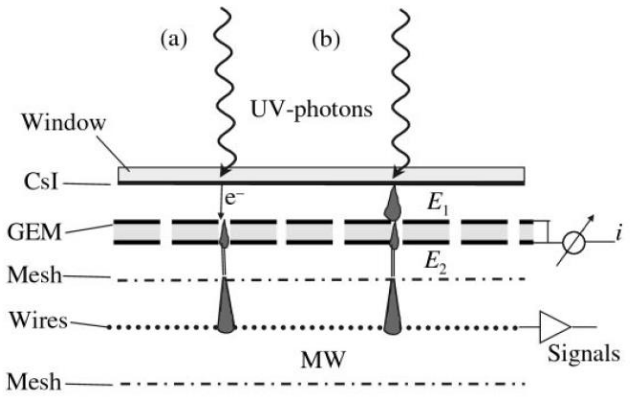
Vacuum PMT

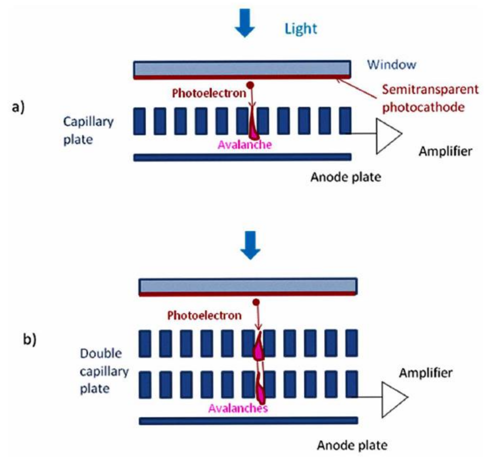
Vacuum MCP

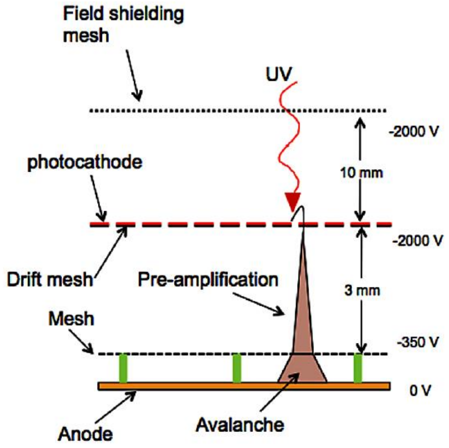
ALICE RICH-
each module
40x60cm2

The problems, however are: feedback, cathode degradation by ion bombardment, etc.

This is why micropattern structures are so important in gaseous PMTs:
due to their geometry they are capable to <u>supress photon and ion feedbacks</u>







Book structure

Chapter 8

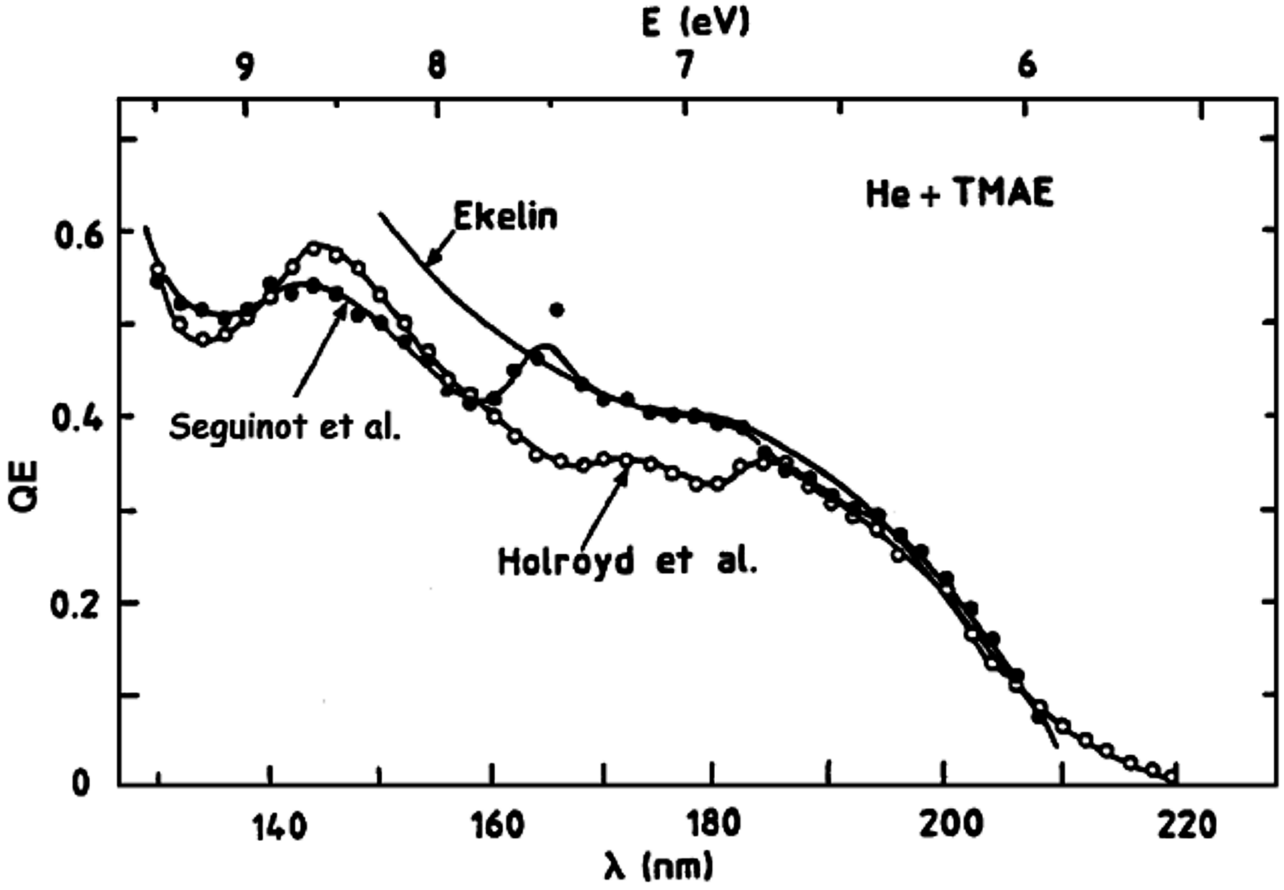
Chapter 9

Chapter 10

Chapter 11

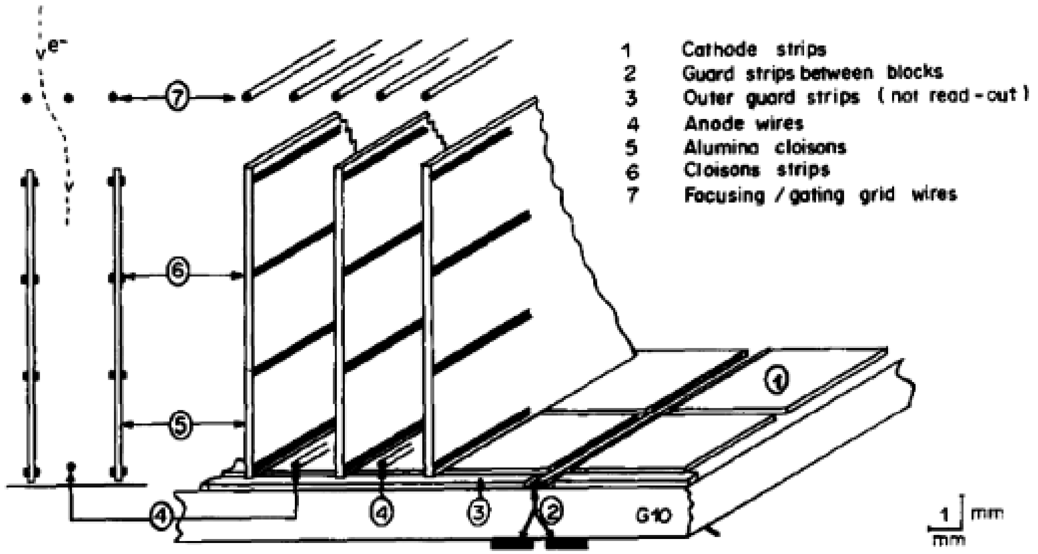
Let me highlight some achievements, designs, developments and associated problems

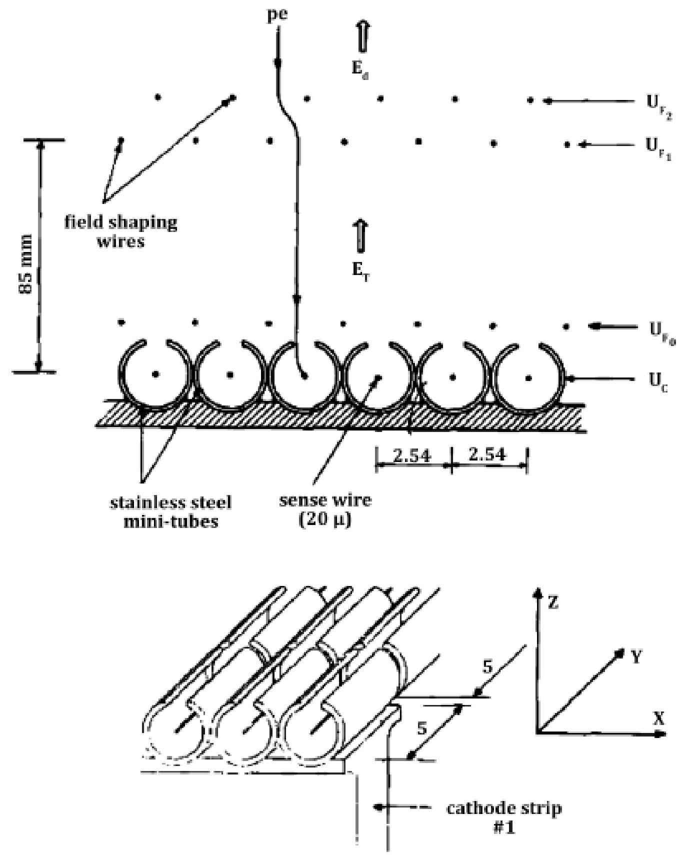
1.TMAE photocathode- was a breakthrough in 1980th



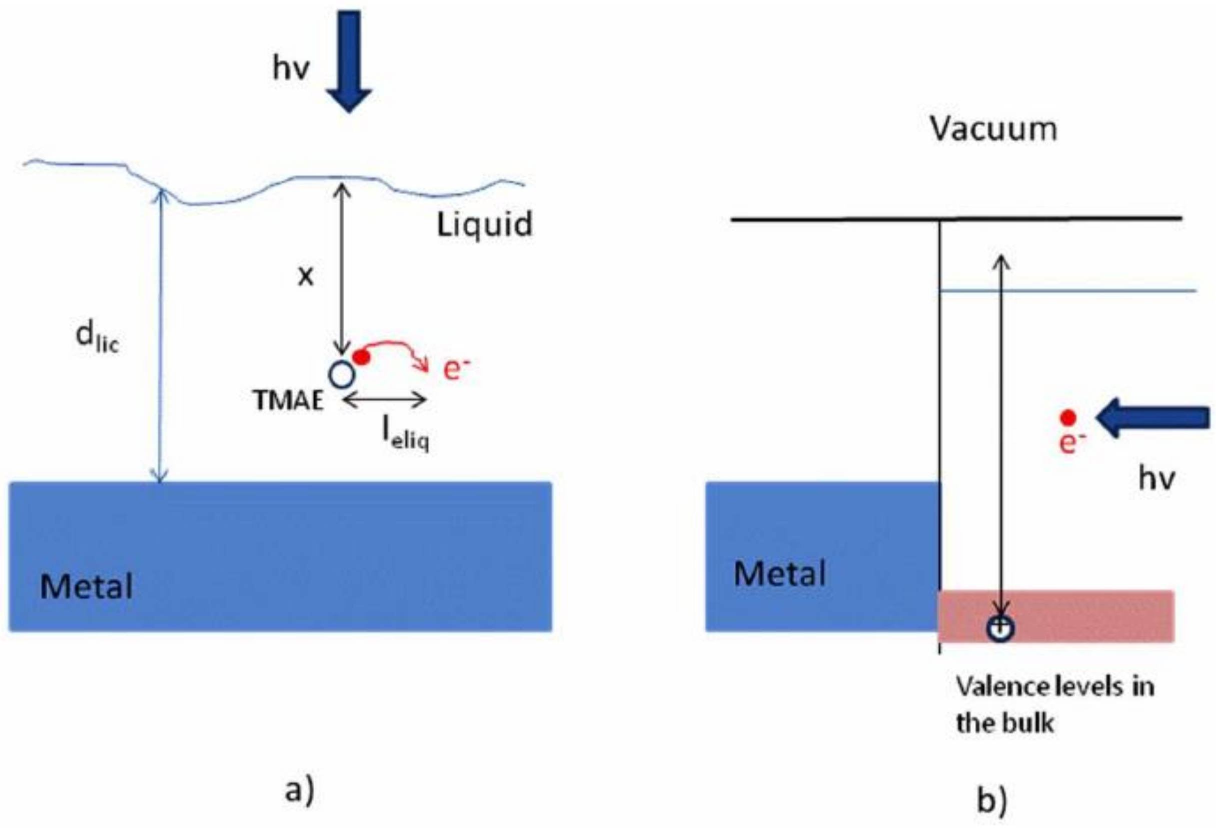
Highest QE, however chemical aggressive. It requires also careful cleaning. In books can be find the recipes and solutions

Feedback and its suppression

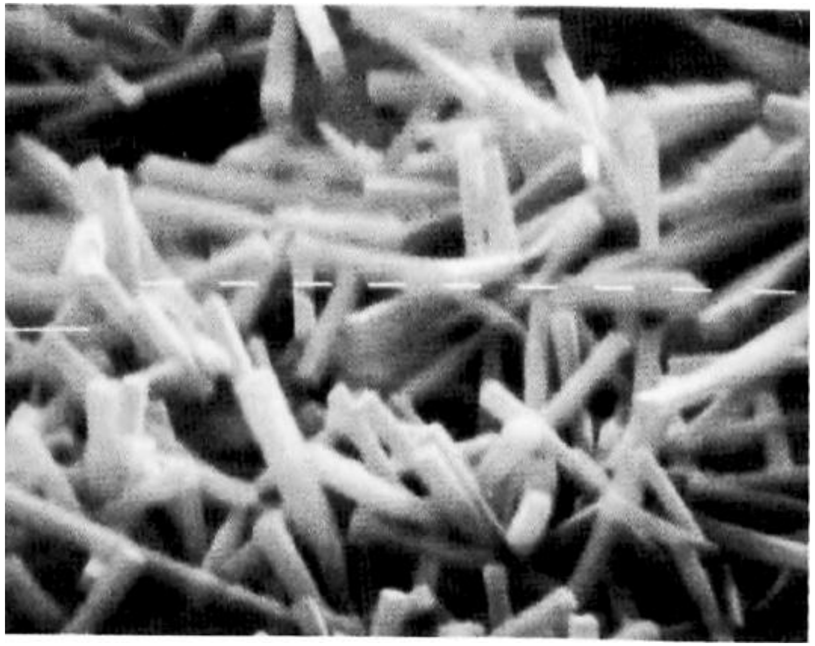


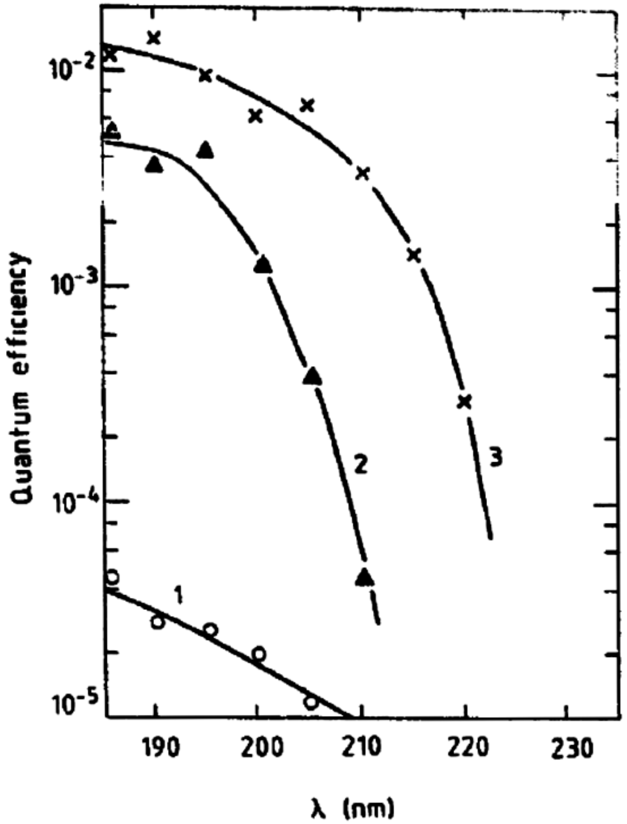


2. Liquid photocathode- a nice physical effect

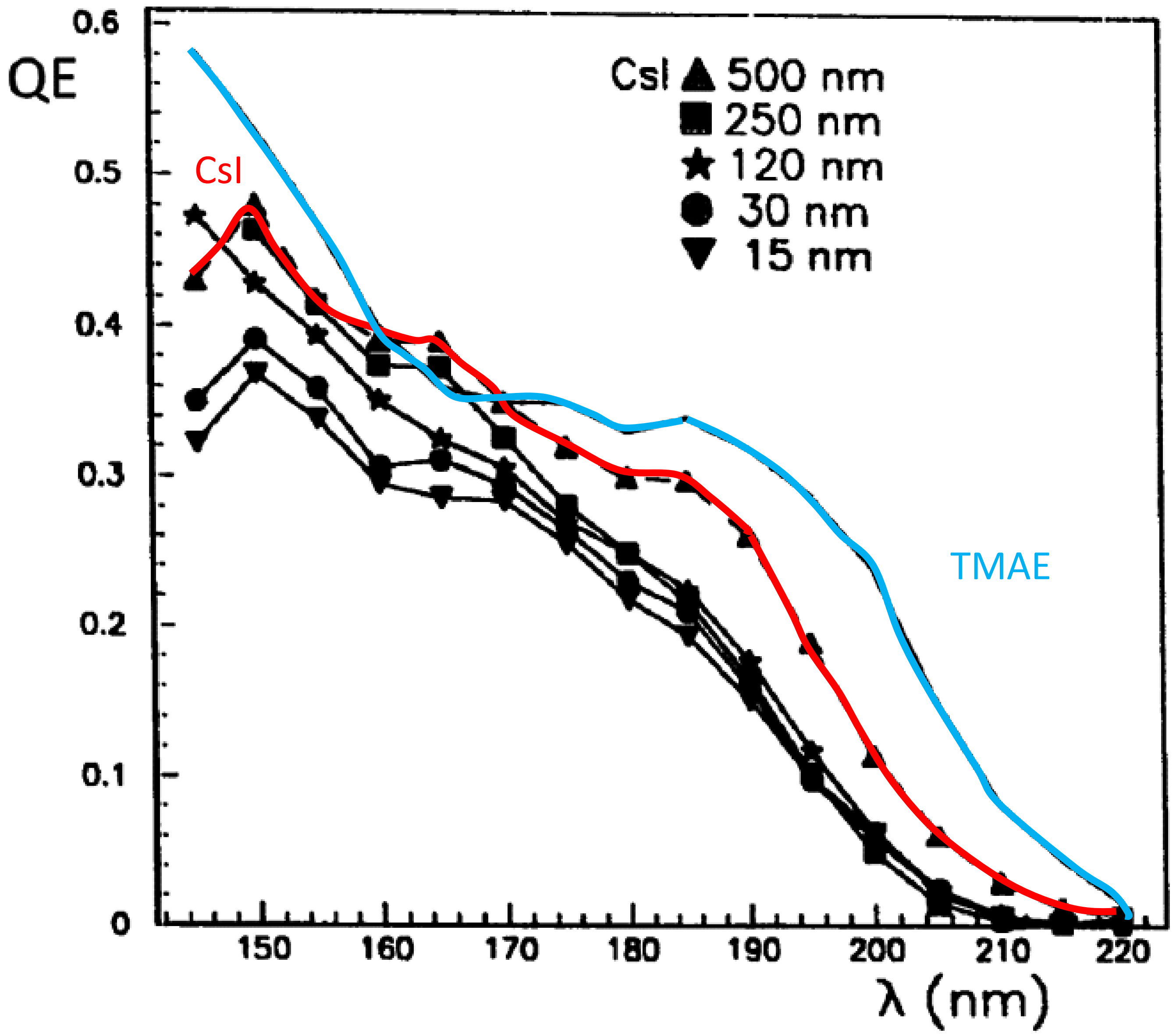


3. Search for air-stable solid photocathodes





4. CsI photocathode

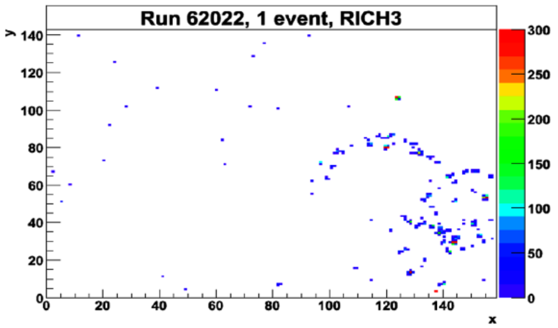


CsI has quantum efficiency comparable to TMAE, but is not chemically aggressive, tolerates a shot contact with air and thus it is much easier to handle. This is why it fully replace TMAE in most of detectors

It has also potential foe better time resolution since there is practically no jitter in creation photoelectrons

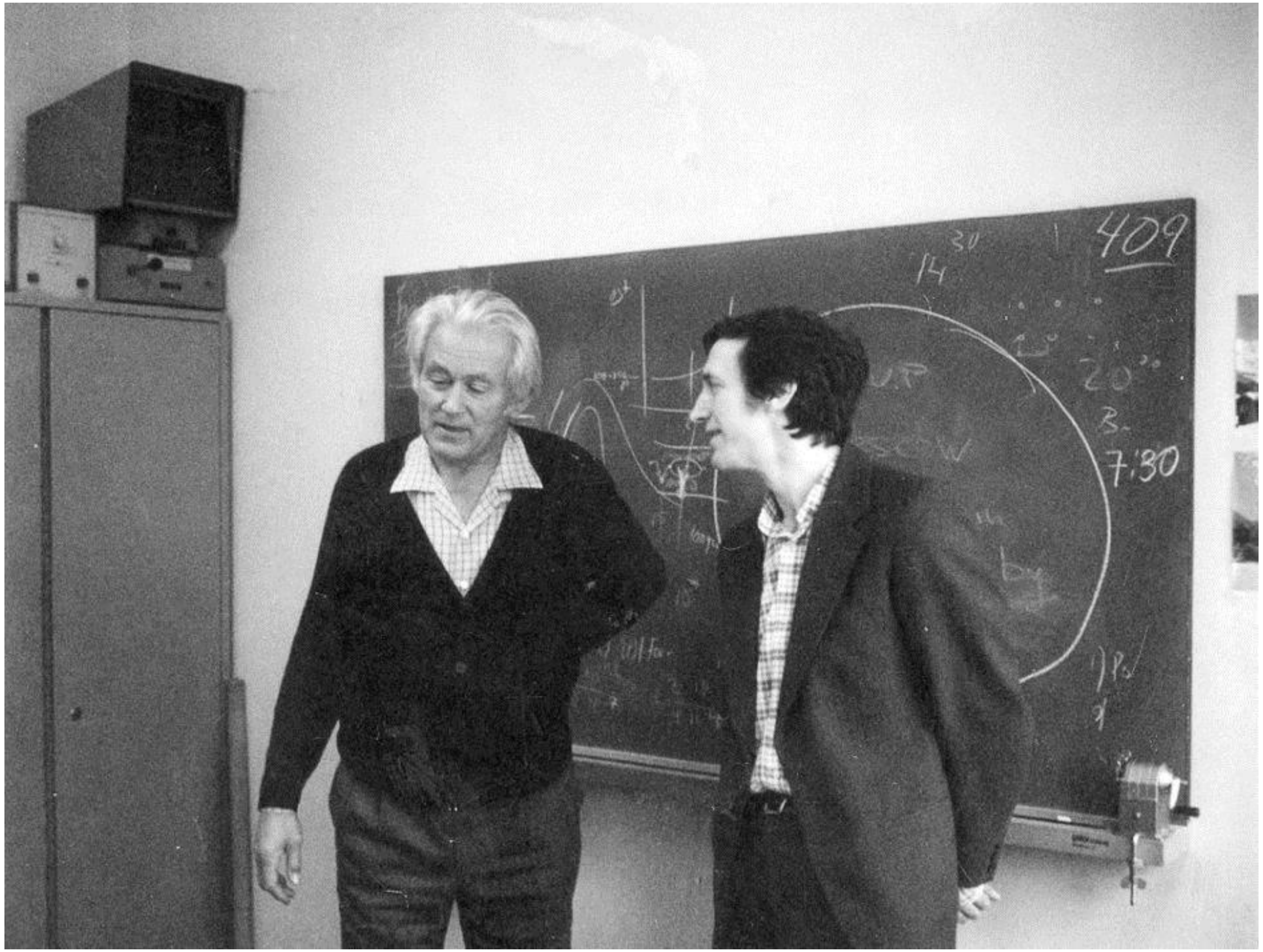
Feedback problem also exists , hut the electronics was improved with time , so the operation at lower gains becomes possible

In CsI -RICH detector small feedback was even useful



One of the remaining problems –is discharges induced at high rate environment (COMPASS)

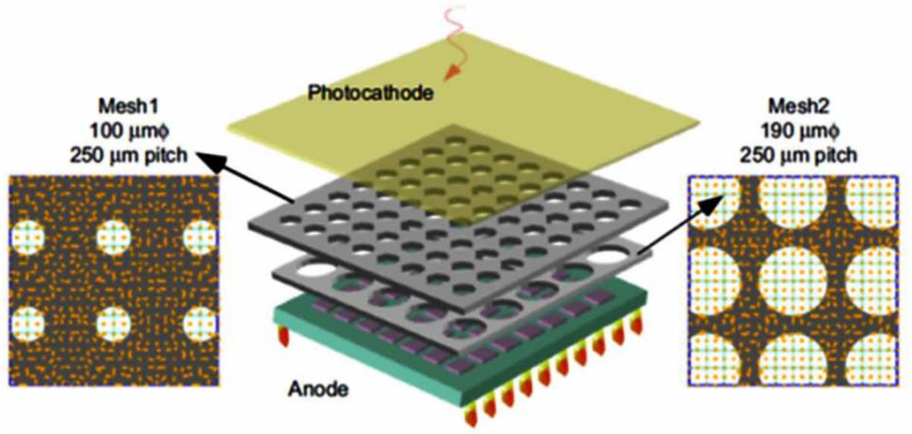
5. The future: gaseous detectors sensitive to visible light?



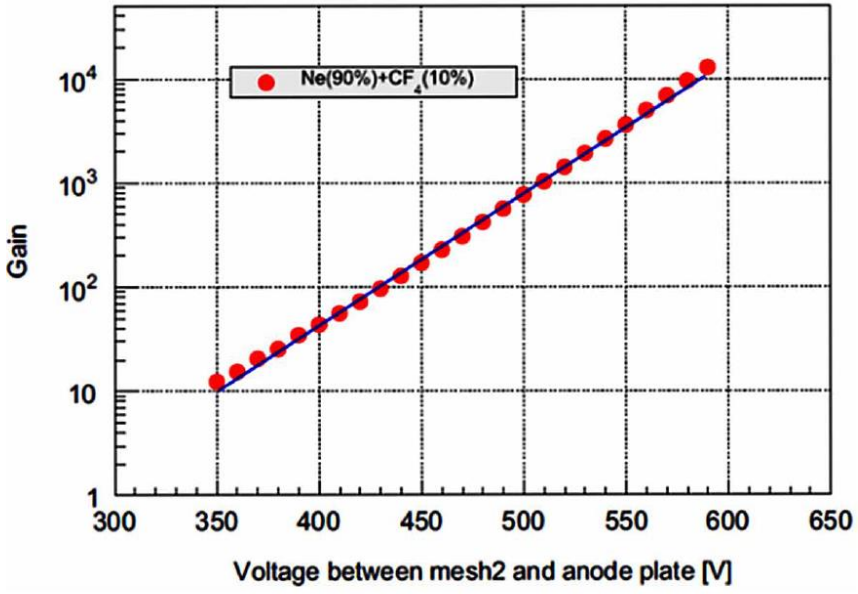
Famous Charpak joke:

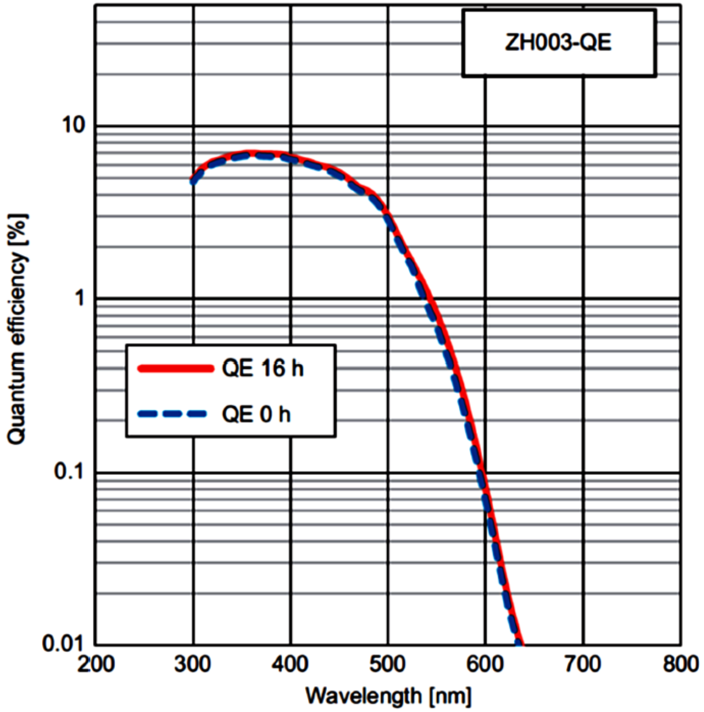
"The next Noble prize in the field of gaseous detectors will be given the persons who develop position-sensitive gaseous detectors sensitive to visible light"

The progress



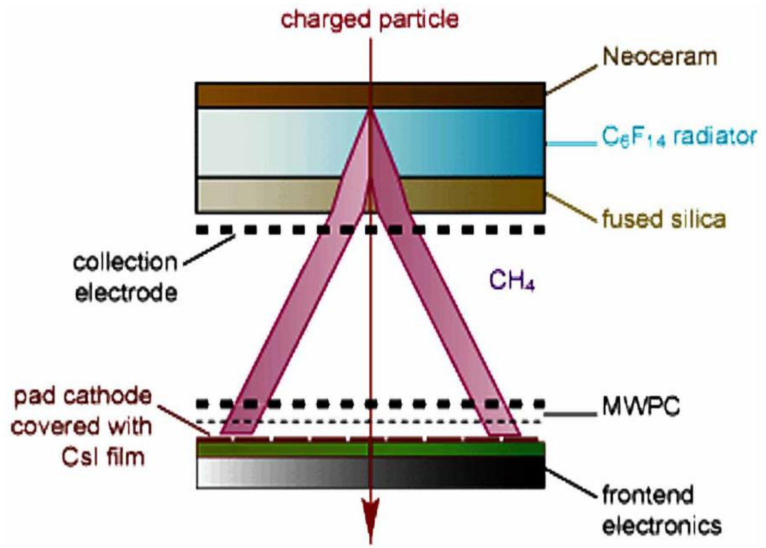
First Hamamatsu gaseous detectors sensitive to visible light had gains ~ 10 now is ~10000

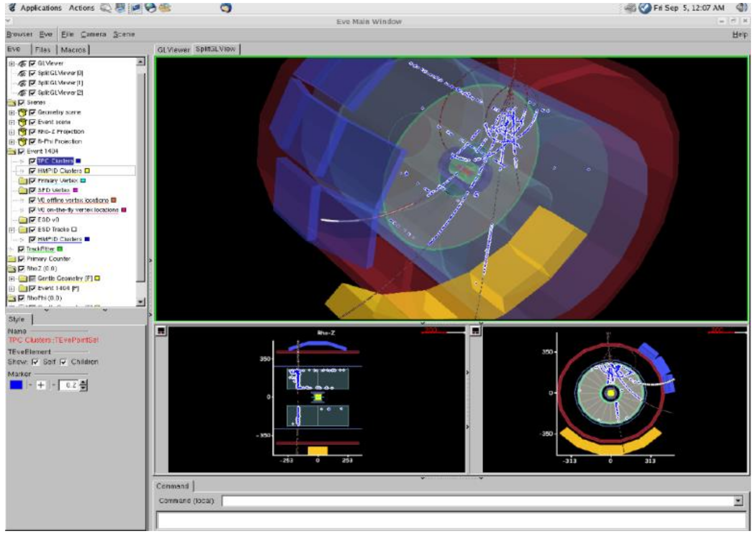




Applications

The main application is, of course, RICH

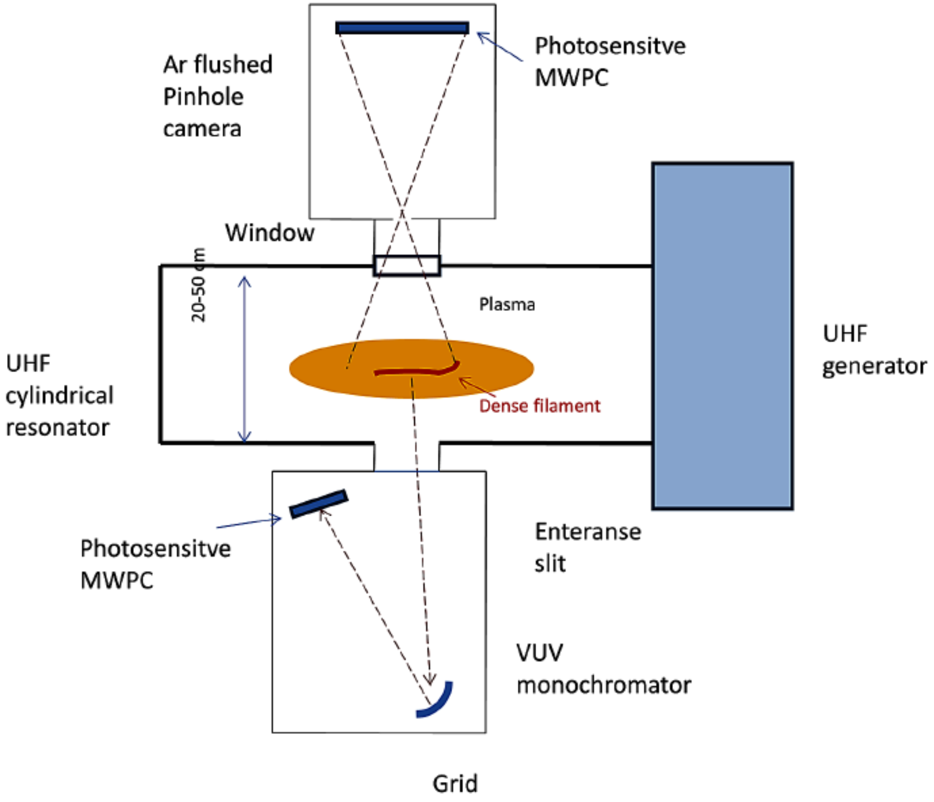


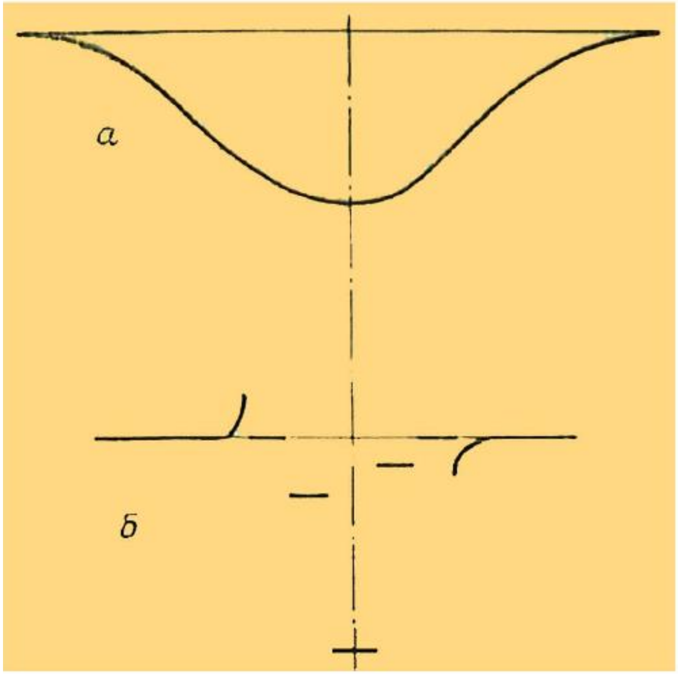


Experiment-Lab	3σ π/K Separation Momentum Range (GeV/c)	Max Interaction Rate (Hz)	Radiator (Length)	CsI Active Area (m^2)
ALICE-CERN/LHC	0.8-3	10^4	C_6F_{14} (15 mm)	11
STAR-BNL/RICH	0.8-3	10^4	C_6F_{14} (10 mm)	1.2
COMPASS-CERN/SPS	3-40	10^6	C_4F_{10} (3 m)	5.5
HALL A-TJNAF	0.8-3	10^6	C_6F_{14} (15 mm)	0.7
HADES-GSI	hadron blind	10^6	C_4F_{10} (0.4 m)	1.4

From Nappi, 2005.

Other applications were mentioned as well, like plasma diagnostic, astrophysics ets





Conclusions

We tried to give in this book an exhaustive compilation of knowledge on photosensitive gaseous detectors: their technology , main design and physics of operation.

We think that one of its important feature is that it contains unpublished or difficult reachable information on handling some products, like cleaning of TMAE, preparation of some photocathodes etc.

The latest, probably has a special value because people participating in these exciting developments and possessing the unique “know- how” are gradually stepping down from the scientific activity and their experience can be lost

We hope the book will be useful for researches, technicians, engineers, university professors and especially for students