

# 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 position-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?

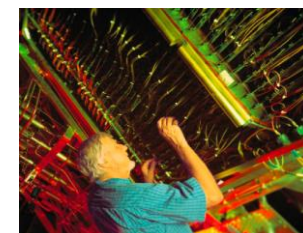
The main advantage is-a large sensitive area, since there are no constrains on the window size.

(Vacuum detectors max. diameter is 20 inch for PM and for MCP 8x8 inch<sup>2</sup>)

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



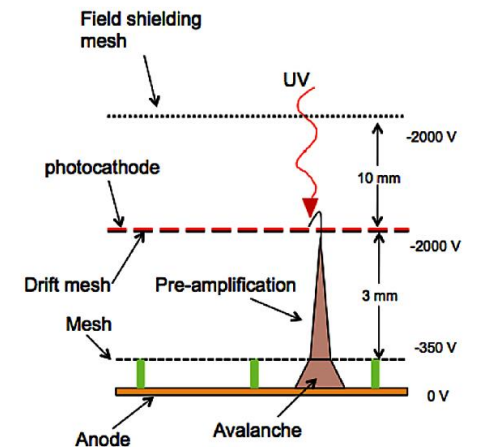
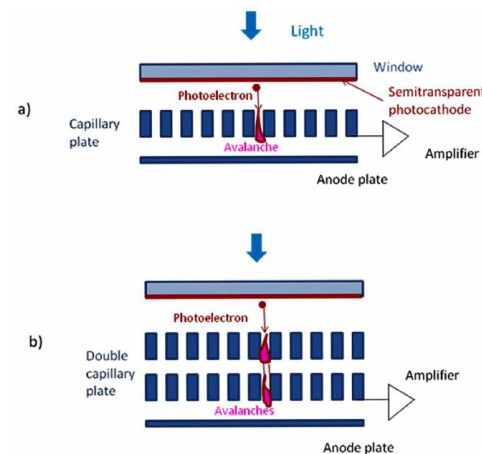
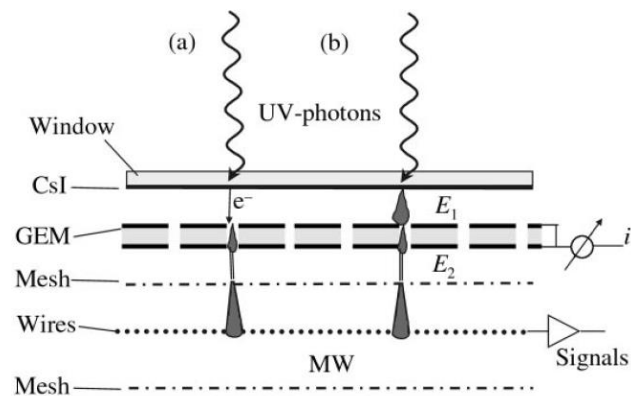
Vacuum MCP



**ALICE RICH-**  
each module  
40x60cm<sup>2</sup>

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 supress photon and ion feedbacks



# Book structure

<b>Preface</b> .....	X
<b>Acknowledgment</b> .....	XX
<b>Introduction</b> .....	21
<b>Chapter 1</b>	
<u>Conversion of UV and Visible Photons to Photoelectrons</u> .....	1
1. PHOTOIONIZATION OF GASES .....	1
2. LIQUID PHOTOCATHODES .....	2
3. SOLID PHOTOCATHODES .....	4
CONCLUSIVE REMARKS .....	7
<b>Chapter 2</b>	
<u>Electron Multiplication and Electron Multipliers</u> .....	9
1. ELECTRON AVALANCHE MULTIPLICATION IN GASES.....	9
2. SECONDARY PROCESSES DURING AVALANCHE DEVELOPMENTS .....	11
3. THE MAIN DESIGNS OF AVALANCHE GASEOUS DETECTORS AND THE PRINCIPLE OF THEIR OPERATION .....	15
CONCLUSION AND REMARKS .....	38
<b>Chapter 3</b>	
<u>Position-Sensitive Gaseous Photomultipliers Filled with Photosensitive Vapours</u> .....	49
1. INTRODUCTION .....	49
2. SEARCH FOR VAPOURS WITH LOW IONIZATION POTENTIAL .....	51
3. EXPERIENCES LEARNED WHEN OPERATING GASEOUS DETECTORS FILLED WITH PHOTOSENSITIVE VAPOURS.....	63
4. THE SINGLE PHOTOELECTRON PULSE HEIGHT SPECTRUM .....	71
5. AGING OF PHOTOSENSITIVE GASEOUS DETECTORS.....	75
6. CATHODE EXCITATION .....	80
7. LEAKAGE CURRENT IN DETECTORS FILLED WITH TMAE VAPOURS .....	82
8. CONCLUSIVE REMARKS .....	84



## Chapter 4

<u>Liquid Photocathodes</u> .....	91
1. INTRODUCTION: EARLY OBSERVATIONS.....	91
2. SYSTEMATIC STUDIES OF TMAE BASED PHOTOCATHODES.....	93
3. OTHER LIQUID PHOTOCATHODES.....	108
4. CONCLUSIVE REMARKS.....	115

## Chapter 5

<u>Early Work on UV Sensitive Solid Photocathodes for Gaseous Detectors</u> .....	119
1. INTRODUCTION.....	119
2. A MWPC COMBINED WITH A CUI PHOTOCATHODE.....	121
3. OTHER SOLID PHOTOCATHODES.....	124
4. CONCLUSIVE REMARKS.....	130

## Chapter 6

<u>CsI and Cs<sub>2</sub>Te Photocathodes</u> .....	137
1. INTRODUCTION.....	137
2. CsI PHOTOCATHODES.....	140
3. A Cs <sub>2</sub> Te PHOTOCATHODE.....	200
4. CONCLUSIVE REMARKS.....	205

## Chapter 7

<u>Gaseous Detectors Sensitive to Visible Light</u> .....	220
1. INTRODUCTION.....	220
2. EARLY WORK ON GASEOUS DETECTORS SENSITIVE TO VISIBLE LIGHT.....	222
3. MASTERING PHOTOCATHODE MANUFACTURING.....	232
4. SYSTEMATIC STUDIES OF PHOTOCATHODE PROTECTION.....	238
5. HOLE TYPE GASEOUS PHOTOMULTIPLIERS.....	242
6. CONCLUSIVE REMARKS.....	266

## Chapter 8

<u>Alternative Position Sensitive Photomultipliers</u> .....	273
1. INTRODUCTION .....	273
2. MULTI-ANODE PMTs .....	277
3. MCP-BASED POSITION SENSITIVE PMTs.....	282
4. HYBRID VACUUM PHOTODETECTORS .....	292
5. THE MAIN APPLICATIONS OF POSITION SENSITIVE VACUUM PMTs .....	298
6. SOLID-STATE DETECTORS .....	300
7. APPLICATION OF SOLID-STATE DETECTORS .....	306
8. CONCLUSIVE REMARKS .....	309

## Chapter 9

<u>Cherenkov Light</u> .....	317
1. INTRODUCTION .....	317
2. CHERENKOV LIGHT .....	317
3. GENERAL THEORY .....	320
4. CONCLUSION AND REMARKS .....	333

## Chapter 10

<u>The History of Cherenkov Detectors</u> .....	336
1. CHERENKOV DETECTORS .....	336
2. THE PIONEERS.....	337
3. THE BIRTH OF RICH COUNTERS .....	339
4. MODERN RICH COUNTERS.....	342
5. CONCLUSION AND REMARKS .....	344

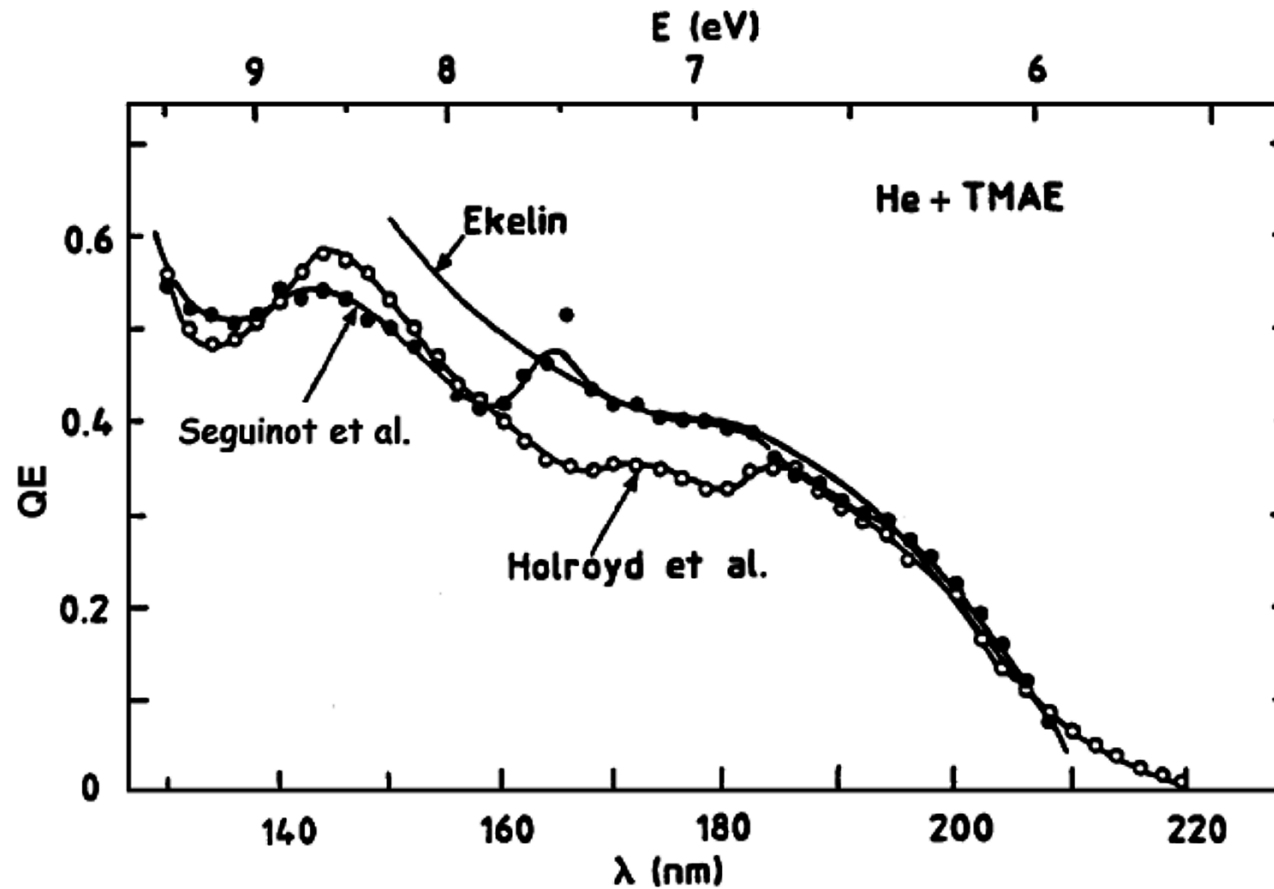
## Chapter 11

<u>A NaF RICH Counter</u> .....	346
1. THE HISTORY OF THE NaF RICH PROJECT: THE CPLEAR SPECTROMETER.....	346
2. THE CONVENTIONAL CHERENKOV COUNTER .....	348
3. THE NaF RICH COUNTER.....	349
4. THE ATMOSPHERIC PRESSURE NaF RICH DETECTOR USING A QUARTZ WINDOW AND PAD READOUT .....	359
5. SEPARATION POWER .....	373
6. CONCLUSION.....	377

<b>Chapter 12</b>	
<u>Performance of the CAPRICE94 RICH Detector during the 1994 Balloon Flight</u> .....	381
1. INTRODUCTION .....	381
2. THE CAPRICE94 RICH DETECTOR.....	382
3. EXPERIMENTAL RESULTS.....	383
4. CONCLUSION.....	390
<b>Chapter 13</b>	
<u>Performance of the CAPRICE98 Balloon Borne Gas-RICH Detector</u> .....	393
1. INTRODUCTION .....	393
2. THE GAS-RICH DETECTOR.....	394
3. RESULTS FROM FLIGHT DATA.....	401
4. CONCLUSION.....	412
<b>Chapter 14</b>	
<u>CsI-RICH Detectors</u> .....	417
1. INTRODUCTION .....	417
2. CsI-MWPC RICH DETECTORS.....	418
3. CsI-GEM RICH DETECTORS .....	426
4. CsI-TGEM/RETGEM RICH DETECTORS .....	430
5. THE COMPASS RICH UPGRADE.....	437
6. CONCLUSIVE REMARKS .....	438
<b>Chapter 15</b>	
<u>Other Applications of Photo-Sensitive Detectors</u> .....	443
1. INTRODUCTION .....	443
2. PLASMA DIAGNOSTICS.....	443
3. SPECTROSCOPY .....	448
4. ASTROPHYSICS .....	453
5. DETECTION OF SPARKS AND FLAMES.....	454
6. PHOTSENSITIVE GASEOUS DETECTORS FOR THE READOUT OF SCINTILLATORS.....	472
7. CONCLUSIVE REMARKS .....	487
<b>Conclusion</b> .....	498
<b>Appendix</b> .....	512
<b>Glossary</b> .....	522
<b>Compilation of References</b> .....	526

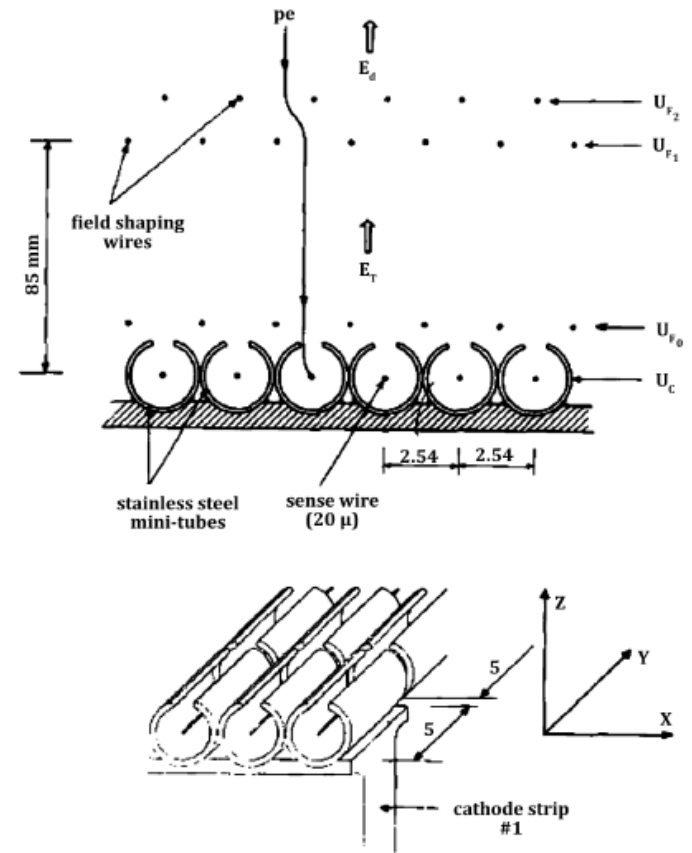
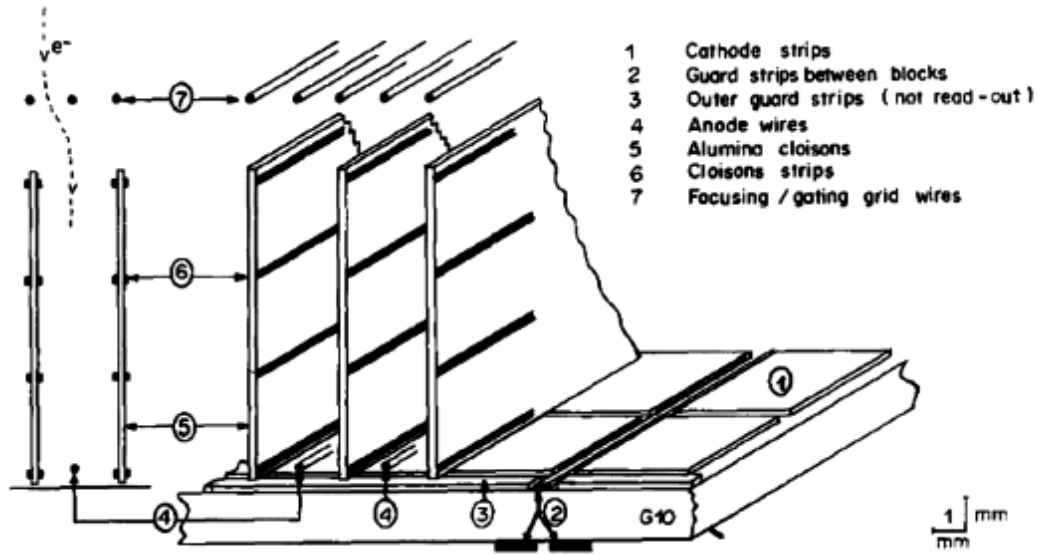
Let me highlight some  
achievements, designs,  
developments and associated  
problems

# 1. TMAE photocathode- was a breakthrough in 1980th

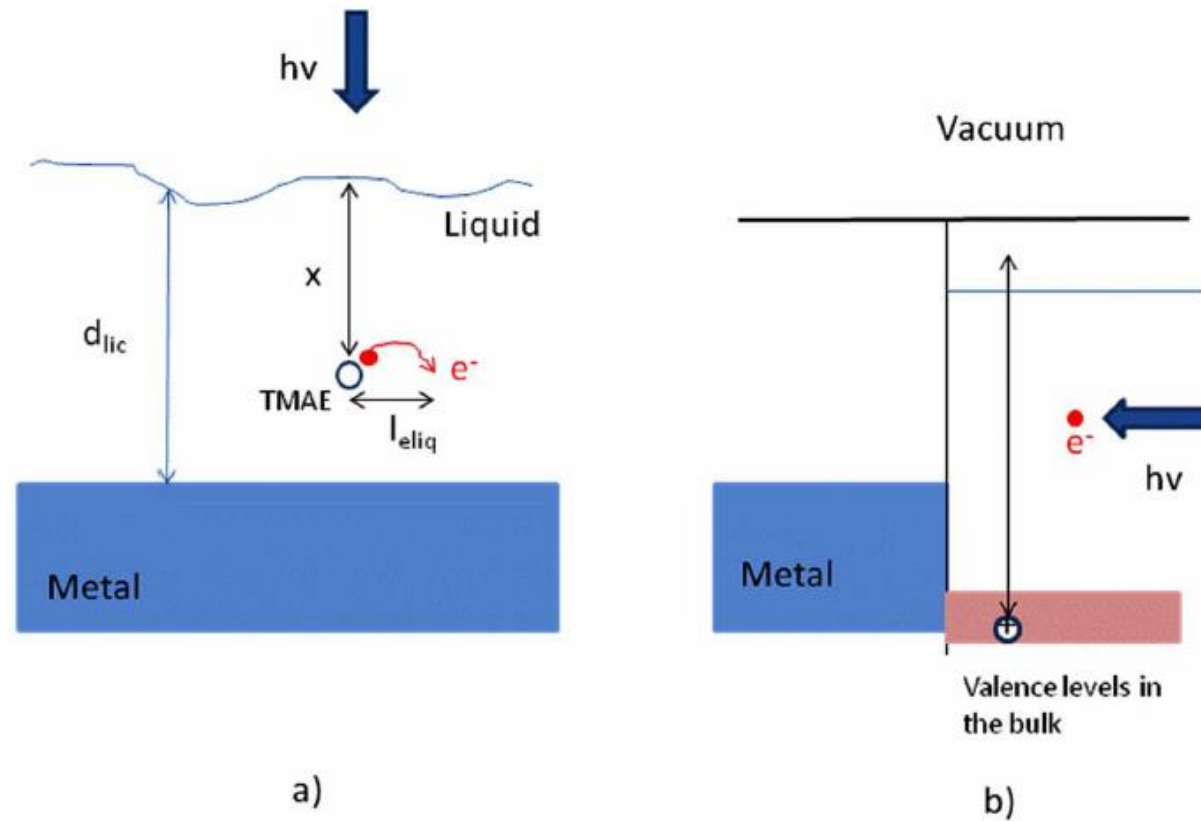


Highest QE, however chemical aggressive. It requires also careful cleaning. In books can be find the recipes and solutions

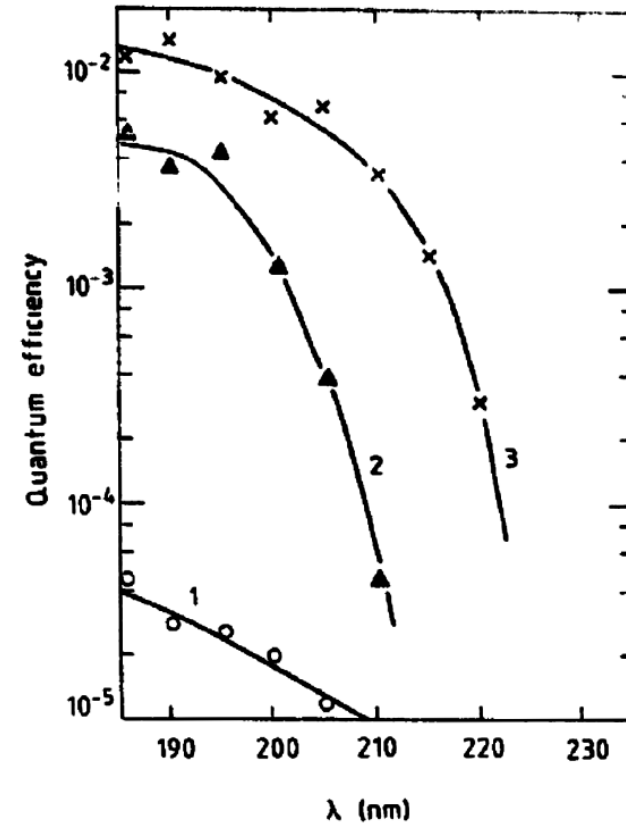
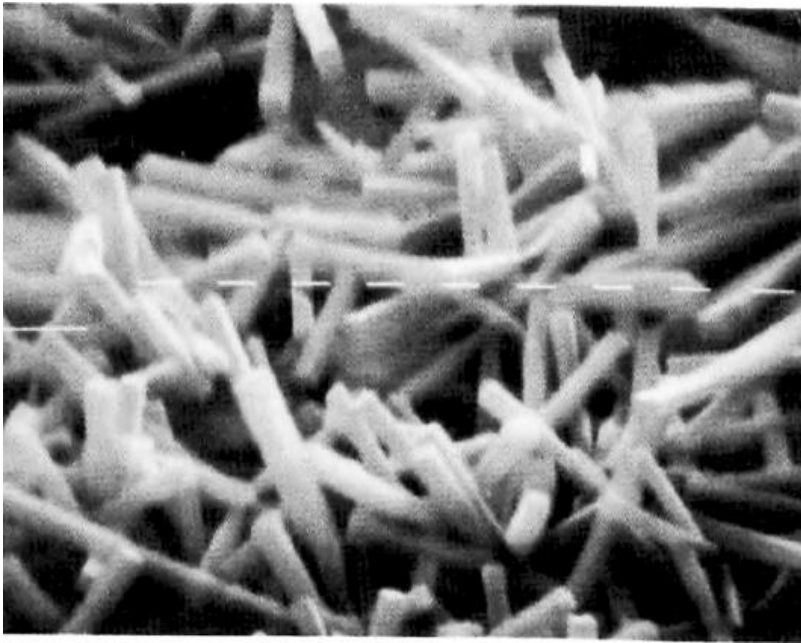
# Feedback and its suppression



## 2. Liquid photocathode- a nice physical effect

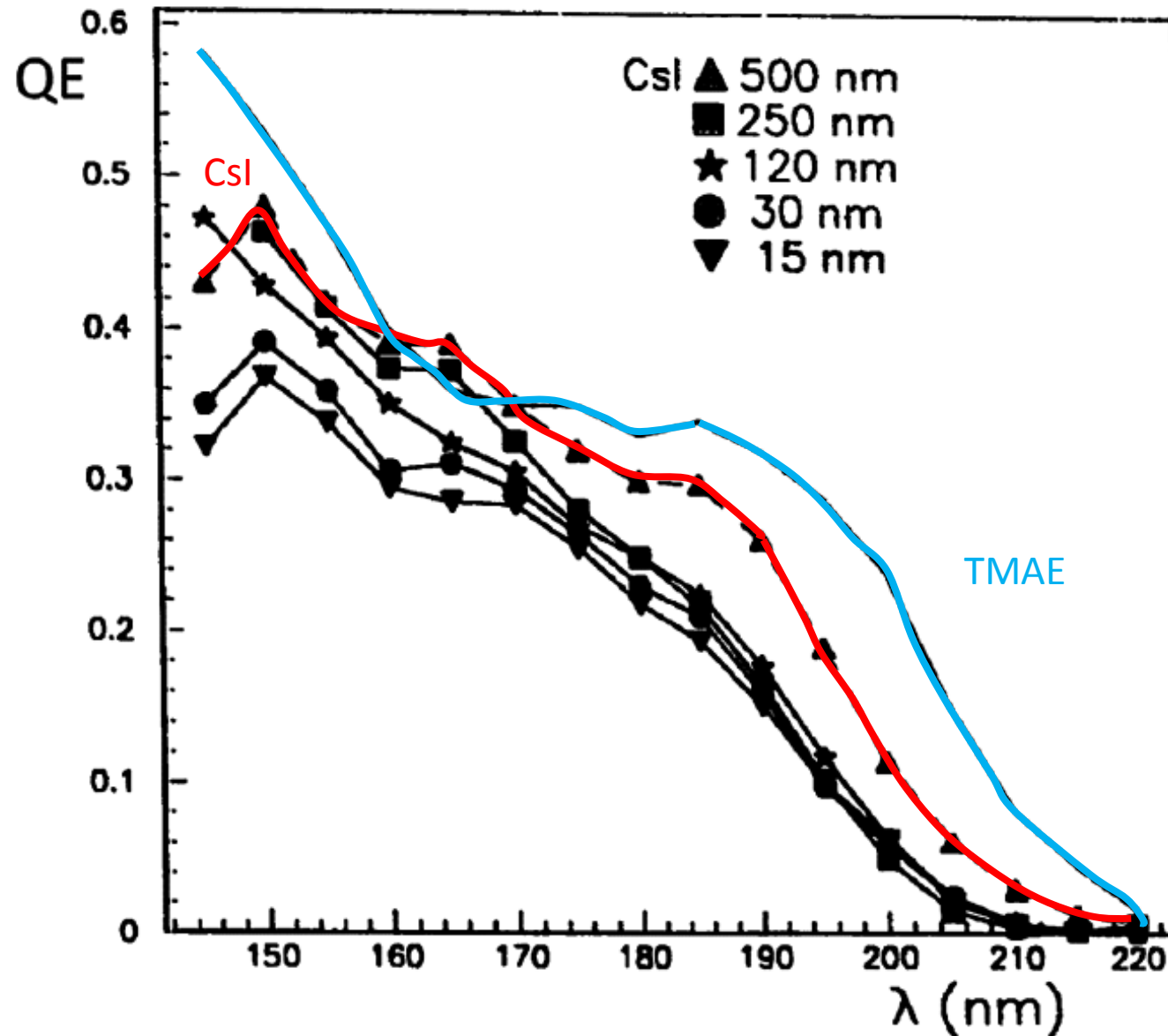


### 3. Search for air-stable solid photocathodes





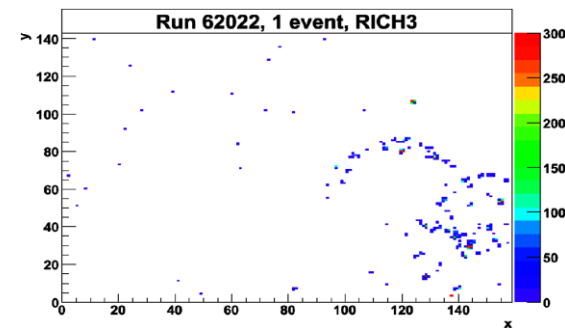
## 4. CsI photocathode



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.

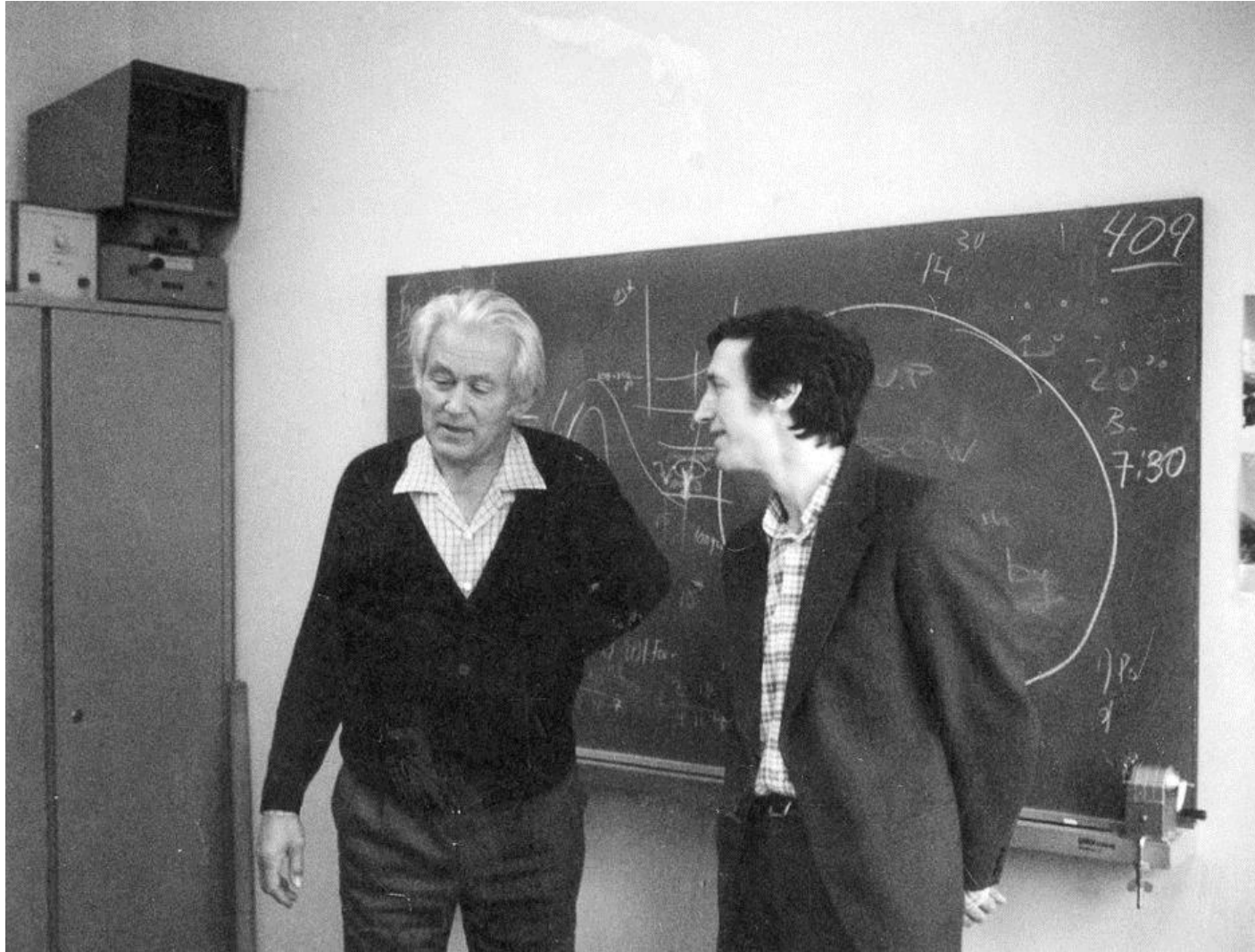
Feedback problem also exists , hut the electronics was improved with time , so the operation at lower gains becomes possible

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?

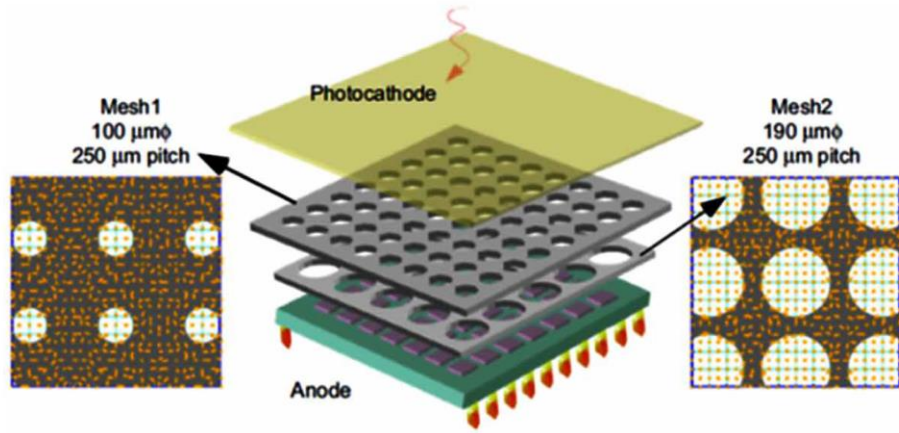


## Famous Charpak joke:

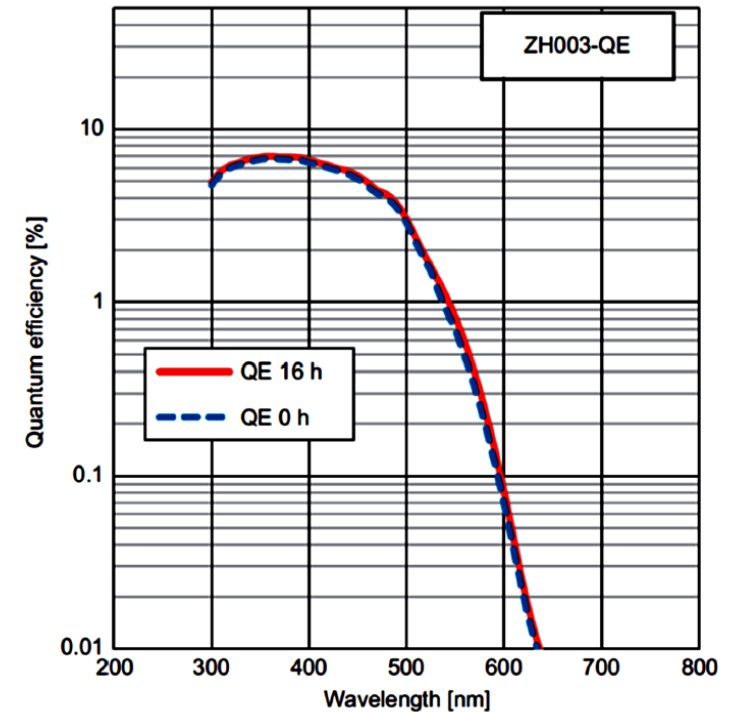
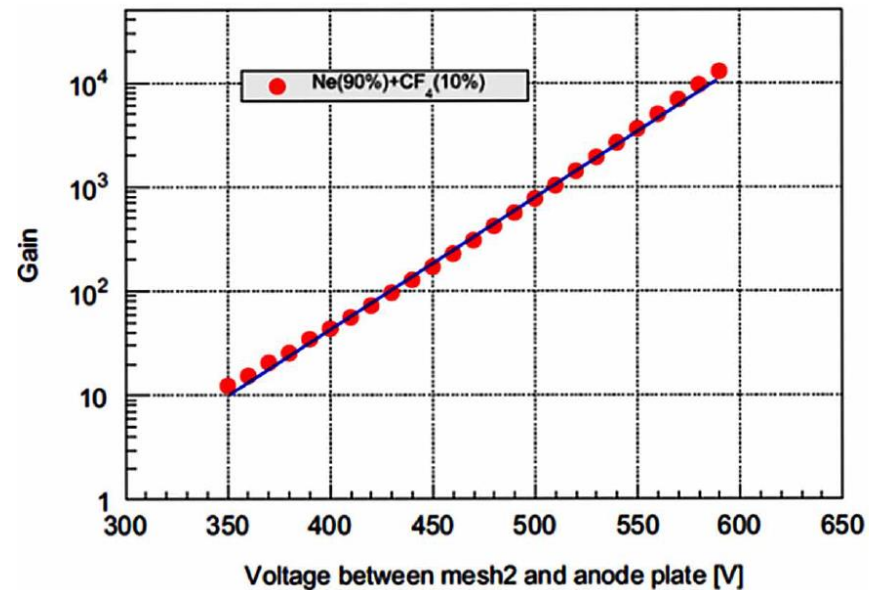
“The next Noble prize in the field of gaseous detectors will be given the persons who develop position-sensitive gaseous detectors sensitive to visible light”



# The progress

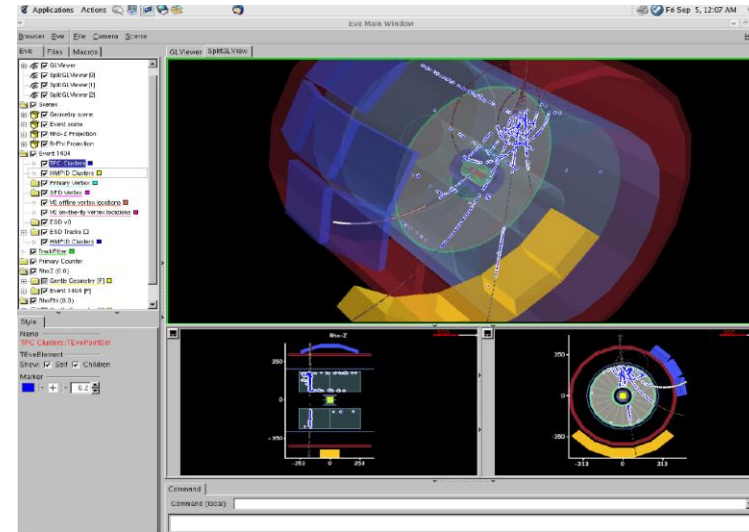
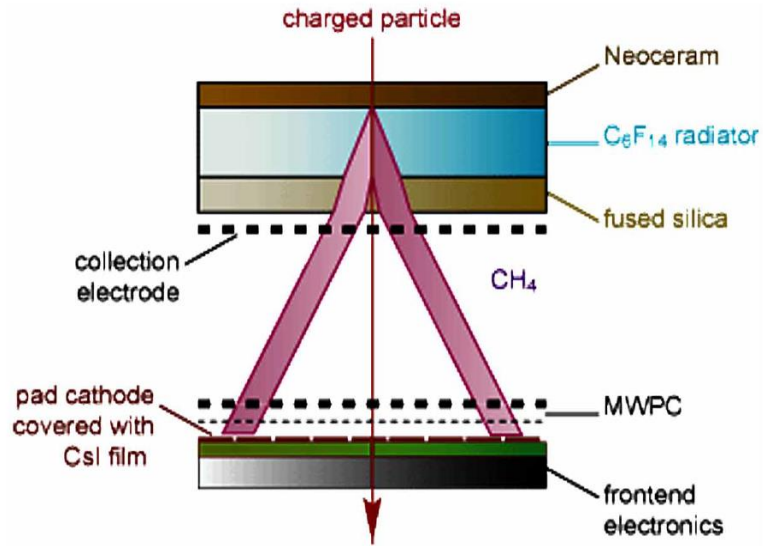


First Hamamatsu gaseous detectors sensitive to visible light had gains  $\sim 10$  now is  $\sim 10000$



# Applications

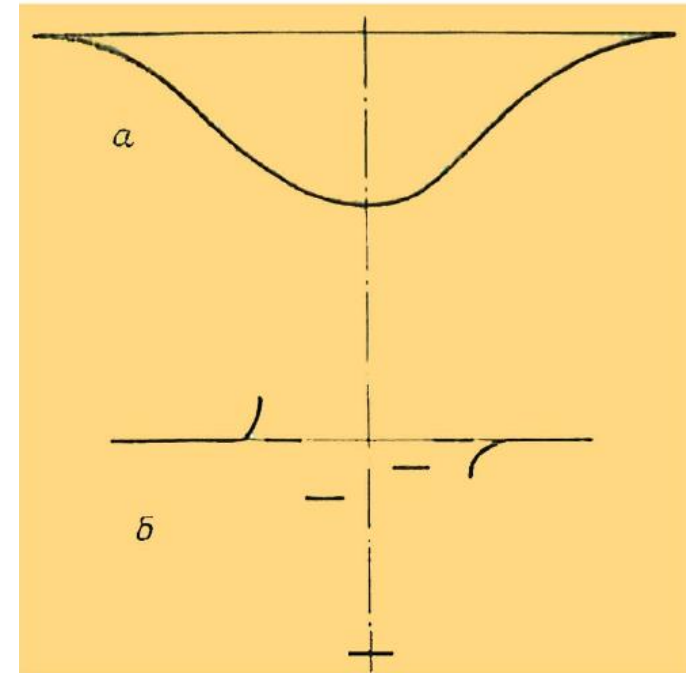
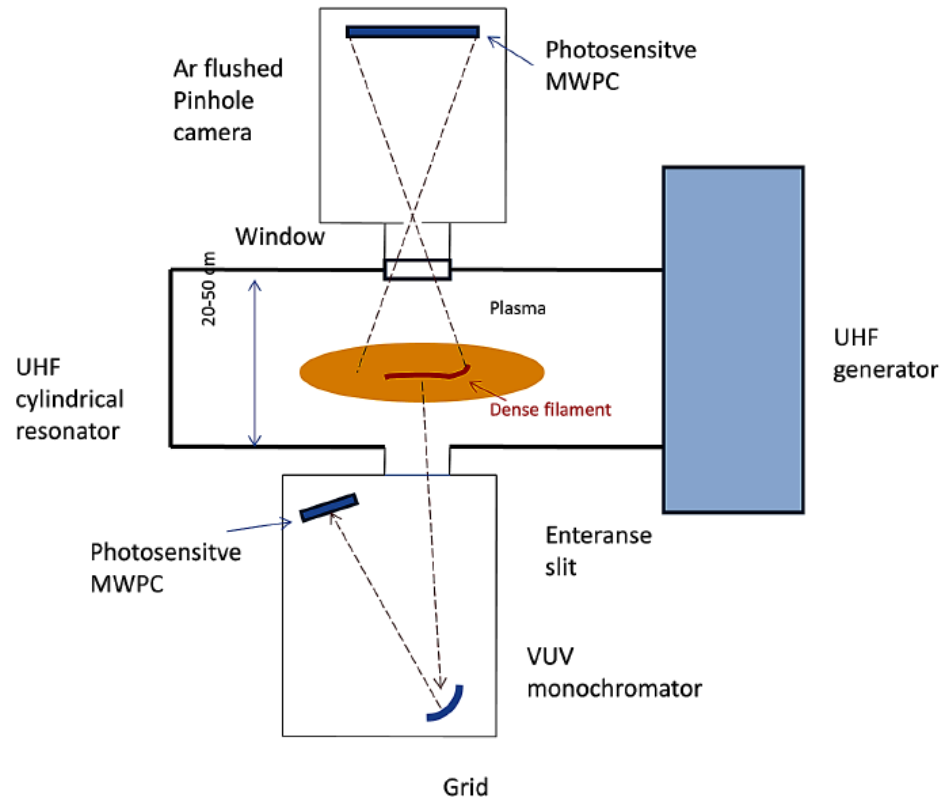
# The main application is, of course, RICH



Experiment-Lab	$3\sigma$ $\pi/K$ Separation Momentum Range (GeV/c)	Max Interaction Rate (Hz)	Radiator (Length)	CsI Active Area (m <sup>2</sup> )
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 etc





# 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

