



# Innovative Applications and Developments of Micropattern Gaseous Detectors

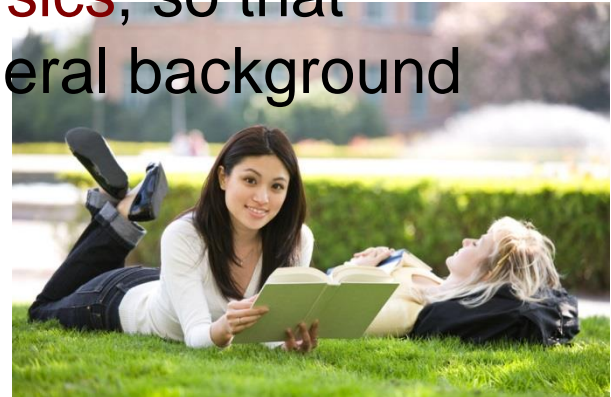
By Tom Francke (Myon, Sweden)  
and Vladimir Peskov (CERN, Switzerland)

Released in April 2014

<http://www.igi-global.com/book/innovative-applications-developments-micro-pattern/97377>

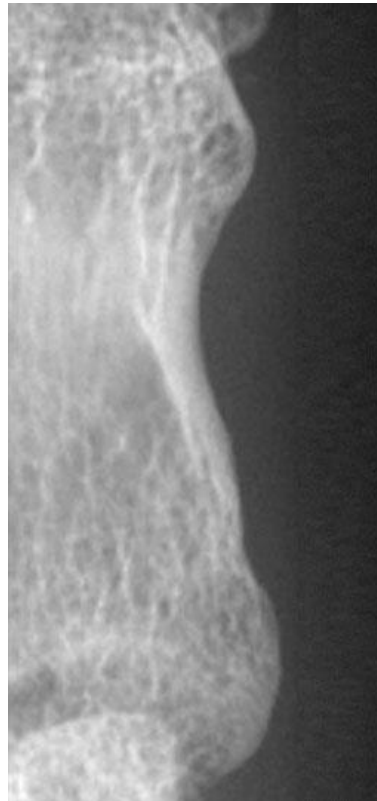
The book is oriented on newcomers to this fields: students, engineers, physicists

Consequently, we tried to present the subject in a systematic, but simplified way with a main focus on **physics**, so that newcomers can obtain a general background



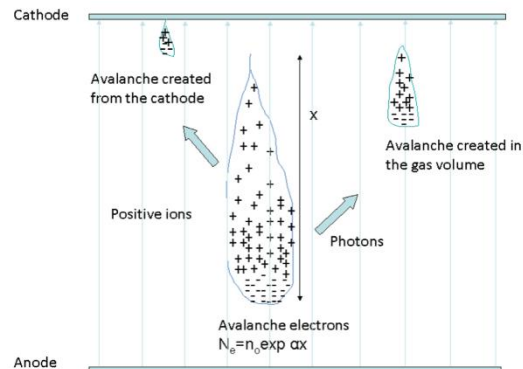
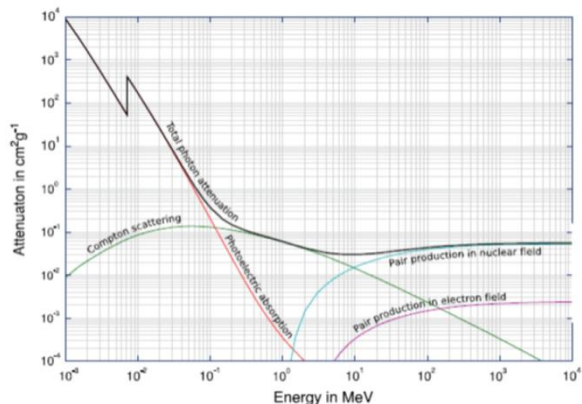


Tom Francke, an experimentalist, worked at CERN, a professor of the KTH, Stockholm, a former director of the XCounter AB, which developed various micropattern detectors for medical applications. We know each other and closely worked together for many years



# The book content

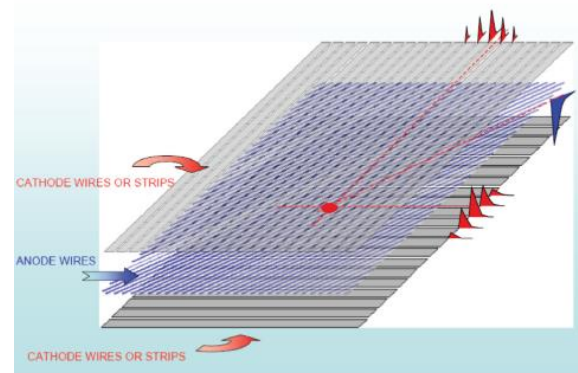
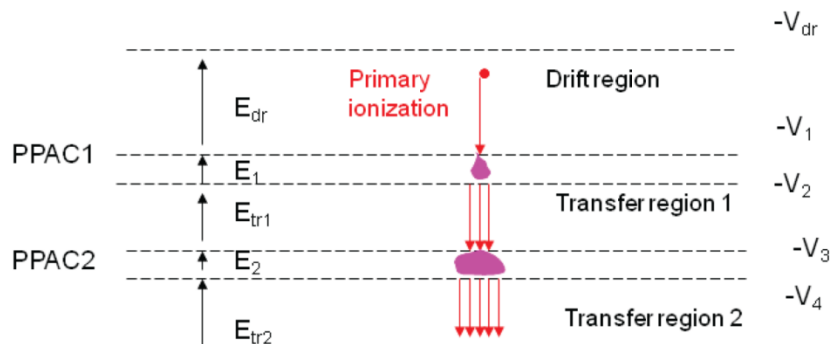
The book consist from 12 Chapters ( 303 pages)



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Anton Oed

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..."it will never work!.."



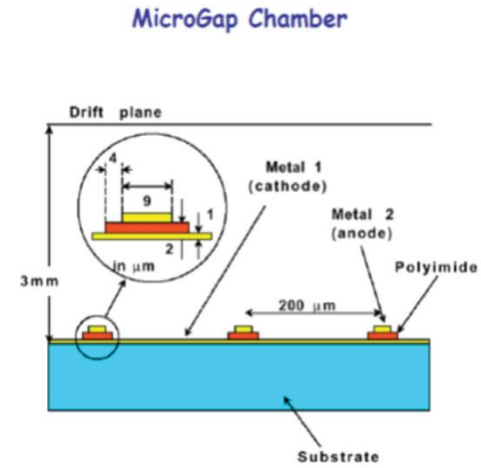
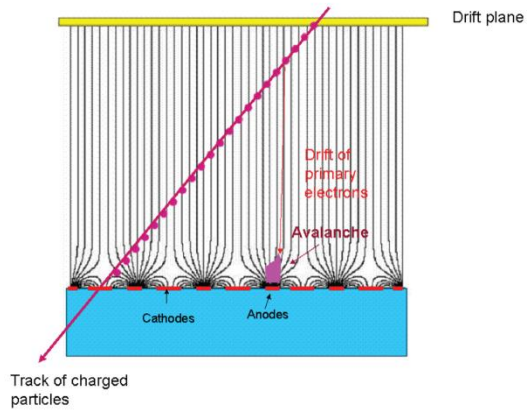
# The time shows, however that A.Oed made a revolution contribution

He was the first who applied microelectronic technology for manufacturing gaseous detectors His invention triggered a chain of other similar developments performed by various groups. Due to the contributions from a large community of physicists, nowadays united by the [CERN RD-51](#) collaboration, micropattern gaseous detectors are currently in a stage of very fast development and are starting to be used in many applications: from high-energy physics experiments to medicine and homeland security

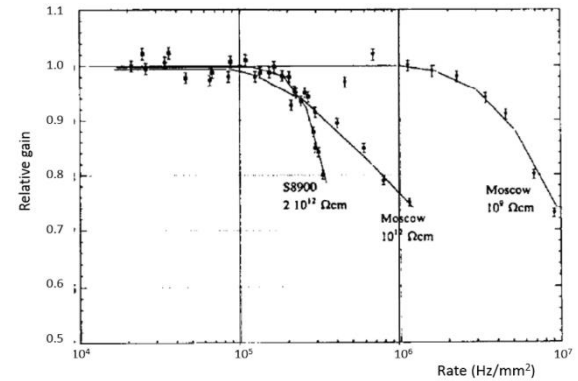
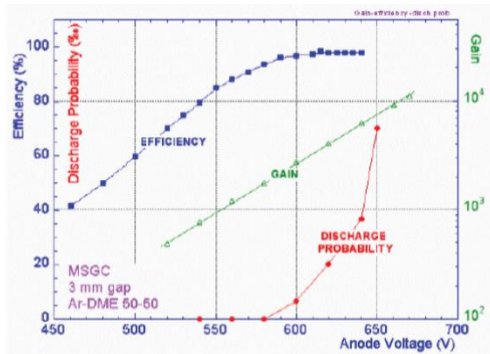


# Highlights

## 1. Designs and manufacturing

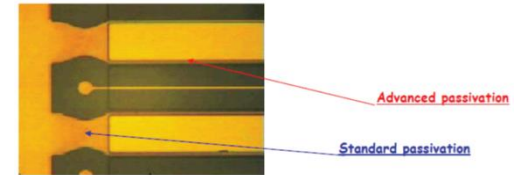
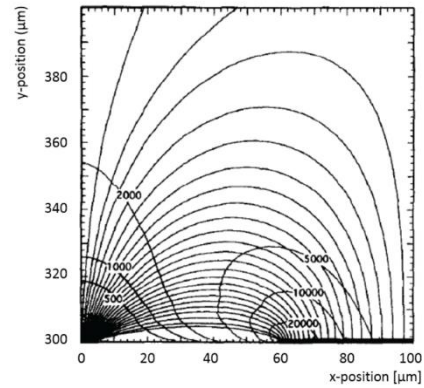
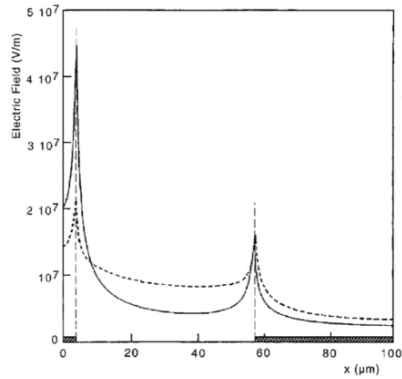


## 2. Gas gain, stability

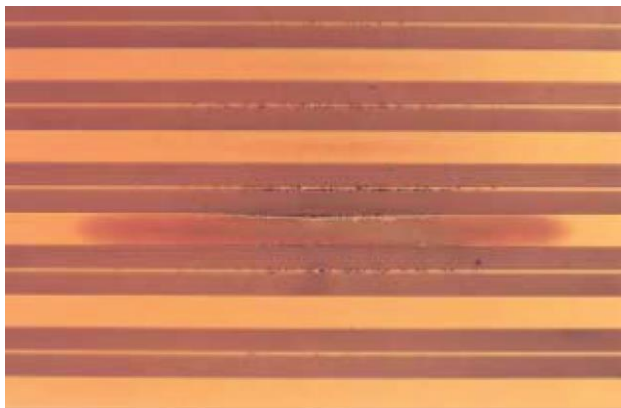




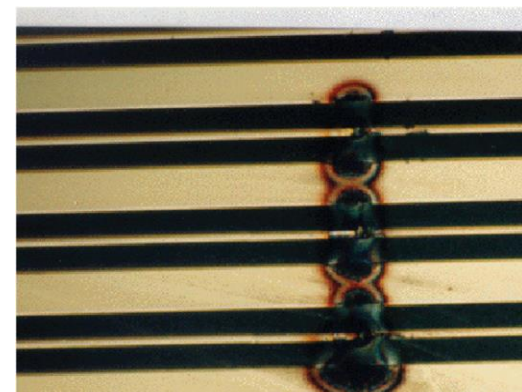
### 3. Physics: Raether limit, edge effects



### 4. Aging

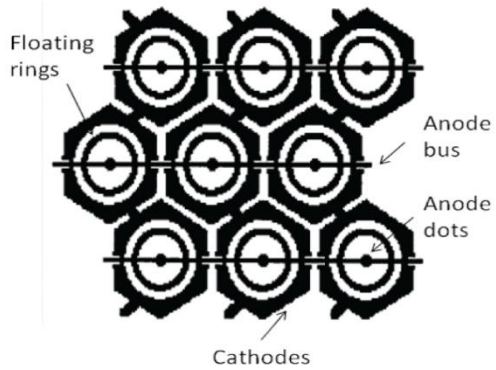


### 5. Sparking, destructions...



Looking back to Charpak's skeptical notes about MSGCs, one have to admit that in many respects he was absolutely right. As he foresaw, the first designs of MSGCs suffered from charging up effects and they could be easily be destroyed by sparks.

However, by the hard work of a large community of scientists ([RD28](#)) most of these problems by a step by step approach has been successfully solved.

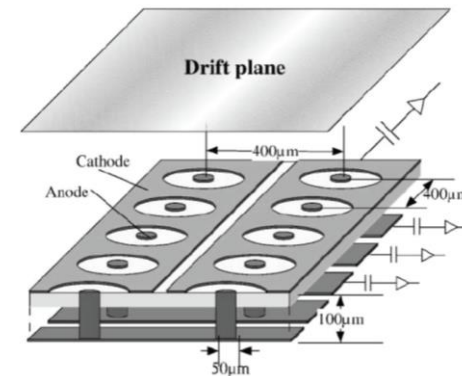


S.F. Biagi, et al., NIM A361, 1995, 72

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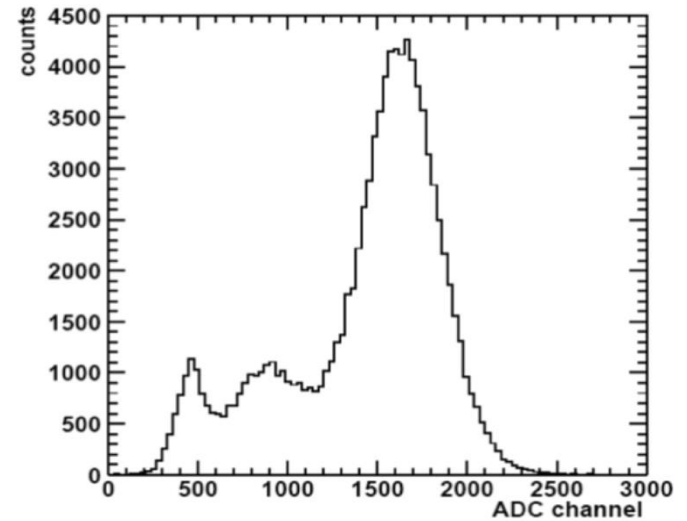
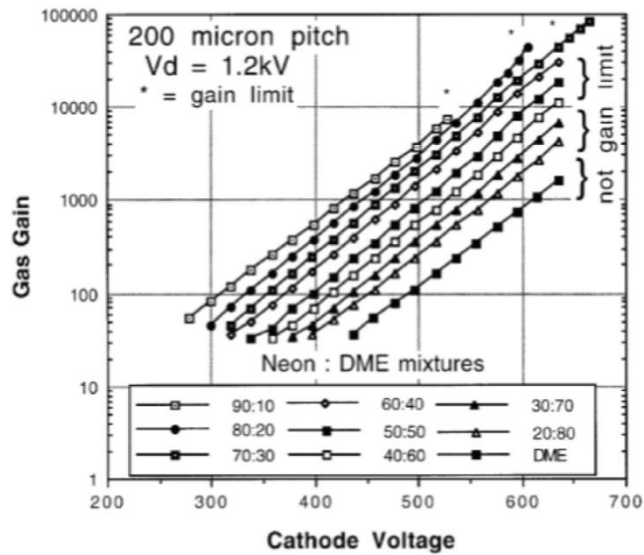
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A.Ochi, A., et al., NIM., A471, 2001, 264

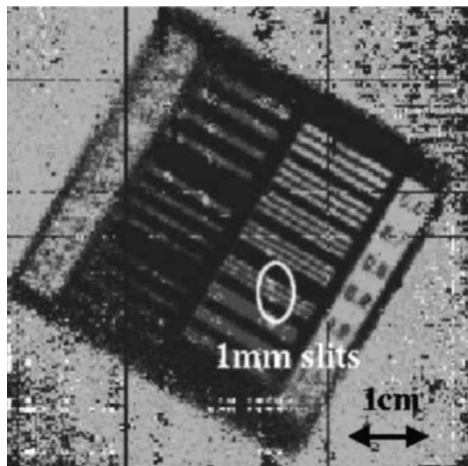


# Highlights

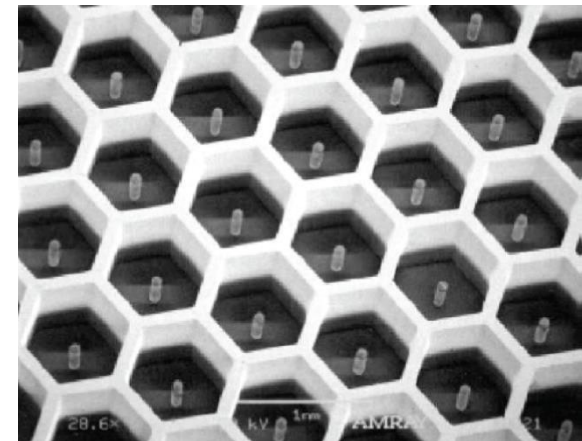
## 1. Performance

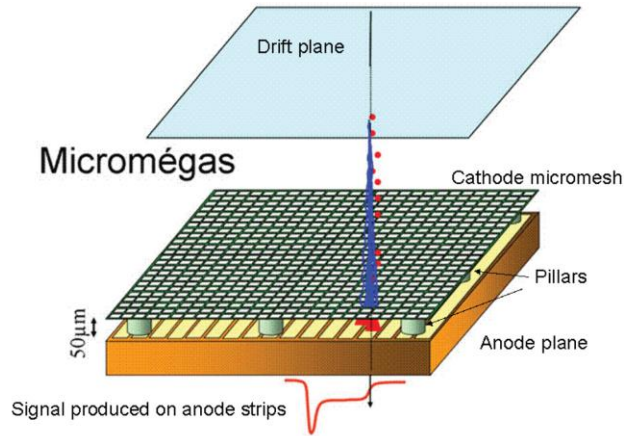


## 2. Imaging capability



## 3. Potentials...





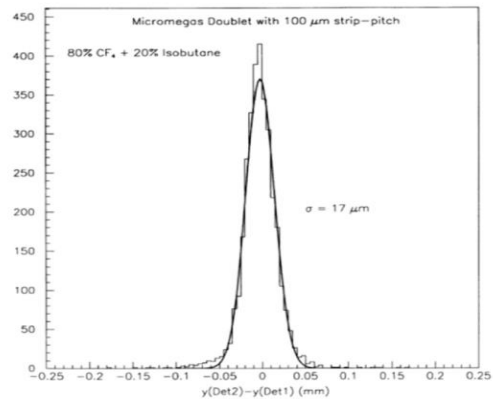
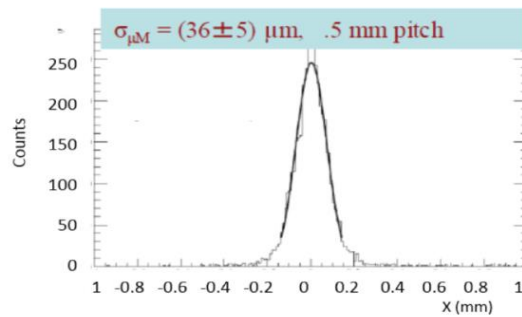
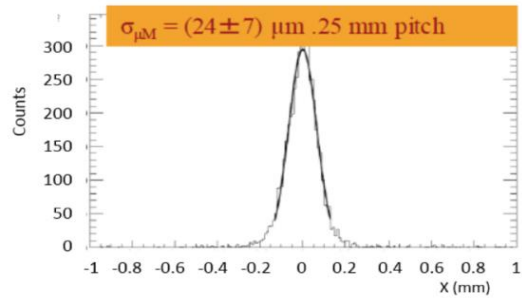
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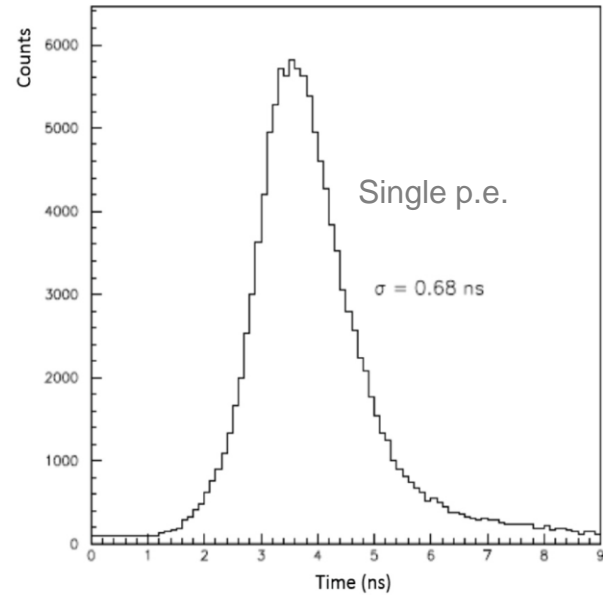
...As philosophers say:  
 “Transition of quantity to quality”

# Highlights

## 1. Position resolution

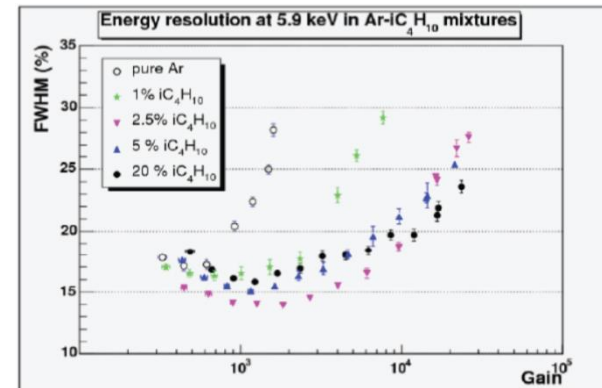


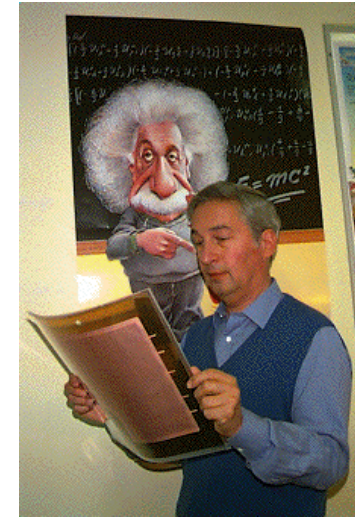
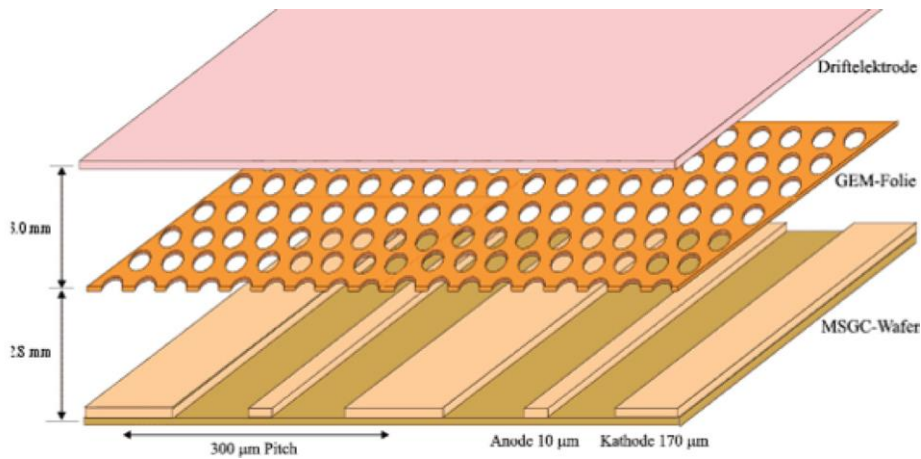
## 2. Time resolution



~5 ns with  
Charged  
particles

## 3. Energy resolution



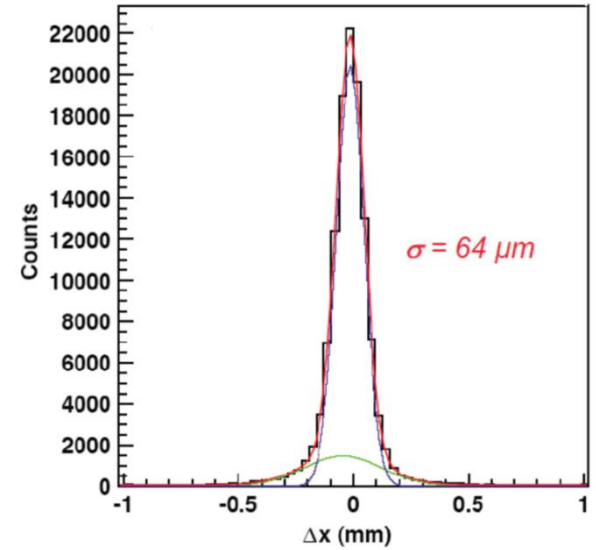
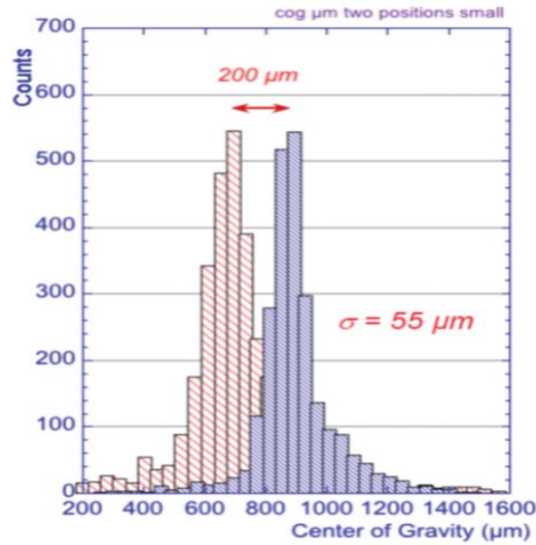


## Chapter 5

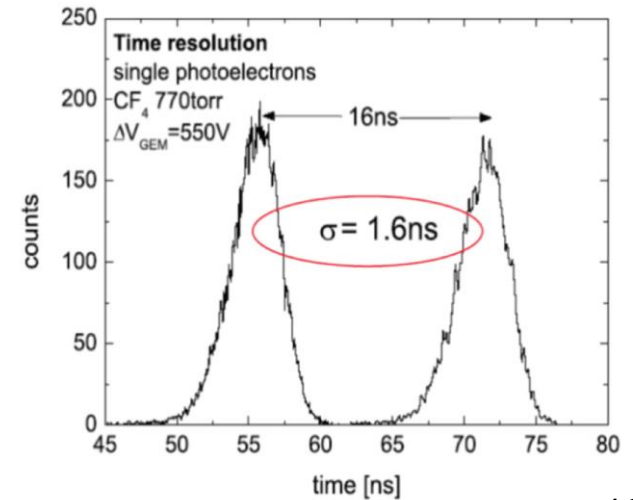
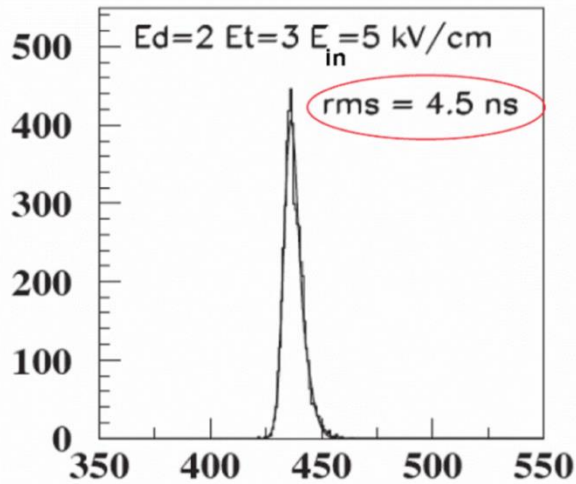
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# Highlights

## 1. Position resolution



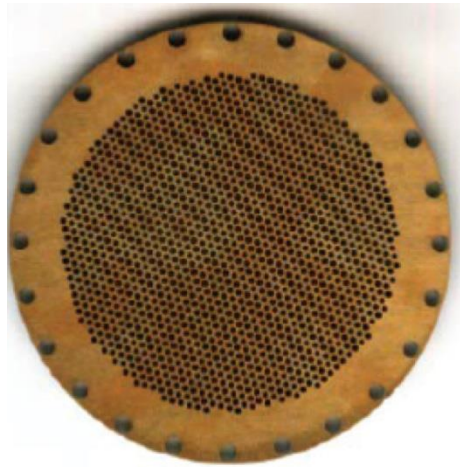
## 2. Time resolution



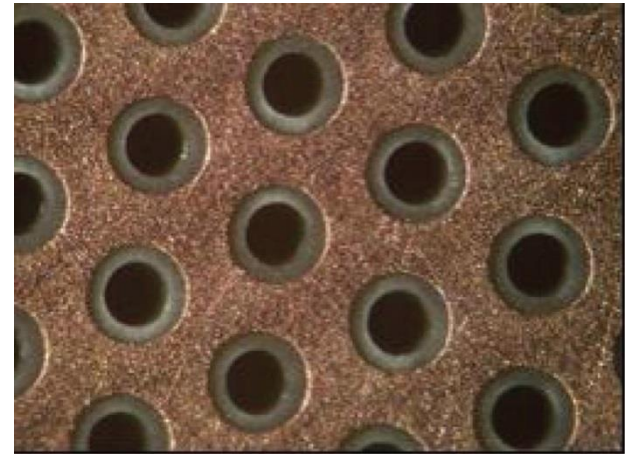
One of the unique features-operation in cascaded mode



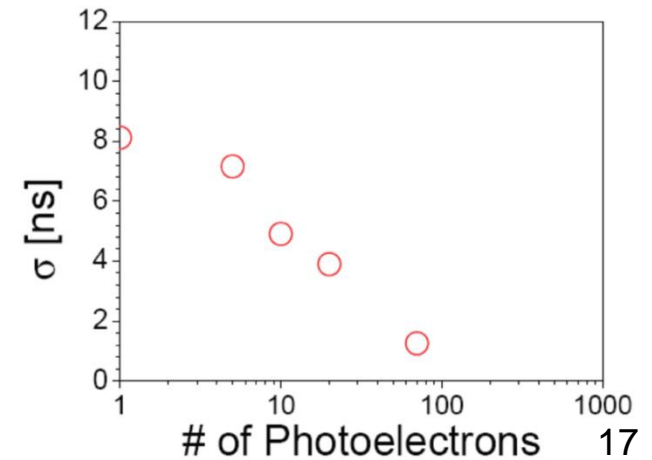
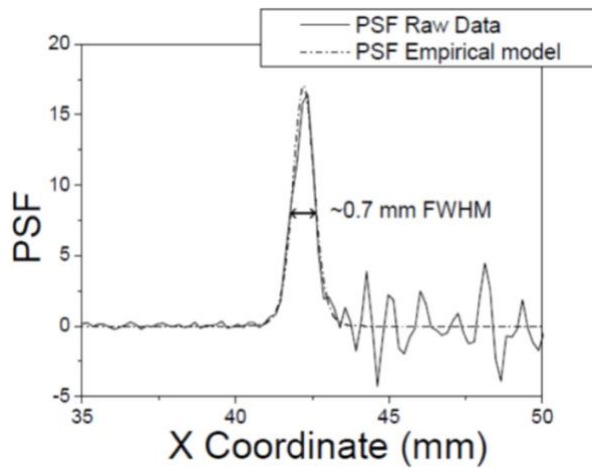
# THGEM (attractive for some applications)

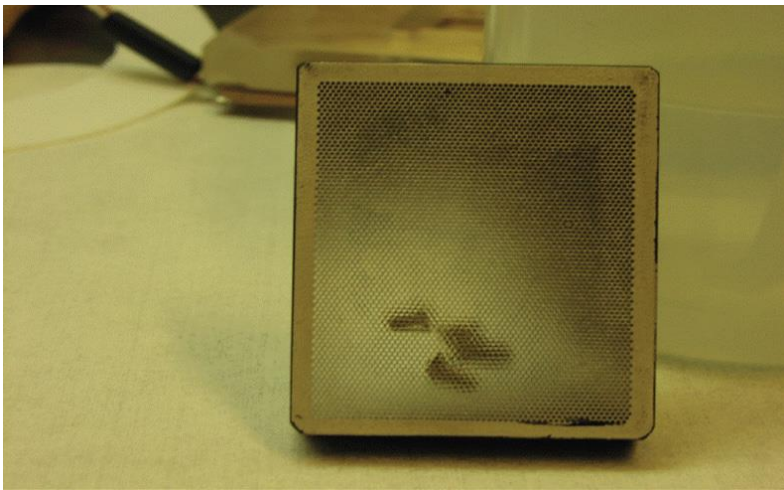


L. Periale, et al. *ArXiv, Physics/0106048*, 2001



C. Shalem, et al. (2006). *NIM, A558*, 2006,475



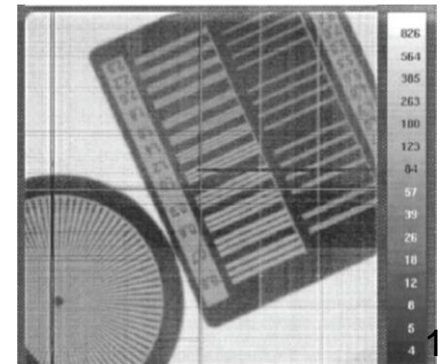


Del Guerra

## Chapter 6

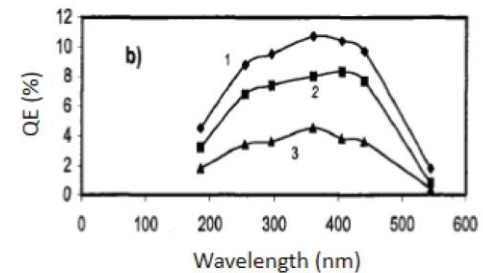
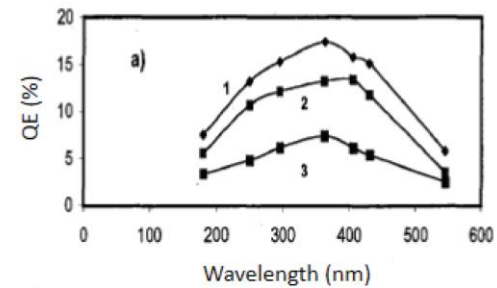
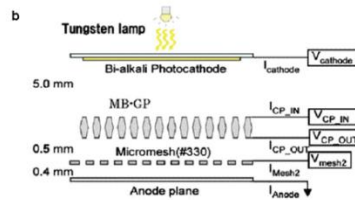
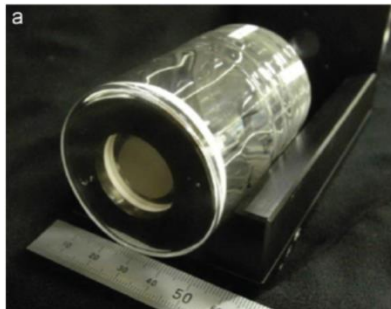
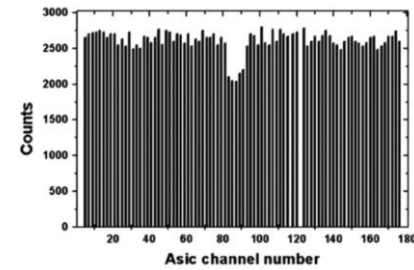
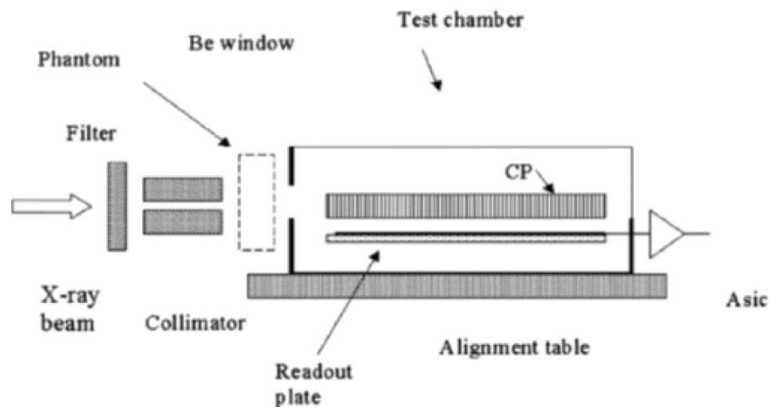
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Sakurai, Ochi...



# Highlights

Field of applications: as a convertor or as a detector in ultraclean conditions

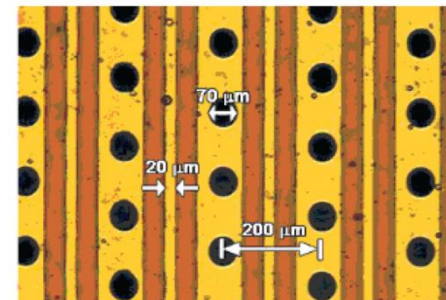
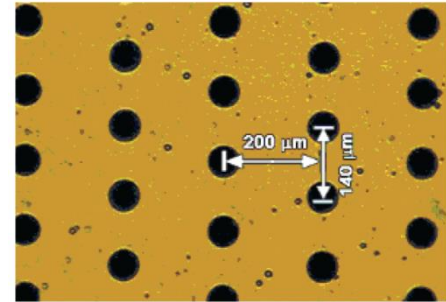
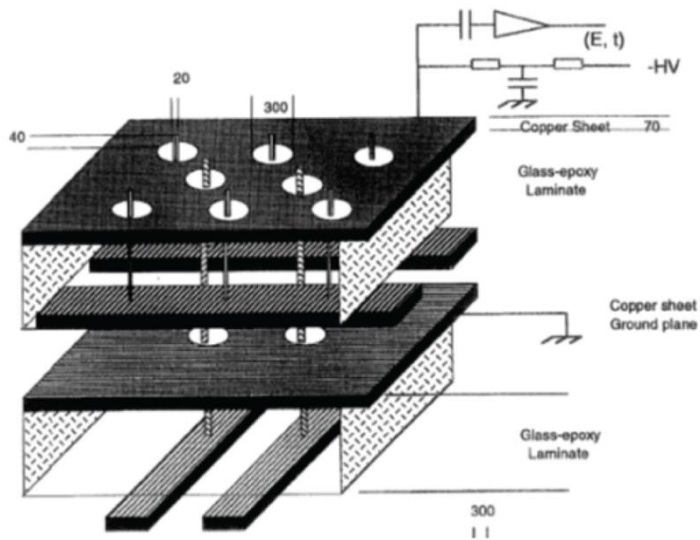
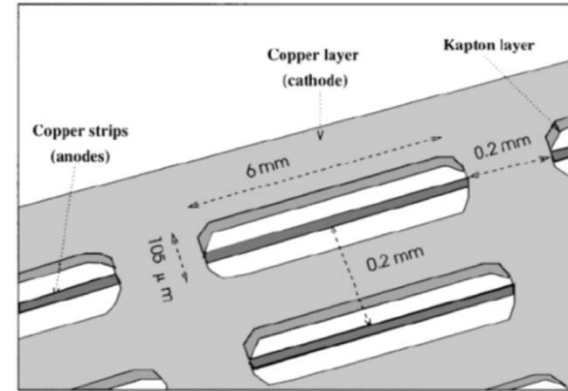
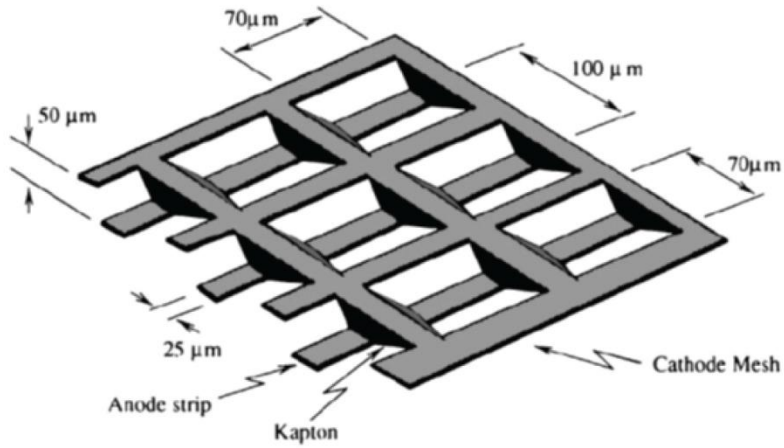


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A. Oed invention excited imagination of physicists...

# Highlights

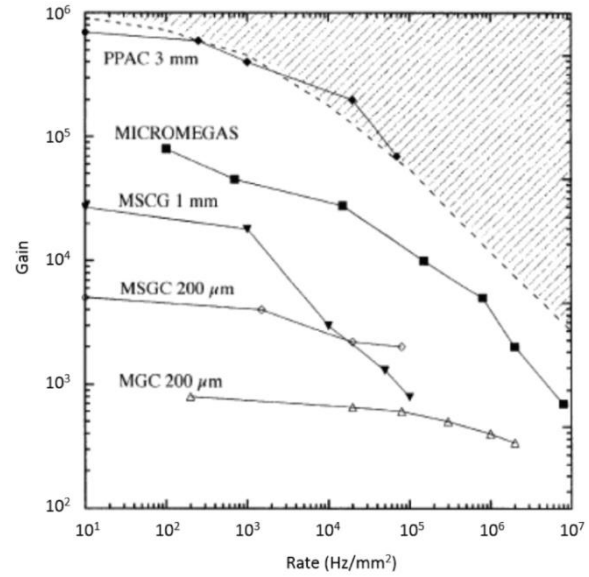
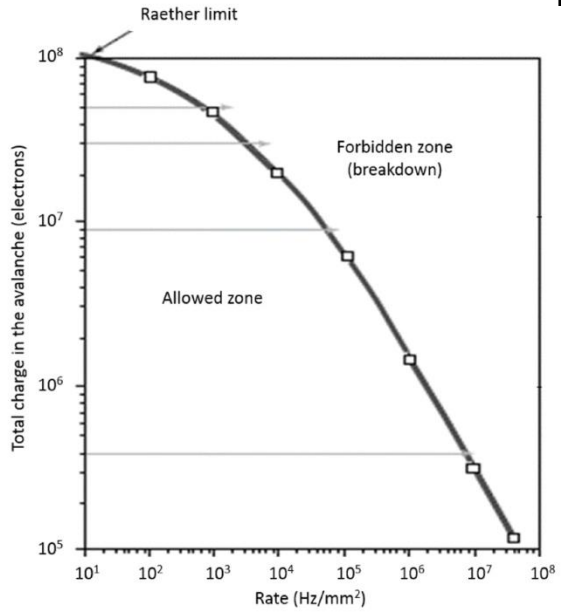


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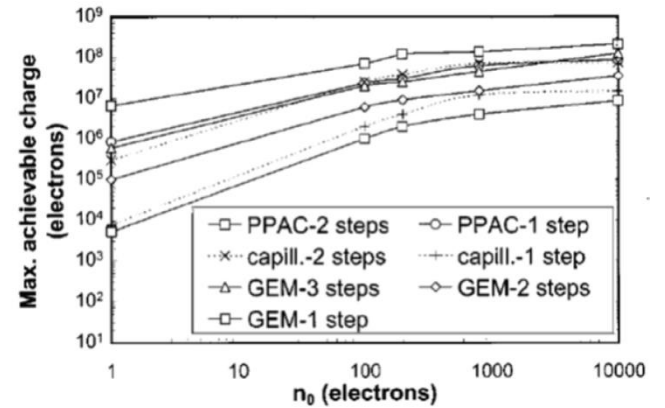
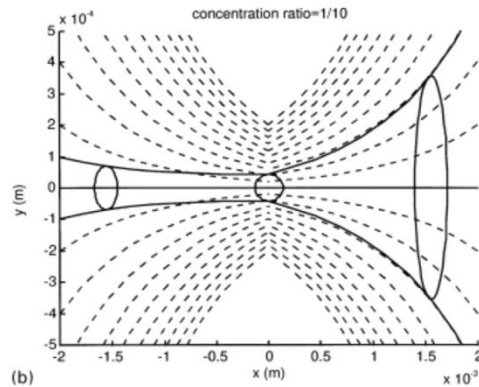
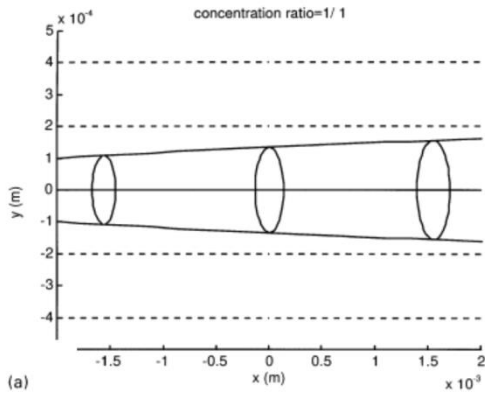
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# Highlights

## 1. Raether limit and rate effect

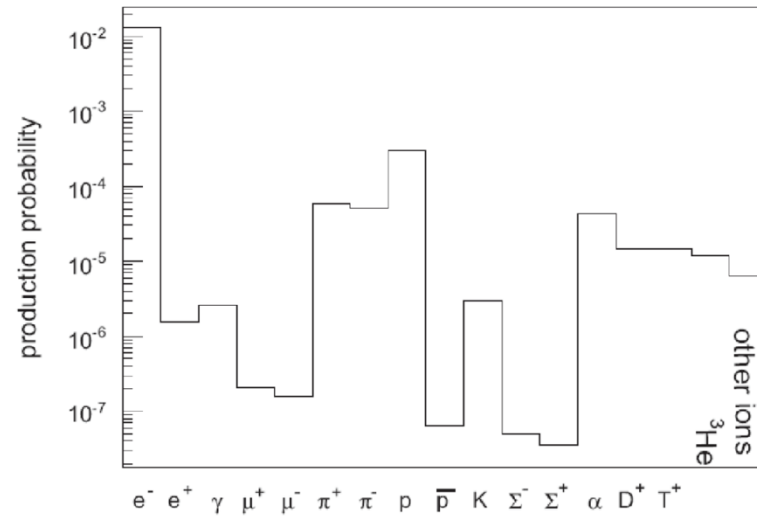
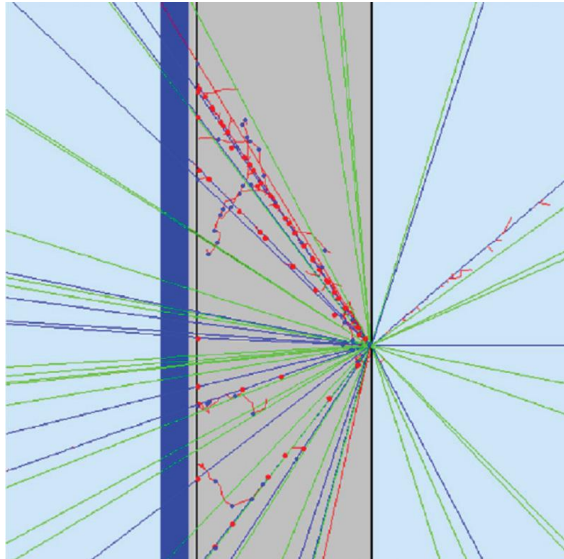


## 2. Raether limit and diffusion



(See yesterday discussion at the RD-51/TPC meeting)

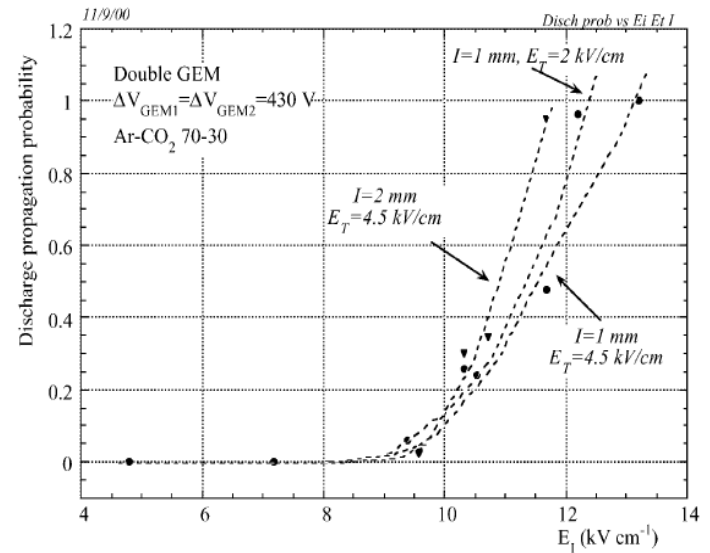
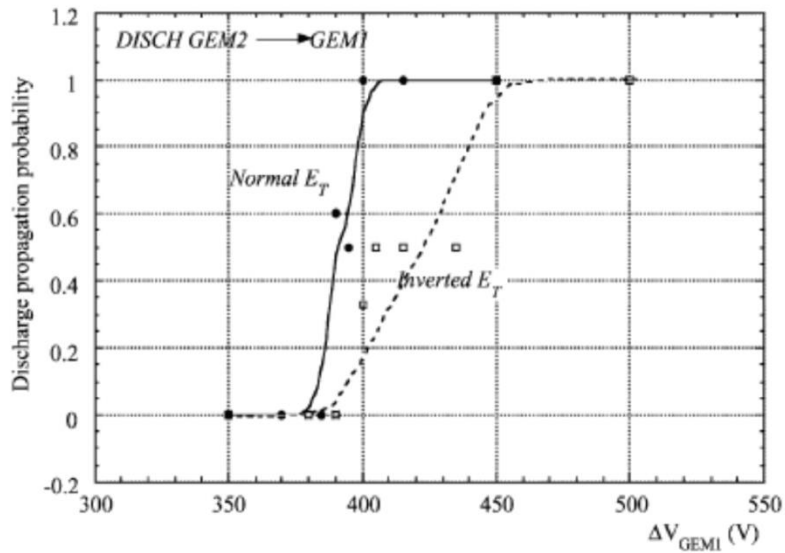
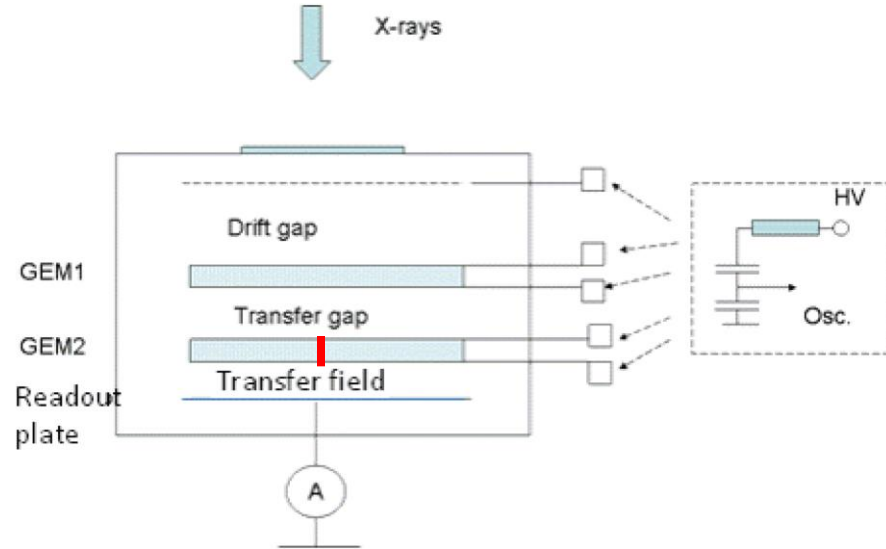
### 3. Sebastian model and calculations



(also discussed yesterday during RD-51/TPC meeting)



## 4. Discharge propagations

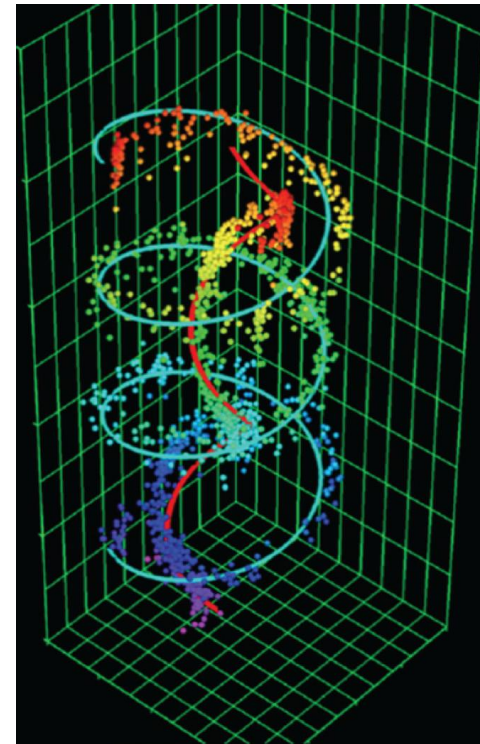
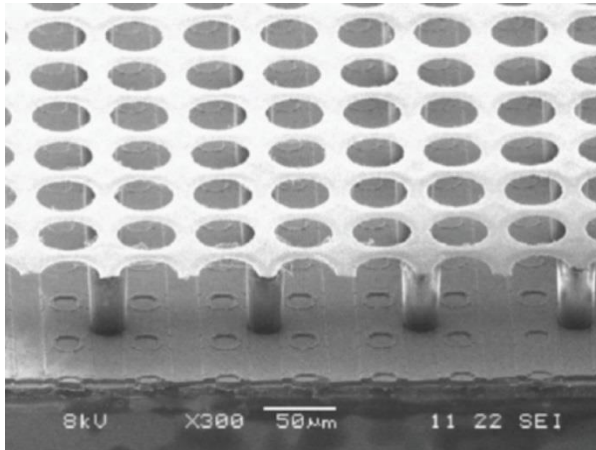
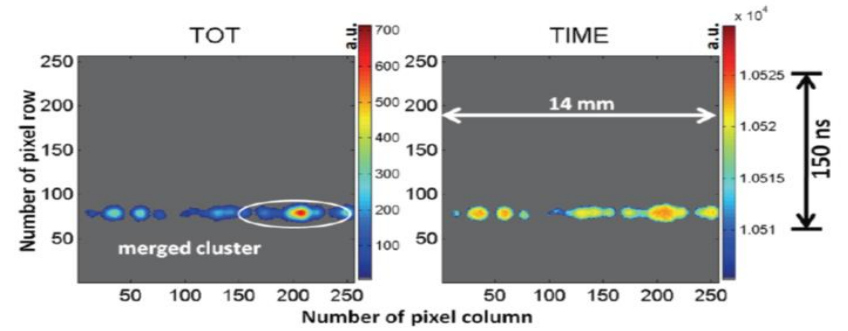
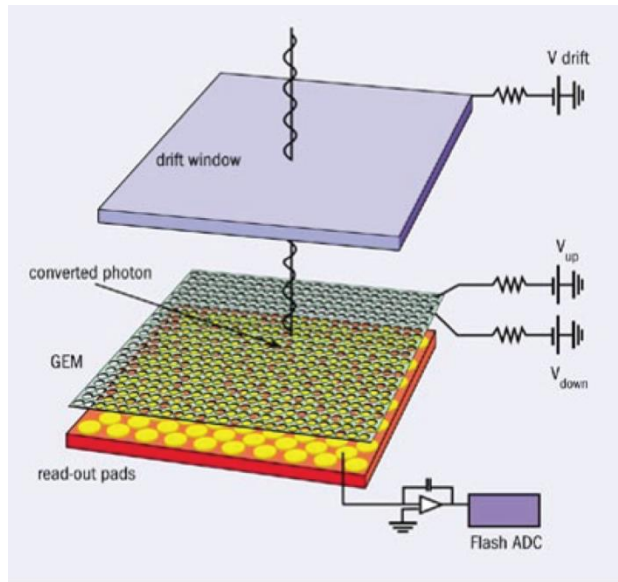


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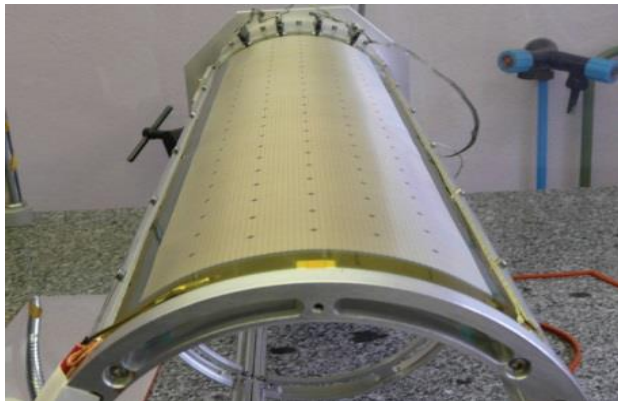
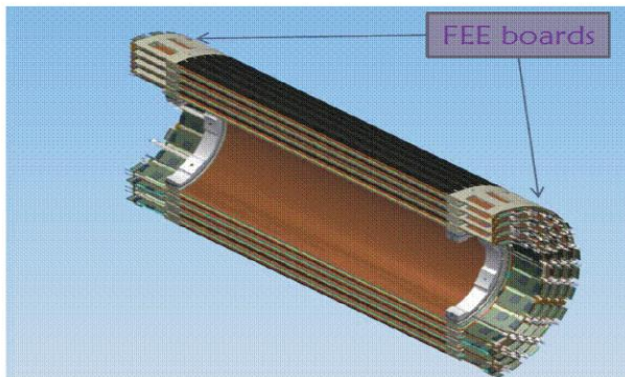
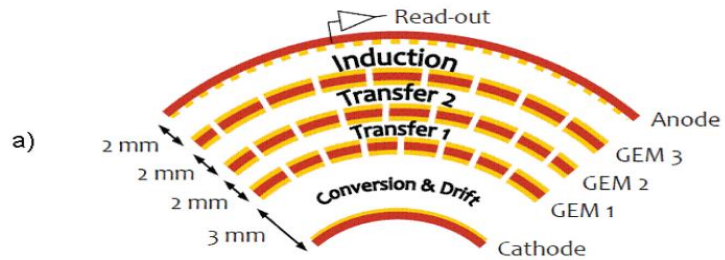
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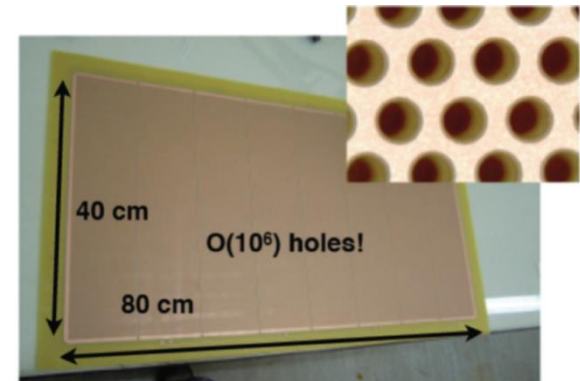
## 1. Pixelized readout (Timepix, Medipix..)



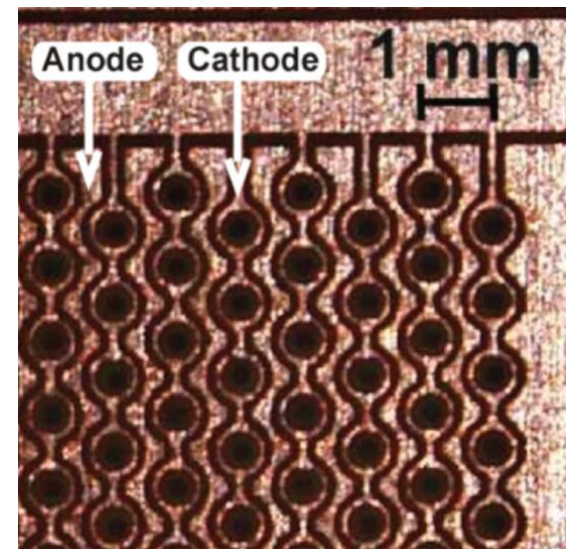
## 2. Curved detectors



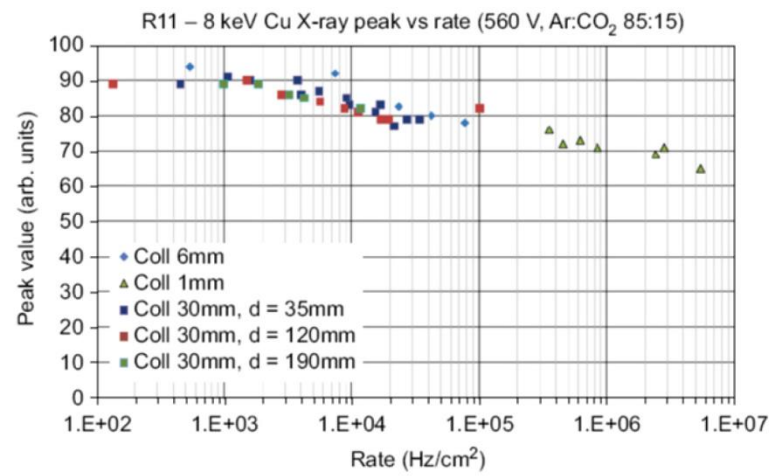
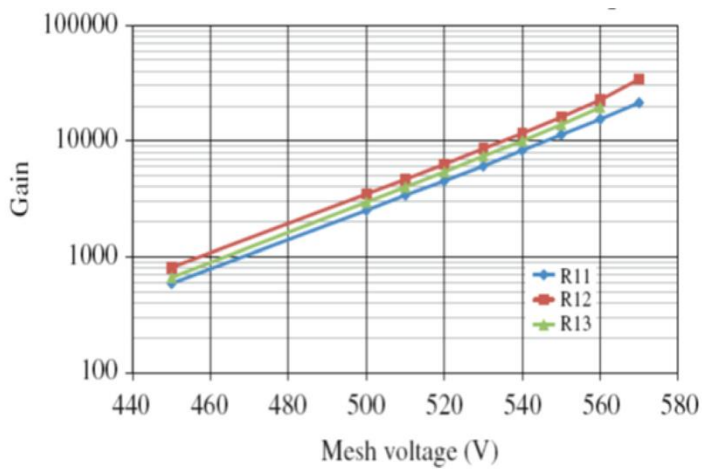
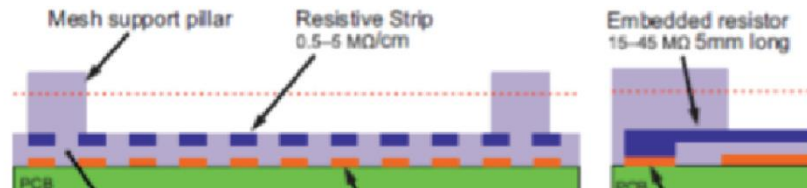
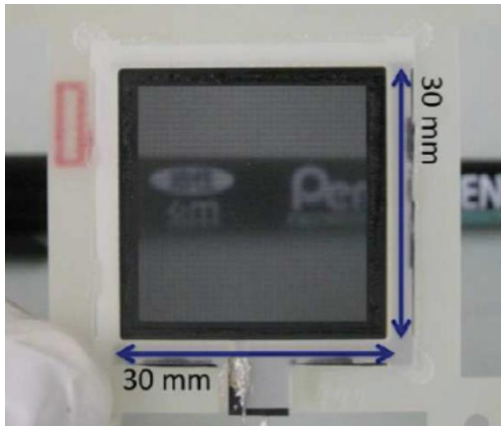
## 3. Large-area detectors

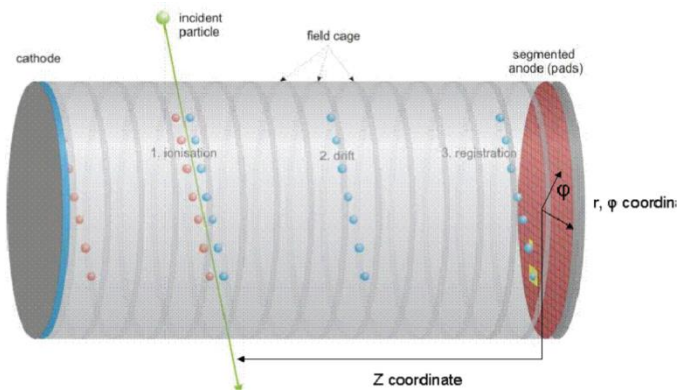


## 4. ThCOBRA



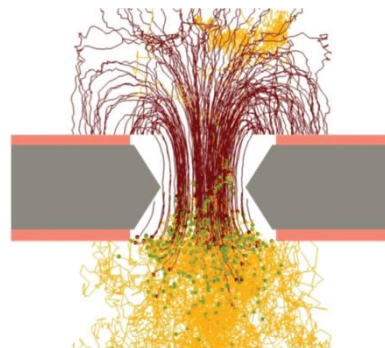
#### 4. Resistive, spark-protected detectors





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This chapter summarises what is known up to now.

It well overlaps with yesterday “IBF suppression section”



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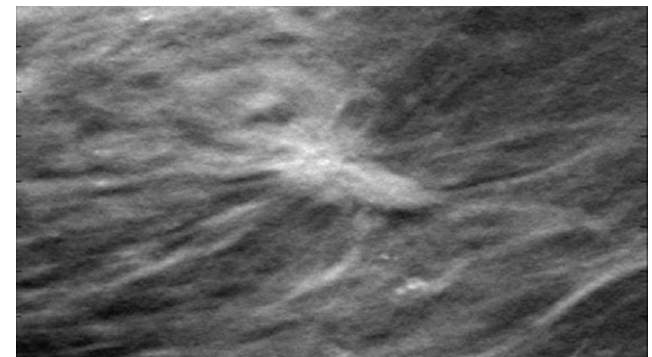
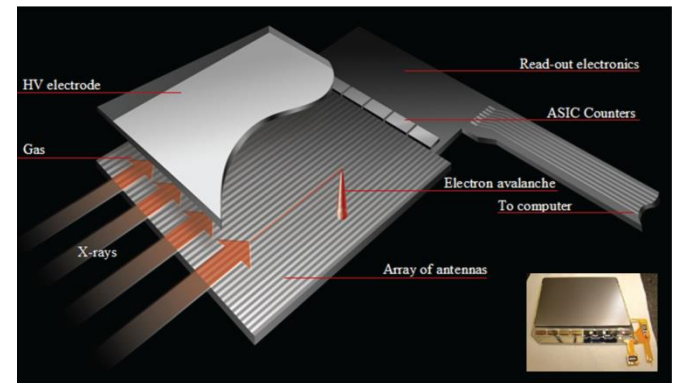
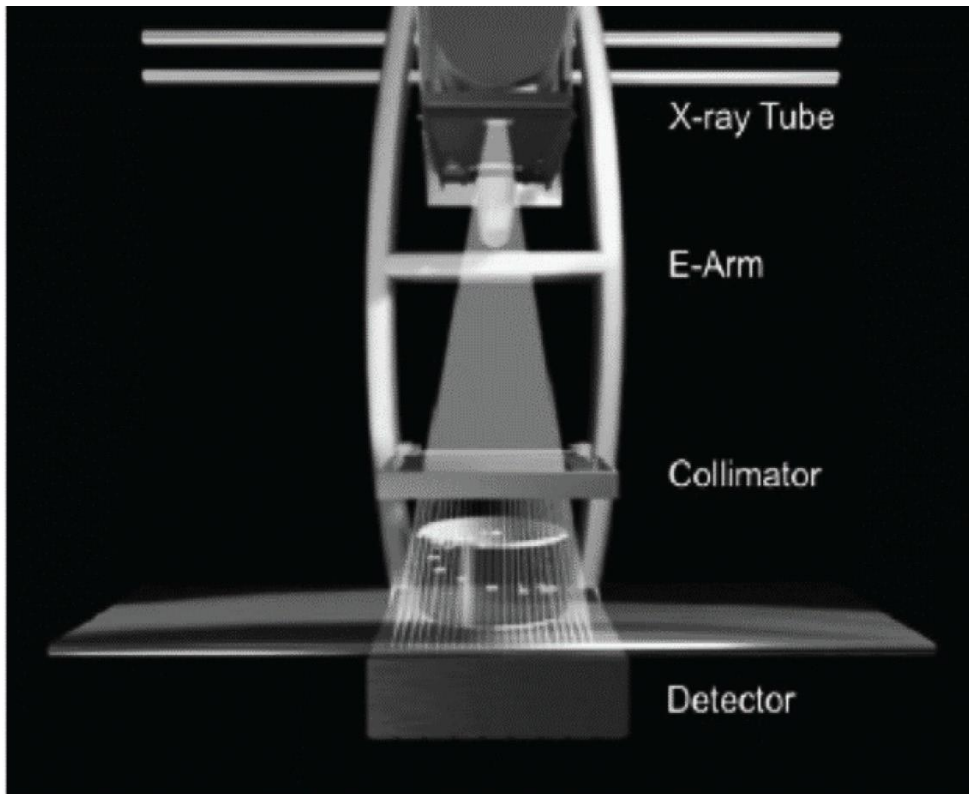
The Main/Most Promising Designs of Micropattern Detectors	Raether Limit (electrons)	Position Resolution ( $\mu\text{m}$ )	Energy Resolution (%FWHM for 6 keV photons)	Time Resolution (Measured with Charged Particles) (ns)	Rate at Gain of 1000 (Hz/ $\text{mm}^2$ )	Commercially Available Sizes ( $\text{cm}^2$ )
MSGC	$-10^6$	35	10.7		$10^6$	30x30
Pixel and microdot	$10^6$ - $10^7$	200-400	30			10x10
MICROMEAS	$10^6$ - $10^7$	36 (14 -only in $\text{CF}_4$ )	12	5 0.7 (with light)	$3 \times 10^6$	50x150
Microgap RPC for medical imaging	$-10^7$	30-50				10x10
Capillary plates	$-10^6$	90	26		70 (ordinary glass) and $10^3$ with H treated)	10x10
GEM/ triple GEM	$-10^6/10^7$	64	20	-5	$-10^3$	50x150
TGEM	$-10^7$	300	21	-10	$10^3$ without rims	30x30
RMSGC	$-10^6$	<200	23			10x10
RETGEM	$10^7$		25-27		$\sim 10^2$	10x20
Res. GEM	$2 \times 10^4$					5x5
RMICROMEAS	$10^6$ - $10^7$	64		5	$-10^2$	Up to 100x220
Res. Multigap-multistrip	$-10^7$	38		0.044	-30	8x8

## Chapter 12

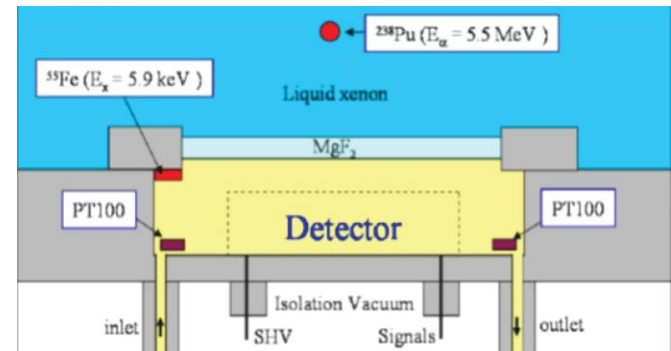
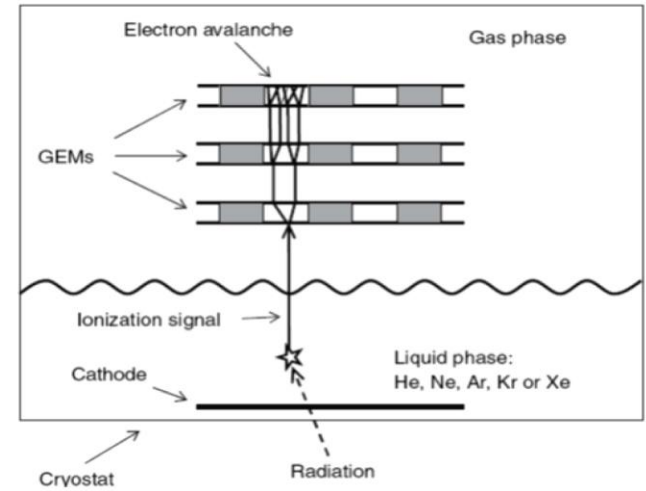
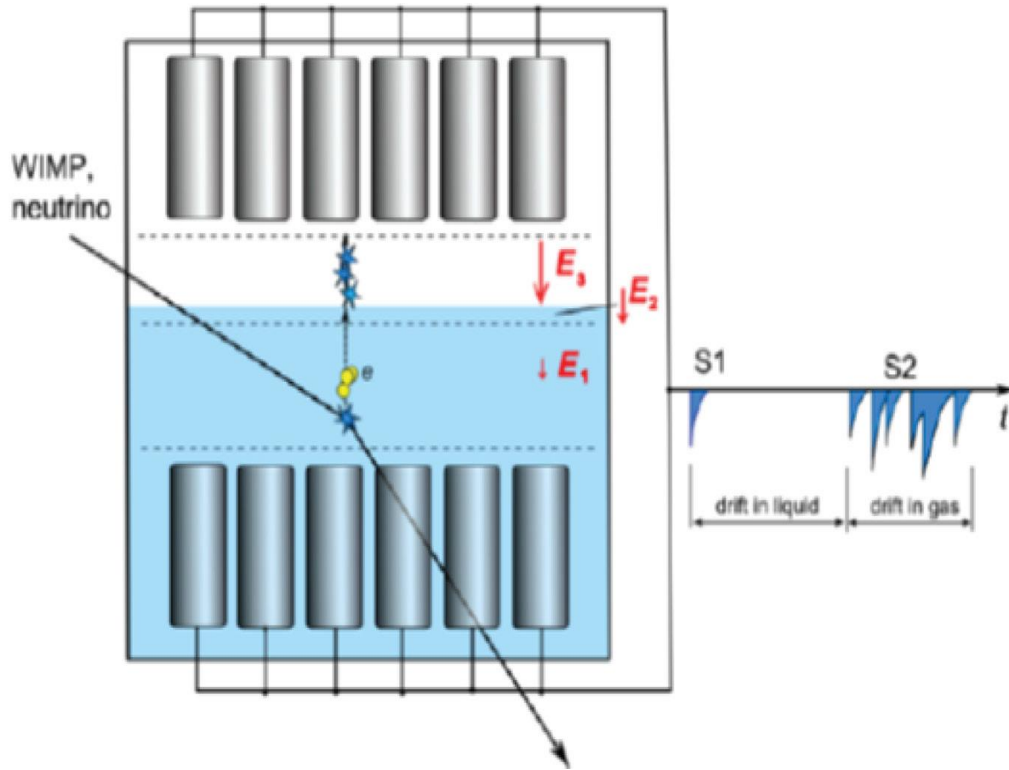
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## Highlights: some innovative applications

### 1. Low dose mammographic scanner

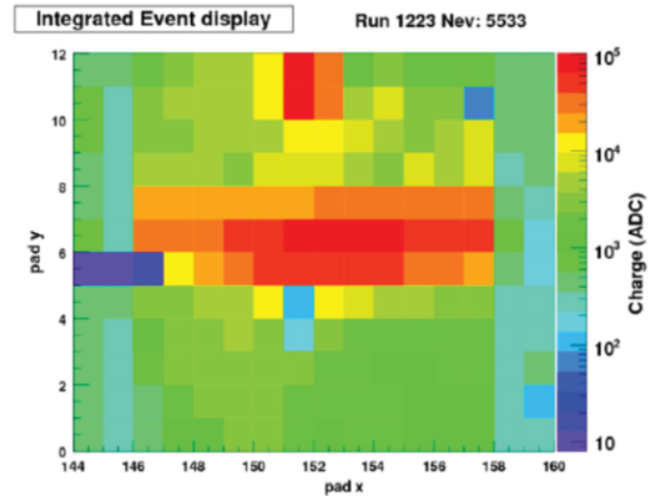
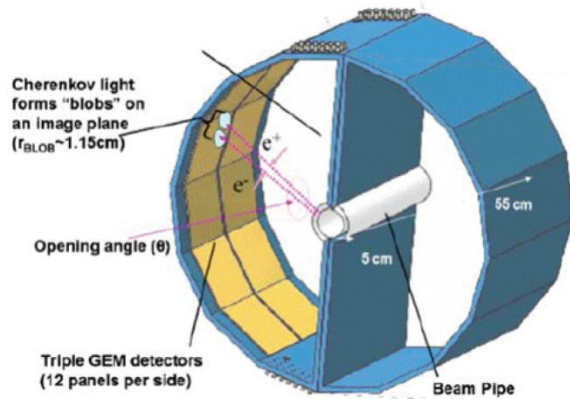


## 2. Cryogenic detectors

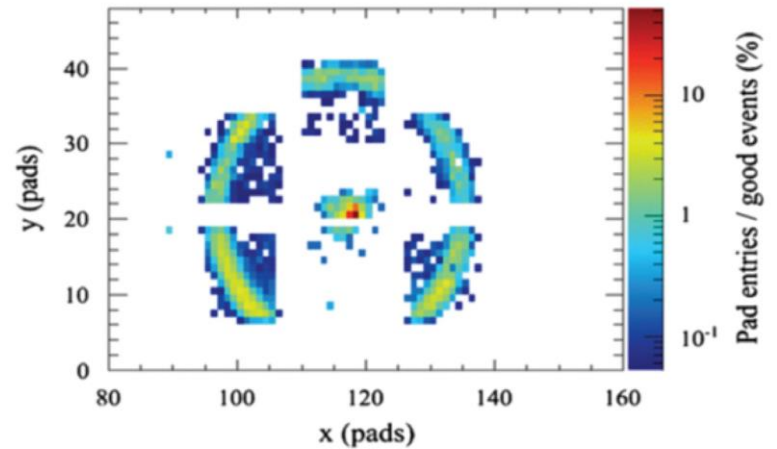
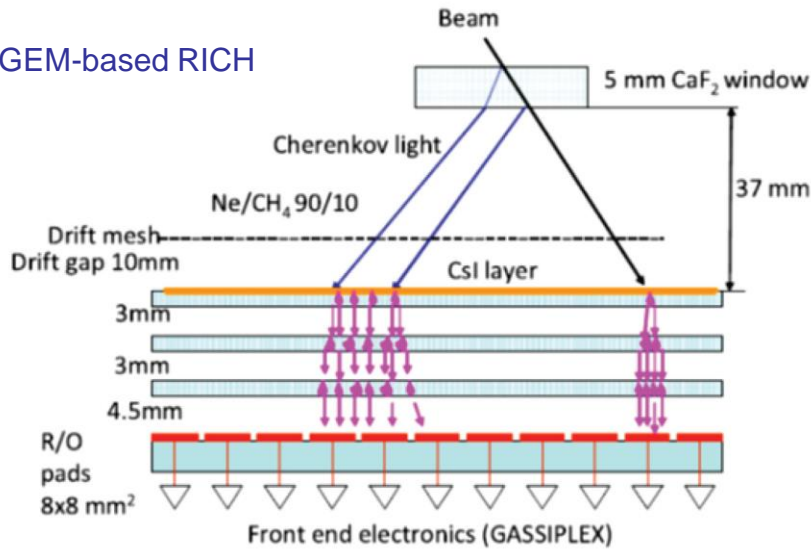


### 3. RICH detectors (including COMPASS upgrade)

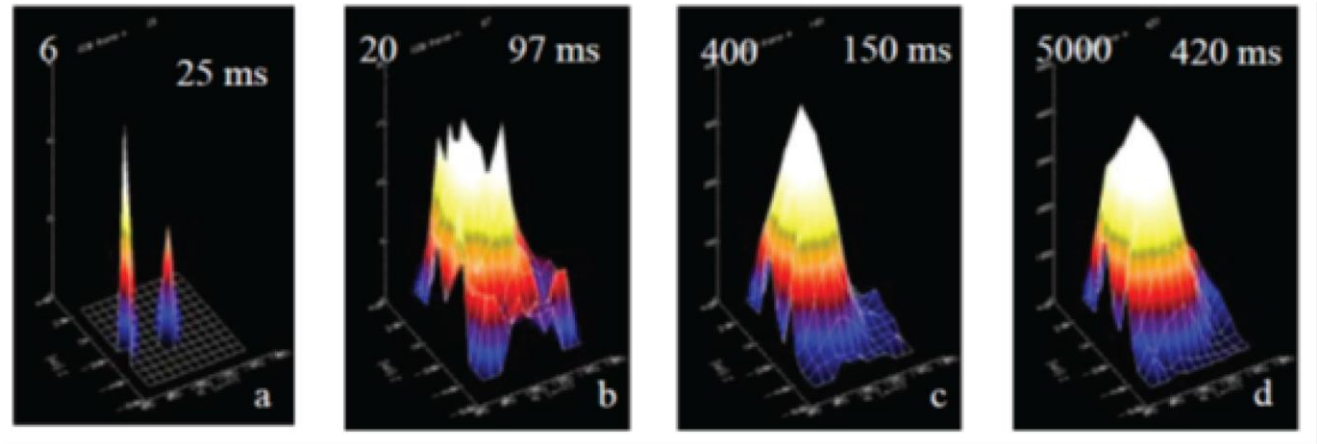
3a) PHENIX



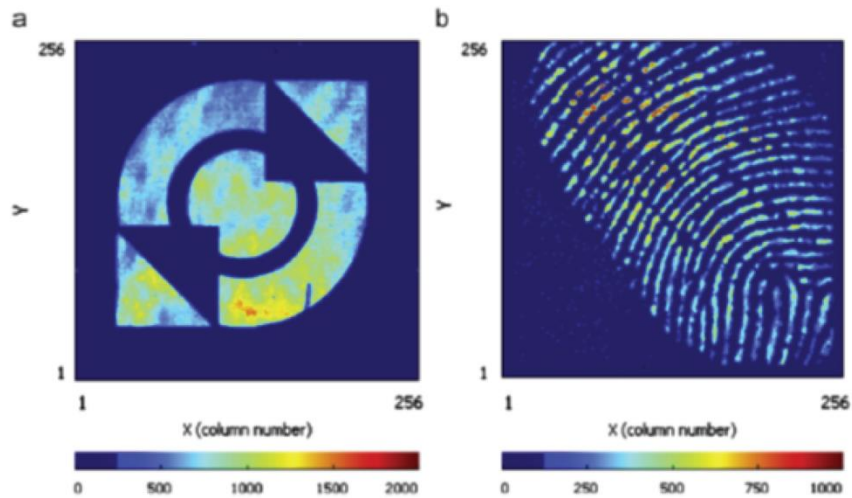
3b) ThGEM-based RICH



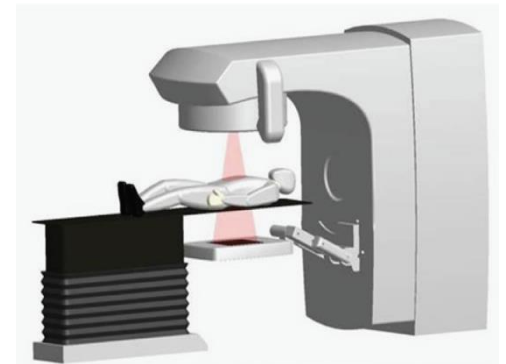
#### 4. Plasma diagnostics



#### 5. Potentials...



High-resolution UV imaging



Portal imaging

# Special paragraph :RD51

...”Five years of activities in these groups has led to significant results. The main one is the growing attention to this type of detectors in many fields of research, technology and applications. Thanks to the efforts of the RD-51 collaboration the micropattern detector technology is becoming mature and competitive, opening a new era in imaging techniques.

The results of the RD-51 collaboration is continuously being published and are available for further reading at <http://rd51-public.Web.cern.ch/RD51-Public/>.

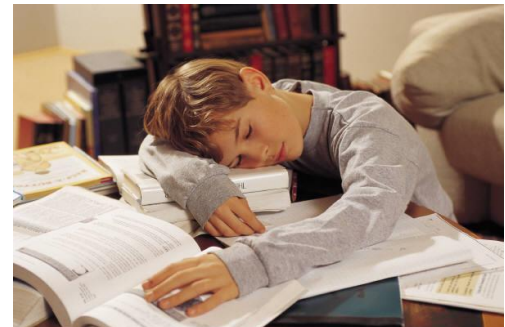
An excellent review of the RD51 collaboration activity can be found in the recent paper written by M. Titov and L. Ropelewski (Titov, 2013)...”

# Conclusion

We believe that the monograph gives a comprehensive description of recently invented new gaseous detectors which are currently under the intense development by the International collaboration RD-51 hosted by CERN.

We hope this book will be useful for many researches, engineers, professors and especially students.

**Electronic version is now available for free  
for CERN stuff and all users via CERN library**







# Acknowledgement

This work will be impossible to accomplish without daily interactions with our teachers and colleagues. **We** thanks all of them and especially **RD-51** members for many discussions

