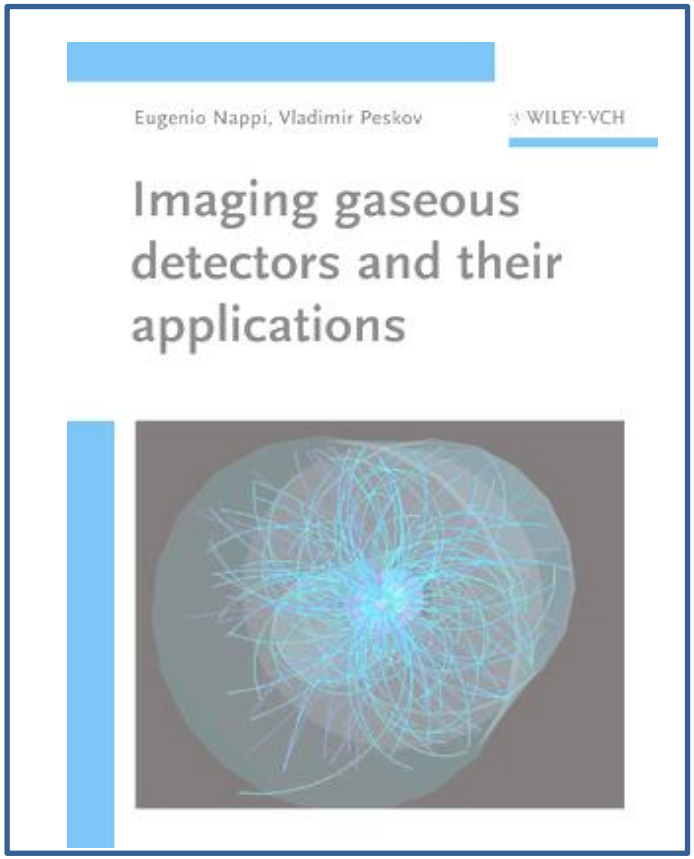
Imaging gaseous detectors and their applications



Monograph
Edition January 2013
324 Pages,
ISBN 978-3-527-40898-6
Wiley-VCH, Berlin

Describing advanced detectors and their visualization and investigation techniques, this monograph presents the major applications in nuclear and high-energy physics, astrophysics, medicine and radiation measurements.

Why we decided to present this monograph at the RD51 meeting?

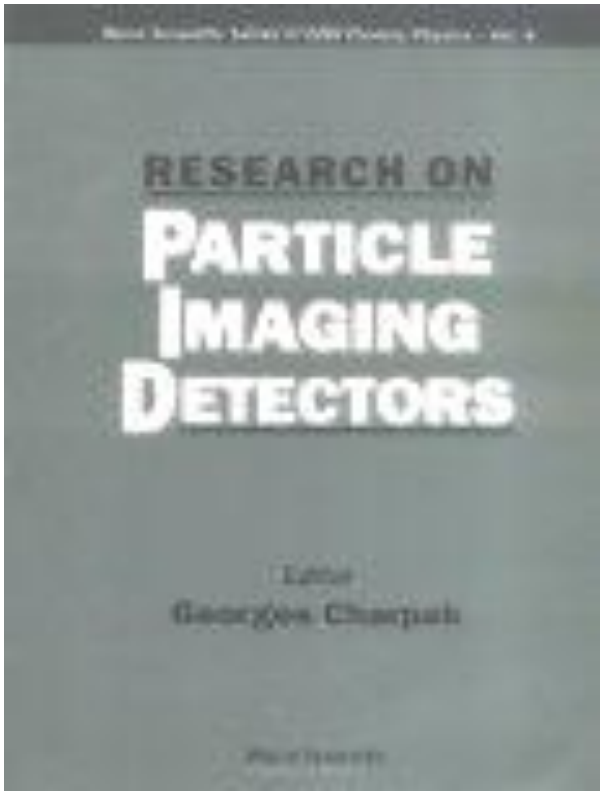
Because it gives a review of gaseous defectors developments from the past up to the present.

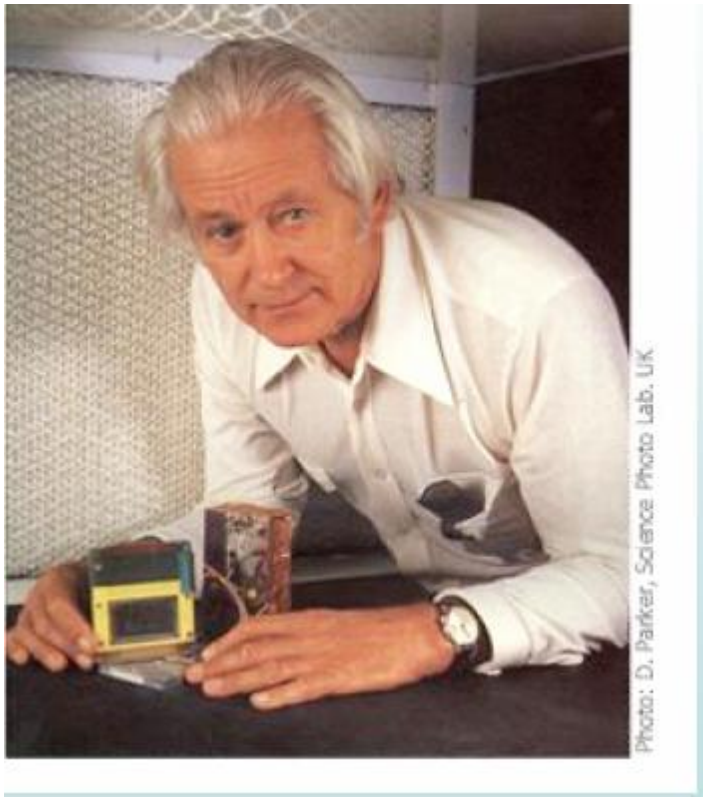
It summaryzs all latest achievements and understandings .

Actually, the main focus in this monograph was done on physics of the gaseous detectors operation.

We believe that this monograph will serve as a reference for daily work of the **RD-51 members** and will be also very useful students and any newcomers to this field.

The cross talk in title with Charpak book was done for the purpose…



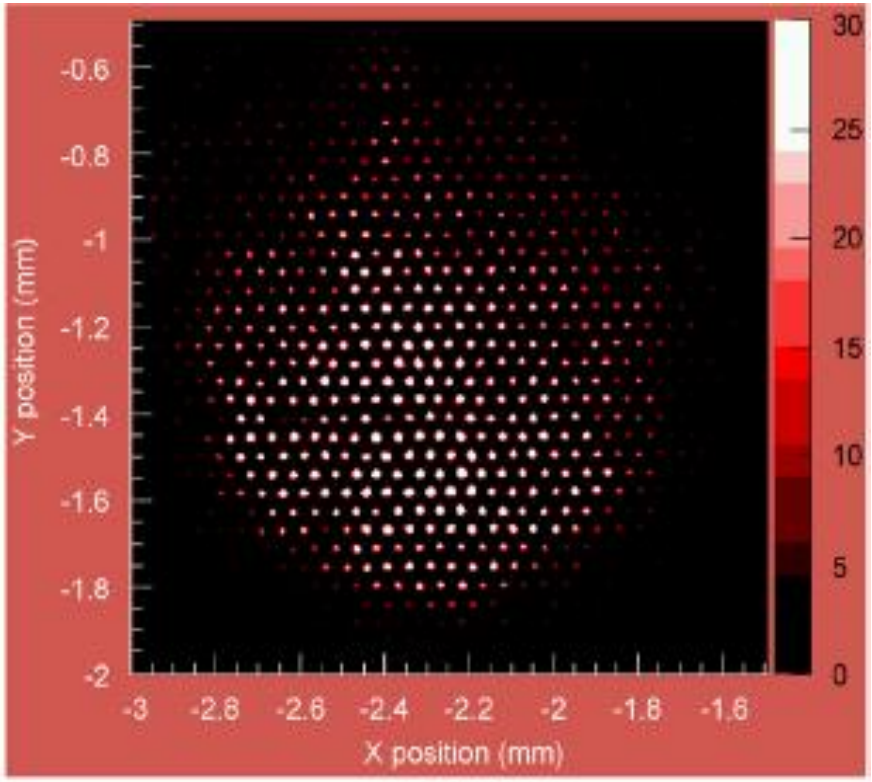


Our monograph dedicated to G. Charpak

Originally this book was planned to be written together with Georges,
but then he becomes very weak and refuced to work further

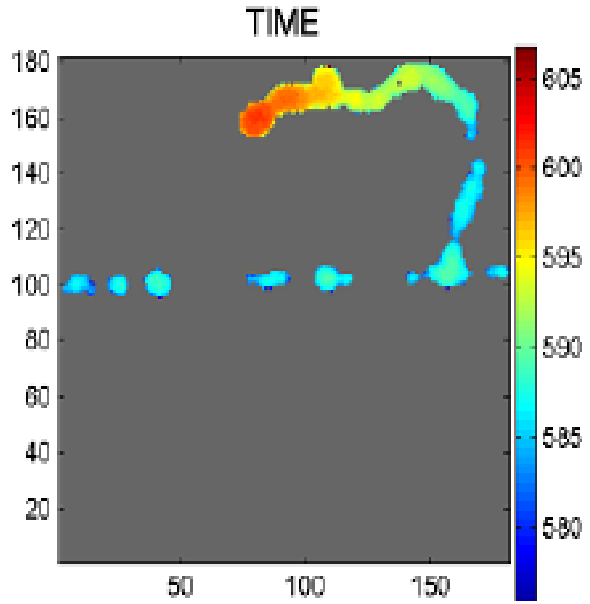
He agreed, however, to write an introduction to the book, but even this was not materialized due to his sudden death

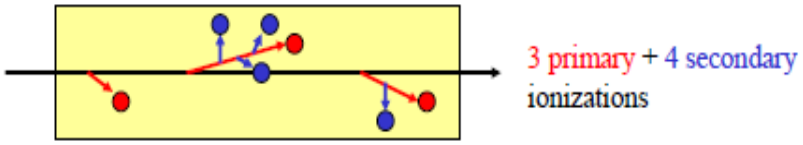
From the contents:

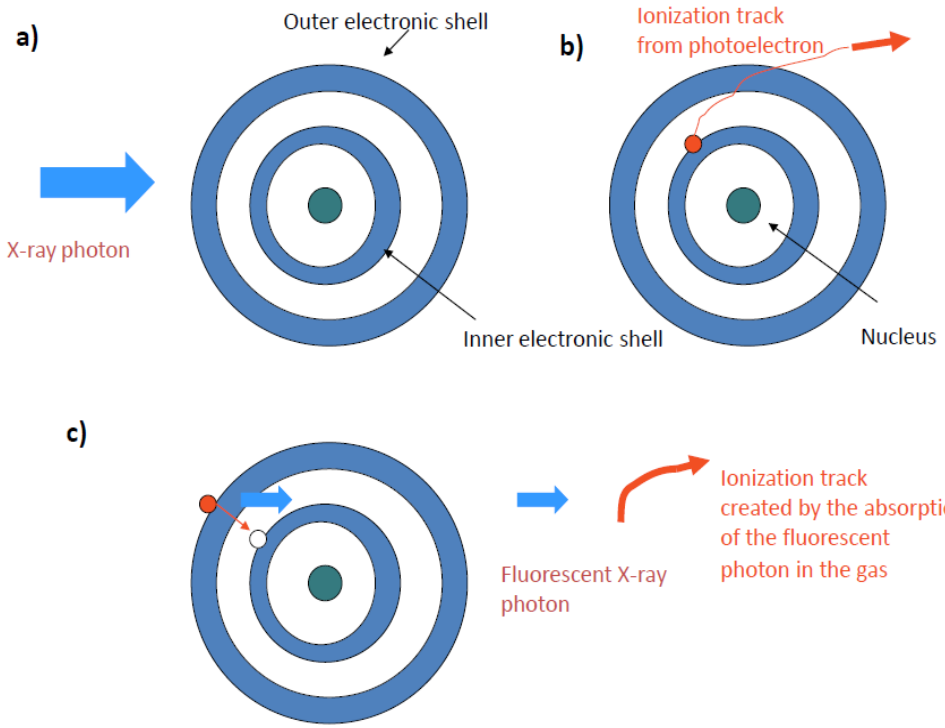


A short review of chapters

Chapter 2.Basic processes in gaseous detectors were considered



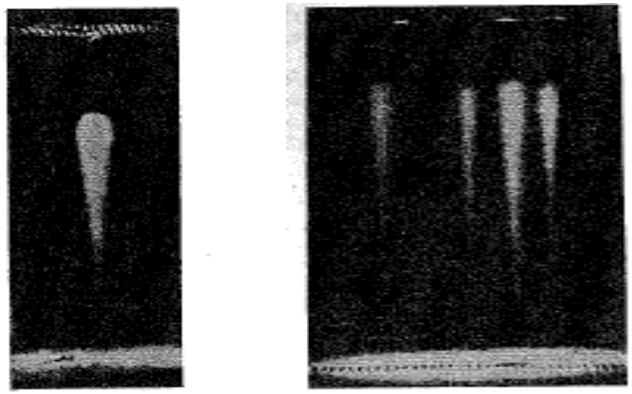


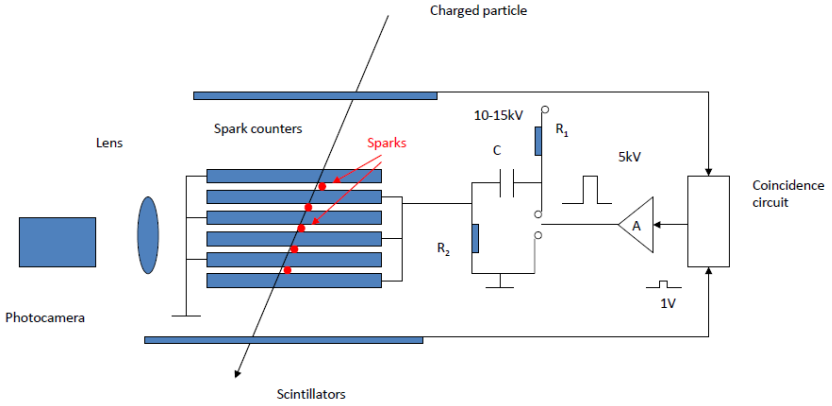


…interaction of charges particles and photons with gas, liquid and solid absorbers

Chapter 3. Gaseous detectors used before MWPC era are described

… a history of these developments was given





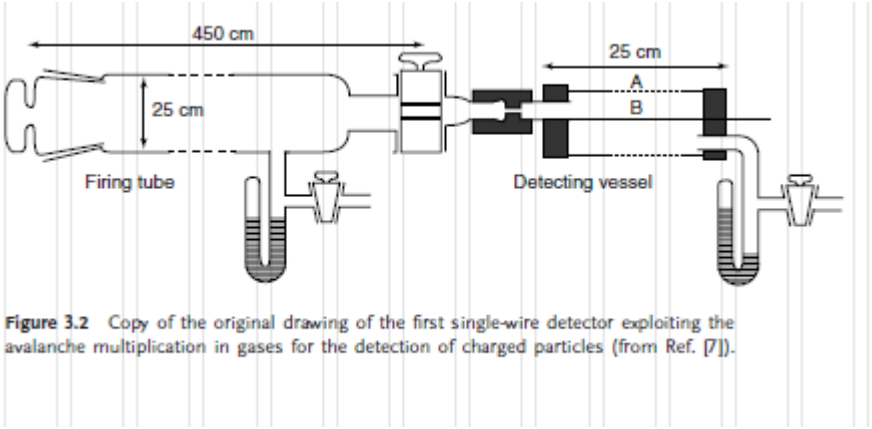
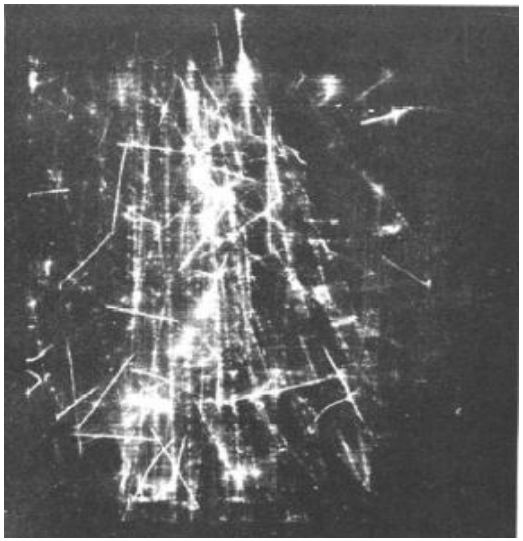
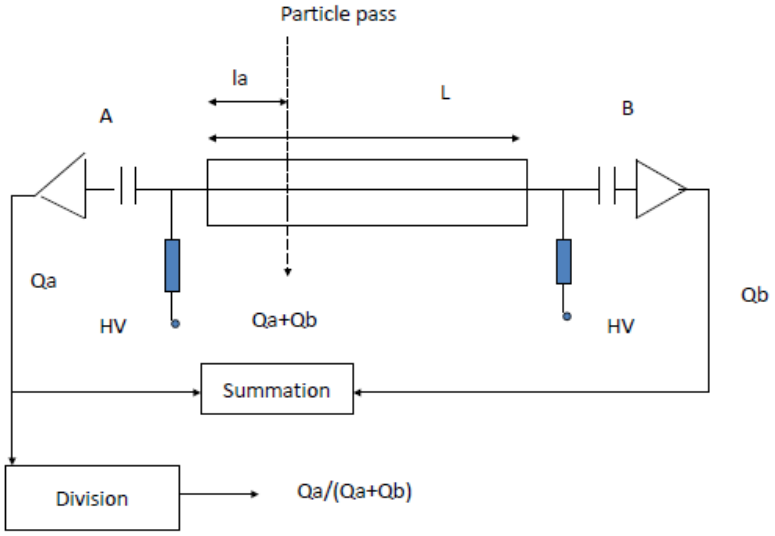


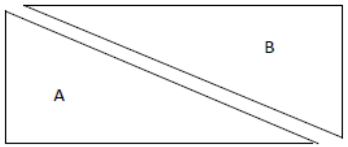
Figure 3.2 Copy of the original drawing of the first single-wire detector exploiting the avalanche multiplication in gases for the detection of charged particles (from Ref. [7]).



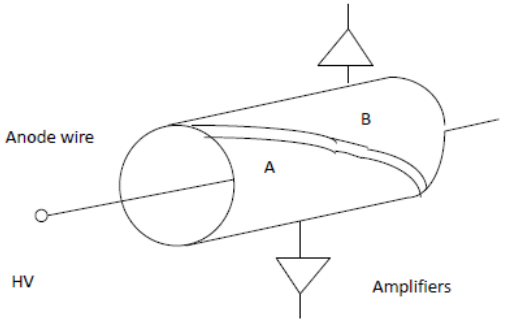
Note: before invention of MWPC G. Charpak worked with spark imaging chambers

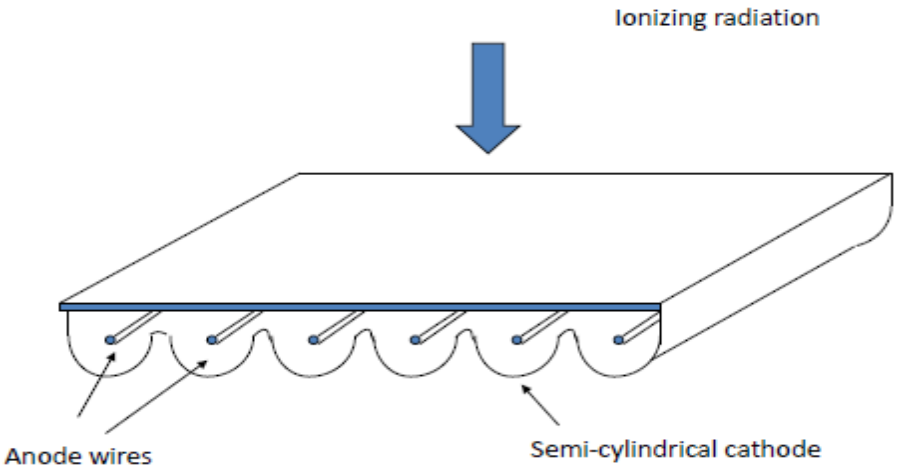
We mentioned also position-sensitive wire detectors, developed before MWPC era





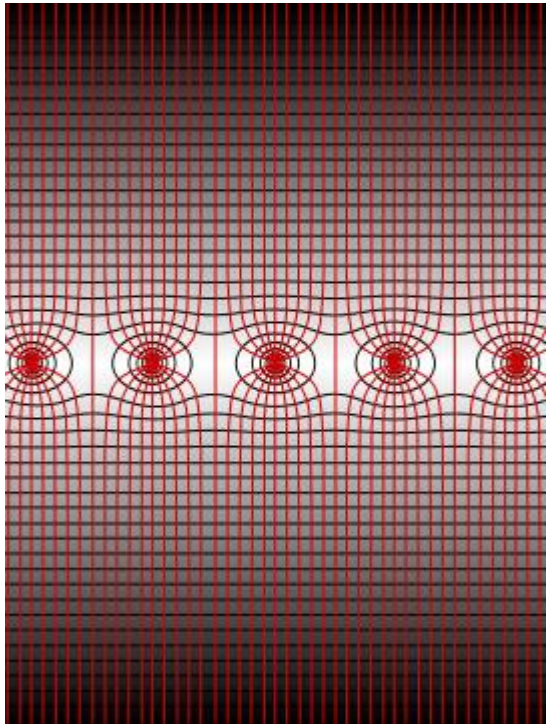
Two isolated wedge shape parts from which the cathode cylinder is made

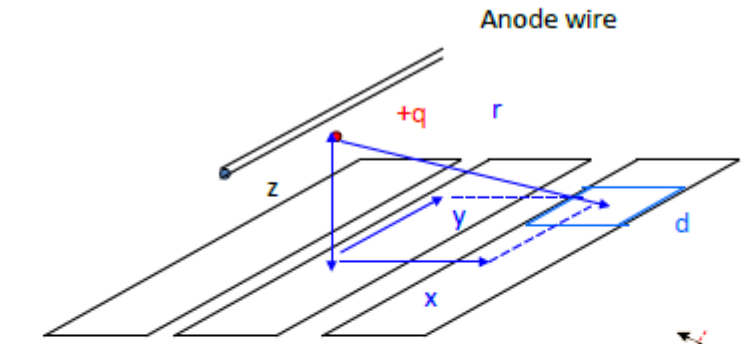




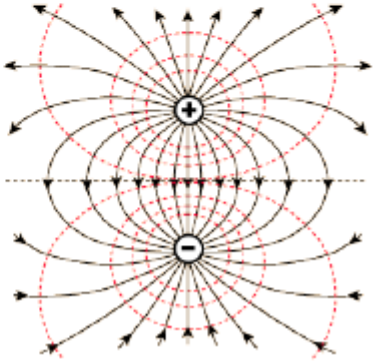
…they, however, did not find wide range applications…

Chapter 4. The MWPC era





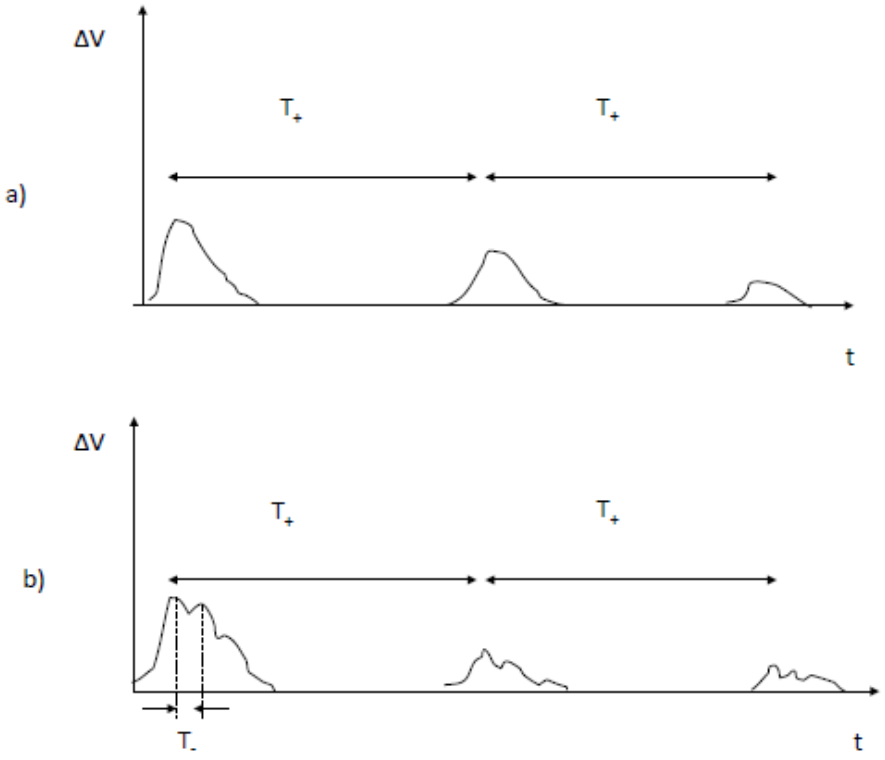
Dipole electric field



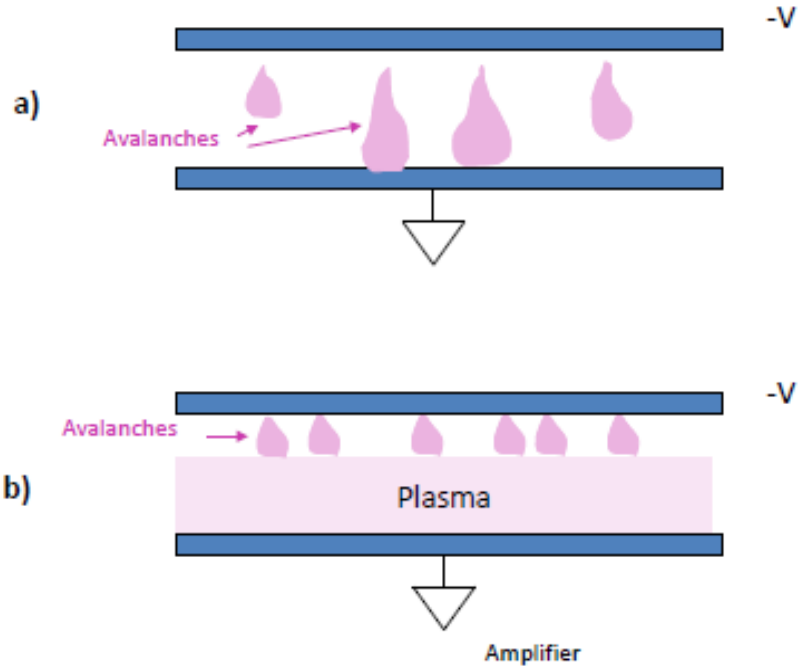
… in this chapter we tried to answer the question: why MWPC s revolutionized the detector developments..

Chapter 5. More in dept about physics of gaseous detectors

…feedbacks



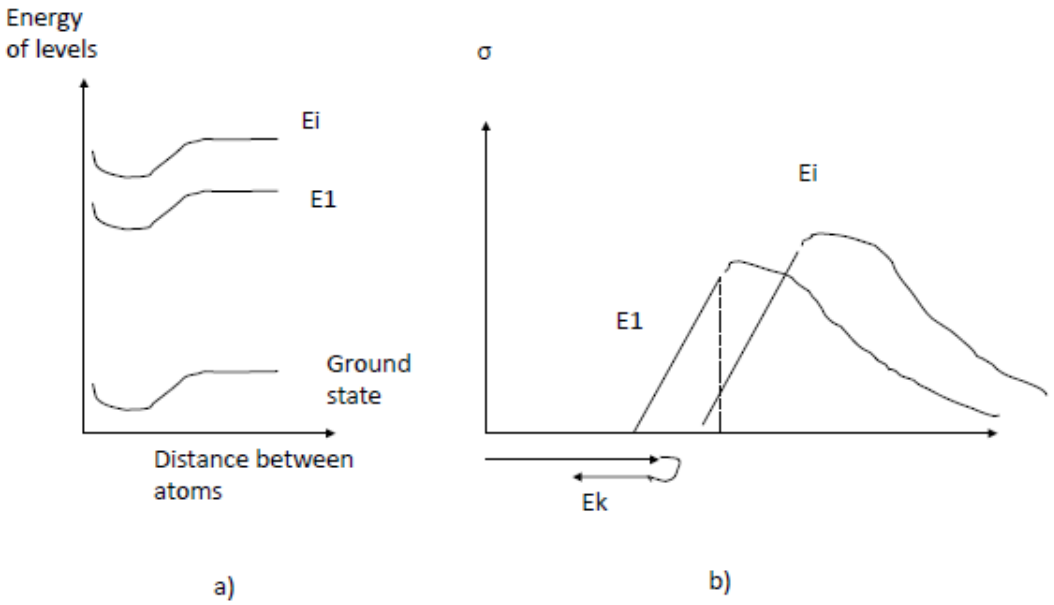
…a ”slow” breakdown

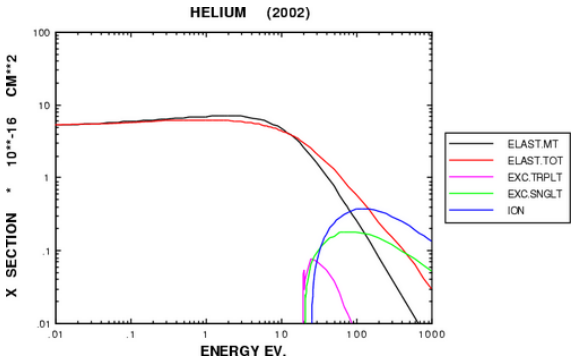


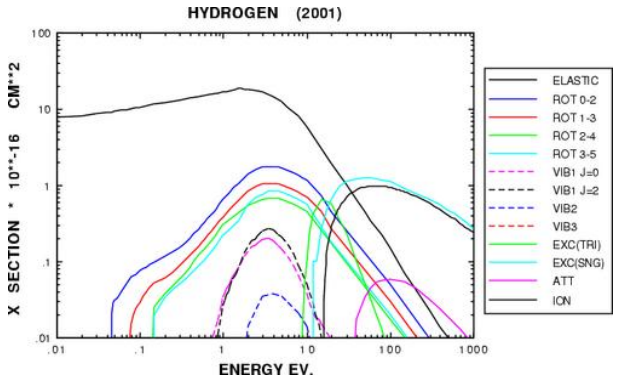
Aγ<1

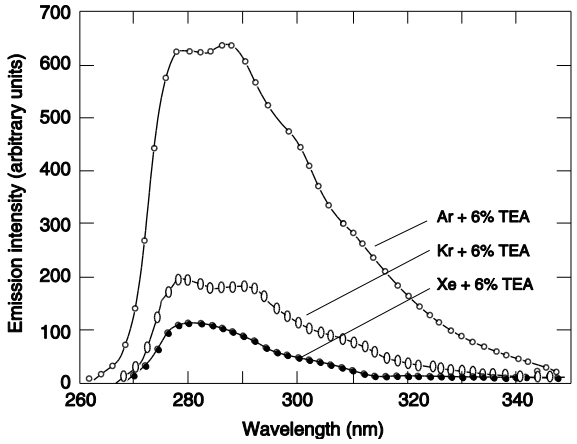
Aγ=1

…avalanche light emission

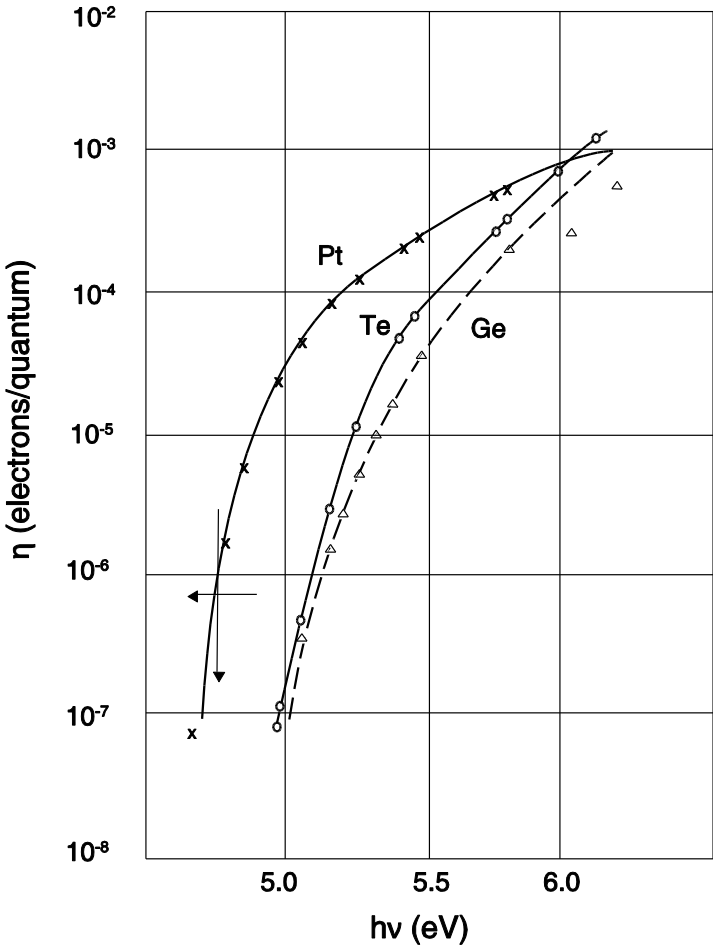


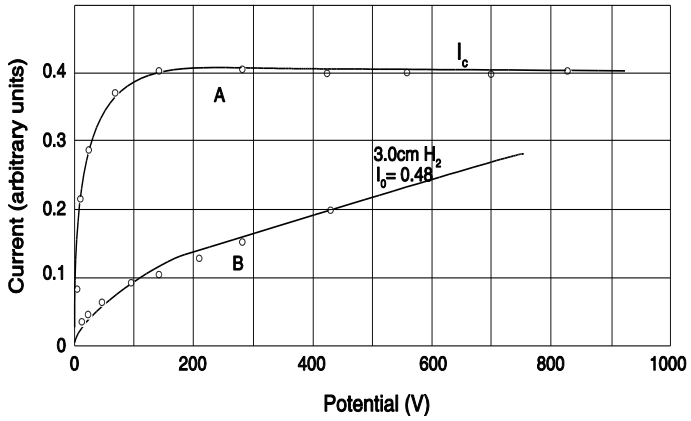


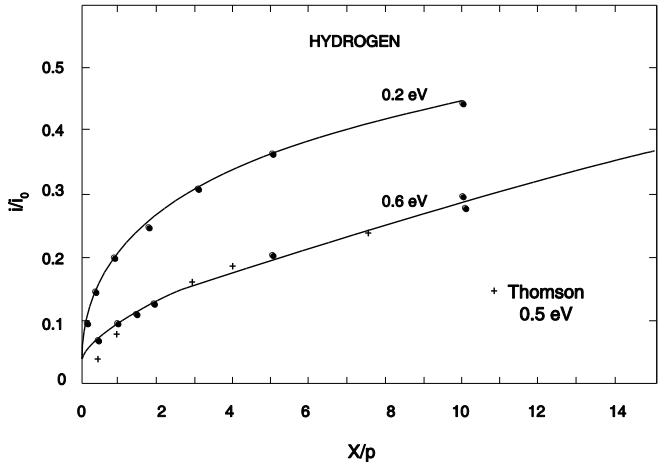




…photoeffect and back diffusion

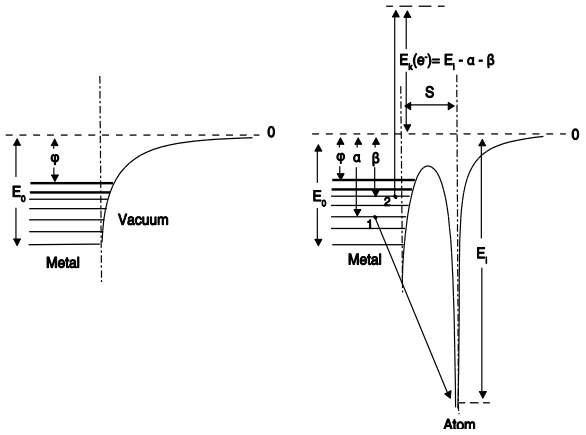


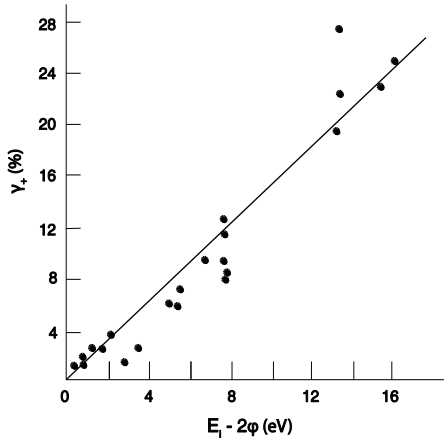


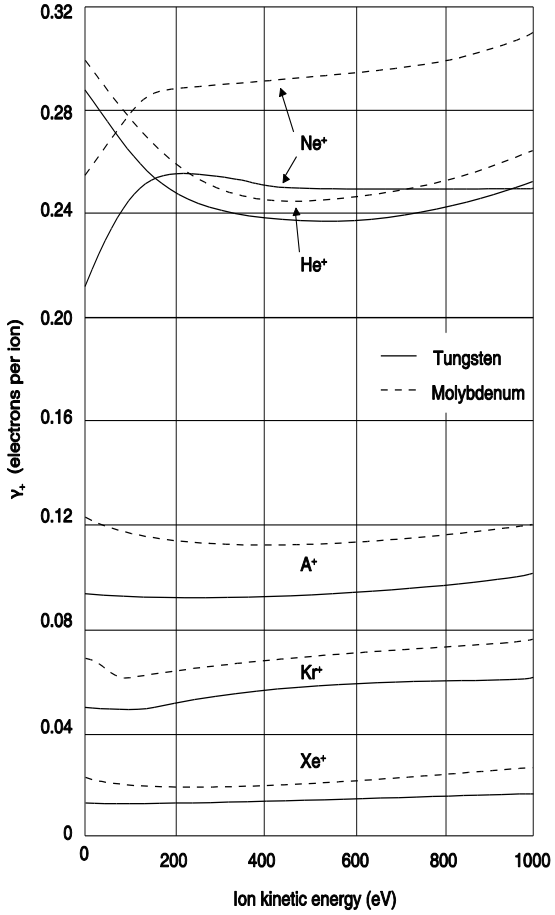


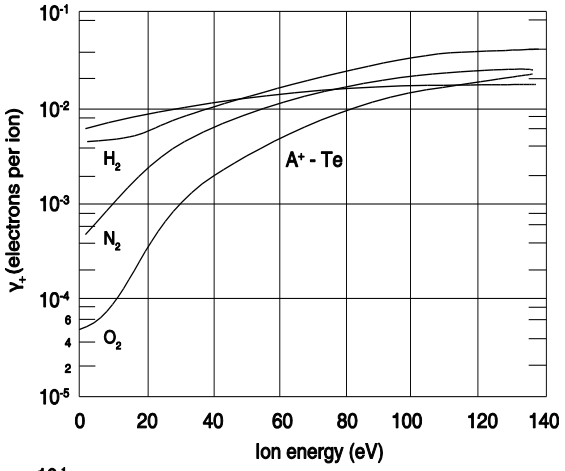
…an important role of UV photons

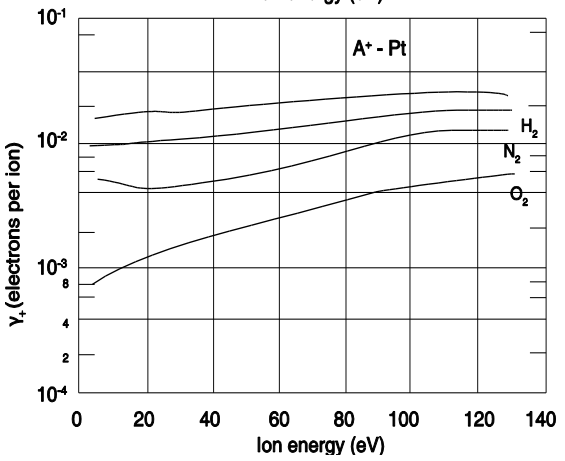
…Ion recombination







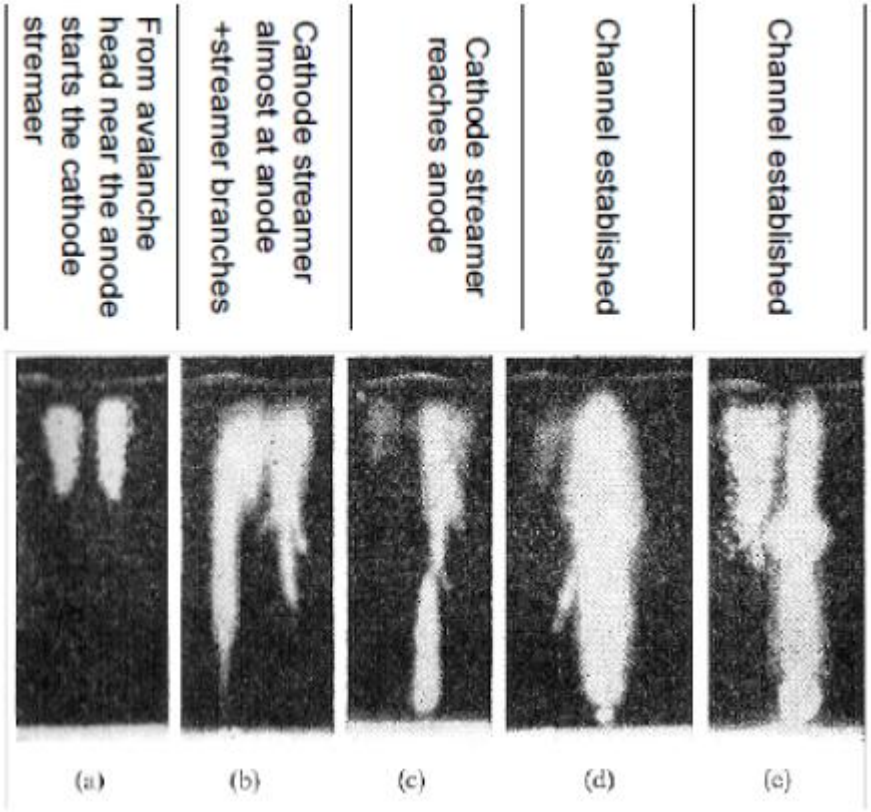


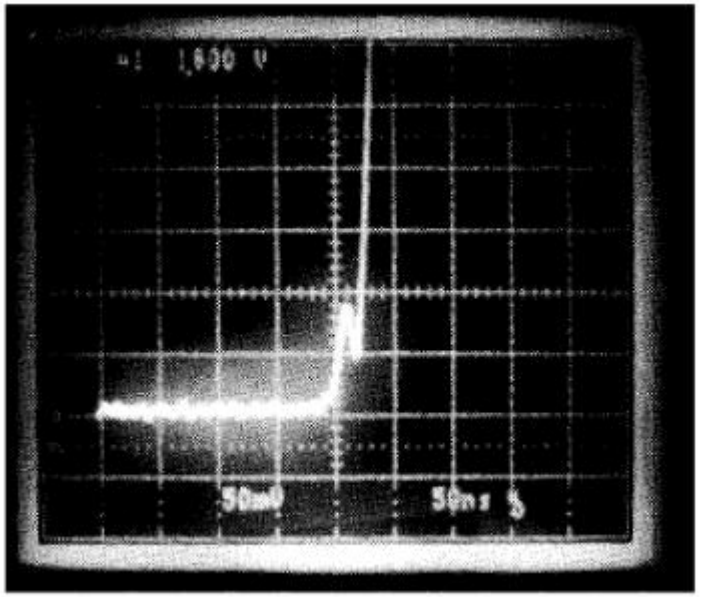


…how ions extract electrons from cathodes: in vacuum $\gamma_{+v}=k_v(E_i-2\phi)$ and in gas $\gamma_{+g}=k_g(E_i-2\phi)$

$k_g<k_v$ …and depends on surface layers

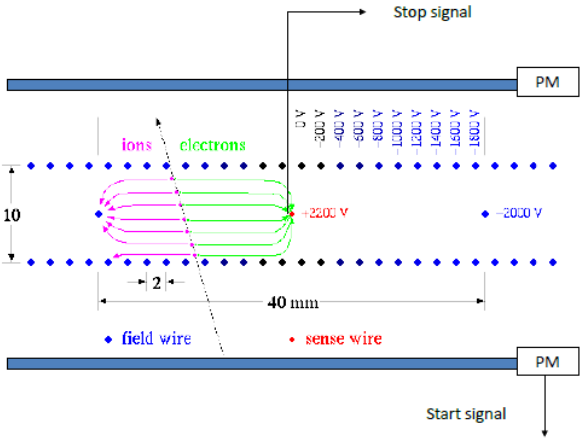
…"fast" breakdown

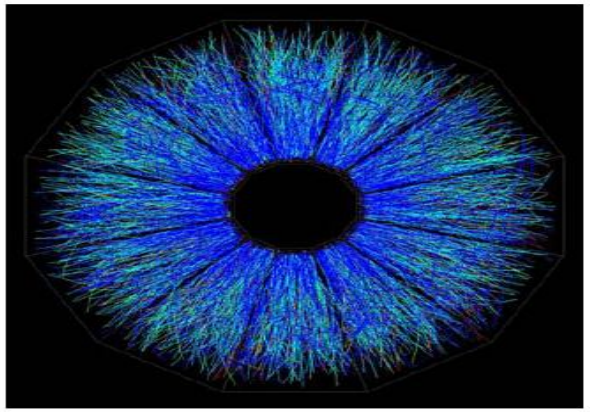


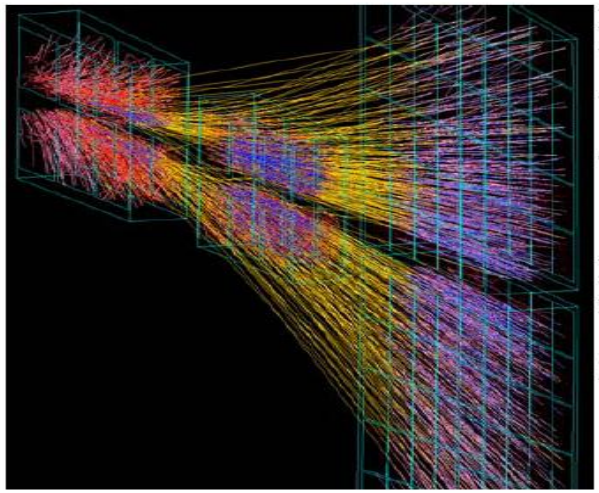


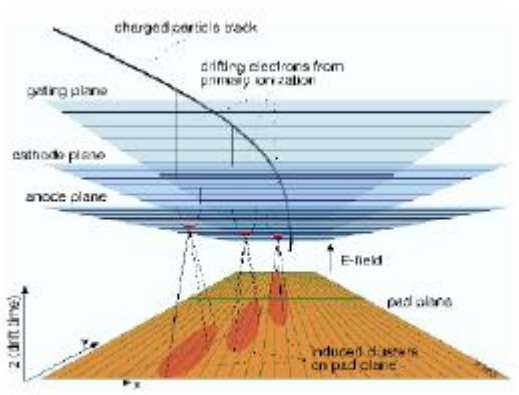
Raether limit: $An_0 \approx 10^8$ electrons

Chapter 6,7. New ideas during the MWPC era

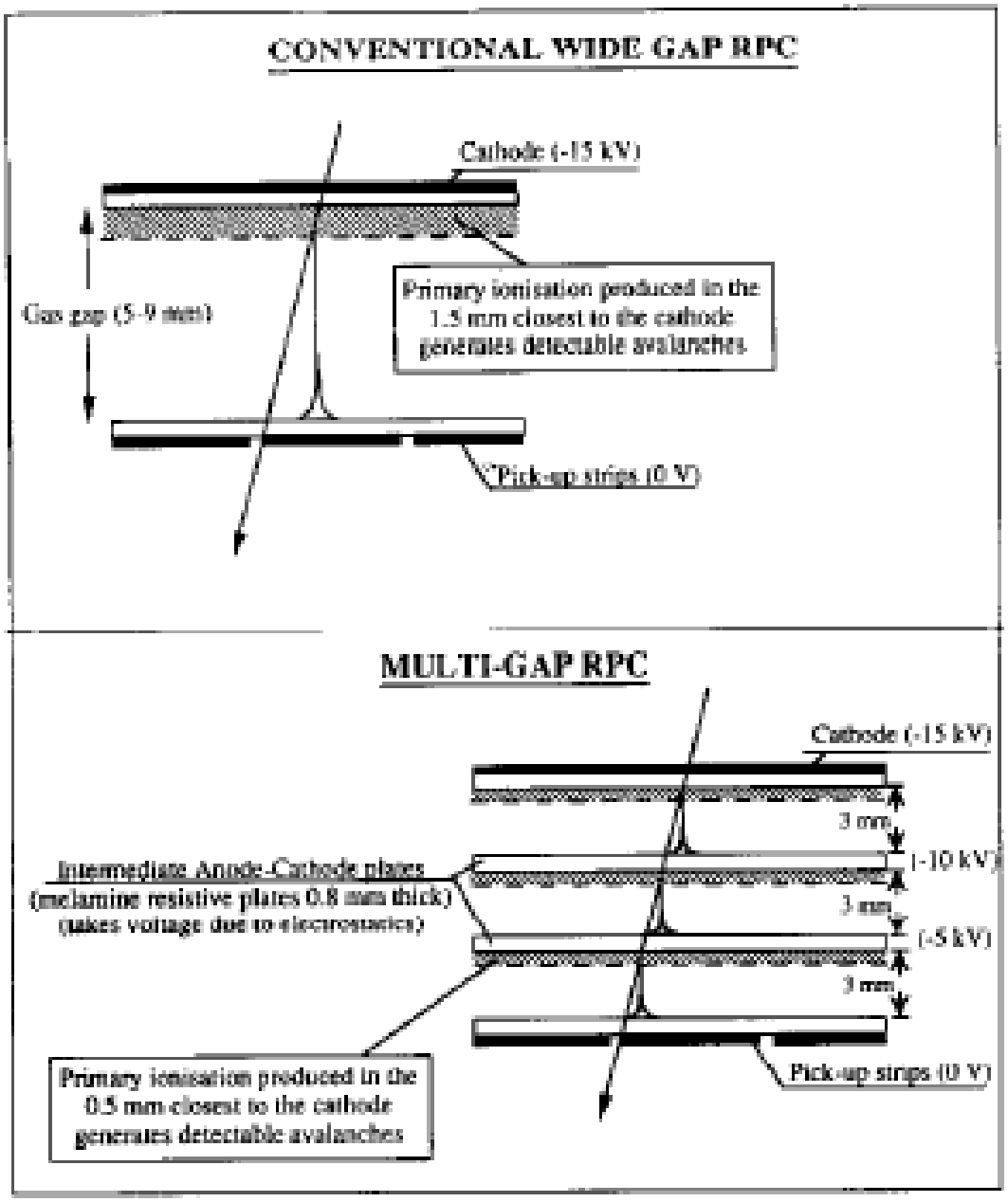








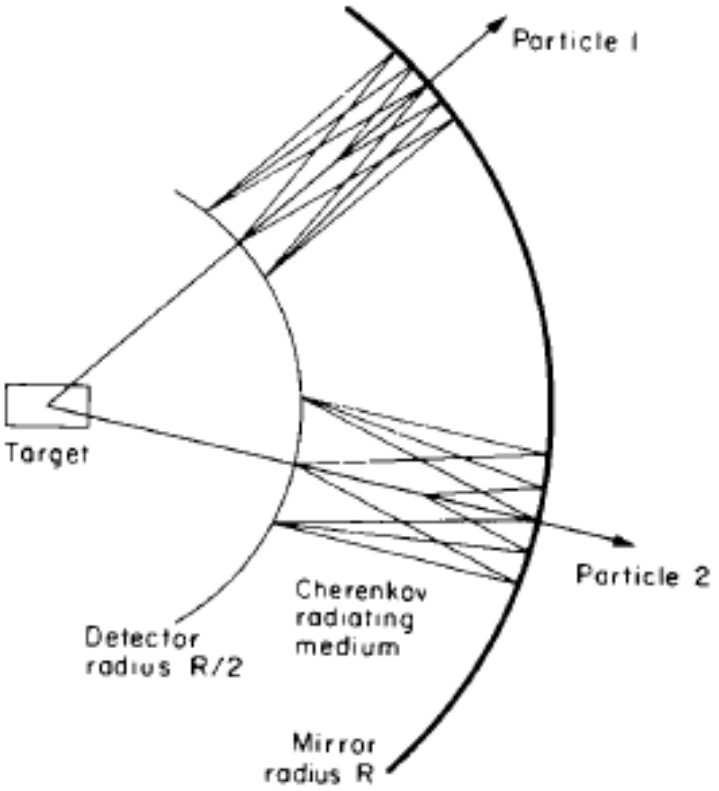
…drift chamber, TPCs…



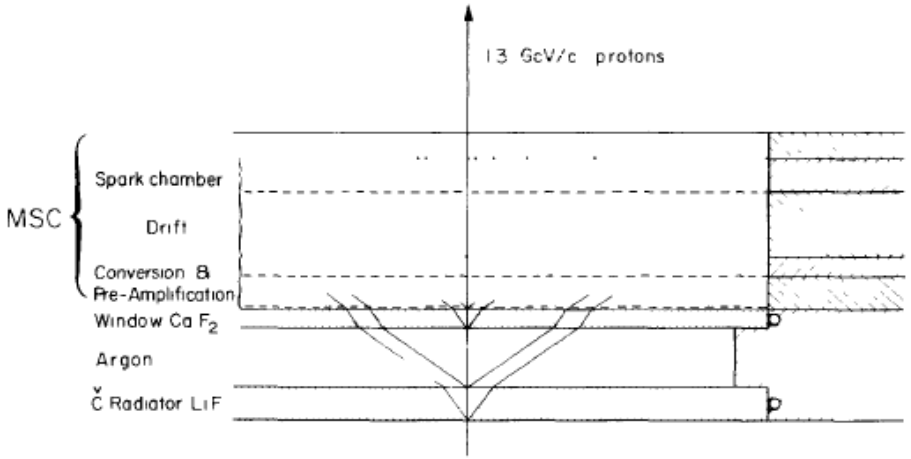
…RPCs:
streamer and
avalanche modes
(Pestov, Santonico)

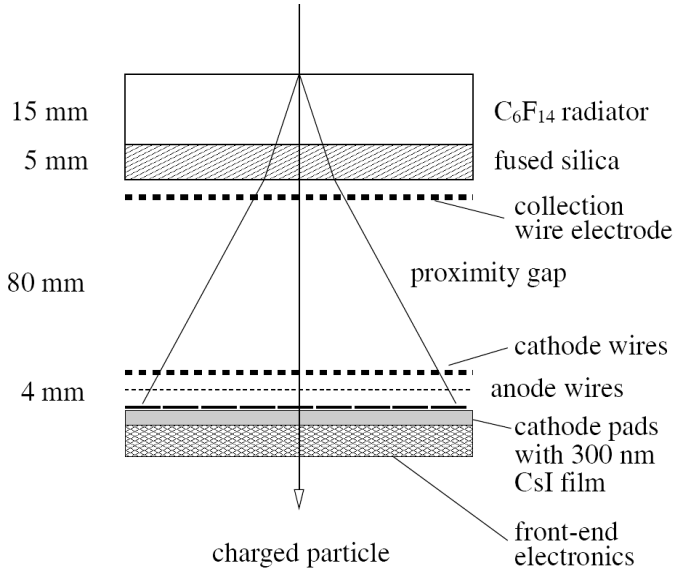
Timing RPCs:
$\sigma = 1.28/\{(\alpha - \xi)v\} = 50ps$
(Fonte, Williams et al)

…RICH and other photodetectors



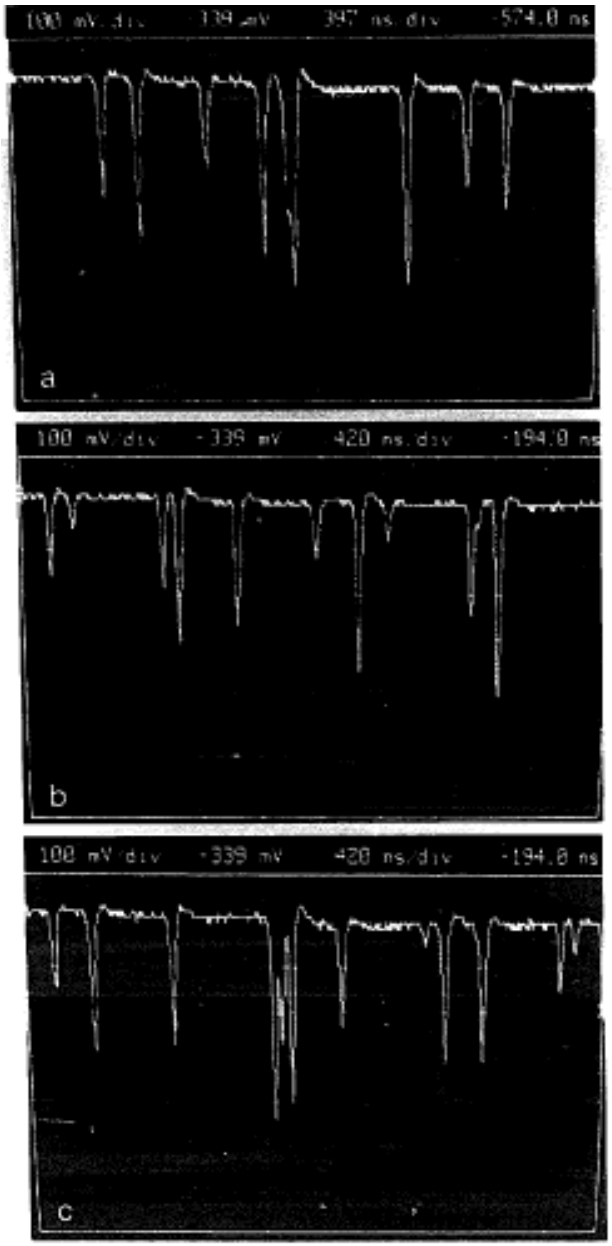
Original idea…





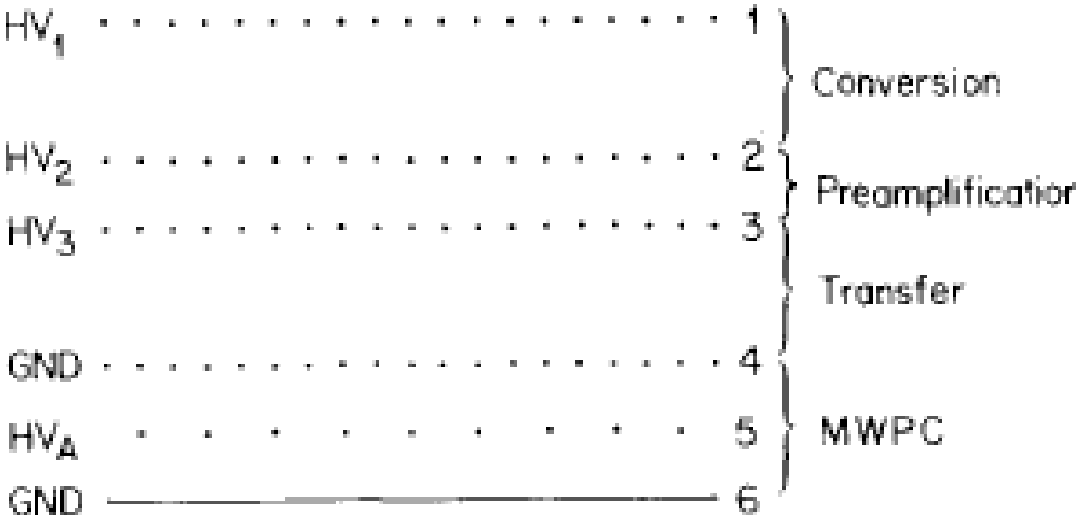
…ALICE RICH…

…cluster counters

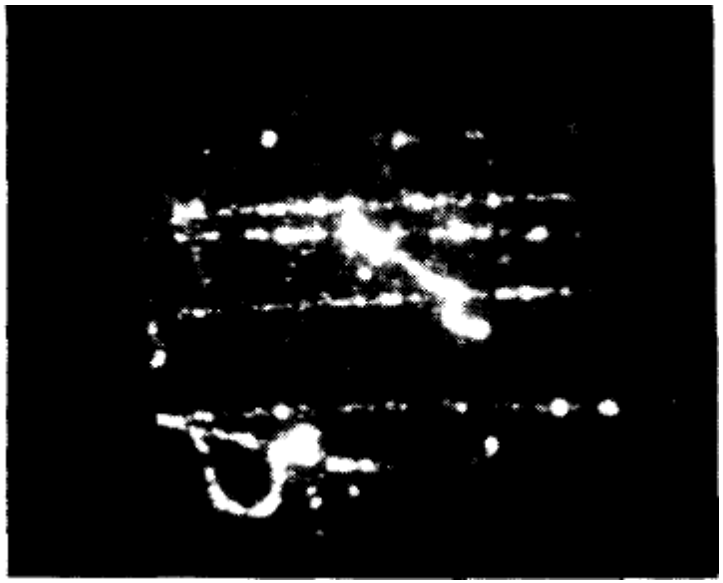


Walenta, Puiz, Breskin

…PPAC (Sauli)

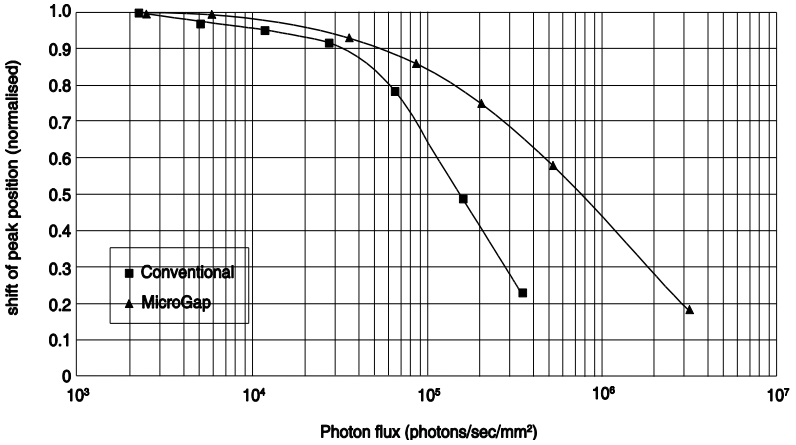


…light imaging chambers



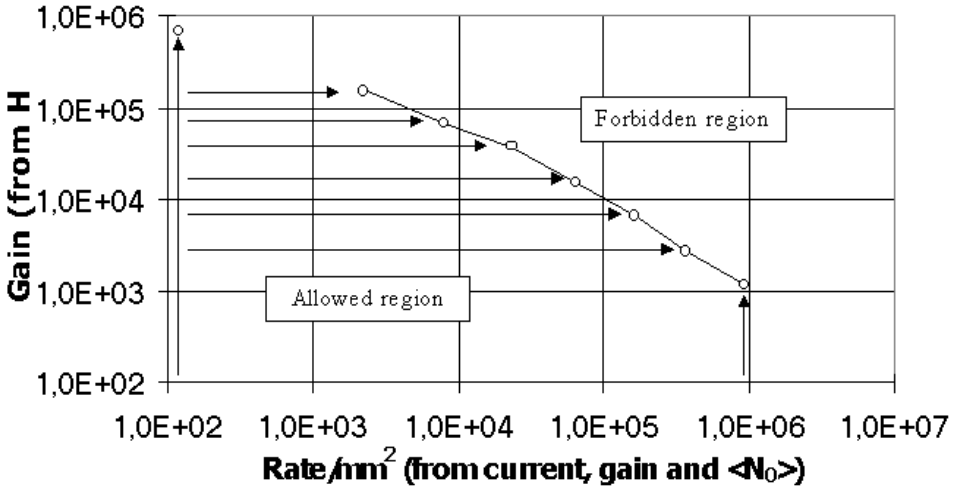
Charpak and other groups

New understanding in physics: a rate effect

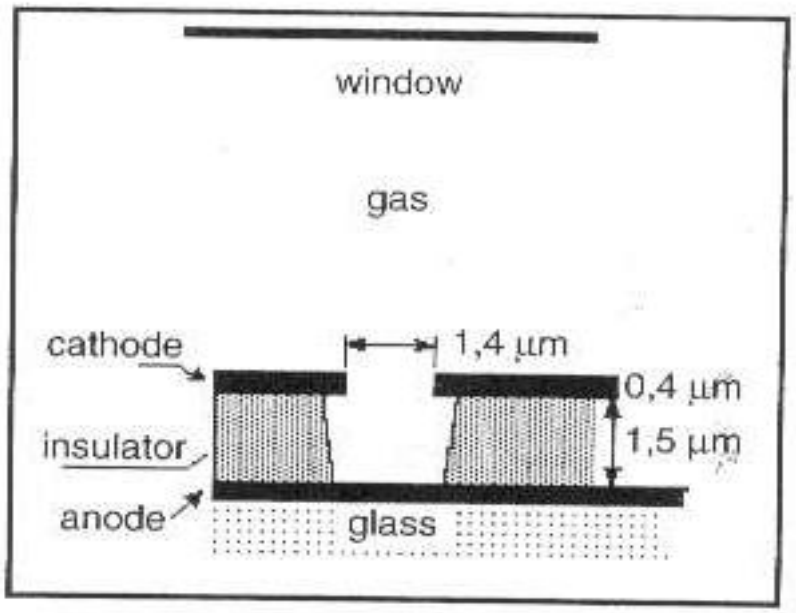


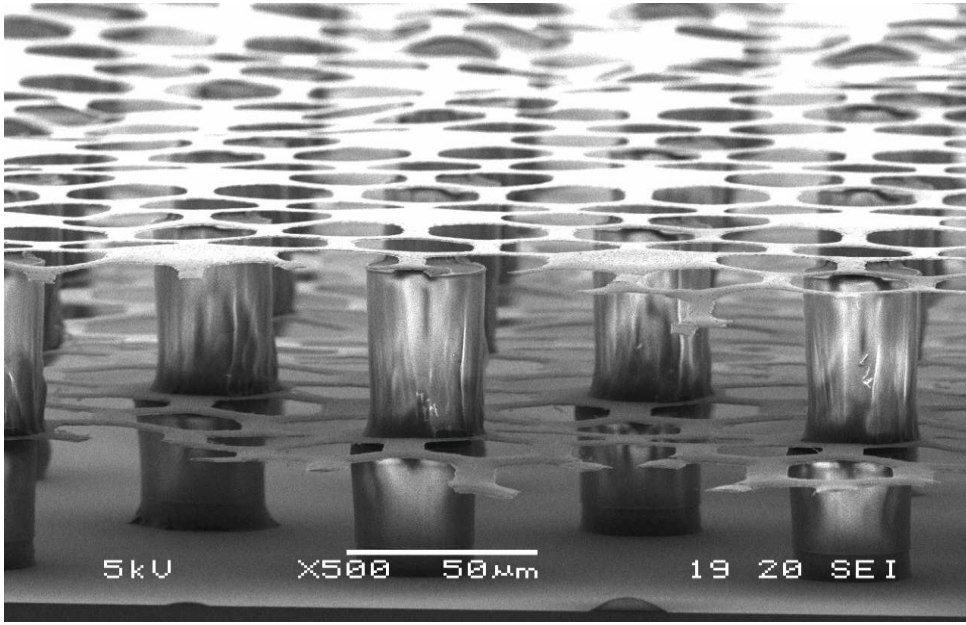
Space charge in wire-type detectors

New physics in the case of PPAC



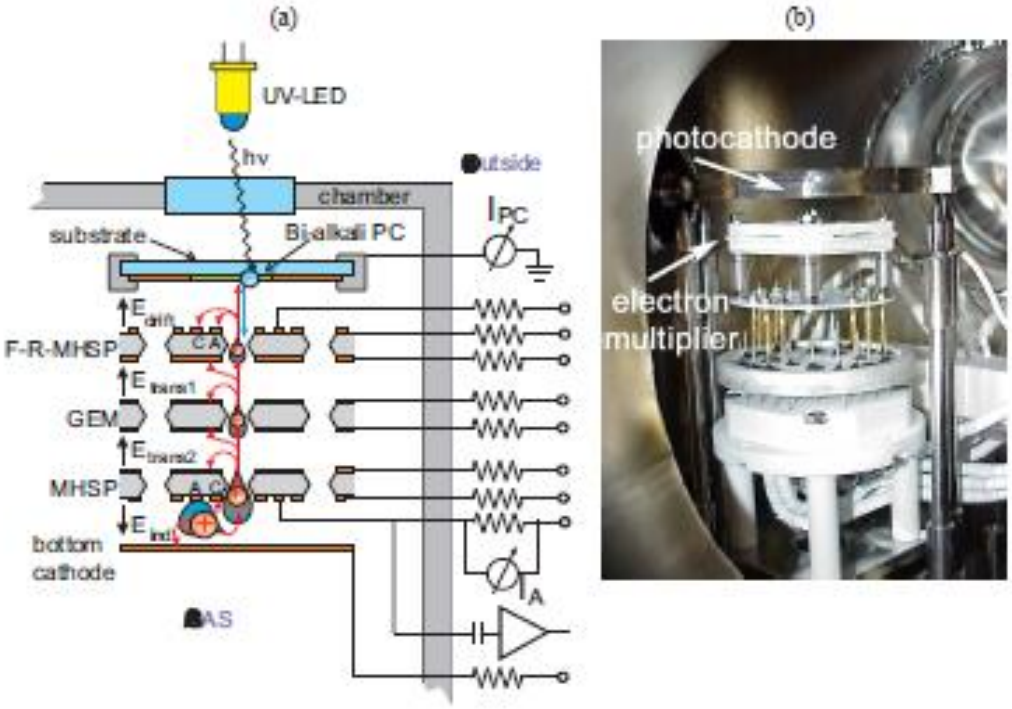
Chapter 8. Micropattern gaseous detectors





…main detectors were reviewed: microstrip, microdot, GEM, MICROMEGAS…

…"exotic" developments…



..detectors of visible photons

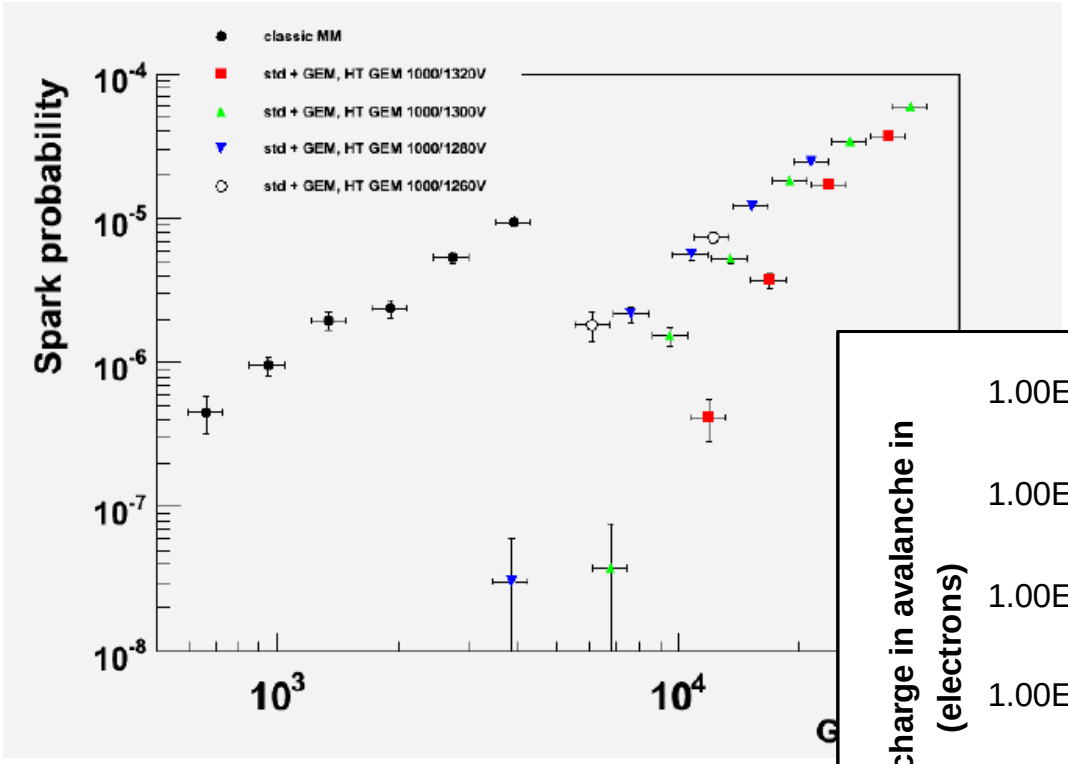
Akγ<1,

K<<1

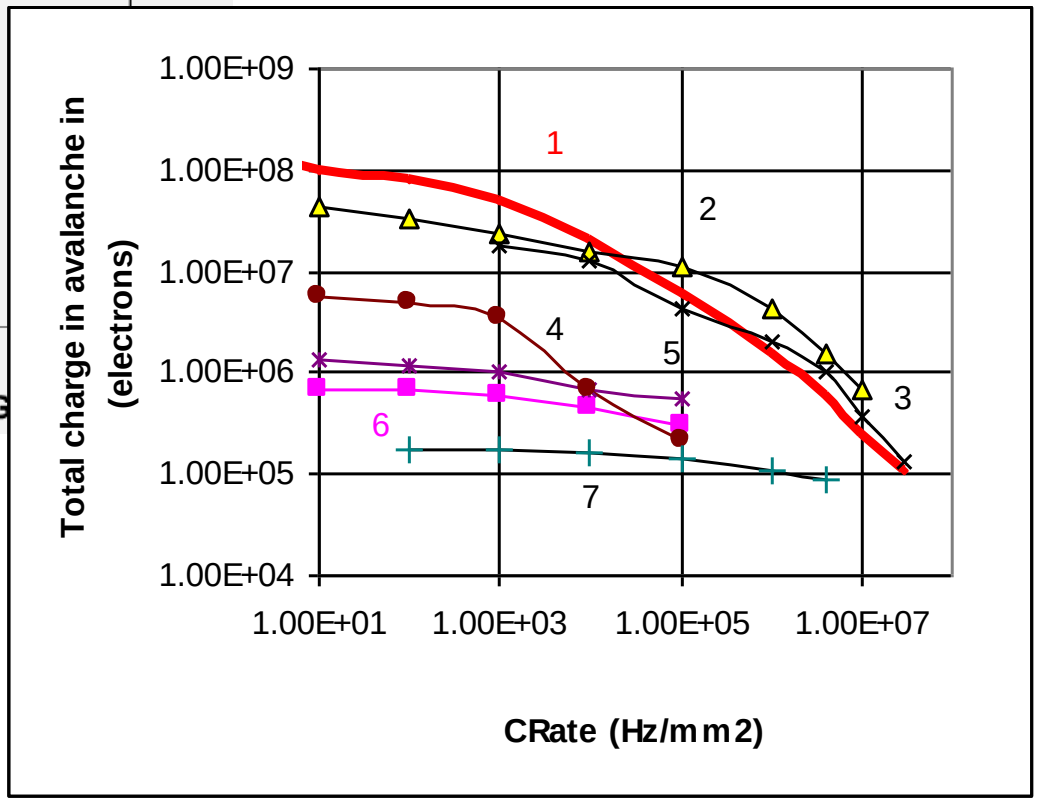
(Breskin and Japanes group)

Ropelewski, Durte Pinto et al

Main focus is on physics of operation…

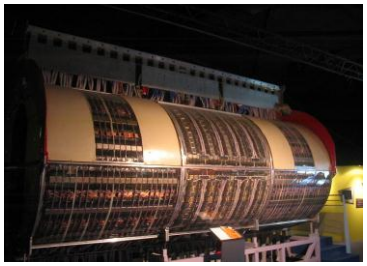


…**Raether limit** in micropattern detectors: $An_0 \approx 10^6$ -10^7 electrons

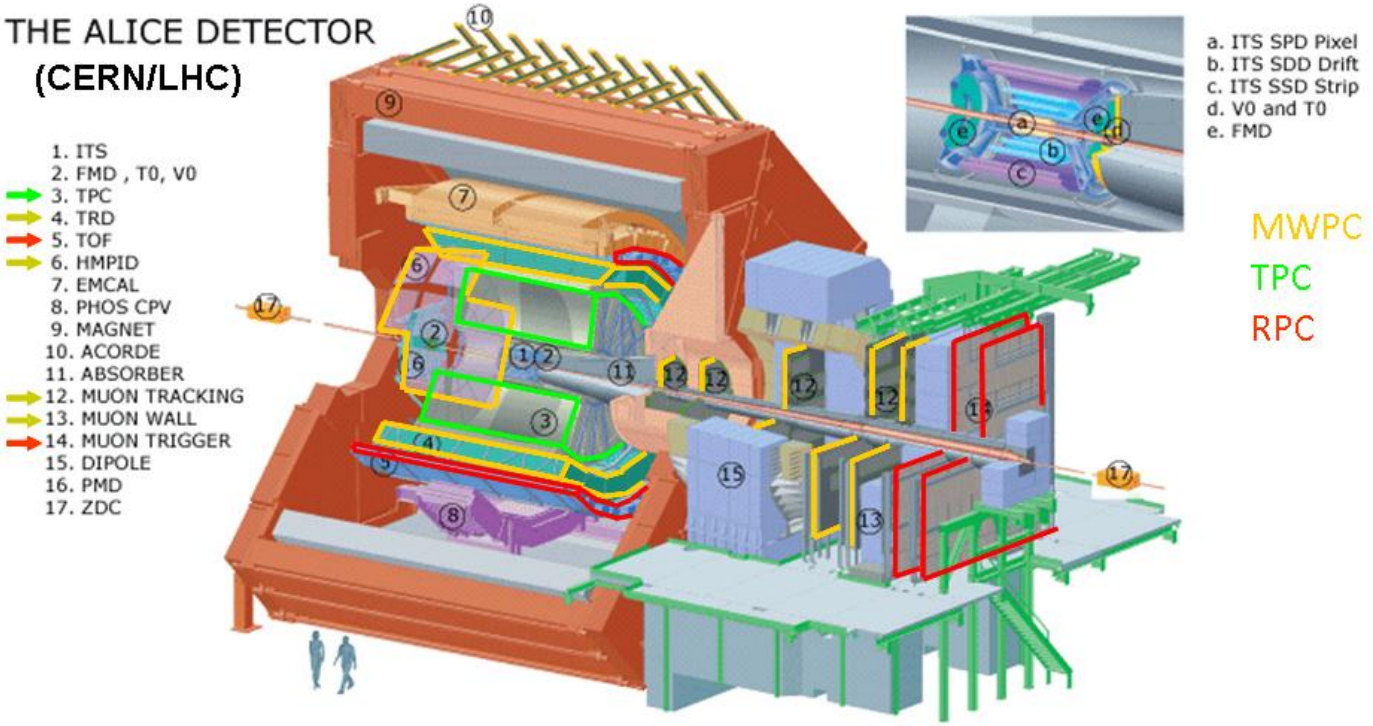


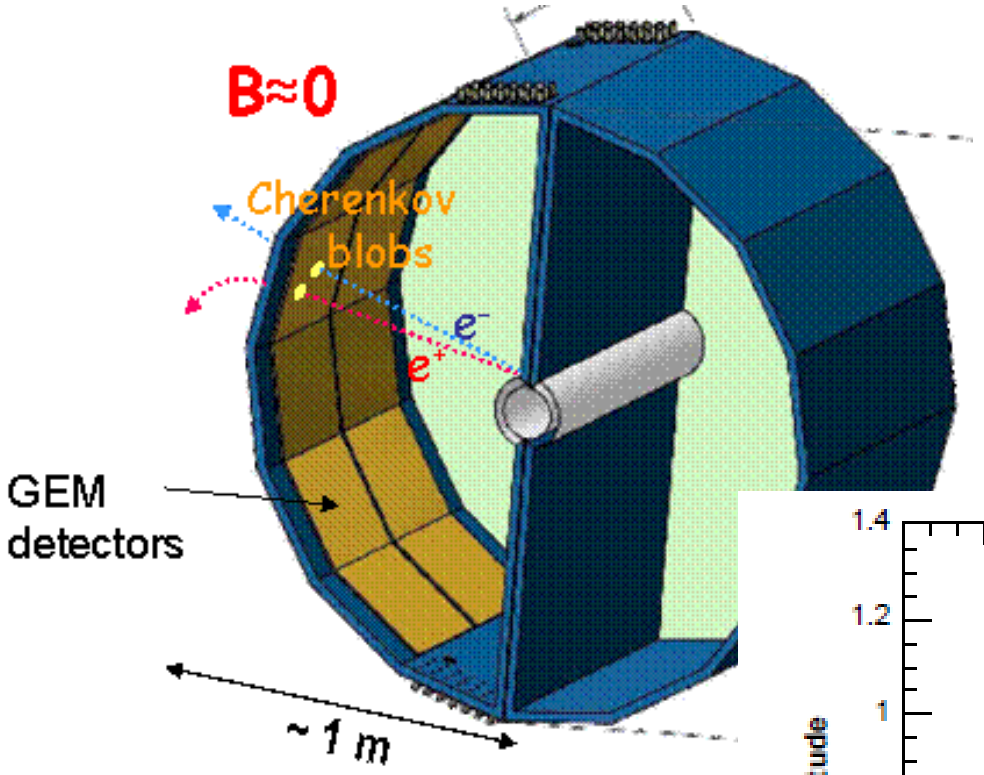
…**rate effect** in micropattern detectors (cannot be much better than in PPAC!)

Chapter 9. Applications of imaging gaseous detectors



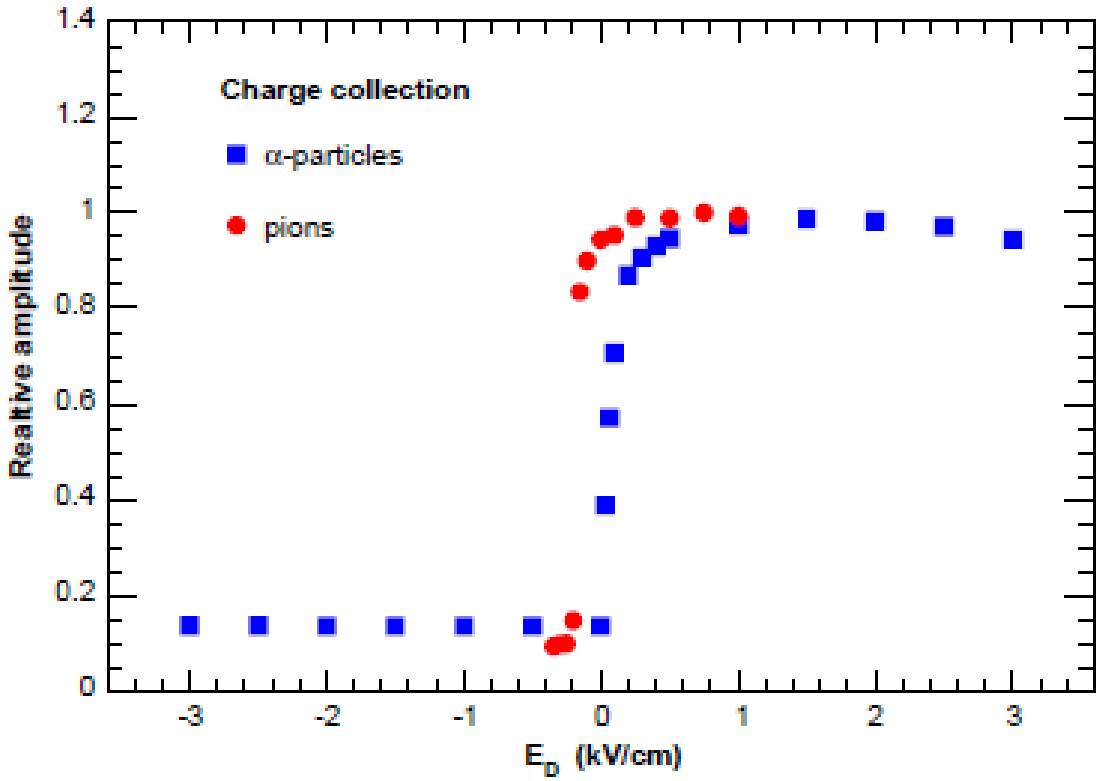
…in high-energy physics…
from UA1 to LHC



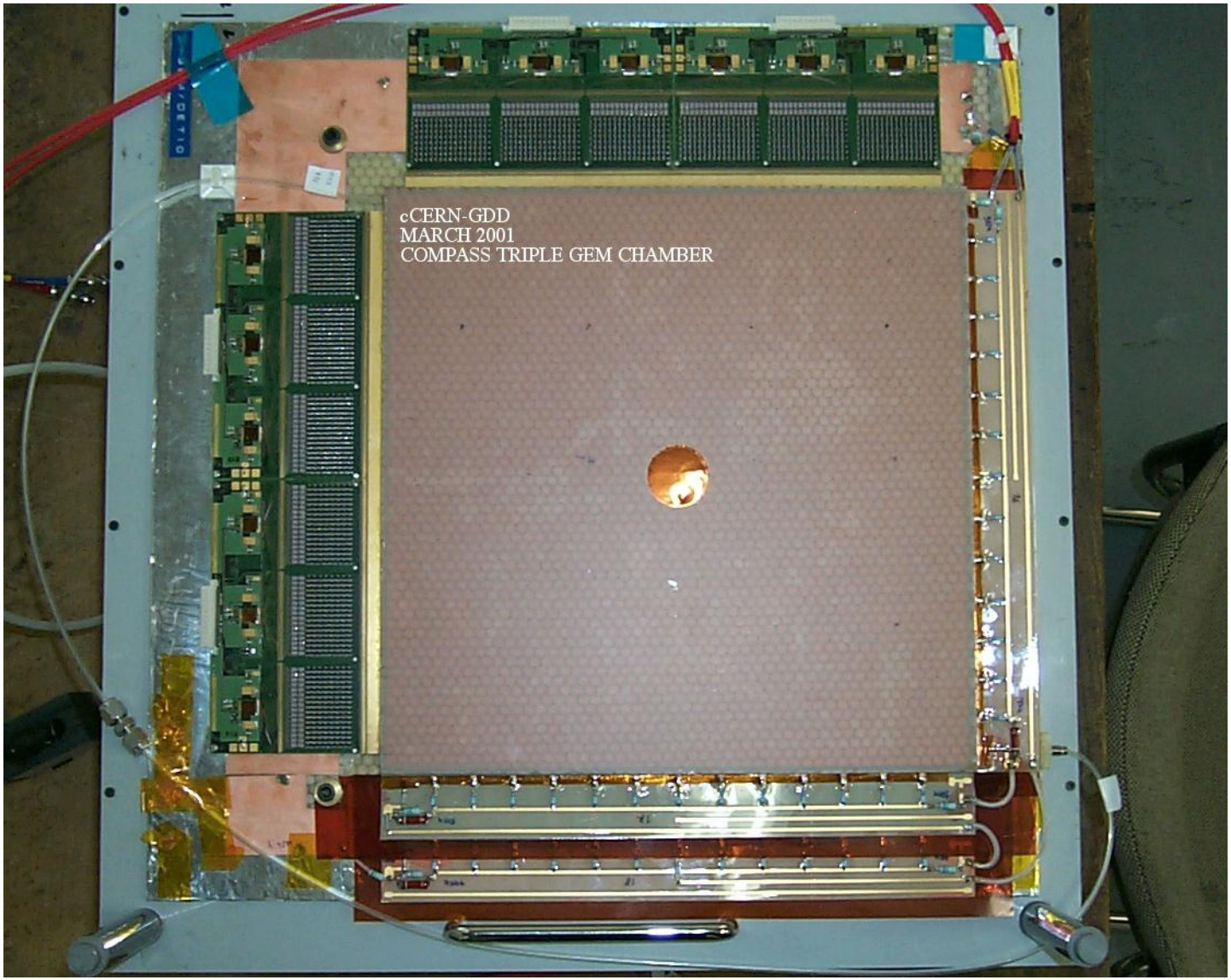


PHENIX hadron –blind detector

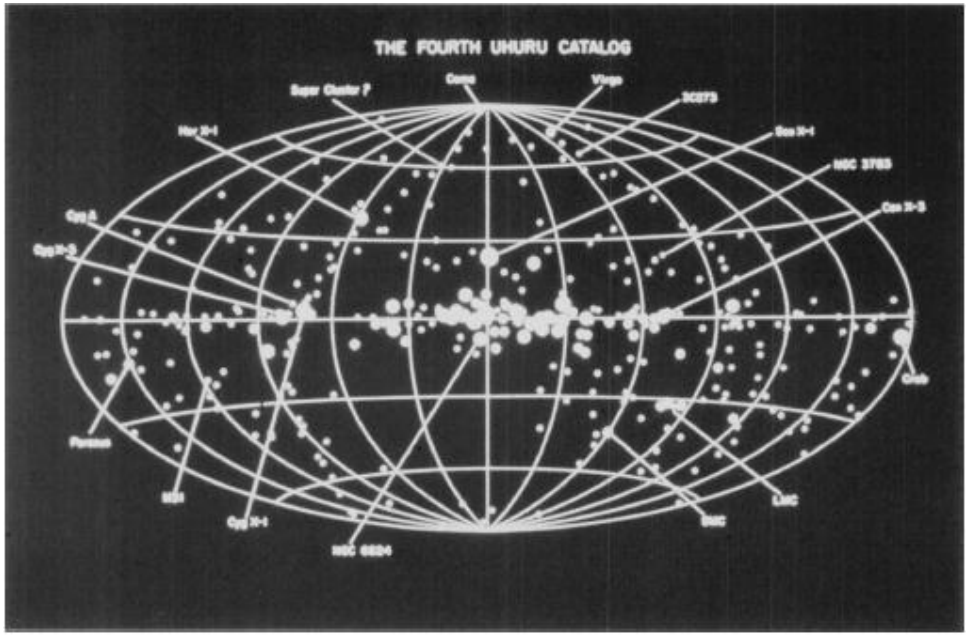
CsI -coater GEMs!



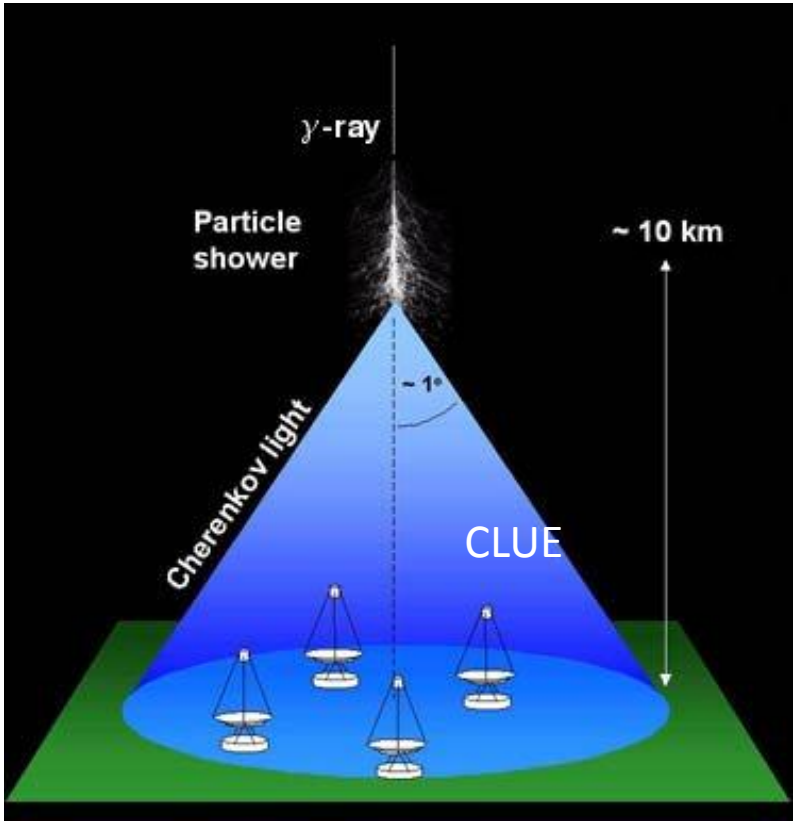
From COMPASS to TOTEM…

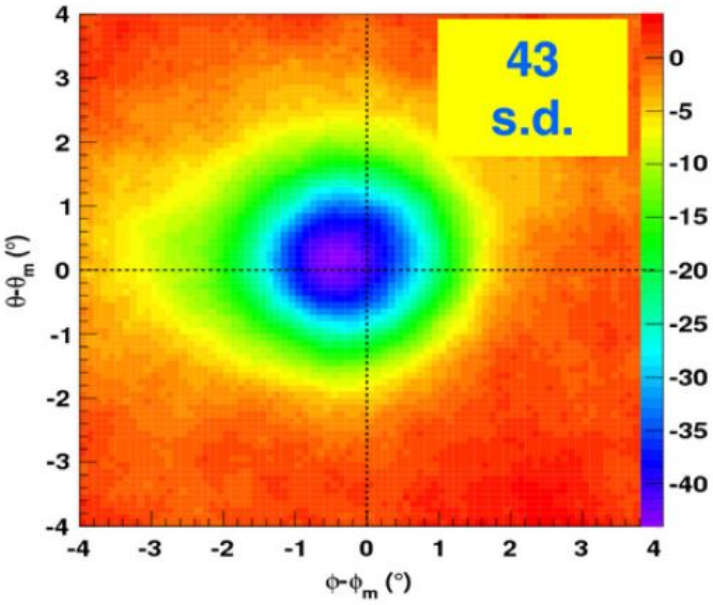


…in astrophysics

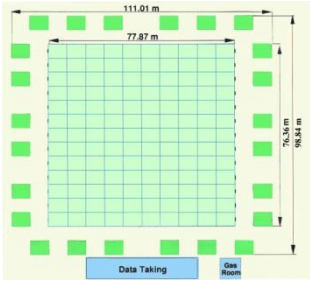


X-ray source map
(Giacconi Noble prize)

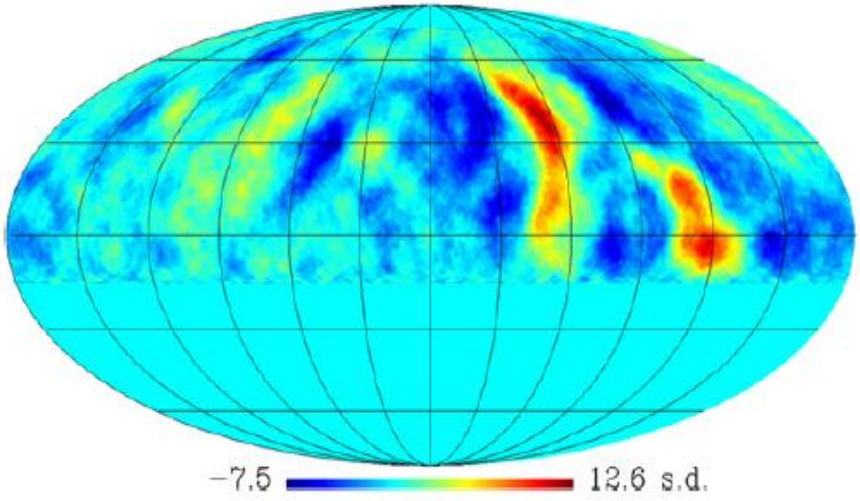




Moon shadow significance map
(obtained from analysis of air showers)

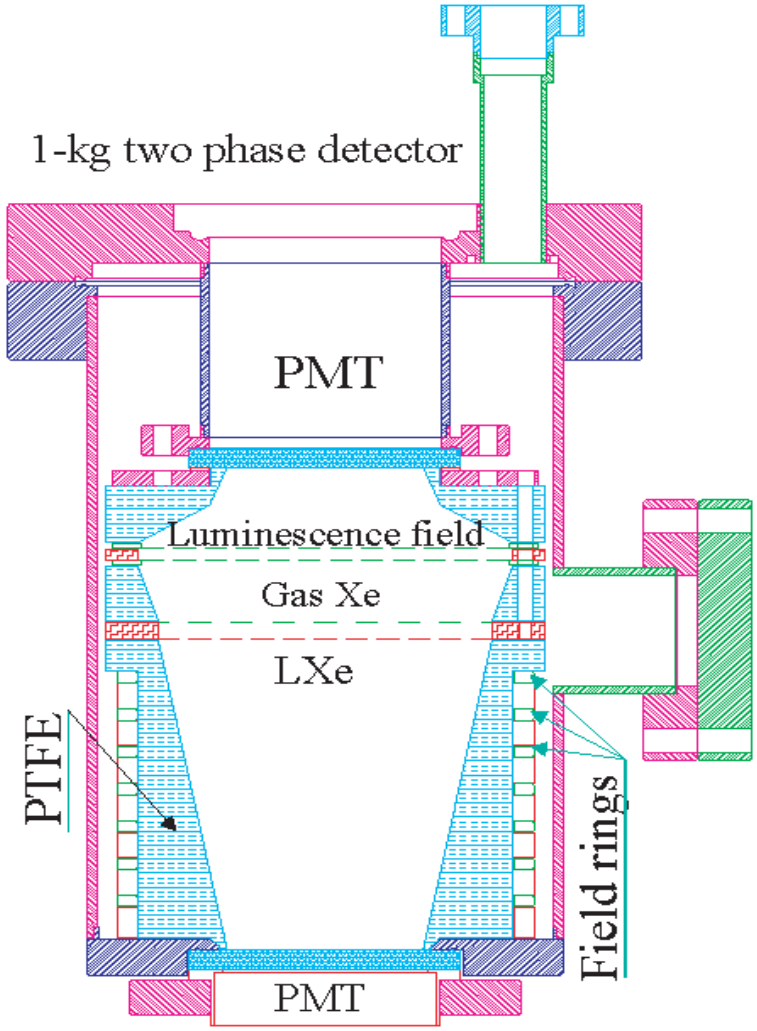


ARGO cosmic rays visualizing
RPCs

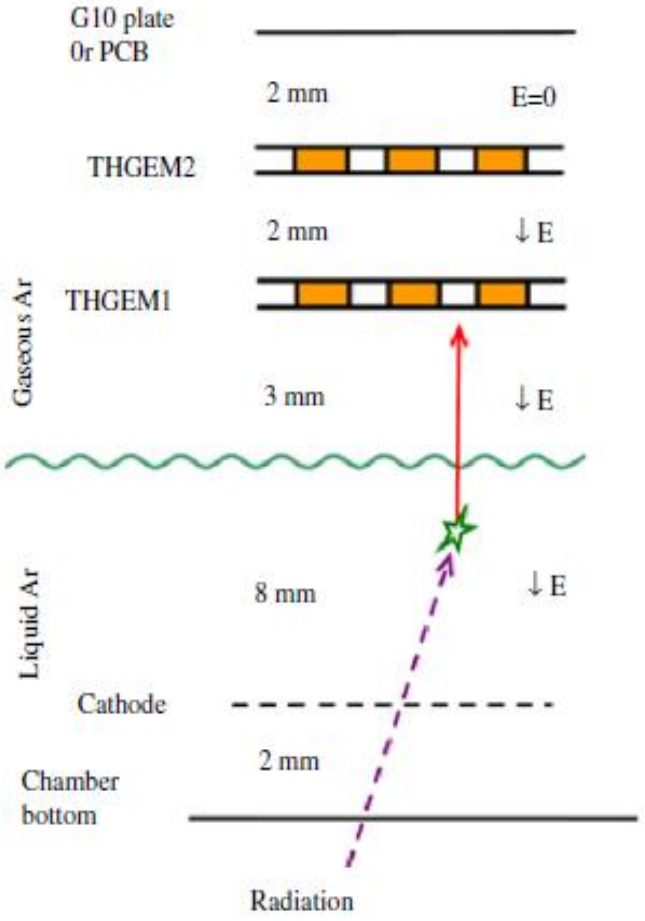


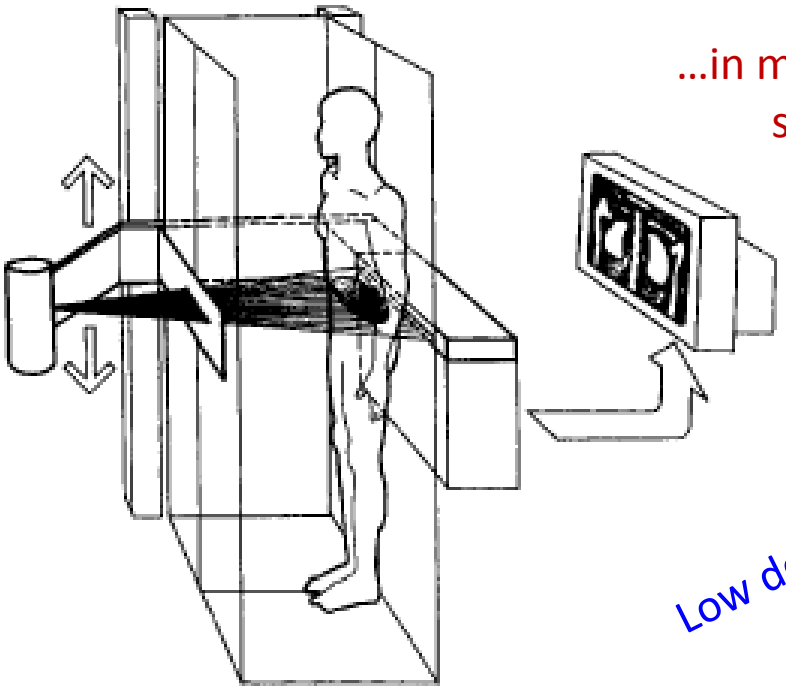
Medium scale say map (an anisotropy was discovered)

…in underground experiments



?



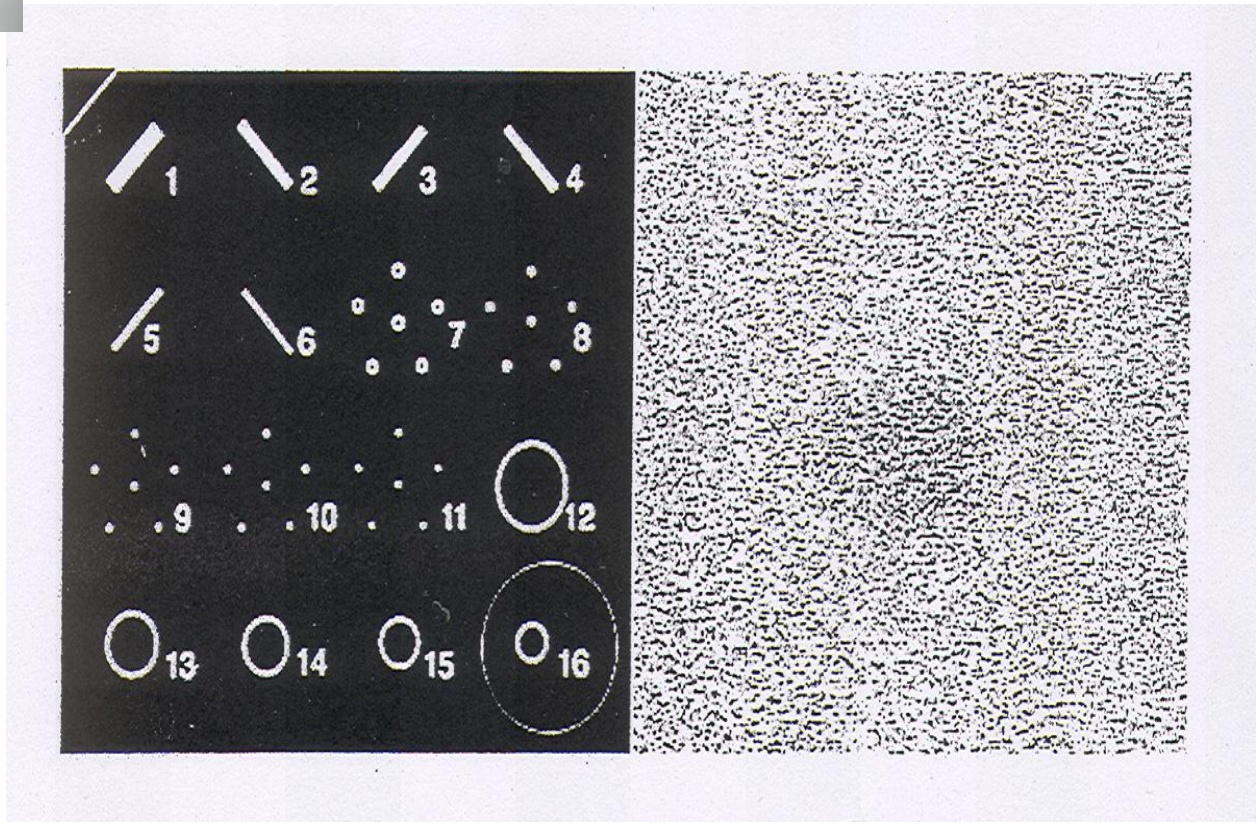


…in medicine and security

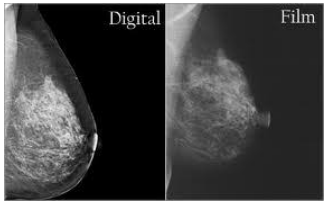
Low dose scanners!

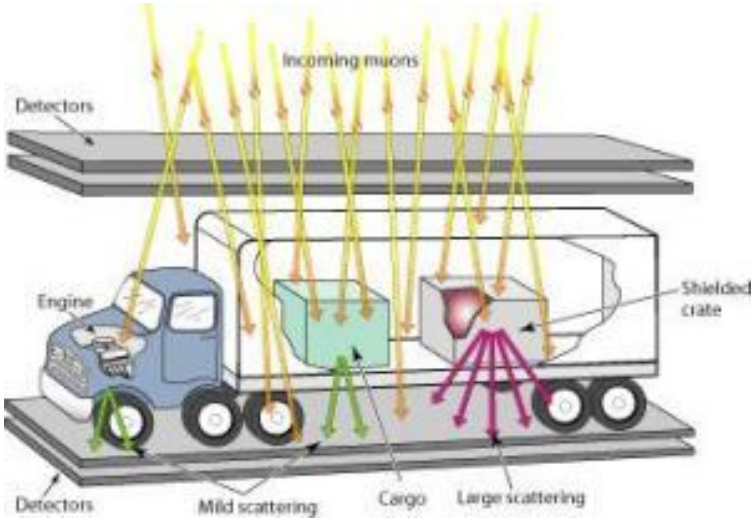
Novosibirsk (delivered dose is equivalent of 10 min of flight!)

Biosapce

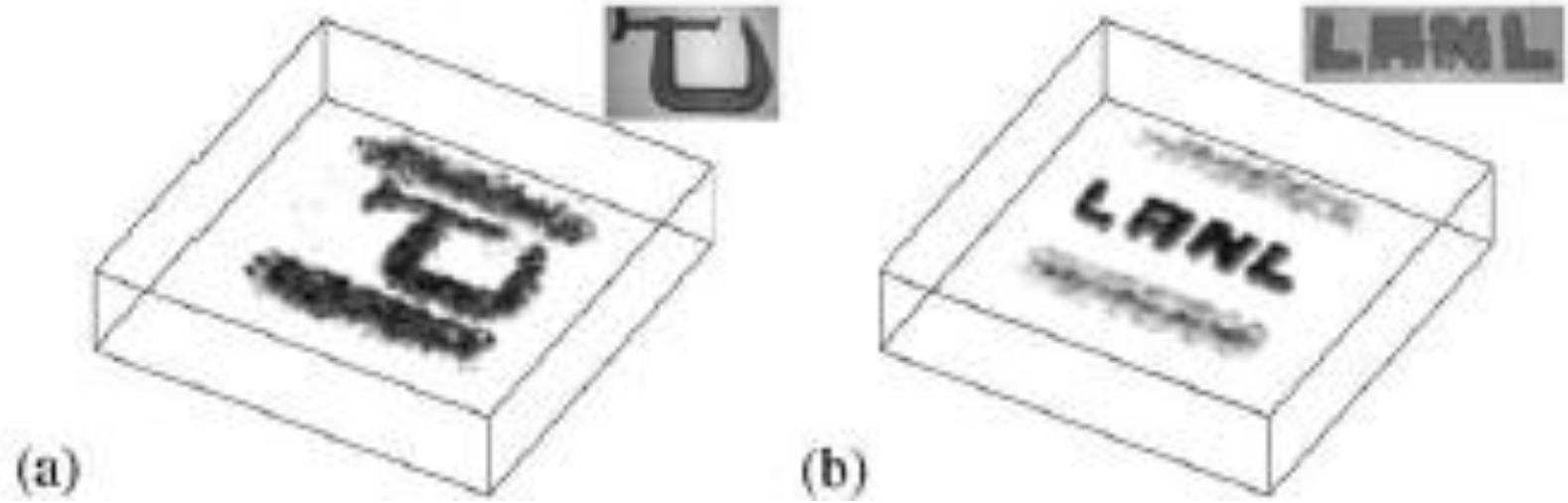


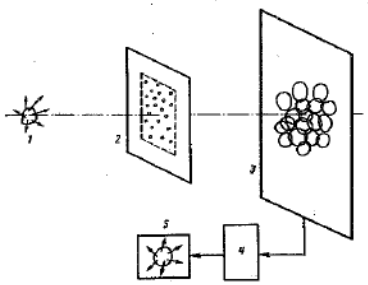
Microgap-microstrip RRPC for mammography (XCounter AB)
(10 time less dose)



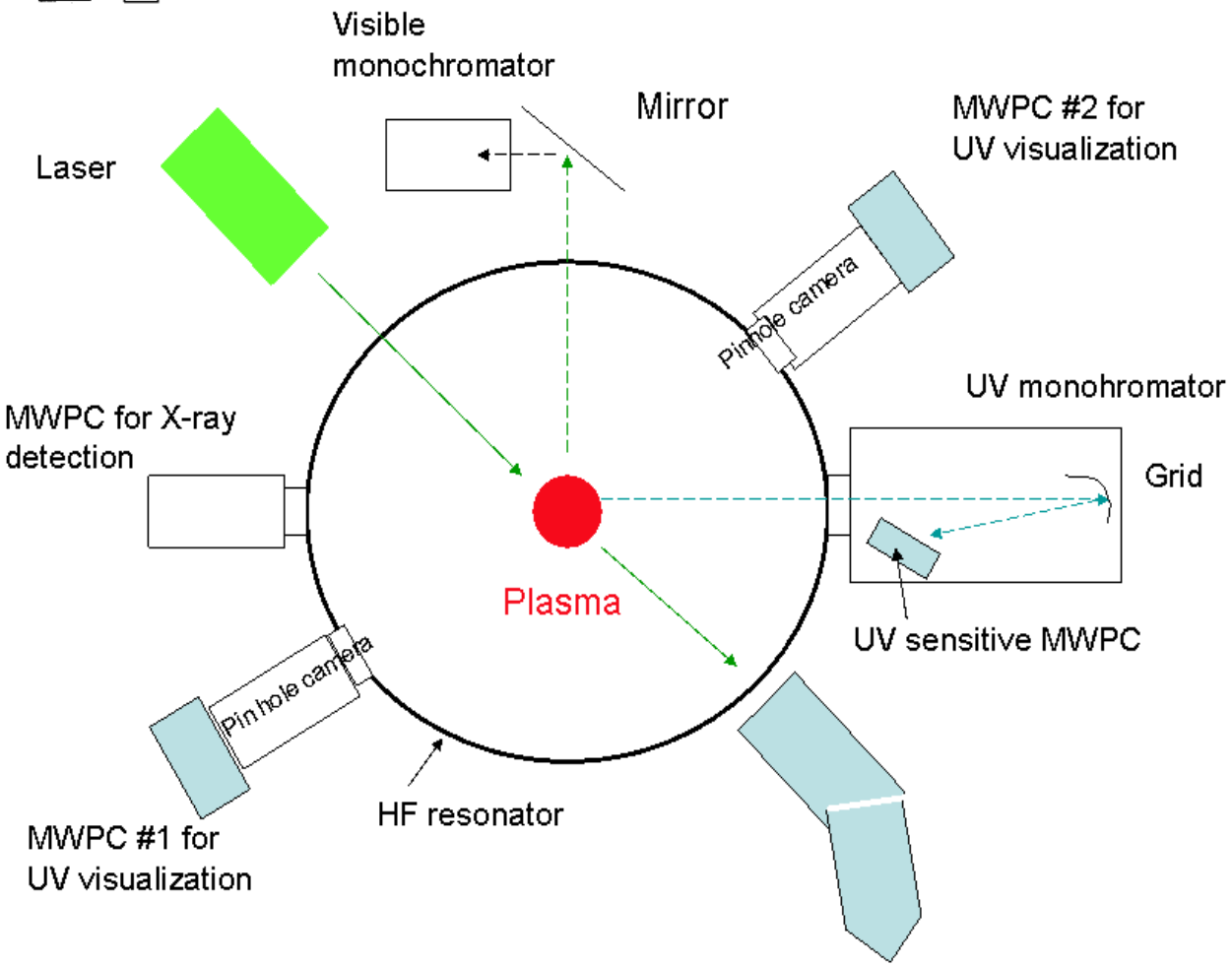


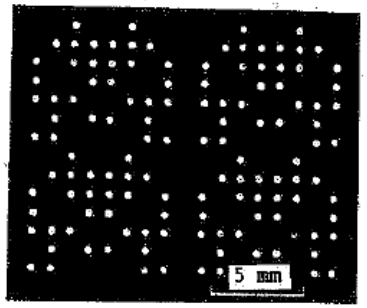
…in muon tomography



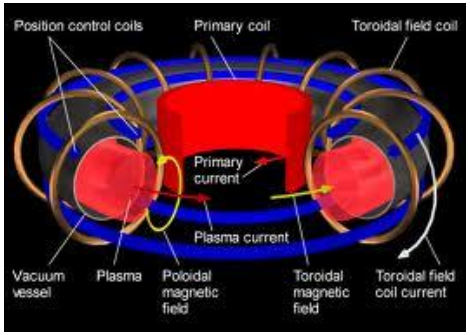


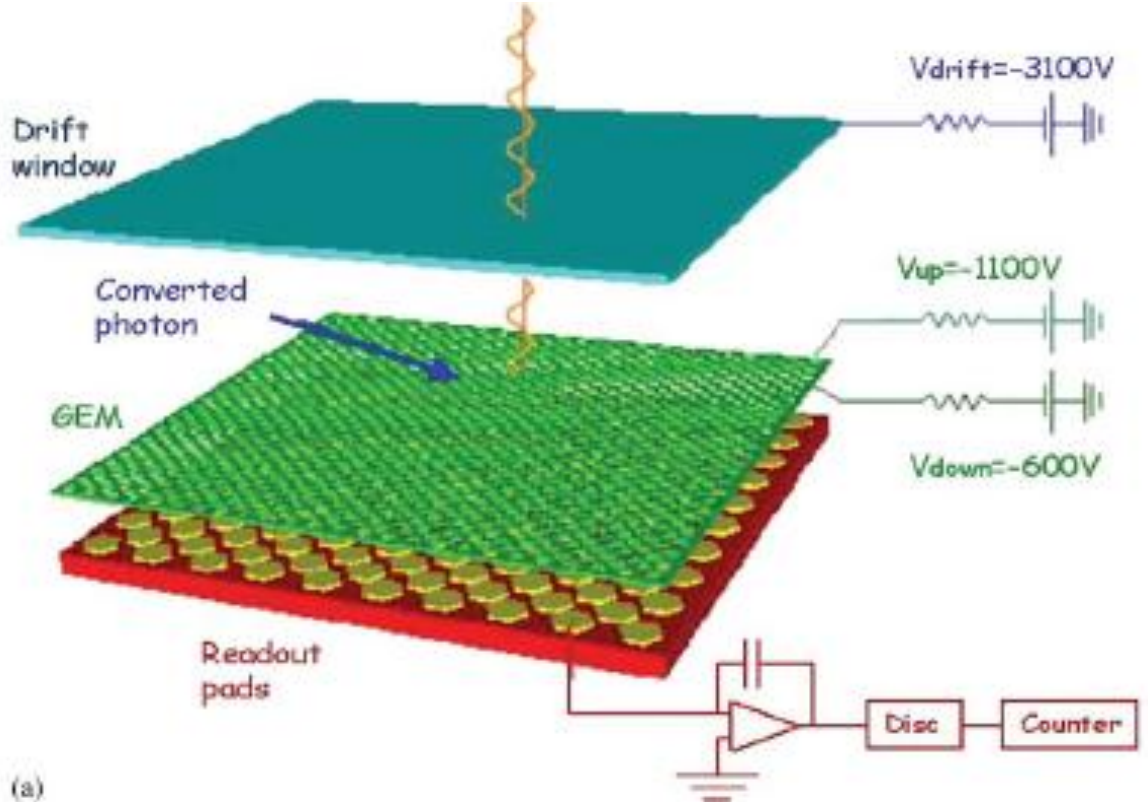
…in plasma diagnostics



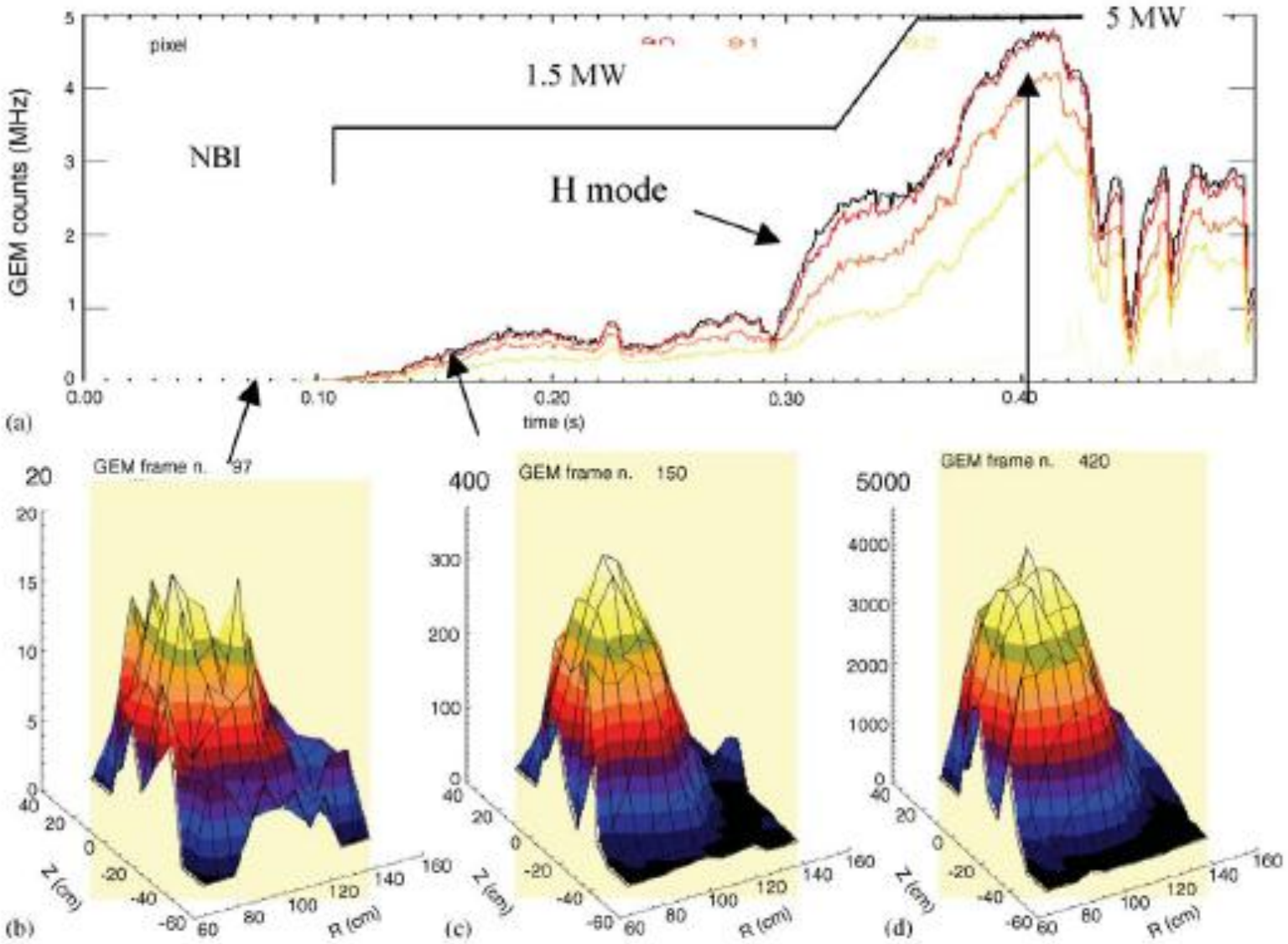


…P.L. Kapitza Lab



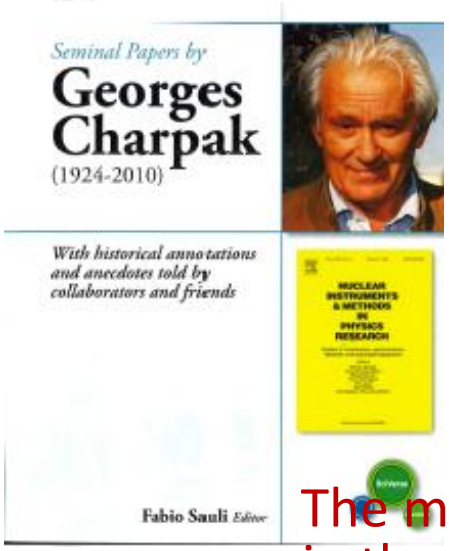


Bellazzini X-ray detector for plasma studies



…time resolved images of Tokamak plasma

… and so on



Conclusion:

The monograph is a **summary** of main developments in the field of gaseous detectors and, hopefully, it will be useful for various specialists(physicists, engineers, medical physicists etc) and especially for newcomers to this field (students, freshmen…)

It will be difficult to accomplish this work without daily interactions with our colleagues and especially with the RD51 members

Thank you!