Mesurer l'infiniment petit et observer l'infiniment grand

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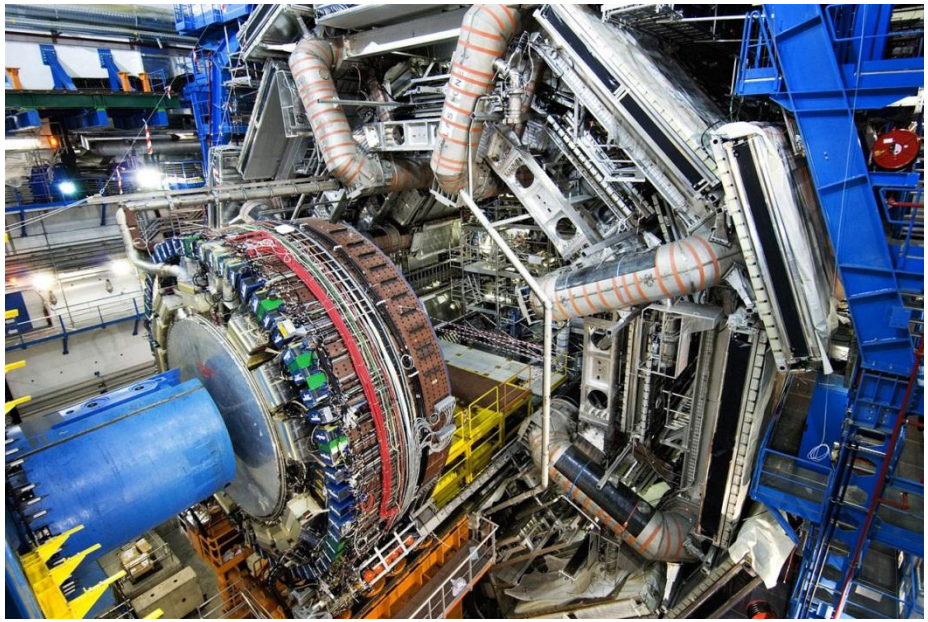
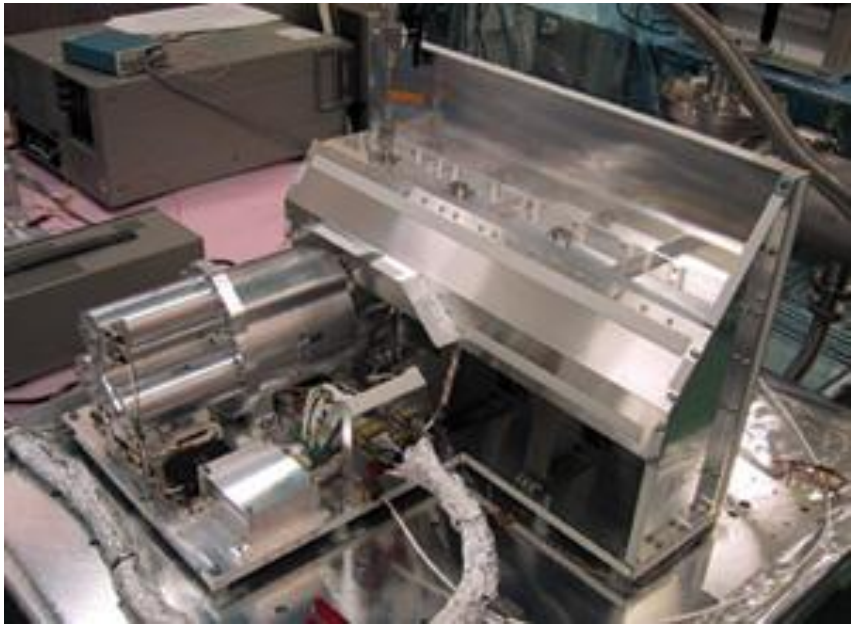


Détecteur ATLAS - CERN

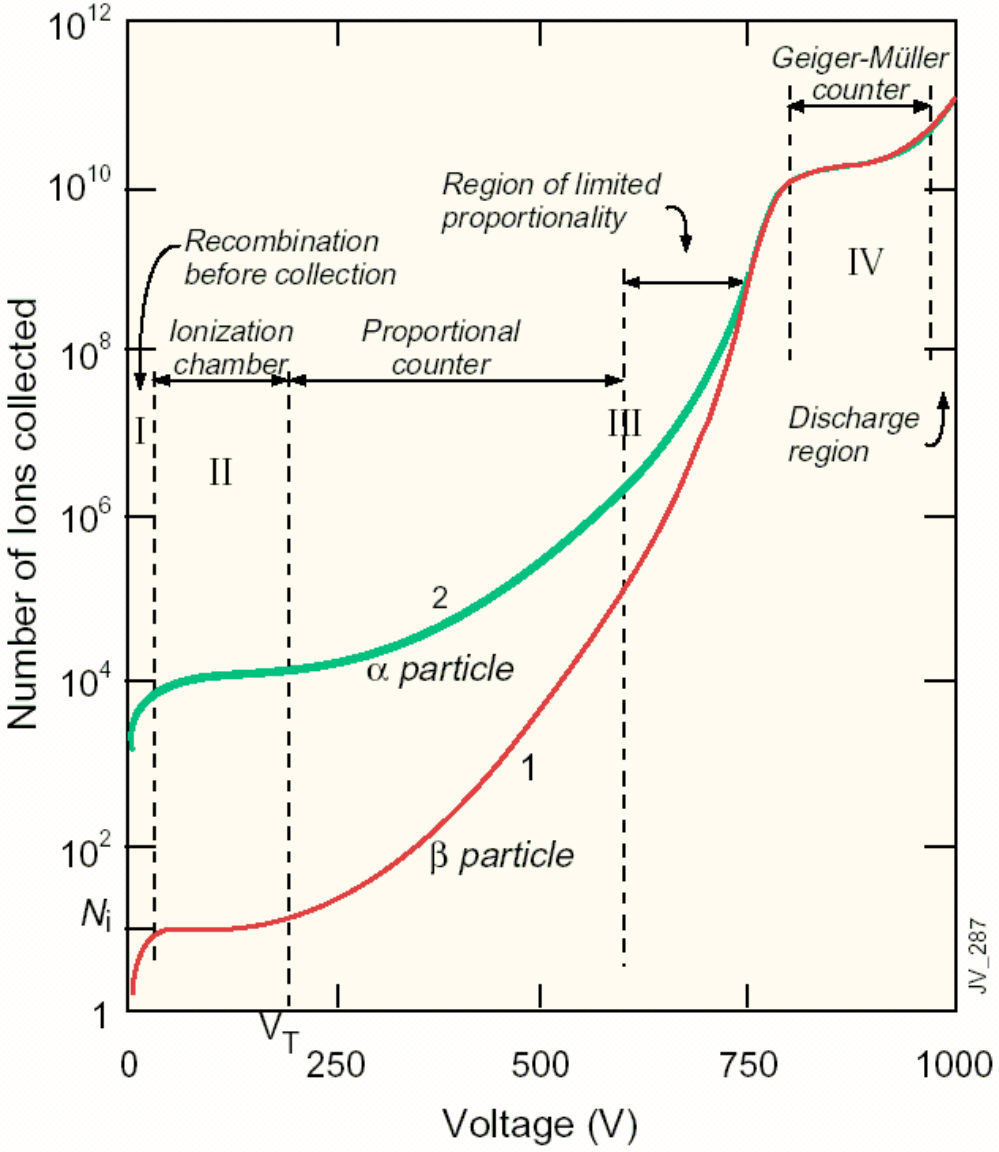


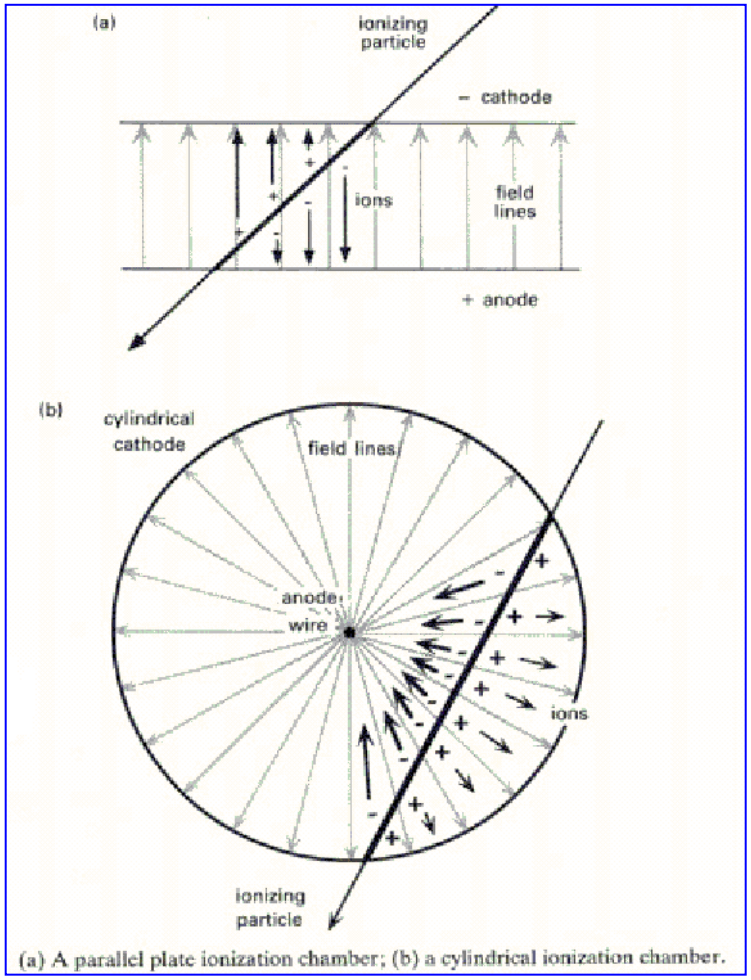
Détecteur GRD- KAGUYA

Plan des cours

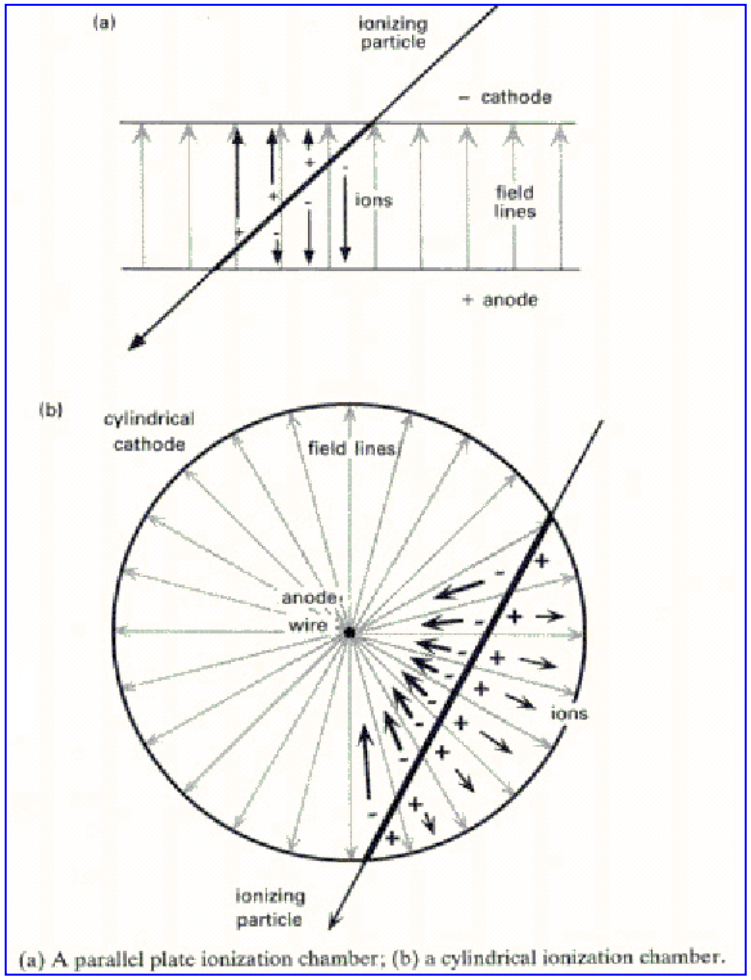
- 1er cours
  - Comment mesurer des particules subatomiques?
  - Comment ces particules interagissent-elles avec la matière?
- 2ème cours
  - Les détecteurs à ionisation
  - Les détecteurs à scintillation
- 3ème cours
  - Les détecteurs semi-conducteurs
  - L'électronique de lecture

Les détecteurs à ionisation

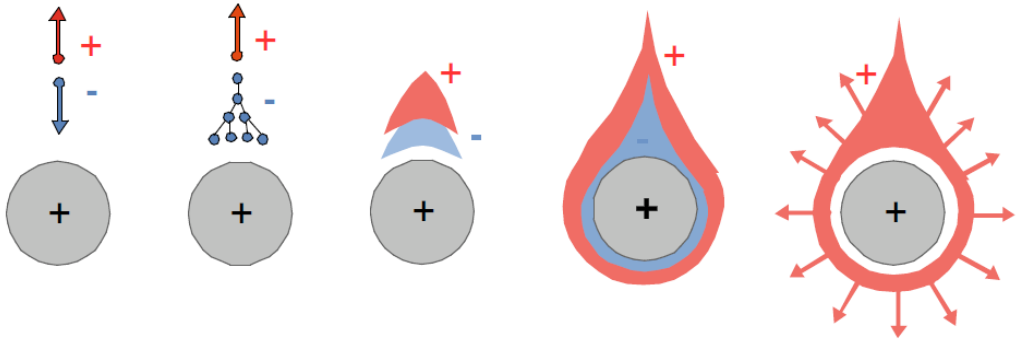

Number of Ions collected
10^{12}
10^{10}
10^{8}
10^{6}
10^{4}
10^{2}
1
N_i
V_T
0
250
500
750
1000
Voltage (V)
Geiger-Müller counter
Region of limited proportionality
Recombination before collection
Ionization chamber
Proportional counter
Discharge region
I
II
III
IV
2
α particle
1
β particle
JV_287

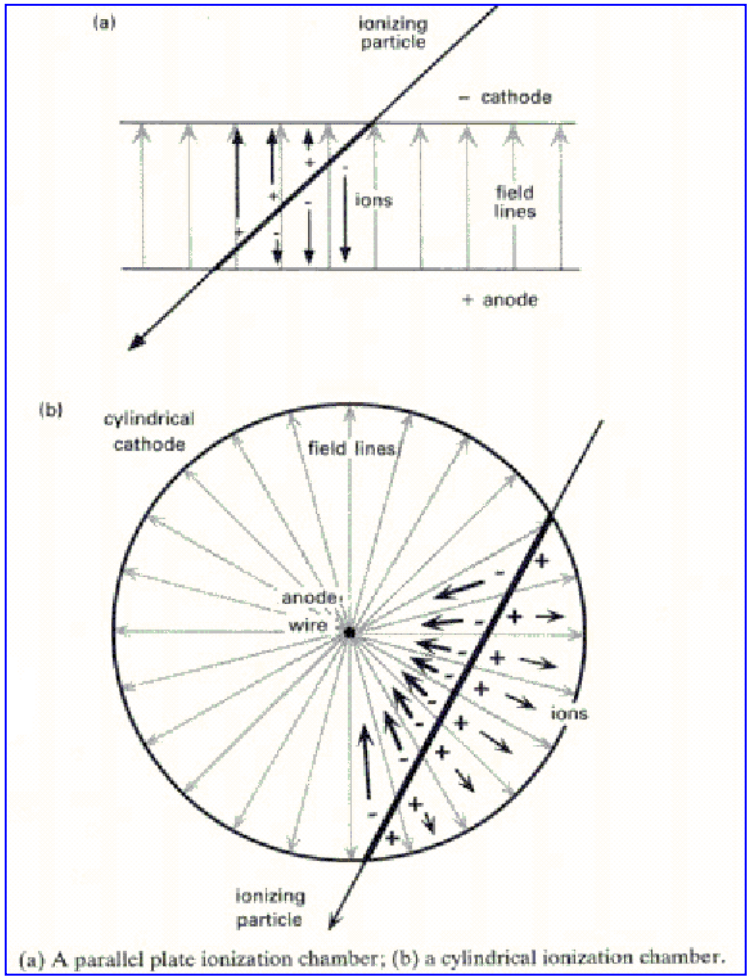


(a) A parallel plate ionization chamber; (b) a cylindrical ionization chamber.



(a) A parallel plate ionization chamber; (b) a cylindrical ionization chamber.





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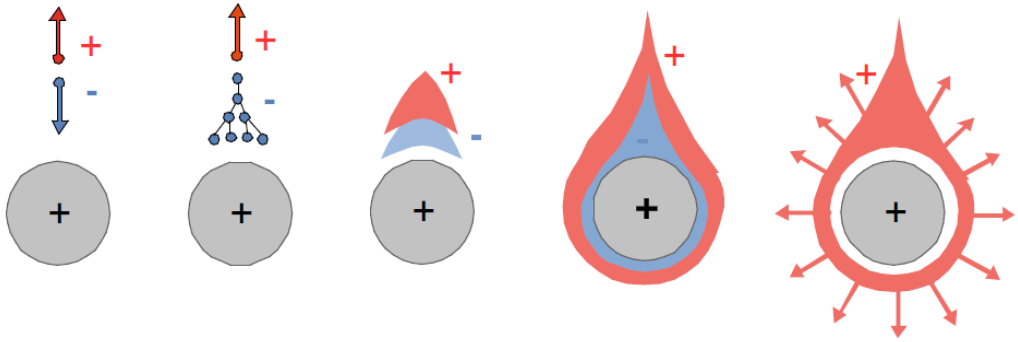
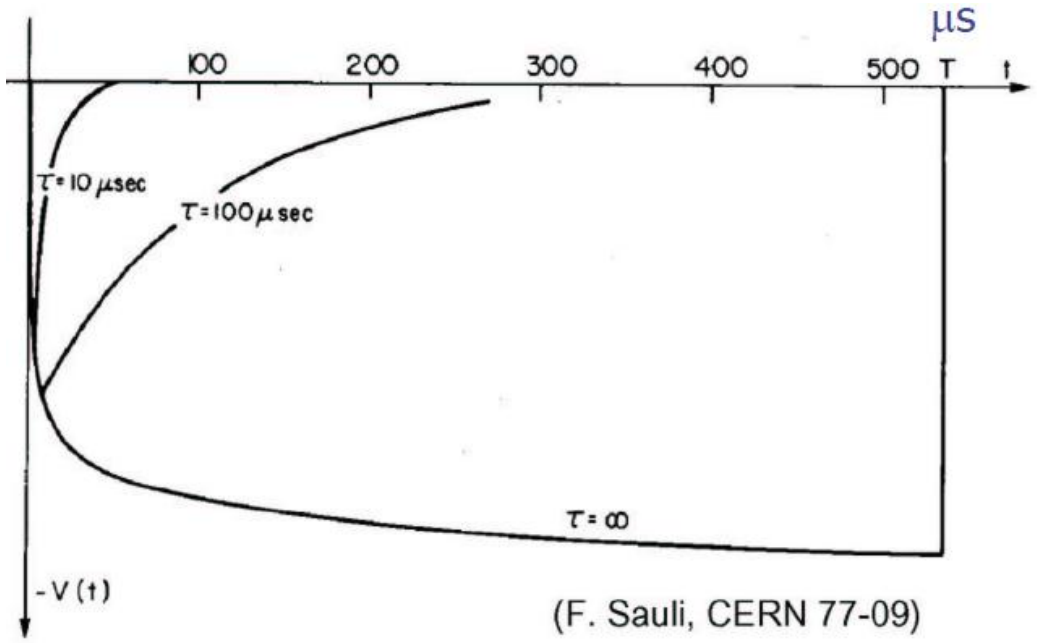
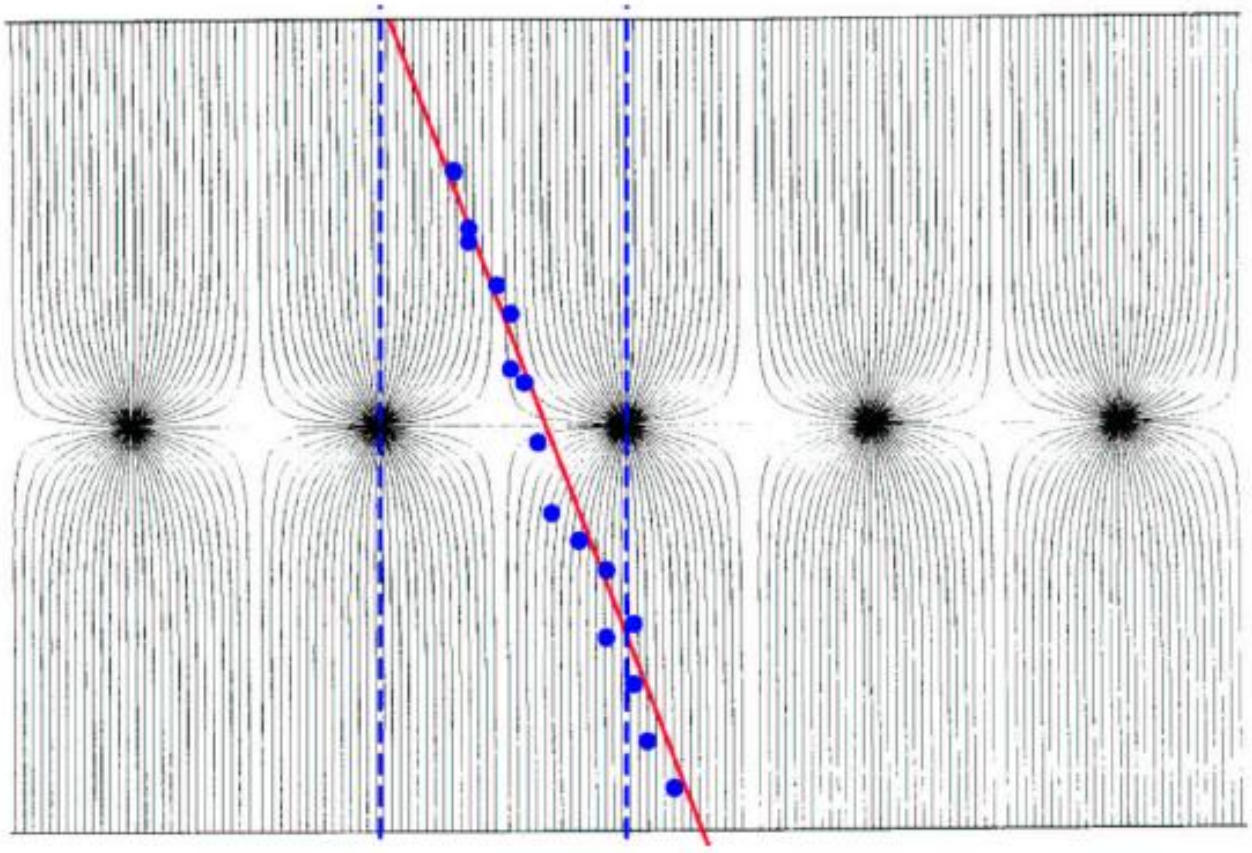
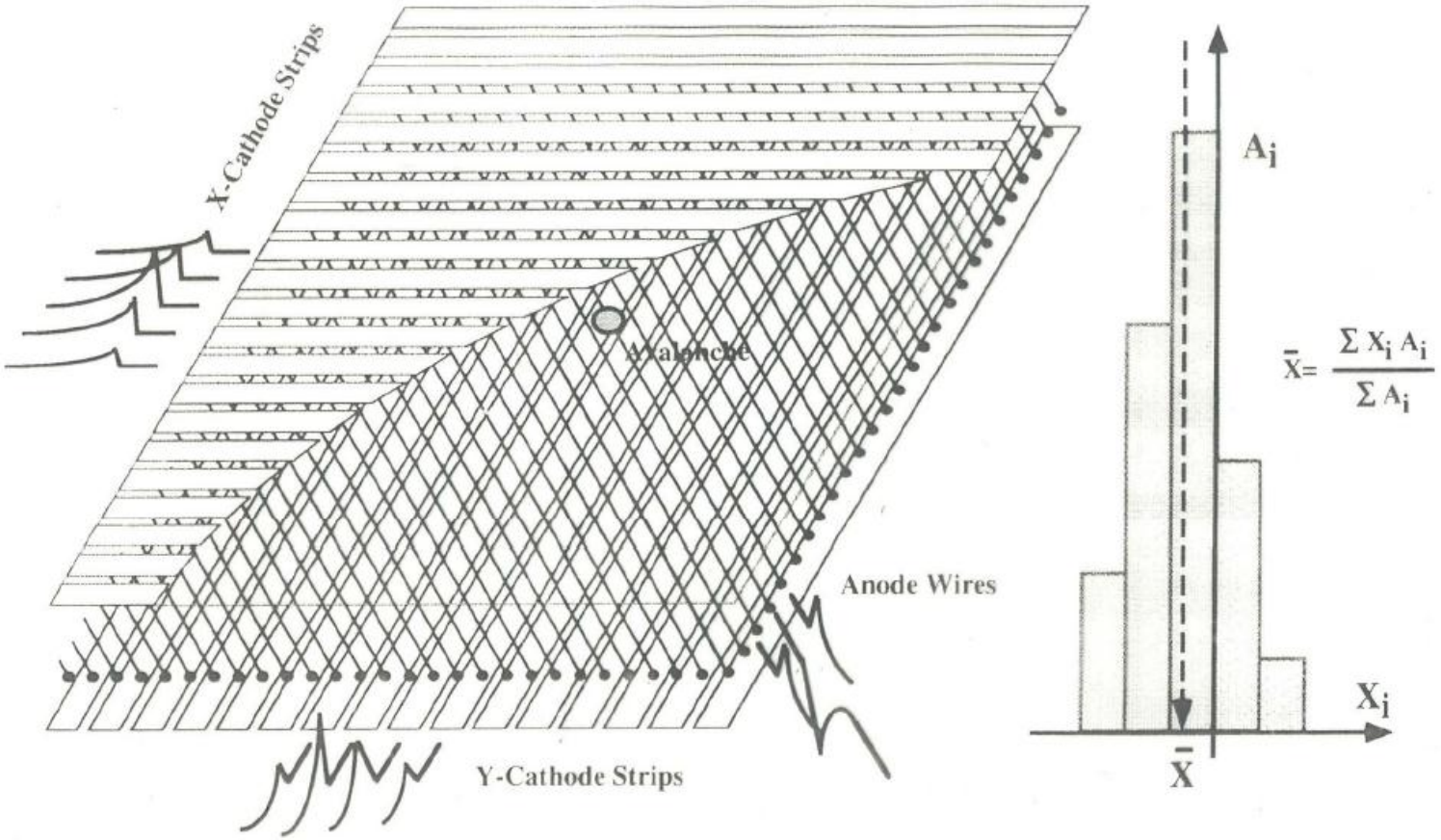
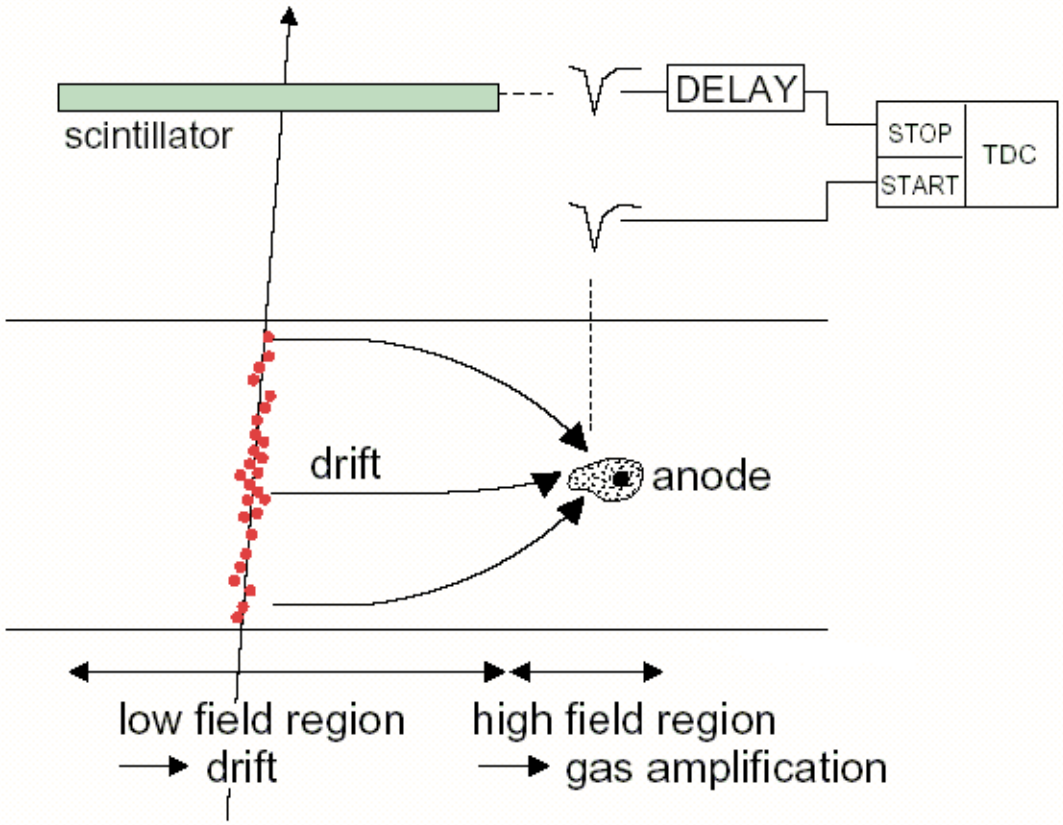




(F. Sauli, CERN 77-09)

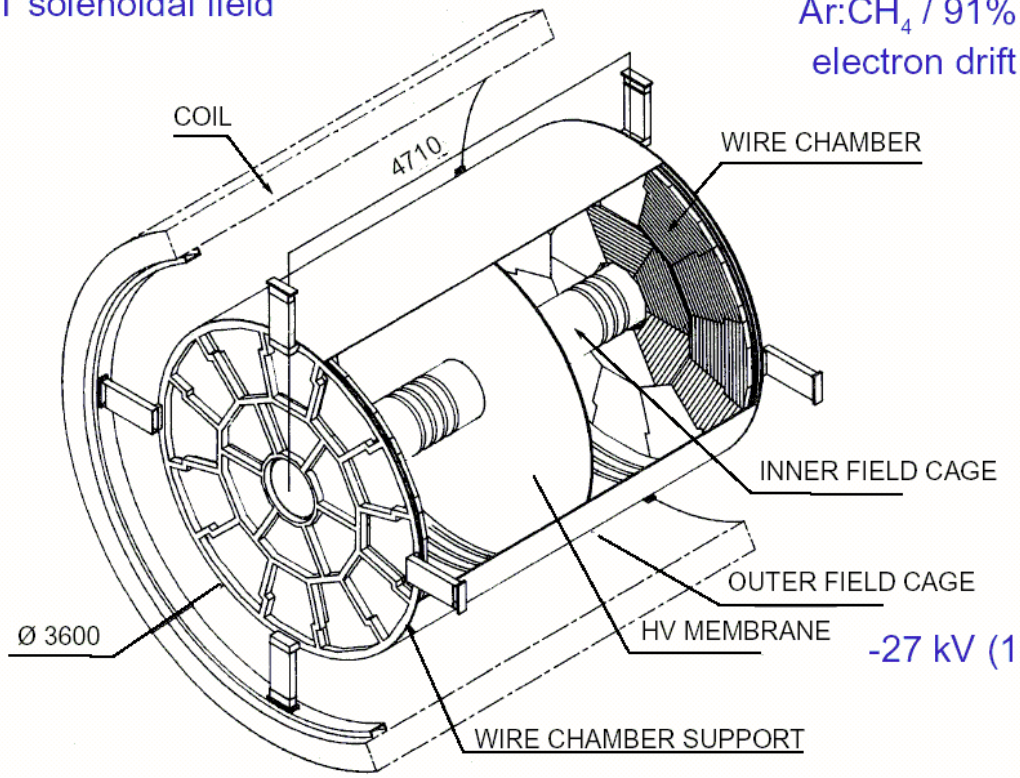


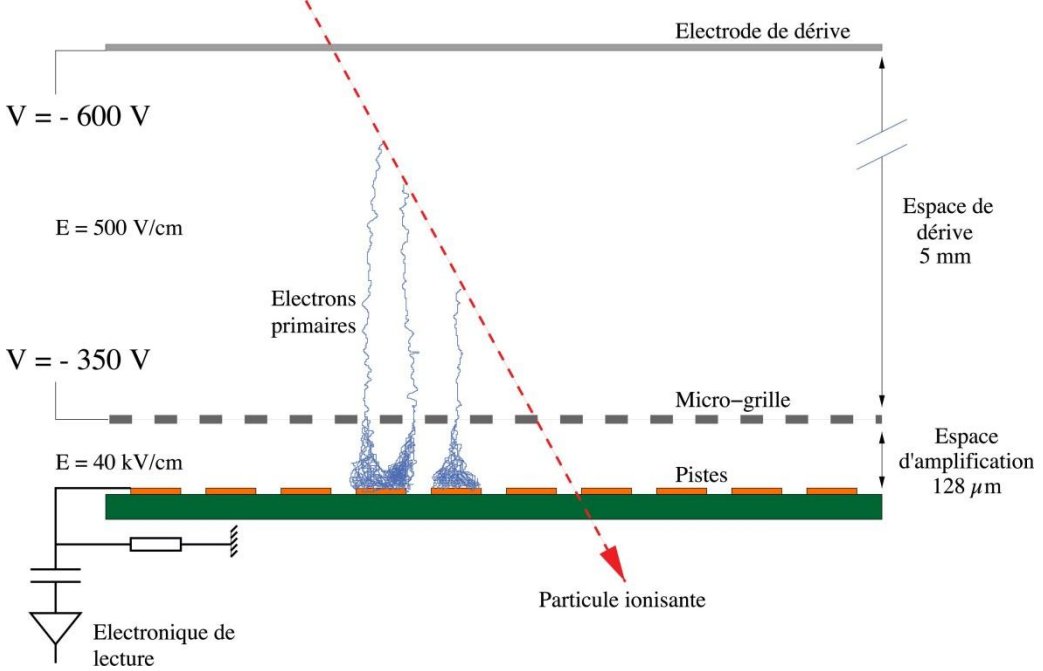

X-Cathode Strips
Avalanche
Anode Wires
Y-Cathode Strips
A_i
$\bar{X} = \frac{\Sigma X_i A_i}{\Sigma A_i}$
X_i
$\bar{X}$

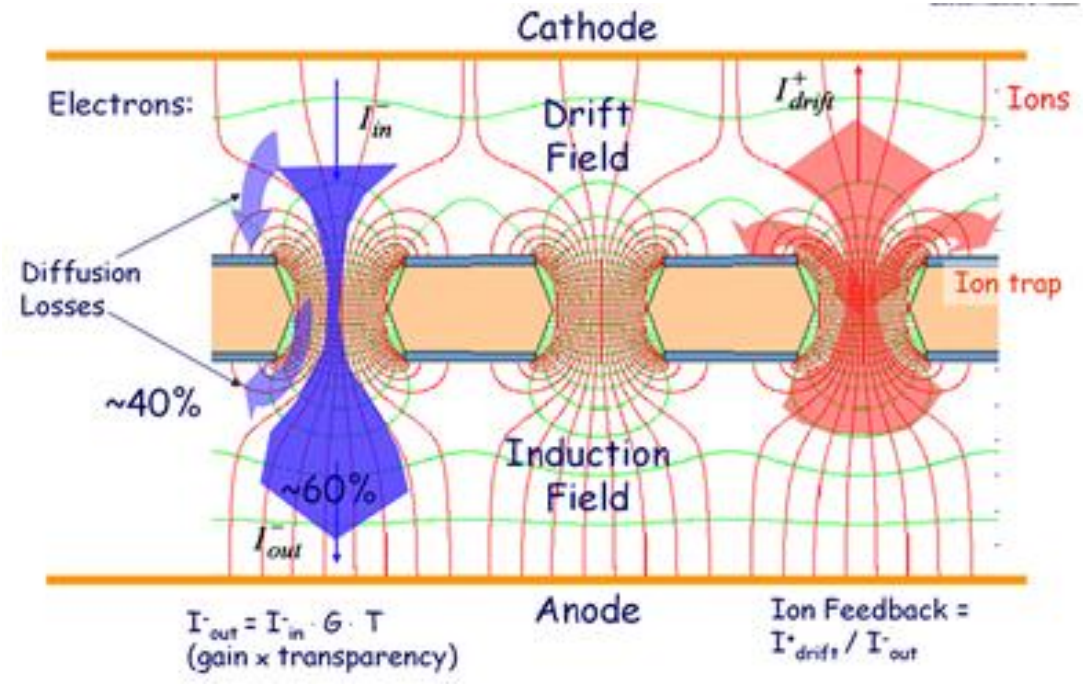

scintillator
DELAY
STOP
START
TDC
drift
anode
low field region
drift
high field region
gas amplification

1.2 T solenoidal field

Ar:CH_4 / 91%:9% at 1 atm
electron drift time ≈ 45 μs

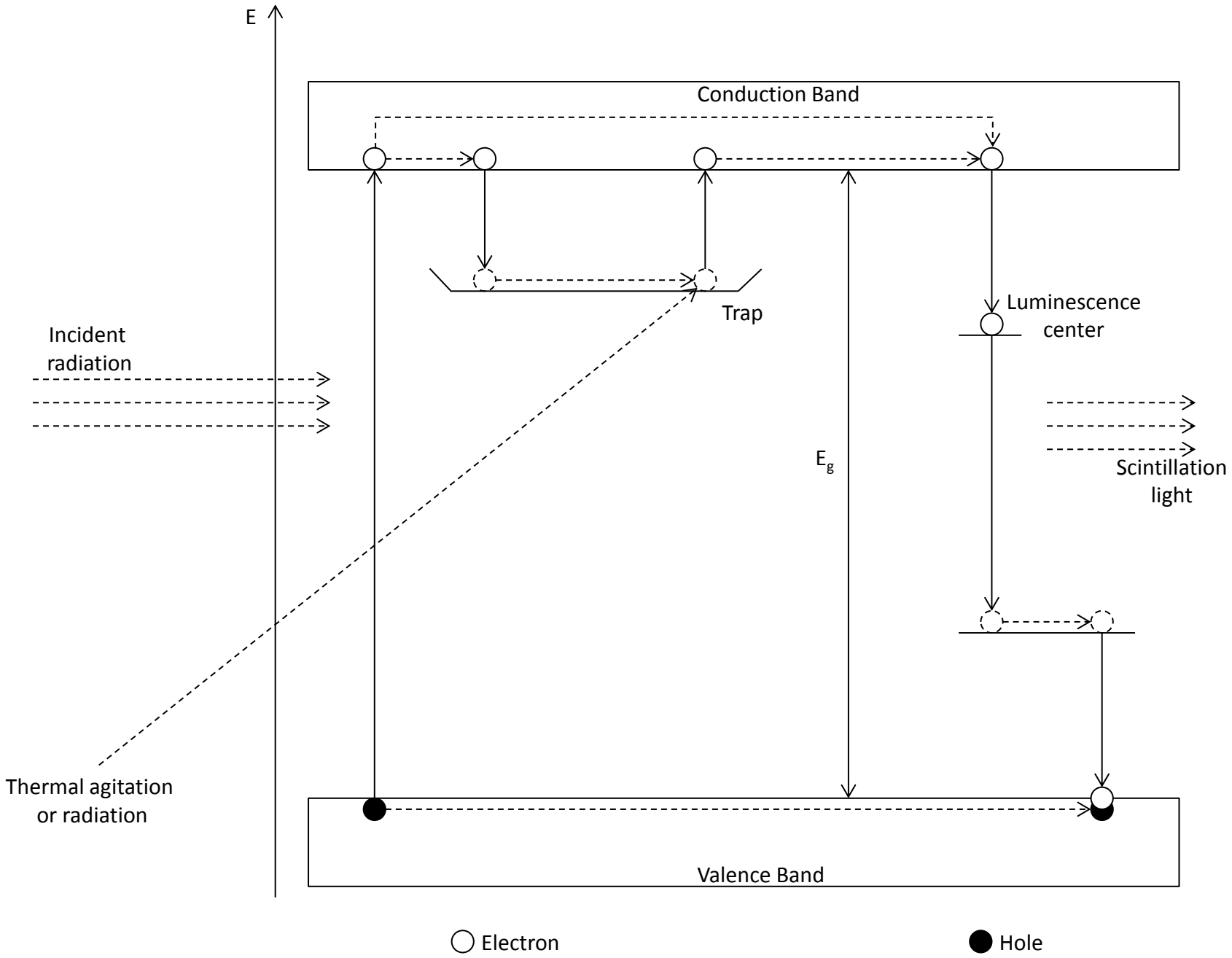


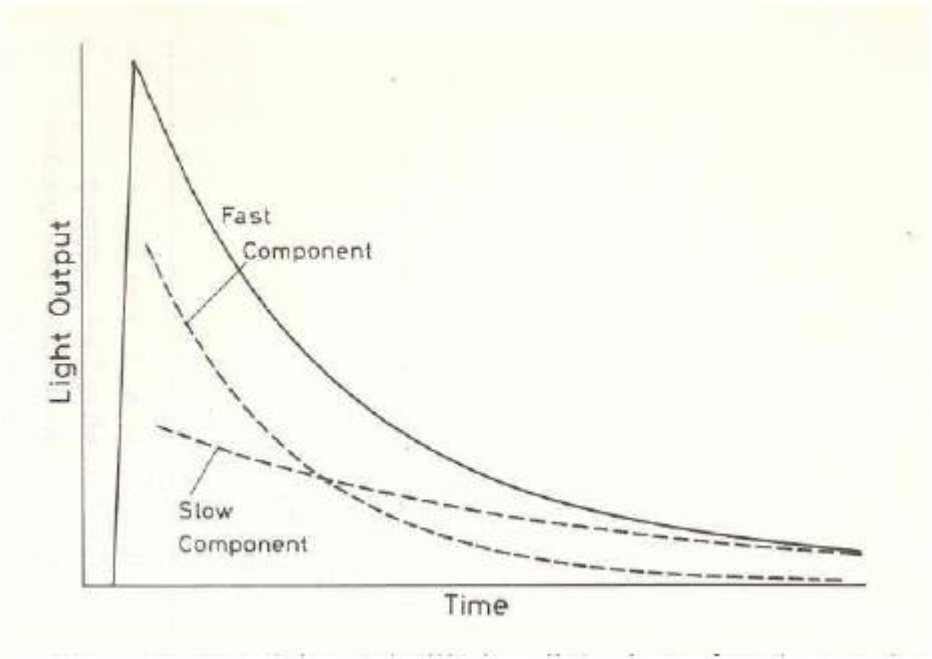

Electrode de dérive
V = - 600 V
E = 500 V/cm
Espace de dérive 5 mm
Electrons primaires
V = - 350 V
Micro−grille
Espace d'amplification 128 μm
E = 40 kV/cm
Pistes
Particule ionisante
Electronique de lecture

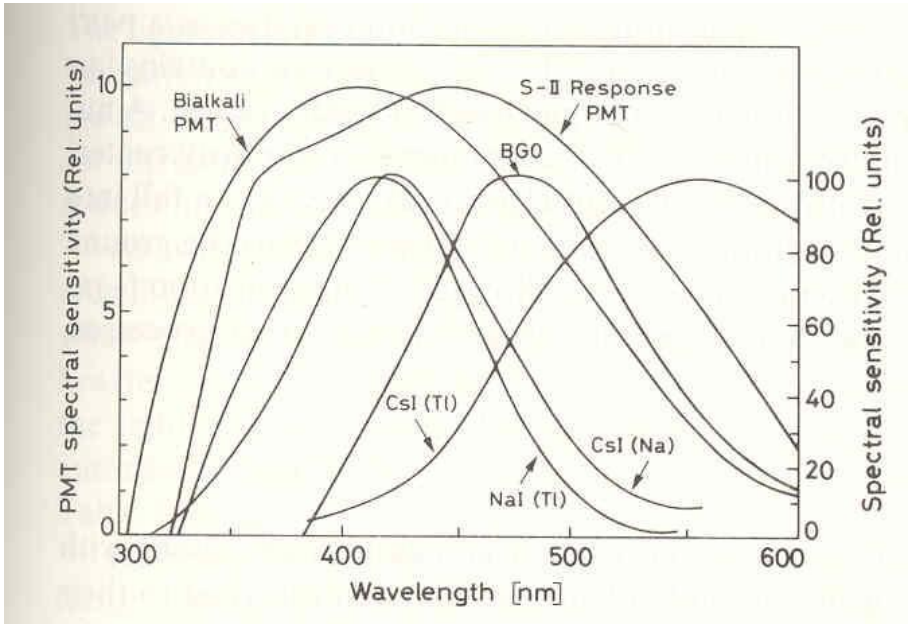

Cathode
Electrons:
I^-_{in}
Drift Field
I^+_{drift}
Ions
Diffusion Losses
Ion trap
~40%
~60%
Induction Field
I^-_{out}
Anode
$I^-_{out} = I^-_{in} \cdot G \cdot T$
(gain x transparency)
Ion Feedback = I^+_{drift} / I^-_{out}

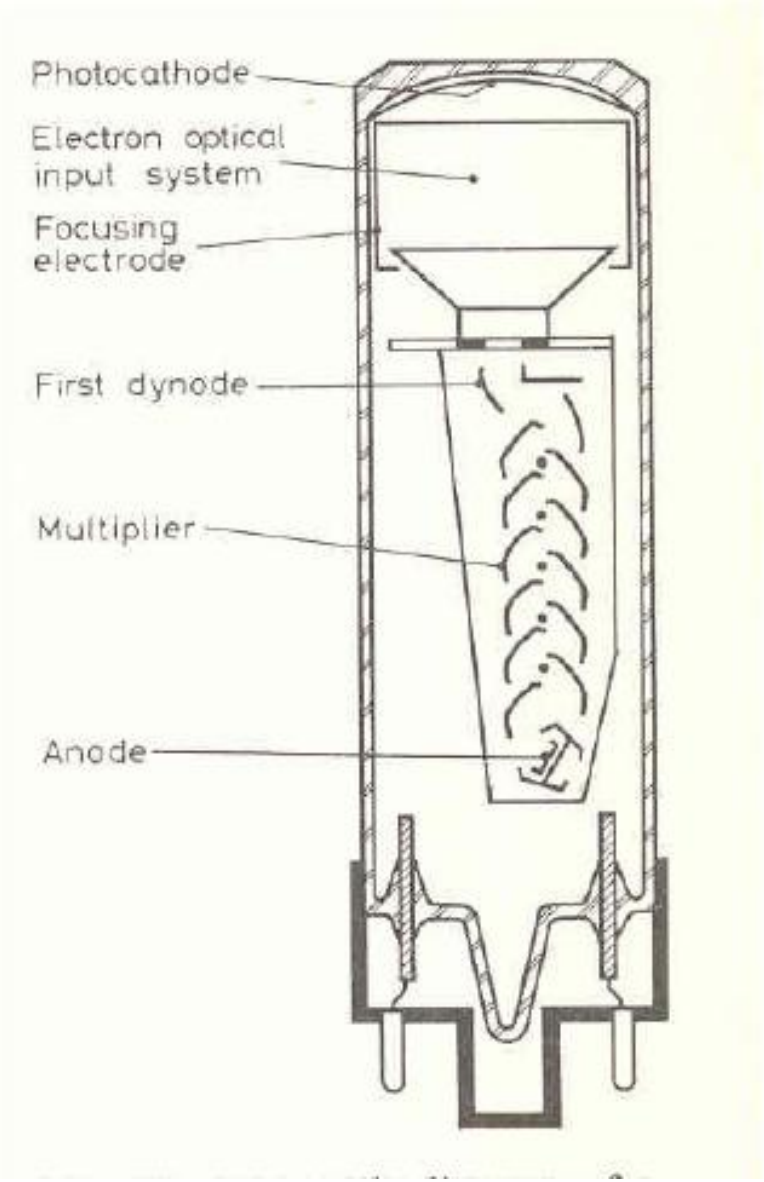
Les détecteurs à scintillation

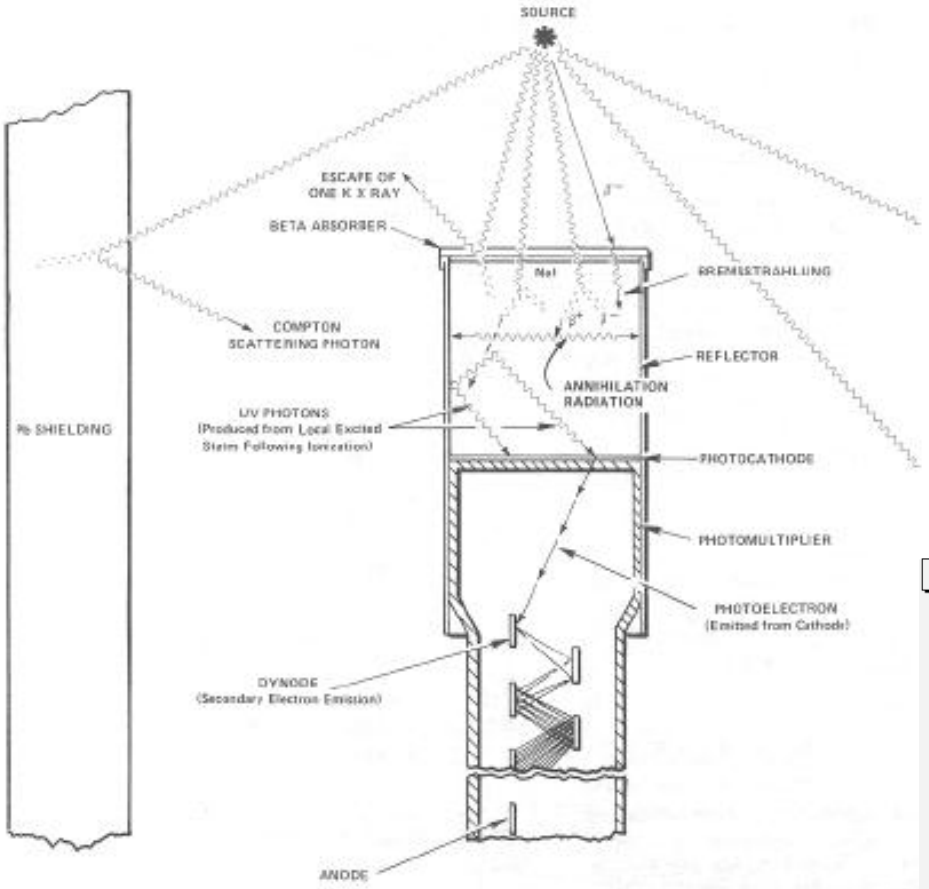
Principe du mécanisme de scintillation

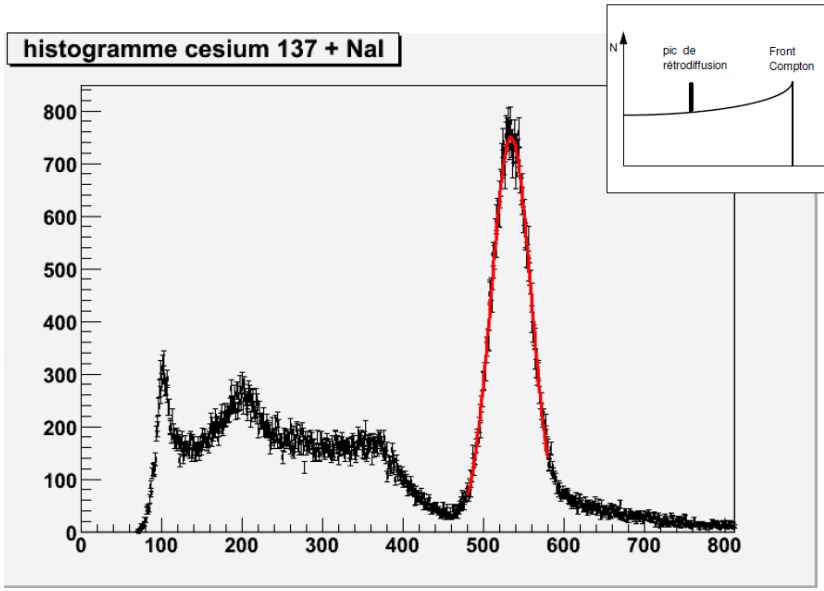



Light Output
Fast
Component
Slow
Component
Time


PMT spectral sensitivity (Rel. units)
Spectral sensitivity (Rel. units)
Wavelength [nm]
Bialkali
PMT
S-II Response
PMT
BGO
CsI (Tl)
CsI (Na)
NaI (Tl)
10
5
0
100
80
60
40
20
0
300
400
500
600


Photocathode
Electron optical input system
Focusing electrode
First dynode
Multiplier
Anode


SOURCE
ESCAPE OF ONE K X RAY
BETA ABSORBER
NaI
BREMSSTRAHLUNG
COMPTON SCATTERING PHOTON
REFLECTOR
ANNIHILATION RADIATION
Pb SHIELDING
UV PHOTONS (Produced from Local Excited States Following Ionization)
PHOTOCATHODE
PHOTOMULTIPLIER
PHOTOELECTRON (Emitted from Cathode)
DYNODE (Secondary Electron Emission)
ANODE


histogramme cesium 137 + NaI
800
700
600
500
400
300
200
100
0
0
100
200
300
400
500
600
700
800
N
pic de rétrodiffusion
Front Compton
pic photoélectrique
Eg