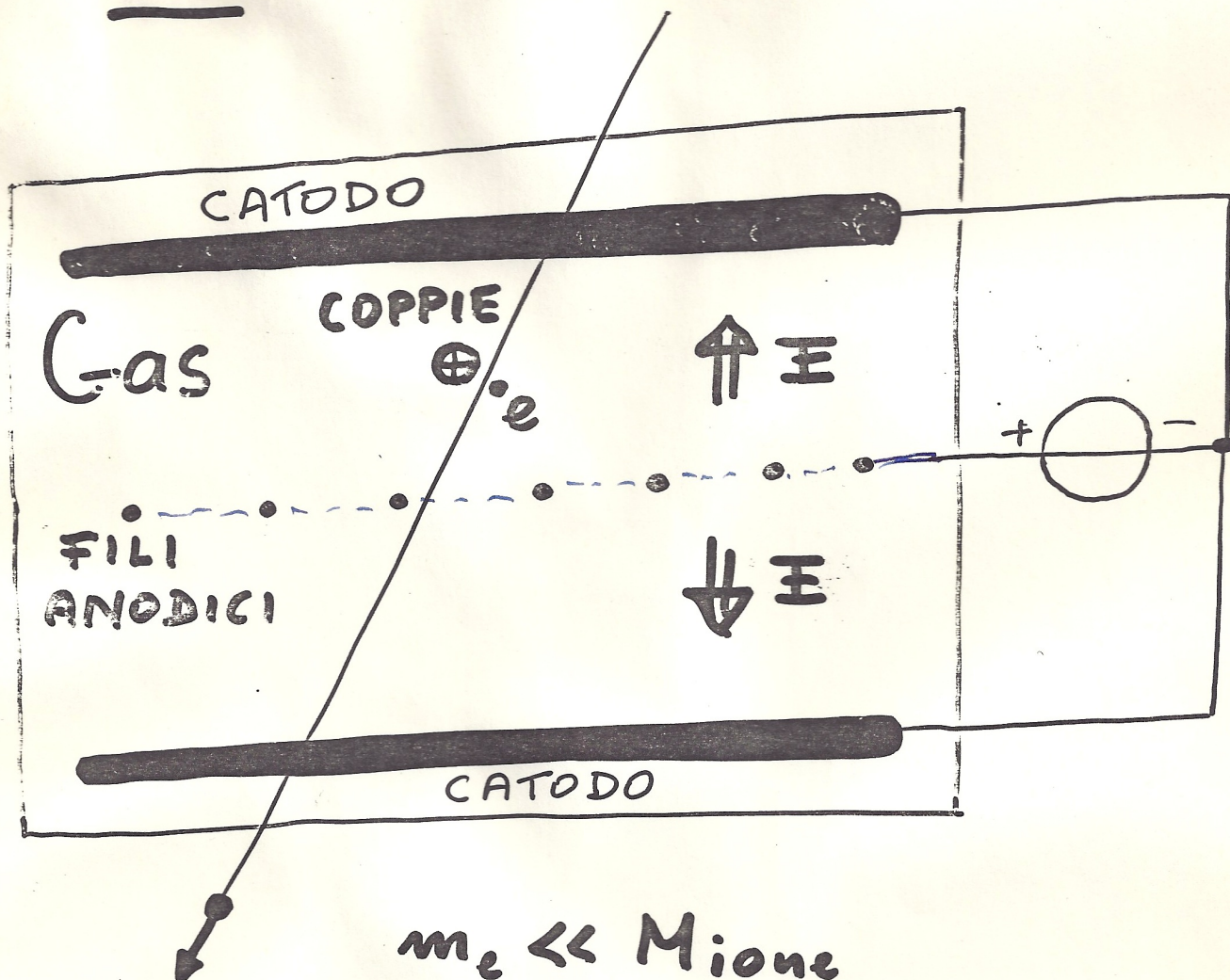


schema



$$m_e \ll M_{\text{ione}}$$

$$\text{mobilit\`a}(e) \gg \text{mobilit\`a}(\text{ione})$$

IL RIVELATORE OPERA SU e LIBERI

$\Rightarrow$ Gas non elettronegativi

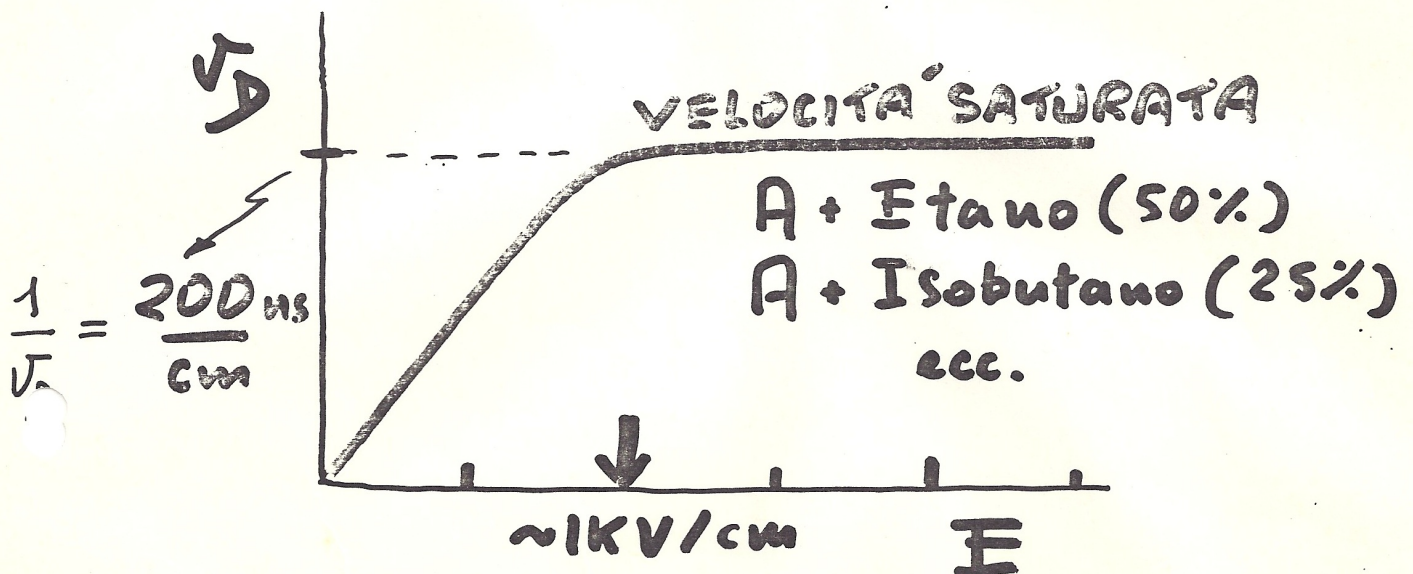
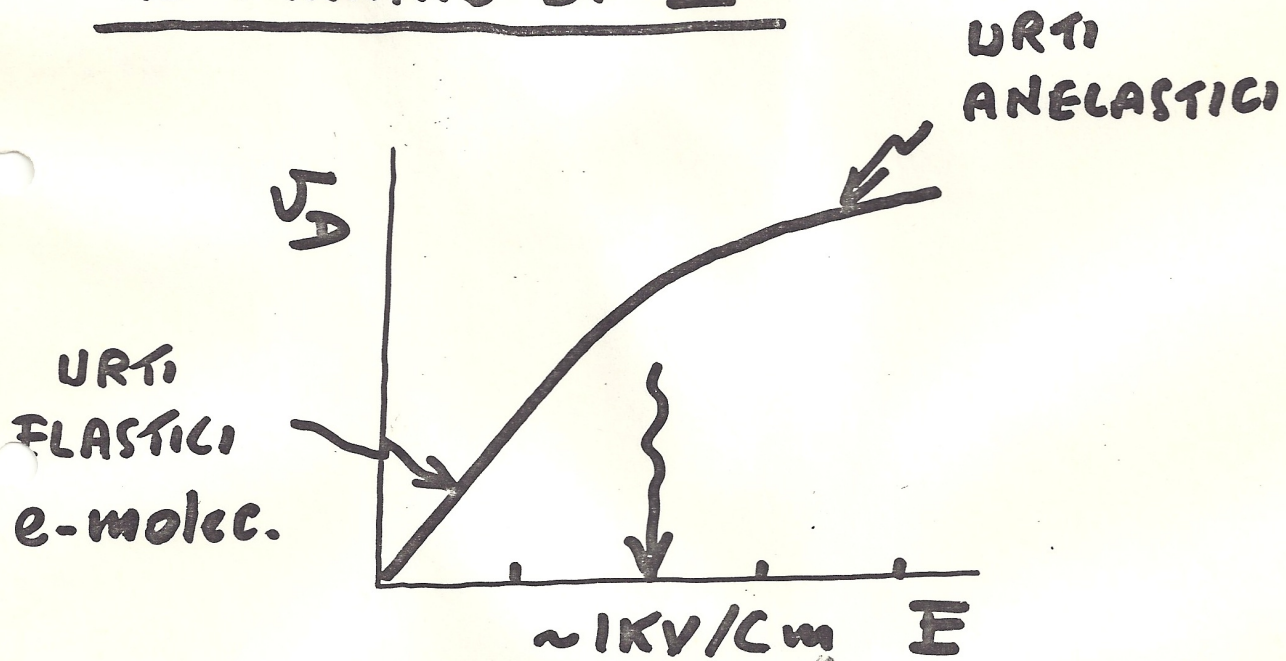
• A (He, Ne, Xe)

• Idrocarburi: METANO - ETANO
(CO₂) PROPANO - ISOBUTANO
PENTANO

TIPICA MISCELA A + Idroc., 7atm
DERIVA $\bar{v}_D$ IN CAMPO ELETTRICO

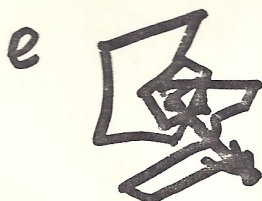
E cost. $\Rightarrow \bar{v}_D$ cost.

AL VARIARE DI E



D I F F U S I O N E

$$E = 0$$



RANDOM
WALK
TERMICO

$$\langle r^2 \rangle \propto S_{tot} \propto t$$

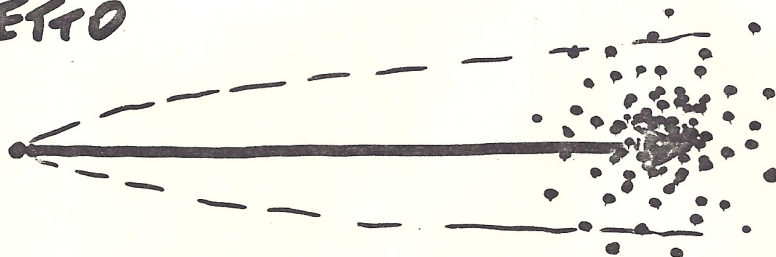
$E \neq 0$: DRIFT + DIFFUSIONE
 $\vec{J}_D // \vec{E}$ SFERICA

SINGOLO
e



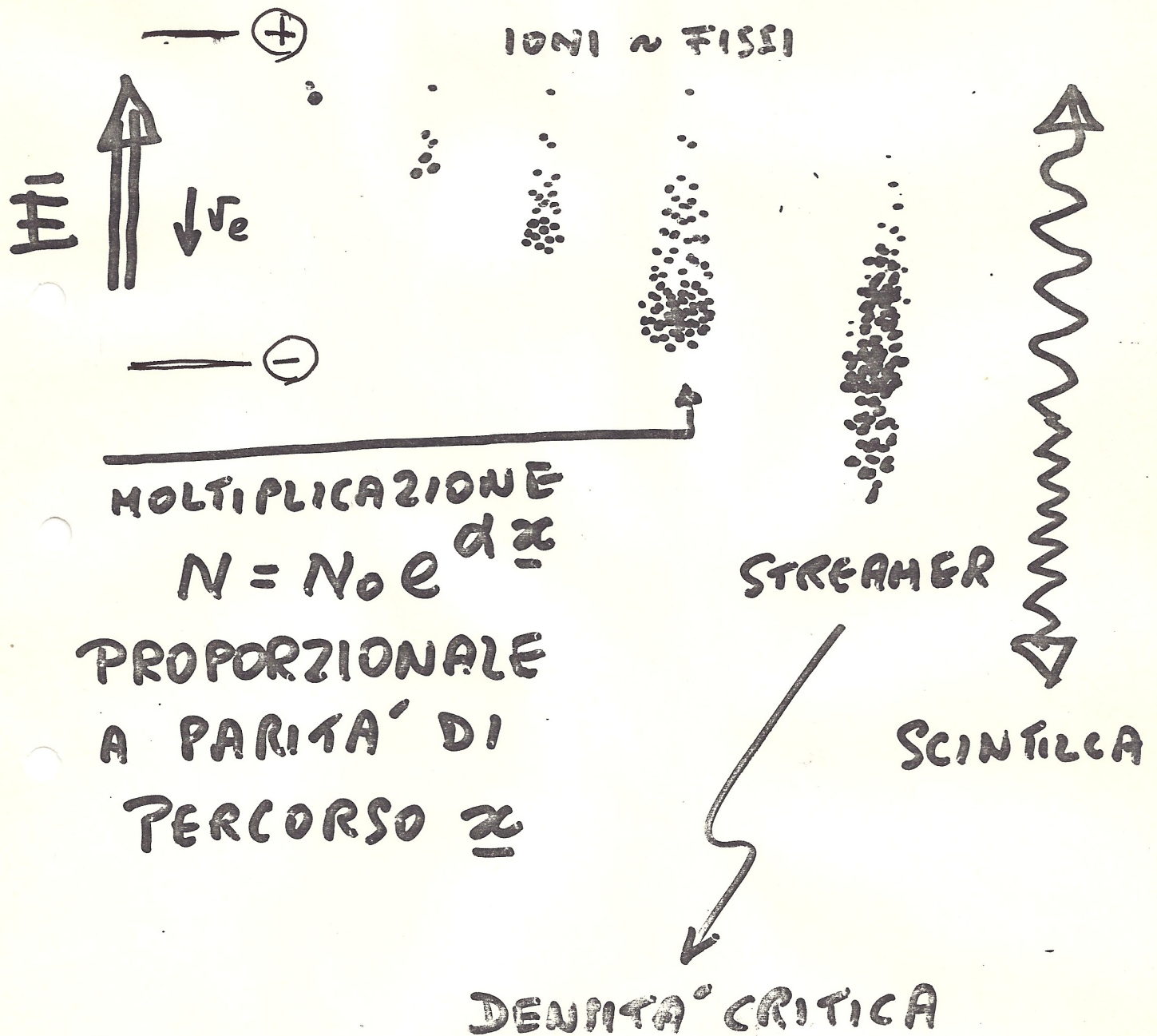
$$\langle \Delta S \rangle \propto \sqrt{S} \propto \sqrt{t}$$

PACCHETTO
e



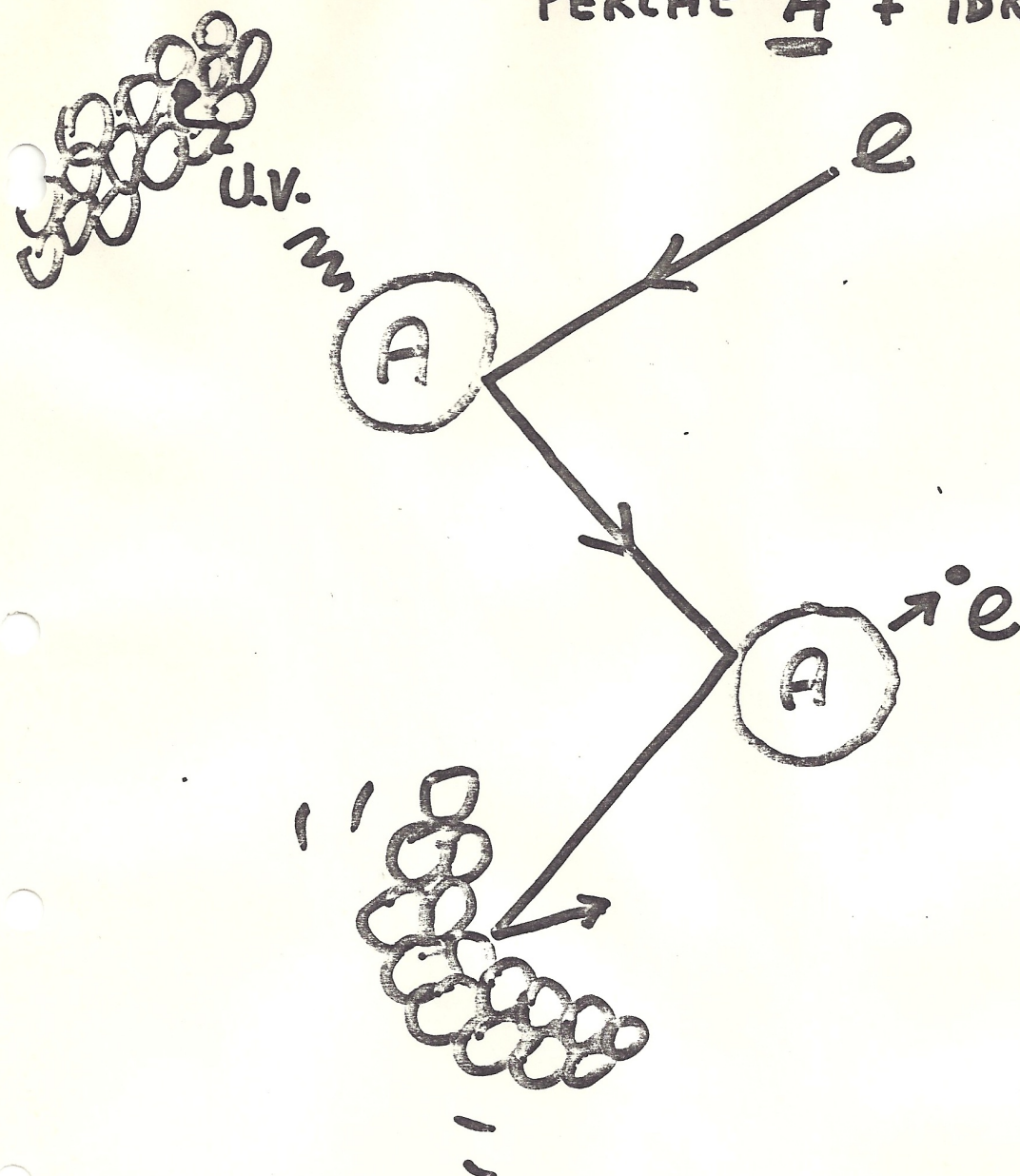
$E > 10 \text{KV/cm}$, UNIFORME

MOLTIPLICAZIONE A VALANGA



⇒ U.V. DA RICOMBINAZIONE +
+ CAMPO E DA CARICA SPAZIALE
(CAMPO DI DIPOLO)

PERCHE' A + IDROCARBURO



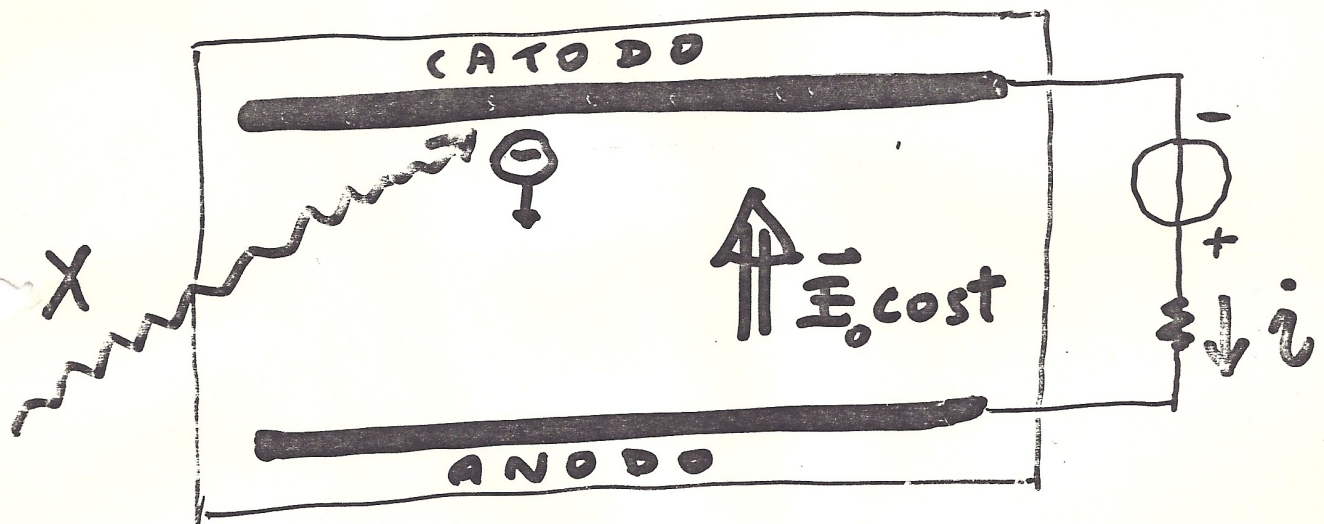
A : URTI ELASTICI, ECCITAZ., IONIZZ.

MOLECOLA ORGANICA COMPLESSA :

URT. INELASTICI,
ASSORBIMENTO U.V.

SEGNALE DI CORRENTE IN CAMERA A IONIZZAZIONE

ESTRAZIONE PACCHETTO e A $t=0$



in Gas

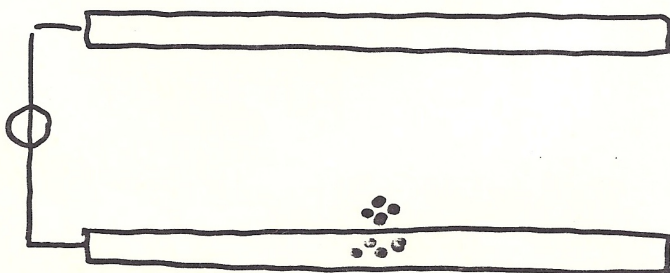
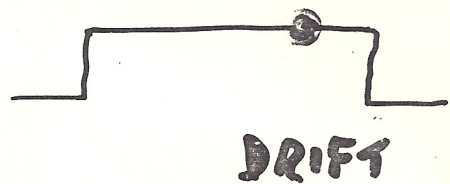
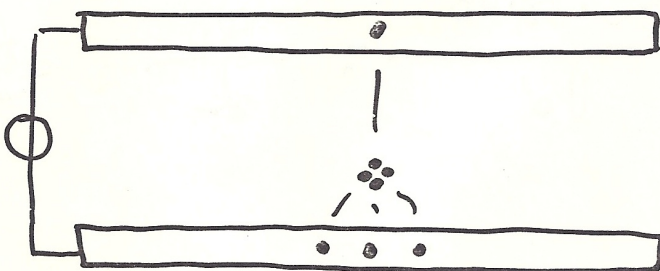
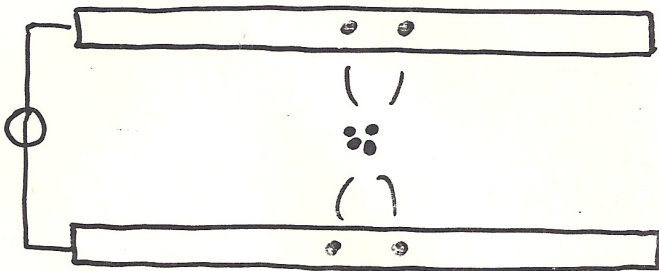
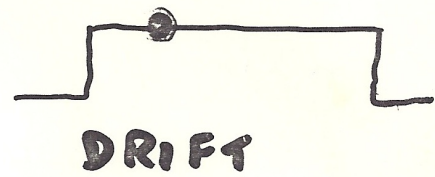
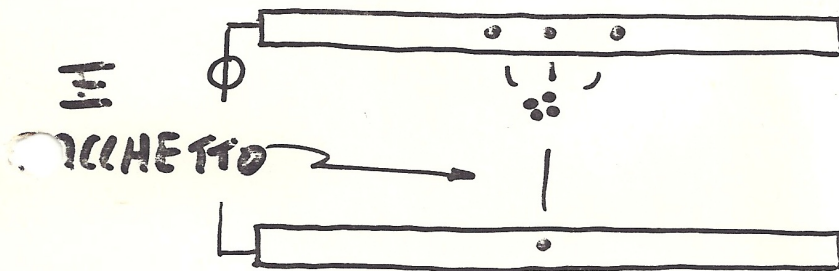
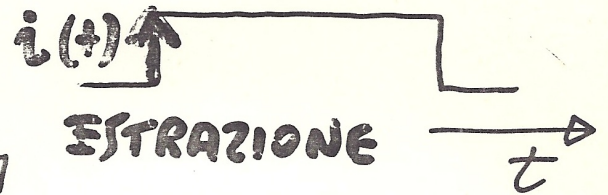
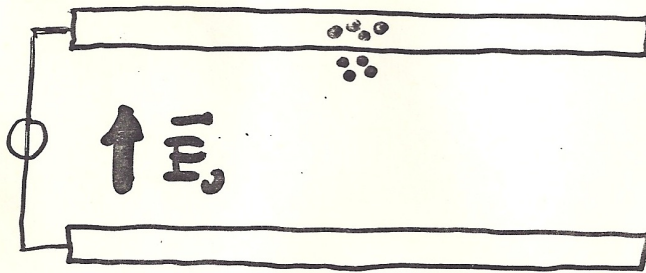
o Liquido

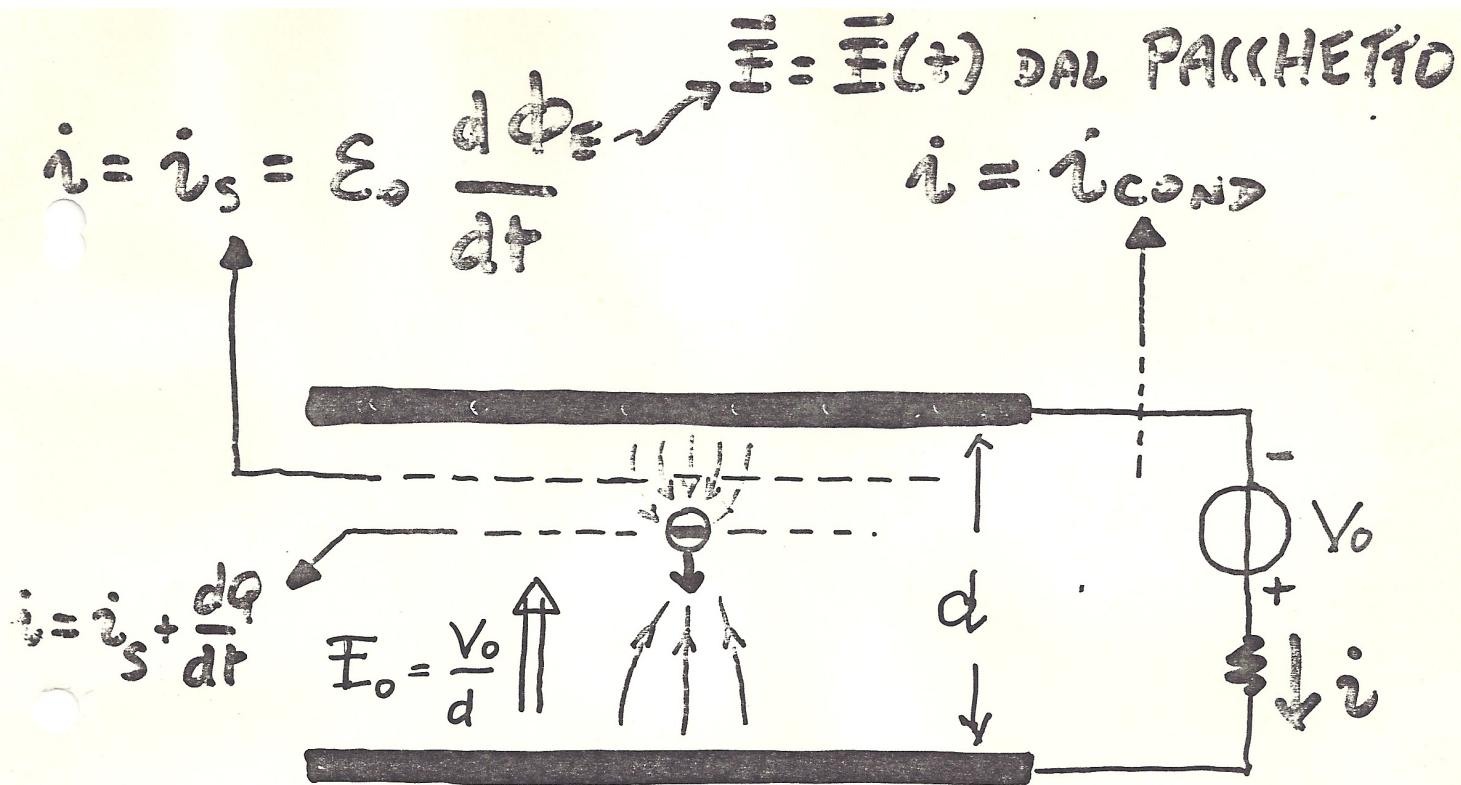
(calorimetri A liquido, ecc.)

$$* i(\text{TRACCIA}) = \sum i(\text{PACCHETTI})$$

VISUALIZZAZIONE DEL MOTO DI TUTTE LE CARICHE

$\oplus$
 $\ominus$



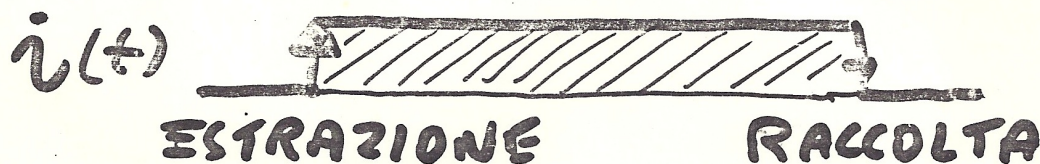


POTENZA EROGATA DAL GENERATORE =
= LAVORO DEL CAMPO E_0 SU $Q_{PACH.}$

$E_0 \cdot d \cdot i = E_0 \frac{d}{t} \cdot Q =$

$P = V_0 i = F v = Q E_0 v$

$i = \boxed{Q v \frac{E_0}{V_0}} = Q \frac{v}{d} = \text{cost}$



SE UN CLUSTER DI ELETTRONI E' PRODOTTO
VICINO ALL'ANODO IL SEGNALE E'
PRATICAMENTE NULLO

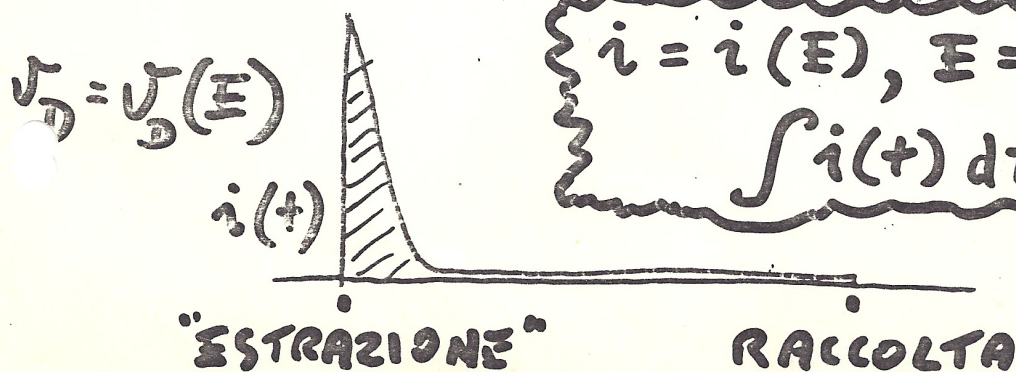
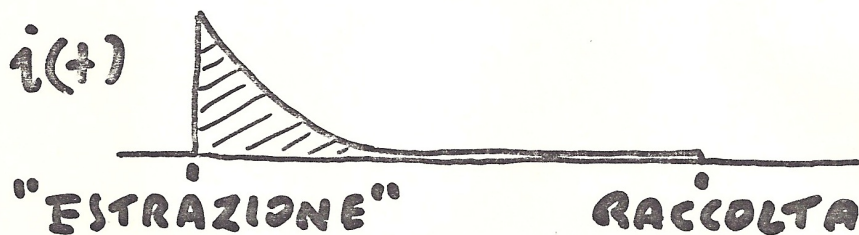
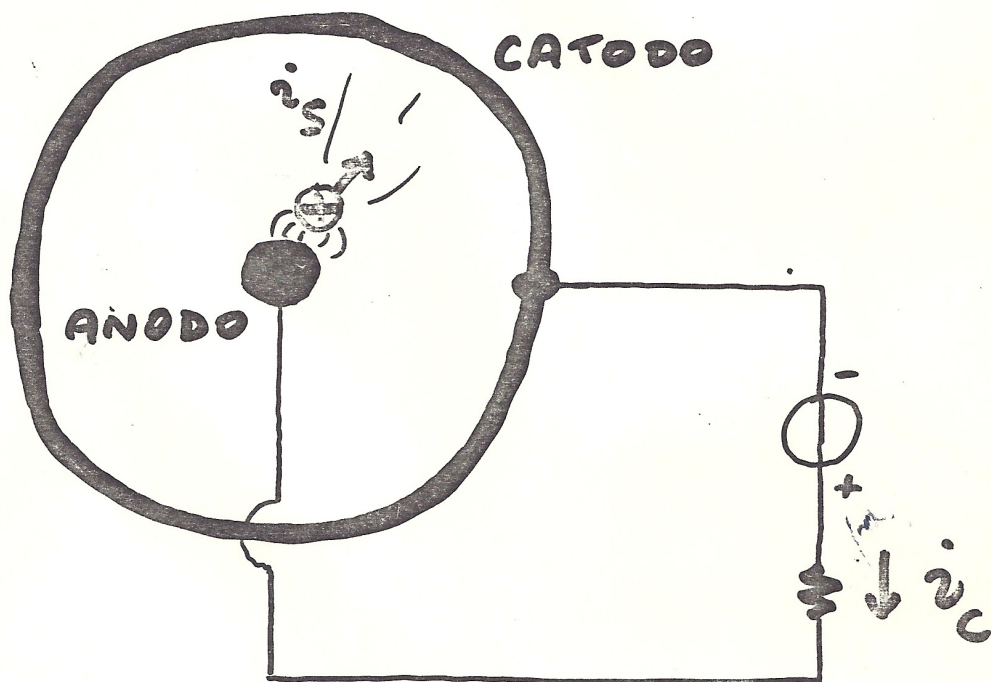
$$i = Q v_D \frac{E_0}{V_0}$$

SOLO MOTO
DI DERIVA

Consideriamo E_0 stazionario
ma non uniforme

$$E \propto \frac{1}{r}$$

$\uparrow$
 $v_D \cdot t$



$$v_D = v_D(E)$$

$$i = i(E), E = E(s) = E[s(t)]$$

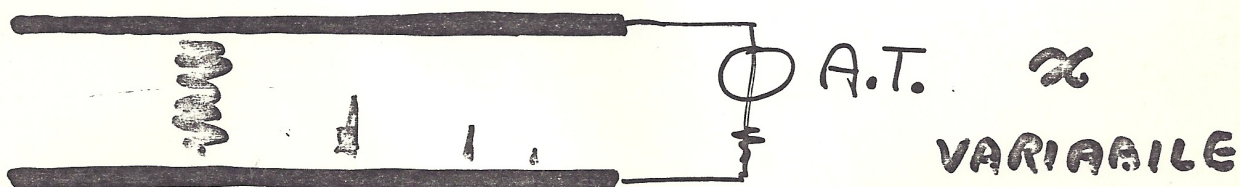
$$\int i(t) dt = Q_{PACCH.}$$

PARTICELLA ION. AL MIN. IN GAS

⇒ E' NECESSARIA LA MOLTIPLICAZIONE A VALANGA DEGLI ELETTRONI

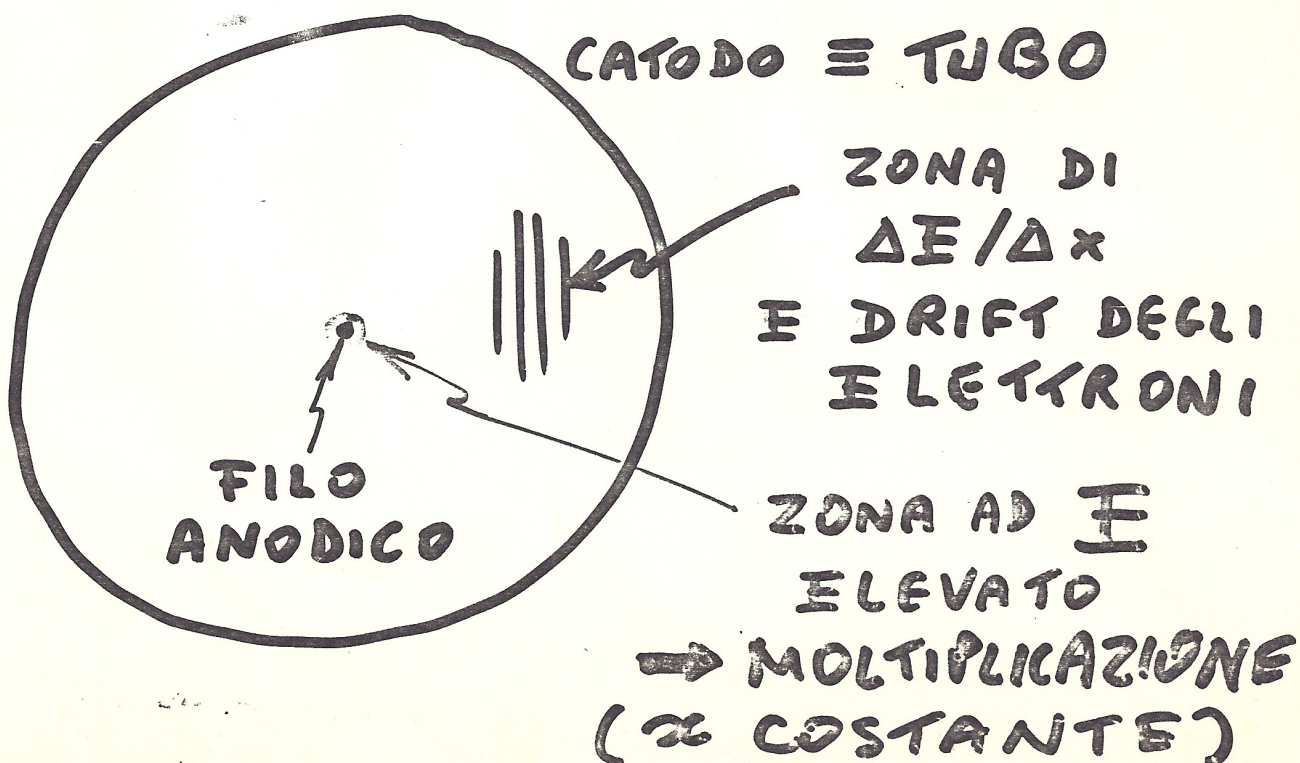
$$N = N_0 e^{d/\alpha}$$

* GEOMETRIA PIANA O QUASI PIANA IMPRATICABILE (salvo trucchi)



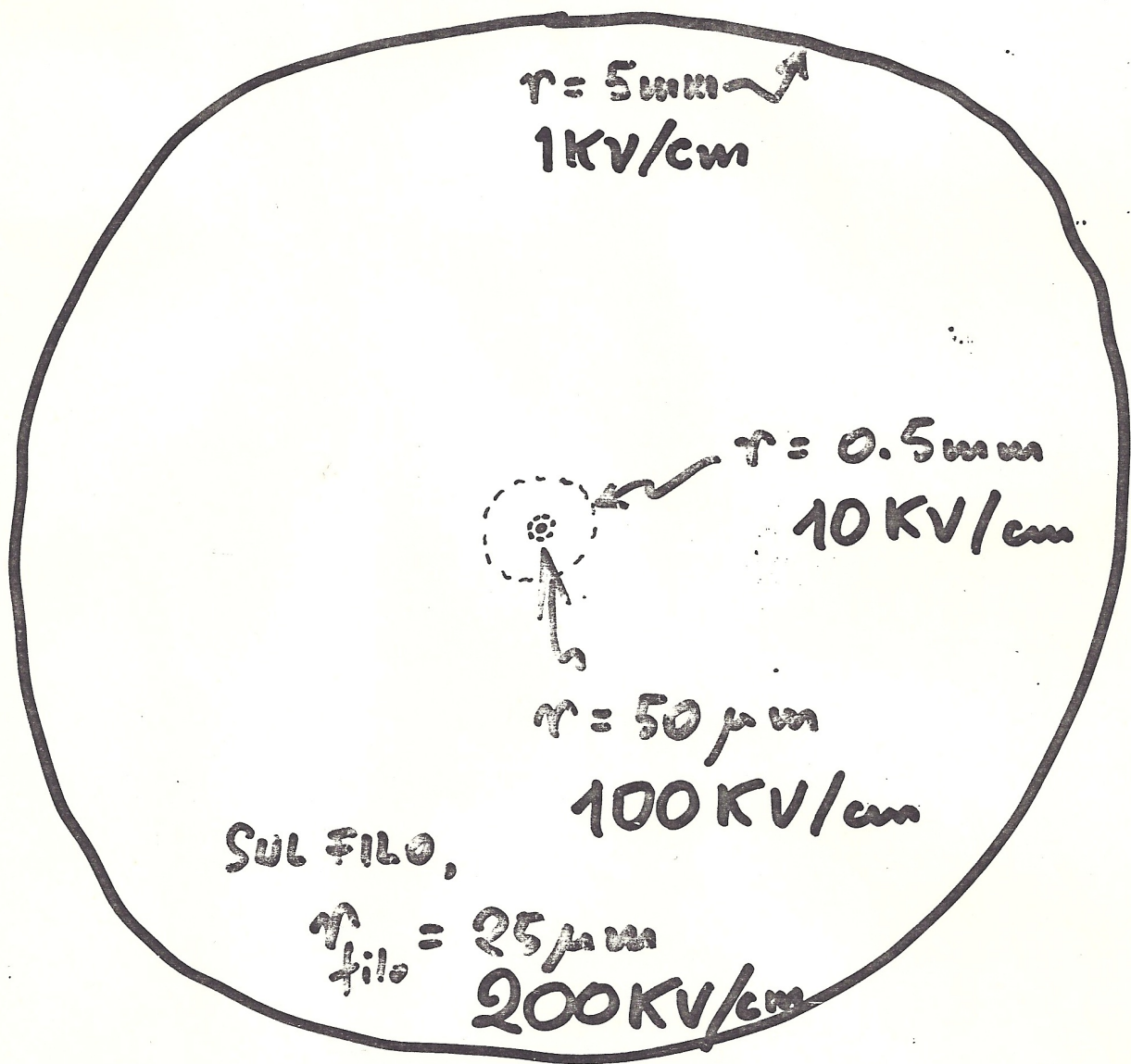
DISPOSITIVI A FILO

≡ $\frac{1}{r}$

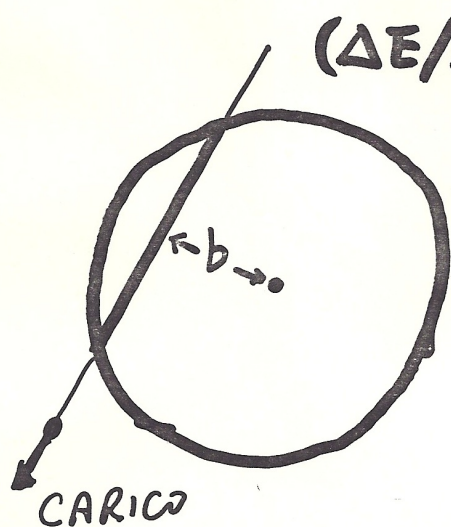


SITUAZIONE TIPICA

$$\Phi_{\text{TUBO}} = 1 \text{ cm} \quad \Phi_{\text{FILO}} = 50 \mu\text{m}$$

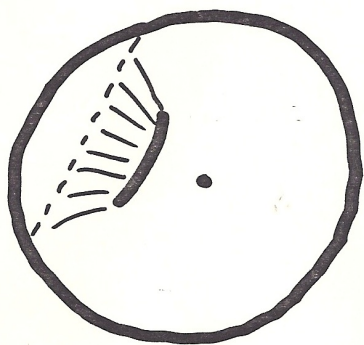


TUBO PROPORZIONALE

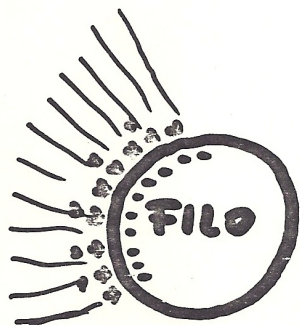


A + Idrocarburo
p.es. A + Etano (.5+.5)

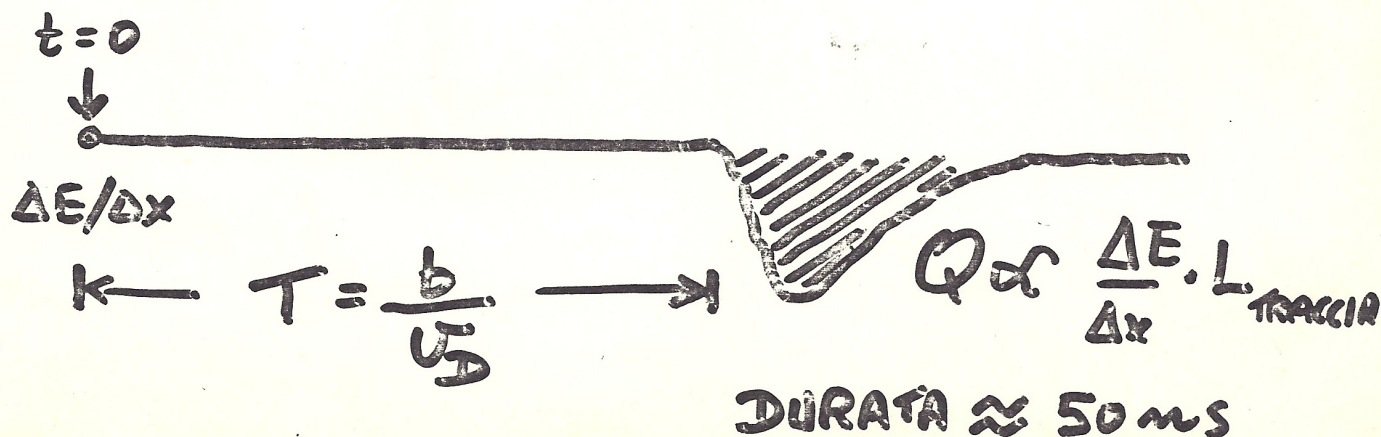
FILLO ANODICO $\sim 50\mu\text{m}$
CATODO METALLICO $\sim 1\text{cm}$
A.T. $\sim 3\text{KV}$

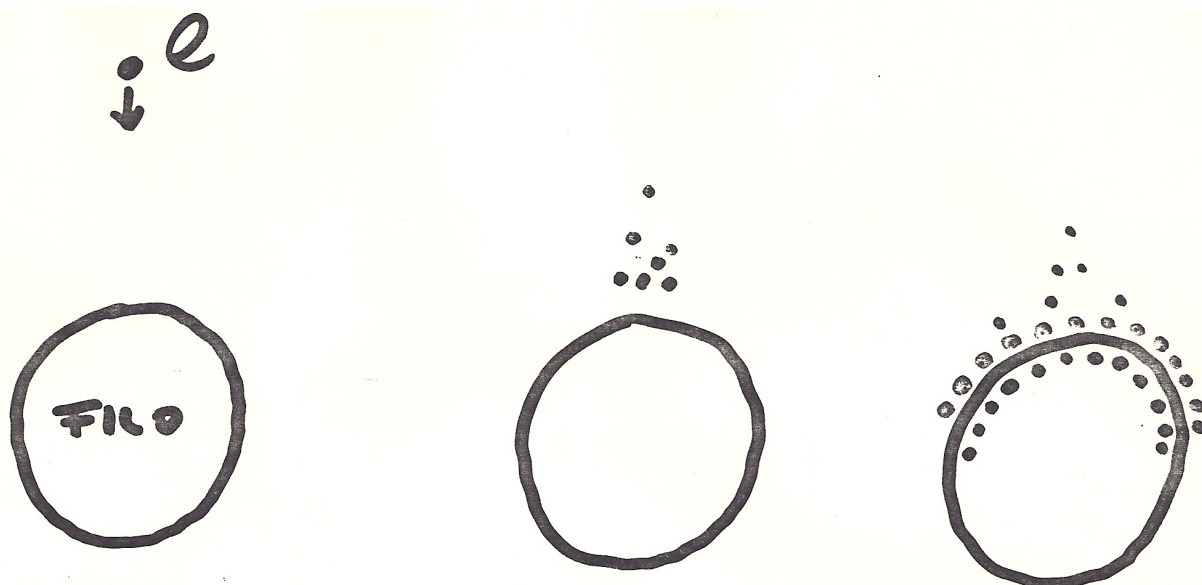


MOTO DI DERIVA
E DIFFUSIONE Q
 v_D SATURATA
 $1/v_D \approx \frac{200\text{ns}}{\text{cm}}$



MOLTIPLICAZIONE
PROPORZIONALE
 $A \sim 10^5$ TIPICO



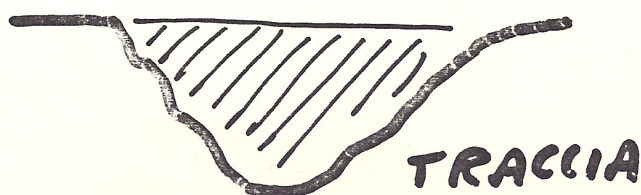
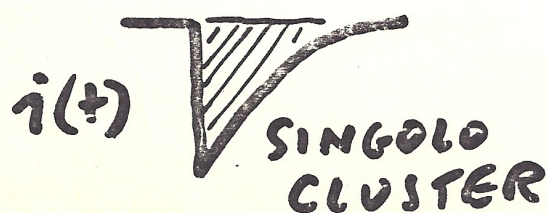


LA MAGGIOR PARTE DELLA IONIZZAZIONE
VIENE PRODOTTA VICINO AL FILO

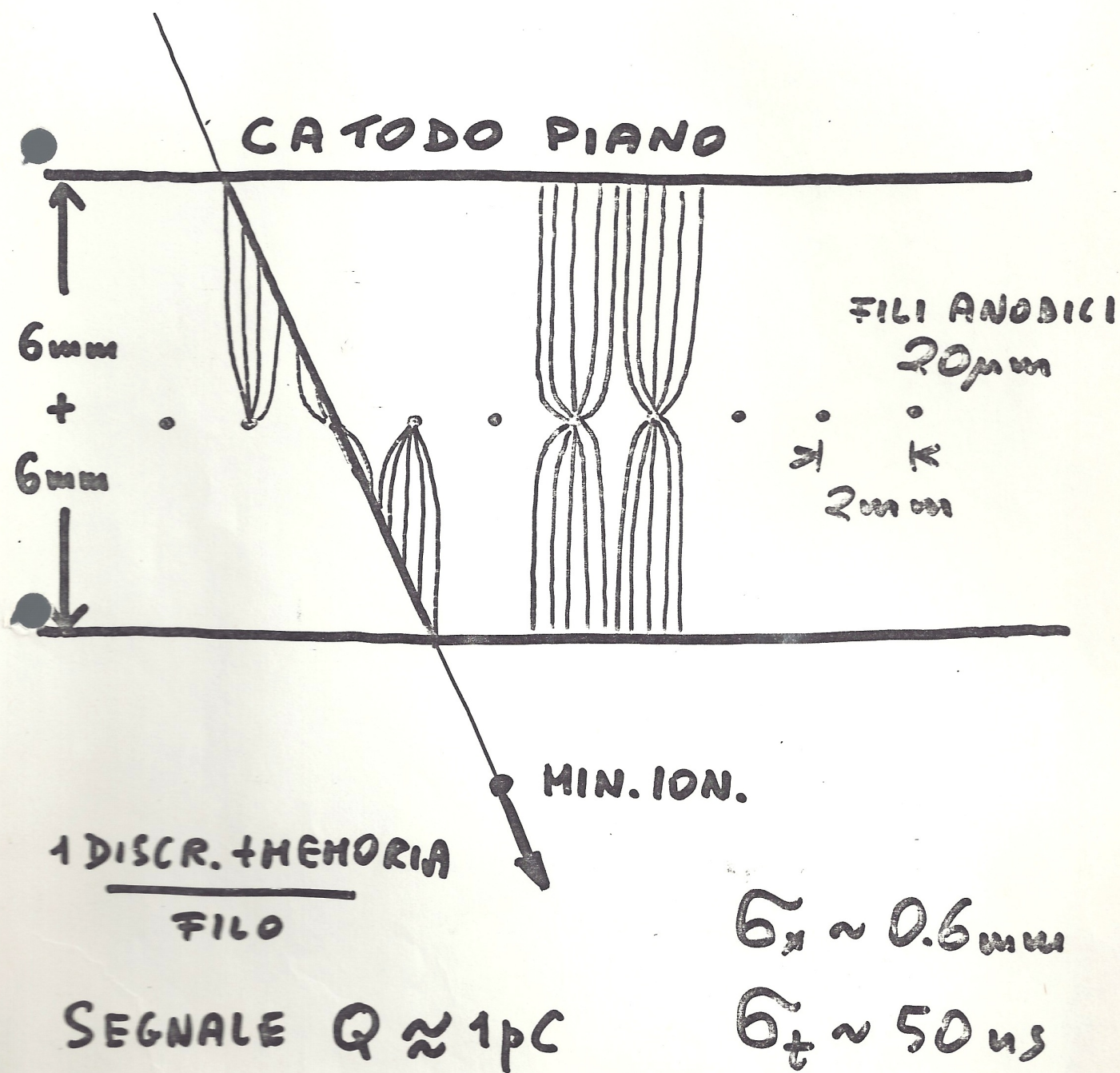
➔ IL SEGNALE DOVUTO AL DRIFT
DEGLI ELETTRONI E' TRASCURABILE
PERCHE' E' PICCOLO LO SPAZIO
MEDIANAMENTE PERCORSO

➔ IL SEGNALE DI CORRENTE E'
DOVUTO AL DRIFT DEGLI IONI

$$i = Q U_{ion}(\vec{E}) \cdot \frac{\vec{E}}{V}$$



CAMERA PROPORZIONALE

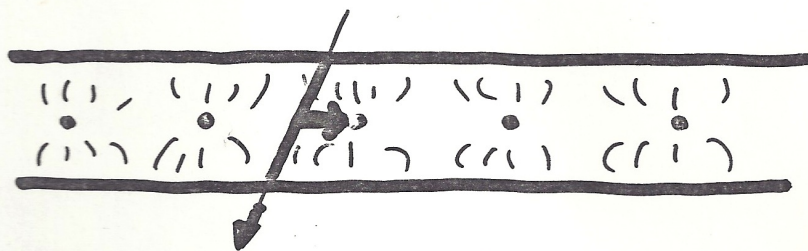


CAMERA A DERIVA

- meno fili (meccanica)
- elettronica più complessa

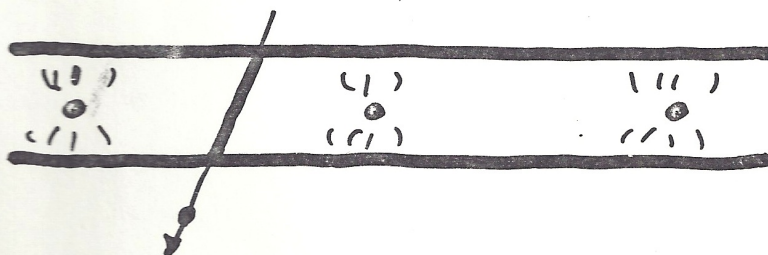
DISPONIBILE A COSTO DECRESCENTE

- COMPATIBILMENTE CON PERDITA DI RISOLUZIONE TEMPORALE

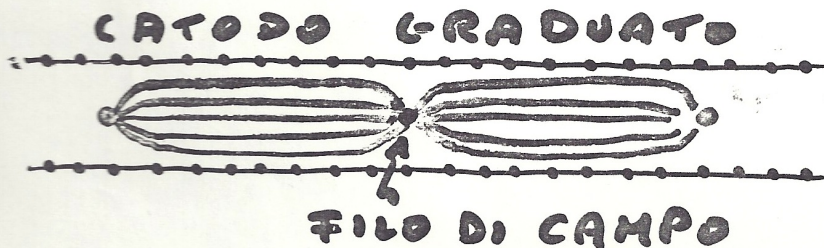


$$X = X_{\text{FILO}} (\pm) \sqrt{t}$$

RITARDO
RISPETTO
A $t=0$



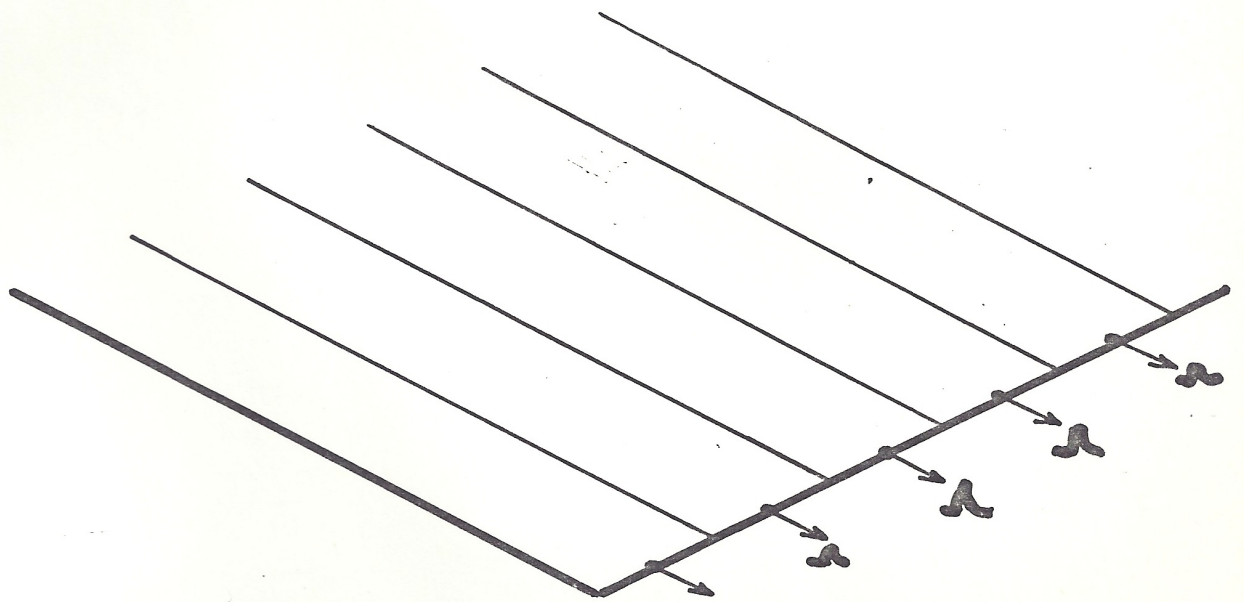
NO



$$G_x = 200\mu\text{m}$$

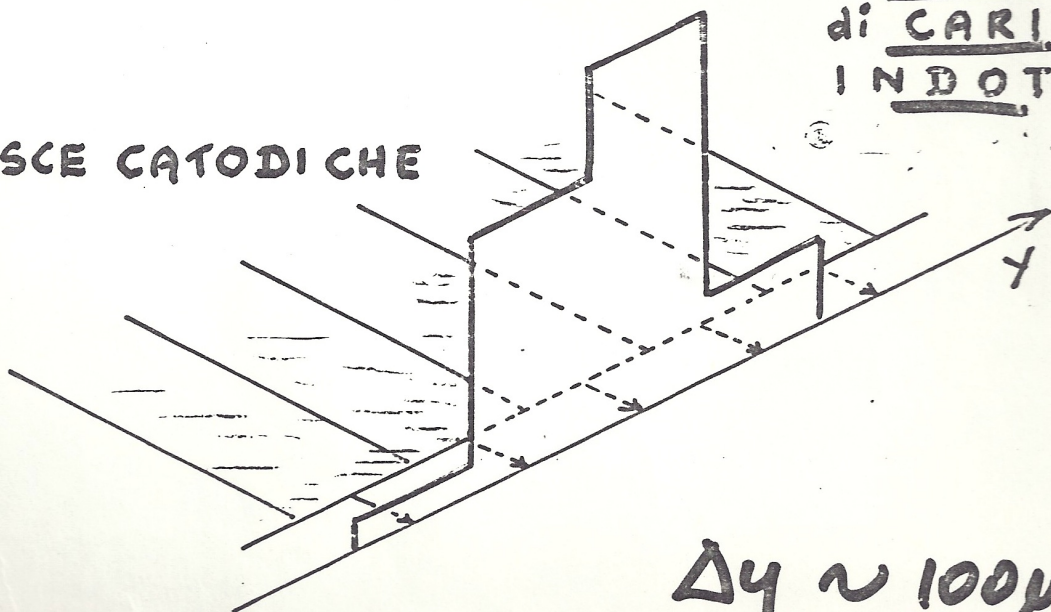
TROPPO MATERIALE

A LETTURA CATODICA



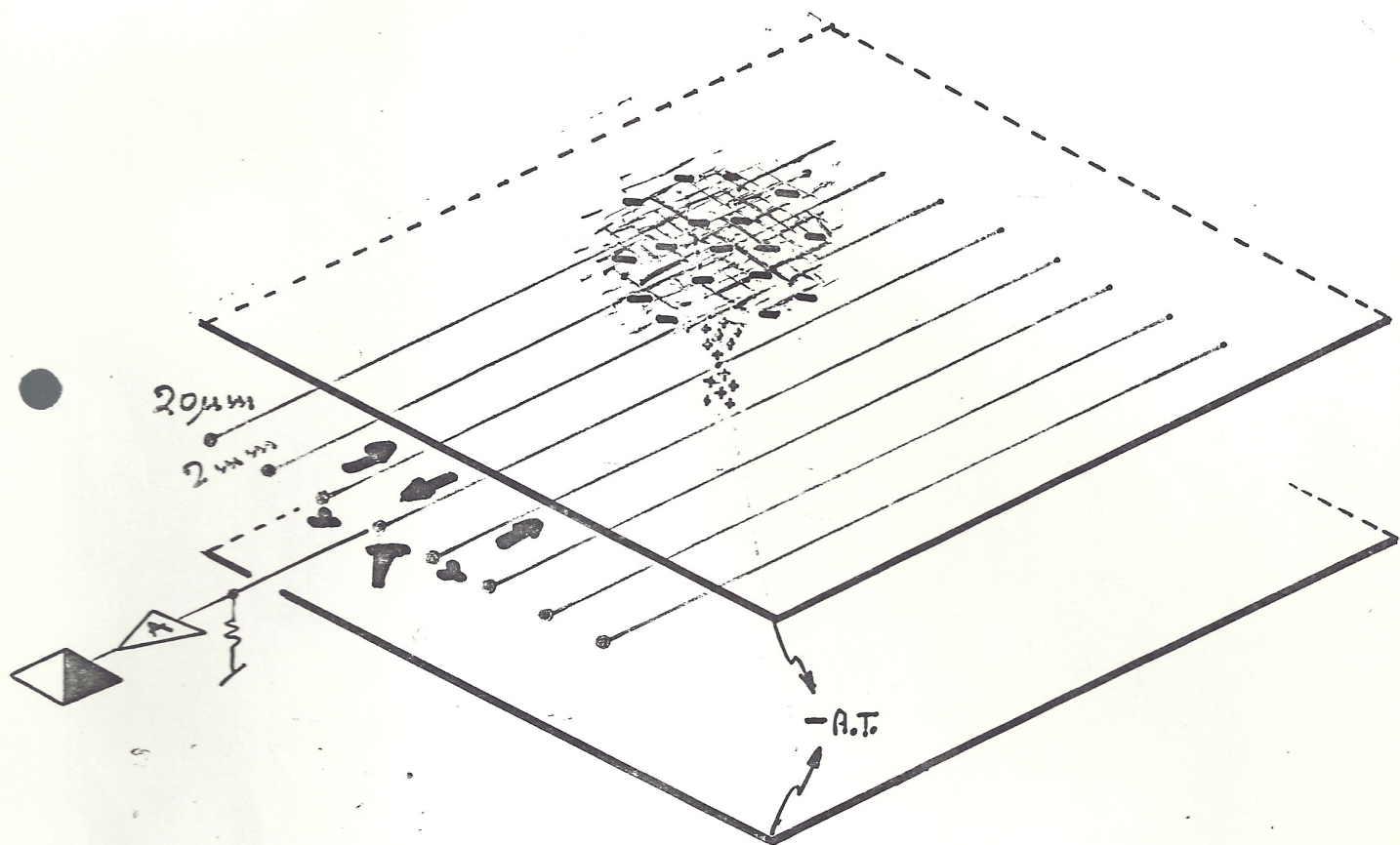
STRISCE CATODICHE

CENTROIDE
di CARICA
INDOTTA

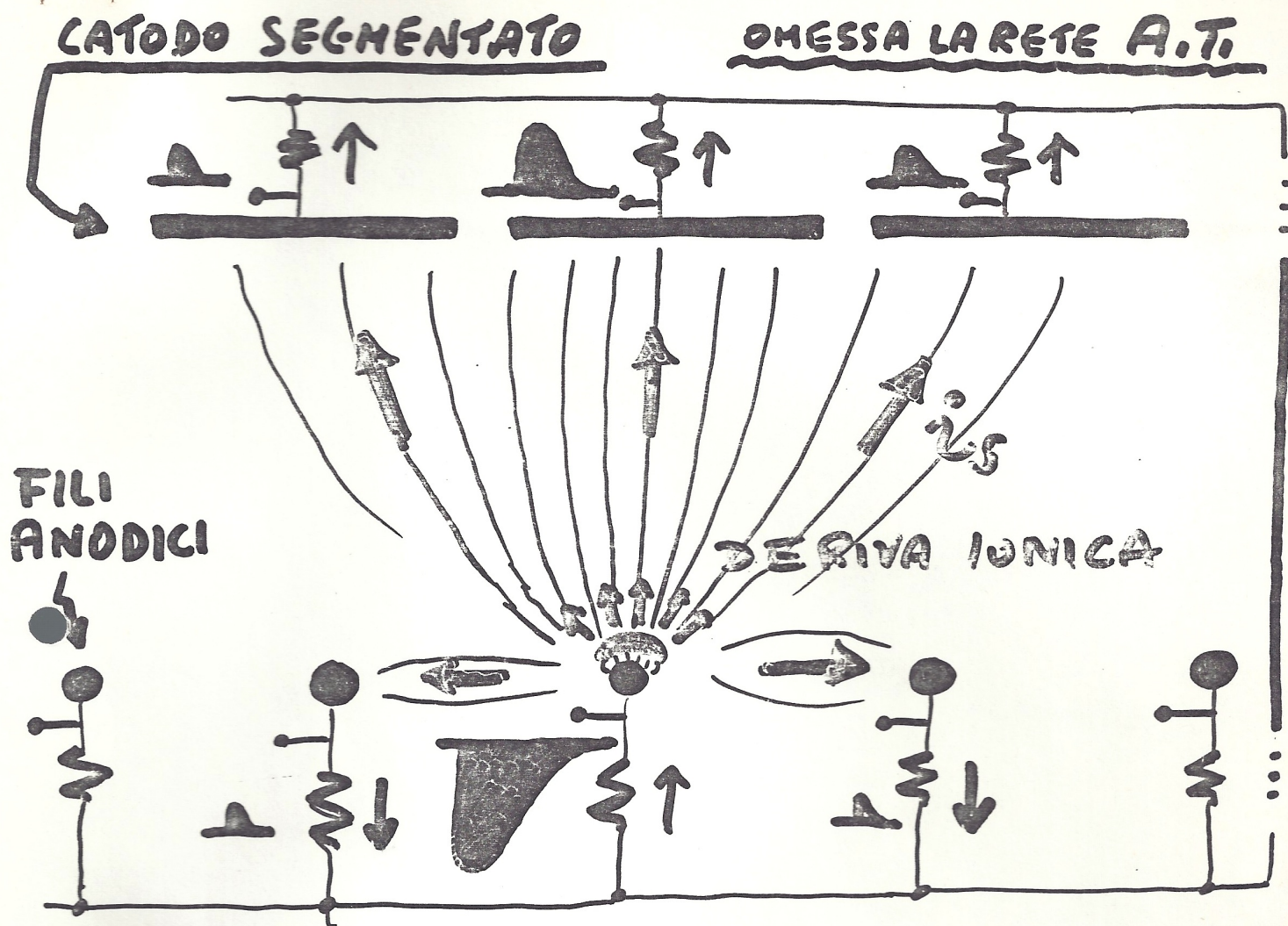


$$\Delta y \sim 100 \mu m$$

IN CAMERA PROPORZIONALE



131



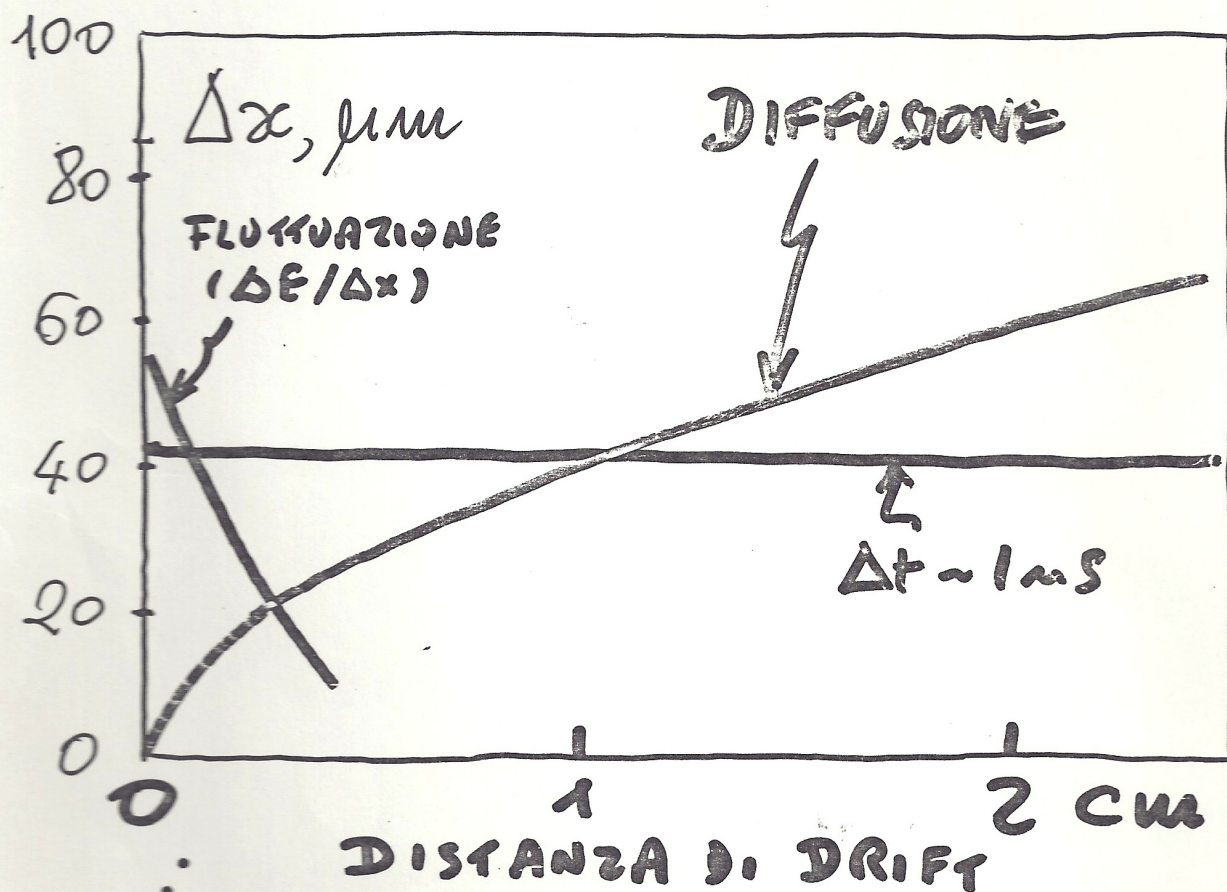
● SEGNALI "INDOTTI" DAL
DRIFT IONICO
SU TUTTI GLI ELETTRODI PIÙ VICINI

$$i_{si} = \epsilon_0 \left(\frac{d\phi_i}{dt} \right) \quad i\text{-ELETTRODO}$$

POICHE' LO SPOSTAMENTO IONICO EFFICACE
E' TRASCURABILE, LA i_s SI DISTRIBUISCE
COME LA CARICA INDOTTA IN SITUAZIONE
ELETTROSTATICA
(LA SITUAZIONE E' QUASI-STAZIONARIA)

PRECISIONE SPAZIALE C. A. DRIFT

CAUSE LIMITANTI



$(\Delta E/\Delta x)_{ion}$
 $\langle d \rangle \sim 300 \mu m$
a 1 atm

RIVELATORI DI
VERTICE A GAS
 $\Delta x = 30 \div 50 \mu m$

TPC

DRIFT $\approx 1\text{m}$

$\vec{J} \parallel \vec{B}$

: CONFINAMENTO
ELICOIDALE

CATODO CENTRALE
(100KV)

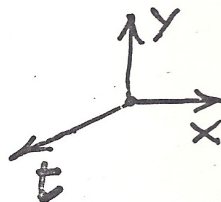
FILI ANODICI

DERIVA
 $\vec{B}$

CATODO a PLACCHETTE

$\rightarrow 20'000$

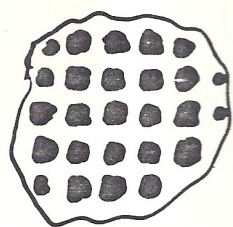
evoluzione temporale
della carica indotta



• CENTROIDE di CARICA: $\Delta x-y \sim 0.2\text{mm}$

• ALEPH: ~ 300 PUNTI DI $\Delta E/\Delta x$

(DAI FILI DEL TAMBORO di LETTURA)



PLACCHETTE
CATODICHE

$< 1 \text{ cm}^2$

WAVEFORM
DIGITIZER

ALTA PRECISIONE DA
CENTROIDE DI CARICA

CIASCUNA PLACCHETTA "GUARDA" UN TUBO

GASSOSO LUNGO

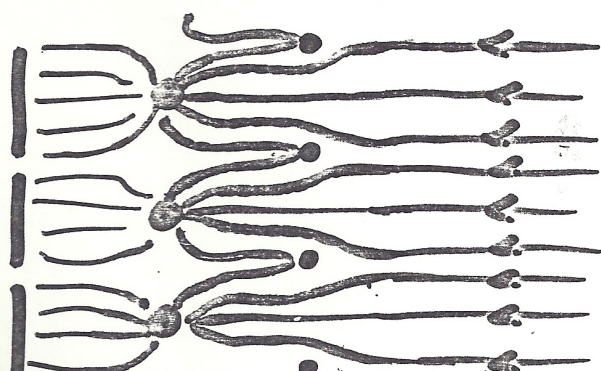
$\sim 1.5 \text{ m}$

←
DRIFT

MWPC

$\sim 1 \text{ cm}$

GRIGIA
TRASPARENTE



←
CAMPO DI DRIFT
DA CATODO
LONTANO



ZONA A CAMPO PIU' ELEVATO
PER L'AMPLIFICAZIONE

IL REGIME DI STREAMER (LIMITATO)

CONDIZIONI

STRINGENTI:

1) MISCELA AD ALTISSIMO QUENCHING

2) QUENCHING "  " 1
Distanza CAT.-ANODO

MENO STRINGENTE

(forte sfasamento fra
onset e la carica)

3) FILO SPESSO $50 \div 100 \div 200 \mu\text{m}$



→ volage solo su un lato: comp non elevato ⇒
gli elettroni non avvolgono il filo

⇒ • REGIME ~ SATURATO

• ALTO "GUADAGNO" → 30 pC/streamer

• BASSO "RUMORE"

• ELEVATA LOCALIZZAZIONE

(200 μm CON IL CENTROIDE DI CARICA
(Pd), 30 μm CON IL T. DI DRIFT (Rit_{ion}))

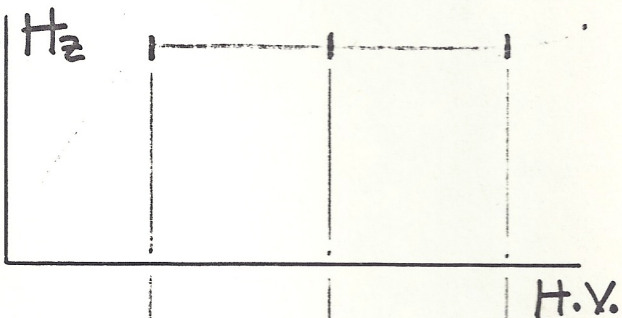
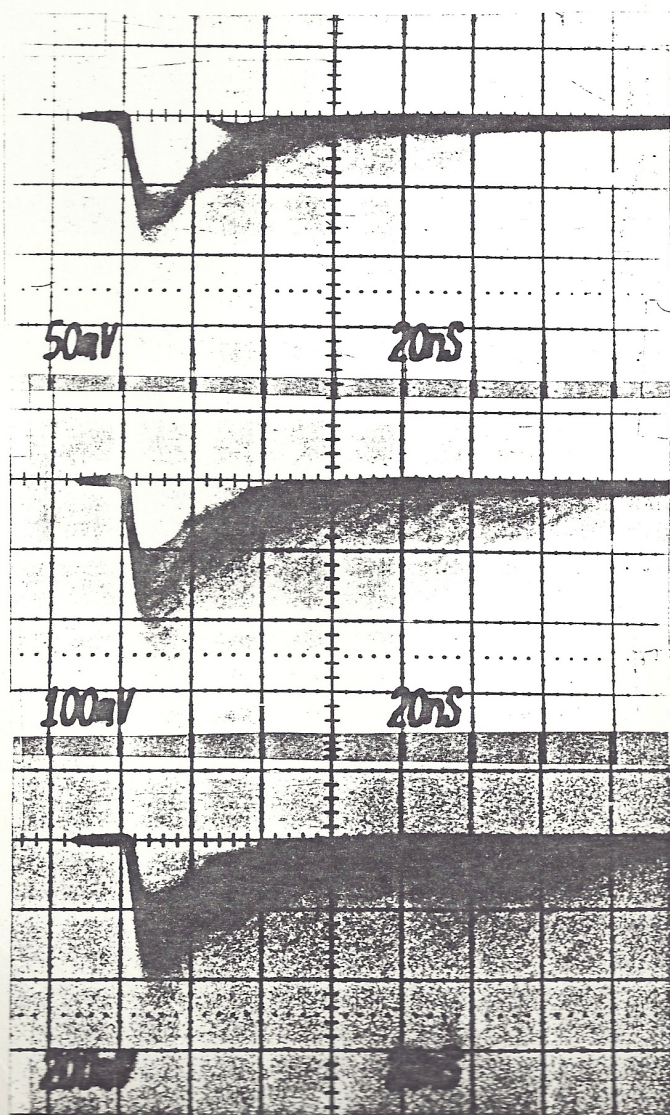
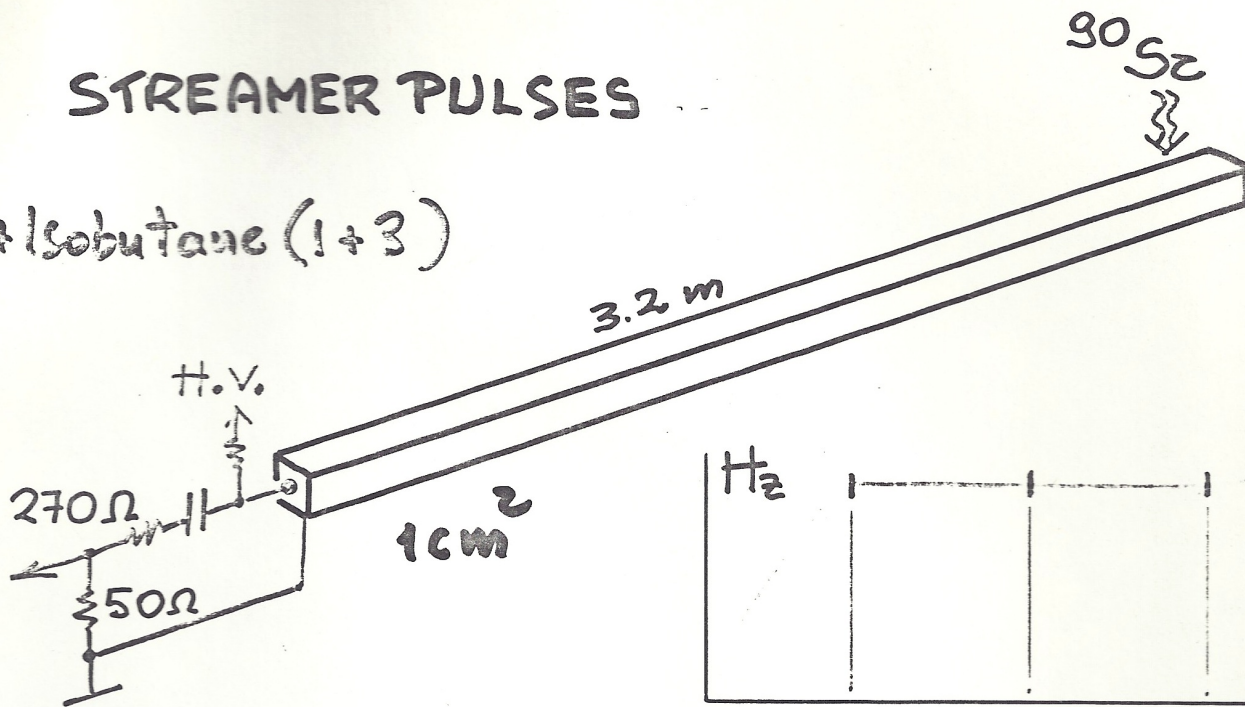
• BASSA SOGLIA $(\Delta E/\Delta x)_{ion} : 1 \text{ e}$

• RISPOSTA LOGARITMICA A ALTI $(\Delta E/\Delta x)$

TEMPO MORTO LOCALE $\approx 200 \mu\text{s}$

STREAMER PULSES

A+Isobutane (1+3)



40 μ m WIRE - 8x8mm² TUBE

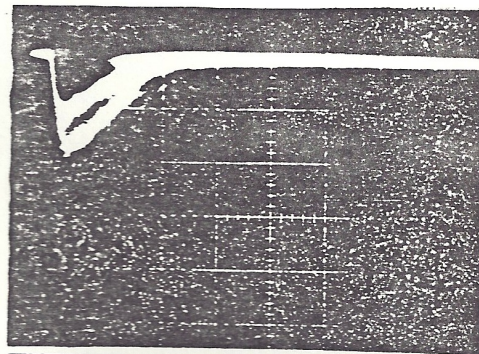
ARGON + ISOBUTANE

ISOBUTANE FRACTION: 50%

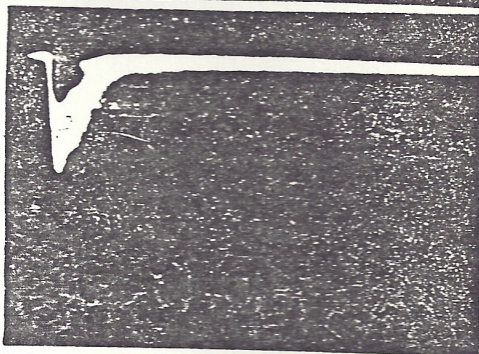
60%

70%

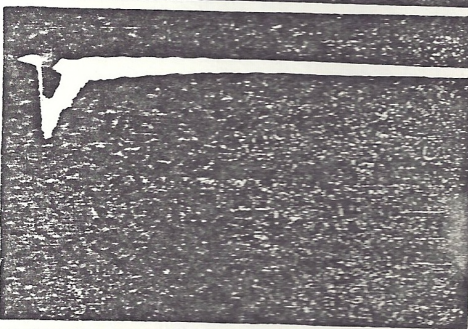
80%



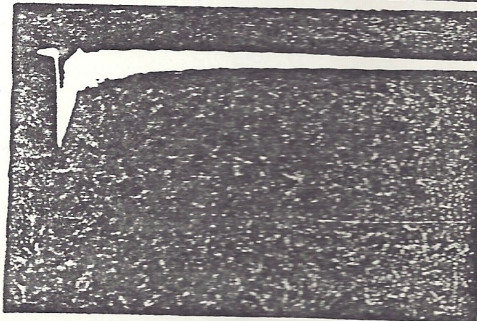
a



b



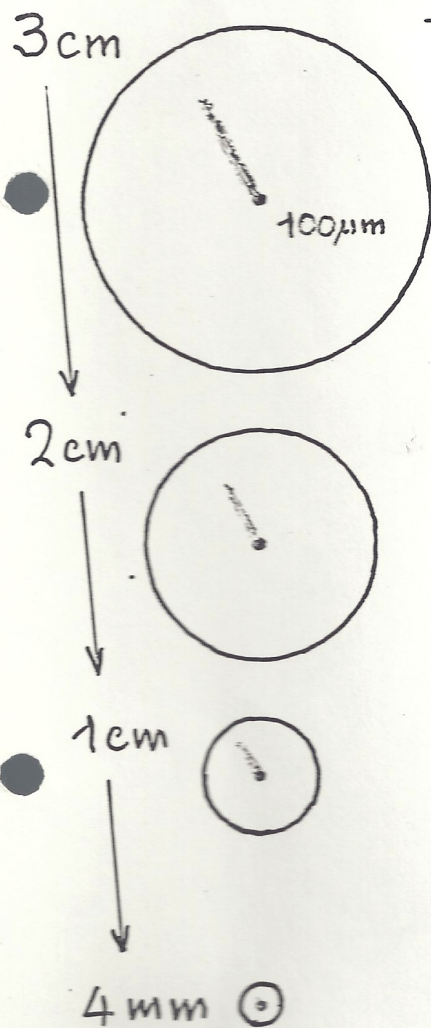
c



d

50mV/div
50ns/div
50 Ω load

QUENCHING VS DURATA VS d (FILO-CATODO)



$L \propto d \approx 20$

(limite di scarica)

$Ar + Isobutano (1+3) \approx$
 $\approx CO_2 + \text{Pentano} (4+1)$

Isobutano

Argon

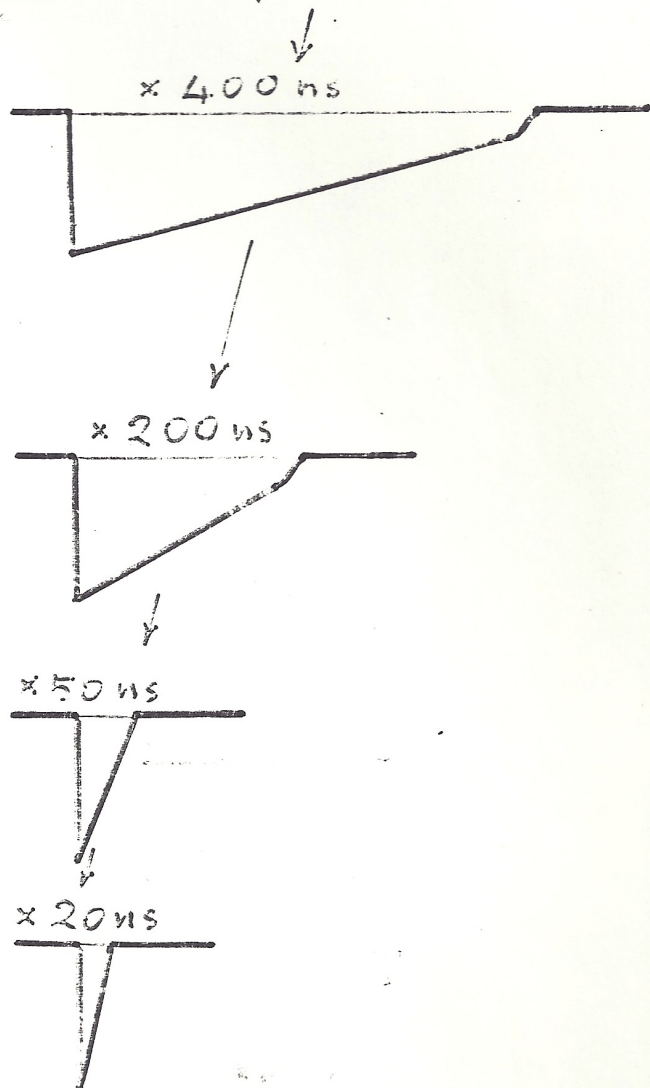
~ 0.3

~ 0.4

~ 0.7

~ 0.9

l'impulso STREAMER = 1ms



Le tubi grandi si raffreddano più rapidamente
le condizioni di scarica. Per x grande
e si raffreddano con le condizioni
di scarica. Per tubi grandi.

