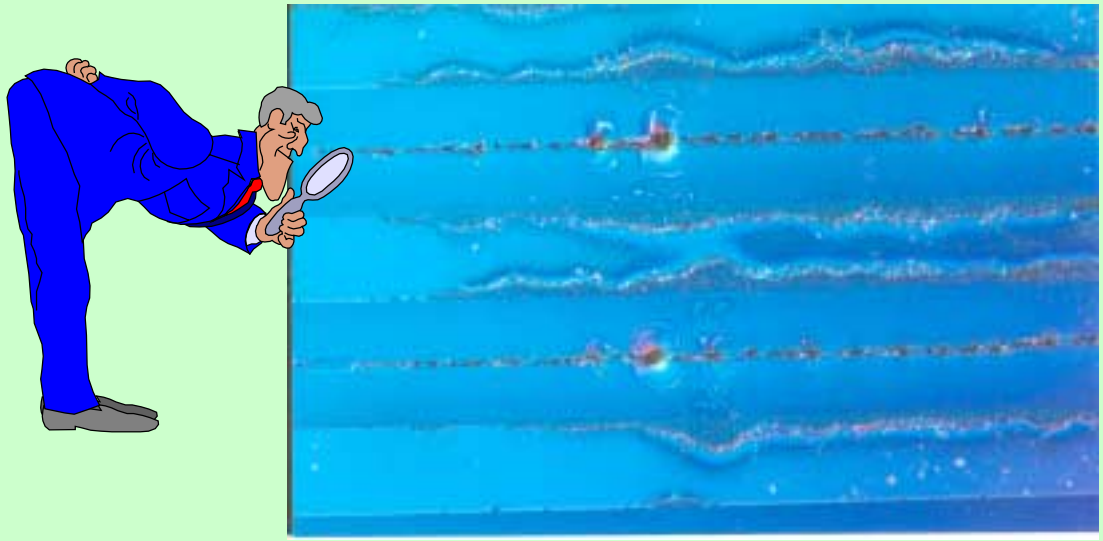
Aging tests of MSGC detectors at Mons university

I. Boulogne, E. Daubie, F. Defontaines

1. Introduction : framework of the tests
2. Experimental set-up
3. Aging results & comments



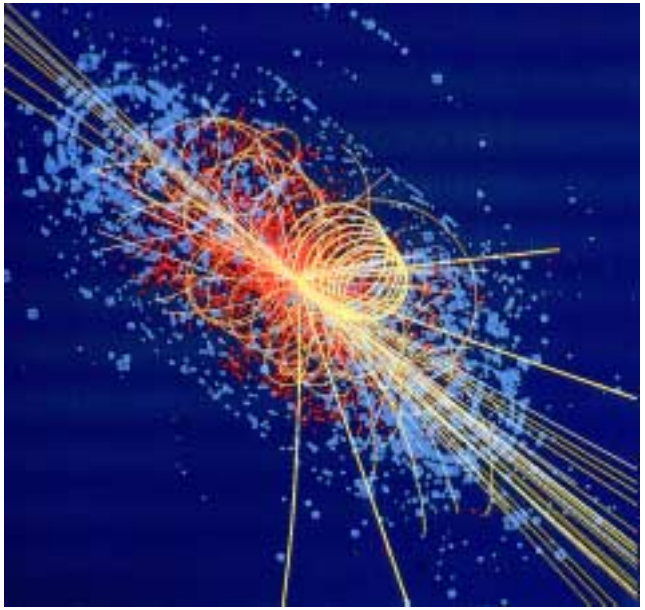
4. Conclusions & issues

Tests framework

FW MSGC tracker of CMS experiment

1995 $\rightarrow$ 1999 (design change) ⇒ aging tests @Mons

- max charged particle rate :
  $\approx 5\ 10^4 \rightarrow 10^4$ Hz/mm^2
- max current density :
  $\approx 0.5 \rightarrow 0.1$ nA/mm^2
- max accumulated charge (10 years@LHC) :
  $\approx 100 \rightarrow 20$ mC/cm of anode strip



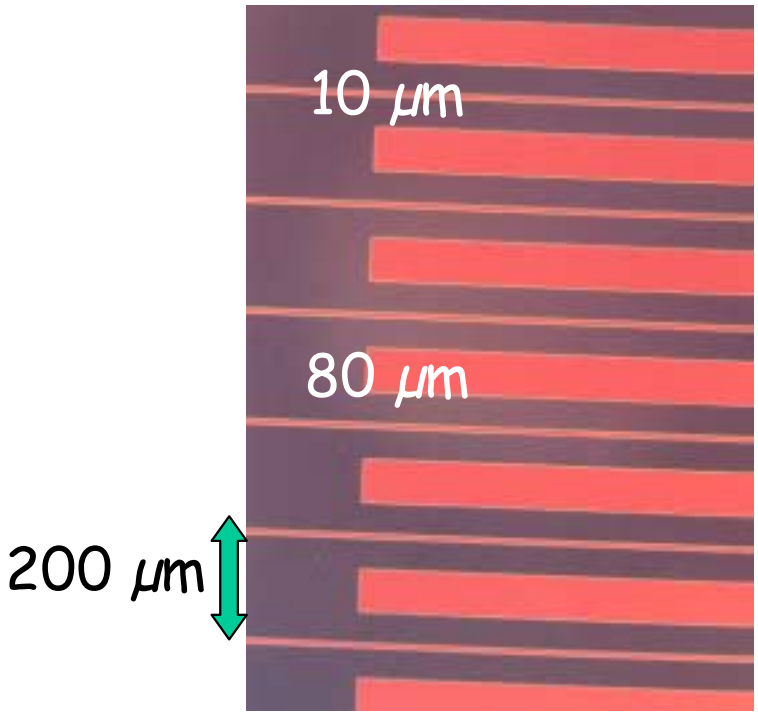
Kind of substrates (1) active area 3 × 3 cm²

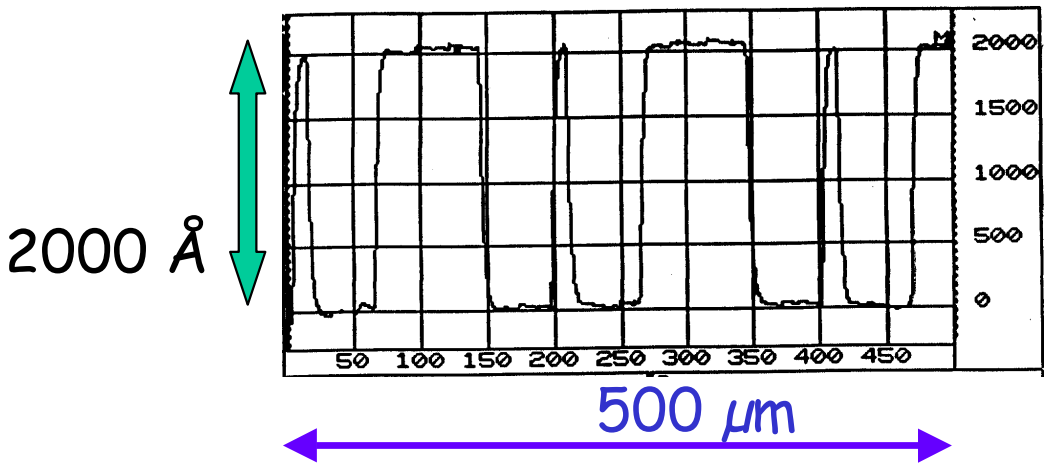
GLASS

- Bare borosilicate glass
  Desag D263 ≈$10^{17}\Omega$/sq
- DLC undercoated
  DESAG ≈ $10^{14}\Omega$/sq

+ strips : Cr or Au

from IMT / CH
(SURMET coating)

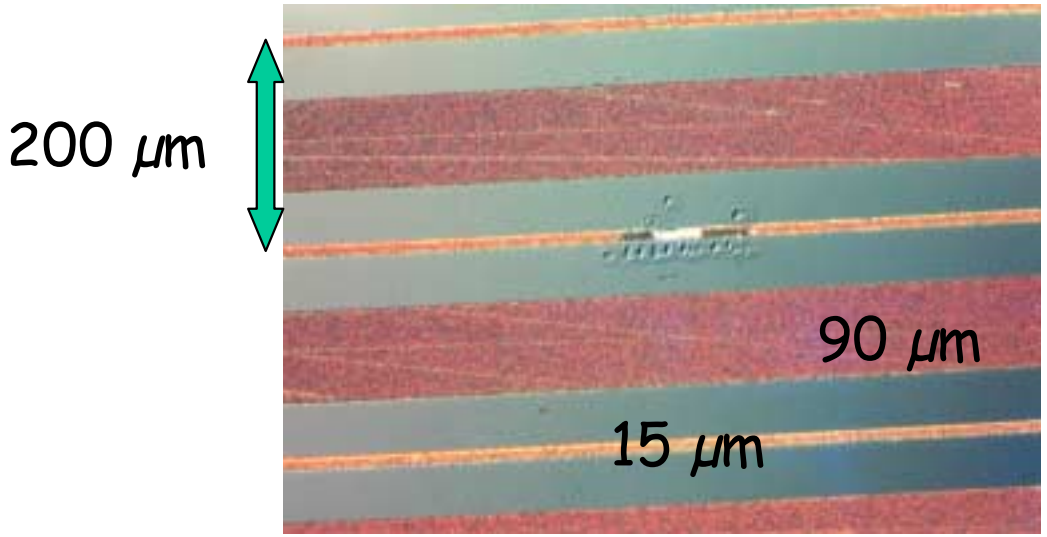




Kind of substrates (2)

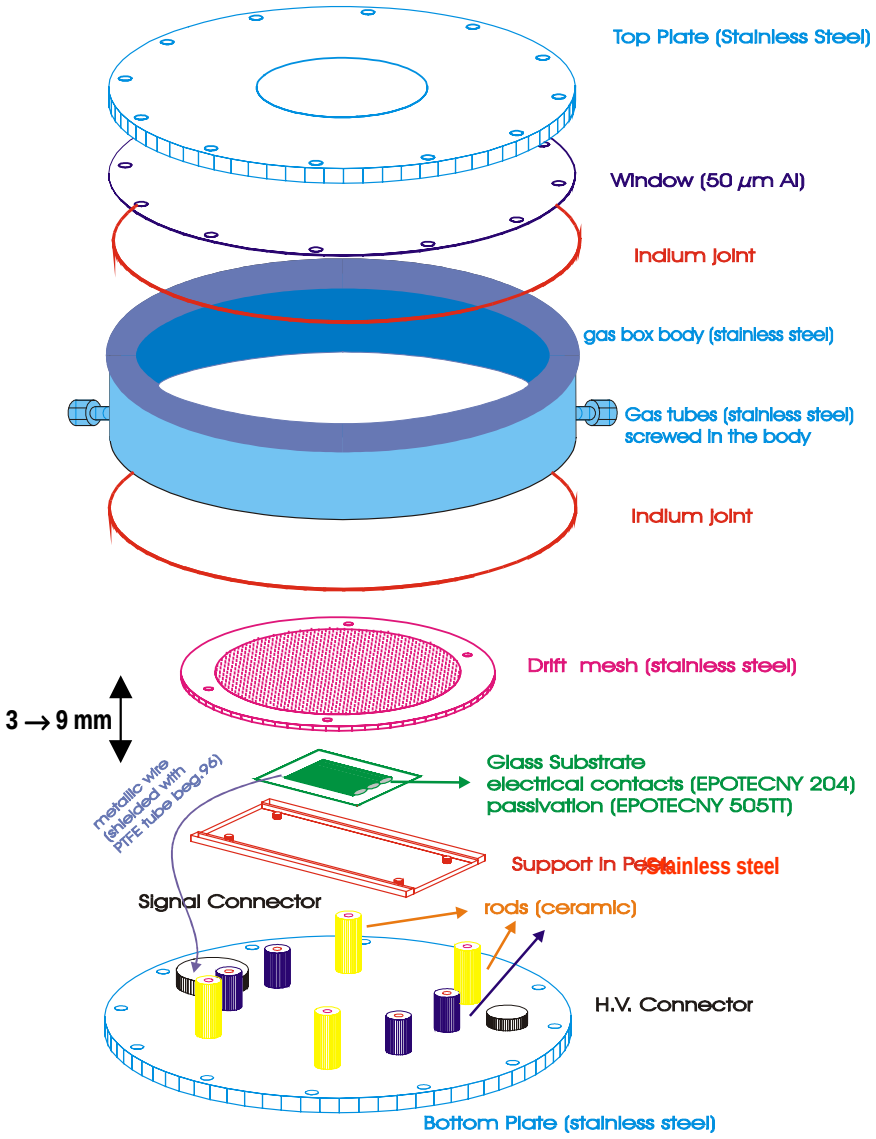
active area 3 × 3 cm²

- **semi conductive glass**
  - ≈ 10^{13} Ω/sq
- ☞ Au strips



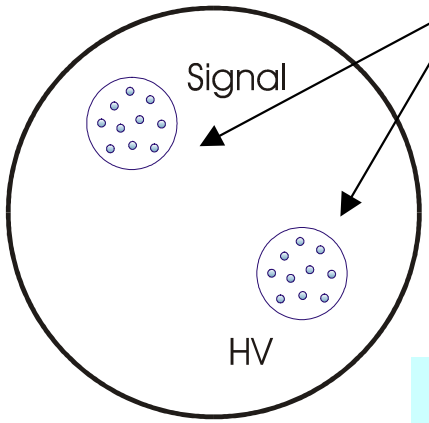
kindly provided by
Dr Lev Shekhtman
(Novosibirsk)

Gas boxes (1) : stainless steel box

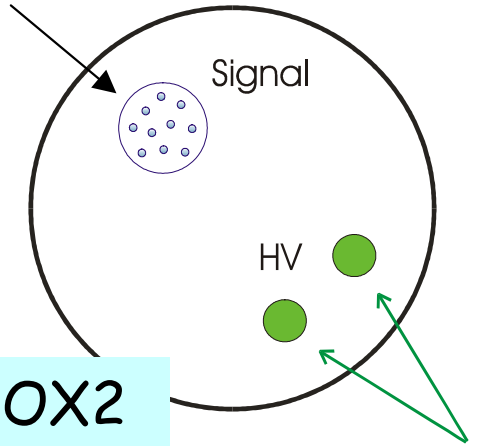


3 kinds of bottom plate

Metal-glass feedthrough connectors



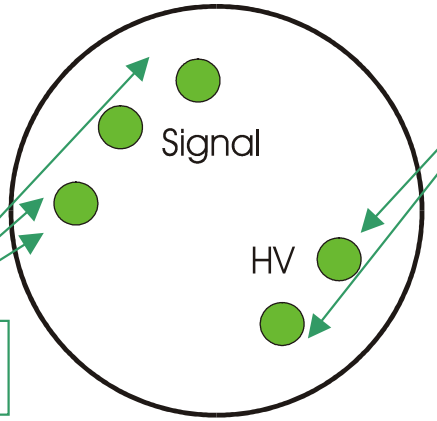
BOX1



BOX2

SHV connectors

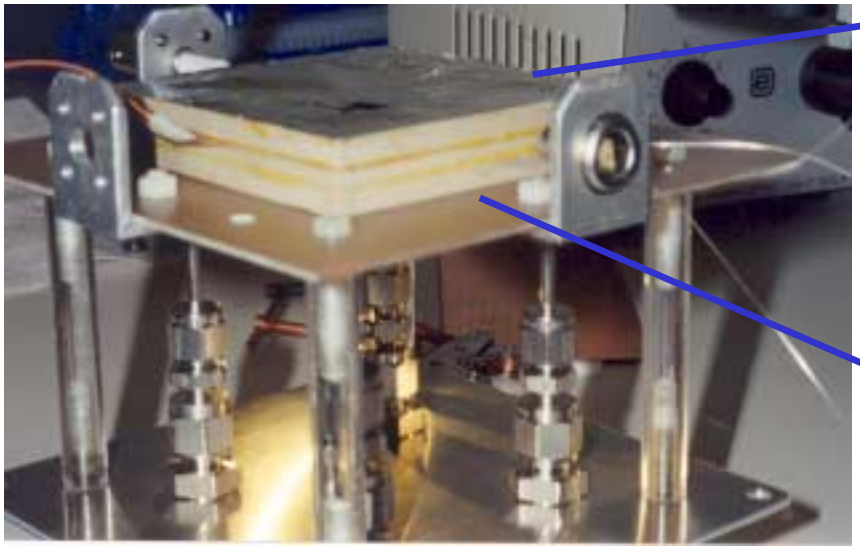
BOX3

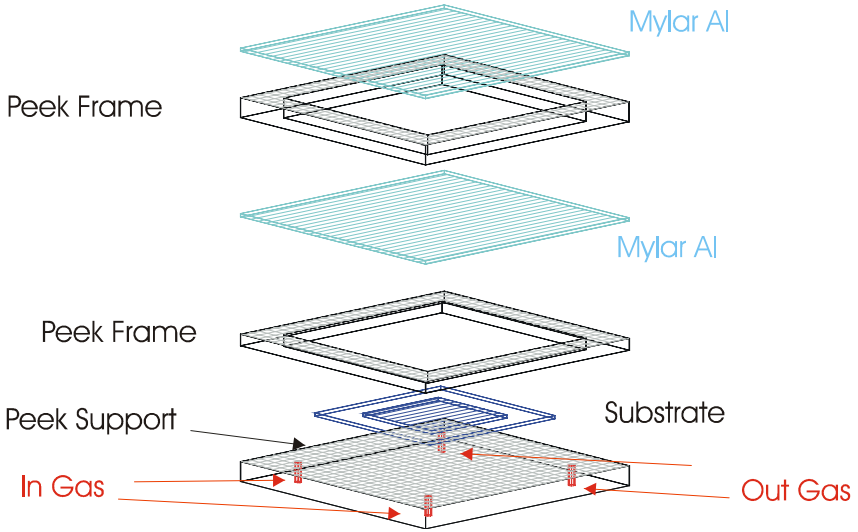


BNC connectors

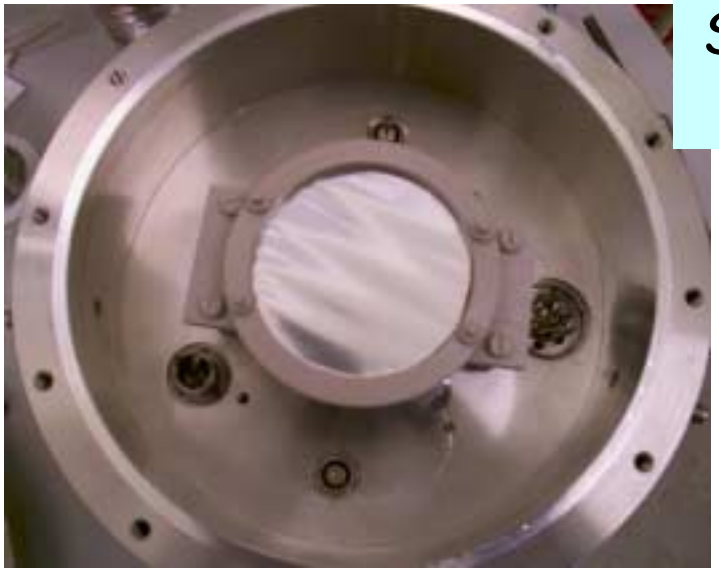
Gas boxes (2)

PEEK BOX

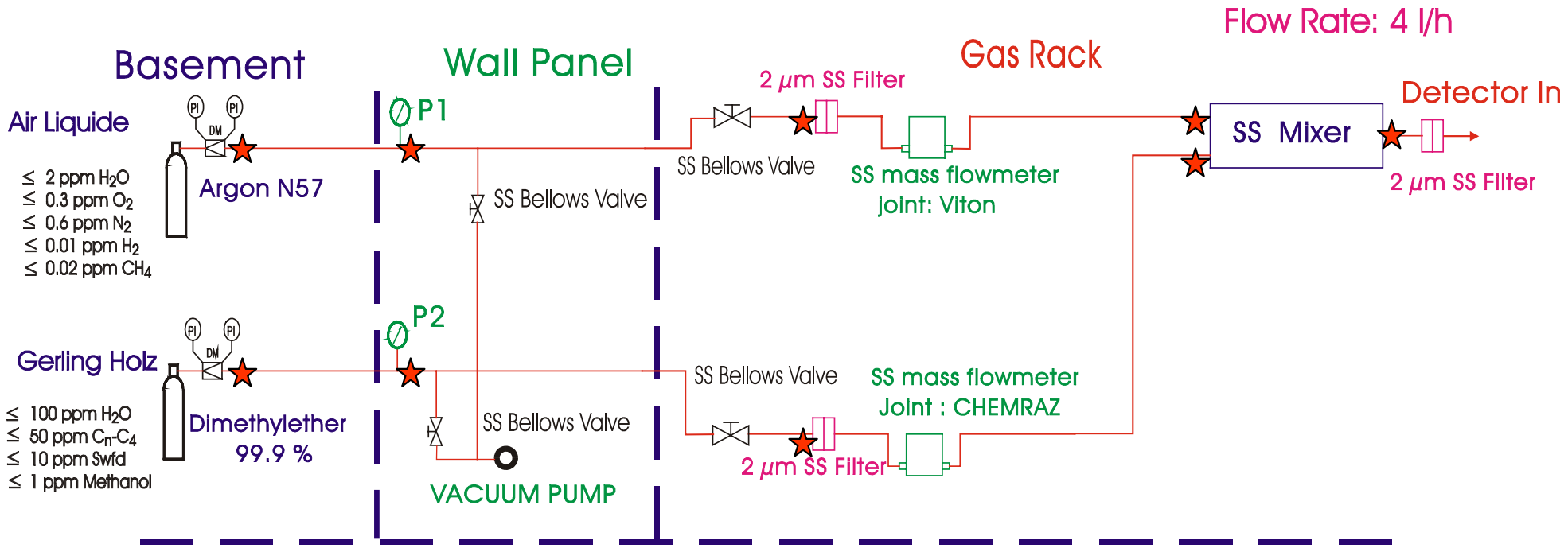


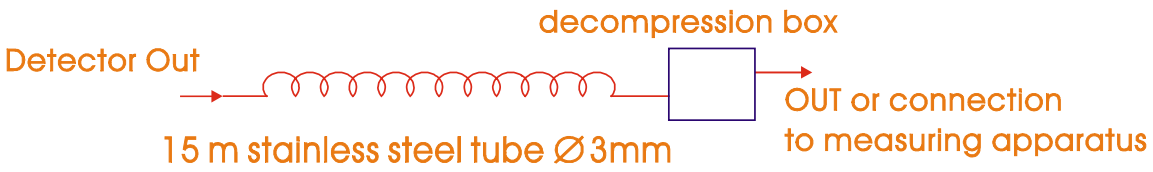


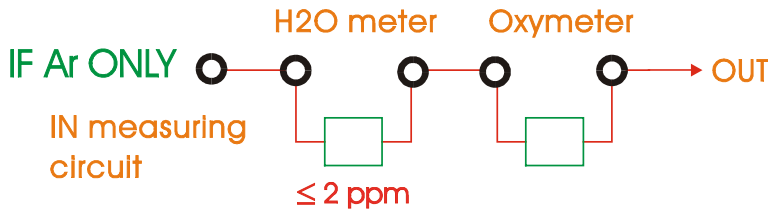
Stainless steel box
+ PEEK inside



Gas circuit (beginning 1996) Ar-DME or Ne-DME (50-50)

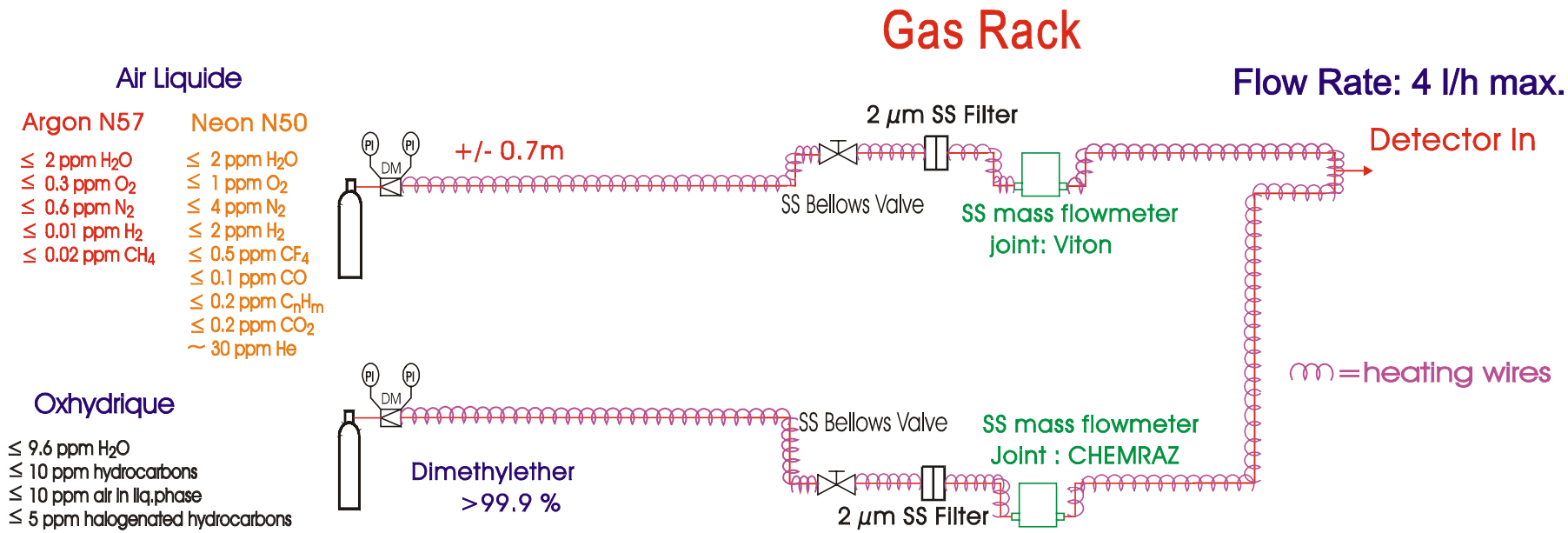






★ sealant : TFE paste

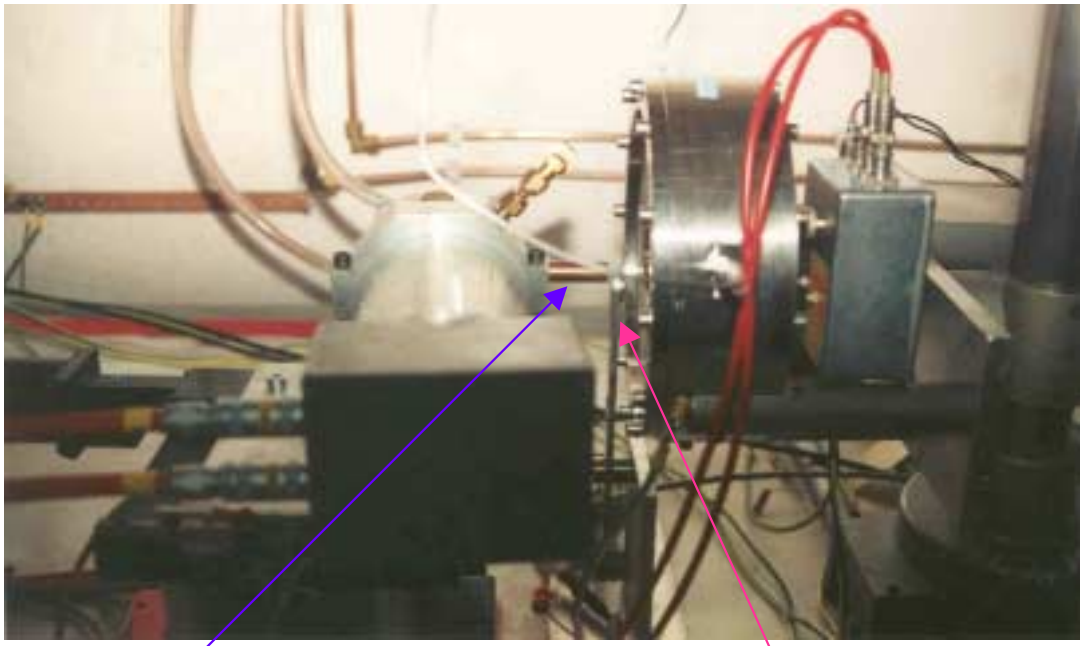
Gas circuit *simplified step by step* (beginning 1997)



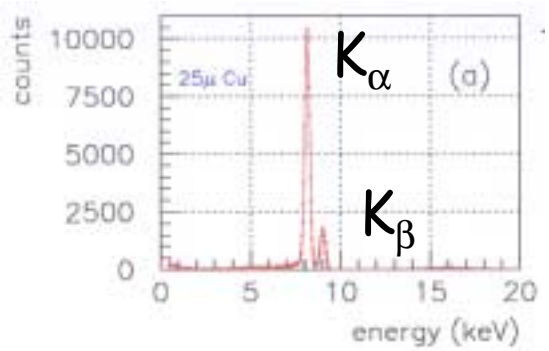
- lines shortened
- TFE selant removed
- mixer suppressed
- no more connections to vacuum pump

MSGC irradiation by means of X-rays

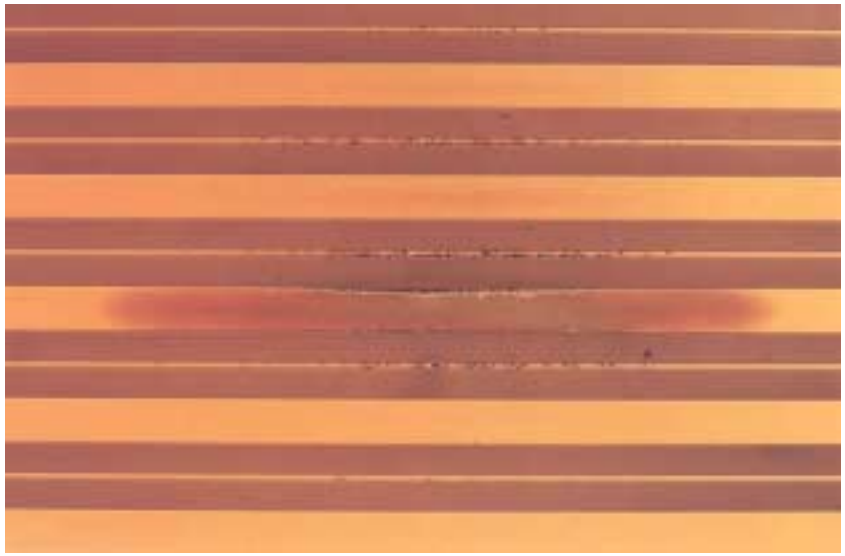
X-ray tube : Fe / Cu anode → 6.4 / 8 keV



Brass collimator
0.5/0.7/1.1 mm ∅ Pb shutter



irradiation spot :
S ☞ 1 mm²



MSGC readout

PH = pulse height measurement

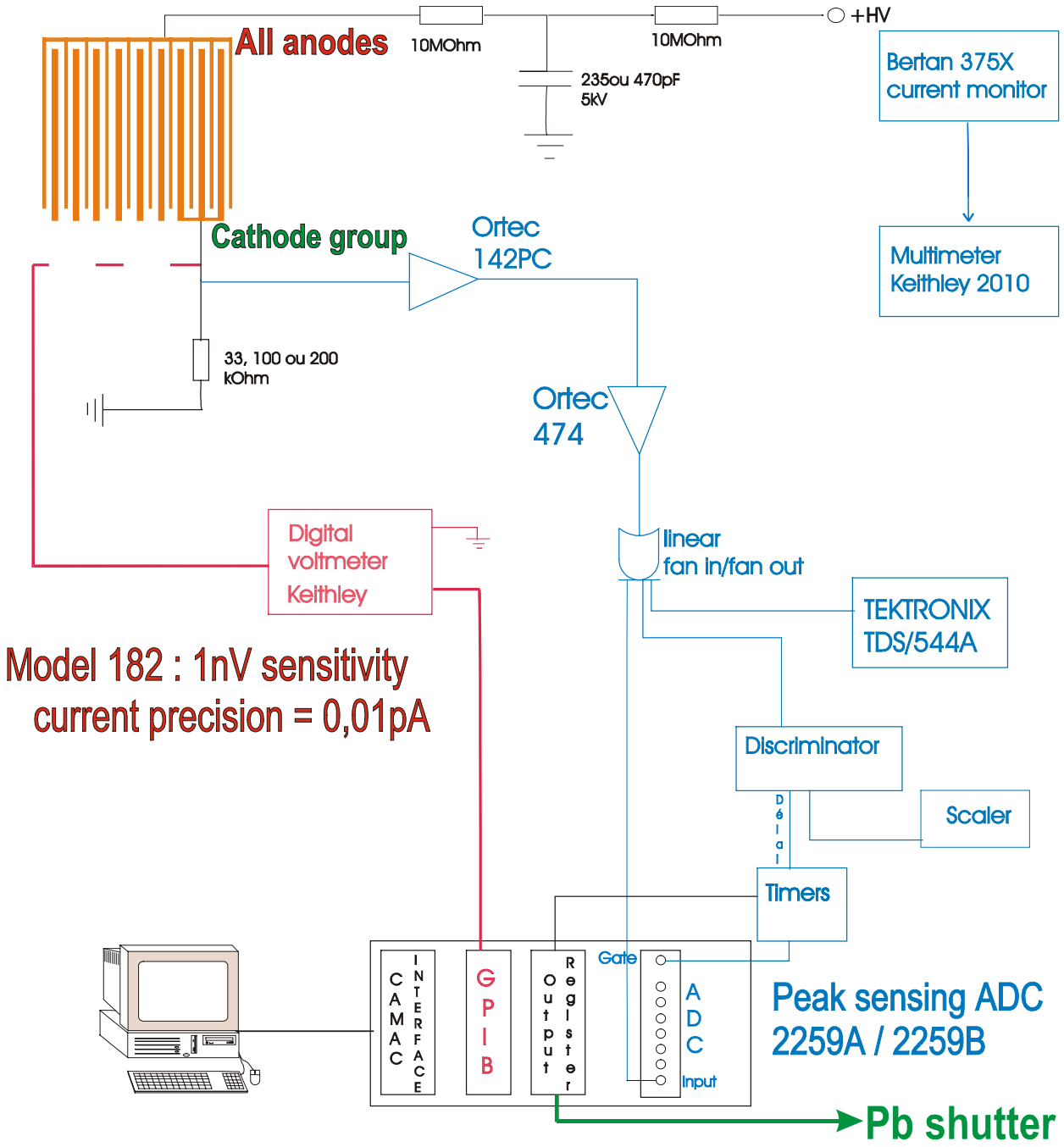
@low X rate → absorber

Icath = cathode current signal

@high X rate

$I_{cath} = I_{tot} - I_{dark}$

Pb shutter



RESULTS (1) : Bare DESAG / Cr strips
GAS BOX #1 Ar-DME(50-50) 4l/h

1st test (end 95)

substrate #1

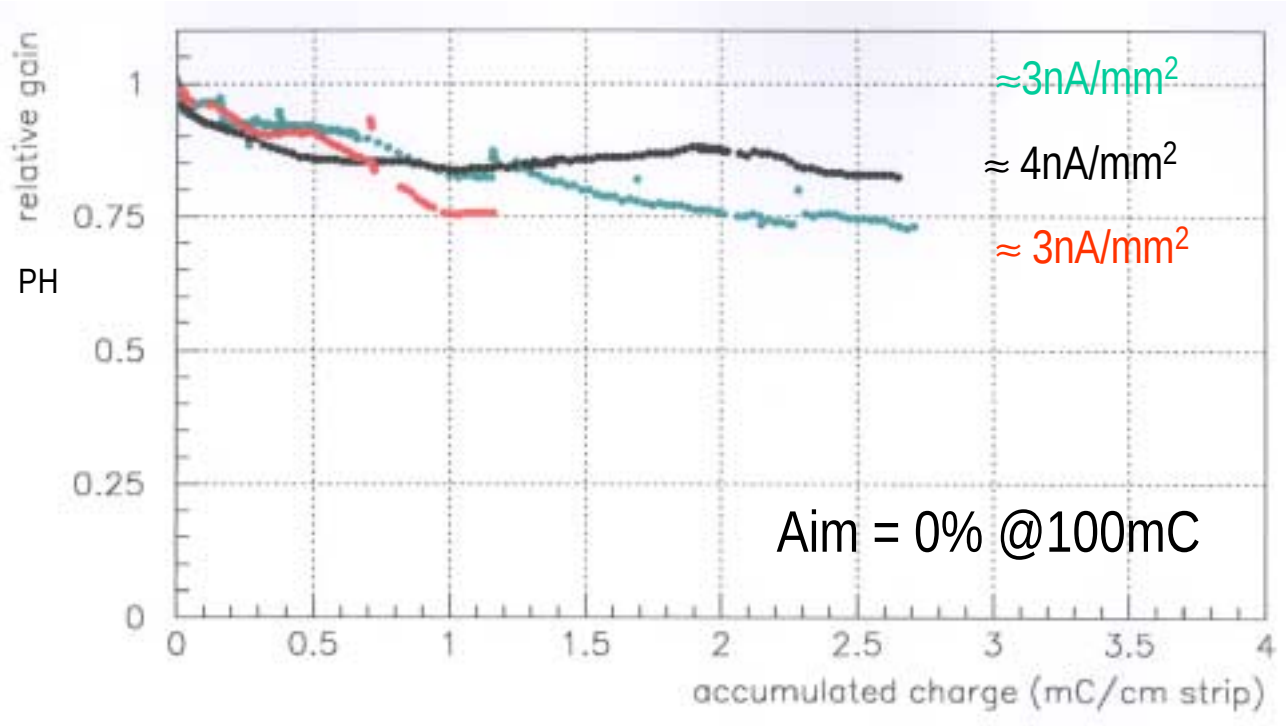
-1000V/9mm G≈1400

higher drift field

-1500V/4.5mm G≈1200

substrate # 2

-500V/4.5mm G≈1400



Gain loss : 25% @2.5mC/cm strip

quasi no change compared to 1st test

better : < 20% @2.5mC no loss : 0.5 → 2.5 mC

Bare DESAG / Cr strips

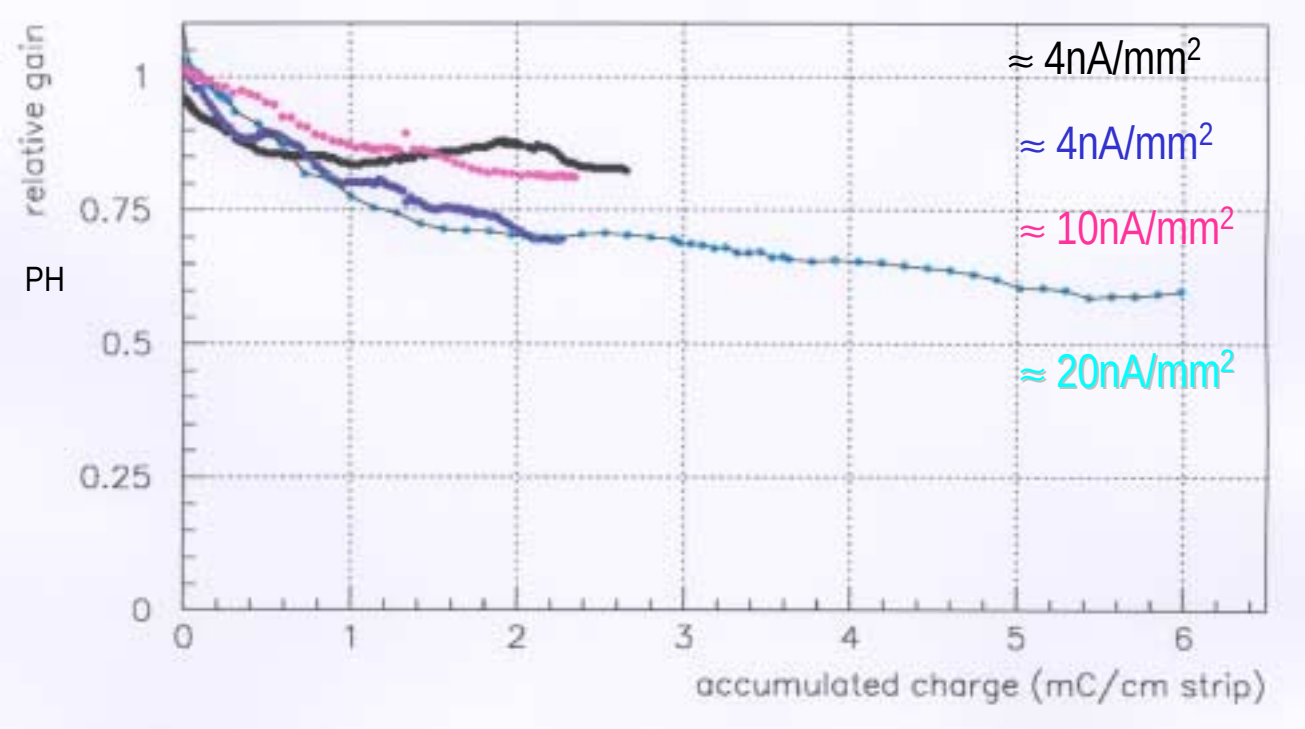
GAS BOX #1 substrate # 2 -500V/4.5mm G≈1000

Ar-DME (4l/h)

lower gas flush (1l/h)

higher XR flux (4l/h)

Ne-DME (4l/h)



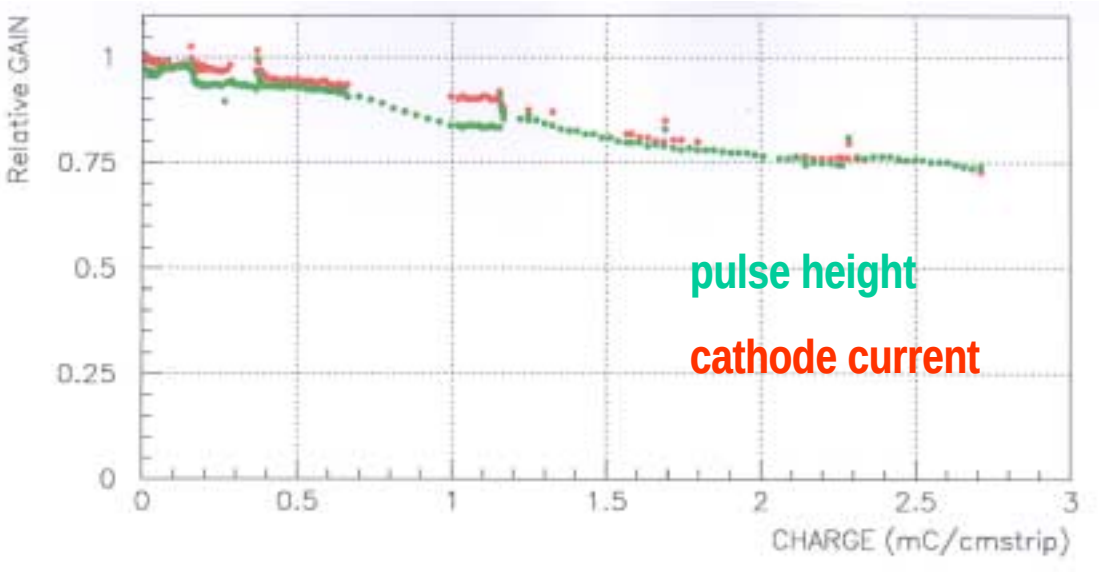
Gain loss : < 20% @2.5mC no loss : 0.5 → 2.5 mC/cm strip

worse : sign of pollution

fast decrease @start (30% 0 →2 mC 10% 2 → 6 mC)

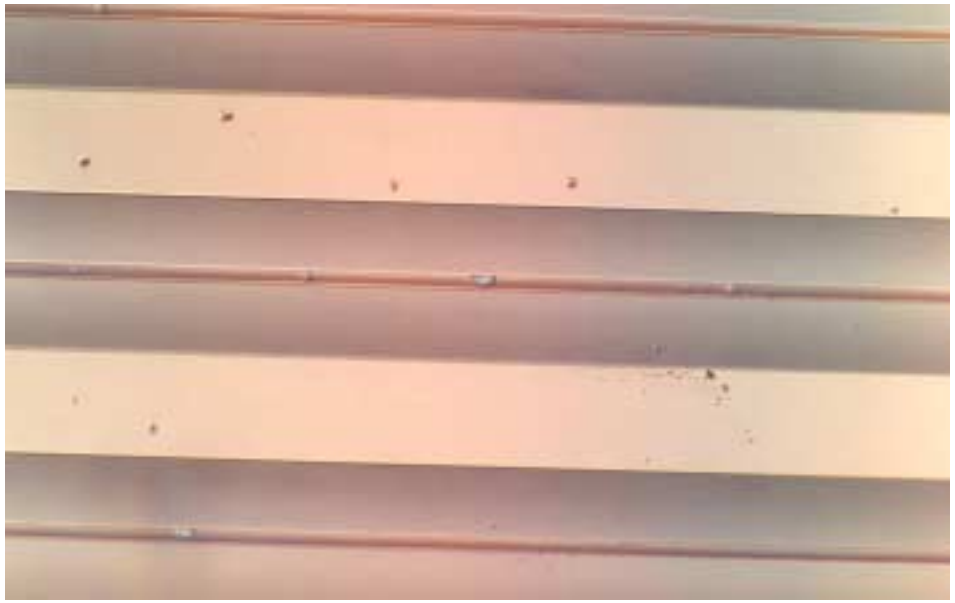
quasi no change compared to Ar

Bare DESAG / Cr strips



Same result from PH or Icath measurement

@irradiation points : anode strips ➡ faint brown discoloration



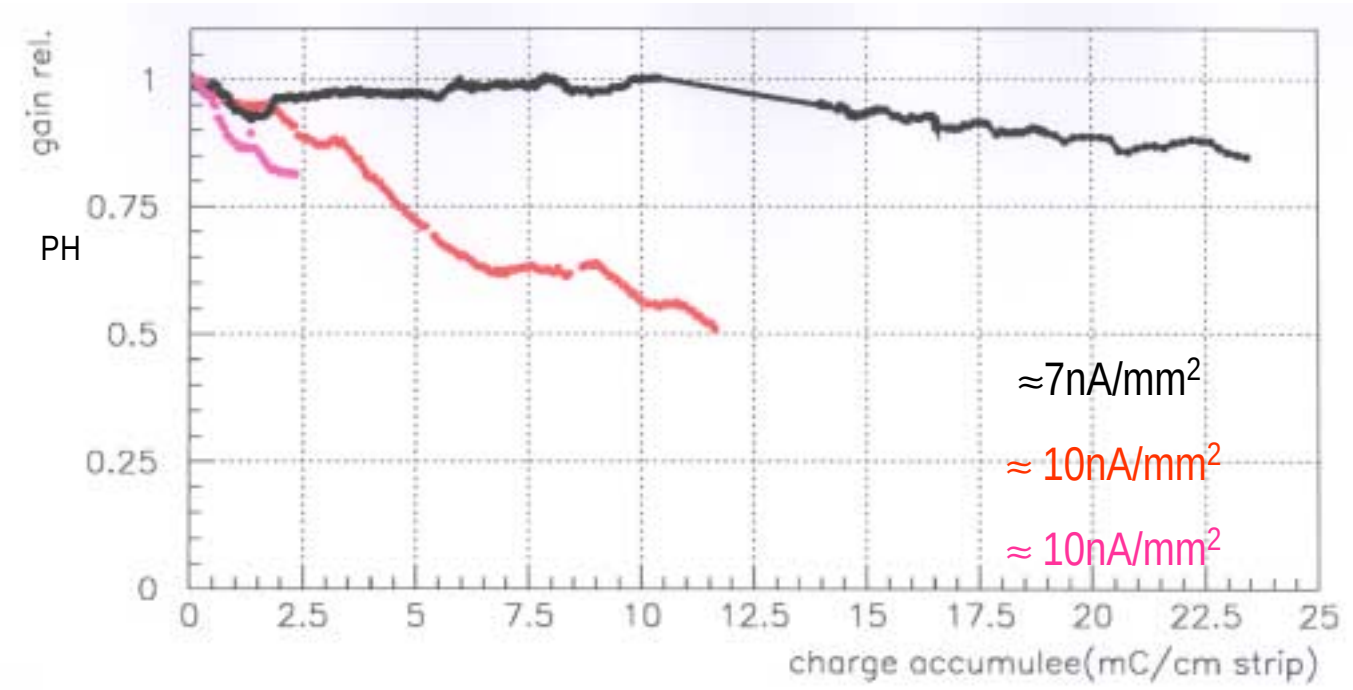
Results (2) : semi-conducting glass / Au strips

GAS BOX #2 -1000V/9mm G≈1000

Ne-DME (4l/h)

Ar-DME (4l/h)

Desag Ne-DME



Very few aging : Gain loss = 14% @23 mC/cm strip

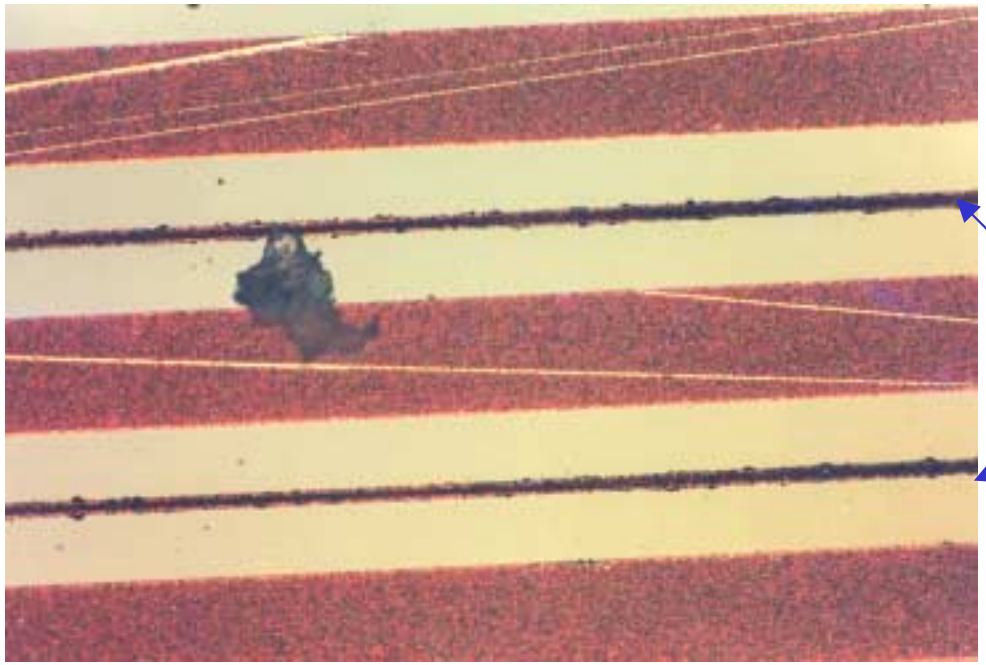
worse : sign of pollution ...

better compared to bare DESAG

Good result obtained despite pollution (TFE + box#2)

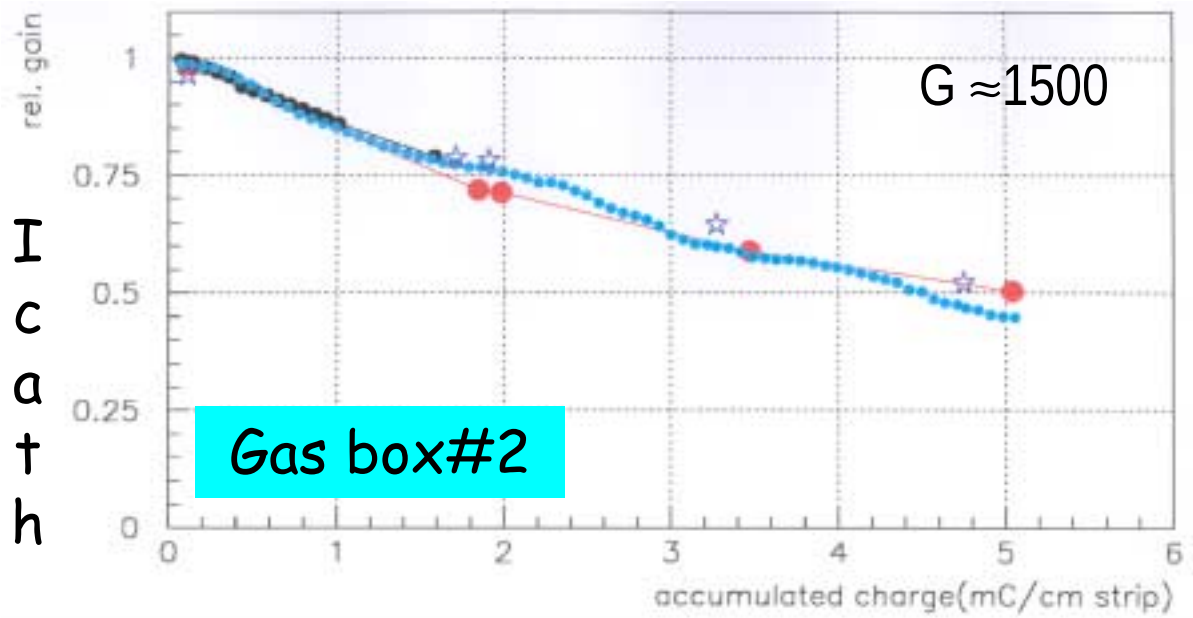
semi-conducting glass / Au strips : end of tests

N.B. Substrate found broken (fixation springs too tight)
influence on aging ?

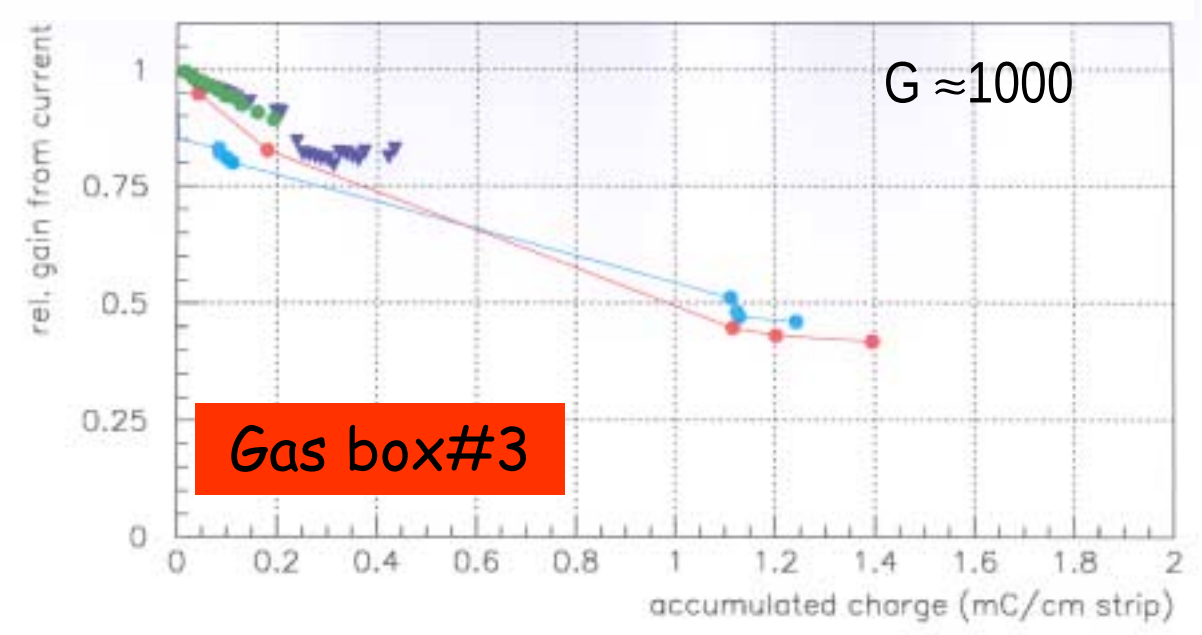


@irradiation points :
Anode strips covered
by a black deposit

RESULTS (3) : coated DESAG / Cr strips (10nA/mm²)



I cath



Ar- DME Gerling Holz 4l/h

id. Air Liquide

3d test PHmeast ☆

Very fast aging : gain loss = 50% @ 5 mC/cm strip

Sub.1 Ar- DME

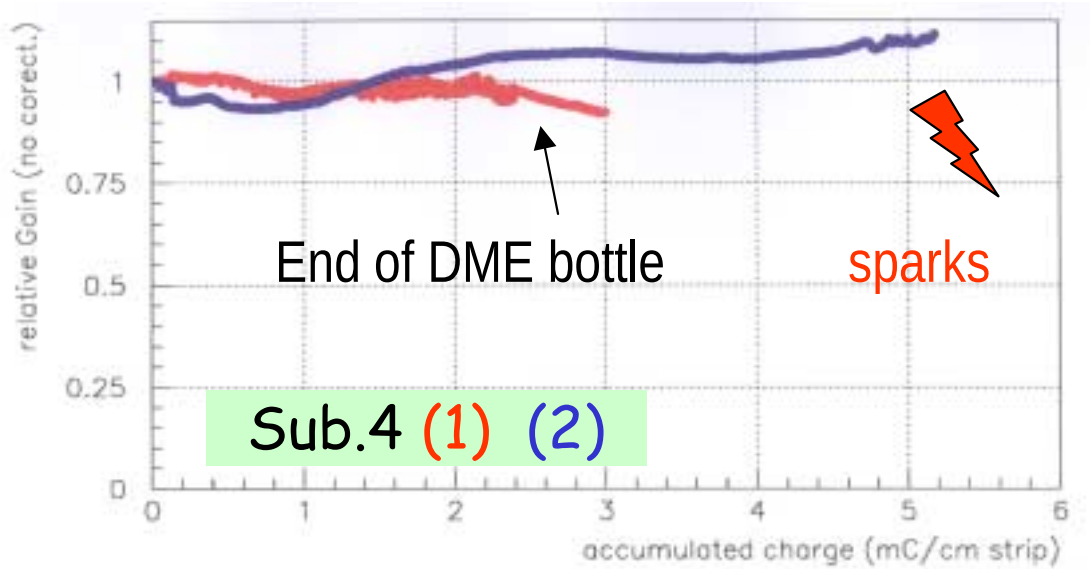
sub.2 Ar- DME

Ar- iC_4H_{10}

sub. 3 Ar- DME(Messer)

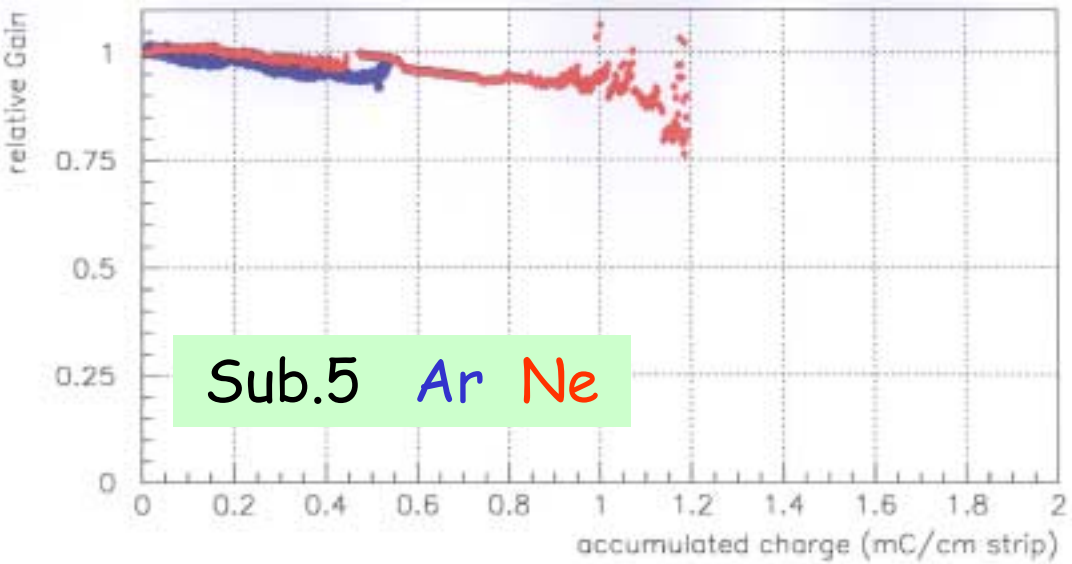
Catastrophe !

Gas box #1 + tube heating coated DESAG / Cr strips



Quasi no aging

but sparks appear !

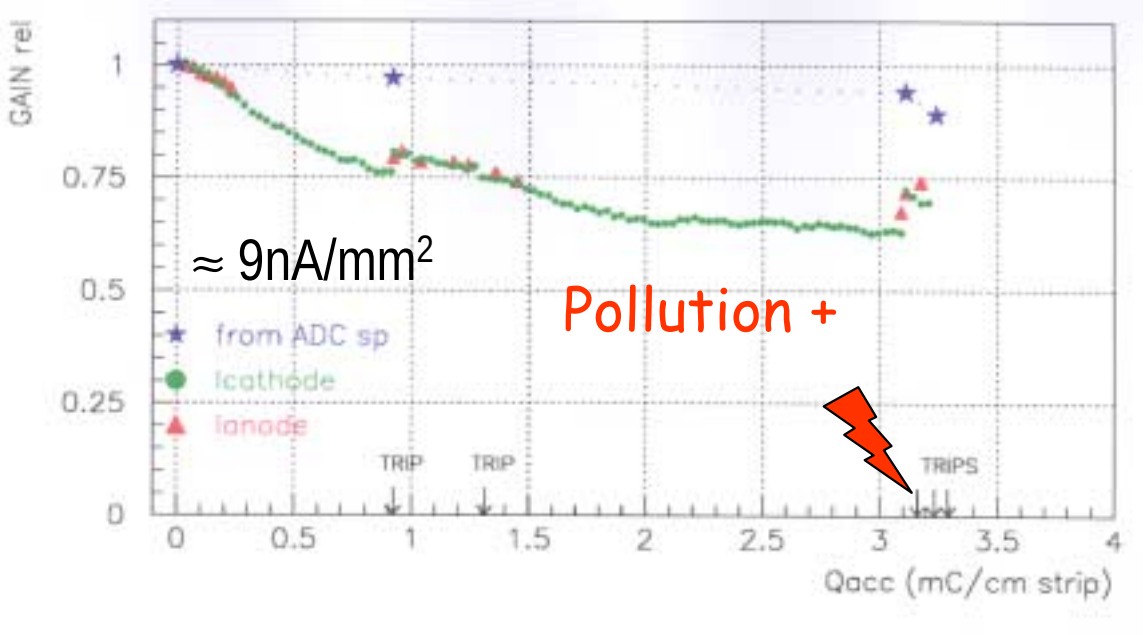


Quasi no aging

and many sparks occur for both gas mixtures !

Gas box in PEEK coated DESAG /Cr strips Ne-DME(50-50)

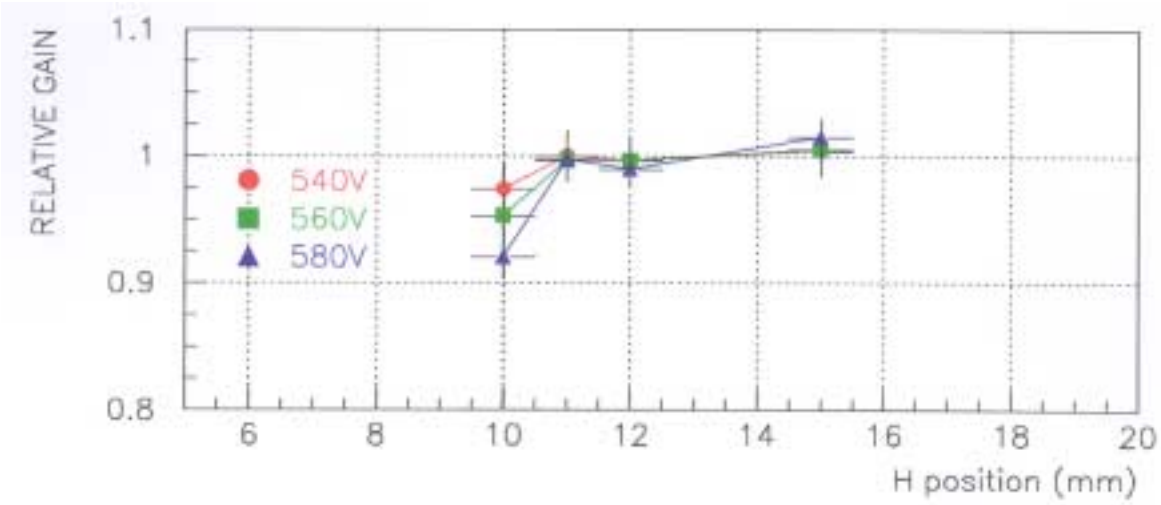
Sub.6 G ≈1000



Decrease of Icath

& sparks !

discrepancy PH / Icath



Scan after aging :

confirm meast.from PH

& depend on HVa ?

coated DESAG / Cr strips

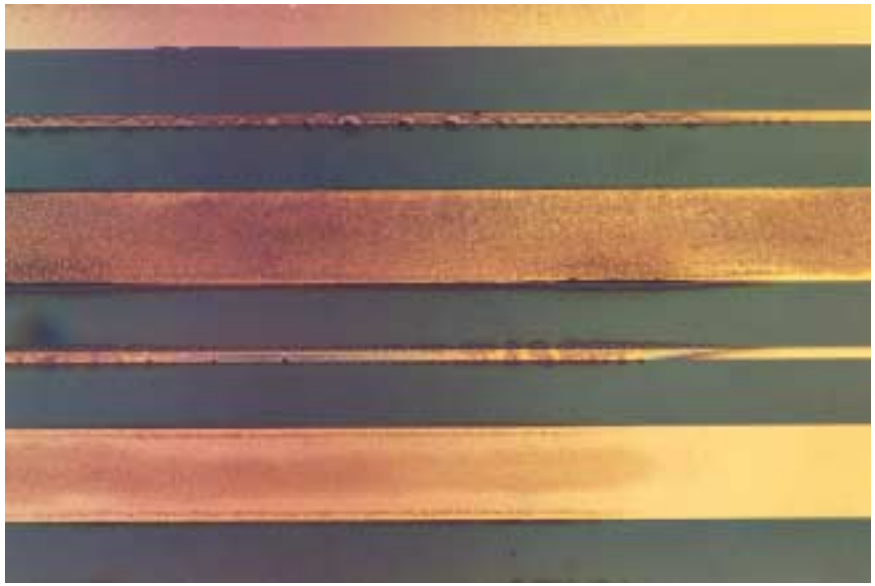
@ irradiation points :

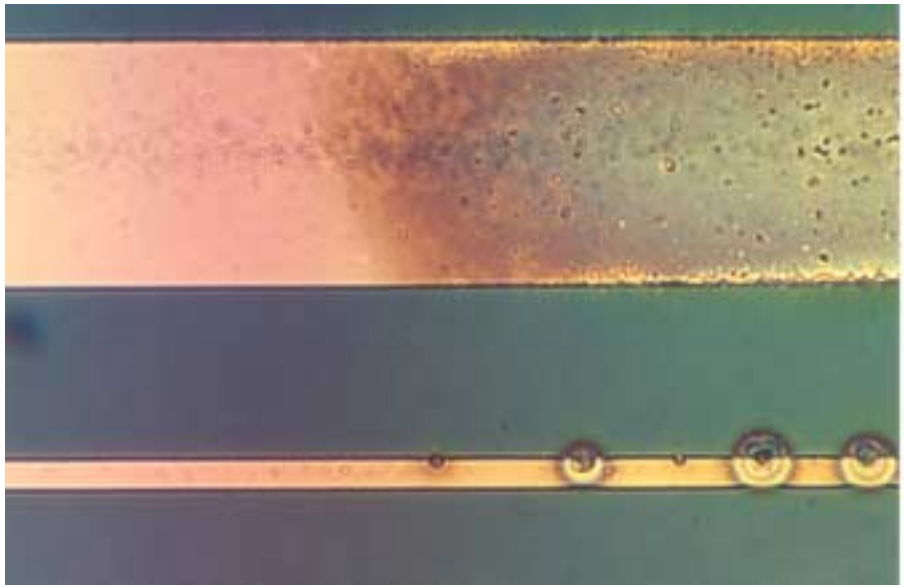
Sub.1 2 3 :

discoloration of anode strips

Sub. 4 & 5 :

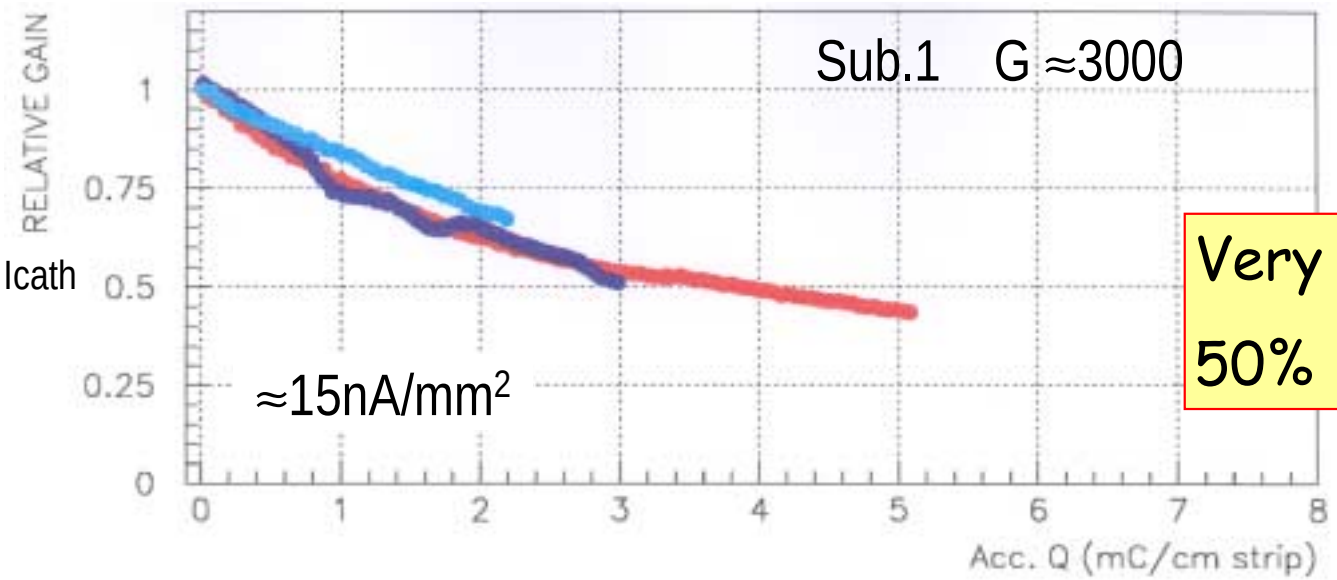
sign of sparks !





RESULTS (4) : coated DESAG / Au strips

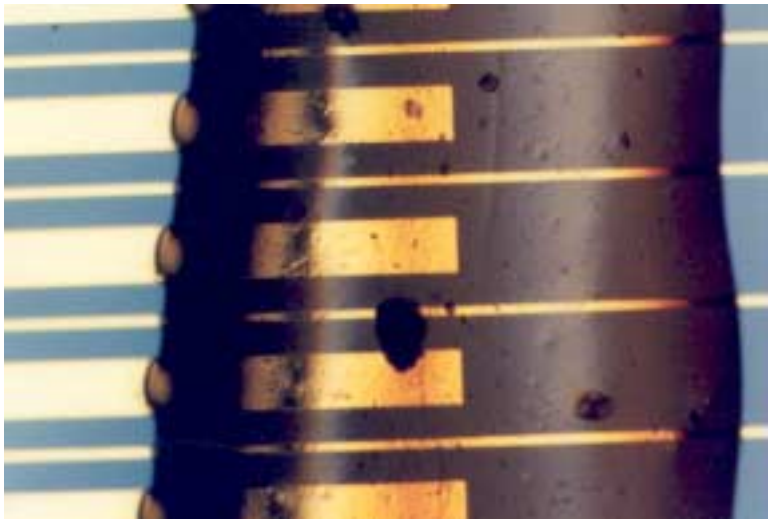
Gas box #1 **PEEK support** ⟹ **-3000V/3mm** Ne-DME



Very fast aging : gain loss = 50% @ 3 mC/cm strip !! ?

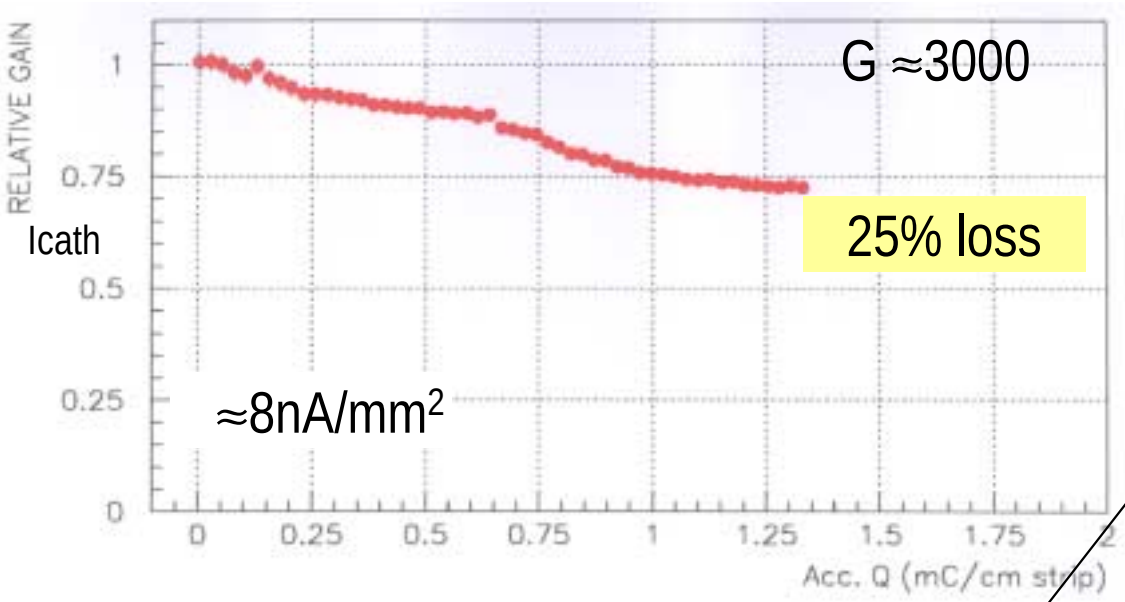
Visual inspection @irradiation points : no sign of aging !

But passivation glue darker



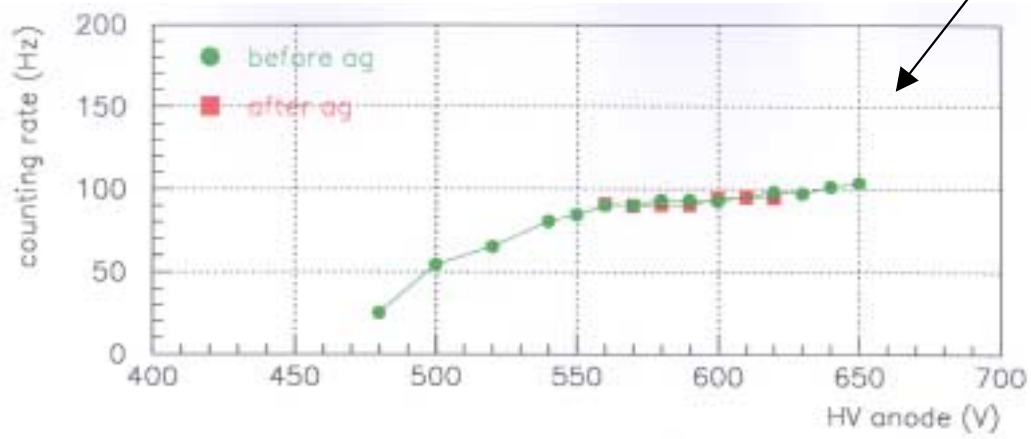
Gas box #1 PEEK support coated DESAG / Au strips Ne-DME

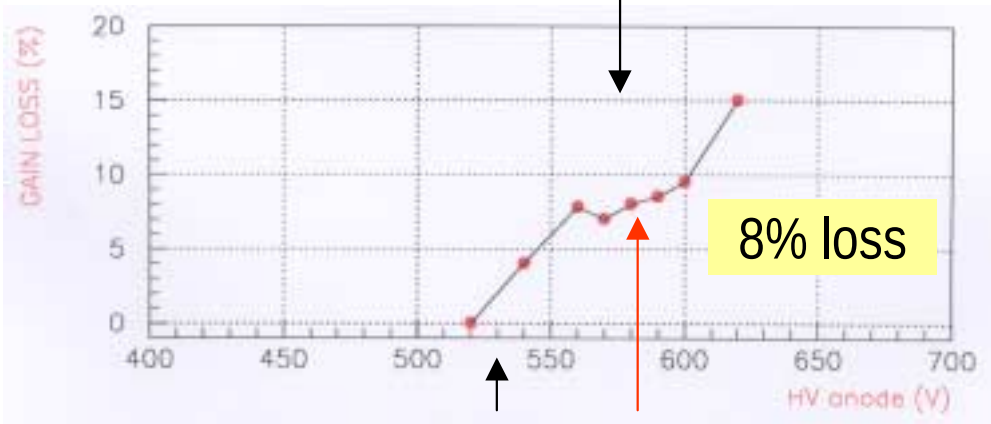
Sub.2 : no passivation glue



Once more : very fast aging !

the real loss seems not so big :
plateaux before and after aging
+ mean Pulse Height @ low rate
→ loss of gain (HVa)



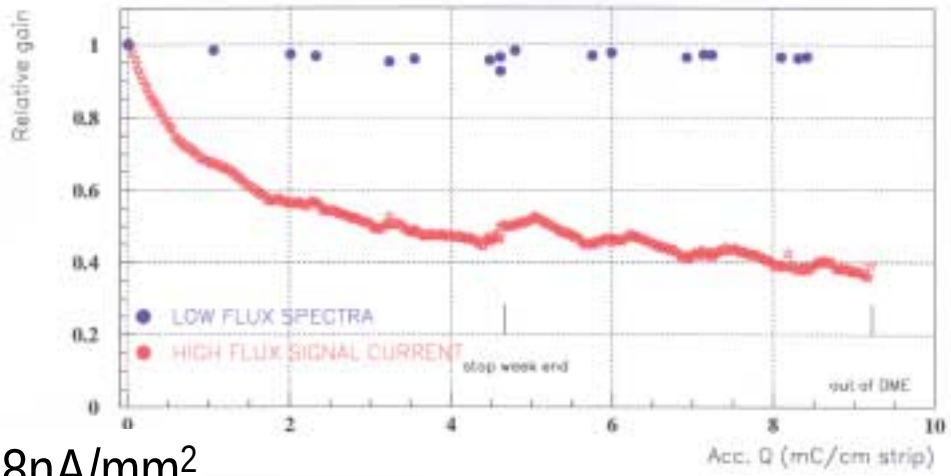


520V 580V

Gas box #1 PEEK support coated DESAG / Au strips Ne-DME

Sub.2 : 2 tests @ lower HVa (520V)

G ≈1000



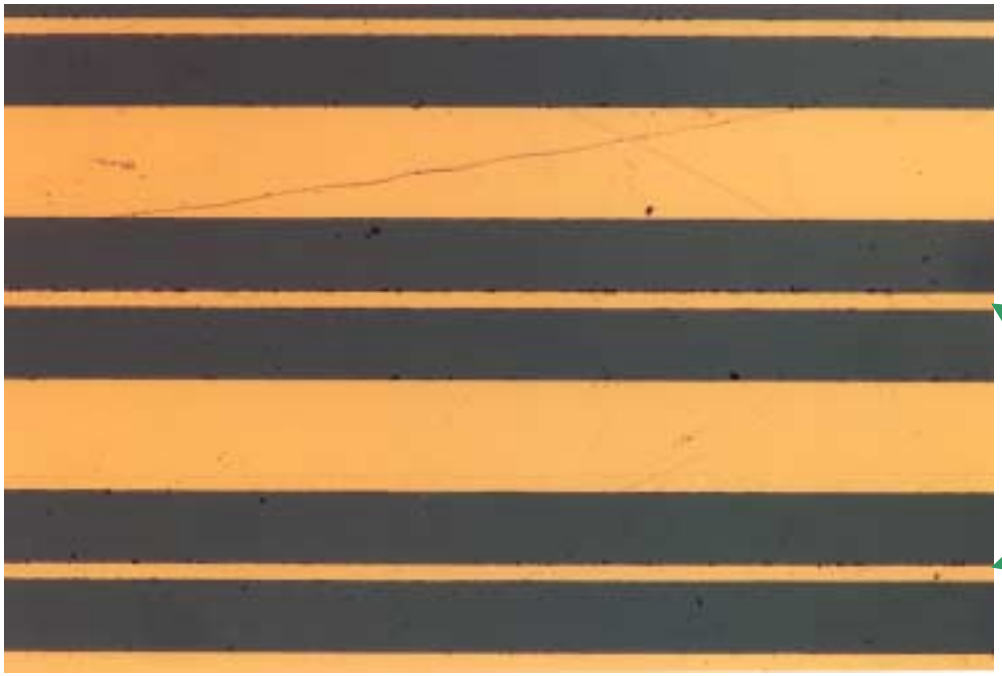
≈8nA/mm²

fast aging from Icath monitoring @ high rate

lower aging rate from PH measurement @ low rate

gain loss = ≈10% @ 20 mC/cm strip

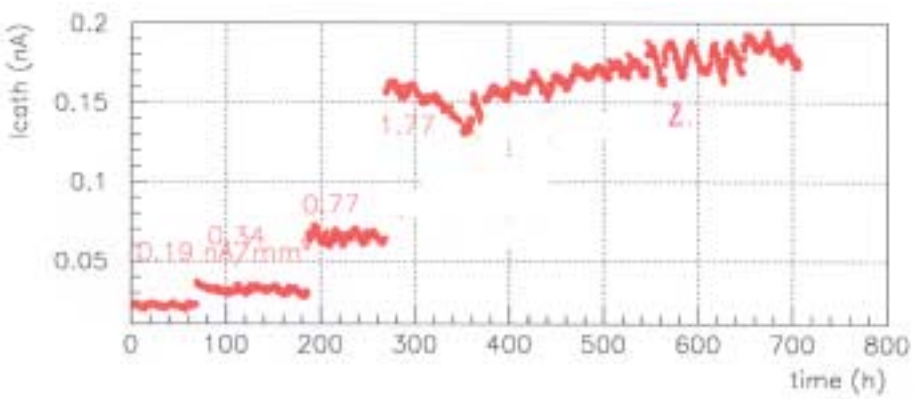
coated DESAG / Au strips



@irradiation points :
anode strips

black edges

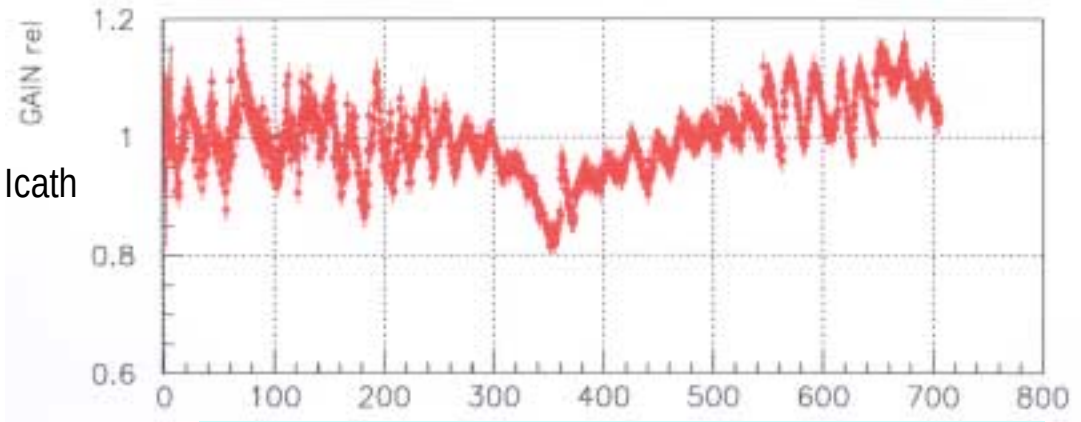
RESULTS (5) *few months later* : bare DESAG / Au strips
Gas box mix Ar-DME (50-50) 6l/h



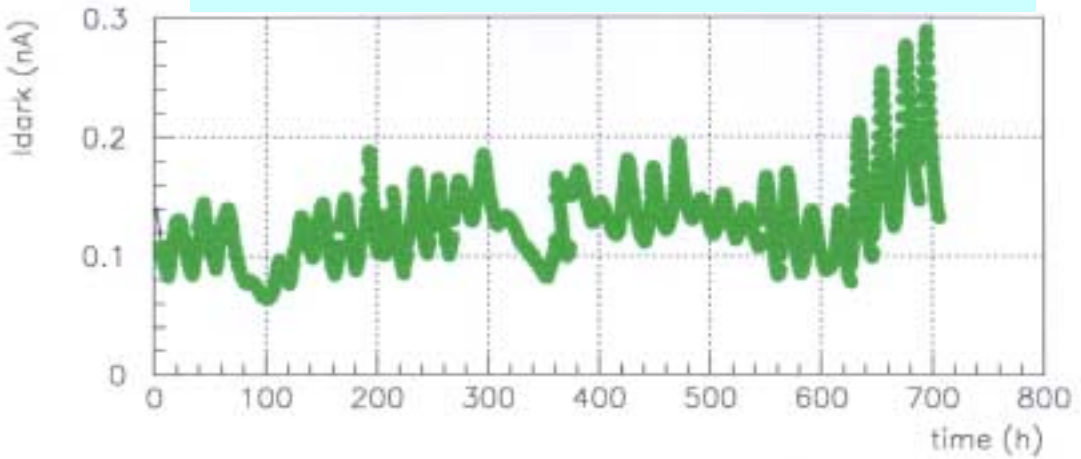
Progressive increase of irradiation rates :

0.19 → 0.34 → 0.77 → .1.77 → 2.0 nA/mm²

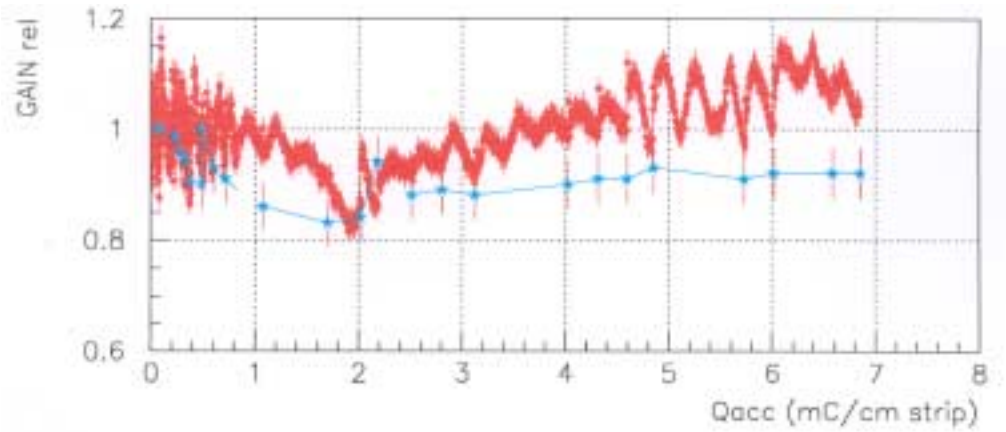
-1500V/3mm +540V G≈1000



Variations of relative gain = Idark fluctuations ➡ T°

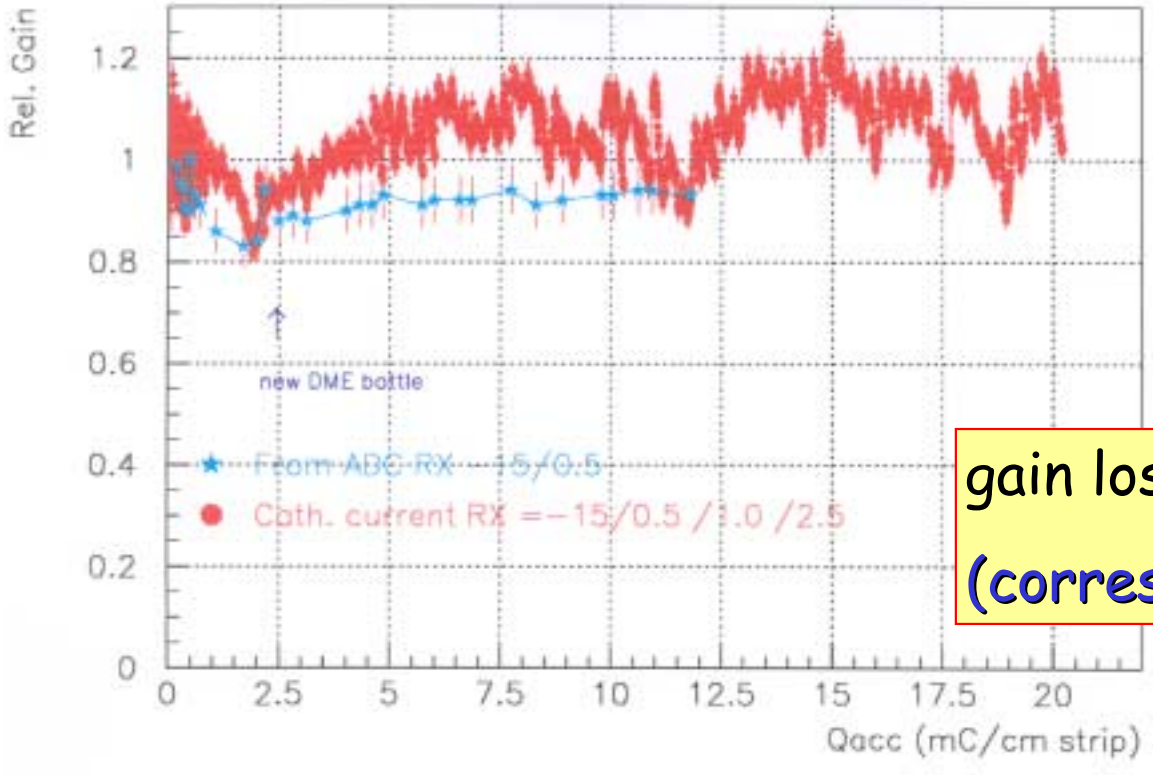


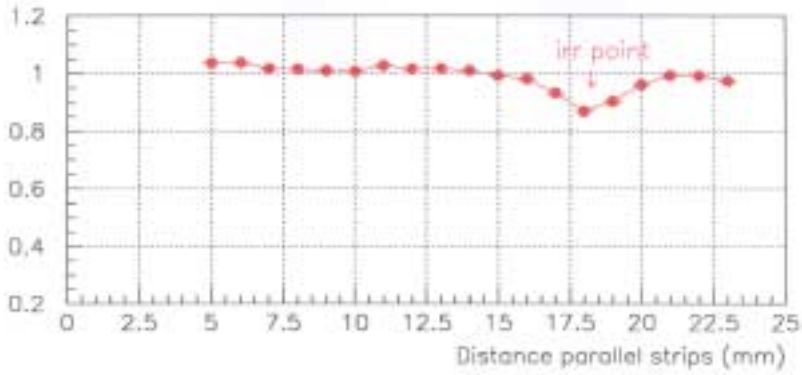
Gas box mix bare DESAG / Au strips Ar-DME



Quasi no aging from Icath monitoring @ high rate

same aging rate from PH measurement @ low rate (except ≈10% initial decrease)





gain loss = ≈10% @ 20 mC/cm strip

(corresponding to the initial loss)

Conclusions in our set-up :

1/ Many parameters seem to play a role in MSGC aging !

+/- correlated to a possible pollution of the gas set-up

2/ no significant difference between Ar-DME & Ne-DME

3/ DLC coating doesn't increase the detector lifetime

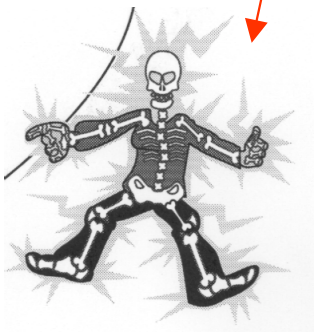
equipped with Cr strips !

4/ best results obtained with :

semi-conductive glass

bare DESAG glass

} equipped with Au strips



- Be aware of the importance to get a very clean set-up
- be patient …

Questions

1/ What are the optimal electrical potentials of the detector to study its aging? position on the plateau, gain ?

2/ What are the optimal irradiation settings ? (acceleration factor, surface of irradiation ?)

3/ Which parameter has to be measured as aging sign ?

4/ Does aging include sparking ?