

# Status of the LHCb RPC detector



G.C. Roma 2

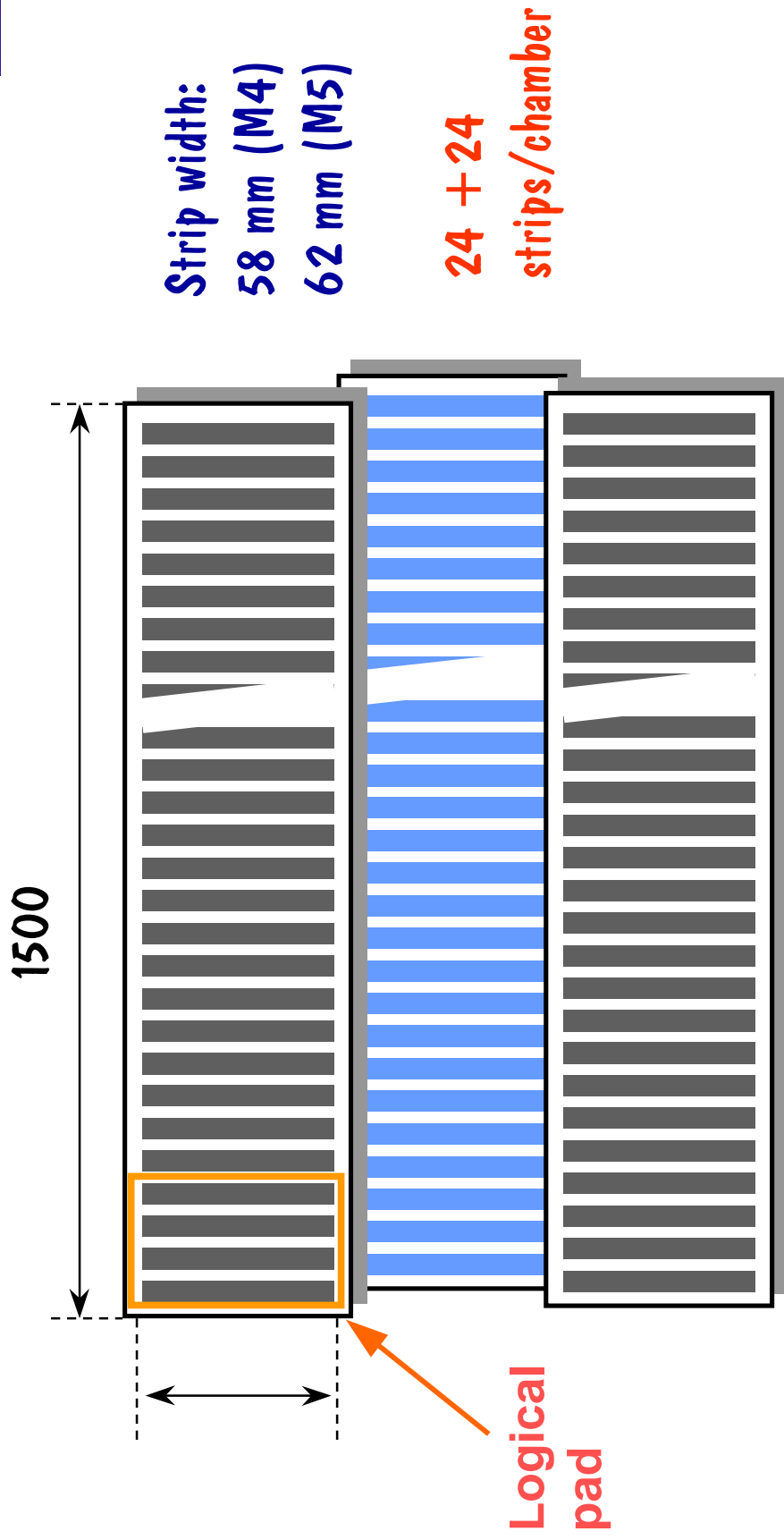
## Changes with respect to Note 2000-053

- 6 cm strips instead of 3 cm (cost optimization)
- All gaps same size (standardization)
  - ➔ Sensitive area defined by graphite paint
- GaAs discarded in favor of CMS chip for F/E

## Ongoing/planned tests

- Ageing at GIF (January → June)
- 6 cm strips
- non-oiled gaps

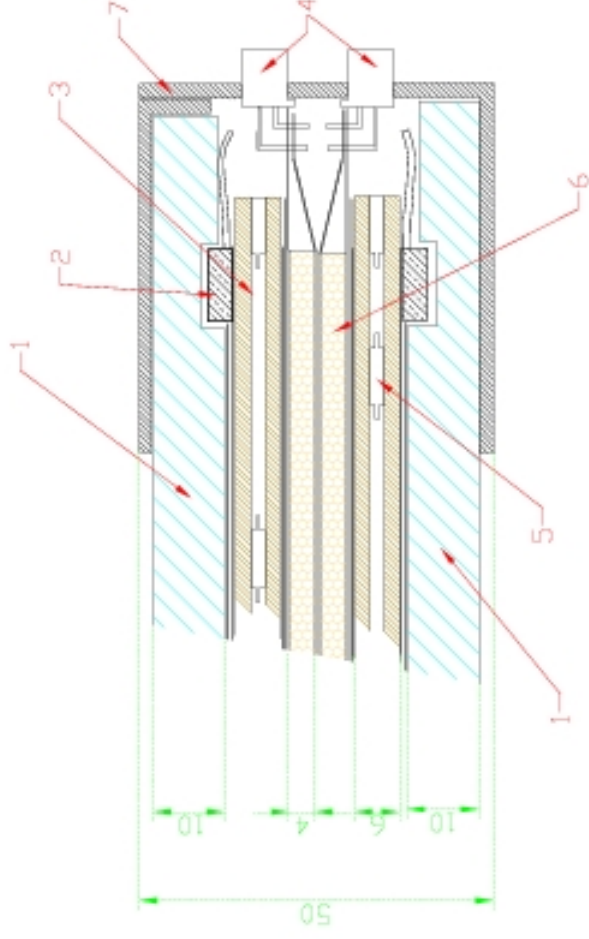
# Schematic layout for region IV (M4-M5)



Total region IV: 768 gas gaps, 18432 physical channels



## RPC cross-section



- Al-poly sandwich
- HV connection
- Gas-gap
- Signal connectors
- Spacing button
- Strip planes
- Al box



## RPC construction

**Chambers:** 480 → 960 gas-gaps

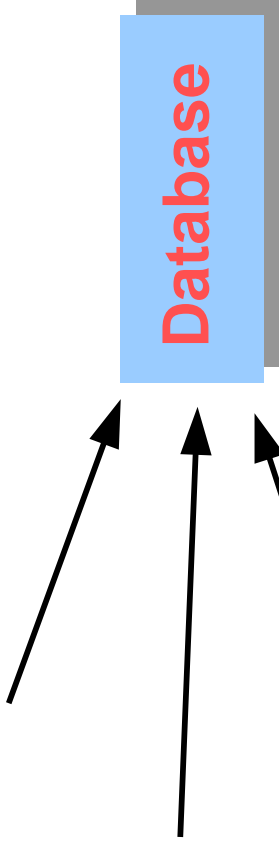
**Bakelite:** 960x1 m<sup>2</sup> ≈ 1 week production time

Resistivity measurement in factory (CMS facility)  $\rho = (8 \pm 2) 10^9 \Omega \text{ cm}$

**Gas-gap production: industry (GT)**  
also first HV check

**Detector assembly and test: in FI and RM2**

I-V characteristic of gas-gaps  
chamber assembly (strip planes, external panels)  
installation of electronics boards  
cosmic ray test



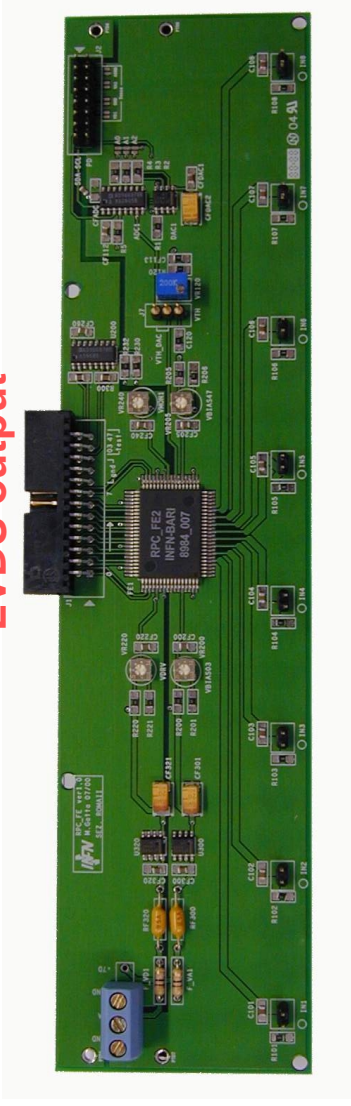
## FE electronics

### Baseline choice: CMS BiCMOS chip

Technology	0.8 um BiCMOS
Dimensions	2.9x2.6 mm
Input impedance	15 ohm
Dynamic range	20 fC - 20 pC
Charge sensitivity	1 mV/fC
Bandwidth	90 MHz
Dead time	50 ns

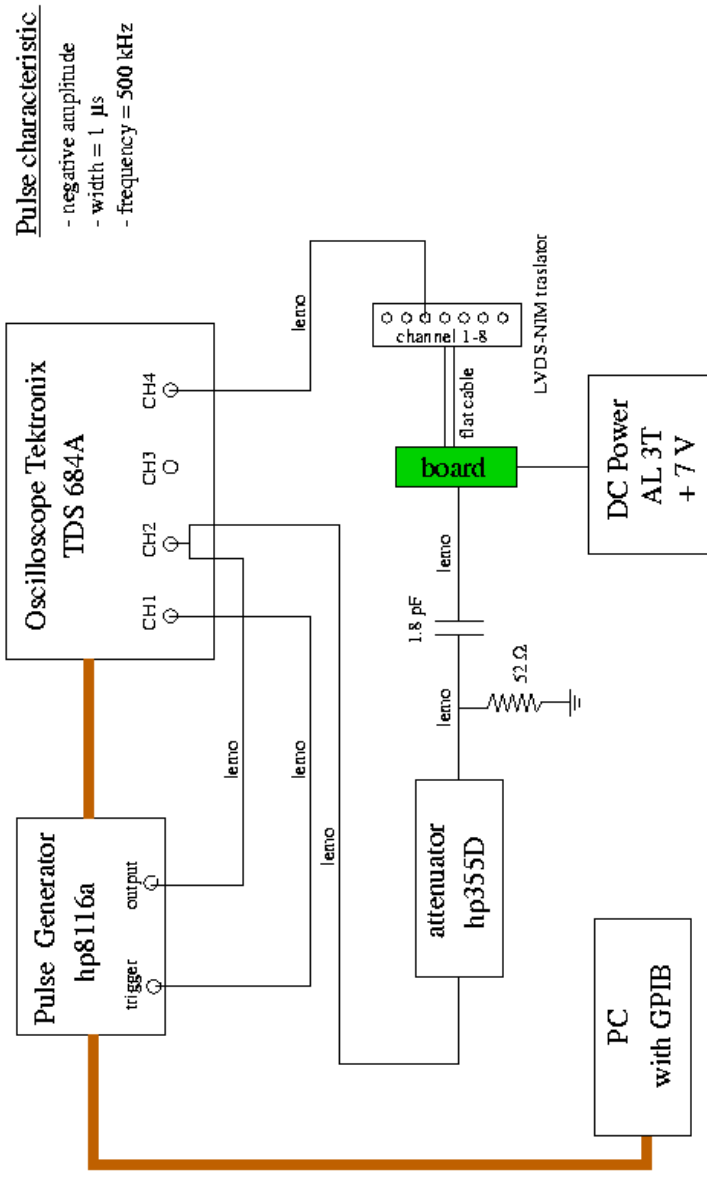
### Prototype board used in beam tests (8 ch)

LVDS output



**Final board will be 16 ch**  
**Region III: 6 boards/chamber → 576 boards**  
**Region IV: 3 boards/chamber → 1152 boards**

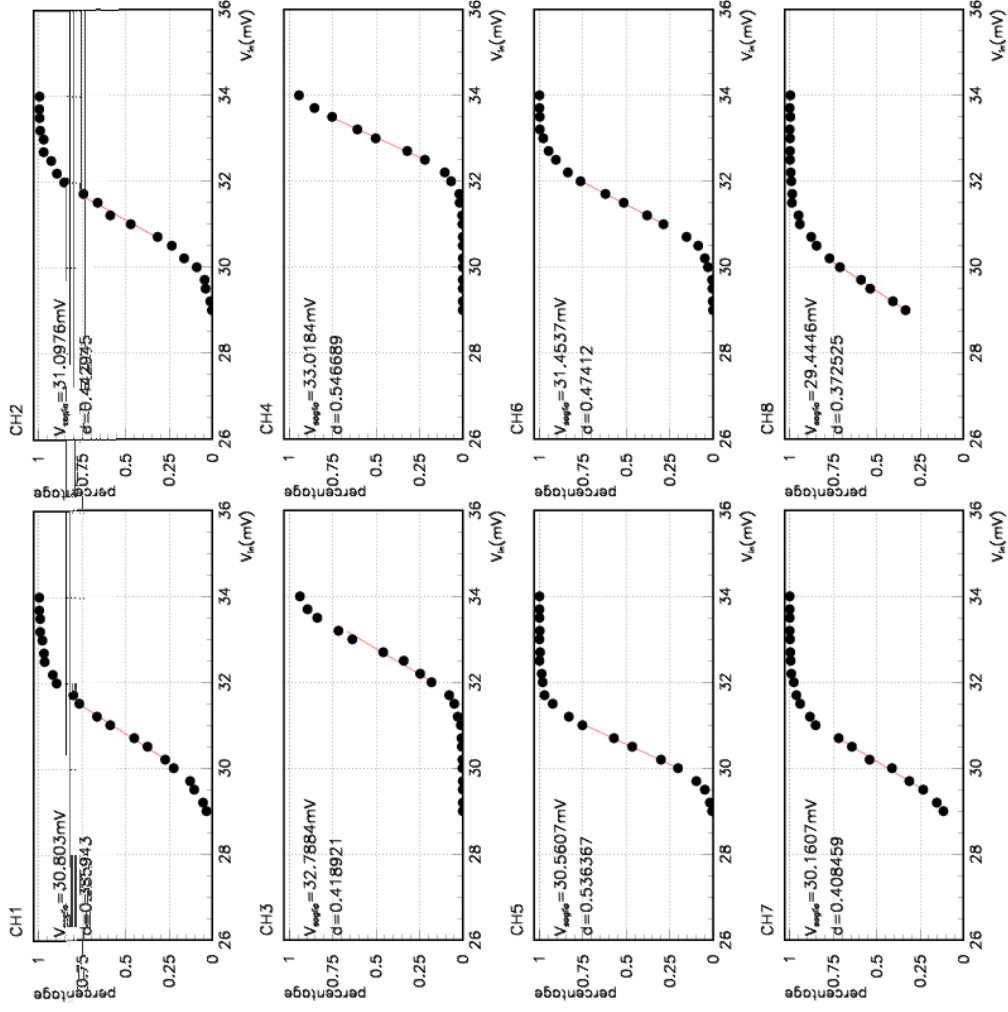
# FE electronics: test setup





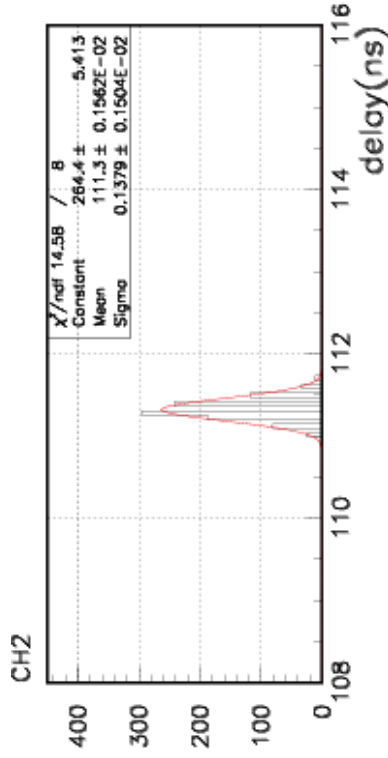
board-1

$V_{set} = 75\text{mV}$



**Rms noise  
2 - 3 fC**

**Time Jitter < 0.2 ns**



**Channel-to-channel  
delay spread 0.35 ns**

**Muon Meeting - March 2001**



## HV system

960 HV and LV supplies are needed

CAEN system with Distributor Boxes

Each DB has 2 HV and 4 LV outputs

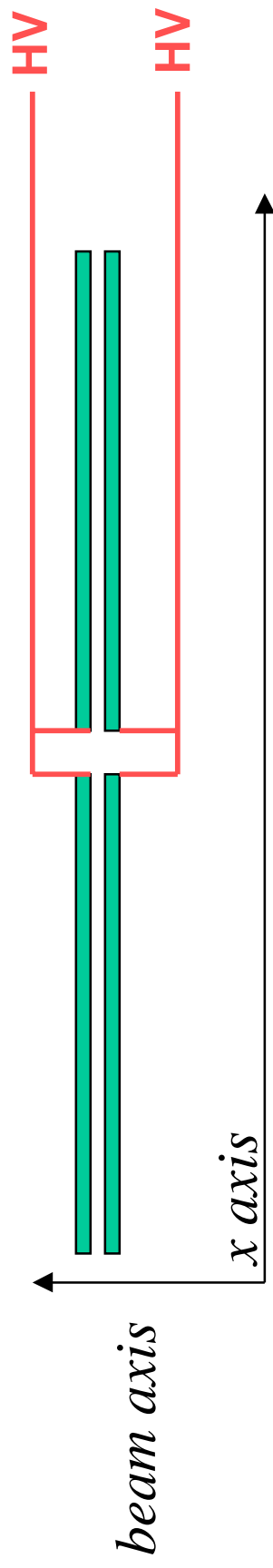
HV: up to 12 kV/1 mA

LV: 7V/1A

Use 1 HV channel to power 2 gas-gaps  
each chamber will have independent  
supplies for the 2 gaps



Plateau of gaps must match closely!





G.C. Roma 2

## GIF Ageing test

Ageing in LHCb (with safety factors)

$$J = 18 \text{ nA cm}^{-2}$$

$$\text{10-year fluence } \Phi = 6 \cdot 10^{10} \text{ cm}^{-2}$$

$$30 \text{ pC/avalanche} \rightarrow 1.8 \text{ C cm}^{-2} \text{ in 10 years}$$

CMS test	0.2 C cm <sup>-2</sup>
ATLAS test	0.3 C cm <sup>-2</sup>

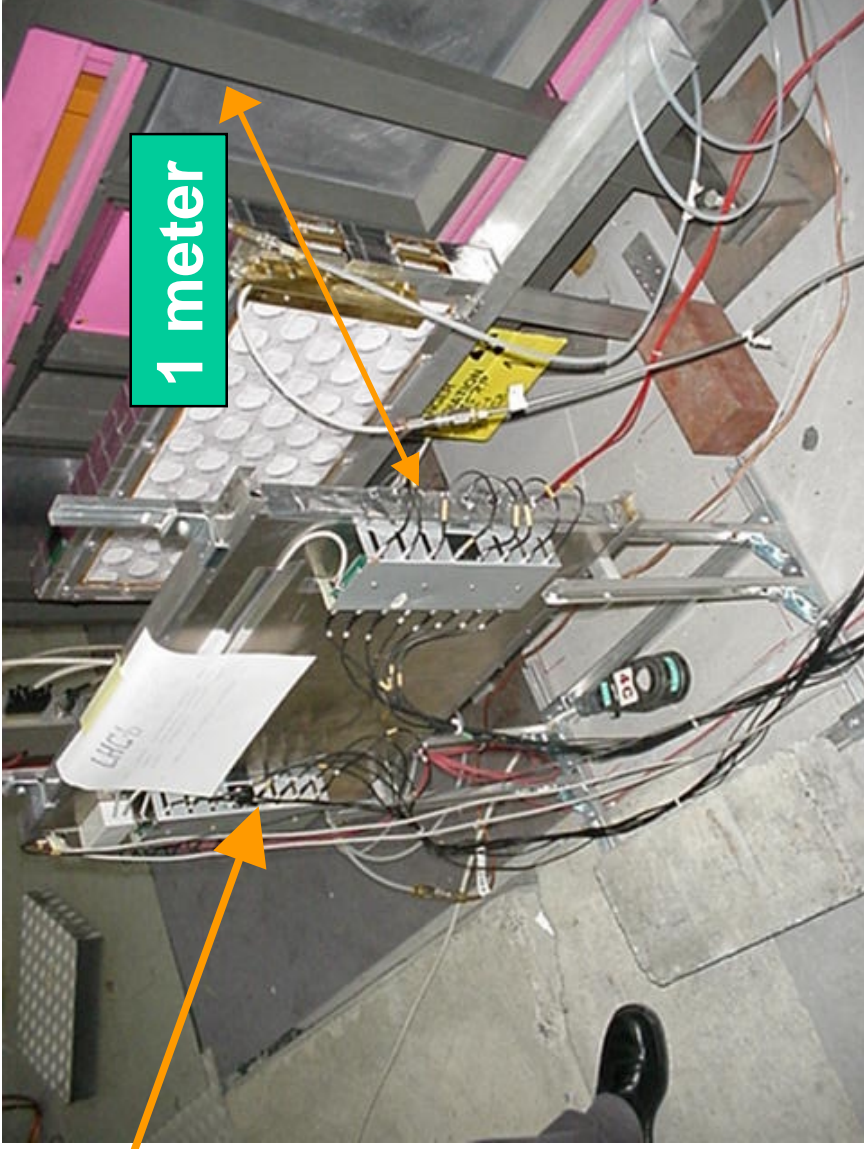
GIF test: started Jan. 15, to be continued up to June  
≈ 0.12 C cm<sup>-2</sup>/month → 4 LHCb years possible in 6 months  
( bad GIF duty cycle: up to now only 0.15 C cm<sup>-2</sup> )

**RPC under test**  
**0.5x0.5 m<sup>2</sup>**

**A second equal RPC**  
**is monitored as a**  
**reference**

$\rho = 9 \cdot 10^9 \Omega \text{ cm}$   
(oiled)

**Gas mixture:**  
**95% C<sub>2</sub>H<sub>2</sub>F<sub>4</sub>**  
**4% I-C<sub>4</sub>H<sub>10</sub>**  
**1% SF<sub>6</sub>**



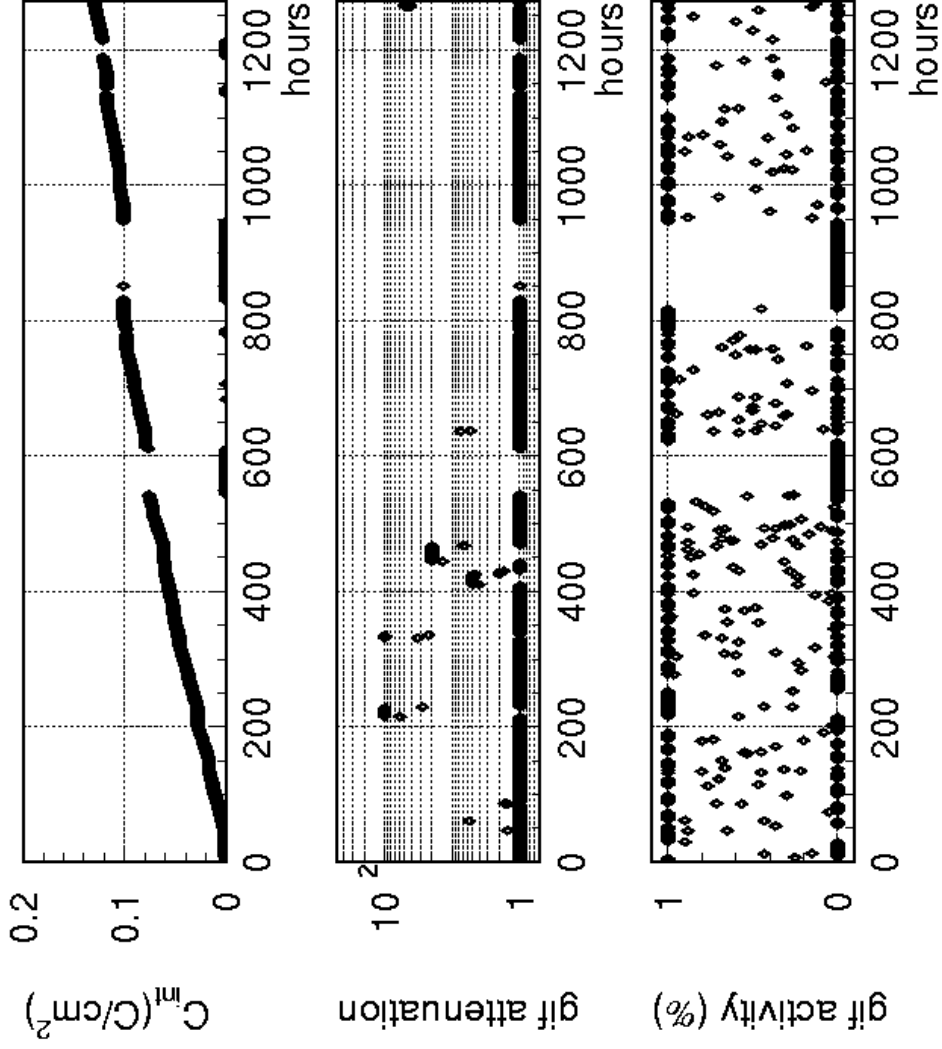
**Both RPC were previously measured on test beam.**  
**They will be measured again in April and in June to check any**  
**change in performance.**



# GIF Ageing test

2001/03/12 10:17

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Duty cycle about 50%

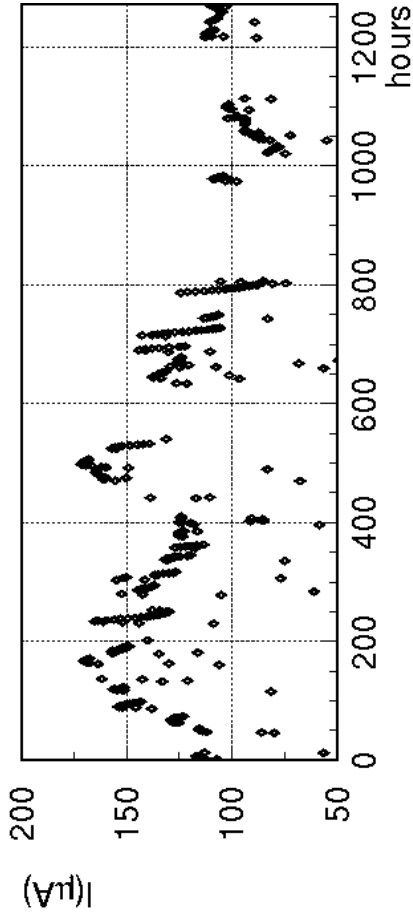
# GIF Ageing test



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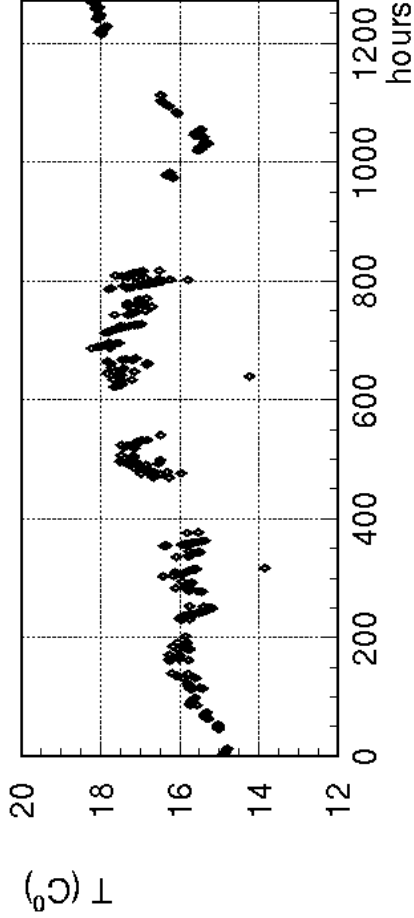
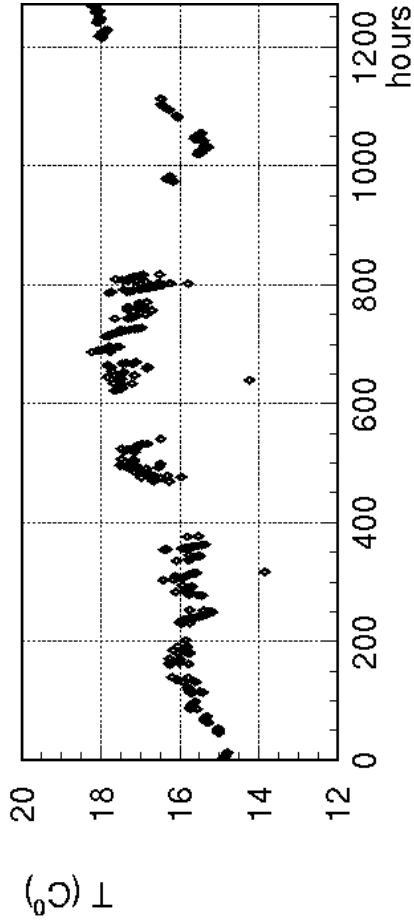
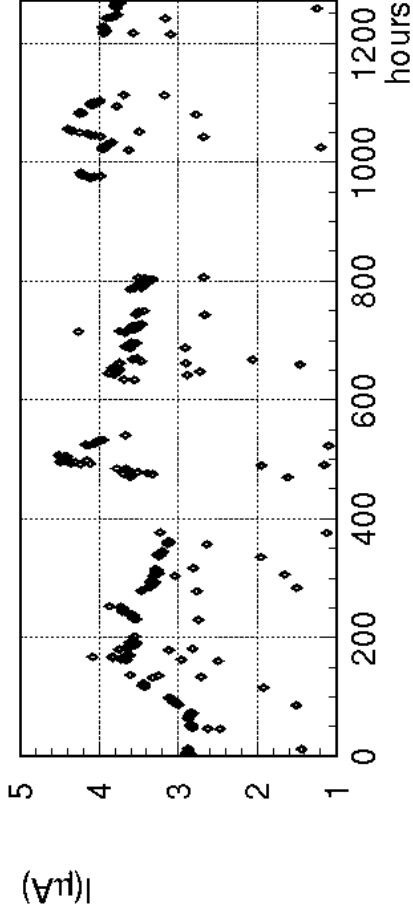
Irradiated RPC

2001/03/12 10.

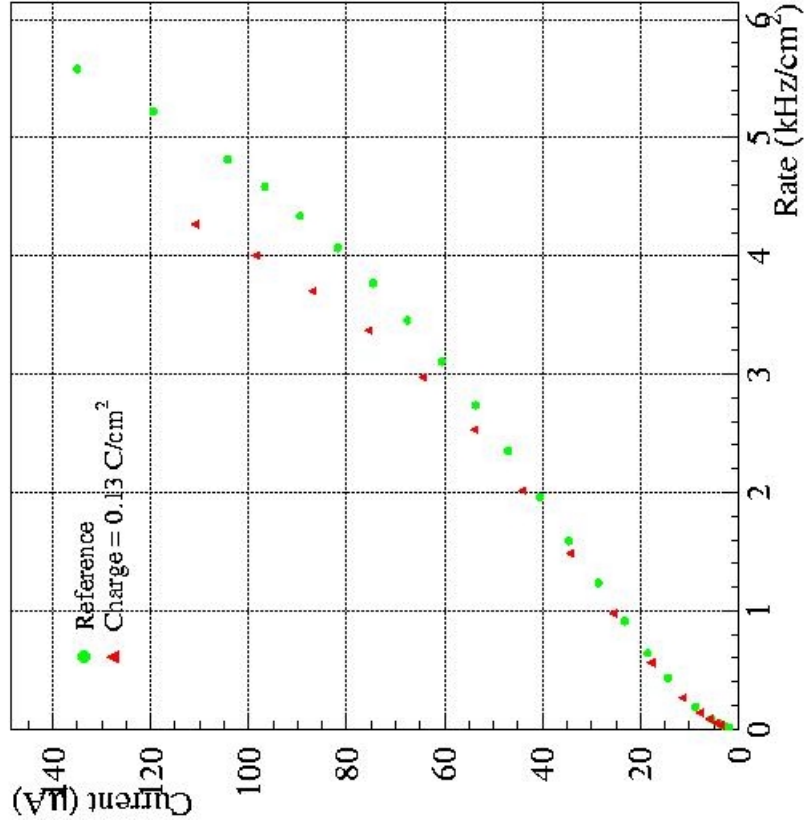


Reference RPC

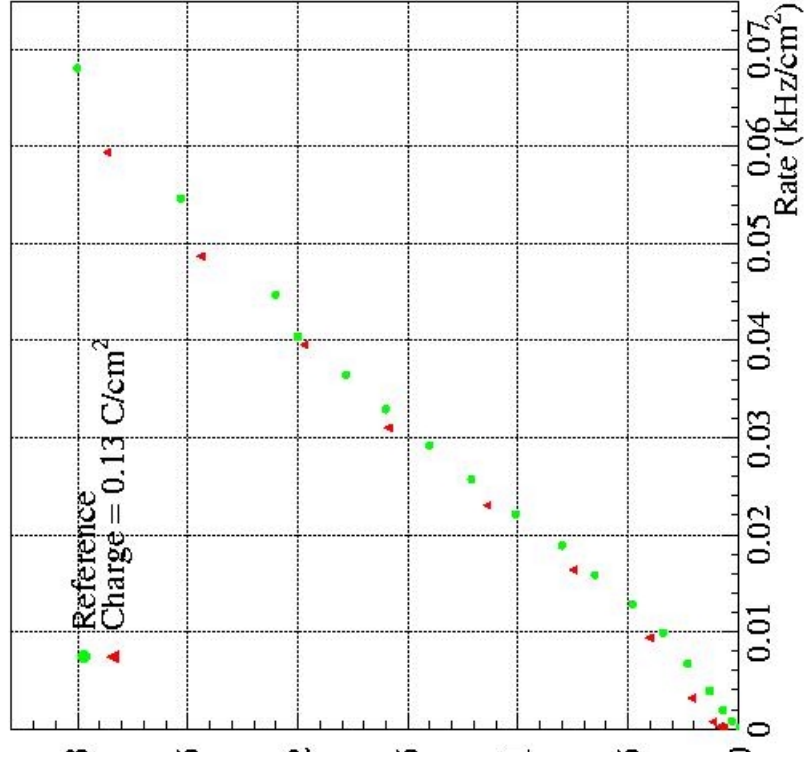
2001/03/12 10.17



Currents vs Rate - Chamber: a Abs: 1 - Date: 0903



Currents vs Rate - Chamber: b Abs: 1 - Date: 0903



## About oil

Linseed oil on bakelite

✓ improves

- Noise (less load on trigger)
- Dark current (less ageing)

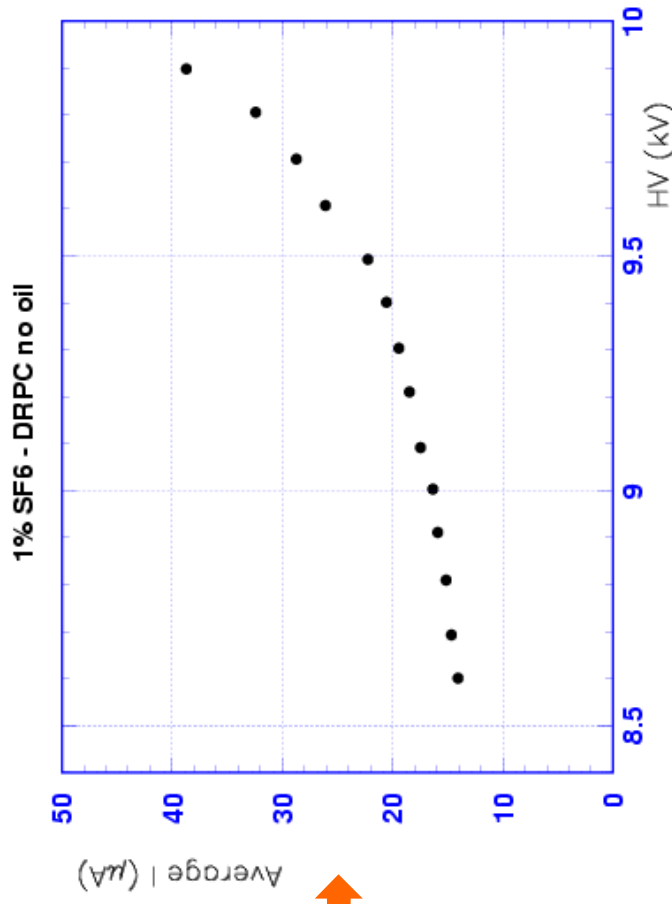


makes construction more critical

DRPC 50x50 cm<sup>2</sup>, tested in 1999  
The gaps were powered in parallel  
The current **I** is the average per gap

Current density: 10 nA/cm<sup>2</sup> →

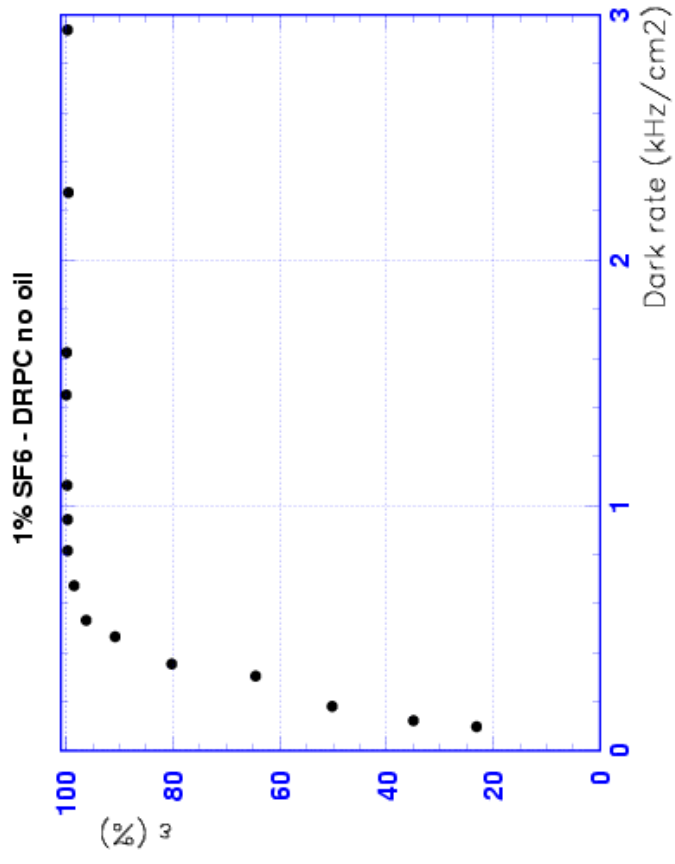
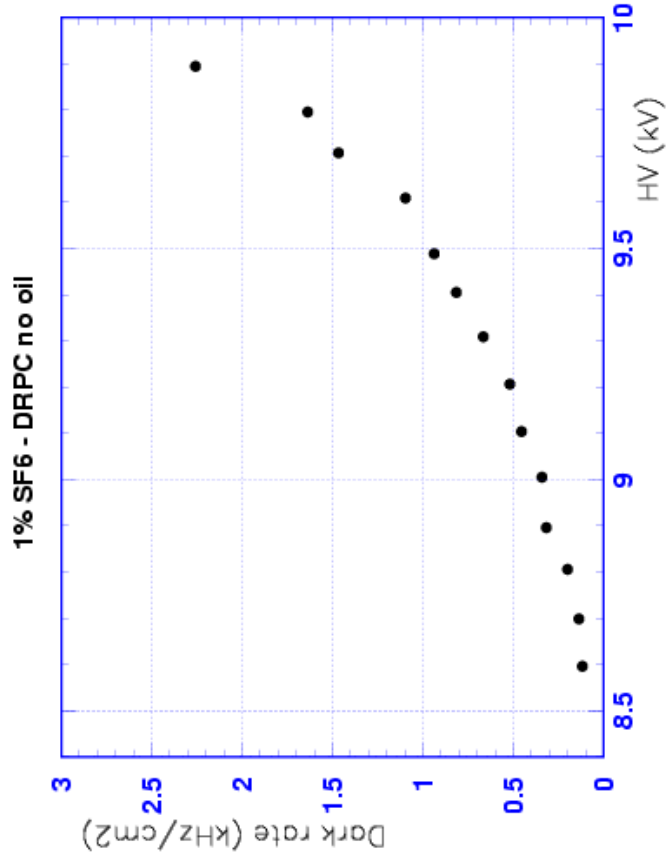
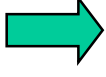
From physics in LHCb:  
expect < 18 nA/cm<sup>2</sup>



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Plateau from 1 kHz/cm<sup>2</sup>



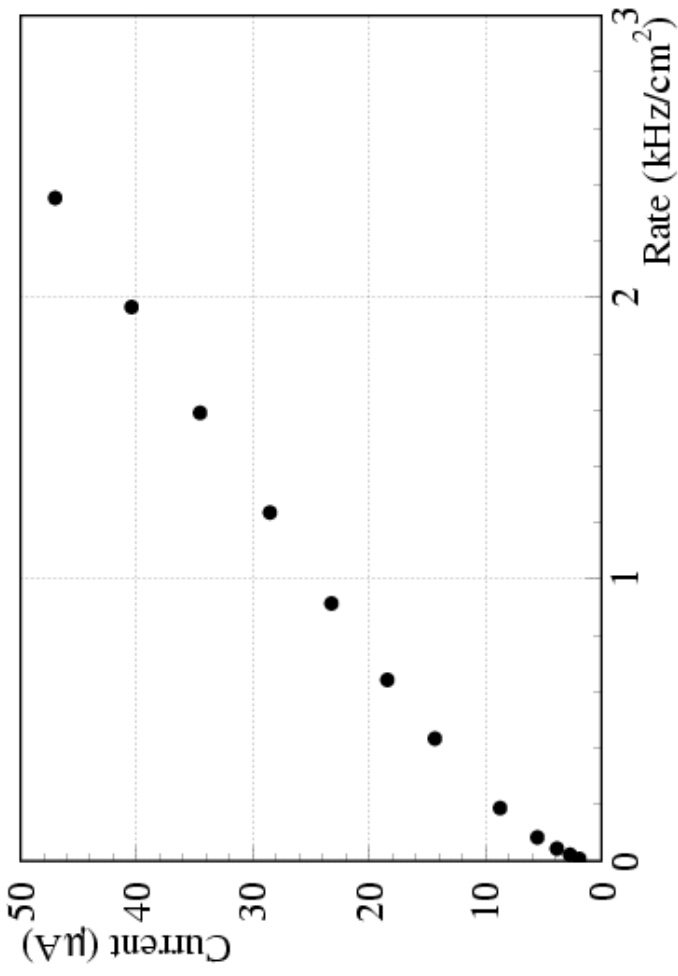
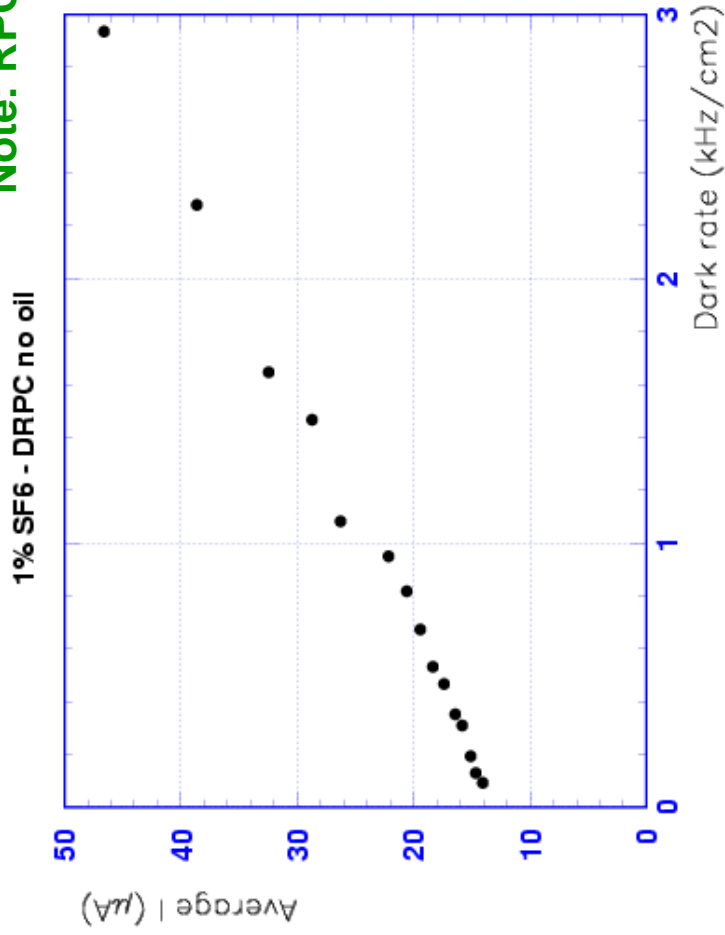




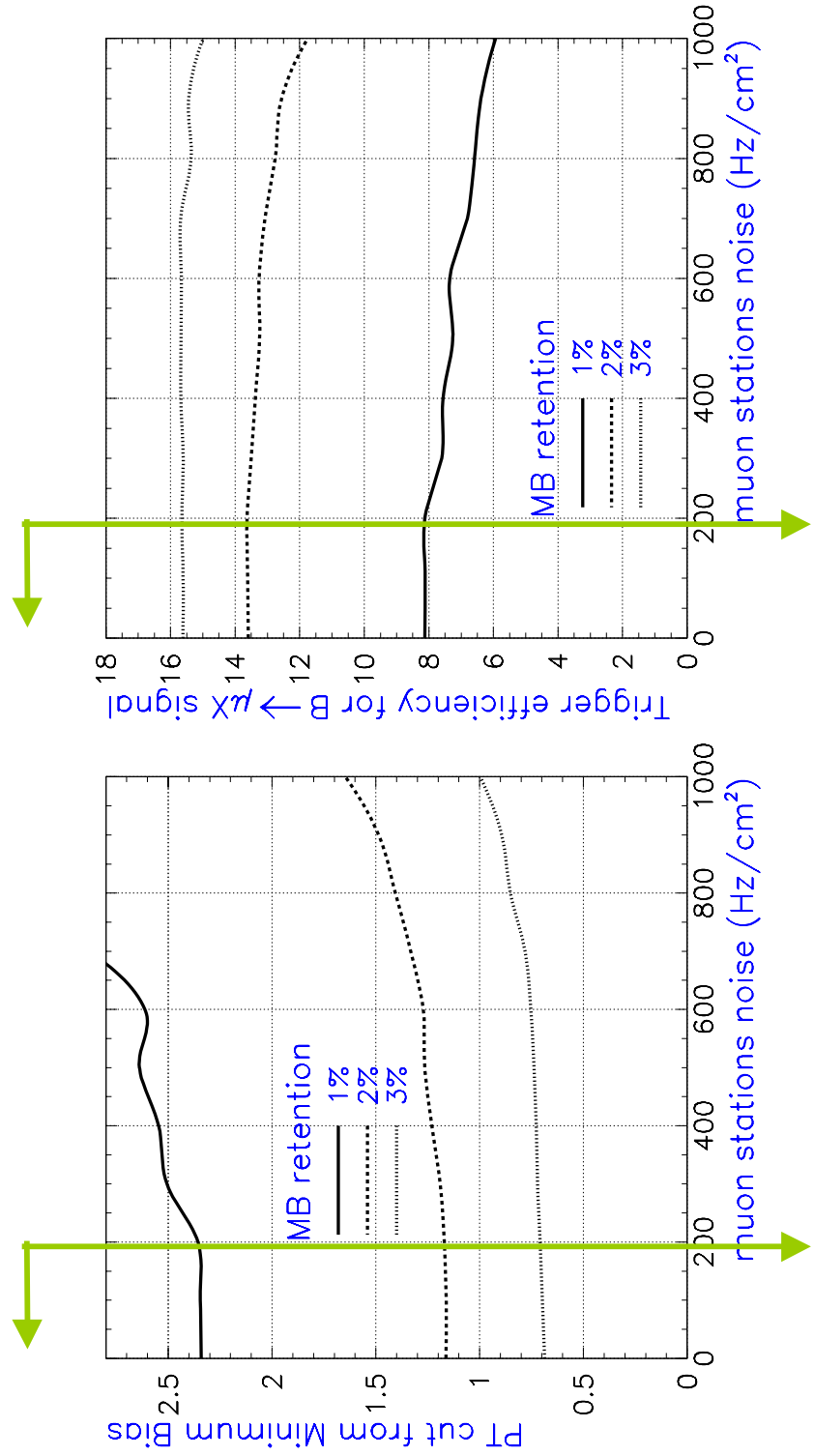
**Dark current data  
(non-oiled DRPC)**

**GIF Abs=1 data  
(oiled RPC)**

Note: RPC area=0.25 m<sup>2</sup>



# Effect of noise on trigger



200 Hz/cm²

200 Hz/cm²



## Conclusions

### Ageing:

Test to be continued up to the end of the year

Milestones: June and December

### Oil vs. non-oil:

current and noise ok without oil. However we favor a solution without oil.

### Milestones: by October prove that:

- the current density can be kept below  $2 \text{ nA/cm}^2$  ( $20 \text{ } \mu\text{A/m}^2$ ) (extra ageing effect  $< 10\%$ )
- the noise rate can be kept below  $200 \text{ Hz/cm}^2$  (can be handled safely by the trigger)

**New melaminic bakelite plates without oil to be tested soon**