First Results of an Aging Test of a Prototype RPC for the LHCb Muon Detector

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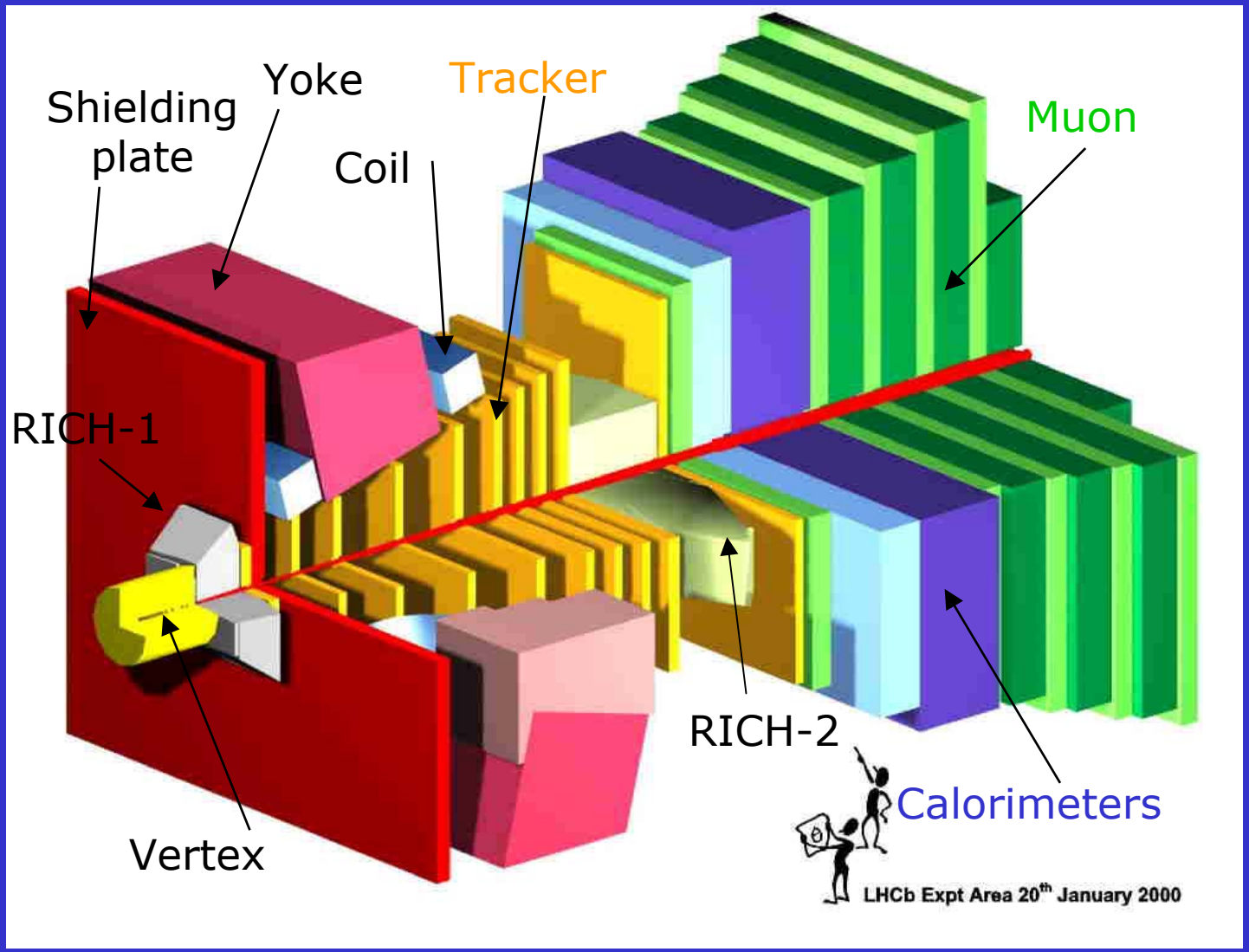
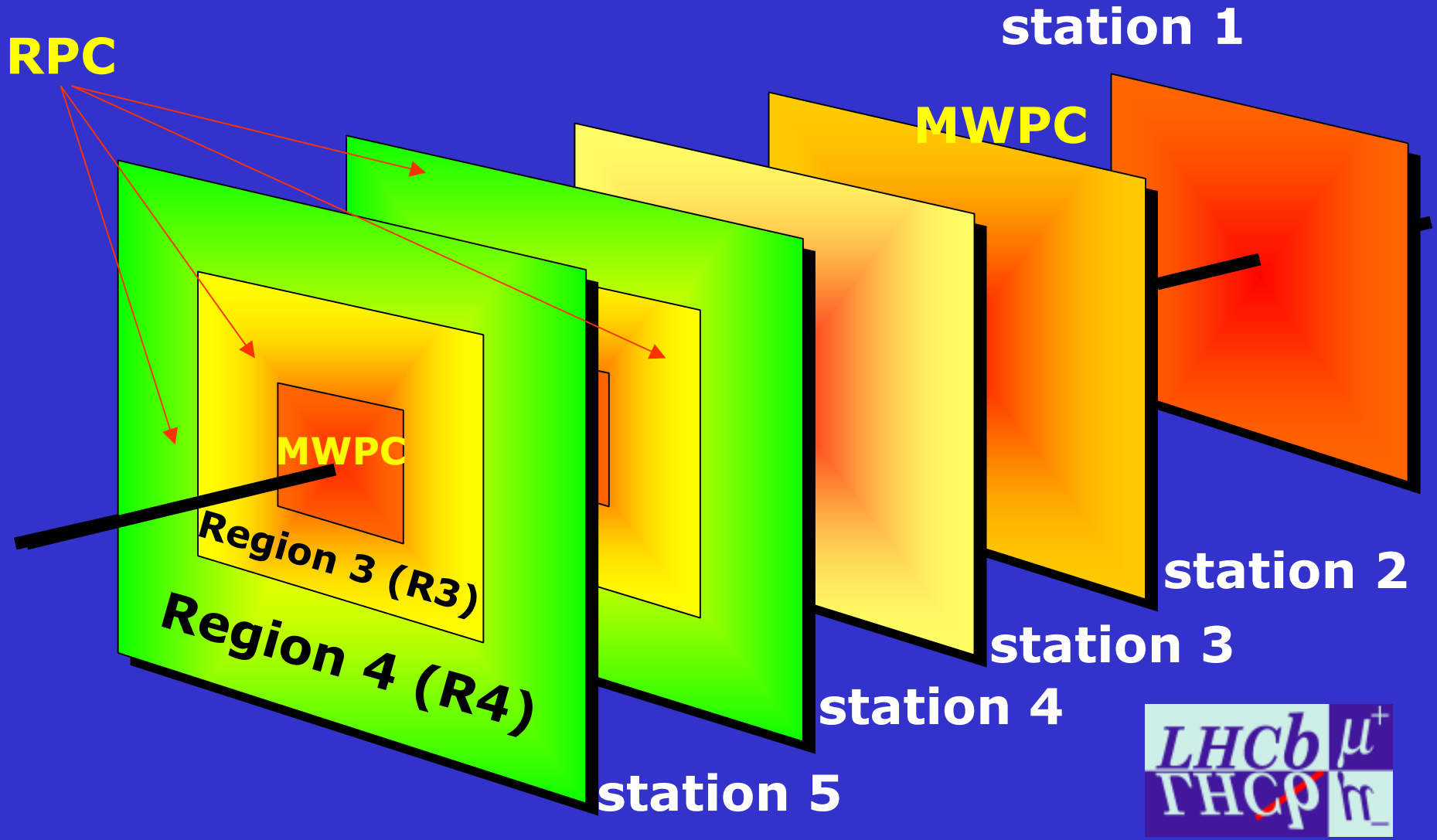
The LHCb Experiment



RPC in the Muon Detector



The Muon Detector RPC: requirements

	Station 4	Station 5
R3	750 Hz/cm^2	650 Hz/cm^2
	11 nA/cm^2	9.8 nA/cm^2
	1.1 C/ cm^2	1.0 C/ cm^2
R4	250 Hz/cm^2	225 Hz/cm^2
	3.8 nA/cm^2	3.4 nA/cm^2
	0.4 C/ cm^2	0.3 C/ cm^2

Maximal rates @ 2.5 nominal luminosity with a safety factor of 2

Integrated charge over 10 LHCb years

Drawn currents @ half max. rate Assuming 30 pC per hit

Aging Test at the GIF*

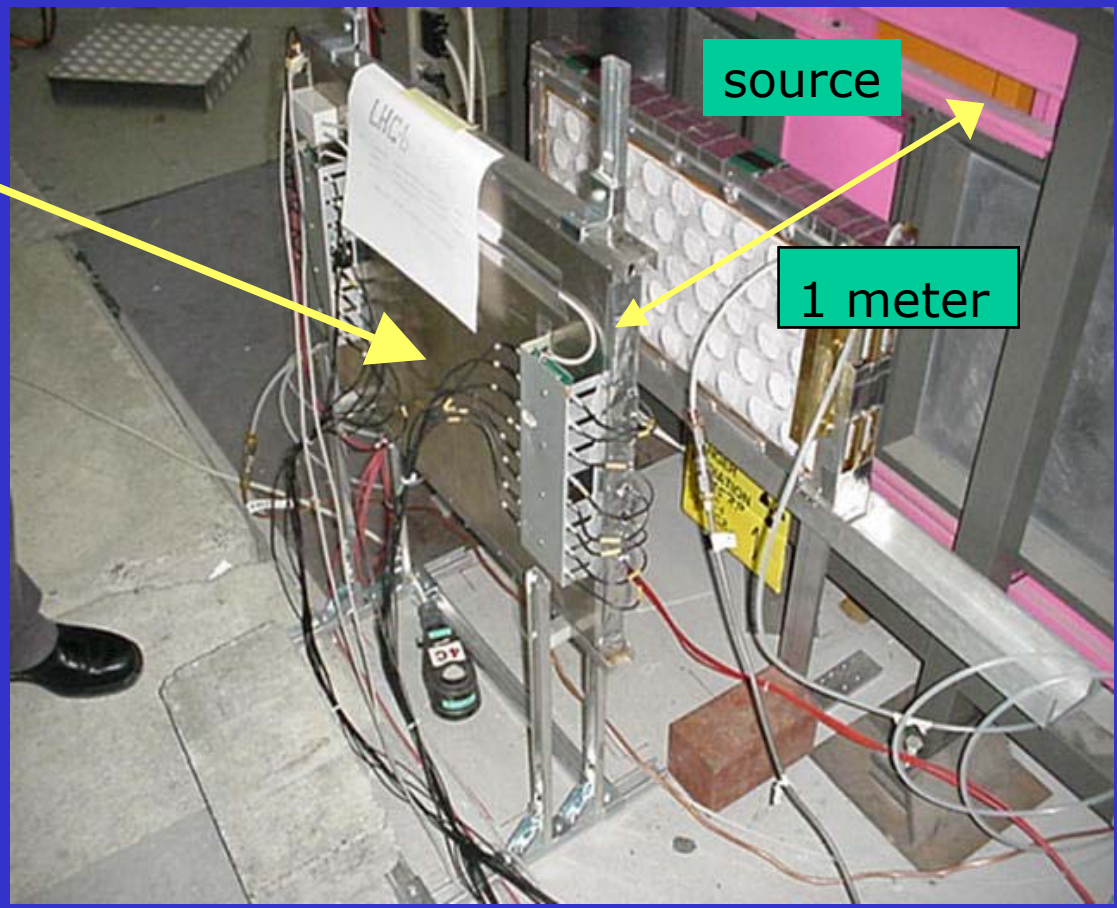
RPC under irradiation
0.5x0.5 m^2

$\rho = 9x10^9\ \Omega$ cm (oiled)

Gas mixture:
95% $C_2H_2F_4$
4% I-C_4H_{10}
1% SF_6

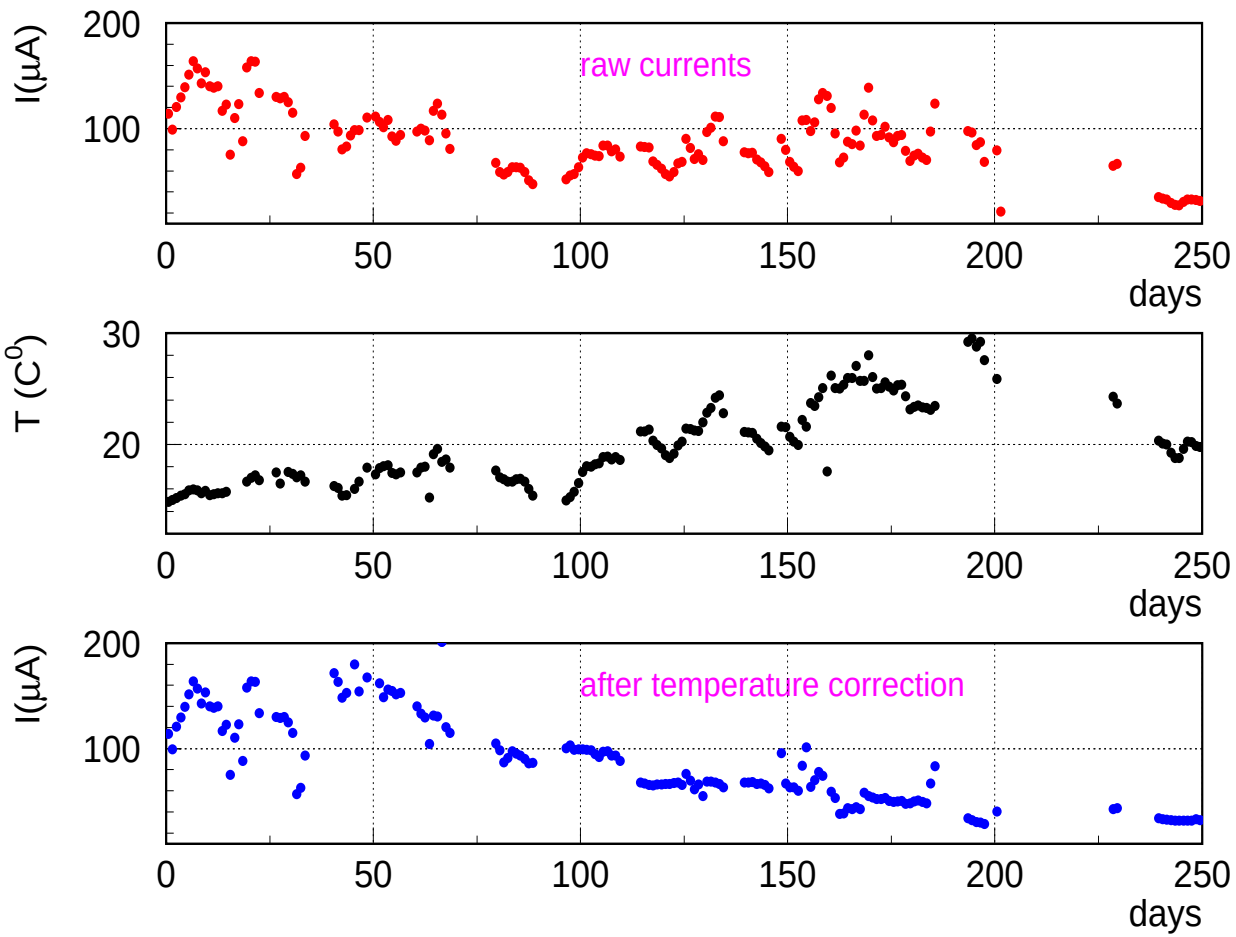
A second equal RPC placed outside the irradiation area is monitored as a reference

Both RPC share the same gas and HV lines



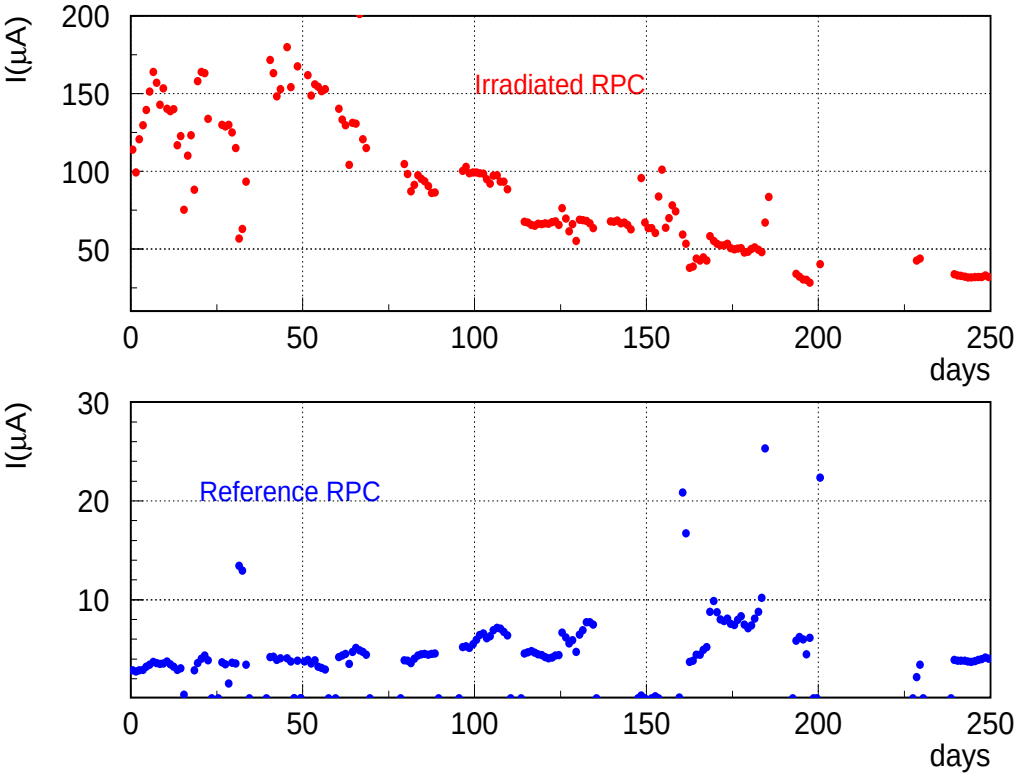
* Gamma Irradiation Facility at CERN; ^{137}Cs γ-source – 740 GBq

Currents: irradiated RPC



Currents, HV and temperature are continuously monitored

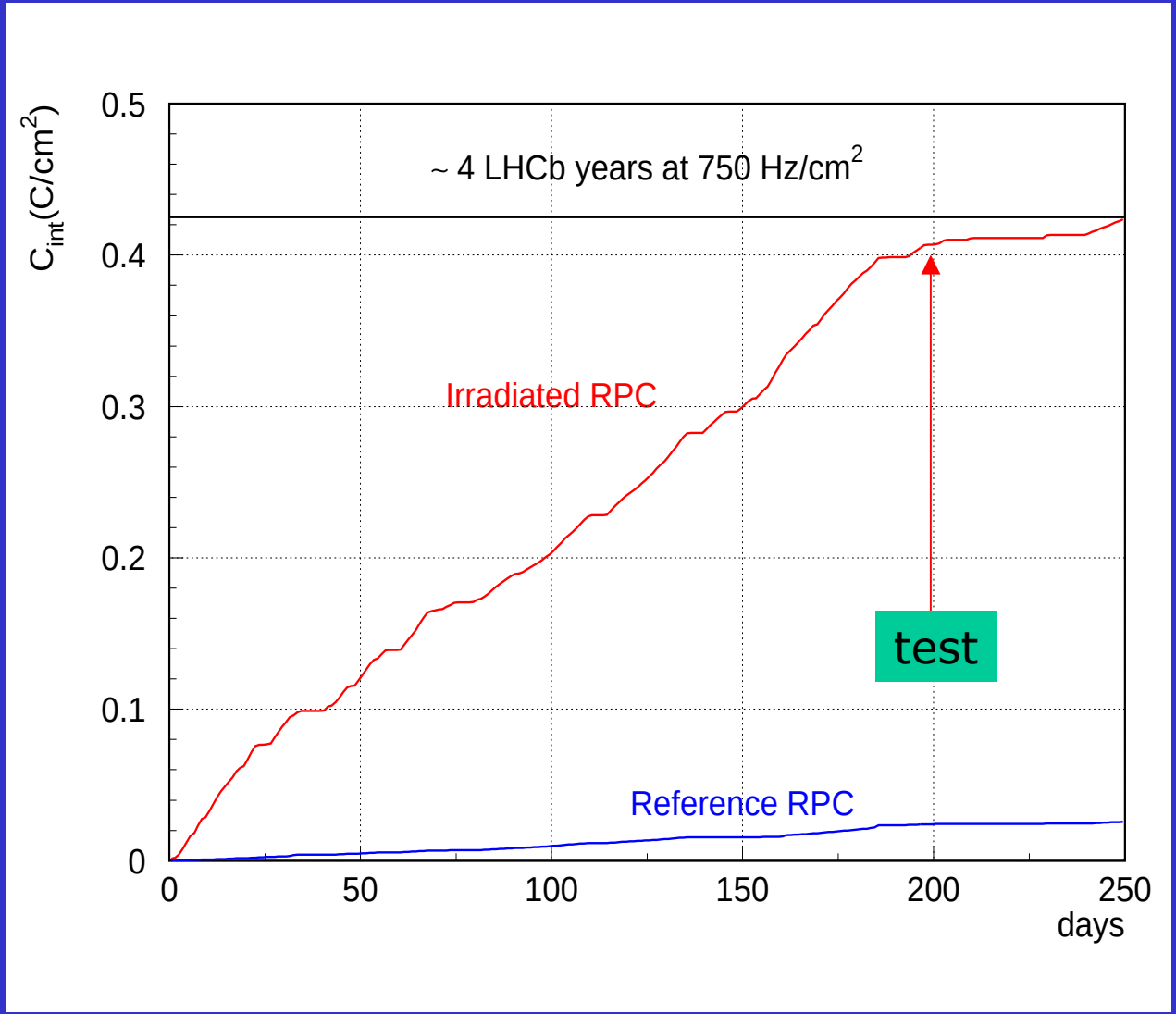
Currents: irradiated vs reference RPC



Current of irradiated RPC steadily decreasing

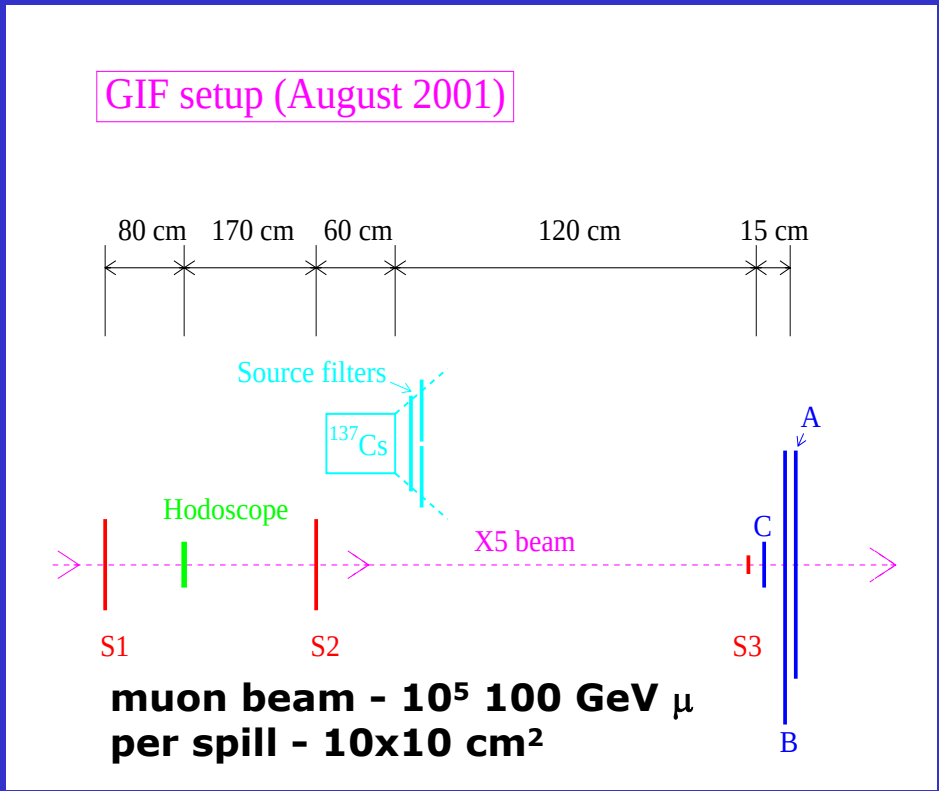
Current of reference RPC reasonably constant
⇒no large systematic effects

Integrated Charge



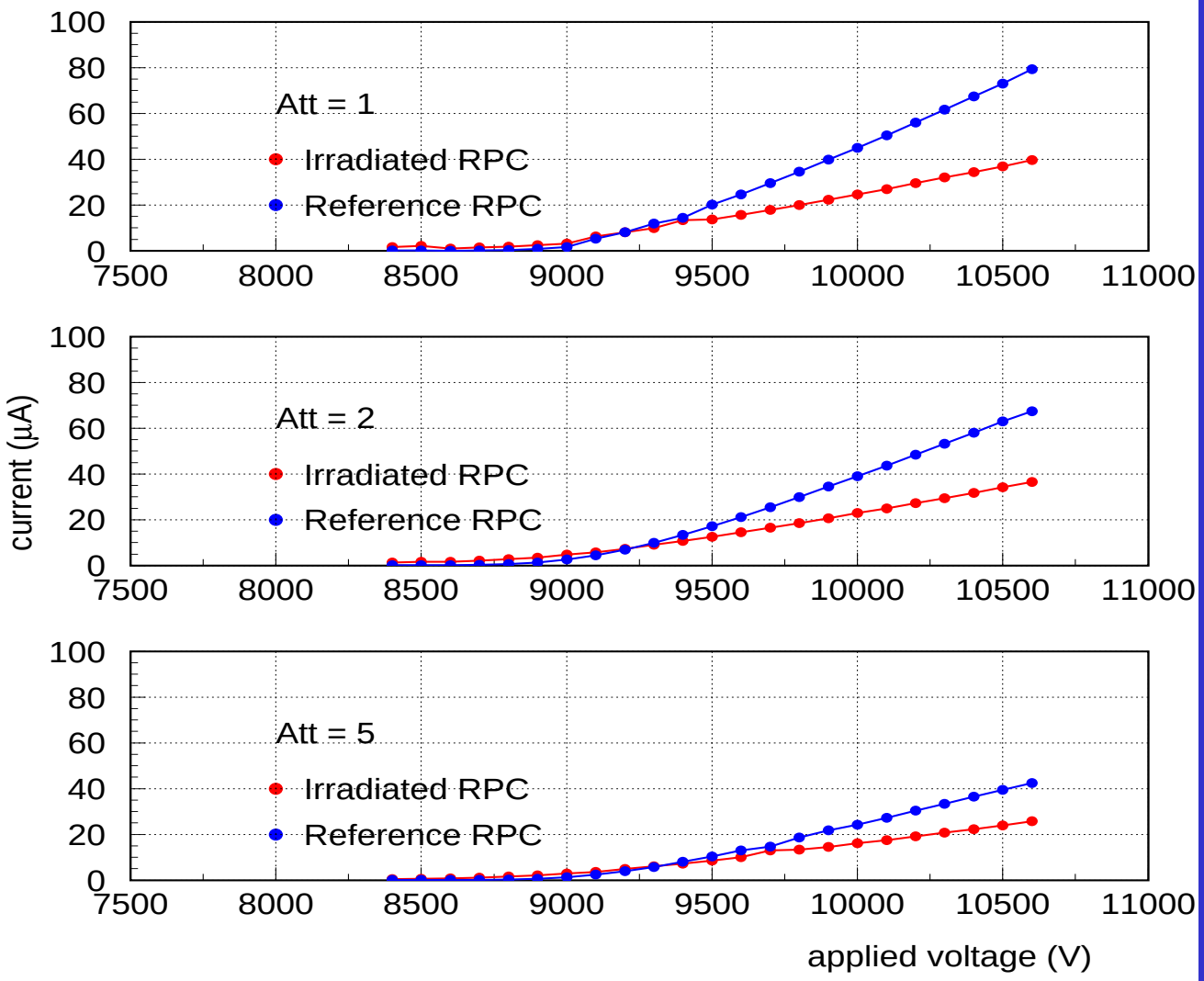
Beam Test August 2001

test @ 0.4 C/cm² ≡ 10 LHCb years in the outer regions

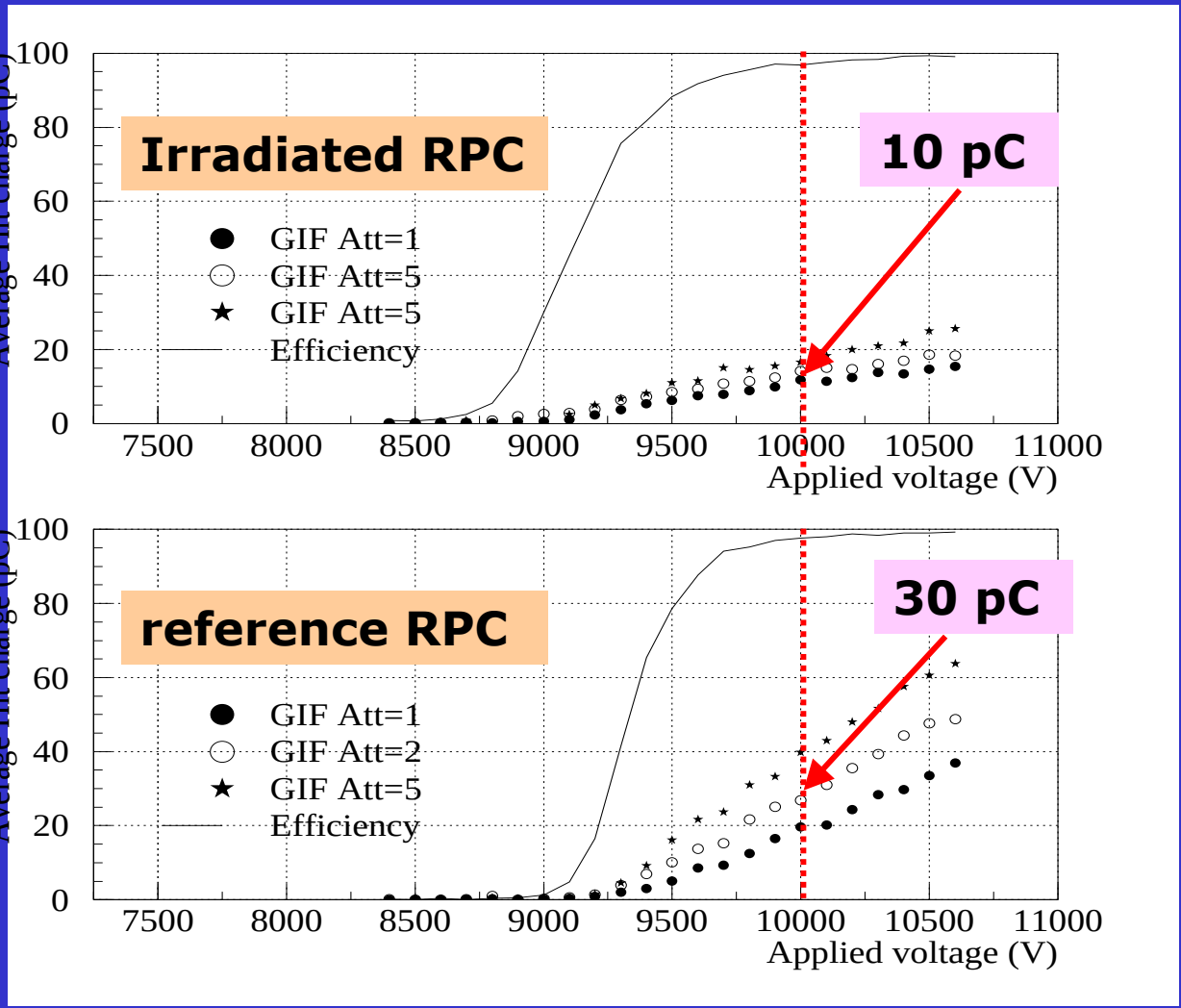


- **B = reference RPC**
- **A = irradiated RPC**

Test results:currents



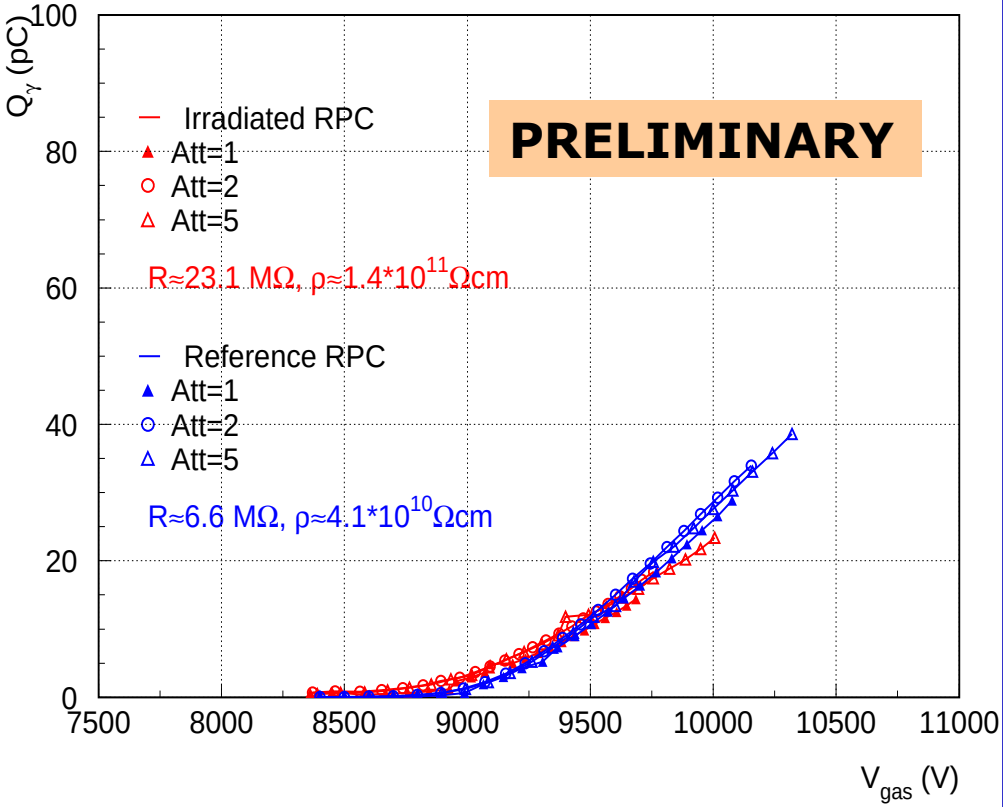
Test results: average hit charge



Average hit charge (pC)

Applied voltage (v)

Test results: average hit charge



Define the average charge as:

Qγ = current/expected γ rate

Qγ depends only on

V_{gas} = V - IR

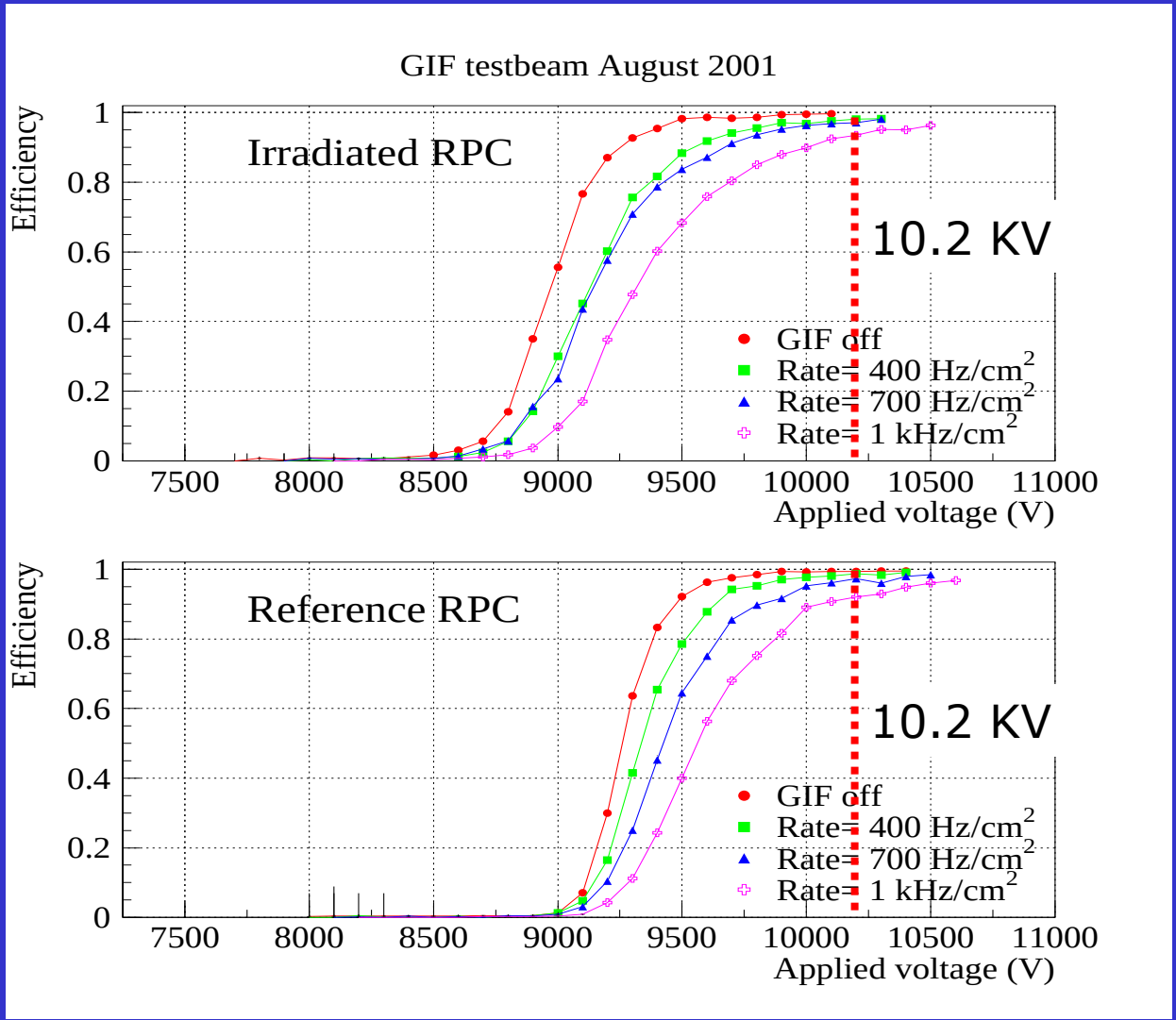
Find R giving an universal curve:

$Q\gamma = f(V_{gas})$

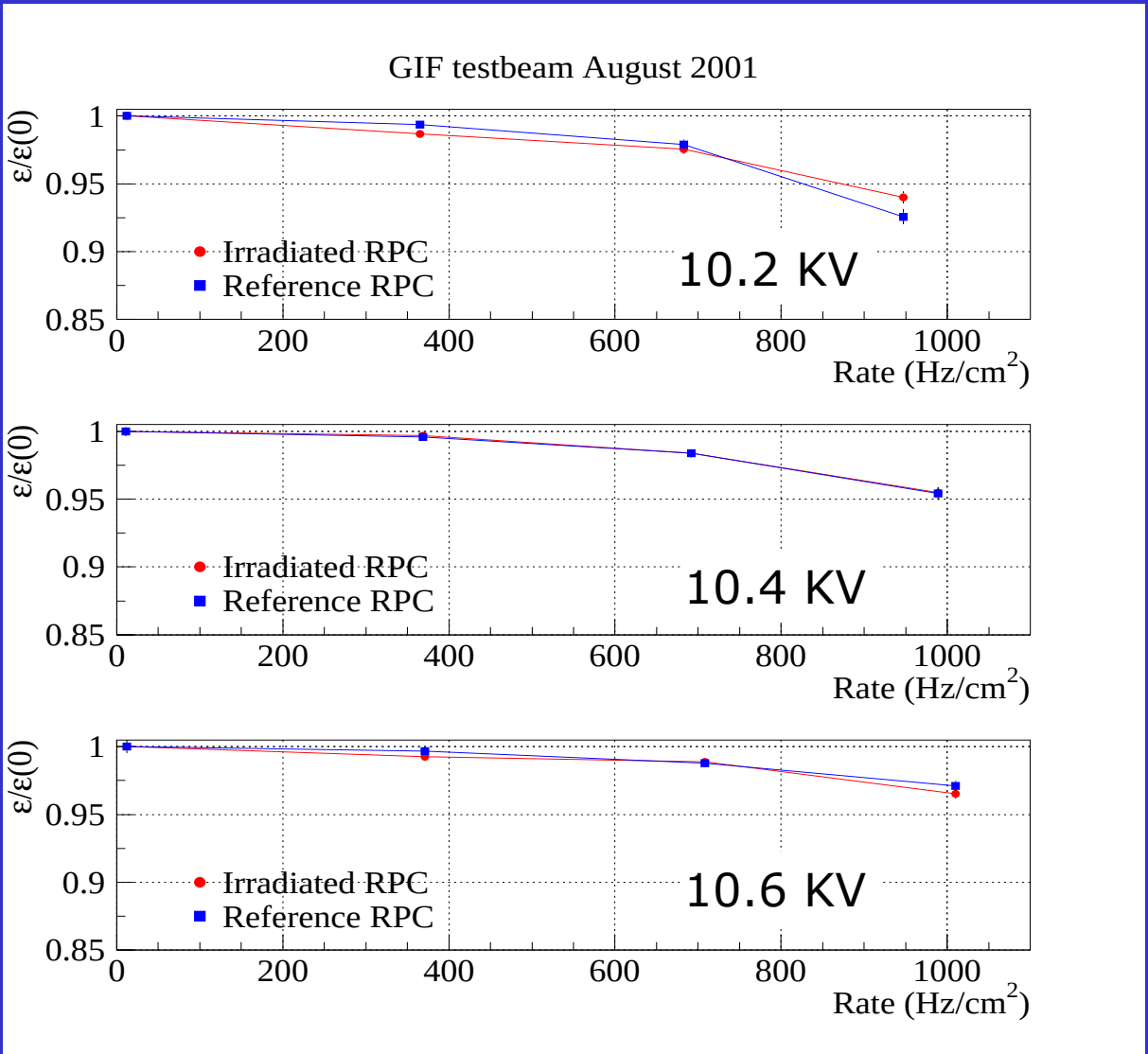
ρ(irr.) ~10^{10} ➔ 1.4x10^{11}

ρ(ref.) ~10^{10} ➔ 4.1x10^{10}

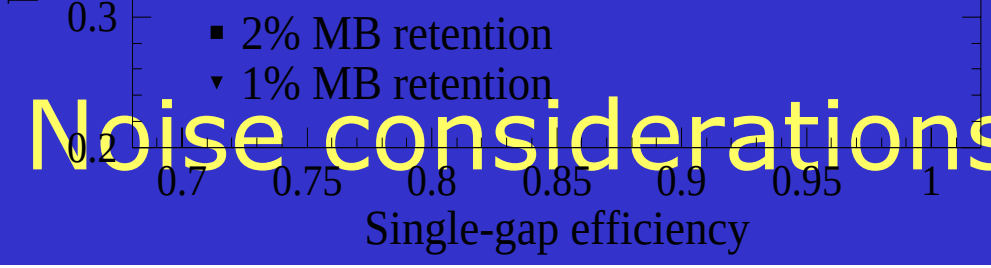
Test results: efficiencies

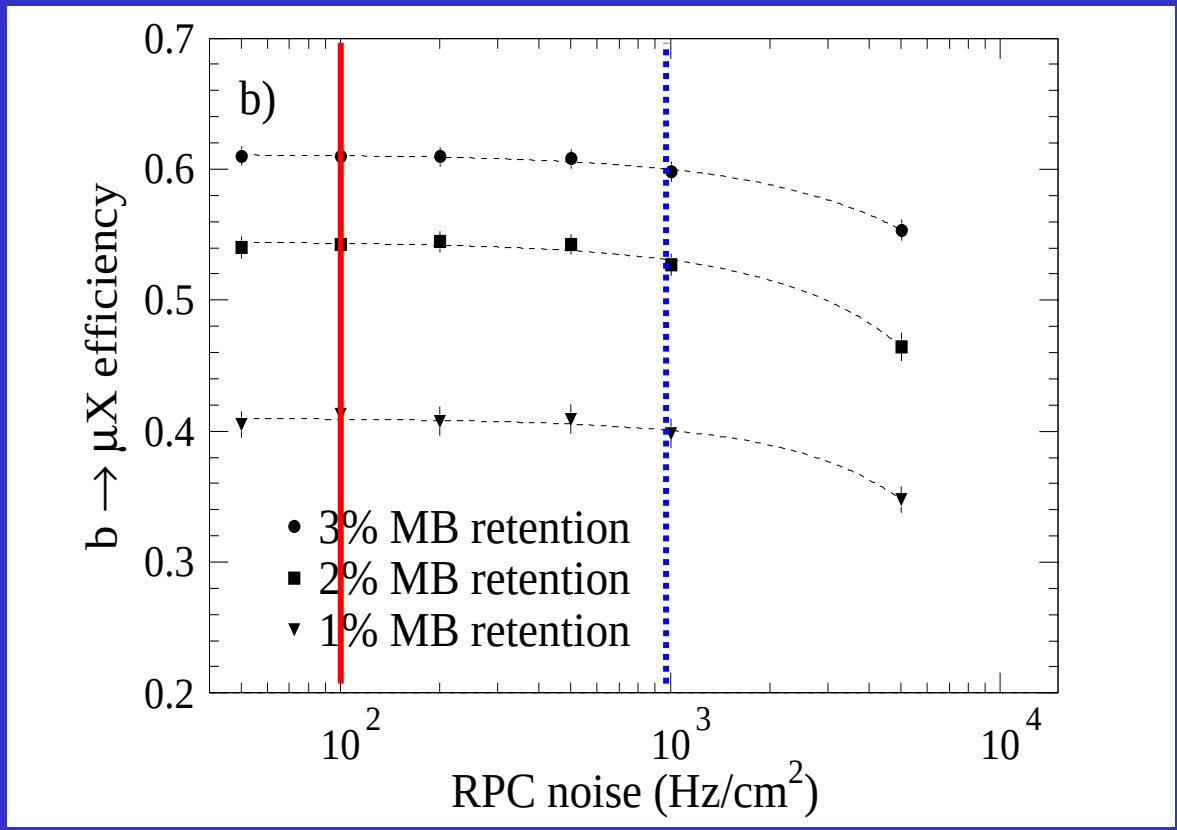


Test results: rate capability



Noise considerations

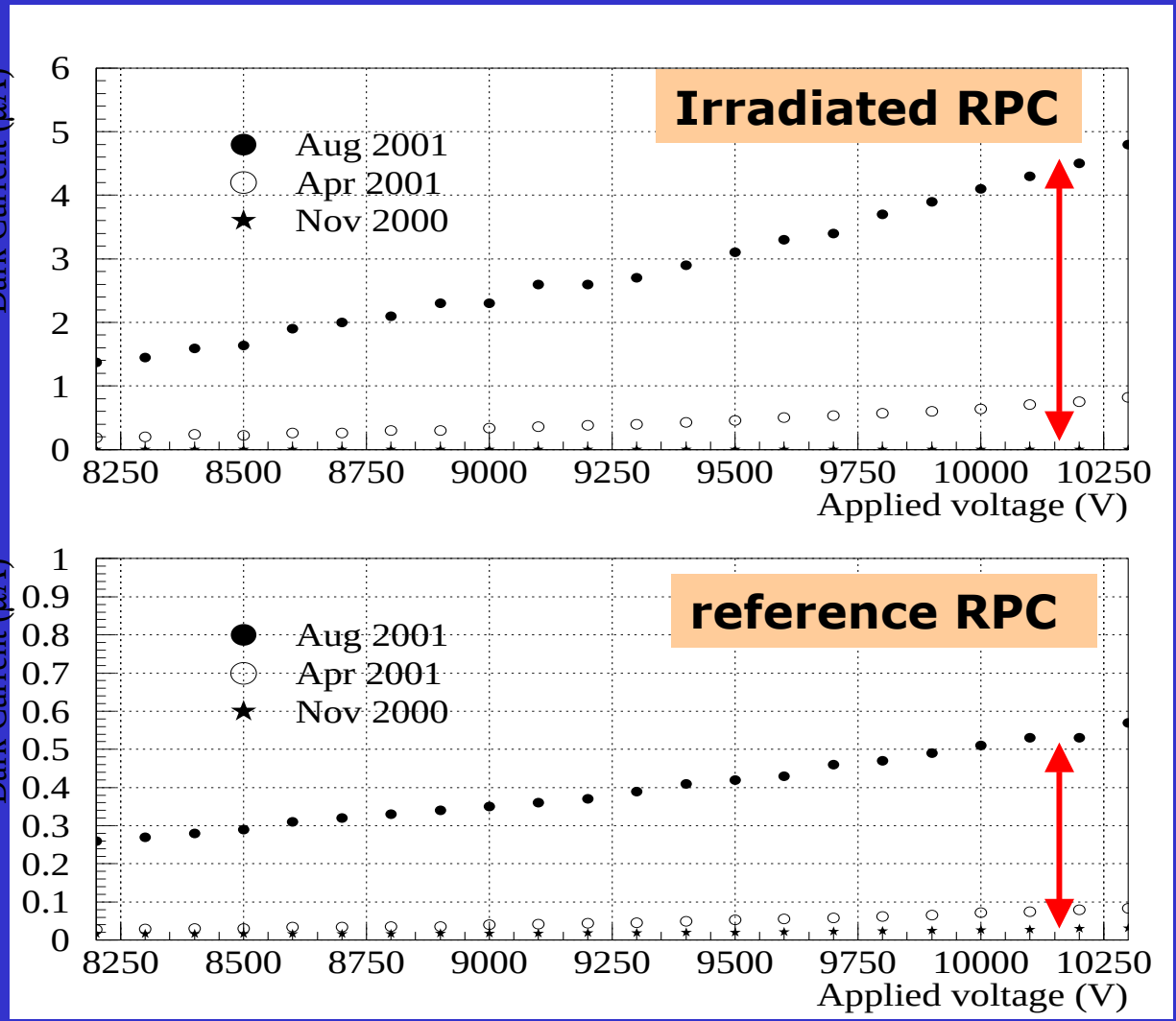




I_{dark} < 3 nA/cm² (< 25% of extra aging)

Noise < 100 Hz/cm²

Test results: noise



Radiation effects: ~5 μA (2nA/cm²)

Other systematic effects: ~0.5 μA

Applied voltage (v)

Conclusions

- **0.45 C/cm^2 integrated at the GIF by an LHCb RPC prototype**
- **large increase of the bakelite resistivity clearly seen in the irradiated RPC**
- **a clear increase of the dark current is also observed**

Conclusions

- **The RPC prototype is still well efficient up to a rate of ~ 1 KHz/cm^2**
- **The noise level is under control**
- **The test will continue up to 1.1 C/cm^2; other prototypes will be irradiated next year**