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RESISTIVE PLATE COUNTERS IN H. E. EXPERIMENTS

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FRAMEWORK

ε, residuals, τ properties, sensitivities

FE chips/FE boards quality assurance radiation damage

Bakelite resistivity

RPCs successful detectors

- No wires
- High efficiency
- Fast response
- Low cost production
- Large areas

- High rate capability
- Low gas gain operation
- TOF measurements
- Position measurements

- **n-$\bar{n}$ oscillations (Reactor) 1980 – FIRST**
- **E771, E831**
- **L3 Babar Belle**

WORKING CONDITIONS
PERFORMANCE REQUIREMENTS

25 ns/bunch crossing
av. 20 interaction/bx
(beam frequency 40 MHz)

γ ray and neutron bkgrnd
(1– 10^3 Hz/cm^2)

Doses (1- 100 Gy/10y)

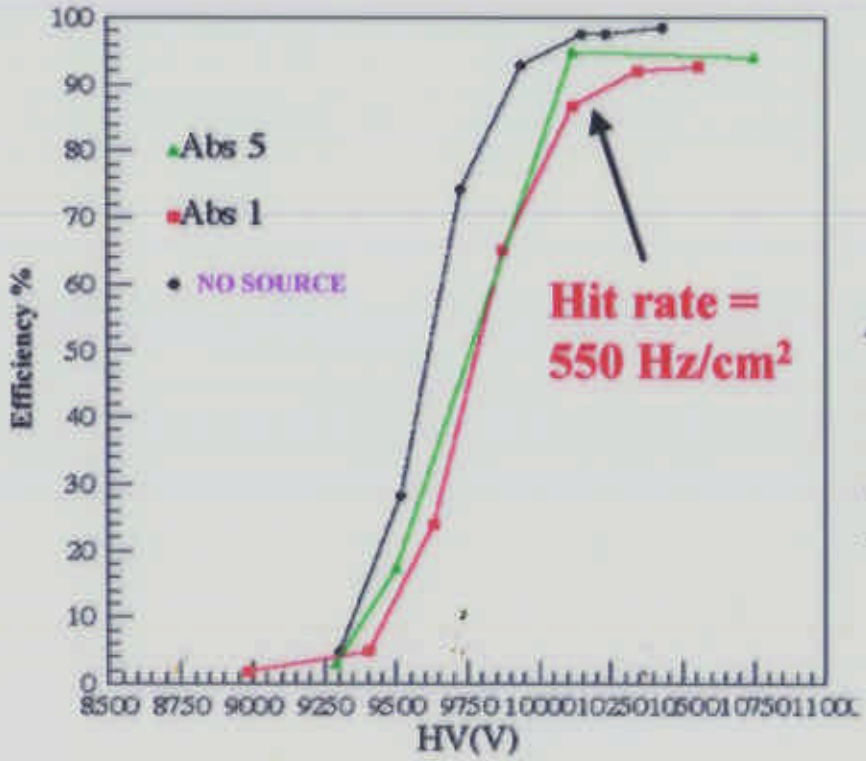
FAST TRIGGER (fast detector)
appropriate bunch crossing
assignment (overall time $\sigma_{tot} < 4$ ns)

Low γ ray and neutron sensitivity
and high rate capability

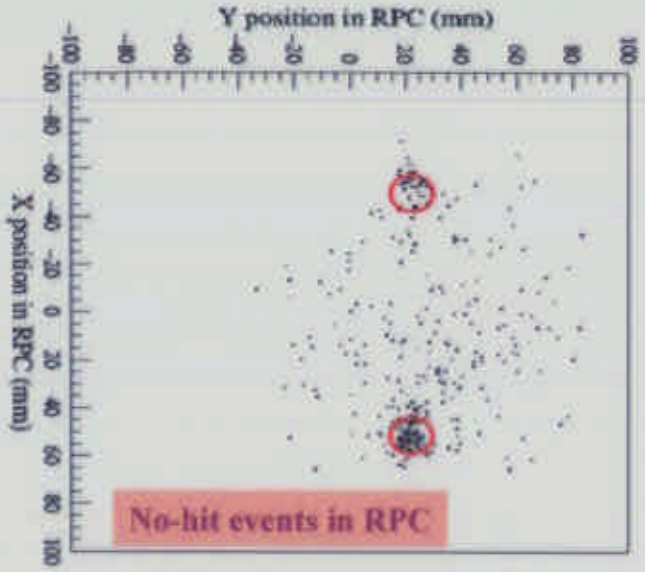
Low radiation damage on detector's
componentes and front-end electronics

RATE CAPABILITY (AT CERN-G.I.F.)

Efficiency vs H.V. for different γ fluxes on (10x10 cm² beam spot) RPC (2.5x2.0 m²)



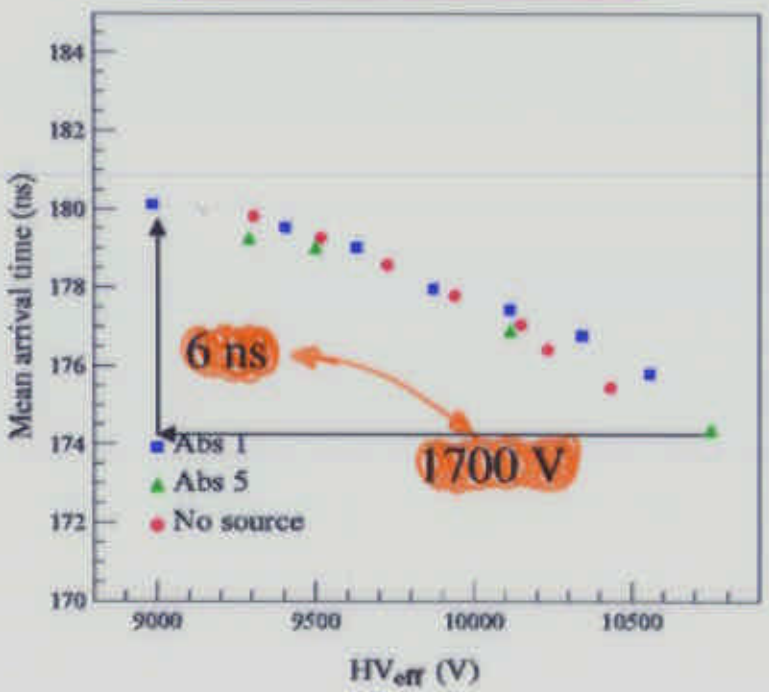
Inefficiency (=1%) due to spacers (diameter=1.2 cm)



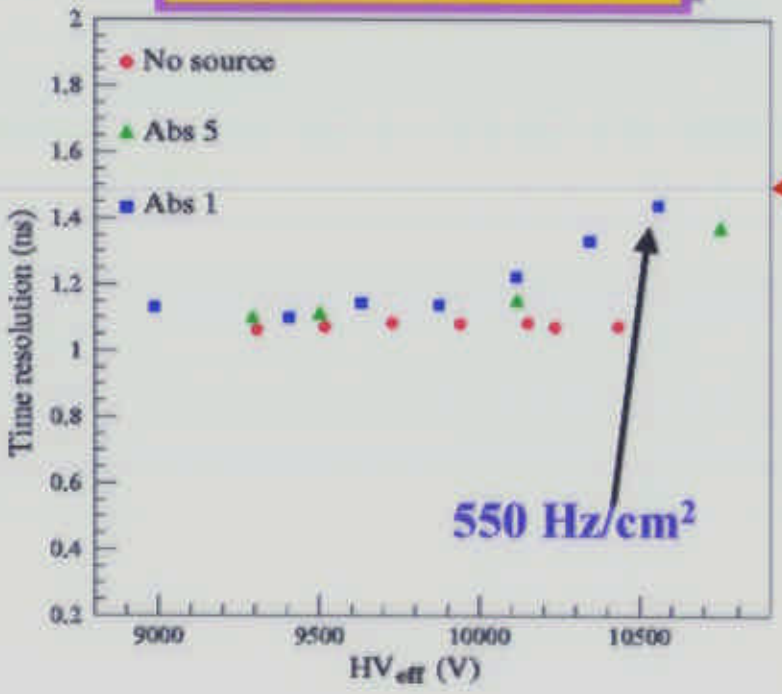
DOUBLE GAP BUT SINGLE GAP READOUT

TIMING PROPERTIES

Arrival time vs HV



Time resolution vs HV



⇦ 1.4 ns

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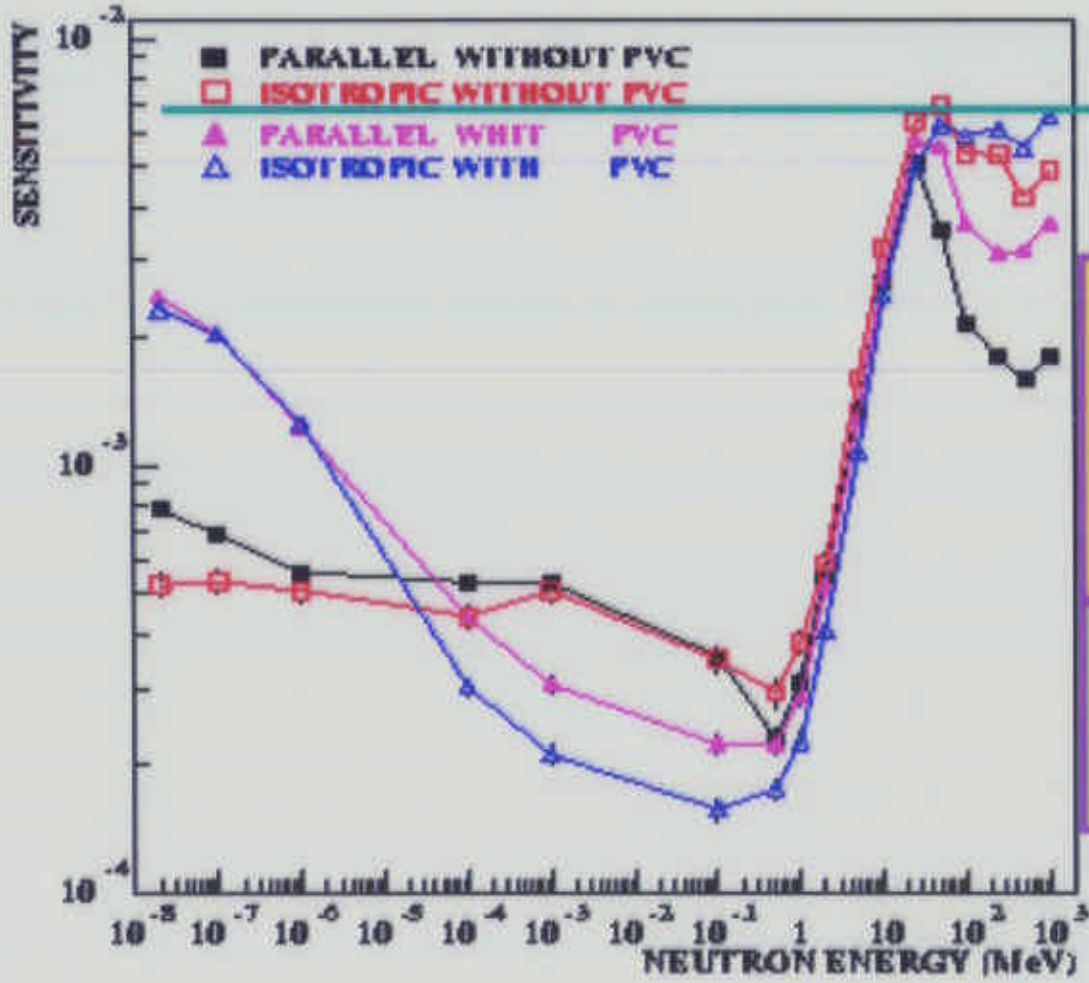
Simulated neutron sensitivity vs. n energy for different double-gap RPC finishing



7×10^{-3}

Given the CMS neutron RB1 spectrum and the sensitivity, the overall RPC hit rate due to neutrons would be about

<u>0.5 Hz/cm²</u>

For the equivalent γ spectrum in RB1 the hit rate is about

<u>5 Hz/cm²</u>

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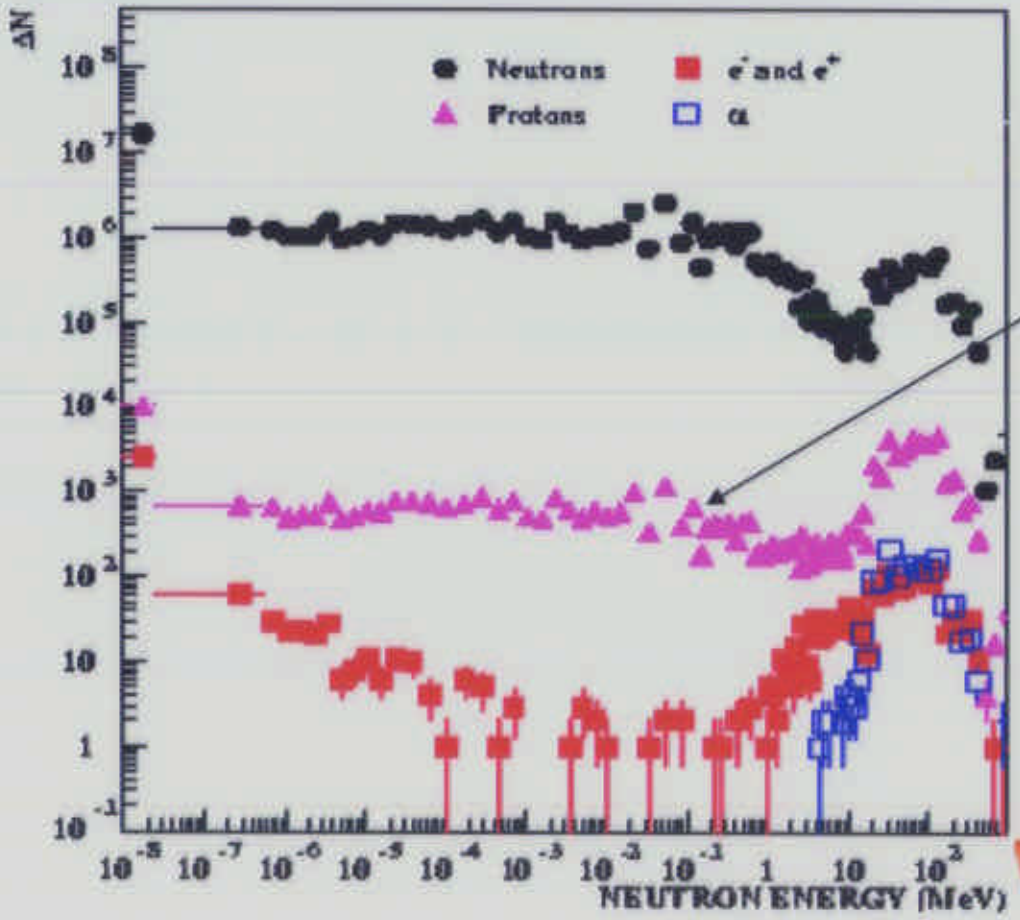
Neutron spectrum in RB1



Proton contribution (n,p) to sensitivity

within the bakelite about 1000 n produce 1 p entering the gas gap

1 GeV

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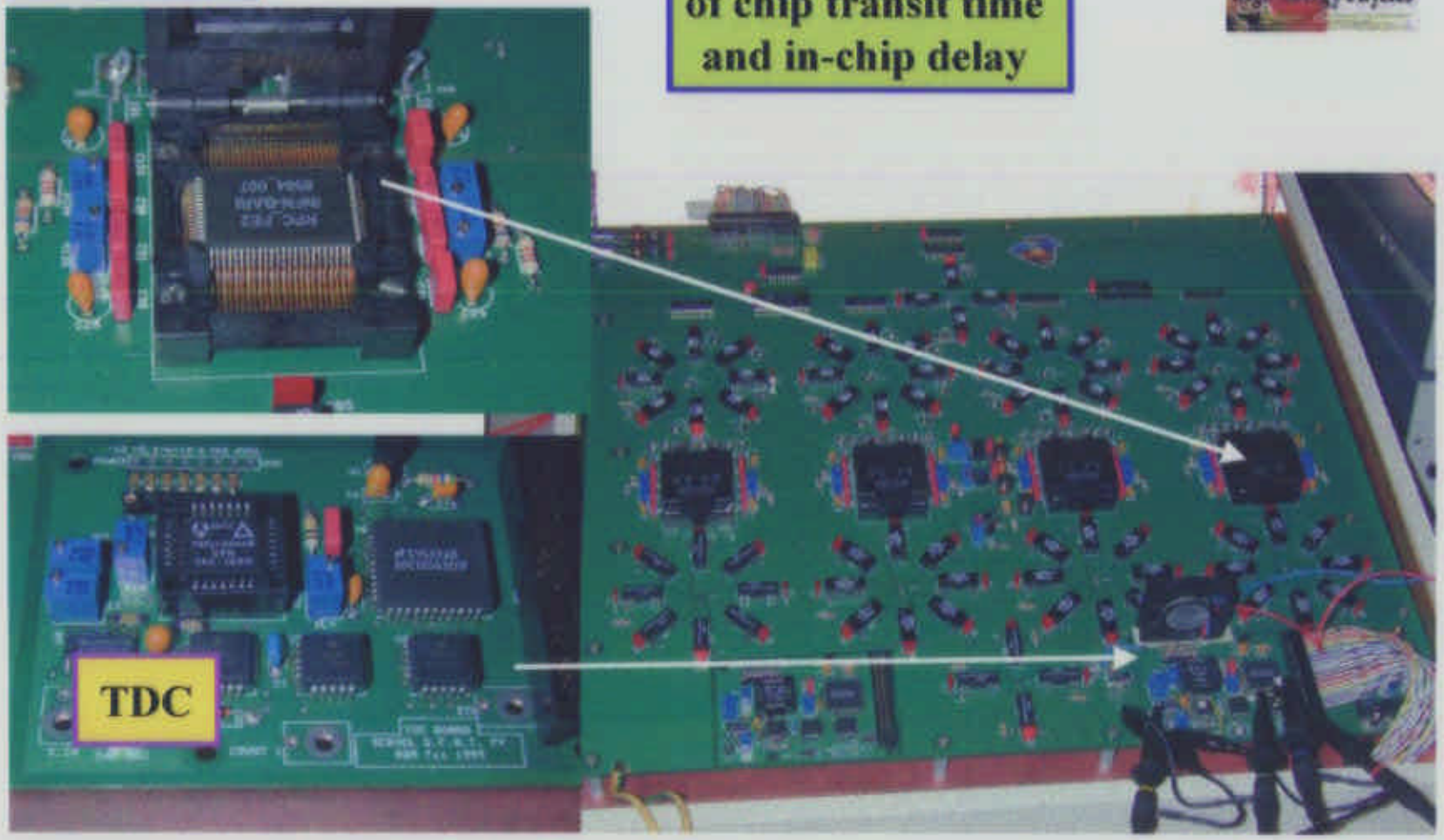
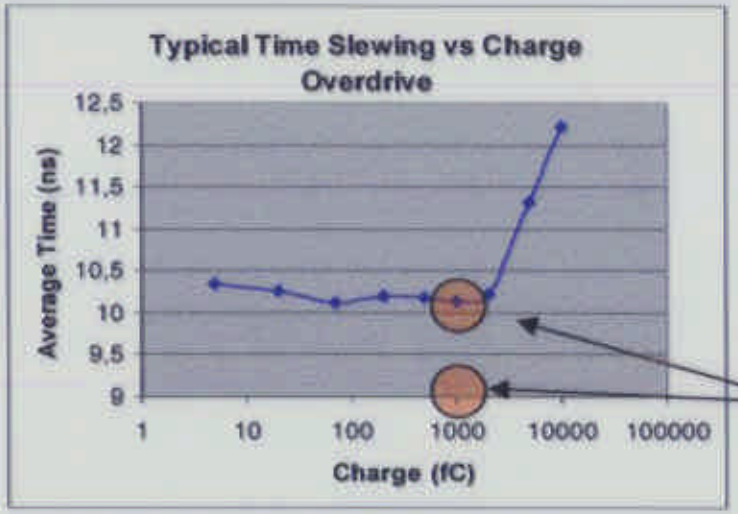
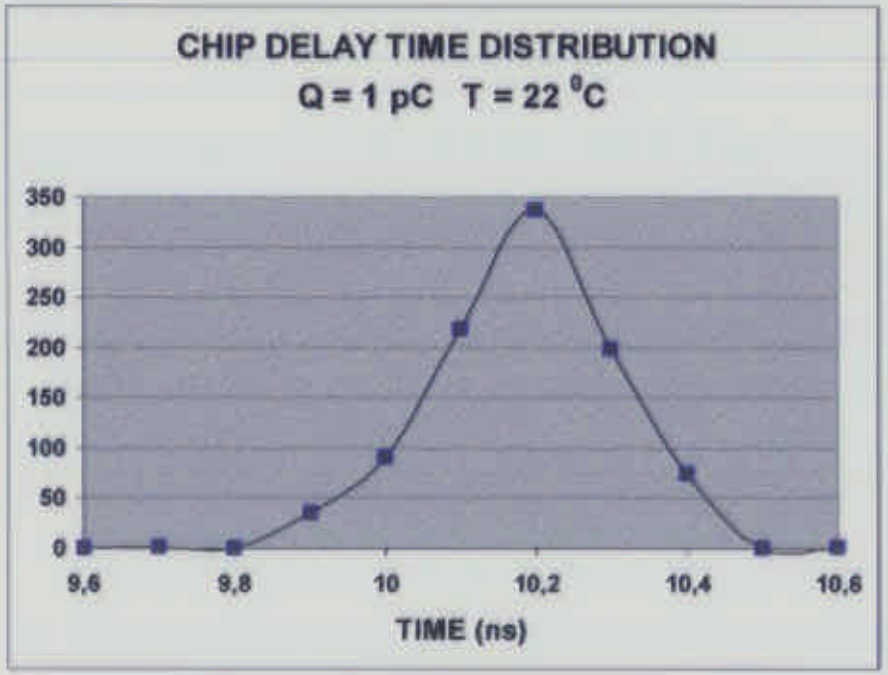
F.E. quality control of chip transit time and in-chip delay

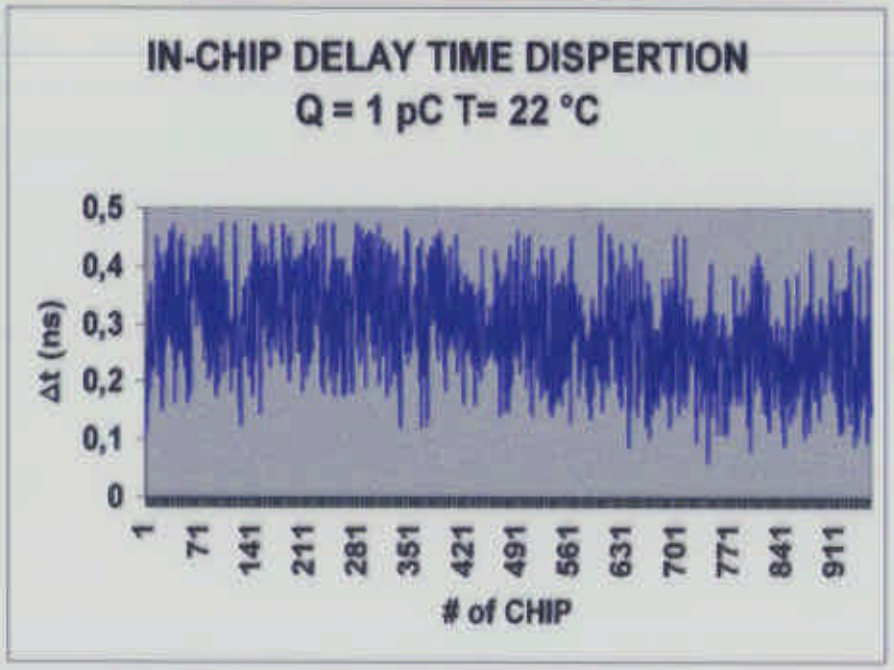




1000 CHIPS

Characterisation Point at 1 pC





RADIATION DAMAGE to F.E. chips

radiation damage to electronic components comes predominantly from:

DISLOCATION	**(particles/cm^2)**	**fluence**
TOTALE DOSE	**(Gray = 100 rad)**	**threshold effect**
SINGLE EVENT UPSET		**spurious transient hits**

effects could be:

1. **"reversibile" as typically in S.E.U.**
2. **severely disruptive, if the energy of the incoming particle is high enough.**

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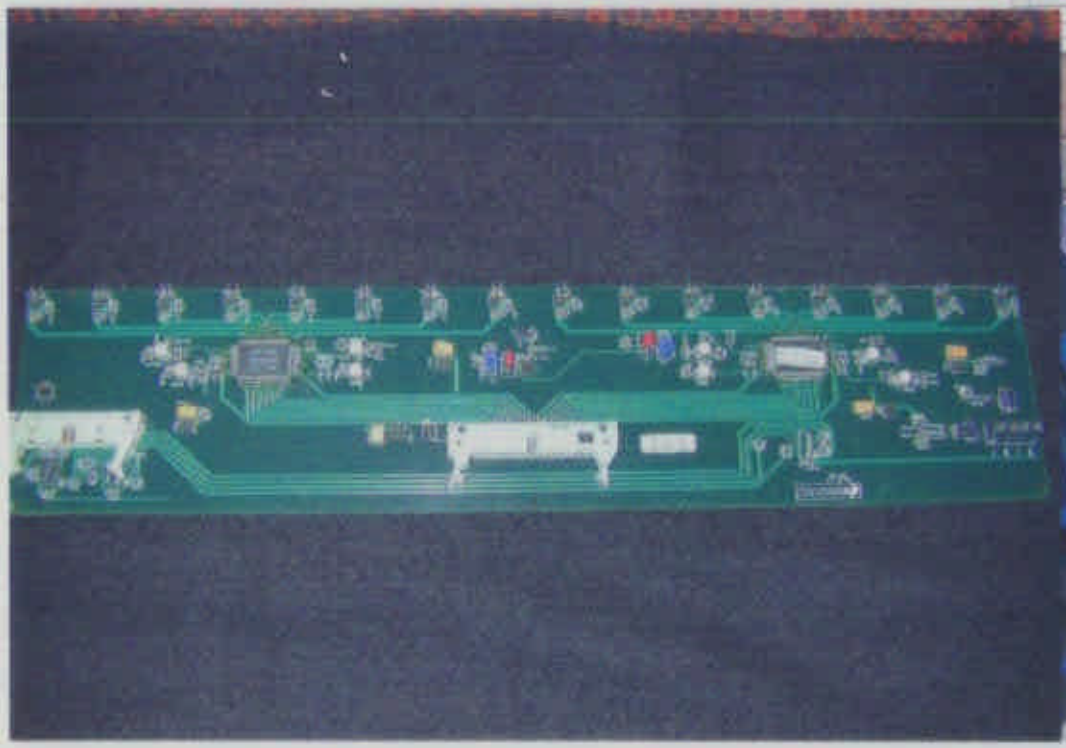
Two RB2 – like FE board irradiated at the Triga Mark II 250 kW Reactor in PAVIA



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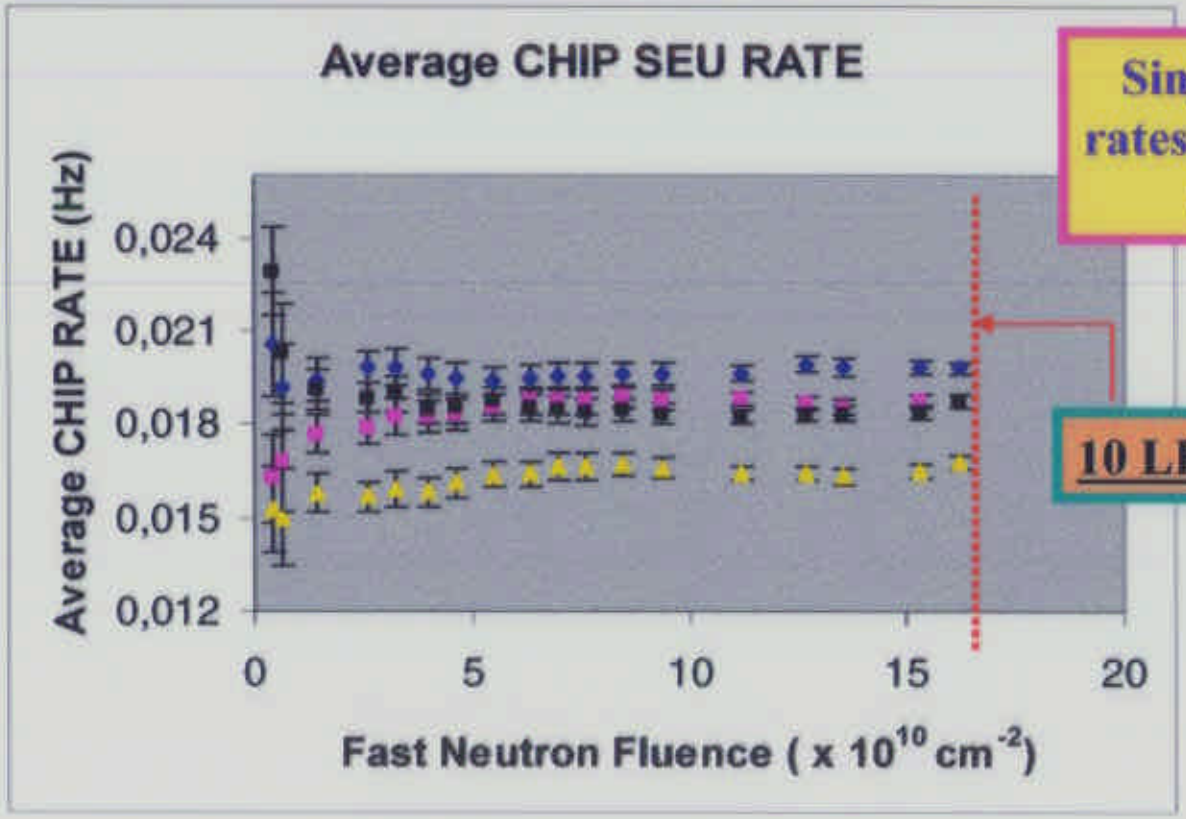
SPURIOUS SEU COUNTING RATE REACTOR ON



Single event upset rates are background subtracted

10 LHC years

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RELEVANCE OF BAKELITE RESISTIVITY

Compromise between rate capability and noise

$$\tau = \varepsilon_0 (\varepsilon_r + 2) \rho$$

recovery time τ of an RPC's elementary cell (loss in rate capability)

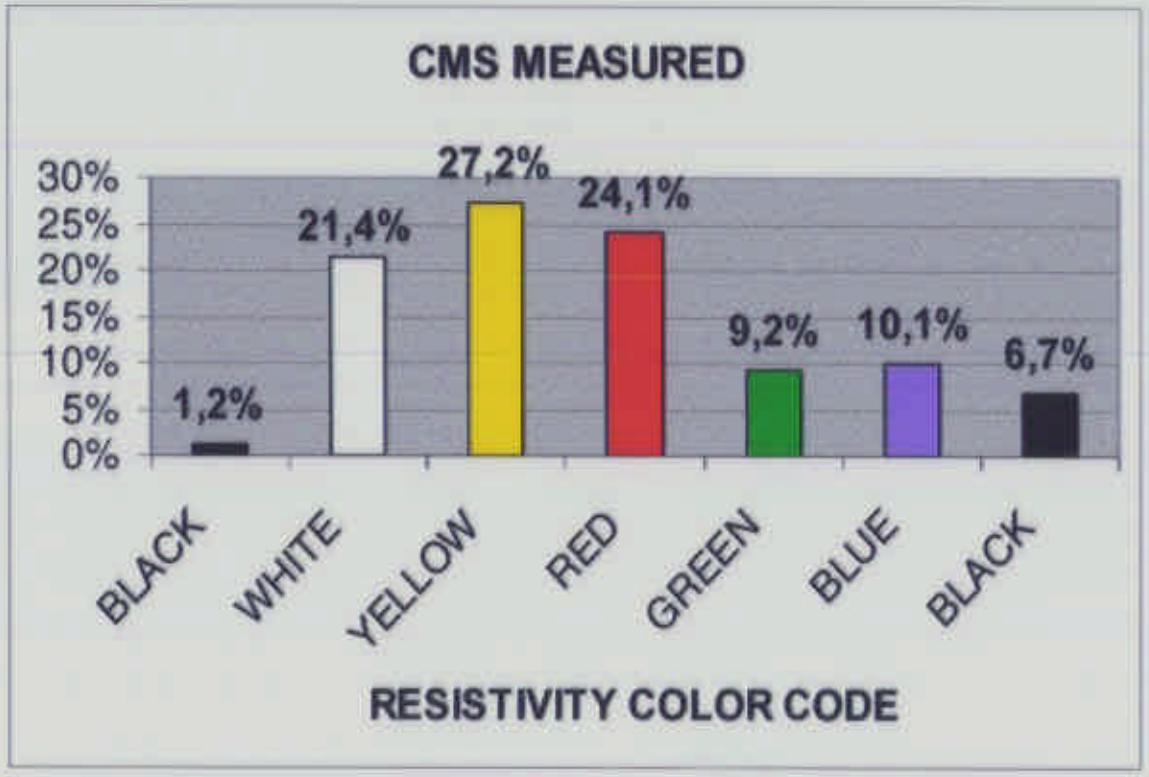
$$V = 2 < Q_e > R\, s\, \rho$$

Average charge in the gas, per event

bakelite thickness

Voltage drop V in gas due to high rate (R) of any incoming particle (loss in gas gain and in drift velocity)

First results from the mass production



400 slabs

COLOR CODE	RANGE (x 10^{10} Ω cm)
BLACK	< 0.95 or >6.3
WHITE	[0.95 – 2[
YELLOW	[2 – 3[
RED	[3 – 4 [
GREEN	[4 – 5 [
BLUE	[5 – 6.3]

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Conclusions

"avalanche"

- RPC's in proportional mode have adequate properties to challange LHC backgrounds
  (ε , τ properties, sensitivity to unwanted particles)

- RPC's and FE chips tolerate predicted radiation damage.
  Single Event Upset don't spoil significantly trigger rates:
  accidental rate by Fast Neutrons (0.4 eV -10 MeV)
  on each channel of FE chips is 2.5×10^{-3} Hz

- Production of both chips and RPC's are being kept well under control.