ATLAS Internal Note
LARG-NO-xxx
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Pollution of liquid argon after neutron irradiation measured at SARA: summary of raw data

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In the following pages, one should find the basic information concerning the liquid argon pollution studies after neutron irradiation of various parts of the em calorimeter. The tests were performed at the SARA facility in Grenoble. Detailed information about this irradiation facility and about the way the pollution is measured can be found in:

J. Collot et al., Nucl. Instr. and Meth. A350 (1994) 525.
Ph. Martin, ATLAS Internal Note, LARG-NO-052.
J. Collot et al., ATLAS Internal Note, LARG-NO-056.

For each sample, its reference and/or origin are given. The neutron fluence has been averaged over the volume of the samples. Two pieces of data are displayed on two graphs. The first one shows the evolution of the monitor response before (where it is averaged to 1.0), during and after the irradiation. The second one shows the attenuation of the monitor response due to irradiation as a function of the electric

[a]now at CPPM

field. Error bars are purely statistical. The volume of liquid argon was between 5 and 5.5 litres. The comparison of the amount of irradiated material (area, length, number of pieces as the case may be) to the amount relevant to the calorimeter should allow to derive the pollution to be expected therein. The loss of signal predicted in the calorimeter must take into account the local neutron fluence worked out in the simulation (see TDR). Finally, a factor of three down must be applied to the calculated loss, due to the difference in the shaping times in SARA and ATLAS electronics.

Almost for every test, a fairly fast drop seems to show up at the very beginning of the irradiation. In some cases, the pollution does not get worse after this first drop, the attenuation is then around 1 or 2 percent. There, the observed attenuation might be due to some pollution coming from the cryostat itself and not from the samples. This is suggested by the data with no samples in the cryostat, see “EMPTY CRYOSTAT”. Therefore, pollutions of one or two percent are not absolutly significant and should be interpreted as a maximum. Most of the time, the pollution is not compatible with the presence of oxygen.

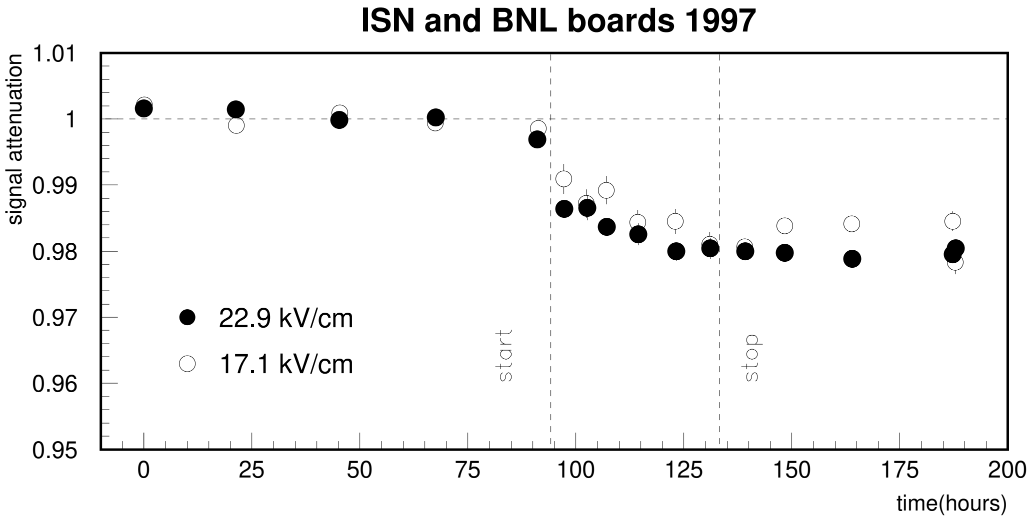
Barrel and Presampler boards

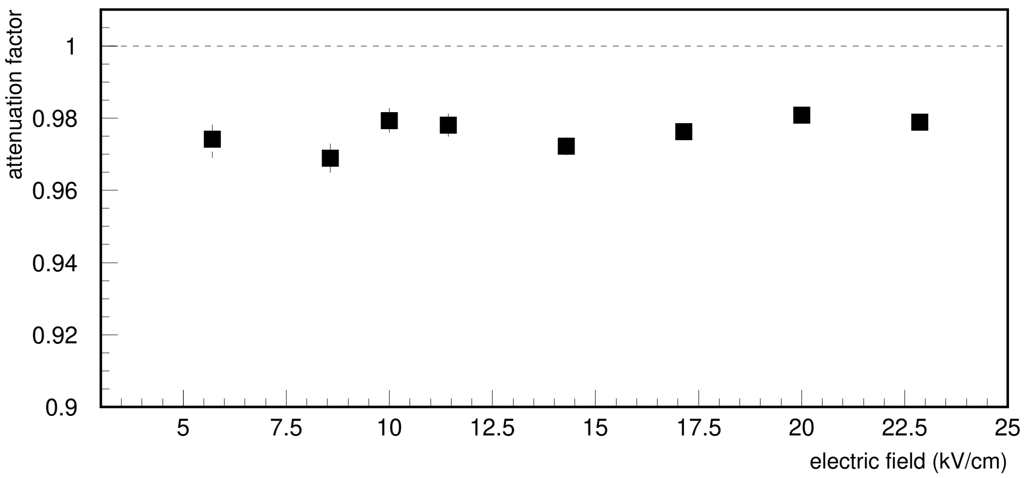
three types of samples

> **12 pieces of presampler boards, area=0.15m^2**
> **origin:ISN**
>
> **4 pieces of barrel mother boards, area=0.04m^2**
> **origin:BNL**
>
> **4 pieces of barrel summing boards, area=0.033m^2**
> **origin:BNL**

date of irradiation: 6 Octobre 1997

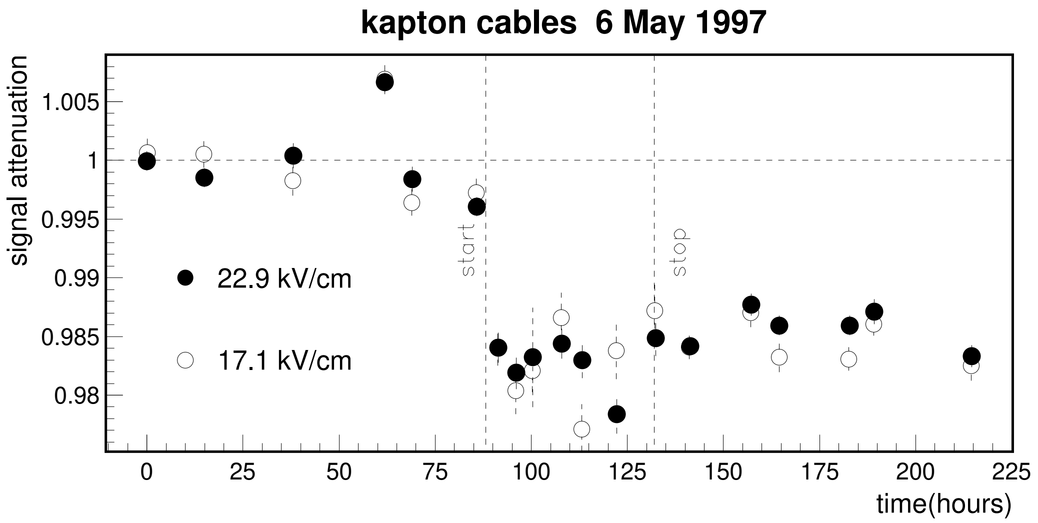
mean fluence: 1.8 10^{14} n.cm^{-2}

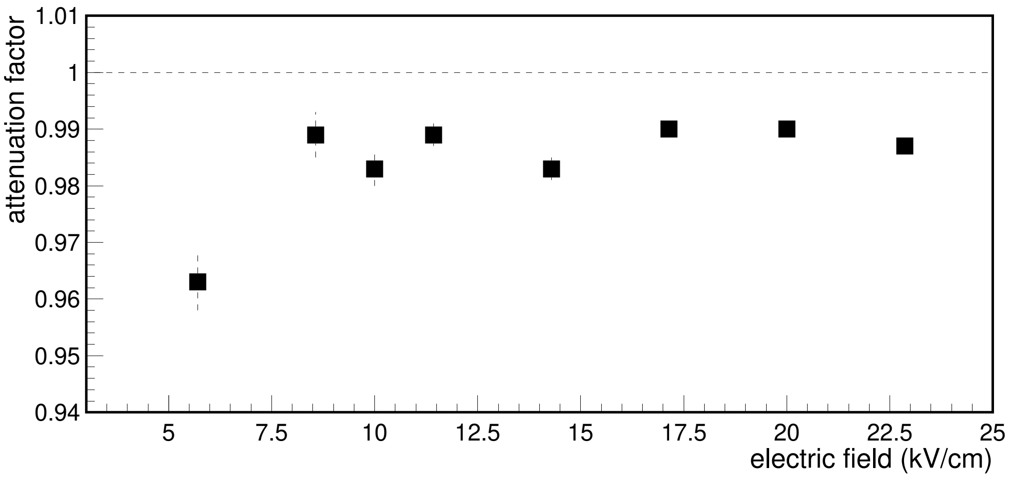




Kapton signal cables

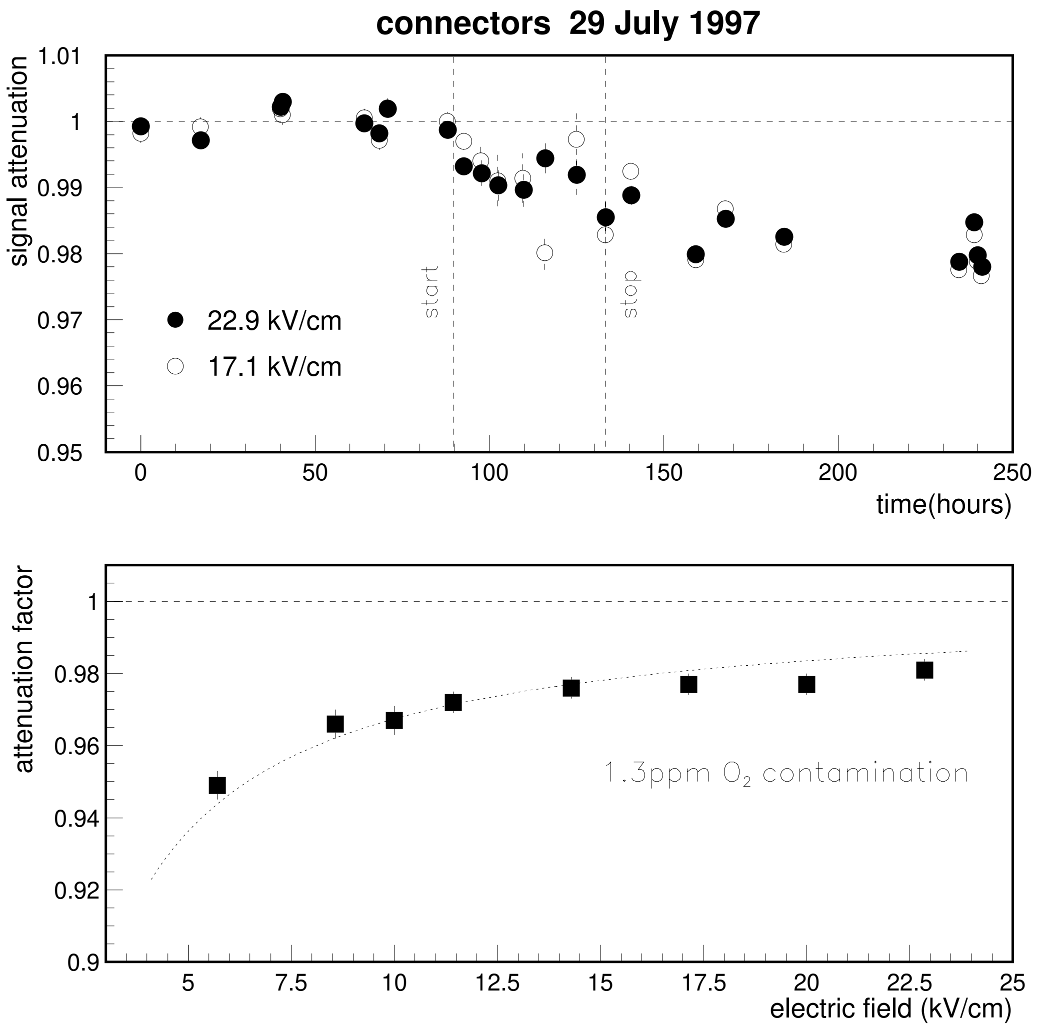
origin: LAL
reference: AXON P511295
total length = 64m
date of irradiation: 6 May 1997
mean fluence: 2.4 10^{14} n.cm^{-2}





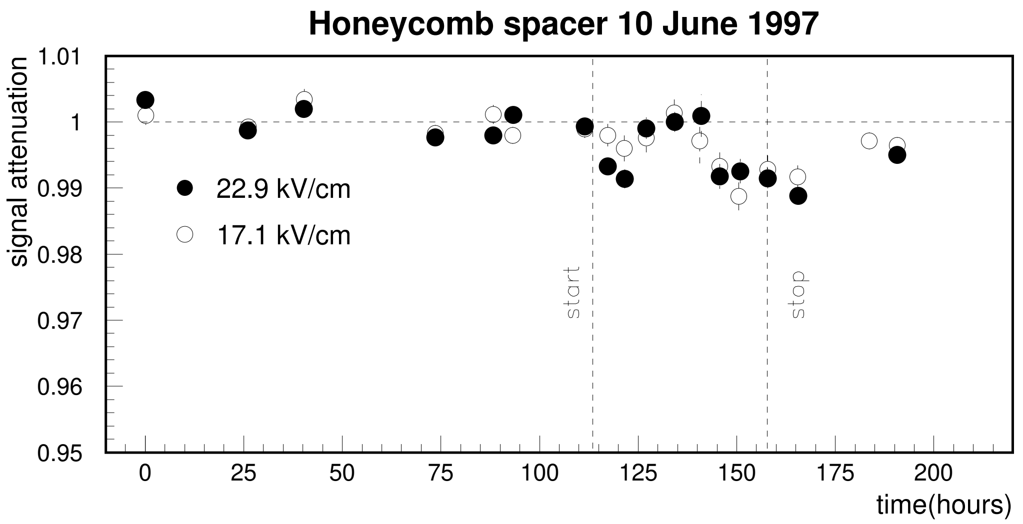
Connectors

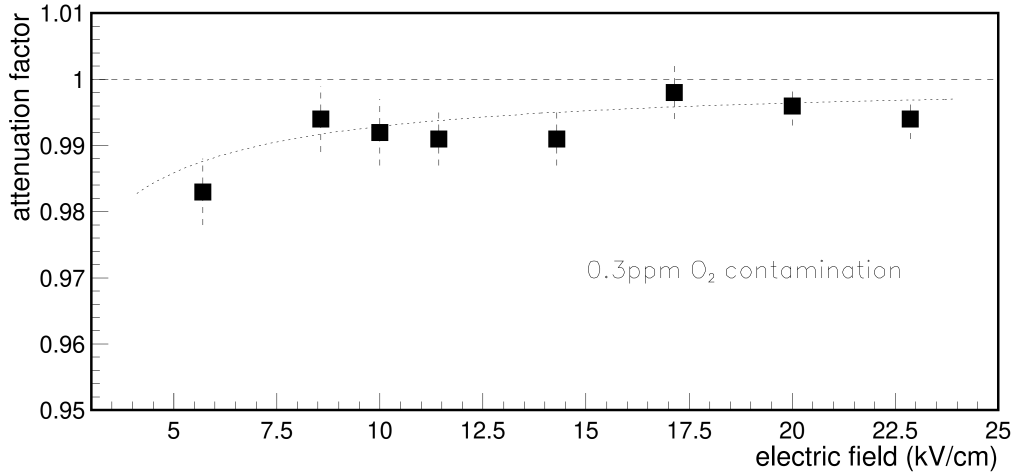
origin: LAL
reference: no data from the manufacturor yet
only one connector
date of irradiation: 29 July 1997
mean fluence: 3. 10^{14} n.cm^{-2}
comment: The line drawn on the second picture is not a fit. It only shows what should be expected with some oxygen pollution.



Honeycomb spacer

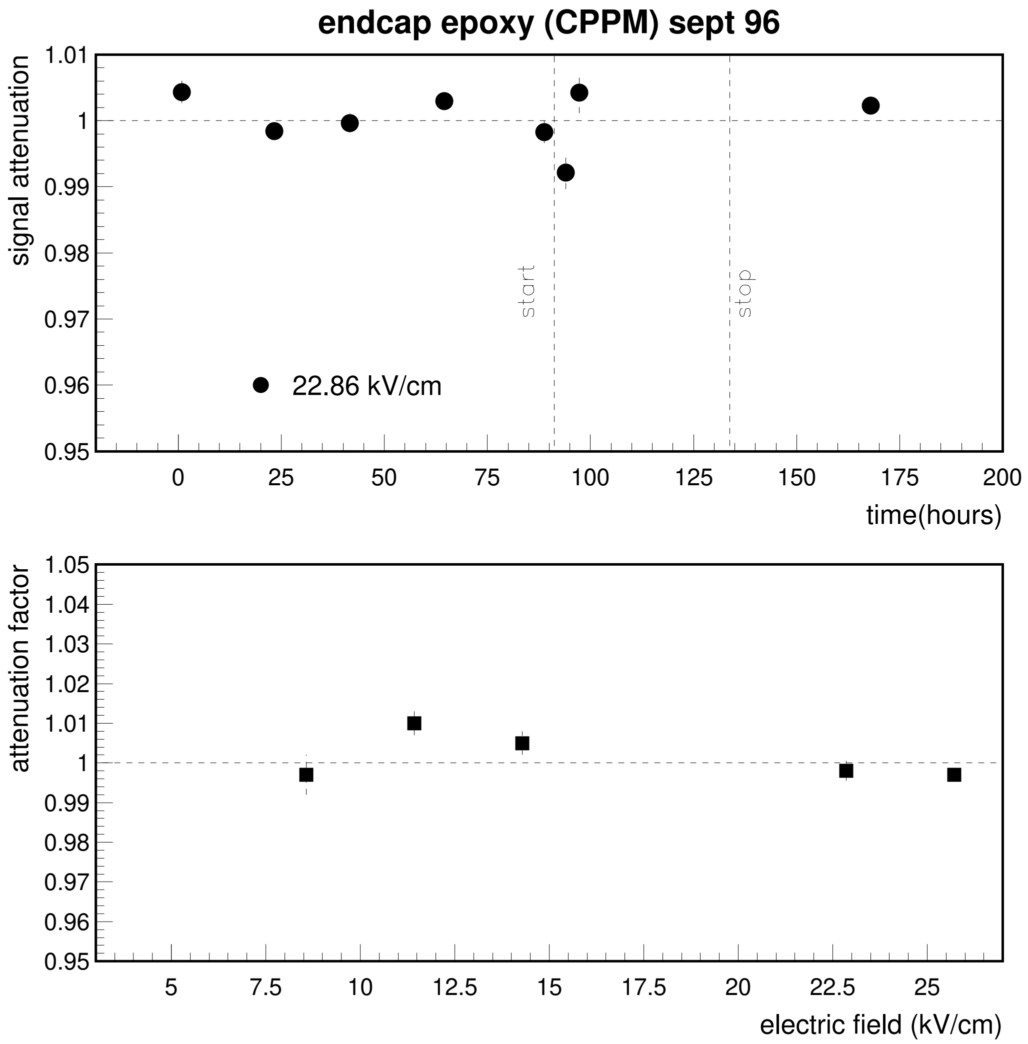
origin: Saclay
reference: Hexcel-Honeycomb HRH 10 3/8 2.0
total area: 1m^2
date of irradiation: 10 June 1997
mean fluence: 1.4 10^{14} n.cm^{-2}
comment: The line drawn on the second picture is not a fit. The signal attenuation is compatible with a 0.3ppm oxygen pollution.





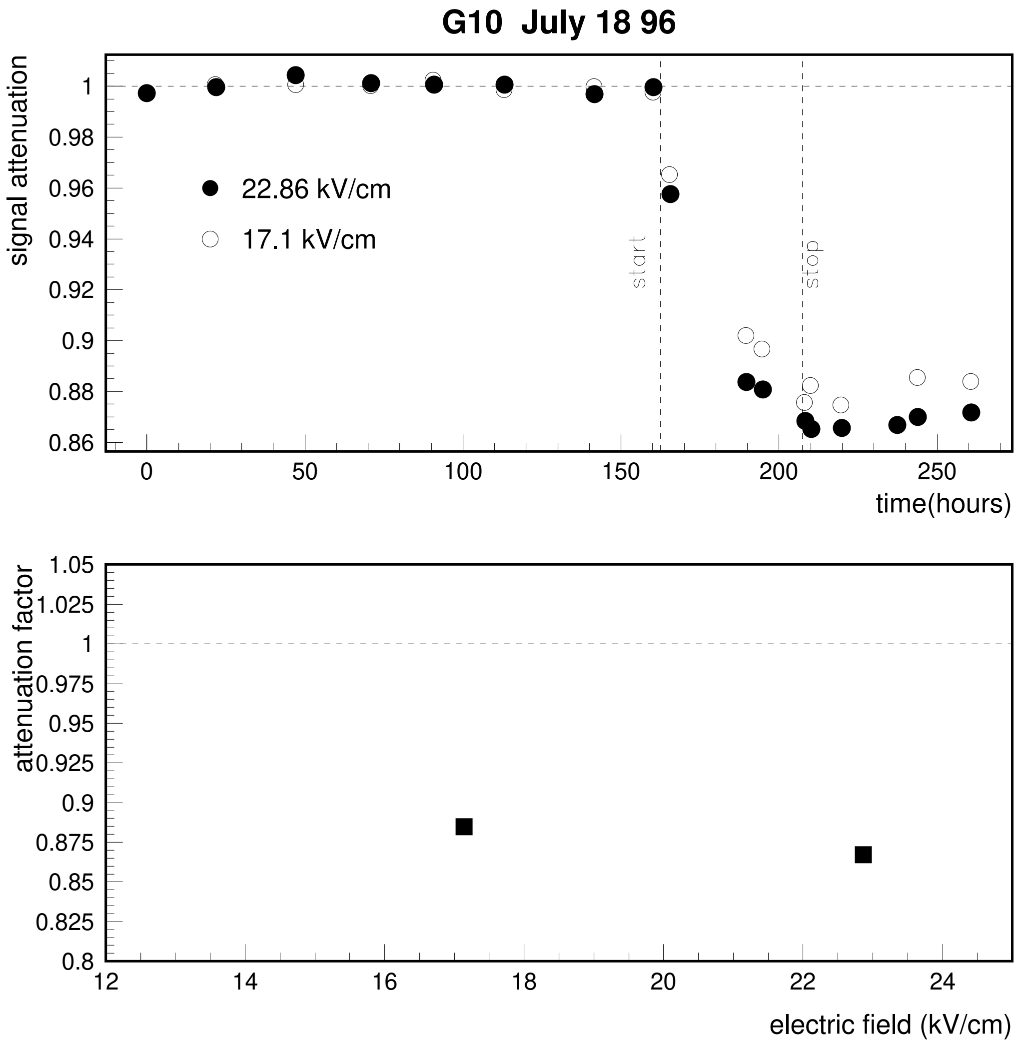
EM Endcap epoxy

origin: CPPM
reference: G10 using Ciba-Geigy 5052 epoxy
total area: 0.056m^2
date of irradiation: 3 Septembre 1996
mean fluence: 2.5 10^{14} n.cm^{-2}



G10

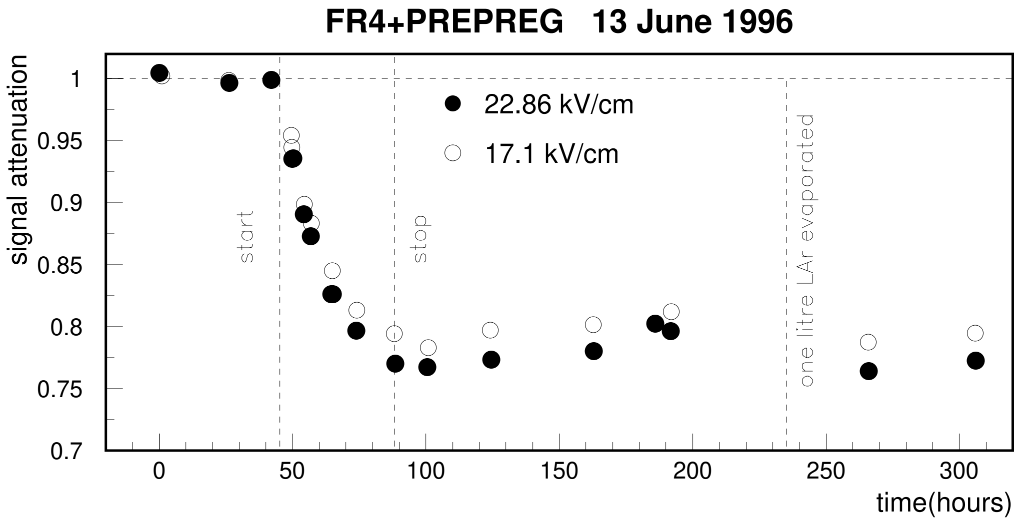
origin: ISN
reference: von Roll Isola 64220 and 64060
total area: 0.38m^2
date of irradiation: 18 July 1996
mean fluence: 2.5 10^{14} n.cm^{-2}

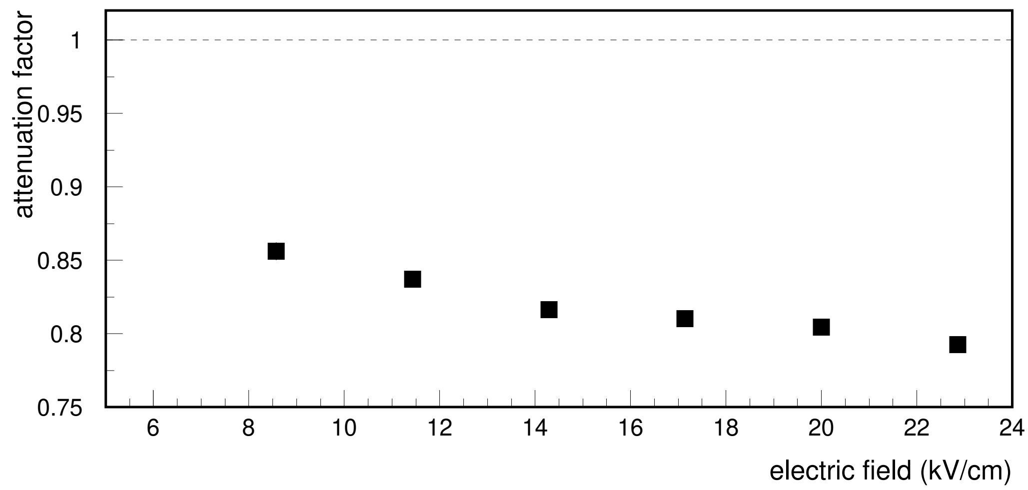


Prepreg-1

glued on both sides of FR4 plates.

origin: ISN
reference:CTMI 5512-1383-1808-50/110
total area: 0.37m^2
date of irradiation: 13 June 1996
mean fluence: 2 10^{14} n.cm^{-2}



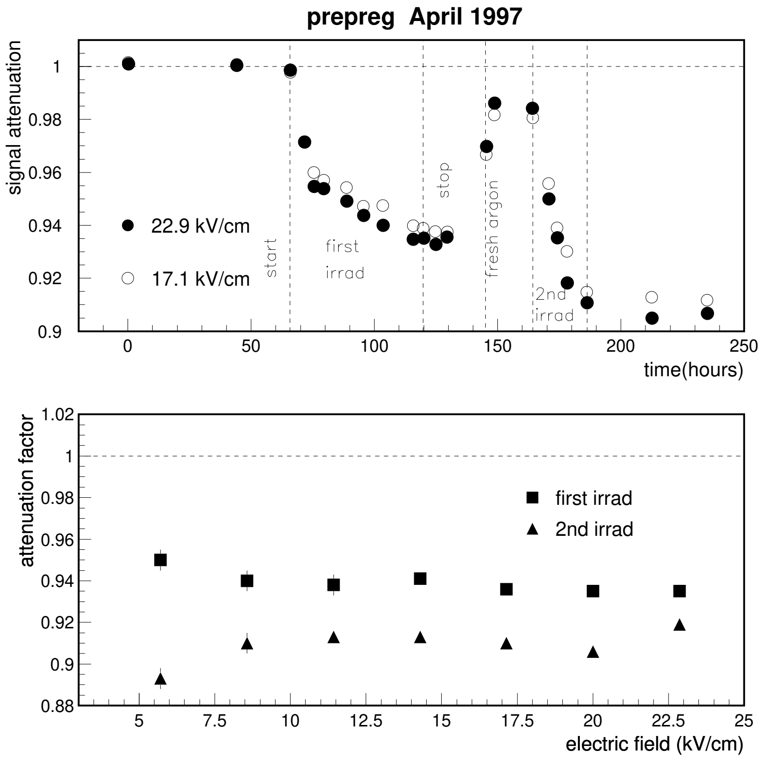


Prepreg-2

glued on both sides of FR4 plates.

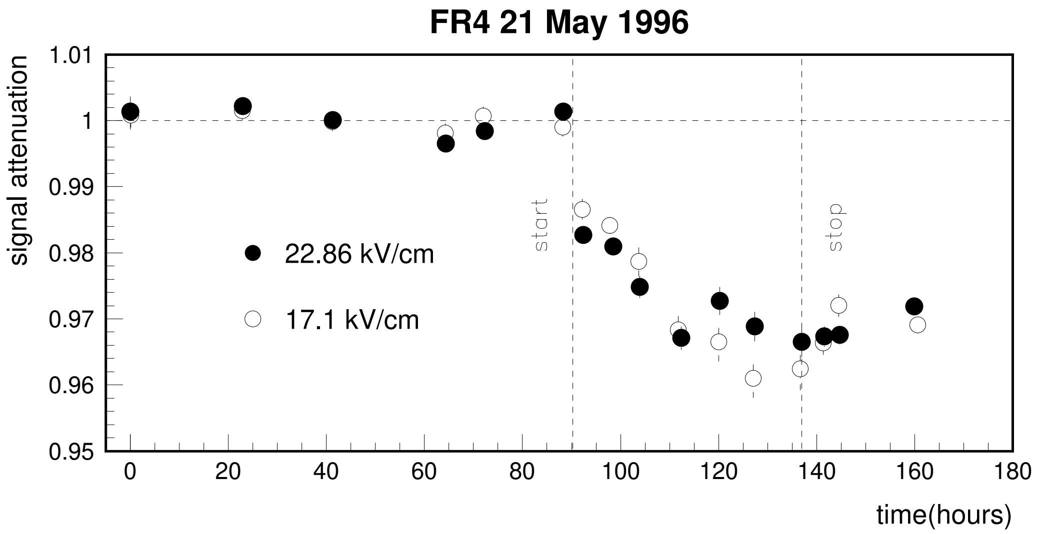
origin: ISN
reference: CTMI 5512-1383-1808-50/110
total area: $0.20 m^2$
date of irradiation: 21 April 1997
mean fluence: $2.5\ 10^{14}\ n.cm^{-2}$ (first irrad), then $0.9\ 10^{14}$ $n.cm^{-2}$ (2nd irrad)

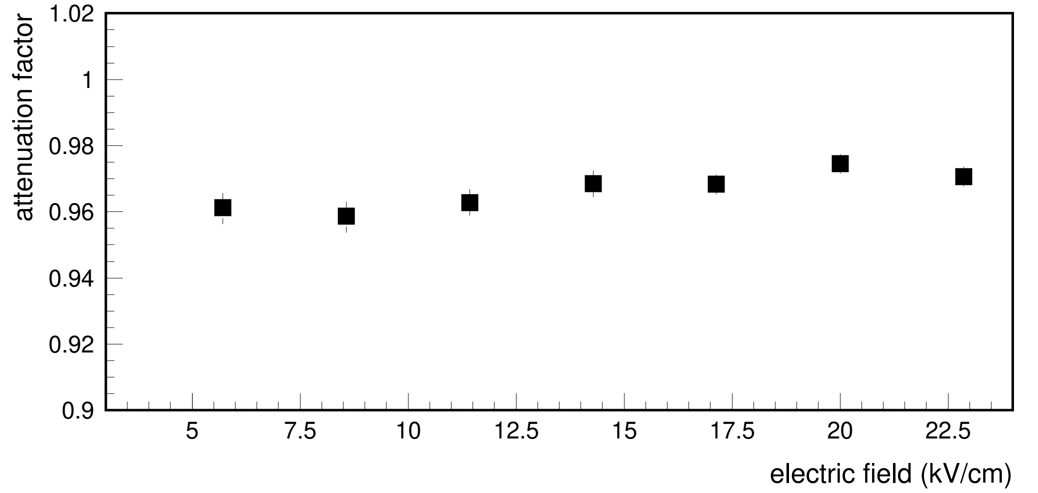
comments: The main point was to check that the pollution does actually scale with the amount of irradiated material. Therefore, it has to be compared to the Prepreg-1 page.
The first picture shows the data after two irradiations. Twenty four hours after the cryostat was refilled with fresh argon, this operation was stopped when the level reached 2 litres and the alpha-cell response was measured (time=145h). The signal loss was then 3.5%. It was measured again when filling was completed and the loss was found to be 1.5%, which implies that impurities were present when refill was started. Either the impurities released after the first irradiation remained in the cryostat after the evaporation (see Prepreg-1), or some air was accidently let in during the operation. In any case, the pollution rate seems to have been the same during the second irradiation, if not larger.



FR4

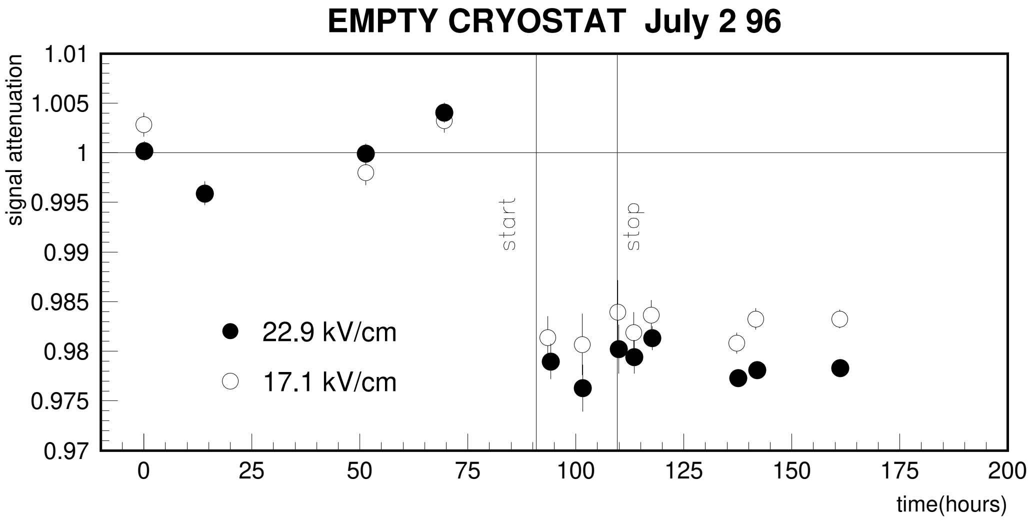
origin: ISN
reference: von Roll vetronite 64220
total area: $0.37m^2$
date of irradiation: 13 May 1996
mean fluence: $1.6\ 10^{14}\ n.cm^{-2}$

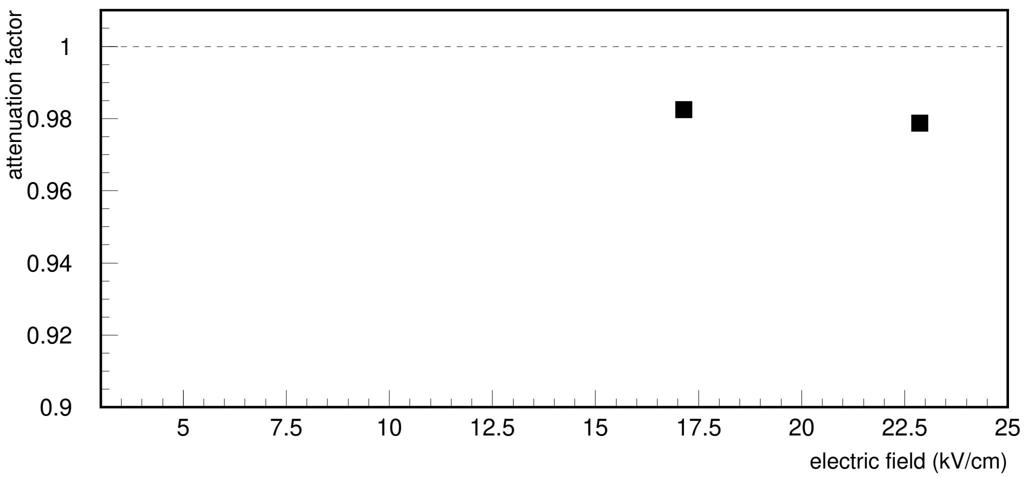




EMPTY CRYOSTAT

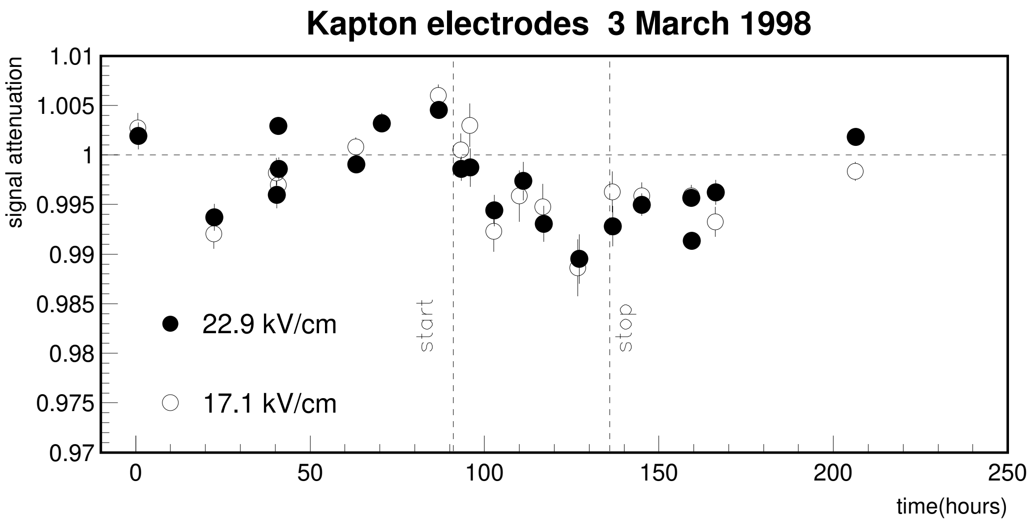
date of irradiation: 2 July 1996
mean fluence: 0.8 10^{14} n.cm^{-2}

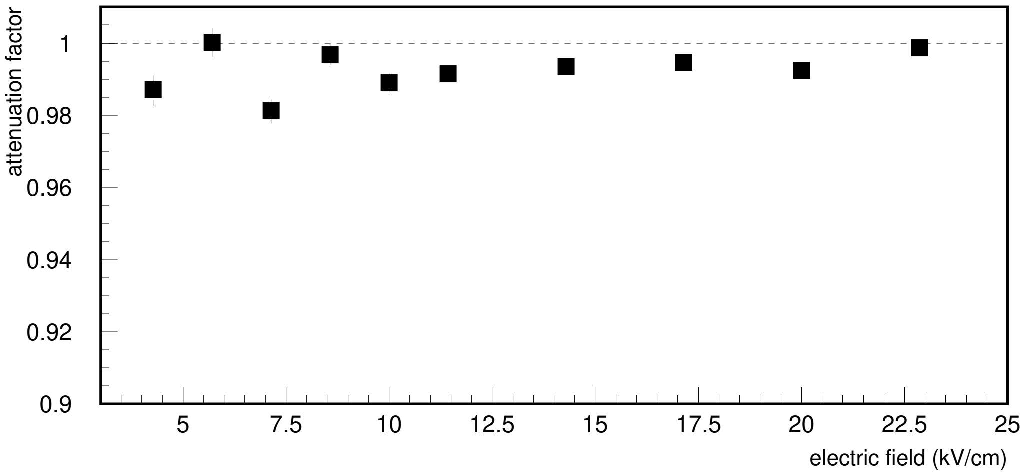




Kapton electrodes, no resistive ink

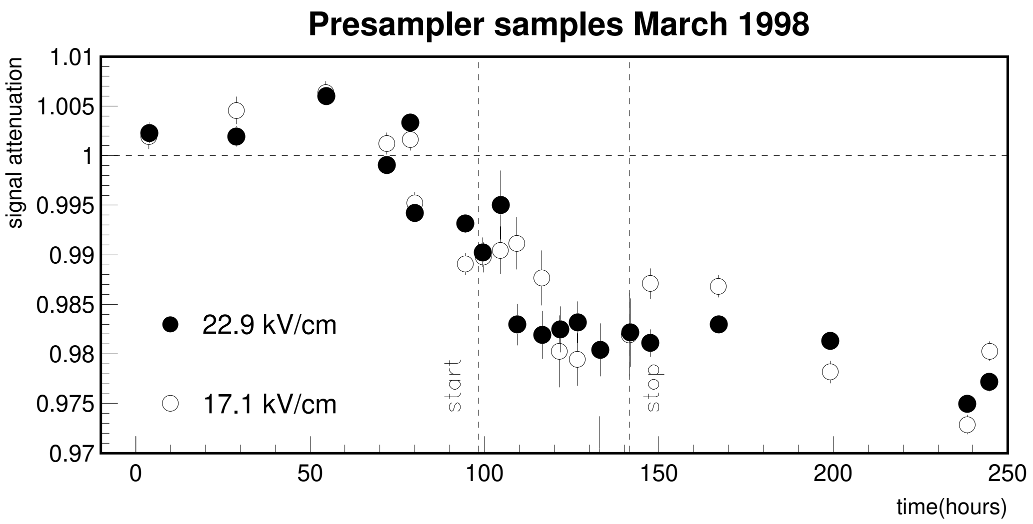
origin: CERN, CICOREL
reference: prototype EST electrode
total area: 0.86m^2
date of irradiation: 3 March 1998
mean fluence: 1.8 10^{14} n.cm^{-2}
comments: no visible damage on the gluing.
The calibration pulser was not perfectly stable.

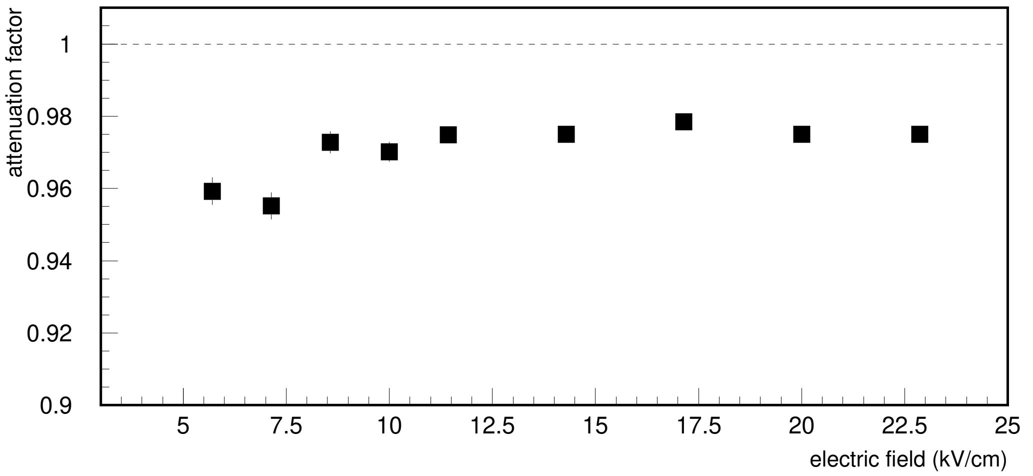




Presampler

origin: ISN
reference: pieces of the final presampler:
detection unit, shell, protection board (two pieces of each).
specific amount: three times ATLAS (in m^2/m^3)
date of irradiation: 18 March 1998
mean fluence: 2.3 10^{14} $n.cm^{-2}$



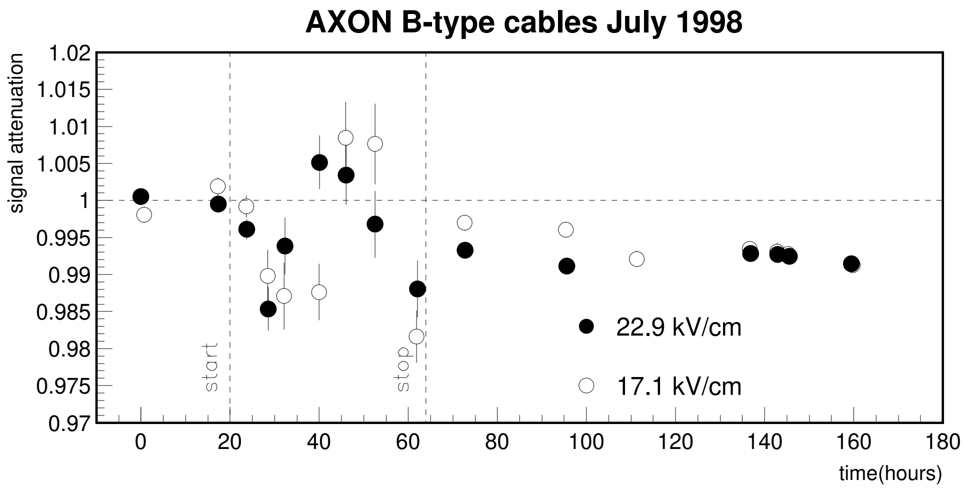


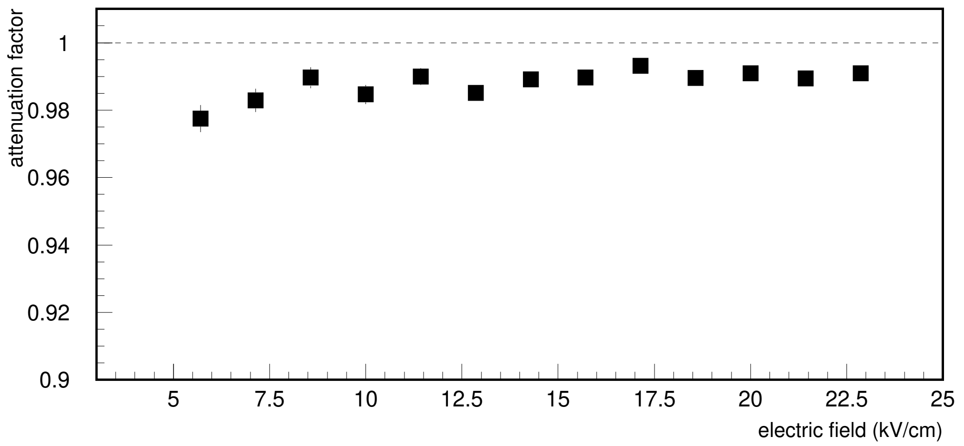
Signal cable harness, connectors, putty

origin: LAL(EMEC test cryostat) and AXON.
references:

- **64 signal cables: B-type AXON.**
- **connector ATI B683C03.**
- **HOLT MELT putty AXON.**
- **male and female micro-D connectors with LCP putty.**

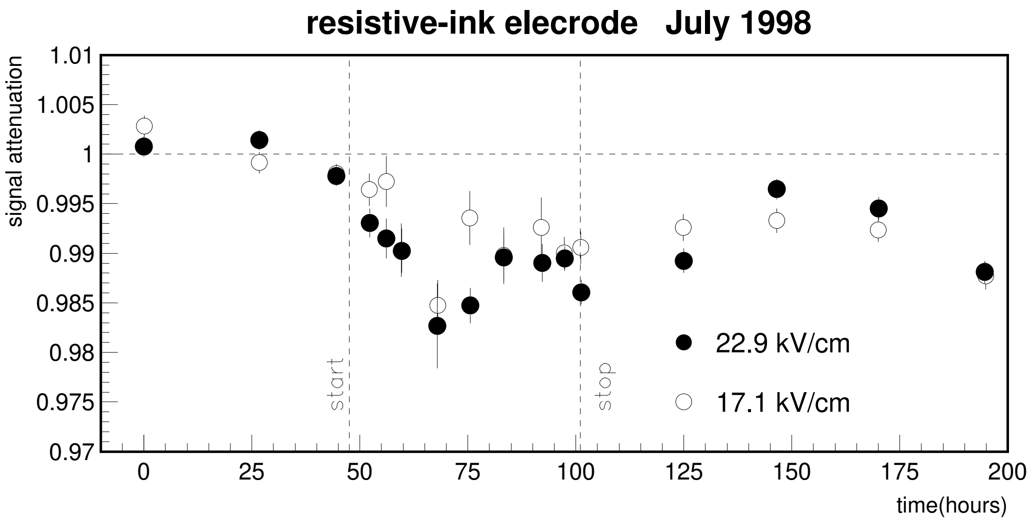
Harness length: 4 metres.
date of irradiation: 1 July 1998
mean fluence: 1.5 10^{14} n.cm^{-2}

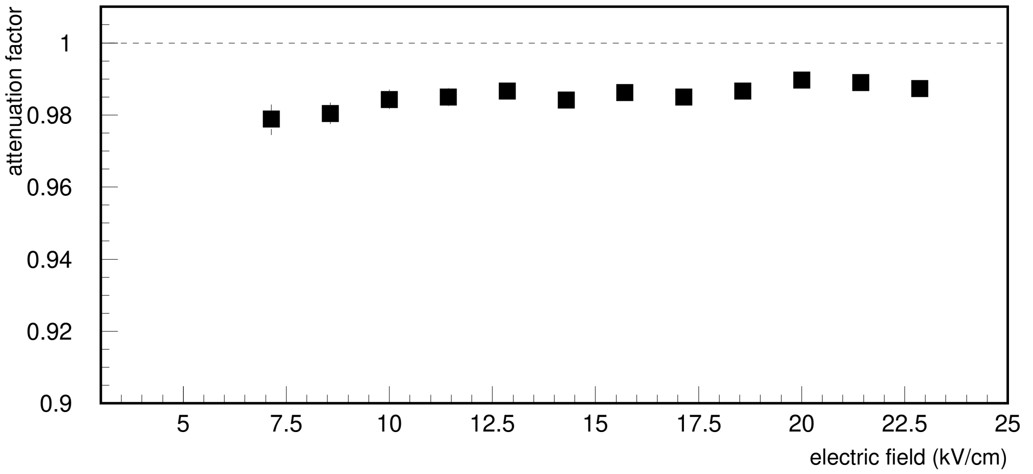




Kapton electrodes, with resistive ink

Whole BARREL electrode, with connectors.
origin: LAPP, MCB
reference: type A, #21/011, ESL ink
date of irradiation: 13 July 1998
mean fluence: 2. 10^{14} n.cm^{-2}





Irradiations at SARA, summary of raw data

date	material	fluence	signal loss	
			E=10kV/cm	E(10) & 2. 10^{14}
04/96	**prepreg+anodes +unmoulding (PS)**	**1.6 10^{14}**	**24 %**	**26 %**
05/96	**FR4 (PS)**	**1.6 10^{14}**	**4 %**	**4 %**
06/96	**prepreg (PS)**	**2. 10^{14}**	**16 %**	**16 %**
07/96	**empty**	**0.8 10^{14}**	**2 %**	**2 %**
07/96	**G10**	**2.5 10^{14}**	**11 %**	**10 %**
09/96	**epoxy CPPM**	**2.5 10^{14}**	**0 %**	**0 %**
09/96	**prepreg (PS)(less Cl)**	**2.2 10^{14}**	**17 %**	**16 %**
04/97	**prepreg (PS)(15/29)** **prepreg (argon refill)**	**1.4 10^{14}** **0.9 10^{14}**	**6 %** (1.5+7) %	**7 %** (1.5+11) %
05/97	**cables**	**2.4 10^{14}**	**1.5 %**	**1.5 %**
06/97	**honeycomb**	**1.4 10^{14}**	**1 %**	**1 %**
07/97	**μD connector**	**3. 10^{14}**	**3 %**	**2 %**
09/97	**mother boards**	**1.8 10^{14}**	**2 %**	**2 %**
03/98	**EST electrodes**	**1.8 10^{14}**	**1 %**	**1 %**
03/98	**Presampler**	**2.3 10^{14}**	**3 %**	**3 %**
07/98	**signal cable harness**	**1.5 10^{14}**	**1.5 %**	**1.5 %**
07/98	**resistive ink electrodes**	**2 10^{14}**	**1.5 %**	**1.5 %**