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LAr week, March'99

Irradiation Tests at Dubna
- Status -

Have been done since October'98 (LARG Note in preparation):

Cold tests facility

- **October** - EMPTY run (no materials in the cryostat, 10^{16} n/cm^2)
- **November** - PEEK fibres (10^{16} n/cm^2)
- **December** - sintered tungsten slugs (10^{16} n/cm^2) and Kapton cables
- **January** - HEC materials (1/2 of the LAr gap, $1.1 \cdot 10^{16}$ n/cm^2)
- **January** - pollution tests at the Mainz facility with ($0 \div 2.8$) ppm of O_2

Tests of the cold electronics

- **February** - GaAs preamplifiers (2 boards, 8 chips, $1.1 \cdot 10^{15}$ n/cm^2)
- **March** - GaAs preamplifiers (γ-irradiation has started on 15/03)

To be done:

- facility tests with oxygen polluted argon (calibration of the α-cell)
- pollution stability in long period (2-3 weeks)

IBR-2 reactor schedule for 1999:

March 15 - 26 - HEC preamps (γ-irradiation is going on)

April 12 - 23 - FCAL (interconnectors, cables... to 10^{16} n/cm^2)
(parasitic irradiation of GaAs chips)

May 17 - 28 - HEC sensors (LAr temperature system)

—- summer vacations —-

October 18 - 29 (to be fixed)

November 15 - 26 (to be fixed)

December 6 - 18 (to be fixed)

Pollution tests with different materials

The cold tests facility is operating at IBR-2 reactor at JINR, Dubna since October'98. Different samples of the FCAl and HEC materials have been exposed to the fast neutron fluence of about 10^{16} n cm^{-2}. The samples were immersed into the liquid argon cryostat, and the α-cell has been used as a purity monitor.

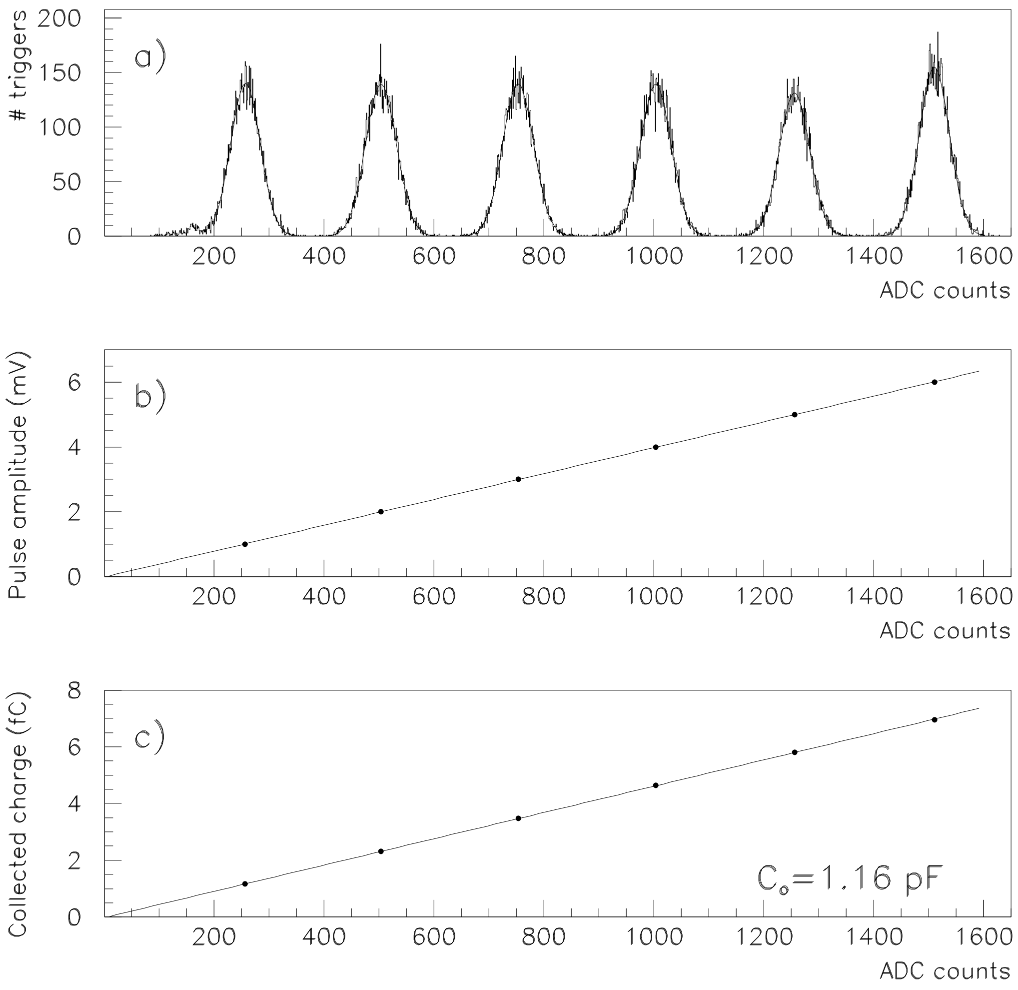

Figure 1: *Calibration of the ADC scale. The calibration pulses produced by the pulse generator inject the test input of the preamplifier (RD-33 type, operated "in warm") with calibrated input capacitor* $C_\circ$ *= 1.05 pF.*

The data processing is rather simple in our case: *i*) we have to fit the ADC spectrum by some functional to find the position of the α-signal, *ii*) the result has to be corrected assuming the stability of the reference pulse, and finally, *iii*) the ADC counts must be transfered into the collected charge units (fC) for further processing. Each step gives certain contribution to the

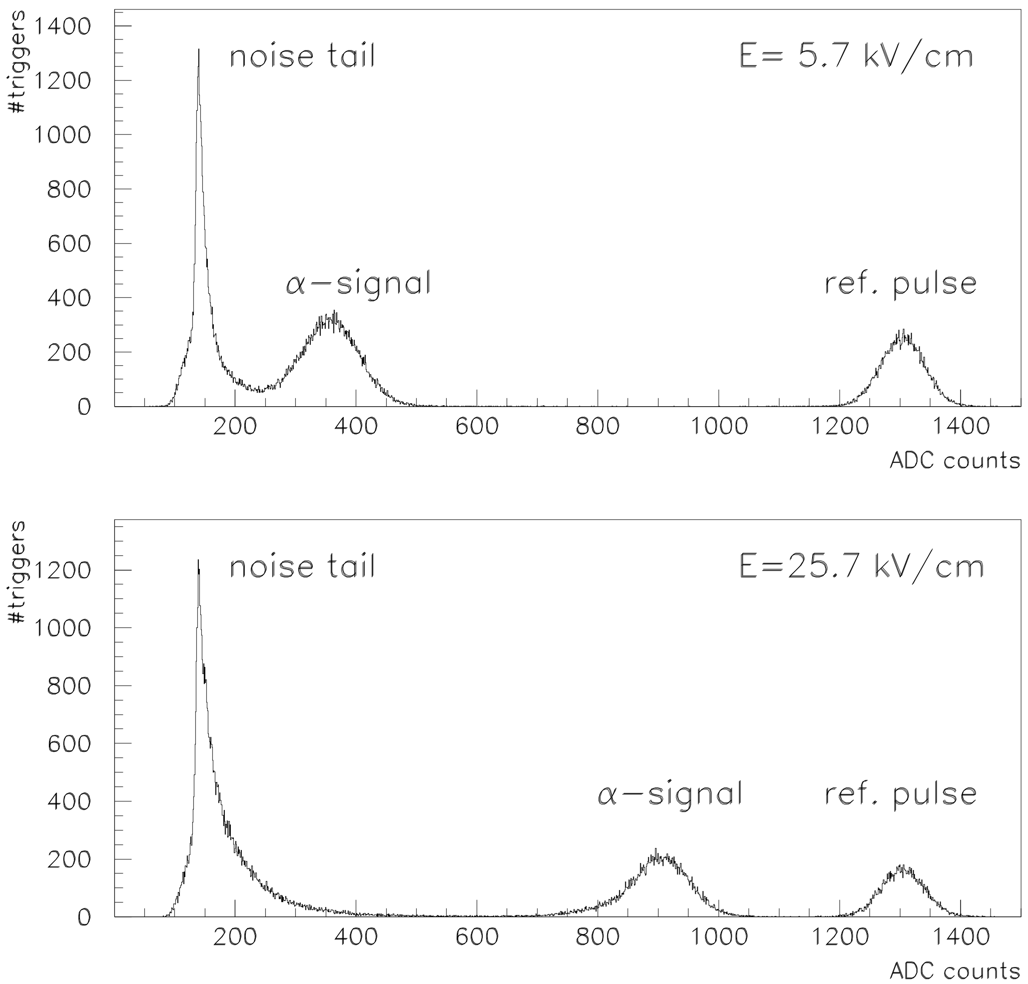

Figure 2: *An example of the raw data. Each histogram contains 100K triggers. The shown are ADC spectra measured at two different values of high voltage applied. Evidently, the amplitude of the α-signal is growing with electric field, whereas the position of the reference peak, which we use to monitor the gain of the preamplifier, is stable. The contribution of the pick-up signals reveals as non-gaussian tail of the pedestal distribution and the α-peak.*

systematics which has to be summed with the statistical uncertainty taken from the (gaussian) fit. **Uncertainties due to the fit** could be estimated as the variations of the peak position determined by the different fitting procedures. It is seen from the Fig. 2 that at E=5 kV/cm the exponential tail of the noise peak which is cut by the threshold has to be taken into account. The contribution of additional charge sources at higher E values probably could be described by the additional Gaussians.

On the other hand, each peak of the ADC spectra could be fitted by the only Gaussian in the $\pm 1\ \sigma$ interval around the peak position. The difference of these approaches is presented in Fig. 3 a). The variations are in frame of ± 4 ADC counts.

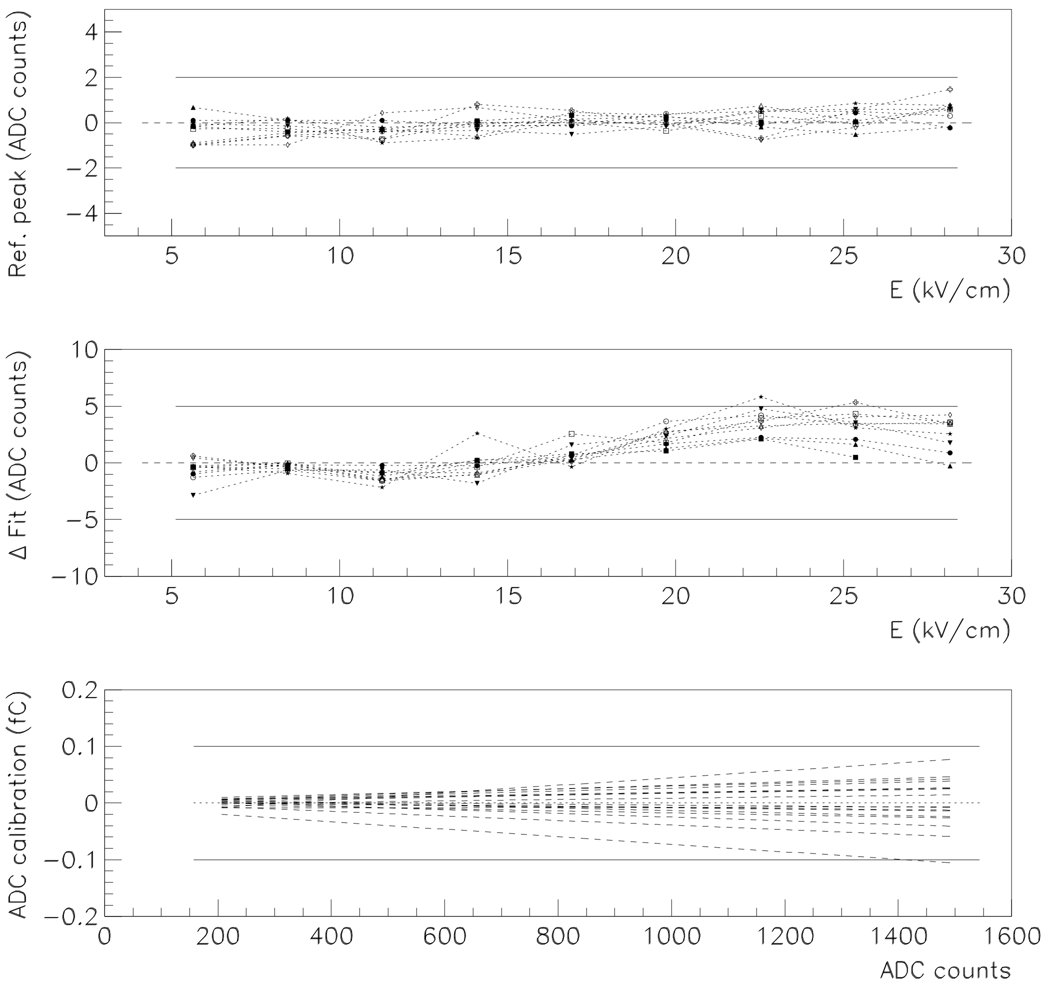

Figure 3: *Systematic errors estimated in different runs of measurements.*

Reference pulse position was used to correct the gain of the preamplifier at each HV-point. It is seen from the Fig. 3 c) that the reference peak is varying during the measurements in frame of ± 2 ADC aroung the average value. This conclusion was checked to be valid over the whole ADC scale.

Calibration of the ADC scale in terms of fC was obtained from the linear fit of the calibration pulse positions. The fitted parameters were averaged over a set of measurements, and the deviations from this averaged calibration are presented in Fig. 3 d). Based on this calibration method we may expect the uncertainty at the level of $\sim$0.01 fC.

The detail analysis of the systematic errors was performed for all irradiation runs, and we did not find a significant variations of systematics from run to run.

We have started the pollution tests for ATLAS in October'98. First of all, the cryostat filled by the liquid argon with no testing materials inside was irradiated to high dose. The collected charge dependence on high voltage was measured twice - before and after the irradiation run (two weeks later). During the run the cryostat was exposed to the total fluence of fast neutrons about 10^{16} n cm^{-2}. Results of the "EMPTY" run are presented in Fig. 4.

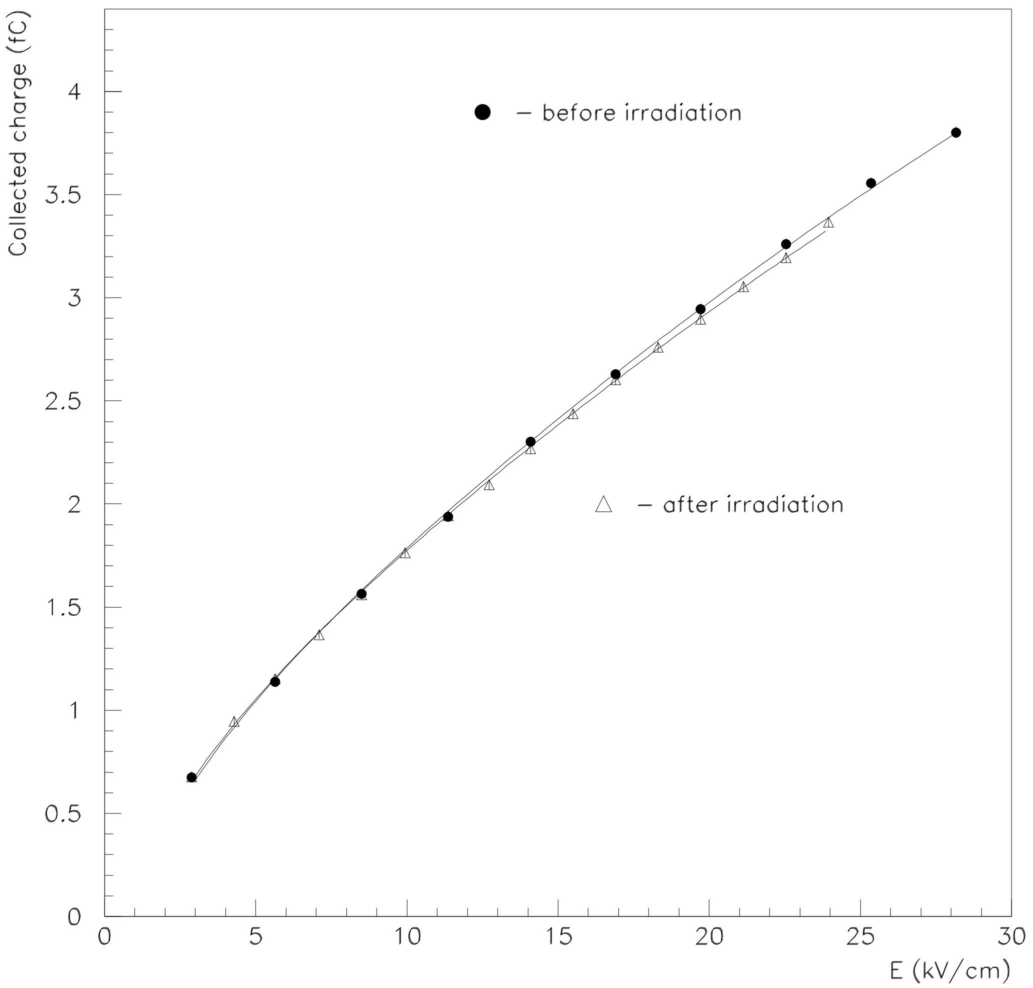

Figure 4: *Results of an "EMPTY" irradiation run with no materials in the cryostat. The collected charge dependence on high voltage was measured before and after the irradiation to the neutron fluence of 10^{16} n cm^{-2}.*

The liquid argon purity before and after the irradiation run is similar. So, the irradiation itself does not cause additional pollution which one has to keep in mind for the further pollution tests with different materials in the cryostat.

A set of different materials used in the liquid argon gap of the hadronic endcap calorimeter was collected for the pollution tests in January'99. The materials were combined in such a way so that one half of the LAr gap was presented. Finally, two honeycomb sheets, one EST board, one half of the PAD and PSB boards, fasteners, different connectors, striplines and cables were immersed into the cryostat which was filled by 0.6 litres of liquid argon.

Total fluence of the fast neutrons was $1.1 \cdot 10^{16}$ n cm^{-2}. Summary of the measurements is presented in Fig. 5.

It is seen that the value of the collected charge value is always higher after the irradiation than before the run. This means that the liquid argon became cleaner. We would have to flash and pump out the cryostat during a long period of time before the run to eliminate the initial contamination cause by the outgasing from the tested samples (honeycomb materials, namely, could absorb a lot of water during its transportation). In the same way as it was done before one may obtain an indication of the argon purity before and after the irradiation: (1.7 ± 0.1) ppm and (0.03 ± 0.08) ppm, correspondently.

Thus, no pollution due to the irradiation of the HEC materials has been found after the neutron fluence of $1.1 \cdot 10^{16}$ n cm^{-2}.

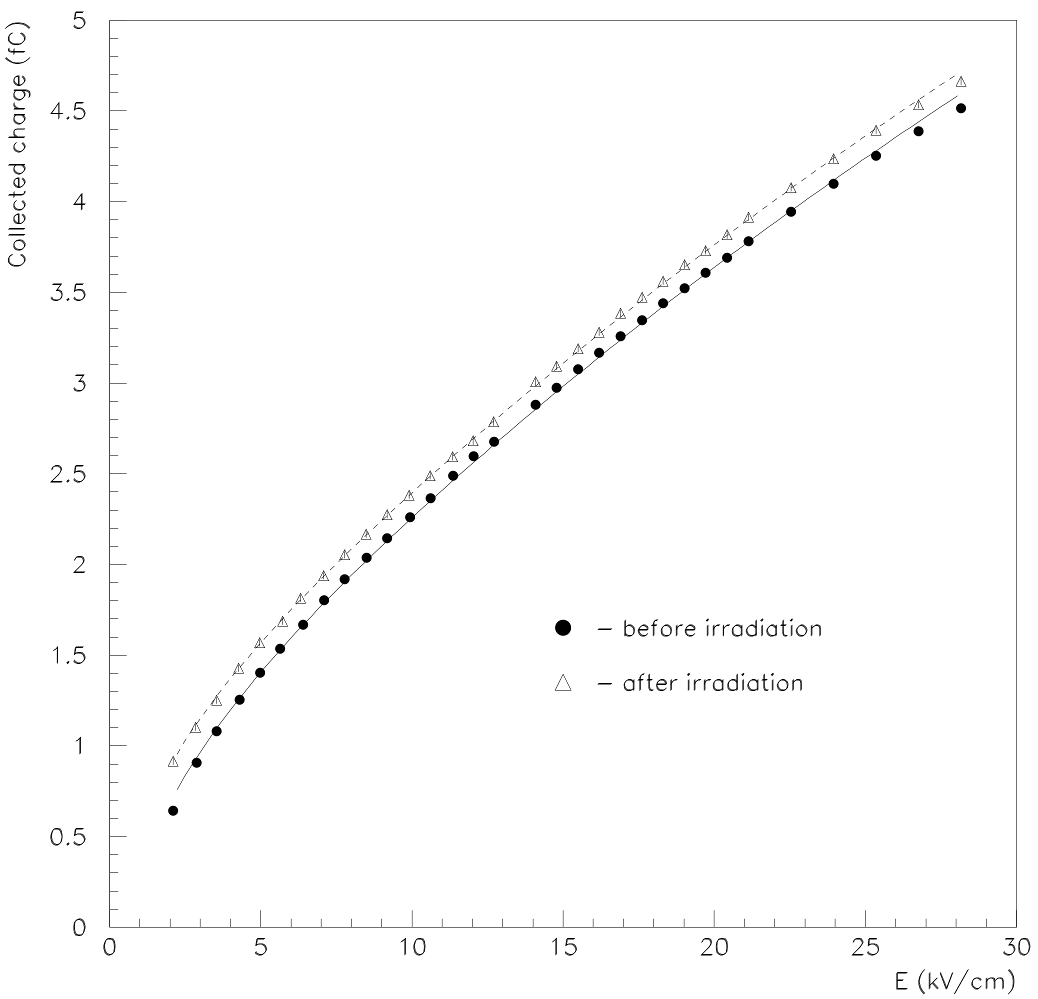

Figure 5: *Results of the "HEC" run. Collected charge was measured before and after the irradiation to the neutron fluence of $1.1 \cdot 10^{16}$ n cm^{-2}.*

February run with GaAs preamplifiers

- 2 motherboards, 8 chips, 64 PAs, 56 output channels with C_d=(0÷300) pF

- cold conditions (LN_2)

- neutron fluences (10^{14} n/cm^2): 0.5, 1.2, 1.9, 2.6, 3.2, 3.8, 4.4, 5.0, 5.6, 6.8, 9.2, 9.8, 11.1

- total doses: $(1.10\pm0.15)\cdot10^{15}$ n/cm^2 and (3.5 ± 0.3) kGy

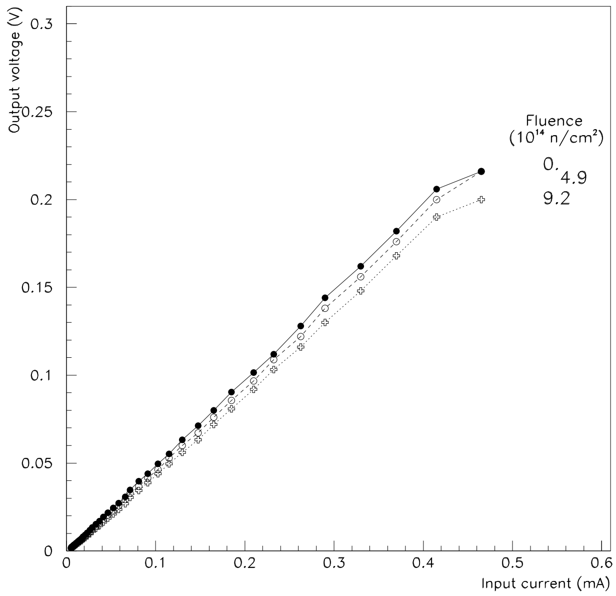

Figure 6: *Linearity of the particular channel with C_d=10 pF.*

Table 1: *Preliminary results for an output channel with C_d=10 pF*

Neutron fluence (10^{14} n/cm^2)	0.	1.8	4.9	9.2
TRANSFER FUNCTION [V/A]	3.475E+04	3.324E+04	2.917E+04	2.079E+04
PEAKING VOLTAGE [V]	5.647E-02	5.402E-02	4.740E-02	3.378E-02
PEAKING TIME [s]	2.721E-08	2.672E-08	2.893E-08	2.988E-08
NOISE VOLTAGE [V]	4.661E-03	4.940E-03	5.785E-03	4.296E-03
NOISE CURRENT [A]	1.322E-07	1.459E-07	1.953E-07	2.025E-07