DEAR Technical Note IR-33

# Kaonic nitrogen X rays detection by background subtraction

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## 1 Introduction

The aim of the present Note is to prove that with a good knowledge of the background-shape it is possible to identify *with 3* $pb^{-1}$ *of collected integrated luminosity* an X-ray signal from kaonic nitrogen even if the *ratio signal to background is as low as 1 to 20.*

The chosen configuration to perform the present Monte Carlo study is the cryogenic target setup with 8 CCD-22 and 4 CCD-05, filled with nitrogen at 5 equivalent bars at room temperature. The X-ray signals for this configuration, taken from ref. [1], are:

- 1700-1800 X rays detected at 7.6 keV;
- 700 -800 X rays detected at 4.6 keV.

Taking these rates as input, a Monte Carlo simulation of experimental-like spectra was performed for different background conditions. The background - assumed as smooth and simple - was afterwards fitted and the fitting-curve subtracted from the experimental-like spectra. The obtained background-subtracted spectra show clear evidence of the 7.6 keV signal and of the 4.6 keV line, also in the worst background condition (signal/background ratio = 1/20).

The working procedure, the obtained spectra and the results are reported in Section 2. In Section 3 conclusions are drawn.

## 2 Monte Carlo spectra for nitrogen lines for different background levels

In order to perform the Monte Carlo simulation of the measured-like spectra one needs to make some assumptions. The working hypotheses which were done are the following:

- a total integrated luminosity of 3 $pb^{-1}$;
- the number of X rays of 7.6 keV in this condition is $1750 \times 3 = 5250$;
- the number of X rays of 4.6 keV in this condition is $750 \times 3 = 2250$;
- for the background two situations were studied:

  - background 10 times higher than the signal (S/B = 1/10);

  - background 20 times higher than the signal (S/B = 1/20);

  The background was referred to that under the 7.6 keV-line.

The background shape for this study was considered to be linear. Once the experimental-like spectra were obtained (by randomizing the function obtained by summing the two X rays lines and the background function) for the 3 $pb^{-1}$ considered, the free-of-signal part of the spectra were fitted with a linear function. Then, in order to obtain the background-subtracted spectra, the contribution of the background-fitting function was subtracted, bin-by-bin, from the experimental-like ones.

The results of such a procedure are presented in Figures 1 (S/B = 1/10) and 2 (S/B = 1/20); for each condition two of such distributions are shown. Both the raw data spectra of Fig. 1a) and c) and Fig. 2 a) and c) show up the 7.6 keV line and hints of the 4.6 keV one. In the background-subtracted spectra of Fig. 1 b) and d) for S/B = 1/10 and Fig. 2 b) and d) for S/B = 1/20, the 7.6 keV-peak is clearly visible. The 4.6 keV-peak is seen as well - less marked than the 7.6 keV-one.

## 3 Conclusions

The present study demonstrates that with 3 $pb^{-1}$ of collected luminosity and a signal to background ratio also as low as 1/20, the kaonic nitrogen 7.6 and

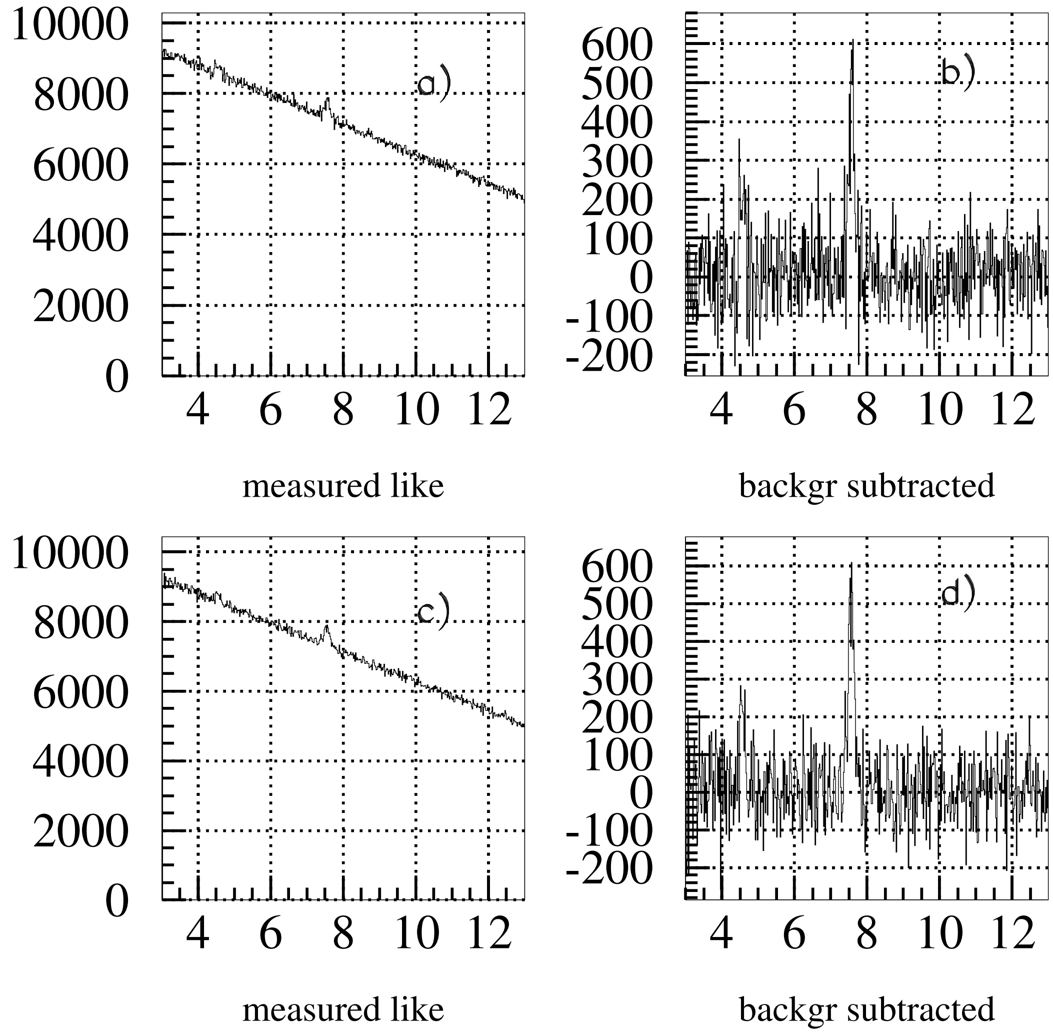


Figure 1: Experimental-like and background-subtracted distributions for the case of S/B = 1/10 and an integrated luminosity of 3 $pb^{-1}$. a) and c) are two experimental-like distributions, while b) and d) are the obtained background-subtracted distributions.

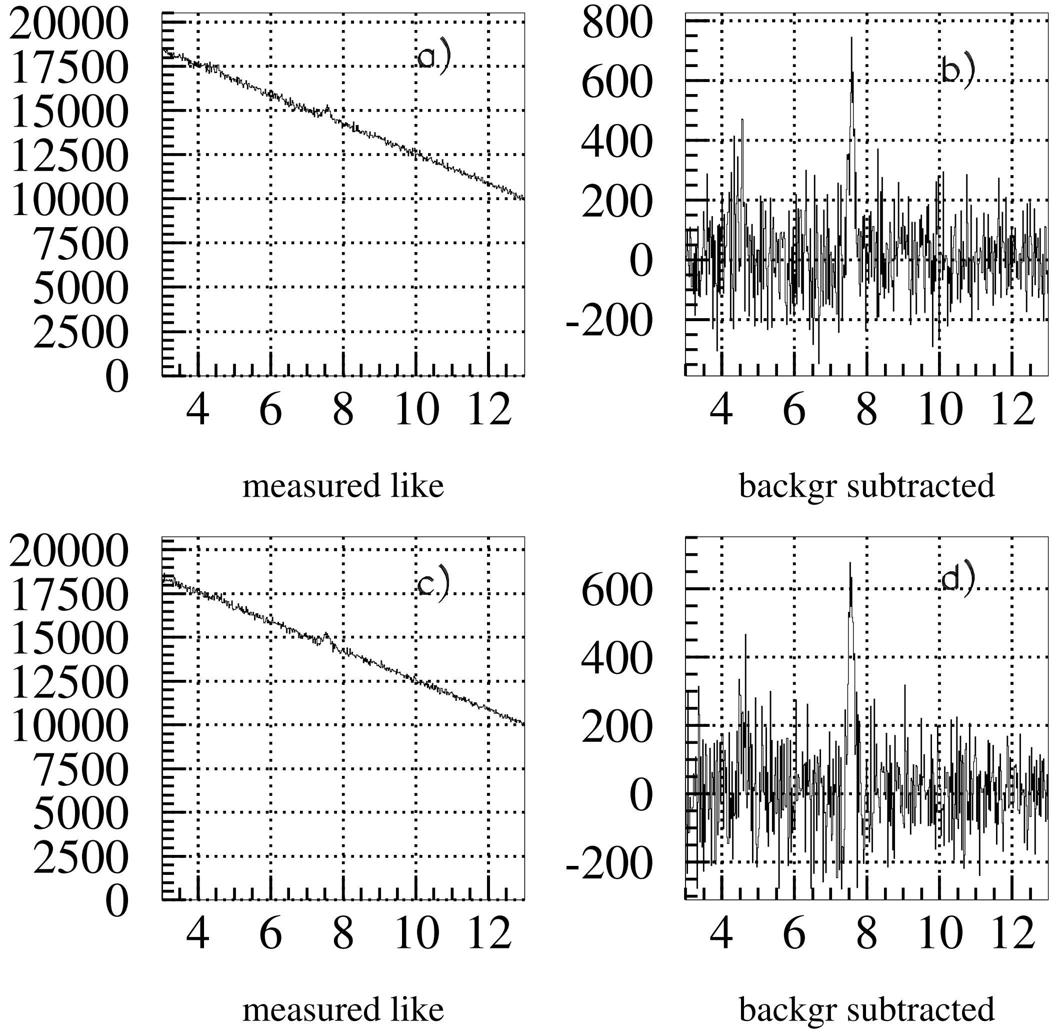


Figure 2: Experimental-like and background-subtracted distributions for the case of S/B = 1/20 and an integrated luminosity of 3 $pb^{-1}$. a) and c) are two experimental-like distributions, while b) and d) are the obtained background-subtracted distributions.

4.6 keV lines can be unambigously detected, provided that an appropriate background subtraction is performed, under the assumption of a good knowledge of its shape. This can be obtained by using the cryotarget setup filled by nitrogen at the equivalent pressure of 5 bars.

# References


[1] C. Petrascu, "DEAR Monte Carlo results for the cryogenic target setup filled with nitrogen", DEAR Technical Note IR-31, 06 November 2000.