DEAR Technical Note IR-23

Comparison of background measurements in the DEAR interaction region for collisions in KLOE in December 1999 and July 2000.

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1) Introduction

In the winter shutdown period 1999/2000 of the DAΦNE accelerator hardware changes were applied to the DAΦNE main rings; e.g. new kicker magnets were inserted along the rings, the magnets inside the KLOE solenoid were newly aligned. These changes allowed to tune the machine at a working point which could not be accessed before. Therefore a new study and comparison with pre-2000 data of the overall background situation in the DEAR interaction region was required.
The discussed measurements were performed with the shielded DEAR NTP setup without the lead walls on both sides of the interaction region.

2) Number of clusters / CCD / beamloss (mA)

In Table 1 the results for the **quantity "Number of Clusters per CCD divided by the Beamloss (mA)"** is given**. This quantity is normalized to the lost beam current and therefore compares the conditions of the beam, i.e. the beam quality**, at the CCD position in the DEAR interaction region. For other points along the rings the situation might be different.

Two different periods of data taking are compared.

1) July 2000 - electron and positrons colliding in the KLOE interaction point (I.P.)
2) December 1999 - electrons and positrons colliding in the KLOE I.P.

In both periods the beams were kept vertically separated in the DEAR interaction point.

Beam type	**Clusters /CCD / beamloss (mA)**
Collisions in KLOE, July 19, 2000	
19.7. - 1	510 ± 50
19.7. - 2	570 ± 60
19.7. - 3	550 ± 60
Mean value	**543 ± 40**
Collisions in KLOE, Dec.11, 1999	
Mean value	**175 ± 20**

Tab.1: The number of clusters / CCD divided by the beamloss (mA) is given for the two measurement periods.

It has been observed several times that if the time behaviour of the considered quantity is plotted for subsequent data taking periods, it is a constant. This shows the normalization with respect to the beams. Figure 1 shows the observed behaviour for two short beam periods on December 11, 1999.

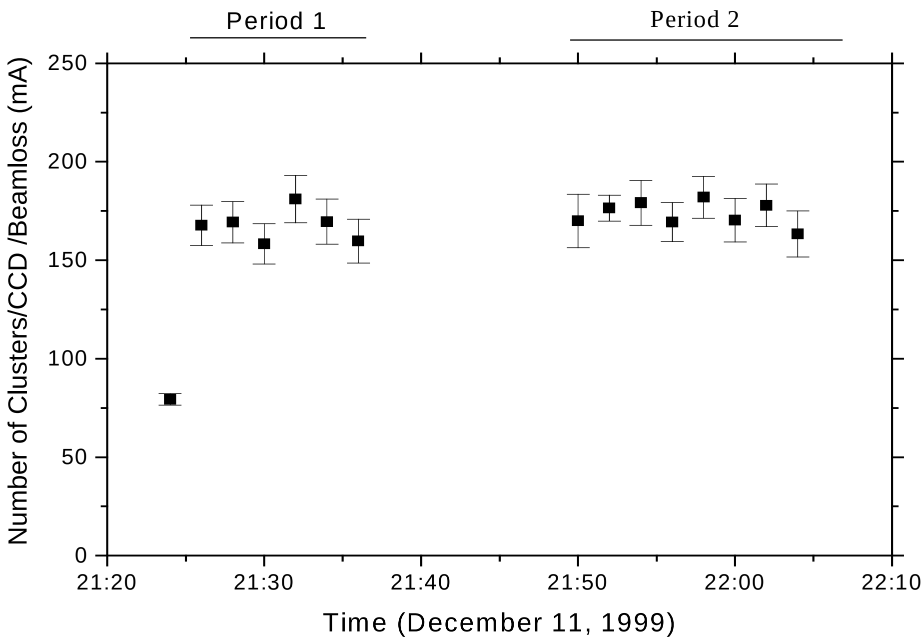

Fig.1: Number of clusters normalized to the beam loss, as measured on **December 11, 1999**. The measurement time for an individual CCD exposure was 2 minutes, which was short enough to have CCD **occupancies smaller than 5 %**.

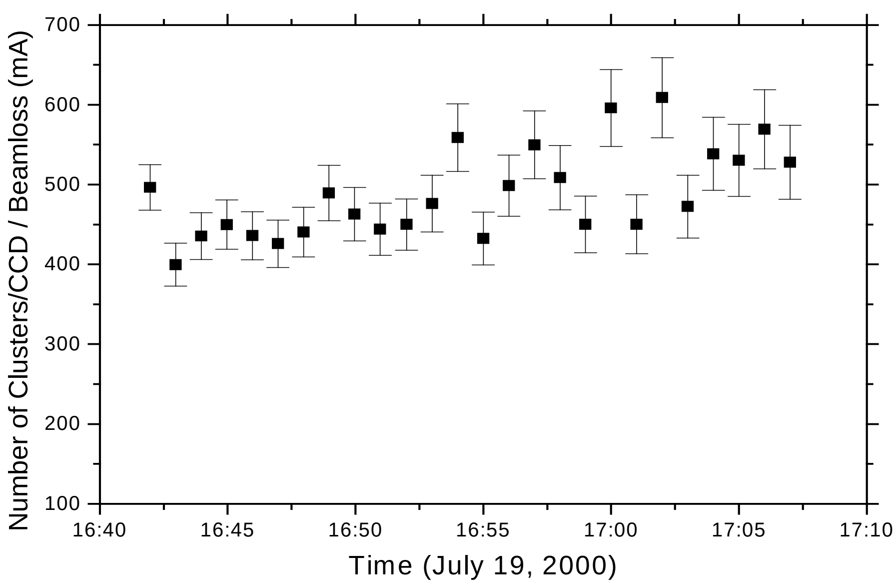

Fig.2: Number of clusters normalized to the beam loss, as measured on **July 19, 2000**. The measurement time for an individual CCD exposure was 1 minute allowing for **occupancies smaller than 10 %**.

The same measurements performed on **July 19, 2000** had to take into account that there was a higher background level immediately visible. Therefore one beam period was investigated with 1 minute measurements, others with 1.5 minutes measurements. 2 minutes resulted already in **occupancy levels of 10% - 15% or more**.

3) Observation of a saturation effect in background measurements of July 2000

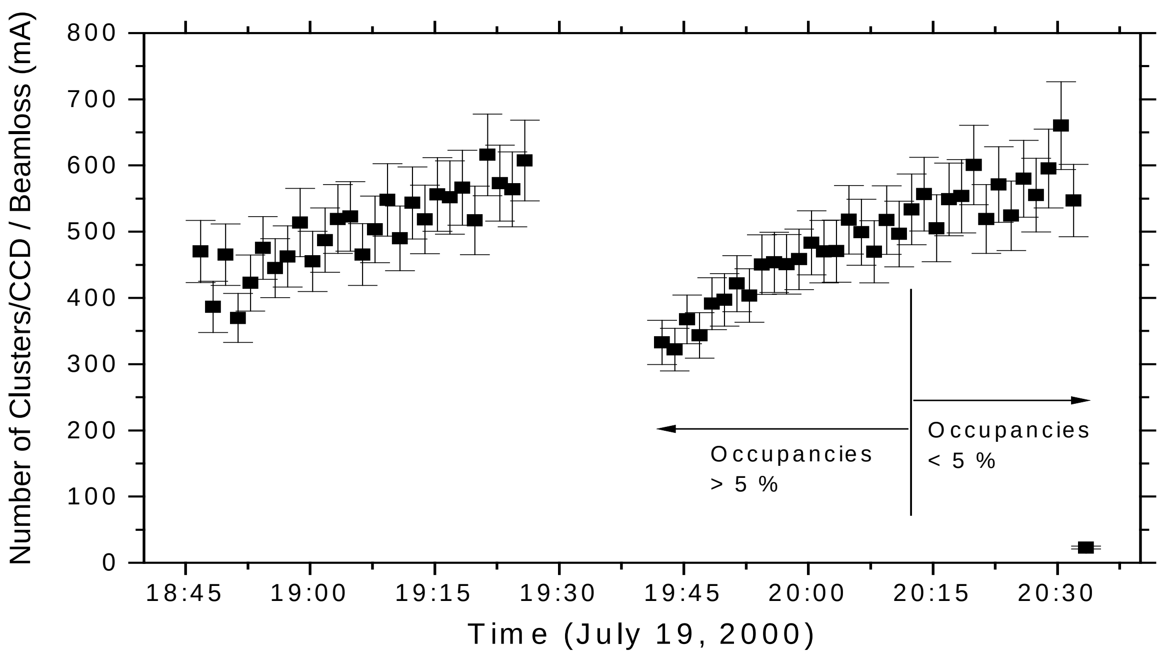

Fig.3: Number of clusters normalized to the beam loss, as measured on July 19, 2000. The measurement time for an individual CCD exposure was 1.5 minutes. 2 beamperiods are shown.

A saturation effect due to long or intense CCD exposure was observed already in [1] and extensively investigared in [2].

For the measurements of July 2000, shown in Figure 3, lasting 1.5 minutes clearly a time dependence is visible which is indirectly proportional to the beam currents and contradicts the earlier measured constant behaviour. But it can be easily explained by looking at the occupancies, which are between 5% and 10 %. This means that at the beginning of a measurement period one has already to take into account that the number of clusters is reduced by the effect of saturation, i.e. two neighbouring clusters cannot be separated anymore and are counted as single cluster only, therefore reducing the number of clusters counted in absolute. This effect is reduced at the end of a measurement where the occupancies are lower and therefore a constant time behaviour is observed. The mean values given in Table 1 are mean values extracted from the time periods of constant behaviour.

From the comparison of the background levels normalized to the beam losses between December 11 and July 19, one can extract a worsening of the background situation of a factor of 3 due to the intrinsic beam conditions.

4) Number of clusters /CCD/minute at specific beam currents

The number of clusters / CCD / minute measures the background due to particles and gammas arriving at the CCD detectors. It therefore reflects the real overall background which is relevant for the final measurements.

In Figures 3, 4 and 5 the background levels of December 11, 1999 and July 19, 2000 are compared.

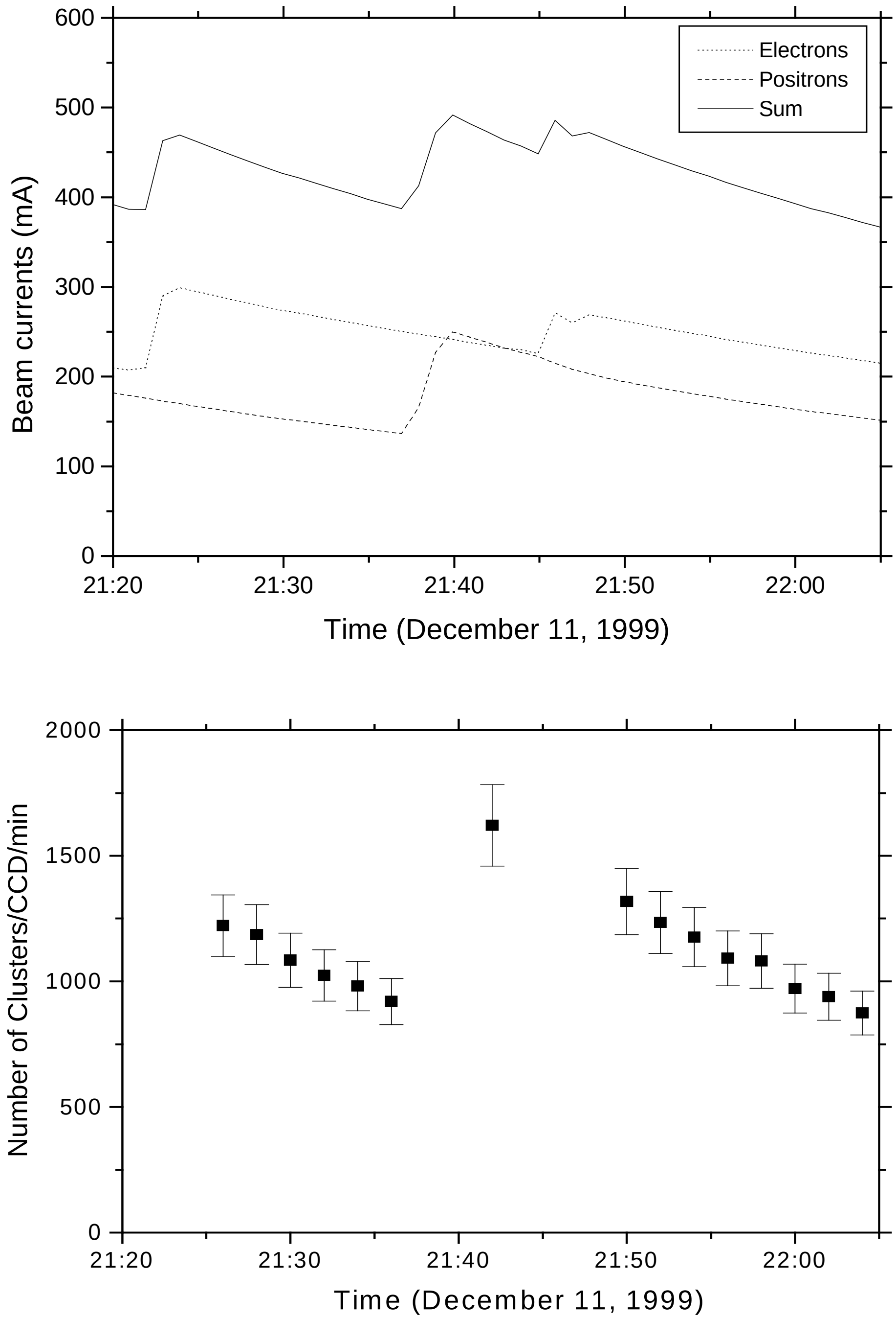

Fig.4: Comparison of the observed number of clusters per CCD per minute for two subsequent beam periods of December 11, 1999 with 2 minutes exposure time, together with the beam currents as given by the DAΦNE beam monitor.

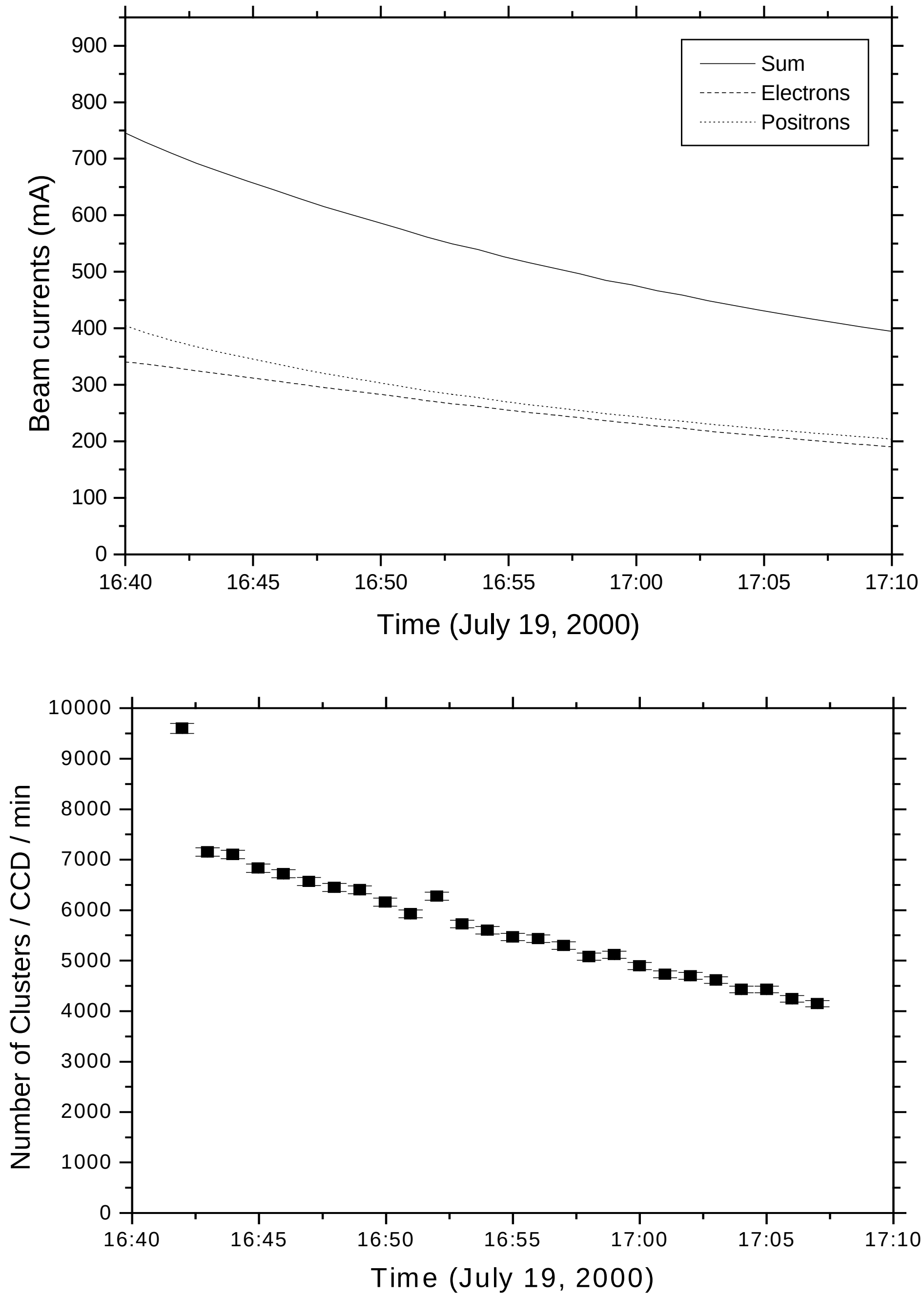

Fig.5: Comparison of the observed number of clusters per CCD per minute for the beam period of July 19, 2000 with subsequent 1 minute CCD exposures, together with the beam currents as given by the DAΦNE beam monitor.

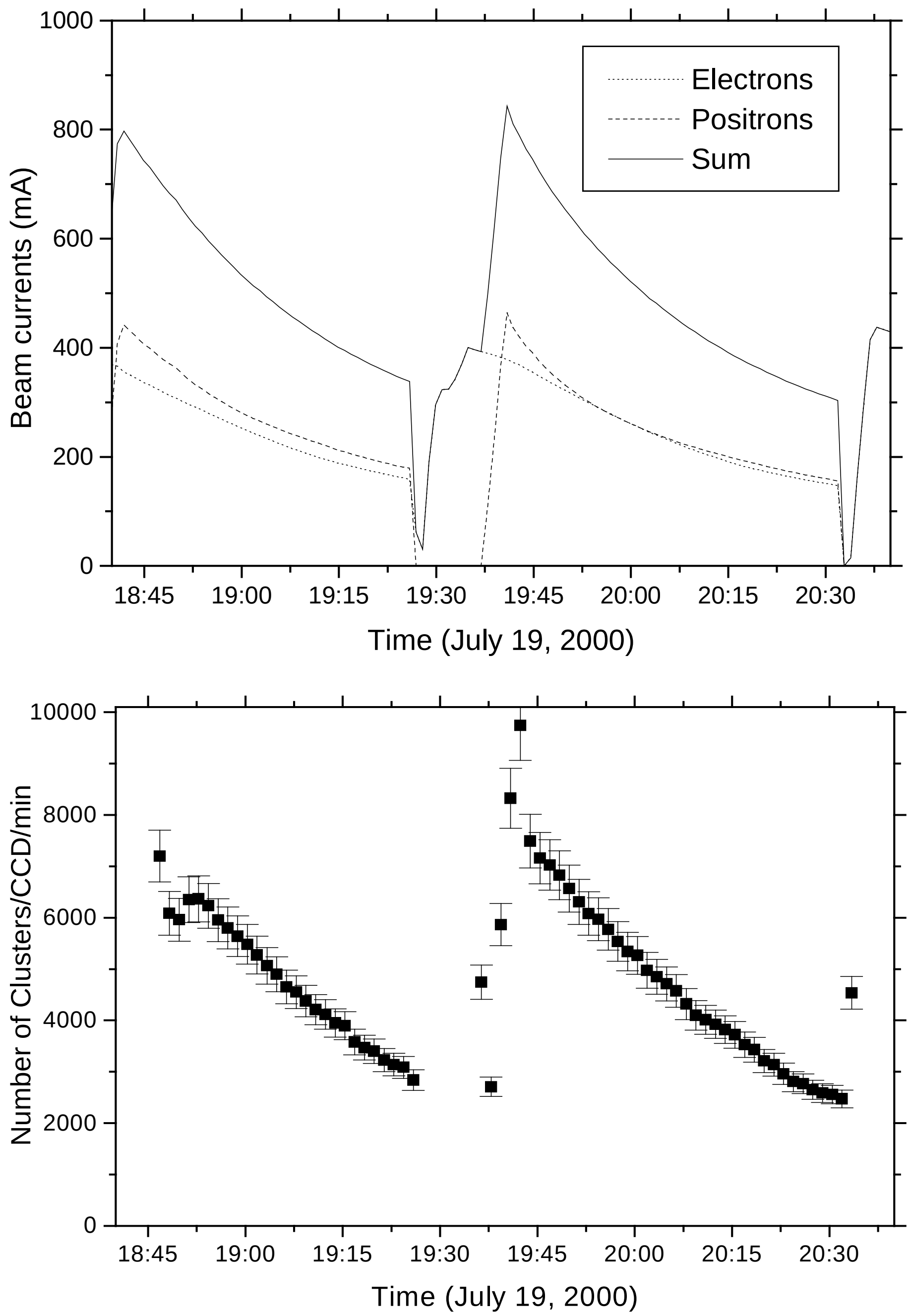

Fig.6: Comparison of the observed number of clusters per CCD per minute for two subsequent beam periods of July 19, 2000 with 1.5 minutes CCD exposure times, together with the beam currents as given by the DAΦNE beam monitor.

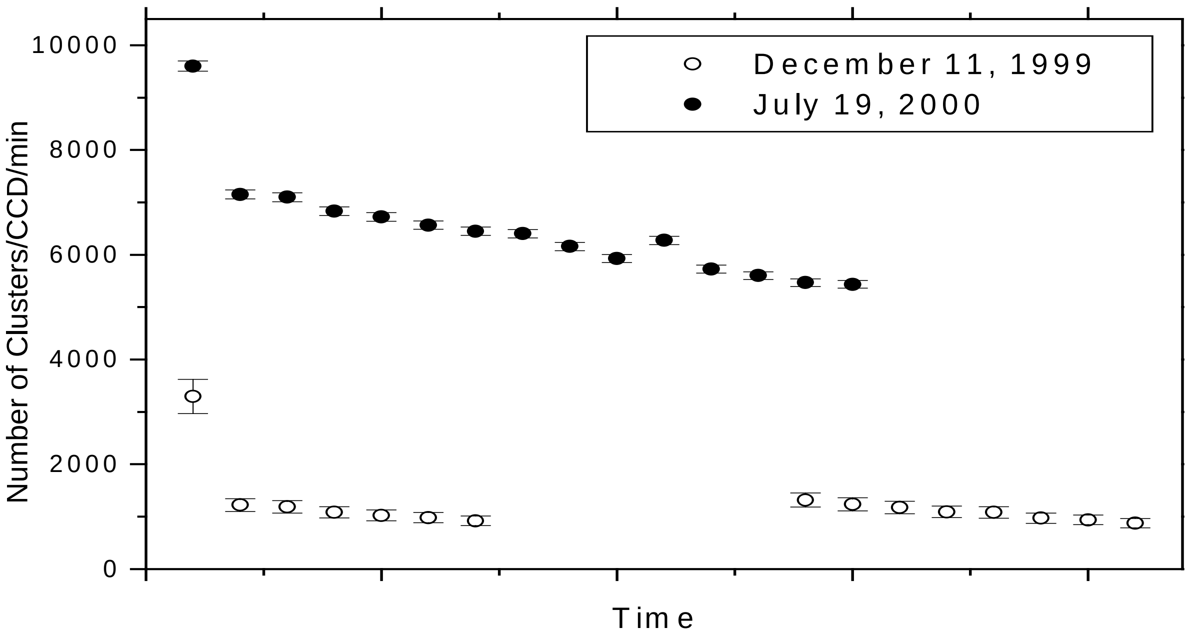

Fig.7: Comparison of the number of clusters per CCD per minute observed on December 11 and July 19.

Figure 7 shows a direct comparison of the number of clusters observed on December 11, 1999 and July 19, 2000. The observed difference is striking.

From the figures one can derive that on December 11, the number of clusters observed at a beam current of approximately 400 mA was about 1000 Clusters/CCD/min; on July 19, the corresponding measurement at a beam current of approximately 700 mA was 7000 Clusters/CCD/min and approximately 3000 Clusters/CCD/min at 400 mA. These results are reported in Table 2.

Date	Beam current (mA)	Number of Clusters /CCD/min
Dec. 11	400	1000
July 19	400	3000
July 19	700	7000

Tab.2: Observed number of clusters / CCD / min with the corresponding beam currents.

Comparing the two values at 400 mA, again the factor 3 difference in beam conditions is found. The higher background level for higher beam currents is easily explained by the fact that the beam loss scales proportional to the beam currents.

5) Summary

Comparing the background measurements done in the DEAR interaction region with electron and positron beams colliding in the KLOE I.P., performed on December 11, 1999 and July 19, 2000, one can find an increase in the overall observed background level in the DEAR interaction region, which can be attributed to three different contributions: 1) a change in beam currents,
2) beam lifetime at high currents and
3) beam conditions (quality).

For the highest observed beam currents the measured background increased by a factor of ~ 7, which consists of:
- a factor of ~ 1.7 due to an increase in beam currents (400 mA → 700 mA),
- a factor of ~ 1.35 due to a shorter beam lifetime at high currents and
- a factor of ~ 3 due to a change in beam conditions (quality).

References:

[1] M. Augsburger et al., "First measurements at the DAΦNE ϕ-factory with the DEAR experimental setup", LNF-99/32(P) (1999), Accepted for publication by Nuclear Instruments and Methods in Physics Research A.

[2] B. Lauss, "X-ray rate restriction in charge-coupled devices", DEAR Note-IR 25, to be published in Nuclear Instruments and Methods in Physics Research A.