**DAΦNE TECHNICAL NOTE**

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# Report on DAΦNE MD on 20 and 24/03/2006

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*Abstract*

Background measurements have been performed, evaluating the scrapers effectiveness by counting the KLOE calorimeter hot rates. These measurements have been performed at the end of KLOE data taking, and compared to 2002 measurements. A big increase of scrapers effectiveness is found, together with an overall background reduction.

## 1. INTRODUCTION

On 20th and 24th March 2006 beam lifetime and background measurements have been performed. They have been done in single beams with the standard dataset used for KLOE data taking, at a current of ~500 mA with 105 bunches.

At the beginning of KLOE and DEAR data taking, both experiments suffered from large induced background, mainly due to Touschek scattering. Tracking simulation studies, measurements and comparisons have been performed to reduce these background rates. Many actions have been undertaken to control the KLOE background rates, some of them are: the shape optimization of existing scrapers [1], the reduction of $\beta_x$ at the IP with the detuned lattice [2], the new KLOE IR with a doublet low-β configuration, the contemporary insertion of a shielding between the beam pipe and the low-β quads and the insertion of additional collimators in large dispersion regions [3] [4]. However, machine background reduction has been obtained also adiabatically, with smooth optics adjustments during the machine runs. The background rates as a function of luminosity during two typical KLOE run periods in June 2002 and November 2005 are shown in Fig. 1; the decrease of the slope for the last period of KLOE data taking is clear. It is not easy to quantify the single contributions to the total background rate reduction. We investigate here essentially the scrapers effectiveness in the machine configuration for the KLOE data taking. Performed measurements show that scrapers are now much more effective than in the past. Possible reason is vacuum improvements with high current operation and this process is slow. Moreover, adiabatic improvements to optics during data taking helped to optimize the scrapers effectiveness.

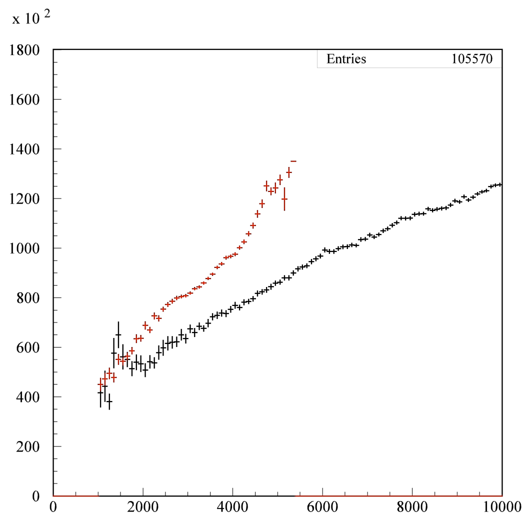


Figure 1: Average west and east hot rates (HZ) versus luminosity L($10^{28}$ $cm^{-2}s^{-1}$) during two typical KLOE runs in June 2002 (red) and November 2005 (black).

## 2. BEAM LIFETIME AND TRANVERSE SIZE

Beam parameters related to backgrounds are mostly lifetime and beam sizes. We firstly measured these parameters both to find the correct scaling of the background rates with current and to better compare results with older measurements performed in other machine configurations. Beam lifetimes and transverse dimensions have been measured without scrapers in a single beam configuration.

Completely different behaviour has been found for the electrons and positrons lifetime. Figure 2 shows the measured lifetime as a function of the beam current for the two beams. It appears that the lifetime is constant with current for the positron beam, while for the electron beam it decreases quadratically with the current. This is a clear indication that many different effects contribute to lifetime.

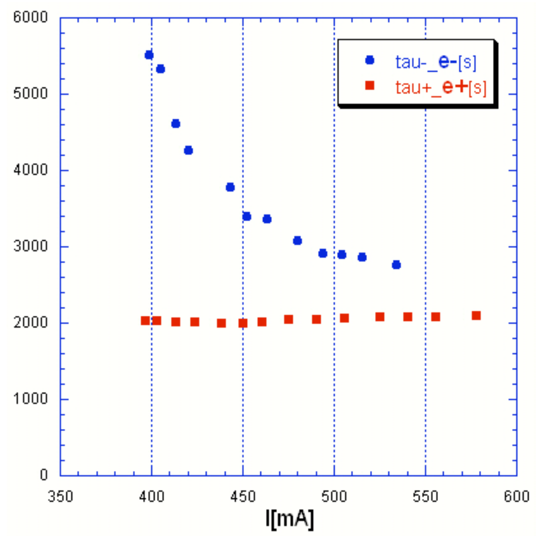


Figure 2: Electron (blue) and positron (red) lifetime without scrapers as function of the beam current.

The transverse beam sizes of the two beams have been measured at the synchrotron light monitor (SLM) in single beam operation and without scrapers. The beam roundness $R=\sigma_y/\sigma_x$ is shown in Fig. 3 as a function of the current. A different behaviour of R versus I is found for the two beams. In fact, R increases with I for the positron beam, while it decreases for the electron beam. Moreover, for the positron beam the increase with R is quite linear, while for electrons it looks like there is a step at $I^- \sim 420$ mA (see blue dots in fig 3). Comparing the two beams at I=500 mA, $R^+$ is greater than $R^-$ by a factor 1.8.

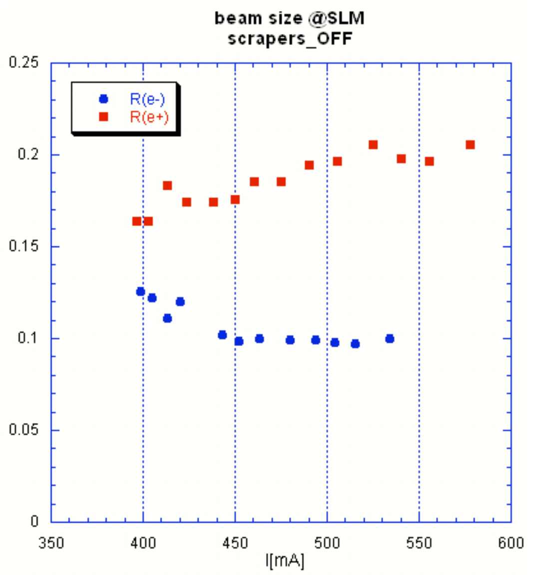


Figure 3: Beam roundness $R=\sigma_y/\sigma_x$ without scrapers for the e- and e+.

The horizontal (left) and vertical (right) beam sizes measured at the SLM are reported in Fig. 4 as a function of beam current. It appears that the electrons are larger horizontally and smaller vertically with respect to positrons, thus resulting $R^-$ smaller than $R^+$.

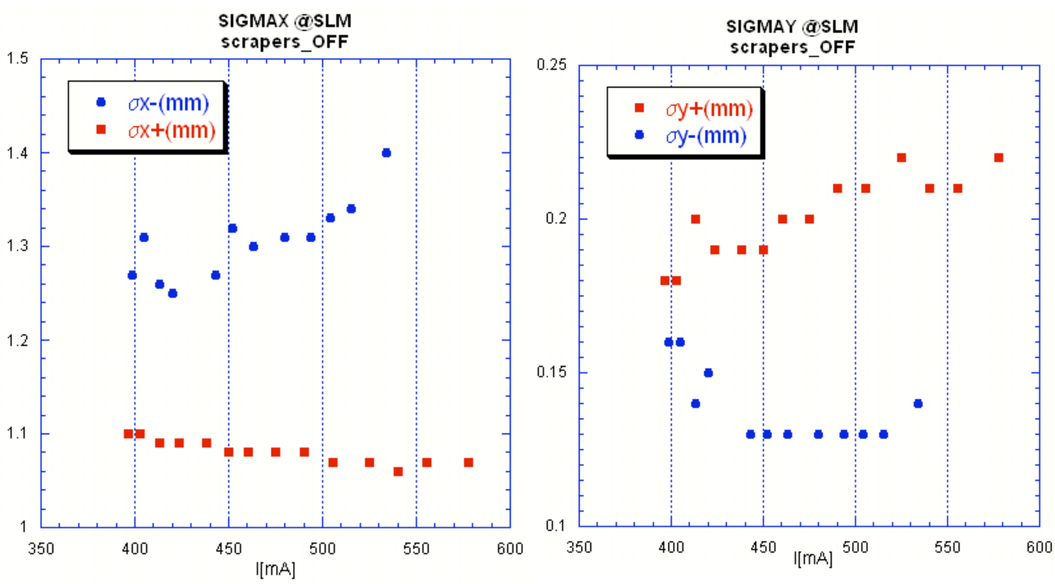


Figure 4: Horizontal (left) and vertical (right) beam size at the SLM for the two beams as a function of beam current.

## 3. SCRAPER SCANS

The first measurement for the scrapers effectiveness consisted in counting the hot rates with and without the whole set of scrapers used during KLOE runs. Comparison of hot rates with on/off scrapers has been done at the same beam conditions, that is: same current, lifetime and transverse size. Table 1 summarizes this measurement for electrons (upper) and positrons (lower).

The ratio of calorimeter rates without and with the insertion of scrapers is a factor 20 for electrons and a factor 49 for positrons. This is the overall effectiveness of scrapers. We can also observe from table 1 that lifetime does not change much at scrapers insertion.

Moreover, without scrapers hot rates produced by the positron beam are almost a factor 4 higher than those produced by the electron beam. However, as scrapers result more effective for the positron beam, with scrapers inserted hot rates related to positrons are only a factor 1.5 higher than electrons.

Measurements of on/off scrapers performed in 2002, right after the installation of the additional ones close to wigglers, evidenced an efficiency of a factor 3 for positrons and 7 for electrons [4]. The same efficiency was found in single and colliding beams operation.

Table 1: Scrapers on/off measurement with 105 bunches and $I_{bunch}$~ 5mA in single beam operation.

| electrons | I(mA) | $\sigma_y / \sigma_x$ | $\tau$(s) | ECM2(KHz) |
|---|---|---|---|---|
| All scrapers off | 474 | 0.11 | 3561 | 252.3 |
| All scrapers on | 461 | 0.10 | 3125 | 12.5 |

| positrons | I(mA) | $\sigma_y / \sigma_x$ | $\tau$(s) | ECM2(KHz) |
|---|---|---|---|---|
| All scrapers off | 524 | 0.187 | 2378 | 946.4 |
| All scrapers on | 524 | 0.185 | 1959 | 19.4 |

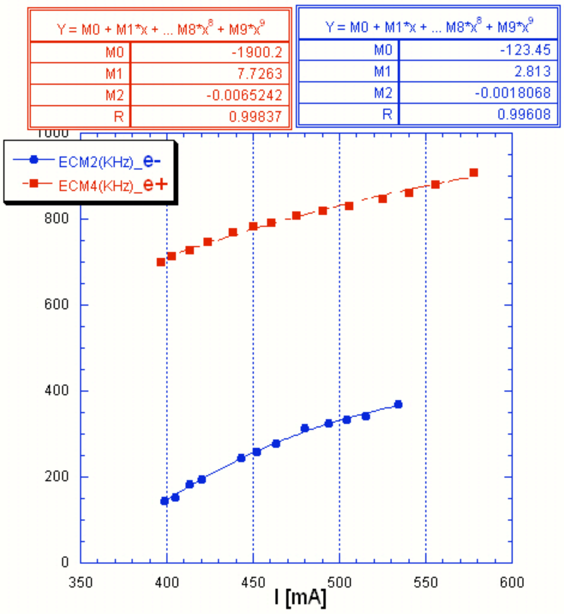


Figure 5: Rates of the two KLOE forward calorimeters ECM2 and ECM4 as a function of the beam e- and e+ current, respectively.

In the following subsections single scraper scans for the two beams are presented. Rates of the two forward calorimeters in KLOE are taken as a function of the opening of the horizontal external and internal scrapers along the rings. The two rates from the calorimeters ECM2 and ECM4 integrate the signals over the four innermost sectors of the west and east forward calorimeters each. ECM2 counts events coming from Touschek scattered electrons, ECM4 counts events coming essentially from positrons. These counting rates depend not only on the scraper position, but also by the beam current. The current normalizations used for the hot rates have been found experimentally, by measuring ECM2 and ECM4 without scrapers as a function of the current (see Fig. 5). These normalization has been used for the scrapers scans discussed below.

A layout showing the scrapers position along the main rings is reported in Fig. 6.

As shown in the following, scrapers behaviour is different with respect to first past KLOE runs. In fact, they are now very efficient: most of them are at their maximum inner position, reducing continuously hot rates at calorimeter; scrapers never reduce lifetime and never enhance backgrounds.

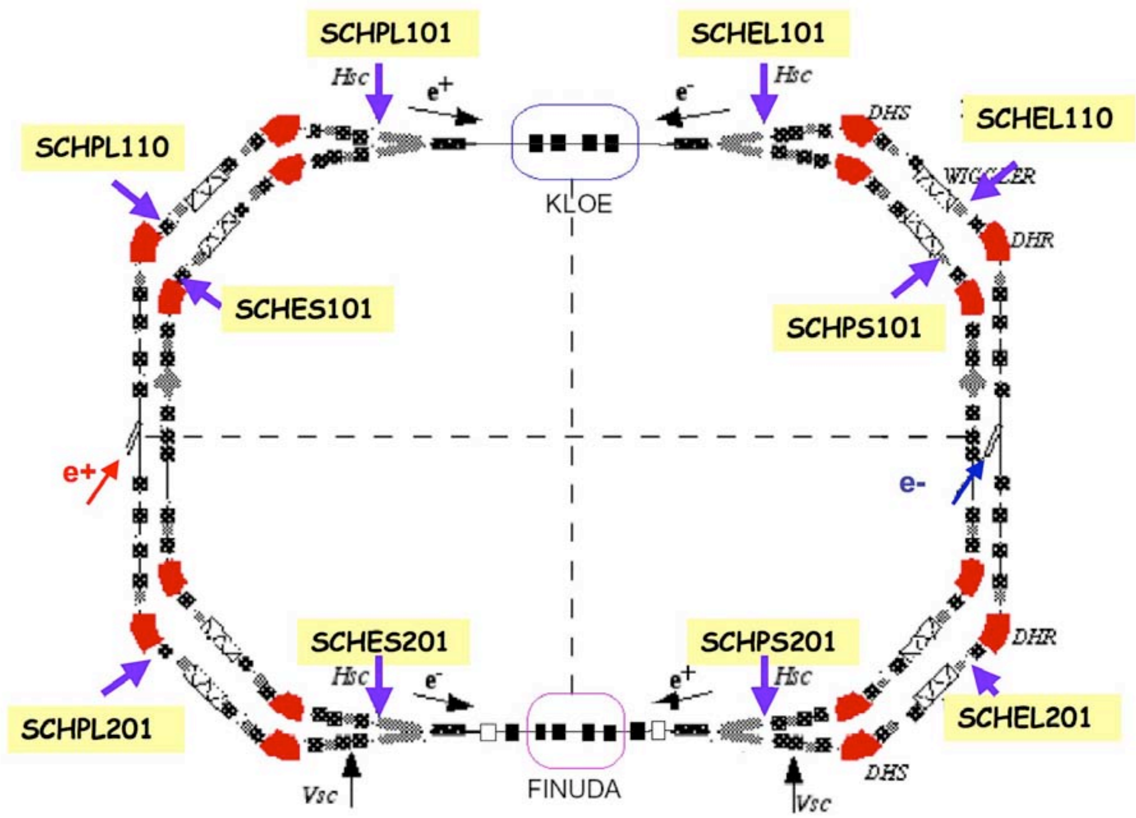


Figure 6: Layout of all the scrapers positions in the two main rings.

### 3.1 Scans with Positrons

The normalized hot rates of the KLOE forward calorimeter are shown in Fig. 7 as a function of the opening of the external and internal jaws of the horizontal scrapers around IP1 (SCHPL01) and SCHPL110 (see Fig. 6). Lifetime is also plotted. The scraper openings are measured from the central beam axis. As all the scrapers jaws are inserted, background is reduced and lifetime is kept constant.

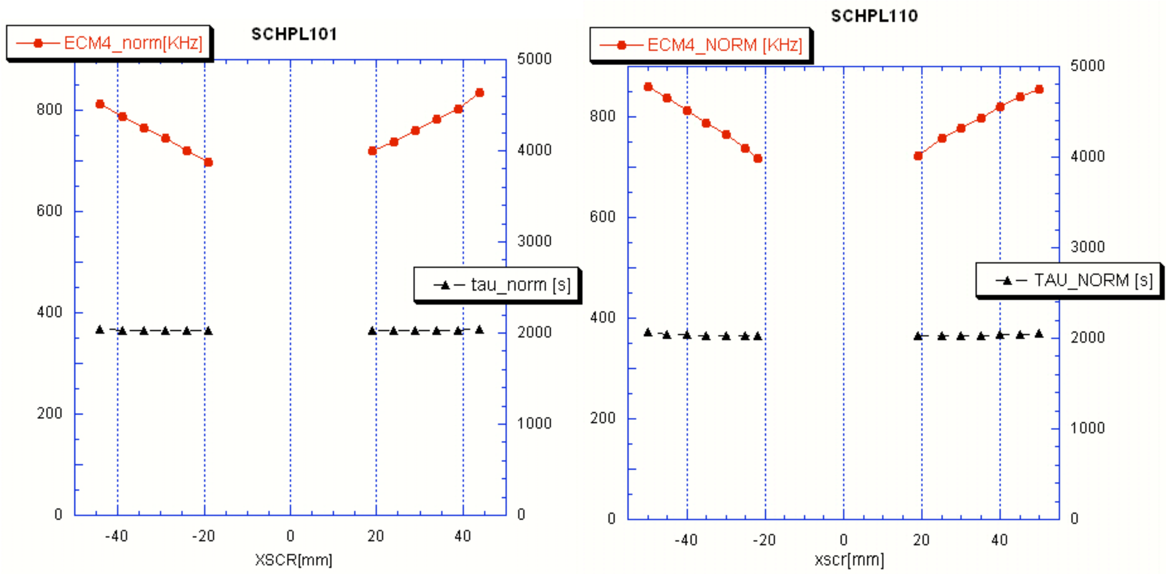


Figure 7: Scan of the background rate in the KLOE forward calorimeter ECM4 as function of the opening of the external and internal jaws of the positron scrapers SCHPL101 and SCHPL110 in single beam operation (red dots). Corresponding beam lifetime is also shown (black triangles). The scraper openings are measured from the central beam axis.

### 3.2 Scans with Electrons

Same scans have been performed for the electron beam. The behavior of scrapers SCHEL101 and SCHEL201 is shown in Fig. 8, while the behavior of scrapers SCHES201 and SCHEL110 is given in Fig. 9; their position in the ring is shown in Fig. 6.

In all these measurements the scrapers jaws reduce background rates.

In particular, the internal jaw of scraper SCHEL110 results to be very effective and with the chosen normalization background is reduced almost to zero.

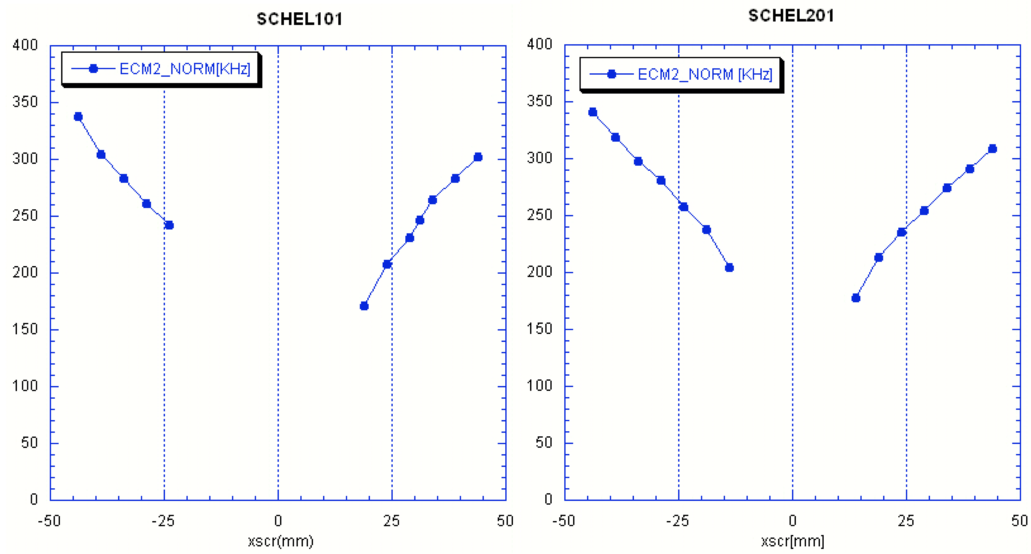


Figure 8: Scan of the background rate in the KLOE forward calorimeter ECM2 as function of the opening of the external and internal jaws of the electron scrapers SCHEL101 and SCHEL201 in single beam operation.

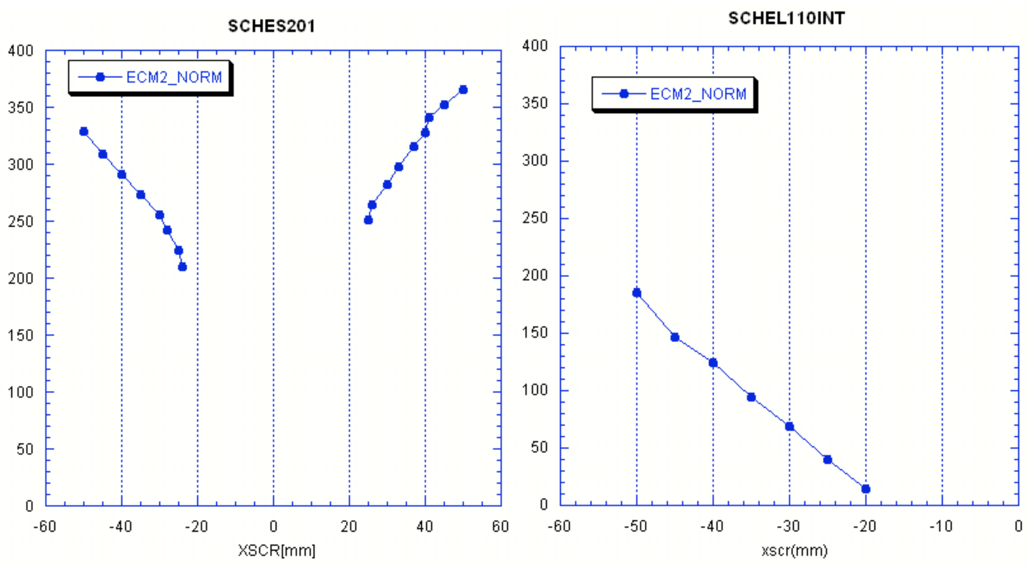


Figure 9: Scan of the background rate in the KLOE forward calorimeter ECM2 as function of the opening of the external and internal jaws of the electron scraper SCHES201 in single beam operation. SCHEL110 has only the internal jaw; it is very efficient.

## 4. CONCLUSIONS

In the two dedicated days of measurements 20 and 24 March 2006 scrapers efficiency resulted to be 95% for the electron beam and 98% for the positron beam. These measurements are in a better agreement with simulations, which predicted an overall efficiency of 99.4% [3] [4], with respect to the ones performed right after their installation. In fact, measurements of on/off scrapers performed in 2002 evidenced an efficiency of a factor 3 for positrons and 7 for electrons [4]. The same efficiency was found in single and colliding beams operation. This indicates that the smooth optics adjustments during the machine runs have been useful. A slow process of scrapers cleaning during the high current runs might have also been useful.

Moreover, if we compare the KLOE calorimeter counting rates in collision at same currents during a typical run in June 2002 (close to the installation of the additional scrapers) and in last November 2005 (last period of data taking), we find out that background has been reduced by 40% during this period. This gain is due to adiabatic optimizations of scrapers position, and to smooth optics adjustments during the machine runs.

## 5. REFERENCES

[1] M.Boscolo, S.Bertolucci, C.Curceanu, S.Guiducci and G.von Holtey, “Experience with beam induced backgrounds in the DAFNE detectors”, proc. of PAC01, Chicago, USA, June 2001.

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