Photon reflectivity from Al vacuum chamber of DAΦNE

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Darâne is an electron–positron collider with 1.02 GeV center of mass energy. For each circulating beam the maximum design current is 5A at an average dynamic pressure of 1 nTorr. The simulations predict severe e-cloud induced beam instabilities in the positron ring for the design parameters. Such calculations did not include the use of realistic parameters, such as chamber geometry, measured secondary electron yield, reflectivity and photon yield of the vacuum chambers walls, etc.

Conclusions

With these measurements we gave quantitative estimations of the reflectivity and photon yield of the vacuum chamber walls material of Darâne. These values are very useful to make realistic simulations of the e-cloud build up and therefore to prevent beam instabilities.

Reflectivity simulations

The reflectivity has been simulated, using the online software of Berkeley Lab. (http://www.lbl.gov/optical-films/software-constants), considering an Al substrate covered by a 30nm thick contaminant layer. The contaminant chosen are carbon (in no particular form) and aluminium oxyde. The reflectivity was measured in forward direction (0°-45° geometry, specular reflected light) at three different incidence angles using monochromatic light from 10eV to 1000eV.

Photon yield measurements

$$PF = \frac{N \text{ emitted electrons}}{N \text{ incident photons}} \times \frac{n_e(E)}{n_i(E)}$$

The number of incident photons $$n_i(E)$$ is given by the photodiode current; the total number of emitted electrons $$n_e(E)$$ is given by the measure of the drain current of the sample.

It is possible to calculate the number of photons produced by the electron beam in Darâne and reflected by the Al vacuum chamber walls.

From the reflectivity measurements made with monochromatic light, it is possible to estimate the reflectivity of the white light (all photon energies).

<table>
<thead>
<tr>
<th>Incidence angle</th>
<th>Integrated reflectivity</th>
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</thead>
<tbody>
<tr>
<td>85°</td>
<td>24%</td>
</tr>
<tr>
<td>45°</td>
<td>0.3%</td>
</tr>
<tr>
<td>5°</td>
<td>0.1%</td>
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</tbody>
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The total photon yield is obtained by integration of the values measured with monochromatic light. For all the three incidence angle the value is $$PF = 0.2$$. The synchrotron photon flux at the bending magnet of Darâne has been calculated assuming an electron energy of 500MeV, bending magnet field 1.2T and a beam current 1A.