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SYNCHROTRON RADIATION ANALYSIS OF THE SUPERKEKB POSITRON STORAGE RING

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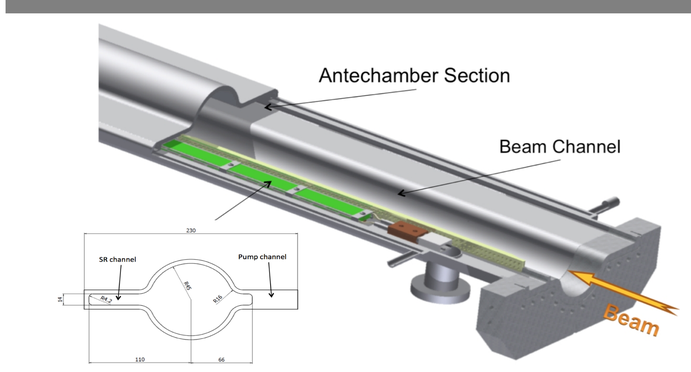
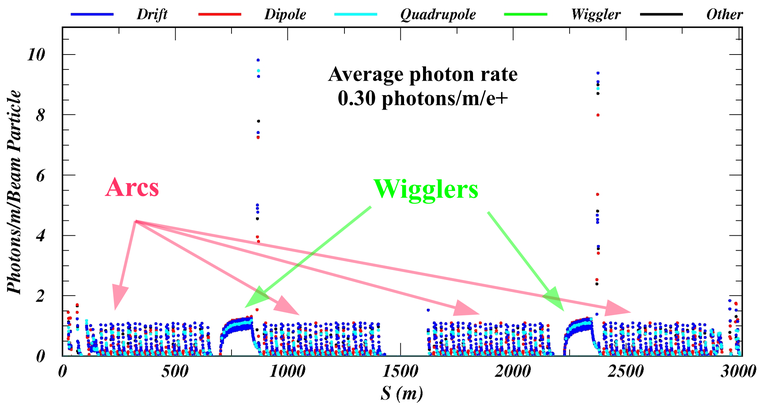
Abstract

We report on modeling results for synchrotron radiation absorption in the SuperKEKB storage ring vacuum chamber including the effects of photon scattering on the interior walls. A detailed model of the geometry of the inner vacuum chamber profile, including roughness parameters, has been developed and used as input to a photon tracking code. Particular emphasis is placed on the locations of high absorbed power in the wiggler magnet regions and on the photon rates in the electron-positron interaction region.

Vacuum chamber design in the arc regions



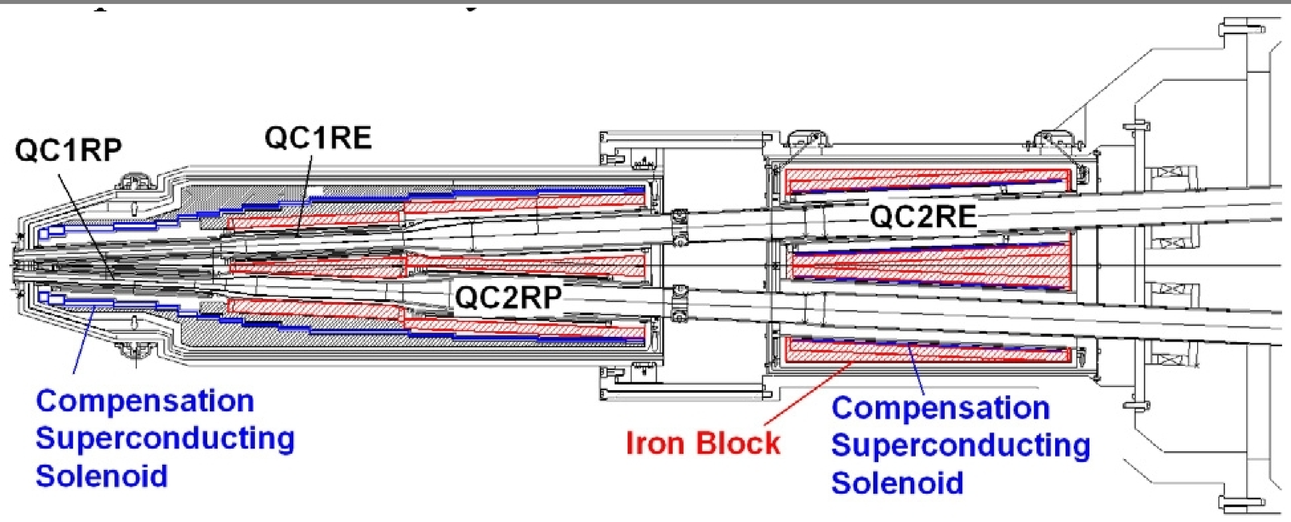
Synchrotron radiation photon rates incident on outside wall in mid-plane ignoring reflection and scattering



Synchrotron radiation photon absorption rates around the entire positron ring including the effects of reflection and scattering

These photons produce photoelectrons, seeding electron clouds !

Final-focus quadrupoles in the positron ring upstream of the interaction point
The QC1RP magnet extends from 0.76 m to 1.1 m from the IP



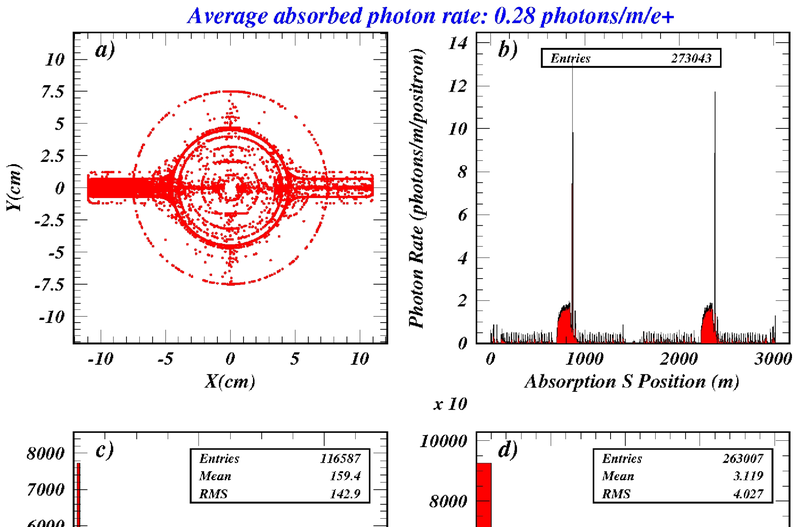
The rate of photons absorbed in the IR is of special concern for electron cloud buildup in regions where the beta functions are large such as the final-focus region, where the vertical beta function reaches values greater than 3000 m.

The figure below shows the characteristics of scattered and reflected photons absorbed within 10 m of the IP. The rate is particularly high in the region of the QC1RP magnet just upstream of the IP, higher than in the wiggler regions of the ring.

The 5-cm-diameter mask near the IP prevents photons from hitting the wall in the downstream region from 1 m to 7 m from the IP, but there is a small rate of photons absorbed in the QC1LP magnet.

The design of the final focus magnet system includes 8 superconducting magnets located within 3 m of the IP. The figure below shows characteristics of photons absorbed the magnet closest to the IP in the positron ring on the upstream side, the 334-mm-long QC1RP magnet, the center of which is located 935 mm from the IP. The design field gradient in this quadrupole magnet is 68.7 T/m. The analytic calculation of the synchrotron radiation incident on the beam pipe wall, and the photon scattering model with scattering turned off, each find a low rate of incident photons of about 0.04 photons/m/e+ originating in an anti-bend magnet 5 m upstream of QC1RP. With photon scattering enabled in the model, the absorbed photon density increases by a factor of nearly 30 to 1.25 photons/m/e+, comparable to the maximum rates reached in the arcs.

Average absorbed photon rate: 0.28 photons/m/e+



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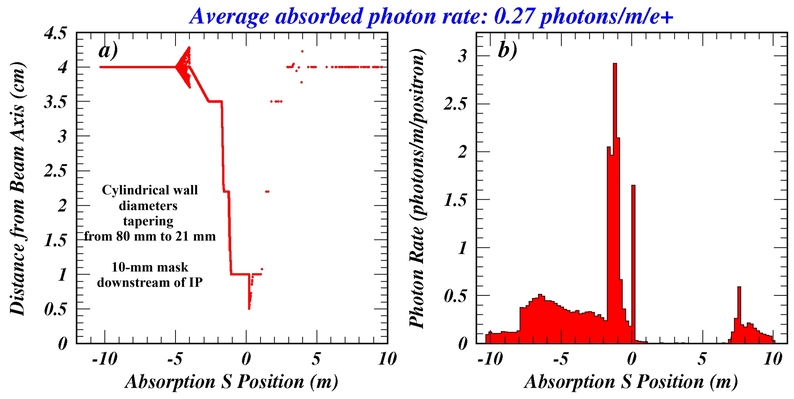
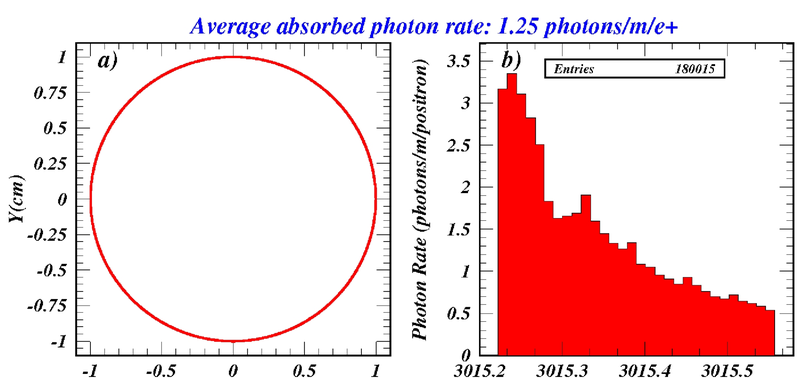
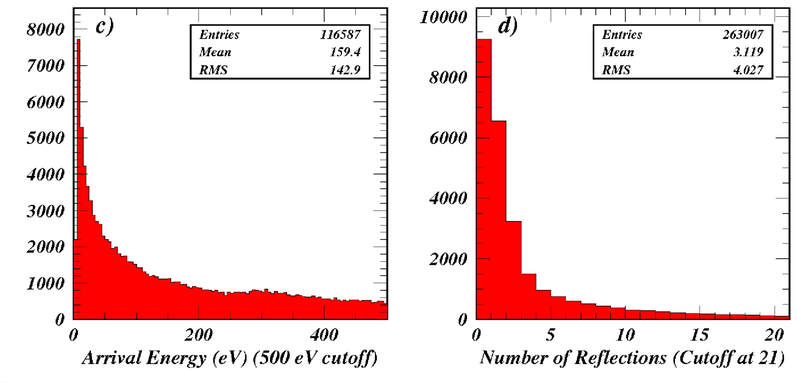
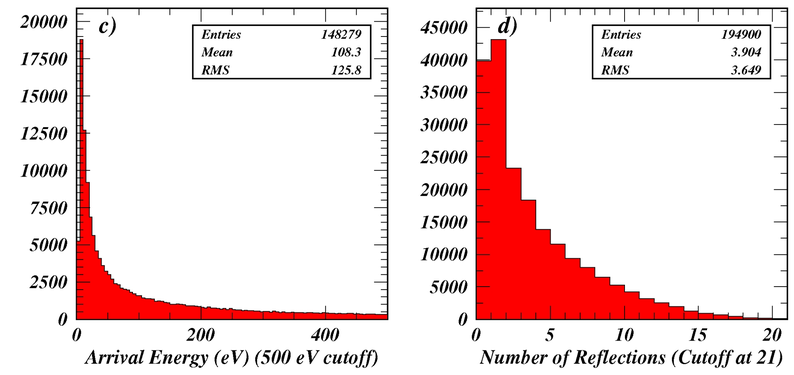
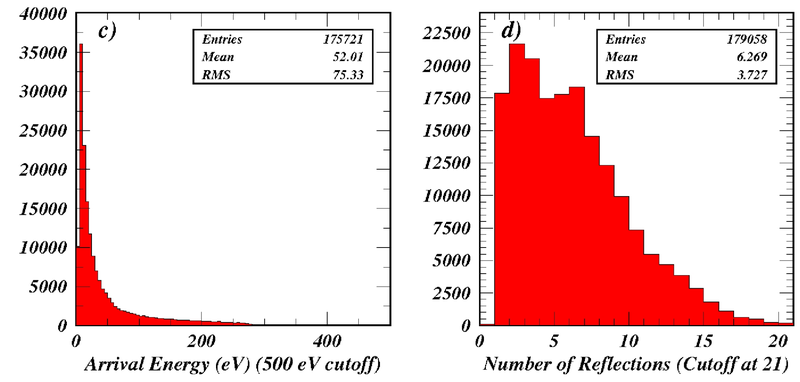


Average absorbed photon rate: 1.25 photons/m/e+









Summary

We have applied the X-ray photon tracking and scattering/absorption code Synrad3D to the positron ring of the SuperKEKB e+e- collider. When the effects of photon scattering are thus taken into account, the rate of absorbed photons is comparable to the incident rate of photons without scattering effects at the level of about 50%. However, the calculated rate of absorbed photons is dramatically higher in regions where no light hits the walls directly, such as near the IP. We find that the predicted rate for photon absorption within 10 m of the IP is comparable to the ring-averaged rate. In the particular case of the upstream final-focus quadrupole nearest the IP, the modeled rate is found to be 1.25 photons/m/e+, which is about half the rate in the wiggler regions and comparable to the highest rates reached in the arcs of the ring. An initial study of the consequences of such a rate of absorbed photons for electron cloud buildup in the final-focus quadrupoles is contributed to these proceedings (TUPTY079).

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