MULTIPACTING IN HOM COUPLER OF LCLS-II 1.3 GHZ SC CAVITY

NAPAC2016
Chicago, IL, USA
October 9-14, 2016

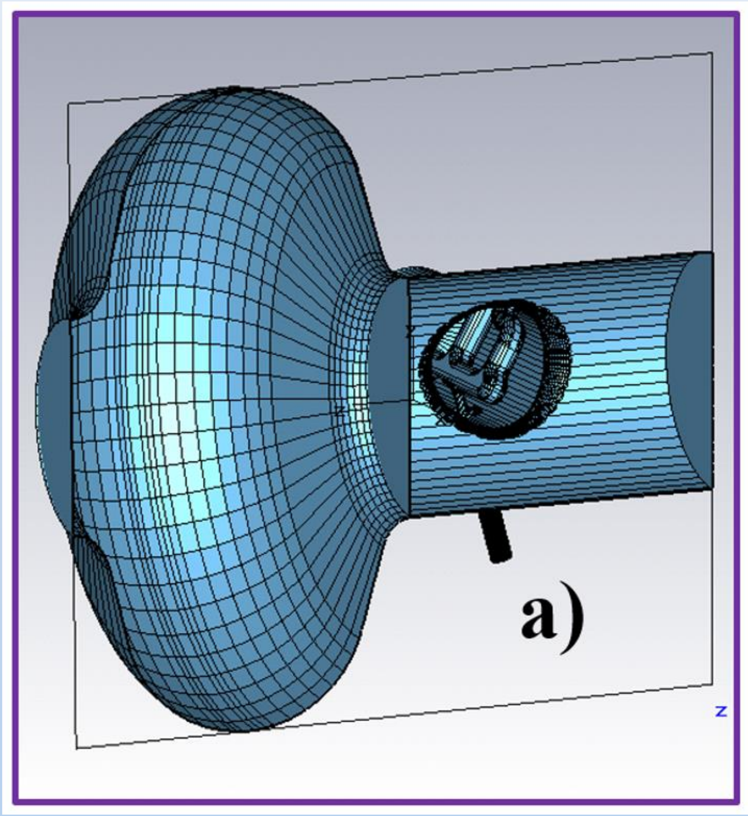
Gennady Romanov, Andrei Lunin, Timergali N. Khabiboulline,
Fermilab, Batavia, Illinois, USA

Fermilab

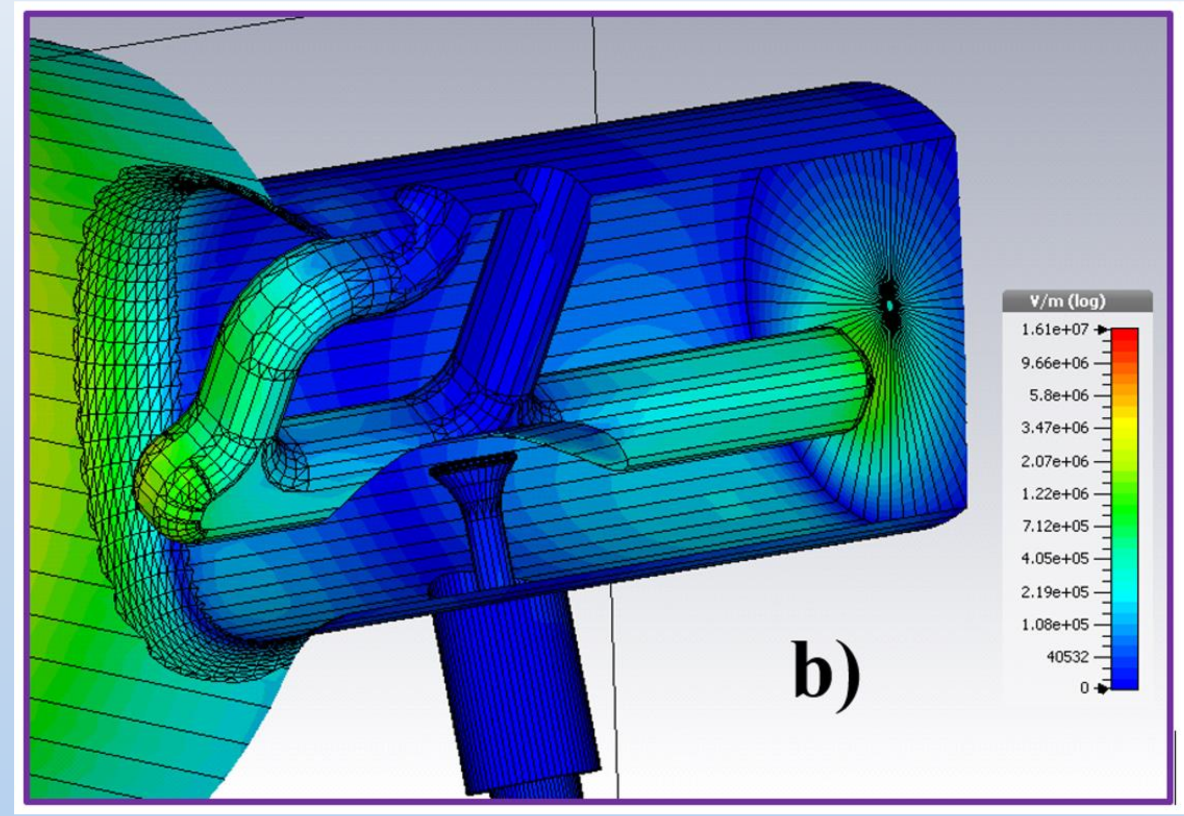
Abstract

During high power tests of the 1.3 GHz LCLS-II cavity on the test stand at Fermilab an anomalous rise of temperature of the pickup antenna in the higher order mode (HOM) coupler was detected in accelerating gradient range of 5-10 MV/m. It was suggested that the multipacting in the HOM coupler may be a cause of this temperature rise. In this work the suggestion was studied, and the conditions and the location, where multipacting can develop, were found.

Fields in the models



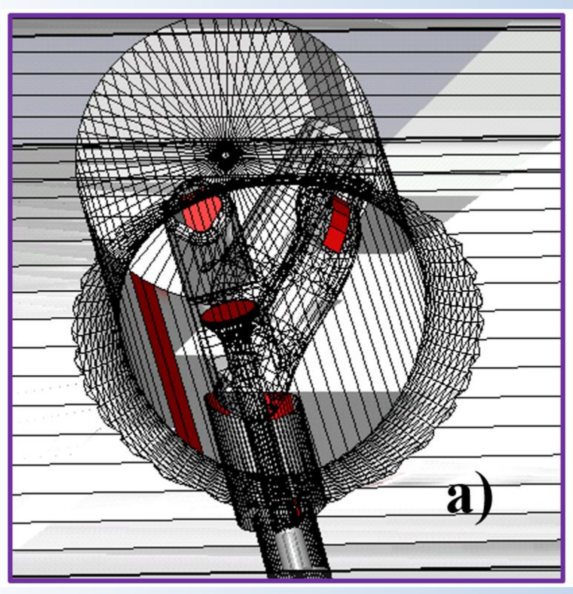
Eigenmode model of HOM coupler.

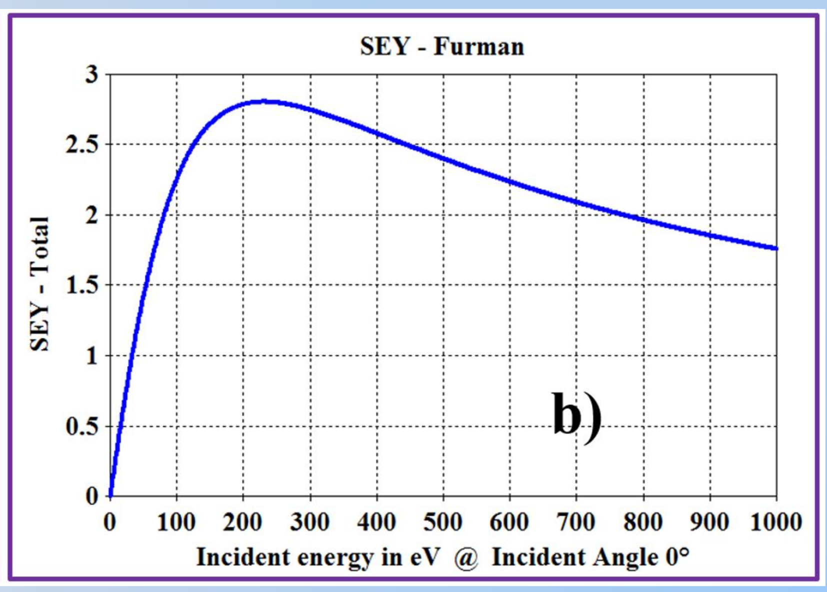


RF electric field imported into PIC solver.

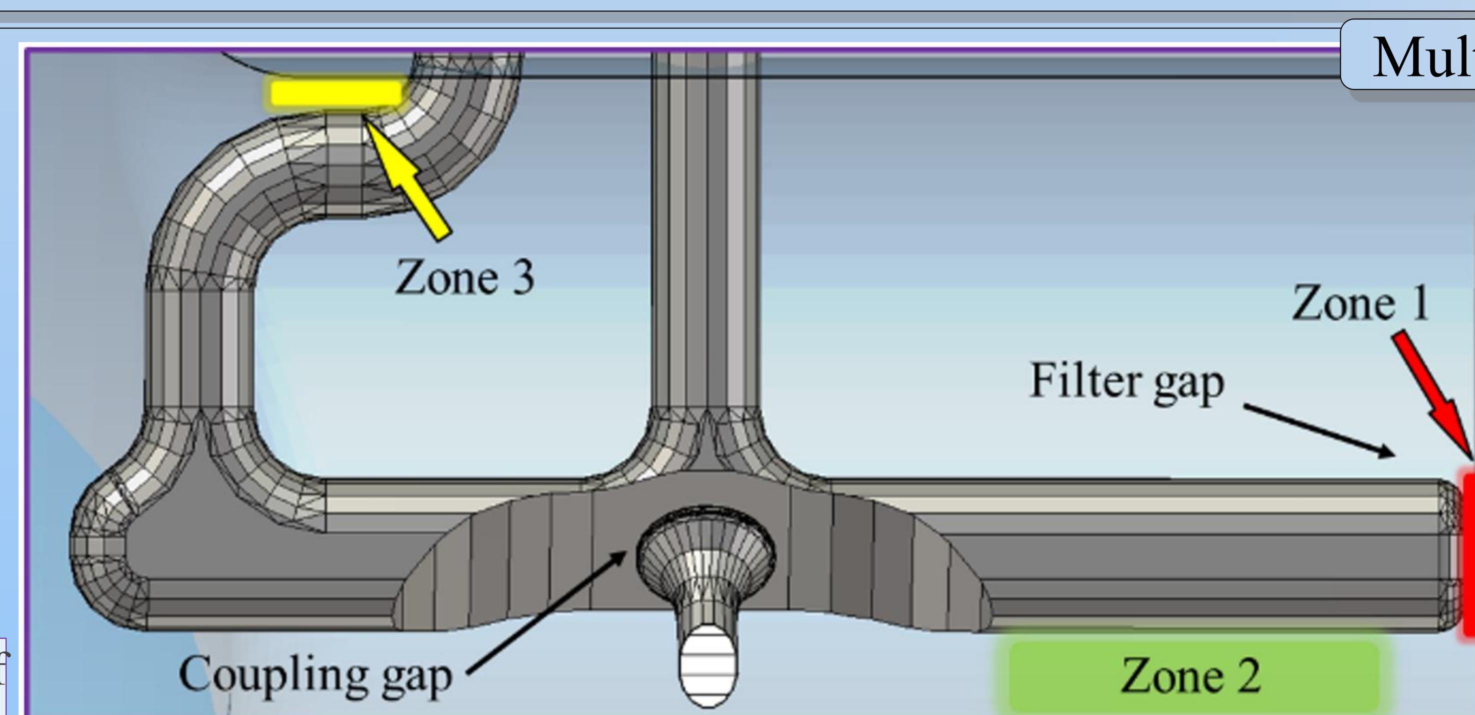
The simulations of multipacting were performed with the use of CST Studio Suite. The electromagnetic fields inside the coupler were calculated by eigenmode solver. Then the properly scaled fields were imported into PIC solver.

Multipacting in the known zones



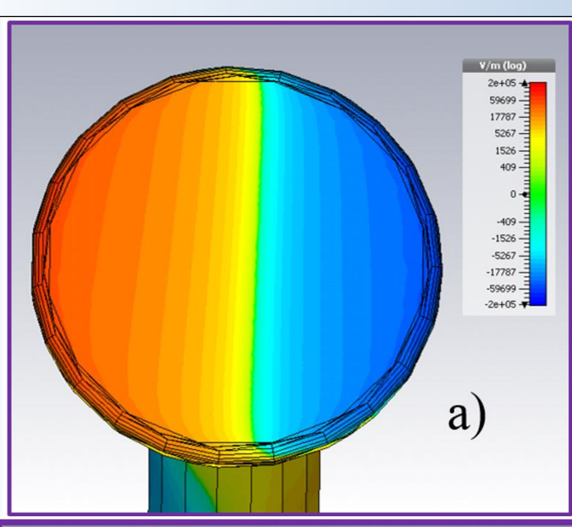


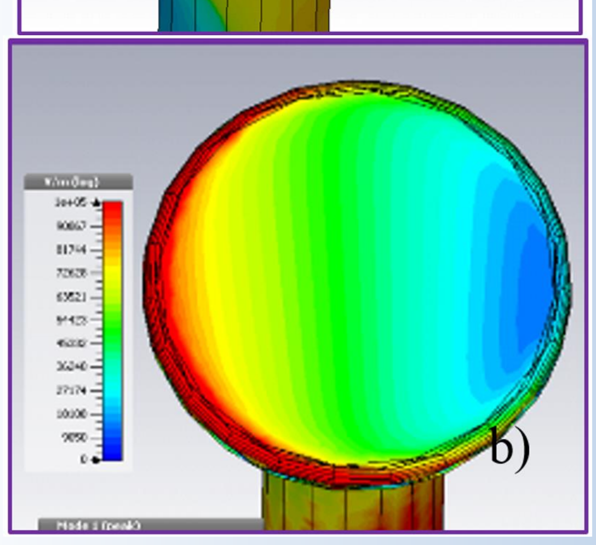
The sources of primary electrons were placed in all possible locations of multipacting. Secondary emission yield curve is for wet treated niobium.



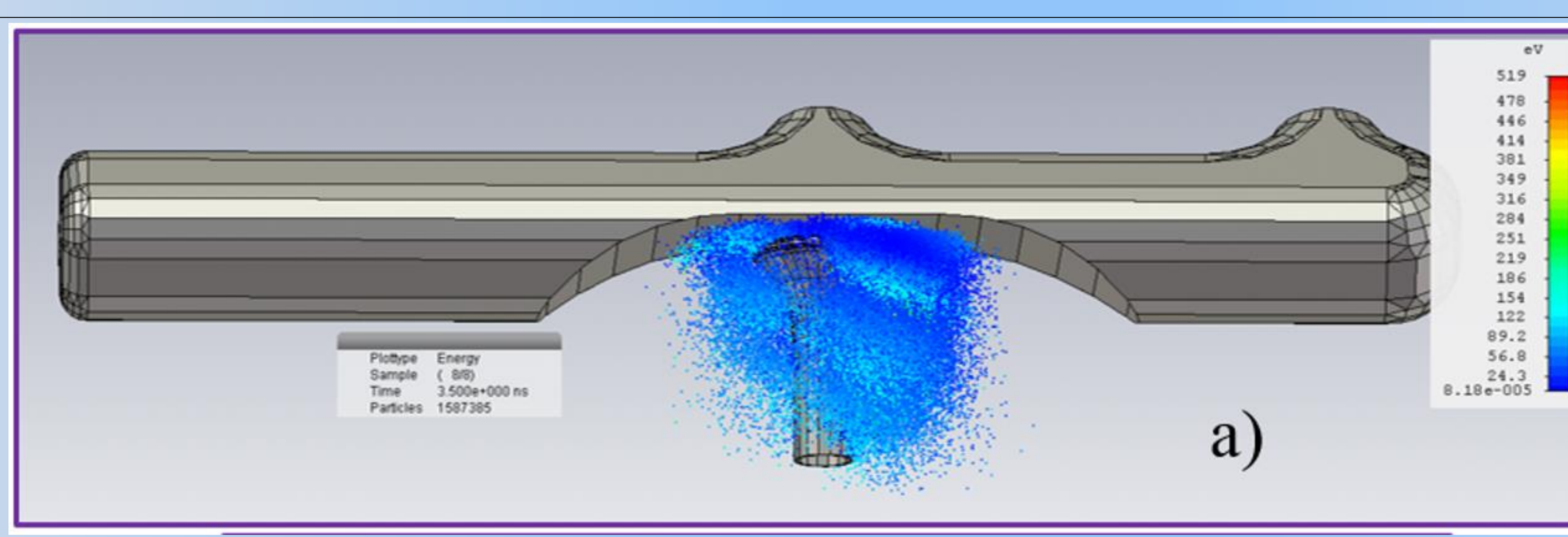
Secondary emission from multipacting in these well known zones 1,2 and 3 do not generate sufficient power deposition on the pickup antenna that could explain thermal runaway during high power tests. Less than 0.1% of total collision power falls on the antenna from these multipacting sites.

Multipacting in the coupling gap

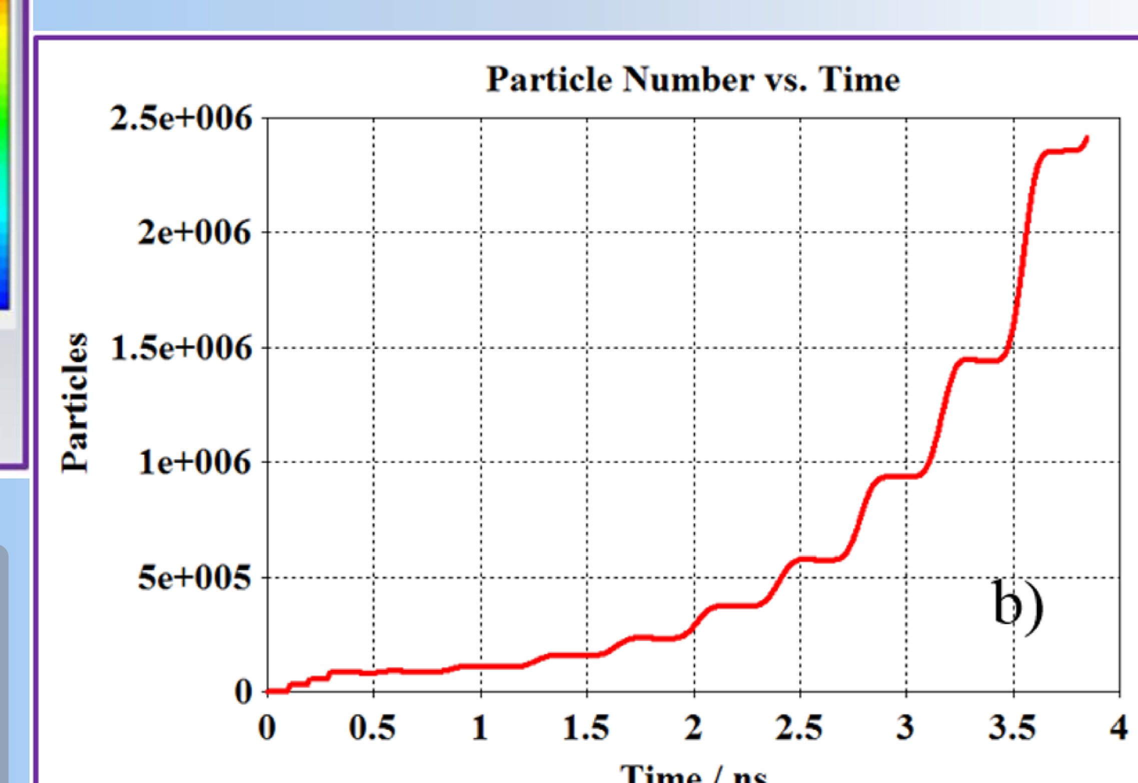




Distribution of electric field component normal to surface on the antenna tip for properly tuned coupler a) and detuned coupler b).

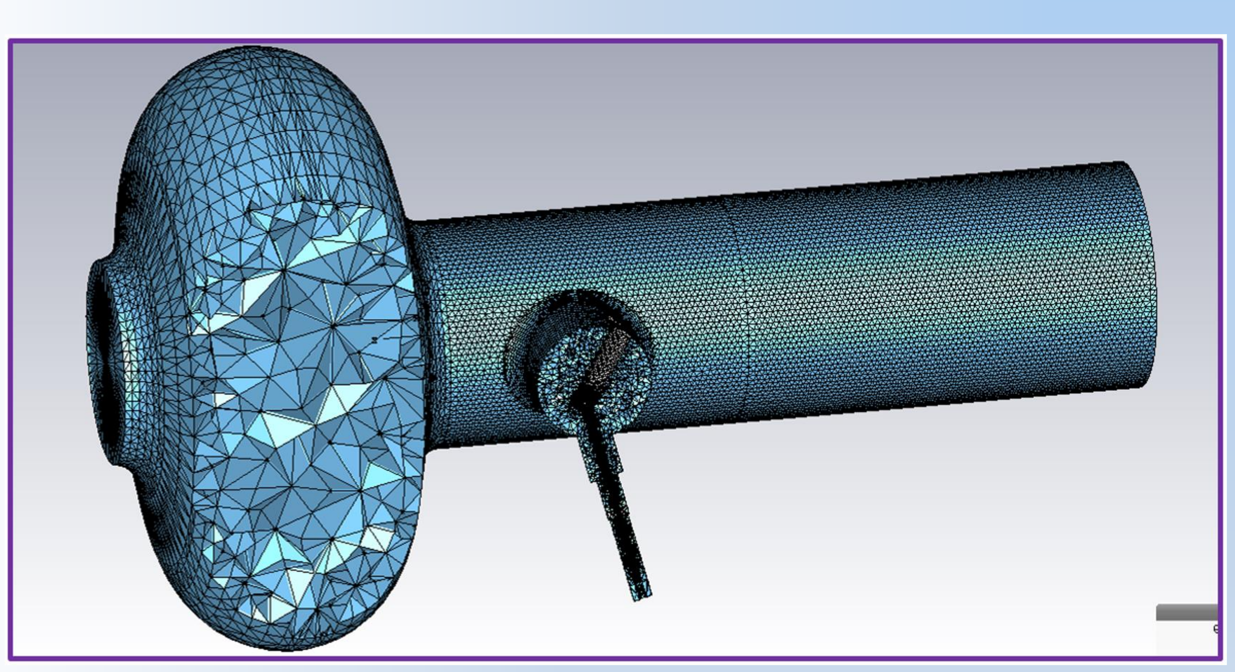


The MP process that could explain the antenna heating would be multipacting directly in the coupling gap. But normally for nominal gap size of 0.5 mm there is no conditions for multipacting, since parameter f·d < 80-90 MHz·cm. On the other hand, parameter f·d is very sencitive and exceeds the threshold already at d=0.615 mm. It is possible that such small deviation can happen due to inaccurate assembly or misalignment. Additionally a deviation of the filter gap size from optimal value redistribute the fields and increases uniformity and average level of electric field component normal to the antenna tip surface.

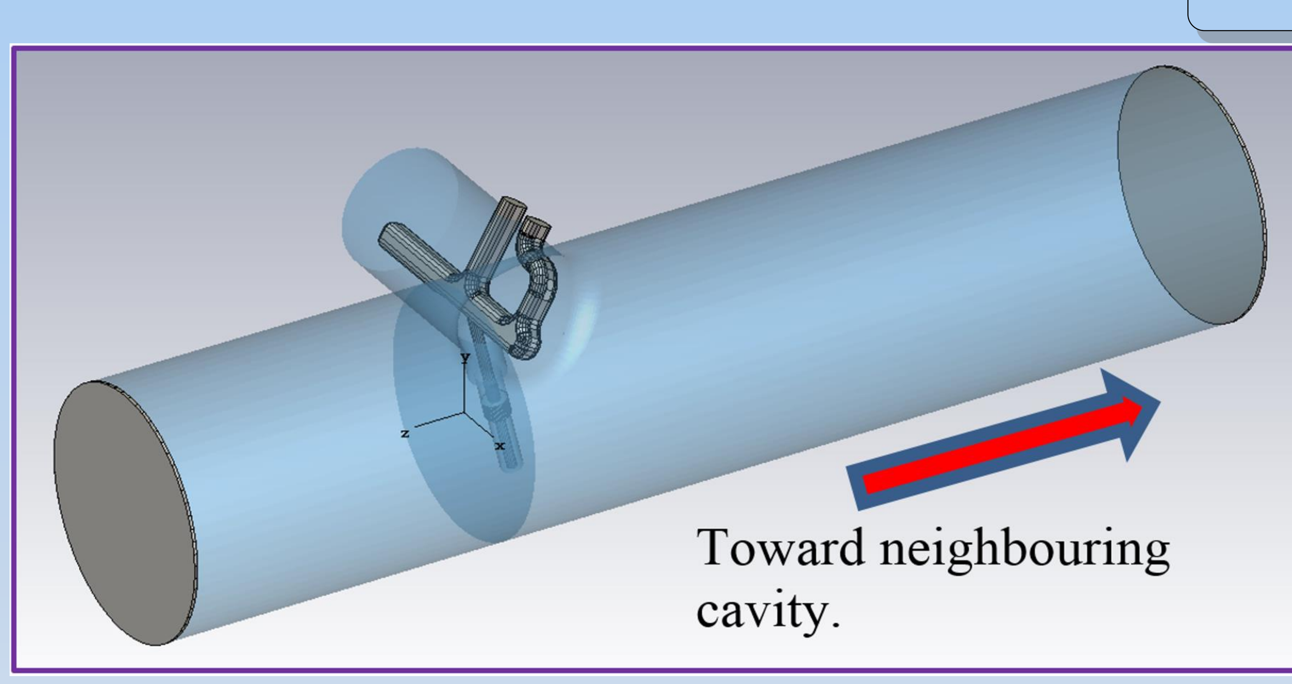


Particle number vs time at the accelerating gradient of 12.7 MV/m for properly tuned coupler.

On dark current generation



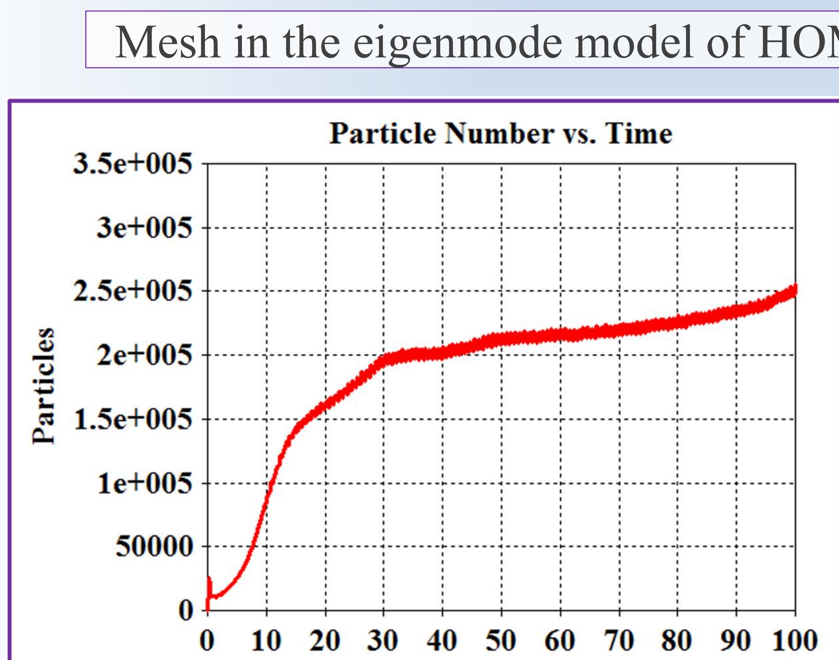
Mesh in the eigenmode model of HOM coupler.



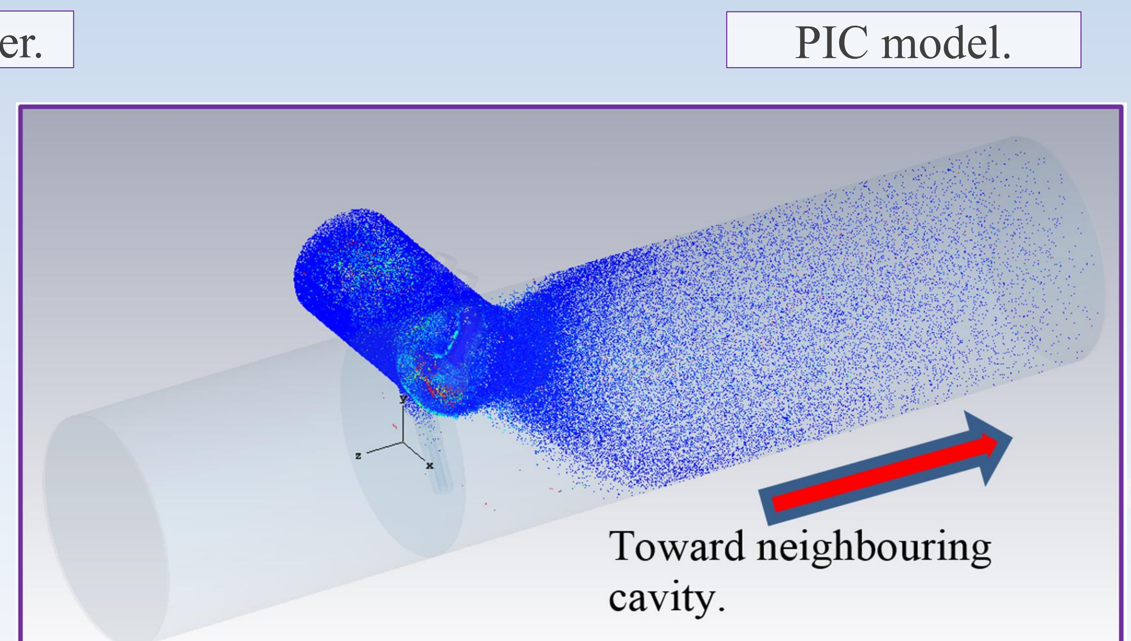
PIC model.

There was a suspicion that the multipacting in HOM coupler of the 1.3 GHz LCLS cavity can be a source of dark current in the cavities of this part of the accelerator. The suspicion was based on the fact that the secondary electrons generated by the MP discharge come out from the HOM coupler into the beam pipe between cavities, and there they presumably can be captured in acceleration.

The simulations performed to check this speculations took space charge effect into account



Saturation of particle number.



Snapshot of the multipacting in the saturated regime.

Conclusion

In a properly assembled and properly tuned HOM coupler the known multipacting cases do not heat the pickup antenna. At the same time a combination of coupling and filter gaps deviations can create conditions for specific multipacting in the coupling gap. This multipacting can be responsible for the antenna heating.

The electrons generated by multipacting in the HOM coupler do not enter the first cells of the neighboring cavities. Therefore the multipacting that may occur in the HOM couplers of 1.3 GHz cavities cannot contribute to or initiate the dark current.