

in Fig. 2, since the tapering would minimize the microwave generation.

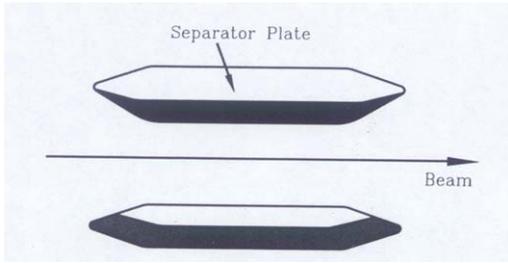


Figure 2: Schematic drawing of the metallic plates with tapered ends.

The physical design of the separator is described in detail in [2]. In this paper focus is on the calculation of the impedance of separator using MAFIA [5] code. The simulation method and result are reported.

2 MODELING OF HSP AND VSP

2.1 Simplified model

The length of each separator is about 2.6 meters, and the radius of the vacuum tank containing the high voltage electrode is about 0.22m. Thus, to calculate the wake potential generated by 1cm bunch, the number of meshes is too large. However, due to the symmetry of the structure, we can use 1/4 solid model as the first step of simplification.

Since it is the wake field generated at the discontinuous structures that mostly affect the longitudinal motion of the bunch, the tapering part between the vacuum tank and the beam pipe dominant the impedance. To verify this, we have calculated the wake potential of a 4cm bunch (to reduce the mesh number) in difference cases by varying the length of the high voltage electrode. The results are almost the same when the length is changed from 0.2m to 2.0m, as shown in Fig. 3. So in MAFIA simulation we can build the 1/4

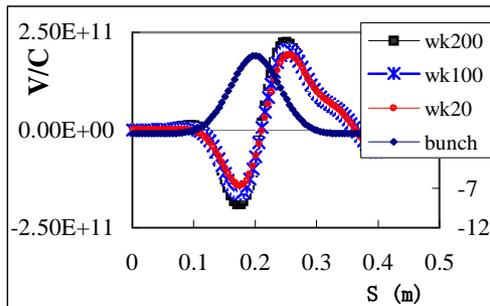


Figure 3: Wake potential vs length of the high voltage plates, wk200, wk100, wk20 refers to its length of 20cm, 100cm and 200cm, respectively.

solid model with 1/10 length of high voltage plate instead of the full structure of the separators to save computer memory and CPU time.

2.2 Indirect method

In MAFIA calculation, to avoid the numerical noise, the indirect method is preferred by integrating the wake field generated in a cavity-like structure. But in the separator case, the electrode intrudes into the beam pipe. Though the direct method can be used, an alternate way [6] is by introducing artificial beam pipes at the ends to convert them to cavity-like structure. Then the indirect method is applied twice, one on the structure with the electrodes as shown in Fig. 4(a) and the other without the electrodes as Fig. 4(b), to obtain the wake field by subtraction. Fig. 5 shows the subtraction result of the wake potential of a Gaussian distribution bunch with $\sigma_0=1\text{cm}$ due to the vertical separator. The wake potential shows most resistive with small inductance. For horizontal separators, the wake potential shows the similar property.

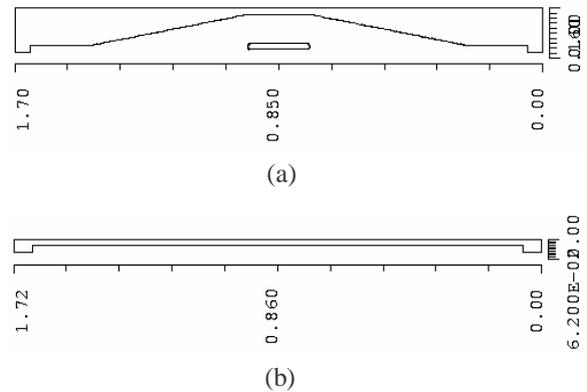


Figure 4: The two cavity-like structures used to get the wake field by subtraction. (a) with electrode, (b) without electrode.

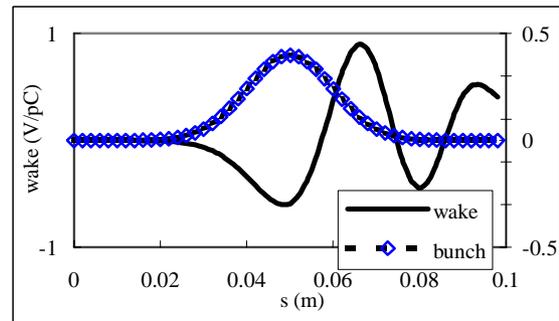


Figure 5: Wake potential of a $\sigma_0=1\text{cm}$ bunch.

3 PRELIMINARY RESULT

To study the effect on reducing the longitudinal broadband impedance by importing the ground electrodes and 3D tapering the high voltage electrodes, simulation has been done in the cases of with no ground electrodes (g.e.), with g.e., and with both g.e. and 3D tapering of the electrodes, respectively. Primary results of the vertical and horizontal separators have been obtained. The comparison between the results of the vertical separator in the above 3 cases is listed in Table 2.

Table 2: Impedance of VSP.

| | L (nH) | kl (V/pC) |
|--------------------------|--------|-----------|
| No tapering, no g.e. | 8.6 | 1.05 |
| Partially tapering +g.e. | 3.8 | 0.55 |
| 3D tapering + g.e | 1.93 | 0.25 |

From Table 2, it can be seen that the loss factor is halved due to the ground electrode. Another half reduce of loss factor comes from the 3D tapering of the voltage plate. The result of the horizontal separators shows the similar property, as Table 3.

Table 3: Impedance of HSP.

| | L (nH) | kl (V/pC) |
|----------------------|--------|-----------|
| No tapering, no g.e. | 13.9 | 1.02 |
| 3D tapering + g.e | 2.59 | 0.38 |

The HOM power generated by the beam can be calculated as,

$$P_{HOM} = k_l (eN_e)^2 n_b f_{rev} = k_l I_b^2 n_b / f_{rev}$$

where N_e is the electron number in a bunch, I_b the bunch current, n_b the bunch number, f_{rev} the revolution frequency. In BEPCII case, $I_b=16\text{mA}$, there are 6×3 bunches for e^+ , e^- respectively, so the HOM power is more than 2kW. Thus, microwave absorber (ferrite or SiC) should be adopted, which has been included in the design [2]. Previous study [7] showed that resonant modes may be generated in the separators, ways to extract these modes effectively have been also considered [2].

4 CONCLUSION AND DISCUSSION

It's an effective way to reduce the impedance of separators by importing the ground electrode and 3D tapering the high voltage electrode. However, the inductance is still larger than expected. Optimisation of the width of high voltage plates, the shape of the ground electrode and the tapering at two ends are still under way. For the vertical separator, SR may hit on the ground electrode if it's introduced, so an alternative way should be investigated to reduce impedance while meantime to shield the SR to an acceptable level. The possible HOM trapped in the vacuum tank is being studied. If the R&D work continues, a prototype that has the similar shape of the separators will be made to measure the impedance on mockup so as to verify the calculation and optimise the design.

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