Wakepotentials of an Array of Electrodes

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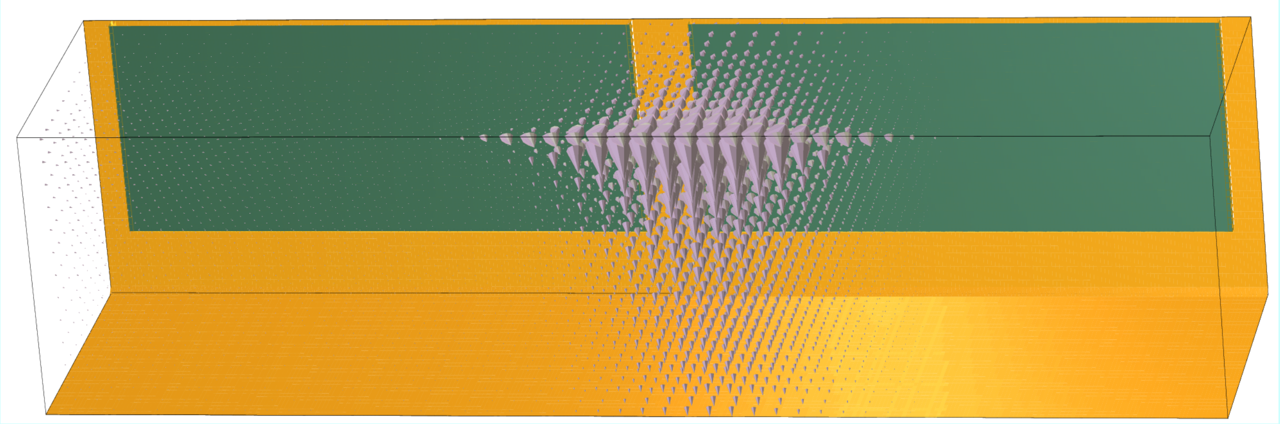
The thickness of the metal is neglected, the beampipes and the electrodes are assumed to be rectangular.
Epsr=2 and Epsr=1 is considered.
Substrate thickness= 1mm, width of the electrodes 30 mm,
gap between electrodes is 4mm,
the beampipe is 40mm times 40mm.

The metallisation fully covers the dielectric.



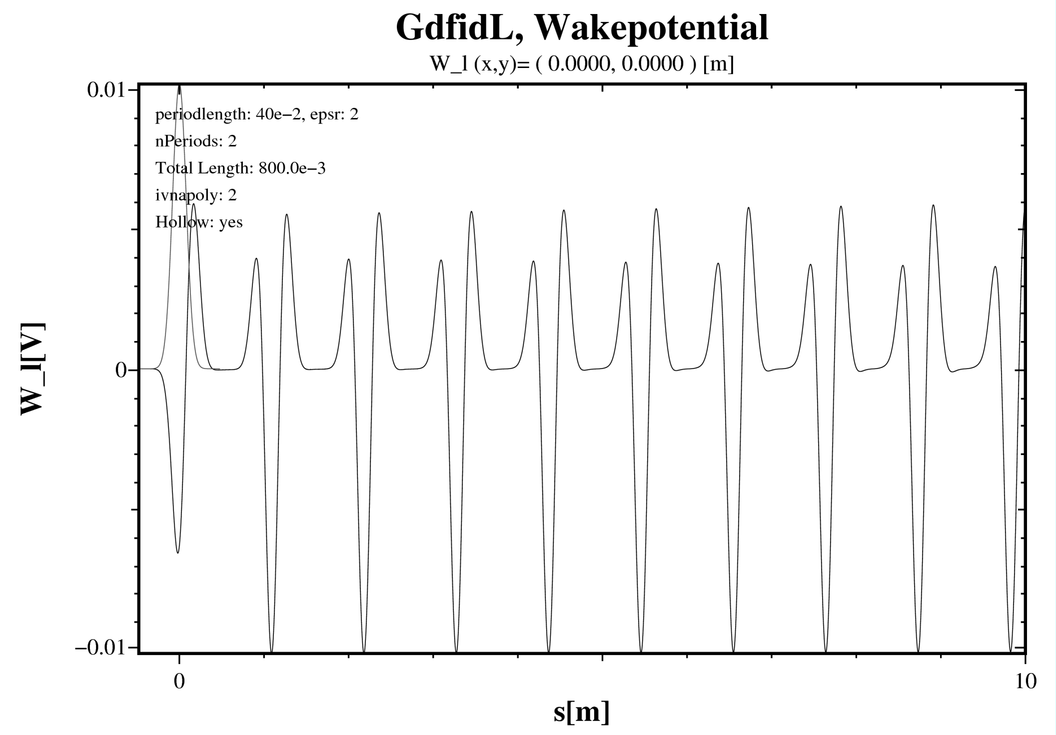
The really used computational volume is much larger,
as up to 16 electrodes of 40 cm each were analysed.
Also the visible beam is much shorter than the used beam.

If the electrodes would be located at places of constant beam-potential, and if the substrate would consist of invisible material, ie. epsr=1. they would not have any wakepotential at all, as they then would not disturb the primary field of the relativistic beam. The part of the primary field which enters the space between the electrodes and the wall travels with the velocity of light towards the end of the electrode, where it recombines with the primary field of the beam above the electrode. No field scattering occurs. No wakepotential is experienced. Because the electrodes are very near to the beam pipe walls, they almost fulfil the condition of being on places of constant beam-potential.

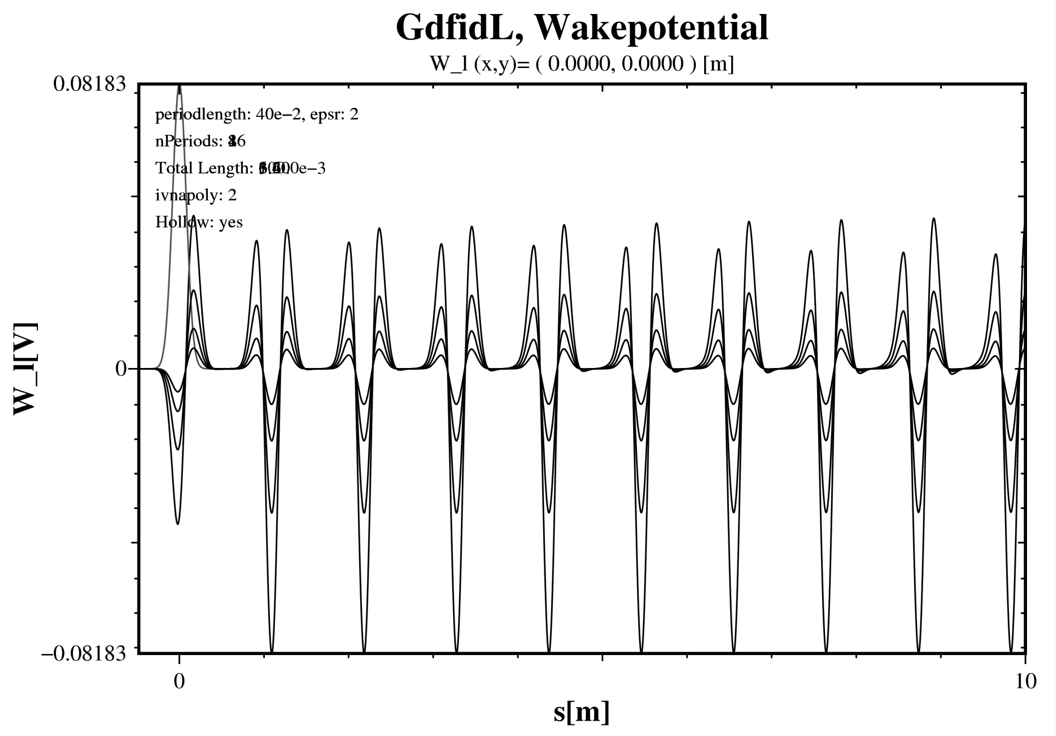
The wakepotential of the conducting foil with dielectric is much larger. This is because the energy in the dielectric travels with a velocity much less than the velocity of light. The field which travels through the dielectric reaches the end of the foil much later than the beam reaches the end of the foil. The beam field above the foil therefore cannot recombine with the field below the foil.

Wakepotential of LHC-Beam

Two electrodes, 40cm.
On dielectric of epsr=2.
Periodicity of 10/9 metres:
twice the length of the
electrodes times sqrt(epsr)

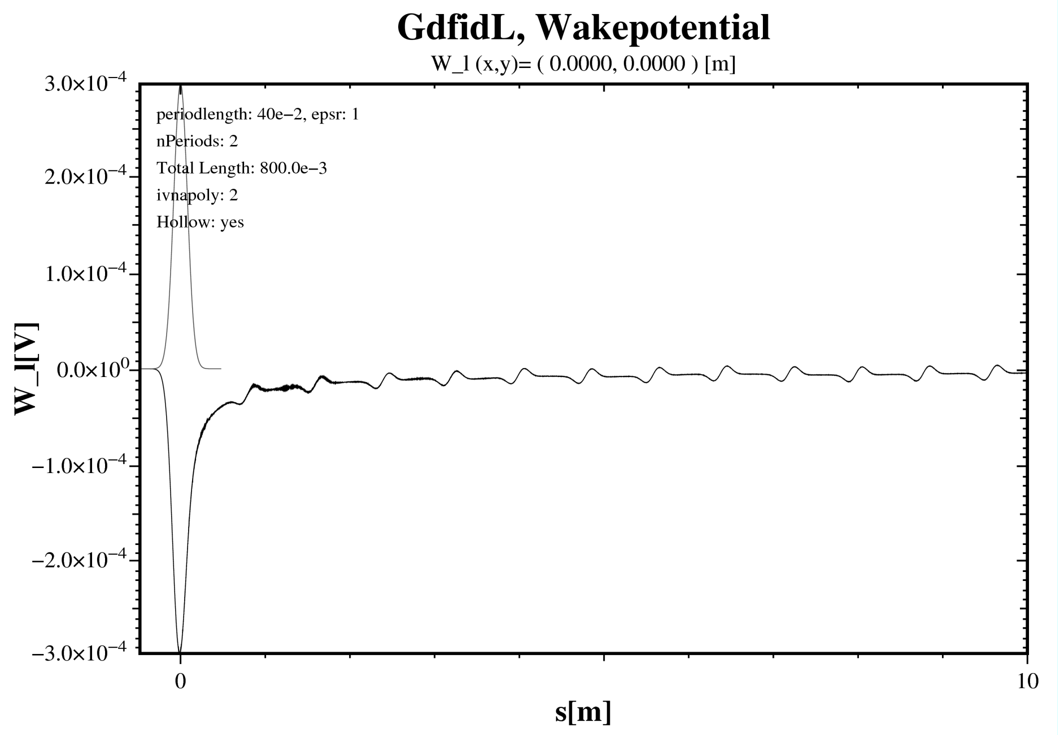


2,4,8,16 Electrodes

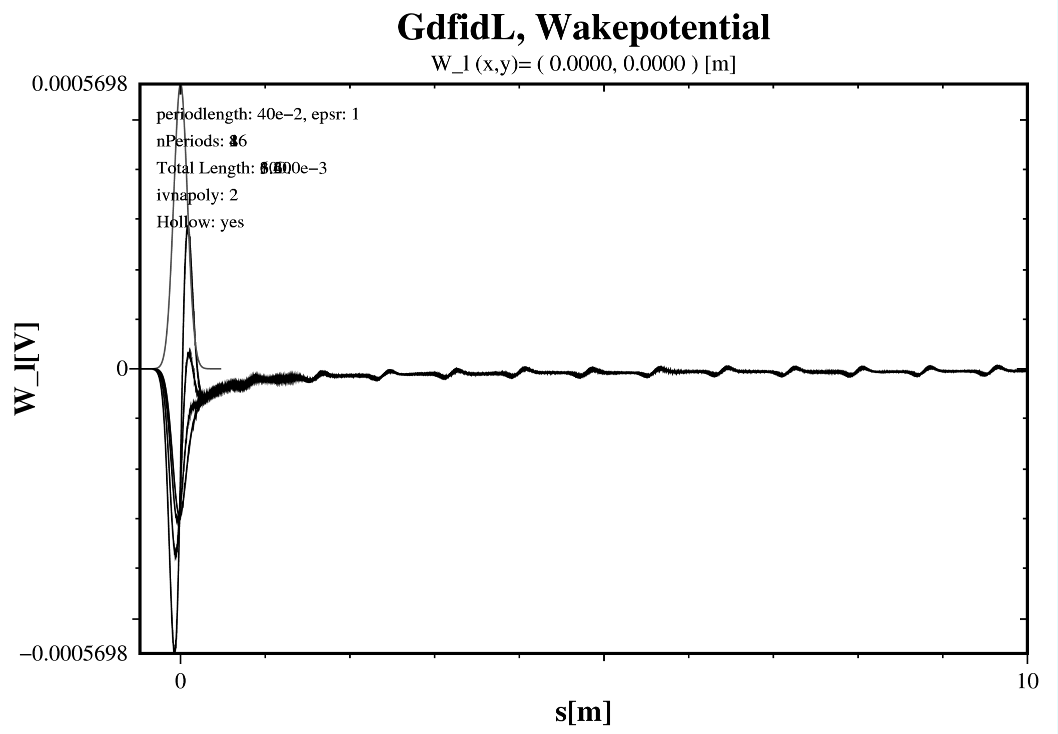


Wakepotential of LHC-Beam

Two electrodes, 40cm, without dielectric
Periodicity of 10/12.5 metres: twice the length of the electrodes times sqrt(epsr)

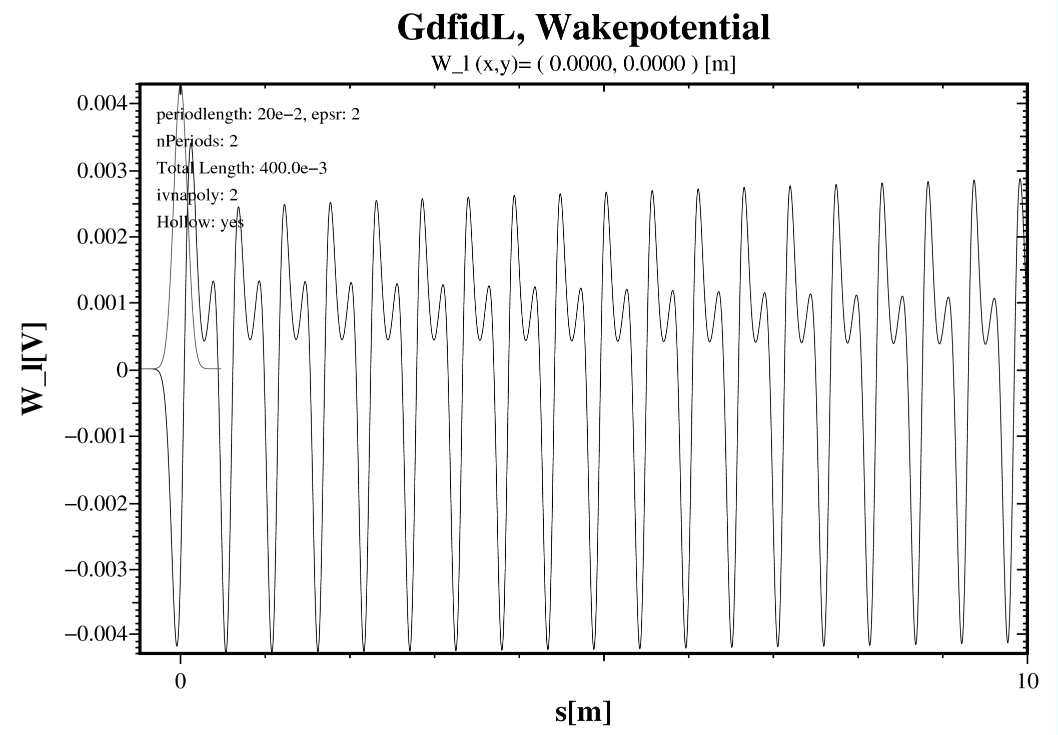


2,4,8,16 Electrodes

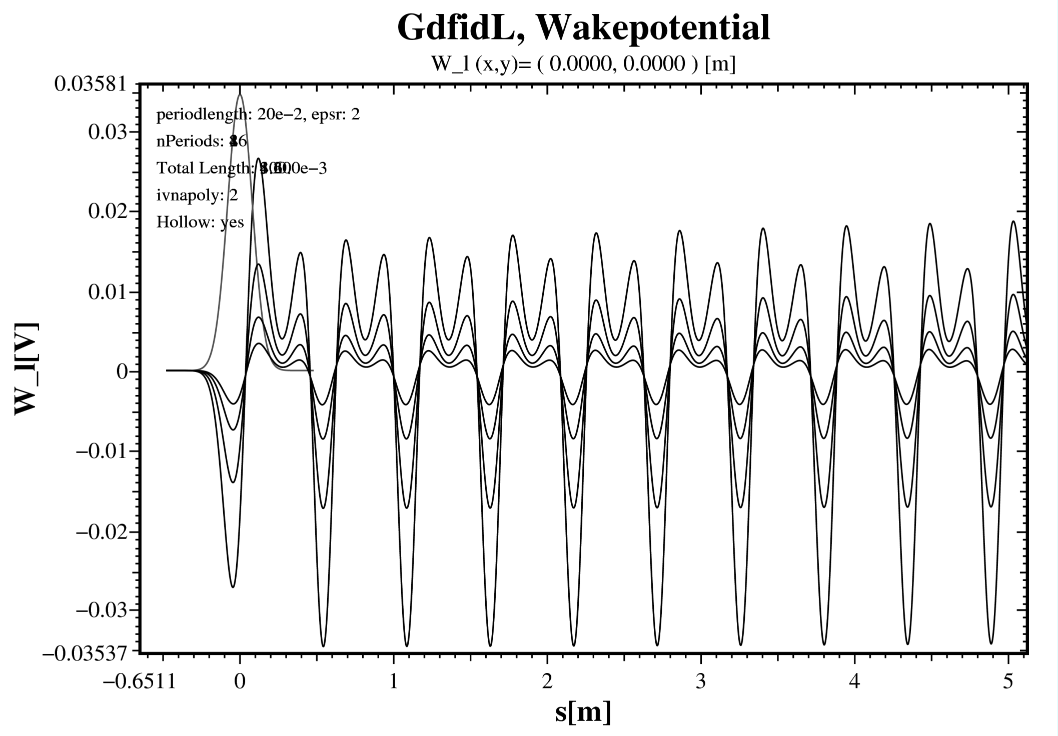


Wakepotential of LHC-Beam

Two electrodes, 20cm,
Epsr=2
Periodicity of 10/18 metres:
twice the length of the
electrodes times sqrt(epsr)

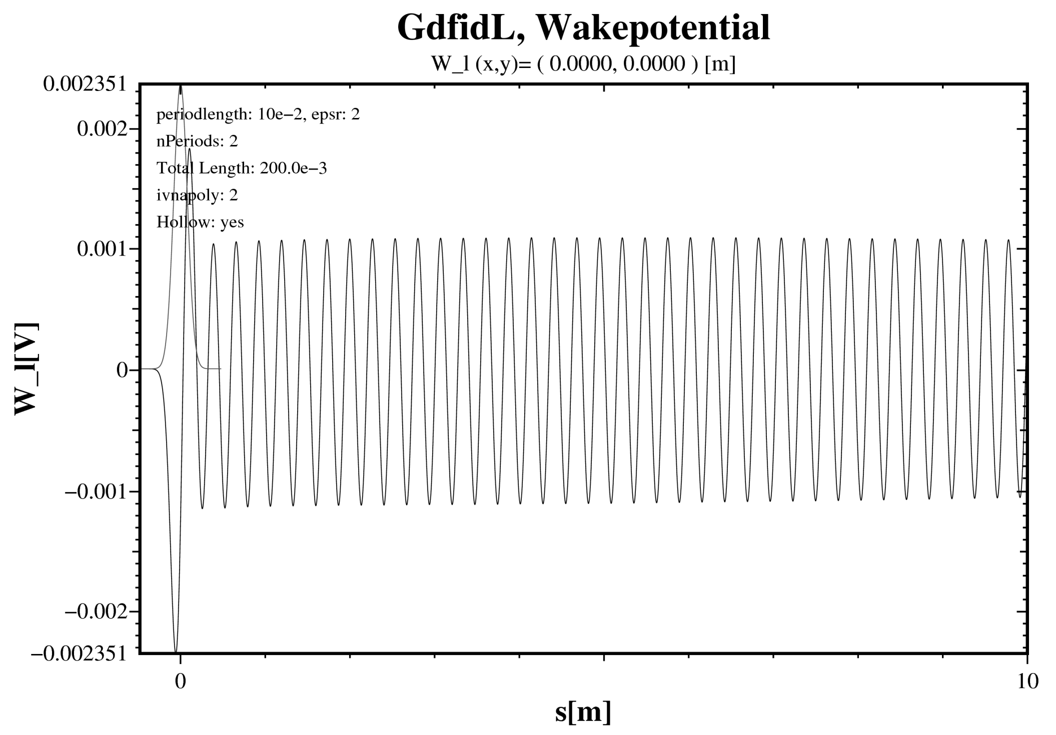


2,4,8,16 Electrodes

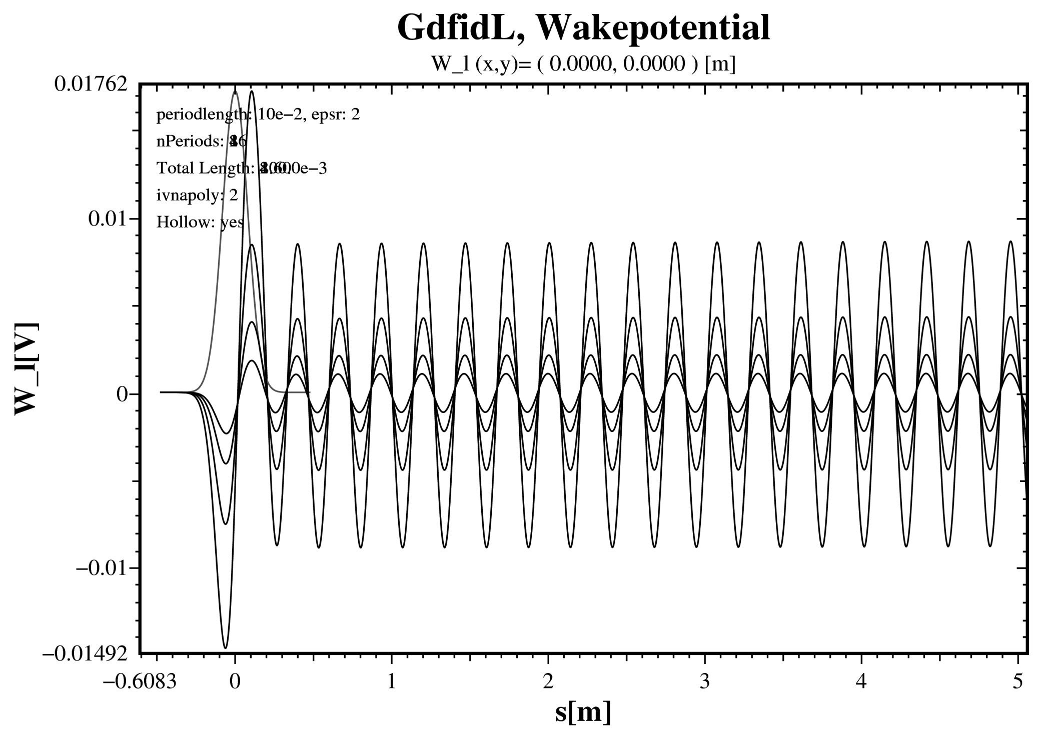


Wakepotential of LHC-Beam

Two electrodes, 10cm,
Epsr=2
Periodicity of 10/37 metres:
twice the length of the
electrodes times sqrt(epsr)



2,4,8,16 Electrodes



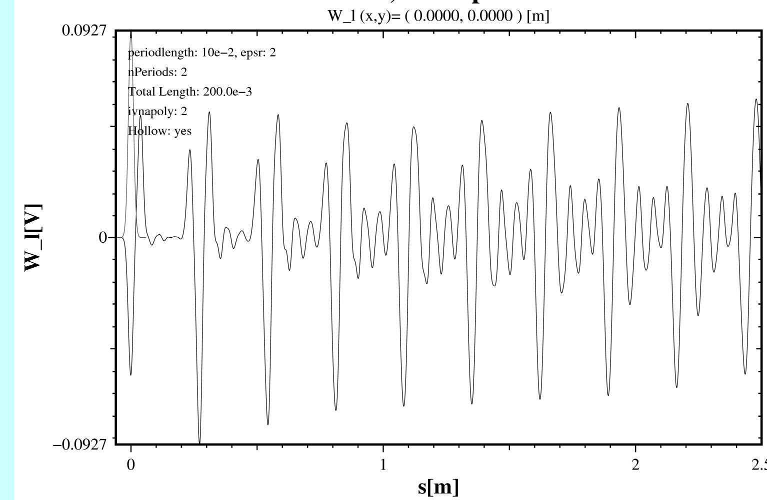
Wakepotential of LC-Beam

The amplitude of the wakepotentials grow linearly with the number of electrodes.

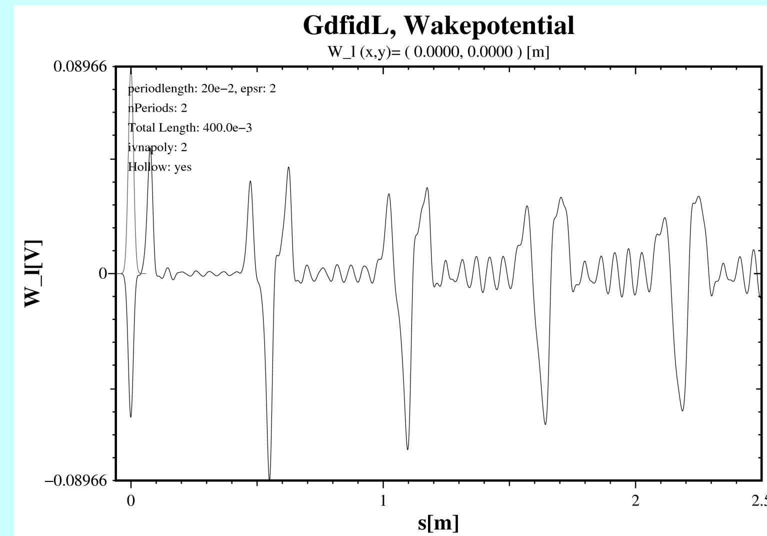
The amplitude of the wakepotential of two electrodes with a length of 40cm, is 0.01 V/pC.
The wakepotential of two electrodes of half length, 20cm, is 0.004 V/pC.
The wakepotential of two electrodes of quarter length, 10cm, is 0.001 V/pC.
This suggests that the wakepotential grows with the length of the electrodes.
This is not expected from the model that the wakepotential comes from the fact that the energy flowing below the electrodes cannot recombine with the energy flowing above. From that model one would expect that the wakepotential only depends on the number of the electrodes, not on their length. It might be, that the wakepotential has this dependence on the length of the electrodes, because the length of the exciting bunch is comparable with the length of the electrodes.

Wakepotential of shorter Beam,
1cm instead of 8cm

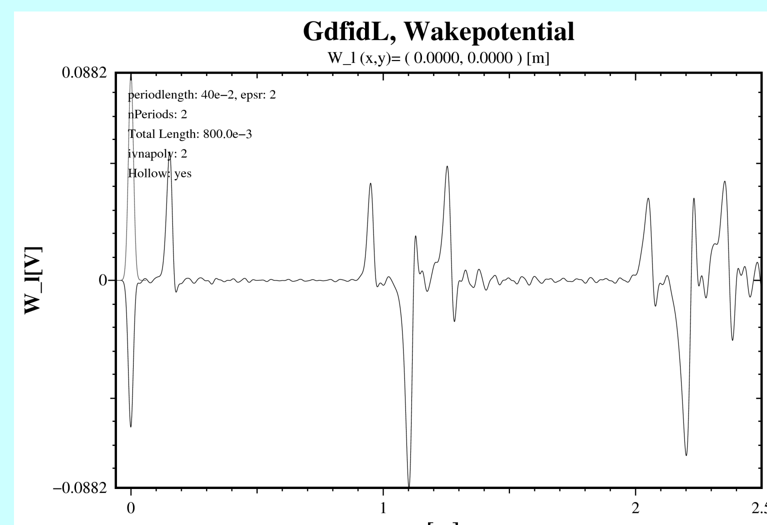
Two electrodes, Epsr=2
Length of 10cm



Two electrodes, Epsr=2
Length of 20cm



Two electrodes, Epsr=2
Length of 40cm



Amplitude of Wakepotential is independent
on the length of the electrodes.