Measurement Of The Magnitude And Direction Of The Electric Field Of A Mobile Phone In The Near Field

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INTRODUCTION

Worldwide intensive use of mobile phones has been accompanied by concern for the microwave radiation they emit.

The effects of interaction of the mobile phone microwave radiation with human tissue are distinguished into two main categories:

- thermal effects
- non thermal effects

- Thermal effects are based on the rise in tissue temperature, that radiation at the mobile phone frequencies can cause.

To date no significant tissue heating has been reported in the literature, which was shown to be caused by the microwave radiation alone

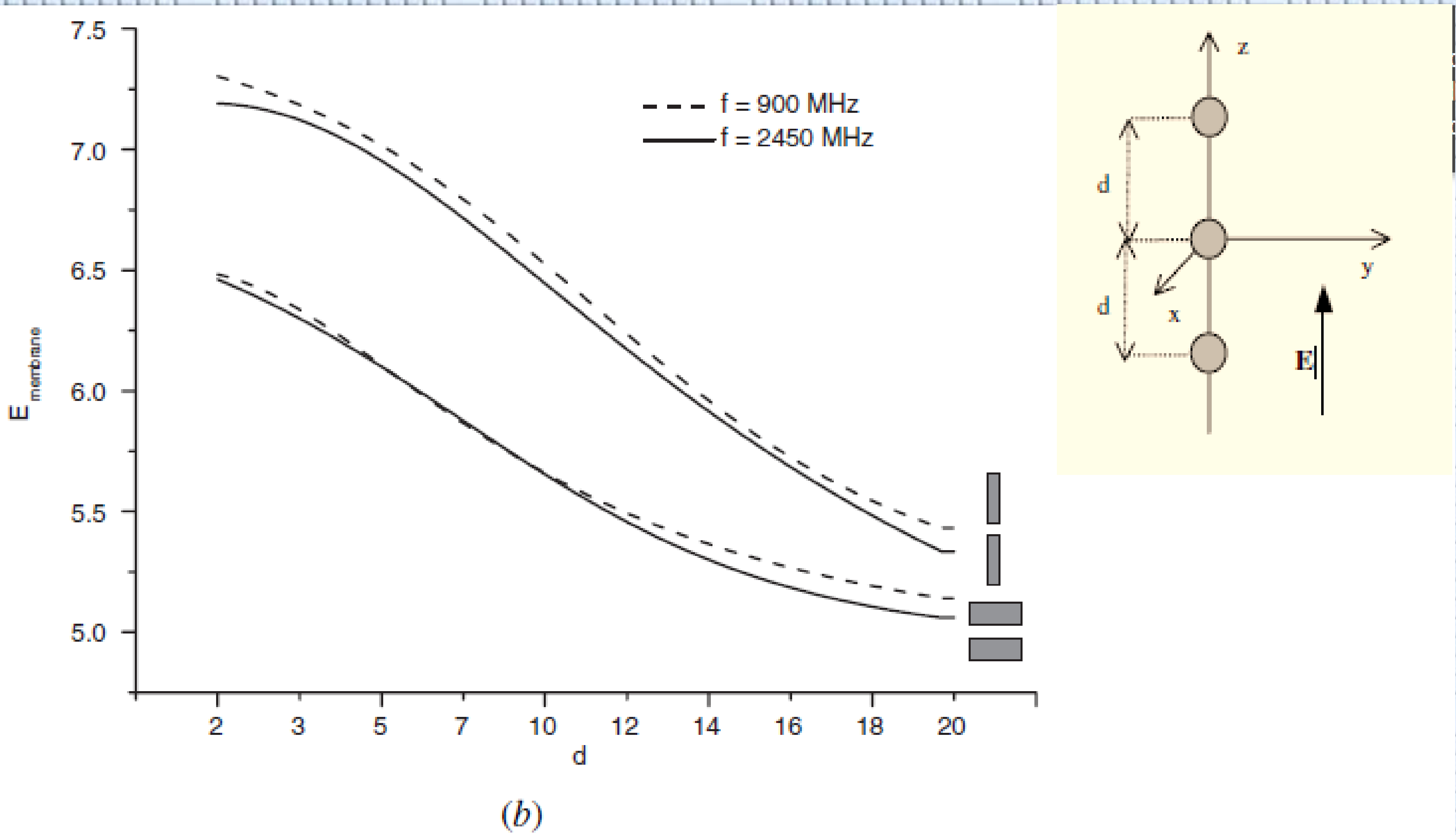
- Non thermal effects however span a much wider area of possible routes for the interaction of rf fields with human cells.

One of those is the proposal that electromagnetic fields act through an interaction mediated at the *plasma membrane* that affects enzyme activities and signal transduction pathways.

Studies in the past, involving cell orientation (with respect to *electric field direction)* include JL Sebastian et al :

'Analysis of the influence of the cell geometry, orientation and cell proximity effects on the electric field distribution from direct RF exposure' , Phys. Med. Biol. 46, 213–225 (2001)

After Sebastian et al :



(*b*)

Figure 7. Induced *E*-field in the membrane as a function of the distance *d* between two cylindrical cells placed along the *y*-axis (*a*) and the *z*-axis (*b*). The distance *d* is normalized to the radius of the cylinder.

In this work, experimental results are presented, for both the *magnitude* and the *direction* of the rf electric field of a mobile phone, at distances very close to the phone, that is within the *'near-field'* region, which is the region of phone standard operation

'near field' ~ $\lambda/2\pi$ ~ 2.7 cm (1800 MHz

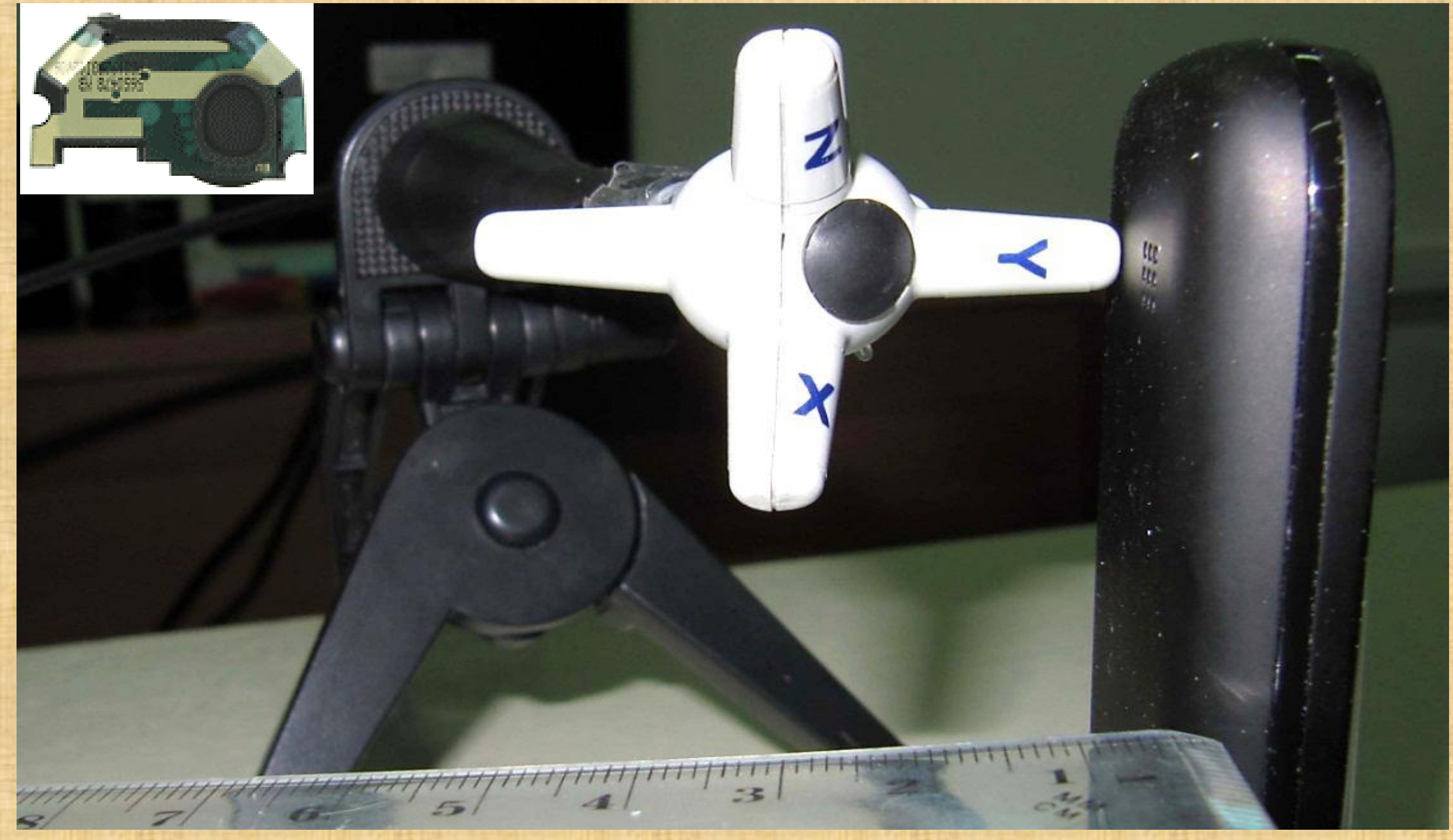
Our measurements reveal, for the first time to our knowledge, that, in the '*near field*' region, the electric field has a large component *parallel* to the the propagation direction. This contrasts with the propagation of e-m ***plane waves*** in the 'far field' region, in which the electric field is *at right angles* to the propagation direction.

Thus the mobile phone electric field '*cuts-through*' the human tissue at the cheek, and is not parallel to it.

MATERIALS AND METHODS

The measuring apparatus consists of an ordinary mobile phone (Nokia, model 2330 classic) and a 3 axial electric field probe, of Narda, model EP 600

A PC is used for data storage.



The 3-axis electric field probe at the phone rear, at antenna (inset) height. The antenna is nearer the rear cover and parallel to it

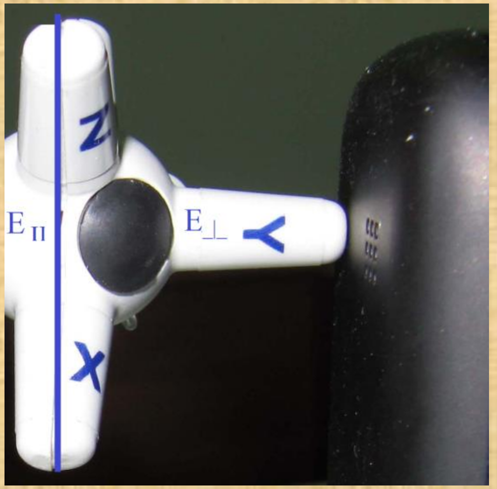
Measurements were conducted, of the three *cartesian* components of the electric field vector, at several distances from the mobile phone, both for the front lobe of the antenna(rear side of the phone, as in photo) and for the back lobe (front side of the phone)

The mobile phone was operated in ‘call’ mode (it was called and was left ringing but not answered throughout each measurement). During the calling period the voltages from all 3 Cartesian sensors of the probe, were sampled repeatedly and the corresponding components of the electric field were stored, for a period of between 30-60 sec, after which, the average value of the readings was taken.

All 3 measured electric field components were within the linear response range of the probe and at least one order of magnitude above its noise level.

RESULTS AND DISCUSSION

E-field component measurements at the rear side of the phone (antenna front lobe)

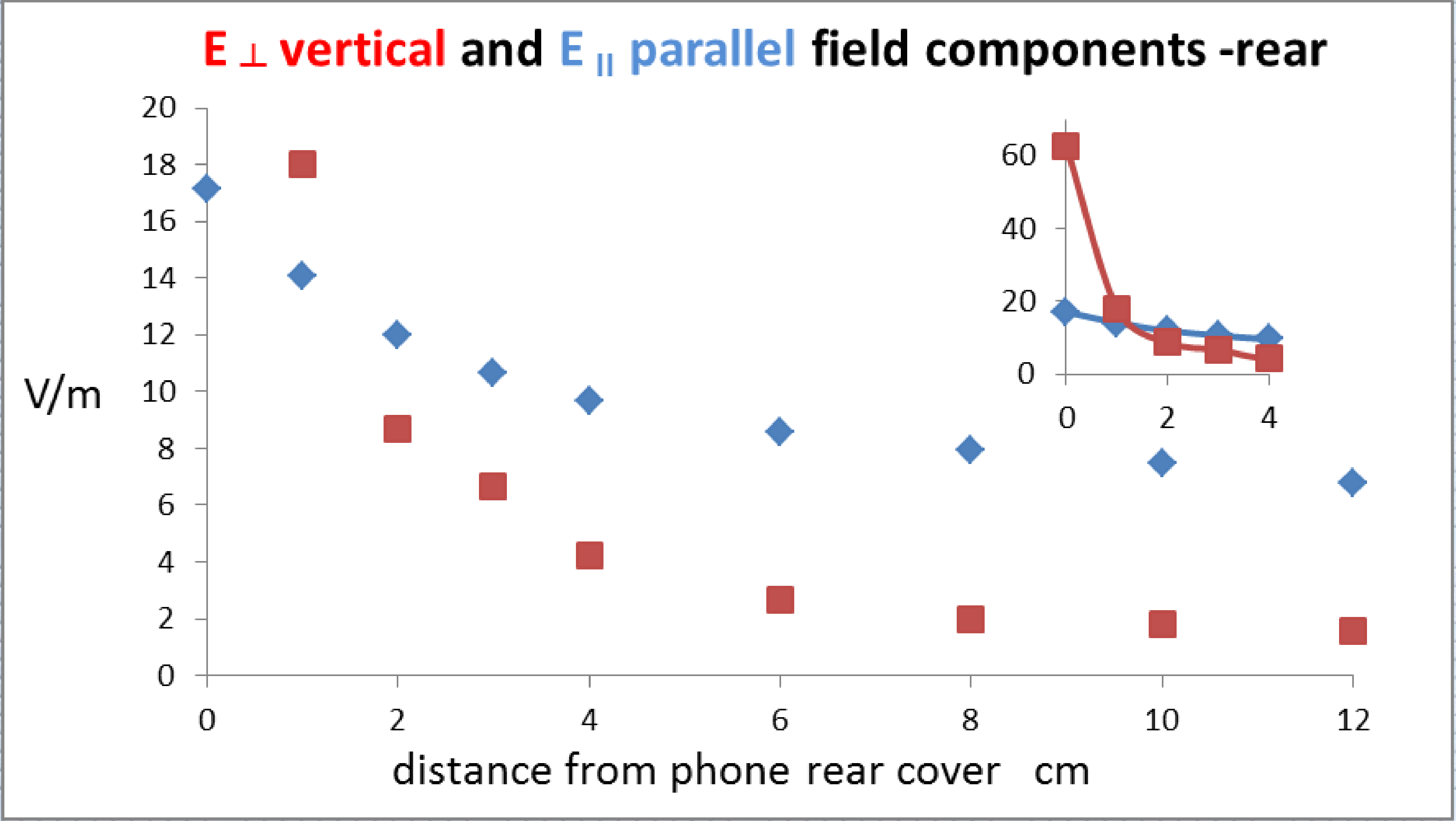


Ex, Ey, Ez

$E_{\perp} = Ey$, $E_{II} = \surd(E^2x + E^2y)$

Vertical ***parallel***

E – field components at the rear side

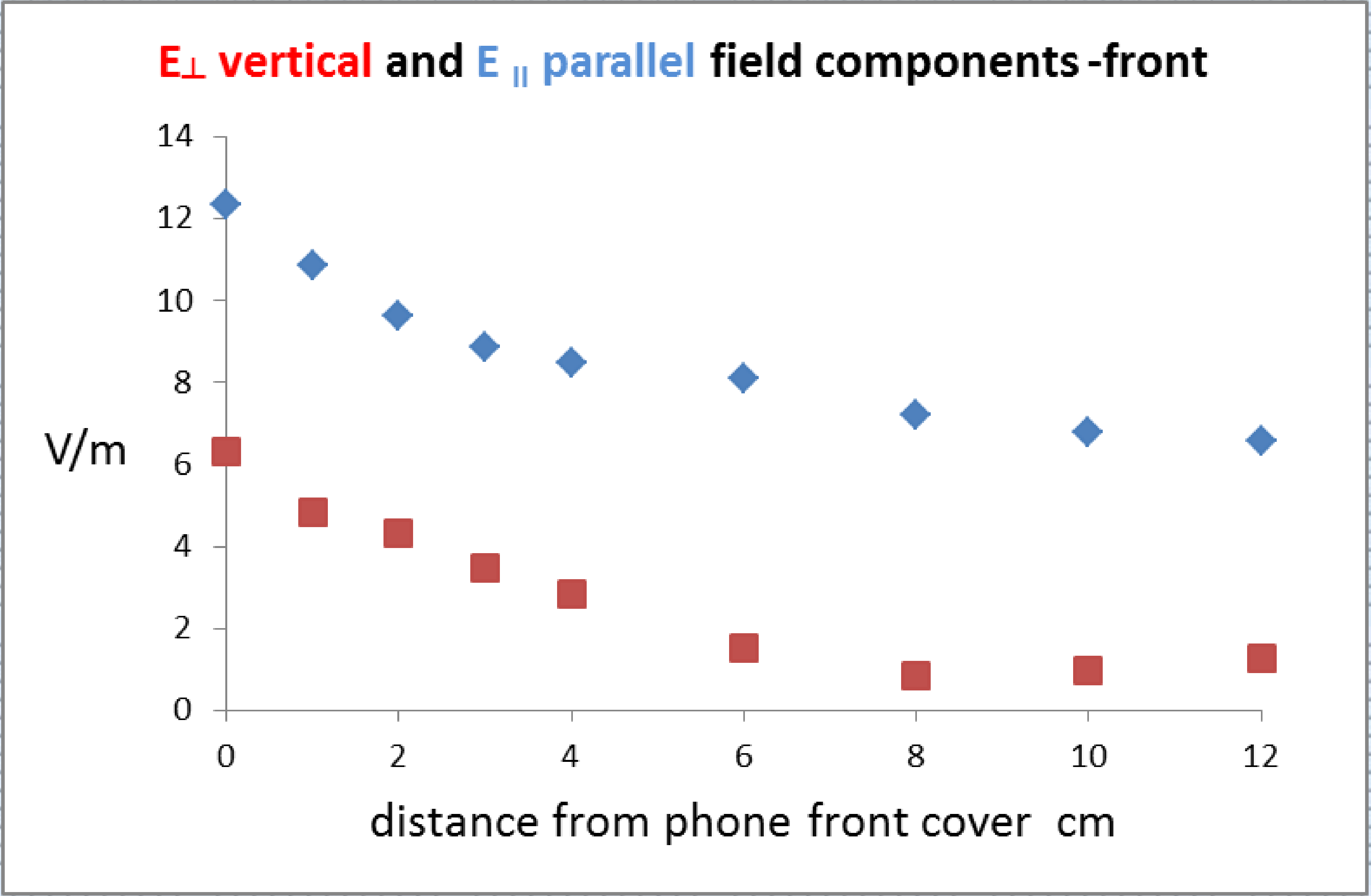


The measurements at the rear side indicate:

- very close to the phone, the *vertical* component of the electric field predominates (and falls rapidly with distance)
- at distances larger than 2 cm, the *parallel* component of the electric field predominates (as expected for plane wave propagation)
- both components stay practically constant at distances larger than 6 cm.

Therefore, it is only at distances larger than 6 cm that the electric field vector becomes nearly parallel to the antenna and perpendicular to the propagation direction, ie it acquires its ‘normal’ far field orientation

E – field components at the front side



The measurements at the front side indicate:

- at all distances, the *parallel* component of the electric field predominates
- at short distances, the *vertical* component is most significant with respect to the *parallel* component .
- both components stay practically constant at distances larger than 6 cm.

Therefore, it is only at distances larger than 6 cm that the electric field vector becomes nearly parallel to the antenna and perpendicular to the propagation direction, ie it acquires its far-field orientation.

CONCLUSIONS

- The above behavior means that in the near field, which corresponds to the position of the phone under normal use, the electric field direction deviates from the far field direction and has a considerable component *non parallel* to the skin.
- Therefore, a higher electric field may penetrate inside cells, in cases where the relative orientation of the field (with respect to the cells) could be associated with increased effectiveness of the field to tissue interaction.

Future extension:
mobile phone E-field vector mapping

THANK YOU FOR YOUR ATTENTION

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