Electromagnetic fields may have different targets affecting the biological systems. At cell level one of the possible way to evidentiate the biological effects of electromagnetic fields are probably mediated by plasma membrane. An important role is played by the Intramembrane Proteins (IMP) which represent a class of proteins located in the lipid bilayer of the cell membrane which function as ion channels, enzymes or receptors.

The cell cultures were exposed to a PMF generated by a pair of rectangular horizontal coils powered by a pulse generator (Igea, Italy). The characteristics of the field were constituted by a wave shape of the magnetic signal which was approximately triangular, the rise time 1.2 ms, the frequency 50 Hz and the peak amplitude of the magnetic field 1.8 mT corresponding to a peak current of 30 mA. The induced electric field depended on the position inside the flasks. Taking into account their shape and size, the maximum electric field close to the internal walls can be estimated of the order of 0.05 mV/cm.

The electromagnetic fields can affect the native distribution of the IMP in the plasma membrane of Swiss NIH 3T3 fibroblasts modifying its arrangement to clustered patterns. Evaluations were based on the calculation of a distribution factor, which allows us to discriminate between random, regular and clustered distribution on electron microscope images of freeze fractured control and PMF exposed cells. The results indicate that cells exposed to the PMF for more than two hours show a significant clusterization of the IMP distribution. Cell maintained in culture for 24 hours without field, after exposition to PMF, reach again a protein regular pattern distribution showing to be able to restore the native pattern distribution. This approach can be useful to better understand the key point in which cells show sensitivity to the electromagnetic fields, and can be a suitable hypothesis about the reverting of symptoms when people come out of the fields.

*) Translation: Language Promotion, Zell am See, Austria
### TARGETS AFFECTED BY EMR IN THE CELL
- Cell membrane
- Signaling
- Calcium efflux
- DNA breaks
- Micronuclei
- Metabolic changes

### INTRAMEMBRANE PROTEINS (IMP)
- Phospholipid bilayer
- Different kind of proteins

### INTRAMEMBRANE PROTEINS (IMP)
- Represent a class of proteins which are located in the lipid bilayer of cell membrane
- They show a regular distribution pattern

### FUNCTIONS
- They function as:
  - Ion channels
  - Enzymes
  - Receptors of chemical signal

### KIND OF CELLS EXPOSED
- Swiss NIH 3T3 (Double Blind)
- SAOS cells
- HOS (Osteosarcoma)
- Friend cells
- 5 different experiments

### EMF EXPOSURE
- Cells exposed to a 50 Hz 1.8 mT pulsed magnetic field generated by a pair of Helmholtz coils powered by a pulse generator

### FIELD CHARACTERISTICS
- Triangular shape
- Rise time 1.2 ms
- Frequency 50 Hz
- Peak amplitude of magnetic field 1.8 mT
- Peak current 30 mAmp
- Electric field 0.05 mV/cm

### CONTROL CELLS SHOW REGULAR IMP DISTRIBUTION
- EMF affects the native regular distribution of the IMP in the cell membrane
EMR EXPOSED CELLS SHOW CLUSTERS OF IMP

RESULTS

- LEFT : CONTROLS
- RIGHT : EXPOSED CELLS
- G=1 h,
- H=2 h,
- I=24 h,
- J=48 h,
- K=72 h
- F= SHAM
- A-E=CONTROLS

PATTERN ANALYSIS

- THE FV DISTRIBUTION FACTOR WAS CALCULATED BY IMP COUNTING INSIDE THE MESHES OF A GRID
- VARIANCE OF N. OF IMP

\[
FV = \frac{\text{VARIANCE OF N. OF IMP}}{\text{MEAN OF N. OF IMP}}
\]

FACTOR FV

- FV=1 RANDOM DISTRIBUTION (POISSON)
- FV<1 NON RANDOM REGULAR PATTERN DISTRIBUTION
- FV>1 CLUSTER DISTRIBUTION

CLUSTERIZATION REVERTS WITHOUT FIELD

- MAINTAINING THE CELLS IN AFTER EXPOSURE, (48 h EXPOSURE 24 h WITHOUT FIELD) THE CLUSTERIZATION REVERTS TO REGULAR PATTERN
- FV= 1.8(AFTER FIRST 48 h)
- FV= 0.9(+ 24 h WITHOUT FIELD)
- (STATISTICALLY SIGNIFICANT

PROLIFERATION TESTS

- LYMPHOBLASTOID HUMAN T-LEUKEMIA CELLS
- EXPOSED 24 h TO THE ABOVE REPORTED FIELD
- SHOW AN HIGHER PROLIFERATION RATE (SEE DIAGRAM)

PROLIFERATION RESULTS 24 h EMR EXPOSURE
**CONCLUSIONS**

- **ELECTROMAGNETIC FIELD CAN AFFECT THE PROTEIN DISTRIBUTION PATTERN AND THE PROLIFERATION RATE OF DIFFERENT KIND OF CELLS.**
- **PROTEIN CLUSTERIZATION MAY INDUCE A CHANGEMENT IN CELL PERMEABILITY CONTROL**

**CONCLUSIONS**

- **THE EXPOSURE TO THE 50 Hz EMR CAN CAUSE THE FORMATION OF ION CHANNELS WITHOUT CELL CONTROL AND CAN INDUCE BY THIS WAY IMPORTANT METABOLIC MODIFICATIONS**

**CONCLUSIONS**

- **RESTORATION OF NORMAL IMP DISTRIBUTION AFTER EXPOSURE CAN BETTER EXPLAIN THE KEY POINTS IN WHICH CELLS SHOW SENSITIVITY TO THE EMF AND...**
- **…… CAN BE A SUITABLE HYPOTHESIS TO EXPLAIN THE REVERTING OF SYMPTOMS WHEN PEOPLE COME OUT OF THE FIELDS**

**CONCLUSIONS**

- **THE HIGHER PROLIFERATION RATE CAN CORROBORATE THE HYPOTHESIS ABOUT THE ACCELERATION ACTIVITY OF EMR ON CANCER DEVELOPMENT**

**MULTIGENERATIONAL EXPOSURE TO RF/MW** (Magras Xenos 1997)

- **MICE BECAME INFERTILE AT:**
  - V th generation
  - At 0.168 µW/cm2.
  - III rd generation
  - At 1.053 µW/cm2.

**SUTRA TOWER S.FRANCISCO**

- **LEUKEMIA CLUSTERS CORRESPOND TO EMISSION PEAKS (SELVIN 1992)**

**SUTRA TOWER**

- **DOUBLE RISK WITHIN 4.5 Km**
- **DOSE-RESPONSE RELATIONSHIP**
- **LOAEL 0.063 µW/cm2 (SAME VALUE FOR INTRACELL CALCIUM EFFLUX - Schwartz 1990 at 0.08 µW/cm2 )**
<table>
<thead>
<tr>
<th>MORBIDITY RATE OF NEOPLASM 1971-80 IN EXPOSED AND UNEXPOSED PEOPLE TO RF/MW</th>
<th>CONCLUSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• LEFT : EXPOSED PEOPLE</td>
<td>• THE EVIDENCE OF BIOLOGICAL EFFECTS ARE SO STRONG THAT:</td>
</tr>
<tr>
<td>• RIGHT : UNEXPOSED PEOPLE</td>
<td>• THE ICNIRP GUIDELINES ARE TO BE MODIFIED TO LOWER EPIDEMIOLOGICAL LIMITS</td>
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<table>
<thead>
<tr>
<th>CONCLUSIONS</th>
<th>MOBIL TELEPHON</th>
</tr>
</thead>
<tbody>
<tr>
<td>• EXPOSURE TO ELECTROMAGNETIC RADIATION (LOW AND HIGH, ALSO OF NON-THERMAL INTENSITY) CAN CAUSE HEALTH ADVERSE EFFECTS</td>
<td>• DURING A CONVERSATION CAN REACH 6 TO 60 V/m</td>
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<tr>
<td></td>
<td>• IN ITALY 30 MILLIONS OF MOBIL TELEPHONS ARE IN USE</td>
</tr>
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<td></td>
<td>• MANY BY YOUNG PEOPLE</td>
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</tbody>
</table>

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<thead>
<tr>
<th>CONCLUSIONS</th>
<th>PUBLIC EXPOSURE LIMIT</th>
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</thead>
<tbody>
<tr>
<td>• THE DISCLAIMER</td>
<td>• TO AVOID THE DEMONSTRATED HEALTH EFFECTS THE PUBLIC EXPOSURE LIMIT SHOULD BE:</td>
</tr>
<tr>
<td>• HEALTH HAZARDS</td>
<td>• 0.02 µW/cm²</td>
</tr>
<tr>
<td>• SHOULD BE WRITTEN ON TELEPHONS</td>
<td>• 0.2 mW/m²</td>
</tr>
<tr>
<td></td>
<td>• 0.27 V/m</td>
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