Surprising discoveries *in vitro*

In terms of cellular biology, the effects of the electromagnetic fields to which current technologies expose us – ranging from the very low frequencies of electrotechnical applications to telecommunications radio frequencies – have remained unknown territory to date. A pioneer in this field, the European Reflex project recently shed light on some of the mysteries, producing results that raise many questions.

The effects of radiation on DNA *in vitro*. On the left, no change; in the centre, showing breaks in the DNA bonds after exposure to gamma rays; on the right, the breaks are caused by a high-frequency electromagnetic field applied continuously during 24 hours.

Many research studies on cancer have demonstrated the genotoxic methods by which ionising radiation disturbs and destroys the cell universe by breaking the DNA chemical bonds. In this respect, the very recent European project Reflex[1] sought to fill a gap in our fundamental knowledge that had previously kept us totally in the dark about the possible biological effects of standard electromagnetic fields.

The project, pursued by a consortium of 12 laboratories based in seven European countries, sought to take an initial step in verification in this field. Intensive tests were carried out – which sought to be as exhaustive as possible – that involved exposing *in vitro* various isolated human cell systems (fibroblasts, lymphocytes, etc.) to variable ranges of electromagnetic fields. These samples were then examined closely to observe whether or not this radiation had produced any genotoxic or phenotypical effects on the cells of a kind that would normally be susceptible to result in cancerous and/or neurodegenerative pathologies.

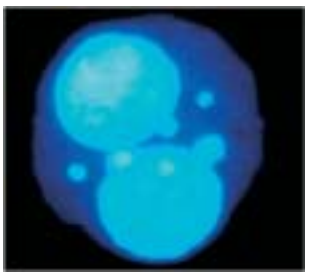
Undeniable breaks in the DNA chain

The surprise effect of the Reflex results, which were obtained during the 2000-2004 period, is in two Reflex laboratories that DNA simple- or double-strand breaks are produced in several cell systems under the effect of the very low frequencies or radio frequencies to which these cell samples were exposed. Furthermore, these genotoxic phenomena are present even when descending below the magnetic flux densities or specific absorption rates that comply with the safety standards in place.

"At this stage, these results – the reliability of which we can guarantee as they originate in a common work platform with several participating laboratories – do not enable us to draw any conclusions in terms of health," stresses Franz Adlkofer of the Verum Foundation in Munich (DE), the project coordinator. "The research we have carried out provides biological indications that clearly concur and constitute an initial knowledge base. Other studies must now investigate the specific points of our results – such as the fact that the genotoxic effect of very-low-frequency electromagnetic fields is only produced on intermittent exposure, not on continuous exposure, and that in the radiofrequency range intermittent exposure generates stronger genotoxic effects than continuous exposure."

The limits of *in vitro*

"To return to the subject of real risks to health, what we obtain from *in vitro* research offers no positive or negative certitude as to what actually happens in a living organism," Dr Adlkofer is careful to point out. "The questions raised by the Reflex results must clearly be an incitement for further research, switching to *in vivo* studies on animal models and on man.



***In vitro* experiment: cell division, revealing several micronuclei, the result of the genotoxic effects of electromagnetic rays.**

To find out more

- **Verum Foundation – Stiftung für Verhalten und Umwelt (Munich, DE)**
  www.verum-foundation.de/

Contact

- **Frans Adlkofer**
  prof.adlkofer@verum-foundation.de

(1) Risk evaluation of potential environmental hazards from low-energy electromagnetic field exposure using sensitive in vitro methods

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Lessons from the REFLEX* study on biological effects of radiofrequency electromagnetic fields

Franz Adlkofer
Verum Foundation
Munich Germany

*Risk evaluation of potential environmental hazards from low energy electromagnetic field exposure using sensitive *in vitro* methods

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Computer controlled exposure setup (Kuster et al., IT'IS Foundation, Zurich, Switzerland).)

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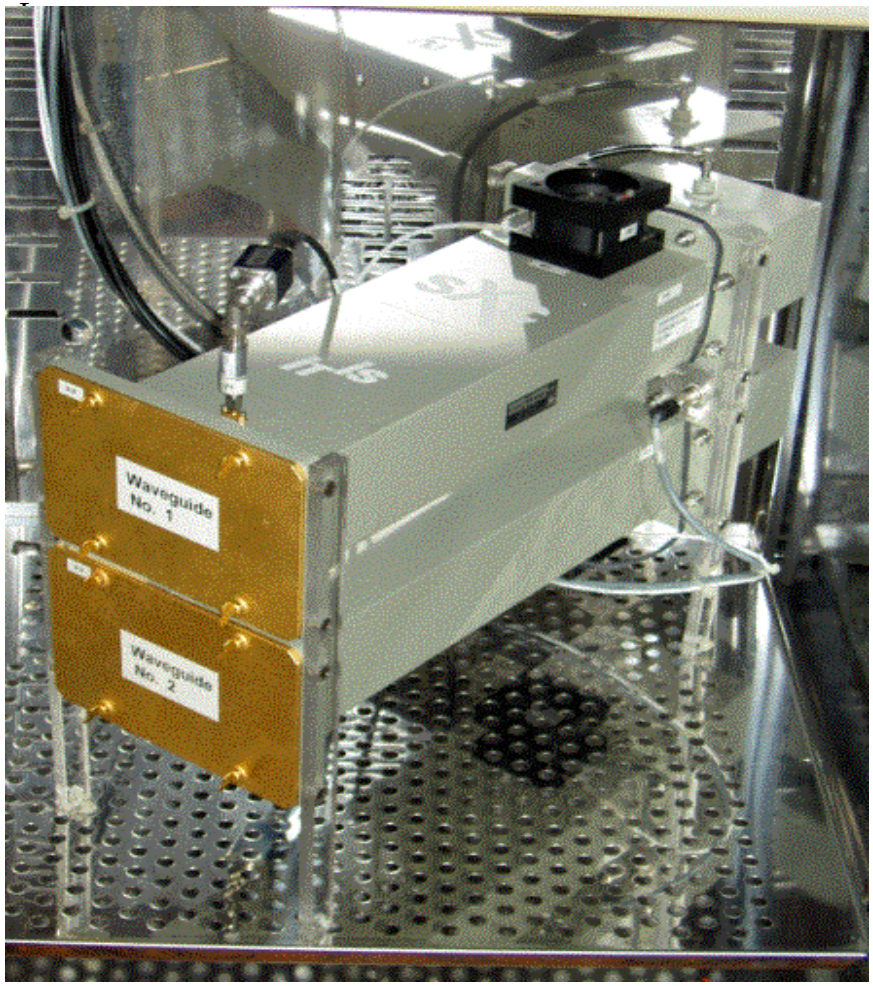

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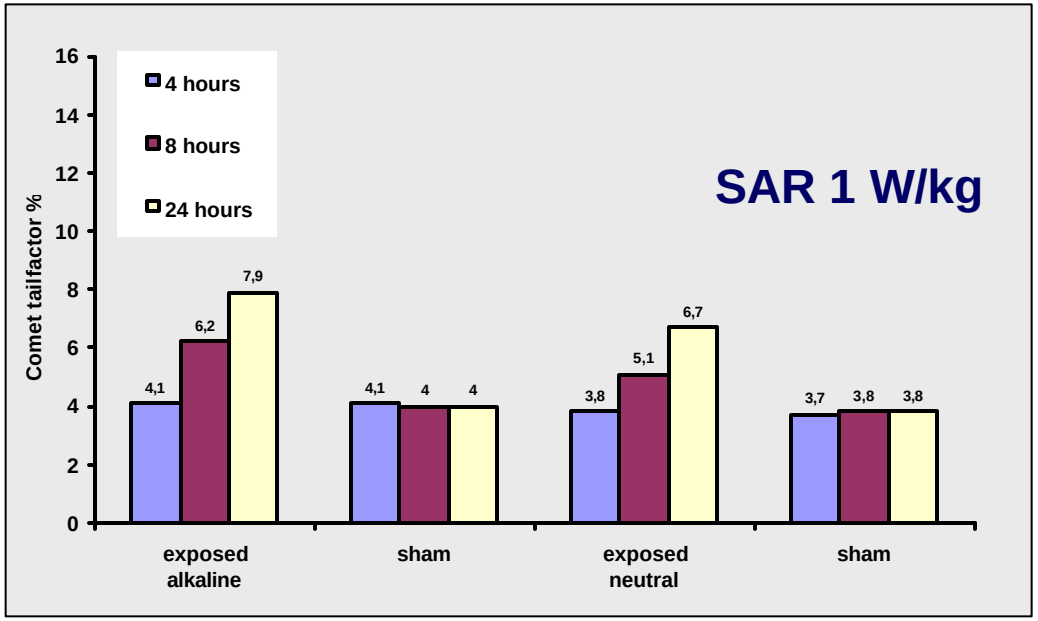
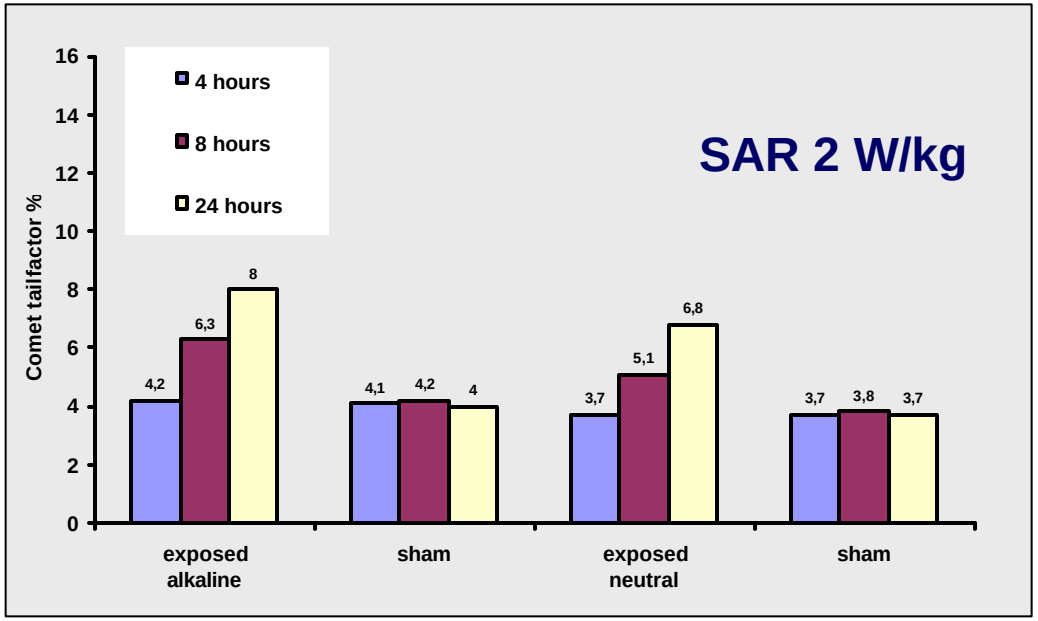
Increase in DNA strand breaks in human fibroblasts after intermittent RF-EMF exposure for 4, 8 and 24 hours (1950 MHz, 5 min on/10 min off) at a SAR value of 1 and 2 W/kg (Rüdiger et al.).





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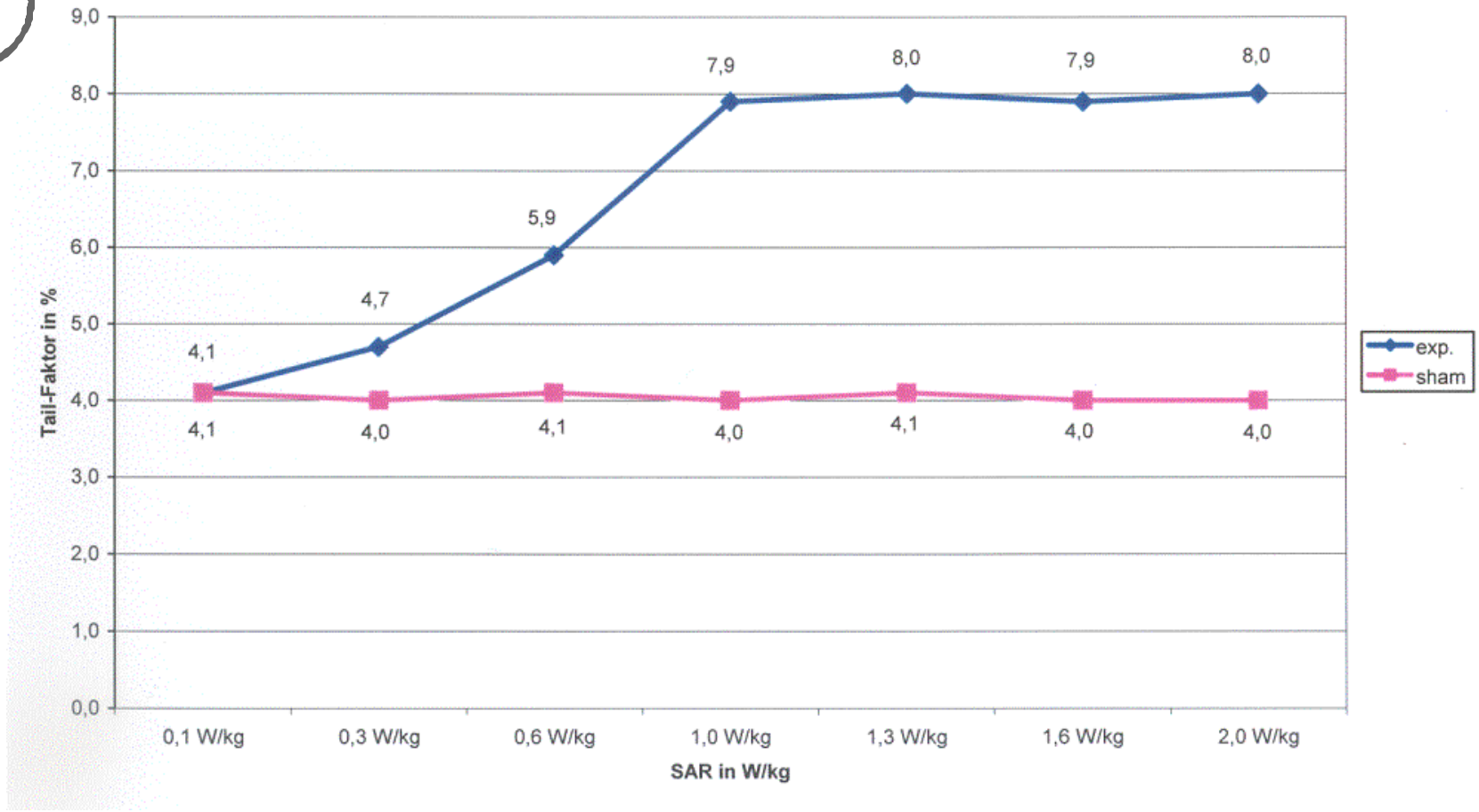
Increase in DNA strand breaks in human fibroblasts after intermittent RF-EMF exposure (1950 MHz, 5 min on/10 min off, 24 hrs) at increasing SAR values (0 – 2 W/kg) (Rüdiger et al.).



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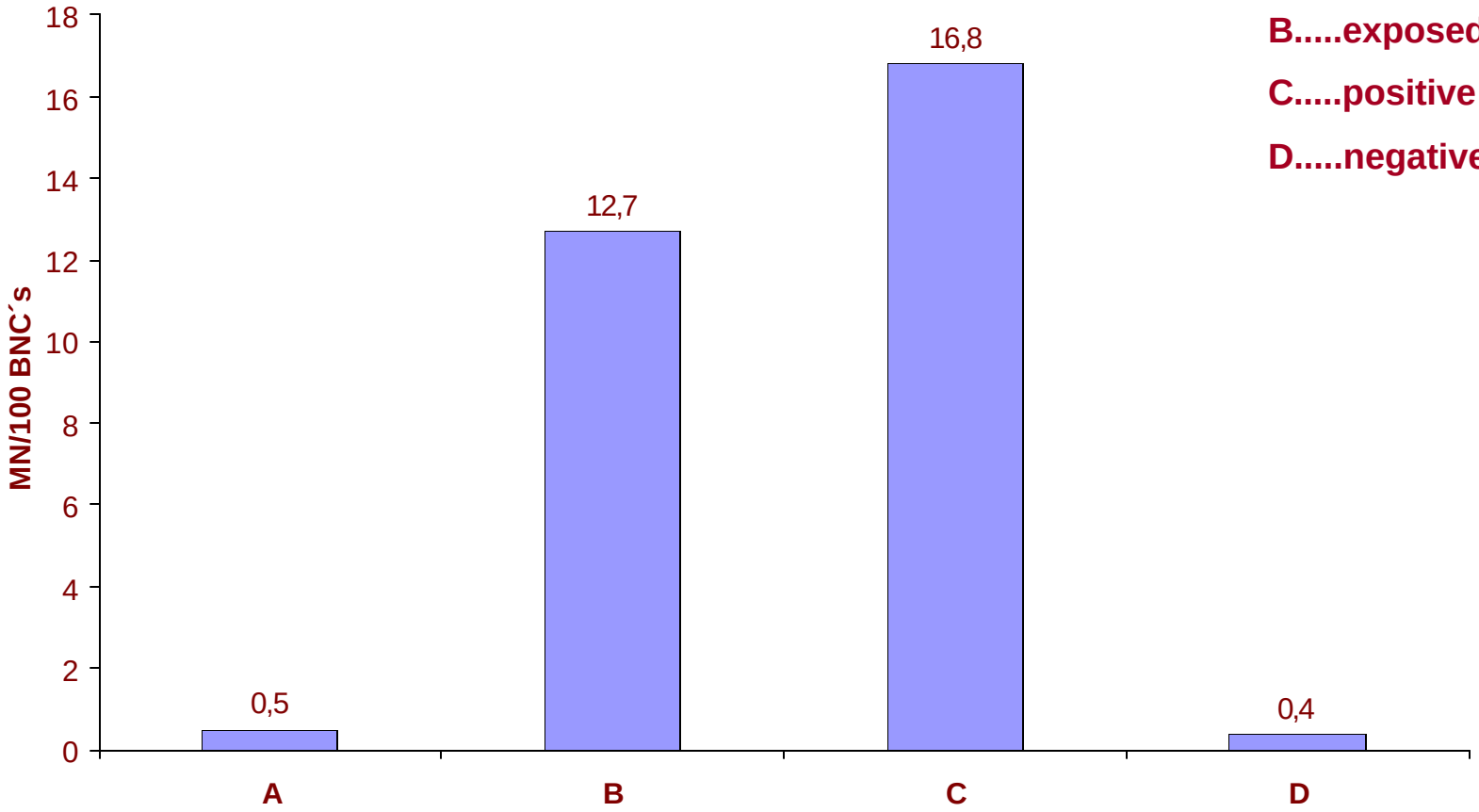
Increase in micronuclei in human fibroblasts after intermittent RF-EMF exposure (1950 MHz, 5 min on/10 min off, 24 hrs) at a SAR value of 2 W/kg (Rüdiger et al.).

A.....sham exposed

B.....exposed

C.....positive control

D.....negative control



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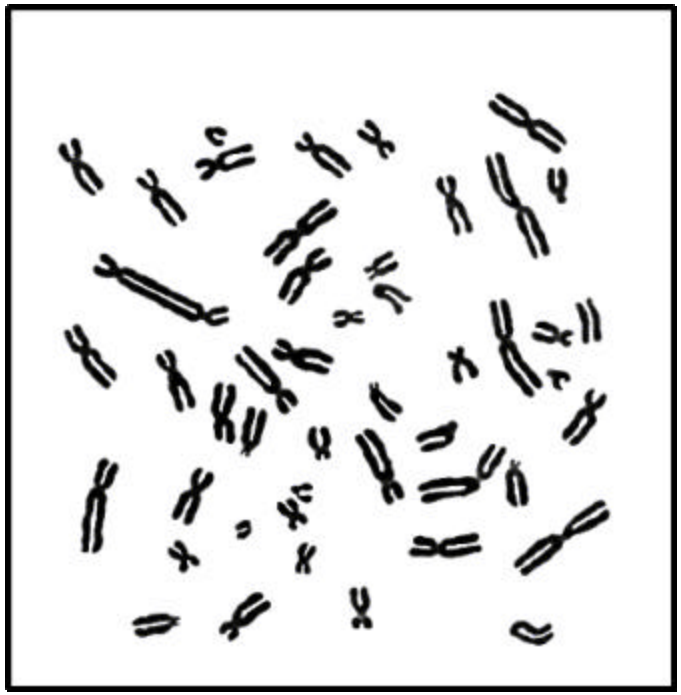
Increase in chromosomal aberrations in human fibroblasts after RF-EMF exposure (1950 MHz, 5 min on/10 min off, 2 W/kg, 24 hrs) (Rüdiger et al.)

aberrations	exposed	sham
break	8.5 ± 0.7 %	1.7 ± 0.1 %
ring	---	----
DIC	4.5 ± 0.7%	---
ACF	1.5 ± 0.7 %	---

in addition to these aberrations also gaps were detected:

exposed: 57,5 ± 2,1% **sham: 4,8 ± 1,6%**



scored metaphases: 5 X 1000

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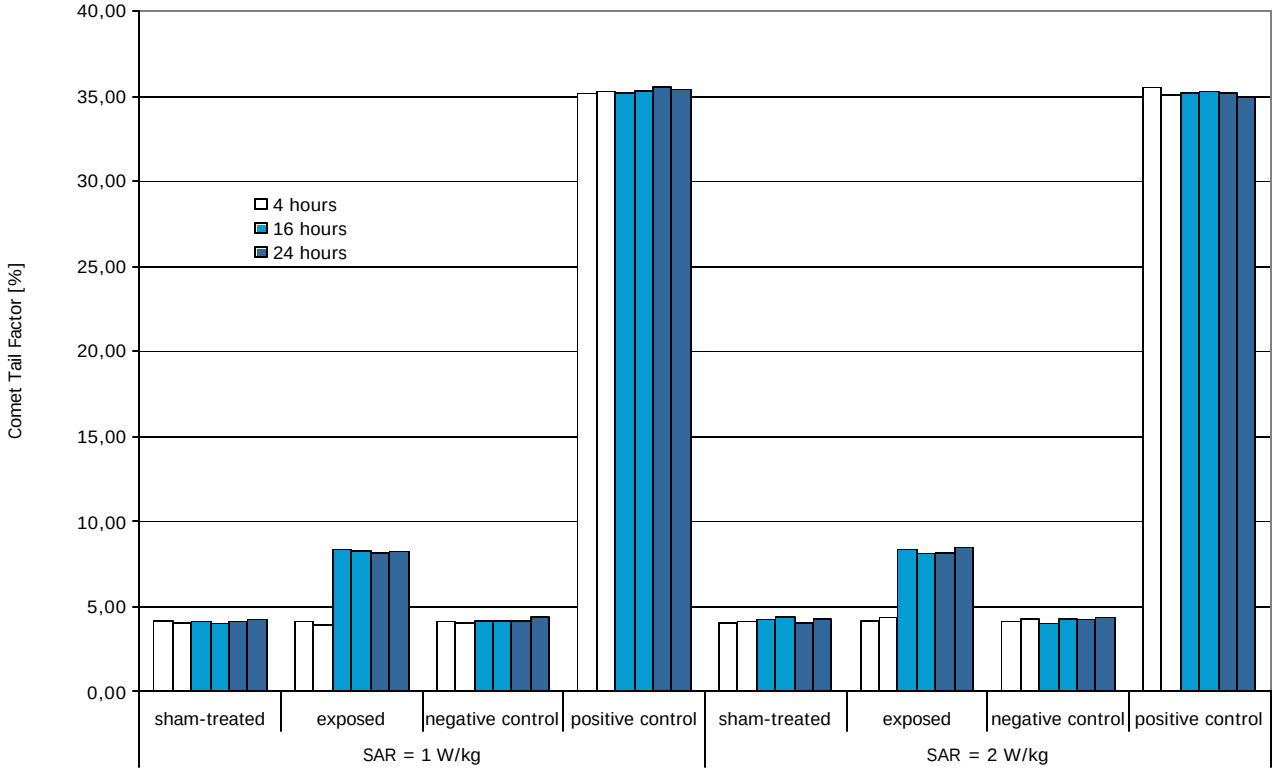
Increase in DNA strand breaks in human fibroblasts after continuous exposure to UMTS test signals for 4, 16 and 24 hours at a SAR value of 1 and 2 W/kg. Each exposure condition was tested in duplicate (Rüdiger et al.).



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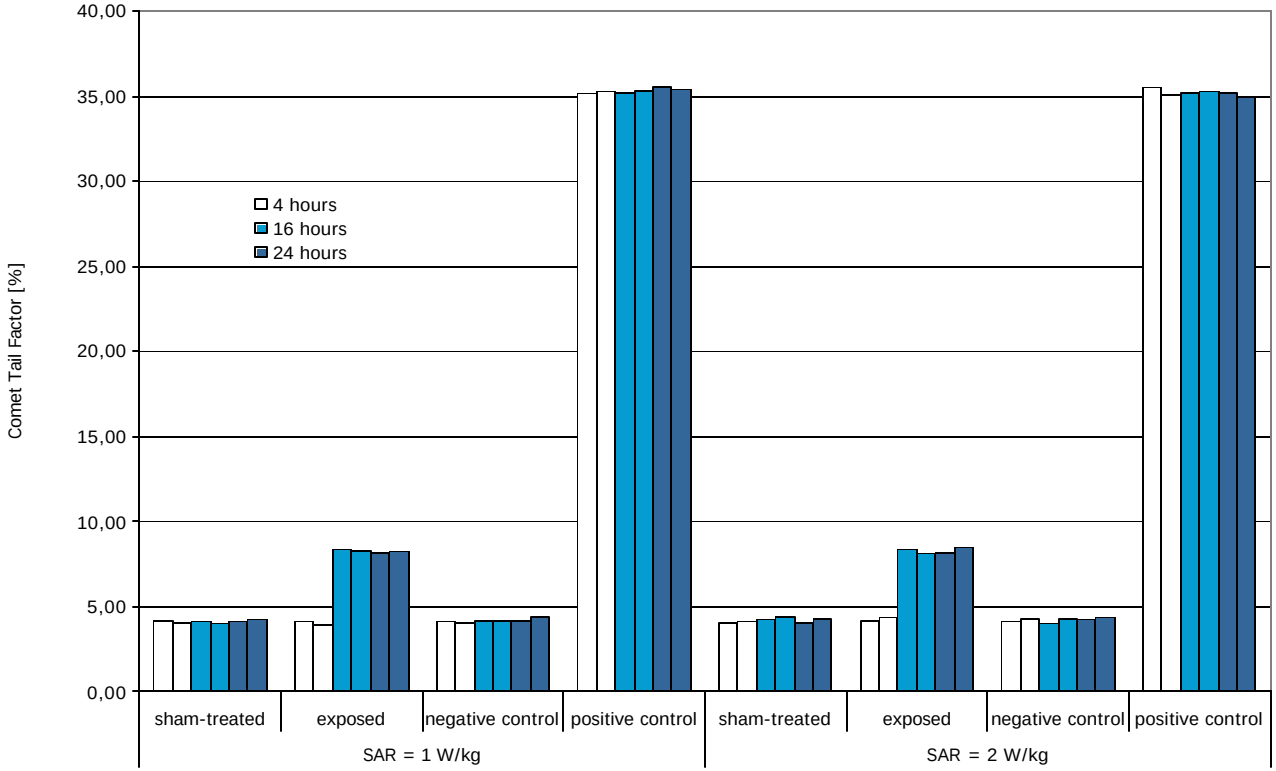
Increase in micronuclei in human fibroblasts after continuous exposure to UMTS test signals for 4, 16 and 24 hours at a SAR value of 1 and 2 W/kg. Each exposure condition was tested in duplicate (Rüdiger et al.)



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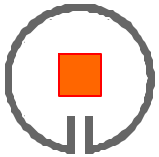

Summary

- **Intermittent and to a lesser extent also continuous *in vitro* exposure of human fibroblasts to RF-EMF below the safety limit of 2 W/kg for more than 4 hours produced genotoxic effects in various cell types as measured by**
  - **an increase in DNA single and double strand breaks,**
  - **an increase in micronuclei and**
  - **an increase in chromosomal aberrations.**
- **A significant increase in DNA strand breaks was observed in human fibroblasts at a SAR value as low as 0,3 W/kg.**
- **Exposure of human fibroblasts to UMTS at and below the safety limit of 2 W/kg resulted in an increase in the rate of DNA strand breaks and micronuclei, thus sugesting a genotoxic potential of UMTS, too.**

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Conclusions I

1. From the scientific point of view, the REFLEX data do not prove a causal link between EMF exposure and any adverse health effects, but may in connection with other findings speak more in favour of than against such an assumption.

2. Further research is needed a) to confirm the REFLEX results by additional laboratories, b) to extend the investigations to other EMF frequency ranges such as used e.g. for RFID, and c) to find out whether or not comperable results can be obtained in appropriate animal models and human volunteers.

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Conclusions II

With this message it should be made clear to politicians, to health officials in governmental administrations and also to the leaders of industrial companies

1) **that a potential risk to the health of people through EMF exposure can in no way with some certainty be excluded at present,**
2) **that help to escape the existing dilemma can only be expected from scientific research,**
3) **that it is their responsibility to provide the necessary financial means, so that science can do what has to be done, and**
3) **that the acceptance of the pre-cautionary principle at least in its softest form, especially for children, is certainly justified already now.**

