

EMF Portal – An Internet on the effects of

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Introduction

The electromagnetic fields from radio applications are encountered everywhere in our daily life and work. They are frequently the subject of public discussion. Many people are afraid of the possible (negative) effects of such fields on their health. However, in the clash between opponents and supporters it is difficult to make one's own picture of the actual state of expert knowledge and to form one's own opinion.

Scientific studies, which represent an important basis for assessing current knowledge about the effects of electromagnetic fields on human health and the environment, could provide assistance in rectifying the lack of objective information. They do suffer from the following problems, however:

- They are inaccessible to lay persons without a great effort being made and
- They are frequently difficult to understand;
- Individual studies often contradict each other,
- They are usually published in international specialist journals and they
- Contain a large number of technical terms of which even scientists from other fields understand little and non-experts understand nothing.
- In addition, they are often in a large and complex setting which calls for a wide-ranging background knowledge.

Besides this, it is very difficult and time-consuming to find the appropriate publication from a growing body of technical literature already containing more than 10,000 titles on current topics and a variety of changing subjects.

In a nutshell: Concerned citizens, decision makers and disseminators of information who want to make up their own minds about the effects of electromagnetic fields on humans and the environment can only access scientific information with difficulty.

Currently compact, comparable and understandably edited research findings from the appropriate studies of the last 25 years are only available in the context of the portal outlined here (<http://www.emf-portal.de>), an information platform covering the effects of electromagnetic fields on human beings and their surroundings.

When developing the EMF portal, the vision that was pursued was also to give non-experts the chance to inform themselves about the environmental compatibility of electromagnetic fields. In order to achieve this, the findings of scientific research from individual studies have been summarized in an understandable way. A "Glossary", a "Summary of the fields encountered every day" and an "Introduction to the basic mechanisms of electromagnetic fields" are tools that provide support.

This online information system consists of two modules: The literature database, which is backed by the Forschungsgemeinschaft Funk (Research Association for Radio Application) and the *Forschungsstelle für Elektropathologie* (the German Research Centre for

information system electronic fields

Electropathology – the ‘fFe’) and is embedded in the literature database along with the so-called EMF portal itself. The EMF portal has been developed with the support of the *Bundesamt für Strahlenschutz* (Federal Office for Radiation Protection – BfS) in order to be able to tailor the contents of the literature database to the information needs of different user groups. Summary of the information sources being provided The opening page of the EMF portal (Fig. 1) provides the user with a summary of the different information that can be directly selected with the navigational tool (left on the page) and which is explained below. In addition, a comprehensive range of assistance is

available, which explains the individual modules and functions to the user, a step at a time (“Help“ menu item).

The language (German or English) of the information offered can be selected using the icons. In the centre of the page one finds the actual information chosen by the user or a brief summary of what is offered on entering the EMF portal.

The literature database – the centrepiece

The centrepiece of the EMF portal is the literature database, in which published scientific studies in the fields of bio-electromagnetic interactions between low



Figure 1: The information system's home page

and high frequency fields and the organism are collected and prepared in a variety of levels of detail. Articles are found using the “Publication search“ menu item, as well as by extracting the biological, medical, technical and dosimetric data contained in them in different detail levels.

The extract (in German and English) provides clear and understandable summaries of the individual articles. Interested users can use of the Internet-based data and evaluations to make their own impressions of the most important contents and quality of the edited publications, without having to see the original scientific texts concerned.

The abstracts are written by specialists from the discipline concerned: first the information on the exposure used is prepared, then the medical/biological investigation parameters (*basic data*).

The basic data (Fig. 2) thereby reflects the essential contents of the published research findings and gives the reader a brief and precise overview of the publication, without him or her having to delve into details. The structure of the basic data is identical for each article, which helps provide both a rapid orientation and makes the studies comparable. The structure is as follows:

- Bibliographical details
- Aim of the study with facultative background information
- Conclusion(s)
- The most important exposure data (if desired, all the information on the exposure data can be called up)
- Details of the methodology (measurement parameters and the system investigated)
- Main findings, as described by the author of the study
- Additional information such as study features and reference articles

News from science

Here, current scientific information from national and international organisations, bodies and research groups is presented. This news is not intended to compete with other available news tickers, but is limited to pure-

General Data for article

"902 MHz mobile phone does not affect short term memory in humans."

by Hertz C, Dietl G, Grotberg L, Lahn M, Pionzato A, Pionzato M, Harsanauer W, published in: *Bioelectromagnetics* 2005, 26 (6): e12-200 ([PubMed Entry](#))

For this survey use the following ext. data accessible: [Data](#)

Aim of study (according to author)
To study the effects of an electromagnetic field as emitted by a 902 MHz mobile phone on human short-term memory.
Background/other details:
The study was a randomised with methodological improvements (multi-centre testing and a double-blind study design) to a previous study (publication #4728). A total of 64 subjects in two independent laboratories performed a short-term memory task.

Abstract

- epidemiological endpoints: short-term memory

Exposure

Field characteristics	Parameters
902 MHz (F) modulated (FM) exposure duration: 65 min	0.017 W/m ² (mean value) (measured using a Planar) (EMF: 2.07 W/kg) (reference value)

[View further exposure parameters](#)

Exposed system:
phone
peripheral environment: head

Methods
Measurement parameters:

- epidemiological endpoints: short-term memory, working memory load performance in sequential letter memory task, memory load was rated from 0-3 times in a 6-back task (reaction time, accuracy of response)

investigation on living organism
time of investigation: during exposure

Main outcomes of study (according to author)
No statistically significant differences in performance between the two laboratories were found. The authors could not replicate the previous results. The electromagnetic field had no effect on reaction times or on the accuracy of the subjects' answers. The inability to replicate previous results could have been caused by lack of actual electromagnetic field effects or the magnitude of effects being of the variability threshold of the test used.

Study identifier: medical/biological study, experimental study, replication/reproduction study, replication study of Konrad M, Pionzato C M, Pionzato A, Lahn M, Harsanauer W: The effects of electromagnetic field emitted by mobile phones on working memory in humans (part 2005, 11 (1): 1841 - 1847) ([PubMed Entry](#), [PubMed ID: 16110070](#), [PubMed Link](#))

[Click to search result](#)

in:
epidemiological, cognitive (double blind), electromagnetic field, endpoints, exposure, GSM, human, memory, MHz, mobile phone, a back task, random, FM, reaction times, replication, replication study, SAR, sequential, threshold, working memory

Figure 2: Basic data (general data of a study)

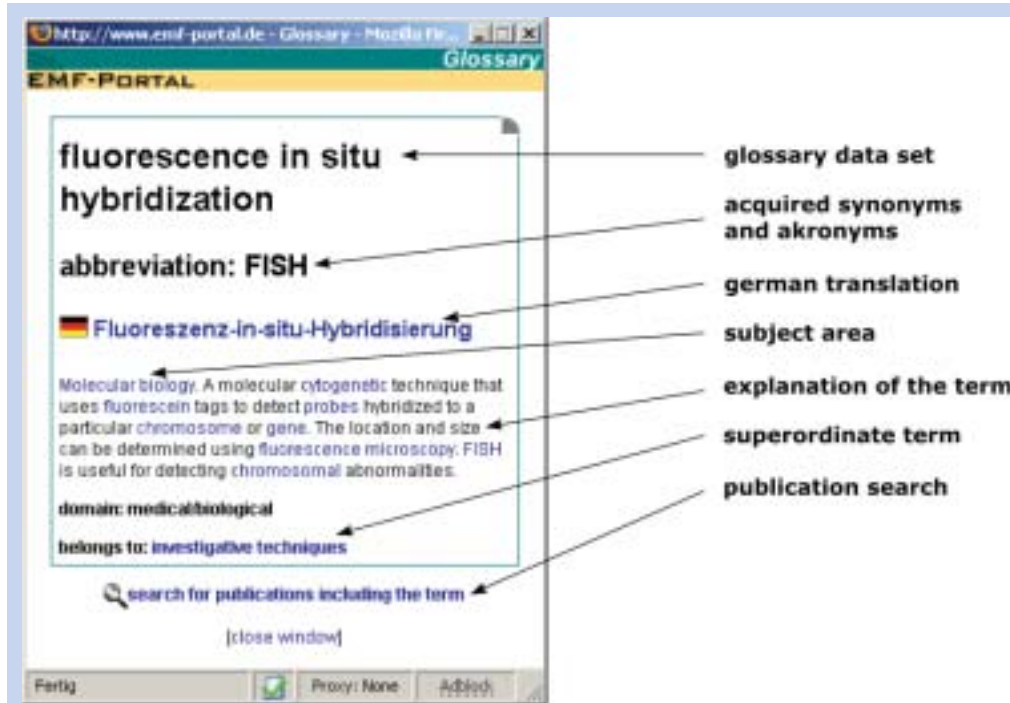


Figure 3: Example of a glossary entry

ly scientific facts. The focus is on predominantly scientific topics, which are not described in the individual publications in the literature database (e.g. reports on the German mobile telephony research program).

Basics

For an introduction to the interdisciplinary issues that can be readily understood by the lay person, *Basics* offers extensive fundamental information. The issues offered in detail:

- Introduction to the physical basics,
- Electromagnetic fields in the human environment,
- Biological effects and
- Limits.

Glossary

Technical terms (in English and German) from the electromagnetic environmental compatibility sector. Because the research in this field covers a broad spectrum of specialist areas such as neurophysiology, molecular biology, genetics, epidemiology, oncology, medical technology, physics, electrical engineering and communication technology, the glossary gives

users with different levels of knowledge the opportunity to look up terms they do not understand. With the aid of the glossary, even a layman can acquire the most important background knowledge on the biological effects of electromagnetic fields.

In order to ensure as precise a reproduction of the original work in the database as possible, technical terms are used during the extraction of the basic data, which are then added to the glossary at the same time. Hence those terms from the contents of the EMF portal that are included in the glossary are automatically linked to the glossary entries (the blue-highlighted expressions within the basic data in figure 2 are cross-references to the glossary; a click on one opens the corresponding glossary entry with the explanation). Figure 3 shows an example of an explanation offered by the glossary. A *simple explanatory note* gives the non-specialist an initial assessment of the term (example: fluorescence in situ hybridisation – method for depicting hereditary material) while the full scientific explanation also provides the information required by the specialist (for instance: fluorescence in situ hybridisation – molecular biology. A

molecular cytogenetic technique that uses fluorescein tags to detect probes hybridized to a particular chromosome or gene. The location and size can be determined using fluorescence microscopy. FISH is useful for detecting chromosomal abnormalities.) To help formulate the concise explanation, non-experts are also involved in order to ensure a genuinely understandable explanation. *Synonyms and abbreviations* (for example, FISH) supplement the explanations, a *classification* (e.g.: medicine/biology) and the higher term (e.g.: investigative methods) give the term context. The glossary currently covers 1650 entries each in German and English, of which 1400 are from the field of medicine/biology, 240 from technology/dosimetry and 50 from epidemiology. In order to supplement the entries, a further 890 synonyms and 180 abbreviations have been added. A total of 350 terms contain additional introductions suitable for non-specialists.

Database of exposure sources

The database of sources that are encountered daily records the most important parameters and characteristics of exposure that people have to regularly face. The database currently lists more than 100 exposure sources with their characteristics, and over 150 synonyms.

Only the actual parameters of the sources are recorded in the database (e.g. In a household conductor through which current is flowing, the magnetic flux density plays the decisive role. The electrical field, although certainly measurable, can be neglected). The parameter that is assigned the maximum measured value is that which can occur at a freely accessible location. Figure 4 shows the exposure source view for a German D-Netz cellular phone. With the aid of a graphic, the frequency spectrum is shown in relation to the frequencies of known sources.

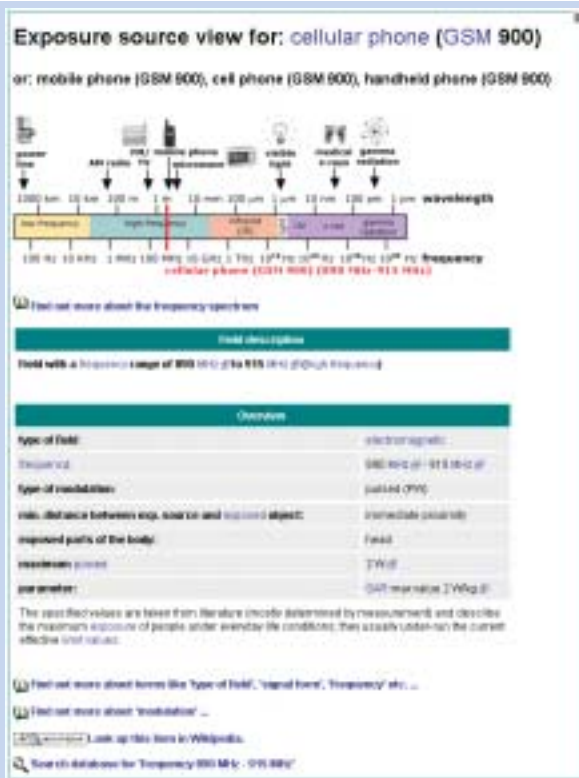


Figure 4: Example of exposure source



Figure 5: Menu



Figure 6: Site search and choice of language functions

Using the information provided in the EMF-Portal

Navigation within the EMF portal

There are two different ways of navigating within the EMF portal.

The menu (Fig. 5) on the left-hand side of the portal is suitable for using the information without asking any concrete questions. It can be employed to directly access and use information.

With the aid of the site search function (Fig. 5), the individual information sources can be searched, e.g. glossary entries or exposure sources. The site search function is located at the top right of the screen, near the buttons for the choice of language (German/English). The actual main window can be seen in the centre of figure 7. This displays the information required. In this example, letter A from the glossary can be seen. The right-hand side of the Web presence shows a help-text, tailored to the data being viewed (the glossary help-text in this example). Basically, all the (technical) terms used in the portal's information texts are linked to the glossary. Figure 8 shows a text in which the terms concerned are joined to the glossary entries by hyperlinks (blue text). By clicking on these, the corresponding entry will open in a separate window.

Application – an example

The actual use of the information system is explained on the basis of an example query. The person asking is an informed citizen who wants to know whether the electromagnetic fields used by mobile telephone could have any influence on human behaviour or cognition.

The basic facts on mobile (cellular) telephony

Using the site search function (search term *cellular radio*, selected in *Basics*) the user will find a text on the basics of mobile phones (Fig. 8), in which such aspects as transmitting power, radio cells, network planning, and antenna site selection are explained. Should the requirements extend beyond this, other items of background information can be called up using the table of contents (e.g. on the physical characteristics of electromagnetic fields, electrosensitivity, limits, etc.) (Fig. 9).



Figure 7: Main window and help

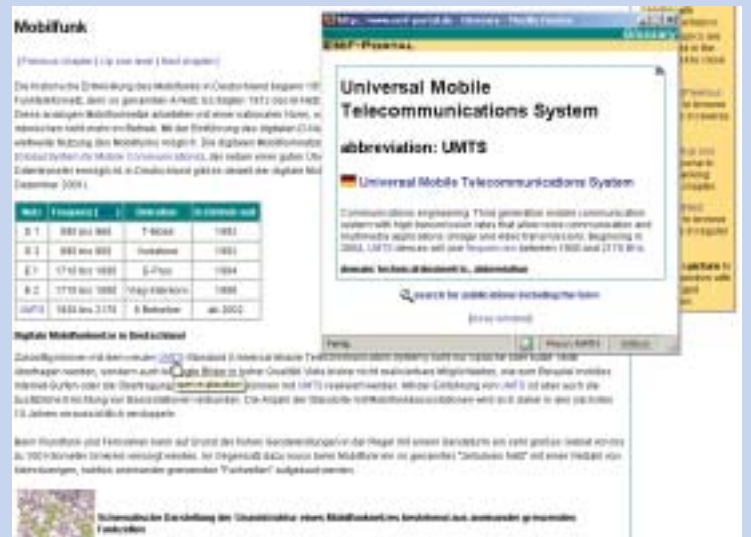


Figure 8: Basic information with the „UMTS“ glossary entry

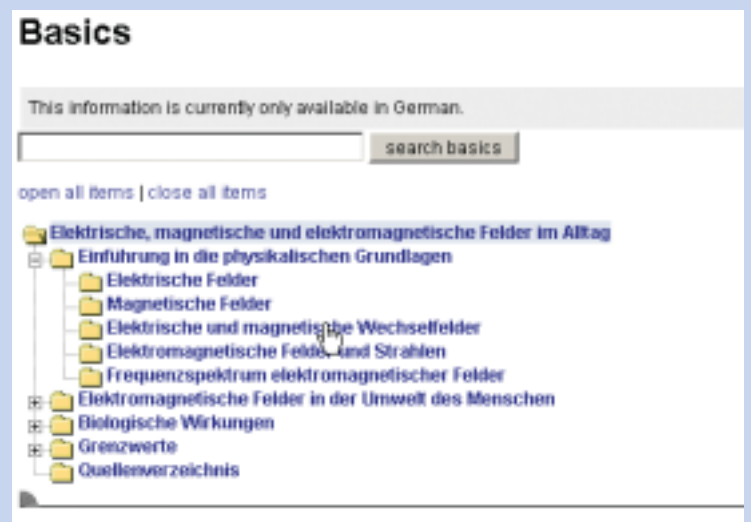


Figure 9: The basics - contents



Figure 10: Detailed query



Figure 11: Exposure parameters: search possibilities



Figure 12: General data: search possibilities

Glossary entries on the subject of cellular radio and behaviour

The next place to go in this example would be the glossary, in which the still unknown terms can be looked up (e.g. hypersensitivity, SAR). By linking the glossary entries with each other, the user will then be encouraged to look at other explanations. In the explanation to the entry on *operant behavior* for instance, the term *conditioning* is used and linked to the appropriate glossary item. Figures 3 and 8 show examples of glossary entries.

Exposure sources – cellular radio

With the aid of the exposure sources database, the user can get information on the actual exposure from the different technical devices that make mobile telephony possible (base station, cellular phone, the German *D-Netz* and *E-Netz* networks, etc.). Figure 4 shows an example entry.

Search for scientific studies on the subject of cellular radio and behaviour

With terms and basic features to aid a general understanding of the problem in the foreground, the research findings published in scientific studies are aimed at providing an initial answer to the questions. There are two different search methods to find studies relating to the issues concerned. In this example, the terms *cellular radio* and *behavior* are entered in *standard query* mode. The search machine translates the terms into English (english language) and looks for related terms to add to the query. In addition, the frequencies used in mobile telephony are automatically integrated into the query by the search machine. The *detailed query* mode also allows the user to restrict the question very well (Fig. 10). First of all, the query can be limited according to bibliographic details (author, title, abstract, journal, year, and keywords). By clicking on the *exposure parameters* link (Fig. 11) and/or *general data* (Fig. 12) a number of additional selection opportunities become available and the query can be further limited. In the case under consideration, the user is looking for all publications dealing with exposures in the 900 MHz to 2 GHz frequency range. The search is limited to the

cognitive/behavioural endpoint parameters and the human being as an „exposed system“ in the general data. It has to be borne in mind that in *detailed query*, merely including *exposure parameters* and/or *general data* represents a limitation of the number of hits, as the search for suitable data can only be made in publications from which data has already been extracted. Looking for articles on the basis of bibliographic data means that the entire data contents are searched through (currently approx. 8,000 articles). By looking in the exposure parameters, the hits will be reduced to just 3000 articles, while by including the general data the data from approx. 1000 publications can be searched through.

Results from the query on the subjects of cellular radio and behavior

The articles are first shown in a hit list. Figure 13 shows the first four texts to be found on the subject. To provide a better summary, the list not only contains bibliographical data, but also extracted details on the respective study.

The list can be sorted on the basis of the following parameters (in ascending or descending order):

- Accuracy (the place where the terms were found provides an indication of the relevance of the findings)
- Type of publication (medical and biological works first)
- Journal
- Title
- Author
- Year

By clicking on an article in the hit list, relevant details can be called up, such as the basics (Fig. 3) or detailed exposure data.

It is also possible to generate a variety of graphics with the help of the hit lists. Figure 14 shows an example where the findings are broken down according to year of publication.

The information system's perspectives

The EMF portal has already become the subject of lively interest, as the access statistics and feedback



Figure 13: Hit list

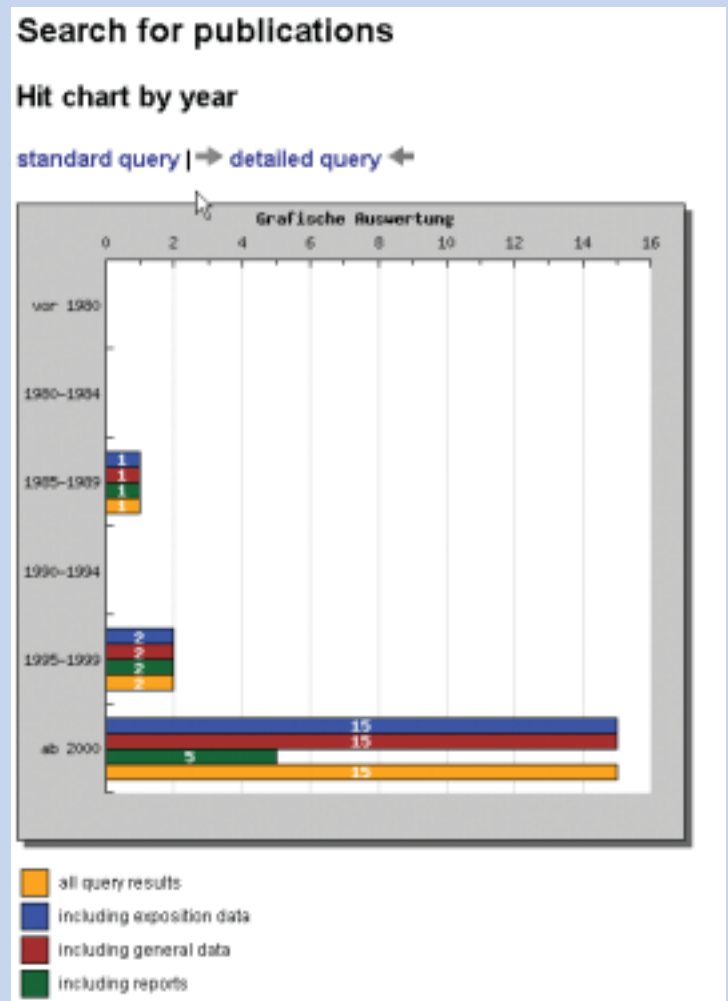


Figure 14: Graphic evaluation (based on years)

from the users show. In order to be able to satisfy user requirements in the future too, an information system on the scale of the EMF portal and literature database has to be continuously maintained and further developed. On the one hand, new research findings are being published and have to be recorded and extracted. On the other hand, there are still many new ideas waiting to be put into practice. In order to give readers a small impression of what may be expected in future, we will introduce a few ideas here, the implementation of which (provided manpower is available) is already being planned.

- The main emphasis remains on the continuous expansion and maintenance of the data resources, in other words quality assurance, enquiry and entry of new publications, as well as extracting data from them.
- Up to now, the main emphasis has been on medical and biological papers when extracting data from publications. In the context of the resources available, the acquisition and extraction of epidemiological studies will be one of our next focuses.
- In addition to the basic data, a so-called full extract (containing all the information in the original publication) is to be developed and made available.

It is envisaged that this fully extracted text will be offered for selected publications (milestones, etc.).

- It is aimed to make it possible to generate additional interactive graphics, for instance showing those studies where an effect has been determined and those where it has not.
- Later versions of the EMF portal will pay great attention to the usability and the appearance of the Website. The wide-ranging texts will be made more attractive with the aid of symbols and graphics.

Roman Wienert and Dr. Sarah Drießen work at the **femu**, Forschungszentrum für Elektro-Magnetische Umweltverträglichkeit (Research Centre for Electromagnetic Compatibility in the Environment) at the RWTH Aachen University and are in charge of the „EMF-Portal“ project.

The technically function – how does

User of the portal have two ways to search for the required publications. The *detailed search*, which is not outlined here, employs conventional algorithms that have been adapted the needs of the search.

On the other hand, the *standard search* represents a particular form of search machine, as the search terms are linked to the glossary and the exposure sources database. The way of these technically functions has to be briefly explained here. The figure shows the *standard search* flow chart. The search terms are written in an array¹, words in quotation marks are treated as words that belong together, as is usual search machine practice (e.g. “*in vitro*”). Each of the array elements is then run through the search machine routine and each plays its separate role in helping generate the actual database query. The array elements are treated differently, depending on the information content found:

- If the array element looks as it is probably a year (condition: number and range of numbers between 1850 and 2006; numbers between 70 and 99 are interpreted as 1970 to 1999), the search result is limited to that one year (AND year = ...)
- The subject found in the table of abbreviations is also treated as *case sensitive*, in other words the lower and the upper case are considered. All contents which are clearly not abbreviations are treated as *case insensitive*. This restriction plays a major role in full text searches. If one were looking for a word fragment (e.g. RF as abbreviation for Radio Frequency) in a *case insensitive* search the word „performance“ would also be found as a fragment – though it has nothing to do with the desired result).
- The array element is then looked for in the glossary tables: in the actual glossary table, the syn-

of the search machine it work?

onyms and similar words. The word found can be translated (German into English) and transmitted to the search machine with all the appropriate entries, as well as the superordinate terms. In addition, it is determined whether the search query concerns medical/biological or technical terms.

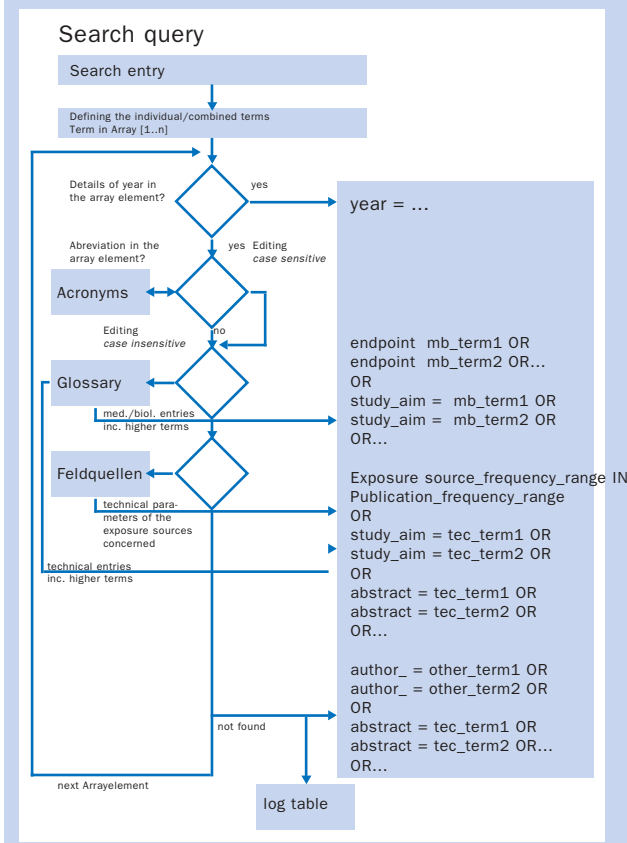
- If the array element is located in the exposure sources database, the characteristic technical parameters are also employed in order to further limit the search result.

Finally, only those search terms remain that cannot be found in any of the existing tables. These terms are written out to ascertain possible glossary entries that may be missing.

After each array element has run through this loop, the information gathered is linked to a database query by means of a logical AND operation:

The *medical/biological* contents are linked to each other by means of logical OR operations. All the relevant glossary entries and their subordinate terms are employed for the search in the full text index. For the search in the specially created search index, based on the data extracted, it is sufficient just to look for appropriate key entries or for the key entries of the superior elements.

The *technical contents* is initially linked with a logical OR operation, like the *medical/biological* contents. In addition, in the tables with the exposure characteristics, studies are searched for fields similar to those described in the exposure sources database (e.g. the user is looking for the German word *Handy*. First of all, the translations *cell phone*, *mobile phone*, etc. are determined. Then the corresponding frequency details are obtained from the exposure sources database and compared with the frequencies of the exposure sources described in the publications. Then the



search parameters are linked by a logical OR search parameter and a database query is generated. Those contents that could not be assigned are viewed as conditions and thus linked by a logical AND.

The user has the chance to view the database query hit list produced by the search machine and where possible to learn from it how the result was achieved and why it did not provide that which was anticipated or hoped for.

Footnote

¹ An array logs any required data of a uniform data type in the computer memory in an orderly manner. Access is via an index. Example: The search entry is "mobile phone behavior human", which gives the following search array: search array [1] = "mobile", search array [2] = "phone", search array [3] = "behavior", search array [4] = "human"