
Current State of Radiation Research in Germany

K. Komorowski, H.G. Friederichs *, A. Artmann*

Federal Ministry for Education and Research (BMBF)

**(GRS)*

Abstract: In July 2000, the Commission on Radiological Protection (Strahlenschutzkommission, SSK) issued a comment in favour of maintaining radiation research at German universities and research institutes and warned of the foreseeable negative consequences of current developments. At the beginning of the year, the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) was commissioned by the Federal Ministry of Research and Education (BMBF) to prepare a substantiated and comprehensive survey of radiation research and teaching in Germany. The statements made in the SSK comments can be confirmed in all points. Without any countermeasures, the lack of young academics – together with the strong reduction in the number of relevant professorships in radiation research at the universities and the on-going cuts affecting established posts in public-funded radiation research will probably lead to the fact that in future, the expertise in issues related to radiation protection will no longer be available in Germany to the extent that is necessary.

To round off the GRS survey on the situation of radiation research in Germany, a workshop was held at which ways to maintain radiation research were shown up and recommendations for first steps were given. GRS believes the following suitable measures can be derived from the general stock-taking, that talks that were held and the results of the workshop: pinpointing job perspectives for junior scientists in research, industry and administration on the basis of an analysis, provision of special incentives to take up a university course and promotion of project-oriented research projects involving the longer-term financing of junior scientists, networking and bundling of research capacities by the increased joint use of equipment at the various research institutes, preservation and strengthening of the few remaining professorships at the universities dealing with radiation research, measures to maintain competence by the well-directed provision of funds for equipment and staff and the promotion of joint projects and increase of public acceptance in connection with the use of ionising radiation in research, medicine and technology by enhanced public information.

1. INTRODUCTION

Radiation research deals with the impacts of ionising and, to an increasing extent, also of non-ionising radiation. It makes important contributions to environmental research, significantly influences the developments in medicine and biology and considerably contributes to the development of technical and organisational measures for the reduction of the radiation risk

In July 2000, the Commission on Radiological Protection (SSK) issued a comment in favour of maintaining radiation research at German universities and research institutes and warned of the foreseeable negative consequences of current developments. Since the beginning of the nineties, chairs becoming vacant in the field of radiation research are no longer filled with the corresponding experts. The Federal Government has been requested to resolutely counteract the trend of reducing activities in the field of radiation research. The German Federation of institutions for statutory accident insurance and prevention (HVBG) has also expressed concerns about the increasing lack of senior experts and with regard to a sufficient number of young academics in the field of radiation research in a letter to the Federal Government.

Similar requests and concerns are expressed by the

- Nuclear Chemistry Section of the German Chemical Society (GDCh), position paper February 2000, and the
- German Association for Radiation Oncology (DEGRO), position paper 2001

In the field of radiation research, the objectives of R&D activities performed are very different. Radiation research is an essential part of the following fields of study:

- radiation biophysics, radiation biology
- nuclear chemistry, radio- and radiation chemistry
- radiation measuring technique, radiation protection engineering
- radioecology
- radiation epidemiology
- radiation protection in medicine
- medical radiation physics
- medical radiation biology
- radiopharmaceutics

GRS has been commissioned by the BMBF on 13th February 2001 to prepare a substantiated and comprehensive survey of research and teaching on ionising radiation in Germany.

2. SURVEY

Initially, the BMBF sent a circular letter to the respective authorities of the *Länder* requesting them to name the responsible contact persons and institutions/working groups. The information received and additional searches in the data bases of the data collection on the “Centre of Competence” of the EU and the data collection on “Nuclear safety and repository research in Germany“ have been the basis for the further works.

The survey was prepared in three steps:

- In a first step, freely accessible data were acquired via an Internet search and collected in a GRS data base.
- The current state of radiation research was then determined by means of a **questionnaire campaign**. A questionnaire was developed that should give information about the current situations of the organisations and institutions in Germany working in the field of radiation research with regard to finances, personnel, education and research. The questionnaire was sent to 307 institutes, universities and companies. By the end of September 2001, 89 questionnaires have been returned. 16 further institutes declared that they are not or nor longer conducting radiation research.
- To supplement the questionnaire campaign, “**on-site interviews**” were conducted with institute directors and scientists being active in the field of radiation research. These were, in particular, the Institute of Radiation Biology of the University of Essen, the GSF-National Research Center for Environment and Health near Munich, the Federal Office for Radiation Protection (BfS) Munich, PTB Braunschweig, the University of Applied Sciences, the Giessen University, the Center for Radiation Protection and Radioecology Hannover of the Hannover University and the Mainz University.

The survey of the current state will serve as a basis to determine the need for action considered to be necessary to ensure a continuation of the highly-qualified radiation research in Germany and to derive recommendations on the required sponsoring of radiation research in future.

3. RESULTS

The data and information of the returned questionnaires were registered in the GRS data base and evaluated. The results achieved from the questionnaire campaign were discussed with the experts of the institutions interviewed “on-site”. The consequences of reductions in the field of radiation research and possible measures of the Federal Government, the *Länder* and the scientific institutions on maintenance and stabilisation of radiation research have been discussed in detail. The interviews were about 1.5 to 2 hours in duration. They were recorded and respective minutes were prepared.

3.1 Questionnaire return

Table 3.1 shows the distribution of the questionnaires over the *Bundesländer* and the return rate in percents. The *Bundesland* Saxony shows the highest return rate, whereas no data have been received from Thuringia, Saxony-Anhalt, Bremen and Brandenburg. With about 30%, the total return rate is to be regarded to be representative, since questionnaires have also been sent to institutes and research institutions dealing with related research topics. Two institutes stated that they did not reply since they had participated in a similar campaign before. In one case, the questionnaire was completed during a personal conversation and in another case during a telephone conversation with institute directors, thus receiving information for the evaluation.

Table 3.1: Return rate of the questionnaires at federal level

Bundesland	Dispatch	Answers	%
Hamburg	11	7	64%
Lower Saxony	18	7	39%
Baden Württemberg	57	18	32%
North Rhine-Westphalia	58	18	31%
Saarland	4	1	25%
Hesse	37	9	24%
Schleswig-Holstein	5	1	20%
Rhineland-Palatinate	6	1	17%
Bavaria	41	6	15%
Berlin	21	3	14%
Mecklenburg-Western Pommerania	9	1	11%
Brandenburg	2	-	
Bremen	2	-	
Saxony-Anhalt	2	-	
Thuringia	10	-	
Saxony	24	17	71%
Total	307	89	29%

3.2 Financial situation

From 82 institutes, only 6 stated that the budget will rise in the next years. 18 institutes expect a stagnation and 23 a reduction of financial means in the next years. The other institutes did not make any specifications on this question.

For a fairly long time, the financial means for basic financing and R&D projects for radiation research have been decreasing. Apart from a few exceptions, the budget at the Universities in the field of radiation research stagnates or decreases, respectively. Moreover, the financial means at large research institutions, such as GSF, are regularly adapted to the current staff number, so that cutbacks in funding cannot be counterbalanced, thus inevitably leading to further reduction in staff.

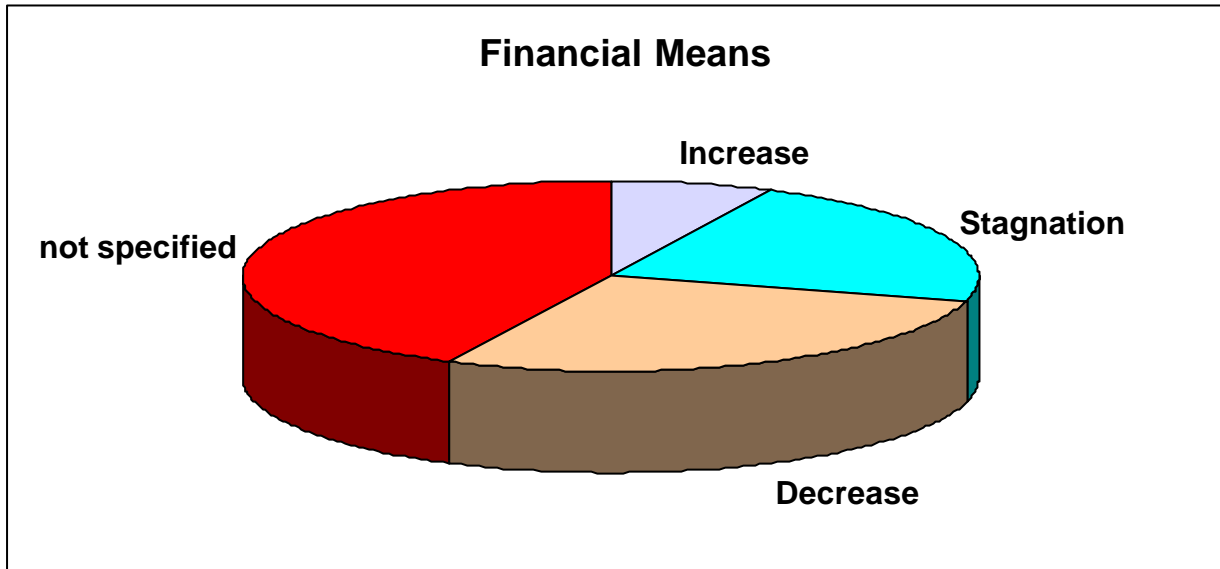


Fig. 3.2: Financial situation of the surveyed institutes

In the case of the PTB, e.g., the situation is different. The budget stagnates above all regarding the figures, i.e. it decreases in value depending on the inflation rate. However, it provides sufficient planning certainty for personnel and real investments.

3.3 Personnel situation

The evaluation of the questionnaires gives reason for concerns regarding the personnel situation in the field of radiation research. The average age at institutes, research institutions and chairs is high. Many notable experts will retire from the universities within the next five years. Chairs will not be filled again or rededicated and are assigned to other faculties. The expertise in Germany in the field of radiation research is close to extinction. So, there will presumably be no more experts for internal dosimetry in Germany in three to five years; the last chair for radiation biology at a scientific faculty will be discontinued next year. At GSF, half of the staff members of the institute for radiation protection will retire within the next five years without any successors foreseeable.

Junior scientists leave the universities due to employment cutbacks, only temporary employment contracts, difficulties in the application for and performance of research projects or non-competitive salaries compared to the industry. Obviously, the choice of occupation is largely influenced by the factors financial security and permanent employment contracts, since the PTB still has a sufficient number of applicants for advertised vacancies. Today, new entrants receive a salary of BAT (Federal Collective Agreement for Public Employees) IIa $\frac{3}{4}$ at the PTB, compared to BAT IIa $\frac{1}{2}$ at the universities.

3.4 Education situation

Some universities complain about the drastic decline in the number of students in the scientific fields physics and chemistry. At the Giessen University, e.g., only 135 physicists enrolled in the winter semester 2001. 38 of it were first-year students. In this semester, there were no undergraduates at all in chemistry. At the TU Munich only 7 undergraduates enrolled in physics during this period of time. According to the ZVS (Central Admissions Office), the share of scientific fields of study among undergraduates has decreased from formerly 39% to 27%. The decline in these subjects of study is accompanied by the decline in interdisciplinary subjects, such as radiation biology, radiation physics and nuclear chemistry. This is attributed to the assumed lack of employment prospects.

In many cases, dissertations can only be financed through outside funds, where the employment contracts may only be limited to a maximum of five years. The familiarisation period was estimated by the different institutions at one to two years, the subsequent research period at two years and the preparation of the dissertation at one year. In some cases, chairs have also to compete with IT companies who entice doctoral candidates even before completion of the dissertation.

The education of scientists in the field of radiation research is exclusively provided by the universities. Thus, each discontinuation of a chair has a direct impact on the education of junior scientists.

Large research institutions or authorities mainly recruit graduate scientists, whereas the universities of applied sciences mainly qualify technicians and engineers. A lateral entry of a graduate from a university of applied sciences to a university for earning a doctorate is practically impossible due to the existing examination regulations. In the field of radiation research, engineers are even more seldom than scientists.

3.5 Evaluation of the answers to the questions: consequences of the reduction and proposals on support/measures

3.5.1 Is your institution affected by the reduction of radiation research, described in the SSK statement, and if so, which consequences does it have?

At companies, authorities, technical inspection agencies and radiation clinics, the lack of young scientists is directly noticeable, since vacancies can no longer be refilled. For the same reason, chairs at universities cannot be filled with the respective experts, which aggravates the situation in the educational sector even more.

3.5.2 Which form of support/measure would be suitable to prevent or, at least, mitigate the negative consequences for your institution?

In the short term, the shortage in Germany can be bridged by foreign scientists. In the long term, only a specific support of basic research and corresponding promotion of junior scientist will remedy the situation.

The Deutsche Forschungsgemeinschaft (DFG) should be asked for assistance, e.g. to contribute to the maintenance of basic research by call for tenders in the field of radiation research.

Many answers showed that the chair holders would like to have more flexibility with regard to the establishment of temporary positions for scientific assistants to provide an additional incentive to study for junior scientists.

3.5.3 What would, in your opinion, be suitable measures to keep the subject fields radiation protection and radiation protection research alive?

In order to counteract the consequences from the reduction of chairs, proposals were made to concentrate the existing competence at a few specified locations. Only a sound infrastructure provides the possibility to sponsor diploma and doctoral theses in this field or even to attract foreign experts to Germany, where required. Primarily, basic research has to be strengthened.

The public acceptance regarding the use of ionising radiation has to be regained by specific information of the public. The fields of radiation protection and radiation research require a general reevaluation politically and also be the general public. It has to be made clear that, despite of phasing-out commercial use of nuclear power, experts are needed over several decades for the dismantling and decommissioning of nuclear facilities and for the final storage of radioactive wastes. A study in this field absolutely has good future prospects.

The newly introduced concept of programme-oriented sponsoring (PROF) promotes a "cross-institutional" application for research projects, which can hardly be realised in the field of radiation research to the lack of contract partners in Germany. Research in the field of radiation research represents an "interdisciplinary" environment-health research which can be applied in practice whose clear assignment to research areas of the PROF, such as "environment", "health" or "innovative technologies", is difficult to be done. One of the proposals was to establish an additional research area with the title "preventive research", in which, among others, radiation research could also be promoted explicitly.

An increase in the number of permanent employments could attract young scientists to the institutions.

3.5.4 By which measures can the Federal Government and the Länder - from your point of view as expert - counteract the downward trend in the field of radiation research?

According to the opinion of the research institutions, the universities should provide more funds for the maintenance and repair of facilities. Further, they stated that parts of the equipment was completely obsolete. Moreover, it was proposed to exclude the area of radiation research from the annual employment cutbacks in the public sector temporarily.

The basic research in the radiation therapy should be sponsored to a greater degree to link radiation research with modern technical developments on radiation generation, on radiation detection and on dose application on the one hand, and with the highly topical field of molecular biology for the selective efficiency increase in radiotherapy on the other hand.

3.5.5 Which fields of work of radiation research in Germany, in your opinion, are currently endangered the most and which the less?

Some fields of radiation research are imminently endangered. So, there are only less than four scientists dealing with the following fields in Germany: internal dosimetry and retrospective dosimetry. The radiation chemistry has already ceased to exist in Germany. Regarding neutron metrology, the PTB is the only institution in Germany dealing with this field.

In the following fields of work, there are only ten renowned experts active in the German radiation research: radioecology, measurement of radioactivity in environmental specimens, risk analyses and animal-experimental research.

In addition, the following fields of research are also endangered:

- radiation biology in natural sciences, and
- dispersion of radionuclides in atmosphere and water.

At present, radiation research in the fields of oncology and radiation measuring technique is not endangered yet.

However, there are also positive developments. So, progression is to be expected in the fields of non-ionising radiation and effect of small doses.

3.5.6 Which future consequences are to be expected, in your opinion, after cessation of radiation research in Germany?

Authorities and public institutions will no longer be able to fulfil their assigned duties. To some extent, this already applies to local authorities and communities.

If the current development persists, Germany will continuously less or in the end not at all be able to be represented in international committees. In the ICRP, e.g., Germany participates by three professors emeriti and one professor aged 64. The participation in UNSCEAR is also endangered, since the SSK cannot find a qualified expert in Germany at present. Without own research activities, an information exchange in partnership at an international level can no longer be realised.

Although the globalisation will increasingly influence national issues, Germany will not have the possibility to exert influence on international decisions regarding the legislation concerning radiation protection etc. in future, and will be over-directed by such committees in the near future.

The education of physicians and veterinarians in Germany is endangered, since a basic course in radiation biology is mandatory according to the license regulations, but the number of teachers will continuously decrease.

4. WORKSHOPS

On 7th and 8th March, the workshop "Situation of Radiation Research in Germany" was held at GRS Cologne. Scientists from large research centres, the universities, institutions from the Federal Government and the Länder and other technical institutions discussed possibilities to improve the alarming situation of radiation research in Germany. The only deficiency of the workshop was that, despite repeated invitation, it was not attended by representatives from ministries of education, science and research of the *Länder*.

The topics "radiation research" and "radiation protection" should not only be discussed in expert circles but also in public. The German Physical Society (DPG), which currently sponsors a campaign at schools for the study of physics to the amount of 0.25 million €, was proposed as possible co-operation partner for a public campaign. The joint use of facilities of the PTB or GSF, e.g., can increase the research capacities of the universities. A co-operation of radiation research and fusion research has

also been considered to be very advantageous. The proposal was made to prepare a demand analysis giving reliable and binding information on future prospects for new entrants and on the planning which fields of radiation research should be promoted primarily. The analysis should also give information on the demand of the research institutions regarding equipment and personnel.

DFG and BMU declared their readiness to sponsor projects in the field of radiation research more intensively.

The BMBF could provide annual funds for the sponsoring of research projects and postgraduate and postdoctoral positions in radiation research; respective applications can be submitted immediately.

At the end of the workshop, a list was prepared with main fields of research relevant in future, which is to be further specified and completed. In half a year, at the latest, another workshop shall be held with the title "The Future of Radiation Research", mainly intended for the discussion of future-oriented technical key issues.

Another workshop was held from 3rd to 7th October at the radiation centre of the Giessen University with the title "Radiation Research - Science for the Future".

Scientists from the field of radiation research in Germany, Japan, Italy, USA and UK were invited to this workshop. In addition to the survey of the scientific status of national and international radiation research, the great future potential was particularly pointed out. The heavy competition with the molecular biology, the difficult education due to its interdisciplinary character and the lack of acceptance due to its alleged closeness to the nuclear technology have been identified as main problems to be dealt with in the field of radiation research. The problems pointed out also exist similarly in the UK, Japan and Italy. Despite of the low number of active scientists in Germany, the quality of research is still very high.

Genomic stability, systemic radiation effects and "radiation and environment" have been identified as future main topics deserving promotion. Among these main topics, the future basic research on carcinogenesis, apoptosis, cell communication, low-dose effects, bystander effects, DNA repair and radiation therapy shall be performed and promoted.

5. MEASURES

The results of the survey and the of the workshops have shown that measures are required to be taken by the Federal Government and the Länder if the decline in expertise in the field of radiation research in Germany, already becoming observable, is to be counteracted and if the development shall be reversed, if possible.

In order to initiate a reversal of the trend and to maintain radiation research in Germany in the long run, two essential tasks have to be fulfilled in the opinion of GRS:

1. Maintenance and expansion of the "infrastructure"
2. Increasing the interest in studying radiation research

Partial success in one of the tasks can have a supportive effect on the other task. So, e.g., a modern equipment can be an additional incentive for young scientists to choose the respective field of study. An increase of the number of students in the field of radiation research, e.g., can influence the successor discussion for radiation research in the positive sense. For this reason, both fields should be dealt with in parallel to be able using such "side effects".

5.1 Maintenance and expansion of the “infrastructure”

5.1.1 Financial support

An adequate provision of personnel and materials enables the chairs and institutes to do research on the one hand, and also being attractive for young scientists on the other hand. By awarding or sponsoring of research projects, institutes can be supported financially.

An increase in research capacities and prevention of shortages can be achieved by buying new equipment or also by joint use of facilities of other institutes or research facilities.

5.1.2 “Educational-political” support

The filling of chairs is solely the responsibility of the universities. By corresponding information of the Länder ministries of education and the arts and also of the responsible university organs, the filling of chairs could be influenced positively regarding radiation research

5.1.3 Award of a promotion prize

An additional incentive for universities and institutions to be active in the field of radiation research in Germany is the award or sponsoring of a highly-endowed promotion prize for excellent achievements in this field.

As incentive for young scientists, the award of grants to especially outstanding young scientists is the mean of choice.

5.2 Increasing the interest in studying radiation research

In addition to the maintenance of the infrastructure, the attention of prospective students has to be drawn to the scientific possibilities and job perspectives offered in the field of radiation research. These information as well as possible contact persons, study opportunities etc. should be accessible as easy and fast as possible. As media, brochures, information sheets and the Internet are suited best.

The brochures and information sheets should be available from all relevant contacts of the students, such as:

- school (secondary schools, vocational schools),
- career counselling for secondary school graduates and degree holders,
- AStA (general committee of students) and students unions,
- job centres, in particular counselling for academics,
- institutes and chairs.

5.2.1 Establishment of a central platform for information exchange

The Internet offers a simple and very effective possibility for establishing a central information platform. The website to be established should be updated every day. It is important that the website is linked

with all relevant institutions and companies in the field of radiation research, universities and search engines, so that an access as simple as possible is ensured at any time.

The contents of the website should be:

- job market: search opportunities for graduate, postgraduate and postdoctoral positions and offers
- search opportunities for grant awards
- search opportunities for contract partners for joint projects
- list of institutions and chairs dealing with radiation research, including chair holders and contact persons
- scientific information

5.3 Identification of efficient promotion measures

In co-operation with the most important institutions and experts it should be investigated which disciplines and fields of radiation research have to be promoted primarily, to use the available means efficiently.

- **Science**
Assessment in which disciplines of radiation research an urgent demand for junior scientists exists or is foreseeable for the near future.
- **Research facilities**
Assessment which demand for equipment and personnel exists at the different research facilities for continuation of their research activities.
- **New entrants**
Assessment of the employment situation at universities, research facilities, nuclear power plants, supervisory authorities, expert organisations and insurance companies.

The results of the demand analyses are required to use the available means efficiently for the maintenance of the "infrastructure". Further, they serve as basis for the information offer and as guidance for first-year students.