Code of practice BNCT dosimetry: A European project

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Abstract. The guidelines followed for the dosimetry of BNCT in the European research reactors have been finalised by a consortium of 11 institutions. The work programme anticipated is outlined and the present status described.

1. INTRODUCTION

Boron Neutron Capture Therapy (BNCT) is a new form of radiotherapy expected to be beneficial to cancer patients with glioma, a type of brain tumour. The first European clinical trials with BNCT on glioma patients have started in Petten, The Netherlands, in October 1997. Other European countries, Finland, United Kingdom and Czech Republic, are approaching clinical trials, and pre-clinical BNCT-studies are progressing in Portugal and Hungary. To ensure the comparability and critical assessment of the results from pre-clinical radiobiological experiments and from clinical trials on human patients, it is of crucial importance that the basic characteristics of the neutron beam (beam geometry, neutron and gamma ray spectra, absorbed dose and fluence distributions) are determined in a coherent and reproducible way. The existing international recommendations on radiotherapy dosimetry are not applicable to BNCT. Therefore, accepted dosimetric procedures are urgently needed to provide credibility and reliability for BNCT, to the benefit of the patients and to facilitate the recognition and clinical acceptance of this new treatment modality by the radiotherapeutic community and the national health authorities.

2. OBJECTIVES OF THE EUROPEAN COLLABORATION

The objective of the project is to prepare detailed guidelines for the dosimetry of epithermal neutrons to be used for BNCT at European research reactors and accelerators. These guidelines will ensure the level of accuracy, reliability and reproducibility, which is generally required in radiotherapy and which will be of crucial importance for the success and optimisation of the BNCT treatments.

The project is carried out by a consortium consisting of Nuclear Research and Consultancy Group NRG (Petten NL, Xo-ordinator), Netherlands Cancer Institute (Amsterdam The Netherlands), Institute for Advanced Materials of the Joint Research Centre of the Commission of the European Communities (Petten The Netherlands), Radiation and Nuclear Safety Authority (Helsinki, Finland), University of Helsinki (Helsinki Finland), University of Birmingham (Birmingham, United Kingdom), Nuclear and Technological Institute (Sacavém Portugal), Technical University of Budapest (Budapest, Hungary), Nuclear Research Institute (Rez, Czech Republic), Technical Research Centre of Finland (Espo, Finland) and Universitätsklinikum Essen (Essen, Germany).

3. WORK PROGRAMME

The project is limited to the basic problems of the physical dosimetry prior to clinical treatment in order to attain control of the most urgent topics. To meet the objectives, the partners are studying and developing the methodology for the basic BNCT-dosimetry by:

- theoretical review and analysis of the available knowledge,
- selection of the most promising methods and procedures,
- systematic experimental investigations of the most promising methods,
- verification of experimental results by theoretical calculations in order to determine the critical physical parameters affecting the overall accuracy of the measurements,
- selection of recommended dosimetry procedures, and
- systematic intercomparison of the selected dosimetry procedures in the available European BNCT beams.

The project pursues the following dosimetry steps of research:

- characterisation of the mixed neutron-gamma beam emerging free in air from the neutron source (nuclear reactor or particle accelerator);
- characterisation of the mixed field of radiation generated in a phantom exposed to the mixed neutron-gamma beam:

- in a reference phantom under reference conditions;
- in a patient simulation (non-reference conditions);

- characterisation of beam monitors as a tool to establish an unambiguous relation between significant free-beam parameters and the field of radiation generated in a phantom.

As a structured approach the work is divided into work packages. All work packages include both quality control and evaluation of uncertainties.

3.1. Work package 1: Beam characterisation

1.1 Beam geometry
1.2 Spectrum characterisation of the neutron component
1.3 Spectrum characterisation of the gamma ray component

3.2. Work package 2: Beam calibration

2.1 Reference phantom material
2.2 Reference geometry
2.3 Absorbed dose to tissue
2.4 Non-reference conditions
2.5 Thermal neutron fluence rate
2.6 Intercomparison of methods

3.3. Work package 3: On-line monitoring

3.1 Beam monitoring

Work package 4: Writing the code
4.1 Drafting and editing the text
4.2 Referee reading

4. STATE OF PROGRESS

During a kick-off meeting in Petten on 13–14 November 1998 the overall time schedule and a detailed work plan for the next six months were established. The partners are currently in the process of reviewing i/ their own dosimetry procedures and ii/ other dosimetry procedures worldwide in order to select the most promising procedures for further research.