QUADOS: quality assurance of computational tools in radiation dosimetry – an EU funded CA of EU framework V establishing harmonization within Europe

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Abstract
EURADOS (European Dosimetry Group) Working Group 4 "Numerical Dosimetry" has, since the end of the eighties, investigated the training and quality assurance needs associated with the irregular use of computational dosimetry codes. Two training courses were run (Bologna 1996, London 1998) on the use of MCNP in computational dosimetry. Within the 5th Framework Programme, an EU funded action named QUADOS (QUAlity Assurance of Computational Tools for DOSimetry), wrote a Compendium of Computer Codes and developed and analysed a European questionnaire on how users benchmarked their code generated solutions. The results of the questionnaire were a motivating force for the development of the QUADOS intercomparison study (2003) which asked code users to solve one or more predefined problems and to report back their analysis and methods. The culmination of this was a detailed handbook of results and findings (that can be used in individual laboratories as a QA guide) and a symposium (Bologna 2003) where participants and problem authors discussed the overall findings and conclusions of the study. We here present the conclusions drawn from each of these events and present an overall picture of the perceived training needs, successes and shortfalls in the application of radiation transport codes in safety critical fields.

1. Introduction

The "Concerted Action" QUADOS was a project sponsored by the EC within its 5th Framework Program; it has a long lineage beginning with a very successful EU Action that started in 1994 under the 3rd Framework Program. This investigated training and quality assurance associated with the irregular use of computational codes in radiation dosimetry. Built on these firm foundations, a second Concerted Action followed under the 4th Framework Program which provided details of the status of code users within Europe. The results of that Concerted Action lead to the work of QUADOS in the 5th Framework Program and the proposal of an intercomparison on the usage of computer codes. More recently, the work of the group has continued with Work Package 4 of CONRAD. CONRAD (A Coordinated Network for Radiation Dosimetry) is a project sponsored by the EC within its 6th Framework Program; Work Package 4 "Computational Dosimetry" is devoted to encouraging uncertainty assessment in general and with computations in particular.

2. In the Beginning – Framework Three Action

This Concerted Action investigated the training and quality assurance needs associated with the irregular use of computational dosimetry codes. The group ran its first training course on the use of MCNP in radiation dosimetry; this was organized by Dr. Gianfranco Gualdrini of ENEA Bologna who is the current chairman of WP4. The course was held in Bologna, Italy during May 1996 with the support of ERPET. It brought together international experts in the different and diverse fields of computational

radiation dosimetry together with experienced and novice users of the MCNP code. Tuition was provided by members of the Concerted Action and Dr. Grady Hughes, one of the key developers of the MCNP code from Los Alamos, USA. Dr. Hughes presented the state of the art of the code and its future directions of development. The course attracted 46 attendees, all of whom were able to take part in full practical problem-based sessions dealing with topics related to neutron, photon and photo-electron transport. The training course has long since been regarded as a major success; it resulted in the publication of an extensive collection of lectures, seminars and problems - (Figure 1) that ran to some 474 pages and was published by ENEA Rome [1].

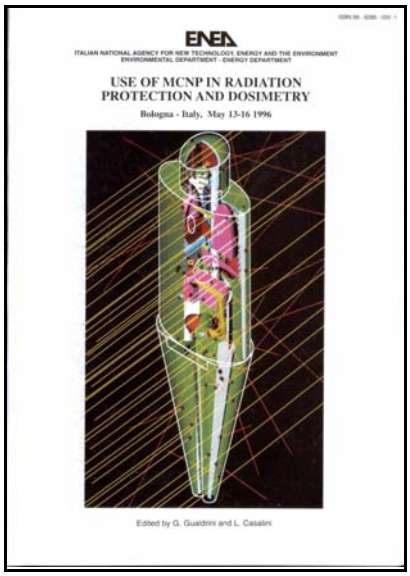

Fig 1. Front page of the MCNP Training Course Proceedings

3. The Framework Four Concerted Action

The 4th Framework Concerted Action was a natural extension of the work started in 1994.The achievements of this Concerted Action were extensive; resulting in four major deliverable packages. A follow-on course to the Bologna course was organized and held at Imperial College, London – hosted by Dr. Robert Price: it extended the repertoire of the Bologna course to include specialist lectures on deterministic methods and again, this was extensively supported by ERPET.

The course was an excellent companion to another of the Action's major deliverables: 'A Review of Monte Carlo and Deterministic Codes in Radiation Protection and Dosimetry' – Published by NPL Teddington [2] (Figure 2). This document, didactic in nature, provides guidance on the selection of appropriate codes. It features chapters on Monte Carlo and Deterministic methods and provides a basic understanding of each method such that the reader can judge which of the methods is most appropriate for solving her or his problem. In addition the need to specify uncertainties is clearly demonstrated.

Fig 2 Front pages of i) The compendium (left) and ii) The Questionnaire summary (right)

A third deliverable was the distribution, within Europe, of an extensive questionnaire with the goal to state to what extent computer code users applied correct quality assurance criteria to the application of these tools. Here, the aim was to establish a realistic panorama of the use of computer programmes in the field of radiation protection and dosimetry as well as to obtain a perspective on the types of problems solved. An additional goal of the investigation was to ascertain the need for intercomparison studies which could be proposed at the European level and to motivate the Concerted Action towards actual needs in dosimetry. The outcome was the publication "European Questionnaire on the Use of Computer Programmes in Radiation Dosimetry, Published by ENEA Rome [3] (Figure 2). In it, the replies of over 150 respondents were analysed. One of the most significant outcomes of the investigations was that a large number of the participants (about 30%) did not check their results neither against experimental data nor with data taken from the literature (see Figure 3) and it was concluded that there was an overwhelming need to provide applicable guidance to occasional users of computational codes for radiation protection and dosimetry calculations.

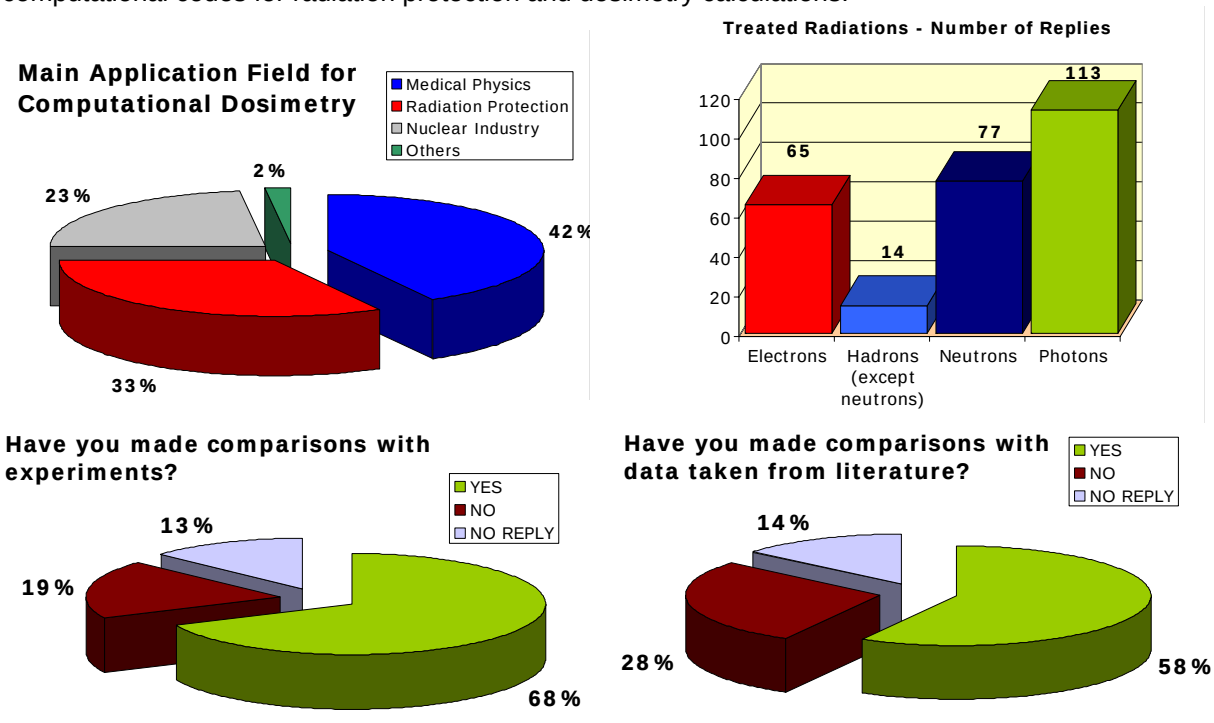

Fig 3. The main outcomes of the questionnaire

4. The Framework Five Concerted Action

The 5th Framework Program saw the emergence of the Concerted Action called QUADOS – this Concerted Action built on the excellent results and achievements of the 4th Framework Program Concerted Action. In particular, it capitalised on the results of the questionnaire, that showed that a high proportion of people didn't correctly identify and analyse the uncertainty in their computational problem and further, they didn't compare their results with literature or other benchmarked calculations or experiments. To further understand this and to promulgate good practice, QUADOS organised a European-wide intercomparison on the usage of computational codes in Radiation Dosimetry. The aim was to: provide a snapshot of the methods and codes currently in use; furnish information on the methods used to assess the reliability of computational results; disseminate "good practice" throughout the radiation dosimetry community; provide the users of computational codes with an opportunity to quality assure their own procedures; inform the community about the benefits to be obtained from sensitivity and uncertainty analysis and inform the community about more sophisticated approaches that may be available to them.

Eight problems were selected for their relevance to the radiation dosimetry community and distributed throughout Europe. A three-day workshop was organised by ENEA Bologna at which the solutions were presented by the authors of the problems, including an analysis of the returns (the anonymity of the participants was preserved). The final QUADOS Workshop provided the opportunity for an open discussion amongst all scientists interested in the application of numerical tools in the field of radiation dosimetry, especially those that participated in the intercomparison. It attracted around 70 participants from Europe and the US. Included in the workshop were experts in the use and development of some of the codes discussed. The final deliverable was an extensive handbook 'Intercomparison on the Usage of Computational Codes in Radiation Dosimetry', published by ENEA Rome [4] (Figure 4).

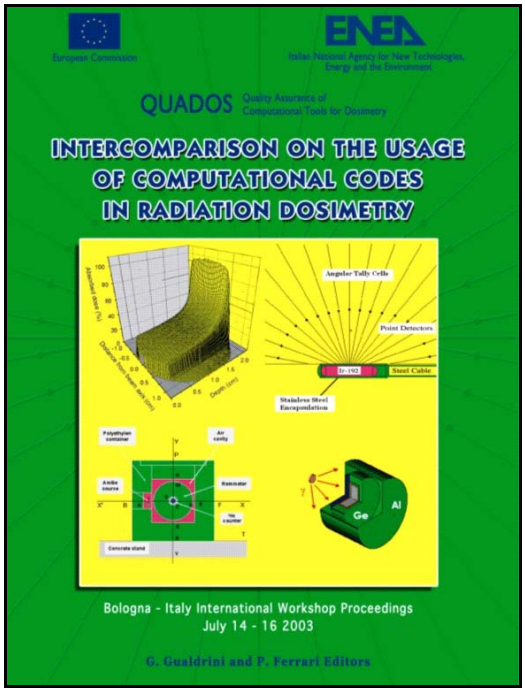

Fig 4. Front page of the Bologna Workshop Proceedings

5. Conclusions

The Working Groups established in the field of Computational Dosimetry, previously under the aegis of EURADOS and afterwards in the context of targeted Concerted Actions funded by the European Union, provided a good floor for knowledge dissemination on the quality assured usage of complex computer codes through training initiatives and international intercomparison studies. It is foreseen in the future to enlarge this coordinated action within the scope of the CONRAD European project.

References

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