Khaled Elleithy
Editor

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Edited by

Khaled Elleithy
University of Bridgeport
CT, USA

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To my wife and sons.

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Preface

This book includes Volume I of the proceedings of the 2006 International Conference on Systems, Computing Sciences and Software Engineering (SCSS). SCSS is part of the International Joint Conferences on Computer, Information, and Systems Sciences, and Engineering (CISSE 06). The proceedings are a set of rigorously reviewed world-class manuscripts presenting the state of international practice in Advances and Innovations in Systems, Computing Sciences and Software Engineering.

SCSS 06 was a high-caliber research conference that was conducted online. CISSE 06 received 690 paper submissions and the final program included 370 accepted papers from more than 70 countries, representing the six continents. Each paper received at least two reviews, and authors were required to address review comments prior to presentation and publication.

Conducting SCSS 06 online presented a number of unique advantages, as follows:

- All communications between the authors, reviewers, and conference organizing committee were done on line, which permitted a short six week period from the paper submission deadline to the beginning of the conference.
- PowerPoint presentations, final paper manuscripts were available to registrants for three weeks prior to the start of the conference.
- The conference platform allowed live presentations by several presenters from different locations, with the audio and PowerPoint transmitted to attendees throughout the internet, even on dial up connections. Attendees were able to ask both audio and written questions in a chat room format, and presenters could mark up their slides as they deem fit.
- The live audio presentations were also recorded and distributed to participants along with the power points presentations and paper manuscripts within the conference DVD.

The conference organizers are confident that you will find the papers included in this volume interesting and useful.

Khaled Elleithy, Ph.D.
Bridgeport, Connecticut
June 2007

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The 2006 International Conference on Systems, Computing Sciences and Software Engineering (SCSS) and the resulting proceedings could not have been organized without the assistance of a large number of individuals. SCSS is part of the International Joint Conferences on Computer, Information, and Systems Sciences, and Engineering (CISSE). I had the opportunity to co-found CISSE in 2005, with Professor Tarek Sobh, and we set up mechanisms that put it into action. Andrew Rosca wrote the software that allowed conference management, and interaction between the authors and reviewers online. Mr. Tudor Rosca managed the online conference presentation system and was instrumental in ensuring that the event met the highest professional standards. I also want to acknowledge the roles played by Sarosh Patel and Ms. Susan Kristie, our technical and administrative support team.

The technical co-sponsorship provided by the Institute of Electrical and Electronics Engineers (IEEE) and the University of Bridgeport is gratefully appreciated. I would like to express my thanks to Prof. Toshio Fukuda, Chair of the International Advisory Committee and the members of the SCSS Technical Program Committee, including: Abdelaziz AlMulhem, Alex A. Aravind, Ana M. Madureira, Mostafa Aref, Mohamed Dekhil, Julius Dichter, Hamid Mcheick, Hani Hagras, Marian P. Kazmierkowski, Low K.S., Michael Lemmon, Rafa Al-Qutaish, Rodney G. Roberts, Sanjiv Rai, Samir Shah, Shivakumar Sastry, Natalia Romalis, Mohammed Younis, Tommaso Mazza, and Srini Ramaswamy.

The excellent contributions of the authors made this world-class document possible. Each paper received two to four reviews. The reviewers worked tirelessly under a tight schedule and their important work is gratefully appreciated. In particular, I want to acknowledge the contributions of the following individuals: Yongsuk Cho, Michael Lemmon, Rafa Al-Qutaish, Yaser M. A. Khalifa, Mohamed Dekhil, Babar Nazir, Khaled Hayatleh, Mounir Bousbia-Salah, Rozlina Mohamed, A. Sima Etner-Uyar, Hussein Abbass, Ahmad Kamel, Emmanuel Udoh, Rodney G. Roberts, Vahid Salmani, Dongchul Park, Sergiu Dumitriu, Helmut Vieritz, Waleed Al-Assadi, Marc Wilke, Mohammed Younis, John Zhang, Feng-Long Huang, Natalia Romalis, Hamid Mcheick, Minkoo Kim, Khaled Rasheed, Chris Panagiotakopoulos, Alex Aravind, Dinko Gichev, Dirk Mueller, Andrew Vincent, Ana Madureira, Abhilash Geo Mathews, Yu Cai, Spyros Kazarlis, Liu Xia, Pavel Osipov, Hamad Alhammady, Fadel Sukkar, Jorge Loureiro, Hemant Joshi, Hossam Fahmy, Yoshiteru Ishida, Min Jiang, Vien Ngo Anh, Youming Li, X. Sheldon Wang, Nam Gyu Kim, Vasso Stylianou, Tommaso Mazza, Radu Calinescu, Nagm Mohamed, Muhammad Ali, Raymond Wu, Mansour Tahernezhadi, Trevor Carlson, Sami Habib, Vikas Vaishnav, Vladimir Avdejenkov, Volodymyr Voytenko, Vygantas Petrauskas, Shivakumar Sastry, U. B. Desai, Julius Dichter, Hani Hagras, Giovanni Morana, Mohammad Karim, Thomas Nitsche, Rosida Coowar, Anna Derezinska, Amala Rajan, Aleksandras Vytautas Rutkauskas, A. Ismail, Mostafa Aref, Ahmed Abou-Alfotouh, Damu Radhakrishnan, Sameh ElSharkawy, George Dimitoglou, Marian P. Kazmierkowski, M. Basel Al-Mourad, Ausif Mahmood, Nawaf Kharma, Fernando Guarin, Kaitung Au, Joanna Kolodziej, Ugur Sezerman, Yujen Fan, Zheng Yi Wu, Samir Shah, Sudhir Veerannagari, Junyoung Kim and Sanjiv Rai.

Khaled Elleithy, Ph.D.
Bridgeport, Connecticut
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Information System in Atomic Collision Physics

V.M. Cvjetković
Faculty of Science
Radoja Domanovića 12
34000 Kragujevac, Serbia
B. M. Marinković
Institute of Physics
Pregrevica 129
11000 Belgrade, Serbia
D. Šević
Institute of Physics
Pregrevica 129
11000 Belgrade, Serbia

Abstract - **Fundamental aspects of scientific research in the field of atomic physics are discussed in this paper from the point of view of information system that would cover the most important phases of research. Such information system should encompass the complexity of scientific research trying to incorporate data scattered in various books, articles, research centers, databases, etc. We started from scratch with principal analysis of basic research processes and data that represent needs and condensed research experience. Particular problem of search for data is specially discussed and the main idea for new proposed approach is described. We developed a prototype of information system to be used by researchers in various research phases. Search for data is based on the web, as it is the standard way for easy data access.**

I. INTRODUCTION

Organizing of any research implies several stages of activity. It starts with defining the process of interest, getting information about published data concerning the chosen processes, planning the research by choosing the methods and parameters, then performing research, obtaining and processing data and finally presenting and publishing results in appropriate form. Each of these stages could be time consuming and there is no doubt that specific research could last for years.

In this paper we have developed the logical model of Information System (IS) in the field of Atomic Collision Physics (ACP). The model should reflect all stages of activities. It is also implemented as a web application based on developed logical model. The aim of such IS is to facilitate the search for published data in a specific field of ACP, to make possible the critical evaluation of published data and used methods of research, as well as to keep track of own research. During the same period of time, the thematic of research could be changed and/or increased in sense of new results or new methodology invented.

Research activity has complex structure and its stages overlap not only in time domain, but also in domain of concepts. That often leads the researchers to repeat the same activity that is usually unnecessary. In planning own research, the researchers have at their disposal only the extensive databases of whole publications that can usually be browsed by authors and keywords. However, the analysis of research procedures is left to researchers. That analysis in its essence includes the reading of the whole text i.e., expressed in the informatics terms, the selection of research categories by "free text search". Also, there are available specific databases that include numeric or graphics data but without any knowledge considering the methodology, preparation, parameters describing how data were obtained, and these are the key for evaluation of existing research. Without such performed analysis, these numerical results could hardly be compared or evaluated. There is no IS available that would comprise the research process in whole.

Large number of data bases exist on the Internet nowadays, that cover the field of atomic and molecular physics. Atomic and molecular databases can be divided in two main groups, numerical and bibliographical databases. Numerical databases are specific and comprise for instance Fundamental Physical Constants – NIST [1], spectroscopic data, data for collision processes, etc. Some representatives of these databases are NIST Atomic Spectroscopic Data [2], NIST Molecular Spectroscopic Data [3], TOPbase [4], Center for Astrophysics, Atomic and Molecular Physics Division [5] for spectroscopic data, and NIFS [6], NIST [7], IAEA ALADDIN [8], Atomic Data for Astrophysics, Univ. Kentucky, USA [9] for collisional processes data.

Bibliographical databases are somewhat less numbered, and there are also two basic kinds - spectroscopic and databases for collision processes. Bibliographical databases for spectroscopy are for instance NIST [10], STARK [11], while collision are IAEA [12], GAPHYOR [13], ORNL CFADC [14] etc.

There are also systems that act as "search engines" for databases, collecting data from several databases. Typical representative is GENIE [15] collecting data from nine different databases throughout the world, among which are some of the above mentioned. The other representative is DANSE [16] that was developed for the ICAMDATA [17] 2002, Gatlinburg, Tennessee. Most of the features in DANSE are still in the

K. Elleithy (ed.), Advances and Innovations in Systems, Computing Sciences and Software Engineering, 485–490.

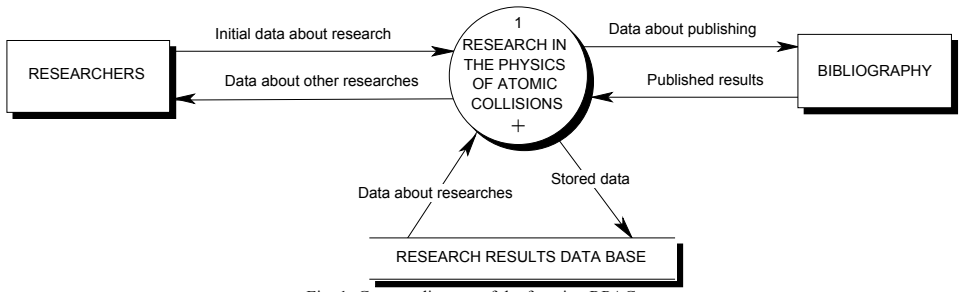

Fig. 1. Context diagram of the function RPAC

preparation level. There are systems that offer online computing for calculation of some important specific atomic features like AAEXCITE [18] and RATES [19]. All mentioned examples are undoubtedly very important and contain large number of valuable data at disposal for scientists committing various researches thru ought the world. On the other side, these databases are specific for some area and offer search for data based on criteria that are most frequently used, not necessarily optimal for any research. Also, these databases are no complete, and in general they lack customization. Therefore, the support for research is only partial, not to mention that they are just "one way" and generally do not offer the easy input or storing of some specific data of interest for current ongoing research or for the whole field of activity.

The proposed answer to all the mentioned could be the creation of Information System (IS) designed to support specific research tasks, but at the same time to be based on ground wide enough to provide common foundation for research in the area of atomic and molecular physics. The significance of existing databases will be primarily to serve as the source for data of interest for the given institution.

The basic idea for IS that is developed here would be to serve as a tool for researcher, which implies that it should comprise as much of research activities in all stages, as possible. As the IS was made from scratch, the starting point for designing such IS are detailed and elaborated process model and data model. Process model is largely based on, and expresses the knowledge and the long term experience of researchers in the ACP field. Process model also served as a guideline for the data model. During data modeling, very important concept or idea emerged and became the unique characteristic of this IS. We call it the Expert Decomposition of the Article (EDA). It expresses the semantic meaning of the article text being analyzed, using a number of selected, universal, most important notions that characterize the research in the area of ACP. EDA enables the IS to selectively store the most important data that characterize the research described in the article, and these include results of numerical and graphical type, important parameters, preparation, methodology, used particles, bibliographical and other data. In that way, the IS contains the most necessary data that characterize the research, without the need to contain the full text of the article, as it can be obtained by well known means. This IS also enables very selective and efficient data retrieval such as particular numerical or graphical results, that are obtained on the basis of expert characterization of results. By forming the complex search condition consisting of mentioned notions obtained by EDA, researcher can quickly obtain particular research results with corresponding bibliographical data. Whether the search yields results or not, researcher spends minimum time on the search through numerous scientific articles. Testing of the partial implementation of the IS that contains some decomposed scientific articles, confirms the basic expectations, and thus justifies the fundamental structure of the IS.

In the following text, process and data models are presented in order to describe the specific "science research" system and to give the basis for EDA. After that, EDA its use and possibilities with some implementation details are discussed.

II. PROCESS MODEL

Process model defines those processes from the research area of atomic physics that are to be modeled and supported by the appropriate informational technology. Generally, all activities performed by researchers that contribute to scientific research are described as Research in the Physics of Atomic Collisions (RPAC). In the process model, it is represented by the corresponding RPAC function. All other activities are derived from that function by the process of hierarchical decomposition. On the highest hierarchical level - context level, process model can be represented with Data Flow Diagram (DFD) as shown in Fig 1. Researchers perform the RPAC function, and publish the research results in some of the bibliographical forms. For obtaining necessary data for other researches in this area, researchers have the opportunity to search the existing database. Database also serves as storage for own research results, and research results of other researchers. Researchers supply the RPAC function with initial data for the research that they plan, and from the RPAC function they get data about other earlier published researches. Data flows between RPAC function and bibliography as the element from its surrounding, are established in both directions, so that RPAC gives data for publishing, and also accepts published results from the earlier performed researches. To make the search for data more effective, RPAC stores new and published data in Research Results Database.

RPAC function is a complex one, as it encompasses all research activities. For more detailed analysis, it has to be decomposed on a number of hierarchical levels. The structure for the next level can be obtained by following reasoning.

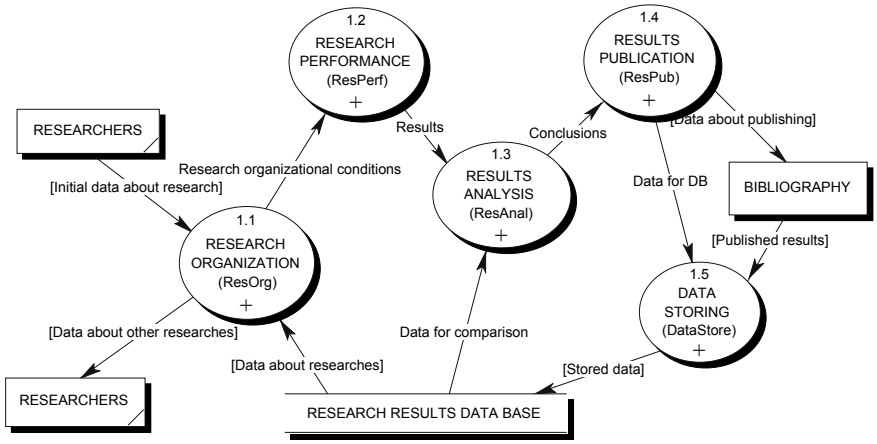

Fig 2 DFD of the decomposed RPAC function

Researchers, on the base of the set aim, define criteria for searching and make insight into available data from the earlier performed researches. In this procedure, which can be iterative, initial conditions of the planned research are prepared, i.e. preparation for computer aided research, and for its organization is performed. After the organizing process is over, the next step is performing of the research in which the measurement of the observed phenomenon is made, i.e. some results are obtained. By the analysis of these results certain conclusions are drawn, that are the basis for their publishing. In the phase of publishing there are two important activities. On one side relevant data and information are published in some of the bibliographical forms, and on the other preparation of data is made for their processing and storing in the information system database. Processing and storing in the database is also enabled for data that were published earlier. Accordingly, RPAC function can be decomposed on sub processes as shown in corresponding DFD on Fig. 2. This data flow diagram makes the first decomposition level.

III DATA MODEL

Data model implemented here is relational and it is developed up to the level of recognition of all the entities. It defines identifiable and descriptive attributes of entities, relationships between entities and properties of these relationships, in details enough for implementation.

DFD's that describe the process model are defined both on the context level and on the following two or three levels of decomposition (not discussed here in detail). While the processes are the basis for design of the process logical and physical model that has to enable data transformation from input to output data flows, the very data flows are the basis for defining the data logical and physical model. In the following text on the basis of data flows analysis, the structure of the relational model for support of the RPAC function is given. This is achieved by using the diagrams of the parts of whole model with symbolic according to Integration Definition for Information Modeling (IDEF1X) [20] standards, and which relates to development of the data logical model. For that purpose, method of logical design for data modeling and database design - "Entity-Relationship Modeling" ("ER" modeling) was used. Analysis of the data flows in DFD's of the function RPAC data model, led to independent entities and their characteristics. As a result, the following entities are considered in data model: Author, Laboratory, Country, Editor, Journal, Publication, Particle, Preparation, Process, Interaction Method, Method, Parameter, Research, Quantity, Result, Table Result, and Graph.

Data model consists of two main sub models, the first describing entities and their relationships important for publishing, and the other describing entities and their relationships important for experiment or research. Entity relationship diagram for the whole data model is shown in Fig. 3.

Experiment is the central entity of the data model. It gathers around and connects all the other entities. That model characteristic corresponds to the fact that experiment is the central part of research in the ACP.

Upper left part of the data model in Fig. 3 includes entities and relationships that are important for publishing. Publication can contain one or more experiments. Experiment can be understood here in wider context, and can include both theoretical and experimental research.

Particle is subject of the research in the physics of atomic collisions. In experiment particle can appear in two roles, as a target and as a projectile. Every particle can be in both roles. Particle can be categorized to chemical element – atom or compound – molecule, that can be ionized or not. Chemical element compound describe some common physical and chemical characteristics for atoms and molecules. Besides, particle can be electron or photon, that are simple elementary particles with very well known attributes, so there is no need for photon or electron entities. It is enough just to evident photon or electron. Some characteristics like energy, polarization can be specified as parameters or with Preparation entity.

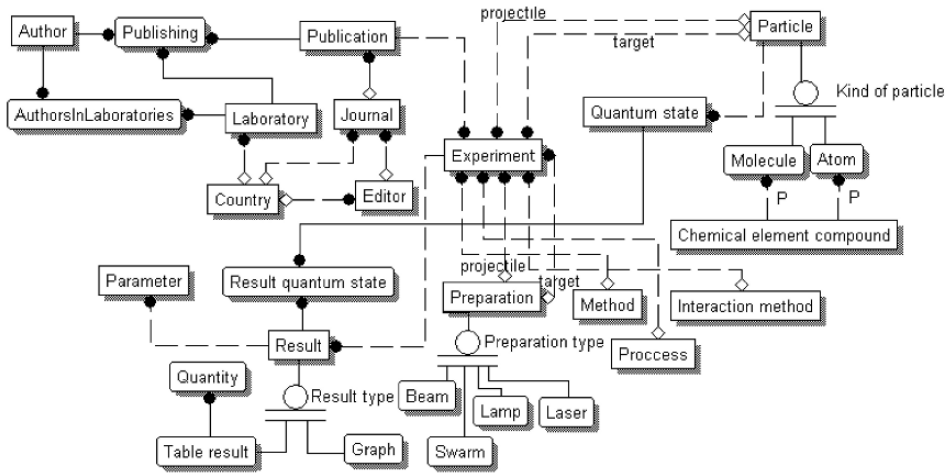

Fig. 3. Relational data model diagram

Preparation is the entity used to describe the form in which the particle is during the experiment performance. Particle can be prepared in the form of light beam (laser, lamp), particle beam, swarm and gas cell, independently from whether it has the role of projectile or target in the experiment. Not all combinations of particles and preparations are allowed depending on whether the particle is photon (laser or lamp) or not (beam and swarm). Particles in atomic physics – atoms and molecules are characterized by quantum states, as it is usual way of describing particles that are governed by the laws of quantum physics. For each particle there can be number of quantum states that also depend on degree of particle ionization.

Result is outcome of every experiment and its final aim. Results can be displayed in many forms: tabular, graphical, descriptive texts and combined.

Process is the kind of interaction between particles with the target role and particles with projectile role during the experiment. It can be elastic scattering, excitation, ionization, absorption, decomposition, etc.

Interaction method describes interaction between target particle and projectile during the experiment.

Method is the way the research of some process in physics of atomic collisions is made.

Parameter is characteristic that can be used for additional description of some research. The need for use of the Parameter entity appears if some specific property of the research being performed has to be defined. Using parameters, it is possible to enter in database quite arbitrary data that are necessary to further characterize the research, in addition to model entities.

IV IS MAIN CHARACTERISTICS

When searching for very specific data like experimental results from some research, that can not be retrieved by keyword search, even when data are in some kind of electronic form, one has to know in advance where to look for, exact references, titles, authors, etc. If the fact whether some result is published or not, or where it is published is not known to researcher, than there is high probability that the necessary data if exist, will remain hidden somewhere in the huge mass of published literature. In the case of experimental results in atomic physics, search for results is complex one for the simple reason that the given result is connected or depends on a number of characteristics - parameters that characterize it. The intention is to create a system for search and retrieval on the basis of given conditions i.e. experimental parameters. Output of the search for experimental result should contain result value or corresponding graph, values of parameters and full reference of article in which the result is published. In that way, it is possible to search for particular result starting from experimental conditions and parameters that characterize result, without knowing whether it exists or not, and where it is published. If it exists, i.e. if it is entered in data base, complete reference will be obtained as a result of search together with quantified values.

Search is based here on fragmentation – decomposition of text into many important categories that characterize the field of investigation, in this case atomic collisions. Of course, principles are of universal kind, and are directly applicable to other areas. Main categories for text fragmentation of the article or book contents are in principle the same as independent entities that arose in the data model of information system. Those entities are for instance Author, Publication, Laboratory, Projectile Particle, Target Particle, Process, Method, Interaction Method, Parameter, Variable Quantity, Measured Quantity, and others already mentioned in the previous section. Entity named publication contains data about texts and documents that were published and fragmented. For the time being, the necessary work on text fragmentation is human, more precisely the expert, as the document fragmentation must be done by people very well acquainted with the research area that the given document that is analyzed

belongs to. Data resulting from the text fragmentation are stored in the tables of the database that ensures minimum redundancy of data and that the fragmentation of the given text has to be done only once, but that the results of fragmentation can be used unlimited number of times by various people.

Fragmentation categories could be viewed as dimensions of text, and data for each category resulting from fragmentation as particular coordinate values, thus positioning the analyzed text into some kind of point in multidimensional space in which the document resides. With such concepts introduced, we could say that the search is to be performed by giving one or more "coordinate" values, and checking the set of "points" thus obtained.

Second very important specificity of such approach is to realize that no text or document has to be in the underlying database, but just the data resulting from the text decomposition or fragmentation. Search would yield just the one or more particular results from articles or books that were already fragmented - analyzed. The useful information obtained in such way besides results, is the complete reference to text, enabling researcher to find it in a conventional way (library or publisher's documentation), not the text itself. This information system is not to compete with the library, but is rather complementary one.

V EXAMPLES OF IMPLEMENTATION

Access to data – information retrieval, in this IS is based on the WEB server. Certain access, review and search are also possible from the interfaces of programs for data entry. Data search can be performed in many ways and specially allows specific search for experiments results, that is one of the most important characteristic of IS structure and implementation. Currently implemented search consists of "Search for publications" and "Search for results". Those two kinds of the search are complementary from the aspect of starting data, but both enable access to particular results in publications.

Search for publications can in principal start from various groups of data – categories that can be selected. Possible groups of data are authors, particles, processes, methods, and journals – independent entities in data model. As this kind of search resembles classic search with keywords, (although it is not) attention will be paid to search for results.

The other, complementary kind of search starts from data that describe particular results in the research. Fig. 4 gives the web page with overview of quantities that define particular experiment result. Combo box on the top gives the list of various result types, with DCS value selected. Differential cross section (DCS) is one of the basic quantities that are measured in collision type experiments. Evidenced particles in database - atoms and molecules can be selected from their combo boxes. Depending on chosen particle – atom or molecule, and degree of ionization, corresponding quantum states appear in atom quantum states or molecule quantum states combo box. Quantum states characterize the state of excited target particle right after the collision. Pressing the

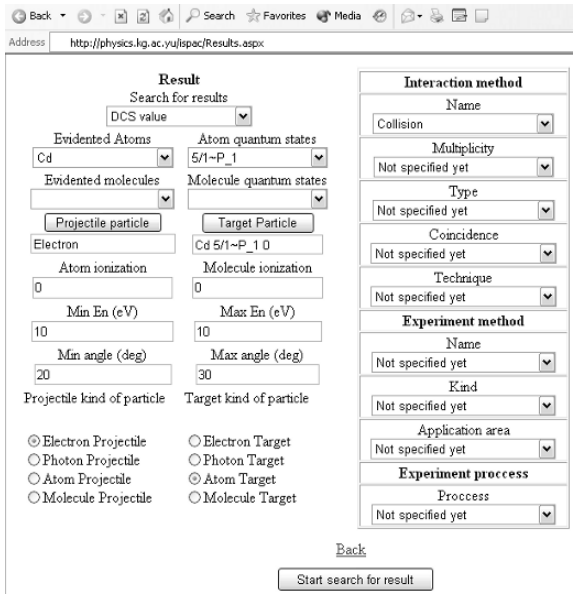

Fig. 4 Quantities that define experiment results

buttons named projectile particle and target particle, selected particles, quantum states and ionization are entered in text boxes below mentioned buttons. Values in these text boxes are used for results search. Text boxes with minimum and maximum energy define energy interval for projectile particles that will be used in the search. Similarly, minimum and maximum angle define the angle interval for scattered particles that will be used for search. Two groups of option buttons below are used for specifying type of particle for projectile and target. Selection in Fig. 4 is electron as projectile and atom as target. On the right there are three groups of combo boxes for specifying the attributes for interaction method, experiment method and experiment process. In the case when "Not specified yet" value is selected, corresponding attribute does not limit the search. If it is important to limit the search with some attribute, then any other value but "Not specified yet" has to be selected from corresponding combo box. After all desired adjustments are set, search starts with pressing the "Start search for result" button.

Information system is fully implemented using Microsoft technology. Microsoft Access 2002 is used for database and programs for data entry. Web server is Internet information server 5.1, which executes Active Server Pages – ASP.NET for all web pages. Contents of web pages are dynamically generated, depending on search conditions. For access to database from web server ADO.NET is used.

VI CONCLUSION

Information system in the physics of atomic collisions presented in this paper was developed with the aim to enable fast and simple access to various data, which are necessary to

every researcher. It has double role, on one side using this information system researcher can form own (local) information system, and on the other side, using the query for search, selective access to information from the bibliography is enabled. As these both sides are just parts of the same information system, it is easy to set up connection between them.

Besides, as the decomposition of articles was performed on large number of attributes, the search is not performed on "free text". That enables much faster data selection process. It is important to emphasize that data systematization in RPAC enables its use in other areas of physics or chemistry, and whereas specific data are needed (cross sections, rates, etc.).

Information system model was built so that it follows the procedures and processes that researcher goes through during consideration, organization and realization of his experiment. Process model presented in this paper is in fact the logical decomposition of the usual procedures of every researcher that is performed not just in physics of atomic collisions but also in majority of other areas in natural sciences. Even though here presented information system is connected by its attributes for physics of atomic collisions, its logical structure is easy adaptable to other scientific areas.

Implemented IS is based on given process and logical models, and has WEB access for data search. Described process model is not fully implemented, as it includes complex activities in research that are performed by competent scientists exclusively. Part of process model that is implemented includes activities for data input, logical consistency check of data, various kinds of local and WEB data search. Data input enables evidence of data for planned research, current research or data from any kind of reference. The main feature of data search is that it is possible to obtain particular results with full reference to article they belong to, on the basis of various selected experiment parameters. That kind of search gives researcher the unique opportunity to check whether one or more experimental results described with its parameters exist, and if it is the case, to see the value, and reference data. This kind of IS enforce various kinds of standardization, such as for given research model, article decomposition, data organization, search for data, used verbal expressions for entities, attributes and their values.

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