Fifth General Conference of the Balkan Physical Union BPU-5

Vrnjačka Banja, Serbia and Montenegro, August 25-29, 2003

Editors: S. Jokić, I. Milošević,
A. Balaž, Z. Nikolić

Book of Abstracts

Serbian Physical Society
Belgrade, 2003

SO04 - 003

INFORMATION SYSTEM AIDED RESEARCH IN ATOMIC PHYSICS

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ABSTRACT

Information system (IS) described in this paper, supports the research in atomic physics. It can be used in various ways, as a kind of notebook for specification of data characterising the future research – research framework, for evidencing of all data and results obtained in the current research, for insight into references and obtained results – by selective search that can even retrieve particular results in numerical or graphical form. IS supports search for evidenced references and results by specifying authors, used particles, experimental method, kind of interaction, process, and some research details such as particle quantum state, ionization, energy of the impact particles, scattering angle. Access to data in the IS is based on the Internet WEB service, that allows the maximal possible availability to all interested researchers. In addition, the structure of IS and data implicitly proposes the standard for specification and description of references and results.

Keywords: Atomic Physics, Information System, Database

1. Introduction

Traditionally, information systems were used for a purpose of supporting the business of large companies and institutions. With development of computer science, information systems gained more power and areas of application. The main benefit from information system is to help the management to get the right information at the right time and place, and that is the main precondition for making the right decision at the right time. It is important in any kind of human work. Important characteristic of scientific research today is that it is largely based on contemporary technology. New research can be inspired with new ideas, but is largely based on previous research and results, that are present in scientific literature. Increasing number of articles require new means for information storing, processing, transmission and selective retrieval. Research organization and performance can be quite demanding and sometimes impossible without applying some kind of information technology.

This article is devoted to information system (IS) in atomic physics. Implemented IS is based on IS model that consists of two models – process model and data model. Process model is result obtained from the real system analysis. It represents the generalized or abstract research in atomic physics, or in some close discipline. Research is logically decomposed on basic activities on few levels of decomposition, in order to be represented clearly and detailed at the same time. It could be treated also as a kind of research template. The role of process model is double. On one hand it systematically represents the complex structure of analyzed activity, and thus offers good insight that can be basis for studying the real system and better understanding, for improvement and changes. On the other hand, it is also the basis for design of the software that will implement the IS. Data model is another view of the same real system (scientific research in this case), and it describes entities, their attributes and mutual relationships. Entity represents notions (in atomic physics) like researcher, method, particle, interaction, experiment, publication or anything of the kind important for given system. Process and data model are connected so that processes (activities) transform data that are the instances (examples) of entities into output data for another process or for final user.

On the basis of developed logical model (process and data) for research in atomic physics, prototype IS is built. The main idea for this IS is to be a tool for researcher that will help to quickly and efficiently find data and results from publications, and to use it for research organization. Following text briefly describes both models and IS prototype implementation.

2. IS model

At the highest level of process model also called context, is activity named "Research in the physics of atomic collisions". As it is the complex activity, gradual decomposition on many decomposition levels is necessary in order to obtain the level of detail necessary for understanding and implementation. Figure 1 gives the data flow diagram (DTD) [1] for context level. Arrows represent flows of data and rounded symbols are functions or activities. Rectangular symbols are entities on the border of the system also called interfaces. Symbol with two parallel lines is database or data storage.

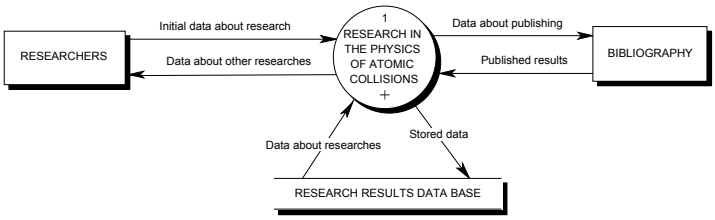


Fig. 1 *Context diagram for process model*

Researchers in their research work rely on bibliography and existing database with research results. Next decomposition level from the researchers' point of view is given in figure 2.

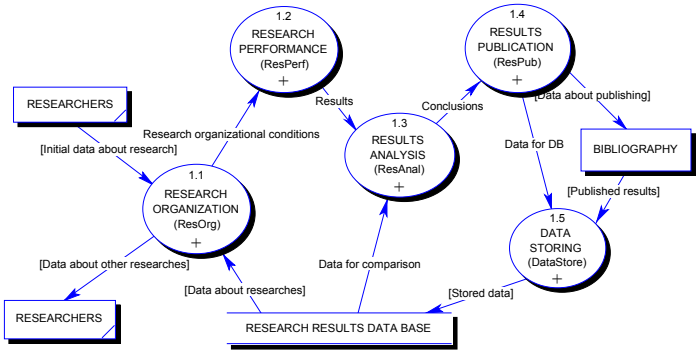


Fig. 2 *Second decomposition level*

There are five key activities on second decomposition level that constitute the activity "Research in the physics of atomic collisions" from the context level. "Research organization" activity mainly deals with the search for necessary references, and making the research specification. Search for references is possible using existing database, or other sources outside the IS digital or classical. Benefits of the implemented search are obtained only for references in the inner database. Research specification is choosing and determining of the research main entities and their attributes like particles, interaction, particle preparation, experiment method, various parameters that further describe research. Next activity "Research performance" is a complex one not implemented in this IS, and is given here for the purpose of completeness and better understanding of the whole system. Research performance can be theoretical and experimental, and in its essence is creative activity that is hard or impossible to find the proper template that is general enough. However, such a template is necessary for potential implementation. "Results analysis" activity that follows is also hard for implementation for similar reasons, although in some special cases some standard algorithmic procedures might be used where adequate. The other possibility is to use expert system [2]. One more aspect of results analysis is comparison with similar previous results. One of the indicators of successful research is publication of obtained results. Analyzed results obtained in the research are selected and prepared in adequate form for publishing. This activity is also hard for implementation, as preparation and writing of the scientific article is creative, although general but not strict rules do exist. Data storing as the last activity in IS model is implemented in the IS as it comprise very important entry of data in database from earlier published researches and also from currently published research. All five mentioned activities can be and are further decomposed on additional levels. Although there

Structure of data model enables various kinds of data search. Certain data search is possible from programs for data entry, as they allow access to data and display of data. Second part of IS enables WEB access to data in database.

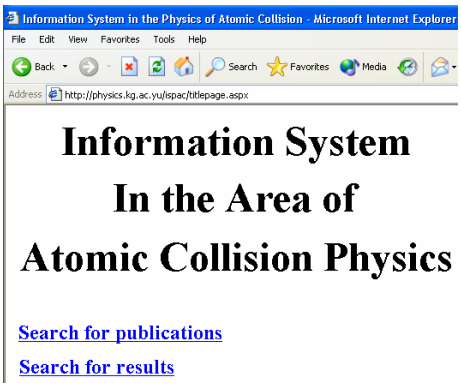


Fig 4 *Home page*

It is available on the following WEB address: physics.kg.ac.yu/ispac/titlepage.aspx. Currently, two different kinds of search are possible –search for publications and search for results as can be seen in figure 4 with home page. Search for results is unique for this IS as it is not present in other systems for data search, for instance INIS [4]. Various search systems mainly allow search by keywords, and as a result they can give numerous references, web addresses that is only the part of the work to find the necessary data. If certain result is necessary, or check is to be made whether some results exist or not, additional search work is necessary in order to check obtained search results. For instance, proposed web sites have to be visited and searched, and all proposed references should be found first in order to see whether they contain data that are looked for.

Implemented prototype IS allows search for particular results that can be numerical values from table results in references or results on graphs, diagrams or figures. It is possible to obtain particular experimental results because database contains extracted results from publications, and database structure allows flexible definition of search conditions that allow IS to find particular results. There is one more very important reason that such search is possible, and that is work of experts in atomic physics on publication analysis and extraction of data for IS database.

Selection of hyperlink “Search for results” on the home page given in figure 4 leads to “Results” web page given in figure 5. Combo, text boxes and option buttons on results web page hold and display data that form complex condition for results search. Combo boxes reduce input data for the search condition, to data present in database, thus eliminating input of data not present in database. It doesn’t mean that any combination of such data will give result, as they can be in some non existing combination. User can choose kind of result (DCS values, normalization factors, …), kind of projectile and target particle, select atom, molecule, specify ionization, select quantum state for atom and molecule, specify energy limits for particles, angle limits for scattered particles, select items for interaction method (name, multiplicity, type coincidence, technique), experiment method (name, kind, application area) and experiment process. Data for interaction method, experiment method and process doesn’t have to be specified. If “Not specified yet” is selected, then it just doesn’t limit the search. After the search conditions are specified, pressing the “Start search for result” button starts the search. Search result for data given in figure 5, is given in figure 6.

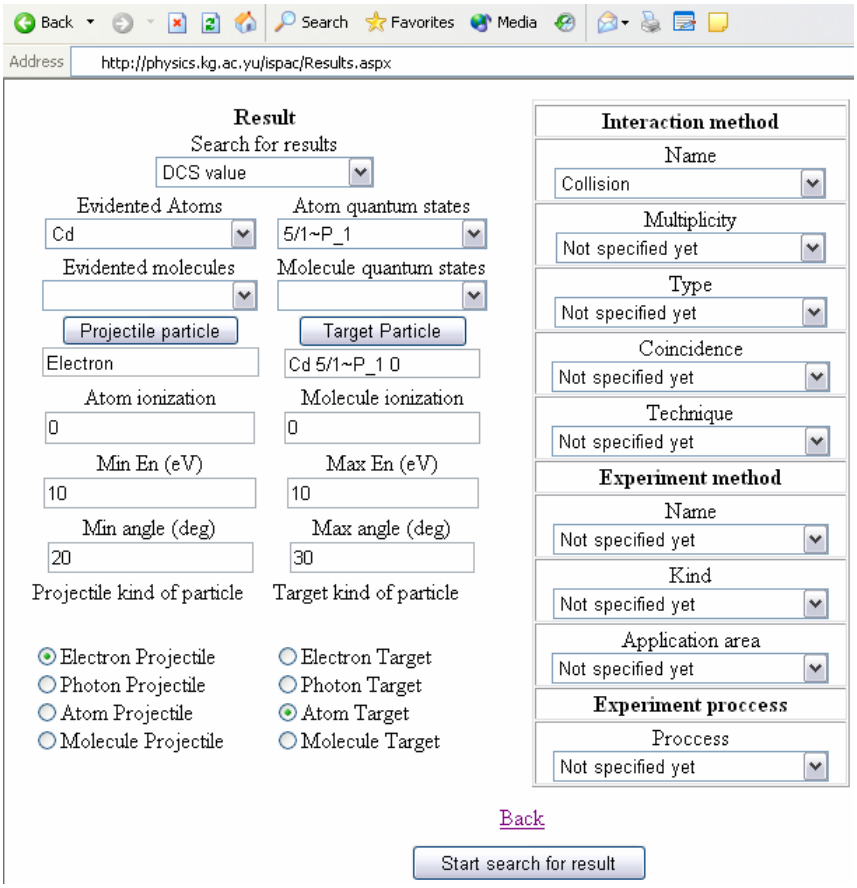
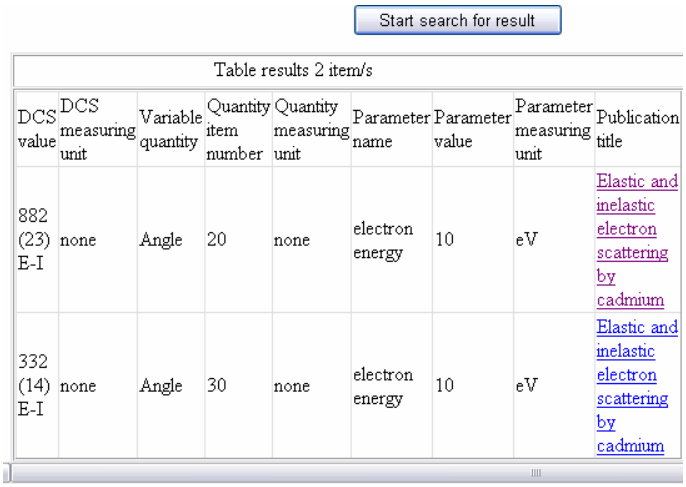


Fig 5 *Search for results web page*

Two values for DCS – differential cross section, satisfy the search conditions. Both values are from the same publication which title is also hyperlink in the column on the right. Other columns are for variable quantity and parameter. Clicking the publication hyperlink opens the next web page with complete data for publication given in figure 7. Data for publication are arranged in two tables, one of which is for authors, as number of authors for publication can vary.



DCS value	DCS measuring unit	Variable quantity	Quantity item number	Quantity measuring unit	Parameter name	Parameter value	Parameter measuring unit	Publication title
882 (23) E-I	none	Angle	20	none	electron energy	10	eV	Elastic and inelastic electron scattering by cadmium
332 (14) E-I	none	Angle	30	none	electron energy	10	eV	Elastic and inelastic electron scattering by cadmium

Fig 6 *Search results for search conditions in fig 5*

IS can give two different kinds of search results, as already mentioned. One is already discussed with numerical values, and the other is figure that can represent diagram, graph or something else. Search conditions in figure 5

also give the figure type of result. Those results are organized on web page similar to numerical results in figure 6. Clicking on corresponding hyperlink, web page with graph figure is presented, that is given in figure 8.

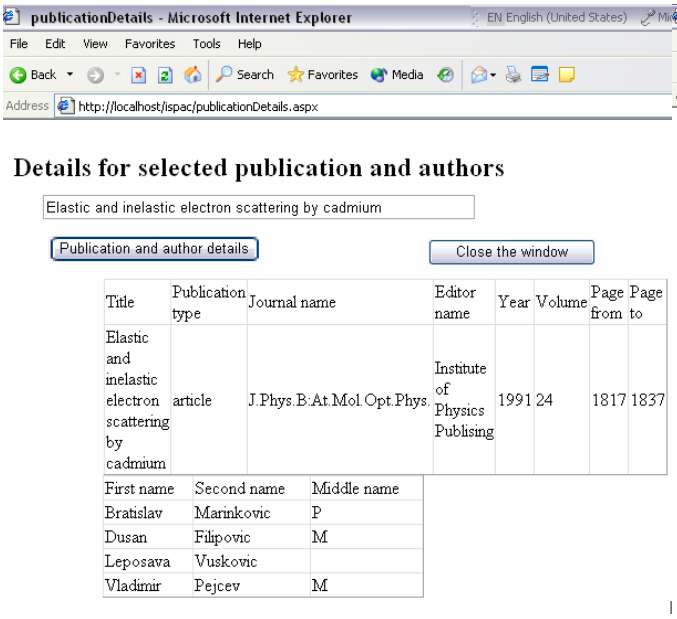


Fig 7 *Complete data for publication*

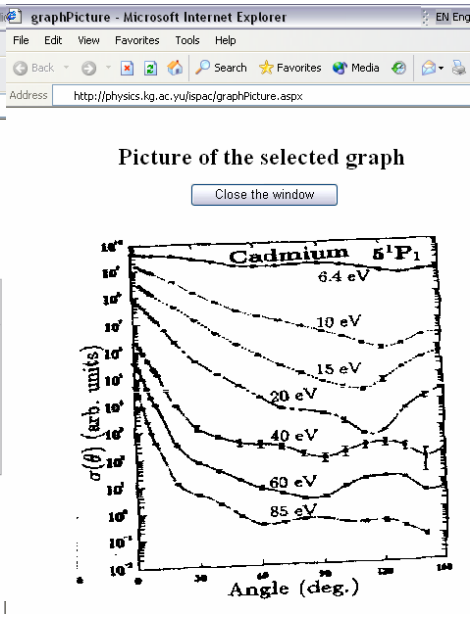


Fig 8 *Graph result*

The other type of search that is just mentioned but not described here is search for publications All web pages are of type *.aspx that means active server pages in Microsoft latest dot NET technology. ASPX web pages are dynamic, their contents is formed on the basis of current users selection, in this case selection of items that form the search condition.

4. Conclusion

Implemented IS is based on detailed logical model developed by physicists in the area of atomic physics. The main purpose of IS is to be used as a tool for research, and to support informatics side of research – effective and precise search for data, that can even be particular values or figures published in scientific publications. Research planning and recording of current research is supported by database and programs for data entry and editing. Web technology gives maximum available access to all data. Further development of IS that will enable new kinds of data search or results analysis is possible without or with minor changes of database that was designed as universal.

5. References

[1] De Marco "Structured Analysis and System Specification", Yourdon Press, 1978.
[2] V. Cvjetković, V. Bočvarski, B. Radenković, Expert system for analysis of electron - atom scattering energy loss spectra, Expert Systems With Applications, Vol 14, No 3, April 1998, p 275-282
[3] Standard "Integration Definition for Information Modeling (IDEF1X)", Federal Information Processing Standards Publications (FIPS PUBS), Computer Security Act of 1987, Public Law 100-235. 1993 December 21
[4] International Nuclear Information System, The International Atomic Energy Agency (IAEA) 1990 to the present

are activities that are not implemented as a whole, researchers can use implemented IS whenever effective data search for references and results is needed, and to plan the future research by gradually specifying research characteristics.
Data model [3] is given in figure 3, and contains all important entities for research and publication.

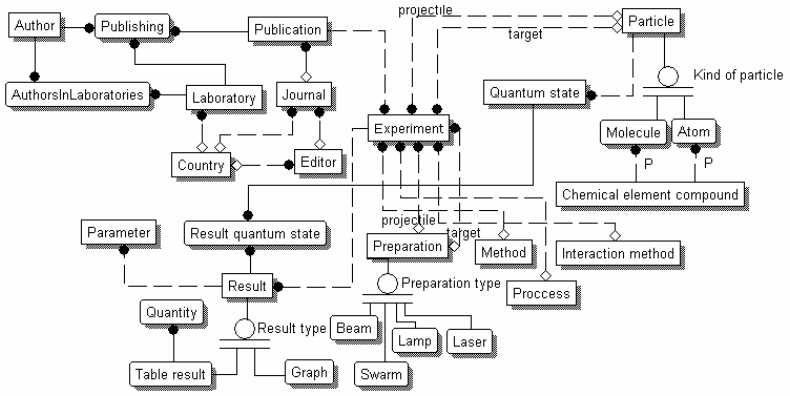


Fig 3 *Data model*

Relationships between entities are expressed with connecting lines. Line end with black dot means there can be zero, one or more entity instances on that end, while dot absence means there is only one instance. Full lines designate identifying relationship, while dashed lines designate non identifying one. End with diamond means that entity instance does not have to be specified. Experiment or research is the central entity, and it is characterized by many others like particle, preparation, process, method, interaction method. Each publication can have zero, one or more experiments, while each experiment can have zero, one or more results. Left part of the model characterizes the publication and authors. Each particle can appear in the role of projectile and target, and can be prepared in the form of beam, swarm or (photons only) laser or lamp. Molecules and atoms are described with their characteristics and quantum states for each ionization level. Each result for a given experiment can be in the form of table or picture – graph, diagram or similar. Any kind of table result from an article with arbitrary number of columns and rows can be stored in database. Entity named quantity contains data for each column in table result. Black dot on quantity designates that table result entity can have arbitrary number of columns. Any experiment characteristics not mentioned here can be evidenced as parameter. Each result can be characterized with zero, one or more parameters. Parameters that have the same values for each result can be connected directly with experiment without need to repeat for each experiment. Parameter names and types can be arbitrary, so any important experiment characteristic can be evidenced in database. Each entity in figure 3 have a number of attributes not shown here for the reasons of simplicity.

3. IS implementation

Implemented IS consists of two main parts. The first part is local which means that it can be accessed locally from the same computer on which it operates. The second part enables WEB access to database and various kinds of data search. IS is implemented using latest Microsoft technology (dot NET). The first part of the information system consists of database and programs for data entry. Database implements given data model in full detail. Programs for data entry have graphical user interface and multi level hierarchical structure. Multi level structure enables logical control of data entry as data have to be entered in strict order that is a consequence of data interdependence. Data on the first level does not depend on specific publication and experiment, but characterize publication and experiment – particle, quantum state, laboratory, author, journal, process, interaction and method. Data on the second level are specific for given experiment – ionization, preparation, parameter, result. Data on the third level are specific for given result within given experiment – parameter, graph table. On the fourth level are data for given result table.

CIP - Katalogizacija u publikaciji
Narodna biblioteka Srbije, Beograd

53(048)

GENERAL Conference of the Balkan Physical Union (5; 2003; Vrnjačka Banja)
Book of Abstract / 5th General Conference of the Balkan Physical Union (BPU-5), Vrnjačka Banja, Serbian and Montenegro, 25-29 August 2003; [editors Stevan Jokić... et al.]. - Belgrade: MST Gajić). - XXIX, 435 str.; 24 cm

Tiraž 800. - Registar

ISBN 86-902537-3-4
1. Dop. nasl. 2. Jokić Stevan
a) Fizika - Bibliografije, referativne
COBISS. SR-ID 107686156