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PRINCIPLES OF CONSTRUCTING SYSTEMATIZED, BIBLIOGRAPHIC NUCLEAR DATA FILES

A.I. Abramov
Institute of Physics and Power Engineering
Obninsk, USSR

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IAEA NUCLEAR DATA SECTION, KÄRNTNER RING 11, A-1010 VIENNA

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A.I. Abramov
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The author discusses the general principles of constructing systematized, bibliographic nuclear data files for information storage on magnetic computer tape and suggests modifications to the CINDA system which would permit the inclusion of data on all nuclear reactions. Principles for a single approach to the compilation of keywords are set forth. To demonstrate the possibilities of such a system, the author presents information on all known investigations relating to photoneutron reactions near the threshold and, giving a number of examples, demonstrates the possibility of using the system to record information on other types of nuclear reaction.

1. INTRODUCTION

The growing interest in non-neutron nuclear data has raised the question of the need to create systematized bibliographic files for such data. In the case of neutron data, a file (CINDA) was devised 15 years ago by Prof. Herbert Goldstein of Columbia University, USA. In 1965, CINDA was adopted as an international system for the exchange of bibliographic information, and since then four nuclear data centres have joined in collecting data for CINDA. As a result of their combined efforts the number of references has greatly multiplied, the quality of the references has improved and considerable experience has been accumulated of the technical aspects of data collection, the processing of data and the use of data by specialists working in a wide variety of fields.

In view of the fact that many scientists in a large number of countries have found the CINDA system satisfactory after working with it for several years, it is natural to ask whether the system could be used for systematizing bibliographic information relating to all nuclear data. This is an attractive prospect, for one could make full use not only of the specialists' experience, but also of the available machine processing programmes, keyword lists, codes, etc. However, we do not consider it feasible, for the reasons given below.

CINDA was designed from the outset exclusively for neutron data. This automatically led to a number of limitations as regards the codes used and the format, so that the system cannot be applied to all kinds of nuclear data. For example, in the CINDA system quantities and types of reaction are as a rule coded without any indication of the particle which caused the reaction (as it is always tacitly assumed that the particle was a neutron). Obviously, the use of keywords such as "elastic" or "absorption" and of the corresponding codes for all nuclear reactions would leave users in the dark as to what particles had been scattered or absorbed.

Moreover, CINDA can be used for systematizing references only on the basis of neutron energy. The corresponding columns could easily be used for information on the energy of other primary particles; however, in the case of several nuclear reactions (for example, when one is measuring the energies of inelastically scattered charged particles or using the time-of-flight method to measure the energy distributions of photoneutrons) it is necessary to indicate - in addition to the energy of the primary particles - the energy range of the secondary particles, the latter often being more important than the former. The "Comments" column is clearly not convenient for this purpose. Even less convenient is the use of the CINDA format for systematizing data such as information on nuclear masses, spins, level structures, decay schemes and lifetimes.

Lastly, the experience of working for several years with CINDA files has shown that the present system of entries requires some modification in the interests of easier reading and more rapid information selection. It would be very useful if one could, say, select on the basis of the form of data presentation (in the CINDA system, this parameter is dealt with under "Comments" and cannot be used as a basis for selecting references), for specialists are often interested not in all information relating to a particular quantity, but merely in whether the information is in graph or tabular form. Essentially worthless references containing no factual information (the letters "NDG" - "No Data Given" - appear in the "Comments" column alongside such references) are a form of interference which causes loss of time when one is handling CINDA files, for one has to read a line through to its end in order to establish that a reference contains no data.

From what has been said above it would seem that there is a need for several systems of compiling bibliographic references relating to nuclear data, these systems differing in particular details. At the same time, the number of systems should not be too great (3-5), so that each is as comprehensive as possible, and in devising them one should apply as far as possible the principles underlying the CINDA system, which have proved themselves in practice. A great many workers in various countries are familiar with the format of the CINDA system, its coding designations and the procedures for compiling and reading entries, and a large proportion of them will need to take an interest in non-neutron nuclear data also. All bibliographic systems should therefore have as much in common as possible.

To demonstrate the workability of the principles formulated above, we attempt in this paper to construct a system which could be used in the compilation and systematization of data relating to a very wide range of nuclear reactions. We discuss the format of such a system and propose general rules for the construction of keywords; in addition, we indicate what modifications and additions to the CINDA glossaries we consider necessary, these modifications and additions being incorporated in the system proposed by us here (Annex 1). In Annex 2, we present - as an example of how the system would function - entries for all information known to us on investigations relating to photoneutron reactions near the threshold. We would mention in this connection that, while there is in all glossaries and in this paper a strong bias in favour of this particular kind of data, we believe the principles formulated above could easily be applied in compiling glossaries for the recording of information on any nuclear reactions in the low-energy region (this can be seen from examples given in Annex 3).

2. FORMAT

2.1. General remarks

We consider here only the output format in which the information is presented in reference works and machine printouts. The question of input format would have to be solved in the course of writing programmes for the recording of data on computer tapes and for data processing. It might be necessary to devise, for different types of machine, different input formats for use with a single output format.

To suit the digital printers used in conjunction with many Soviet computers, we chose a line length of 128 characters (including spaces). The system employs Latin letters, Arabic numerals and the usual symbols, so that it is compatible with foreign as well as Soviet computers.

We took as a basis the CINDA format, making certain changes in the number, order and size of the columns. The columns are separated by two spaces and the entries within a column by one line space.

2.2. Column headings and widths

1. Nuclide (6 vertical lines; 1-6). The method of recording is the same as for CINDA except that the ordinal number of the nuclide is omitted. Even this difference could be eliminated by inserting the ordinal number and the atomic weight above the set of entries relating to a particular nuclide, as was done in CINDA 71 [1]. Column 1 would then disappear, with the result that either the line would be shortened to 120 characters or the eight characters thereby released would become available for other purposes (for lengthening the entries in the last column, numbering the lines, etc.).

2. Quantity (12 vertical lines; 9-20). This corresponds to the "Quantity" column in the CINDA system. However, the code glossary needs to be expanded considerably (see Annex 1-1). The main principle in devising codes to designate nuclear reactions is that the type of reaction should be indicated by the beginning of the code. For example, GN DIF SIG denotes the differential cross-section for a (γ,n) reaction.

3. Form of data presentation (4 vertical lines; 23-26). There is no such column in the CINDA system, the information in question being included under "Comments". We have already referred to the usefulness of such a column. The code glossary is based on CINDA (see Annex 1-2).

4-5. Energy of primary particles (9 vertical lines; 29-37). The method of making entries is exactly the same as in the CINDA system. The maximum and minimum energy values are separated by one space. If measurements have been made at only one primary particle energy, the energy in question is indicated in the four left-hand vertical lines (29-32).

6-7. Energy of secondary particles (9 vertical lines; 40-48). The CINDA system does not have these columns. The method of making entries is similar to that used in columns 4-5 for the energies of primary particles.

8. Type of publication (2 vertical lines; 51 and 52). The method of making entries is exactly the same as in the CINDA system (see Annex 1-3).

9. Laboratory (3 vertical lines; 55-57). The method of making entries is exactly the same as in the CINDA system. For code glossary see CINDA 71 [1].

10. Author(s) (10 vertical lines; 60-69). There is no such column in the CINDA system, the surname of the first author appearing at the beginning of the "Comments" column. The column is a useful one in that, together with columns 11 and 12, it corresponds to the traditional method of formulating bibliographic references; it also enables one to pick out the works of a particular author. As in the CINDA system, the symbol "+" after a surname indicates co-authorship.

11. Source (14 vertical lines; 72-85). The method of making entries is exactly the same as in the CINDA system. For abbreviations of the titles of journals and other sources see CINDA 71 [1].

12. Month and year of publication (3 vertical lines; 88-90). The method of making entries is exactly the same as in the CINDA system [1].

13. Comments (36 vertical lines; 93-128). Like the "Comments" column of the CINDA system, this column is intended for the presentation in uncoded form of information on experimental techniques, treatment of the data and - where possible - the results obtained. The glossary of abbreviations used in this column is again based on the corresponding CINDA glossary (see Annex 1-4); in this column, however, in contrast to the preceding ones, any other abbreviations comprehensible to the unprepared reader without additional explanation are permitted. It is recommended that the order employed in the corresponding glossary (Annex 1-4) be adhered to in the making of entries in the "Comments" column.

2.3. Ordering of entries

As in the CINDA system, all entries are sorted and arranged on the machine printout tape by element, isotope mass number, quantity (in accordance with the order shown in Annex 1-1) and date of publication. Sorting on the basis of other parameters is not normally required; in the extremely rare cases of a coincidence of all four above-mentioned parameters, any ordering of the entries is possible.

The groups of lines relating to different nuclei are separated by one blank line.

As a rule, for each type of nucleus each measured quantity for which there is a corresponding code in Annex 1-1 should be presented in a separate line. For example, if the authors of a particular work have investigated two isotopes of an element, measuring for each of them the differential cross-sections and deriving the resonance parameters, four lines will be needed for the entries relating to this work.

3. EXAMPLES

In Annex 2 we illustrate how the proposed system would function by presenting information on all investigations relating to photoneutron reactions near the threshold; the energy of the primary particles (columns 4 and 5) is taken to be the maximum bremsstrahlung energy E_{γ}^{max}. If measurements have been performed at various E_{γ}^{max}, the lowest (column 4) and highest (column 5) values are given. We present in columns 6 and 7 respectively the lowest and highest neutron energies for which data on measured quantities are available in graph or tabular form. If only one value has to be given for the energy of primary or secondary particles, it is always written on the left (in column 4 or column 6 as appropriate).

In the case of the CINDA system, if the same data are contained in several works (report, preprint, conference paper, article), only an entry relating to the most recent work appears, all preceding works being referred to under "supersedes". In Annex 2, on the other hand, there is a complete line for each work as we feel that slight changes in minor details may sometimes be of interest; moreover, one never knows which of the sources is most readily accessible to the reader.

We present below by way of example a one-line entry (the line has been broken into two parts to fit the page):

I	2	3	4	5	6	7	8	9	I0
MG 025	GN DIF SIG	GRPH	II+7		25+4	20+6	NJ	LRL	BAGLAN+

II	I2	I3
PR 3 C672	27I	TOF SCU5GG I.6 NS/M I35 DEG

The meaning of this entry is as follows: for magnesium-25 (1) information is presented on differential cross-sections for a (γ,n) reaction (2) in graph form (3). The measurements were performed at a maximum bremsstrahlung energy of 11 MeV (4) in the neutron energy range from 25 keV (6) to 2 MeV (7). The work which was experimental and an account of which was published as an article in a journal (8), was carried out at the Lawrence Radiation Laboratory (9) by

Baglan et al. (10). The journal, Physical Review 3 p. C672 (11), appeared in February 1971 (12). The authors employed the time-of-flight method, using a scintillation detector with a ^{235}U plate and recording gamma-gamma coincidences. The measurements were performed with a resolution of 1.6 ns/m and at an angle of 135° (13).

In Annex 3 we present examples of entries for various nuclear reactions. The entries are only illustrations and are not exhaustive even as regards the works to which they relate.

4. COMPATIBILITY WITH THE CINDA SYSTEM

If the proposed system is adopted, but the CINDA system is used in parallel at some centres, despite the above-mentioned drawbacks (which also apply to the recording of non-neutron data) it will be necessary to devise algorithms for the transfer of data from one system to the other.

The transfer of data from the proposed system to the CINDA system will consist simply in transferring information from columns 3, 6, 7 and 10 to the "Comments" column, it being possible to retain CINDA's traditional order of entries in this column (first the author's surname from column 10, then the form of data presentation from column 3, etc.). The energy of the secondary particles, from columns 6 and 7, can be written as follows (this is applicable not only to the case under consideration): E(N)=(2.5E+4)-(2.0E+6), or E(N)=25 keV - 2 MeV. The entire entry in the "Comments" column thus becomes

BAGLAN+, GRPH, E(N)=25 keV - 2 MeV, TOF.

As the space available for entries in the "Comments" column of the CINDA system and in column 13 of the proposed system is about the same, the transfer of information from columns 3, 6, 7 and 10 to the "Comments" column will require that some data be omitted. In the case under consideration, for example, we have omitted all information about the detectors, the energy resolution and the measurement angle, while the entry has also acquired a form which is less convenient for reading. The reverse process - the transfer of information from the CINDA system to the proposed system - is more complex and would require special study.

5. CONCLUSION

From what has been said and from the examples given in Annexes 2 and 3, it follows that the system proposed by us possesses the following features:

1. Suitability for recording data on measurements of many quantities for virtually any nuclear reactions;

2. Close relationship with the CINDA system as regards format, codes and abbreviations;

3. Possibility of data transfer to the CINDA system;

4. Order of entries more convenient for reading, with the form of data presentation, the energy of secondary particles and the author's surname placed before the name of the journal;

5. Allowance for the printing capabilities of Soviet computers.

This paper is in no way an attempt to present a completely thought-out system for the compilation of bibliographic data on nuclear reactions. Before such a system can become operative, it will be necessary to do a great deal of work on preparing code glossaries for different types of quantity, different reactions, details of experimental methods, etc. Moreover, many serious problems will have to be overcome in devising the input format and the supporting programmes; for example, the limited amount of information that can be put onto one punch card (78 or 80 symbols) may lead to some shortening of the line length (even if abbreviated codes are used) or to the use of two punch cards for one line. Moreover, with the creation of non-neutron data libraries the proposed system will become useful as a catalogue for such libraries (an attempt is being made at present to use CINDA as a catalogue for the EXFOR system); this will entail the introduction of special subscripts in each line, which will reduce by several more characters the amount of information recorded. All these questions would have to be solved during the development of a working version of the system.

It should be noted that this paper is not connected with any current organizational activities. Its purpose is merely the discussion of a general approach to the development of one kind of information system in the nuclear data field, and any observations will be welcome.

The author wishes to thank L.N. Usachev and V.M. Bychkov for their interest in this work and for their valuable advice.

REFERENCE

[1] CINDA 71, An Index to the Literature on Microscopic Neutron Data, IAEA, Vienna (1971).

A N N E X 1

Additions to code glossary

1-1 Quantities

GN YIELD	Yield of (γ,n) reaction. Used when data presented in relative units or as number of counts recorded in analyser channel, or when it is simply stated that a reaction has been detected but no information on it is given.
PA YIELD	As above, but for (p,α) reaction.
GN DIF SIG	Differential cross-section for (γ,n) reaction. The measurement angle should be indicated in "Comments" column.
GN RES PARAM	Resonance parameters measured in studying (γ,n) reaction. It usually denotes parameters of the levels of the compound nucleus created during the reaction in question.
RES PARAM	Resonance parameters of the nucleus indicated in column 1 regardless of how it is created.
NON RESN GN	Non-resonance process (direct or semi-direct) in (γ,n) reaction.
STRNG FNC GO	Radiative strength function.
STRNG FNC N3	Strength function for neutrons with $\ell = 3$.
ANALG STATES	Any information on analog states.
DOORWAY STS	Any information on doorway states.
GN-NG	Comparison of information on direct (γ,n) reaction and inverse (n,γ) reaction, or use of data on direct reaction in calculating parameters of inverse reaction.
DN POLAR	Investigation of polarization of neutrons from (d,n) reaction; measurement of polarization coefficients.
P SCAT ANG D	Proton scattering - angular distribution.
GNP+GD SIG	Total cross-section for (γ,np) and (γ,d) reactions.
G TOT SIG	Total cross-section for photons.
D2N ISOM	Investigation of isomers occurring in $(d,2n)$ reaction.

1-2 Form of data presentation

NDG	No data given. The reason for the lack of data (data processing not completed, sought effect not detected, etc.) may be indicated in "Comments" column.
GRPH	Data presented in graph form.
TBL	Data presented in digital form in table.
TEXT	Data presented and discussed in text of paper.
GRTB	Paper contains both graph and table.

1-3 Type of publication

First vertical line

E	Experimental work
T	Theoretical work
M	Joint presentation of experimental and theoretical data.
R	Review
C	Compilation of experimental data.
D	Evaluation of results of experimental works.

Second vertical line

J	Journal
C	Conference paper
B	Book
D	Dissertation
R	Report
A	Abstract (also abstracts in progress reports)
P	Preprint
W	Private communication

1-4 Comments

Method

ACT	Activation
TRNSM	Measurements by transmission method
TOF	Time-of-flight method

Detectors

SC	Scintillator; scintillation counter.
SC+B10	Scintillator with boron-10.
SC+H(NN)	Hydrogenous scintillator with recording of recoil protons produced in elastic neutron scattering.
SCU5GG	Scintillation detector with ^{235}U plate and gamma-gamma coincidence recording.
LIGLASS	Scintillation detector with lithium glass.
SCC	Semiconductor detector (SI SCC - silicon semiconductor detector).

Other experimental details

1.6 NS/M	Resolution (1.6 ns/m.)
135 DEG	Measurement angle (135^o).
TGT	Target (AL TGT - aluminium target).

Measured quantities

E(N)	Neutron energy.
SIG(NR)	Cross-section for non-resonance process
S(GO)	Radiative strength function: $S_{\gamma o} = <\Gamma_{\gamma o}>/<D>$.
TRNS	Transition (EI TRNS - EI transition).
WG	Radiative width: Γ_{γ}
WGO	$\Gamma_{\gamma o}$
WGODS	Radiative width of doorway state: $\Gamma_{\gamma o}^{in}$.
WNAS	Neutron width of analog state: Γ_n^{an}

Numbers

1.1 + - 0.5 should be read as 1.1 ± 0.5; 1.9E-5 should be read as $1.9 \cdot 10^{-5}$.

Nuclide	Quantity	Form of data presen-tation	E_1 min.	E_1 max.	E_2 min.	E_2 max.	Type of publi-cation	Lab.	Reference Author(s)	Reference Source	Month and year	Comments
I	2	3	4	5	6	7	8	9	IO	II	I2	I3
HE 004	GN-NG	GRPH	22+7	3I+7	I0+5	80+6	EA	LRL	BERMAN+	WASH II36 87	969	
BE 009	GN DIF SIG	GRPH	35+6		I +3	40+4	EJ	LRL	BERMAN+	PR I63 958	N67	TOF SC+BIO I35 DEG PT TGT
BE 009	RES PARAM	TBL	35+6		I +3	40+4	EJ	LRL	BERMAN+	PR I63 958	N67	WG =I.8 EV
B 0I0	GN DIF SIG	GRPH	I0+7		I0+4	9I+5	ED	LRL	VAN HEMERT	UCRL 5050I	968	RES STRCT NO OBSRVD
F 0I9	GN DIF SIG	GRPH	II+7		I0+4	I0+6	ED	LRL	VAN HEMERT	UCRL 5050I	968	TOF Y+AL TGT
F 0I9	GN DIF SIG	GRPH	II+7		20+4	80+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	TOF SCU5GG 3.5 NS/M I35 DEG
F 0I9	RES PARAM	TBL	I2+7		I0+5		EJ	LRL	BAGLAN+	PR 3 C672	27I	
MG 024	GN DIF SIG	GRPH	I6+7	I9+7	I0+4	22+6	ED	LRL	VAN HEMERT	UCRL 5050I	968	TOF C TGT
MG 024	GN DIF SIG	GRPH	20+7		I0+4	20+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	TOF SCU5GG 2.3 NS/M I35 DEG
MG 024	RES PARAM	NDG					EA	LRL	BOWMAN+	WASH II27 96	469	
MG 024	RES PARAM	TBL	20+7		22+4	20+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	
MG 024	ANALG STATES	TEXT					ED	LRL	VAN HEMERT	UCRL 5050I	968	
MG 025	GN DIF SIG	GRPH	83+6	II+7	I0+4	I4+6	ED	LRL	VAN HEMERT	UCRL 5050I	968	TOF Y+AL TGT
MG 025	GN DIF SIG	GRPH	II+7		30+4	20+6	EJ	LRL	BERMAN+	PRL 24 3I9	270	TOF I35 DEG Y TGT
MG 025	GN DIF SIG	GRPH	II+7		25+4	20+6	ED	LRL	BAGLAN	UCRL 50902	870	TOF SCU5GG I.6 NS/M I35 DEG
MG 025	GN DIF SIG	GRPH	II+7		25+4	20+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	TOF SCU5GG I.6 NS/M I35 DEG
MG 025	RES PARAM	TEXT	II+7		30+4	20+6	EJ	LRL	BERMAN+	PRL 24 3I9	270	
MG 025	RES PARAM	TBL	83+6	II+7	4I+4	I2+6	ED	LRL	BAGLAN	UCRL 50902	870	
MG 025	RES PARAM	TBL	83+6	II+7	4I+4	I8+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	
MG 025	NON RESN GN	NDG					EA	LRL	BOWMAN+	WASH II27 96	469	
MG 025	ANALG STATES	NDG					EA	LRL	BOWMAN+	WASH II27 96	469	

I	2	3	4	5	6	7	8	9	I0	II	I2	I3
MG 025	ANAIG STATES	TEXT	II+7		30+4	20+6	EJ	LRL	BERMAN+	PRL 24 3I9	270	
MG 025	ANALG STATES	TEXT	II+7		40+5		ED	LRL	BAGLAN	UCRL 50902	870	FOR ANALG OF GND ST E(N)=438.5 KEV
MG 025	ANALG STATES	TEXT	II+7		44+5	I2+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	
MG 026	GN DIF SIG	GRPH	II+7	I3+7	I0+4	I5+6	ED	LRL	VAN HEMERT	UCRL 5050I	68	TOF
MG 026	GN DIF SIG	GRPH	I3+7		I0+4	I5+6	EJ	LRL	BERMAN+	PRL 23 386	869	TOF I35 DEG FOR ASTROPHYS PROBLEMS
MG 026	GN DIF SIG	GRPH	I3+7		I0+4	I5+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	TOF SCU5GG 2.3 NS/M I35 DEG
MG 026	RES PARAM	NDG					EA	LRL	BOWMAN+	WASH II27 96	469	
MG 026	RES PARAM	TBL	I3+7		54+4	II+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	
MG 026	STRNG FNC GO	TBL					EA	LRL	BAGLAN+	NCSAC 33 I06	D70	S(GO)=(3.I+-2.0)E-5
SI 028	GN DIF SIG	GRPH	I8+7		I0+4	70+5	ED	LRL	VAN HEMERT	UCRL 5050I	68	TOF
P 03I	GN DIF SIG	GRPH	I4+7		I0+4	I3+6	ED	LRL	VAN HEMERT	UCRL 5050I	68	TOF RES STRCT NO OBSERVED Y+AL TGT
P 03I	RES PARAM	TBL	I4+7		I0+5	94+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	
S 032	GN DIF SIG	GRPH	I7+7		I0+4	I0+6	ED	LRL	VAN HEMERT	UCRL 5050I	68	TOF C TGT
CA 040	GN DIF SIG	GRPH	I7+7		I0+4	I0+6	ED	LRL	VAN HEMERT	UCRL 5050I	68	TOF RES STRCT NO OBSERVD C TGT
CR 052	GN DIF SIG	GRPH	I4+7		60+4	I0+6	ED	LRL	BAGLAN	UCRL 50902	27I	TOF SCU5GG I.I NS/M I35 DEG AL TGT
CR 052	GN DIF SIG	GRPH	I4+7		60+4	I0+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	TOF SCU5GG I.I NS/M I35 DEG AL TGT
CR 052	RES PARAM	TBL	I2+7	I4+7	68+4	39+5	ED	LRL	BAGLAN	UCRL 50902	870	
CR 052	RES PARAM	TBL	I2+7	I4+7	68+4	39+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	
CR 052	STRNG FNC GO	TBL					ED	LRL	BAGLAN	UCRL 50902	870	S(GO)=2.7E-5
CR 052	ANALG STATES	NDG					EA	LRL	BOWMAN+	WASH II27 96	469	
CR 052	ANALG STATES	NDG	I4+7		60+5	I0+6	ED	LRL	BAGLAN	UCRL 50902	870	NO OBSERVD
CR 052	ANALG STATES	NDG					EA	LRL	BAGLAN+	NCSAC 33 I06	D70	NO OBSERVD
CR 052	ANALG STATES	TEXT	I4+7		60+5	I0+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	

I	2	3	4	5	6	7	8	9	I0	II	I2	I3
CR 053	GN YIELD	GRPH			20+4	52+5	EA	ANL	JACKSON	NCSAC 33 9	D70	TOF I35 DEG
CR 053	GN DIF SIG	GRPH			20+4	20+5	EA	LRL	BAGLAN+	NCSAC 3I I00	570	TOF I35 DEG
CR 053	GN DIF SIG	GRPH	I2+7		20+4	I6+6	ED	LRL	BAGLAN	UCRL 50902	870	TOF SCU5GG I.I NS/M I35 DEG
CR 053	GN DIF SIG	GRPH	I2+7		20+4	I6+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	TOF SCU5GG I.I NS/M I35 DEG
CR 053	GN DIF SIG	GRPH	I2+7		20+4	I6+6	EJ	LRL	BAGLAN+	PR 3 C2475	67I	TOF SCU5GG I35 DEG
CR 053	RES PARAM	NDG					EA	LRL	BOWMAN+	WASH II27 96	469	
CR 053	RES PARAM	TBL	92+6	I2+7	2I+4	52+5	ED	LRL	BAGLAN	UCRL 50902	870	
CR 053	RES PARAM	TBL			2I+4	37+5	EA	ANL	JACKSON	NCSAC 33 9	D70	
CR 053	RES PARAM	TBL	92+6	I2+7	2I+4	55+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	
CR 053	STRNG FNC GO	TBL					ED	LRL	BAGLAN	UCRL 50902	870	S(GO)=2.9E-5
CR 053	STRNG FNC GO	TBL					EA	LRL	BAGLAN+	NCSAC 33 I06	D70	S(GO)=(I.6+-0.8)E-5 FOR EI TRNS
CR 053	DOORWAY STS	TEXT			20+4	20+5	EA	LRL	BAGLAN+	NCSAC 3I I00	570	
CR 053	DOORWAY STS	TEXT	I2+7		50+4	60+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	
CR 053	DOORWAY STS	TEXT	I2+7		20+4	I6+6	EJ	LRL	BAGLAN+	PR 3 C2475	67I	CORREL NO OBSERVD
FE	GN DIF SIG	GRPH	I3+7		I +3	I2+4	EJ	LRL	BERMAN+	PRL I7 76I	066	TOF SC+BIO I5-30 NS/M I35 DEG
FE	GN YIELD	GRPH	I2+7		I +3	I0+4	EC	FEI	ABRAMOV+	7I KIEV	57I	TOF SC+BIO 30 NS/M 75 DEG AL TGT
FE 056	GN DIF SIG	GRPH	I3+7		I +3	70+4	EJ	LRL	BOWMAN+	PR I63 95I	N67	TOF SC+BIO I35 DEG AL TGT
FE 056	GN DIF SIG	NDG					EA	GA	SUND+	NCSAC 3I 68	570	TOF SC+BIO AU+AL TGT
FE 056	GN DIF SIG	GRPH	I3+7		60+4	I0+6	ED	LRL	BAGLAN	UCRL 50902	870	TOF SCU5GG I.I NS/M I35 DEG
FE 056	GN DIF SIG	GRPH			50+4	I0+6	EA	LRL	BAGLAN	NCSAC 33 I06	D70	TOF I35 DEG
FE 056	GN DIF SIG	GRPH	I3+7		60+4	I0+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	TOF SCU5GG I.I NS/M I35 DEG
FE 056	RES PARAM	TBL	I2+7	I3+7	I9+3	98+3	EJ	LRL	BOWMAN+	PR I63 95I	N67	
FE 056	RES PARAM	TBL	II+7	I3+7	83+4	7I+5	ED	LRL	BAGLAN	UCRL 50902	870	
FE 056	RES PARAM	TBL	II+7	I3+7	83+4	7I+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	
FE 056	STRNG FNC GO	TBL					ED	LRL	BAGLAN	UCRL 50902	870	S(GO)=3.2E-5
FE 056	ANALG STATES	NDG					EA	LRL	BOWMAN+	WASH II27 96	469	
FE 056	ANALG STATES	NDG	I3+7		25+5	75+5	ED	LRL	BAGLAN	UCRL 50902	870	NO OBSERVD

I	2	3	4 5	6 7	8	9	IO	II	I2	I3
FE 056	ANALG STATES	TEXT		30+5 75+5	EA	LRL	BAGLAN+	NCSAC 33 I06	D70	
FE 056	ANALG STATES	TEXT	I3+7	30+5 75+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	
FE 057	GN DIF SIG	GRPH	I2+7	20+4 I6+6	ED	LRL	BAGLAN	UCRL 50902	870	TOF SCU5GG I.I NS/M I35 DEG
FE 057	GN DIF SIG	GRPH	I2+7	20+4 I6+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	TOF SCU5GG I.I NS/M I35 DEG
FE 057	GN DIF SIG	GRPH	I2+7	20+4 I6+6	EJ	LRL	BAGLAN+	PR 3 C2475	67I	TOF
FE 057	RES PARAM	NDG			EA	LRL	BOWMAN+	WASH II27 96	469	
FE 057	RES PARAM	TBL	86+6 I2+7	26+4 39+5	ED	LRL	BAGLAN	UCRL 50902	870	
FE 057	RES PARAM	TBL	86+6 I2+7	26+4 39+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	
FE 057	STRNG FNC GO	TBL			ED	LRL	BAGLAN	UCRL 50902	870	S(GO)=I.9E-5
FE 057	STRNG FNC GO	TBL			EA	LRL	BAGLAN+	NCSAC 33 I06	D70	S(GO)=(I.I+-0.6)E-5
FE 057	DOORWAY STS	NDG		I0+5 40+5	ED	LRL	BAGLAN	UCRL 50902	870	
FE 057	DOORWAY STS	TEXT		50+4 25+5	EA	LRL	BAGLAN+	NCSAC 33 I06	D70	
FE 057	DOORWAY STS	TEXT	I2+7	60+4 60+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	NO STRONG CORRELATION
FE 057	DOORWAY STS	TEXT	I2+7	20+4 I6+6	EJ	LRL	BAGLAN+	PR 3 C2475	67I	DOORW STS NEAR 50 AND 250 KEV
FE 057	NON RESN GN	TEXT		22+4 28+4	ED	LRL	BAGLAN	UCRL 50902	870	SIG(NR)=4.2 MUB/SR
PB	GN YIELD	GRPH	82+6	30+4 50+5	EJ	MIT	BERTOZZI+	PL 6 I08	863	TOF SC+AG(NG) I2 NS/M 77 DEG
PB	GN YIELD	GRPH	74+6	I2+5 40+5	EA	ANL	JACKSON	NCSAC 3I I0	570	TOF LIGLASS I35 DEG
PB	GN DIF SIG	GRPH	9 +6	36+4 44+4	ED	LRL	BAGLAN	UCRL 50902	870	TOF SCU5GG I.I NS/M I35 DEG
PB	GN DIF SIG	GRPH	98+6	35+5 II+6	EJ	LRL	BOWMAN+	PRL 25 I302	N70	TOF SC+H(NN) I35 DEG
PB 206	GN YIELD	GRPH	83+6 I0+7	I +3 50+4	EJ	LRL	BOWMAN+	PR I78 I827	269	TOF SC+BIO PULSE-SHAPE DISCR
PB 206	GN DIF SIG	GRPH	I0+7	6 +3 I0+6	ED	LRL	BAGLAN	UCRL 50902	870	TOF SCU5GG I.6 NS/M I35 DEG
PB 206	GN DIF SIG	GRPH	I0+7	6 +3 I0+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	TOF SCU5GG I.6 NS/M I35 DEG
PB 206	RES PARAM	NDG			EA	LRL	BAGLAN+	NCSAC 33 I06	D70	AT E(N)=7.3 KEV SIG(GN)=3 B
PB 206	RES PARAM	TBL	83+6 I0+7	I +3 50+4	EJ	LRL	BOWMAN+	PR I78 I827	269	

I	2	3	4	5	6	7	8	9	I0	II	I2	I3
PB 206	RES PARAM	NDG					EA	LRL	BOWMAN+	WASH II27 96	469	
PB 206	RES PARAM	TBL	9 +6	I0+7	7 +3	I0+5	ED	LRL	BAGLAN	UCRL 50902	870	
PB 206	RES PARAM	TBL	9 +6	I0+7	I5+3	I0+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	
PB 207	GN YIELD	GRPH	93+6		25+5	20+6	EJ	MIT	BERTOZZI+	PL 6 I08	863	TOF SC+H(NN) 50 DEG TA TGT
PB 207	GN YIELD	GRPH	88+6		3 +3	25+4	EJ	LRL	BOWMAN+	PR I78 I827	269	TOF SC+BIO I35 DEG
PB 207	GN DIF SIG	GRPH			25+4	35+5	EA	LRL	BOWMAN+	WASH II36 78	969	
PB 207	GN DIF SIG	GRPH			20+4	I5+6	EA	LRL	BOWMAN+	WASH II36 83	969	
PB 207	GN DIF SIG	GRPH	84+6		I5+4	30+5	ED	LRL	BAGLAN	UCRL 50902	870	TOF SCU5GG I.I NS/M I35 DEG
PB 207	GN DIF SIG	GRPH	98+6		20+5	I0+6	ED	LRL	BAGLAN	UCRL 50902	870	TOF SC+H(NN) 0.6 NS/M I35 DEG
PB 207	GN DIF SIG	GRPH	84+6		I5+4	30+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	TOF SCU5GG I.I NS/M I35 DEG
PB 207	GN DIF SIG	GRPH	98+6		20+5	I0+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	TOF SC+H(NN) 0.6 NS/M I35 DEG
PB 207	GN DIF SIG	GRPH	98+6		20+4	70+5	EJ	LRL	BAGLAN+	PR 3 C2475	67I	TOF SC+H(NN) 0.7 NS/M I35 DEG
PB 207	RES PARAM	TBL	77+6	88+6	3 +3	25+4	EJ	LRL	BOWMAN+	PR I78 I827	269	
PB 207	RES PARAM	NDG					EA	LRL	BOWMAN+	WASH II27 96	469	
PB 207	RES PARAM	TBL	74+6	98+6	I4+4	57+5	ED	LRL	BAGLAN	UCRL 50902	870	
PB 207	RES PARAM	TBL	74+6	98+6	3 +3	58+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	
PB 207	STRNG FNC GO	TBL					EA	LRL	BAGLAN+	NCSAC 33 I06	D70	
PB 207	NON RESN GN	TEXT			40+4		EA	LRL	BOWMAN+	WASH II36 78	969	
PB 207	NON RESN GN	NDG					EA	ANL		NCSAC 33 8	D70	
PB 207	DOORWAY STS	TEXT			20+5	70+5	EA	LRL	BOWMAN+	WASH II36 83	969	
PB 207	DOORWAY STS	TEXT			20+5	60+5	ED	LRL	BAGLAN	UCRL 50902	870	WGODS =36.5 EV
PB 207	DOORWAY STS	TEXT			50+4	20+5	ED	LRL	BAGLAN	UCRL 50902	870	WGODS =I6.3 EV
PB 207	DOORWAY STS	TEXT	98+6		20+4	70+5	EJ	LRL	BAGLAN+	PR 3 C2475	67I	
PB 208	GN YIELD	GRPH	93+6		25+5	20+6	EJ	MIT	BERTOZZI+	PL 6 I08	863	TOF SC+H(NN) 50 DEG TA TGT
PB 208	GN YIELD	GRPH	I0+7		25+5	20+6	EJ	MIT	BERTOZZI+	PL 6 I08	863	TOF SC+H(NN) 50 DEG TA TGT
PB 208	GN YIELD	GRPH	9 +6		3 +3	40+4	EJ	LRL	BOWMAN+	PR I78 I827	269	TOF SC+BIO PULSE-SHAPE DISCRIM

I	2	3	4 5	6 7	8	9	IO	II	I2	I3
PB 208	GN DIF SIG	GRPH		I +3 35+5	EA	LRL	BOWMAN+	WASH II27 96	469	TOF
PB 208	GN DIF SIG	GRPH	90+6	25+4 35+5	EJ	LRL	BOWMAN+	PRL 23 796	069	TOF SCU5GG I35 DEG
PB 208	GN DIF SIG	GRPH	98+6	5 +3 35+5	ED	LRL	BAGLAN	UCRL 50902	870	TOF SCU5GG I.6 NS/M I35 DEG
PB 208	GN DIF SIG	GRPH	IO+7	35+5 I4+6	ED	LRL	BAGLAN	UCRL 50902	870	TOF SC+H(NN) 0.6 NS/M I35 DEG
PB 208	GN DIF SIG	GRPH	98+6	I +3 35+5	EJ	LRL	BOWMAN+	PRL 25 I302	N70	TOF SCU5GG I35 DEG
PB 208	GN DIF SIG	GRPH	98+6	5 +3 35+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	TOF SCU5GG I.6 NS/M I35 DEG
PB 208	GN DIF SIG	GRPH	IO+7	35+5 I4+6	EJ	LRL	BAGLAN+	PR 3 C672	27I	TOF SC+H(NN) 0.6 NS/M I35 DEG
PB 208	GN DIF SIG	GRPH	98+6	IO+4 IO+6	EJ	LRL	BAGLAN+	PR 3 C2475	67I	TOF SC+H(NN) AND U5GG I35 DEG
PB 208	RES PARAM	TBL	93+6 IO+7	26+5 85+5	EJ	MIT	BERTOZZI+	PL 6 IO8	86	WGO FOR 7 RESONANCES
PB 208	RES PARAM	TBL	77+6 9 +6	3 +3 40+4	EJ	LRL	BOWMAN+	PR I78 I827	269	
PB 208	RES PARAM	NDG			EA	LRL	BOWMAN+	WASH II27 96	469	
PB 208	RES PARAM	TBL	78+6 IO+7	8 +3 86+5	ED	LRL	BAGLAN	UCRL 50902	870	
PB 208	RES PARAM	TBL	98+6	30+4 86+5	EJ	LRL	BOWMAN+	PRL 25 I302	N70	
PB 208	RES PARAM	TBL	78+6 IO+7	29+3 86+5	EJ	LRL	BAGLAN+	PR 3 C672	27I	
PB 208	STRNG FNC GO	TBL			EA	LRL	BAGLAN+	NCSAC 33 IO6	D70	S(GO)=(4.0+-3.6)E-5 FOR RI TRNS
PB 208	NON RESN GN	NDG			EA	LRL	BOWMAN+	WASH II27 96	469	
PB 208	NON RESN GN	TEXT	90+6	4I+4	EJ	LRL	BOWMAN+	PRL 23 796	069	SIG(NR)=3.4 MB AT 40 KEV
PB 208	NON RESN GN	TEXT		4I+4	TA	LRL	WEISS	NCSAC 3I IO2	570	SIG(NR)=2.5 MB AT 40 KEV
PB 208	NON RESN GN	TEXT		36+4 44+4	ED	LRL	BAGLAN	UCRL 50902	870	SIG(NR)=0.5 MB/SR
PB 208	NON RESN GN	TEXT		25+4 40+4	EA	ANL	JACKSON	NCSAC 33 8	D70	
PB 208	DOORWAY STS	TEXT	98+6	30+4 86+5	EJ	LRL	BOWMAN+	PRL 25 I302	N70	OBSRV 7 MI RESONANCES
PB 208	DOORWAY STS	TEXT	98+6	IO+4 IO+6	EJ	LRL	BAGLAN+	PR 3 C2475	67I	OBSRV 7 MI RESONANCES FROM 30 TO 860 KEV
BI 209	GN YIELD	GRPH	83+6	I +3 IO+6	EA	WRL	WINHOLD+	AERE PR/NP I6	869	TOF LI GLASS I2 NS/M
BI 209	GN DIF SIG	GRPH	II+7	I +3 I3+4	EJ	LRL	BOWMAN+	PRL I7 76I	066	TOF SC+BIO I5-30 NS/M I35 DEG

I	2	3	4	5	6	7	8	9	I0	II	I2	I3
U 235	GN YIELD	NDG					EA	GA	SUND+	NCSAC 3I 68	570	
U 235	GN YIELD	NDG	7 +6				EA	ANL	JACKSON	NCSAC 33 I2	D70	TOF RES STRCT NO OBSERVD
U 238	GN YIELD	NDG					EA	GA	SUND +	NCSAC 3I 68	570	
PU 239	GN YIELD	NDG					EA	ANL	SUND+	NCSAC 3I 68	570	
MANY	RES PARAM	NDG					RC	ANL	BOLLINGER	66 WASH 2 I064	366	REV OF POSSIB OF NEAR THRSHLD MEASRM

I	2	3	4	5	6	7	8	9	I0	II	I2	I3
D 002	DN POLAR	TBL	I2+6	27+6			EA	ITE	MOROZOV+	YFI II 62	7I	FOR 37 DEG
HE 004	P SCAT ANG D	GRPH	I0+7	3I+7			TJ	NBL	BATTY+	NP AI75 I	N7I	OPTMDL CALC
LI 007	DG YIELD	GRPH	35+5		I2+7	I7+7	EJ	STR	SCHAEFFER+	NP AI75 2I7	N7I	
O 0I6	GN DIF SIG	GRPH	35+7	65+7			EJ	RPI	NAGLE+	NP AI27 669	469	TOF 0.25 NS/M
O 0I6	DN POLAR	NDG	3 +6	4 +6			EA	WRU	ANDERSON+	NCSAC 33 36	D70	
F 0I9	DP YIELD	GRPH	25+6	40+6			EJ	IFU	ZAHDGAY+	YF II 277	270	SI SCC I5+I69 DEG
SI 028	GP YIELD	GRPH	23+7	27+7	35+6	II+7	EJ	MOS	GORYACHEV+	YF I I005	665	SI SCC
CA 040	GNP+GD SIG	GRPH	20+7	30+7			TJ	ANL	BRAMANIS	NP AI75 I7	N7I	COMP OF THEORY WITH EXPT
FE	G TOT SIG	GRPH	I0+7	25+7			EJ	LEB	DOLBIIKIN+	YF 9 675	469	TRNSM
NI 062	DP YIELD	GRPH	28+6				EJ	LGU	LITVIN+	YF II 273	270	MAGN ANALYSER
BI 209	GN YIELD	GRPH	I6+7		I +5	5 +6	TJ	CCP	BAZ+	ZET 47 I04I	664	
NP 237	D2N ISOM	NDG	9 +6	I5+7			EA	NBL	ECCLESHALL	NCSAC 33 I54	D70	DELAYED FIS ISOM I00+900 NS

ANNEX 3