**Relational Nuclear Databases**
**upon the MSU INP CDFE Web-site**
**and Nuclear Data Centres Network CDFE Activities**

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Progress Report
to the IAEA Technical NRDC Meeting (28 - 30 May 2001, Vienna)

This report contains the only **short review** of the works carried out by the CDFE concern the IAEA Nuclear Reaction Data Centres Network activities for the period of time from the IAEA Advisory Group Meeting (15 - 19 May 2000, Obninsk, Russia) till May 2001 and the description of the main results obtained.

1. The **new** CDFE EXFOR **TRANS M030** has been produced and transmitted to the IAEA NDS. The TRANS contains (**Annex 1**) 10 retransmitted and 11 new (M0613 - M0623) ENTRYs with 150 data SUBENTs.

2. The CDFE photonuclear databases have been put upon the Web-site (**http://depni.npi.msu.su/cdfe**) before were upgraded significantly by adding a new data and software improvement:

- the “1999” part was added to the “Photonuclear Data Index”; the 2000 “part” is in processing; as whole the **“Photonuclear Data Index 1955 -1999”** database was added by a number of entries from /1/;

- in addition to the former data collection of the CDFE database **"Giant Dipole Resonance Parameters"** 180 **new entries** and **150 new** reaction **cross sections** were added; the last database version includes now altogether **1710 entries and 1230** various photonuclear reaction cross section EXFOR data sets available in forms of both table and graph;

- the new CDFE Web-site **Search Engines** were produced using the Linux MySQL database management system (DBMS) instead of former hypertext data presentations for the following databases (the correspondent search forms are presented in **Annexes 2 – 4**):

  - "Giant Dipole Resonance Parameters. Photonuclear Reaction Cross Sections";
  - “Photonuclear Data Index 1955 -1999”;
  - “CAJAD Charge Particle Reaction Cross Section Catalogue”.

3. Using the MySQL Data Base Management System (Linux) two new relational databases **“Nucleus Ground State Parameters”** and **“Nuclear Reaction Database (EXFOR)”** were developed:

- **“Nucleus Ground State Parameters”** database was produced (**Annexes 5, 6**) for all known stable and radioactive nuclei using several well known sources /2, 3/ of nucleus parameters information and new CDFE data /4/ for first isobar analogue state energies includes the following data:

- nucleus Z and A numbers;
- $T_{1/2}$ or $\Gamma$ or Abundance /2, 3/;
- spin-parity $J^{\pi}$ /2/;
- atomic mass M (with correspondent uncertainty) /3/;
- mass excess M-A (with correspondent uncertainty) /3/;
- nucleus binding energy (with correspondent uncertainty) /3/;
- nucleus ground state isospin (N-Z) /2 value;
- first isobar analogue $T_>$-state energy /4/ (**Annex 7**);
- nucleus dipole and quadrupole moments /5/;

- **"Nuclear Reaction Database (EXFOR)"** database was produced (**test version is available now**); Search Engine (**Annex 8**) gives to one the possibility to find the following data from the complete international EXFOR charge particle and photonuclear reaction data fund (the possibility to add the neutron reaction data fund exists and is under discussion now):

  - Target Nucleus (REACTION SF1);
  - Incident Particle (REACTION SF2);
  - Inc-Source;
  - Outgoing Particle/Process (REACTION SF3)
  - Product nucleus (REACTION SF4);
  - Quantity (REACTION SF5 - SF9);
  - Energy/Angle range;
  - Method;
  - Facility;
  - Detector;
  - Status;
  - Reference;
  - Author;
  - Institute.

4. The "**Relational Nuclear Spectroscopy Database NESSY"** (New ENSDF Search SYstem) has been put upon the CDFE Web-site before. The main advantages of the NESSY PC version search system /6/ are the following:

- configuration on both search conditions and output information is not limited;

- automatic formation of tables containing the search parameters can be included into the common query configuration:

  - Query_1 (ENSDF) $\Rightarrow$ Result_1,
  - Query_2 (Result_1) $\Rightarrow$ Result_2,
  - and so on;

- requests are posed by means of both values and the relations between them;

- Arithmetical and other operations over searched values are possible.

The method of the realisation of the advantages mentioned above has been the using of so-called bank of standard requests /6/. Several new standard requests were realised for the NESSY Internet version /7/ during the period reviewed.

The following searches are available now:

- **"Show Levels"**.
  This query allows one to search the levels of any number of nuclei using several criteria.

- **"Show Decay Modes"**.
  This query shows to one the scheme of decay modes for the selected nucleus.

- **"Show Levels and Gammas"**.
  This query shows to one the scheme of gamma-transitions between the levels of selected nucleus.

- **"Show Scheme of Levels"**.
  This query shows to one the scheme of levels of selected nucleus.

- **"Show Levels with Equivalent Energies"**.
  This query allows one to search the various nuclear levels with energies equivalent to entered.

## References


1. E.G.Fuller, H.Gerstenberg. Photonuclear Data - Abstracts Sheets 1955 - 1982. NBSIR 83-2742. U.S.A. National Bureau of Standards, 1986.
2. G.Audi, A.H.Wapstra. The 1995 Update to the Atomic Mass Evaluation. Nucl.Phys., A595 (1995) 409.
3. J.K.Tuli. Nuclear Wallet Cards (Sixth Edition), U.S.A. Brookhaven National Laboratory National Nuclear Data Center, January 2000.
4. I.N.Boboshin, B.S.Ishkhanov, V.V.Varlamov. Energy of the first $T_>$–isospin Nuclear State New Formula. International Conference on Nuclear Data for Science and Technology. Embracing the Future at the Beginning of the 21st Century (October 7 - 12, 2001). Tsukuba, Japan, JAERI (submitted Abstract N50, **Annex 7**).
5. N.Stone. Table of New Nuclear Moments. 1997 Preprint (A revision of the Table of Nuclear Moments by P. Raghavan (Atomic Data Nuclear Data Tables 42, 189 (1989))).
6. I.N.Boboshin, V.V.Varlamov. The New ENSDF Search System NESSY: IBM/PC Nuclear Spectroscopy Data Base. Nucl.Instr. and Meth., A369 (1996) 113 - 119.
7. I.N.Boboshin, V.V.Varlamov, E.M.Ivanov. The CDFE Relational Nuclear Spectroscopy Data Base NESSY in Internet. Report on the IAEA Advisory Group Meeting on Network of Nuclear Reaction Data Centres (15 - 19 May 2000, Obninsk, Russia). INDC(NDS)-418, IAEA NDS, Vienna, Austria, 2000, pp. 142 - 143.

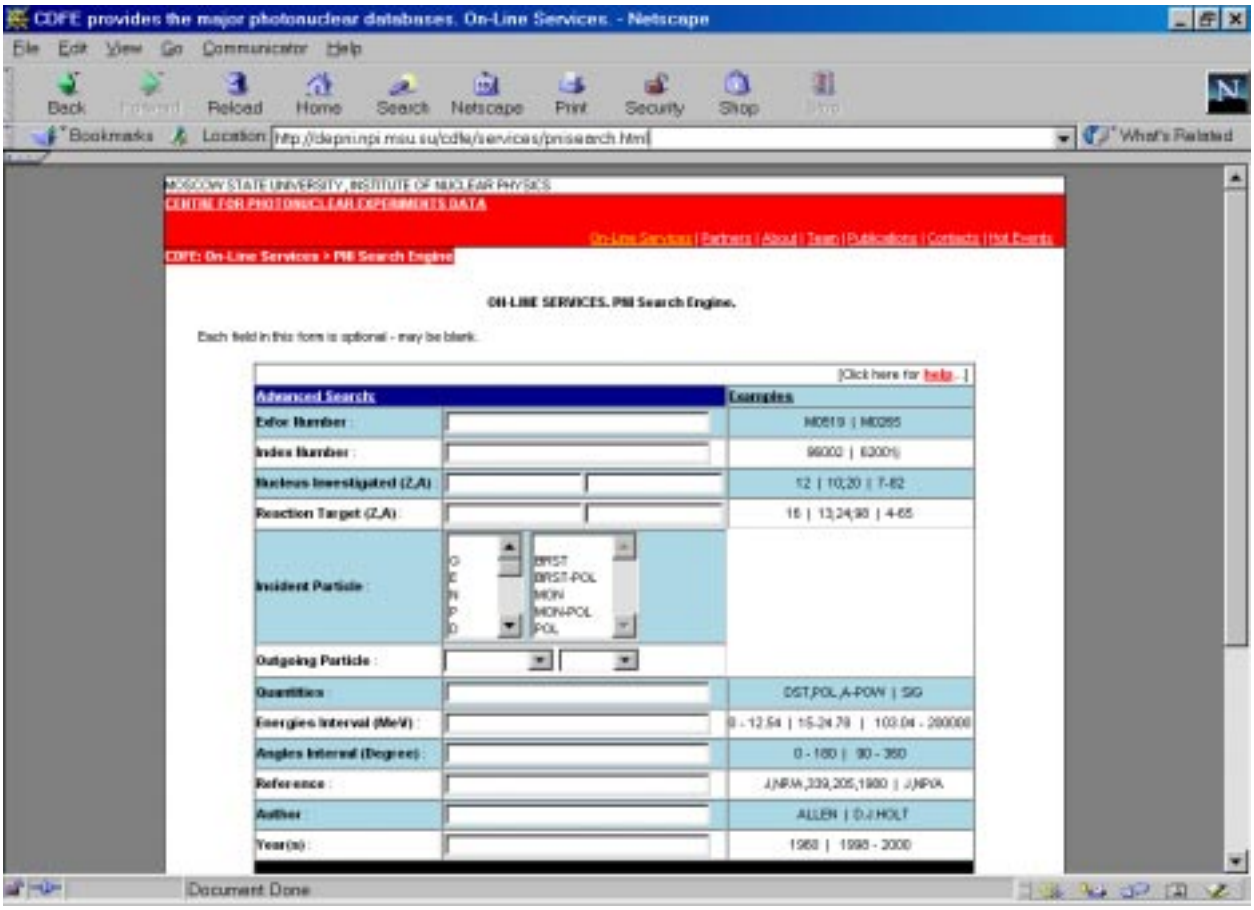
**Annex 1.**

**The CDFE EXFOR TRANS M030 contents (*corrected old* and new ENTRYs)**

| **ENTRY's Number** | **Amount of DATA TABLEs** |
|---|---|
| *M0043* | *26* |
| *M0045* | *24* |
| *M0166* | *2* |
| *M0296* | *2* |
| *M0397* | *7* |
| *M0428* | *11* |
| *M0431* | *3* |
| *M0434* | *2* |
| *M0539* | *10* |
| *M0598* | *4* |
| M0613 | 2 |
| M0614 | 6 |
| M0615 | 5 |
| M0616 | 5 |
| M0617 | 2 |
| M0618 | 10 |
| M0619 | 12 |
| M0620 | 3 |
| M0621 | 3 |
| M0622 | 3 |
| M0623 | 9 |
| **Total: 21** | **Total: 150** |

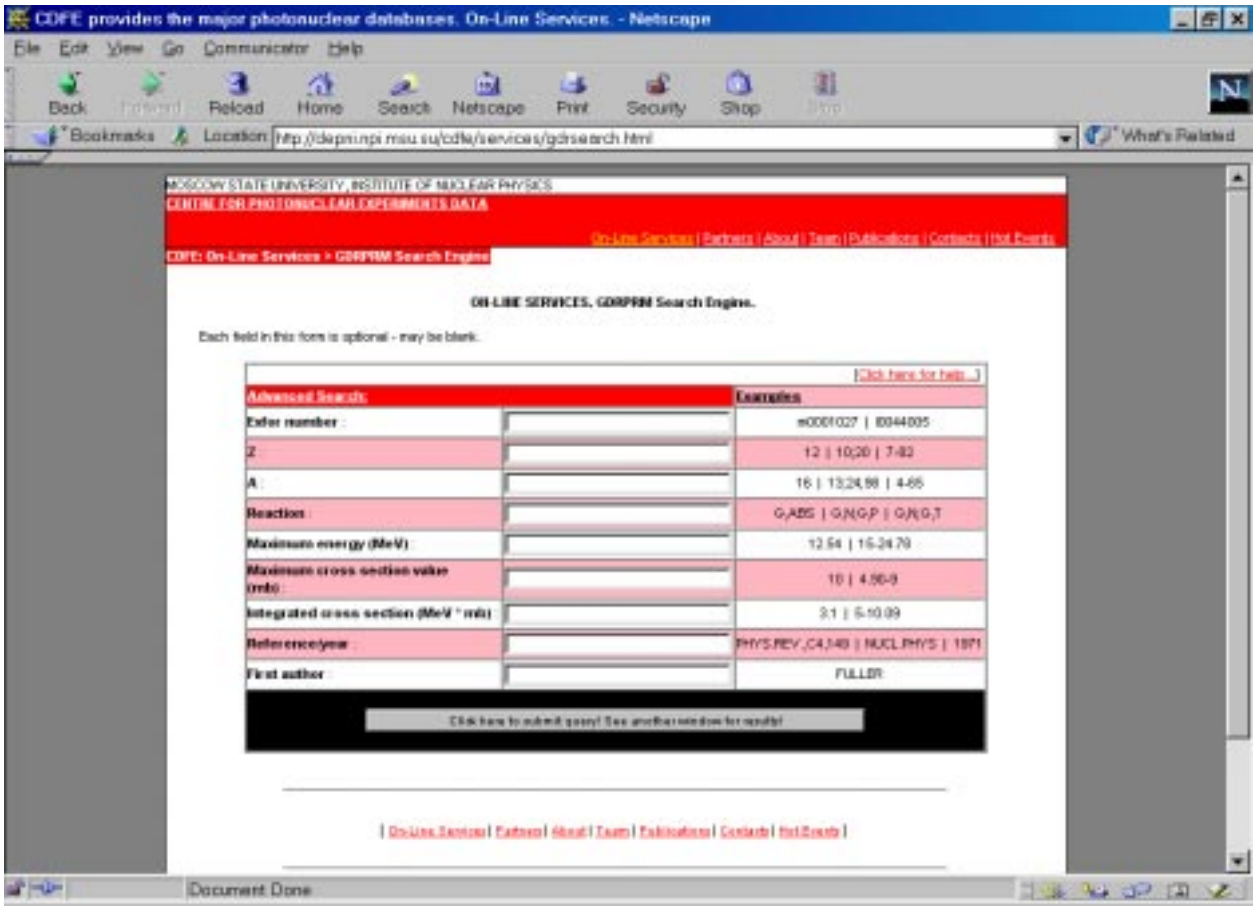
**Annex 2.**

**The search form for the relational database**
**"Photonuclear Data Index 1955 -1999"**



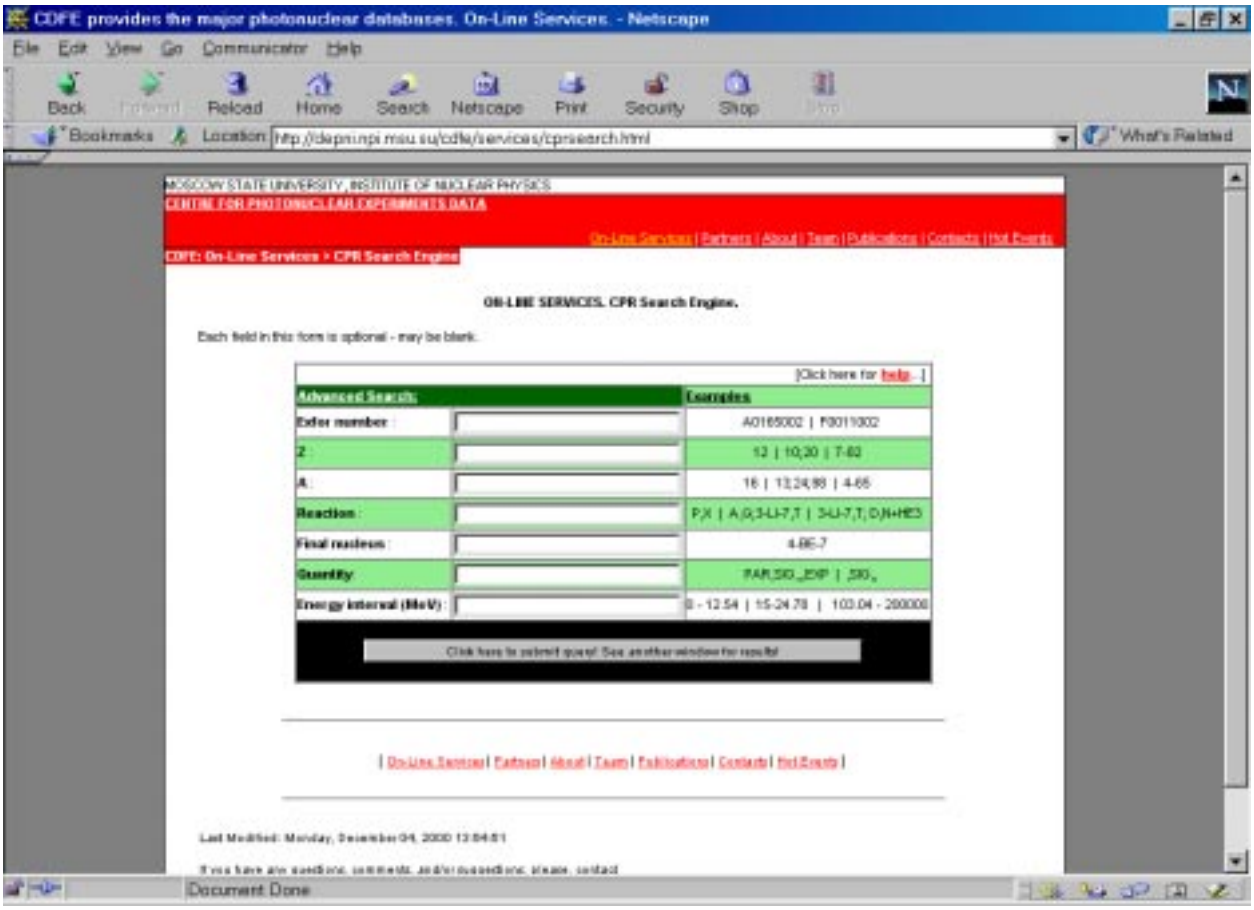
**Annex 3.**

**The search form for the relational database**
**"Giant Dipole Resonance Parameters. Photonuclear Reaction Cross Sections"**



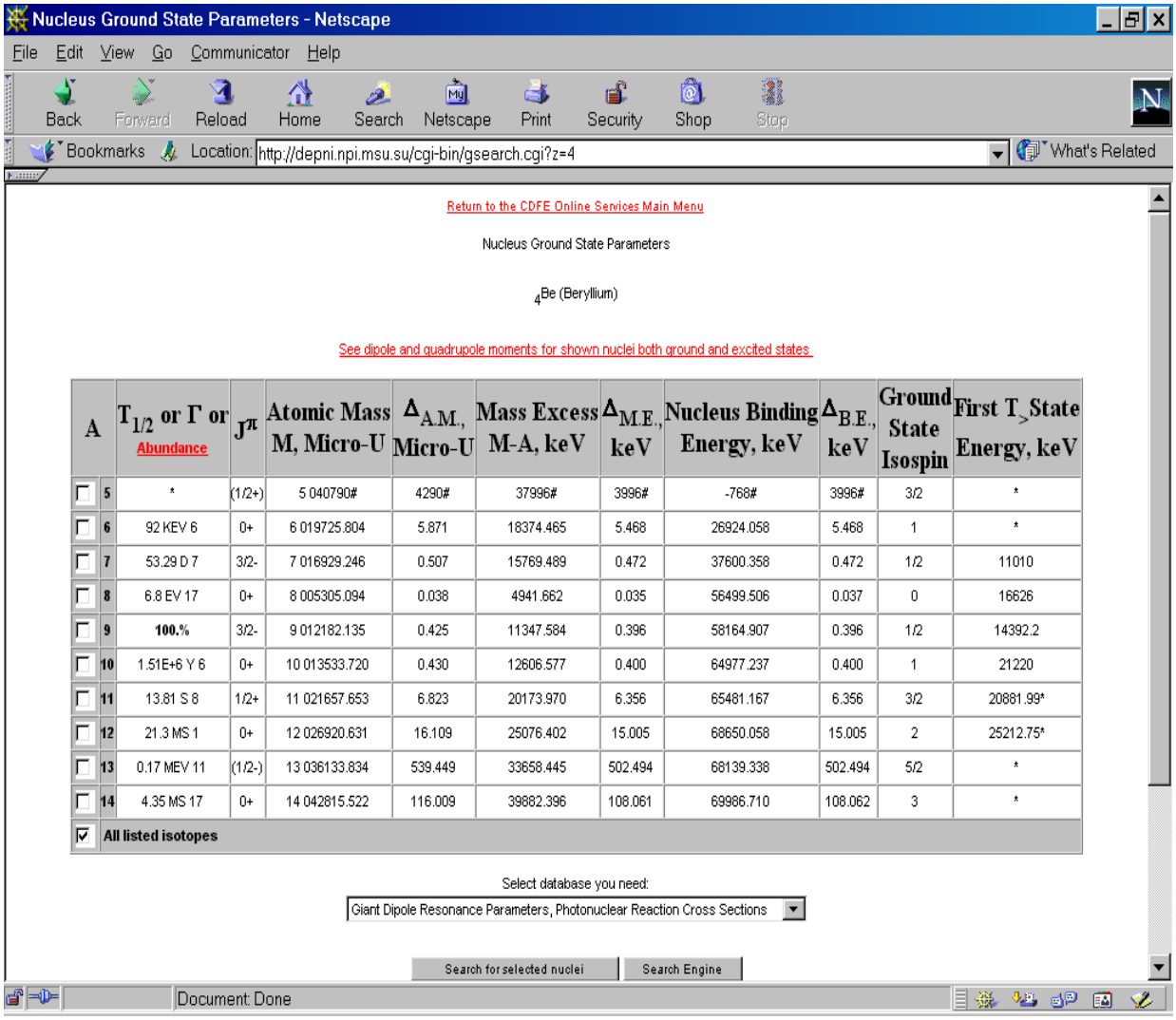
**Annex 4.**

**The search form for the relational database**
**“CAJAD Charge Particle Reaction Cross Section Catalogue”**




**Annex 5.**

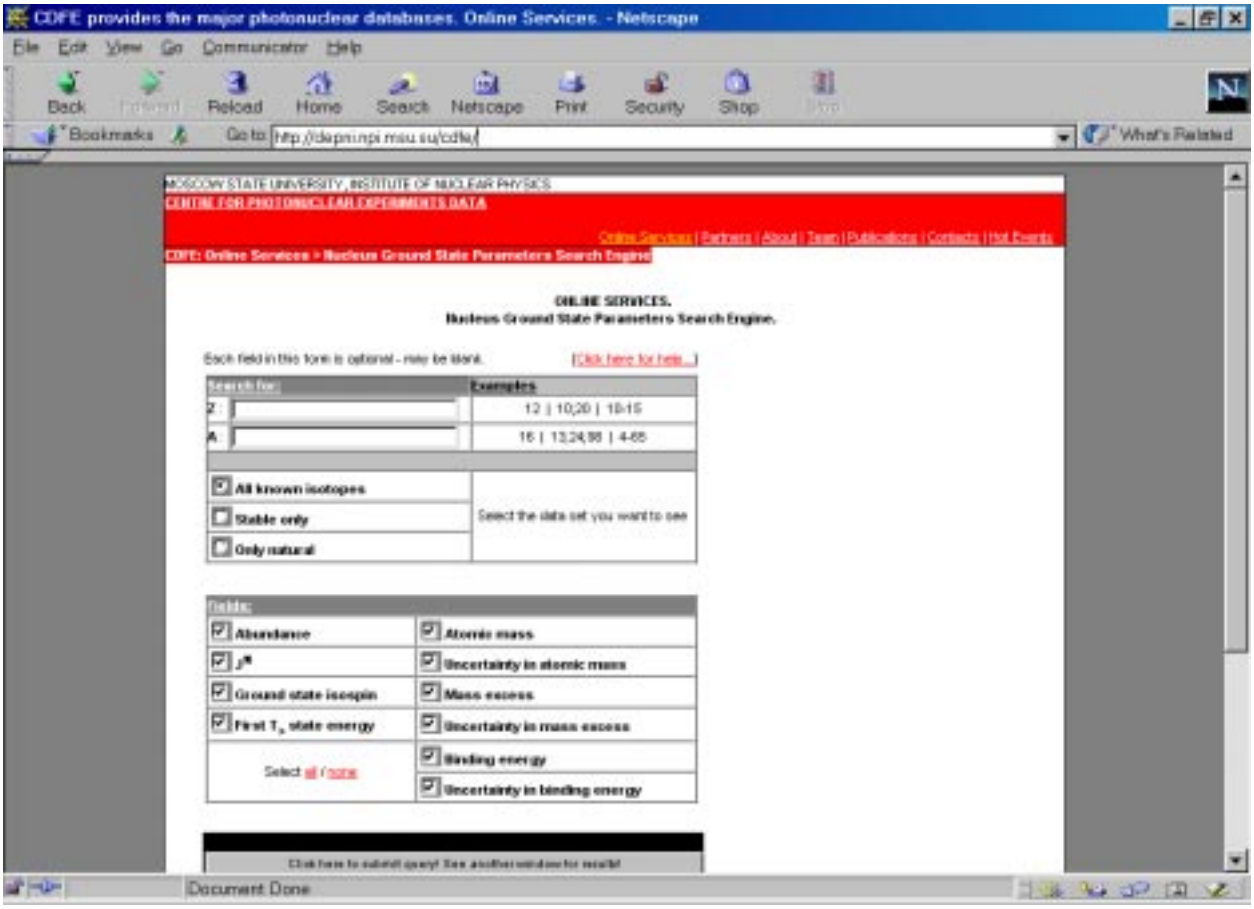
**The new relational database “Nucleus Ground State Parameters”**
**(Berilium isotopes part example)**




| A | $T_{1/2}$ or Γ or Abundance | $J^{\pi}$ | Atomic Mass M, Micro-U | $\Delta_{A.M.}$, Micro-U | Mass Excess M-A, keV | $\Delta_{M.E.}$, keV | Nucleus Binding Energy, keV | $\Delta_{B.E.}$, keV | Ground State Isospin | First $T_>$ State Energy, keV |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | * | (1/2+) | 5 040790# | 4290# | 37996# | 3996# | -768# | 3996# | 3/2 | * |
| 6 | 92 KEV 6 | 0+ | 6 019725.804 | 5.871 | 18374.465 | 5.468 | 26924.058 | 5.468 | 1 | * |
| 7 | 53.29 D 7 | 3/2- | 7 016929.246 | 0.507 | 15769.489 | 0.472 | 37600.358 | 0.472 | 1/2 | 11010 |
| 8 | 6.8 EV 17 | 0+ | 8 005305.094 | 0.038 | 4941.662 | 0.035 | 56499.506 | 0.037 | 0 | 16626 |
| 9 | **100.%** | 3/2- | 9 012182.135 | 0.425 | 11347.584 | 0.396 | 58164.907 | 0.396 | 1/2 | 14392.2 |
| 10 | 1.51E+6 Y 6 | 0+ | 10 013533.720 | 0.430 | 12606.577 | 0.400 | 64977.237 | 0.400 | 1 | 21220 |
| 11 | 13.81 S 8 | 1/2+ | 11 021657.653 | 6.823 | 20173.970 | 6.356 | 65481.167 | 6.356 | 3/2 | 20881.99* |
| 12 | 21.3 MS 1 | 0+ | 12 026920.631 | 16.109 | 25076.402 | 15.005 | 68650.058 | 15.005 | 2 | 25212.75* |
| 13 | 0.17 MEV 11 | (1/2-) | 13 036133.834 | 539.449 | 33658.445 | 502.494 | 68139.338 | 502.494 | 5/2 | * |
| 14 | 4.35 MS 17 | 0+ | 14 042815.522 | 116.009 | 39882.396 | 108.061 | 69986.710 | 108.062 | 3 | * |
| ☑ | **All listed isotopes** | | | | | | | | | |

**Annex 6.**

**The search form for the relational database**
**"Nucleus Ground State Parameters"**




**Annex 7.**

**The $T_>$-state energy values**
**for the new relational database "Nucleus Ground State Parameters"**

ENERGY OF THE FIRST $T_>$–ISOSPIN NUCLEAR STATE NEW FORMULA

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In the frame of nuclear physics isobaric state formalism the lowest isobar-analog state (isospin $T_> = |N-Z|/2+1$) energy value is very important parameter for many research concerned to various nuclear processes (giant dipole resonance decay, various nuclear reaction mechanisms, etc.). But there is evident lack of such information in the modern databases. For example the Evaluated Nuclear Structure Data File (ENSDF) /2, 3/ contains these values for slightly more than 100 nuclei. Therefore a formula for the first $T_>$–isospin state energy value calculation is very actual. As a rule a well-known semi-empirical formula /1/ is used

$$E = E_{be}(N, Z) - E_{be}(N + 1, Z - 1) + 1.444\cdot(Z - 1/2) / A^{1/3} - 1.131, \text{ MeV}$$

where $E_{be}(N, Z)$ and $E_{be}(N + 1, Z - 1)$ are the correspondent nucleus binding energy values (in MeV).

The check of this formula was carried out using the $T_>$–isospin state energy experimental data from the ENSDF modern version for 118 nuclei from $^{6}$Li to $^{61}$Zn. It was found out that above formula describes correctly the $T_>$–isospin state energy values only for nuclei with $N > Z$. The disagreements between experimental and calculated values for other nuclei are too high, for example, –274.95 keV instead of 12255.00 keV for $^{15}$O, 100.44 keV instead of 11192.90 keV for $^{17}$F, and –9348.88 keV instead of 5900.00 keV for $^{28}$P.

For improving the situation it was proposed that for nuclei with $N \le Z$ the formula must be changed. Using the symmetry assumptions it was shown that the following two formulae must be used instead of the above one:

$$E = E_{be}(N, Z) - E_{be}(N + 1, Z - 1) + 1.484\cdot(Z - 1/2) / A^{1/3} - 1.293, \text{ MeV} \quad \text{for } N > Z,$$

$$E = E_{be}(N, Z) - E_{be}(N - 1, Z + 1) - 1.484\cdot(Z + 1/2) / A^{1/3} + 1.293, \text{ MeV} \quad \text{for } N \le Z.$$

Instead of above formula second parameter 1.131 the neutron-proton mass difference 1.293 MeV parameter was used: the formula term concerned described the isospin symmetry violation. After that the new value of the formulae first parameter (1.484 instead of 1.444) was obtained using the variation of formulae for the same accuracy obtaining.

The averaged disagreement $\Delta = 0.107$ MeV between estimations calculated using proposed two new formulae and experimental ENSDF data has been obtained for 116 nuclei from 118 investigated. The only two exceptions for $^{15}$O ($\Delta = 1.40$ MeV) and $^{26}$Mg ($\Delta = 5.04$ MeV) have been found out. Both items could be interpreted as results of possible mistakes in the ENSDF. The point is that the spins of states under discussion are not in accordance with the spins of the ground states of the correspondent isobar–analog nuclei. It looks like that in the ENSDF for both nuclei mentioned above the data are presented for not first but second $T_>$–isospin states.

The $T_>$–isospin state energy data calculated for 2560 nuclides using above formulae are available now at the MSU INP CDFE Web-site (http://depni.npi.msu.su/cdfe).

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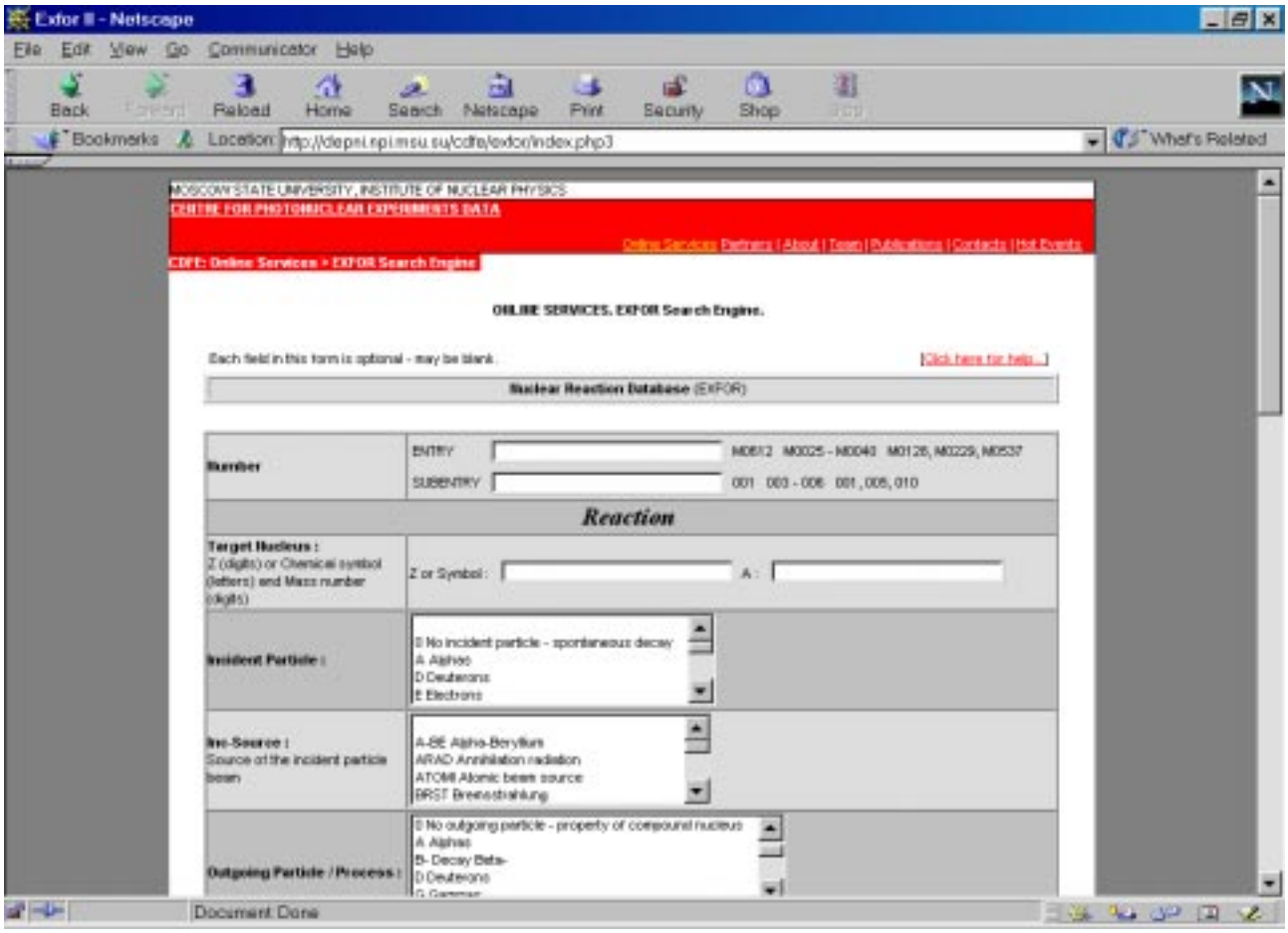
1. J.D.Anderson, C.Wong, V.MacClare. Phys.Rev., 138 (1965) B615.
2. T.W.Burrows. Nucl.Instr. & Meth., A286 (1990) 5953.
3. J.K.Tuli. National Nuclear Data Center, Brookhaven National Laboratory. Report BNL–NCS–51655–Rev. 87. 1987.

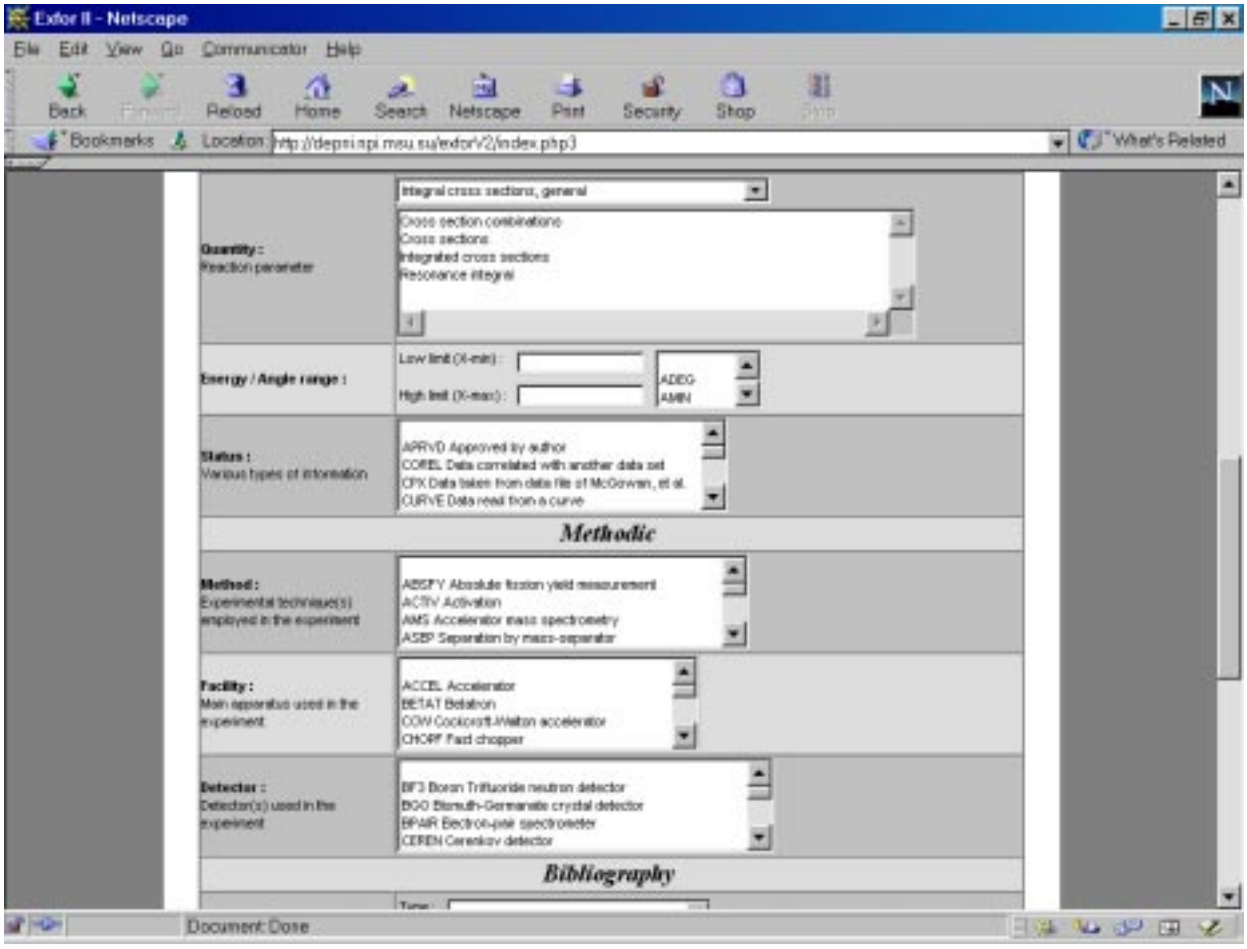
**Annex 8.**

## The search form for the relational database "Nuclear Reaction Database (EXFOR)"



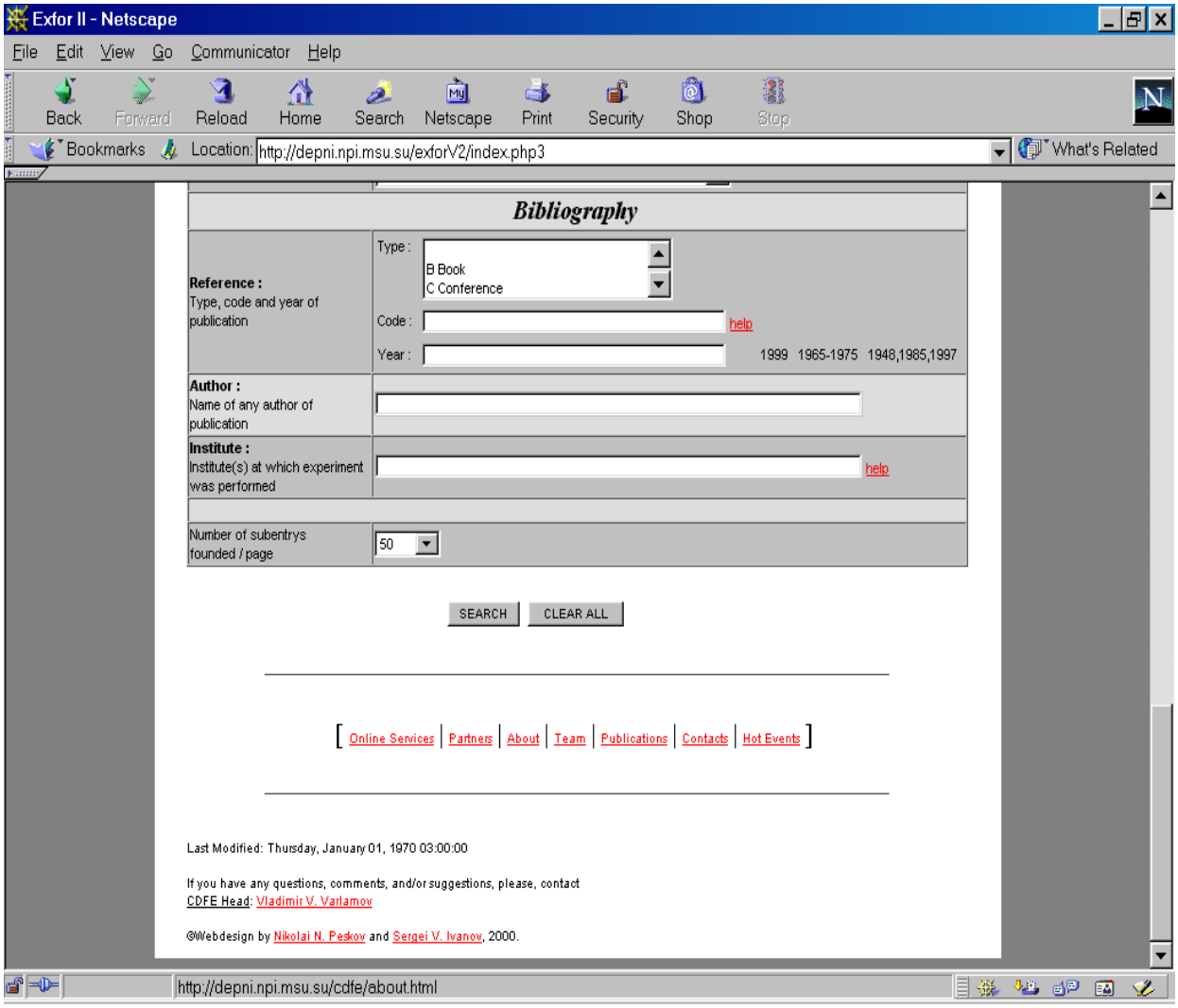

**Annex 8 (continuation 1).**

**The search form for the relational database**
**"Nuclear Reaction Database (EXFOR)"**
**(continuation 1)**




**Annex 8 (continuation 2).**

**The search form for the relational database**
**"Nuclear Reaction Database (EXFOR)"**
**(continuation 2)**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Code :
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Year :
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Author :
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