Some Aspects of Preparation and Testing of Group Constants

Group Constant System ABBN-90

M.N. Nikolaev, A.M. Tsiboulia, G.N. Manturov
Institute of Physics and Power Engineering
(Fiziko-Energeticheskij Institut)
Bondarenko Sq. 1
249020 Obninsk, Kaluga Region
THE RUSSIAN FEDERATION
FAX: 095-2302326
TEL.: (08439) 97908
E-MAIL: root@ippe.obninsk.su

Abstract

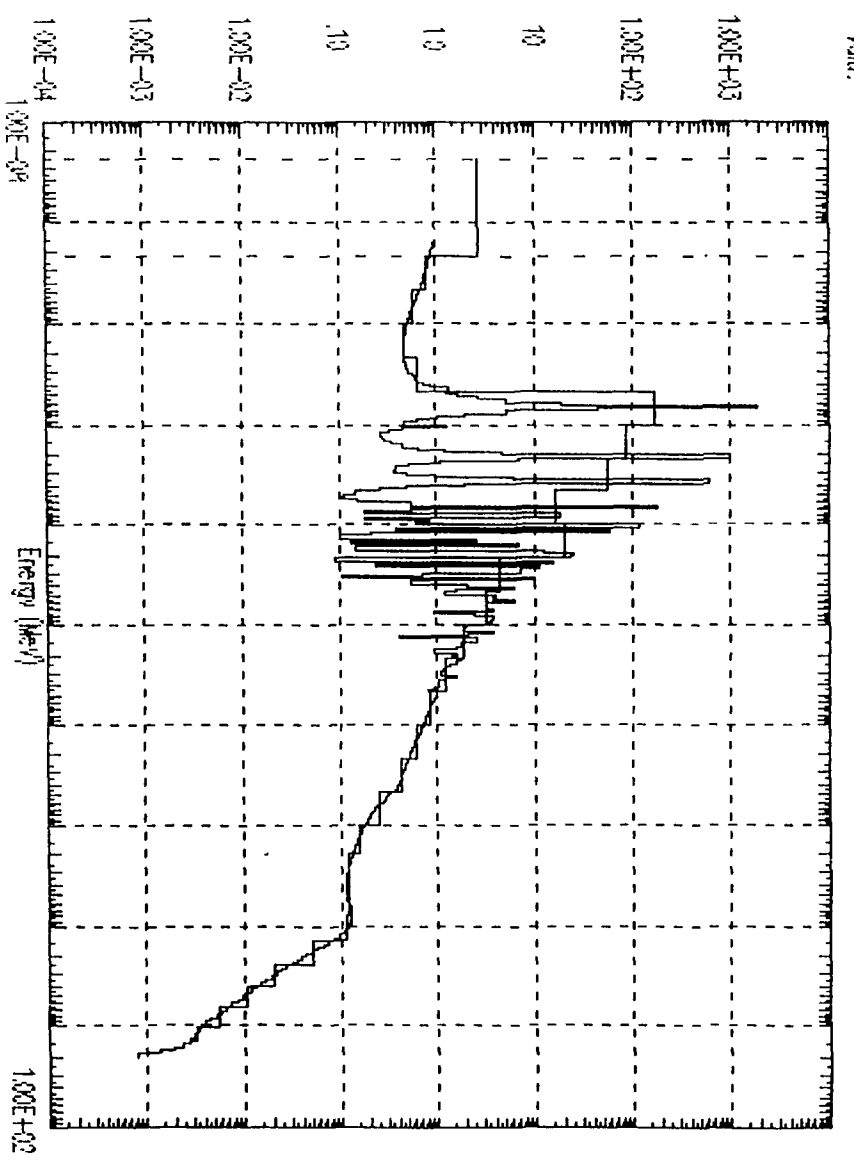
This paper presents an overview of activities performed to prepare and test the group constants ABBN-90. The ABBN-90 set is designed for application calculations of fast, intermediate and thermal nuclear reactors. The calculations of subgroup parameters are discussed. The processing code system GRUCON is mentioned in comparison to the NJOY code system. Proposals are made for future activities.

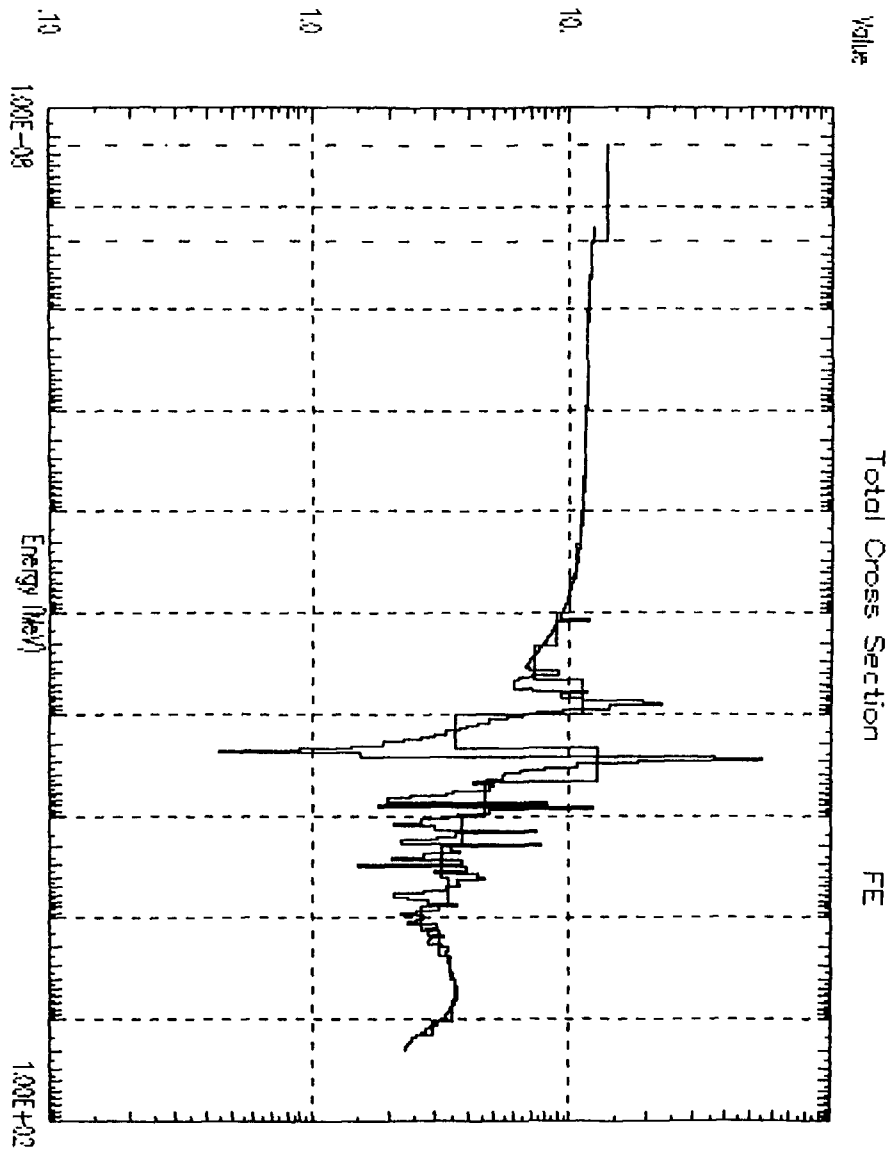
NUCLEAR DATA SET
ABBN-90

GROUP CONSTANT UNIVERSAL SYSTEM
FOR ENGINEERING CALCULATIONS OF:

- nuclear fast, intermediate and thermal reactors;
- nuclear safety;
- radioactive shielding;
- electro-nuclear and thermonuclear installations,
- radio-nuclide production.

Number of the neutron groups: 28 (0 0001 eV - 15 MeV)
300 (0.0001 eV - 20 MeV)
Number of the photon groups 15 (10 KeV - 11 MeV)





ABBN-90 CONSTANT SET STRUCTURE.

- text library of the obvious tables;
- main parameters for table:

NAM - name of nuclide;
MF - type of data.

MF	DESCRIPTION:
1	- main neutron cross-sections;
2	- inelastic scattering transition matrixes;
3	- elastic scattering transition matrixes;
4	- resonance self-shielding factors;
5	- it's Doppler increments;
6	- subgroup resonance structure parameters;
7	- Westkott's g-factors;
301-307	- multigroup neutron data;
8	- KERMA-factors;
9	- neutron cross-sections;
10	- photon production matrixes;
11	- photon interaction data;
61	- delayed neutron data;
90	- radio-nuclide decay data;
91	- radioactive decay photon spectra.

```
*
* revision: 1) 0 group cross sections was corrected
*              corresponding with U238V78 data.
*           2) Self Shielding Factor table (MF=4,5) was
*              obtained from subgroup parameters table.
*              In 17 group doppler increment was corrected
*              same as in BNAB78.
*           3) 12, 13, and 14 group constant set (MF=1 MT=0)
*              was taken from multygroup data.
*
NAM=U238      BIB=FOND  MF=  1  MT=  0  AWR=2.36006E+02
              LT =  28  LC= 10  LS= 10  LF = (I4,E7.0,2E9.0,E7.0,5E6.0)
*                          92-U -238
*                    MAIN NEUTRON CONSTANTS
* NG   total   capture   fission  elast  inel  mult    nu     mu    ksi
*
  -1    5.80    0.0027    1.1892   2.92 1.696 2.147 4.538 .8615 .0012
   0    5.77    0.0033    0.9992   2.87 1.906 1.797 4.087 .8277 .0015
*
   1    6.46    0.0056    0.9424   3.49 2.021 1.369 3.513 .7866 .0018
   2    7.55    0.0107    0.5733   4.33 2.638 1.001 3.115 .7673 .0020
   3    7.76    0.0206    0.5380   4.24 2.965 1.000 2.811 .7363 .0022
   4    7.12    0.0489    0.4651   3.84 2.769 1.000 2.642 .5510 .0038
*
   5    7.11    0.1099    0.0396   4.66 2.301 1.000 2.546 .4506 .0046
   6    8.14    0.1154    0.0011   6.33 1.697 1.000 2.493 .3577 .0054
   7    9.79    0.1185    0.0001   8.46 1.211 1.000 2.434 .2201 .0064
   8   11.35    0.1500    0.0000  10.44 0.756 1.000 2.397 .1209 .0074
*
   9   12.54    0.2424    0.0000  11.99 0.303 1.000 2.378 .0586 .0080
  10   13.63    0.4335    0.0000  13.19 0.000 1.000 2.369 .0248 .0083
  11   14.88    0.6107            14.27             2.364 .0100 .0084
*
  12   16.60     .8646            15.74             2.362 .0028 .0084
  13   19.86    1.2458            18.61             2.361 .0028 .0084
  14   21.84    1.8521            19.98             2.361 .0028 .0084
*
  15   22.28    3.3105            18.96             2.361 .0028 .0084
  16   21.88    4.5296            17.35             2.361 .0028 .0084
  17   89.09   20.2163            68.88             2.360 .0028 .0084
*
  18   41.00   16.5577            24.44             2.360 .0028 .0084
  19  143.40   54.1026            89.30             2.360 .0028 .0084
  20  126.47   83.8098            42.66             2.360 .0028 .0084
*
  21  189.36  169.7841            19.58             2.360 .0028 .0084
  22    8.87    0.6553             8.21             2.360 .0028 .0084
  23    9.14    0.4814             8.66             2.360 .0028 .0084
*
  24    9.39    0.5938             8.80             2.360 .0028 .0084
  25    9.67    0.8155             8.85             2.360 .0028 .0084
  26   11.61    2.7100             8.90             2.360 .0028 .0084
*
```

```
NAM=U238      BIB=FOND  MF=  2  MT=  0  AWR= 2.36006+ 2
              LT =  12  LC= 14  LS= 14  LF = (I4,13E5.0)
*                     INELASTIC TRANSITION MATRIX
*                     ZERO MOMENT (TRANSITIONS  G -> K)
* G/K  -1     0     1     2     3     4     5     6     7     8     9    10    11
*
  -1 .161 .047 .000 .010 .099 .519 .918 1.05 .549 .203 .065 .016 .004
   0      .216 .033 .008 .098 .527 .881 .926 .467 .179 .064 .018 .008
*
   1           .274 .035 .059 .304 .571 .731 .469 .214 .081 .022 .007
   2                .315 .092 .406 .670 .677 .321 .112 .036 .009 .003
   3                     .370 .253 .725 .893 .476 .175 .056 .013 .004
   4                          .635 .509 .924 .466 .164 .054 .013 .004
*
   5                               1.13 .513 .404 .192 .047 .011 .004
   6                                    1.34 .320 .007 .021 .007 .002
   7                                         .860 .346 .005
   8                                              .392 .363 .001 .000
*
   9                                                   .057 .168 .078
  10                                                              .000
*
NAM=U238      BIB=END6  MF=  2  MT=  1  AWR= 2.36006+ 2
              LT =  12  LC= 14  LS= 14  LF = (I4,13E5.0)
*                     INELASTIC TRANSITION MATRIX
*                     FIRST MOMENT (TRANSITIONS  G -> K)
* G/K  -1     0     1     2     3     4     5     6     7     8     9    10    11
*
  -1 .034 .068 .014 .025 .020 .022 .018 .010 .002 .000 .000 .000 .000
   0      .078 .051 .010 .017 .015 .016 .009 .003 .000 .000 .000 .000
*
   1           .098 .049 .010 .005 .011 .007 .003 .001 .000 .000 .000
   2                .105 .047 .028 .012 .005 .001 .000 .000 .000 .000
   3                     .084 .051 .029 .010 .003 .000 .000 .000 .000
   4                          .062 .031 .020 .002 .000 .000 .000 .000
*
   5                               .056 .011 .006 .000 .000 .000 .000
   6                                    .058 .003 .000 .000 .000 .000
   7                                         .028 .001 .000 .000 .000
   8                                              .008 .001 .000 .000
*
   9                                                   .002 .000 .000
  10                                                              .000
*
```

NAM=U238 BIB=FOND MF= 3 MT= 0 AWR=2.36006E+02
LT = 14 LC= 7 LS= 7 LF = (I4,6E11.0)
* ANGULAR MOMENTA OF ELASTIC TRASITIONS
* FROM GROUP g TO THE SAME GROUP

G/L	0	1	2	3	4	5
-1	0.9375	0.8141	0.6931	0.5782	0.4889	0.4205
0	0.9861	0.8252	0.6878	0.5850	0.4937	0.4030
1	0.9885	0.7849	0.6469	0.5521	0.4552	0.3502
2	0.9928	0.7664	0.6255	0.5181	0.4056	0.2937
3	0.9933	0.7363	0.5801	0.4494	0.3302	0.2098
4	0.9919	0.5516	0.3649	0.2935	0.1716	0.0552
5	0.9902	0.4516	0.2572	0.1529	0.0642	0.0019
6	0.9899	0.3593	0.1539	0.0490	0.0178	-.0033
7	0.9884	0.2228	0.0680	0.0064	0.0039	-.0038
8	0.9881	0.1242	0.0240	-.0024	0.0034	-.0023
9	0.9888	0.0621	0.0087	-.0015	0.0019	-.0003
10	0.9889	0.0284	0.0033	-.0006	0.0005	-.0000
11	0.9886	0.0137	0.0008	-.0002	0.0001	-.0000
12	0.9890	0.0065	0.0000	-.0000	-.0000	0.0000

NAM=U238 BIB=FOND MF= 3 MT= 1 AWR=2.36006E+02
LT = 14 LC= 7 LS= 7 LF = (I4,6E11.0)
* ANGULAR MOMENTA OF ELASTIC TRASITIONS
* FROM GROUP g TO THE NEXT GROUP

G/L	0	1	2	3	4	5
-1	0.0625	0.0474	0.0415	0.0358	0.0297	0.0255
0	0.0139	0.0025	0.0002	0.0008	0.0010	0.0003
1	0.0115	0.0017	0.0010	0.0016	0.0015	0.0013
2	0.0072	0.0009	0.0008	0.0008	0.0008	0.0007
3	0.0067	-.0000	0.0006	0.0004	0.0004	-.0000
4	0.0081	-.0006	-.0004	0.0006	-.0000	-.0005
5	0.0098	-.0010	-.0000	-.0003	0.0000	-.0003
6	0.0101	-.0016	-.0003	-.0004	0.0000	-.0001
7	0.0116	-.0027	-.0004	-.0003	0.0001	-.0001
8	0.0119	-.0033	-.0003	-.0001	0.0001	-.0000
9	0.0112	-.0035	-.0001	-.0000	0.0000	0.0000
10	0.0111	-.0036	-.0000	0.0000	0.0000	0.0000
11	0.0114	-.0037	-.0000	0.0000	0.0000	0.0000
12	0.0110	-.0037	-.0000	0.0000	-.0000	-.0000

NAM=U238 BIB=FOND MF= 4 MT= 1 AWR=2.36006E+02
LT = 14 LC= 18 LS= 18 LF = (I4,I2,1X,16I4)
* RESONANCE SELFSHIELDING FACTORS
* TRANSPORT

* G	N	0	.1	...	...	1	...	...	10	...	...	100	215	465	1000...*10		
8	0	955	955	956	956	958	960	964	970	976	981	985	986	987	988	988	988
9	0	917	917	917	918	920	924	932	942	955	967	975	980	982	983	984	984
10	0	880	881	881	882	885	890	900	916	938	961	978	988	994	997	998	999
11	0	797	797	798	799	802	807	818	838	871	911	946	971	985	993	996	998
12	0	704	705	705	706	707	711	718	734	766	816	876	927	962	981	991	995
13	0	574	575	575	576	578	581	588	600	622	661	722	801	876	931	965	983
14	0	205	224	243	277	325	372	411	445	485	535	597	672	761	847	913	955
15	0	349	353	357	365	376	391	407	424	448	482	530	599	691	792	877	935
16	0	480	480	481	484	487	494	502	513	527	546	575	619	684	766	849	915
17	1	72	81	89	99	110	121	133	148	175	223	301	416	565	717	839	916
18	1	203	208	212	218	225	234	244	260	285	319	368	452	584	730	847	922
19	1	60	62	64	67	72	78	86	95	108	127	155	197	273	410	590	757
20	1	63	63	63	64	65	66	68	74	86	105	134	185	289	459	650	804
21	1	56	57	58	59	61	65	72	82	96	118	156	224	350	529	709	842

*

NAM=U238 BIB=FOND MF= 4 MT=102 AWR=2.36006E+02
LT = 14 LC= 18 LS= 18 LF = (I4,I2,1X,16I4)
* CAPTURE

* G	N	0	.1	...	...	1	...	...	10	...	...	100	215	465	1000...*10		
8	0	984	984	984	985	985	986	988	991	994	996	998	999	999	999	999	999
9	0	963	963	964	964	965	968	972	978	985	991	995	997	998	999	999	999
10	0	929	929	930	931	932	936	943	954	967	980	989	994	997	998	999	999
11	0	853	853	854	855	858	864	876	894	920	947	969	984	992	996	998	999
12	0	730	730	731	733	736	743	756	781	820	870	918	954	976	988	994	997
13	0	569	569	570	571	574	579	590	611	648	707	782	857	918	956	978	989
14	0	267	270	274	280	290	306	332	374	437	520	619	726	825	900	947	974
15	0	170	171	172	174	178	186	203	234	286	364	469	596	729	838	913	956
16	0	126	126	127	128	131	136	147	168	205	267	357	476	616	750	855	924
17	1	42	45	48	52	60	74	98	136	196	283	402	547	697	820	904	953
18	1	47	48	49	52	59	71	94	131	188	267	377	520	677	810	898	949
19	1	33	34	35	36	39	45	54	70	95	135	195	287	422	586	742	858
20	1	18	18	19	20	23	29	39	57	87	134	206	318	474	646	792	890
21	1	27	28	29	32	37	45	59	81	115	171	256	381	542	704	832	913

*

NAM=U238 BIB=FOND MF= 4 MT= 2 AWR=2.36006E+02
LT = 14 LC= 18 LS= 18 LF = (I4,I2,1X,16I4)
* ELASTIC

* G	N	0	.1	...	...	1	...	...	10	...	...	100	215	465	1000...*10		
8	0	980	980	981	981	982	983	985	989	992	995	997	998	999	999	999	999
9	0	961	961	961	962	963	966	970	977	984	990	995	997	998	999	999	999
10	0	928	928	928	929	931	935	942	953	967	979	989	994	997	998	999	999
11	0	862	862	863	864	867	873	883	901	925	951	972	985	993	996	998	999
12	0	770	770	771	772	775	781	793	814	848	891	931	962	980	990	995	997
13	0	638	638	639	640	643	648	659	678	711	761	822	883	933	964	982	991
14	0	457	462	467	475	487	503	524	554	594	647	712	785	856	915	954	977
15	0	487	488	489	492	497	504	517	536	566	609	666	738	816	886	937	967
16	0	634	635	635	636	638	642	649	659	674	697	729	773	827	883	930	962
17	1	135	141	146	154	165	180	203	238	294	376	484	610	739	845	916	958
18	1	356	361	364	371	380	392	409	434	468	517	586	680	784	872	932	966
19	1	103	106	108	113	120	130	143	160	186	225	282	365	486	632	771	874
20	1	167	167	168	169	172	177	185	201	227	268	330	425	556	701	824	907
21	1	435	436	438	440	444	451	462	477	498	530	579	649	740	832	904	950

*

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NAM=U238      BIB=FOND  MF=  5  MT=  1  AWR=2.35955E+02
              LT =  28  LC= 18  LS= 18  LF = (I4,I2,1X,1614)
*                     DOPPLER INCREMENTS
*                     F(900K)-F(300K) and F(2100K)-F(900K)
*                     TRANSPORT
*  G N    0   .1  ...  ...   1  ...  ...   10  ...  ... 100 215 465 1000...*10
*
   8 0   13  13  13  13  12  11  10   7   5   3   1   0   0   0   0   0
          8   8   7   7   7   6   5   4   3   1   0   0   0   0   0   0
   9 0   25  25  25  24  24  22  20  16  11   6   3   1   0   0   0   0
         15  15  15  15  15  14  12   9   6   4   2   1   0   0   0   0
  10 0   39  39  39  38  38  36  34  29  22  14   8   4   2   0   0   0
         27  26  26  26  25  24  22  19  14   9   5   2   1   0   0   0
  11 0   49  49  49  49  49  48  47  43  36  26  16   9   4   2   1   0
         36  36  36  36  36  35  34  31  25  17  10   5   2   1   0   0
  12 0   51  51  51  51  51  51  51  50  47  40  29  18   9   5   2   1
         39  39  39  39  39  39  38  37  35  29  20  12   6   3   1   0
  13 0   43  43  43  43  43  43  43  44  44  44  40  32  21  12   6   3
         33  33  33  33  33  33  33  34  34  33  30  23  15   8   4   2
  14 0   96  88  81  68  52  40  34  33  35  40  48  52  47  35  21  11
         81  76  70  61  49  38  32  30  31  35  41  44  39  27  16   7
  15 0   45  43  41  37  31  26  22  20  22  30  46  62  66  54  36  20
         41  41  40  38  35  32  29  28  28  31  40  50  51  40  26  14
  16 0   24  23  22  21  18  15  11   9  10  16  28  43  54  54  42  27
         17  17  17  17  17  17  16  16  17  19  26  36  43  40  29  17
  17 1    2   2   2   2   1   2   3   4  16  28  41  52  63  74  66  57
          5   5   4   4   3   4   6   7  22  37  52  54  56  58  52  45

  18 1    0   0   0   0   0   0   0   1   7  26  55  78  80  62  39  20
          3   4   4   5   6   7   8   8   8  17  41  68  73  56  34  18
  19 1    0   0   0   0   0   0   0   0   0   0  10  38  69  84  74  50
          0   0   0   0   0   0   0   0   1   1   5  28  64  87  77  51
  20 1    0   0   0   0   0   0   0   0   0   4  27  60  85  87  67  41
          0   0   0   0   0   0   0   0   0   0  14  51  91 100  76  45
  21 1    0   0   0   0   0   0   0   0   0   0  12  43  76  80  55  25
          0   0   0   0   0   0   0   0   0   5  15  32  44  33   5   0
*
*
NAM=U238      BIB=FOND  MF=  5  MT=102  AWR=2.35955E+02
              LT =  28  LC= 18  LS= 18  LF = (I4,I2,1X,1614)
*                     CAPTURE
*  G N    0   .1  ...  ...   1  ...  ...   10  ...  ... 100 215 465 1000...*10
*
   8 0    7   7   7   7   7   6   5   4   2   1   0   0   0   0   0   0
          4   4   3   3   3   3   2   2   1   0   0   0   0   0   0   0
   9 0   16  16  16  16  15  14  12  10   7   4   2   1   0   0   0   0
          9   9   9   8   8   7   6   5   3   2   1   0   0   0   0   0
  10 0   32  32  32  31  31  29  26  21  15   9   5   2   1   0   0   0
         18  18  18  18  17  16  14  12   8   5   2   1   0   0   0   0
  11 0   55  55  55  54  53  51  47  41  31  21  12   6   3   1   0   0
         36  36  36  35  34  33  30  26  19  13   7   3   1   0   0   0
  12 0   78  78  78  78  77  75  72  66  56  41  27  15   8   3   1   0
         56  56  55  55  55  53  51  46  38  28  17   9   5   2   1   0
  13 0   87  87  87  87  87  86  85  82  76  66  51  35  20  11   5   2
         65  65  65  65  65  64  63  60  56  47  36  24  14   7   3   1
  14 0   72  71  70  69  69  69  71  76  83  88  85  71  50  30  16   7
         70  70  70  69  69  69  69  70  72  71  65  52  35  19   9   3
  15 0   40  41  41  42  43  45  49  57  70  87  99  96  77  51  30  16
         54  54  54  54  55  56  58  62  69  78  84  78  60  39  23  13
  16 0   25  25  25  26  27  29  32  39  51  68  85  94  88  67  43  23
         35  35  35  36  36  37  40  44  51  62  73  77  69  50  30  15
  17 1    4   3   3   3   3   4   7  14  28  47  62  63  51  34  18   8
          0   3   5   7  11  16  23  32  44  59  71  71  58  39  23  13
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```
NAM=U238      BIB=FOND  MF=  6  MT=  0  AWR=2.36006E+02
              LT =  47  LC=  5  LS=  5  LF = (I4,E5.0,9E7.0)
*                    SUBGROUP PARAMETERS
* G share    capt   elast    fis
*
   9.3511 1.1732 1.2425 0.0
    .6489 0.9063 0.8688 0.0
  10.3567 1.3065 1.3758 0.0
    .6433 0.8301 0.7916 0.0
  11.1058 2.3591 2.4065 0.0
    .8607 0.8695 0.8518 0.0
    .0335 0.0600 0.3667 0.0
  12.0384 4.7587 5.1930 0.0
    .3874 1.5140 1.1184 0.0
    .5696 0.4021 0.6440 0.0
    .0046 0.3615 0.1105 0.0
  13.0247 8.9924 10.124 0.0
    .1361 3.3327 1.8650 0.0
    .8241 0.3889 0.6002 0.0
    .0151 0.2540 0.0961 0.0
  14.0198 15.058 16.941 0.0
    .0650 7.6782 2.8316 0.0
    .8920 0.2241 0.5374 0.0
    .0232 0.1254 0.0503 0.0
  15.0196 24.915 19.069 0.0
    .0581 7.0192 2.8172 0.0
    .8801 0.1134 0.5192 0.0
    .0422 0.0970 0.1334 0.0
  16.0116 49.981 25.209 0.0
    .0276 12.268 2.7856 0.0
    .7857 0.0933 0.7149 0.0
    .1751 0.0477 0.3940 0.0
  17.0213 37.891 34.171 0.0
    .0701 2.3471 1.8306 0.0
    .8161 0.0298 0.1732 0.0
    .0925 0.0443 0.0267 0.0
  18.0093 86.755 59.505 0.0
    .0191 7.9674 3.3303 0.0
    .7437 0.0484 0.4555 0.0
    .2279 0.0220 0.1943 0.0
  19.0142 62.687 56.127 0.0
    .0472 1.7148 1.7974 0.0
    .5564 0.0375 0.1737 0.0
    .3822 0.0210 0.0563 0.0
  20.0143 59.091 50.288 0.0
    .0182 6.8134 5.8890 0.0
    .0553 0.3659 0.4617 0.0
    .9122 0.0118 0.1624 0.0
  21.0272 30.739 17.956 0.0
    .0392 3.1657 2.0815 0.0
    .1900 0.1627 0.6167 0.0
    .7436 0.0120 0.4207 0.0
*
```

NAM=U238 BIB=BNAB MF= 10 MT= 1 AWR=0.00000E+00
LT = 28 LC= 18 LS= 9 LF = (I4,8F8.0)
* PHOTON PRODUCTION MATRIX
* ZERO MOMENT

* N/G	1	2	3	4	5	6	7	8
-1	0.0011	0.0027	0.0126	0.0415	0.1414	0.3674	0.6933	0.8096
0	0.0007	0.0023	0.0105	0.0339	0.1157	0.3216	0.6513	0.7951
1	0.0000	0.0007	0.0071	0.0291	0.1295	0.3315	0.6018	0.6868
2		0.0002	0.0029	0.0116	0.0497	0.2293	0.5011	0.5986
3		0.0002	0.0025	0.0090	0.0347	0.1065	0.2685	0.4141
4		0.0001	0.0021	0.0076	0.0310	0.0821	0.1825	0.2566
5		0.0000	0.0002	0.0010	0.0105	0.0246	0.0554	0.0529
6		0.0000	0.0000	0.0002	0.0089	0.0196	0.0454	0.0350
7		0.0000	0.0000	0.0002	0.0101	0.0222	0.0515	0.0393
8				0.0004	0.0166	0.0366	0.0847	0.0646
9				0.0012	0.0530	0.1164	0.2702	0.2060
10				0.0029	0.1319	0.2897	0.6724	0.5125
11				0.0029	0.1320	0.2890	0.6700	0.5120
12				0.0029	0.1310	0.2890	0.6690	0.5110
13				0.0029	0.1310	0.2880	0.6690	0.5100
14				0.0029	0.1310	0.2880	0.6690	0.5100
15				0.0029	0.1310	0.2880	0.6680	0.5100
16				0.0029	0.1310	0.2880	0.6680	0.5100
17				0.0029	0.1310	0.2880	0.6680	0.5100
18				0.0029	0.1310	0.2880	0.6680	0.5100
19				0.0029	0.1310	0.2880	0.6680	0.5100
20				0.0029	0.1310	0.2880	0.6680	0.5100
21				0.0029	0.1310	0.2880	0.6680	0.5100
22				0.0029	0.1310	0.2880	0.6680	0.5100
23				0.0029	0.1310	0.2880	0.6680	0.5100
24				0.0029	0.1310	0.2880	0.6680	0.5100
25				0.0029	0.1310	0.2880	0.6680	0.5100
26				0.0029	0.1310	0.2880	0.6680	0.5100

* N/G	9	10	11	12	13	14	15	EGAM
-1	1.6519	1.8877	1.1975	0.5834	0.1533	0.1201	0.0416	7.7447
0	1.5971	1.8040	0.9940	0.4200	0.0845	0.0871	0.0322	7.1596
1	1.3498	1.5730	0.9418	0.4610	0.1932	0.1495	0.0558	6.5370
2	1.0816	1.1631	0.6025	0.2560	0.1059	0.1006	0.0367	4.8384
3	0.9436	1.2404	0.7325	0.2924	0.1414	0.1282	0.0513	3.5675
4	0.7196	1.0988	0.7515	0.3247	0.1768	0.1393	0.0589	2.7599
5	0.2441	0.3677	0.0846	0.3486	0.6520	0.0049	0.0025	0.8665
6	0.0407	0.0817	0.0223	0.1782	0.7141	0.0023	0.0016	0.3993
7	0.0447	0.0648	0.0228	0.0964	0.7069	0.0025	0.0018	0.4160
8	0.0732	0.1064	0.0373	0.0916	0.6796	0.0041	0.0030	0.6475

NAM=U238 BIB= SAI MF= 11 MT= 0 AWR=0.00000E+00
LT = 15 LC= 9 LS= 9 LF = (I4,F7.3,2F8.3,5F9.2)

PHOTON INTERACTION CROSS SECTIONS

GR	SKN	SBD	SN	SPH	STT	ST	SA	SAE
1	4.746	4.746	15.145	0.33	20.19	20.19	18.66	12.95
2	5.583	5.583	12.880	0.44	18.93	18.93	17.02	12.12
3	6.627	6.627	10.791	0.61	18.04	18.04	15.68	11.46
4	7.673	7.673	9.046	0.81	17.59	17.52	14.69	10.90
5	8.918	8.918	7.263	1.11	17.37	17.25	13.78	10.41
6	10.741	10.726	5.064	1.71	17.67	17.49	12.89	10.12
7	13.221	13.123	2.698	2.92	19.00	18.78	12.63	10.63
8	15.973	15.855	0.866	5.34	22.56	22.09	14.06	12.66
9	19.647	19.504	0.095	11.58	32.27	31.18	20.24	18.58
10	25.899	25.459	0.000	46.73	76.08	71.99	55.64	47.17
11	35.143	33.229	0.000	357.78	410.89	390.78	366.08	218.77
12	44.007	37.705	0.000	970.59	1086.52	1009.64	978.52	590.21
13	50.296	36.670	0.000	3106.72	3387.35	3141.30	3108.69	2764.82
14	55.020	30.756	0.000	19578.06	20283.80	19578.06	19578.06	15159.77
15	57.793	22.249	0.000	34839.41	36456.70	34839.41	34839.41	33594.88

NAM=U238 BIB=END6 MF= 61 MT= 0 AWR= 2.36006+ 2
LT = 13 LC= 8 LS= 8 LF = (I4,7E8.0)

DELAYED NEUTRON DATA

NG	1	2	3	4	5	6	vd
	.0139	.1128	.1310	.3851	.2539	.1031	.0450
	.0136	.0313	.1233	.3237	.9059	3.0487	.0270
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0000	.0000	.0000	.0000	.0000	.0000	.0000
3	.0000	.0000	.0001	.0021	.0053	.0097	.0032
4	.0073	.0096	.0132	.0576	.0499	.0639	.0444
5	.1586	.1885	.0992	.1737	.1276	.1406	.1502
6	.2964	.3782	.3390	.3069	.2980	.2858	.3145
7	.2679	.2363	.2750	.2369	.2582	.2515	.2491
8	.1363	.0843	.1556	.1291	.1481	.1317	.1327
9	.0795	.0637	.0652	.0518	.0702	.0697	.0618
10	.0318	.0211	.0304	.0239	.0238	.0243	.0245
11	.0223	.0183	.0223	.0180	.0189	.0229	.0194

MT= 0 Z = 28.
LT = 32 LC= 25 LS= 7 LF =(I4,7E9.0)

*

NEUTRON CROSS - SECTIONS

*

	260540.	260560.	260570.	260580.	260000.	260540.	260540.
	1.90	1.90	1.90	1.90	1.90	1.90	1.90
	102.	102.	102.	102.	102.	16.	28.
	260550.	260570.	260580.	260590.	260000.	260530.	250530.
*							
-1	.001	.001	.001	.001	.001	.009	.251
0	.001	.000	.000	.001	.000		.055
1	.002	.000	.000	.001	.000		
2	.003	.001	.000	.001	.001		
3	.004	.002	.001	.002	.002		
4	.005	.002	.001	.002	.002		
5	.007	.003	.001	.003	.003		
6	.007	.005	.001	.005	.006		
7	.010	.006	.003	.005	.006		
8	.017	.007	.010	.008	.007		
9	.020	.011	.016	.012	.011		
10	.023	.016	.038	.024	.014		
11	.058	.001	.062	.072	.005		
12	.177	.001	.191	.044	.014		
13	.017	.003	.074	.004	.005		
14	.012	.239	.117	.006	.221		
15	.015	.012	.014	.008	.011		
16	.020	.021	.021	1.127	.022		
17	.029	.033	.032	.018	.031		
18	.042	.050	.047	.025	.047		
19	.062	.075	.070	.036	.071		
20	.090	.111	.102	.053	.106		
21	.132	.163	.150	.078	.156		
22	.194	.240	.221	.115	.230		
23	.285	.353	.325	.169	.338		
24	.417	.517	.476	.247	.497		
25	.613	.760	.699	.364	.729		
26	2.140	2.655	2.441	1.270	2.561		
*							
*							
	260540.	260540.	260560.	260560.	260560.	260560.	260570.
	1.90	1.90	1.90	1.90	1.90	1.90	1.90
	103.	107.	16.	28.	103.	107.	16.
	250540.	240510.	260550.	250550.	250560.	240530.	260560.
*							
-1	.370	.082	.479	.073	.111	.040	.625
0	.550	.059	.052	.011	.095	.028	.422
1	.554	.019			.039	.013	.033
2	.389	.002			.004	.002	
3	.163						
4	.024						
*							
*							
	260570.	260570.	260580.	260580.	260580.	260000.	260000.
	1.90	1.90	1.90	1.90	1.90	1.90	1.90
	103.	107.	16.	103.	107.	16.	22.
	250570.	240540.	260570.	250580.	240550.	260000.	260000.
*							
-1	.056	.023	.787	.016	.021	.445	.002
0	.057	.019	.272	.004	.007	.061	
1	.031	.021				.001	
2	.001	.006					
3		.002					
*							
*							

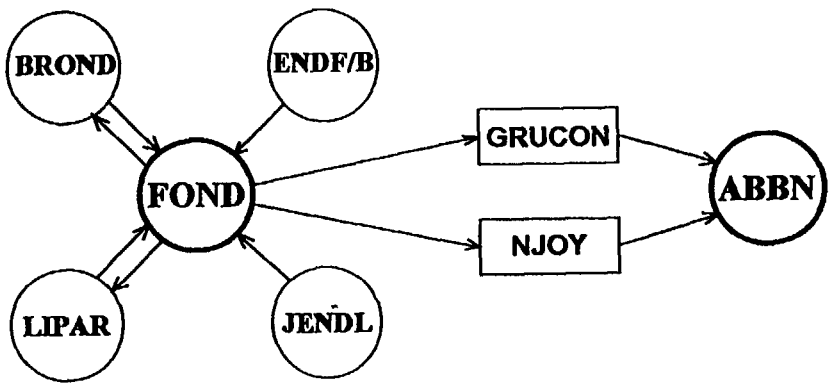
PROCEEDING

FOND≠BROND

- *FOND* contains more materials than *BROND*
- some materials from *BROND* are not included in *FOND*
- *all files* from *FOND* were proceeded by *GRUCON* and some by *NJOY* also

LIPAR- resonance parameter library below 1 Kev

- the basic isotopes were included in *ABBN*

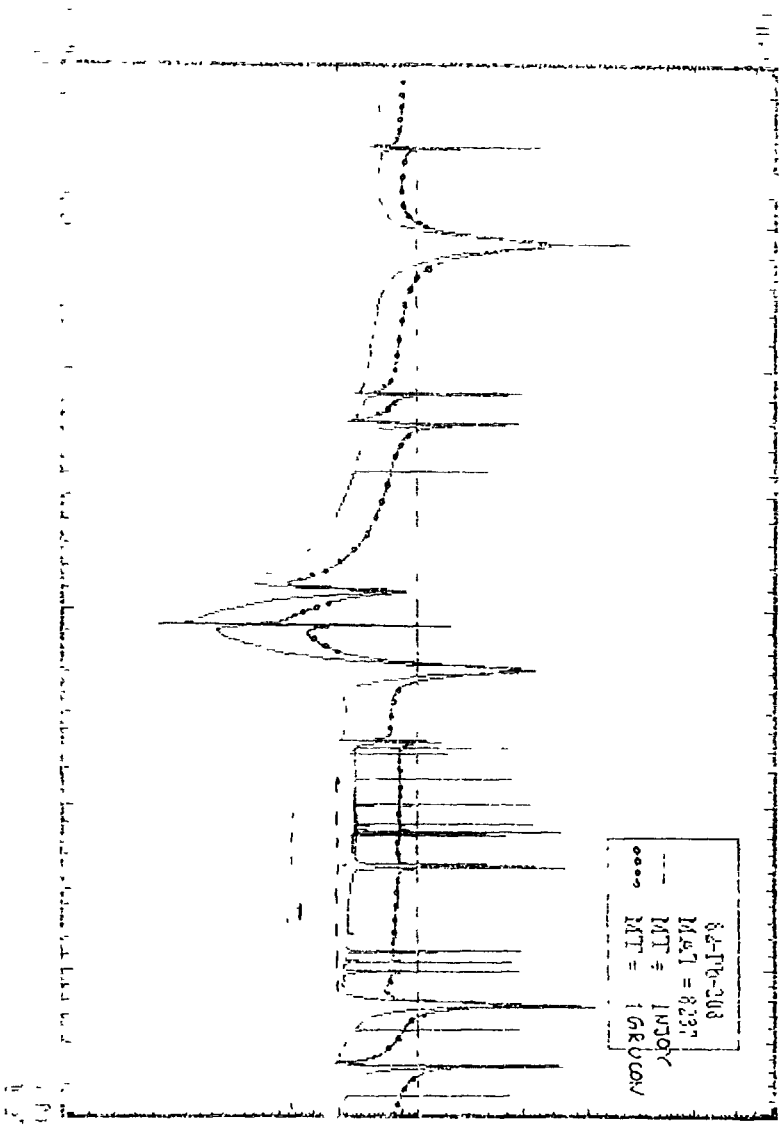


GRUCON

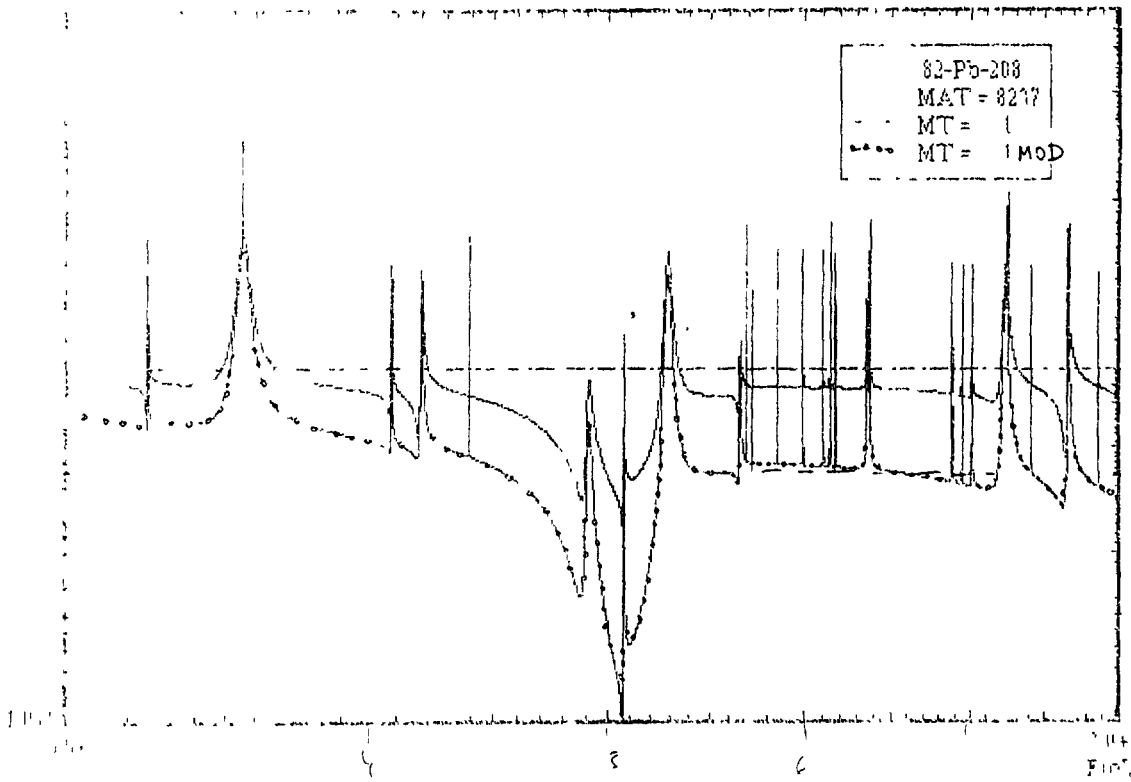
- own development (Sinitsa V.);
- possibility of local energy problem solution;
- various method of subgroup calculation;
- analysis of transmission experiment results;
- file editing.

NJOY

- reliability (many users)
- completeness (not only neutron cross-section)

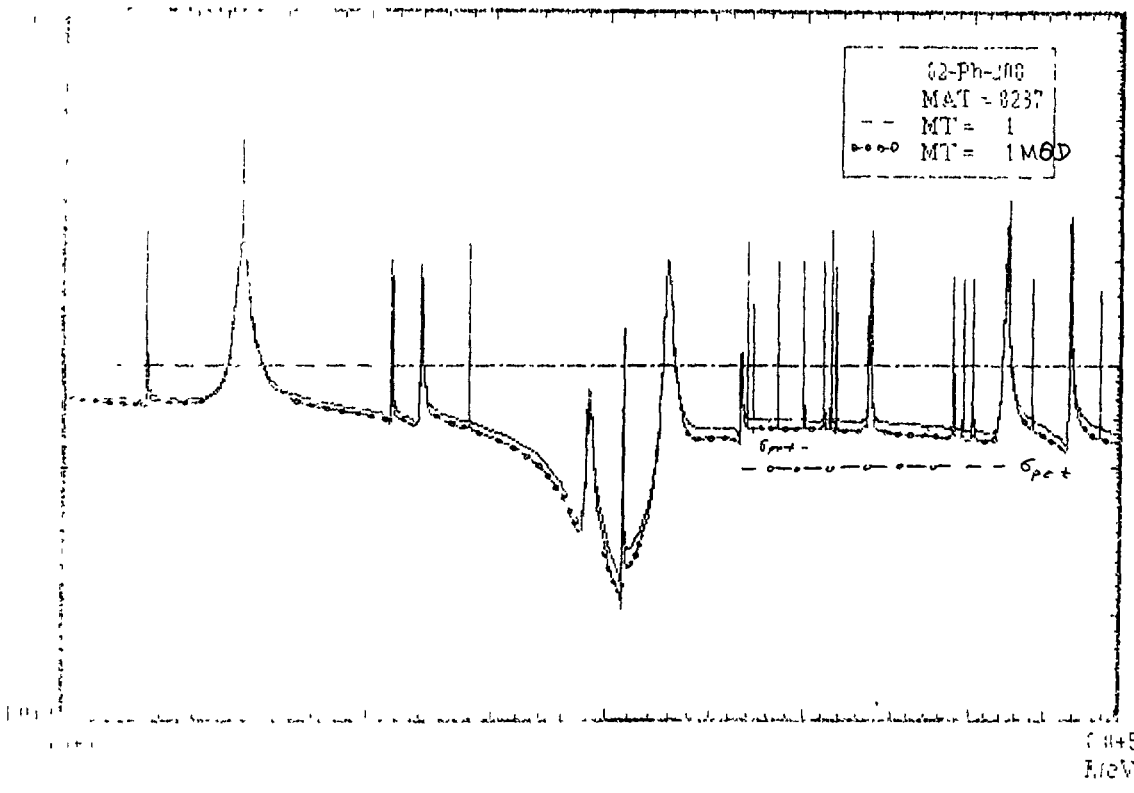


Cross-Sections after GROCON



a - a 123 A^1/3 + 0.08

Cross-Sections after NJOY



a = AP
a - 0.123 A^1/3 + 0.08

SUBGROUP PARAMETER CALCULATION.

a) Moment method:

a_s, $\sigma_{r,s}$ are determinated from equation

$$\sum_{s=1}^{NS} \frac{a_s \sigma_{r,s}}{(\sigma_{t,s}+\sigma_0)^n} = \left\langle \frac{\sigma_r}{(\sigma_t+\sigma_0)^n} \right\rangle$$

b) Method of least squares:

a_s, $\sigma_{r,s}$ are determinated from condition

$$\min \left\{ \sum_k \left[\sum_{s=1}^{NS} \frac{a_s \sigma_{r,s}}{\sigma_t+\sigma_{0,k}} - \left\langle \frac{\sigma_r}{\sigma_t+\sigma_{0,k}} \right\rangle \right]^2 \right\}$$

c) Combinations of previous methods:

In all cases:

1) NS≤5,

2) a_s does not depend from temperature,

3) the balance conditions are strongly fulfilled:

$$\sum a_s = 1, \quad \sum a_s \sigma_{r,s} = \langle \sigma_r \rangle.$$

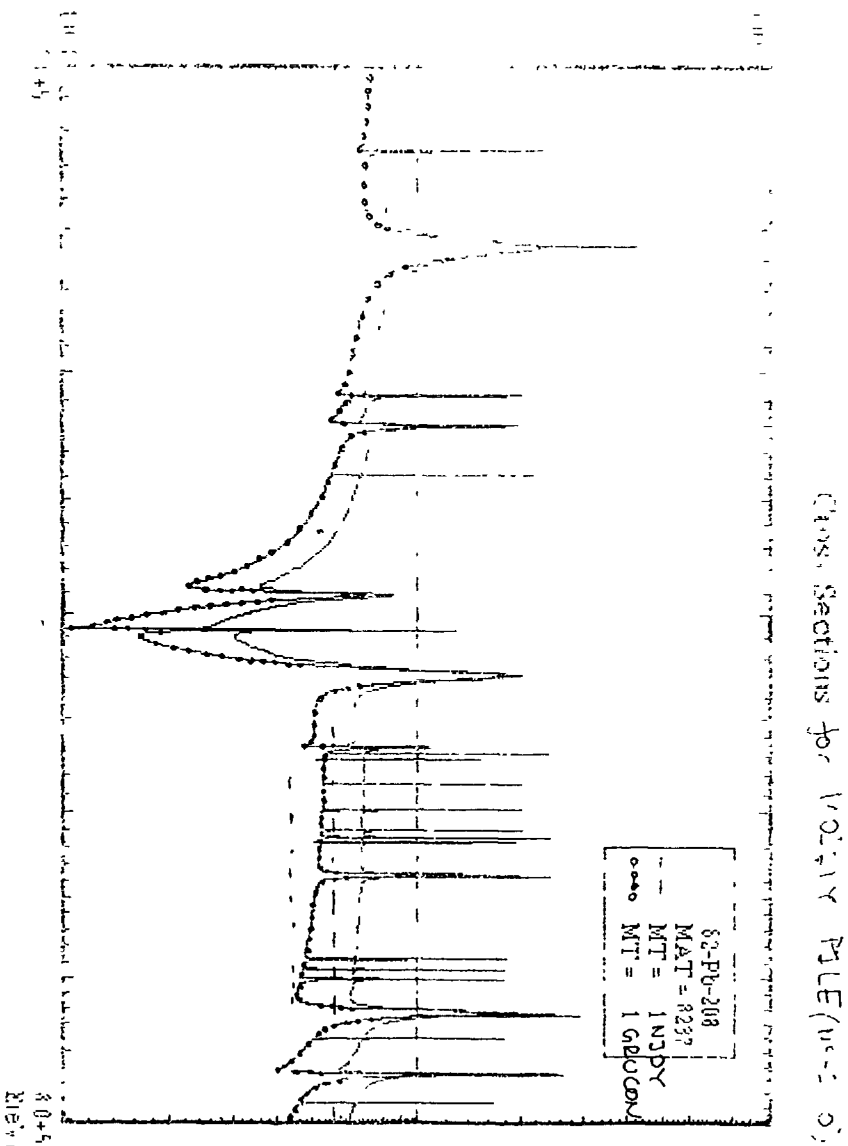
SUBGROUP PARAMETERS IN ABBN:

AT 300K - for all materials.

AT 300,900,2100K - for U-238 and Pu-239 only.

SUBGROUP PARAMETERS CALCULATION PROCESS IN GRUCON IS NOT FULLY AUTOMATIZED TILL NOW!

SOLVING THIS PROBLEM IN THE FRAME ON NJOY APPEARS AS VERY USEFUL.



UNRESOLVED RESONANCE REGION

IMPORTANT REGION FOR FAST REACTORS AND ELECTRO-NUCLEAR ACTINIDE TRANSMUTATORS ESPECIALLY FOR TH-232, U-233,235,238, PU-239,240,241, NP-237, AM-241,243

THE NEXT IS DONE

1. NJOY and GRUCON results are compared using the same input data files.
2. Indefiniteness of f and f(T) caused by different evaluation are estimated and the more certain value are adopted.
3. Energy dependent subgroup parameters with temperature independent subgroup shares are constructed for U-238 and Pu-239.
4. Data for Th-237,U-235,U-238 and Pu-239 are verified in the deep transmission experiments on the IBR reactor in Dubna.
5. Recent calculations based on ENDF/B-6 and JENDL-3 agreed with ABBN subgroup data
6. Unresolved resonance structure subgroup paramiterisation used in detail energy CM Monte-Carlo calculations.

IT WOULD BE WANTED

1. To introduce the subgroups in the ENDF URR format.
2. To verify the Np-237 and U-233 data by the deep transmission experiments
3. Data revision for U-238,U-235 and Pu-239 only if some contradictions with new experimental data would be found

UNRESOLVED RESONANCE REGION

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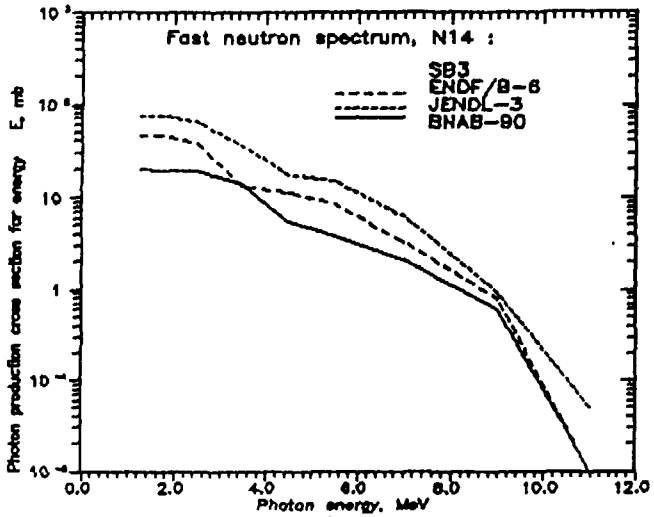
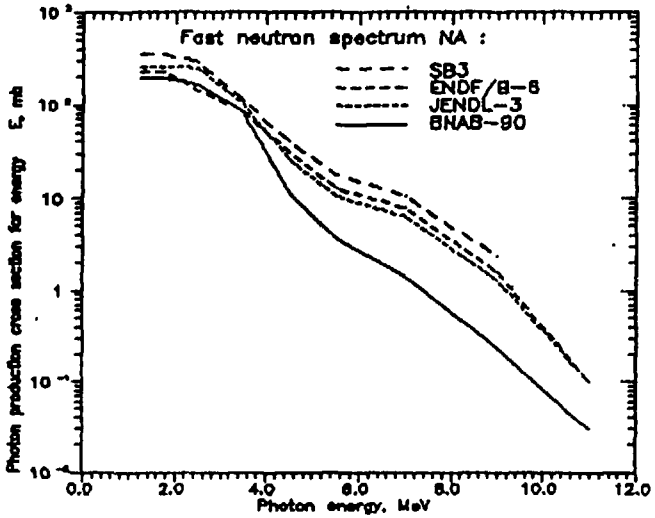
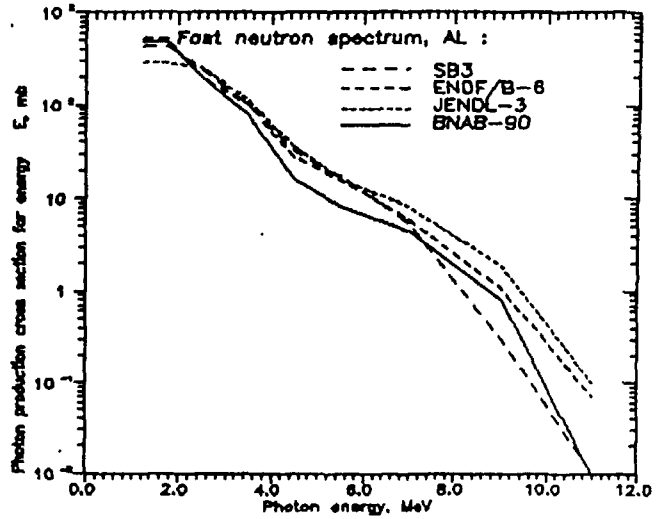

Fast neutron spectrum, N14 :
SB3
ENDF/B-6
JENDL-3
BNAB-90
Photon production cross section for energy E, mb
Photon energy, MeV


Fast neutron spectrum NA :
SB3
ENDF/B-6
JENDL-3
BNAB-90
Photon production cross section for energy E, mb
Photon energy, MeV


Fast neutron spectrum, AL :
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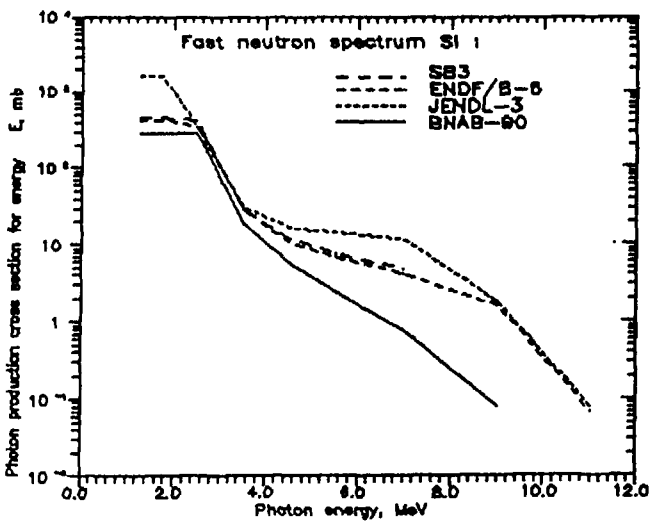
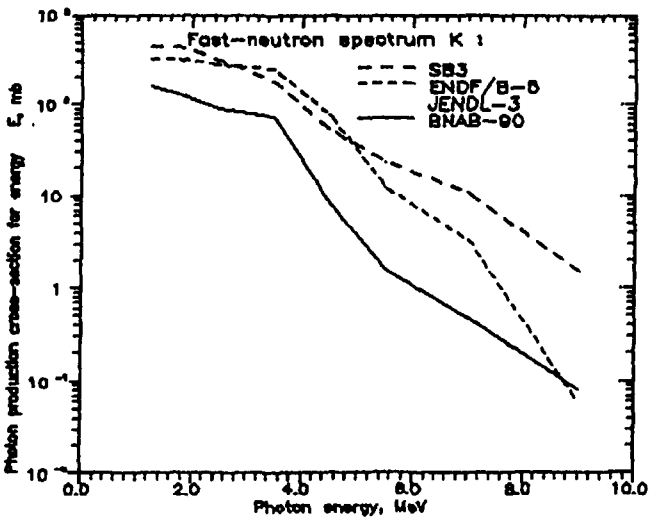
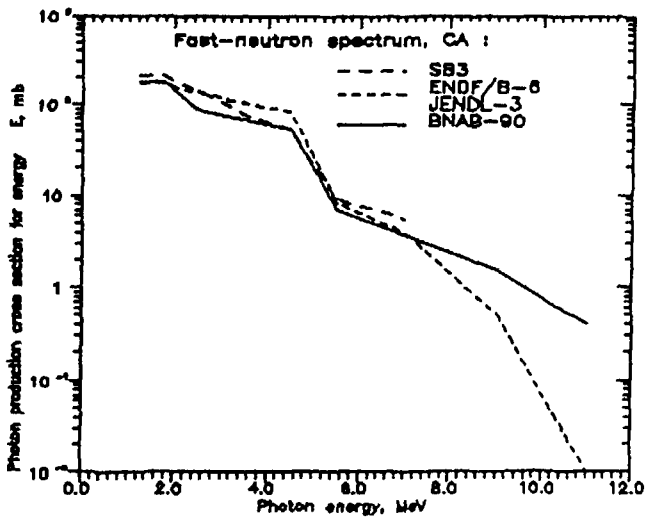
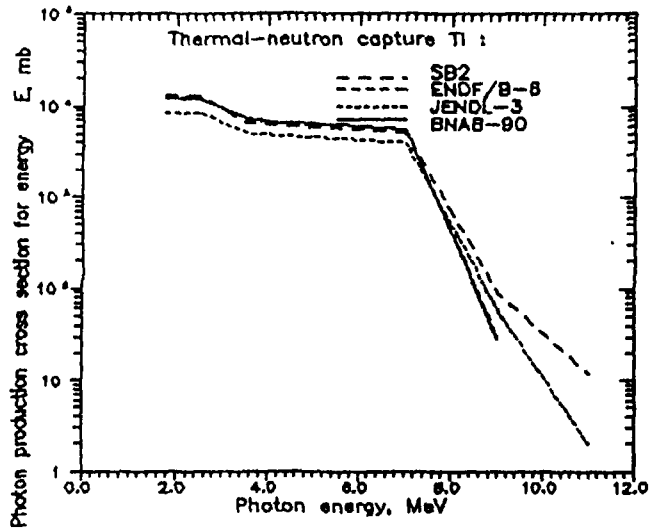
ENDF/B-6
JENDL-3
BNAB-90
Photon production cross section for energy E, mb
Photon energy, MeV

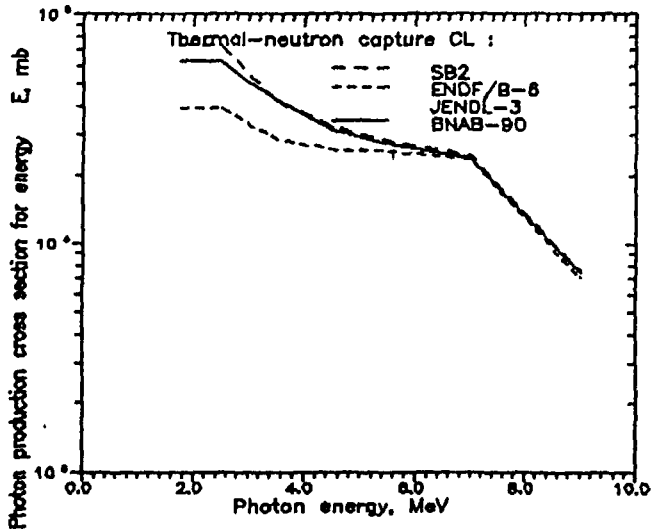

Fast neutron spectrum SI :
SB3
ENDF/B-6
JENDL-3
BNAB-90
Photon production cross section for energy E, mb
Photon energy, MeV

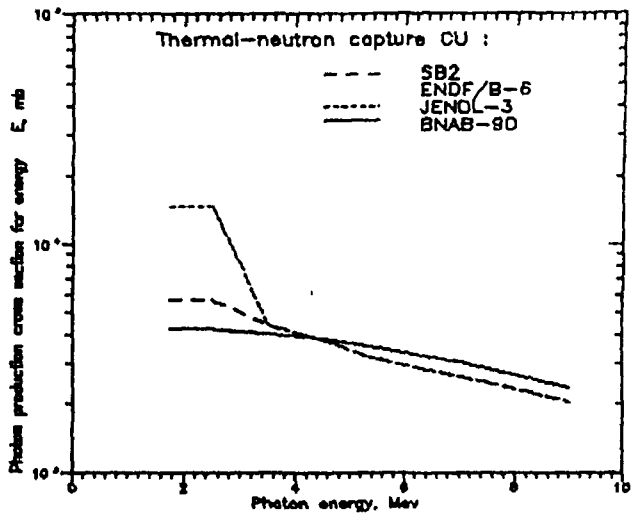

Fast-neutron spectrum K :
SB3
ENDF/B-6
JENDL-3
BNAB-90
Photon production cross-section for energy E, mb
Photon energy, MeV

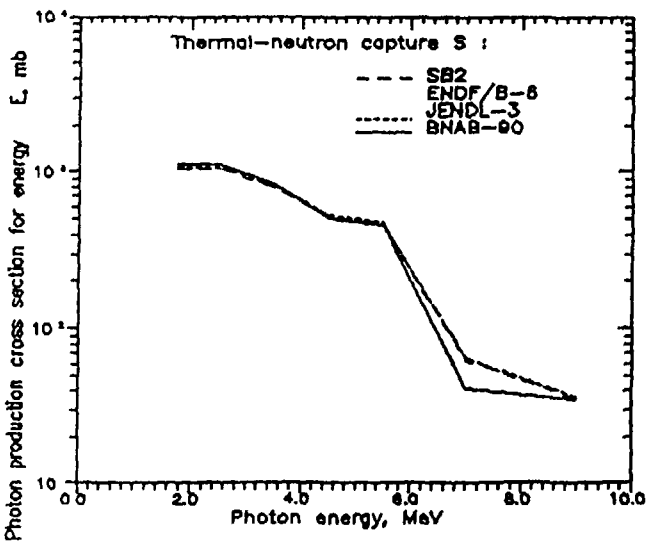

Fast-neutron spectrum, CA :
SB3
ENDF/B-6
JENDL-3
BNAB-90
Photon production cross section for energy E, mb
Photon energy, MeV

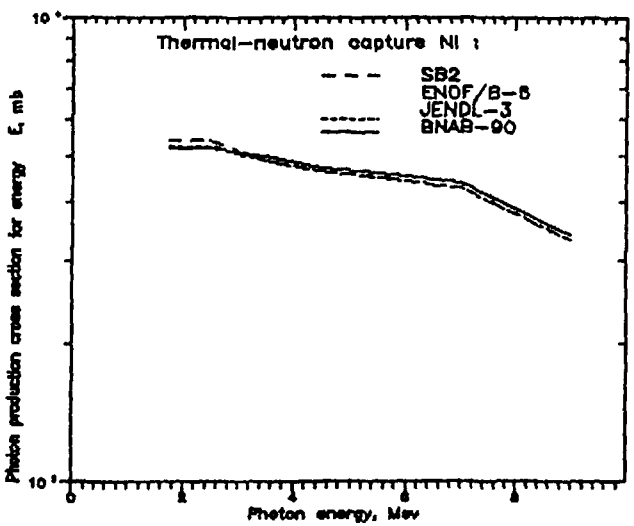
3.4.3

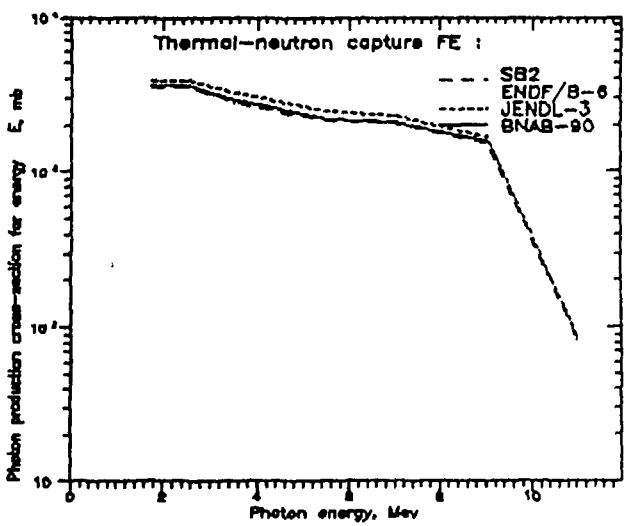

Thermal-neutron capture Ti :
SB2
ENDF/B-6
JENDL-3
BNAB-90
Photon production cross section for energy E, mb
Photon energy, MeV

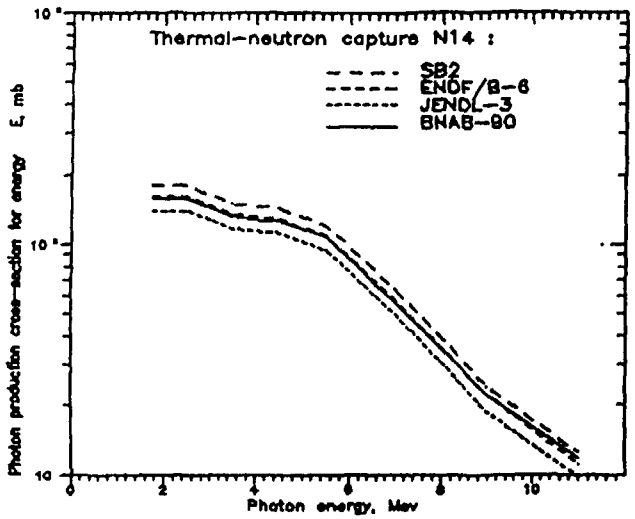

Thermal-neutron capture CL :
SB2
ENDF/B-6
JENDL-3
BNAB-90
Photon production cross section for energy E, mb
Photon energy, MeV

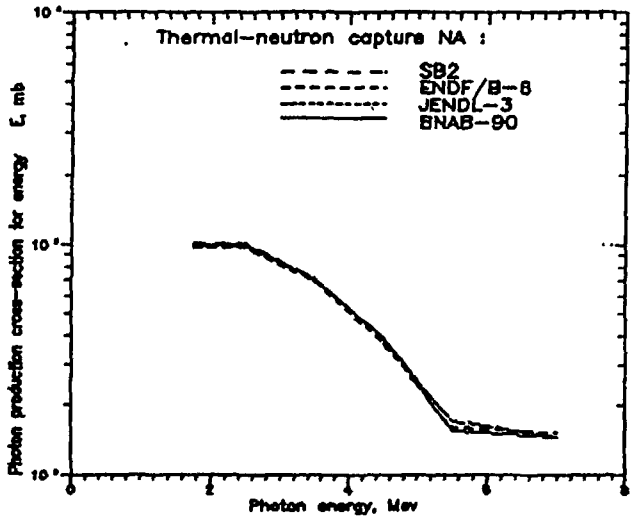

Thermal-neutron capture CU :
SB2
ENDF/B-6
JENDL-3
BNAB-90
Photon production cross section for energy E, mb
Photon energy, Mev

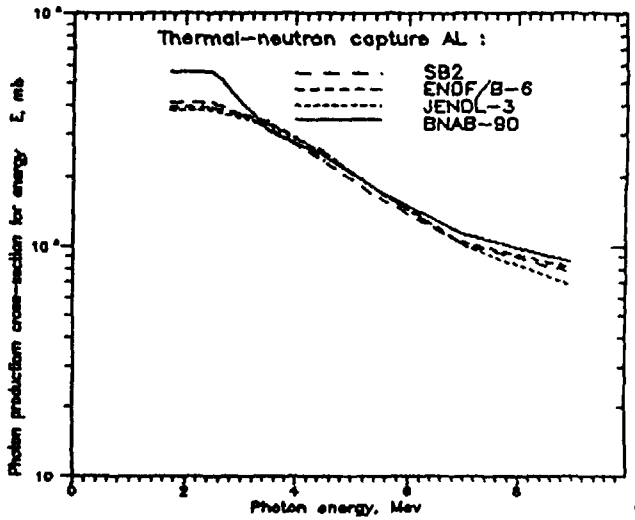

Thermal-neutron capture S :
SB2
ENDF/B-6
JENDL-3
BNAB-90
Photon production cross section for energy E, mb
Photon energy, MeV

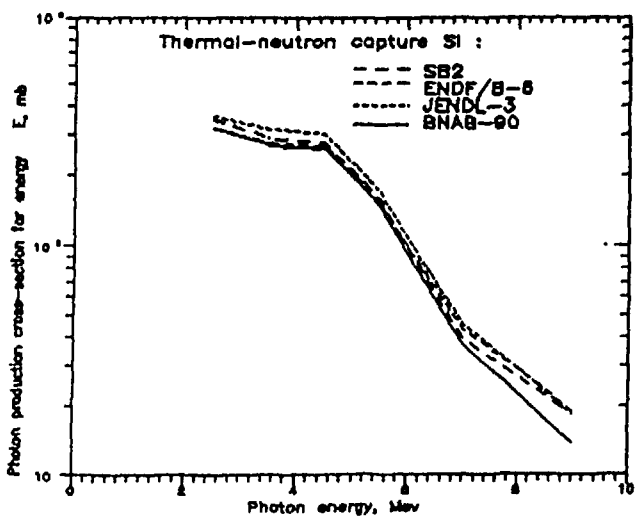

Thermal-neutron capture NI :
SB2
ENDF/B-6
JENDL-3
BNAB-90
Photon production cross section for energy E, mb
Photon energy, Mev

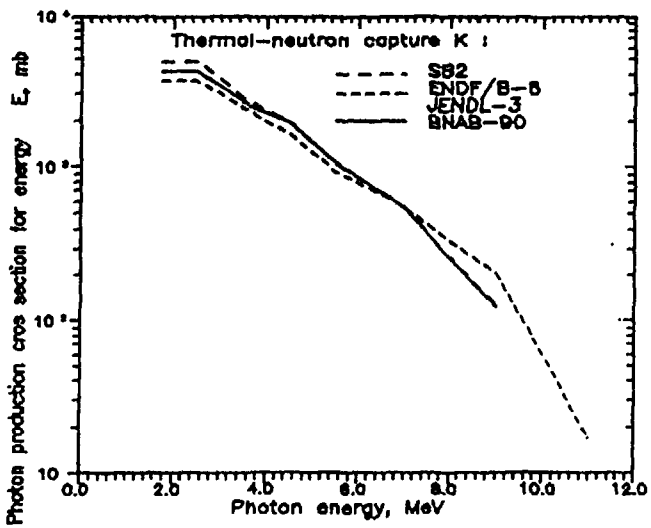

Thermal-neutron capture FE :
SB2
ENDF/B-6
JENDL-3
BNAB-90
Photon production cross-section for energy E, mb
Photon energy, Mev

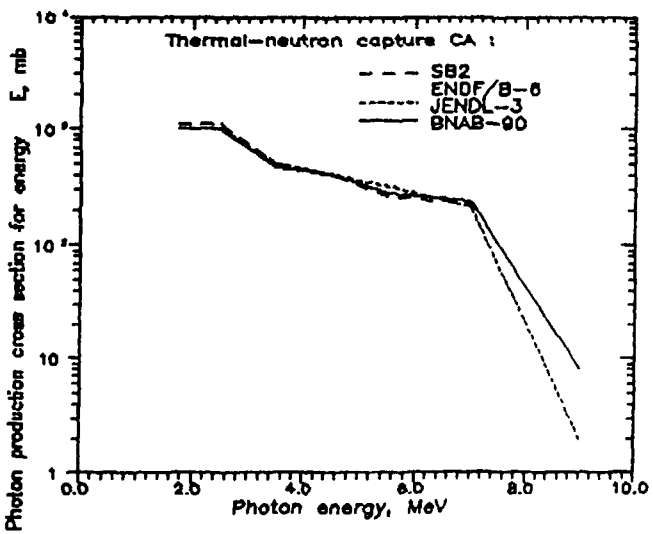

Thermal–neutron capture N14 :
SB2
ENDF/B–6
JENDL–3
BNAB–90
Photon production cross–section for energy E, mb
Photon energy, Mev


Thermal–neutron capture NA :
SB2
ENDF/B–6
JENDL–3
BNAB–90
Photon production cross–section for energy E, mb
Photon energy, Mev

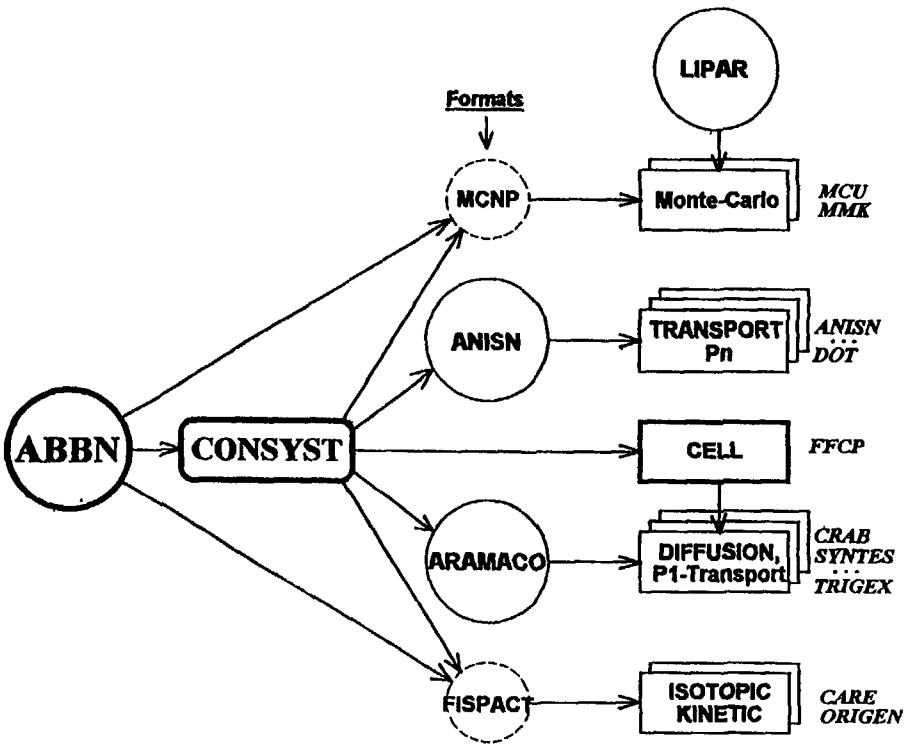

Thermal–neutron capture AL :
SB2
ENDF/B–6
JENDL–3
BNAB–90
Photon production cross–section for energy E, mb
Photon energy, Mev


Thermal–neutron capture SI :
SB2
ENDF/B–6
JENDL–3
BNAB–90
Photon production cross–section for energy E, mb
Photon energy, Mev


Thermal–neutron capture K :
SB2
ENDF/B–6
JENDL–3
BNAB–90
Photon production cros section for energy E, mb
Photon energy, MeV


Thermal–neutron capture CA :
SB2
ENDF/B–6
JENDL–3
BNAB–90
Photon production cross section for energy E, mb
Photon energy, MeV

CONstant SYSTem
for group constant preparation.



ARAMACO - NGN=26 group
ANISN - NGN=1 - 300 , NGG=15 .group

TESTING

Integral experiments (well known spectrum):
- -average cross-section;
- -resonance integrals;
- -transmissions;
- -cross-section of removing under fission threshold.

Direct file testing.

Macroscopic experiments:
- compact critical assembles (GODIVA type);
- solution experiments (U,Pu - fuel);
- fast critical assembles;
- regular lattices.

We test: files, reprocessing codes, calculational codes.

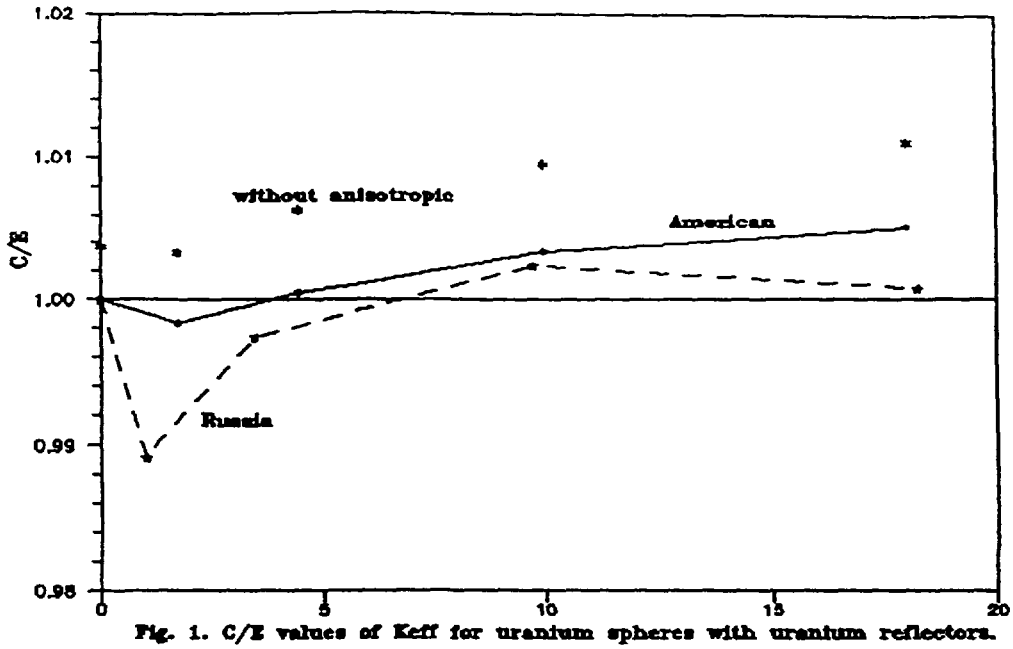


Fig. 1. C/E values of Keff for uranium spheres with uranium reflectors.

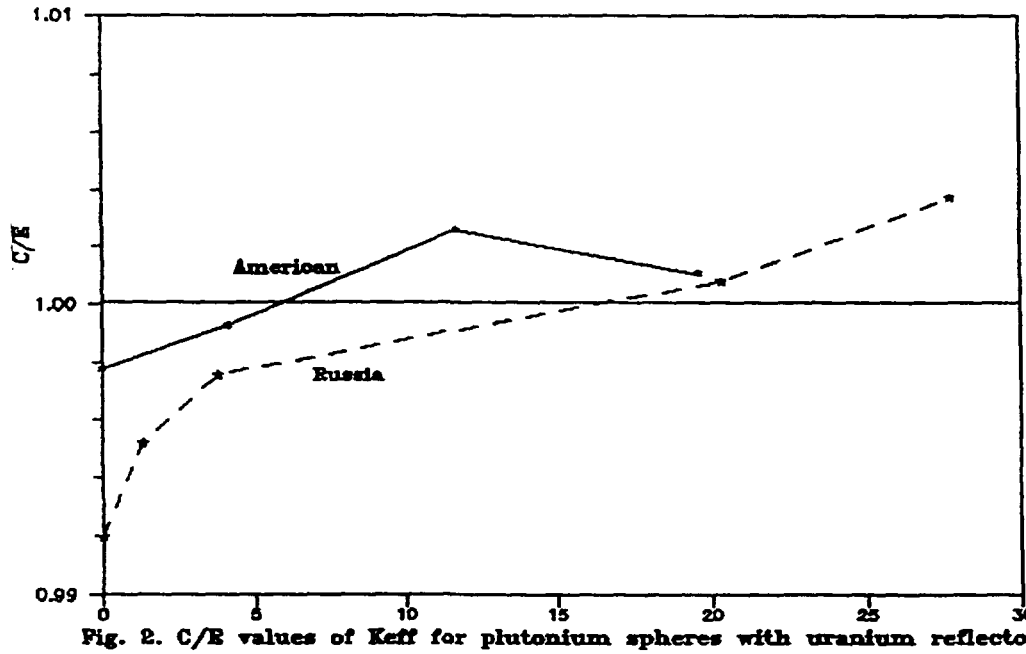


Fig. 2. C/E values of Keff for plutonium spheres with uranium reflectors.

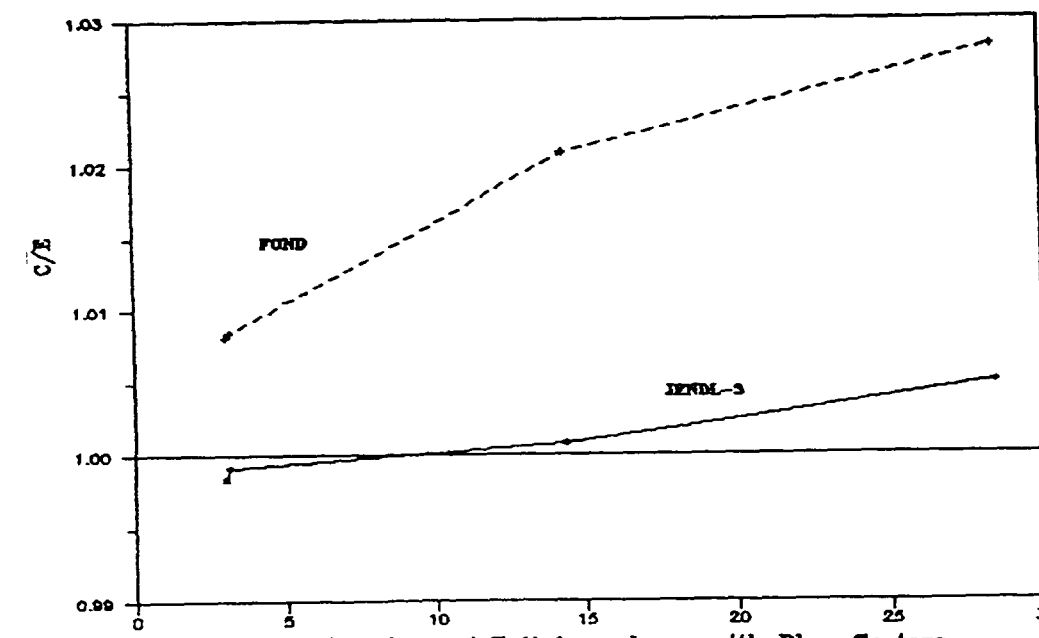


Fig. 3. C/E values of Keff for spheres with Pb reflectors.

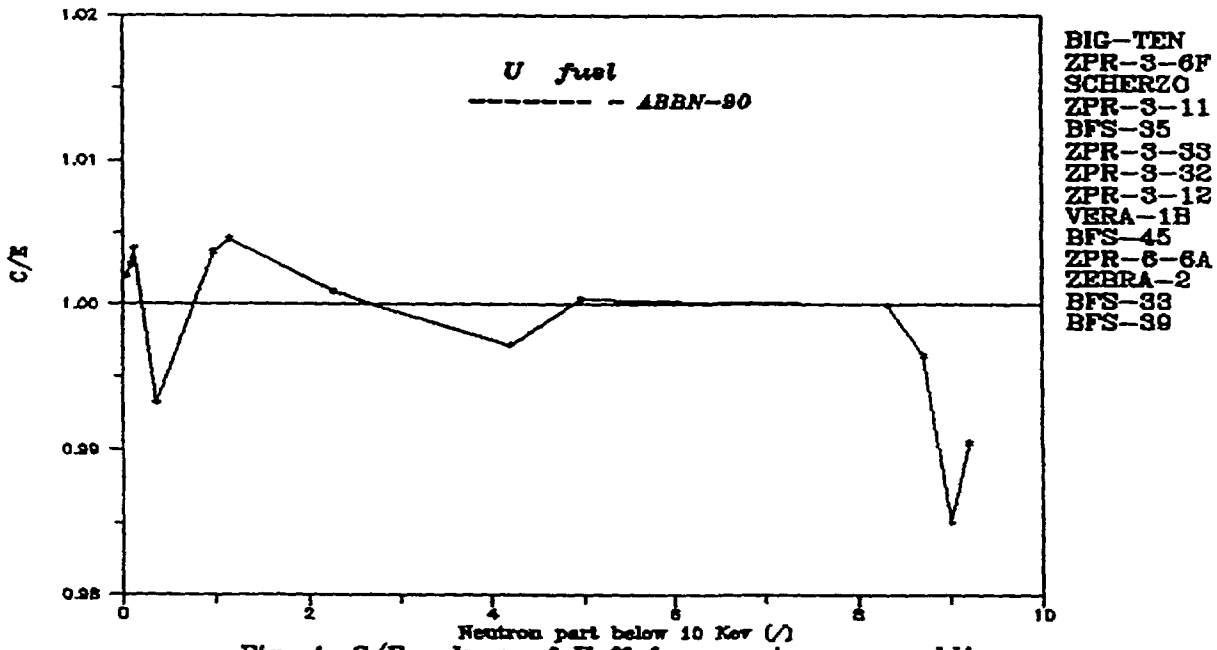


Fig. 4. C/E values of Keff for uranium assemblies.

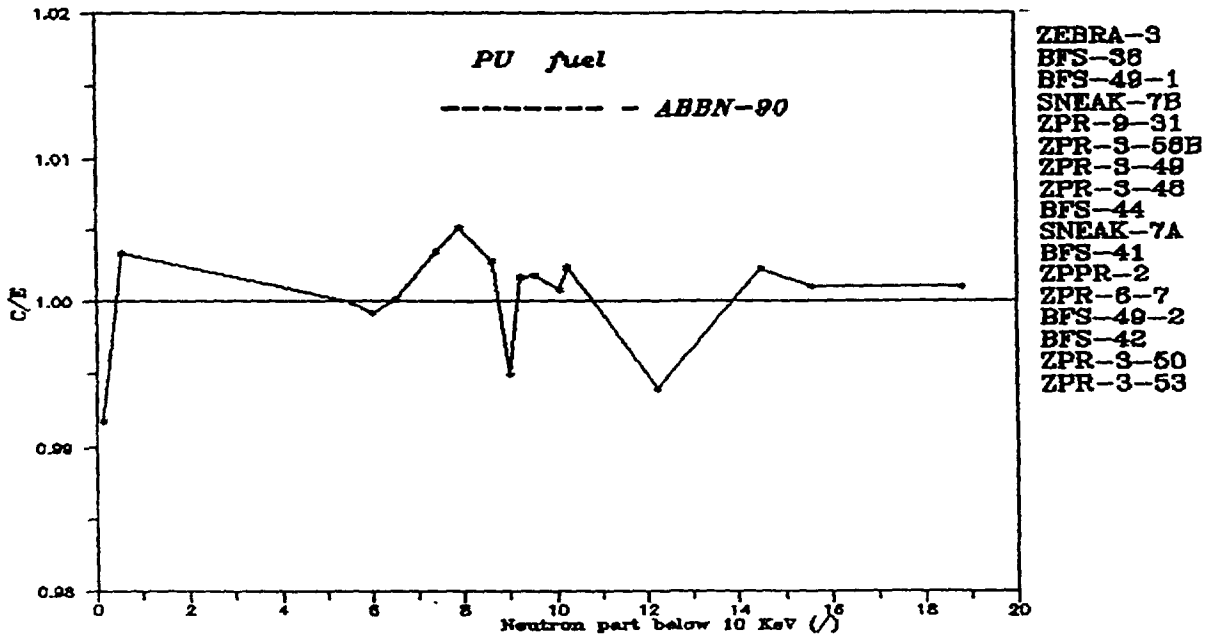
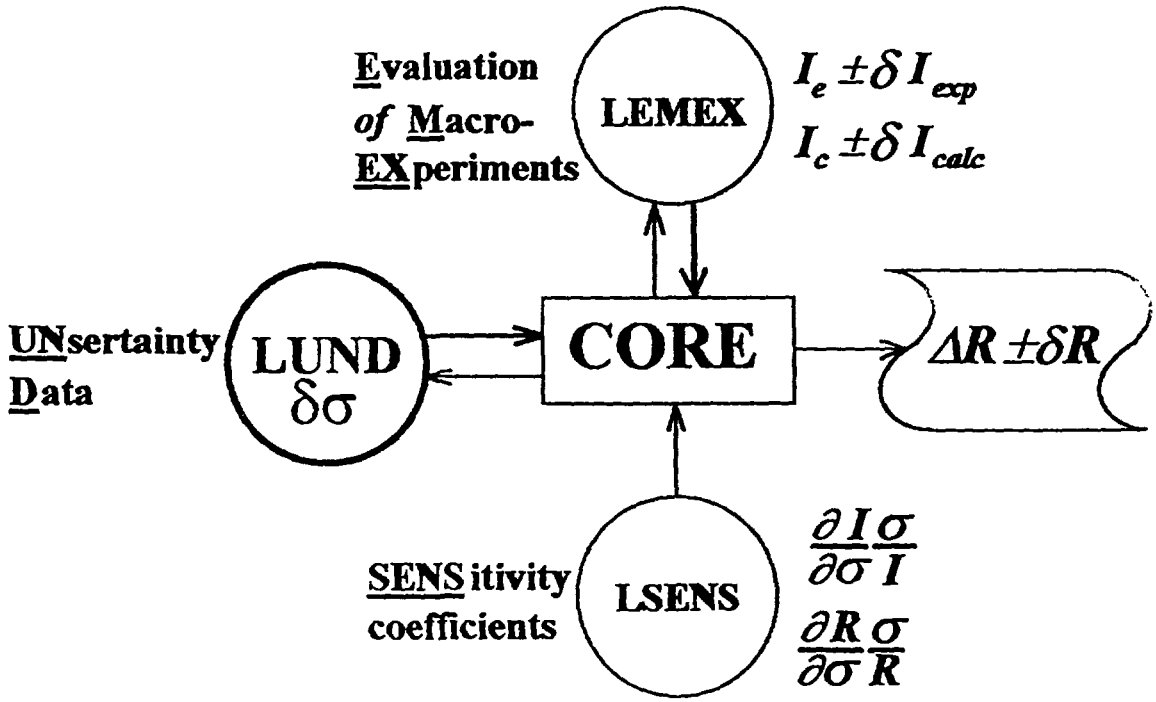


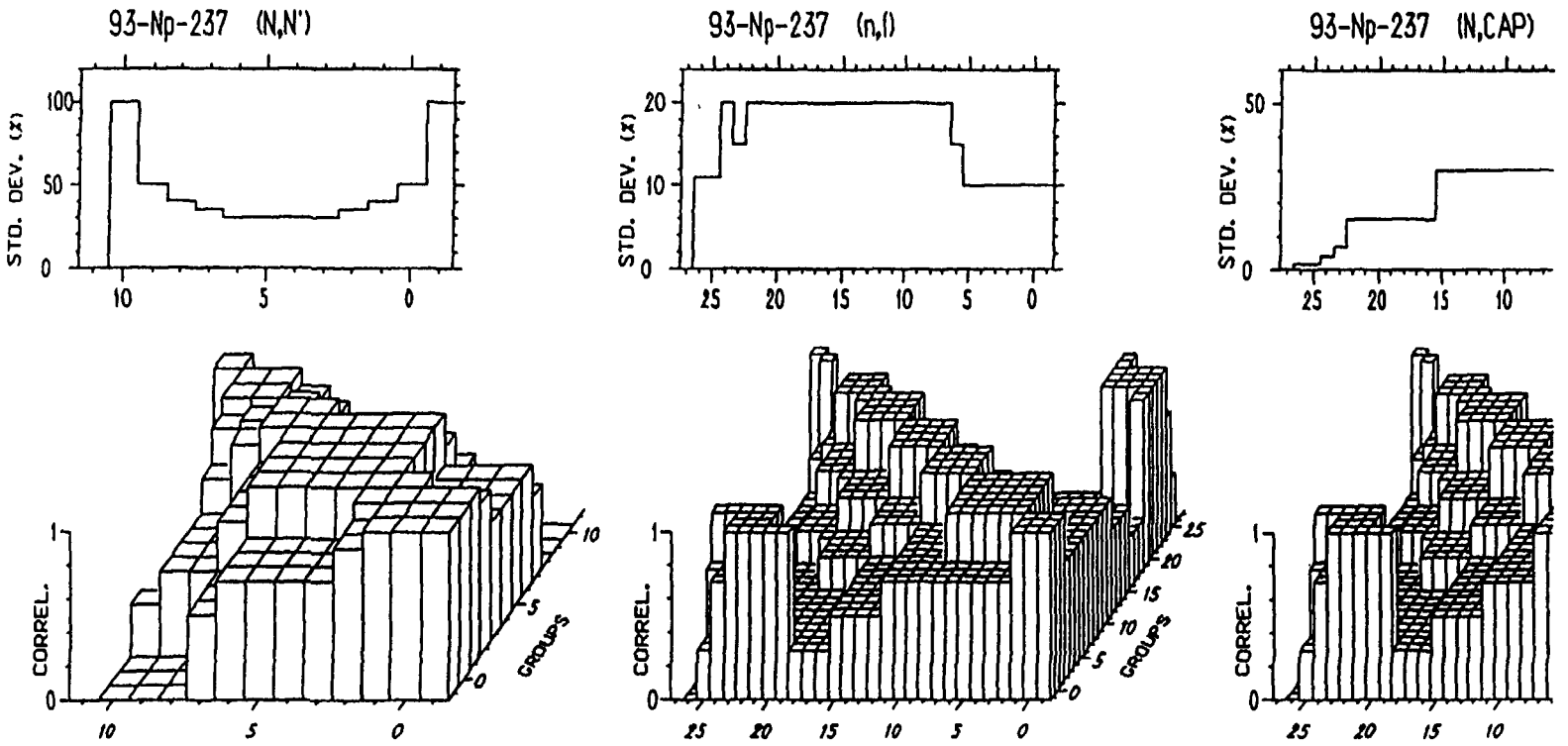
Fig. 5. C/E values of Keff for plutonium assemblies.

COVARIANCE MATRIX

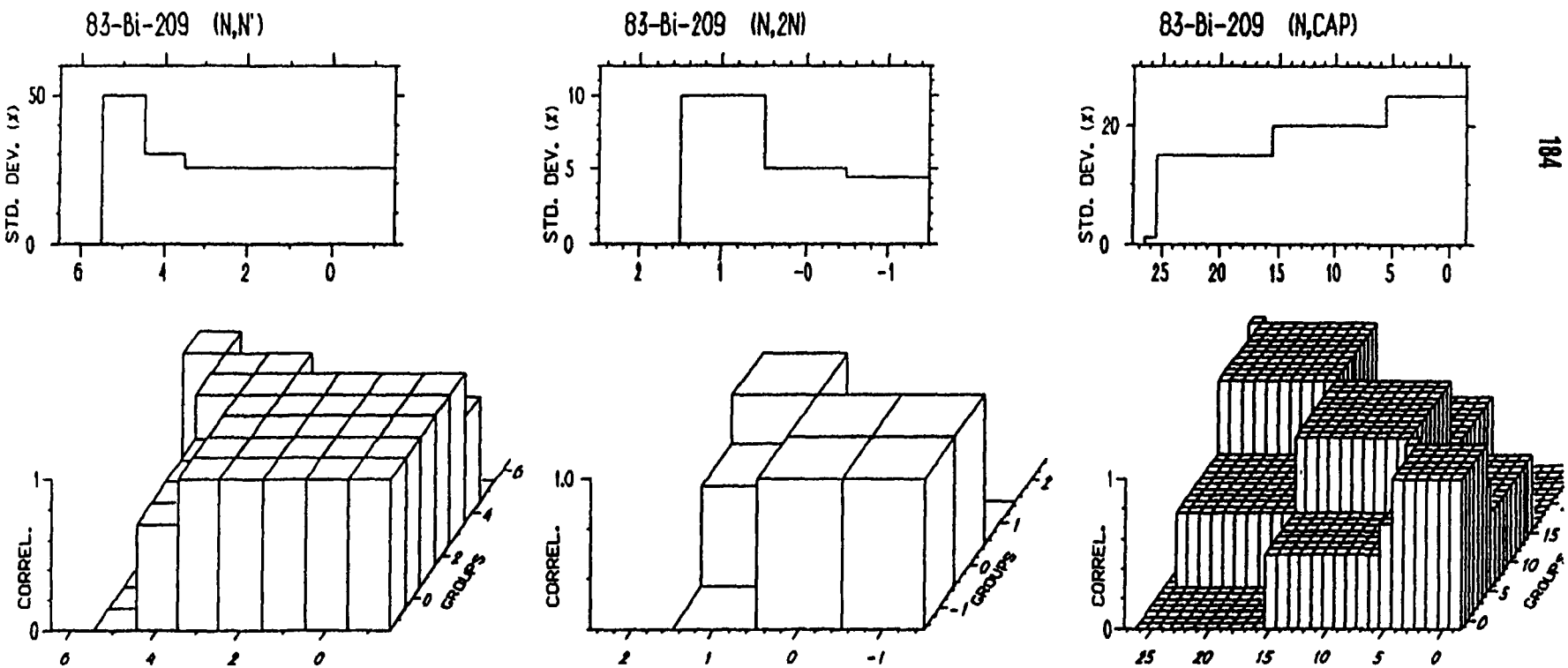
WAS - ABBN-78 12 groups, 60 reactions
NOW - ABBN-90 28 groups 500 reactions

- is obtained not from ENDF/B file but from consideration of experimental conditions and theoretical parameterization;
- is widely used in uncertainty analysis of reactor physics calculations;
- 28 groups are quite sufficient;
- all ENDF/B-6 MF=3 data are processed by NJOY but are not analyzed;
- results obtained on the basis of covariance matrix should be interpreted with the care taking into account the common sense.





КОВАРИАЦИОННЫЕ МАТРИЦЫ ДЛЯ НЕПТУНИЯ-237


83-Bi-209 (N,N')
STD. DEV. (%)
50
0
6
4
2
0
CORREL.
1
0
GROUPS
83-Bi-209 (N,2N)
STD. DEV. (%)
10
5
0
2
1
-0
-1
CORREL.
1.0
GROUPS
83-Bi-209 (N,CAP)
STD. DEV. (%)
20
0
25
20
15
10
5
0
CORREL.
1
0
GROUPS

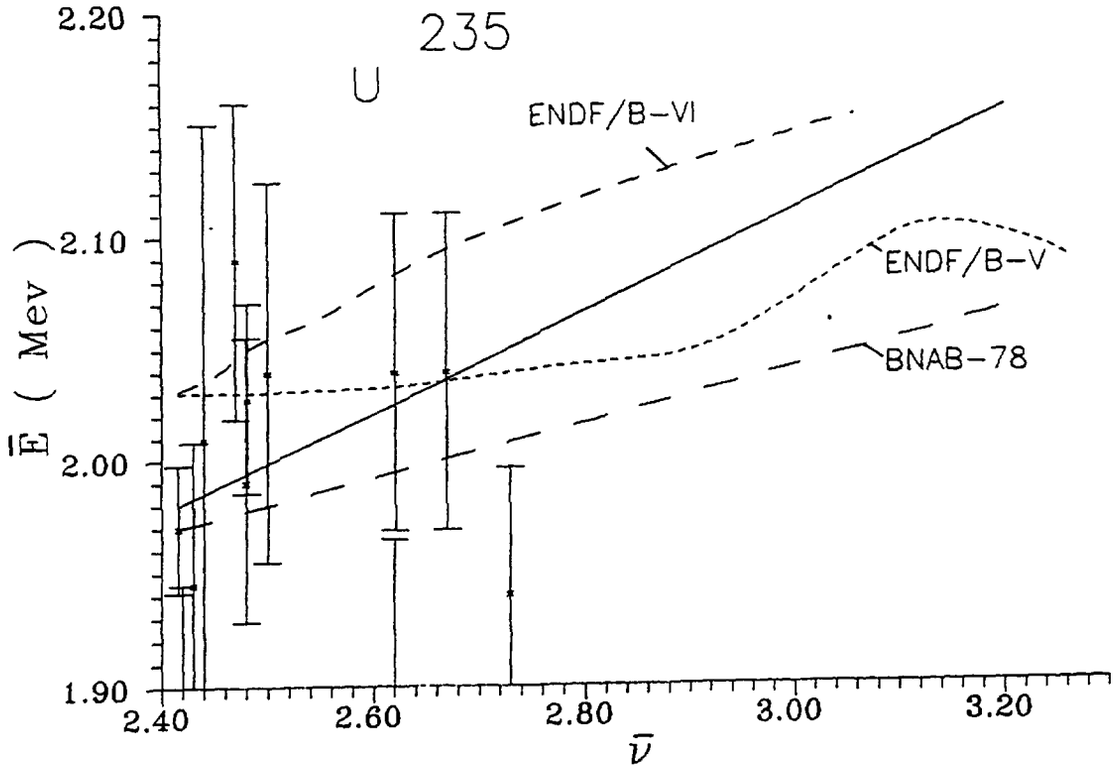


Рис. 6

FISSION SPECTRUM

1. It was considered that average energy (E) of U-235 fission spectrum induced by thermal neutrons is equal 1.97 Mev with the accuracy which is better than 1%. Such accuracy meets requirements of fast and thermal reactors.
2. ENDF/B-5 increases E up to 2.03 Mev (3%). Macroscopic experiments ask the same value of E.
3. The results of automatic adjustment will mainly depend on evaluated accuracy of average energy (E) of fission spectrum. What is a real accuracy of E for the basic nuclei (U-235, Pu-239) ?

HYDROGEN TOTAL CROSS-SECTION

1. Evaluated accuracy of hydrogen scattering cross-section is equal 0.2% .
2. The difference of current ENDF/B-6 data and ABBN-64 data is about 1.5% (in average).
3. Calculation of homogeneous critical assembles with U-235 (90%)and water shows :
   - MCNP and MCU give the same results;
   - calculation with H(ENDF/B-6) overestimates the Keff value critical assemblies;
   - calculation with ABBN-64 data gives good results.
4. Can we believe to 0.2% accuracy of hydrogen scattering cross-section ?

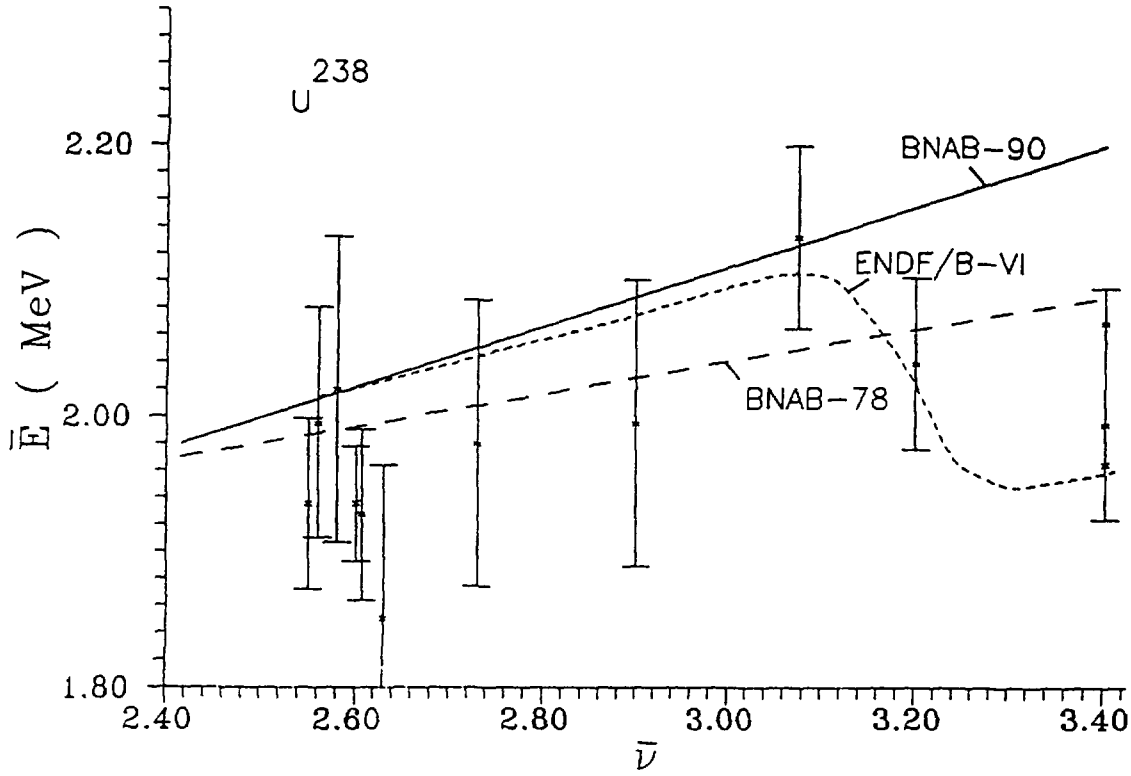

U 238
BNAB-90
ENDF/B-VI
BNAB-78
Ē (MeV)
2.20
2.00
1.80
2.40
2.60
2.80
3.00
3.20
3.40
ν̄

Рис. 7

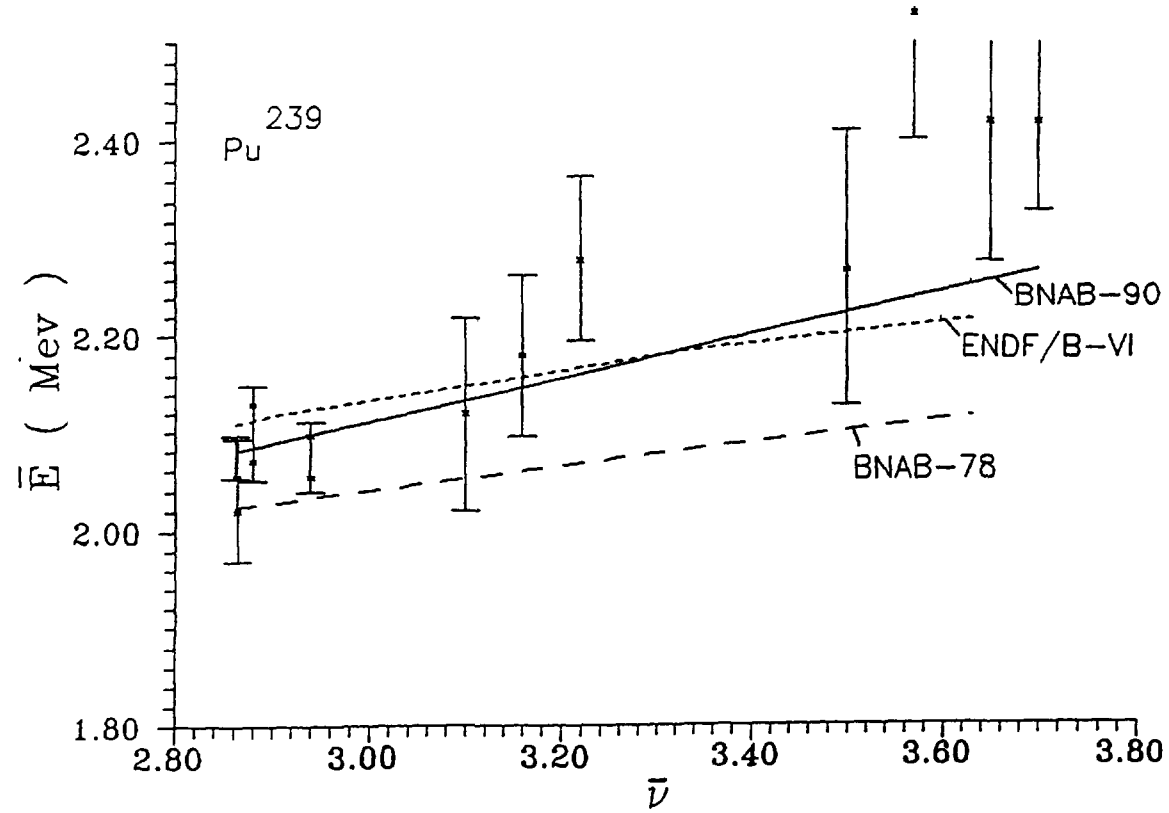

Pu 239
BNAB-90
ENDF/B-VI
BNAB-78
Ē (Mev)
2.40
2.20
2.00
1.80
2.80
3.00
3.20
3.40
3.60
3.80
ν̄

Рис. 8

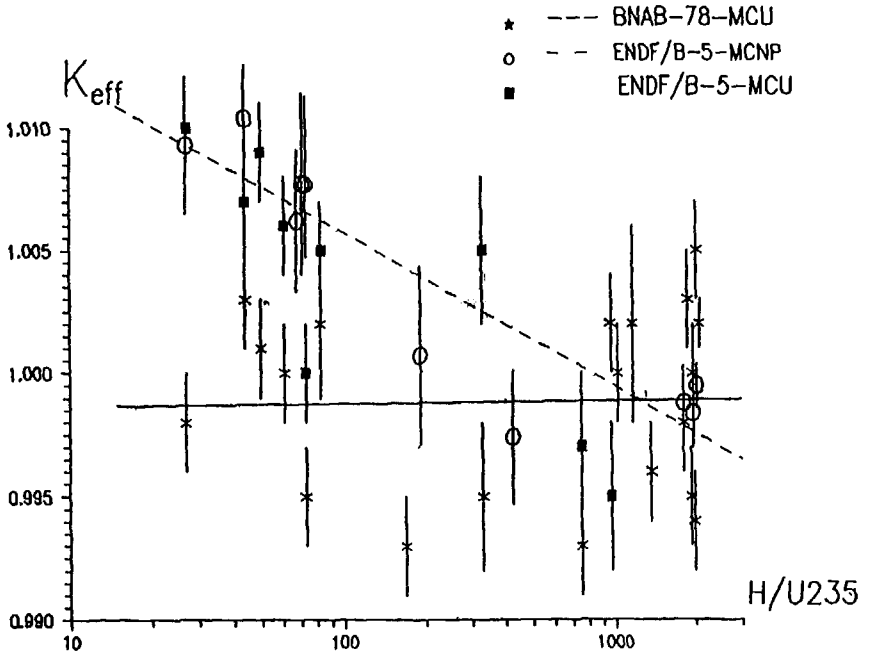
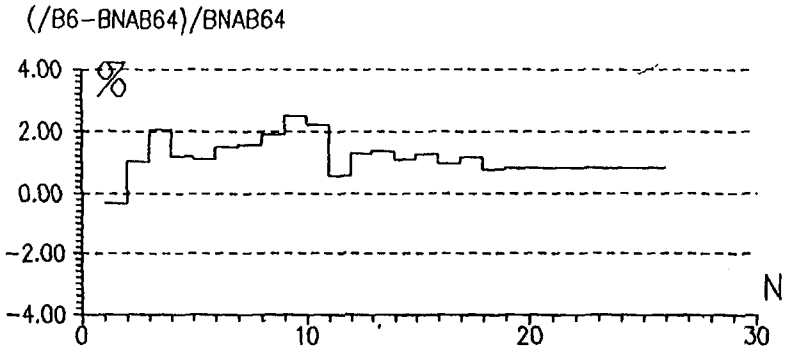

BNAB-78-MCU
ENDF/B-5-MCNP
ENDF/B-5-MCU
K_{eff}
1.010
1.005
1.000
0.995
0.990
10
100
1000
H/U235

Рис 1


(/B6-BNAB64)/BNAB64
%
4.00
2.00
0.00
-2.00
-4.00
0
10
20
30
N

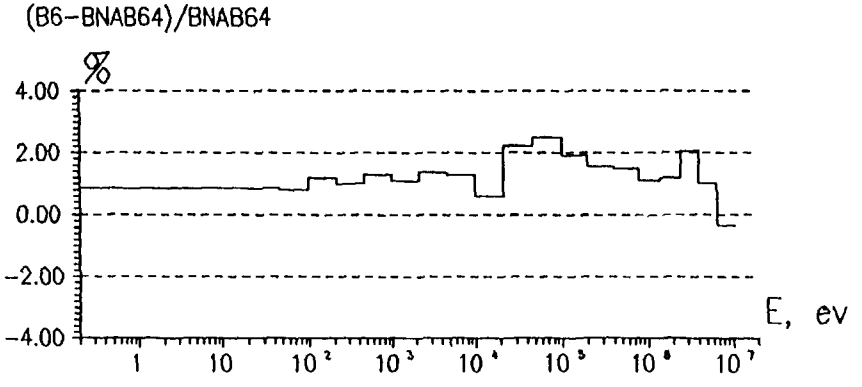

(B6-BNAB64)/BNAB64
%
4.00
2.00
0.00
-2.00
-4.00
1
10
10^2
10^3
10^4
10^5
10^6
10^7
E, ev

Рис 2

PROPOSALS

1. To do additional NJOY testing concerning Reich-Moore, General R-Matrix and Hybrid R-Function formalism treatment especially in the regions where p-wave scattering is important.
2. To include the subgroup calculation module into NJOY.
3. To include subgroup approximation of cross-section resonance structure in ENDF format for URR (with LSSF=1) (for direct using in Monte-Carlo codes).
4. To create the international library of evaluated integral in macroscopic experiments (under the NDS IAEA aegis) for validation of neutron constants used in technology.
5. To publish ABBN-90 group constant set and supplement documentation by IAEA.

UPDATING OF THE WIMS GROUP CONSTANTS.

What is done

1. Subroutine for calculation of detailed neutron spectrum in homogeneous resonance media is included in GRUCON.
2. Code for the WIMS library edition is written:
   - inclusion or deletion of material from the library;
   - infinite dilution cross-section may be changed;
   - inclusion or changing of resonance tables;
   - graphical comparison of cross-sections.
3. Data for new materials are included into the WIMS library: W, Mo, Sn, Hf, Ta, Am-241, Np-237.
4. Data for fission spectrum and for next materials are changed: U-235, U238, Pu-239, Pu-240, Zr .
5. H20 thermalization matrices calculated by NJOY and TERMAC were compared and good agreement was found.
6. Reaction cross-sections for fission products and actinides for WIMS energy grid are completed in the ABBN format. Collapsed one-group cross-sections may be calculated using WIMS neutron spectra for ORIGEN and other isotopic codes.

What has to be done

1. Resonance self-shielding has to be taken in to account below 4 eV (for Pu-242, Hf).