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ICTP 40th Anniversary

SMR.1555 - 28

Workshop on
Nuclear Reaction Data and Nuclear Reactors:
Physics, Design and Safety

16 February - 12 March 2004

Introduction to SAMMY

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UT-BATTELLE

SAMMY Workshop

Workshop on Nuclear Reaction Data and Nuclear Reactors: Physics, Design and Safety

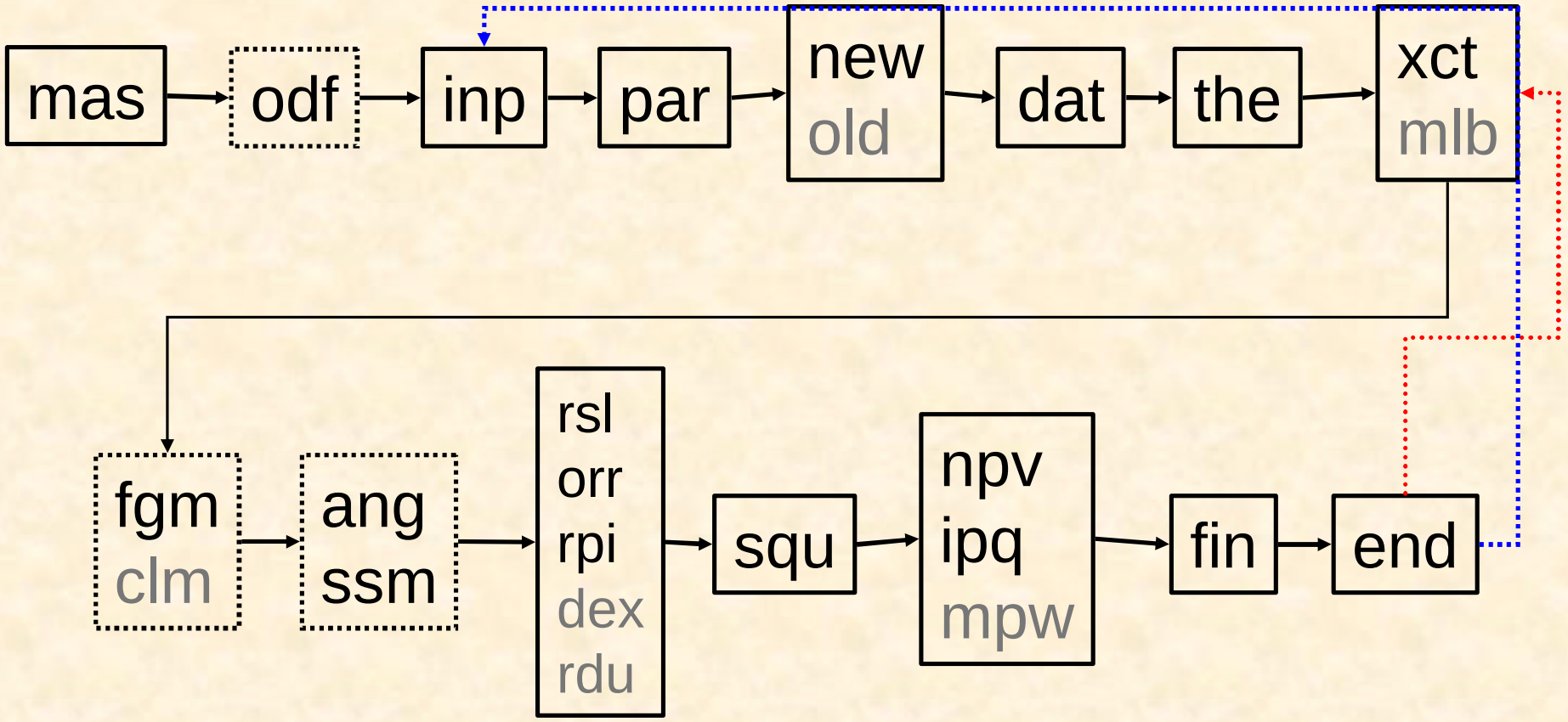
(16 February - 12 March 2004)

Dr. Nancy M. Larson
Oak Ridge National Laboratory

Part 2, details about use of the code SAMMY

OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

Flow chart for SAMMY



What appears on the screen as you run SAMMY

Warning – address on screen is not correct, use what was in the intro.

(e-mail address is still OK)

```
*********************************************************
***                                                   ***
***                                                   ***
***                      SAMMY                        ***
***                                                   ***
***                   Version M5                      ***
***                 November 2000                     ***
***                                                   ***
***                                                   ***
***                  written by                       ***
***                                                   ***
***           Dr. Nancy M. Larson                     ***
***           Oak Ridge National Laboratory           ***
***           Building 6011  5700  MS 6370  6171     ***
***           P O Box 2008                            ***
***           Oak Ridge, TN 37831-6370  USA           ***
***                                                   ***
***                                                   ***
***           Telephone      (865) 574-4659           ***
***           FAX            (865) 574-3527           ***
***                                                   ***
***           e-mail      LarsonNM@ornl.gov           ***
***                                                   ***
***           two web sites --                        ***
***       http://www.nea.fr/html/dbdata/sammy.htm     ***
***       http://www.cad.ornl.gov/~jzw/NUCDATA/       ***
***                              STAFF/nml.html       ***
***                                                   ***
***                                                   ***
*********************************************************
```

... the screen

```
*** M5-SAMMY       16 Feb 01 ***
 WHAT IS NAME OF INPUT FILE?
 >>> ex001a.inp                                          <<<
 WHAT IS NAME OF PARAMETER FILE?
 >>> ex001a.par                                          <<<
 WHAT IS FIRST DATA FILE NAME? EMIN? EMAX?
 >>> ex001a.dat                                          <<<
 WHAT IS NEW EMIN? EMAX? DATA SET NAME?

 *** M5-SAMMY-ODF    7 Nov 00 ***
 *** M5-SAMMY-INPUT  7 Nov 00 ***
 *** M5-SAMMY-PAR   15 Dec 00 ***
 *** M5-SAMMY-NEW    7 Nov 00 ***
 *** M5-SAMMY-DATA   7 Nov 00 ***  8.040     TO  11.96
 *** M5-SAMMY-THEOR  7 Nov 00 ***
 *** M5-SAMMY-XCT   21 Dec 00 ***
 *** M5-SAMMY-FGM    7 Nov 00 ***
 *** M5-SAMMY-INTRP  7 Nov 00 ***
 *** M5-SAMMY-(N+V)  7 Nov 00 ***
 *** M5-SAMMY-FINAL  5 Jan 01 ***
```

No iterations for this run

What appears on the screen, more typical case

```
*************************************************************
***                                                       ***
***          November 2000  Version M5 of SAMMY           ***
***                                                       ***
*************************************************************


*** M5-SAMMY       16 Feb 01 ***
WHAT IS NAME OF INPUT FILE?
>>> ex001b.inp                                            <<<
WHAT IS NAME OF PARAMETER FILE?
>>> ex001b.par                                            <<<
WHAT IS FIRST DATA FILE NAME? EMIN? EMAX?
>>> ex001a.dat                                            <<<
WHAT IS NEW EMIN? EMAX? DATA SET NAME?
...
```

… the screen, more typical case

```
*** M5-SAMMY-ODF     7 Nov 00 ***
*** M5-SAMMY-INPUT   7 Nov 00 ***
*** M5-SAMMY-PAR    15 Dec 00 ***
*** M5-SAMMY-NEW     7 Nov 00 ***
*** M5-SAMMY-DATA    7 Nov 00 ***  8.040     TO  11.96
*** M5-SAMMY-THEOR   7 Nov 00 ***
*** M5-SAMMY-XCT    21 Dec 00 ***
*** M5-SAMMY-FGM     7 Nov 00 ***
*** M5-SAMMY-INTRP   7 Nov 00 ***
*** M5-SAMMY-SQUAR   7 Nov 00 ***
*** M5-SAMMY-(I+Q)   7 Nov 00 ***
*** M5-SAMMY-FINAL   5 Jan 01 ***
*** M5-SAMMY-THEOR   7 Nov 00 ***
*** M5-SAMMY-XCT    21 Dec 00 ***
*** M5-SAMMY-FGM     7 Nov 00 ***
*** M5-SAMMY-INTRP   7 Nov 00 ***
*** M5-SAMMY-SQUAR   7 Nov 00 ***
*** M5-SAMMY-(I+Q)   7 Nov 00 ***
*** M5-SAMMY-FINAL   5 Jan 01 ***
...
```

... the screen, more typical case.

```
...
*** M5-SAMMY-INPUT   7 Nov 00 ***
*** M5-SAMMY-PAR    15 Dec 00 ***
*** M5-SAMMY-OLD     7 Nov 00 ***
Number of non-zero off-diagonal cov matrix elements is       1
*** M5-SAMMY-DATA    7 Nov 00 ***  8.040     TO  11.96
*** M5-SAMMY-THEOR   7 Nov 00 ***
*** M5-SAMMY-XCT    21 Dec 00 ***
*** M5-SAMMY-FGM     7 Nov 00 ***
*** M5-SAMMY-INTRP   7 Nov 00 ***
*** M5-SAMMY-(N+V)   7 Nov 00 ***
*** M5-SAMMY-FINAL   5 Jan 01 ***
```

Iterating to find best-fit values of the resonance parameters

Input to SAMMY

Three kinds of files are needed for (almost) every SAMMY run:

1. INPut file
- **control information**
- **quantum numbers**

2. PARameter file
- **resonance parameter values**
- **values for all variable parameters**
- **a priori uncertainties**

3. DATa file
- **energy**
- **measured value for cross section**
- **uncertainty**

We will discuss all of these in greater detail later.

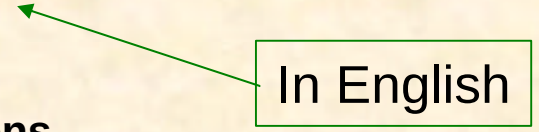
Input to SAMMY, cont.

Other files are needed for some runs:

4.	**COVariance**	**par covariance mtrx from previous run**
5.	**DCV (data cov)**	**experimental covariance matrix**
6.	**AVG (average)**	**energy ranges for averaging**
7.	**NDF**	**to produce output ENDF/B-6 files**
8.	**MXW**	**temperatures for Maxwellian averages**
9.	**SSM**	**edge-effects corrections from earlier run**
10.	**NTG**	**experimental values for integral quantities**

The INPut File

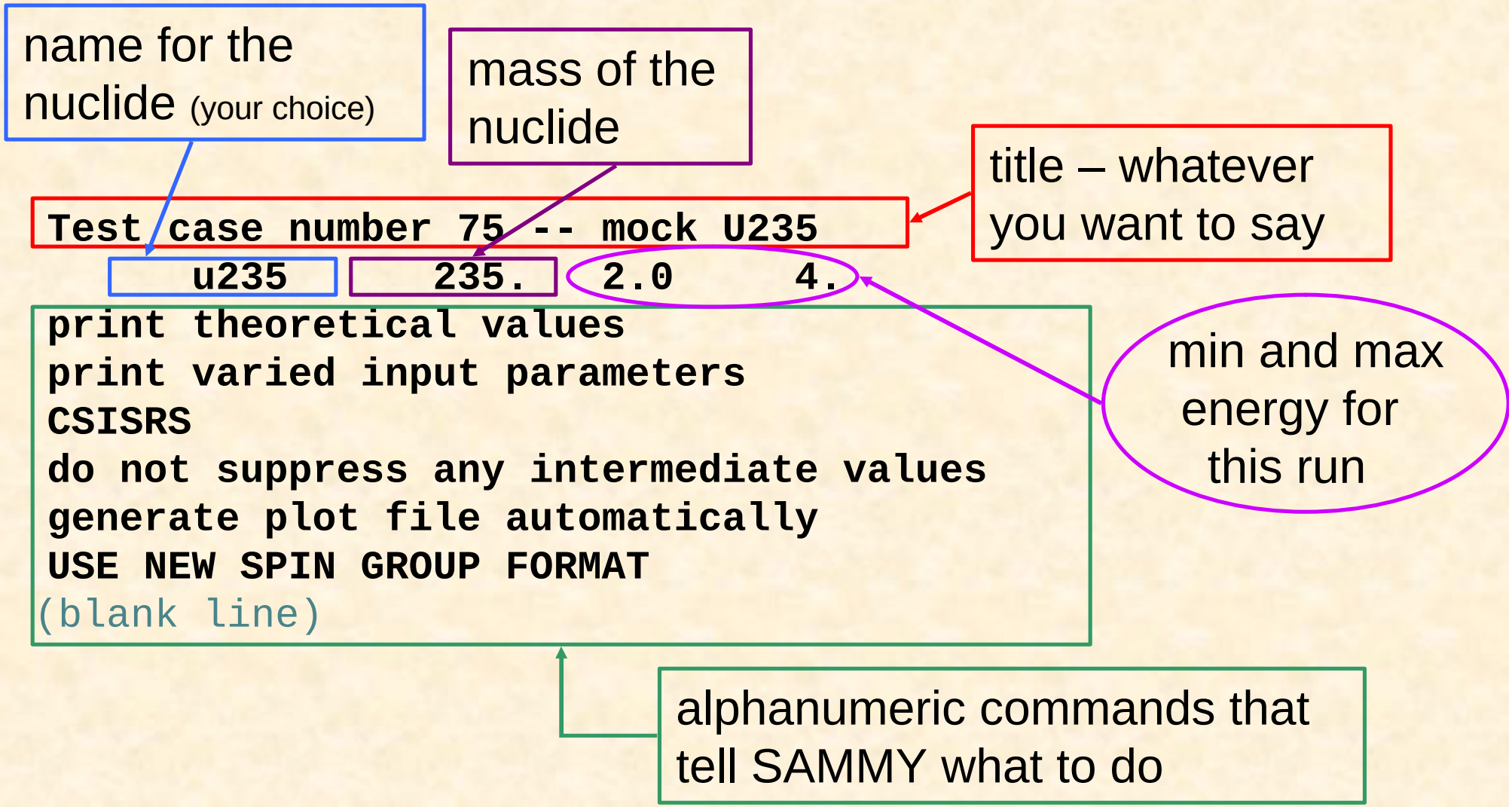
- Title
- Miscellaneous information: atomic weight, Emin and Emax, density for auxiliary grid
- Alphanumeric control information
  - input / output specifics
  - solve / do not solve Bayes' equations
  - which type of R-matrix to use
  - which Doppler broadening
  - which resolution function
  - do not / do produce group averages
- Doppler- and resolution-broadening parameters
- Data type
- Quantum numbers for the sample nuclides and for the resonances
- Size information for multiple-scattering corrections
- Angles for detectors if angular distribution



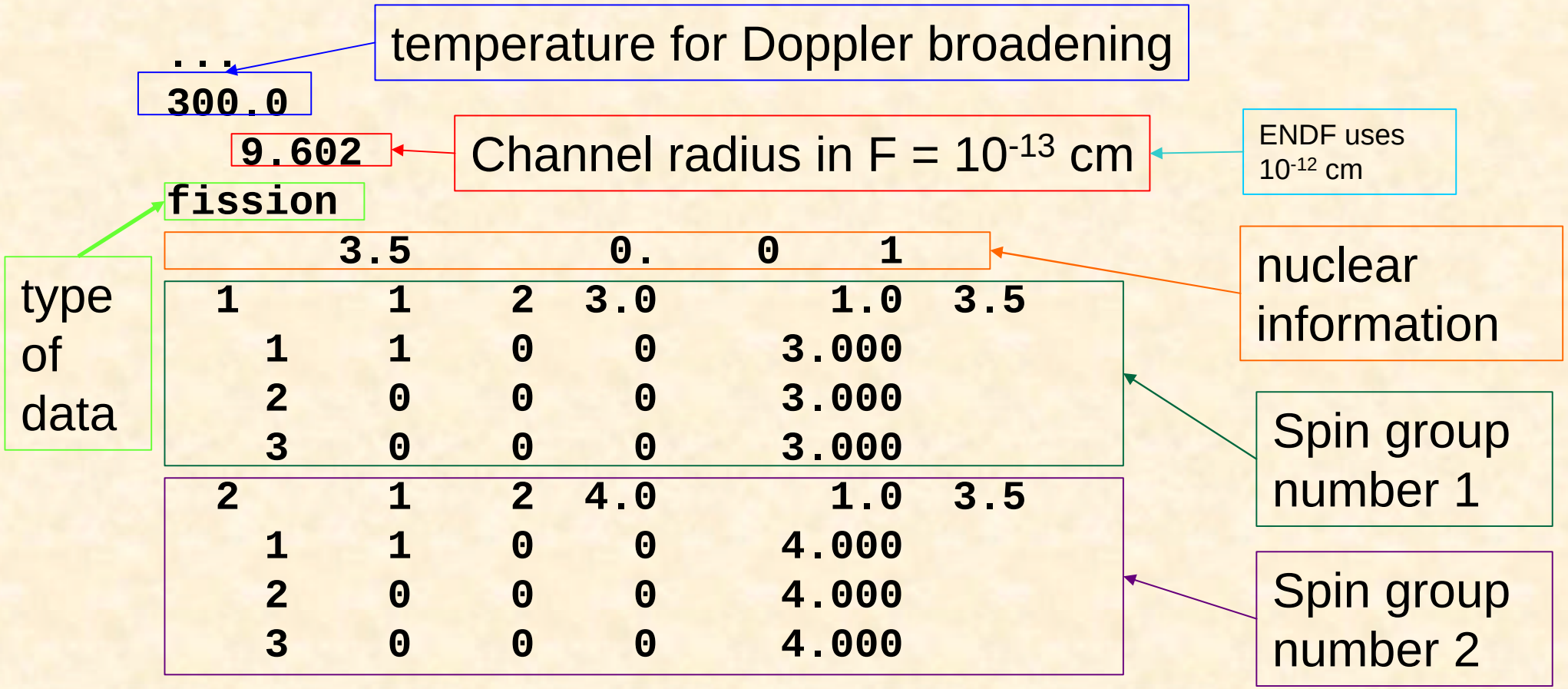
Example of INPut file

```
Test case number 75 -- mock U235
      u235      235.   2.0     4.
print theoretical values
print varied input parameters
CSISRS
do not suppress any intermediate values
generate plot file automatically
USE NEW SPIN GROUP FORMAT

   300.0
   9.602
fission
       3.5          0.    0    1
  1      1    2  3.0        1.0  3.5
    1    1    0    0      3.000
    2    0    0    0      3.000
    3    0    0    0      3.000
  2      1    2  4.0        1.0  3.5
    1    1    0    0      4.000
    2    0    0    0      4.000
    3    0    0    0      4.000
```

Example of INPut file, in more detail



INPut file detail, continued



The PARameter File

- **Values for resonance parameters:**
  - **resonance energy**
  - **capture width, neutron width(s), other widths: inelastic, fission, ...**
- **Values for other parameters:**
  - **effective temperature**
  - **resolution parameters**
  - **normalization & backgrounds**
  - **channel radii**
  - **nuclide abundances**
  - **etc.**
- **A priori uncertainties on all parameter values**
- **Flags to indicate which parameter values are to be varied and which held fixed**

Example of PARameter file (^{235}U)

(entire listing requires ~3000 lines)

Spin group number

Energy in eV	$G_?$ in meV	G_n in meV	G_{f1} in meV	G_{f2} in meV	flags	
-2.0383E+03	3.3792E+01	1.9703E+01	-4.6652E+01	-1.0088E+02	0 0 0 0 0	1
-1.8121E+03	3.7445E+01	8.5740E-01	7.3617E+02	-7.4187E+02	0 0 0 0 0	1
-1.5862E+03	3.4439E+01	8.2845E+00	1.5365E+02	-9.9186E+01	0 0 0 0 0	1
-1.3575E+03	3.8506E+01	5.0787E+01	-1.6914E+02	-3.8622E+02	0 0 0 0 0	1
-1.1321E+03	3.9794E+01	1.7144E+03	4.7701E+02	-4.6937E+02	0 0 0 0 0	2
...						
.3018678427	4.0705E+01	4.8608E-03	1.2139E+02	1.9661E-01	1 1 1 1 1	1
1.132577300	3.1770E+01	1.4131E-02	9.8006E-02	1.2898E+02	1 1 1 1 1	2
1.308605790	4.5120E+01	1.9938E-04	-1.8055E-01	1.8730E+01	1 1 1 1 1	2
2.037662983	3.8027E+01	9.2671E-03	-9.8491E+00	9.3994E-01	1 1 1 1 1	1
...						

Example # 2 of PARameter file

(trivial case, one resonance)

```
 3.000000000 5.0000E+01 3.0000E-02-4.0000E+01 6.5000E+01 1 1 1 1 1 1
 (blank line)
 0.50
```

Resonance parameters
plus flags & spin group number

Blank line
Indicates end of resonances

“fudge” factor
used to determine default uncertainties on resonance parameters

Note: default value for fudge = 0.10

Example # 3 of PARameter file
(two resonances, no fission channels, lots of other information)

```
-1.0400E+02 1.2000E+02 3.3200E+02                    0 0 0     1
  1617.0000 8.0000E+01 2.8087E+02                    1 1 0     1

 0.99
RADIUS PARAMETERS FOLLOW
   5.14000   5.14000 0 0 1 2 3

ISOTOPIC MASSES AND ABUNDANCES FOLLOW
133.904495 0.8420600 0.0000500 0 1 2 3

BROADENING PARAMETERS FOLLOW
  5.140000   300.000  0.001135  0.020000  0.020000  0.000000 0 0-2 0 0 0

ORRESolution function parameters follow
BURST 0         7.000     1.000
WATER 0004      3.614    -0.089     0.037
WATER 0004      0.050     0.002     0.001
LITHI 000       1.000     0.692     1.000
LITHI           0.100     0.000     0.100
CHANN 0         7.482  4096.000     0.100
CHANN 0        14.611  1024.000     0.100
CHANN 0        27.949   512.000     0.100
CHANN 0        58.712   256.000     0.100
CHANN 0       116.675   128.000     0.100
CHANN 0       224.719    64.000     0.100
CHANN 0       415.621    32.000     0.100
CHANN 0      1089.655    16.000     0.100
CHANN 0      3672.072     8.000     0.100
CHANN 0      6540.650     6.000     0.100
CHANN 0     21321.801     4.000     0.100
CHANN 0     59782.000     2.000     0.100

NORMAlization and "constant" background follow
 1.0000000 4.695E-03 0.385     0.000E+00 0.000E+00 0.000E+00 0 0 0 0 0 0
```

Here's the whole thing, maybe too small to read.
Next pages: look at the pieces.

Example # 3 continued (part a)

No fission channels (only capture and neutron channels)

```
-1.0400E+02 1.2000E+02 3.3200E+02                    0 0 0      1
  1617.0000 8.0000E+01 2.8087E+02                    1 1 0      1
(blank line)
0.99
RADIUS PARAMETERS FOLLOW
   5.14000   5.14000 0 0 1 2 3
(blank line)
ISOTOPIC MASSES AND ABUNDANCES FOLLOW
133.904495 0.8420600 0.0000500 0 1 2 3
(blank line)
BROADENING PARAMETERS FOLLOW
  5.140000   300.000  0.001135  0.020000  0.020000  0.000000 0 0-2 0 0 0
(blank line)
```

Fudge factor

Channel radius information

Masses and abundances for each nuclide in the sample

Doppler and resolution parameters

Blank lines are used to end each Card Set

Example # 3 continued (part b)

```
ORRESolution function parameters follow
BURST 0          7.000      1.000
WATER 0004       3.614     -0.089      0.037
WATER 0004       0.050      0.002      0.001
LITHI 000        1.000      0.692      1.000
LITHI            0.100      0.000      0.100
CHANN 0          7.482   4096.000      0.100
CHANN 0         14.611   1024.000      0.100
CHANN 0         27.949    512.000      0.100
CHANN 0         58.712    256.000      0.100
CHANN 0        116.675    128.000      0.100
CHANN 0        224.719     64.000      0.100
CHANN 0        415.621     32.000      0.100
CHANN 0       1089.655     16.000      0.100
CHANN 0       3672.072      8.000      0.100
CHANN 0       6540.650      6.000      0.100
CHANN 0      21321.801      4.000      0.100
CHANN 0      59782.000      2.000      0.100
(blank line)
NORMAlization and "constant" background follow
 1.0000000 4.695E-03 0.385      0.000E+00 0.000E+00 0.000E+00 0 0 0 0 0 0
(blank line)
```

Oak Ridge Resolution function

normalization

constant background

energy-dependent background

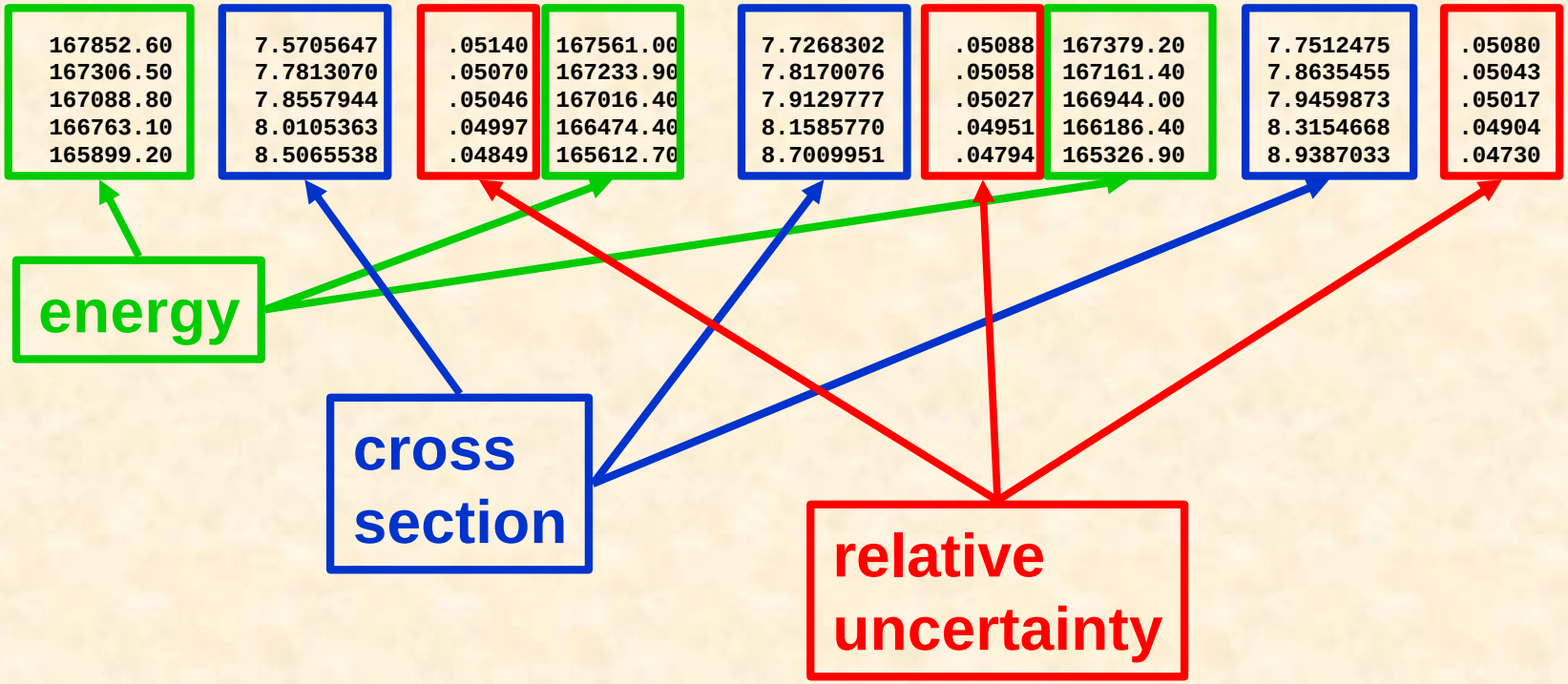
The DATa File

- **Energy**
- **Measured value of cross section (or transmission, or eta, or yield, or ...) at that energy**
- **Uncertainty on the measured value**

Format Options for DATa files

- **CSISRS or EXFOR, one data point per line, uncertainties are absolute, 3E11.8**
- **TWENTY significant digits**
- **PENDF files**
- **MULTI-style (the original version), three data points per line, uncertainties are relative, 3(2E14.8,F7.5)**
- **Binary ODF format (ORELA Data Format) -- not recommended**

Examples of DATa files –
Multi-style DATa file (relative uncertainties)



Examples of DATa files, continued –
CSISRS DATa file (absolute uncertainties)

95661.445	0.3759465	.037595
95664.094	0.6009411	.060094
95666.750	0.9116803	.091168
95669.398	1.2838910	.128389
95672.047	1.6690609	.166906
95674.695	2.0074561	.200746
95676.023	2.1419671	.214197
95677.344	2.2495730	.224957
95678.008	2.2913780	.229138
95678.672	2.3249400	.232494
95679.336	2.3505211	.235052
...		

energy

cross section

absolute uncertainty

END of "SAMMY Input Files"

- **Note: this was only an introduction; a *lot* of information has been omitted here.**
- **There are many other input options.**
- **For complete details, see the SAMMY users' guide.**

Next: "Output files from SAMMY"

Output files from SAMMY

File produced by every SAMMY run:

1. **SAMMY.LPT** — **to be (printed and) examined by the user!!**

Files we will use in this workshop

Other output files produced by SAMMY:

2. **SAMMY.IO** — **Input/Output parameter values**
3. **SAMMY.PAR** — **New values of resonance parameters and other varied parameters**
4. **SAMMY.COV** — **Binary file with covariance matrix for varied parameters**
5. **SAMMY.ODF** — **Binary file to be used for plotting**

5a. **SAMMY.PLT** — **Another version of the plot file**

6. **SAMMY.NDF** — **Resonance parameters in ENDF/B-6 format**
7. **SAMMY.PDS** — **Partial derivatives in ascii format**
8. **SAMNDF.INP** — **SAMMY-style INPut file, produced when ENDF/B File 2 was used instead of SAMMY-style PARameter file**
9. **SAMNDF.PAR** — **SAMMY-style PARameter file, produced when ENDF/B File2 was used for input**
10. **SAMXAC.ODF** — **Binary file with auxiliary grid and unbroadened cross section**
11. **SAMMY.SSM** — **Binary file with edge-effects corrections for single-scattering correction for capture yields**
12. **SAM??.DAT** — **Temporary files for communication between segments**

To be deleted after the run concludes properly

SAMMY.LPT

- Values for varied and fixed parameters (what you actually told SAMMY to use, not what you *intended* to tell SAMMY to use!)
- Verbatim alphanumeric commands (with notification if a command is unacceptable)
- Input file names; title for run (from INPut file)
- Chronological listing of modules used

for the INPut, PARameter, and DATa files (& others)

- Updated parameter values, uncertainties, and correlations (also intermediate values if requested)
- $?^2$ values

Not $?^2$/(degrees of freedom) but $?^2$/(number of data points)

- Error messages (which are often repeated on-screen or in log file)

Sample "LPT" file

version of SAMMY

Not today's date, but date at which this version was created

Names of input files

```
*** M5-SAMMY        16 Feb 01 ***
Name of user's input file:
>>> t075a.inp <<<
Name of user's parameter file:
>>> t075a.par <<<
Values used for constants -- kvendf=1
  mass of neutron =   1.008664904000000 in amu
  sqrt(m/2)       =  72.298263153907186
  sqrt(2m)/hbar   =   0.002196807121290
  sqrt(Boltzman)  =   0.009282987126997
  finestructure   =   0.034447597682295 in 1/(amu*F)
 Name of user's experimental data file is:
>>> t075a.dat <<<

********** READY TO RUN SAMODF *********

********** READY TO RUN SAMMY VERSION M5 **********
```

Sample “LPT” file, continued

```
### Estimated array size for SAMMY-INP is      177 ###


**************************************************************************
*****                                                                *****
***** Test case number 75 -- mock U235                               *****
*****                                                                *****
**************************************************************************


Input quantities from card number 2 are:
  alfnm1, alfnm2 = ##      u235##       Atomic Weight =   235.0
  energy range =       2.000           4.000
  nepnts itmax  icorr  nxtra  iptdop iptwid ixxchn
       0      0      0      0      0      0      0
  ndigit idropp matnum kkkkza
       2      2      0      0
Adjusted - itmax,icorr,nxtra,iptdop,iptwid     =      2 50  0  9  5


TARGET ELEMENT IS       u235
ATOMIC WEIGHT IS  235.000
```

Title from INPut file

Sample “LPT” file, continued

```
********** Alphanumeric Control Information *********

 PRINT THEORETICAL VALUES
 PRINT VARIED INPUT PARAMETERS
 CSISRS
 do not suppress any intermediate values
 USE NEW SPIN GROUP FORMAT
 ODF FILE IS WANTED--SAMMY.ODF ,ZERO-TH O
 PRINT BAYES CHI SQUARED
 SOLVE BAYES EQUATIONS
 CHI SQUARED IS WANTED

**** end of Alphanumeric Control Information *********
```

Error message would appear in here if you misspell a command

Find the best-fit parameter values.

Some of these are yours, some were added by SAMMY.

Sample “LPT” file, continued

```
 EFFECTIVE TEMPERATURE= 300.00000
   FLIGHT PATH=   0.00000 METERS +/-   0.00000/2 METERS
     DELTAE=     0.00000    DELTAG=     0.00000
     delttt=     0.00000    ELOWBR=  0.00000000

CHANNEL RADIUS=   9.602
TARGET THICKNESS=  0.0000E+00
```

broadening parameters

fission

type of data, as given in the INPut file

Sample “LPT” file, continued

```
  Spin of incident particle is  0.5
      #of  #of
group ent  exit Jspin relative  Ispin  g    chn LPNT iSHift el CHSPN  in
   #  chn  chn         abndnc                 #                      data?
   1    1    2    3.0  1.0000    3.5 0.4375
                                                1   1    0     0   3.0
                                                2   0    0     0   3.0
                                                3   0    0     0   3.0
   2    1    2    4.0  1.0000    3.5 0.5625
                                                1   1    0     0   4.0
                                                2   0    0     0   4.0
                                                3   0    0     0   4.0

### Array size used for SAMMY-INP is       178 ###
```

Spin group information from INPut file

Sample “LPT” file, continued

```
### Estimated array size for SAMMY-PAR is      252 ###

Total  number of resonances is    1
Number of particle channels is    3
Number of varied parameters is    5
Number of spin groups is          2
### Array size used for SAMMY-PAR is      250 ###
### Estimated array size for SAMMY-NEW is      269 ###
```

A few details you may find useful when debugging your runs

Sample "LPT" file, continued

Resonance parameters, ordered by spin groups

```
*****INITIAL VALUES FOR PARAMETERS

SPIN GROUP NUMBER 1  WITH SPIN= 3.0, ABUNDANCE= 1.0000, AND G=0.4375
                  "true" radius =  9.6020E+00       9.6020E+00       9.6020E+00
               effective radius =  9.6020E+00       9.6020E+00       9.6020E+00
     ENERGY          GAMMA-           GAMMA-           GAMMA-           GAMMA-
                     GAMMA           CHANNEL 1        CHANNEL 2        CHANNEL 3
                                    L=0  SPIN= 3.0   L=0  SPIN= 3.0   L=0  SPIN= 3.0
      (eV)         (MILLI-EV)       (MILLI-EV)       (MILLI-EV)       (MILLI-EV)
 3.00000E+00(  1) 5.0000E+01(  2) 3.0000E-02(  3) -4.0000E+01(  4) 6.5000E+01(  5)
```

Numbers in parenthesis are "varied parameter number"

If you are having problems with a run, compare these values to the values you intended to use. There may be differences!

Sample "LPT" file, continued

```
 RADIUS          TEMPERATURE     THICKNESS
 9.6020E+00       3.0000E+02       0.0000E+00

   DELTA-L         DELTA-T-GAUS     DELTA-T-EXP
 0.0000E+00       0.0000E+00       0.0000E+00



***** CORRELATION MATRIX FOR INPUT PARAMETERS


***** STANDARD DEVIATION (SQRT OF DIAGONAL OF COV MATRX)

          STD. DEV.              STD. DEV.              STD. DEV.              STD. DEV.
(   1)   8.6638E-02   (   2)    25.00        (   3)   1.5000E-02   (   4)    20.00
(   5)    32.50
### Array size used for SAMMY-NEW is       269 ###
```

varied parameter numbers

uncertainties on the varied parameters

Sample “LPT” file, continued

```
     Emind                Emins                Eminr                Emin
        1.8536592399         2.0000000000         2.0000000000         2.0000000000
     Emax                 Emaxr                Emaxs                Emaxd
        4.0000000000         4.0000000000         4.0000000000         4.2136676614

Doppler Width at Emin =  2.926815E-02 and at Emax =  4.273353E-02

      E(keV)    Dopp_FWHM(keV)  Gauss_FWHM(keV)  Total_FWHM(keV)
      0.002000          0.0000          0.0000          0.0000
      0.003000          0.0001          0.0000          0.0001
      0.004000          0.0001          0.0000          0.0001
```

Sample “LPT” file, continued

```
### Estimated array size for SAMMY-DAT is 41666734 ###

Energy range of data is from 2.00000E+00 to 4.00000E+00 eV.
Number of experimental data points =      41
Number of points in auxiliary grid =      49

### Array size used for SAMMY-DAT is 49999972 ###
### Array size used for SAMMY-DAT is      324 ###
### Estimated array size for SAMMY-THE is      464 ###
Number of parameters affected by this data set=    5
### Array size used for SAMMY-THE is      464 ###
### Estimated array size for SAMMY-XCT is     1358 ###
### Array size used for SAMMY-XCT is     1329 ###
### Estimated array size for SAMMY-FGM is     1094 ###
### Array size used for SAMMY-FGM is     1094 ###
### Estimated array size for SAMMY-INT is      679 ###
```

Sample “LPT” file, continued

```
***** THEORETICAL VALUES (broadnd,normed,...as required)

     ENERGY    THEORY          ENERGY    THEORY          ENERGY    THEORY
(  1)2.000000 0.367704    ( 15)2.940000  32.3681    ( 29)3.136610  12.6401
(  2)2.100000 0.442535    ( 16)2.960000  38.9885    ( 30)3.154915  10.3105
(  3)2.200000 0.546350    ( 17)2.980000  44.0630    ( 31)3.173219  8.52119
(  4)2.300000 0.696259    ( 18)3.000000  45.8657    ( 32)3.200000  6.59250
(  5)2.400000 0.924150    ( 19)3.015000  44.5803    ( 33)3.250000  4.34505
(  6)2.500000  1.29477    ( 20)3.025908  42.3619    ( 34)3.300000  3.05564
(  7)2.600000  1.95425    ( 21)3.030000  41.3055    ( 35)3.400000  1.72165
(  8)2.700000  3.33407    ( 22)3.034092  40.1510    ( 36)3.500000  1.09644
(  9)2.800000  7.03688    ( 23)3.040796  38.0915    ( 37)3.600000 0.755665
( 10)2.843390  10.6577    ( 24)3.047500  35.8868    ( 38)3.700000 0.549590
( 11)2.865085  13.4732    ( 25)3.065000  29.9244    ( 39)3.800000 0.416114
( 12)2.886780  17.3261    ( 26)3.082500  24.3524    ( 40)3.900000 0.325007
( 13)2.900000  20.3112    ( 27)3.100000  19.6277    ( 41)4.000000 0.260205
( 14)2.920000  25.8412    ( 28)3.118305  15.6837
```

Theoretical values are not usually printed in the LPT file; instead, they’re in the plot file.

Sample "LPT" file, continued

```
### Array size used for SAMMY-INT is      434 ###

### Estimated array size for SAMMY-SQU is      425 ###
### Array size used for SAMMY-SQU is      425 ###

USE (I+Q) INVERSION SCHEME
### Estimated array size for SAMMY-IPQ is      943 ###

CUSTOMARY CHI SQUARED =  1.296590E+06
CUSTOMARY CHI SQUARED DIVIDED BY NDAT =   31624.2

BAYESIAN CHI SQUARED =    4749.55
BAYESIAN CHI SQUARED DIVIDED BY NDAT =   115.843
### Array size used for SAMMY-IPQ is      943 ###
### Estimated array size for SAMMY-FIN is      440 ###
```

Remember this value (initial chi-squared)

Two types of chi-squared values…
we'll talk about these later if there is time.

Sample “LPT” file, continued

```
*****INTERMEDIATE VALUES FOR RESONANCE PARAMETERS

SPIN GROUP NUMBER 1  WITH SPIN= 3.0, ABUNDANCE= 1.0000, AND G=0.4375
                  "true" radius =  9.6020E+00       9.6020E+00       9.6020E+00
               effective radius =  9.6020E+00       9.6020E+00       9.6020E+00
     ENERGY          GAMMA-           GAMMA-           GAMMA-           GAMMA-
                     GAMMA           CHANNEL 1        CHANNEL 2        CHANNEL 3
                                    L=0  SPIN= 3.0   L=0  SPIN= 3.0   L=0  SPIN= 3.0
      (eV)         (MILLI-EV)       (MILLI-EV)       (MILLI-EV)       (MILLI-EV)
 3.02107E+00(  1) 5.5578E+01(  2)  2.2791E-02(  3) -3.9517E+01(  4)  6.3728E+01(  5)


   RADIUS           TEMPERATURE     THICKNESS
 9.6020E+00        3.0000E+02      0.0000E+00

   DELTA-L          DELTA-T-GAUS     DELTA-T-EXP
 0.0000E+00        0.0000E+00      0.0000E+00
```

Intermediate values

Sample “LPT” file, continued

```
### Array size used for SAMMY-FIN is      445 ###
### Estimated array size for SAMMY-THE is      464 ###
Number of parameters affected by this data set=    5
### Array size used for SAMMY-THE is      464 ###
### Estimated array size for SAMMY-XCT is     1358 ###
### Array size used for SAMMY-XCT is     1329 ###
### Estimated array size for SAMMY-FGM is     1094 ###
### Array size used for SAMMY-FGM is     1094 ###
### Estimated array size for SAMMY-INT is      679 ###
```

Sample “LPT” file, continued

***** THEORETICAL VALUES (broadnd,normed,...as required)

	ENERGY	THEORY		ENERGY	THEORY		ENERGY	THEORY
(| 1)	2.000000	0.262519	(15)	2.940000	18.4256	(29)	3.136610	11.8228
(| 2)	2.100000	0.314503	(16)	2.960000	22.9620	(30)	3.154915	9.54736
(| 3)	2.200000	0.386085	(17)	2.980000	27.5661	(31)	3.173219	7.79505
(| 4)	2.300000	0.488475	(18)	3.000000	31.1416	(32)	3.200000	5.92141
(| 5)	2.400000	0.642228	(19)	3.015000	32.4279	(33)	3.250000	3.78740
(| 6)	2.500000	0.888238	(20)	3.025908	32.3987	(34)	3.300000	2.60249
(| 7)	2.600000	1.31655	(21)	3.030000	32.1732	(35)	3.400000	1.41997
(| 8)	2.700000	2.17973	(22)	3.034092	31.8352	(36)	3.500000	0.886689
(| 9)	2.800000	4.34586	(23)	3.040796	31.0542	(37)	3.600000	0.603070
(| 10)	2.843390	6.35034	(24)	3.047500	30.0218	(38)	3.700000	0.434372
(| 11)	2.865085	7.86784	(25)	3.065000	26.4669	(39)	3.800000	0.326462
(| 12)	2.886780	9.92303	(26)	3.082500	22.3465	(40)	3.900000	0.253515
(| 13)	2.900000	11.5217	(27)	3.100000	18.3556	(41)	4.000000	0.202028
(| 14)	2.920000	14.5626	(28)	3.118305	14.7406			

generated from intermediate value of resonance parameters

Sample “LPT” file, continued

```
### Array size used for SAMMY-INT is      392 ###


USE (I+Q) INVERSION SCHEME
### Estimated array size for SAMMY-IPQ is      943 ###

CUSTOMARY CHI SQUARED =   45556.9
CUSTOMARY CHI SQUARED DIVIDED BY NDAT =   1111.14

BAYESIAN CHI SQUARED =    133.555    =    986763.    -    986629.
BAYESIAN CHI SQUARED DIVIDED BY NDAT =   3.25743
### Array size used for SAMMY-IPQ is      943 ###
### Estimated array size for SAMMY-FIN is      440 ###
```

Intermediate value for chi-squared

evaluated at the intermediate parameter values

Sample "LPT" file, continued

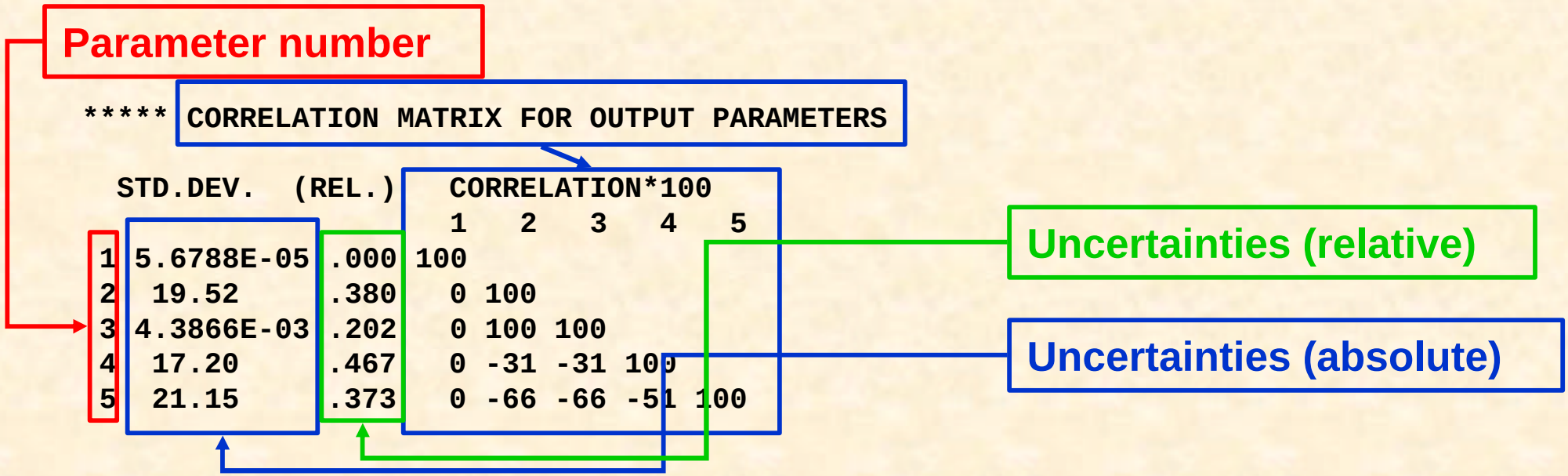
Final (best-fit) values for resonance parameters

values for resonance parameters

```
*****  NEW VALUES FOR RESONANCE PARAMETERS

SPIN GROUP NUMBER 1  WITH SPIN= 3.0, ABUNDANCE= 1.0000, AND G=0.4375
                  "true" radius =  9.6020E+00       9.6020E+00       9.6020E+00
               effective radius =  9.6020E+00       9.6020E+00       9.6020E+00
     ENERGY          GAMMA-           GAMMA-           GAMMA-           GAMMA-
                     GAMMA          CHANNEL 1        CHANNEL 2        CHANNEL 3
                                   L=0  SPIN= 3.0   L=0  SPIN= 3.0   L=0  SPIN= 3.0
      (eV)         (MILLI-EV)       (MILLI-EV)       (MILLI-EV)       (MILLI-EV)
 3.03039E+00(  1) 5.1328E+01(  2) 2.1761E-02(  3) -3.6829E+01(  4) 5.6764E+01(  5)
Expected          5.1328E+01       2.1761E-02       3.6829E+01       5.6764E+01
 Value       +/-  1.9524E+01  +/-  4.3866E-03  +/-  1.7202E+01  +/-  2.1153E+01
EV changed        0.0000E+00       0.0000E+00       0.0000E+00       0.0000E+00
parameters   +/-  0.0000E+00  +/-  0.0000E+00  +/-  0.0000E+00  +/-  0.0000E+00

RADIUS          TEMPERATURE     THICKNESS
 9.6020E+00       3.0000E+02       0.0000E+00

   DELTA-L         DELTA-T-GAUS     DELTA-T-EXP
 0.0000E+00       0.0000E+00       0.0000E
```

Average values

Sample "LPT" file, continued




```
***** RATIO OF UNCERTAINTIES ON VARIED PARAMETERS
        NEW/OLD                NEW/OLD                NEW/OLD                NEW/OLD
(   1)  6.5546E-04    (   2)  0.7809        (   3)  0.2924        (   4)  0.8601
(   5)  0.6509


***** RATIO OF UNCERTAINTIES ON VARIED U-PARAMETERS
        NEW/OLD                NEW/OLD                NEW/OLD                NEW/OLD
(   1)  6.5217E-04    (   2)  0.7708        (   3)  0.3425        (   4)  0.8964
(   5)  0.6965

 ### Array size used for SAMMY-FIN is      494 ###
```

Sample “LPT” file, continued

```
********** READY TO RUN SAMMY VERSION M5 **********


Name of binary parameter covariance file is:
>>> SAMMY.COV                                                    <<<
### Estimated array size for SAMMY-INP is      177 ###


*****************************************************************************
*****                                                                   *****
***** Test case number 75 -- mock U235                                  *****
*****                                                                   *****
*****************************************************************************


Input quantities from card number 2 are:
  alfnm1, alfnm2 = ##      u235##       Atomic Weight =   235.0
  energy range =       2.000           4.000
  nepnts itmax  icorr  nxtra  iptdop iptwid ixxchn
       0      0      0      0      0      0      0
  ndigit idropp matnum kkkkza
       2      2      0      0
Adjusted - itmax,icorr,nxtra,iptdop,iptwid     =      2 50  0  9  5
```

Sample “LPT” file, continued

```
TARGET ELEMENT IS       u235
ATOMIC WEIGHT IS  235.000


********** Alphanumeric Control Information *********

PRINT THEORETICAL VALUES
DO NOT PRINT ANY INPUT PARAMETERS
CSISRS
do not suppress any intermediate values
USE NEW SPIN GROUP FORMAT
ODF FILE IS WANTED--SAMMY.ODF ,FINAL VAL
DO NOT PRINT BAYES CHI SQUARED
DO NOT SOLVE BAYES EQUATIONS
PRINT LS CHI SQUARED

**** end of Alphanumeric Control Information *********
```

This time through, calculate cross sections and determine chi-squared. Do not do any fitting.

Sample “LPT” file, continued

```
EFFECTIVE TEMPERATURE= 300.00000
   FLIGHT PATH=   0.00000 METERS +/-   0.00000/2 METERS
     DELTAE=     0.00000    DELTAG=     0.00000
     delttt=     0.00000    ELOWBR=  0.00000000

CHANNEL RADIUS=   9.602
TARGET THICKNESS=  0.0000E+00

fission


Spin of incident particle is  0.5

### Array size used for SAMMY-INP is      178 ###
### Estimated array size for SAMMY-PAR is      252 ###

Total  number of resonances is    1
Number of particle channels is    3
Number of flagged parametrs is    5
Number of spin groups is          2
### Array size used for SAMMY-PAR is      250 ###
### Estimated array size for SAMMY-OLD is      264 ###
Number of non-zero off-diagonal cov matrix elements is      10
```

Sample “LPT” file, continued

```
Broadening (etc.) parameters actually used for this run

            Radius (CRFN) =   9.60200       9.60200      CYCRFN =  2.100359E-03
    Effective Temperature =   300.000       300.000          DO =  1.053387E-02
         Sample Thickness =  0.000000E+00  0.000000E+00
FLIGHT PATH LENGTH (DIST) =  0.000000E+00
                   DELTAL =  0.000000E+00  0.000000E+00     BO2 =  0.000000E+00
                   DELTAG =  0.000000E+00  0.000000E+00     AO2 =  0.000000E+00
                   DELTAE =  0.000000E+00  0.000000E+00     CO2 =  0.000000E+00
                                                            DO2 =  0.000000E+00
### Array size used for SAMMY-OLD is      265 ###
    Emind                Emins                Eminr                Emin
       1.8536592399         2.0000000000         2.0000000000         2.0000000000
    Emax                 Emaxr                Emaxs                Emaxd
       4.0000000000         4.0000000000         4.0000000000         4.2136676614

Doppler Width at Emin =  2.926815E-02 and at Emax =  4.273353E-02

     E(keV)    Dopp_FWHM(keV)  Gauss_FWHM(keV)  Total_FWHM(keV)
     0.002000         0.0000          0.0000          0.0000
     0.003000         0.0001          0.0000          0.0001
     0.004000         0.0001          0.0000          0.0001

### Estimated array size for SAMMY-DAT is 41666734 ###
```

Sample “LPT” file, continued

```
Energy range of data is from 2.00000E+00 to 4.00000E+00 eV.
Number of experimental data points =      41

Number of points in auxiliary grid =      49
### Array size used for SAMMY-DAT is 49999972 ###
### Array size used for SAMMY-DAT is      324 ###
### Estimated array size for SAMMY-THE is      412 ###
### Array size used for SAMMY-THE is      412 ###
### Estimated array size for SAMMY-XCT is      935 ###
### Array size used for SAMMY-XCT is      902 ###
### Estimated array size for SAMMY-FGM is      586 ###
### Array size used for SAMMY-FGM is      586 ###
### Estimated array size for SAMMY-INT is      459 ###


***** THEORETICAL VALUES (broadnd,normed,...as required)

     ENERGY    THEORY          ENERGY    THEORY          ENERGY    THEORY
(  1)2.000000 0.223027    ( 15)2.940000  15.5835    ( 29)3.136610  12.2798
(  2)2.100000 0.266735    ( 16)2.960000  20.0658    ( 30)3.154915  9.72828
(  3)2.200000 0.326766    ( 17)2.980000  25.1774    ( 31)3.173219  7.80564
(  4)2.300000 0.412358    ( 18)3.000000  29.9294    ( 32)3.200000  5.80325
(  5)2.400000 0.540378    ( 19)3.015000  32.3720    ( 33)3.250000  3.60614
(  6)2.500000 0.744189    ( 20)3.025908  33.1636    ( 34)3.300000  2.43173
```

Sample "LPT" file, continued

```
(  7)2.600000  1.09674    ( 21)3.030000  33.2151    ( 35)3.400000  1.29678
(  8)2.700000  1.80072    ( 22)3.034092  33.1294    ( 36)3.500000 0.799861
(  9)2.800000  3.55077    ( 23)3.040796  32.6976    ( 37)3.600000 0.539828
( 10)2.843390  5.16933    ( 24)3.047500  31.9248    ( 38)3.700000 0.386703
( 11)2.865085  6.40329    ( 25)3.065000  28.6110    ( 39)3.800000 0.289469
( 12)2.886780  8.09630    ( 26)3.082500  24.2313    ( 40)3.900000 0.224098
( 13)2.900000  9.43693    ( 27)3.100000  19.7458    ( 41)4.000000 0.178153
( 14)2.920000  12.0632    ( 28)3.118305  15.6069
### Array size used for SAMMY-INT is      418 ###

### Estimated array size for SAMMY-NPV is      473 ###

CUSTOMARY CHI SQUARED =   259.957
CUSTOMARY CHI SQUARED DIVIDED BY NDAT =  6.34041
### Array size used for SAMMY-NPV is      471 ###
### Estimated array size for SAMMY-FIN is      374 ###
### Array size used for SAMMY-FIN is      232 ###
```

End of LPT file

Chi-squared started as 31,624.2
became 1,111.1
and finally 6.3

Other output files
[Rename these so you do not lose them!]

- SAMMY.PAR
  - In the same format as the input parameter file
  - Contains updated parameter values, plus a message explaining the existence of a covariance file
  - May be used as input for another SAMMY run
    - with or without modification
- SAMMY.COV
  - Binary file produced by SAMMY, contains
    - Covariance matrix for varied parameters
    - “Exact” values for all parameters
  - May be used as input for another SAMMY run

Other output files, continued

- **SAMMY.PLT and SAMMY.ODF**
  - **In "generic" binary or ODF (ORELA Data Format)**
  - **To be used for making plots of data vs theory**
  - **Contain:**
    - S1 • **Energy grid**
    - S2 • **Experimental data**
    - S3 • **Absolute uncertainties for experimental data**
    - S4 • **Initial calculated values for cross section (or transmission, etc.)**
    - S5 • **Final calculated values for cross section (ditto)**
  - **May also contain**
    - **Uncertainties on calculated values**
    - **Revised energy grid**

To be used for this workshop

```
END OF Output files
```

GLOSSARY (words frequently used with a SAMMY run)

- **NO BAYES**
  - **run SAMMY with no parameter variation (i.e., just calculate the cross section, do not solve Bayes' equations for updated parameter values)**
- **BAYES**
  - **run SAMMY and vary some parameters (i.e., solve Bayes' equations)**
- **ODF file**
  - **also called "plot file"; binary file generated by SAMMY, from which plots can be made using either FORODF or RSAP**
- **COV file**
  - **SAMMY output file which contains (among other things) the calculated parameter covariance matrix**
- **INPut file**
  - **SAMMY input file which contains general information such as operator commands, spin and mass for the nuclides in the sample, spin group quantum numbers, etc.**

GLOSSARY continued

- **PARameter file**
  - **file containing resonance parameters and any other parameters which are to be varied**
- **DATa file**
  - **sometimes called “SAM file”; contains experimental data; formats available for this file – MULTI (original, default), CSISRS, TWENTY, ODF)**
- **ENDF file**
  - **file in the ENDF/B-VI format (often, File 2 portion only)**
- **NDF file**
  - **SAMMY input file needed to create ENDF file**
- **FGM**
  - **free gas model for Doppler broadening**
- **HEGA**
  - **high-energy Gaussian approximation to the free gas model**

SAMMY Workshop

Workshop on Nuclear Reaction Data and Nuclear Reactors: Physics, Design and Safety

(16 February - 12 March 2004)

Dr. Nancy M. Larson
Oak Ridge National Laboratory

Part 2a: How to get Help

OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

When SAMMY doesn't work ...

- **Usually this is the result of input errors**
  - **See next page for what to do in this case**
- **Sometimes it's a bug**
  - **SAMMY *does* have bugs**
  - **If you find one, please tell me about it!**

What to do when SAMMY doesn't work?!

- Do not panic -- this happens to **everybody**.
- Is this run *really* the same as the one that worked last week?
  - Think carefully -- exactly what did you change?

What to do, continued

- Look at the LPT file **in detail**.
  - Did SAMMY understand all of your instructions?
    - *Maybe you had a typo.*
    - *Maybe you made up your own command instead of using one SAMMY understands.*
  - Is SAMMY using the same parameter values that you intended?
    - *Maybe you had a typo. Look for factors-of-ten.*
  - Would additional information help?
    - *Maybe you need to ask SAMMY to print out more initial values, or more intermediate steps.*
  - Did SAMMY give you an error message?
    - *Look at the very end of the file.*

What to do, continued

- Can you simplify and/or isolate the problem?
  - Use a smaller energy range.
  - Vary fewer parameters.
  - Drop normalization & background options.
  - Do no broadening.
- Find the smallest case for which the error occurs, and try to understand what is unique about that case.
- If the problem persists, ask for help!

HELP is available

- During the workshop, talk to me.
  - Remember, there is no such thing as a dumb question.
- Back home, talk to your office-mate.
  - *Maybe you've just been looking at it for too long, and someone else can see immediately what you can no longer see!*
- Talk to the most experienced SAMMY user in the neighborhood.
  - *It does get easier with practice!*

HELP is available, continued

- Talk to me at LarsonNM@ornl.gov
  - First, send information but not files. Describe the problem in some detail:
    - What version of SAMMY are you using?
    - What features are in use?
    - Did the code bomb or just give wrong answers?
    - In which module did the bomb occur?
      - For example, SAMMY-RSL might be the last thing in the LPT file. Or M6-SAMMY-SSM might appear on the screen right before the bomb.
    - What error message did SAMMY give you?
    - Does a minor perturbation of this case work properly?

HELP is available, continued

- Talk to me, continued
  - When requested, send very small files from the simplest case which has the problem: command file, INPut file, PARameter file, and DATa file
    - as attachments if possible
    - otherwise as separate e-mail messages

Please return the favor...

- If you find and fix a bug in your version of SAMMY, please tell me about it so I can fix it in my version!
  - In the code
  - In the lecture notes
  - In the users' guide
- SAMMY is imperfectly dummy-proofed –
  - Error messages do not always exist.
  - When they exist, they may not always be helpful.
  - If you can suggest a more informative error message, I'd be happy to consider using it.

SAMMY Workshop

Workshop on Nuclear Reaction Data and Nuclear Reactors: Physics, Design and Safety

(16 February - 12 March 2004)

Dr. Nancy M. Larson
Oak Ridge National Laboratory

Part 2b: Tutorial Exercises

OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

Tutorial exercises

#	Description of feature emphasized in this example
000	use of plotting package RSAP (or FORODF)
001	simple one-resonance non-fissile nucleus, capture experiment
002	fissile nucleus, several resonances, capture experiment
003	different kinds of cross sections
004	$l > 0$ (s, p, d waves); $l > 0$
005	Doppler broadening
006	resolution broadening (Gaussian)
007	resolution broadening (ORR)
008	resolution broadening (RPI)
009	normalization
010	backgrounds
011	more than one channel radius
012	multiple nuclides within a single sample
013	uncertainties on parameters
...	

Tutorial exercises, continued

#	Description of feature emphasized in this example
…	
014	angular distributions
015	sequential vs. simultaneous fitting of data
016	sequential fitting of three data sets; parameter covariance matrix as inpu t
017	several data sets; varying data-reduction parameters
018	data covariances (implicit and explicit)
019	self-shielding and multiple-scattering corrections to capture yields
020	integral quantities
021	almost real data: W transmission with many complications
022	almost real data: U235. How to do an evaluation
023	finding input errors
024	ladder program for generating artificial resonance parameters
025	samdist program for calculating statistical properties
026	create ENDF File 2

To begin the exercises ...

- **Go to subdirectory samexm**
- **Find and read the file README.FIRST**
- **Follow the instructions there**

/samexm/README.FIRST

```
##############################################################################
PURPOSE of these exercises:  to learn how to run the major features of the
       SAMMY code for evaluation of neutron-induced cross section data.

DESCRIPTION:

    Exercises 1, 2, 3, ... are provided in subdirectories ex001, ex002,
        etc.  These can be used as a self-guided tutorial by reading and
        following the instructions provided in the README.FIRST file in
        each subdirectory.  Results that the SAMMY author obtained for
        those exercises are given in sub-subdirectories /ans/; these
        results can be used to check your answers if needed.
  ...
```

/samexm/README.FIRST continued

```
GENERAL INSTRUCTIONS:

    Begin with example EX000 to learn how to make plots using the
        plotting package rsap or forodf.


    Begin learning to use the SAMMY code by starting with Example EX001
        in subdirectory ex001, and progressing through all examples in
        order from 1 to N (where N is 26 as of April, 2000).

    In each subdirectory read the README.FIRST file to learn the purpose
        of the exercise, read a DESCRIPTION of the problem, and obtain
        specific INSTRUCTIONS re what is to be done during this exercise.
        It is recommended that you read this file for each exercise, even
        if you choose not to do that particular exercise because you are
        already familiar with the feature being presented there -- there
        may be information of which you are not aware.

##################################################################
```

/samexm/ex000/README.FIRST.forodf

```
##################################################################
Instructions for Exercise EX000:

This exercise is a mini-tutorial on how to use the ORNL plotting package
        "forodf" to produce simple plots from SAMMY output plot files.
        Only the very basic features are covered here.

The following command stream will permit plotting of file ex000.odf.
        You will type lower-case characters; the code types the upper
        case.  Notes to the right of the page, in square brackets, are
        explanations.  Try the commands as-is first, then vary by changing
        energy-range, setting limits for y-axis, making log-log plots,
        etc...

For your first attempt, be sure to type the commands EXACTLY as given below.
```

See info in red boxes or circles for this workshop

The one possible exception is the "dvt" command, which causes the plot to be put up on the screen. The forodf program contains a variety of such plotting commands, for use on different computer platforms and different terminal emulators. In particular, with X-terminals (or X-terminal emulators) on unix or Linux, it is necessary to "stop" prior to the dvt command, bring up a tektronix window, re-enter the forodf program using the "forcom" command, and then use "tek" rather than "dvt".

/samexm/ex000/README.FIRST.forodf

```
-----------------
forodf                                                    [run the program]
  FILENAME 1=ex000.odf                                       [name of file]
  RUN 0 7 DATASETS 315 CHANNELS/DATASET MODE 3 (S1=E)
  FILENAME 2=   carriage return                             [no more files]

  *** FORCOM ***   8- 9-95
 TYPE EQUATION
```

forodf is asking you for your input

/samexm/ex000/README.FIRST.forodf

It is not necessary to repeat these commands each time.

```
/xsn1                          [Section 1 will be used for x-axis of the plot]
  TYPE EQUATION
f1s2sc1                                  [print the first channel]
  1       .32540001E-01  .80466003E+01
  TYPE EQUATION
f1s2sc315                            [print the last channel, # 315]
  315     .16050000E-01  .11953890E+02
  TYPE EQUATION
/xmin 8.00                             [set min x for plot = 8.00]
  TYPE EQUATION
/xmax 12.00                            [set max x for plot =12.00]
  TYPE EQUATION
```

The values in section 2, channels 1 and 315

The energies in section 1, channels 1 and 315

This “channel” is different from an R-matrix channel. This channel refers to a time-of-flight bin (i.e., to an energy bin).

ex000/README.FIRST.forodf, cont.

```
########## on some systems ###########
dvt f1s2,f1s4                                    [plot file 1 section 2 & 4]
carriage return                                                [ends the plot]
dvt /sym3 f1s2,/nosy f1s4              [plot file 1 S2 as symbols, S4 as line]
carriage return
dvt /sym3 f1s2,/nosy /dash0.1 f1s4, /nodash f1s5
          [plot file 1 S2 as symbols, S4 as dashed line, S5 as solid line]
carriage return
stop                                                           [end the program]
STOP
##########
```

ex000/README.FIRST.forodf, cont.

```
########## with X-windows ############
stop                                                    [exit forodf]
STOP
xterm -t&                                    [bring up a tektronix window]
forcom                                       [re-enter the forodf program]
tek f1s2,f1s4                                  [plot file 1 section 2 & 4]
carriage return                                                [ends the plot]
tek /sym3 f1s2,/nosy f1s4          [plot file 1 S2 as symbols, S4 as line]
carriage return
tek /sym3 f1s2,/nosy /dash0.1 f1s4, /nodash f1s5
          [plot file 1 S2 as symbols, S4 as dashed line, S5 as solid line]
carriage return
stop                                                    [end the program]
STOP
^D                                             [exit the tektronix window]
##########
```

Three different plot commands

ex000/README.FIRST.forodf, cont.

```
----------------

Other useful commands:
/reset          [reset all "/" commands]
/ymin 0.01      [sets minimum y-value at 0.01]
/ymax 100.0     [sets maximum y-value]
/noymin         [resets ymin to default: program chooses ymin]
/noymax         [resets ymax]
/ylog           [plot y on log scale]
/noylog         [plot y on linear scale]
/xlog           [plot x on log scale]
/noxlog         [plot x on linear scale]
/ave3           [plots the average of three consecutive points]
stop            [get out of forodf]
------

It is possible to use "command files" to store frequently-used commands;
       the command file is then invoked by typing the "@" sign followed
       by the file name.  For example, all of the initialization commands
       from the example above might be stored in a file named "x." (the
       period is necessary), then you can type @x (without the period) to
       execute, as illustrated below.  Similarly, file "y." holds the
       plot command.
```

ex000/README.FIRST.forodf, cont.

```
----------------
forodf
 *** FORODF ***   8- 9-1995

 FILENAME 1=ex000.odf
 RUN 0 7 DATASETS 315 CHANNELS/DATASET MODE 3 (S1=E)
 FILENAME 2=

 *** FORCOM ***   8- 9-95
 TYPE EQUATION
@x                    [to initialize]
 TYPE EQUATION
@y                    [to make plot]

 *** FORPLT ***   8- 9-1995


 *** FORCOM ***   8- 9-95
 TYPE EQUATION
stop
STOP
----------------
```

You will notice that forodf creates several temporary files in your area. So long as those are not deleted, any switches you may have set (e.g. /xmin8.0) remain active. Also, if you "stop" and then wish to re-enter forodf using the same file, typing "forcom" rather than "forodf" will put you directly into the "TYPE EQUATION" mode.

```
##################################################################
```