

RADCOP : Manipulation and Visualization of SAMMY Covariances

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Nuclear data evaluations typically yield resonance parameter representations that can be used by processor codes (e.g., AMPX [1], NJOY [2], etc.) to compute cross sections and integral quantities needed for criticality safety and other nuclear applications. An important part of the evaluation process involves the generation of covariance matrices (CMs) that contain both the variances of resonance parameters and the correlations between parameters. The ENDF format now permits use of resonance parameter CMs from File 32, MT=151, that correspond to resonances in File 2, MT=151. The SAMMY [3] code is widely used to fit neutron cross-section data to obtain both resonance parameter representations and the corresponding CMs, which are output to binary files.

Since a typical evaluation produces a representation with hundreds or thousands of parameters, one needs to examine and display subsets of the diagonal and off-diagonal matrix elements. We have written a code, RADCOP, that facilitates the manipulation and visualization of information from SAMMY CMs. RADCOP can produce both one- and two-dimensional (1D and 2D) plots of the parameter correlations for user-specified neutron energy ranges; the display formats permit the user to quickly trace the important off-diagonal correlations. RADCOP also outputs ENDF File 2 and File 32 files for the Reich-Moore representation (LRF=3 and LRF=7).

SAMMY also writes an ASCII file that lists the resonance parameter uncertainties. This "PUB" file can be edited, either manually or with the RSAP code [4], to modify the uncertainties. This procedure is generally utilized when analyzing data sets for which nonstatistical uncertainties in quantities such as normalization or background are poorly known. We have written another code, PUB2COV, that reads the modified PUB file and replaces the uncertainties (diagonal elements) in the CM file while preserving the off-diagonal correlations. PUB2COV may be run from a RADCOP script file.

We distinguish between resonance parameters (resonance energy E, gamma width G, neutron width N) and nonresonance parameters (radii, isotopic abundance, broadening parameters, etc.). For each resonance parameter the CM file also contains several associated quantities (AQs) such as the type of parameter (gamma width, particle width, etc.), the resonance energy, spin group, parameter value, etc. The parameters are ordered by spin group, not resonance energy.

RADCOP reads a user-specified CM file and a user-specified energy range, indexes the parameters in order of increasing resonance energy, and outputs an energy-ordered list of AQ information. The list includes parameter type, value, absolute and relative uncertainty, spin group, and extreme off-diagonal correlation. A 2D plot of the correlation matrix may be produced with symbols of size proportional to the correlation; an option is to plot the two-digit numeric value of the correlation. A parameter type tag (e.g., E, G, N), associated resonance energy, spin group, and parameter number are written along the plot axes. Up to 50 parameters may be plotted. Nonresonance parameters are also plotted. RADCOP can also make 1D plots

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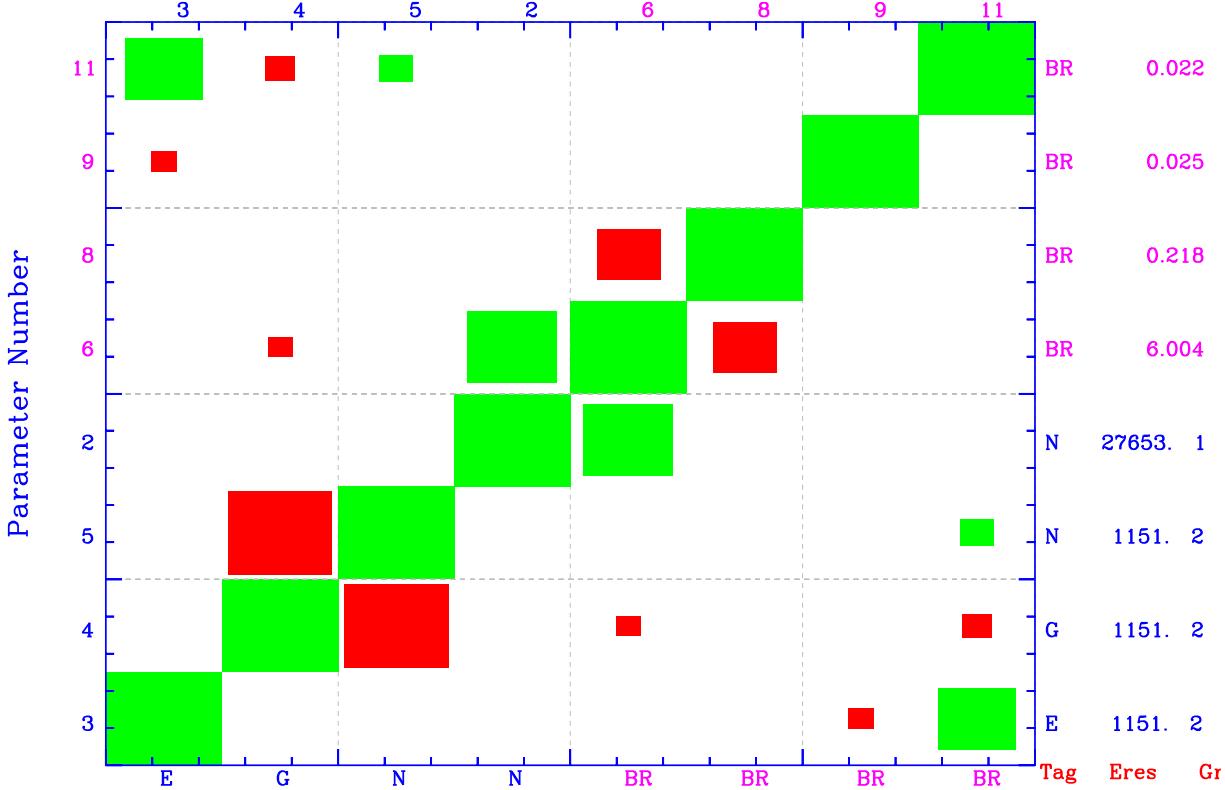


Figure 1: Example RADCOP 2D correlation plot (three parameters excluded). Positive (negative) correlations are shown in green (red). The label BR denotes broadening parameters.

of the correlations of a given parameter with all parameters in the specified energy range. Plots are output to both the user's X window and to color postscript files. The code is written in Fortran 90 and currently runs on the Linux platform.

An example of a RADCOP 2D plot is shown in Fig. 1, and part of the list output is given below.

```

11 parameters (5 resonance, 6 non-resonance)
min,max E = 0,      3.00000D+05 eV          correlation threshold = 0.200
***** Flagged Resonance Parameters :
Index param      Eres Tag      Value      Abs.      Rel. Group Max_OffDiag param Exclude
      #       (eV)          Value      Unc.      Unc.      Correlation      #
----- ----- -----
 1    3    1151.12  E   1.1511D+03 5.820D-02  0.000      2     +.67    11    0
 2    4    1151.12  G   5.8274D+02 1.295D+02  0.222      2     -.90     5    0
 3    5    1151.12  N   5.8820D+01 6.812D+00  0.116      2     -.90     4    0
 4    1   27652.55  E   2.7653D+04 3.998D+02  0.014      1     -.16     6    1
 5    2   27652.55  N   1.4780D+06 1.146D+05  0.078      1     +.77     6    0

3 parameters excluded from plot (Extreme off diag. correlation below threshold)

```

The 2D plot in Fig. 2 illustrates the option to plot off-diagonal correlations as two-digit numbers; positive (negative) correlations are shown in green (red). Values for parameter tags,

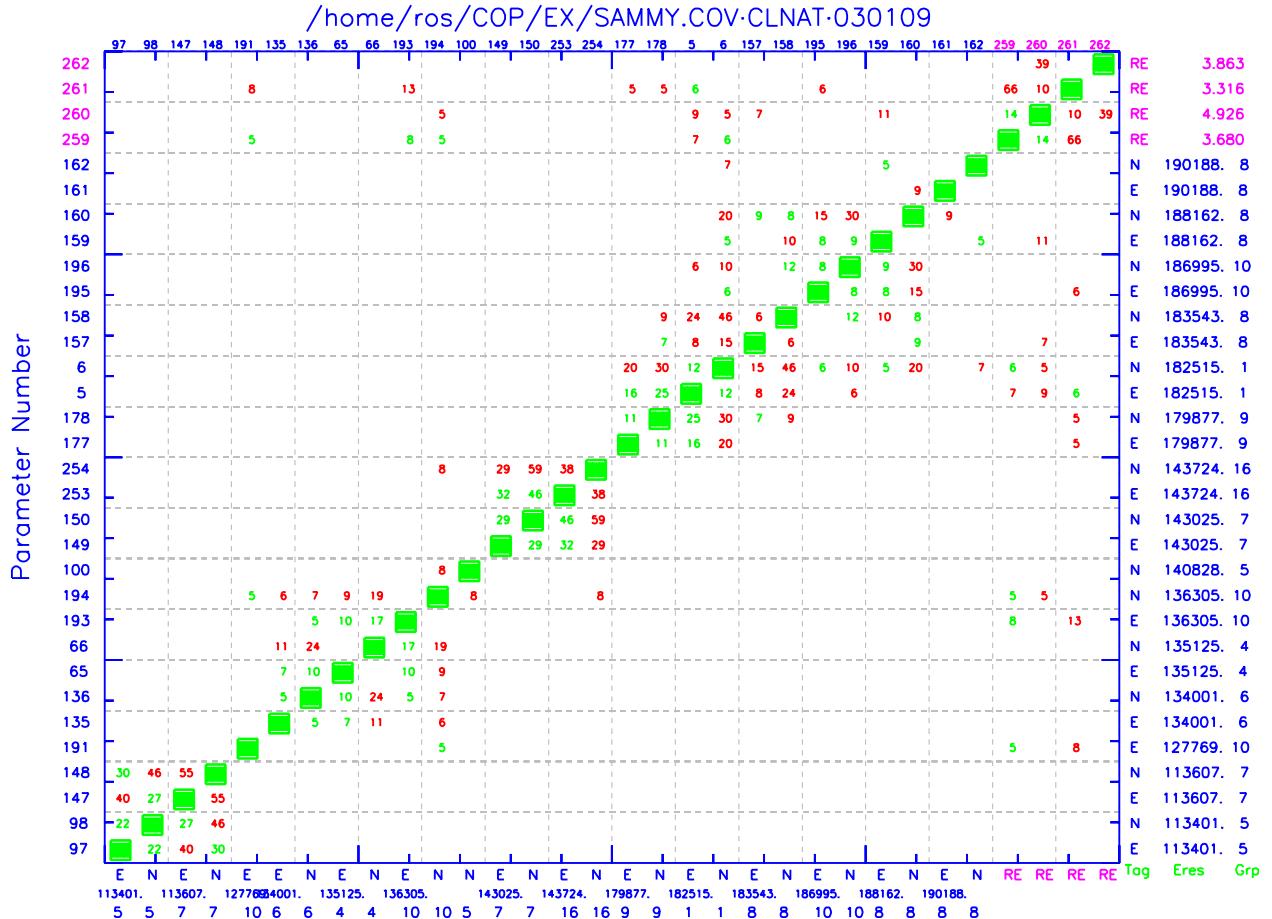


Figure 2: Example RADCOP 2D plot with numerical off-diagonal correlations.

resonance energies in eV, and SAMMY spin group numbers are written below the *x-axis* and to the right of the plot. The tags E, G, and N indicate resonance energy, gamma width, and neutron width, respectively. The label RE denotes effective radii; values in fm are written to the right of the plot.

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References

- 1) M. E. Dunn and N. M. Greene, *AMPX-2000*, *Trans. Am. Nucl. Soc.* (2002).
 - 2) R. E. MacFarlane and D. W. Muir, Los Alamos National Laboratory Report LA-12740-M (1994) .
 - 3) N. M. Larson, Oak Ridge National Laboratory Report ORNL/TM-9179/R6 (2003).
 - 4) R. O. Sayer, Oak Ridge National Laboratory Report ORNL/TM-2003/133 (2003).