Extension of EXFOR Formats Manual

(by V.Zerkin, 22-April-2013)

A14 : Zerkin : Submit an update of the EXFOR Formats Manual (Appendix B) for the new covariance format (WP2012-27).

Coding covariance data in EXFOR file

Covariance data may be stored in EXFOR file under keyword COVARINCE. These covariance data can describe several types of correlations including: correlations between data measured on different energies (correlations between experimental points and energy intervals); correlations between data of different reactions; correlations between Legendre coefficients of angular distributions; full and fractional, covariance and correlation matrices.

Covariance information is placed in free text starting from column 13 under the keyword COVARINCE using the following conventions. The text describe and store one-dimensional arrays X_i, Y_j and two-dimensional arrays with covariance or correlation matrices $Z_{i,j}(X_i,Y_j)$. For every array X, Y, Z the following information should be given in two parts:

1. Code (Descriptor): a text enclosed in parentheses and having four parameters separated by commas: (1) type and (2) length of array, (3) units and (4) data type
2. Data array: lines following the Code with real numbers separated by blanks or text lines with leading index

Code (Descriptor) should have four parameters:

1. Type of array: “X”, “Y”, “Z”, “XY” (when x-grid equals to y-grid), “ZP” for fractional matrix
2. Length of array: number of elements of the array following the line with the code. If X is equals to Y and LZ=(LX*(LX+1))/2, then the matrix is considered as symmetric squared matrix given as lower triangle
3. Units of the following data array. It can be “PER-CENT” and “NO-DIM” for matrices, MeV for energy array. Value “N” is used as indication that the following array of X or Y will be given as text lines.
4. Type of data with optional data specification.
    1) Data types: “COR” – correlation matrix, “COV” - covariance matrix, “EN” - incident energy, etc.
    2) Data specification is separated by “:” from the type and used to specify type of partial information for fractional matrices, such as: name of uncertainty, incident energy for Legendre coefficients

Data arrays

1. Numerical array: data values separated by space (one or more symbols ‘0x20’):
    1) length of a single data value is not fixed;
    2) number of values in one text line is not specified;
    3) decimal point “.” can be dropped
2. Text array (used only for X and Y)
    1) Consists of the lines: one line for one element of array
    2) One line contains the pair: *<index> space <text>*
    3) *<index>* is sequential number from 1 to the length of array

4) *<text>* is any text

Typical cases

1. Energy-Energy correlations

For example, we have correlation matrix for a dataset with four experimental data points measured on four incident energies. Matrix 4×4 is symmetric and given in per-cents, energy is given in MeV. This can be coded as:

```
1            (XY,4,EN,MEV)
2             0.597 0.797 0.898 0.906
3            (Z,10,COR,PER-CENT)
4             100
5             46  100
6             40  32  100
7             56  43  37  100
```

Line-1. Code `(XY,4,MEV,EN)` means: two independent variables are equal and given below as array with 4 elements; it is array with energy given in MeV.

Next line has four real numbers present 4 energies.

Line-3. Code `(Z,10,PER-CENT,COR)` means: several following lines will contain array with 10 elements which is correlation matrix given in per-cents. Comparing lengths of X, Y and Z arrays we can see that Z array is given as lower triangular matrix, 10=4*(4+1)/2. If it would be given as squared matrix, array Z would contain 16 elements.

Lines 4 to 7 contains real numbers – correlation coefficients.

Because number of values in one line and format and precision of data are not specified, equivalent presentation can be given differently, for example:

```
1            (XY,4,MEV,EN)
2             0.597 797e-3
3             0.898 0.906
4            (Z,10,PER-CENT,COR)
5             100 46 100 40. 32.0 1e2 56 43 37 1e+02
```

The same data given as full matrix and using other units:

```
1            (XY,4,KEV,EN)
2             597 797 898 906
3            (Z,16,NO-DIM,COR)
4              1  .46 .40 .56
5             .46  1  .32 .43
6             .40 .32  1  .37
7             .56 .43 .37  1
```

In the cases where we need to specify some additional information about matrix, “specification” part of the data type can be used. For example, fractional correlation matrices for different uncertainties and full correlation matrix can be coded as:

```
(ZP,45,PER-CENT,COR:MONIT-ERR)
(ZP,45,PER-CENT,COR:ERR-4)
(Z,45,PER-CENT,COR:ERR-T)
```

2. Reaction-Reaction correlations

Some EXFOR Entries describe correlations between data of different reactions stored in different Subentries. Such cases need another type of independent variable – different from array with real numbers as we have for description of energy grid. We need more general X and Y arrays, namely - text array, i.e. indexed text describing, for example, reactions or reaction-ratios.

```
1               (XY,6,N,Reaction)
2                 N Reaction
3                 1 Al-27(n,a)Na-24
4                 2 Mg-24(n,p)Na-24
5                 3 Ti-46(n,p)Sc-46
6                 4 Ti-47(n,p)Sc-47
7                 5 Ti-48(n,p)Sc-48
8                 6 Fe-54(n,p)Mn-54
```

Line-1. In the code `(XY,6,N,Reaction)` - `N` is used as indication that following array will contain text lines instead of real numbers.

Line-2. This is free text.

Lines 3 to 8. Every line contains index (i from 1 to 6) and Text to fill in text array X[i]=Text. Reading program should scan lines expecting leading integer number from 1 to 6 and interpret it as next element of the text array. Other lines (including line-2) should be considered as comments (really free-text).

3. Correlations of the Legendre coefficients

This type of correlations can be described with independent variable (number of the coefficient) in integer array and data type specification indicating incident energy:

```
1               (XY,6,NO-DIM,NUMBER)
2                0 1 2 3 4 5
3               (Z,21,PER-CENT,COR:EN=13.33 MEV)
4                  100
5                    7 100
6                   -1  51 100
7                    7  60  57 100
8                    4  31  50  57 100
9                    3  33  43  62  46 100
```