Coding of covariance data in EXFOR convenient for software

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"Technical Meeting Neutron Cross Section Covariances, IAEA Headquarters Vienna, Austria 27-30 September 2010":
- The EXFOR formats should be flexible enough to accommodate information as provided by the experimenters. The EXFOR format should be extended to accommodate the full explicit covariance matrix, if provided by the authors or, alternatively, data required by a recipe for constructing covariance matrices based on providing partial error and correlation components.

Today EXFOR has very few entries having some information about experimental covariance data: 43 Entry with keyword COVARIANCE having data as free text and 6 Entries with code COVAR (files *.COV with covariance data in ENDF format have been lost). Because there are no coding rules for covariance data placed in EXFOR files as free text, but data exist, and EXFOR users are interested to have such a data in the EXFOR files, there is a need to introduce rules (conventions) for coding covariance data. This paper is presented to NRDC community in order to emphasise that the coding rule should be not overcomplicated for users, which means nowadays – not too difficult for programming.

Proposal:

1. to introduce a convention to present existing in EXFOR free text covariance data in a unified style simple for programming (possibly compatible with z(x,y) input format of plotting package ZVView, used from 2009);
2. to foresee extension of the coding rules for the needs/convenience of EXFOR compilers/physicists.

The essential and absolutely necessary information for program reading covariance matrix Z(X,Y):

- X array (dimension, units, name of axis)
- Y array (dimension, units, name of axis)
- Z array (dimension, units, name of axis)

Typical options:

- X array can be equal to Y array (e.g. squared matrix energy-energy correlation)
- Z array can be given as triangle (symmetric squared matrix)
- matrix can present various correlations (e.g. reaction-reaction)

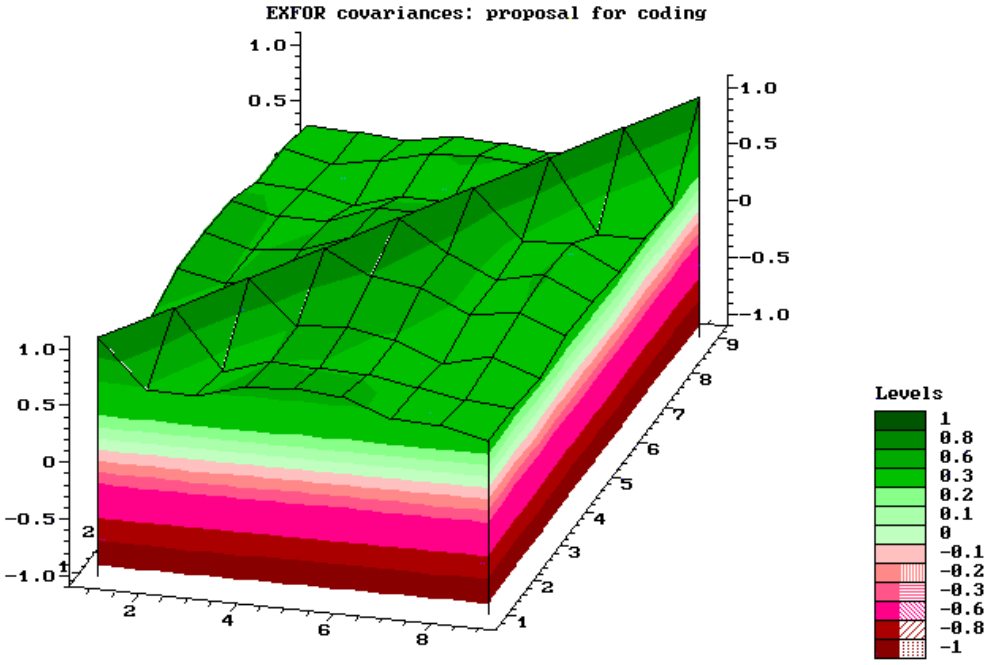
The proposed format is following:

- For every array:
    a. Line-Header for every array:
    code in brackets starting from 12 column;
    first values are fixed: type of array (X, Y, Z, XY), dimension (integer), meaning (e.g. EN) and units (e.g. MeV); the rest can be extended later
    b. Following lines with real numbers separated by blanks until number of values reaches dimension of array

Examples:

1) Triangle symmetric matrix Energy-Energy correlation (EXFOR: 2211003)

```
123456789.123456789.123456789.123456789.123456789.123456789.123456
COVARIANCE .Covariation matrix in percent
           (XY,17,EN,MEV)
            0.597 0.797 0.898 0.906 1.01  1.098 1.117 1.193 1.376
            1.39  1.693 2.144 3.908 5.182 5.7   6.195 6.759
           (Z,153,CORR,PER-CENT)
            100
            46  100
            40  32  100
            56  43  37  100
            37  29  25  34  100
            56  44  38  53  35  100
            37  30  26  35  24  35  100
            40  32  28  37  26  38  26  100
            55  44  38  51  35  52  35  38  100
            57  45  38  53  35  54  36  38  53  100
            57  45  39  54  35  55  36  39  53  55  100
            52  41  36  49  33  50  33  36  49  51  52  100
            58  45  39  54  35  54  36  38  53  55  55  51  100
            49  38  33  46  30  47  31  33  46  47  48  44  48
            100
            46  36  31  44  29  44  29  31  43  45  45  42  45
            39  100
            43  34  29  10  27  41  27  29  40  42  42  39  42
            37  35  100
            39  31  26  37  24  38  25  26  37  38  39  36  38
            34  32  30  100
```



2) Correlation between different reactions in different subentries (EXFOR: 13134)

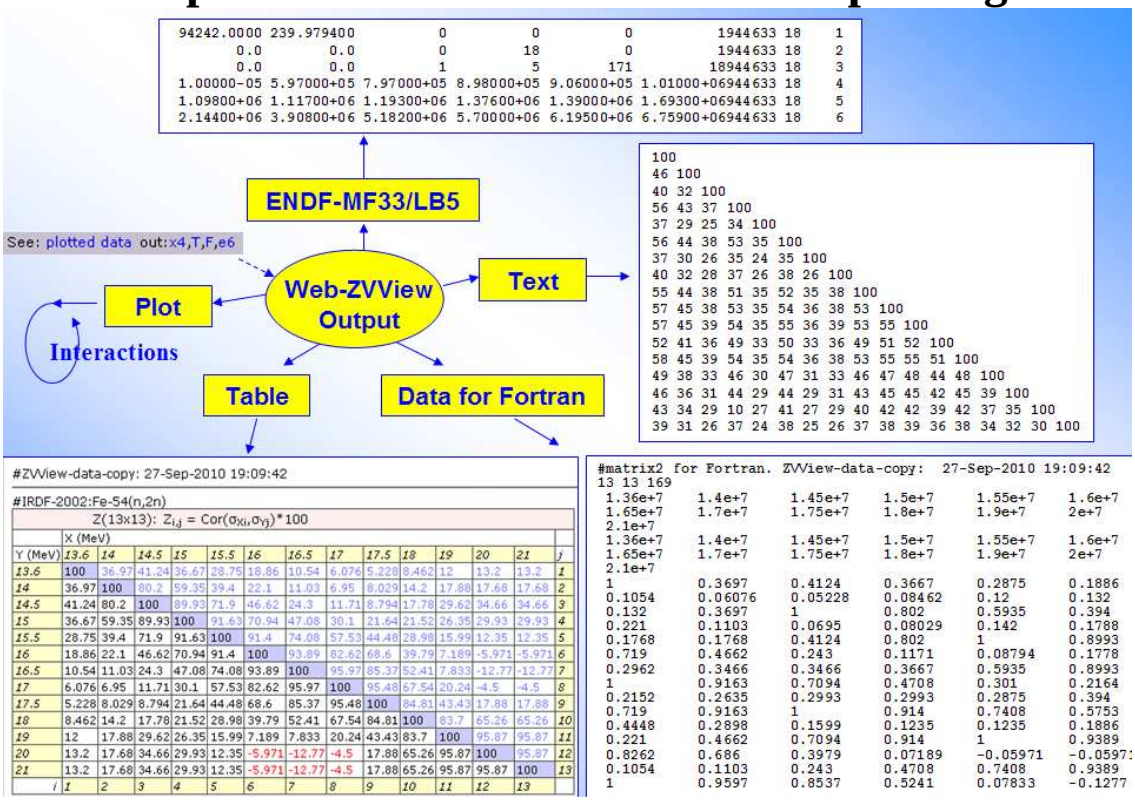
```
123456789.123456789.123456789.123456789.123456789.123456789.123456
COVARIANCE Correlation matrix for fission cross section ratios
           (XY,9,Reaction-Ratio,N)
             N Reaction Ratio
              1 230Th/235U
              2 232Th/235U
              3 233U/235U
              4 234U/235U
              5 236U/235U
              6 238U/235U
              7 237Np/235U
              8 239Pu/235U
              9 242Pu/235U
           (Z,45,CORR,PER-CENT)
             100
              57 100
              58  48 100
              69  60  62 100
              71  59  64  78 100
              68  58  58  73  73 100
              53  51  41  53  53  56 100
              52  43  50  59  62  59  36 100
              42  40  37  44  43  39  37  35 100
```

There is already Web interface for display of EXFOR covariances coded in this style using Web-ZVView package, where user can input matrix in almost free format, display it with various options and produce output in simple text, html table, ENDF MF33 and draft for EXFOR. What is also important for general users that system produce data for reading in a program including Fortran code together with data. This should attract wide range of users to write applications if they have interest in this field.

Conclusion

The proposal of coding of EXFOR covariance data is trivial, easy for programming, extendable, compatible with existing software and can be easy implemented for all data existing now in EXFOR database.

Output formats from Web-ZVView plotting



Output for Fortran users: data + code in one file

```
#matrix2 for Fortran. ZVView-data-copy:  27-Sep-2010 19:09:42
13 13 169
 1.36e+7    1.4e+7     1.45e+7    1.5e+7     1.55e+7    1.6e+7
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
#//fortran program for reading
      integer lx,ly,lz
      character*80 filename
      character*80 title
      real xx(200),yy(200),zz(40000)
      in=30
      filename='m2.txt'
      write (*,*) 'file: ',trim(filename)
      open (unit=in, file=filename, status='old')
      read (in,*) title
      read (in,*) lx,ly,lz
      read (in,*) (xx(ii),ii=1,lx)
      read (in,*) (yy(ii),ii=1,ly)
      read (in,*) (zz(ii),ii=1,lz)
      close(unit=in)
      call matrix2out(lx,ly,xx,yy,zz)
      stop
                                  end
      subroutine matrix2out(lx,ly,xx,yy,zz)
      dimension xx(lx),yy(ly),zz(lx,ly)
      write (*,*) ' LX=',lx,' LY=',ly,' LZ=',lx*ly
      write (*,200) (' i=',ii,' x=',xx(ii),ii=1,lx)
      write (*,200) (' j=',jj,' y=',xx(jj),jj=1,ly)
200   format(' ',a3,i3,' ',a3,g13.7)
      do jj=1,ly
        do ii=1,lx
          write (*,*) jj,ii,' x=',xx(ii),' y=',yy(ii),' z=',zz(ii,jj)
        enddo
      enddo
      return
      end
```