

# Proposal to include LCT flag in MF34 of ENDF

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## **Background**

The classical method of solving the neutron transport equation by deterministic methods is to perform an expansion of the equation in Legendre moments and solve a coupled system of equations. It is relatively easy to calculate the sensitivity of integral parameters on P1 components of the scattering cross sections.

The P1 component of the scattering cross section is the product of the cross section and the average cosine of scattering ( $\mu_{bar}$ ), which is by definition the first term of the Legendre polynomial expansion of the angular cross section in the LAB system. The relative covariance matrix of the P1 scattering cross section is the sum of covariance matrices of the P0 component and  $\mu_{bar}$ .

Similar relations can be derived for higher order terms.

Transformation matrix for converting Legendre coefficients between CM and LAB system is a full matrix. Uncertainty in one component in the LAB system affects all components in the CM system, and vice versa. The Legendre terms in MF4 of an ENDF file are usually given in the CM system. Since the covariances in MF34 are restricted to a small number of terms, some information from an "accurately known" covariance of a P1 scattering cross section will be lost when converting to CM, and again when reconstructing the P1 cross sections in the LAB system.

## **Proposal**

Allow covariance matrix in MF34 of an ENDF file to be given in the LAB system even when Legendre coefficients in MF4 are given in the CM system.

## Justification

MF34 is defined only for Legendre coefficients, even when the data in MF4 are given in a different representation (e.g. pointwise tabulation). The proposal is therefore not a precedent.

## Impact on data processing

There are very few codes that can process the data in MF34. The ERRORJ code reads the Legendre coefficients in CM and performs conversion into the LAB system. A brief look into the code indicated that only the conversion from CM to LAB of the covariance matrix would need to be skipped. The impact on PUFF and any other codes would need to be assessed.

## ENDF Format changes

In MF4 the LCT flag that defines the coordinate system is given in the first CONT record after the HEAD record on position L2. There is no LCT flag in MF34. A place for LCT equivalent to the place in MF4 is not available in MF34. A simple solution is to place the LCT flag on the second CONT record of a subsection at position N1, which is not used at present:

```
[MAT,34,MT/ 0.0, 0.0, MAT1, MT1, NL, NL1]CONT
[MAT,34,MT/ 0.0, 0.0, L, L1, LCT, NI]CONT
[MAT,34,MT/ 0.0, 0.0, LS, LB, NT, NE/ {Data}]LIST
... ..
```

A less attractive solution is to introduce a new CONT record after the HEAD record. This could be recognised (for backward compatibility) from the AWR value in position C2, with LCT in position L2:

```
[MAT,34,MT/ 0.0, AWR, 0, LCT, 0, 0]CONT
```

The interpretation of LCT in MF34 is as follows (for backward compatibility):

LCT=0 - assume same as in MF4

LCT>0 - force specified coordinate system (normally LCT=1 for LAB).

## Request to CSEWG

Endorse one of the above variants of the ENDF-6 format extension for testing purposes.