

Combination of Process and Other Codes in REACTION SF3

(N. Otsuka and O. Schwerer, 2021-04-24, Memo CP-D/993 Rev.)

Note added to this Working Papers

Main question: How to express a process (e.g., fission) following inelastic scattering?

Option 1: Use INL. For example,

(N,INL+F) for inelastic scattering followed by fission

(N,INL+P) for inelastic scattering followed by proton emission

Option 2: Use scattered particle code. For example,

(N,N+F) for inelastic scattering followed by fission

(N,N+P),SEQ for inelastic scattering followed by proton emission

It is understood that scattering and fission are always the first and last process of SF3, respectively.

EXFOR Formats Manual allows combination of (a) a process code, (b) a particle code and (c) a nuclide code in REACTION SF3.

SF3. Process.

....

- d) Combinations of a), b) and c), with the codes connected by '+'. Outgoing particles are ordered starting with the *lightest*¹ at the left of the subfield, followed by the *Z-S-A-X* formatted codes, in *Z, A* order, followed by process codes given in the same order as given in Dictionary 30.

An exception to this order is when SF5 contains the code SEQ, which indicates that the particles and/or processes are ordered in the sequence in which the reaction proceeds (see **LEXFOR, Outgoing Particles**).

Examples: HE3+8-0-16
X+N

SF4. Reaction Product. In general, the heaviest of the products is defined as the reaction product (also called residual nucleus). In the case of two reaction products with equal mass, the one with the larger *Z* is considered as the *heavier* product. Exceptions or special cases are:

- a) If the branch code SEQ is given in SF5, indicating that the sequence of several outgoing particles and/or processes coded in SF3 is meaningful, the nuclide to be coded in SF4 is the heaviest product of the last process (e.g., break-up).

Examples:

(... (... , D+N) 2-HE-4 , SEQ , ...) Emission of deuteron followed by break-up of ⁵He
(... (... , D+X) , SEQ , ...) Emission of deuteron followed by unspecified process
(... (... , D+F) , SEQ , ...) Emission of deuteron followed by fission.

The branch code SEQ may not be used when there are only two products in SF3 and SF4.

We checked all combinations of a process code with other codes in REACTION SF3:

1. F+* (1 subentry)
2. *+F (103 subentries in 22 entries)
3. FUS+* (1 subentry)
4. INL+* (10 subentries in 7 entries)
5. *+X (236 subentries in 52 entries)
6. X+* (117 subentries in 15 entries)
7. XN+* (1 subentry)

Cases 1, 3 and 7

The code string in SF3 must be replaced by a single process code. (For the C0905.002 case, We are asking a confirmation of the first author just in case.)

| SF3 | Subentry | REACTION | Remark |
|-------|-----------|---|----------------|
| F+* | 13752.004 | 92-U-235(N,F+X)2-HE-4,,SIG,,FST | SF3 must be F. |
| FUS+* | C0905.002 | 83-BI-209(2-HE-6,FUS+F),,SIG | SF3 must be F. |
| XN+* | G0016.004 | 40-ZR-0(G,XN+1P)39-Y-86-M/G,,SIG/RAT,,BRA | SF3 must be X. |

Case 2 (*+F)

We propose to code a process followed by fission by *+F without SF5=SEQ. This is because particle emission from a fission fragment is not explicitly coded in SF3 in general.

Case 4 (INL+*)

This combination always appears without SF5=SEQ in the EXFOR Master though such appearance is against the current rule. On the other hand, we expect the inelastic scattering is always at the beginning of the process, namely SEQ is redundant if INL is followed by another code in SF3. There can be two options for SF3 coding for inelastic scattering followed by another process:

1. use of the process code INL without SEQ in SF5.
2. use of the particle code for inelastically scattered particle in SF3 with SEQ in SF5 (except for fission).

Examples

| | Option 1 | Option 2 |
|--|----------------|-----------------|
| Neutron inelastic scattering followed by fission (e.g., 30606.002) | (N,INL+F),,SIG | (N,N+F),,SIG |
| Neutron inelastic scattering followed by proton emission (e.g., 40596.008) | (N,INL+P),,SIG | (N,N+P),SEQ,SIG |

Case 6 (X+*)

This combination always appears without SF5=SEQ, and therefore they are illegal under the current rule. We propose to code X at the end of SF3 without SEQ in SF5. **Corrections are suggested in the Appendix of this memo.**

Note that the usage of X is summarized in Dictionary 30:

```

X          Process unspecified          3000003000014
Examples   3000003000015
- (... ,X)Z-S-A = production of the product specified in3000003000016
  SF4          3000003000017
- (... ,P+X)Z-S-A = emission of a proton plus the product3000003000018
  specified in SF4, and of other unspecified particles 3000003000019
- (... ,P+X),SEQ,... = emission of a proton followed by 3000003000020
  the emission of other unspecified particles or other 3000003000021
  processes.   3000003000022
  
```

Case 5 is consistent with the second example of the dictionary.

Proposed revisions of manuals

EXFOR Formats 6.3 – Double underline is for addition if we adopt option 1.

SF3. Process.

....

- d) Combinations of a), b) and c), with the codes connected by '+'. Outgoing particles are ordered starting with the *lightest*¹ at the left of the subfield, followed by the *Z-S-A-X* formatted codes, in *Z, A* order, ~~followed by process codes given in the same order as given in Dictionary 30.~~ Such a combination may follow the process code INL, and may be followed by F or X. Other process codes are not connected by '+.

An exception to this order is when SF5 contains the code SEQ, which indicates that the particles ~~and/or processes~~ are ordered in the sequence in which the reaction proceeds (see **LEXFOR, Outgoing Particles**).

Examples: ~~HE3+8-0-16~~
~~X+N~~
~~N+X~~

(7-N-14(P,HE3+3-LI-6)3-LI-6,...) Emission of ³He and two ⁶Li.

(82-PB-0(9-F-17,P+X)8-O-16,...) Emission of proton, ¹⁶O and anything

(92-U-235(N,INL+F),,...) Inelastic scattering followed by fission (*option 1*), or

(92-U-235(N,N+F),,...) Inelastic scattering followed by fission (*option 2*)

SF4. Reaction Product. In general, the heaviest of the products is defined as the reaction product (also called residual nucleus). In the case of two reaction products with equal mass, the one with the larger *Z* is considered as the *heavier* product. Exceptions or special cases are:

- a) If the branch code SEQ is given in SF5, indicating that the sequence of several outgoing particles and/or processes coded in SF3 is meaningful, the nuclide to be coded in SF4 is the heaviest product of the last process (e.g., break-up).

Examples:

(...(...,D+N)2-HE-4,SEQ,...) Emission of deuteron followed by break-up of ⁵He

~~(...(...,P+A+X),SEQ,...)~~ Proton emission followed by alpha emission followed by unspecified process

~~(...(...,D+X),SEQ,...)~~ ~~Emission of deuteron followed by unspecified process~~

~~(...(...,D+F),SEQ,...)~~ ~~Emission of deuteron followed by fission.~~

The branch code SEQ may not be used when there are only two products in SF3 and SF4.

LEXFOR F.2 (“Fission”)

Partial Fission Cross Sections

The fission cross section is a sum cross section, for example:

$$(n,f) = \text{direct fission}^1 + (n,n'f) + (n,2nf) + \dots$$

the partial fission cross sections are coded under the keyword reaction as follows:

| | | |
|-----------------|---------------------------------|----------------------|
| (n,n'f) | (N, N INL+F),SEQ,SIG | <i>(option 1) or</i> |
| (n,n'f) | (N,N+F),,SIG | <i>(option 2)</i> |
| (n,2nf) | (N,2N+F),SEQ,SIG | |
| (n, γ f) | (N,G+F),SEQ,SIG | |

LEXFOR O.1 (“Outgoing Particles”) – Double underline is for addition if we adopt option 1.

...

Note that the code SEQ should be given within the reaction code **only when it is a partial reaction**. If the author states that the reaction proceeds, *e.g.*, totally in the sequence (n,pn) without any contribution in the sequence (n,np), then the reaction is coded primarily as (1), above. A comment stating that the reaction proceeds entirely in the sequence (n,pn) may be added in free text (if this occurs at all) or, alternatively, both codes may be given in the form of a tautology:

Example:

REACTION ((...N,N+P)....,SIG)=(... (N,P+N)....,SEQ,SIG))

For the following partial reactions the specified sequence of process and particle codes is always indicated ~~by~~ without the code SEQ.

1. ~~Excitation of excited level(s) that decay by fission~~ Particle emission or process followed by fission:

~~— (n,n'f) cross section: (N,N+F),SEQ,SIG~~

(n, γ f) cross section: (N,G+F),SEQ,SIG

The process code F is always coded at the end in REACTION SF3.

2. Inelastic scattering followed by particle emission or process

(p,p'+ α) cross section: (P,INL+A),,SIG

(n,n'f) cross section: (N,INL+F),,SIG

The process code INL is always coded at the beginning in REACTION SF3.

3. ~~Emission of a primary gamma ray followed by unidentified decays~~ A process followed by an unspecified process:

(n, γ x) cross section for gamma ray emission followed by unspecified process cross section : (N,G+X),SEQ,SIG

~~— This formalism can occur only for the process codes F and X.~~

Only three process codes F, INL and X may be combined with other codes in REACTION SF3. For general rules on the coding of sequence of process/particle codes in REACTION SF3 and SF4 see EXFOR Formats Manual Chapter 6.

Appendix: Datasets compiled with SF3=X+* (EXFOR Master 2021-04-22)

| Dataset | REACTION | Remark |
|----------------|---|--|
| 11302.003 | (7-N-14(N,X+A)2-HE-4,,SIG) | Use SF3=A+X. |
| C0150.006 | (52-TE-0(P,X+N)53-I-126,,SIG) | Use SF3=X (activation). |
| C0150.007 | (52-TE-0(P,X+N)53-I-128,,SIG) | Use SF3=X (activation). |
| C0150.008 | (52-TE-0(P,X+N)53-I-130-G,M+,SIG) | Use SF3=X (activation). |
| C0410.002 | (62-SM-144(16-S-32,X+F),,SIG) | Use SF3=F (exclusion of quasi-fission is not discussed) |
| C0410.003 | (62-SM-150(16-S-32,X+F),,SIG) | Use SF3=F (exclusion of quasi-fission is not discussed) |
| C0410.004 | (62-SM-152(16-S-32,X+F),,SIG) | Use SF3=F (exclusion of quasi-fission is not discussed) |
| C0410.005 | (62-SM-154(16-S-32,X+F),,SIG) | Use SF3=F (exclusion of quasi-fission is not discussed) |
| C0410.006 | (70-YB-170(8-O-16,X+F),,SIG) | Use SF3=F (exclusion of quasi-fission is not discussed) |
| C0988.003 | (1-H-1(9-F-17,X+P)1-H-1,,DA,P+P,MSC) | Use SF3=P+X. |
| C0988.004 | (1-H-1(9-F-17,X+P)1-H-1,,DE,P+P,MSC) | Use SF3=P+X. |
| C0988.005 | (1-H-1(9-F-17,X+P)1-H-1,PAR,SIG,P+P) | Use SF3=P+X. |
| D0896.003 | (83-BI-209(3-LI-8,X+T)2-HE-4,,DA,T+A,AV/MSC) | Use SF3=T+X. |
| D0896.004 | (83-BI-209(3-LI-8,X+T)2-HE-4,,SIG,,AV/MSC) | Use SF3=T+X. |
| D6220.002 | (13-AL-27(3-LI-7,X+T)2-HE-4,,DA/DA) | Use SF3=T+X. |
| D6220.003 | (13-AL-27(3-LI-7,X+T)2-HE-4,,DA/DA) | Use SF3=T+X. |
| M0797.006 | (6-C-12(G,X+N)1-H-1,,DA/DE,P) | Use SF3=N+X. |
| M0797.007 | (6-C-12(G,X+N)1-H-1,,DA/DE,P) | Use SF3=N+X. |
| M0797.008 | (6-C-12(G,X+P)1-H-1,,DA/DE,P) | Use SF3=P+X. |
| M0797.009 | (6-C-12(G,X+P)1-H-1,,DA/DE,P) | Use SF3=P+X. |
| M0797.010 | ((6-C-12(G,X+PIN)1-H-1,,DA/DE,P)+ (6-C-12(G,X+PIP)1-H-1,,DA/DE,P)) | Use SF3=PIN+X and PIP+X (charged pion and proton detected) |
| M0797.011 | (6-C-12(G,X+N)1-H-1,,DA/DE,P) | Use SF3=N+X. |
| M0797.028 | (6-C-12(G,X+N)1-H-1,,DA/DE,P) | Use SF3=N+X. |
| M0797.029 | (6-C-12(G,X+N)1-H-1,,DA/DE,P) | Use SF3=N+X. |
| M0797.030 | (6-C-12(G,X+N)1-H-1,,DA/DE,P) | Use SF3=N+X. |
| M0797.031 | (6-C-12(G,X+N)1-H-1,,DA/DE,P) | Use SF3=N+X. |

| | | |
|-----------|---|--|
| M0797.032 | (6-C-12(G,X+N)1-H-1,,DA/DE,P) | Use SF3=N+X. |
| M0797.033 | (6-C-12(G,X+N)1-H-1,,DA/DE,P) | Use SF3=N+X. |
| M0797.034 | (6-C-12(G,X+N)1-H-1,,DA/DE,P) | Use SF3=N+X. |
| M0797.035 | ((6-C-12(G,X+PIN)1-H-1,,DA/DE,P)+ (6-C-12(G,X+PIP)1-H-1,,DA/DE,P)) | Use SF3=PIN+X and PIP+X (charged pion and proton detected) |
| M0797.036 | ((6-C-12(G,X+PIN)1-H-1,,DA/DE,P)+ (6-C-12(G,X+PIP)1-H-1,,DA/DE,P)) | Use SF3=PIN+X and PIP+X (charged pion and proton detected) |
| M0797.037 | ((6-C-12(G,X+PIN)1-H-1,,DA/DE,P)+ (6-C-12(G,X+PIP)1-H-1,,DA/DE,P)) | Use SF3=PIN+X and PIP+X (charged pion and proton detected) |
| M0797.038 | ((6-C-12(G,X+PIN)1-H-1,,DA/DE,P)+ (6-C-12(G,X+PIP)1-H-1,,DA/DE,P)) | Use SF3=PIN+X and PIP+X (charged pion and proton detected) |
| M0797.039 | ((6-C-12(G,X+PIN)1-H-1,,DA/DE,P)+ (6-C-12(G,X+PIP)1-H-1,,DA/DE,P)) | Use SF3=PIN+X and PIP+X (charged pion and proton detected) |
| M0797.040 | ((6-C-12(G,X+PIN)1-H-1,,DA/DE,P)+ (6-C-12(G,X+PIP)1-H-1,,DA/DE,P)) | Use SF3=PIN+X and PIP+X (charged pion and proton detected) |
| M0797.041 | ((6-C-12(G,X+PIN)1-H-1,,DA/DE,P)+ (6-C-12(G,X+PIP)1-H-1,,DA/DE,P)) | Use SF3=PIN+X and PIP+X (charged pion and proton detected) |
| M0797.042 | (6-C-12(G,X+P)1-H-1,,DA/DE,P) | Use SF3=P+X. |
| M0797.043 | (6-C-12(G,X+P)1-H-1,,DA/DE,P) | Use SF3=P+X. |
| M0797.044 | (6-C-12(G,X+P)1-H-1,,DA/DE,P) | Use SF3=P+X. |
| M0797.045 | (6-C-12(G,X+P)1-H-1,,DA/DE,P) | Use SF3=P+X. |
| M0797.046 | (6-C-12(G,X+P)1-H-1,,DA/DE,P) | Use SF3=P+X. |
| M0797.047 | (6-C-12(G,X+P)1-H-1,,DA/DE,P) | Use SF3=P+X. |
| M0797.048 | (6-C-12(G,X+P)1-H-1,,DA/DE,P) | Use SF3=P+X. |
| M0797.049 | (6-C-12(G,X+P)1-H-1,,DA/DE,P) | Use SF3=P+X. |
| M0797.050 | (6-C-12(G,X+N)1-H-1,,DA/DE,P) | Use SF3=N+X. |
| M0797.051 | (6-C-12(G,X+N)1-H-1,,DA/DE,P) | Use SF3=N+X. |
| M0797.052 | (6-C-12(G,X+N)1-H-1,,DA/DE,P) | Use SF3=N+X. |
| M0797.053 | (6-C-12(G,X+P)1-H-1,,DA/DE,P) | Use SF3=P+X. |
| M0797.054 | (6-C-12(G,X+P)1-H-1,,DA/DE,P) | Use SF3=P+X. |

| | | |
|-------------|-------------------------------|---|
| M0797.055 | (6-C-12(G,X+P)1-H-1,,DA/DE,P) | Use SF3=P+X. |
| O0761.010 | (1-H-1(P,X+PI)1-H-2,,DA) | Use SF3=PI+X (Events selected not by pi meson detection but by selection of pd~1370 MeV/c. Mention it under ANALYSIS) |
| O0761.011 | (1-H-2(P,X+PI)1-H-2,,DA) | Use SF3=PI+X (Events selected not by pi meson detection but by selection of pd~1370 MeV/c. Mention it under ANALYSIS) |
| O0761.012 | (3-LI-6(P,X+PI)1-H-2,,DA) | Use SF3=PI+X (Events selected not by pi meson detection but by selection of pd~1370 MeV/c. Mention it under ANALYSIS) |
| O0761.013 | (3-LI-7(P,X+PI)1-H-2,,DA) | Use SF3=PI+X (Events selected not by pi meson detection but by selection of pd~1370 MeV/c. Mention it under ANALYSIS) |
| O0761.014 | (6-C-12(P,X+PI)1-H-2,,DA) | Use SF3=PI+X (Events selected not by pi meson detection but by selection of pd~1370 MeV/c. Mention it under ANALYSIS) |
| O0761.015 | (13-AL-27(P,X+PI)1-H-2,,DA) | Use SF3=PI+X (Events selected not by pi meson detection but by selection of pd~1370 MeV/c. Mention it under ANALYSIS) |
| O0761.016 | (29-CU-63(P,X+PI)1-H-2,,DA) | Use SF3=PI+X (Events selected not by pi meson detection but by selection of pd~1370 MeV/c. Mention it under ANALYSIS) |
| O0761.017 | (45-RH-103(P,X+PI)1-H-2,,DA) | Use SF3=PI+X (Events selected not by pi meson detection but by selection of pd~1370 MeV/c. Mention it under ANALYSIS) |
| O0761.018 | (82-PB-208(P,X+PI)1-H-2,,DA) | Use SF3=PI+X (Events selected not by pi meson detection but by selection of pd~1370 MeV/c. Mention it under ANALYSIS) |
| O0837.011.1 | (6-C-12(P,X+P)1-PP-0,,SIG) | Use SF3-SF5=(PIP+X)1-H-1,NUM with PART-OUT=1 |
| O0837.011.2 | (6-C-12(P,X+2P)1-PP-0,,SIG) | Use SF3-SF5=(PIP+X)1-H-1,NUM with PART-OUT=2 |
| O0837.011.3 | (6-C-12(P,X+3P)1-PP-0,,SIG) | Use SF3-SF5=(PIP+X)1-H-1,NUM with PART-OUT=3 |
| O0837.012.1 | (6-C-12(P,X+P)1-PN-0,,SIG) | Use SF3-SF5=(PIN+X)1-H-1,NUM with PART-OUT=1 |
| O0837.012.2 | (6-C-12(P,X+2P)1-PN-0,,SIG) | Use SF3-SF5=(PIN+X)1-H-1,NUM with PART-OUT=2 |
| O0837.012.3 | (6-C-12(P,X+3P)1-PN-0,,SIG) | Use SF3-SF5=(PIN+X)1-H-1,NUM with PART-OUT=3 |
| O0837.013.1 | (41-NB-93(P,X+P)1-PP-0,,SIG) | Use SF3-SF5=(PIP+X)1-H-1,NUM with PART-OUT=1 |
| O0837.013.2 | (41-NB-93(P,X+2P)1-PP-0,,SIG) | Use SF3-SF5=(PIP+X)1-H-1,NUM with PART-OUT=2 |
| O0837.013.3 | (41-NB-93(P,X+3P)1-PP-0,,SIG) | Use SF3-SF5=(PIP+X)1-H-1,NUM with PART-OUT=3 |
| O0837.014.1 | (41-NB-93(P,X+P)1-PN-0,,SIG) | Use SF3-SF5=(PIN+X)1-H-1,NUM with PART-OUT=1 |
| O0837.014.2 | (41-NB-93(P,X+2P)1-PN-0,,SIG) | Use SF3-SF5=(PIN+X)1-H-1,NUM with PART-OUT=2 |

| | | |
|-------------|---------------------------------|---|
| O0837.014.3 | (41-NB-93(P,X+3P)1-PN-0,,SIG) | Use SF3-SF5=(PIN+X)1-H-1,NUM with PART-OUT=3 |
| O0837.015.1 | (82-PB-0(P,X+P)1-PP-0,,SIG) | Use SF3-SF5=(PIP+X)1-H-1,NUM with PART-OUT=1 |
| O0837.015.2 | (82-PB-0(P,X+2P)1-PP-0,,SIG) | Use SF3-SF5=(PIP+X)1-H-1,NUM with PART-OUT=2 |
| O0837.015.3 | (82-PB-0(P,X+3P)1-PP-0,,SIG) | Use SF3-SF5=(PIP+X)1-H-1,NUM with PART-OUT=3 |
| O0837.016.1 | (82-PB-0(P,X+P)1-PN-0,,SIG) | Use SF3-SF5=(PIN+X)1-H-1,NUM with PART-OUT=1 |
| O0837.016.2 | (82-PB-0(P,X+2P)1-PN-0,,SIG) | Use SF3-SF5=(PIN+X)1-H-1,NUM with PART-OUT=2 |
| O0837.016.3 | (82-PB-0(P,X+3P)1-PN-0,,SIG) | Use SF3-SF5=(PIN+X)1-H-1,NUM with PART-OUT=3 |
| O1855.002 | (4-BE-9(6-C-14,X+N)6-C-13,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.003 | (4-BE-9(6-C-15,X+N)6-C-14,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.004 | (4-BE-9(6-C-16,X+N)6-C-15,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.005 | (4-BE-9(6-C-17,X+N)6-C-16,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.006 | (4-BE-9(6-C-18,X+N)6-C-17,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.007 | (4-BE-9(6-C-19,X+N)6-C-18,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.008 | (4-BE-9(7-N-16,X+N)7-N-15,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.009 | (4-BE-9(7-N-17,X+N)7-N-16,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.010 | (4-BE-9(7-N-18,X+N)7-N-17,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.011 | (4-BE-9(7-N-19,X+N)7-N-18,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.012 | (4-BE-9(7-N-20,X+N)7-N-19,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.013 | (4-BE-9(7-N-21,X+N)7-N-20,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.014 | (4-BE-9(7-N-22,X+N)7-N-21,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.015 | (4-BE-9(8-O-19,X+N)8-O-18,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.016 | (4-BE-9(8-O-20,X+N)8-O-19,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.017 | (4-BE-9(8-O-21,X+N)8-O-20,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.018 | (4-BE-9(8-O-22,X+N)8-O-21,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.019 | (4-BE-9(8-O-23,X+N)8-O-22,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.020 | (4-BE-9(9-F-21,X+N)9-F-20,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.021 | (4-BE-9(9-F-22,X+N)9-F-21,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.022 | (4-BE-9(9-F-23,X+N)9-F-22,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.023 | (4-BE-9(9-F-24,X+N)9-F-23,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.024 | (4-BE-9(9-F-25,X+N)9-F-24,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |

| | | |
|-------------|--|---|
| O1855.025 | (4-BE-9(9-F-26,X+N)9-F-25,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.026 | (4-BE-9(10-NE-24,X+N)10-NE-23,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.027 | (4-BE-9(10-NE-25,X+N)10-NE-24,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.028 | (4-BE-9(10-NE-26,X+N)10-NE-25,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.029 | (4-BE-9(10-NE-27,X+N)10-NE-26,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.030 | (4-BE-9(10-NE-28,X+N)10-NE-27,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.031 | (4-BE-9(11-NA-27,X+N)11-NA-26,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.032 | (4-BE-9(11-NA-28,X+N)11-NA-27,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.033 | (4-BE-9(11-NA-29,X+N)11-NA-28,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.034 | (4-BE-9(11-NA-30,X+N)11-NA-29,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.035 | (4-BE-9(11-NA-31,X+N)11-NA-30,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.036 | (4-BE-9(12-MG-31,X+N)12-MG-30,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.037 | (4-BE-9(12-MG-32,X+N)12-MG-31,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.038 | (4-BE-9(12-MG-33,X+N)12-MG-32,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.039 | (4-BE-9(13-AL-34,X+N)13-AL-33,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1855.040 | (4-BE-9(13-AL-35,X+N)13-AL-34,,SIG) | Use SF3=X (production cross section from GSI MUSIC) |
| O1856.005 | (30-ZN-64(4-BE-11,X+N)4-BE-10,,DA) | Use SF3=X (10Be events). |
| O1868.005.1 | (14-SI-28(5-B-8,X+A)2-HE-3,,SIG) | Use SF2=4-BE-7, SF3=HE3+X, SF4=2-HE-4 |
| O1868.005.2 | (14-SI-28(5-B-8,X+3-LI-6)1-H-1,,SIG) | Use SF2=4-BE-7, SF3=P+X, SF4=3-LI-6 |
| O1868.005.3 | (14-SI-28(5-B-8,X+P+A)2-HE-3,,SIG) | Use SF3=P+HE3+X, SF4=2-HE-4 |
| O1868.005.4 | (14-SI-28(5-B-8,X+2P)3-LI-6,,SIG) | Use SF3=2P+X, SF4=3-LI-6 |
| O1918.004 | (6-C-12(13-AL-23,X+P)12-MG-22,PAR,SIG,G) | Use SF3=X (22Mg events). |
| S0081.004.1 | (79-AU-197(7-N-17,X+A)5-B-10,,SIG) | Use SF3=A+X. |
| S0081.004.2 | (79-AU-197(7-N-17,X+A)5-B-11,,SIG) | Use SF3=A+X. |
| S0081.004.3 | (79-AU-197(7-N-17,X+A)5-B-12,,SIG) | Use SF3=A+X. |
| S0081.004.4 | (79-AU-197(7-N-17,X+A)5-B-13,,SIG) | Use SF3=A+X. |
| S0081.005.1 | (4-BE-9(7-N-17,X+A)5-B-10,,SIG) | Use SF3=A+X. |
| S0081.005.2 | (4-BE-9(7-N-17,X+A)5-B-11,,SIG) | Use SF3=A+X. |
| S0081.005.3 | (4-BE-9(7-N-17,X+A)5-B-12,,SIG) | Use SF3=A+X. |
| S0081.005.4 | (4-BE-9(7-N-17,X+A)5-B-13,,SIG) | Use SF3=A+X. |

| | | |
|-------------|--|----------------------------------|
| S0081.006.1 | (79-AU-197(7-N-17,X+3-LI-6)4-BE-7,,SIG) | Use SF3=3-LI-6+X. |
| S0081.006.2 | (79-AU-197(7-N-17,X+3-LI-6)4-BE-9,,SIG) | Use SF3=3-LI-6+X. |
| S0081.006.3 | (79-AU-197(7-N-17,X+3-LI-6)4-BE-10,,SIG) | Use SF3=3-LI-6+X. |
| S0081.007.1 | (4-BE-9(7-N-17,X+3-LI-6)4-BE-7,,SIG) | Use SF3=3-LI-6+X. |
| S0081.007.2 | (4-BE-9(7-N-17,X+3-LI-6)4-BE-9,,SIG) | Use SF3=3-LI-6+X. |
| S0081.007.3 | (4-BE-9(7-N-17,X+3-LI-6)4-BE-10,,SIG) | Use SF3=3-LI-6+X. |
| S0081.008.1 | (79-AU-197(7-N-17,X+3-LI-7)4-BE-7,,SIG) | Use SF3=3-LI-7+X. |
| S0081.008.2 | (79-AU-197(7-N-17,X+3-LI-7)4-BE-9,,SIG) | Use SF3=3-LI-7+X. |
| S0081.008.3 | (79-AU-197(7-N-17,X+3-LI-7)4-BE-10,,SIG) | Use SF3=3-LI-7+X. |
| S0081.009.1 | (4-BE-9(7-N-17,X+3-LI-7)4-BE-7,,SIG) | Use SF3=3-LI-7+X. |
| S0081.009.2 | (4-BE-9(7-N-17,X+3-LI-7)4-BE-9,,SIG) | Use SF3=3-LI-7+X. |
| S0081.009.3 | (4-BE-9(7-N-17,X+3-LI-7)4-BE-10,,SIG) | Use SF3=3-LI-7+X. |
| S0081.010.1 | (79-AU-197(7-N-17,X+3-LI-8)4-BE-7,,SIG) | Use SF3=4-BE-7+X and SF4=3-LI-8. |
| S0081.010.2 | (79-AU-197(7-N-17,X+3-LI-8)4-BE-9,,SIG) | Use SF3=3-LI-8+X. |
| S0081.011.1 | (4-BE-9(7-N-17,X+3-LI-8)4-BE-7,,SIG) | Use SF3=4-BE-7+X and SF4=3-LI-8. |
| S0081.011.2 | (4-BE-9(7-N-17,X+3-LI-8)4-BE-9,,SIG) | Use SF3=3-LI-8+X. |
| T0178.003 | (3-LI-6(3-LI-6,X+A)2-HE-4,,DA2/DE2,A/A) | Use SF3=A+X. |
| T0178.004 | (3-LI-6(3-LI-6,X+D)1-H-2,,DA2/DE2,D/D) | Use SF3=D+X. |