

## Coding of Fragment Separator (FRS, PRJFS)

(N. Otsuka, 2018-04-26, Memo CP-D/958)

The LEXFOR “Measurement Techniques” explains that

FACILITY is used to identify the main apparatus or machine used in the experiment, e.g., reactor or cyclotron.

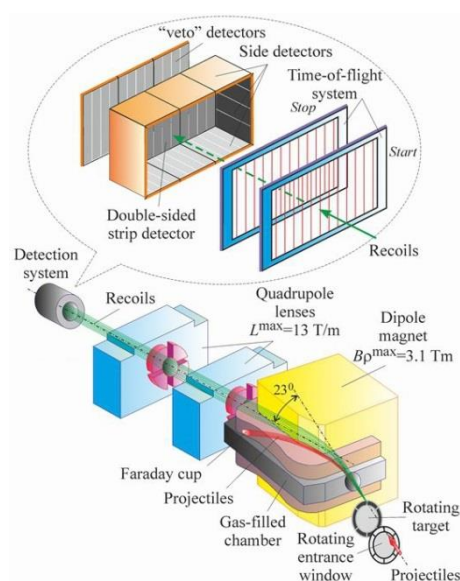
A fragment separator may be used to analyze (1) secondary beam (REACTION SF2), or (2) reaction products (REACTION SF4), and two codes FRS (fragment separator) and PRJFS (Secondary beam from projectile fragment separator) are currently defined in Dict. 18 (Facility). I observe some problems in their actual usages:

### Example 1 (EXFOR A0920): Separation of fragment produced by the reaction of interest

FACILITY	(CYCLO,4ZZZDUB) Experiments were Carried Out at the	A085600100020
	U-400 Cyclotron	A085600100021
	(FRS,4ZZZDUB) the Dubna gas-filled recoil separator	A085600100022
METHOD	(TOF)	A085600100023
...		
DETECTOR	(MCPLT) a 4-cm*12-cm semiconductor detector array with	A085600100031
...		
REACTION	(98-CF-249(20-CA-48,3N)118-OG-294,,SIG)	A085600200003

$^{48}\text{Ca}$  accelerated by a JINR cyclotron induced  $^{249}\text{Cf}(^{48}\text{Ca},3n)^{294}\text{Og}$  reaction. The produced  $^{294}\text{Og}$  was analyzed by a recoil separator (Dubna Gas Filled Recoil Separator DGFRS, see the image downloaded from a JINR website), and its decay as were detected by a semiconductor detector.

The recoil separator is one of the major instruments of this experiment. However it is a part of the *detection system*, and must be coded by MAGSP under DETECTOR.



### Example 2 (EXFOR A0493): Separation of fragment producing secondary beam

```
INC-SOURCE (SPALL) The helium ions produced by fragmentation of 18-O entered FRS and were separated according to their magnetic rigidity. The beam intensities were 1000 1/sec, with the duty factor between 25% and 50%.
...
FACILITY (FRS,2GERGSI)
ERR-ANALYS (ERR-1).The uncertainty in the data normalization.
...
REACTION ((1-H-1(2-HE-6,EL)1-H-1,,DT)=(2-HE-6(P,EL)2-HE-6,,DT))
```

$^{18}\text{O}$  accelerated by a GSI synchrotron on Be target produced  $^4\text{He}$ ,  $^6\text{He}$  and  $^8\text{He}$  secondary beams, and they irradiated a hydrogen target after separation by a fragment separator (FRS):

The fragment separator one major instruments of the experiment. However the synchrotron is the apparatus to be coded under FACILITY. The role of the fragmentation Be( $^{18}\text{O}$ , $^6\text{He}$ ) etc. is an incident source reaction similar to D-T neutron production by  $^3\text{H}(\text{d},\text{n})^4\text{He}$ . Some entries actually use INC-SOURCE to indicate the secondary beam production under INC-SOURCE:

```
TITLE Quasielastic scattering of 9Li on 12C
INC-SOURCE A1200 fragment separator at Michigan State University.
FACILITY (CYCLO,1USAMSU)
...
```

### Proposals

I suggest to

1. indicate separation of reaction product MAGSP under DETECTOR
2. indicate use of fragmentation for secondary beam production by FRAGM (fragmentation) under INC-SOURCE. This new code is similar to SPALL (spallation) for high energy neutron production.
3. make PRJFS and FRS obsolete (which have not been distinguished in a consistent manner.)

There are a number of entries coded with FRS or PRJFS, and I do *not* suggest retransmission of affected entries only for this change.

### Revision of LEXFOR “Measurement Techniques”

Below is an explanation on INC-SOURCE existed in the same LEXFOR “**Measurement Techniques**” extracted from an old LEXFOR (IAEA-NDS-3, Rev.96/11):

This keyword is used exclusively for the nuclear reaction used as an incident projectile source. The apparatus in which this reaction took place is entered under FACILITY, and the quality of the resulting particle beam is entered under INC-SPECT (see under Incident-Projectile Energy).

This explains the proper use of FACILITY, INC-SOURCE and INC-SPECT very well, and I propose to restore this paragraph in LEXFOR.

**Dictionary 5 (Facility)**

FRS (Obsolete)  
PRJFS (Obsolete)

**Dictionary 19 (Incident sources)**

FRAGM Fragmentation