

NUMEXO2 data formats v1.4

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Revisions	Comments
Rev 1.2	Modification of status fields of EXOGAM Crystal Data Frame
Rev 1.3	Modification of Cristal number in CrystalId field (§2.2) Correction of an error on metaType on all frames
Rev 1.4	Frame size aligned on 32 bits word, and expressed in block units of 32 bits

1 Introduction

This document specifies version 1.4 of data frames produced by the NUMEXO2 boards. The specification is based on version 2.2 of the Multiframe Meteformat (MFM2.2) defined in the corresponding document.

The NUMEXO2 board is able to produce data for EXOGAM and for NEDA detectors.

There are presently 4 use cases, each corresponding to a data frame type:

- Exogam Crystal data issued from a physical event (EC-Frame)
- Oscilloscope data (O-Frame)
- Neda raw sample data (NR-Frame)
- Neda compressed data (NC-Frame)

2 EXOGAM Physics Data Format

2.1 EXOGAM general remarks, conventions and constraints

- (1) Physics Data produced by NUMEXO2 are issued from two Ge Crystals. Data of one Crystal will be contained in a Crystal-Frame (EC-Frame).
- (2) Data are coded on 16 bits, which can be signed or not, depending on the channel (*to be precised after algorithms debugging*)
- (3) Three status words mark the status of the 16 channels with the following organization:
bit [0:7] CRYSTAL NUMBER 1 (HALF CLOVER) with:
 - bit [0] : INNER 1_1 6MeV
 - bit [1] : INNER 1_1 20MeV
 - bit [2] : OUTER 1_1
 - bit [3] : OUTER 2_1
 - bit [4] : OUTER 3_1
 - bit [5] : OUTER 4_1
 - bit [6] : BGO 1_1
 - bit [7] : CsI 1_1bit [8:15] CRYSTAL NUMBER 2
 - bit [8] : INNER 1_2 6MeV

bit [9] : INNER 1_2 20MeV
 bit [10] : OUTER 1_2
 bit [11] : OUTER 1_2
 bit [12] : OUTER 1_2
 bit [13] : OUTER 1_2
 bit [14] : BGO 1_2
 bit [15] : Cs I1_2

- (4) Valid data will be marked in the status1 word
- (5) Pile-up information will be marked in the status2 word
- (6) The status3 word will mark if Outer data result from mirror charges
- (7) As the readout fifo of NUMEXO2 is made of 32 bits words, frame size has to be aligned on 32 bits.

2.2 EXOGAM Crystal Data Frame Format

A Crystal Frame (EC-Frame) is a fixed length Frame , of type « Blob Frame » in the MFM2.2 terminology.

The following table describes all the fields of a Crystal Frame.

Field name	Bytes	Description
metaType	1	Set to 0x42 (binary 01000010) big endian, blob frame, unit block size of $2^2=32$ bits
frameSize	3	Total size of the Frame <i>expressed in block units of 32 bits</i> set to 13
subsystemNumber	1	Number of the detector subsystem in the complete data acquisition system. <i>To be initialized at the setup of the configuration</i>
frameType	2	The EC-Frame frameType code is set to 0x10
revision	1	Set to 0 because it is the revision 0 of the EC-Frame
EventNumber	4	Event number issued from the GTS trigger
TimeStamp	6	Time offset of the frame as compared to the last reset of the GTS trigger
CrystalId	2	The CrystalId is composed of a Board index in the system from which the frame originates (bits 15..5) and of the Trigger Request number (TR) in the board (bits 4..0). <i>TR=0 for Crystal number 1, TR=8 for Crystal number 2</i>
Status1	2	Pattern of valid data for each channel 0 -> NO VALID DATA => ENERGY[15..0] = 0xFFFF when Overflow (ADC samples) => ENERGY[15..0] and TIME[15..0] = 0 for all other cases 1 -> VALID DATA
Status2	2	Pattern for PILE-UP information for each channel 0 -> NO PILE-UP 1 -> PILE-UP
Status3	2	Pattern of MIRROR CHARGES of OUTER channels ONLY 0 -> ENERGY 6MeV 1 -> MIRROR CHARGE STATUS3 [1..0] = 0 and STATUS3 [8..9] = 0 -> INNER bits not used

STATUS3 [6..7] = 0 and STATUS3 [14..15] = 0 -> BGO & CsI bits not used		
Inner Delta T	2	Time measurement between the inner discriminator and an external Stop signal
Inner 6 Mev	2	Energy Inner (6 Mev range)
Inner 20 Mev	2	Energy Inner (20 Mev range)
Outer 1	2	Energy Outer 1 (6 Mev)
Outer 2	2	Energy Outer 2 (6 Mev)
Outer 3	2	Energy Outer 3 (6 Mev)
Outer 4	2	Energy Outer 4 (6 Mev)
BGO	2	Energy BGO
Csi	2	Energy Csi
Inner T30	2	Rise time at 30% of final value
Inner T60	2	Rise time at 60% of final value
Inner T90	2	Rise time at 90% of final value
Padding	2	0

A Crystal Blob Frame looks like the following figure :

15	8	7	0
metaType = 0x42		frameSize[23..16] = 0	
frameSize[15..0] = 13			
subsystemNumber		frameType[15..8] = 0	
FrameType[7..0] = 0x10		revision = 0	
EventNumber [31..16]			
EventNumber [15..0]			
TimeStamp[47..32]			
TimeStamp[41..16]			
TimeStamp[15..0]			
CrystalId			
Status1			
Status2			
Status3			
Delta T			
Inner 6 Mev			
Inner 20 Mev			
Outer 1			
Outer 2			

Outer 3
Outer 4
BGO
Csi
InnerT30
InnerT60
InnerT90
padding

3 Oscilloscope Data Format

An oscilloscope data block for an electronic channel is a « Basic Frame », in the MFM2.2 terminology, containing a « Header » followed by a data section composed of a variable number of fixed sized « Items »

3.1 Oscilloscope general remarks, conventions and constraints

- (1) The oscilloscope functionality of the NUMEXO2 board provides a 4 oscilloscope channels. An input channel of the board can be connected to any oscilloscope channel.
- (2) The *channelId* field identifies the oscilloscope channel. The input channel associated is described in the *config* field containing the configuration word as defined in the oscilloscope documentation of NUMEXO2

3.2 Header field of the Oscilloscope Data Frame (O-Frame)

The following table described the fields of an O-Frame Header beginning with the standard Header fields of the MFM2.2 Basic Frame and completed with specific fields.

Field name	Bytes	Description
metaType	1	Set to 0x2 (binary 00000010) big endian, basic frame, unit block size of $2^2=32$ bits
frameSize	3	Total size of the Frame (including Header) expressed in block units of 32 bits
subsystemNumber	1	Number of the detector subsystem in the system.
frameType	2	The O-Frame frameType code is set to 0x11
revision	1	Set to 0 , because it corresponds to revision 0 of the O-Frame data format
headerSize	2	Must be expressed as an integer number of units blocks defined in the metaType field which is 32 bits. So the value of the headerSize is set to 5
itemSize	2	Size of a data item in bytes. It is set to 2
nItems	4	Total number of items in the frame. Because of the 32bits data readout fifo of NUMEXO2, the number of samples has to be even
channelId	2	The channelId is composed of a Board index in the system from which the frame originates (bits 15..5)and of the oscilloscope

<i>channel number in the board</i> (bits 4..0)		
config	2	Configuration word as defined in the oscilloscope documentation of NUMEXO2

The O-Frame header looks like as follow :

15	8	7	0
MetaType = <i>0x02</i>		FrameSize[23..16]	
FrameSize[15..0]			
subsystemNumber		FrameType[15..8] = <i>0</i>	
FrameType[7..0] = <i>0x11</i>		Revision = <i>0</i>	
HeaderSize = <i>0x05</i>			
ItemSize = <i>2</i>			
nItems[31..16]			
nItems[15..0]			
channelId			
Config			

3.3 Data section of the Oscilloscope Data Frame (O-Frame)

An « Item » of the data section contains one sample defined as a 16 bits value.

15	0
Sample value	

4 NEDA Physics Data Frame Format

Physics data produced by NUMEXO2 for NEDA detectors are 14 bits data samples. Two cases arise according to whether some compression is applied or not, leading to the two different frames : Neda raw data frames (NR-Frame) and Neda compressed data frames (NC-Frame)

A data block for an electronic channel is contained in a « Basic Frame », in the MFM2.2 terminology, containing a « Header » followed by a data section composed of a variable number of fixed sized « Items ». The Header is common to the NR-Frame and the NC-Frame, except the frameType.

4.1 Header field of the NEDA Data Frame

The following table described the fields of a Data Frame Header beginning with the standard Header fields of the MFM2.2 Basic Frame and completed with specific fields.

Field name	Bytes	Description
metaType	1	<i>Set to 0x02 (binary 00000002)</i> big endian, basic frame, unit block size of $2^2=32$ bits
frameSize	3	Total size of the Frame (including Header) <i>expressed in block units of 32 bits</i>
subsystemNumber	1	Number of the detector subsystem in the system.
frameType	2	The NR-Frame frameType code is <i>set to 0x12</i> The NC-Frame frameType code is <i>set to 0x13</i>
revision	1	<i>Set to 0</i> , because it corresponds to revision 0 of the NR-Frame data format
headerSize	2	Must be expressed as an integer number of units blocks defined in the metaType field which is 32 bits. So the value of the headerSize is <i>set to 7 (0x7)</i>
itemSize	2	Size of a data item in bytes. It is <i>set to 2</i>
nItems	4	Total number of items in the frame. Because of the 32bits data readout fifo of NUMEXO2, the number of samples has to be even
channelId	2	The channelId is composed of a <i>Board index</i> in the system from which the frame originates (bits 15:5)and of the <i>channel number in the board</i> (bits 4:0)
eventNumber	4	Event number issued from the GTS trigger
timeStamp	6	Time stamp of the data

The header has the following format :

15	8	7	0
metaType = 0x02		frameSize[23..16]	
FrameSize[15..0]			
subsystemNumber		frameType[15..8] = 0	
frameType[7..0] = 0x12		revision = 0	
headerSize = 0x07			
itemSize = 2			
nItems[31..16]			
nItems[15..0]			
channelId			
eventNumber[31..16]			
eventNumber[15..0]			
timeStamp[47..32]			
timeStamp[41..16]			
timeStamp[15..0]			

4.2 Raw Data Item

An « Item » of the Raw data section contains one sample defined as a 16 bits value.

15	0
Sample value	

4.3 Compressed data Item

A proposition could be to code the data section with an index of the sample coded on 8 bits (range 0 to 255) followed by the sample value on 16 bits.

An Item of the Compressed data section is defined as a 24 bits structure :

23	16	15	0
sampleIndex		Sample value	