

Confocor3 Raw Data Specification

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Klaus Weisshart from Zeiss provided this updated annotated hex dump of a ConfoCor3 file (in a 5/2/2007 8:17 E-mail):

File offset	Hexadecimal	ASCII	
000000	43 61 72 6C 20 5A 65 69 73 73 20 43 6F 6E 66 6F	Carl Zeiss Confo	<input type="checkbox"/> File identifier (incl. channel) <input type="checkbox"/> Measurement identifier <input type="checkbox"/> Position (zero based) <input type="checkbox"/> Kinetics index (zero based) <input type="checkbox"/> Repetition (zero based) <input type="checkbox"/> Detector clock frequency (Hz) <input type="checkbox"/> First pulse distance in detector clocks
000010	43 6F 72 33 20 2D 20 72 61 77 20 64 61 74 61 20	Cor3 - raw data	
000020	66 69 6C 65 20 2D 20 76 65 72 73 69 6F 6E 20 33	file - version 3	
000030	2E 30 30 30 20 2D 20 43 68 61 6E 6E 65 6C 20 31	.000 - Channel 1	
000040	A3 7C 29 64 37 8E BD 41 8A D4 BD 0A EC D2 59 C8	.|)d7 .A Y.	
000050	00 00 00 00 00 00 00 00 00 00 00 00 00 2D 31 01	. . . . . -1.
000060	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	
000070	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	
000080	60 42 03 00 95 34 02 00 91 0A 00 00 C3 24 03 00	"B. .4. . . . \$.	
000090	27 B7 02 00 9D 00 00 00 9A 6F 01 00 41 DC 00 00	. . . . . A.
0000a0	49 6C 00 00 1A 92 01 00 30 C9 0E 00 E7 4F 01 00	Il 0 . . . 0 .	
0000b0	10 0D 00 00 FA 1A 00 00 1B BE 00 00 7E 78 00 00	. . . . . x.
0000c0	31 E8 00 00 44 6D 00 00 44 96 02 00 73 63 01 00	l . . Dm . . D . . sc .	
0000d0	AD 71 00 00 C1 6E 02 00 E2 3B 00 00 23 96 00 00	. q . n # . . .	
0000e0	AF 30 00 00 F3 67 06 00 C5 9D 00 00 70 C4 04 00	. 0 . . g p . . .	
0000f0	76 DB 01 00 E4 32 02 00 27 0F 01 00 79 B6 02 00	v . . . 2 y . . .	
000100	23 0F 00 00 9F 51 03 00 C6 46 01 00 3A 46 00 00	# . . . Q . . F . . F . .	
000110	29 59 00 00 97 A6 01 00 DD 33 01 00 D8 A3 05 00	)Y 3
000120	A4 80 01 00 19 1B 01 00 C4 95 03 00 74 CE 02 00	. . . . . t
000130	74 BA 0B 00 37 29 04 00 DC 63 01 00 78 3E 01 00	t . . . 7) . . . c . x > . .	
000140	2F FE 02 00 FB 00 00 00 01 01 00 00 58 50 01 00	/ XP	
000150	EB 27 00 00 99 A2 01 00 D3 79 00 00 EA B6 00 00	. . . . . y
000160	75 61 01 00 47 68 01 00 CA 22 00 00 60 4B 00 00	ua . Gh K . . .	
000170	F1 AF 00 00 73 78 01 00 47 EF 01 00 E0 E5 01 00	. . . . . sx . G
000180	16 F6 02 00 44 E7 00 00 94 5B 05 00 0C 6B 03 00	. . . . . D [. . k . .
000190	8B 69 00 00 29 F1 03 00 29 14 05 00 98 B8 01 00	. i)	
0001a0	92 89 00 00 01 D1 01 00 0D F3 00 00 00 C4 00 00	
0001b0	4A 1B 04 00 51 3D 00 00 AB 7F 00 00 D2 3D 02 00	J . . Q = = . . .	
0001c0	DF DB 00 00 A0 76 01 00 03 00 00 00 C2 24 03 00	. . . . . v \$. . .
0001d0	79 02 02 00 3F C0 02 00 32 32 05 00 C8 38 00 00	y . . . ? . . 22 . . 8 . .	
0001e0	67 3F 00 00 0C 18 01 00 64 5F 00 00 9C 7E 01 00	g ? d ~ . . .	
0001f0	00 D1 06 00 74 EF 04 00 08 E9 00 00 DB AD 02 00	. . . . . t
000200	2C 21 02 00 19 C3 02 00 2A 74 02 00 2B 76 00 00	. . . . . * t . . + v . . .
000210	B1 6C 01 00 7A 21 00 00 3E B5 00 00 69 51 00 00	. l . z ! . . > . . i Q . . .	
000220	B5 63 00 00 1E 4D 00 00 7F 78 02 00 2C E6 01 00	. c . . M . . . x	
000230	99 F3 01 00 9A 48 00 00 A6 21 02 00 E5 2C 00 00	. . . . . H l
000240	9E 23 00 00 98 D2 00 00 7B 95 01 00 B0 27 03 00	. # {	
000250	63 50 02 00 FF 39 00 00 02 A3 01 00 B5 93 02 00	cP . . . 9	
000260	66 08 02 00 61 37 00 00 B4 30 00 00 72 4E 00 00	f . . a 7 . . . 0 . r N . . .	
000270	F7 07 04 00 1F 32 01 00 08 00 03 00 66 C3 01 00	. . . . . 2 f
000280	86 7C 00 00 44 2C 00 00 DA 29 01 00 CD AF 01 00	. | . . D)	
000290	6F 28 00 00 5C 71 02 00 D6 09 08 00 AB 28 00 00	o (. . \ q (. . . .	
0002a0	B5 68 06 00 F1 6A 01 00 C9 2F 01 00 3D 85 00 00	. h . . . j . . . / . . = . . .	
0002b0	97 9B 00 00 86 0B 00 00 79 D6 00 00 3D 39 01 00	. . . . . y = 9 . . .
0002c0	CD E7 02 00 B4 77 01 00 83 9A 09 00 2D BF 03 00	. . . . . w -
0002d0	68 B0 01 00 FD 24 00 00 15 B1 01 00 D3 97 00 00	h \$	
0002e0	15 19 01 00 8D 98 00 00 43 AC 01 00 75 20 00 00	. . . . . C u
0002f0	77 86 03 00 8F CC 00 00 20 F0 00 00 95 25 00 00	w %	
000300	9B AE 01 00 3F 39 00 00 57 23 01 00 63 52 01 00	. . . . . ? 9 . . W # . . c R . . .
000310	E7 73 01 00 C0 05 01 00 41 A9 00 00 9D 7B 01 00	. s A {	
000320	87 FA 02 00 4D E6 00 00 15 8D 01 00 85 52 02 00	. . . . . M R
000330	61 8F 00 00 40 2A 00 00 72 DB 02 00 0C D4 02 00	a . . . @ * . . r	
000340	DC 21 03 00 80 53 03 00 CE 2E 01 00 7D 1F 00 00	. l . . . S }	
000350	84 C4 01 00 A2 17 03 00 A3 12 00 00 BF E6 00 00	. . . . . * . . lu
000360	9A 84 02 00 9F 2A 00 00 21 75 00 00 F9 84 00 00	. 8 s &	
000370	C1 38 00 00 A8 9A 02 00 73 E0 01 00 A3 26 02 00	. ? 3 . MJ	
000380	FF 0C 01 00 AB E5 01 00 C7 11 00 00 CC 03 01 00	. . . . . X . . . c . . # . . .
000390	3F 2E 00 00 F6 A9 00 00 D8 33 00 00 4D 4A 01 00	. u A	
0003a0	A3 15 00 00 58 DA 03 00 63 B0 00 00 82 23 06 00	. . . . . X
0003b0	BA 75 05 00 1A 1D 05 00 15 41 01 00 E3 22 01 00	. & . . \ (. . Y . . Je . . .	
0003c0	CC CE 00 00 BF 95 00 00 60 DA 00 00 FB 58 03 00		
0003d0	C9 26 00 00 5C 28 00 00 59 93 05 00 4A 65 00 00		

The ConfoCor3 Operating Manual (Release 4.0, March 2006) provided some additional details about the fields, but the file layout has changed somewhat.

Using this new information, I now interpret a raw Confocor3 file as follows:

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ConfoCor 3 File Layout

Example filename: **dc0a40540b831f7efb272a095c923f5_R10_P1_K1_Ch1.raw**

Field	Start	Size [Bytes]	Type	Comments
File Identifier	0	64	Character[64]	File Identifier with channel number. This field can be parsed into several parts: Carl Zeiss ConfoCor3 - raw data file - version 3.000 - Channel 1
Measurement Identifier	64	16	Integer4[4]	This will be assigned to all channels of the same repetition. Hence, in a cross-correlation experiment, the two auto-correlation pairs that belong together can be identified. In this example: dc0a40540b831f7efb272a095c923f5 (Note: this is the hex form from 4 32-bit little endian integers processed one at a time)
Measurement Position	80	4	Integer4	Zero based: P1 in filename means this will be 0
Kinetic Index	84	4	Integer4	Zero based: K1 in filename means this will be 0
Repetition Number	88	4	Integer4	Zero based: R10 in filename means this will be 9
Sampling Frequency	92	4	Integer4	0x002D3101 (little endian) 20000000 (decimal) (i.e., 20 MHz)
Reserved	96	32	Integer4[8]	Always 0s?
Pulse Distances	128	Filesize – 128	Integer4[(Filesize -128)/4]	

Integer4 = 4-byte "little endian" unsigned integer

The Time Delta Array (Pulse Distances) are all Integer4s representing detector clocks at the given Sampling Frequency (usually 20 MHz). The size of this array can be computed: $[\text{FileSize} - 128] / 4 =$ number of elements in time delta array.

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With a 20 MHz Sampling Frequency, the sum of the time deltas will overflow a 32-bit integer after 214.74 seconds of data collection. If data samples are shorter than this, then 32-bit integers are sufficient to process the time delta array.

Example of Confocor3 Processing

Form Time Array

Convert time deltas to absolute time values (detector clocks):

$$\Delta T[\text{Clocks}] = 484459 \ 261406 \ 32838 \ 15657 \ 23050 \ (\text{decimal})$$

$$T0[\text{Clocks}] = 0$$

$$T1 = T0 + \Delta T0 = 0 + 484459 = 484459$$

$$T2 = T1 + \Delta T1 = 484459 + 261406 = 745865$$

$$T3 = T2 + \Delta T2 = 745865 + 32838 = 778703$$

...

$$T = 484459 \ 745865 \ 778703 \ 794360 \ 817410$$

This array of time values, T, in detector clocks can be divided by the sampling frequency, 20 MHz (i.e., 20E6) to give values in seconds.

Use Integer Division to Bin

Bins should be chosen to correspond to a time interval that is a multiple of the sampling frequency. Each "width" of the bin in bits can be chosen to be any number, say BinSize.

Simple integer division (DIV) gives the bin index, and the counts in each bin can be easily computed:

$$\text{BinIndex} = T \text{ DIV } \text{BinSize}$$

$$\text{Bins}[\text{BinIndex}]++ \quad [\text{sum bin counts in IDL}]$$

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Annotated Example:

Filename: **dc0a40540b831f7efb272a095c923f5_R10_P1_K1_Ch1**.raw

<----- hex -----> <---- ASCII ---->

File identifier (including channel) [first 64 bytes]

```
1 4361726C205A6569737320436F6E666F Carl Zeiss Confo
2 436F7233202D20726177206461746120 Cor3 - raw data
3 66696C65202D2076657273696F6E2033 file - version 3
4 2E303030202D204368616E6E656C2031 .000 - Channel 1
```

Measurement identifier [16 bytes (4 4-byte integers)]

```
5 05A4C00DF731B840A072B2EFF523C995 .....1.@.r...#..
   |           |           |           |           |
   0DC0A40540B831F7EFB272A095C923F5 (big endian)
```

Note: Zeiss should have processed this byte-by-byte so a hex dump matches the value in the filename. The "big endian" format is used in the filename, but with any leading zero dropped.

Various parameters

Detector clock frequency (Hz)

```
6 000000000000000009000000002D3101 .....-1.
Position (zero based): 00000000
Kinetics index (zero based): 00000000
Repetition (zero based): 09000000 little endian → 00000009 big endian → 9 (decimal)
Detector clock frequency: 0x002D3101 (little endian) = 0x01312D00 (big endian) = 20000000 (decimal)
```

Ignore 32 bytes

```
7 00000000000000000000000000000000 .....
8 00000000000000000000000000000000 .....
Skip 8 4-byte integers
```

Array of pulse distances (detector clocks)

```
9 9F000000EA0000007D00000089000000 .....}.....
10 C10000001B0000002802000078020000 .....( ...x...
11 100000007D000000B800000092000000 ....}.....
. . .

13243 6201000037000000F0400006C010000 b...7.....1...
13244 59010000470100005A040000A3020000 Y...G...Z.....
13245 21010000390000000B070000 !...9.....
Number of elements in array: (FileSize - 128) / 4
In this case: (211,916 - 128) / 4 = 52947 events
```

The first event delta is represented in "little endian" form as 9F000000, which would be 0x0000009F in "big endian", which is the decimal number 159. The last event is 0B070000 "little endian".

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IDL Example 1: FCS3Demo1.prj Project

IDL Structure:

```
PRO TConfoCor3Header__define

struct =
  {TConfoCor3Header,
   FFileIdentifier      : bytarr(64), $
   FMeasurementIdentifier: ulonarr(4), $
   FMeasurementPosition : 0ul,      $ ; zero based
   FKINETICINDEX       : 0ul,      $ ; zero based
   FREPETITIONNUMBER   : 0ul,      $ ; zero based
   FSAMPLINGFREQUENCY  : 0ul,      $ ; 20,000,000 (0x002D3101 little endian)
   FRESERVED            : ulonarr(8) $ ; normally 00000000s?
  }

END
```

Output from IDL FCS3Demo1.pro program file in U:\efg\lab\IDL\FCS3 that processed file
dc0a40540b831f7efb272a095c923f5_R10_P1_K1_Ch1.raw

Carl Zeiss ConfoCor3 - raw data file - version 3.000 - Channel 1
Channel 1

Measurement Identifier = hex: DC0A40540B831F7EFB272A095C923F5

Measurement Position = hex:00000000, dec: 0

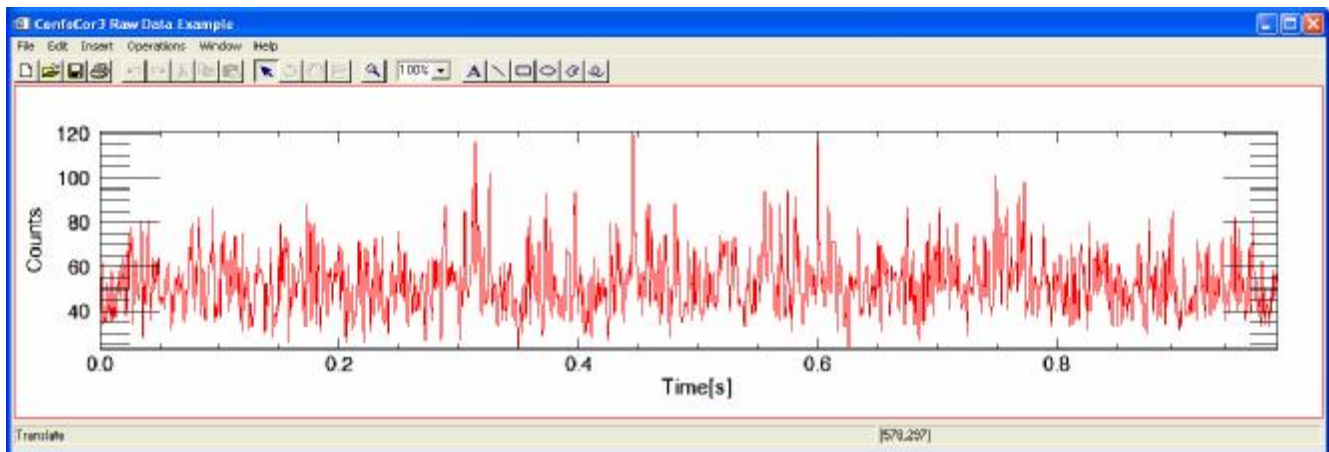
Kinetic Index = hex:00000000, dec: 0

Repetition Number = hex:00000009, dec: 9

Sampling Frequency = 20000000

Reserved = hex: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000

First/Last Event Deltas (hex/dec) = 0000009F 159 0000070B 1803

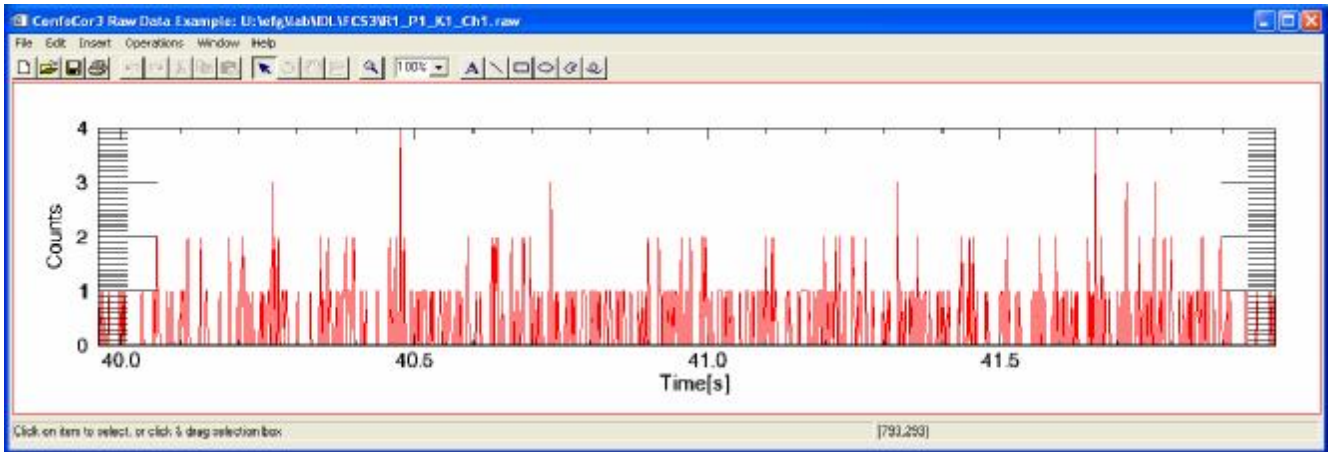


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IDL Example 2: FCS3Demo2.prj Project

Output from IDL FCS3Demo2.pro program file in U:\efg\lab\IDL\FCS3 that processed file U:\efg\lab\IDL\FCS3\R1_P1_K1_Ch2.raw

bits in each bin = 40800 for bin width(sec) = 0.00204000



This matches Delphi FCS Viewer program for the same dataset.

