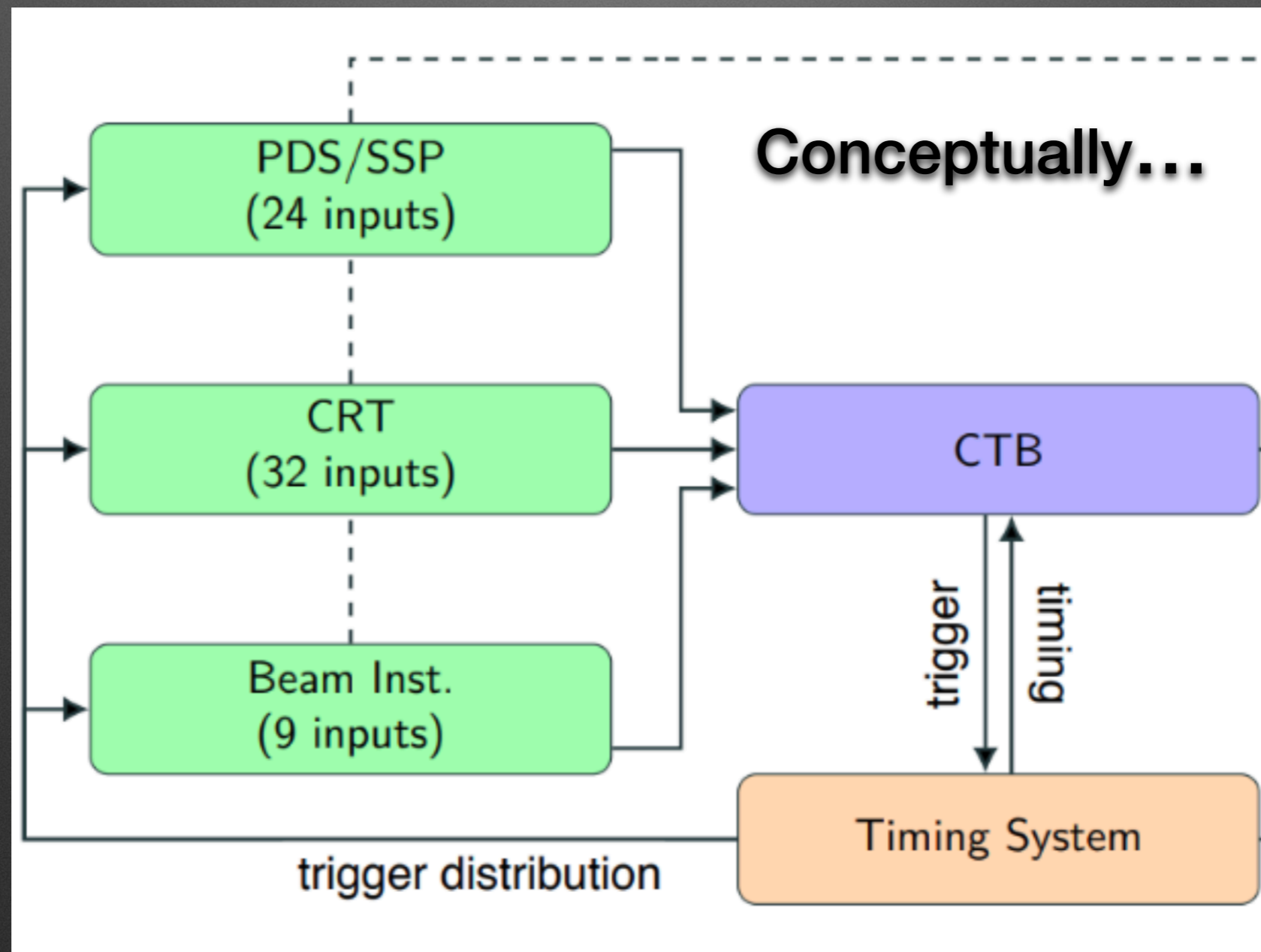


Progress on PDS Timing

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Fermilab
PDS WG
January 17, 2019

Introduction

- After calibration, critical to the operation of the PDS is the timing and how that compares to other systems



Single Event Case Study

Run 5786, Event 742

```
Begin processing the 61st record. run: 5786 subRun: 1 event: 742 at 17-Jan-2019 00:06:38 CET<>>  
Timing: 77072382965882966
```

Timing System has a single value for each event at
77072382965882966 (50 Mhz/20 ns ticks unix time)

```
SSP: 77072382965882637  
SSP: 77072382965882637  
SSP: 77072382965882637  
SSP: 77072382965882637  
SSP: 77072382965882637  
SSP: 77072382965882637  
SSP: 77072382965882637  
SSP: 77072382965882637  
SSP: 77072382965882637  
SSP: 77072382965882637
```

SSP Timing puts out a block of “48s” at
77072382965882637 (Converted 50 Mhz/20 ns ticks unix time)

Timing-SSP = $329 \times 20 \text{ ns} = 6.58 \text{ microseconds}$

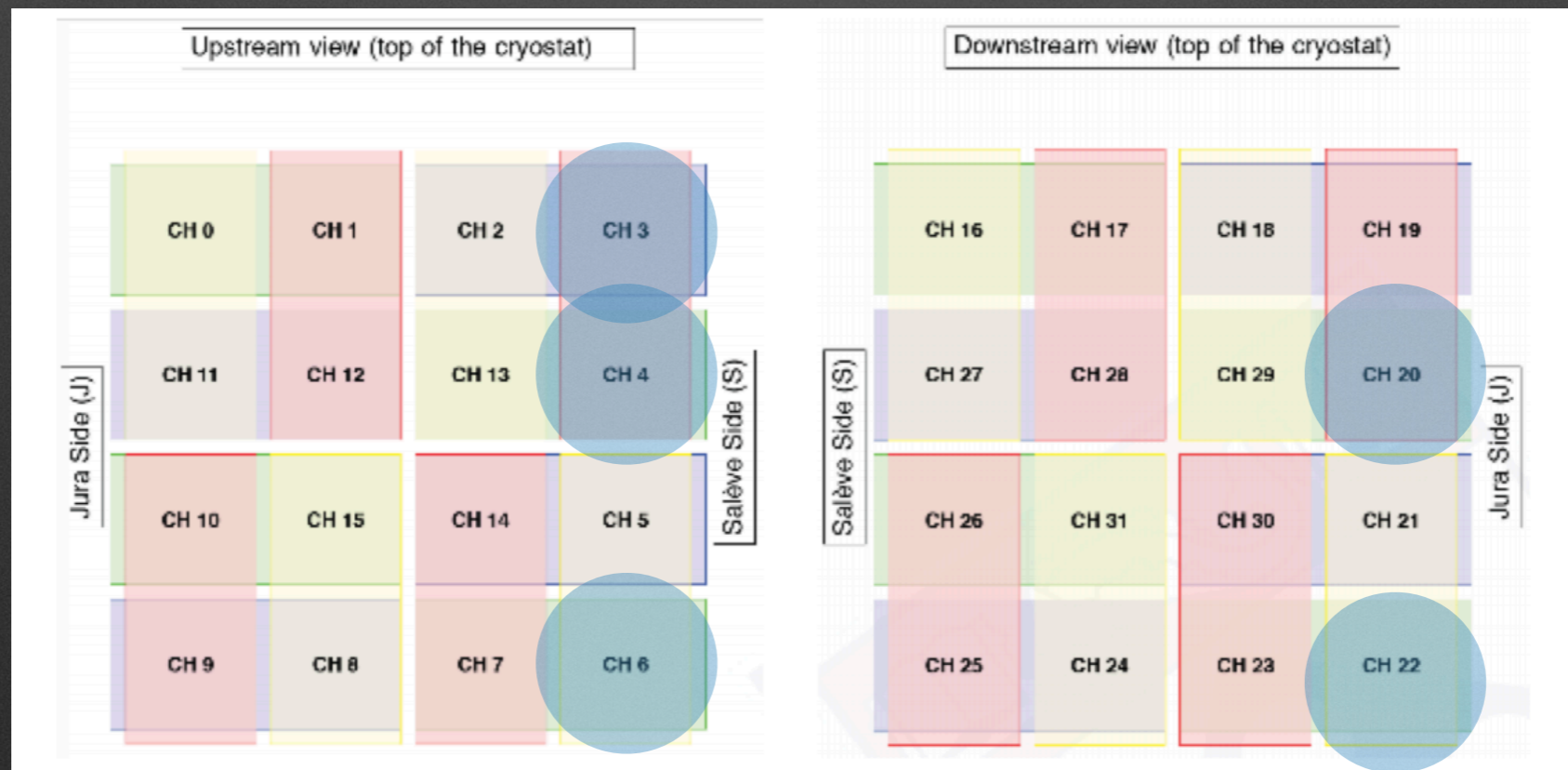
Case Study Cont.

```
CRT: 0 Number of hits: 2 Fifty MHz time: 77072382965866624
CRT: 4 Number of hits: 5 Fifty MHz time: 77072382965882855
CRT: 3 Number of hits: 11 Fifty MHz time: 77072382965882854
CRT: 6 Number of hits: 9 Fifty MHz time: 77072382965882855
CRT: 5 Number of hits: 2 Fifty MHz time: 77072382965883328
```

```
CRT: 26 Number of hits: 3 Fifty MHz time: 77072382965876347
CRT: 22 Number of hits: 3 Fifty MHz time: 77072382965882856
CRT: 20 Number of hits: 2 Fifty MHz time: 77072382965882854
CRT: 23 Number of hits: 3 Fifty MHz time: 77072382965892203
```

CRT Timing puts out a block with closest numbers at:
77072382965882854 (50 Mhz/20 ns ticks unix time)

Timing-CRT = 110-112 x 20 ns = 2.20-2.24 microseconds



Case Study Cont.

```
CTB: Timing: 77072382965881758 Word Type: 1 Word: 65536
CTB: Timing: 77072382965882942 Word Type: 1 Word: 32768
CTB: Timing: 77072382965882943 Word Type: 1 Word: 98304
CTB: Timing: 77072382965882944 Word Type: 2 Word: 32
CTB: Timing: 77072382965886708 Word Type: 1 Word: 32768
CTB: Timing: 77072382965892290 Word Type: 1 Word: 65536
```

CTB puts out a block at:

77072382965882944 (50 Mhz/20 ns ticks unix time)

Timing-CTB = 22 x 20 ns = 0.44 microseconds

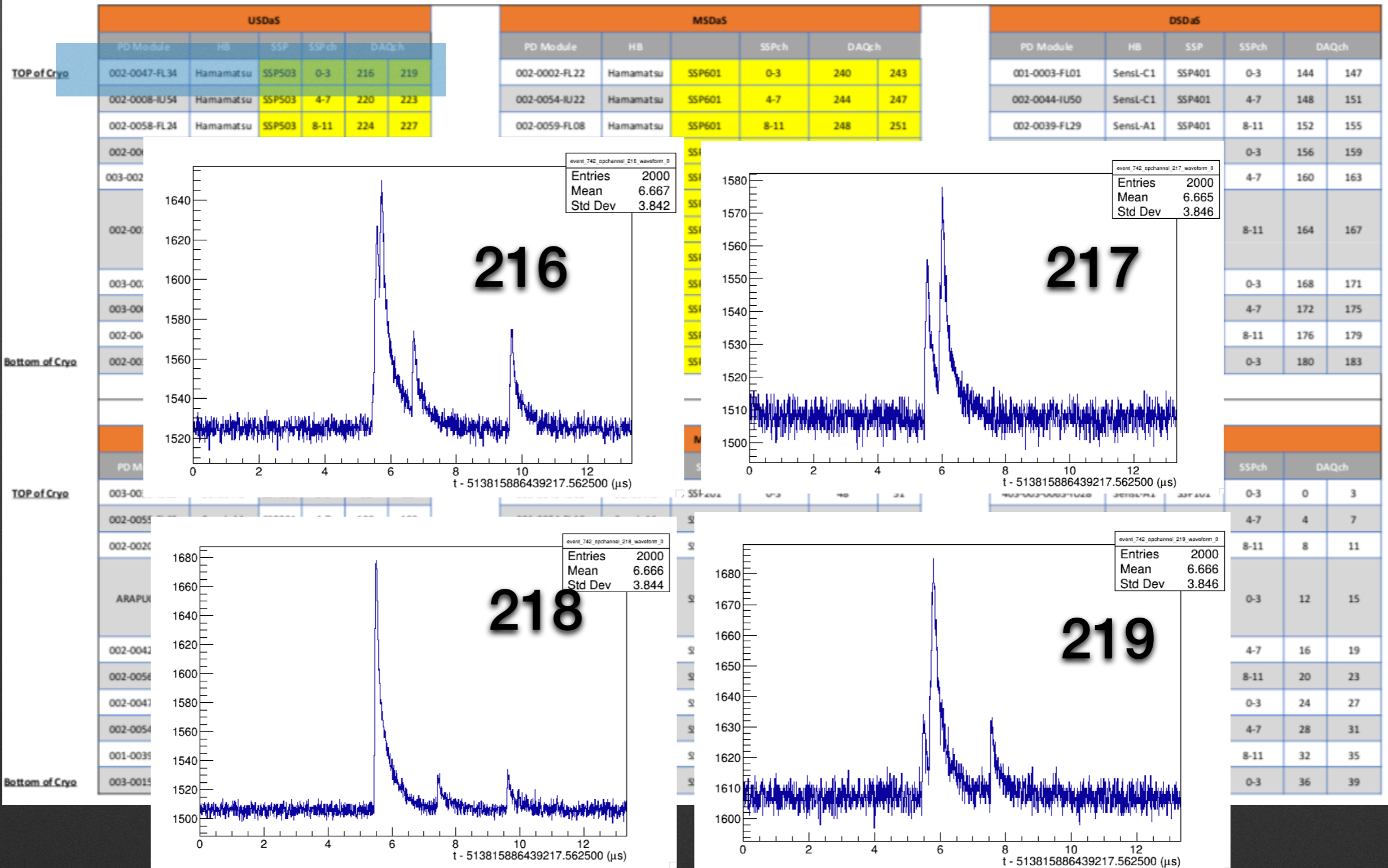
	A	B	C	D	E	J	K	L	N	O	P
	ID	Include Mask	Exclude Mask	Prescale	Bit in HLT word	Included LLTs	Excluded LLTs	Command	Status	Description	
2	Random_1				0	0	0	0xF(15)	Disabled		
3	HLT_1	0x2	0x0	0x1	1	1		0xC(12)	Disabled	Standard beam trigger without particle selection	
4	HLT_2	0xE	0x0	0x1	2	3,2,1		0xC(12)	Disabled	Beam trigger with Cherenkov particle selection (H1L1)	
5	HLT_3	0xA	0x0	0x1	3	3,1		0xC(12)	Disabled	Beam trigger with Cherenkov particle selection (H?L1)	
6	HLT_4	0	0		4			Unmasked	Spare		
7	HLT_5	0x18000	0x40	0x14	5	16,15	6	0xD(13)	Disabled	Off-spill cosmic trigger	
8	HLT_6	0x18000	0	0x1	6	16,15		0xD(13)	Enabled	Cosmic trigger US/DS	
9	HLT_7	0x2	0xC	0x1	7	1	3,2	0xC(12)	Disabled	Beam trigger with Cherenkov particle selection (not H1L1)	
10	HLT_8	0xc0000	0	0x1	8	19,18		0xD(13)	Disabled	Crossing muons Jura Side	
11	HLT_9	0x3000	0	0x1	9	13,12		0xD(13)	Disabled	Crossing muons Saleve Side	
12	HLT_10	0	0		10			Unmasked	Spare		
13	HLT_11	0	0		11			Unmasked	Spare		
14	HLT_12	0	0		12			Unmasked	Spare		
15	HLT_13	0	0		13			Unmasked	Spare		
16	HLT_14	0	0		14			Unmasked	Spare		
17	HLT_15	0	0		15			Unmasked	Spare		
18	HLT_16	0	0		16			Unmasked	Spare		
33	Random_2				31	0		0xF(15)	Disabled		

LLT @ 98304 = $2^{15} + 2^{16}$ (ie 15th and 16th bits are flipped)

HLT @ 32 = 2^5 (ie 5th bit flipped)

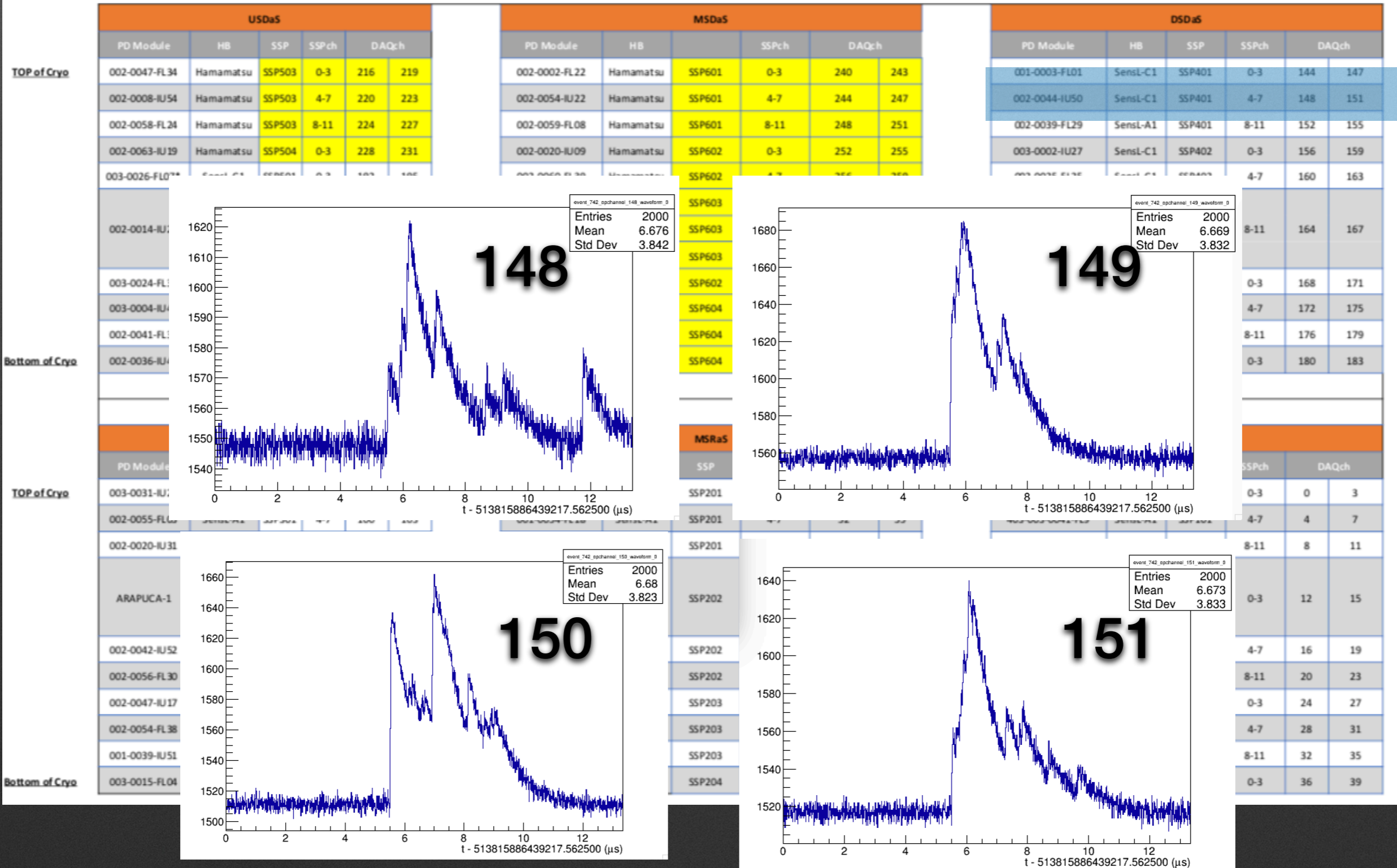
Case Study Cont.

Entire PD Channel Map



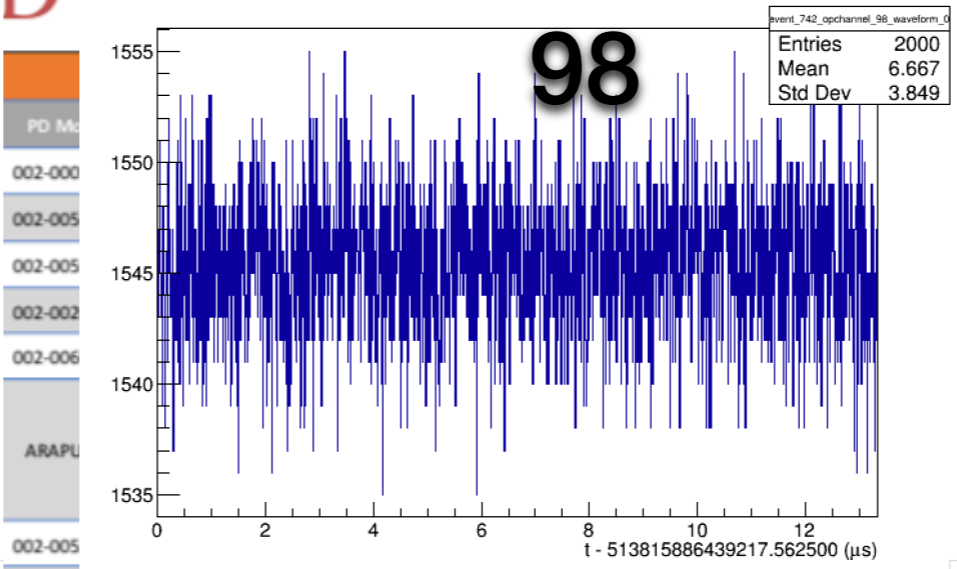
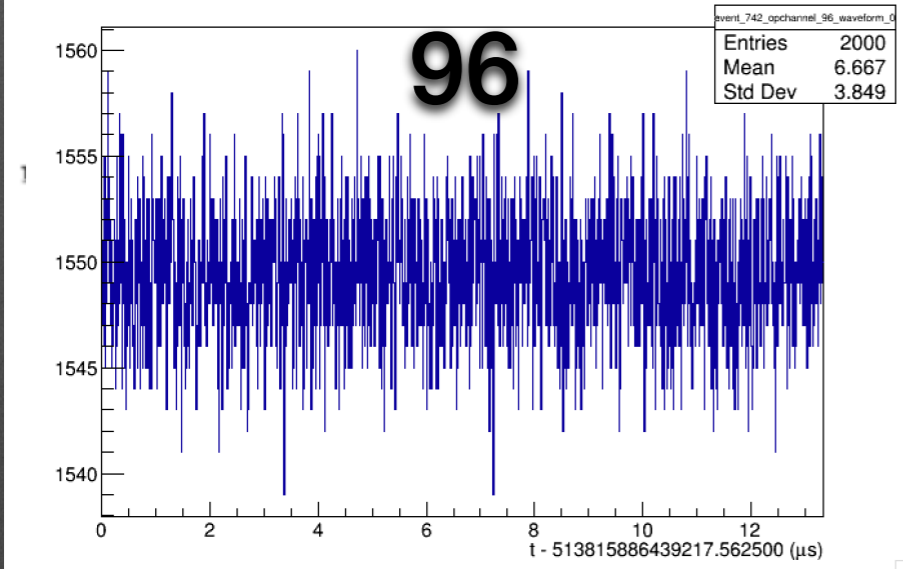
Case Study Cont.

Entire PD Channel Map



Case Study Cont.

Entire PD Channel Map

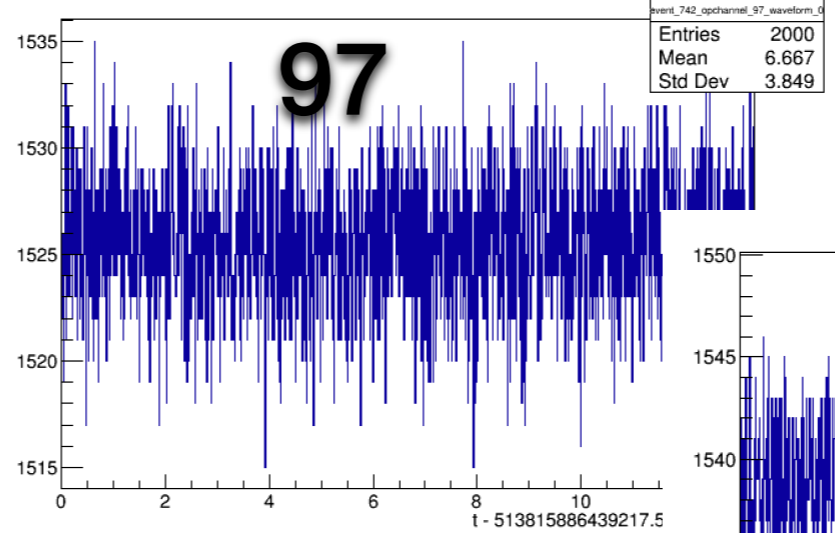


DSDa5					
Module	HB	SSP	SSPch	DAQch	
3-FL01	SensL-C1	SSP401	0-3	144	147
4-IU50	SensL-C1	SSP401	4-7	148	151
9-FL29	SensL-A1	SSP401	8-11	152	155
2-IU27	SensL-C1	SSP402	0-3	156	159
5-FL25	SensL-C1	SSP402	4-7	160	163
1-IU37	SensL-C1	SSP402	8-11	164	167
8-FL42	SensL-C1	SSP403	0-3	168	171
002-0023-IU53	SensL-C1	SSP403	4-7	172	175
002-0038-IU35	SensL-C1	SSP403	8-11	176	179
002-0040-FLP06*	SensL-C1	SSP404	0-3	180	183

Bottom of Cryo

003-0004-IU48	SensL-C1	SSP501	8-11	200	203
002-0041-FL36	Hamamatsu	SSP504	8-11	236	239
002-0036-IU47	SensL-C1	SSP502	0-3	204	207

002-0013-IU01	Hamamatsu	SSP604	0-3	276	279
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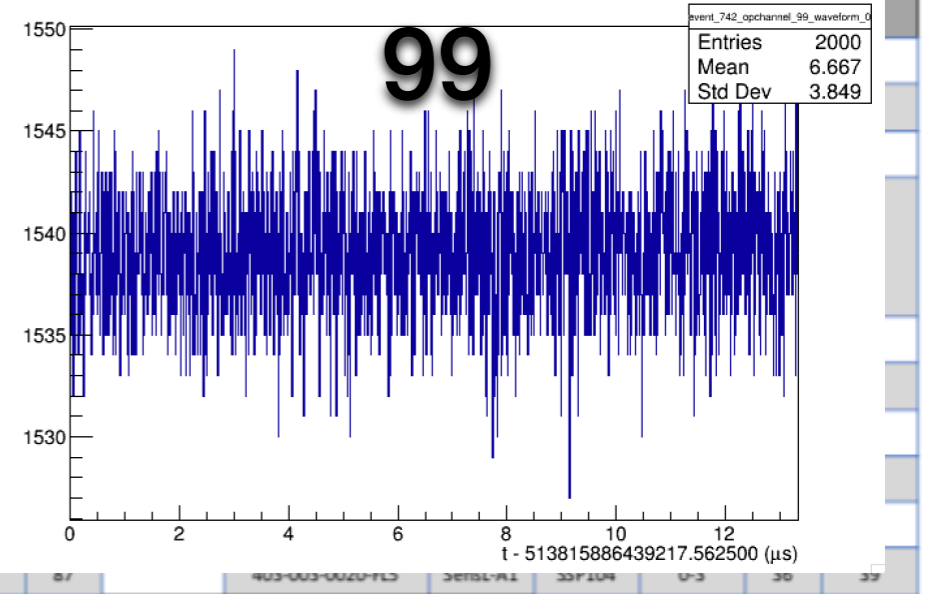


DSRa5

TOP of Cryo

USRa5					
PD Module	HB	SSP	SSPch	DAQch	
003-0031-IU20	SensL-A1	SSP301	0-3	96	99
002-0055-FL08	SensL-A1	SSP301	4-7	100	103
002-0020-IU31	SensL-A1	SSP301	8-11	104	107
ARAPUCA-1	Hamamatsu	SSP304	0-3	132	135
		SSP304	4-7	136	139
		SSP304	8-11	140	143
002-0042-IU52	SensL-A1	SSP302	0-3	108	111
002-0056-FL30	SensL-A1	SSP302	4-7	112	115
002-0047-IU17	SensL-A1	SSP302	8-11	116	119
002-0054-FL38	SensL-A1	SSP303	0-3	120	123
001-0039-IU51	SensL-A1	SSP303	4-7	124	127
003-0015-FL04	SensL-C1	SSP303	8-11	128	131

001-0044-IU18	SensL-A1	SSP202	4-7	64
002-0012-FL19	SensL-A1	SSP202	8-11	68
002-0027-IU12	SensL-A1	SSP203	0-3	72
002-0015-FL21	SensL-A1	SSP203	4-7	76
001-0052-IU14	SensL-A1	SSP203	8-11	80
003-0025-FL06	SensL-A1	SSP204	0-3	84

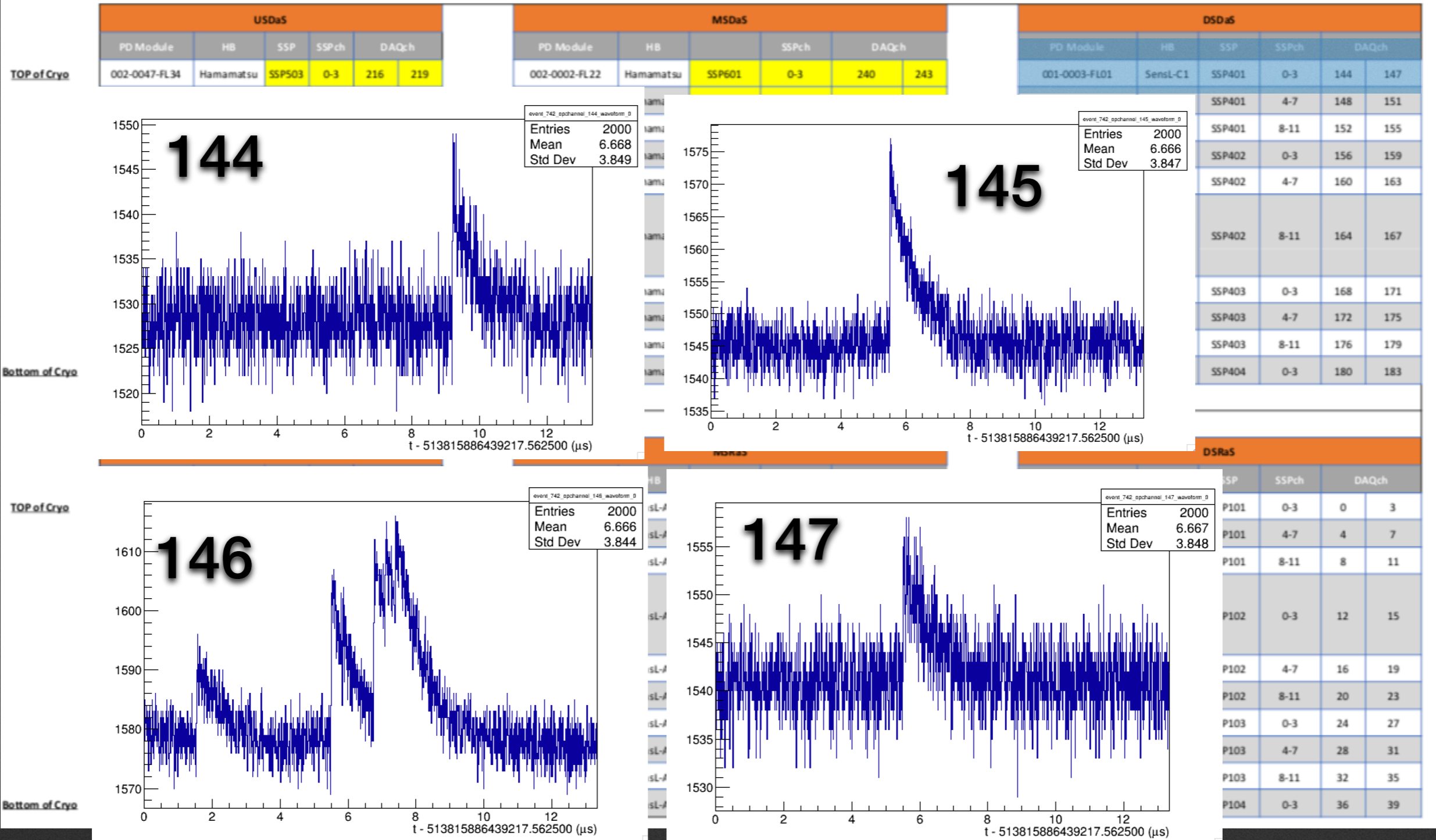


Bottom of Cryo

003-0015-FL04	SensL-C1	SSP303	8-11	128	131
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Case Study Cont.

Entire PD Channel Map



Conclusions

- Timing looks stable at offset values (SSP: 329, CRT: 112: CTB: 22)
- Delay looks taken care of in code
- CRT misses downstream or upstream hits sometimes (investigating)
- Haven't yet figured out detailed timing (down to ns)