

# PDS Channel Map for ProtoDUNE Single Phase

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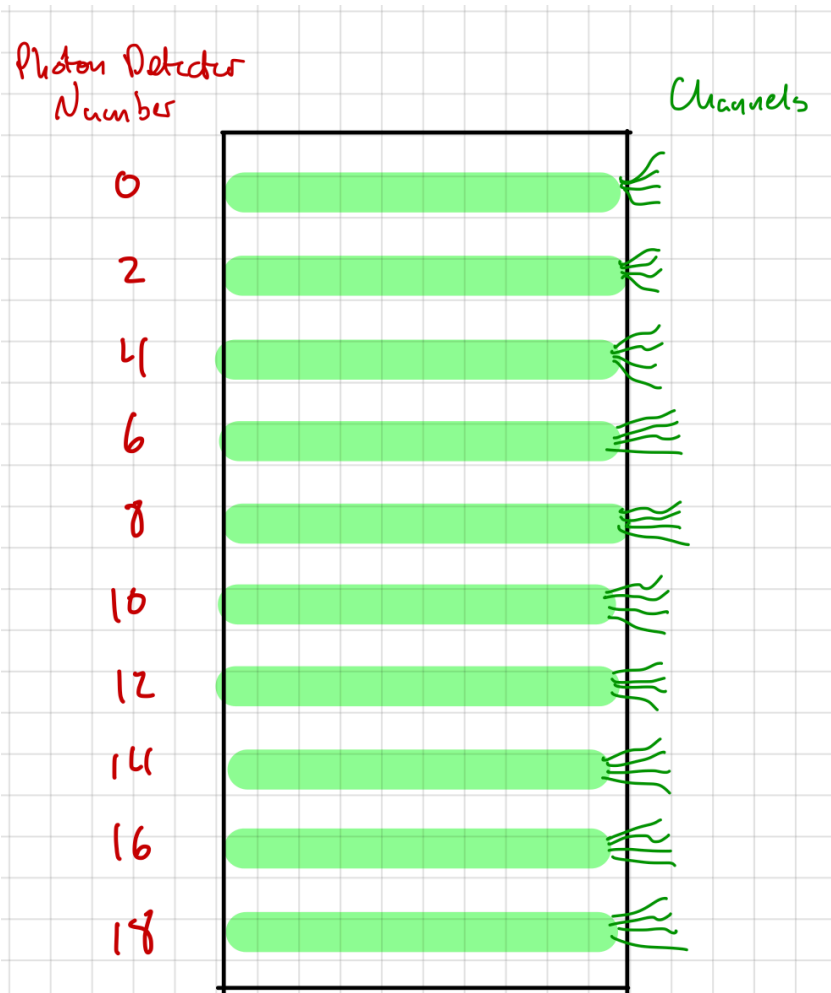
ProtoDUNE DRA Meeting

August 29<sup>th</sup>, 2018

Note: **Chris Macias** did all the work on the ground to figure out the map. I just put it in the geometry.

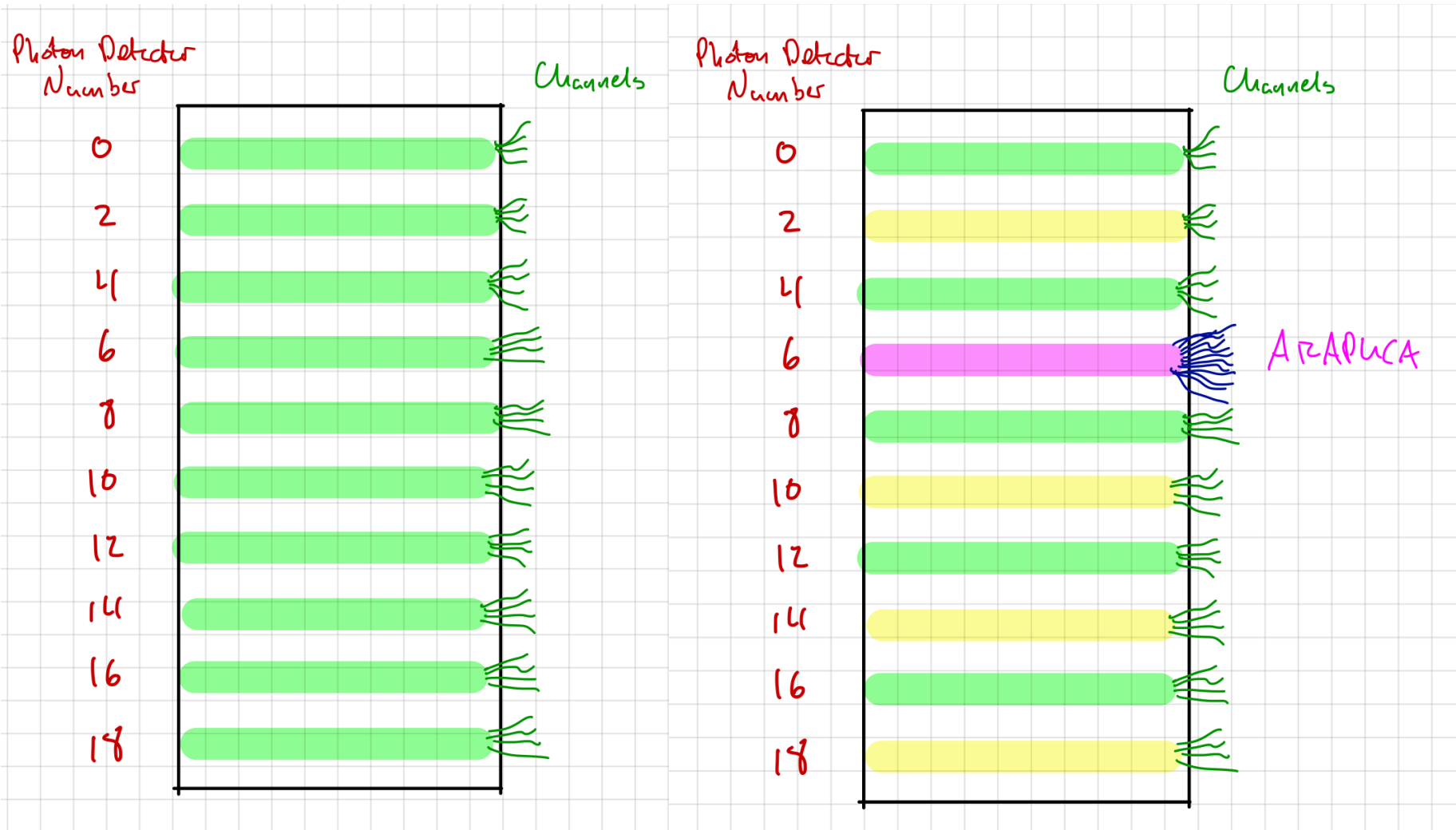
# Simulation vs. Real Detector

- Each APA has 10 photon detectors.
- In simulation, each photon detector has 4 channels.



# Simulation vs. Real Detector

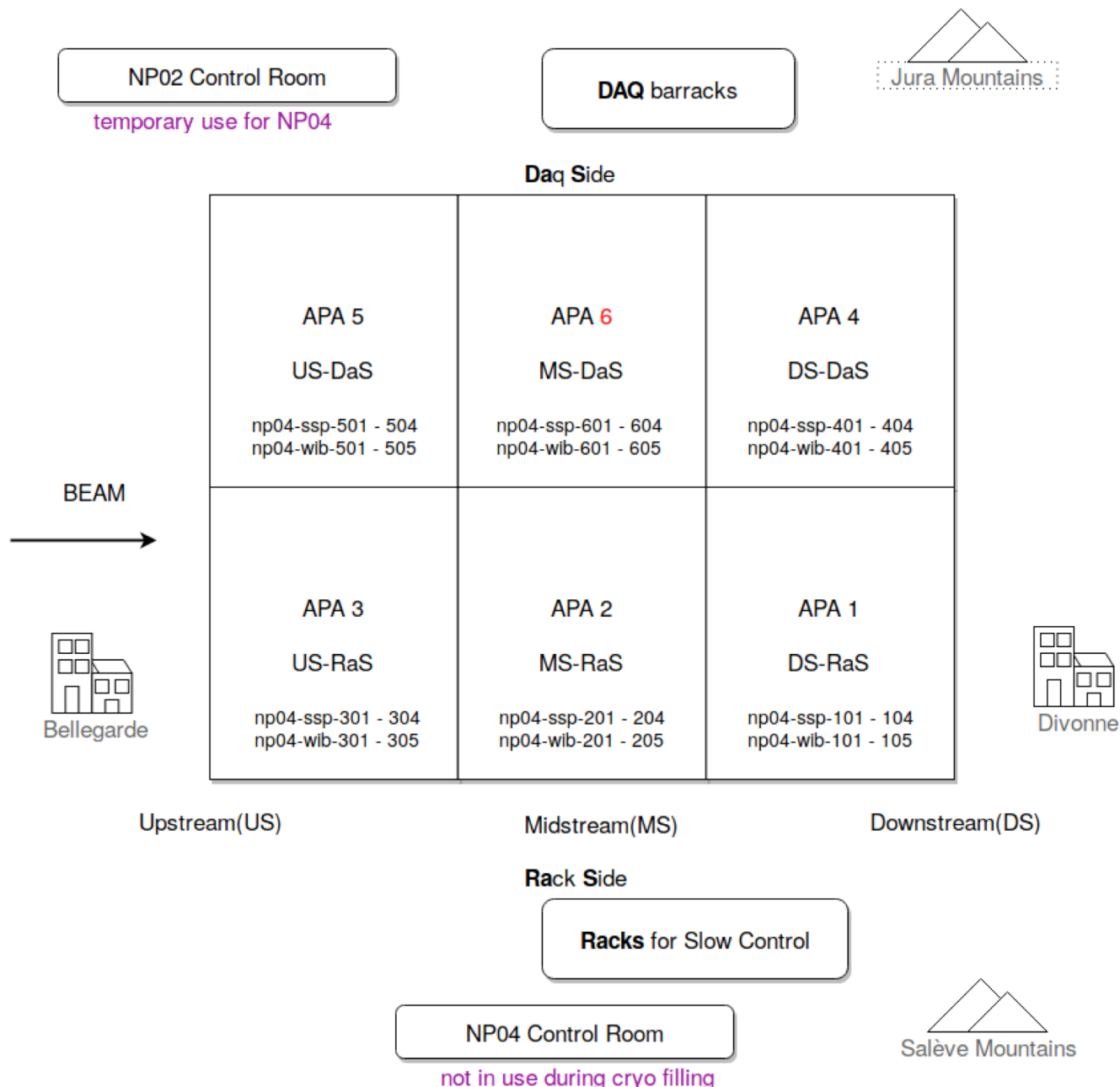
- Each APA has 10 photon detectors.
- In simulation, each photon detector has 4 channels.
- In reality, the ARAPUCA photon detectors each have 12 channels.



## How to Map Channels

- Since simulation and data had different *numbers* of **channels**, no way to write a simple map between them.
- Important note: all analysis is based on **OpDet number**, not **Channel number**.
  - Thanks to total internal reflection, channel number within an OpDet is arbitrary.
  - Except the ARAPUCAs, but we are not simulating the segmentation.
- So, to reduce the number of maps needed, we decided to:
  - Use simulation **OpDet numbers**.
  - Use the real DAQ **Channel numbers**.

# ProtoDUNE Layout



# ProtoDUNE Channel Map

		USDaS							MSDaS							DSDaS						
		PD Module	HB	SSP	SSPch	DAQch			PD Module	HB	SSP	SSPch	DAQch			PD Module	HB	SSP	SSPch	DAQch		
<b>TOP of Cryo</b>		002-0047-FL34	Hamamatsu	SSP503	0-3	216	219	41	002-0002-FL22	Hamamatsu	SSP601	0-3	240	243	21	001-0003-FL01	SensL-C1	SSP401	0-3	144	147	1
		002-0008-IU54	Hamamatsu	SSP503	4-7	220	223	43	002-0054-IU22	Hamamatsu	SSP601	4-7	244	247	23	002-0044-IU50	SensL-C1	SSP401	4-7	148	151	3
		002-0058-FL24	Hamamatsu	SSP503	8-11	224	227	45	002-0059-FL08	Hamamatsu	SSP601	8-11	248	251	25	002-0039-FL29	SensL-A1	SSP401	8-11	152	155	5
		002-0063-IU19	Hamamatsu	SSP504	0-3	228	231	47	002-0020-IU09	Hamamatsu	SSP602	0-3	252	255	27	003-0002-IU27	SensL-C1	SSP402	0-3	156	159	7
		003-0026-FL07*	SensL-C1	SSP501	0-3	192	195	49	002-0060-FL39	Hamamatsu	SSP602	4-7	256	259	29	002-0025-FL25	SensL-C1	SSP402	4-7	160	163	9
		002-0014-IU26	Hamamatsu	SSP504	4-7	232	235	51	ARAPUCA-2	Hamamatsu	SSP603	0-3	264	267	31	003-0011-IU37	SensL-C1	SSP402	8-11	164	167	4
								SSP603			4-7	268	271									
								SSP603			8-11	272	275									
		003-0024-FL33	SensL-C1	SSP501	4-7	196	199	53	002-0055-FL40	Hamamatsu	SSP602	8-11	260	263	33	003-0048-FL42	SensL-C1	SSP403	0-3	168	171	13
		003-0004-IU48	SensL-C1	SSP501	8-11	200	203	55	002-0013-IU01	Hamamatsu	SSP604	0-3	276	279	35	002-0023-IU53	SensL-C1	SSP403	4-7	172	175	15
	002-0041-FL36	Hamamatsu	SSP504	8-11	236	239	57	002-0011-FL15	Hamamatsu	SSP604	4-7	280	283	37	002-0038-IU35	SensL-C1	SSP403	8-11	176	179	17	
<b>Bottom of Cryo</b>	002-0036-IU47	SensL-C1	SSP502	0-3	204	207	59	002-0031-IU02	Hamamatsu	SSP604	8-11	284	287	39	002-0040-FLP06*	SensL-C1	SSP404	0-3	180	183	19	

		USRaS							MSRaS							DSRaS						
		PD Module	HB	SSP	SSPch	DAQch			PD Module	HB	SSP	SSPch	DAQch			PD Module	HB	SSP	SSPch	DAQch		
<b>TOP of Cryo</b>		003-0031-IU20	SensL-A1	SSP301	0-3	96	99	40	002-0049-IU16	SensL-A1	SSP201	0-3	48	51	20	403-003-0063-IU28	SensL-A1	SSP101	0-3	0	3	0
		002-0055-FL03	SensL-A1	SSP301	4-7	100	103	42	001-0054-FL18	SensL-A1	SSP201	4-7	52	55	22	403-003-0041-FL9	SensL-A1	SSP101	4-7	4	7	2
		002-0020-IU31	SensL-A1	SSP301	8-11	104	107	44	002-0035-IU13	SensL-A1	SSP201	8-11	56	59	24	403-002-0001-IU15	SensL-A1	SSP101	8-11	8	11	4
		ARAPUCA-1	Hamamatsu	SSP304	0-3	132	135	46	002-0006-FL14	SensL-A1	SSP202	0-3	60	63	26	403-003-0054-FLP12	SensL-A1	SSP102	0-3	12	15	6
				SSP304	4-7	136	139															
				SSP304	8-11	140	143															
		002-0042-IU52	SensL-A1	SSP302	0-3	108	111	48	001-0044-IU18	SensL-A1	SSP202	4-7	64	67	28	403-001-0006-IU49	SensL-A1	SSP102	4-7	16	19	8
		002-0056-FL30	SensL-A1	SSP302	4-7	112	115	50	002-0012-FL19	SensL-A1	SSP202	8-11	68	71	30	403-003-0064-FLP13	SensL-A1	SSP102	8-11	20	23	10
		002-0047-IU17	SensL-A1	SSP302	8-11	116	119	52	002-0027-IU12	SensL-A1	SSP203	0-3	72	75	32	403-001-0061-IU04	SensL-A1	SSP103	0-3	24	27	12
		002-0054-FL38	SensL-A1	SSP303	0-3	120	123	54	002-0015-FL21	SensL-A1	SSP203	4-7	76	79	34	403-001-0042-FLP4	SensL-A1	SSP103	4-7	28	31	14
	001-0039-IU51	SensL-A1	SSP303	4-7	124	127	56	001-0052-IU14	SensL-A1	SSP203	8-11	80	83	36	403-001-0025-IU21	SensL-A1	SSP103	8-11	32	35	16	
<b>Bottom of Cryo</b>	003-0015-FL04	SensL-C1	SSP303	8-11	128	131	58	003-0025-FL06	SensL-A1	SSP204	0-3	84	87	38	403-003-0020-FL5	SensL-A1	SSP104	0-3	36	39	18	

- “Simple” formula to convert (SSP#, SSP Channel) → Channel#
- Non-trivial (manual) mapping between SSP# and OpDet#.

# Implementation Details

- Added **ProtoDUNEChannelMapAlg** channel mapping algorithm.
  - These algorithms are used by the Geometry Service, via GeometryHelper, to determine channel numbers.
- It inherits from **DuneApaChannelMapAlg**, and only overrides the photon detector parts.
  - This algorithm is used for most single phase DUNE detectors.
- Added a “do nothing” map to **dune-raw-data**.
  - Kept in case we need to fix channel mapping after production begins.
  - Also includes the mapping between channel #, SSP #, and OpDet #.
  - Created using a channel map making code which includes a terrible copy-paste of the ProtoDUNEChannelMapAlg.
    - The “right” way to do this is to use gallery to load the service, but I didn’t have time to make that work.
- In the future, we need to change the ordering for assigning OpDet#.
  - With more than 2 sets of APAs in X, having OpDet# increase in X will become very confusing.