Towards final tests with new ACQ1002 modules

The DAQ team

“Duplicated(repeated) sample issue”

Per David’s suggestion to reduce low frequency noise looking at the distribution of the difference between consecutive (even/odd) pairs of ADC samples

Discovered that in each channel, from time to time, ADC samples are duplicated from previous, or even earlier samples. (Will explain in detail in the following slides)

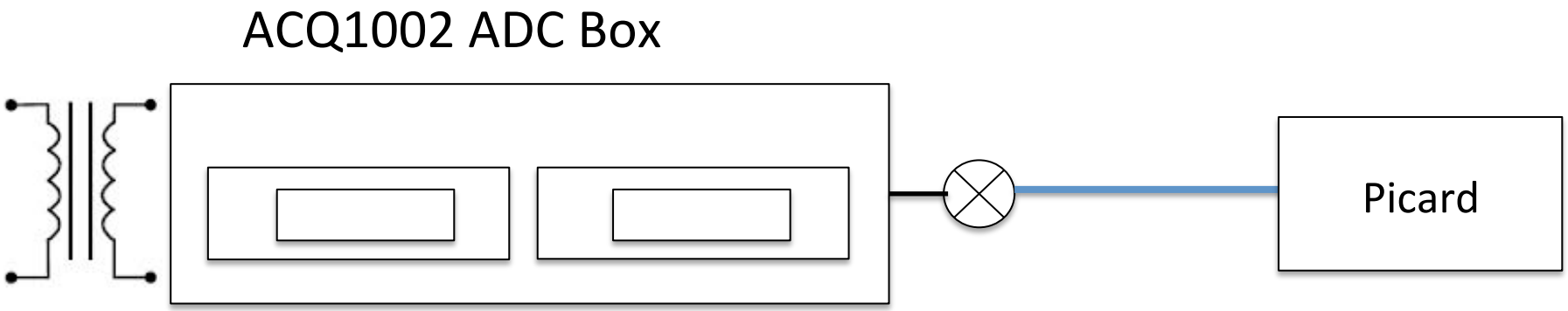
First saw this in “synchronized trigger mode”, however the issue is observed in “continuous mode”.

The issue is independent of chosen frequency, FPGA averaging or ADC box

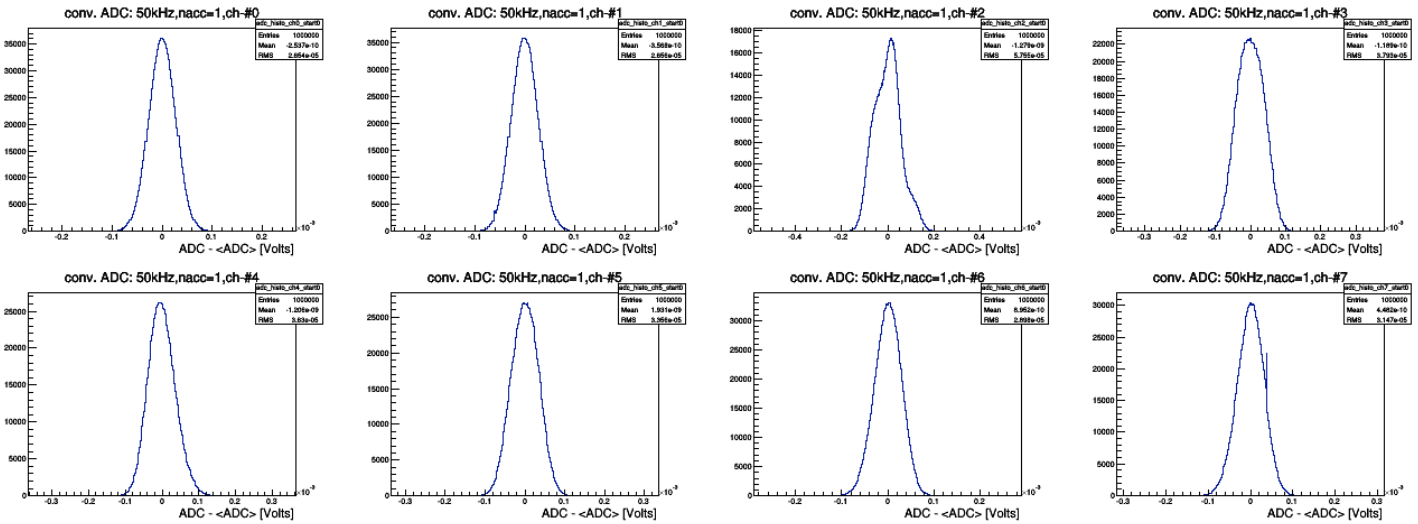
Perhaps it is indicative of memory issue at the readout stage in FPGA ?

“duplication issue” appears to be random so in principle shouldn’t introduce additional false asymmetry

DAQ test setup in CONTINUOUS mode

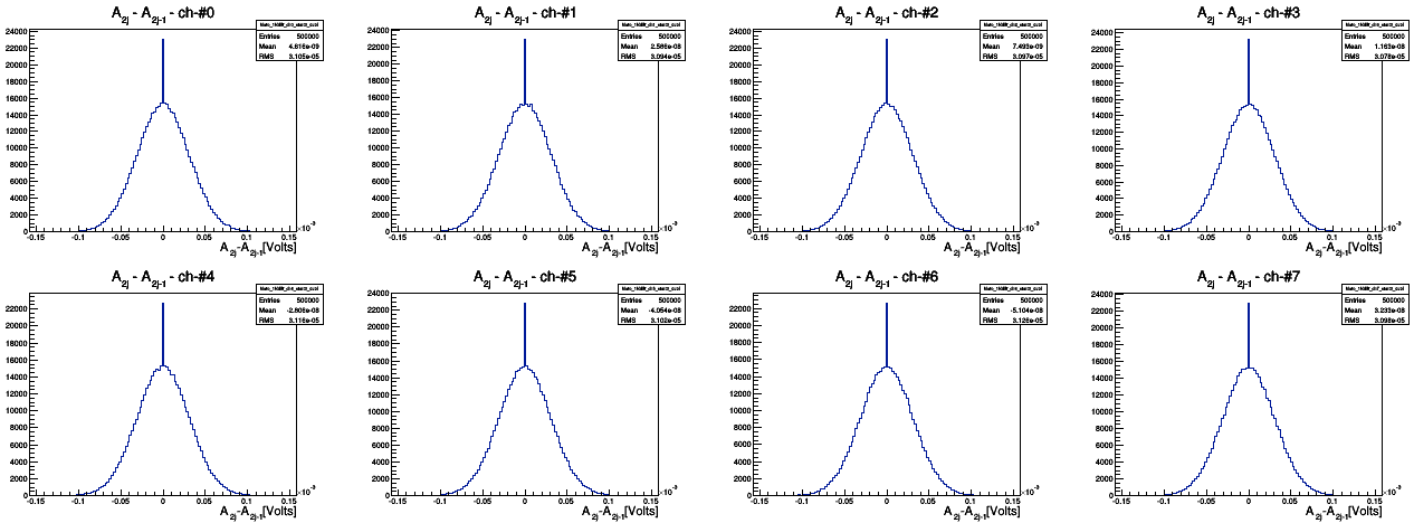


Single vs. “pair” ADC sample distributions: CONT, 50kHz, nacc=1



Single ADC (conv) distribution for first 8 channels of box021:

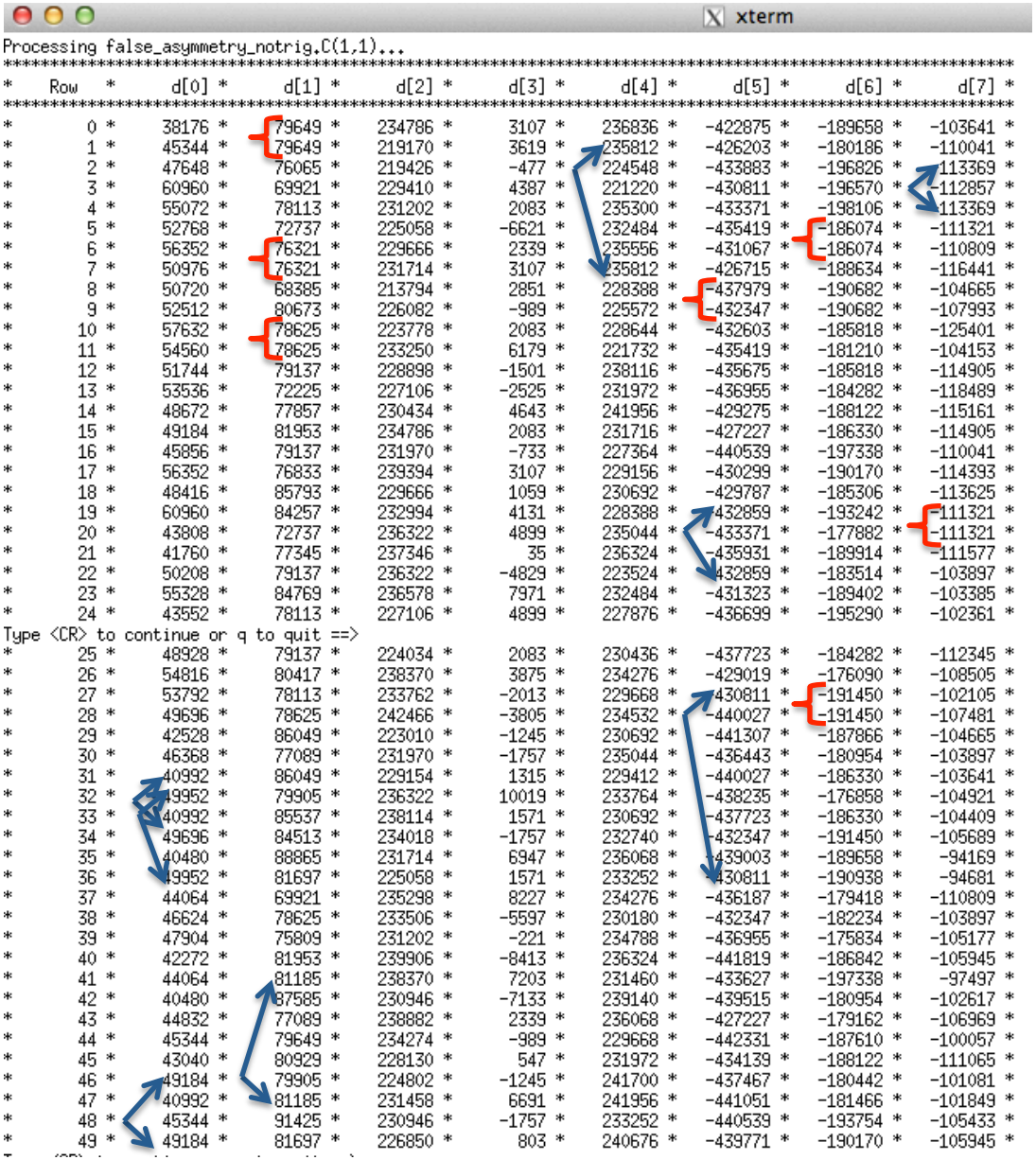
1.) CONTINUOUS
2.) 50 kHz
3.) nacc=1 (No Averaging



$A_{2j} - A_{2j-1}$: adjacent pair difference distribution for first 8 channels of box021:

1.) CONTINUOUS
2.) 50 kHz
3.) nacc=1 (No Averaging

Raw datastream: Box021, CONT, 50kHz, No averaging



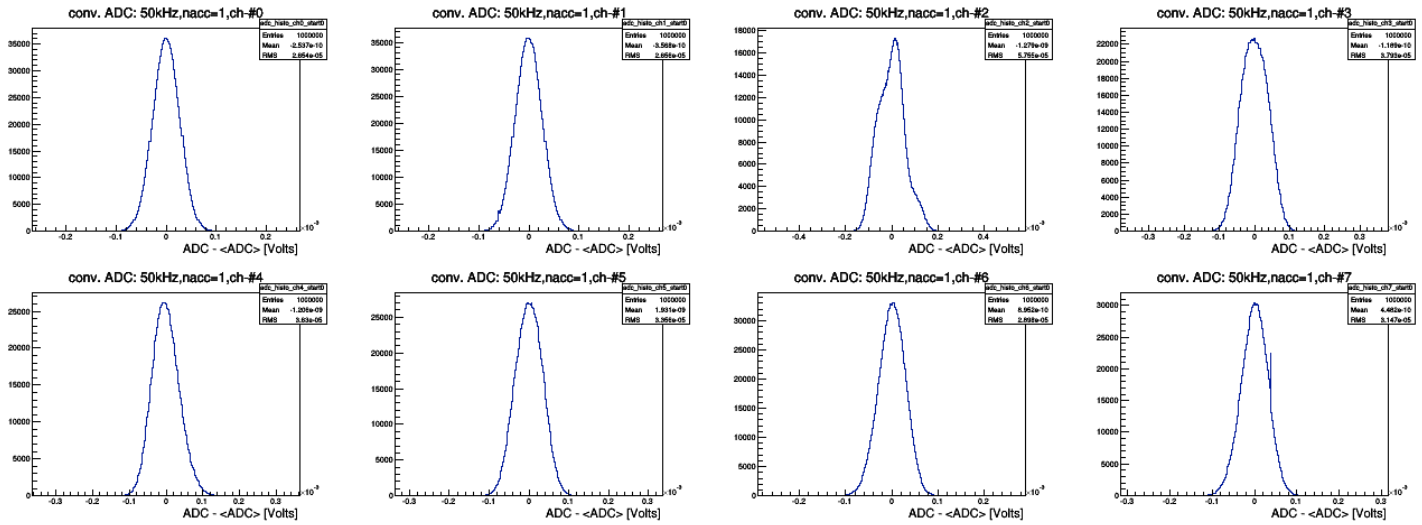
Row	d[0]	d[1]	d[2]	d[3]	d[4]	d[5]	d[6]	d[7]
0	38176	79649	234786	3107	236836	-422875	-189658	-103641
1	45344	79649	219170	3619	235812	-426203	-180186	-110041
2	47648	76065	219426	-477	224548	-433883	-196826	-113369
3	60960	69921	229410	4387	221220	-430811	-196570	-112857
4	55072	78113	231202	2083	235300	-433371	-198106	-113369
5	52768	72737	225058	-6621	232484	-435419	-186074	-111321
6	56352	76321	229666	2339	235556	-431067	-186074	-110809
7	50976	76321	231714	3107	235812	-426715	-188634	-116441
8	50720	68385	213794	2851	228388	-437979	-190682	-104665
9	52512	80673	226082	-989	225572	-432347	-190682	-107993
10	57632	78625	223778	2083	228644	-432603	-185818	-125401
11	54560	78625	233250	6179	221732	-435419	-181210	-104153
12	51744	79137	228898	-1501	238116	-435675	-185818	-114905
13	53536	72225	227106	-2525	231972	-436955	-184282	-118489
14	48672	77857	230434	4643	241956	-429275	-188122	-115161
15	49184	81953	234786	2083	231716	-427227	-186330	-114905
16	45856	79137	231970	-733	227364	-440539	-197338	-110041
17	56352	76833	239394	3107	229156	-430299	-190170	-114393
18	48416	85793	229666	1059	230692	-429787	-185306	-113625
19	60960	84257	232994	4131	228388	-432859	-193242	-111321
20	43808	72737	236322	4899	235044	-433371	-177882	-111321
21	41760	77345	237346	35	236324	-435931	-189914	-111577
22	50208	79137	236322	-4829	223524	-432859	-183514	-103897
23	55328	84769	236578	7971	232484	-431323	-189402	-103385
24	43552	78113	227106	4899	227876	-436699	-195290	-102361
25	48928	79137	224034	2083	230436	-437723	-184282	-112345
26	54816	80417	238370	3875	234276	-429019	-176090	-108505
27	53792	78113	233762	-2013	229668	-430811	-191450	-102105
28	49696	78625	242466	-3805	234532	-440027	-191450	-107481
29	42528	86049	223010	-1245	230692	-441307	-187866	-104665
30	46368	77089	231970	-1757	235044	-436443	-180954	-103897
31	40992	86049	229154	1315	229412	-440027	-186330	-103641
32	49952	79905	236322	10019	233764	-438235	-176858	-104921
33	40992	85537	238114	1571	230692	-437723	-186330	-104409
34	49696	84513	234018	-1757	232740	-432347	-191450	-105689
35	40480	88865	231714	6947	236068	-439003	-189658	-94169
36	49952	81697	225058	1571	233252	-430811	-190938	-94681
37	44064	69921	235298	8227	234276	-436187	-179418	-110809
38	46624	78625	233506	-5597	230180	-432347	-182234	-103897
39	47904	75809	231202	-221	234788	-436955	-175834	-105177
40	42272	81953	239906	-8413	236324	-441819	-186842	-105945
41	44064	81185	238370	7203	231460	-433627	-197338	-97497
42	40480	87585	230946	-7133	239140	-439515	-180954	-102617
43	44832	77089	238882	2339	236068	-427227	-179162	-106969
44	45344	79649	234274	-989	229668	-442331	-187610	-100057
45	43040	80929	228130	547	231972	-434139	-188122	-111065
46	49184	79905	224802	-1245	241700	-437467	-180442	-101081
47	40992	81185	231458	6691	241956	-441051	-181466	-101849
48	45344	91425	230946	-1757	233252	-440539	-193754	-105433
49	49184	81697	226850	803	240676	-439771	-190170	-105945

Printout of raw ADC DataStream indeed confirms the existence of “duplicate” adjacent samples

But “duplication” issue goes beyond adjacent samples

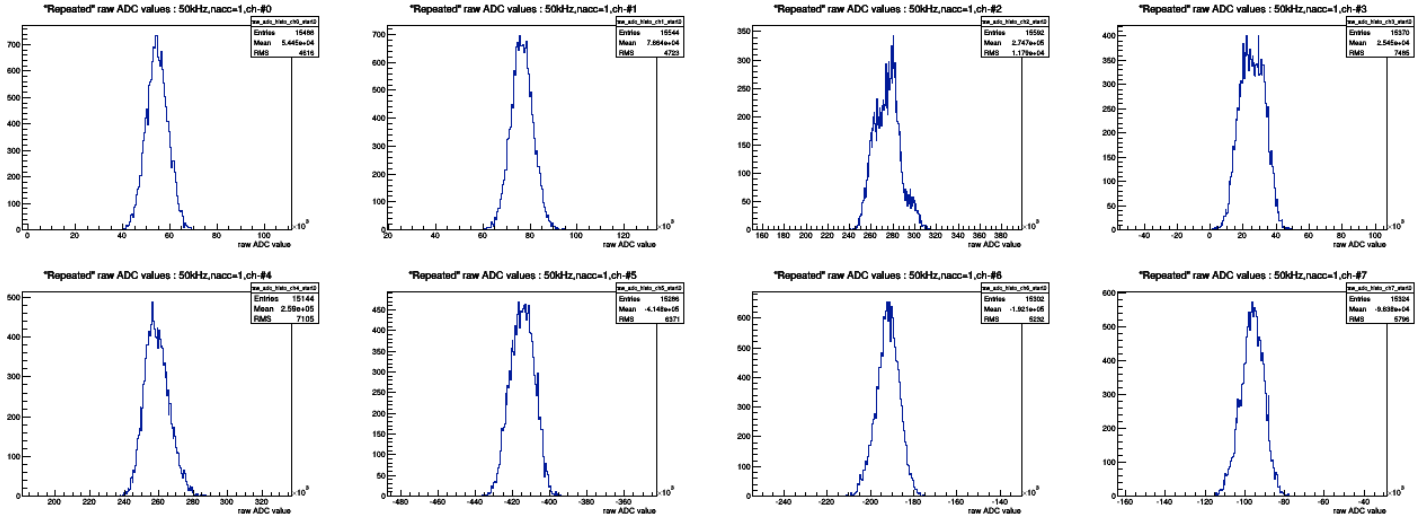
Samples are often repeated after Several

Single ADC sample distr. ALL vs. ONLY duplicated : CONT, 50kHz, nacc=1



Single ADC (conv) distribution for first 8 channels of box021:

1.) CONTINUOUS
2.) 50 kHz
3.) nacc=1 (No Averaging



<u>Raw ADC samples</u> ONLY when “adjacent duplication” occurs

The shape of upper and lower distributions look alike, which shows that duplicated sample values are random!

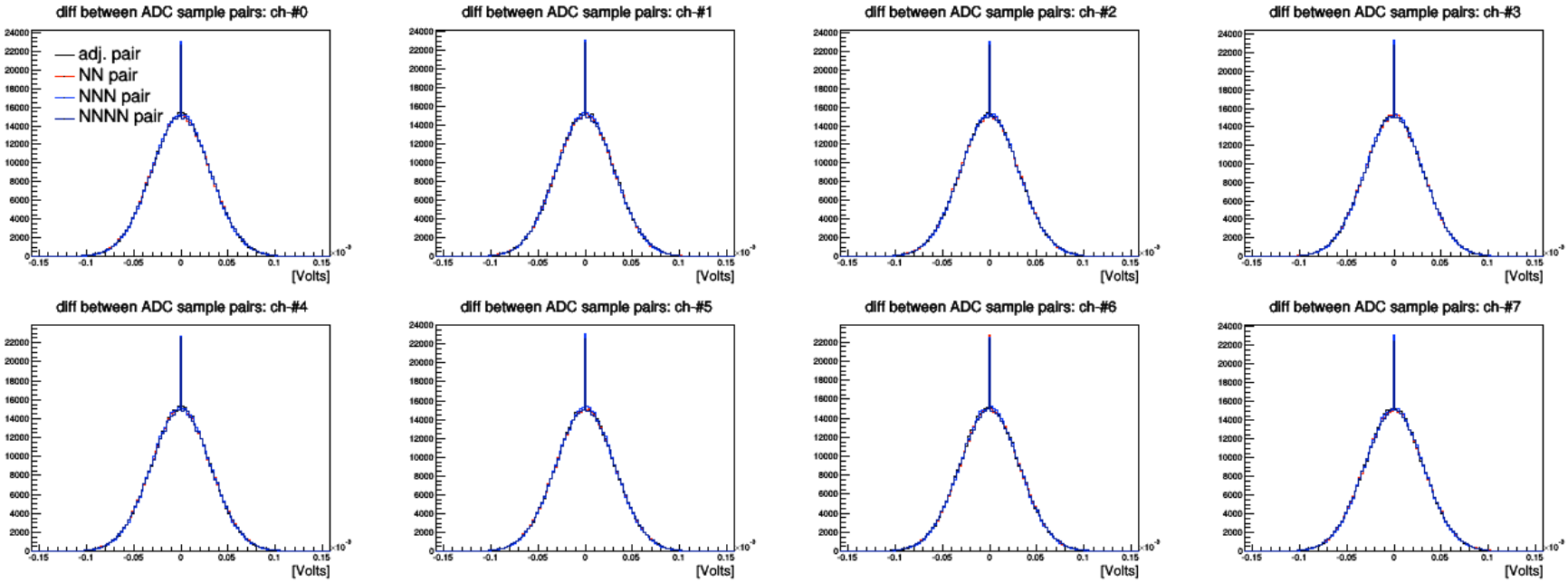
Pair distributions for testing data

"difference between ADC sample pairs" distributions:

A_1, A_2, A_3, A_4, A_5, A_6, A_7, A_8, A_9, A_{10}, …..

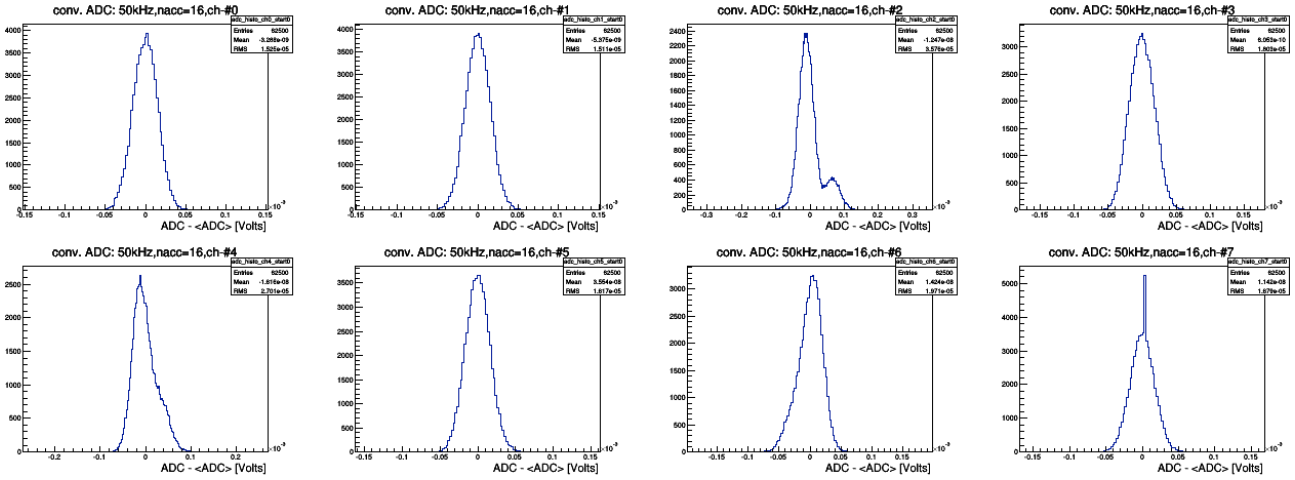
- "adjacent pair diff" (A_2-A_1), (A_4-A_3), (A_6-A_5), (A_8-A_7), (A_{10}-A_9), …
- "NN pair diff" (A_3-A_1), (A_4-A_2), (A_7-A_5), (A_8-A_6), (A_{11}-A_9), (A_{12}-A_{10}), …
- "NNN pair diff" (A_4-A_1), (A_5-A_2), (A_6-A_3), (A_{10}-A_7), (A_{11}-A_8), (A_{12}-A_9), …
- "NNNN pair diff" (A_5-A_1), (A_6-A_2), (A_7-A_3), (A_8-A_4), (A_{11}-A_8), …

Adjacent and beyond “pair” ADC sample distributions: CONT, 50kHz, nacc=1



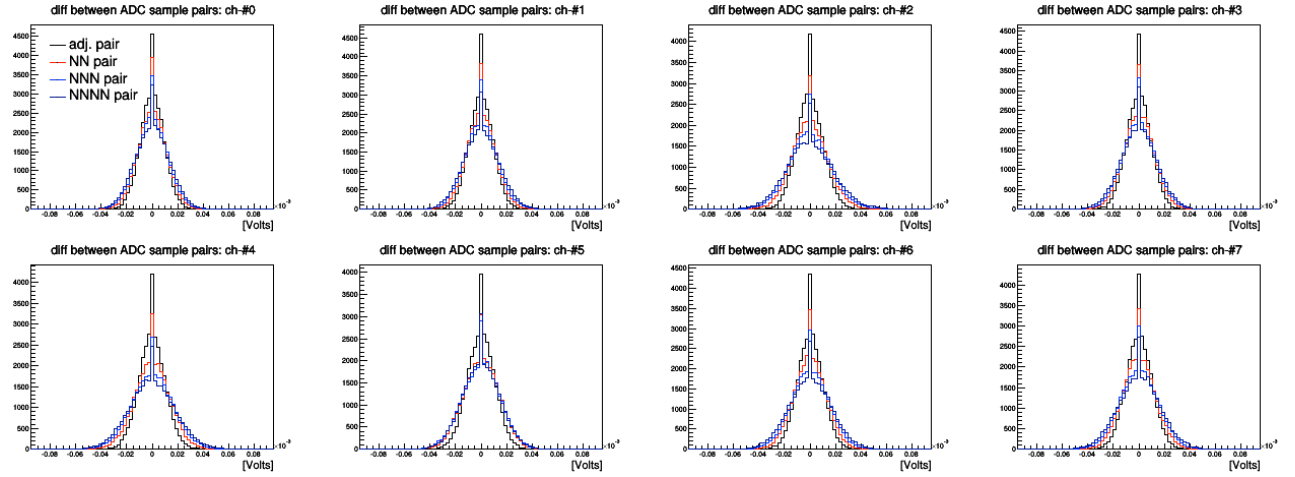
The effect is still there for Next-to-Next-to-Next-to-Next pair difference distributions

How about when we FPGA Average data? CONT, 50kHz, nacc=16



Single ADC (conv) distribution for first 8 channels of box021:

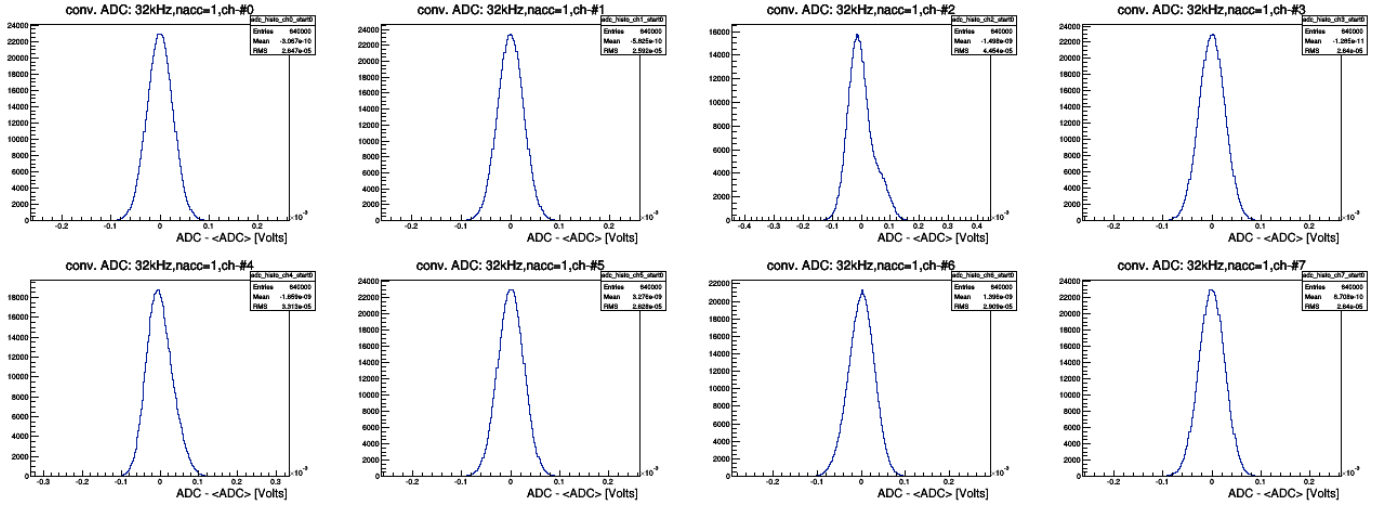
1.) CONTINUOUS
2.) 50 kHz
3.) nacc=16



Duplication issue still there from pair distributions when we FPGA average

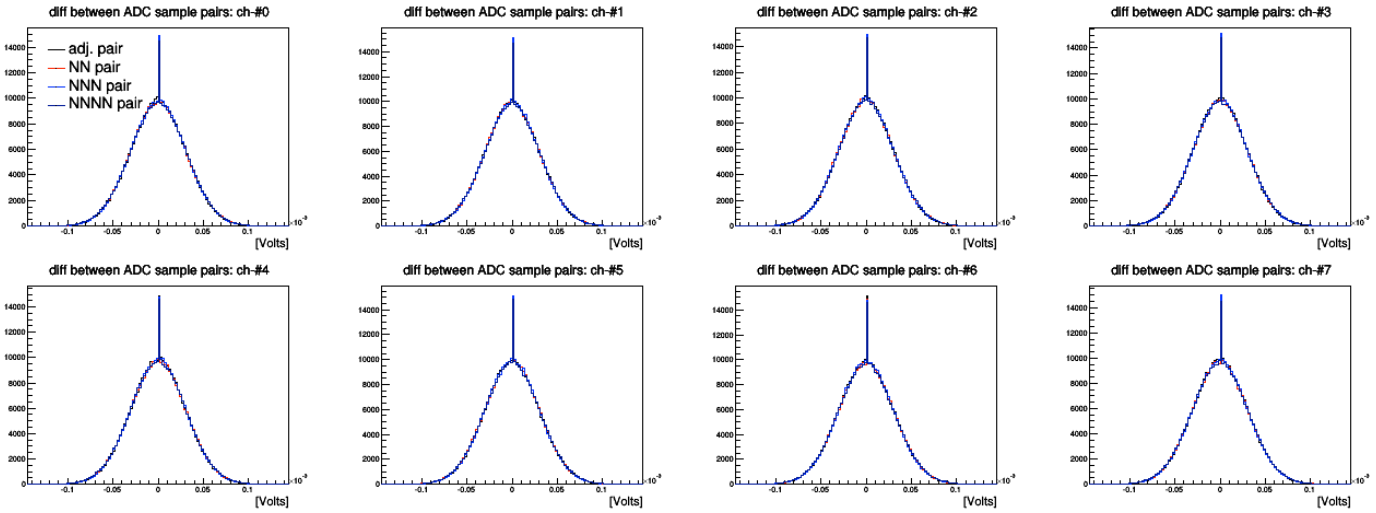
But width of the distributions varying, which wasn't the case for Non-Averaged case!

Let's change sampling rate? CONT, 32kHz, nacc=1



Single ADC (conv) distribution for first 8 channels of box021:

1.) CONTINUOUS
2.) 32 kHz
3.) nacc=1



Same effect!

"duplication" doesn't depend on sampling rate

Conclusions

I quickly checked data with “old” ACQ2006 box and the issue is there as well.

The duplication doesn’t depend on running mode, sampling rate, box

Vince suggested that this might be a FIFO memory issue at the readout. But this is really Peter’s job to determine

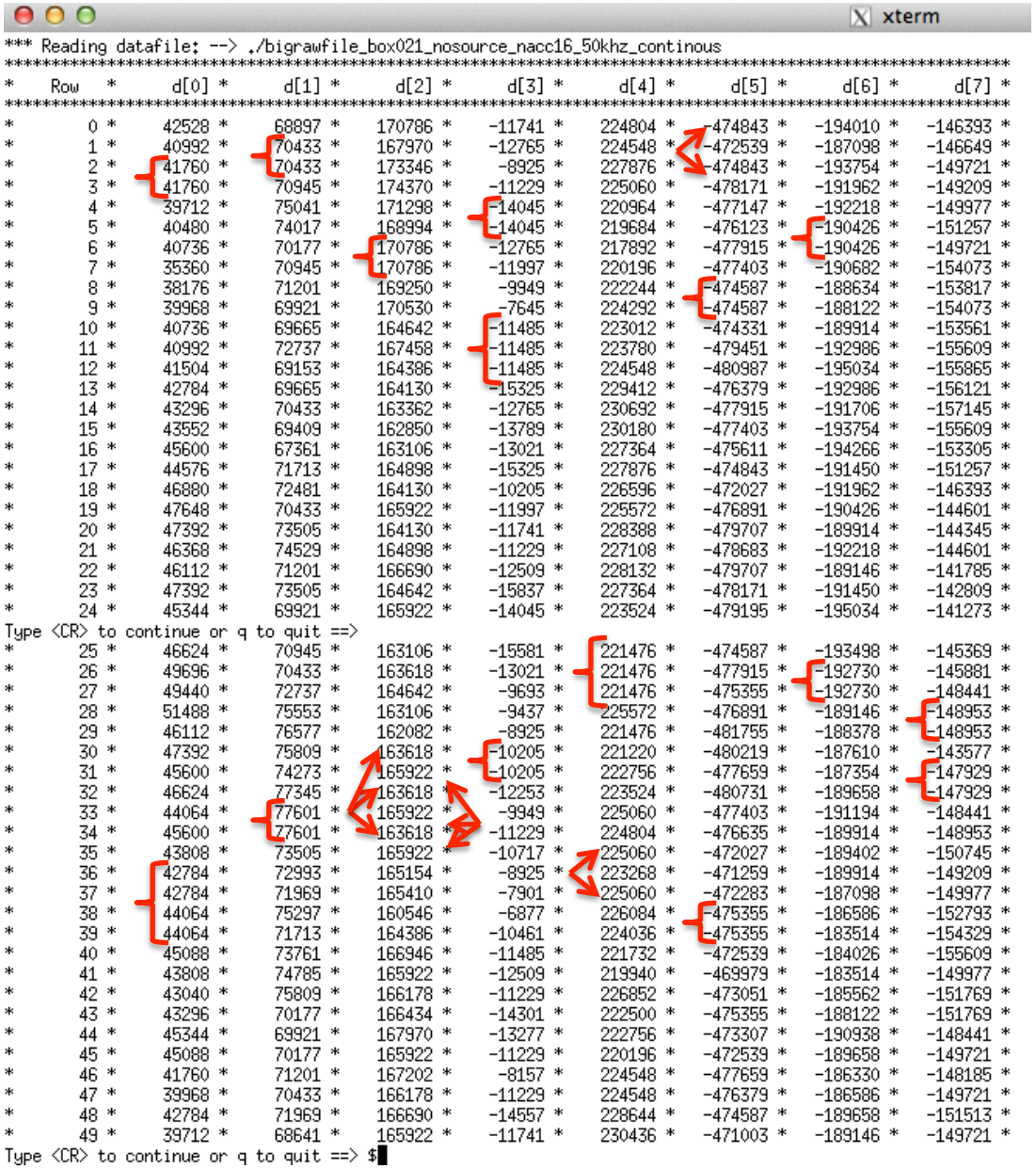
Very next step is to check this thing with input signal. Sinusoidal, Slope, etc.

Other quick tests.

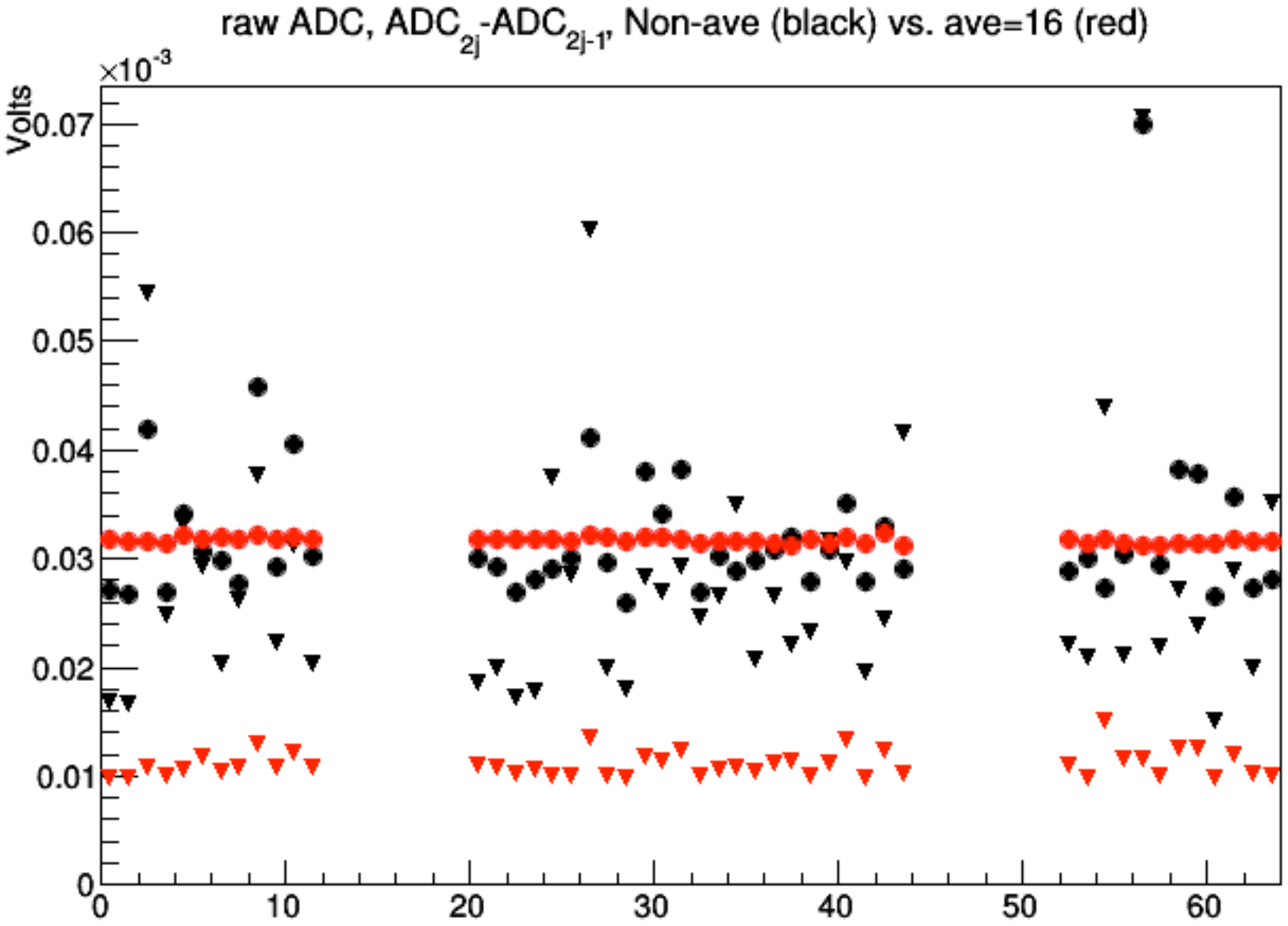
But looks like the issue is random.

Backup slides

Raw datastream: Box021, CONT, 50kHz, ave coef = 16



Row	d[0]	d[1]	d[2]	d[3]	d[4]	d[5]	d[6]	d[7]
0	42528	68897	170786	-11741	224804	-474843	-194010	-146393
1	40992	70433	167970	-12765	224548	-472539	-187098	-146649
2	41760	70433	173346	-8925	227876	-474843	-193754	-149721
3	41760	70945	174370	-11229	225060	-478171	-191962	-149209
4	39712	75041	171298	-14045	220964	-477147	-192218	-149977
5	40480	74017	168994	-14045	219684	-476123	-190426	-151257
6	40736	70177	170786	-12765	217892	-477915	-190426	-149721
7	35360	70945	170786	-11997	220196	-477403	-190682	-154073
8	38176	71201	169250	-9949	222244	-474587	-188634	-153817
9	39968	69921	170530	-7645	224292	-474587	-188122	-154073
10	40736	69665	164642	-11485	223012	-474331	-189914	-153561
11	40992	72737	167458	-11485	223780	-479451	-192986	-155609
12	41504	69153	164386	-11485	224548	-480987	-195034	-155865
13	42784	69665	164130	-15325	229412	-476379	-192986	-156121
14	43296	70433	163362	-12765	230692	-477915	-191706	-157145
15	43552	69409	162850	-13789	230180	-477403	-193754	-155609
16	45600	67361	163106	-13021	227364	-475611	-194266	-153305
17	44576	71713	164898	-15325	227876	-474843	-191450	-151257
18	46880	72481	164130	-10205	226596	-472027	-191962	-146393
19	47648	70433	165922	-11997	225572	-476891	-190426	-144601
20	47392	73505	164130	-11741	228388	-479707	-189914	-144345
21	46368	74529	164898	-11229	227108	-478683	-192218	-144601
22	46112	71201	166690	-12509	228132	-479707	-189146	-141785
23	47392	73505	164642	-15837	227364	-478171	-191450	-142809
24	45344	69921	165922	-14045	223524	-479195	-195034	-141273
25	46624	70945	163106	-15581	221476	-474587	-193498	-145369
26	49696	70433	163618	-13021	221476	-477915	-192730	-145881
27	49440	72737	164642	-9693	221476	-475355	-192730	-148441
28	51488	75553	163106	-9437	225572	-476891	-189146	-148953
29	46112	76577	162082	-8925	221476	-481755	-188378	-148953
30	47392	75809	163618	-10205	221220	-480219	-187610	-143577
31	45600	74273	165922	-10205	222756	-477659	-187354	-147929
32	46624	77345	163618	-12253	223524	-480731	-189658	-147929
33	44064	77601	165922	-9949	225060	-477403	-191194	-148441
34	45600	77601	163618	-11229	224804	-476635	-189914	-148953
35	43808	73505	165922	-10717	225060	-472027	-189402	-150745
36	42784	72993	165154	-8925	223268	-471259	-189914	-149209
37	42784	71969	165410	-7901	225060	-472283	-187098	-149977
38	44064	75297	160546	-6877	226084	-475355	-186586	-152793
39	44064	71713	164386	-10461	224036	-475355	-183514	-154329
40	45088	73761	166946	-11485	221732	-472539	-184026	-155609
41	43808	74785	165922	-12509	219940	-469979	-183514	-149977
42	43040	75809	166178	-11229	226852	-473051	-185562	-151769
43	43296	70177	166434	-14301	222500	-475355	-188122	-151769
44	45344	69921	167970	-13277	222756	-473307	-190938	-148441
45	45088	70177	165922	-11229	220196	-472539	-189658	-149721
46	41760	71201	167202	-8157	224548	-477659	-186330	-148185
47	39968	70433	166178	-11229	224548	-476379	-186586	-149721
48	42784	71969	166690	-14557	228644	-474587	-189658	-151513
49	39712	68641	165922	-11741	230436	-471003	-189146	-149721


raw ADC, ADC2j-ADC2j-1, Non-ave (black) vs. ave=16 (red)
×10-3
Volts
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
10
20
30
40
50
60