

# Data analysis – *matching* BPC and Digitizer events

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# Where to get programs?

`/data1/tb2021/savine_programs`

# What this “*matching*” is about?

- Data analysis requires 100% confidence that we are matching proper event from BPC and Digitizers data streams.
- For example, geometrical alignment of Beam Position Chambers (BPC data), Trigger counters and Lar system including Tubes and Shower Calorimeters (DIG data).
- Following issues were found:
  1. Some spills are missing from one of data streams while present in another. Most common: there is a BPC spill but no matching DIG record, DIG record size is 0 (or close to 0).
  2. Occasional loss of synchronization between three digitizers. Makes whole bunch of events useless.
  3. At least in one case two DIG spills are saved as one long spill.
  4. Some relatively rare cases which are spotted but not yet interpreted.

# Why problems with timing:

- BPC data and DIG data has different structure. BPC recorded run-by-run, DIG recorded spill-by-spill.
- Different time stamping technic:
  1. BPC has an absolute high precision “wall time” for every trigger.
  2. DIG has ROOT object TDateime (not working currently!), which supposed to mark start of spill with 1sec precision plus Trigger Time Tag provided event-by-event by each digitizer.
- As a result, we have no actual matching between the spills in two data streams.
- Only relative time (event-event intervals) within a spill as a reliable tool of matching two data streams.



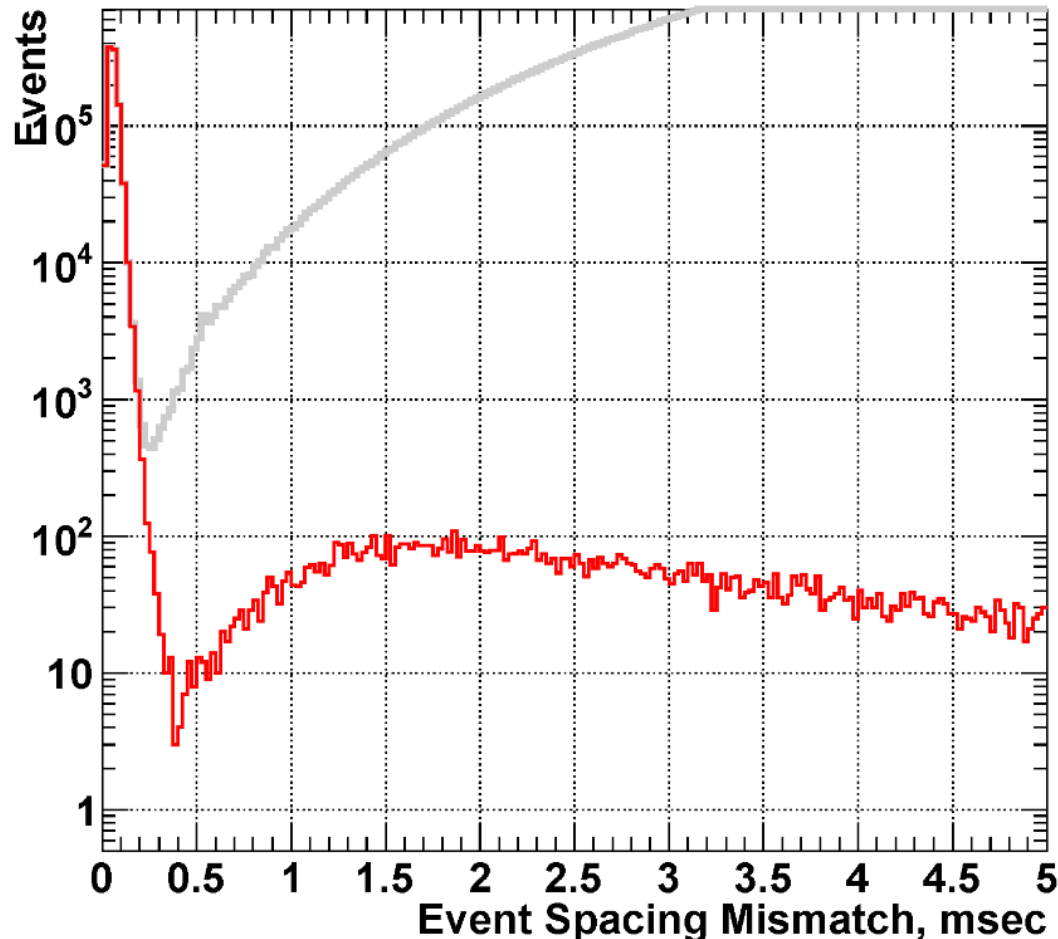
# Calculation of the *Mismatch* parameter – run-by-run

- Since we can rely only on relative timing, I picked 6(\*) consecutive events ( $i-2$  to  $i+3$ ) from one stream (BPC) and matched them against ALL groups of consecutive events from another stream (DIG);
- (\*) at the beginning and end of spill I have less than six intervals to compare
- BPC events and DIG events must belong to the same spill;
- $M = \sqrt{\frac{\sum_{i=0}^5 (t_{Bi} - t_{Di})^2}{6}}$
- Disadvantage – some events called “**failed**” if there is a bad one in a group. May be fixed by finding the “black sheep”.

BPC event #i	T-T <sub>PREV</sub>	DIG event #j	T-T <sub>PREV</sub>
$i-2$	tB0	$j-2$	tD0
$i-1$	tB1	$j-1$	tD1
$i$	tB2	$j$	tD2
$i+1$	tB3	$j+1$	tD3
$i+2$	tB4	$j+2$	tD4
$i+3$	tB5	$j+3$	tD5

# *Mismatch* parameter, all runs

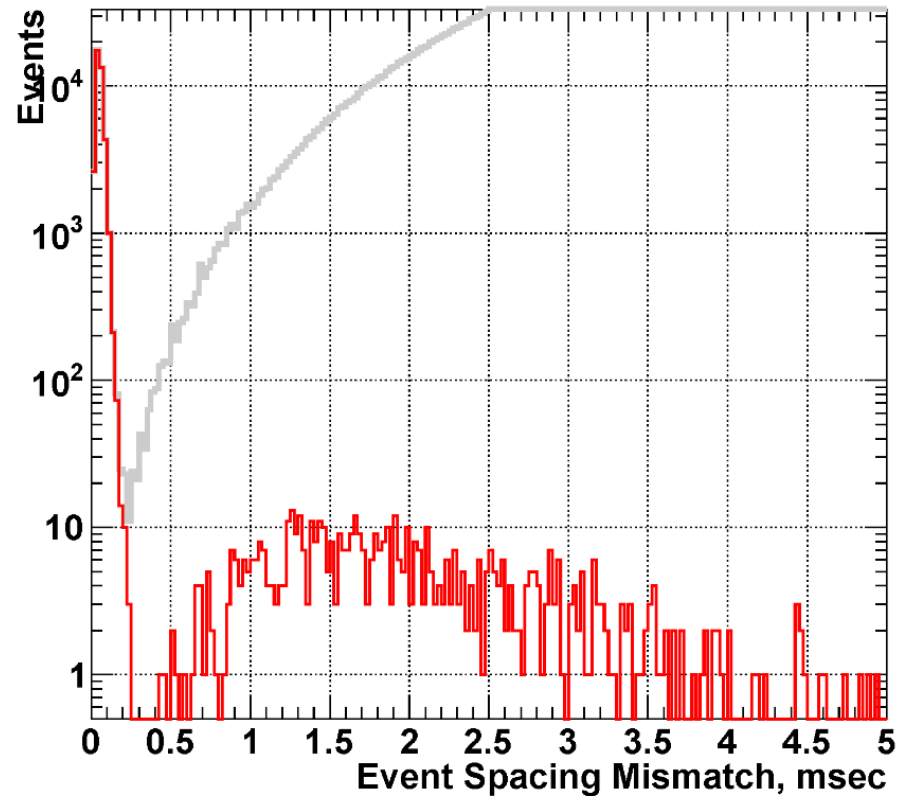
Mismatch, All Runs



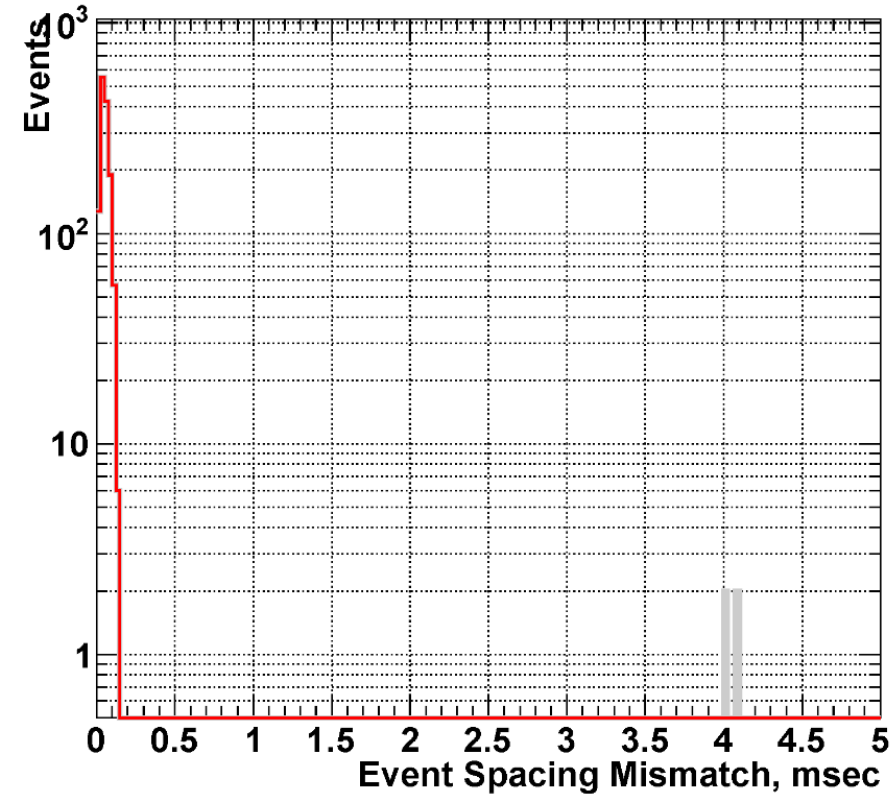
- Gray curve – all possible BPC-DIG event pairs
- Red curve – best matches (BPC->DIG and DIG->BPC mixed together)
- Used cut – 0.3msec

# *Mismatch* parameter, selected runs

Mismatch, Run#288



Mismatch, Run#321



# Run summary, early runs

Run	BPC spills	BPC triggs	DIG spills	DIG triggs	failed BPC->DIG	failed DIG->BPC
172	9	1096	13	1000	116	24
173	1	213	5	310	0	97
174	6	785	8	785	0	0
175	10	1201	12	1201	9	8
176	67	7046	89	6937	225	115
177	2	156	-1 no digitizer triggers			
179	2	204	-1 no digitizer triggers			
180	3	436	-1 no digitizer triggers			
181	8	924	-1 no digitizer triggers			
182	112	11551	126	11552	9	9
183	26	2658	32	2561	97	0
184	6	2	7	2	0	0
185	-1 no BPC trigger					
186	49	7458	51	7318	140	0
187	64	9119	66	9119	9	8



# Run summary, late runs

Run	BPC spills	BPC triggs	DIG spills	DIG triggs	failed BPC->DIG	failed DIG->BPC
308	90	2181	92	2181	0	0
309	132	3076	135	3076	0	0
310	3	96	4	43	56	3
311	23	605	25	372	280	47
312	135	2964	136	2964	0	0
313	45	817	47	807	10	0
314	43	892	45	842	50	0
315	44	1015	46	1000	14	0
316	65	1549	67	1549	3	3
317	67	1450	69	1450	0	0
318	68	1575	70	1554	27	6
319	136	2425	139	2401	22	0
320	66	1406	67	1377	29	0
321	42	701	43	679	22	0
322	44	717	46	717	0	0

# Event Matching Files – missing spill in Digitizer data

176 939 8 121 6.78696e-05 939 10 121  
176 940 8 122 6.31811e-05 940 10 122  
176 941 8 123 5.97543e-05 941 10 123  
176 942 8 124 5.61171e-05 942 10 124  
176 943 8 125 4.56096e-05 943 10 125  
176 944 8 126 5.75845e-05 944 10 126  
176 945 8 127 5.30985e-05 945 10 127  
176 946 8 128 5.72039e-05 946 10 128  
176 947 8 129 6.34984e-05 947 10 129  
176 948 8 130 7.33e-05 948 10 130  
176 949 9 0 0.000613301 -1 -1 -1  
176 950 9 1 0.00316659 -1 -1 -1  
176 951 9 2 0.00553874 -1 -1 -1  
176 952 9 3 0.00383832 -1 -1 -1  
176 953 9 4 0.005746 -1 -1 -1

176 939 10 121 6.88358e-05 939 8 121  
176 940 10 122 6.84045e-05 940 8 122  
176 941 10 123 6.51002e-05 941 8 123  
176 942 10 124 6.14577e-05 942 8 124  
176 943 10 125 3.0972e-05 943 8 125  
176 944 10 126 4.98578e-05 944 8 126  
176 945 10 127 5.64802e-05 945 8 127  
176 946 10 128 5.72039e-05 946 8 128  
176 947 10 129 6.34984e-05 947 8 129  
176 948 10 130 7.33e-05 948 8 130  
176 949 12 0 4.33051e-05 1054 10 0  
176 950 12 1 4.36807e-05 1055 10 1  
176 951 12 2 5.35743e-05 1056 10 2  
176 952 12 3 6.70005e-05 1057 10 3  
176 953 12 4 6.8058e-05 1058 10 4

# Event Matching Files – digitizer failure

176 5902 57 10 5.34692e-05 5796 70 10  
176 5903 57 11 3.19144e-05 5797 70 11  
176 5904 57 12 3.21524e-05 5798 70 12  
176 5905 57 13 3.19028e-05 5799 70 13  
176 5906 57 14 3.37771e-05 5800 70 14  
176 5907 57 15 3.31977e-05 5801 70 15  
176 5908 57 16 4.00263e-05 5802 70 16  
176 5909 57 17 0.00566077 -1 -1 -1  
176 5910 57 18 0.0128409 -1 -1 -1  
176 5911 57 19 0.0128134 -1 -1 -1  
176 5912 57 20 0.00903328 -1 -1 -1  
176 5913 57 21 0.00756278 -1 -1 -1  
176 5914 57 22 0.00432469 -1 -1 -1  
176 5915 57 23 0.00411334 -1 -1 -1  
176 5916 57 24 0.00356667 -1 -1 -1

176 5796 70 10 5.68369e-05 5902 57 10  
176 5797 70 11 2.24141e-05 5903 57 11  
176 5798 70 12 3.42724e-05 5904 57 12  
176 5799 70 13 3.4801e-05 5905 57 13  
176 5800 70 14 3.49181e-05 5906 57 14  
176 5801 70 15 3.38545e-05 5907 57 15  
176 5802 70 16 3.34991e-05 5908 57 16  
176 5803 70 17 3.46797e-05 5909 57 17  
176 5804 70 18 0.0128566 -1 -1 -1  
176 5805 70 19 0.0124748 -1 -1 -1  
176 5806 70 20 0.00691583 -1 -1 -1  
176 5807 70 21 0.00412714 -1 -1 -1  
176 5808 70 22 0.00279134 -1 -1 -1  
176 5809 70 23 0.002508 -1 -1 -1  
176 5810 70 24 0.00251377 -1 -1 -1



# Conclusions

- Matching of events is done. BPC->DIG and DIG->BPC event-by-event files are available for valid runs as  
/data1/tb2021/BPCtoDIGmatching/run\*\*\*[version].dat  
/data1/tb2021/DIGtoBPCmatching/run\*\*\*\_[version].dat
- List of runs analyzed is available after this slide and as a file attached to presentation;
- If more problems found, new version(s) will be added;
- **For future runs:** “wall time” (high precision clock) shall be used for the spill start, so it will be possible to make direct event-by event time check;
- **Digitizer synchronization failure** must be investigated. It has to be excluded (hardware or software) or fixed automatically during data taking once occurred without affecting large sets of data. No more than one spill!



Run	BPC spills	BPC triggs	DIG spills	DIG trigs	failed BPC->DIG	failed DIG->BPC
172	9	1096	13	1000	116	24
173	1	213	5	310	0	97
174	6	785	8	785	0	0
175	10	1201	12	1201	9	8
176	67	7046	89	6937	225	115
177	2	156	-1 no digitizer triggers			
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180	3	436	-1 no digitizer triggers			
181	8	924	-1 no digitizer triggers			
182	112	11551	126	11552	9	9
183	26	2658	32	2561	97	0
184	6	2	7	2	0	0
185	-1 no BPC triggers					
186	49	7458	51	7318	140	0
187	64	9119	66	9119	9	8
188	0	131	-1 no digitizer triggers			
189	0	144	-1 no digitizer triggers			
190	0	132	-1 no digitizer triggers			
191	64	8573	66	8573	0	0
192	37	4845	66	8396	9	3559

Run	BPC spills	BPC triggs	DIG spills	DIG trigs	failed BPC->DIG	failed DIG->BPC
193	-1 no BPC triggers					
195	-1 no BPC triggers					
196	-1 no BPC triggers					
197	-1 no BPC triggers					
198	1	43	-1 no digitizer triggers			
199	3	75	5	75	0	0
200	84	1388	87	1349	45	6
201	1	593	-1 no digitizer triggers			
202	1	17	-1 no digitizer triggers			
203	48	976	51	976	0	0
205	1	589	-1 no digitizer triggers			
206	62	18535	64	17629	906	0
207	1	594	-1 no digitizer triggers			
208	65	19153	67	19153	0	0
209	64	18424	66	18424	0	0
210	63	17793	64	17256	536	0
211	1	524	-1 no digitizer triggers			
212	62	16666	64	16393	273	0

Run	BPC spills	BPC triggs	DIG spills	DIG trigs	failed BPC->DIG	failed DIG->BPC
213	1	557	-1 no digitizer triggers			
214	63	17200	67	16925	283	8
215	1	569	-1 no digitizer triggers			
216	63	16836	65	16836	0	0
217	67	17927	69	17378	548	0
218	1	527	-1 no digitizer triggers			
219	65	16911	67	16911	0	0
220	65	17380	70	17069	336	24
221	1	600	-1 no digitizer triggers			
222	68	19750	72	19147	612	8
223	1	531	-1 no digitizer triggers			
224	65	17030	67	16768	262	0
225	1	556	-1 no digitizer triggers			
226	71	19067	73	19067	0	0
227	-1 no BPC file					
229	-1 no BPC triggers					
230	22	2991	24	2868	126	3
236	8	1246	9	71	1181	6
242	18	2166	19	2035	131	0

Run	BPC spills	BPC triggs	DIG spills	DIG trigs	failed BPC->DIG	failed DIG->BPC
243	5	161	6	161	0	0
244	27	3685	29	3685	0	0
245	21	3225	23	2925	300	0
246	21	3227	23	3227	0	0
247	19	2993	21	2993	0	0
248	23	2208	25	2208	0	0
249	26	2349	28	2349	0	0
250	20	5051	22	4786	268	3
251	2	61	4	61	0	0
252	21	485	23	463	22	0
253	63	1596	66	1580	16	0
254	6	129	7	129	9	8
255	51	1290	53	1255	44	8
256	71	1646	73	1592	54	0
257	66	1687	68	1663	24	0
258	63	1610	65	1610	0	0
259	3	82	4	65	26	8
260	19	491	21	491	0	0
261	27	587	28	587	9	8
262	64	1500	66	1500	0	0



Run	BPC spills	BPC triggs	DIG spills	DIG trigs	failed BPC->DIG	failed DIG->BPC
263	63	1394	66	1407	8	21
264	63	1468	65	1447	21	0
265	63	1461	66	1376	109	23
266	62	1479	64	1421	58	0
267	66	1636	68	1577	68	8
268	63	1512	67	1488	24	0
269	63	1550	65	1550	18	16
270	62	1476	64	1474	2	0
271	60	1445	62	1445	0	0
272	62	1475	64	1422	53	0
273	61	1576	64	1545	31	0
274	62	1581	64	1558	23	0
275	61	1563	64	1474	89	0
276	62	1540	64	1486	54	0
277	64	1662	66	1616	46	0
278	62	1628	65	1546	91	8
279	53	19268	56	18583	693	8
280	62	1588	64	1503	94	8
281	63	1706	65	1706	0	0
282	69	1878	72	1828	59	8

Run	BPC spills	BPC triggs	DIG spills	DIG triggs	failed BPC->DIG	failed DIG->BPC
283	59	1594	62	1567	27	0
284	63	1697	65	1697	0	0
285	59	1541	61	1518	23	0
286	60	1384	62	1356	28	0
287	60	1517	62	1490	27	0
288	61	20206	63	19575	629	0
289	66	21719	69	21384	344	8
290	63	1931	66	1886	61	16
291	39	877	41	877	0	0
292	28	481	30	481	0	0
293	84	6986	85	6986	0	0
294	3	112	5	112	0	0
295	109	33187	112	32242	948	3
296	41	1029	43	1000	29	0
297	28	441	29	441	0	0
298	37	916	39	916	0	0
299	32	792	36	792	0	0
300	38	949	40	949	0	0
301	2	54	4	54	0	0
302	52	1272	54	1272	0	0

Run	BPC spills	BPC triggs	DIG spills	DIG trigs	failed BPC->DIG	failed DIG->BPC
303	35	880	37	880	0	0
304	3	72	5	72	0	0
305	44	1083	46	1083	0	0
306	67	1639	69	1616	22	0
307	88	2094	91	2043	54	3
308	90	2181	92	2181	0	0
309	132	3076	135	3076	0	0
310	3	96	4	43	56	3
311	23	605	25	372	280	47
312	135	2964	136	2964	0	0
313	45	817	47	807	10	0
314	43	892	45	842	50	0
315	44	1015	46	1000	14	0
316	65	1549	67	1549	3	3
317	67	1450	69	1450	0	0
318	68	1575	70	1554	27	6
319	136	2425	139	2401	22	0
320	66	1406	67	1377	29	0
321	42	701	43	679	22	0
322	44	717	46	717	0	0