



清华大学
Tsinghua University

Scaler Analysis

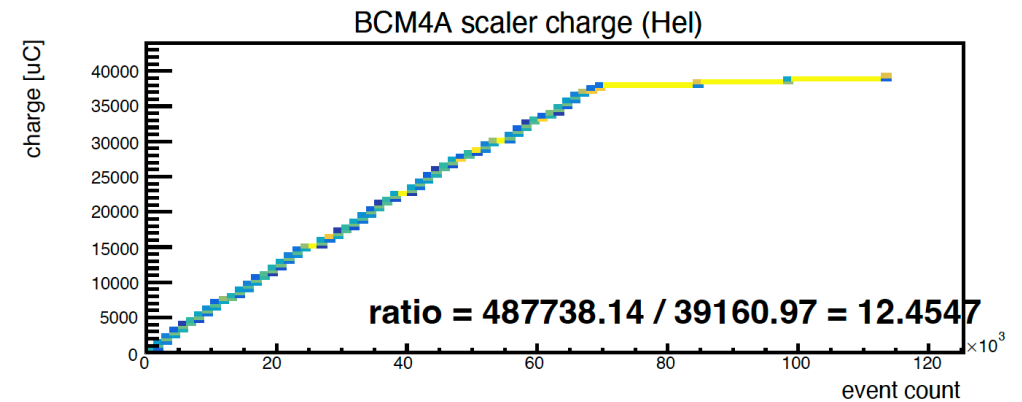
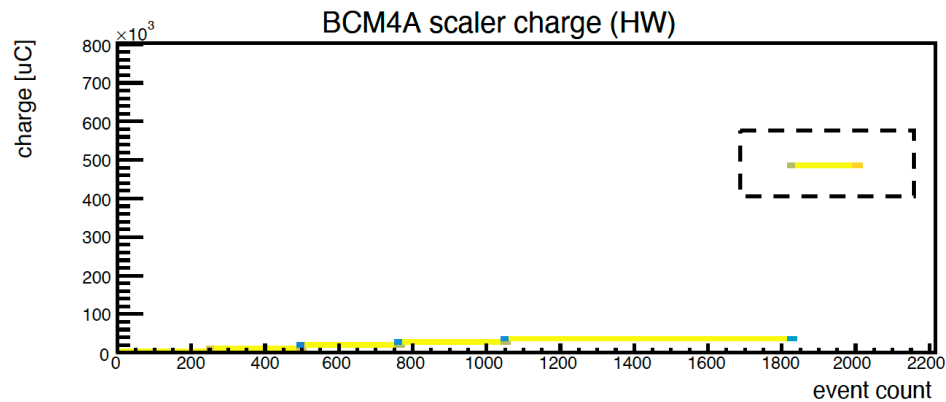
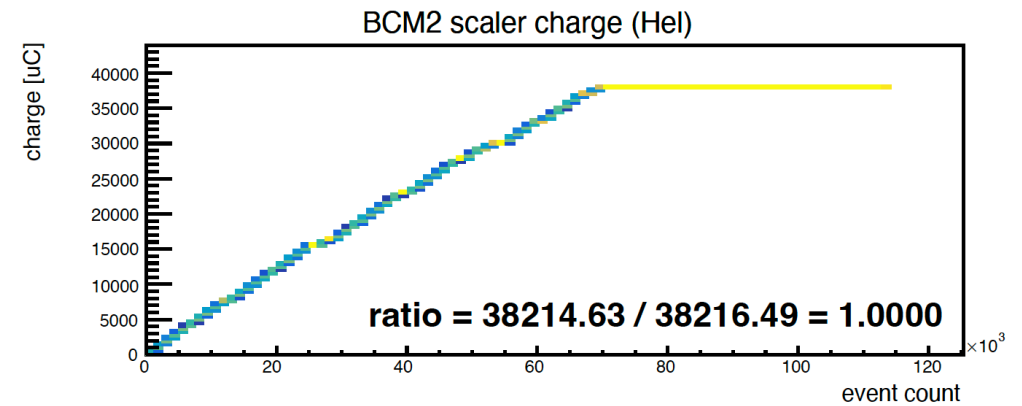
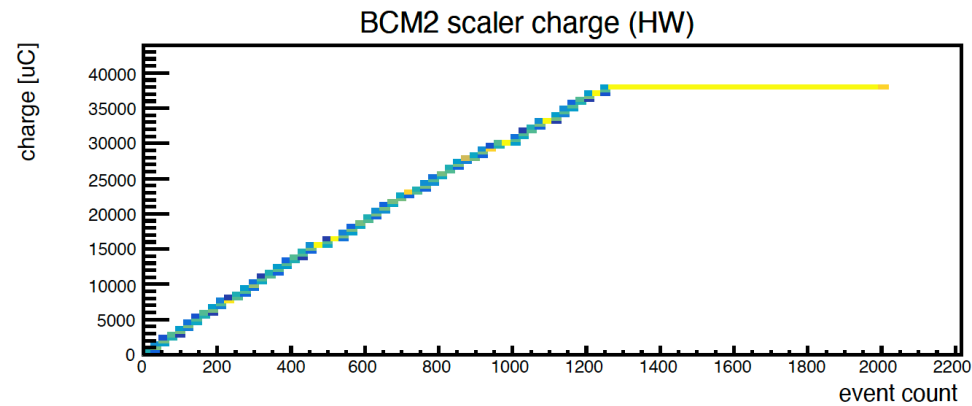
Yaopeng Zhang

Collaboration meeting 05/06/2025



HW scaler issues

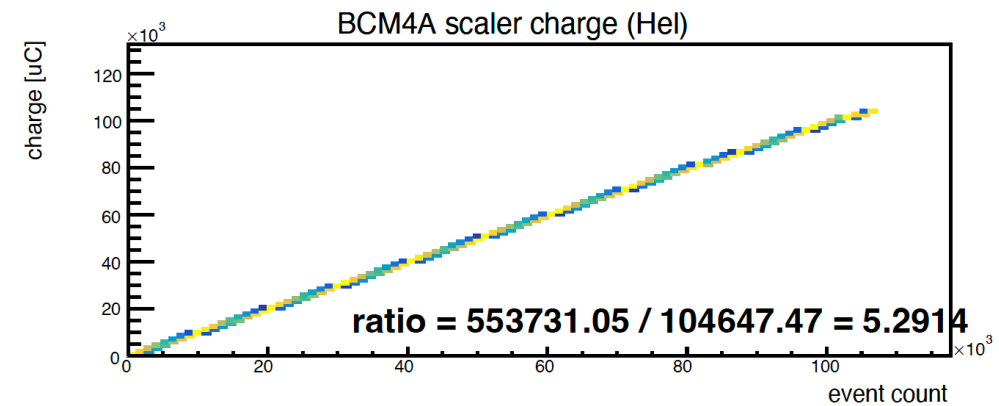
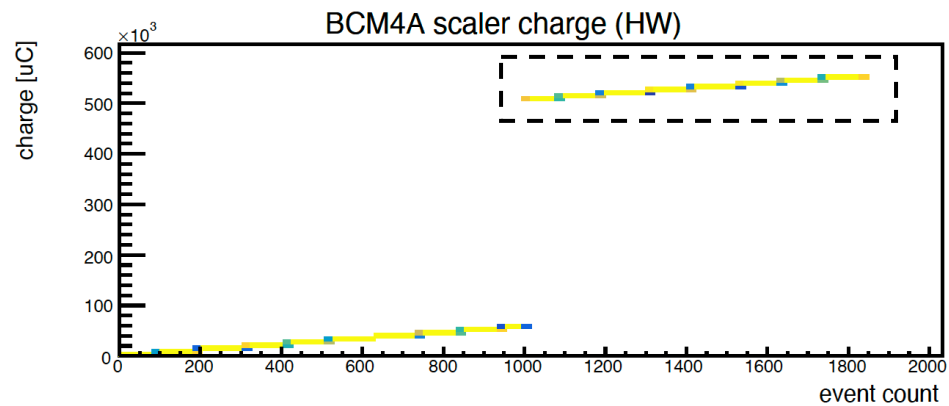
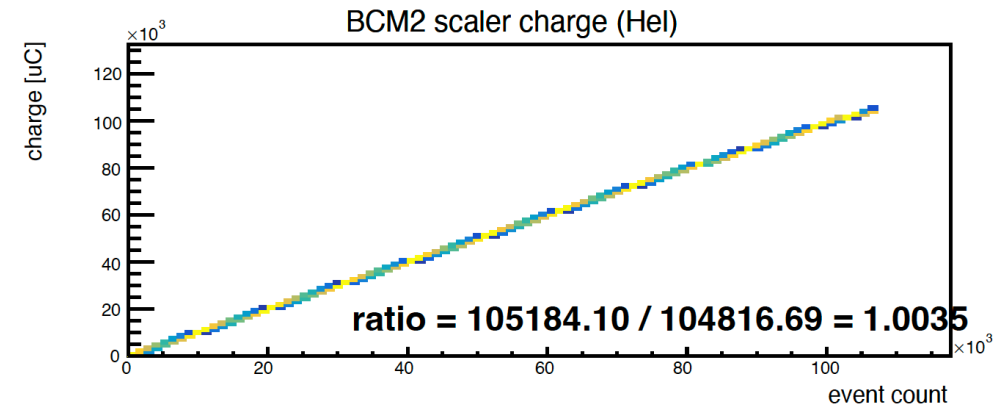
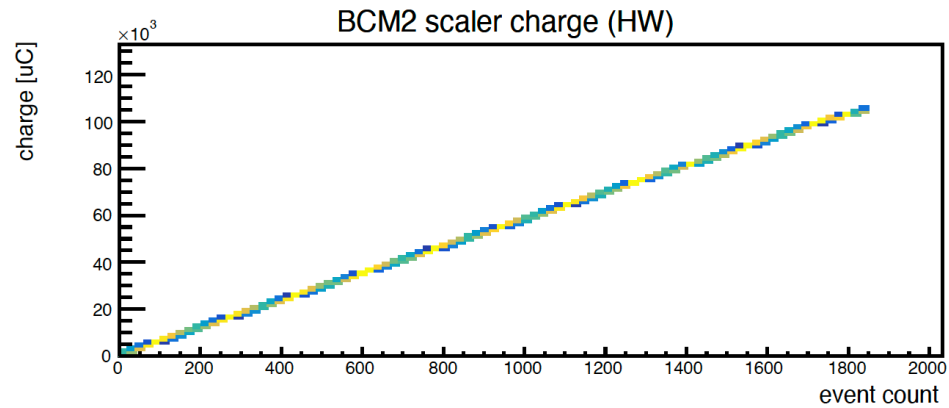
1. Sometimes some scaler channel could have a big jump of 2^{32} .



■ HW scaler issues

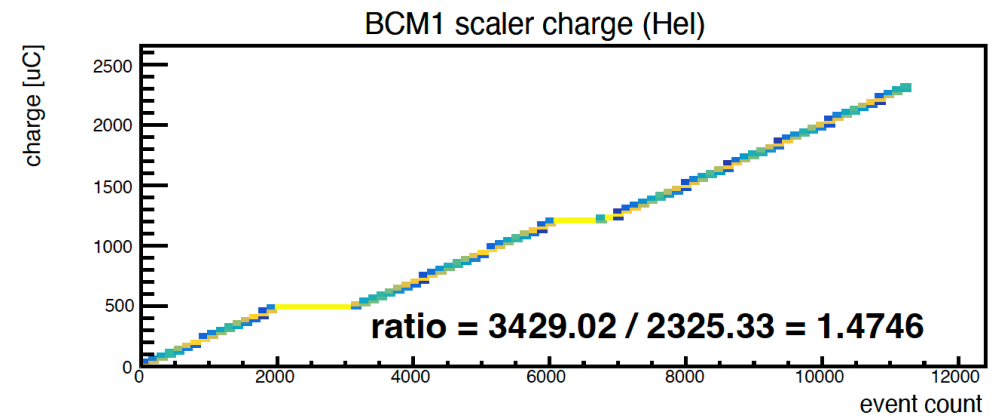
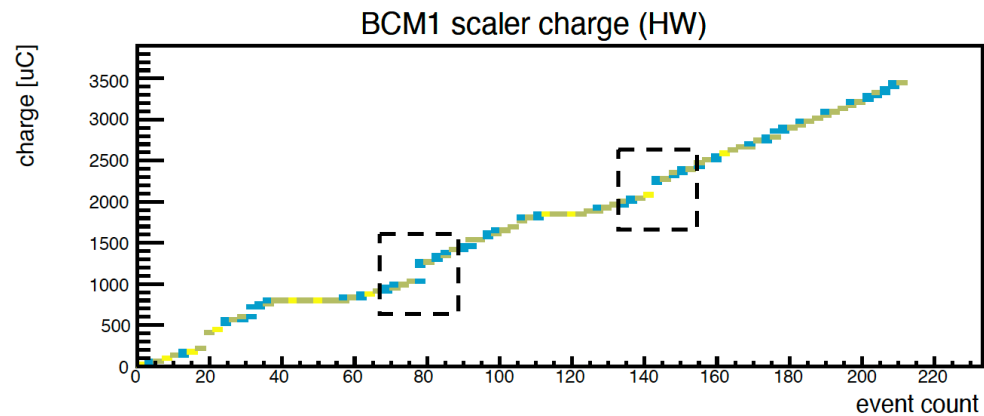
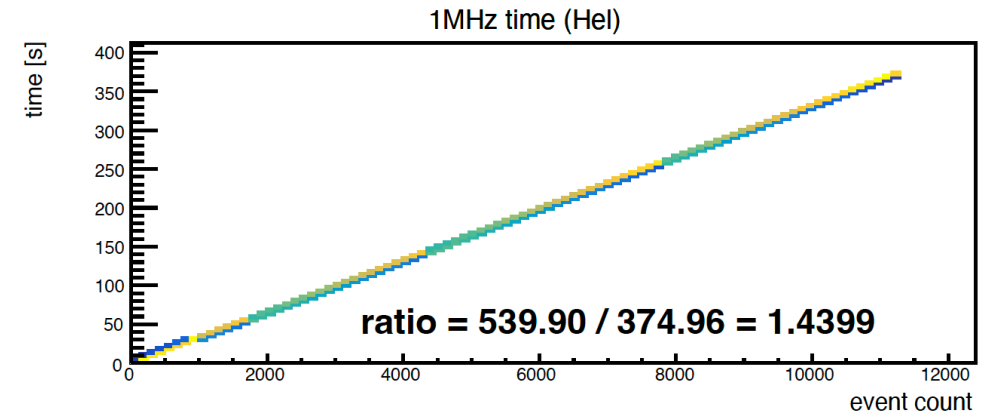
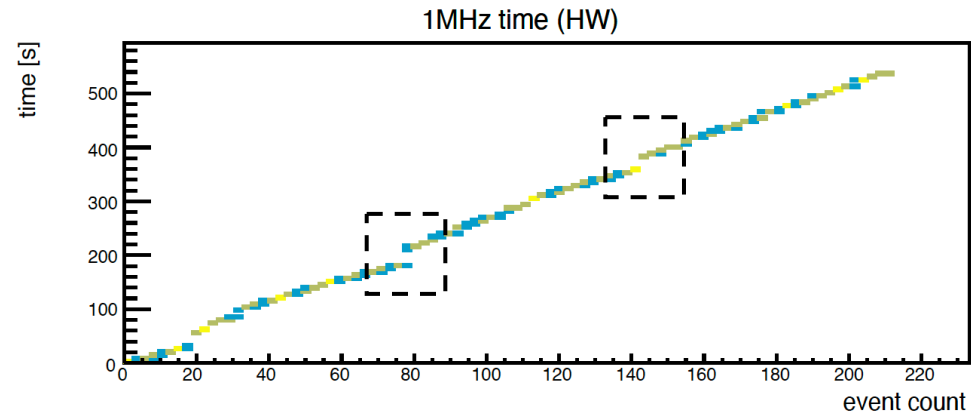
1. Sometimes some scaler channel could have a big jump of 2^{32} .

❖ That's because those scalers were getting cleared and software assumed 32-bit rollover.



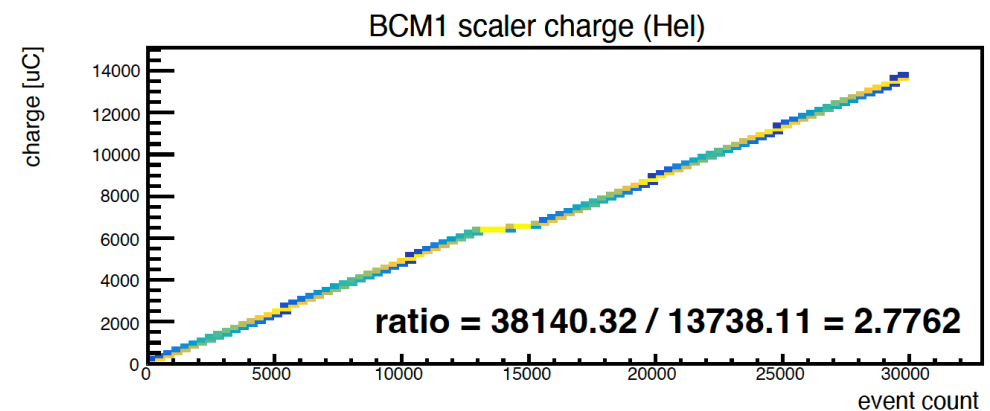
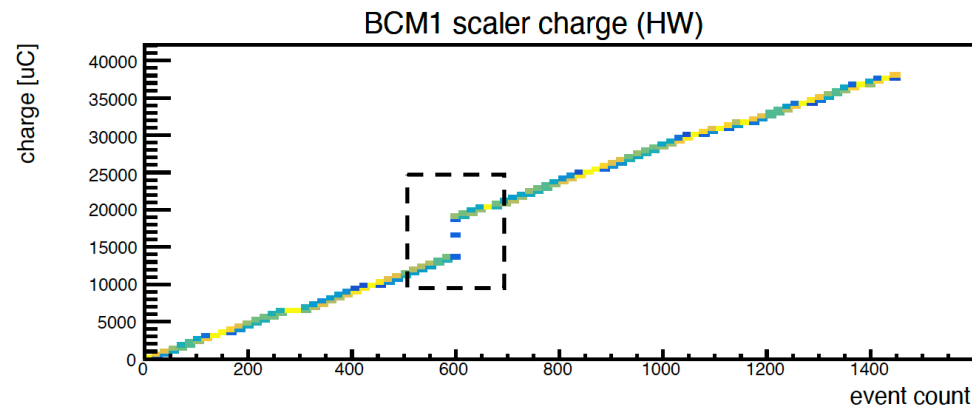
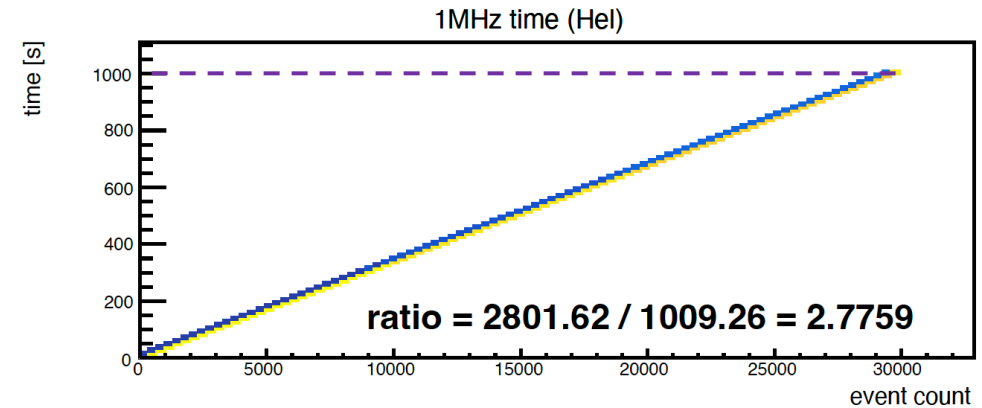
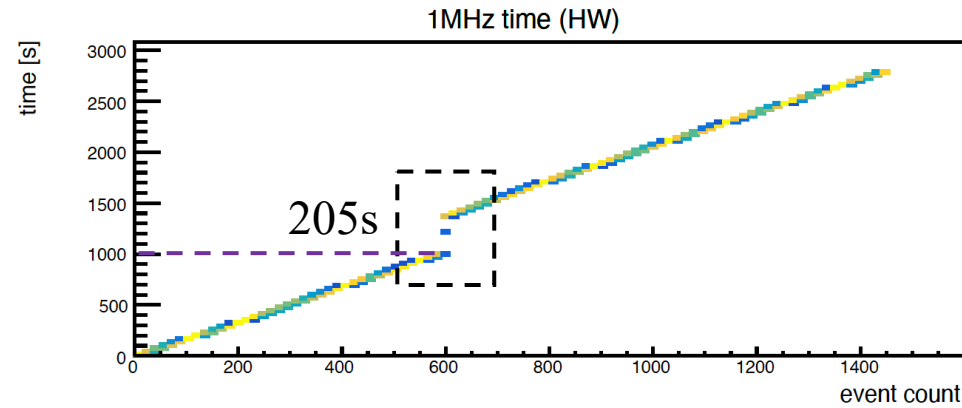
HW scaler issues

1. Sometimes some scaler channel could have a big jump of 2^{32} .
2. Sometimes some scaler channel could have small jumps.



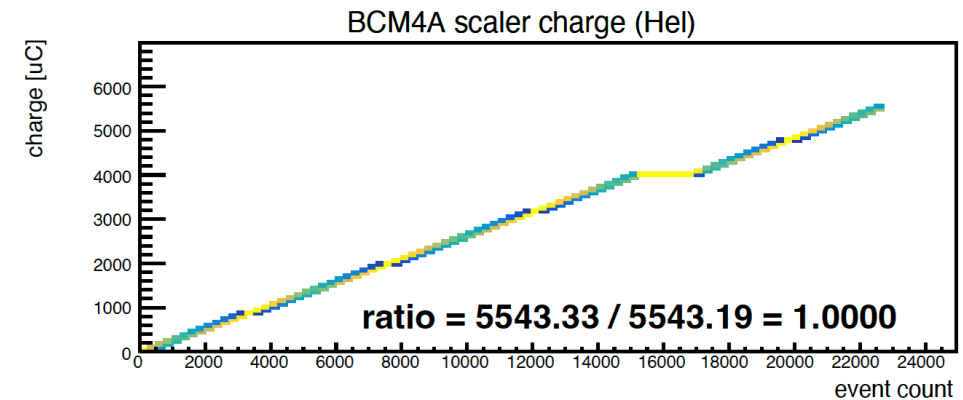
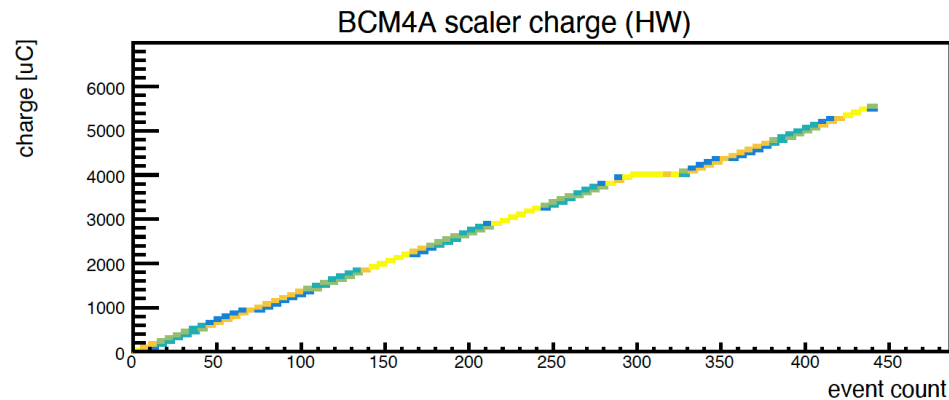
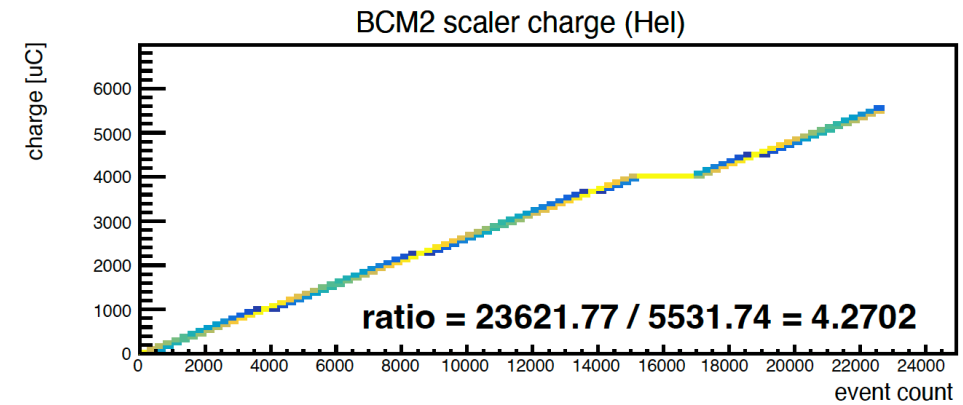
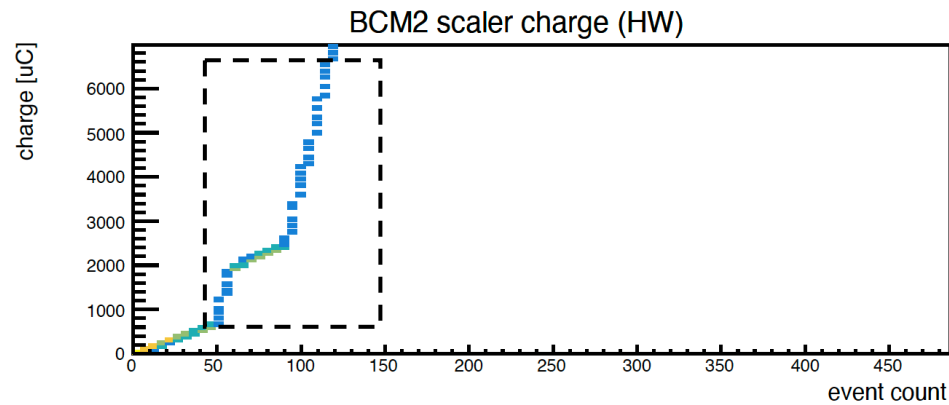
HW scaler issues

1. Sometimes some scaler channel could have a big jump of 2^{32} .
2. Sometimes some scaler channel could have small jumps.
 - ❖ In some cases, the helicity scaler terminates when there is a HW jump



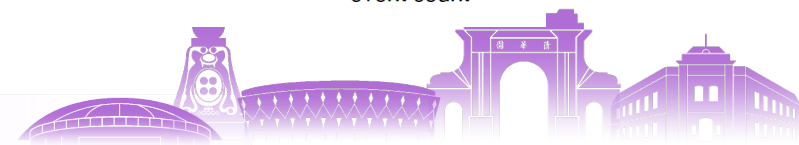
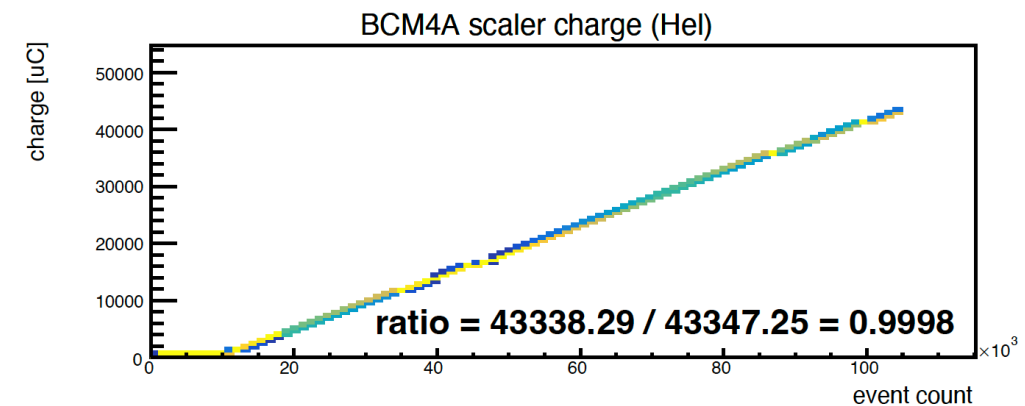
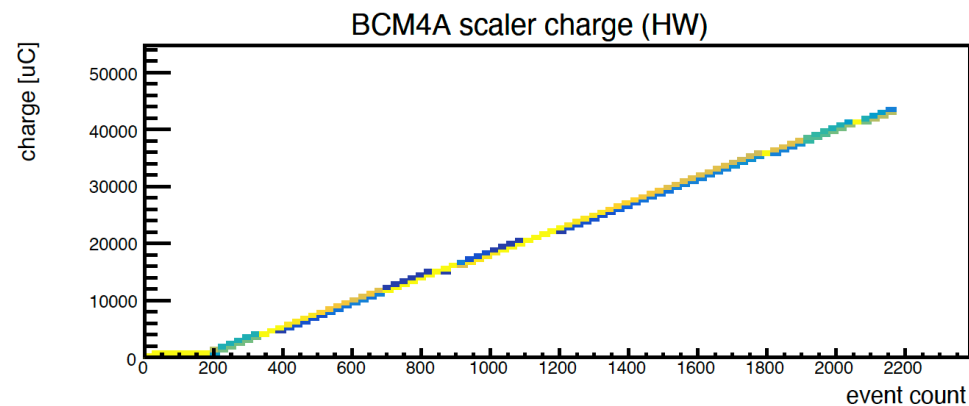
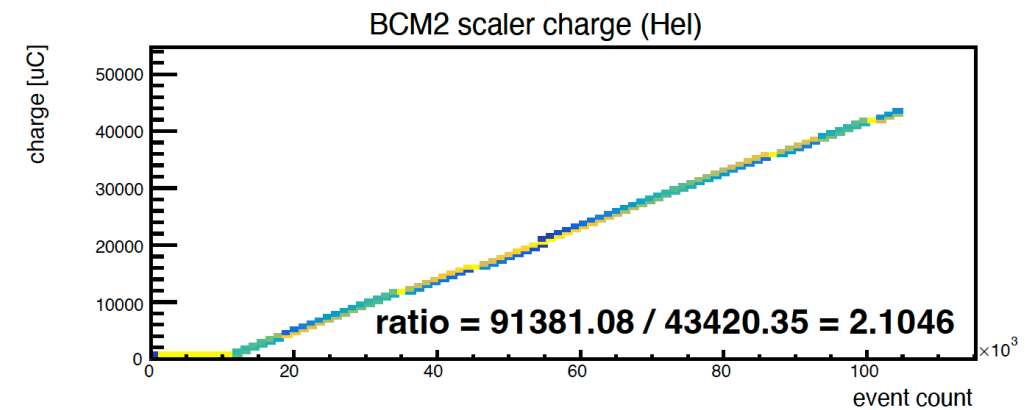
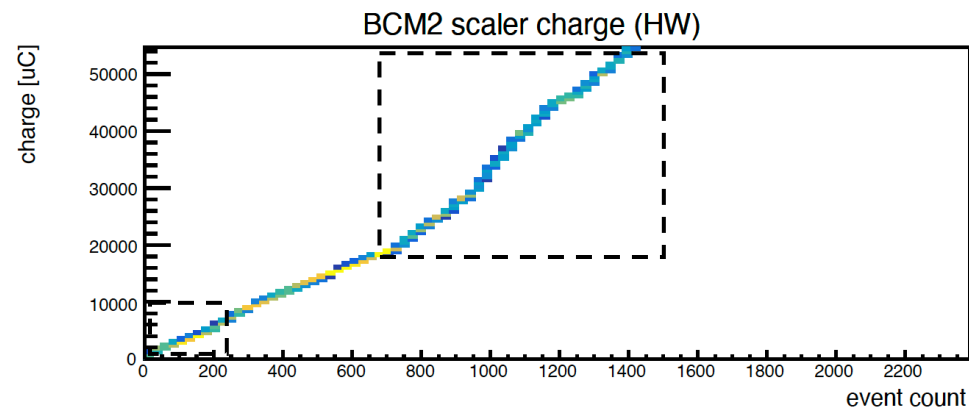
HW scaler issues

1. Sometimes some scaler channel could have a big jump of 2^{32} .
2. Sometimes some scaler channel could have small jumps.
3. Sometimes some scaler channel could have weird behavior.



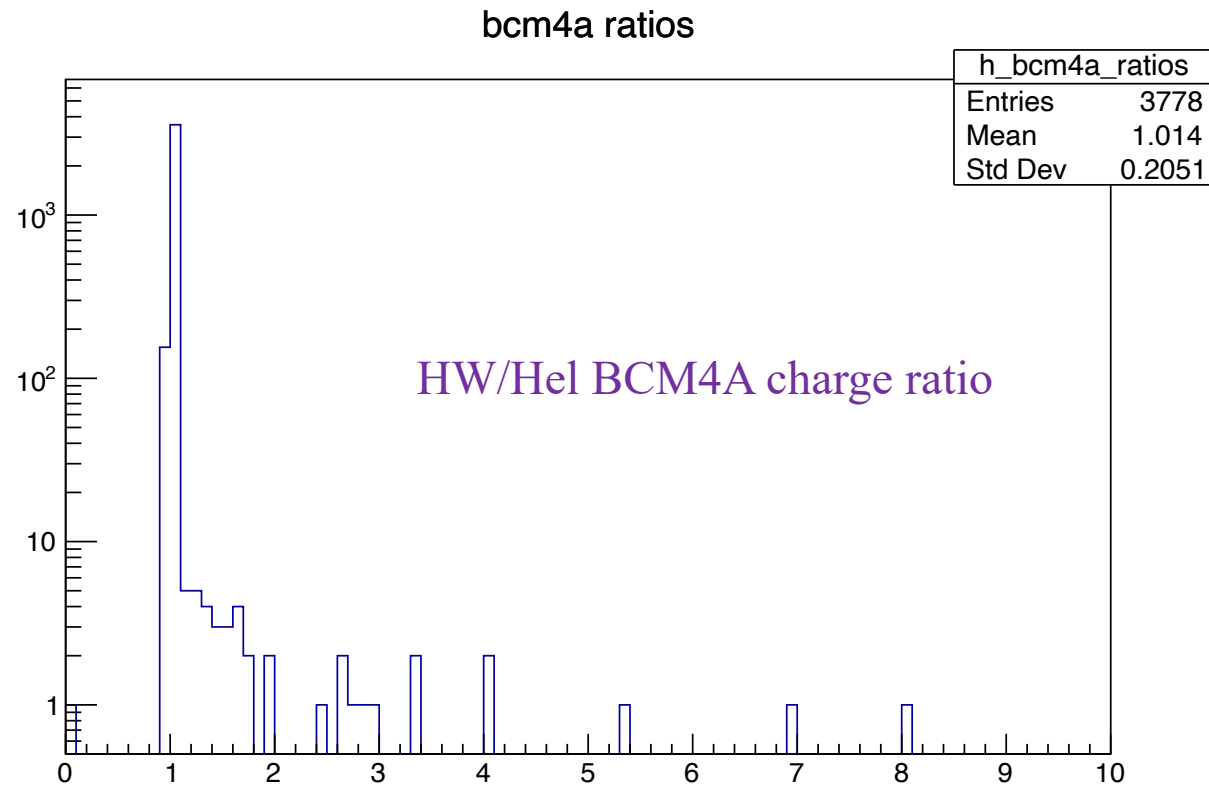
■ HW scaler issues

1. Sometimes some scaler channel could have a big jump of 2^{32} .
2. Sometimes some scaler channel could have small jumps.
3. Sometimes some scaler channel could have weird behavior (especially BCM2).



■ Hypothesis

- Hanjie Liu: the helicity (Hel) scalers should always lead to good scaler values
- Bob Michaels worked on exploring this hypothesis and found that that's basically correct
- But Bob found that the HW/Hel ratios from COIN segments and SKIM are different for some runs



■ Issue in Pass0

- HW/Hel ratios from COIN segments and SKIM are different for some runs
- Take run 3136 as an example:
 - ❖ HW scaler: The last scaler entry in TSH tree
 - ❖ Hel scaler: $counts = \sum_{i=0}^N |scaler_i|$

BCM4A charge (mC)	HW	Hel	ratio
COIN	36890.4	36889.1	1.000035
SKIM	36890.4	13910.5	2.651982



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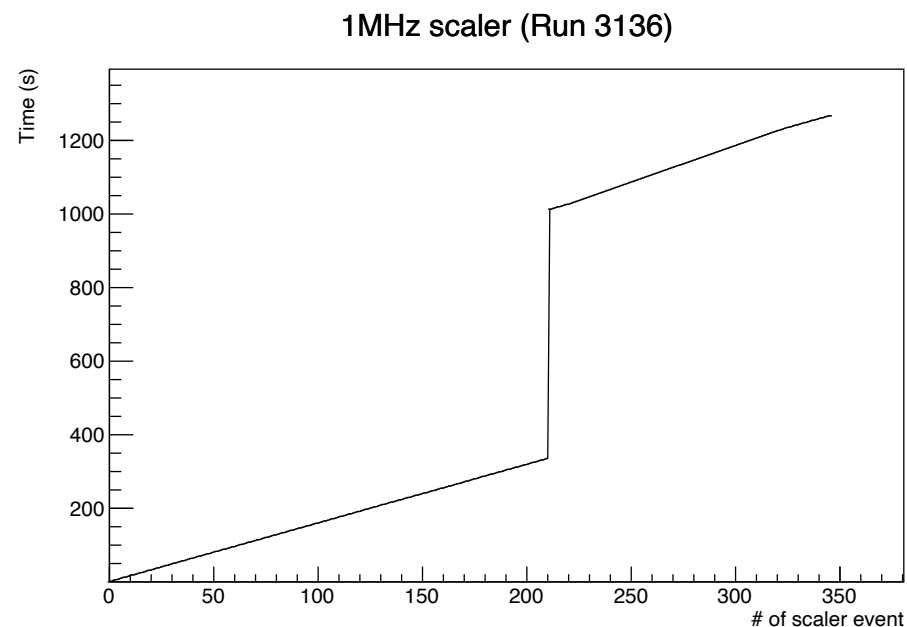
BCM4A charge (mC)	HW scaler	Hel scaler	ratio
seg 0	11456.0	11513.3	0.995023
seg 1	22954.1	11472.8	1.002205
seg 2	34478.3	11505.8	1.001599
seg 3	36890.4	2397.24	1.006199
COIN total	36890.4	36889.1	1.000035
SKIM	36890.4	13910.5	2.651982



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	HW scaler entries	Hel scaler entries
seg 0	212	9977
seg 1	213	9935
seg 2	213	9991
seg 3	136	7550
COIN total	774	37453
SKIM	347	17527
seg 0 + seg 3	348	17527



■ Replay test

- I replayed two runs using the SKIM script: 3136, 3144

```
Search paths:
./raw
./raw/../raw.copiedtotape
./cache
/net/cdaq/cdaql1data/coda/data/raw
File names:
nps_coin_3136.dat.0
nps_coin_3136.dat.1
nps_coin_3136.dat.2
nps_coin_3136.dat.3
Default stream:
nps_coin_3136.dat.0
./raw/nps_coin_3136.dat.1
./raw/nps_coin_3136.dat.2
nps_coin_3136.dat.3
Initializing analysis objects
```

Normal case

All the segments were found

```
523000
524000
525000
526000
527000
528000
529000
Normal end of file nps_coin_3136.dat.0 encountered
MultiFileRun::Read: Switching to next segment idx = 1, file = "./raw/nps_coin_3136.dat.1"
530000
531000
532000
533000
534000
535000
```

```
Search paths:
./raw
./raw/../raw.copiedtotape
./cache
/net/cdaq/cdaql1data/coda/data/raw
File names:
nps_coin_3144.dat.0
nps_coin_3144.dat.1
nps_coin_3144.dat.2
nps_coin_3144.dat.3
nps_coin_3144.dat.4
nps_coin_3144.dat.5
Default stream:
nps_coin_3144.dat.0
nps_coin_3144.dat.5
Initializing analysis objects
```

Segment missing

Only 2 segments were found

```
567000
568000
569000
Normal end of file nps_coin_3144.dat.0 encountered
MultiFileRun::Read: Switching to next segment idx = 1, file = "nps_coin_3144.dat.5"
THcHelicity: Missed 2274568 events at event 2844551
Disabling helicity decoding for rest of run.
Make sure "RawDecode_master in cuts file accepts all physics events.
THcHelicityScaler: Quartet bit expected but not set (7865)
2845000
2846000
2847000
2848000
```



■ Pass1 scaler check

- I only analyzed all the runs that are marked as “production” in Josh’s run list
- Total number of production runs: 3571
- Number of runs that the skim root file doesn't exist: 62
- Number of runs that were analyzed: 3509
- For each run:
 1. Calculate the total charge and beam time for each BCM (BCM1, BCM2, BCM4A, BCM4C)
 2. Remove the big jumps (>10s) in the 1MHz scaler when calculating the total beam time
 3. Applied the 2uA beam current cut for each BCM charge and the corresponding total beam time
- Classify all the production runs into 4 categories roughly

HW/He1 ratios from the COIN
segment root files are still bad.

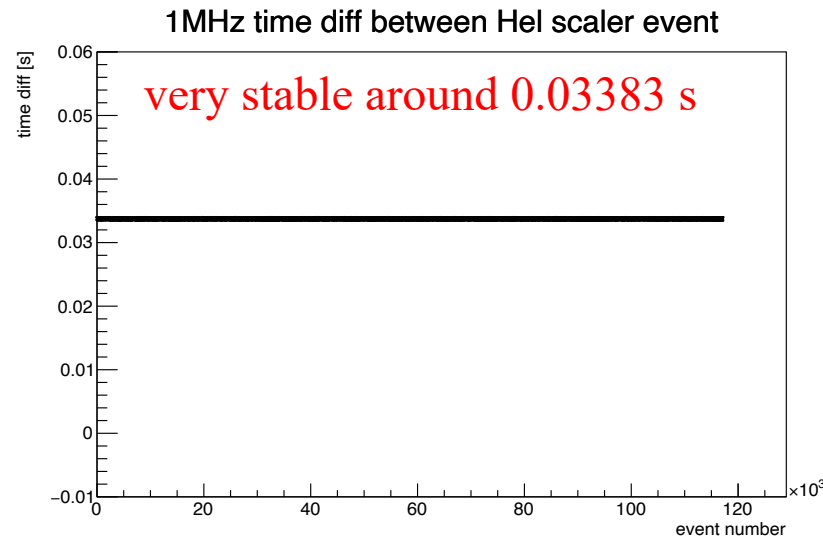
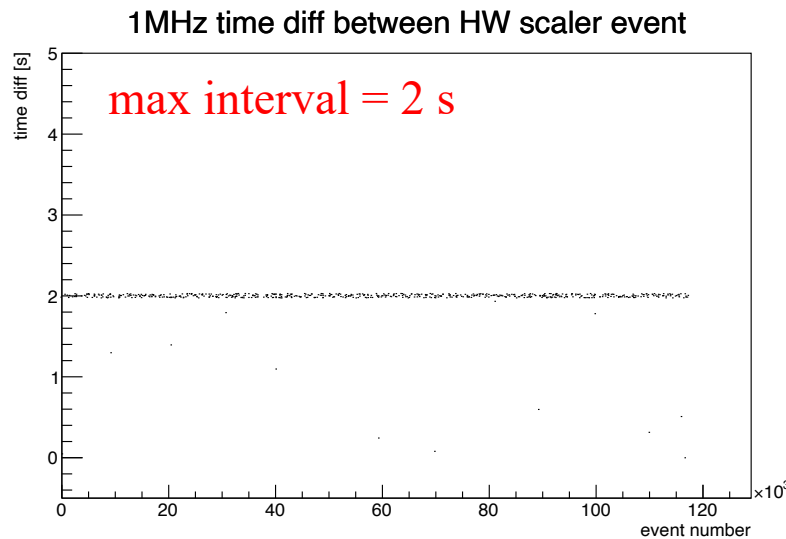
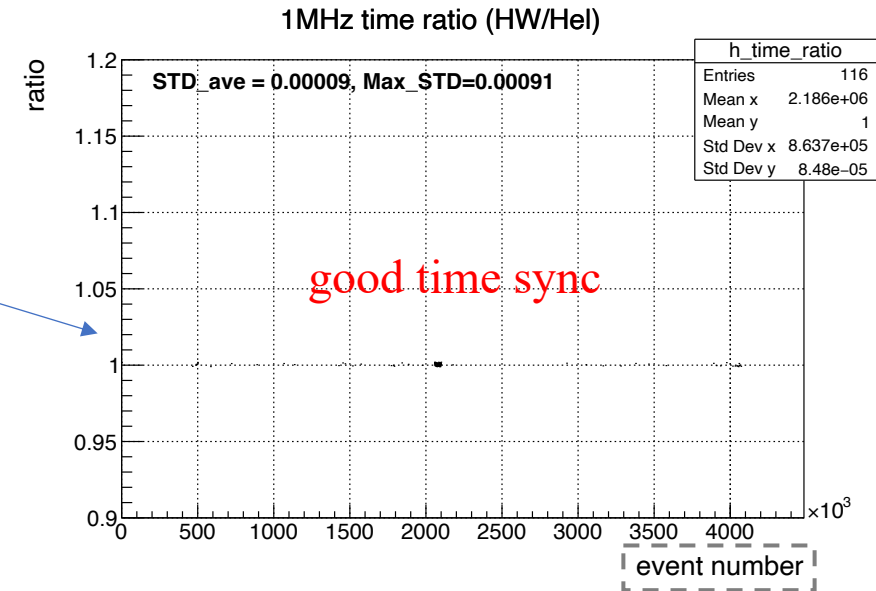
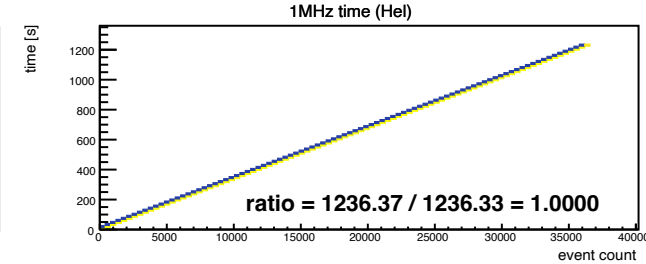
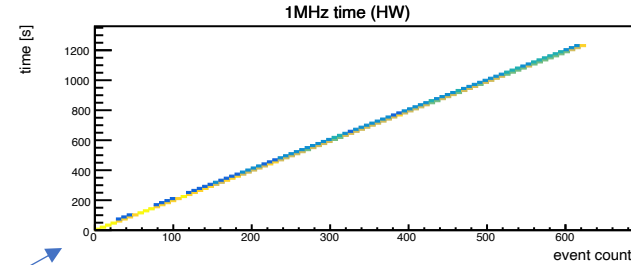
Pass1 SKIM replay → Good

	Charge ratios (R_i)	Time ratios (T_i)	Number of runs	Percentage
Good ratios	All $R_i < 1.02$		3313	94.41%
Bad ratios but good He1 scaler	Any $R_i > 1.02$	Any $T_i < 1.02$	139	3.96%
Need more investigation	Any $R_i > 1.02$ All $R_i < 1.2$	All $T_i > 1.02$	13	0.37%
Broken He1	Any $R_i > 1.2$	All $T_i > 1.02$	44	1.25%



Investigation on the bad ratio runs

- Why the ratios are not close to 1?
- Let's look at the 1MHz time ratio since it's beam independent
- Good ratio runs:
 1. The ratios of HW/Hel are very close to 1
 2. Both the HW and Hel 1MHz time is very stable
 3. The 1MHz time from HW and Hel is in good sync
 4. Time interval between 2 scaler events is stable
 1. HW scaler max interval is about 2s
 2. Hel scaler interval is stable around 0.03383 s

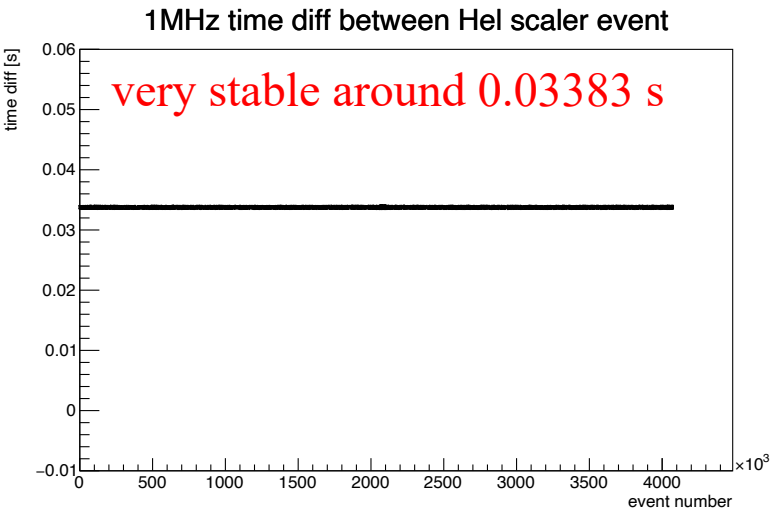
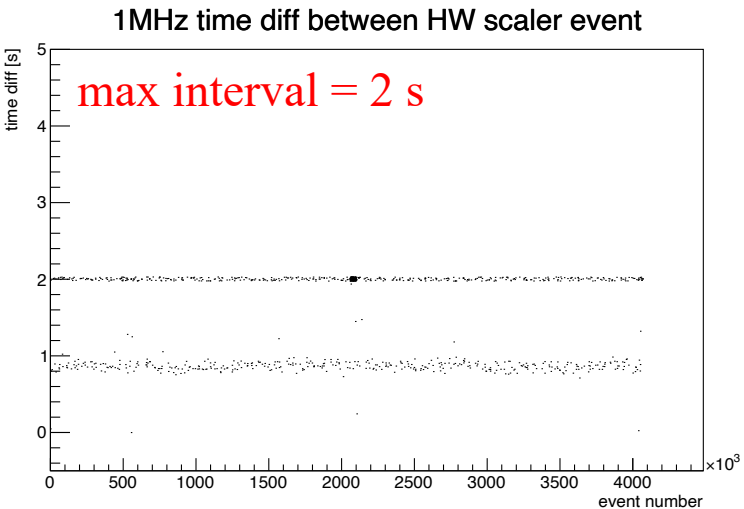
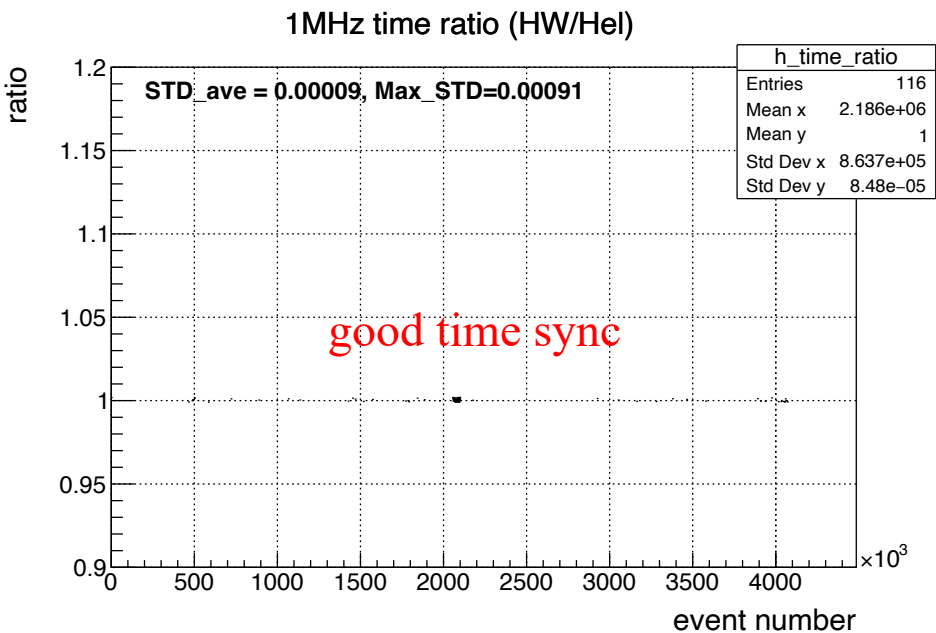
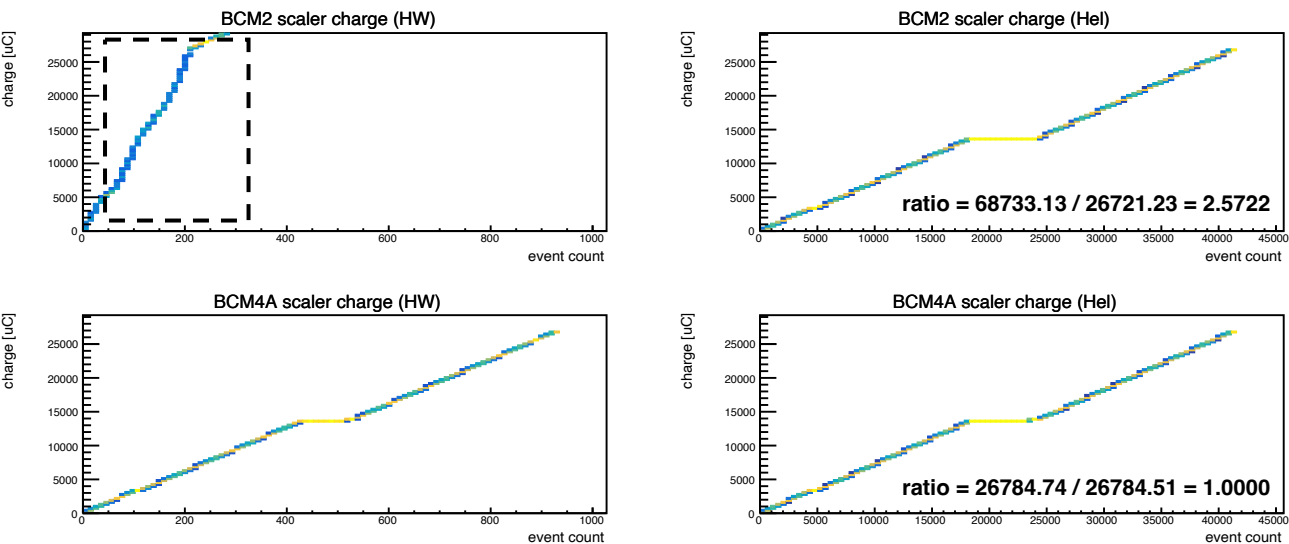


- Branch "evNumber" is the physics event number for a scaler event
- Find the HW/Hel scaler events that has the same "evNumber"



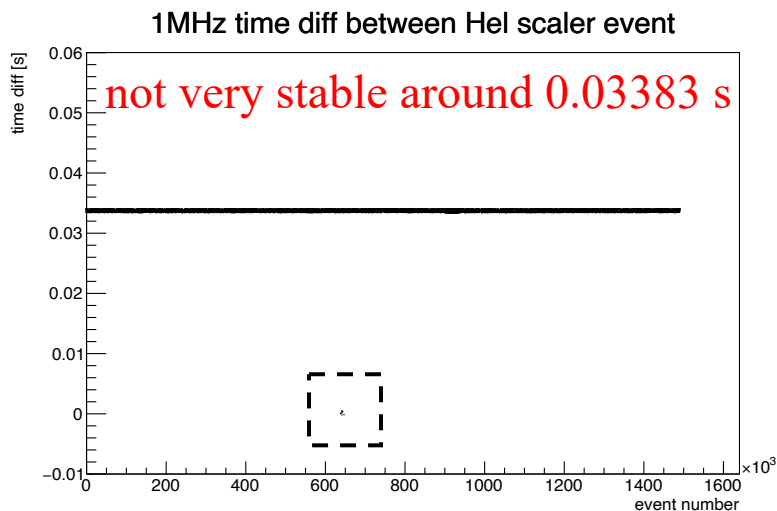
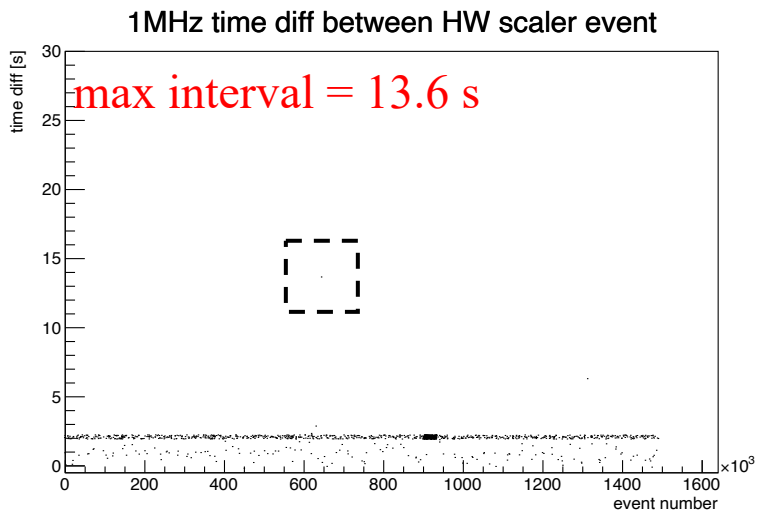
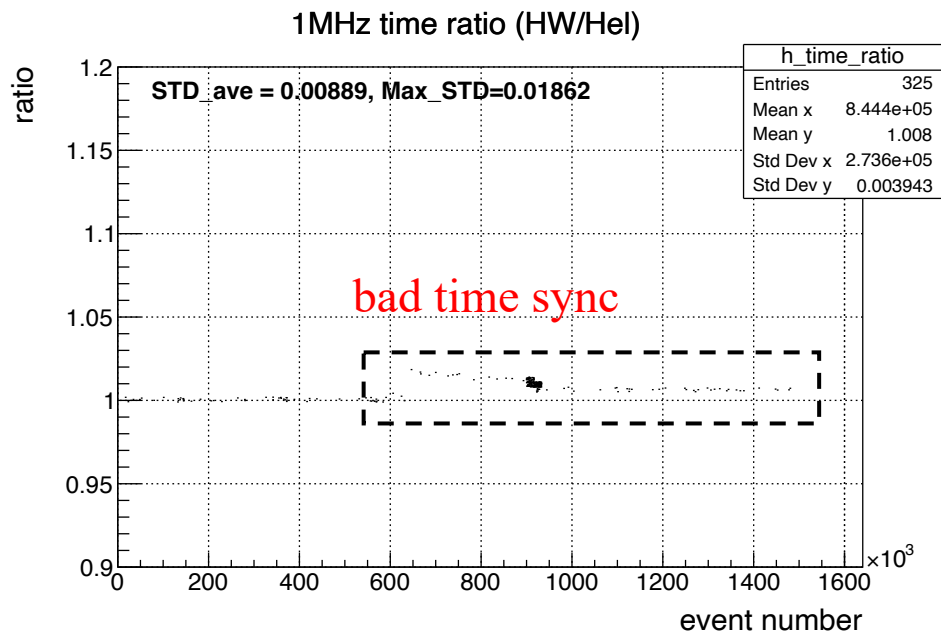
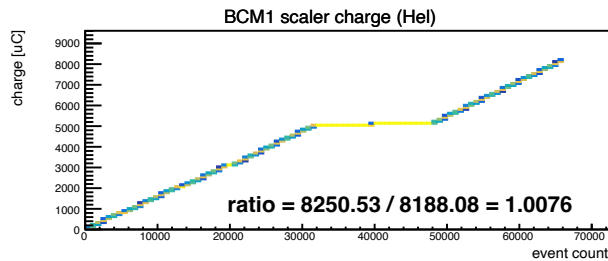
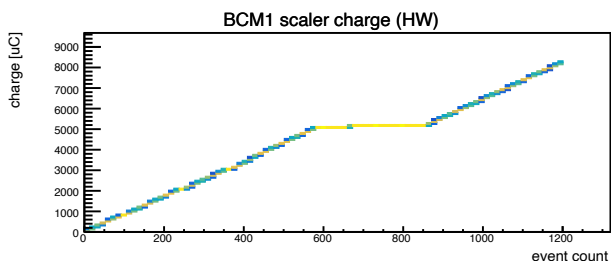
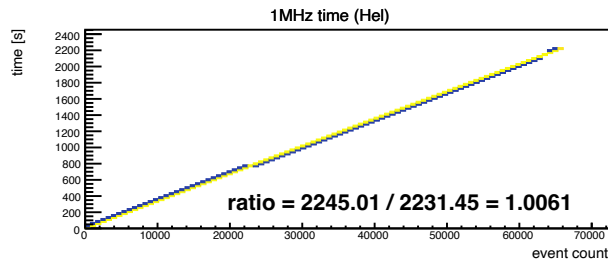
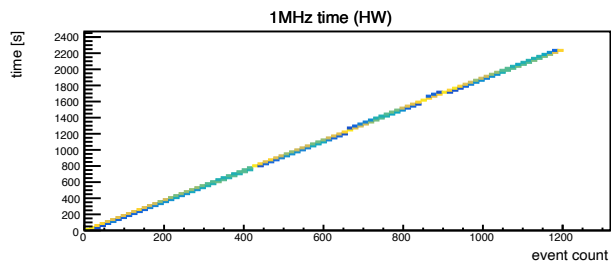
■ Examples for bad ratio runs

➤ Run 3126 (Bad ratios but good Hel scaler)



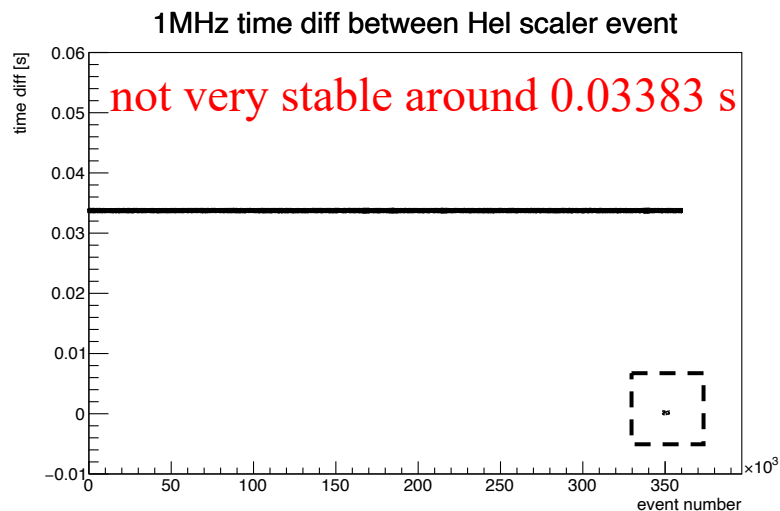
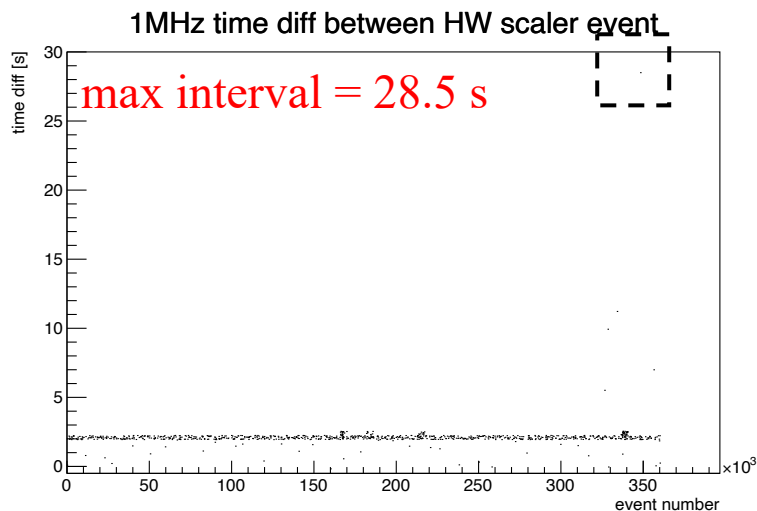
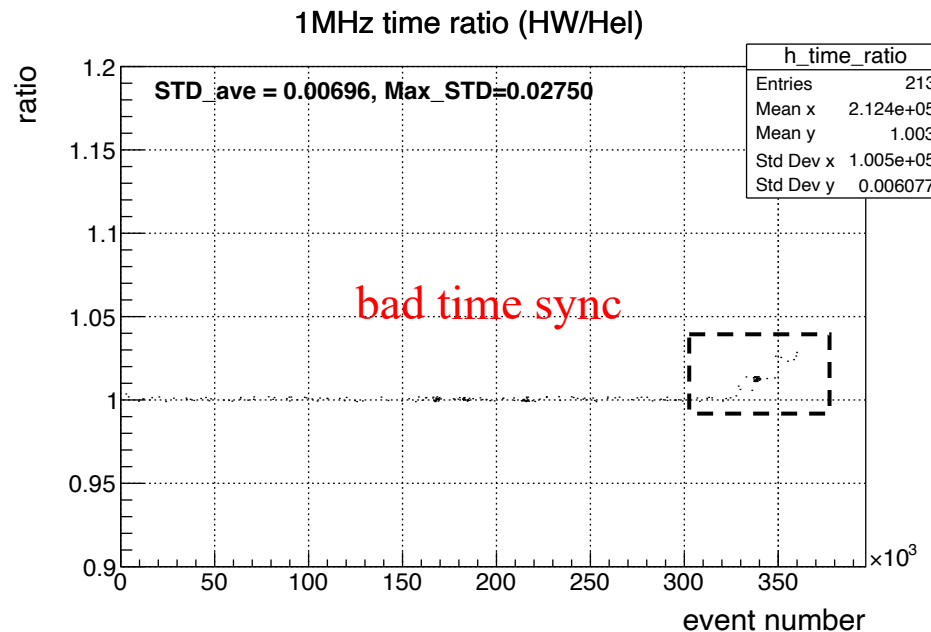
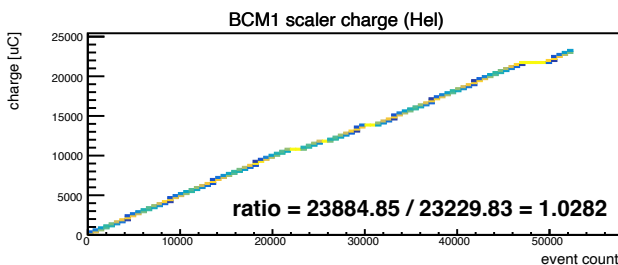
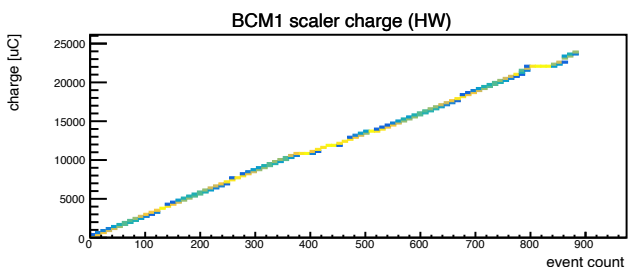
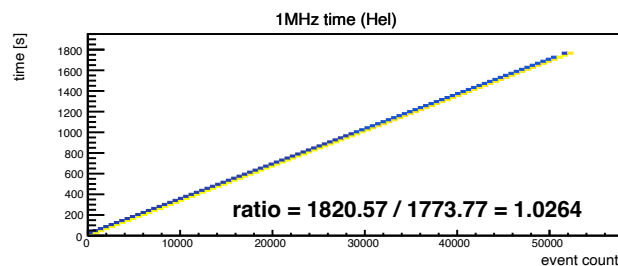
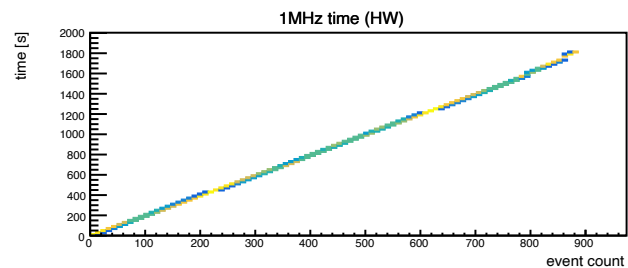
Examples for bad ratio runs

➤ Run 2082 (Good ratios)



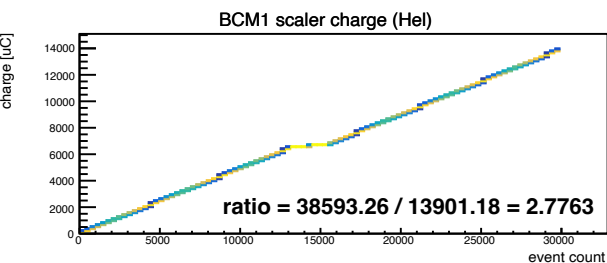
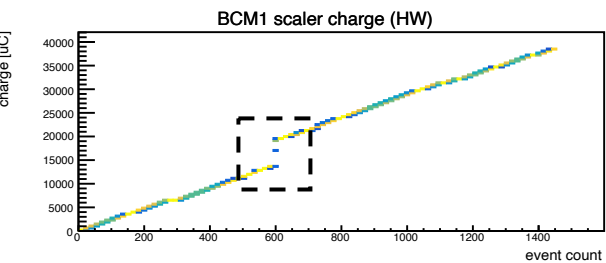
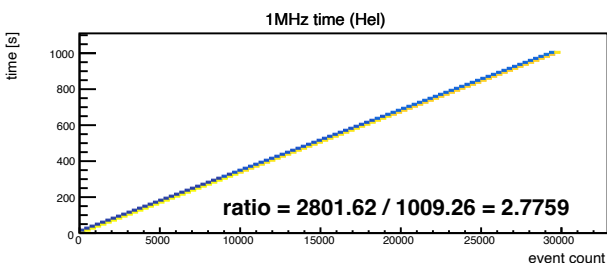
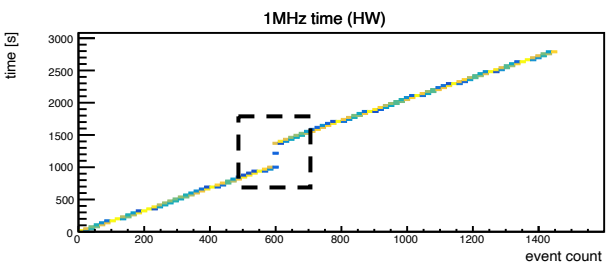
Examples for bad ratio runs

➤ Run 2069 (Bad ratios but good Hel scaler)

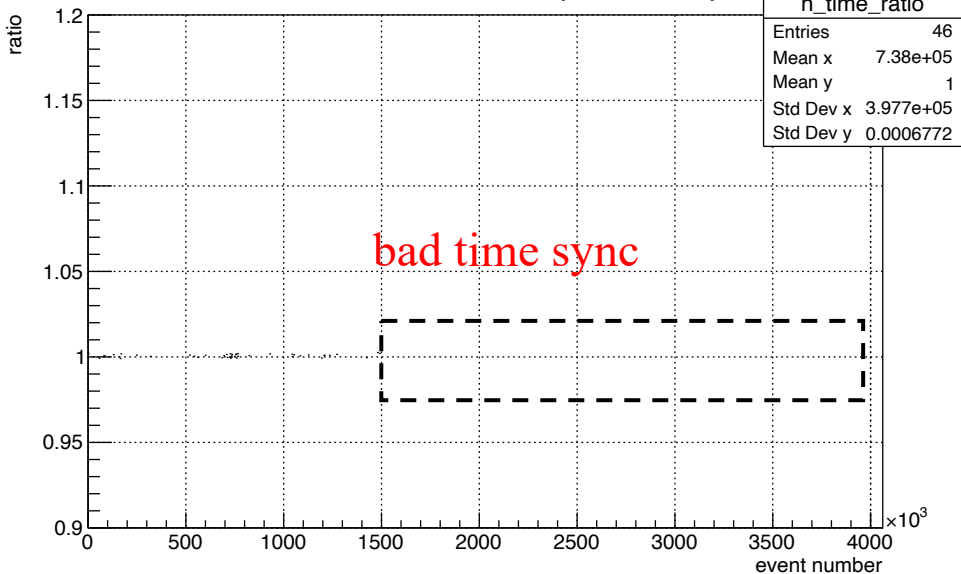


■ Examples for bad ratio runs

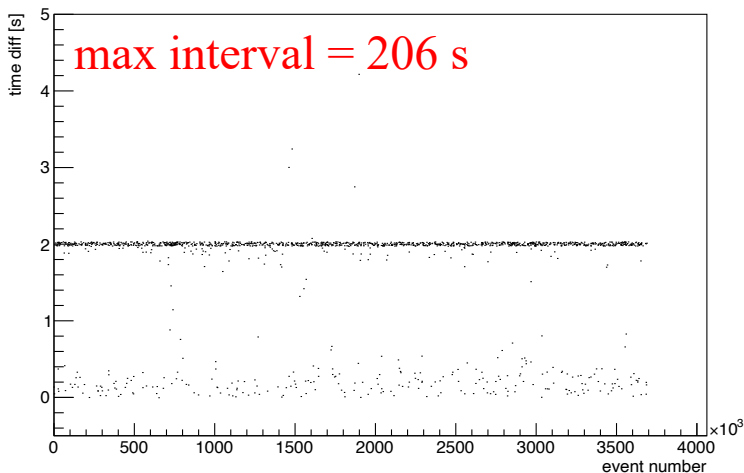
➤ Run 1688 (Broken Hel)



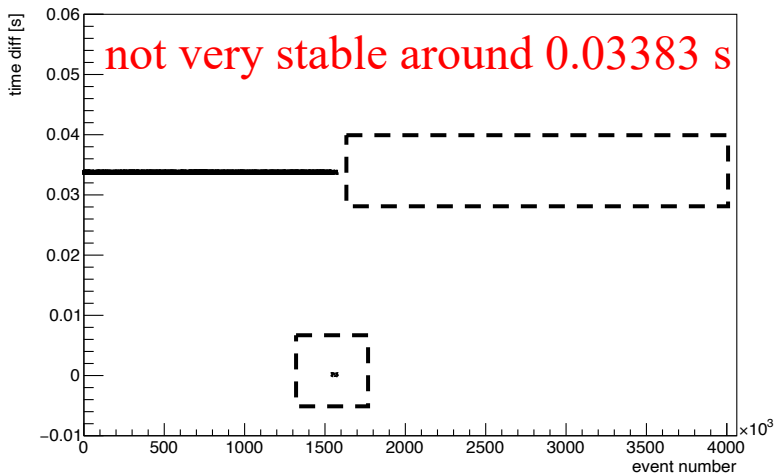
1MHz time ratio (HW/Hel)



1MHz time diff between HW scaler event

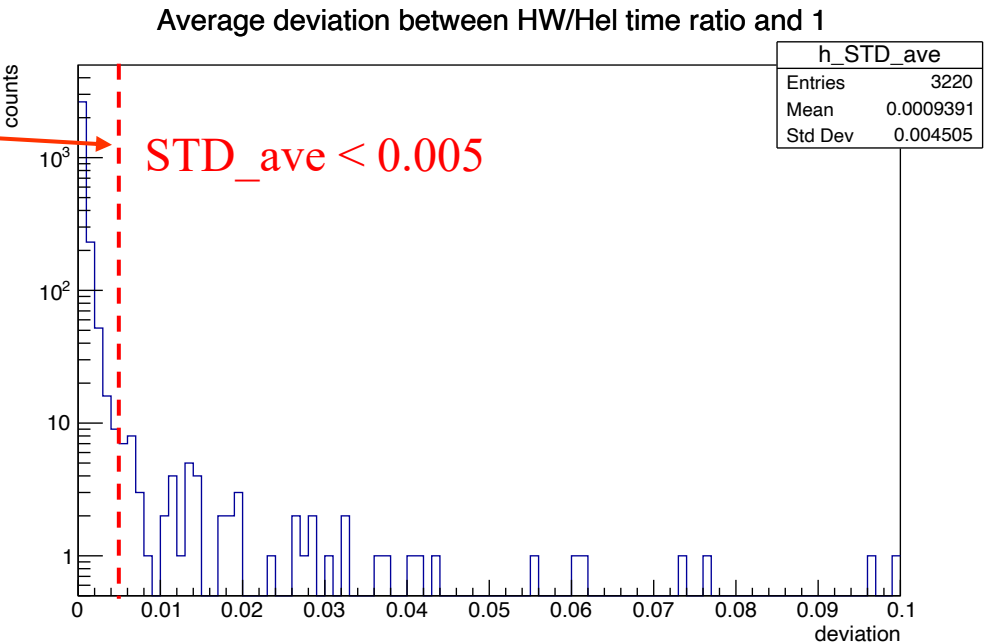
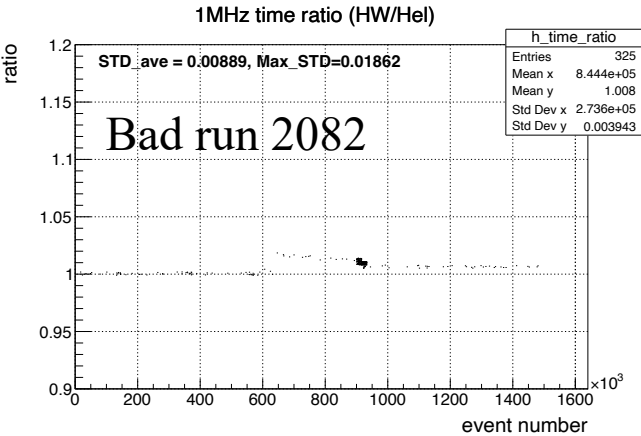
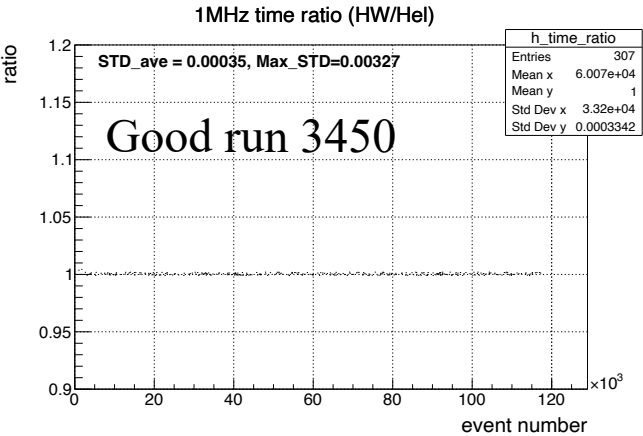


1MHz time diff between Hel scaler event



Criteria for good helicity scaler

- 1. The time sync between HW scaler and Hel scaler is good
- 2. The time interval between Hel scaler events is very stable at 0.03383s



- If both of the two criteria are not satisfied, the helicity scaler health is suspicious
- It doesn't mean that the helicity scaler is bad but we need to be careful

	Number of runs	Percentage	Good Hel	Suspicious Hel	Bad Hel
Good ratios	3313	94.41%	3122	191	0
Bad ratios but good Hel scaler	139	3.96%	109	30	0
Need more investigation	13	0.37%	8	3	2
Broken Hel	44	1.25%	0	0	44

■ Helicity scaler status

➤ I added a new column in Josh’s run list (column H) and there are 4 classes for it

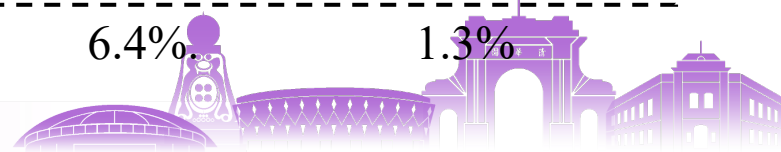
A1	fx x48_q33_p5											
	A	B	C	D	E	F	G	H	I	J	K	L
1	x48_q33_p5	Kin_number	Kin_old	day	run_number	Type	class	Hel_scaler_status	SHMS_angle	lbeam(uA)	charge(mC)	#events
779	x36_q30_p5	6	KinC_x36_3	10/21/2023	2036	production	g	good	32.261	9.46	11.45	4138858
780	x36_q30_p5	6	KinC_x36_3	10/21/2023	2037	junk	b	unknown	32.261	4.99	0	18450
781	x36_q30_p5	6	KinC_x36_3	10/21/2023	2038	production	g	good	32.261	4.83	5.63	1045954
782	x36_q30_p5	6	KinC_x36_3	10/21/2023	2039	efficiency	g	unknown	32.261	7.14	8.99	2521387
783	x36_q30_p5	6	KinC_x36_3	10/21/2023	2040	junk	b	unknown	32.261	5.02	0	121909
784	x36_q30_p5	6	KinC_x36_3	10/21/2023	2041	efficiency	g	unknown	32.261	4.86	5.76	2935175
785	x36_q30_p5	6	KinC_x36_3	10/21/2023	2042	junk	b	unknown	32.261	7.26	0	234030
786	x36_q30_p5	6	KinC_x36_3	10/21/2023	2043	production	g	good	32.261	7.15	4.91	1367678
787	x36_q30_p5	6	KinC_x36_3	10/21/2023	2044	production	g	good	32.261	14	18.63	1284293
788	x36_q30_p5	6	KinC_x36_3	10/21/2023	2045	production	g	good	32.261	7.3	8.98	359391
789	x36_q30_p5	6	KinC_x36_3	10/21/2023	2046	production	u	bad	32.261	17.03	21.58	2208445
790	x36_q30_p5	6	KinC_x36_3	10/21/2023	2047	production	g	suspicious	32.261	13.44	30.9	2425837
791	x36_q30_p5	6	KinC_x36_3	10/22/2023	2048	production	u	bad	32.261	15	0	0
792	x36_q30_p5	6	KinC_x36_3	10/22/2023	2049	junk	b	unknown	32.261	10	0	0
793	x36_q30_p5	6	KinC_x36_3	10/22/2023	2050	junk	b	unknown	32.261	10	0	0
794	x36_q30_p5	6	KinC_x36_3	10/22/2023	2051	production	u	good	32.261	9.43	13.53	782693

	Number of runs	Percentage	Good Hel	Suspicious Hel	Bad Hel
Good ratios	3313	94.41%	3122	191	0
Bad ratios but good Hel scaler	139	3.96%	109	30	0
Need more investigation	13	0.37%	8	3	2
Broken Hel	44	1.25%	0	0	44

92.3%

6.4%

1.3%



■ Summary

- The HW scaler is not very stable sometimes and we want to get better scaler results from Hel scaler
- The Hel scaler is much more reliable than HW scaler
- Hypothesis: the Hel scalers should always lead to good scaler values
 - ❖ For the runs with suspicious Hel scaler, we need to be careful but it's still better than the very unstable HW scaler

■ To-Do List

- Produce a database (text file) with charges, # triggers and CPU live time for each run. (# of segments)

			92.3%	6.4%.	1.3%
	Number of runs	Percentage	Good Hel	Suspicious Hel	Bad Hel
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THANKS!



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