SVT Data Integrity

Data error and consistency information exists in the data stream from the spring run

Implemented data integrity checks in the evio converter

Were possible, these checks will be applied in firmware and stop the run (unless there is a good reason not to)

SVT Data Integrity

System synchronization given by a combination of sources

- APV frame level (in the multisample header)
  - APV buffer addresses not in sync
  - APV frame counts not increasing sequentially
  - APV read error flags
- SVT frame/event level
  - APV error bit
  - Sync error (comes from the APV buffer address)
  - Missed frames due to event builder push back (e.g. buffers full)
- Some of these cannot happen by themselves necessarily
- Newest firmware (not in engineering run) will lock up in case any of these occur

Inserted frames to complete a APV frames

- The “multisample” header has an error flag for this case
- Does not lock up in firmware: handle occasional glitches on e.g. the links

Current software (evio converter) will throw a handled exception for any of these.

- Could imagine a dedicated process running with unhandled exceptions during/offline data taking in the future to catch errors

Analysis

Sho help me run over unblinded data

- Saved the RCE, header/tail and “multisample tails” for each SVT event frame to a small collection
- I don’t have access to e.g. the buffer addresses themselves for all these files but I catch all the errors
- Processed stuff at SLAC

Looked at ~2708 files (some jobs didn’t finished)

Analysis Summary

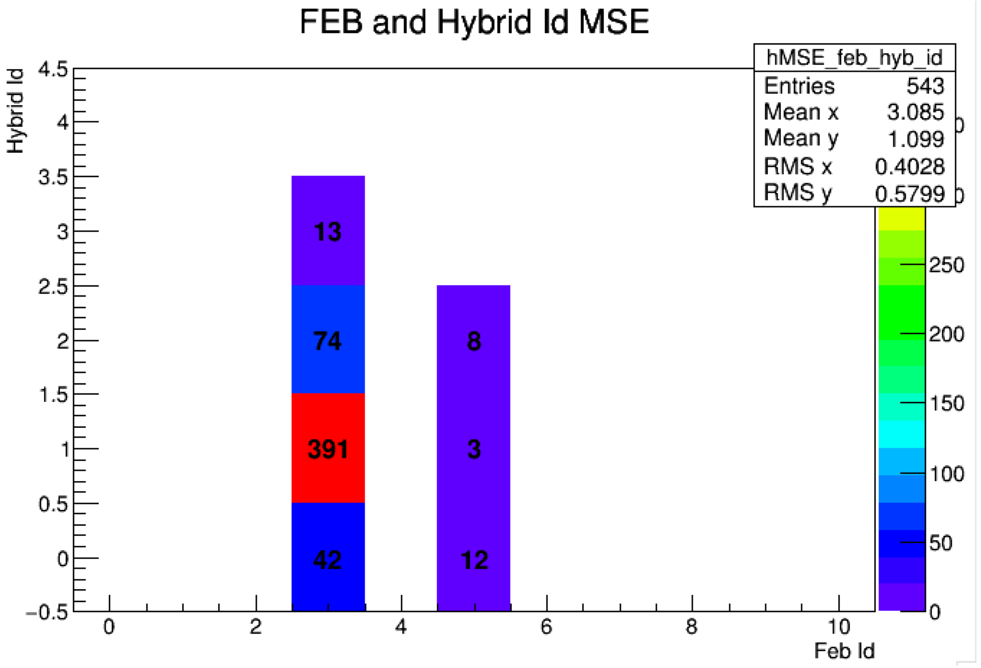
```
===
Total nr of runs:  226
Total SVT headers analyzed:       9863217126 ( 14 ROCs/event =>  ~ 704515509  events)
Total SVT header errors:  19197784  (fraction of headers with error  0.00194640184382 )
Total SVT headers with  nRceOFErrorCount  errors:  0  (fraction of headers with error  0.0 )
Total SVT headers with  nRceSyncErrorCountN  errors:  19197255  (fraction of headers with error  0.001946 )
Total SVT headers with  nRceSkipCount  errors:  0  (fraction of headers with error  0.0 )
Total SVT headers with  nRceMultisampleErrorCount  errors:  529  (fraction of headers with error  5.363e-08 )
Total multisampleheader errorbits:  543  (fraction of headers with error  5.50530311828e-08 )
===
```

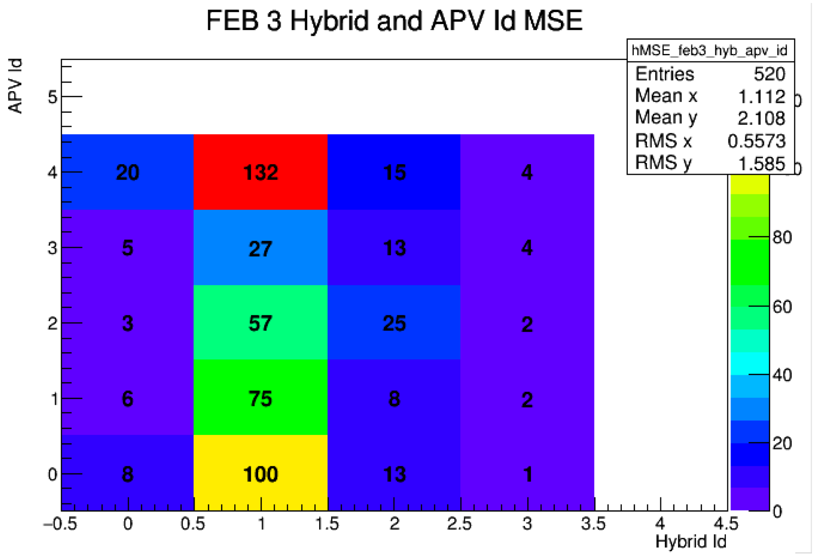
Fraction of the events that I ***looked at*** with errors:

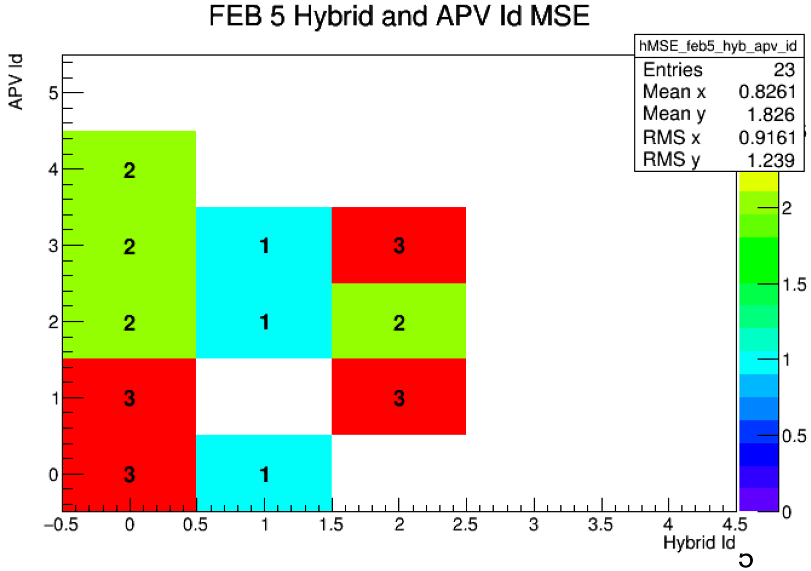
Multisample error bit (e.g. link error):
~529/704M =7e-7 (randomly occurring)

SyncErrors (system not in sync):
~19M/704M = 0.027 (single hybrid locks)

Multisample Error Bits


FEB and Hybrid Id MSE


FEB 3 Hybrid and APV Id MSE


FEB 5 Hybrid and APV Id MSE

- ⇒ Errors occur randomly throughout runs
- ⇒ Don't seem to be obviously grouped together within
  - ⇒ A few runs had ~20, some had 1...
- ⇒ Errors on two FEBs, problematic links with errors

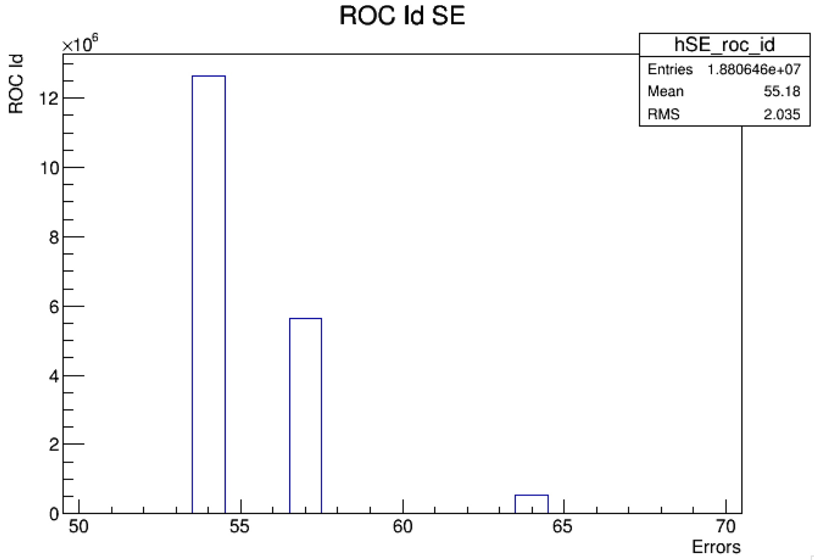
Example of multisample error (5768.361)

```
Oct 05, 2015 10:28:19 AM org.lcsim.job.EventMarkerDriver process
INFO: Event 92251054 with sequence 0
Oct 05, 2015 10:28:42 AM org.lcsim.job.EventMarkerDriver process
INFO: Event 92261054 with sequence 10000
Oct 05, 2015 10:29:04 AM org.lcsim.job.EventMarkerDriver process
INFO: Event 92271054 with sequence 20000
Oct 05, 2015 10:29:27 AM org.lcsim.job.EventMarkerDriver process
INFO: Event 92281054 with sequence 30000
Oct 05, 2015 10:29:48 AM org.lcsim.job.EventMarkerDriver process
INFO: Event 92291054 with sequence 40000
Mon Oct 05 10:30:01 PDT 2015 org.hps.evio.LCSimEngRunEventBuilder makeLCSimEvent
SEVERE: Error reading header information from the SVT for run 5768 event 92296597. Don't stop!
org.hps.evio.SvtEvioHeaderMultisampleErrorBitException: A multisample header error bit was set for  headernum 55 header 1805594 tail 23 nMultisamples 60 multisample: feb 5
hybrid 2 apv 2
buffer address 0  252 ( fc )
buffer address 1  253 ( fd )
buffer address 2  0 ( 0 )
buffer address 3  254 ( fe )
buffer address 4  250 ( fa )
buffer address 5  251 ( fb )
frame count   0  8 ( 8 )
frame count   1  9 ( 9 )
frame count   2  0 ( 0 )
frame count   3  11 ( b )
frame count   4  12 ( c )
frame count   5  13 ( d )
read error    0  1 ( 1 )
read error    1  1 ( 1 )
read error    2  0 ( 0 )
read error    3  1 ( 1 )
read error    4  1 ( 1 )
read error    5  1 ( 1 )
                at org.hps.evio.AugmentedSvtEvioReader.checkSvtHeaders(AugmentedSvtEvioReader.java:177)
                at org.hps.evio.AbstractSvtEvioReader.makeHits(AbstractSvtEvioReader.java:301)
                at org.hps.evio.LCSimEngRunEventBuilder.makeLCSimEvent(LCSimEngRunEventBuilder.java:155)
                at org.hps.evio.EvioToLcio.run(EvioToLcio.java:569)
                at org.hps.evio.EvioToLcio.main(EvioToLcio.java:99)
Mon Oct 05 10:30:09 PDT 2015 org.hps.record.scalers.ScalersEvioProcessor getScalerData
FINE: found scaler data in bank 57621 and EVIO event 48948
Oct 05, 2015 10:30:11 AM org.lcsim.job.EventMarkerDriver process
INFO: Event 92301054 with sequence 50000
```

New software catches them and prints debug
In this case the run resumed here normally

SyncError

The SVT header bit flags that APV pipeline buffer address do not match across an RCE. In the converter I check also between RCE's



List of runs with SVT header error " nRceSyncErrorCountN "

run	#headers w/ error
5569	3298048
5378	535190
5347	655980
5380	264193
5382	792181
5351	2654155
5576	797211
5385	265042
5610	1655034
5383	265234
5410	527823
5265	460204
5697	1055843
5559	1700353
5768	1783589
5305	266565
5725	509178
5310	1711432

⇒ Few runs had all errors

⇒ Error "latches" for the rest of the run

⇒ Occurs for three ROCS (mainly two)

  ⇒ The hybrids we lost during runs are the cause here (for the ones I checked in detail): F3H2

  ⇒ Only some were mentioned in the log book

  ⇒ The others might have been the same issue (will see it next pass over the data in the logs I think)

Example of SyncError (5768.361)

```
Mon Oct 05 11:48:14 PDT 2015 org.hps.evio.LCSimEngRunEventBuilder makeLCSimEvent
SEVERE: Error reading header information from the SVT for run 5768 event 92502263. Don't stop!
org.hps.evio.SvtEvioHeaderApvBufferAddressException: The APV buffer addresses in this event do not match  headernum 57 header 18378f6 tail 400001b
nMultisamples 60 multisample: feb 3 hybrid 2 apv 0
buffer address 0  164 ( a4 )
buffer address 1  172 ( ac )
buffer address 2  173 ( ad )
buffer address 3  175 ( af )
buffer address 4  79 ( 4f )
buffer address 5  77 ( 4d )
frame count   0  0 ( 0 )
frame count   1  1 ( 1 )
frame count   2  2 ( 2 )
frame count   3  3 ( 3 )
frame count   4  4 ( 4 )
frame count   5  5 ( 5 )
read error    0  1 ( 1 )
read error    1  1 ( 1 )
read error    2  1 ( 1 )
read error    3  1 ( 1 )
read error    4  1 ( 1 )
read error    5  1 ( 1 ) compared to
buffer address 0  79 ( 4f )
buffer address 1  77 ( 4d )
buffer address 2  76 ( 4c )
buffer address 3  68 ( 44 )
buffer address 4  69 ( 45 )
buffer address 5  71 ( 47 )
frame count   0  4 ( 4 )
frame count   1  5 ( 5 )
frame count   2  6 ( 6 )
frame count   3  7 ( 7 )
frame count   4  8 ( 8 )
frame count   5  9 ( 9 )
read error    0  1 ( 1 )
read error    1  1 ( 1 )
read error    2  1 ( 1 )
read error    3  1 ( 1 )
read error    4  1 ( 1 )
read error    5  1 ( 1 )
	at org.hps.evio.AugmentedSvtEvioReader.checkSvtHeaders(AugmentedSvtEvioReader.java:199)
	at org.hps.evio.AbstractSvtEvioReader.makeHits(AbstractSvtEvioReader.java:301)
	at org.hps.evio.LCSimEngRunEventBuilder.makeLCSimEvent(LCSimEngRunEventBuilder.java:155)
	at org.hps.evio.EvioToLcio.run(EvioToLcio.java:569)
	at org.hps.evio.EvioToLcio.main(EvioToLcio.java:99)
Mon Oct 05 11:48:14 PDT 2015 org.hps.evio.EvioToLcio run
INFO: first physics event time: 1431831108 - Sat May 16 19:51:48 PDT 2015
Mon Oct 05 11:48:14 PDT 2015 org.hps.evio.LCSimEngRunEventBuilder makeLCSimEvent
SEVERE: Error reading header information from the SVT for run 5768 event 92502264. Don't stop!
org.hps.evio.SvtEvioHeaderApvBufferAddressException: The APV buffer addresses in this event do not match  headernum 57 header 18378f7 tail 4000018
nMultisamples 60 multisample: feb 3 hybrid 2 apv 4
buffer address 0  76 ( 4c )
buffer address 1  68 ( 44 )
```

New software catches APV buffer addresses
Also checks the SVT header info.
The SyncError never goes away as expected.

Summary

Data seems to behave as expected

Expect to throw away ~2% of un-blinded data if we reject the whole event due to this (easiest, obviously)

Next steps

- Add information to event header for skimming when there was an error: a few ints for debugging
- Take a look at the logs from the next pass over the data