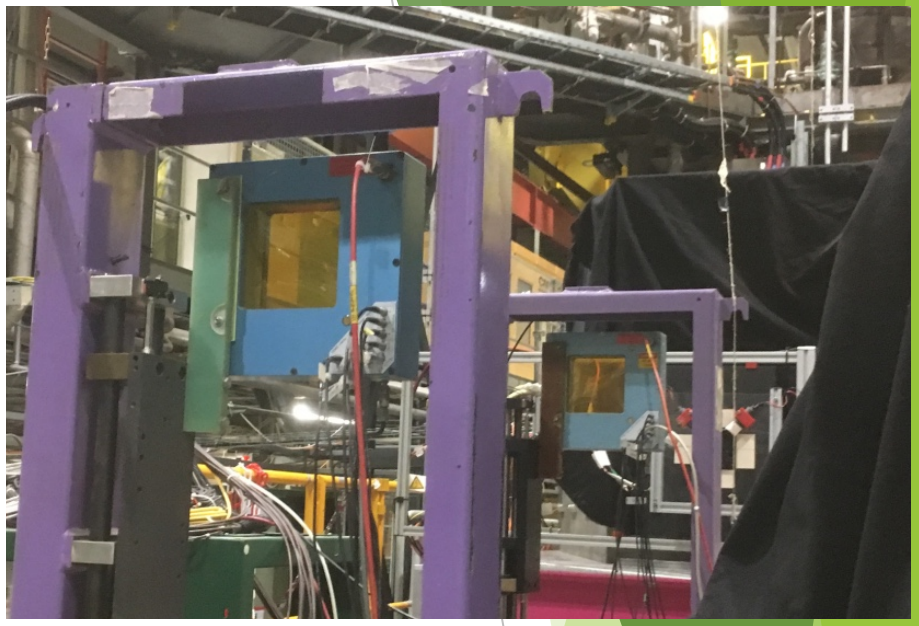
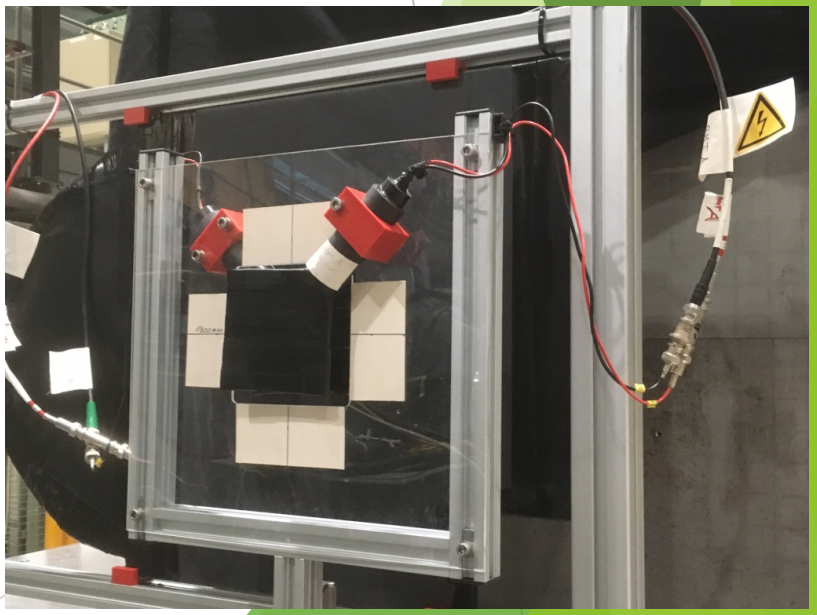
Synchronization with The Wire Chamber Data

Beam Monitors at Testbeam

- Delay wire chambers
  - 4 DWC placed on up-stream of the AHCAL
  - Beam position monitoring
  - Time resolution is not good
- Scintillators
  - Placed just before the AHCAL
  - Beam triggering and time measurement
  - Controlled by BIF





Synchronization

- Stand-alone program
  - https://github.com/linghuiliu/DwcTimeCorrelation/
- Requires 3 input files
  - BIF raw file
  - SPIROC raw file
  - DWC root file
- Output
  - AHCAL and DWC event matching
  - .txt / .root file

Synchronization Algorithm

- **BIF – AHCAL Matching**
- BIF and AHCAL are synchronized in the first place
- They can miss some of the events
  - BIF can miss events at the very beginning of readout cycle
  - AHCAL can miss events that are too close to each other
  - AHCAL can miss events at the very end of readout cycle
- By combining the BIF and AHCAL, we can conceptually catch all the event
- BIF and AHCAL timestamp difference is at most just 1, very easy to match

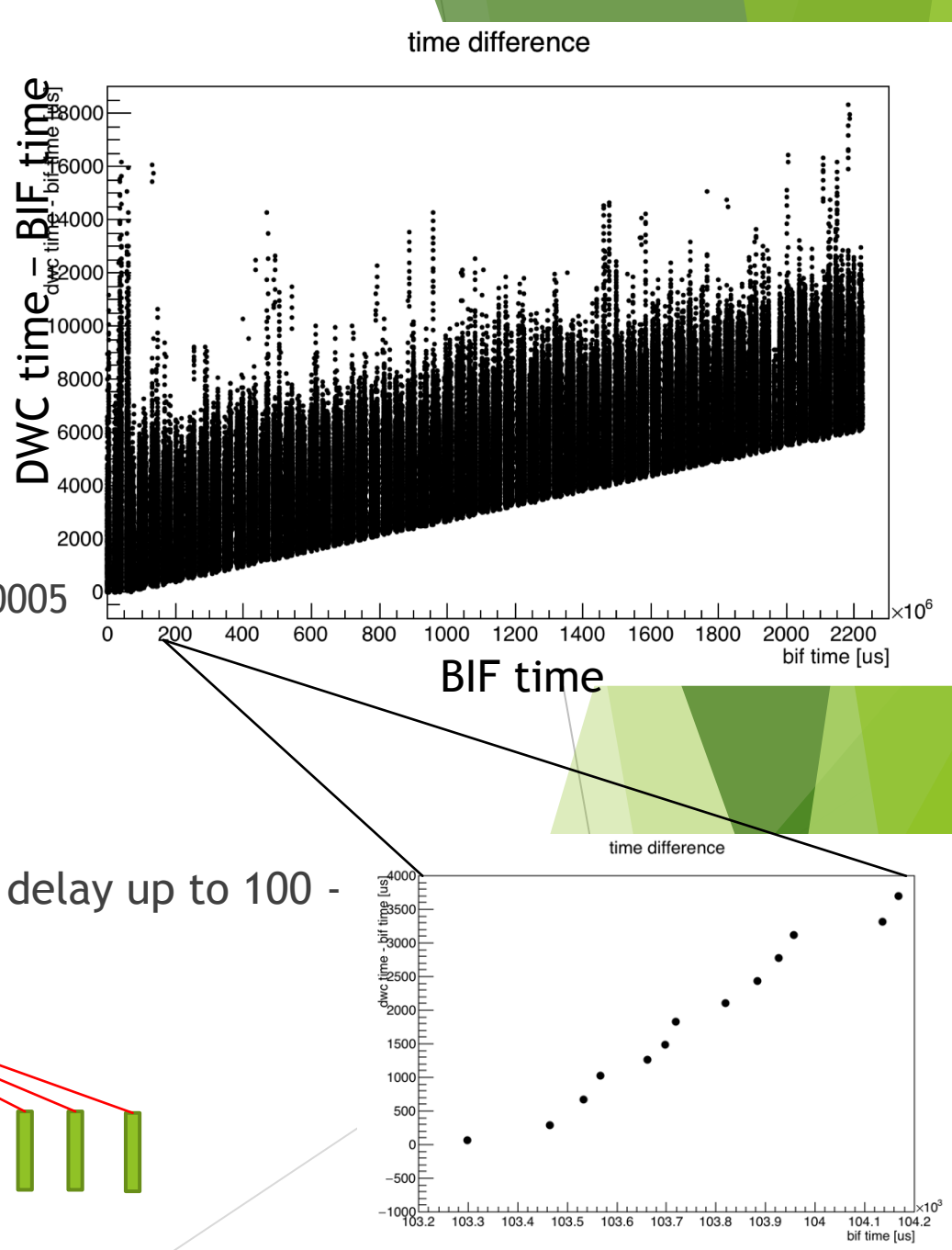
ROC	BifTrg#	AHCTrg#	DWCTrg#	tdc (in BIF)
25	345	346	346	817363
25	346	347	347	817419
26	-------	348	348	851188
26	347	349	349	851377
26	348	350	350	851414

ROC	BifTrg#	AHCTrg#	DWCTrg#	tdc (in BIF)
124	1612	1615	1615	21080674
124	1613	1616	1616	21080863
124	1614	-------	1617	21080864
124	1615	1617	1618	21080888
124	1616	1618	1619	21080979

ROC	BifTrg#	AHCTrg#	DWCTrg#	tdc (in BIF)
3319	45567	45609	45639	432707428
3319	45568	45610	45640	432707439
3319	45569	-------	45641	432707446
3320	45570	45611	45642	432743148
3320	45571	45612	45643	432743395

DWC Time Structure

- The clock of the DWC and AHCAL are different
  - DWC with 1 MHz clock, AHCAL with 40 MHz
  - Clock ratio can vary a bit from run to run as 39.99995 – 40.00005
  - Variation is small, but un-ignorable in 30 min run
    - Matching should be managed locally
- When an event is too close to the previous, the DWC time delay up to 100 - 300 us



Synchronization

- **BIF – DWC Matching**
- DWC timestamp behaves non-linear, matching according time seems impossible
- Beam have bunch structure, bunch distinction is possible

- Compare the number of events in one bunch
- If the numbers are same in DWC and AHCAL then we can assume events are well matched
- If the numbers are different, we can only put some error message ”event matching failed”

Synchronization Test

- Looked a few runs with electrons/pions, power-pulsing on/off
- As far as examined, all events are matched without any problem

- txt file: ROC, Trig# and TDC for both ahcal and DWC
  - TDC starts from 0 in unit of us
  - For short look / debug
- root file: ROC, Trig# and TDC for both ahcal and DWC
  - TDC is original; not normalized, not offset suppressed
  - For analysis

output.txt

ROC	BifTrg#	AHCTrg#	DWCTrg#	tdc (in BIF)	tdc (in DWC)
1	0	1	1	0	0
1	1	2	2	66	5681
1	2	3	3	612	6054
1	3	4	4	867	6399
1	4	5	5	1080	6741
1	5	6	6	1445	7072
1	6	7	7	1569	7864
1	7	8	8	1598	11132
1	8	9	9	2671	11506
1	9	10	10	2822	11832
2	10	11	11	35117	35043
2	11	12	12	35329	35398
2	12	13	13	35539	35771

output.root

```
*******************************************************************************
*Tree    :combined  : combined events                                          *
*Entries :   230928 : Total =         7414739 bytes  File  Size =    2686612 *
*        :          : Tree compression factor =   2.76                       *
*******************************************************************************
*Br    0 :ROC       : ROC/I                                                   *
*Entries :   230928 : Total  Size=     926724 bytes  File Size  =      59402 *
*Baskets :       29 : Basket Size=      32000 bytes  Compression=  15.59     *
*.............................................................................*
*Br    1 :bif_Trig  : bif_Trig/i                                              *
*Entries :   230928 : Total  Size=     926889 bytes  File Size  =     325944 *
*Baskets :       29 : Basket Size=      32000 bytes  Compression=   2.84     *
*.............................................................................*
*Br    2 :ahc_Trig  : ahc_Trig/i                                              *
*Entries :   230928 : Total  Size=     926889 bytes  File Size  =     325673 *
*Baskets :       29 : Basket Size=      32000 bytes  Compression=   2.84     *
*.............................................................................*
*Br    3 :bif_Time  : bif_Time/l                                              *
*Entries :   230928 : Total  Size=    1853480 bytes  File Size  =     868537 *
*Baskets :       58 : Basket Size=      32000 bytes  Compression=   2.13     *
*.............................................................................*
*Br    4 :dwc_Trig  : dwc_Trig/i                                              *
*Entries :   230928 : Total  Size=     926889 bytes  File Size  =     324560 *
*Baskets :       29 : Basket Size=      32000 bytes  Compression=   2.85     *
*.............................................................................*
*Br    5 :dwc_Time  : dwc_Time/L                                              *
*Entries :   230928 : Total  Size=    1853480 bytes  File Size  =     779853 *
*Baskets :       58 : Basket Size=      32000 bytes  Compression=   2.37     *
*.............................................................................*
```

Implementation to Reconstructer

- Next step : add DWC information in the reconstructed lcio / root file
  - Add a new collection and root tree writing engine
  - How should be matching failed events? (if any)
- Then finally we can get beam tracking combined with the AHCAL events