Time-Of-Flight in Data Stream in Run 4 and Run 5

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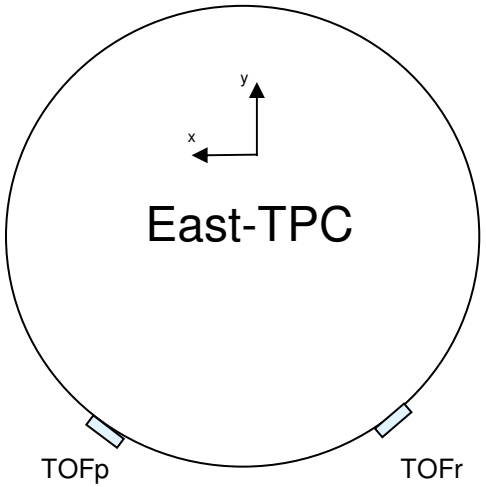
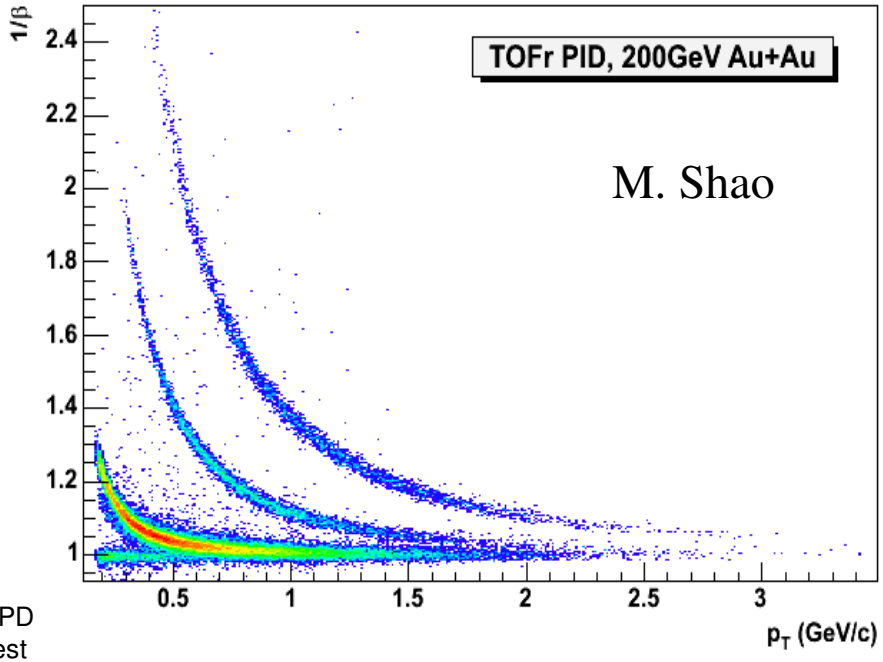
Outline

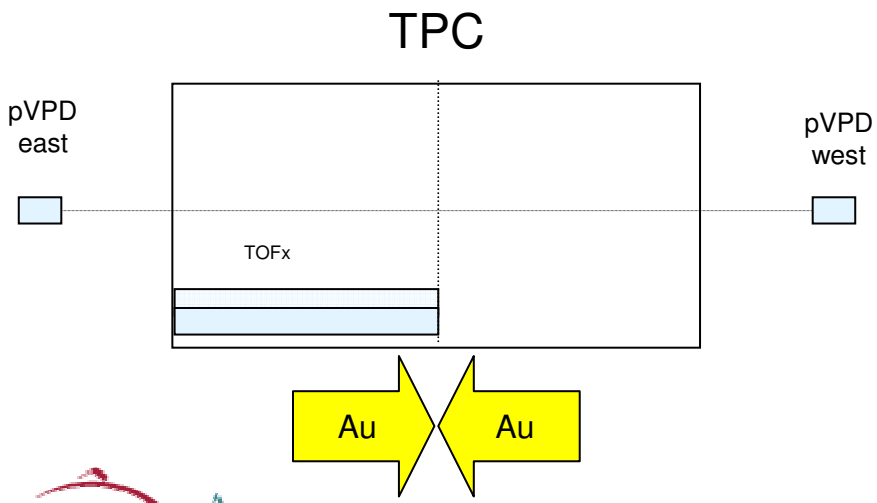
- *TOF in Run 4*
- *New design of TOF for Run 5*
- *Offline software preparation*
- *Summary and outlook*

TOF in Run 4





85ps (~27ps start timing)

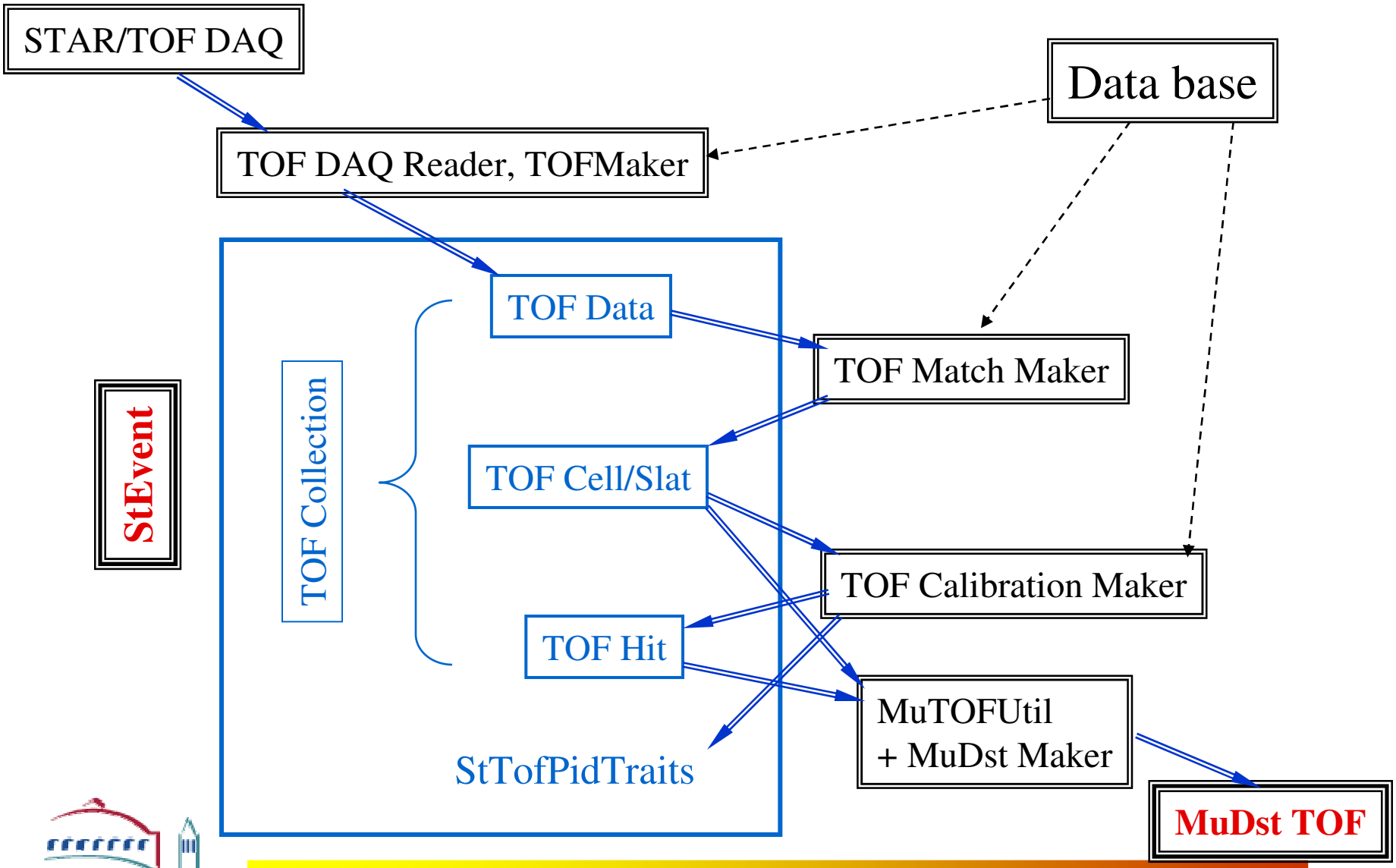


TOF detectors performance

			Timing Resolution (ps)		
			pPVDs	TOFr system	TOFp system
Run 3	d+Au @ 200GeV		85	120 (85)	100-140
	p+p @ 200GeV		140	160 (85)	-
Run 4	Au+Au @ 62GeV		55	105 (89)	110 (95)
	Au+Au @ 200GeV	FF&RFF, w/o E pVPD	40	95 (86)	96 (87)
		FF&RFF	27	86 (82)	92 (88)
		HF	20	82 (80)	85 (83)

(F. Geurts, W.J. Llope, L.J. Ruan, M. Shao, P.R. Sorensen, J.S. Wang)

TOF Offline Software in Run 4



TOF in Run 4 data stream

For the Au+Au 200 GeV production:

Both raw data and preliminarily calibrated hits are stored in StEvent and MuDst.

Usage of TOF

In StEvent:

StTrack -> StTofPidTraits -> tof, beta, nSigmaE (Pi, K, P), etc.

In MuDst

```
for ( primary tracks … )  { …
      for ( tofhits ) { …
          StMuTofHit *tofhit = …
          if (tofhit->associatedTrackId()==trkId) {
                  ….
          }
       } // end tof hit loop
 } // end track loop
```

TOF tray in Run 5

1. pVPDs are still used as the start detector to date.
2. TOFp was removed from STAR.
3. A new TOFr tray was built.
   All 32 modules were installed in the tray.
   They were equipped with new electronics.
   The tray was installed in the position where TOFp located last year

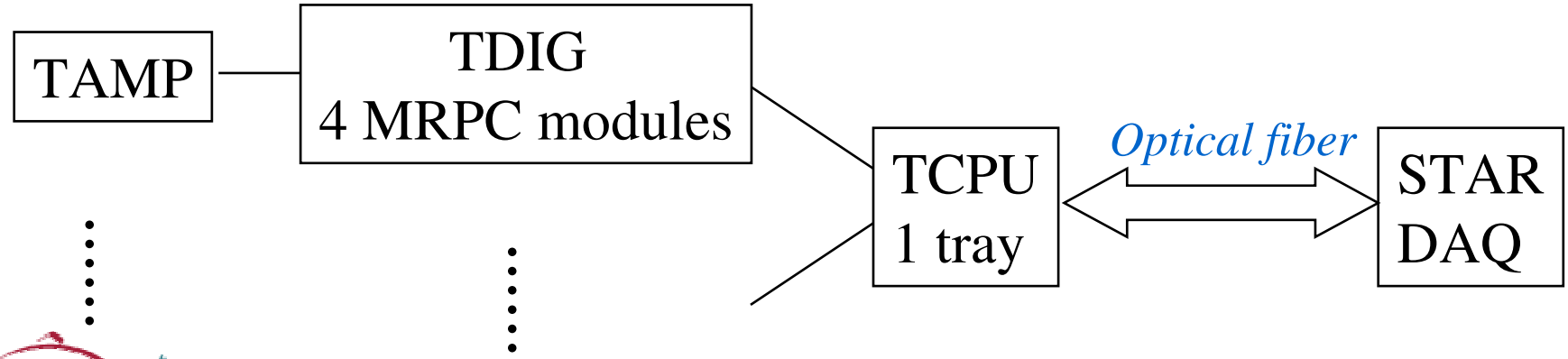
This year run is an engineering for the test of electronics and DAQ system !

See W.J. Llope's status report on Thursday

New design of TOF electronics

NIM/CAMAC based local trigger
and DAQ systems provided by the TOFp system

TAMP/TDIG/TCPU
- digitalization on board with respect to a 40MHz clock
Optical fibers used to STAR DAQ



TOF fiber data

Fiber data format --- 32-bit word *(Jo Schambach)*

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
p	p	p	p	data																											

pppp	**Packet Use**
0100	Leading edge HPTDC data
0101	Trailing edge HPTDC data
1001	Multiplicity data
1010	Header trigger data
1011	Header debug data
1100	Geographical data
1101	Header tag word
1110	TDIG Separator word
1111	reserved

HPTDCs measured *leading* and *trailing* edge timing.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	0	TDC				Channel			Inter.		Leading edge time																		

Res = 25ps

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	1	TDC				Channel					Trailing edge time																		

Res = 100ps

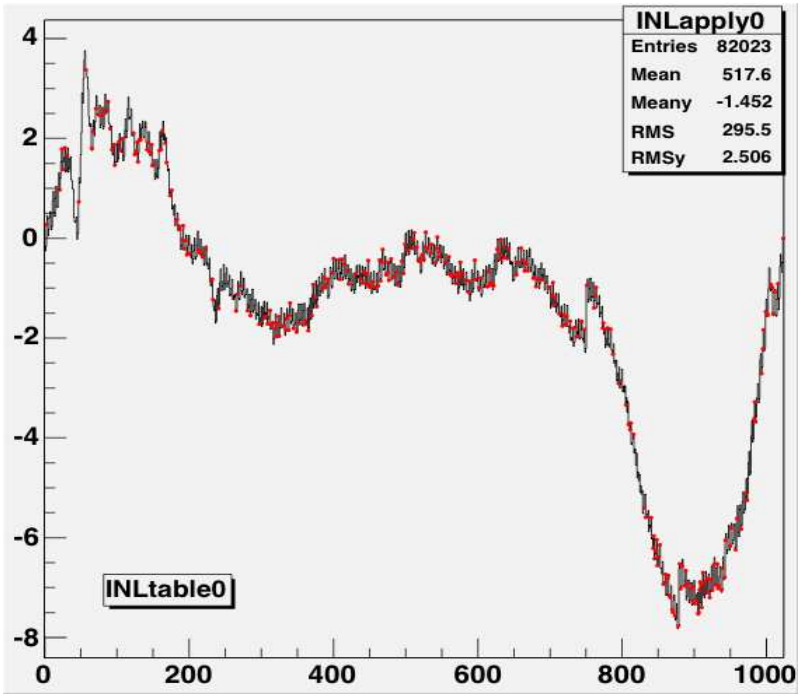
TOF fiber data

For Run 5:

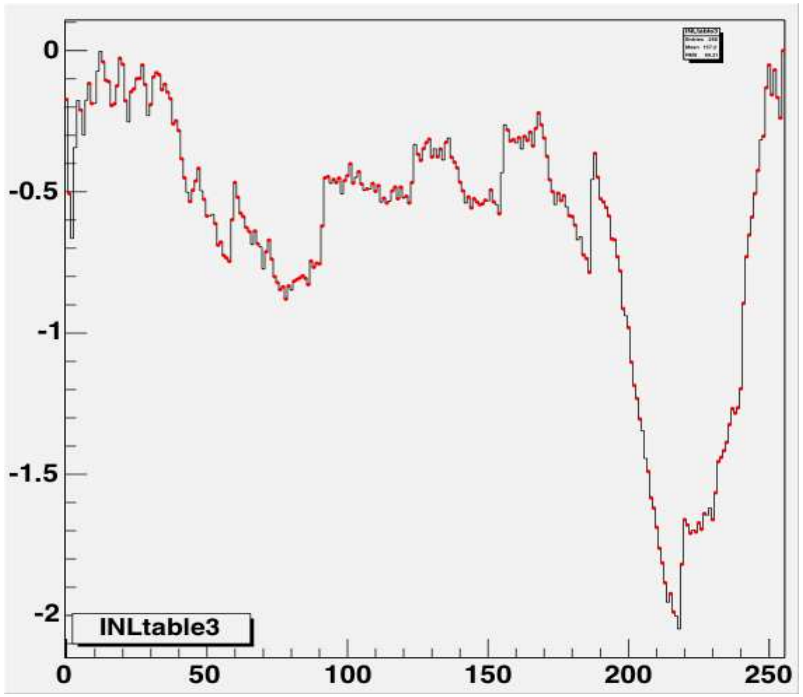
Word #:	Contents:
1	Header Trigger Data Word
2	Header Debug Data Word, L2 data
3	Header Tag Word (0xdeadface)
4	Geographical Data (tray 93, half tray 0)
5	HPTDC data word (Board 0)
…	…
5+n	HPTDC data word (Board 0)
5+n+1	Separator Word Board 0
5+n+2	HPTDC data word (Board 1)
…	…
m	HPTDC data word (Board 1)
m+1	Separator Word Board 1
m+2	HPTDC data word (Board 2)
…	…
o	HPTDC data word (Board 2)
o+1	Separator Word Board 2
o+2	HPTDC data word (Board 3)
…	…
p	HPTDC data word (Board 3)
p+1	Separator Word Board 3
p+2	Geographical Data (tray 93, half tray 1)
p+3	HPTDC data word (Board 4)
…	…
q	HPTDC data word (Board 4)
q+1	Separator Word Board 4
q+2	HPTDC data word (Board 5)
…	…
r	HPTDC data word (Board 5)
r+1	Separator Word Board 5
r+2	HPTDC data word (Board 6)
…	…
s	HPTDC data word (Board 6)
s+1	Separator Word Board 6
s+2	HPTDC data word (Board 7)
…	…
t	HPTDC data word (Board 7)
t+1	Separator Word Board 7

INL correction

INL: Integral Non-Linearity correction for HPTDCs *(Jing Liu)*



Leading Edge HPTDC=0



Trailing Edge HPTDC=3

This correction need to be done for each HPTDC.

Multi-hit in TOF

Multi-hit in start timing due to reflection was solved by adding terminators.

Multi-hit in stop timing:

due to the wide timing window (~26μs) and new electronics.

→ all particles in this timing window can be recorded.

(only first hit in CAMAC system before)

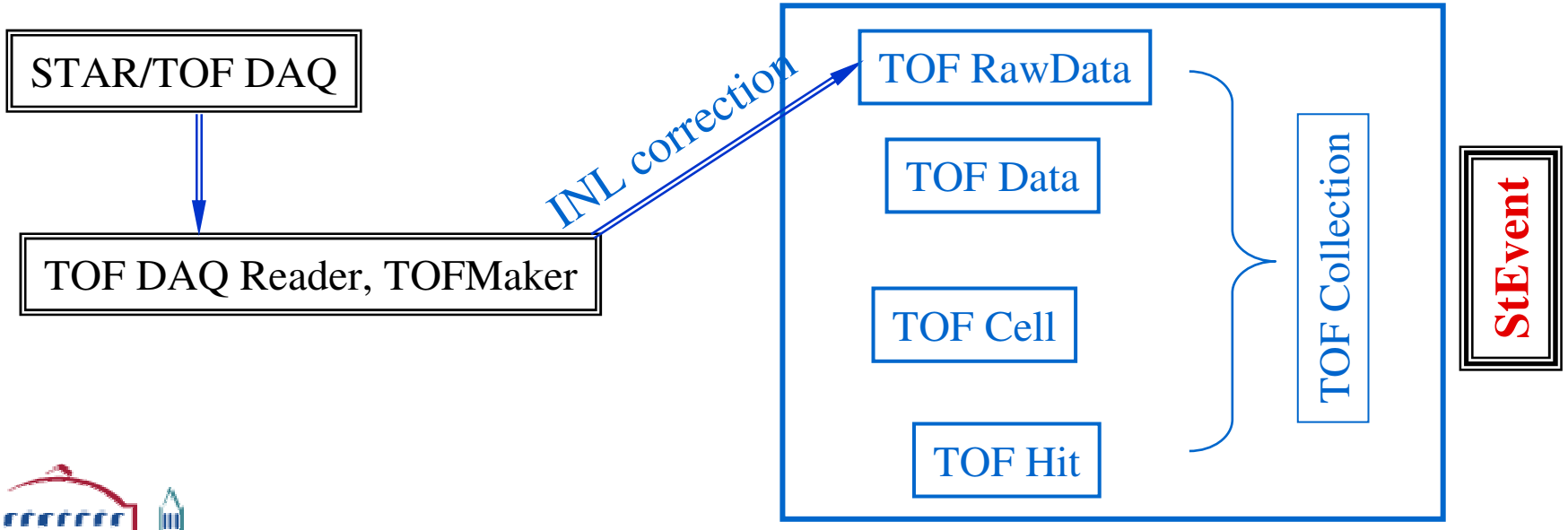
Solution: save all raw TOF hits, leave the selection in offline

Offline software preparation - I

DAQ→TOF_Reader/StTofMaker →StEvent

Due to the presence of multi-hits, the basic idea is to save all raw TOF hits into StEvent

StTofRawData is needed --- a raw-TOF-hits collection
push all leading and trailing timing information into this collection



Offline software preparation - II

Physics hits selections:

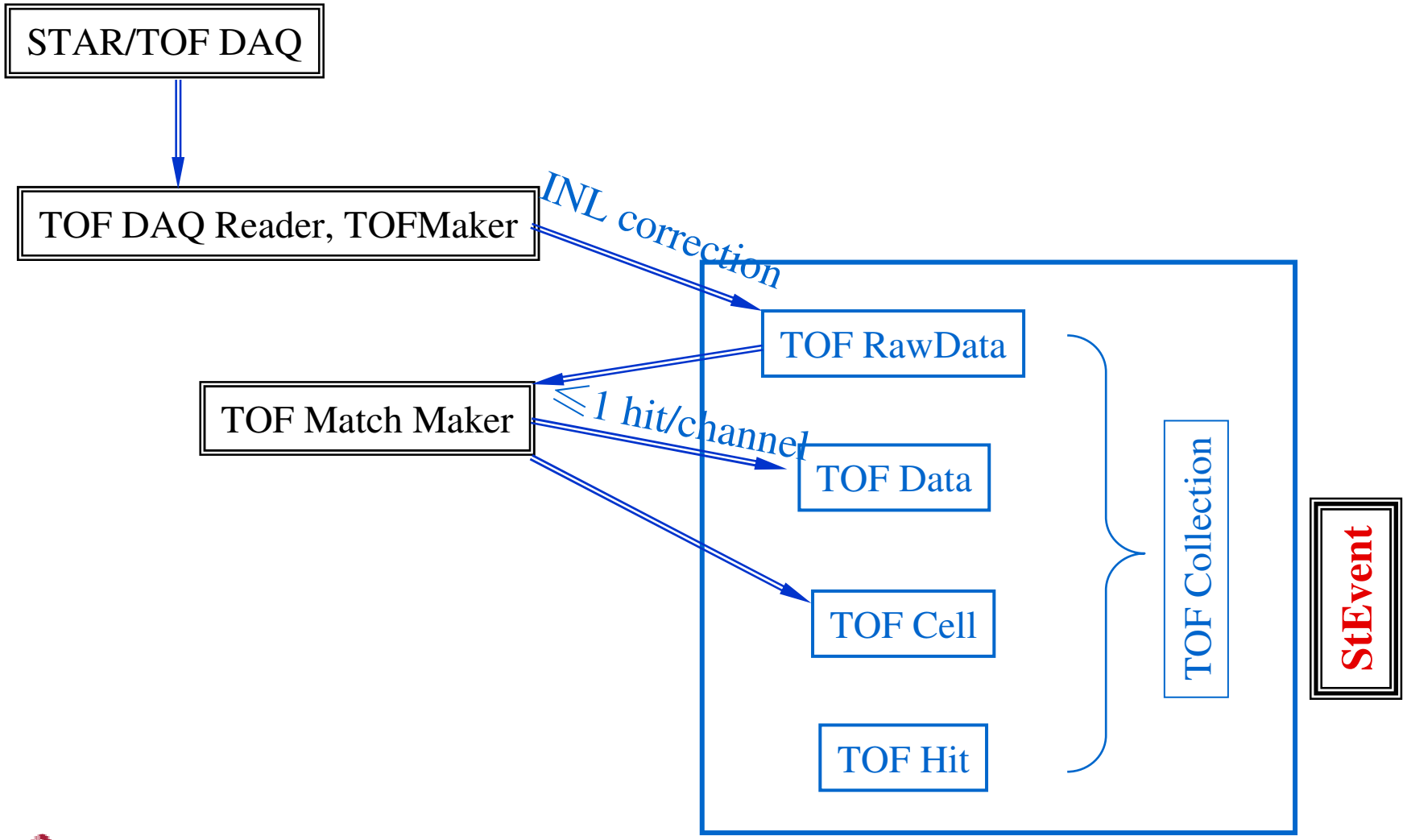
Multi-hits in the same channel:

1) Event-wise rejection:
   information from other detectors (ZDC etc.)
2) Track-wise rejection:
   stable particles hypothesis

→ at most one best hit in each channel

TPC track→TOF hit
Matching algorithm is the same as before.

Offline software preparation - II



Offline software preparation - III

Calibration:

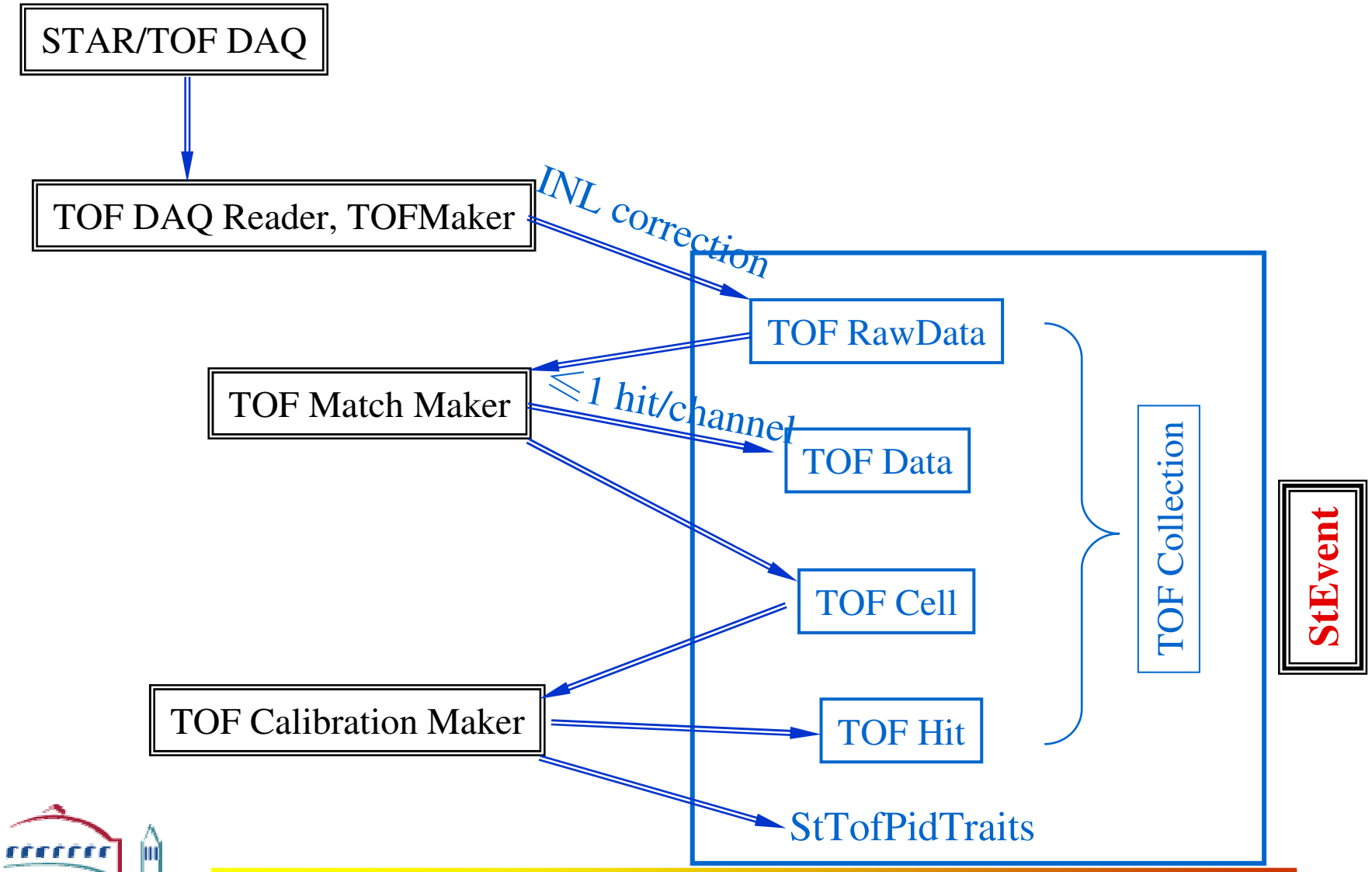
Similar calibration procedure as before:

One change about slewing correction:
- ADC (pulse area) before
- Time-Over-Threshold (width) this year.

This has been tried for the start timing from pVPDs. *(W.J. Llope)*

→ The start timing resolution is ~ 54ps in Cu+Cu 200 GeV

Offline software preparation - III



Offline software preparation - IV

MuDst:

In addition to push TofData and TofHit into MuDst in last year, we would like to save the raw data collection TofRawData into MuDst for check later on.

MuEvent
MuTracks (primary)
MuGlobalTracks
….
V0
....
→ MuTofHit (calibrated physical variables)
→ MuTofData (Tof Data <=1 hit per channel)
→ MuTofRawData (Raw Tof Hits w/ multi hits)
…

Summary

TOF physics data are included and can be easily accessed in Run 4 Au+Au production

A new TOF tray with new electronics was installed for Run 5

The first attempt for TAMP/TDIG/TCPU readout with optical fiber path looks successful.

Offline software need update accordingly for Run 5. This is particularly being worked on now.

STAR TOF group

STAR TOF Team:

16 institutions

US

Electronics,

tray assembly

and integration

BNL, LBL, MEPI, NASA, UNAM, RICE, UCLA, UT-Austin, U. Washington, Yale

China

Module construction

and QA

Huazhong Normal University, IHEP(Beijing), IMP(Lanzhou), SINR, Tsinghua, USTC

Backup slides