



FST Software

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Outline

- How to get FST offline chain
- IST offline chain
- FST offline chain
- Online software status
- Summary and outlook

How to get FST offline chain

Follow the IST offline chain approach:

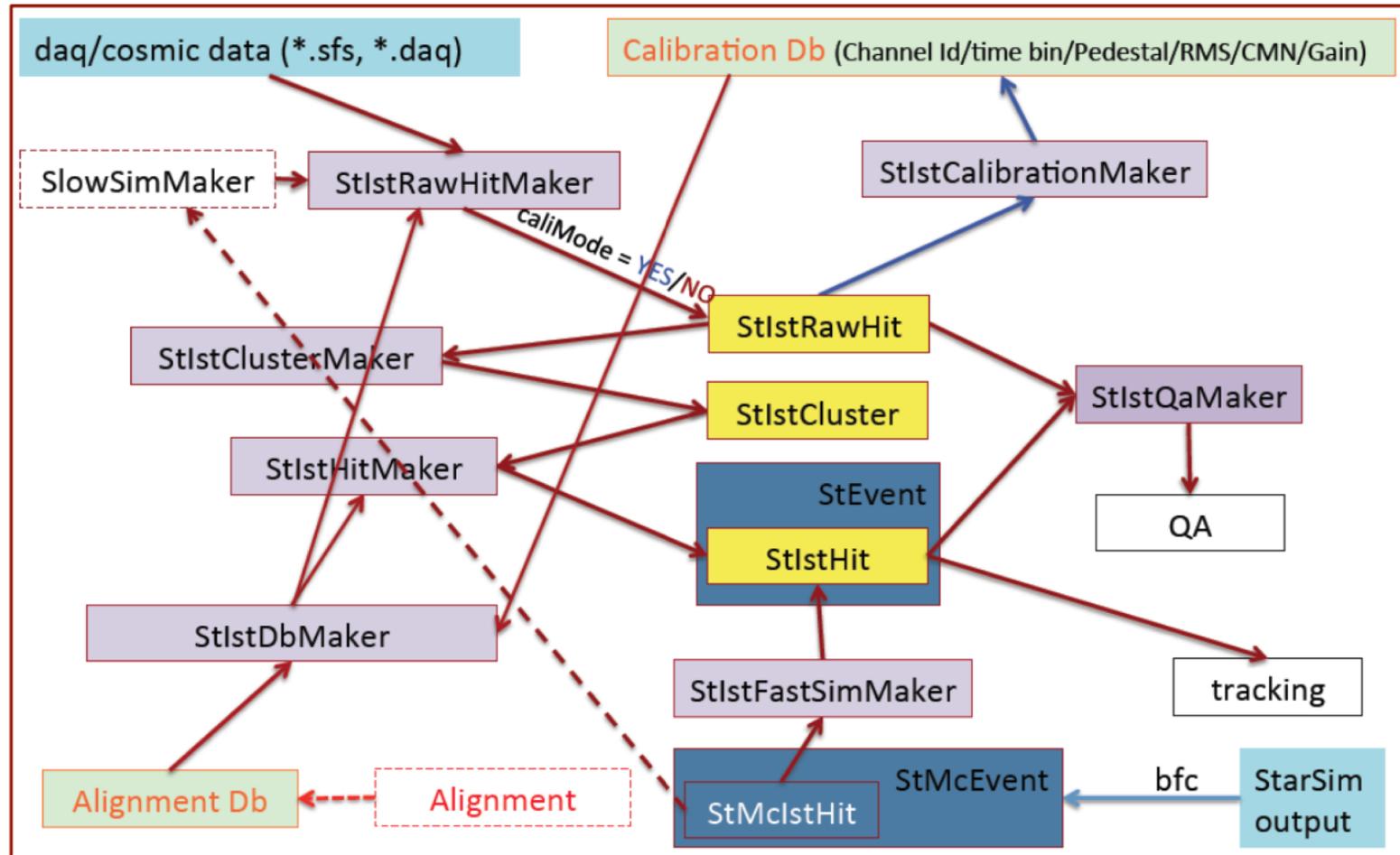
- ❖ reconstruct hits: StIstRawHitMaker->StIstClusterMaker->StIstHitMaker
- ❖ DBs: geometry DBs and calibration DBs

Detailed steps:

- ❖ Combining the note and code to understand the IST offline chain
- ❖ all the IST offline chain files
- ❖ Make changes for IST offline chain files based on the FST set up to get FST offline chain
- ❖ Test the code using the data from the DAQ integration and cosmic test data
- ❖ Prepare for the review

(Authors for IST offline chain(Yaping, Leszek and Zhenyu) still work at STAR and can discuss with them when having issues.)

IST offline chain infrastructure



- ❖ The offline chain processes raw data and reconstructs IST hit within STAR BFC chain for STAR tracking

IST offline chain file list

StRoot/StEvent/

- StIstHit.h/cxx
- StIstHitCollection.h/cxx
- StIstLadderHitCollection.h/cxx
- StIstSensorHitCollection.h/cxx

StRoot/StIstUtil/

- StIstConsts.h
- StIstRawHit.h/cxx
- StIstRawHitCollection.h/cxx
- StIstCluster.h/cxx
- StIstClusterCollection.h/cxx
- StIstCollection.h/cxx
- StIstDigiHit.h/cxx

StRoot/StIstRawHitMaker/

- StIstRawHitMaker.h/cxx

StRoot/StIstClusterMaker

- StIstClusterMaker.h/cxx
- StIstIClusterAlgo.h.h/cxx
- StIstSimpleClusterAlgo.h/cxx
- StIstScanClusterAlgo.h/cxx

StRoot/StIstHitMaker

- StIstHitMaker.h/cxx

StRoot/StIstDbMaker

- StIstDbMaker.h/cxx

StRoot/StIstCalibrationMaker

- StIstCalibrationMaker.h/cxx

StRoot/StIstQAMaker

- StIstQAMaker.h/cxx

StRoot/StIstFastSimMaker

- StIstFastSimMaker.h/cxx

StRoot/StEvent/

- StIstContainer.h: [lines 162, 220](#)
- StIstContainer.cxx: [lines 146, 204](#)
- StEvent.h: [lines 206, 268-269, 339](#)
- StEvent.cxx: [lines 223, 783-797, 1247-1251, 1367, 1393](#)
- StEventType.h: [lines 278-281](#)
- StEventClusterHints.cxx: [lines 165, 189](#)
- StEnumerations.h: [//lines 533-542](#)

StRoot/StEventUtilities/

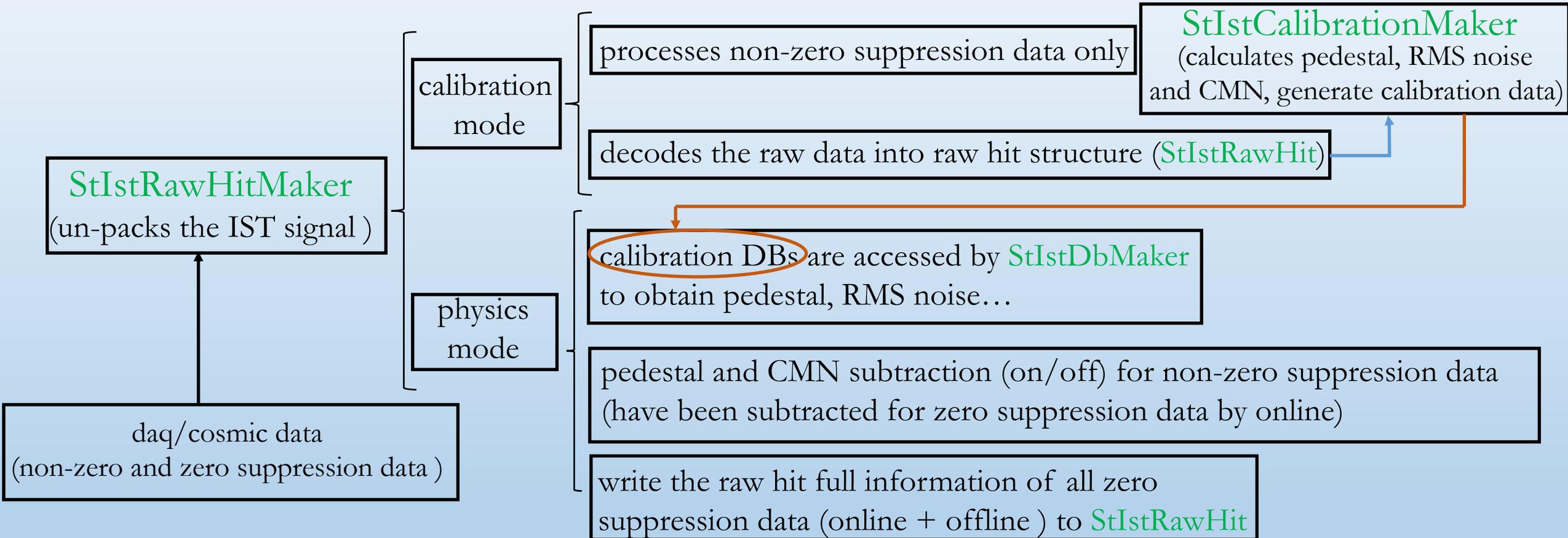
- StEventHitIter.cxx: [lines 20, 450-525, 750](#)
- StuFixTopoMap.cxx: [lines 126-131](#)

StRoot/StBFChain/

- BigFullChain.h: [following lines are added \(1349-1356\)](#)

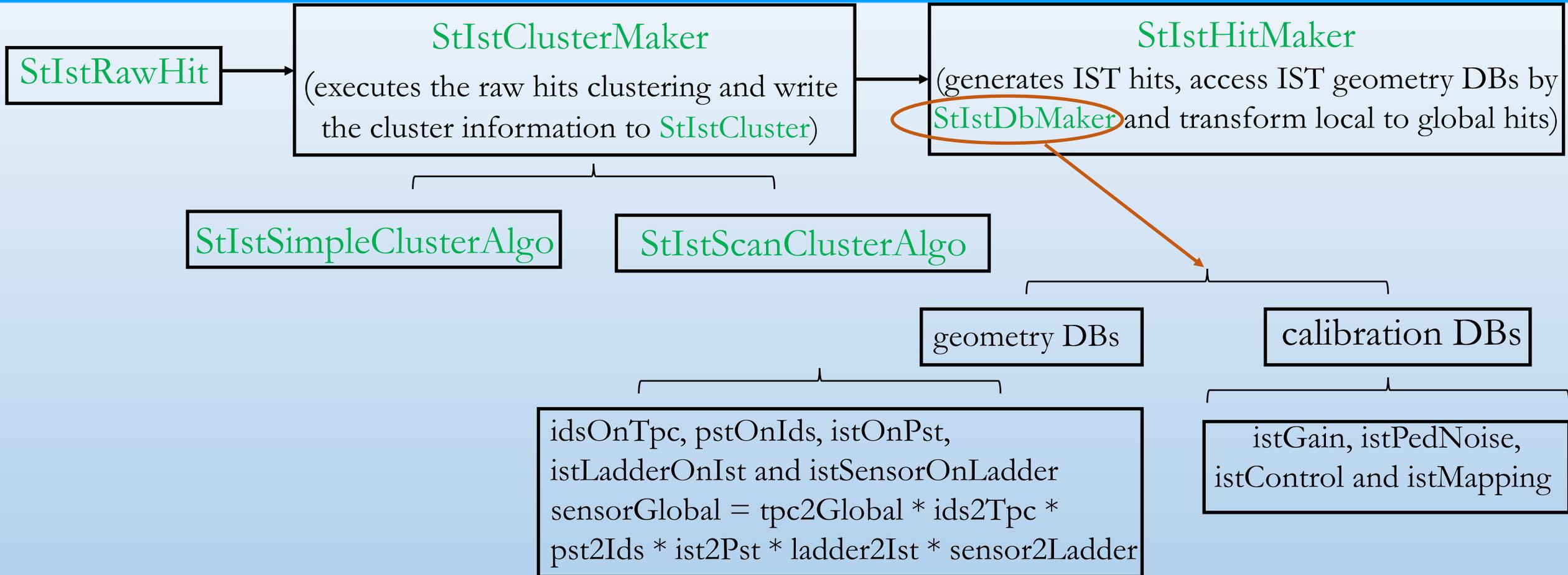
❖ All the IST offline chain files and their locations.

StIstRawHitMaker



In this process, the IST raw hits are stored in the **StIstRawHitCollection** container, which is saved to a temporary dataset, called **StIstCollection**.

StIstClusterMaker, StIstHitMaker and StIstDbMaker



IST clusters are stored in the `StIstClusterCollection` container, which is saved to a temporary dataset, called `StIstCollection`.
IST hits are stored in the three-level hierarchy containers: `StIstHitCollection`->`StIstLadderHitCollection`-> `StIstSensorHitCollection`.
`StIstHitCollection` container is saved to `StEvent` for tracking.

Other classes and files

- ❖ StIstQAMaker: generate histograms and trees for fast QA on both IST raw hit and IST hit.
- ❖ StIstFastSimMaker: for IST tracking in simulation.
- ❖ StIstSlowSimMaker: for embedding.
- ❖ StRoot/StIstUtil/StIstConsts.h
- ❖ StRoot/StEventUtilities/StEventHitIter.cxx
- ❖ write_ist_control.C
- ❖ write_idsOnTpc_ideal.C
- ... } filled with latest calibration/alignment results, and can be run to populate DB.
- ❖ ...

FST offline chain status

1) Difference between IST and FST and their corresponding files

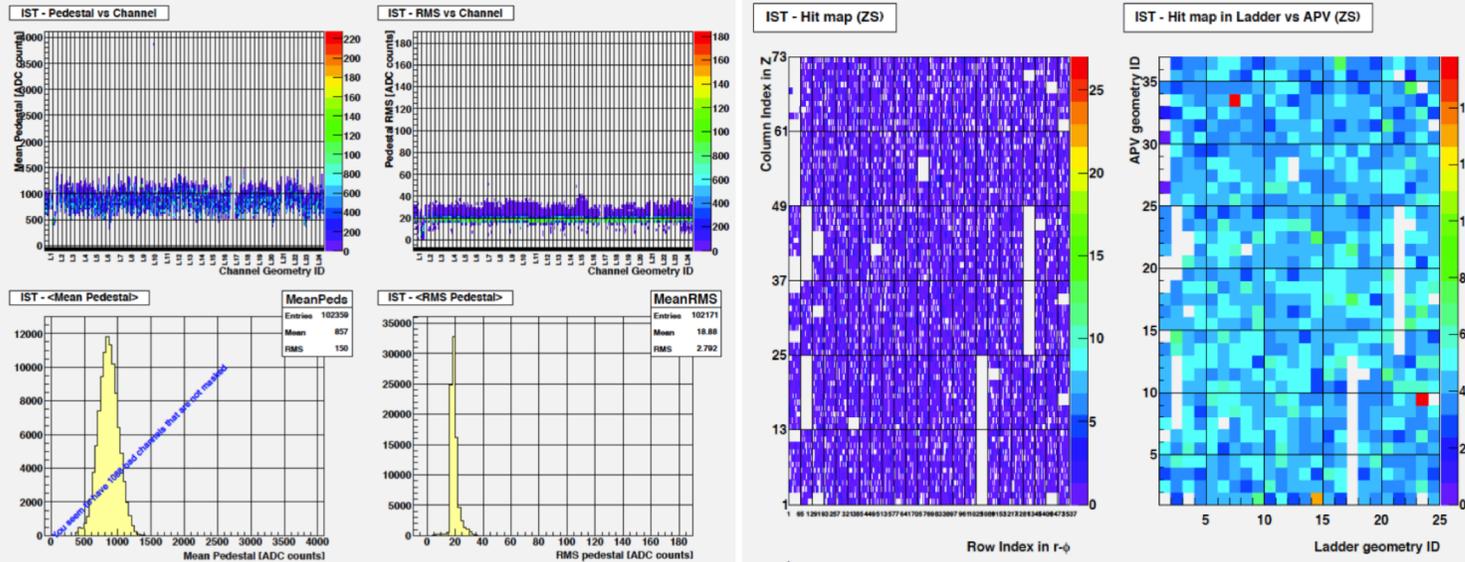
Difference	Files
Geometry/Mapping	StIstRawHit, StIstCluster, StIstFastSimMaker, StIstSlowSimMaker...
CMN calculation method	StIstRawHitMaker & StIstCalibrationMaker & calibration DBs
Clustering algorithms	StIstClusterMaker
Alignment	StIstHitMaker & StIstDbMaker & geometry DBs

2) Make changes for IST offline chain files based on the difference to get FST offline chain

- ❖ Working on StFstRawHitMaker, StFstClusterMaker, StFstRawHit and StFstCluster
- ❖ Will work on StFstHitMaker, StFstDbMaker, StFstCalibrationMaker and calibration DBs
- ❖ Geometry DBs by Gavin/Shenghui
- ❖ StFstFastSimMaker is reviewed.
- ❖ StFstSlowSimMaker by Gavin

FST online status

Online Monitoring



- Re-use the old IST online QA plots with modification for FST.
- Able to check out and compile old IST code.
- Need to update to FST geometry.
- Will test with the data collected in the DAQ integration test, then send to Jeff for implementation.

provided by Xu Sun (thanks!) and can be found at the below link:

https://indico.bnl.gov/event/10319/contributions/45004/attachments/32375/51479/FstSloControlOnlineMonitoringF2F_Jan2021.pdf

Summary

1) Offline

✓ Status

- ❖ Have went through IST offline chain and understood the processes.
- ❖ Have found the difference between IST and FST, and their corresponding files.
- ❖ Have started to work on StFstRawHitMaker, StFstClusterMaker, StFstRawHit, StFstCluster and StFstConsts.

✓ Discussion

- ❖ Should CMN be done in DAQ PCs? If yes how are calibrations achieved and made available and stored.
- ❖ What is the numbering scheme for FST? It should match the STAR official nomenclature. E.g the Geometry model certainly does not.
- ❖ Cross talk corrections (presumably in the RawHitMaker) do they require additional DB entries? Is it possible to keep enough information so it could be redone later by afterburner? What would it mean for data volumes.

2) Online

- ❖ The code is checked out and compiled.

Outlook

1) Offline

- ❖ Finish offline chain in 1-2 months. (Maybe a delay due to FST module test.)

2) Online

- ❖ Will start the updates after the updates of slow control system.

Back Up

Back Up

StIstRawHitMaker

- 1) Daq data Reader (currently use fgt daq_dta)
- 2) un-packs the IST signal (such as RDO Id, ARM Id, APV Id, channel Id, time bin index, ADC) for all channels every event from the raw data.

StIstCalibrationMaker

- 1) Calculate pedestal/rms noise by histogram method for each channel over all time bins
 - Broken/noisy channels can be marked out by setting high rms noise values (1000)
- 2) Calculate common mode noise for each APV chip over all time bins
 - Bad/Strange chips can be marked out by setting high CM noise value (1000)
- 3) Two calibration data files are generated, which are used to write calibration DBs.

StIstClusterMaker

- 1) executes the raw hits clustering in a sensor area ladder by ladder.

StIstHitMaker

- 1) Create IST hits according to clusters info.
- 2) Access IST geometry DBs via StIstDbMaker, and get geometry matrix list by: `gStIstDbMaker->GetRotations()`
- 3) Transform local to global position by: `geoMSensorOnGlobal->LocalToMaster(local, global)`

Back Up

StIstDbMaker

1)The StIstDbMaker is designed to obtain geometry and calibration Db tables.

idsOnTpc: translations/rotations of IDS relative to the TPC coordinate system, formatted as geometry matrix ids2Tpc.

pstOnIds: translations/rotations of PST relative to the IDS coordinate system, formatted as geometry matrix pst2Ids.

istOnPst: translations/rotations of whole IST detector relative to the PST coordinate system, formatted as geometry matrix ist2Pst.

istLadderOnIst: translations/rotations of IST ladder relative to the whole IST detector's coordinate system, formatted as geometry matrix ladder2Ist.

istSensorOnLadder: translations/rotations of IST silicon sensor relative to the IST ladder coordinate system, formatted as geometry matrix sensor2Ladder.

The translations and rotations of IST silicon sensor relative to the STAR coordinate system can be calculated as below formula:

$$\text{sensorGlobal} = \text{tpc2Global} * \text{ids2Tpc} * \text{pst2Ids} * \text{ist2Pst} * \text{ladder2Ist} * \text{sensor2Ladder}$$

Here the tpc2Global represents the translations and rotations of TPC relative to the STAR global coordinate system.

istMapping: translation of channel electronics ID to geometry ID. The mapping table is produced based on IST readout map in 2014: [http://www4.rcf.bnl.gov/~ypwang/IST_software/IST_Readout_Map_21Feb2014 .xlsx](http://www4.rcf.bnl.gov/~ypwang/IST_software/IST_Readout_Map_21Feb2014.xlsx)

istControl: several pre-set cuts, such as hit cut, pedestal cut, noise thresholds, data types, dynamical number of time bin, and so on.

istGain: translation of IST signal from ADC counts to charge/energy.

istPedNoise: common-mode noise of all APV chips, pedestal and RMS noise of all channels.

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The translations and rotations of IST silicon sensor relative to the STAR coordinate system can be calculated as below formula:

$$\text{sensorGlobal} = \text{tpc2Global} * \text{ids2Tpc} * \text{pst2Ids} * \text{ist2Pst} * \text{ladder2Ist} * \text{sensor2Ladder}$$

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Back Up

Fast simulation maker (StIstFastSimMaker)

The StIstFastSimMaker takes StMcIstHit as input, which is generated by StarSim output. In the fast simulator, the smearing effect is considered. The MC hits are packed as StIstHit format, and are stored into StIstHitCollection. The StiIstDetectorBuilder and StiIstHitLoader (located in StRoot/StiIst) are used for IST tracking.