FVTX DAQ Commissioning

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DAQ Commissioning Time-line

- Oct-Dec 2011 – Detector final assembly and test
  Quality check on all wedges

FVTX → IR

- Late Dec 2011 – First data from PHENIX IR
  Reached Dec 30 milestone
- Late Jan 2012 – First full detector readout from IR

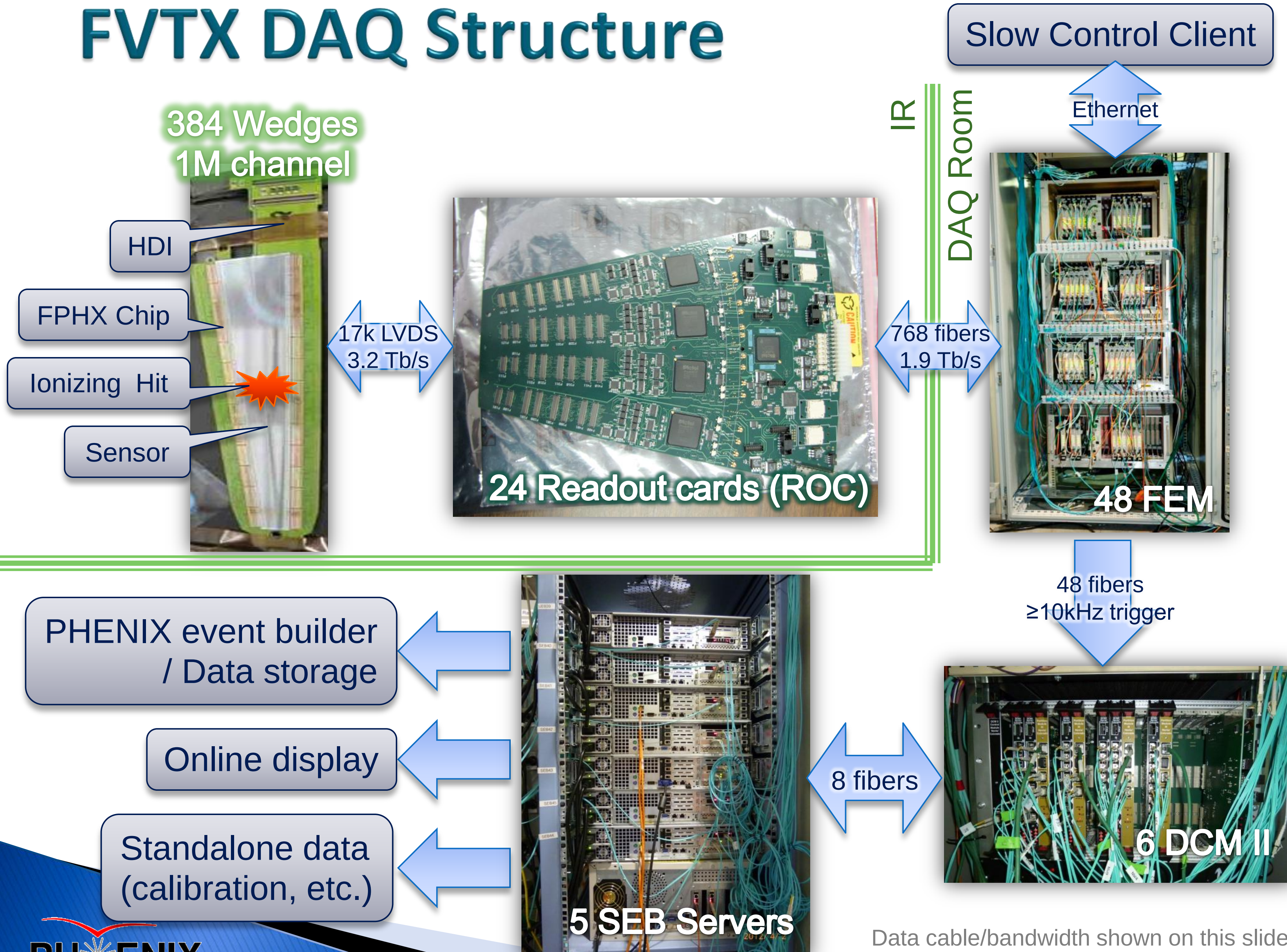
200 GeV p-p start

- Feb 8 2012 – First data (self-triggered) with beam, shortly after stable run 12 collision were established
- Feb 24 2012 – First physics data with 1/6 acceptance

510 GeV p-p start

- Mid March 2012 – Detector operational
  with ~90% of acceptance ON
  Have taken all 510 GeV p-p data
- Late March 2012 – Detector operation by shift workers

FVTX DAQ Structure



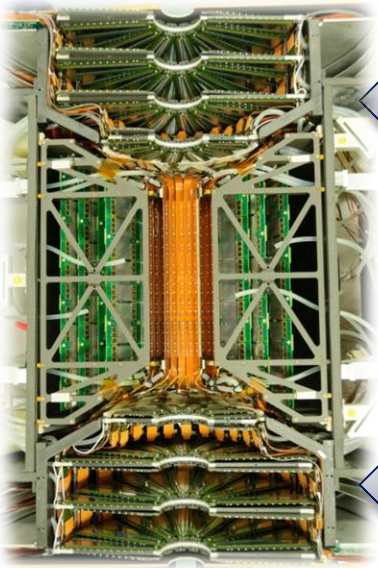
DAQ Slow-control

- FVTX Slow-control
  - Control parameters of FEM/ROC/each individual FPHX chips
  - Read back system status
- Two Slow-control interfaces
  - C++ based: integrated into PHENIX run control
  - FVTX Expert GUI (next page)
- Slow-control commissioning
  - Debugged slow-control communication to IR
  - Established slow-control to all wedges
  - Verified control commands functionality

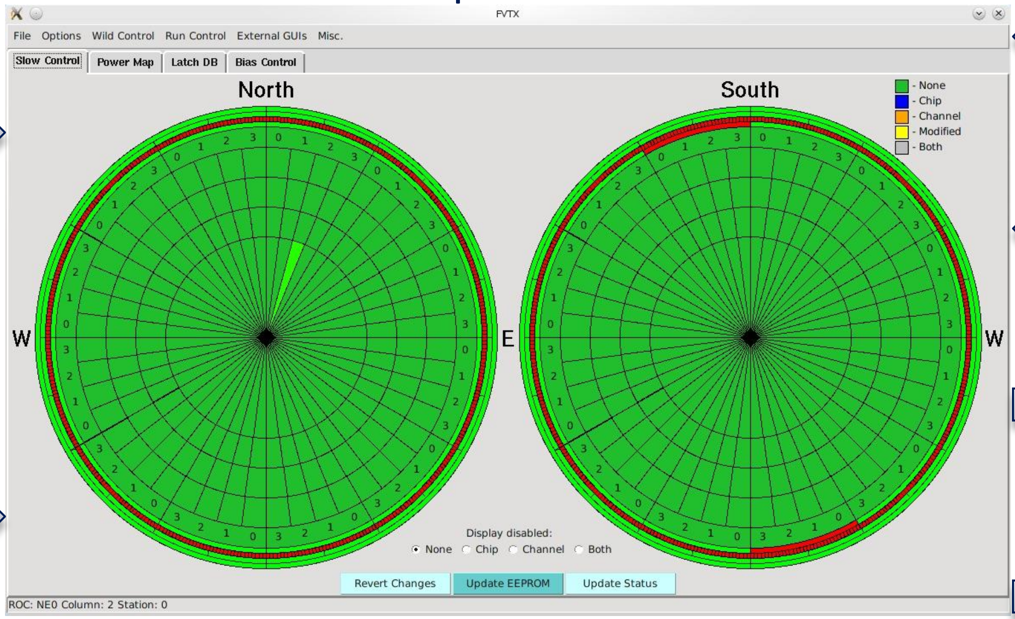
FVTX Expert GUI

- Centralized super toolkit for FVTX control/monitoring

FVTX



Expert GUI



Database

LV/HV Control

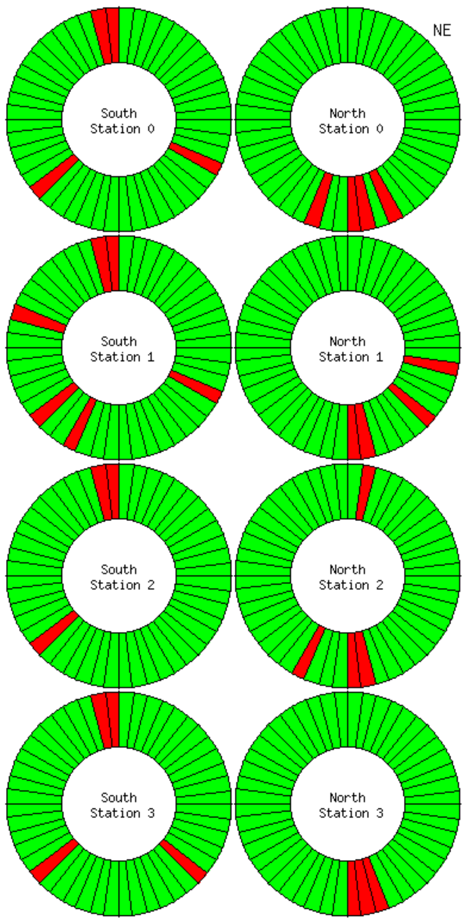
Standalone run control

Specialized GUIs e.g. GTM, bias

Initial DAQ commissioning

- Stage 1: before Dec 30, 2011
  - Immediately after detector installed in IR
  - Using portable power supply / fiber routes to readout one ROC
  - Noise level is small (≤ 500 electrons)
  - 1st operational experience
- Stage 2: Jan 2012
  - Fully power on all ROCs one by one
  - Test aliveness/solve any problem
  - Refinement of FPGA code
  - All ROCs other than SW5 (broken transceiver) were operational

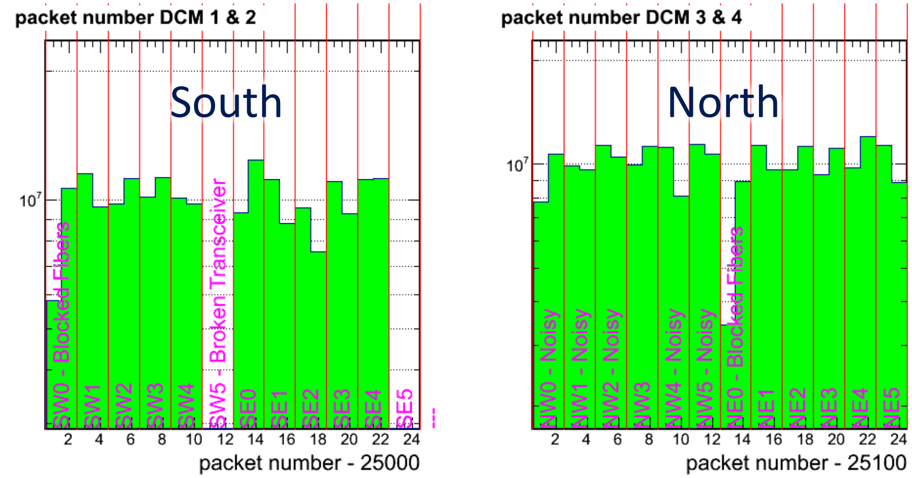
Status Monitoring Webpage (End of Stage 2)

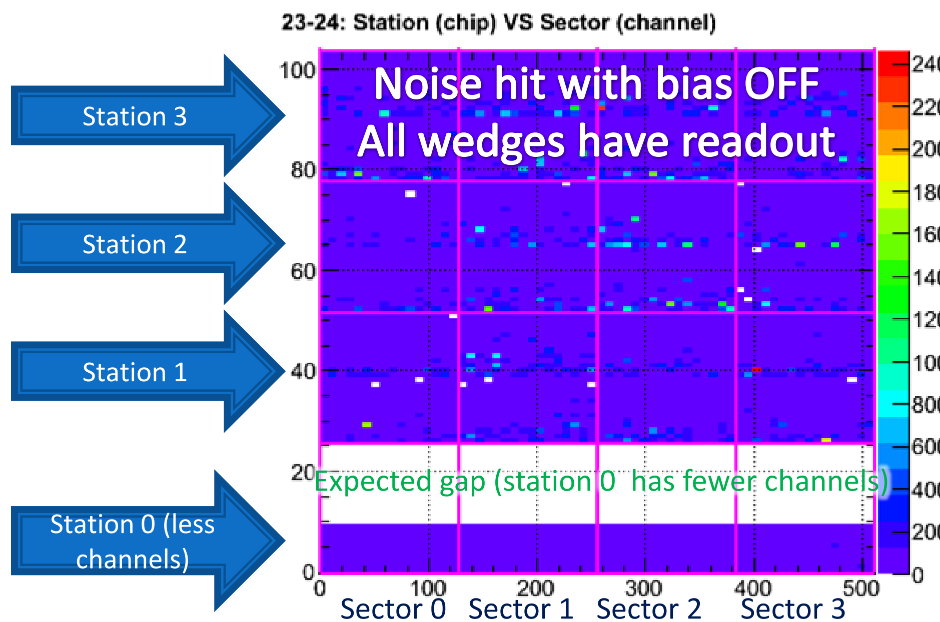


Standalone Data Taking

- Provide quick data readout to check detector status
- Without disturbing data taking of other subsystems
- Special runs:
  - Calibration
  - Timing scan

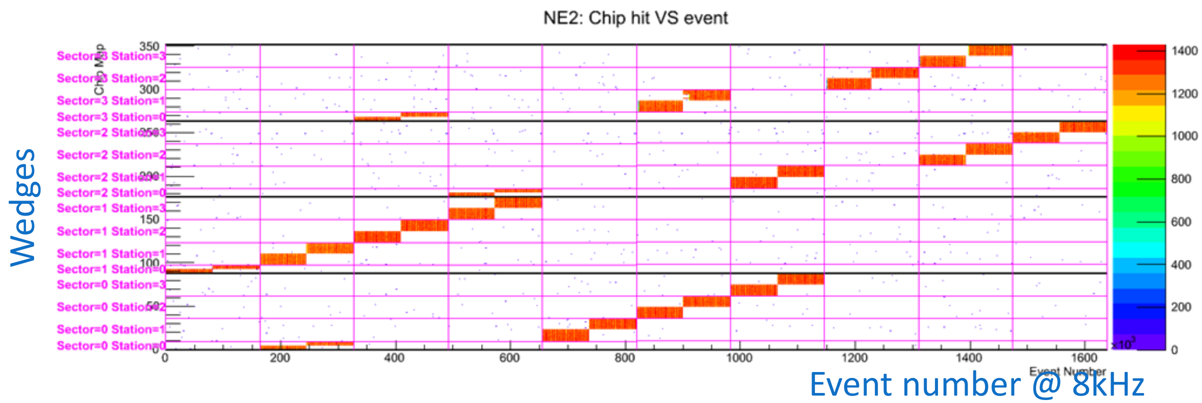
Packet hit map

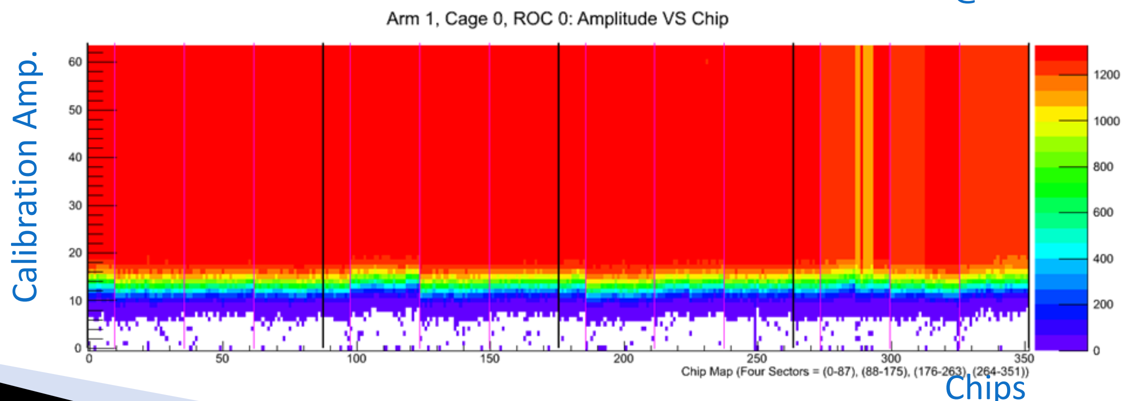




Calibration of FVTX

- Inject pulse of known charge into FEE chips and vary pulse size
- Measure channel status, noise level, check mapping
- 2.5 min of data taking @ 8kHz, 1.7M event



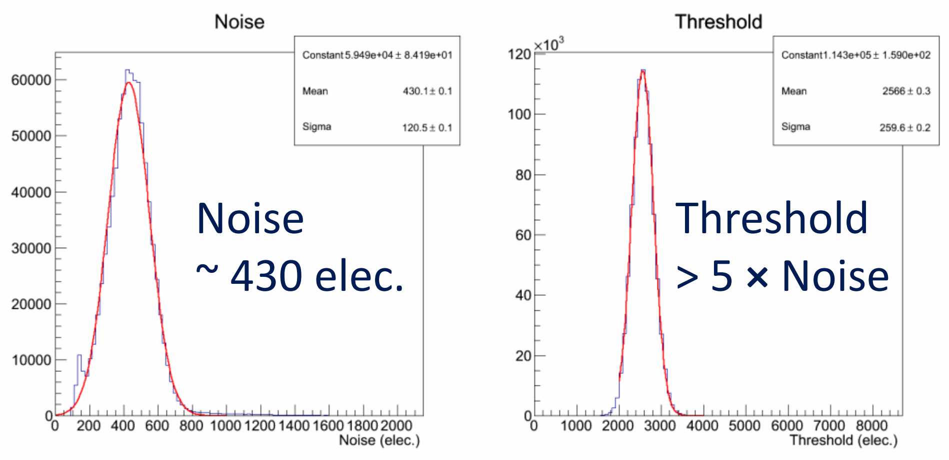


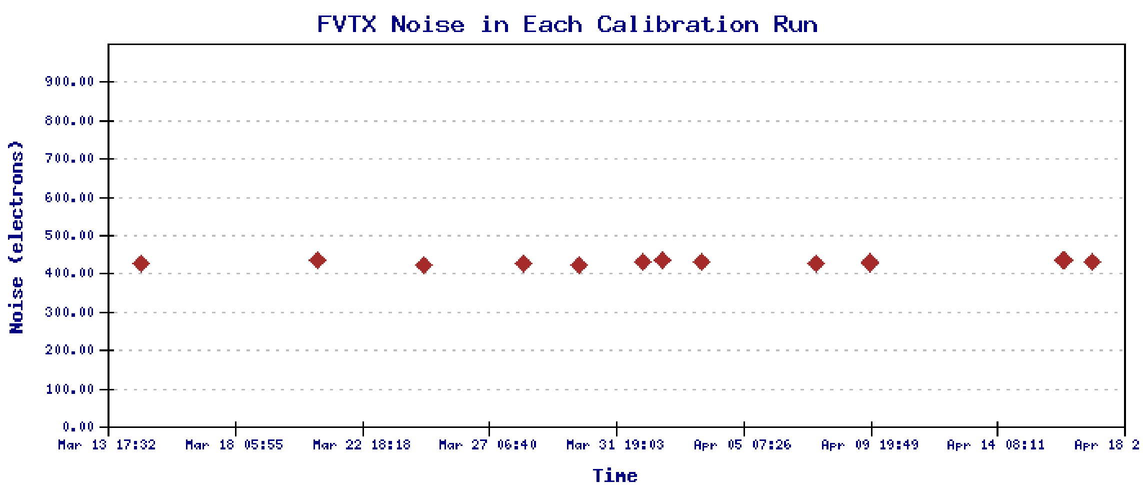
Calibration Results

https://www.phenix.bnl.gov/phenix/WWW/p/draft/fvtx/calibration/

- Calibration Results
  - Detector status channel by channel
  - Noise level / threshold
- Status
  - Runs taken regularly
  - Automated analysis
  - HTML report generated/archived

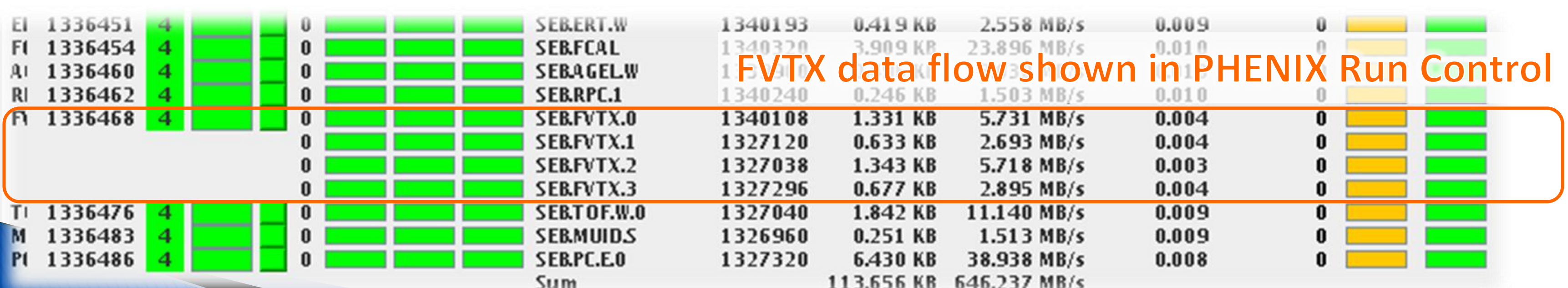
Noise and threshold for each channel





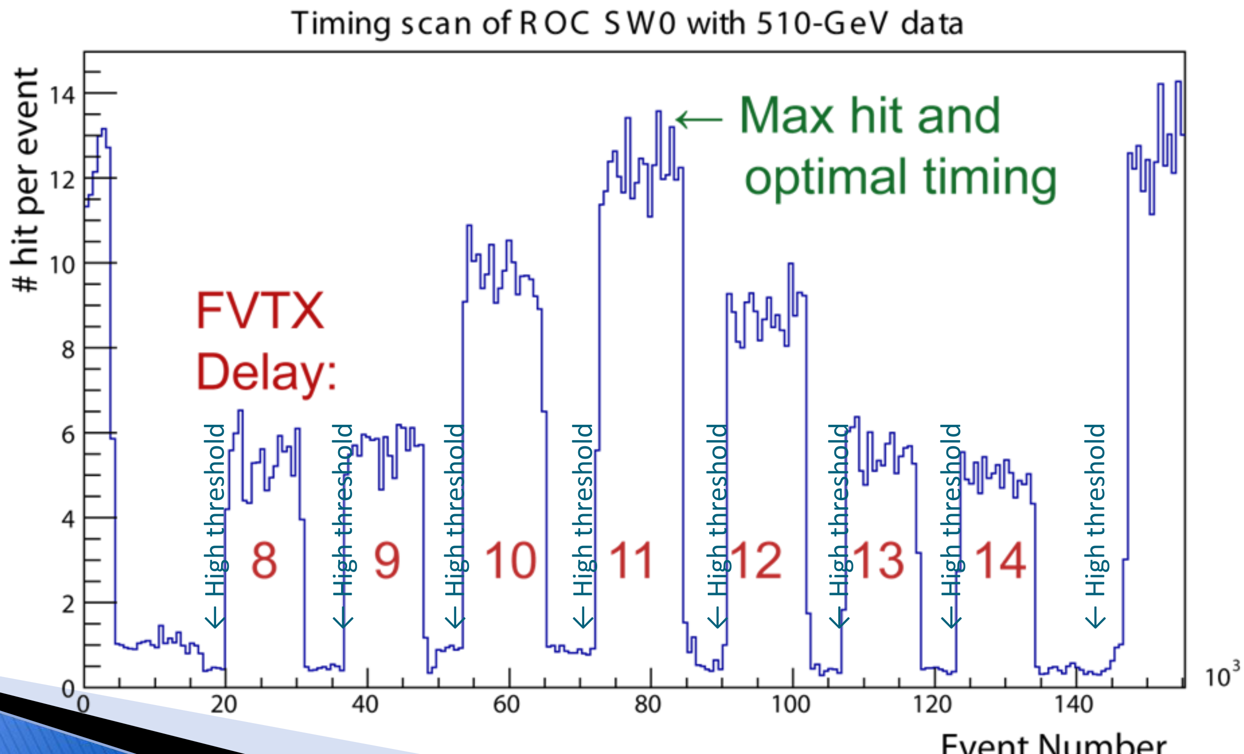
Integration into PHENIX DAQ/ Data flow and stability

- Data flow
  - FVTX → DCM II → SEB Server → PHENIX event builder → Storage
- Joined Main DAQ smoothly
  - Standalone timing (Feb 22) → Granted Joining (Feb 23) → Joined Main DAQ (Feb 24) → Took 100M event (Feb 24 + 28)
- Stability and flexibility
  - Continuous running since 510 GeV p-p run (Mid March)
  - Minimal DAQ failure rate during a production run
  - Can join/exit big-partition running in few minutes (e.g. for standalone test or debugging)



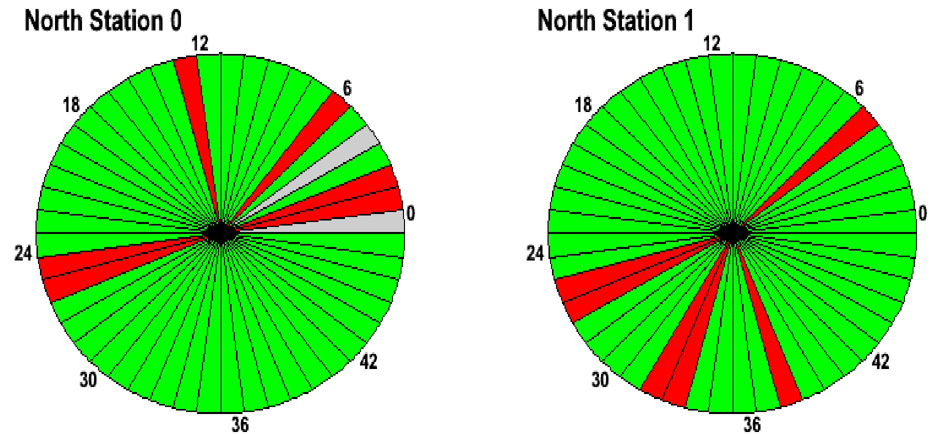
Integration into PHENIX DAQ/ Timing

- Adjust delay to taking FVTX data in coherent timing with PHENIX
- Scan FVTX FEM delay to find best match in time
  - Special method allows the FVTX to time in much faster (~5 min)
  - Optimal timing → max hit
  - Side band → hits are centered in trigger window (2 beam-clock)

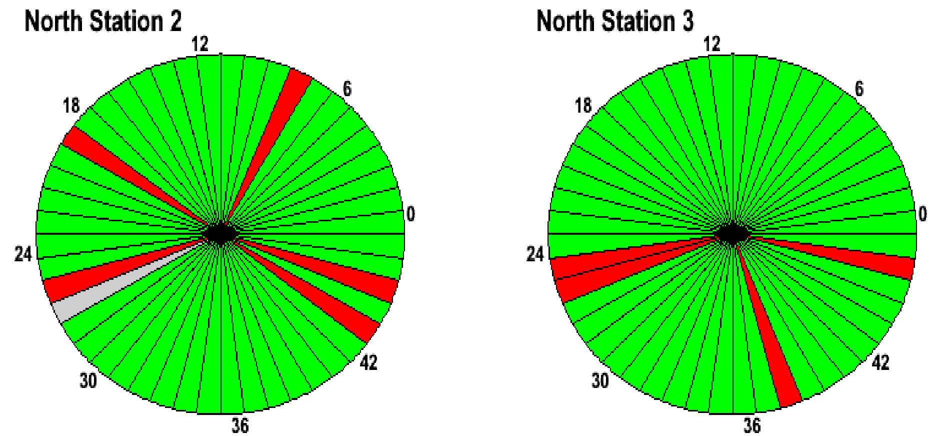


Online Monitoring

- FVTX Online Monitoring
  - Immediate data analysis of raw hit information
  - Monitor status of detector for possible hardware problems so expert can quickly fix
  - First data quality check
- Online monitoring status
  - Operational and integrated with PHENIX main
  - Can be easily accessed by shift worker
  - Mainly used by expert for now
  - Provide out-of-counting house access and archiving



Typical online monitoring plot (510 p-p)
Showing most wedges in north arm is normal



Legend: Normal, Low/High yield, OFF

Credit

- Many institutions and physicists worked on DAQ commissioning and made this work possible
  - Los Alamos: Christine Aidala, Melynda Brooks, Matt Durham, Hubert van Hecke, Jin Huang, Jon Kapustinsky, Kwangbok Lee, Ming Liu, Pat McGaughey, Cesar da Silva, Walter Sondheim, Xiaodong Jiang
  - University of New Mexico: Sergey Butsyk, Doug Fields, Aaron Key
  - Columbia University: Cheng-Yi Chi, Beau Meredith, Aaron Veicht, Dave Winter,
  - New Mexico State University: Abraham Meles, Stephen Pate, Elaine Tennant, Xiaorong Wang, Feng Wei
  - Brookhaven: Carter Biggs, Stephen Boose, Ed Desmond, Paul Gianotti, John Haggerty, Jimmy LaBounty , Mike Lenz, Don Lynch, Eric Mannel, Robert Pak, Chris Pinkenburg, Rob Pisani, Sal Polizzo, Christopher Pontieri, Martin Purschke, Frank Toldo
  - University of Colorado: Mike McCumber
- Many other collaborators also provided crucial support

Conclusion

- FVTX DAQ commissioning is successful
  - Steady progress was made
  - 90% of the detector is operational
- DAQ operation is stable
  - Stable noise level – monitored regularly
  - Stable big-partition runs
  - Taken all 510 GeV p-p data
- Routine data taking handed to shift worker in late March
  - 24/7 expert on-call and close monitoring of detector performance

Back up

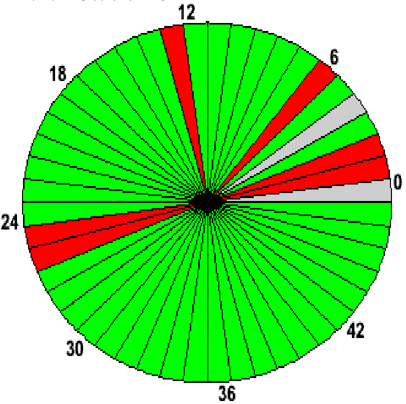
First data in PHENIX Big-Partition DAQ

- Evaluated it is safe to run detector with 1/6 acceptance
- Timed-in Feb 22 morning in standalone mode
- Granted big partition test on Feb 23
- Timed-in Feb 24 in PHENIX big partition
  - Identified optimal timing (Next slides)
  - Smooth data taking
- Took ~100M events in big partition
  - Two batches of data taking on Feb 24 and Feb 28
  - Almost no errors in data taking
  - Data was analyzed quickly
    - Online: ensured data quality
    - Offline: tracking, vertex correlation to BBC and matching with Muon Arm

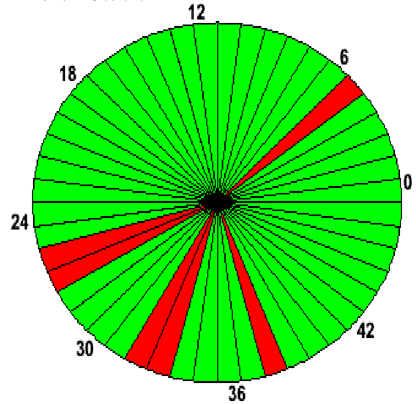
Online Monitoring

Legend: Normal, Low/High yield, OFF

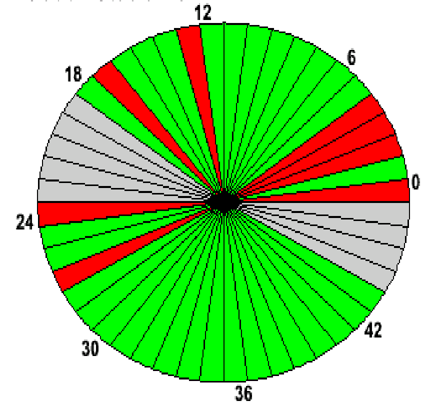
North Station 0



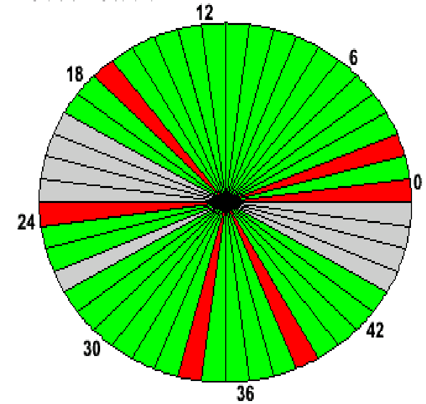
North Station 1



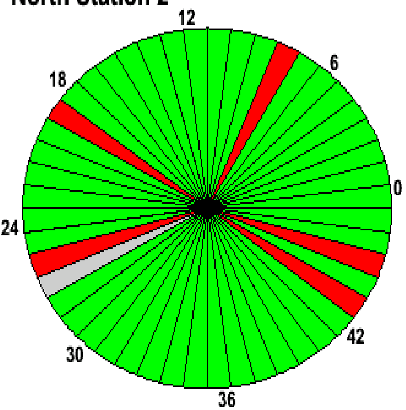
South Station 0



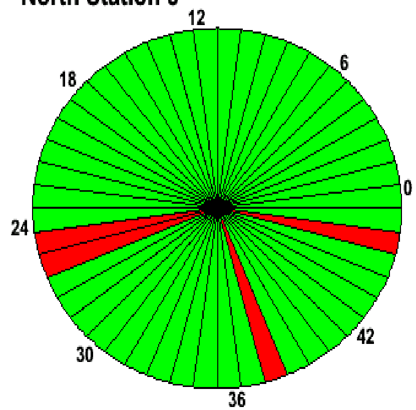
South Station 1



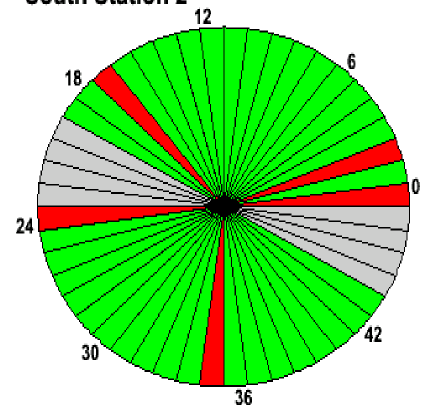
North Station 2



North Station 3



South Station 2



South Station 3

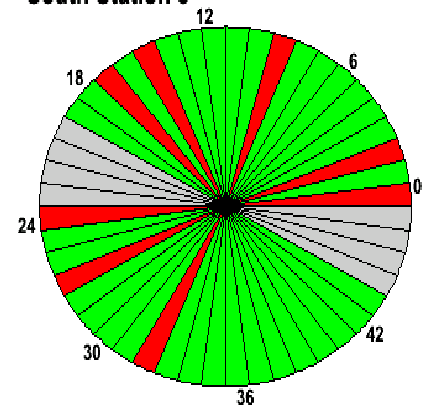
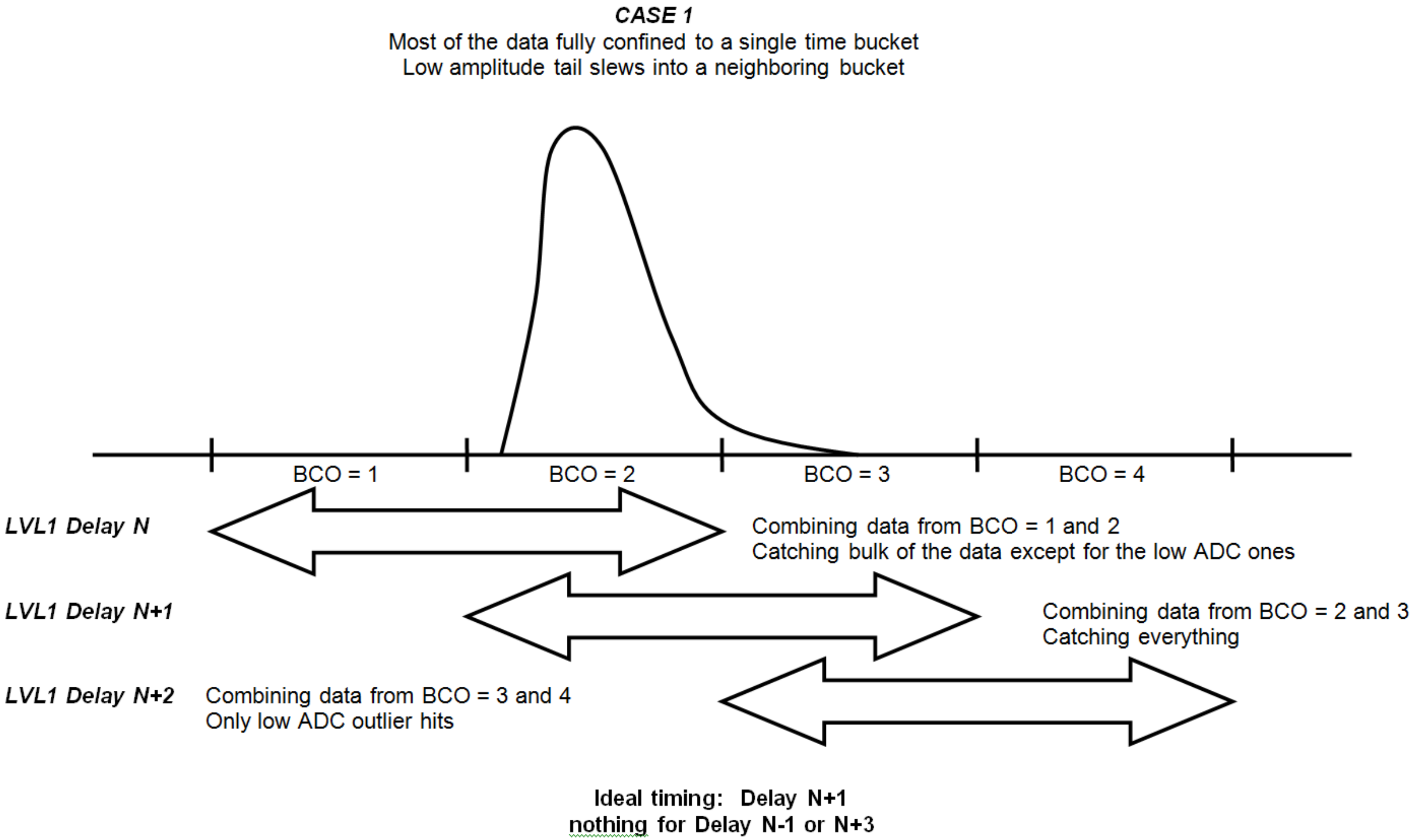


Illustration of trigger window



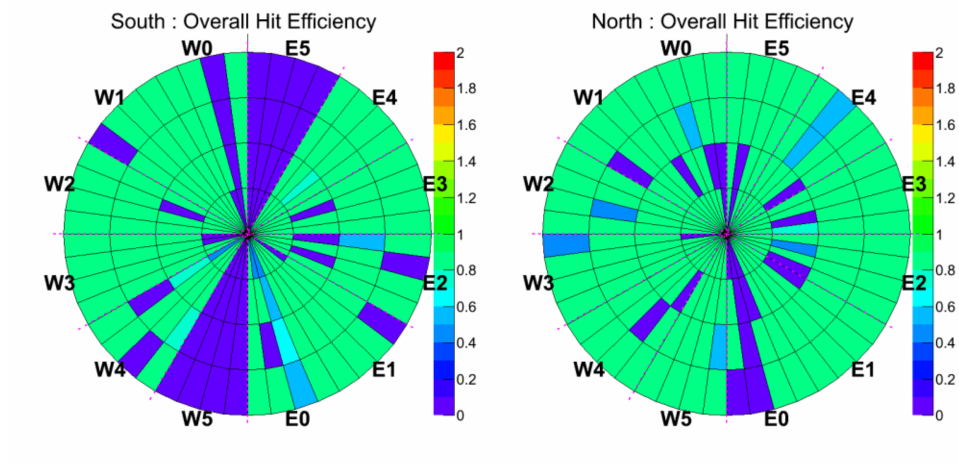
Known problems and solution

- Disabled ROC
  - Electrical issues, to be fixed in the summer
- Missing few wedges
  - Able to communicate through slow-control
  - Under debugging, expect to recover
- Occasional missing clock for few ROCs
  - Suspect quality of clock signal to those ROCs
  - Not affect majority of data taking

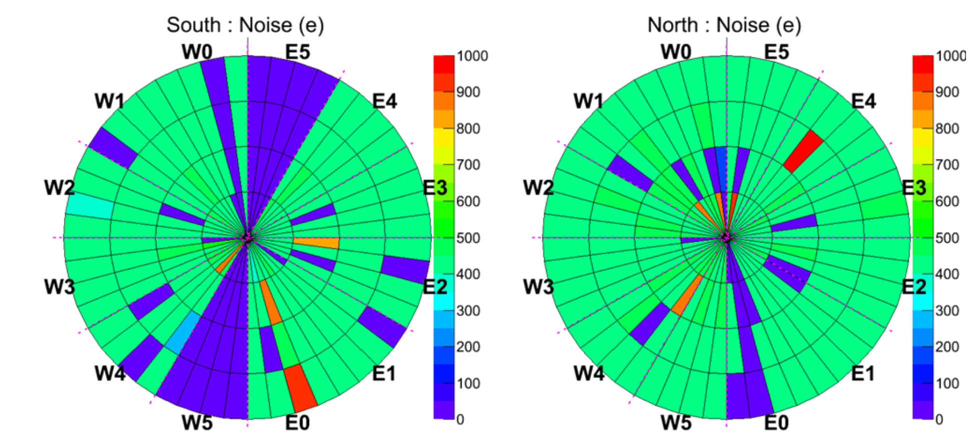
Calibration Results

FVTX Overall hit eff.

(% of chan. alive) × (eff. per chan.)

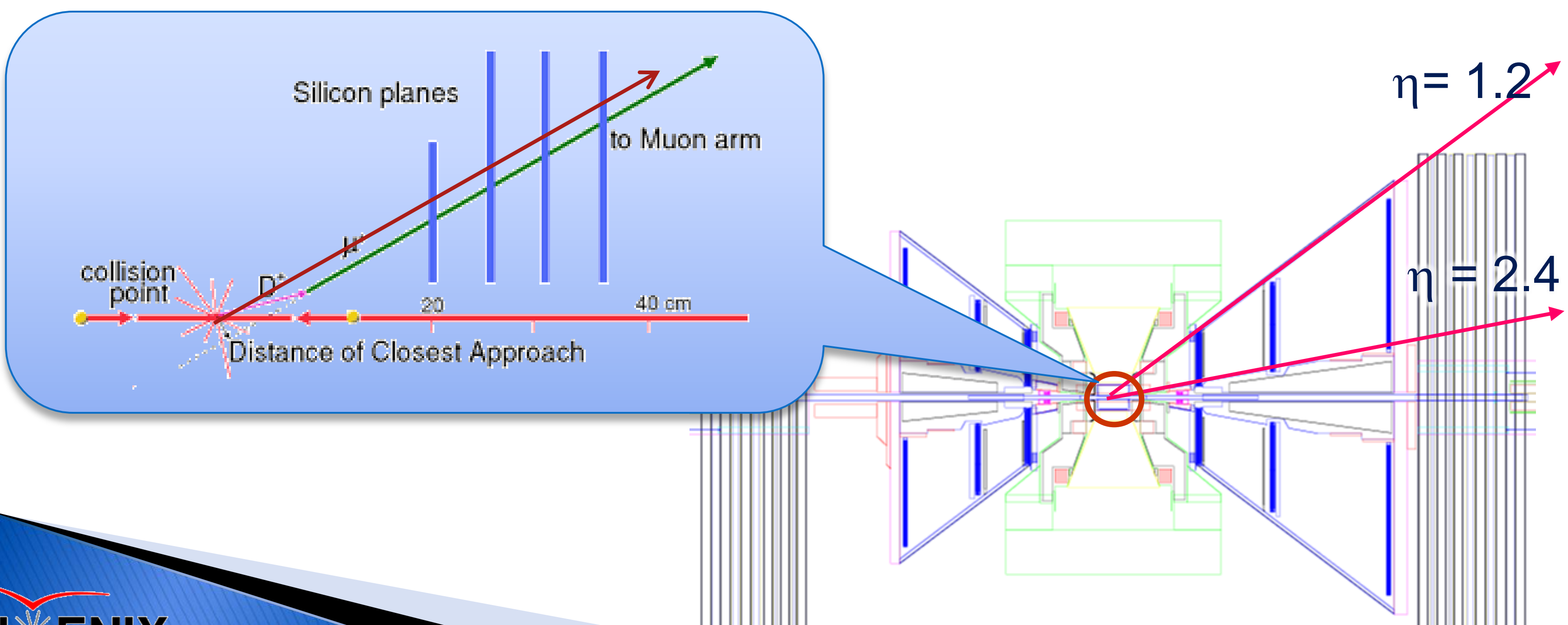


Noise for each wedge



Forward vertex detector (FVTX)

- Tracking in forward region and close to IP
- Provide
  - Differentiate primary vertex / secondary decay
  - Track isolation : suppress hadrons from jet for W measurement
  - Precisely measure opening angle : J/ψ mass
  - Jointed tracking with MuTr : suppress delay-in-flight

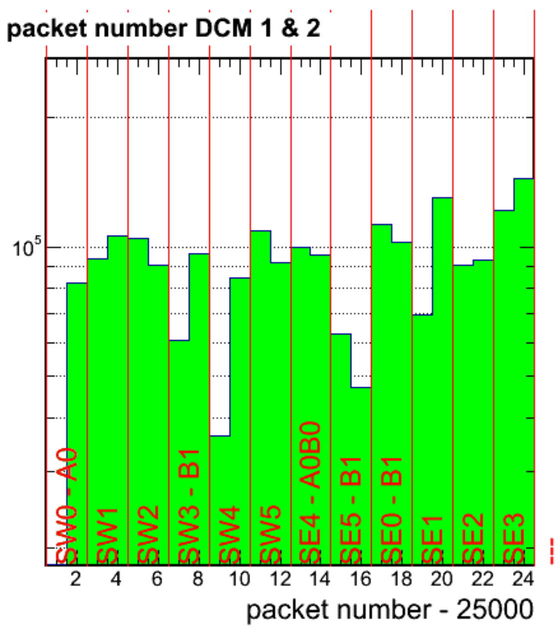


Project history

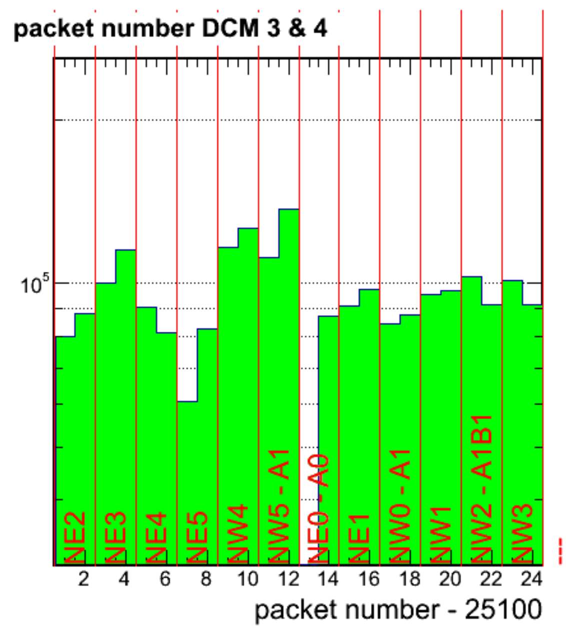
- 2003 – 2008 LANL supported R&D
- 2007 – BNL / DOE / Technical reviews
- 2008 – prototyping
- 2009 – first production modules
- 2010 – assembly started in earnest
- 2011 – assembly and installation COMPLETE
- <u>2012 – first data in beam</u>

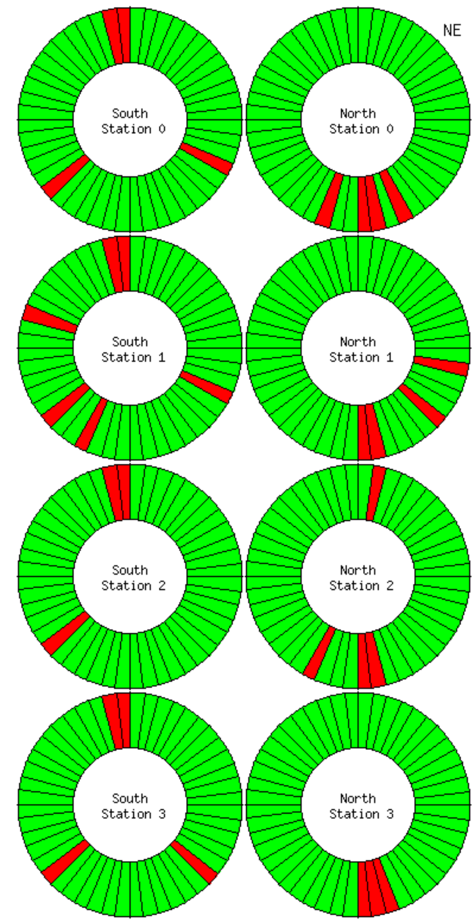
Alive test after Installation

South Arm



North Arm





ROC Hit map

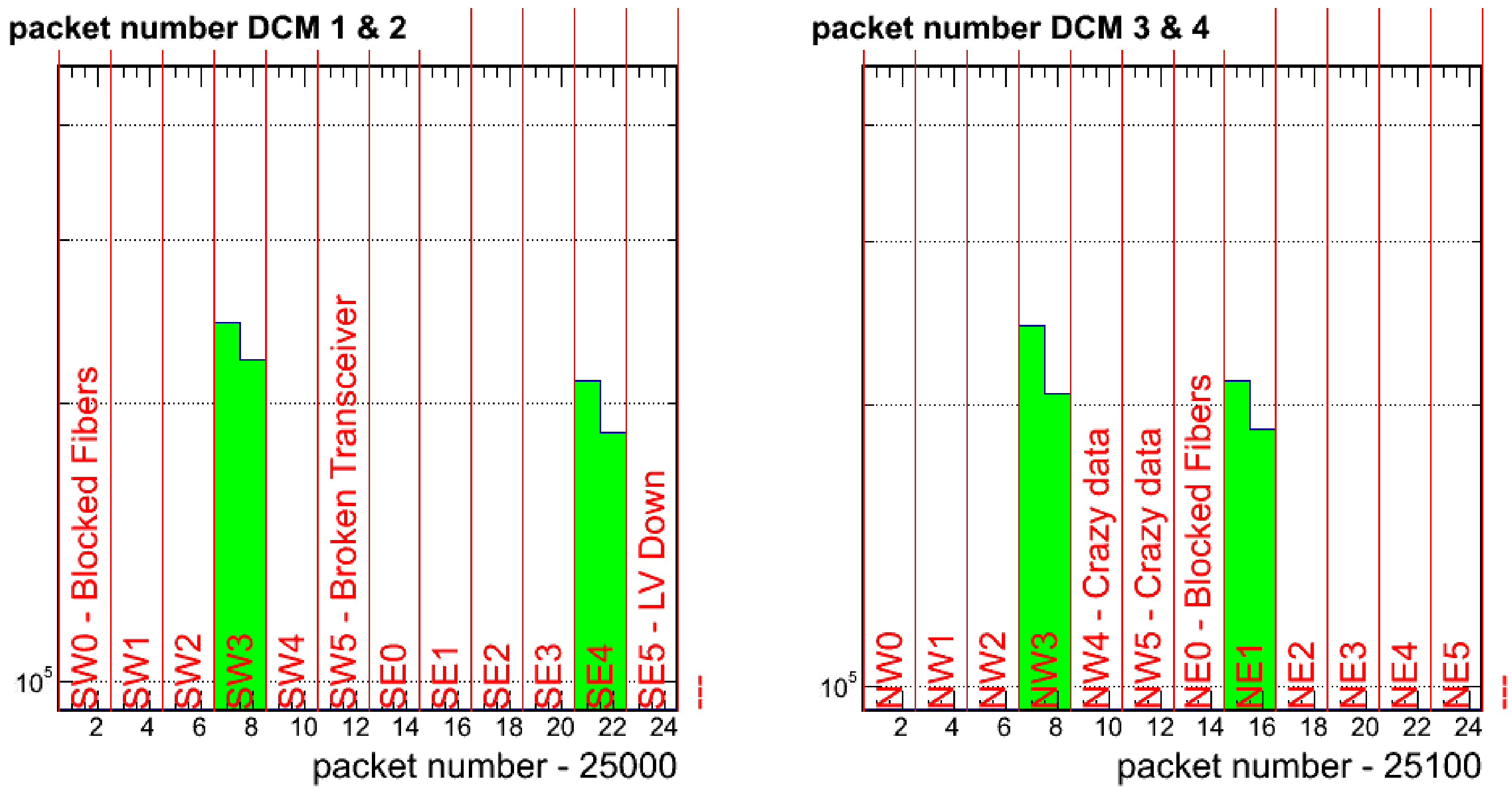
Showing Data from 24 ROCs in a single run

Wedges that have data

+ Can control 95% wedges

We activated 1/6 of our acceptance

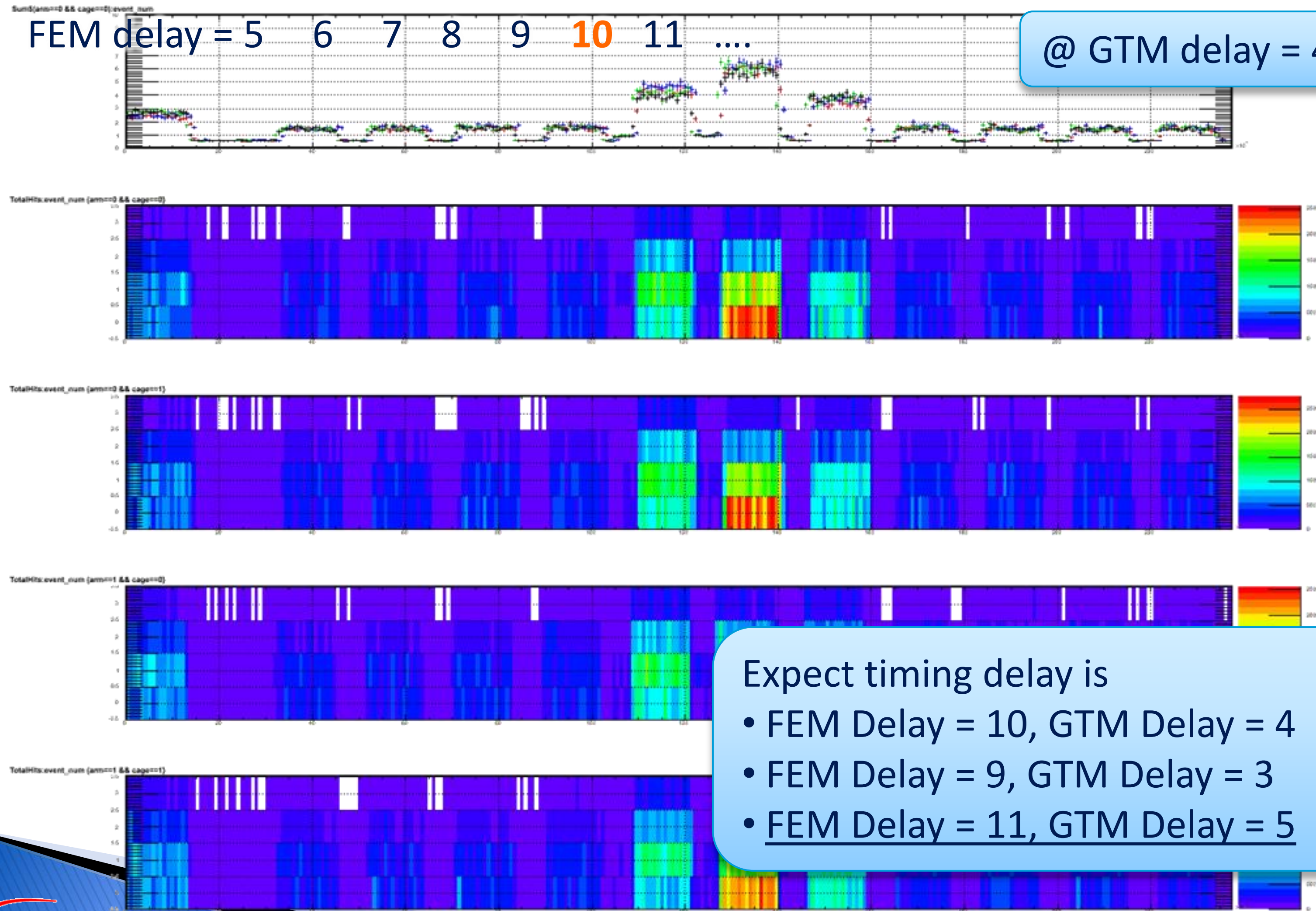
to control possible over heating



Packet Hit map for Run 360476, @ timing peak

Time-in FVTX in Big Partition

Special technique to speed the scan by changing FVTX delay



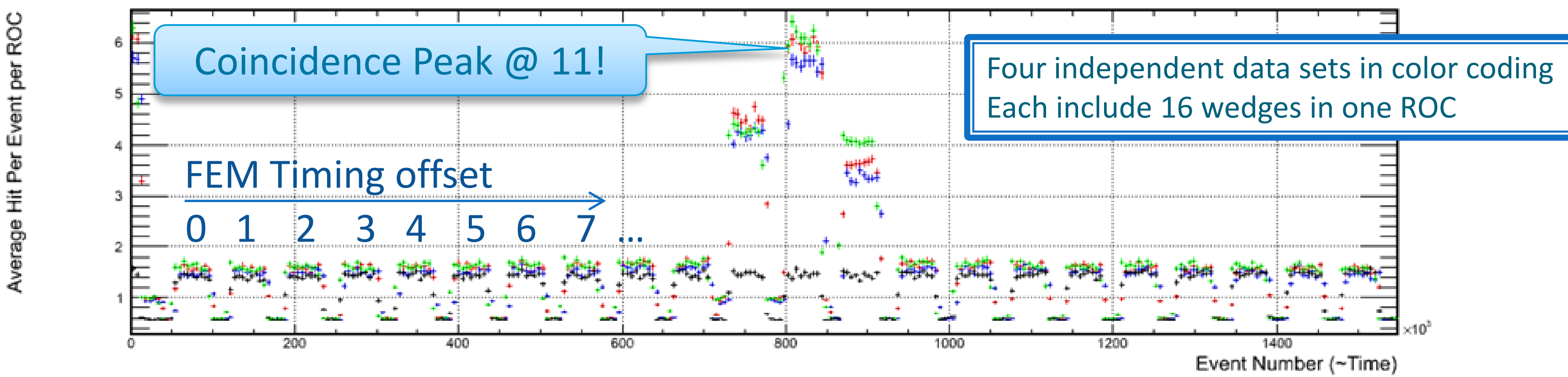
@ GTM delay = 4

Expect timing delay is

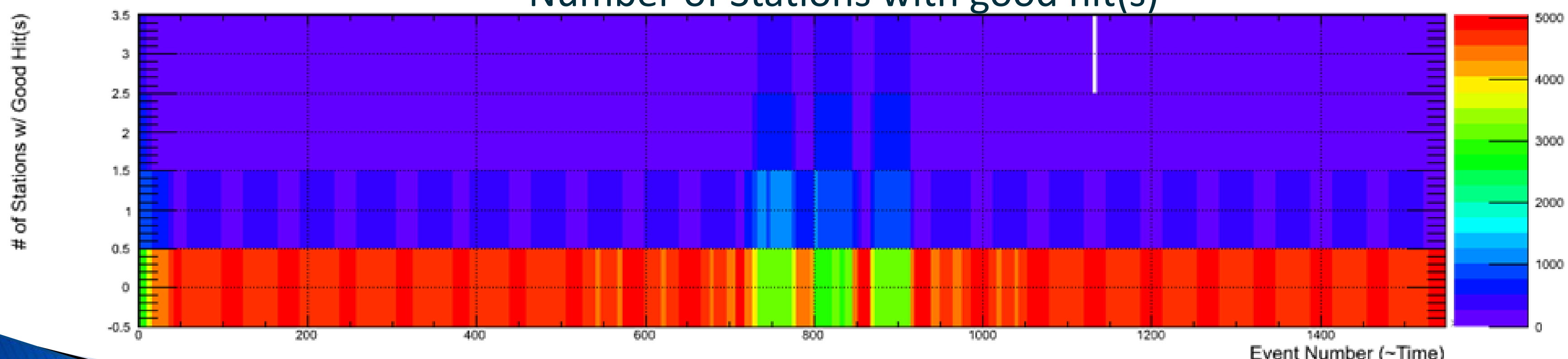
- FEM Delay = 10, GTM Delay = 4
- FEM Delay = 9, GTM Delay = 3
- <u>FEM Delay = 11, GTM Delay = 5</u>

Time-in FVTX

Number of hit per event

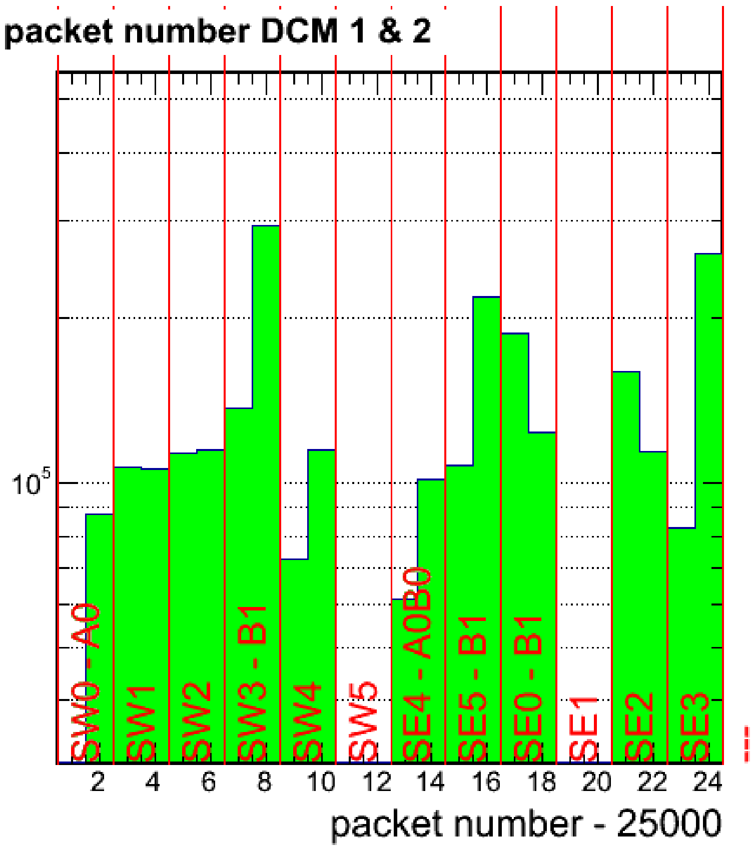


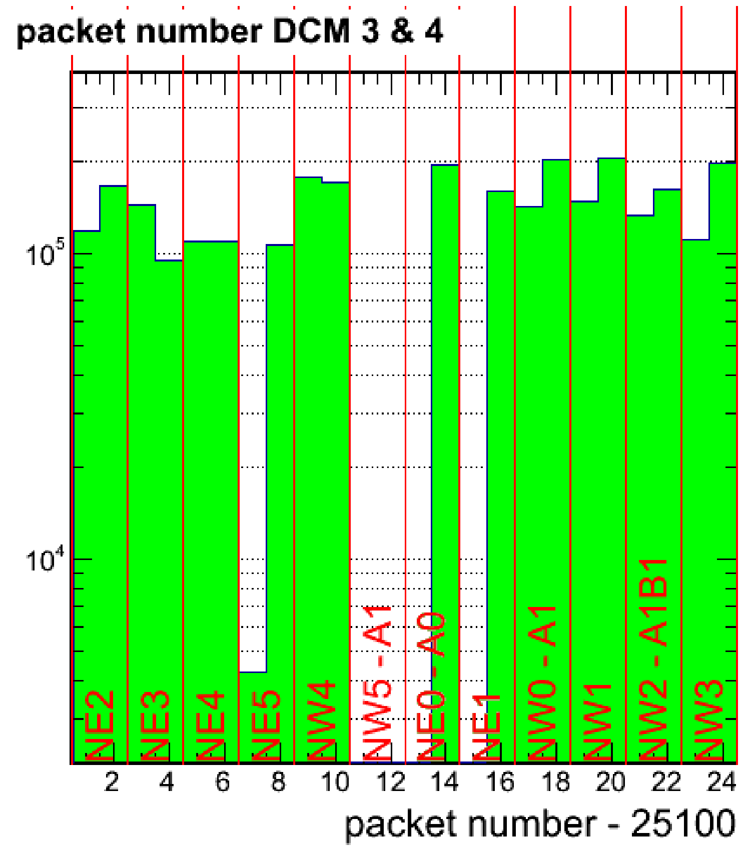
Number of Stations with good hit(s)



PHENIX

FVTX Readout using PHENIX DAQ (aka. big partition)





ROC Hit map

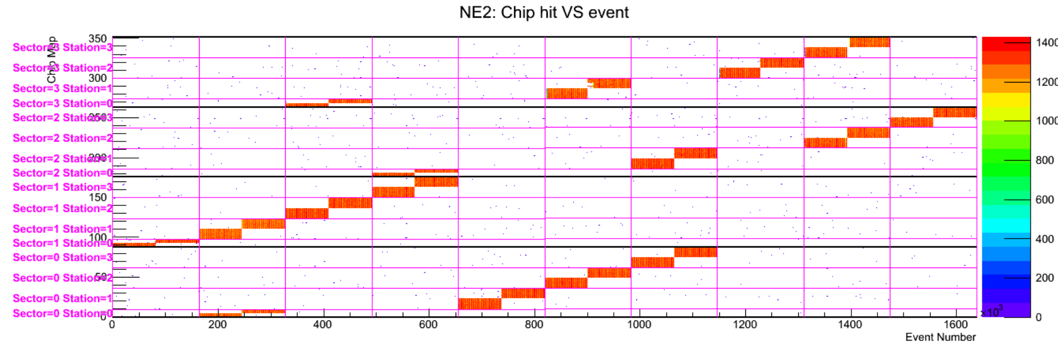
Readout from PHNEX run control. Few ROCs missing which are under firmware update

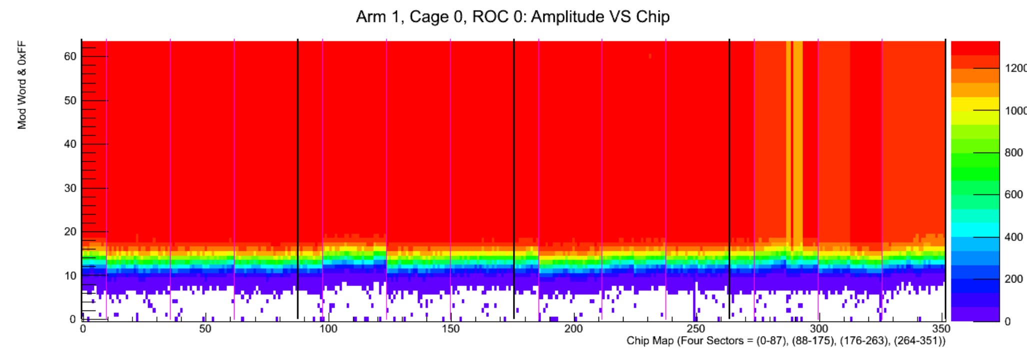
FPGA Firmware R&D

- To hear from Sergey

Full system calibration

- Calibration map for ROC NE2 (1/12 of south arm acceptance)
- Showing stable communication to all wedges and low noise level
- 3.5 min to calibration 1M channels using PHENIX DAQ





- Noise level ~ 500 electron in PHENIX
- Threshold ~ 300 elec.