

sPHENIX Integration Testing

John Haggerty

BNL

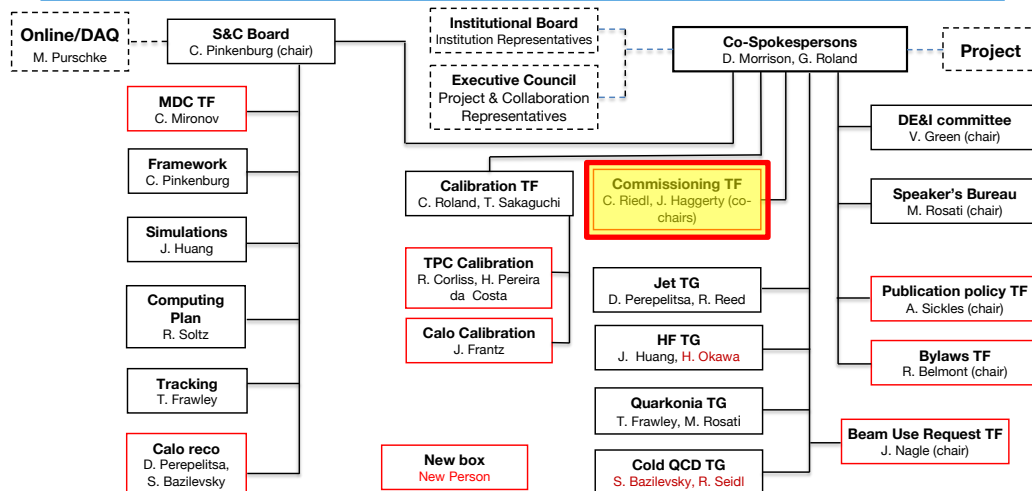
Commissioning stages

1. Pre-installation commissioning and testing
 2. Installation commissioning
 3. Post-installation commissioning
 4. Magnet commissioning
 5. DAQ and Electronics Commissioning and Installation (chain and slice tests)
 6. Full detector commissioning (DAQ/Trigger/computing commissioning)
 7. Trigger commissioning
 8. Cosmic ray running
 9. Beam operation
- } covered in this talk

Commissioning

- Integration and commissioning activities have been ongoing for several years as part of the system development for the MIE, but the collaboration has recently formalized the process by forming a Commissioning Task Force
- First meeting yesterday (2021-05-19)

Collaboration organization (2021)



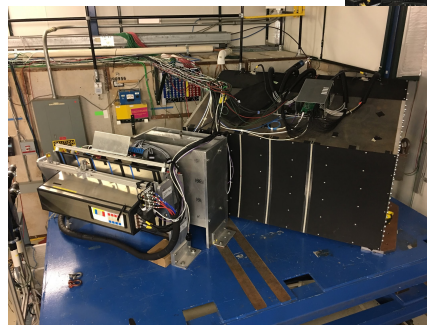
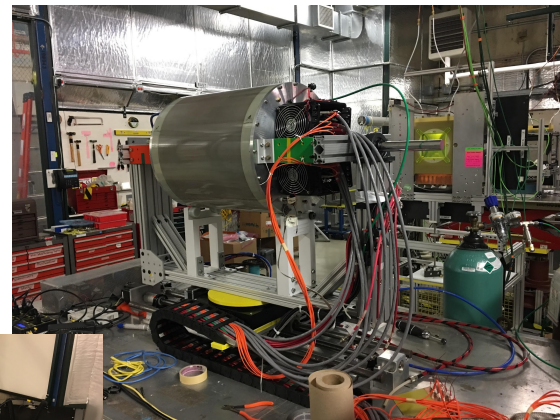
March 23-24, 2021

3rd sPHENIX Software & Computing Review

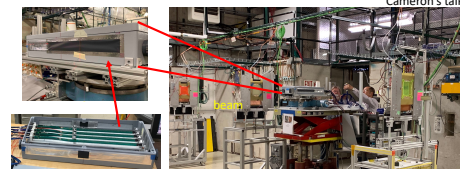
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Fully integrated during development

- sPHENIX detectors and electronics was developed and subjected to a series of beam tests with apparatus as close as possible to the final production electronics
- Beam tests at FTBF:
 - **2019 TPC, INTT, MVTX**
 - TPC v1 FEE with V4 SAMPA
 - INTT production ROC, PHENIX FEE
 - MVTX stave-FELIX
 - **2018 EMCAL, IHCAL, OHCAL**
 - Production digitizers



2019 MVTX Test Beam Setup @Fermilab



Stave housing sits on a motion table which can be moved in x, y plane perpendicular to the nominal beam direction. It can also be rotated (± 45 , 90) degrees (see photo on right). Operation was done at counting house.

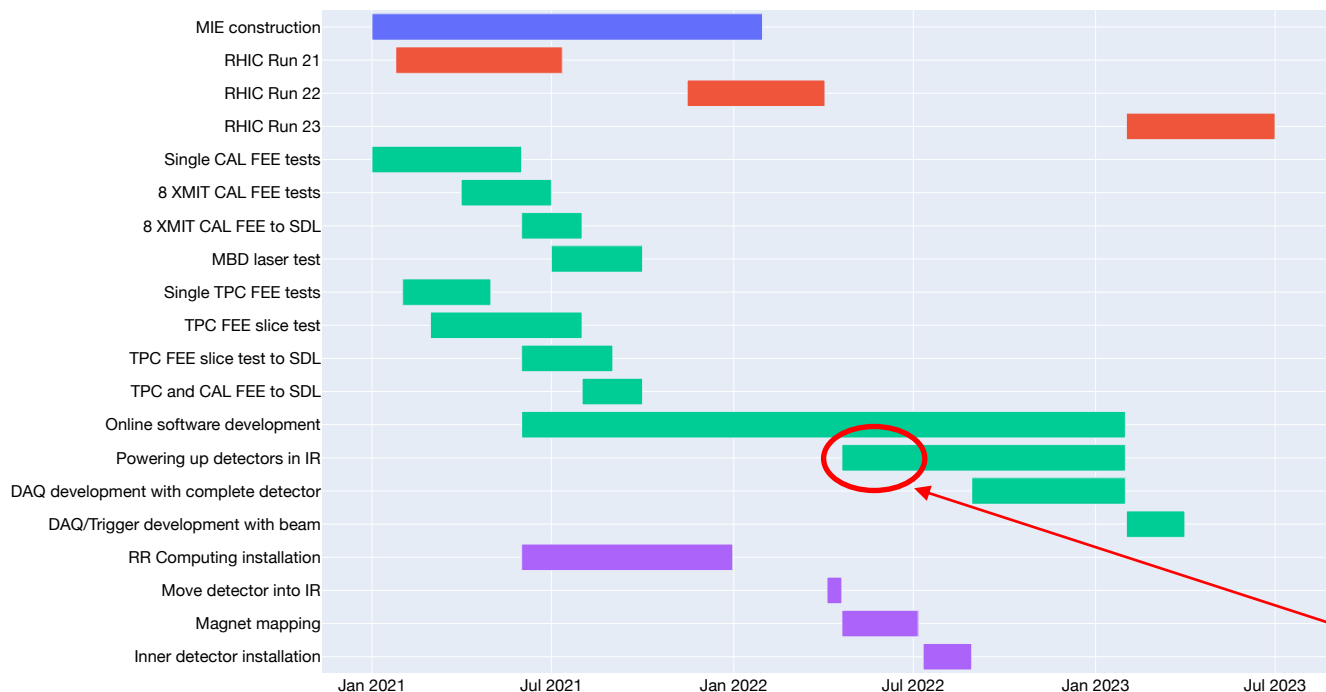
July 29-30, 2019

MVTX C&S Review - Overview

Commissioning timeline



sPHENIX Commissioning



Type
■ Project
■ RHIC Run
■ Development
■ Installation



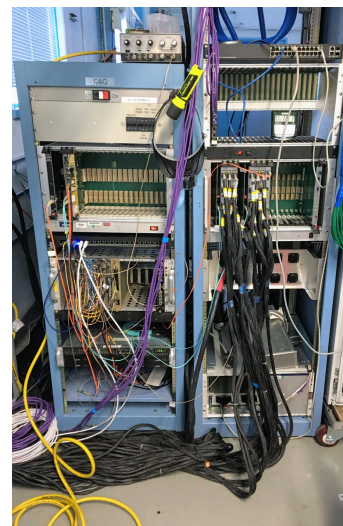
First time detectors can begin to be fully powered on carriage

1. Pre-installation commissioning and testing

- Testing of components prior to installation in detector
- May or may not involve connection to complete services (power, cooling, DAQ, trigger), but should as much as feasible
- This stage is largely covered by the detector MIE project, but requires a clean (and quick!) segue to the next stage
- Mostly not in 1008 (except for DAQ/Trigger/Computing/Control/Monitoring)
- Collaborators at this stage develop the experience and expertise needed for all subsequent stages

Sector testing of calorimeters

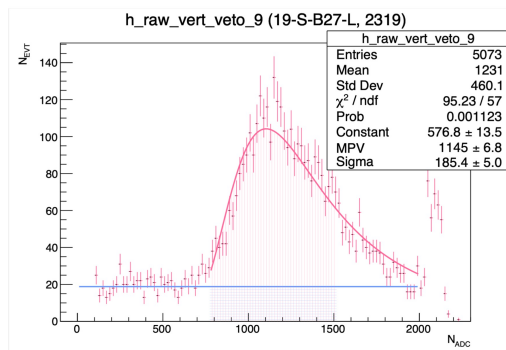
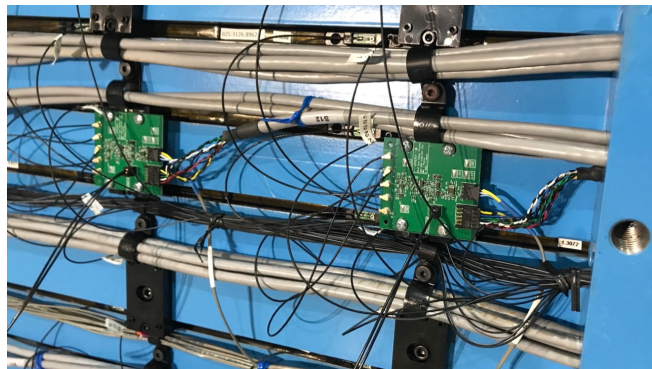
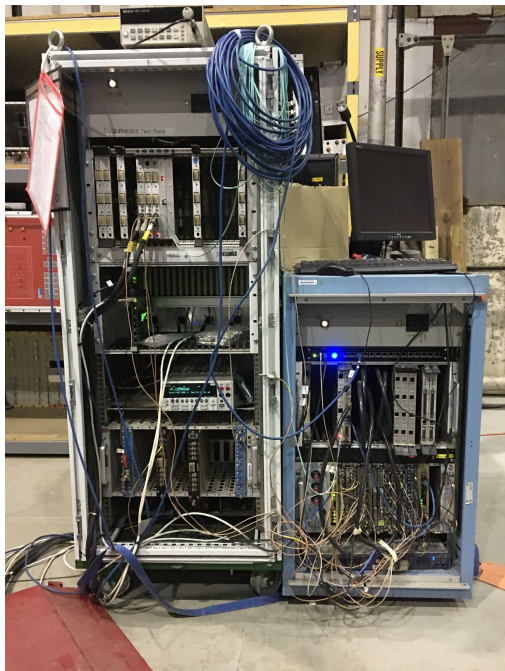
- EMCAL, OHCAL, and (when it begins) IHCAL are tested with production electronics
 - SiPM boards, preamps, interface boards, control boards
 - DAQ via Data Collection Module (DCM), logged directly to local disk
 - Some exceptions to the rule due to availability of electronics (production digitizers not used in OHCAL testing, e.g., therefore earlier generation DCM's)



EMCAL testing



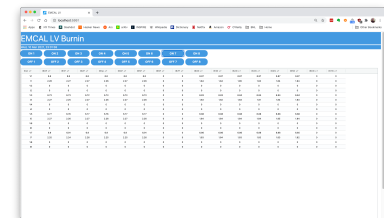
OHCAL Sector testing



OHCAL tested with
Test Pulse, LED pulser,
self-triggered cosmics

Burn-in of calorimeters

- We plan to burn-in calorimeter electronics for 1-4 weeks to weed out infant mortality
 - **Power 8 sectors of EMCAL at once**
- We are using the production LV power supply and control rack for the EMCAL now, the HCAL one will go into service soon



- Working to power 1 sector (of 24) of TPC FEE now
 - **30 production TPC FEE cards (with SAMPA v5) smoke-tested**
- This will expand into the TPC slice test” in 1008
- TBD: burn-in testing here as well?



- MVTX testing is ongoing at Los Alamos and Oak Ridge, and a half-detector test is in preparation at LBNL; discussing feasibility of full system test at BNL in 2022
- INTT system testing at BNL ramping up as readout engineering ramps up

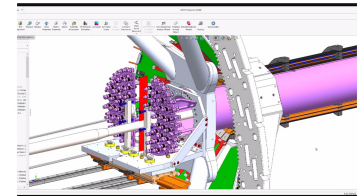
MVTX Half-Detector Test @LBNL

1. Test staves at each assembly step on the assembly jig, with MOSAIC setup
 - Noise/occupancy
 - Threshold
 - Dead pixels ...
2. Also after each layer assembled
 - Repeat tests from #1, MOSAIC
3. After the half-detector assembled
 - Final connectors & cables installed
 - Need the full readout for testing?

Test setup at LBNL:

- MOSAIC system
 - Individual Stave QA
 - Good for setup #1
- Small scale MVTX readout?
 - FELIX + RU + PU
 - use the final readout cables
 - Possible multiple stave readout
 - QA software and online monitoring

@PP3: power and signal connectors



4/1/21

MVTX Readout Weekly Meeting

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2. Installation commissioning

- As detector elements are delivered to 1008 and installed, they must be checked
- Only a very short period of testing is possible in order to maintain a reasonable installation schedule
- Natural for detector MIE groups to conduct these tests (possibly repeating pre-installation tests in 1008)
- Many parts of the detector cannot be tested with production electronics because the infrastructure is insufficiently complete
 - For example, the OHCAL has to be installed before there are racks on the carriage
- Power to the carriage in the Assembly Hall is not feasible—although technically possible, there is so little time between when the last sector of OHCAL goes in and the top platform is installed that we would have at best a few months of powered detector in the AH before the detector starts to move
 - Post-installation testing will have to take place with some temporary power feeds

- As sectors are installed, we envision either using portable test setups that have been built for EMCAL and HCAL construction, or moving test setups from factories shown on previous slides
- Temporary cabling will be used for this



- The TPC, INTT, and MVTX are planned to be fully tested as far as possible before arriving in 1008
 - **They are installed as a single unit into the detector, so must be ready to be cabled and tested when they arrive**
- We are working out the details of how much equipment we move to SBU for the TPC

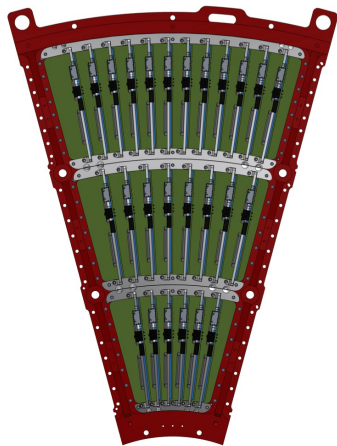
3. Post-installation commissioning



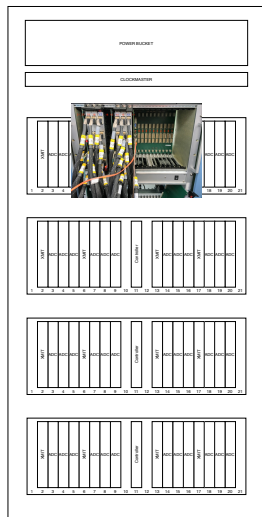
- As services (cabling, power, controls, DAQ, triggering) come online, installed components are energized and checked and debugged with production electronics and software
- As much as possible, detector groups, or even detector subgroups, should be able to work in parallel (i.e., EMCAL testing should be able to proceed while HCAL testing is taking place)
- Computing and networking will be approaching full operation in the rack room
- A lot of this work fell to the DAQ/electronics group in PHENIX and upgrades; a successful model is that the DAQ/electronics group trains users and the users go on to complete the full detector commissioning
- The PHENIX equivalent of “running standalone”
- This will occur after the detector is moved into the IR
- There are implications for safety for this kind of testing, since there will be energized components on the carriage
- Safety reviews and walkthroughs will have to be cleared to allow “limited operation”

- Production computers and interface boards are starting to arrive in 1008
 - **2 racks of SEB or EBDC for Calorimeters and TPC/INTT/MVTX readout**
 - **FELIX and JSEB boards**
 - **Buffer box for data storage**
 - **Network switch**
- These will be coupled with GL1/GTM (trigger and timing) for DAQ/Trigger development of 1/24 TPC, 1/16 EMCAL, others as possible
- Discussing now when we could test the MBD and trigger this summer/fall

Building blocks of commissioning



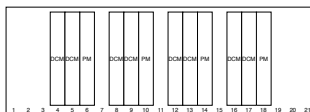
1/24 TPC FEE sectors



1/11 ADC Racks
(EMCAL, HCAL, MBD)

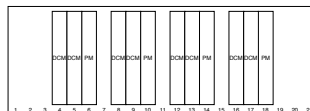


FELIX



EMCAL North

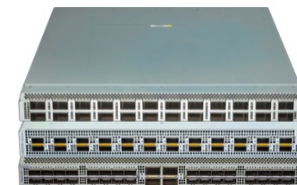
64 Slaves from XMIT groups



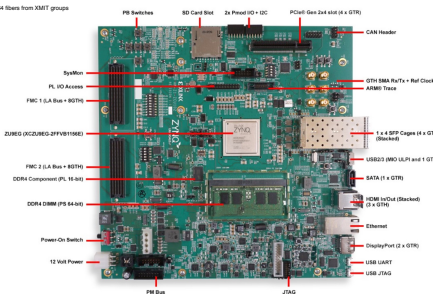
EMCAL South

64 Slaves from XMIT groups

1/4 DCM crate



Network to
Buffer Boxes



1 GL1GTM

- We have a plan for testing that will assure us that our detectors, electronics, data acquisition, and trigger will be ready for data at startup
- The sPHENIX collaboration has formed a Commissioning Task Force to ensure this happens