CMS Subproject QA Activities

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ESH&Q internal Review

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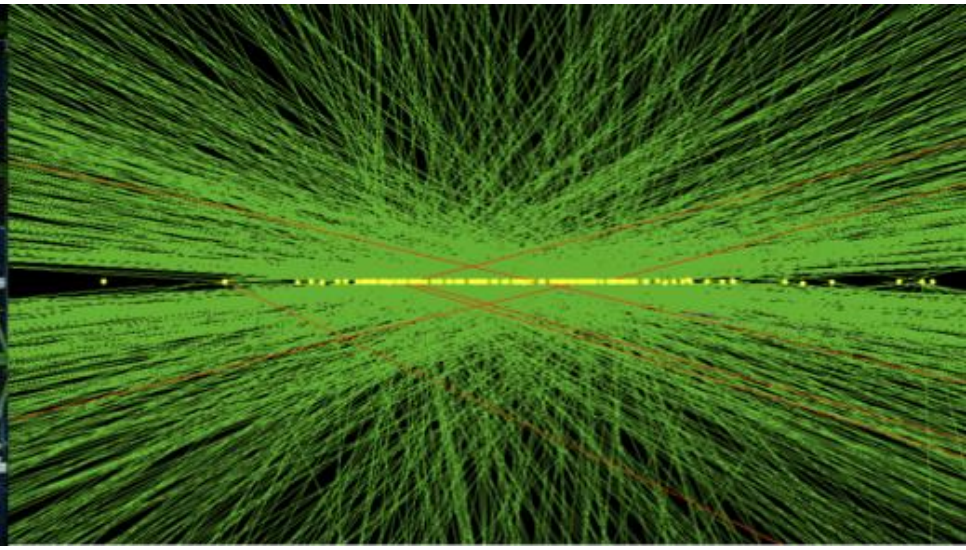

Outline - QA Activity Planning

- Biographical Sketch
- Goals
- Subproject QA Documents
  - Subproject QAP Appendices
  - Subproject QA Activities Spreadsheets
- Examples
- Completion Schedule
- Summary

Biographical Sketch

- Carol Wilkinson
  - Project Management Consultant for large scientific facilities
  - CMS Associate Project Manager (2017 – present)
  - Caltech Science Research Manager (2003 – 2017)
    - Advanced LIGO Project Manager (2003 -2013)
    - Visiting Facility Advisor with NSF Large Facilities Office (2013-2016)
  - Los Alamos Project Manager - Nuclear Weapons Hydrotesting Program (2002 – 2003)
  - Los Alamos Group Leader – DAHRT Accelerator Operations; and Project Manager– DAHRT Facility Construction (1999-2002)
  - Los Alamos Deputy Group Leader – DAHRT Accelerator Operations; and Deputy Project Manager– DAHRT Facility Construction(1998-1999)
  - Los Alamos LAMPF Team Leader - Beam Line and Accelerator Physics (1989-1998)
  - 25+ years of experience in managing the development, construction, and operations of large scientific facilities for DOE and NSF.
  - Panelist with project management expertise for many external reviews of NSF and DOE construction projects

Goals

QA Activities for U.S. CMS ensure that its deliverables meet the approved CMS technical and scientific requirements.

- Every engineering and/or scientific requirement in the U.S. CMS subproject documents below should be validated and verified by a QA activity

  - 402.2 Outer Tracker Requirements and Interfaces, CMS Document 13388
  - 402.3 Barrel Calorimeter Requirements and Interfaces, CMS Document 13317
  - 402.4 Calorimeter Endcap Requirements and Interfaces, CMS Document 13447
  - 402.5 Endcap Muons Requirements and Interfaces, CMS Document 13281
  - 402.6 Trigger and DAQ Requirements and Interfaces, CMS Document 13318
  - 402.7 Forward Pixels Requirements and Interfaces, CMS Document 13304
  - 402.8 MIP Timing Detector – Requirements and Interfaces, CMS-doc-13536

Subproject QAP Appendix

- Summary level description of QA plans highlighting details specific to each subproject
  - Description of scope => type of deliverables
  - Organization, CMS interactions, Participating institutions
  - Summary of QA activities for development and production
  - Documentation management
- Helpful introductions to subproject
- Not expected to change significantly once written

QA Appendices Status

- All 4 DOE appendices have been drafted and posted
  - Outer Tracker - ready for review
  - Trigger/DAQ - ready for review
  - MIP Timing Detector - first draft posted
  - Endcap Calorimeter – first draft posted

QA Activities Spreadsheets

- Titles and summary descriptions
- Assigned responsibilities/contacts
- Links to technical engineering and/or scientific requirements
  - Some activities and technical requirements still being finalized
- References to procedures, related hardware, training, calibration
- Working documents expected to evolve and mature over time
- Ultimate goal to combine with subproject technical requirements to complete science flowdown

QA Activities Documentation Status

- Current work focused on DOE subprojects, to be followed by NSF subprojects
- All 4 DOE subprojects have posted QA Activities spreadsheets
  - Outer Tracker (DOE) - mature
  - Trigger/DAQ (joint funding DOE and NSF) - mature
  - Endcap Calorimeter – preliminary (still adding references to tech reqs)
  - MIP Timing Layer - preliminary, without references to reqs (undergoing internal review)

Example 1: Outer Tracker Appendix

- Scope: Procurement, assembly, and performance testing of silicon sensor modules; integration into larger assemblies and testing
- U.S. one of 11 entities producing these modules; common assembly and testing procedures controlled by CMS
  - U.S. strong participant in determining procedures
  - Independently manages its work while meeting requirements
- Nine participating U.S. institutions
  - Strong history of CMS work
- QA activities: design validation, production process control, QC inspections, performance and acceptance testing

Example 1: OT QA Spreadsheet

- QA activity identification and responsibility

QA Activities List							Pick appropriate activities	
WBS	**WBS Title**	**L2, L3, L4 Lead**	**Sub-Project/Sub-component**	**Institution/ Work Area**	**QA Coordinator/ Contact**	**Quality Control or Assurance Activity/ Parameter**	**Validation / Verification Activities**	**Inspection / Acceptance Test Activities**
402.02.3-7	OT Technical WBS	Multiple	Global Tracker Construction Database	iCMS OT institutes	iCMS	Process Control	Database will be programmed to test and only accept valid input	
402.02.05.01	Module Assembly Sites	L. Spiegel, M. Narain	Local Tracker Construction Database	FNAL/East Coast	L3s	Process Control	Database will be programmed to test and only accept valid input	
402.02.03	Sensors	U. Heintz	Sensor QC development	Brown, Rochester	Hinton / Korjevenski	Measurement		Testing small sample of sensors from each delivered batch
402.02.03	Sensors	U. Heintz	Process QC Development	Brown, Rochester	Hinton / Korjevenski	Measurement		Testing test structures incorporated into the sensors wafers (flutes) to verify consistency of each sensor batch
402.02.03	Sensors	U. Heintz	Neutron Irradiation	Brown	Heintz	Measurement		Sample of sensors irradiated with neutrons to verify radiation tolerance
402.02.03	Sensors	U. Heintz	Proton Irradiation	FNAL	Merkel	Measurement		Sample of sensors irradiated with protons to verify radiation tolerance

Example 1: OT QA Spreadsheet (cont.)

- References to Technical Requirements

QA Activities List

WBS	WBS Title	L2, L3, L4 Lead	Sub-Project/Sub-component	Institution/ Work Area	Requirements/ Specifications	Requirement ID	Requirement Title	Measurement/ Method
402.02.3-7	OT Technical WBS	Multiple	Global Tracker Construction Database	iCMS OT institutes	CMS DocDb Ref # 13680	OT-eng-29, OT-eng-38	PS/2S Module Assembly	All technical metrics and performance results are captured in a global database used by all proponents of the international Outer Tracker project, for all electronic and mechanical detector components and composite assemblies
402.02.05.01	Module Assembly Sites	L. Spiegel, M. Narain	Local Tracker Construction Database	FNAL/East Coast	Must maintain compatibility with global DB	OT-eng-29, OT-eng-38	PS/2S Module Assembly	Specific to the U.S., the module assembly sites will also utilize a local database to capture metrics and performance results, insuring continuous production during global database outages
402.02.03	Sensors	U. Heintz	Sensor QC development	Brown, Rochester	CMS DocDb Ref # 13384, 13388	OT-eng-048, OT-eng-52, OT-eng-56	PS-p/PS-s/2S Sensor Layout	Sensor QC consists of a suite of tests on sensors done on a small fraction of sensors per wafer, to sample the sensor quality per wafer and verify sensor quality throughout production
402.02.03	Sensors	U. Heintz	Process QC Development	Brown, Rochester	CMS DocDb Ref # 13384, 13389	OT-eng-048, OT-eng-52, OT-eng-56	PS-p/PS-s/2S Sensor Layout	Process QC consists of a suite of more incisive and potentially destructive tests done on test structures included in the sensor wafer mask, to verify wafer quality/consistency throughout production
402.02.03	Sensors	U. Heintz	Neutron Irradiation	Brown	CMS DocDb Ref # 13384, 13390	OT-eng-008, OT-eng-028, OT-eng-37, OT-eng-045	PS/2S/MaPSA Radiation Tolerance	Neutron Irradiation and evaluation is carried out on a subset of sensors per batch to ensure radiation tolerance throughout production
402.02.03	Sensors	U. Heintz	Proton Irradiation	FNAL	CMS DocDb Ref # 13384, 13391	OT-eng-028, OT-eng-37, OT-eng-045	OT/PS/2S/MaPSA Radiation Tolerance	Proton Irradiation and evaluation is carried out on a subset of sensors per batch to ensure radiation tolerance throughout production

Example 1: OT QA Spreadsheet (cont.)

- Associated activities

QA Activities List

WBS	WBS Title	L2, L3, L4 Lead	Sub-Project/Sub-component	Institution/ Work Area	Measurement/ Method	Associated Hardware/ Software	Standard / Procedure / Process Doc	Calibration Planning	Record (Data, Calibration, etc.)	Training and Qualifications
402.02.3-7	OT Technical WBS	Multiple	Global Tracker Construction Database	iCMS OT institutes	All technical metrics and performance results are captured in a global database used by all proponents of the international Outer Tracker project, for all electronic and mechanical detector components and composite assemblies	Database Interface software	TBD	Not Needed	Physical dimensions, Electrical and/or Thermal parameters, Pedestal and Noise	Minor introduction to DB interface
402.02.05.01	Module Assembly Sites	L. Spiegel, M. Narain	Local Tracker Construction Database	FNAL/East Coast	Specific to the U.S., the module assembly sites will also utilize a local database to capture metrics and performance results, insuring continuous production during global database outages	Database Interface software, local DB implementation	TBD	Not Needed	Physical dimensions, Electrical and/or Thermal parameters, Pedestal and Noise	Minor introduction to DB interface
402.02.03	Sensors	U. Heintz	Sensor QC development	Brown, Rochester	Sensor QC consists of a suite of tests on sensors done on a small fraction of sensors per wafer, to sample the sensor quality per wafer and verify sensor quality throughout production	Test Hardware and control software	Sensor and Sensor QC specifications	Periodic calibration with known standard candle, cross-calibration between sites	Test results stored in database, available through etraveler	Training on Sensor QC probe station and control software
402.02.03	Sensors	U. Heintz	Process QC Development	Brown, Rochester	Process QC consists of a suite of more incisive and potentially destructive tests done on test structures included in the sensor wafer mask, to verify wafer quality/consistency throughout production	Test Hardware and control software	Process QC intro Update	Periodic calibration with known standard candle, cross-calibration between sites	Test results stored in database, available through etraveler	Training on Process QC probe station and control software
402.02.03	Sensors	U. Heintz	Neutron Irradiation	Brown	Neutron Irradiation and evaluation is carried out on a subset of sensors per batch to ensure radiation tolerance throughout production	Access to RINSC, post-irradation Sensor/Process QC tests		Neutron Flux and Energy spectrum calibrated periodically	Test results stored in database, available through etraveler	Irradiation done professionally, evaluation as above
402.02.03	Sensors	U. Heintz	Proton Irradiation	FNAL	Proton Irradiation and evaluation is carried out on a subset of sensors per batch to ensure radiation tolerance throughout production	FNAL ITA, post-irradiation testing			Test results stored in database, available through etraveler	Irradiation done professionally, evaluation as above

Example 2: Trigger/DAQ Appendix

- Design, production, and performance testing of trigger electronics and DAQ hardware and firmware
- Primary responsibility for deliverables, but with tight interfaces to entities responsible for trigger inputs and outputs
  - Independently manages its work while meeting requirements
  - Jointly funded by NSF and DOE
- Ten participating DOE institutions and six NSF
  - Strong history of CMS work
- QA activities: vendor/assembler pre-qualification, QC inspections, integrated testing using simulated data and demonstrators

Example 2: Trigger/DAQ QA Spreadsheet

- Different spreadsheet approach: assign QA activity to each technical requirement
  - Anticipates Flowdown from tech requirements to QA
  - Creates redundancies for QA plans addressing multiple reqs
  - Provides verification that each requirement has QA

Ex 2: Trigger/DAQ QA Spreadsheet (cont.)

- QA activity and technical requirements

WBS	WBS Title	L2, L3, L4 Lead	Institution/ Work Area	QA Coordinator/ Contact	Requirements/ Specifications	Requirement ID	Requirement Title	Sub-Project/Sub-component	Quality Control or Assurance Activity/ Parameter	Validation / Verification, Inspection / Acceptance Test, Measurement/ Methods, Activities
402.06	Trigger/DAQ	Jeff Berryhill (FNAL), Richard Cavanaugh (UIC, Deputy), Keith Ulmer (CU, Deputy)	Colorado, Fermilab, Florida, Wisconsin	Robert Glein (CU), Ryan Rivera (FNAL), Alex Madorski, (UF), Tom Gorski (UW)	CMS DocDB Ref # 13318, 13431	Trig-engr-001	Trigger/DAQ System Integration	All hardware, firmware, and software	Measurement/ Testing	Verification will be performed using the APT board itself, which has on-board quality control tests. Successful prototype testing will assist in ensuring a successful production test.
402.06	Trigger/DAQ	Jeff Berryhill (FNAL), Richard Cavanaugh (UIC, Deputy), Keith Ulmer (CU, Deputy)	Florida, Wisconsin	Alex Madorski, (UF), Tom Gorski (UW)	CMS DocDB Ref # 13318, 13431	Trig-engr-002	Trigger/DAQ Fiber Data Rate	Optical Links on Advanced Processor Trigger Board	Measurement/ Testing	Link speed measurement tests will include loopback tests and tests between boards that meet the required interface specifications.
402.06	Trigger/DAQ	Jeff Berryhill (FNAL), Richard Cavanaugh (UIC, Deputy), Keith Ulmer (CU, Deputy)	Colorado, Fermilab, Florida, Wisconsin	Robert Glein (CU), Ryan Rivera (FNAL), Alex Madorski, (UF), Tom Gorski (UW)	CMS DocDB Ref # 13318, 13431	Trig-engr-003	Trigger Latency	All hardware, firmware, and software	Design Verification and Measurement/ Testing	Verification that the Trigger Latency fits within the allocated budget will be performed by summing unit estimates of individual processes, followed by vertical slice tests involving multiple boards, layers, and processes.
402.06	Trigger/DAQ	Jeff Berryhill (FNAL), Richard Cavanaugh (UIC, Deputy), Keith Ulmer (CU, Deputy)	Colorado, Fermilab, Florida, Wisconsin	Robert Glein (CU), Ryan Rivera (FNAL), Alex Madorski, (UF), Tom Gorski (UW)	CMS DocDB Ref # 13318, 13431	Trig-engr-004	Trigger Algorithm L1A Rate	All hardware, firmware, and software	Measurement/ Testing	Verification that the trigger accept rate meets the target rate involves producing a trigger menu and testing it using simulations.
402.06	Trigger/DAQ	Jeff Berryhill (FNAL), Richard Cavanaugh (UIC, Deputy), Keith Ulmer (CU, Deputy)	Wisconsin	Tom Gorski (UW)	CMS DocDB Ref # 13318, 13431	Trig-engr-005	Trigger Processor System Architecture Compatibility	Advanced Processor Trigger Board	Design Verification	Verification that the Advanced Processor Trigger boards follow the ATCA standard will be conducted via a design review

Schedule for Work in Progress

Director's Review in Feb 2019; CD-1 in April 2019

- Complete appendices and activity spreadsheets for all DOE QA subprojects (Dec)
  - Finish Endcap Cal and Timing Layer documents
  - Standardize formats for all QA Activity sheets
- Create DOE Technical Requirements Flowdown to QA activities (Dec - Feb)
  - Add references to QA activity IDs in Technical Requirements
  - Verify all requirements are matched by QA activity
- Address recommendations and comments from this committee (Dec - Feb)
- Add NSF QA appendices and activities (TBD)

Summary for Subproject QA Activities

- The process for capturing and documenting U.S. subproject QA activities is known.
- Implementation is underway but not complete
  - QAP appendices are posted; two of the 4 are first drafts
  - QA activities spreadsheets are posted; two are still adding references to technical requirements
  - Need standardized format for QA activity spreadsheets
  - QA plans will need to evolve as design work progresses
- Final step of incorporation into Technical Requirements spreadsheet with Flowdown needs to be implemented
- Expect to be ready for review in Feb and April 2019