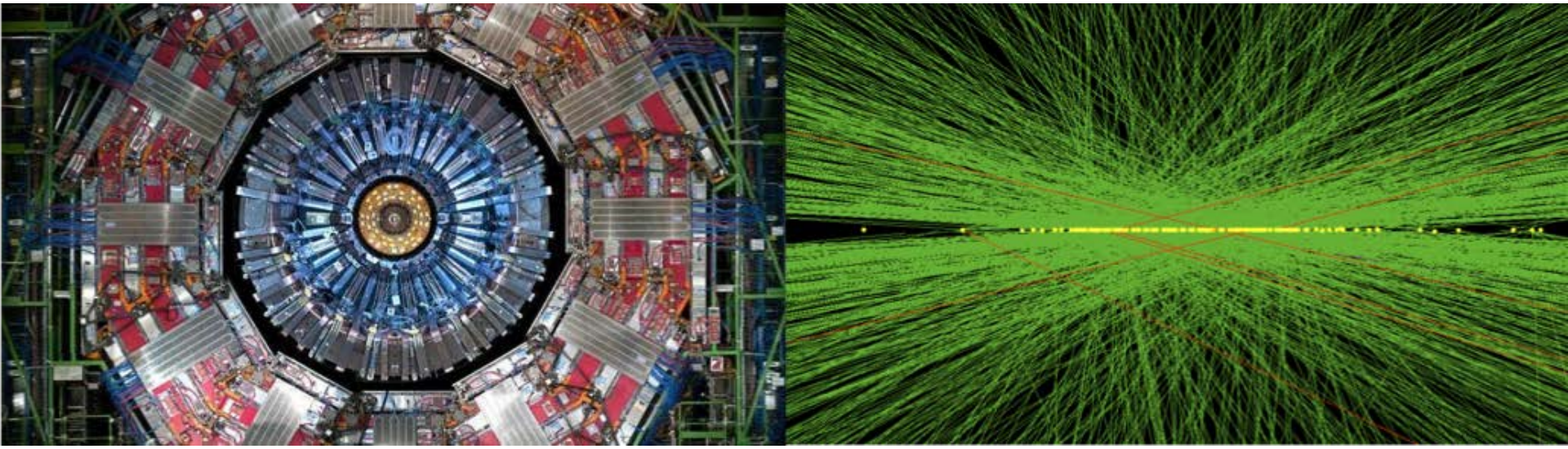
B05: Quality Assurance Implementation and Response to Previous Reviews

T.J. Sarlina, HL-LHC CMS ESH&Q Coordinator

CD-1 Director's Review

March 19-21, 2019



Outline

- Presentation will include:
  - Biographical Sketch
  - Response to Previous Recommendations
  - CMS Collaboration QA Program
  - QA Plan Overview
    - International CMS Review & Approval
    - Roles & Responsibilities
    - U.S. CMS QA Program
  - Site Audits and Reports
  - Lessons Learned
    - Database for Projects

Biographical Sketch – T.J. Sarlina

- CMS Upgrade ESH&Q Coordinator
  - Assistant Radiation Safety Officer for Meson Department (1979-1982)
  - Senior Safety Officer for Research Division and Particle Physics Division (1982-2002)
  - Project Scheduler (2002-2008)
    - CDF Upgrade Project, DO Upgrade Project, Minerva, Dark Energy Camera
  - Project Manager at Fuel Tech, Inc. (2008-2010)
    - Air Pollution Control Projects (power plants and refineries) in Hong Kong, Guangzhou, Liaoning Province
    - Austin, TX and
    - Seattle, WA
  - Associate Project Manager for ESH and QA on NO*v*A (2010-2014)
    - Constructed and commissioned Near Detector at Fermilab and Far Detector in Ash River, MN
  - Fermilab Quality Assurance Manager (2014-2017)
    - Transitioned the Fermilab QA Program from consultant led to internally owned
  - Fermilab Quality Assurance Specialist (2017-present)
    - Supporting the Fermilab QA Program under Jemila Adetunji, IERC QA Coordinator, CMS US HL-LHC ESHQ Coordinator

Response to June 2018 IPR

Charge #6 and #8

- #22 - Revise the ISM and QAP to accurately document the process for receipt, review, concurrence, coordination, and oversight of project specific plans and activities prior to the issuance of any contract instrument.
  - The QA Plan and associated documents have defined the process flow from international CMS to the U.S. participating institutions.
- #23 - Develop a clear plan for identification and documentation of codes, standards, requirements, and timing for inclusion.
  - CMS-doc-13717 has been developed to document the applicable codes and standards.

Response to Nov 2018 ESH&Q Review

Charge #6 and #8

- #1 - Develop a clear list of design codes and standards that are applicable to both the U.S. and CERN operations.
  - CMS-doc-13717 has been developed to document the applicable codes and standards.
- #2 - The QA Plan needs to address the packaging and shipping requirements for components to be sent to CERN.
  - QAP has been updated to include shipping requirements (Section 6.10).

CMS Collaboration Quality Assurance

- CERN has a formal review and approval process for all LHC experiments so the overall responsibility for CMS QA is held by CERN and the international CMS collaboration.
- The CMS Technical Coordinator – Austin Ball, appointed by CERN, holds overall responsibility for all CMS activities.
- U.S. QA processes are derived from international CMS QA processes and the Fermilab Quality Assurance Manual.
- Follows formal CERN/CMS review process to approve requirements, designs, activities, acceptance.

U.S. CMS Quality Assurance

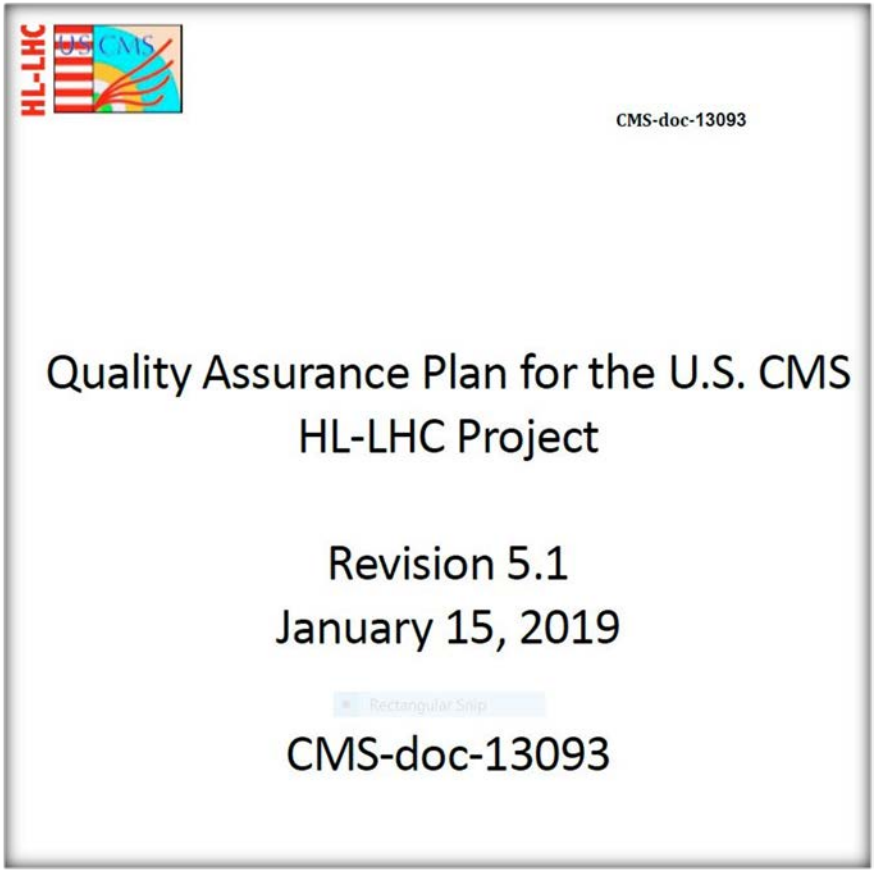
- QA is an integral part of the design, fabrication, and construction of the HL-LHC U.S. CMS Upgrade Project.
- All components and subproject deliverables must meet approved science, engineering, and programmatic requirements listed for each WBS Level 2 subproject.
- The QA Plan applies to all U.S. CMS Project activities funded and undertaken by the Department of Energy and the National Science Foundation.
- QAP is a controlled document and is approved & signed by the PM (DOE), Deputy PM (NSF), Fermilab Chief Project Officer, and CMS ESH&Q Coordinator.
- Each U.S. participating institution is responsible for the day-to-day QA practices relevant to their work.

U.S. CMS QA Program

- The primary goal of Quality Assurance for U.S. CMS deliverables is to ensure that the CMS experiment achieves the science requirements and goals listed in the document *Science Requirements for U.S. CMS HL-LHC* (CMS-doc-13337).
- Major components of the U.S. CMS QA Program are:
  - Quality Assurance Plan (CMS-doc-13093)
  - Subproject (L2) Quality Assurance Plan Appendix (overview)
  - Subproject (L2) QA Activities Spreadsheets (implementation)
  - Experienced, dedicated, and pro-active technical leads
  - Assigned ESH&Q Coordinator for U.S. CMS effort
  - QA oversight by CERN, CMS, and U.S. CMS management

Quality Assurance Plan

Charge #7



- Key Elements
  - Defines QA expectations from international CMS through Fermilab to U.S. participating institutions.
  - Assigns roles and responsibilities for QA oversight.
  - Outlines the work process controls and QA validation to achieve the stated science requirements.
  - Satisfies 413.3B requirements.
  - Applies to both DOE and NSF funded activities.

CERN-doc-13093

Quality Assurance Plan Overview

- Describes the QA requirements and processes for international CMS and CERN QA oversight as well as U.S. CMS QA oversight.
- General in nature due to differences in the type of deliverables for each subproject as well as the methods of interaction between subprojects.
- QA activities are tied to technical requirements and subproject details are described in the QA appendix and QA spreadsheets.
- Carol will go into more depth in her presentation.

QA Plan Section 4

- Highlights the international CMS review & approval
  - Determination of technical requirements
  - Design validation
  - Compliant with relevant codes and standards
  - Approval of QA activities and acceptance of components
- Approvals are scheduled at four stages of the project:
  - Stage 1 – Initial Design
  - Stage 2 – Baseline Design
  - Stage 3 – Final Design/Start of Construction
  - Stage 4 – Installation and Commissioning
- Each review & approval stage includes a QA component

CMS Project Reviews

- The formal approval process described in the *LHC Experiments Phase II Upgrades Approval Process* [CERN LHCC-2015-007] and referenced in the QAP.
- Standard technical or engineering design reviews, procurement readiness reviews, etc. provide QA during R&D and Preproduction activities.
- Standard acceptance reviews, such as production readiness reviews or installation readiness reviews provide QA during production and installation activities.
- Ad Hoc reviews may be called on an as-needed basis by the U.S. Project.

QA Plan Section 5

- Roles and Responsibilities for CMS, CERN, and U.S. personnel
- CMS Subdetector Leads (assigned by CMS)
  - Oversight and management of each integrated detector subsystem, including efforts from all contributors.
- CMS Subdetector QA Managers (assigned by CMS)
  - Coordinate QA processes across all collaborators
  - Define/approve procedures for each component or subassembly.
- U.S. CMS Project Manager
  - Project Manager has ultimate QA responsibility for U.S. scope.
- U.S. CMS Project Scientist
  - Coordinates QA planning of WBS Level 2, 3, and 4 Systems Engineers/Managers to ensure that the work at all participating institutions meets the Science and Technical Requirements

Roles and Responsibilities

- U.S. ESH&Q Coordinator
  - Provides planning support & review/surveillance of QA/QC activities at participating institutions.
  - Ensures QA planning and execution follows QAP.
  - Participates in surveillance reviews of work execution.
- U.S. CMS Level 2 Managers
  - Work with the ESH&Q Coordinator to review and approve the QA plans and monitor/verify compliance.
  - Ensure adherence to CMS requirements and approved procedures, subject to CMS review and approval process. This includes work under sub-awards to vendors or other participating institutions.
- U.S. CMS Subproject Leads (WBS L2, L3, L4)
  - Define/approve procedures for each component or subassembly.
  - Oversee day to day work
- QA contact at participating institutions
  - Responsible for QA/QC involving their scope of work and communication with Subproject leads.
  - Verify compatibility of QA plans to local institutional QA programs.

QA Plan Section 6

- Describes the U.S. QA efforts
  - Personnel Qualifications and Training
  - Meeting CMS Requirements and Quality Validation
  - Design & Production Work Processes and Controls
  - Software Quality Assurance Guidelines
  - Procurements (In line with institutional requirements)
  - Inspection and Acceptance Testing
  - Shipping Requirements
  - Issue Tracking via Fermilab iTrack program
  - Documents and Records
  - Technical and Management Assessments
  - Control of Suspect/Counterfeit Items (S/CI)

Site Field Audit Checklist

- Site Visit Audit Checklist (where work is being performed) - [CMS-doc-13668]

US-HL-CMS Quality Assurance Audit Field Checklist

WBS X.X.X *Date:*

Contacts: *Location:*

1.	**Material/Component Receipt and Shipment**	**Yes**	**No**	**N/A**
	Have acceptance criteria been defined by the organization?			
	Are the criteria written down, approved, and entered into a database?			
	Did the criteria change over time with documentation entered into a database?			
	If changes have occurred, have they been approved by appropriate authority?			
	Is data transmitted from last organization in a timely way and is it useful?			
	Do written procedures exist and are they followed?			
	Are personnel properly trained to conduct acceptance checks?			
	Are the results being documented in a consistent manner?			
	Are test results entered into a database?			
	Is all measuring and test equipment properly calibrated?			
	Are components stored in secure/segregated locations to prevent damage or loss?			
	Have shipping requirements been defined to prevent damage during transport?			
2.	**Quarantine of Deficient or Non-Conforming Product**	**Yes**	**No**	**N/A**
	Are storage areas properly identified?			
	Is product labeling clearly visible and consistent?			
	Have non-conformance procedures been written and approved?			
3.	**Personnel Training**	**Yes**	**No**	**N/A**
	Do current, written procedures exist for each process?			
	Do posted instructions agree with authorized, written procedures?			
	Is there a process for informing or re-training workers when procedures change?			
	Are procedural changes reviewed for impact on the final product?			
4.	**Acceptance Criteria For Finished Product**	**Yes**	**No**	**N/A**
	Have acceptance criteria been defined by the organization?			
	Are the criteria written down, approved, and entered into a database?			
	Have updated acceptance specs been approved and documented in a database?			
	Have shipping requirements been defined to prevent damage during transport?			
5.	**Records, Logs, and Databases**	**Yes**	**No**	**N/A**
	Have standard forms/spreadsheets been created to record data?			

US HL CMS QA Audit Report for WBS X.X.X – (Insert WBS Name)
Level 2 Manager – (Insert Name
(Date)

BACKGROUND:

The U.S. HL CMS Project Office conducts internal QA audits on operations related to construction of the experiment to ensure acceptance criteria have been defined and documentation is up to date. This WBS Section X.X.X audit, conducted by (Insert Names), examined operations at (Insert Facility) in (Insert Location) and (Any other locations if necessary).

FINDINGS AND OBSERVATIONS:

Section I - Material/Component Receipt, Testing, and Shipment

1. Detail findings from field checklist and tie to specific Recommendations at the end of this document. (See Recommendation #X)
2. List Best Practices as appropriate.

Section II - Quarantine of Deficient or Non-Conforming Product

1. Detail findings from field checklist and tie to specific Recommendations at the end of this document. (See Recommendation #X)
2. List Best Practices as appropriate.

Section III - Personnel Training/Operational Procedures

1. Detail findings from field checklist and tie to specific Recommendations at the end of this document. (See Recommendation #X)
2. List Best Practices as appropriate.

Site Audit Checklist Topics

- Material/Component Receipt and Shipment
- Quarantine of Deficient or Non-Conforming Product
- Personnel Training
- Acceptance Criteria for Finished Product
- Records, Logs, and Databases
- Information Flow Between Facilities
- Trend Analysis
- Preventing Problem Recurrence

Site Audits

WBS #	WBS Description	Facilities
402.02.03	Outer Tracker: Sensors	Brown, Rochester, Fermilab
402.02.04	Outer Tracker: Electronics	Fermilab, Princeton, Rutgers
402.02.05	Outer Tracker: Modules	Brown, Fermilab, Princeton, , Rutgers
402.02.06	Outer Tracker: Flat Barrel Mechanics	Fermilab
402.02.07	Outer Tracker: Integration	Fermilab
402.04.03	Calorimeter Endcap: Sensors	Brown, Fermilab, Texas Tech, FSU
402.04.04	Calorimeter Endcap: Modules	Carnegie Mellon, Texas Tech, UC Santa Barbara
402.04.05	Calorimeter Endcap: Cassettes	Fermilab, Minnesota
402.04.06	Calorimeter Endcap: Scintillator Caorimetry	Fermilab, FSU, Maryland, NIU, Rochester
402.04.07	Calorimeter Endcap: Electronics and Services	Fermilab, Minnesota
402.06.03	Trigger / DAQ: Cal Trigger	Wisconsin
402.06.05	Trigger / DAQ: Correlator Trigger	Wisconsin
402.06.06	Trigger / DAQ: DAQ	Fermilab
402.08.03	Timing Layer: Barrel Timing Layer	Virginia, Caltech, KSU
402.08.04	Timing Layer: Endcap Timing Layer	Fermilab, Nebraska, Kansas

Table 2: Major work or assembly sites for the U.S. CMS HL-LHC detector upgrade project.

Lessons Learned - Projects

Organization > Office of the Chief Operations Officer > IPPM

Strategic Planning Database + | Risk Management + | Annual Lab Plan +

Lessons Learned

Edit	LL-ID	Title of lesson
⊞ **Project :** (22)		
⊟ **Project : CMS Upgrades Phase 1 -- Project 401** (50)		
⊞ Review : CD23 (39)		
⊞ Review : Institutional Review (1)		
⊞ Review : OTHER (10)		
⊞ **Project : IPPM** (1)		
⊞ **Project : LBNF / DUNE -- Project 131** (2)		
⊞ **Project : NOvA -- Project 425** (35)		
⊞ **Project : SLI-UUP -- Project 600** (23)		
⊞ **Project : US ATLAS / CMS / LHC Construction** (17)		

Lessons Learned - CMS

Edit	LL-ID	Title of lesson
⊞	**Project : (22)**	
⊟	**Project : CMS Upgrades Phase 1 -- Project 401 (50)**	
⊞	Review : CD23 (39)	
⊞	Review : Institutional Review (1)	
⊟	Review : OTHER (10)	
☑	401-L-OTHER-01	Shipments between institutions collaborating on the project and vendors
	401-L-OTHER-08	Shipping to Brazil
	401-L-OTHER-02	Embedded processors in Trigger Hardware
	401-L-OTHER-03	Estimation of Programming Resources
	401-L-OTHER-05	Baseline Dates and free float
	401-L-OTHER-04	Allow planning packages for work in the far future
	401-L-OTHER-06	Lab resources and resource leveling
	401-L-OTHER-07	University labor and Standing Army costs
	401-L-OTHER-09	Smooth Management Transitions
	401-L-OTHER-10	Funding delays

Summary

- A comprehensive QA Plan exists that meets the requirements of DOE Order 413.3B.
- Quality Assurance resources have been assigned with defined roles and responsibilities.
- We have established the hierarchy of Quality Assurance controls from CERN/CMS through Fermilab to participating U.S. institutions.
- We have addressed the comments from the previous reviews.
- Ready to proceed to CD-1.

Back-up Slides

QAP Subproject Appendix

The QAP appendix contains high level descriptions of each L2 U.S. CMS subproject, including:

- Short description of the types of deliverables (designs, hardware, software, test results, etc.)
- Subdetector organization and communication methods within CMS and U.S. CMS
- Short description of the types of QA activities (electronic prototyping, simulations or other modeling, material testing, procurement, assembly, QC, performance testing, etc.)
- List of participating institutions
- Management of non-conforming parts
- Document and Record keeping

QA Project Reviews

*The following steps are required for **each** CMS subdetector in the Upgrade:*

- *Step 1: Initial Design*
  - review overall scope and cost for the entire upgrade program for each experiment, retaining the possibility for different options which may depend on technical issues and/or on funding availability. Approve readiness to proceed to Step 2. Step 1 is documented in the CMS Upgrade Technical Proposal [Ref-7] and Scope Documents [Ref-8].
- *Step 2: Baseline Design*
  - **review and approve Technical Design Reports** and QA plans for each subdetector. This documents the baseline scope, cost and schedule for the subsequent change control process.
- *Step 3: Final Design / Start of Construction*
  - **review and approve the final design** and the production of the major detector components, verifying that they meet the requirements and are compatible with the installation plan. Establish follow-up reviews/approvals for installation readiness.
- *Step 4: Installation and Commissioning*
  - review and approve the installation and commissioning of the major detector components. Evaluate the capability of the integrated detectors to provide the expected performance. Review and approve readiness for operations.

*Each of these steps **includes review/approval at the CMS level, followed by review/approval by CERN LHCC/UCG and RB.***

CERN/CMS Roles & Responsibilities

- CERN LHCC/UCG
  - Approve plans for QA as part of Step 2 baseline design approval and at Step 3 for detailed implementation approval.
- CMS TC and Electronics Coordination (EC) Leads
  - Keep up-to-date drawings and ensure inter-compatibility between CMS subcomponents and LHC infrastructure.
  - Participate in planning/coordination of QA activities and metrics.
  - Call for reviews of all subprojects leading to Step 3
  - Maintain technical documentation in the CMS EDMS or DocDB document systems, including specifications and QA procedures.
- CMS Upgrade Coordination Lead
  - Calls for and conduct the CMS internal reviews leading to Step 2
  - Works with the CMS TC for reviews leading to Step 3.

CMS Associate PM – Carol Wilkinson

- Project Management Consultant for large scientific facilities
  - 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
- 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)

CMS QA Oversight

- CERN LHCC/UCG
  - Responsible for approving plans for QA as part of Step 2 baseline design approval and at Step 3 for detailed implementation approval.
- CMS Upgrade Coordination Lead
  - Responsible for calling for and conducting the CMS internal reviews leading to Step 2 and working with the CMS Technical Coordinator for reviews leading to Step 3.
- CMS Subdetector Leads
  - Responsible for oversight and management of their integrated detector subsystems, which include efforts from all participating contributors.
- CMS Subdetector QA Manager
  - Responsible for coordinating QA processes across all participating institutions for that subdetector.
  - Responsible for defining or approving test procedures for each component or subassembly and the use of a common data-base and tracking tools to ensure selection/matching of components in the final assembly and to allow correlation between operational performance and the history of components in the construction process.

CMS QA Oversight

- CMS Technical Coordination and Electronics Coordination Leads
  - Responsible for providing technical oversight and coordination of all parts of the detector.
  - Keeping up-to-date drawings and ensuring overall inter-compatibility between CMS subcomponents and LHC infrastructure.
  - Participating in planning of QA activities and metrics
  - Calling for reviews of all subprojects during design, after final designs, before production, before installation, and before operations (EDR, PRR, IRR, ORR
  - Coordinating CMS subprojects points of contact to CMS Technical and Electronics Coordination
  - Maintaining technical documentation in the CMS EDMS document system, including specifications and QA procedures

US CMS Project Scientist

- Developing Technical Requirements using the Science Flow Downs, working with the L2 and L3 Managers
- Supporting planning and providing review of the Quality Tests and Inspections developed by the WBS Level 2, 3, & 4 Systems Engineers/Managers, as identified in the CMS reviewed and approved Technical Requirements
- With the QA Coordinator, coordinating the Quality Assurance planning of WBS Level 2, 3, and 4 Systems Engineers/Managers to ensure that the work at all participating institutions meets the Science and Technical Requirements

US CMS ESHQ Coordinator

- Develops the U.S. CMS QA Plan. Reviews the QAP and updates the Plan as necessary or at least once a year;
- With the Project Scientist, coordinates the QA planning of WBS Level 2, 3, and 4 Systems Engineers/Managers to ensure that the work meets science objectives and Technical Requirements;
- Provides planning support, review, and approval of the participating institutions' QA plans/procedures developed by WBS Level 2, 3, and 4 Systems Engineers/Managers, including site visits as necessary;
- Participates in surveillance reviews of work execution to ensure that the QA plans/procedures are followed;
- Provides training and coaching in QA practice for Project Office and WBS Level managers, as needed;
- Tracks the U.S. Quality Assurance efforts, ensures proper documentation, and facilitates integration with overall CMS.

US CMS Subproject L2 Managers

- Working with CMS subproject leads, the Upgrade Coordination, Technical Coordination, and Electronics Coordination Leads to provide integrated QA for the U.S. scope
- Developing their Level 2 System's Quality Assurance programs per the graded approach in this Plan, working with the U.S. QA Coordinator and participating U.S. institutions as appropriate
- Overseeing Level 3 and 4 QA planning and execution to ensure that it follows their QA plans/procedures and meets science objectives and Technical Requirements
- With the QA Coordinator, providing review and approval of the Quality Assurance planning and execution of work at all participating institutions, including site visits, to ensure that it meets science objectives and Technical Requirements
- Promptly notifying Project Managers, Project Scientist and Project Engineer of proposed or potential changes to Technical Requirements Acceptance Methods

US CMS Subproject L3, L4 Managers

- Developing their System's Quality Assurance programs per the graded approach in this Plan, working with the Level 2 Managers and the participating institutions and QA Coordinator as appropriate
- Overseeing execution of work at all participating institutions to ensure that it follows the QA plans/procedures and meets science objectives and Technical Requirements
- Promptly notifying Level 2 Managers of proposed or potential changes to Technical Requirements Acceptance Methods

Codes and Standards

CMS-doc-13717

Codes and Standards for the HL-LHC CMS Project

CMS-doc- 13717

CMS-doc-13717

1 Introduction and Purpose

The purpose of this document is to identify the codes and standards, and their equivalence, between CERN, where the CMS HL-LHC upgrades will be installed, and the U.S, where the U.S. Project deliverables will be built. All of the upgrade materials built in the U.S. will ultimately be installed in the CMS detector located in the underground area at the LHC Point 5 in Cessy, France. CERN generally follows all European Union regulations except where explicitly stated. All CMS upgrade detector components that will be installed in the CMS detector must be CERN compliant, and additionally components which remain in the U.S., or are tested in the U.S., must also be compliant with U.S. Codes and Standards.