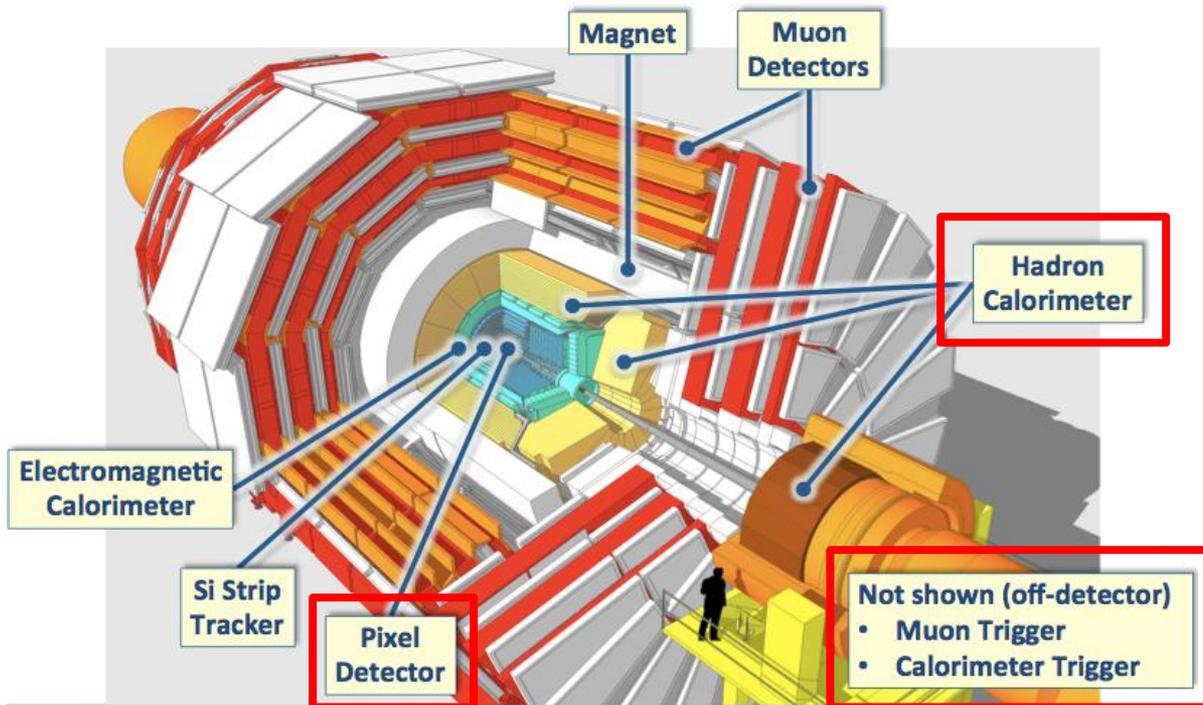


DOE IPR

LHC CMS Upgrade Project



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Outline

- Purpose and Scope
- WBS
- Completion Definition (KPP's)
- Schedule
- Cost and Funding
- ES&H
- Project Status
- Conclusions

Purpose and Scope

Purpose:

- Install detector upgrades by the end of operational shutdown in 2019
- Enable CMS to exploit the physics opportunities afforded by these machine upgrades
- Provide at least 3 to 4 years of operation at much higher luminosity than original CMS design

Project Scope:

- Hadron Calorimeter (HCAL): Replacement of hybrid-photodiode detectors in the Barrel and Endcap with silicon photomultipliers, readout electronics to increase bandwidth, off-detector electronics for higher bandwidth and improved trigger information
- Forward Pixel detector (FPiX): Two endcap pixel detectors, each consisting of modules of 100 mm x 150 mm pixels, organized into 6 half-disks, housed in 2 half-cylinders
- Trigger (TRIG): Layer-1 of the upgrade Calorimeter Trigger, Endcap Muon Trigger

Work Breakdown Structure

WBS#	WBS NAME
401	Large Hadron Collider (LHC) Compact Muon Solenoid (CMS) Detector Upgrade Project
401.01	Project Management
401.01.01	Project Milestones and Interfaces
401.01.02	Project Management and Administration
401.01.03	Project Controls and Finance
401.01.04	Project Office Support
401.02	Hadron Calorimeter (HCAL)
401.02.01	HCAL Milestones and Interfaces
401.02.02	HCAL Management
401.02.03	HF Frontend
401.02.04	HB/HE Frontend
401.02.05	HCAL Backend
401.03	Forward Pixel Detector (FPIX)
401.03.01	FPIX Milestones and Interfaces
401.03.02	FPIX Management
401.03.03	FPIX Components
401.03.04	FPIX Assembly and Testing
401.03.05	FPIX Pilot System
401.04	Trigger
401.04.01	Trigger Milestones and Interfaces
401.04.02	Trigger Management
401.04.03	Muon Trigger
401.04.04	Calorimeter Trigger

Key Performance Parameters

HCAL

Threshold KPP- defined to de-couple from CERN LHC Shutdown schedule

- Produce HCAL Front and Back end Electronics
- Install Back End electronics and connect to Calorimeter Trigger
- Test stand integration of HCAL electronics to demonstrate readiness for install

Objective KPP- Complete installation only if Shutdown schedule allows

- Complete installation and checkout of HCAL Front End electronics in the CMS Detector
- Integration of the HCAL Back End electronics with the CMS data acquisition system

Key Performance Parameters(Cont.)

FPIX

Threshold KPP- Not dependent on CERN shutdown schedule

- Produce 4 half cylinders, each with 3 half disks
- Demonstrate read out in test stand at CERN
- Turn over to CMS Technical Coordination

Objective KPP

- Produce components for a spare half disk

Key Performance Parameters(Cont.)

Trigger

Threshold KPP- defined to meet physics objective

- Install Layer 1 of upgrade calorimeter and muon trigger
- Demonstrate 98% agreement between installed upgraded electronics at CERN and trigger emulation using test data patterns
- Factor of 2 reduction trigger rates for electrons, photons, muons, and taus from current system
- Less than 15% efficiency loss from current system
- Incorporate additional CSC chamber data into muon trigger logic

Objective KPP- improves possible reach of physics objective

- 99.5% agreement between installed upgraded electronics at CERN and trigger emulation using test data patterns
- Less than 10% efficiency loss to the present system

Cost and Funding

Project Funding Profile in Millions

Fiscal Year	2013	2014	2015	2016	2017	2018	2019	2020	Total
OPC - Design	1.50	6.75	3.75						12.00
TEC - MIE			3.75	9.50	8.00				21.25
Total DOE	1.50	6.75	7.50	9.50	8.00				33.25
NSF (June 15-June 14)*	0.45	3.50	4.50	1.20	2.00	0.30			11.95
Total	1.95	10.25	12.00	10.70	10.00	0.30	0.00	0.00	45.20

* Year 1 prespending from Jan 1

As of August 2015

	Percent Complete	Remaining Contingency	RC/ETC
DOE	55%	5,915,675	0.47
NSF	35%	2,112,949	0.40
Total	51%	8,028,624	0.47

Project Status

- 51 % complete
- HCAL: HCAL Backend installation is complete. HCAL Barrel/Endcap Front-end completed a successful test beam campaign in August, results will be used for the production readiness review.
- FPIX: Production is continuing smoothly for the most part. First 2 batches of sensors are in with a 95% yield, last 2 batches expected in January. Custom ASICs delivered and being diced, first bump bonded modules expected by end of October. Purdue has recovered from their flooding event and module assembly equipment has been recommissioned.

Project Status

- Trigger: Installation of major electronics complete, 2 level 2 milestones achieved. Some auxiliary component fabrication remain, main focus moved to running parallel to main CMS DAQ. L1 Calorimeter trigger ready for inclusion in CMS DAQ parasitically, Muon trigger expected to join next month.

Project Issues

- High Density Interconnect problem. There have been a series of flaws in fabrication making first deliveries unusable. Last batch of 200 only 25% met vendor specifications, of that 75% met project standards. Project is working with vendor to alter design for robustness, next batch of 800 will have 200 produced using a modified production process. Additionally two other vendors are being explored. One order for 50 HDI's and another order of 100 HDI's are underway from them.
 - Goal of installation during the 2015-1016 technical stop
 - FPIX installation not required for project completion
 - KPP just to build and deliver FPIX equipment
 - FPIX is not on critical path and has 1.3 years of float

Conclusion

Project is progressing well. Although it has run into some problems. Such as flooding of a manufacturing area at Purdue and production problems with the HDI's. The project has continued to move forward and apply appropriate solutions to these problems. Communication within the IPT is open and constructive.