POSTER #FERMILAB-POSTER-24-0179-STUDENT

Development of POTATO for 2S Module Grading for the CMS Phase-2 Outer Tracker Upgrade

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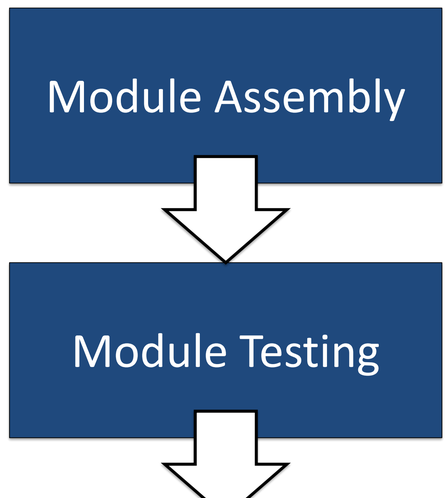
Abstract

Due to the High Luminosity-Large Hadron Collider (HL-LHC) upgrade, several detectors of the Compact Muon Solenoid (CMS) will need to be replaced, specifically the new Outer Tracker (OT) that will be assembled with 13,200 silicon modules. The OT is composed of two types of modules; the PS (pixel-strip) and the 2S (strip-strip) modules. With a large influx of production of modules, extensive testing is required to ensure quality of the modules. This research introduces POTATO (Phase-II Outer Tracker Analyzer of Test Outputs), a specialized software developed in C++ to analyze, grade, and store results in a centralized database. Module data will be collected from various international production facilities. The implementation of POTATO will facilitate with selecting the best performing modules for the Outer Tracker upgrade. This research is focused on the implementation of the analysis of 2S Module results within POTATO.



Analysis and Grader

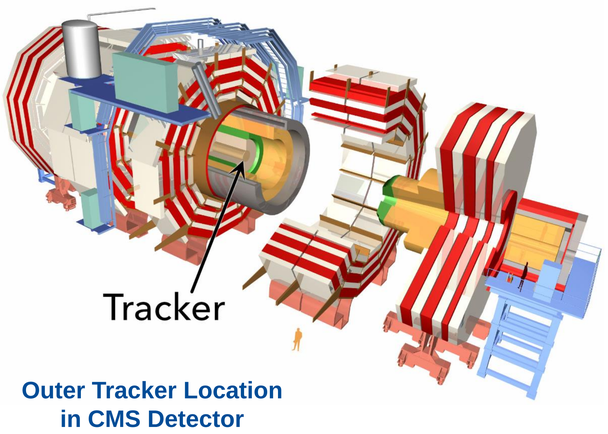
POTATO is equipped with a graphical user interface that allows for the user to search for specific modules and analyze corresponding histograms. The analysis function of POTATO details metrics, such as noise averages, for each module while the grading feature assigns grades based on defined criteria decided by the Outer Tracker community. The analysis summary and grading is saved in separate XML files that can be uploaded to the database. Users can analyze and grade modules at various component levels to identify potential issues or determine if the module needs to be discarded.

POTATO Development

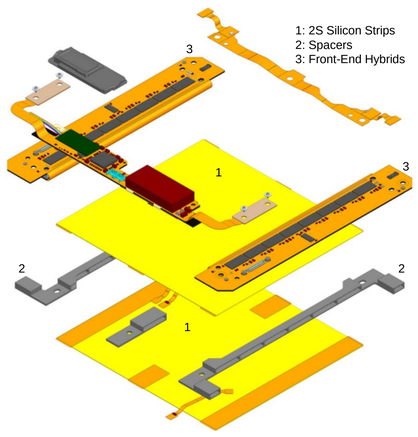
We have the initial version of POTATO to a near completion with future iterations expected to evolve alongside increased data from module testing. Additionally, we have begun discussion to add fields into the database.

Features we have added:

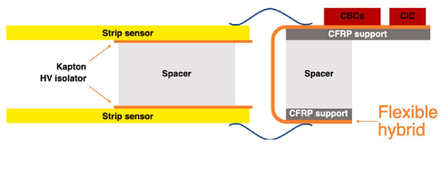
- Noise average and outlier count
- Pedestal average and outlier count
- Checking for efficient communication between module components

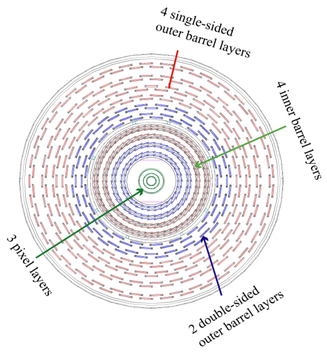


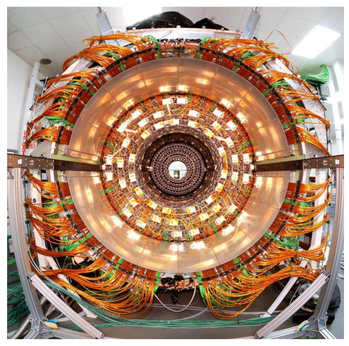
Outer Tracker Location in CMS Detector



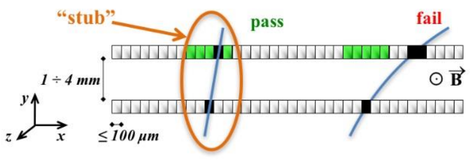
2S Module Exploded View



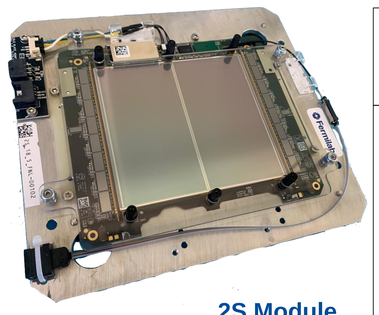




Current Outer Tracker

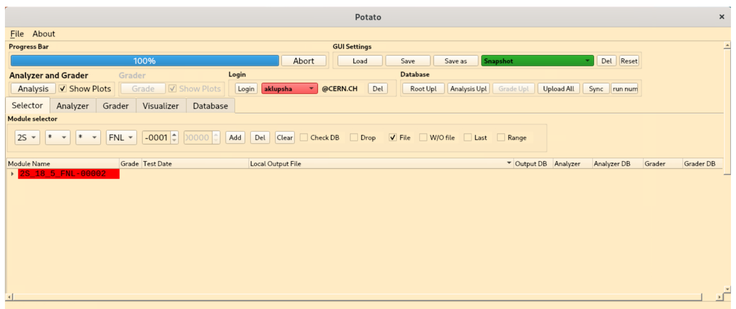


Stub Diagram



2S Module

Burnin Box



POTATO User Interface

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F	*	CONDITION_DATA_SET_ID	NUMBER (38)
F	*	ROOT_FILE	NUMBER (38)
	*	ANL_VER	VARCHAR2 (40 BYTE)
	*	ANL_CUTS_VER	VARCHAR2 (40 BYTE)
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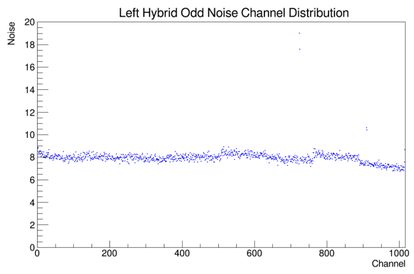
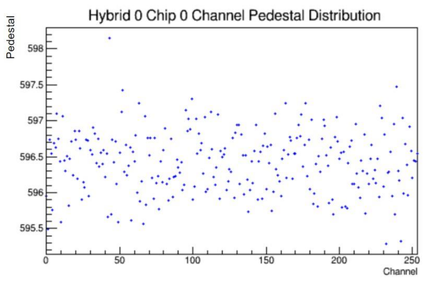
		IV_CURR_MAMP	FLOAT (126)
		IV_RATIO	FLOAT (126)
		IV_BREAKDOWN_V	FLOAT (126)
		READ_ERR	FLOAT (126)
		NOISE_AVG	FLOAT (126)
		NOISE_RMS	FLOAT (126)
		NOISE_NOUTL_LOW	NUMBER (38)
		NOISE_OUTL_LOW	VARCHAR2 (2000 BYTE)
		NOISE_NOUTL_HIGH	NUMBER (38)
		NOISE_OUTL_HIGH	VARCHAR2 (2000 BYTE)

MD2SANLSMMRY_PK (RECORD_ID)
MD2SANLSMMRY_CNDTST_FK (CONDITION_DATA_SET_ID)
MD2SANLSMMRY_RTFL_FK (ROOT_FILE)
MD2SANLSMMRY_CNDTST_FK_I (CONDITION_DATA_SET_ID)
MD2SANLSMMRY_PK (RECORD_ID)

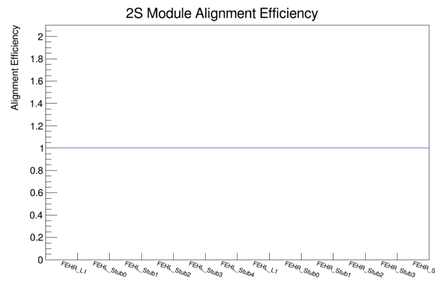
Variable Table



Example of Noise Histogram



Example of Pedestal Histogram



Example of Alignment Efficiency Histogram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Example of Analysis XML


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Example of Grading XML

Summary and Outlook

The assembly of modules is set to begin within the coming year, signaling the start of substantial data collection efforts for POTATO. This software will be utilized globally as production commences. Fermilab plans to produce 1,000 2S Modules and 1,250 PS Modules. In total, the OT will require 7,608 2S Modules and 5,592 PS Modules. Each module will be assembled in production facilities around the world and graded with the POTATO software. The work presented will facilitate the CMS collaboration to identify the modules that will be installed in the detector.

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