The CMS Inner Tracker Phase-2 Upgrade for the HL-LHC

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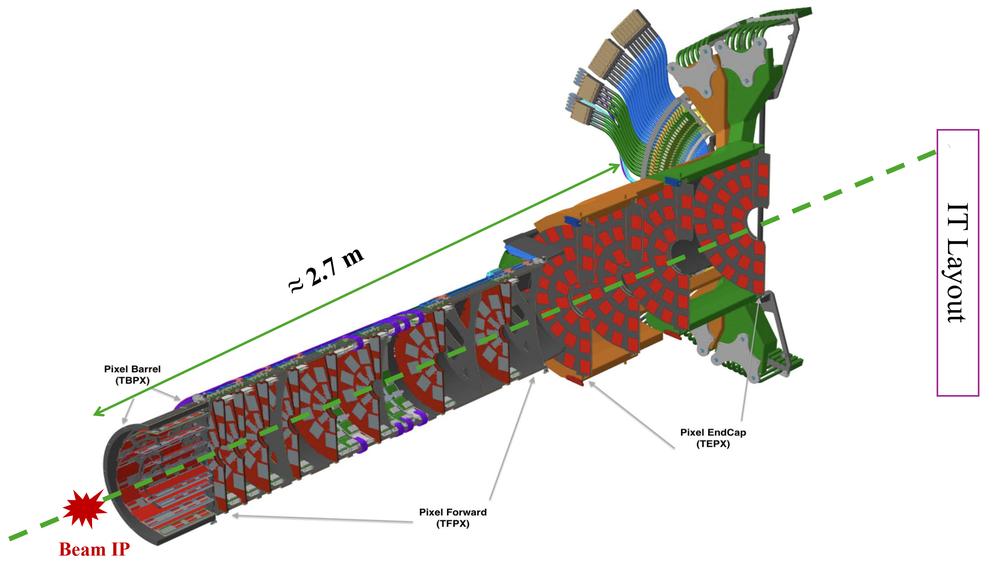
CMS Inner Tracker Phase-2

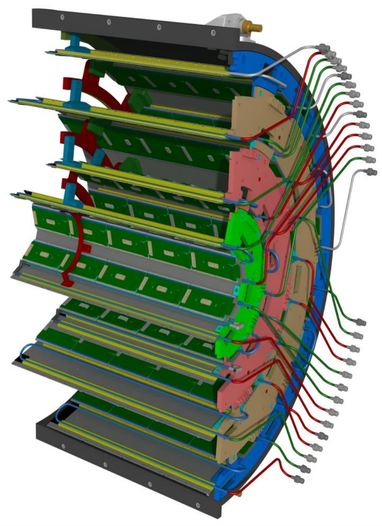
The Phase-2 upgrade of the Compact Muon Solenoid (CMS) detector is part of the HL-LHC program. The CMS detector will face extreme radiation levels and an average pileup of up to 200 interactions per bunch crossing. To meet these challenges and fully exploit the HL-LHC physics potential, the CMS Collaboration is constructing a new Inner Tracker.

Features of the IT Phase -2 upgrade

- Pixel size reduced from 100 × 150 μm² to 25 × 100 μm².
- Extended |η| coverage from 3.0 to 4.0.
- Compact and low-mass system via serial powering.
- CO_2 cooling system operating down to −35 °C.
- Lightweight carbon fiber structure.
- Power budget: 60 kW.

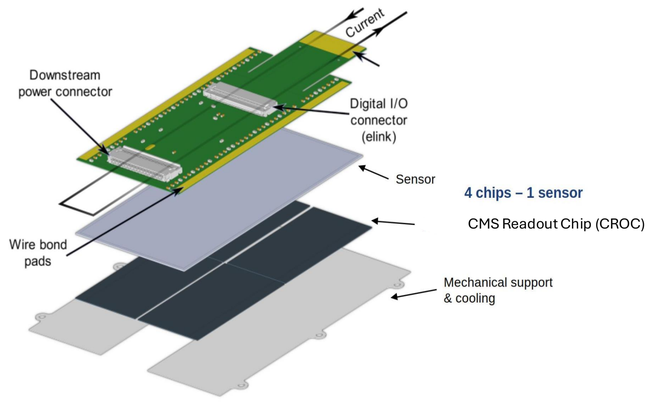


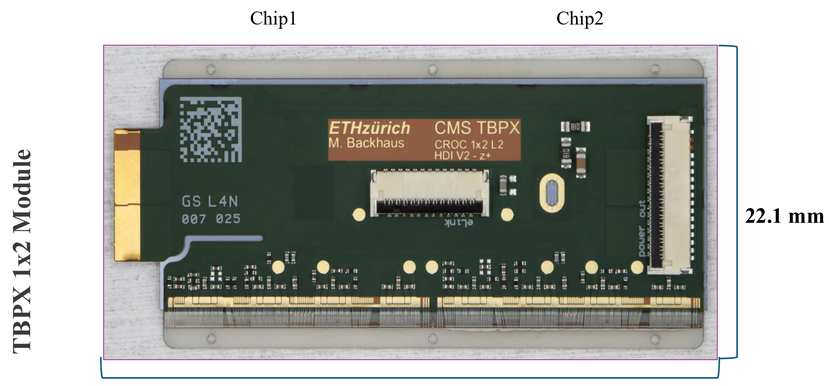
TBPX one quarter



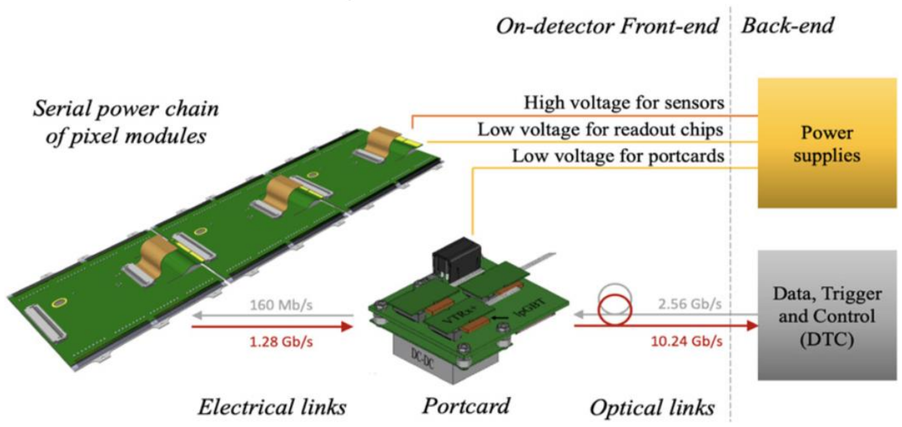
Layers	Module	No. of Modules
1	1x2 3D	54
2	1x2 Planar	108
3+4	2x2 Planar	90+126

Module Design

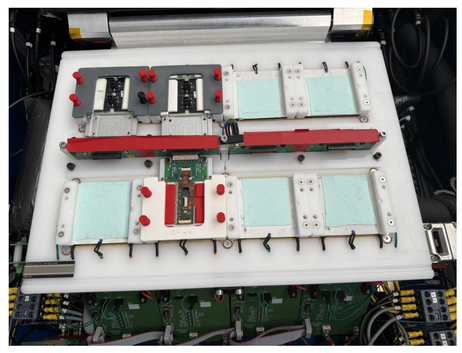




Module Powering and Readout Scheme



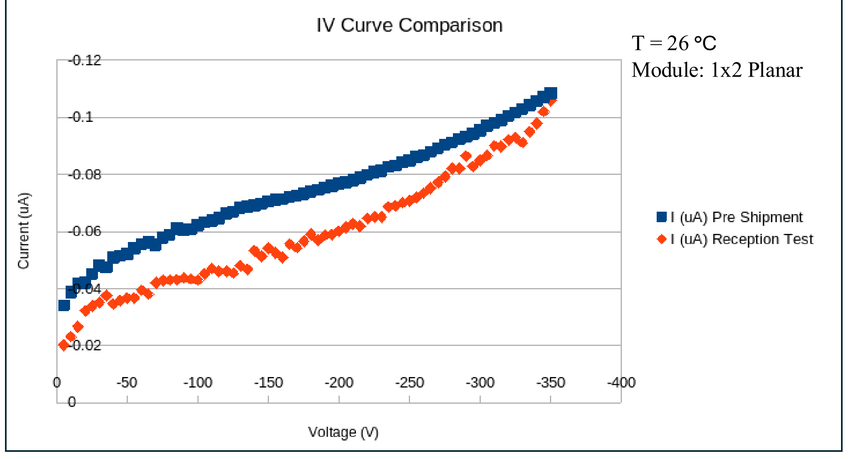
Cold Box Setup for Reception Test



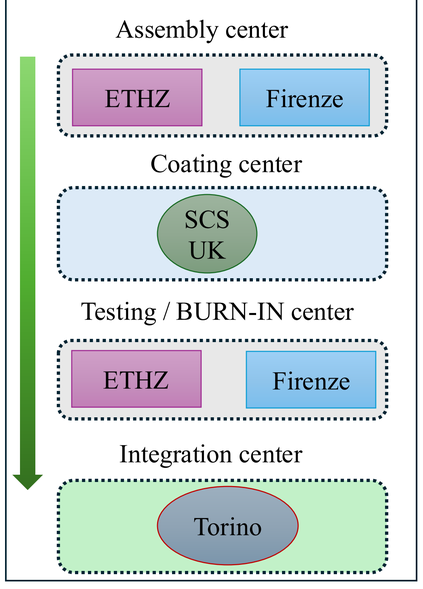
Reception Test

Reception tests are performed on modules received from assembly centres to evaluate and compare their performance before and after shipment.
The tests are conducted at low temperature (-30 °C) to validate module quality prior to integration.

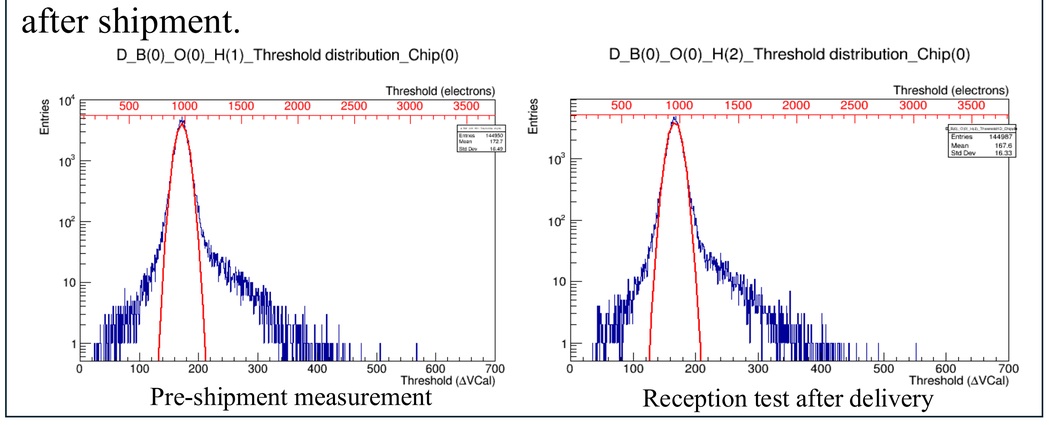
IV_comparison:
Inspect if any unexpected high leakage current or early breakdown caused by damage to sensors happened. Stable IV curve before and after shipment shown below.



TBPX Production Workflow



Threshold Distribution Comparison
Threshold distribution of a single CROC measured across all pixels. The distribution shows a narrow spread around the target threshold value, indicating good threshold uniformity. The close agreement between both measurements confirms stable module performance after shipment.



Summary

The CMS Phase-2 IT incorporates advanced technologies specifically developed to meet the demanding requirements of the High-Luminosity LHC environment. Reception test procedures are performed to ensure that each module satisfies the necessary performance standards and is fully qualified for installation.

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