

Exp. High Energy Physics
at
National Center for Physics
Islamabad, Pakistan

Introduction

- Introduction to Exp. HEP Group activities at NCP
 - Hardware projects at NCP
 - Performance studies
 - Physics analysis of the LHC data

EHEP Facilities at NCP

- Gaseous detectors (RPC/GEM) R&D lab with testing setup such as cosmic muon stands, power supply, gas mixing setup, Keithley picoammeter, x-rays source, radiation box etc
- Class 10k clean room
- Developing Semiconductor Lab at NCP for CMS Silicon Module assembly and Tracker mechanics for Phase II upgrade
- Electronics lab with PCB design capabilities
- Tier 2 computing Grid
- Trained manpower

Physics Research Area's

☐ Top quark Physics:

- Study of associated production of top quark and Z-boson using CMS data collected in 2012 at 8/13 TeV center-of-mass energy
- Measurement of $t\bar{t}$ Cross-section at 13 TeV
- Measurement of the single top t-channel charge asymmetry

☐ Exotica Searches:

- Search for the Black Holes with the Early Run 2 CMS Data

☐ SUSY Searches:

- SUSY searches in multilepton final states

Recent Important Physics Analysis Finished at NCP

- ❑ The cross section measurement of top quark in association with Z boson (Measured for the first time in any HEP experiment)
 - Analysis Note: CMS/AN-14-182 and Paper: CMS/Top-12-039 (published in JHEP, arxiv.org/abs/1702.01404)
 - Analysis at 13 TeV in progress, CMS/AN-16-285, Paper: CMS/Top-16-020

- ❑ Measurement of $t\bar{t}b\bar{r}$ cross-section in $l+jets$ channel at 13 TeV
 - Documented in CMS Paper: Top-16-006

- ❑ Search for Microscopic Black Holes with the Early Run 2 CMS Data
 - Documented in CMS Paper: EXO-15-007

Research Area's (Performance Studies)

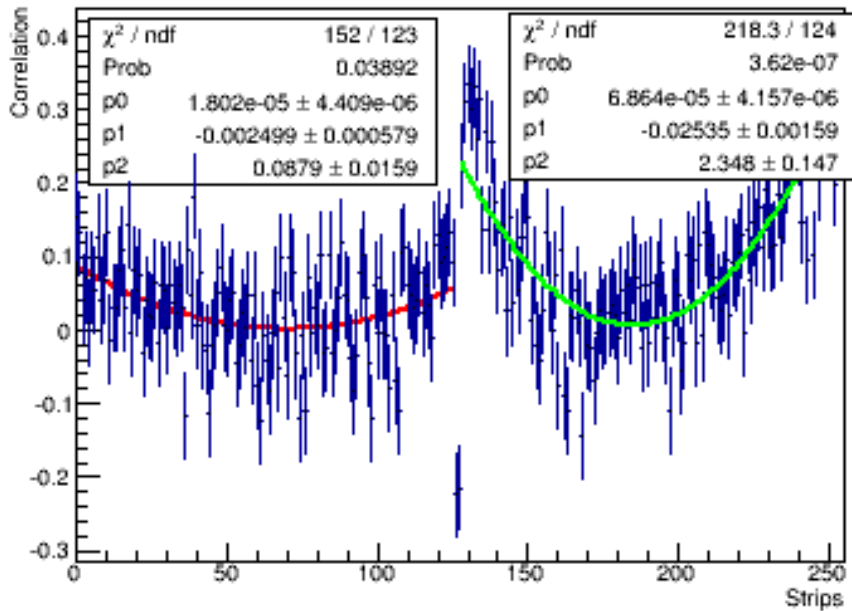
□ Performance studies:

- Study of coherent noise in Silicon Tracker at CMS
 - ❖ Modeling of correlated noise and variation w.r.t conditional parameters
- Energy Loss measurement in the CMS Silicon Tracker
- Backplane corrections and Lorentz angle measurement in CMS silicon Tracker
- Lepton Efficiency measurement and fake rate estimation
- RPC Performance studies: Efficiency, cluster size and noise measurements

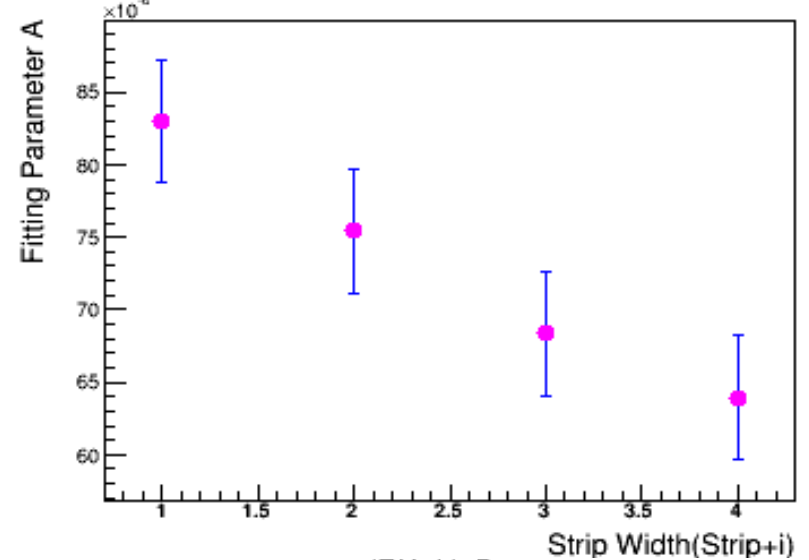
Coherent Noise in Silicon Detector at CMS

Study helps to improve track reconstruction by reducing the chance of noisy clusters

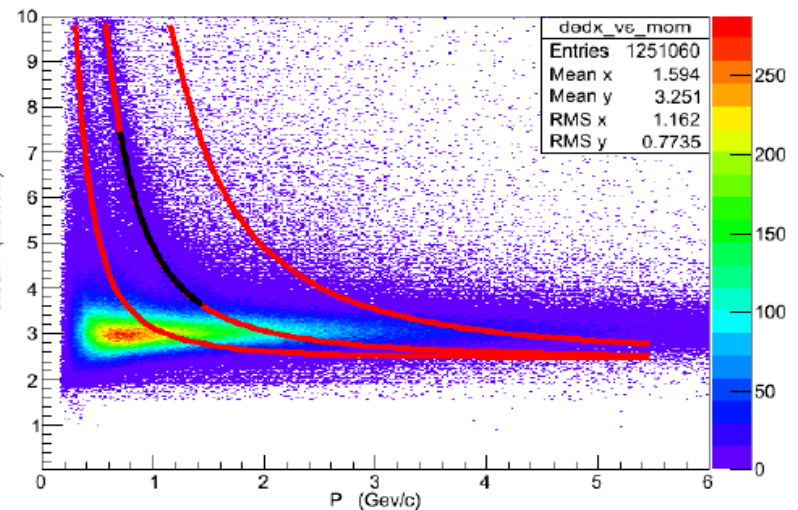
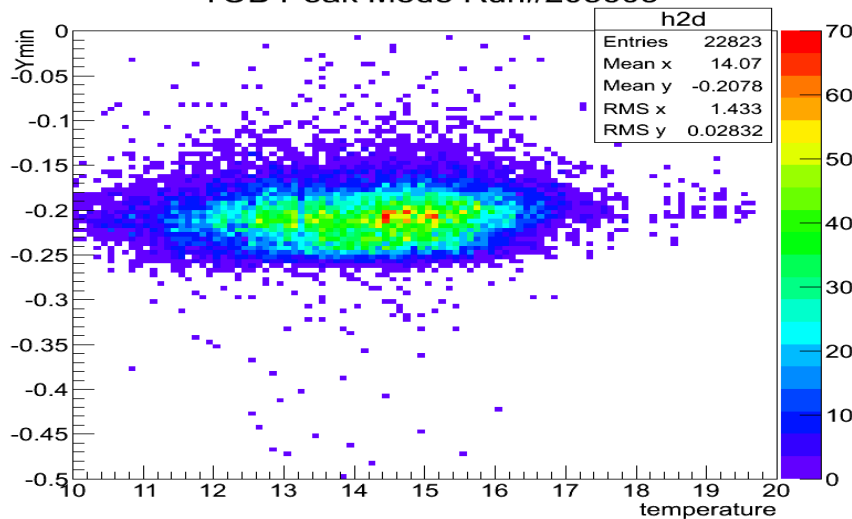
Normalized Noise Product Strip+2



Right_Fit Parameter(A)(Quadratic)Variation vs Increasing Correlation Length



TOB Peak Mode Run#208605



Detector Hardware R&D

□ Detector R&D:

- Resistive Plate Chambers(RPC's) Project at NCP
- Gas Electron Multipliers(GEM) Detector R&D
 - ❖ Thin/Thick GEM R&D (Assembly and testing)
 - ❖ GEM DCS developments
 - ❖ GEM Assembly and testing for CMS Phase I upgrade
- Silicon Strip Tracker R&D for CMS Phase II upgrade
 - ❖ Lab. Setup for silicon sensor qualification, module assembly and ladder mechanics
 - ❖ Plan to built silicon modules at NCP

□ Projects/funding for Tracker Phase II upgrade and GEM Phase I approved by the Govt.

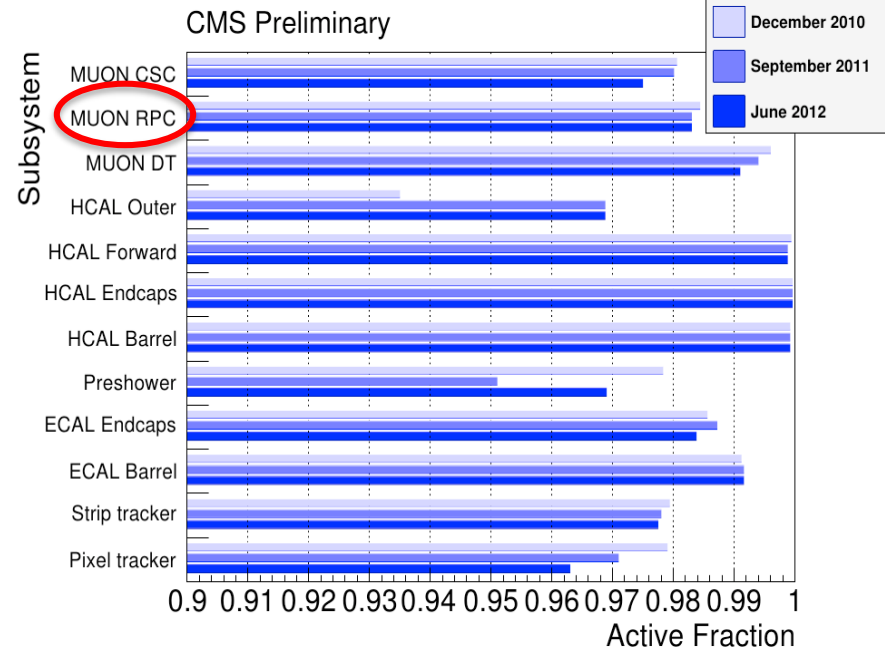
CMS Resistive Plate Chambers(RPC's) Project at NCP

❑ Built, tested, installed and commissioned (288 + 10% contingency) RPCs

- Installed and commissioned 144 RPCs during LS1 (RE4 project)
- Responsible for the operation and maintenance of Endcap RPC's

❑ Detectors are performing very well

- During data taking RPC's are operational 99.8% of the time with very high efficiency (more than 98%, comparable to any other sub-detector)



Preparation for GEM assembly and testing at NCP

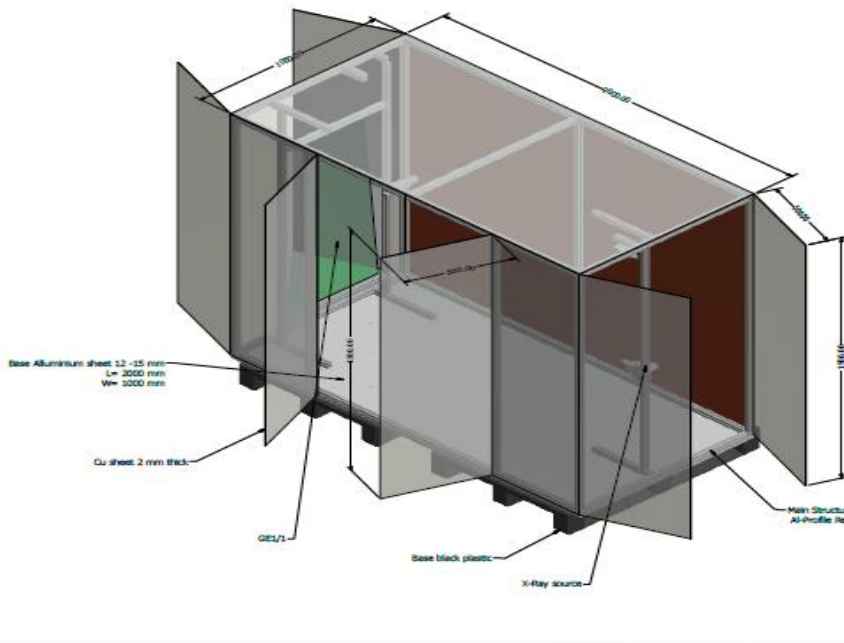
Cosmic test stand



Class 10, 000 clean room



Radiation test box being prepared

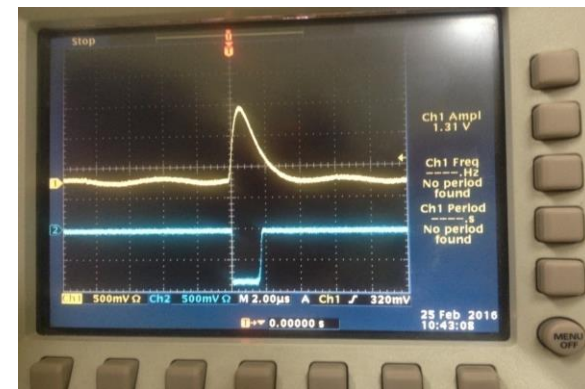
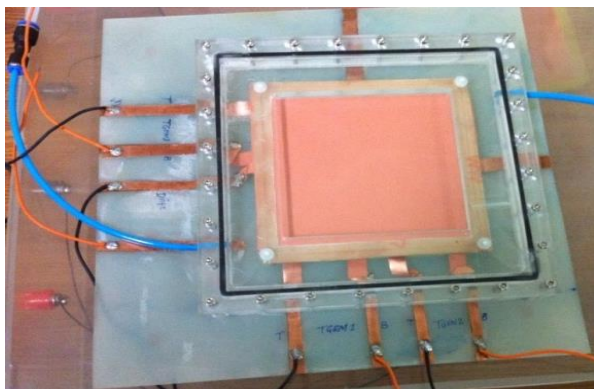


HV power supply



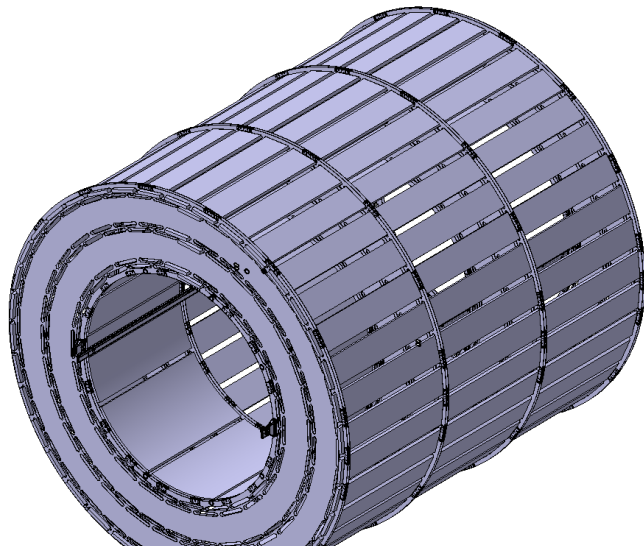
Thick GEM Project at NCP

- ❑ To overcome GEM foil issues, indigenous R&D on thick GEM has been established in parallel
 - Easy to fabricate locally
 - Developed basic readout setup
 - Test with cosmic muons
 - Detail studies underway with recently procured x-rays source

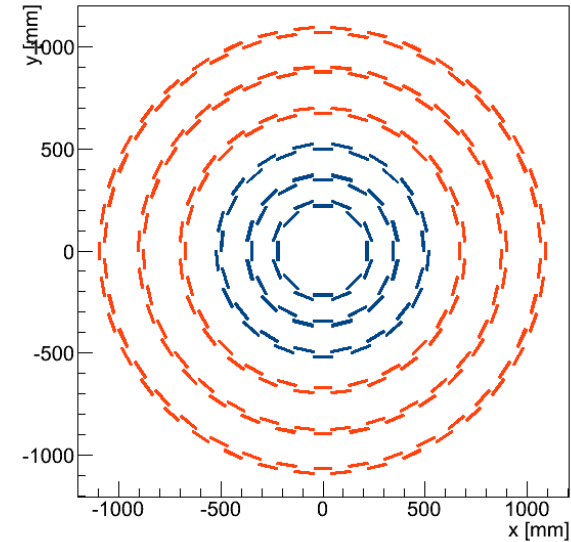
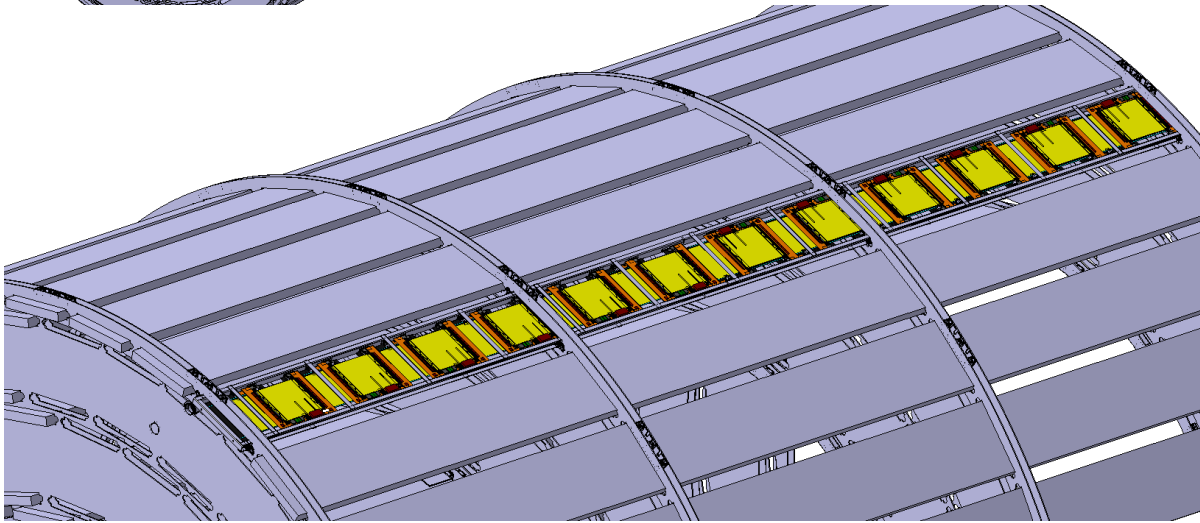
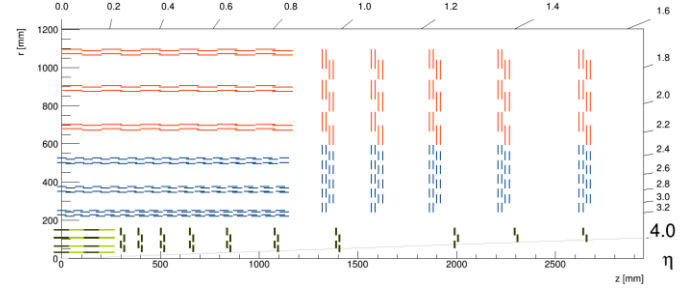


Hole diameter $d = 0.3-1\text{mm}$
Distance between holes $a = 0.7-7\text{mm}$
Plate thickness $t = 0.4-3\text{mm}$

Silicon Tracker Project at NCP



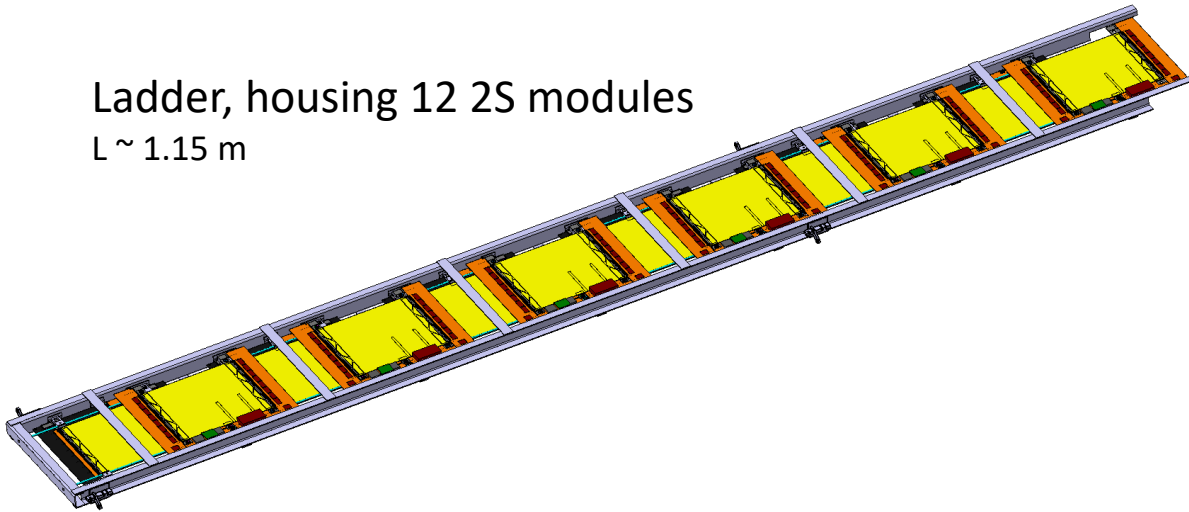
TB2S



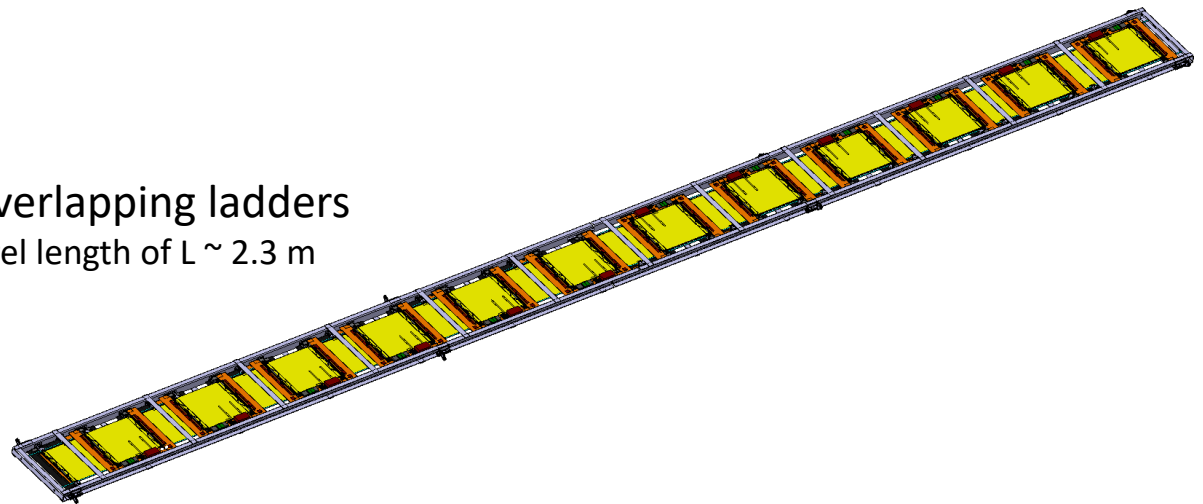
Z overlap within one “ladder”
 ϕ overlap between consecutive ladders

Modules Support Structure(Ladder)

Ladder, housing 12 2S modules
 $L \sim 1.15$ m

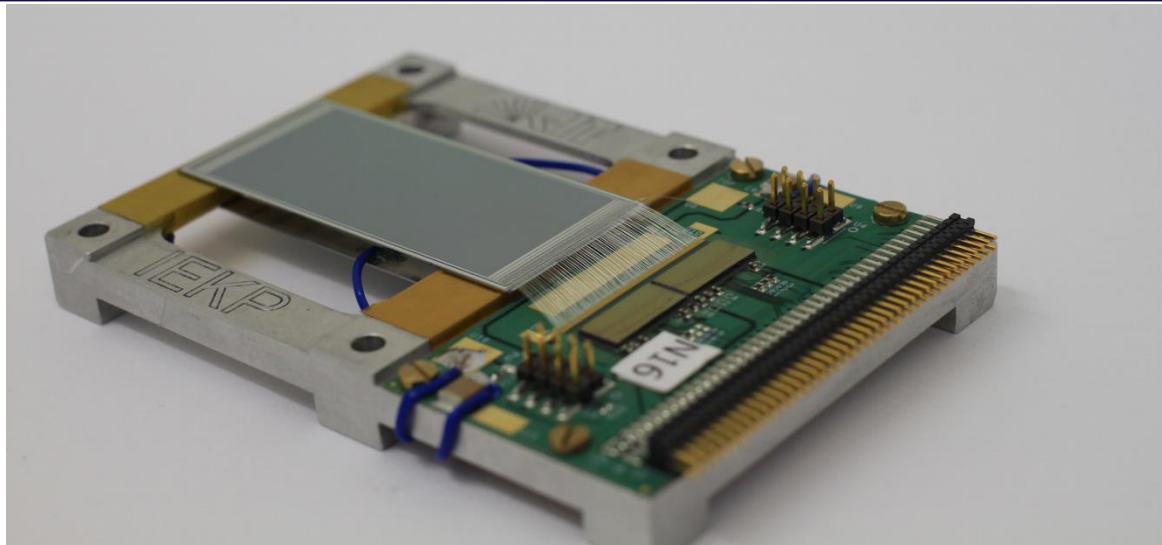


Two overlapping ladders
Full barrel length of $L \sim 2.3$ m

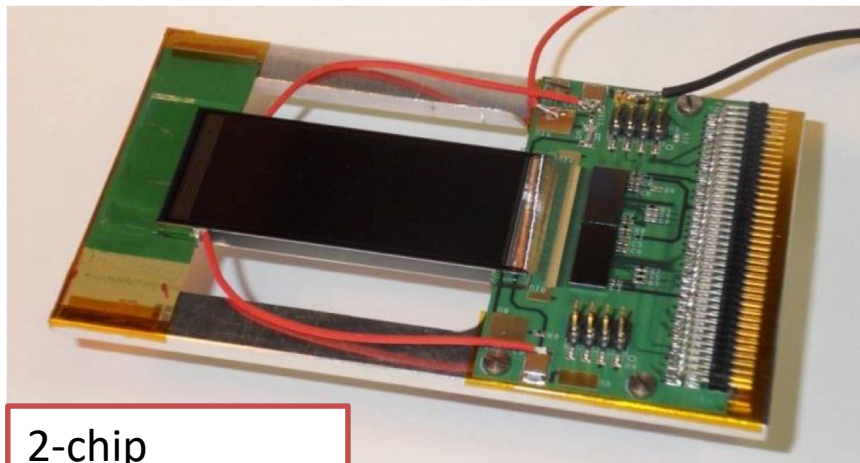


Our team of engineers are working on the design of these ladders, fabrication of the components is ongoing. Final assembly will happen at NCP.

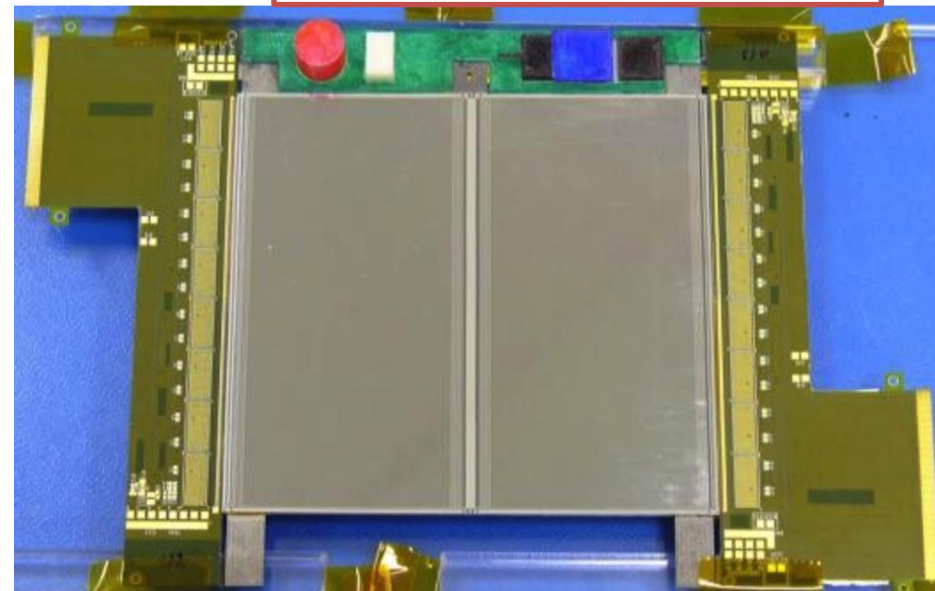
Prototype Modules Underway



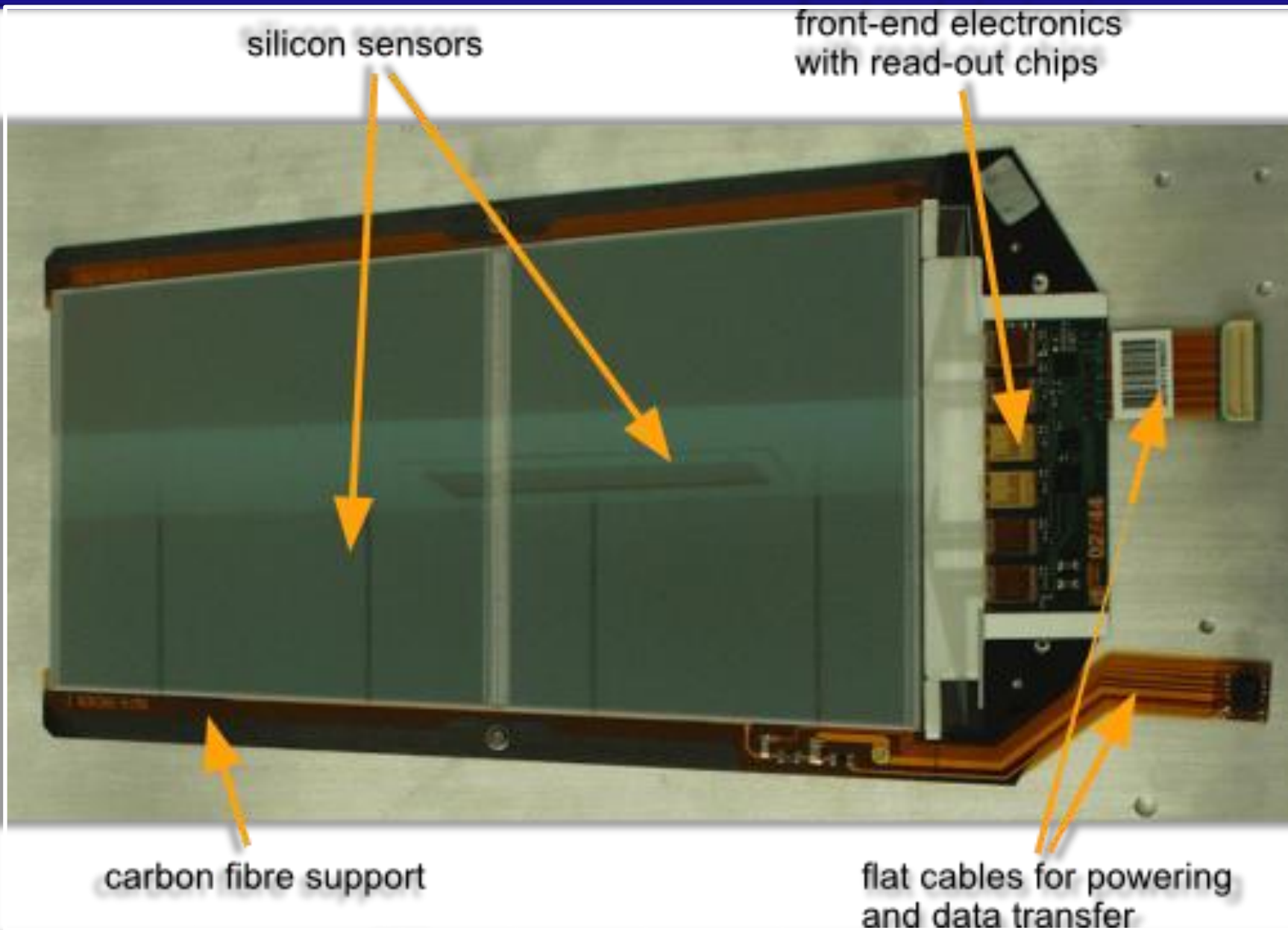
Full size dummy (real hybrid)



2-chip
Fully functional



Silicon Module



Grid Node to access LHC data



- ❑ Processing of huge amount of LHC/CMS data needs a lot of computational power, hence resources
- ❑ First Pakistani Tier2 was deployed in June 2004
- ❑ Immediate access to wealth of LHC data with up-to-date CMS software releases



CPU	Storage	Network Connectivity
524	360 TB	1 Gbps (dedicated)

Summary

- ❑ Well covered research areas in Exp. HEP group at NCP,
 - Detector development for HEP experiments
 - Performance studies of the CMS sub-detectors
 - Physics analysis of the LHC data