CONSTRUCTION OF A COSMIC-RAY TELESCOPE WITH SMALL-SCALE CMS DRIFT TUBES CHAMBERS

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ALMA MATER STUDIORUM UNIVERSITA DI BOLOGNA

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TELESCOPE SYSTEM

Aim to develop a setup in Bologna for local tests of CMS DT Phase-2 electronics and algorithms.

Hardware:

- MiniDTs
- Scintillator planes
- Phase-2 CMS readout test system

Software:

- Data taking online monitor
- CMS offline analysis



MINIDT

- spare material from the original CMS DT chambers
- Gas: premixed 85% Ar-15% CO2
- High Voltage: V(wire)=+3600V, V(cathode)=-1200V, V(strip)=+1800V



• Two chambers manually assembled at INFN LNL in 2021 – 2022 using

• Drift cell geometry identical to CMS DTs, with the exception of a new endcap design -> alignment from aluminium sheets pre-processing



READOUT SYSTEM



Low Voltage Front End (LVFE) board

- Padova and Bologna design
- Powered using a 12V bench power supply
- LVFE board provides power, I2C interface and analogue settings (e.g. thresholds) to the Front End Boards
- A portable replacement for "CMS DT Splitter Boards"

Triggerless readout

- MiniDTs FE LVDS signals to OBDTv1
- OBDTv1 is the early prototype TDC board for the Phase-2 upgrade of CMS DTs
- TDC hits are streamed over optical links to a Xilinx evaluation board implementing the backend functionalities
- Python script reads Xilinx board and produces readout file





SCINTILLATORS

- Plastic scintillators enclosed in aluminium plates
 Each instrumented with 2 Hamamatsu PMT H3165-04
- Each instrumented with 2 F Signal logic:
 - AND of the PMTs on the same scintillator tile
 - OR of all the scintillators' signals
 - NIM signal converted with custom NIM-LVDS board to read scintillators' signal through the OBDT





DATA TAKING MONITOR



5



Chamber 8 - Occupancy monitor

Timebox and Scintillator Occupancy





Chamber 7 - Scinitllator events monitor







Chamber 8 - Scinitllator events monitor





Chamber 8 - Occupancy monitor

Chamber 8 - Scinitllator events monitor

Occupancy Monitor

Rate: 1152 Hz





MiniDT 7 Rate: 541 Hz



MiniDT 8 Rate: 524Hz





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Chamber 8 - Occupancy monitor

Timebox and Scintillator Occupancy

Chamber 8 - Scinitllator events monitor

Occupancy Monitor 0 Rate: 1152 Hz الشمائل والمسم وحماله Scintillator Rate: 87 Hz 100-- 0 (...) 1_ 80-60-40-20-0-25 40 45

MiniDT 7 Rate: 541 Hz

15 20

30

35

10

0

5



MiniDT 8 Rate: 524Hz





Timebox and Scintillator Occupancy

Chamber 8 - Scinitllator events monitor





Occupancy Monitor

Rate: 1152 Hz



Chamber 8 - Occupancy monitor

Timebox and Scintillator Occupancy

Chamber 8 - Scinitllator events monitor

OFFLINE ANALYSIS



• Hit recostruction after calibration procedure

OFFLINE ANALYSIS (II)





$\frac{\Sigma \operatorname{digi} \operatorname{in} \operatorname{cell} \pm 1}{\Sigma \operatorname{segment} \operatorname{extrapolated} \operatorname{in} \operatorname{cell} \pm 1}$

OFFLINE ANALYSIS (III)



- position

• Space resolution estimated from the width of the distribution of residuals • For each hit, the residual is the difference between the position extrapolated with the segment information and the measured

For both MiniDTs: ~ 360 μm

OFFLINE ANALYSIS (IV)



- t0 distribution
- as the time needed for the signal to propagate along the anode wire

- Free parameter in the segment fit • Takes into account many effects, such • For both MiniDTs: ~ 6 ns

• Time resolution from the width of the

CONCLUSION

- Assembled the cosmic ray telescope • Developed online monitor software • Customized CMS offline analysis for the MiniDTs
- Assessed performance of the two chambers

Next steps:

- Address and solve MiniDTs problems • Evaluate scintillator layer contribution to time
- resolution
- When available, insert in the telescope setup and test OBDTv2

THANK YOU

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BACKUP MONITOR

Occupancy

Cumulative information from the beginning of the monitoring program.

- per channel,
- 2D, to visualize the position inside the chamber
- relative to scintillator events

Timebox

Time difference distribution of chamber hits after the scintillator signal, used as a trigger for a basic event reconstruction.

Both cumulative and relative to the latest 30s of data taking.

Channels Rate

Channels occupancy in the latest 30s of data taking, both general and relative to the scintillators events.

- per channel,
- 2D, to visualize the position inside the chamber
- relative to scintillator events

MiniDT and scintillators rate

Trend over time of the total event rate for the MiniDTs and the scintillators' plane.

BACKUP: EVENT DISPLAY

Run_127 - Event n.304732

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BACKUP: HIT INFO MINIDT8



BACKUP: EFFICIENCY PER LAYER



BACKUP: CELL EFFICIENCY



BACKUP: MINIDT7 INEFF. CELL



BACKUP: RESIDUAL MINIDT7



BACKUP: RESIDUAL MINIDT8

