



System test for the certification of the pixel detector of the ATLAS tracker for the High-Luminosity LHC run, and search for new physics in Higgs pair production with machine learning application

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LHC upgrade to High-Luminosity LHC (HL - LHC)



 $\mathcal{L} = 2.1 \times 10^{34} \text{ cm}^{-2} \text{s}^{-1} \qquad \qquad \mathcal{L} = 7.5 \times 10^{34} \text{ cm}^{-2} \text{s}^{-1}$

Inner Detector (ID, actual ATLAS tracker) \rightarrow Inner Tracker (ITk)

ATLAS-TDR-030 (2017)

ITk for HL - LHC

- All-silicon system
- Strip (in blue) and pixel (in red and green) subdetectors
- ID pixel size (today): 50 μm × 250 μm, 50 μm × 400 μm
- ITk pixel size (future): 25 μm × 100 μm, 50 μm × 50 μm



ITk hybrid pixel detector



ITk RD53A chip

Single Chip Card (SCC) RD53A chip: 76800 pixel



INFN Lecce tasks

- We received some prototype of the ITk pixel module and performed reception tests to check their functionality
- Our group has the task to build a section of the ITk pixel detector



INFN Lecce laboratory

Development of DAQ software

- The software used for the reception tests cannot be used in the ITk Data AcQuisition system (DAQ)
- I am working on the development of a new DAQ software in collaboration with the ATLAS pixel group at CERN
- Software written in C++, collaboration with other groups possible thanks to the version control software github

Development of DAQ software





Setup for the development of the new DAQ software

Occupancy maps produced with the new DAQ software

Search for Higgs pair production

- \bullet Goal of the ATLAS experiment: measurement of the Higgs self coupling λ
- If physics Beyond the Standard Model (BSM) exists: $\lambda \neq \lambda^{SM}$
- λ accessible through the observation of Higgs pair production



Machine learning studies

- SM cross section so small that this process can be observed only in the HL LHC run
- Possible backgrounds: Z-jet, W-jet, $t\overline{t}$...
- I am taking part in the development of a neural network for signal/background discrimination
- Neural network built using python and the open-source library Keras

Machine learning studies (simulated data)

