The ATLAS/Brazil Cluster: Current Status and Perspectives from the ATLAS Upgrade Programme

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Contributions from UERJ/UFBA/UFJF/USP/UFRJ

II Latin American Strategy Forum for Research Infrastructure: an Open Symposium for HECAP
ATLAS/Brazil Cluster

- **Outlook (upgrade)**
  - Calorimetry
  - HGT
  - Trigger
  - Physics analysis
  - Collaboration Management Tools
  - Outreach

- Since 1988 (new detector technologies for LHC)
- Institutes: UERJ, UFBA, UFJF, UFRJ, USP – 19 researchers, 22 graduate students, 27 undergraduate students, 7 high-school and technical school students. Two other institutions planning to join
- Physicists, Engineers, Computer Scientists
- Brazilian industry
- Startups
Calorimetry (hadronic)

- **Energy Estimation (high pileup conditions)**
  - OF2 (currently used): noise variance minimization.
  - COF: linear signal deconvolution.
  - Wiener: (noise + signal) variance minimization.
  - Neural network (nonlinear correction)

- **Granularity Improvement**
  - Factor of 2 by software
  - Deep learning models (need high volume statistics)
  - Synthetic data (Generative Adversarial Networks – GANs)
  - Blind Source Separation
Phase-II High Granularity Timing Detector

- USP activities: LGAD Prototype sensors characterisation
- UFJF and UFRJ: ASIC development (collaboration with Clermont-Ferrand)
- Sensors are being produced by a few manufactures (Hamamatsu, FBK, CMN) with different geometries and doping profiles
- Based on semiconductor detectors (Low Gain Avalanche Detectors): Detectors will be tested after neutron irradiation for performance evaluation (IV, CV, timing, intrinsic gain) Prototype test board for sensor evaluation developed and built at IF-USP with intrinsic jitter < 25ps

2x2 LGAD array test

Electronics designed at USP for sensor test and 90Sr ($\beta$) induced signal
Trigger System

Level 1:
- Muon trigger assisted from the hadronic calorimeter (Barrel, Extended Barrel)
- Supercells
- Ringer (FPGA)

Level 2
- Fast (NeuralRinger for electrons – full range – and photons. New machine learning developments)
- Data Quality
- Online Monitoring (electrons and photons)
- Forward Region
Phase-I Electromagnetic Trigger

- Signal reconstruction
  - Reconstruction of energy and timing from each super-cell signal
  - Uses optimal filtering for estimation
  - Electronic calibration is used to extract filter parameters based on the electrical model of the electronic chain
- Cell capacitance
  - Pre-Amplifier pole
  - Effects from reflections
  - LC time constant of electrodes

- Tests of LTD electronic components performance under irradiation using São Paulo facilities
  - Testes of TID 12.6 Gy/h IEaV
  - Tests of SEE using ions ($^{12}$C, $^{16}$O) from Pelletron accelerator at IF-USP
Physics Analysis

• Participation in several analysis working groups
  ➢ Higgs
  ➢ Standard Model
  ➢ Heavy Ions
  ➢ ALP (Neural Ringer application)

• All analysis steps
  ➢ Coordination
  ➢ MC validation
  ➢ Data preparation/framework development
  ➢ Background evaluation
  ➢ Signal extraction
  ➢ Support note/paper elaboration
Fence Framework Service

- A framework that gathers the required knowledge for building knowledge systems suitable to CERN
  - Different blocks are assembled together in a standard fashion, i.e., DB connection as procedural system functions, user-oriented interfaces
  - High level of configuration for attempting different users and needs
  - ATLAS, LHCb, and ALICE using for different purposes => 31 systems in production
  - Continuous development for fulfilling detectors' progress and upgrade requirements
Outreach

• Virtual Visits (from COPPE-UFRJ and different places. Since 2012. SBPC in 2018)
• Scientific exposition
• Master Classes
São Paulo includes students from the cities: São Paulo, Santo André, Bauru, Guaratinguetá, Ilha Solteira, Presidente Prudente, Rio Claro, Ribeirão Preto, and many others.

Lavras includes students from: Lavras, Divinópolis, Varginha, Pimenta, Nepomuceno, Boa Esperança, Itanhandú, Passa Quatro, Itamonte.
Conclusions

• ATLAS upgrade phases:
  ➢ Challenges (instrumentation, machine learning, signal processing, analysis tools, systems)
  ➢ Science
  ➢ Technology
  ➢ Innovation (hardware and software - startups)
  ➢ Pave the way for the future experiments
  ➢ Brazil: CERN association? Fostering HEP activities out of Rio and São Paulo
  ➢ New opportunities for outreach
  ➢ Latin American: some connections to Argentina