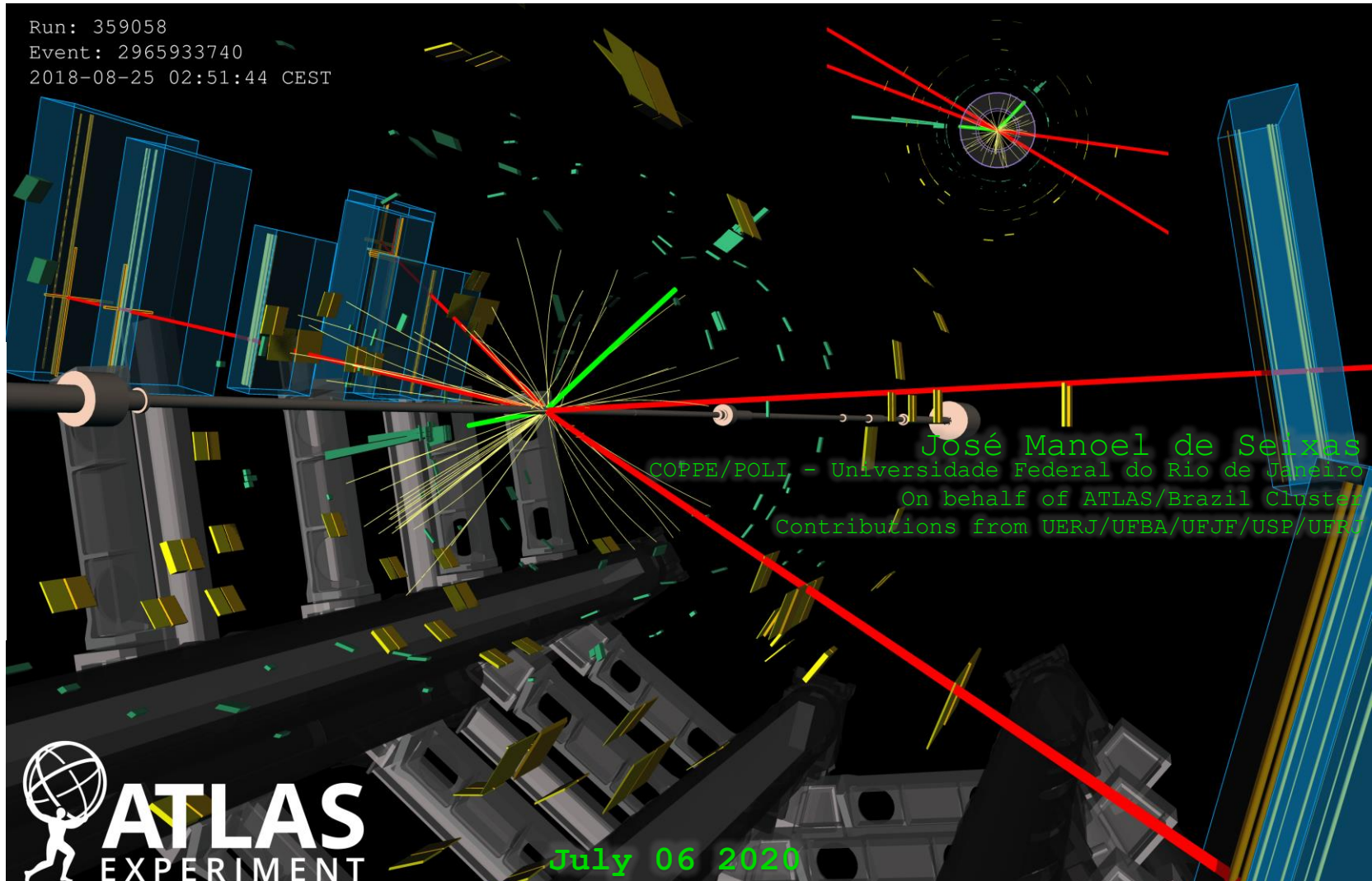
II Latin American Strategy Forum for Research Infrastructure: an Open Symposium for HECAP

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



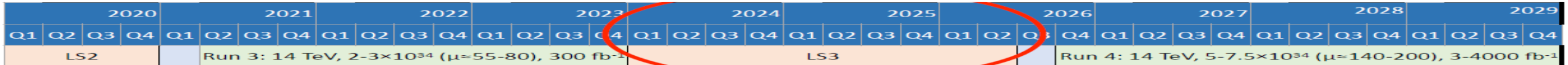
José Manoel de Seixas
COPPE/POLI - Universidade Federal do Rio de Janeiro
On behalf of ATLAS/Brazil Cluster
Contributions from UERJ/UFBA/UFJF/USP/UFRJ

lps
COPPE/Poli/UFRJ
Laboratório de Processamento de Sinais
Inteligência Computacional. Inovação

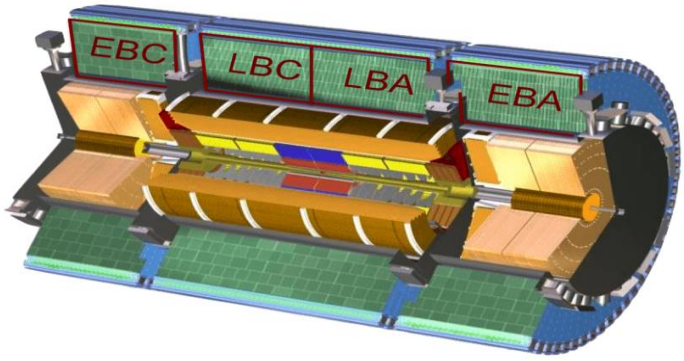
ATLAS/Brazil Cluster

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

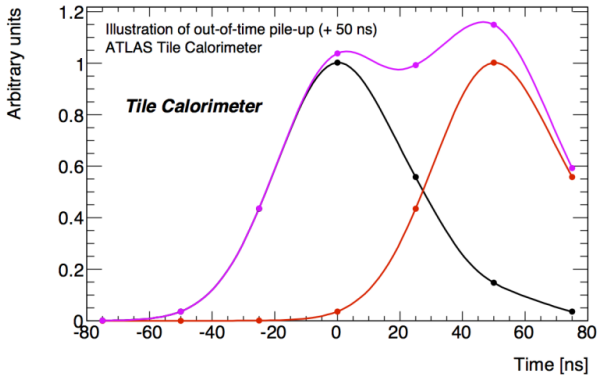
- Since 1988 (new detector technologies for LHC)
- Institutes: UERJ, UFBA, UFJF, UFRJ, USP – 19 researchers, 22 graduate students, 27 undergraduate students, 7 high-school and technical school students. Two other institutions planning to join
- Physicists, Engineers, Computer Scientists
- Brazilian industry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

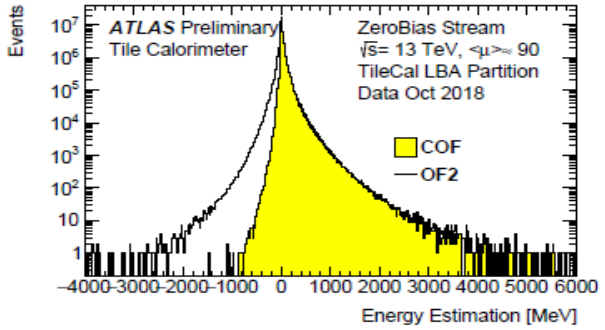


Calorimetry (hadronic)

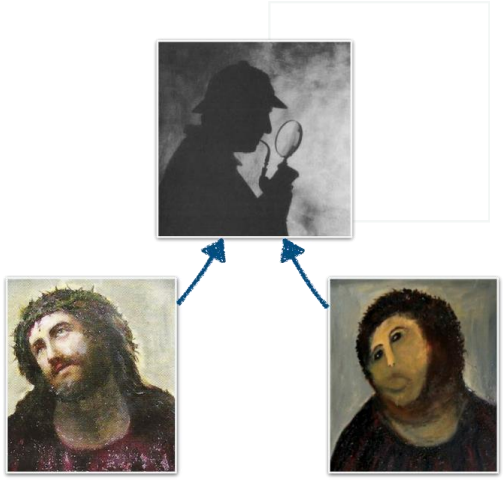


- Energy Estimation (high pileup conditions)
  - OF2 (currently used): noise variance minimization.
  - COF: linear signal deconvolution.
  - Wiener: (noise + signal) variance minimization.
  - Neural network (nonlinear correction)

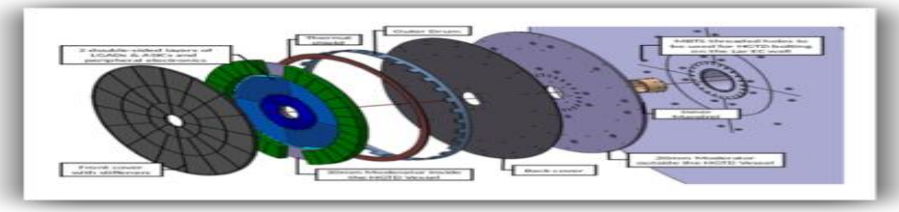




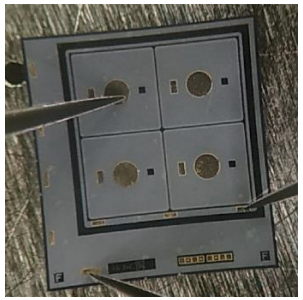
- Granularity Improvement
  - Factor of 2 by software
  - Deep learning models (need high volume statistics)
  - Synthetic data (Generative Adversarial Networks – GANs)
  - Blind Source Separation

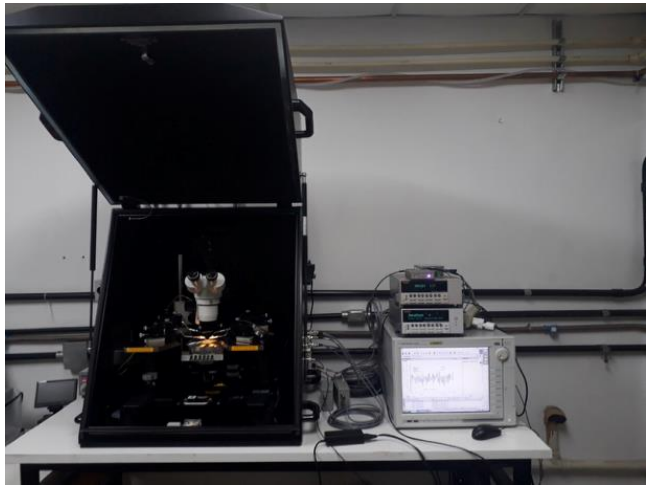


Phase-II High Granularity Timing Detector

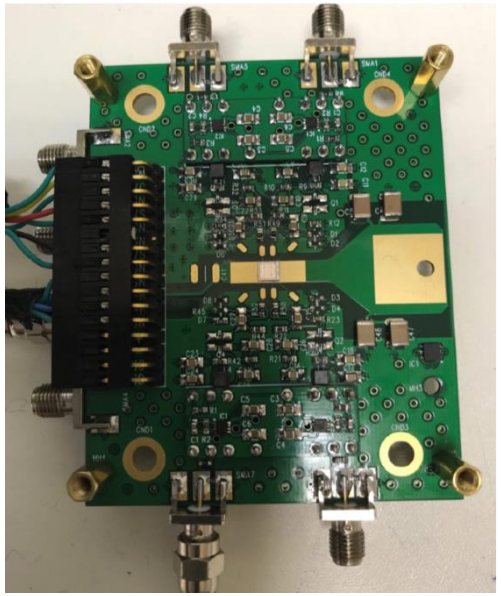


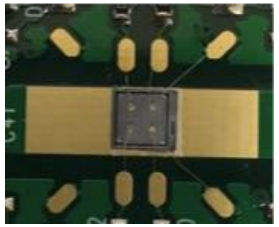
- USP activities: LGAD Prototype sensors characterisation
- UFJF and UFRJ: ASIC development (collaboration with Clermont-Ferrand)
- Sensors are being produced by a few manufactures (Hamamatsu, FBK, CMN) with different geometries and doping profiles
- Based on semiconductor detectors (Low Gain Avalanche 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

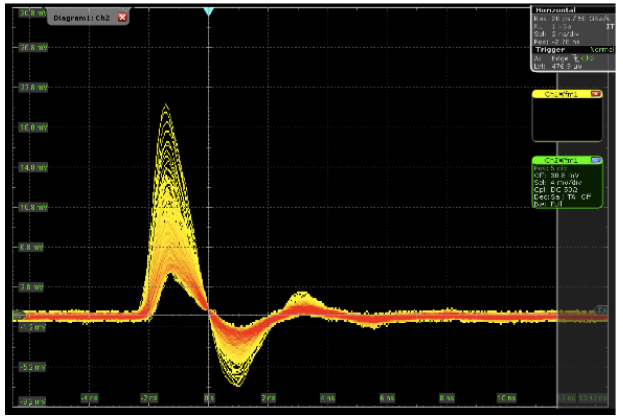




2x2 LGAD array test

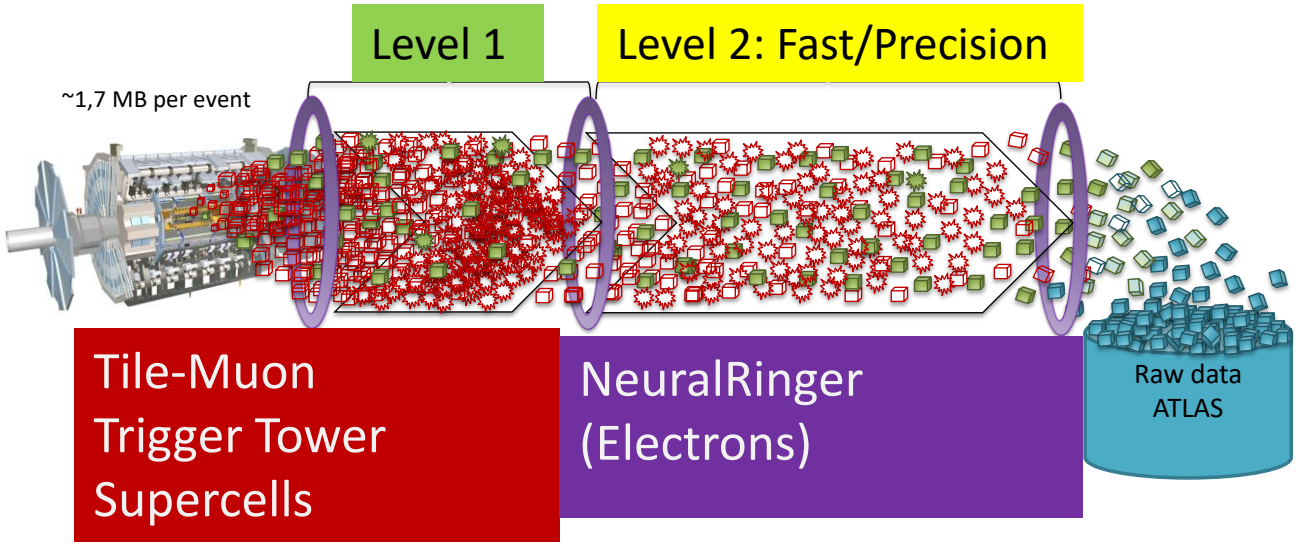






Electronics designed at USP for sensor test and 90Sr (β) induced signal

Trigger System

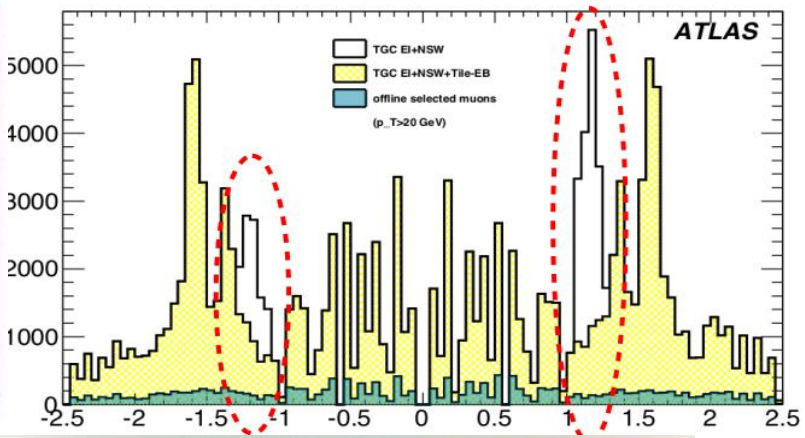


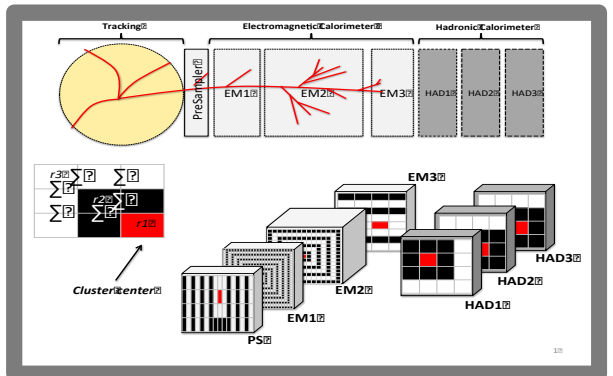
Level 1:

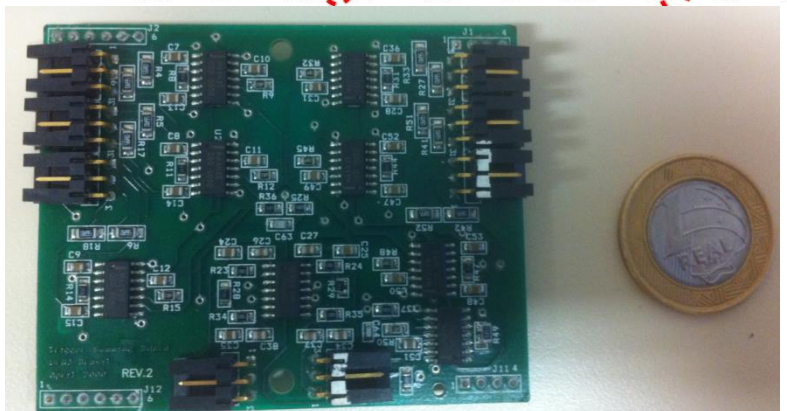
- Muon trigger assisted from the hadronic calorimeter (Barrel, Extended Barrel)
- Supercells
- Ringer (FPGA)

Level 2

- ✓ Fast (NeuralRinger for electrons – full range – and photons. New machine learning developments)
- ✓ Data Quality
- ✓ Online Monitoring (electrons and photons)
- ✓ Forward Region

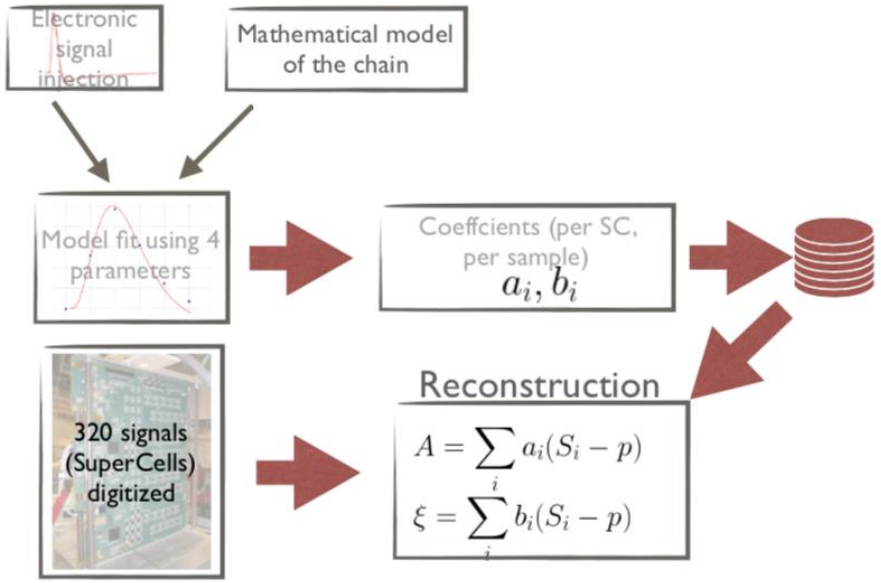




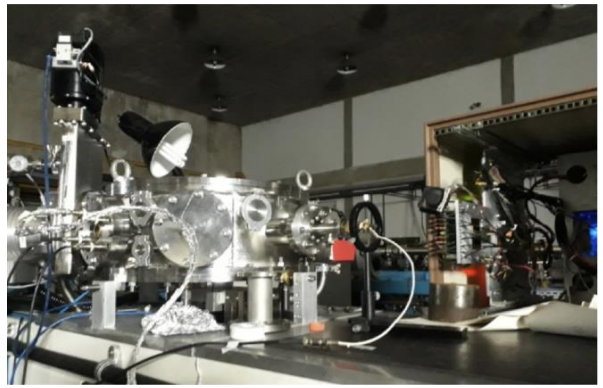


Phase-I Electromagnetic Trigger

- 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



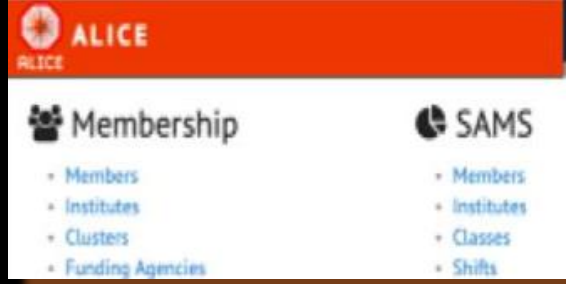
- Tests of LTD electronic components performance under irradiation using São Paulo facilities
  - Testes of TID 12.6 Gy/h IEaV ^{60}Co source
  - Tests of SEE using ions (^{12}C, ^{16}O) from Pelletron accelerator at IF-USP



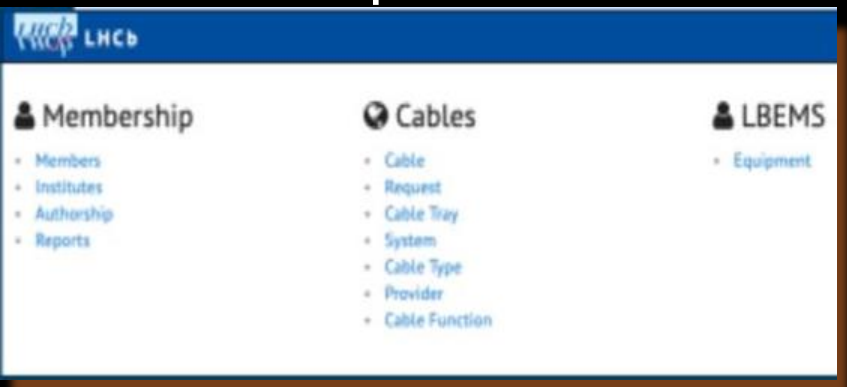
Physics Analysis

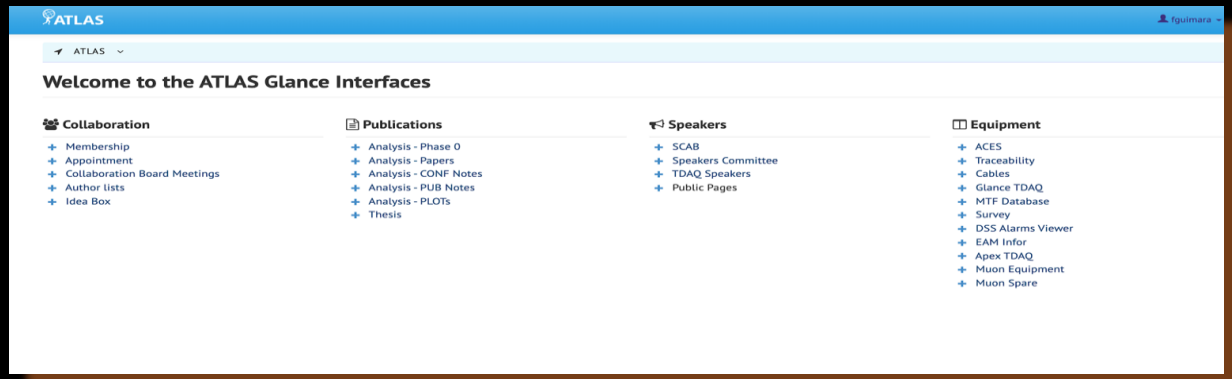
- Participation in several analysis working groups
  - Higgs
  - Standard Model
  - Heavy Ions
  - ALP (Neural Ringer application)
- All analysis steps
  - Coordination
  - MC validation
  - Data preparation/framework development
  - Background evaluation
  - Signal extraction
  - Support note/paper elaboration

Fence Framework Service



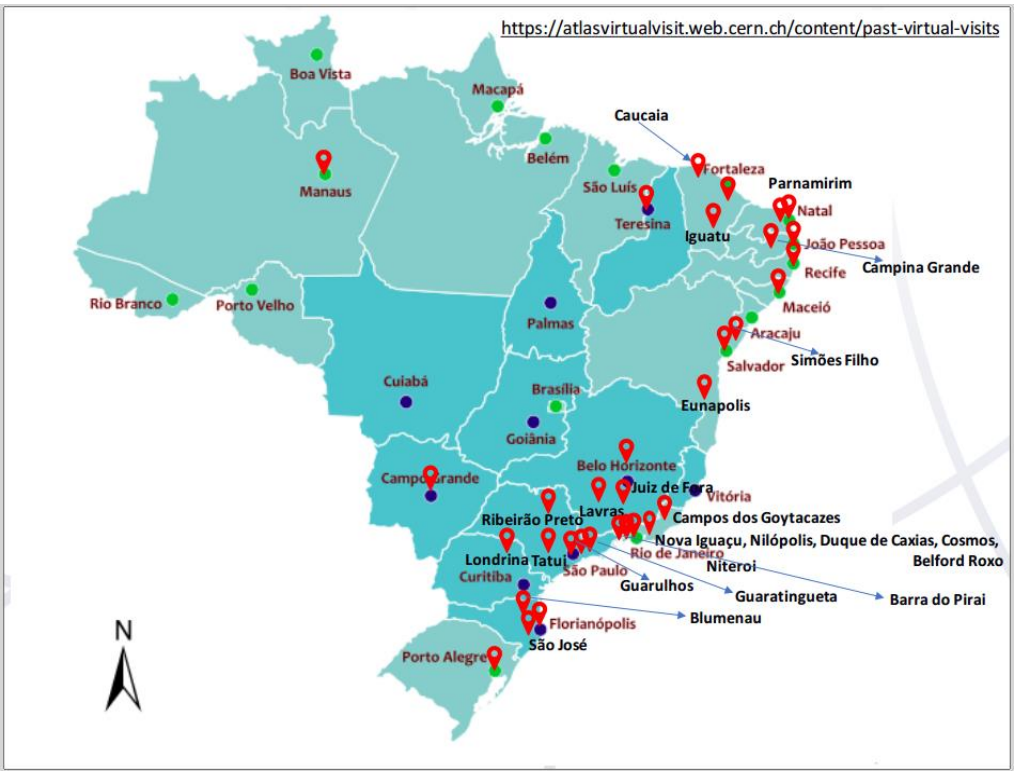
- A framework that gathers the required knowledge for building knowledge systems suitable to CERN
  - Different blocks are assembled together in a standard fashion, ie: DB connection as procedural system functions, user-oriented interfaces
  - High level of configuration for attempting different users 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



IPPOG - Masterclasses in Brazil

***São Paulo** includes students from the cities:*
São Paulo
Santo André
Bauru
Guaratinguetá
Ilha Solteira
Presidente Prudente
Rio Claro
Ribeirão Preto
and many others

Campos do Jordão, Pindamonhangaba, Guaratinguetá

***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