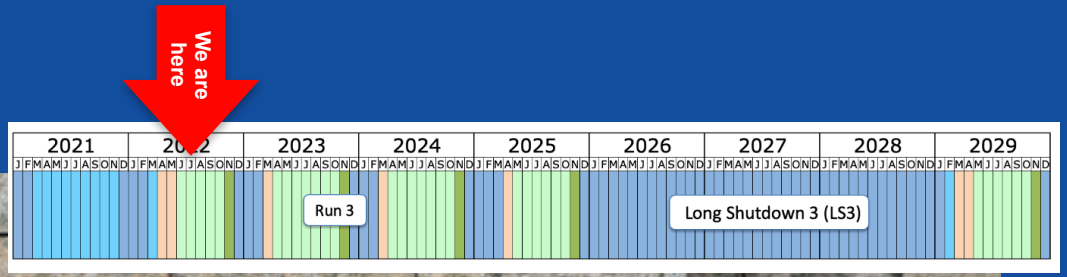
ATLAS Physics & Operations

Inês Ochoa on behalf of LIP ATLAS

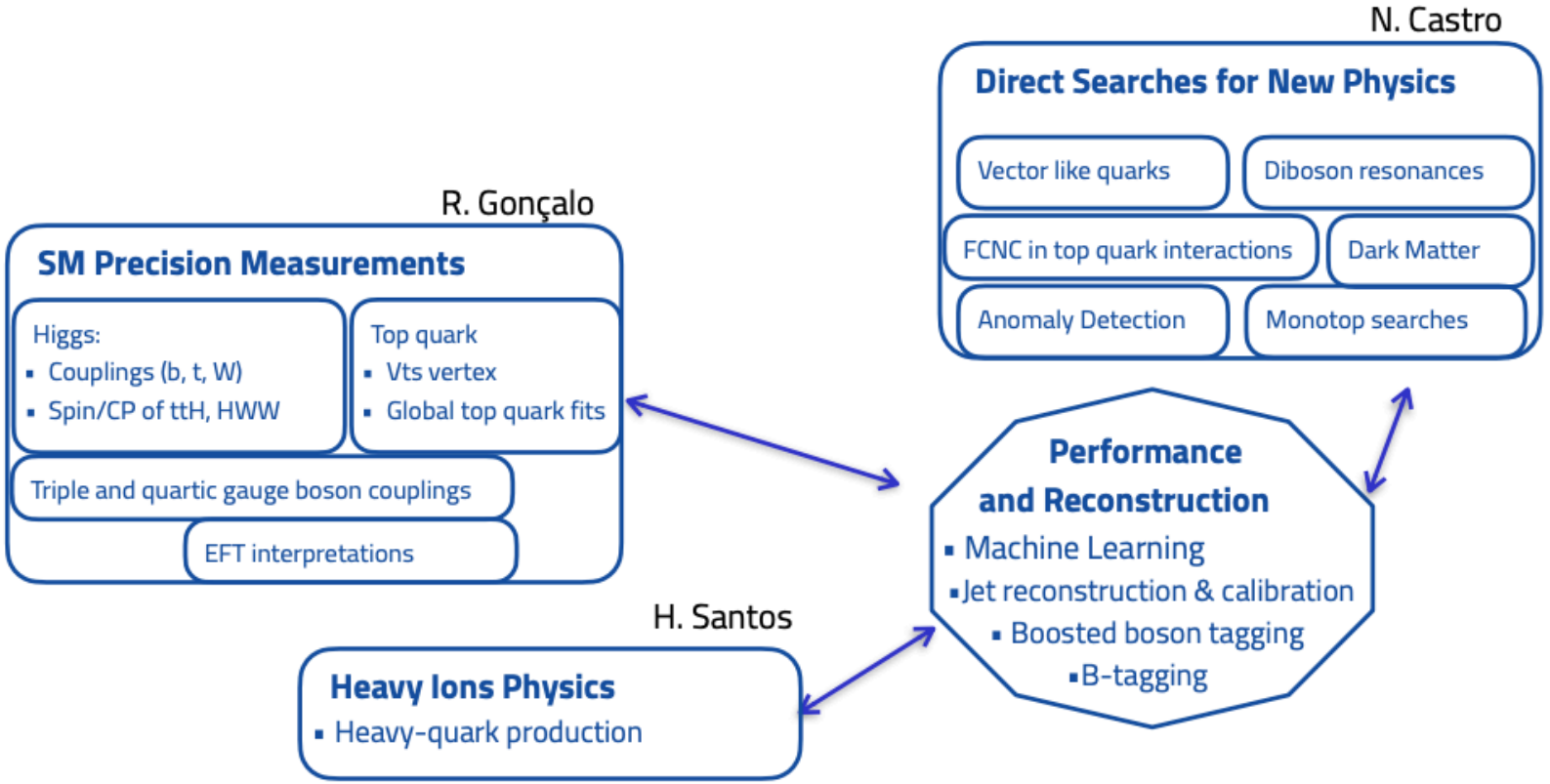
July 8, 2022

The LIP ATLAS team



Physics

Overview

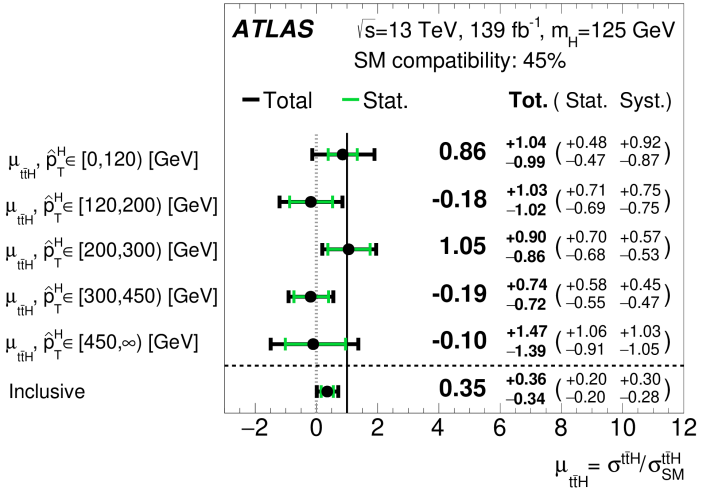

N. Castro
Direct Searches for New Physics
Vector like quarks
Diboson resonances
FCNC in top quark interactions
Dark Matter
Anomaly Detection
Monotop searches
R. Gonçalo
SM Precision Measurements
Higgs:
Couplings (b, t, W)
Spin/CP of ttH, HWW
Top quark
Vts vertex
Global top quark fits
Triple and quartic gauge boson couplings
EFT interpretations
Performance and Reconstruction
Machine Learning
Jet reconstruction & calibration
Boosted boson tagging
B-tagging
H. Santos
Heavy Ions Physics
Heavy-quark production

Higgs Boson 🎂 properties (I)

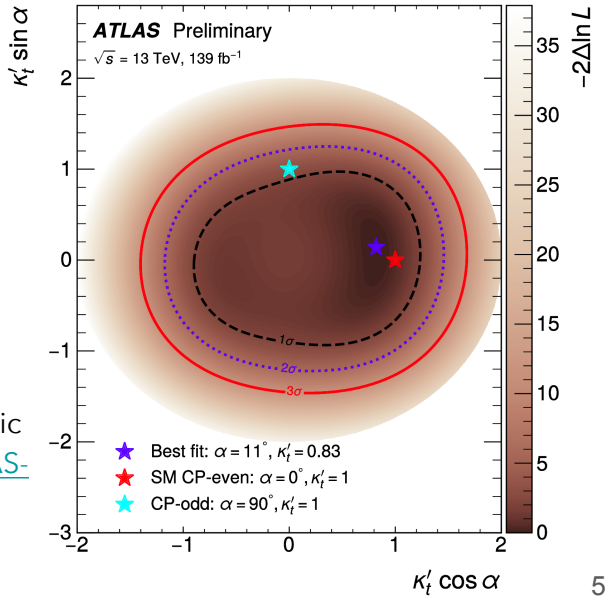
Luísa Carvalho, Luís Coelho, Ricardo Gonçalo, Patricia Muiño, António Onofre

Higgs boson produced in association with top quarks

- First **differential measurement** of $t\bar{t}H$ signal strength in bins of Higgs p_T: JHEP 06 (2022) 097
- Measuring **CP properties** of the Higgs-top Yukawa coupling:
  - Pure CP-odd coupling disfavoured at 1.2σ.



$$\mathcal{L}'_{t\bar{t}H} = -\kappa'_t y_t \phi \bar{\psi}_t (\cos\alpha + i\gamma_5 \sin\alpha)\psi_t$$



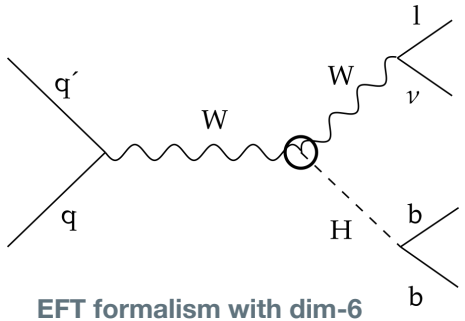
Preliminary results public for Moriond 2022: ATLAS-CONF-2022-016

Ricardo Barrué, Patricia Muiño, Rui Santos

Higgs Boson 🎂 properties (II)

Higgs boson produced in association with a W: $WH(b\bar{b})$

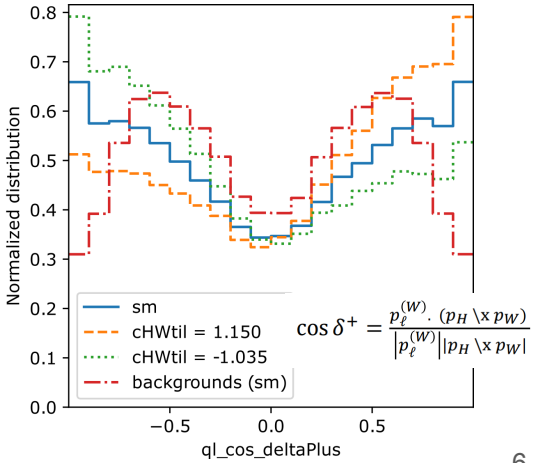
- Search for **CP-odd couplings** in HWW vertex:
  - Studying sensitivity of energy-related and angular observables to interference and/or quadratic EFT terms.
  - Exploring **novel simulation-based inference** methods.



EFT formalism with dim-6 operator $c_{\tilde{HW}}$

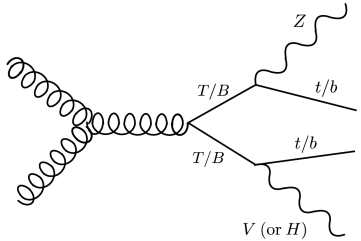
Observable	$c_{\tilde{HW}}$ S+B 95% CL (L= 300 fb^-1)
1D: transverse momentum of W boson	[-1.62,1.62]
2D: W boson transverse momentum x transverse mass of WH system	[-1.4,1.4]
1D: $Q_\ell \times \cos\delta^+$	[-0.227,0.227]
2D: W boson transverse momentum x $Q_\ell \times \cos\delta^+$	[-0.088, 0.088]
MVA: SALLY, w/ final state particle 4 vectors	[-0.067, 0.067]
MVA: SALLY, w/ final state particle 4 vectors + 3 angular observables	[-0.062, 0.062]

Sensitivity to interference terms only: MVA methods outperform.
In the presence of quadratic terms, 2D analysis yields best results.



Tiago Vale, Nuno Castro

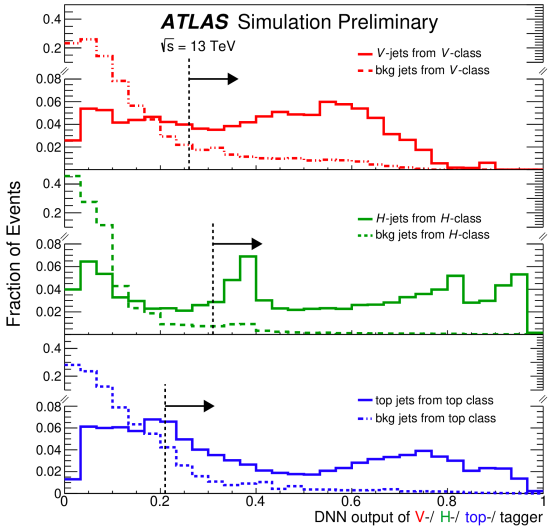
Exotic searches (I)

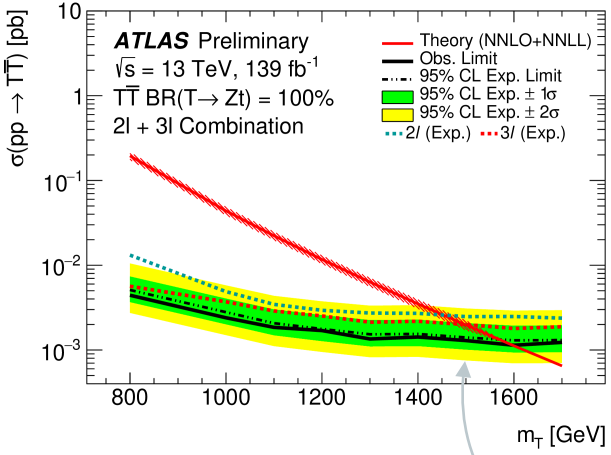


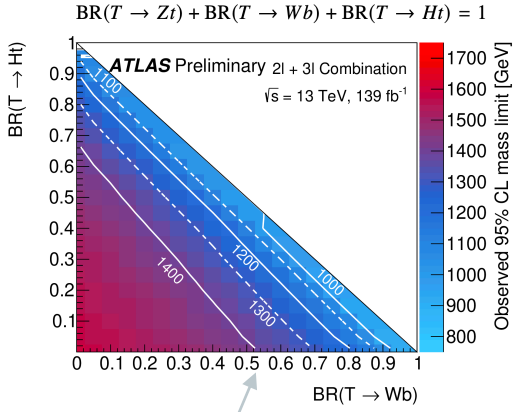
Preliminary result for 2021 summer conference: ATLAS-CONF-2021-024

Search for vector-like-quarks

- **Pair-production of T or B quarks** in Zt/b + X, where X = hadronic decays of W,Z,H + t/b.
- Neural-network boosted V/H/top tagger using large-radius jets reclustered from small-radius jets.







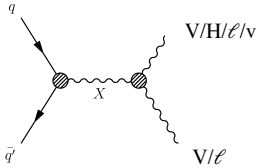
95% CL limits on benchmark models or for combinations of decay channels.

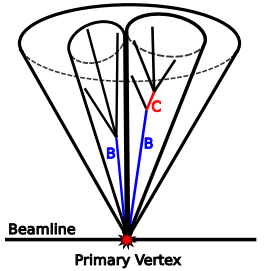
Exotic searches (II)

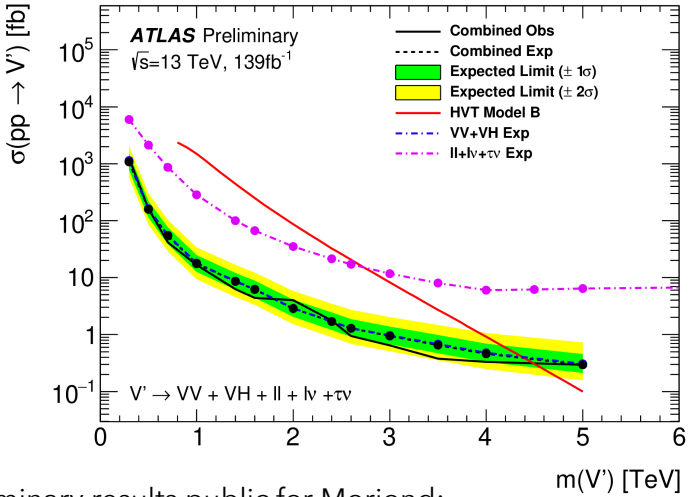
Artur Semião (BII), Augustin Vestner (CERN summer student), Inês Ochoa, Marcin Stolarski

Wide program of searches for narrow-width resonances

- **Combination** of heavy resonance searches:
  - $VV : qqqq, \nu\nu qq, \ell\nu qq, \ell\ell qq, \ell\nu\ell\ell$
  - $VH : qqbb, \nu\nu bb, \ell\nu bb, \ell\ell bb$
  - $\ell\nu, \ell\ell, \tau\nu$





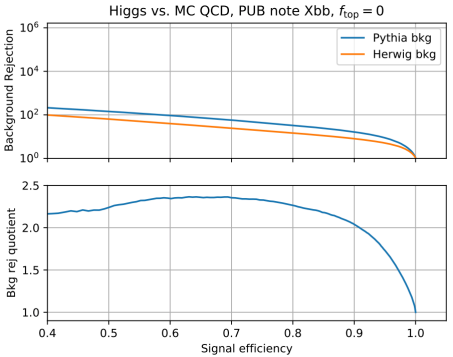


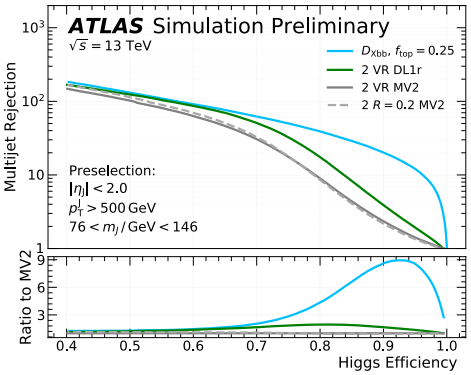
Preliminary results public for Moriond:
ATLAS-CONF-2022-028

Heavy resonances → large boosts:

new $H \to b\bar{b}$ tagger

ATL-PHYS-PUB-2020-019



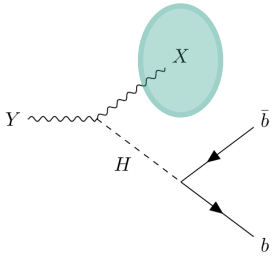


Exotic searches (III)

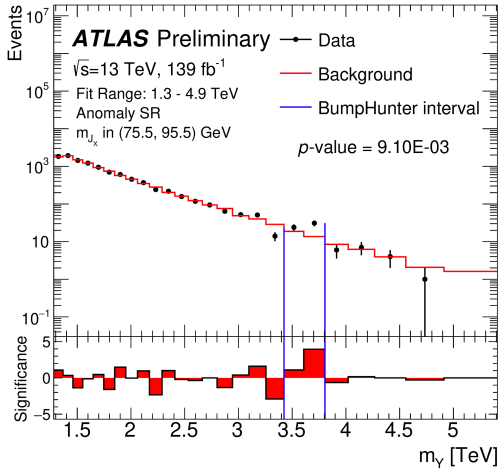
Maura Barros, Nuno Castro, Rute Pedro, short-term involvement of undergrad/internship students Inês Ochoa

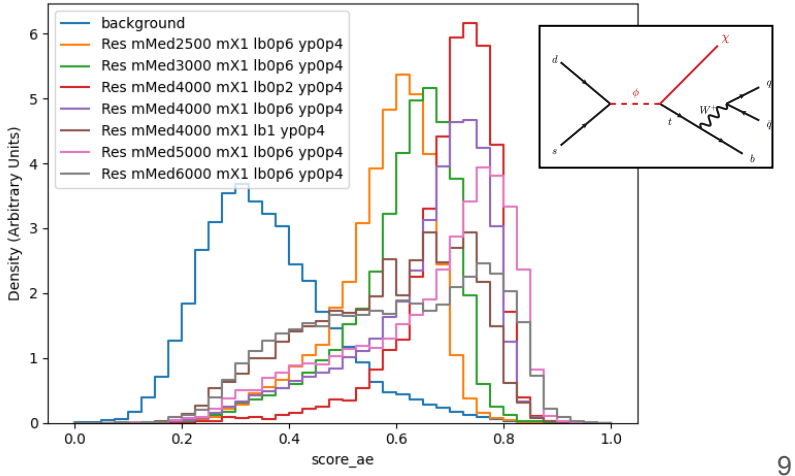
On the forefront of anomaly detection techniques

- Goal is to increase **generality of searches**.
- Mono-top searches: train auto-encoder to learn SM background (mostly $t\bar{t}$ and W/Z+jets). Take reconstruction error as an **anomaly score**.
- $Y \to XH$ resonance search: generic boson X tagged via anomaly score, followed by bump-hunting in m_Y.



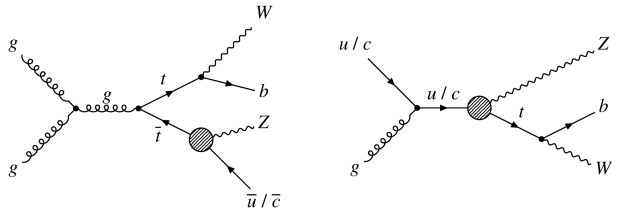
Preliminary results presented *today* at ICHEP: ATLAS-CONF-2022-045





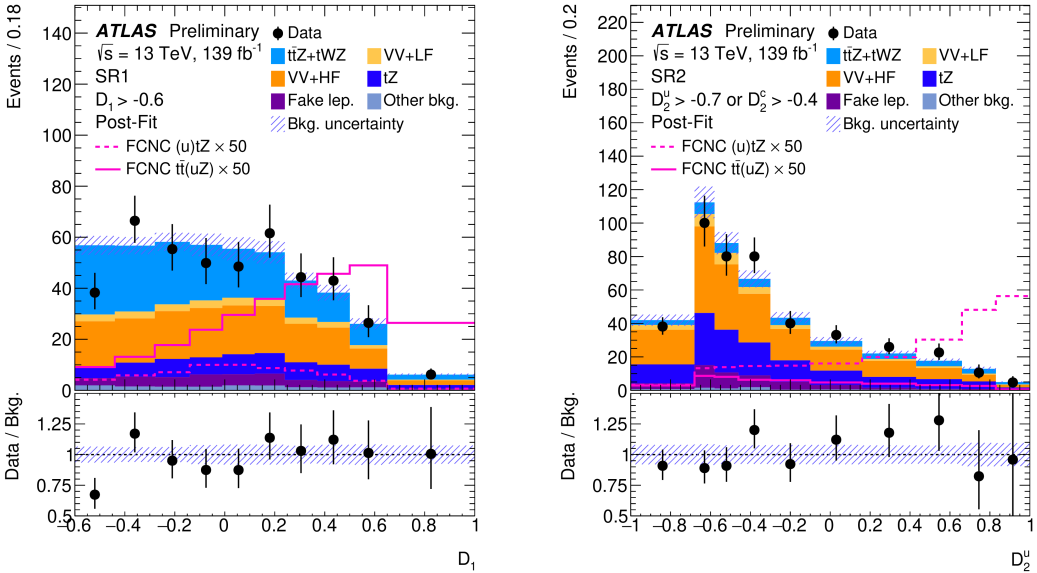
Exotic searches (IV)

Ana Peixoto, Nuno Castro, Filipe Veloso



Flavour changing neutral currents in tZq vertex

- Via top decay in $t\bar{t}$ and via single-top production.



Signal regions for FCNC tZu coupling extraction.

Preliminary result for 2021 summer conference: ATLAS-CONF-2021-049

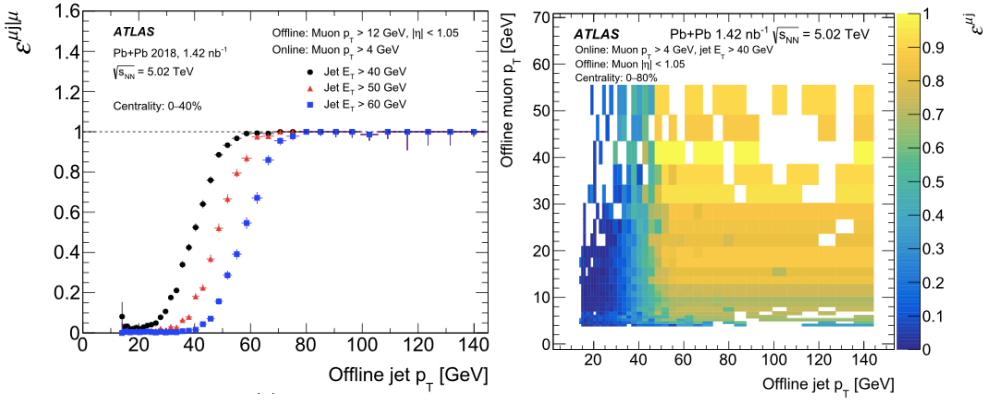
- 95% CL observed limits (left-handed couplings):
  - $BR(t \to Zu) = 6.2 \times 10^{-5}$
  - $BR(t \to Zc) = 13 \times 10^{-5}$
- Factor of 2-3 improvement with respect to previous result
- **Most stringent limits to date.**

Heavy Ion Physics

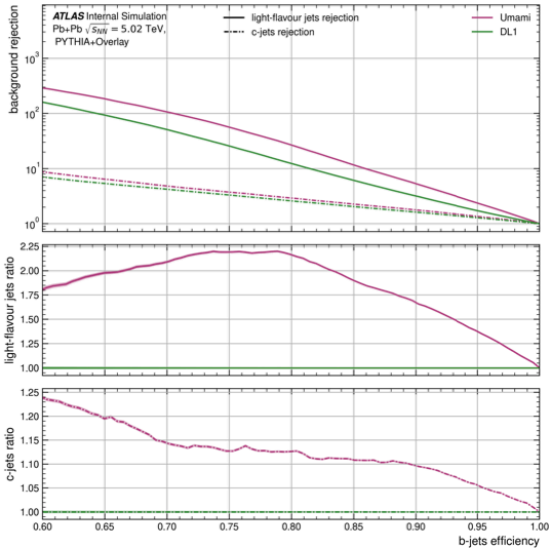
João Pires, Helena Santos, short-term involvement of undergrad/internship students

Heavy flavour jets in Pb+Pb collisions:

- Development and performance study of **b-jet** and **muon-jet triggers**:
  - 3 papers with direct contribution: JINST 15 (2020) P09015, EPJC 81 (2021) 1087, 2204.13530 (submitted to EPJC)
- Development of **b-tagging algorithms:**
  - Impact of low-level taggers in DNN performance - Afonso Azenha, PIC-2022, LIP/IST
  - b-tagging performance in Pythia8 vs Herwig7 - Vicente Mendes, PIC-2022, LIP/IST
  - Hyperparameter optimisation for DL1 algorithm - Mariana Ribeiro, PIC-2022, LIP/IST



Efficiency of *b*-jet trigger as a function of muon and jet p_T



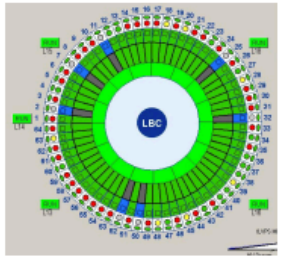
João Pires' Master thesis - LIP/FCUL

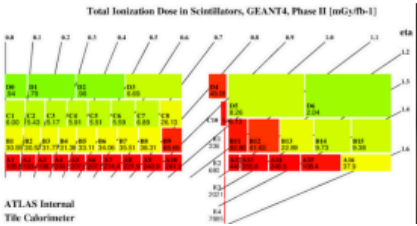
Operations

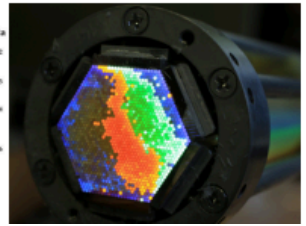
Overview

TileCal
(A. Gomes, R. Pedro)

Leading DCS and Calibration







Distributed computing
(H. Wolters)

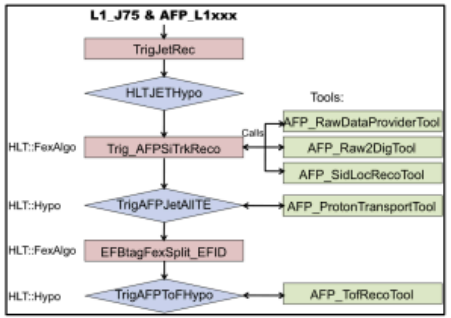
Iberian cloud coordination

Monitoring tools

Tier-2 infrastructure responsibility

Jets HLT
(R. Gonçalo)

Operations, validation



ATLAS Roman Pot Detectors
(P. Conde, N. Castro)

Co-leading DCS

HLT algorithms

Trigger activities

Maura Barros, Luísa Carvalho, Nuno Castro, Patricia Muiño

Ricardo Barrué, Ricardo Gonçalo, Patricia Muiño

AFP dijet central exclusive trigger:

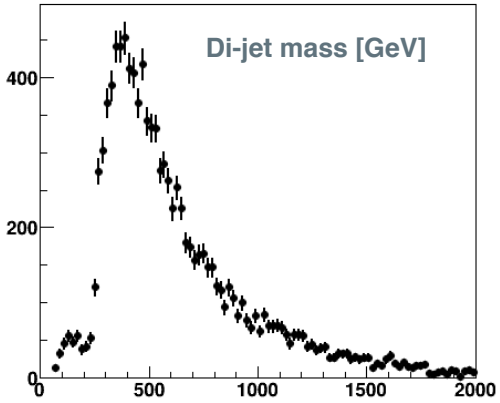
- Development of trigger algorithm **combining information** from jets / leptons reconstructed in central detector with tracks reconstructed in AFP.
- Implementation and validation of trigger chains with different jet p_T thresholds and L1 seeds.

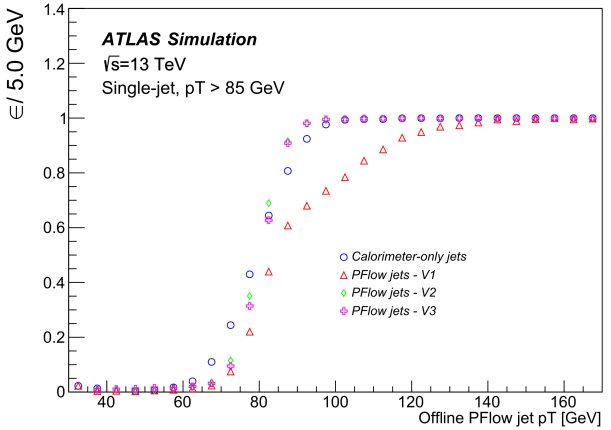
Jet reconstruction @ HLT:

- Optimisation of online reconstruction of PFlow jets taking advantage of new **full event tracking** @ HLT: tuning of calorimeter jet-based preselection and study of tracking selections and primary vertex reconstruction.

Calorimeter trigger @ L1:

- Tuning of p_T thresholds to take advantage of **finer granularity** in L1 calorimeter trigger readout.



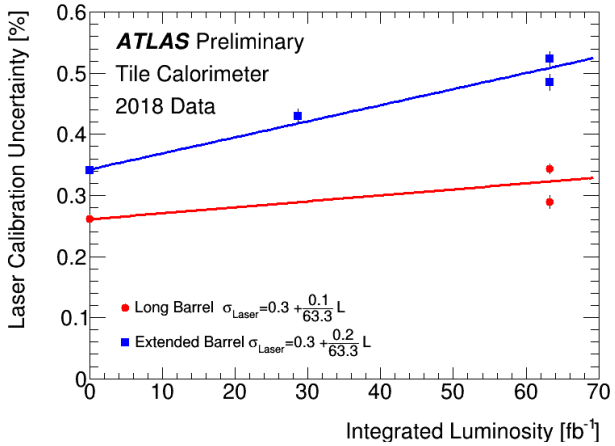


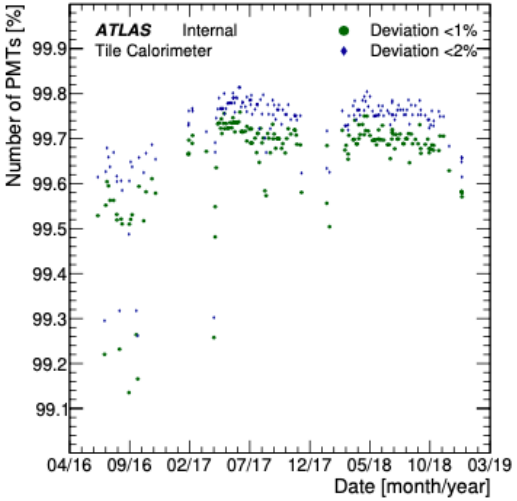
HLT_j85 turn-ons for small-R calo and PFlow jets

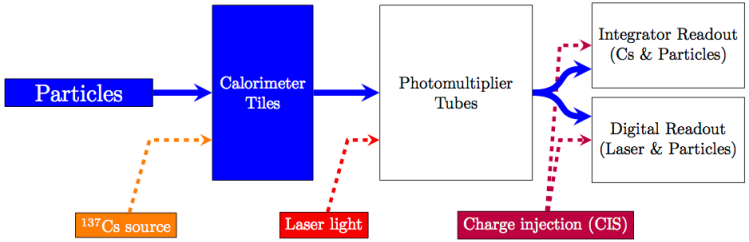
TileCal calibration

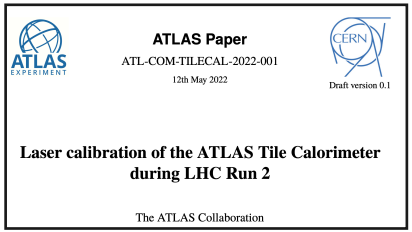
Laser calibration:

- Calibration of photomultipliers with Laser II System:
  - Determination of **uncertainty on PMT calibration constants**.
- Linearity survey of ~10k channels using 2016-2019 data (internal note under review): (99.66±0.11)% of channels with deviations under 1%.
- Paper on upgraded laser system (editor: R. Pedro) under review for JINST submission.








ATLAS Paper
ATL-COM-TILECAL-2022-001
12th May 2022
Draft version 0.1

Laser calibration of the ATLAS Tile Calorimeter during LHC Run 2

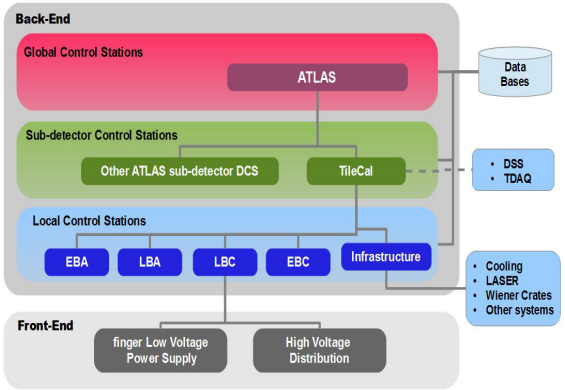
The ATLAS Collaboration

Detector Control Systems

Filipe Martins
Luís Seabra

TileCal Detector Control System:

- Update of control system and development of new components for integration of new hardware:
  - NIM Power supplies for DAQ and Cesium calibration system
  - High Voltage bulk power supplies
  - Cesium calibration system (only monitoring)
- Implementation of new alarm/safety routines.
- **Training sessions** for 24h shift experts held in 2021, more planned for 2022 (F. Martins).



ATLAS Roman Pots DCS (ALFA + AFP):

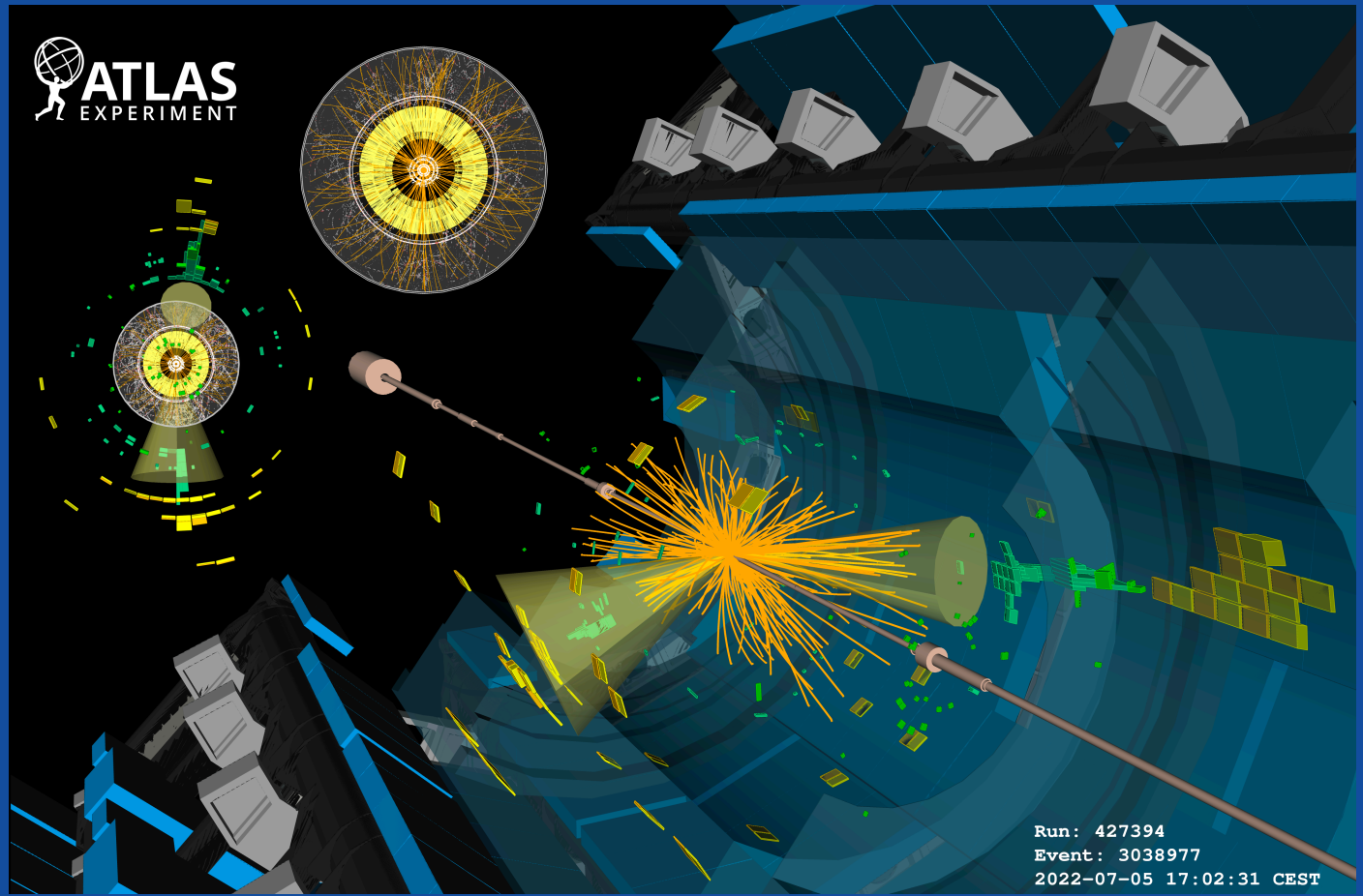
- New DCS equipment: server and power distribution.
- Migration to OPC-UA for HV and LV systems.
- AFP: Vacuum interlock mechanism and ToF integration.
- ALFA: integration of PLC (vacuum system) outside ATLAS network.

Leadership roles within collaboration

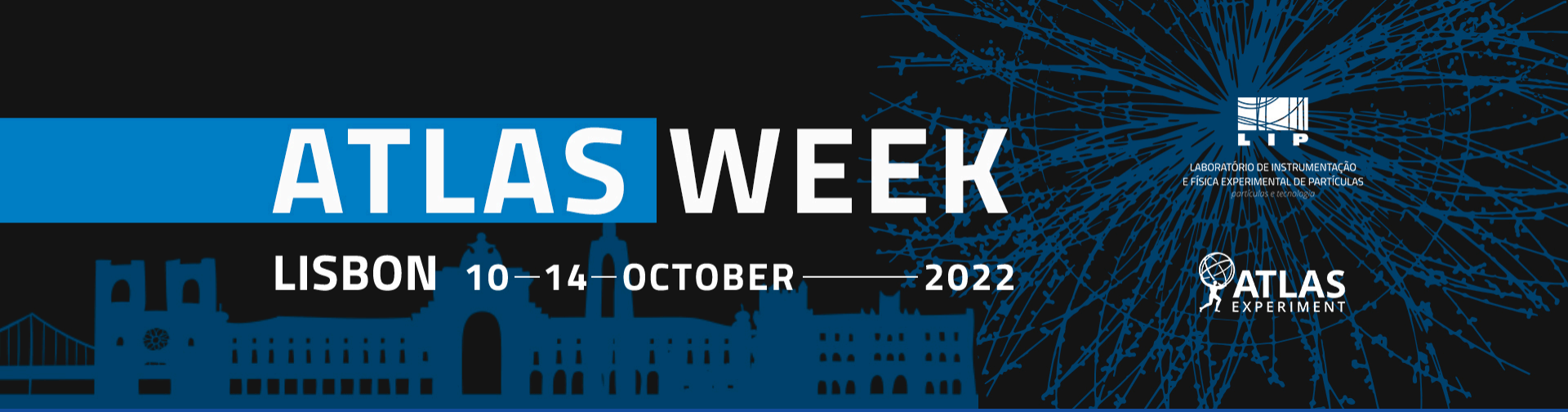
Overview of activities and leadership roles

- P. Conde Muíño: member of the ATLAS Executive Board (March 2019 - February 2021)
- H. Wolters: coordinator of the Iberian Cloud
- H. Wolters: responsible for the Portuguese Federated Tier2 in the Iberian Cloud Squad
- H. Wolters: member of the ATLAS International Computing Board
- H. Santos: member of the Publications Committee
- H. Santos: member of the Authorship Committee
- N. Castro: member of the Speakers Committee.
- N. Castro: coordinator of gitlab/continuous integration team for the Physics Office.
- N. Castro: coordinator of LHC Effective Field Theory Working Group
- I. Ochoa: convener of Diboson searches group (2020-2022)
- I. Ochoa: coordinator of Physics Validation group (2019-2021)
- L. Carvalho: trigger contact for HTop group
- F. Martins: TileCal DCS Development / Maintenance and Coordination
- R. Pedro: TileCal Coordination of Calibration
- H. Santos: TileCal Run Coordinator (2020)
- L. Seabra: ALFA and AFP Deputy DCS Coordination
- H. Santos: Interlocks coordinator for HGTD

First 13.6 TeV collisions last Tuesday! 🍾🍾🍾



Looking forward to Run 3… 🥳



https://www.lip.pt/events/2022/atlasweek/

…and to welcoming our collaborators in Lisbon next October, for the ATLAS Collaboration Week.

Backup