The electroweak sector
of the SM and Run-3 operations
WG-2

Status Report

FAPESP Thematic 2020/04867-2

May. 22nd 2024

Marco Leite - IFUSP

1. **Physics analysis**

    1.1. Precision measurements in SM

    1.2. HH→ bb$\tau\tau$

2. **Operations**

    2.1. Run-3 data taking

3. **Phase-II upgrade**

    3.1. Report will go on WG-5.2

Perspectives for the next months highlighted in blue

ATLAS Note

ANA-STDM-2018-41-INT1

21st May 2022

Draft version 0.1

Double-differential charged-current Drell-Yan cross sections at high transverse masses in pp collisions at $\sqrt{s} = 13$ TeV

Tim Beumker[a], Christoph Dingel[a], Frank Ellinghaus[a], Alison Elliot[b], Uta Klein[c], Johanna Kraus[a], Marco Leite[d], Jesal Mandalia[b], Michael O'Keefe[c], Eram Rizvi[b], Frederic Schröder[a]

[a]*Bergische Universität Wuppertal*
[b]*Queen Mary University of London*
[c]*University of Liverpool*
[d]*University of Sao Paulo*

Details on
[kick-off meeting](#)

- On-going analysis, EB interaction
- ~~Wrap-up still this year (2023?)~~ (SM Approval meeting done, note finalization, publication 2024)
- Unfolding tests and model systematics (Sherpa, PowhegPythia)
- **M. Leite**
  - Rivet routine for particle level kinematics
  - New Sherpa validation
- ~~Aiming to publication in 2023~~ (2024) - no more people will be involved

Details on
kick-off meeting

- Spin-off : ΓW (starting with some prospect studies in 2023).
  - Run-3 luminosity
  - MS student (P. Mascarenhas) working on this
  - MC Only - Sherpa 2.2.14
  - In touch with ATLAS PMG to generate samples with ΓW variations
  - Rivet only based analysis (ATLAS implementation) -> **Already working !**
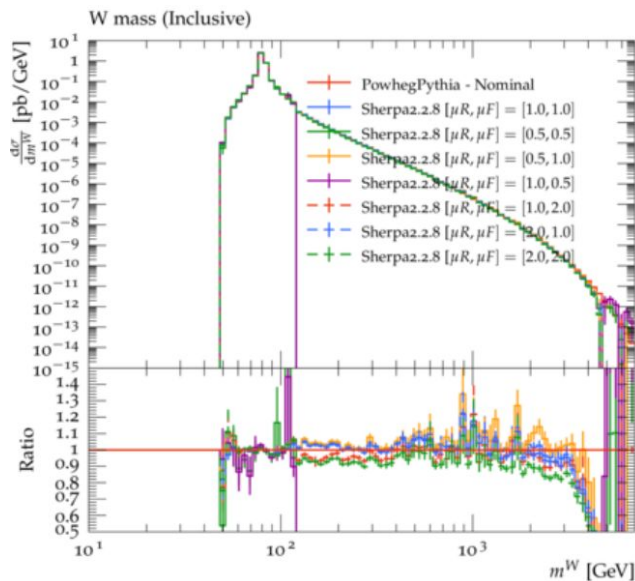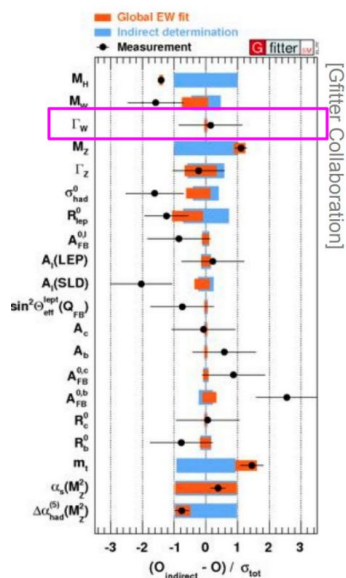
ATLAS Note

ANA-STDM-2021-10-INT1

13th January 2023

Draft version 0.3.1

Measurements of high-mass di-lepton production with at least one τ-lepton and a search for leptoquarks with couplings to third-generation fermions at $\sqrt{s}$ = 13 TeV with the ATLAS detector

Alderweireldt, Sara[c], Bauce, Matteo[d], Butterworth, Jonathan[b], Corradi, Massimo[d], Daumann, Caio Cesar[e], Farrington, Sinead[c], Giagu, Stefano[d], Gutschow, Christian[b], Hamity, Guillermo Nicolas[c], Hays, Chris[a], Hrynova, Tetiana[f], Juzek, Monika Katarzyna[g], Koch, Simon Florian[a], Lisboa Leite, Marco[e], Morodei, Federico[d], Mueller, Roman[h], O'Neill, Aaron Paul[h], Padovano, Giovanni[d], Pleskot, Vojtech[k], Pollard, Chris[a], Richter-Was, Elzbieta[i], Rieck, Patrick[j], Yue, Luzhan[b], Zhu, Yuanda[b]

[a]University of Oxford (GB)
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[c]The University of Edinburgh (GB)
[d]Sapienza Universita e INFN, Roma I (IT)
[e]Universidade de Sao Paulo (BR)
[f]Centre National de la Recherche Scientifique (FR)
[g]Polish Academy of Sciences (PL)
[h]Universitaet Bern (CH)
[i]Jagiellonian University (PL)
[j]New York University (US)
[k]Charles University (CZ)

- Ongoing Run-2 analysis,
- EB ongoing (Lepton+X)
- Target is summer conferences 2024 (postponed)
- **C. Daumann** (MS) : mass reconstruction (✅ April)
- **R. Macedo** (MS) :τ reconstruction
- **Long range analysis (beyond Run-3)**, will also involve charged current, new interpretations etc.
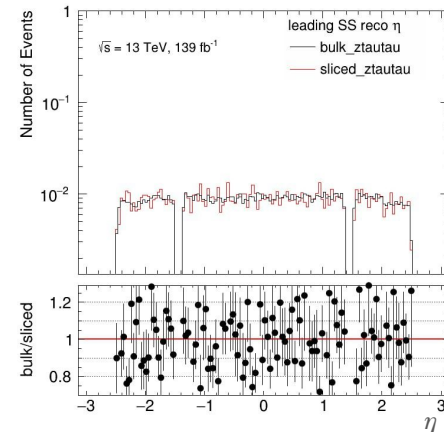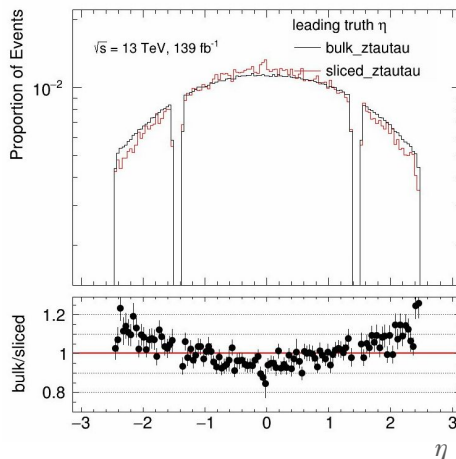
Details on <u>kick-off meeting</u>

ATLAS CONF Note

ATLAS-CONF-2023-071

25th November 2023

Search for the non-resonant production of Higgs boson pairs via gluon fusion and vector-boson fusion in the $b\bar{b}\tau^+\tau^-$ final state in proton-proton collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector
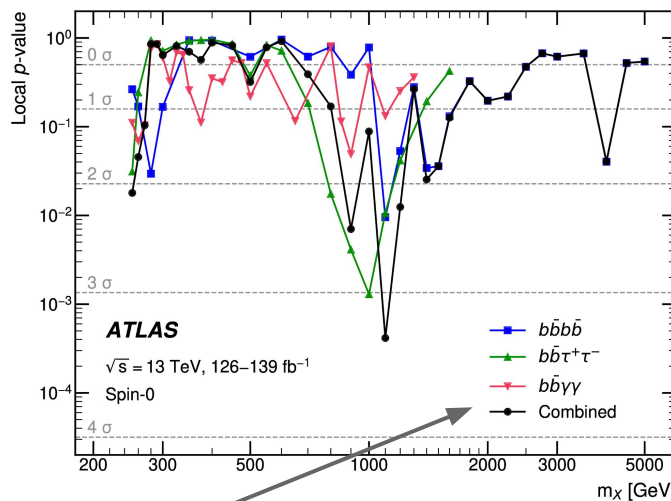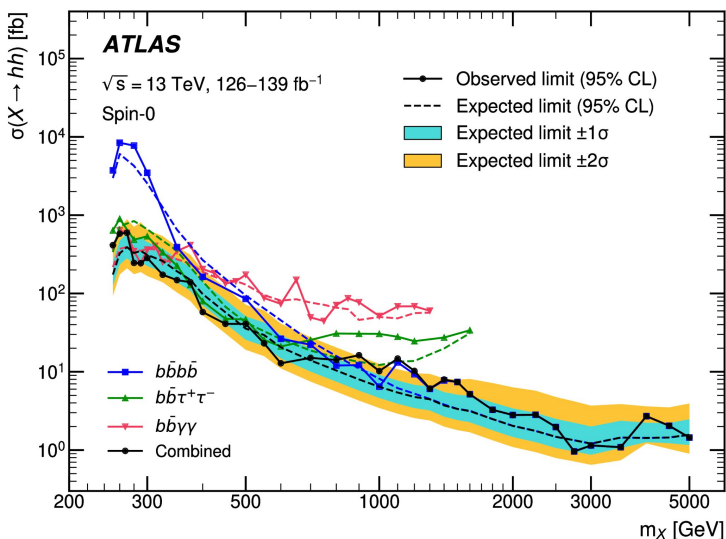
The ATLAS Collaboration

- Full Run-2 dataset analysis with focus on κ_λ and κ_{2V} optimisation
- **M. Donadelli :**
  - contact editor, MVA analysis strategy, VBF/ggF categorisation
  - contributions in : $\tau_{had}\tau_{had}$ and $\tau_{lep}\tau_{had}$ channels
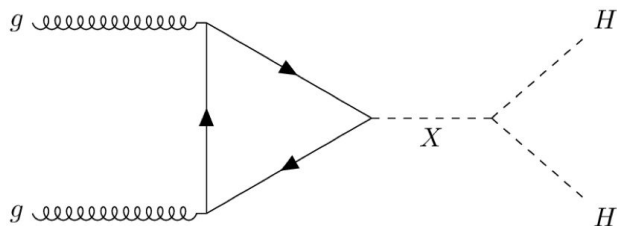
Accepted by Phys. Rev. Lett.

Details on
kick-off meeting

- Combination
- most sensitive channels: bbbb, bb$\tau\tau$ and bb$\gamma\gamma$
- 251 GeV - 5 TeV (resolved and boosted regimes)
- improvement of a factor of 2-5, depending on m_X with respect to previous ATLAS result (Phys. Lett. B **800** (2020) 135103)
- excess at 1 TeV (3.3 σ local): will be an interesting follow-up with new data and improved techniques

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Focus efforts on HH →bb$\tau\tau$

- **Di-Higgs analysis is a _flagship and high profile LHC analysis_**
- **Very large effort in ATLAS and CMS**
- **New PostDoc (Hajar Imam) joyned us since March 2024**
  - **Welcome Hajar 🎉 !**
- **Tasks for this analysis :**
  - **New analysis framework (_easyjet_)**
  - **New format for the data containers**
  - **Trigger validation on semi-leptonic channel**
  - **Performance studies (compare with Run-2)**
- **ATLAS PO now is enforcing that all new analyses to contribute with Software and Performance**
- **2025 :Early Run-3 with HH->bbbb, HH->bb$\tau\tau$, HH->bb$\gamma\gamma$**
- **202x : All Run-3 with all channels**
- **202x : Run2+Run3**

(See Marisilvia's slides for a discussion on these)
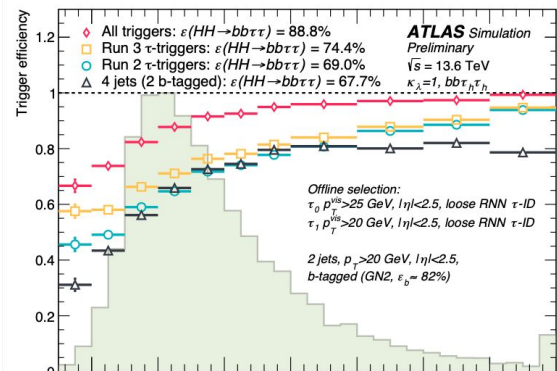
Tau trigger public results

	bb	WW	$\tau\tau$	ZZ	$\gamma\gamma$
bb	34%				
WW	25%	4.6%			
$\tau\tau$	7.3%	2.7%	0.39%		
ZZ	3.1%	1.1%	0.33%	0.069%	
$\gamma\gamma$	0.26%	0.10%	0.028%	0.012%	0.0005%

HH → bb$\tau\tau$ modeling systematics *(H. Imam)*

- Objective:
  - Enhance the accuracy of our analysis by addressing uncertainties in the modeling of the HH → bb$\tau\tau$ process.

- Examples of Systematics:
  - b-tagging Uncertainties: Variations in b-jet identification.
  - Scale Variations (muR, muF): Changes in renormalization (muR) and factorization (muF) scales.
  - PDF Uncertainties: Differences in Parton Distribution Functions.
  - NNLO Reweighting: Higher-order corrections.
  - Fake Factor Systematics: Handling fake τ contributions.

- Current work:
  - Use new functionality to read and apply systematic variations using histograms, and integrate that on the new analysis framework developed by the analysis team.
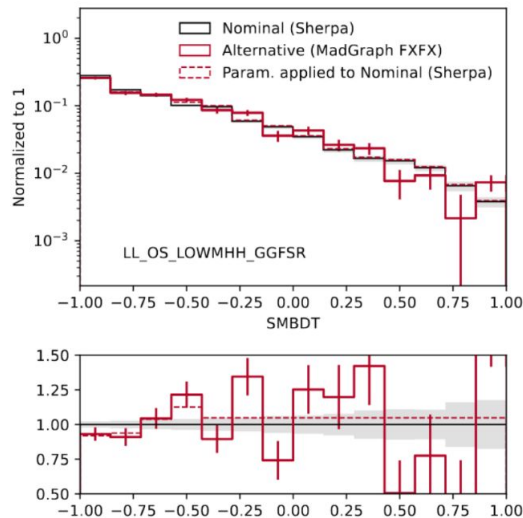
Background modelling uncertainties on MC-based processes: Ex. ttbar BDT score distribution for Sherpa vs. MadGraph in τhadτhad SRs

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# WG-2: **Strategy for the next months**

Focus efforts on HH →bb$\tau\tau$

- **This analysis will also lay the groundwork for the HL-LHC HH program**
- **Large intersection with HGTD for pile-up mitigation**
  - **VBF signatures**
- **HL-LHC will test the Higgs self-interaction with 95% CL**
- **Need new tracking strategies to cope with the Physics requirements (see WG 5.2 presentation)**

- Liquid Argon Calorimeter Operations
- Phase-I Upgrade Liquid Argon Trigger Digital Board (LTDB) commissioning studies
- **R. Estevam (PhD) : 2 very important contributions**
  - ADC non-linearities and calibration across all calorimeter ($\sim$320ch x 128 boards)
  - Baseline correction of performance studies for LATOME firmware with offline data
  - Very important for 2023 ($<\mu> = 60\sim70$) - developed code being used for validation
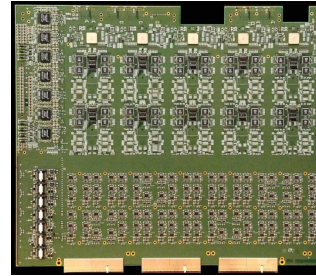
ATLAS internal note in preparation :
https://cds.cern.ch/record/2863410/files/ATL-COM-LARG-2023-019.pdf

ATLAS Note
GROUP-2021-XX
16th February 2024

Draft version 0.1

ATLAS Liquid Argon Calorimeter Digital Trigger Board (LTDB) digitizer calibration and linearities studies

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[a]Universidade de São Paulo, [b]CERN

During the Large Hadron Collider's (LHC) second Long Shutdown (LS2, 2018-2022) the trigger system of the ATLAS Liquid Argon Calorimeters (LAr) went through a significant upgrade. It aimed to enhance the physics reach of the experiment during the upcoming operation at increasing LHC luminosities. The ATLAS experiment operated at a maximum average number of collisions per beam crossing ($<\mu>$) of 40 during the Run 2 data taking period (2015-2018). For Run 3 (2022-2025), the current plan aims to reach a luminosity levelled to $2\times10^{34}\text{cm}^{-2}\text{s}^{-1}$, with a $<\mu> \approx 80$. If the currently used LAr trigger readout system was to remain unchanged, the transverse energy (E_T) trigger thresholds would need to be raised, degrading the physics performance. To prevent this efficiency loss, the new system increases the readout granularity by up to a factor of ten: instead of summing the E_T of calorimeter cells in towers of $\Delta\eta \times \Delta\phi = 0.1 \times 0.1$, it introduces additional lateral and longitudinal segmentation to form smaller clusters called Super Cells. One Super Cell can thus cover a region as small as $\Delta\eta \times \Delta\phi = 0.025 \times 0.1$, depending on which longitudinal layer it is located in. The new trigger system front-end (LAr Trigger Digitizer Board - LTDB) digitizes the Super Cell information which allows for shower shape parameter calculation at the Level-1 trigger stage, thereby increasing the trigger rejection power while retaining high efficiency. In this document, we present studies done on the LTDB's Analogue to Digital Converters (ADCs) to evaluate their performance regarding linearity. The analysis is done by injecting current into the calorimeter to recreate the transfer function of the ADCs' channels responsible for each Super Cell. From the transfer function, we investigate the effects of non-linearity errors on that channel. The ADCs need to be calibrated to prevent effects from non-linearity errors, which is done by loading the appropriate calibration constants. The created framework was proven capable of detecting channels with bad calibration and to tune the calibration constants based on the analysis evaluation.

Support on Operations (data-taking)

- Presence at CERN: Class-2 & 3 Shifts
  - Need planning with analysis and HGTD activities
- Marisilvia provided important contribution in the past year while at USP
  - LAr data quality expert
  - but FAPESP only supports travel from researchers from São Paulo

- All analysis : on track (benefit from ATLAS pace and organization)
  - Regular reports on ATLAS analysis groups
- Commitments on Run 3 operations → LAr subsystem
  - Already took 83 fb^{-1}(2022+2023+2024)
  - Only 2 years left before Long Shutdown !

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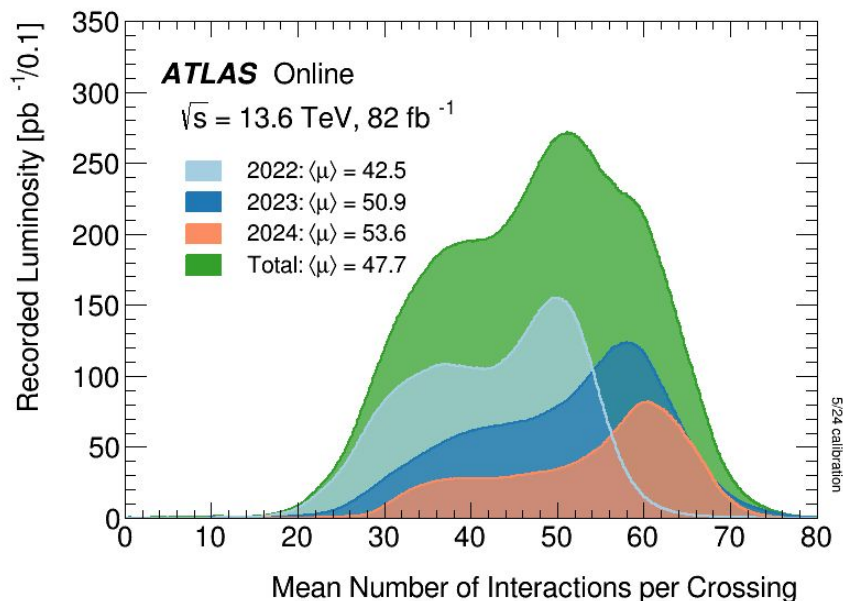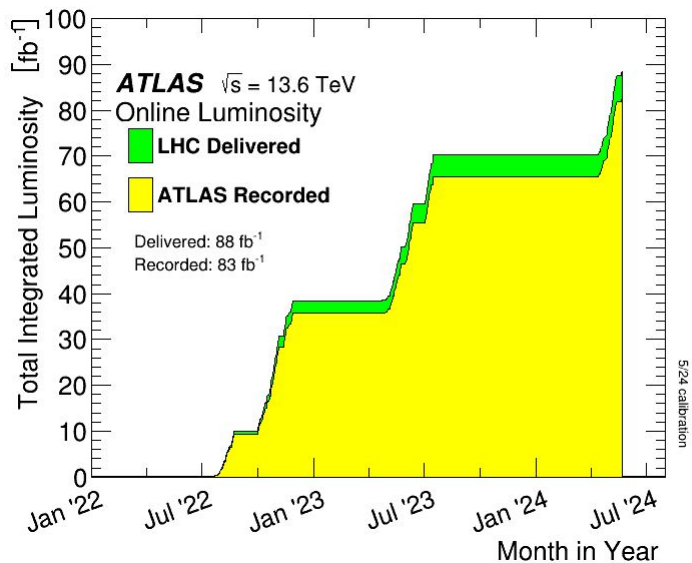
Backup

WG-2: **Deliverables**

- ATLAS journal publications during the period (10/2023 -> today)
  - **ATLAS Collaboration** : 52
- ATLAS editorial Boards :
  - **ML**: *"Measurement of The Lund Jet Plane in ttbar Events"* (ANA-STDM-2020-31)
  - **MD**:*"A search for decays of the Higgs boson into a pair of pseudoscalar particles in the bbττ final state using pp collisions at √s= 13 TeV with the ATLAS detector"* (ANA-HDBS-2021-07)
- ATLAS appointments :
  - **MD**: ATLAS HDBS Monte Carlo contact - (Aug. 2023 - Aug. 2025)
  - **MD:** Higgs and di-boson searches (HDBS) HEPData Validator: (Jan 2024 -> Jan 2026)
  - **ML**: ATLAS Upgrade Speakers Committee (04/2020 -> 04/2024, Chair 2023->)
  - **ML**: ATLAS Upgrade Steering Committee (Member, 04/2020 -> 04/2024)
  - **ML**: ATLAS International Computing Board (Member)
- ATLAS presentations in ATLAS internal meetings
  - **ALL**: SM, Higgs, LAr, HGTD
- ATLAS presentation in conferences
  - **ML**: Precision measurements of jet and photon production at ATLAS (EPS-HEP 2023)