

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

Status Report

FAPESP Thematic 2020/04867-2

October 04<sup>th</sup> 2023

Marisilvia Donadelli - IFUSP



## 1. Physics analysis

1.1. Precision measurements in SM

1.2.  $HH \rightarrow bb\tau\tau$

## 2. Operations

2.1. Run-3 data taking

2.2. Phase-I commissioning

## 3. Phase-II upgrade

3.1. Report will go on WG-5.2

Perspectives for the next years highlighted in blue

# WG-2: Physics analysis report 1: Run 2 High mTW



**ATLAS Note**

ANA-STDM-2018-41-INT1

21st May 2022



Draft version 0.1

Details on [kick-off meeting](#)

1

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

- On-going analysis, EB interaction
- Wrap-up still this year (?)
- Unfolding tests and model systematics (Sherpa, PowhegPythia)
- **M. Leite**
  - Rivet routine for particle level kinematics
- Aiming to publication in 2023 - no more people will be involved
- **Spin-off :  $\Gamma W$  (starting with some prospect studies in 2023). Includes Run-3**

# WG-2: Physics analysis report 2: Run 2 $Z \rightarrow \tau\tau$



**ATLAS Note**  
ANA-STDM-2021-10-INT1  
8th August 2022




1

2 **Measurements of high-mass production of  $\tau$ -lepton**

3 **pairs at  $\sqrt{s} = 13$  TeV with the ATLAS detector**

*Details on*  
[\*kick-off meeting\*](#)

- On-going Run-2 analysis, aiming at EB @ end of the year
- Full day workshop in October to push the analysis
- **C. Daumann** (MS finalised)
  - mass reconstruction studies 
- **R. Macedo** (MS)
  - $\tau$ Fake factors and fake rates
- **New student** (MS) may start next year
- **Long range analysis (beyond Run-3)**, will also involve charged current, new interpretations etc.

# WG-2: Physics analysis report 3: Run 2 HH $\rightarrow$ bb $\tau\tau$



PUBLISHED FOR SISSA BY SPRINGER

RECEIVED: September 23, 2022

REVISED: December 20, 2022

ACCEPTED: February 5, 2023

PUBLISHED: July 5, 2023

**Search for resonant and non-resonant Higgs boson pair production in the  $b\bar{b}\tau^+\tau^-$  decay channel using 13 TeV  $pp$  collision data from the ATLAS detector**



The ATLAS collaboration

E-mail: [atlas.publications@cern.ch](mailto:atlas.publications@cern.ch)

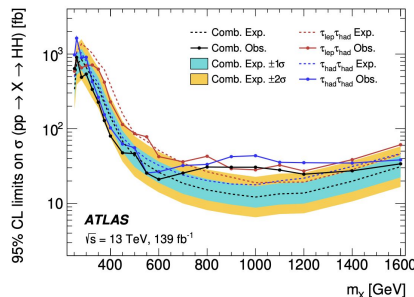
**ABSTRACT:** A search for Higgs boson pair production in events with two  $b$ -jets and two  $\tau$ -leptons is presented, using a proton-proton collision dataset with an integrated luminosity of  $139\text{ fb}^{-1}$  collected at  $\sqrt{s} = 13\text{ TeV}$  by the ATLAS experiment at the LHC. Higgs boson pairs produced non-resonantly or in the decay of a narrow scalar resonance in the mass range from 251 to 1600 GeV are targeted. Events in which at least one  $\tau$ -lepton decays hadronically are considered, and multivariate discriminants are used to reject the backgrounds. No significant excess of events above the expected background is observed in the non-resonant search. The largest excess in the resonant search is observed at a resonance mass of 1 TeV, with a local (global) significance of  $3.1\sigma$  ( $2.0\sigma$ ). Observed (expected) 95% confidence-level upper limits are set on the non-resonant Higgs boson pair-production cross-section at  $4.7$  ( $3.9$ ) times the Standard Model prediction, assuming Standard Model kinematics, and on the resonant Higgs boson pair-production cross-section at between 21 and  $900\text{ fb}$  ( $12$  and  $840\text{ fb}$ ), depending on the mass of the narrow scalar resonance.

**KEYWORDS:** Higgs Physics, Hadron-Hadron Scattering, Proton-Proton Scattering

Details on  
[kick-off meeting](#)

JHEP07(2023)040

- Paper published !
  - [https://link.springer.com/article/10.1007/JHEP07\(2023\)040](https://link.springer.com/article/10.1007/JHEP07(2023)040)
- Sensitivity improved by factor of four on the previous ATLAS search (Phys. Rev. Lett. 121, 191801 (2018) )
- M. Donadelli
  - contributions in :  $\tau_{\text{had}}\tau_{\text{had}}$  and  $\tau_{\text{lep}}\tau_{\text{had}}$  channels (MVA, MC)
- A narrow CP-even scalar particle (X) with a mass between 251 and 1600 GeV is used as the benchmark model for the resonant signal.



- Many implications for Run 3 over the next years

# WG-2: Physics analysis report 4: Run 2 HH $\rightarrow$ $bb\tau\tau$

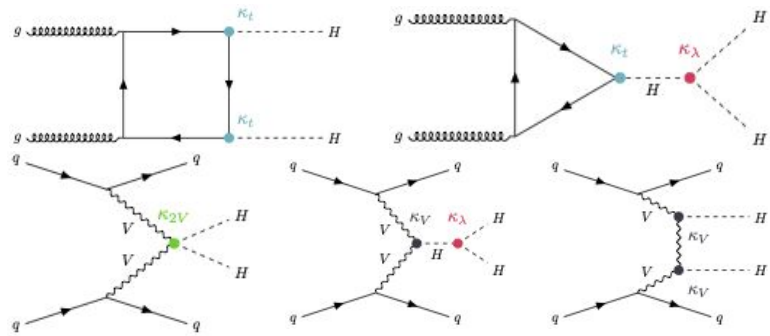
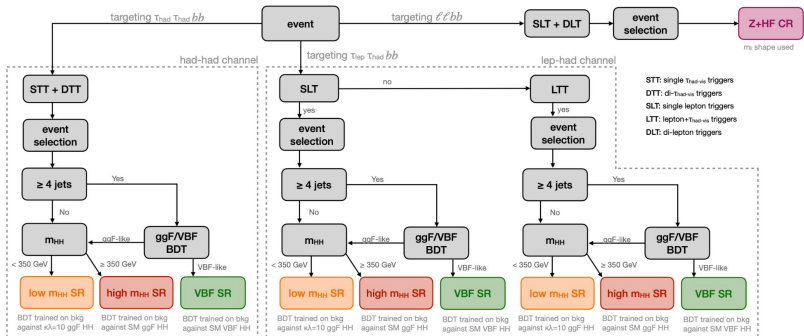


**ATLAS Note**  
ANA-HDBS-2019-27-INT1  
6th September 2023



Draft version 0.7

Legacy 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



- Full Run-2 dataset analysis ( $140 \text{ fb}^{-1}$ ) with focus on  $\kappa_\lambda$  and  $\kappa_{2V}$  optimisation
- M. Donadelli:
  - contact editor, MVA analysis strategy, VBF/ggF categorisation
  - contributions in:  $\tau_{had} \tau_{had}$  and  $\tau_{lep} \tau_{had}$  channels
- Aiming for publication in Nov (Higgs 2023, Beijing).
  - Internal note ready for ATLAS circulation!

- Many implications for Run 3 over the next years:

- improve sensitivity to HH searches (bb $\tau\tau$  amongst the 3 most sensitive channels), set stricter constraints on the Higgs boson self-coupling, and probe possible BSM signatures.

Details on [kick-off meeting](#)



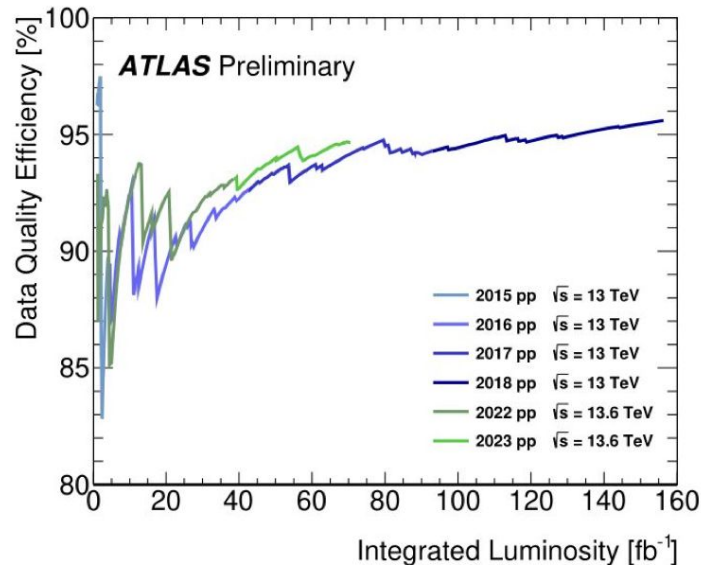
# WG-2: Run 3 Operations

- Liquid Argon Calorimeter Operations
- Data Quality and Calibration
- **M. Donadelli**
  - @CERN 27/07/2023 a 31/08/2023
  - DQ & calibration infrastructure development (digital trigger (Phase-I) and main readout)
  - LAr preparation for HI runs
  - **on-call expert**
- Annual effort during Run 3 (end of 2025)

Week	Start	End	Top	Mid	70%	80	90	95
31	0-24 24h Shift	100%	100%	100%	100%	100%	100%	100%
No group								
32	0-24 24h Shift	100%	100%	100%	100%	100%	100%	100%
No group								
33	0-24 24h Shift	100%	100%	100%	100%	100%	100%	100%
No group								
34	0-24 24h Shift	100%	100%	100%	100%	100%	100%	100%
No group								

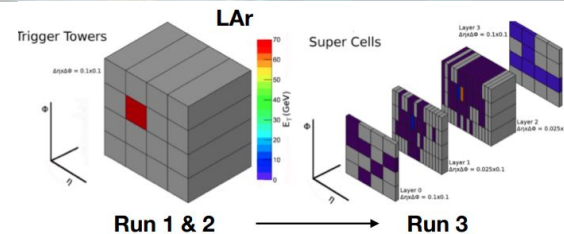
ATLAS pp Run-3: 2023										
Trigger	Inner Tracker			Calorimeters		Muon Spectrometer			Magnets	
L1+HLT	Pixel	SCT	TRT	LAr	Tile	MDT	RPC	TGC	Solenoid	Toroid
97.5-99.6	99.8	99.7	100	99.5	99.6	99.7	99.9	99.8	100	100
<b>Good for physics: 94.6%-96.5% (27.2-27.8 fb<sup>-1</sup>)</b>										
<p>Luminosity weighted relative detector uptime and good data quality efficiencies (in %) during stable beam in pp collision physics runs at <math>\sqrt{s}=13.6</math> TeV for the 2023 Run-3 period, corresponding to a delivered integrated luminosity of 30.6 fb<sup>-1</sup> and a recorded integrated luminosity of 28.8 fb<sup>-1</sup>. Runs with specialized physics goals or non-standard running conditions, amounting to 1.1 fb<sup>-1</sup>, are not considered and thus not included in the denominator of the efficiency calculation. Dedicated luminosity calibration activities during LHC fills used 0.35% of recorded data in 2023 and are included in the inefficiency. When the stable beam flag is raised, the tracking detectors undergo a so-called "warm start", which includes a ramp of the high-voltage and turning on the pre-amplifiers for the Pixel system. The inefficiency due to this, as well as the DAQ inefficiency, are not included in the table above, but accounted for in the ATLAS recording efficiency. The luminosity good for physics is 27.2-27.8 fb<sup>-1</sup>, with the lower number being applicable to analyses relying on triggers based on electrons, photons or non-isolated tau leptons at L1. It is reduced to 25.8 fb<sup>-1</sup> for analyses relying on triggers based on jets at L1 or HLT. The trigger DQ inefficiencies are due to trigger commissioning in early 2023 and an occasion of mistimed jet triggers in May 2023.</p>										

**Still achieving high DQ efficiency, despite many roadblocks !!!**

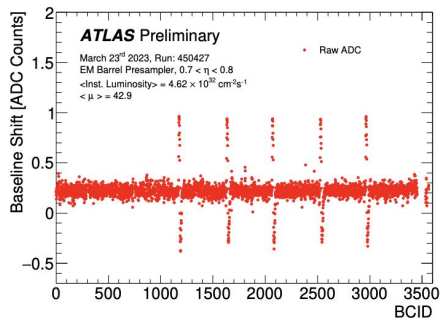
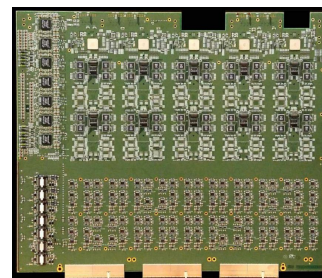


# WG-2: Run 3 Operations

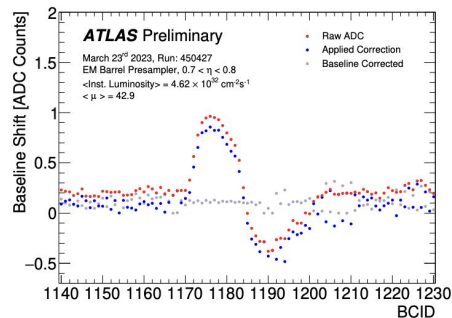
- Liquid Argon Calorimeter Operations
- Phase-I Upgrade Liquid Argon Trigger Digital Board (LTDB) commissioning studies
- **R. Estevam (starting PhD)**
  - ADC non-linearities and calibration across all calorimeter (~320ch x 128 boards)
  - Baseline correction of performance studies for LATOME firmware with offline data
    - Integration in DQ
  - **Important contributions to ATLAS** ( $\langle \mu \rangle = 60 \sim 70$ )



- **Phase-1:** LAr trigger electronics with higher granularity “Super Cells”, longitudinal shower information



(a) Full orbit (3564 BCIDs)



(b) Beginning of Bunch Train

Measurement of the baseline shift on the ATLAS LAr digital trigger system as a function of the Bunch Crossing Identifier (BCID) of presampler supercells in the Electromagnetic Barrel at  $\eta = 0.75$  for the full orbit (a) and the beginning of a bunch train (b)



# WG-2: Deliverables

- ATLAS journal publications during the period (07/2022 -> today)
  - **ATLAS Collaboration** : 52
- ATLAS editorial Boards :
  - **ML**: "Measurement of The Lund Jet Plane in  $t\bar{t}b\bar{b}$  Events" (ANA-STDM-2020-31)
  - **MD**: "A search for decays of the Higgs boson into a pair of pseudoscalar particles in the  $b\bar{b}\tau\tau$  final state using  $pp$  collisions at  $\sqrt{s}=13$  TeV with the ATLAS detector" (ANA-HDBS-2021-07)
- ATLAS appointments :
  - **MD**: HDBS MC Contact (09/23-09/26)
  - **ML**: ATLAS Executive Board (until Feb. 2023)
  - **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)
  - **ML**: ATLAS Search Committee for SCAB members (12/2022)
- ATLAS presentations in ATLAS internal meetings
  - **ALL**: 33 (SM, Higgs, LAr, HGTD)
- ATLAS Class-2 Shifts (Expert on Call)
  - **MD**: 35 days in 2023 (Calorimeter Calibration and Data Quality)
- ATLAS presentation in conferences
  - **MD**: Highlights from ATLAS (Lishep 2023)
  - **ML**: Precision measurements of jet and photon production in ATLAS (EPS-HEP 2023 Hamburg)
- ATLAS Upgrade Technical support
  - **MK, RM**: 0.5 FTE 2022, 0.5 FTE 2023

# WG-2: Final remarks and action items

- All analysis : on track (benefit from ATLAS pace and organization)
- Regular reports on ATLAS analysis groups
- Commitments on Run 3 operations → LAr subsystem : on track
  - Data quality and calibration @ CERN
  - Phase-I commissioning

## Action items for next months

- $Z \rightarrow \tau\tau$ 
  - Resonant and non-resonant leptoquark signal generation (analysis)
  - $\tau$  polarization modeling impact on phase space analysis
- $HH \rightarrow b\bar{b}\tau\tau$ 
  - EB final interactions by the EOY
  - Ramp-up Run-3 analysis with UERJ (MB)+ UFRJ (YC)
- Phase-I LTDB commissioning
  - Request FAPESP TT-II for R. Estevam

