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

Status Report

FAPESP Thematic 2020/04867-2

Feb. 22nd 2024

Marco Leite - IFUSP

FAPESP
FUNDAÇÃO DE AMPARO À PESQUISA DO ESTADO DE SÃO PAULO

ATLAS EXPERIMENT

HEPIC IFUSP

UFRJ

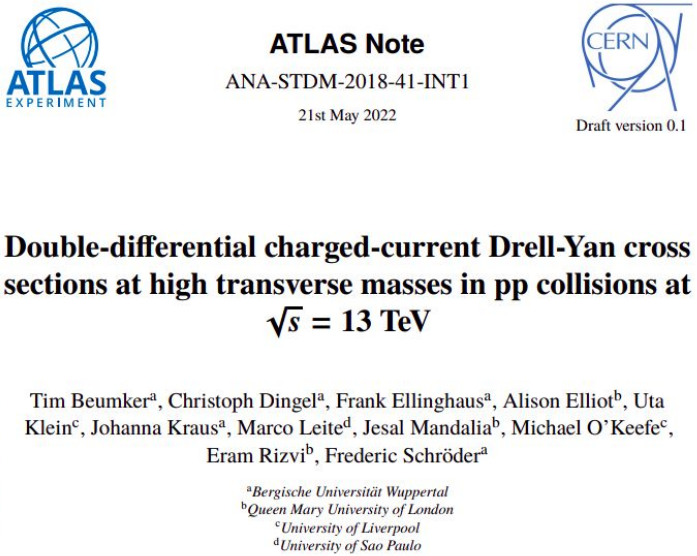
UERJ
UNIVERSIDADE DO ESTADO DO RIO DE JANEIRO

# WG-2: Summary

1. **Physics analysis**
   1.1. Precision measurements in SM
   1.2. HH$\rightarrow$ 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

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



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*

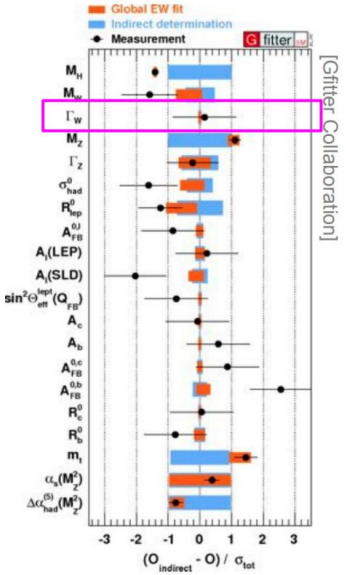

*Details on kick-off meeting*

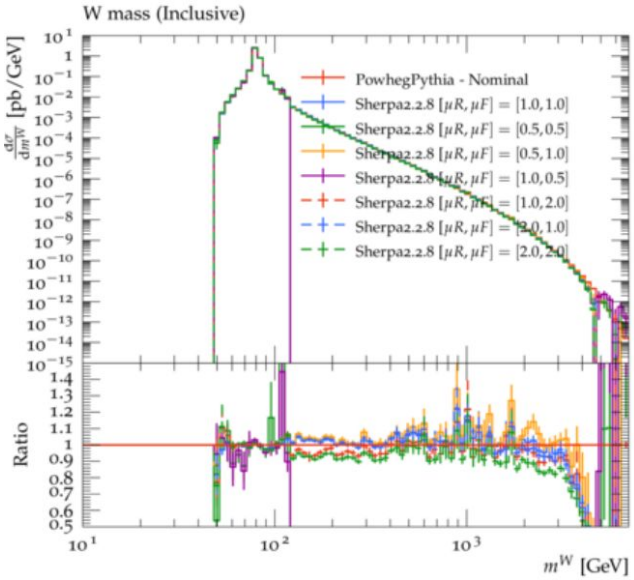
- On-going analysis, EB interaction
- ~~Wrap-up still this year (?)~~ (Still needs to understand discrepancy between e and mu channels →2023)
- Unfolding tests and model systematics (Sherpa, PowhegPythia)
- **M. Leite**
  - Rivet routine for particle level kinematics
- ~~Aiming to publication in 2023~~ (2024) - no more people will be involved

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

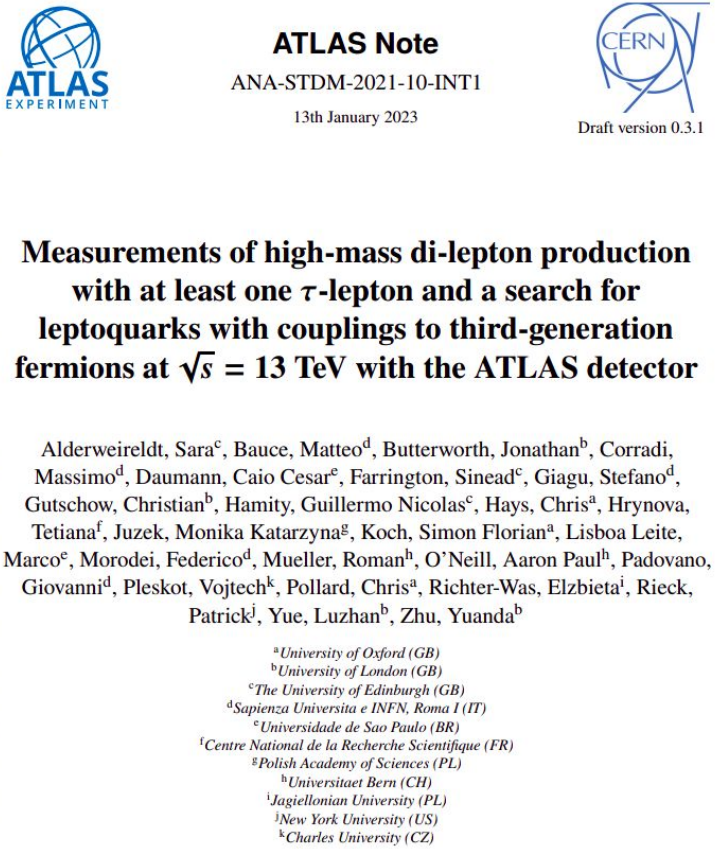
*Details on kick-off meeting*

- 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)



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



ATLAS Note

ANA-STDM-2021-10-INT1

13th January 2023

Draft version 0.3.1

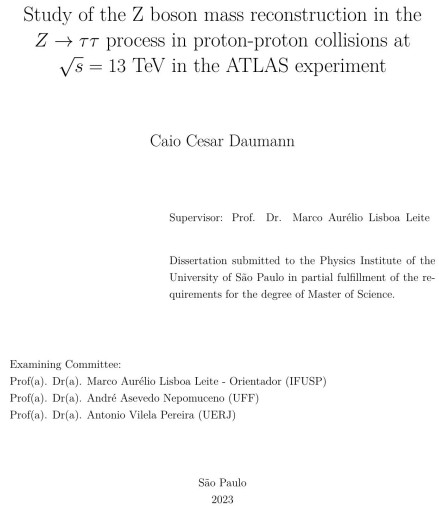
**Measurements of high-mass di-lepton production with at least one $\tau$-lepton and a search for leptoquarks with couplings to third-generation fermions at $\sqrt{s}$ = 13 TeV with the ATLAS detector**


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)*
[b] *University of London (GB)*
[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
- **C. Daumann** (MS) : mass reconstruction (✅ April)
- **R. Macedo** (MS) : $\tau$ reconstruction
- **Long range analysis (beyond Run-3)**, will also involve charged current, new interpretations etc.

*Details on kick-off meeting*



Study of the Z boson mass reconstruction in the $Z \to \tau\tau$ process in proton-proton collisions at $\sqrt{s} = 13$ TeV in the ATLAS experiment

Caio Cesar Daumann

Supervisor: Prof. Dr. Marco Aurélio Lisboa Leite

Dissertation submitted to the Physics Institute of the University of São Paulo in partial fulfillment of the requirements for the degree of Master of Science.

Examining Committee:
Prof(a). Dr(a). Marco Aurélio Lisboa Leite - Orientador (IFUSP)
Prof(a). Dr(a). André Asevedo Nepomuceno (UFF)
Prof(a). Dr(a). Antonio Vilela Pereira (UERJ)

São Paulo
2023

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


**ATLAS CONF Note**

ATLAS-CONF-2023-071

25th November 2023


*Details on kick-off meeting*

**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**

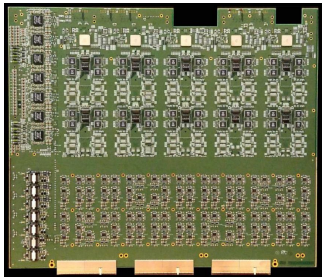
The ATLAS Collaboration

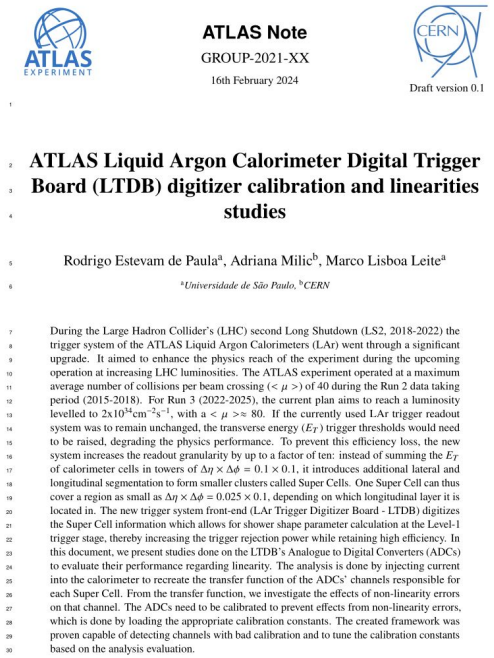
- Full Run-2 dataset analysis with focus on $\kappa_\lambda$ and $\kappa_{2V}$ optimisation
- **M. Donadelli :**
  - contact editor, MVA analysis strategy, VBF/ggF categorisation
  - contributions in : $\tau_{had}\tau_{had}$ and $\tau_{lep}\tau_{had}$ channels
- Draft in final preparation for ATLAS circulation

# WG-2: **Run 3 Operations**

- 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 (~320ch x 128 boards)
  - Baseline correction of performance studies for LATOME firmware with offline data
  - Very important for 2023 (<$\mu$> = 60~70) - 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**

Rodrigo Estevam de Paula[a], Adriana Milic[b], Marco Lisboa Leite[a]

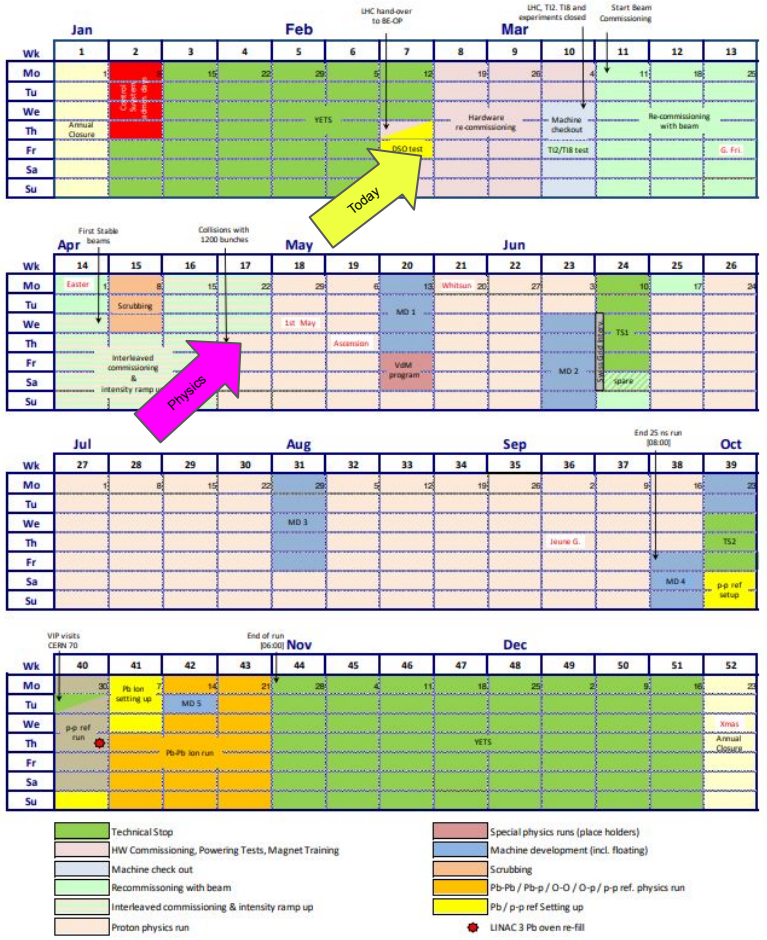
[a]*Universidade de São Paulo,* [b]*CERN*

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 $2x10^{34}cm^{-2}s^{-1}$, with a < $\mu$ >≈ 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.

# WG-2: Operations

## 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



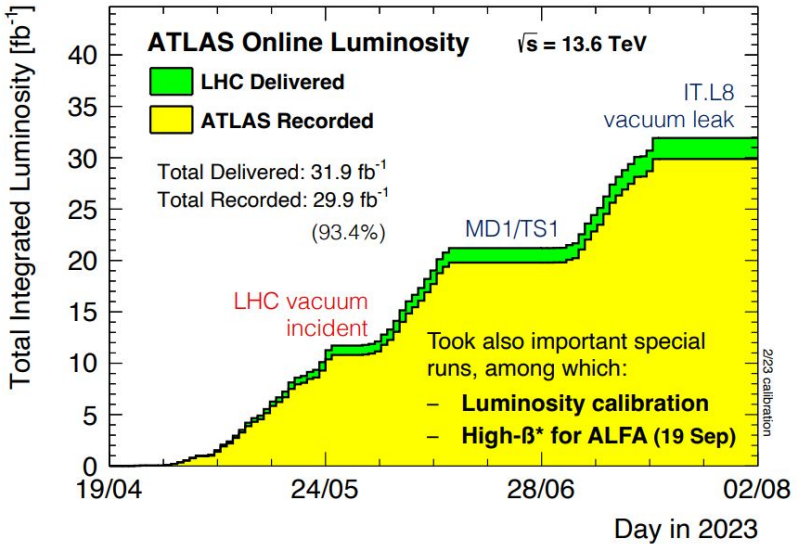
# WG-2: **Deliverables**

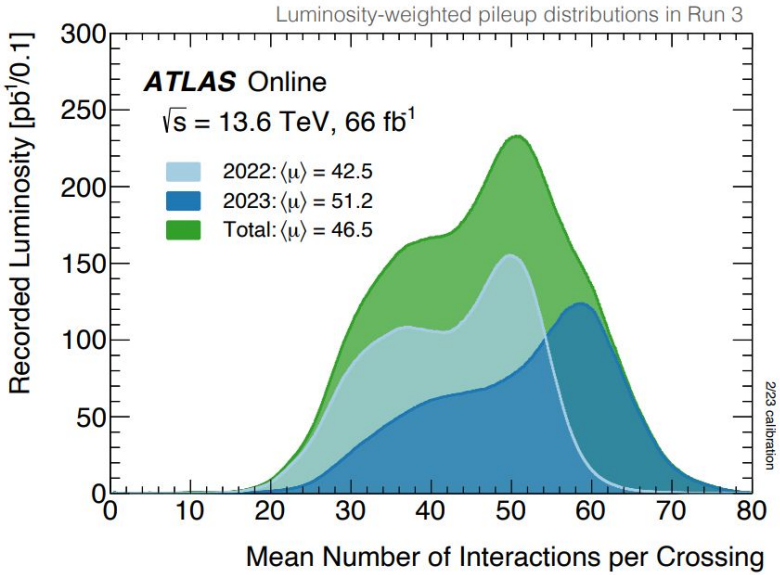
- ATLAS journal publications during the period (10/2023 -> today)
  - **ATLAS Collaboration** : 52
- ATLAS editorial Boards :
  - **ML**: "*Measurement of The Lund Jet Plane in ttbar Events*" (ANA-STDM-2020-31)
  - **MD**:"*A search for decays of the Higgs boson into a pair of pseudoscalar particles 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)

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

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

- 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 60 $fb^{-1}$(2022+2023)
  - Only 2 years left before Long Shutdown !

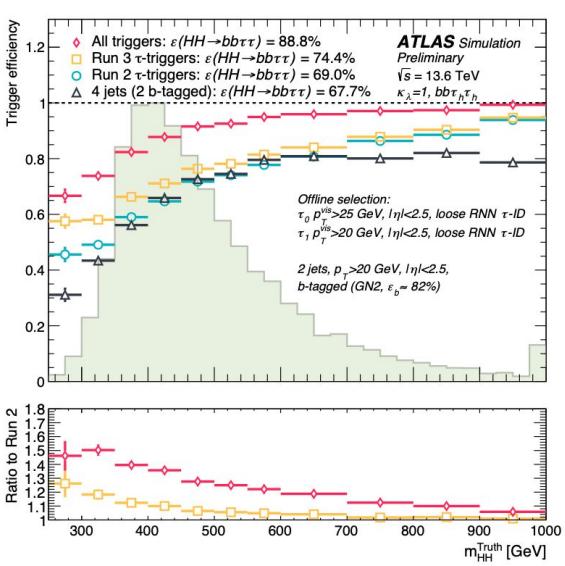


# WG-2: Strategy for the next months

## 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 joining early March (Hajar Imam)
  - Welcome Hajar 🎉 !
- We + Academia Sinica will work together
  - 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




*Tau trigger public results*

| | bb | WW | ττ | ZZ | γγ |
|---|---|---|---|---|---|
| bb | 34% | | | | |
| WW | 25% | 4.6% | | | |
| ττ | 7.3% | 2.7% | 0.39% | | |
| ZZ | 3.1% | 1.1% | 0.33% | 0.069% | |
| γγ | 0.26% | 0.10% | 0.028% | 0.012% | 0.0005% |

*(See Marisilvia's slides for a discussion on these)*

# 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 Rodrigo's presentation)**


*Elizabeth Petit - CPPM*