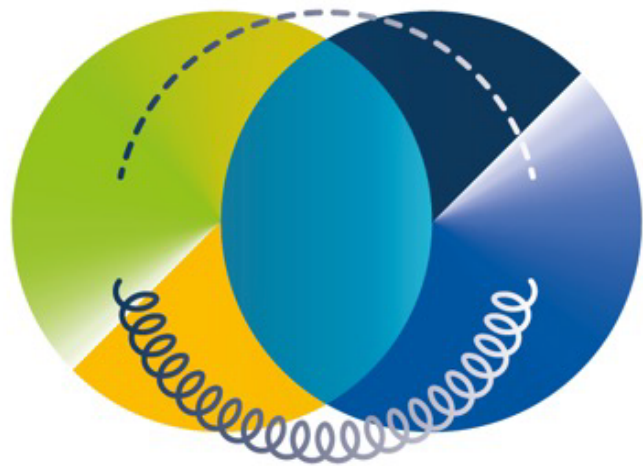


Rare Processes Subgroup Activities

Tatjana Lenz (Uni Bonn)
14 July 2026

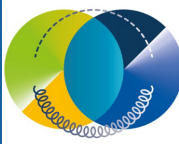


color meets flavor

First subgroup meeting on May 13th 2026

RA3 Rare processes (preparation for plenary in June 10)

Wednesday 13 May 2026, 09:00 → 11:00 Europe/Berlin



color meets flavor

Description ZOOM-only meeting. Please join:
<https://cern.zoom.us/j/62753805760?pwd=Q0palhvCheSW9MXW2qHN4KE1nDwnsU.1>

09:00	→ 09:10	Introduction	🕒 10m	✎
Speaker: Tatjana Lenz (uni-bonn)				
 Introduction.pdf				
09:10	→ 09:20	FCNC search in $t \rightarrow Hq$	🕒 10m	✎
Speakers: Elisabeth Schopf, Inês Pinto (Universität Siegen)				
 talk.pdf				
09:20	→ 09:30	BSM Higgs	🕒 10m	✎
Speaker: Tatjana Lenz (uni-bonn)				
 Projects_Lenz.pdf				
09:30	→ 09:40	Higgs-$\rightarrow$tautau CP and A-$\rightarrow$tautau searches	🕒 10m	✎
Speakers: Dr Christian Greife (Physikalisches Institut Universität Bonn), Laney Klippfahn (Physikalisches Institut Universität Bonn), Luka Vomberg (Uni Bonn), Philip Bechtle (uni-bonn)				
 Ra3-H:A_tautau.pdf				
09:40	→ 09:50	Carmen's contribution	🕒 10m	✎
Speaker: Carmen Diez Pardos (Universität Siegen)				
 CDiezPardos_Col...				

Discussed many ongoing
and future projects

More projects to come!

CmF Funded Projects

E. Schopf “Search for FCNC in top-quark decays to a Higgs boson and a charm or up quark”

T. Lenz “Search for new signatures in CP-violating 2HDM”

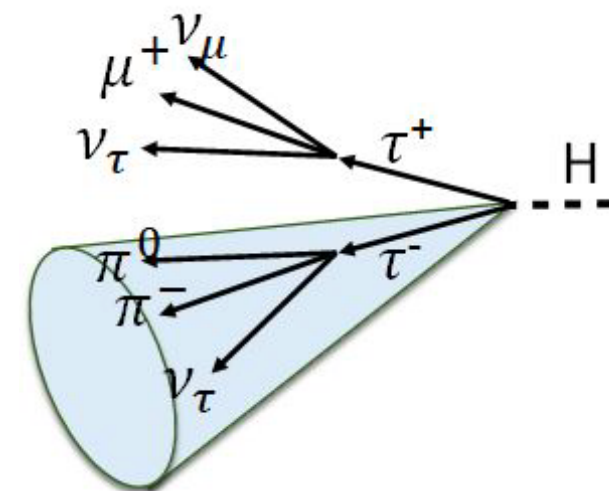


Congratulations!!!

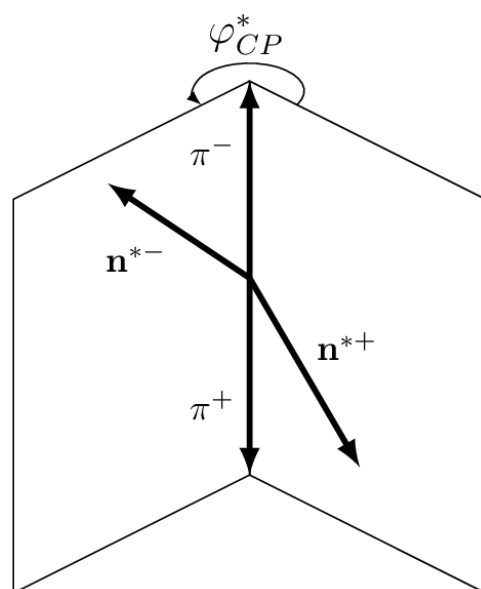
$H \rightarrow \tau\tau$ and $A \rightarrow \tau\tau$ at ATLAS

Team: Klaus Desch, Philip Bechtle, Christian Greife, Luka Vomberg and Laney Klippfahn

Project 1: Determination of CP properties of the 125 GeV Higgs boson in $\tau\tau$ final state

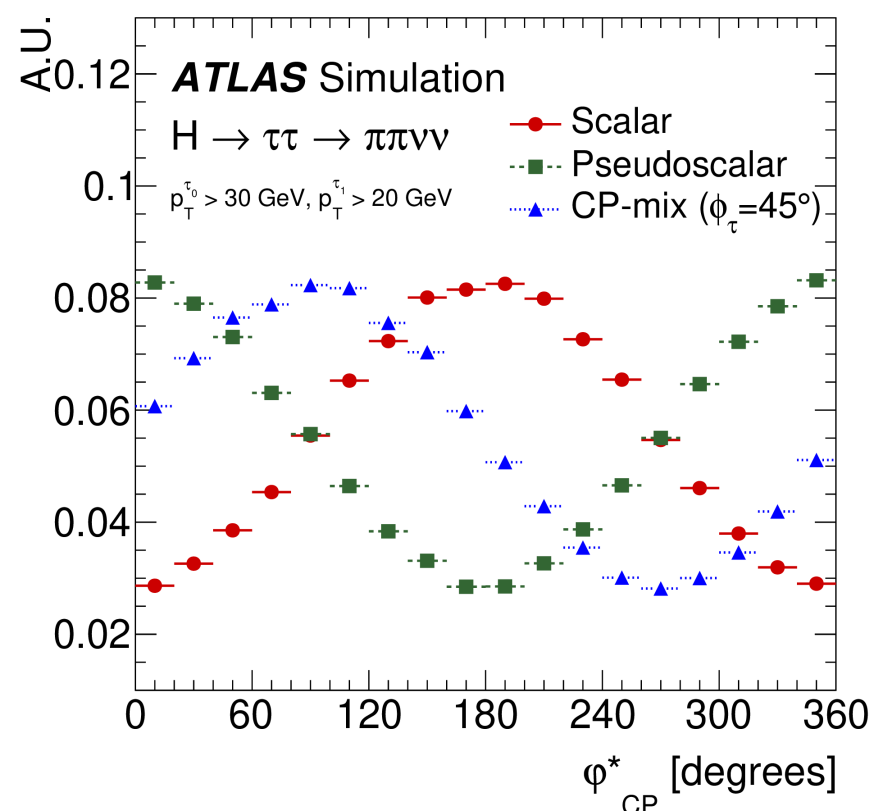


Previous work:



n^* : 3D impact parameter vector of charged particle

EPJC 83 (2023) 563



Current Focus:

- Reconstruction of CP-observables in $H \rightarrow \tau\tau$ with Machine Learning techniques
- Analysis of Run 2 and Run 3 ($\sim 330 \text{ fb}^{-1}$) ATLAS data



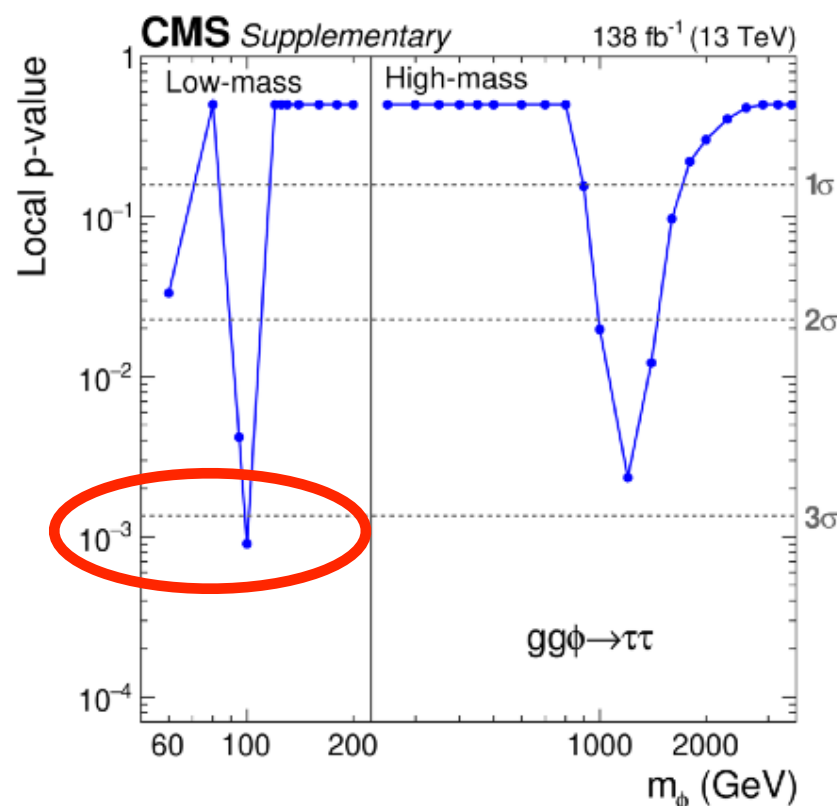
$H \rightarrow \tau\tau$ and $A \rightarrow \tau\tau$ at ATLAS

Project 2: Searching for $A \rightarrow \tau\tau$

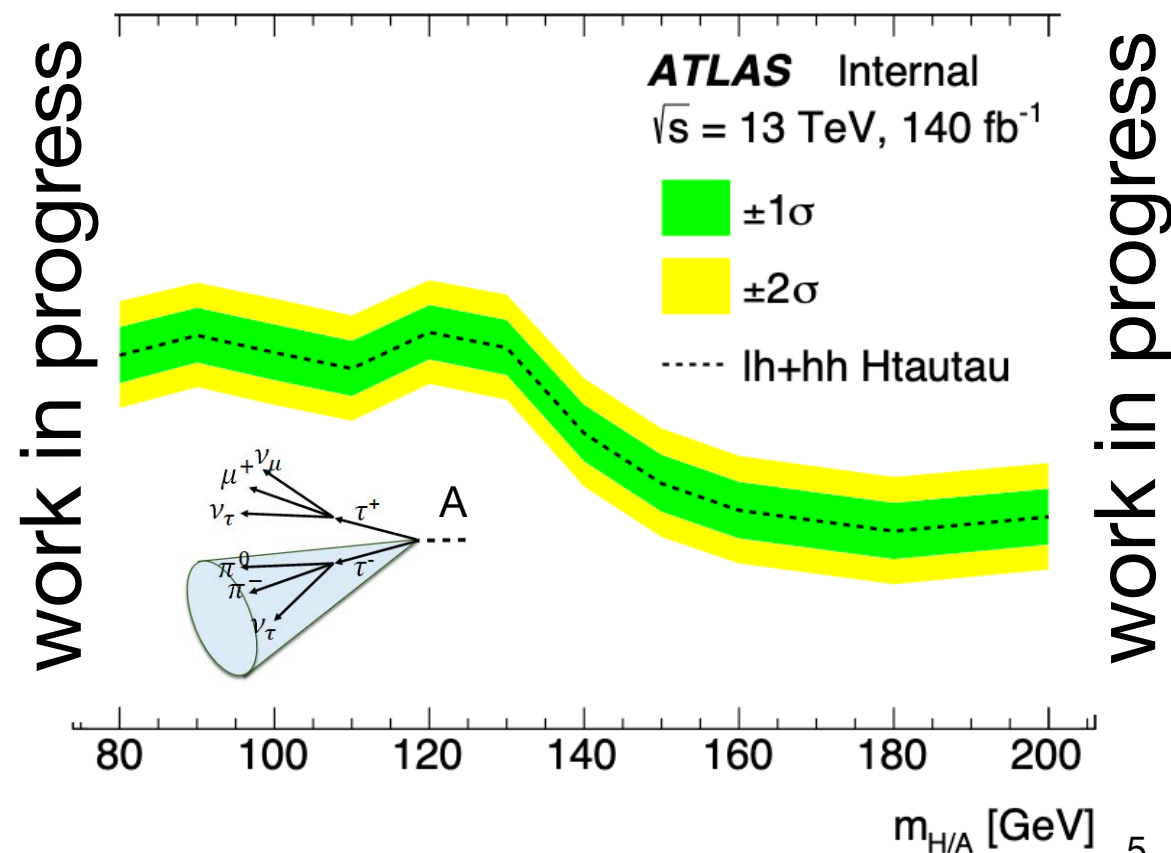
Currently finalising re-interpretation of the $H \rightarrow \tau\tau$ cross section measurement with Run 2 ATLAS data

Future plans: repeat analysis with Run 3 data, add spin-sensitive variables

2.8 (2.3) σ local
(global) **excess**
observed in CMS
Run 2 data



$\sigma(pp \rightarrow H/A + X) \times \text{BR}(H/A \rightarrow \tau^+ \tau^-)$ [pb]



Team: Jochen Dingfelder, Tatjana Lenz, Satyajit Chakraborty

Project 1: CP violation in Higgs sector @ ATLAS

- Search for neutral Higgs bosons h_1, h_2 and h_3 with CPV signatures
- **Simultaneous** measurement of rates
CP-even decays and CP-odd decays
 $\sigma(h_2) \times \mathcal{B}(h_2 \rightarrow h_1 h_1) = 191 \text{ fb}$
 $\sigma(h_3) \times \mathcal{B}(h_3 \rightarrow h_1 h_1) = 235 \text{ fb}$
 $\sigma(h_2) \times \mathcal{B}(h_2 \rightarrow h_1 Z) = 122 \text{ fb}$
 $\sigma(h_3) \times \mathcal{B}(h_3 \rightarrow h_1 Z) = 76 \text{ fb}$

related CmF project:
CPV in $H \rightarrow \tau\tau$

JHEP 09 (2022) 011

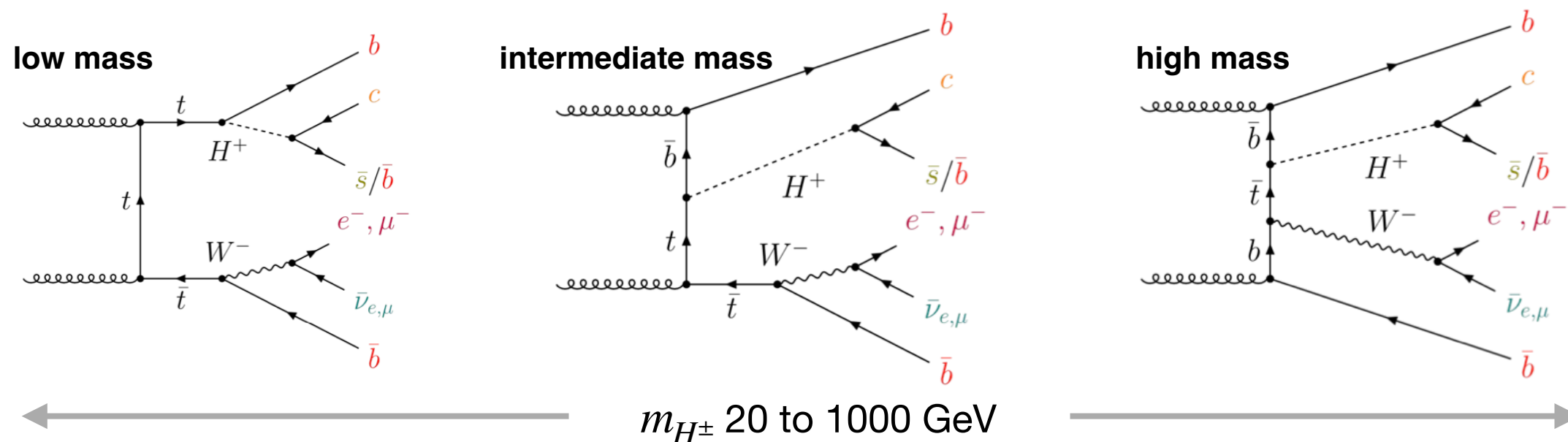
Mass of additional Higgs bosons is close to the EW scale

Current status: MC benchmarks studies to identify promising experimental signatures

Charged Higgs Searches

Team: Jochen Dingfelder, Tatjana Lenz, Johannes Klas

Project 2: Search for $H^\pm$ produced in association with top quarks



e.g. **Flavourful 2HDM:** breaks flavour universality

Altmannshofer et al
Ghosh et al

- Simultaneous measurement of $H^\pm \rightarrow cs$ and $H^\pm \rightarrow cb$ final states with Run 2 & Run 3 ATLAS data $\longrightarrow$ often high BRs at high $\tan \beta$ values

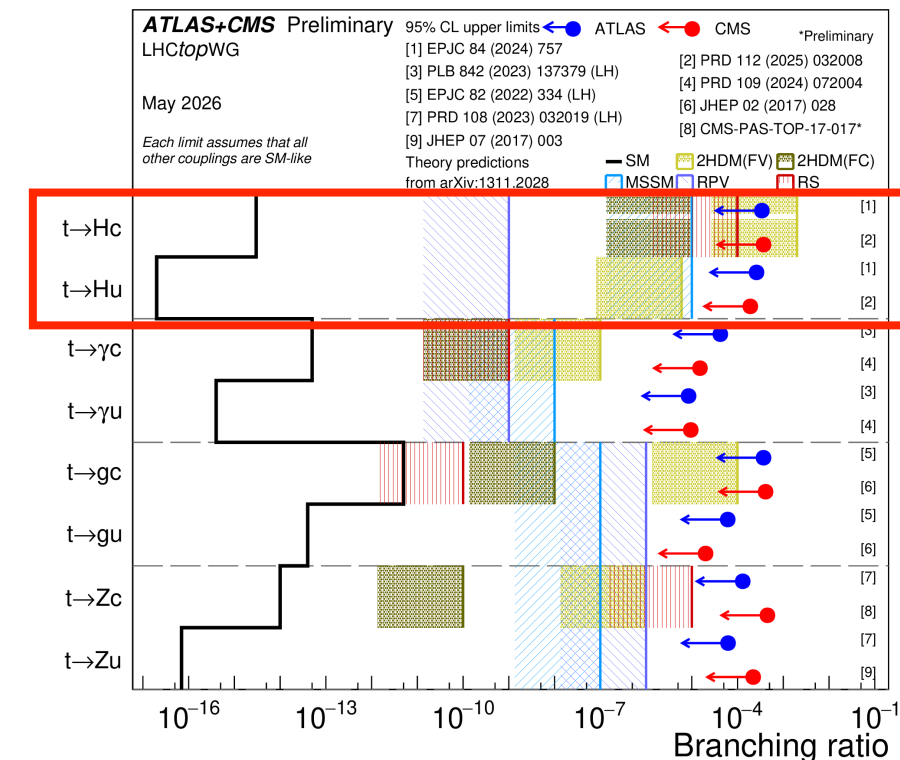
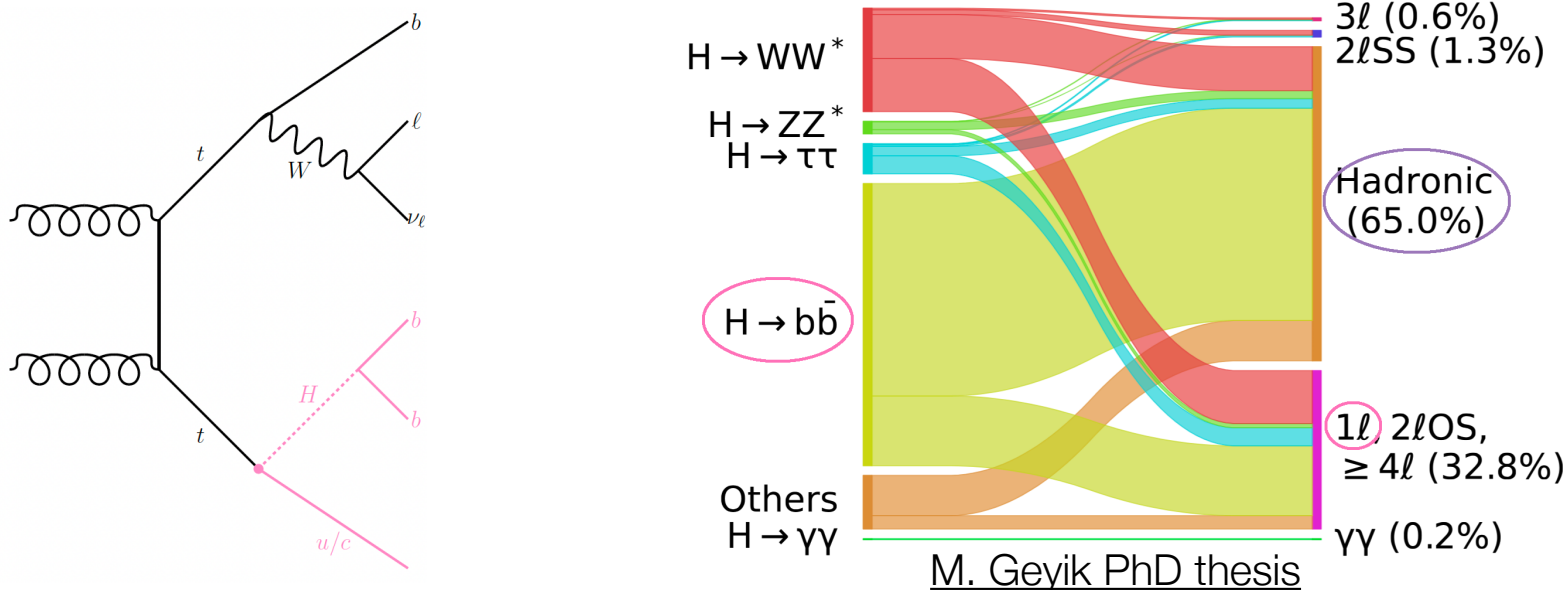
Current status: analysis R&D, plan to establish collaboration with Siegen on c- and s-tagging

FCNC in $tqH(bb)$ @ ATLAS

Team: Markus Cristinziani, Elisabeth Schopf, Inês Pinto

Project: Search for FCNC in $t \rightarrow Hq$

ATL-PHYS-PUB-2026-010



- Extract ratio $t \rightarrow Hu$ to $t \rightarrow Hc$ in Run 2 & Run 3 ATLAS data
- Use latest FTAG transformer (GN2) to tag light/c-jets

Current status: analysis R&D for 1 ℓ channel and feasibility of fully hadronic final state; alternative c-jet calibration

Top quark precision measurements and interpretations

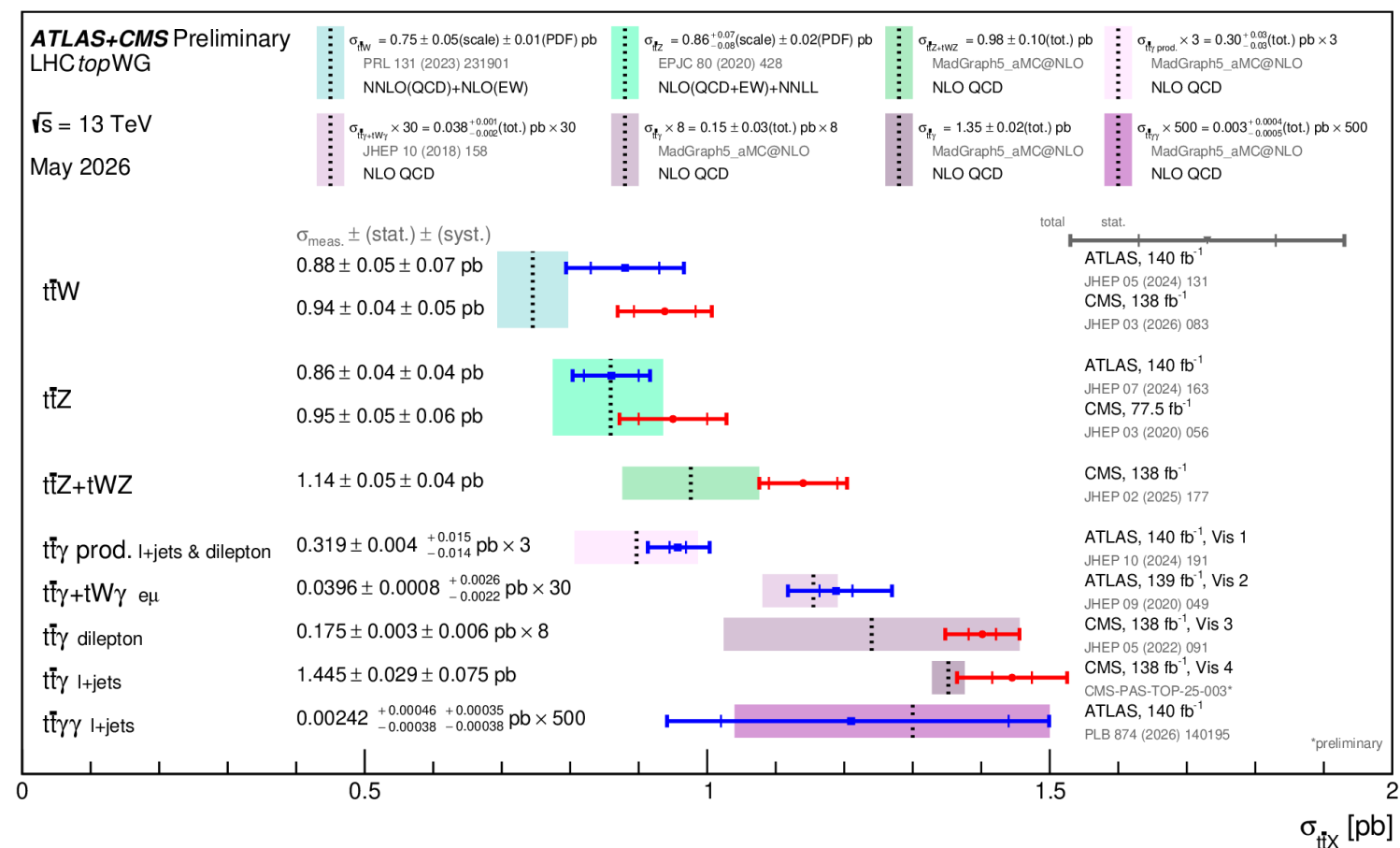
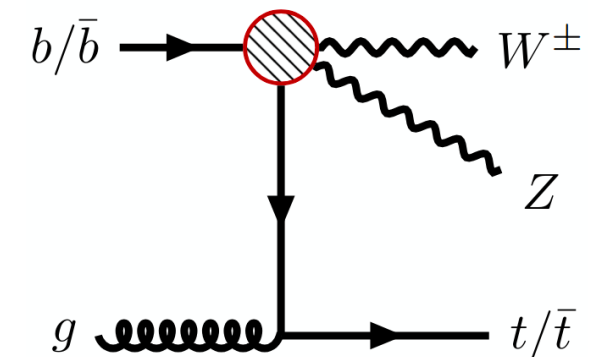
Team: Carmen Diez Pardos, Carolina Costa, Denise Müller, Ivor Fleck

Project: Measurement of associated process tWZ

- Measure tWZ cross section

- CMS Run 2+3 result:
5.8 (3.5) σ obs (exp)

- Constrain anomalous top-quark couplings with EW bosons
- Combined measurement of $t\bar{t}Z$ and tWZ
- Interest in combined measurements of $t\bar{t}$ and t +bosons

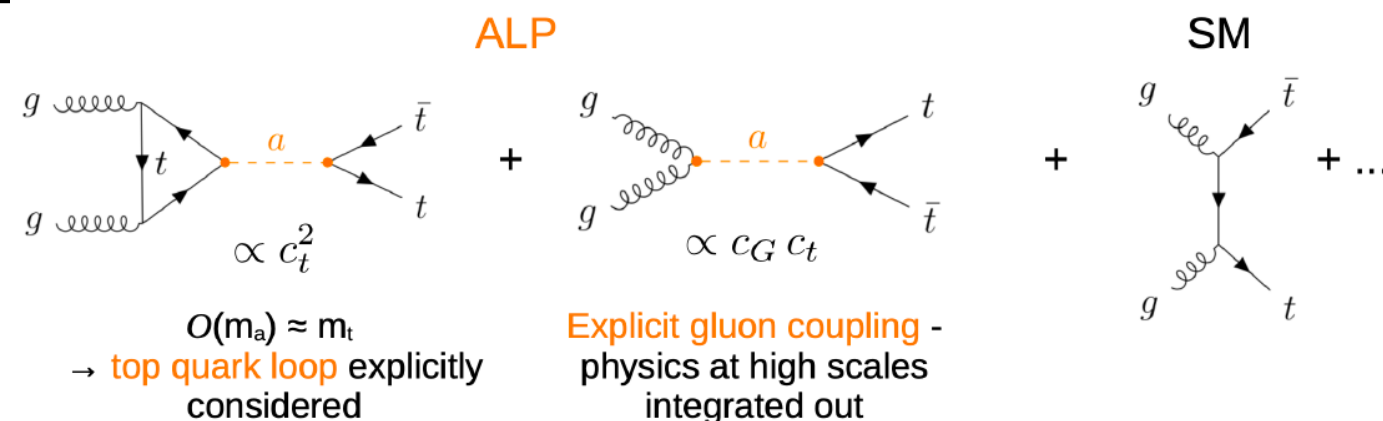


Top quark precision measurements and interpretations

Team: Carmen Diez Pardos, Nikolaos Kamaras, Ivor Fleck

Project: Top quark precision measurements and interpretations with Run 2 + Run 3 data

- Improve reconstruction of $t\bar{t}$ system and $t\bar{t}$ modelling
 - Synergies with theory and simulations
- Interpretations from angular and other observables
 - Quantum observables → collaboration with Siegen Theory and Quantum Optics group ([arxiv:2604.2713](https://arxiv.org/abs/2604.2713))
- CP violation in $t\bar{t}$ system
- EFT interpretations
- Other models: ALPs, ...



Conclusions

- Various projects in the RA3 “Rare Processes”
 - Connection to Top/Higgs precision measurements, Tagging, Simulation and SMEFT
- Subscribe to cmf-ra3@listen.uni-bonn.de to follow the activities
 - Get in touch with me if you plan a new activity
- For discussion:
 - Regular meetings to strength the connection?
 - RA3 group & subgroup level
 - Frequency?