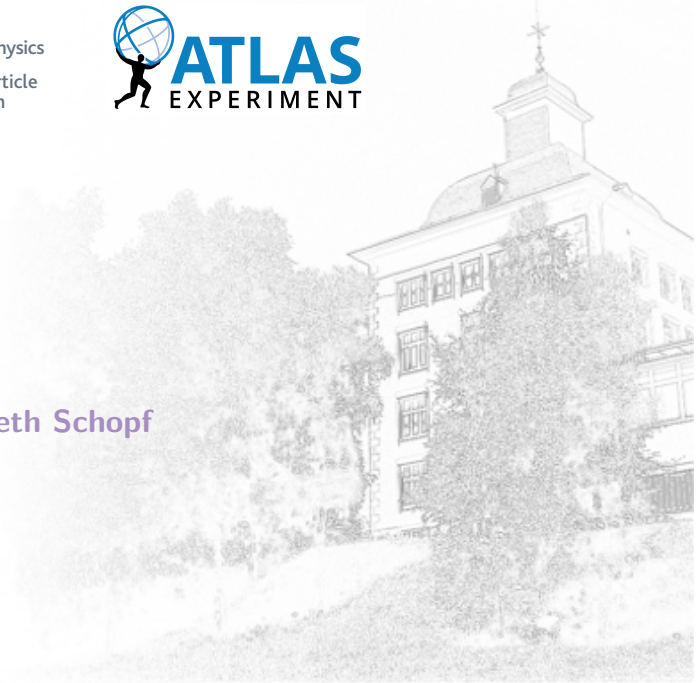
Universität Siegen

HEP Experimental High Energy Physics
CPPS Center for Particle Physics Siegen

ATLAS EXPERIMENT



FCNC in $tqH(bb)$: Siegen Efforts

Markus Cristinziani, Inês Pinto, Elisabeth Schopf

CmF RA3 Meeting Rare Processes
13th May 2026

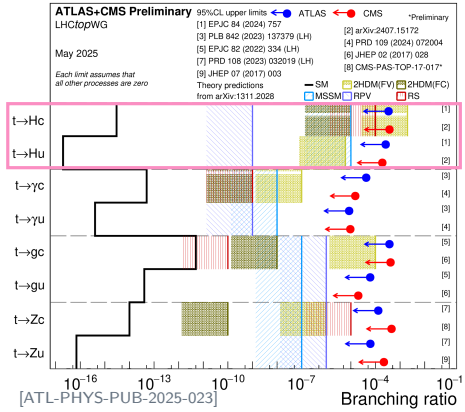
Motivation

- In the SM, FCNCs are forbidden at tree level and highly suppressed at loop level (GIM mechanism)
- Any observation would be a clear sign of physics beyond the SM
- Search interpreted in an EFT framework using TopFCNC UFO [Phys.Rev.D 91 (2015) 034024], [Phys.Rev.D 91 (2015) 074017]

$$\mathcal{L} = \mathcal{L}_{\text{SM}} + \sum_{q=u,c} \left[\frac{C_{u\phi}^{qt}}{\Lambda^2} \mathcal{O}_{u\phi}^{qt} + \frac{C_{u\phi}^{tq}}{\Lambda^2} \mathcal{O}_{u\phi}^{tq} \right]$$

★NEW Extract ratio of $t \to Hu$ to $t \to Hc$

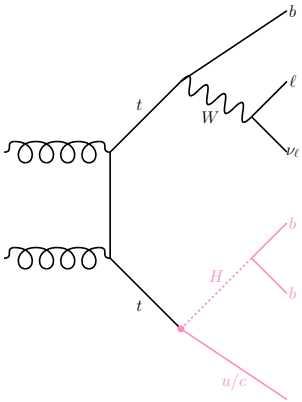
- $t \to Hq$ on the verge of excluding several BSM physics!



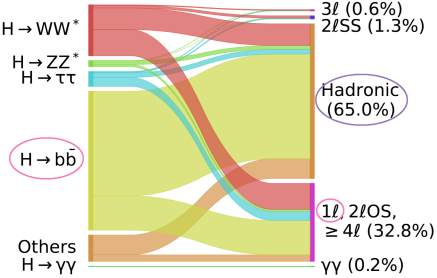
[ATL-PHYS-PUB-2025-023]

- Outdated BSM models: potential new physics to probe eg. 3HMD [2601.16647]

Motivation



- LHC: $t\bar{t}$ factory



[PhD Thesis M. Geyik]

- Highest Higgs branching ratio: $H \to b\bar{b}$ (∼58%)
- Only explored in ATLAS at 36 fb^{-1} so far! [1812.11568]
- 1ℓ + feasability of fully hadronic final states

★NEW Make the most of full Run 2+3 dataset (∼ 450 fb^{-1})
★NEW Latest ATLAS FTAG transformer (GN2) with c/light jet tagging for increased sensitivity

Person Power & Expertise

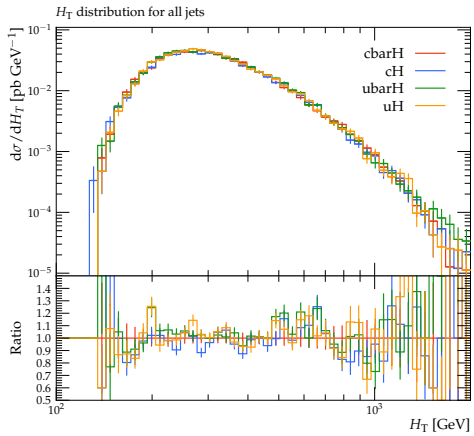
- Prof. Markus Cristinziani: 0.1 FTE
- Dr. Elisabeth Schopf: 0.3 FTE
- PhD student Inês Pinto: 0.4-0.5 until June (expected ATLAS qualification), $\sim$ 0.8 FTE onwards

- Siegen group with extensive experience in top quark physics
- Elisabeth with expertise in $H \rightarrow bb$

- Siegen group very involved in FTAG and ML in general (Dr. Vadim Kostyukhin and Dr. Diptaparna Biswas)
- Inês' AQP focusing on alternative calibration for c-jet tagging efficiency

Plans/Ideas for collaboration

- Complementarity of ATLAS/Belle II/LHCb FCNC searches? Would a combination of results make sense?
- New possible BSM scenarios to constrain?
- New quark/gluon tagging for reduced QCD backgrounds.
- SPANet/graph-based full event reconstruction.

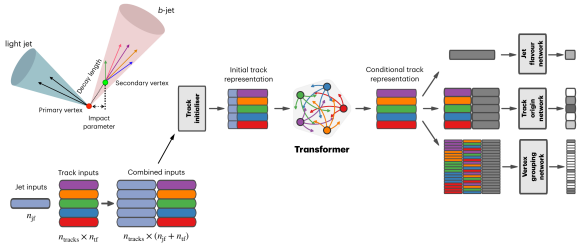


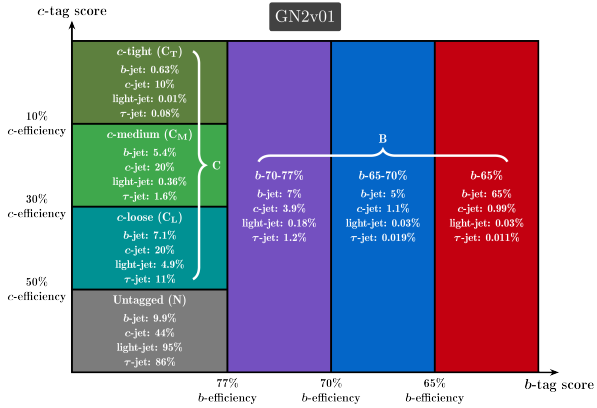
★ Current status: working on FCNC MC event generation with analysis effort within ATLAS expected to kick-off soon

Thank you!

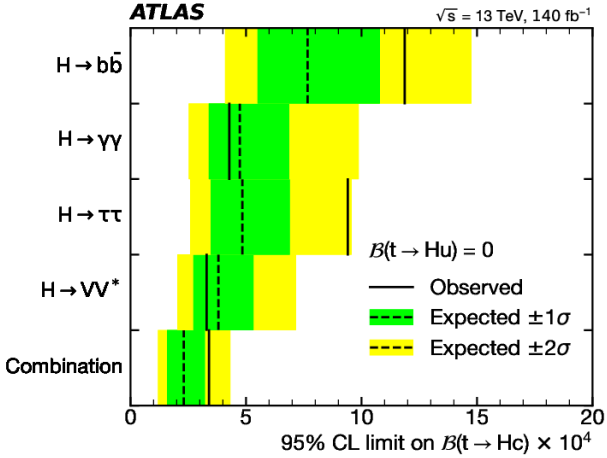
Backup

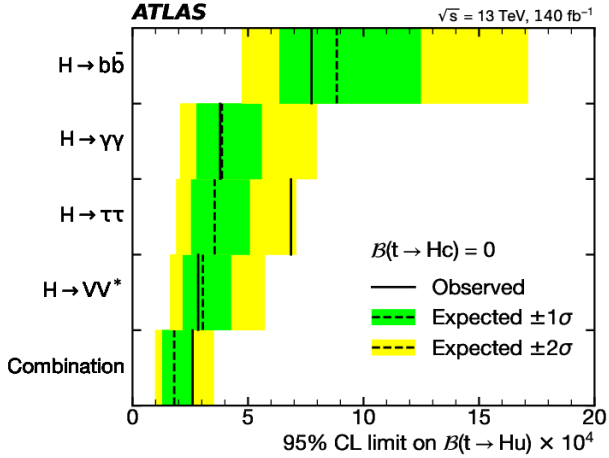
GN2 Scheme


b-jet
light jet
Decay length
Secondary vertex
Primary vertex
Impact parameter
Track initialiser
Initial track representation
Transformer
Conditional track representation
Jet flavour network
Track origin network
Vertex grouping network
Track inputs
Jet inputs
Combined inputs
n_{jf}
$n_{\text{tracks}} \times n_{tf}$
$n_{\text{tracks}} \times (n_{jf} + n_{tf})$


c-tag score
GN2v01
c-tight (C_T)
b-jet: 0.63%
c-jet: 10%
light-jet: 0.01%
τ-jet: 0.08%
c-medium (C_M)
b-jet: 5.4%
c-jet: 20%
light-jet: 0.36%
τ-jet: 1.6%
c-loose (C_L)
b-jet: 7.1%
c-jet: 20%
light-jet: 4.9%
τ-jet: 11%
Untagged (N)
b-jet: 9.9%
c-jet: 44%
light-jet: 95%
τ-jet: 86%
C
B
b-70-77%
b-jet: 7%
c-jet: 3.9%
light-jet: 0.18%
τ-jet: 1.2%
b-65-70%
b-jet: 5%
c-jet: 1.1%
light-jet: 0.03%
τ-jet: 0.019%
b-65%
b-jet: 65%
c-jet: 0.99%
light-jet: 0.03%
τ-jet: 0.011%
10% c-efficiency
30% c-efficiency
50% c-efficiency
77% b-efficiency
70% b-efficiency
65% b-efficiency
b-tag score

Top Higgs FCNC in ATLAS





[2404.02123]