People who have expressed interest

<u>Theory</u>

Manimala Mitra

Thomas Biekotter

Benjamin Fuks

Arindam Das

Tania Robens

<u>Experiment</u>

Tetiana Moskalets + Spyros Argyropoulos + Zirui Wang + Katharina Behr + James Frost + Alvaro Lopez (ATLAS)

Christian Schwanenberger + students + Debabrata Bhowmik + Jonatan Piedra Gomez + Jezus Manuel Vizan Garcia (CMS)

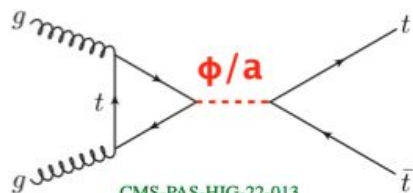# Christian Schwanenberger, DESY/Uni Hamburg

CMS experimental analyses:

- Search for dark matter produced in association with a single top quark or a top quark pair
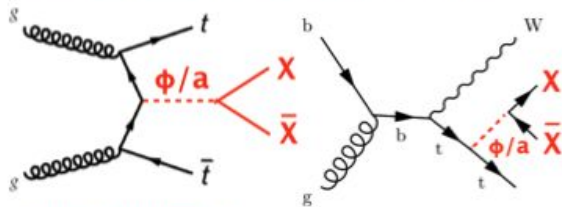
CMS-PAS-EXO-22-014
Phys. Rev. Lett. 122, 011803 (2019)

- Search for DM in association with b-quark and lepton pairs
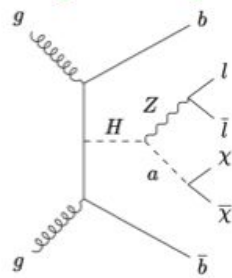
CMS-PAS-SUS-23-018

particle phenomenology:

- Hunting the dark Higgs

Phys. Dark Univ. 16, 49 (2017)

- Towards the next generation of simplified Dark Matter models
  JHEP 1704, 143 (2017)

- ALP-ine quests at the LHC: hunting axion-like particles via peaks and dips in $t\bar{t}$ production

arXiv:2404.19014 [hep-ph]

- A new LHC search for dark matter produced via heavy Higgs bosons using simplified models
  JHEP 08 (2023), 151

(a) 1-vs-1 unbalanced   (b) 2-vs-1 balanced
(c) 2-vs-1 balanced   (d) 2-vs-2 balanced

- Possible indications for new Higgs bosons in the reach of the LHC: N2HDM and NMSSM interpretations
 Eur. Phys. J. C 82 (2022) no.2, 178

- Search for heavy scalars and pseudoscalars decaying to a top quark pair

CMS-PAS-HIG-22-013
JHEP 04, 171 (2020)

- I can contribute writing and supervising
- my students can perform analyses
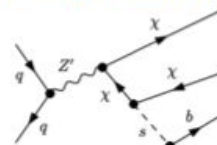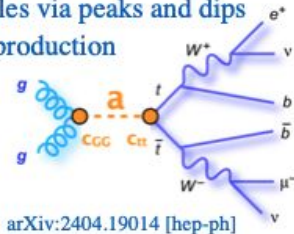- myself I can only spend 0.1 FTE's, but my students can spend more
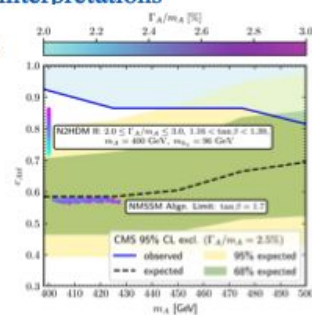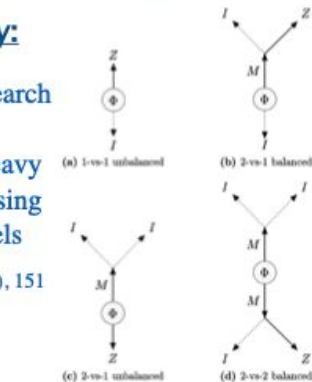
Potential contributions to the upcoming whitepaper - B. Fuks

Expertise relevant for the upcoming whitepaper

- **Monte Carlo tools**
  - � Author of: FeynRules, UFO & MoGRe
  - � Experienced user of NLOCT, & MG5aMC
  - � **NLO UFO model generation**

- **Reinterpretation studies**
  - � Author of MadAnalysis 5
  - � Implementation of new searches in the tool
  - � Use of the tools to extract bounds on models

Topic proposals

- Exploration of **non-minimal models**
  - � NLO UFO implementation
  - � QCD impact on bounds

- Derivation of **existing bounds** (run 2)
  - � MET and non-MET searches in MadAnalysis 5
  - � Projections for Run 3 and HL-LHC
  - � Combination of searches?

- Lepto-philic models
  - � DM searches with soft objects
    (*cf.* concurring CMS and ATLAS excesses)

10%-15% FTE
+ 1 student

- ▸ Experience:
  - – 2HDM+a dark matter combination paper Sci.Bull. 69 (2024) 3005
    - – studies of the high-m_A 2HDM+a benchmark for the DM mass scan with mono-h(bb) signals (recasting the previous mono-h(bb) analysis)
    - – studies about the validity limits of the 2HDM+a model
  - – s-channel dark matter summary paper review (Editorial Board member) arXiv:2404.15930

- ▸ Expertise: signal MC generation with MadGraph, signal sensitivity studies

- ▸ Can contribute with 0.1 FTE

Aristotle University of Thessaloniki

- Spyros Argyropoulos + student (0.2 FTE) - collaboration with Tetiana Moskalets (SMU)
- Contributed to:
  - A->ZH->vvbb/lltt
  - Mono-Higgs(bb)
  - ATLAS 2HDMa combination
- Areas where we can help:
  - Generation of Monte-Carlo samples
  - Rivet routines
- Main interest:
  - Already started working on projection for tbW final state - as studied in https://arxiv.org/abs/1807.07734 but with extra pseudoscalar

Zirui Wang (University of Michigan)

- 0.2 FTE
- Contributed to:
    - ATLAS Mono-Z(ll) (analysis contact)
    - ATLAS 2HDMa combination (analysis contact)
- Areas where I can help:
    - MC generation (Madgraph)
    - Truth-level analysis

Katharina Behr (DESY)

Expertise, interests, and FTE

> Long-standing expertise with in 2HDM+a and related searches:

- Analysis contact for 36 ifb DM summary paper (2018) in which 2HDM+a was first used
- Contributed to first 2HDM+a whitepaper that was closely related to ATLAS summary effort
- Particular expertise on interference search for gg → a/A/H → ttbar
  - Extended 2HDM+a UFO to allow for interference modelling
  - First ttbar constraints on 2HDM+a [JHEP08(2024)013]

> Interests:

- Scenarios with $m_A = / = m_H$
- Commonalities with ALP searches
- Scenarios away from alignment limit and possible di-Higgs constraints

> FTE:

- 1 senior: 0.1 – 0.2 FTE starting from January
- 1 PhD (tbc): 0.2 FTE from spring'25

James Frost (University of Oxford)

- 0.1-0.2 FTE until spring, possible student/postdoc effort later.
- Relevant experience:
  - ATLAS mono-h(bb)
  - ATLAS 2HDMa paper
  - ATLAS di-higgs searches (esp. HH->4b)
- Interests:
  - New Type-I/mass non-degenerate signatures
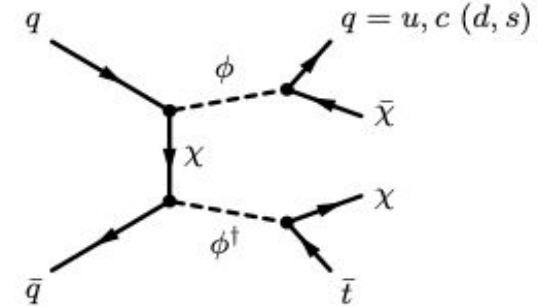 - Impact of moving away from alignment limit on signatures.

Alvaro Lopez - Interests and person-power

Worked in the 2HDM+a tW+MET final state in Run-2.
Current interests in final states containing top-quarks in the final states (flavoured DM models)
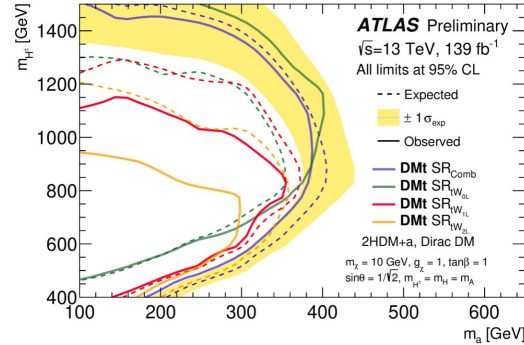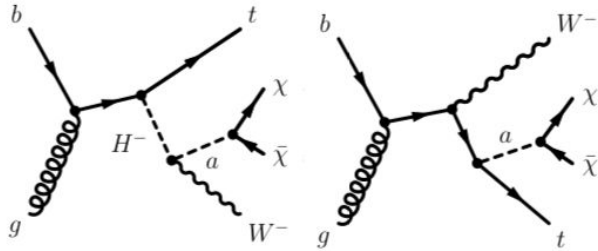
[JHEP 01 (2021) 194](#)

Expertise:
- General experience in searches within the SUSY group (tt+MET, tc+MET) and DM (2HDM+a tW+MET, monoHiggs→ yy early Run-2).
- MadGraph and Madspin generation. Truth level analysis.

Person-power: currently quite limited due to change of job. To increase after 1st of February.
- Alvaro Lopez (post-doc): ~ 0.05 - 0.1 FTE

Participation proposal : Debabrata Bhowmik(national Central University, Taiwan)

- Interests and expertise : Experimental and phenomenological signatures of Dark matter search; Higgs physics & machine learning based analysis techniques

- Experimental involvement (in CMS since 2015) :
  Search for dark matter produced in association with a Higgs boson decaying to two photons (monoHiggs to diPhotons)
  - The main interpretation is in the lights of 2HDM+a model
  - involved in the analysis since 2017, was major topic of my Ph.D and now leading the analysis

- Phenomenological involvement :
  - The mono-Higgs + MET signal at the Large Hadron Collider: a study on the $\gamma\gamma$ and bb final states
  10.1140/epjc/s10052-022-10828-6

- Possibile contribution in the white paper:
  - Possible new final states, variable formation and correlation studies between them to rank importance of the variables
  - MC based Analysis and possibility of machine learning based approach to improve significance
  - Sensitivity studies and indication of benchmark choices for experiments

Estimated FTE: ~20%

Thomas Biekötter

Main expertise: **pheno of extended Higgs-sector models**

→ Theory constraints (e.g. vacuum stability, thermal history)

→ `HiggsTools`: application and interpretation of LHC limits

→ Quantum corrections to DD scattering

Possible contributions to white paper:

→ Public implementation of 2HDM+a in `HiggsTools`

→ Comparison to other DM models → pNG DM

→ Definition of benchmark planes

→ Phase transitions and gravitational waves?

→ Impact of CP violation?

IFCA interest in 2HDM+a Run 3 white paper

Our expertise

We have worked in the t(t)+DM dilepton final state, both in **Phys. Rev. Lett. 122, 011803** and in **EXO-22-014**. We plan to continue our effort for Run 3

We have worked in the mono-Higgs WW decay channel in **JHEP03 (2020) 025**

Our expertise in analysis covers from the definition of analysis objects, such as muons, b-tagging or fake leptons, to the analysis optimization and signal / limits extraction

How we would like to be involved. Based on our expertise we could contribute in $tH^- \rightarrow tW^- + DM$ where the dilepton final state dominates at low H^- mass (see **arXiv:1712.03874**)

We can also contribute in $tt + DM$, where both a and A may decay to DM. Given the right $\sin\theta$ and M_H it can reach $M_a = 360 \text{ GeV}$ (see **arXiv:1701.07427**)

Estimated FTE until paper publication. Two senior scientist contributing together about **0.2 FTE**