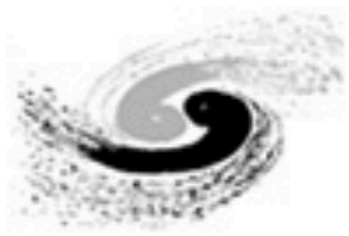
实验物理中心考核报告

徐达

2026–11



中国科学院高能物理研究所

Institute of High Energy Physics Chinese Academy of Sciences

报告内容

- 岗位职责
- 本年度工作情况
- 存在问题
- 下年度工作计划

岗位职责

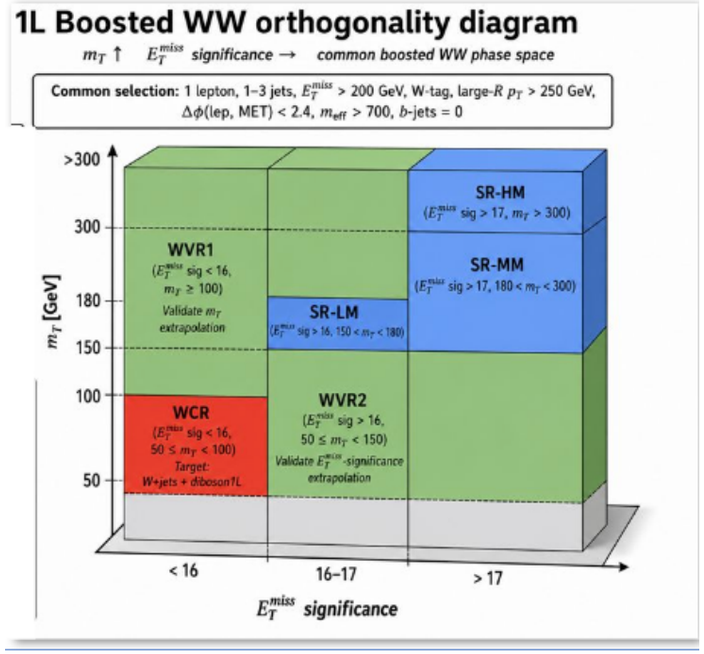
- 岗位职责：在ATLAS和CEPC上寻找新物理。
- 主要工作:
  - ATLAS物理
    - 1L/2L末态的wino、higgsino、bino
    - Compressed stau
    - Compressed electroweakino
    - H-Za-ll$\gamma\gamma$
    - H++
    - mono-bc
  - CEPC物理：smuon search

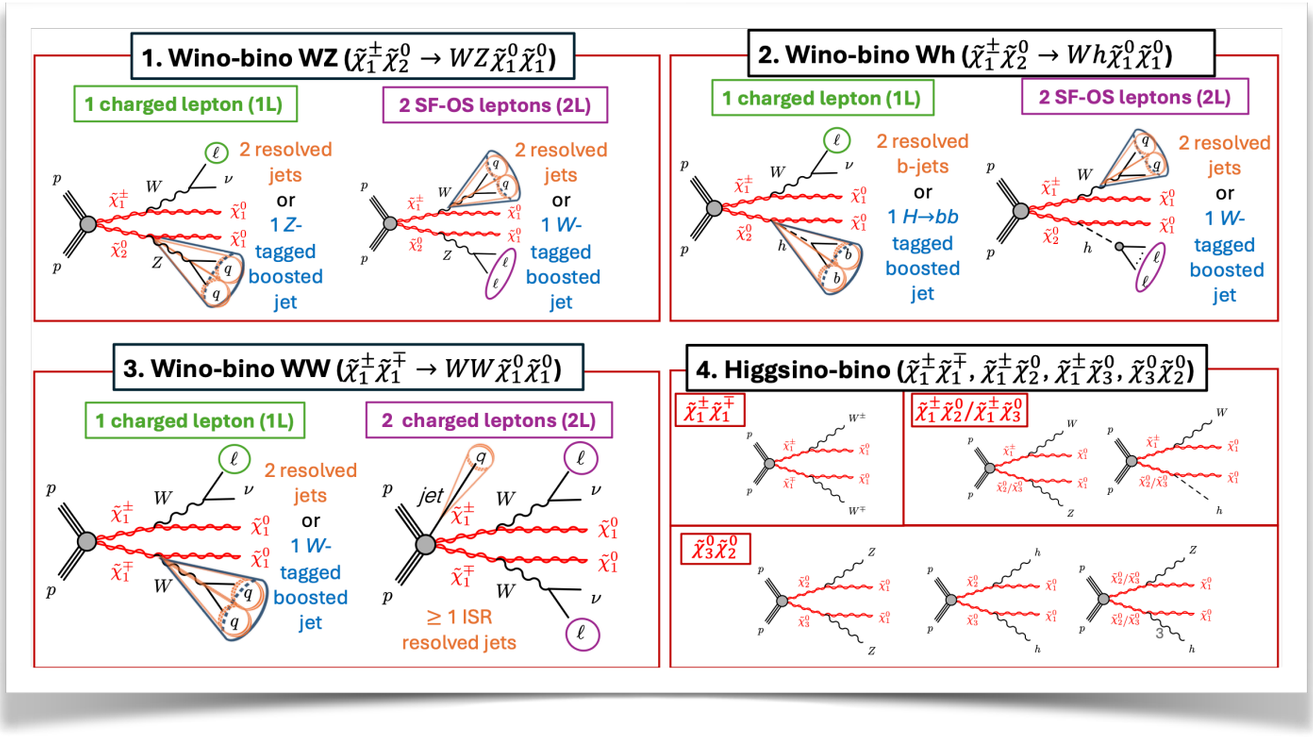
本年度工作完成情况

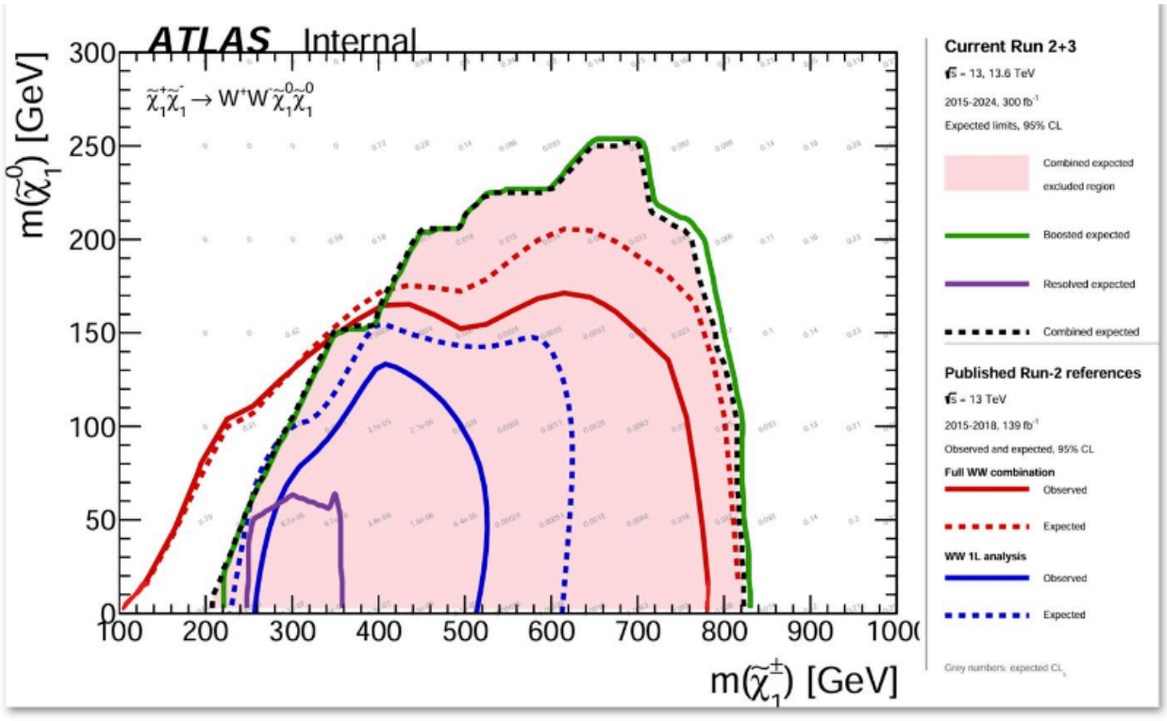
ATLAS物理分析：1L/2L末态的wino、higgsino、bino寻找

- 首次在**ATLAS**上提出研究**Higgsino-bino**过程，联合不同的**resolved/boosted**喷注类型来寻找一系列超对称粒子，进一步拓展**EWKino**的敏感度。

- 分析基于**ATLAS Run2+partialRun3**（**300ifb**）已完成初步本底研究、信号敏感度分析，已通过**HMBS**组**Partial Analysis Review**；正在产生新一轮包含完整系统误差的**ntuple**；预计年底申请**Editorial Board**，明年发表。





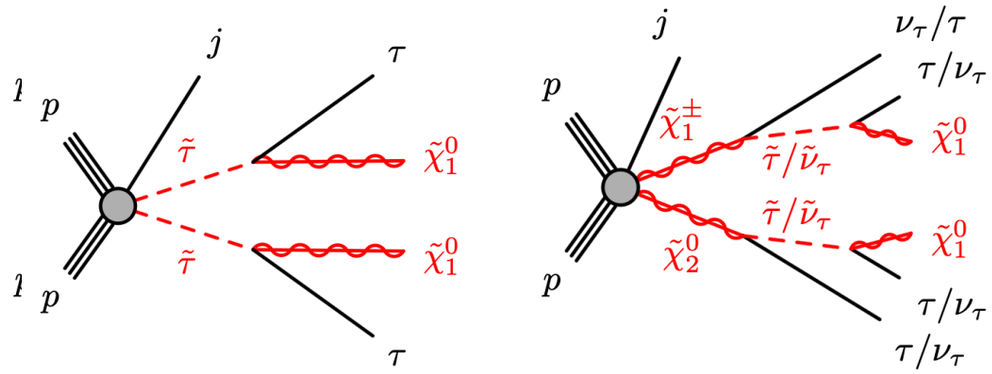


相较于同分析末态Run2结果，提升～200GeV

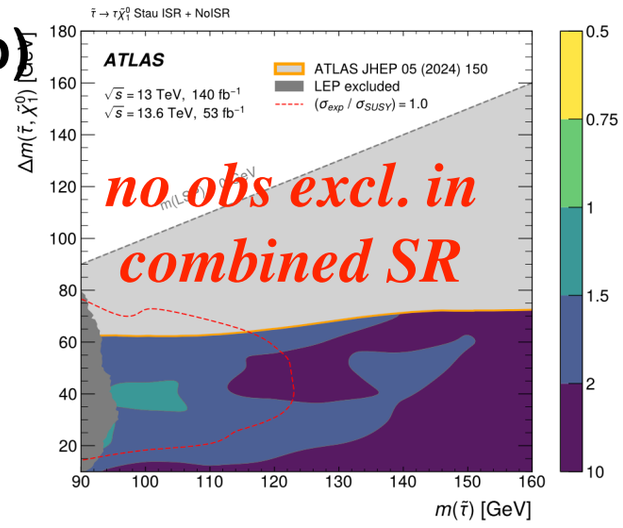
本年度工作完成情况

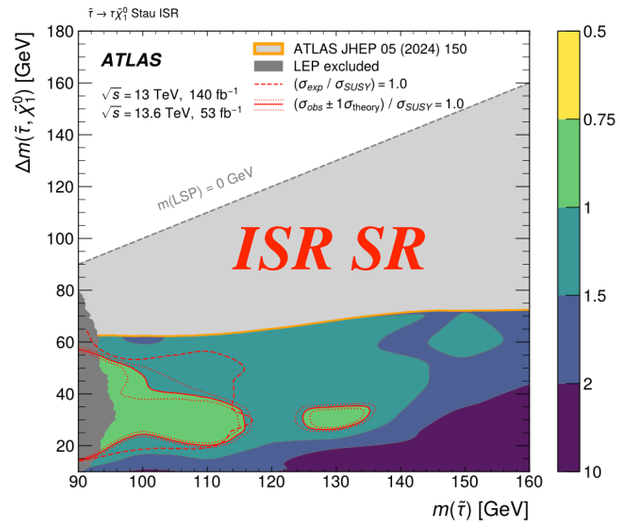
ATLAS物理分析：质量压缩空间stau的寻找

- 研究质量压缩区域的**soft stau**。通过**ISR+largeEtmiss** 模式来触发事例；结合**2tau**的纯强子衰变末态（**had-had)**和含轻子衰变末态**(lep-had)**；使用深度学习**DNN**。



- 基于**ATLAS Run2+early Run3(140+53ifb)**文章结果已发布；已投稿期刊。



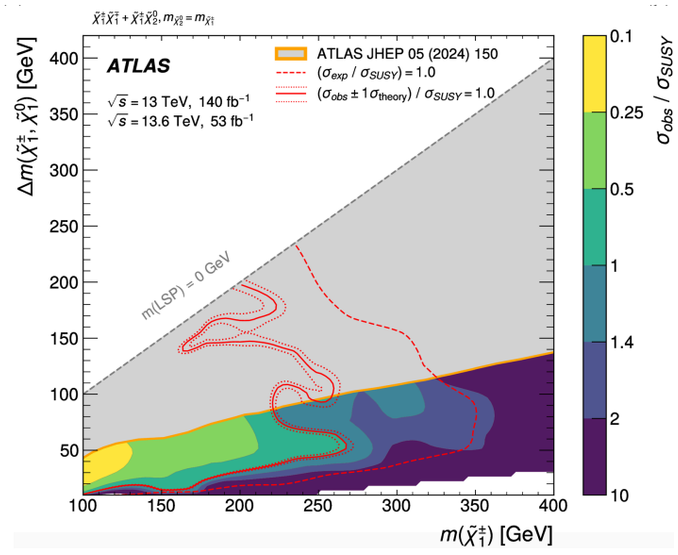


Strategy

- Target **direct stau pairs and C1N2/C1C1 production via staus**
- Final states: **tau_had tau_lep or 2 tau_had**
- **ISR jet + large Etmiss** to enhance sensitivity to compressed spectra

Innovation

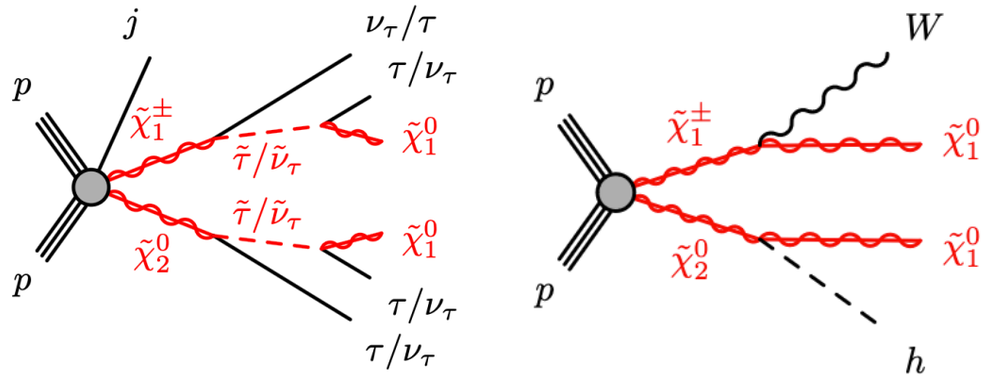
- Dedicated **soft-tau down to pT~15 GeV**
- **Multiclass DNNs** for signal/background discrimination
- Complementary ISR and non-ISR searches; Run 2 (140 fb-1) + Run 3 (53 fb-1)

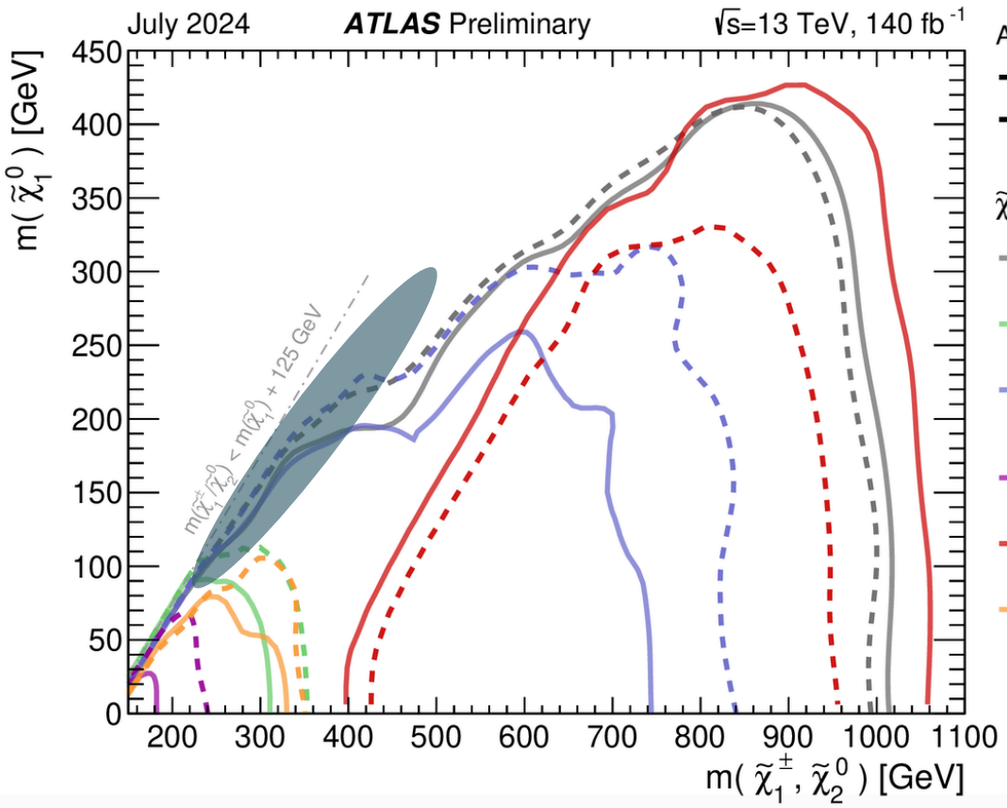


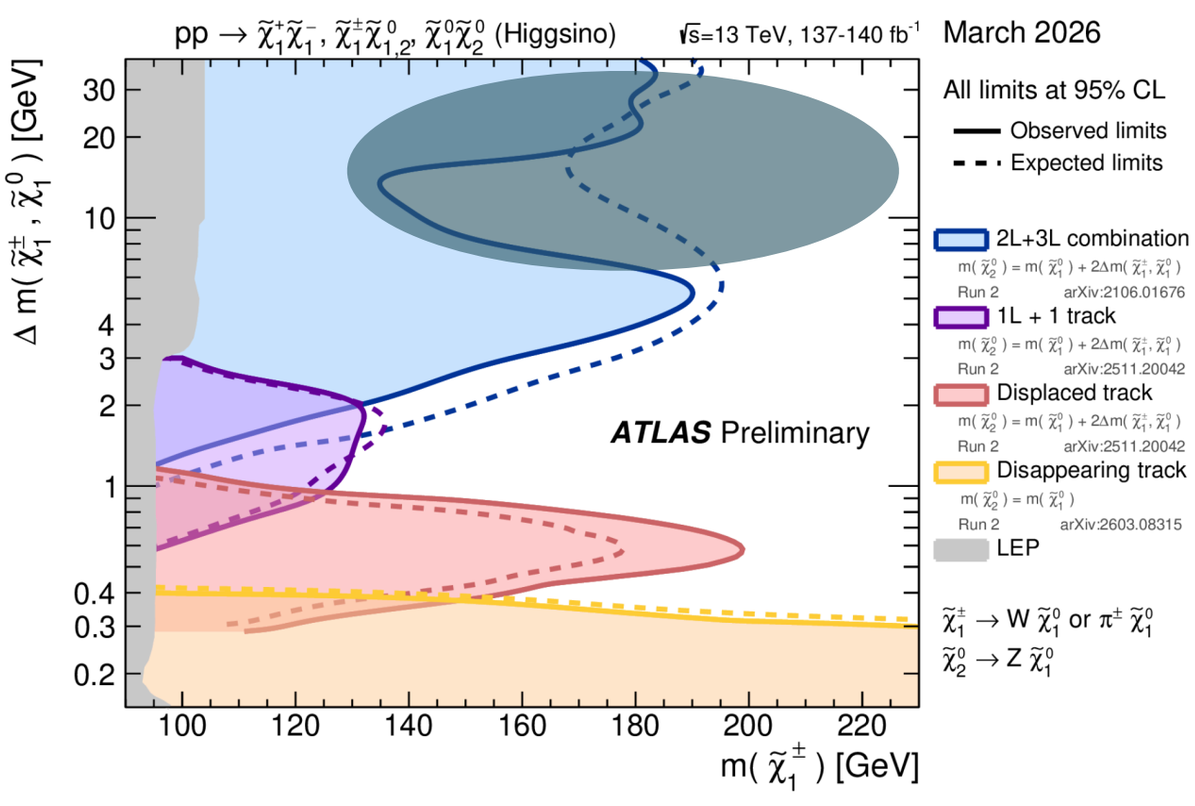
本年度工作完成情况

ATLAS物理分析：质量压缩空间Electroweakino的寻找

- **NEW！Target ATLAS Run2+FullRun3**
- 深度挖掘质量压缩空间的**Electroweakino！（wino、higgsino）填补现有Gap：C1N2 via stau, C1N2 via Wh, N2N3 via Zh**
- 新信号申请中：**Filter、trigger**等的研究





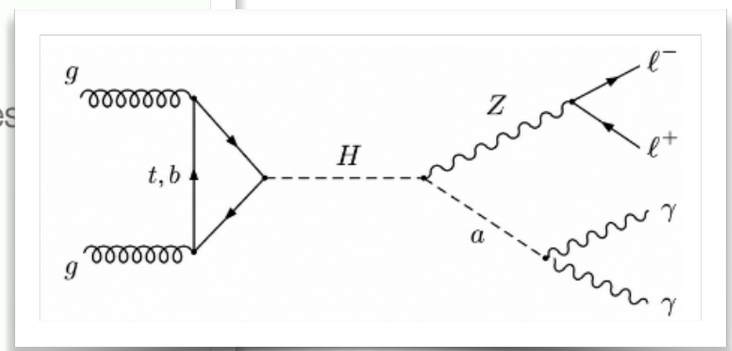


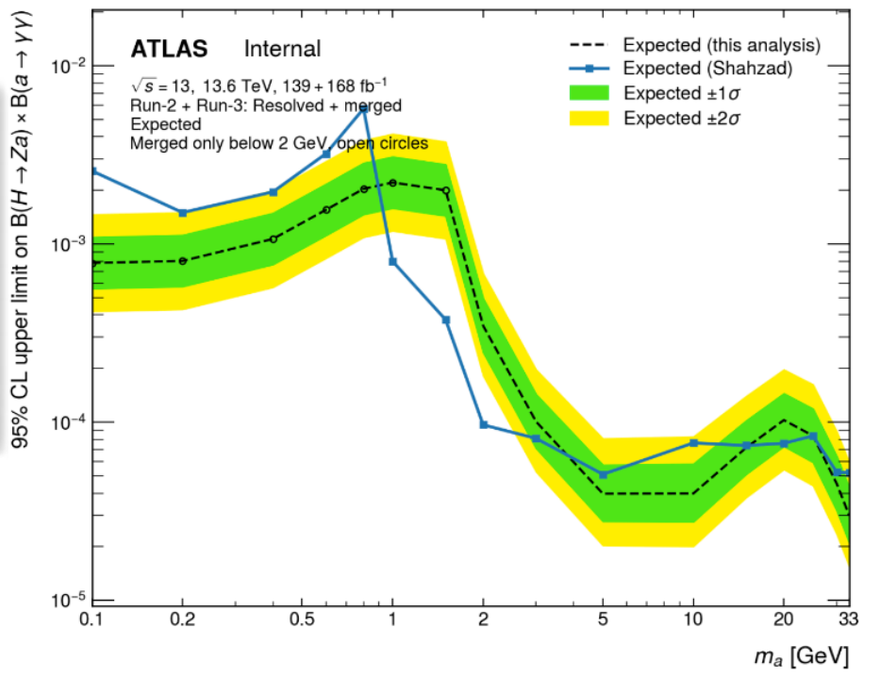
本年度工作完成情况

ATLAS物理分析：H-Za-ll$\gamma\gamma$的寻找

- 寻找**H-Za-ll$\gamma\gamma$**的奇异衰变过程，寻找**axion**，探索希格斯与新轻标量粒子的相互作用。
- 基于**ATLAS Run2+partialRun3**（**300ifb**）数据，针对质量范围为**0.1–33 GeV**的新粒子**a**，分别研究光子**Merged**和**Resolved**两类末态。
- 目前已完成信号与背景参数化、虚假信号检验及背景建模系统误差的评估、正在整合统计分析提取联合上限，计划年底申请**EB**。预计明年发表。

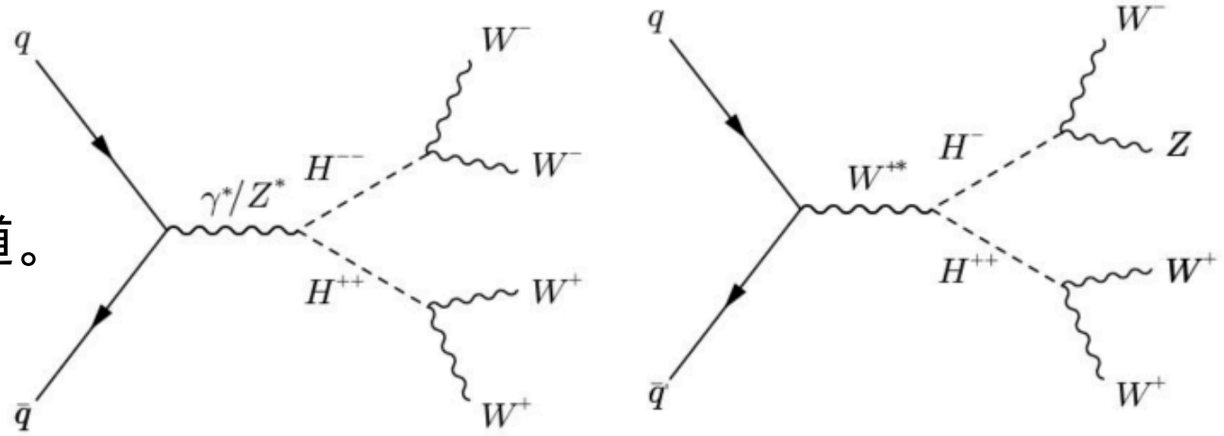
- SM Higgs exotic decay to low-mass a:
  - Signal grid: 0.1 GeV < m_a < 33 GeV.
- Main backgrounds: Z+γ, Z+γγ, Z+jets, and di-boson.
- Z → ee/μμ: provides trigger and event-selection handles
  - OS leptons, within the Z-mass window
  - Single-ℓ and di-ℓ triggers.
- Two event categories:
  - Resolved: 2 γ, with p_T > 10 GeV.
  - Merged: 1 γ, with p_T > 20 GeV, not-resolved.
- SRs:
  - Initial cut-based SR strategy, using kinematic and γ shower-shapes.
  - Transitioned to BDT, now testing PGNN-based selections.





ATLAS物理分析：H++的寻找

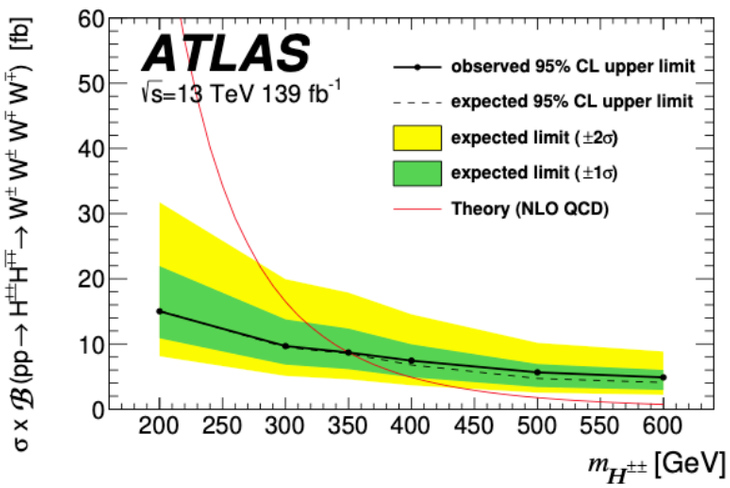
- **NEW**！双电荷希格斯玻色子（**H++**）是标准模型之外扩展希格斯场的重要预言，广泛存在于 **Type-II Seesaw** 等新物理模型中。其研究与中微子质量起源、电弱对称性破缺机制密切相关。
- 前一轮**Run2**分析道集中于**SS2L, 3L, 4L**；
- **NEW**！新一轮**Run3**分析，开展新的**1L**分析道。

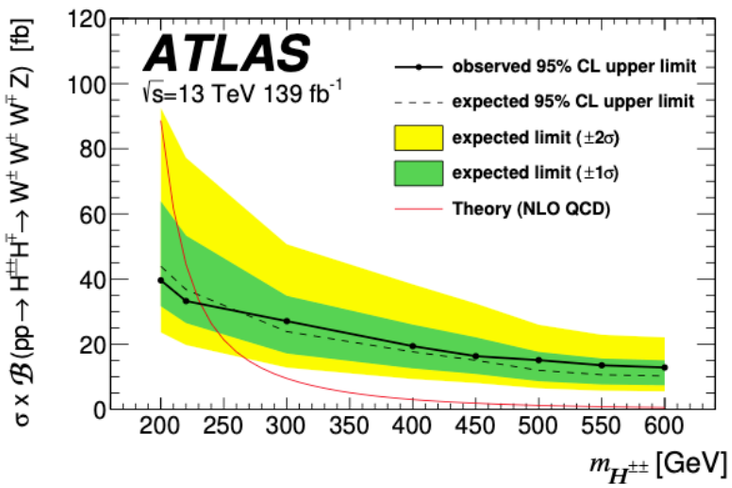


Pair production: $H^{\pm\pm}H^{\pm\pm}$ Associated production: $H^{\pm\pm}H^{\mp}$

$H^{\pm\pm}H^{\mp\mp} \to 4W$	BR (in %)
$\to 0l$ + 8 jets	20.1
$\to 1l + E_T^{miss}$ + 6 jets	39.7
$\to 2l + E_T^{miss}$ + 4 jets	29.3 (same-sign: 14.7)
$\to 3l + E_T^{miss}$ + 2 jets	9.6
$\to 4l + E_T^{miss}$ + no jets	1.2
$H^{\pm\pm}H^{\mp} \to WWWZ$	BR (in %)
$\to 0l$ + 8 jets	22.0
$\to 0l + E_T^{miss}$ + 6 jets	6.3
$\to 1l + E_T^{miss}$ + 6 jets	31.1
$\to 1l + E_T^{miss}$ + 4 jets	8.9
$\to 2l$ + 6 jets	3.1 (same-sign: 0)
$\to 2l + E_T^{miss}$ + 4 jets	14.6 (same-sign: 4.7)
$\to 2l + E_T^{miss}$ + 2 jets	4.2 (same-sign: 1.4)
$\to 3l + E_T^{miss}$ + 4 jets	4.4
$\to 3l + E_T^{miss}$ + 2 jets	2.3
$\to 3l + E_T^{miss}$	0.7
$\to 4l + E_T^{miss}$ + 2 jets	2.1
$\to 5l + E_T^{miss}$ + no jets	0.3

1: Pair-production of $H^{\pm\pm}$ and associate-production of $H^{\pm\pm}$ and $H^{\mp}$: decay channels and BRs.





本年度工作完成情况

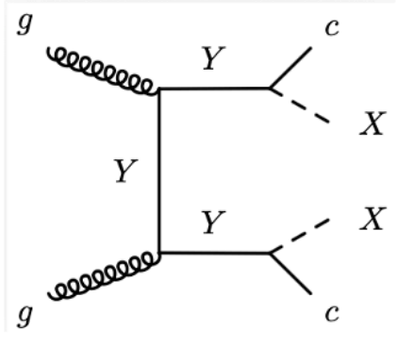
ATLAS物理分析：Dark matter with mono-b/c

- 基于**ATLAS新的GN2 flavor tagging**技术，经由**mono-b/c jet**寻找暗物质。
  - 首次寻找**charm-philic DM**
  - 首次寻找**single-stop**
- 信号已申请；**framework**已建立；开展了初步的信号优化。

Category	Mono-b SR	Mono-c SR
Trigger	MET	
Leading jet	$p_T \geq 150$ GeV	
	$\|\eta\| < 2.4$	
	tight jet cleaning	
Subleading jet	$p_T \geq 30$ GeV $\|\eta\| < 2.8$	
p_T^{recoil}	≥ 200 GeV	
Multijet suppression	$\Delta\phi(p_T^{recoil}, jet1) > 0.6$ $\Delta\phi(p_T^{recoil}, jet2,3,4) > 0.4$	
b/c-tagging GN2v01 (2D PCBT)	$N_{B\ jets} \geq 1$	$N_{C\ jets} \geq 1$, b-veto
Jet multiplicity	$N_{jets} \leq 4$	
Leptons	None	

Heavy-flavour jet(s) + Etmiss

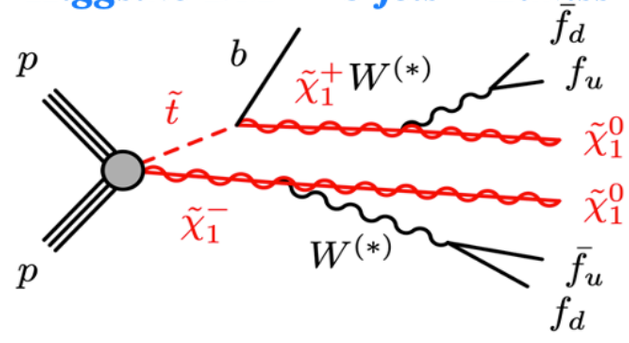
Charm-philic DM --- c-jets + Etmiss



- QCD production of coloured mediator pairs (YY)
- **t-channel flavour-dependent DM (X)**
- Final states with **≥1 c-jet(s) + large Etmiss**

→ **First** dedicated ATLAS charm-philic DM search

Higgsino DM --- b-jets + Etmiss



- Natural SUSY motivates **light higgsinos and a relatively light stop**
- **Single-stop production associated with a Higgsino-like chargino**
- Final states with **b-jet(s) + Etmiss** probe complementary SUSY/DM parameter space

→ **First** ATLAS search targeting single-stop production

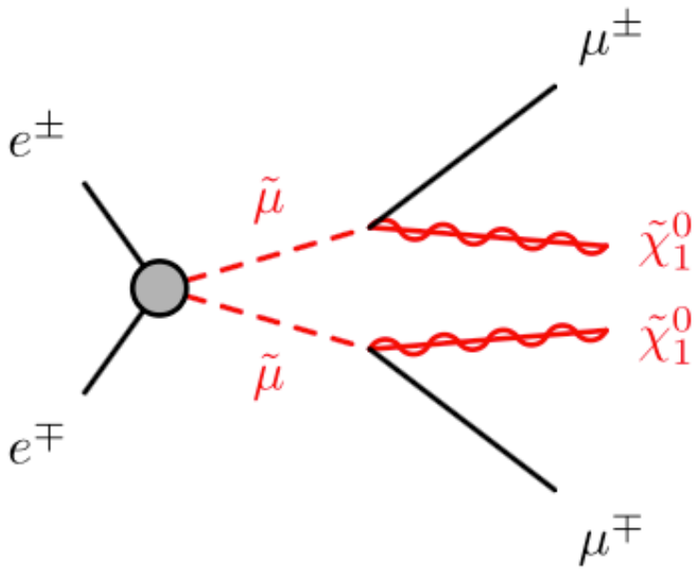
本年度工作完成情况

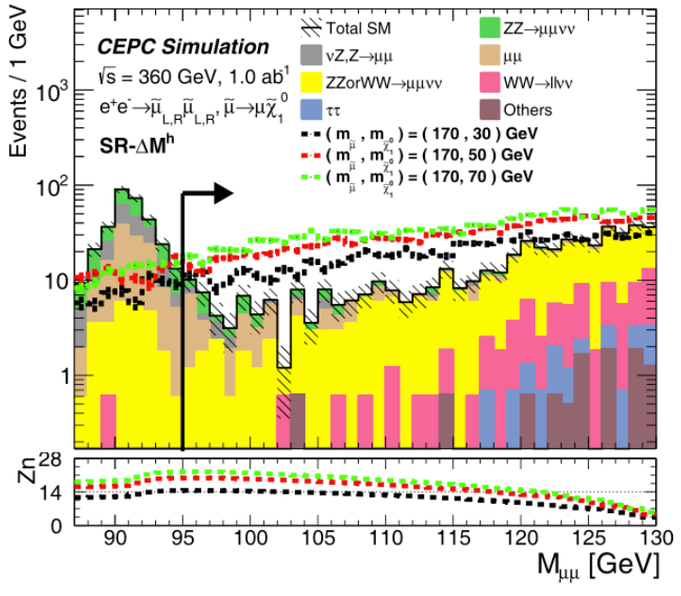
CEPC物理分析： Smuon的寻找

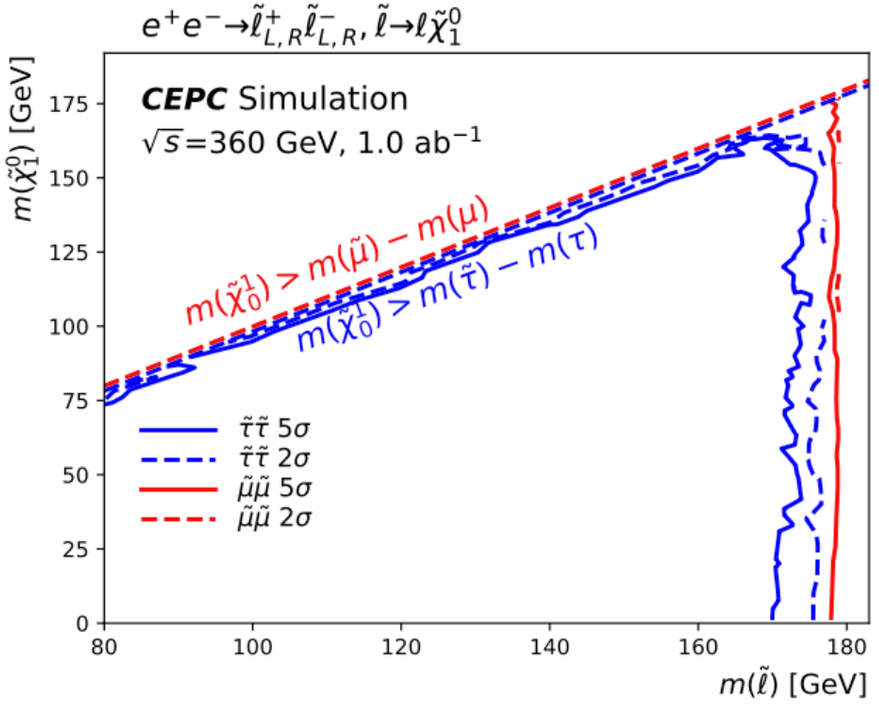
- 基于**CEPC**寻找超对称**Smuon**粒子
  - **Smuon pair @CEPC 360GeV** 已发表
  - **ONGOING：Smuon pair @ CEPC 240GeV with RefTDR**
  - 目前已完成**RefTDR vs CDR**时期的对照检查
  - 预计明年初发表

Smuon signal events final selection

SR-ΔM^h	SR-ΔM^m	SR-ΔM^l
$E_{\mu 1,2} > 40$ GeV	$9 < E_{\mu 1,2} < 48$ GeV	–
$E_{\mu 1,2} \in (40-50, >50)$ GeV	$E_{\mu 1,2} \in (9-29, 29-48)$ GeV	
$\Delta R(\mu, \text{recoil}) < 2.9$	$1.5 < \Delta R(\mu, \text{recoil}) < 2.8$	
$M_{\mu\mu} < 60$ GeV	$M_{\mu\mu} < 80$ GeV	–
$M_{\text{recoil}} > 40$ GeV	–	$M_{\text{recoil}} > 220$ GeV







研究成果 & 经费情况

文章

- ***Search potential for direct slepton pair production at the CEPC with √s=360 GeV Chin. Phys. C 50 (2026) 033001***

- ***Search for compressed electroweak SUSY production in final states with two $ \tau$-leptons in $\sqrt{s} = 13$ and 13.6 TeV pp collisions with the ATLAS detector submitted to JHEP***

- ***ATLAS* 实验上的超对称寻找，科学通报，*https://doi.org/10.1360/CSB-2026-0706***
  （唯一通讯）

经费

- **基于 ATLAS 高亮度数据检验标准模型和 Higgs 机制与寻找新物理：子课题：寻找新粒子新现象研究，国家重点研发大科学装置前沿研究，525万元，2024-2028，参与**

- **今年参与NSFC-CERN重点ATLAS物理项目的申请《探寻隐藏的极化与暗物质》，未获批**

会议报告/学生/其他

会议报告

- ***SUSY search in ATLAS and CMS, Corfu2026，Aug 2026 （Plenary）***
- ***Recent SUSY search in LHC, Higgs Potential 2026，Dec 2026 (Plenary)***
- ***ATLAS HGTD Logistics，ATLAS+CMS Logistics Workshop, May 2026***

- 学生
  - 指导博士生 Rabia（副导师）；协助指导ATLAS SUSY组的学生

- 服务
  - ATLAS物理文章审稿人（今年已发表）
  - ATLAS HGTD 芯片海关事务
  - 基金委项目评审
  - 所研究生中期考核评审
  - 所博士后中期考核评审

- 存在问题
  - 学生、经费缺乏

PUB-SUSY-2022-09
2023-01-16

Prospects for EWK all-had at HL-LHC Reader - Member

Prospects for electroweak all-hadronic searches at HL-LHC

下年度工作计划

- 推动完成正在开展的一系列ATLAS/CEPC物理分析
- 开展未来对撞机上的新物理研究

Thanks!