

Highlights from ZZU

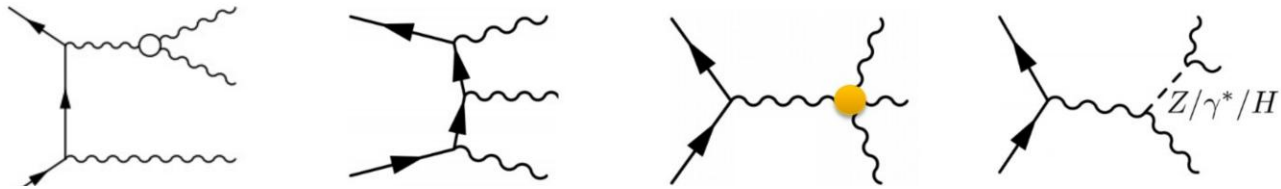
Xiaocong Ai (ZZU)

ATLAS-China Faculty meeting 2026, April 25, Dengfeng, Zhengzhou

About ZZU ATLAS group

- Joined ATLAS (SDU-ZZU-NKU cluster) in July 2023
- Currently only two faculties (one M&O author, 0.57 OTP in 2025):
 - Xiaocong Ai : EWK and Higgs physics, advanced tracking algorithms development & performance
 - Yi Liu (full-time hardware developer): RPC Phase-II detector development, beam-test particle telescope development
- 2 Ph.D + 1 master students on analysis + tracking
- 2 master students on hardware

Physics analysis



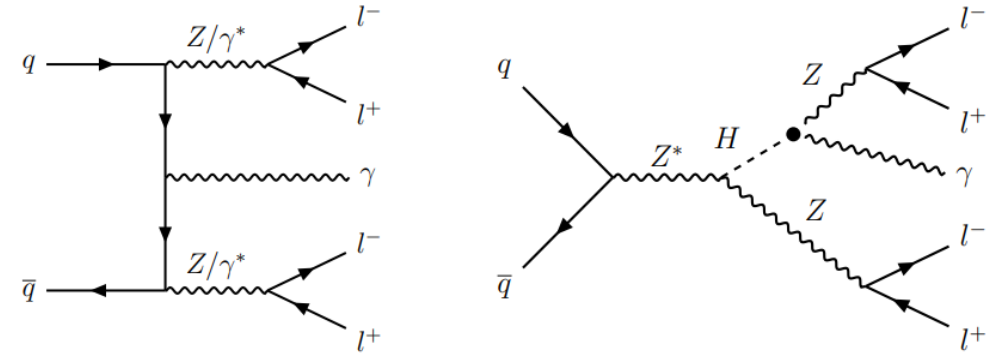
Evidence of ZZ γ production (using Run2 data)

arXiv: 2602.17165, under PRL review

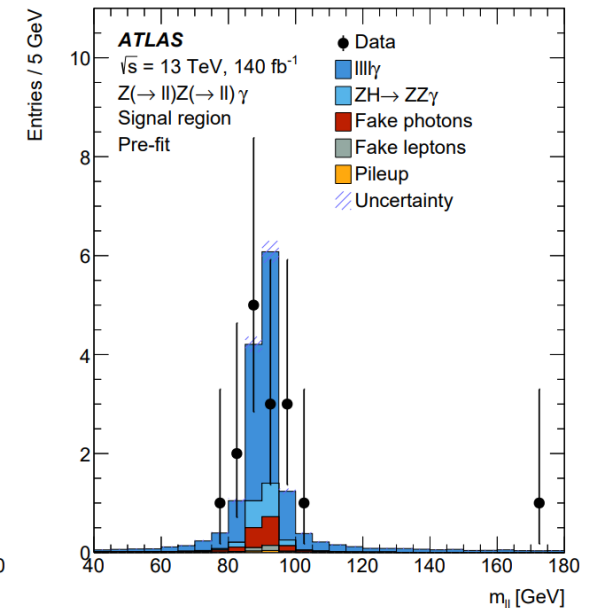
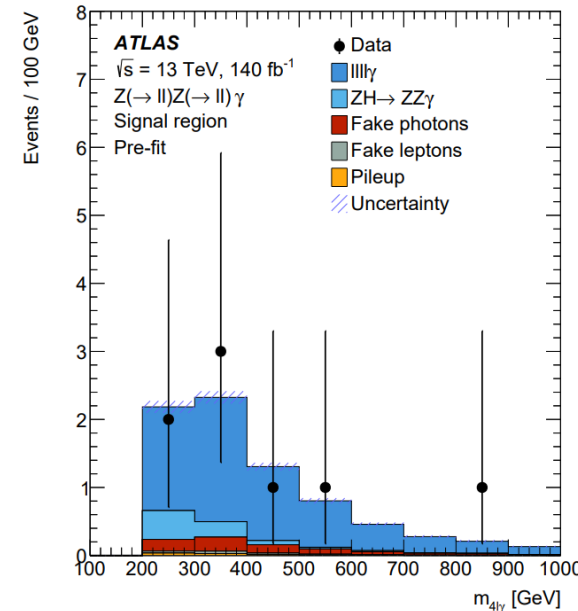
X. Ai as Contact Editor

- **First evidence of very rare ZZ γ production** with observed (expected) significance of 4.4σ (4.4σ)
 - CMS reported evidence of 3.7σ recently
- Measured cross section:

$$\sigma_{ZZ\gamma} = 0.144^{+0.064}_{-0.051} \text{ (stat.)}^{+0.007}_{-0.005} \text{ (syst.) fb}$$

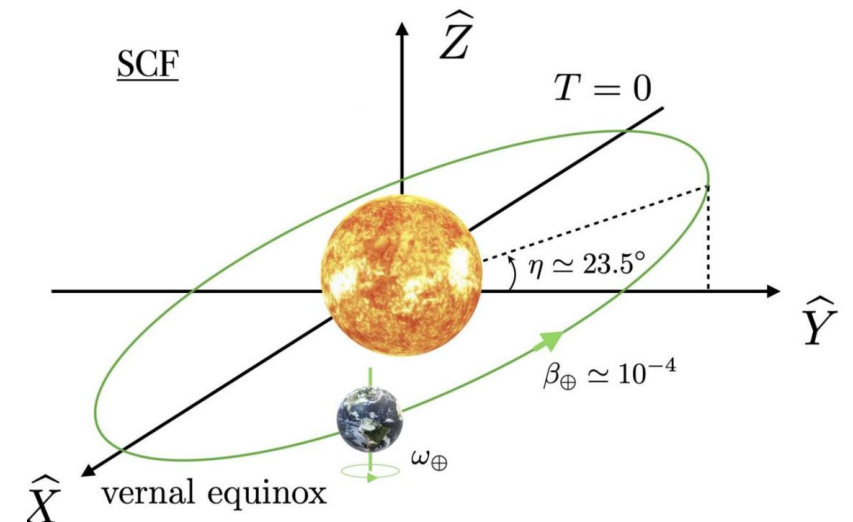
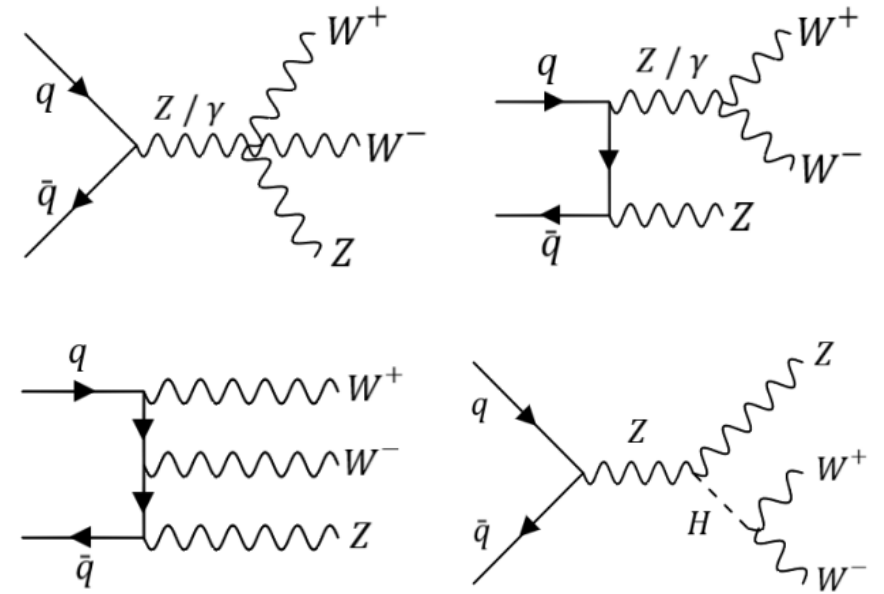


	Number of events
SHERPA 2.2.11 $4\ell\gamma$	6.28 ± 0.09 (stat.) ± 0.18 (syst.)
POWHEG+PYTHIA8 $ZH \rightarrow ZZ\gamma$	0.76 ± 0.03 (stat.) ± 0.03 (syst.)
Signal	7.04 ± 0.09 (stat.) ± 0.18 (syst.)
Fake photons	0.71 ± 0.02 (stat.) ± 0.13 (syst.)
Fake leptons	0.12 ± 0.02 (stat.) ± 0.08 (syst.)
Pileup	0.09 ± 0.002 (stat.) ± 0.02 (syst.)
Total background	0.92 ± 0.03 (stat.) ± 0.15 (syst.)
N_{tot} prediction	7.96 ± 0.09 (stat.) ± 0.23 (syst.)
N_{tot} data	8

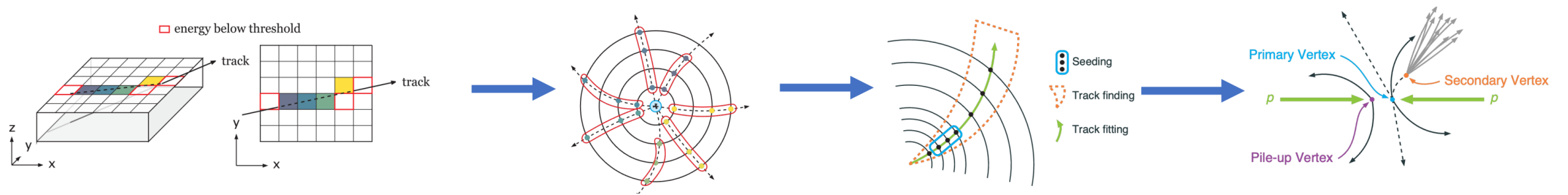


Ongoing analysis

- ATLAS Run2+3 WWZ analysis
 - Kicked-off on May 9, 2025. Aiming for first WWZ production observation.
 - ZZU is contributing to fake lepton background estimation etc. as Analysis Contact
- Search for CPT violation in $H \rightarrow \gamma\gamma$ using Run2 + partial Run 3
 - First CPT violation search in Higgs sector (searching for oscillations of $\sigma(H \rightarrow \gamma\gamma)$ over sidereal phase). Analysis strategy has converged.
 - ZZU is contributing to time-dependent fake photon background decomposition etc.



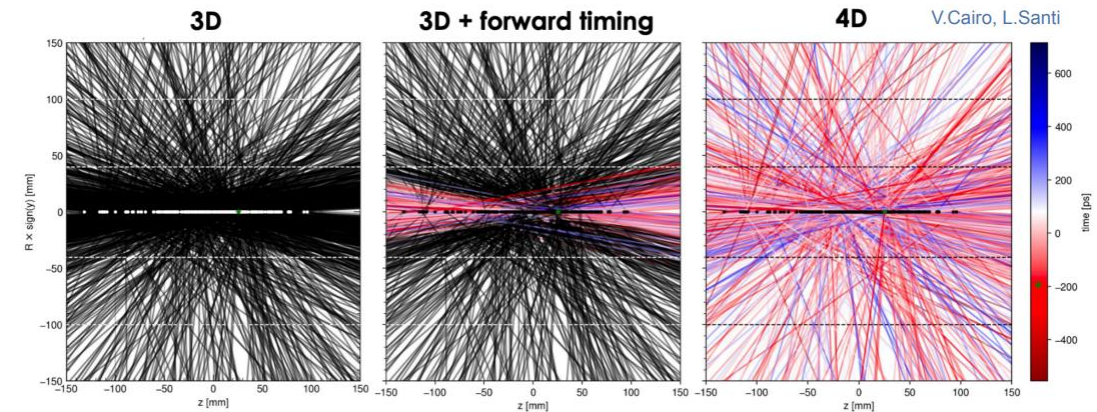
Tracking software and performance



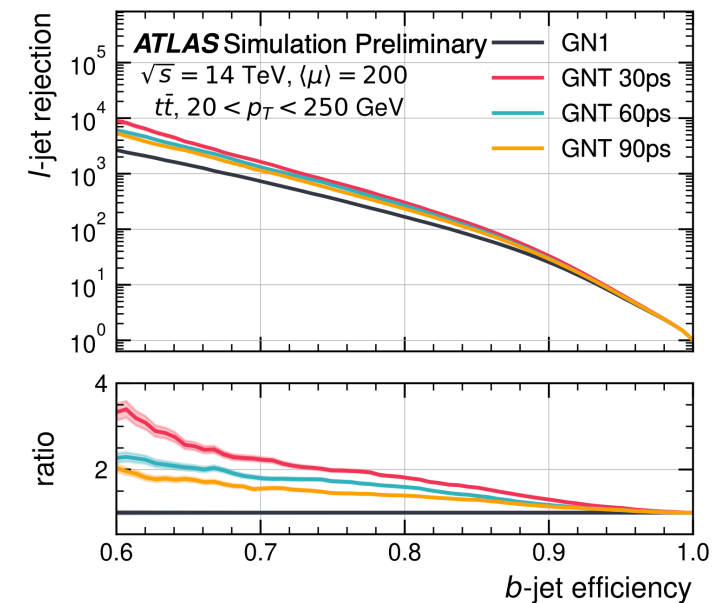
Developing A Common Tracking Software



- ZZU is core developer of KF-based track finding, fitting and detector alignment algorithms in ACTS for ATLAS Run4
 - First prototype of new **KF-based alignment** available for ATLAS (targeting at ITk)
- Extensive R&D on ACTS-based 4D tracking for HL-LHC and beyond, in close collaboration with USTC (Hongtao Yang) and CERN, SLAC
 - Developed and validated 4D tracking + vertexing for ITk with timing information
 - Now looking into 4D flavour-tagging



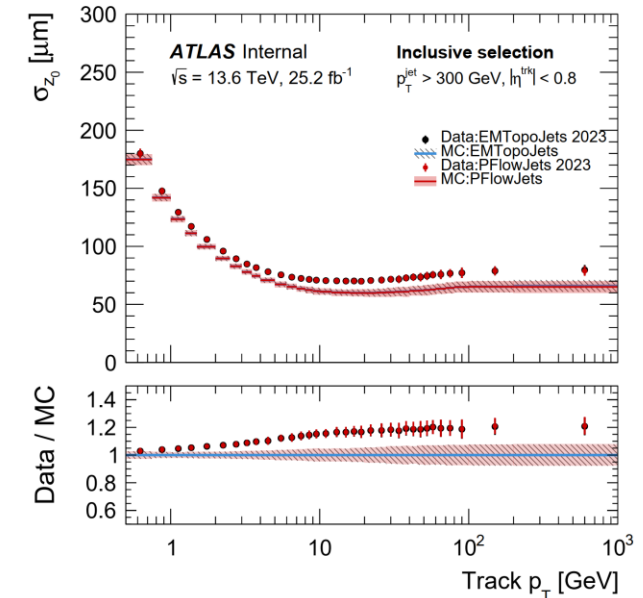
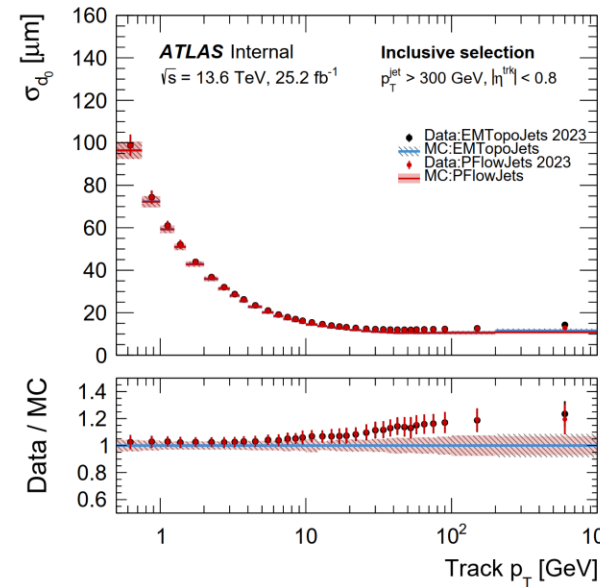
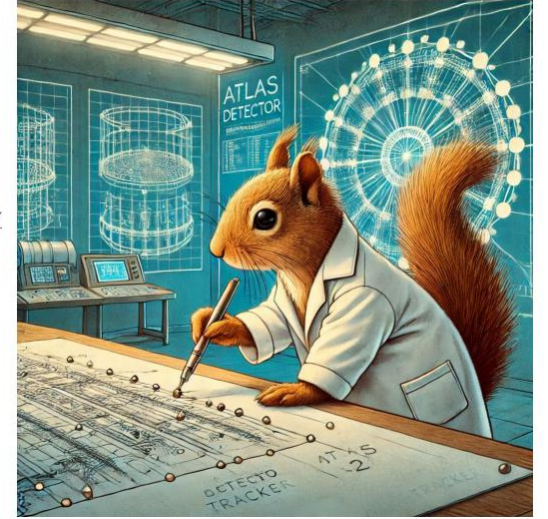
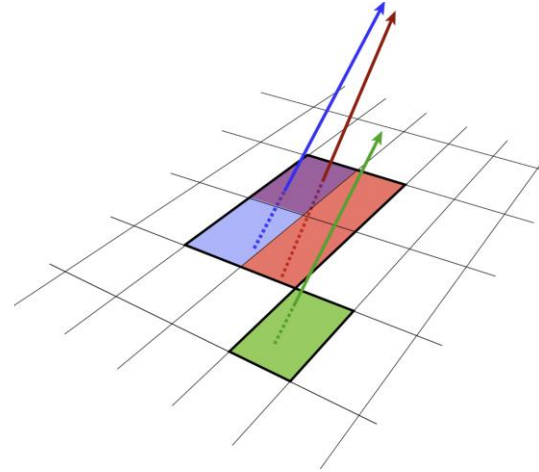
V.Cairo, L.Santi



See [PF's slides at CTD2025](#) (in collaboration with X.C. Ai, V. Cairo, P. Gessinger, L. Santi, A. Stefl, A. Swartzman, H. T. Yang, Y. Q. Wang)

ATLAS Run3 tracking and performance

- ATLAS Tracking and Performance studies (TPerf, previously CTIDE) subgroup convener during April 1, 2024-March 30, 2026
- Analysis Contact of **Run3 Tracking CTIDE perf analysis** (ANA-IDTR-2025-03) contributing to recommendations of Run3 tracking resolution, efficiency etc. and Run4 tracking algorithms optimization
 - Will request EB soon



ATLAS Run3 tracking resolution

Detector development

Hardware lab in operation

- 42 m² lab for gaseous particle detector manufacturing
 - Focusing on RPC detector module R&D and manufacturing for both ATLAS Muon upgrade and other experiments
 - In close collaboration with USTC and SDU
- 45 m² lab for detector electronics
 - e.g. beam telescope development



ZZU lab for particle detectors development



PRC module produced by Yi Liu et al. in USTC under test in ZZU₁₀

TaichuPix3 telescope

- Built first TaichuPix3-based beam telescope and validated with beam test at CERN
- Will be used for beam-based detector prototyping in China utilizing domestic test beam



Taichupix3 beam telescope



Beam test on July 16-22, 2025 @CERN SPS

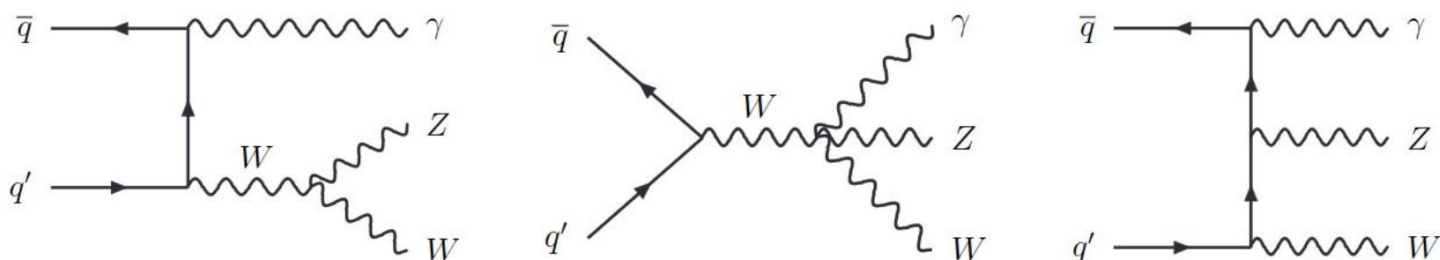
Summary

- ZZU ATLAS group activities and accomplishments:
 - **Physics analysis: Run2 ZZ γ is under PRL review**, WWZ and LIV in H $\rightarrow\gamma\gamma$ are ongoing
 - **Tracking software and performance: developed new alignment and 4D tracking + vertexing for ITk; Run3 CTIDE performance analysis will request EB soon**
 - **Hardware development: lab is in operation for PRC test and R&D; built first TaichuPix3-based beam telescope**
- Lots of collaboration with USTC, IHEP and SDU! Looking forward to more collaboration with other ATLAS-China institutes in various research topics
- **We would like to express our thanks to many of you for your support and help all along!**

backup

WZ γ observation at 13 TeV

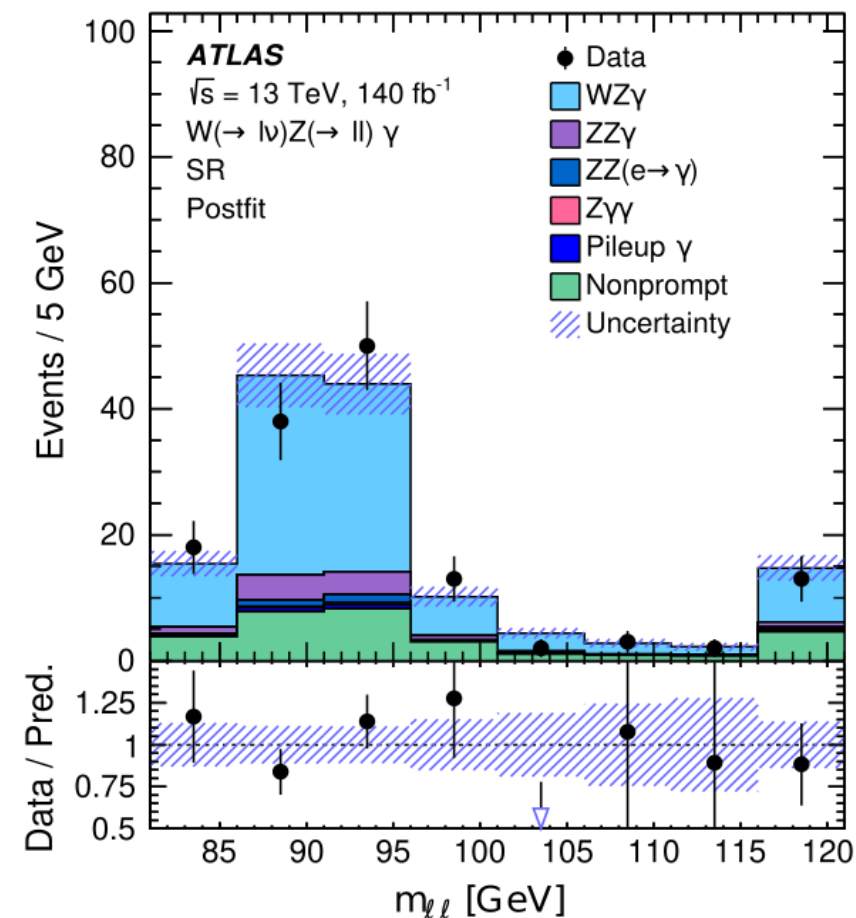
PRL132 (2024) 021802, X. Ai as Analysis Contact & Contact Editor



Fully leptonic channels in SR+2CRs

Process	SR	ZZ γ CR	ZZ($e \rightarrow \gamma$) CR
WZ γ	92 ± 15	0.21 ± 0.07	0.56 ± 0.14
ZZ γ	10.7 ± 2.3	23 ± 5	1.8 ± 0.4
ZZ($e \rightarrow \gamma$)	3.0 ± 0.6	0.028 ± 0.020	30 ± 6
Z $\gamma\gamma$	1.05 ± 0.32	0.15 ± 0.06	0.29 ± 0.10
Nonprompt background	30 ± 6
Pileup γ	1.9 ± 0.7
Total yield	139 ± 12	23 ± 5	33 ± 6
Data	139	23	33

6.3 (5.0) σ obs.(exp.)



$$\sigma_{WZ\gamma} = 2.01 \pm 0.30 \text{ (stat.)} \pm 0.16 \text{ (syst.) fb}$$