

Reproducing the VH , $H \rightarrow WW^*$ HS3 Workspace

DEMOS/HS3 gallery and pyhs3 workflow status

Simon Cello

Technische Universität Dortmund

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Premise: one statistical model, two implementations

- Publication: associated WH and ZH production with $H \rightarrow WW^*$, using 140 fb^{-1} at $\sqrt{s} = 13 \text{ TeV}$.
- HEPData provides the combined statistical model as an **HS3 JSON workspace**.
- The physics target is the combined two-POI likelihood

$$\mathcal{L}(\mu_{WH}, \mu_{ZH}, \theta),$$

where θ contains nuisance parameters and background normalisations.

- Goal: reproduce the same profile likelihood and post-fit yields with **xRooFit** and **pyhs3**.

Workspace at a glance

Combined channels	14
Signal / control regions	8/6
Histogram bins	72
HistFactory samples	237
Modifiers	3423
Snapshot parameters	495

HEPData resource 3969484

DOI: 10.17182/hepdata.157861.v1/r1

What is contained in the HS3 workspace?

Serializable model components

- analyses and likelihoods: connect the model to observed and Asimov datasets.
- distributions: HistFactory channels, samples, and modifiers.
- data: observed binned counts for every channel.
- domains: parameter ranges and constants.
- parameter_points: four snapshots, including the unconditional observed-data point.

Primary analysis: `combPdf_obsData`
POIs: μ_{WH} and μ_{ZH}

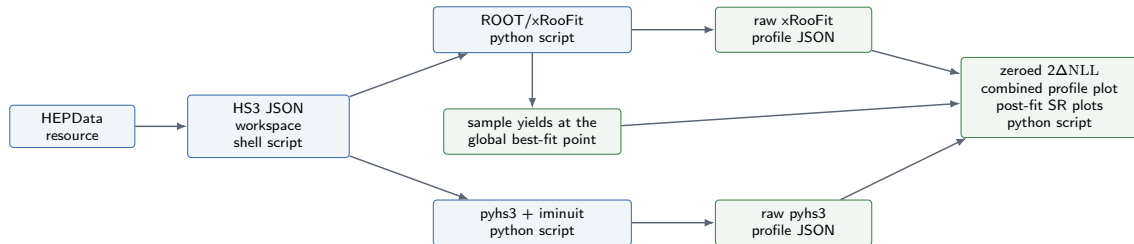
Channels entering the combined fit

Channel	SR	CR
Opposite-sign 2ℓ	1	3
Same-sign 2ℓ	3	0
3ℓ	2	2
4ℓ	2	1
Total	8	6

Version information

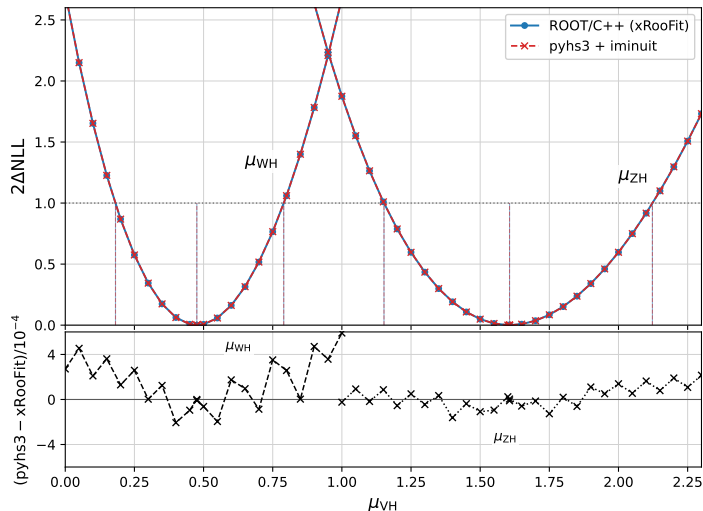
Workspace metadata: ROOT 6.35.01
Validation runtime: ROOT 6.41.01
pyhs3: 0.4.2.dev72, commit 56527f28

Reproduction pipeline



Fixed grids: 23 points for μ_{WH} , 47 points for μ_{ZH} . Absolute likelihood constants differ, so the comparison uses zeroed $2\Delta\text{NLL}$.

Pipeline result: profile likelihoods



	xRooFit	pyhs3
$\hat{\mu}_{WH}$	0.47577	0.47587
68% interval	[0.182, 0.790]	[0.182, 0.790]
$\hat{\mu}_{ZH}$	1.60608	1.60619
68% interval	[1.152, 2.123]	[1.152, 2.123]

Implementation agreement

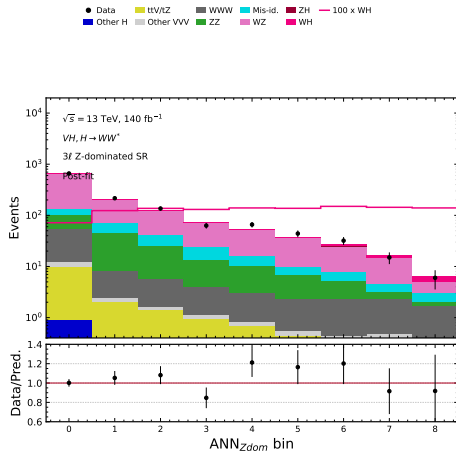
Maximum profile difference:

$$\begin{aligned}\mu_{WH} &: 5.9 \times 10^{-4}, \\ \mu_{ZH} &: 3.4 \times 10^{-4}.\end{aligned}$$

Runtime

xRooFit: approximately 20 min
pyhs3+iminuit: approximately 11 h
recorded fit time (about 12 h wall time)

Post-fit signal-region validation



Representative 3 ℓ , Z-dominated post-fit SR

Across all eight SRs, the largest per-bin total difference is 0.051 events.

Evaluated fit point

	$\hat{\mu}_{WH}$	$\hat{\mu}_{ZH}$
xRooFit	0.47577	1.60608
pyhs3	0.47587	1.60619

Integrated SR yield

Source	Total
xRooFit	1205.03
pyhs3	1205.06
Paper, Table 8	1205
Observed	1237

Both implementations evaluate every SR at their single unconditional global minimum; no per-region minimization is performed.

Comparison with the published result

Combined two-POI signal strengths

POI	Paper, total uncertainty	xRooFit profile	pyhs3 profile
μ_{WH}	$0.48^{+0.32}_{-0.30}$	$0.476^{+0.314}_{-0.294}$	$0.476^{+0.314}_{-0.294}$
μ_{ZH}	$1.60^{+0.54}_{-0.45}$	$1.606^{+0.517}_{-0.454}$	$1.606^{+0.516}_{-0.454}$

The paper quotes statistical and systematic components separately; the total uncertainties above are their quadrature sums.

Post-fit totals: paper vs workflow

SR	Paper	Workflow	SR	Paper	Workflow
OS 2ℓ	1780	1777.1	Z-dom.	1205	1205.1
SS 2μ	2420	2422.2	Z-dep.	92	91.9
SS $2e$	3200	3204.6	1-SFOS	80	80.2
SSDF	5950	5950.0	2-SFOS	326	325.7

Conclusion

- Published best fits and 68% intervals are reproduced.
- Post-fit SR totals reproduce Table 8 after publication rounding.