

| Process  | ME generator                  | ME PDF set         | ME order | Parton shower           | Tune         | Cross section order             |
|--|-------------------------------|--------------------|----------|-------------------------|--------------|---------------------------------|
| <b>Signals</b> ( $m_H = 125$ GeV)                                      |                               |                    |          |                         |              |                                 |
| SM $HH$ (ggF)  | POWHEG BOX v2 [194–196]       | PDF4LHC15NLO [197] | NLO      | PYTHIA 8.244 [166]      | A14 [167]    | NNLO <sub>FTapprox</sub> [46]   |
| SM $HH$ (VBF)  | MADGRAPH5_AMC@NLO 2.7.3 [198] | NNPDF3.0NLO [199]  | LO       | PYTHIA 8.244            | A14          | N <sup>3</sup> LO [49]          |
| $gg \rightarrow X \rightarrow HH$                                      | MADGRAPH5_AMC@NLO 2.6.1       | NNPDF2.3LO [168]   | LO       | HERWIG 7.1.3 [200, 201] | H7.1-Default | –                               |
| <b>Top-quark</b>   |                               |                    |          |                         |              |                                 |
| $t\bar{t}$   | POWHEG BOX v2 [202]           | NNPDF3.0NLO        | NLO      | PYTHIA 8.230            | A14          | NNLO+NNLL [203–209]             |
| Single top   | POWHEG BOX v2 [210, 211]      | NNPDF3.0NLO        | NLO      | PYTHIA 8.230            | A14          | NLO [212]                       |
| $tW$   | POWHEG BOX v2 [213]           | NNPDF3.0NLO        | NLO      | PYTHIA 8.230            | A14          | NNLO approx. [212, 214, 215]    |
| $t\bar{t}Z$  | SHERPA 2.2.1 [216]            | NNPDF3.0NNLO       | NLO      | SHERPA 2.2.1 [217]      | SHERPA       | NLO (NLO EW) [40]               |
| $t\bar{t}W$  | SHERPA 2.2.8                  | NNPDF3.0NNLO       | NLO      | SHERPA 2.2.8            | SHERPA       | NLO                             |
| <b>Vector boson + jets</b>   |                               |                    |          |                         |              |                                 |
| $W \rightarrow \ell \nu$<br>$Z/\gamma^* \rightarrow \ell\ell$          | SHERPA2.2.1                   | NNPDF3.0NNLO       | NLO*     | SHERPA2.2.1             | SHERPA       | NNLO [218, 219]                 |
| <b>Diboson</b>   |                               |                    |          |                         |              |                                 |
| $WW, WZ, ZZ$   | SHERPA2.2.1                   | NNPDF3.0NNLO       | NLO*     | SHERPA2.2.1             | SHERPA       | NLO                             |
| <b>Single Higgs boson</b> ( $m_H = 125$ GeV)                           |                               |                    |          |                         |              |                                 |
| $H \rightarrow \tau^+\tau^-$ (ggF)                                     | POWHEG BOX v2 [220, 221]      | NNPDF3.0NNLO       | NNLO     | PYTHIA 8.212            | AZNLO [222]  | N <sup>3</sup> LO (NLO EW) [40] |
| $H \rightarrow \tau^+\tau^-$ (VBF)                                     | POWHEG BOX v2 [223]           | NNPDF3.0NLO        | NLO      | PYTHIA 8.230            | AZNLO        | NNLO approx. (NLO EW) [40]      |
| $H \rightarrow \tau^+\tau^-/b\bar{b}$ (WH)                             | POWHEG BOX v2                 | NNPDF3.0NLO        | NLO      | PYTHIA 8.212            | AZNLO        | NNLO (NLO EW) [40]              |
| $H \rightarrow \tau^+\tau^-/b\bar{b}$ ( $q\bar{q}/qg \rightarrow ZH$ ) | POWHEG BOX v2                 | NNPDF3.0NLO        | NLO      | PYTHIA 8.212            | AZNLO        | NNLO (NLO EW) <sup>†</sup> [40] |
| $H \rightarrow \tau^+\tau^-/b\bar{b}$ ( $gg \rightarrow ZH$ )          | POWHEG BOX v2                 | NNPDF3.0NLO        | LO       | PYTHIA 8.244/8.212      | AZNLO        | NLO+NLL [40]                    |
| $H \rightarrow \tau^+\tau^-/b\bar{b}$ ( $t\bar{t}H$ )                  | POWHEG BOX v2                 | NNPDF3.0NLO        | NLO      | PYTHIA 8.230            | A14          | NLO (NLO EW) [40]               |