Higgs for POF-V

ATLAS data analysis plans

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The Higgs boson as a probe

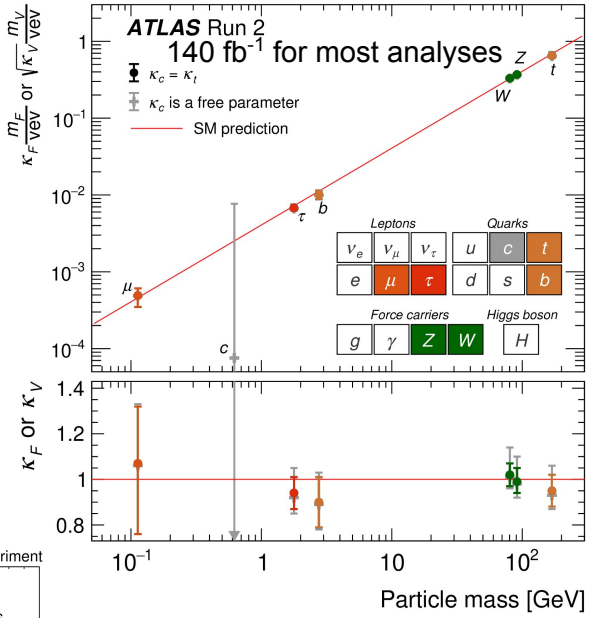
- **Key questions in particle physics:**
  - How do particles get their mass - SM Higgs mechanism or something else?
    - Measure the Higgs boson couplings as precisely as possible, in particular to 2nd generation fermions
    - Search for additional Higgs boson (see Federico M.'s/Katharina B's slides)
  - What is the structure of the vacuum?
    - Constrain the Higgs boson self-coupling through Single- Di- and Tri-Higgs boson production
  - What is dark matter?
    - Search for Higgs to dark matter decays (see Federico M's slides)
  - Why is there a matter-antimatter asymmetry in the universe
    - Search for CP violation in the Higgs sector

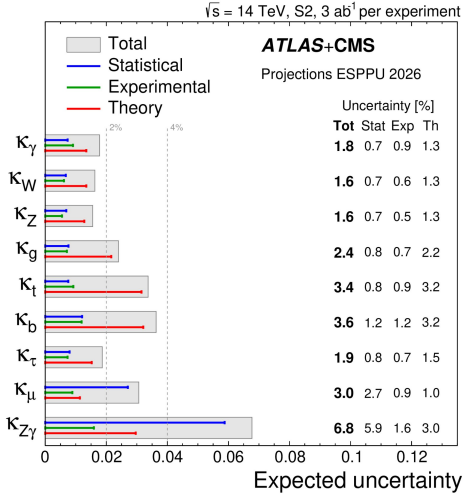
Higgs couplings

How do particles get their mass?

- **Have we found the Standard Model Higgs (mechanism) or something else?**
- Higgs couplings known to 6-12% for bosons and third generation fermions, while many models predict **%-level** deviations from SM
- Run3 data expected to **triple** available dataset, and combination ATLAS+CMS gives another **factor of 2**

- Perform couplings measurements and combined analyses (including ATLAS+CMS)
- Of particular interest: couplings to second generation fermions. Contribute to the discovery potential for H->cc in ttH topologies
- Enhance sensitivity to BSM with differential measurements

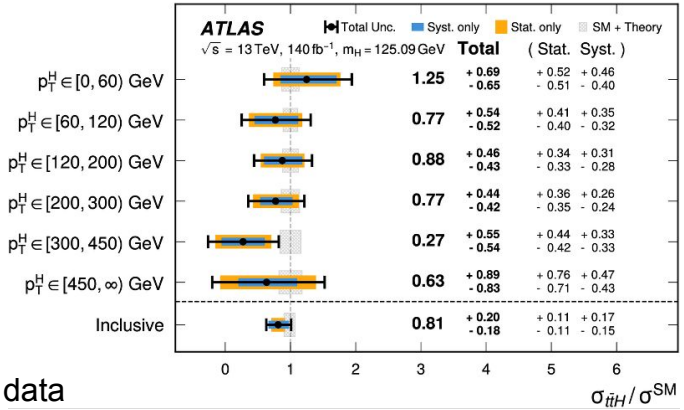




2027-2032:
first step from here towards there (HL-LHC)

Top associated Higgs production (ttH+tH)

- ttH and tH are the only way to measure directly the strongest fermionic Higgs coupling and its properties
  - top-quark Yukawa coupling strength and its sign
  - CP odd mixing in fermionic Higgs couplings
  - BSM contributions in fermionic Higgs couplings
  - (HL-)LHC only way to measure these processes until a potential e+e- collider operates at top-quark pair production threshold

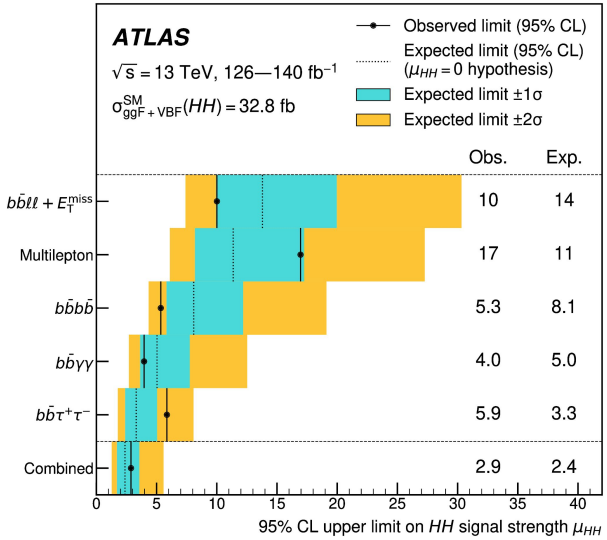


- Measure ttH and tH production in various Higgs decay channels with the LHC data set for 2027-32: full Run 3 data plus start of Run 4:
  - increase precision on the measurements from Run2 in particular those that are statistically limited
  - enhance sensitivity towards observation of tH production

- The highly complex event signatures triggers
  - development of object performance in flavour tagging and boosted topologies
  - development of new Machine Learning methods to optimally explore the data

Di-Higgs

- Constraining the Higgs self-coupling is one of the primary physics goals of HL-LHC
- This is the best way to get access to the Higgs potential
- Perform measurements in channels with expertise on object performance using the new data set:
- Select channels that optimally span the full m_{HH} range
  - bbbb
    - Expertise on flavour and boosted Xbb tagging
    - Connections with tracking activities
  - bbɣɣ
    - Profit from egamma (photon) experience
    - Connections with work on H->ɣɣ
  - Combinations
    - ATLAS and ATLAS+CMS legacy combinations



- General interest to measure tri-Higgs production if person power can be found