CH4 HIGGS PROPERTY MEASUREMENTS

⊙ Many channels:

→ To measure Higgs properties, one needs many ≠ channels.
Very predictive theory (m_h = only missing parameter)

→ To establish that h is the source of EWSB ⇒ measure all couplig to bosons.

→ $h \to \gamma\gamma$ sensitive to new physics
→ heavy particles in the loops

→ More bosons could be presents.

⊙ Mass:

→ CMS: $125,08 \pm 0,12 \pm 0,10$ GeV ⇝ 0,12% uncertainty.

→ Thanks to CMS tracker.

⊙ Decays and spin:

→ For the decay of a scalar:
$0 = 1\uparrow + 1\downarrow$ photons → not with spin 1, and $2 = 1\uparrow + 1\uparrow$
$0 = 1/2\uparrow + 1/2\downarrow$ fermions → $1 = 1/2\uparrow + 1/2\uparrow$, and not with spin 2
$0 = 1\to + 1\to$ } WZ bosons → $1 = 1\uparrow + 1\to$, and $2 = 1\uparrow + 1\uparrow$
$0 = 1\uparrow + 1\downarrow$ → $2 = 1/2\uparrow + 1/2\uparrow + 1$

⊙ Quantum numbers:

→ SM says h has to be 0^+

→ Confirm by statistics.

⊙ Tests of couplings:

→ Everything matches nicely SM.

→ We test deviations from SM by defining κ_X, a multiplicative modifier of the coupling to particle X.
↳ All κ should be = 1 in the SM

→ The number of observed h is $N \propto \sigma(xx \to h) \cdot \mathcal{B}(h \to yy) \propto \frac{\Gamma_{xx}\Gamma_{yy}}{\Gamma_{tot}}$

↳ One needs to determine Γ_{xx}; $xx \in \{WW, ZZ, tt, bb, \tau\tau, gg, \gamma\gamma\}$?
One could add a potential Γ_{BSM}:

$$\Gamma_{tot} = \sum_{xx} \Gamma_{xx} + \Gamma_{BSM}$$

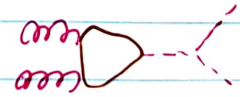
→ One can compare $\lambda_{WZ} \equiv \kappa_W/\kappa_Z$, test κ_V and κ_F, and check $\mathcal{B}_{BSM} \equiv \Gamma_{BSM}/\Gamma_{tot}$, and modified fermions couplings $\lambda_{ud} \equiv \kappa_d/\kappa_u$, etc.

→ For know, everything fits together: $\kappa \simeq 1$ ∀SM

→ Total width:
→ direct measurement: upper limit, limited by exp. resolution
→ off-shell h production: simulation using SM production and decay. Influence the tail of the distribution of CM.

⊙ <u>Coupling measurements: next frontier:</u>

→ Coupling to lighter quarks: charm quarks
→ small $\mathcal{B}$ and big background
→ effort in c-tagging
→ testing with known processes like $Z \to c\bar{c}$
→ Rare meson decay: $h \to J/\psi$; $\phi\,\gamma/Z$; $\rho\,\gamma/Z$
→ allows to test coupling to lighter quark
→ $\mathcal{B} \sim 10^{-5}$
→ Self-coupling: final frontier λ_{hhh}



→ only self-coupling accessible at LHC
→ big interference with

→ constraint the shape of $V(\phi)$