Current status of particle physics

• The SM was established by collider experiments
• No new particle found up to now

• Many problems of the SM, such as neutrino mass, dark matter, baryogenesis, inflation, hierarchy, unification, gravity, ...

Higgs must be an important portal for new physics
Higgs sector

### Mass generation mechanisms

<table>
<thead>
<tr>
<th>Higgs Mechanism</th>
<th>Yukawa Coupling</th>
<th>Dim. 6 Operators</th>
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<td>$h_{WW}$</td>
<td>$h \tau \tau, h_{bb}$</td>
<td>$h_{gg}$</td>
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<tr>
<td>$h_{ZZ}$</td>
<td>$h_{tt}, \ldots$</td>
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\[
L_{\text{eff}} = \left| D_\mu \Phi \right|^2 - y L \Phi R - \frac{1}{v^2} \left| \Phi \right|^2 GG \\
- V_{\text{eff}}(\Phi)
\]

- $hhh$
- $hhhh$

**EW Symmetry Breaking**

**EW Phase Transition**
Higgs sector

Mass generation mechanisms

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$$L_{\text{eff}} = |D_\mu \Phi|^2 - y L \Phi R - \frac{1}{v^2} |\Phi|^2 GG$$

Consistent with the SM, but possibilities of detecting deviations by further precision measurements

$V=246\text{GeV}$

$M_h=125\text{GeV}$

**EW Symmetry Breaking**

**EW Phase Transition**
Higgs sector

Mass generation mechanisms

Higgs Mechanism | Yukawa Coupling | Dim. 6 Operators
---|---|---
hWW | h\tau\tau, hbb | hgg
hZZ | htt, ... | h\gamma\gamma

\[ L_{\text{eff}} = \left| D_\mu \Phi \right|^2 - y L \Phi R - \frac{1}{\nu^2} |\Phi|^2 G G \]

\[ - V_{\text{eff}}(\Phi) \]

V=246GeV \hspace{1cm} hhh
M_h=125GeV \hspace{1cm} hhhh

EW Symmetry Breaking
EW Phase Transition

Yet to be Confirmed
Future experiments

Approved Future Experiments

- HL-LHC
  - Direct/indirect search

- LHC
  - Run II, III

- LISA
  - EWPT via GW

- SuperKEK
  - B

Timeline:
- 2019
- 2026
- 2030
- 2034
- 2040
Future experiments

- **HL-LHC**
  - Direct/indirect search
- **LHC**
  - Run II, III
- **ILC250**
  - Higgs precision
- **LISA**
  - EWPT via GW

Timeline:
- 2040
- 2034
- 2030
- 2026
- 2019
Future experiments

- HL-LHC: Direct/indirect search
- ILC250: Higgs precision
- LISA: EWPT via GW
- Golden time to explore new physics via Higgs
- ILC is key for synergy
Future of Higgs physics:

- **2019**: LHC Run II, III
- **2026**: HL-LHC Direct/indirect search
- **2030**: ILC250 Higgs precision
- **2034**: FCC? 100TeV? ...
- **2040**: ILC500 CLIC?, CEPC?

Golden time to explore new physics via Higgs:

ILC is key for synergy
Why the ILC symposium at HPNP2019?

• We definitely want a high-energy lepton collider
• In particular, ILC250 is designed as a Higgs factory, which should be technically ready
• ILC Project has already a long history, but TODAY it is the really important timing for the realization of the ILC

• Under this circumstance, we believe it quite meaningful to hold a symposium for the ILC at HPNP2019, because here many Higgs experts from around the world meet together
ILC Symposium

1. ILC Project: Status and Prospect  20min.
   Yasuhiro Okada (KEK Director for Research)

2. Physics of ILC: Overview  30min.
   Keisuke Fujii (KEK)

3. ILC as a Higgs Factory: Higgs Precision  45min.
   • EFT                Junping Tian  (U. of Tokyo)
   • Multi Higgs models Kei Yagyu    (Osaka U.)
   • New Physics       Eibun Senaha  (IBS, Korea)

4. New Physics Searches  20min.
   Yutaka Hosotani (Osaka U.)

5. Panel Discussion  30min.   All presenters and you all