ILC Higgs Physics Potential

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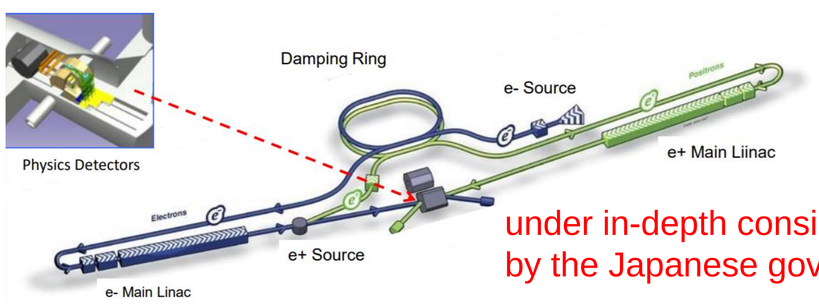
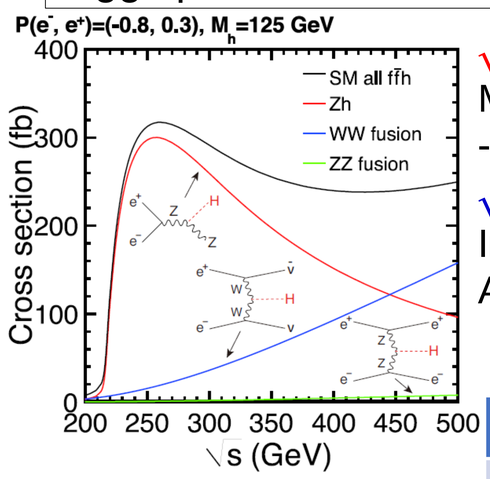
What is the International Linear Collider (ILC) ?

- Proposed future e^+e^- linear collider
- $\sqrt{s}$ = 250 GeV (upgradable to 500 GeV, 1 TeV)
- Polarized beams ($|P_{e^-}|$ = 80%, $|P_{e^+}|$ = 30%)
- Clean environment, well-defined initial state



under in-depth consideration
by the Japanese government

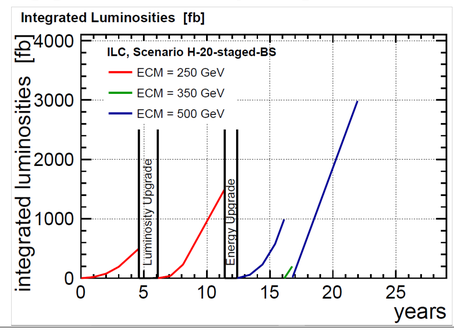
Higgs production at the ILC



$\sqrt{s}$ = 250 GeV: Higgs-strahlung (Zh) dominant
Maximum cross section around 250 GeV
---> Higgs factory, O(1M) Higgs events
$\sqrt{s}$ = 500 GeV: WW-fusion dominant
Improve many couplings
Access to Top-Yukawa, Higgs self-coupling

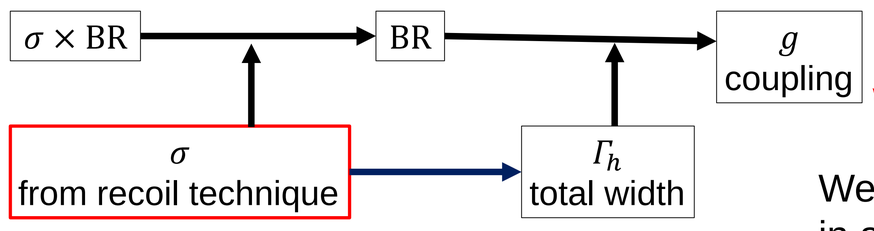
ILC running scenario

$\sqrt{s}$ (GeV)	$\int Ldt$ (ab^{-1})
250	2
350	0.2
500	4



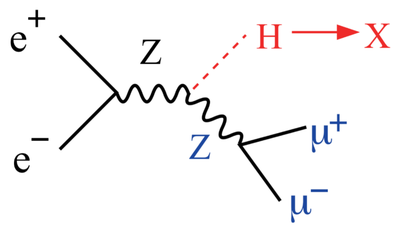
Model independence

LHC	all measurements are $\sigma \times \mathrm{BR}$
ILC	$\sigma \times \mathrm{BR}$ measurements + **σ measurement**



We can determine the coupling constants
in a model-independent way.

Key measurement: σ_{Zh}



Unique measurement at lepton colliders

Recoil mass M_X :

$$M_X^2 = \left(p_{CM} - \left(p_{\mu^+} + p_{\mu^-}\right)\right)^2$$

- Well-defined initial states
- Without looking into Higgs (recoil technique)
- Can use $Z \to \mu^+\mu^-, e^+e^-, q\bar{q}$ channels

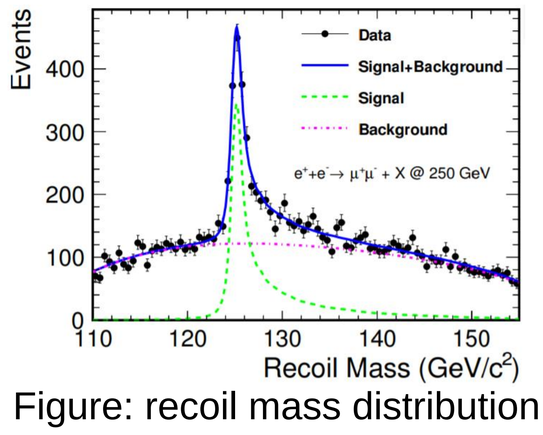
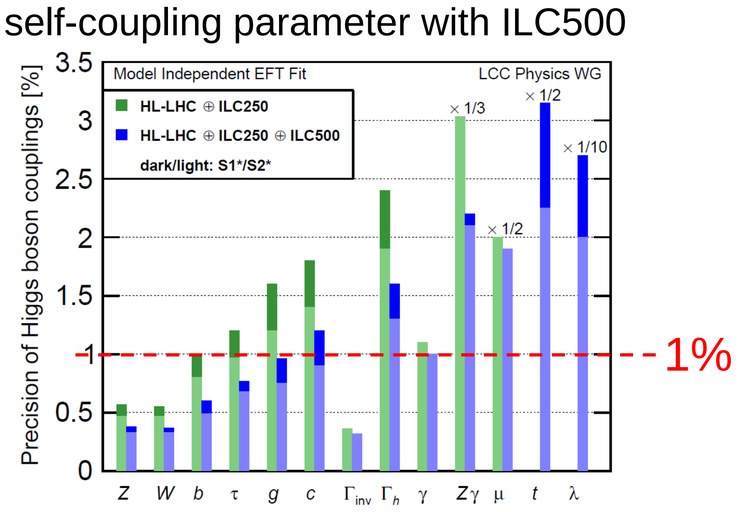


Figure: recoil mass distribution
in $Z \to \mu^+\mu^-$ channel

At ILC250 with 2 ab^{-1} statistics,
We can measure the Higgs mass
with Δm_h = **14 MeV**,
and the σ_{Zh} cross-section
with a precision of **0.7%**.

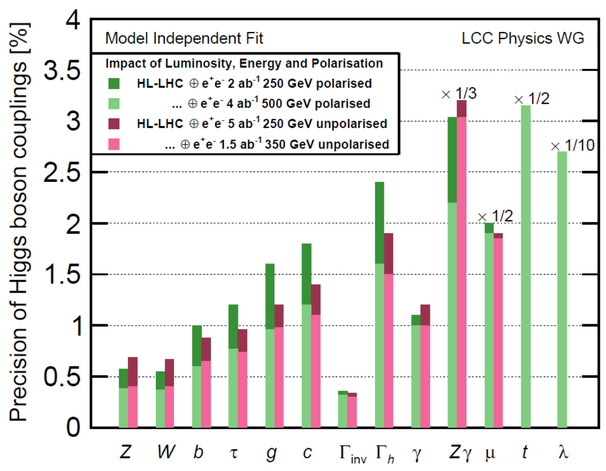
Model-independent determination of Higgs couplings

- Adopted SM EFT (Effective Field Theory) framework
- Can determine ALL 23 EFT parameters simultaneously
  in a highly model-independent way
- **~1-2% or better precisions** in many couplings can be reached
  by combining HL-LHC and ILC250
- More improvements and access to rare decays and
  Higgs self-coupling parameter with ILC500



Power of beam polarization

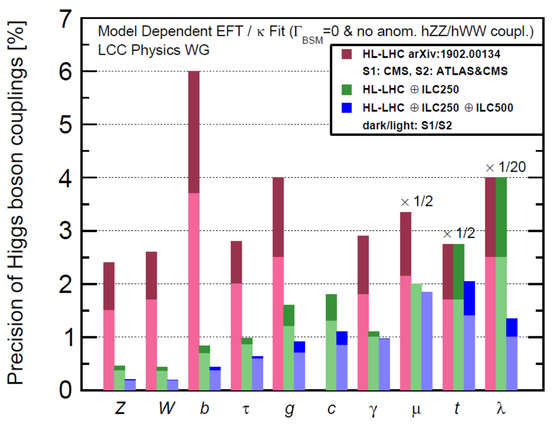
Similar precisions from [2 ab^{-1}, polarized] and [5 ab^{-1}, unpolarized]
---> Polarization is very powerful



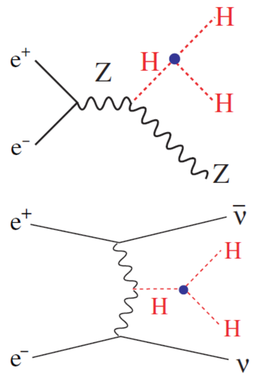
Comparison with HL-LHC Higgs capabilities

Not simple comparison due to different framework
---> add assumptions in EFT fit (model-dependent fit)
no BSM decay of Higgs, no anomalous couplings in hWW and hZZ

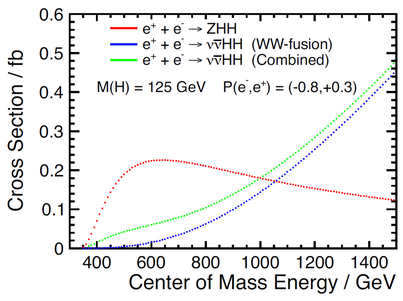
- great improvement at the ILC in many channels
  already at the lowest energy stage
- nice synergy with HL-LHC, typically in rare channel



Higgs self-coupling



Direct probe of Higgs potential

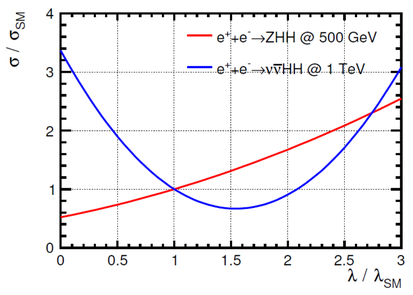


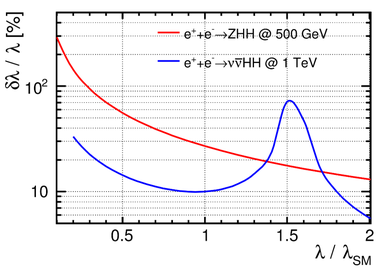
We expect more improvements:
- b-tagging
- jet reconstruction
- kinematic fitting

	$\Delta\lambda_{hhh}/\lambda_{hhh}$
4 ab^{-1} at ILC500	27%
+8 ab^{-1} at ILC1000	10%

What happens if $\lambda_{hhh} \neq \lambda_{\mathrm{SM}}$?

λ_{hhh} can be significantly enhanced in
some BSM scenario (e.g.: EW baryogenesis)
---> very important to measure Higgs self-coupling
using both production process (Zhh/$\nu\nu hh$)





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