

Higgs BR study

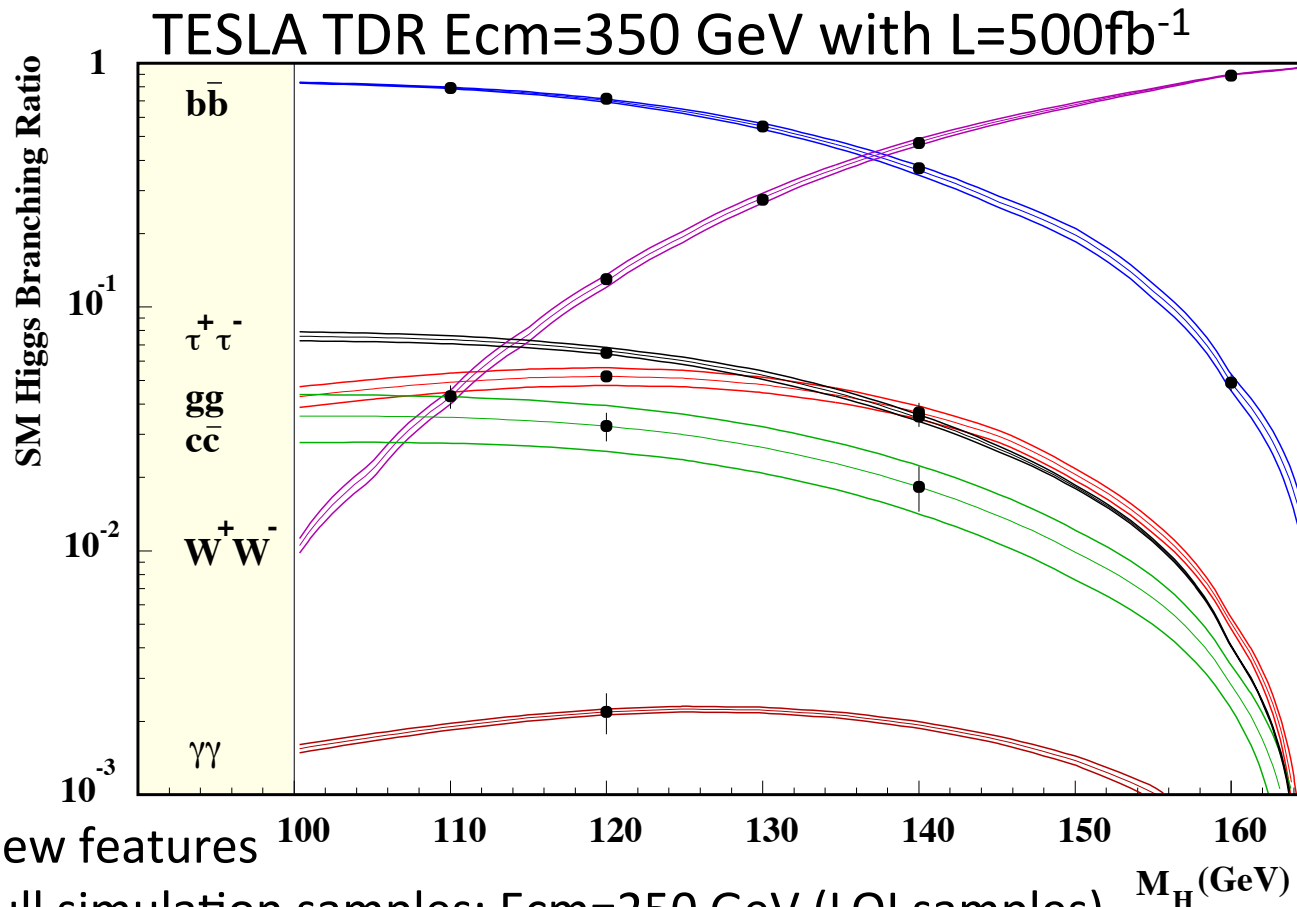
ILC physics and software meeting

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Higgs BR with different mass

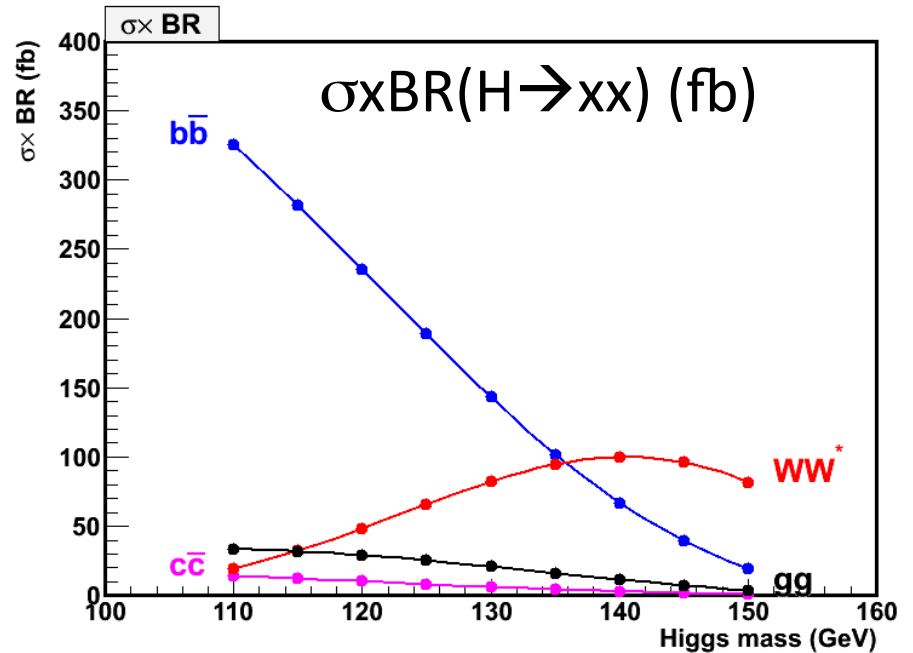
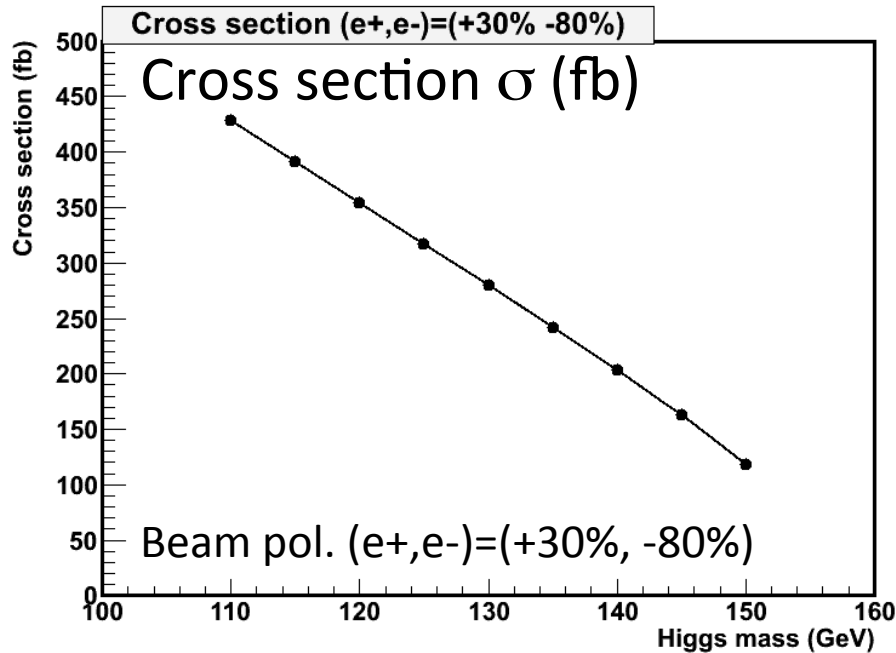
Aim: Update Higgs BR measurement accuracy plot after LOI



Cross section and $\sigma \times BR$

$E_{cm} = 250$ GeV with different Higgs masses

Beam pol. $(e^+, e^-) = (+30\%, -80\%)$



Measurement accuracies are extrapolated from the 120 GeV results

$$\left(\frac{\Delta BR}{BR(x)} \right)_{M_h} = \left(\frac{\Delta BR}{BR(x)} \right)_{120} \cdot \sqrt{\frac{\sigma_{120} \cdot BR(x)_{120}}{\sigma_{M_h} \cdot BR(x)_{M_h}}}$$

Summary table of Higgs BR after LOI

Higgs mass	120 GeV					140 GeV		
Cross section	$\sigma=354.3$ fb					$\sigma=203.1$ fb		
Higgs decay	BR	$\sigma \times \text{BR}$	$\Delta \text{BR}/\text{BR}$			BR	$\sigma \times \text{BR}$	$\Delta \text{BR}/\text{BR}$
			ILD	SiD	Comb.			Scaled
$H \rightarrow bb$	66.5%	235.6	2.7% (2.7%)	4.8%	3.8%	33.0%	67.1	7.1%
$H \rightarrow cc$	2.9%	10.4	8.7% (6.7%)	8.4%	8.6%	1.5%	3.0	16.1%
$H \rightarrow WW^*$	13.6%	48.3	15.7%		15.7%	49.2%	99.8	10.9%
$H \rightarrow gg$	8.2%	29.2		12.2%	12.2%	5.7%	11.5	19.4%
$H \rightarrow \tau\tau$	6.8%	24.1				3.5%	7.1	
$H \rightarrow ZZ^*$	1.5%	5.3				6.7%	13.6	

ILD results are preliminarily combined with $\nu\nu H$ and qqH at 250 GeV ():350GeV
 $P(e^+, e^-) = (+30\%, -80\%)$

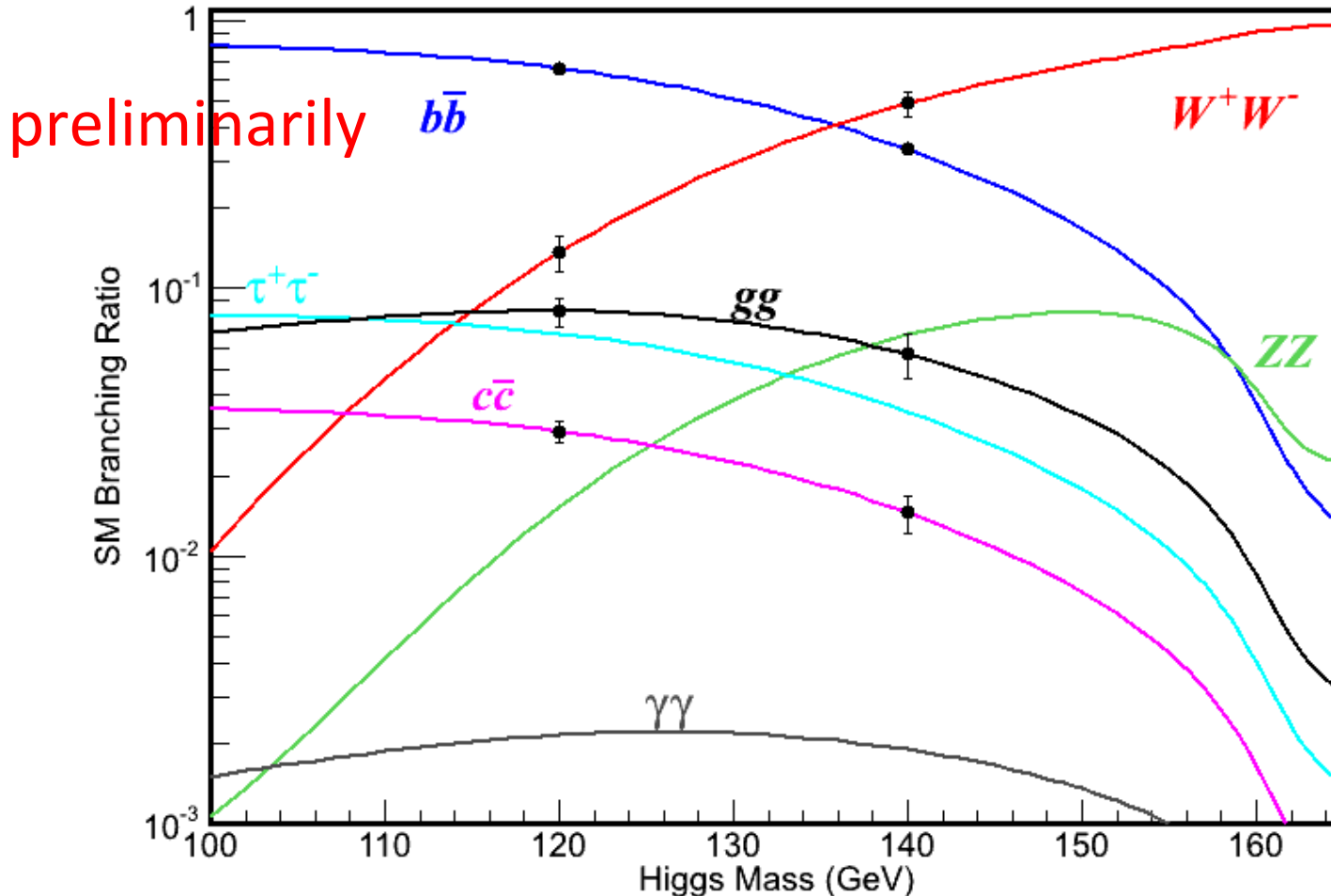
- $H \rightarrow WW^*$ result is obtained from the Takubo-san's analysis at 250 GeV
- $H \rightarrow gg$ was studied at SiD (combined results of $\nu\nu H$ and qqH) at 250 GeV
- σ_{ZH} uncertainty is also included for ILD (2.5%) and SiD (4.7%)

SiD ZH study: Physical Review D 82, 03013 (2010)

Higgs BR with full simulation

SM Higgs BR and its measurement accuracy

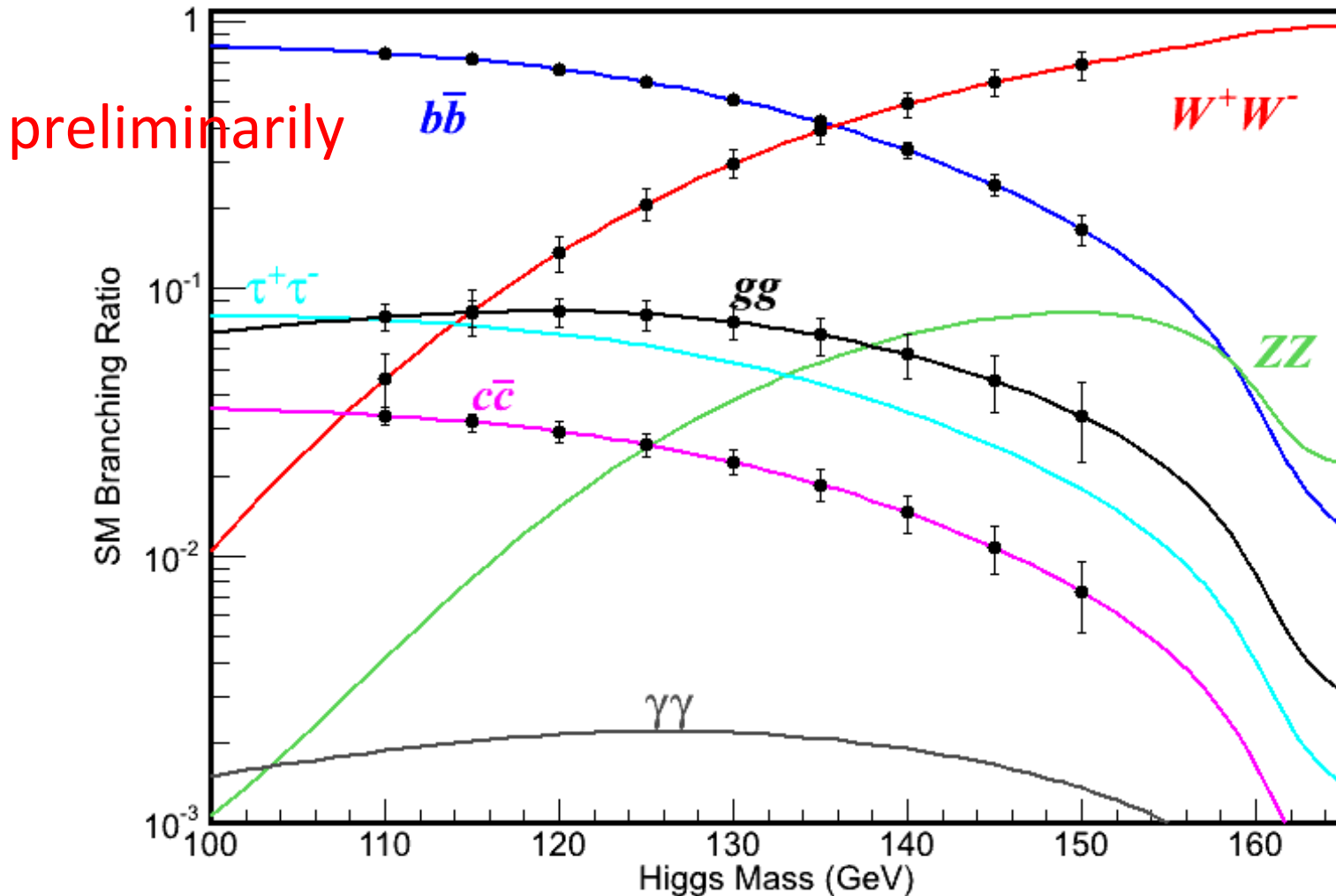
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Accuracy at $M_h=140$ GeV are extrapolated from 120 GeV

Mh=110-150 GeV

$E_{cm}=250$ GeV, $L=250$ fb⁻¹, Beam pol(e^+,e^-)=(+30%, -80%)



Backup

SiD Higgs physics results

TABLE V. Results for the $H \rightarrow c\bar{c}$, $H \rightarrow b\bar{b}$, and $H \rightarrow gg$ decay modes.

	Neutrino	Hadronic	Combined	
$H \rightarrow c\bar{c}$	Signal events	178	407	
	SM background events	140	673	
	Higgs background events	109	213	
	Signal efficiency	27.9	22.2	
	Signal $\sigma_{H \rightarrow c\bar{c}}$	6.8 ± 0.8 fb	6.9 ± 0.6 fb	6.86 ± 0.48 fb
	Relative uncertainty on $\sigma_{H \rightarrow c\bar{c}}$	11.6%	8.8%	7.0%
	Higgs BR	$3.3 \pm 0.4\%$	$3.3 \pm 0.3\%$	$3.3 \pm 0.3\%$
	Relative uncertainty on Higgs BR	12.5%	10.0%	8.4%
$H \rightarrow b\bar{b}$	Signal events	2833	8122	
	SM background events	220	4700	
	Higgs background events	55	423	
	Signal efficiency	24.5	26.2	
	Signal $\sigma_{H \rightarrow b\bar{b}}$	142.7 ± 2.3 fb	142.5 ± 1.9 fb	142.57 ± 1.61 fb
	Relative uncertainty on $\sigma_{H \rightarrow b\bar{b}}$	1.9%	1.4%	1.1%
	Higgs BR	$68.3 \pm 3.4\%$	$68.2 \pm 3.3\%$	$68.2 \pm 5.3\%$
	Relative uncertainty on Higgs BR	5.0%	4.9%	4.8%
$H \rightarrow gg$	Signal events	32	524	
	SM background events	0	3621	
	Higgs background events	4	1431	
	Signal efficiency	3.3	17.7	
	Signal $\sigma_{H \rightarrow gg}$	15.1 ± 1.9 fb	15.6 ± 2.6 fb	15.41 ± 1.74 fb
	Relative uncertainty on $\sigma_{H \rightarrow gg}$	18.7%	14.2%	11.3%
	Higgs BR	$7.2 \pm 1.4\%$	$7.5 \pm 1.1\%$	$7.4 \pm 0.9\%$
	Relative uncertainty on Higgs BR	19.3%	15.0%	12.2%

RDR Physics chapter

TABLE 2.1

Expected precision of the Higgs branching ratio measurements at ILC for $M_H = 120$ GeV and a luminosity of 500 fb^{-1} . Ranges of results from various studies are shown with c.m. energies of 300 GeV [8], 350 GeV [93, 94, 95] and 350/500 GeV [96].

Decay mode	Relative precision (%)	References
$b\bar{b}$	1.0–2.4	[8][93] [94][97]
$c\bar{c}$	8.1–12.3	[8][93] [94][97]
$\tau^+\tau^-$	4.6–7.1	[8] [93] [94]
gg	4.8–10	[8] [93] [94][97]
WW	3.6–5.3	[8][93] [94] [95]
$\gamma\gamma$	23–35	[94] [96]

[8] ACFA Linear Collider Working Group, K. Abe et al., hep-ph/0109166.

[93] M. Battaglia, hep-ph/9910271.

[94] J. C. Brient, LC-PHSM-2002-003.

[95] G. Borisov and F. Richard, hep-ph/9905413.

[96] E. Boos et al., Eur. Phys. J. C19, 455 (2001).

[97] T. Kuhl and K. Desch, LC-PHSM-2007-2.

RDR Physics chapter

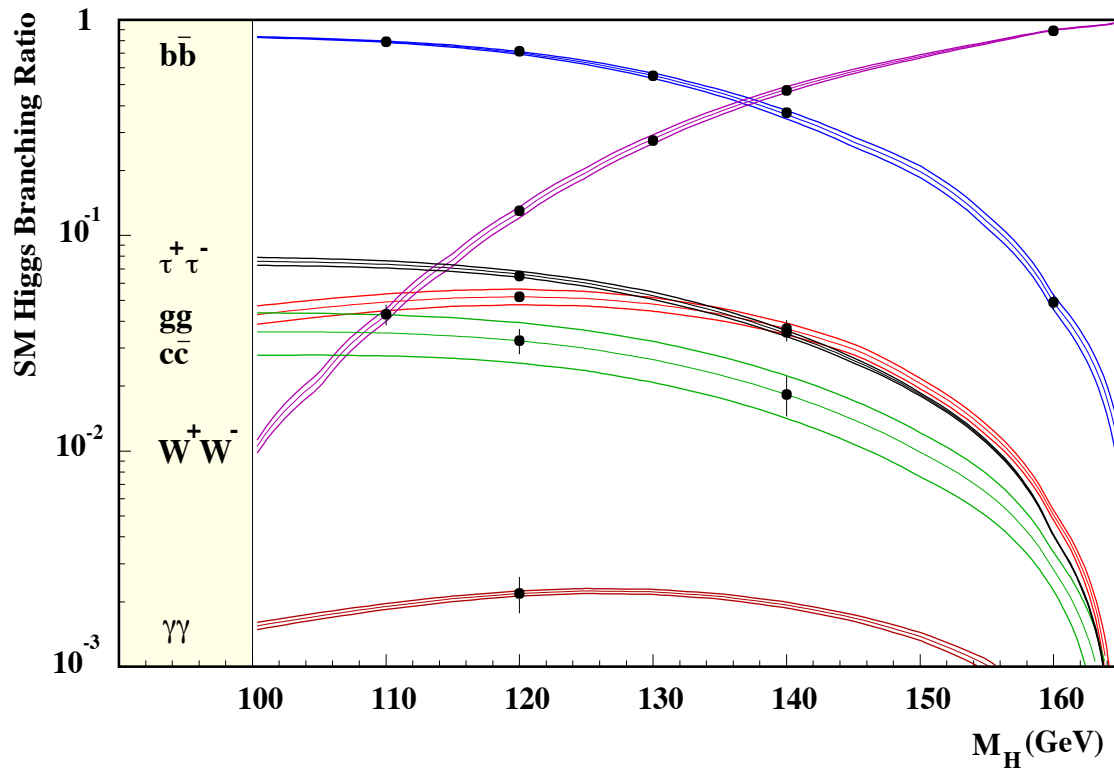


FIGURE 2.12. The branching ratio for the SM Higgs boson with the expected sensitivity at ILC. A luminosity of 500 fb^{-1} at a c.m. energy of 350 GeV are assumed; from Ref. [93].

ILDLOI summary table

Channel	$Br(H \rightarrow b\bar{b})$	$Br(H \rightarrow c\bar{c})$	$Br(H \rightarrow gg)$
$ZH \rightarrow \ell^+ \ell^- q\bar{q}$	$(2.7 \oplus 2.5) \%$	$(28 \oplus 2.5) \%$	$(29 \oplus 2.5) \%$
$ZH \rightarrow \nu\bar{\nu}H$	$(1.1 \oplus 2.5) \%$	$(13.8 \oplus 2.5) \%$	–
$ZH \rightarrow q\bar{q}c\bar{c}$	–	$(30 \oplus 2.5) \%$	–
Combined	2.7 %	12 %	29 %

TABLE 3.3-5

Expected precision for the Higgs boson branching fraction measurements ($\sqrt{s} = 250$ GeV) for the individual Z decay channels and for the combined result. The expected 2.5 % uncertainty on the total Higgs production cross section is added in quadrature. The results are based on full simulation/reconstruction and assume an integrated luminosity of 250 fb^{-1} . Entries marked – indicate that results are not yet available.

Analysis	\sqrt{s}	Observable	Precision	Comments
Higgs recoil mass	250 GeV	$\sigma(e^+e^- \rightarrow ZH)$	$\pm 0.30 \text{ fb}$ (2.5 %)	Model Independent
		m_H	32 MeV	Model Independent
		m_H	27 MeV	Model Dependent
Higgs Decay	250 GeV	$Br(H \rightarrow b\bar{b})$	2.7 %	includes 2.5 % from $\sigma(e^+e^- \rightarrow ZH)$
		$Br(H \rightarrow c\bar{c})$	12 %	
		$Br(H \rightarrow gg)$	29 %	