FNAL Higgs Physics, May 2001

$e^+e^- \to b\bar{b} \to b\bar{b}A$: a Direct Measurement of $\tan\beta$: at a Future e^+e^- LC

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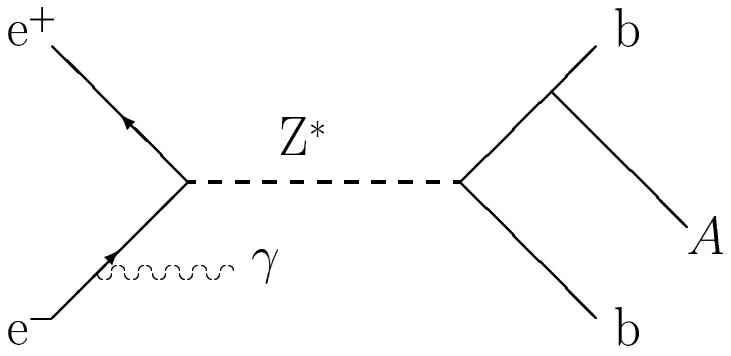
Basic Process

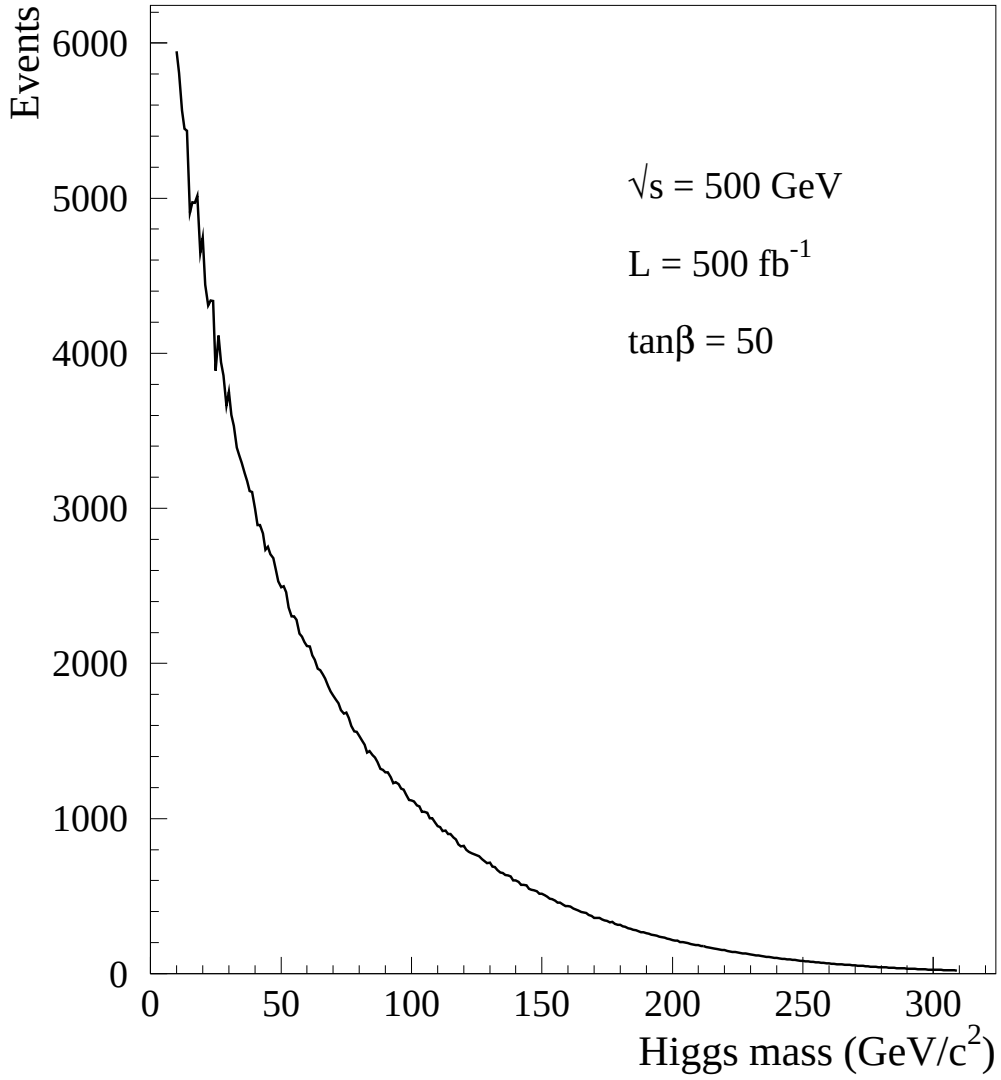


Recall: bbA coupling is proportional to $\tan\beta$.

Generator based on matrix element calculation from

J.Kalinowski and M.Krawczyk.

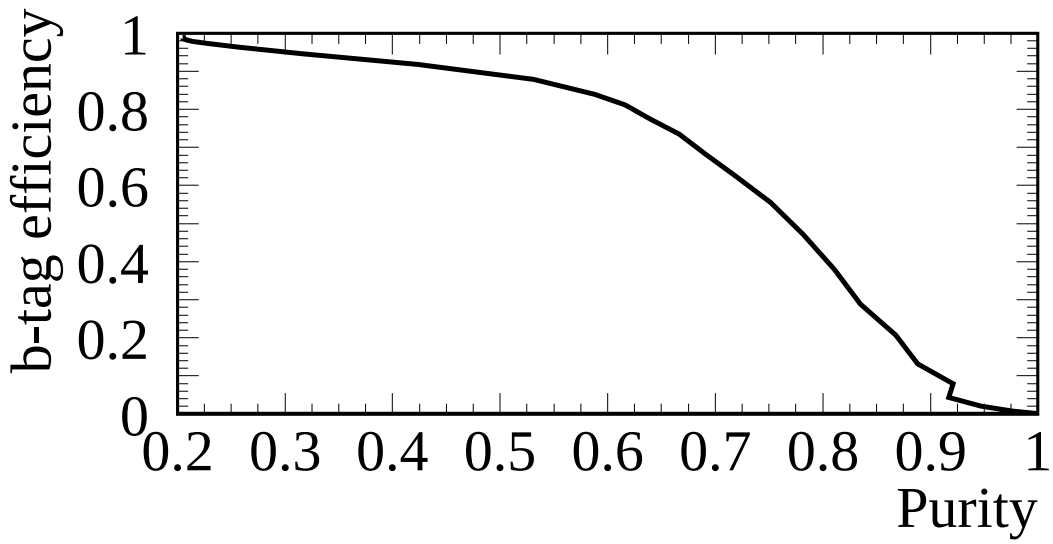
$e^+e^- \to b\bar{b} \to b\bar{b}A$ Rate



SGV Detector Simulation

TESLA detector parameters

Example: b-tagging



Efficiency: ratio of simulated $b\bar{b}$ events after the selection and all simulated $b\bar{b}$ events.

Purity: ratio of simulated $b\bar{b}$ events after the selection and all selected events.

Event Pre-Selection

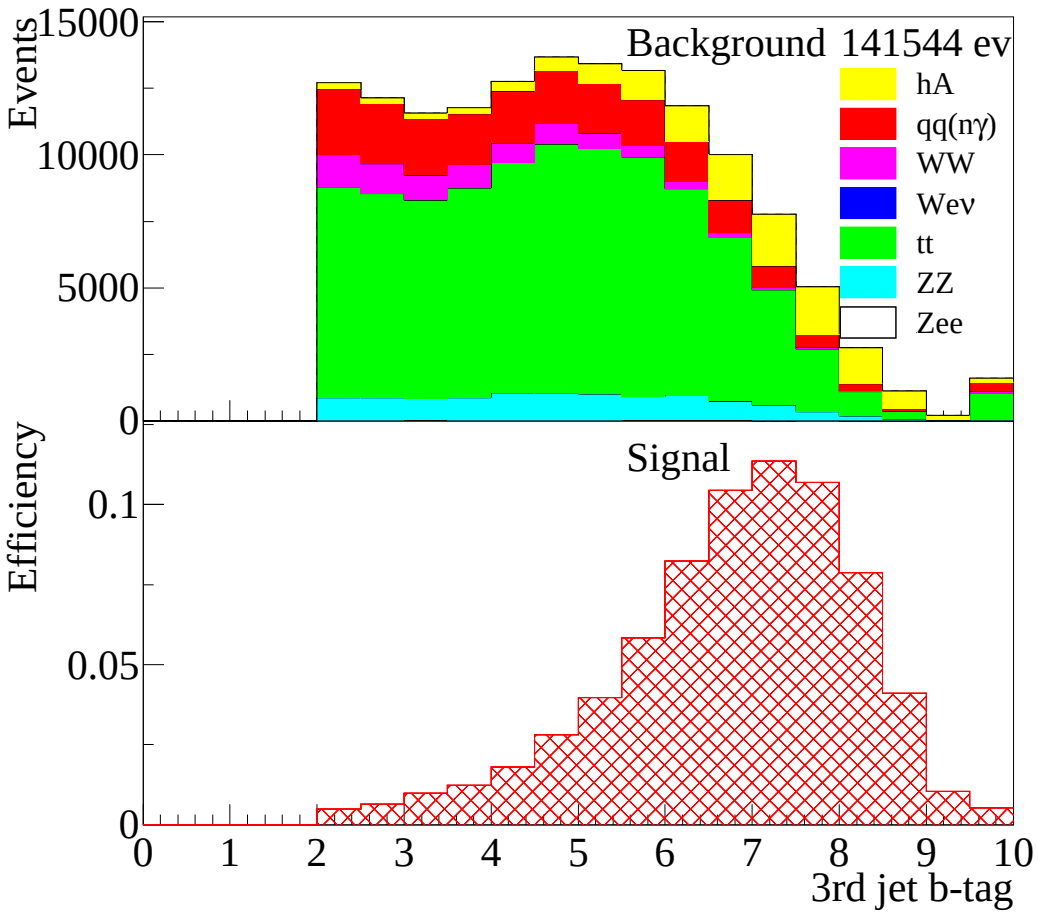
Simulated Higgs boson mass: 100 GeV

Channel	bbA	qq	WW	eWν	tt	ZZ	eeZ	hA	sum
(in 1000)	50	6250	3500	2500	350	300	3000	50	16000
After Presel.	73%	20991	7481	0	89983	10278	145	12665	141544

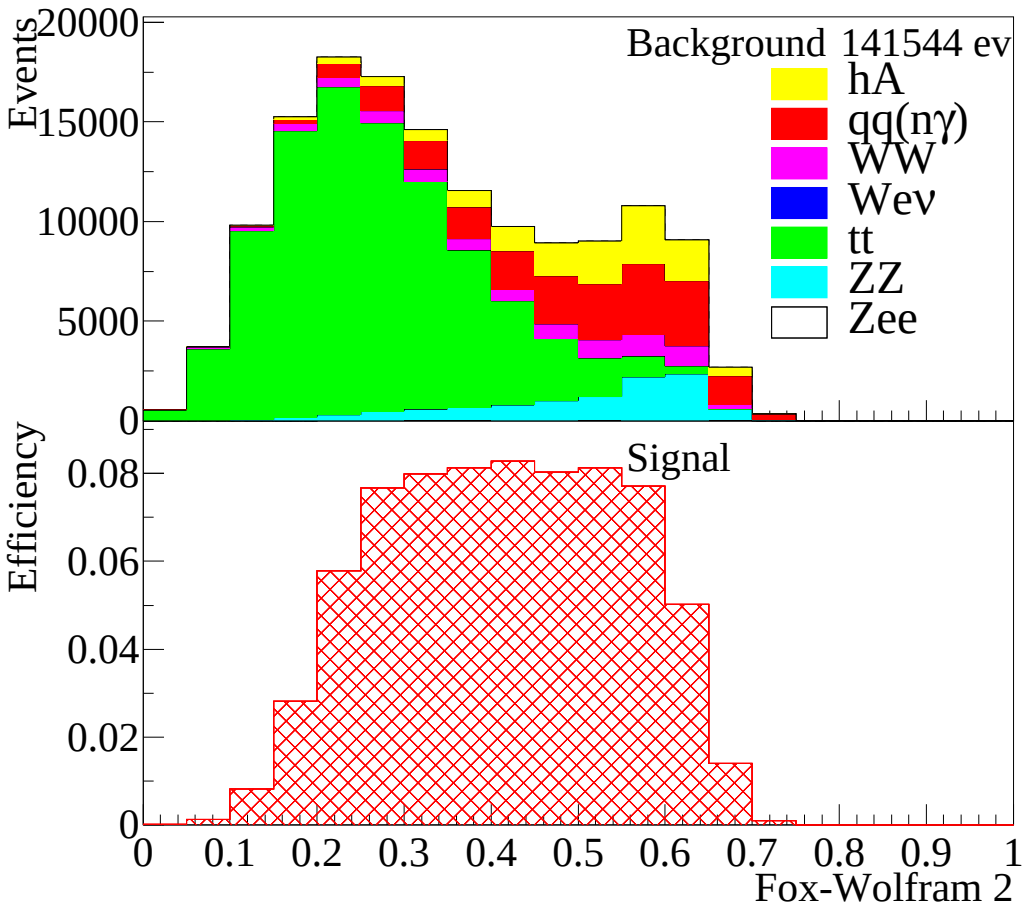
Simulated hA rate corresponds to twice the luminosity (maximum cross section in general Two-Higgs Doublet Model).

- B-tag (3rd jet) > 2
- $N_{\mathrm{Cluster}} > 17$
- $E_{\mathrm{El-magn}} < 0.5\sqrt{s}$
- $E_{\mathrm{tot}} > 0.6\sqrt{s}$
- $E_{\gamma} < 30$ GeV
- Thrust < 0.92

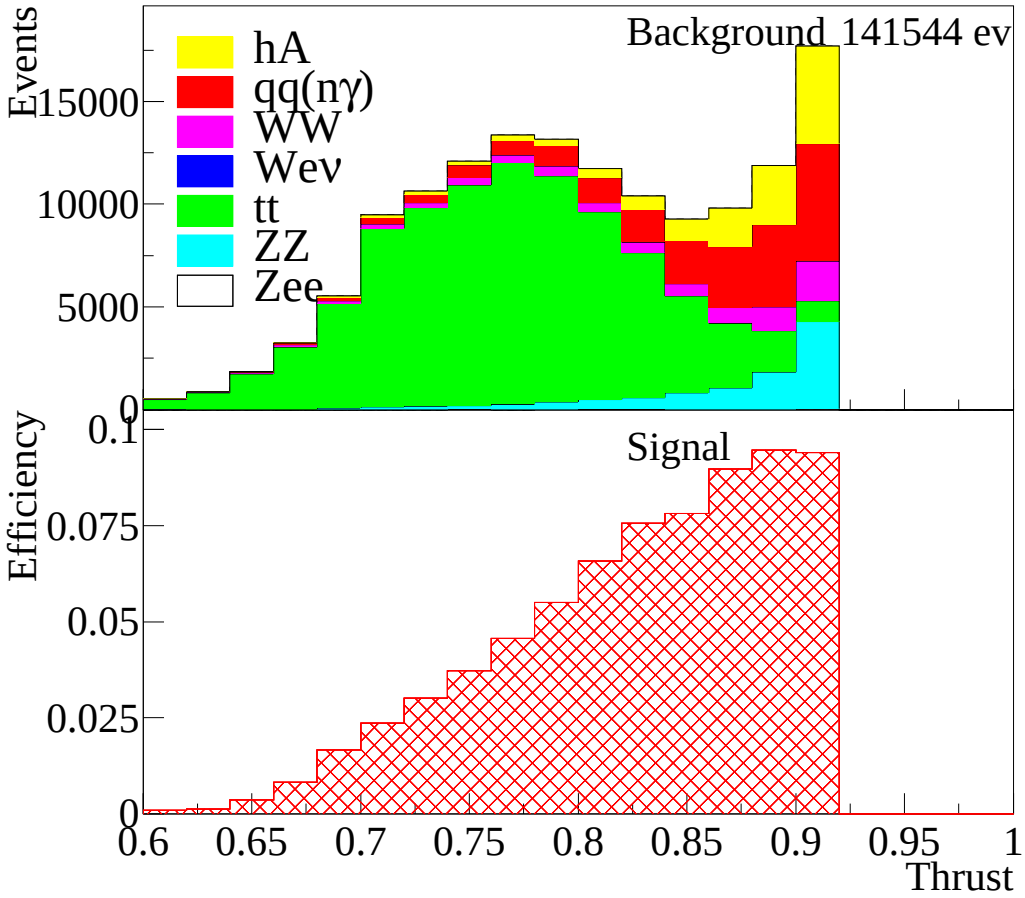
Event Selection



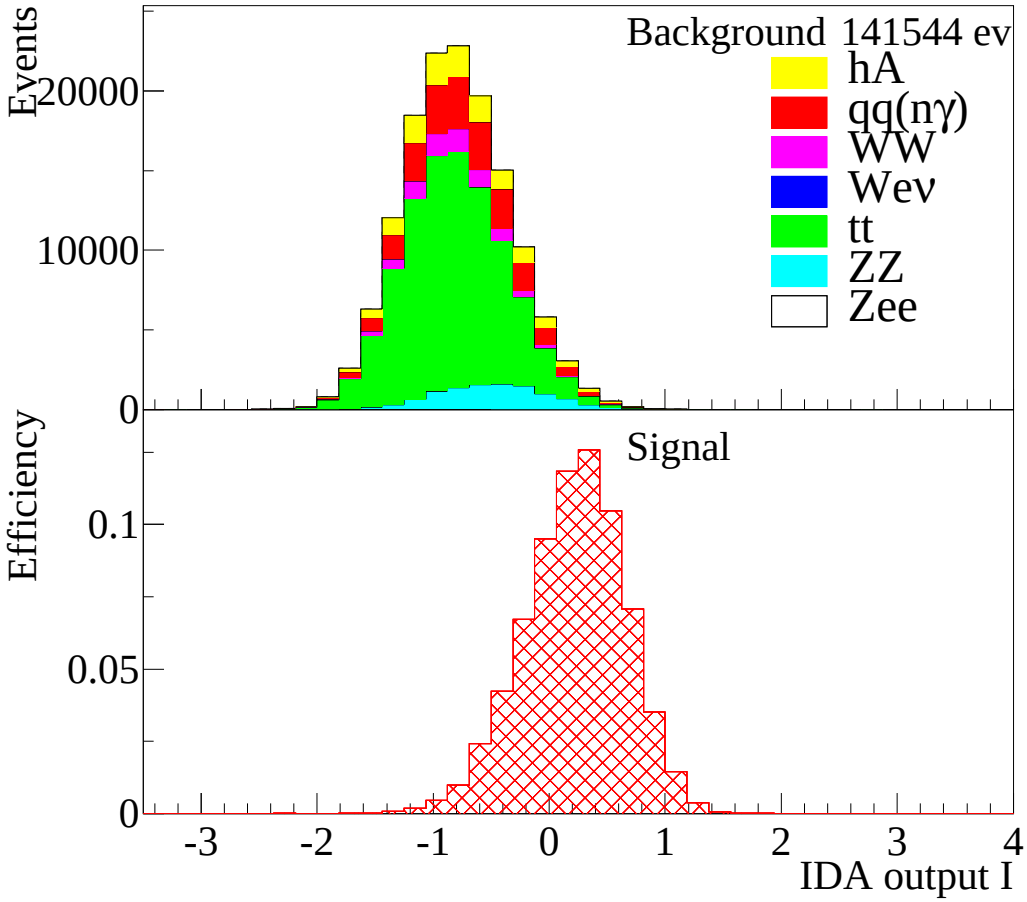
Event Selection



Event Selection

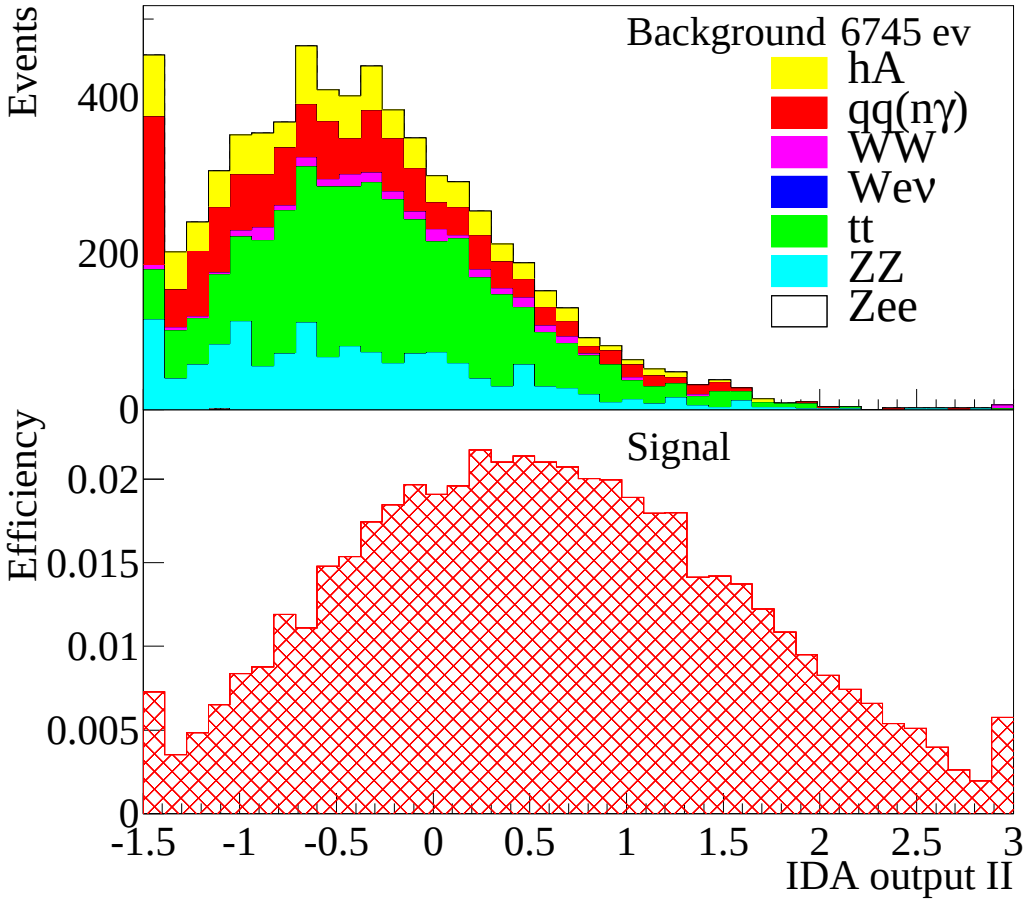


Iterative Discriminant Analysis
1st step



Cut at zero (30% signal reduction)

Iterative Discriminant Analysis
2nd step



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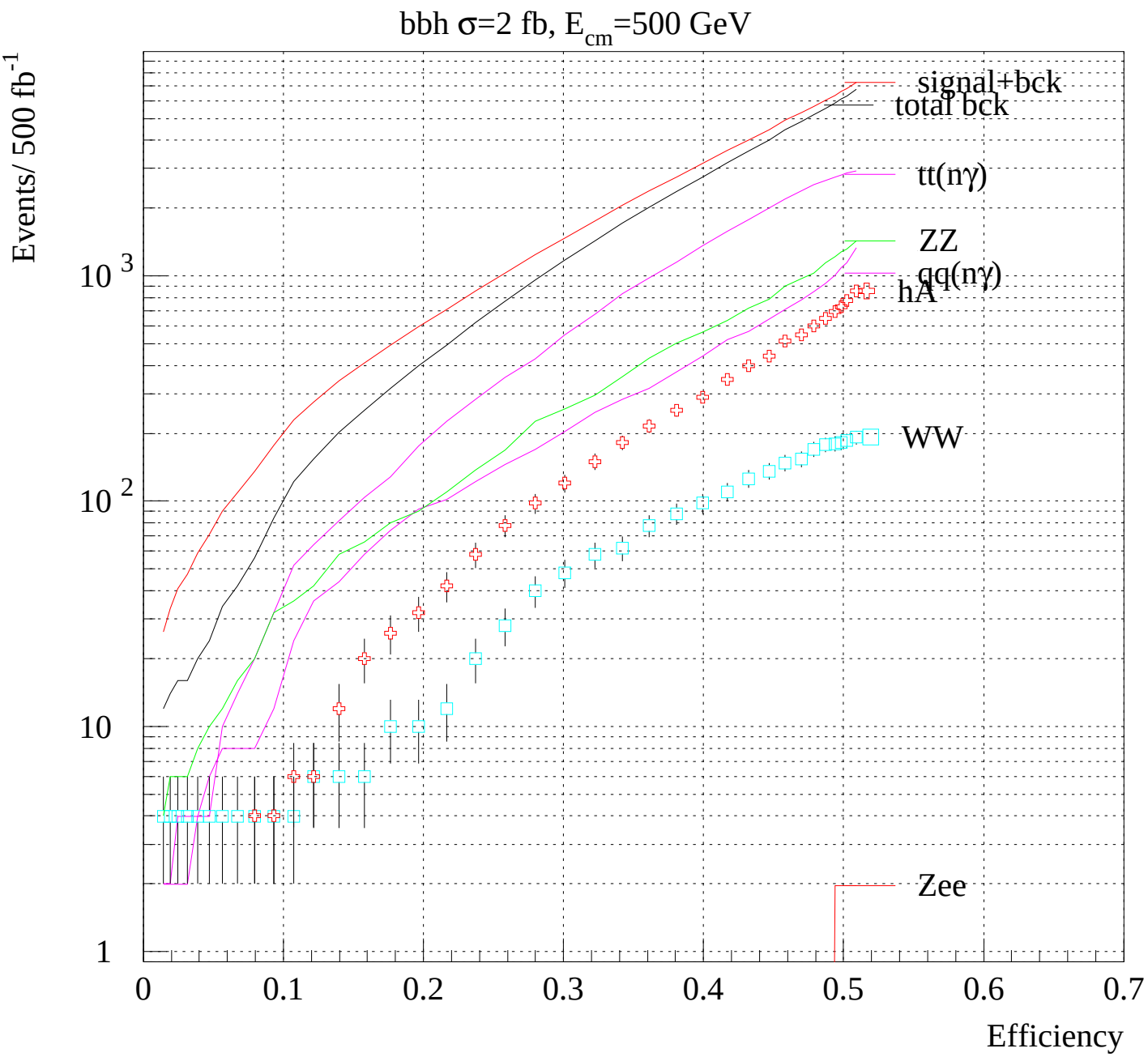
Signal and Background



Interference: $\mathrm{bbA}\ \ \mathrm{hA} \to \mathrm{b\bar{b}b\bar{b}}$

Expected:

100 $\mathrm{bbA} \to \mathrm{b\bar{b}b\bar{b}}$ events

2 ± 1 $\mathrm{hA} \to \mathrm{b\bar{b}b\bar{b}}$ events.

Define:

$\sigma_{\mathrm{bbA}} = \sigma(\mathrm{e^+e^-} \to \mathrm{bbA} \to \mathrm{b\bar{b}b\bar{b}})$

$\sigma_{\mathrm{hA}} = \sigma(\mathrm{e^+e^-} \to \mathrm{hA} \to \mathrm{b\bar{b}b\bar{b}})$

$\sigma_{\mathrm{bbA+hA}} = \sigma(\mathrm{e^+e^-} \to \mathrm{bbA}, \mathrm{hA} \to \mathrm{b\bar{b}b\bar{b}})$

$\sigma_{\mathrm{interf}} = \sigma_{\mathrm{bbA+hA}} - \sigma_{\mathrm{bbA}} - \sigma_{\mathrm{hA}}.$

For $m_{\mathrm{b}} = 4.62$ GeV (CompHEP):

$\sigma_{\mathrm{bbA}} = 1.83 \pm 0.01$ fb

$\sigma_{\mathrm{hA}} = 36.85 \pm 0.10$ fb

$\sigma_{\mathrm{bbA+hA}} = 39.23 \pm 0.12$ fb

$\sigma_{\mathrm{interf}} = 0.55 \pm 0.16$ fb

Results and Conclusions

- 500 fb^{-1} simulated: 16 million events.
- A signal of bbA will be visible:

  100 signal over 100 background events
- $\Delta \mathrm{tg}^2\beta/\mathrm{tg}^2\beta = \Delta \mathrm{N_s}/\mathrm{N_s} = 0.15$
- Thus, 7% error for $\mathrm{tg}\beta = 50$
- Interference is constructive and reduces the statistical error.
- Simultaneous simulation of signal and background for various $\mathrm{tg}\beta$ values controls the systematic interference error.
- Large systematic uncertainty due to the running b-quark mass.
- EPJdirect C 8 (2000) 1