Rare B Decays for the GigaZ TESLA Option

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$b \to s\nu\bar{\nu}$ Decays Theoretical Motivation

✦ Rare transition $b \to s\nu\bar{\nu}$ offers exceptional opportunities to probe the physics of flavour:

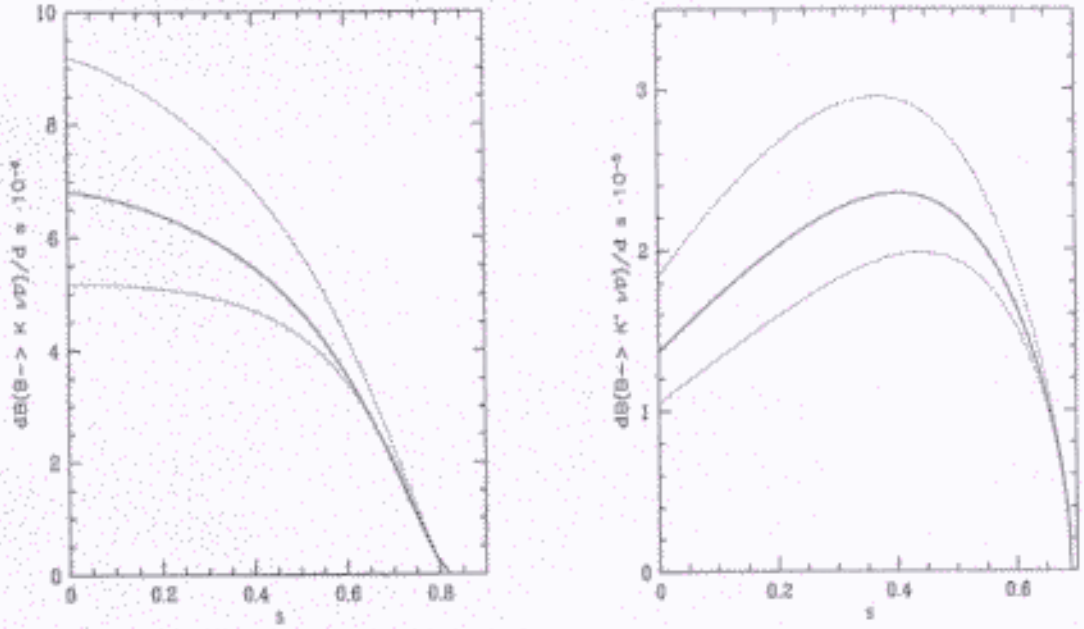
1. Process entirely dominated by short-distance interactions, governed by top-quark loops in SM. Theoretical uncertainties are very small for inclusive $B \to X_s\nu\bar{\nu}$ and $\simeq 30\%$ due to hadronic form factors in exclusive $B \to K^{(*)}\nu\bar{\nu}$.
2. $b \to s\nu\bar{\nu}$ potentially sensitive to effects from physics beyond the SM, in a way complementary to other important processes such as $b \to sl^+l^-$ or $b \to s\gamma$.
3. The SM rate is relatively sizable:

$$B(B \to X_s\nu\bar{\nu}) = 4.1\times10^{-5} \left|\frac{V_{ts}}{V_{cb}}\right|^2 \left[\frac{m_t(m_t)}{170\,\mathrm{GeV}}\right]^{2.30},$$

$$B(B \to K\nu\bar{\nu}) \approx 4.0 \times 10^{-6}$$

$$B(B \to K^*\nu\bar{\nu}) \approx 1.3 \times 10^{-5}$$

✦ Enhancement of the branching fractions from New Physics by a factor 5 - 10 w.r.t. SM is conceivable.



✦ $b \to s\nu\bar{\nu}$ decays unique in flavour physics:

1. Sensitivity to New Physics potentially larger than, and complementary to, $b \to s\gamma$, $s\ell^+\ell^-$.
2. Cleaner theoretical treatment due absence of long distance contributions.

✦ A measurement of the inclusive $b \to s\nu\bar{\nu}$ process will have a major impact on our understanding of flavour dynamics.

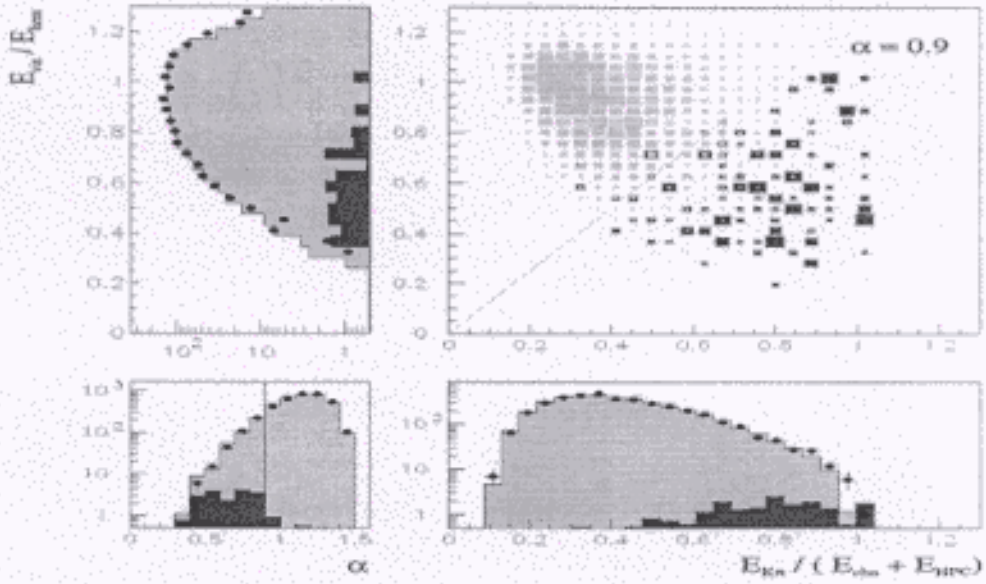
✦ CKM-suppressed decays $b \to d\nu\bar{\nu}$ have similar virtues, branching fractions are about one order of magnitude smaller and may offer valuable additional informations on the dynamics of rare B decays.

$b \to s\nu\bar{\nu}$ Decays Experimental Feasibility

Exclusive Modes

DELPHI (Zeit. Phys. C72 (1996))

$$\mathrm{BR}(B \to K^* \nu\bar{\nu}) < 1.0 \times 10^{-3}$$



BaBar (BaBar Physics Book SLAC-R-504 (1998))

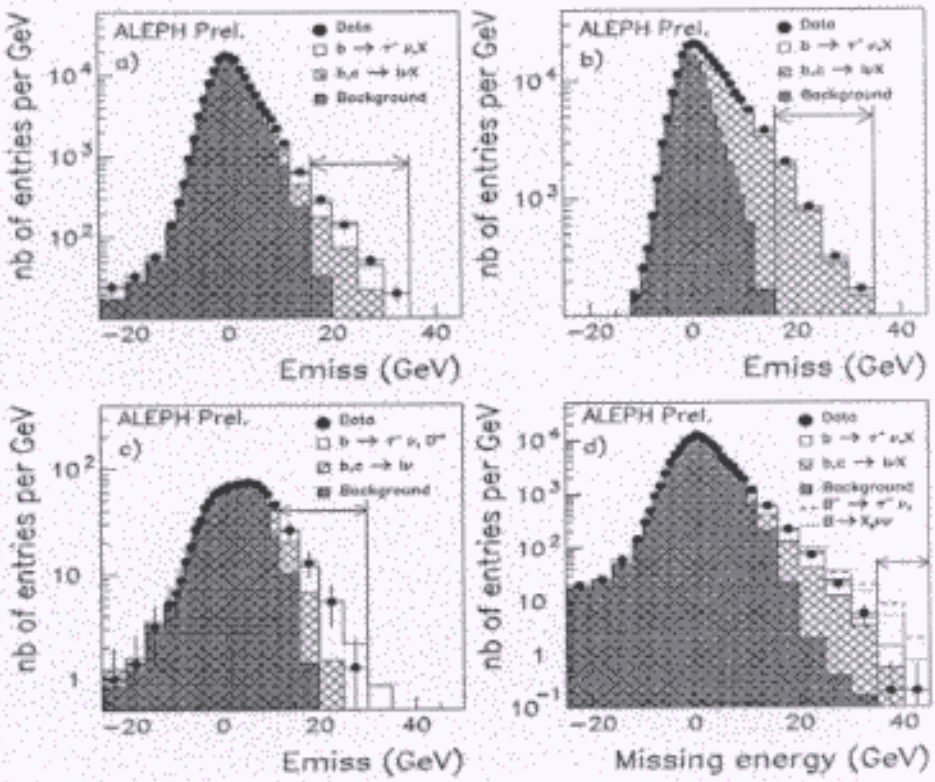
✦ difficult channel at $\Upsilon(4S)$ due to $B\bar{B}$ decay product overlap and hermiticity

✦ *reaching below the* 10^{-4} *exclusive branching ratio level appears difficult in these modes with two neutrinos*

Inclusive Mode

ALEPH (ICHEP-96 PA-10-019)

$\mathrm{BR}(b \to X_s \nu\bar{\nu}) < 7.7 \times 10^{-4}$



✦ b-tag one hemisphere, analyse E_{miss} in other

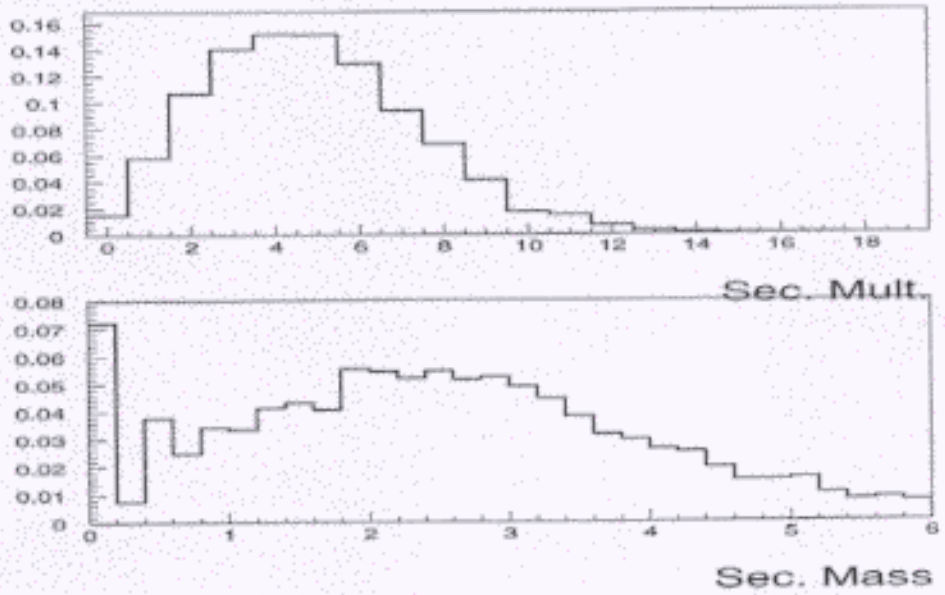
$$E_{miss} = E_{beam} + E_{corr} - E_{vis}$$

$$E_{corr} = \frac{M^2_{same} - M^2_{opposite}}{4E_{beam}}$$

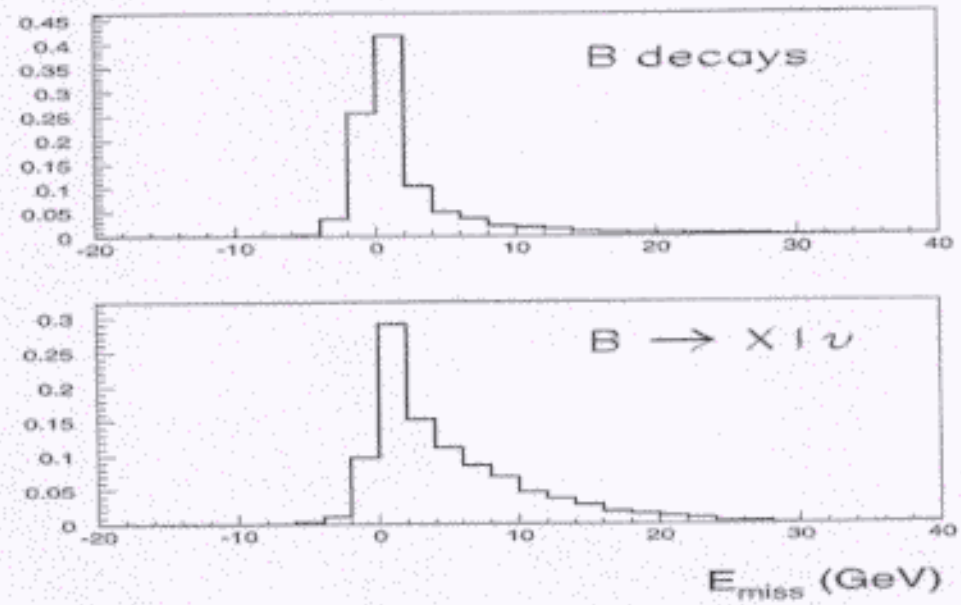
✦ calibrate on s.l. B decays, reject from search

SIMDET STUDIES

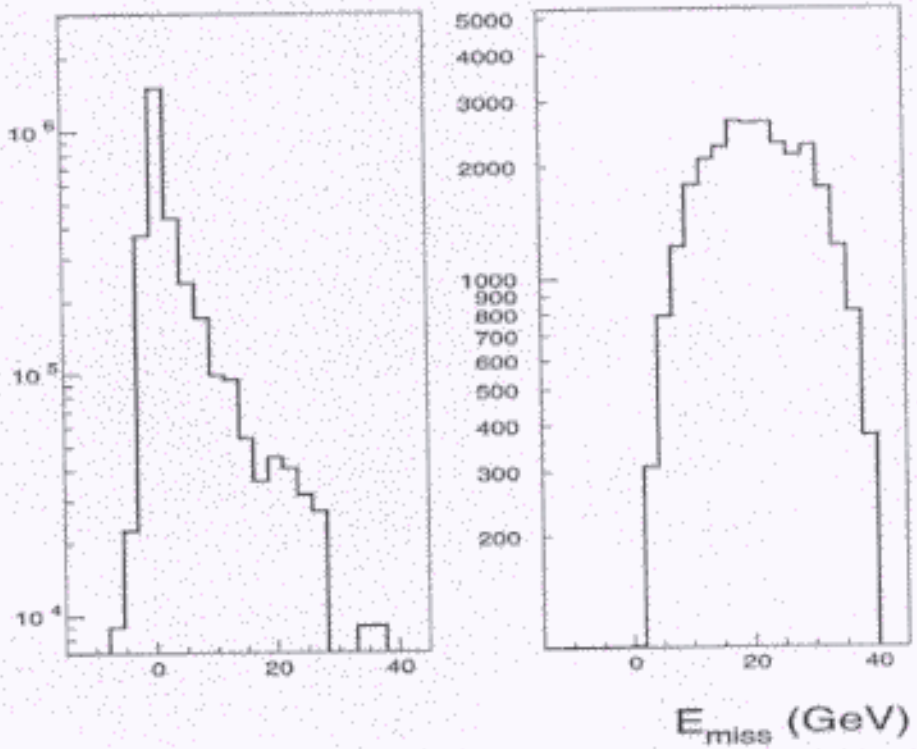
✦ Enhance S/B exploiting low mass & multiplicity of secondary system in $X_s\nu\bar{\nu}$ decay compared to B bkg:



✦ Missing energy in B decays:



✦ S/B separation depends on tails at high E_{miss}



Expected Statistics for 10^9 Z^0

	$b \to X_s \nu\bar{\nu}$	$b \to X \ell\bar{\nu}$
All	22.5k	90M
Lepton Tag ($\epsilon = 95\%$)	21.0k	4.5M
Multiplicity cut	20.0k	2.0M
Mass cut	15k	400k
High E_{miss}		