Background for luminosity measurement
-revised-

T. Jovin, M. Pandurovic, I.Smiljanic, I.B.J.

How well do we know B/S?

Several issues to be taken into account (we did it through scaling factors):

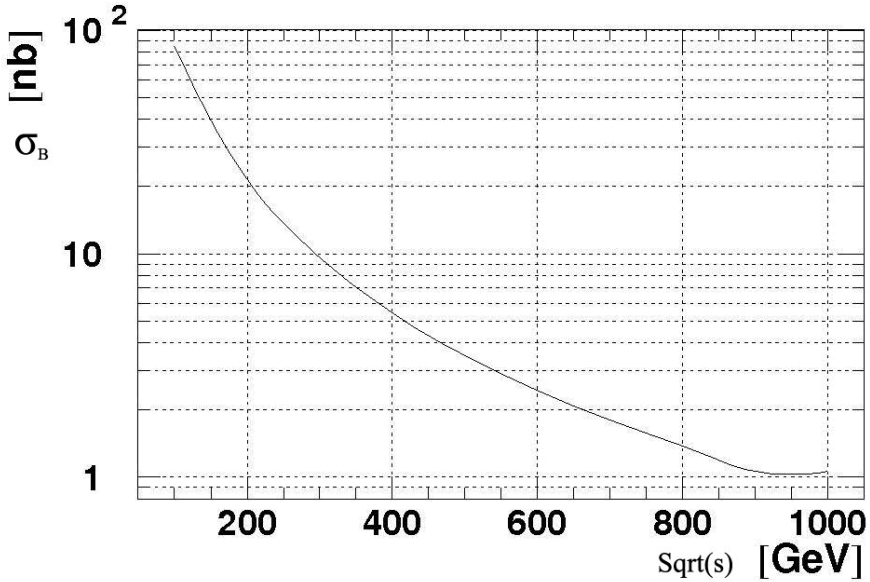
- Different cross-sections (in particular for signal) at 500 GeV and 1 TeV
- 4-f (2-gamma) processes described differently with different generator (WHIZARD vs. BDK) !
- We do not (always) simulate all processes (i.e. hadronic background)
- Topological and asymmetric cuts do not have the same background rejection
- Simulation studies are influenced by statistics (CPU time)

Cross-sections (500 GeV ⇒ 1 TeV)

- Bhabha cross-section drops app. 4 times at 1 TeV (4.7 nb ⇒ 1.2 nb)
- Background rises into saturation

(BDK 4.5 nb ⇒ 5.5 nb, only muons,

19.4 nb ⇒ 24.2 nb total background)



- Can we trust WHIZARD?

(0.5 nb ⇒ 0.2 nb, only muons, 2.4 nb ⇒ 0.9 nb total background)

BDK- WHIZARD AT LEAST FACTOR 10 AT ILC ENERGIES

OVER 150 AT 3 TeV (0.16 nb WHIZARD, ~25nb BDK)

Cross-sections (500 GeV ⇒ 3 TeV)

FURTHER COMPLICATIONS AT 3 TeV

- Background with BDK ~ 25 nb

  (scale WHIZARD at 500 GeV with factor **10^1**)

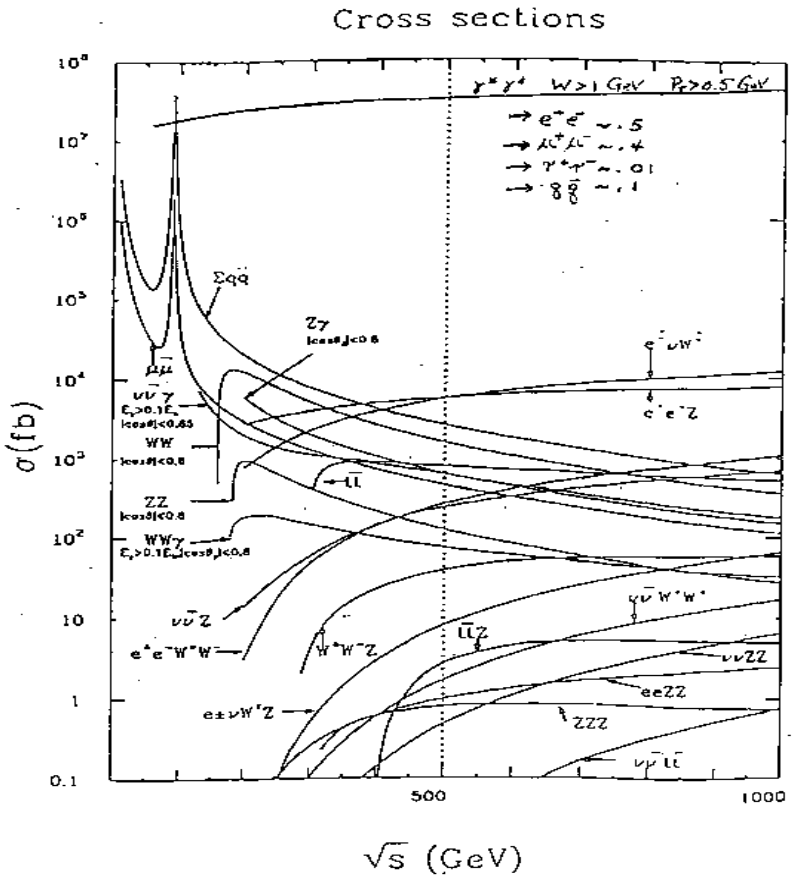
- Bhabha ~ 0.04 nb

  (scale B/S at 500 GeV factor **10^2**)

- (Asymmetric cuts inferior then topological for a factor 10^1)

WHAT TO EXPECT AT CLIK ?

(scaling game)



SCALE WHIZARD RESULT (B/S ~ 10^{-4}) AT 500 GeV FOR A FACTOR 10^3 ⇒ 10% EFFECT

What to expect at ILC?

LUMICAL GEOMETRY

BARBIE 5.0

Rmin, Rmax 8 cm, 19.52 cm

z=2510 mm

31.8-77.5 mrad

30 planes, 48x64pads

- for occupancy

we used BARBIE 4.3

Rmin, Rmax 8 cm, 19 cm

z=2270 mm

35-83.5 mrad

30 planes, 48x64pads

SAMPLES

WHIZARD 40 kEvt eell

BDK 40 kEvt eell

BHABHA 5 pb^{-1}

CUTS

Asymmetric cuts*

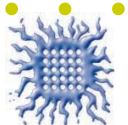
cut 1: 35.8-70.7 mrad;

cut 2: 31.8-77.7 mrad.

$Erel=(E_F+E_B)/2E_{beam}$

* reduces BHSE to a 10^{-2} level –

topological cuts gives factor 10 at 500 GeV

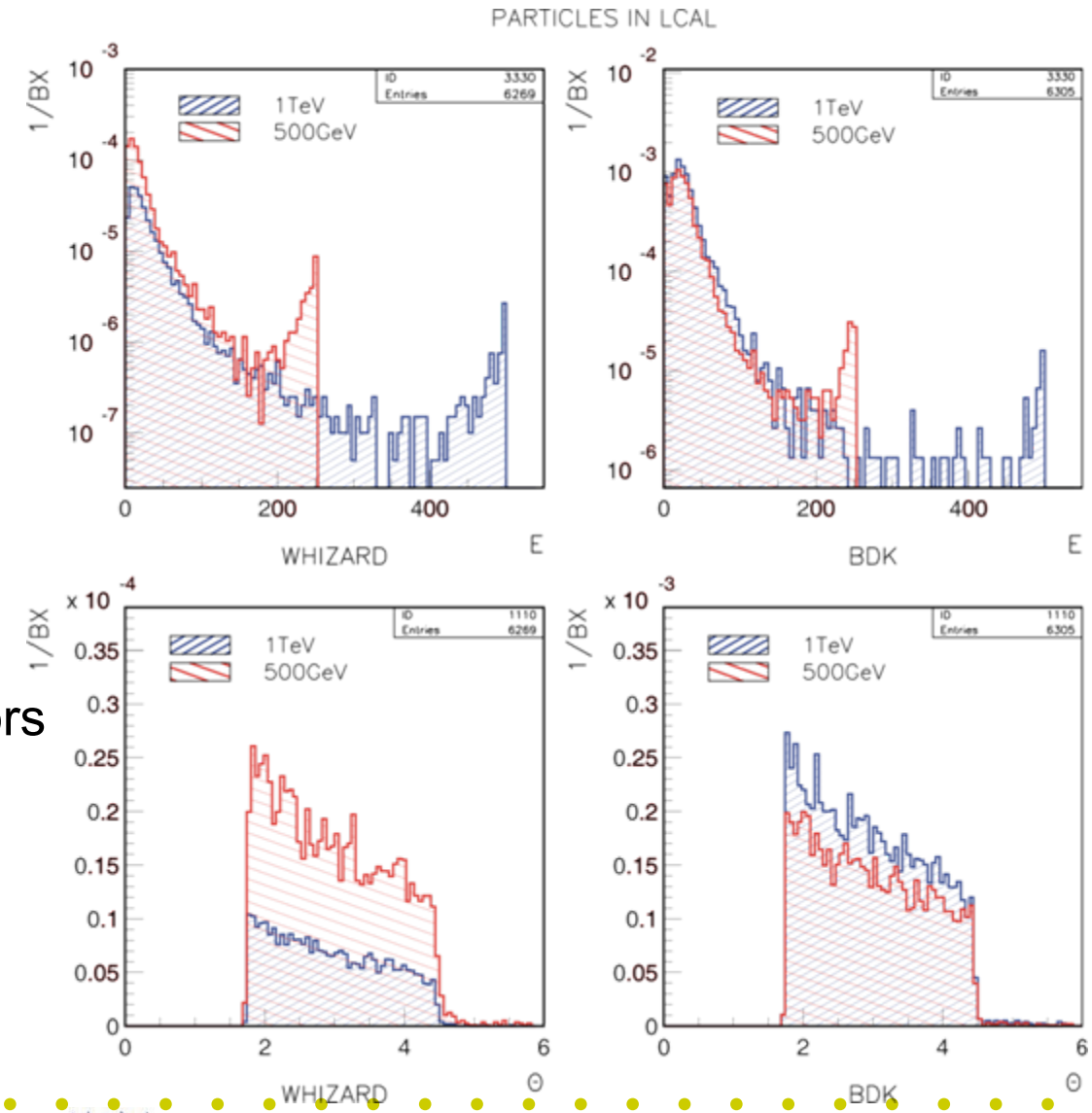


BACKGROUND

in the LumiCal, before selection

WHIZARD – BDK

- Shapes OK
- Order of magnitude difference in N_{LCAL}
- Different cross-section behaviour at 500 GeV and 1 TeV
- Somewhat less spectators at 1 TeV with both generators



What to expect at ILC?

B/S		WHIZARD	BDK
500 GeV	after cuts	$1.8 \cdot 10^{-4}$	$1.0 \cdot 10^{-3}$
	before cuts	$1.4 \cdot 10^{-3}$	$1.2 \cdot 10^{-2}$
1 TeV	after cuts	$4.1 \cdot 10^{-4}$	$4.2 \cdot 10^{-3}$
	before cuts	$1.5 \cdot 10^{-3}$	$2.6 \cdot 10^{-2}$

- Effect of background of order of per mill

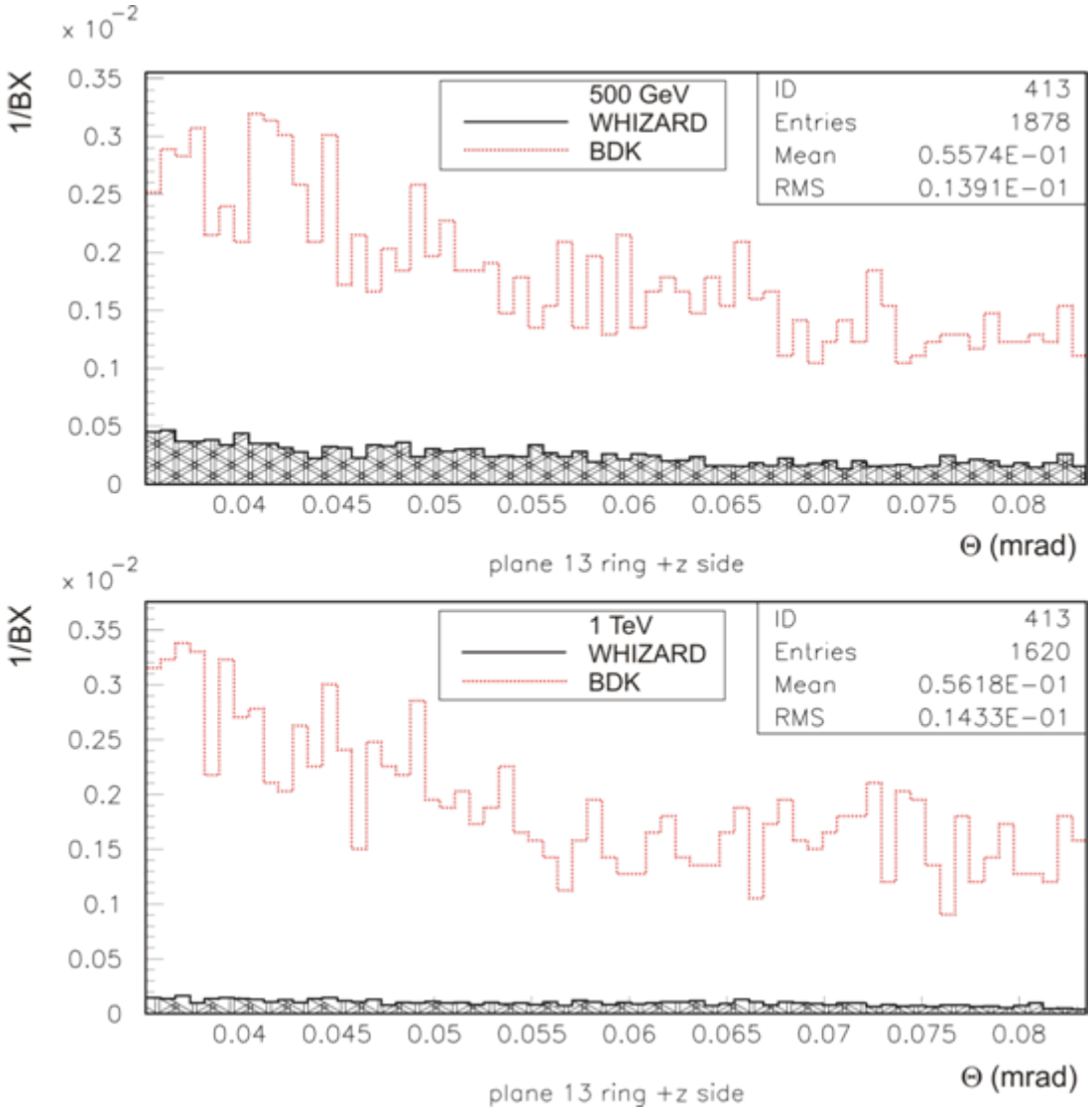
  (only I - should be scaled factor 2 for total background)
- Visible impact of BDK cross-section
- May be a bit optimistic - should be careful with background statistics

What to expect at ILC?

OCCUPANCY

WHIZARD - BDK

- Consistent with previous results
- WHIZARD-BDK difference expected from cross-sections
- Nothing significant happens at 1 TeV



Summary

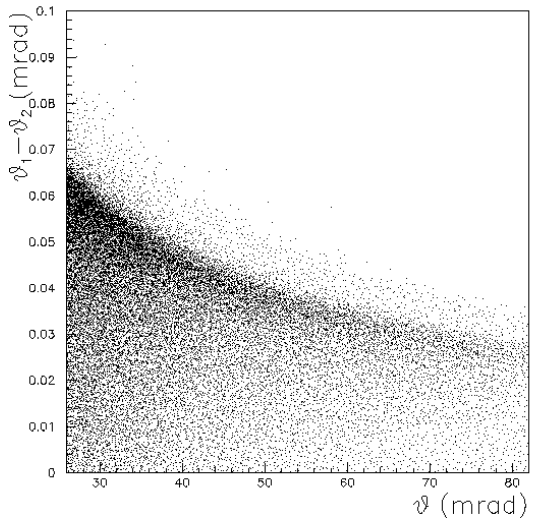
- Asymmetric selection reduces background for a factor 10
- Asymmetric cuts should be optimized for a given geometry with respect to BHSE
- Size of the background effect is of order of 10^{-3} at all ILC energies
- This should be verified with MEvt background samples – could be a few factors up due to statistics
- 3 TeV case (with ILC geometry) seems pessimistic - background is (at least) 10% effect (+ what do you do with BHSE?)
- Occupancy doesn't significantly change with energy (but , depends on the cross-section), should be no more than $3 \cdot 10^{-3}$ hits per BX

BACKUP

More systematics …

Beam-beam interactions

- **Modification of initial state**: **Beamstrahlung** ➔ $\sqrt{s'} \leq \sqrt{s}$, $\Delta\theta_{ini} \neq 0$, $E_{elec} \neq E_{posit}$
- **Modification of final state**: **Electromagnetic deflection** ➔ Bhabha angle reduction (~10^{-2}mrad) + small energy losses



Total BHabha Suppression Effect (BHSE) ~1.5%

Luminosity spectrum reconstruction

- **To control the ΔBHSE from beamstrahlung at the level of 10^{-2}, variations in the rec. lumi spectrum $\Delta x/x$ need to be known with the precision of 4.10^{-3}**

Beam parameters control

- **Bunch length σ_z and horizontal size σ_x should be controlled at the 20% level to keep the ΔBHSE from EM deflection at the level of 10^{-3}**

QUITE A TASK IN REALISTIC BEAM CONDITIONS…