Physics background for luminosity calorimeter at ILC

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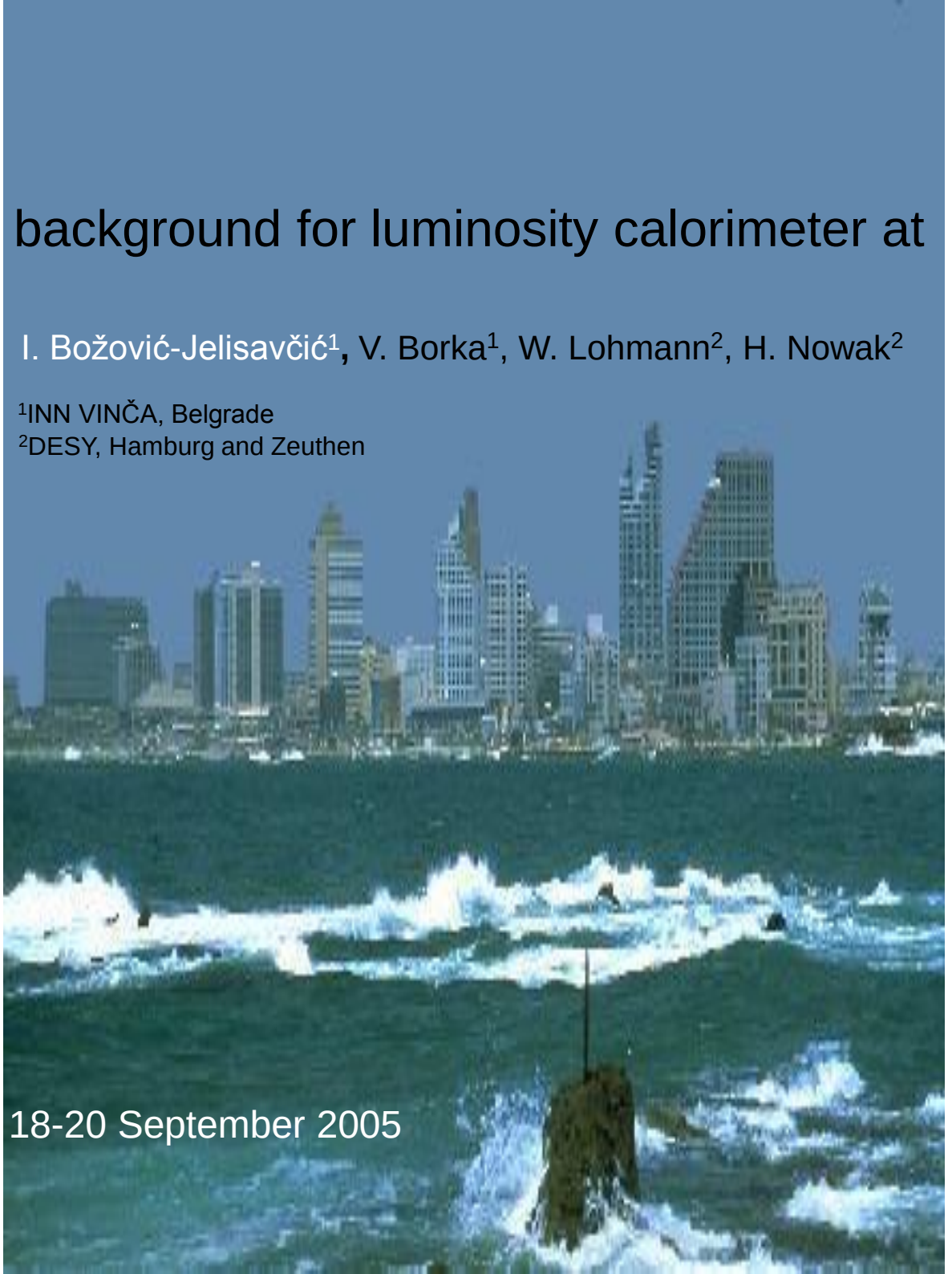

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Status as from LCWS05:

- It has been shown at the generator level that leptons from $e^+e^- \rightarrow e^+e^-\mu^+\ \mu^-$ (NC) process are as frequent as 10^{-4} in the LumiCal and even less in the BeamCal

- Contribution from leptons from W-pair decays is even smaller (despite the high cross-section of order of 100 pb) due to the fact that they are not dominantly distributed in the very forward region

- Properties of the background (i.e. acolinearity) with respect to Bhabha electrons are such to allow cuts to be further applied practically without significant loss of efficiency

What is new:

- Integration over all lepton flavors has been performed ($e^+e^- \rightarrow e^+e^-l^+l^-$) that increased the total cross-section approximately 10 times

- Assumptions on the crossing angle have been introduced, also increasing both cross section and energy generated (deposited) in FCAL per bunch crossing

Event generation:

- With WHIZARD we generated tree-level neutral current $e^+e^- \rightarrow e^+e^-l^+l^-$ processes

- Due to the increased dimensionality of the phase space it may happen that the integral (cross section) is actually infinite and the set of cuts has to be applied to make it converge

- Sample of 10^5 four-lepton events has been generated (that is up to 95% dominated by $e^+e^- \rightarrow e^+e^-e^+e^-$ process)

- 10^5 Bhabha events have been generated with total cross section of (270±8) nb with BHWIDE Bhabha event generator (note that no crossing angle can be included using BHWIDE)

Cuts:

- Invariant mass of (secondary) e^+e^- pair is more than 10 GeV
- Invariant mass of lepton pair is more than 10 GeV
- All outgoing particles are produced with $|\theta|$ between 0.05 deg. and 179.95 deg.
- Minimal *Q* transferred by photon exchange is no less than 1 GeV

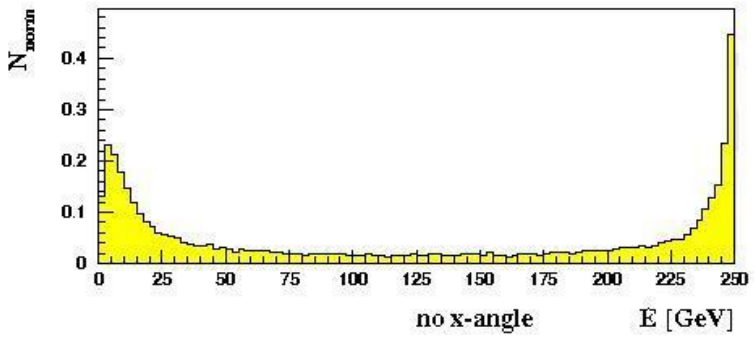
Beam assumptions:

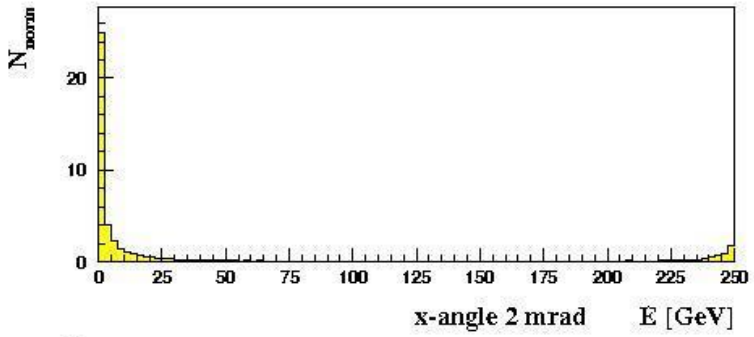
- 250 GeV beams (no ISR, beamstrahlung, polarization)
- Head-on collisions
- Crossing angle: 2 mrad or 20 mrad

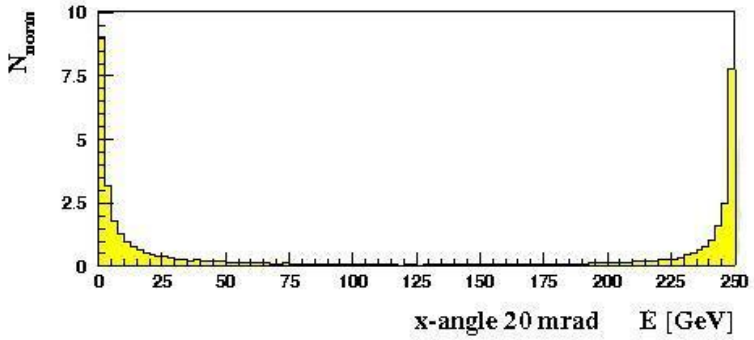
$e^+e^- \rightarrow e^+e^-l^+l^-$	head-on	2 mrad	20 mrad	Bhabha
σ[pb]$\pm\varepsilon_{rr}$ [%]	53±7	580±9	260±13	270±3
S/B^*_{LCAL}	$1.5\ 10^3$	/	/	
S/B^*_{BCAL}	$1.4\ 10^4$	/	/	
$(E^{BX})_{LCAL}$ [MeV]	3.4	13.7	36.7	8.4
$(E^{BX})_{BCAL}$ [MeV]	18.1	113.2	297.8	273.1

*Normalized to the integrated luminosity of 0.37 pb^{-1} corresponding to 10^5 Bhabha events

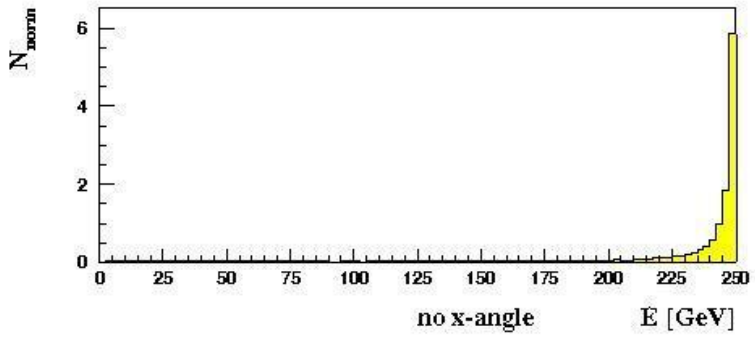
LUMICAL

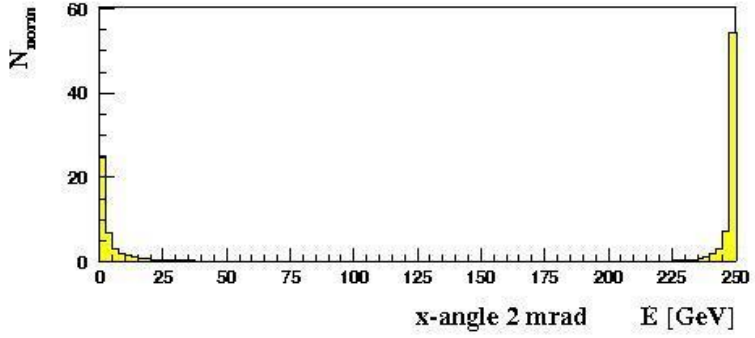


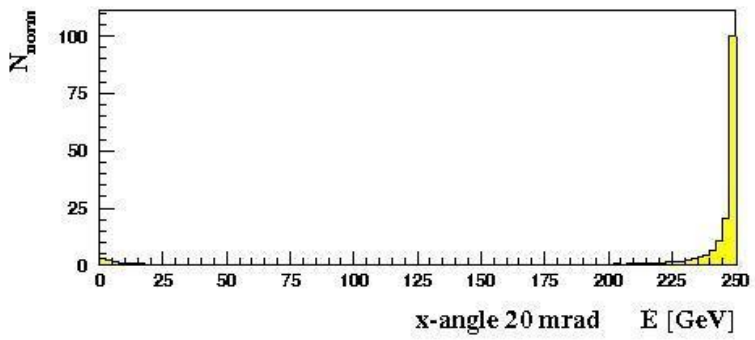




BEAMCAL

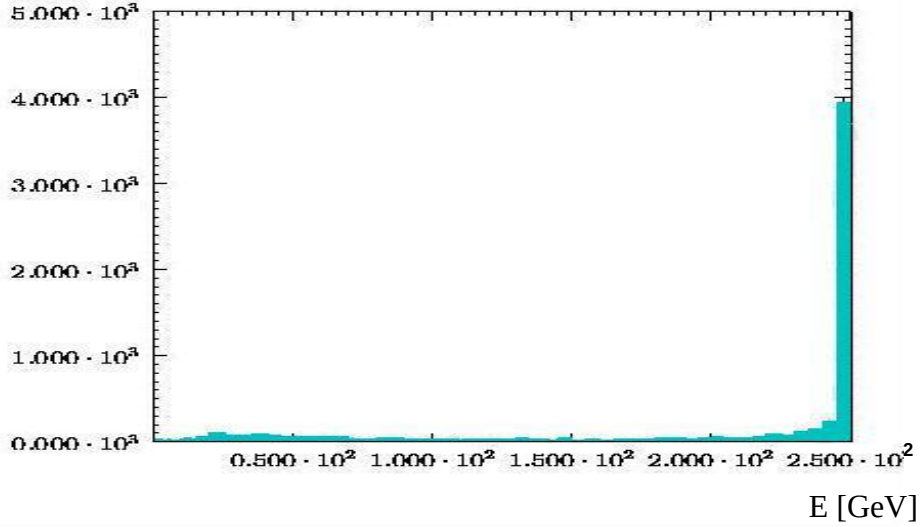




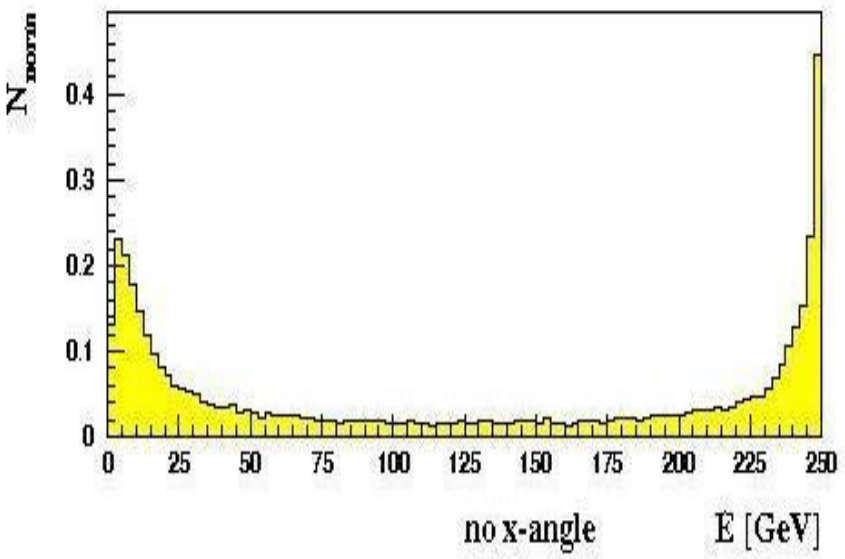


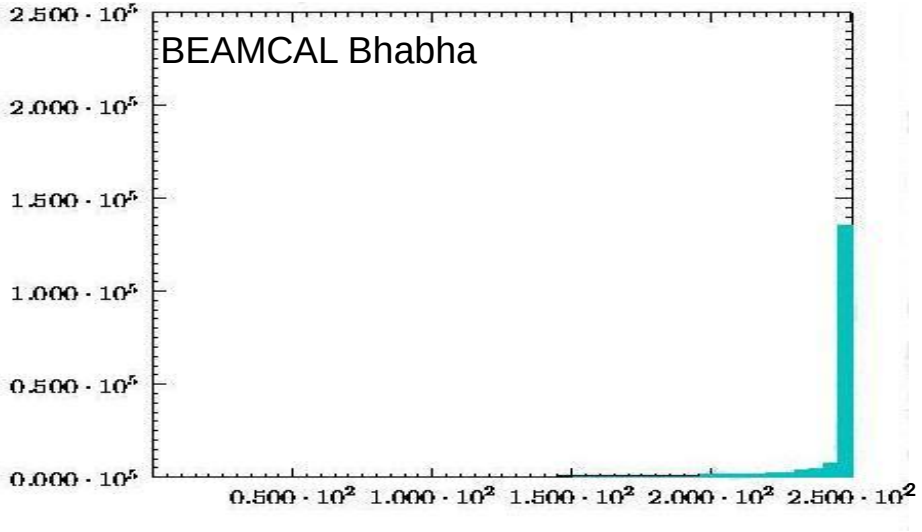
N_{norm} is number of entries normalized to the integrated luminosity of 0.37 pb^{-1} to make the scales comparable to the signal

LUMICAL Bhabha

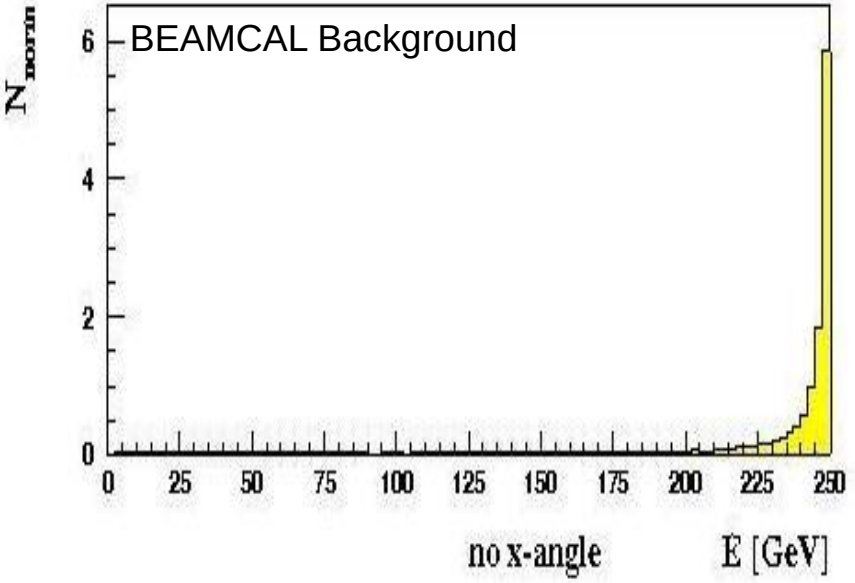


LUMICAL Background





BEAMCAL Background



Summary:

- After flavor integration and assuming no crossing angle, contribution of physics background from the neutral current $e^+e^- \rightarrow e^+e^-l^+l^-$ processes has been estimated to be 10 times larger in luminosity calorimeter then allowed for the required precision of luminosity measurement

- Under the same assumptions, signal to background ratio is of order of 10^4 in beam calorimeter

- Introduction of crossing angle causes the cross section of background to increase up to 10 times, and energy generated in the LumiCal (BeamCal) acceptance region to increase up to 10(16) times per BX.

NEXT steps:

- To introduce detector simulation (BARBIE) in order to be able to give some definite answers on population of the Very Forward Region with physics background, in terms of number of tracks and deposited energy
- To develop selection (a set of cuts) to keep this source of background at the level required for the precision luminosity measurement

Though not being the main source of background for the FCAL (in comparison to the machine background), it is still important to understand these processes and have them under control