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WHAT DELPHI CAN GET WITH AN UPGRADED POSITION FOR THE VERY SMALL ANGLE TAGGER

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A rather large profit can be obtained for two-photon physics studies with an upgrade of the DELPHI very small angle tagger position. Results have been obtained by using FASTSIM simulation both for double tagged and single tagged modes of $\gamma\gamma$ interactions, and for Bhabha events used for the luminosity measurements.

The investigation has been performed at the Laboratory of High Energies, JINR.

Что ДЕЛФИ может выиграть при изменении положения детектора мечения под очень малыми углами

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Довольно большой выигрыш может быть получен при изменении положения детектора мечения под очень малыми углами установки ДЕЛФИ. Приведенные результаты были получены с помощью программы моделирования FASTSIM для двухфотонных взаимодействий с одним и двумя мечеными электронами и для процесса рассеяния Баба, используемого для измерения светимости.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

1. Introduction

It was mentioned in the recently published report of the Workshop on Physics at LEP2 [1] that very interesting resutls can be obtained from studying $\gamma\gamma$ events if one or both photons are tagged by the observation of an electron and a positron in the Very Small Angle Tagger (VSAT) detectors. The DELPHI collaboration (see the detailed description of the detector [2]) has already obtained some new results studying the single tag events in the VSAT [3]. Following DELPHI, similar detectors are currently being used in OPAL or are a part of upgrades in ALEPH and L3. The interest in such studies is mainly due to the opportunity they provide to obtain new results in two attractive regions, on the total $\gamma\gamma$ cross

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section $\sigma_{tot}^{\gamma\gamma}$ and on the so-called P^2 dependence of the photon structure function $F_2^{\gamma}(x, Q^2, P^2)$. The measurement of $\sigma_{tot}^{\gamma\gamma}$ requires both the scattered electron and the positron to be detected by the VSAT while the measurement of the P^2 dependence is possible when one of the scattered leptons is detected by the Small angle TIle Calorimeter (STIC) and another by the VSAT. So in both cases the double tagged mode provides the best possible information about the process, due to the opportunity given to measure both the produced hadronic system and the absolute momentum transfer squared for both photons. The main disadvantage of the double tag mode is limited statistics, due to the small acceptance of detectors used for tag measurements. As a consequence there are some limitations on how to get results with high enough accuracy. In this note we propose the upgrade of the small part of the LEP beam pipe at the VSAT modules which would increase the statistics up to 3.5 times for the VSAT double tags.

2. Apparatus

The VSAT itself is already instrumented to accomodate the larger acceptance. The present scheme of VSAT modules and a simplified geometry of the LEP beam pipe are shown in Fig.1. The VSAT detectors are situated at $\simeq$ 7.7 m from the interaction point, behind the superconducting quadrupole magnets which produce the final focus. These magnets deflect the scattered electrons and positrons from the direction of the beam pipe, and

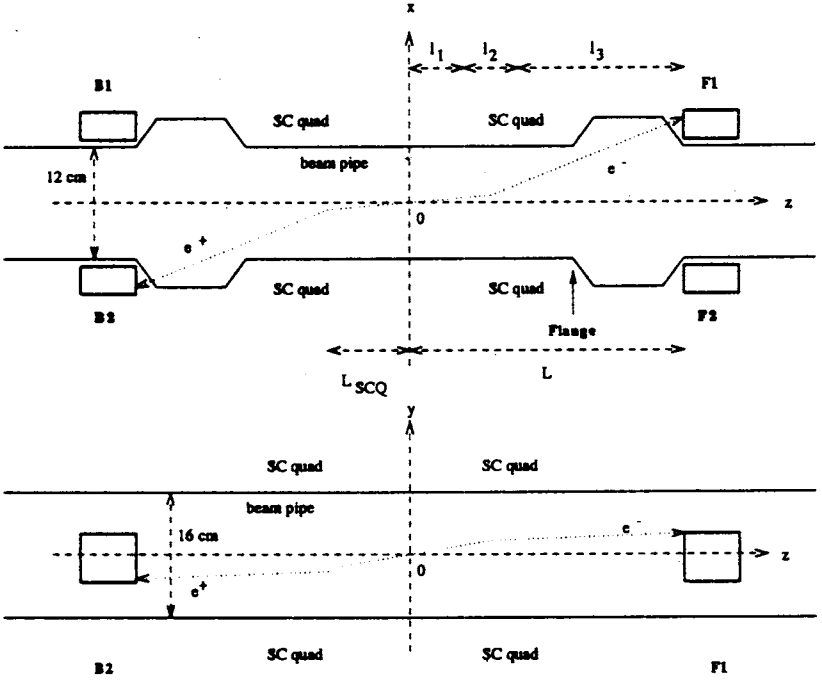

Fig.1. Arrangement of the DELPHI VSAT modules

thus permit measurements at very small polar angles. At the modules there is a small elliptical section ($\simeq$ 60 cm length) of beam pipe providing a thin window in front of the calorimeters. The instrumented area of the VSAT modules is not large, only 5 cm high and 3 cm wide for the x-position measurements (the active area for the calorimeter is 5×5 cm^2). But currently, due to the present construction of the beam pipe, the area used is even smaller, i.e., 2 cm in x-direction, because for the outer range in x of the modules there is a dead zone (see Fig.1) due to a flange in the beam pipe about 70 cm in front of the detectors (see Fig.2). Thus, if a new part of the beam pipe is made with a 1 cm smaller radius in x-direction, the VSAT modules can be moved 1 cm closer to the beam line. This would make the full volume of the detector active allowing us to benefit greatly from the increase in corresponding cross sections, for $\gamma\gamma$ single and double tag measurements, and for the Bhabha scattering processes.

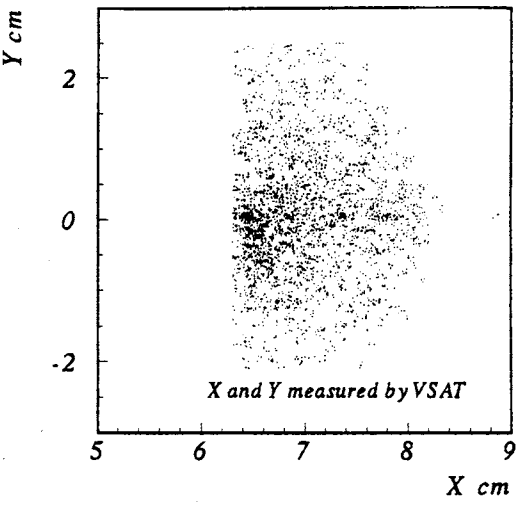

Fig.2. The profile of x and y coordinates measured by the VSAT module in current position

3. Models

Is was shown in our previous study [3] that there is reasonable agreement between DELPHI data and simulation if a so-called QCD-RPC (Resolved Photon Contribution) model is added to the more traditional GVDM and QPM models. The same three-component model is used to obtain an estimate of possible profit for the $\gamma\gamma$ process from the upgrade proposed in LEP2. The standard DELPHI generator is used to simulate Bhabha events. The FASTSIM package together with the standard VSDST program is used to simulate the trajectories of scattered electrons and positrons throughout the DELPHI magnetic field and superconducting quadrupole magnets and to give the response of the VSAT detectors together with all the necessary corrections.

4. Results

When we study the virtuality of the photon structure function $F_2^{\gamma}(x, Q^2, P^2)$, the P^2 is measured by the VSAT only (as a single tagged case), while the Q^2 is measured by the STIC. In the table both the cross sections of single tagged and double tagged modes are estimated. The results are obtained for a LEP2 beam energy of 175 GeV and a 1 cm smaller radius for the LEP beam pipe. Standard criteria to select $\gamma\gamma$ events were applied. Charged particles were accepted if the following criteria were met:

- polar angle from 15° to 165°;
- momentum greater than 0.4 GeV/c.

The event was accepted if the number of charged particles was greater than or equal to 3 with an invariant mass greater than 6 GeV.

One can see that for the double tagged events the statistics available can be increased by a factor 3.5. This is illustrated in Fig.3, where the momentum transfer squared is shown for both the current and new displacements of the VSAT modules. The fact that for the new position the maximum of the distribution is shifted to a lower range can help us also to

Table

Single tagged case				
Models	VDM	QPM	QCD-GS	Total
Current beam pipe	67 pb	9 pb	37 pb	110 pb
Upgraded beam pipe	11 pb	15 pb	63 pb	190 pb
Double tagged case				
Models	VDM	QPM	QCD-GS	Total
Current beam pipe	0.96 pb	0.11 pb	0.61 pb	1.68 pb
Upgraded beam pipe	3.67 pb	0.42 pb	1.79 pb	5.88 pb

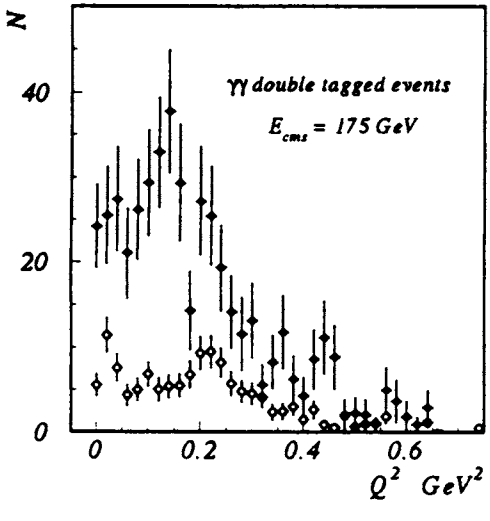

Fig.3. Momentum transfer squared measured by the VSAT detector, in the current position (open circles) and after the upgrade (black circles)

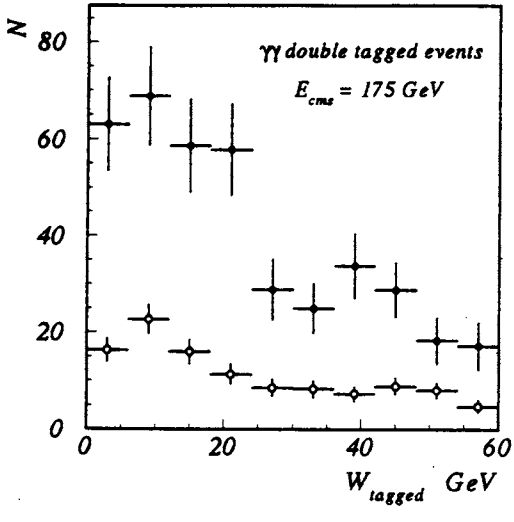

Fig.4. Invariant mass distributions in the current position (open circles) and after the upgrade (black circles)

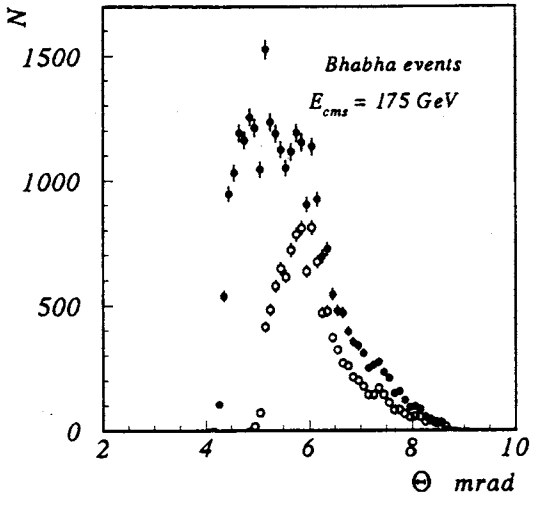

Fig.5. Polar angles measured by the VSAT detector in the current position (open circles) and after the upgrade (black circles)

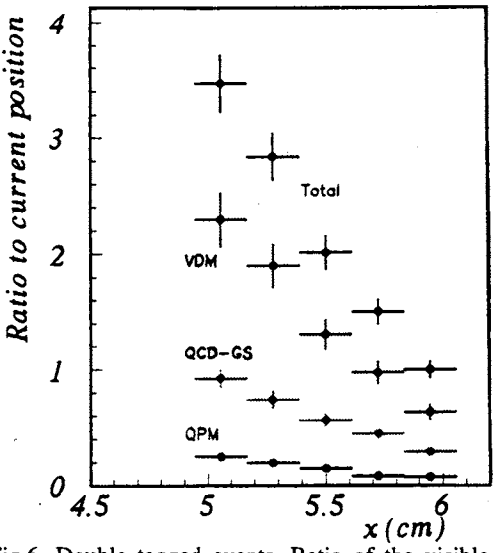

Fig.6. Double tagged events. Ratio of the visible cross section (Total) to the current one (at 6 cm) for smaller displacements in x-direction. Contribution from the VDM, QPM and QCD-RPS (with Gordon-Storrow parameterization) components are also shown

compare results from LEP1 with those from LEP2. It will be possible to find ranges with an overlap of Q^2. Figure 4 shows the invariant mass distribution for both situations. Again it is interesting to note that with the upgrade the statistics can be increased in the higher (more interesting) range of W. Finally, the result for Bhabha events is shown in Fig.5. Here the statistics can also be seen to rise (by a factor of $\simeq 2.5$) together with the angular acceptance ranges in both cases. We believe that the smaller dimension of the beam pipe does not dramatically increase the background of off-momentum electrons. However, it remains to be checked whether such a beam pipe would limit the LEP aperture during injection. If for some reasons a 1 cm smaller radius in x-direction of the LEP beam pipe is unacceptable, the possible profit in statistics for smaller displacement of the VSAT modules (a ratio to the current cross section at 6 cm) is shown in Fig.6. One can see that even 0.5 cm smaller radius arises the statistics for double tagged events by a factor of 2.

5. Conclusions

We have studied hadronic events in simulated two-photon collisions at LEP2 for two positions of the VSAT modules, for the current set-up, and for the new one 1 cm closer to the beam pipe, after a simple upgrade of the LEP beam pipe. It is shown that there will be a considerable increase in statistics with the upgrade proposed.

References

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