

CRAB WAIST SCHEME LUMINOSITY AND BACKGROUND DIAGNOSTICS AT DAFNE



Three different processes are used to measure the DAFNE luminosity: -The Bhabha elastic scattering e+ e- to e+ e-; polar angle range covered by calorimeters 18-27 degrees, expected rate (~440 Hz at a luminosity of 10^{32} cm-2 s-1)

-The very high rate e+ e- to e+ e- g (radiative Bhabha process); 95% of the signal in contained in a cone of 1.7 mrad aperture, but suffers heavily from beam losses due to interactions with residual gas and from Touschek effect.

- e+e- to Φ to K+K-, at a rate of about 25 Hz at 10^{32} is expected in the SIDDHARTA experiment monitor at ~90 degrees.



The SIDDHARTA preliminary setup installed at DAFNE.

Bhabha calorimeter: the construction



1 cm scintillator tiles [Protvino], each read by 3 wavelength shifting fibers [Bicron, 1mm]







In front of each calorimeter, at a distance of 18.5cm from the IR, a ring of triple-GEM detectors is installed around the beam pipe. The two GEM trackers are divided in two units, with an half-moon shape; the top (bottom) half covers azimuthal angles between 14 and 166 degrees (194 and 346 degrees).



- eight cells in azimuth (covering 19 degrees) are arranged in four rings
- of equal radial extension.

When a charged particle crosses the 3 mm drift gap, it generates electrons that will be multiplied by the three GEM foils separated *by 2/1/2 mm*.

Each of the GEM planes is made of a thin (50mm) kapton foil sandwiched between two copper clads and perforated by a dense set of holes (70mm diameter, 140 mm pitch).

As a high potential difference (about 400 kV) is applied between the copper sides, the holes act as multiplicating channels and the gain of each layer is about 20 (and hence roughly 8,000 in total). The GEM trackers, are included into the main DAQ system.



Hit sector map for Bhabha events: back-to-back sectors are fired *[possibly together with the first* neightbor]

2000

Bhabha elastic scattering e+ e- to e+ e- has a very clean signature: two energy deposits in two back-to-back sectors.

At the trigger level, we require two energy deposits in the sum of the 5 sectors of a couple of back-to-back modules, with an equivalent threshold of 200 MeV







Bhabha events



36 fibers/sector, 1 photomultiplier/sector

All tiles wrapped in a Tyvek foil



8 lead plates [5 mm thick] + 3 lead plates [1 cm]







1000

Trigger: *back-to-back coincidences of 2 modules* [1 module=5 sectors] (0 AND 3) OR (1 AND 2)



Total energy deposited in module

is triggering

DAQ based on KLOE acquisition system



slow control system with a sampling time of 15 s, and are available for offline analysis and on the word wide web for online performance presentation.

All online and filtered data are stored by DAFNE



Online luminosity display



In order to correct the Bhabha event rate measured using the calorimeters and the GEM trackers for the detectors' acceptance and selection efficiency, we developed a full simulation of the whole experimental set-up, based on the GEANT3 package. This includes all the materials and fields present in the interaction region as well as a simulation of the detectors response. We estimate an overall systematic uncertainty of 11% without using the GEM information (7% using the GEM tracks).

Background rejection



An online filtering process has been implemented in the DAQ providing an estimate of the rate corrected by the percentage of background contamination.

The correction is estimated analyzing blocks of 1000 events, and by looking at the time distribution In the difference of the arrival time of a Bhabha candidate for a couple of triggering modules we

The diagnostics installed on the new DAFNE IR in order to measure luminosity for the test of the new crab waist scheme, started to operate at the beginning of February 2008 and is collecting the first encouraging results from the machine.

PbWO crystals Radiative Bhabha monitor





oration



Two gamma monitor detectors are located 170 cm away from the IR, collecting the photons radiated by electron or positron beam.

Each counter is made by four PbW04 crystals (squared section of 30×30mm2 and 110mm high) assembled together along z, in order to have a 30 mm face towards the photon beam. Total depth of 120 mm corresponding to about 13X₀.

Each crystal is readout by a Hamamatsu R7600 compact photomultiplier.

Prompt estimate of the luminosity is provided online by the DAFNE control system in order to perform machine optimization and characterization.

