ALEPH 89-34
PHYSIC 89-11

O. Braun et al.
22.2.89

# BACKGROUND EVENTS FROM BEAM-GAS INTERACTIONS

O.Braun, V.Hepp, A.Putzer, and M.Wunsch
HEIDELBERG

Background events have been produced with an improved version of the Monte-Carlo generator for beam-gas interactions (BMGA02). This new file written in KINGAL output format should be used instead of the one previously made available to ALEPH. It contains events in which off-momentum electrons hit either directly the beam-pipe inside the ALEPH detector or firstly the LEP Luminosity counters or the superconducting quadrupole and produce secondaries which then enter the beam-pipe around the interaction region.

This note describes how to use these events as input to GALEPH for studies of background in various detector components. A detailed description of the generator and the physics behind it can be found elsewhere [1,2].

Using a modified version of TURTLE [1,3] the trajectories of electrons through the LEP lattice (LEP13,[4]) were calculated. The program generates beam-gas interactions in a z-region of about 600m upstream up to the interaction point. The resulting off-momentum electrons and secondaries were tracked to the interaction region. Since the LEP lattice is symmetric only electrons have been generated.

We distinguish four different types of events:

- those hitting the LEP luminosity counter [5] (event type 1110) at 15m upstream

- those hitting the beam-pipe between the LEP luminosity counter and the superconducting quadrupole (event type 2220)

- those hitting the superconducting quadrupole magnet (3.50m upstream, event type 8880)

- those hitting the beam-pipe inside the ALEPH volume (event type 9990).

In the following step the detailed geometry of the LEP luminosity counter and of the beam-pipe and also the correct field map of the superconducting quadrupole were used. After tracking through these elements only events with secondaries which eventually can hit parts of the ALEPH detector are written onto the background event file.

Since a lot of computing time is needed to generate a reasonable sample of events and the proper handling of the generator needs detailed understanding of the different processes and the tracking through the lattice we decided to make these events available in KINGAL output format. This does not exclude the direct usage of the generator. However, in this case the authors should be contacted to get some advice.

The running conditions such as pressures in different regions along the lattice as well as the beam currents are stored in the bank KPAR (table 1). Also the integrated open time for this sample of events is given.

The standard KINGAL banks contain information about the history of the interaction:

- primary beam-gas interaction vertex and secondary vertices (VERT) and

- four-momenta of the primary and the secondaries (KINE)

For each event the event type (see above) and the time interval between two successive events of the same event type is stored as "event weight" (EVEH) (event weight = event type + time interval [sec]). To get the correct rate the total number of events on the file has to be divided by the total open time.

Figure 1 shows event dumps for the four event types.

The new file contains 1270 events of the different types and corresponds to an integrated open time of 5.2 seconds with the chosen LEP running conditions (see table 1) where the pressure will be reached after about one year of running. With these numbers one gets a rate of 244 Hz. Remember that only electron interactions have been generated. Therefore the total background rate is twice as high. That also means that background events are coming only from the $e^-$-side.

The event file is stored at CERN in NATIVE format as:

- BMGAKIN NATIVE on PUBXU 205 (IBM)

- ALEPHDATA:BMGAKIN.EPIO (VAX)

In the next version of the generator additional background sources such as beam-wall interactions and deep inelastic beam-gas scattering [3] will be added. This will increase, however, only slightly the rate of background events [2].

[1] V.Hepp,"Background Due to Beam-Gas-Interaction in LEP-Lattice", Aleph note 109
[2] V.Hepp et al., note in preparation
[3] G.Guignard, "Parameter List for LEP Version 13, Phase 1", LEP Parameter Note 9 (1984)
[4] Ch. Iselin, "Decay Turtle", CERN Yellow Report 74-2
[5] J.Y.Hemery at al., "An Interaction Rate Monitor for LEP", CERN/LEP-BI/86-5

TABLE 1: Parameters stored in KPAR bank

+++PRTABL+++ Bank KPAR 0 has 11 columns and 1 rows
and the total length is 13

| word | | |
|---|---|---|
| 1 | running time [sec] | 5.2000 |
| 2 | electron beam current [A] | 0.3000E-02 |
| 3 | positron beam current [A] | 0.3000E-02 (not used) |
| 4 | length of region 1 [m] | 8.700 |
| 5 | pressure in region 1 [1.E-10 Torr] | 30.000 |
| 6 | length of region 2 [m] | 245.000 |
| 7 | pressure in region 2 [1.E-10 Torr] | 2.000 |
| 8 | length of region 3 [m] | 23.500 |
| 9 | pressure in region 3 [1.E-10 Torr] | 5.000 |
| 10 | length of region 4 [m] | 367.800 |
| 11 | pressure in region 4 [1.E-10 Torr] | 30.000 |

FIGURE 1: VRTX and KINE output banks. Examples of the four event types

EVENT DUMP

weight = 9990 . 00391
(event type).(open time since last event of same type [sec])

+++ PRKINE +++ Vertex banks

| Number | Vx | Vy | Vz | TOF nsec | Mother, gener. tracks | |
|---|---|---|---|---|---|---|
| 1 | 0.3319 | -0.0272 | -2791.2354 | 0.0000 | 0 | 1 |
| | (primary interaction point) | | | | | |
| 2 | -8.9968 | -0.1950 | 298.5691 | 0.0000 | 1 | 2 |
| | (intersection point with beam-pipe) | | | | | |

+++PRKINE+++ kinematics banks

| Number | Particle | Px | Py | Pz | Energy | Orig.,gen. Vertex | |
|---|---|---|---|---|---|---|---|
| 1 | Electron | -0.156 | -0.003 | 13.990 | 13.991 | 1 | 2 |
| 2 | Gamma | -0.136 | -0.006 | 11.280 | 11.281 | 2 | |

EVENT DUMP

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weight = 2220.02979

+++ PRKINE +++ Vertex banks

| Number | Vx | Vy | Vz | TOF nsec | Mother, gener. tracks | |
|---|---|---|---|---|---|---|
| 1 | 0.2073 | 0.0116 | -18938.0859 | 0.0000 | 0 | 1 |
| | (primary interaction point) | | | | | |
| 2 | -0.6735 | -9.4487 | -300.0999 | 0.0000 | 1 | 2 |
| 3 | 0.5250 | -9.2609 | -300.0999 | 0.0000 | 1 | 3 |
| 4 | -6.1106 | 6.6792 | -300.0999 | 0.0000 | 1 | 4 |
| 5 | -0.9039 | -9.5435 | -300.1001 | 0.0000 | 1 | 5 |

+++PRKINE+++ kinematics banks

| Number | Particle | Px | Py | Pz | Energy | Orig.,gen. Vertex | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Electron | -0.055 | -0.253 | 31.115 | 31.116 | 1 | 2 | 3 | 4 | 5 |
| 2 | Gamma | -0.020 | -0.079 | 9.410 | 9.411 | 2 | | | | |
| 3 | Gamma | -0.005 | -0.023 | 2.920 | 2.920 | 3 | | | | |
| 4 | Electron | -0.039 | 0.011 | 0.509 | 0.511 | 4 | | | | |
| 5 | Gamma | -0.010 | -0.032 | 3.654 | 3.655 | 5 | | | | |

EVENT DUMP

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weight = 1110.00171

+++ PRKINE +++ Vertex banks

| Number | Vx | Vy | Vz | TOF nsec | Mother, gener. tracks | |
|---|---|---|---|---|---|---|
| 1 | 1.0464 | -0.0153 | -29904.0742 | 0.0000 | 0 | 1 |
| | (primary interaction point) | | | | | |
| 2 | 8.5654 | -2.7599 | 207.5920 | 0.0000 | 1 | 2 |

+++PRKINE+++ kinematics banks

| Number | Particle | Px | Py | Pz | Energy | Orig.,gen. Vertex | |
|---|---|---|---|---|---|---|---|
| 1 | Electron | -0.025 | 0.001 | 49.161 | 49.161 | 1 | 2 |
| 2 | Gamma | 0.020 | -0.004 | 2.613 | 2.613 | 2 | |

EVENT DUMP

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weight = 8880.01953

+++ PRKINE +++ Vertex banks

| Number | Vx | Vy | Vz | TOF nsec | Mother, gener. tracks | |
|---|---|---|---|---|---|---|
| 1 | -0.2791 | 0.0002 | -5947.7266 | 0.0000 | 0 | 1 |
| | (primary interaction point) | | | | | |
| 2 | -16.2435 | -0.1487 | -300.0994 | 0.0000 | 1 | 2 |
| 3 | -11.6462 | -0.1649 | -300.0999 | 0.0000 | 1 | 3 |
| 4 | -11.7708 | -0.2485 | -300.0999 | 0.0000 | 1 | 4 |

+++PRKINE+++ kinematics banks

| Number | Particle | Px | Py | Pz | Energy | Orig.,gen. Vertex | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Electron | -0.548 | -0.002 | 10.664 | 10.678 | 1 | 2 | 3 | 4 |
| 2 | Electron | -0.501 | -0.005 | 4.916 | 4.941 | 2 | | | |
| 3 | Gamma | -0.054 | -0.001 | 1.062 | 1.064 | 3 | | | |
| 4 | Gamma | -0.169 | -0.006 | 3.267 | 3.272 | 4 | | | |