The rates and payloads of the BIVS detector

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The results of MC simulation of the BIVS are presented. The detector payload under the standart 50 MHz kaon beam was determined. The ineffiencies for different classes of events and the detector influence to the overall acceptance was calculated.

1 The MonteCarlo Simulation

The subject of this study is the investigation of the BIVS detector behavior under the standart 50 MHz kaon beam. The BIVS is designed to veto hadron interactions of the kaon beam in the matter before the Vacume Decay Volume. Such interections can give one of the main backgrounds in the experiment and should be vetoed. The BIVS detector is a shashlyk type calorimeter, that is located before the Vacume Decay Volume.

The following aspects of the detector should be investigated by means of MC simulation for the technical construction:

- Detector payloads
- Detector ineffeciency (in particular for hadron interactions near the front window)
- Detector influence to the global acceptance

This study was perfomed with help of **CKM_GEANT** software package (version 4.2). The BIVS geometry was choosen as it is in the CKM Proposal:

- Length 4m
- Outer radius
- Inner radius
- Scintillator thinkness 5mm
- Lead thinknes 1mm

For the simulation of energy deposition in the detector counter was choosen the following approach: Any energy diposition in the counter scintillator is integrated in the 5 nsec time window. The beginning of integration corresponds to the time of beam crossing the plane of the counter (this allows to avoid any ambiguities due to the length (4 m) of the detector). This energy deposition together with the integration beginning time is called **The HIT** and saved for future analyses.

2 The study of detector payload

To study the payload of the detector the standart kaon beam was simulated. Kaon decays were allowed at all Z's. The overall payload of the detector is 16% from the beam rate. (It fits to 8 MGh). The main sources of hits in BIVS are the following:

- Beam hits in BIVS
- Decays before BIVS and in BIVS
- The hadron interactions in the RICH mirror and before it
- The hadron interaction in wich the primary kaon remains
- The hadron interactions after the RICH mirror

Event type	*%*
Beam hits	1.4 %
Decays	12 %
Hadron interactions befor KEAT	2.2 %
Hadron interactions kaon remains	0.57 %
Hadron interactions in KEAT	0.14 %

Table 1: Different types of events in BIVS

So one can see, than BIVS rate is determined by the kaon decays and hadron interections before KEAT. This two sources are not very dangerous in the sence of background, but they will determine the detector dead time. The hadron interactions after the RICH mirror gives the smallest contribution to the BIVS rates, but they are the main source of backgrounds and therefore should be studied more precisely (see section Future Plans).

3 The determination of inefficiency

The events in the groups, wich are deternined in the previous section, has very different signature in BIVS, so for the inefficiency studies of the detector better to treat these groups seperatly.

1. Kaon beam hits in BIVS. These hits has a big energy deposition and always can be detected. The coordinate distribution of these hits is presented on the Fig.1. It seems that almost all such events can be eliminated by the tuning of the beam or the BIVS geometry.

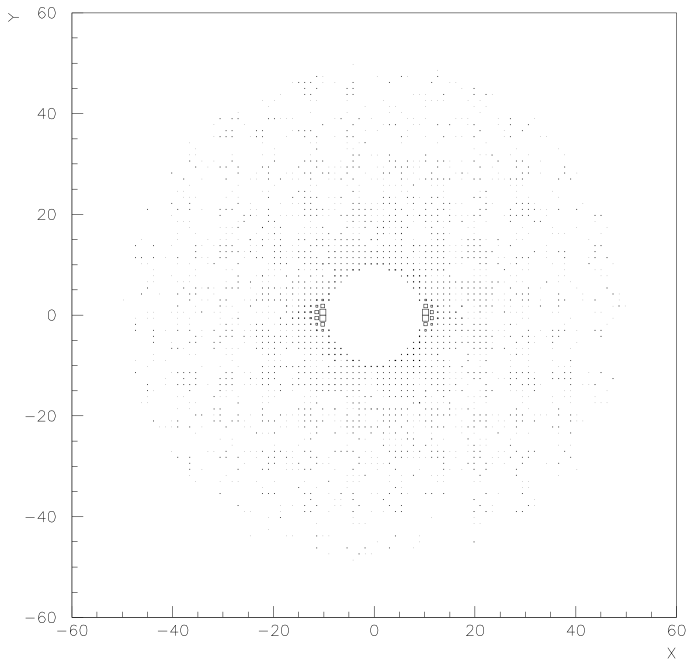

Figure 1: The coordinate distribution of beam kaons hits in BIVS

The BIVS hits, the sources of wich are in the others groups, are produced by the particles with smearing momentum and angle. The inefficiency curve in dependence on the threshould in one counter is presented on the Fig. 3.

2. Decays. Secondary particles from kaon decays before the BIVS and in it can hit the detector. As was hightlighted above it happens in 12% of beam kaons. Fortunately such particles has big energy and in almost all cases can be detected. For typical threshould 20 Mev the inefficiancy is 5%.

3. Hadron interactions before KEAT. Such interections lies too far from Decay

Volume to be a source of background. So the inefficiency to detect such events not a critical poit and for threshould 20 Mev is 30%

4. Hadron interactions,kaon remains. In these cases the primary kaon is flying further, but someone another particle hits the BIVS (typiclally an electron). The inefficiency for such events is very small (near 80%), it is due to the small energy of another particle (¡2 Gev.). But it is also not an important case, as the kaon charcteristics change very slightly.

5. Hadron interactions in KEAT. This is the most dangerous events. These interactions are haracterised by the number of adrons, wich are flying at the angles near 90 degrees.

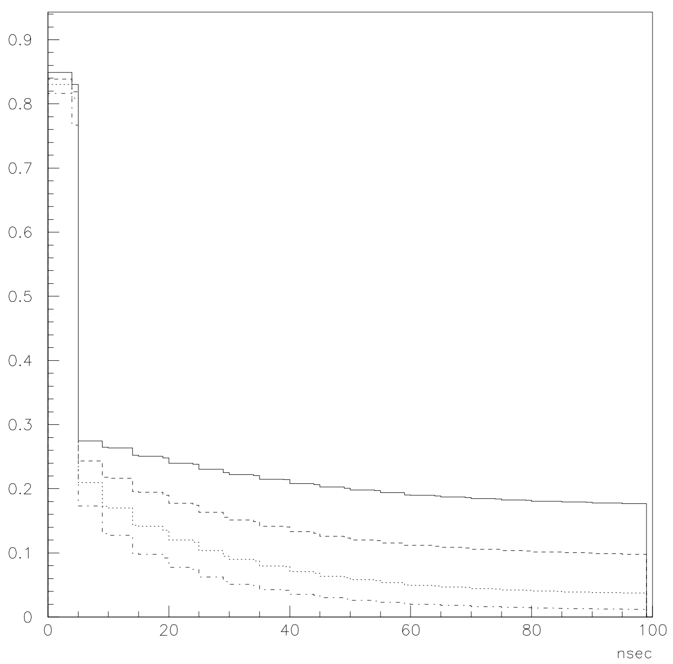

Figure 2: The fraction of hits with hit time greater than time on axis X for different thresholds in one counter (solid line-10 Mev, dashed line-15 Mev, dotted line-20 Mev, dashed-dotted line-25 Mev)

4 The detector influence to the global acceptance

There are two factors that can have influence to the effiency of detection the signal decay. The first one is the detector dead time (finite detector responce time) and is the subject of future studies. The other one is connected with the presence of very slow particles in hadronic interactions (hadrons with enrgies several Gev.) Such particle can produce a hit in BIVS after a long time of the kaon passing the detector (typical time for such particles are 60-150 nsec). The dependence of the number of such hits on the time is presented on the Fig. 2 for different threshoulds in one counter. One can see that number of hits with time greater then 15 nsec for threshould 25 Mev(dash-dotted curve) is 10%. So the overall influence to the global acceptance is $0.1 \times 0.16 = 0.016 = 1.6\%$

5 Future plans

- More precise study of Hadron interections after RICH mirror (by using several Hadron genarators)
- The investigation of detector dead time
- Study of different geometries for this detector (maybe the internal and external radii will need some changes)
- Study of energy distribution in counters and determination the optimal number of layers per one photomultiplyer

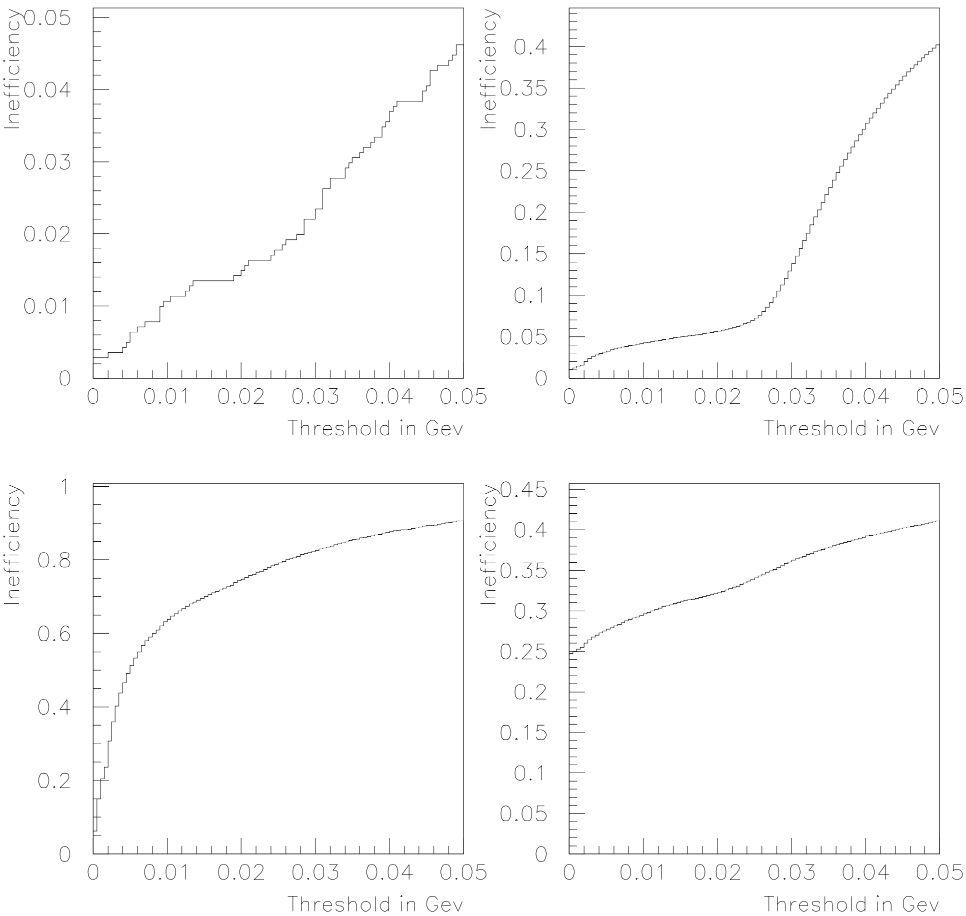

Figure 3: The dependence of inefficienecy on the threshold in one counter (in Gev) for different types of events (top-left: hadron interections after RICH mirror, top-right: decays before BIVS and in BIVS, bottom-left: the hadron interaction in wich the primary kaon remains, bottom-right: the hadron interactions in the RICH mirror and before it)

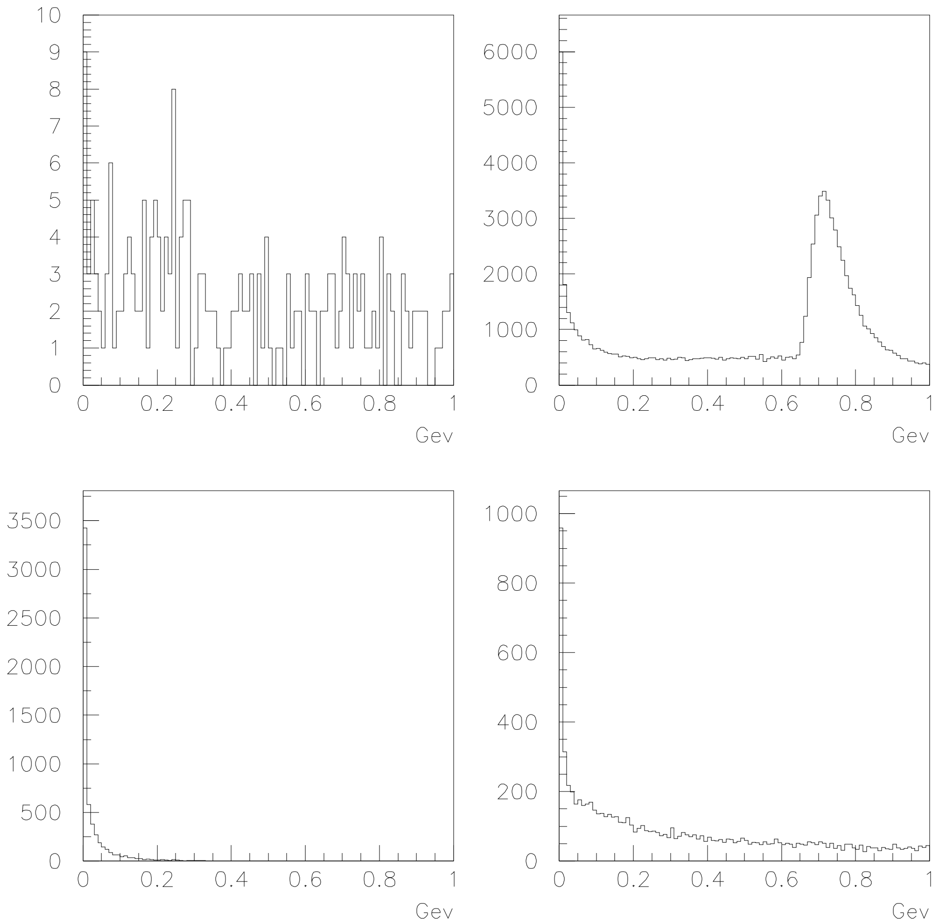

Figure 4: The Energy deposited in BIVS for different types of events (top-left: hadron interections after RICH mirror, top-right: decays before BIVS and in BIVS, bottom-left: the hadron interaction in wich the primary kaon remains, bottom-right: the hadron interactions in the RICH mirror and before it)

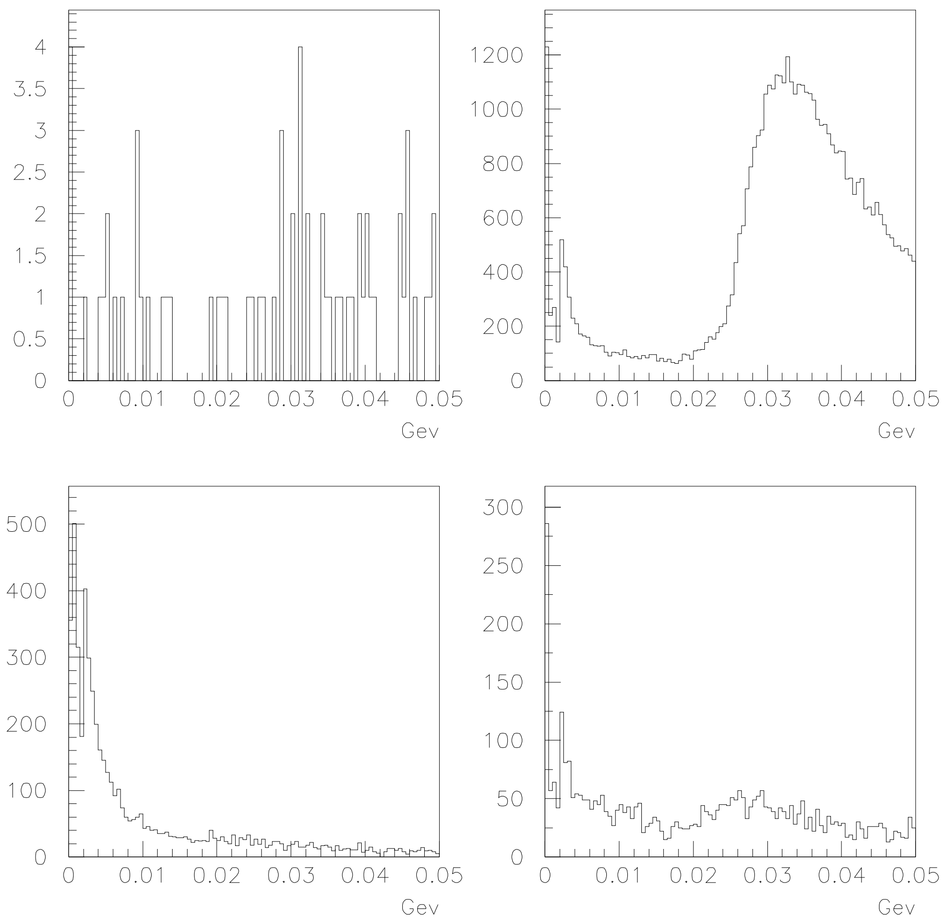

Figure 5: The Max energy deposited in one counter for different types of events (top-left: hadron interections after RICH mirror, top-right: decays before BIVS and in BIVS, bottom-left: the hadron interaction in wich the primary kaon remains, bottom-right: the hadron interactions in the RICH mirror and before it)