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Lead-glass detector for NA49

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Abstract. An experimental report on the construction and operation of a lead-glass calorimeter at the CERN-NA49 experiment is presented.

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1. Introduction

After the exciting and interesting RHIC results on suppression of high p_T particles in very high energy nucleus-nucleus collisions – and their absence for proton-nucleus reactions – it is reasonable to ask: what about lower, SPS, energies, do we see anything interesting there?

In case of proton-nucleus collisions the enhancement of high p_T particles compared to nucleon-nucleon collisions is the well known Cronin-effect. Some recent calculation of this phenomenon for SPS energy is given in Ref. [1]. As the data available from experiments are scarce (e.g. unpublished analysis from WA98), it is worthwhile to measure high p_T particles, for example neutral pions, with a small supplement using the existing detector system of the NA49 experiment. Its completion can also help when making exclusive studies, because the experiment up to now could detect charged particles only, with the exception of neutrons.

The NA49 experiment is a large acceptance hadron detector for charged particles (Fig. 1). Although the SPS is closed, our group got 10 days of running in 2003, in order to test a lead-glass detector prototype, put behind the time projection chambers. For most of the particles having photonic decay one has acceptance in the central region.

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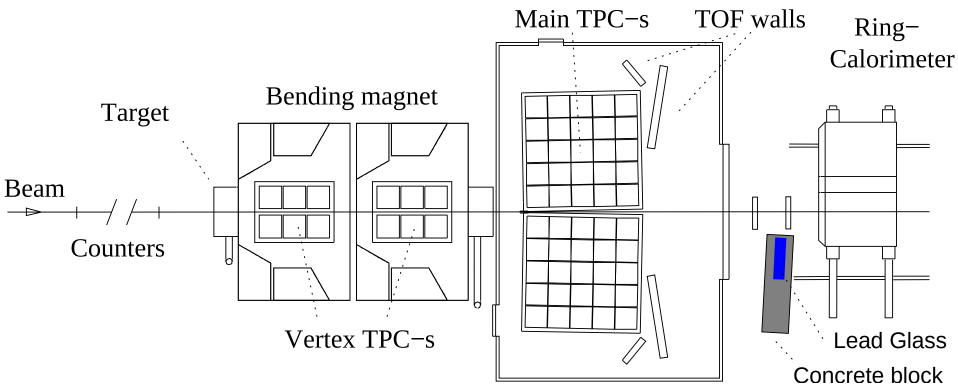

Fig. 1. Layout of the NA49 experiment with the position of the new lead-glass detector.

2. OPAL end cap electromagnetic calorimeter

The hardware for the new detector came from the OPAL experiment which finished data-taking in 2000. During the dismantling big part of the end cap calorimeter hardware and electronics [2] was salvaged. The calorimeter functions in the following way. The incoming γ creates an electromagnetic shower, which produces Cherenkov light. The lead-glass has good light transmission below 400 nm and it is long enough, thus a shower is easily contained. The light is converted to electronic signal, by the vacuum photo triode, and it is further amplified. The triode contains one dynode only, meaning small amplification. The unit is sensitive to magnetic fields but also tolerates high voltage changes. The device has acceptable resolution in the percent range and enables hadron-electron separation.

The resulting negative signals are integrated by a dual 12 bit charge integrating ADC of the type CIAFB F583C [3]. It digitizes 96 channels, measuring both the signal and the amplified one, thus achieving 15 bit dynamic range. The device can be gated from the front, but the generation of a test gate and a test pulse is also possible. The device gives out the analog trigger output before conversion, thus it may be used for triggering purposes. To enable fast clear, the conversion can be delayed by 10-60 μs, the conversion time is 1 ms for 96 channels. The device was used with 2 μs gate and read out via its Fastbus interface.

3. Assembly

A lead-glass wall with 16×12 units was assembled, giving 1.5 m^2 sensitive area. Big part of electronics was placed in the experimental area, see photos in Fig. 2.

In order to enhance events with photons, a photon-trigger has been developed and built by the institute: electronic cards sum the signals from four adjacent channels. The trigger thresholds can be set one-by-one via serial port, using a

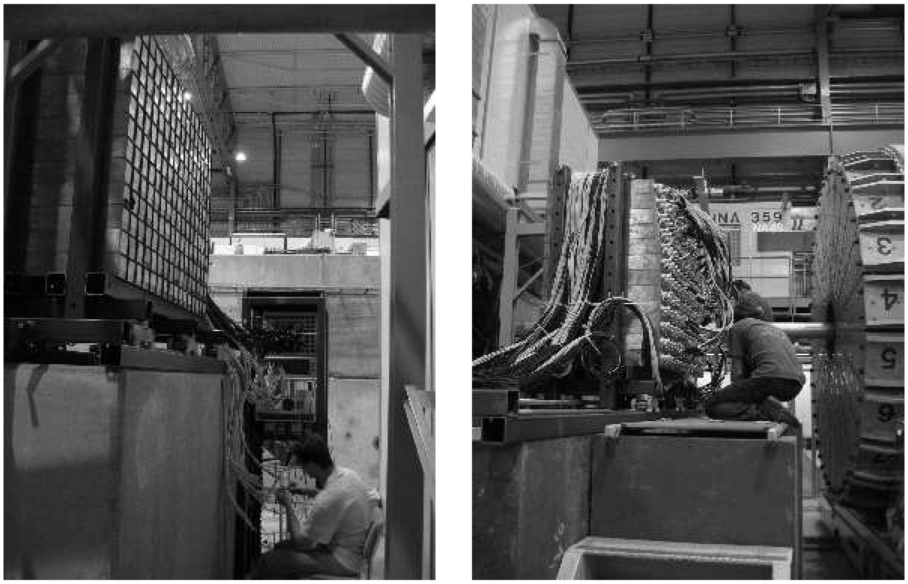

Fig. 2. Installation and assembly. Front of the detector is shown on the left, with the in-area electronics. The back side and cabling can be seen one the right.

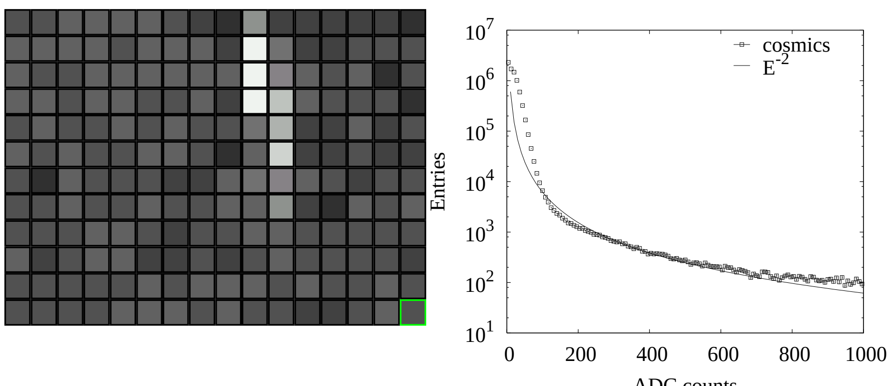

Fig. 3. Left: example of a cosmic event, creating vertical shower starting at the top of the detector. Cells with higher energy deposit are whiter. Right: distribution of ADC counts in all cells, compared to the expected $1/E^2$ shape.

graphical interface. The response time of the trigger is of the order of 0.5 μs, depending on signal amplitude.

The data acquisition software runs on FIC 8234 machine, with Motorola 68040, running OS-9 (interrupt handling, events, modules, semaphores). Fastbus is reached via FVSBI interface. The software not only controls the measurement, but provides an on-line display of the occurring hits in the detector.

4. Data taking

As a first check, data have been taken with triggering on cosmic particles (Fig. 3). The obtained uncalibrated ADC spectrum, which in this sense is the energy spectrum, gives dependence close to $1/E^2$. By plotting the units separately one finds that the gains are within 20-30%.

Due to problems with the accelerator and some chambers, half of the beamtime was lost. Finally interactions of fragmented deuterons on liquid hydrogen target with spectator proton trigger, n+p reactions, were taken. The photon-trigger, mostly giving high p_T π^0s, appeared to be too slow: only minimum bias events were recorded. Still, this data sample was enough for checking hit frequencies, event multiplicities.

The first attempt on reconstructing π^0s failed, the correct determination of pedestal and relative gain appears to be crucial. This information can be extracted from the acquired data and the study of events with cosmics. Nevertheless an absolute calibration with electron beam would be important.

5. Summary

Theoretical predictions and poor measurements of high p_T particles at SPS show that the project discussed above is reasonable. Using existing hardware parts a working detector could be built which provided results only from some days of running.

Acknowledgment

Full details of the analysis, with calibrated units and nice π^0 mass spectrum, will be available in the thesis of A. László. This would not have been possible without the work of G. Vesztergombi and D. Varga, many graduate and PhD students, with other researchers of the institute. This work is supported by the Hungarian Sientific Research Fund (T043514, F034707). The author wishes to thank to the János Bolyai Research Grant.

References

1. G. G. Barnafoldi, G. Papp, P. Levai and G. I. Fai, arXiv:nucl-th/0307062.
2. P. W. Jeffreys *et al.*, Using Nucl. Instrum. Meth. A **290** (1990) 76.
3. A. Beer, G. Critin and G. Schuler, Density Nucl. Instrum. Meth. A **234** (1985) 294.