A New Particle Detector for Gamma-Coincidence Experiments ◇

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Gamma-particle coincidences with good time resolution are used to pin down the reaction kinematics and to reduce the background from target radioactivity and from unwanted reaction channels. A PIN-diode particle-detector array has been constructed for this purpose as an inner-ball detector in the NORDBALL gamma spectrometer and for gamma spectroscopy at the Munich tandem accelerator.

Its segmentation allows Doppler-shift corrections to be performed and also to calculate the angular distribution of the gamma rays following Coulomb excitation. The detector system is built up in a modular way, so that a segmented mosaic detector around the beam entrance hole and/or arrays of PIN diodes can be used. The PIN-diodes have an active area of 5x5mm^2 each. They may be placed at 120 different positions in the backscattering hemisphere. The configuration can be adapted to the needs of experiments.

At angles close to 180^0 a mosaic detector can be used consisting of 35 segments on three concentric rings. The scattering angles corresponding to the 120 pin diodes and the mosaic detector range from 167.5^0 to 110.1^0 covering a solid angle of up to 40% of the backward hemisphere. Space needed for easy replacement of the diodes and because of the problem of covering a sphere with rectangles maintaining pentagonal symmetry are the reason that only 50% of the covered area is active.

The entire detector system is contained inside a sphere of 5 cm radius. The particle detectors are mounted at a distance of about 4 cm from the beam spot.

The 120 individual detector channels are connected to the outside of NORDBALL through five holes of 1.6 cm diameter each by subminiature 45 fold connectors.

The detector system was designed allowing the improvement of the existing setup [1] at the Munich tandem accelerator by increasing the solid angles of particle counters and of germanium counters at a closer distance.

The degradation of the gamma-energy resolution due to Doppler shift after correction is less than 0.4% in the case of a head on collision of a Ni projectile under Coulex conditions accelerating a mass $A \simeq 100$ target to 6% c.

With the presently available electronics 55 channels can be read out separatly via individual amplifiers, each giving a timing and an energy signal. For two channels a common bias supply is used.

Because only single particle-hits in a coincidence event are useful, it is possible to reduce the datastream by four 16-fold multiplexers, so that four ADC and one TFC channels are needed. A pattern unit is used to identify the hit location [2].

After a successful test run at the Warsaw cyclotron the detector system was mounted into NORDBALL. There it was used for Coulex experiments in November and December 1995. The performence of the detector system matches its specifications, enabeling nearly background-free measurements.

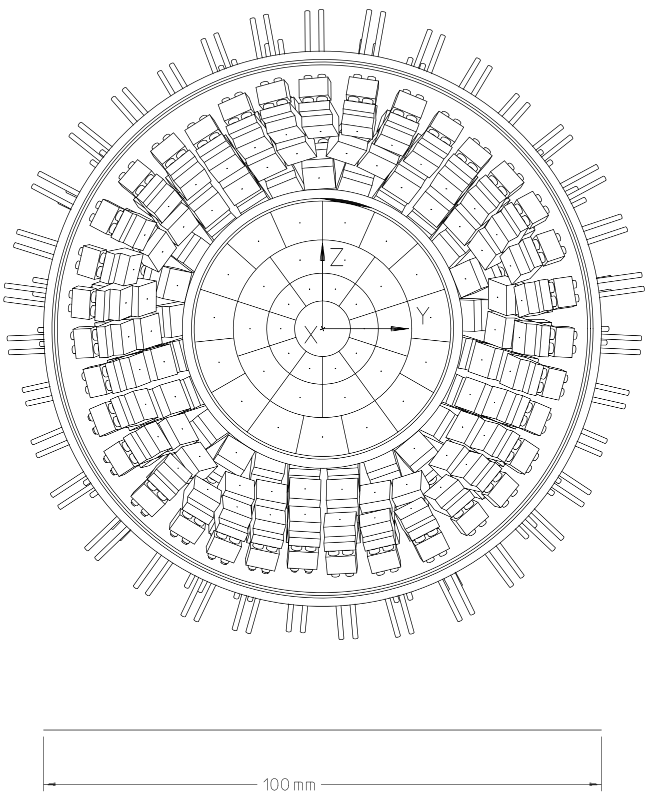

Fig. 1: The modular detector system showing PIN-diodes and mosaic detector looking in the direction of the beam entrance

References

[1] M. Springer, diploma thesis, LMU München, 1. March 1993
[2] M. Würkner et al., Jahresbericht 1994, p. 247ff and Verhandl. DPG (VI) 31 (1996) 1016

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