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Development of a bump cathode element for two-dimensional neutron detection

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A neutron detection element consisting of circular cathode bumps was developed for two-dimensional neutron measurement, and an irradiation experiment was performed using a Cf-252 neutron source. The element has triangularly arranged small-sized circular cathode bumps, and the bumps are linked together in x- and y-directions for the detection of incident neutrons. The sensitive area was 128 × 128 mm2 with a pitch of 1 mm in both directions. The bump cathodes act as a collector of the charged signal arisen from a nuclear reaction between neutron and He-3. Preliminary irradiation experiments for the developed element were performed using a neutron detection system consisting of a pressure vessel, amplifier-shaper-discriminator boards, optical signal transmission devices, position encoders with field-programmable gate arrays, and a data acquisition device. The 256 signal lines (x: 128 lines, y: 128 lines) are individually readout by signal-processing electronics. The element was arranged in the pressure vessel with a fill gas of composition $He/(15\%)CF4$ at 0.7 MPa. Neutron irradiation was performed by embedding a Cf-252 neutron source with an intensity of 100 MBq in a graphite cube with dimensions of 80 cm. The detector system exhibited a one-dimensional uniformity of response of 2.5% and 5.3% in the x- and y-directions, respectively. The uniformity of all pixels in the two-dimensional image was 10.1%. The average intrinsic spatial resolution was 1.9 mm full width at half maximum in the sensitive region calculated by taking into account the track lengths of secondary particles.

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