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SOFA : a new approach for Quality Assurance in GEM FOIL

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Gas Electron Multiplier (GEM) is one of the best popular and potent technologies for gaseous ionization detectors used in high energy physics. One of the fundamental elements of a GEM are foils with micro perforations and quality of such holes is determinant for an ideal performance of the GEM. Regardless of the drilling method used, it is possible to find defects, imprecisions and distortions in the geometry and distribution of the holes, disturbing the performance and quality of the detector.

In this paper we compare and analyze different measures and developing different computational methods for this purpose, in order to determine the quality of GEM-foils and other micro structures from high and low resolution images of the foils. These computational techniques will provide an automatic and high accuracy alternative to the current procedures which are expensive, time taking and imprecise, restraining the development and application of this significant technology of detectors.

Software named SOFA was developed and designed for inspection of GEM Foils from high and low quality images, exactly using those acquired by the Helsinki Institute of Physics and modified for some proposes in this research on Centro de Investigaciones en Ciencias Básicas y Aplicadas (CICBA) at Universidad Antonio Nariño.

This tool is proposed to be a beneficial tool for physics with no programming skills and then all functionalities and directly available for an intuitive graphical user interface. The integration of geometry analysis and the incorporating of robust images algorithms enable quality assurance of GEM foils and classification in order to find defects, imprecisions and alterations in the geometry and distribution of the holes, computing measures to quantify the quality of the holes.

An important quality of this procedure is that it is self-consistent; it uses the information of the image itself and does not use any external parameter, giving to the procedure enough robustness to be highly independent of the quality of the image within an ample range of image qualities.

The method includes three steps: a fast procedure of initial centers identification, calculation of centroids or precise centers and contours, and finally the calculation of statistical and other quality measures. Defects are identifying with contour collection algorithm, SFR and results can be exported to spread-sheets for additional analysis.

The software was entirely written in JAVA programming Language and all functionalities are invoked from an easy graphical user interface which permits the study and automatic identifying of imperfect holes in GEM Foil, to assist in decision of install this or not in the particles detector. Its multitasking programming allows processing different images simultaneously to decrease processing times.

The results of the experiments presented in this work show the robustness, precision and efficiency to build basic information like centers coordinates and pixels of contour to make different measures, in addition to applying different methods to identify defects with a parameter that allows it's be adjusted to investigate and establish the criteria and values to stablish that there is a defective hole that could be affecting the functionality of the foil in the detector.

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