ORAnGE: Optically ReAdout GEM

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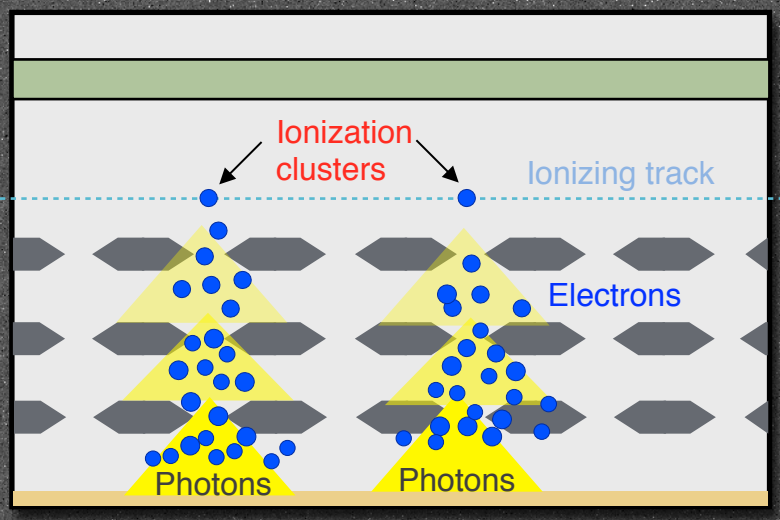
Introduction

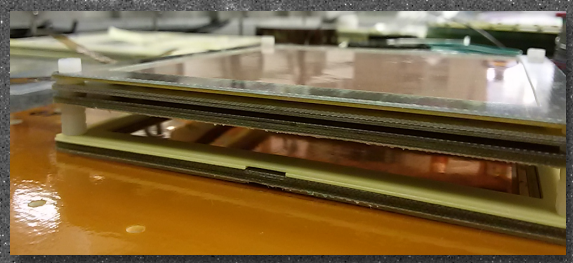
The possibility of reconstructing particle trajectories is becoming crucial in different aspects of Physics.

A high precision tracking of low energy massive particles will play a key role in the future of fields ranging from Particle Therapy to the Dark Matter Search. Gas based devices are natural candidates, but the increasing amount of readout channels is becoming a bottleneck.



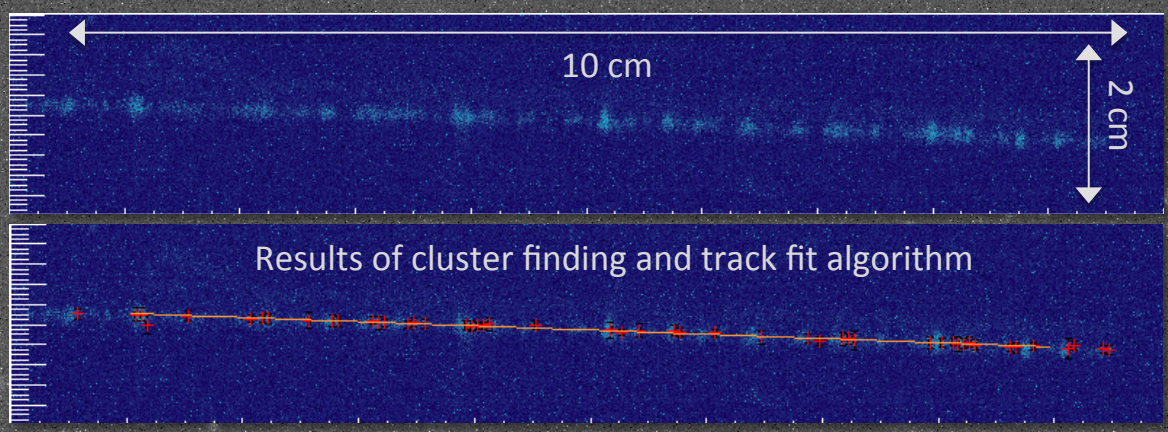
From the Concept to the Reality

The evolution of CMOS based technology provided high granularity sensors with high light sensitivity combined with very low noise level. These devices are promising for reading out the light produced during the electron multiplication processes in GEM-based detectors. This allows to obtain a light, compact and high performing particle tracker.



The Triple-GEM with **2 mm** transfer gaps, a **10 mm** wide drift gap and an active area of 10x10 cm^2.

A high sensitivity (**70% quantum efficiency, 2 photon noise**) and high granularity (**4 Mega Pixels**) CMOS Camera (Hamamatsu ORCA 4.0) instrumented with a high aperture lens (Schneider 25mm FL, **f/0.95**) allowed a very efficient and precise track reconstruction.



The amount of collected light was measured along the tracks.
About **1000 photons are detected** by the CMOS sensor per track millimeter, i.e.
150 **photons are per primary electrons**.
The distribution of the residuals of the reconstructed cluster positions from the fitted tracks has a sigma of **75 µm**.

Summary and Potential Impact

The optical readout of GEM-based structures it's a very promising technology for obtaining precise and sensitive particle trackers. The large amount of light allows to illuminate thousands of pixels making possible to reconstruct the direction of particles moving within the gas with a resolution of tens of micrometers