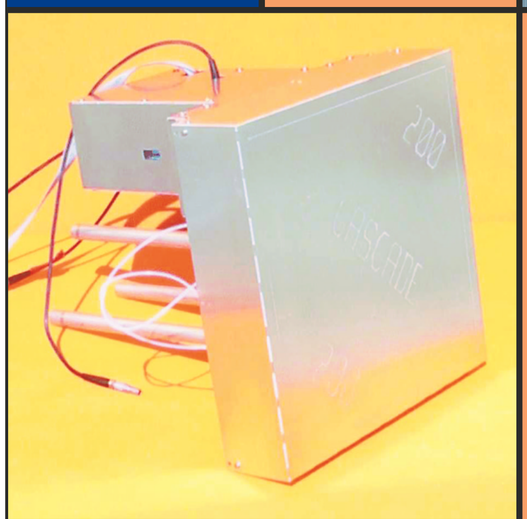
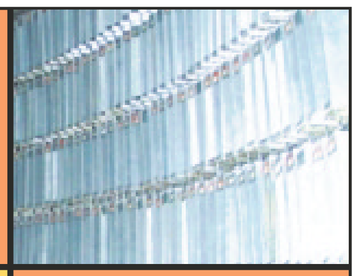
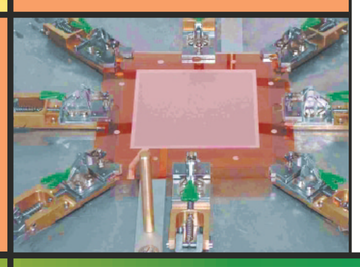
European Organization for Nuclear Research







One application of the GEM: the CASCADE Neutron Detector

The large area, position sensitive detector solution, capable of coping with SNS count rates and sub-µs timing requirements

CASCADE

Technical questions
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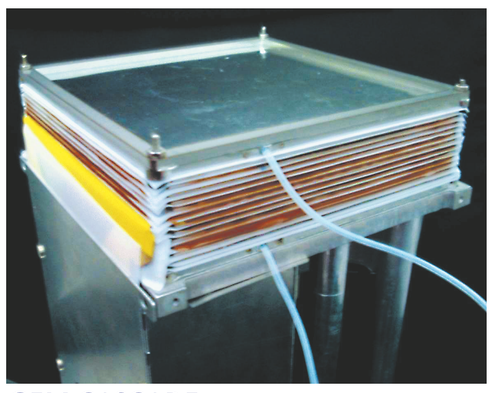
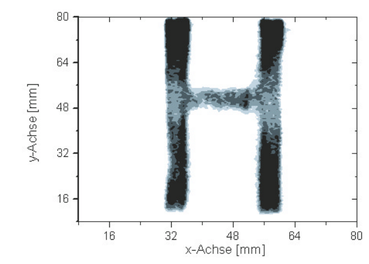
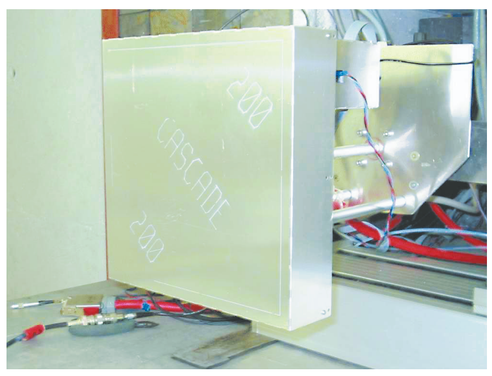
Concept

The CASCADE detector is a GEM-based hybrid solid converter gas detector. GEM-technology inherently provides a rate capacity on the order of 10^7 Hz/cm^2. The GEM is operated in a mode in which it is transparent for charges. It serves as the perfect substrate for the solid converter, facilitating the cascade of several converter layers one behind the other without loss of position information. This concept results in an entirely disentangled neutron detection scheme. As a result neutron conversion, charge transport and amplification as well as charge collection are entirely independent processes. As a consequence, an enormous technical advantage over current detector technology is universally available for specialized applications. The neutron detection bottleneck shifts to data read-out electronics and its bandwidth. This problem has already been solved in High Energy Physics (HEP): highly integrated ASIC-technology provides for thousands of individual detection channels at low cost. The ASIC-technology is the first example of technology transfer from HEP to neutron detection. Rate capacity can be realized according to needs through the ASIC electronic front-end.

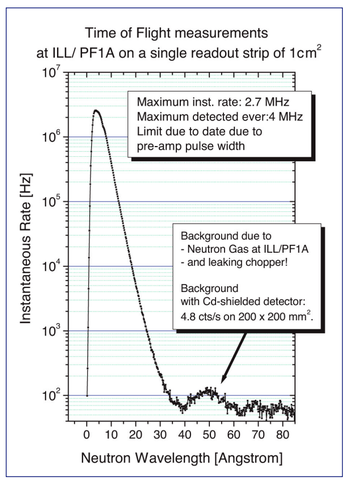


GEM CASCADE



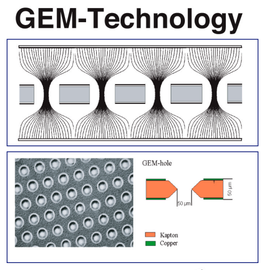


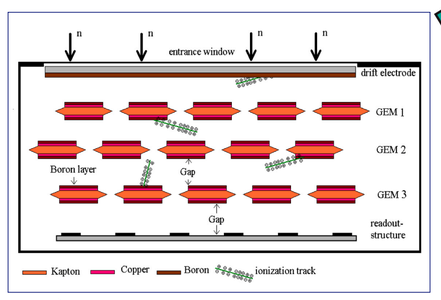
Current Size 200x200mm^2



Rate Capability

GEM-Technology





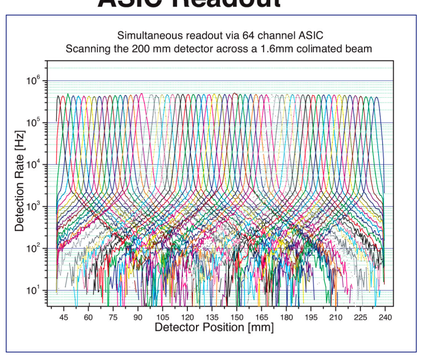
Timing Res.

Localize point of conversion through signal on each GEM
Experimental proof to be realized.

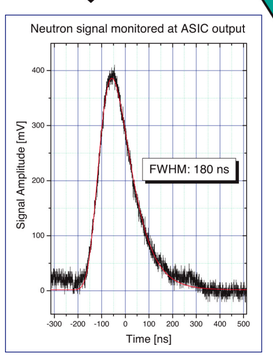
$\Delta t = \Delta s/v < 1\mu s$

Features

64-Channel ASIC Readout



Signal



Modularly Scaleable, Industrially Manufactureable, Robust and Serviceable

Features

- Operation at ambient pressure gives lightweight detectors
- Thin windows, e.g. < 500µm Aluminum
- Large sensitive area (300 x 300 mm^2 with < 15% blind area)
- Easy and quick to service, detector service within 2 hours
- The cascade of ^{10}B coated GEM-foils allows detection efficiencies of 50% for thermal neutrons (1.8 Å), up to 80% for cold neutrons
- Spatial resolution approx 3 mm, down to 1mm for customized solutions
- Micro structured GEM-foils provide count rate capacity up to 10^7 neutron/cm^{2}s
- Low Z converter material (^{10}B), high energy of charged conversion products together with the property of being a gas detector, makes the CASCADE-detector insensitive to background
- Continuous purge of cheap counting gas avoids ageing effects encountered in other detectors. This translates to long term stability as well as long life time
- Potential for sub-µs time resolution, opening the door towards new Time Of Flight applications
- Highly integrated ASIC front-end
- Quick adaptation to application through FPGA data processing

Applications

CASCADE is a modular concept which allows customized solutions to best suit specific application needs in terms of:

- Sensitive Area
- Count Rate Capacity -> Readout Electronics
- Timing Resolution.

CASCADE is developed to allow for large scale industrial production.
All prototypes have proven to operate immediately after construction and transport to a neutron source. Two hour exposure to a capture flux of around 5x10^9 cm^{-2} s^{-1} yielded the detector operational.
CASCADE can be serviced with negligible down-time:
on test campaigns, the detector was frequently opened, GEM modules were removed or interchanged and reassembled with a down-time of less than two hours.

The European Organization for Nuclear Research (CERN), one of the world's foremost particle physics laboratories, has introduced an active Technology Transfer policy to establish its competence in European industrial and scientific environments, and to demonstrate clear benefits of the results obtained from the considerable resources made available to particle physics research.

Technology Transfer is an integral part of CERN's principal mission of fundamental research.

CERN Technology Transfer

http://www.cern.ch/TTdb/Technologies/GEMcascade