Vision On Gas Detector Development

--Brighter Vision from Bright Present--

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In DAE, We have expertise in gas detectors for detecting particles ranging from ~eV to TeV.

We have built:
Ionisation Chamber,
Proportional Counter,
GM Counter.

For URHIC,
High granularity gas proportional array,
→ 100,000 detecting cells each having 1cm^2 area (STAR expt, BNL)
→ Large area position sensitive pad Chambers giving ~5mu position resolution. (ALICE expt, CERN)

Based on this bright present we built our vision for luminuos future.

1. Detectors to enhance SANS data throughput : Large Area Detector and B^{10} coated GaAs monitor.

A.K. Patra and D. Sen.BARC

2. Design and Development of high resolution, high efficiency neutron/X-ray position sensitive detector.

S.S. Desai, BARC

3. Gas detector developments, future facility

Subhasis Chattopadhyay, M. R. DuttaMajumdar, VECC

Applications of gas detectors

- *Detector Applications – Charge particle, Neutron in NP & HEP, Solid state physics.*
- *Medical Imaging*
- *Beam Monitor in Accelerator*
- *Plasma Monitoring*
- *X- ray monitoring*
- *Astrophysics*

First 2 proposals deal with the vision of detector development for studies in materials research via SANS/SAXS/WAXS.

Neutron detection:

Why gas:

- *Small angle scattering signals are weak (need very low background)*
- *requirement of low gamma sensitivity*

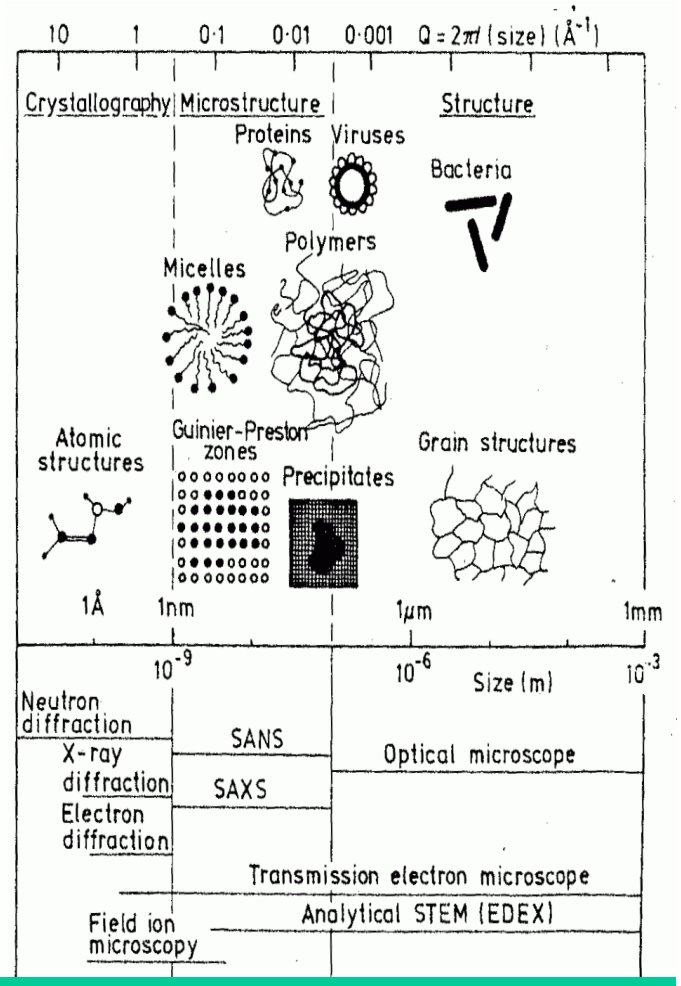
→ Gas detector preferable than scintillator.

Towards an efficient and FAST SANS setup:

Physics goals of SANS:

→ *Study size and shape of sample,*

→ *size distribution inhomogeneities*

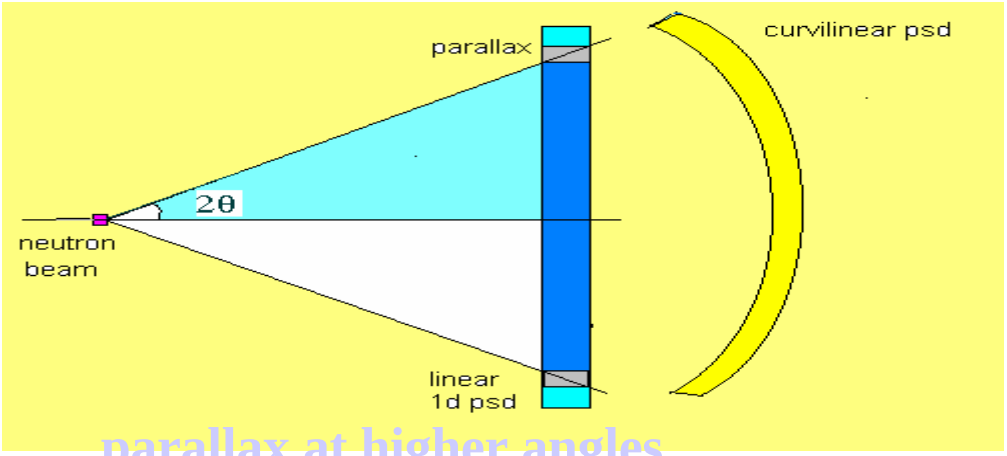


Conventional detectors need scanning over a region of interest, so time consuming.

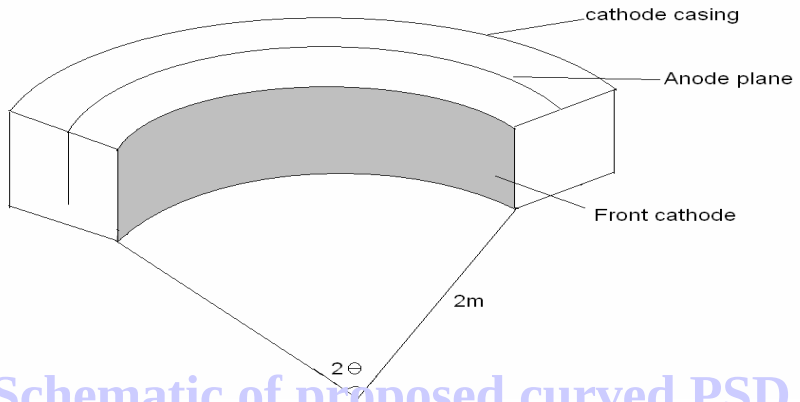
For faster/efficient use of setup,
proposed facility should have POSITION SENSITIVE DETECTORS.

Specifications of the Area Detector for proposed SANS Diffractometer

- Large position sensitive detector of sensitive area 1 m^2
- He-3 gas based
- Pixel size 1 mm^2 to 1 cm^2
- Detection efficiency 70% to 100%
- Rate capability beyond 100 kHz (10^8 Hz over Detector)
- Time resolution better 1 µs in particular for spallation-sources
- Negligible sensitivity to gamma radiation
- No aging problem
- Robust technology and serviceability



parallax at higher angles



Schematic of proposed curved PSD

Multimodule curvilinear array of anode wires

- 2m arc length at 2m radius covers scan angle 60º
- wire spacing 1mm with automated wire mounting facility for higher accuracy
- Delay line method for pulse encoding and
- Individual wire screening for advantage of higher count rate capability

Microstrip detector as a module for curvilinear PSD

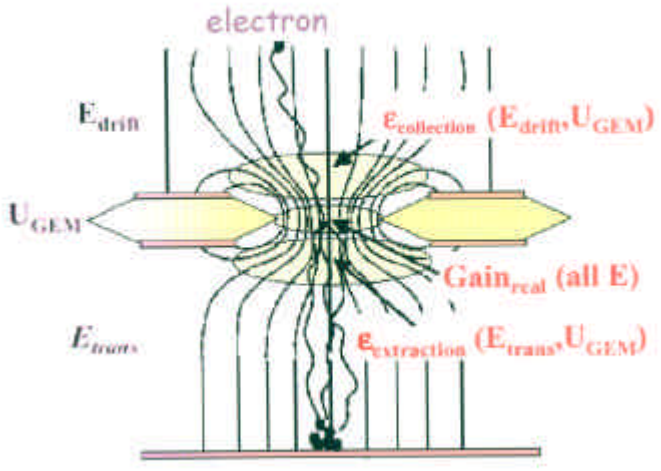
1) Higher accuracy of anode cathode dimensions and pitch because of lithography technique.
2) Higher gas gain and count rate
3) Good repeatability of modules and cost effective

Anode: 12mm , cathode: 300 mm
Anode Cathode spacing:150mm
Pitch: 612mm ,Sensitive area: 15 X 20mm

Towards wireless gas detector:
(FUTURE GAS DETECTOR)

Safer
Good position and time resolution,
Can be moulded in any shape,
Can be used for any position sensitive detector purpose.
High Rate capability
Radiation hard

PRINCIPLE OF GAS ELECTRON MULTIPLIER (GEM)

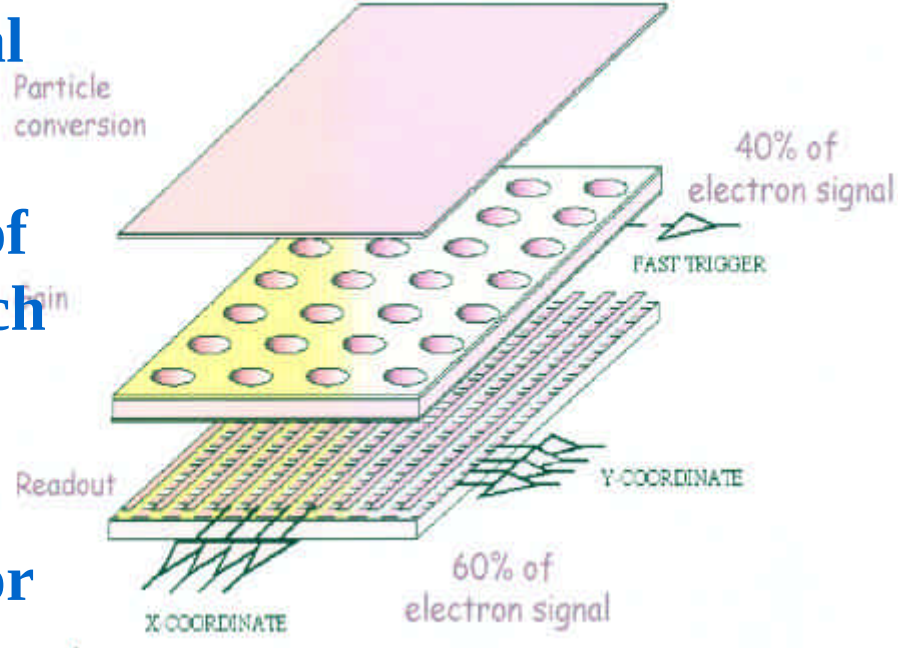


GEM foil consists essentially of a Polyimide foil (~50 um), copper clad (~5 um) on both side and perforated holes with typically 90-200um pitch and ~60 um diameter.

With the application of a potential typically 500 V between the

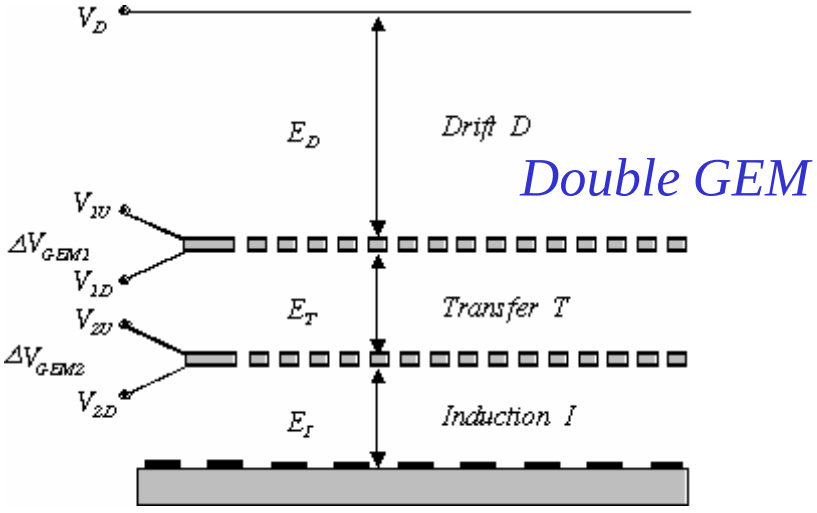
Two surfaces, the field at centre of each hole exceeds ~50KV/cm, which is sufficiently high for electron multiplication

Improved version- Triple GEM for high gain ~10^6

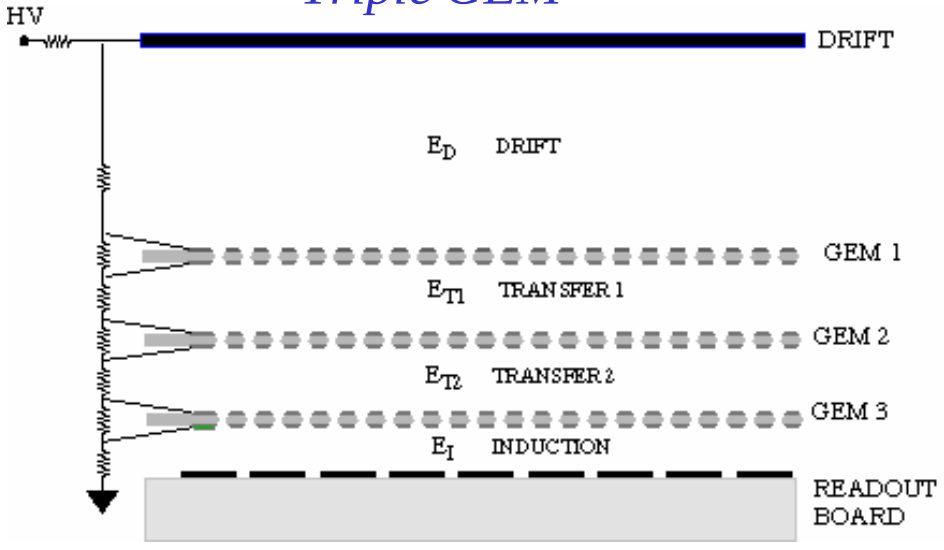


Multiple GEM Structures

Cascaded GEMs permit to obtain larger gains



Triple GEM



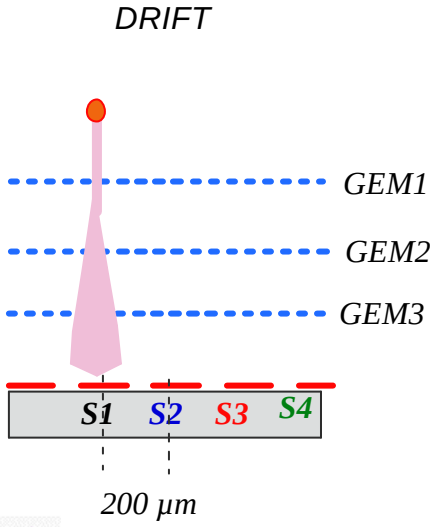
- **Wireless**
- **Can be moulded in any shape**
- **Low voltage (safe) operation.**

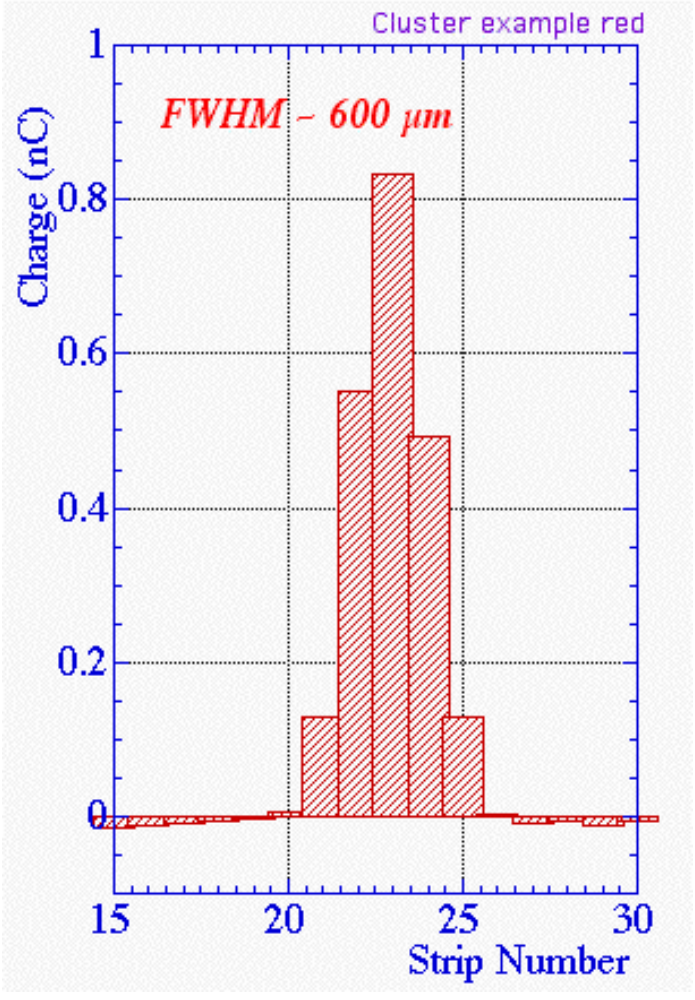
Time resolution = 12nsec
Position resolution : 57 micron

GEM TPC

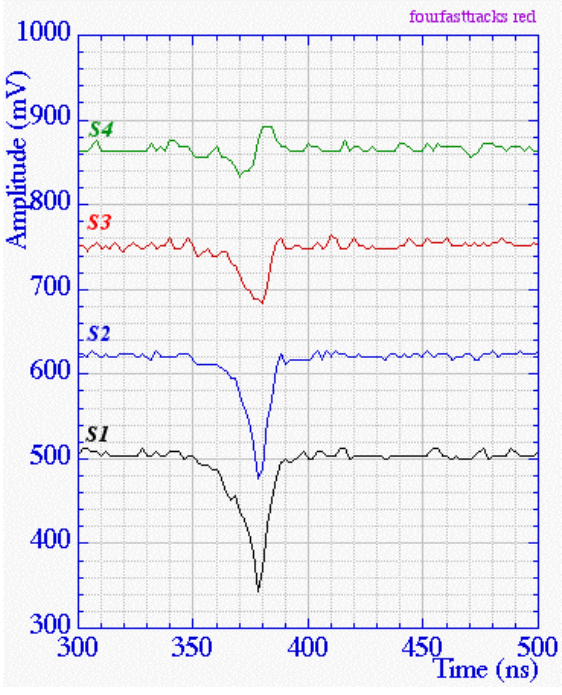
Narrow pad response function (Ds ~ 1 mm):

Improved multi-track resolution





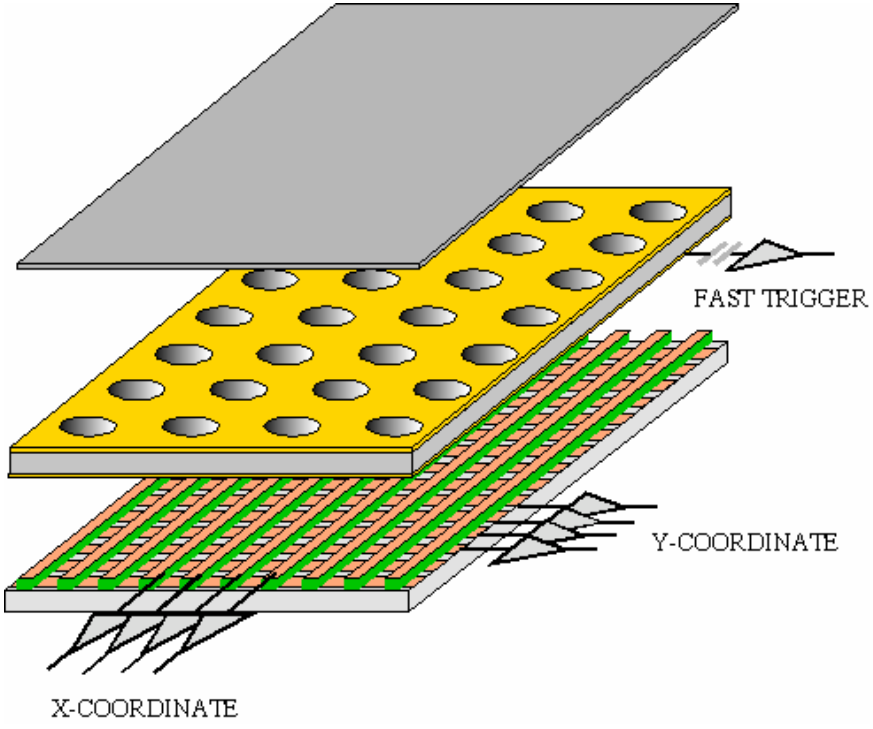
Fast signals (no ion tail) DT~20 ns :



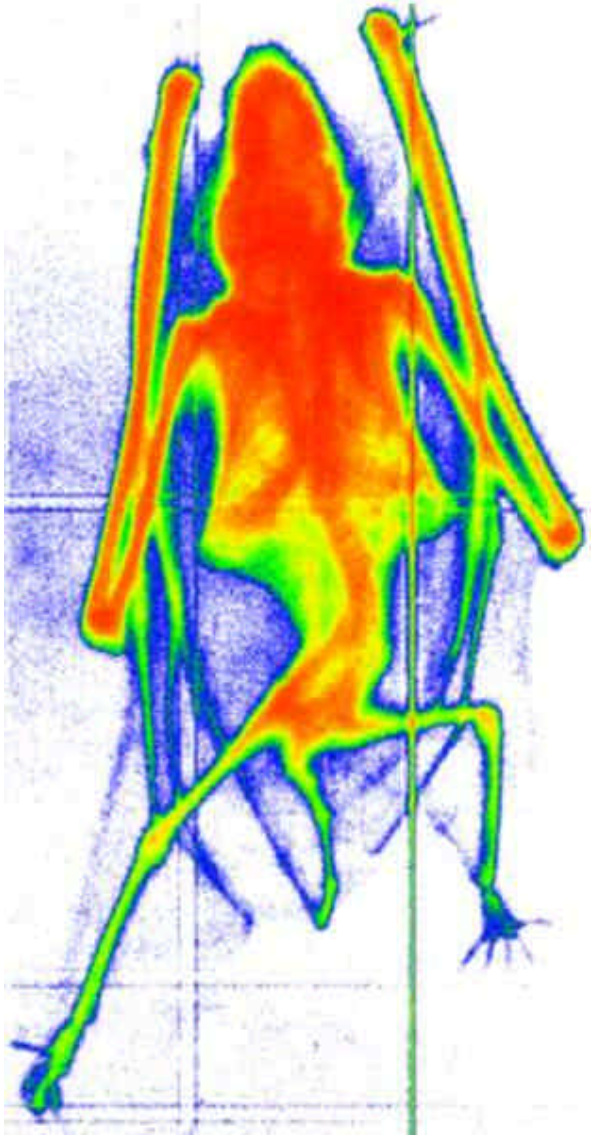
☞ **Intrinsic multi-track resolution DV ~ 1 mm³**
(Standard MWPC TPC ~ 1 cm³)

X-ray imaging

Using the lower GEM signal, the readout can be self-triggered with energy discrimination:



A. Bressan et al,
Nucl. Instr. and Meth. A 425(1999)254
F. Sauli,
Nucl. Instr. and Meth.A 461(2001)47



9 keV absorption radiography of a small mammal (image size ~ 60 x 30 mm^2)

Proposal of Facility

- **Simulation on GEM and GEM based detector system**
- **Design and micro-pattern Generation, photo plotting of masks**

- **Fine Pitch Copper and polyimide etching and Gold plating**
- **Testing and assembly of of GEM foils (needs clean environment)**

- **R&D Lab and Industry interaction**
- **Use of Indigenous MANAS chip for GEM readout**

CONCLUSIONS AND SOME OBSERVATIONS:

Use Gas Detectors.
Develop position sensitive gas detectors.

Will make SANS faster/more efficient.
Will solve parallax problem. (needs musec/mm resolution)

In HEP experiment we built cost effective position sensitive detector (giving nsec/mu resolution).

USE GEM.

Intra-DAE collaboration for R&D and we will have GEM, gem of detectors.