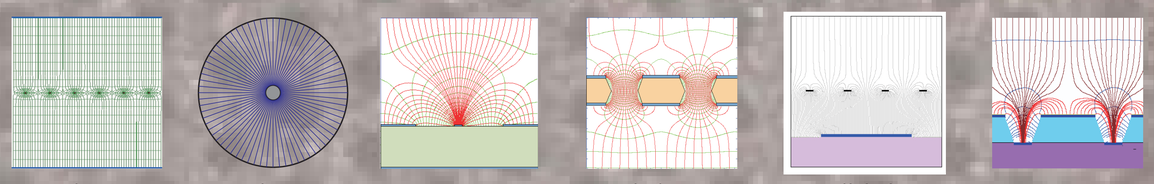
Gas Electron Multiplier

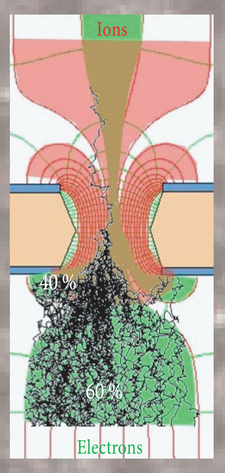
Research & development on gaseous detector technology

Serge Duarte Pinto, on behalf of the CERN DT-GDD group — Eiroforum school on instrumentation, 11–15 May 2009

Large area GEMs

Gas detectors





From wires to planar structures.

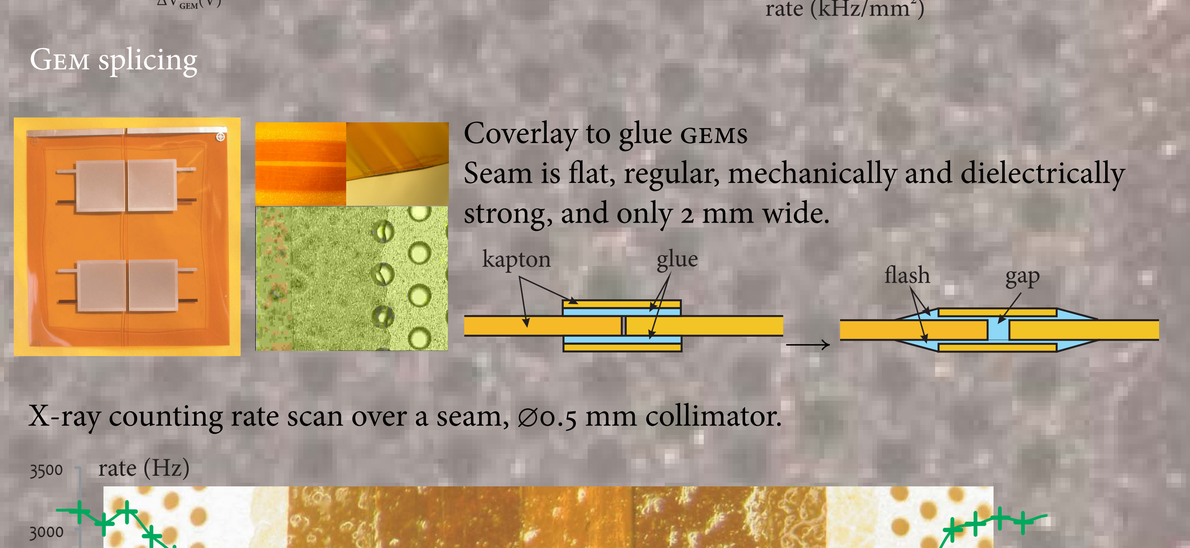
General properties of MPGDs compared to wirechambers:

- Narrow pitch, short distance anode-cathode
- Good position resolution (~ 50μm)
- Good time resolution (~ 5 ns)
- High rate capability (~ MHz/mm^2)
- Natural ion feedback suppression (~ 10^{-3})
- Radiation tolerant and resistant to aging
- Photon feedback reduction
- Manufacturing based on industrial materials & procedures

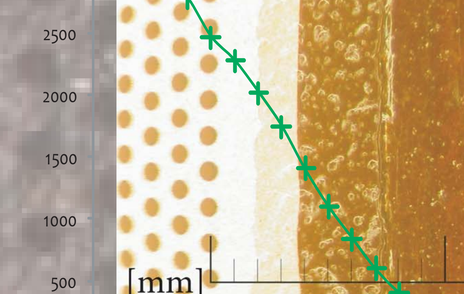
Technical challenges for large area

- Double mask technique introduces alignment errors ⟶ *use single-mask technique*
- Base material is only 457 mm wide ⟶ *splice foils together*

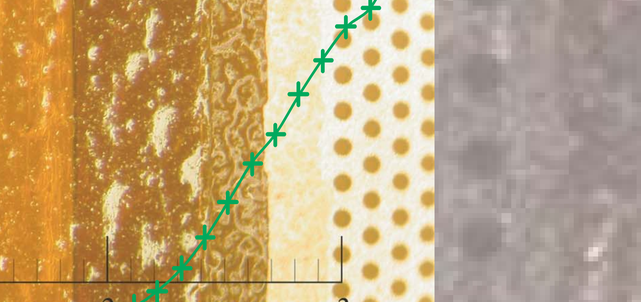
Single-mask technique



Single-mask single GEM gain curves.



Rate capability of single mask triple GEM.



GEM splicing

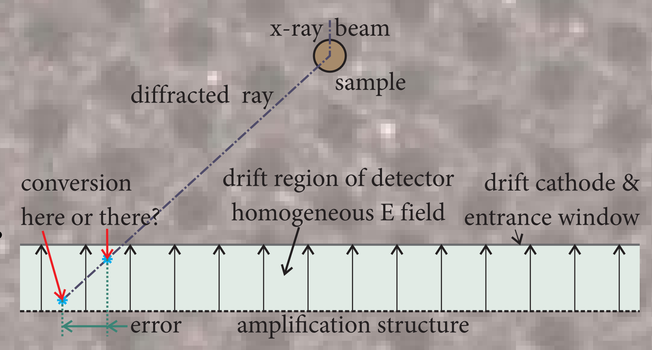
X-ray counting rate scan over a seam, ∅0.5 mm collimator.

Spherical GEMs

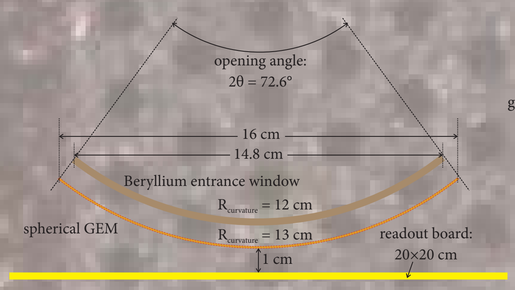
X-ray imaging & parallax error

Ways to reduce parallax error:

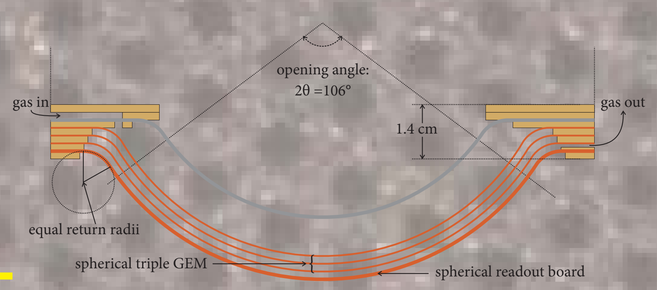
- Efficient x-ray conversion gas reduces the probable conversion depth
- Increase in pressure has same effect, but necessitates thicker window
- Spherical entrance window helps a lot, and allows higher pressure
- Truly spherical conversion gap would be optimal (zero parallax error)



Spherical GEM detectors

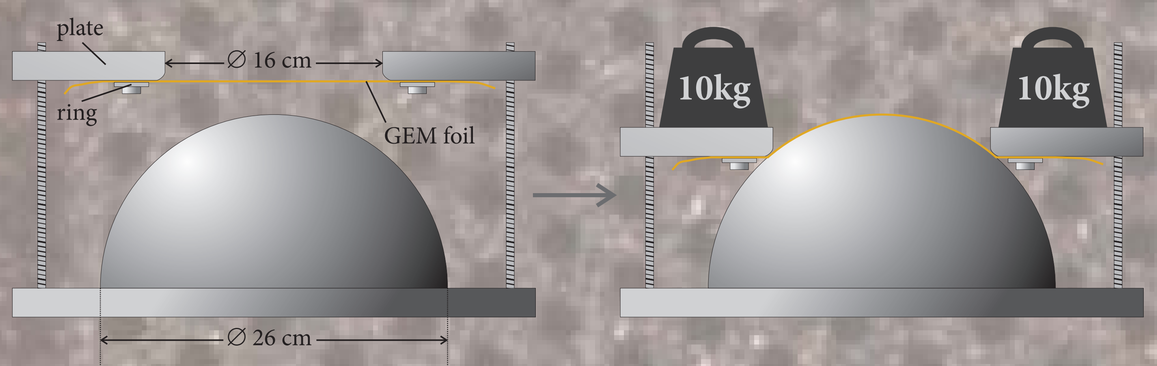


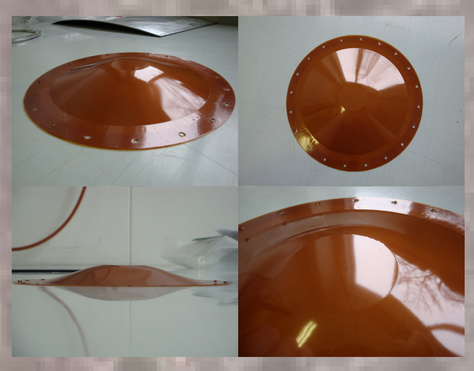
A spherical conversion gap.



The first entirely spherical gas detector.

Procedure & tooling

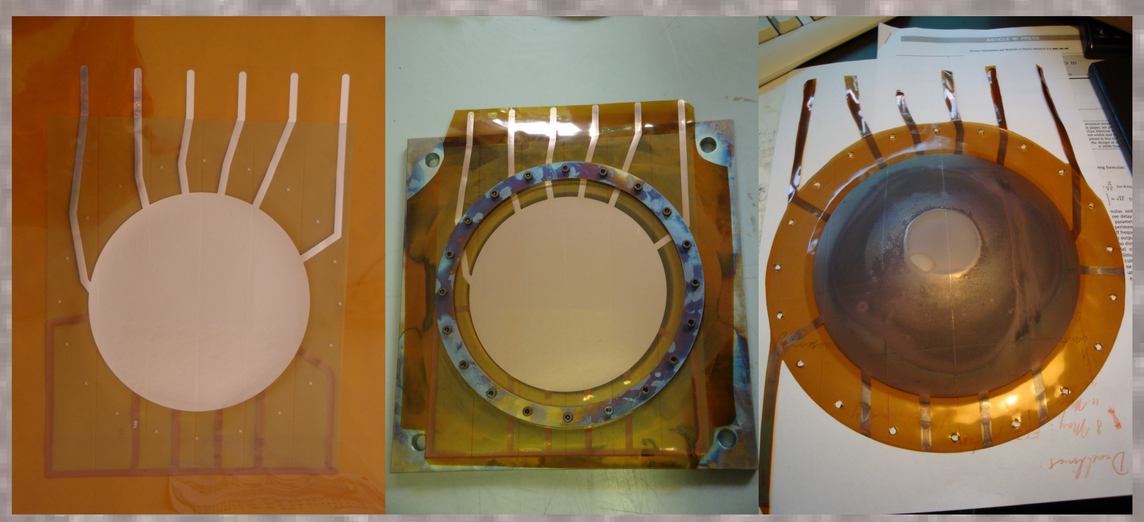




Bending method

- Temperature: 350° C
- Bending force: at least 20 kg
- Takes about 24 hours
- Atmosphere of argon to prevent oxidation
- Can add few % of H_2 to create reductive atmosphere

A real spherical GEM



Preparation of a GEM foil for bending, and the resulting spherical GEM.

Challenges ahead

- In case the maximum bending angle is limited, well-defined cuts can be applied to achieve a wider opening angle.
- Curved spacers for triple GEM
- Conical field cage for wide drift gaps
- Spherical readout structure