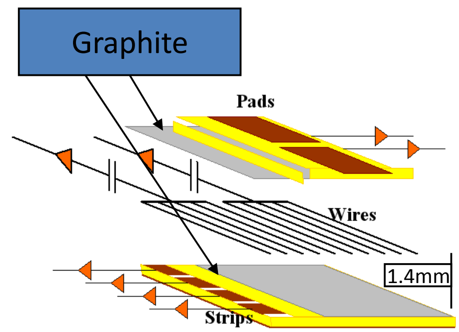
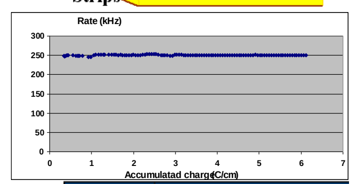
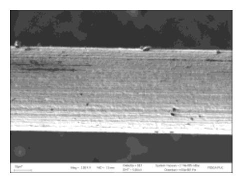
TGC Laboratory

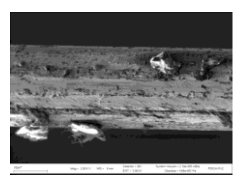
Short Introduction to TGC's

- CSC-like structure, except that anode-to-cathode distance=1.4mm, while anode-to-anode distance=1.8mm.
- Anode wires sandwiched between 2 high resistive layers.
- Readout behind resistive layers (strips, pads) or anodes.
- Operating voltage: 2.9-3.0 KVolts.
- Gas: CO2-n Pentane (55%-45%): n Pentane increases the ionization, while absorbing the photons in the avalanche.
  - This provides high gain, without sparks.
  - N-Pentane acts also as cleaning agent (no major wire deposits after 6 Coulomb/cm).
  - For a small volume, one can afford to use flammable gas, and take precautions for leaks. C-H3 chains provide a good quencher, and avoids other problems.

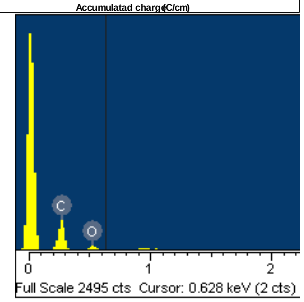








Wires in non-irradiated
And
Irradiated areas



1) Why to have a resistive cathode layer:
   a. It provides a smooth cathode surface for a uniform electric field with respect to the wires, while being transparent to fast signals (can be readout from outside).
   b. In case of a spark, the energy is being absorbed by the high resistivity layer.
   c. The smooth cathode surface allows to go to a high electric field.
2) Why do we need a quencher:
   a. The high field allows for a fast response (little drift-time for the electrons)
   b. The high field allows for a high local (10-20µm from the wire) amplification (10^6 e for each incoming electron), however at such an electric field, the avalanche is mainly carried by photons. The quencher (molecular chains of CH_3) absorbs the photons and does not allow the become too big, independent of the initial ionization of the measured particle.

3) What is the advantage of reading out from outside the amplification volume:
   a. One can have any desired readout geometry (strips, circles, spirals, etc)
   b. In the dimension parallel to the wires, the best spatial resolution that can be achieved is the distance between 2 wires (the avalanche occurs mainly in one wire), however in the direction perpendicular to the wire, one can get position resolutions similar to the size of the avalanche (~50µm).
4) Where are they being used:
   a. To count particles in a calorimetric environment (OPAL), by sampling with these detectors.
   b. To trigger on µ in the ATLAS MUON Spectrometer. In particular since they can give a signal within the 25ns period between bunch crossings.

5) What can go wrong in such a detector:
   a. Any non uniformity in the electric field. This can be due to:
      i. Disconnected elements in the cathode.
      ii. Local deformation on the anode to cathode distances.
      iii. External elements inside the amplification volume, like glue, that will charge-up with time, due to the ionization.
6) What are we going to do in the Laboratory:
   a. One small chamber where various readout patterns can be glued (Cu tape), so they can be connected to a scope, and the students can see directly on the scope the passage of particles on the corresponding readout Cu strip (and lack of signals in the others) when irradiated with a collimated source. The students will try various geometries, that will allow him/her to determined the width of the avalanche.
   b. An open detector on which different cathodes can be attached to see the effect of various potential problems:
      i. Putting pressure in a small point, which changes the gap.
      ii. Making a discontinuous path in the graphite cathode, which will again charged up and produce sparks close to the edges of the graphite.
   c. Look at an open and close model of one of the ATLAS TGC chambers.

References:

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4) **Studies on ageing effects and rate dependence of** Thin Gap **Chambers.**
   H. Fukui *et al.* 1998. Published in **Nucl.Instrum.Meth.A419:497-502,1998**.
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