MEASURING THE SHIELDING PERFORMANCE OF MATERIALS

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OBJECTIVES:

- *Original objective: to develop general method to measure shielding performance of materials (10Hz to 1GHz)*
- *More recent work: to gain information at lower frequencies (10Hz to MHz) relevant to risks of incendive sparks*

BASIC SHIELDING REQUIREMENTS for electronics:

- *Avoidance of voltage transients over say 100V inside packaging for transport in uncontrolled environments with 20kV body voltages requires attenuation 200:1*
- *Electrostatic spark discharges involve current risetimes and voltage collapse times down to below 1ns. Lower voltages shorter times.*
- *Transport packaging hence needs to provide >200:1 attenuation for frequencies to 1GHz.*

Present test methods:

- *Do not cover adequately wide frequency range*
- *Do not provide any information on frequency effects*
- *Do not allow electric stress up to sparking level*
- *Are not applied with well defined geometry*
- *Do not include any calibration*

Aims for new method of measurement:

- *provide opportunity to match shielding performance to 'end use' requirements*
- *be fair to materials of various constructions*
- *avoid problems of common mode signal linkage to observations circuits*

MEASUREMENT PHILOSOPHY:

Six basic features of new approach:

a) electric field stress applied to a defined planar area of the material

b) stress applied by bipolar symmetrical signals - so no common mode signal to the sample

c) stress applied over wide range of frequencies

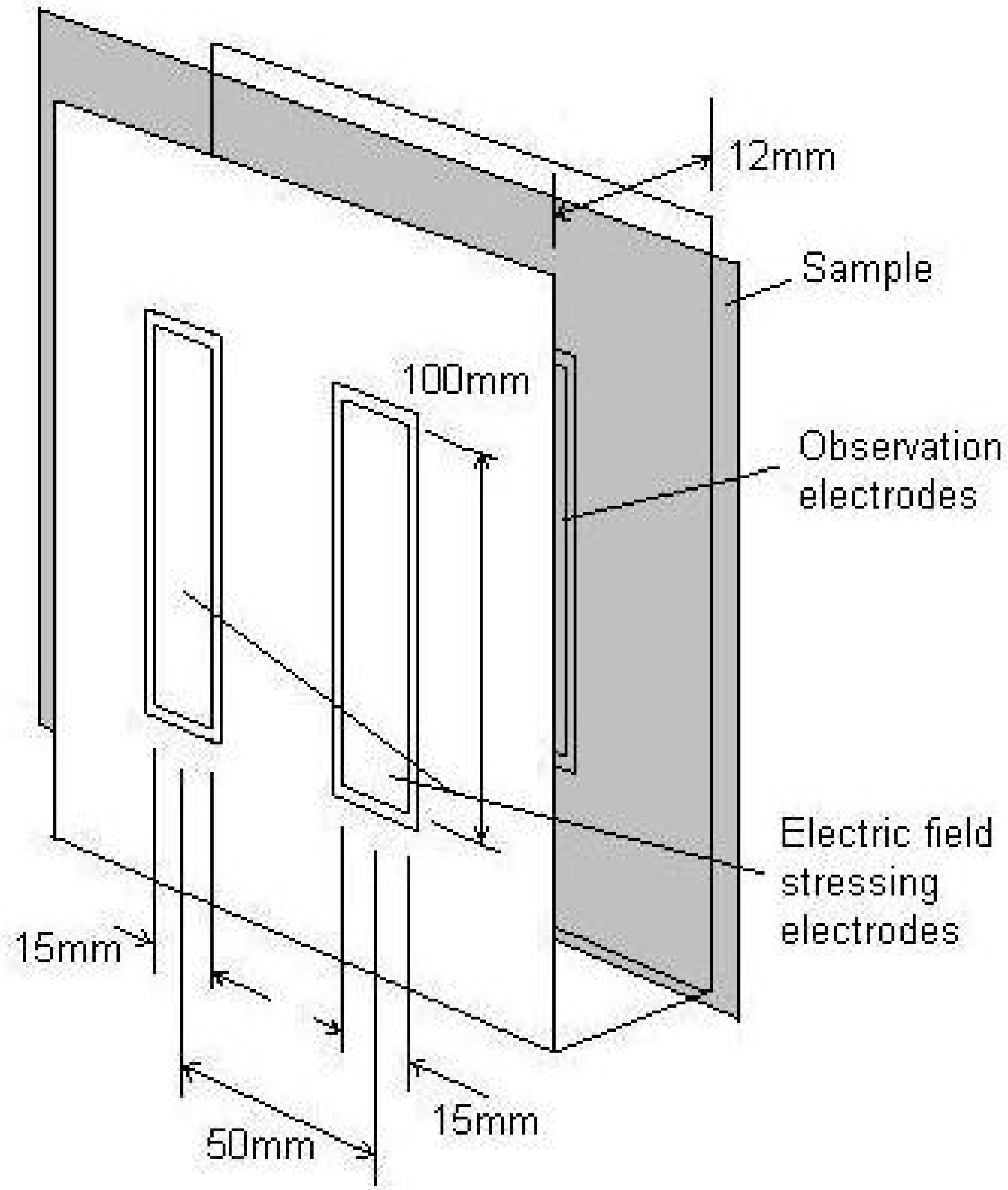
d) stress able to be applied up to level of spark breakdown

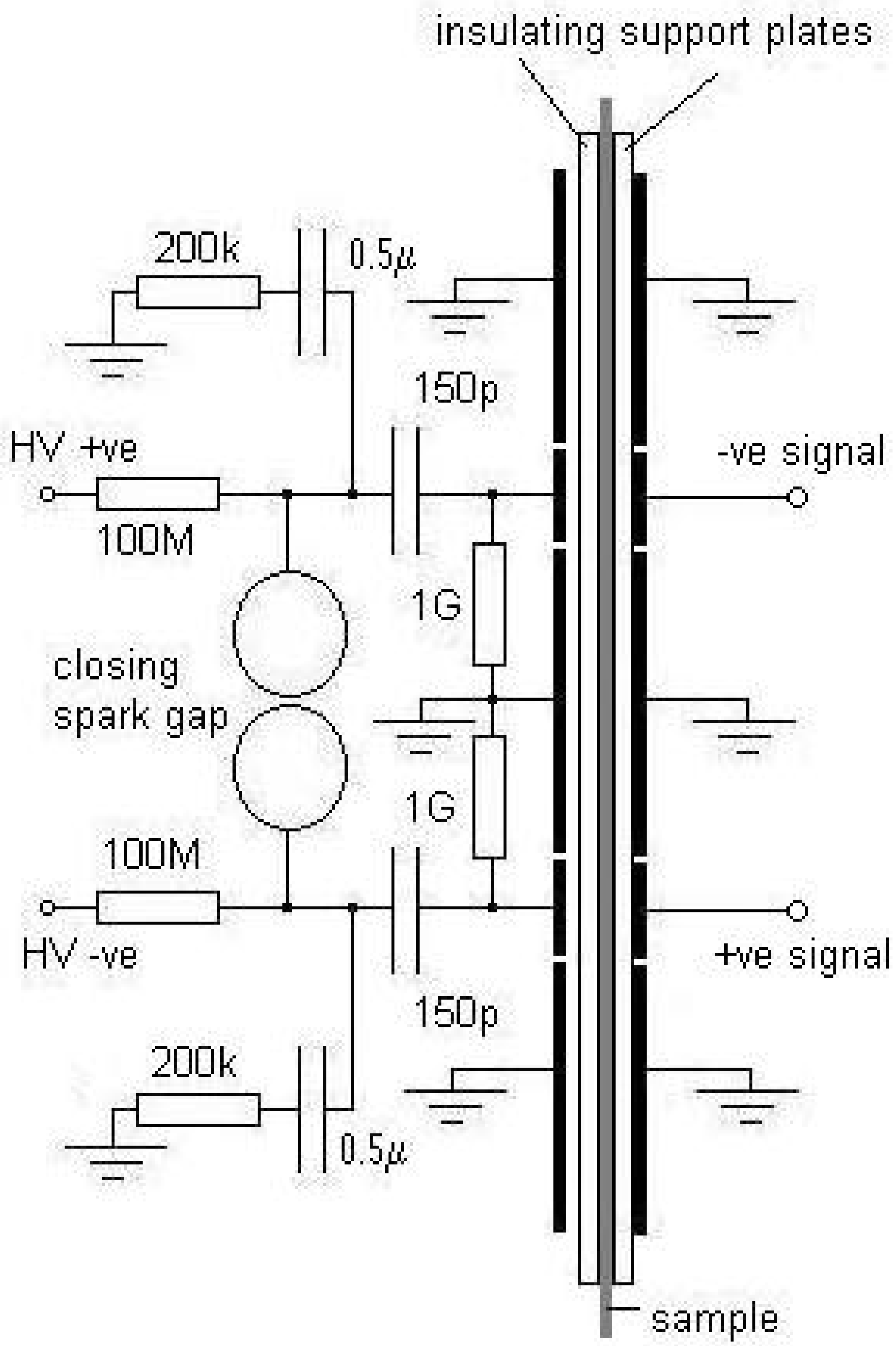
e) observations analysed and presented as the variation of shielding performance with frequency

f) performance assessed as ratio of signals observed with the material compared to those without

General arrangement

- *2 electrodes in one earthy surface with bipolar test signals*
- *2 matching electrodes in opposing conducting surface with circuits to measure signals*
- *sample held flat with no earth contact*

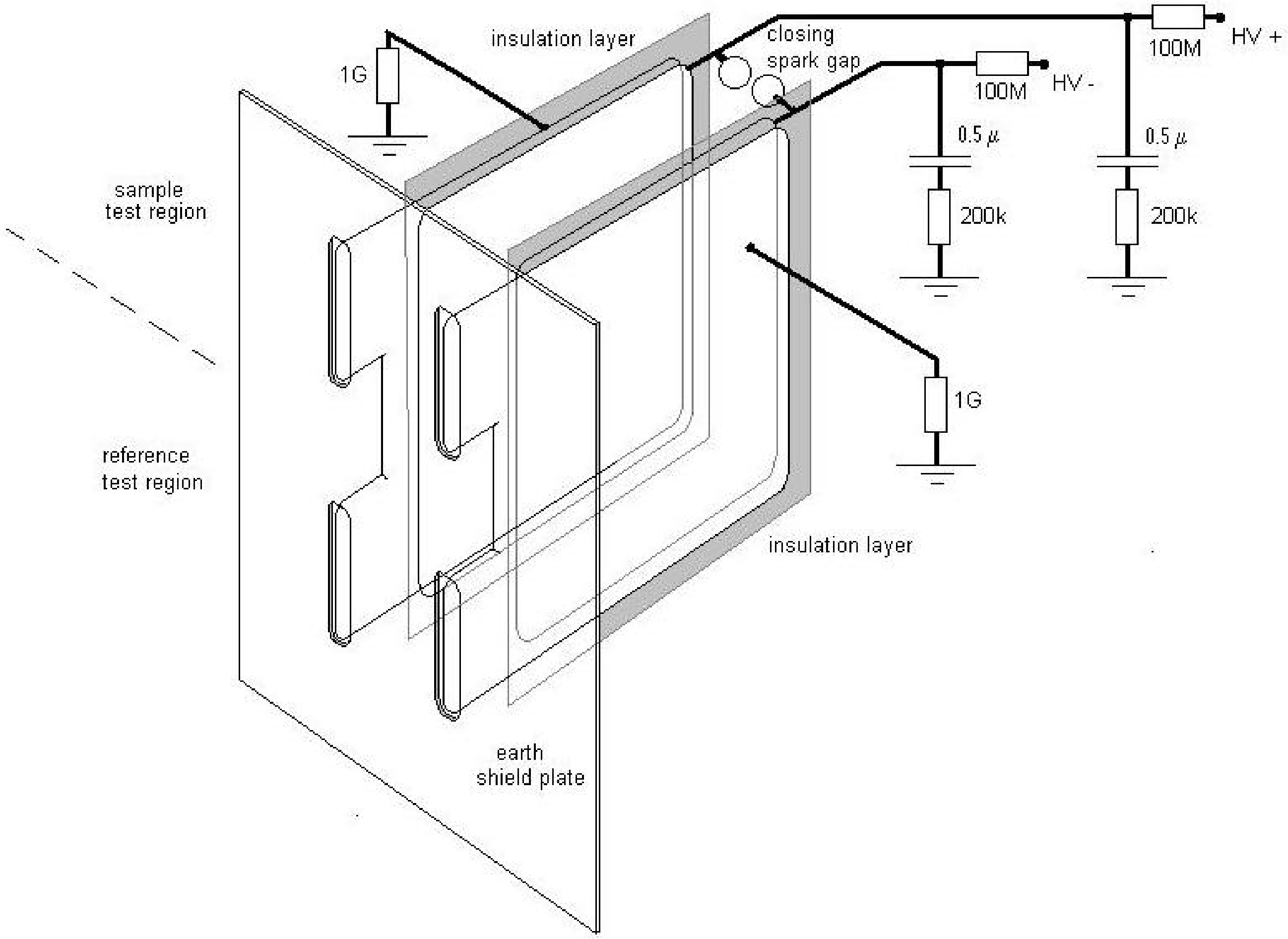




Basic HV pulse circuitry

Practical arrangement for generating symmetrical bipolar HV pulses with fast rise (ns) and slow fall (0.1s)

- *Voltages to $\pm$10kV*
- *Risetimes about 1ns*
- *Fall times about 0.1s*



Observations split by low Q filters into frequency bands:
10, 100Hz, 1, 10, 100kHz, 1, 10, 100MHz, 1GHz

Simultaneous observations of sample and reference signals

Observations into micro by scanning sample and hold circuits

Signal ratios calculated for each band (10^4 dynamic range)

CALIBRATION

(Not often considered in electrostatics measurements - but see BS 7506: Part 2: 1996)

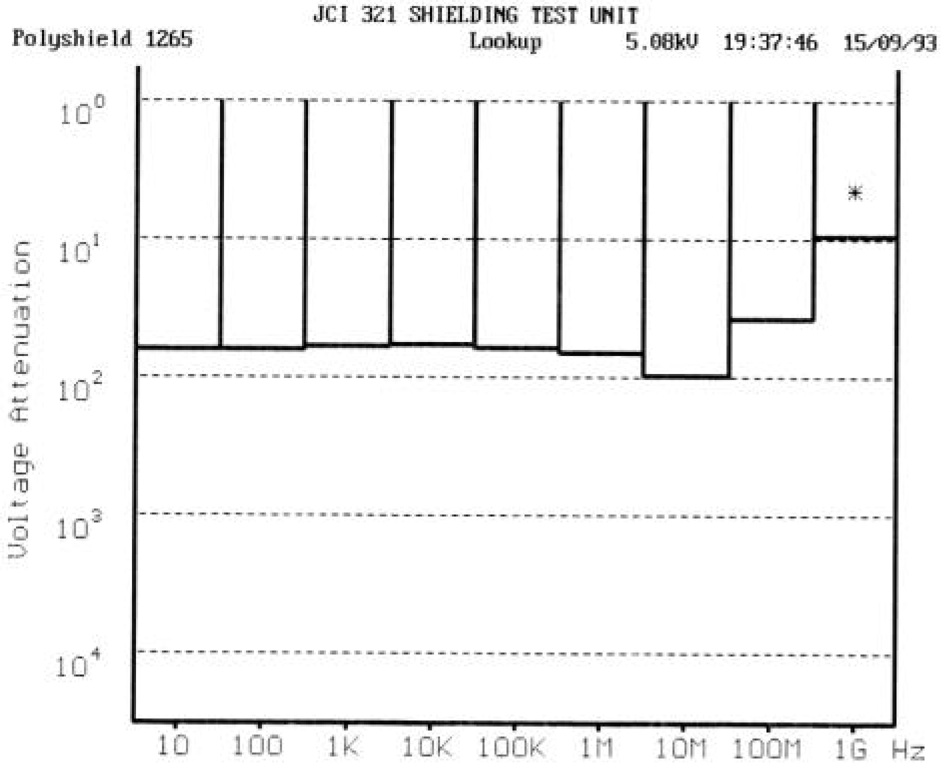
Symmetry – *use of isolated fully conductive plate 'sample'*

Response *– variation of response on each frequency band vs applied HV for each gain setting*

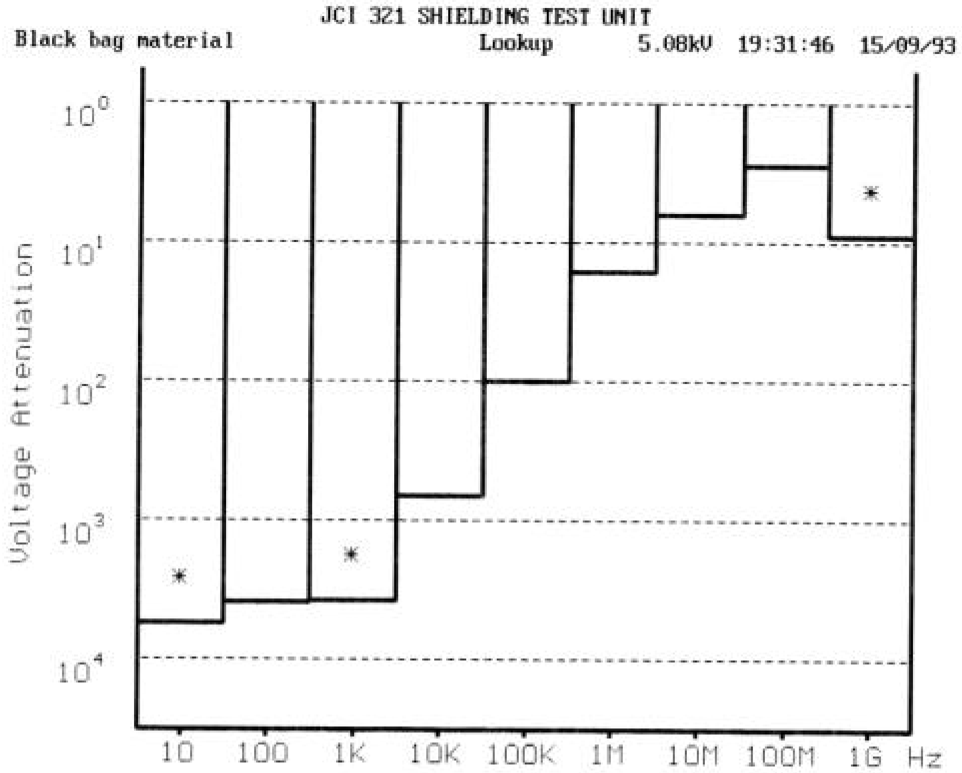
Dynamic range *– use of 'aperture plates' with uniform width slots across test and observation electrodes. Measure overlapping response curves.*

Should be feasible to 'normalise' with measurements on known resistivity material (Not done).

EXPERIMENTAL RESULTS



Shielding performance of metallised shielding bag



Shielding performance of carbon loaded 'black bag'

RISKS OF INCENDIVE STATIC DISCHARGES

- *Energy in sparks to charged surfaces can be limited if surface is resistive*

  Seems resistivity needed 10^8 to 10^9 ohms

- *Variation of shielding with frequency has dependence on resistivity*

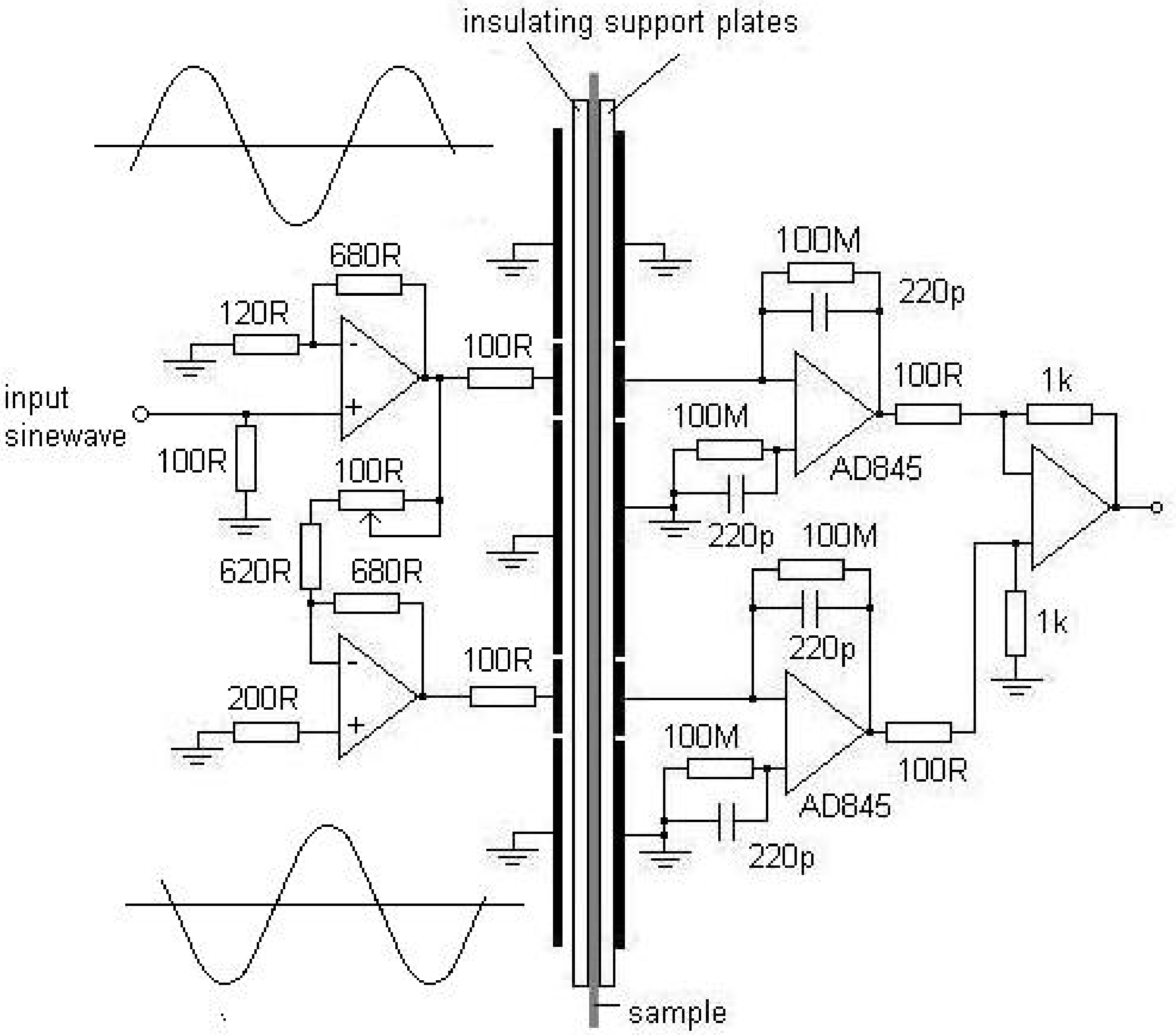
Proposition:

- that risks of incendive sparks can be predicted by variation of shielding with frequency

Benefits in prospect:

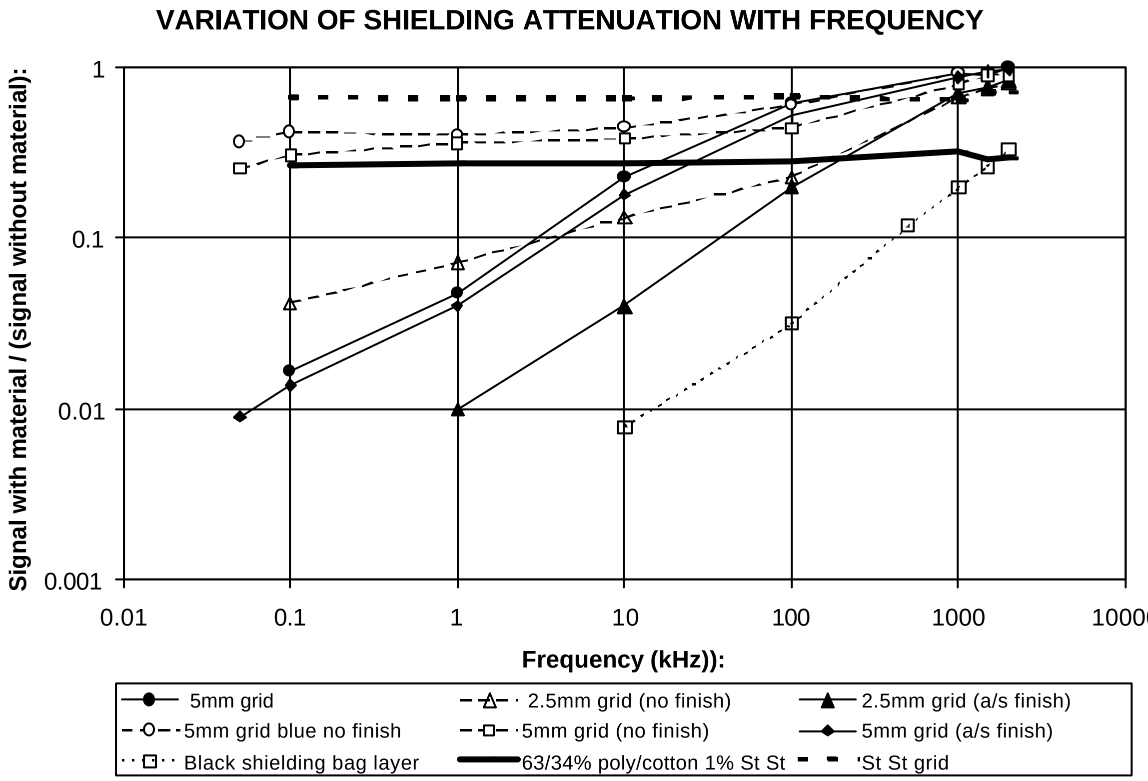
- *Restrict need for gas ignition testing – time and expense*
- *Ease of developing new materials*
- *Easy QA testing*

Arrangement for measuring shielding 10Hz to 2MHz



Bi-phase sinewave drive circuit

Difference signal observation circuit



For 'metallic' conduction

– flat response with frequency to over 2MHz

For 'resistive' conduction

- attenuation decreases with increasing frequency

Note: 1) influence of 'antistat' treatment extends to 100kHz

2) attenuation by 2.5mm grid about 4x 5mm grid

CONCLUSIONS

The method of measuring shielding performance described:

- *Suitable for use with variety of planar materials*
- *Avoids problems in current test methods*
- *Provides fair basis for assessing suitability of materials to match applications*

Experimental results show:

- *Shielding performance of metallic conduction materials fairly flat with frequency*
- *Shielding performance of 'resistive' materials decreases with increasing frequency*
- *that 'resistive' materials not adequate to provide shielding to highest frequencies of spark type discharges*
- *prospect for assessing resistive nature of material relevant to ignition risks*

Aims for future work:

- *to understand features of static discharges relevant to ignition*
- *check opportunity to limit incendivity by localised resistive features (e.g. conductive threads)*
- *check match of shielding assessment to gas ignition testing*