

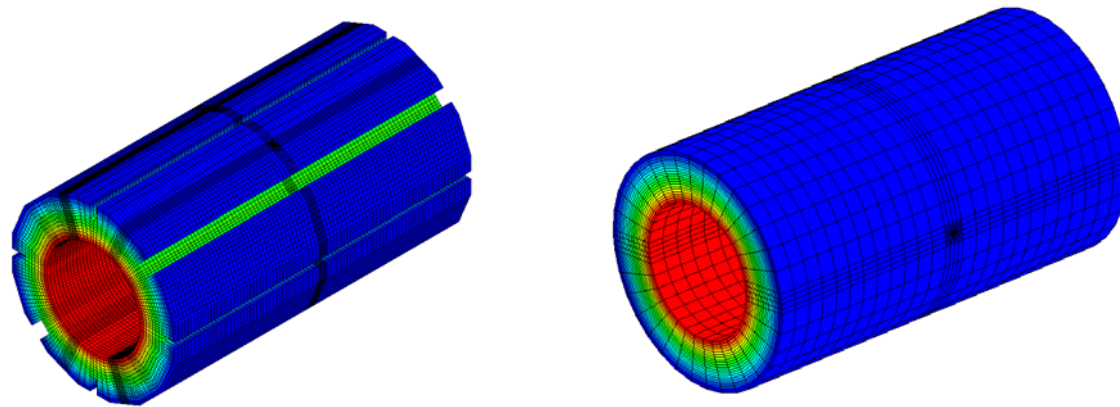
Soheil Nakhodchi, Peter Flewitt ,David Smith

Measurement of internal strains in nuclear graphite

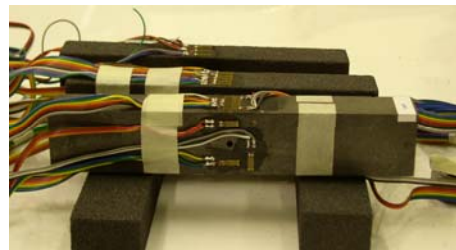


Outline of the presentation

1: Finite element studies

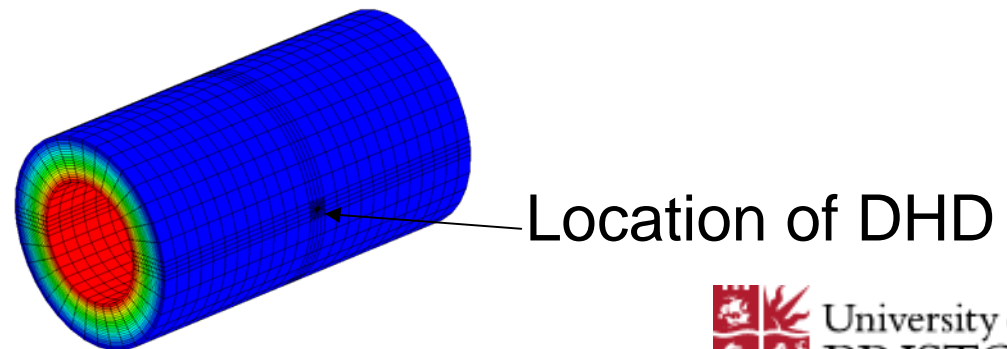
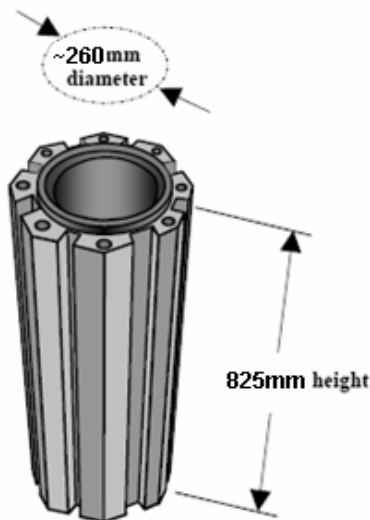


2: Laboratory deep-hole measurements on graphite

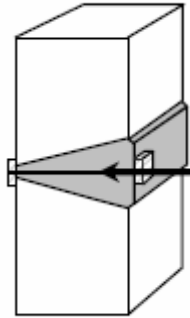


• FE simulation is aimed to:

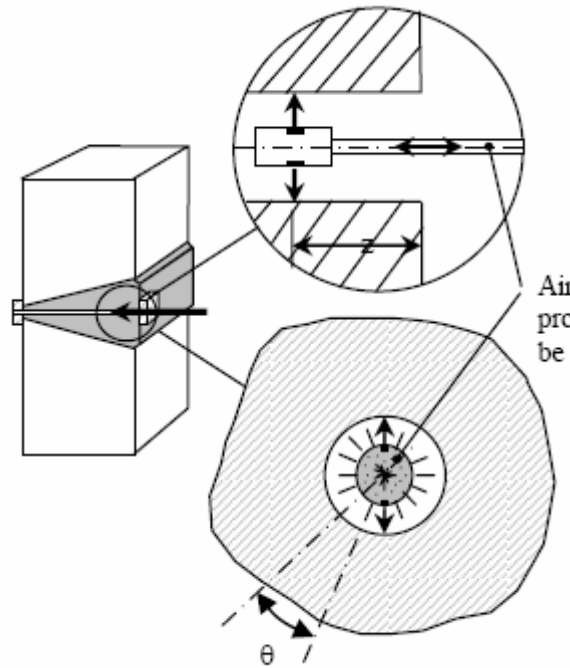
- Evaluate the DHD to measure thermal stress/strain distribution in AGR graphite brick
 - First, effect of E and through wall distribution of E in a simple hollow cylinder is investigated
 - Then, DHD is simulated in the thermal stress field resulted from above models



DHD procedure

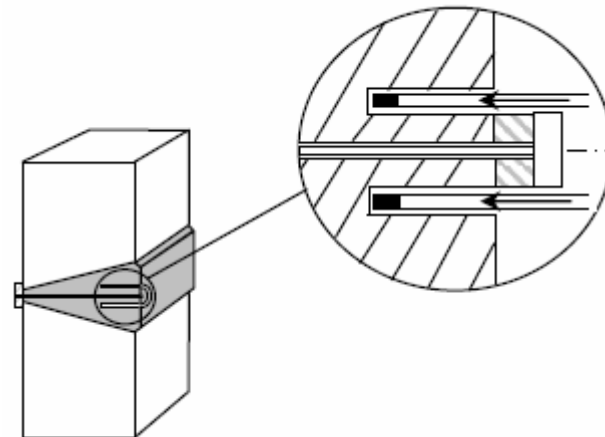


1. Drill a reference hole



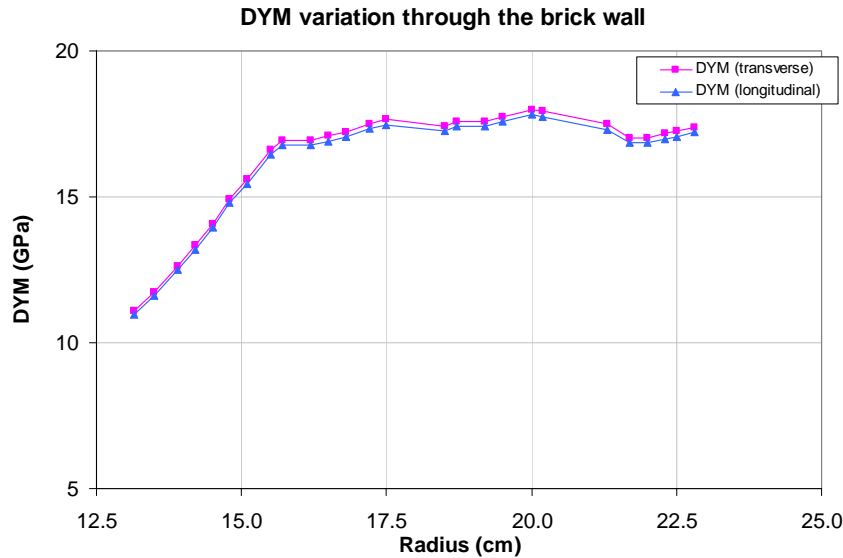
2. Measure reference hole diameter

3. Trepanning a core around the reference hole

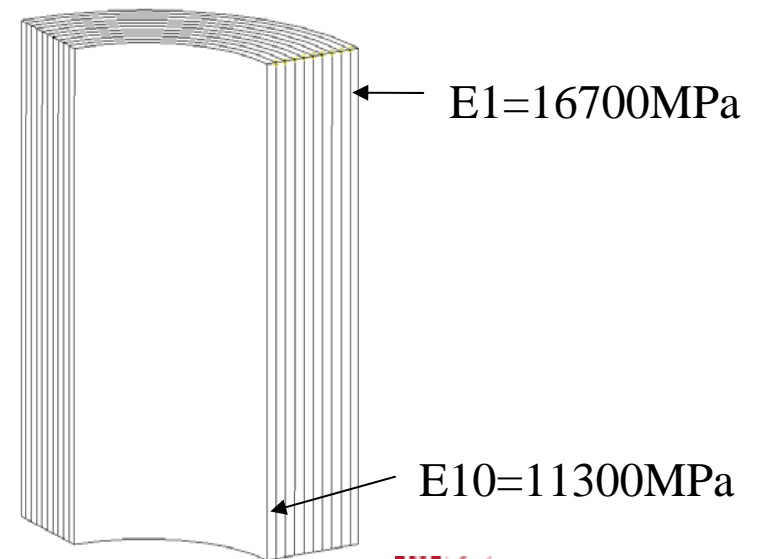


4. Re measure reference hole diameter

Effect of variation of E through thickness

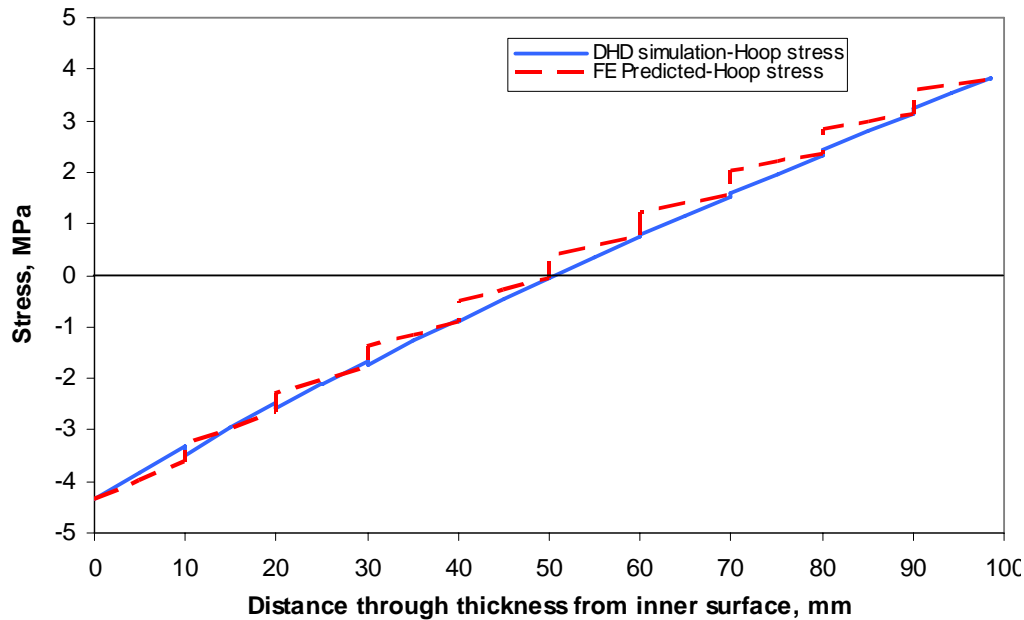
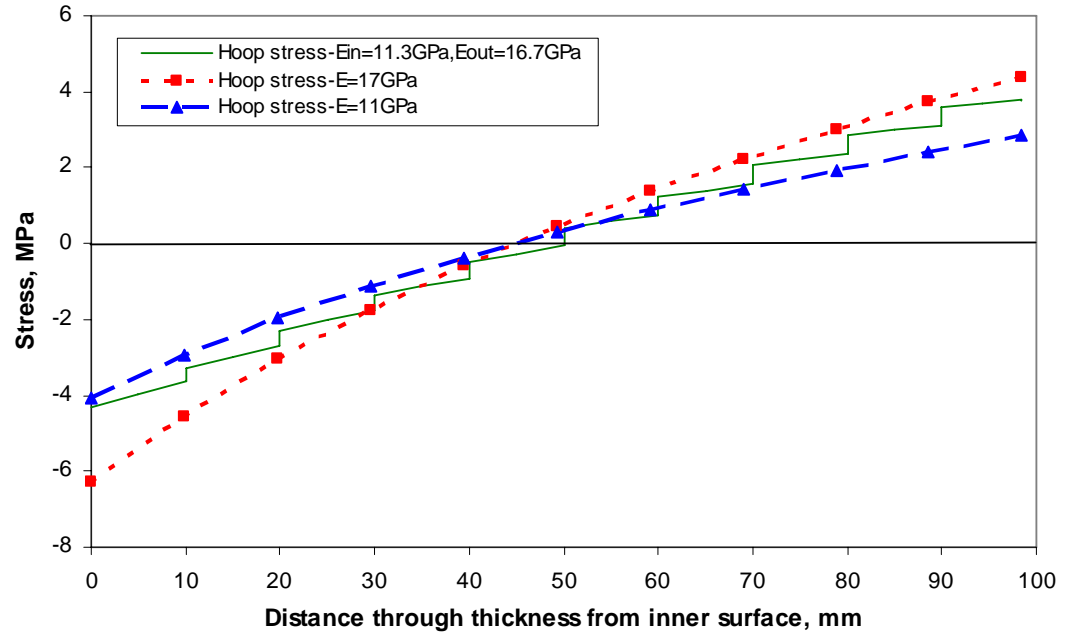


Variation of E in irradiated graphite brick



Through wall variation
of E set up as layers

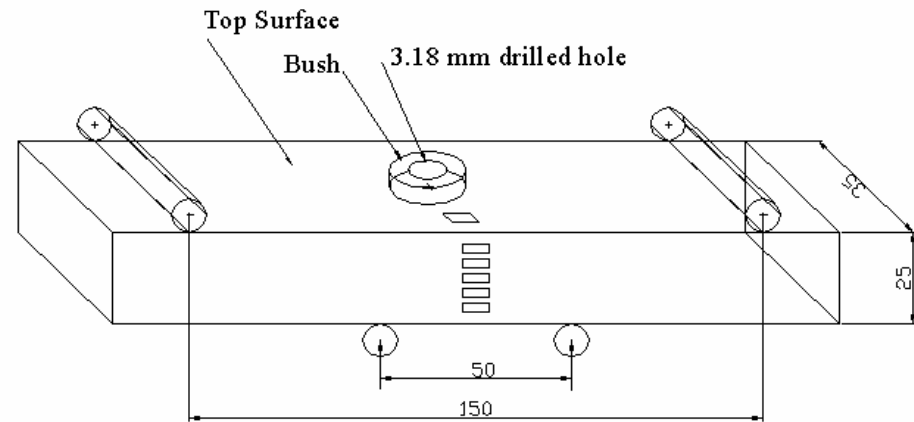
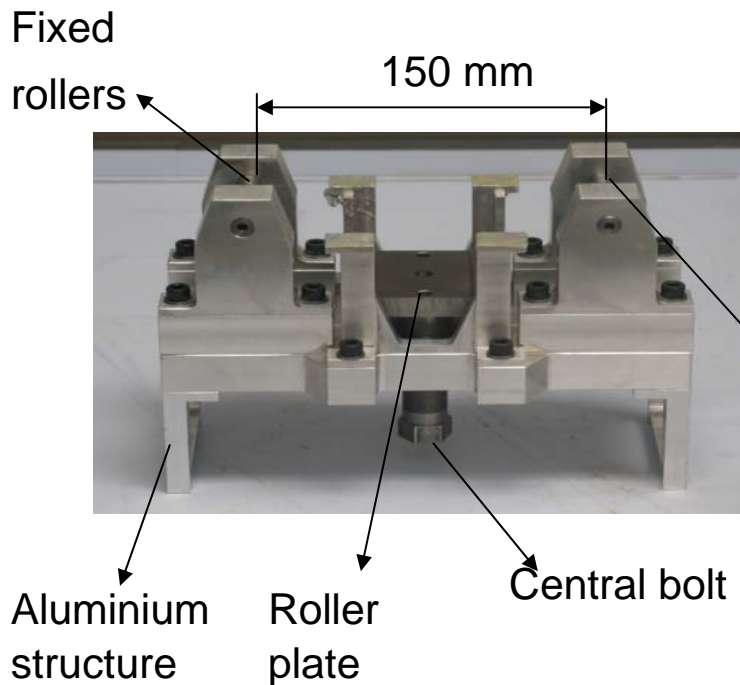
Comparison of thermal stresses for different E



FE-Predicted and DHD stress while E is changing

Set up of the experiment

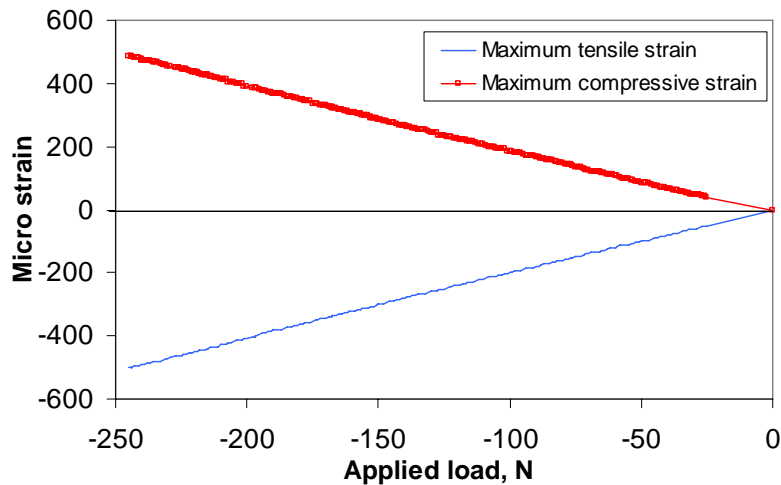
- Strain gauges bonded to the graphite samples
- Samples subjected to 4-point bend stress field using 4-point bend rig



Fixed rollers

Determination of the Young's modulus

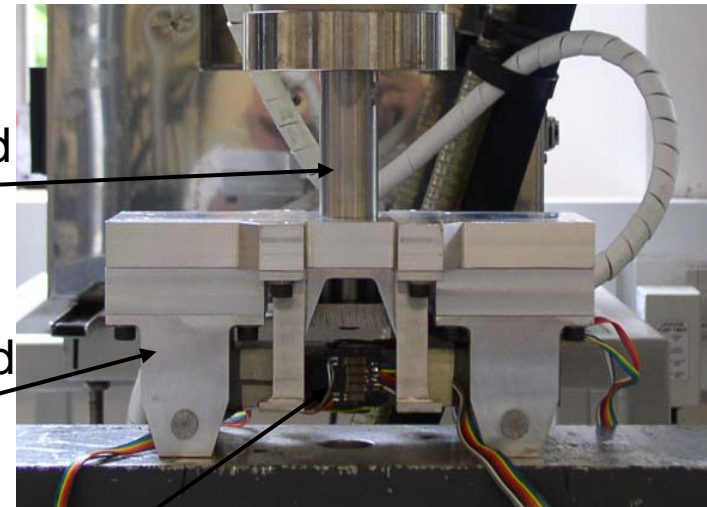
- Known load applied by instron machine using 4-point bending rig
- Using the beam theory equations, E was calculated



Load applied by instron

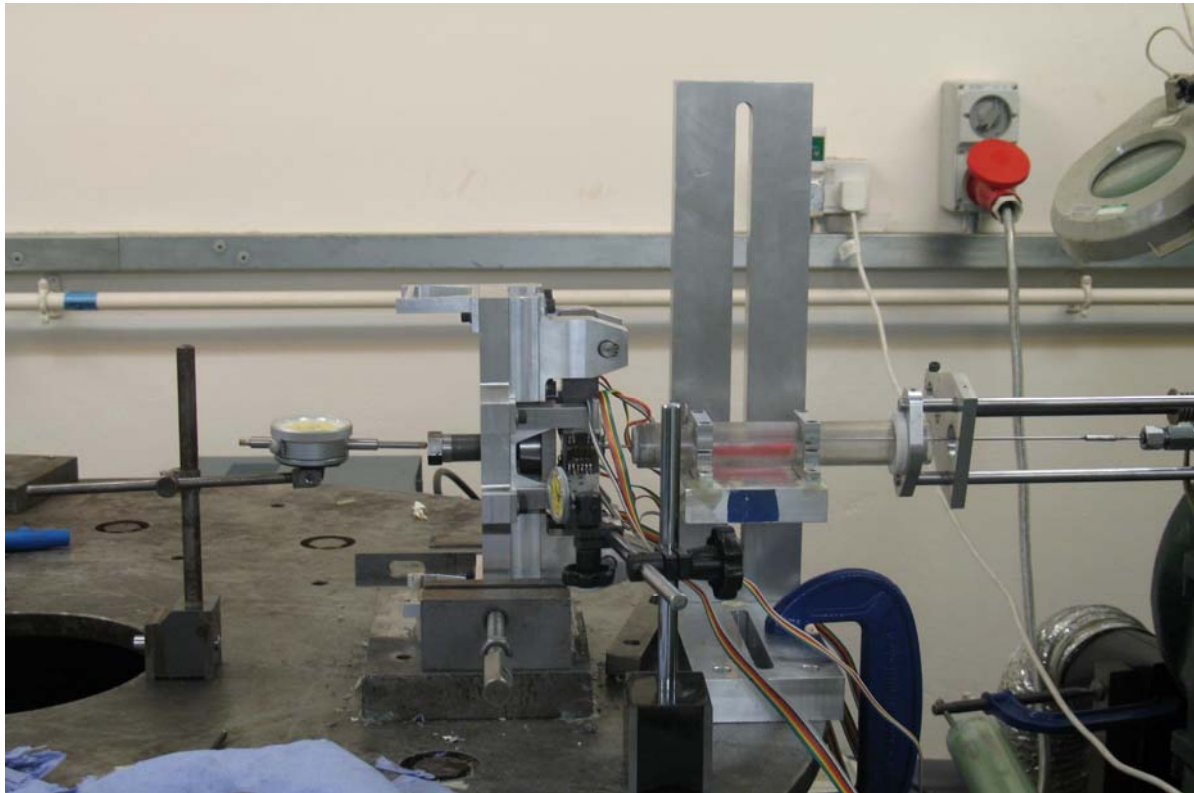
4-point bend rig

Specimen

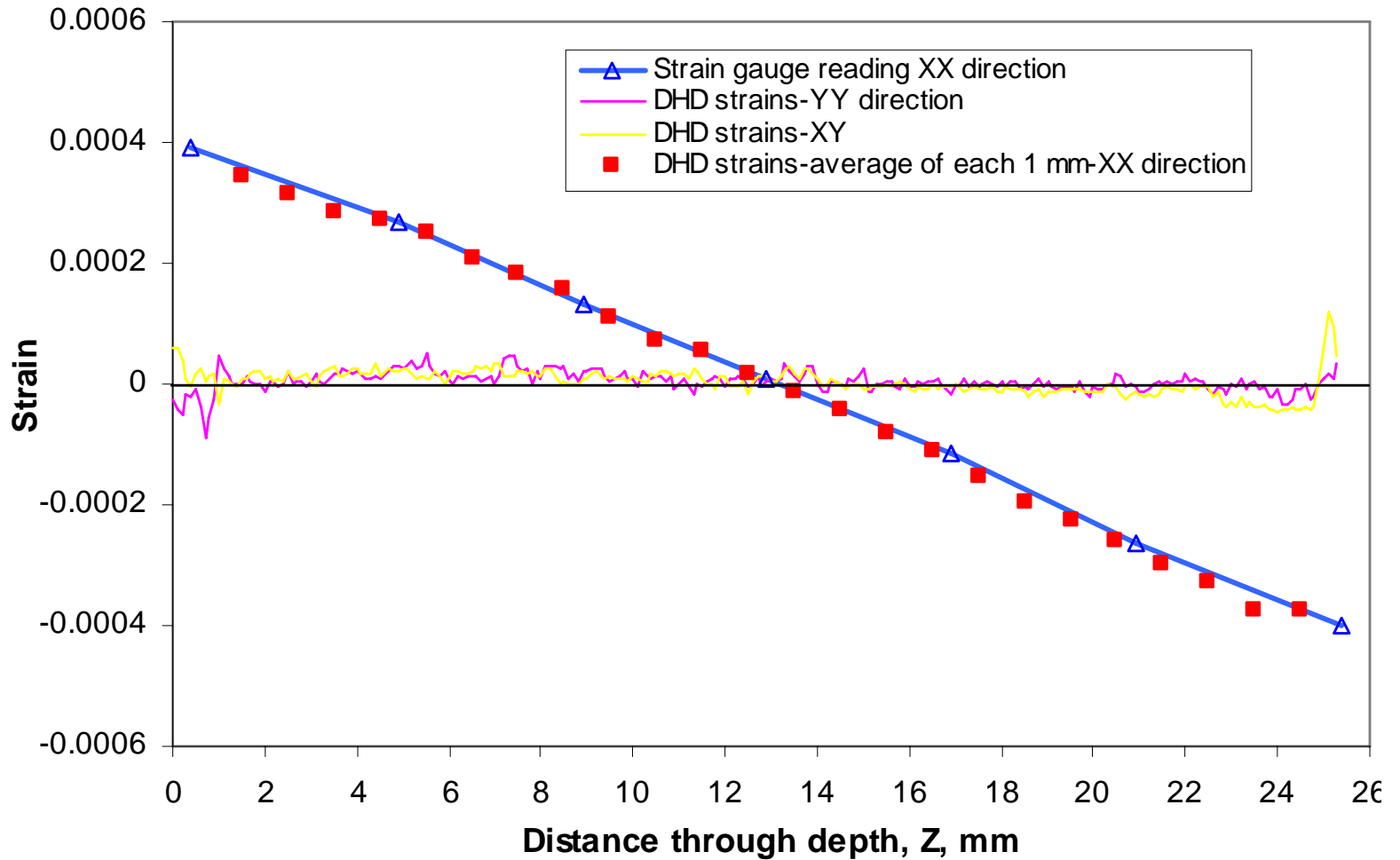


DHD measurement

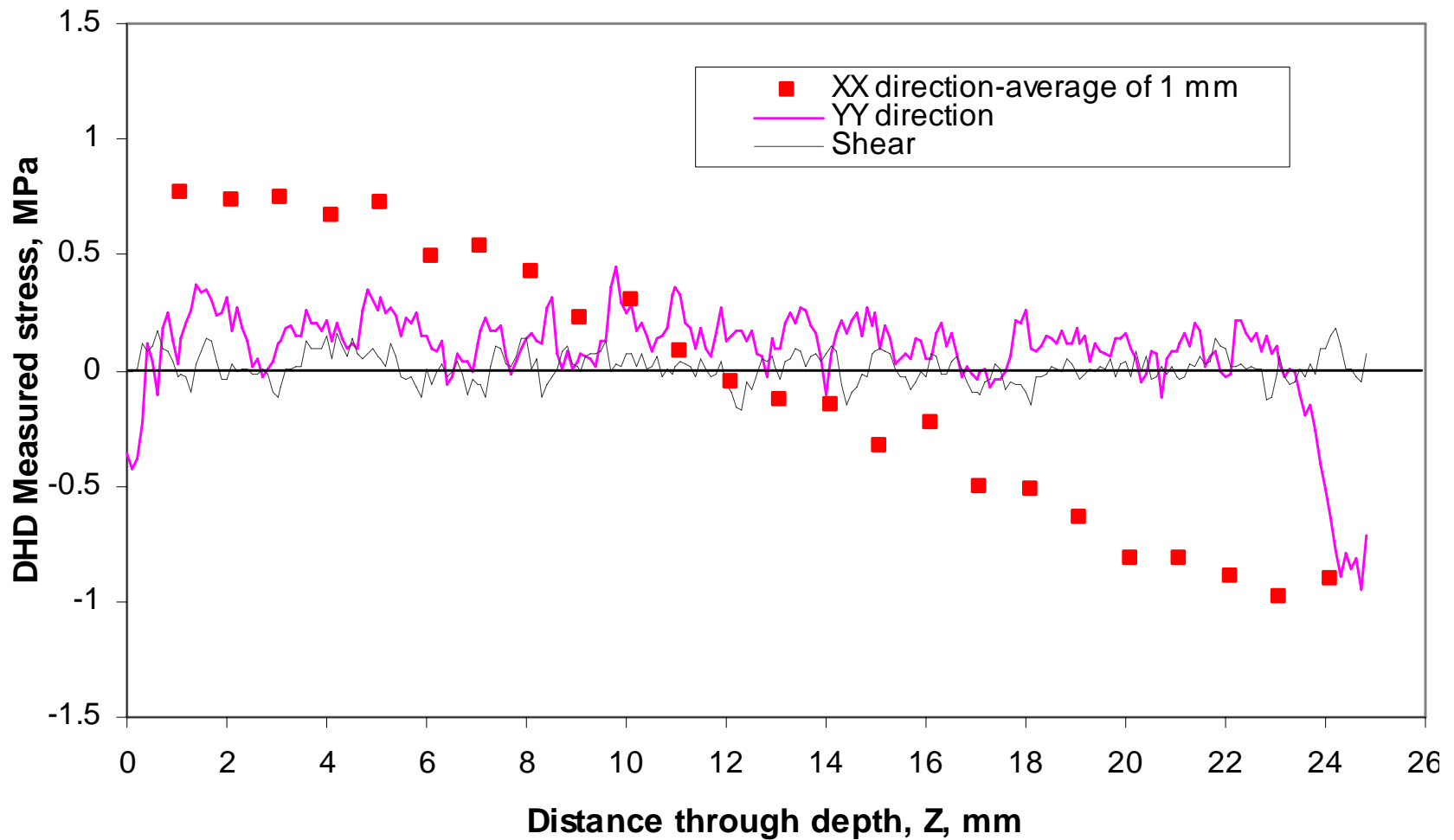
Known stress field resulted from 4-point bend was measured using DHD technique



DHD strain distribution in PGA sample



DHD stress distribution in PG25 sample



Conclusions

- FE simulations of DHD for thermal strains/stresses show that DHD can measure internal in-plane strain/stress distribution
- Experiments using PGA & Porous Graphite PG25 show that DHD can measure the through thickness distribution of applied strains/stresses for simple loading conditions