Real-time X-ray Micro-radiographic Imaging and Image Correlation for Local Strain Mapping in Single Trabecula under Mechanical Load

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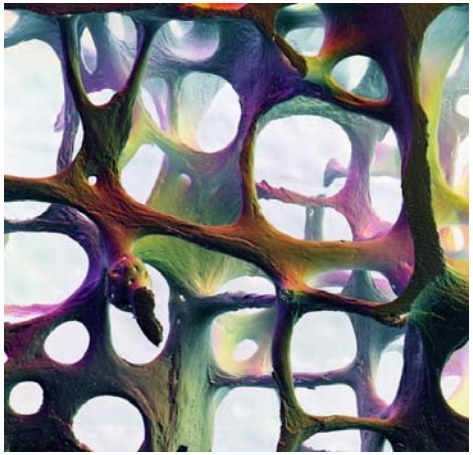
Motivation

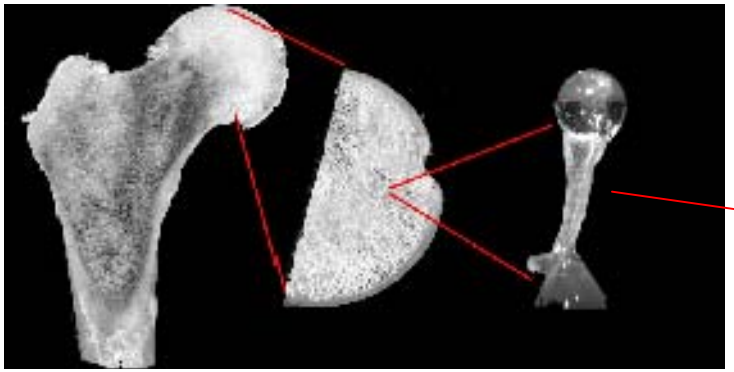
- single trabecula micro-mechanical properties estimation
- real-time micro-radiography of deformation behaviour
- precise strain measurement

Methods

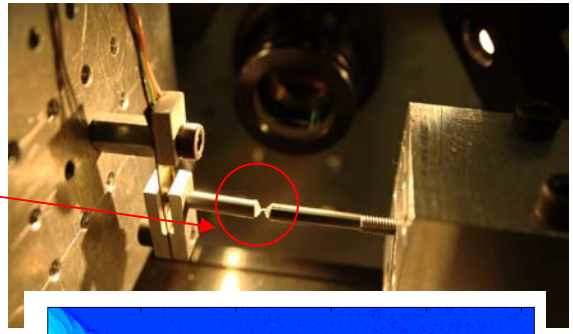
- isolated human trabeculae micro-mechanical testing
- continual irradiation (5μm spot source)
- single-photon counting pixel detector Medipix2

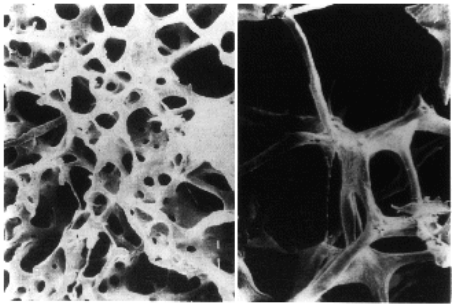


Healthy trabecular bone



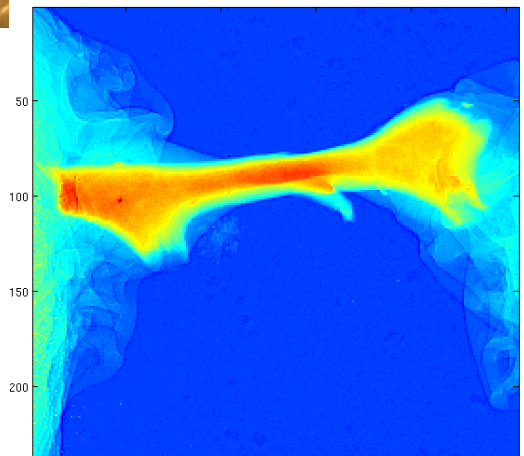
Microtensile testing device

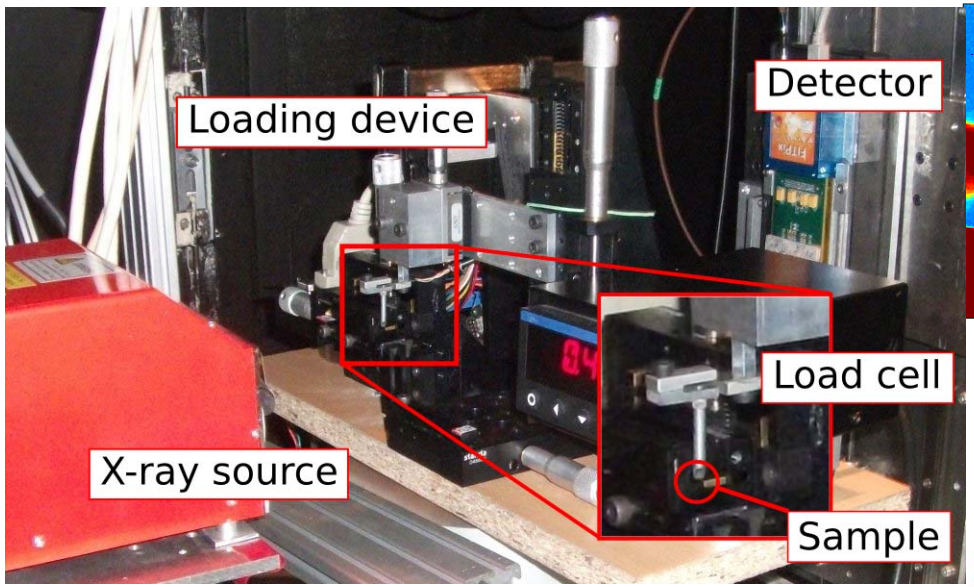




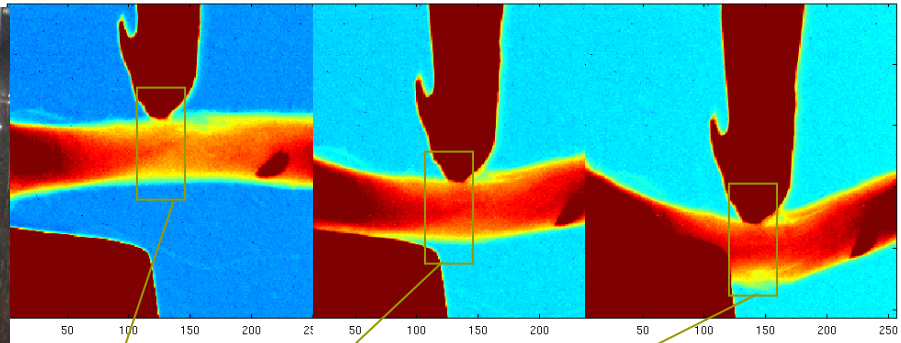
Osteoporotic trabecular bone

RTG projection of glued tensile sample. Glue as well as structural changes due to mechanical load can be detected

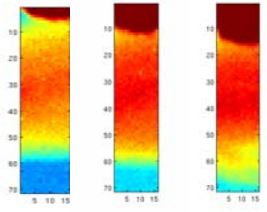


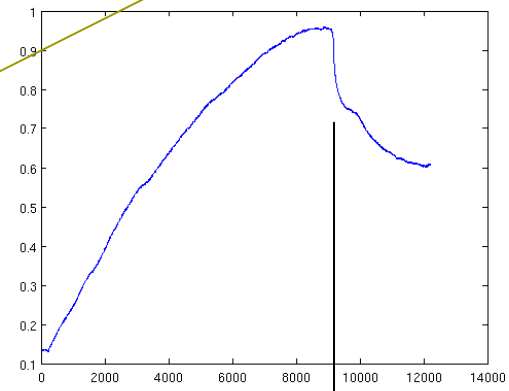


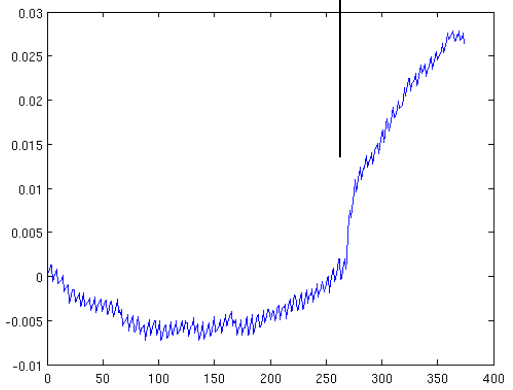
Three-point bending test inside X-ray shielded box



Example of a sequence of X-ray projections







Measured applied force [N] versus the thickness reduction

Precise strain mapping

- 55um pitch detector
- Digital Image Corelation
- Thickness reduction measured in a moving window (tracked by DIC)

CONCLUSIONS:

i) design of the experimental loading device enables precise micro-mechanical testing of isolated human trabeculae

ii) high sensitivity and high contrast of the Medipix2 enables measurement of very small strains using DIC

iii) material thickness reduction can be correlated with strain localization