MECHANICAL STUDIES FOR LHC UPGRADES

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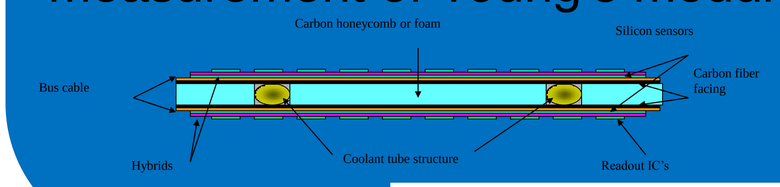
Abstract

The design of the stave for the ATLAS upgrade tracker involves materials of low mass such as Pocofoam and carbon fiber reinforced polymer (CFRP) arranged as a sandwich of CFRP outer skins (for module attachment) and a low mass core. The CFRP skins provide bending stiffness but allow shear to the core. The Pocofoam is important for its good thermal performance. The stave is expected to experience a low stress (up to 30 MPa) resulting from its own weight and an additional force induced by thermal contracts due to the cooling. The stave must be dimensional stable in order to allow satisfactory track reconstruction and must survive numerous thermal cycles. In order to understand these requirements a mechanical system for measurement of Young's modulus at low stress was constructed. The apparatus has been benchmarked against materials with well understood properties.

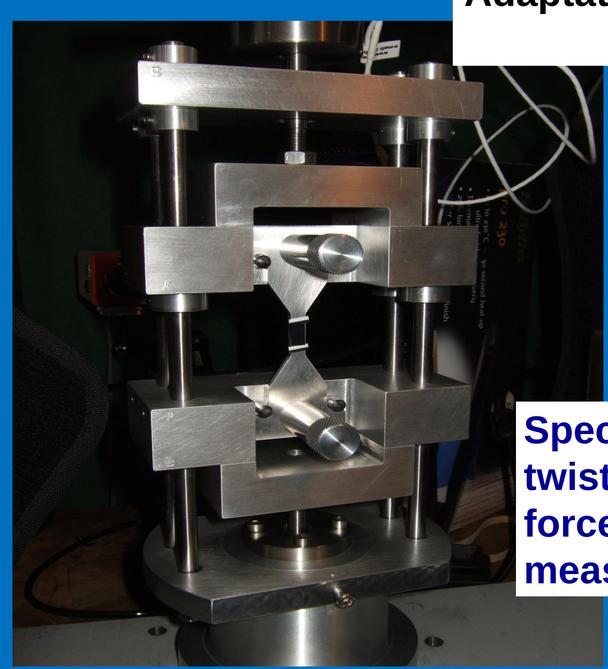


Atlas upgrade tracker stave

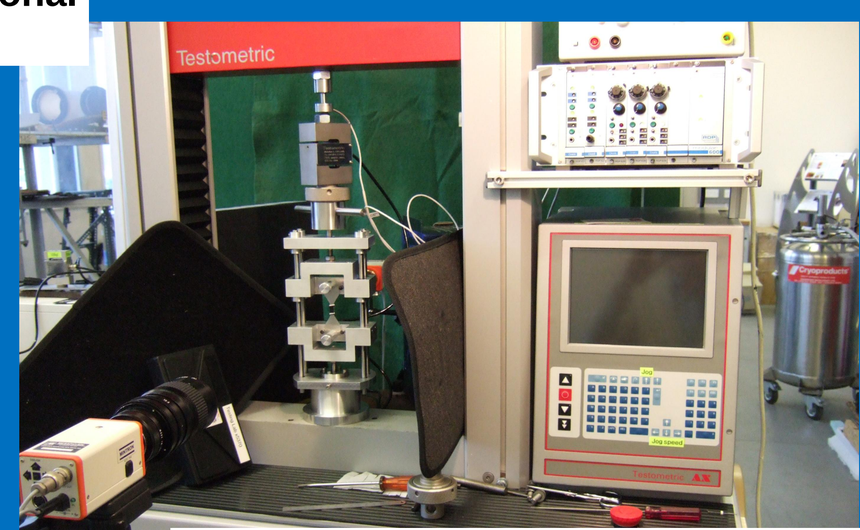
Test Setup

Traditional measurements techniques are ill suited for measurements as low as 30 MPa, a load that is considered appropriate for the stave design. Two modifications to a high-end universal testometer have enabled accurate measurements to the required low loads.

Adaptation of the jig to a conventional extensometer



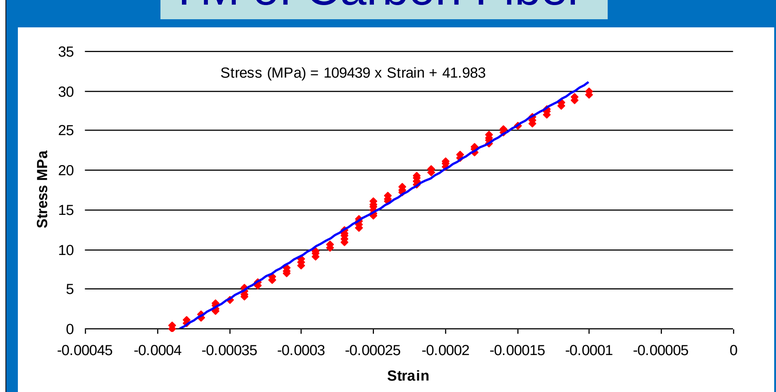
Special jig to remove twisting and bending forces in the measurement system



Use of video extensometer system to measure low strains with high accuracy

Results

YM of Carbon Fiber



Stress-strain curve linear even at these low strains

Directions	Average measured YM (GPa)	Yield strength (MPa)	Ultimate Yield strength (MPa)
x	1.1	0.6	0.8
y	1.3	0.6	0.8
z	3.8	1	2

Measurements on Pocofoam

Tests (GPa)	Average YM (GPa)	High strain Data (GPa)
Tensile modulus (0/60/0) Atlas barrel	109	114
Tensile modulus (90/0/90) BNL sample	126	125

CFRP YM is the same at high and low strain

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