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.

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.

### Test Setup

The apparatus has been benchmarked against materials with well understood properties.

- **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

<table>
<thead>
<tr>
<th>Tests (GPa)</th>
<th>Average YM (GPa)</th>
<th>High strain Data (GPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile modulus (0/60/0) Atlas barrel</td>
<td>109</td>
<td>114</td>
</tr>
<tr>
<td>Tensile modulus (90/0/90) BNL sample</td>
<td>126</td>
<td>125</td>
</tr>
</tbody>
</table>

- **YM of Carbon Fiber**
  - Stress-strain curve linear even at these low strains

- **Measurements on Pocofoam**

- **CFRP YM is the same at high and low strain**

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