Specifications of ALPIDE stave design for the ALICE ITS upgrade

WP5

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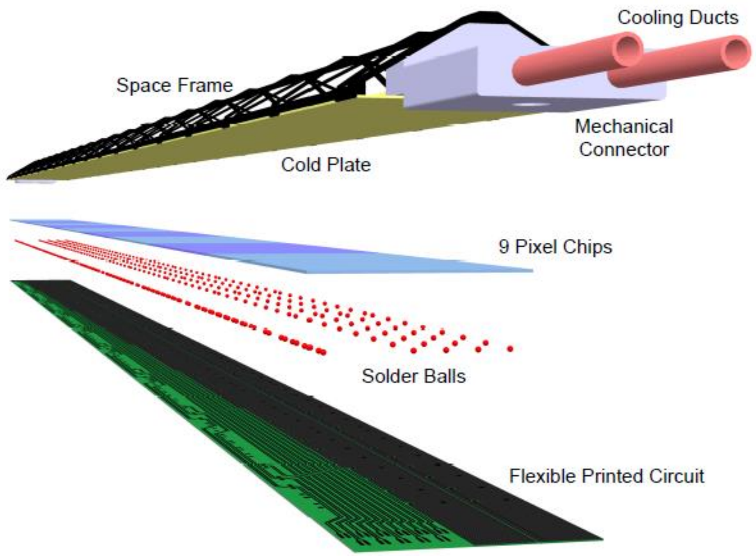


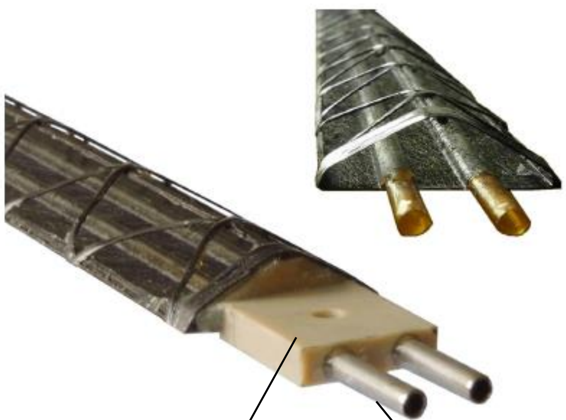
- Schematic view of the IB stave

- The Space Frame
  - A Carbon fibre support structure
  - Support and stiffness

- Cold Plate
  - A sheet of high thermal conductivity carbon fibre with embedded polyimide cooling pipes (d = 1.024 mm and t = 25 um)
- HIC
  - Assembly of a FPC, 9 pixel chips and some passive components
  - Total active area of 15 mm x 270.8 mm (100 um gap between the chips)

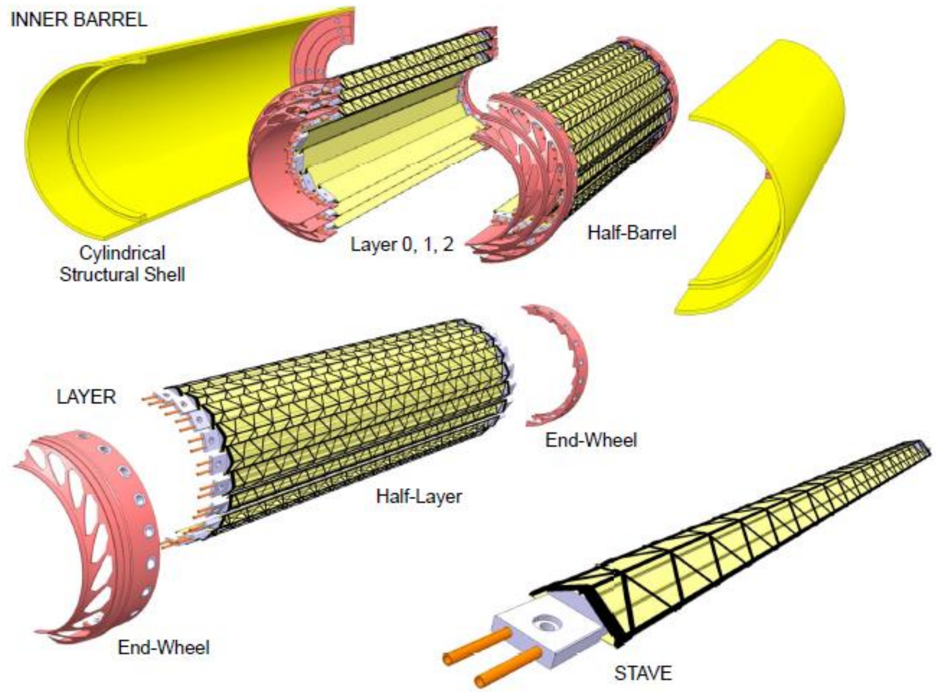
- Module
  - HIC glued to the cold plate

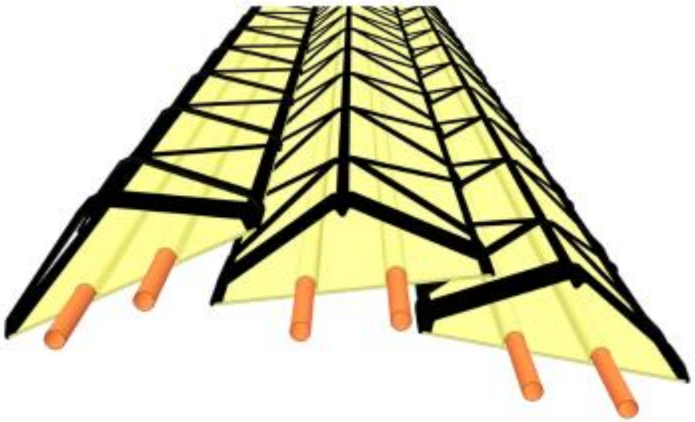
- A mechanical connector at each end of the stave → fixation and alignment of the stave on the end-wheels

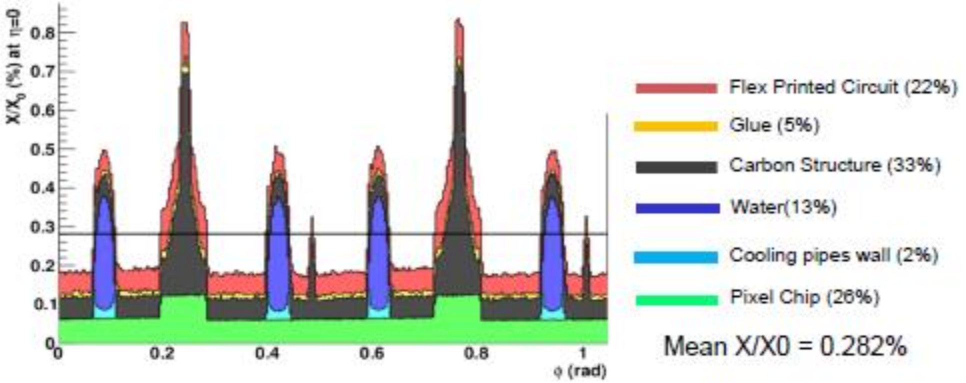


Mechanical connector

Cooling ducts







- Stave overlaps → detector hermeticity (left)
- Material budget distribution (right)

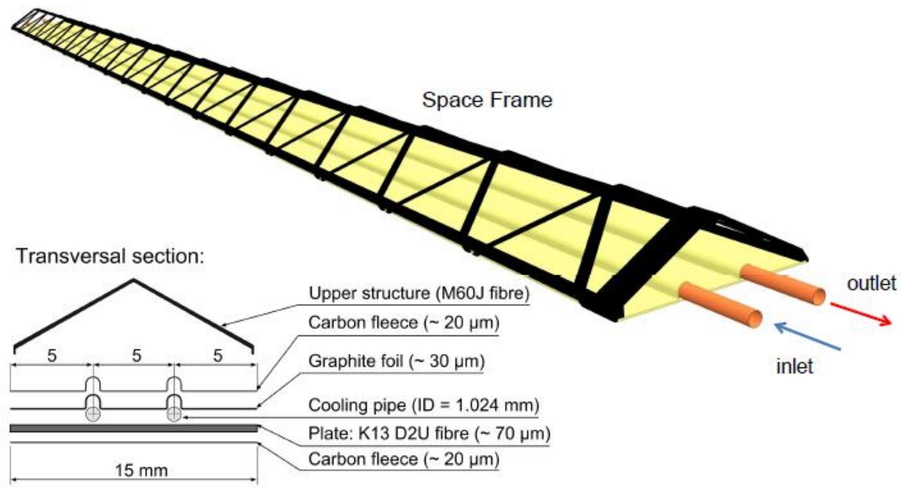
- Mechanical support structure and cooling

- The heat is conducted into the cooling pipes by the carbon fibre structure and is removed by the coolant (water)

- Space Frame (a light filament wound Carbon structure) → stiffens the Cold Plate

- Carbon Fibre Reinforced Plastics (CFRP)
    - High specific stiffness (Young's modulus > 300 Gpa)
    - High thermal conductivity (> 600 W mK^{-1})
    - Long radiation length (26.08 cm)

- The coolant inlet and outlet are provided by a connector at one end and U-bent connector to join the pipes → fixation at the two ends



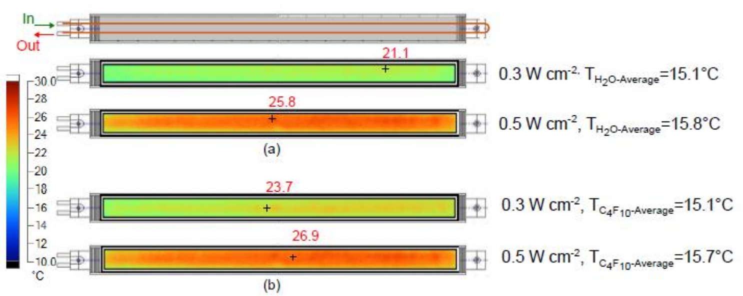
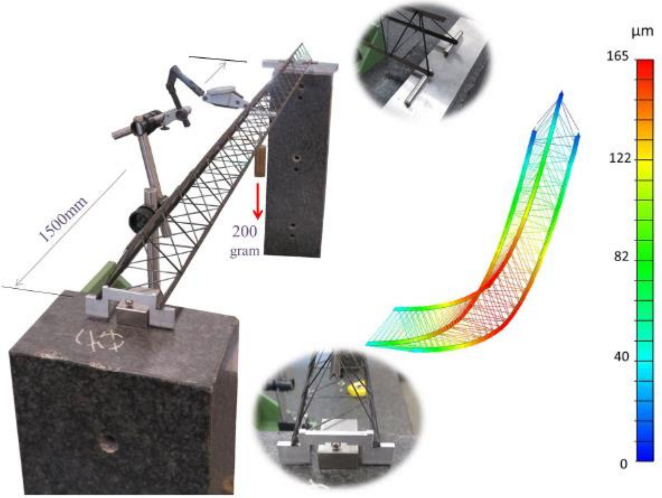


Figure 4.10: Thermographic images showing the chips temperature map at 0.3 and $0.5\,\mathrm{W\,cm^{-2}}$ power densities for the Inner Barrel Stave prototype: a) water, $3\,\mathrm{l\,h^{-1}}$; b) C_4F_{10}, $480\,\mathrm{kg\,m^{-2}\,s^{-1}}$.

- Important points to consider
  - Stave sagging under its own weight → stability in the position of the chips
  - Natural frequency → frequency at which an external impulse can induce resonance phenomena in the structure



- A maximum sag between 4 um and 9 um and a natural frequency of 100 Hz under the assumption of a distributed mass of 0.002 kg (HIC + stave with clamped extremities)
- Also the cooling pipes have been tested at 10 bar → no damage / Also, good erosion resistance → no change in surface roughness or weight after 6 months