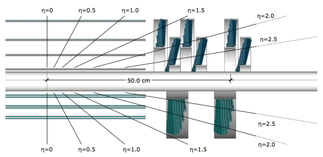
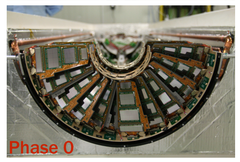
The CMS Phase 1 Upgrade: Forward Pixel Detector Mechanical Support and Cooling

Maral Alyari on behalf of FPix Mechanics Group

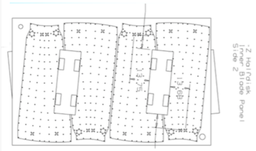
Mechanics Design Motivation

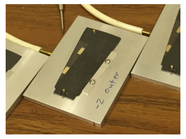




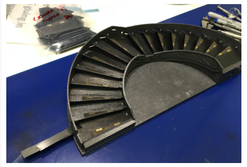
- Reduced material per disk compared to Phase 0 even with an additional disk
- Easier production and maintenance

Half Disk Production

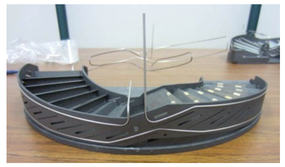




- 110 TPG panels (Thermal conductivity to 4 times copper)
- Drill holes to aid encapsulation
- Encapsulation with CF layer and laminate grounding mesh
- Cut into blades

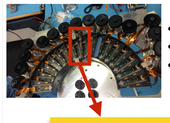


- Machined graphite rings with grooves; Glued TPG blades
- Stainless steel tubes for CO2 316L stainless steel seamless tubing; 304L VIMVAR coupling parts
- Carbon fiber facing

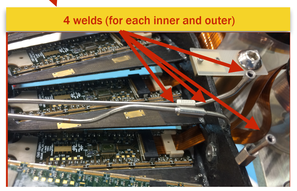


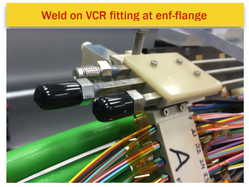
- Bond blades to graphite rings
- Bend cooling tubes to shape
- Embed cooling tubes in graphite rings and glue CF facing
- Coat TPG blades and all faces of graphite/CF facing with epoxy

Location of FPIX Welds



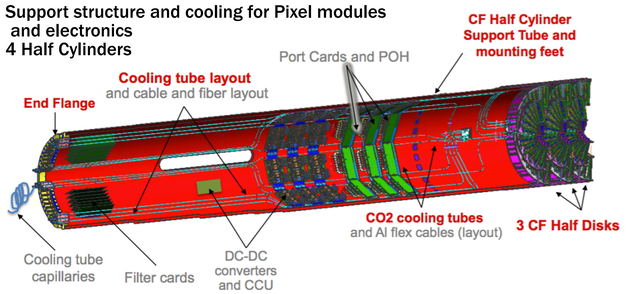
- 6 stainless steel CO_2 cooling loops/HC (supply-HD-return)
- 8 Welds per loop
- 48welds/HC, 192 welds in FPIX

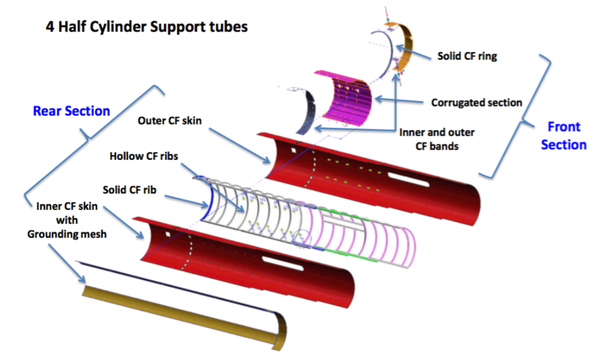


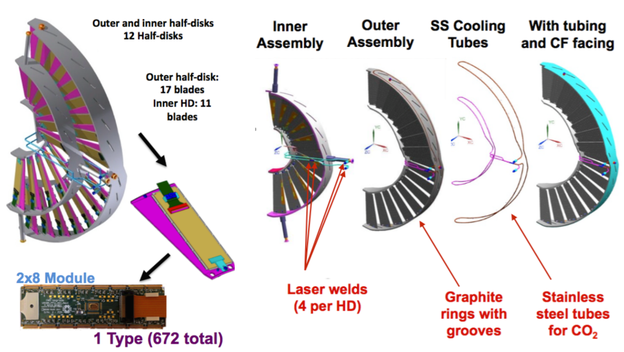


FPIX Mechanics Parts

- Support structure and cooling for Pixel modules and electronics
- 4 Half Cylinders

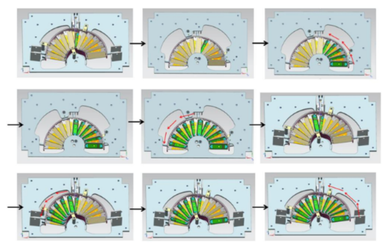






Module Installation

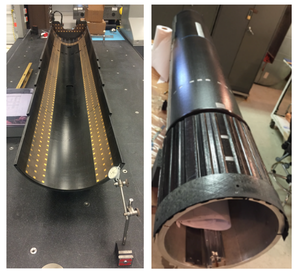
Summary of Proposed Installation Sequence



Half Cylinder Production

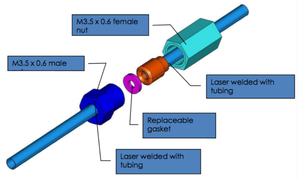
- Tubing are installed prior to electronics integration

As purchased nominal tube sizes:
HD tube: 1.65 mm OD, 0.10 mm thick wall
Supply tube: 2.41 mm OD, 0.13 mm thick wall
Return tube: 3.07 mm OD, 0.20 mm thick wall



CO2 Removable Coupling Design

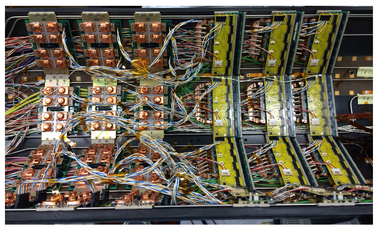
- Based on proven VCR metal sealing technology of commercial part

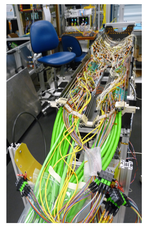


Welding Batch Validation

- A total of 200 cooldown/warmup cycles from liquid nitrogen temperature to room temperature.
- Pressure test at 2280 PSI (157 bars) for 1 hour and leak test at 1600 PSI (110 bars) for 24 hours

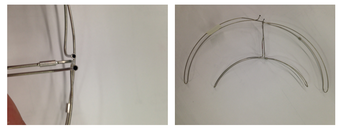
Half Cylinder Assembly and Testing



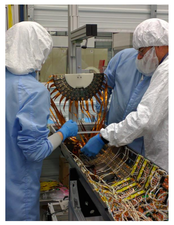


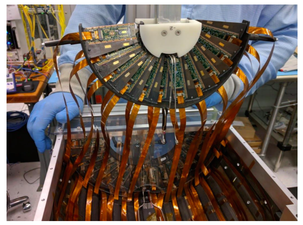
Loop QA/QC

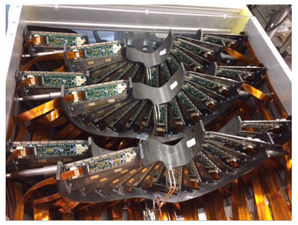
- Pressure test at 2280 PSI
- 24 hour leak test

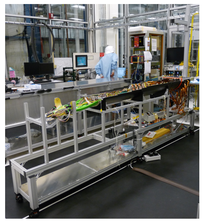


Half Disk Installation and Testing



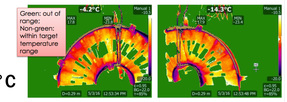


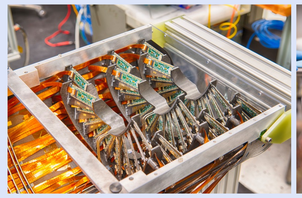




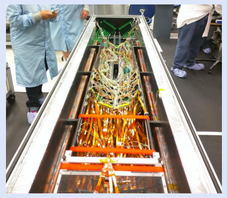
Detector QA/QC and Thermal Test

- Thermal cycle half disk assembly 30 cycles form +40 °C to -40 °C
- Thermal test – ΔT(blade to cooling) < 10 °C





Higher instantaneous luminosity causes unacceptable dynamic inefficiencies due to buffer overflows. The more complex track pattern recognition due to higher pileup require an additional pixel detector layer to maintain good efficiency. The Phase 1 pixel detector replacement addresses these shortcomings



Shipping and Storage Boxes