University of Huddersfield
Centre for Precision Technologies

HI-LHC-UK, WP1, Task 2
STFC/CERN/UoH

Adaptive Collimation System (ACS)
CoLUSM #115

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Contents

• ACS Recap
• Fibre Probe development, Radiation testing results, and calibration
• PZT development
• Jaw design changes
• Procurement and manufacture.
• Control System Development
• ACS test plan (@ UoH)
• Forward plan
Adaptive Collimation System (ACS)

• Measuring system
  – Fibre based strain sensors
  – Single point interferometer
• Actuation system
  – High powered PZT stack actuators
• Control system
  – NI PXI control
Adaptive Collimation System (ACS)

- ACS modes of operation:
  1. Correction of the slow thermal deformation caused by quasi-static losses. Maintain straightness tolerance of ±100µm.
  2. Effectively damp high amplitude vibrations caused by accidental beam impacts.

- Actuation system requirements – PZT actuators
  - Based on FEA each jaw will require 8 high power stacks to achieve upper actuation limit of 500µm.
  - Must be able to actuate at speeds up to 200Hz to incorporate 1st modal frequency damping.
  - Must be able to survive 250C bake out temp.
  - Must be UHV compliant.

- Optical Strain fibre optic system requirements.
  - Temperature and UHV requirements same as Actuation system.
  - Optical resolution – 850nm
  - 10 cavities per jaw (5 per track), to ensure good spatial resolution.
Fibre Probe development - Coatings

- New $\eta \approx 2.7$ ($\eta$ in vacuum 1)
- Increased sensitivity
- More resilient to radiation darkening
Fibre Probe development - Coatings

Returned light intensity

- coated 150 us low polarization
- coated 150 us good polarization
- uncoated 150 us good polarization
Fibre Probe development – radiation hard and High Temp

• New fibres to be used in probes:
  • SM780 variant
  • Copper clad
  • Pure silica core
  • Long term max temp 450°C
  • Due to metal cladding, in theory they can be welded to the jaw. (to be investigated)
• New Flanges to be used on tank
  • VACOM 6 core FC/APC feedthroughs
  • The same feedthroughs are being investigated my M. Butcher and S. Danzeca for high temp applications.

Fibre Radiation testing
• Sent fibres to a NDT facility in N.Yorkshire.
• 2 standard patch cables, and copper clad version currently being tested.
• Exposed to a 9MeV linear accelerator giving average dose of 117Gr per week.
• Total accumulative dose currently at 1.3KGr
Fibre Probe development – Radiation testing

Fibre Transmission Power

Date (dd/mm/yyyy)

Transmission power (mW)


F1  F2  H1
• PI Ceramic have designed a high temperature version of the P.025-80P Stack
• Same stack as used in FEA
• Version able to withstand sustained 250°C
• Pi’s initial testing showed successful results.
• Some issues with delamination due to insufficient preload.
• 16 stacks with TiN coated semi-spherical ends ordered.

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<td>Operating Voltage V</td>
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Jaw design changes

- Modular back stiffener
- Actuator body
- Piezo Mount
- PZT power connection
- ACS Piezo back stiffener
- Trunking
- Rear fibre track
- Recess for fibre housing
- Recess for fibre trunking
- Top stiffener
- Fibre channels
- Recess to allow probe/pitch cable junction
- Cuts outs for new stiffener design
Procurement and manufacture

Slide table/drive system
- 90% complete
- Few minor components still to be manufactured
- All motors, drives, bearings, procured
- To be completed end of may (M1.14)

Vacuum tank
- 95% complete
- Only fibre trunk clamp outstanding
- All feedthroughs delivered, with the exception of the fibre feedthroughs (ordered)
- All tooling manufactured
- To be welded ASAP
- To be completed end of may (M1.14)

Jaws.
- 10% complete
- Only jaws, taperings, and heat pads delivered.
- Top/bottom stiffeners in manufacture – material delivered.
- Piezos ordered
- Material for all additional parts delivered
- Cooling jacket and front stiffener being manufactured by CERN.
- Aluminium alternative ordered.
- Fibre sensors to be ordered.
Control System Development

Shaker XL-80

Mini-jaw
Control System Development

Detecting strain in the transverse direction – raw signal

XL-80 magnitude normal to the front face of the jaw

Filtered signal from which the control signal is deduced
Test plan at UoH

DYNAMIC TESTING

Stinger

Optic

Shaker

XL-80
Test plan at UoH

THERMAL TESTING (UNDER VACUUM)

Displacement (mm) vs. Temperature (°C)

RH TEMP DISP vs. TEMP

LH TEMP DISP vs. TEMP

MIDDLE TEMP DISP vs. TEMP

Jaw Length (mm) vs. Temperature (°C)
Forward plan

• Tank and drive system assembly – complete end of May 19 – M1.14
• Jaw assembly and validation checks for normal and localised heating – end of July 19 – D1.12
• Final validation for jaws and collimator system Oct 19 – D1.13
Questions?