WEAVE
The Mechanical Design for the WEAVE Prime Focus Corrector System

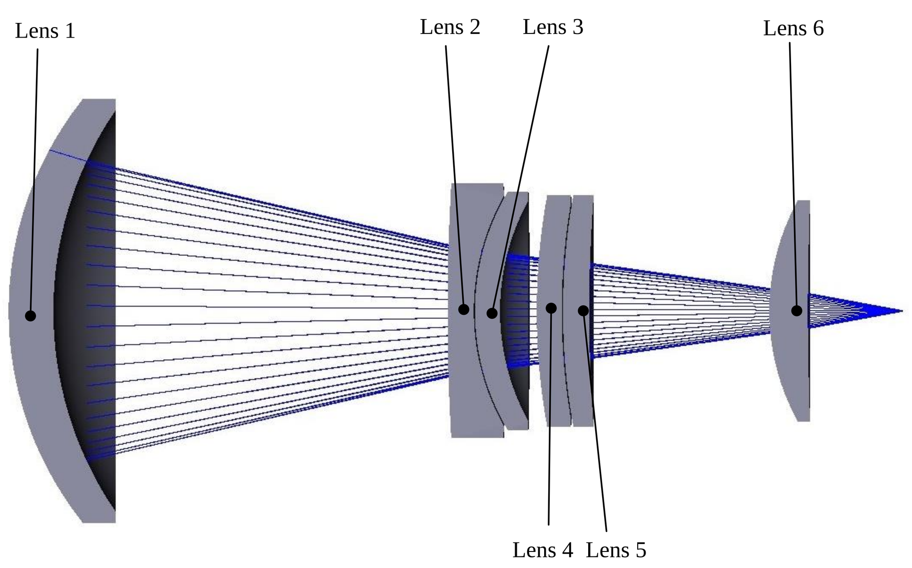
Don Carlos Abrams (Isaac Newton Group), Kevin Dee (Isaac Newton Group), Tibor Agócs (NOVA), Emilie Lhome (Isaac Newton Group), José Peñate (Instituto de Astrofísica de Canarias), Attila Jaskó (MTA Research Centre for Astronomy and Earth Sciences), Evelin Bányai (MTA Research Centre for Astronomy and Earth Sciences), José Alonso Burgal (Instituto de Astrofísica de Canarias), Gavin Dalton (Oxford University, RAL Space), Kevin Middleton (RAL Space), Piercarlo Bonifacio (L'Observatoire de Paris), J. Alfonso L. Aguerri (Instituto de Astrofísica de Canarias), S. C. Trager (Kapteyn Institut) and Marc Balcells (Isaac Newton Group).

Introduction

The William Herschel Telescope will be converted into a spectroscopic survey facility capable of providing spectroscopic follow-up of the fainter end of the Gaia astrometric catalogue, chemical labelling of stars to V~17, and spectroscopic analysis of numerous sources from the medium deep LOFAR surveys. In 2012, the decision was taken to pursue the development of a corrector with a two-degree field of view and an integrated atmospheric dispersion compensator (ADC). This forms part of the Prime Focus Corrector System which also includes an instrument rotator and an instrument focussing mechanism.

Optical Layout

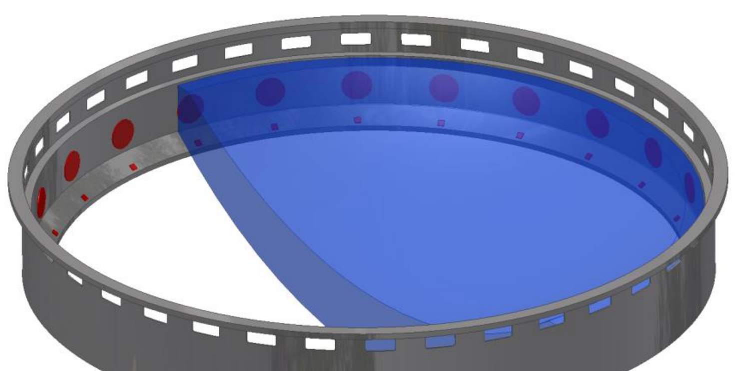
The WEAVE Prime Focus Corrector consists of six optical elements and its purpose is to correct for the optical aberrations in the two-degree field of view and to compensate for atmospheric dispersion whilst the telescope is moving in elevation. The compensation is performed by a pair of counter-rotating, air-separated doublets (lenses 2 and 3/lenses 4 and 5).



To maintain the required image quality the behaviour of both the opto-mechanical and mechanical components need to be well understood and analysed within the constraints within which the corrector is expected to operate. Maintaining the overall optical performance of the system places some interesting challenges on the mechanics especially in terms of lens mounting and stability.

Lens Mounting

It is envisaged that the mounting of the lenses will follow the process that was used by Fata et al. which involves the use of RTV rubber pads which sit between the lens cell and the lens. The following model shows the position of the pads within lens cell 1. The radial pads are round and the axial pads are square. The radial pads are glued on both faces and their primary function is to compensate for CTE differences between the lens and its cell. The primary function of the axial pads is to compensate for any irregularity in the mounting cell surface thus ensuring an even spread of the load on the lens.



Extensive work has been carried out to determine the number and sizes of pads required for each lens cell. The results of this work are shown below:

Radial pads

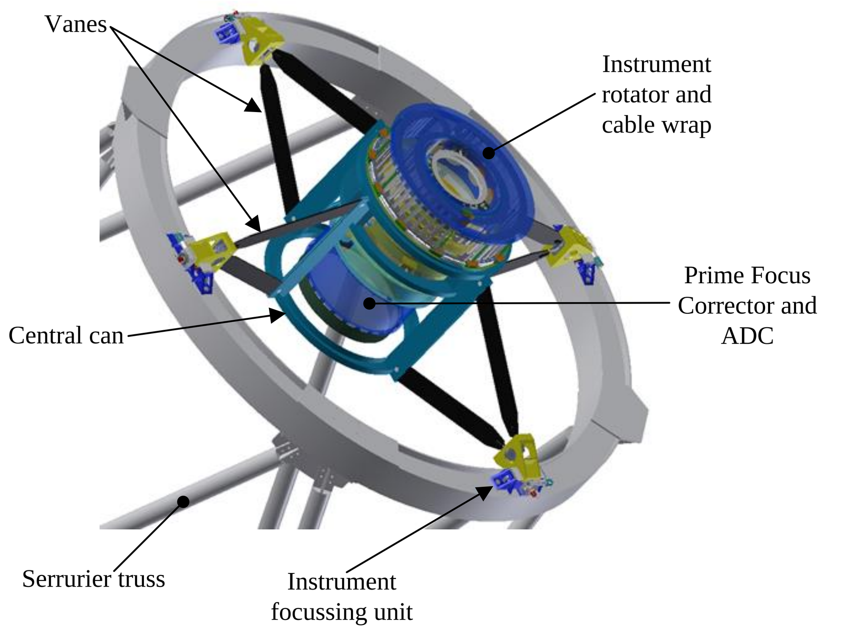
Lens	Cell material	Lens edge thickness	Pad Ø (mm)	Number of pads	Thickness (mm)	Shape Factor
L1	Invar 38	84	50	24	2.12	5.91
L2	Steel	136	52	24	2.90	4.48
L3	Steel	52	32	24	1.50	5.34
L4	Steel	62	32	24	1.45	5.51
L5	Steel	52	50	24	2.64	4.74
L6	Invar 38	31	26	24	1.12	5.81

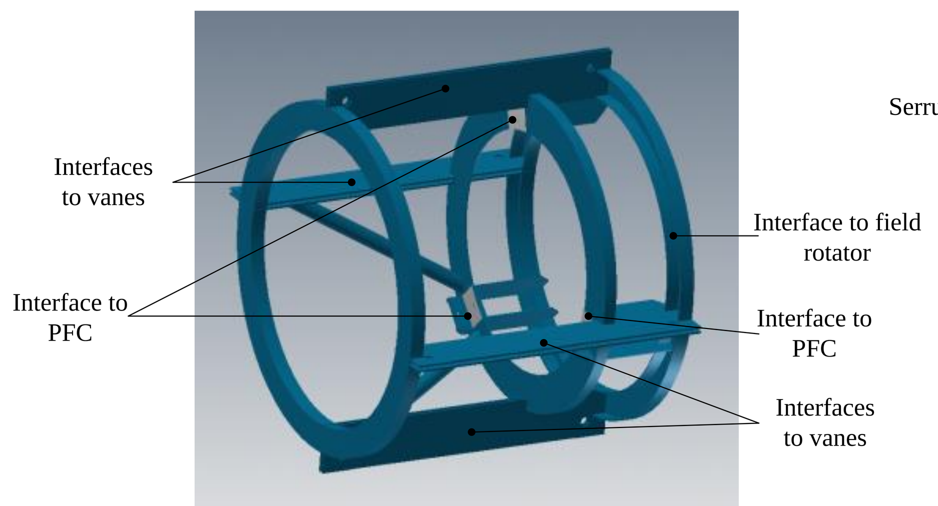
Axial pads

Lens	Force per pad (N)	Compression (µm)	Width (mm)	Number of pads	Thickness (mm)	Shape Factor
L1	94.42	74	10	24	1	2.5
L2	77.66	72	9.5	12	1	2.375
L3	48.23	79	8	12	1	2
L4	44.96	74	8	12	1	2
L5	35.97	72	7.5	12	1	1.875
L6	31.88	80	7	12	1	1.75

Mechanical Layout

Right: A model showing the subsystems of the WEAVE PFC System. The coloured subsystems are those that are being produced by the project. All other subsystems exist as part of the telescope. The fibre positioner, which will sit adjacent to the cable wrap, is not shown. The four drive units are responsible for focussing the instrument by translating the whole of the central section along the optical axis.

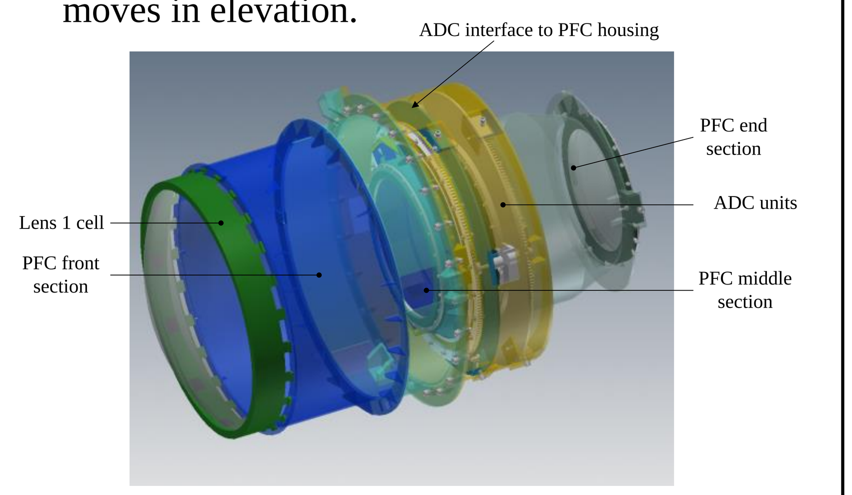


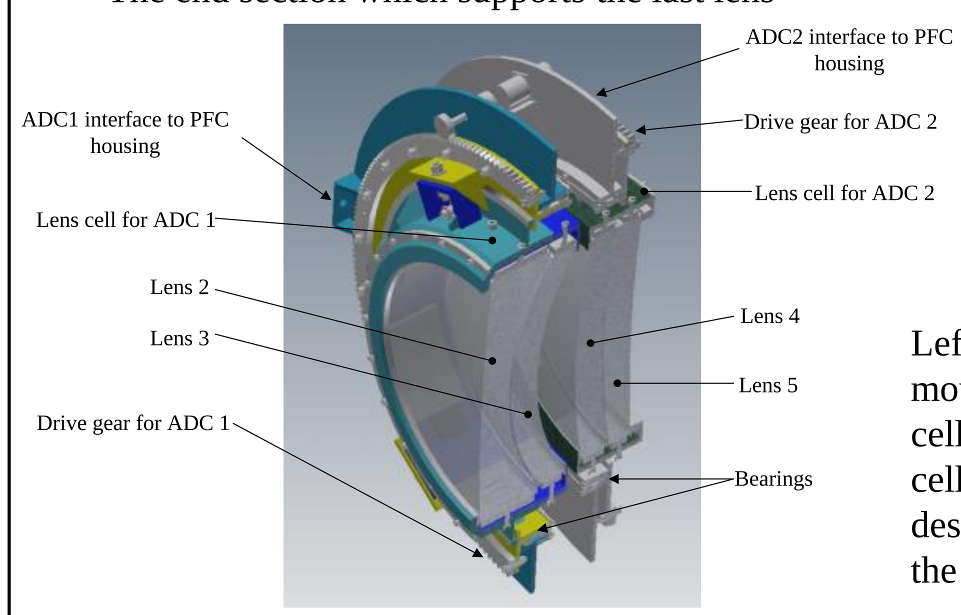


Left: The central can is responsible for providing the three critical interfaces: the interface between the telescope vanes and the can, the interface between the field rotator and the can and lastly the interface between the PFC/ADC and the can. Four pairs of pre-tensioned vanes will connect the central can to the telescope ring. The pre-tension will be such that the central can will not move (relative to the telescope) as the telescope moves in elevation.

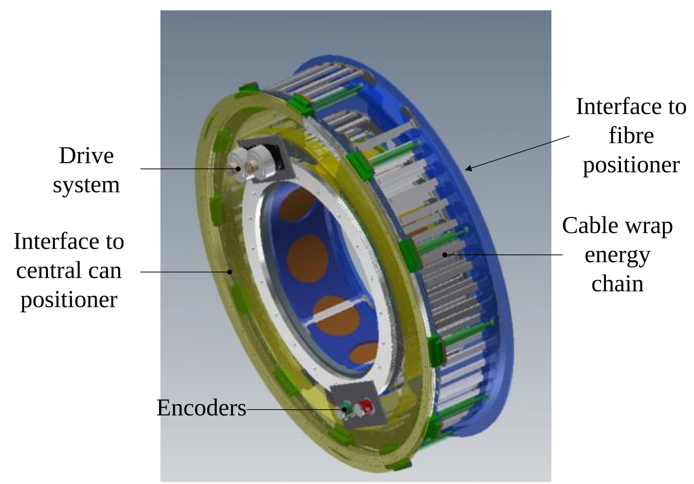
Right: The PFC housing is the structure that supports the lens cells and provides the mechanical interface to the central can. It is divided into three sections:

- The front section which supports the first lens
- The middle section which connects to the ADC and provides the interface to the central can
- The end section which supports the last lens



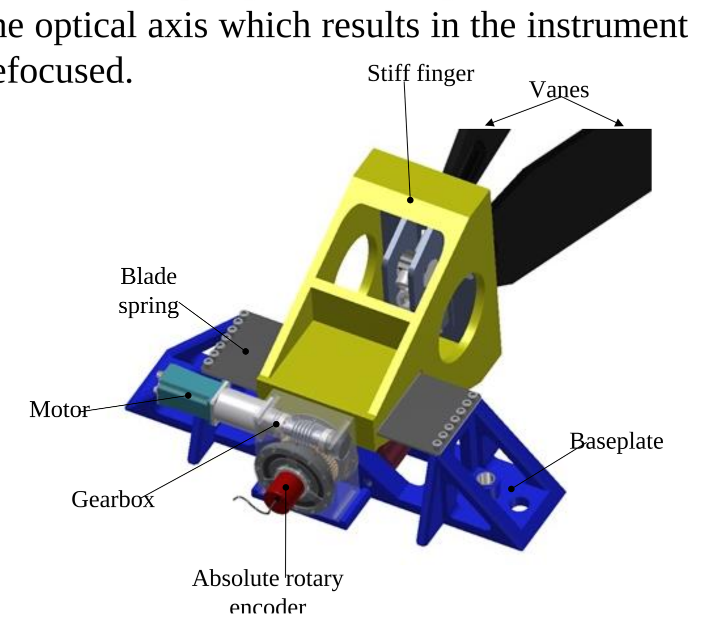


Left: The ADC mechanical design consists of mounting each pair of doublets in a common lens cell and providing a control mechanism to rotate the cells by equal amounts in opposite directions. The design is very similar to the existing ADC design for the WHT.



Above: The preliminary design for the rotator with the integrated cable wrap is shown. This will be further developed through an industrial contract which is expected to include prototyping of the cable wrap.

Below: The drive unit showing the connection to the vanes and the blade spring. The baseplate is bolted to the telescope ring and an eccentric cam is used to displace the blade spring thus moving the central can along the optical axis which results in the instrument being refocused.



Summary

The mechanical design for the Prime Focus Corrector System has progressed to the stage where the majority of the subsystems are now in their final design stage and extensive analyses are being carried out on the detailed designs to understand better the expected performance of the subsystems. All final designs for the mechanical subsystems will be carried out with the industrial partner selected to construct, assemble and test the completed system. The current expectation is that this system will be completed by Q3/17 as per the overall project schedule.

WEAVE Design, Construction and Exploitation

WEAVE is the new wide-field spectroscopy facility for the prime focus of the William Herschel Telescope. The facility comprises a two-degree field-of-view Prime Focus Corrector with a 1000-multiplex fibre positioner, a small number of individually deployable integral field units, and a large single integral field unit feeding a dual-beam spectrograph. The instrument is being designed and built by a European consortium. The final design review is expected to be complete by Q2/15. Science observations are planned for Q1/18 and will include spectroscopic sampling of the fainter end of the Gaia astrometric catalogue, chemical labelling of stars to V~17, and dedicated follow-up of a substantial number of sources from the medium deep LOFAR surveys.

Science & Technology Facilities Council
rijksuniversiteit groningen
UNIVERSITY OF OXFORD
NWO
ASTRON
LIVERPOOL JOHN MOORES UNIVERSITY
l'Observatoire de Paris
UNIVERSITY OF CAMBRIDGE
RAL Space