Mechanical features of the OzPoz fibre positioner for the VLT

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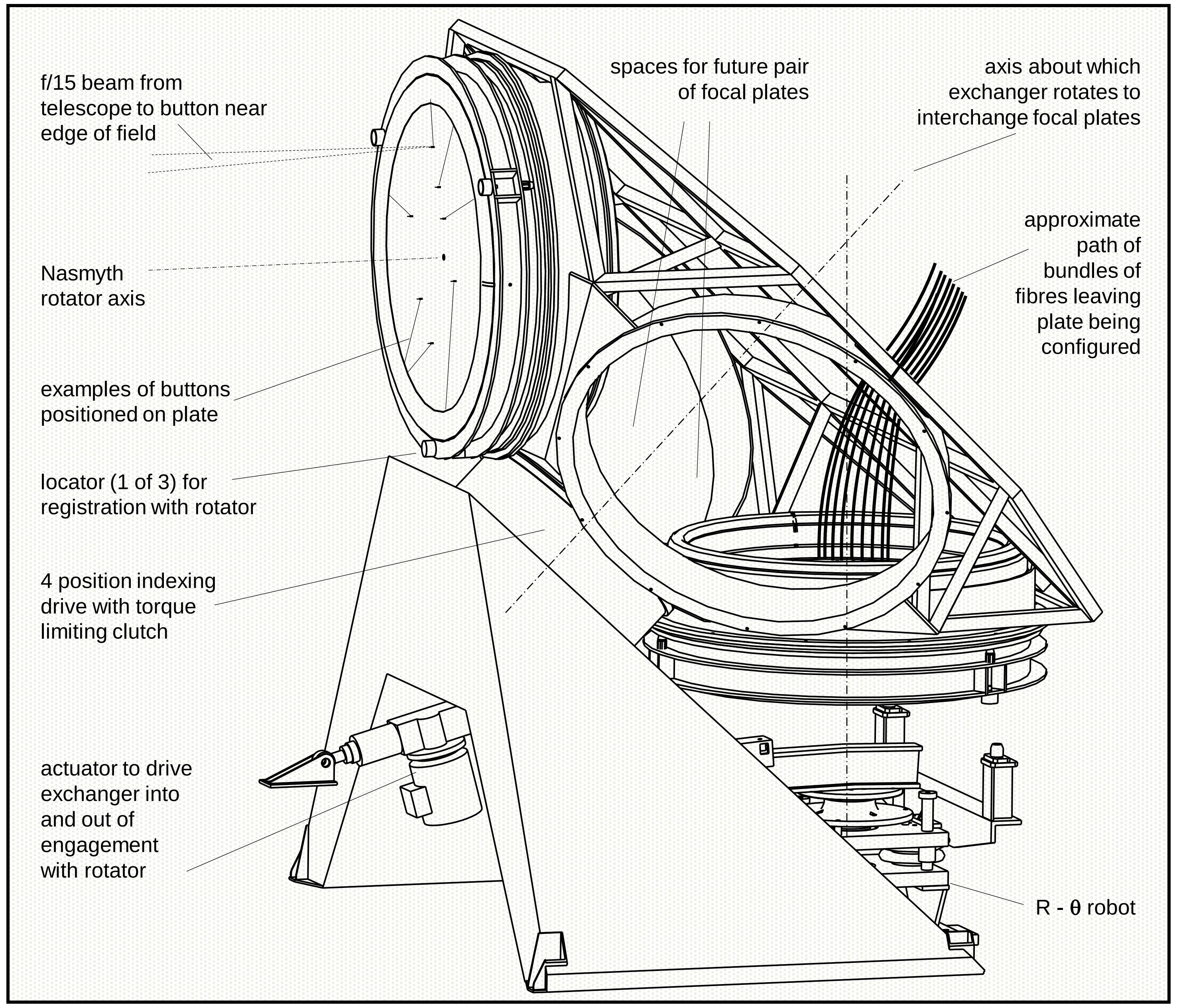


Figure 1. View of OzPoz showing the front of the focal plate in observing position.

OzPoz is a multi-fibre positioner to feed Nasmyth spectrographs on VLT UT2. Its concept follows that of the two degree field facility on the Anglo-Australian Telescope. Thus its fibres will be fed from prisms in buttons which attach magnetically to steel focal plates, a robotic system will position the buttons, and the plates will be interchanged so one is re-configured while the other is gathering starlight.

However, OzPoz has a number of novel features, most notably the use of a pneumatically operated gripper which relies for its accuracy and friction free rotation on air bearings. The robot motions also employ air bearings, with vacuum preloading.

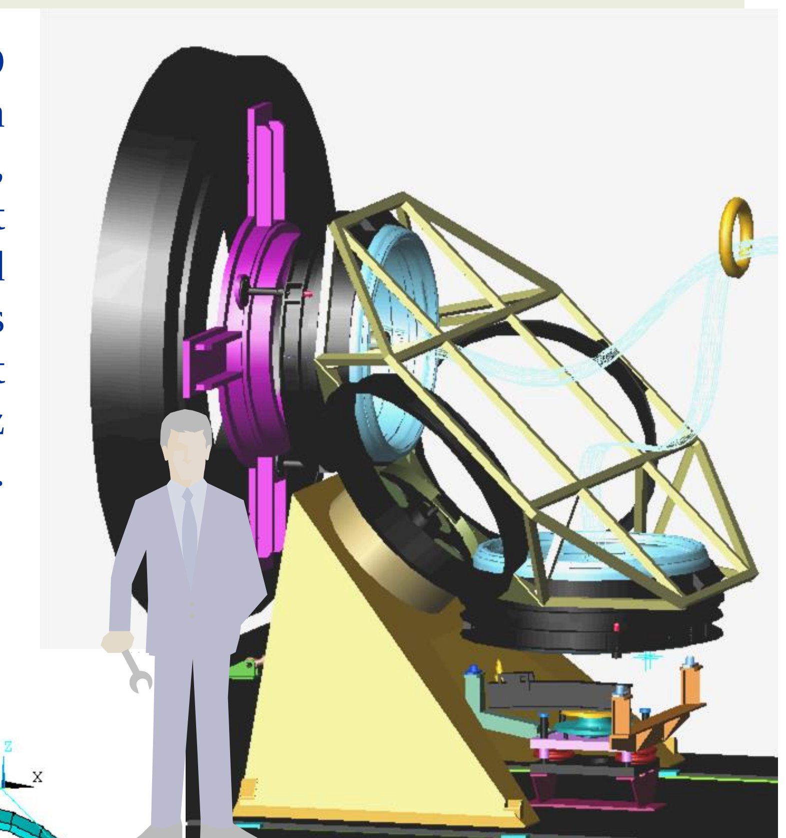
To interchange plates, the whole exchanger is driven on linear bearing rails several cm away from the VLT instrument rotator, with which it is engaged during an observation. Then the tumbler rotates 180° around its axis and the exchanger advances to engage the newly configured plate with the rotator. The positioner robot then rises into engagement with the plate to be re-configured and is ready to re-position buttons during observing with the other plate.

The focal surface behind the Nasmyth corrector is spherically curved so the focal plates are similarly curved. Partly on this account, the robot works in R- θ coordinates, the R motion being along an arc to match the focal plate.

As in 2dF, the fibres leading from the buttons are lightly tensioned in retractors, employing a moving pulley preloaded with a constant force spring.

The exchanger structure was changed from an earlier version in which the focal plates were supported on much smaller diameter bearings carried on cantilevered tubes, mainly to achieve higher natural frequencies of vibration and so minimise the risk of earthquake-induced damage.

Figure 2. CAD model of OzPoz on Nasmyth platform, with instrument rotator and corrector lens support but without the OzPoz enclosure.



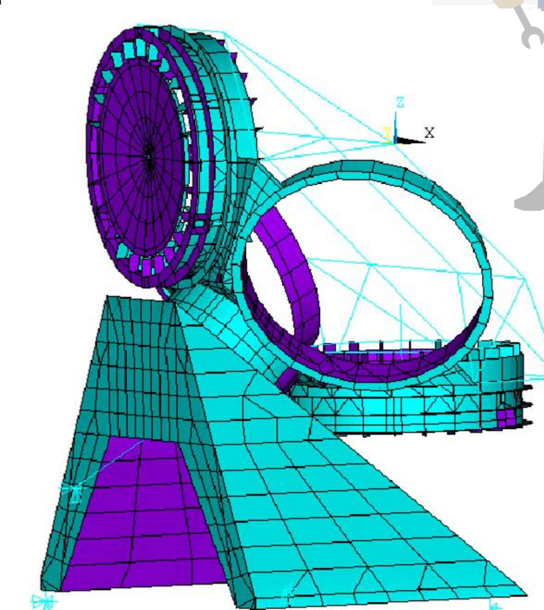


Figure 3. FEA model of exchanger created to check dynamic performance and stresses under earthquake loading.

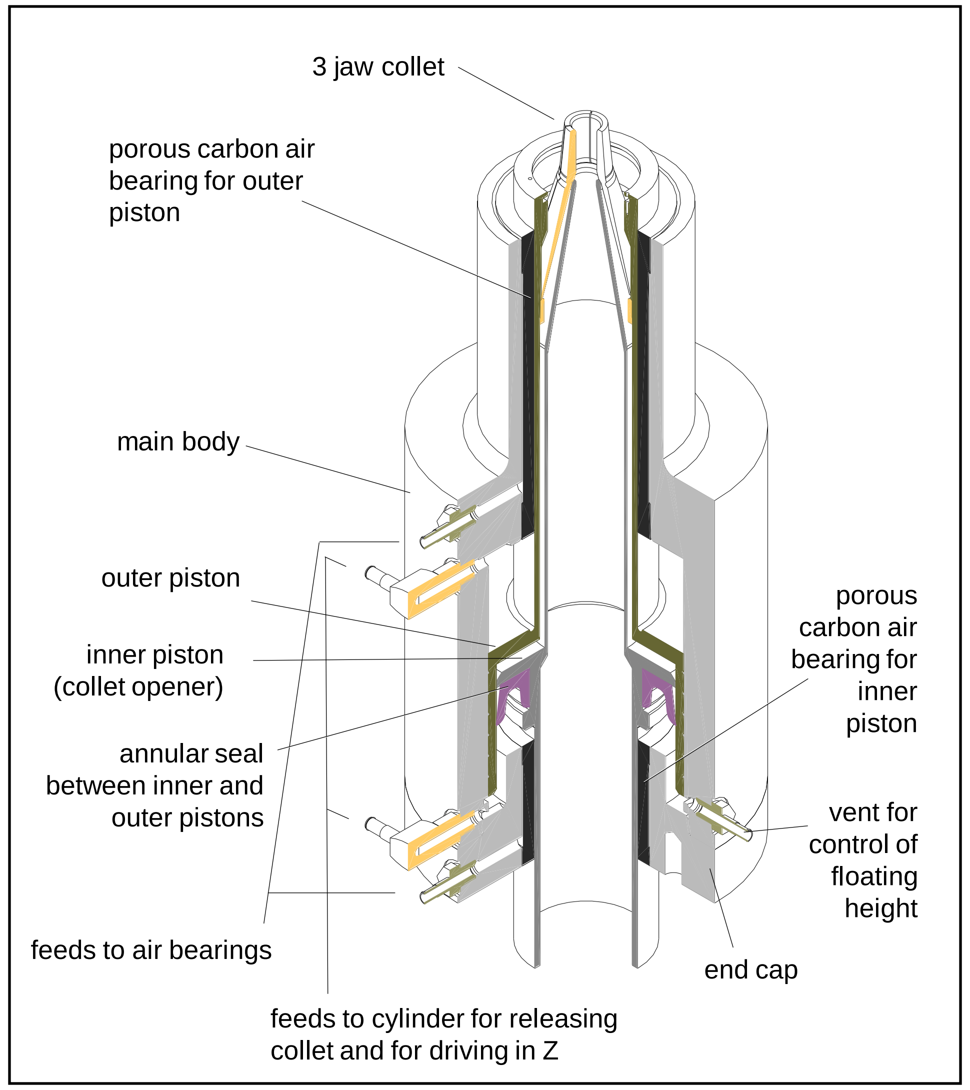
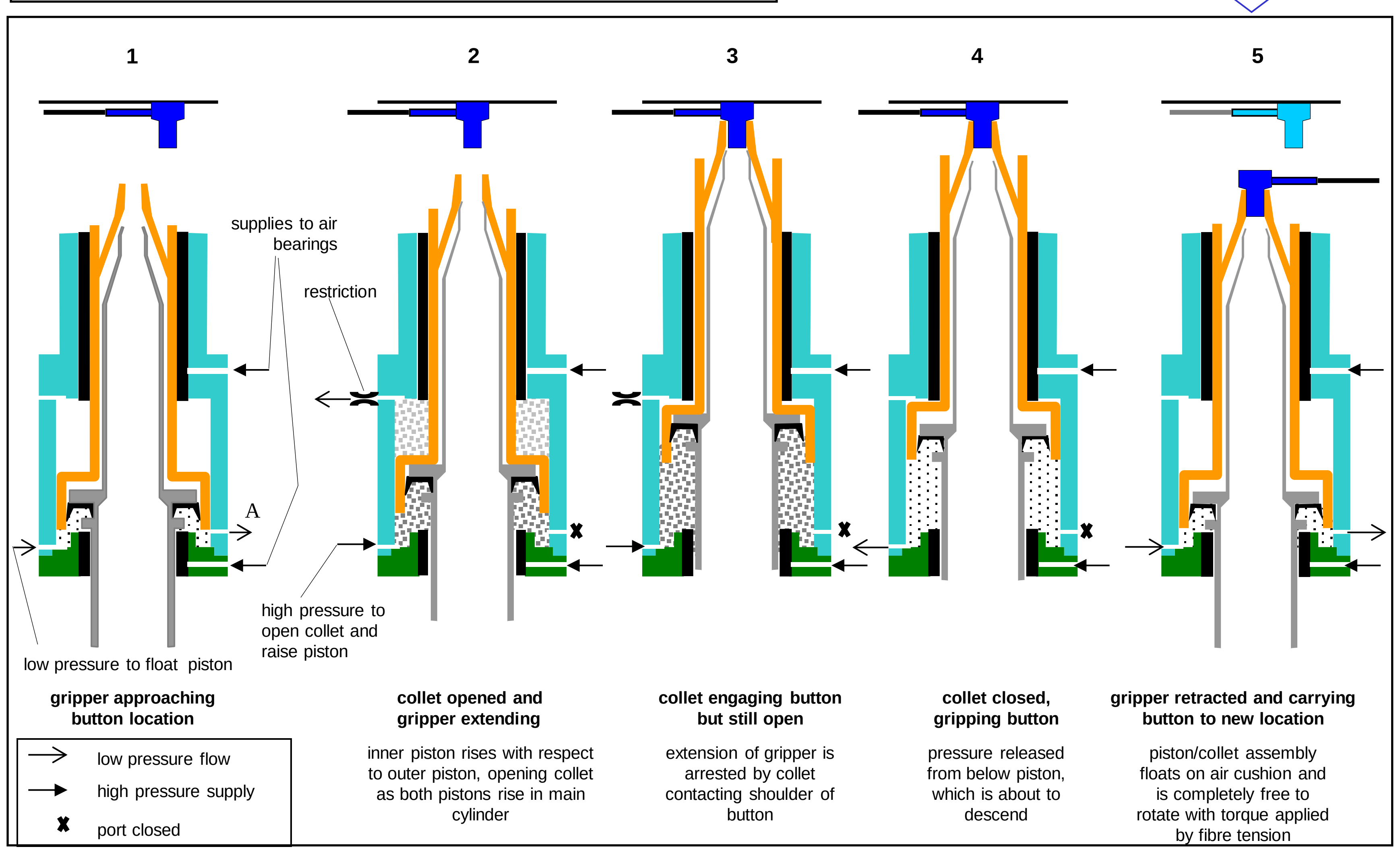


Figure 4. Section through gripper assembly with main components identified.

The gripper is operated pneumatically with solenoid valve control and its rotation is entirely free of static friction. While it is being carried to a new location, the button must rotate with respect to the R carriage. Rather than drive this rotation, it will be a natural consequence of the tension (of about 0.4N) on the fibre.

The bore of the collet is finish machined while the gripper piston rotates on its air bearing, to give very accurate concentricity. The prototype gripper repeated positioning of a button to better than 1µm.

Figure 5. Sequence of gripper operations during pick/place cycle. Not to scale; relative motion of collet and opener is greatly exaggerated.



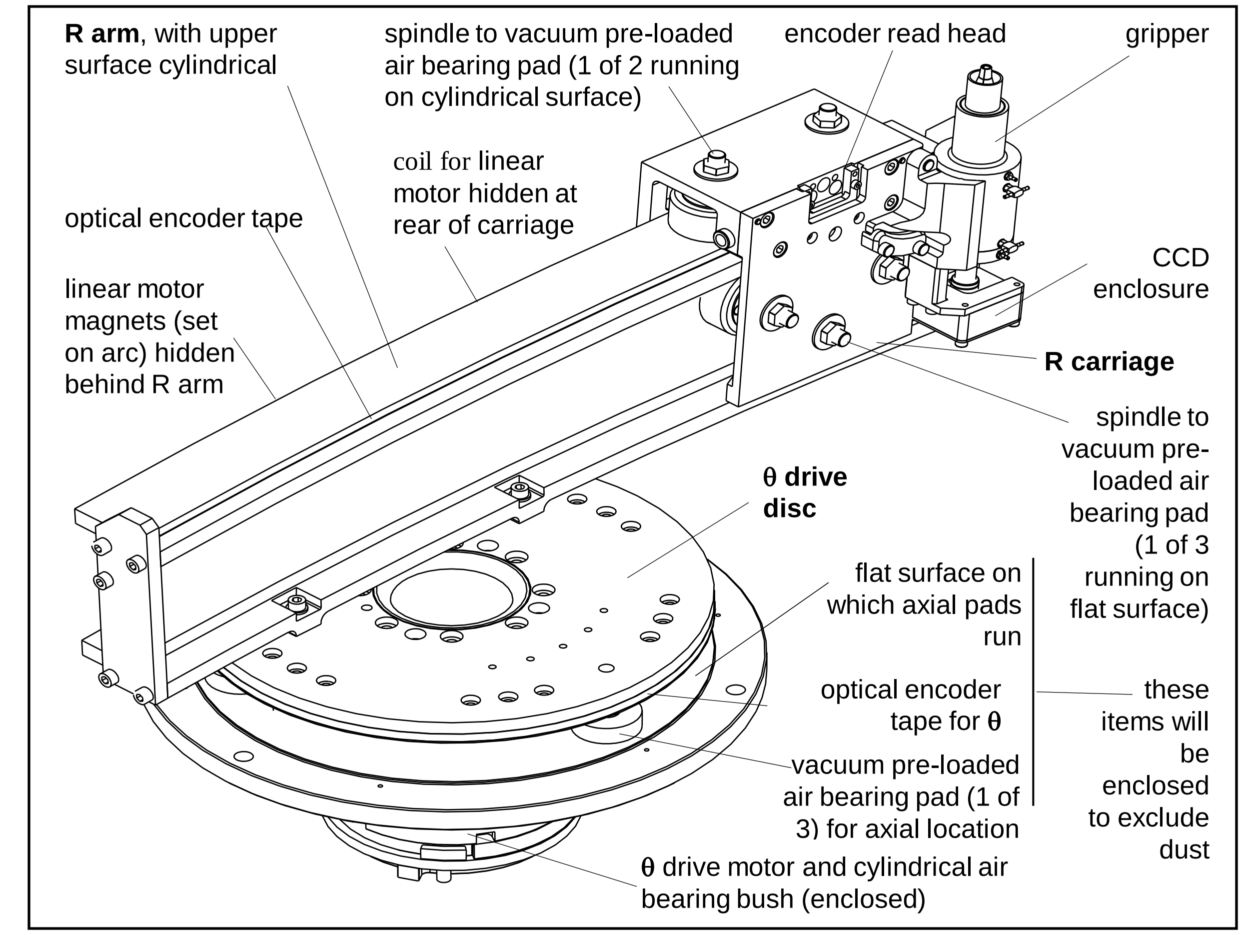


Figure 6. Details of R-θ robot.

The R carriage is kinematically guided against a flat surface and a cylindrically curved surface with vacuum pre-loaded air bearings. The θ motion is also constrained kinematically with air bearing pads and an air bush. An ironless linear motor is used in R and a brushless frameless torque motor for θ.

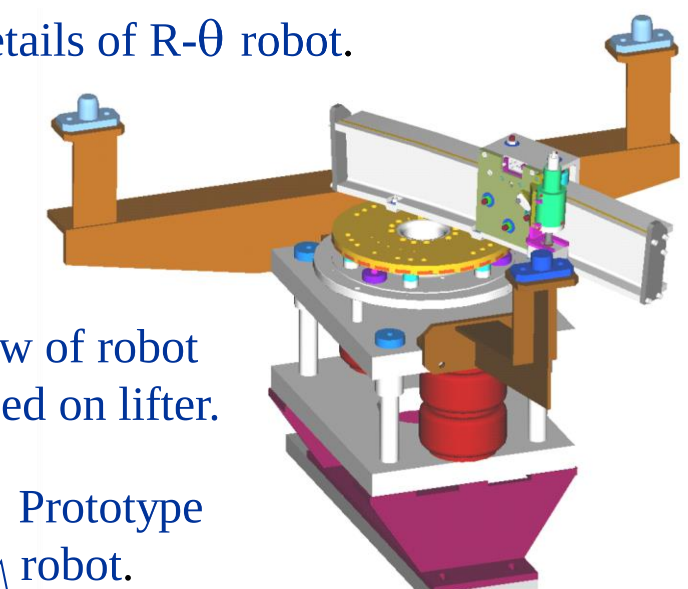
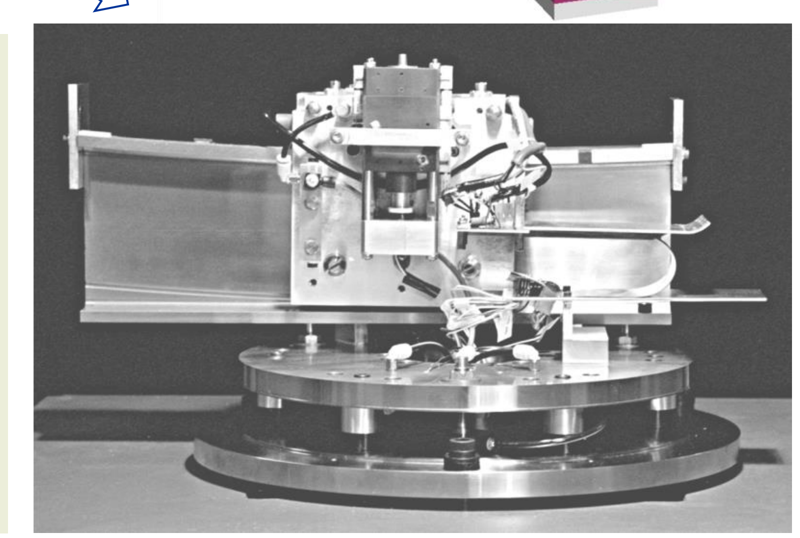


Figure 7. View of robot raised on lifter.

Figure 8. Prototype robot.



The prototype R drive moves 150 mm and settles to within 1µm (the encoder resolution) in less than 0.3 second.

The rms error in placement of buttons without iteration is predicted from a thorough analysis of the contributing causes to be < 4 µm, much better than the requirement in the VLT Nasmyth case.