

*EXTRACT FROM*

A Personal History of the  
Royal Greenwich Observatory  
at Herstmonceux Castle  
1948 – 1990

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Sidford, Devon: 2009

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## APPENDIX E. BUILDINGS, TELESCOPES AND EQUIPMENT

The aim of this appendix is to collect together the basic information about the various facilities and items of equipment used in the RGO. In particular it will try to give the dates of their development, building and use; brief descriptions if the name is not sufficient, and references to further information, especially to the main account. In some cases, I have given further detail to supplement that in the main account. I had hoped to give estimates of the costs of the new developments, but this does not appear to be possible. I have not found precise dates for some of the changes.

### E.1 Herstmonceux Castle and nearby buildings

#### E.1.1 The Castle

The Castle was built in c. 1440 for Sir Roger de Fiennes. Much of it was demolished in c. 1776. Rebuilding of the south wing started in 1911 for Col. Lowther, who used it until his death in 1929. The rebuilding of the other three sides was completed by Sir Paul Latham during the 1930s.

The Castle was used by Hearts of Oak Friendly Society during the war. Some temporary buildings were erected on the south side of the moat.

The Castle and the estate of 375 acres was bought by the Admiralty in 1946 for £76000. Work on adapting it for use by the RGO began in 1947. The Astronomer Royal and the General Office moved into the Castle in August 1948.

The ownership of the Castle and estate passed from the Ministry of Defence to the Science Research Council in 1965 and later to the Science and Engineering Research Council. It was bought by James Developments in May 1989 and it was sold to the Queen's University, of Ontario, Canada, in early 1993.

The initial uses by the RGO of the principal parts of the Castle are as follows.

The **AR's Residence** was in the north part of the east wing and in the north-east tower. The **AR's Office** was a large room in the south part of the east wing on the ground floor. The **General Office**, including the **Typing Pool**, was in the south-east tower; it subsequently took over the room that Spencer Jones had used for his office.

In 196? Woolley gave up some of the residence for use for offices and other purposes. The light-oak panelled lounge on the first floor was used for committee meetings and the dining room on the ground floor was eventually used for the first **Conservation Laboratory**. In 198? these rooms were converted to provide extra accommodation for visitors.

The deconsecrated **Chapel** in the centre of the east wing was used for lectures. In 1984 it was used for the **Airy Collection of Rare Books**.

The **Staircase Hall** in east part of the south wing was mainly used for presentations to staff and similar occasions, but it was sometimes used for committee meetings.

The **Drummer's Hall**, above the south gatehouse, was used mainly for interview boards for new staff and for some committee meetings.

The **Staff Dining Room** was in the west part of the south wing on the ground floor and the **Kitchen** was in the adjacent south-west tower. At first there was also a

temporary hut in the south-west corner of the courtyard that was used for the serving hatch, but this was removed in 195? and the window was replaced. The canteen manageress had a first-floor flat in the south-west corner. These rooms were used for the second **Conservation Laboratory** from 198?

The **Great Hall** in the west wing was converted for use as the **Library** from 195? by the addition of a balcony for additional book-stacks. The Minstrels Gallery was, at first, used for the librarian's office.

The rooms below the library was used by the **Chronometer Department** as rating rooms. These were later used for **Archives**. The rooms on the north side of the Library landing were used for Chronometer Department's office. These were later used for the librarian's office and for more Archives.

The **Long Gallery** on the first floor of the north wing was divided by wooden partitions for use as offices by the **Astrophysics Department**. The rooms below the Long Gallery were used by the **Meridian Department**. The partitions were removed in 1958? and the Long Gallery became also known as the **Ballroom**. It was used for conferences, etc, as well as for social events. The lower rooms were converted for use for the **Exhibition** in 1976.

The attic rooms above the Long Gallery were used for the **Women's Hostel** until 196?. Other attic rooms, and some first-floor rooms, were used for accommodation for night observers, or for storage, or were left empty. There was a **Dove Cote** in the south-east tower.

### E.1.2 Buildings near the Castle

Close to the West Entrance of the Castle was a house that was allocated to the Head Messenger. It was at the corner of a yard with the gardeners' 'shed' on one side and a garage for the AR's cars (official and personal) on the other. [I do not know when these were built, or extended.]

There was also a pair of modern semi-detached bungalows, usually referred to as cottages. One was allocated to the Leading Man of Works and the other to the Head Electrician. These were probably built in 1947/1948 by converting the garages used by guests of Sir Paul Latham..

There was also another house by the West Gate that was allocated to the Head Gardener. The **RGO Clubhouse** was built on the opposite side of the road by the gate in 1959-1960.

The **Nautical Almanac Office** occupied two 'huts' on the east and west sides of the South Courtyard. I suspect that were built specially for this purpose as it was Spencer Jones' intention that the NAO should use the attic rooms in the north wing. I suspect that they were built with breeze blocks. The hut on the west side housed for the punched-card equipment. It also had a store for other equipment. These huts were demolished early in 1958 after the NAO had moved to the West Building.

The large wooden huts on the south side of the road that linked the east and west gates were built for the Hearts of Oak Friendly Society during the ware. They were used for the **Chronometer Workshop** at the west end and there were two rooms for use by the RGO Sports and Social Club. (See appendix D.1.1) The Works Department used the huts for stores, but I believe that most were empty. There was a boiler room for heating in the wooden huts and, presumably, for the NAO huts as there was a

connecting pipe over the road. After demolition the site was used for surplus spoil from the construction of the West Building.

The **Men's Hostel** was on the south side of the wooden huts. (See section 2.1.2.1) This was probably built and demolished at the same time as the NAO huts.

There was a **sewage filter bed** to the south east of the huts. This was renewed to cope with a greater flow in 19??. An **electricity sub-station** was built in the same area in 19??. This was connected to two different supplies to reduce the risk of a complete loss of power.

There were **air-raid shelters** near the south-west corner of the moat. These were dug out and filled in 19??

## **E.2 Buildings in the West Building area**

The term 'West Building' referred originally to the three three-storey blocks for the NAO, Time and Chronometer Departments and, possibly also, to the single-storey buildings for the Engineering Department that were linked to it around the courtyard on the north side. Later, the term tended to be used for the northward extensions and even for the Garage and Works Pound that were further to the north, near the West Gate. There were farm buildings beyond the boundary on the west side, and there was an access road between the farm and the fields on the east side of this area.

### **E.2.1 The main part of the West Building**

Building work started in August 1954. Some time-service equipment was installed in 1957 and the buildings were occupied in October 1957 and onwards. There were two north-south spurs for the NAO and Time Departments and an east-west spur for the Chronometer Department. The NAO and Time spurs were 'staggered' as they were linked by the main entrance, which included a stairwell giving north-south views.

The basement of the NAO spur was above ground and was used for the punched-card system, for some offices and for stores for publications etc. The ICT 1201 computer replaced the punched-card machines in 1959, but in 1966 the ICT 1909 computer took over the whole of north end of the basement, displacing the publication store. This area was later used by the ICL 1903T and the VAX 750 computers. [Check the latter.] The top floor of the NAO spur included the NAO Library as well as the Superintendent's office, with its view over the Pevensy Levels to the English Channel and the South Downs, and the secretariat.

The Time spur had four storeys as there was a sub-basement that was completely below ground. This was used for a set of temperature controlled cubicles for the quartz-crystal oscillators, but these were superseded by caesium atomic frequency standards. This area was then used by the GALAXY measuring machine from 1972. The time-service control panels etc were on the basement level, while the ground floor was used for the Electronics Laboratory as well as for offices for the staff of the Time Department. They had to 'squeeze up' as the astronomers who were displaced from the Long Gallery were allocated to the top floor of the Time spur!

The Chronometer spur included a store for eclipse instruments, but this was used for the Chronometer Department from May 1962. The basement, which was mainly below ground, was used as a store for stocks of RGO publications and later for the Archives. It was converted to offices for the NHO team in 1976. The building had been designed to withstand enemy attack in the event of war and so it was a massive task to

drill through the reinforced concrete walls in order to make it possible to install windows!

The ‘atomic-clock cellar’ was at the south end of the Time spur; it was the full height of the sub-basement and the basement. It remained an empty hole for many years as the proposed atomic-fountain frequency standard was never built. A make-shift staircase was built in 1978? to allow it to be used a temporary store for the publications and archives that were displaced when the basement of the Chronometer spur was converted for use as offices. Later, in 198?, a new staircase and balcony was constructed so that it could be used properly for a much wider range of archives, including the solar-plate collection that covered 100 years of observations.

In about 1958 a wooden hut was built near the Time spur for the equipment for monitoring cosmic ray neutrons. It was, however, removed in 1969? when the programme was stopped. (See section 3.3.3)

A new east-west wing was added to the West Building in 1978. It was linked to the south end of the Time spur. Part of its above-ground basement was used for the VAX 780 computer and the associated image-processing facilities.

## **E.2.2 The northward extensions of the West Building**

The west side of the courtyard on the north side of the Chronometer spur contained a loading bay and the stores for the Engineering Workshop on the north side of the courtyard. There was a bicycle shed on the east side. The buildings were completed before February 1958, but flagstones around the car-park by the Time spur were still being laid then. In 19?? more car-parking spaces were provided in an area below the east wall of the original car-park.

Further north, the east-west single-storey Physics Building was completed in 1969. It was linked to the Engineering Workshop by a new Drawing Office in a similar north-south building. These buildings were separated from the main garage on the south side of the Works Pound by an access road, which was also used by farm vehicles. The buildings of the Works Pound were arranged around a square courtyard, with access by a short road just inside the West Gate. It included a stonemason’s workshop, carpenter’s shop, stores and a canteen for the industrial staff. It was probably completed in 1957, but it may have been earlier. It also included the boiler house for the heating of the West Building.

## **E.3 Telescopes and their associated buildings**

### **E.3.1 The Solar/SLR Dome**

The Solar Dome was situated on the brow of the hill to the south-west of the Castle. It was built by staff from the Chatham Dockyard and was completed in April 1949. (See section 2.3.1). Apart from the dome itself, there was small attached office on the north side and a coelostat leading to a cellar on the south side. The cellar was completed after the dome in ?? 1951.

The dome was used for a refracting telescope (aperture ?? cm), which was donated by ? Newbegin, and to which was attached a **photoheliograph** (aperture c. 23 cm) from Greenwich. The system was mainly used for taking daily photographs of the Sun, but the telescope was sometimes used at night, for example, for timing occultations of stars by the Moon. A Lyot H-alpha filter was fitted to it in 1954 for direct

observations of the activity on the Sun. (See section 2.3.2)

The main mirror of the coelostat had a diameter of ?? cm and it was used with two **spectrohelioscopes**, one from Newbegin and one from Greenwich.

[What were the dates of the telescope, photoheliograph and coelostat?]

Solar observations ceased in 1977. (See section 5.5.5) The dome was later converted for use for **satellite laser ranging**. (See section 5.5.6.3) The original conventional dome (with a slit) was replaced by a eyelid dome in February 1981 and a small radome (for a radar system) was added to the roof of the office, which became the control room for the SLR system. The original dome was given (?) to the Hampshire Astronomical Society.

The SLR telescope was installed in July 1981, but the associated equipment (laser, detector, timer, computer) was not commissioned completely until March 1983. (See section 6.4.3.2)

The SLR system continued in use at Herstmonceux after the move of the RGO to Cambridge. Changes were made to the equipment from time to time and GPS equipment was added. A small building for use for office accommodation was added to the south of the main building in 199?.

The **Meteorological Station** was built on the east hill, just off the road to the Equatorial Group, and was used from 1952 to 1956. (See section 2.3.4) It was later brought into use again by the Meteorological Office in 19??.

### **E.3.2 The Meridian/Spencer Jones Group**

The Meridian Group of astrometric instruments was to the north-north-east of the Castle, beyond the formal gardens. There was view down the valley and across the Pevensey Levels to the church at Pevensey, where an azimuth mark was set up. The Group was renamed the Spencer Jones Group in 195?.

The Pavilion for the **Cooke Reversible Transit Circle** was completed by November 1954 and the instrument was brought from Greenwich in ? 1955. The RTC was being commissioned at Greenwich at the outbreak of war in 1939 and commissioning continued from 1946 onwards at Greenwich. The first observations were made at Herstmonceux in 1956. (See 2.5.1, 2.5.2, 3.3.2.1) There was an azimuth mark with a lamp under a small wooden cover to the south in the field near to the cottages. There was a similar mark to the north. [?] There was an OS triangulation pillar close to the pavilion.

Observations with the RTC ceased in 1982. It was transferred to the Copenhagen University Observatory for use in developing software for La Palma.

There were two buildings for the operation of the **Photographic Zenith Telescope, or Tube, (PZT)**. A small one for the instrument itself and another for the control room. The latter also contained a lounge and kitchen for use by observers using the telescopes in the Group. The buildings were completed by November 1954.

The PZT was designed by Dr. D. S. Perfect, then in the Time Department at Abinger, and it was built by Grubb-Parsons at Newcastle. The first observations were made towards the end of 1955, and regular observations began in ?? 1956. (See 2.5.1, 2.5.2, 3.3.2.1).

Observations with the PZT ceased on 30 June 1984. The instrument is at the Science Museum, but I do not know the whereabouts of the control desk.

The fourth building in a group was for the **Bamberg small-transit instrument** that had been used for time determination at Greenwich, Abinger and then Greenwich. Abinger. The transit was used at Herstmonceux from April to October 1957 only. From 1960 to 1964 this small pavilion was used for a **Danjon prismatic astrolabe**, which also measured time and latitude. Later, it was used from time to time (?) by the Ordnance Survey after the astrolabe had been moved to South Africa for use there for a few years.

I believe that the PZT control building is now used as the estate office, but I do not know about the other buildings.

### E.3.3 The Equatorial Group

The Equatorial Group consists of 6 domes, which were referred to by the letters A to F, or by the names of the telescopes in them, and two laboratory blocks, A and B. The buildings and connecting walls are arranged in a rectangle. The north side, from west to east, consists of dome A, lab. A, dome B, lab. B. and dome C, while the south side, from west to east consists of only domes, D, E, and F. There are walkways, with steps in places, around the area between the domes and there is also an ornamental pool between domes B and E. There is a formal pedestrian entrance on the west side, through wrought-iron gates flanked by flint-faced retaining walls. Work on the buildings started in 1953 and was nearly completed by the end of 1956, when the installation of the Greenwich telescopes began. They were all mounted and working by September 1958.

Dome A contains the 30-inch Thompson reflector, which was originally brought into use in 1897. The mirror was refigured in 1960 and a new coude spectrograph, made by RGO, was installed in 1963.

Dome B contains the Yapp 36-inch reflector, first used at Greenwich in 1934.

Dome C was intended for a new Schmidt telescope, but was actually used for smaller telescopes (with varying success) until 1982 when the Hewitt satellite-tracking camera was installed in it.

The small telescopes that were installed in Dome C for short periods included: the Isaac Roberts' 20-inch reflector on loan from the Science Museum; from ??? until July 1961;

a Cooke 6-inch refractor (built in about 1874) in December 1965; and

the Steavenson 30-inch reflector, which was returned from the Cape; it was tested at Herstmonceux before use in Spain.

Dome D contains the 26-inch refractor that was presented by Thompson in 1892. This dome has a 'rising floor' as the telescope was mainly used for short exposures for the determination of stellar parallaxes.

Dome E contains a 13-inch astrographic refractor, which was obtained in 1890 for participation in the Carte du Ciel programme.

The large Dome F was designed for the 28-inch refractor which has a focal length of 28 feet and which was built in 1894. This telescope was returned to Greenwich in 1971. It was later used for the Hargreaves, or Congo, 38-inch reflector, which was built in about 1960. It was designed for use in various modes, but it did not perform well.

Laboratory block A contained the aluminising plant, which was designed to take the 36-inch Yapp mirror. It was first (?) used in 195? for a 1-m mirror for the Vatican Observatory. Both blocks contained optics laboratories.

### **E.3.4 The Isaac Newton Telescope**

Approval for the building of the Isaac Newton Telescope was given in 1946, but the design was not agreed until 1956. Work on the construction of the dome, on a site to the south of the Equatorial Group, began in March 1965 and the dome arches were fitted in February 1966. The exterior of the dome was finished by about June 1966, and the installation of the telescope began in September 1966. The telescope was in working order late in 1967 and was formally inaugurated by the Queen on 1 December 1967.

The telescope was taken out of service in 1979 and the parts were lifted out of the dome in June 1979 for eventual transfer to the island of La Palma.

See section 4.2.2 and other paragraphs in the main text for further details.

### **E.3.5 The Carlsberg Automatic Meridian Circle**

*The following note on the programmes of the CAMC was supplied by Leslie V. Morrison, 2005-02-05/ (See also sections 5.5.2.2 and 6.3.2.2)*

The CAMC was operated on La Palma jointly with Copenhagen University Observatory and the Real Instituto y Observatorio de la Marina en San Fernando, Spain until the closure of the RGO in October 1998. The good observing conditions on La Palma and the efficiency of the automated telescope enabled the CAMC to make over a million observations in the period May 1984 to May 1998 with a positional accuracy and limiting magnitude unprecedented meridian circles. The telescope was operated remotely via the Internet from April 1997 onwards. The programme of stellar positions included reference stars for the extension of the HIPPARCOS reference frame to magnitudes fainter than  $V=11$ , and the determination of positions and proper motions for various programmes in galactic kinematics, with particular emphasis on variable stars and high proper motion stars. Positions of the outer planets, their satellite systems and many minor planets were measured, mainly in support of space missions, such as the *Galileo* mission to Jupiter and the *Cassini* mission to Saturn. The collected observations were published in 1999 on a CD-ROM by the three participating institutions.

## **E.4 Scientific equipment (except telescopes)**

### **E.4.1 Computing and related equipment**

#### **E.4.1.1 Pre-electronic period**

In 1949 the NAO brought its calculating equipment from Bath. At the time the most common desk machine was the **Brunsviga 20**, so named because the product register held 20 digits. This was a manually operated machine as was the Facit calculator, which was also in use. It had 2 electromechanical calculators, made by the American companies, Marchant and Friden. (See section 2.2.6.1)

The NAO also had two ‘**National machines**’; these were commercial accounting machines made by the National Cash Register Company. One worked in

decimal arithmetic and the other was adapted for sexagesimal arithmetic. These could print the results of building up the successive lines of a table. (See section 2.2.6.3)

The NAO obtained its own set of **punched-card machines** in 1951 on hire from the British Tabulating Machine Company. The system was supplemented by an IBM 602A calculating punch. (See section 2.2.6.4 &.5)

As far as I am aware none of the other departments of the RGO used calculating machines to any significant extent. The NAO did, however, carry out some work for the Meridian Department, and possibly for others, on the punched-card machines.

#### **E.4.1.2 Main-frame and mini computers**

An **ICT 1201 electronic computer** was installed in the NAO in 1959 for general use. (See section 3.3.1.2) It was taken out of service in September 1965 and was replaced by an **ICT 1909 computer** in May 1966. (See section 4.2.1) (In the meantime, use was made of IBM 7090 series computers in London.) It had four 7-track magnetic-tape drives.

A **GEC 2050 computer** was installed in June 1973 for use in a link to the ICL 1906A computer at the Atlas Computer Laboratory (Chilton). It continued in use until June 1983. (See section 5.5.3.1)

The 1909 was enhanced in several ways, including the addition of two 9-track tape drives and exchangeable-disc storage units. The central processor was replaced by an **ICT 1903T** unit in January 1974. (See section 5.5.3.1) It was taken out of service in March 1983.

A **VAX 11/780** was installed in March 1980 for image processing as part of the STARLINK network. A **VAX 11/750** was installed for general purpose computing was installed in March 1982. (See section 7.3.2.3)

A Calcomp 1039 drum plotter was shared between the ICT and VAX computers.

Mini-computers included:

An Interdata 7/16 was installed in 197? for use with instruments on the Yapp telescope; replaced in 1980 by an Interdata 7/32. Another was obtained for the INT.

A PDP 11/34 was installed in 1979 for use with the PDS microdensitometer.

A Nova was used with GALAXY (see below).

#### **E.4.1.3 Programmable calculators and personal computers**

I do not know how early in the 1970s hand-held programmable calculators became available and were first used in the RGO, but the NAO first published data for them in 1981.

Programmable desk calculators also became available in the 1970s. A PET was used in the Time department in 1979 [236] and a PET may have been tried in the NAO. Other types may have been used by Dickens and others in the research teams. (See section 5.5.3.2)

IBM Personal Computers (or compatibles) were first obtained in 198?. (See section 6.3.2.3)

#### **E.4.1.4 Auxiliary equipment for printing**

An IBM card-controlled typewriter was installed in March 1953 to produce high-quality copy for printing the Nautical Almanac and other publications. (See section 2.2.6.6) It was replaced in 1963 by a new system that was based on the IBM 870 Document Writing System. (See section 3.3.1.2)

The typists used Varitypers for the production of high-quality copy for scientific papers. (See section 2.6.4)

[Did the typing pool change to Flexowriters or other systems?]

The card-controlled typewriter was replaced in 1971 by a more flexible UDS 6000 Automatic Writing System, which used paper tape rather than punched cards for input. (See section 4.3.4.2)

Two Data Logic word processors were installed in February 1980. (See section 5.5.3.3)

Diamond word processors were introduced in 198?. (See section 6.3.2.3)

The special-purpose word processors were eventually replaced by IBM-compatible personal computers.

#### **E.4.2 Measuring machines**

It is probable that many items are missing from the following list as I did not attempt to note their acquisition and use when drafting the main account. The earliest measuring machines were used manually, but they were replaced by electronic systems. At present, I am not aware of any book or paper that reviews such essential equipment.

[Note: a microdensitometer measures the variations in density over an exposed photographic plate (e.g. of a spectrum), whereas a microphotometer is a microdensitometer that has been calibrated to give measurements of the initial intensity of the light that fell on the plate.]

The D-Mac digitising machine was not strictly a measuring machine as it was designed for the digitisation of graphical material for input to a computer. It was also used for the pre-processing of plates for GALAXY.

GALAXY = General Automatic Luminosity and XY. This large system was developed at the ROE and the second model was obtained by RGO in 1972. It was housed in the sub-basement of the Time spur of the West Building. It ceased operation in 198?. (See section 5.5.2.3 and AR 75) [Where did it go?]

PDS microdensitometer (linked to a PDP 11/34 computer). (See AR 75).

Zeiss Ascorecord measuring machine with automatic digital readout, for astrometry. (See section 3.3.2.1).

Coradograph, linked to GALAXY via Nova computer

#### **E.4.3 Instruments for telescopes**

See remark for E.4.2

The following items were designed and built by RGO:

An image-tube spectrograph in 1970 for the Radcliffe Observatory.

An image-tube spectrograph in 197? for use on INT (?) and 36-inch.

An electronographic camera – first test September 1974.

A spectrograph for the Anglo-Australian Telescope (AAT).

A CID = charge-injection device camera – first test April 1980.

A CCD = charge-coupled device detector – first test ???.

Prime focus camera for WHT on La Palma; in 198?.

CCD detectors for WHT; in 198?

Faint-object spectrograph (FOS) for WHT; in 198?

#### **E.4.4 Workshop facilities**

The Engineering Workshop was moved from Greenwich to Herstmonceux early in 1958. It built up a comprehensive range of machines and tools for construction of instruments of high precision. I do not know whether any of them were unusual, but it did have a telescope simulator that would not have been found elsewhere! This was built in 198? so that it was possible to test large and heavy instruments in situations that were similar to those on telescopes in use.

The Electronics Department transferred from Abinger in 1957. The new workshop was in the Time spur since at first it was primarily concerned with the maintenance and development of the equipment for the Greenwich Time Service. The Physics Building, which came into use in November 1969, also had facilities for the construction and maintenance of sophisticated electronic devices.

#### **E.5 The gardens and grounds**

In addition to the buildings described above the Herstmonceux estate contained the following non-technical facilities that were enjoyed by the staff:

formal gardens, parkland, and woodlands (see section 2.7.4.2);

a hard tennis court at the end of the formal garden;

a swimming pool (after 1975 – see end of section 5.3) ;

and a sports-field (see above and appendix D.2).

The gardens and grounds were open to the public at certain times. A very large number of trees were planted in the early years. The rest of the estate was rented out for farming.

I have a several hundred slides of the gardens and grounds, as well as a smaller number of the buildings. Almost all have titles and dates and so I hope that they will be included in the RGO archives.