COMPUTER - CONTROLLED ASTRONOMICAL TELESCOPE 800 MM RITCHEY-CHRETIEN OPTICS

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ASTRONOMICAL TELESCOPE - 800 MM RITCHEY-CHRETIEN OPTICS

THIS TELESCOPE SYSTEM IS REPRESENTATIVE OF A NEW GENERATION OF MODERN, FULLY COMPUTER-CONTROLLED RESEARCH AND EDUCATIONAL ASTRONOMICAL INSTRUMENTS, AVAILABLE WITH MANY OPTIONAL FEATURES TO SUIT EVERY INSTITUTION REQUIRING HIGHLY SOPHISTICATED YET EASILY MANAGABLE TOOLS FOR EDUCATION AND RESEARCH IN ASTRONOMY. THE TELESCOPE SYSTEM WAS DESIGNED WITH THE NEEDS OF TODAY'S SCIENTIST, EDUCATOR AND STUDENT IN MIND:

* VERSATILITY * HIGH PRECISION * THE LATEST TECHNOLOGICAL FEATURES
* RUGGED, YET EASILY HANDLED BY CONSTANTLY CHANGING OPERATORS *

OPTICS: THE TELESCOPE SYSTEM FEATURES A COMPUTER RAY-TRACED WIDE-ANGLE RITCHEY-CHRETIEN OPTICAL SYSTEM OF ZERODUR (SCHOTT) OPTICS WITH EASY ACCESS TO EVERY FOCUS POSSIBLE

1. A FAST PRIME FOCUS OF F/3,5 WITH DIFFERENT CORRECTORS FOR PHOTOGRAPHIC APPLICATIONS WITH A FIELD OF 2.5 DEGREES.
2. FIRST SECONDARY FOCUS AT F/10 EITHER THROUGH THE PRIMARY OR AT THE END OF THE DECLINATION AXIS, VIA A TERTIARY FLAT FOR PERMANENT INSTRUMENTATION MOUNTING, A FIELD OF 1.5 DEGREES FOR PHOTOGRAPHY IS ACHIEVED.
3. SECOND SECONDARY FOCUS AT F/30 FOR LONG FOCAL LENGTH WORK. THIS IS ALSO AVAILABLE EITHER THROUGH THE PRIMARY OR AT THE END OF THE DECLINATION AXIS.
4. COUDÉ FOCUS AT F/120 THROUGH THE DECLINATION AND POLAR AXIS WITH ACCESS TO A SEPARATE COUDÉ ROOM BELOW THE TELESCOPE.

ALL SECONDARY FOCI ARE MOTORIZED AND CONTROLLED EITHER VIA CONTROL CONSOLE, OPERATOR'S HAND-PANEL OR BY COMPUTER WITH MEMORY SETTINGS FOR DIFFERENT FOCI. UNDER COMPUTER CONTROL, THE FOCUS IS CONSTANTLY MONITORED.

THE OPTICS ARE MANUFACTURED TO SWISS PRECISION QUALITY, MADE OF ZERO-EXPANSION CERAMIC MATERIAL ZERODUR (SCHOTT/W-GERMANY) AND MOUNTED WITH EXTREME CARE TO AVOID TENSION AND FLEXURE. THE PRIMARY RESTS ON AN AIR CUSHION CELL WITH CONSTANT FORCE LATERAL SUPPORT.

MOUNT: THE MODERN DESIGN OFF-AXIS MOUNT FEATURES A SHORT DECLINATION AXIS TO ALLOW ACCESS TO THE POLAR AXIS FOR THE COUDÉ BEAM AND PERMANENT INSTRUMENTATION MOUNTED AT THE END OF THE DECLINATION AXIS.

THE MOUNT IS OF EXCELLENT STABILITY AND INTENDED FOR HEAVY PAYLOADS (500 KG OR MORE) WITH A MINIMUM OF FLEXURE.

DECLINATION AXIS: RESTS IN A PAIR OF HIGH PRECISION X-ARCHED BALL BEARINGS OF DIFFERENT DIAMETERS TO DISTRIBUTE THE VARYING LOADS.

POLAR AXIS: OF EXTRA LARGE DIAMETER HEAVY STEEL TUBING, RESTS ON TWO POLISHED SELF-ALIGNING ROLLERS AS NORTH BEARINGS, SUPPORTING THE POLISHED RING (1:10) ON THE POLAR AXIS. A LARGE ROLLER BEARING ACTS AS SOUTH BEARING. THE ENTIRE MOVING WEIGHT IS OVER 7 TONS AND EVENLY DISTRIBUTED ON A TRIANGULAR BASE TO PROVIDE OPTIMUM RIGIDITY.

DRIVES: THE DRIVE MECHANISM FOR EACH AXIS CONSISTS OF A SINGLE DC SERVO MOTOR FOR SLEWING, SETTING AND GUIDING WHICH IS ELECTRONICALLY CONTROLLED FOR FAST SLEW SPEEDS UP TO 180 DEGREES PER MINUTE. THE DRIVE MOTORS CAN BE CONTROLLED MANUALLY FROM THE CONSOLE, THE OPERATOR'S HAND-PANEL, OR BY COMPUTER VIA HIGH RESOLUTION AUTOMATIC GUIDE CONTROL.

COMPUTER CONTROL:

ALL TELESCOPE CONTROLS ARE EFFECTED EITHER MANUALLY FROM A LARGE CONTROL CONSOLE WITH WORKING AREA FOR CHARTS, ETC. OR BY A 16-BIT HONEYWELL MINI-COMPUTER VIA TERMINAL AND MONITORS LOCATED IN

(A) THE CONSOLE INSIDE THE DOME
(B) AN OFFICE BELOW THE DOME
(C) THE COMPUTER ROOM.

LOCATIONS (B) AND (C) WERE CREATED TO AVOID OPERATOR INTERFERENCE RESULTING FROM FATIGUE AND TO REDUCE AIR TURBULENCE INSIDE THE DOME. IN THESE THREE LOCATIONS, DATA ON ALL NECESSARY FUNCTIONS IS DISPLAYED VIA VIDEO TERMINALS. THIS DATA INCLUDES:

POSITION: ALPHA AND DELTA COORDINATES, ACTUAL AND TRUE, WITH PRESET, REFRACTION AND ERRORS, HOUR ANGLE
TIME: UNIVERSAL AND SIDEREAL TIME
FOCUS: FOCUS POSITION FOR DIFFERENT SECONDARIES
DOME: DOME POSITION AND DOME SLIT POSITION
ATMOSPHERE: OUTSIDE TEMPERATURE, DOME INSIDE TEMPERATURE, PRIMARY AND SECONDARY MIRRORS, WITH TEMPERATURE GRADIENTS, HUMIDITY AND PRESSURE
COUNTERWEIGHT: POSITION OF CENTRAL COUNTERWEIGHT
TIMER: STOPWATCH IN FIVE FUNCTIONS TO 1/100 OF A SECOND
ALPHA-BRAKE: ALPHA-AXIS BREAK POSITION (ON/OFF)

COORDINATES: COORDINATE PRESETTING CAN BE DONE BY HAND ON THE CONTROL CONSOLE VIA ROTARY SWITCHES FOR BOTH AXES, OR BY STORED DATA INSIDE THE COMPUTER. REFERENCE FOR POSITION IS THE SAO STAR CATALOGUE STORED ON MAGNETIC TAPE COMPRISING 258’000 STARS.

READOUTS: ALL READOUTS ARE IN LARGE ORANGE LEDS, EASILY READ FROM ACROSS

THE DOME, INCREMENTAL POSITION ENCODERS ASSURE PRECISE READOUT TO 1 SECOND OF TIME AND 1 SECOND OF ARC IN ALPHA AND DELTA, RESPECTIVELY.

SOFTWARE: COMPUTER PROGRAMS PROVIDE POSITIONING AND OBSERVATIONAL DATA STORAGE FOR AN ENTIRE NIGHT'S WORK WITH FULLY AUTOMATED CONTROL OF ALL FUNCTIONS OF DOME, TELESCOPE, AND ATTACHED INSTRUMENTS.

ON-LINE DATA PROCESSING: BESIDES POSITIONING, THE COMPUTER PROVIDES ON-LINE DATA ACQUISITION AND REDUCTION TO AID THE ASTRONOMER IN HIS TIME SCHEDULE, IMPORTANT INFORMATION CAN BE PROCESSED WHILE MEASURING IS IN PROGRESS, ALLOWING FOR ADJUSTMENTS DURING THE NIGHT FOR THE MOST EFFICIENT DATA TIME HANDLING,

FOR THE EDUCATOR AND STUDENT, THE COMPUTER IS AN INVALUABLE TOOL FOR EFFICIENT HANDLING OF THE OBSERVATIONAL PROGRAM DUE TO THE VAST AMOUNT OF OBJECT DATA STORAGE IN THE S.A.O. STAR CATALOG, OBLIVIATING THE TEDIOUS SEARCH FOR NEW OBJECTS

MODULARITY: THE ENTIRE TELESCOPE SYSTEM IS OF MODULAR DESIGN FEATURES CAN BE ADDED AT SOME LATER DATE AS THE DEMAND ON THE INSTALLATION INCREASES (SCANNERS, DIGITAL IMAGE PROCESSING, PLOTTERS, CCD CAMERAS, TV MONITORS, PHOTOMETERS, SPECTROGRAPHS, ETC.)

FLEXIBILITY AND VERSATILITY: ARE THE BASIC DESIGN CONCEPTS THAT ALLOW CUSTOMIZING OR AFOREMENTIONED PARAMETERS; NAMELY: OPTICALLY, MECHANICALLY, AND THE SOFTWARE SIDE OF THE TELESCOPE SYSTEM.

LARGER AND SMALLER PRIMARY MIRROR SIZES WITH DIFFERENT OPTICAL CONFIGURATIONS AND OTHER TYPES OF MOUNTS (FORK, ETC.) CAN BE QUOTED. FOR MORE DETAILED INFORMATION PLEASE CONTACT:

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TECHNICAL DESCRIPTION
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800 MM RITCHEY - CHRETIEN TELESCOPE
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DESIGN BY ARTHUR SUTSCH, ALTERSWIL/SWITZERLAND

OPTICS:

DIAMETER OF PRIMARY MIRROR 800 mm
CENTRAL BORE 180 mm
THICKNESS 150 mm
APERTURE AND FOCAL LENGTH OF PRIMARY MIRROR F / 3.5 OR F = 2775 mm
MATERIAL : DURAN 50 OR ZERODUR (EQUIVALENT TO PYREX AND CERVIT, RESP.)

OPTICAL SYSTEM: RITCHEY-CHRETIEN, COMPUTER RAY-TRACED OPTICS,
PRIMARY FOCUS PHOTOGRAPHIC ACCESS WITH 5" x 7" PLATES,
1.5 DEGREES FIELD WITH CORRECTOR,

FIRST SECONDARY MIRROR DIAMETER 275 mm, AT γ= 3
MIRROR SEPARATION 1925 mm
FOCAL PLANE 550 mm BEHIND PRIMARY MIRROR,
MATERIAL OF SECONDARY: ZERODUR
EQUIVALENT SYSTEM FOCAL LENGTH F1 = 8250 mm OR F/10.13
FIELD: 1.10 DEGREE WITH CORRECTOR (2 LENS)

SECOND SECONDARY MIRROR
DIAMETER 150 mm, γ = 8,727
MIRROR SEPARATION 2411 mm
MATERIAL: ZERODUR

EQUIVALENT SYSTEM FOCAL LENGTH F2 = 24 000 mm OR F/30
FIRST TERTIARY FLAT MIRROR FOR OBSERVING THROUGH DECLINATION AXIS
OPPOSITE POLAR AXIS (MODIFIED NASMYTH FOCUS),
DIAMETER MINOR AXIS 125 mm, MATERIAL: ZERODUR.

SECOND TERTIARY FLAT MIRROR FOR REFLECTING BEAM INTO POLAR AXIS FOR
COUDE CONFIGURATION, DIAMETER OF MIRROR MINOR AXIS 125 mm,
MATERIAL: ZERODUR.

ALL OPTICS FIGURED UNDER **CAUSTIC (AUTO-COLLIMATION) TEST AND HARTMANN TEST**
TO EQUIVALENT OF λ/10 AT λ(eff)= 5600 Å.

TUBE ASSEMBLY

TUBE DIAMETER 1100 MM, CLOSED TUBE DESIGN, LENGTH 2500 MM

CONSTRUCTION: QUARTZ, GLASS-FIBRE RE-INFORCED TUBE 24 MM THICK.

PRIMARY CELL WITH AIR CUSHION MIRROR SUPPORT SYSTEM.

SECONDARY FOUR-VANE SPIDER WITH 230 MM DIAMETER ACCESS TUBE TO PRIMARY FOCAL PLANE AND QUICK CHANGE SECONDARY CONFIGURATION. ELECTRIC SECONDARY FOCUSING REMOTE OR AUTOMATIC CONTROL WITH LED DISPLAY IN CONTROL CONSOLE. PERMISSABLE SECONDARY TRAVEL: 9.45 MM FOR F/3.5 PRIMARY.

BAFFLE FOR PRIMARY AND SECONDARY MIRRORS.

REAR PRIMARY CELL PLATE 230 KG FOR INSTRUMENTATION ATTACHMENT (IN EXCESS OF 500 KG) VIA PRE-DRILLED, THREADED HOLE PATTERNS.

EYEPIECE HOLDER WITH INTERIOR DIAMETER 175 MM, RACK AND PINION FOCUSING, TRAVEL 100 MM WITH QUICK LOCK MECHANISM.

FOCAL PLANE CAMERA 5" x 7" PLATE ATTACHMENT AND OFF - AXIS GUIDER WITH ILLUMINATED RETICLE FOR MANUAL GUIDING OR ELECTRONIC REPLACEMENT PACKAGE FOR AUTOMATIC GUIDING DURING EXPOSURE (UP TO 8 MAGNITUDO VIS).

FILTER HOLDER FOR 5" x 7" PLATES.

OFF-AXIS GUIDER CAN BE ROTATED AROUND FIELD OF VIEW FOR FINDING SUITABLE GUIDE STAR.

MOUNT - OFF-AXIS EQUATORIAL SINGLE POLAR AXIS MOUNT:

POLAR AXIS: LENGTH 2700 MM, DIAMETER 550 MM
SOUTH ROLLER BEARING DIAMETER 200 MM.
NORTH BEARINGS: ROLLER DRIVE MECHANISM WITH RING/ROLLER 918 mm / 91.8 MM RATIO (1:10), ROLLERS RIDE IN MATCHED CONICAL BEARINGS AND ARE SELF-ADJUSTING TO PROVIDE EVEN LINE PRESSURE ON RING 95 MM WIDE MADE OF HARDENED STEEL, POLISHED, ALPHA RING CAN BE LIFTED OFF ROLLERS BY HYDRAULIC BRAKE SHOE TO ALLOW SERVICING ROLLERS AND DRIVE.

COUNTERWEIGHT IS ATTACHED TO POLAR AXIS DIRECTLY ABOVE DRIVE TRAIN ASSEMBLY TO ALLOW FREE ACCESS TO DELTA AXIS (MODIFIED NASMYTH FOCUS) ON OPPOSITE SIDE OF TUBE FOR PERMANENT MOUNTING OF INSTRUMENTATION. ELECTRIC POSITIONING OF 300 KG (140 MKG) WITHIN COUNTERWEIGHT PERMITS BALANCING OF TELESCOPE WITHIN SPECIFIED PARAMETERS WHEN ADDING HEAVIER/LIGHTER INSTRUMENTATION TO TUBE ASSEMBLY WITHOUT REMOVAL OR ADDITION OF EXTRA COUNTERWEIGHTSI MIRROR CELL BACK PLATE AND COUNTERWEIGHT ARE KEPT FREE FROM ADDED WEIGHTS.

TUBE BALANCING IS DONE FRONT/REAR VIA TWO TUBES CONTAINING 50 KG LEAD WEIGHTS THAT CAN BE DISPLACED ALONG 1200 MM RAIL TO OFFSET IMBALANCE IN PRIMARY/SECONDARY INSTRUMENTATION.

SCHMIDT CAMERA DIAMETER 300 MM F=1400 MM F/2.2 FURTHER INSTRUMENTS INCLUDE A 6” REFRACTOR WITH 5.5 DEGREES FIELD ON 70 MM DIAMETER PLATES.

310 MM CASSEGRAIN F/15 IS MOUNTED OPPOSITE A GUIDE AND DEMONSTRATION TELESCOPE DURING PRIMARY FOCAL PLANE PHOTOGRAPHYI

DELTA AXIS DIAMETER IS ALSO 550 MM WITH TWO SPECIAL X-ARCHED DOME BEARINGS 25" AND 18" DIAMETER, PRELOADED AND PERMITTING LIGHT BEAM ACCESS TO POLAR AXIS.

BASE TRIANGULAR STEEL PLATE AND TUBE DESIGN WITH ALIGNMENT SCREWS FOR POLAR AXIS ADJUSTMENT RESULTING MOUNT/TELESCOPE MOMENT LIES WITHIN BASE THUS ALLOWING FREE STANDING OF TELESCOPE WITHOUT SECURING MOUNT TO FOUNDATION.

DRIVES SINGLE DC SERVO CONTROL MOTORS AT 500 VA POWER FOR ALPHA AND DELTA AXIS (BBC AXEM MOTORS), THE ALPHA MOTOR DRIVES TWO PRECISION WORM AND BRONZE GEAR ASSEMBLIES THROUGH A 1 : 14 REDUCTION CONICAL GEAR BOX ON BO TH ROLLERS TO MINIMIZE GEAR TRAIN ERRORS (REDUCTION IN WORM GEAR ASSEMBLY IS 1:2140) SLEW RATE IS 180 DEGREES IN 2 MINUTES. DELTA MOTOR DRIVES 820 MM WORM GEAR ASSEMBLY FOR SLEWING AND SETTING.

COORDINATE READOUTS COORDINATE DISPLAY IS REALIZED VIA INCREMENTAL SHAFT

ENCODERS ON THE DRIVEN AXIS AND DISPLAYED TO 23 H 59 MIN 59 SEC IN ALPHA AND TO +/- DEGREES 59 MINUTES 59 SECONDS IN DELTA WITH 0.6" LED DISPLAYS IN CONTROL CONSOLE.

TELESCOPE CONTROLS ARE HOUSED IN A MOVABLE CONTROL CONSOLE OR HAND PANEL WITH PUSH BUTTON CONTROLS FOR MANUAL OPERATION, 0.6 " LED DISPLAYS FOR: COORDINATES ALPHA AND DELTA, SIDEREAL AND STANDARD TIME, HOUR ANGLE, FOCAL PLANE POSITION, CHRONOMETER WITH 1/100TH SECOND TIMING, TEMPERATURES OF EXTERIOR, DOME, PRIMARY MIRROR, SECONDARY MIRROR, LIGHTING, COUNTERWEIGHT, AND DOME ROTATION AND SHUTTER ARE DISPLAYED/CONTROLLED EITHER MANUALLY FROM THE CONSOLE OR CAN BE CONTROLLED AUTOMATICALLY VIA THE ELECTRONIC GUIDING DEVICE ON THE OFF-AXIS GUIDER OR F/15 CASSEGRAIN GUIDE TELESCOPE.

CONTROLS CAN ALSO BE EFFECTED BY A **HONEYWELL-BULL MINI COMPUTER** PROGRAMMED TO FULLY AUTOMATICALLY DRIVE, POSITION AND GUIDE THE TELESCOPE DURING VARIOUS MODES FOR SHORT / LONG TERM ONLINE DATA COLLECTION (PHOTOMETER, SPECTROPHOTOMETER, ETC.), PHOTOGRAPHY, DIGITAL IMAGE PROCESSING, SCANNING, ETC. THE DATA DISPLAYED ON THE CONSOLE ARE ALSO FED INTO THE COMPUTER TO EFFECTIVELY CONTROL THE TELESCOPE IN AUTOMATIC MODE OR VIA A VIDEO TERMINAL WITHIN THE CONSOLE ON THE OBSERVING FLOOR, FROM 4A VIDEO TERMINAL IN AN OFFICE BELOW THE TELESCOPE, OR BY A VIDEO TERMINAL IN THE COMPUTER ROOM DIRECTLY.

COMPUTER FULFILLS TWO PURPOSES: A. DRIVE CONTROL OF TELESCOPE AND B. ON-LINE DATA PROCESSING DURING OBSERVATION AND DURING THE DAY FOR DATA REDUCTION, TO OPTIMIZE TELESCOPE TIME AND ALSO REDUCE OPERATOR INTERFERENCE WITH THE TELESCOPE OPERATION,

THE **COMPUTER IS A 16-BIT HONEYWELL-BULL H-316** DOUBLE INSTALLATION WITH THE DRIVE COMPUTER MEMORY SIZE OF 16 K WORDS AND THE DATA PROCESSING COMPUTER OF 32 K WORD MEMORY, ACCESS TO A 10 SURFACE 7,5 MBYTE DISK AND A TAPE DRIVE UNIT, AN ASR CONSOLE, TWO INTELLIGENT VIDEO TERMINALS AND A MONITOR AND KEYBOARD IN THE TELESCOPE CONTROL CONSOLE, TWO PRINTERS FOR HARD-COPY.

TERMINET 1200 AND A **1100 LINE PER MINUTE LINE PRINTER**, INPUT/OUTPUT INTERFACES AND ELECTRONIC CONTROLS, PROGRAM INFORMATION IS BASED ON THE SMITHONIAN ASTROPHYSICAL OBSERVATORY (S.A.0.) STAR CATALOG FOR 258’000 STARS, SOFTWARE HAS BEEN DEVELOPPED IN-HOUSE FOR TELESCOPE CONTROL.

ALTERSWIL OBSERVATORY THE TELESCOPE IS HOUSED IN A 6.50 M DIAMETER WOOD-PANELLED DOME WITH 2 M OPENING, THREE-SECTION UP-AND-OVER SHUTTER. DOME ROTATION IS 180 DEGREES IN 2 MINUTES. HEIGHT IS 4,50 M ABOVE OBSERVING FLOOR, THE OBSERVATORY UILDING IS A SPLIT-LEVEL, 3-FLOOR BUILDING, HOUSING AN OFFICE/ DESIGN CENTER/OCCASIONAL BEDROOM, ENTRANCE HALL, BATHROOM ON THE GROUND LEVEL, DOWNSTAIRS A SMALL WORKSHOP, DARKROOM, ELECTRONICS LABORATORY AND THE COMPUTER ROOM PLUS UTILITY ROOMS, UPSTAIRS ANOTHER OFFICE / LECTURE ROOM, KITCHEN AND EATING AREA, ACCESS TO TELESCOPE PIER, STAIRCASE TO OBSERVING FLOOR,IN ALL COMPRISING 170 SQUARE METER OF CARPETTED WORKING SPACE.

DOME AND FOUNDATIONS: DOME IS TEMPERATURE CONTROLLED, THE TELESCOPE FOUNDATIONS ARE SET IN BED ROCK ON A 70 TON CEMENT PIER.

ALTITUDE IS 830 M IN PRE-ALPINE COUNTRY LANDSCAPE ON A SOFTLY ROLLING HILLTOP, USUALLY ABOVE THE AUTUMN FOG. OBSERVING CONDITIONS ARE GOOD PROVIDING DARK SKIES AND LITTLE TURBULENCE WITH A NO-POLLUTION ATMOSPHERE, ACCESS IS VIA A SMALL PRIVATE ROAD FROM A SMALL FARM ROAD 2 KM FROM THE VILLAGE. NEAREST TOWN IS FRIBOURG AT 40’000 PEOPLE AND 14 KM AWAY.