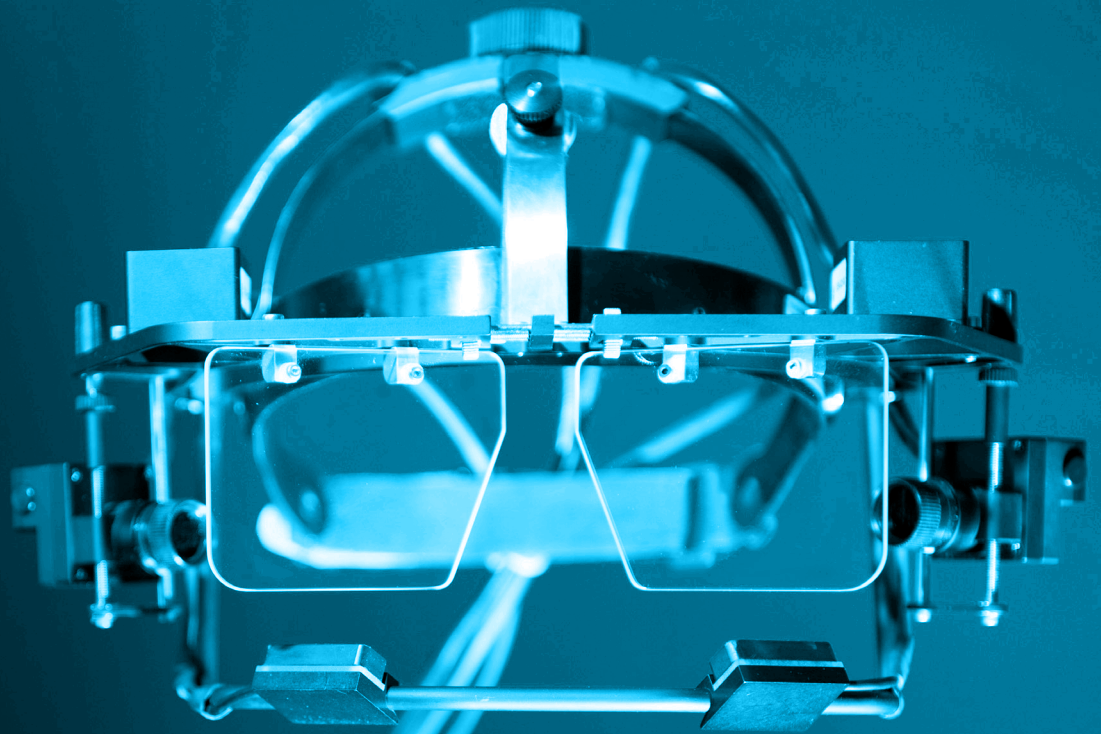




CHRONOS VISION

Your partner for vision based decisions



Chronos Eye Tracking Device

- User selectable sampling rate (50/100/200/400 Hz)
- NASA qualified for use on humans during spaceflight
- Ergonomic design of head unit for comfort and minimal slippage

MADE IN GERMANY

C-ETD

Ergonomic Design

Drawing from our previous experience with VOG systems and consultation with experts in the fields of visual-vestibular research, optometric and neurological examination

and human factors studies, a number of innovative features have been included in the Head Unit design.



The inertial load on the head has been kept to a minimum by selection of lightweight components and uniform distribution on the head frame.



Field-of-view of $\pm 90^\circ$ horizontal and $+40/-60^\circ$ vertical.



Device slippage is reduced by the use of custom-formed facemasks.

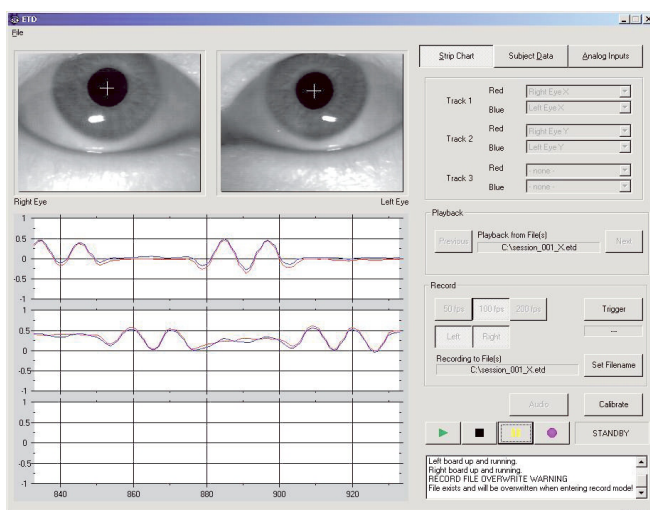
Technology

The digital eye-tracking cameras - designed around CMOS image sensors - are interfaced to a dedicated processor board in the host PC via bi-directional, high speed digital transmission links (400 Mb/s). This PCI plug-in board carries the front-end processing architecture, consisting of digital signal processors (DSP) and programmable logic devices (FPGA) for binocular, online image and signal acquisition. For the eye tracking task, a substantial data reduction is

performed by the sensor and the front-end processing. Thus, only preselected data are transferred from the image sensor through to the host PC where the final algorithms and data storage are implemented. This eliminates the bottleneck caused by standard frame-by-frame image acquisition, and thus facilitates considerably higher image sampling rates.

Software

Circle and ellipse fitting algorithms for pupil tracking are included, together with a new implementation of the polar correlation algorithm. The interactive software provides the user with a comprehensive set of options via pull-down menus or pre-stored parameter files.



Eye Tracker graphic user interface showing eye images and 2D trace of calculated eye position.

HIGHLIGHTS

- Selectable acquisition modes (sampling rate, monocular/binocular, 2D/3D tracking)
- Sampling rate 50/100/200/400 Hz
- Online/offline calculation of 2D/3D eye coordinates
- Internal/external trigger for record, start/stop
- Selection of measurement algorithms
- Online storage of the resultant data set (ASCII format)
- Archiving, selection and visualisation
- Storage of selected setups as parameter files

Reference

The space-qualified version was contracted by the German Space Agency (DLR) and designed and built in cooperation with Kayser Threde GmbH, Munich.

The Image shows a Cosmonaut on-board the International Space Station (ISS) during an experiment with the Chronos 3D Eye tracker, which has been in use as a general purpose research instrument since its deployment in early 2004.



Technical Specifications

Measuring principle	Digital image processing and full storage of eye sequences
Recording configuration	Binocular and/or monocular (left/right) for all frame rates
Selectable frame rates	50, 100, 200 and 400 Hz
Operating modes	Online 2D (2 ms delay), 11 bit output range Online storage of complete image sequences Offline 3D evaluation software
Offline 3D evaluation software	Selectable algorithms for 2D-pupil tracking Corneal reflection tracking Iris segment tracking (up to 36 selectable Iris segments) Comparison of torsional results of different recordings possible 3D eye position output in raw or Fick coordinates (13 bit output range) Support for Matlab interfaces for integrating/testing own algorithms
Measurement range	Horizontal and vertical between -30° and +30° Torsional between -25° and +25°
Measurement resolution	< 0.05° for all three components
Noise	< 0.02° RMS
Artifacts	Eye blinks easily distinguished
Interpupillary adjustment range	Horizontal: 55-74 mm Vertical: ± 20 mm
I/O	Input camera connector Record Trigger in (TTL level) Start synchronous recording with help of external trigger Output Sync (clocked to sampling rate) Start external experiments/simulations by synchronous output sync DD (Digital to Digital output) Standard Video Monitor Output (PAL; only for principal inspection of eye adjustment)
Eye illumination	IR LEDs (940 nm) Irradiance < 7.5 mW/cm ² within recommended safety levels EU: EN 60825 - 1: 8.79 mW/cm ² USA: ACGIH: 10.0 mW/cm ²
Host computer	IBM-compatible PC Supply Voltage: AC ~115 V, ~230 V (Auto Full Range), Power consumption: 100 VA

Product Configurations

Product Version			
Monocular		Binocular	
2D	3D	2D	3D
Art.No. 5220010	Art.No. 5220011	Art.No. 5220012	Art.No. 5220013

Head Unit



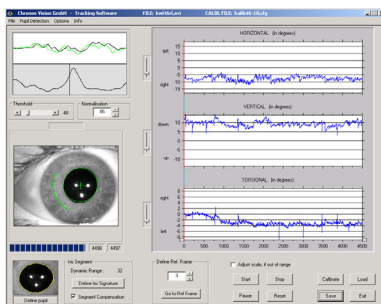
Adjustable headband and visor		•
Camera assembly with optics and infrared illumination source	1 (left or right)	2
Dichroic mirror [glass]	1	2
Cable set for connection to System Unit (up to 8 m)		•
Thermoplastic facemasks 2 x unformed 1 x pre-formed		•
Head unit stowage box		•

System Unit



State-of-the-art IBM compatible PC with power supply DIN EN 60950 (100-240 V~, 8 A, 50-60 Hz, Auto Full Range)		•
CPU Intel Duo Core 3 GHz		•
4 GB RAM		•
Hard Disc Drives (HDD) System HDD: minimum 320 GB Exchangeable HDD: minimum 500 GB Exchangeable HDD: minimum 200 GB (USB-compliant)		•
CD/DVD-RW Drive		•
Standard System Unit accessories (i. e. CD OS MS Windows, power cable, keyboard and mouse)		•
PCI Eye Tracker Boards (half-length, installed in the PC)	1	2
Sync Out Board		•

Software






Pre-installed standard software:		
MS Windows XP Professional, English		•
Adobe Acrobat Reader 8.0 or higher, English		•
Pre-installed Chronos Eye Tracker application software:		
Online recording SW: <i>ETD</i>		•
Offline analysis SW: <i>Iris</i> horizontal and vertical eye movement torsional eye movement		• only 3D-Version
Audio-Video synchronization SW		•

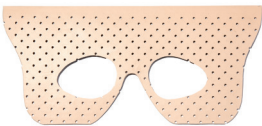



Documentation

C-ETD User Manual	•
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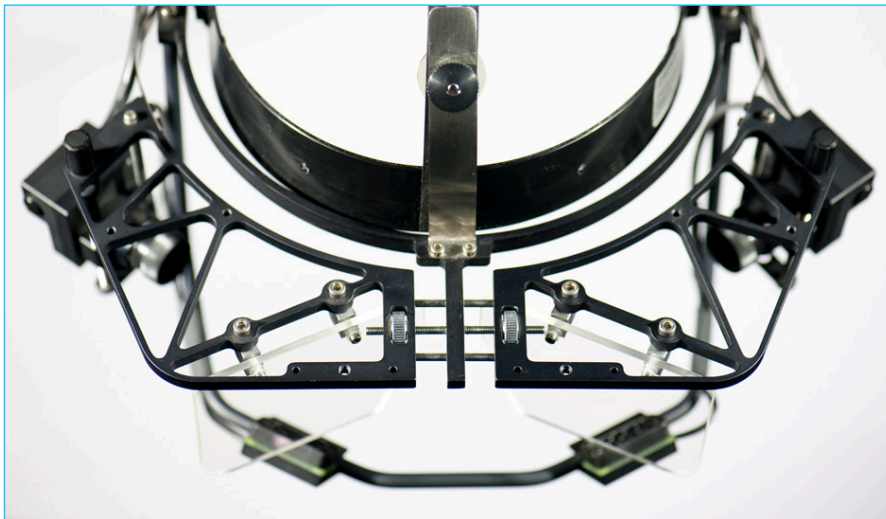
Options

	<p>16 channel ADC acquisition board</p> <p>The ADC board is an analog-to-digital converter of the C-ETD System. If an ADC board is installed in the system the ADC data can be stored in an ASCII-file. It can be delivered as 16 Ch or 31 Ch board. All ADC inputs are optically isolated from the PC circuitry. One 37 pin sub-D female connector is edge-mounted on the ADC Interface board. This permits connection for channels 1 to 16, plus sync and trigger.</p>	<p>Art. No. 5220002</p>
	<p>ADC extension for 31 channels</p> <p>A second 37 pole sub-D connector is provided for channels 17 – 31. (Channel 32 is reserved as a zero reference voltage for calibration purposes). The second 37 pole sub-D connector is mounted on an additional edge plate and is connected by flatribbon cable to the ADC Interface board.</p>	<p>Art. No. 5220003</p>
	<p>4 channel DAC board</p> <p>The DAC (digital-to-analog converter) board provides analog output signals for the horizontal and vertical eye positions of each eye (in total 4 channels). The output signals are accessed via the 9-pin sub-D connector on the slot bracket. The DAC board should be inserted into a PCI slot adjacent to the PCI processor boards. This option is not available for monocular systems! The output voltage level is $\pm 2.5V$ full scale.</p>	<p>Art. No. 5220004</p>

Accessories and spares

	<p>Additional facemask</p> <p>The facemask is an extension of the C-ETD system, in order to prevent the slippage on the head of the user. The facemasks can be delivered pre-formed and unformed. The pre-formed mask can be used initially. For better comfort and minimal slippage effects it will be necessary for the user to form his/her own masks. The facemasks are made of so called thermoplastic. This material becomes very flexible at temperatures above 65°- 70° Celsius (150°-160° Fahrenheit). In principle, the facemasks can be fitted to any facial form.</p>	<p>Art. No. 5220006</p>
	<p>Dichroic mirrors</p> <p>The IR mirrors positioned in front of the right and left eye are essential for the correct functioning of the Eye Tracker. They are made of quartz glass. Each mirror is delivered with two brackets which are already attached to the mirror by fixing screws.</p>	<p>Art. No. 5220007</p>
	<p>Chronos Inertial Tracking System (C-ITS) *</p> <p>The mechanical interface permits mounting on the head unit of the Chronos Eye Tracking Device. In this case the analog output signals would normally be connected to the ADC interface of the C-ETD for synchronous recording of eye and head movements.</p> <p>The Chronos Vision Inertial Head Tracker consists of two triaxial sensor assemblies - one for measurement of linear acceleration along each of the three orthogonal axes, and one for measurement of angular rate around each of the three orthogonal axes. The output signals of the sensor assemblies (3 plus 3) are connected to a signal conditioning system with buffer output amplifiers. The C-ITS can be used as a stand-alone six degree-of-freedom sensor device, and can be mounted to an arbitrary object, whose movement is to be measured.</p>	<p>Art. No. 5220008</p>
	<p>Exchangeable HDD (according to EN 60950)</p> <p>On request. Please contact us and tell us which capacity you need.</p>	<p>Art. No. 5220009</p>

* ADC board required



Ultra light alloy frame with fittings for mirrors and gyro sensors. The frame concept with its flexible mounting and fine thread in the front allows accurate mirror adjustment.



Originally developed in cooperation with Kayser Threde GmbH under the auspices of the DLR for deployment on the International Space Station, the Chronos Eye Tracker introduced a new generation in image-based eye movement measurement technology.



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