EOS European Optical Society

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# 6th EOS Topical Meeting on Visual and Physiological Optics (EMVPO 2012)

**20 - 22 August 2012,** University College Dublin (UCD), Dublin, Ireland

## FINAL PROGRAMME

Sponsors:

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imagine eyes
Adaptive optics, adapted to eye care

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LASER PHYSICS

OSA The Optical Society

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## SUNDAY, 19 AUGUST

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|---|---|
| 17:00-18:00 | Pre-Registration |
| 18:30-20:30 | Welcome Reception |

## MONDAY, 20 AUGUST | Room: Clinton Auditorium

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|---|---|
| 08:30-09:30 | Registration |
| 09:30-09:45 | Welcome by the General Chair |
| 09:45-10:30 | **Keynote talk: An Eye for Optical Illusions**<br>Michael Bach, Universitäts-Augenklinik Freiburg, Ophthalmology (DE) |
| 10:30-11:00 | Coffee break Sponsored by: imagine eyes Adaptive optics. Adapted to eye care |
| 11:00-13:00 | **Session I: Eye Models, Intraocular Lens Design and Analysis** |
| 13:00-14:00 | Lunch break |
| 14:00-15:30 | Poster Session I & Coffee break |
| 15:30-18:30 | **Session II: Retinal Imaging and Photoreceptor Analysis** |

## TUESDAY, 21 AUGUST | Room: Clinton Auditorium

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|---|---|
| 09:00-10:30 | **Session III: Visual Acuity, Adaptation, and the Stiles-Crawford Effect** |
| 10:30-11:00 | Coffee break |
| 11:00-13:00 | **Session IV: Aberrations and Wavefront Sensing** |
| 13:00-13:45 | Lunch Break & Pick-up Lunch bags |
| 14:00 | Departure Social Programme |
| 14:00-18:00 | Social Programme |
| 18:30-21:00 | Conference Dinner |

## WEDNESDAY, 22 AUGUST | Room: Clinton Auditorium

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|---|---|
| 09:00-10:30 | **Session V: Ocular Scattering Mechanisms and Analysis** |
| 10:30-11:00 | Coffee break |
| 11:00-13:00 | **Session VI: Accommodation, Presbyopia and Visual Impairment** |
| 13:00-14:00 | Lunch break |
| 14:00-15:30 | Poster Session II & Coffee break |
| 15:30-17:00 | **Session VII: Multiphoton Imaging and Analysis of the Eye** |
| 17:00 | EOS Student Awards & Farewell |
| 17:15 | End of EOS Topical Meeting |

**POSTER SESSION II:** Wednesday, 22 August | 14:00 - 15:30 CEST
**Room:** Exhibition area

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|---|---|
| EMVPO2012_5717_039<br>STUDENT PRESENTATION | **Peripheral aberrations and changes in refractive error during one year**<br>A. Hartwig, N.W. Charman, H. Radhakrishnan; University of Manchester, Faculty of Life Sciences (GB) |
| EMVPO2012_5730_040<br>STUDENT PRESENTATION | **Comparison of Accelerated Corneal Cross-Linking to Standard Cross-Linking using Second-Harmonic Optical Microscopy**<br>R. McQuaid[1,2], J. Li[2], A. Cummings[1], M. Mrochen[3], B. Vohnsen[2]; [1]Wellington Eye Clinic (IE); [2]AOI-Group, School of Physics, University College Dublin (IE); [3]IROC (CH) |
| EMVPO2012_5743_041 | **Demonstration of Digital Holographic Display, Optimized for Human Eye Perception**<br>V. Venediktov[1,2], M. Lyakh[3], A. Sevryugin , M. Solov’ev[2], I. Pasechnik[1]; [1]St.-Petersburg State Electrotechnical University ”LETI” (RU); [2]National Research University of Information Technologies, Mechanics and Optics (RU); [3]Intel Labs (RU) |
| EMVPO2012_5749_042<br>STUDENT PRESENTATION | **Waveform of the Pupil light reflex analysis taking into account intrinsically photosensitive retinal ganglion cells activity**<br>W. Nowak[1], A. Hachoł[1], A. Sobaszek[1], M. Nakayama[2], H. Ishikawa[3]; [1]Wroclaw University of Technology, Group of Biomeasurements and Biomedical Signal Analysis (PL); [2]CRADLE, Tokyo Institute of Technology (JP); [3]School of Allied Health Sciences, Kitasato University (JP) |
| EMVPO2012_5753_043<br>STUDENT PRESENTATION | **Optical Quality and Intraocular Scattering in eyes treated of Amblyopia**<br>J.C. Ondategui-Parra[1], J. Martínez-Roda[1], M. Vilaseca[2], A. Wert[3], J. Pujol[2]; [1]Technical University of Catalonia, University Vision Centre (ES); [2]Technical University of Catalonia, Centre for Sensors, Instruments and Systems Development (ES); [3]Instituto de Microcirugía Ocular (ES) |
| EMVPO2012_5762_044<br>STUDENT PRESENTATION | **A New Tool for Depth Perception Training for Autism and Other Conditions**<br>E. Ansbro[1], C. Overhauser[2], Alova[2]; [1]Open University, PSSRI (GB); [2]RealView Innovations Ltd (IE) |
| EMVPO2012_5768_046<br>STUDENT PRESENTATION | **A Method to Evaluate Peripheral Visual Perception**<br>I. Timrote, G. Krumina, T. Pladere, M. Skribe; University of Latvia, Department of Optometry and Vision Science (LV) |
| EMVPO2012_5770_047<br>STUDENT PRESENTATION | **Vortex beams in Visual Optics**<br>J.P. Trevino, J.E. Gomez-Correa, S. Chavez-Cerda; Instituto Nacional de Astrofísica, Optica y Electrónica (MX) |
| EMVPO2012_5773_048<br>STUDENT PRESENTATION | **Second-harmonic cornea microscopy enhancement with annular aperture filters**<br>J. Li, B. Vohnsen; AOI Group, University College Dublin, School of Physics (IE) |
| EMVPO2012_5774_049<br>STUDENT PRESENTATION | **Myopes visual acuity with positive and negative contrast stimuli**<br>G. Ikaunieks, E. Caure, E. Kassaliete, Z. Meskovska; University of Latvia, Department of Optometry and Vision Science (LV) |
| EMVPO2012_5775_050<br>STUDENT PRESENTATION | **Measurement of accomodative response curve based on brightness of the retinal reflex**<br>V. Karitans[1,2], M. Ozolinsh[1,2], E. Skutele[2]; [1]Institute of Solid State Physics, Department of Ferroelectrics (LV); [2]University of Latvia, Department of Optometry and Vision Science (LV) |
| EMVPO2012_5776_051<br>STUDENT PRESENTATION | **Printed test plates for color discrimination threshold determination**<br>K. Luse[1], S. Fomins[2], M. Ozolinsh[1,2]; [1]University of Latvia, department of Optometry and Vision Science (LV); [2]University of Latvia, Institute of solid State Physics (LV) |

EMVPO2012_5762_044 **STUDENT PRESENTATION**

## A New Tool for Depth Perception Training for Autism and Other Conditions

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### Summary

Many conditions, physiological and psychological, have been found to benefit from depth perception training, including autism. Recent research suggests that the original cause of autistic behaviour is perceptual. Recent developments in 3D technology address this problem.

### Introduction

It is commonly recognised that vision is the dominant sense, as seventy-eighty percent of the information we receive enters the brain through the eyes. Any problems in how the brain processes visual information can cause difficulties in one's general ability to function and can result in various disabilities. When all the senses are integrated, a deficiency in one may lead to disturbances in the others. There are numerous conditions that benefit from depth perception training. The focus here will be on autism, but the discussion can easily be extended to ADD, ADHD, and other conditions.

### Discussion

Children with autism are challenged by a sensory overload and by aversions to a variety of auditory, visual, and tactile stimuli. In addition, their ability to attenuate and/or ignore these stimuli differs from that of a "typical" child. Autistic people report unusual sensory experiences. Autism spectrum disorders are characterized by core deficits in social interaction, communication, and repetitive or stereotypic behaviour. It is crucial to develop intervention strategies to help individuals with autism. For this purpose, virtual reality (VR), a simulation of the real world, has been shown to be an effective training tool.[1] Technological advances including the VR have contributed enormously to improving the treatment, training, and quality of life of children with disabilities.

Virtual reality (VR) training has rehabilitative potential for people with intellectual disabilities, both as intervention and assessment. It can provide a safe setting in which to practice skills that might carry too many risks in the real world. Unlike human tutors, computers are infinitely patient and consistent. Virtual worlds can be manipulated in ways the real world cannot be and can convey concepts without the use of language or other symbol systems. The training can promote mental simulation of social events, potentially allowing a greater insight into minds. Practice of behaviours, both within and across contexts, encourages a more flexible approach to social problem solving. VR has been shown to help minimize the effects of the disability, enhance skills training, and improve the child's social participation and quality of life.[2]

Enhancing depth perception is a valuable addition to VR techniques. However, consumer 3D displays, like 3D TVs and games, force the viewer into an unnatural view of the world. This is directly opposed to what an autistic person needs.

This has been addressed by a new training tool called “Deep Screen” which provides a natural viewing experience with enhanced depth perception. In contrast to other technologies that require unnatural content rendering and/or unnatural eye-brain coordination, the Deep Screen utilizes only natural optical principles to enhance depth. The eyes and brain operate with their natural coordination.

### Conclusion

Virtual reality technology requires the natural viewing attributes that are impossible with existing commercial 3D displays. It is important to provide a safe environment for learning without the side effects of existing 3D displays. This new tool can provide the necessary view of the world that could significantly improve the wellbeing of an autistic child. The long term use of the technology should address the symptoms of the reflections of the child’s mental construction of the world by creating normal set of sensory information over time.

### References

[1] M. Wang, D. Reid, “Virtual reality in pediatric neurorehabilitation: attention deficit hyperactivity disorder, autism and cerebral palsy,” *Neuroepidemiology,* **36(1)**, 2-18, 2011

[2] D. Gourlay, K.C. Lun, Y.N. Lee, J. Tay, Virtual reality for relearning daily living skills,” *Int J Med Inform.,* **60(3)**, 255-61, 2000

[3] D.C. Strickland, D. McAllister, C.D. Coles, S. Osborne, “An Evolution of Virtual Reality Training Designs for Children With Autism and Fetal Alcohol Spectrum Disorders,” *J Intellect Disabil Res*, **46 (Pt 5)**, 430-43, 2002

[many more references]

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EMVPO2012_5768_046 **STUDENT PRESENTATION**

## A Method to Evaluate Peripheral Visual Perception

*I. Timrote, G. Krumina, T. Pladere, M. Skribe; University of Latvia, Department of Optometry and Vision Science, Riga, LV-1063 (LV).*
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### Summary

We are developing a method that should help evaluating peripheral visual perception. All the tests help looking at how different peripheral stimuli affect the performance of near vision task – whether the peripheral stimuli sidetracks attention hence worsening the time needed to accomplish the near vision task.

### Introduction

In everyday life we do not differentiate central and peripheral visual field. It is known that P visual pathway is addressed to properties concentrated in central visual field and M visual pathway – in peripheral visual field [1]. And there are several disorders connected to M, P visual pathways that can be improved until certain age [2]. Because of this, it is essential to differentiate which pathway is responsible for the problem as soon as possible. Hence our goal is to make a test that would divide individuals in two different groups – with and without problem concerning peripheral visual properties.

### Methods

We have made a method consisting from several tests. An individual has to count how many times one specific letter is repeated in a set of letters (ten letters in ten rows). This set of letters is demonstrated randomly in three different central conditions – on white background, in lines or in squares (overall three times per each central background). Three different days are used to perform this central task so that different peripheral noise could be used – white background, five times five or ten times ten black dots. To make the task more difficult, there can be peripheral stimulus appearing while counting the letters. Another kind of task is when an individual has to name all the letters appearing on the screen and changing every second. Meanwhile red, green or blue stimulus appears in the peripheral visual field.

### Results

The results demonstrate that the time needed to accomplish the visual search task improves with adding the peripheral noise. All the individuals can be divided in two groups – there are ones whose performance is better when counting the specific letters in squares and worse on white central background. For the other group it takes less time to accomplish the task when they have to count letters in lines and more when counting on white central background. When adding a peripheral stimulus, there are cases when an individual can exclude their peripheral vision hence not seeing the peripheral stimulus of different size.

### Discussion

Usually there are tests that consist of a single spot or a letter while there are several moving stimulus in the peripheral visual field [3]. We decided to improve the central stimuli so that an individual would be more occupied. Developmental Eye Movement Test is done naming all the letters from the blank and counting the score [4]. In this case they do not pay attention to the background that could affect the result. As far as there could be people whose peripheral vision sidetracks attention, these test results could be worsen with peripheral stimuli. For this reason we decided to add noise in the periphery consisting from black dots either five times five or ten times ten across the screen. Hence an individual is asked to either name the letters while there are coloured peripheral stimuli side-tracking attention or count a specific letter from a grid of letters while the there are additional central and peripheral stimulus.

### Conclusions

This test can be used to divide individuals in different groups hence looking for a problem in visual pathways. Still there have to be improvements made to adapt this test for children.

### Acknowledgement

This work has been supported by the European Social Fund within the project «Support for Doctoral Studies at University of Latvia». Thanks to S. Fomins for the help with the program.

### References

[1] E. Kaplan, The M, P, and K Pathways of the Primate Visual System, In: *The Visual Neurosciences*, ed., L.M. Chalupa, J.S. Werner (MIT Press, Hong Kong, 2004), pp. 481-493

[2] E.E. Parrish, D.E. Giaschi, C. Boden, R. Dougherty, The maturation of form and motion perception in school age children, *Vision Research*, **45**, 827-837 (2005)

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EMVPO2012_5770_047 STUDENT PRESENTATION

## Vortex beams in Visual Optics

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### Summary

We present an analysis of aberrations of Vortex Fields and suggest an application to increase resolution when imaging the photoreceptor mosaic of the retina.

### Introduction

Many of the concepts and techniques currently employed in Visual Optics have their origin in astronomy. This is the case of Zernike Polynomials and Adaptive Optics systems for aberration correction. Recently, Optical Vortices have been implemented as coronagraphs [1] and to study the surroundings of bright stars to detect nearby planets, with this technique it is possible overcome Rayleigh's resolution limit [2]. We examine this novel technique presenting an aberration analysis of systems in the presence of Vortex Beams.

### Discussion

An optical vortex is a wave field wich features an azimuthally varying phase factor of the form $e^{im\varphi}$. The azimuthal coordinate is $\varphi$ and $m$ is an integer known as the topological charge. The exponent in this factor represents a phase that varies linearly with respect to $\varphi$ and thus generates a helicoidal wavefront. For a uniform field, as a consequence of the vortex, a dark core is created at the center of the point spread function (PSF). Vortices can be generated by Spatial Light Modulators or by refractive or reflective elements suitably shaped for this purpose. One of such devices, described in [3] is designed as an achromatic doublet having a helicoidal interface between the glasses. This device is designed for a specific wavelength and therefore has a limited bandwidth. The field at the focal plane, is obtained by means of the Frounhoffer integral:

$$U_f(\rho,\varphi) = PSF = \int_{-\pi}^{\pi}\int_{0}^{\infty} A(r)e^{ikW(\rho,\varphi)}\,e^{im\varphi}e^{i\frac{k}{2f}r\rho\cos(\varphi-\theta)}\,r\,dr\,d\varphi$$

where $W(\rho,\varphi)$ represents the wavefront aberration, $k$ is the wave number for a specific wavelength and the focal distance. This integral is the PSF of the system and it gives information of its aberrations. An aberration free system with a vortex has a PSF that displays a central dark region and bright rings as depicted in figure 1B. Radial dependence of the PSF is shown in figure 1C for increasing values of the topological charge.

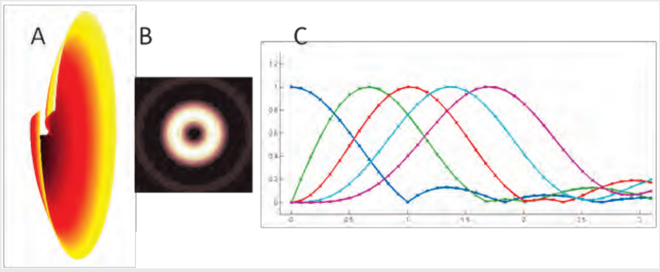

Fig. 1: A: Converging wavefront featuring a vortex phase factor. B: The psf of a system with $= 2$ C: Transversal cut of the psf for different values of .

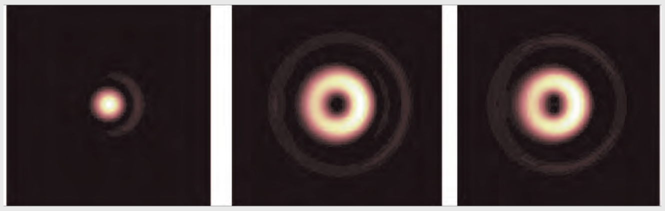

Fig. 2: Effects of a vortex wavefronts on an aberrated field with comma. Left: Single source with no vortex. Center: Single source with $= 2$. Right: two sources with $= 2$. Notice that the dark regions are present and thus we can infer the presence of two close sources.

Two luminous sources cause the dark central dark zone to divide into dark zones. Given different coefficients of primary aberrations, the dark zones remain, as shown in figure 2. In this picture, a pair of barely resolved sources in a vortex field with comatic aberration are presented with no vortex $= 0$ (left) and with $= 2$.(right). We can distinguish the presence of two sources in the second case because of the pair of dark zones at the center of the PSF. Astigmatism shows fringe-like patterns even for single sources, so the system is sensitive to this aberration.

### Conclusions

We apply the concepts first introduced by Swartzlander, to image the photoreceptor mosaic of the retina.. We explore the limit to which aberrated elements would still detect multiple sources and resolve them.

### References

[1] G. A. Swartzlander. *Peering into Darkness*. Opt. Lett. **26**, 8. 2001.

[2] F. Tamburini, G. Anzolin, G. Umbriaco,, A. Bianchini, and C. Barbieri. *Overcoming the Rayieigh Criterion Limit with Optical Vortices.* Phys. Rev. Lett. **97**, 16. 63903 (2006).

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EMVPO2012_5774_049 **STUDENT PRESENTATION**

## Myopes visual acuity with positive and negative contrast stimuli

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### Summary

In this research influence of spectacle and contact lenses on positive and negative contrast visual acuity is evaluated for myopes. With each correction difference between positive and negative contrast visual acuity was not statistically different.

### Introduction

Some researches showed that for corrected myopes visual acuity is better with positive Weber contrast (white symbols on black background) than with negative contrast (black symbols on white background) optotypes. One explanation of such phenomena is that myopes have neurological changes in ON and OFF pathways [1]. From another studies it is well known that in case of increased light scattering level in the eye symbols with positive contrast are resolved better than with negative contrast, because bright background increases retinal straylight more than dark background [2]. Additional source of retinal straylight for corrected myopes is spectacle [3] or contact lenses [4], so it cannot be excluded that corrected myopes have better visual acuity with positive contrast not only due to neurological but also optical factors. In our research we wanted to find out how optical correction influences myopes visual acuity with positive and negative contrast stimuli.

### Discussion

17 persons (11 myopes and 6 emmetropes) at the age from 20 to 22 participated in this research. The spherical equivalent refractive error of the myopic subjects ranged from -2.5 to -6.75 D. Monocular visual acuity (VA) with positive (97%), reversed negative and low contrast (-10%) Landolt optotypes was determined using FrACT computer program. Measurements for myopes were done using spectacle or contact lenses correction. As was expected, the worst visual acuity was found with the low contrast optotypes. For myopes these values were lower than for emmetropes, but for myopes visual acuity obtained with high contrast stimuli also were lower, so we can't conclude that myopes have worse contrast sensitivity than emmetropes.

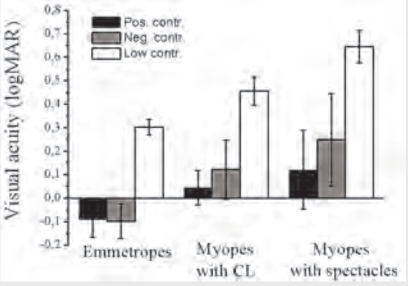

Fig1. Visual acuity for emmetropes and corrected myopes with different contrast stimuli. Standart deviations for each data serie are showed.

For emmetropes visual acuity with positive and negative contrast was not significantly different, while for myopes visual acuity was better with positive than with negative contrast stimuli. We tested myopes with their own spectacles which were used at least one year. Therefore we expected that difference between positive and negative contrast visual acuity will be greater with spectacles than with contact lenses. However differences in both cases were not statistically significant.

### Conclusions

Better visual acuity for myopes with positive than negative contrast stimuli is related mainly with neurological not optical factors.

### References

[1] B.D.Stoimenova, *Invest Ophthalmol Vis Sci*, 48, 2371-4, 2007
[2] G. Westheimer et al., *Optometry and Vision Science*, 80, 749-752, 2003
[3] G.C. De Wit and J.E. Coppens, *Optometry and Vision Science*, 80, 395-400, 2003
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EMVPO2012_5775_050 **STUDENT PRESENTATION**

## Measurement of accomodative response curve based on brightness of the retinal reflex

*V. Karitans[1,2], M. Ozolinsh[1,2], E. Skutele[2]; [1]Institute of Solid State Physics, Department of Ferroelectrics, Riga, LV-1063 (LV); [2]University of Latvia, Department of Optometry and Vision Science, Riga, LV-1063 (LV).*
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### Summary

We describe development of a device measuring the accomodative response based on brightness of the retinal reflex and the results obtained. A photodiode and light integrating circuit is used to measure the gathered light for various refractive states of an eye.

### Introduction

It is known that brightness of the retinal reflex depends on the refractive state of an eye. It depends not only on the refractive error of an eye but also on accomodation. This phenomenon is observed when the patient's fundus is observed using ophthalmoscopy methods. Several devices measuring the refractive state and accomodation of an eye based on the retinal reflex have been designed [1,2]. In this study we describe an electronically optical system measuring dependence of brightness of the retinal reflex on accomodative state. It is known that the tonic accomodation is about 0.75 D. Below this value an eye accomodates lead while above this value the accomodative lag is observed [3]. We employ a light integrating circuit to collect the light reflected from the retina. The aim of the study is to create a device that allows to obtain the accomodative response curve.

### Discussion

The optical setup used in the study is shown in Figure 1. An infrared laser emits radiation at the wavelength l = 850 nm. The light reflected from the retina gives rise to a photocurrent integrated by a capacitor. The photocurrent is generated by a photodiode S1337-66BR (*Hamamatsu*) [4]. Simultaneously with light integration the eye also views the stimulus. Accomodation response required to see the stimulus sharp is changed by varying the distance between the stimulus and the lens.

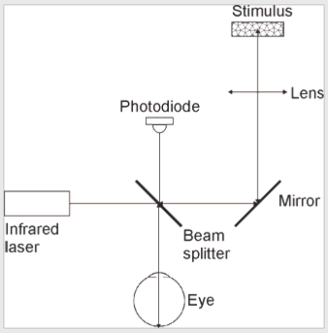

Fig 1. The optical setup used to measure accomodation response curve.

To obtain the accomodative response curve the calibration curve must first be obtained. This is done by placing trial lenses in front of the eye while the pupil is dilated and accomodation has been paralyzed. This was done by using 1 % cyclogyl solution. The calibration curve shows how the signal (voltage) across the capacitor varies with the power of the trial lenses. In the next stage the stimulus is placed at such the distance from the lens that it requires a certain accomodative response. It must be assured that the light gathered by the photodiode isn't altered as a consequence of pupil narrowing. For this purpose a phenylephrine solution was used. By measuring the real response, i.e., the voltage of the capacitor the real accomodative response can be read from the calibration curve. If the real accomodative response is measured and the required accomodative response is known then the response curve of accomodation can be obtained.

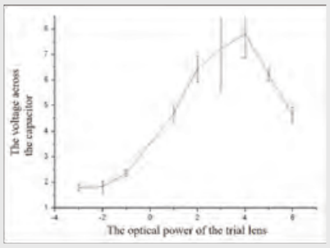

Fig 2. The calibration curve for one subject showing the relationship between the voltage across the capacitor and the optical power of the trial lens.

In Figure 2 the calibration curve for one subject is shown. On the x-axis the optical power of the trial lenses is given whereas on the y-axis the voltage across the capacitor is given. It can be seen that the relationship is an extreme