Philippe Rahm architectes

Spectral Light

Artemide®

Artemide: The Human Light

by Carlotta de Bevilacqua

Working with Philippe Rahm and his thinking seems to be the natural prosecution of the search that Artemide develops for years on the psychological and physiological perception. Starting from the study of light and the relationship with the man, space and the environment we investigate the perception as a tool for the knowledge of the visible world, to the definition of an universal «esperanto» that composes a «Spectral Light» to take care of man, animals and nature wellness.

Carlotta de Bevilacqua is Vice President of Artemide.

Spectral Light

by Philippe Rahm

"Imagination is the analysis, it is the synthesis ... it breaks down all creation and, with the materials collected and arranged according to rules whose origin you can find only in the depths of the soul, it creates a new world, it produces the sensation of new."

Baudelaire, Salon 1859, in Beyond Romanticism. Writings on Art

In the past twenty years, the lighting industry has begun to address the composition of the artificial electromagnetic light spectrum and the wavelengths emitted. Today, there are three reasons for this interest in the composition of the electromagnetic spectrum of the light: one reason is health and biology. The second reason is the quest of energy saving and preventing global warming. The third reason is an intrinsic reason, linked to the technical development of artificial lighting: the physical characteristic of electroluminescent lighting (LED) to compose light by additive synthesis of electromagnetic rays, by an addition of monochromatic wavelengths, because of the characteristics of different LED semiconductors to emit a single wavelength.

Before, the spectrum produced by artificial lights was more or less an involuntary physical consequence, which was caused by the materials or techniques used. The incandescent tungsten filament produced poor light in the blue spectrum, but extremely rich light in the the red and infrared spectrum. Fluorescent lights did not produce a full and continuous electromagnetic spectrum, but a discontinuous and fragmented radiation with limited peaks and wavelengths in the visible spectrum, resulting in the absence of certain colors.

Our method of design, for architecture or industrial design, is to no longer work with the whole, but rather to decompose, disintegrate, and crumble it into a multitude of microscopic particles of heat, vapor, light, and sound, which are disunited from their whole, ie. atomized. The space is no longer a visible, solid, and tactile macroscopic block. Instead, it expands, diffracts, and opens itself to the infinitely small and invisible. We proceed by decomposition, dissociation of the "whole" into elements, and then recompose, but with a certain number of components according to other hierarchies, updated priorities, and new needs. Instead of following gestalt psychology, which opposes a holistic view by stating "the whole is different and not reducible to the sum of its parts," we postulate that the isolated parts are more interesting and more relevant than the whole.

Our work explores the infinitely small. We begin by analysing the biological, or the chemical spectra, then decompose reality into electromagnetic or chemical particles, then recompose it, but with a specific number of its elements -not all of them. Our design technique has a sort of rational brightness of the Enlightenment. It is close to a neutral and objective ecriture blanche, with a lack of narrative, but from which emerges something magical, a "disturbing unreality", related to "a further realism more than a deliberate fiction," as Gerard Genette said about Robbe-Grillet.

Our architectural and design work processes through a chemical dissociation of the space in elementary particles, such as wavelengths, humidity rate, light intensity, heat transfer coefficient, and sound frequencies, but also hormonal secretion level, kilocalories, and nanometers. The scientific knowledge development has created new limits of reality and has modified the field of art, which shifts into new dimensions, slides into other phenomena, and solicits other perceptions. We are now interested in forms which are no longer composed together to create a "whole as gestalt.» Instead, we are interested in forms which are dissociated; fragments of reality exploded into sensible particles. We are looking for a spectral reality; spaces firstly decomposed into elementary particles, or wavelengths, humidity, light intensity, and heat transfer coefficients, then "recomposed" into a new form, one which is more essential and more able to answer contemporary concerns such as energy saving and climate change. Yet our interest -the disintegration of the real and the synthesis of it with just two or three chemical and electromagnetic components- is not only an aesthetic project. It is, more significantly, necessary for the re-evaluation of the historical and fundamental reasons behind human construction, which causes certain kinds of industrial design, architecture, urbanization. Additionally, it is a method of re-thinking architecture and design without triteness and the picturesque to reach some sort of truth, economy and beauty.

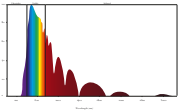
BIOLOGY & HEALTH

Research institutions' developments in scientific and medical knowledge in chronobiology raised health concerns regarding artificial lighting. People working in the limited spectra of fluorescent light, in particular, could develop headaches or insomnia- which is not apparent in people working in natural light.

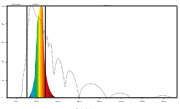
The caused of these health problems problems were twofold. Firstly, the light spectrum emitted by fluorescence is discontinuous compared to the broad, full spectrum of natural sunlight- which covers all visible wavelengths. The few solitary peaks in wavelengths emitted by

all visible wavelengths. The few solitary peaks in wavelengths emitted by fluorescent light were not the one perceived by the human eye, forcing the eye to interpret the unavailable wavelengths. This reinventing of absent wavelengths causes eye strain and headaches.

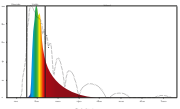
Daylight



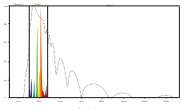
Incandescent



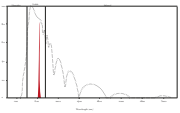
Halogen



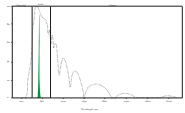
Fluorescent



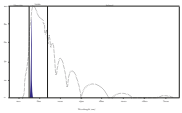
Red LED



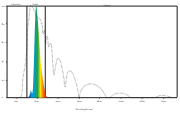
Green LED



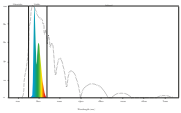
Blue LED



Warm White LED

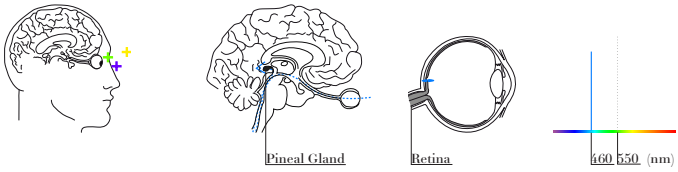


Cool White LED



The second problem appears when it was discover that the light, its intensity and certain wavelengths, has an influence on the hormonal system and the daily human biological rhythms, called circadian. Since 1980, thanks to the contribution of Alfred Lewy (A. Lewy, TA Wehr, RK Goodwin, et al, "Light Suppresses Melatonin, Secretion in Humans." Science 210:. 1267-1269, 1980), it is understood that the light variations between day and night have a direct effect on changes in certain hormones in the body, mainly melatonin but also cortisol or the growth hormone. Intense light, such as daylight, blocks the secretion of these hormones, while the dark, such as nightlight, actives the secretion of these hormones and contributes to the process of sleep. It explains why some people in environ-

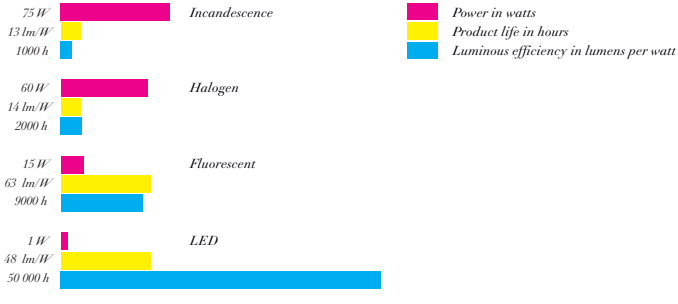
ments composed of electric light are in a permanent state of fatigue and at risk of SAD (Seasonal Affective Disorder), i.e. a type of nervous breakdown caused by the presence of excessive melatonin in the blood due to a lack of light stimulation. Strong light intensity, like the one produced by the sun, blocks the secretion of melatonin, while low intensity light, such as those emitted by fluorescent or incandescent lamps, is too low to block the secretion of melatonin. Since the 2000, scientists began to decompose the light spectrum more precisely to highlight certain wavelengths and their effect in blocking or allowing the secretion of melatonin. Wavelengths around 460 nanometers, in the blue portion of the visible spectrum, block -even at a low intensity- the secretion of melatonin when they touch the retina.



With this knowledge, the light industry has started slowly to readjust the electromagnetic spectrum emitted by its artificial sources.

CLIMATE & SUSTAINABILITY

After health, it's for economy and durability that we have start the examination of artificial electromagnetic spectra by understanding the huge energy loss in the transmission of unnecessary wavelengths of light, those beyond 800 nanometers in the infrared spectrum, by the incandescent or halogen light.



An incandescent bulb only transforms 5% of energy (electrical power used) into light within the visible spectrum, between 400 and 800 nanometers. The rest of the energy is used to emit infrared, or invisible heat; a disproportionate loss of energy. A halogen bulb has the same drawback of generating low visible wavelengths compared to infrared, with ratio of emitting approximately 7% light and 93% heat. By observing the electromagnetic spectrum of the respected light, we see the two spectra reach beyond just the visible spectrum and spread considerably energy into the infrared spectrum. The rising awareness of the importance of responsible energy consumption and the phenomenon of global climate change has drawn criticism to these artificial light sources (incandescence and halogen), promoting the use of fluorescent light. The interest of CFL or fluorescent light, from an energy savings point of view, is twice. Firstly, it doesn't emit in the infrared. Secondly, fluorescent light, unlike incandescent or halogen, does not emit a continuous spectrum and instead emits a few peaks in the visible spectrum. Energy is saved when the entire visible spectrum is not emitted. The reduction of the emitted spectrum may be welcome from an energy point of view, but from a health point of view it's a problem because Fluorescent light does not emit into the good wavelengths perceived by the human eye, which could cause the eye to strain.

WAVE DESIGN

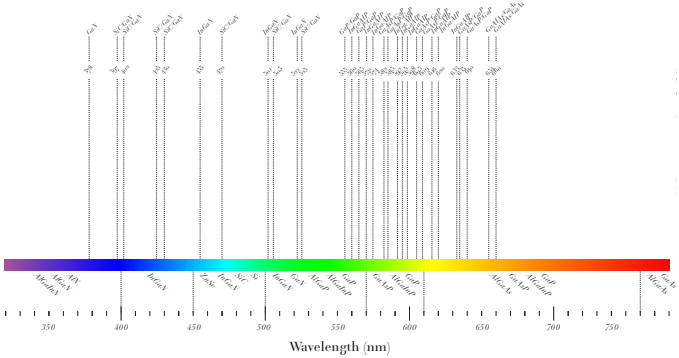
Biological and health values, as well as sustainability and the fight against global climate change, motivated the design of light; a design that is less about the materials and how it is contained, and more about the immaterial and content, i.e. a design of the light spectrum itself, or its electromagnetic composition, like pointillism or divisionism in painting, additive color synthesis. The new technique of using light-emitting diodes progressed the search of a design of the light spectrum because each LED chips emit light at a specific wavelength according to the semiconductor material used.

Semiconductor Composition

Al	Aluminium
As	Arsenide
C	Carbide
Ga	Gallium
In	Indium
N	Nitride
P	Phosphide
Si	Silicon

Semiconductor Material

Gallium arsenide (GaAs)
Gallium aluminium arsenide (GaAlAs)
Gallium arsenide phosphide (GaAsP)
Indium gallium aluminium phosphide (InGaAlP)
Gallium (III) phosphide (GaP)
Aluminium gallium phosphide (AlGaP)
Sinc selenide (ZnSe)
Indium gallium nitride (InGaN)
Silicon carbide (SiC) as substrate
Silicon (Si) as substrate
Aluminium nitride (AlN)
Aluminium gallium nitride (AlGaN)
Aluminium gallium indium nitride (AlGaInN)
Gallium nitride (GaN)



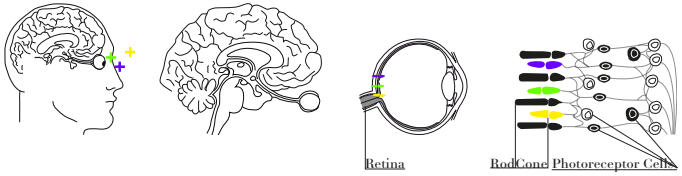
The design of the light by electroluminescence is thus a spectral composition, which proceeds through a specific choice of some semiconductor materials emitting certain wavelengths which are then added together.

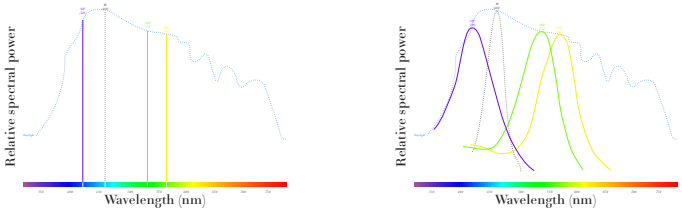
Before the spectral design of electroluminescent lamps has been done following psychological or analogical criteria, like reproducing the reassuring warm incandescent spectrum or that of the natural sun, instead we propose to work according to physiological criteria by adding, wave by wave, the wavelengths that are considered healthy, necessary, and economic. We then carefully assemble together as a perfumer with essences and odor molecules or a cook with ingredients in order to recompose a new light with biological and ecological value.

ELECTROMAGNETIC IMPRESSIONISM

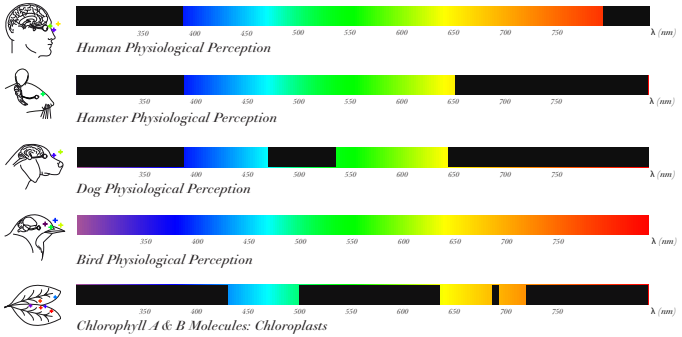
Our project proposes the design of the spectra of the light of the indoor life by adding only the necessary and vital wavelengths, for economical reasons. We proceed according to a technique similar to the Claude Monet's impressionism and Georges Seurat's pointillism by adding particular and separate wavelengths which, by color addition and convergence, reproduce a nearby white light, without the wavelengths that are not perceived by human, animal, and plant physiology. The precise composition of the wavelengths in our light will be at the discretion of the user, who may choose the spectral composition they wish for their home, based on use and in accordance to their pleasure. First, we propose to assemble specifically the biologically active wavelengths of the humans during the day: 437nm, 533nm, and 564nm according to the 3 photoreceptors cones around the

blue, green and yellow, plus the 460 nm wavelength which blocks melatonin. Also we propose to create night light as perceived by the human eye, with a lower intensity achieved by emitting the two wavelengths: 498 nm, perceived by the rods of the human scotopic vision, and 662 nm, a wavelength that does not stimulate the melatonin hormone.

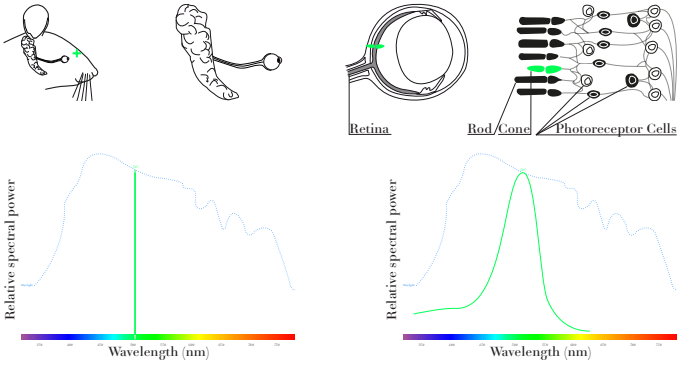




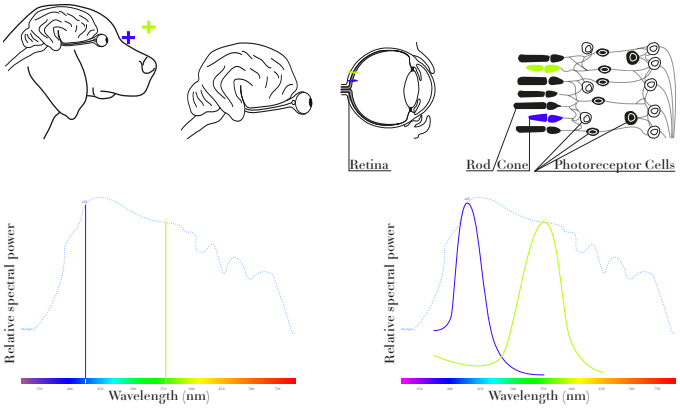
From a specifically human universe, we generously open the spectrum to the other inhabitants of the house (pets, birds, and green plants), which we list the wavelengths that they perceive, for seeing, growing, and photosynthesising. The user can freely assemble the specie specific wavelengths in the lamp to compose their own electromagnetic spectrum, like an interior sun, whilst being economical and healthy.



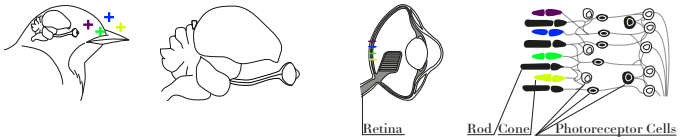
Light enters the hamster eye at the retina and travels through rods and one cone to be anaylized by the photoreceptor cells. The information is transfered to the brain as a monochromatic image.

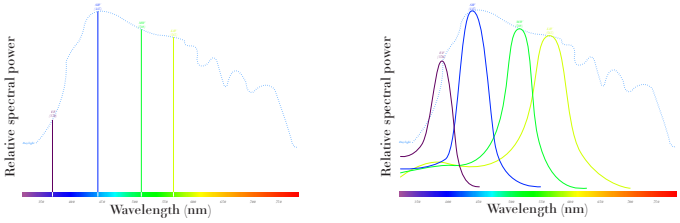


Light enters the dog eye at the retina and travels through rods and cones to be anaylized by the photoreceptor cells. A dog's eye contains two cone, whose peak perception wavelengths are 429 and 555 nanometers. The information is transfered to the brain as a dichromatic image.



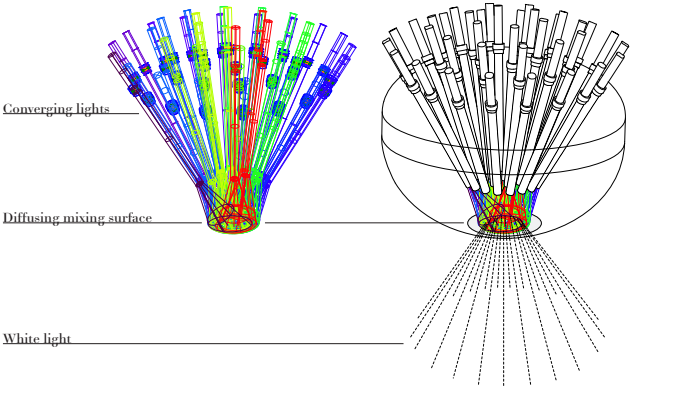
Light enters the bird eye at the retina and travels through rods and cones to be anaylized by the photoreceptor cells. The bird eye contains four different cones, whose peak perception wavelengths are 370, 445, 508, and 565 nanometers. The information is transfered to the brain as a tetrachromatic image.





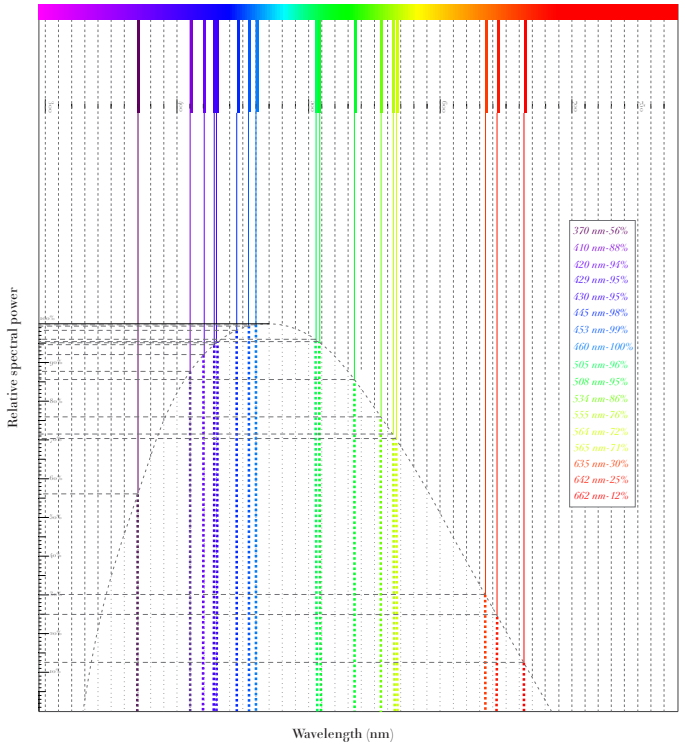
SPECTRAL LIGHT

The lamp we propose consists of a clear glass globe. The lower part is translucent, purposed to mix and diffuse the different wavelengths. The different colors emitted will fade to white, in this area, by the principle of additive color. The upper part of the globe is perforated by 36 electrical connectors, in which the light tubes are inserted and electrically connected. The convex shape of the upper part of the globe orients each of the 36 light tubes towards the lower translucent surface of the globe in order to converge their light, which is mixed and homogenized together for producing, by addition and synthesis, the nearby white light spectrum of the natural sunlight.

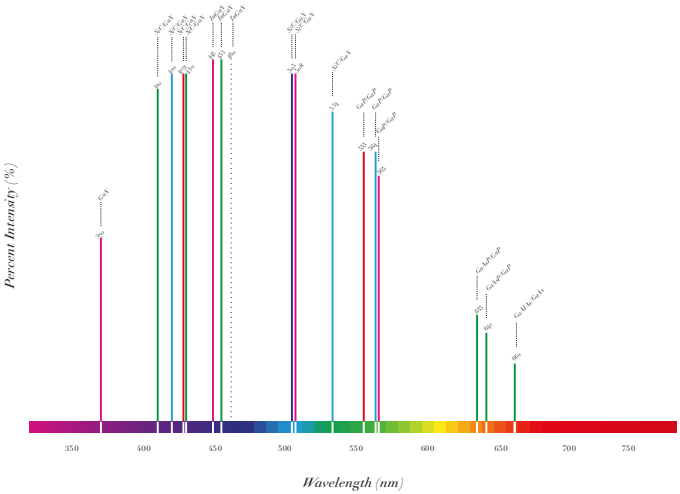


The second part of the lamp is composed of light tubes we call "Artificial rays." Each of these Artificial Rays have a single wavelength. There are 18 different types of Artificial Rays offering 18 different wavelengths, corresponding to 18 wavelengths peaks seen by the living species we have chosen. 6 wavelengths for human (4 for day, 2 for the night), 6 for plants, 4 for birds, 2 for dogs, 1 for hamsters. Depending on the intensity of the natural sunlight, some Artificial Rays must be doubled or tripled in number (especially around the blue) to respect the natural proportion of solar light intensity according to wavelength. The user is then free to assemble the number of Artificial Rays they want, in order to produce a lamp for, as examples, human and plants, or human, dogs and plants, etc ...

Daylight Curve Spectrum with Species' Peak Wavelengths



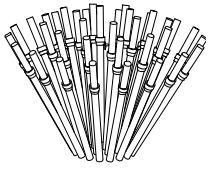
LED Semiconductor Materials Composition

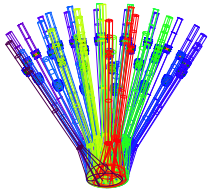


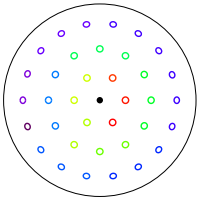
Human	*370 nm-56%-1 light unit*	*Gallium Nitride*
Plant	*410 nm-88%-2 light units*	*Silicon Carbide / Gallium Nitride*
Bird	*420 nm-94%-3 light units*	*Silicon Carbide / Gallium Nitride*
Dog	*429 nm-95%-3 light units*	*Silicon Carbide / Gallium Nitride*
Hamster	*430 nm-95%-3 light units*	*Silicon Carbide / Gallium Nitride*
	445 nm-98%-3 light units	*Indium Gallium Nitride*
	453 nm-99%-3 light units	*Indium Gallium Nitride*
	460 nm-100%-3 light units	*Indium Gallium Nitride*
	505 nm-96%-3 light units	*Silicon Carbide / Gallium Nitride*
	508 nm-95%-3 light units	*Silicon Carbide / Gallium Nitride*
	534 nm-86%-2 light units	*Silicon Carbide / Gallium Nitride*
	555 nm-76%-2 light units	*Gallium Phosphide / Gallium Phosphide*
	564 nm-72%-1 light unit	*Gallium Phosphide / Gallium Phosphide*
	565 nm-71%-1 light unit	*Gallium Phosphide / Gallium Phosphide*
	635 nm-30%-1 light unit	*Gallium Arsenide Phosphide / Gallium Phosphide*
	642 nm-25%-1 light unit	*Gallium Arsenide Phosphide / Gallium Phosphide*
	662 nm-12%-1 light unit	*Gallium Aluminium Arsenide / Gallium Arsenide*

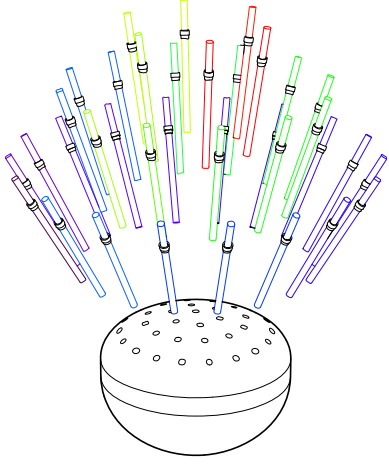
LAMP

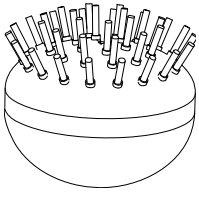
The lamp with 36 holes showcased in the Artemide Showroom of Corso Monforte for the Salone del Mobile 2015, composes all the wavelengths together (for human, plant, bird, dog and hamster). There are 11 rays for plants, 9 rays for humans (we will not take the night rays), 8 rays for birds, 5 rays for dogs, and 3 rays for hamsters, for a total of 36 rays. The different lights of these Artificial Rays converge at the translucent lower part of the lamp and then recompose to produce a white light similar to that of the sun, but more economical and more just from a biological point of view.



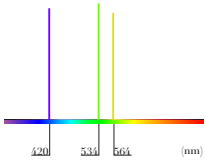






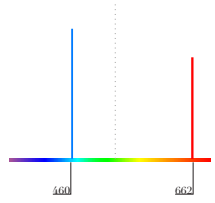


Human Day



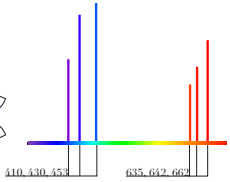
+ *420 nm-2 light units*
+ *534 nm-2 light units*
+ *564 nm-1 light unit*

Human Night



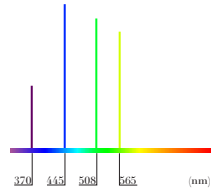
+ *460 nm-1 light unit*
+ *642 nm-1 light unit*

Plant



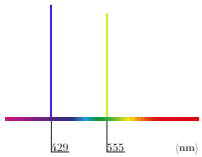
+ *410 nm-2 light units*
+ *430 nm-2 light units*
+ *453 nm-3 light units*
+ *635 nm-1 light unit*
+ *642 nm-1 light unit*
+ *662 nm-1 light unit*

Bird



+ *370 nm-1 light unit*
+ *445 nm-3 light units*
+ *508 nm-2 light units*
+ *565 nm-1 light unit*

Dog



+ *429 nm-3 light units*
+ *555 nm-1 light unit*

Hamster

+ *505 nm-2 light units*

Switch for Lamp

Violet_4 LED

Deep blue_4 LED

Blue_4 LED

Cyan_4 LED

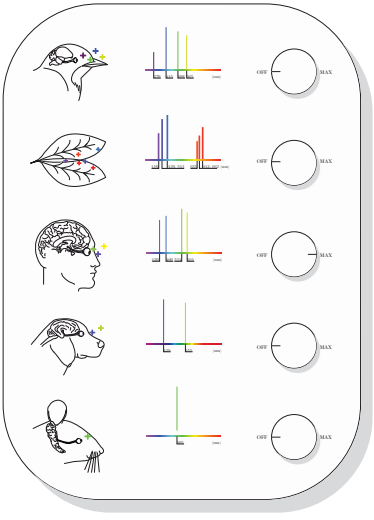
Green_4 LED

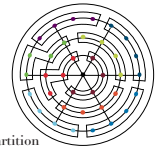
Lime_4 LED

Orange red_4 LED

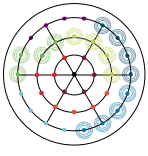
Red_4 LED

Deep red_4 LED

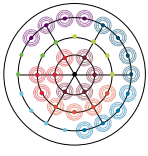




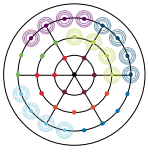
LED Repartition



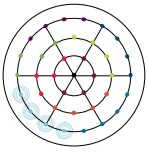
Human



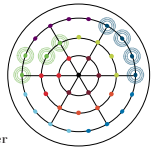
Plant



Bird



Dog



Hamster

All

Philippe Rahm

Philippe Rahm is a swiss architect, principal in the office of Philippe Rahm architectes, based in Paris, France. His work, which extends the field of architecture from the physiological to the meteorological, has received an international audience in the context of sustainability. He started to teach architecture design at the GSD, Harvard University, USA, in the Fall of 2014. In 2002, Mr. Rahm was chosen to represent Switzerland at the 8th Architecture Biennale in Venice, and was one of the 25 Manifesto's Architects of Aaron Betsky's 2008 Architectural Venice Biennale. He is nominee in 2009 for the Ordos Prize in China and in 2010 and 2008 for the International Chernikov Prize in Moscow where he was ranked in the top ten. He has participated in a number of exhibitions worldwide (Archilab, Orléans, France 2000; SF-MoMA 2001; CCA Kitakyushu 2004; Centre Pompidou, Paris, 2003-2006 and 2007; Manifesta 7, 2008; Louisiana museum, Denmark, 2009; Guggenheim Museum, New-York 2010). In 2007, he had a personal exhibition at the Canadian Centre for Architecture in Montreal. Mr. Rahm received his architecture diploma at the EPFL in Lausanne, Switzerland in 1993. He was a resident at the Villa Medici in Rome (2000). He was Headmaster at the AA School in London in 2005-2006, Visiting professor at the Mendrisio Academy of Architecture in Switzerland in 2004 and 2005, at the ETH Lausanne in 2006 and 2007, at the School of Architecture of the Royal Danish Academy of Fine Arts of Copenhagen in 2009-2010, in Oslo at the AHO in 2010-2011. From 2010 to 2012, he held the Jean Labatut Professorship in Princeton University, USA. He has lectured world wide, including at Yale, Cooper Union, UCLA and the ETH Zürich. His recent work includes the First Prize for the 70ha Taichung Gateway Park in Taiwan currently under construction (with mosbach paysagistes and Ricky Liu & Associates), an office building of 13000 m2 at La Défense in France for the EPADESA; a convective condominium for the IBA in Hamburg, Germany; the White Geology, a stage design for contemporary art in the Grand-Palais on the Champs-Elysées in Paris in 2009 and a studio house for the artist Dominique Gonzalez-Foerster in 2008. Monographic books include "Physiological architecture" published by Birkhaüser in 2002, "Distortions", published by HYX in 2005, "Environ(ne)ment: Approaches for Tomorrow", published by Skira in 2006, "Architecture météorologique" published by Archibooks in 2009 and "Constructed atmospheres" published by Postmedia, Milan, Italy, in 2014.

This publication is made for the launch of the Spectral Light designed by Philippe Rahm for Artemide at Artemide's Milan Corso Monforte Showroom on the 14th of April 2015

Graphic Design: Philippe Rahm architectes

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