CREAL

MEDIA KIT

CREAL, founded in 2017 and based in the EPFL Innovation Park in Switzerland, envisions Augmented Reality to be the next major communication platform within this decade. This is why the startup is developing the natural display for AR to be fully accepted and used as an everyday tool from cooking to neurosurgery. By developing the light field display technology, CREAL will enable AR glasses manufacturers to provide their clients with perfectly natural virtual images including genuine depth for comfortable and fully immersive experiences.

CREAL's light field technology -
The display that cares for your vision

Let's make a simple vision test. Close one eye, and look with the other one at your finger in front of you. You will notice that you see it sharp, since you focus on it. What you may never have noticed is that everything around, except from your finger, is blurred. If you now look beyond your finger and focus on another object further, that object will come into focus and your finger will now become blurred. This simple test shows how our three-dimensional perception works with optical depth.

Until today, most AR and VR devices are ignoring this natural focusing function of our eyes. They project the virtual images at approximately 1.4m from the user, on a flat display (just like any screen), meaning we can see the virtual image sharp only when our eye focuses at the distance of the display. However, if the user wants to look at a virtual object at a different distance that the one of the display, there will be a focal rivalry happening: the virtual object will be blurred next to the real object in focus. This leads to very uncomfortable side effects for the users, such as eye strain and nausea.

So how can this focusing function, which is so natural to us, be replicated using technology?

While many technologies are developing tweaks to bring depth in virtual images, such as rapidly moving the flat display based on eye-tracking, or stacking different displays at different distances, CREAL developed a technology that is fixing the issue at its core. Our goal is to recreate the light just like it exists in the real world, and therefore simulate the way in which light rays reach our eyes after reflecting off objects in our environment. To do so, we have developed a near-eye light field display technology that simulates precisely the three-dimensional perception that we experience in the real world. The true 3D perception is achieved by implementing light field projectors in the temples of a pair of glasses, which bounce the light field components on a holographic lens and back to the eye. Each light field component enters the eye through slightly different perspectives (approximately 6000 per seconds) which, brought together, reconstruct the full virtual scene right in front of the user's eyes. This way, the virtual scene is built with genuine depth and is always in focus - it is up to the user to decide where to focus, just like in real life.

By recreating the light itself, CREAL enables the virtual objects to naturally fuse into reality, from arm's reach distance to infinity. Light field technology provides users with AR experiences that are natural and comfortable to the human eyes.

CREAL's light field technology explainer

Current AR displays

CREAL’s light-field display

Founders/management and team

Alex Kvasov
CTO

8+ years in product development and technology commercialization in a start-up environment (Act-Light, Technis).

Tomas Sluka
CEO

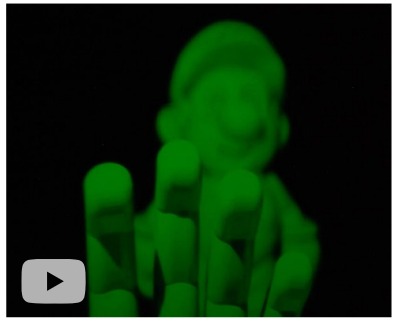
15+ years in high-profile research at CERN and EPFL. Early-stage technology commercialization. Highly cited author, invited speaker.

CREAL team

With dedicated engineers from Intel's smart glasses project as well as Magic Leap, CERN and EPFL, CREAL's expertise covers every aspect of the required technology, from optic and mechanic to electronic and software.

Timeline prototypes

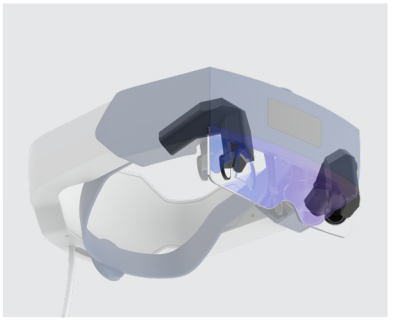
2018

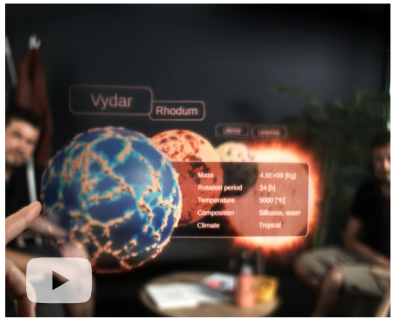


2019

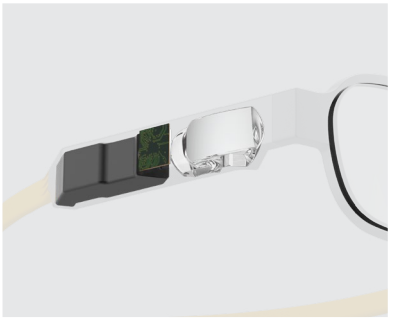
2020

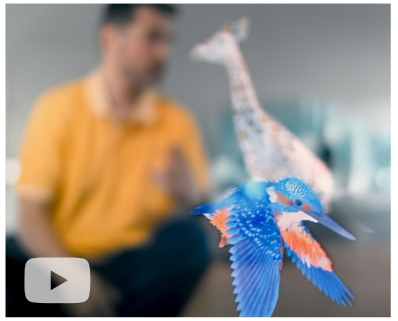
2021



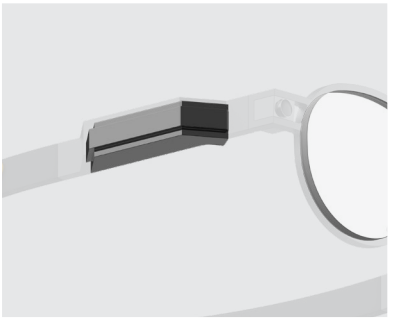


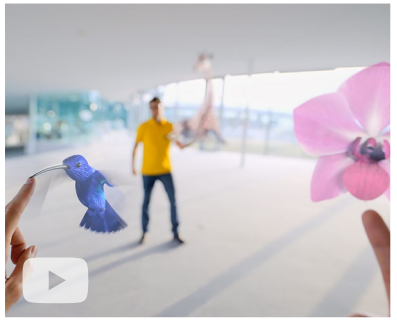
2024





2025+





FAQ

1. What is the CREAL value proposition to consumers?
CREAL uniquely provides fully natural, comfortable and healthy 3D visual experiences in Augmented Reality. CREAL seamlessly combines the real world with equally natural digital imagery, using a standard eyeglasses lens with its centuries-evolved aesthetics. Thanks to the unique properties of light field projection, each eye's prescription correction can be DIGITALLY applied all without distorting or impacting the digital imagery.

2. What is the CREAL value prop for OEM/ODM customers?
CREAL provides its customers with a competitive edge by enabling qualitatively more immersive, comfortable, and healthier visual experiences in AR products without eyestrain, which will enable longer use times and close-proximity visualizations without causing unpleasant nausea.

3. What does "light field" mean exactly?
In physics terms, it is the description of how light exists and functions in the real world. In engineering terms, it is the technical approximation of that in AR and other viewfield technologies. Primarily, light field is different from imagery provided by standard flat displays, as it provides 3D imagery. CREAL's light field is a particularly high quality and high efficiency version of light field that provides 3D imagery with real-world focal depth.

4. How does light field compare to waveguide-based solutions?
Waveguide-based solutions (so far) display only flat imagery and therefore, cannot provide real-world depth of field, making the content appear less realistic (especially at close distances). Waveguides are incompatible with light field in their current form factors and design, as they kill the focal depth for AR images. In addition, waveguides have many other significant drawbacks. Waveguides are unaesthetic (predominantly flat), extremely light-inefficient and are extremely hard to provide aesthetic and cost efficient prescription correction for eyeglass wearers. CREAL's light field is used with a combiner that is a thin film on a classic lens. The film is highly transparent and orders of magnitude more efficient than hard plastic, glass, sapphire or Silicon Carbide waveguides. CREAL provides full prescription correction and regular eyewear aesthetics - and with far more natural imagery.

5. How long has CREAL been working on developing this technology?
As a company since 11/2017 - as the founder's project since ~2015.

6. Is this a University spinoff?
Officially not (CREAL does not have any contractual relation with the local University - EPFL), but we are seen as an EPFL spin off because we come from EPFL and do receive help from it and we are extremely grateful for it.

7. How much money has CREAL raised to date and from whom?
Total funding is ~$18M out of which equity funding is ~$12M.

8. Can anyone else provide near-field focus of AR objects?
Several startups are indeed working on solving the same problem with different approaches and varying degrees of success. For example, Magic Leap promised a complete light field solution all the way back in 2014 - they have delivered a product "only" with two depth planes, but at least more than standard one depth plane. As far as we know, at one point Avegant supposedly had a solution with three depth planes, Light-space technologies enables four, Petaray provides light field with four perspectives, VividQ as well as many researchers and corporations are all hard at work on true holographic displays. These different ap-

proaches all present different pros and cons - but at CREAL we are convinced that our light field solution provides the best tradeoffs between quality, price and practicality.

9. How many employees does CREAL have?
27 (25 FTE), ten of whom have Doctorates in optics, microtech, electronics, and physics, as well as veterans from cutting-edge AR projects at Intel, Magic Leap, AMS and others.

10. Is the company pronounced "See-Real" or "KREAL"?
"See-Real".

11. How difficult is it to integrate CREAL tech into AR glasses?
Like any new technology, there is an integration process but no more difficult than other competing solutions. CREAL provides the micro-display portion of the technology stack, but full product also requires sensors, power management, communication etc, which needs to be combined into one product. Again, this is standard to the industry.

12. How well does this technology scale?
We paid huge attention to both the practicality and scalability of our solution. All CREAL processes needed to produce our components are well proven and scaled in the past decade and thus there are no scalability issues directly inherent to our platform.

13. Is light field a hardware-only solution or does it include software?
Hardware is a major part of our innovation offering, but CREAL does also provide unique software image processing to our customers that is necessary as well to fully implement light field.

14. How is CREAL tech integrated onto the lenses of AR glasses?
This is one of the big advantages of the CREAL solution. ODM's can use classic prescription lens of any aesthetic design and convert it into the so-called combiner, by applying a low-cost holographic film on the lens surface. That's it.

15. This is a laser-based technology – that sounds both scary and potentially damaging?
"Laser" may sound scary because lasers can indeed have high power and be used even for cutting metal, but there is nothing to be worried about in AR as it is exceedingly low-power. Indeed, Intel Vaunt, North Focals, Microsoft Hololens 2 and others all used lasers as their primary light-source.

16. How does light field keep close-up objects in focus when every other AR display tech can't do that?
CREAL light field display is conceptually very different from any other competing display solution we are aware of. It projects many perspectives of the displayed scene to the eye, each perspective seen through a slightly different location at the eye pupil. As a result, each eye receives a digital light field as a discrete approximation of a continuous real-world light field. For the eye or even a camera, the discrete light field is in its essential behavior practically indistinguishable from the real-world light field. In contrast, existing solutions create flat images and magnify them in front of you. They behave like a regular flat screen (one for each eye). Users experience many problems when it comes to flat images seen by your own eyes. If you close one eye and try to virtually touch something far with your own hand in front of your face, you will notice that you cannot focus on both of them at the same time. With light field you can and will see the content behaving as a real world object at the correct focal distances. This is what AR has always promised but never delivered - until CREAL.

17. Why take a risk on unproven tech like light field when waveguides already work?
In our opinion, light field doesn't carry any

more risk than implementing waveguides. Waveguides are far from working in a satisfactory manner and have a number of extra drawbacks. For instance, waveguides have very low light efficiency and therefore have high power consumption just for producing the light. They are also unaesthetic, sit flat on a curved lens, create rainbow artifacts from real world light, and shine light outwards (this compromises privacy). In addition, the digital image suffers from low color homogeneity, they are costly and hard to customize and even harder to provide prescription correction for. Even if they perform perfectly, waveguides provide flat imagery to each eye which is unnatural, unpleasant, and potentially unhealthy for 3D visualization. Light field provides complete, natural and vision-healthy 3D imagery to each individual eye while being significantly better in the aspects named above. In analogy, waveguides are like a black and white TV, where something is missing in the image, while light field is like a colored TV. Plus there is the difference in vision comfort and the eyestrain health aspect.

18. How much extra cost does integrating CREAL tech into AR glasses entail?
Extra cost compared to waveguides? No extra cost. It should in fact be significantly cheaper.

19. Can you use CREAL light field with prescription lenses?
Yes, since the light field combiner is actually a standard prescription lens. On top of it, light field provides the same prescription correction even for the generated AR display content, matching the real and digital imagery.

20. Do you even need to wear your prescription glasses at all with light field?
The prescription lens is needed for the correction of the real-world view, but in Virtual Reality settings (a headset with no direct see-through), the prescription correction can indeed be applied purely digitally - no glasses are needed.

21. Can CREAL light field technology be used outside of the AR glasses market?
Yes, because it is a more natural and immersive 3D micro-display in the general sense. Light field can also be used in Virtual Reality headsets, as well as in vision care instruments where digital light field substitutes for the function of physical lenses, making such instruments much more practical and fully-digital.

22. What kind of color bit depth/color model/ number of colors does CREAL use to generate images?
Since the light field image and the way it is created are very different from conventional flat-display images, we cannot straightforwardly quantify the color resolution in conventional terms. The colors are distributed in an image sequence and sum up in time. Specifically, our light field “display” provides ~100X faster sequence of image frames than a conventional display. Each light field frame provides an image with a low color resolution but with complementary color information to the other frames in the sequence. There is no standard definition to say how long sequences of colors defines the complete color. Nevertheless, we conclude that in a standard situation, the eye receives imagery with ~5 million color levels. Or, to be more specific, we can define the situation so that if we display a static image and the same sequence of frames is repeated, we can count that colors sum up to ~5 million levels. In reality, however, an eye is constantly summing up colors from a changing scene. As a bonus, the fast sequential exposure of the light field image on the retina is closer to the real world exposure, which is practically continuous.

23. Has any ODM officially adopted your tech yet?
Officially and publicly in a final product, no. We

are currently in the stage of product co-development with several leading brands, but cannot comment on their unannounced products. In addition, CREAL are announcing a product with technology maturity for integration into products designed to ship in early 2024.

24. How does CREAL address the "bokeh effect"?
The bokeh effect is as natural in AR as in the real world. The light field is already complete and it is the eye or camera that creates the bokeh effect from the generated imagery - unlike standard AR content.

25. Is watching AR content on CREAL-enhanced AR glasses fatiguing to the eyes the way so many others are?
No. Light field eliminates the main sources of eye-strain and eye-fatigue. Specifically, we address the so-called "vergence accommodation conflict".

26. Why do people need to be able to see objects close-up in AR?
Easy - because that's EXACTLY what we are used to seeing in the real world. It is our hand-interaction and private space - our eyes evolved with the ability to focus to less than 20 cm for that very reason. In AR, the real and digital worlds need to match optically, hence the content has to allow for it as well. We are even convinced that the personal space within our arm's reach is even more important for AR interaction than all the content users are currently FORCED to experience from farther away than is natural.

27. How do Hololens, Vision Pro and Meta address near-field object viewing?
They don't really address it, apart from recommending that content developers display the content from a significant distance away from the eye. Magic Leap, for instance, clips the content that should be closer than 37 cm. Meta is openly presenting their efforts in solving the problem, mostly by complex combining eye tracking with varifocal optics and digital imitation of the bokeh effect.

28. How bad is the "light leakage" in CREAL-based AR glasses?
We already have a very low outward light-leakage (aka the "glowing eyes effect") compared to waveguides. A few % compared to ~50% of the light shines outwards - we are confident we will eliminate it entirely at some point, but already today it allows us to maintain natural eye-contact and ensure no one can see what the user sees (the digital image).

29. Can anyone see the images being projected into the eyes besides the actual viewer?
No.

30. How is Light field technology different to the 3D screens found in volumetric displays or AR laptops?
Some of those 3D panels are called light field displays as well, which is admittedly confusing. CREAL's light field display is a near-eye microdisplay based on a very different concept and serving a different purpose. The large panels provide the different perspectives to enable a wide range of angles to satisfy two eye (binocular) vision and many different viewing positions for a moving viewer or multiple viewers. Unfortunately, most of the image data and light is wasted. CREAL instead projects similar amounts of information to each eye and provides a much richer and more complete visual sensation at much lower computing cost and bandwidth with far less light.

31. On the hardware side of CREAL tech, do you need to use a semiconductor fab to make the part(s)?
Yes, AR glasses or even headsets need to be as small as possible and fabs are a needed manufacturing partner. The only way to do it today is to use micro-technology - our microdisplay

includes several components produced in semiconductor fabs, but do not require state-of-the-art technology to manufacture.

32. What process geometry do the CREAL chips require, in that case?
Our core component is produced using 180nm processing, which is intentionally a low-cost process. The reason is that even microdisplays have relatively large surfaces full of large transistors compared to purely digital electronic components and more advanced processes are wasteful in such situations. As a result, we removed from the chip ANYTHING that would require a more advanced process such as digital drivers and image processors (which many other microdisplays include) in order to minimize the waste of the costly process for the large pixel area where it is not needed. Our processing is made on a much smaller, separate chip. By way of analogy - semiconductor chips are a lot like pizza. Their price depends on the size and the topping - the advanced process for microdisplay would be like a large pizza with caviar, where the caviar would be used only in the tiny left corner, but you would pay as if it was lavishly spread across the whole surface. We instead make a large, plain pizza and a small pizza with the expensive caviar next to it - the same result, but much cheaper.

33. Can any fab make CREAL designs?
Many fabs can, because our process technology does not demand state-of-the-art technology. As mentioned, the needed process is rather standard and we like it that way, as do our customers. Of course, a specific design is always linked to a specific fab, but it can be modified for another fab with extra effort.

34. What about the infamous "VR nausea" experienced by so many people using other technologies?
As in the AR context, Light field removes the main sources of eyestrain, eye fatigue and nausea. AR nausea is actually the fault of the so-called "vergence accommodation conflict". On the other hand, VR nausea can also be caused also by motion sickness - the mismatch between movement observed visually and movement felt "physically" by other senses, such as the inner ear or pressure on the skin. This kind of nausea can be reduced only by preventing a mismatch in content or by accordingly stimulating the other physical senses.

35. Can this tech be used for VR as well as AR?
Yes. We do however see more benefit and potential in AR because the visual reference is real and needs to be optically matched. In VR, everything can be equally "wrong" and the optical mismatch can be absent for that reason.

36. How well can CREAL adapt to people with poor vision, whether near-sighted or far-sighted?
The light field content itself can be digitally adjusted to provide the needed prescription correction for generated AR content. In see-through AR, the real world needs to be corrected as well. The benefit of our tech is that it is directly compatible with classic prescription lenses.

37. What about bad astigmatism, can CREAL compensate for that?
Yes, our light field can digitally correct astigmatism, too. Indeed, it can provide even more complex correction such as the digital imitation of multifocal progressive eyeglass lenses.

38. How bright is this technology, by NITS or Lumens?
Currently, we are 3500 nits with the potential for 7000 nits. Just for reference, the standard indoor brightness requirement for AR is 500 nits, outdoors is 2000 nits. Here, it is important to distinguish between brightness and light-efficiency. Bright imagery can be achieved by

brute force - more and more light means a brighter image. However, light-efficiency is a much more important parameter. For example, a typical waveguide AR system can deliver ~0.05% of the emitted light to the retina. This means that the indoor brightness of 500 nits requires some 200-300 mW of power. That is more than what is considered acceptable for the entire AR headset itself! (ideally <100 mW). Our optical system is ~50X more efficient, resulting in less than 10 mW for the light-source power budget at indoor brightness, leaving a huge amount free for the rest of the headset power.

39. Can CREAL be used to create a so-called "Digital prescription lens"?
It depends on what "Digital prescription lens" means. Once we create the light field, we can also transform the light field and therefore provide prescription correction to the displayed digital content. We are not able to digitally correct the light from the real world - this still needs the conventional prescription lens.

40. Can you see depth if one eye is closed or damaged?
Yes, light field provides correct monocular (one-eye) depth cues.

41. Does eye tracking work with CREAL?
Eye tracking is not needed for the fundamental function of light field, but it could provide extra benefits, such as allowing us to project only a portion of the light and image information that actually enters the eye pupil while increasing the already very good efficiency of the system.

42. What would a pair of AR glasses with CREAL tech probably retail for?
The display itself can reach <$100 price tag in high volumes, but the total cost of the AR glasses depends on other parts, too, and heavily on shipping volumes. Nevertheless, the other parts of the display system are already relatively optional and can be selected in order to define the price point, while the bottom line - the display part - is relatively low cost.

43. If this technology is so innovative, why hasn't Apple adopted it?
This is from our side a speculative question as we don't have any visibility into Apple's plans and development efforts. On the other hand, each technology has its own life cycle. Today's products are based on technologies that were mature several years ago. Light field is reaching product maturity only now. Its primetime will come..

44. How rare or esoteric are the chemicals/films/components needed for the CREAL technology stack?
The only thing that can be even remotely classified as "esoteric" is the ferroelectric liquid crystal that is responsible for the main function of the display. It doesn't contain any rare elements, but it is a special chemical molecule that is available from multiple vendors. The process to manufacture this molecule has already been mastered by our partners and very little of it is needed. Quite literally, 1 liter is enough for millions of glasses!

45. Are the tech components commercially available at consumer products scale from multiple vendors?
Most of the components are, but several core components are designed and owned by us, although they are produced by third parties. We are a fabless company.

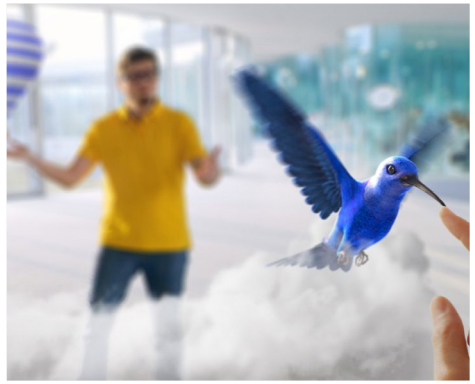
CREAL in the press

RoadToVR about CREAL newest light field display

05.06.2023

CREAL IS #5 IN THE SWISS STARTUP AWARD

08.09.2022



Tomas Sluka introduces the 5 current technologies that are countering VAC in AR Insider

24.06.2022

SPIE Fireside chat with Tomas Sluka

09.06.2022

Tomas Sluka on the AR Show discussing light fields, vision and CREAL's story

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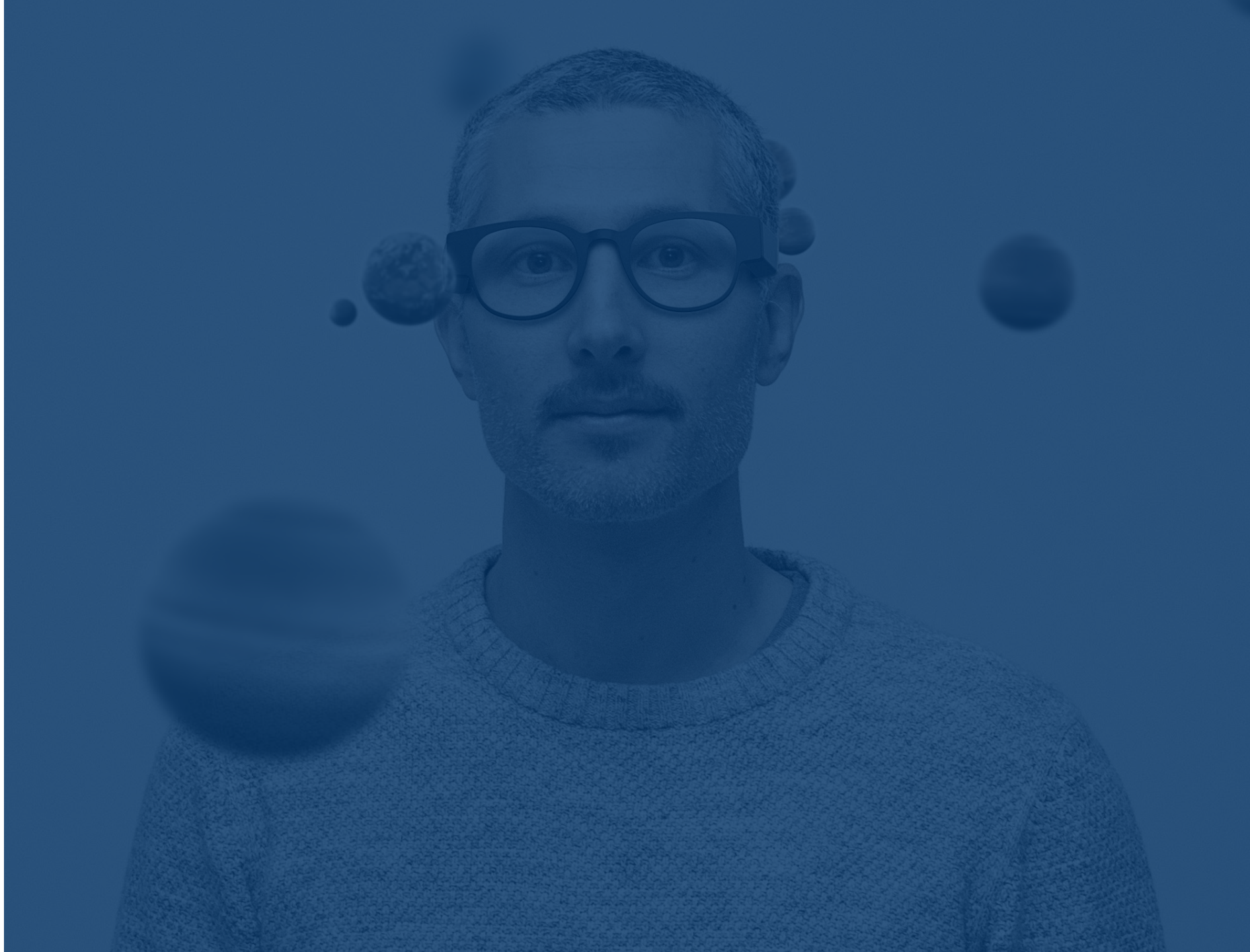

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