# The first EASA-qualified virtual flight simulator with Varjo VR: Live Q&A

We hope you enjoyed the Varjo webinar "How VRM Switzerland achieved the first EASA-qualified VR flight simulator using Varjo virtual reality" featuring our collaborator VRM Switzerland.

We received many interesting questions during the live session. Great thanks to all who joined the expert panelists for this inspiring, intriguing discussion. To address every question and foster further discussion, Varjo and VRM Switzerland teamed up to deliver this in-depth complement to the webinar event.

See what the panelists have to say and tell us what you think.

## The Expert Panelists:

Fabi Riesen
CEO
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Varjo Technologies

# Panelist Insights: Rotary pilot training in VR

**What exactly does the EASA qualification mean for training? Can you log the training time? If so, how many hours of VR training can be logged for license/rating?**
FR: With the EASA qualification, pilots can complete flight hour credits for simulator training hours. In addition, it means, that EASA has validated the FSTD (Flight Simulator Training Device) and considered it valuable for professional flight training. There are many different combinations of ratings, licenses, simulator types & operations, special operations, etc. ending up in different amounts of creditable hours.

You can see a few of them here: vrm-switzerland.ch/easa-qualification/

For details, you will need to refer to the appropriate documents from EASA and NAA's.

**What role did Varjo play in the development of this solution?**
MH: Varjo is the technology provider for the headsets as part of the overall solution.
FR: 3D VR visualization was a necessary part of achieving overall EASA qualification. We've been super happy to have Varjo supporting us on the various integrations and special modifications to achieve this qualification.

**Why did you choose VR over mixed reality, especially with a device as powerful as Varjo XR-3?**
FR: The Varjo XR-3 was used initially over the VR-3 because the VR-3 was not yet available at the time of qualification. Although Varjo XR-3 is the best MR implementation I've been able to test, we do not use any XR capability in the system. A pure VR solution was selected for the qualification because:

- Mixed reality (MR or XR) uses video pass-through, "filming" the cockpit and pilot with cameras integrated into the HMD. This video signal is mixed with the virtual environment in perceived real time. Those cameras are not at exactly the same position as the eyes. Because of this, the representation in the HMD had geometric distortions which did not meet the CS-FSTD(H) standard requirements.

- Whilst the cameras built into Varjo XR-3 do have already a fantastic resolution, its video pass-through resolution does not meet the EASA qualification requirements to represent instruments in a cockpit.

- With our VR-only solution and pose-tracking, we have everything digitized and available in 3D (including the pilot). This enables multi-pilot and multi-crew, even when on separate simulator units.

Watch VRM's video on pose tracking here: www.youtube.com/watch?v=qdGFyO7YU-0

# Panelist Insights: Rotary pilot training in VR

**Does VRM Switzerland have plans to have the simulator approved through the FAA? Is Varjo looking to pursue similar recognition with the FAA?**
FR: Yes, we are working with FAA. We will be announcing our first US customer very soon and are already taking orders for US-based training programs. It is important to note that EASA is not qualifying specific subcomponents, e.g. the headset. EASA qualified the complete FSTD (Flight Simulator Training Device) system according to the CS-FSTD(H) standard. Also important to keep in mind, the EASA has ongoing work to update this standard. More details can be found in RMT.196.

Read RMT.196:
www.easa.europa.eu/document-library/terms-of-reference-and-group- compositions/tor-rmt0196

Find more information about the CS-FSTD(H) standard at:
www.easa.europa.eu/document-library/certification-specifications/cs-fstdh-initial-issue

MH: While Varjo does not have plans to pursue this kind of qualification individually, we are continuously working to enable the use of the Varjo headset in even the most secure environments. We understand and support the security and risk management requirements of defense and security customers, and routinely work with both end-users and system integrators including customers such as Boeing, Lockheed Martin, the US DoD.

Learn more here:
varjo.com/blog/high-security-vr-for-the-enterprise-a-deep-dive-into-varjo-security-measures/

Read about Varjo's recently announced TAA-compliant XR-3 headset variations here:
varjo.com/taa-compliant-xr-3/

**How does EASA compare to FAA standards?**
FR: They are similar, but still different; resulting in separate qualifications. The qualification types and levels also have different naming conventions. For example, an FTD-3 qualification in EASA terms is something complete different than an FTD-3 under the FAA.

**What was actually qualified as FNPT Level 2? You mentioned that you used VR glasses; how about the cockpit components? Were these virtual or was it actual knobs and buttons? P.s. its pretty impressive I have to say.**
FR: The entire FSTD (Flight Simulation Training Device) system must be qualified. That said, yes, we've qualified everything with VR, the motion platform and a full-scale replica cockpit with working controls, knobs and buttons. Take a look at this video to see how this was achieved: www.youtube.com/watch?v=qdGFyO7YU-0

# Panelist Insights: Rotary pilot training in VR

**How was the qualification process with EASA? Could you elaborate on the process similarities / differences with traditional FSTD vs VR simulator?**
FR: The process for the qualification was the same as traditional FSTD. However, for such a landmark achievement (using VR), EASA and VRM Switzerland conducted extensive training evaluation with many pilots and experts from all over Europe prior to the qualification.

**Which aspects of the technology were the most difficult to prove the FSTD equivalent for EASA? HMD Visuals? Motion Base? Cockpit?**
FR: One of the big challenges was building out the full-scale-replica cockpit to enable a haptic experience in VR that met the EASA Standard. But the most difficult aspect was to have the end-to-end system working seamlessly while meeting the FSTD standard.

**What level of qualification is the system?**
FR: Currently, we offer the R22 as an FNPT-II and the H-125 (AS350) as an FTD-3 under EASA.

**In a recent CAT magazine article, a "virtual FSTDO" is mentioned in the EASA qualification process. What does that mean?**
FR: To qualify a simulator, you need to have the FSTD (Flight Simulator Training Device) and an FSTDO (Flight Simulator Training Device Organization). This organization is required for operation of the simulator and also needs to be qualified by the EASA. VRM Switzerland created its own FSTDO registered directly at EASA.

In practical application, a flight school (AKA ATO) must go through this process of building, registering and running as an FSTDO to officially operate the qualified simulator. To simplify this process, VRM Switzerland is providing the FSTDO registration process as a service for customers getting started after purchasing the qualified simulator.

**What kind of ongoing operational calibration/maintenance checks are needed to ensure the EASA certified standard of performance is consistently achieved? What level of skill/knowledge is needed to execute that calibration/maintenance and is suitable training available?**
FR: This is a very important question. One of the biggest challenges with “more affordable simulators” is that many MR/VR simulator vendors sell their machine in a “fire and forget” manner. This is why VRM Switzerland has created its own FSTDO - to provide calibration/maintenance as a service for its customers. This enables you to run an FSTD without the need of all such calibration equipment and knowledge required to keep the FSTD qualified.

# Panelist Insights: Rotary pilot training in VR

**To gain flight credit with this solution, what equipment is required other than Varjo XR-3? What is the price of software?**
FR: In order to complete training credits you will need the complete qualified FSTD by VRM Switzerland and it must be operated by an FSTDO. See above for more information.

**What is your opinion regarding the future of MIXED reality in Flight Simulation?**
FR: Mixed reality is a great tool and XR-3 is a fantastic implementation of Mixed reality. Nevertheless, MR is not the right tool for an aviation qualification meeting the CS-FSTD(H) standard.

**Do you see this technology being applied to fixed wing FSTDs, such as C172? Will you be pursuing EASA qualification for a fixed wing simulator as well?**
MH: Absolutely, e.g. Saab has recently announced implementing XR-3 to their Grippen simulators. You can learn more about this exciting development here:
varjo.com/company-news/saab-and-varjo-bring-virtual-reality-to-flight-simulators/

FR: Yes, being myself an impassioned C172 pilot. If you google for “Martina lernt fliegen” you will find an old proto-type we’ve been building to run a ground-to-air experiment for fixed wing using only the simulator.

**How well can this technology (VR + simulator) be extended to aircraft with a wider cockpit setup (e.g. fighter jet) without introducing negative training on the required head motion for visual scan?**
FR: When looking specifically at the CS-FSTD(H) standard, it’s a trade-off between FOV and resolution. But I do agree, FOV is definitely something to look at it as the technology continues to develop and evolve.

MH: Adding to that...Varjo VR has highest resolution on the market even in the peripherals, resolution stats for outside the “sweet spot”; comment on the balance between FOV and resolution; comment on eye movements vs head movements and mitigating negative training

# Panelist Insights: Rotary pilot training in VR

**Could the field of view issue be solved by using another headset, like Pimax or XTAL? With the new Vive HMDs with 5K, do Varjo headsets still offer better or equal resolution?**
FR: No, stretching the same amount of pixels over a wider FOV reduces the amount of pixels per degree, resulting in lower overall resolution and failure to qualify for the EASA-specified standards.
MH: Varjo HMDs still offer a better resolution. Vive pro 2 will have around 20 PPD. Varjo's focus area (27° x 27°) sits at 70 PPD uOLED, 1920 x 1920 px per eye, with the peripheral area at over 30 PPD LCD, 2880 x 2720 px per eye.

**As this is not a high-volume market, what is Varjo's commitment to improving the products for flight training special requirements (e.g. field of view)?**
MH: Varjo is committed to providing the most advanced technology for professional VR/XR use across industries. We regularly seek out feedback from our customers to gain the best understanding of specific needs and requirements. Field of view is important in many use cases outside of aviation as well. From our first generation devices to now, we have expanded the FOV, now offering 115 degrees FOV in the VR-3 and XR-3 with higher resolution than any other device on the market in both the primary and peripheral areas of the display. We understand how critical these needs are to the future of aviation training specifically and are actively working to improve our product capabilities to address these needs in the future.

**What is your opinion regarding the future of mixed reality in flight simulation?**
FR: Mixed reality is a great tool and Varjo XR-3 is a fantastic implementation of mixed reality. Nevertheless, MR is not yet ready for an aviation qualification meeting the CS-FSTD(H) standard.
MH: While mixed reality is still evolving to meet these needs, there are many other aspects of aviation training where mixed reality is leveraged today to help with learning and development, such as familiarization, part-task and maintenance training, where haptics and environmental awareness are necessary. As technology evolves, becoming more readily accessible and more widely capable, we will continue to see adoption grow.

**Great job on qualification. How does this translate to operation? If we train as we fly (or fly as we train), do helicopter pilots use goggles in normal operations as well?**
Helicopter pilots often use helmets and googles in NVIS operations. With the Varjo headset, the weight and comfort has been proven to be acceptable for longer training sessions. At the end of the day, it is a trade off between having a full flight simulator in dome projection and no googles but without visual cues (e.g. accurate lighting, conditions and perspective) OR using the Varjo headset in a VR simulator with true visual cues and expanded functionality, such as a load transport. See an example of these differences: www.youtube.com/watch?v=YJPpqrKIVmQ

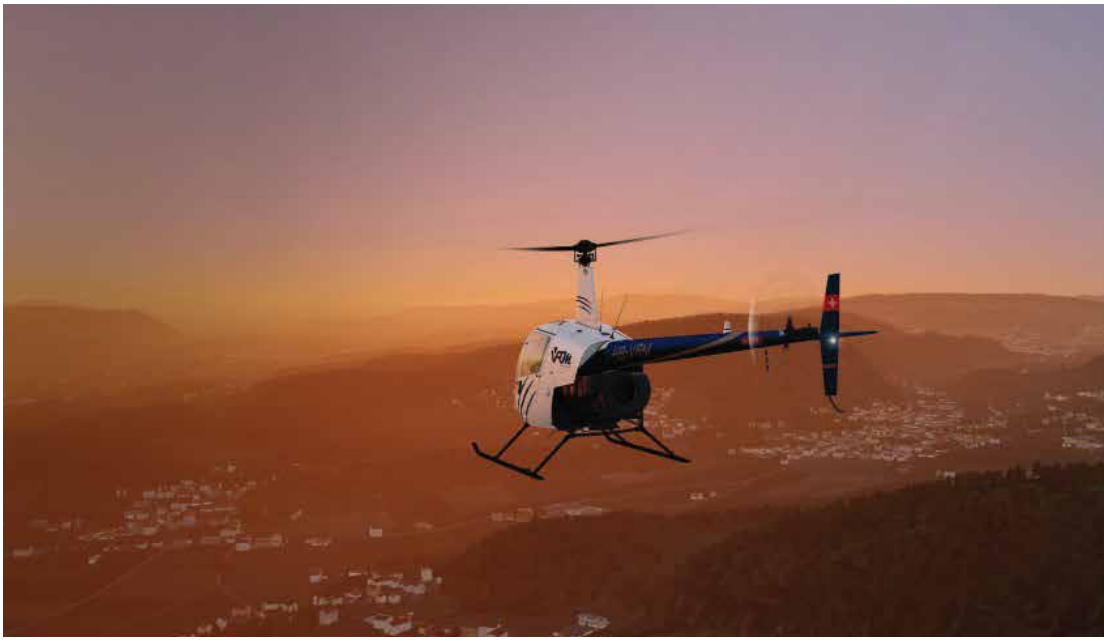
# Panelist Insights: Rotary pilot training in VR

**Did VRM and/or EASA use objective methods to measure motion sickness?**
FR: There are many parameters and components that can impact motion sickness. VRM Switzerland has been researching this since 2015 with the HSR University OST. There have been more than 700 pilots who have provided feedback, which has been incorporated into the simulator system.

You can see a pilot's review of an earlier version of the simulator here:
www.youtube.com/watch?v=Xkyumrnyc00

We've also intentionally tested fly outs with pilots for motion sickness, and are happy to share that we've achieved better results regarding longer simulator training periods using the VRM Switzerland simulators, when compared against traditional dome simulators.

**It is fantastic to learn about the visuals, and the motion (and hopefully about the haptics soon).**
FR: We hope you'll come and try out the haptics and overall experience for yourself. Haptics are not only important to reducing motion sickness; they are essential to the qualification of the simulator. Have a look here, how this has been solved in the VRMotion simulator: www.youtube.com/watch?v=qdGFyO7YU-0



# Panelist Insights: Rotary pilot training in VR

**Audio is an important aspect for immersion, and often neglected. How do VRM and Varjo address this? Does 3D sound help to reduce motion sickness?**
FR: All our FSTD's are delivered with a full 3D sound system and original aviation headsets with all its features including noise cancellations.
MH: All Varjo headsets come equipped with an audio jack that enables easy integration with headphones whenever needed, whether in the VRMotion simulator or other training programs.

**Which image generator/rendering engine/visual system has VRM used to develop this simulator?**
FR: We are using our own IG which is specially developed to drive VR at glance and fulfil all the qualification requirements.

**What response time does XR-3 achieve for foveated image optimization relative to the 200Hz user eye tracking rate?**
MH: The improved 200Mhz eye tracking update rate allows the Varjo compositor to use the latest eye position on the next frame that the client application is about to render. Because the human eye rate of refocus is closer to the 100-200ms range, the delay between that one frame (8-12ms) is not detectable.

**How do you read maps or reference cards in this simulation?**
FR: VRM Switzerland FSTDs are equipped with a virtual eBag, giving the pilot full capability to complete all pilot tasks within VR.

**How is the alignment between real world and virtual world achieved (especially regarding all the switches)? How precise is the alignment between the cockpit buttons in the virtual environment and in the real cockpit?**
FR: This is done by our own developed VRM Switzerland pose tracking system; a system which works without the need of gloves and without mounting any sensors on the pilot. This system works not only for the hands, but also for the entire body. It enables our simulator fleet for multi-crew and multi-pilot trainings in a fully immerse VR training solution. The system is so precise that a pilot can operate the entire cockpit, overhead panel and small avionic buttons on a 6DOF Full motion platform.
Have a look at the link to see how it works: www.youtube.com/watch?v=qdGFyO7YU-0

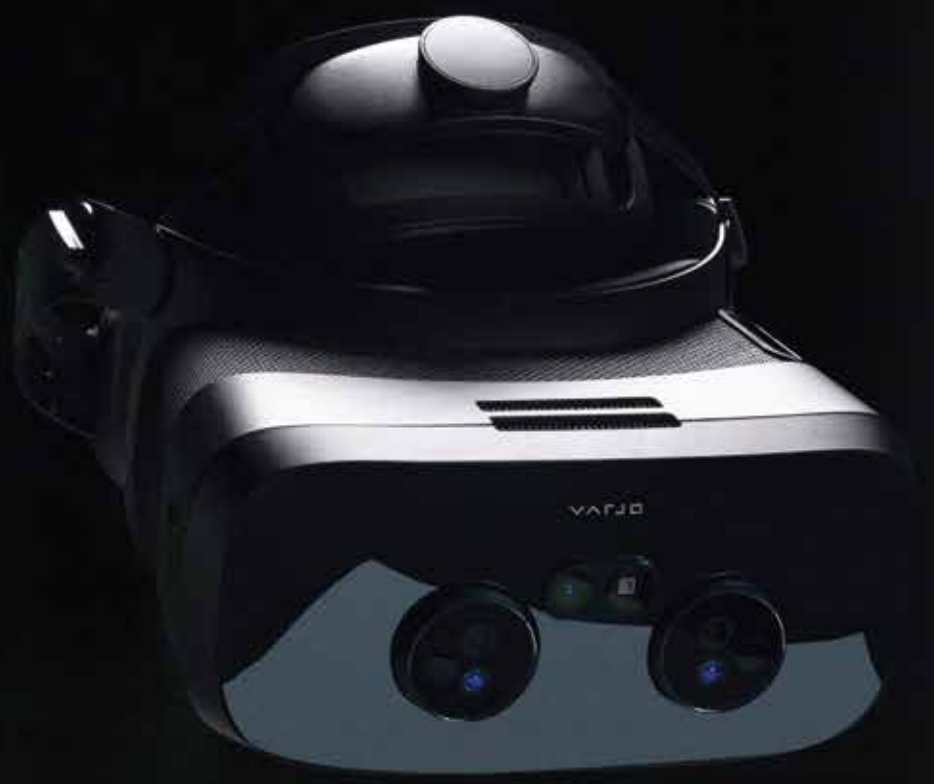
# Curious how your team or program could use immersive technologies?

Explore our industry-leading headsets

VARJO VR-3

VARJO XR-3

TALK TO SALES



# Panelist Insights: Rotary pilot training in VR

**How do you track the VR headset in the motion platform? Please describe the solution you use.**
FR: We use several technologies for HMD tracking and enhance it with our proprietary motion platform specific tracking solution. The current solution on the FSTD is based on Steam Lighthouse tracking.

**For the human pose tracking, where are the cameras placed to enable this?**
FR: Cameras are mounted on the FSTD.

**Did the built-in Varjo hand tracking work well enough unmodified or did you need to customize or replace it?**
FR: The built-in hand tracking is not used for the FSTD.
MH: During the qualification process, the Varjo XR-3 and VR-3 were operating a beta version of the integrated Ultraleap hand tracking. The fifth-generation hand tracking software - Gemini - has since been released and Varjo headsets were the first to fully integrate and bring to market this new release.
Learn more: www.varjo.com/blog/how-hand-tracking-unlocks-enterprise-use-cases-guest-post-by-ultraleap/

**Do you use built-in eye-tracker in the VR headset? Please describe the applicability and typical use cases.**
FR: Follow VRM Switzerland at www.linkedin.com/company/vrm-switzerland/ and you will soon hear more details about this topic.
MH: To learn more about Varjo's built-in eye tracking system and how to leverage it for training, here are a few resources I recommend checking out:
- Industrial-Strength Eye Tracking: varjo.com/blog/industrial-strength-eye-tracking-in-varjo/
- Real-time Eye Tracking Visualization with MetaVR: https://vimeo.com/558417157
- High Quality Eye Metrics & Workload Analytics with EyeTracking LLC: varjo.com/company-news/varjo-eyetracking-enable-high-quality-eye-metrics-workload-analytics-from-vr-xr-simulations/

**What's the weight factor of the headset and does it affect the duration of training compared to previous training sessions in a dome?**
FR: The weight can definitely have an impact on training duration. Varjo did a good job with this, meeting the requirements for the qualification.
MH: With our latest generation of headsets, we've worked to drastically reduce weight and improve ergonomics to enable longer sessions. You can find specifics about the weight and other technical considerations of the headsets here: varjo.com/products/

# Panelist Insights: Rotary pilot training in VR

**What is the typical session length for training? Is there a maximum time-in-VR recommendation?**
FR: On VRM Switzerland's FSTD, the session length is similar to what is recommended when training in a real helicopter.

**Does VRM make a side-by-side cockpit to enable multi-pilot?**
FR: The uniqueness of VRM Switzerland's technology is that it does support multi-pilot and multi-crew training in a fully immerse VR environment. This was an additional reason for choosing VR over MR for the FSTD. Furthermore, the system enables co-training in the same cockpit virtually while the trainees may be at physically separate locations. There's also capability to add a crew member virtually. For example, training a hoist operator, whilst having a virtual pilot for basic training, and adding the real pilot for more advanced and crew training.

Because the pilot gets completely digitized in real-time - enabled by the pose tracking system - to see him/herself in VR as an avatar, that pilot's avatar can then be displayed on several other simulator units. Making the combinations endless, enabling multi-crew and multi-pilot trainings in a fully immerse VR training environment.

**How do you simulate navigation aids and radio equipment (i.e. communication with the controller).**
FR: Visual and systems are simulated in SW, the haptic part of operation is in HW. Additionally, all our FSTD's are equipped with original headsets with the full functions of intercom and radio communication.

**In the simulation, is it possible to replace hardware like the cyclic? An R22 cyclic and a Bell 206 due not behave in the same ways.**
FR: Right now, we offer qualified type-specific simulators to enable as many as possible to earn credits. Changing things on the simulator requires a re-qualification by the qualifying authority (e.g. EASA). Stay tuned for new types here:
www.linkedin.com/company/vrm-switzerland

**Aircraft tend to have variants. How easy is it to configure the simulator (visuals and physical cockpit) to replicate the exact aircraft we would like to simulate?**
FR: Variants which don't require a haptically interface such as mirrors, bubble window, etc. can be changed on the fly in VR. If there is a haptic component, it would need to be phyisically swapped out. See an example of the virtual adaptations in this video:
www.youtube.com/watch?v=elz1EtEYW38

# Panelist Insights: Rotary pilot training in VR

**For the Varjo devices, are there any plug-and-play software interfaces available to consumer flight simulators, i.e. X-plane, Microsoft Flight Simulator**
MH: You can use all consumer flight simulators that have OpenVR integration in Varjo's OpenVR compatibility mode, including X-plane and MS Flight Simulator. This mode slightly limits the full human-eye resolution possible in Varjo devices, but is still the highest resolution over any other device even with this consideration.

**Can we use Unity or Unreal to develop for the headset?**
MH: Yes. Developer documentation can be found here: developer.varjo.com

**Are you looking to publish/conduct any research studies with your devices?**
MH: We do not have plans internally at Varjo currently. However, many of our customers are conducting their own research, and we work to actively support this. One of our customers - MetaVR - recently developed a real-time eye tracking visualization system to enable quantitative analytics specifically for flight training. These developments are not only enabling new research, they also help provide an avenue for more informed pilot training debriefs, and thus more successful and accurate training performance. Learn more here: www.varjo.com/blog/case-metavr-using-eye-tracking-for-pilot-performance-review/

**In some circumstances, it can be impractical for each user to own a personal unit. What sanitization/decontamination arrangements are recommended between users to make the HMD operationally available without degrading the headset hardware materials?**
MH: This is fairly common concern across industries. I recommend reading through Varjo's safety guidelines and suggestions at the link below for our recommendations. Our partners have also recommended using sanitization boxes, such as Cleanbox, that use UVC light to destroy viruses and bacteria.
www.varjo.com/blog/top-tips-for-safe-and-hygienic-use-of-vr-xr-headsets-in-covid-19/

**Do you ship the whole system (XR-3 and motion cockpit) to overseas?**
FR: Yes! Please reach out for more information and to place an order; or contact one of our customers to book a session and try out the simulator first-hand.
MH: For inquiries about Varjo XR-3 and VR-3, feel free to also reach out Varjo at sales@varjo.com

**Have demos on ship and oil platform operations been developed or are they currently being planned?**
MH: Yes, there have been. And, we have a new public showcase/webinar coming up in the next few weeks on this specific topic. Stay tuned for more info on that coming soon.
FR: Yes, feel free to reach out if you would like to get more details to info@vrmotion.ch