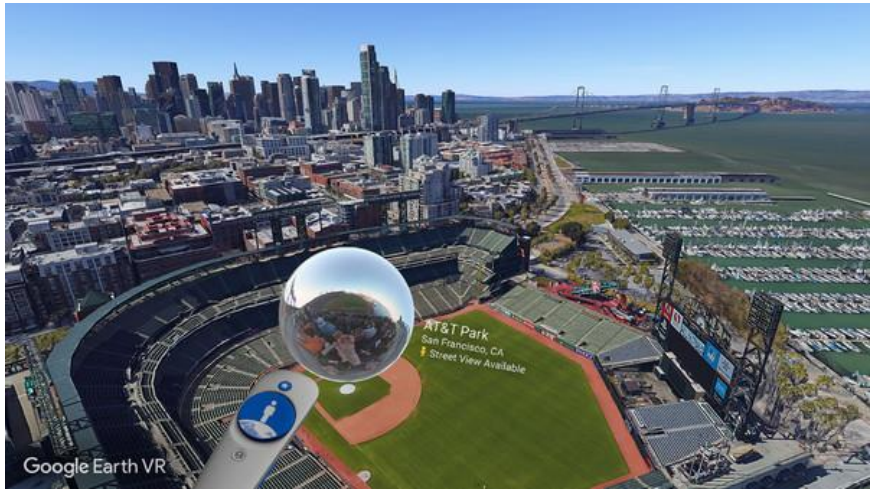
Fully Immersive VR in Teaching and Science Outreach

Jonathan Barrett

Dr. Svetlana Barkanova

Outline

- Defining Fully Immersive VR
- Our VR system
- Why Fully Immersive VR?
- Cybersickness in VR
- Example of VR in subatomic physics education: Belle2VR
- Creating VR content with Unity



Fully Immersive Virtual Reality (VR)

- Technology which enables users to feel present in an artificial 3D environment
- Sense of presence established through:
  - Enclosed field of view
  - Stereoscopic display
  - Movement tracking
  - Haptic feedback
  - 3D realistic audio

Created by nopixel
from Noun Project

virtual reality headset by nopixel from the Noun Project

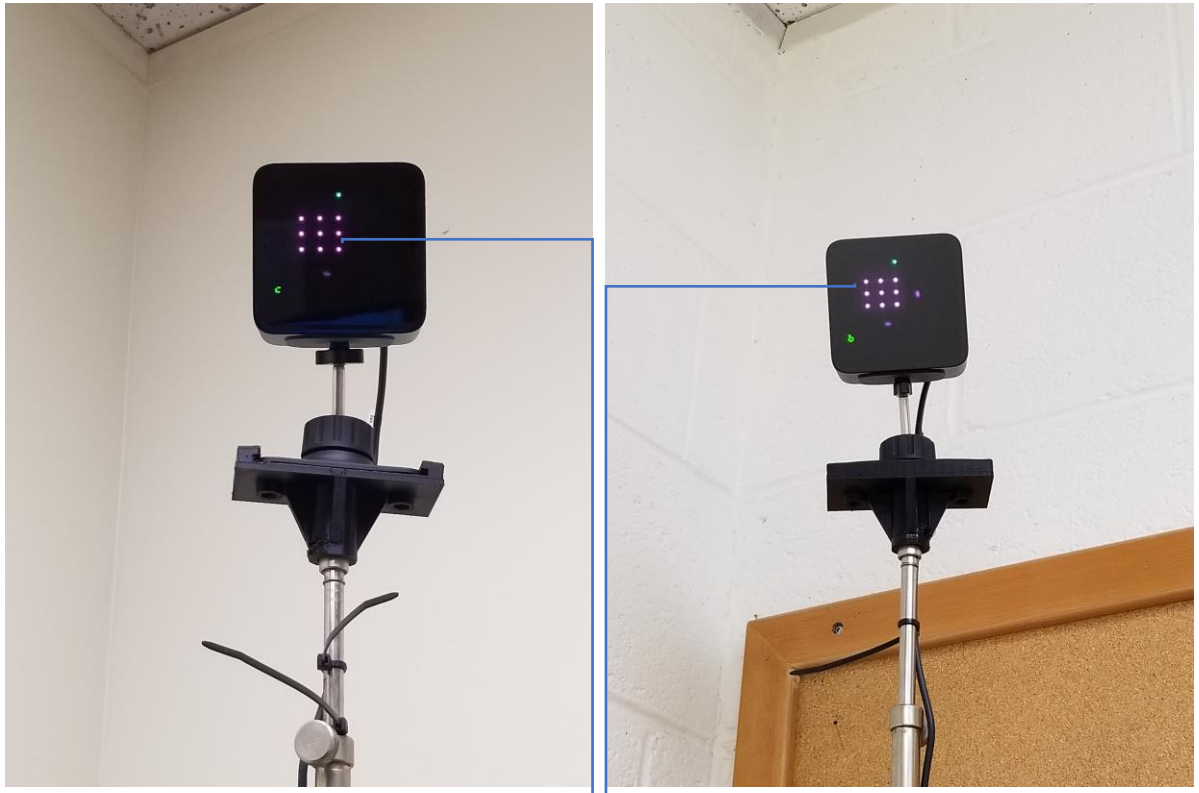
Our VR system: Headset

- 2 HTC Vive Pro headsets each with 2 base stations and 2 controllers
- Tracking sensor

Our VR system: Base Stations/Controllers

- Base stations in opposite corners of the room track the headset and controllers

Tracking sensor



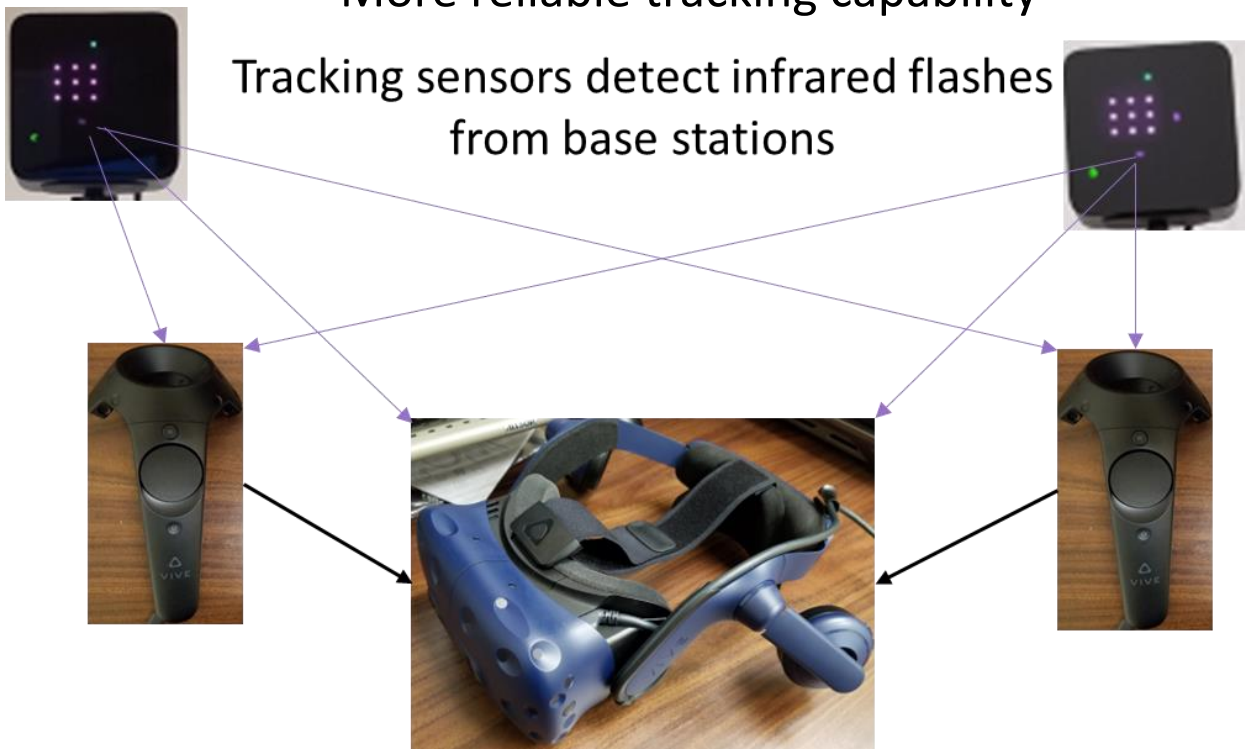
Infrared radiation detected by tracking sensors

Our VR System: Computer

- Desktop computer with four RTX 2060 super (8 GB memory) GPUs
- 128 GB RAM
- Capable of handling up to four VR headsets concurrently

Outside-In Tracking

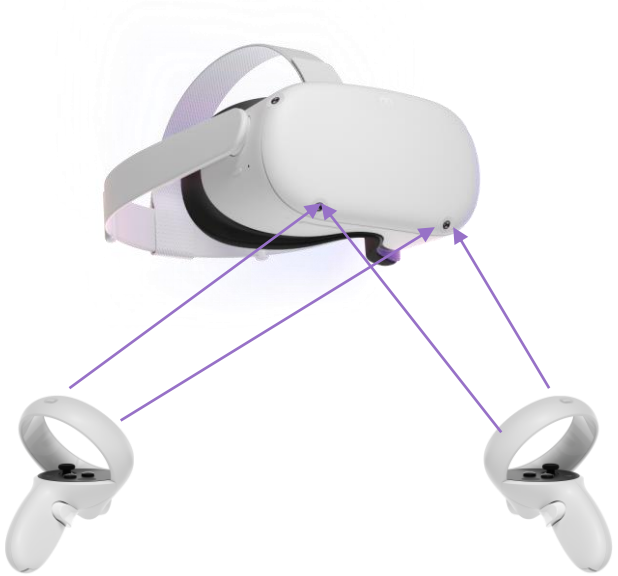
More reliable tracking capability



External hardware (base stations) used to support tracking

Inside-Out Tracking

More convenient



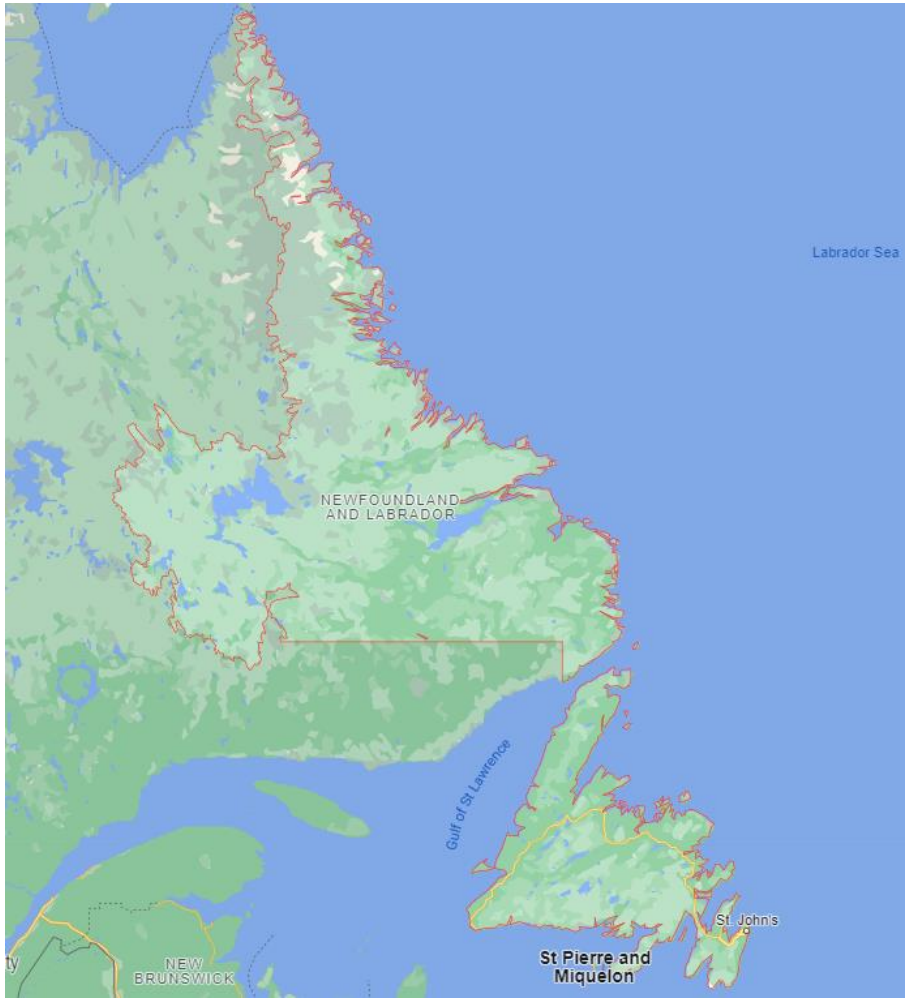
Cameras located on the headset are used to estimate the headset's position relative to the environment

Our VR System: Instructions and Testing

- A step-by-step guide to operate our specific VR system's hardware and software
- Students were able to operate the system on their own after following the instructions

Why Fully Immersive VR? Access

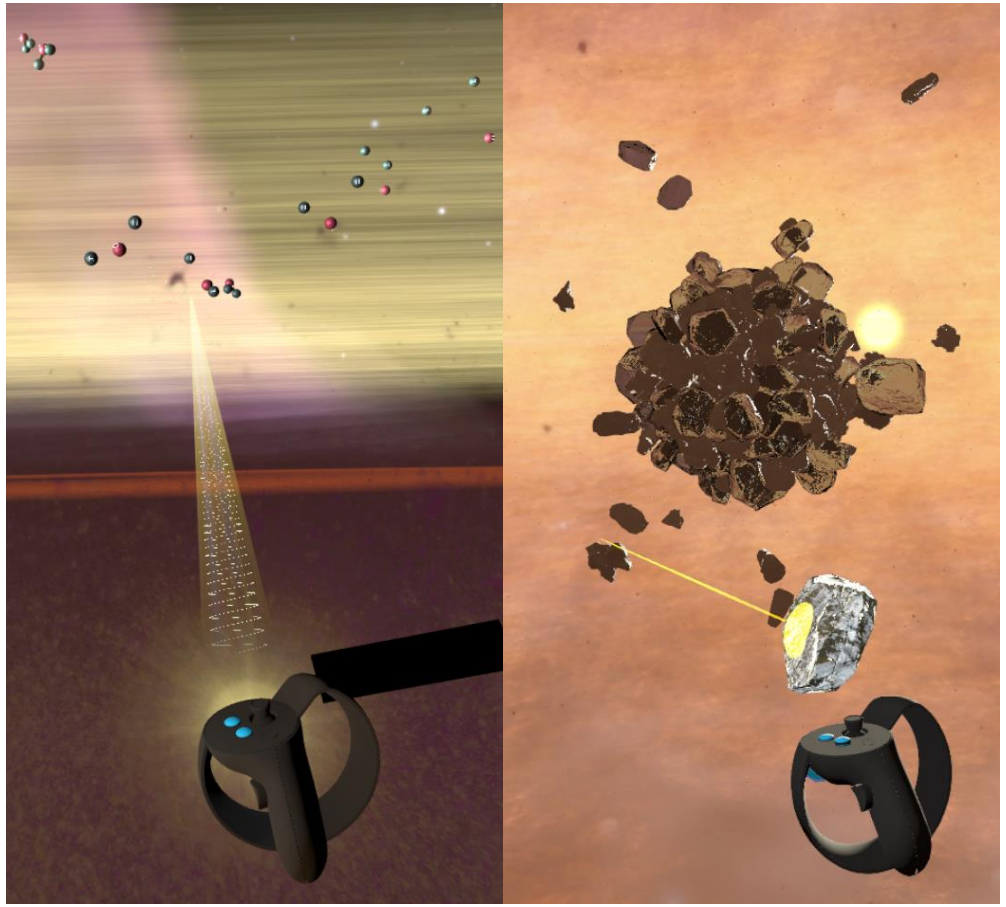
- Distance to physics experiences (Ex: planetariums, experiment tours) can be prohibiting
- Especially in sparsely populated areas
- VR systems are easily transported for science outreach



Map of Newfoundland and Labrador (Source: Google maps)

Why Fully Immersive VR? Application

- Tour realistic environments
- Visualize small and large scale processes
- Realistic safety training without risks



WebbVR: Left: Photoionization module. Right: Planet formation module

Why Fully Immersive VR? Affordability

- Most consumer VR kits (including all required gear) cost less than $2000
- Becoming even more affordable with budget options like the Meta Quest 2

	Quest 2	Vive Pro 2	Index
Kit price:	$459	$1849	$1319
Type:	Standalone	PC Tethered	PC Tethered
Tracking:	Inside-out	Outside-in	Outside-in

Prices according to Meta store, HTC Vive website, Steam
Updated: June 8, 2022

Selected Popular Headset Comparison

	Quest 2	Vive Pro 2	Index
Kit price:	$459	$1849	$1319
Type:	Standalone *	PC Tethered**	PC Tethered
Tracking:	Inside-out	Outside-in	Outside-in

*- No PC connection required but possible with link cable (extra) or through Wi-Fi

**- Wired PC connection. Wireless adapter available (extra)

Per-eye resolution comparison from VRcompare.

Cybersickness in VR

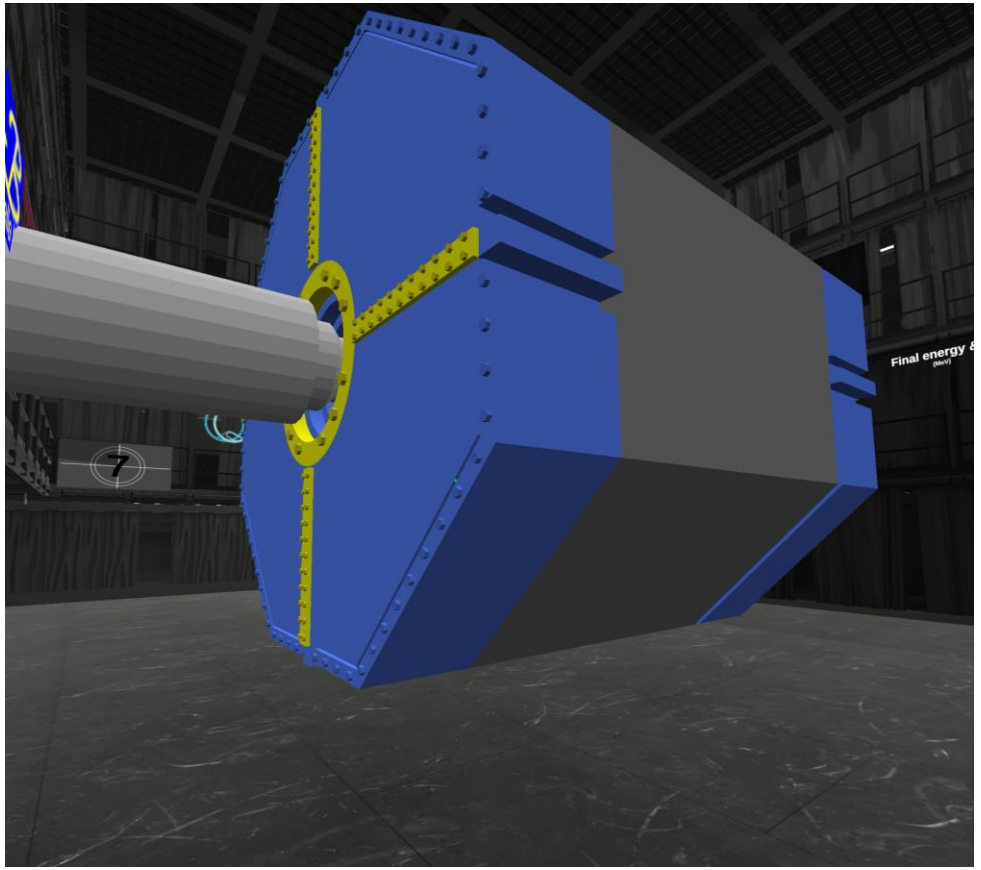
- Some users experience cybersickness while using certain VR applications
- Comparable to motion sickness in a moving vehicle
- Effects can be reduced by using discrete movement options, moving in real life, taking breaks or building a resistance over time

https://newsroom.unsw.edu.au/news/science-tech/why-people-get-sick-virtual-reality

VR for Subatomic Physics Education: Belle2VR

By Virginia Tech

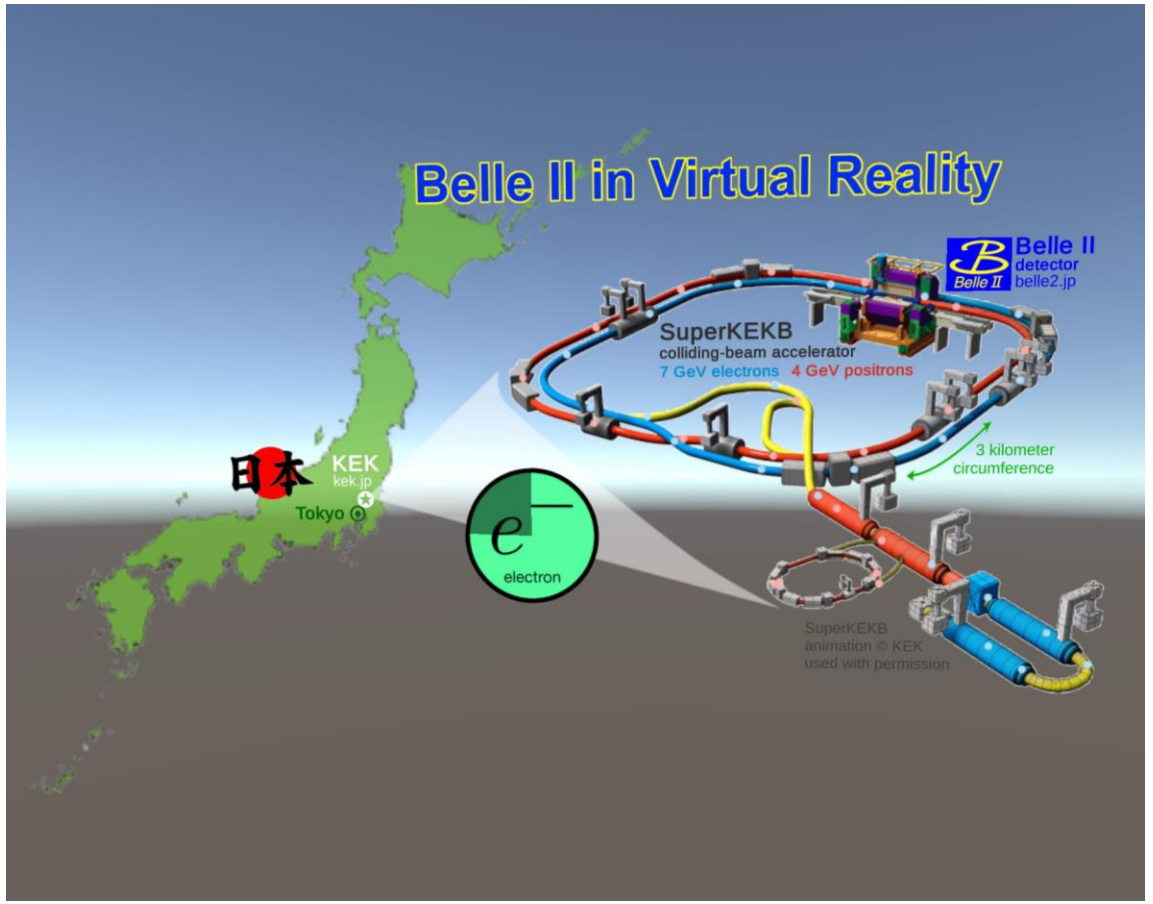
- VR visualization of the Belle II experiment detector and data
- Also compatible with computer screen, mouse, and keyboard



Belle2VR (Steam) outer detector model
(More download options on this webpage)

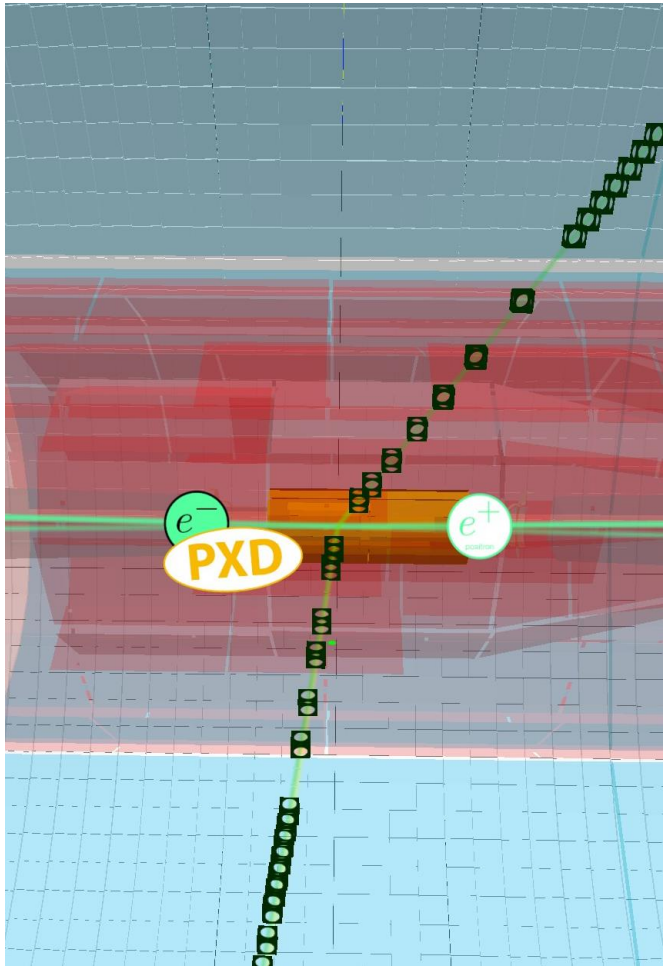
Belle II detector

- Collects data from e^-e^+ collisions
- 7 GeV electrons, 4 GeV positrons
- Located at the SuperKEKB colliding-beam accelerator in Japan.

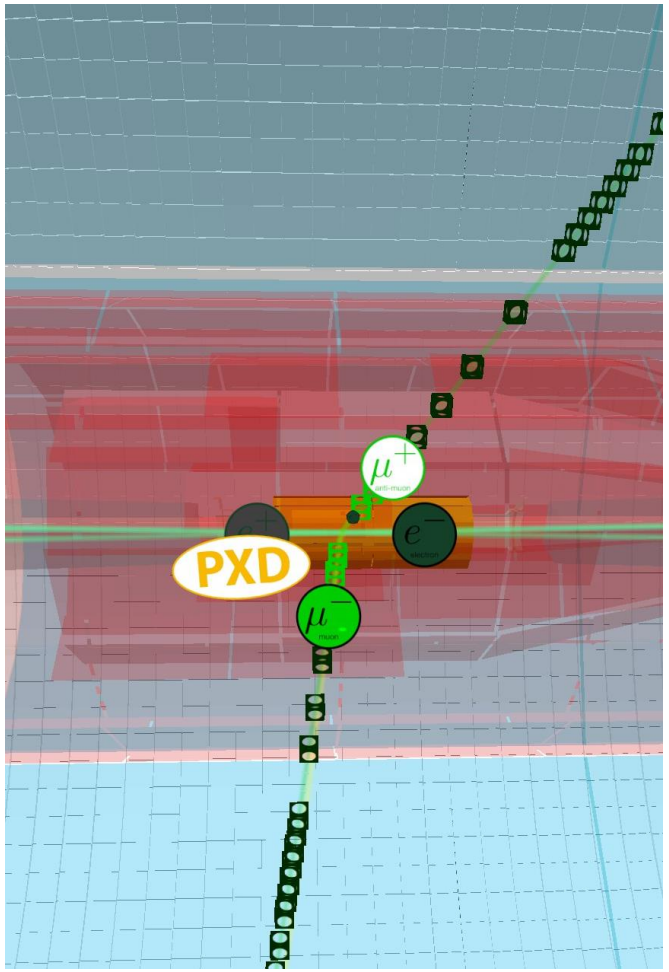


Belle2VR SuperKEKB diagram and location (loading screen)

Belle2VR Visualization



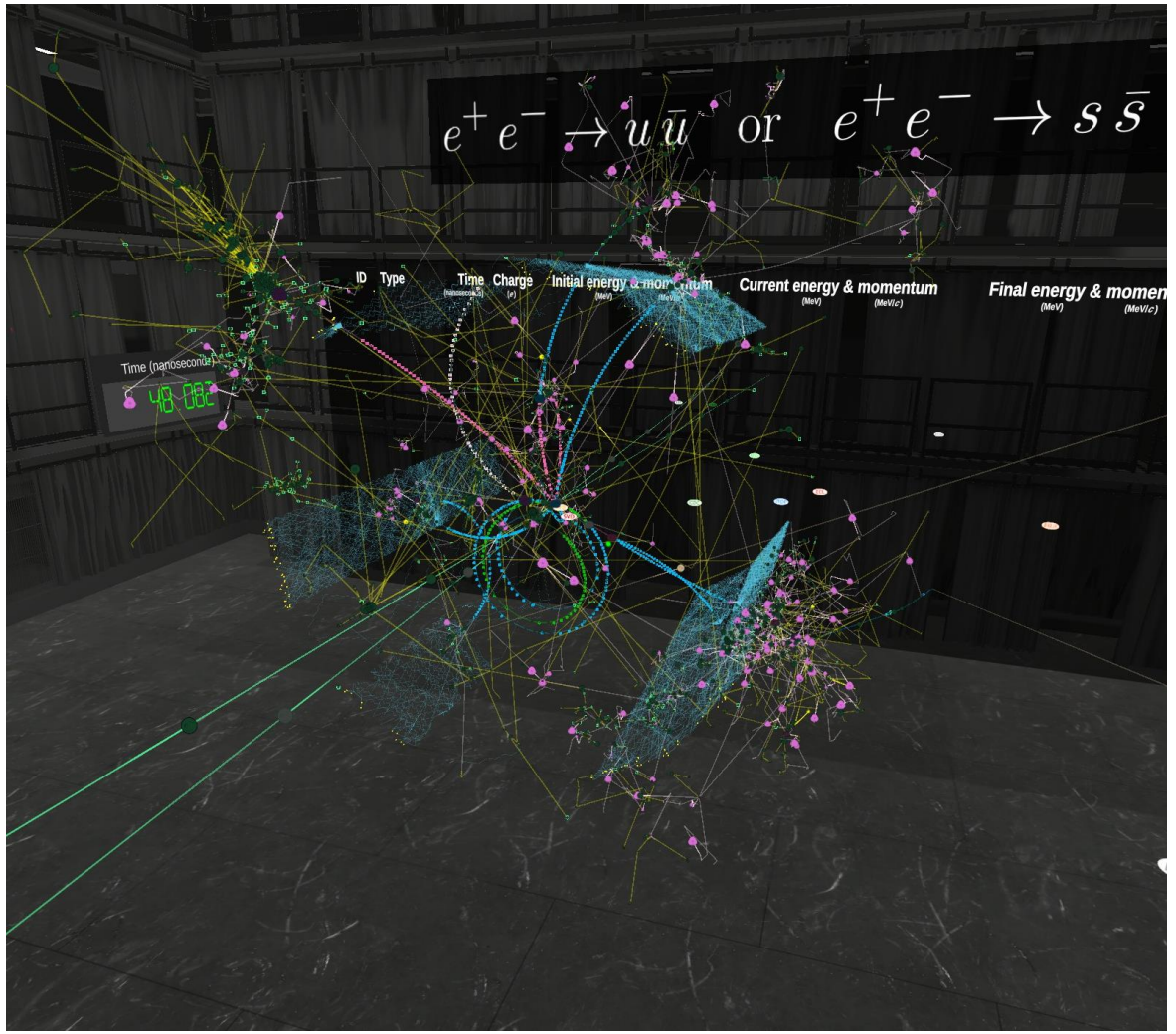
Before interaction



After interaction

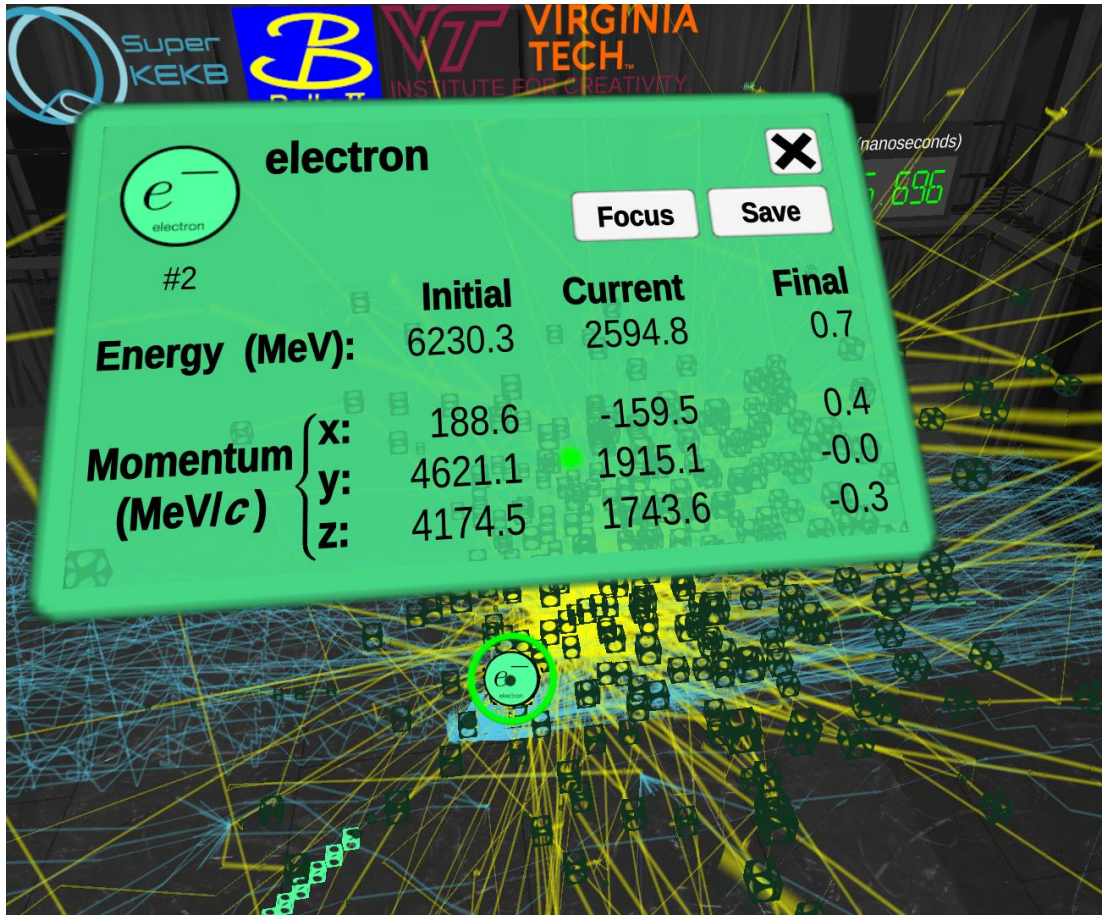
Full event view

- Full view of an event in Belle2VR with all detector parts hidden



Energy and Momentum Information

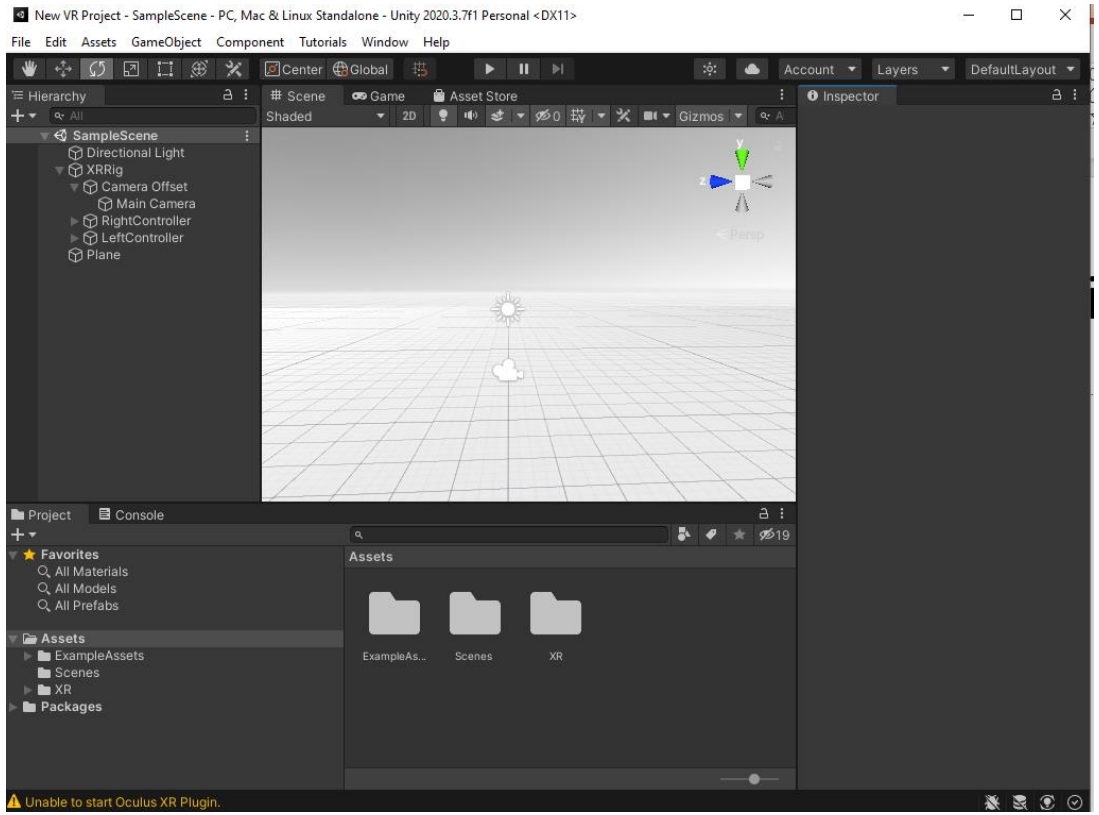
- See energy and momentum of selected particles
- Save the information for later use



Energy and momentum information for an electron

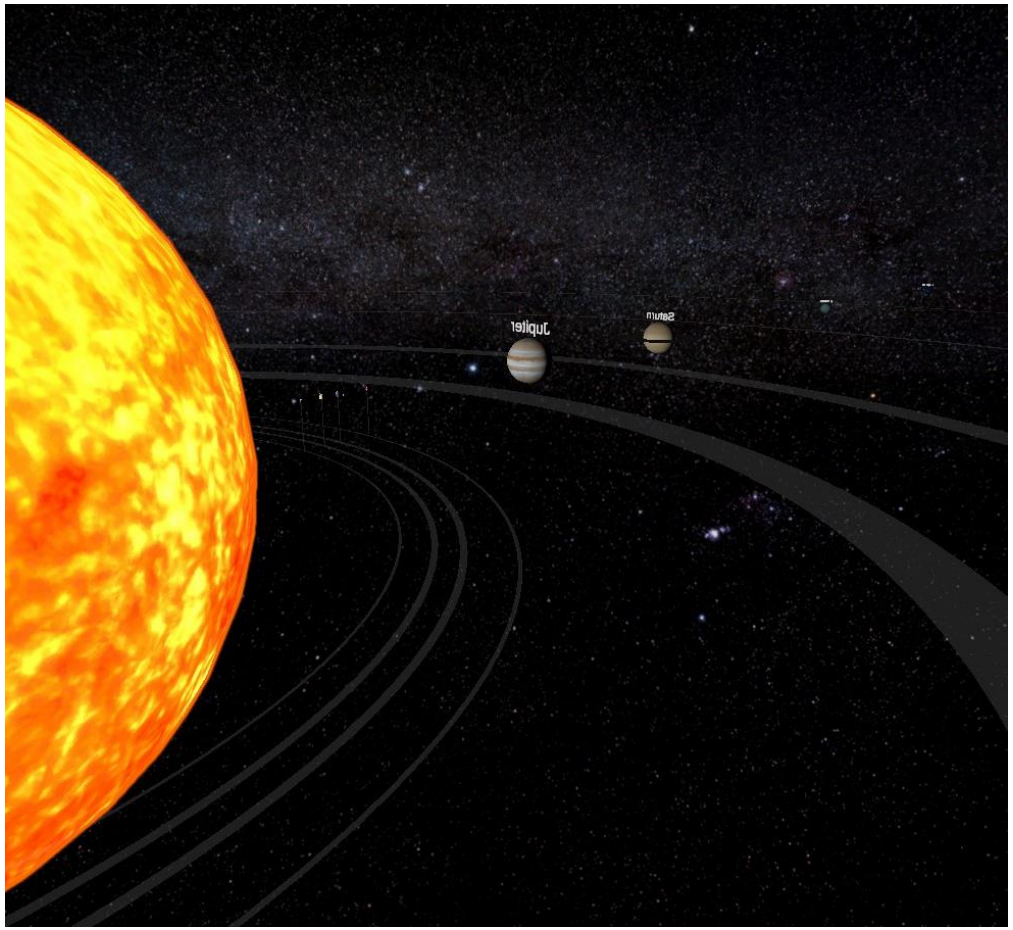
Learning to Create VR Content

- Unity selected for ease of use:
  - https://unity.com/
- Allows for quick testing of applications
- No programming knowledge required to start but additional functionality is added through scripts (In C# by default).



My Solar System project

- 8-10 weeks spent learning to use Unity and building this project
- Model solar system with scripted orbits
- Various interactions implemented
- Ex: Menu/setting interaction, grabbing planets, teleporting.

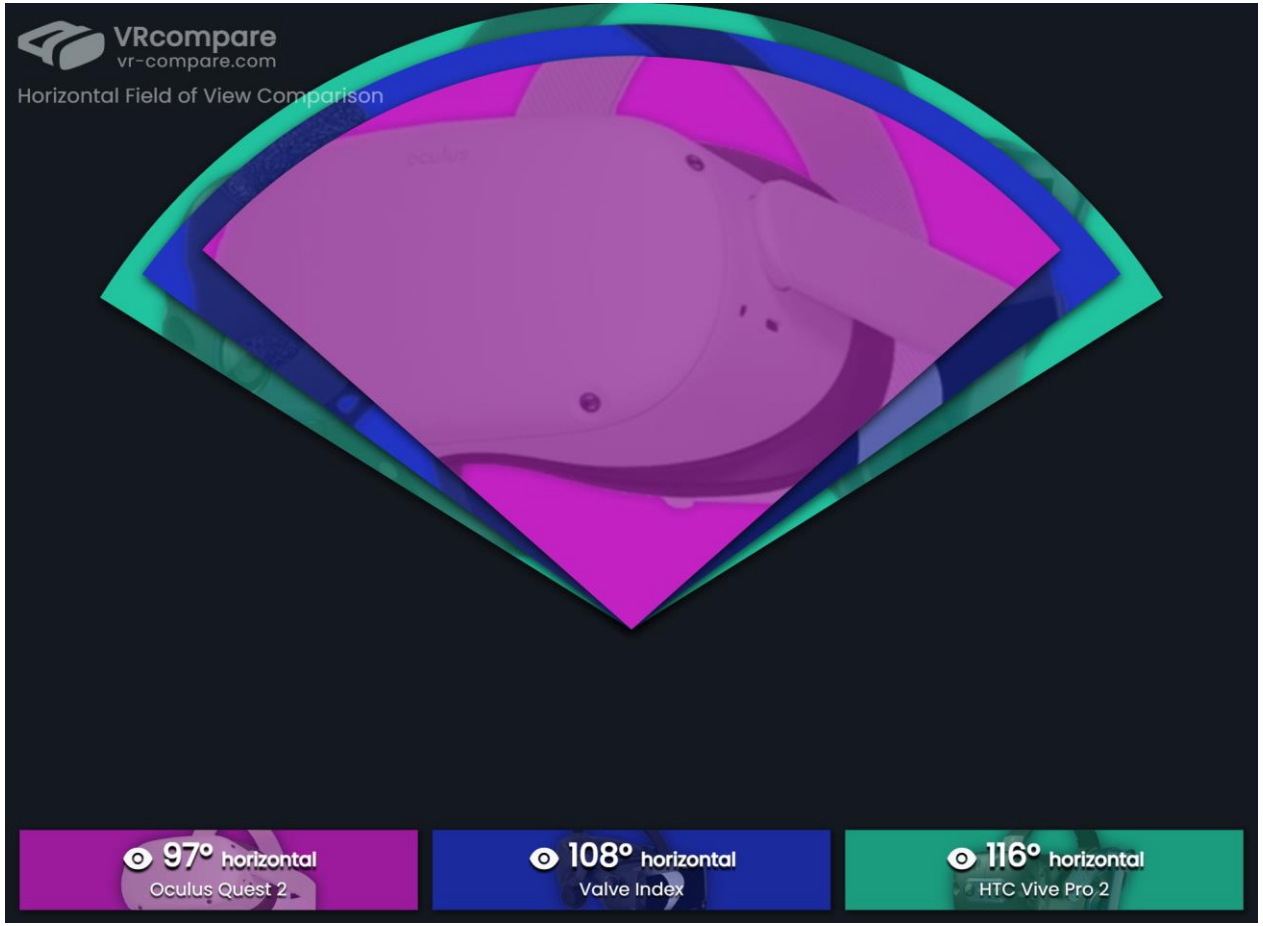


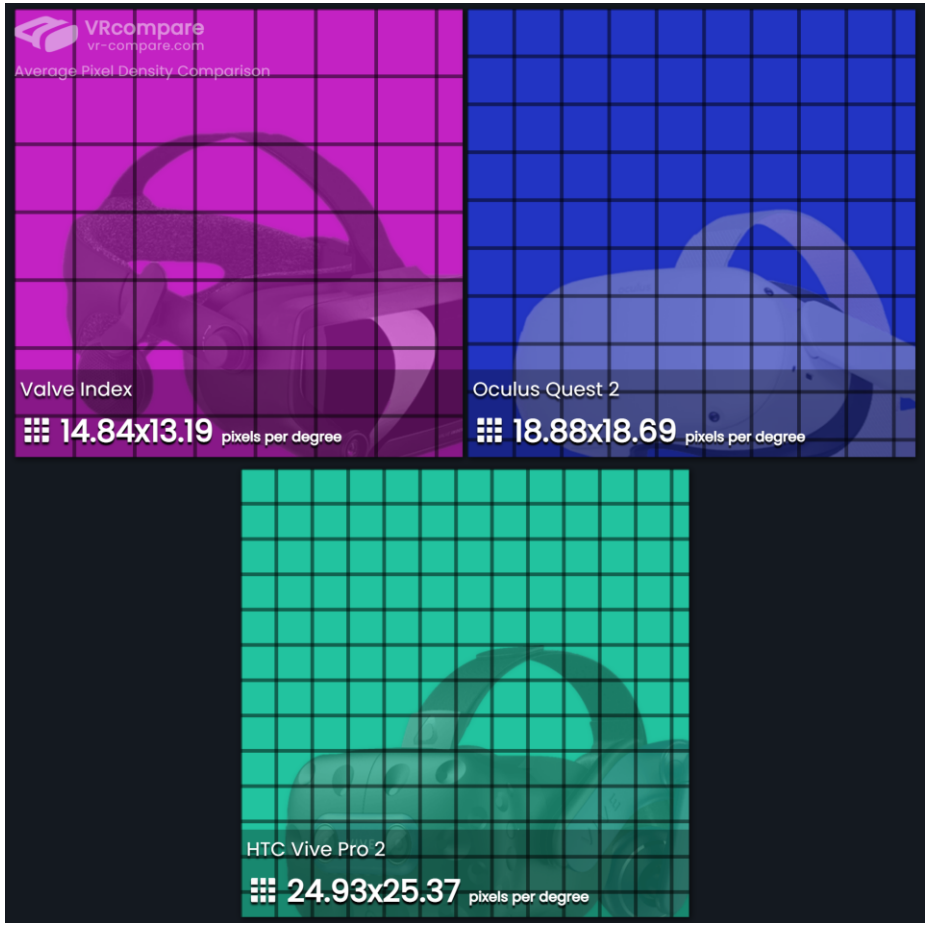
Thank you!

- VR enables new learning experiences
- VR can be easily transported and set up
- VR is Affordable and requires minimal training to operate
- Questions?
- Email: jcbarrett@mun.ca

Special thanks to Dr. Svetlana Barkanova

More graphics from VRcompare





Recommended system specifications

- Processor: Intel i7 11700K or better (prioritize high clock frequency)
- Graphics: Nvidia GeForce RTX 3060 or better
- Memory: 16 GB RAM or more
- Minimum requirements for Vive Pro here
- Recommended specifications by Puget Systems here

Minimum system requirements for a high-end VR game (Half-Life: Alyx)