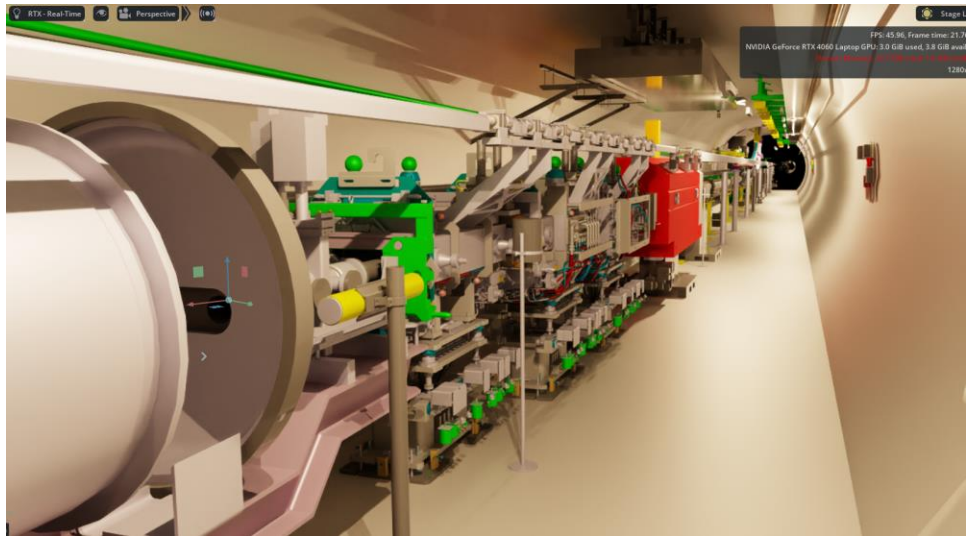
Bi-Directional Isaac Sim and MuJoCo Bridge for 3D Digital Twin Powered LHC Robotic Interventions

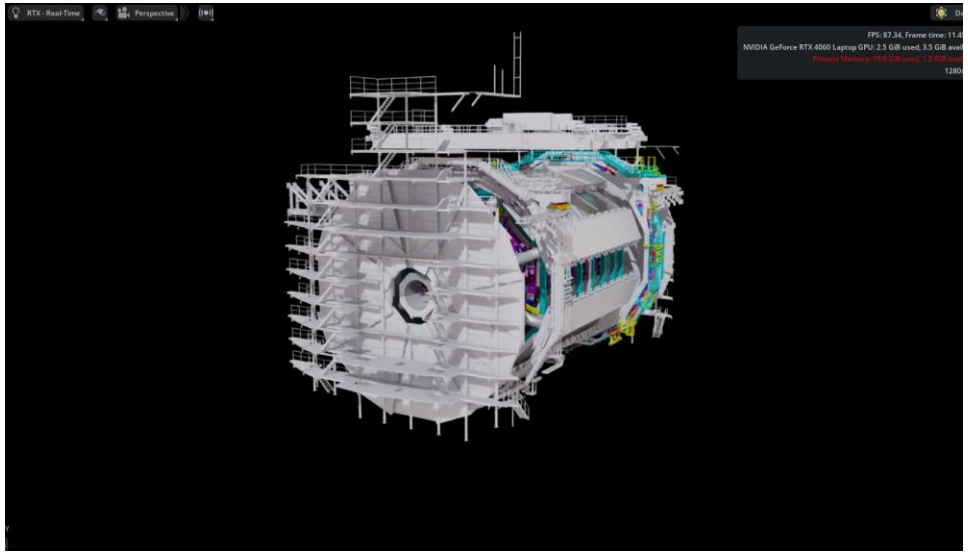
CERN openlab Summer Student Programme Lightning talks

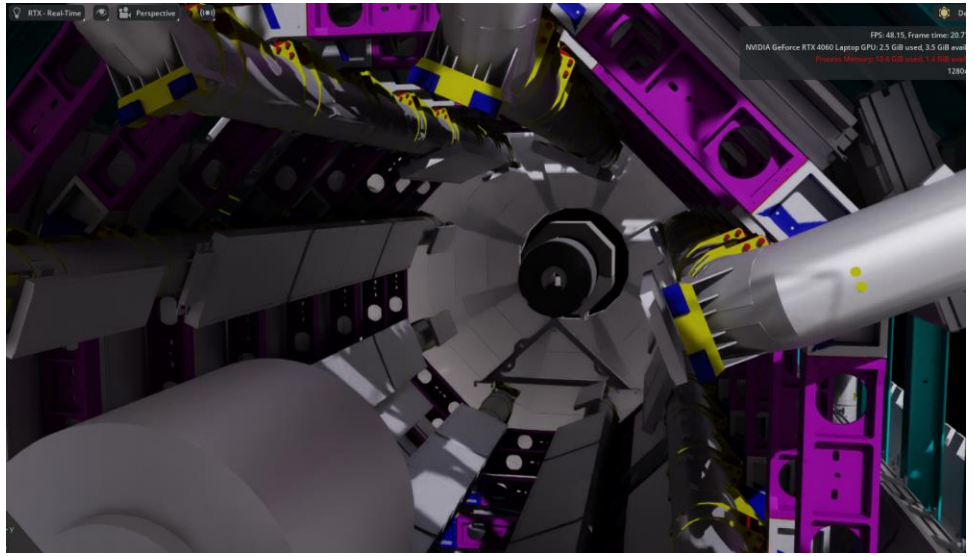
Ogulcan Gurelli

Supervisor: Drew Mason-Laurence

DIGITAL TWINS

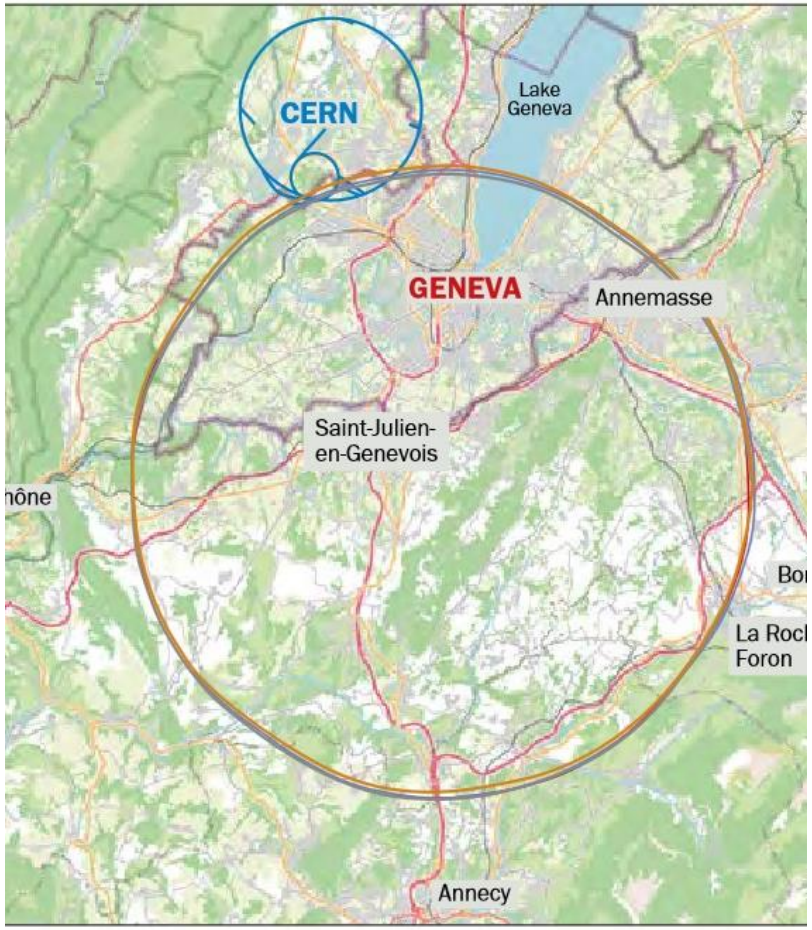


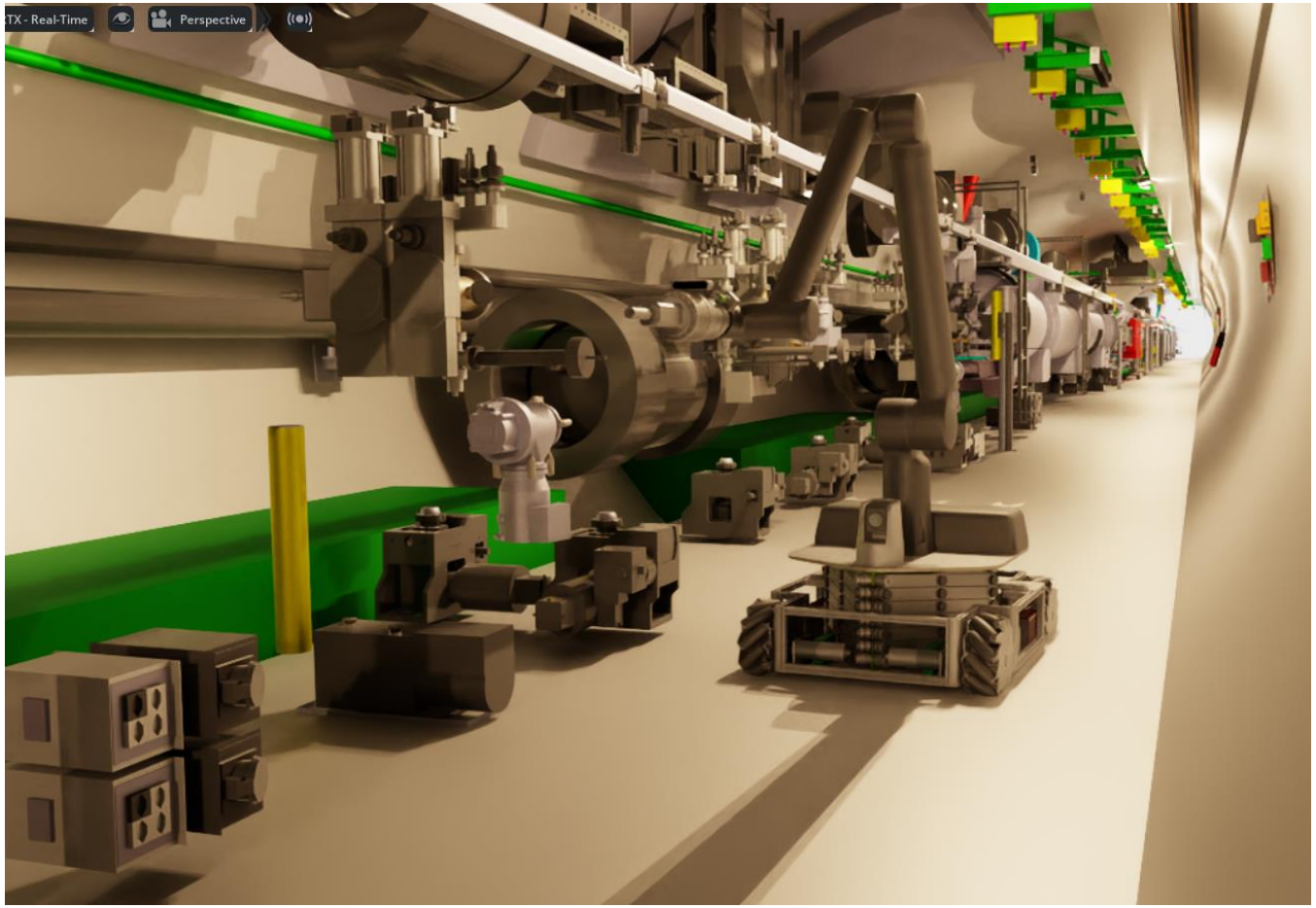




WHY?

[Some places are too dangerous for humans to go, we can't always be in the tunnels, so we test it in the twin]





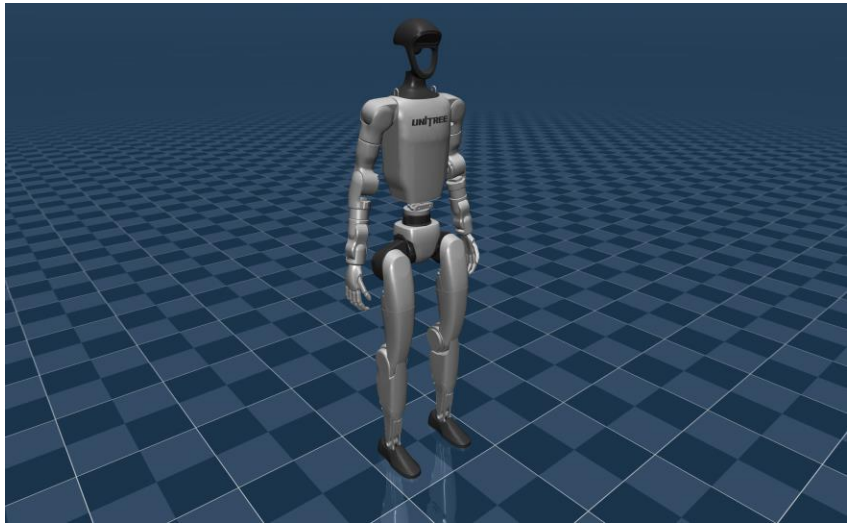
HOW IT WORKS

[MuJoCo runs the physics, Isaac Sim mirrors it live, photorealistically inside CERN's real geometry, Control flows back the other way. You drive, MuJoCo simulates, Isaac shows it 60x a second]

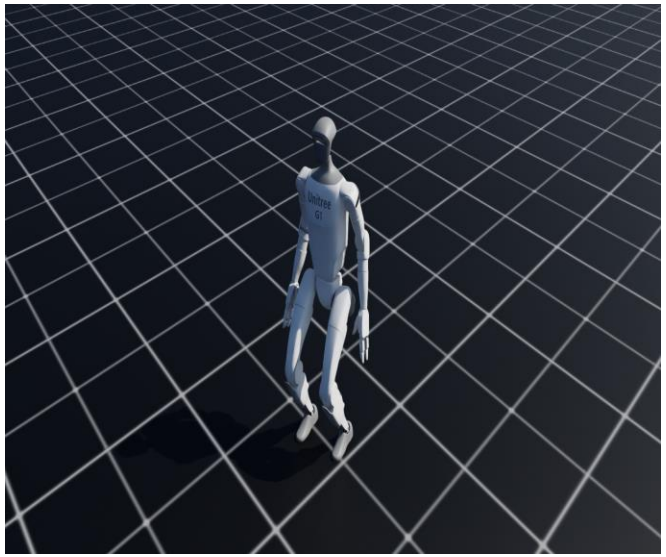
MuJoCo

NVIDIA OMNIVERSE™

[robot state]



[commands]

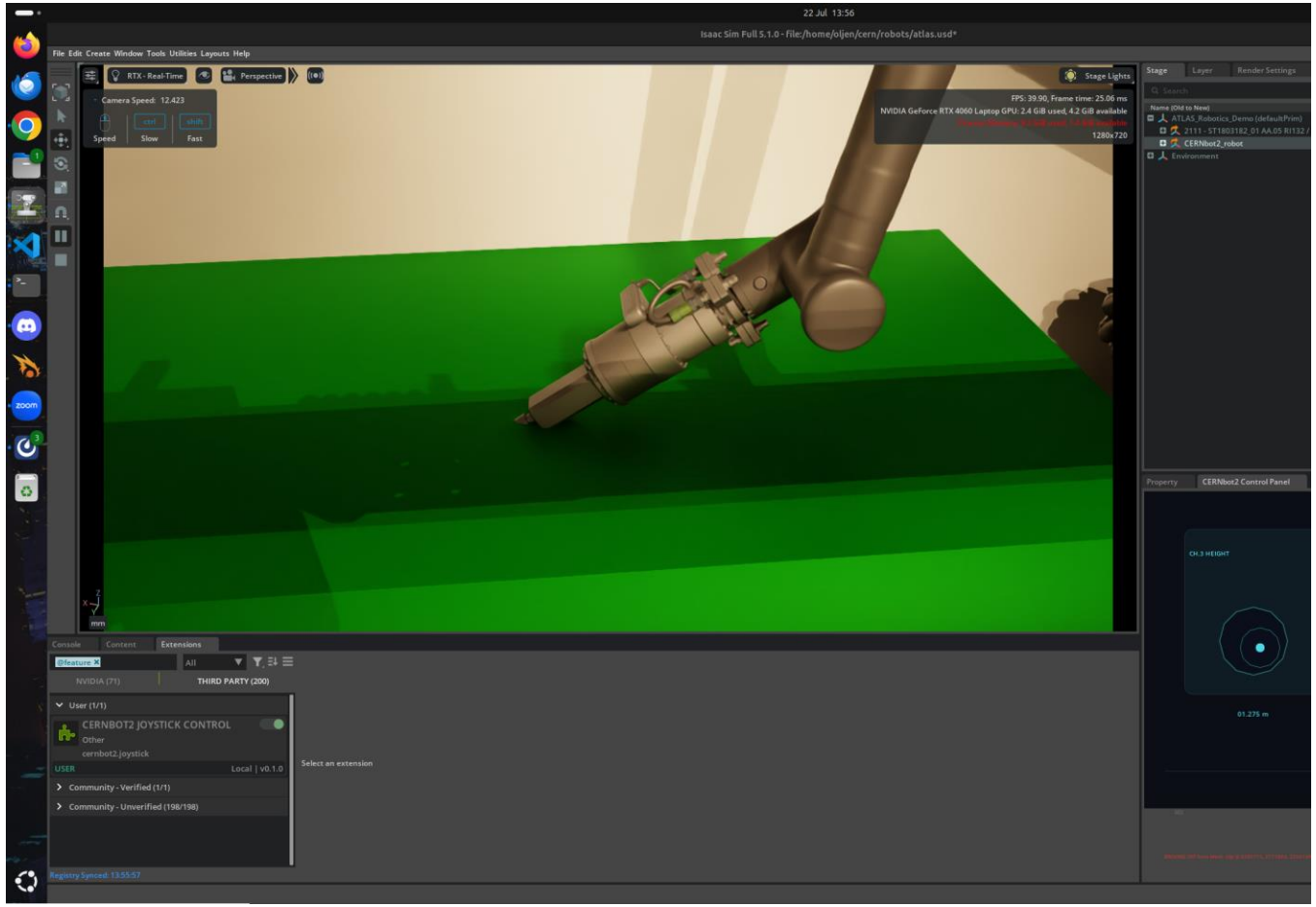


[live, bi-directional, about 60 times a second]

CHALLENGES

Why can't the robots feel the walls of the Digital Twins?

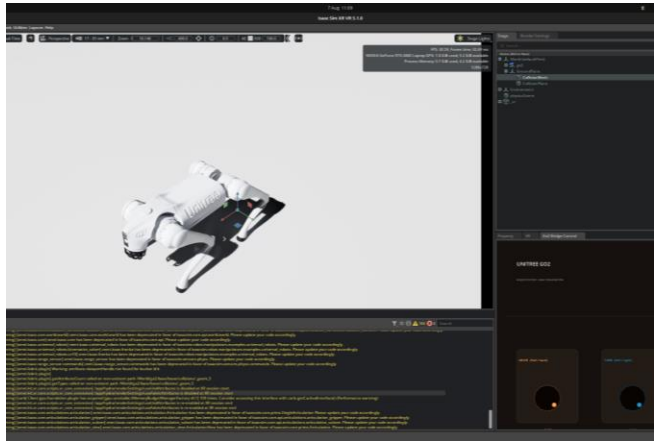
- The LHC Twin is a visual CAD (it has no physics, nothing to collide with)
- I build a collision detector, but it always said "Clear"
- I thought my code was wrong but a millimetres vs metres mismatch in the simulation put the check off by 1000x

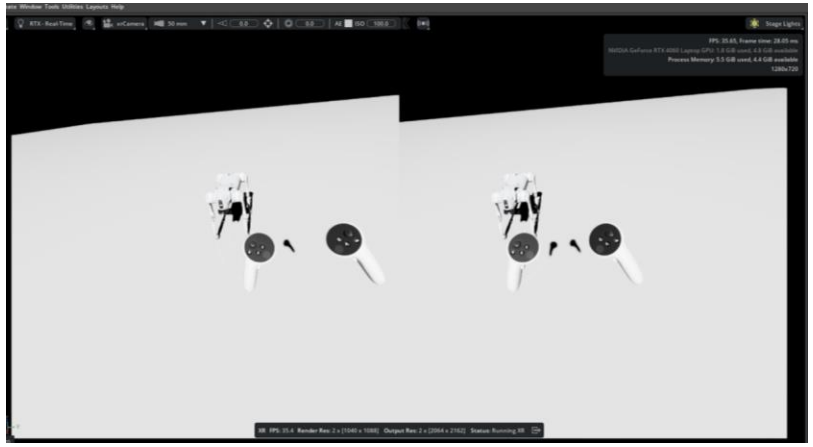


Results

[WORKING NOW]

- Live bi-directional bridge, robots driven through the twin in real time, collision detection against tunnel geometry.
- A quadruped, driven by gamepad (digital or XBOX controller), proves it works with any robot, not just CERNs.





- VR-Controlled robots (Meta Quest 3) using the bridge, you can see the robot before through VR before anyone sets foot in the tunnel.

Thank you!
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