



# ADAS Development using Advanced Real-Time All-in-the-Loop Simulators

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# The Scenario

- The introduction of ADAS and AV has created completely **new challenges** for engineers
- Cars and infrastructures have to be **re-designed** in a completely different way
- The way cars are going to be **tested** during the design process is going to change dramatically
- The interaction between **human being** and the car is going to be different
- **Millions of kilometers** need to be driven to prove new technologies to be **safe** and **reliable**



# Challenges and Solution



It is widely accepted that **millions of kilometers** are needed to accumulate enough confidence on sensors, algorithms and controllers reliability. Each test is potentially **dangerous** for other road users. **Simulation tools are needed.**

# The Simulation Environment Ingredients

- Virtual development of ADAS functions and Autonomous Vehicles requires several bricks like:
  - Reliable **vehicle model** (Ego car)
  - Traffic environment (road networks, signs, other vehicles, pedestrians, ...)
  - Sensors
  - Variable Weather/lighting conditions
  - Controllers
  - Virtual Driver model
  - AI algorithms

All components **MUST** be real-time capable



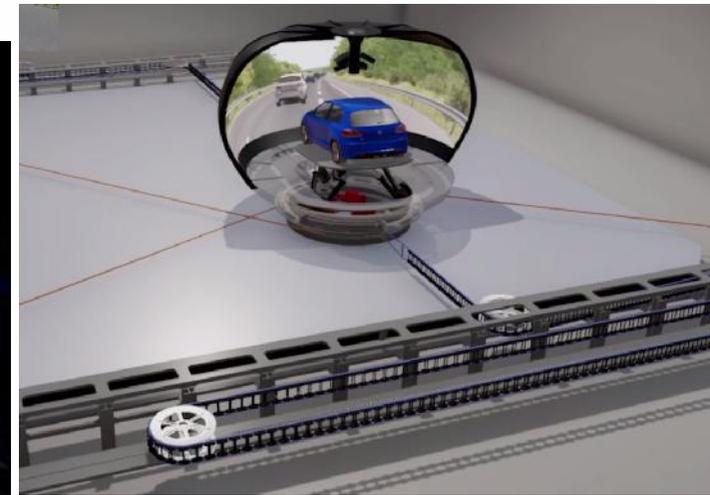
# Off-line and On-line Simulation

- Initial **screening of scenarios** explored using **off-line** simulation:
  - Feasibility studies
  - Set-up of control strategies
- Many scenarios heavily depends on the **human behavior** and its **subjective feedback**.
  - These cases makes the adoption of a **driving simulator** mandatory:
    - Machine-to-Human / Human-to-Machine hand over
    - HMI variants
    - Subjective feeling of ADAS and AV strategies
    - Occupants Motion sickness



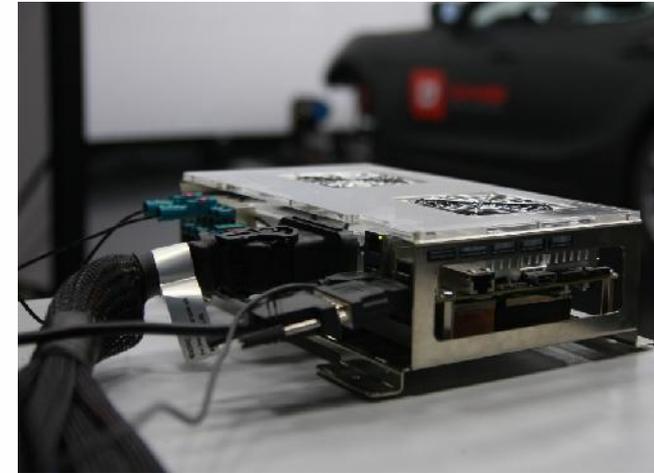
# Driving Simulators from VI-grade

- 4 different flavours of Driving simulators:
  - **COMPACT** Static
  - **FULL** Static
  - **DiM** Dynamic Simulator
  - **DiM C** Dynamic Simulator



# Driving Simulators and ADAS

- VI-grade and AddFor are involved in R&D activities in ADAS and AV field based on **Driving Simulators**
- **NVidia Drive PX-2** is used in VI-grade Driving Simulators as on real AV prototypes with the advantage of being in the laboratory.
- Engineers to test ADAS and AV in an environment:
  - Controllable
  - Safe
  - Repeateable



**We use Deep Learning for two main purposes**

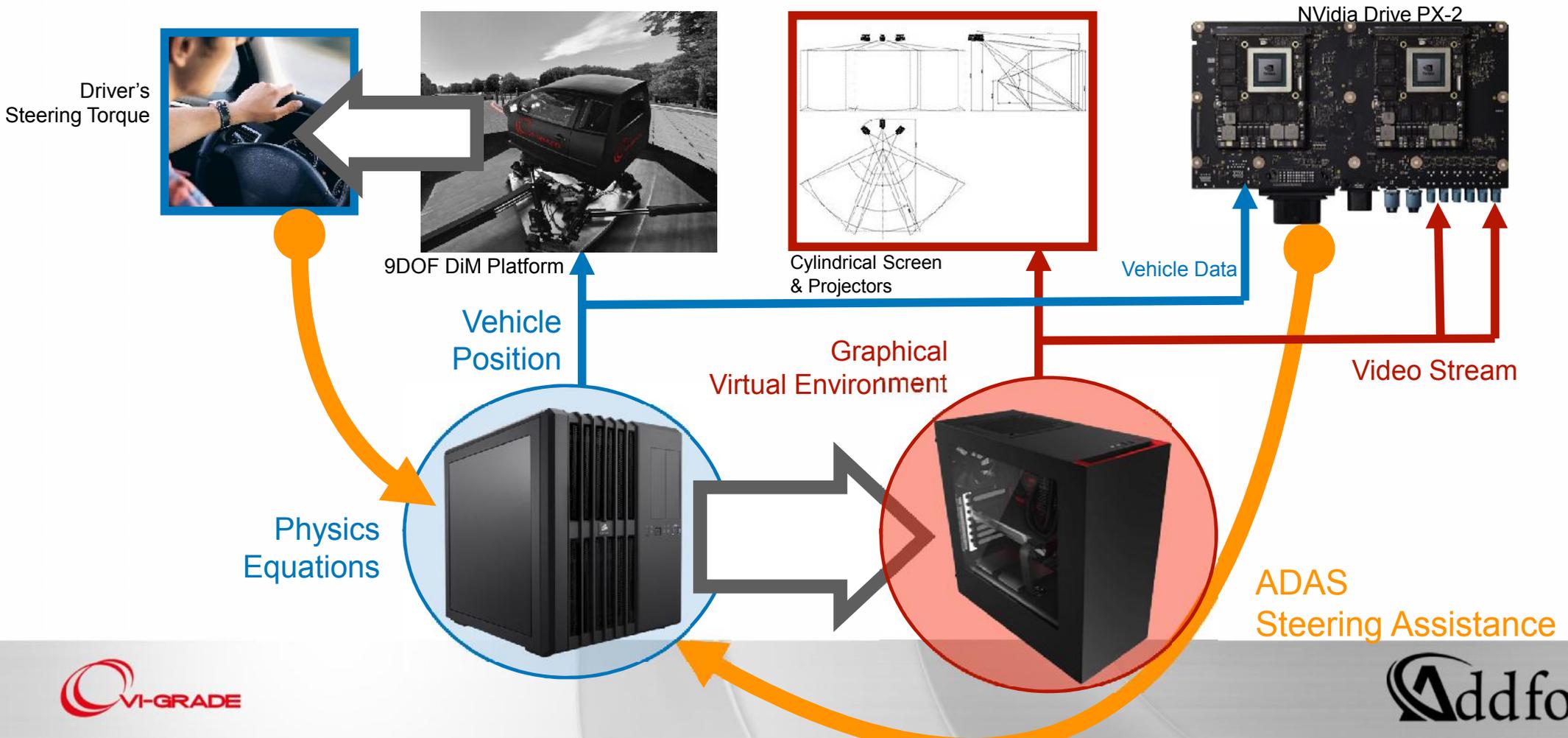
## **Vision**

**Pre-Training Vision Algorithms on Virtual Environments**

## **Control & Feeling**

**Develop Behavioural-Cloning Controls on Simulator**  
**Test Driver's Feeling to Autonomous Driving**

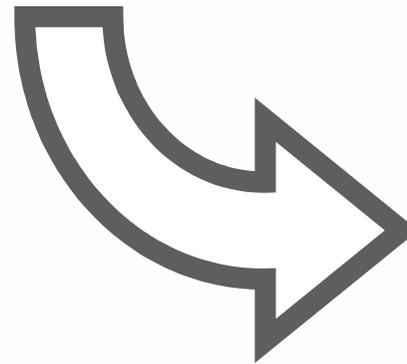
# Integration with DiM Simulator



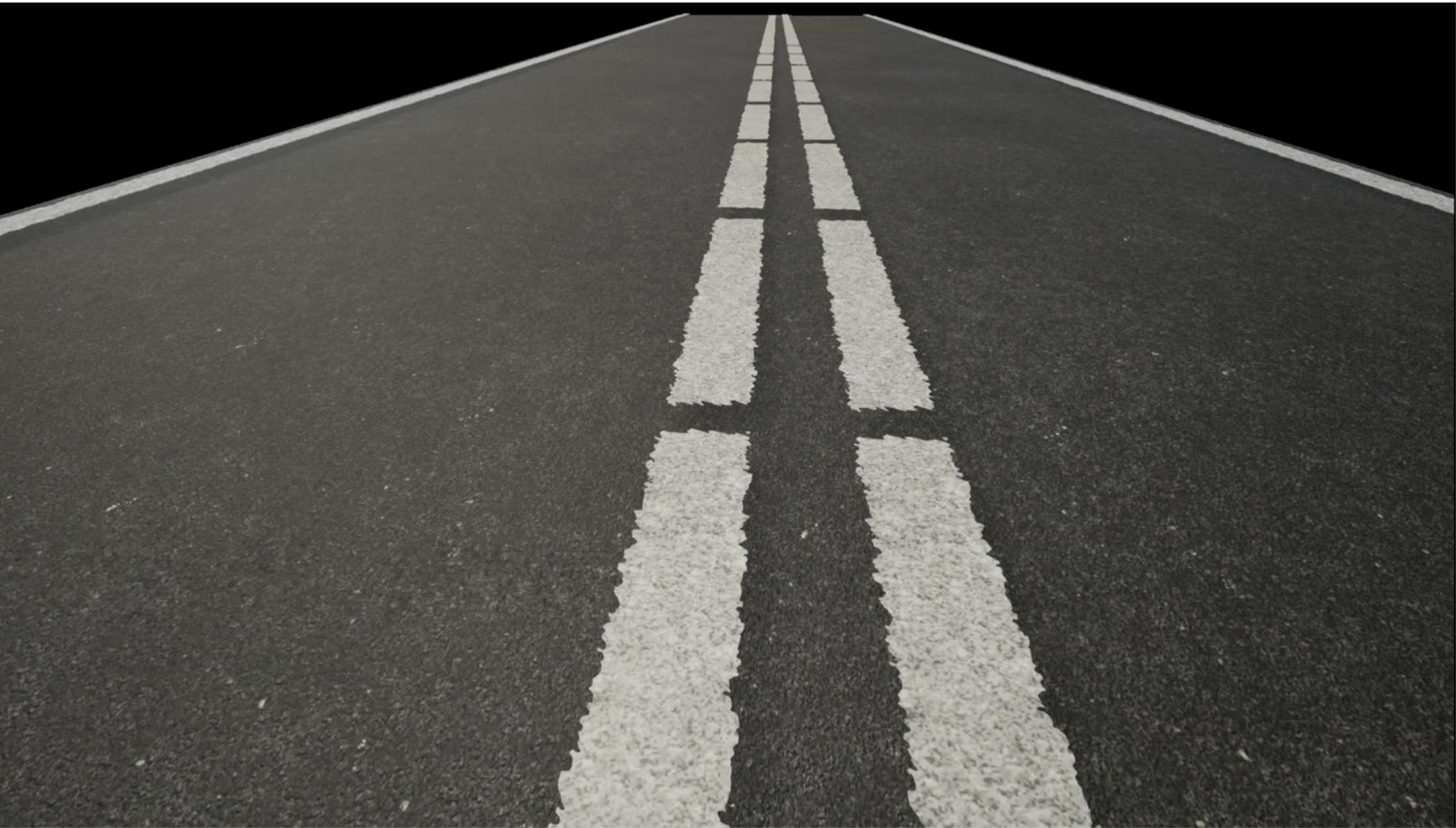


## Virtual Environments

As Close as possible to Reality  
Auto pixel-wise Segmentation  
Super Real-Time rendering



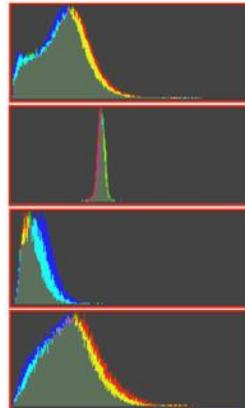
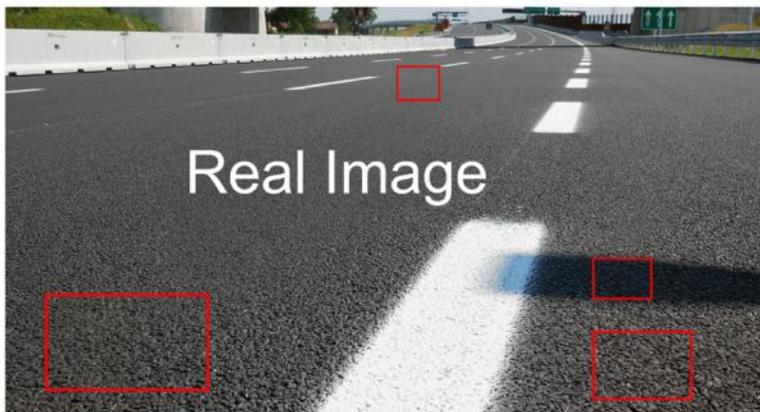
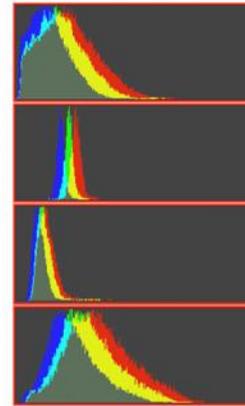
Example of pixel-wise segmentation  
for Lane Detection training tasks



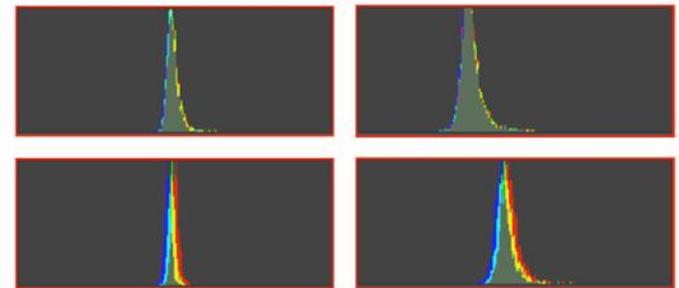
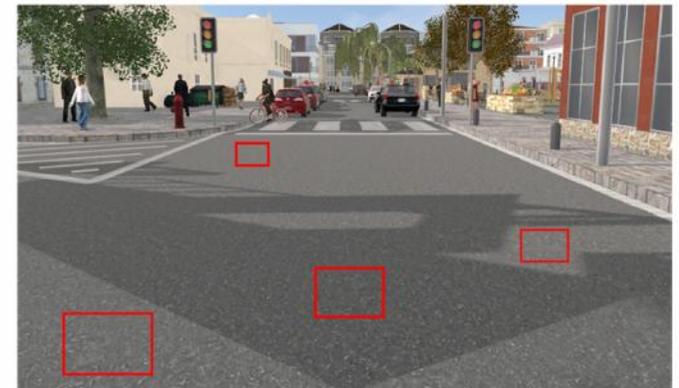


# Virtual Environments

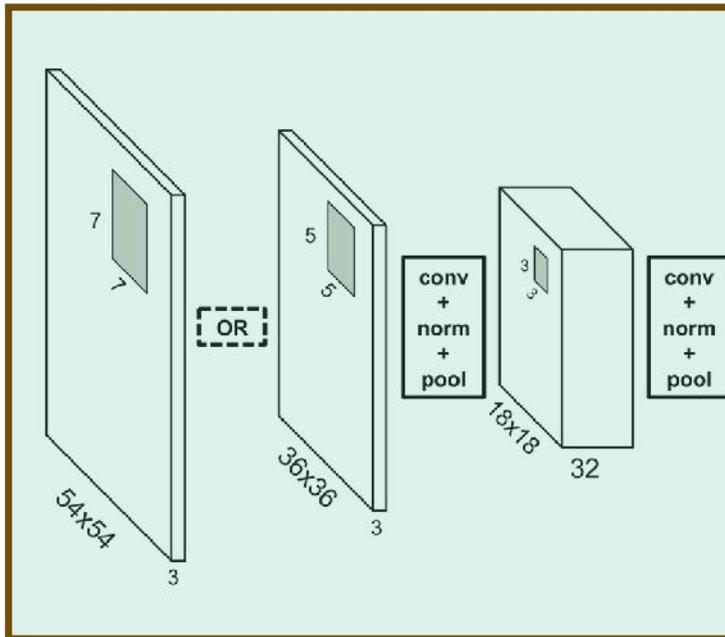
Images must be Statistically Photorealistic  
(Histogram equivalence with reality)



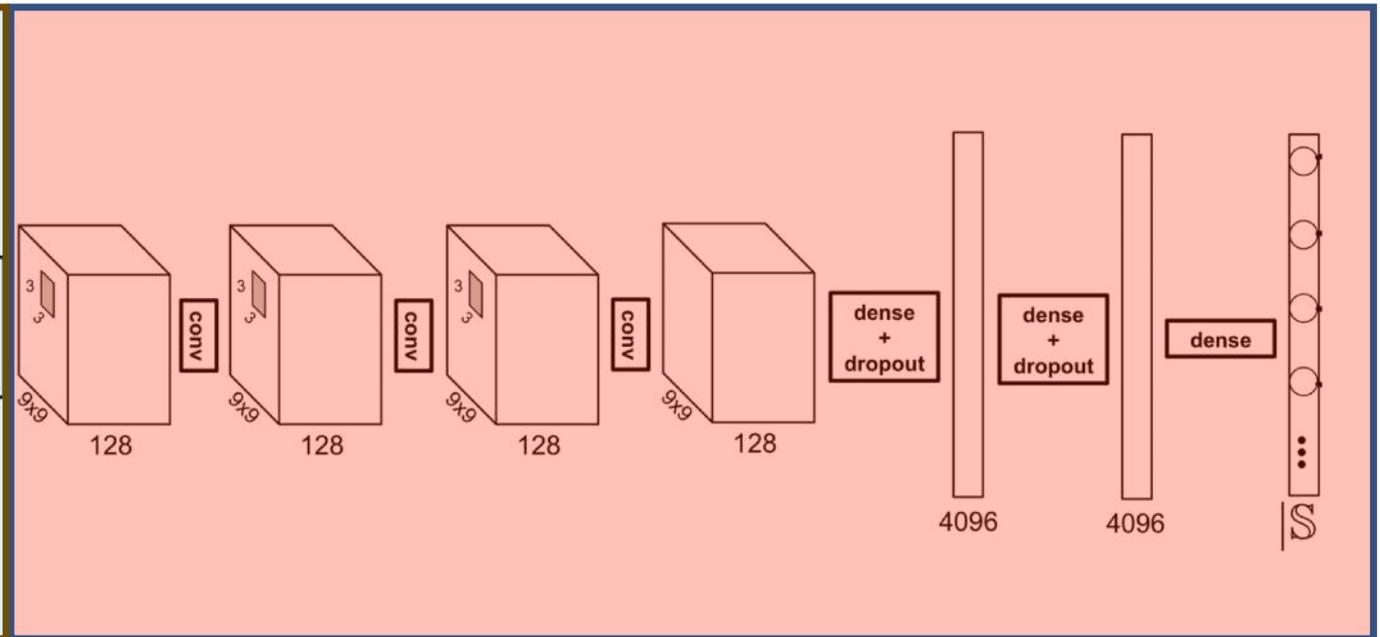
## Generic Simulator for comparison



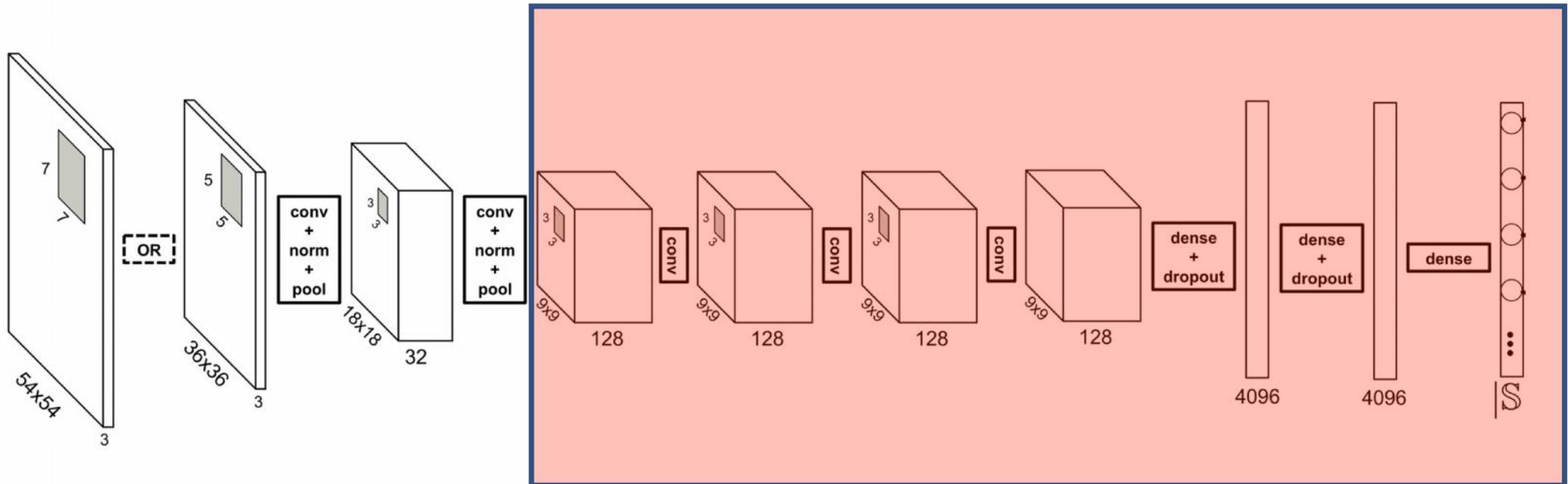
## Fine-Tuning on Real



## Pre-Training on Simulator



# The better the Virtual Environment



# The deeper the Pre-Training

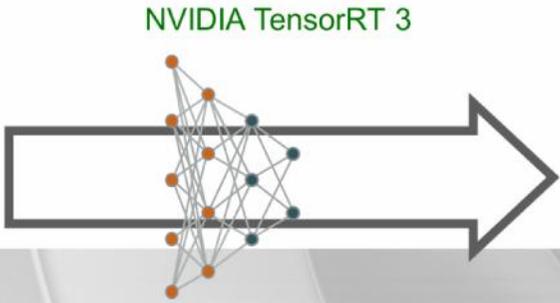
# Virtual Environments

Development Workflow



Photorealistic Images & Automatic Segmentation  
Pre-Training & Algorithm Comparison

Real-World Images & Manual Segmentation  
Fine-Tuning & Validation





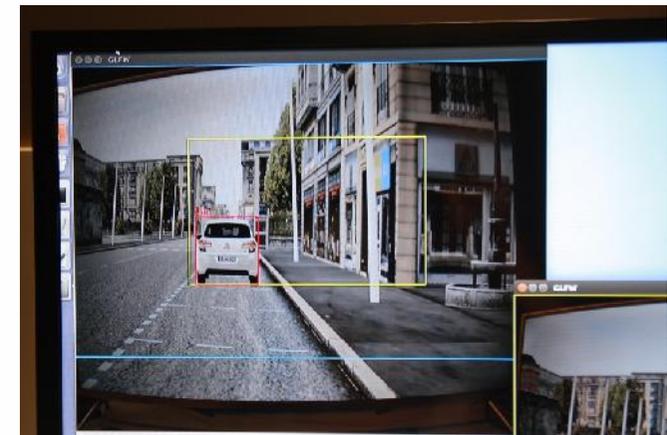
## Control Algorithms

Must have Man-in-the-Loop  
Dynamic Simulator is required  
Driver's Feeling is important



# Conclusions

- Challenges ahead of us can be won only with the help of **simulation**
- Simulation tools are prepared for **accelerating development** of ADAS and AV
- **Driving Simulators** are an excellent tool to test ADAS and AV in a safe, repeatable and controlled environment including interaction with **humans**
- When humans will be pure passengers, the need to improve «**occupants**» **feeling** will remain





**Thank You!**  
**Come and see us at Booth E.20**

