gotthard driverless

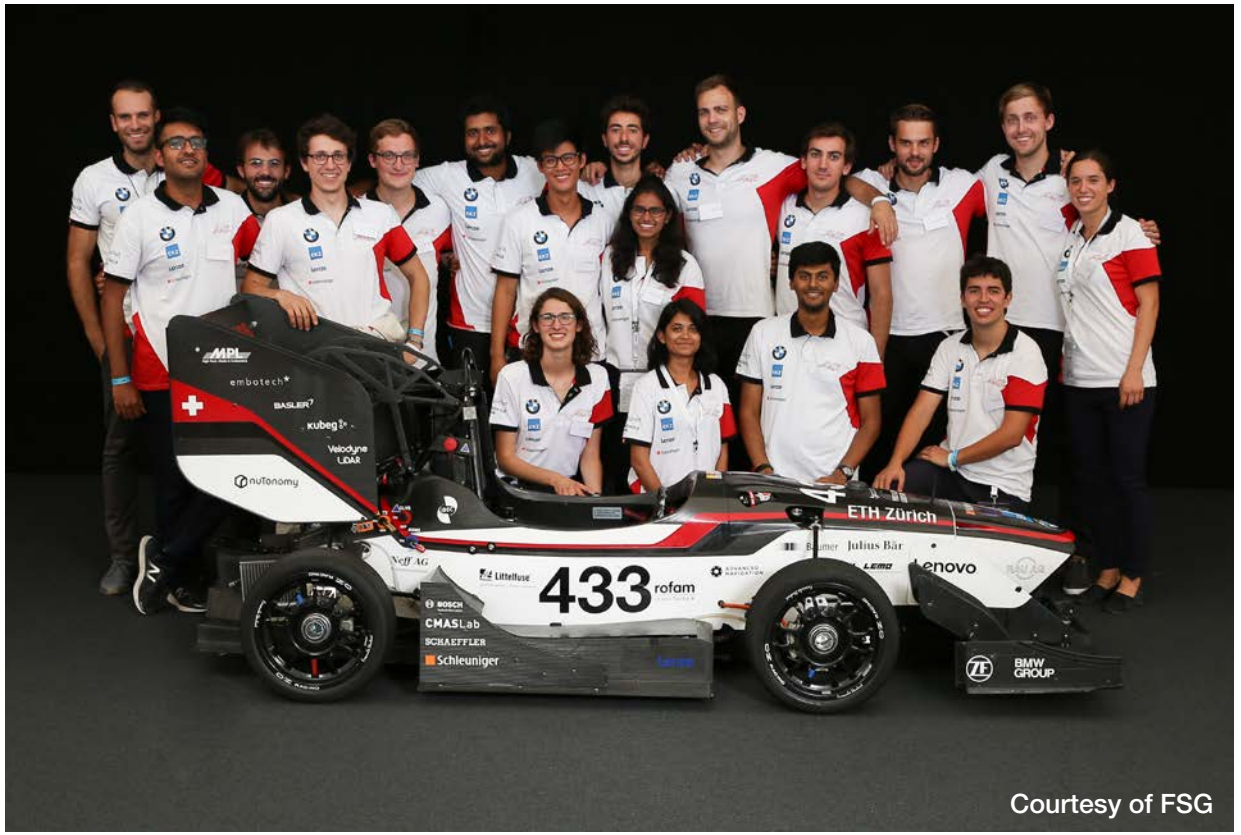
Overall car concept

“Formula Student is not about designing good cars, it’s about designing good teams”

Claude Rouelle

Agenda

- Team
- Methods
- Concept
- Implementation
- Discussion



Courtesy of FSG

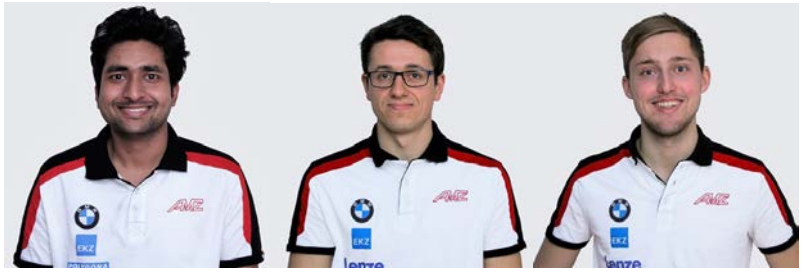
Team

Management

Hardware

SW architecture

Estimation

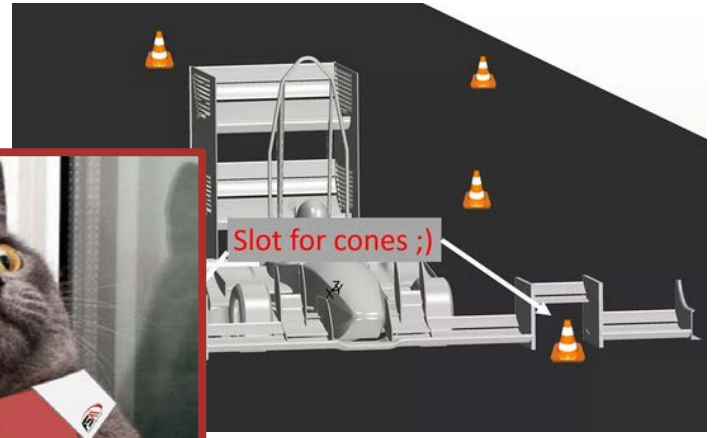


Controls

Perception

Team: Training

- Spread out skills in the team
- Focused workshops
  - ROS
  - Git
  - C++
- But also:
  - Rules (a lot!)
  - Vehicle dynamics
  - Basics of Formula Student
  - CAD and FEM
  - Safety procedures



Courtesy of FSG and FS Austria

Methods: Team discipline

- Knowledge transfer tools
- Meeting records
- Alumni reviews
- Design mocks
- Tech inspections simulations
- Race camps

Courtesy of ZF Friedrichshafen

Methods: Testing

- Efficiency: time, people, money
- Extensive use of simulation and recorded data
- Test “on the real thing”
- Integration tests at home
- Easy visualization

Concept: Team goals

1. Maximise points in a FSD event
2. Finish all disciplines
3. Safety is a priority
4. Solid foundation for AMZ driverless

Courtesy of FSG

Concept

- Hardware reliability and integration
- Sensor redundancy
- Algorithm robustness
- Minimize lap time

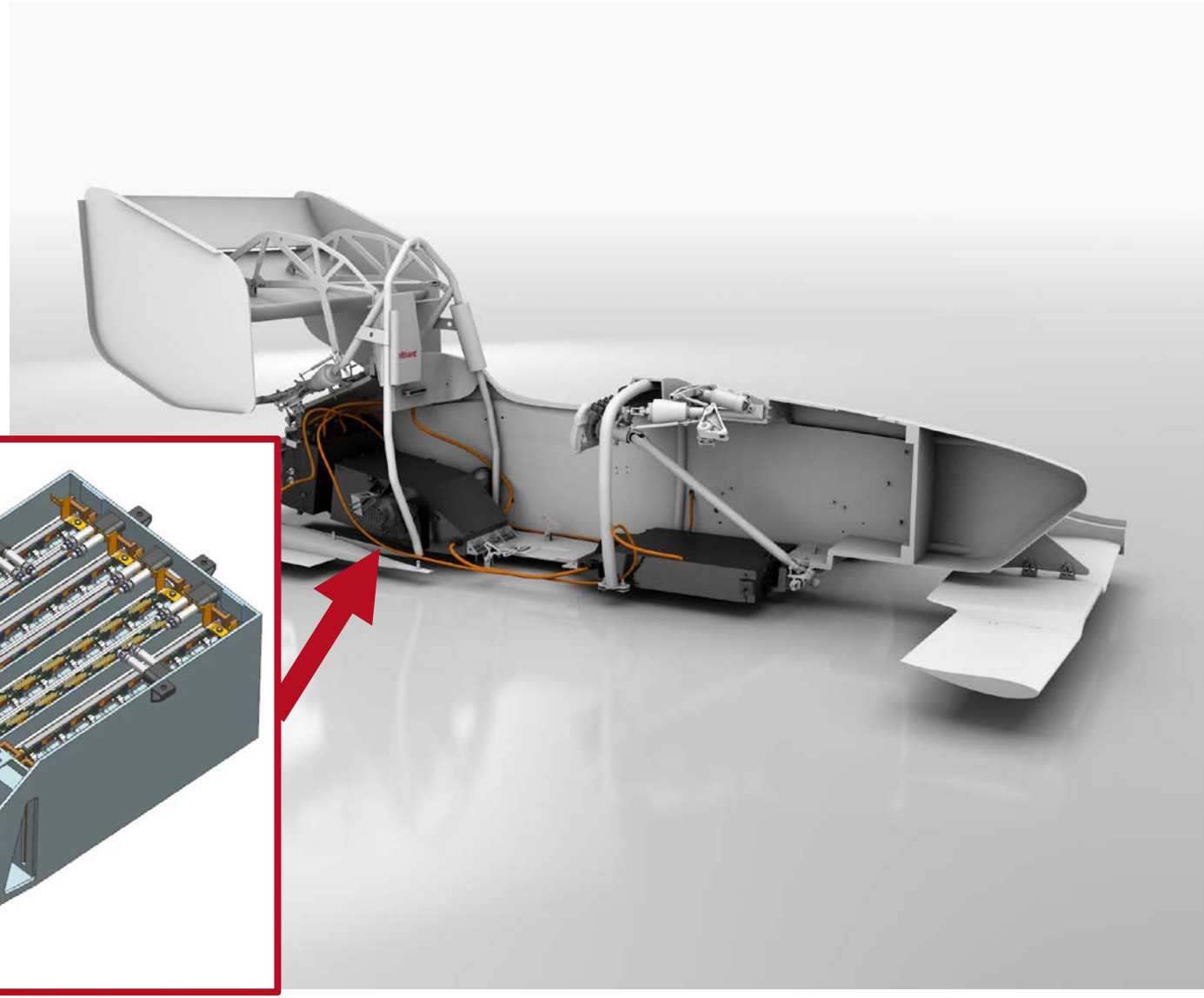
gotthard driverless

Base vehicle

- CFRP one-piece monocoque
- Heave springs
- Air springs with MRF
- Chassis diffuser
- Split accumulator packaging
- Self-designed motors

Accumulator

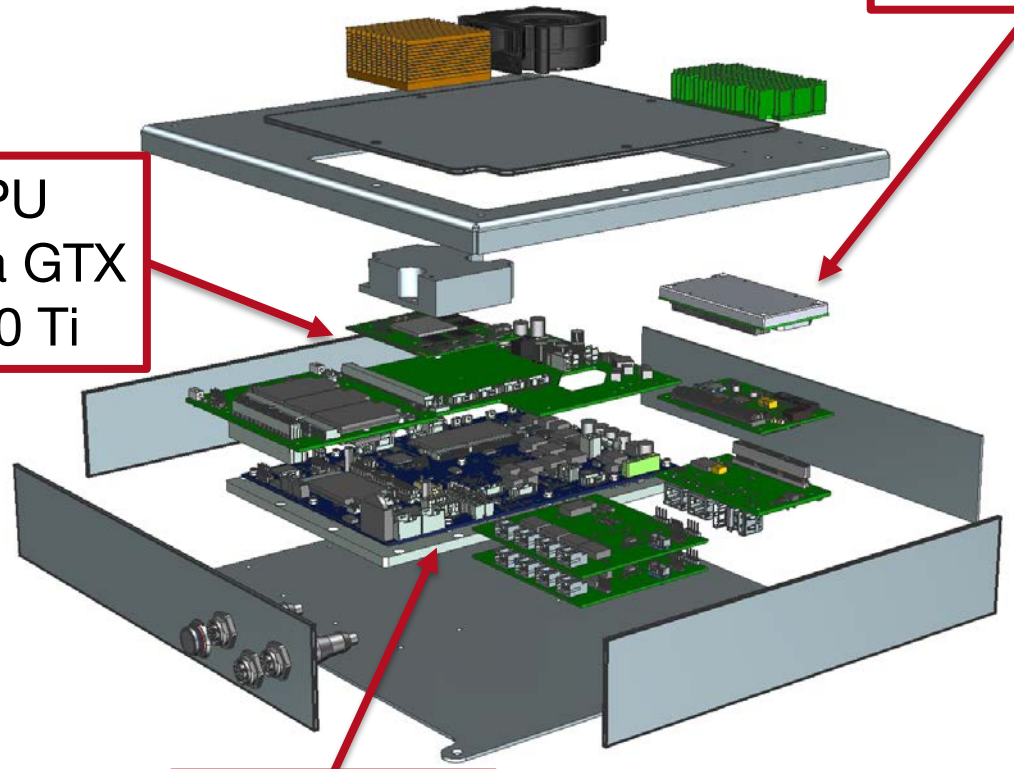
- New accumulator needed
- Decided to rebuild only the rear section
- 43% of the energy
- 17 Kg lighter



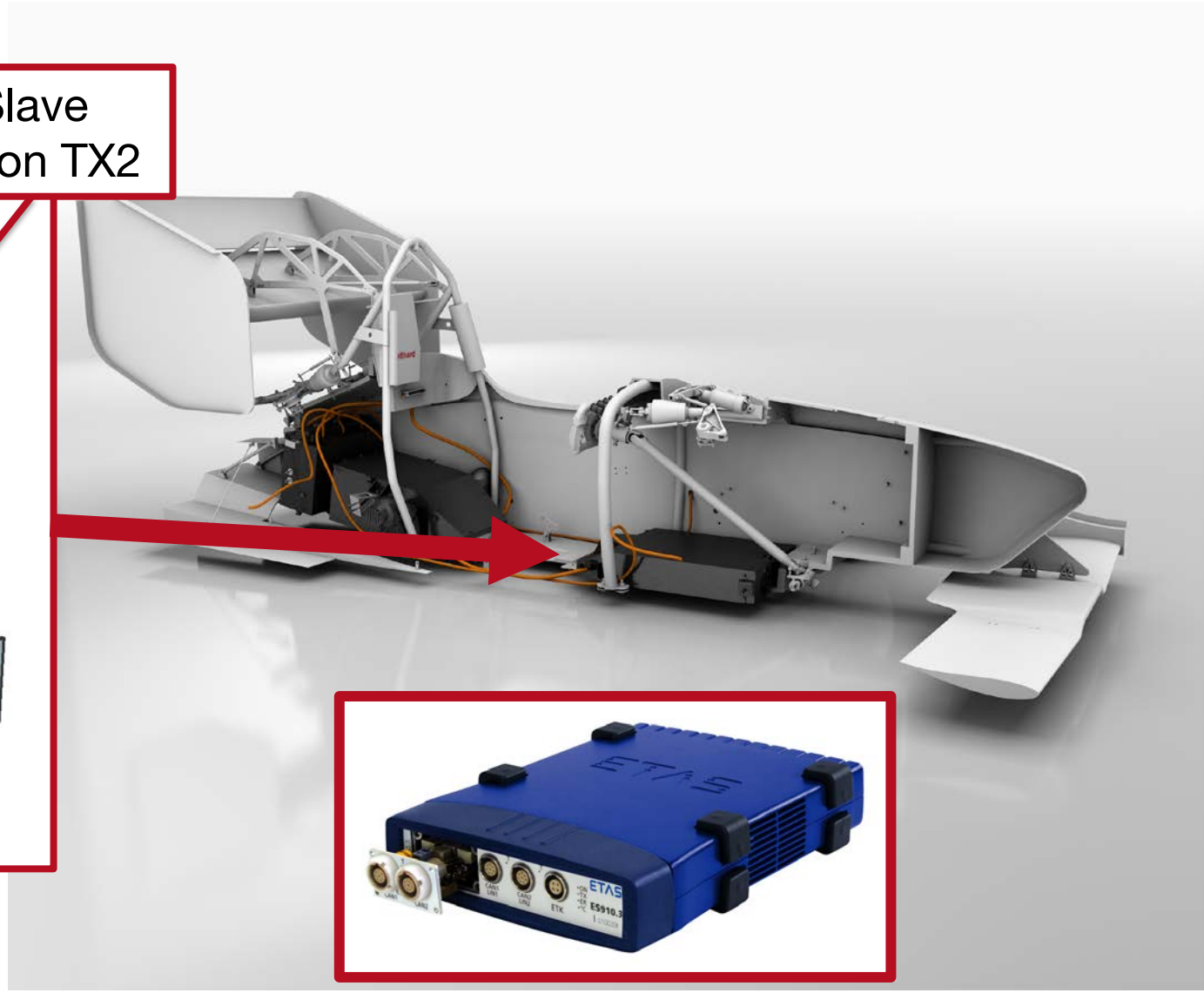
Computing platform

Slave
Jetson TX2

GPU
Nvidia GTX
1050 Ti

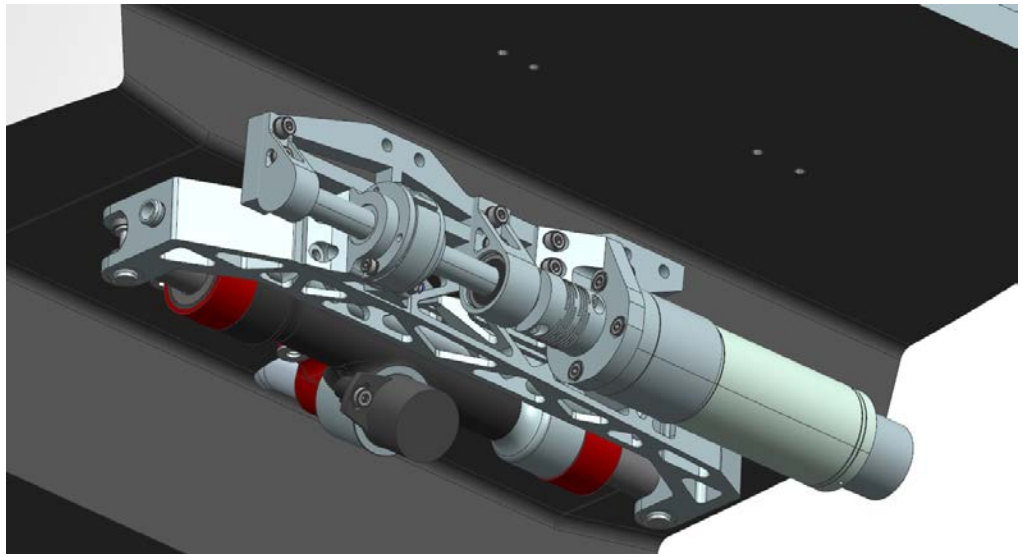


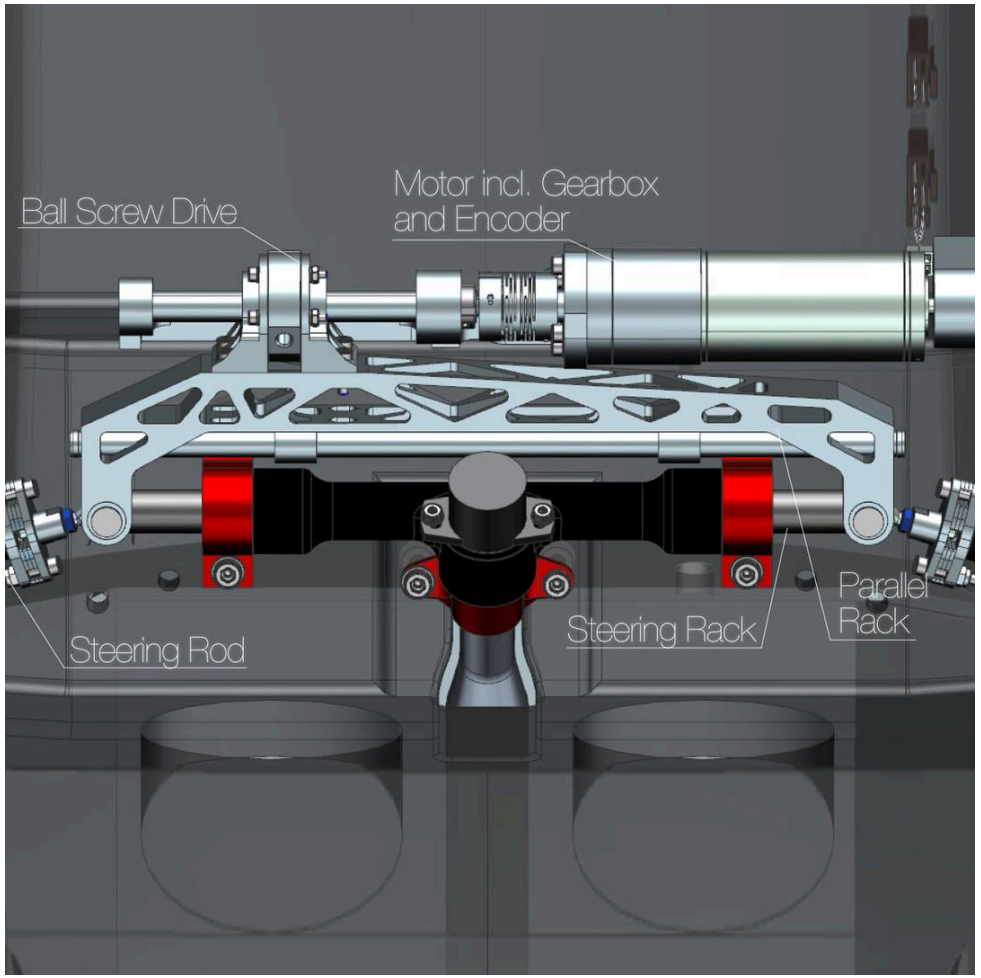
Master
MPL PIP 39



Steering Actuator

- Direct load-path
- Steering rate covers 99% of driver speeds
- Design to withstand parksteer (peak) and skidpad (continuous load)



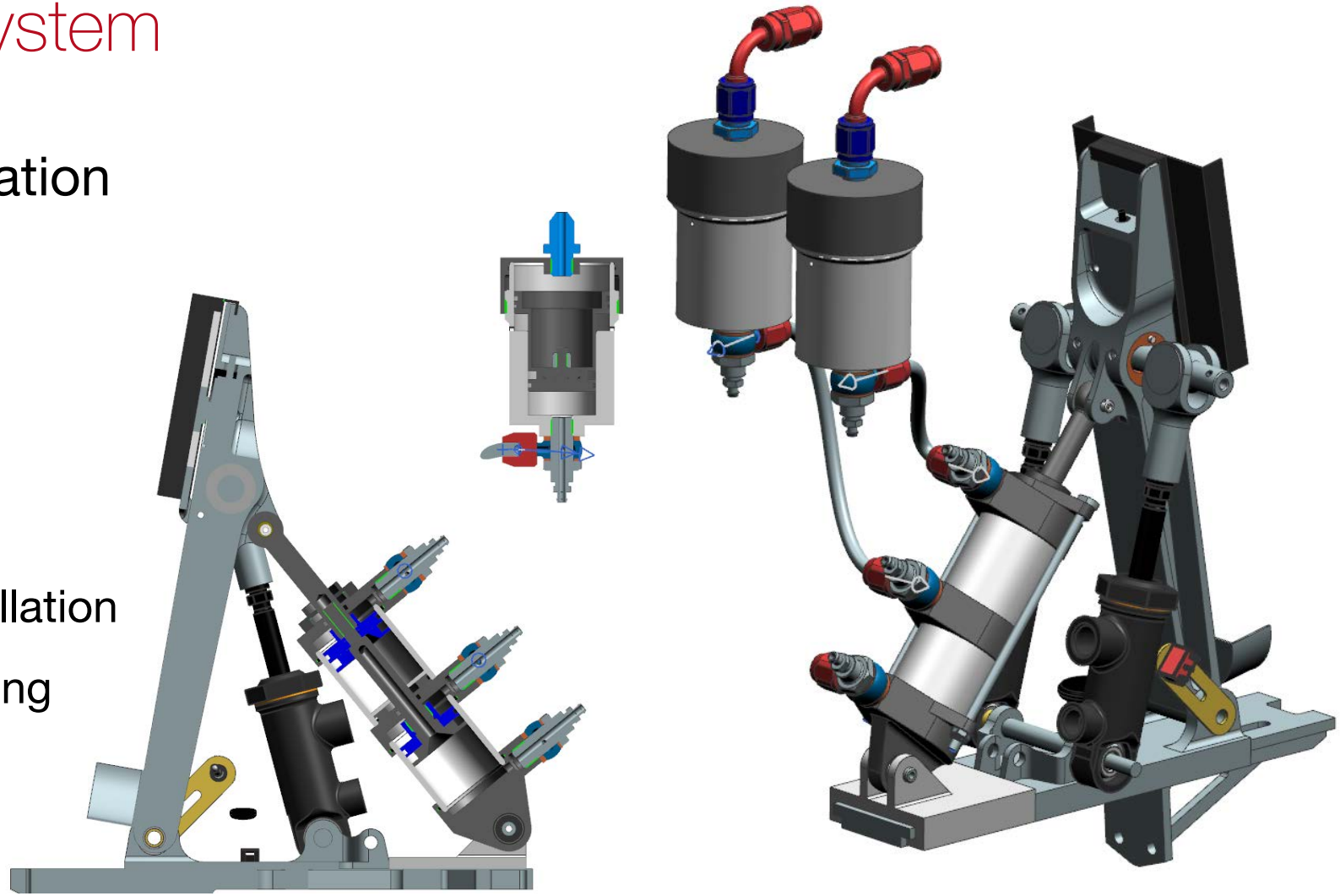


Emergency Braking System

- Normally braking configuration
- Hydro-pneumatic circuit
- Redundant and fail safe
- Compatible with a driver

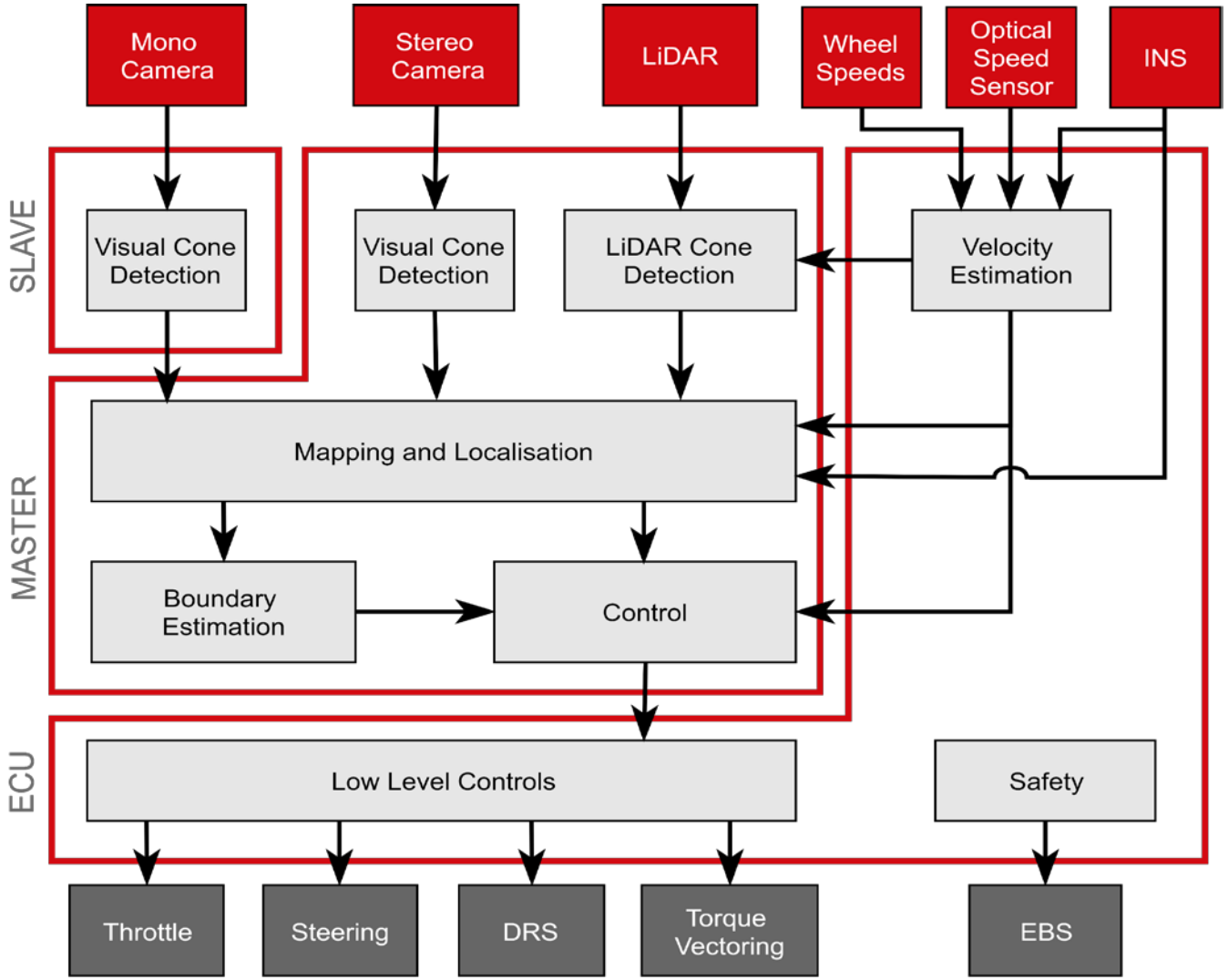
  No need for complex HW installation

  when switching to manual driving



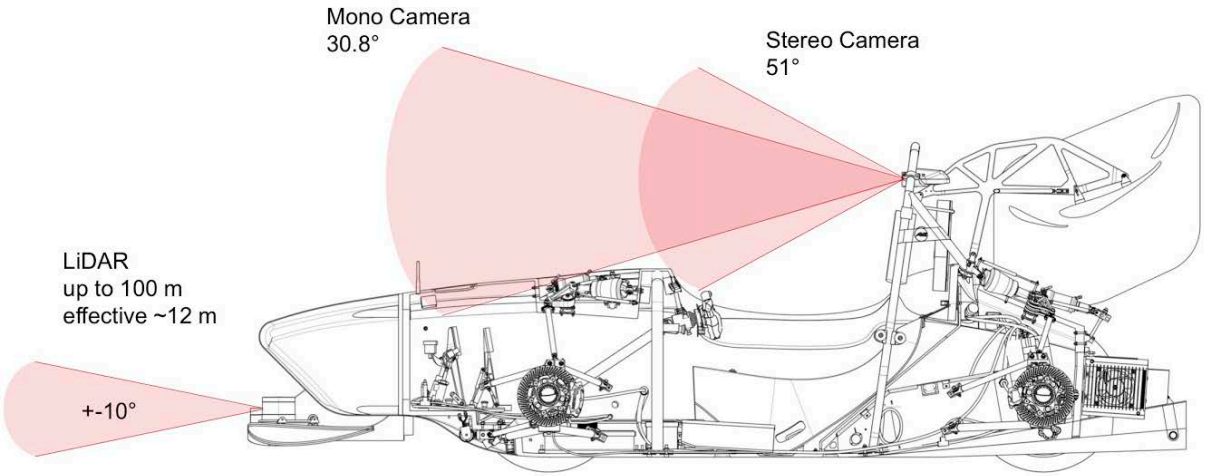
Software Concept

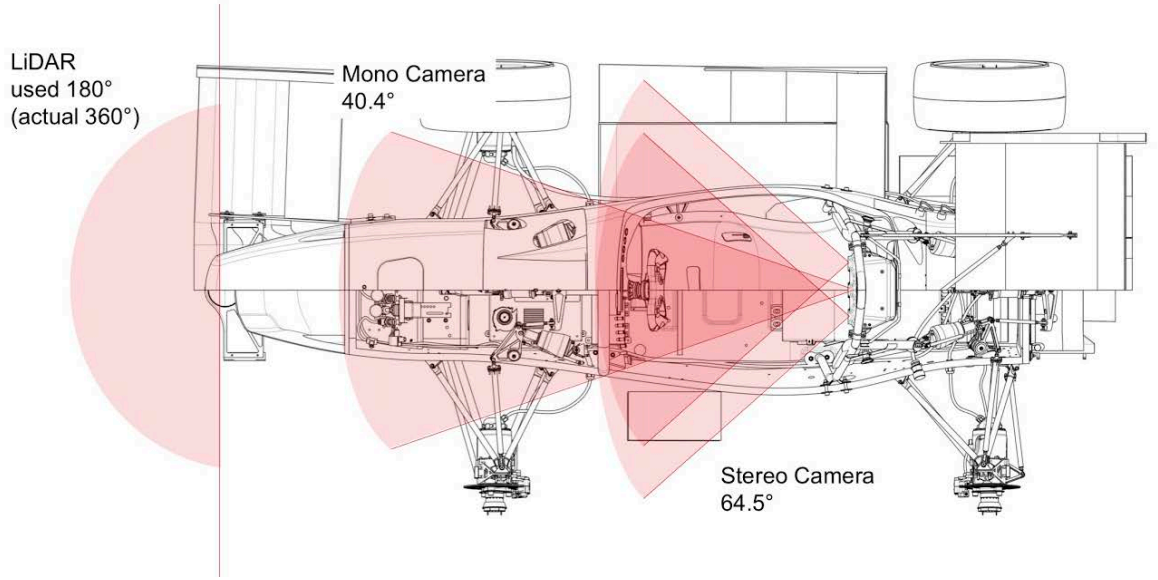
- Perception
  - Vision
  - Lidar
- Estimation
  - Velocity Estimation
  - SLAM
- Controls
  - Discovery mode
  - Race mode



Perception: Sensor setup

- Cameras
  - 3 Basler ace cameras:
    - 2MP resolution
    - GigE cameras
    - CMOS sensor
    - Global shutter
- Lidar
  - Velodyne VLP-16 Hi-Res
    - 16 Channels
    - High range
    - Low power consumption
    - Up to 600,000 points per sec

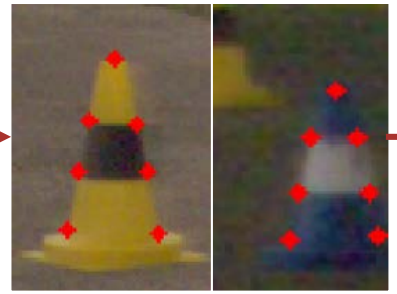




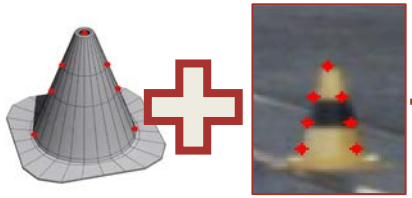
Perception: Mono setup

Cone detection

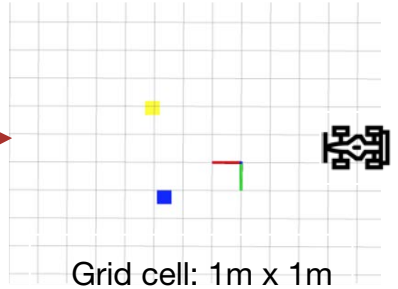
Keypoint extraction



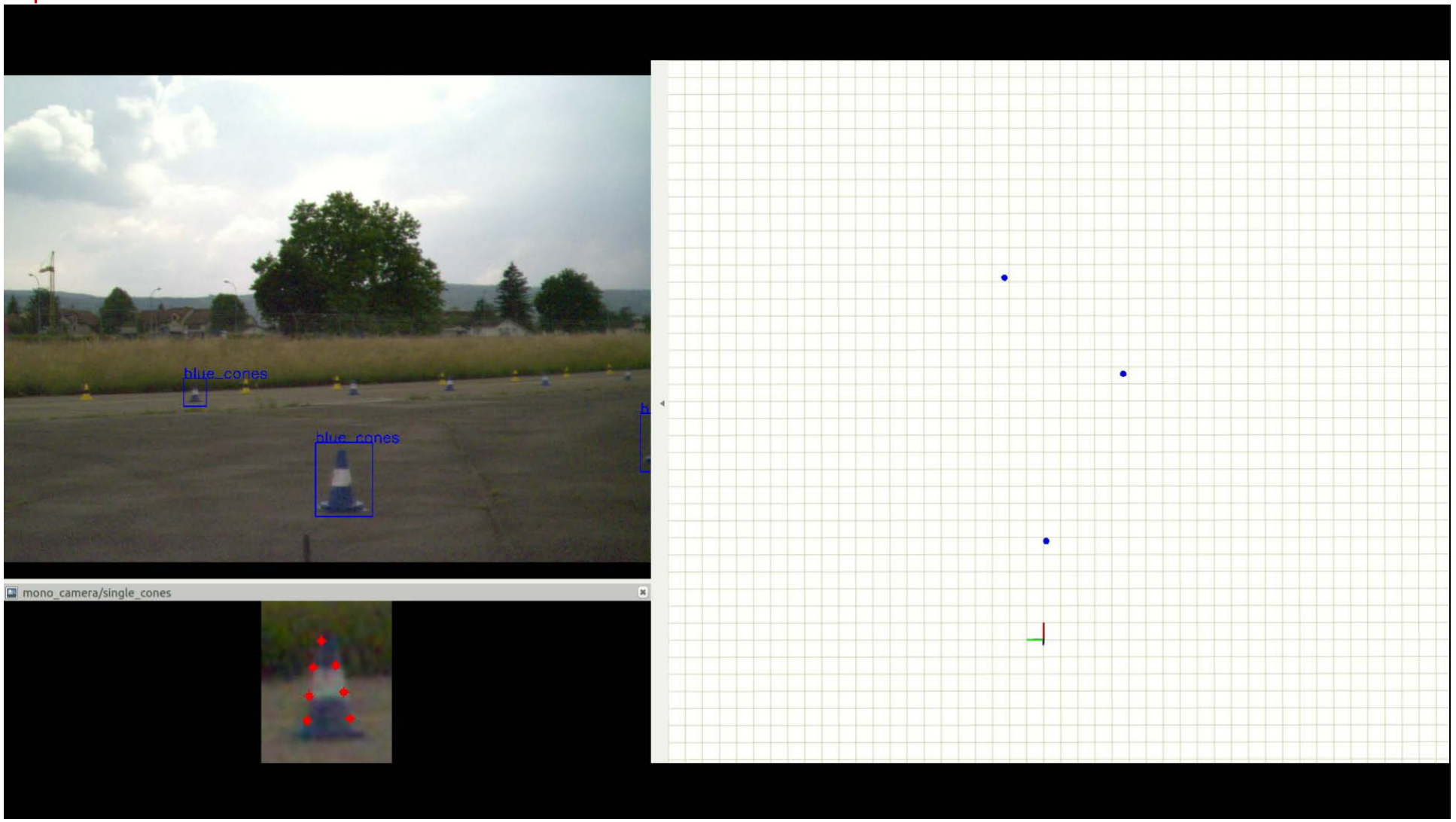
2D to 3D



Position



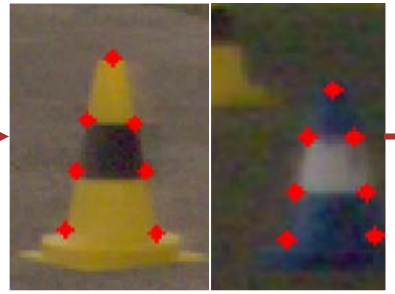
Perception: Mono cone detection



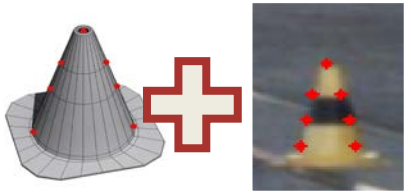
Perception: Stereo setup

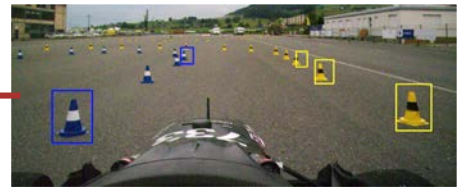
Cone detection

Keypoint extraction

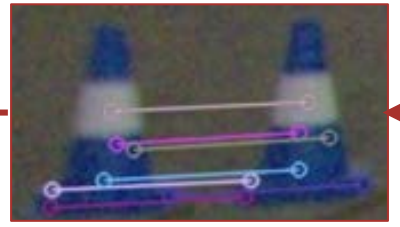


2D to 3D

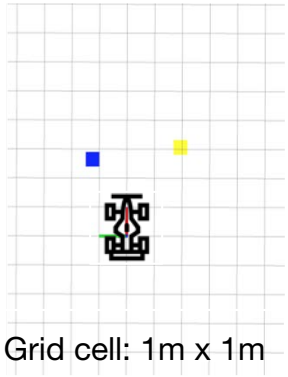




Bounding box propagation

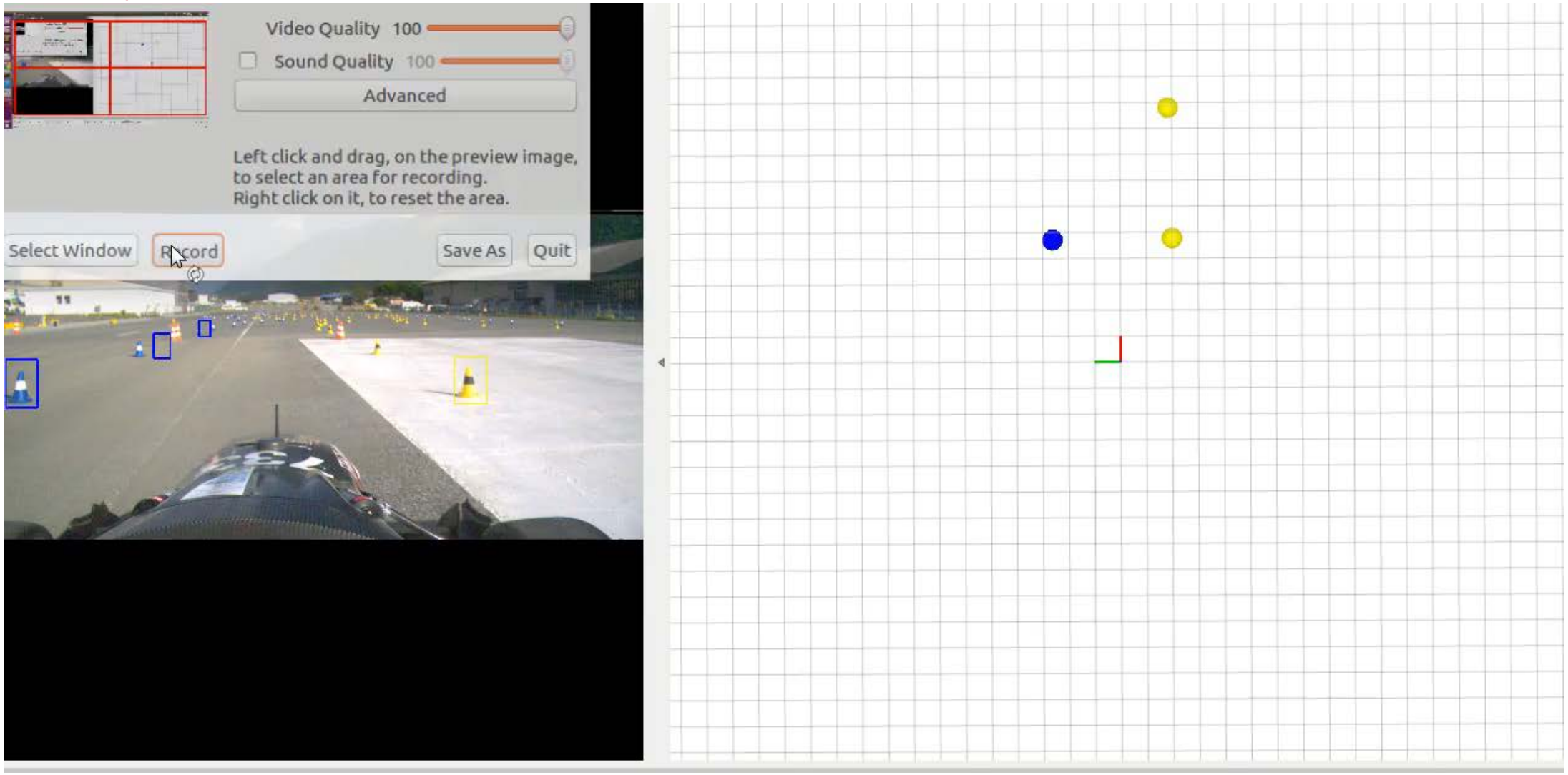


Feature matching

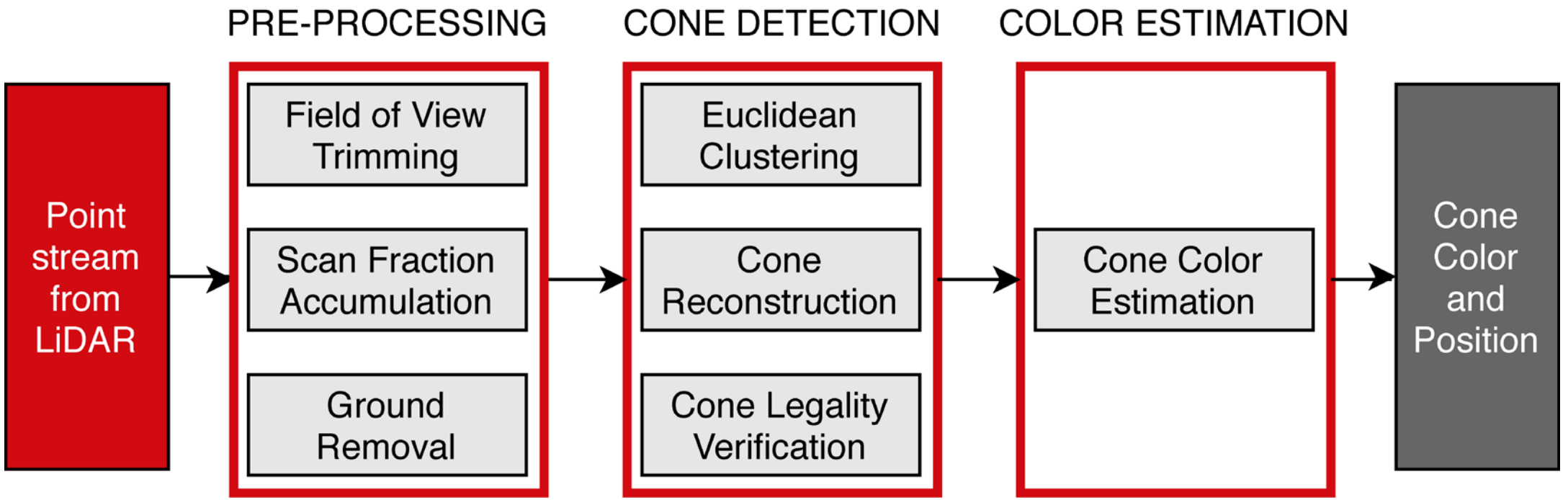


Triangulation

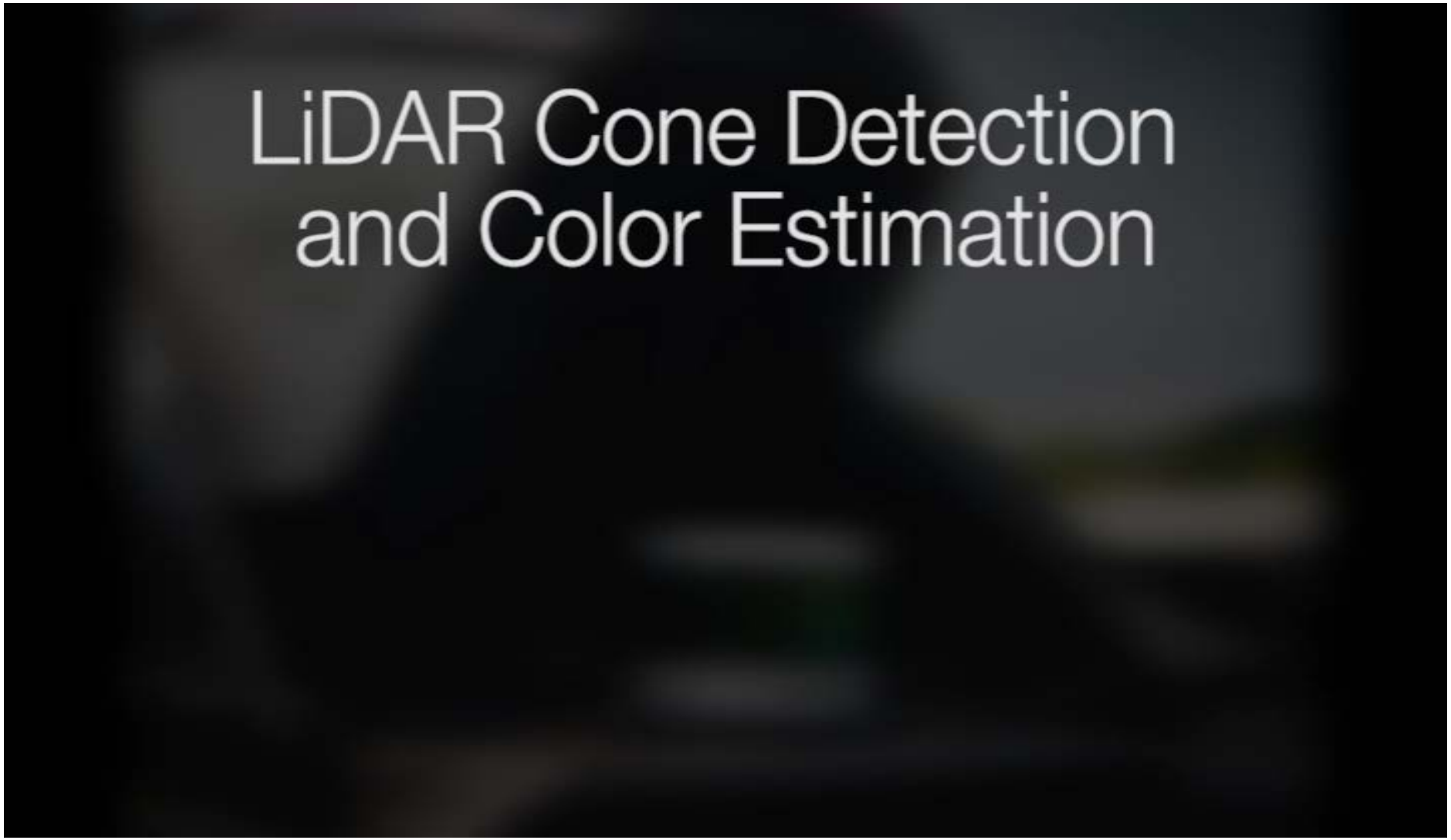
Perception: Stereo cone estimation



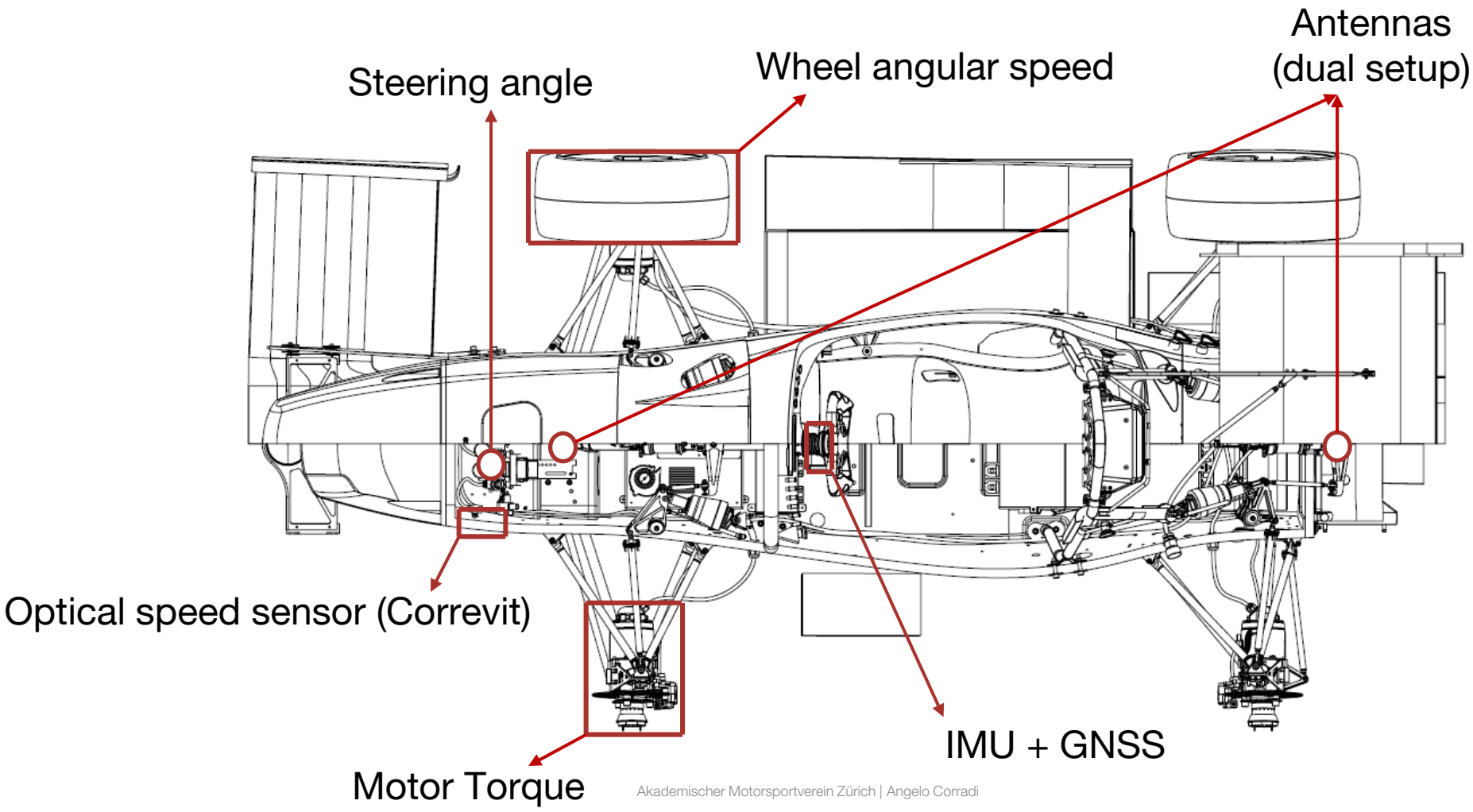
Perception: Lidar



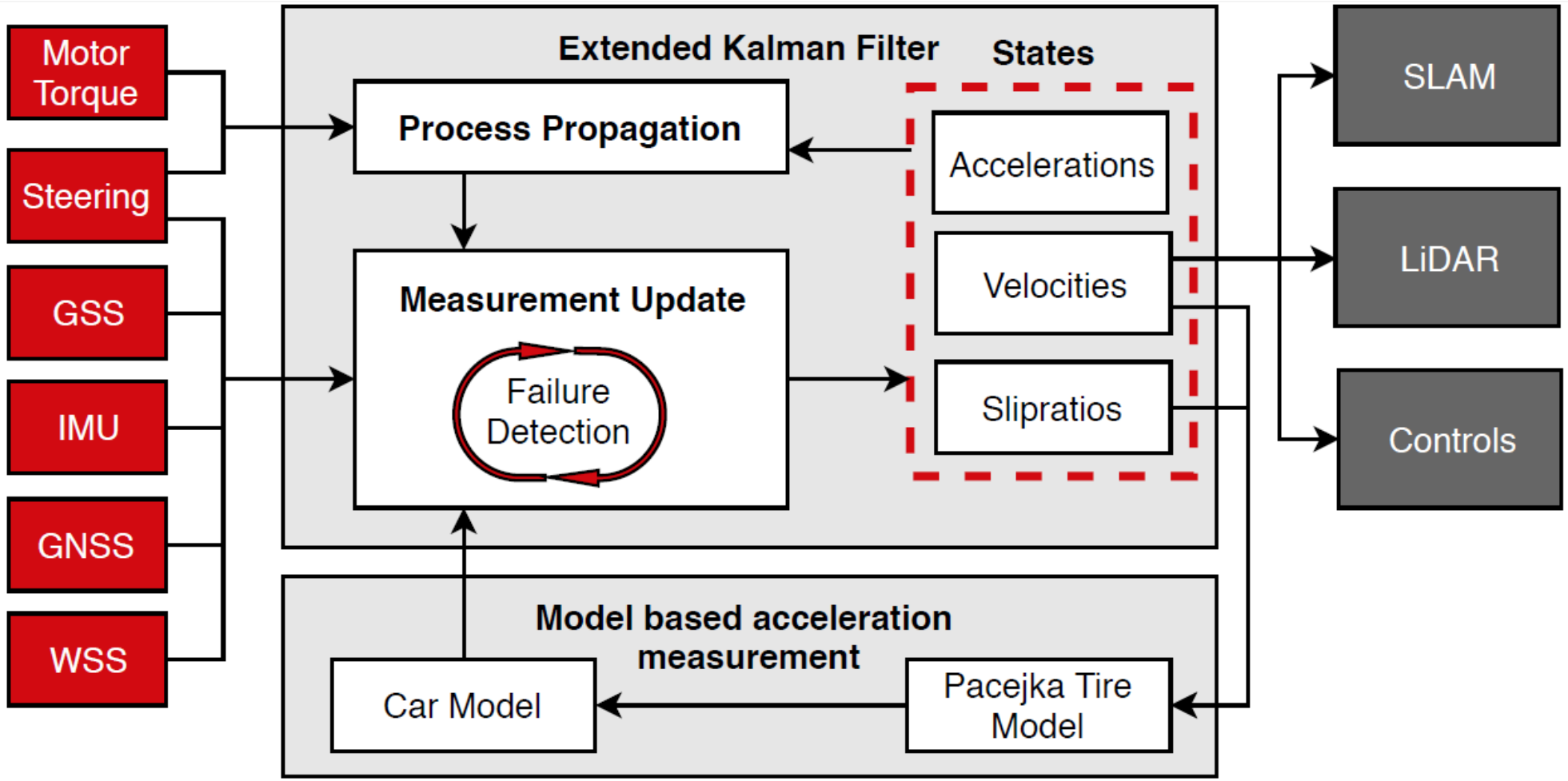
Perception: Lidar visualization



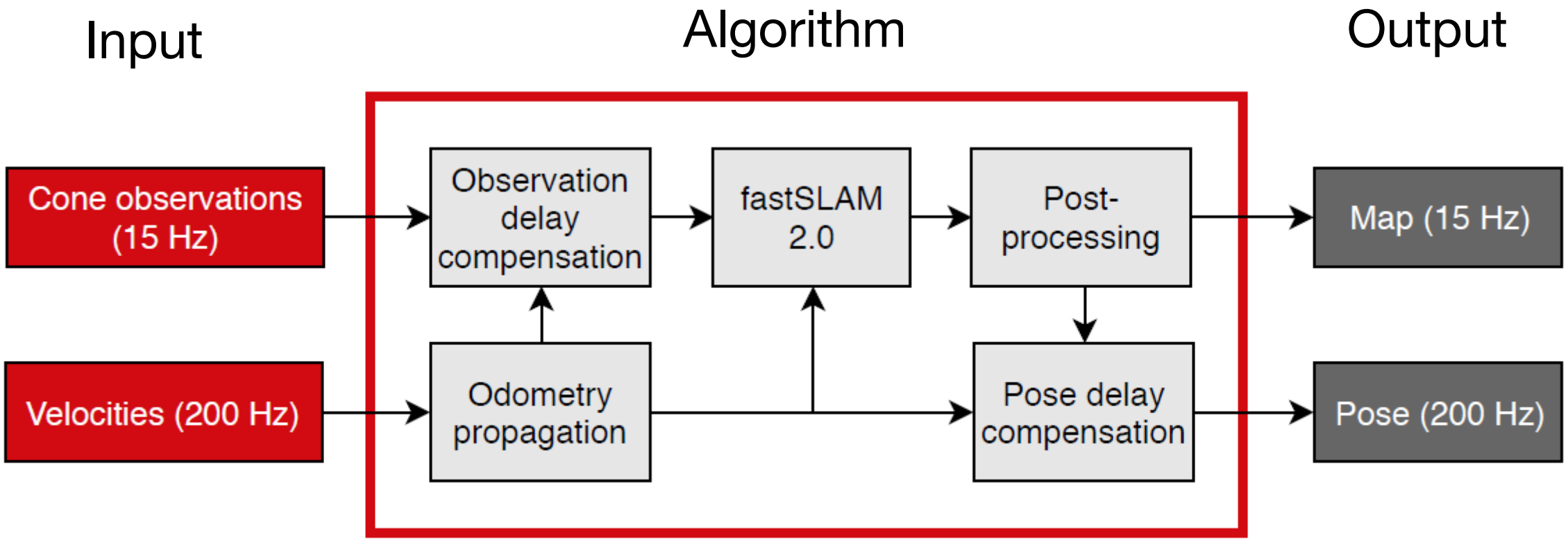
Velocity estimation: Sensor setup



Estimation: Velocity estimation

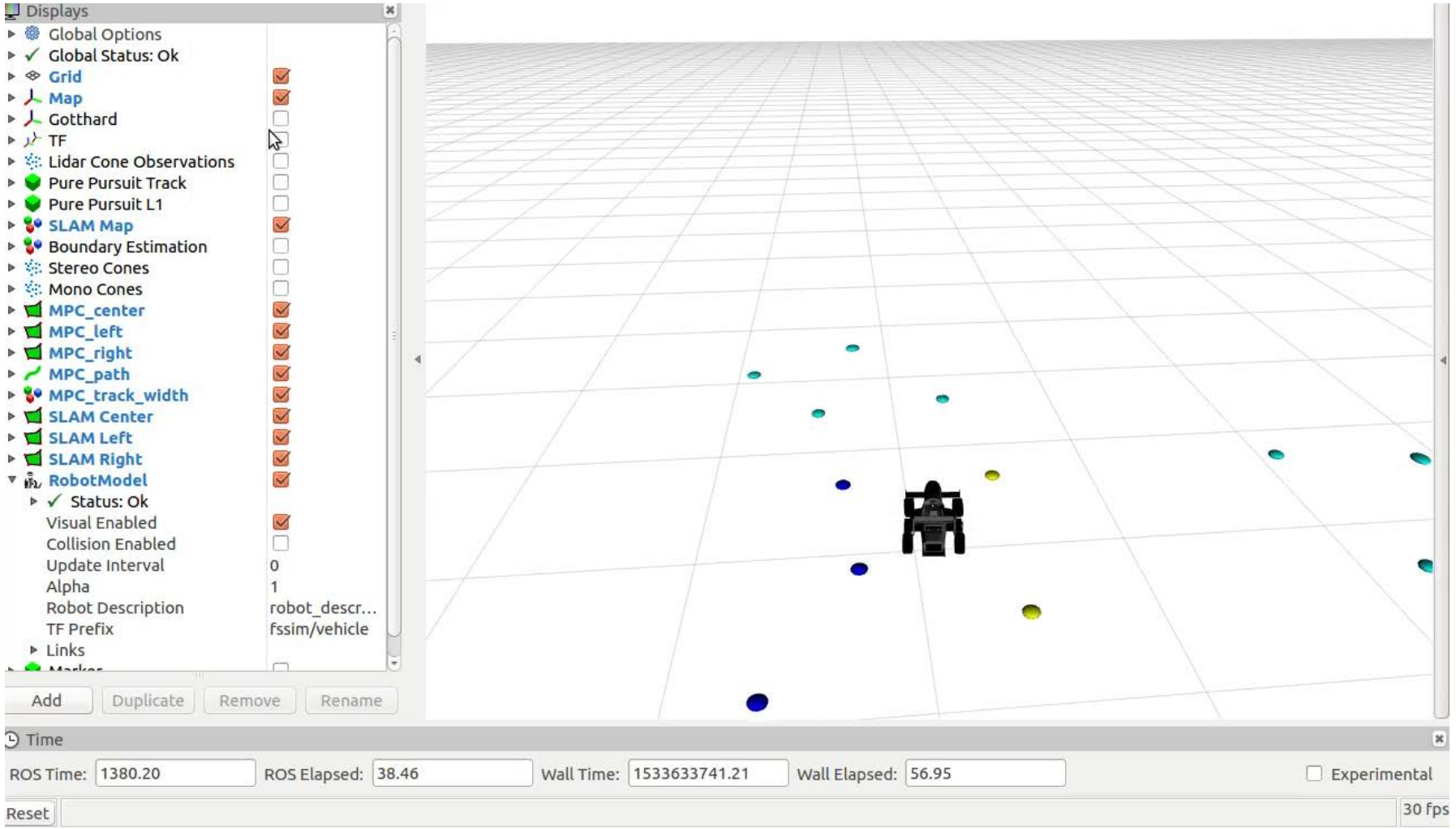


Estimation: SLAM

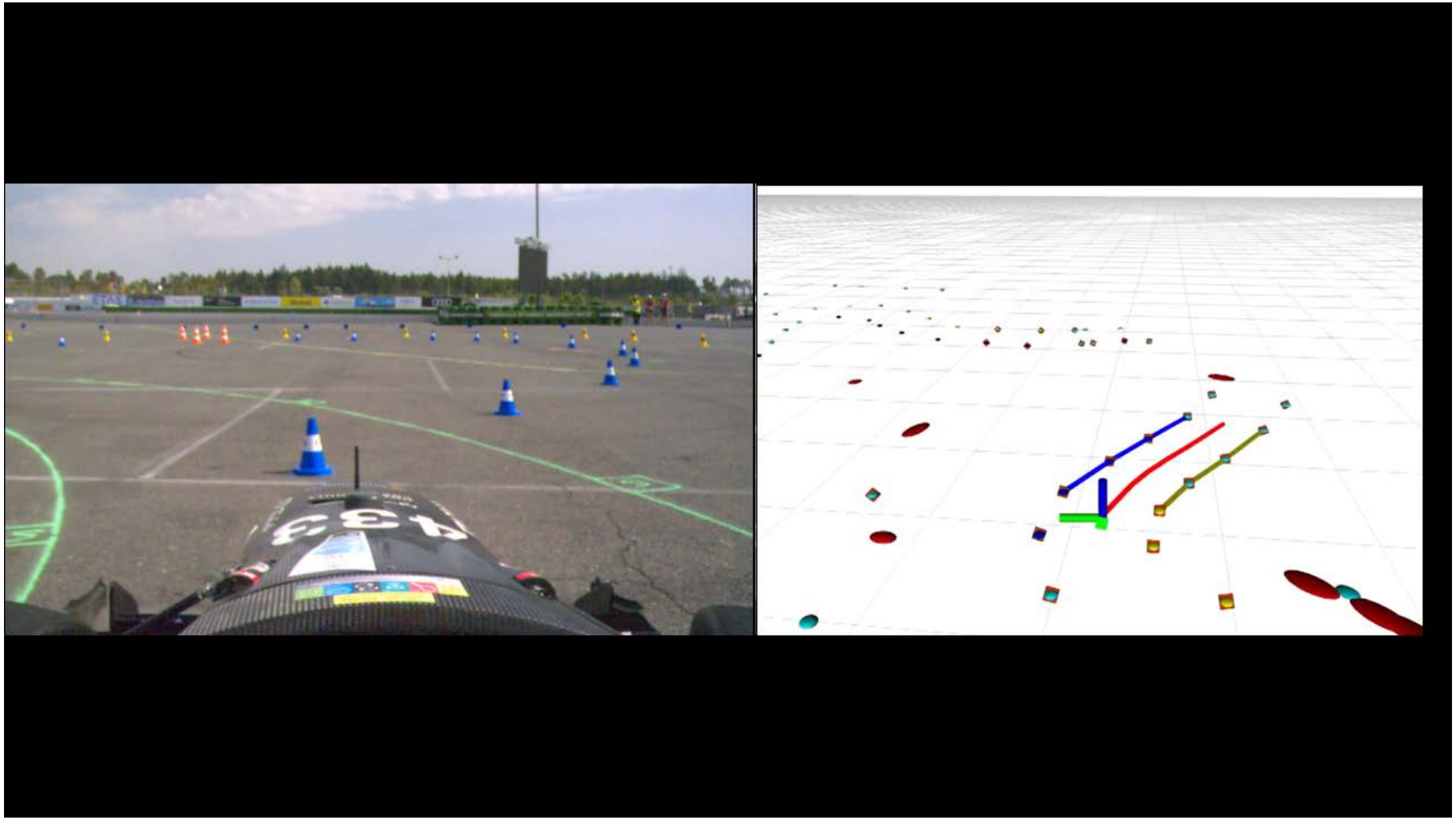


Estimation: SLAM

Controls: boundary estimation



Controls: boundary estimation and MPCC

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“Engineers like to solve problems. If there are no problems handily available, they create their own.”

Scott Adams

FSD is Formula Student

- It’s not a software competition, it’s an engineering competition
- It retains all challenges of Formula Student
  - Trade off decisions and sensitivity analysis
  - Hardware integration
  - Time and budget constraints
  - Project management
- The goal is the same: maximize points by minimizing lap time

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