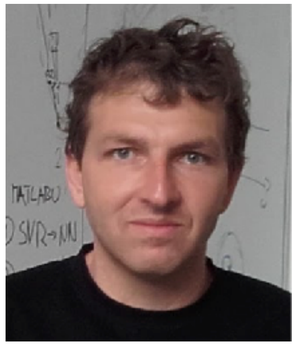
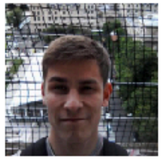
Autonomous robotics: outline

Karel Zimmermann



- **Karel Zimmermann**
- ARO lecturer
- associate professor

- **Vojta Vonásek**
- ARO lecturer
- PostDoc researche

	František Nekovář head of the labs. Exploration path planning lab tutor.
	Robert Pěnička ROS tutor.
	Vít Krátký is the exploration and path following lab tutor.
	Bedřich Himmel is technical support staff
	Martin Pecka is localization labs tutor and can help with ROS-related questions.
	Ruslan Agishev is ICP SLAM lab tutor

Outline:

- Who are we and what are we doing?
- What is the Autonomous Robotics course about?
- Course organization

What is the Autonomous Robotics course about?

Obviously about **robotics**, but what is it?

Merriam-Webster definition:

Robotics == technology dealing with the design, construction, and operation of robots in automation

M. Brady's definition:

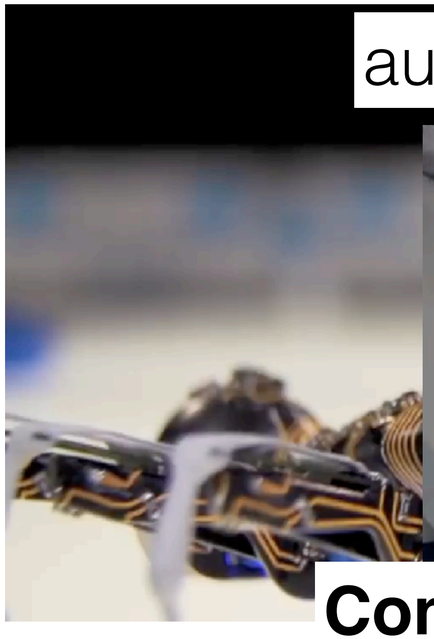
Robotics == the intelligent connection of perception to action

Robotics researchers definition:

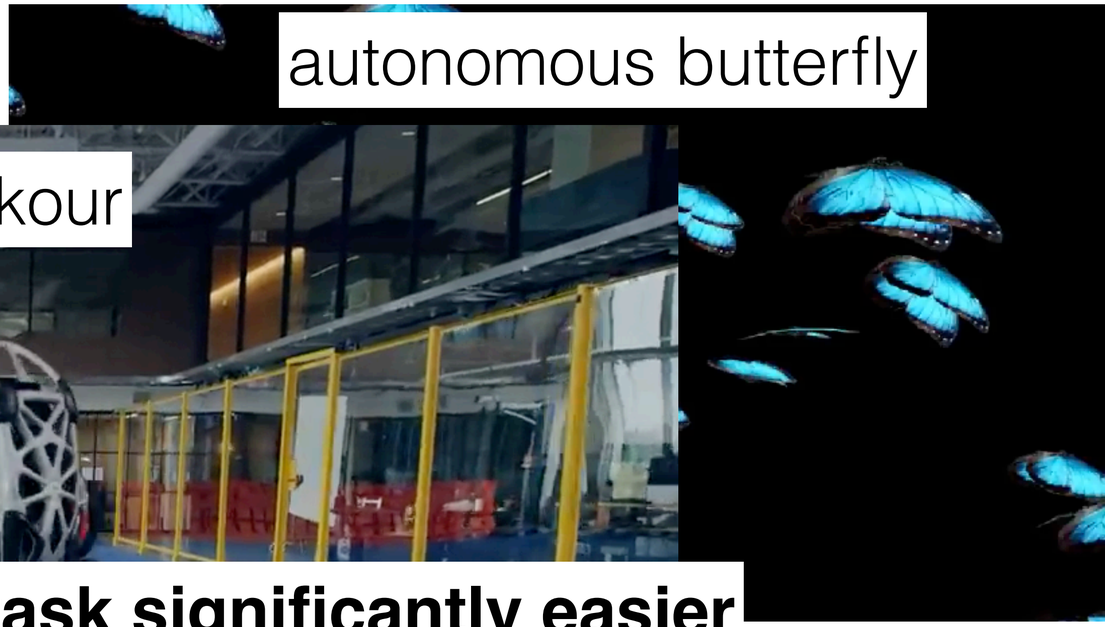
Robotics == do some **fancy** stuff with robots

Robotics == do some **fancy** stuff with robots

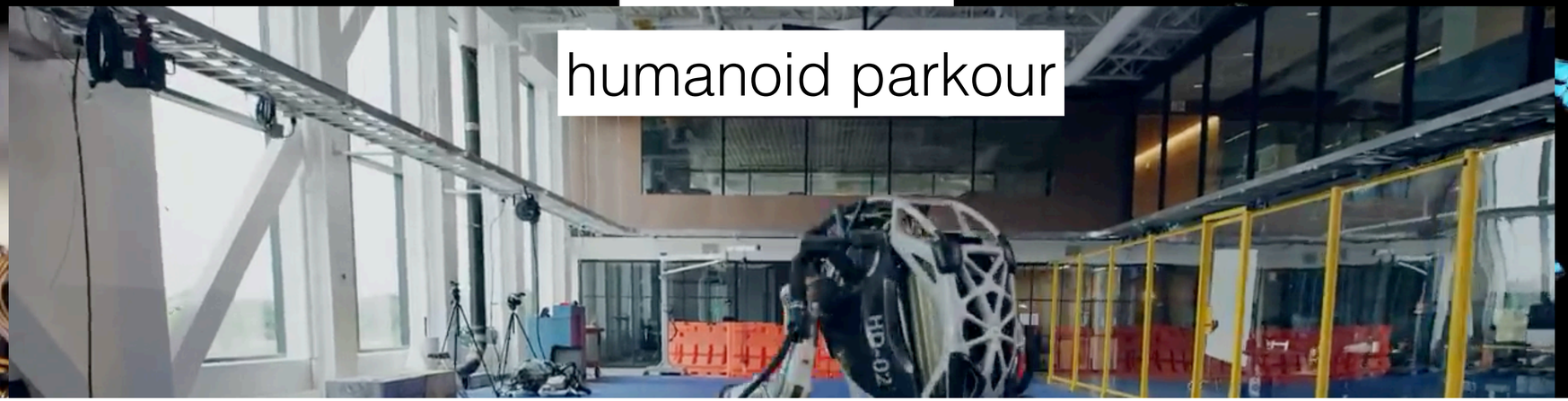
autonomous ants



autonomous butterfly

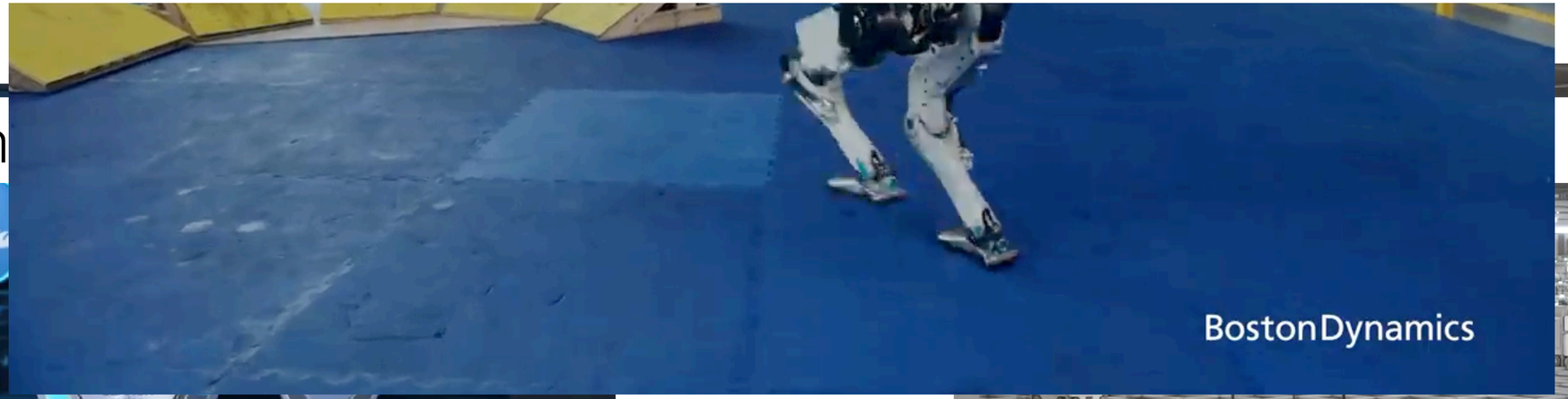


humanoid parkour



Controlled environment makes the task significantly easier

auton



warehouse

What do these robotics solutions have in common?

Robotics == do some **fancy** stuff with robots

autonomous cars

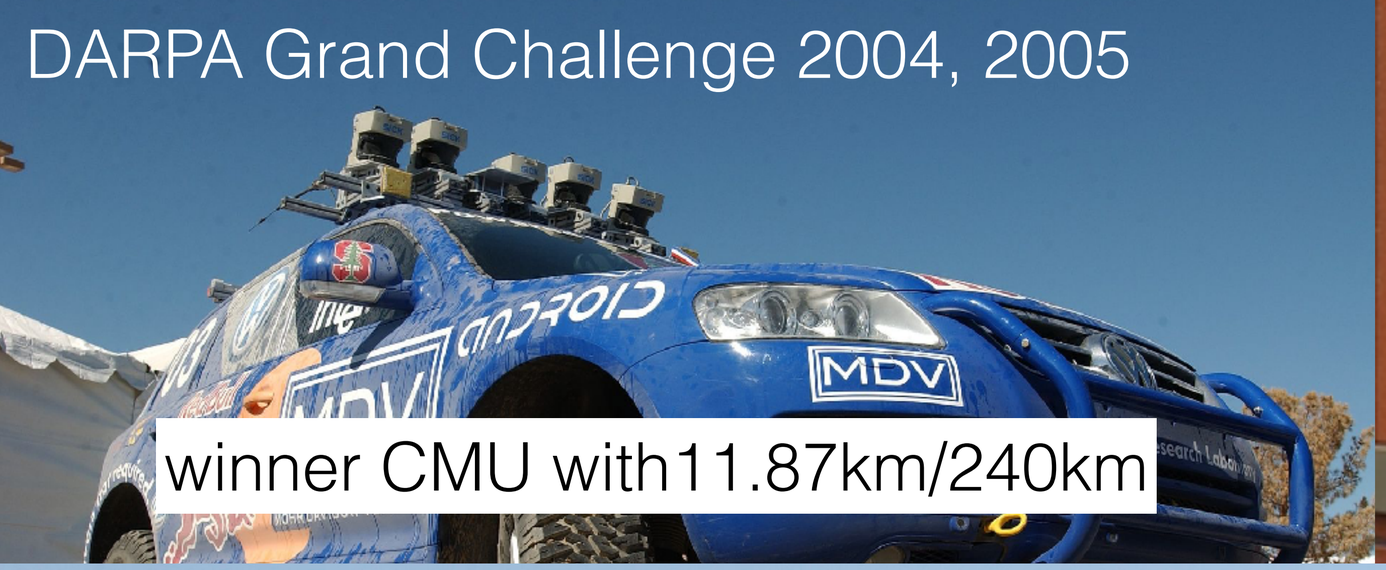
Less controlled environment, but still far from being completely natural

traffic rules, traffic signs, lane markings, prior map, …

In order to motivate the robotics research in less controlled environments

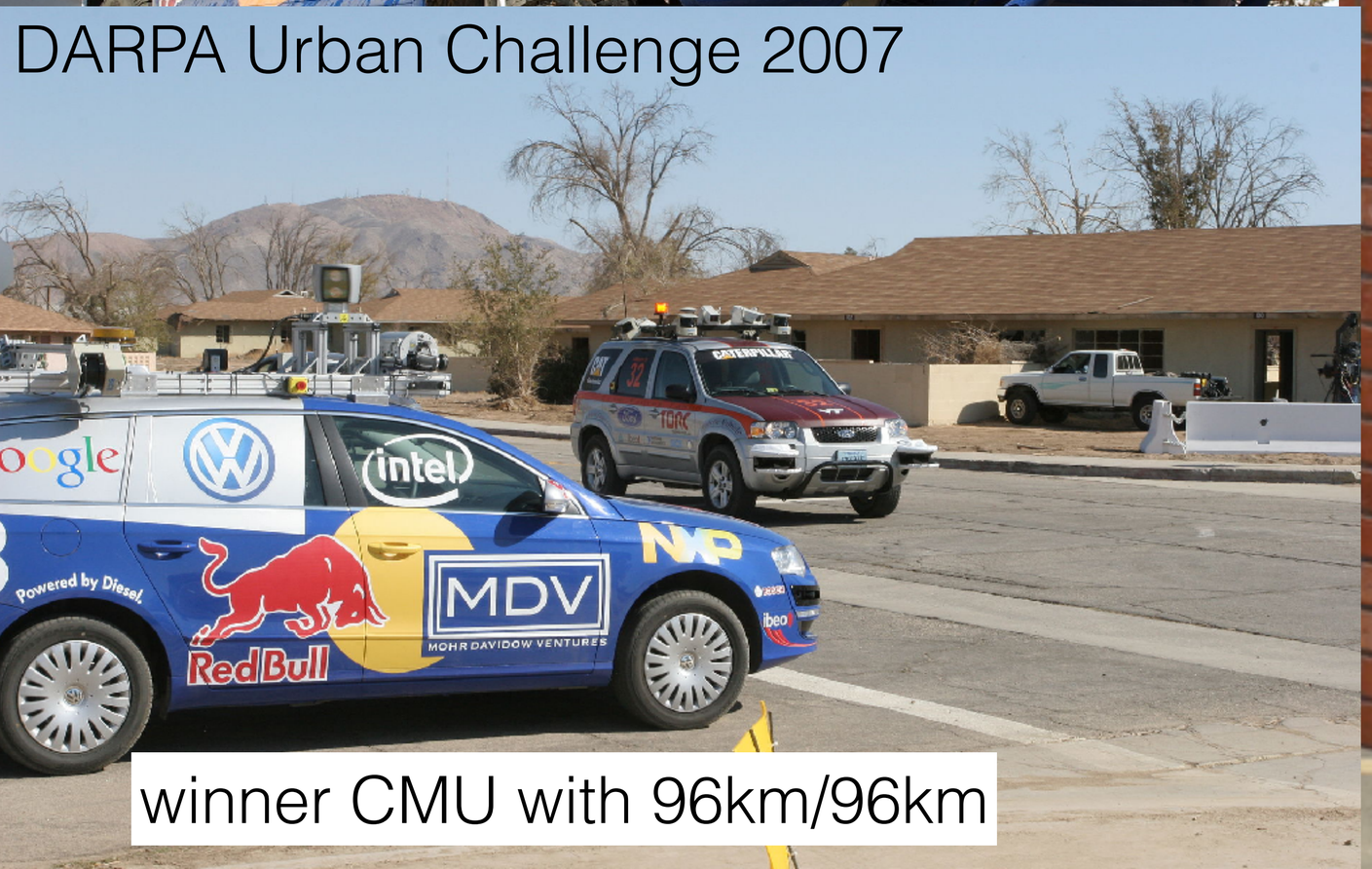
DARPA robotic challenges:
GOAL: Develop robotic capabilities to execute complex tasks in apriori **unknown, uncontrolled environments**.

DARPA Grand Challenge 2004, 2005



winner CMU with11.87km/240km

DARPA Urban Challenge 2007

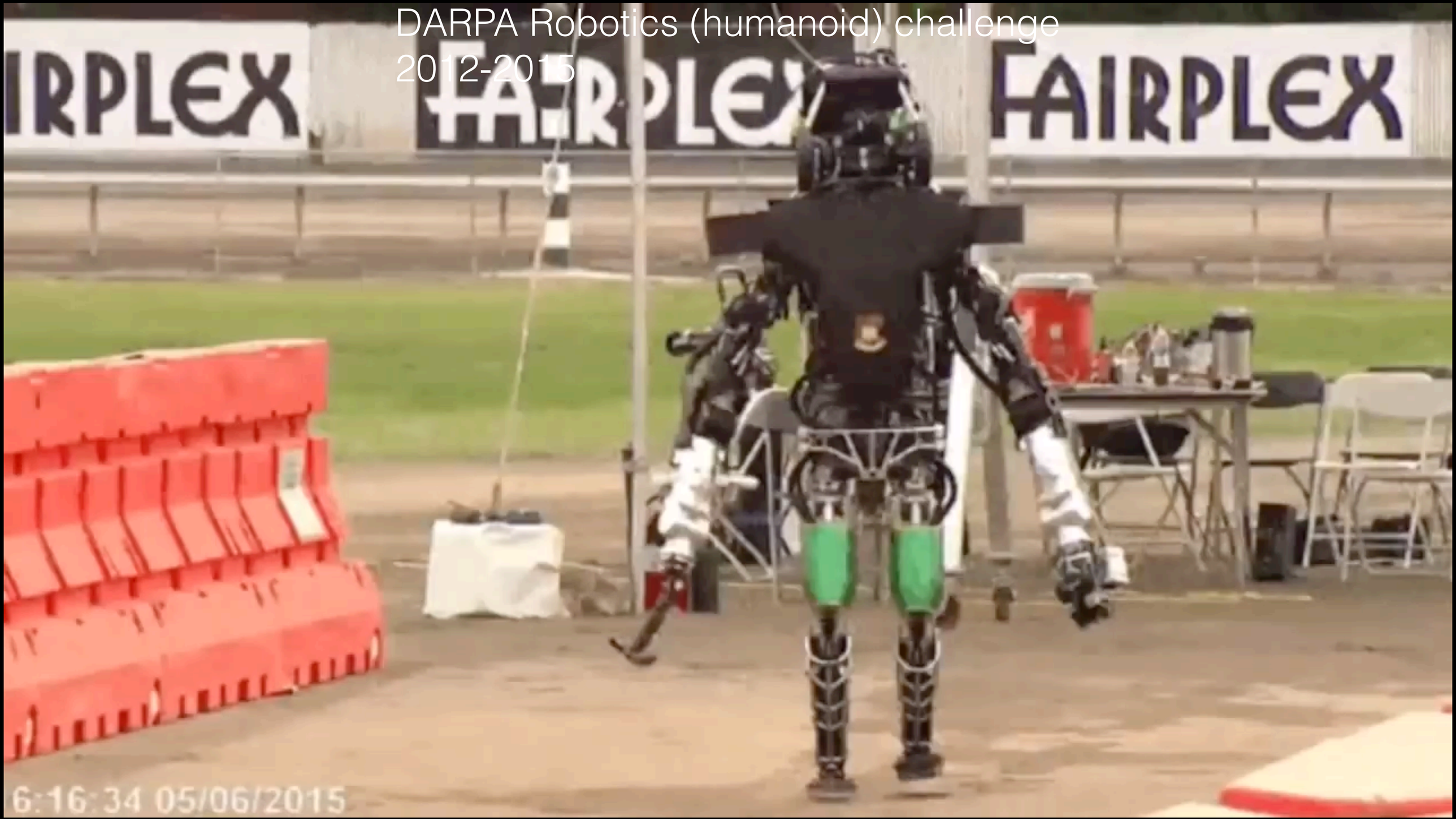


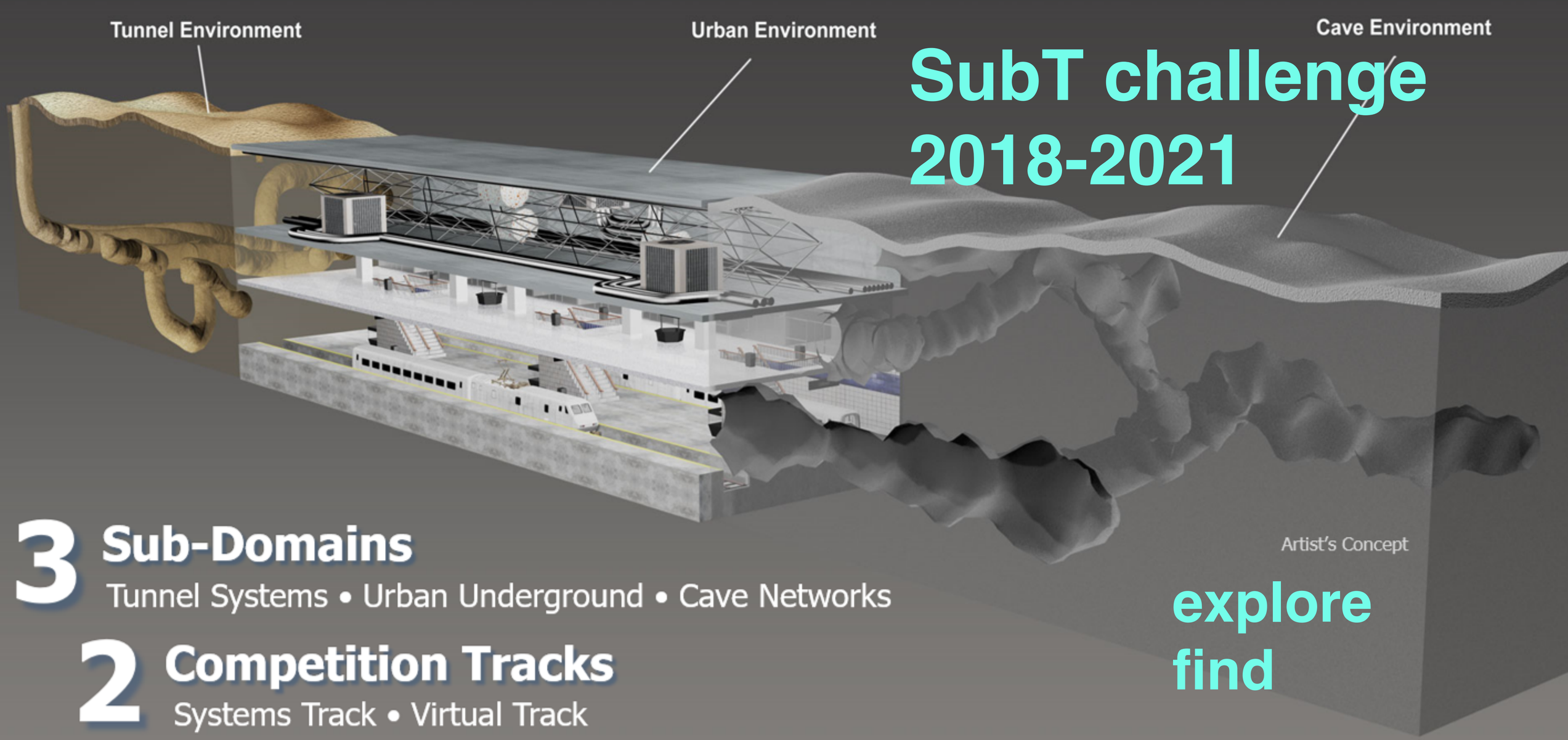
winner CMU with 96km/96km

DARPA Robotics (humanoid) challenge 2012-2015

how did it go?

DARPA Robotics (humanoid) challenge
2012-2015





SubT challenge 2018-2021

Artist's Concept

explore
find

3 Sub-Domains

Tunnel Systems • Urban Underground • Cave Networks

2 Competition Tracks

Systems Track • Virtual Track

1 Revolutionary Vision

Create breakthrough technologies and capabilities for underground operations

Learn More at www.darpa.mil

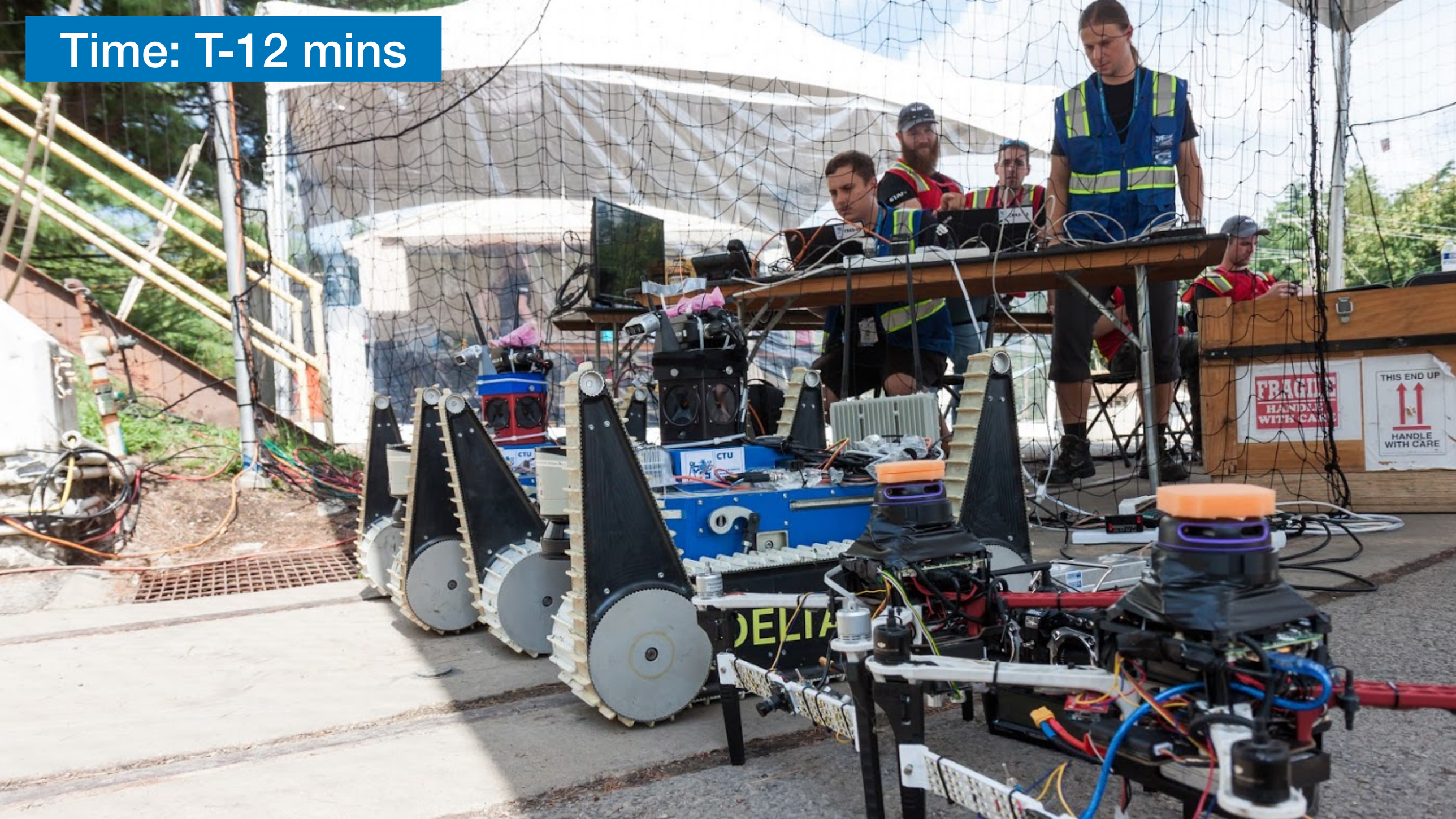
Team of our robots


Time: T-45 mins
CTU-CRAS
TEAM
ECCV16
HARLIE

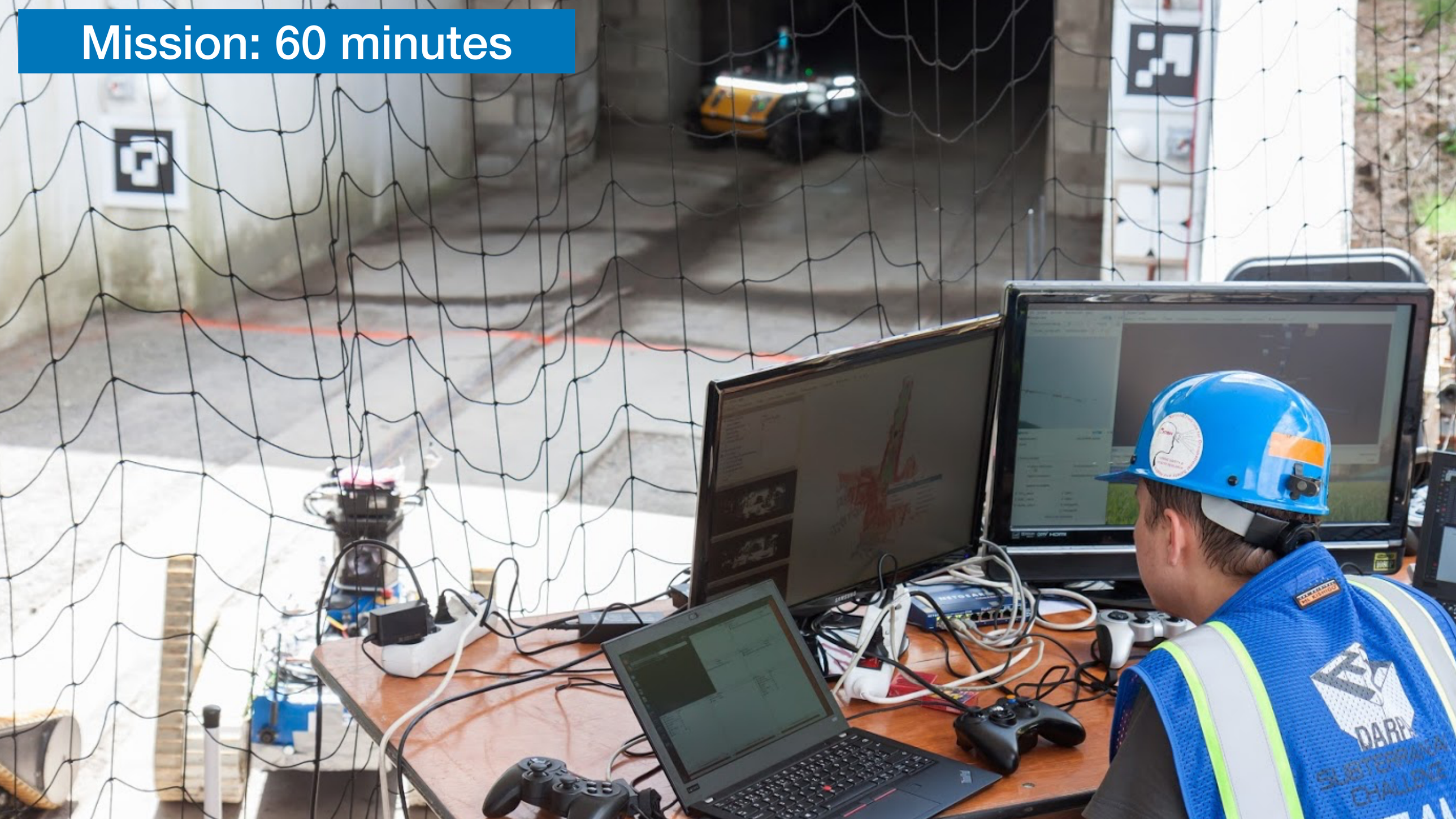

Time: T-35 mins

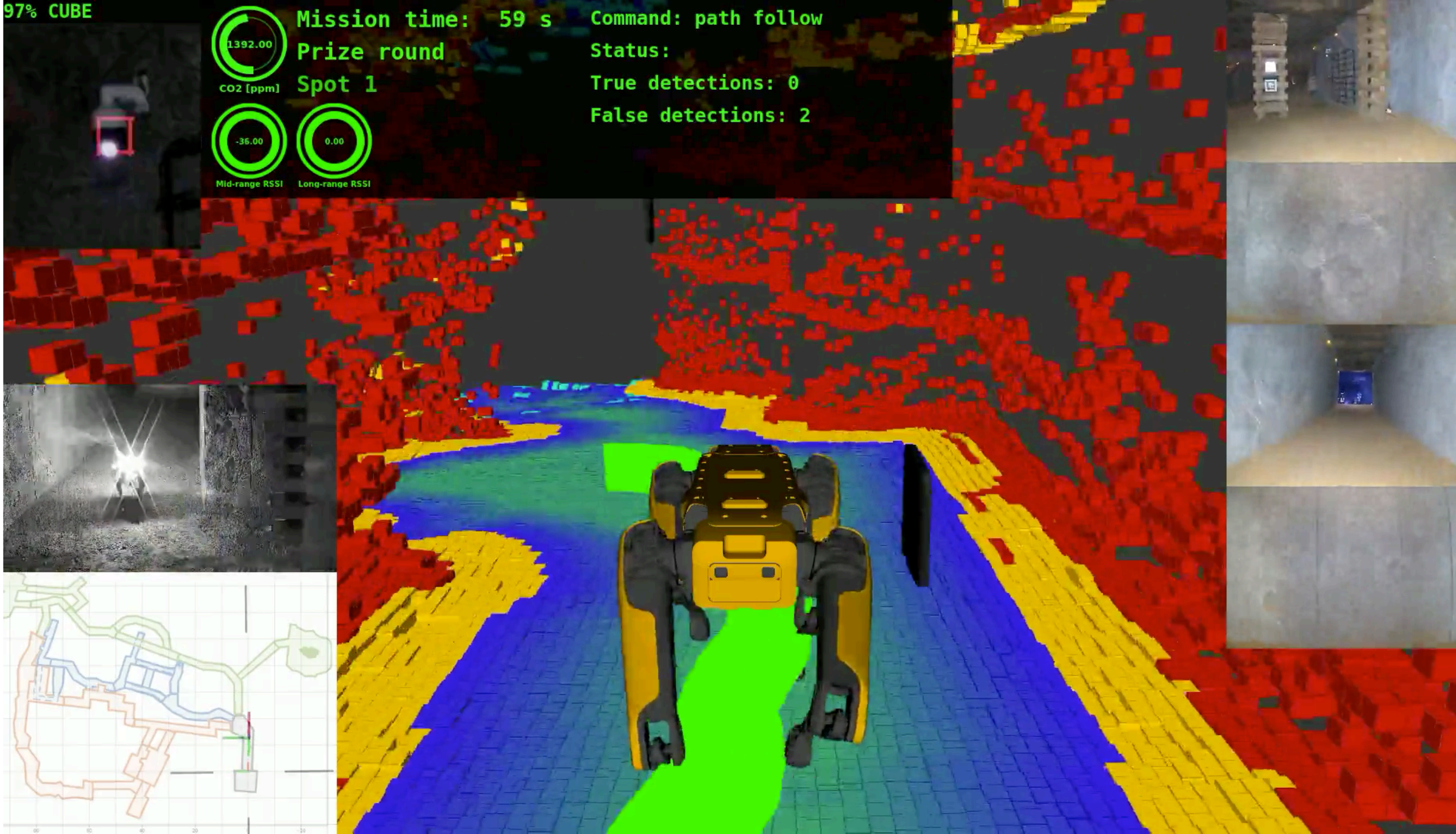

Time: T-30 mins
CTU

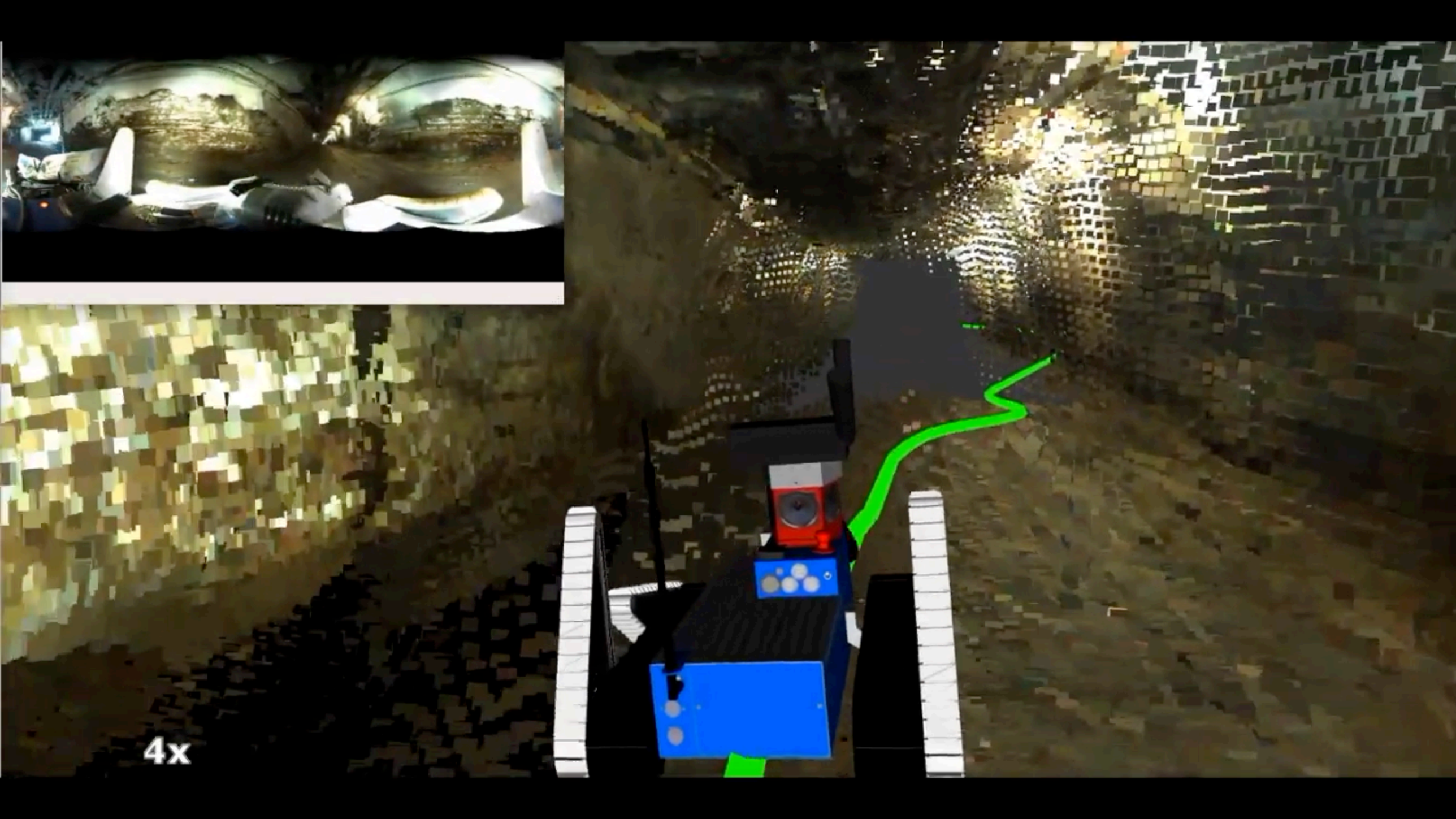

Time: T-15 mins
CRAS-09

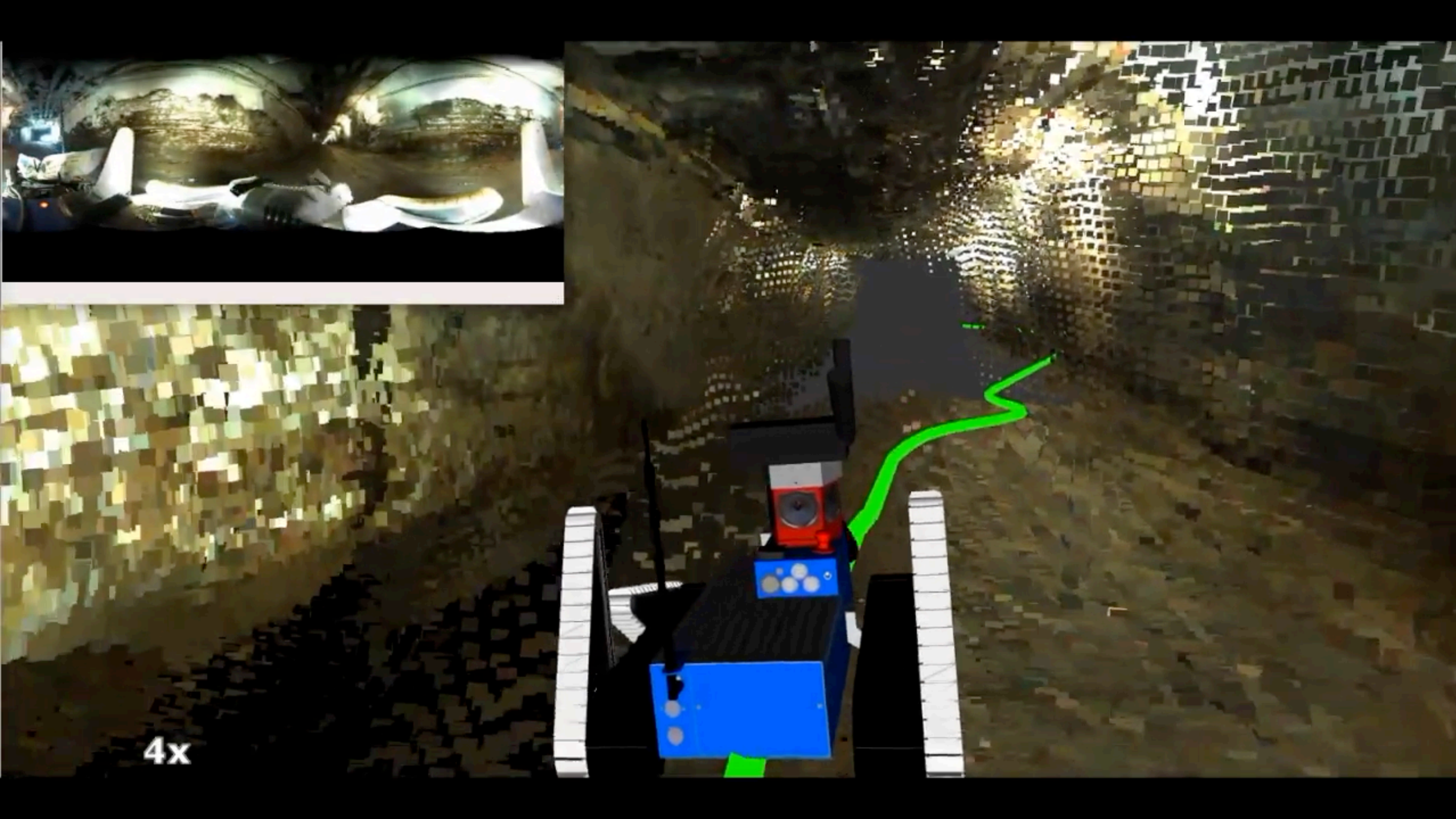

Time: T-12 mins
FRAGILE
HANDLE WITH CARE
THIS END UP
HANDLE WITH CARE
CTU
CTU

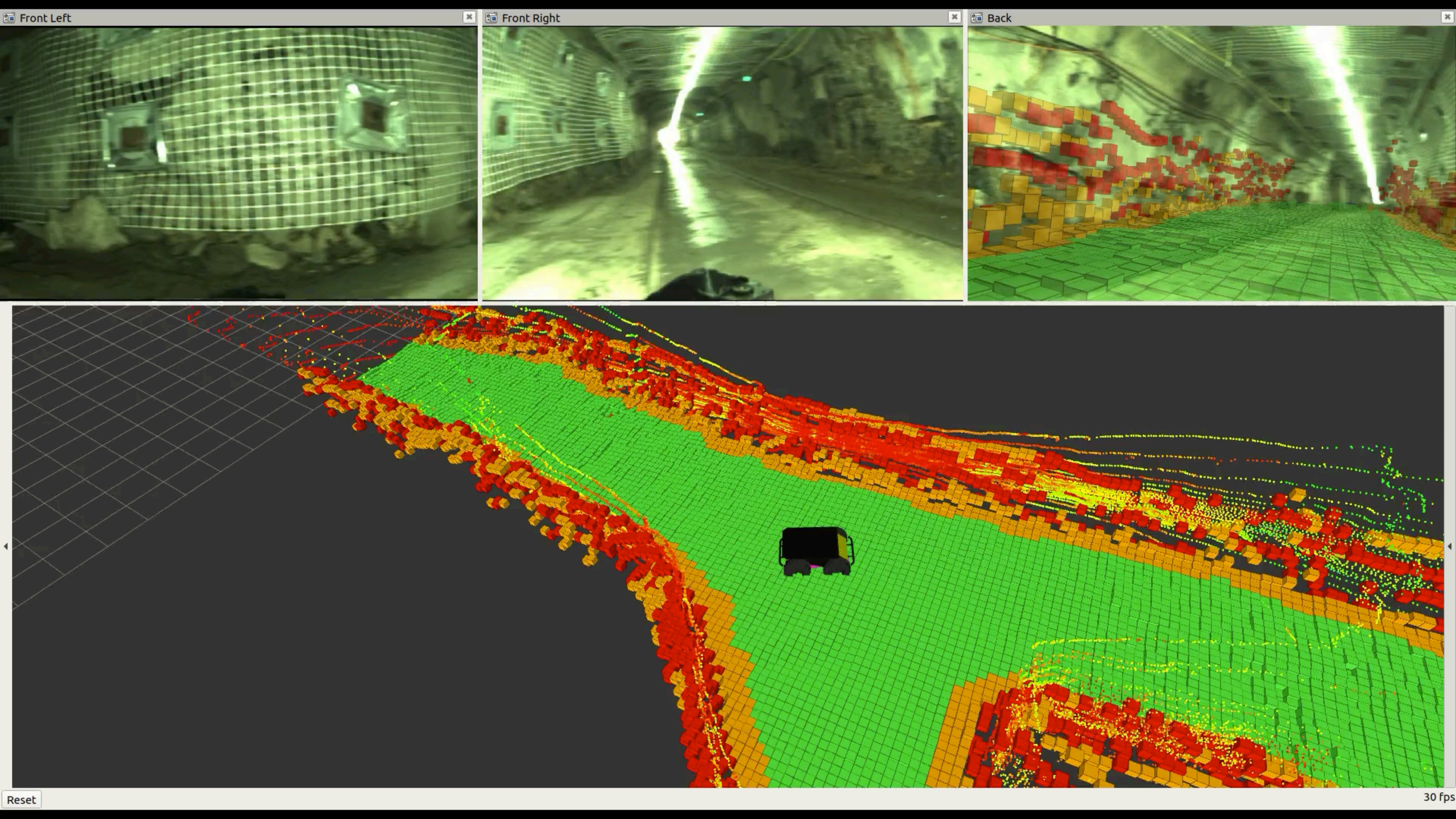
Mission: 60 minutes

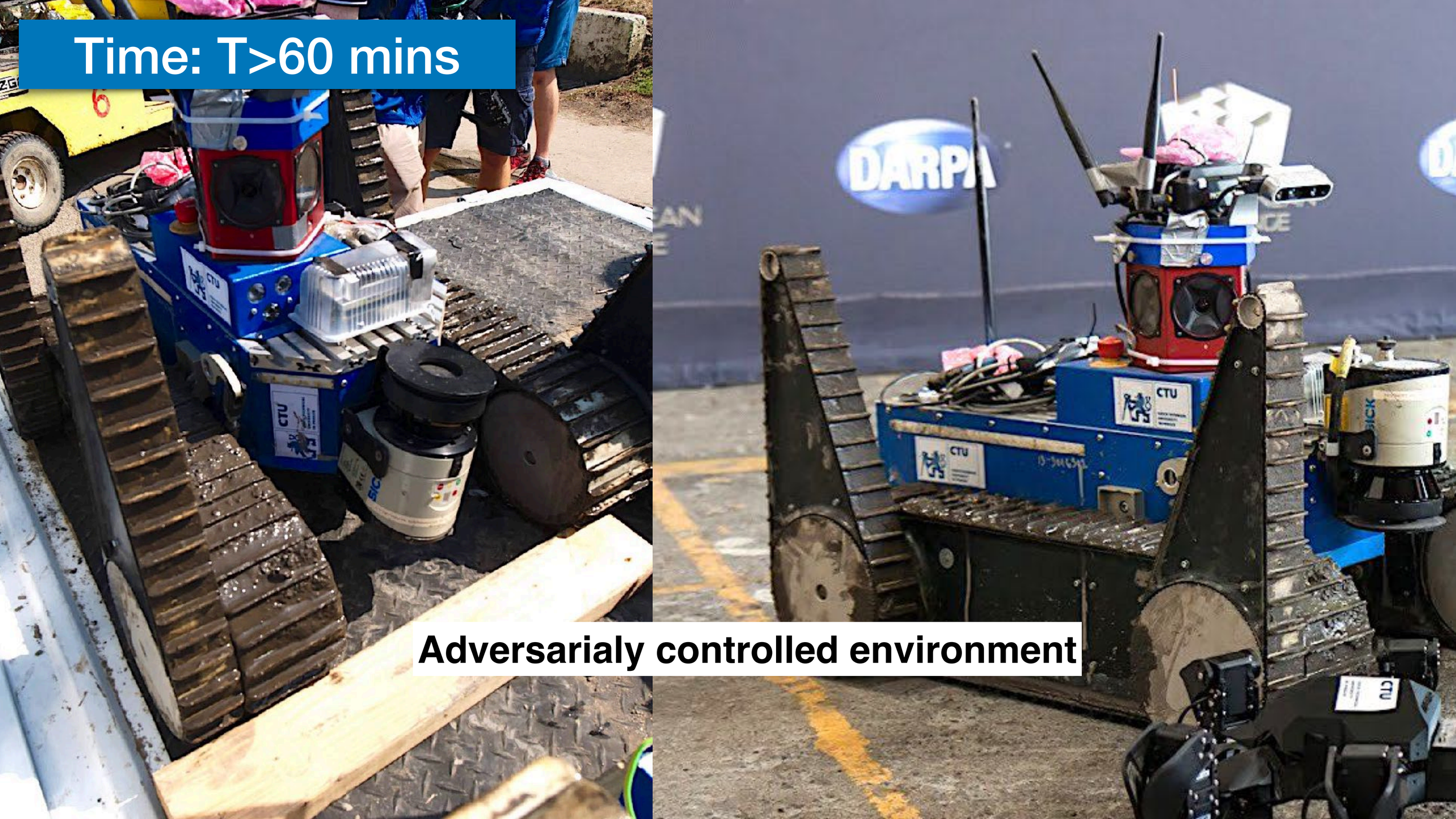



97% CUBE
1392.00
CO2 [ppm]
Mission time: 59 s
Prize round
Spot 1
Command: path follow
Status:
True detections: 0
False detections: 2
-36.00
Mid-range RSSI
0.00
Long-range RSSI


4x


4x


Front Left
Front Right
Back
Reset
30 fps


Time: T>60 mins
DARPA
CTU
Adversarialy controlled environment


DARPA
DARPA
SUBTERRANEAN
CHALLENGE


DARPA
SUBTERRANEAN
CHALLENGE
DARPA
SUBTERRANEAN
CHALLENGE
URBAN CIRCUIT
CTU
DARPA


DARPA
CTU-CRAS-NORLAB
$500,000.00
VIRTUAL COMPETITION WINNER

Outline:

- Who are we and what are we doing?
- What is the Autonomous Robotics course about?
- Course organization

Autonomous robotics course

=

“How we do it”

Mapping & localisation

Autonomous Robotics (KZ lectures)

Husky robot

CTU robot

Planning for exploration

Autonomous Robotics (VV lectures)

Object detection

Not covered (VIR/UROB course)

development, visualization and high-level control

Autonomous Robotics (Labs)

Mapping & localisation

Autonomous Robotics (KZ lectures)

Husky robot

CTU robot

Planning for exploration

Autonomous Robotics (VV lectures)

Object detection

Not covered (VIR/UROB course)

development, visualization and high-level control

Autonomous Robotics (Labs)

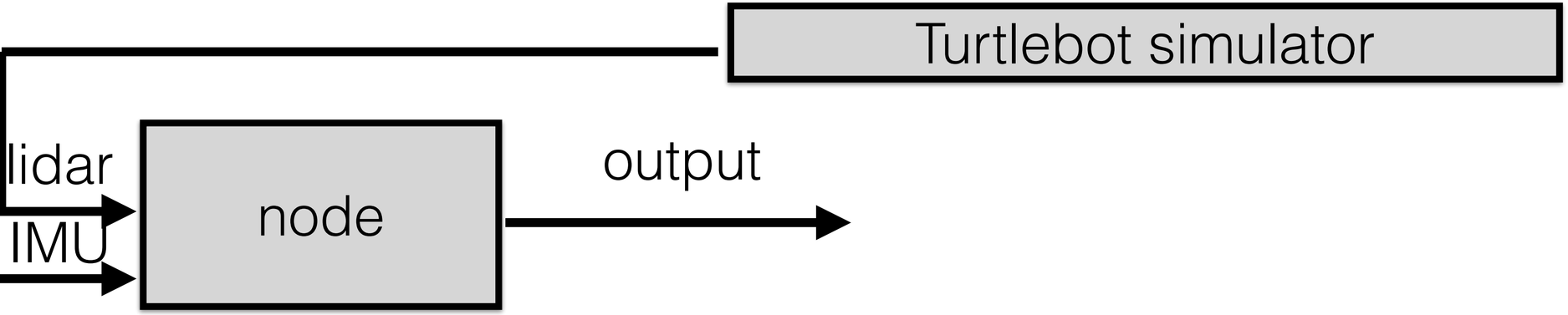
team

Key essence of the victory is relaxed team

- Autonomous robotics course = “How we do it”
- Semestral work=“Autonomous exploration of the unknown environment by Turtlebot”

Outline:

- Who are we and what are we doing?
- What is the Autonomous Robotics course about?
- Course organization

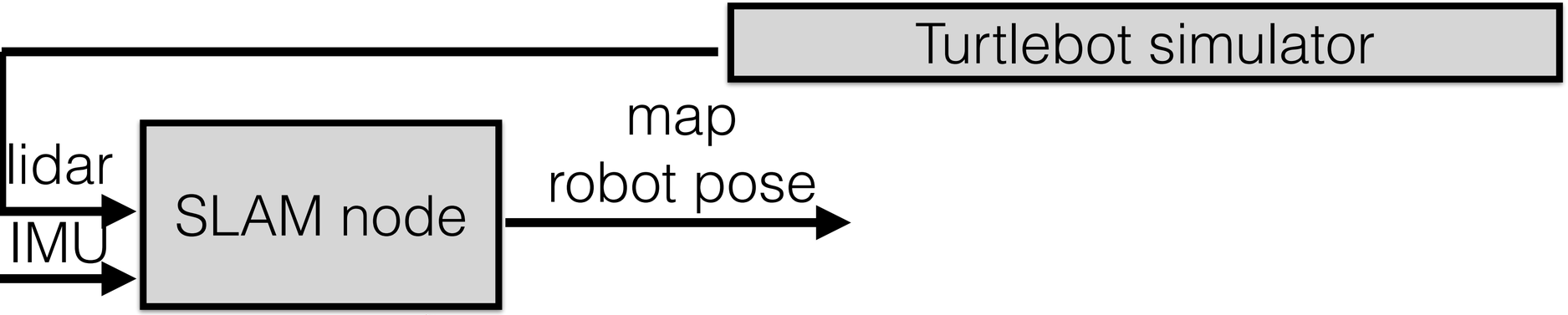


Lectures:

- Simultaneous localisation and mapping (KZ)
- Planning (VV)
- Remaining lectures (not necessary for solving the SW)

Labs:

- ROS
- SLAM from lidar + IMU + markers
- Motion control & Planning
- Semestral work (3 weeks)

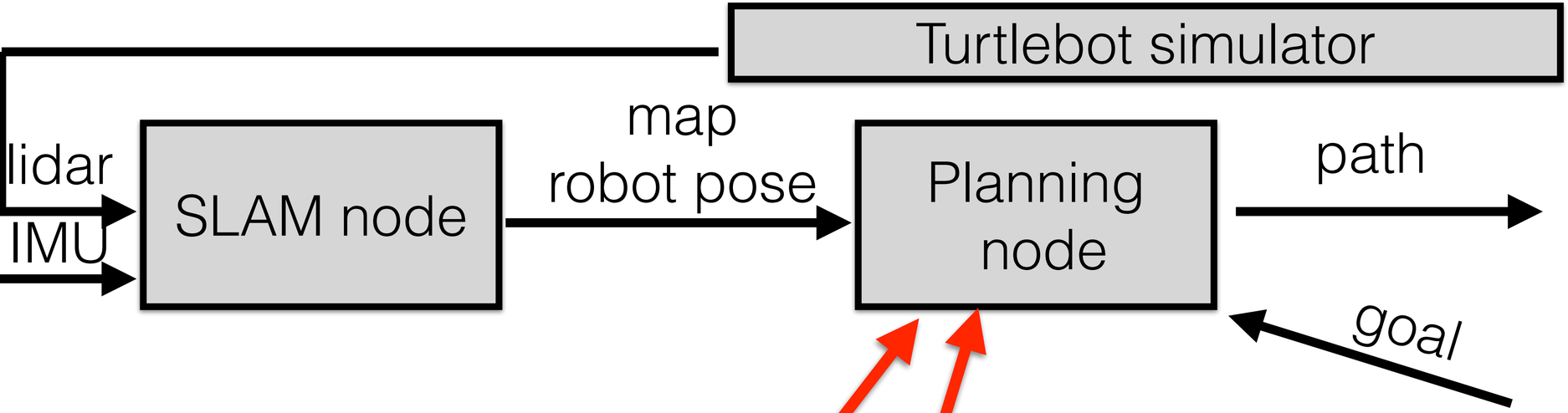


Lectures:

- Simultaneous localisation and mapping (KZ)
- Planning (VV)
- Remaining lectures (not necessary for solving the SW)

Labs:

- ROS
- SLAM from lidar + IMU + markers
- Motion control & Planning
- Semestral work (3 weeks)

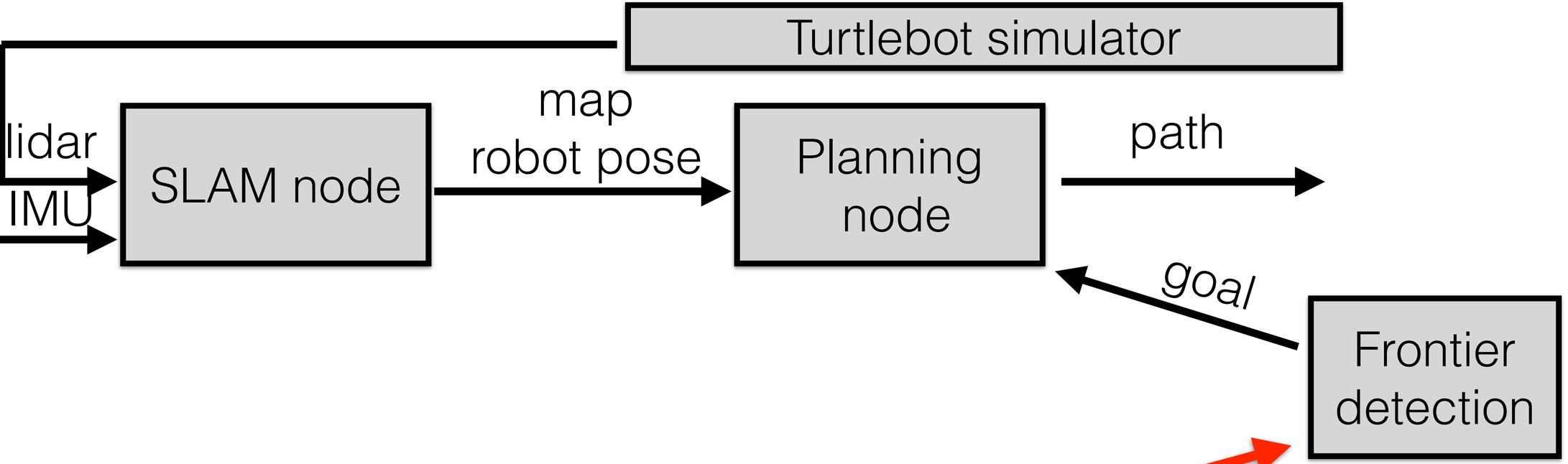


Lectures:

- Simultaneous localisation and mapping (KZ)
- Planning (VV)
- Remaining lectures (not necessary for solving the SW)

Labs:

- ROS
- SLAM from lidar + IMU + markers
- Motion control & Planning
- Semestral work (3 weeks)

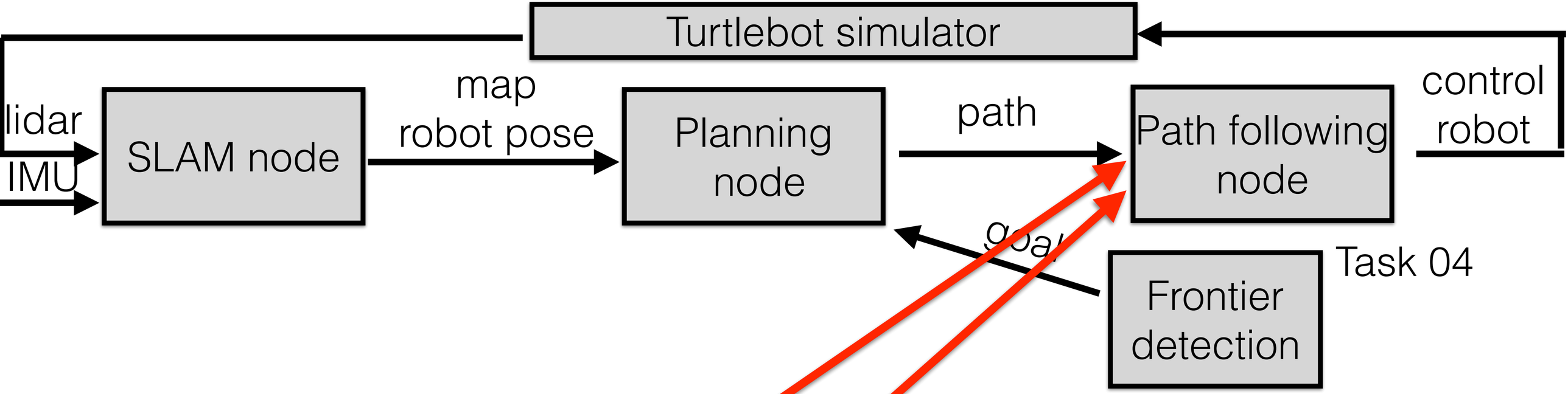


Lectures:

- Simultaneous localisation and mapping (KZ)
- Planning (VV)
- Remaining lectures (not necessary for solving the SW)

Labs:

- ROS
- SLAM from lidar + IMU + markers
- Motion control & Planning
- Semestral work (3 weeks)

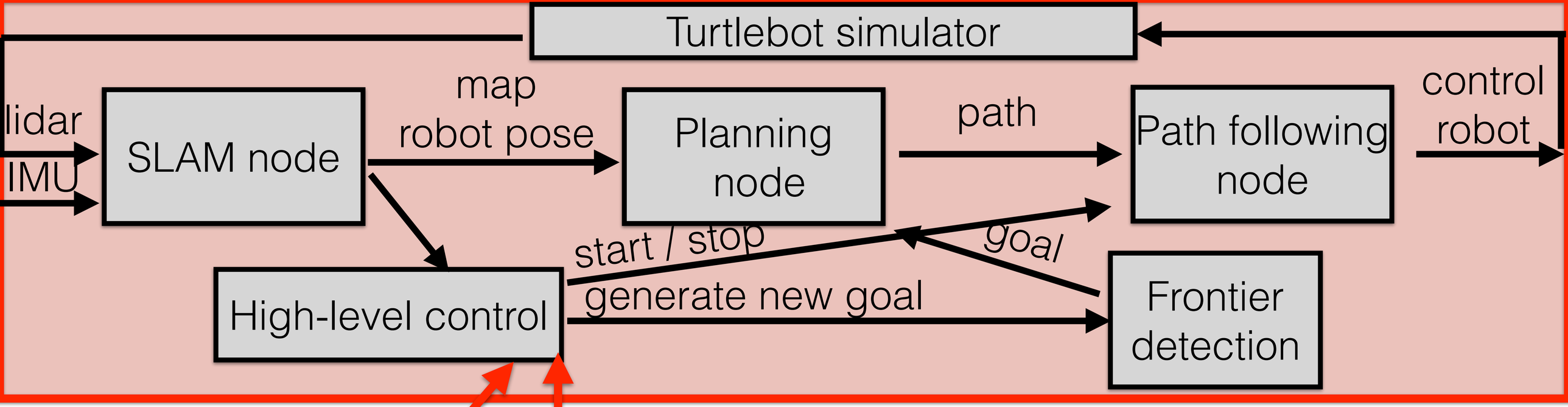


Lectures:

- Simultaneous localisation and mapping (KZ)
- Planning (VV)
- Remaining lectures (not necessary for solving the SW)

Labs:

- ROS
- SLAM from lidar + IMU + markers
- Motion control & Planning
- Semestral work (3 weeks)

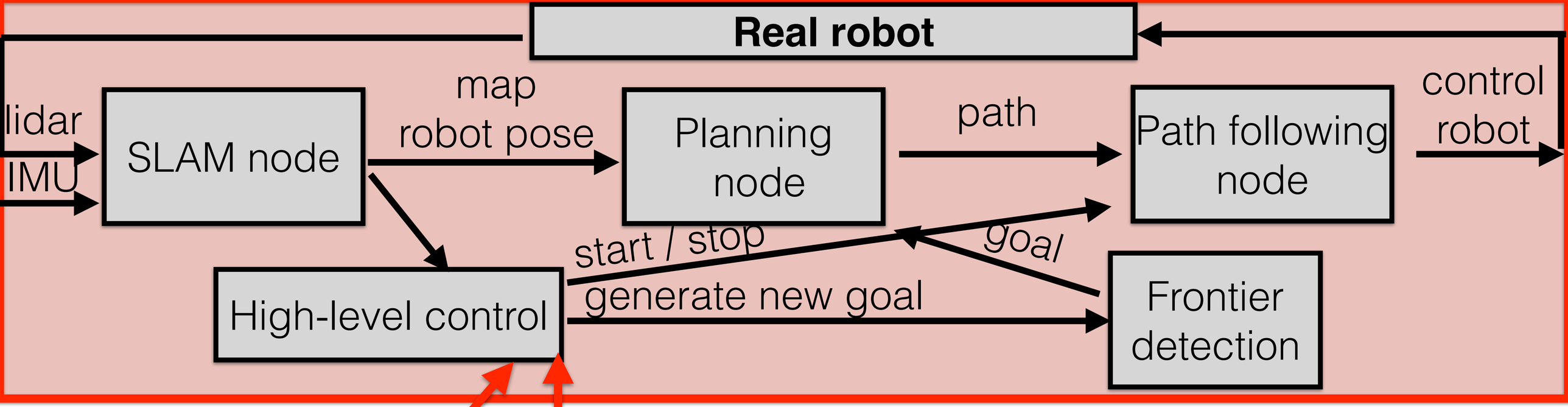


Lectures:

- Simultaneous localisation and mapping (KZ)
- Planning (VV)
- Remaining lectures (not necessary for solving the SW)

Labs:

- ROS
- SLAM from lidar + IMU + markers
- Motion control & Planning
- Semestral work (3 weeks)



Lectures:

- Simultaneous localisation and mapping (KZ)
- Planning (VV)
- Remaining lectures (not necessary for solving the SW)

Labs:

- ROS
- SLAM from lidar + IMU + markers
- Motion control & Planning
- Semestral work (3 weeks)

Outline

Max 100 points

- 30p from homeworks
- 20p from semestral work (10p simulation + 10p real robots)
- 50p points from exam test

Final grade determined by the number of achieved points:

No of points	Exam assessment
0-49	F
50- 59	E
60-69	D
70-79	C
80-89	B
90-100	A

Minimum credit requirements:

- submit own solution of all HWs + SW
- explore at least 50% of map in SW
- active participation in regular labs