Naturwissenschaftliche Geographie und Geoinformatik im Fokus

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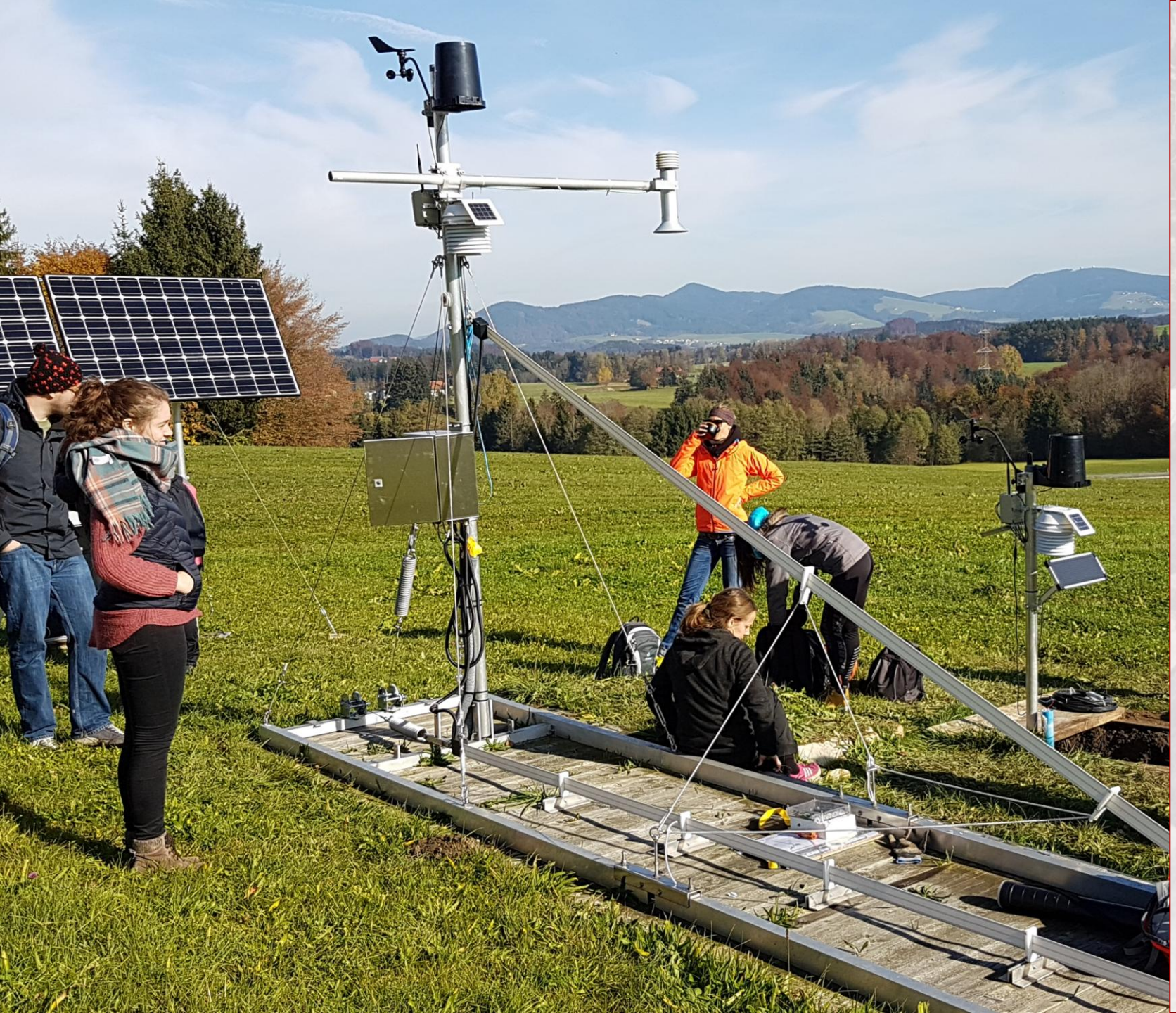
Studieneingangs- und Orientierungsphase (STEOP) ★ Date: 09.10.2025 ★ Time: 13:00 – 14:30 ★ PH Linz, AH01



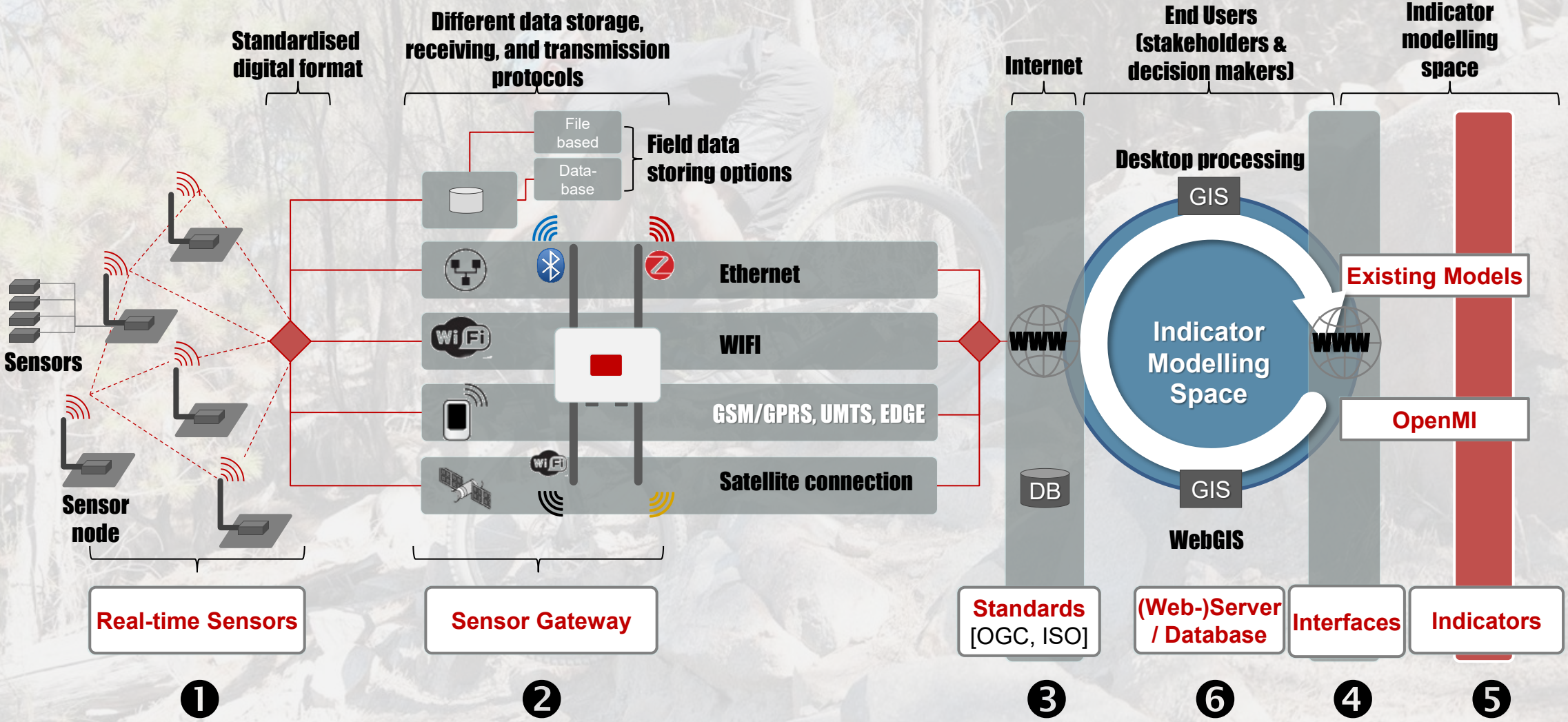
THE LANDSCAPE LAB

- Real-time Environmental Monitoring and Modelling
- Holistic-Integrated Approach
- Transdisciplinary Assessment

THE LANDSCAPE LAB

- Hydrological forecasting and modelling
- Nutrient applications and emissions to surface waterbodies
- Phosphorous as limiting element
- Heavy rainfall events

FROM SENSORS TO INFORMATION



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FROM SENSORS TO INFORMATION

Integrated transformation process from data capturing towards the generation of information and provision of knowledge for spatio-temporal decision support!

Standardised digital format

Different data storage, receiving, and transmission protocols

File based

Data-base

Field data storing options

Internet

End Users (stakeholders & decision makers)

Indicator modelling space

Desktop processing

GIS

WebGIS

Sensor node

Real-time Sensors

Sensor Gateway

Standards [OGC, ISO]

(Web-)Server / Database

Interfaces

Indicators

1 2 3 6 4 5

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Umweltbeobachtung – Messen mit Sensoren im Landschaftslabor

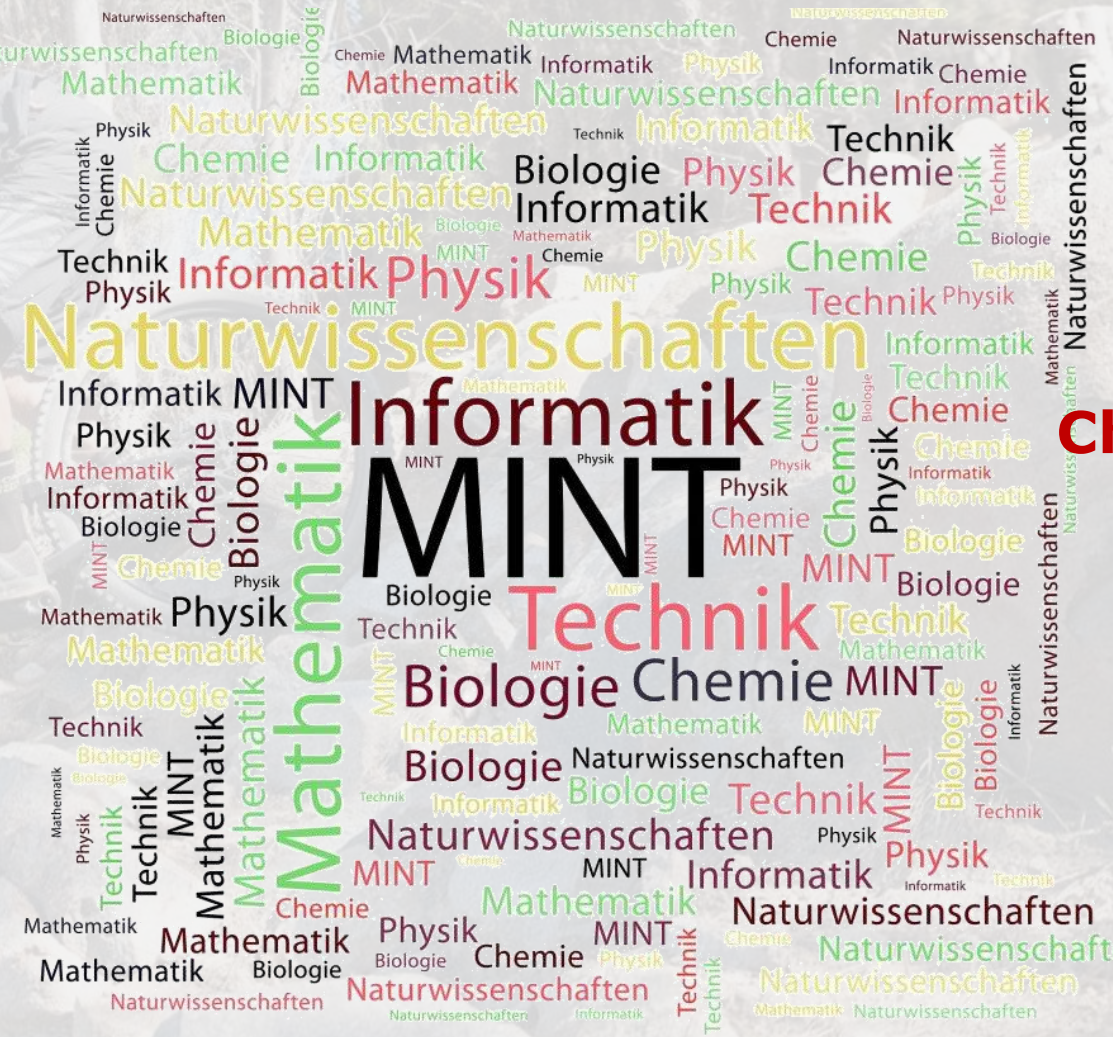
PROPÄDEUTIKUM …

… zur Vorbereitung auf die naturwissenschaftliche Geographie (Propädeutikum im 1. Studienjahr) am Standort Linz

Mathematik

Biologie und Umweltkunde

Physik



Chemie

Physische Geographie

URL: https://gwb.schule.at/course/view.php?id=2053

WAS ERWARTET EUCH IN DER VU "NATURWISSENSCHAFTLICHE GEOGRAPHIE"

- Link zur Lernplattform, Link zu PLUS Online
- Start: Donnerstag 05.03.2026 | 10 Termine |
  pro Termin drei Einheiten zu je 90 Minuten
- Prüfungen: 10./11.06.2026 (mündlich, 15 min Takt)

URL Moodle: https://gwb.schule.at/course/index.php?categoryid=23, URL PLUS: https://online.uni-salzburg.at/plus_online/pl/ui/$ctx/wbLv.wbShowLVDetail?pStpSpNr=688412

DACHSTEINEXKURSION

- Link zur Lernplattform, Link zu PLUS Online
- Gruppe 1: Mo - Mi 01.-03.06.2026
- Gruppe 2: Mi - Fr 03.-05.06.2026

- https://dachsteingletscher.info/
- www.klimawandelanpassung.at/nl50/kwa-gletscherschmelze

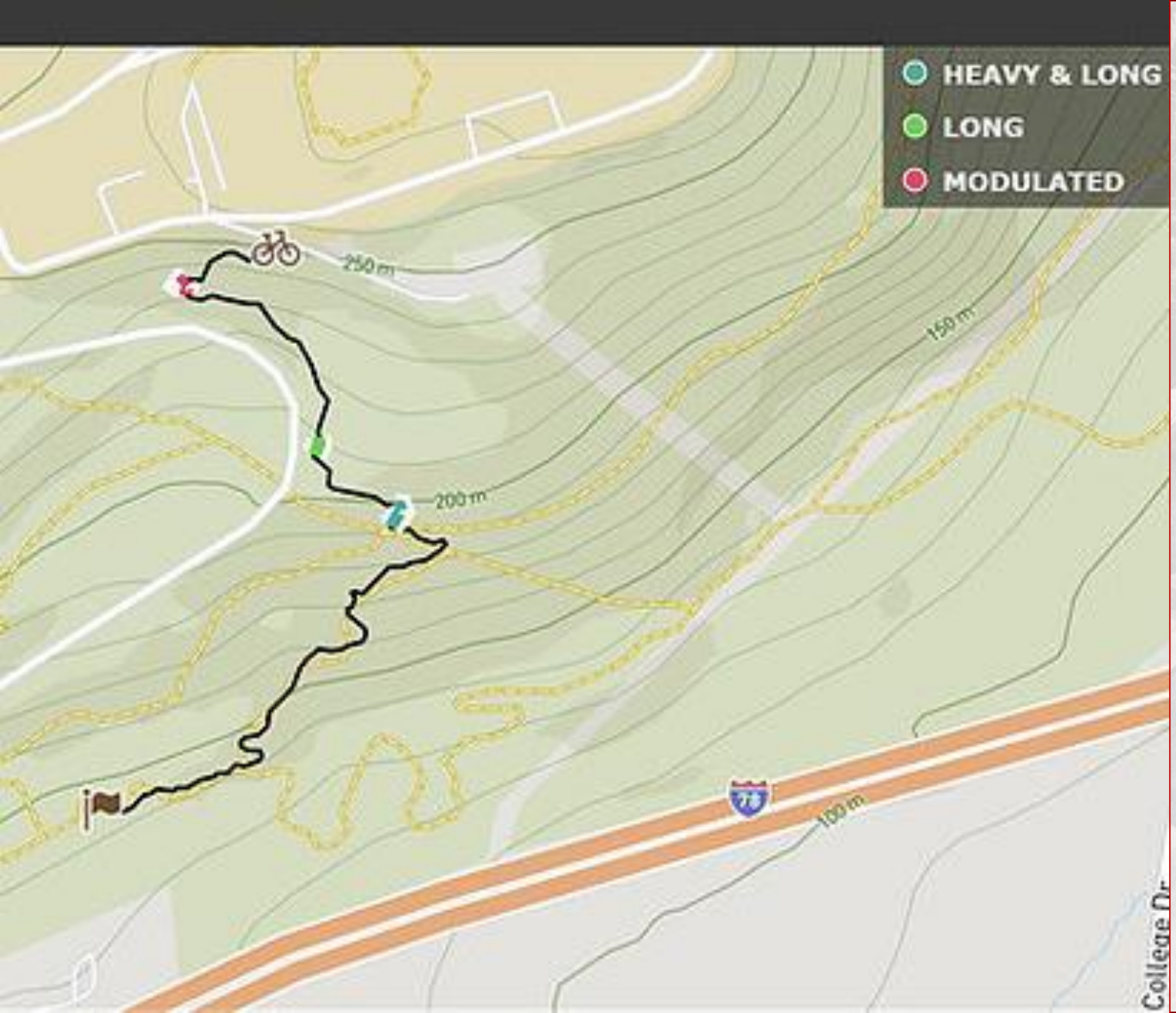
EXKURSION KOPPL

- Link zur Lernplattform, Link zu PLUS Online
- Mo.-Mi. 13.-15.07.2026 & 15.-17.07.2026

http://www.riedlwirt.at/_Resources/Persistent/9747fcd8efca2c49046eea55b2a18e7e5f82b216/Riedlwirt-Sommer-Pano-1778x787.jpg

WHERE MTB MEETS GEOGRAPHY AND GEOINFORMATICS

- Mountainbike trails vary in slope structure and difficulty
- A visual inspection of the track is happening before a race



INTRODUCTION

- Racetrack inspection with track recording based on X/Y/Z coordinates via GNSS systems (Global Navigation Satellite System → GPS, Galileo, GLONASS, Beidou)
- Garmin or similar devices do not record the track in good (cm) spatial accuracy

COMPLEX TERRAIN ANALYSIS

- Track underground information is important to understand riding behaviour and performance of athletes
- (Automated) solution for DEM generation of the track in cm resolution required
  - Drone
  - Stereo camera
  - LiDAR

METHODS

Track Capturing

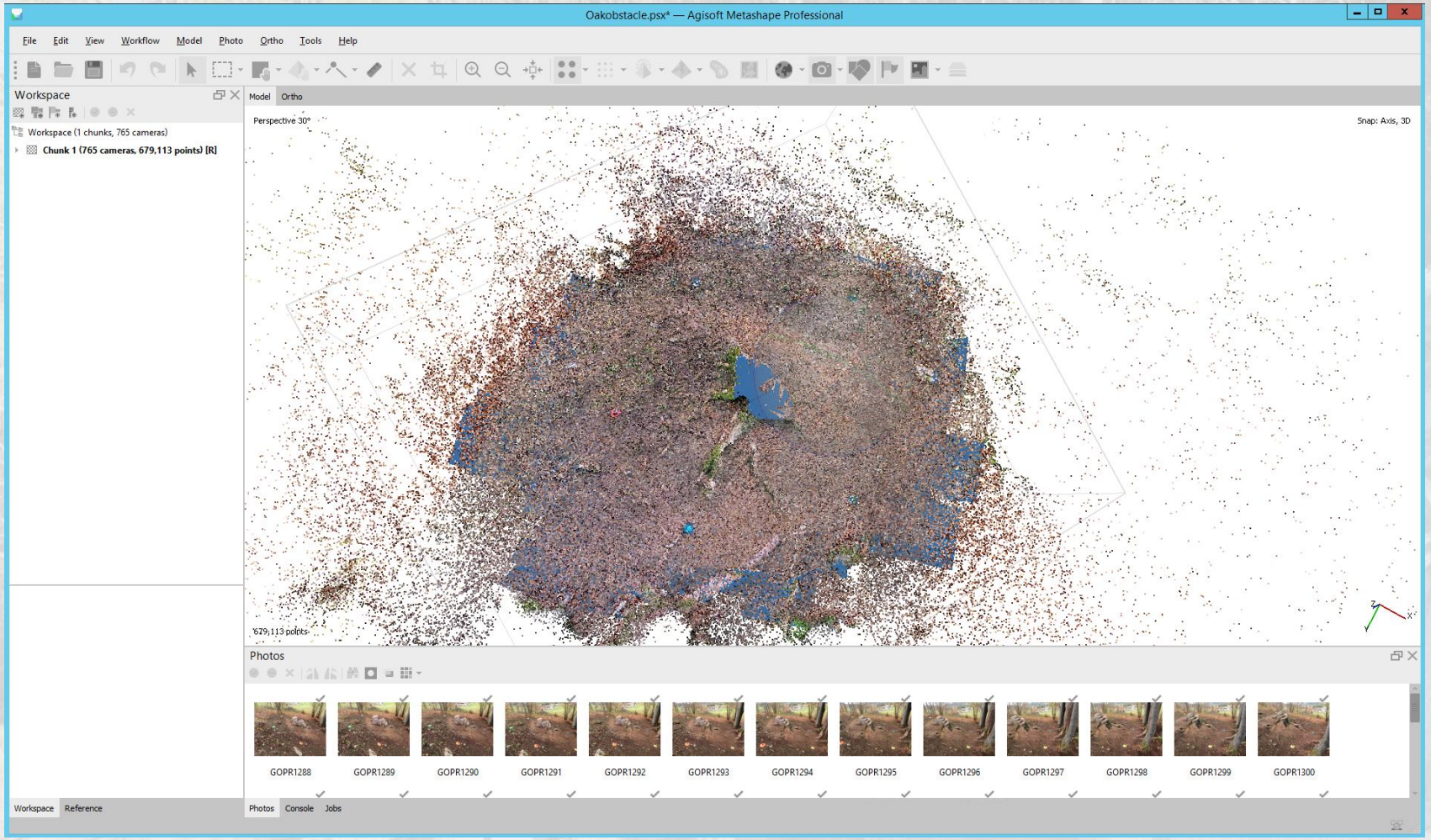
- Measuring wheel in parallel to Garmin Edge 830 or 1030 and a differential GPS
- GoPro Hero 9 mounting bracket including horizontal and vertical level for stereoscopic capturing of 2m wide track

OBJECT ANALYSIS

Object Capturing using pictures & video

- Take single pictures with GoPro Hero 9
  - 60% of side overlap
  - 80% of forward overlap
- GoPro 4K 60 frames per second video

OBJECT PROCESSING



Analysis with Agisoft

- building dense point cloud
- building mesh (3D polygonal model)
- generating texture
- building tiled model
- building digital elevation model (DEM)
- building orthomosaic
- exporting results












VIRTUALISING PRACTICAL EXERCISES

RIDING CONDITIONS

- Wheel size
- frame size
- Body motion
- Bike axis

https://www.mountainbikers.at/pumptrack

PUMPTRACK ANALYSIS

- A pump track is a round course consisting of ups and downs
- An asphalt pump track can be used with rollers, inliners, bikes, and skateboards
- A pump track planning requires a correct allocation of tables, valleys and peaks in respective distance to each other

Area incl. surroundings: 1000 m²
Inner pump track area: 650 m²
Total sealed area: 420 m²
Riding length: 156 m
Track width: 1,5 m

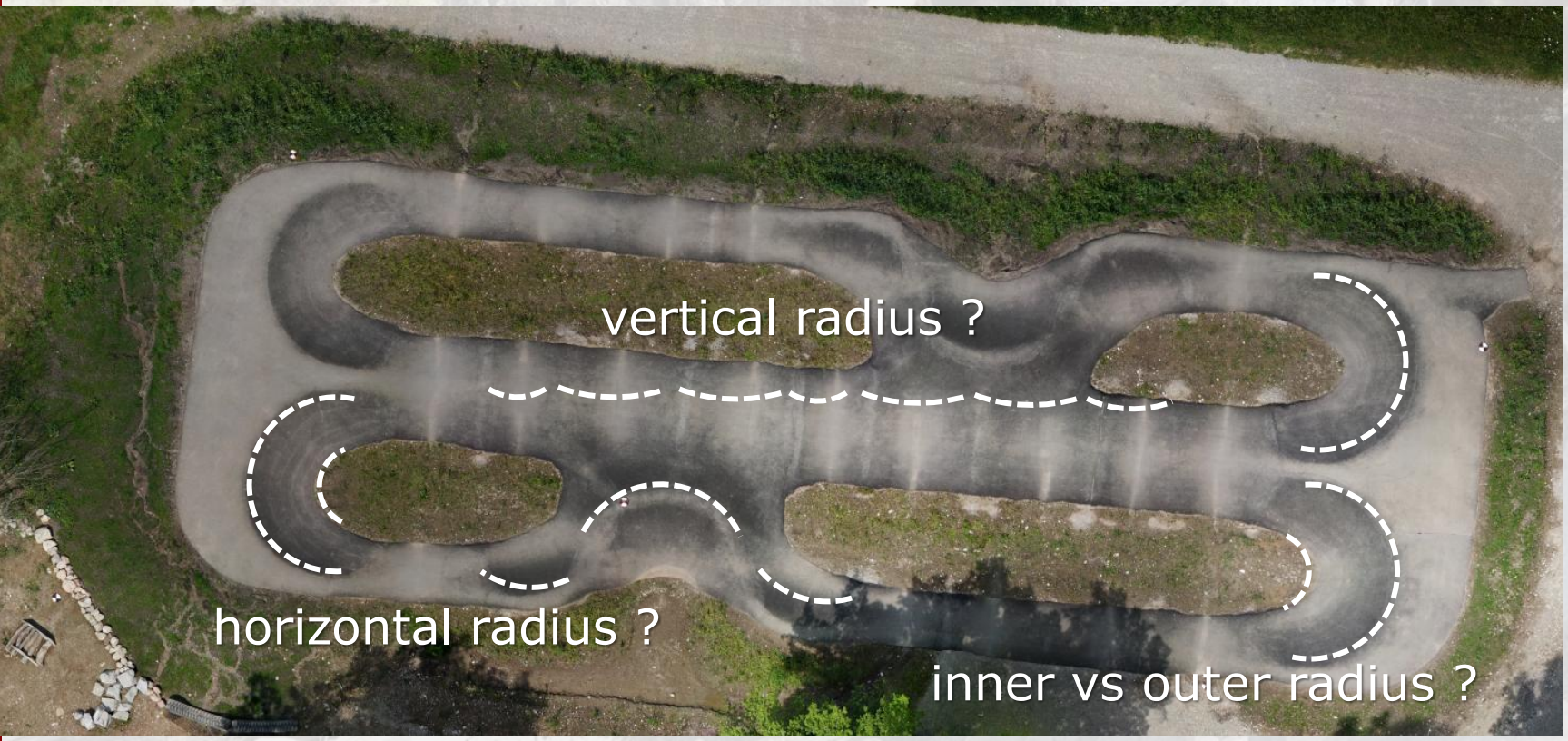
QUESTIONS

- What is the surface sealed area measured in 2D versus 3D?
- If 10 cm of asphalt is used for the pump track design; what is the total volume of asphalt needed to build up the pump track?
- Knowing the unit costs of asphalt, what are the costs associated with the asphalt?

QUESTIONS

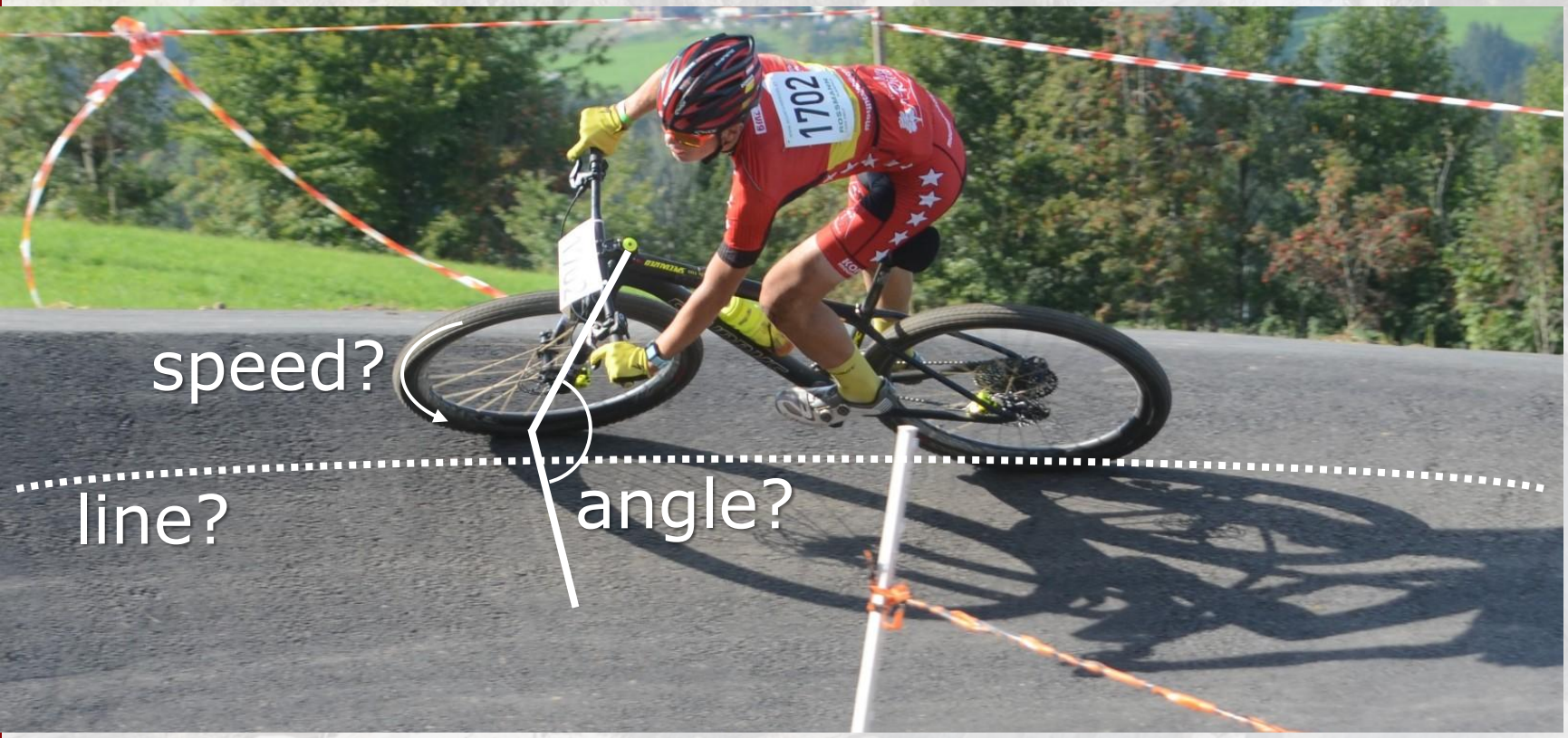
- Hypothesis: Spatial relations matter in pump track design!
- What is the distance between valleys and peaks?
- How are the distances changing with the relative height of a wave?
- Is there a particular relation between distance and height?
- Are there deviations from this relation on the build pump track in Koppl?
- Has the pump track been built according to the plan?

QUESTIONS



- Hypothesis: Spatial relations matter in pump track design
- What are the horizontal and vertical radiuses applied to the pump track? Are they all the same or do they vary among each other?

QUESTIONS



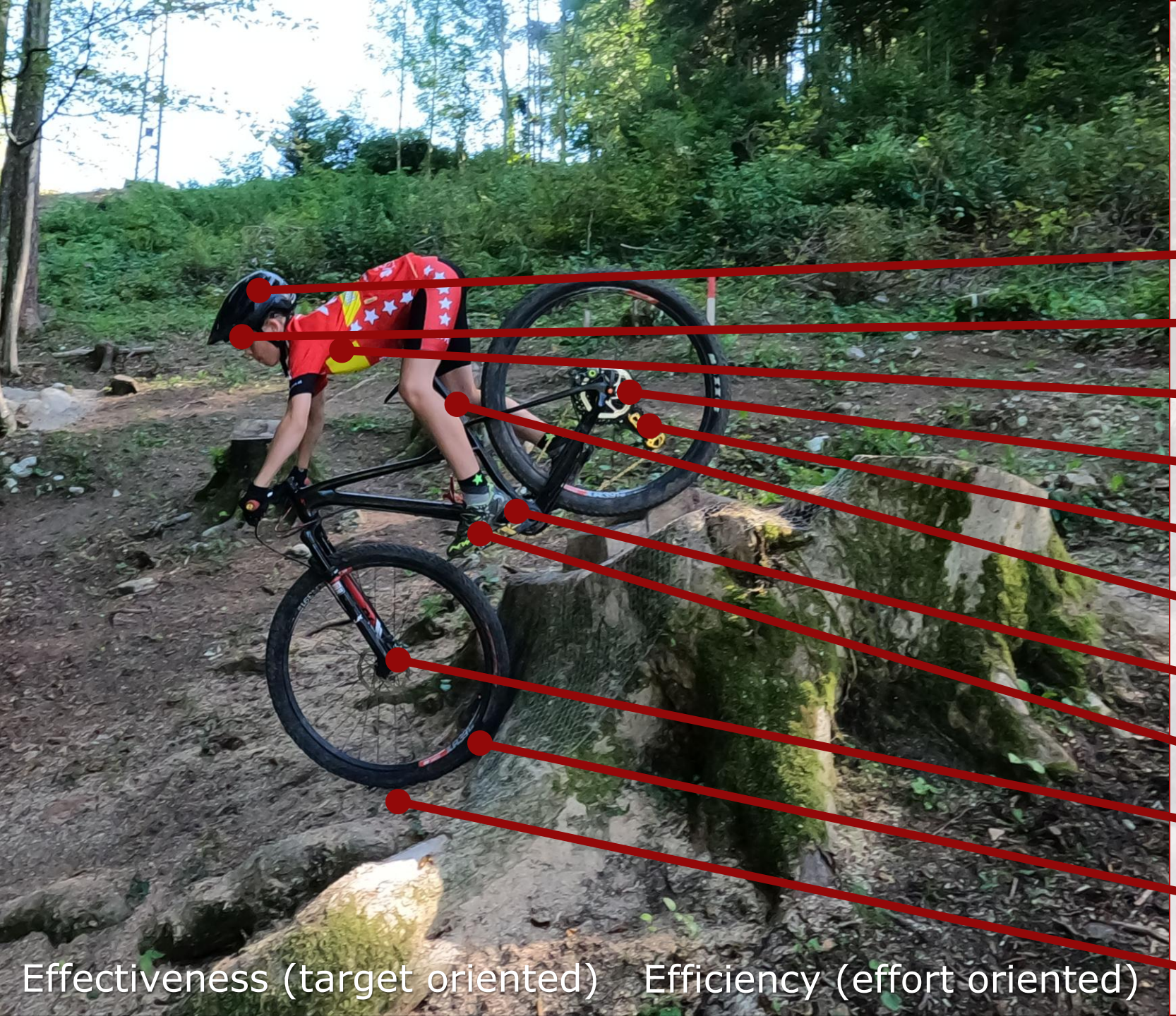
- Hypothesis: The ideal riding line is dependent on bike wheel size (e.g., 29"), speed, curvature, bike angle to underground and can be automatically retrieved from the digital elevation model (DEM)
- What is the ideal riding line on the pump track?

OBJECTIVES

- To trace riders during their exercise from back and/or side
- To correlate motion video with Digital Elevation Model created
- To analyse and classify underground structure and materials (rock, roots, gras/plants, gravel, concrete, asphalt)

DRONE & GOPRO

- Drone: To compare body movements with sensor data
- Action Cam: Front wheel track recording to be analysed with brain waves and braking behaviours



STOP GUESSING YOUR RIDING PERFORMANCE

- Mental strength
- Eye tracking
- Heart rate/body movement
- Braking performance
- Gear used
- Seat post position
- Cadence
- Power
- Speed
- Tyre pressure
- Location awareness

Effectiveness (target oriented) Efficiency (effort oriented)

CONNECTED SENSORS

Cadence (Ant+)

Speed (Ant+)

Powermeter (bluetooth)

Gear (bluetooth)

Bluetooth®

Wi Fi

ANT+

SMART glases

Seatpost (bluetooth)

Brain Sensors (WiFi)

Tyre pressure (Ant+)

GoPro (none)

BioHarness (bluetooth)

Brake Ace (tbd, data logger)

Heart rate (Ant+)

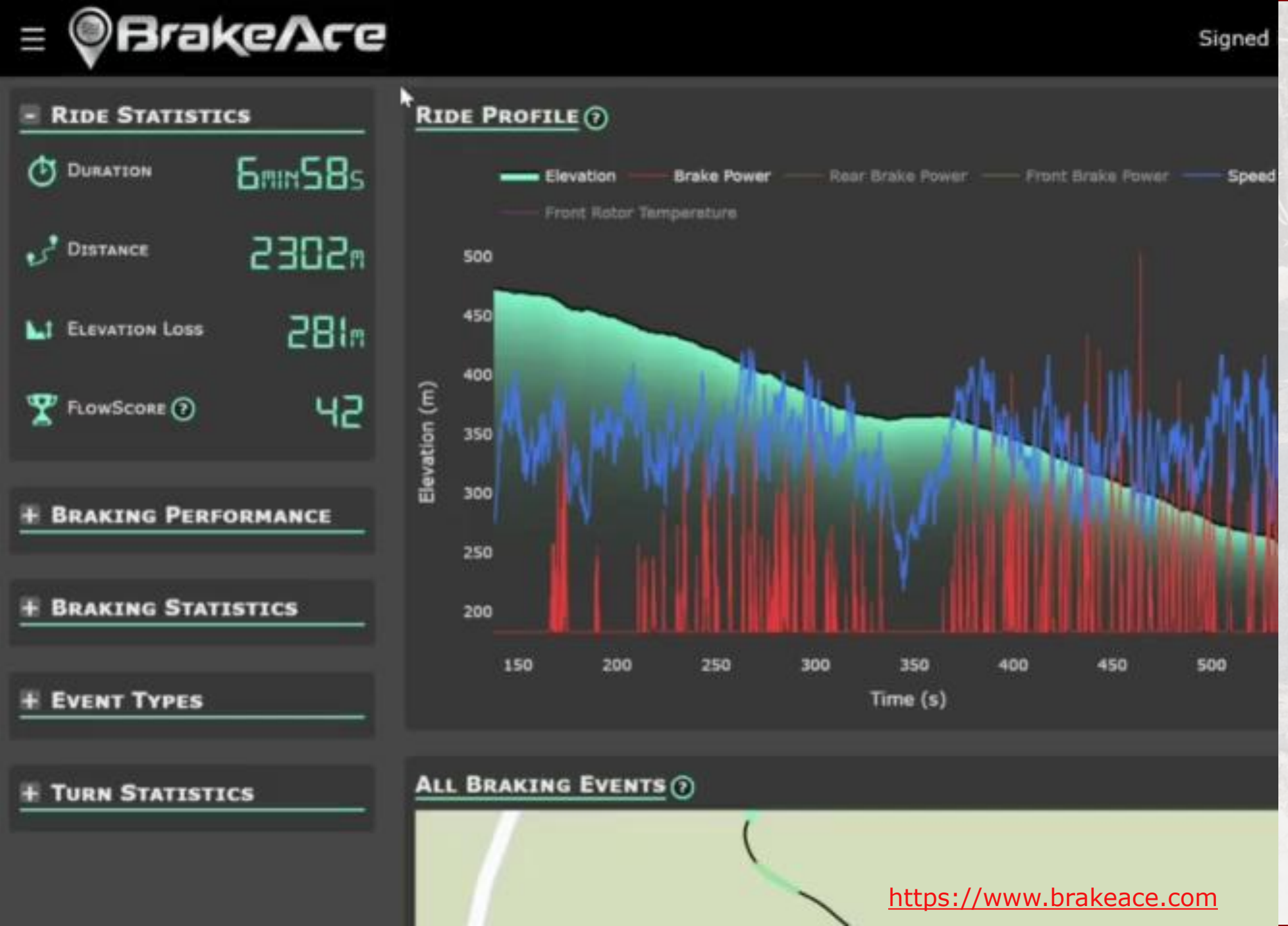
- To analyse sensor specific information spatially explicit
- To compare different riding attempts on a track among one and many athletes

Wireless version (BLE)

BRAKE ACE

- Use of front/rear tyre
- Duration
- Strength (Watt)
- Location (GNSS)

https://www.brakeace.com



BRAKE ACE

- Elevation, Brake power, Speed
- Position on track
- Braking events
- Stats: events, time, Strength

https://www.brakeace.com

BRAKE POWER METER

Chewbacca Trail, Arapuke Forest
New Zealand

https://www.brakeace.com

GOPRO

BODY SENSORS

BioHarness measuring heart rate, movements alongside the three axis at a certain location with a certain speed on a particular underground or obstacle.

HEAD SENSORS

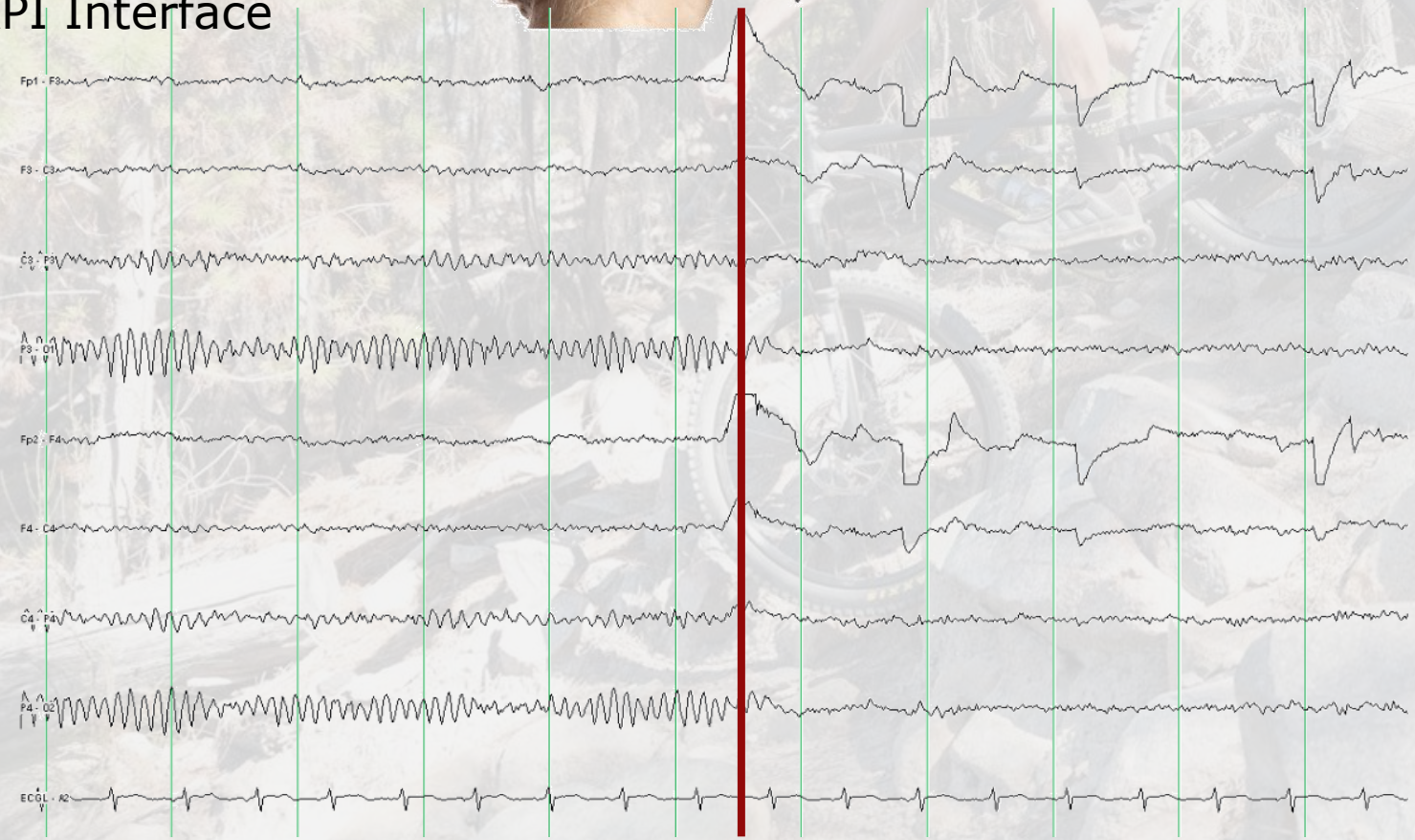
- Stress (FRU)
- Engagement (ENG)
- Interest (VAL)
- Excitement (EXC)
- Focus (FOC)
- Relaxation (MED)

Nautils Cap with
8 sensors

Transmitter

WiFi based receiver

API Interface

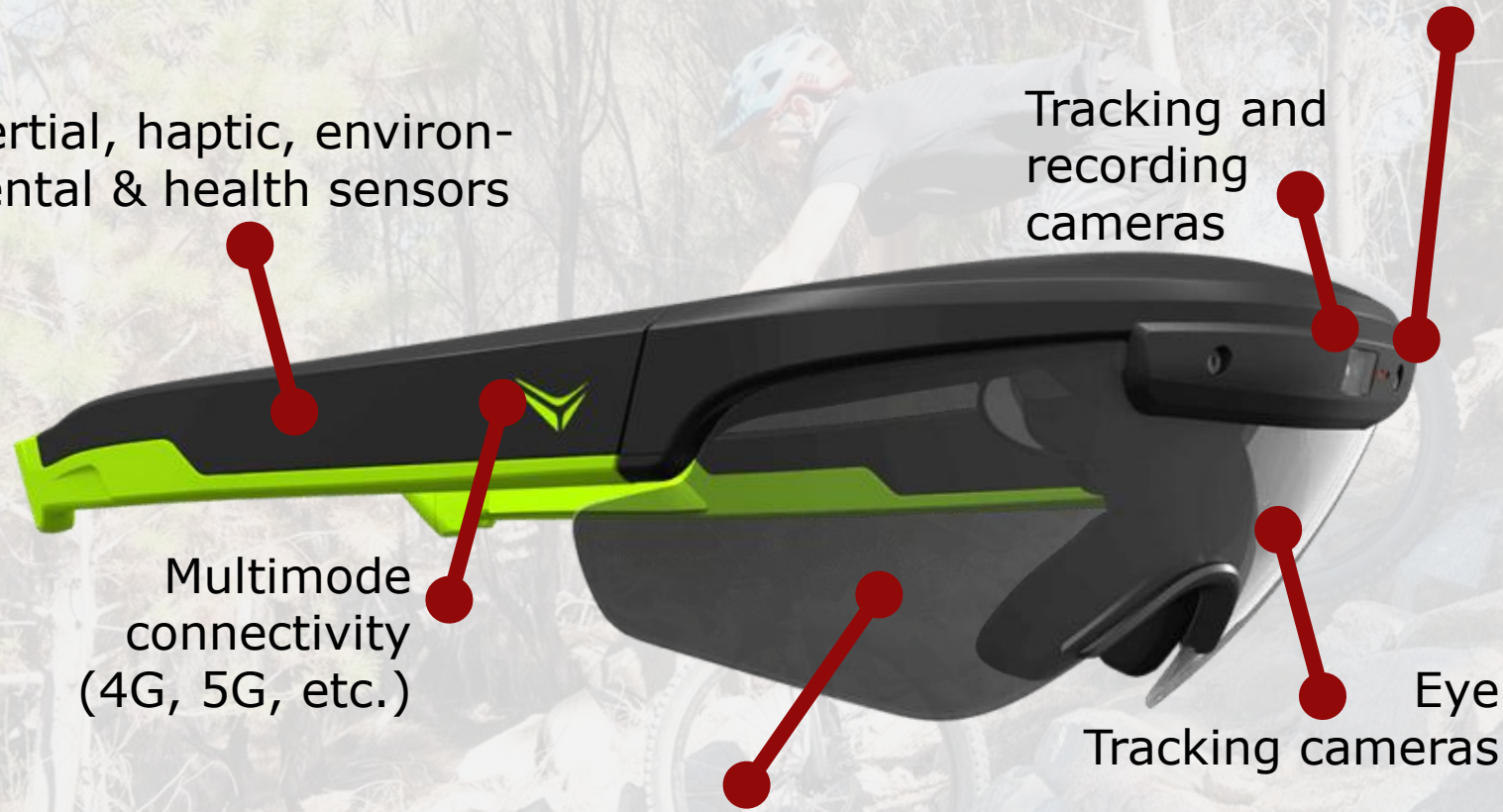


Shit, difficult obstacle!

BRAIN WAVES

- Mental health is related to measurable brain activities
- To understand brain activity in relation to time and space
- To discover how the brain controls behaviour → fear infers braking and reduces speed
- To use brain waves as spatial explicit performance indicators

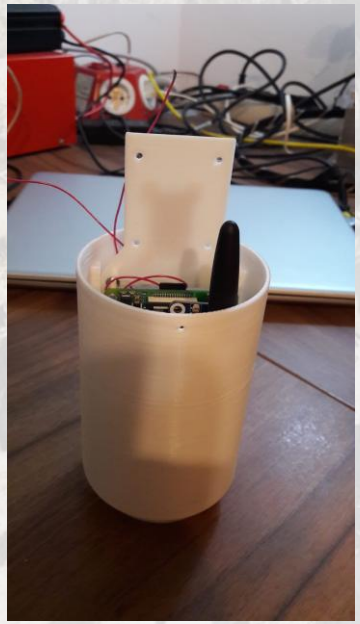
AUGMENTED REALITY THROUGH SMART GLASSES

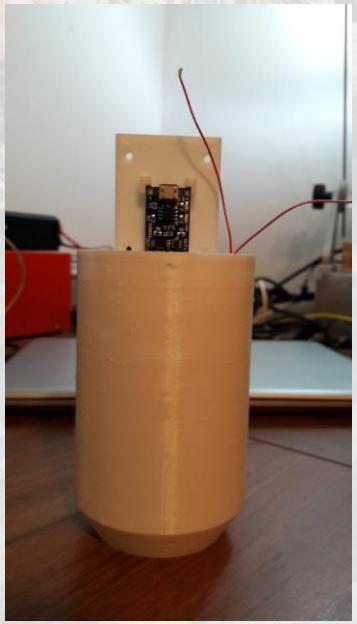


- Eye Tracking cameras
- Tracking and recording cameras (back, front, side)
- Inertial, haptic, environmental & health sensors
- Multimode connectivity (4G, 5G, etc.)
- Optoelectronic night vision and thermal imaging sensors
- New optics and projection technologies with a durable semi-transparent AR display

HARDWARE PROTOTYPE

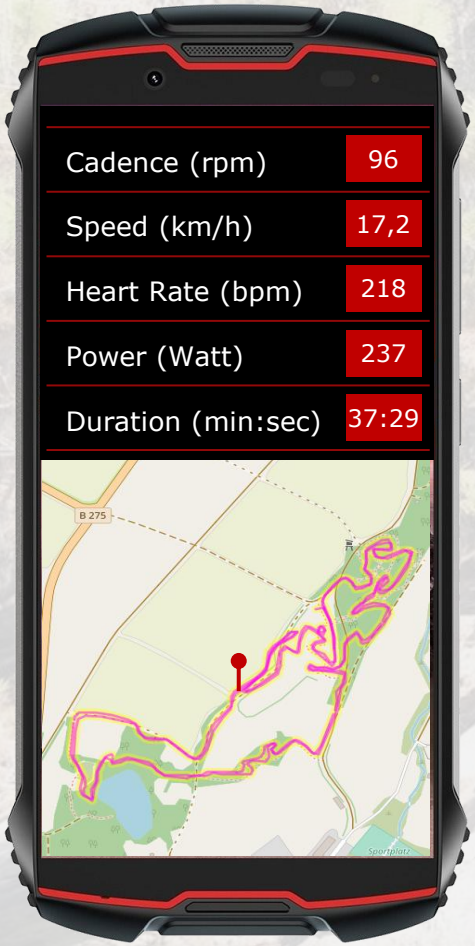
Hardware as is




Hardware as should be

REAL TIME BIKE TRACKER V2.0



Cubot Kingkong Mini 2 Outdoor Smartphone

- Android 10
- 3000 mAh
- IP67 (water/dust)
- Dual SIM
- SD 128 GB
- 13MP Dual Cam
- -35-+60 °C
- USB-C
- 11.9 x 5.8 x 1.21 cm
- 120g
- 139,99 EUR

Syntech USB-C auf USB-Adapter

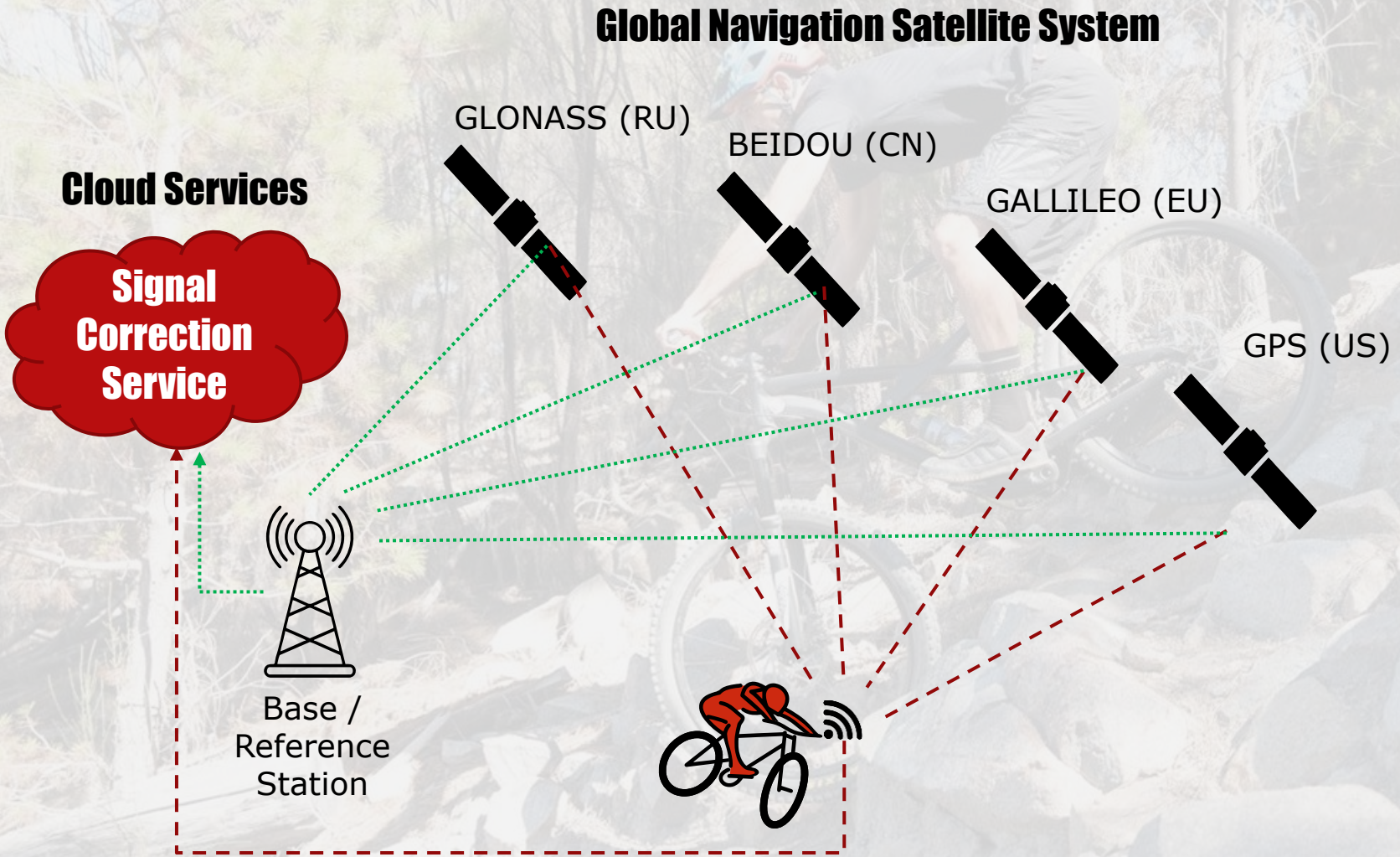
ANT+ Dongle

Sensors

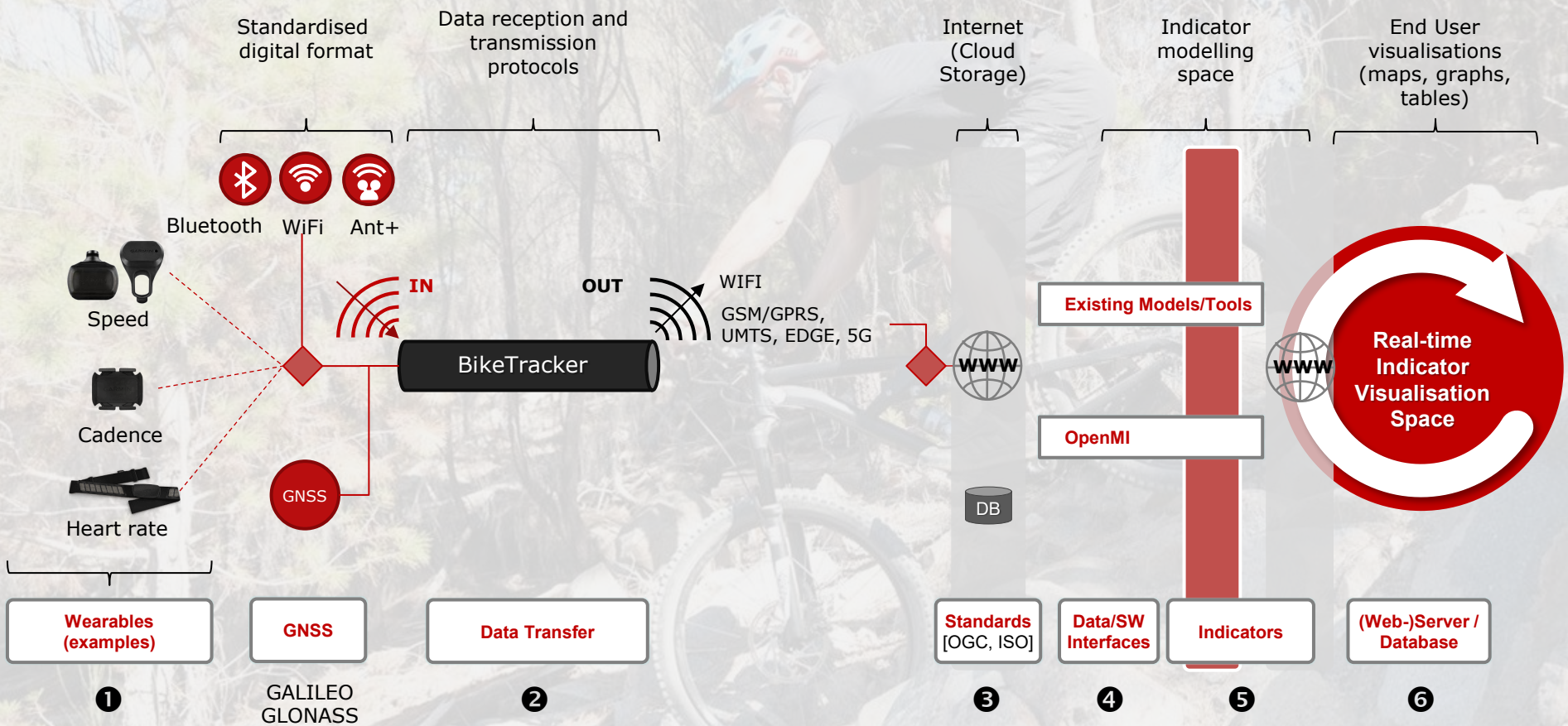
Bluetooth Low Energy via mobile phone

- Bi-/mono directional communiction (messenger in dashboard)
- casing design in 3d print (tbd)

DIFFERENTIAL GNSS



- GNSS: Global Navigation Satellite Systems
- on-the-go corrections to achieve very high spatial accuracy
- Real Time Kinematic (RTK) → RTKLib
- Static Reference Station → info to RTKLib
- precise time measurements



BACKEND

- Is located in the cloud (internet)
- Contains the user management
- Receives, stores, organises, and manipulates data from the bike related hardware

after: Klug, H., Kmoch, A. (2015): Operationalizing environmental indicators for real time multi-purpose decision making and action support. In: Journal Ecological Modelling, Vol. 295 66-74, DOI https://doi.org/10.1016/j.ecolmodel.2014.04.009 [PDF] [RIS]

Amazon Web Service

Google Cloud Platform

Kubernetes
Container

Microsoft Azure

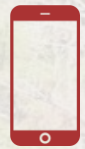
BACKEND

- Example of big cloud platforms for distributed processing
- Free of charge accounts for prototyping or experimenting with students
- Paid account for services
- Spatial Services GmbH uses a Google Cloud Platform

BACKEND

- Tools for visualisation of graphs and tables
- Geoserver
- User management
- Standards for interoperability (OGC, ISO, W3C, …)

GI TECHNOLOGY

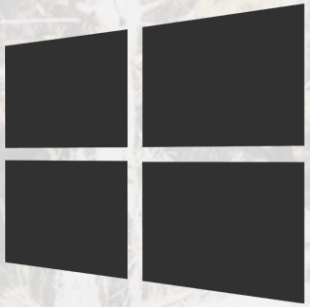


Mobile

Tablet

Laptop

desktop



Windows

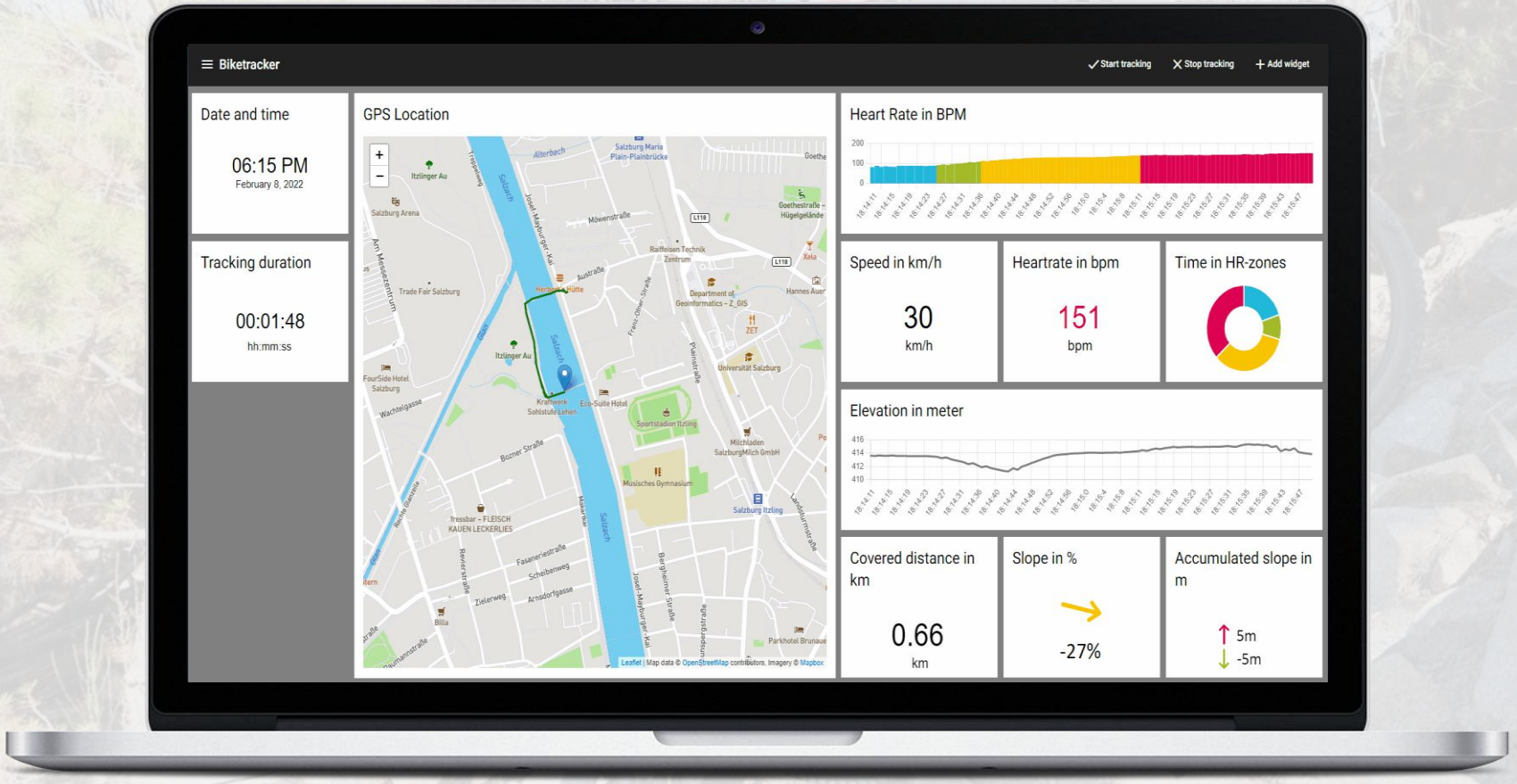
Mac/iOS

Linux

Android

- Device independency (Mobile, Tablet, Laptop, desktop)
- Platform independency (iOS, Android, Mac, Windows, Linux)
- Combination of Internet of Things (IOT), Web 2.0 & Industry 4.0

Windows Mac/iOS Linux Android



FRONTEND

- Real-time Dashboard
- To acquire, visualise, transform, and compare data in (near) real-time via a configurable dashboard
- Remotely supervised indoor and outdoor exercises
- To receive objectively verifiable and comparable indicators on race performance and training needs (stop guessing!)

https://spatial-services-gmbh.gitlab.io/biketracker-dashboard/

RESULTS

- Transdisciplinary working environment
- Many geographical aspects in space and time
- GI Science incl. Spatial Data Infrastructures and Sensor Web Enablement
  - Multi-functional science
  - Interoperability
  - Platform independency
  - Device independency

OUTLOOK

- Have a good ride to the summer semester!
- Enjoy geography and sports!
- Register for the Koppl excursion to give the bike park a trial and to become a proband in our exercises ;-)