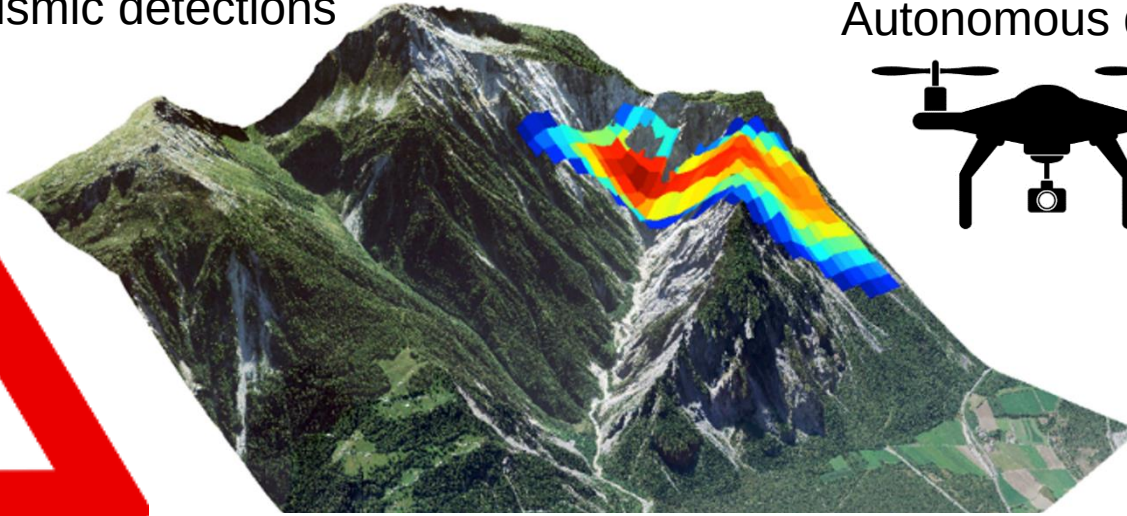


Early warning



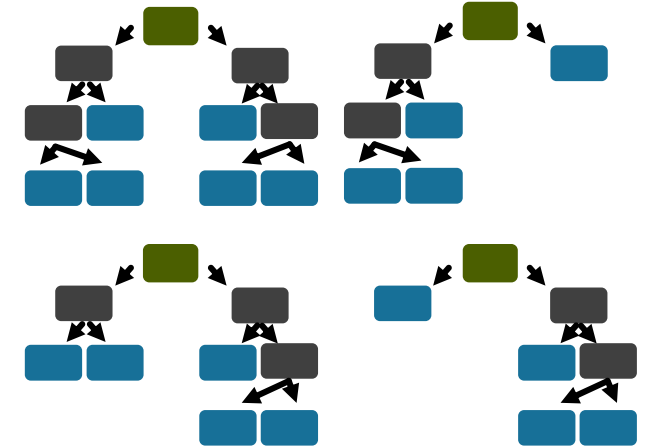
Seismic detections



Autonomous drones



Machine learning



Debris-Flow Seismology: A Playground or a Construction Site?

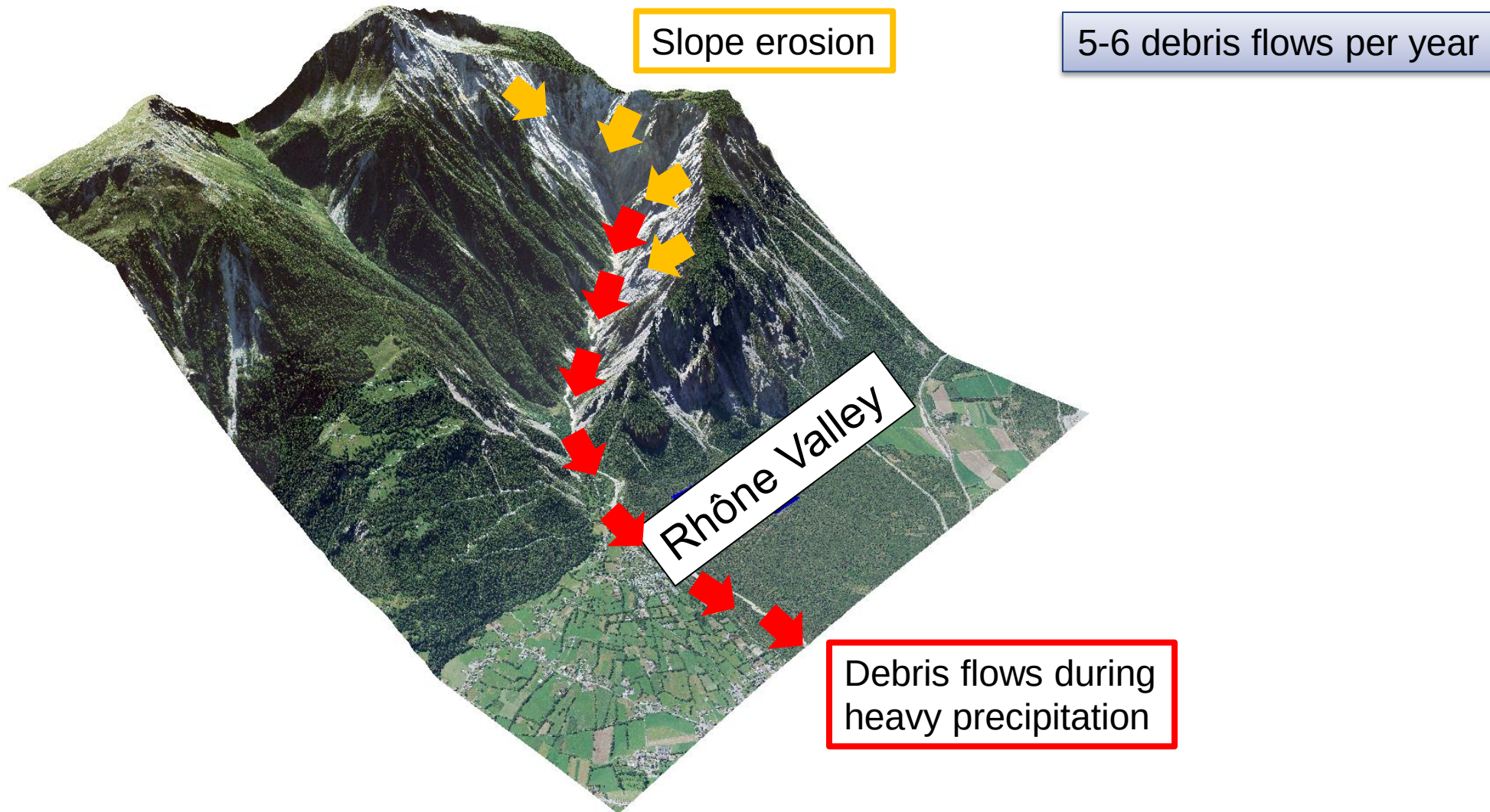
Fabian Walter, ETH Zürich

VAW / ETH Zürich (Michaela Wenner)

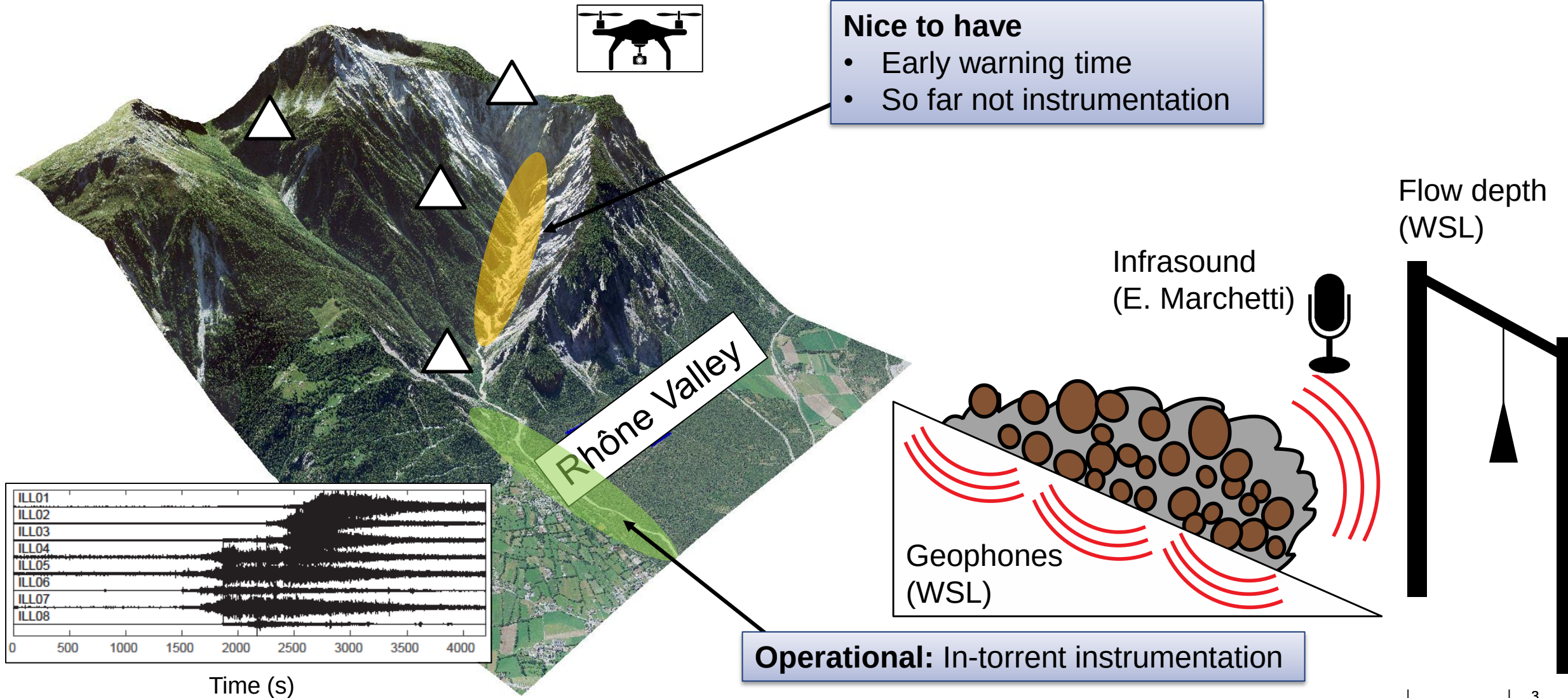
WSL (Brian McArdell, Christoph Graf)

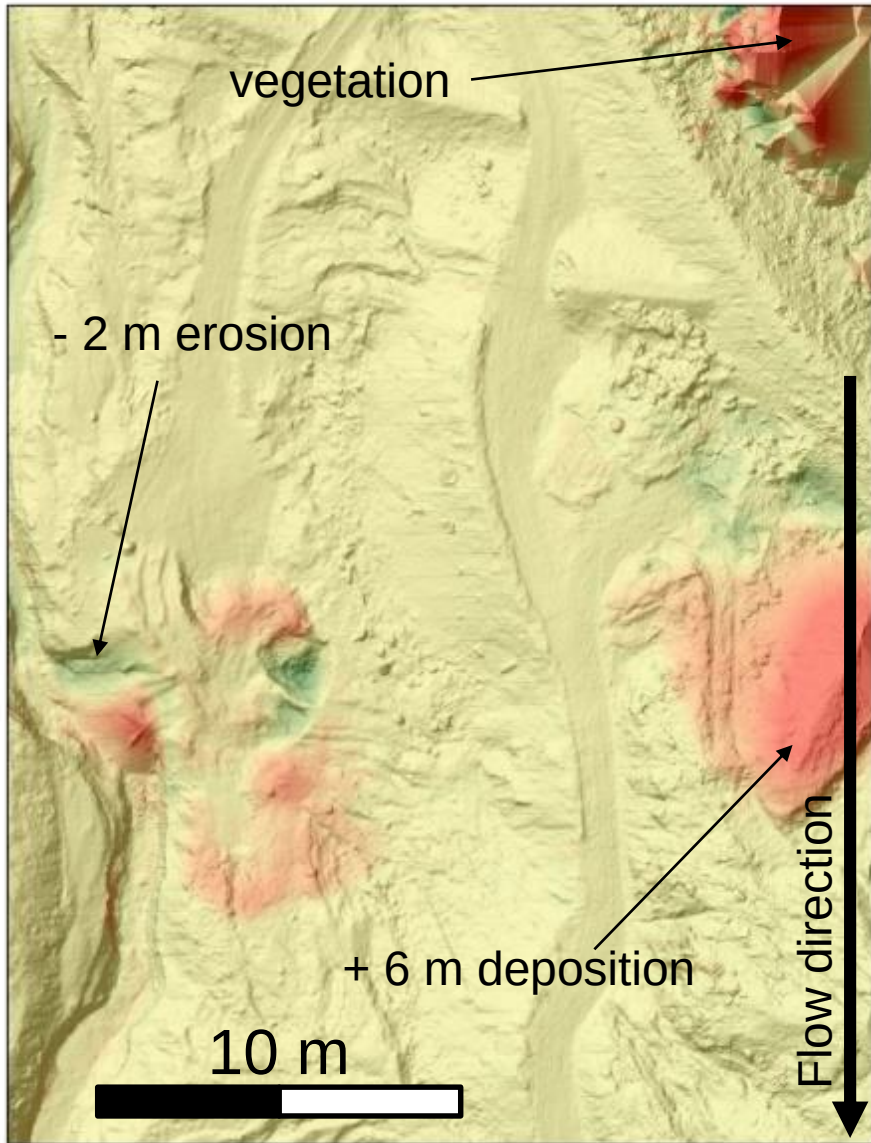
Meteomatics (Martin Fengler), Swisscom Broadcast (Klaus Pilz)

Illgraben Debris Flow Torrent (Valais, Switzerland)



Illgraben Debris Flow Torrent (Valais, Switzerland)





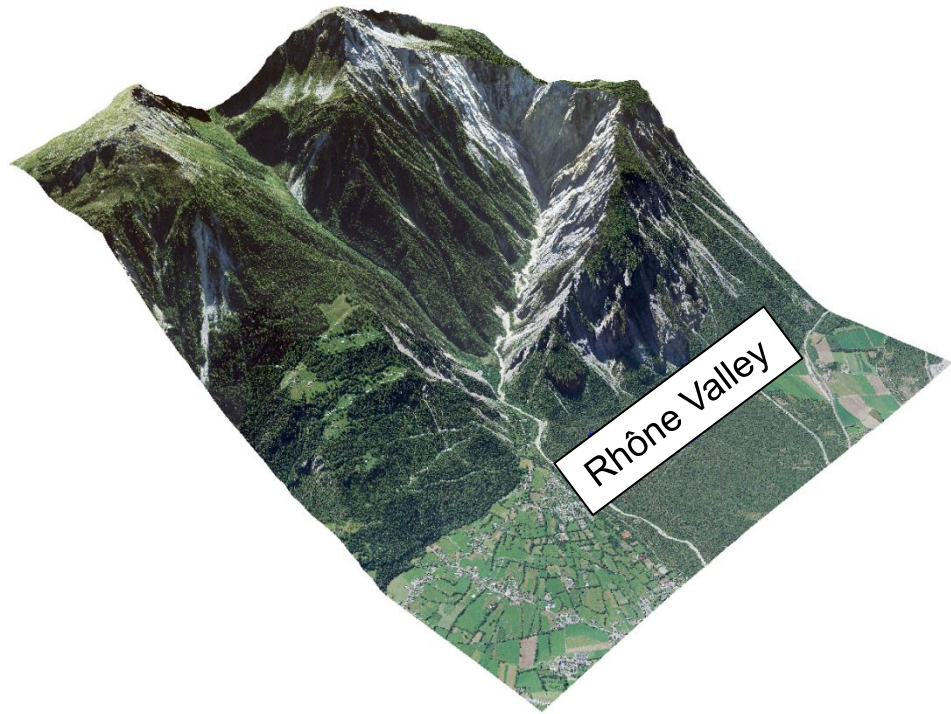
RTS

Drone Data (Tjalling de Haas, Utrecht)

- Repeated flights
- Structure from motion, DEM difference
- Disadvantage: time consuming

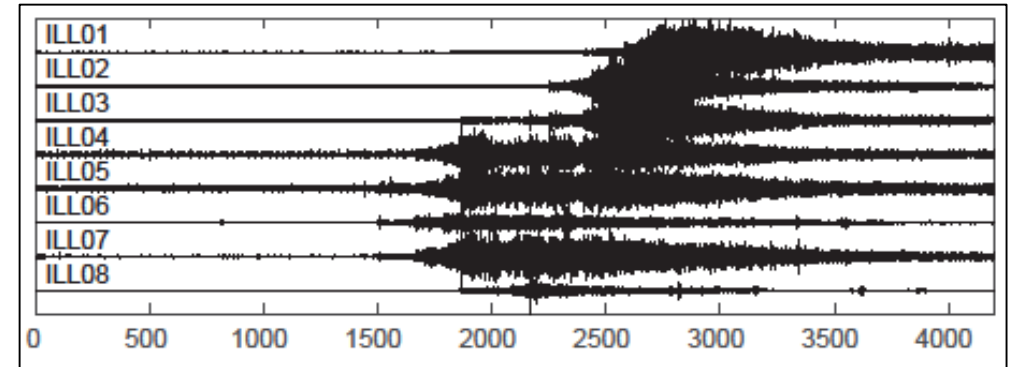
Terrain Changes:
Example of 15 July 2019 Debris Flow

Outline

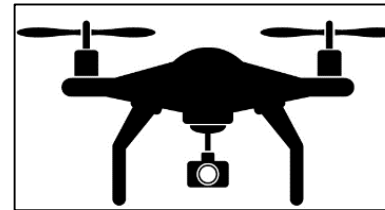


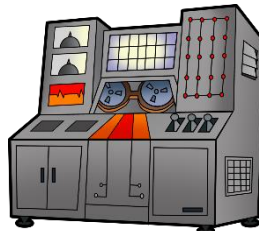
1. **Question:** Can we automatically monitor an inaccessible debris flow catchment?

2. Seismology: Temporal Detection

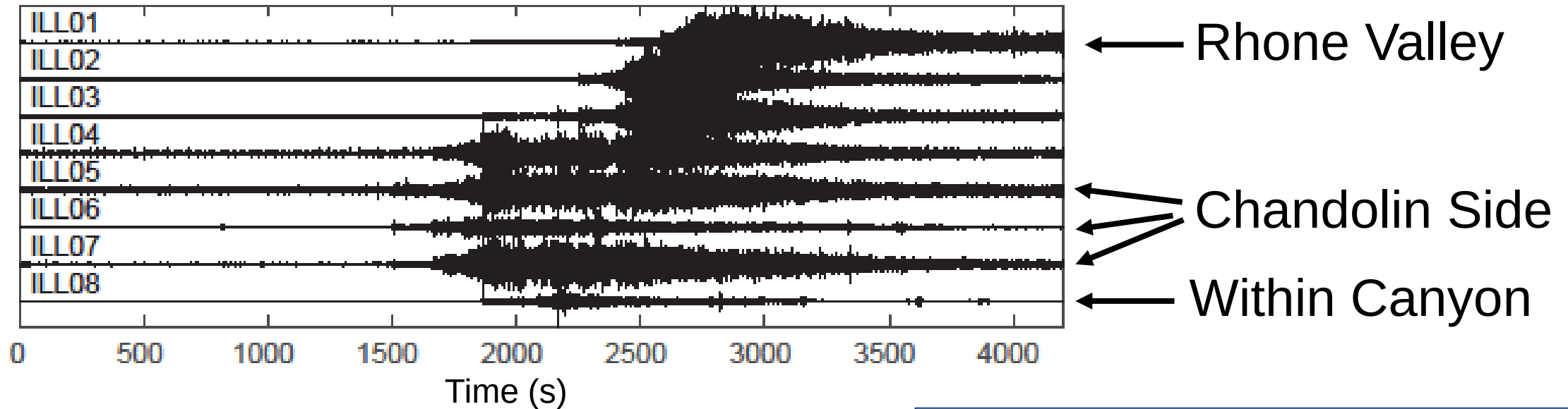


3. Drones: Spatial Detection

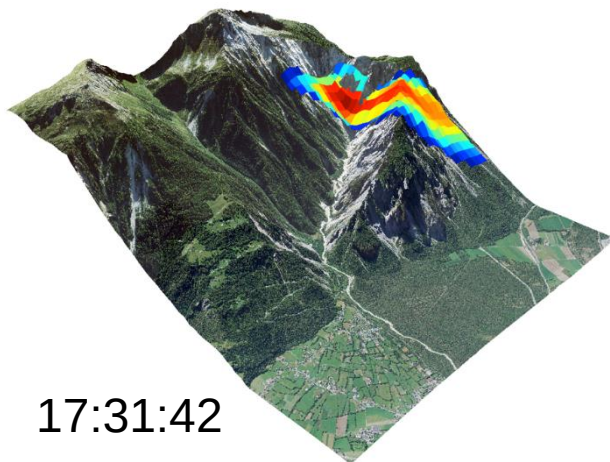


4.  Data Processing

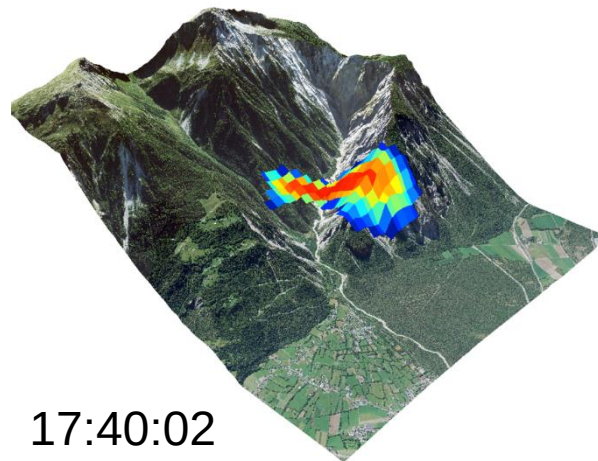
Amplitude Source Location of Debris Flow Front



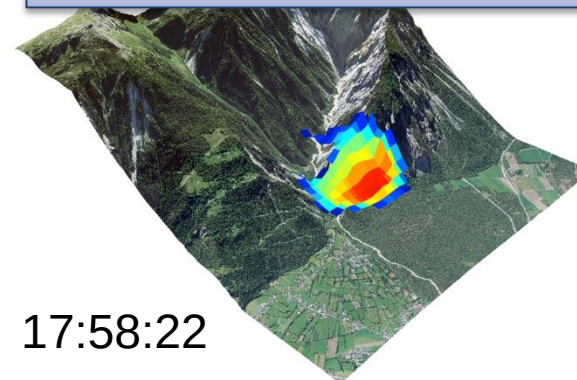
- 20 minutes before leaving Illgraben canyon.
- **BUT:** Too many false detections



17:31:42



17:40:02



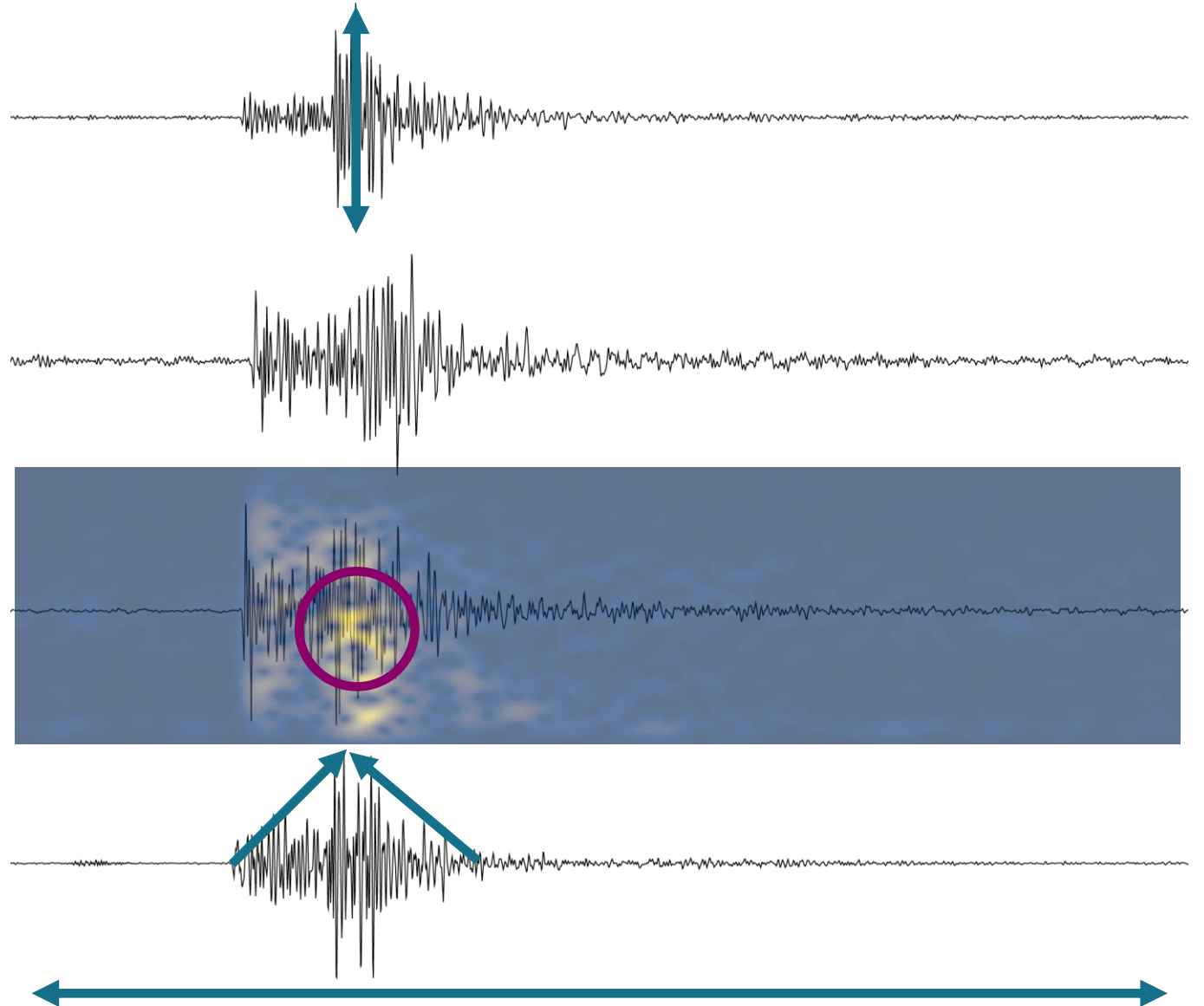
17:58:22

Debris Flow in 2011
(Walter et al., 2017)

From Physics to Machine Learning

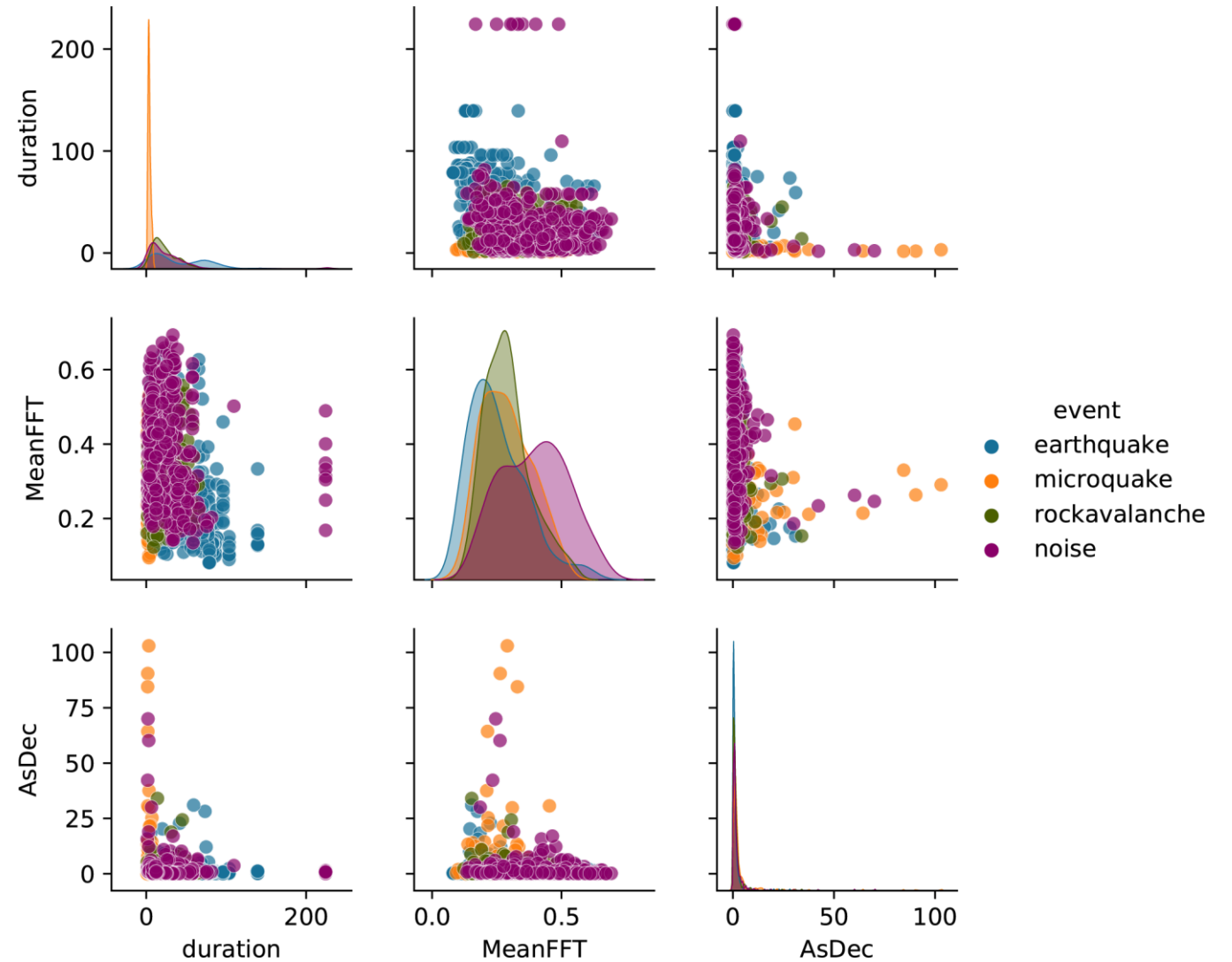
Waveform **features** (e.g., duration, amplitude, ...)

Spectral **features** (e.g., frequency at maximum, central frequency, ...)



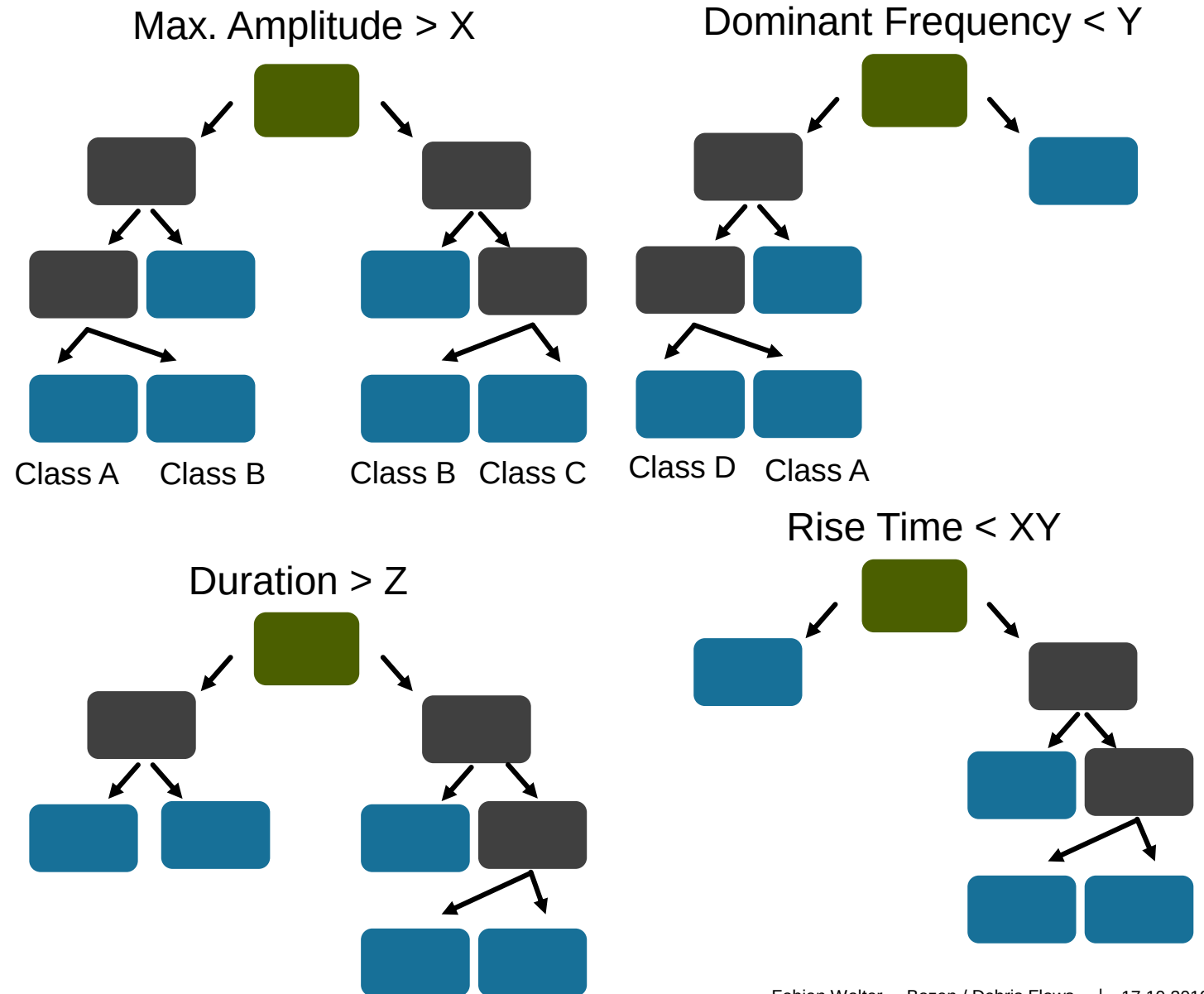
Seismic Feature Extraction

No simple decision rule



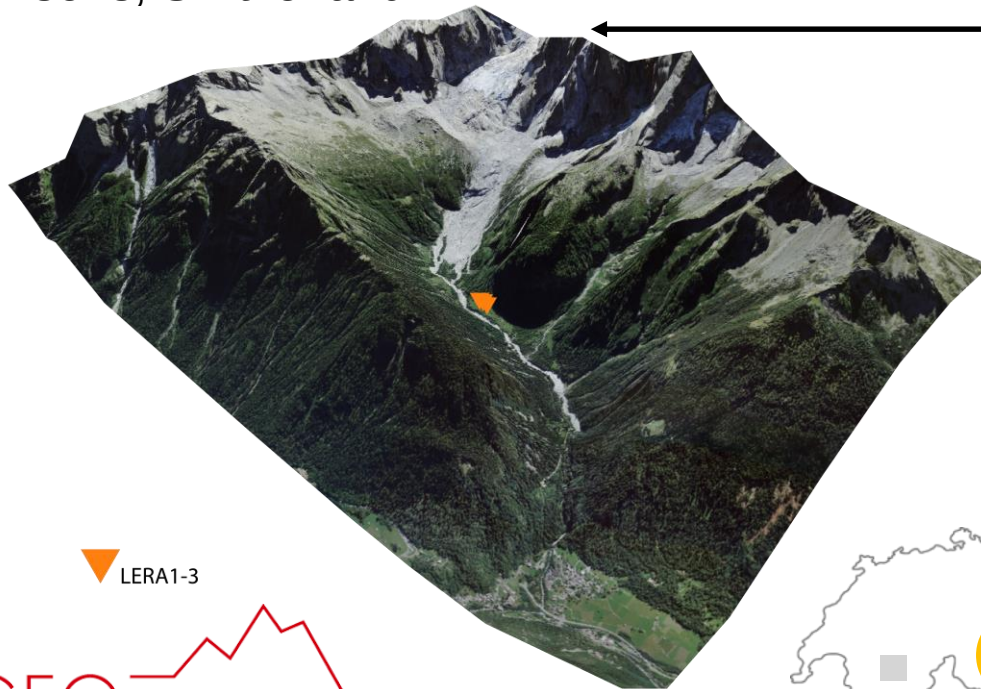
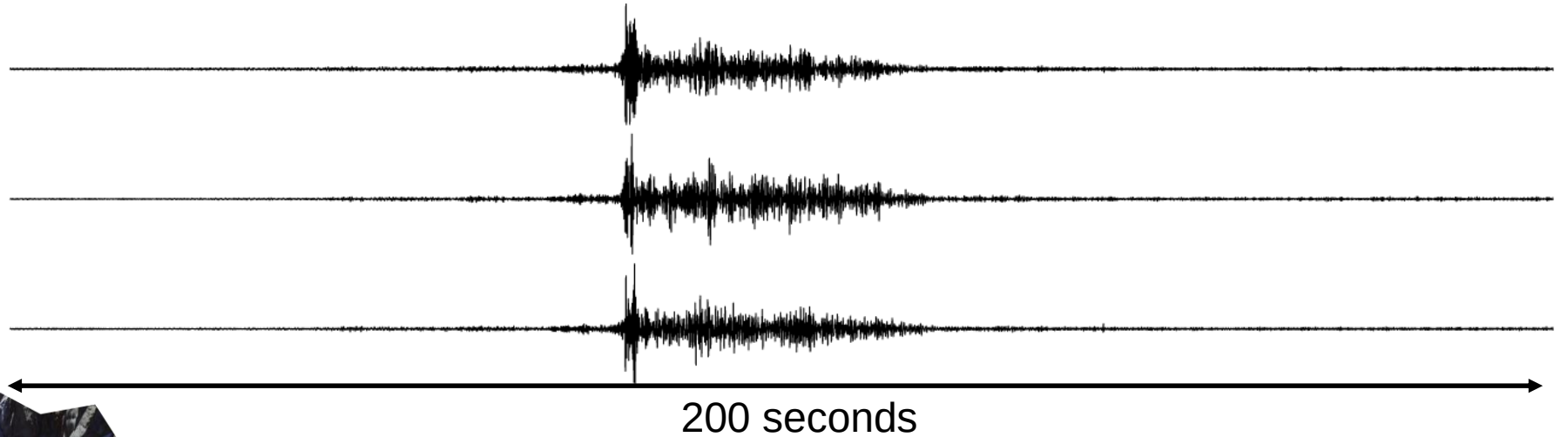
Random Forest Algorithm

- Multiple trees out of random subset of attributes
- Majority vote for classification



Detection: From Physics to Machine Learning

Bondasca Valley,
Grisons, Switzerland



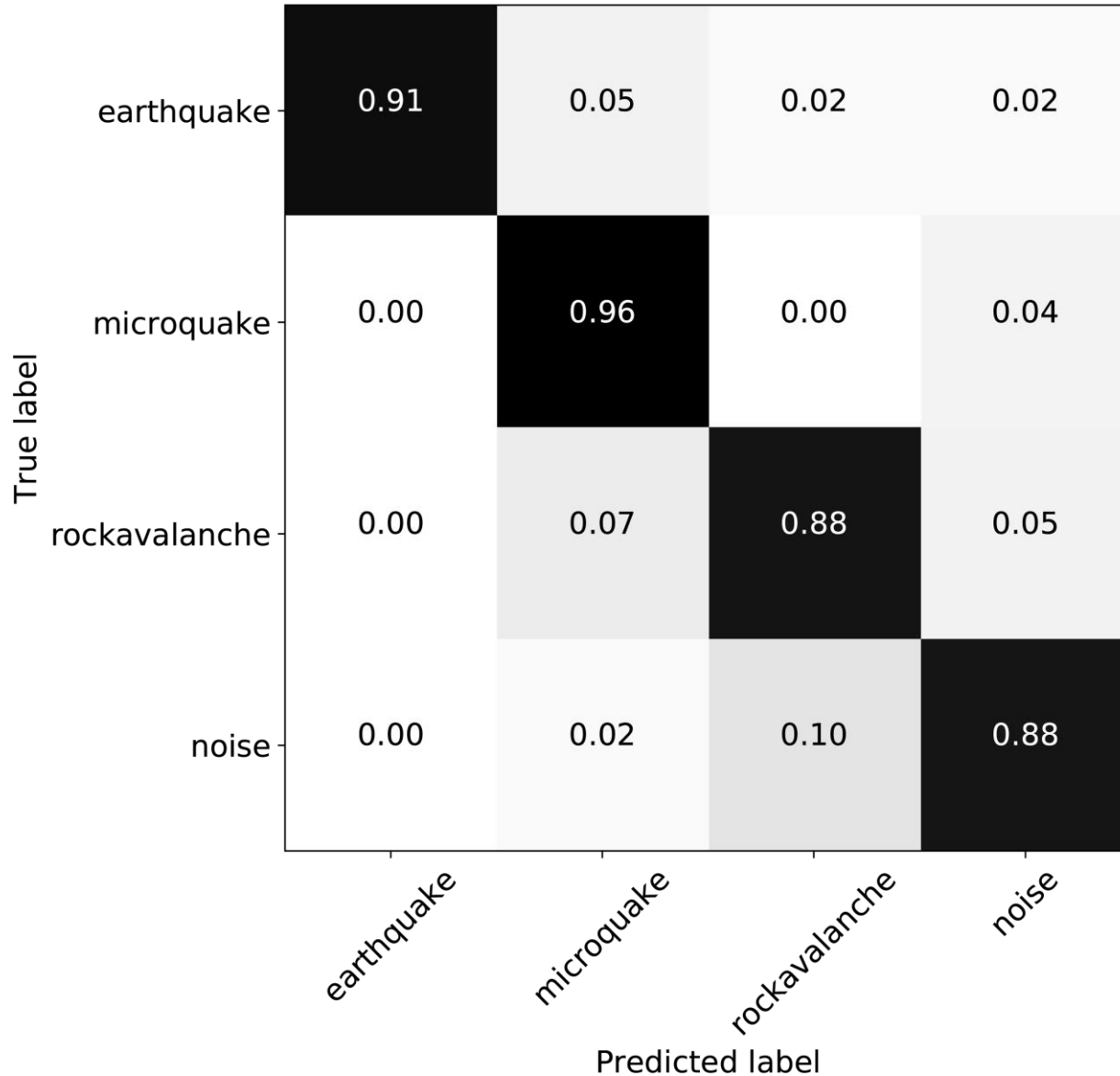
- Goal: monitor rock avalanche activity (small and large)
- 2017 Piz Cengalo rock avalanche
- Seismic monitoring in valley

- Collaboration with U Strasbourg (Clément Hibert)
- Supported by Canton Grison (Martin Keiser)

▼ LERA1-3



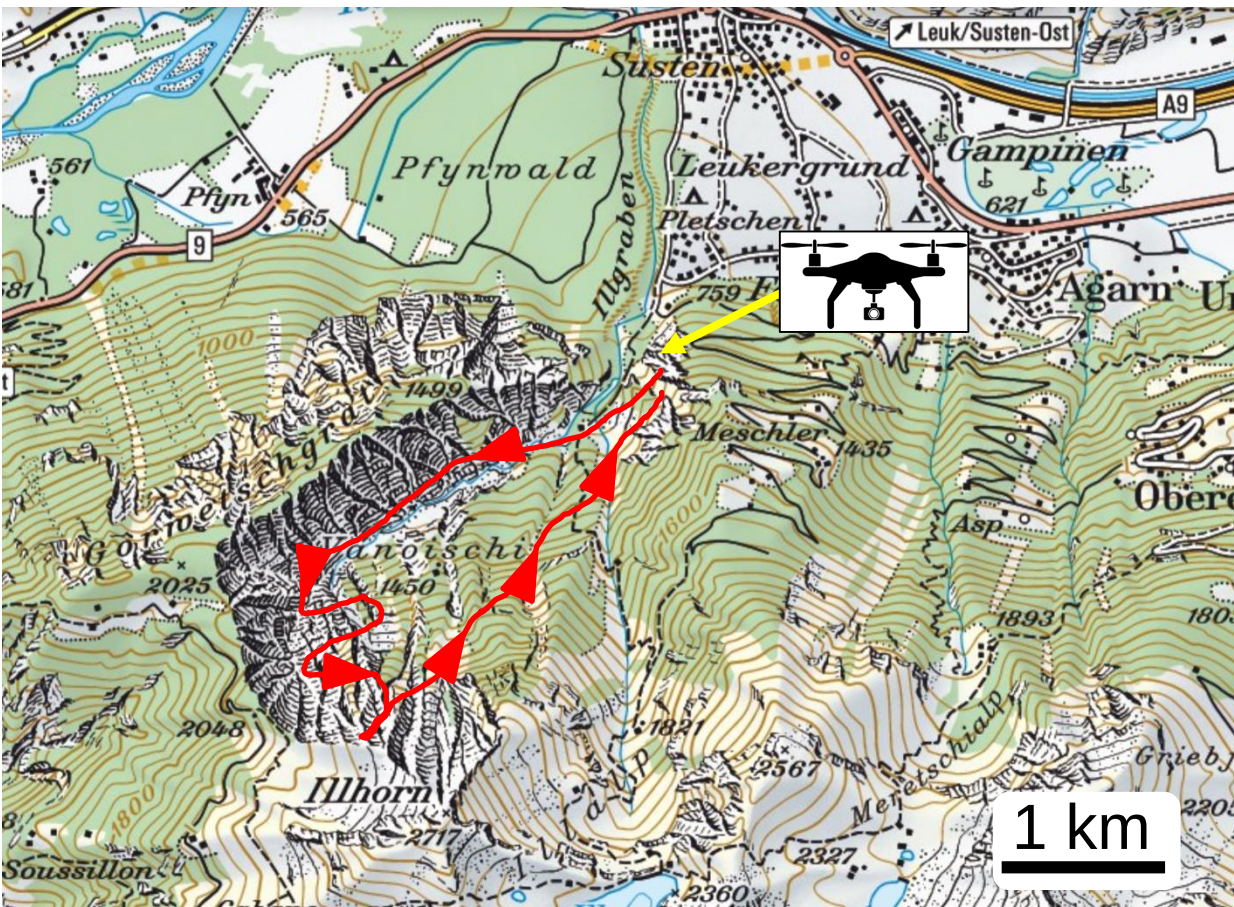
Normalized confusion matrix



- 2000 decision trees
- Training data: ca. 250 signals per class
- Test data: ca. 85 signals per class

To be applied to Illgraben

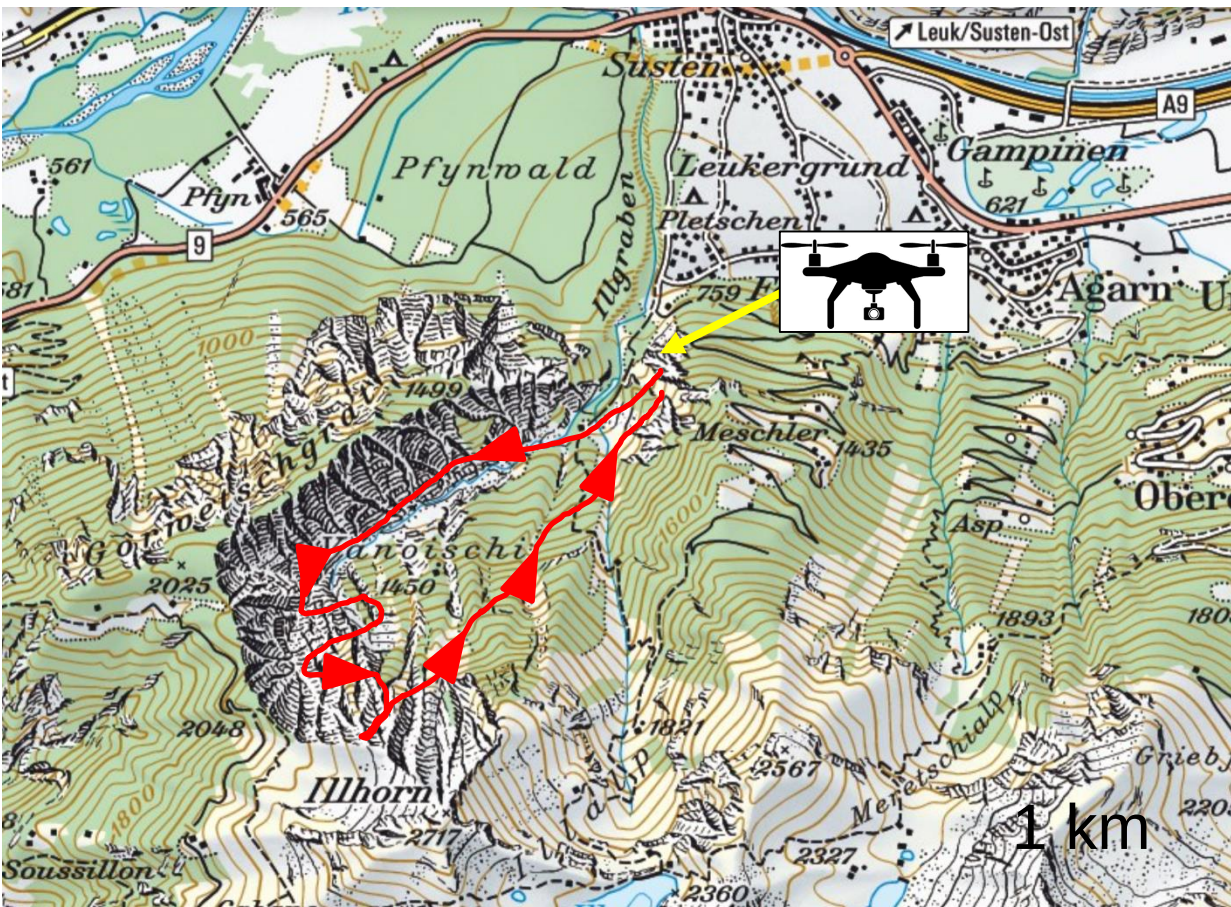
Drone-Derived Digital Elevation Models



Autonomous Drone

- Self-charging
- Shielded from weather
- Powerful enough
 - Flight length
 - **Elevation difference**
- Flight permission (BVLOS)
→ Meteobase by Meteomatics

Meteobase: First Experiences



Meteomatics Meteobase



Meteobase: First Experiences



- First completed flight paths last week
- Daily flights planned for summer 2020

... Work in progress

Swisscom Data Platform

SELECT TIME INTERVAL

1' 5' 10' 15' 30' 45' 60'

SEISMOGRAPH DATA

From 15/7/2019, 05:05:02 AM To 15/7/2019, 05:15:02 AM

HASLI

ILL12

ILL13 - LGS

ILL14

ILL17

ILL18

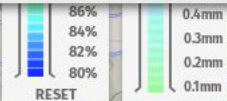
PLUVIOMETER

Accumulated Rain in mm

VSSIE 0 mm 1 mm 1 mm

VSERG 0 mm 1 mm 1 mm

VSVER 0 mm 1 mm 1 mm



DETAIL INFORMATION CHARTS

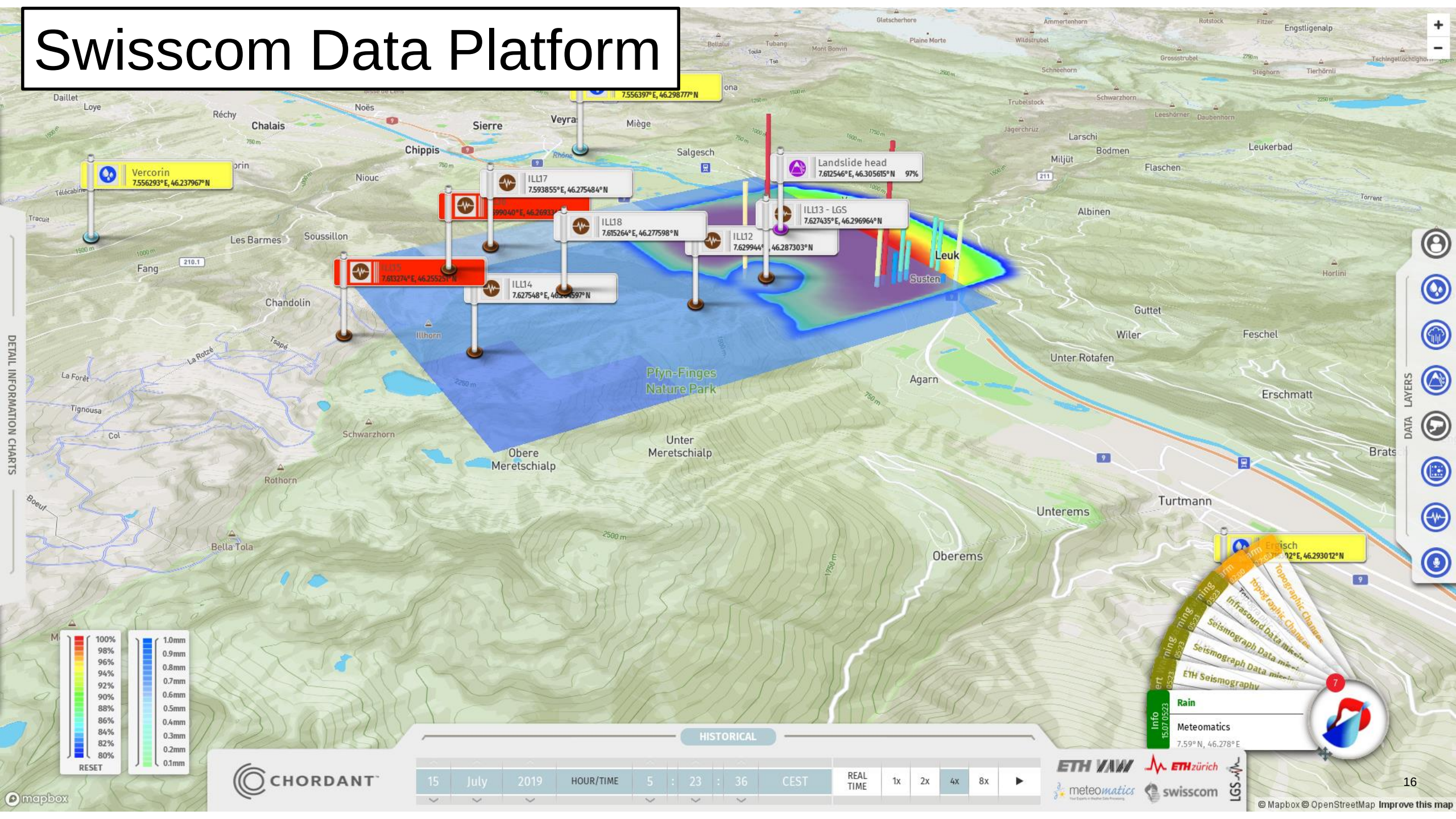
HISTORICAL

15	July	2019	HOUR/TIME	5	:	15	:	2	CEST	REAL TIME	1x	2x	4x	8x	
----	------	------	-----------	---	---	----	---	---	------	-----------	----	----	----	----	--



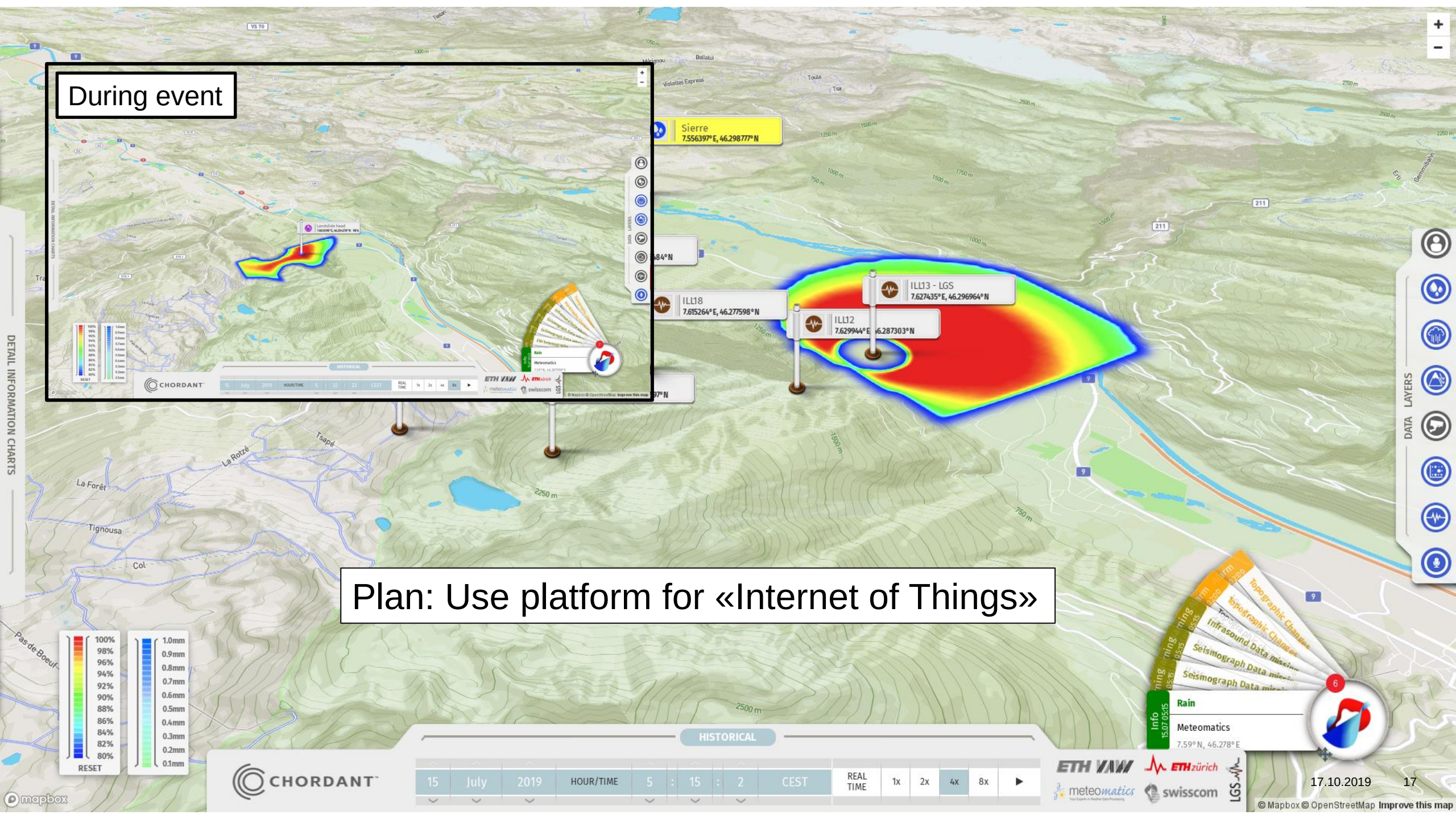
© Mapbox © OpenStreetMap Improve this map

Swisscom Data Platform



During event

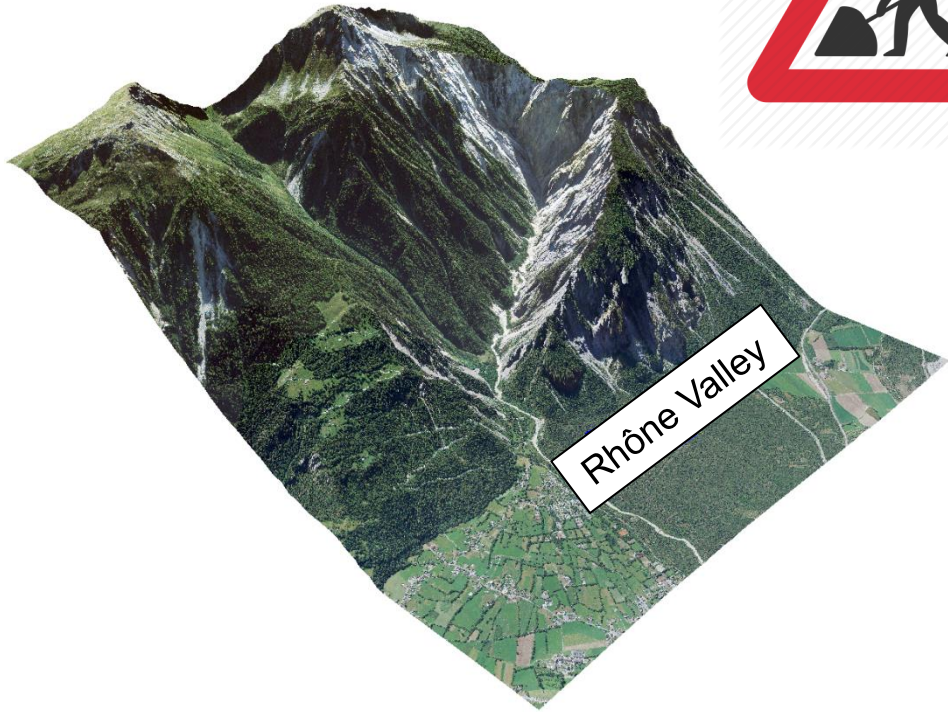
Plan: Use platform for «Internet of Things»



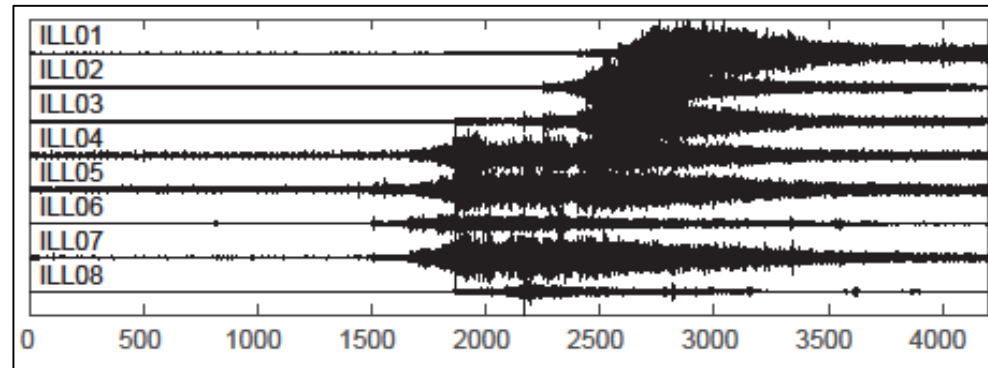
Can we automatically monitor an inaccessible debris flow catchment?



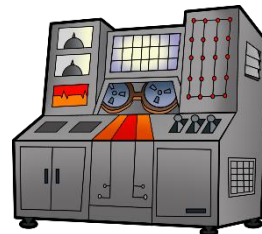
Not there yet ... but some recent progress.



Seismology: Temporal Detection



Data Processing



Drones: Spatial Detection

