

# A novel view on rainfall measuring

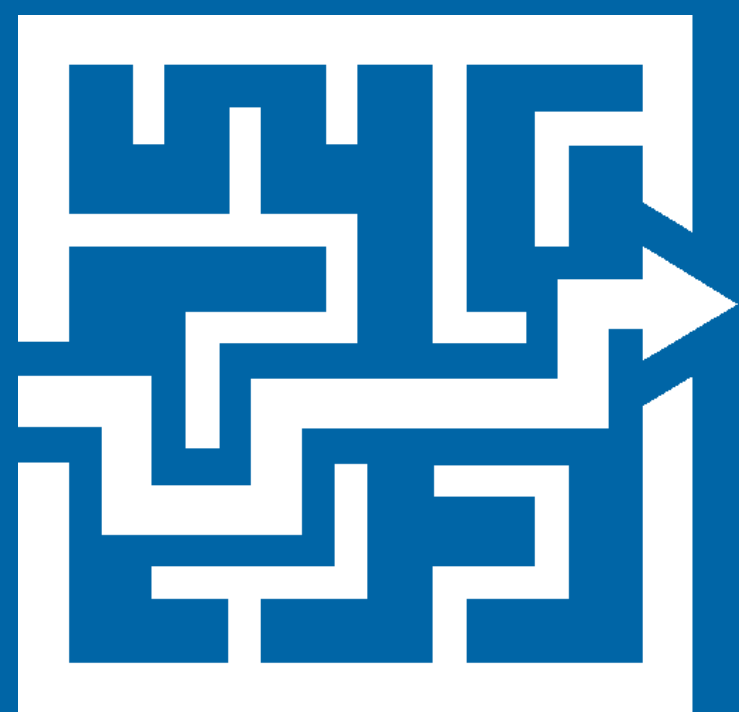
*Cagninei A., Laio F., Croci A., Ricupero R., Cavagnero P., Ferrabone M., Mazzoglio P., Allamano P.*





# Why

Real-time & diffuse precipitation monitoring to:



support decision making



improve alert issuing



optimize water  
management



# How



Devices shoot  
rainy pictures



IR<sup>2</sup> processes the  
images in the cloud



Rain figures are stored  
in our database



```
{"rainrate": 2.1, "timestamp": "2017-04-19T22:00:00+00:00"},  
{"rainrate": 5.3, "timestamp": "2017-04-19T22:30:00+00:00"},  
{"rainrate": 3.4, "timestamp": "2017-04-19T23:00:00+00:00"},  
{"rainrate": 1.4, "timestamp": "2017-04-19T22:00:00+00:00"},  
{"rainrate": 1.7, "timestamp": "2017-04-19T22:00:00+00:00"},  
{"rainrate": 2.6, "timestamp": "2017-04-19T22:30:00+00:00"},  
{"rainrate": 1.1, "timestamp": "2017-04-19T23:00:00+00:00"},  
{"rainrate": 0.5, "timestamp": "2017-04-19T22:00:00+00:00"},  
{"rainrate": 0.0, "timestamp": "2017-04-19T22:30:00+00:00"},  
{"rainrate": 0.0, "timestamp": "2017-04-19T23:00:00+00:00"},  
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{"rainrate": 3.4, "timestamp": "2017-04-20T00:00:00+00:00"},  
{"rainrate": 6.4, "timestamp": "2017-04-20T00:30:00+00:00"},  
{"rainrate": 6.1, "timestamp": "2017-04-20T01:00:00+00:00"},  
{"rainrate": 5.7, "timestamp": "2017-04-19T23:00:00+00:00"},
```



# Method: IR<sup>2</sup> technology

Patented technology<sup>(1)</sup>, based on rain drop streaks identification

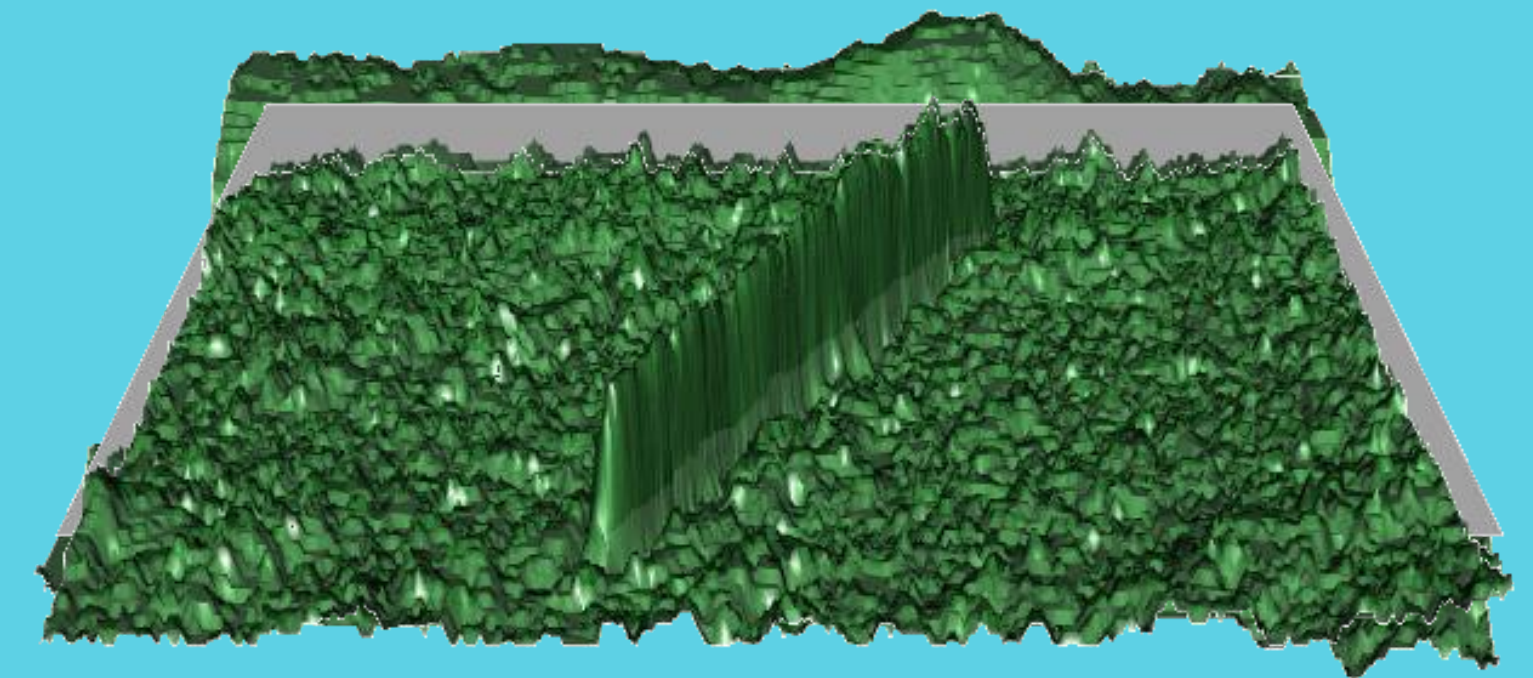
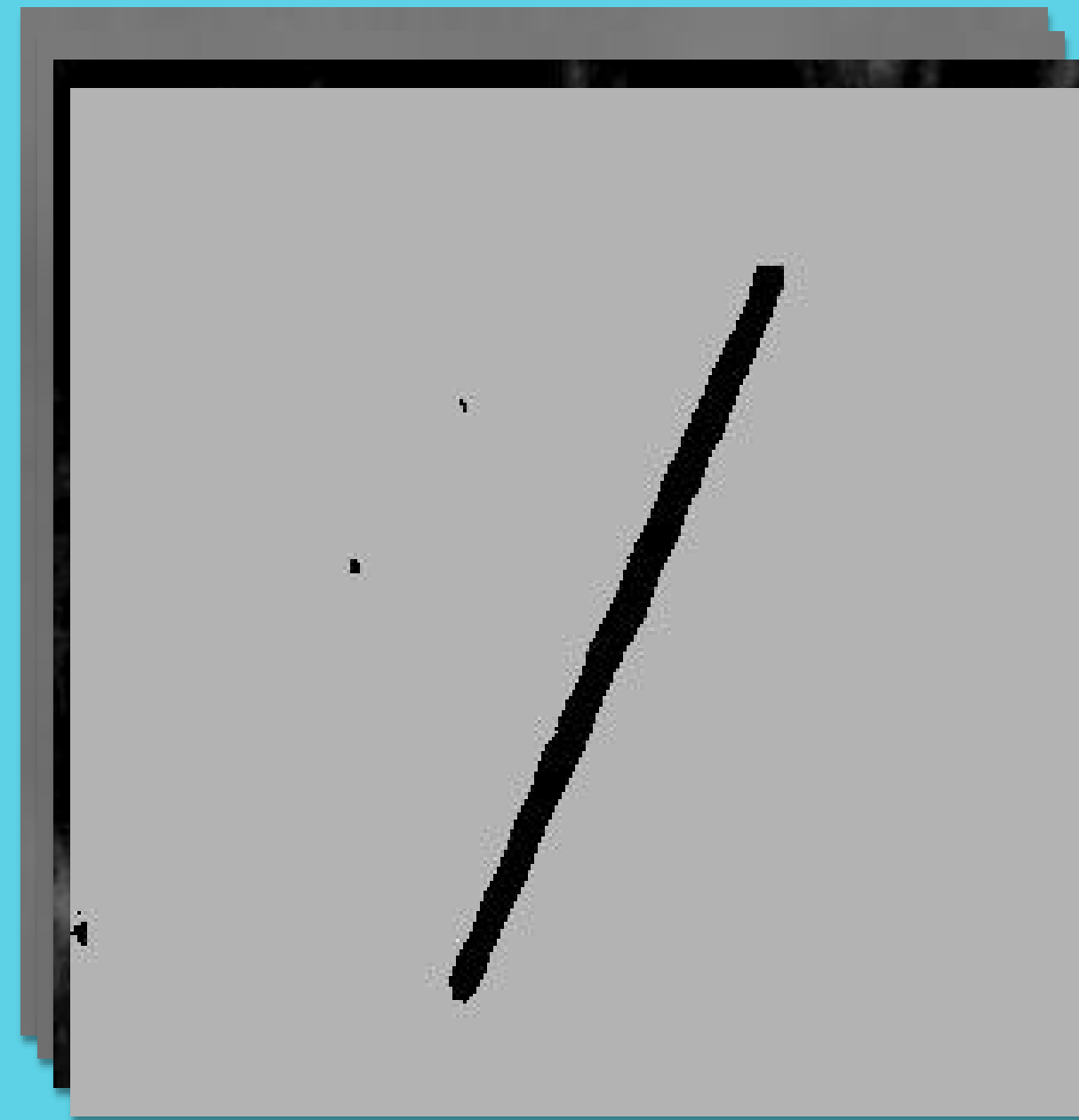
Original drop image

Filtered background

Subtraction

Threshold application

Resulting drop streak

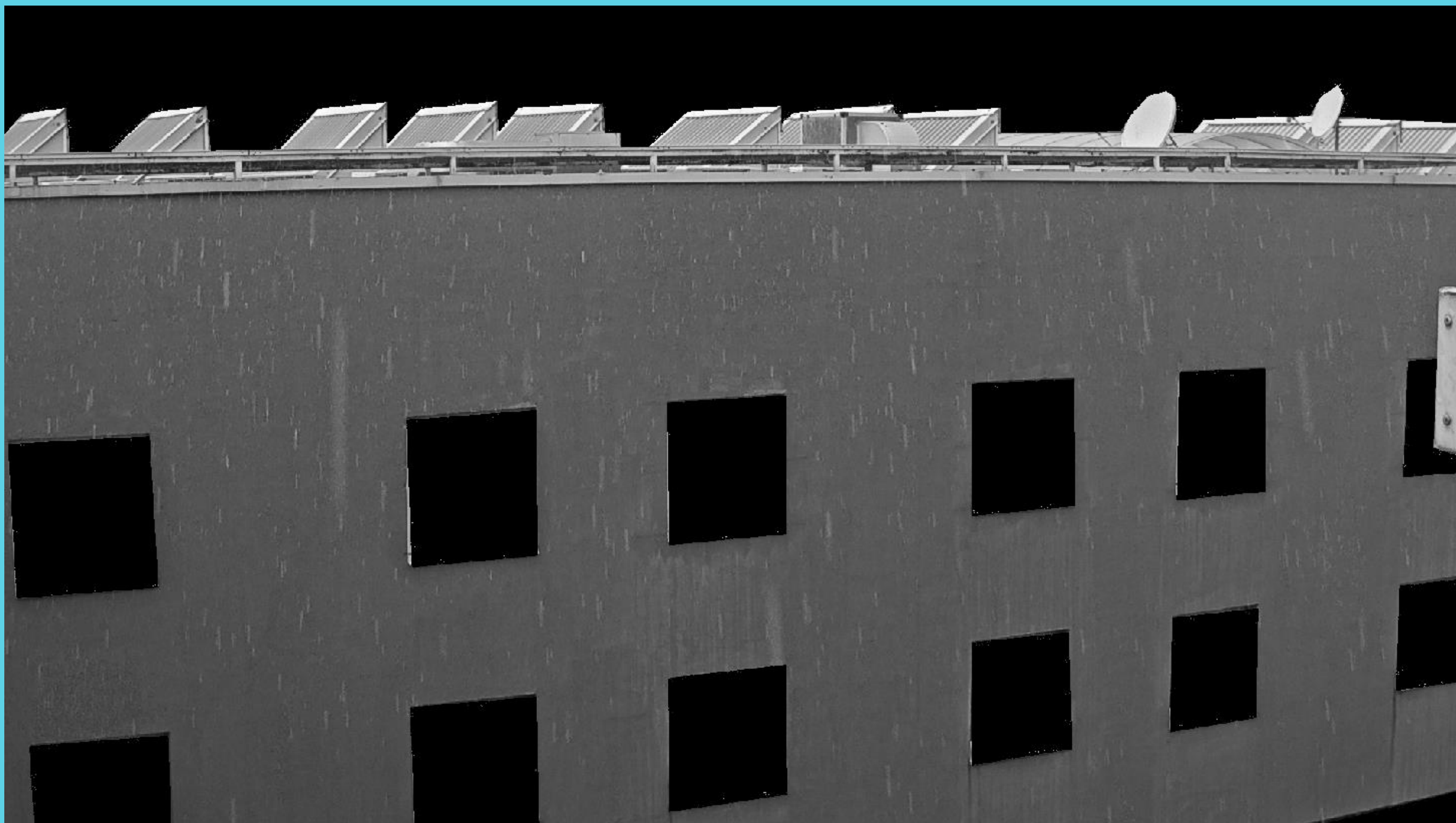


<sup>(1)</sup> Toward the camera rain gauge, Allamano P., Croci A., Laio F., *Water Resource Research*, 2015



# Method: IR<sup>2</sup> technology

Application on rain photo image





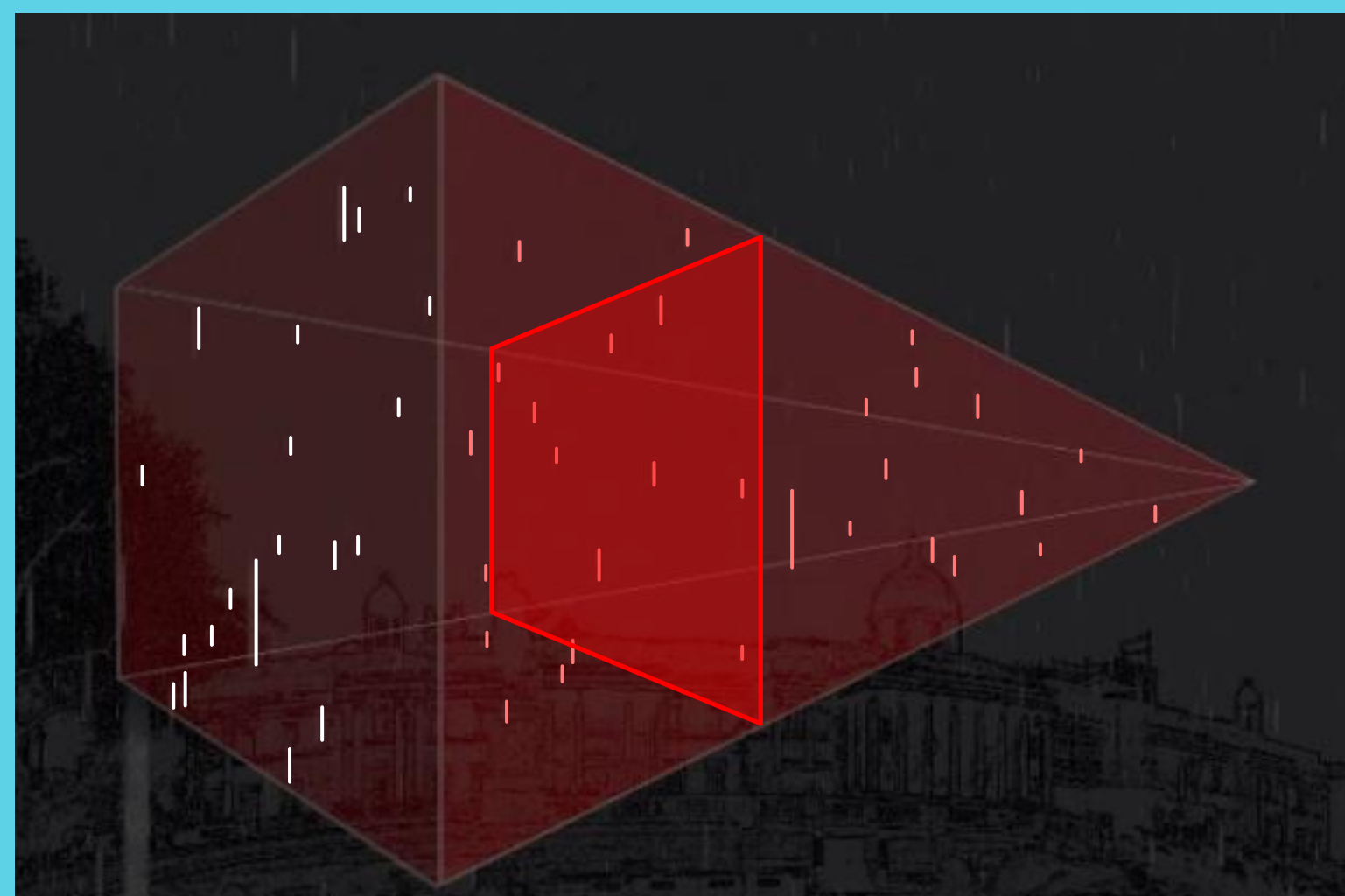
# Method: IR<sup>2</sup> technology

## Istantaneous rain ratio calculation

Sampling volume from camera parameters (exposure time, focal length, aperture, ISO, ...)

Expected rain brightness in the volume given the relative theoretical drop size distribution

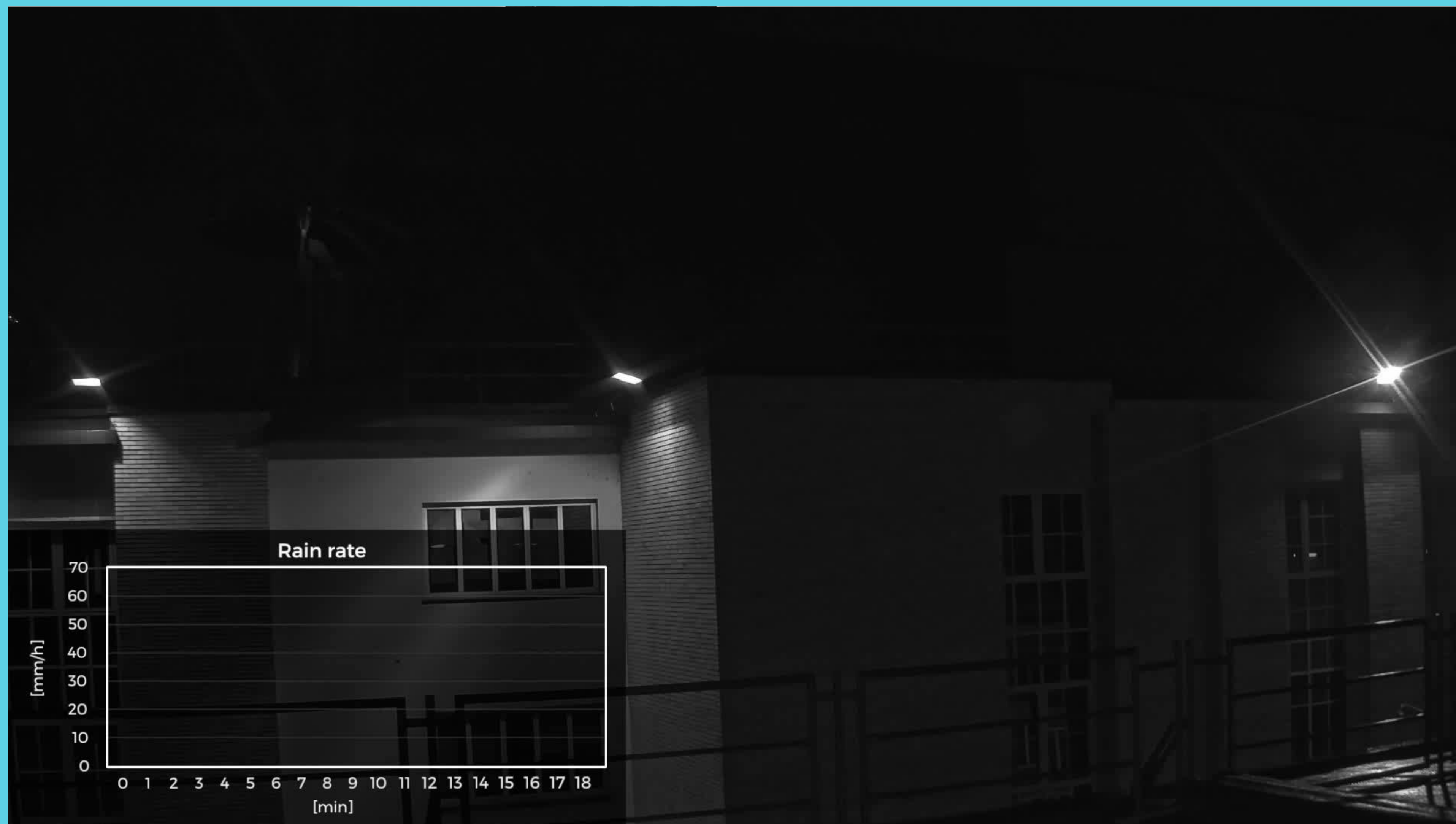
Correct rain rate by comparison between the expected rain brightness and the photo's





# Method: IR<sup>2</sup> technology

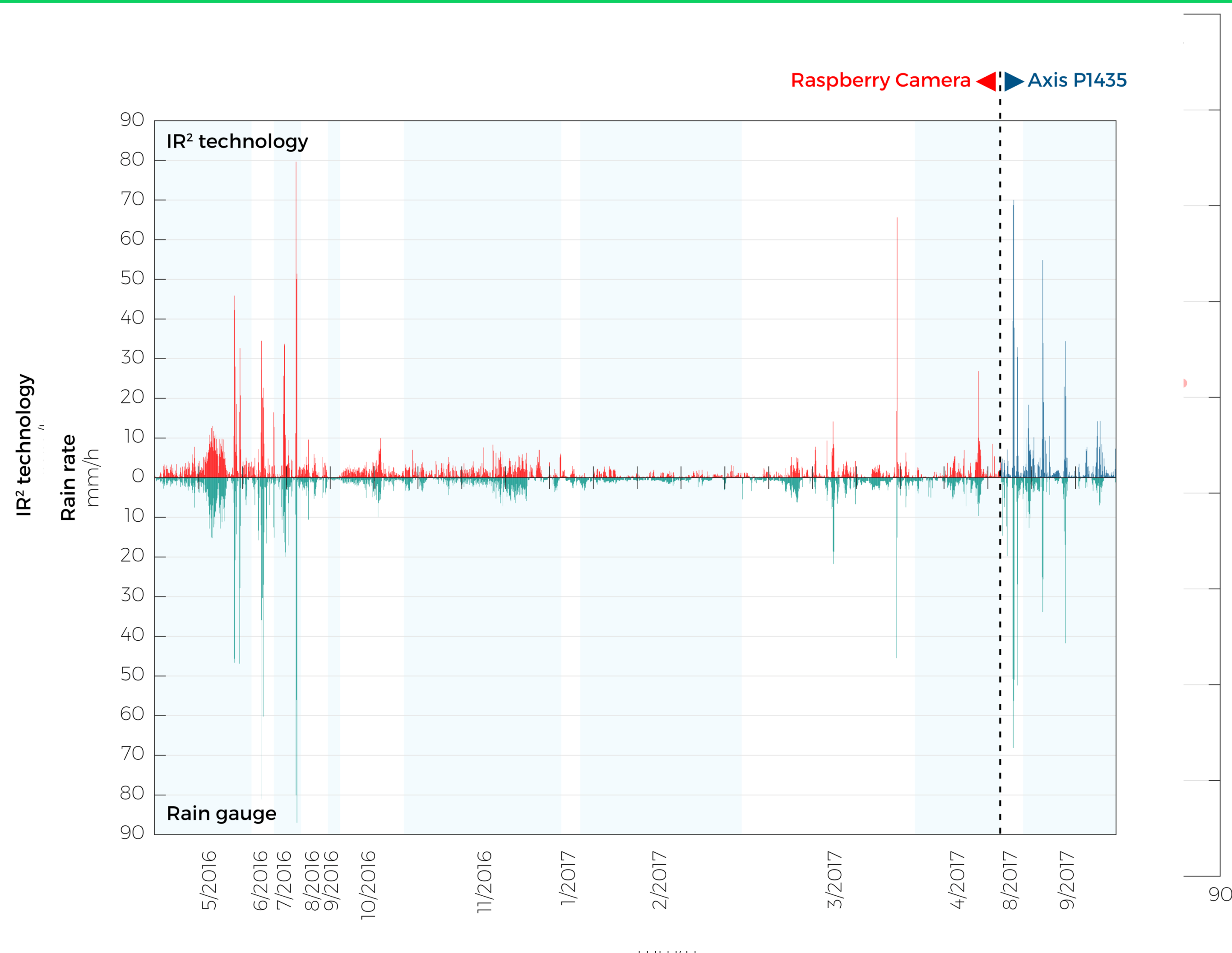
Video examples: day and night





# Applications

## Rain measures on first test site: Polytechnic of Turin



### Guidelines and reference regulations

- WMO - No 8, 7<sup>th</sup> ed. 2008
- UNI 11452:2012
- UNI CEI CEN/TTC 16469: 2014

Variable	Rainfall intensity [mm/h]
Instrument class	Non-catching rain gauge
Sensor type	CMOS sensor 2 Mpx - 1/2.8"
Measuring range	Any rate (tested up to 200 mm/h)
Measurement uncertainty (in field)	4 mm/h at 95% confidence
Temperature range	T > 0 °C (liquid precipitation)



# Applications

## Distributed rain measure grid

