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L'eau dans la ville | Urban water

HOPLU: A low-cost, autonomous, and connected rainfall monitoring station

Qingchuan ZHU, Frédéric CHERQUI, Jean-Luc Bertrand-Krajewski

2023-07-05 8:30 AM

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1. Why do we develop the low-cost rainfall monitoring station?
2. What design objectives should the rainfall monitoring station meet?
3. What is the structure of the rainfall monitoring station?
4. How to evaluate the performance of the system?
5. How do the rain gauges perform?
6. What are the general findings and the future work?

1. Why do we develop the low-cost rainfall monitoring station?



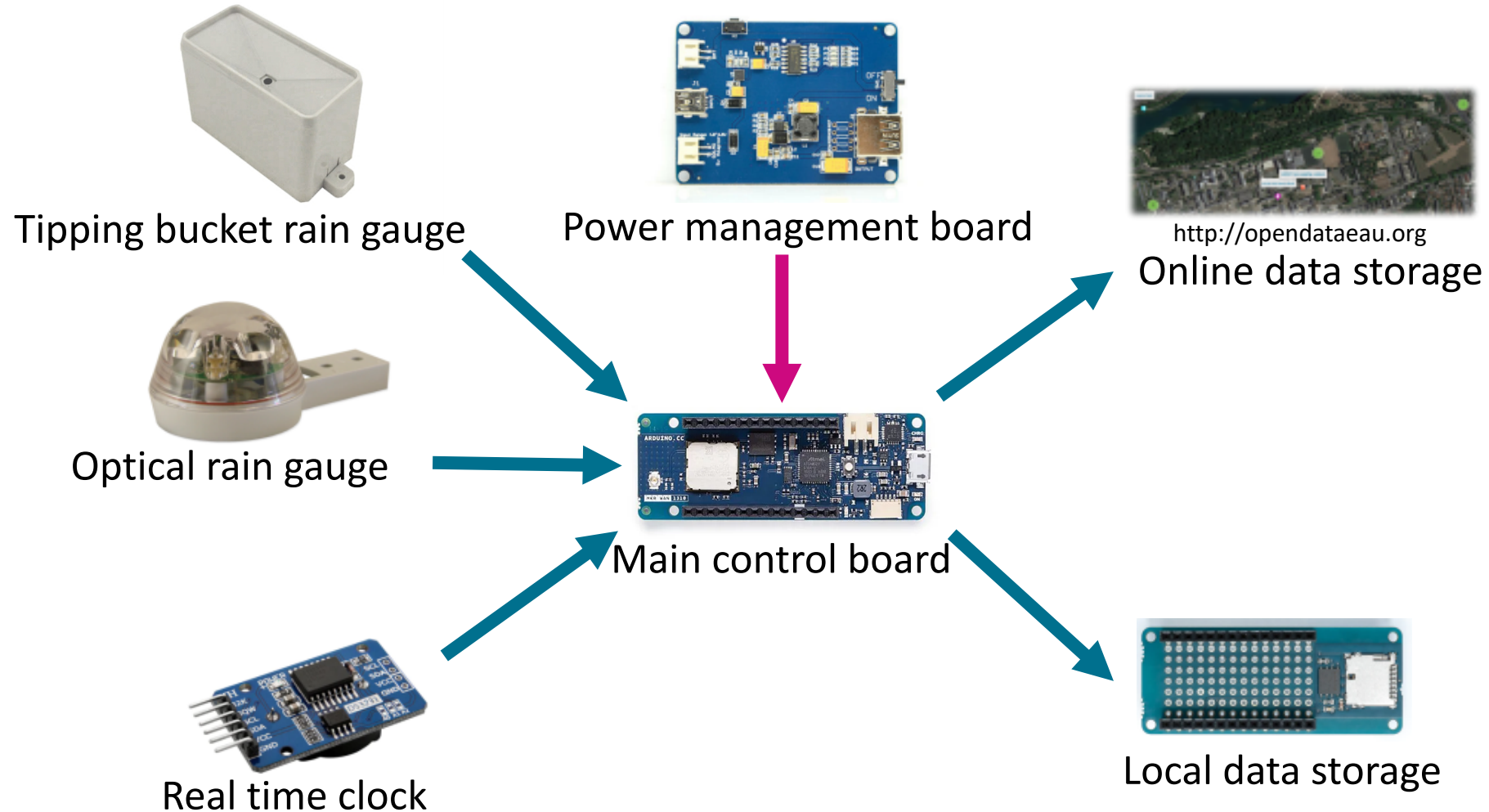
1. Rainfall measurements: key role in hydrology
2. Rainfall events: high spatial variability
3. Smart control: requires *in situ* monitoring
4. Development on:
 1. Low-cost sensor
 2. Open-source hardware
 3. Low-power Wide-Area Network

2. What design objectives should the rainfall monitoring station meet?

1. To monitor the precipitation in real time
2. Enlarged uncertainty: $\pm 10\%$
3. System should:
 1. Be small
 2. < 200 euros
 3. Have remote access to data
 4. Autonomous operation for long periods
 5. Reduce site visits
4. Optical rain gauge RG-15 based on infrared light beam change is chosen due to its low maintenance needs
5. Tipping bucket rain gauge WH-SP-RG is chosen due to its low price and known principle



3. What is the structure of the rainfall monitoring station?



4. How to evaluate the performance of the system?

Reference tipping bucket rain gauge: **0.23 mm/tip**

Low-cost tipping bucket rain gauge
WH-SP-RG, **resolution unknown**



Waterproof box contains hardware Optical rain gauge RG-15

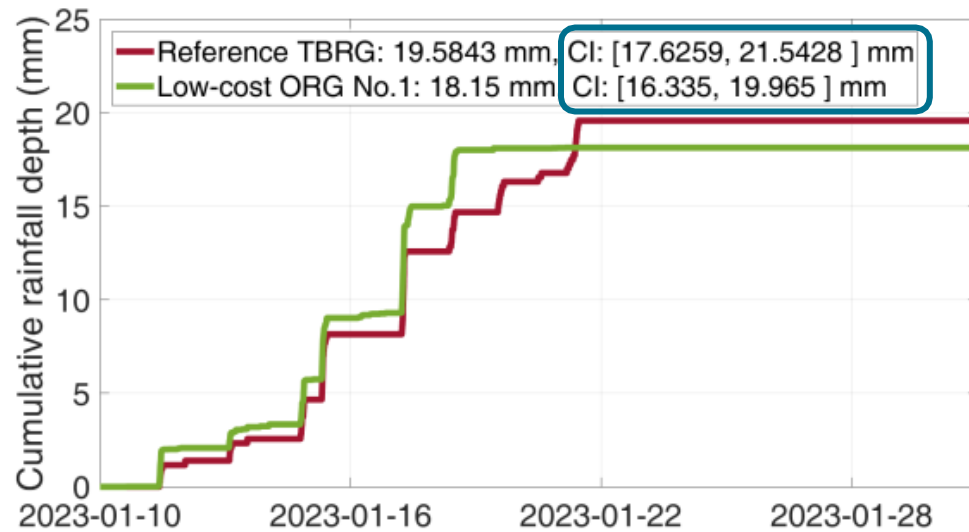
- Last version system, after dozens of improvements for more than one year
- Field test lasted for 4 months in winter

5. How do the rain gauges perform?

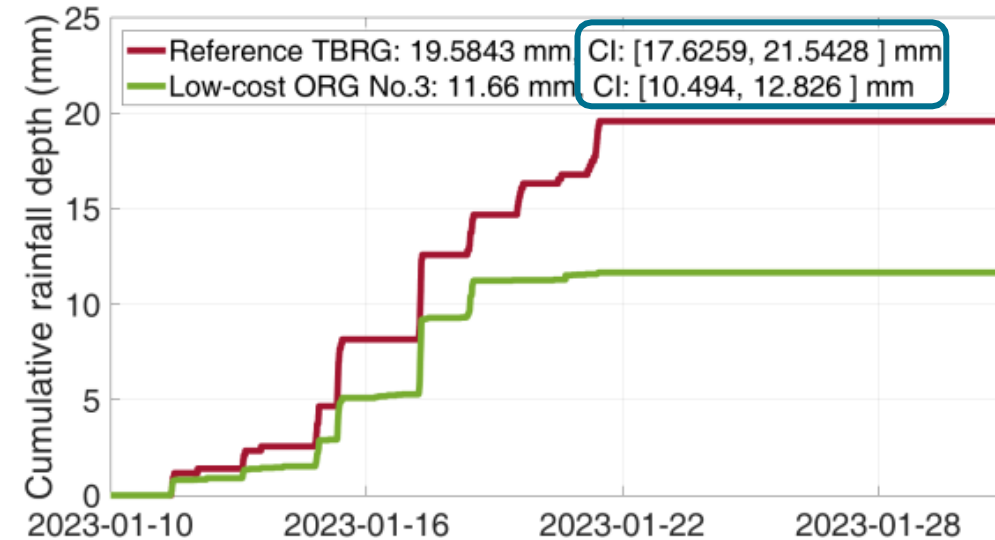
- Low-cost optical rain gauge



Optical rain gauge No.1



Optical rain gauge No.3

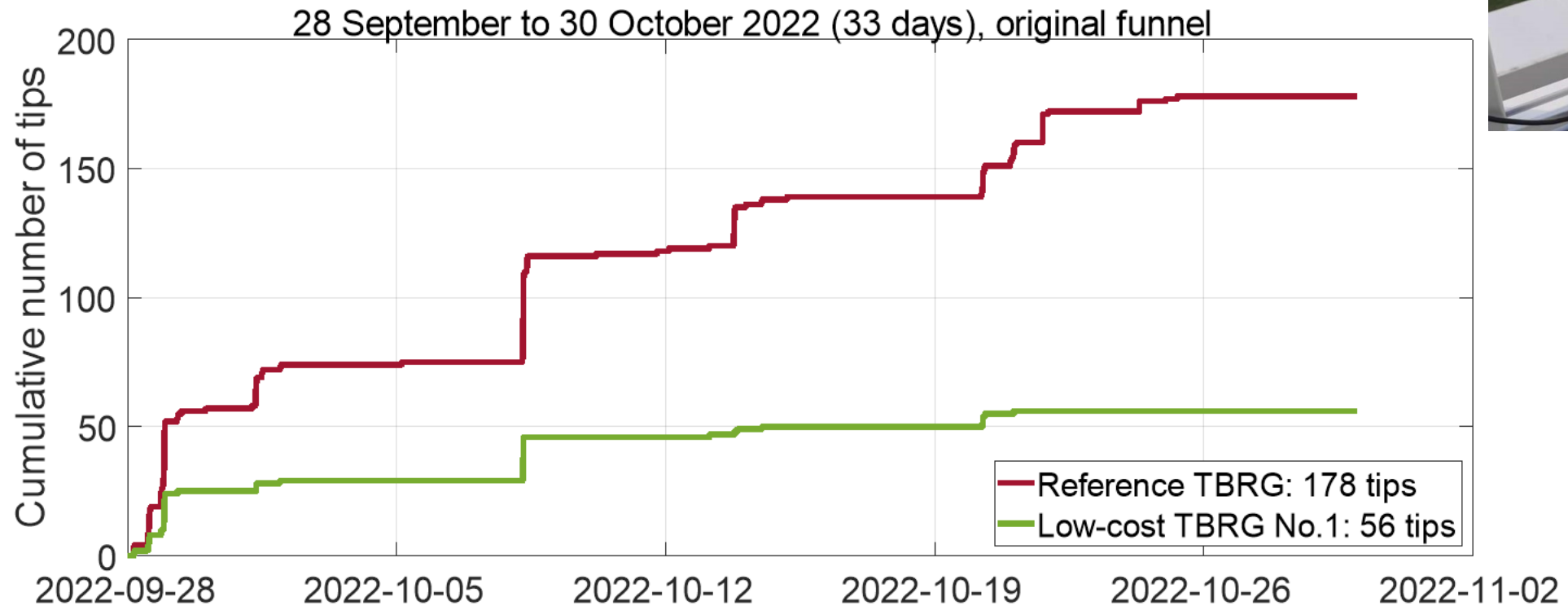


CI: Coverage Interval with enlarged uncertainty 10%

- Low-cost optical rain gauge RG-15 has poor reproducibility

5. How do the rain gauges perform?

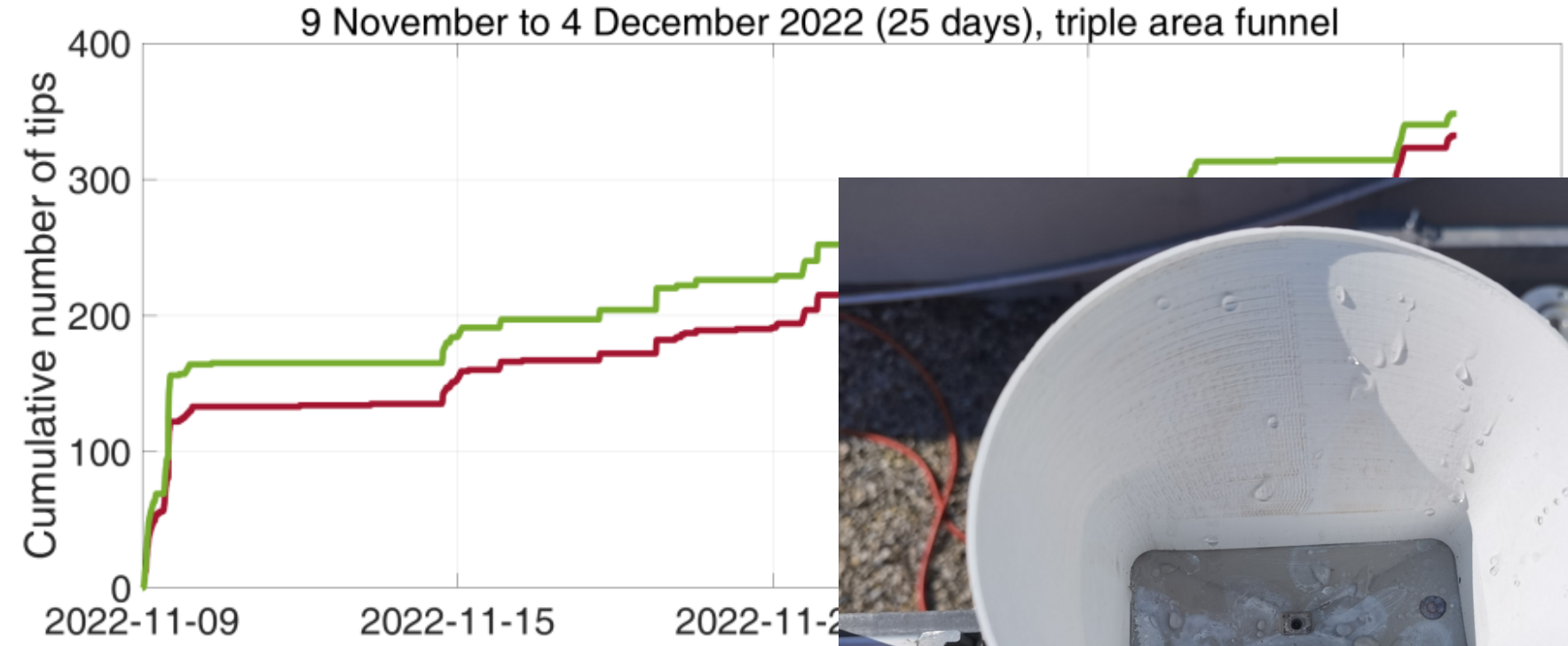
- Low-cost tipping bucket rain gauge



- Low-cost tipping bucket rain gauge resolution with original funnel without lubrication : ~ 0.60 mm/tip

5. How do the rain gauges perform?

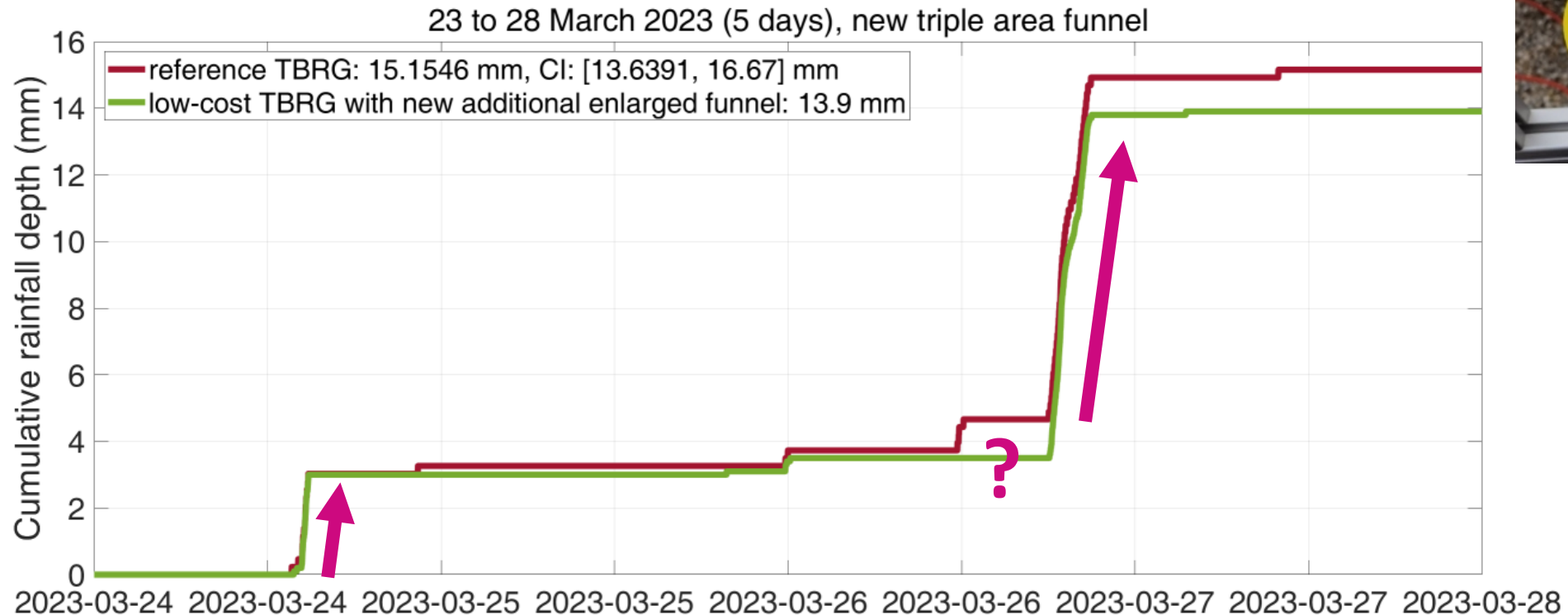
- Low-cost tipping bucket rain gauge improvement



- Low-cost tipping bucket rain gauge enlarged funnel without lubrication.
- Calibration result: ~ 0.10 mm/tip

5. How do the rain gauges perform?

- Low-cost tipping bucket rain gauge improvement



- Low-cost tipping bucket rain gauge resolution with conical shape triple area enlarged funnel and lubrication: ~ 0.10 mm/tip

6. What are the general findings and the future work?

- **General findings**

1. Optical rain gauge RG-15:

1. experiment shows significant sensor to sensor variance

2. Tipping bucket rain gauge WH-SP-RG:

1. The bucket part of this sensor is stable during test
2. Its funnel is too small, shallow and unsmooth, should not try it without modify its stormwater catchment funnel

3. DIY (Do It Yourself) station:

1. Its local data storage function meets the design objective
2. Its online data has imponderable uncertainty

- **Future work**

1. Optimize design for mass production and deployment

2. Develop an automated tipping bucket rain gauge calibration method

3. Validate the effectiveness of large-scale low-cost rainfall monitoring station deployments in practice and in models

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Thank you for your attention

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