Università di Genova
DICCA DIPARTIMENTO DI INGEGNERIA CIVILE, CHIMICA E AMBIENTALE

This presentation participates in OSPP

EGU

Outstanding Student & PhD candidate Presentation contest

A precision raindrop generator to calibrate non-catching rain gauges

Enrico Chinchella, Mattia Stagnaro, Arianna Cauteruccio, Luca G. Lanza

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LC-PrIn B. Castelli

INCIPIT Metrology for non-catching rain instruments

Sharing is encouraged

Calibration of precipitation gauges is necessary to evaluate performance of instruments and improve measurements

Catching type gauges collect precipitation in a reservoir

Calibration can be achieved reproducing only the water flux

EN 17277:2019

A new class of in-situ precipitation gauges is steadily being adopted

Non-catching gauges

No standard procedure for calibration!

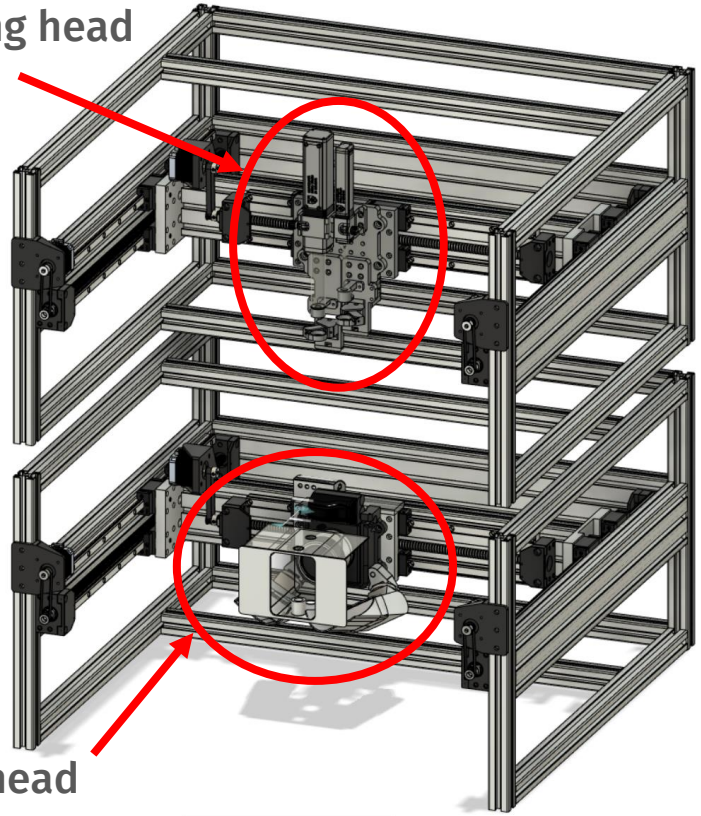
The “Incipit” project “*Calibration and accuracy of non-catching type instruments to measure liquid/solid atmospheric precipitation*”, started July 2019.

Non-catching type gauges sense each hydrometeor independently

For calibration individual drops must be reproduced both in size and fall velocity

Dispensing head

RAINFALL GENERATOR



Camera head

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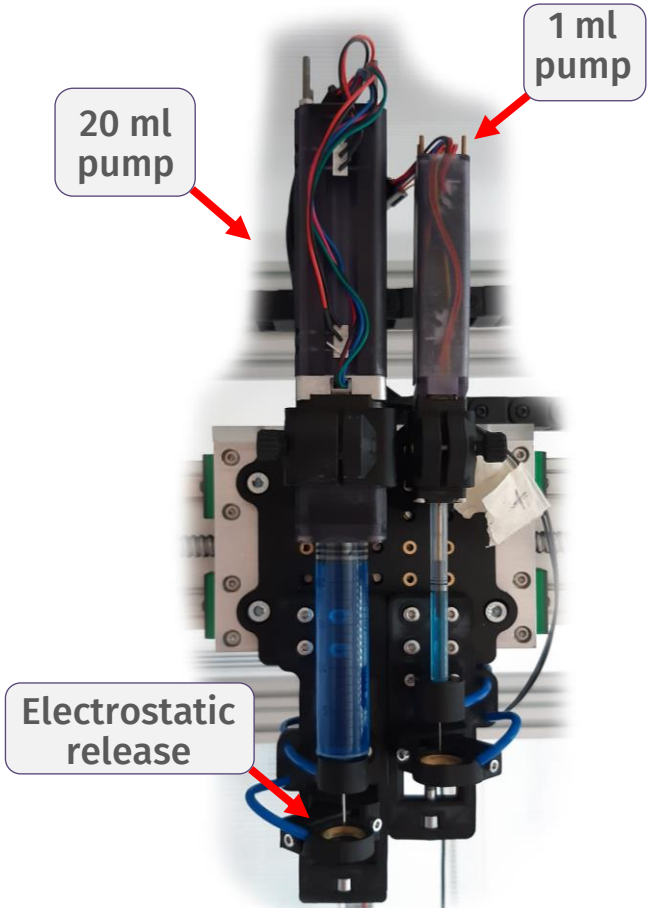
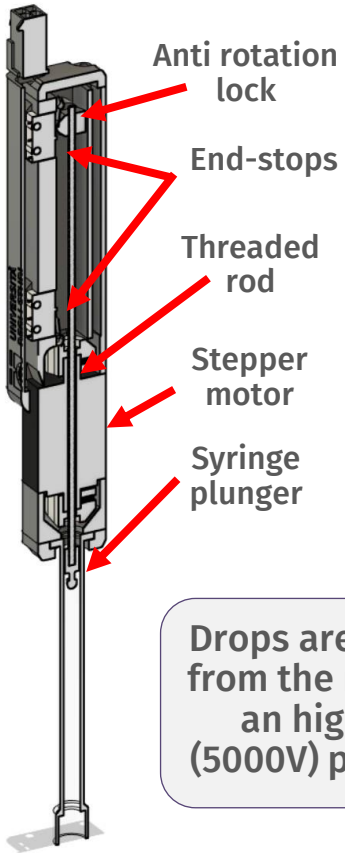
- Drops from 0.5 mm up to 6 mm → Complex drops dispenser with interchangeable nozzles
- Fall velocity close to the terminal → Large height required for release and shielding against air gusts necessary
- Independent measurement of drops → Combination of photogrammetry and high speed photography

To produce individual drops, high precision pumps are used in combination with calibrated needles





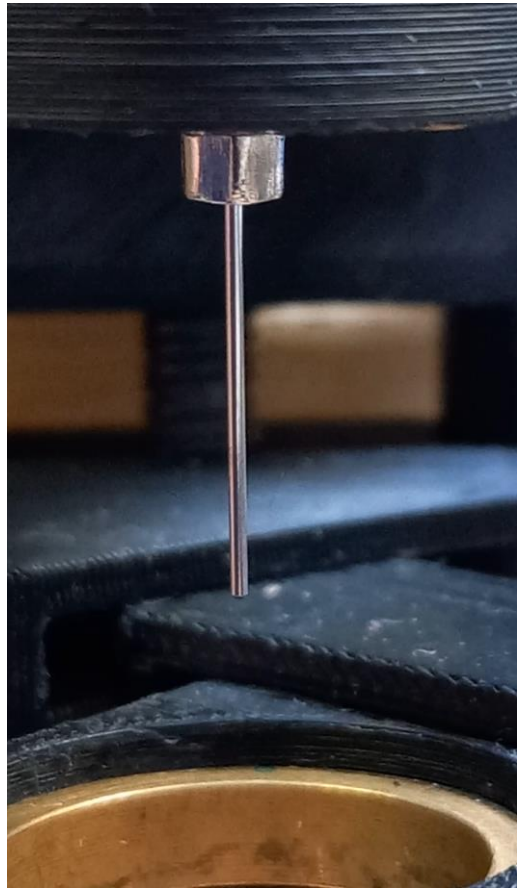
1 ml pump

- Movement resolution **0.001 mm**
- Volume resolution **0.023 µl**

20 ml pump

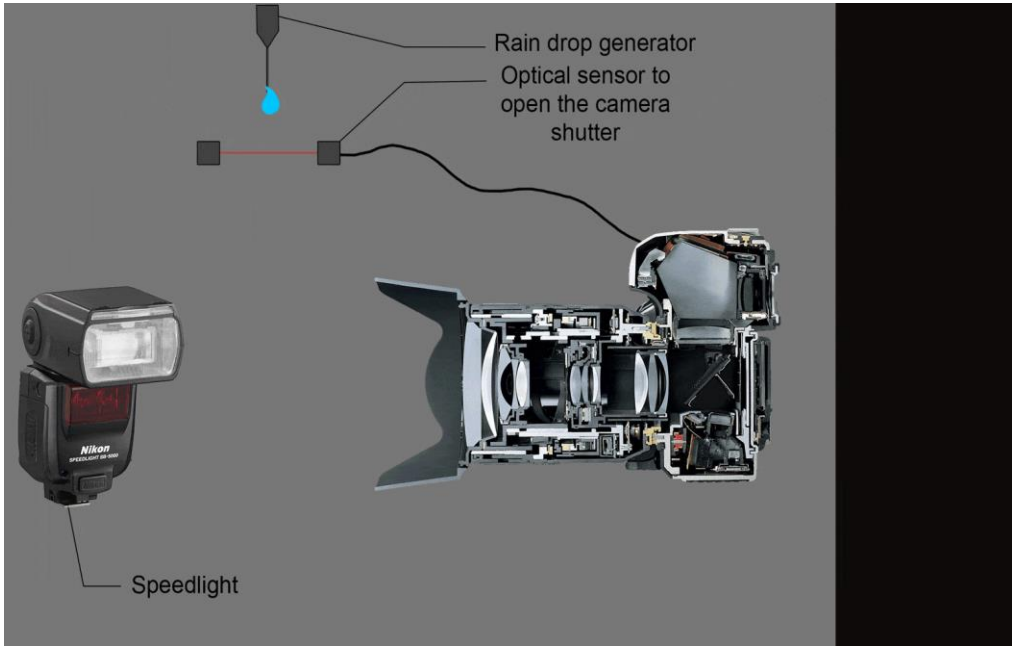
- Movement resolution **0.0013 mm**
- Volume resolution **0.35 µl**

Drops are dethatched from the needle using an high-voltage (5000V) power supply

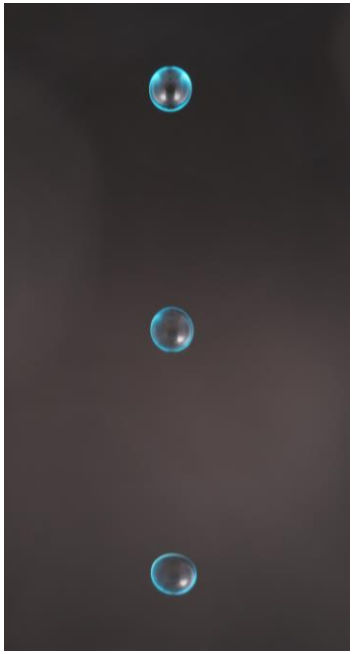


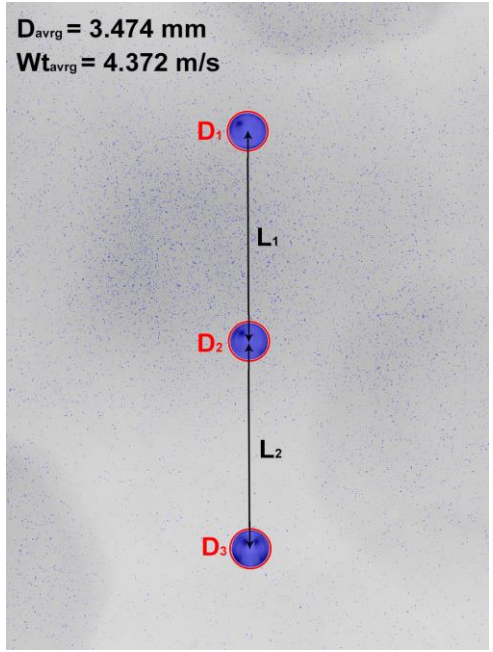
In-flight, contactless, drop measurement

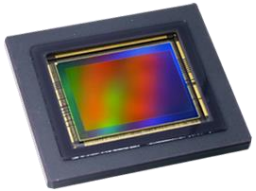
By mean of high speed photography technique 3 images of the drop are recorded



Images are automatically processed by a software obtaining size and fall velocity



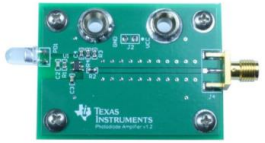




APS-C sensor 23.5 x 15.6 mm

24.2 M pixels 3.89 µm pixel pitch

A photodiode is used to measure the exact time interval between flashes



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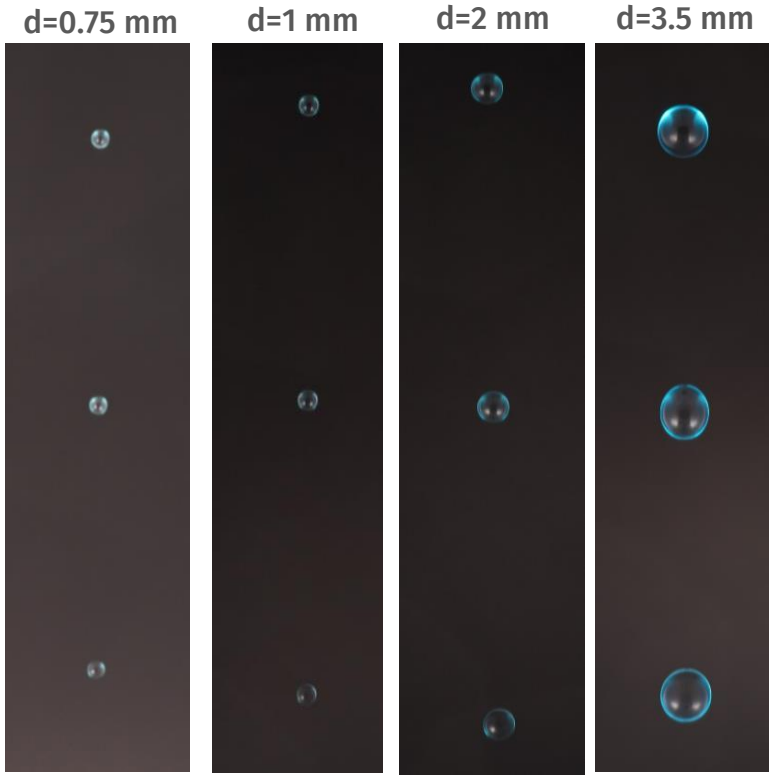
The characterization of the drop generation system was done by releasing 50 drops from an height of 1.2 m in a controlled environment and photographing each one in flight



N drops	Nominal D [mm]	Avg D [mm]	Std dev D [mm]	Max D [mm]	Min D [mm]	Fall velocity of average drop [m/s]	Fraction of the terminal velocity [%]
50	3,5	3,42	0,15	3,77	3,08	4,47	50,8
50	2	1,77	0,05	1,98	1,70	4,06	68,4
50	1	1,12	0,04	1,25	1,06	3,50	81,4
50	0,75	0,85	0,01	0,89	0,83	3,02	91,0

N drops	Nominal D [mm]	Avg V [m/s]	Std dev V [m/s]	Max V [m/s]	Min V [m/s]	Theoretical fall velocity of average drop [m/s]	Fraction of the terminal velocity [%]
50	3,5	4,36	0,12	4,56	3,98	4,47	50,8
50	2	3,79	0,10	4,08	3,65	4,06	68,4
50	1	3,29	0,05	3,19	4,54	3,50	81,4
50	0,75	2,72	0,04	2,81	2,65	3,02	91,0

Software results were tested against the results of a precision scale

N drops	Nominal D [mm]	Scale Avg D [mm]	Software Avg D [mm]	Error [%]
20	5	4,622	5,041	9.07
40	3	3,026	3,072	1.51
20	1.5	1,551	1,538	-0.82

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