

# Performance of Microwave Disdrometer Pludix at very high rainfall rates

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## Abstract

Two very high intensity rainfall events were detected in Bologna, with a Pludix microwave disdrometer, on the terrace of ISAC Institute, with a tipping bucket rain gauge aside. The data from the two instruments are different but while at low RFR the difference is minimal, it increases at increasing rain intensity, with up to 1mm in half an hour. As for comparison with other disdrometers we began by operating a Campbell, aside Pludix. Preliminary results of this disdrometer will be presented. Finally a perspective of microwave disdrometers in the light of advances in antenna design and microwave module will be given.

On september 4, 2012 two high intensity precipitation events occurred in Bologna, the first one at 0400, lasting about 20 min, the second at 1730 lasting more than one hour.

## The afternoon event as seen by Pludix alone.

Before entering the comparison of Pludix and Davis rain gauge we describe how the pm event has been detected by Pludix. The episode started at 17:28 and ended one hour later. Totally 7 mm of rain fell with RFR, for more than 3 minutes above 50 mm/h, one minute above 40mm/h with a peak of 58.76 mm/h and a total of 3.5 mm in less than 4 minutes. It is worth noting that Pludix spectrum did not exhibit a peak in the frequency spectrum, instead the profile as a whole rose almost uniformly indicating that drops in a quite large size interval were contributing. Pludix was capable of measuring without any problem precipitation of such an intensity and at the same time to detect the extreme variability of the phenomenon. The variability in particular was testified by the shift of maximum peak from 350 to 580 Hz. On occasion the spectrum was flat with no size of drops prevailing, except the very small ones, while on others the peak was at high frequencies, an indication of large drop sizes. The effect of "internal" break up was evident and sometimes the "mature" break-up (visible by a "nose" in the profile) was corresponding to the maximum drop size having been reached. Due to the great variability, the "mature" break-up can be observed occasionally, while in other cases the spectrum invades the area of hail indicating the presence of large drops with an ice core, the final stage of small melting groupels.

## Comparison Pludix – Tipping bucket

A Davis tipping bucket rain gauge and the MW Disdrometer Pludix recorded the two events, located as they were, aside, on top of ISAC Institute building in Bologna. The gauge was recording every half an hour while Pludix was regulated to record data every minute. While Davis gauge has two measurements in the morning event and three in the afternoon event, Pludix had 60 and 90 measurement respectively. The different characteristics of the two instruments are evident even considering the rain intensity alone. The "quantum" of rain requested to overturn the bucket is 0,2 mm of rain, while Pludix, based as it is on microwave backscattering of hydrometeors can record non zero values even for few thousands of rain mm. A rough evaluation of the cumulated rainfall quantity shows that at small rainfall rates the difference between the two instruments is of the order of 0,2 mm at most, while the difference is growing at growing precipitation intensities, up to 1 mm in half an hour of data (Fig. 4a and 5a). This is in agreement with the fact that rain overflow is the cause of the difference. The overflow is affecting both maximum intensity level and the value of cumulated quantity, but only in these high intensity legs of the events. The RFR level also is different for the two instruments, with more marked differences for high rates and reduced for smaller intensities. For smaller intensities the difference is reduced, and even reversing sign, without apparent explanation except that for Pludix the data is obtained indirectly from the power spectrum. Davis bucket might be influenced by the rate of filling of the bucket, as is the case when rain ceases at a bucket almost but not totally full (0430 to 0500). The few drops that cause the bucket to overturn mark the full 0,2 mm reading and corresponding RFR in the subsequent half hour, while the data would pertain to the previous one. We remind that Pludix can produce a DSD of rain every minute and lead to hydrometeor identification with PWS (Present Weather Sensor) capability.

We conclude that tipping bucket is reliable up to 50/60 mm/h and it is not at 100mm/h, so the limit of reliable data should be searched in the interval 50-100mm/h

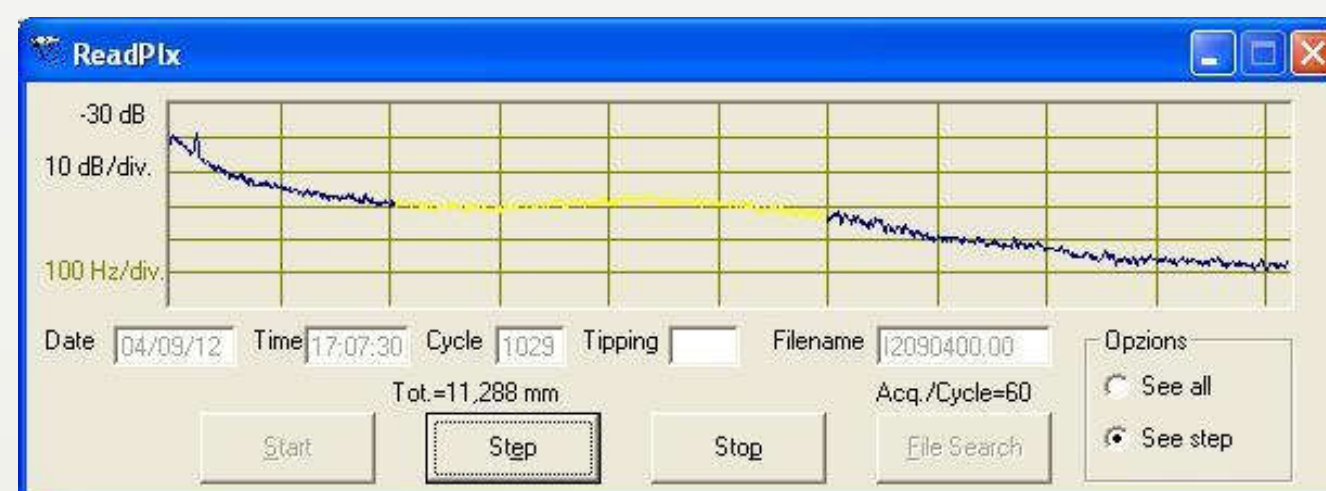


Fig.1 The minute of maximum precipitation intensity as recorded by Pludix

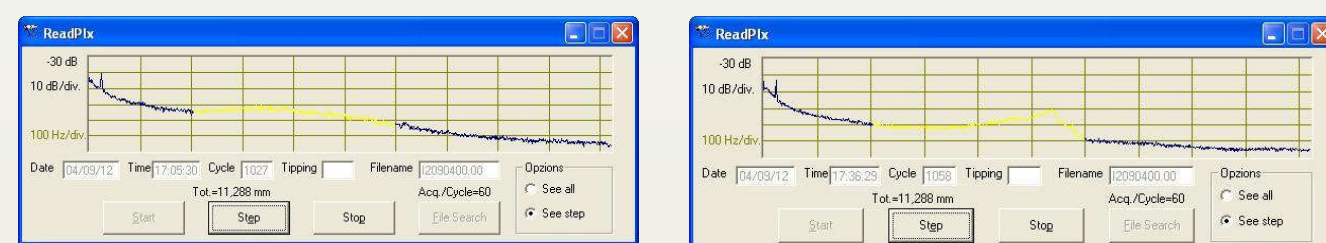


Fig.2 Variability of power spectrum during the event

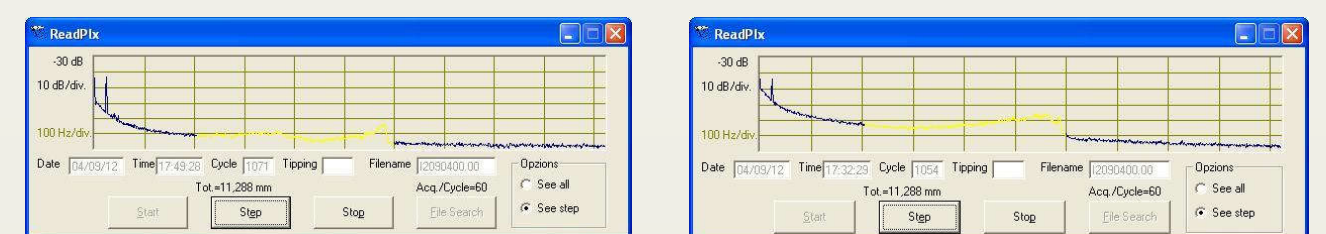


Fig.3 Evidence of "mature break up" indicating that the stage of maximum size of drops has been reached.

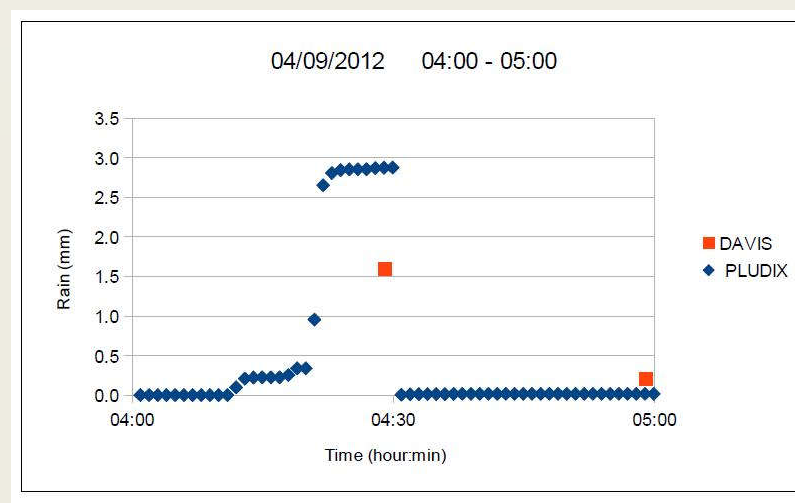


Fig.4a Precipitation cumulated in half hour

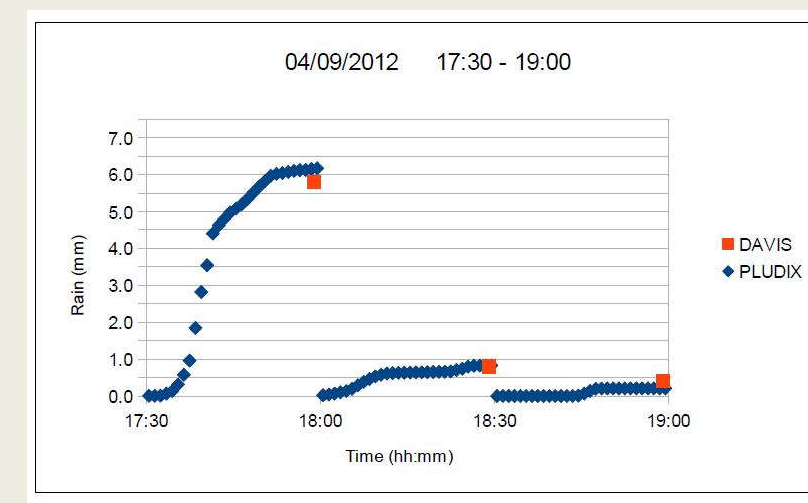


Fig.5a Precipitation cumulated in each half hour

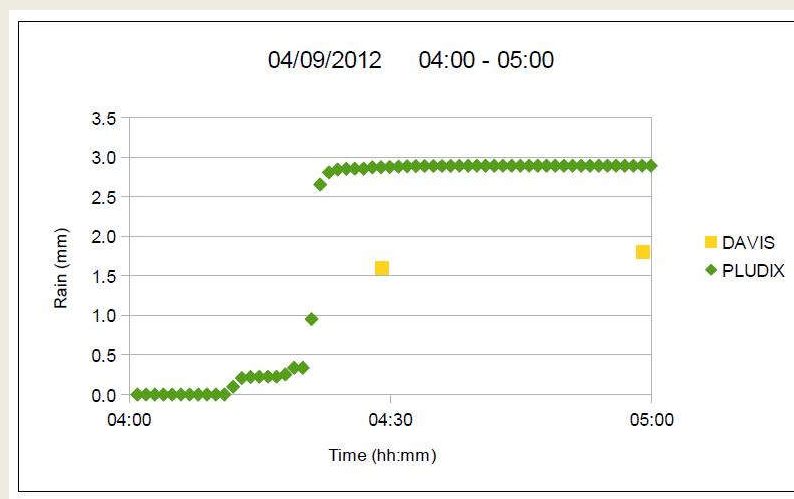


Fig.4b Total cumulated precipitation

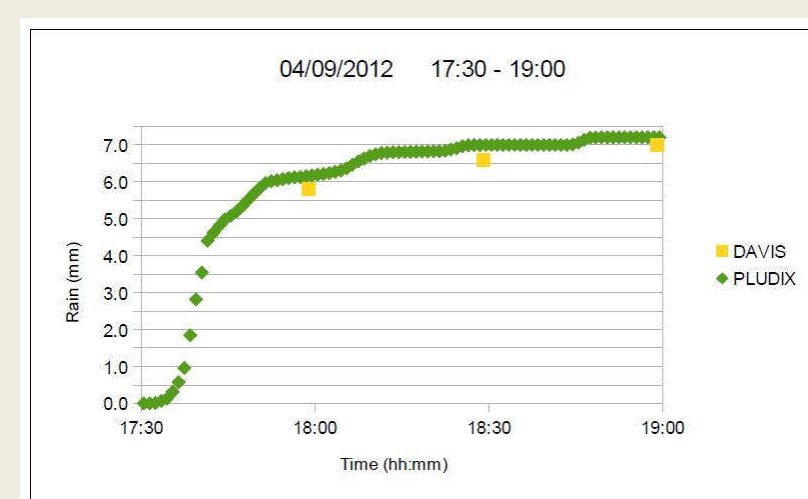
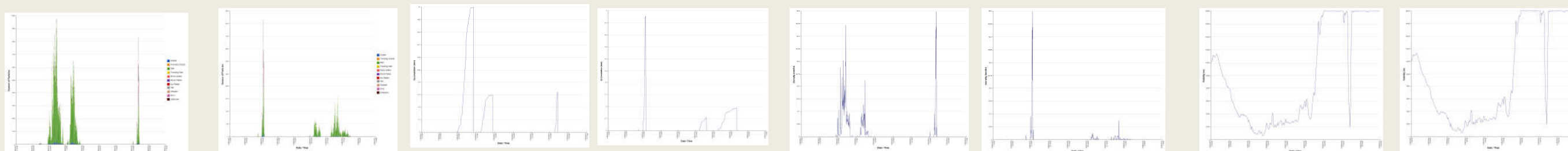


Fig.5b Total cumulated precipitation

## Future activity in this domain

### Inter-comparison of disdrometers

Given the growing interest in ground truth for precipitation detection from space inter-comparison of disdrometers based on different principles has been initiated. Here an example of hailfall detected by Campbell disdrometer on ISAC roof:



### Pludix upgrade activities

New data processing unit Patch antennas replacing horn antennas

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