

# OTT Parsivel® - Enhanced precipitation identifier and new generation of present weather sensor by OTT Messtechnik, Germany

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**OTT PARSIVEL®:** Laser-based optical Disdrometer for simultaneous measurement of **P**ARTicle **S**ize and **V**ELocity of all liquid and solid precipitation

## Background and design requirements:

The design requirements for the instrument lead to a universal Commercial Off-The-Shelf (COTS) equipment which meets substantially the meteorological and hydrological requirements of the sensor specification according to WMO and NWS regulation as an enhanced precipitation identifier and present weather sensor.

The patented extinction method for simultaneous measurements of particle size and velocity of all liquid and solid precipitation performs the direct physical measuring principle and classification of hydrometeors.

The instrument provides a full picture of the precipitation event in all weather phenomena and provides accurate reporting of precipitation types and intensities without degradation of performance in severe outdoor environments. Parsivel® operates in any climate weather regime and the incorporated heating device minimizes the negative effect of freezing and frozen precipitation accreting critical surfaces on the instrument.

This piece of equipment detects and identifies 8 different precipitation types as drizzle, mixed drizzle/rain, rain, mixed rain/snow, snow, snow grains, freezing rain and hail.

The output data - consisting of raw data, classification related to size and velocity of particles, rain accumulation and intensity, present weather reports and housekeeping data - make the instrument suitable to any kind of meteorological and hydrological application.



OTT Parsivel® - Enhanced Precipitation Identification Sensor

Parsivel® can be integrated into an Automated Surface/Weather Observing System (ASOS/AWOS) as part of the sensor suite. The derived data can be processed and included into the transmitted weather observation report and messages (WMO, SYNOP, METAR and NWS codes).

The new generation of Parsivel® disdrometer provides the latest state of the art laser optical technology. The data performance has been tested successfully in comparison with a meteorological observer with a distinction rate better than 97%.

Due to modern and high speed DSP technology the wide spectrum of precipitation from drizzle to tropical rain with extreme intensities up to 20 mm/min can be acquired and processed without limitation regarding influence of wind and

effecting catching orifice problems concerning conventional rain gauges.

The instrument supports meteorological observer missions in general and weather service missions for improving severe winter weather warnings for snow and ice conditions, flood forecast and warnings, support to aviation and road traffic, and severe thunderstorm forecast and warnings.

The derived radar reflectivity coefficient together with ground based precipitation data improves essentially the performance of the spatial weather radar information, improves the regional weather forecasts and high water early warning system by combination and correlation of precise and overall precipitation network data.

**Parsivel® feature unique performance**

- Patented extinction measurement procedure
- Unattended and reliable operation, using maintenance-free laser technology
- Operable in all environmental and weather conditions (lightning protection and self-regulated heating)

- Low power and heating operation by software commands

- Identification of all precipitation types, including mixed precipitation in the melting layer

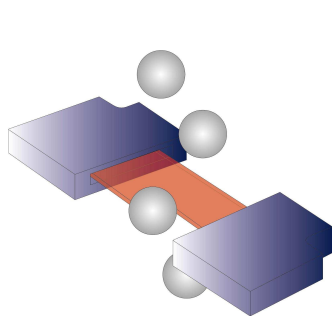
- Comprehensive precipitation analysis using 2-dimensional distribution of size and velocity

- Special measuring head prevents secondary spectra caused by drops splashing on the sensor head

- Transmitter and receiver head in perfect design with no obstacles for precipitation catching

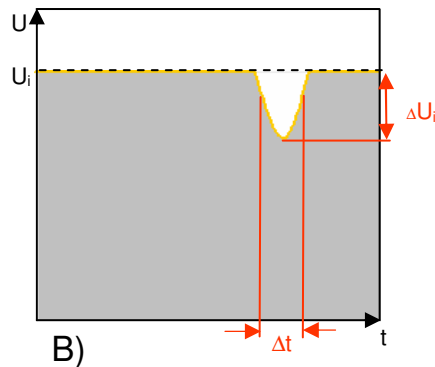
**Extinction measuring principle**

The new generation of enhanced precipitation identifier measures directly each single hydrometeor and performs a revolutionary change compared to forward scattered laser optical systems which needs additional sensors onboard and is based on experimental and proofed algorithm to determine the rain rate and identification of precipitation types.



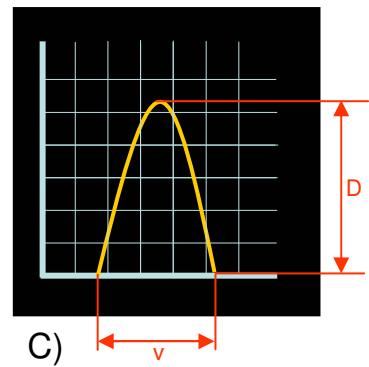
A)

A) The sensor's transmitter unit generates a flat, horizontal beam of light, which the receiver unit converts into an electric signal.



B)

B) This signal changes whenever a hydrometeor falls through the beam anywhere within the measurement area



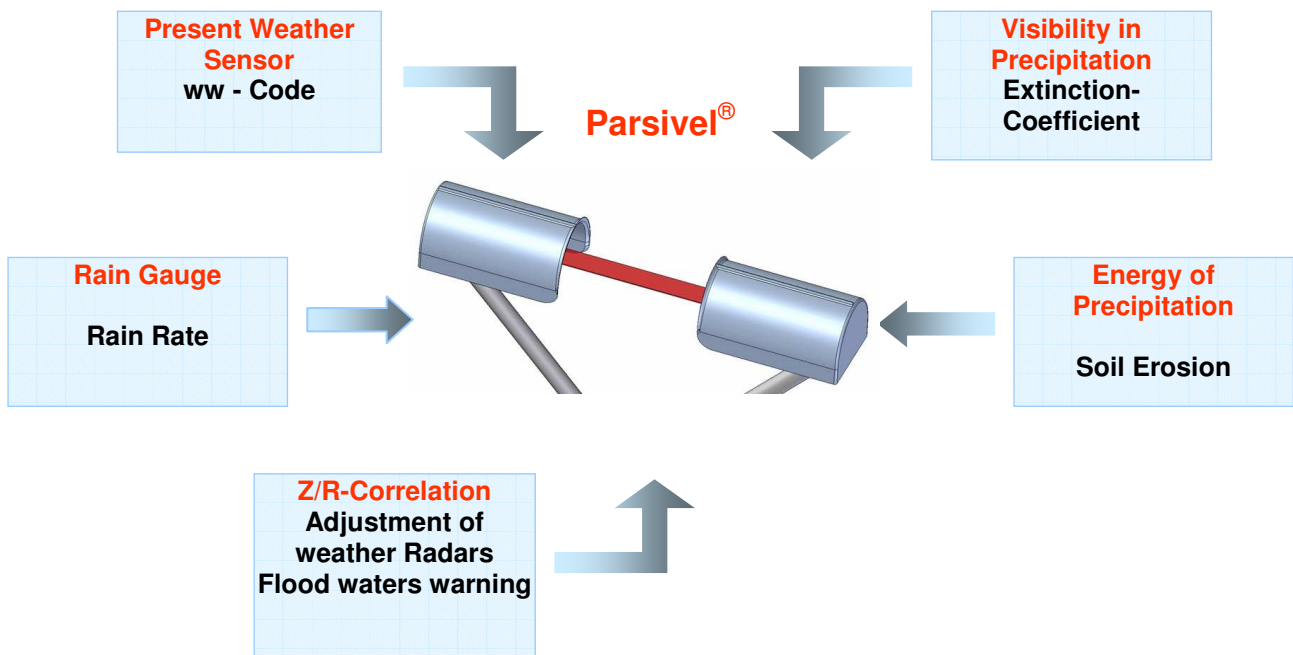
C)

C) The degree of dimming is a measure of the hydrometer's size, and together with duration of the signal, the fall velocity can be derived.

**Multipurpose instrument featuring enhanced precipitation measurements:**

The full data output of precipitation is accomplished with additional algorithm and the derived data make the instrument

suitable for the use in various meteorological and hydrological applications featuring five single instruments in one unique unit:



The different Features of the Parsivel®

**Precipitation**

Measurements designed for determining the distribution and amount of precipitation can be carried out maintenance-free with Parsivel®, regardless of the intensity, duration or type of precipitation. Additionally, its composition – i. e. the distribution of particles with respect to their type – is obtained directly from the measured sizes and velocities of each single particle and is recorded statistically.

**Present Weather Sensor (PWS)**

The present weather and the types of precipitation (rain, drizzle, snow, hail and sleet) are classified in accordance with a weather code established by the WMO. Unmanned weather stations require automatic detection, reliably and unambiguously. Parsivel® can ascertain the type, quantity and composition of the

hydrometeor and the atmospheric visibility – in every kind of weather!

**Monitoring of disposal sites**

The functions of precipitation kinetic energy distribution and precipitation measurement are utilised by Parsivel® to record the effect of rain on the condition of the disposal sites in conjunction with other sensors, e. g. ground-condition probes.

**Monitoring road conditions**

Local intense precipitation can lead to aquaplaning or packed snow on roads. Therefore, rapid traffic warning and control systems are necessary in order to prevent accidents. Precipitation measurement, hydrometeor composition and atmospheric visibility are of considerable importance in such systems. Parsivel® is an integrated instrument that

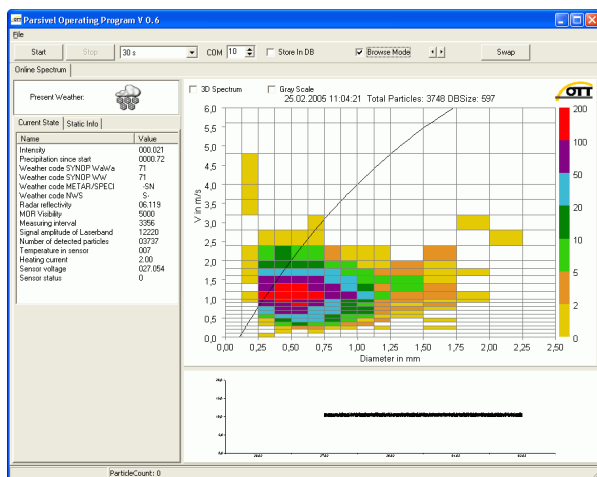
measures all required parameters in accurate quality and performance.

### Flood early warning

To assure a timely warning of impending high water it is necessary to measure the amount and spatial distribution of precipitation rapidly and accurately. This goal can be achieved by combining weather radar measurements (spatial information with reduced accuracy) and ground based disdrometer measurements: Parsivel® provides drop size distributions on the ground and a function to derive a local Z/R relation – ready to be used to adjust the radar data. In combination with water level sensors and drainage modelling, a high-performance regional flood early warning system can be erected.

### Expert Software ASDO

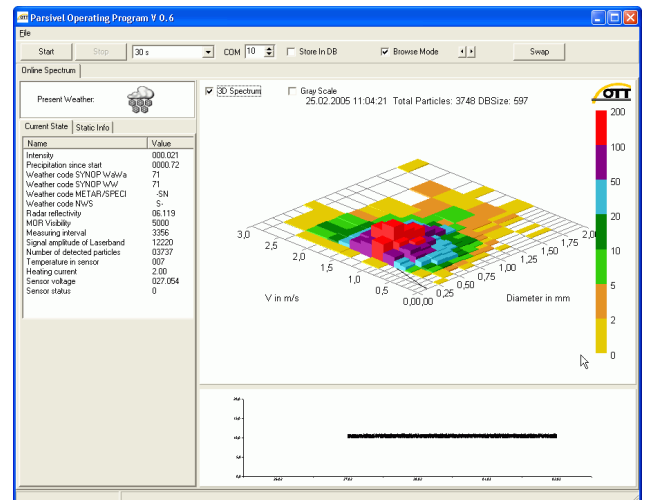
The corresponding Software ASDO monitors the outdoor precipitation event to comfortable indoor evaluation with windows performance.



Screenshot ASDO – Tabular view and 2D Mode

The sensor transmits all data to a PC and supports the observer with full information of present weather and precipitation and provides a history of precipitation falls stored in a data base. Present weather icon, all derived precipitation data and weather codes as well as housekeeping data like supply, voltage laser output

energy and firmware related information are displayed as digital information.



Screenshot ASDO- 3D Mode

The precipitation spectrum can be evaluated as graphical displays and spectrum distribution in 2 and 3 dimensional mode.

All data are stored in a powerful data base and can be retrieved by browser with related date and time and displayed in equal form as online display.

All configuration tasks like time interval from 10 sec to 120 minutes, baud rate and size of telegram and others can be selected and stored as configured variables.

## **Parsivel® references includes e.g.:**

- USA
  - NASA
  - University of Iowa
  - University of Washington
- Europe
  - Deutsche Wetterdienst DWD Hamburg Germany
  - Germatronik Neuss Germany
  - BAST Munich Germany
  - University of Hannover Germany
  - University of Freiburg Germany
  - University of Grenoble France
  - Met Office UK
- Asia/Pacific
  - Meteorological Service Turkey
  - National Space Development Japan
  - CSIRO Australia

## **Scientific Essays**

Löffler-Mang, M., and J. Joss, 2000: An optical disdrometer for measuring size and velocity of hydrometeors. *J. Atmos. Ocean. Tech.*, 17, 130-139.

Löffler-Mang, M., and U. Blahak, 2001: Estimation of the equivalent radar reflectivity factor from measured snow size spectra. *J. Appl. Meteor.*, 40, 843-849.

Jitze P. van der Meulen, 2003: Exploratory actions on automatic Present Weather observations; Final Report with recommendations EUMETNET

Yuter, S. E., D. Kingsmill, L. B. Nance, and M. Löffler-Mang, 2005: Observations of precipitation characteristics near and within the melting layer. *J. Atmos. Sci.*, revised.

## **Parsivel® History**

1995 -1998

First ideas, prototypes and tests of a laser based optical disdrometer by Dr. Löffler-Mang (University Karlsruhe)

1999

Foundation of PMTech motivated by the intention of the DWD to provide it's planned "Messnetz 2000" (OTT delivers the Pluvio) with fully automatic weather stations. The Parsivel® development, characteristics, and practical evaluations were done in close cooperation with DWD, Hamburg.

2000 - 2003

Enhancements on the electronic components and the algorithms were done. During that time intensive tests at customer's sites were performed. PMTech concentrate on development, manufacture and repair, distribution agreement with Scintec AG, Tübingen. Parsivel M300 operational in different applications

2004

OTT took over all rights and the production know-how of the Parsivel® technology



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