Single particle depolarization measurement for aerosol characterization and classification

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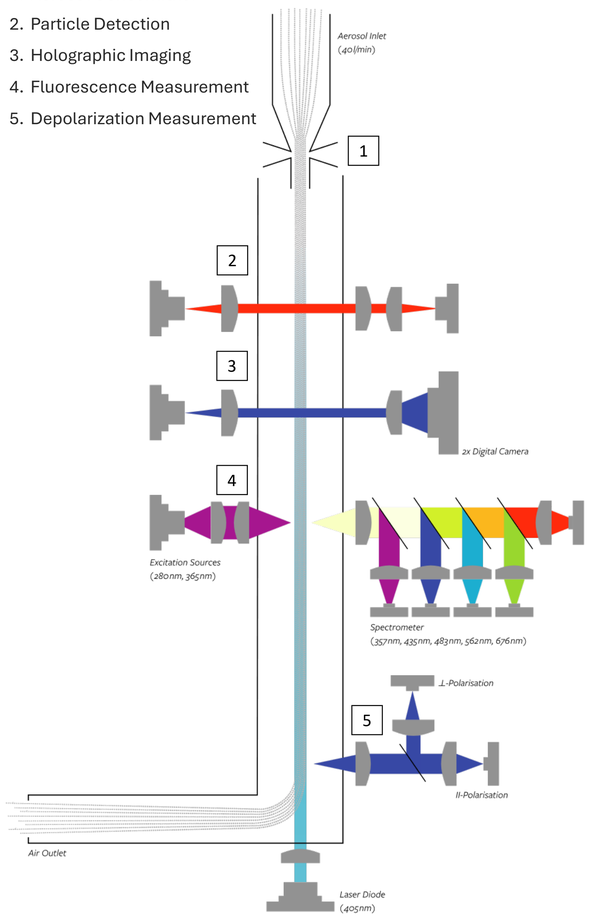
INTRODUCTION

- **Goal:**
  Simplification and validation of depolarization measurement and cross-instrument validation
- **Instrument:** SwisensPoleno Jupiter
  - Light scattering
  - Holography imaging
  - Fluorescence measurement
  - Polarization measurement
- **Approach:**
  Aggregation of time-resolved s/p-intensity, calculation of depolarization ratio
- **Validation:**
  Compare depolarization ratio of pollen, mineral dust, and ultra pure water droplets with multiple SwisensPoleno Jupiter

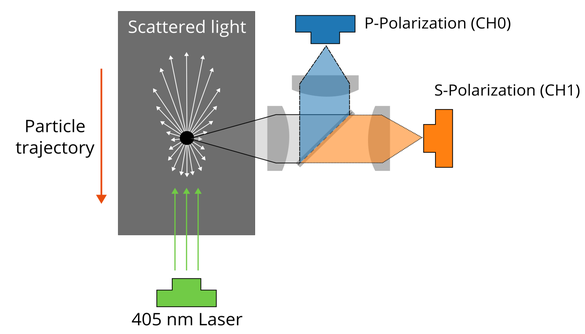
Depolarization: *Change of polarization states of light after interacting with, for example, an aerosol particle.*

SwisensPoleno Jupiter

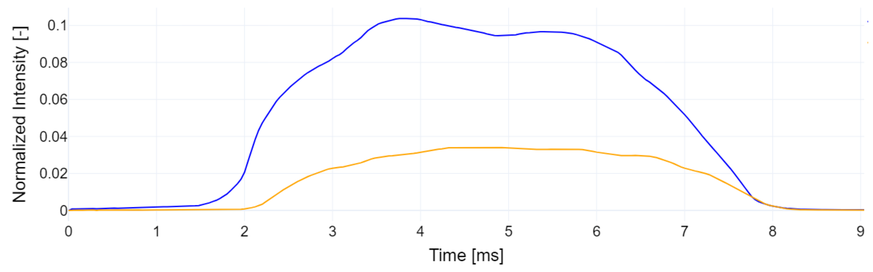
1. Aerosol Concentrator
2. Particle Detection
3. Holographic Imaging
4. Fluorescence Measurement
5. Depolarization Measurement



1 – DEPOLARIZATION MEASUREMENT



- **Illumination** of single particle with 405nm Laser in flight direction (from below)



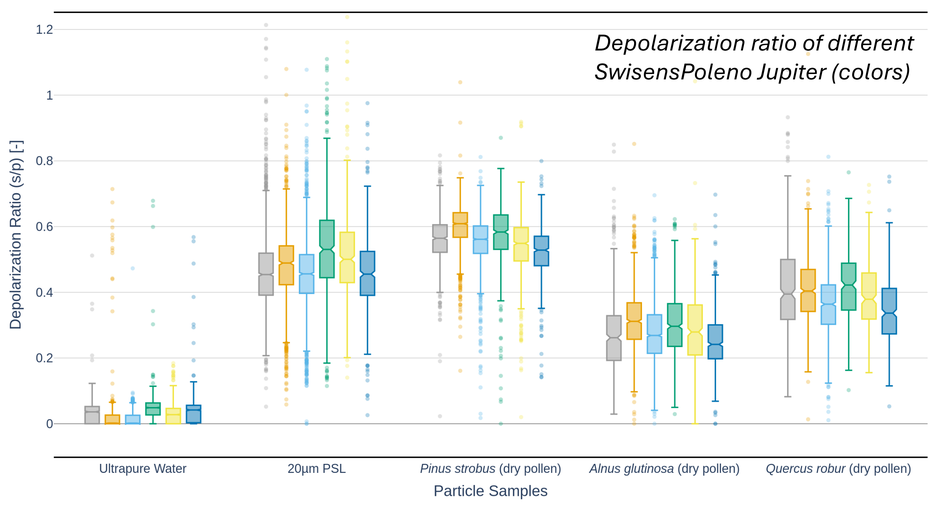
- Time-resolved **measurement** of $I_p(t)$ (blue) and $I_s(t)$ (orange) at 90° scattering angle of the particle (Alnus pollen)

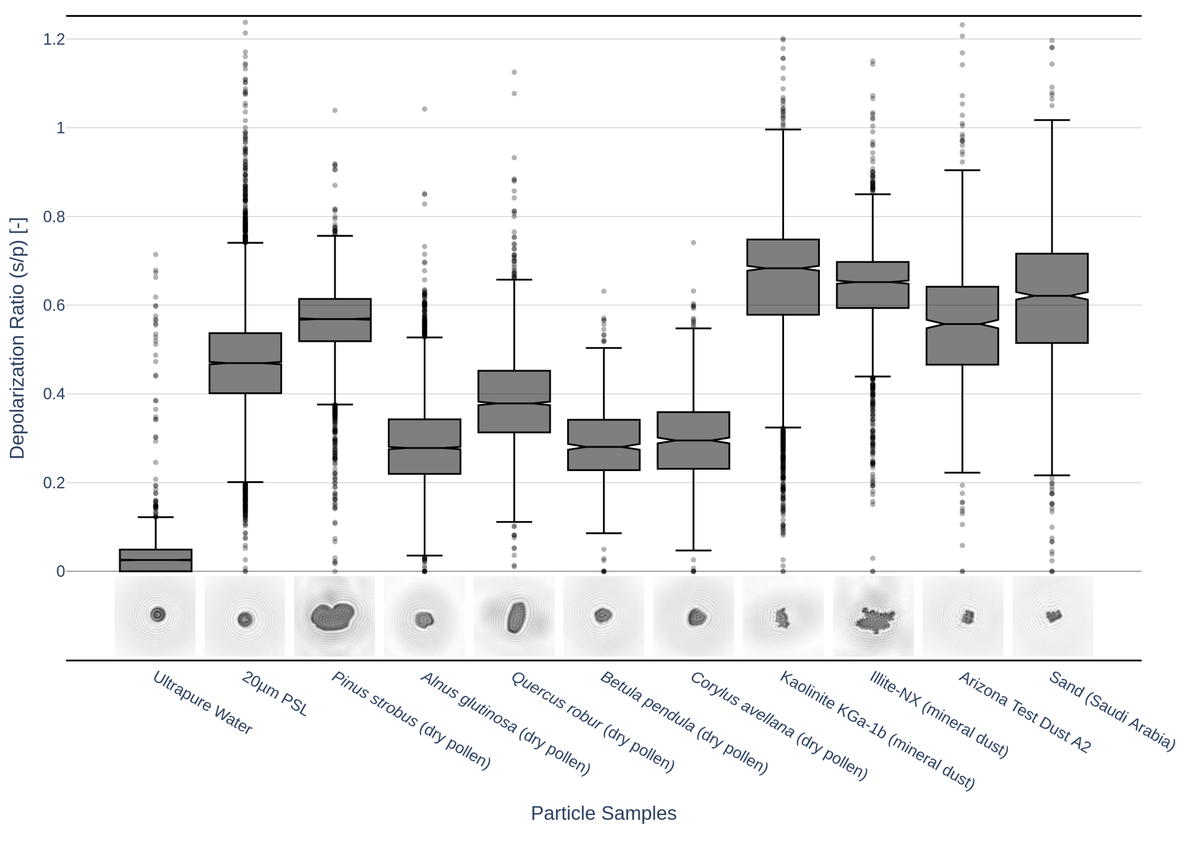
2 – DATA PROCESSING

- **Offset:** Raw depolarization time series were offset corrected by subtracting stray light obtained with background measurements (no particles present)
- **Signal quality:**
  - Intensities below 3.7-times the standard deviation of the background (no particles) are set to zero.
  - Particles for which the maximum of the total normalized intensity of the signal ($I_s(t) + I_p(t)$) does not exceed a threshold (0.015 → less than ~10% error) are discarded.
  - Particles for which the normalized intensity of one channel exceeds 0.99 – $offset$ during more than 10% of the time are discarded, due to saturation.
- **Aggregation:** Channel intensities are integrated over the main signal window (excluding short start/end section) for optimal results.
- **Depolarization ratio** is defined with the integrated intensities as: $$\rho = \frac{\int I_s(t)dt}{\int I_p(t)dt}$$

3 – RESULTS

- **Water droplets:** Expected low depolarization ratio (<0.1) for spherical water droplets
- **Irregular:** Depolarization ratio approx. 0.2 – 0.4 for Alnus, Betula, Corylus and Quercus pollen
- **Very irregular:** Highest depolarization ratio for *Pinus strobus* and dusts, as expected
- **20µm PSL:** Lower depolarization ratio for spherical polystyrene beads than expected (~0.9)
- **Instrument comparisons:** Good overall agreement, with differences possibly explainable with dataset differences.
- Broad distributions per sample indicate too lax signal validation criteria





CONCLUSIONS

- Reasonable depolarization ratios with proposed data processing and aggregation
- Depolarization ratio has expected behavior regarding particle shape
- Further investigation of 20µm PSL necessary, due to unexpected depolarization ratio
- Different SwisensPoleno instruments show very similar depolarization ratios
- Improvement of data quality with stricter data validation
- Benefit of depolarization ratio for aerosol particle classification needs to be analyzed

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