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Visualization of the Transient Fluid Dynamics of a Dense Particulate Liquid-Solid System

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The hydraulic transport of dense particulate systems of solids is in general a three dimensional phenomenon, which cannot be reduced to a pseudo-two dimensional system without losing crucial information about the fluid dynamics of the complex interaction between liquid and solid phase. Especially, if the liquid-solid system is operated in a pulsed state, the distinction between wall-far and wall-near effects cannot be neglected.
To determine the impact of pulsed flow characteristics on the behavior of the disperse phase, the immersed solid phase is visualized by using the method of combined refractive index matched scanning (RIMS) and planar laser induced fluorescence (PLIF) [1]. Preparing the material system includes the search for proper materials (liquid, solid particles and soluble fluorescence dye with a small Stokes Shift), the determination of the temperature- and wavelength-dependent refractive indices and finding the allowed temperature range. Further, a trade-off between light sheet thickness, dye concentration and required pulse energy is needed to optimize the contrast between particles and liquid.

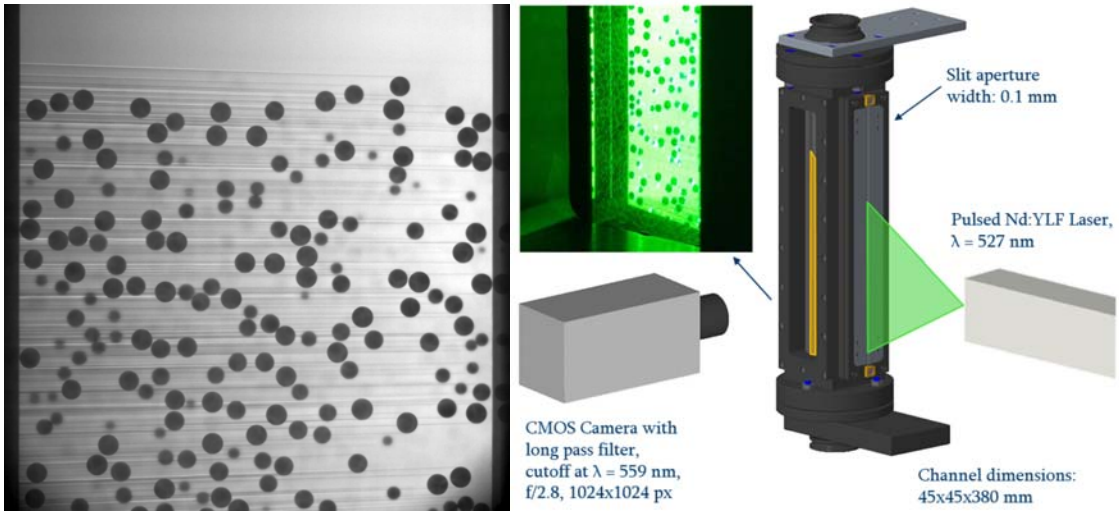

Figure 1: Obtained picture quality (left) and optical setup (right).

Access to the particle system is granted by a measuring channel within the liquid circuit, which can be operated in steady and non-steady states. A long slit aperture mounted to the channel is capable to generate a homogeneous light sheet thickness and allows the particle detection at different bed heights, which means different solid volume fractions. Besides the obtained time-

resolved optical data, the systems pressure and volume flow profiles are measured and can be assigned to the pictures by use of a common trigger signal. The high resolution and a very narrow particle size distribution of the solid particles allow a calibration in depth direction, where changes in particle size can be used to estimate the particles movement in the third axis (traverse to the light sheet).

References

1) Dijksman, J. A. et al: *Invited Article: Refractive Index Matched Scanning of Dense Granular Materials*. In: Review of Scientific Instruments 83, 2012