X-ray multi-projection imaging: enabling fast volumetric information for fluid dynamics

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X-ray multi-projection imaging (XMPI) [1] is an X-ray imaging technique capable of probing natural processes with a micrometer to nanometer resolution and resolving millisecond to microsecond dynamics. This technique splits a single X-ray pulse or flash into several angularly resolved beams, which illuminate the sample simultaneously. This approach, therefore, avoids scanning the sample as required by current 3D X-ray techniques, such as state-of-the-art time-resolved tomography. Thus, it prevents the introduction of forces due to the scanning process that may hinder the studied dynamics, which is especially relevant for non-rigid systems like the ones studied by fluid dynamics.

In this oral contribution, we intend to introduce the concept of XMPI and report our proof-of-concept experiments with micrometer resolution at ESRF-EBS [2] and the European XFEL [3]. In such experiments, we demonstrated the possibility of acquiring volumetric information without rotating the sample at kHz and MHz acquisition rates at ESRF-EBS and the European XFEL, respectively. As an example of the applications of this enabling technique, we will present our study of MHz binary droplet collisions at 1.1 MHz acquisition rate with micrometer resolution [3]. We will also discuss the limits of XMPI, among them the challenge of reconstructing 3D movies from sparse projections. To address this, we will introduce ONIX [4], a novel reconstruction approach that combines several experiments on similar events to retrieve 3D movies from as few projections as three. We envision that XMPI will become an enabling tool to image fast fluid dynamics in 3D, opening the opportunity to study complex processes not yet observed.

References

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