The first year of user operation of the new ID29 for serial crystallography at the ESRF Extremely Brilliant Source

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Keywords: Serial crystallography, Room temperature, Time resolved protein crystallography

Forth generation synchrotron sources create new opportunities for expanding the research in structural biology and in protein crystallography in particular. The ESRF Extremely Brilliant Source upgrade programme was completed with the construction of the new ID29, the first world beamline completely dedicated to room temperature experiment and time resolved macromolecular serial crystallography. ID29 was completed last year and started the user operation in fall 2022. The beamline characteristics were designed in order to obtain diffraction data from micrometer sized crystalline samples and achieve a microsecond time resolution. The commissioning ID29 was made possible thanks to the development of a new class of instrumentation which included a new double chopper timing system, that is able to produce X-ray pulses of 10 microseconds, a new diffractometer, the MD3upSSX, that presents a flexible sample environment, that accommodate fixed target, viscous injectors, microfluidics or tape drive. The experimental setup is completed with a Jungfrau 4M detector that has been integrated in the ESRF data acquisition pipeline and can be operated at 1 khz data acquisition rate. A high repetition rate nanosecond laser is integrated into the beamline data acquisition system to perform pump\&probe experiments across a wide wavelength range. Experiments are performed using standard or in-house developed sample delivery systems. Additionally, novel devices elaborated by the user community can be accommodated upon request. The first experiments revealed how the high repetition rate and the wide bandwidth result in an optimal hit rate, regardless of the sample delivery method selected, with a extremely high percentage of successfully indexed diffraction pattern. Moreover, the pulsed beam, produced by the chopper system, besides allowing for time resolved experiments and mitigate the radiation damage effects which would be produced by continous exposure.

The first year of operation of ID29 reveal new perspectives for serial crystallography in the micro-to-millisecond time resolution across future 4th generation sources that are under development worldwide. In this presentation we will report from the first ground breaking experiments that took place in this initial year of operation of ID29, along with the beamline development roadmap and future plans.

\begin{figure}[h]
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\includegraphics[width=\textwidth]{figure1.png}
\caption{The MD3upSSX sample environment can accommodate viscosity extruder (left) and fixed target (right). Diffraction data are recorded at high repetition rate and microsecond integration time with the new Jungfrau 4M detector}
\end{figure}