Synchronization of Synchrotron Radiation Bursts during a spatio-temporal Instability in accelerator-Based source

Clément Evain[1], Abdoul-Aziz Diallo[1,2,3], Eléonore Roussel[1], Christophe Szwaj*[1], Maxime Herda[2,3], Marie-Agnès Tordeux[4], Fernand Ribeiro[4], Marie Labat[4], Nicolas Hubert[4], Jean-Blaise Brubach[4], Pascale Roy[4], and Serge Bielawski[1]

[1]Laboratoire de Physique des Lasers, Atomes et Molécules - UMR 8523 – Université de Lille, Centre National de la Recherche Scientifique, Université de Lille : UMR8523, Centre National de la Recherche Scientifique : UMR8523 – France

[2]Laboratoire Paul Painlevé - UMR 8524 – Université de Lille, Centre National de la Recherche Scientifique – France

[3]Centre Inria de l'Université de Lille – Institut National de Recherche en Informatique et en Automatique – France

[4]Synchrotron SOLEIL – Centre National de la Recherche Scientifique, Centre National de la Recherche Scientifique : UR1 – France

Résumé

We present a synchronization phenomena occuring in an accelerator-based light source. When relativistic electron bunches circulate in a storage ring and emit synchrotron radiation (used for user experiments), a systematic spatio-temporal instability arises when the bunch contains a large number of electrons. This instability is characterized by the spontaneous formation of microstructures within the bunch, which appear with a bursting behavior. We demonstrate that these bursting events can be synchronized with an external sinusoidal signal by modulating the electric field in a radiofrequency (RF) cavity. This external modulation induces typical synchronization features such as Arnold tongues at fundamental, harmonic, and subharmonic frequencies of the natural bursting rate, as well as phase-slip phenomena near the synchronization threshold. The synchronization mechanism is analyzed using numerical simulations based on the Vlasov–Fokker–Planck equation, and a proof-of-principle experiment is conducted at the SOLEIL synchrotron facility.

*Intervenant