

# Proposition de stages et mémoires

2021-2022

Le Service de Métrologie Nucléaire poursuit des activités dans les domaines de la proton thérapie et de la physique des accélérateurs avec plusieurs partenaires incluant l'Organisation Européenne pour la recherche nucléaire (CERN), Ion Beam Applications (IBA), le SCK-CEN et Royal Holloway (University of London). Les mémoires suivants sont proposés dans le cadre de ces collaborations aux étudiants de MA2 pour l'année académique 2021-2022.

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## 3. Transverse coupling resonance crossing and emittance exchange study in Vertical Fixed-Field Accelerators (VFFAs)

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The transverse emittances are physical beam parameters that characterize the density function of the transverse distribution of particles. They are of significant importance in the study of beam dynamics in particle accelerators. In the linear and uncoupled theory of motion, these transverse emittances are invariant. However, in realistic machines, a coupling of the transverse motion (residual coupling or coupling by design) drives coupling resonances. The transverse emittances are then pseudo-invariants, and a transverse emittance sharing occurs. Moreover, transverse emittance exchange is observed when dynamically crossing a coupling resonance. These phenomena have already been described theoretically and observed in several machines (notably in the CERN Proton Synchrotron).

The project aims to study the emittance exchange mechanism induced by resonance crossing and assess relevant parameters' influence (notably the time-dependent dynamics of the resonance crossing and the coupling strength). In addition to conventional machines, the study of resonances and resonances crossing will be extended to machines strongly coupled by design, such as the novel Vertical Fixed-Field Accelerators. This study will be carried out via simulations using the ray-tracing code Zgoubi and its python interface Zgoubidoo.

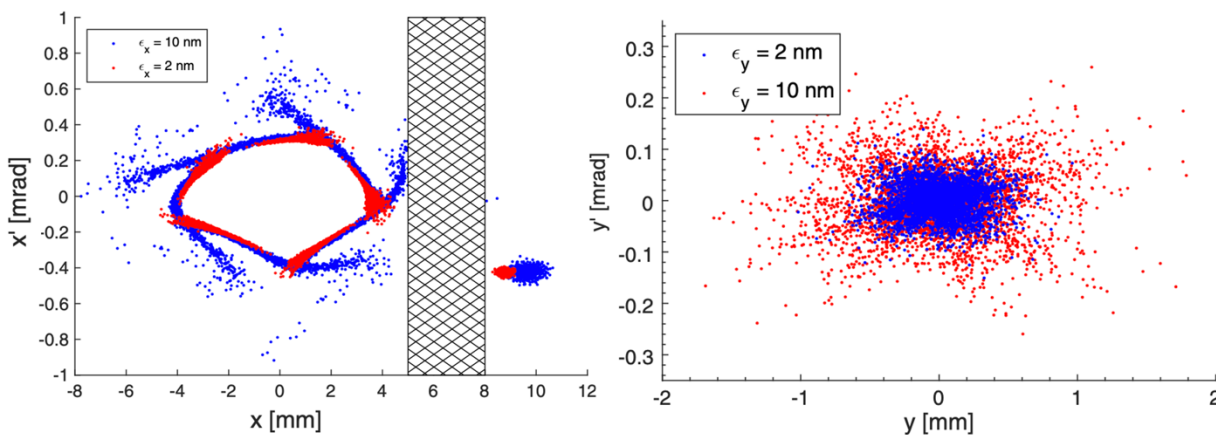


Figure 1 : Example of emittance exchange in the horizontal and vertical phase spaces (Kallestrup, J. and Aiba, M. (2020) 'Emittance exchange in electron booster synchrotron by coupling resonance crossing')