**Reconstruction of beam emission spectra produced by a large negative ion beam for fusion**

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Heating Neutral Beams (HNBs) for ITER will be based on large beams of hydrogen/deuterium atoms, about 1m x 2m in cross section, with a current up to 350 A/m2, and an acceleration energy up to 1 MeV [1]. These beams, made of 1280 individual beamlets, must fulfill strict requirements in terms of current uniformity and divergence to maximize their transmission through beam ducts. The plasma source SPIDER, an intermediate technological step towards the full-scale HNB prototype MITICA, has achieved the first phase of experimentation by testing source performances in caesium and investigating the physics of single isolated negative ion beamlets (28 out of 1280) by multiple beam diagnostics [2]. Upcoming SPIDER experimental activities foresee the extraction of a few hundred beamlets, as a midway goal to full beamlets (1280) extraction. In this configuration, the signal acquired by optical diagnostics will consist of the overlapping of many beamlets along the line of sights, with a consequent difficulty in distinguish the features of the individual beamlets, required to study the beam optics. To overcome the ambiguity due to volume-averaged data, beam emission models are required.

In this contribution, we present a numerical tool based on a Monte Carlo model to synthesize the spectra observed by the diagnostic of beam emission spectroscopy (BES), starting from the interaction of a single beamlet with the background gas. The preliminary results suggest that, despite the beamlets space mixing, the BES diagnostic is expected to provide useful information on the criss-cross effect and the mutual beamlet repulsion. In the case of MITICA, where beamlet groups have different directions converging to the plasma, separating the beam components will be essential. These studies are crucial to characterize the beam performances, while approaching ITER HNBs requirements.

[1] R. S. Hemsworth et al., [New J. Phys. **19,** 025005 (2017)](https://doi.org/10.1088/1367-2630/19/2/025005)

[2] G. Serianni et al., Rev. Sci. Instrum. **93**, 081101 (2022)