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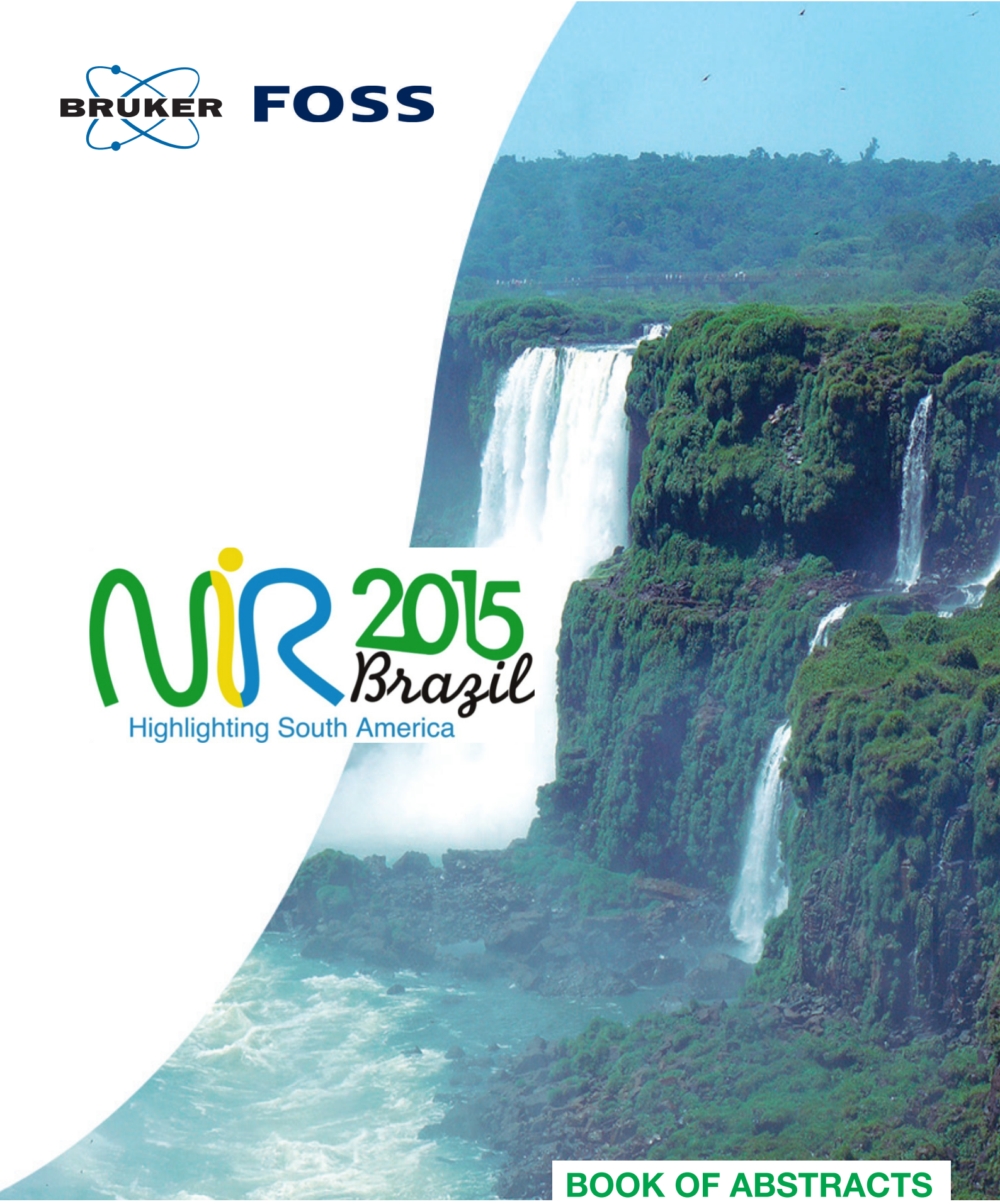

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Evaluation of Near Infrared Spectroscopy as a High-Throughput Phenotyping Method for Assessing the Natural Durability of Larch Wood

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Larch heartwood is appreciated for its aesthetic appearance and mechanical properties, and is deemed to be resistant to wood decay (natural durability). However, its natural durability has been shown to be variable ranging from “not durable” to “very durable” depending on the species, environmental conditions, age of trees, position within the tree and wood structure. It is thus crucial to characterize the natural durability of Larch wood. The natural durability of wood can be investigated in laboratory through a fungal infestation, but the approach is quite long (about 16 weeks). Near infrared spectroscopy (NIRS) is a potentially interesting alternative since wood decay resistance is correlated to the amount of wood extractives, mainly phenols, which can be accurately predicted by NIRS. As a result, NIRS calibration models for decay resistance have been reported in the literature. These models were developed using wood samples harvested on adult trees from natural populations of 2 larch species. However, commercially grown larches in western Europe are mostly hybrids between European and Japanese Larch species. Moreover, the reference data used for building the models were obtained according to the European norm EN 350-1, which has recently been replaced by the CEN/TS 15083-1. It is thus not straightforward to make use of previously developed models for evaluating the natural durability of larches in commercial plantations. Within this context, the present study aimed at developing NIRS calibrations for wood decay in larch hybrids using reference data acquired following the actual European norm. A total of 624 wood samples were collected on 104 trees (6 per tree), corresponding to 2 European, 2 Japanese and 100 hybrid larches that were all grown in the same site (Beaumont-du-Lac, France). Height NIR spectra were recorded from each sample using the NIRA module of a Spectrum 400 Perkin-Elmer spectrometer: 2 on the axial face, 3 on the tangential face, and 3 on the radial face. Natural durability tests were conducted on the same samples using the fungus Coniophora puteana according to CEN/TS 15083-1, yielding mass loss as reference data. A principal component analysis of NIR spectra highlighted differences between the faces on which spectra were collected, the axial face being the most different from the others. We thus decided to perform calibrations using spectra from both individual faces and combinations of 2 or 3 faces. Additionally, the calibrations were developed at both sample and tree levels averaging spectra and mass losses when necessary. Model quality was evaluated by repeated cross-validation. At the sample level, the calibration models were characterized by R^2 and RMSE (CV) ranging from 0.50 to 0.65 and 4.61 to 6.31, respectively. At the tree level, the reference data were more accurate and consequently model quality was improved with R^2 and RMSE comprised between 0.61 and 0.80, and 2.32 and 3.69, respectively. These results confirm that NIRS is useful for evaluating wood durability, even if the calibration models are slightly less accurate than those reported in the literature, most likely because our samples show less variability for decay resistance.

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