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Progresses on compact carbon positive ion mass spectrometry (C-PIMS) at Peking University

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Positive ion mass spectrometry (PIMS) represents an advanced methodology for radiocarbon dating, that operates on principles differ from those of traditional. Current research mainly focuses on the miniaturization and automation of equipment. The Electron Cyclotron Resonance (ECR) ion source is designed to utilize gas sample supply, facilitating automated measurement processes. A compact 2.45 GHz ECR ion source developed by Peking University (PKU) with full permanent magnet structure demonstrates the ability to produce more than 1 mA of C^{2+} ions. Recently memory effect test results prove that this ion source exhibits exceptionally low background levels and possesses a robust capacity for producing highly charged carbon ions, thereby fulfilling the requirements necessary for PIMS applications. Several PIMS related experiments have yielded promising outcomes recently. Using a nonmetallic gas charge exchange target, a charge exchange efficiency of 6.1% from C^{2+} to C^- was achieved, and a C^- beam current of 19 μA was obtained. The configuration of the beamline was meticulously designed through beam dynamics simulations to ensure precise ion focusing and enhanced transmission efficiency for ^{14}C ions. This beamline incorporates two sets of "electrostatic analyzer-magnetic analyzer" to reduce the influence of scattered particles on the background noise, thus improving the measurement accuracy of the system. Consequently, the compact PIMS occupies an area of about 3.6 m × 2.2 m while significantly reducing associated costs.

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