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Alignment system based on a Structured Laser Beam

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Structured Laser Beams (SLBs) are pseudo-non-diffractive optical beams characterized by a low-divergence Inner Core (IC), down to 10 µrad. The dimensions of the IC vary depending on the SLB generator setup. Due to their small IC diameter and theoretically infinite propagation distance, experimentally confirmed over 900 m, SLBs offer strong potential as reference lines in long-distance alignment systems. However, beam straightness can be compromised by atmospheric refraction. To counter this, high-precision alignment systems often use vacuum enclosures, which eliminate refraction but introduce constraints on space, access, and system operation. When propagating through a vacuum pipe, SLBs may experience alterations in intensity distribution and apparent IC displacement, disrupting the reference line. These alterations include changes in the IC shape due to the symmetry breaking of an SLB. Furthermore, reflections from the pipe walls generate stray light, introducing noise that complicates accurate IC position detection. This presentation outlines the development of an SLB-based measurement system prototype and presents a comparative performance assessment against other methods within a 140 m experimental setup.

Author: NIEWIEM, Witold Grzegorz

Co-author: MERGELKUHL, Dirk (CERN)

Presenter: NIEWIEM, Witold Grzegorz

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