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Swarm and bayesian optimization strategies for the PIAVE-ALPI accelerators at LNL

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The ALPI linear accelerator at the Legnaro National Laboratories serves as the final superconducting stage in a complex chain designed to accelerate heavy ions—from carbon to uranium—for nuclear and applied physics experiments. It also plays a key role in the SPES project, aimed at re-accelerating exotic radioactive ion beams. Within the TANDEM-PIAVE-ALPI (TAP) complex, the PIAVE injector provides superconductive acceleration of very low velocity ions before they enter ALPI. Managing the interface between these two systems poses significant operational challenges: manual tuning is often required, resulting in lengthy setup procedures and reduced transmission efficiency. Beam instabilities further complicate operations, requiring frequent manual re-adjustments. To address these limitations, advanced optimization strategies based on swarm intelligence and Bayesian algorithms have been applied. These methods enable coordinated control of multiple subsystems, including beam optics, RF settings, and ion source parameters, offering a more autonomous and adaptive tuning process. Experimental results demonstrating the effectiveness of this approach will be presented.

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Footnotes

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