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A Cherenkov fiber-based safety shut-off system for the ARIEL e-Linac at TRIUMF

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The Cherenkov fiber-based safety shut-off system developed for the ARIEL e-Linac at TRIUMF provides a scalable and cost-effective solution for monitoring beam losses and scattering events, addressing limitations of traditional systems such as large ionization chambers (LICs) and photomultiplier tubes (PMTs) with Bismuth Germanate (BGO) crystals. LICs are bulky and unsuitable for spatially distributed or multiple monitoring points, while PMTs with BGOs, though precise, are costly and require substantial radiation shielding when placed near the beamline.

This fiber-based system is particularly advantageous for experiments like DarkLight, which generate extensive beam loss and scattering and need to be monitored near the emission areas. To ensure operational safety, the system is designed to respond within 10 microseconds to detected instabilities, enabling rapid beam shutdown and protecting experimental equipment integrity. The fiber's flexibility and economic benefit make it ideal for setups requiring numerous detection points. Furthermore, potential position sensitivity could provide 360° directional scattering detection along extended regions, reducing the need for additional sensors.

The system's maintenance is straightforward, as damaged fibers can be replaced without personnel entering radiation-exposed areas. These attributes make the system highly suitable for high-radiation environments and applications such as FLASH radiotherapy, where precise, reliable, and responsive beam control is essential.

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