

Designing a Coded Aperture Cycloidal Mass Analyzer to Detect Perfluorocarbon Tracers

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High voltage transmission cables (HVTCs) exist buried underground as part of the electrical utility grid. These HVTCs degrade over time and the petroleum-based dielectric fluid can leak into the surrounding environment posing a safety, economic, and environmental concern. Current HVTC leak detection methods involve detecting perfluorocarbon tracer (PFT) molecules injected into the dielectric fluid with a truck mounted custom modified gas chromatograph. The gas chromatograph is extremely sensitive, but suffers from poor dynamic range, high cost, and limited portability. Duke University is collaborating with PFT Technology to develop a cycloidal coded aperture portable mass spectrometer capable of detecting PFT molecules for locating leaks in HVTCs in the field. This work presents a preliminary design and finite element analysis simulations of the proposed cycloidal mass analyzer including a 0.7 T NdFeB magnet, aluminum electric sector, electron ionization source, and focal plane capacitive transimpedance amplifier array detector. The mass analyzer is designed to detect fragments of PFT molecules in the mass range of 59-160 amu with a resolution of 0.5 amu. The anticipated footprint of this mass analyzer is 30 cm x 27 cm x 11 cm and will weigh ~ 40 kg.

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