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Femtosecond laser machining of graphitic channels through diamond with dynamic aberration correction BRIAN K. CANFIELD, LLOYD M. DAVIS, Univ of Tennessee Space Inst — Diamond is a uniquely promising, radiation-hard substrate for high-energy particle detectors for next-generation particle tracking telescopes in the High Luminosity Large Hadron Collider. Synthetic polycrystalline diamonds of adequate area and thickness are available, but to overcome charge trapping at grain boundaries and crystal dislocation sites created by radiation damage, a 3D detector geometry comprised of an array of closely spaced internal columnar electrodes must be developed, rather than surface-mounted planar electrodes. We show that tightly focused femtosecond laser pulses can easily produce highly conductive graphitic electrodes on the surface of a diamond, but for creating internal electrodes, aberrations due to beam refraction on entering diamond ($n=2.42$) significantly enlarge the focal region. To correct aberrations and create a micron-sized focal region at variable depths, we have developed a lens system using a 0.68 NA aspheric lens and several other stock lenses with adjustable positions. Through LabVIEW, motorized actuators translate the lenses and diamond and trigger laser pulses. Beginning at the back, narrow columnar graphitic channels can be machined completely through 500 micron thick diamonds. Channel diameters vary with the energy and number of pulses.

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