In this paper, we describe a spiral scanning streak camera based on a new radio-frequency (RF), deflector. This deflector can perform spiral sweeps of keV electrons by means RF fields in a frequency range of 500–1000 MHz. By converting the time dependence of incident electrons to a hit position dependence on a spiral, this device forms a basis for THz bandwidth timing processor with extended dynamic range. The spiral scanning streak camera is capable of digitizing light pulses of a few tens of ns duration with 1 ps time resolution and has possible applications in different fields of science and technology, such as ultrafast science and biomedical imaging. Results of current theoretical and experimental studies will be presented.