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Wilson Prize Talk

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In the late 1950's and the 1960's the MURA (Midwestern Universities Research Association) working group developed fixed field alternating gradient (FFAG) particle accelerators. FFAG accelerators are a natural corollary of the invention of alternating gradient focusing. The fixed guide field accommodates all orbits from the injection to the final energy. For this reason, the transverse motion in the guide field is nearly decoupled from the longitudinal acceleration. This allows a wide variety of acceleration schemes, using betatron or rf accelerating fields, beam stacking, bucket lifts, phase displacement, etc. It also simplifies theoretical and experimental studies of accelerators. Theoretical studies included an extensive analysis of rf acceleration processes, nonlinear orbit dynamics, and collective instabilities. Two FFAG designs, radial sector and spiral sector, were invented. The MURA team built small electron models of each type, and used them to study orbit dynamics, acceleration processes, orbit instabilities, and space charge limits. A practical result of these studies was the invention of the spiral sector cyclotron. Another was beam stacking, which led to the first practical way of achieving colliding beams. A 50 MeV two-way radial sector model was built in which it proved possible to stack a beam of over 10 amperes of electrons.