

**BOOK: RECIRCULATED AND ENERGY RECOVERED  
LINEAR ACCELERATORS (REV 2)**

1. INTRODUCTION TO RECIRCULATED LINEAR ACCELERATORS
  - 1.1. Properties of Storage Rings, Linear Accelerators, and Recirculated Linear Accelerators
  - 1.2. Beam Recirculation: Opportunities and Challenges
  - 1.3. Superconducting RF (SRF)
  - 1.4. Microtrons, Racetrack Microtrons, and Polytrons
  - 1.5. Independent Orbit Recirculators:
  - 1.6. Energy Recovered Linacs (ERLs)
2. INTRODUCTION TO LINEAR OPTICS
  - 2.1. Particle Motion in the Linear Approximation (both Trans and Long.)
  - 2.2. Ellipses in Beam Optics and the Area Theorem
  - 2.3. Unimodular Matrices and their Twiss Parameters
  - 2.4. Hill's Equation and its Solution
  - 2.5. Dispersion Tracking and Longitudinal Stability
  - 2.6. Beam Matching and *Rms* Emittance
3. SINGLE PARTICLE DYNAMICS
  - 3.1. Longitudinal Dynamics
    - 3.1.1. Longitudinal gymnastics
    - 3.1.2. Longitudinal tune choices
    - 3.1.3. Correcting RF curvature (T566 or sextupoles)
    - 3.1.4. Energy spread estimates
  - 3.2. Transverse Dynamics
    - 3.2.1. Basic considerations
    - 3.2.2. Betatron Motion Damping and Antidamping
    - 3.2.3. RF Focussing
    - 3.2.4. Energy ratio limits
    - 3.2.5. Beam Loss
4. RF ISSUES AND BEAM LOADING
  - 4.1. Cavity Equations
  - 4.2. Optimization of loaded Q
  - 4.3. Energy Recovery
  - 4.4. Fundamental Mode Cooling
  - 4.5. Multiplication Factor and System Efficiency
  - 4.6. RF Instruments
5. COLLECTIVE EFFECTS
  - 5.1. Multibunch
    - 5.1.1. Transverse Instability
      - 5.1.1.1. Cumulative
      - 5.1.1.2. Multipass
        - 5.1.1.2.1. Theory
        - 5.1.1.2.2. Computational Tools
    - 5.1.2. Longitudinal Instability
    - 5.1.3. Ions Effects

- 5.2. Single Bunch
  - 5.2.1. CSR
  - 5.2.2. Transverse BBU
  - 5.2.3. Longitudinal wakes
- 5.3. RF Instability
- 5.4. HOM Cooling
- 6. PHOTOINJECTORS
  - 6.1. Laser-driven photocathode guns
    - 6.1.1. DC guns
    - 6.1.2. RF guns
  - 6.2. Polarized electron sources
  - 6.3. Examples of high brightness electron sources
- 7. RADIATION AND BEAM TRANSPORT IN RECIRCULATING LINACS
  - 7.1. Radiation from relativistic electrons
  - 7.2. Quantum fluctuations and particle diffusion
  - 7.3. Aberrations and higher-order transfer maps
  - 7.4. Practical beam optics designs
- 8. PERFORMANCE OF PRESENT RECIRCULATING LINACS
  - 8.1. Electron beam diagnostics devices
  - 8.2. Feedback systems
  - 8.3. Transverse beam stability
  - 8.4. Energy stability
  - 8.5. Longitudinal beam stability
  - 8.6. Beam polarization
- 9. FUTURE APPLICATIONS
  - 9.1. CEBAF physics upgrades
  - 9.2. FELs
  - 9.3. Synchrotron Light Sources (ERL,PERL,MARS)
  - 9.4. Electron-Ion Collider (EIC)