CESR Test Accelerator – Investigation of the physics of charged particle beams

Circumference = 768m  -  Beam energy 1.8-5.5 GeV  -  Electrons and Positrons
Linear Collider
Energy/beam = 250-500 GeV
\(E_{\text{CM}} = 0.5-1.0\ \text{TeV}\)
Electron cloud

- Beam emits synchrotron radiation:
  - provides source of photo-electrons
  - other sources: beam-gas ionization, stray protons→wall
- Photo-electrons get rattled around the chamber from multibunch passages
  —especially for intense positively-charged beams (e⁺, protons, heavy ions)
- Photoelectrons yield secondary electrons
  - yield is determined by the secondary emission yield (SEY) function δ(E):
  - characterized by peak value δₘₐₓ
  - e⁻ reflectivity δ(0): determines survival time of e⁻
- Typical e⁻ densities: \( n_e = 10^{10} - 10^{13} \text{ m}^{-3} \) (~a few nC/m)
Shielded pickup

- Button Diameter: ~1.73 cm
- 2.8 cm
- 2.5 cm
- 9 cm
With no magnetic field, electrons come from the floor of the chamber.
Cloud is generated by the first bunch. The witness bunch follows and kicks the cloud electrons into the pickup. Decay time of the cloud is evident.
Peak SEY Scan
Coherent Tune Shifts (1 kHz ~ 0.0025), vs. Bunch Number
- 21 bunch train, followed by 12 witness bunches
- $0.8 \times 10^{10}$ particles/bunch
- 2 GeV.
- Data (black) compared to POSINST simulations.

Data (black) compared to POSINST simulations.

Train

Witnesses

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David L. Rubin
Low emittance tuning procedure typically yields sub 20pm in one or two iterations

$$\sigma = 17\mu m$$
$$\varepsilon_v = 18\text{pm}$$
20 bunches, 14 ns spacing, 32 channels, pinhole optics
Capability to measure bunches spaced by as few as 4 ns

32 Channel Detector Output For 20 Bunches, 1 mA Per Bunch
CesrTA Grad students

Joe Calvey – Electron cloud
Jim Shanks – Low Emittance Tuning
Mike Ehrlichman – Intra-beam scattering