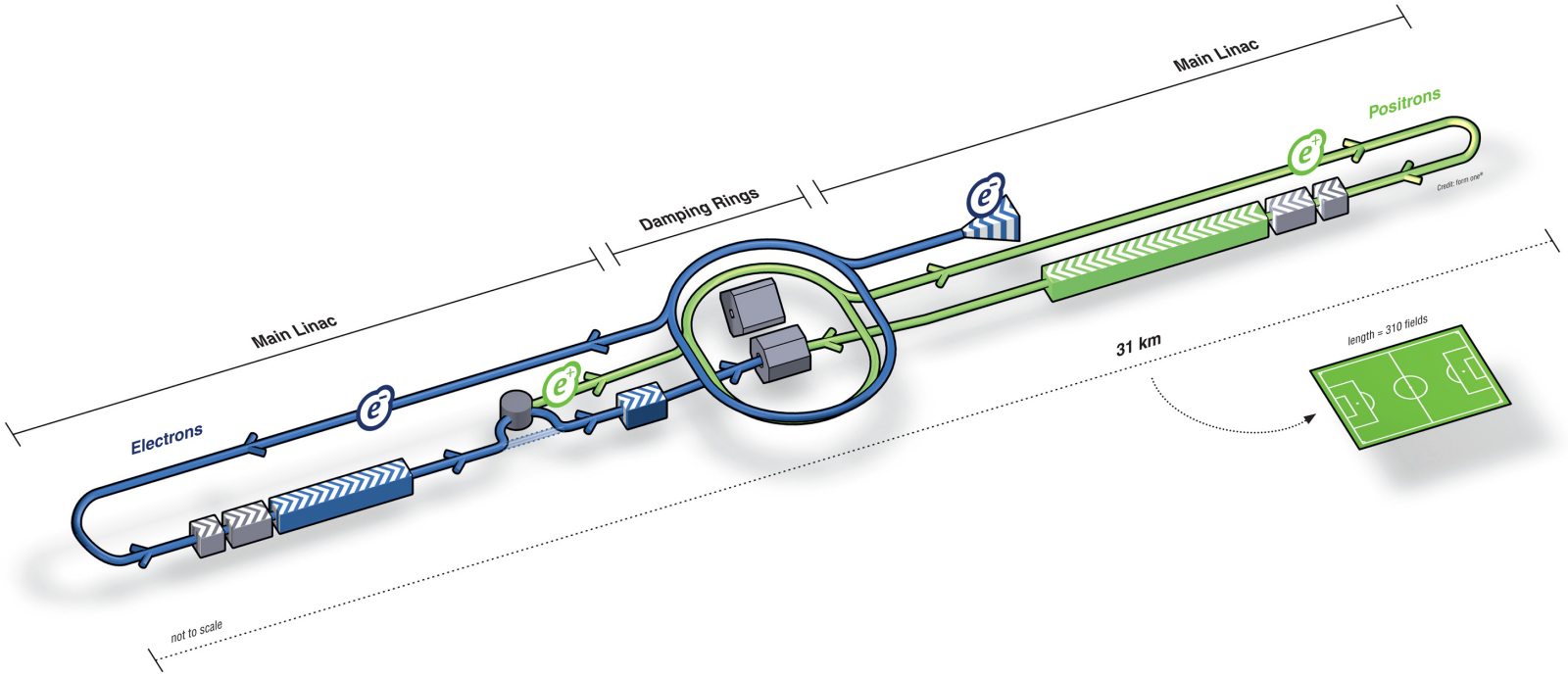
CESR Test Accelerator – Investigation of the physics of charged particle beams

Circumference = 768m - Beam energy 1.8-5.5 GeV - Electrons and Positrons

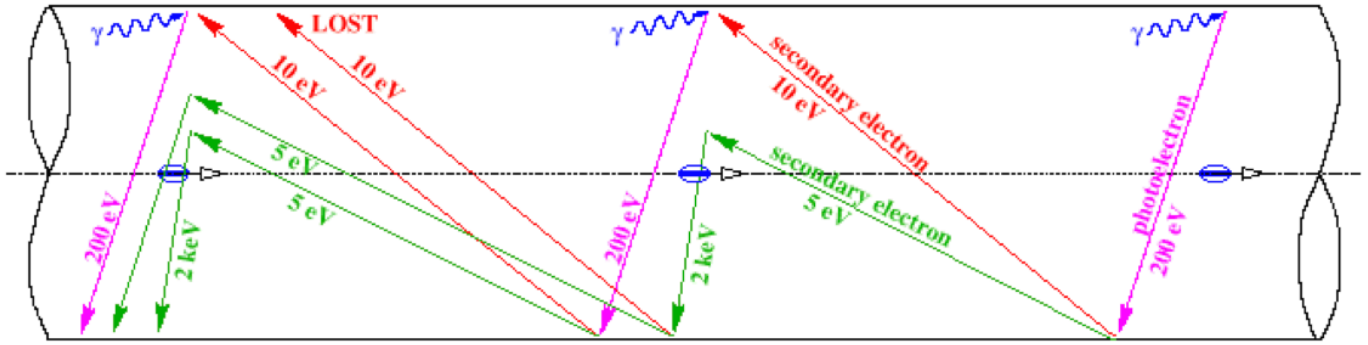
Linear Collider

Energy/beam = 250-500 GeV

E_{CM} = 0.5-1.0 TeV

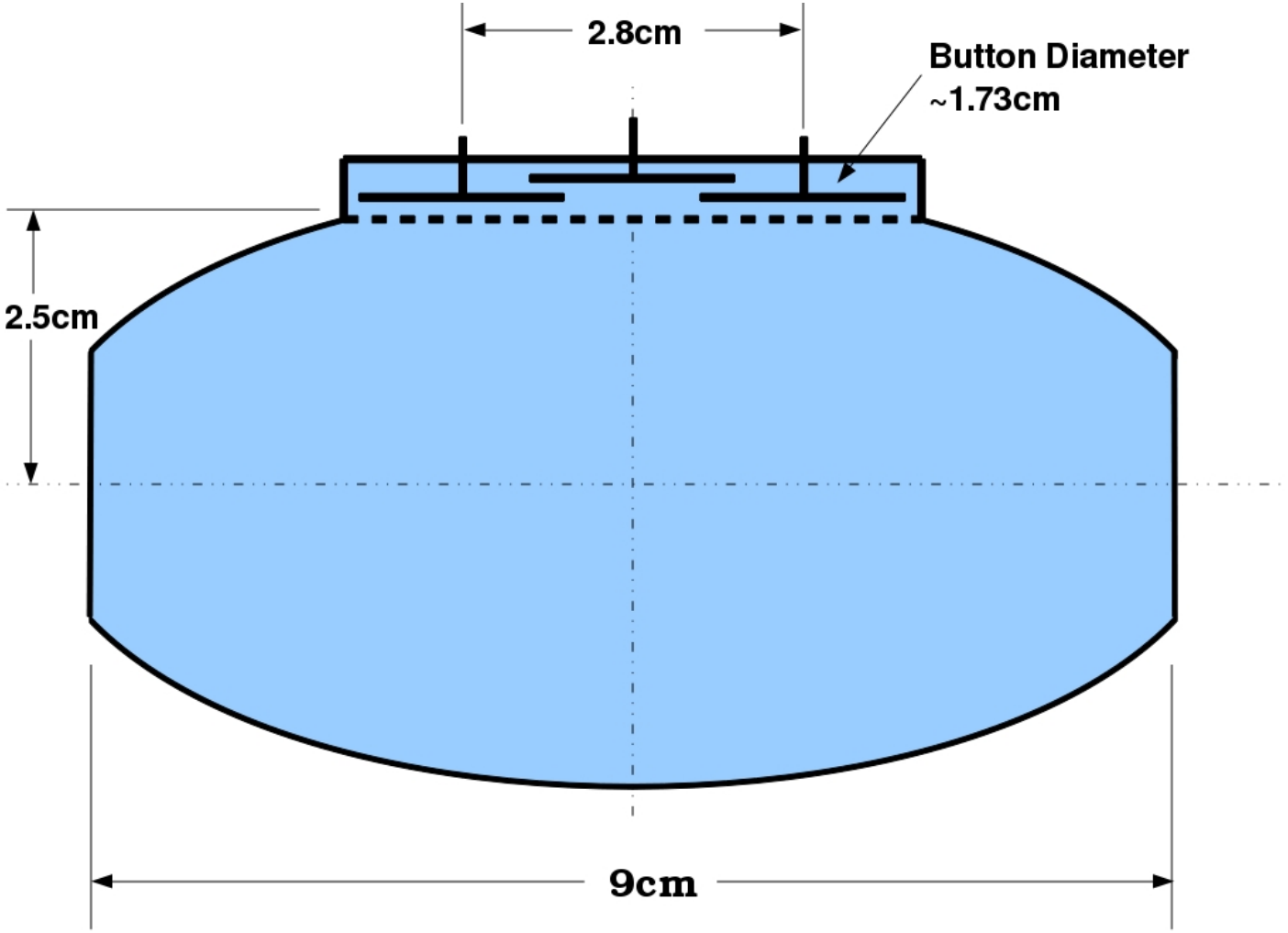


Electron cloud

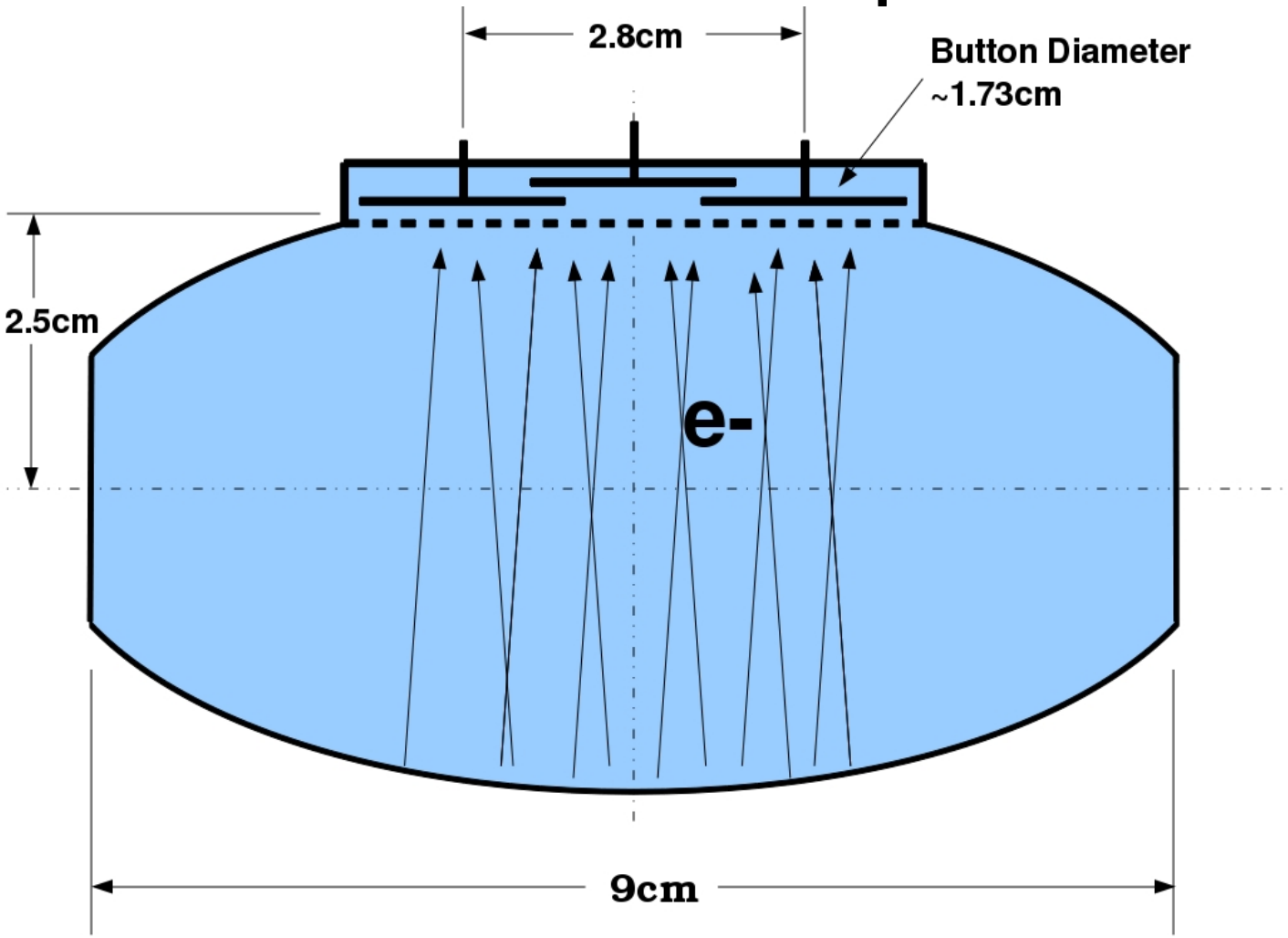


- Beam emits synchrotron radiation:
  - provides source of photo-electrons
  - other sources: beam-gas ionization, stray protons→wall
- Photo-electrons get rattled around the chamber from multibunch passages
  —especially for intense positively-charged beams (e^+, protons, heavy ions)
- Photoelectrons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

Shielded pickup

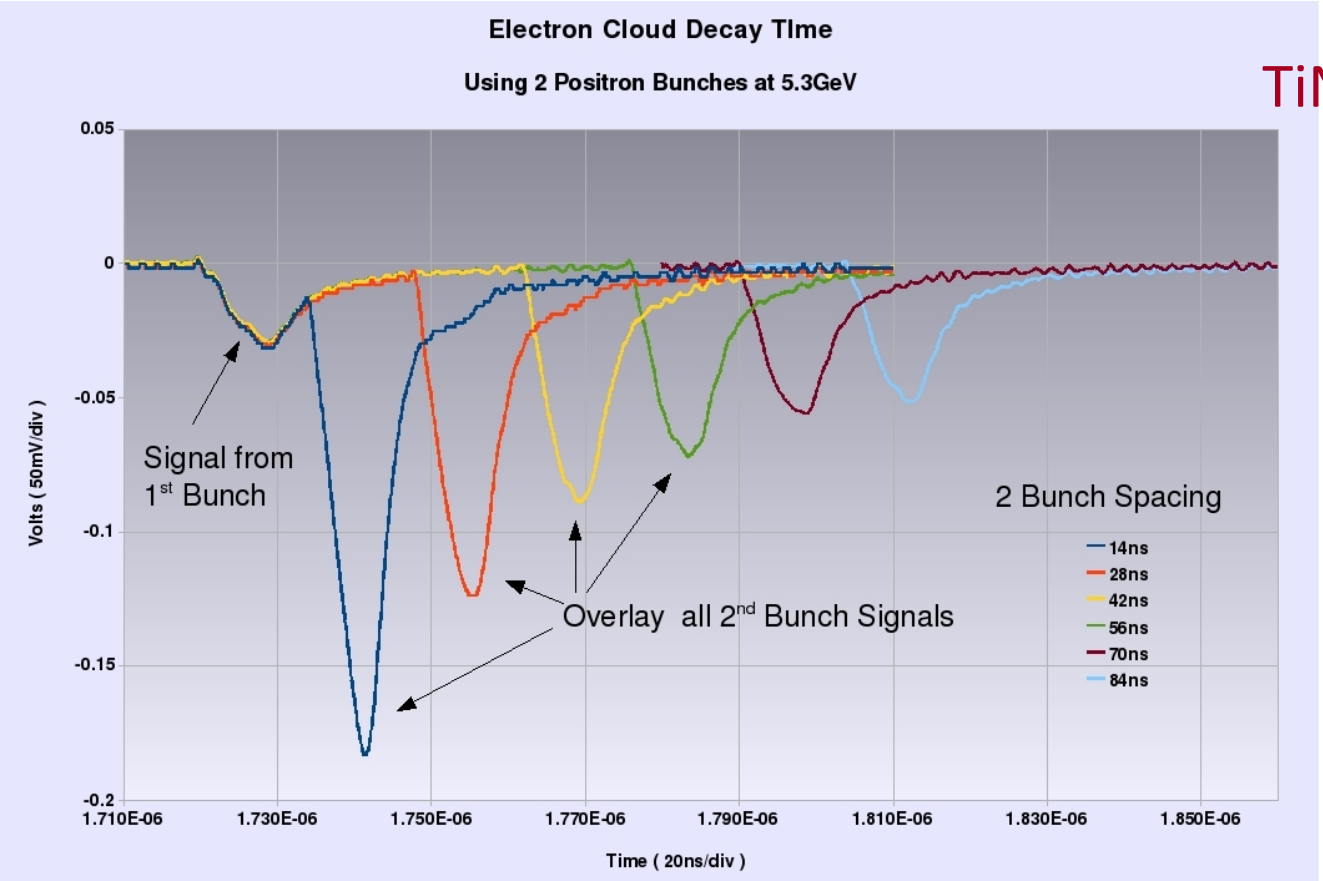


Shielded Pickup



With no magnetic field, electrons come from the floor of the chamber

Cloud Evolution: Witness Bunch Studies



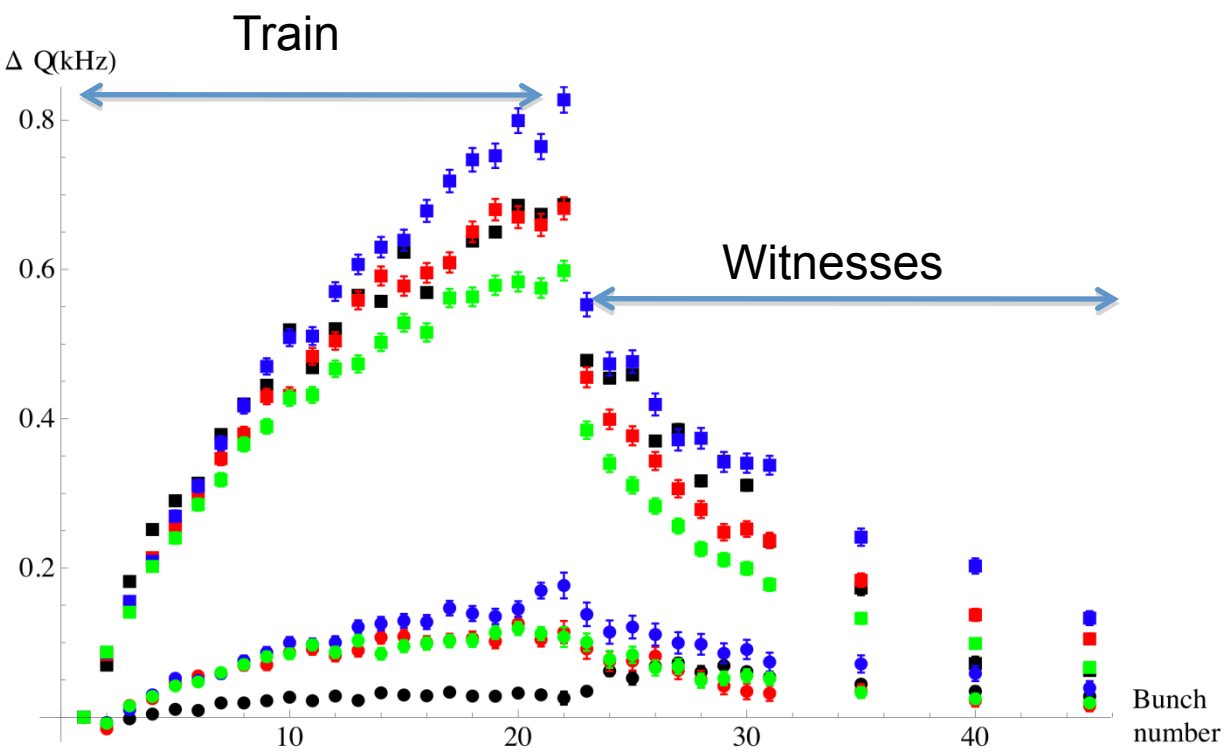
TiN Chamber

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
- 0.8×10^{10} particles/bunch
- 2 GeV.
- Data (black) compared to POSINST simulations.

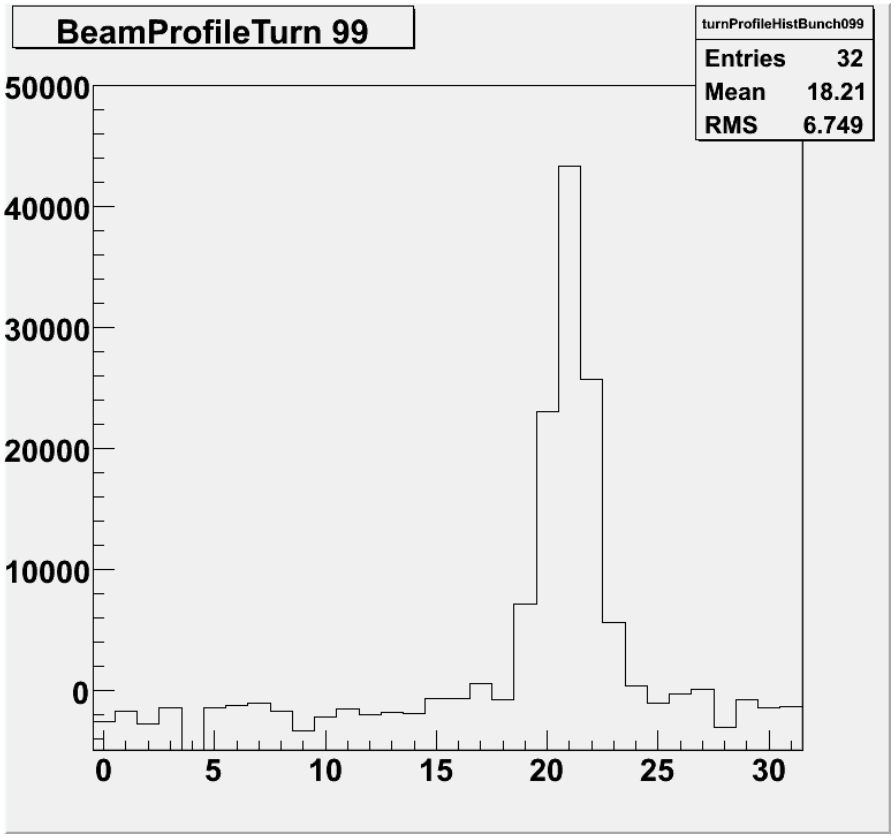


SEY=2.0
SEY=2.2
SEY=1.8

Data: horizontal
Data: vertical
Simulation 1: horizontal
Simulation 1: vertical
Simulation 2: horizontal
Simulation 2: vertical
Simulation 3: horizontal
Simulation 3: vertical

σ =17μm

ε_v = 18pm

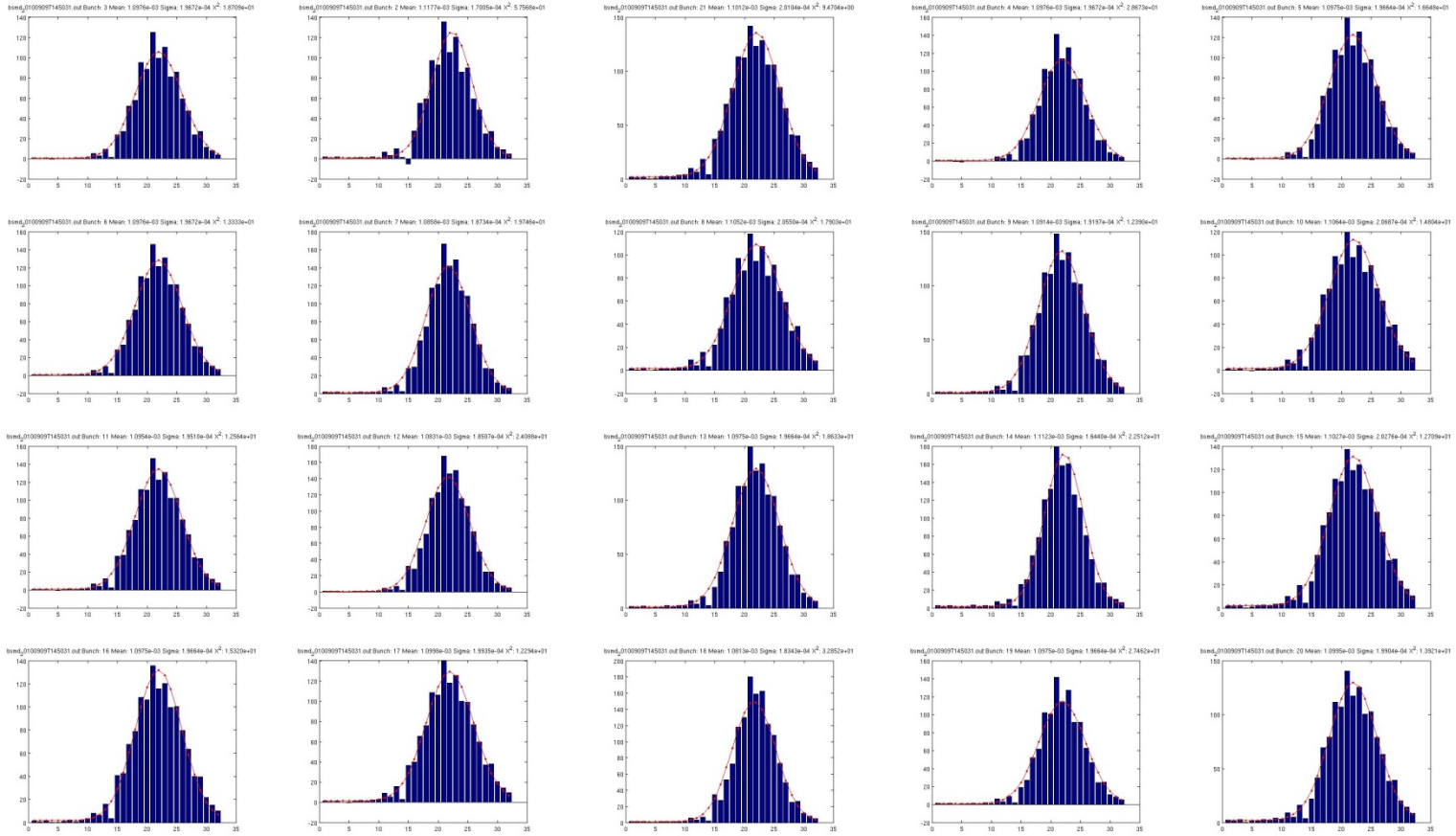


Low emittance tuning procedure typically yields sub 20pm in one or two iterations

20 bunches,14 ns spacing, 32 channels, pinhole optics

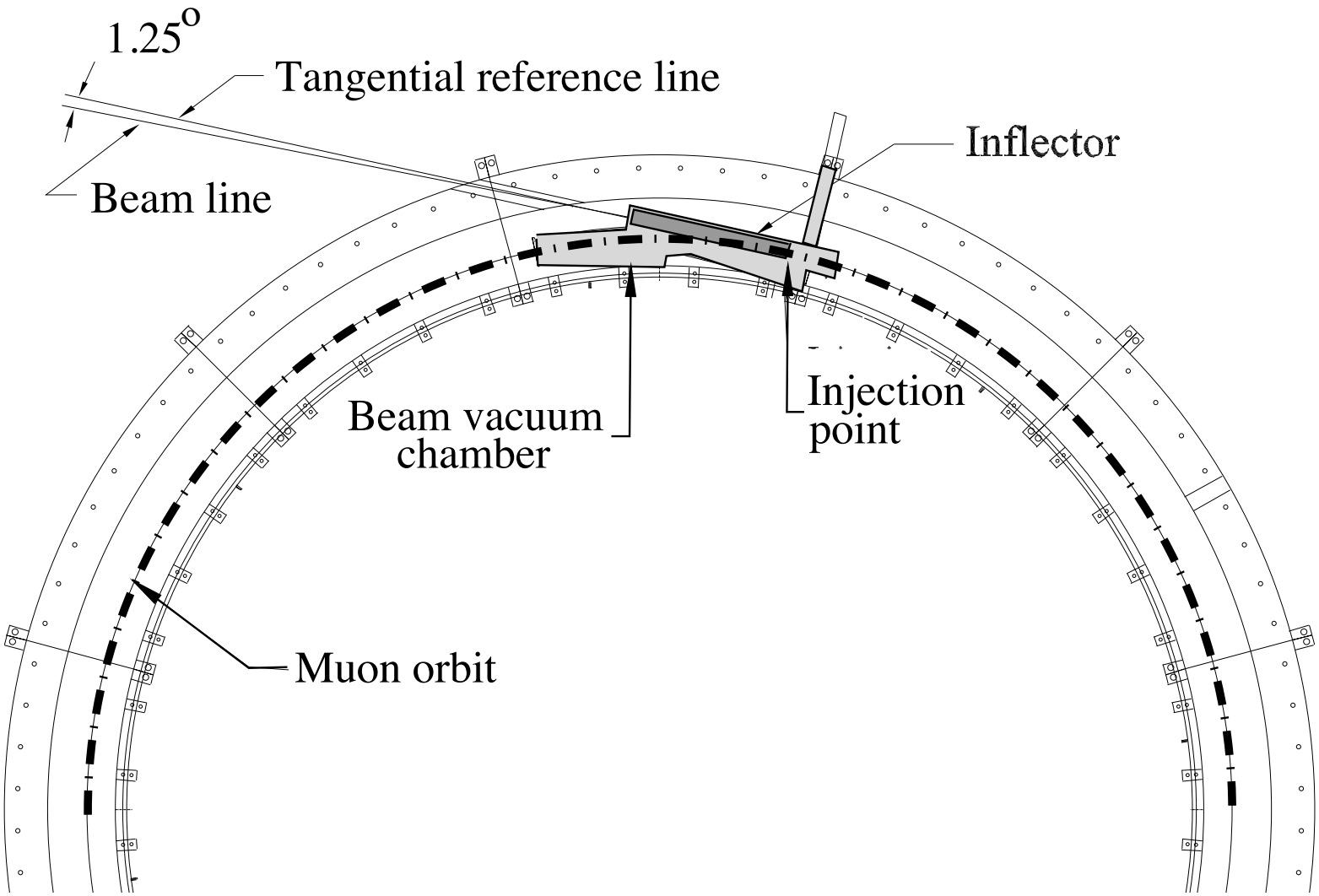
Capability to measure bunches spaced by as few as 4ns

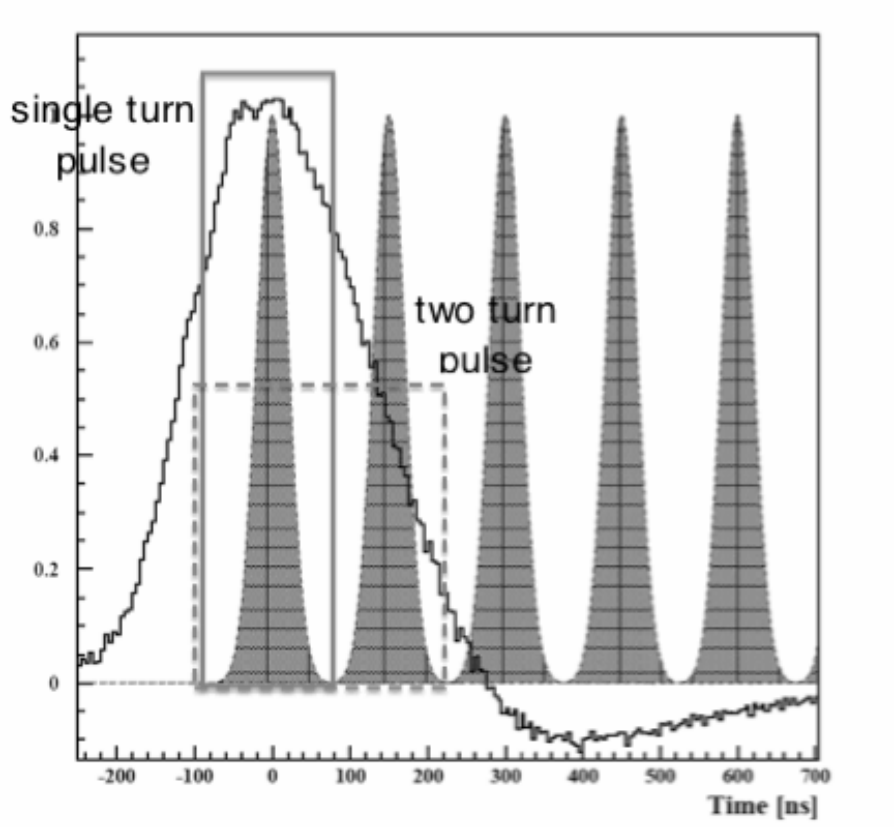
32 Channel Detector Output For 20 Bunches, 1 mA Per Bunch

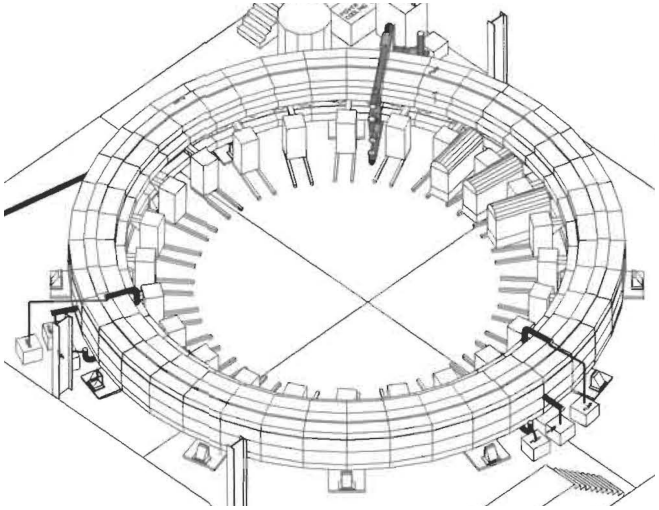


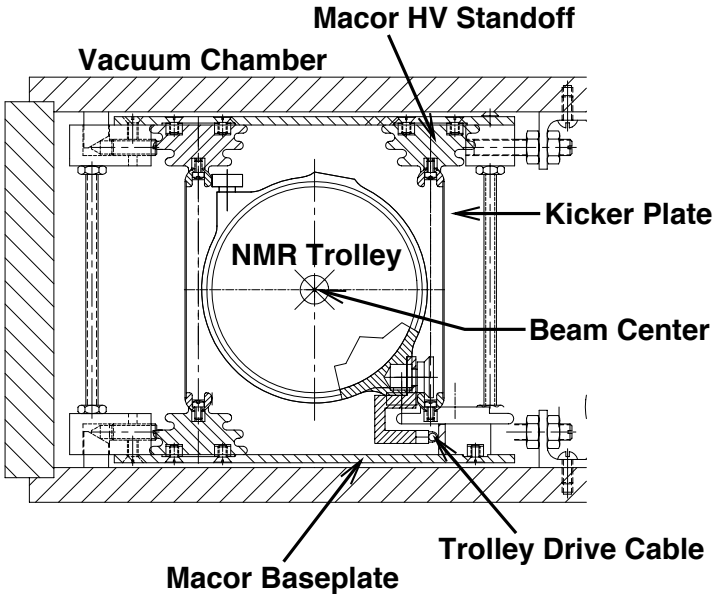
CesrTA Grad students

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


1.25°
Tangential reference line
Beam line
Inflector
Beam vacuum chamber
Injection point
Muon orbit


single turn
pulse
two turn
pulse
0.8
0.6
0.4
0.2
0
-200
-100
0
100
200
300
400
500
600
700
Time [ns]




Macor HV Standoff
Vacuum Chamber
Kicker Plate
NMR Trolley
Beam Center
Trolley Drive Cable
Macor Baseplate