CEBAF, the Continuous Electron Beam Accelerator Facility

CNU Lifelong Learning at Jlab

June 22, 2010

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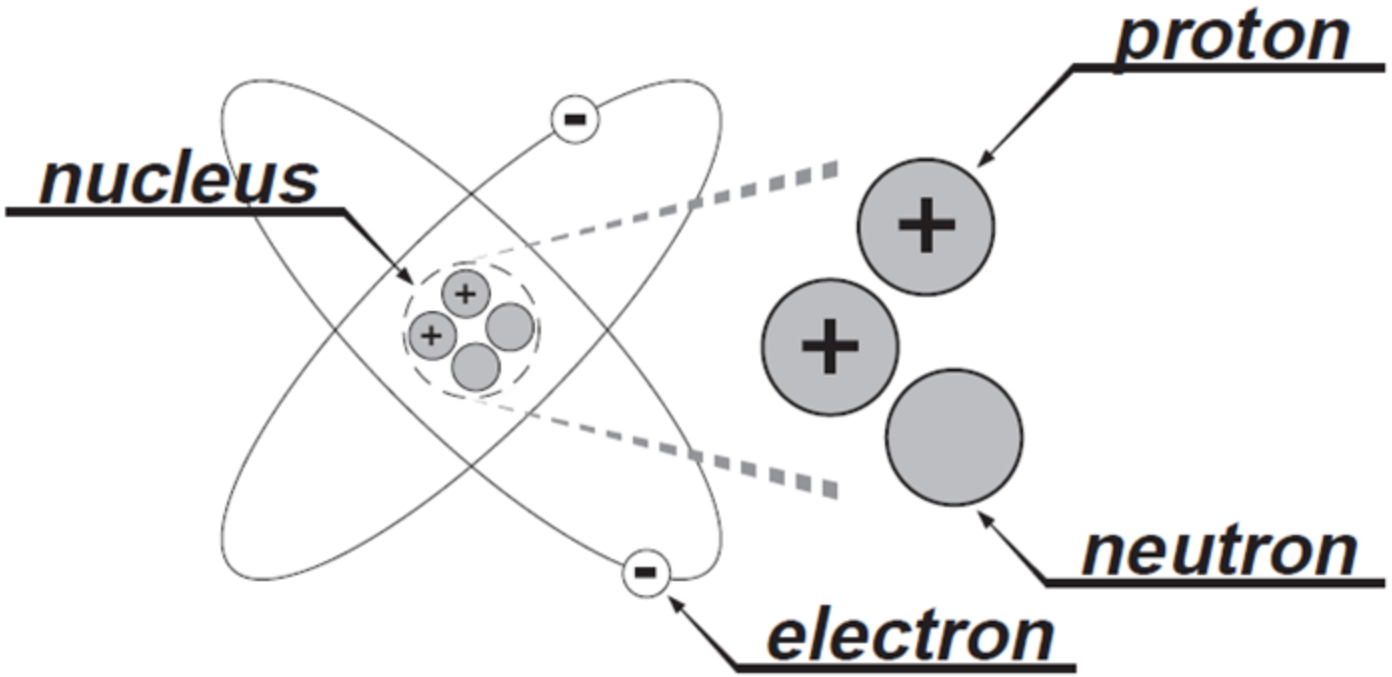
Nuclear Model

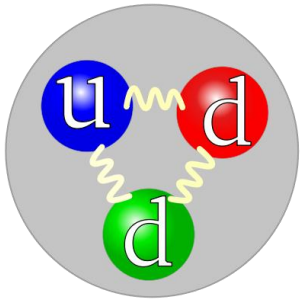


- Need tiny probe to "see" inside the nucleus
- Need lots of energy to penetrate the atom

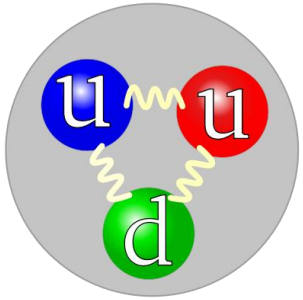
What to do?

Build a 5 mile long electron microscope!

Electron



Neutron

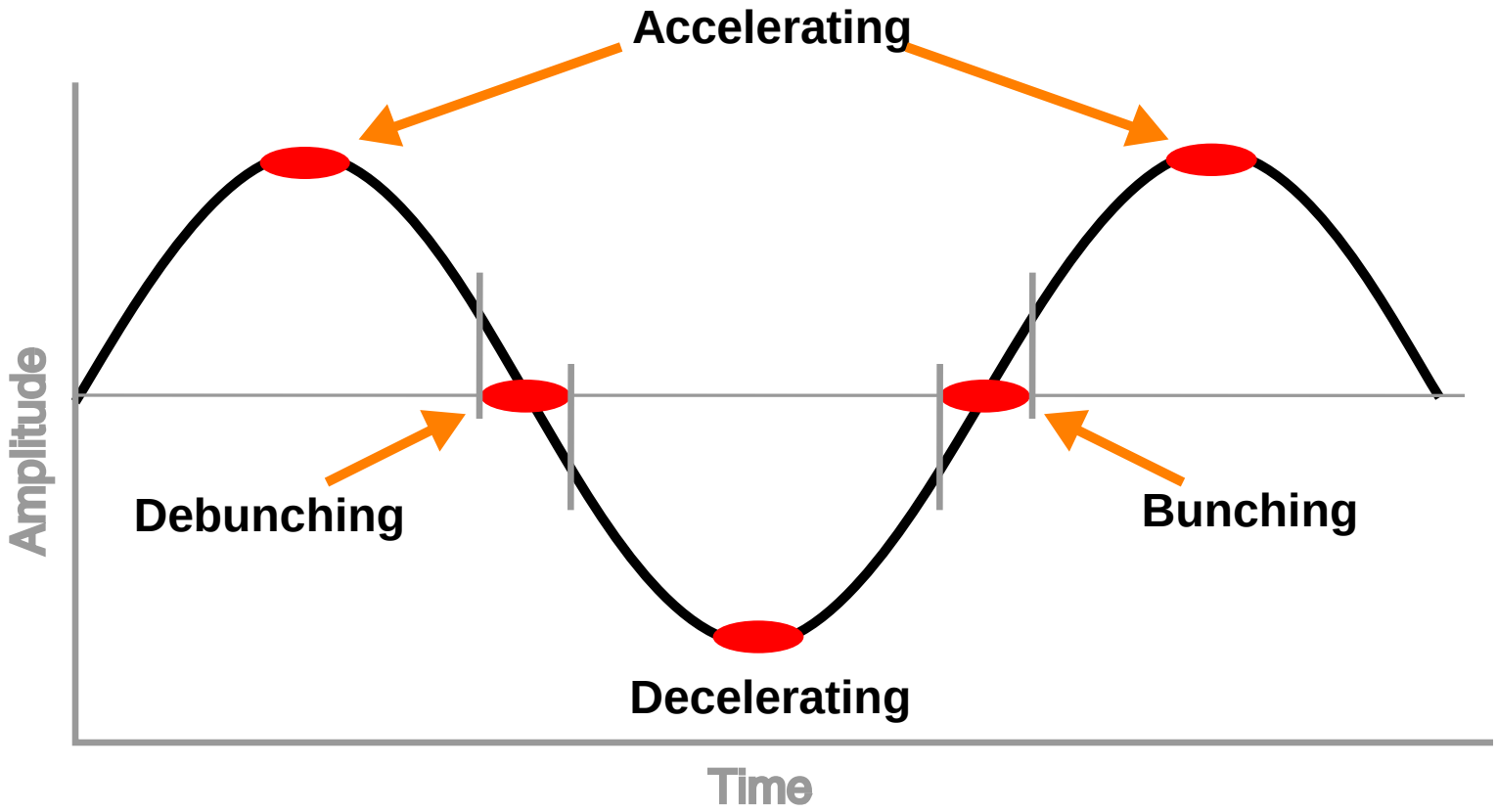


Proton

Make it powerful enough to see inside a proton or neutron.

How to make the electrons "powerful" ?

Use radio(frequency) waves !!!



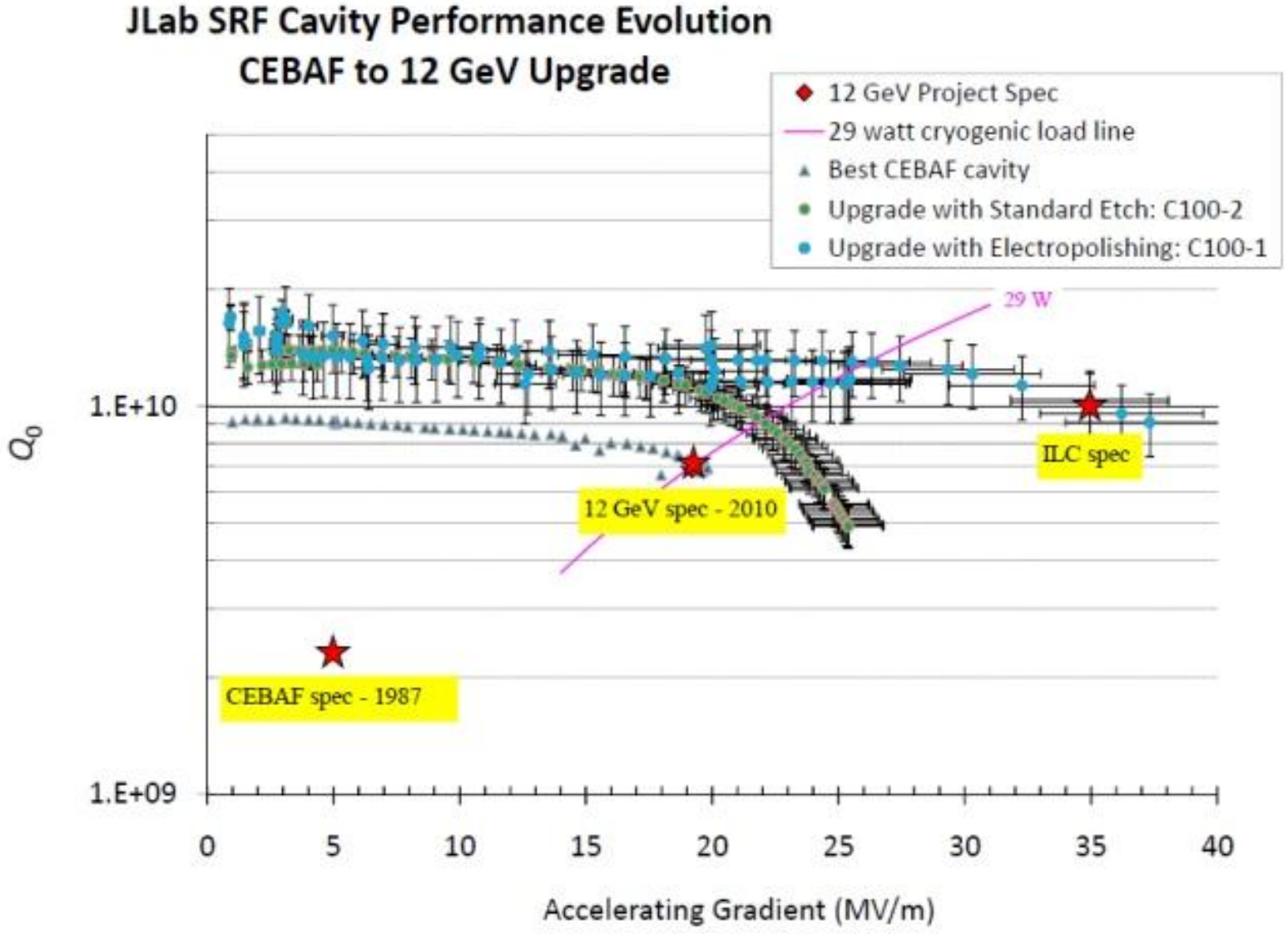
Electrons gain energy on each crest!

CEBAF 5-cell SRF cavities

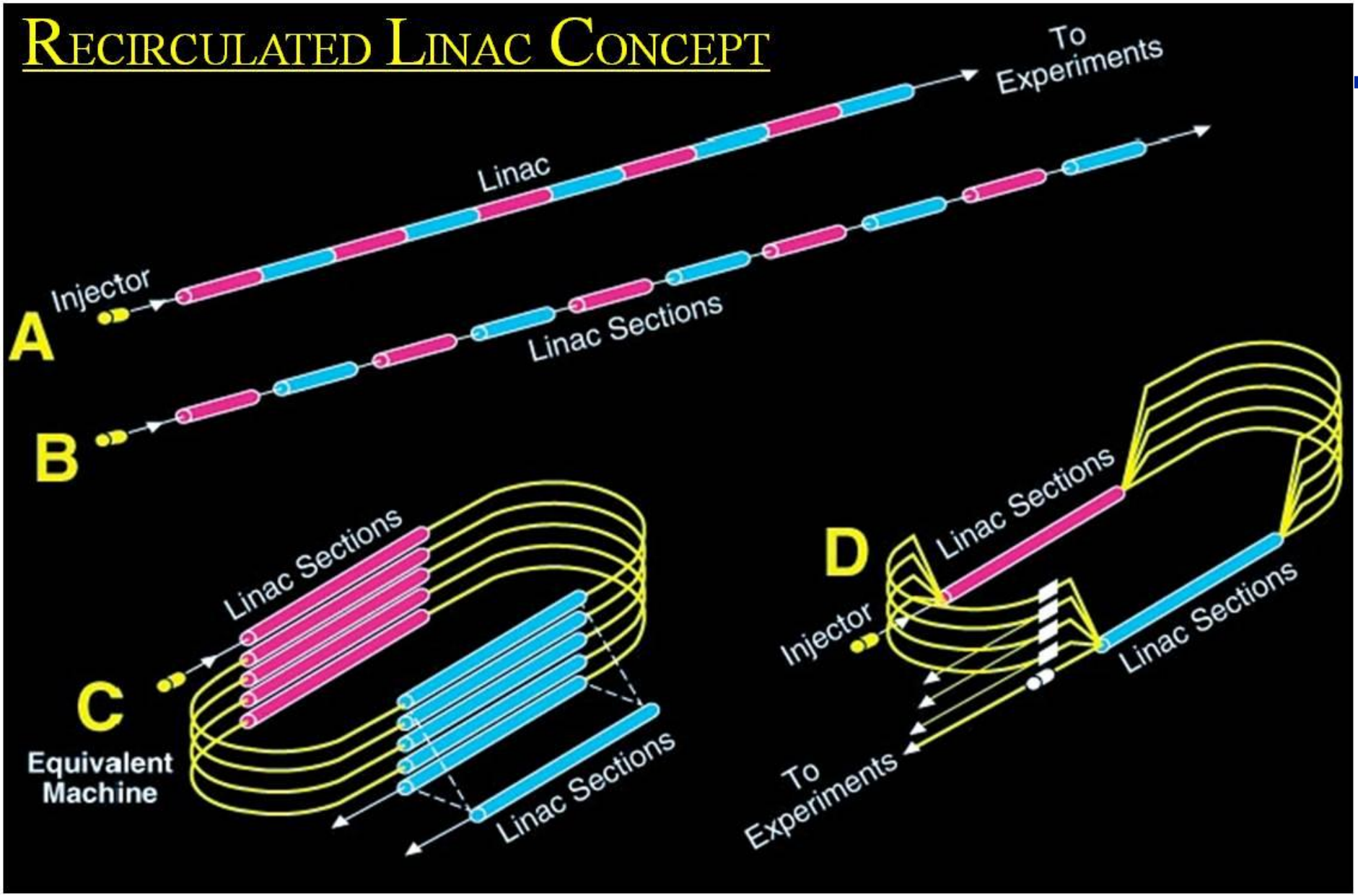
Cavity frequency is 1497 MHz.

Each cavity imparts millions of volts (MV) of energy gain to each passing electron

How to reach Billion Volts (GeV) energy?



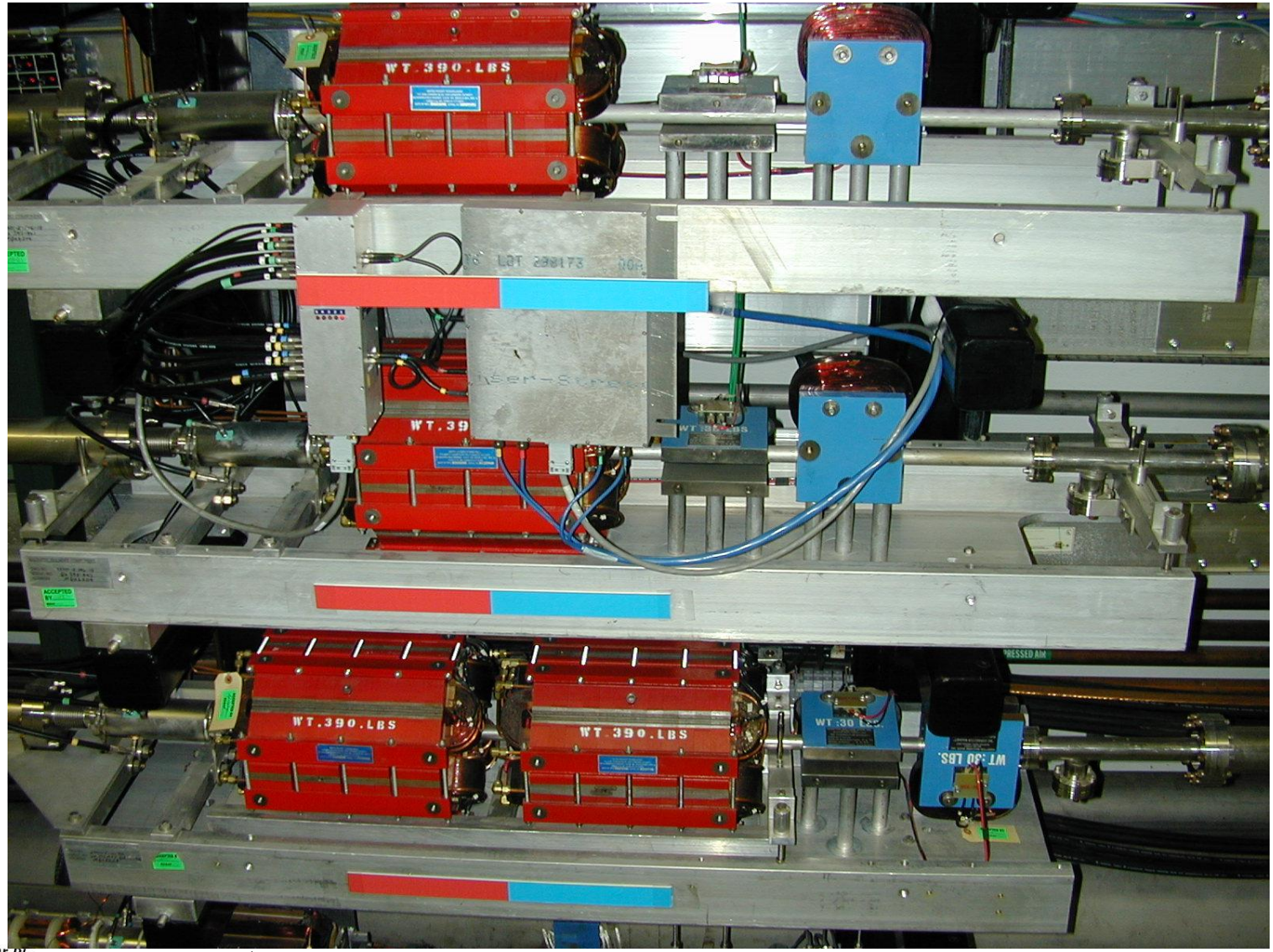
Recirculated Linac Concept



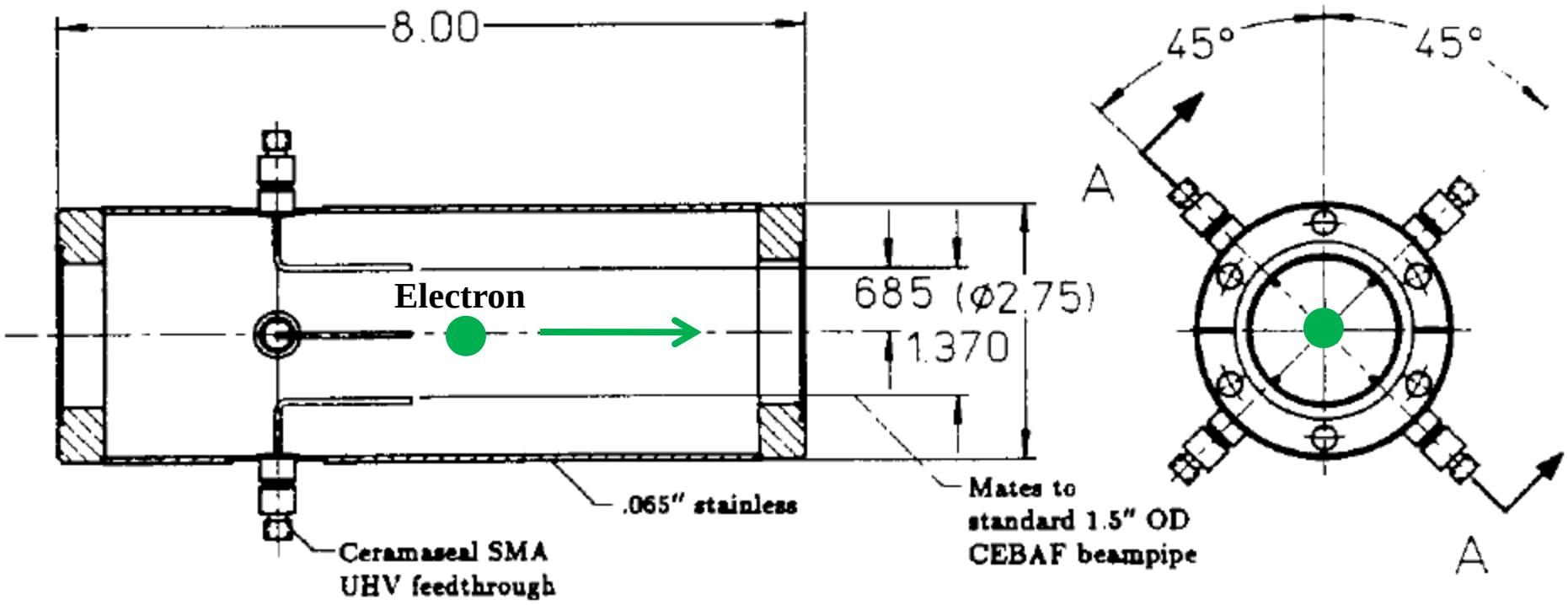
The S in SRF (very cold stuff!)

Magnets Make the Beam Turn

Typical Magnet Assembly



Beam Position Measurement



- Beam has its own radio signal.
- We use 4 antenna to find the beam.

Now that we have a beam, we need an experiment…

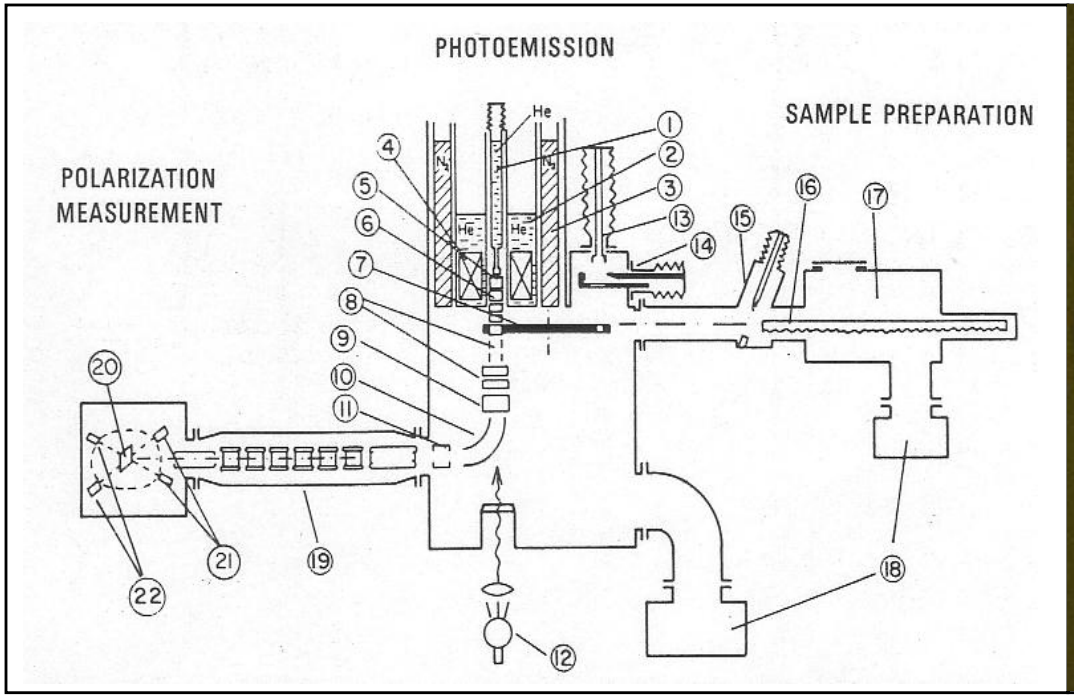
But wait, 1 accelerator & 3 experiments !?!

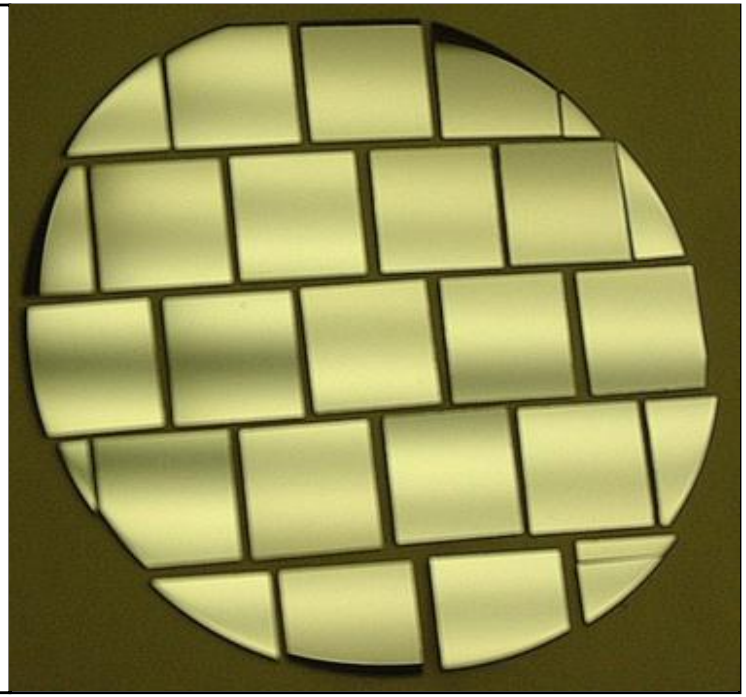
Where do the electrons originate ?

PHYSICAL REVIEW B VOLUME 13, NUMBER 12 15 JUNE 1976

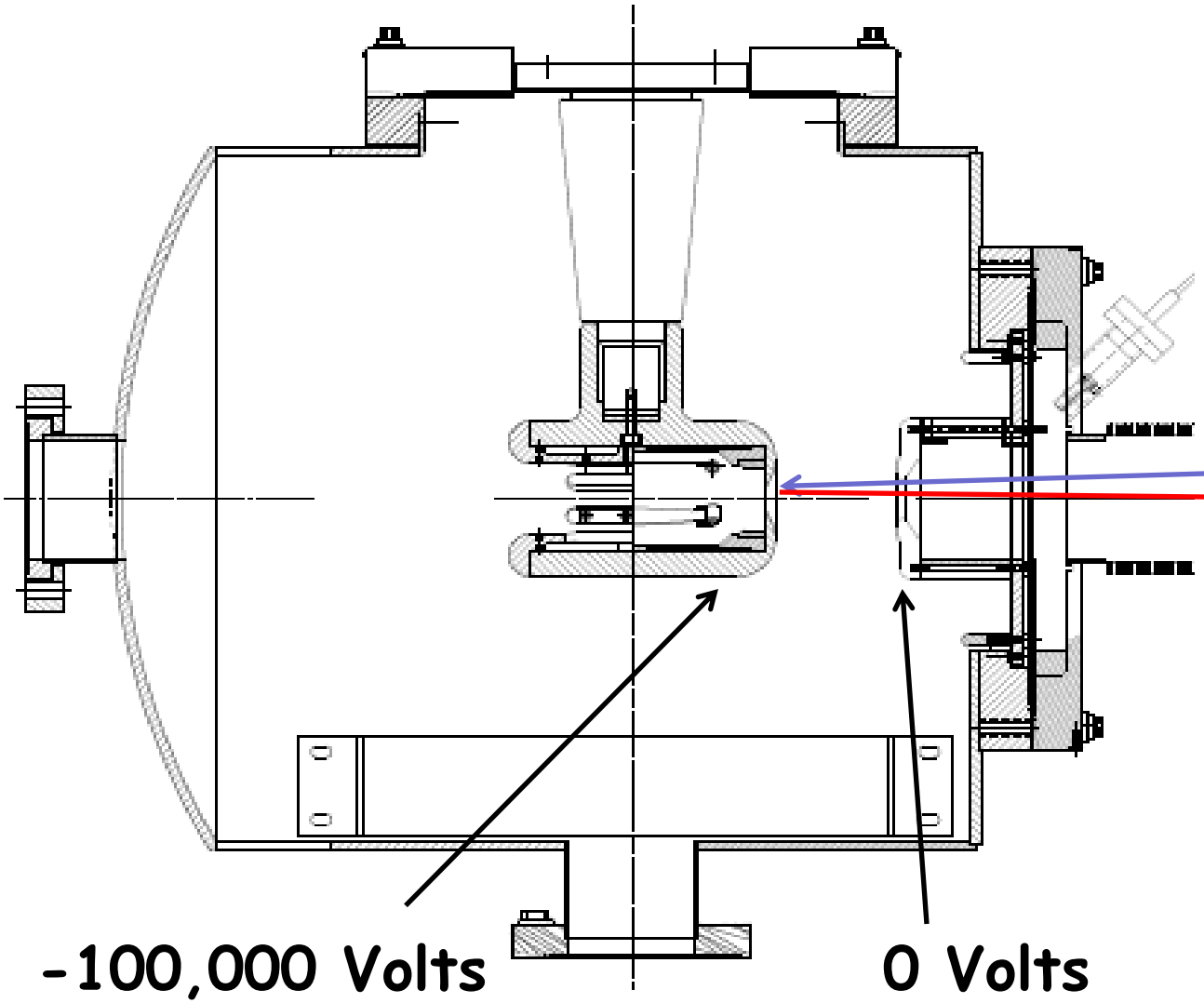
Photoemission of spin-polarized electrons from GaAs

Daniel T. Pierce* and Felix Meier
Laboratorium für Festkörperphysik, Eidgenössische Technische Hochschule, CH 8049, Zürich, Switzerland
(Received 10 February 1976)





Electron Gun Cut-Away



Laser shines on GaAs & frees the electrons…

…the -100kV "battery" accelerates and forms the electron beam.

More modern version of an electron gun!

Continuous Electron Beam Accelerator Facility

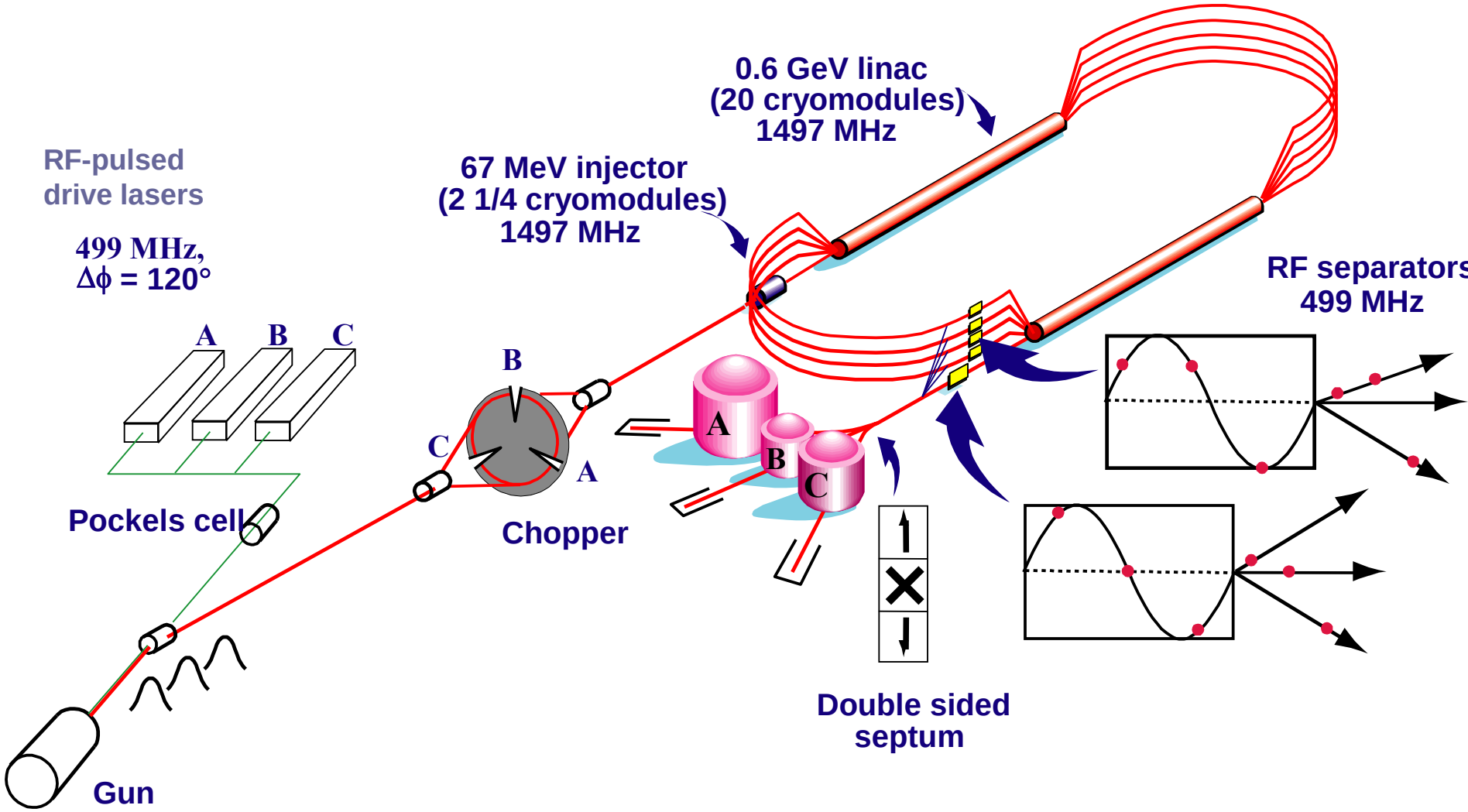
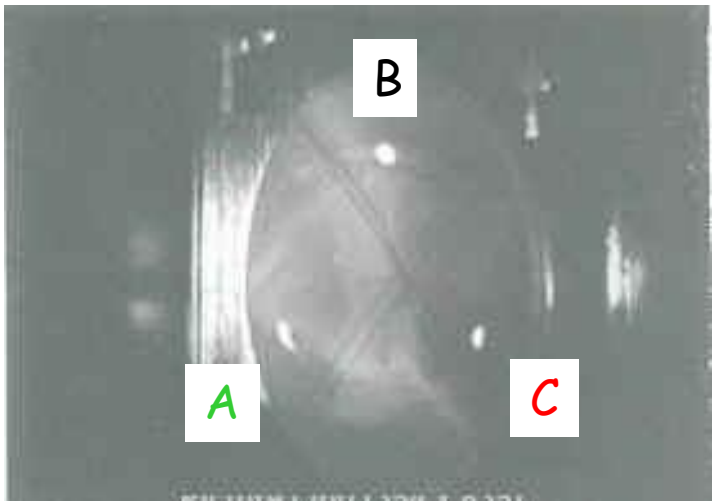
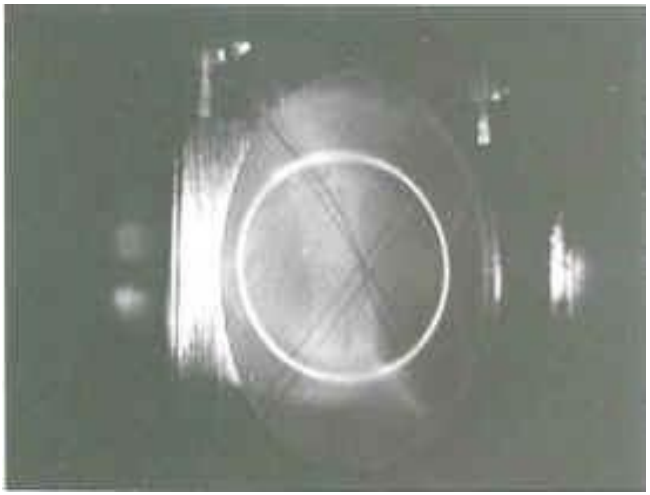


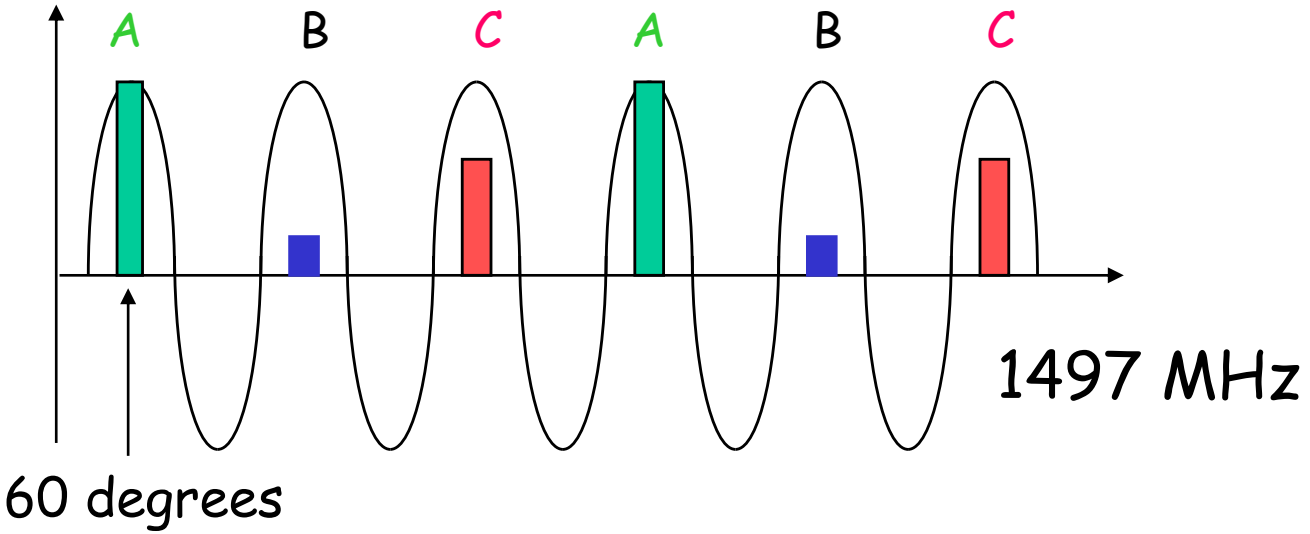
Photo Finish, but at 2 billionths of a second !!!

3 lasers pulsing



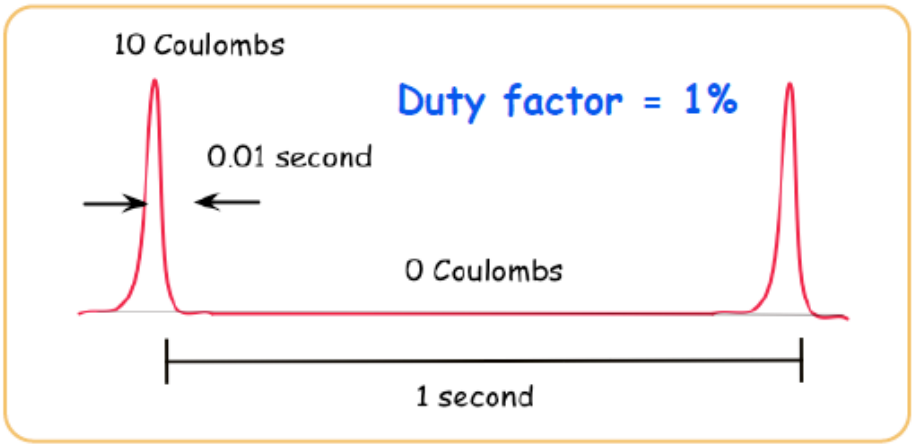
DC beam, not so useful



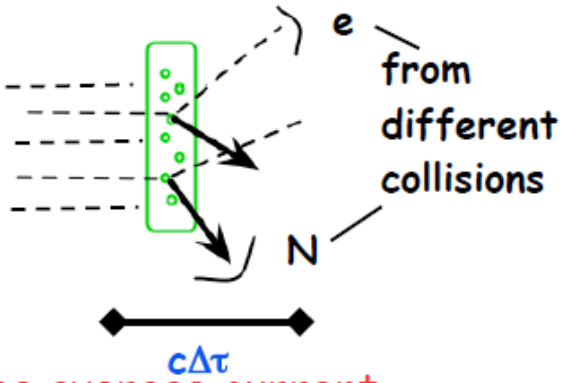


The "C" in CEBAF

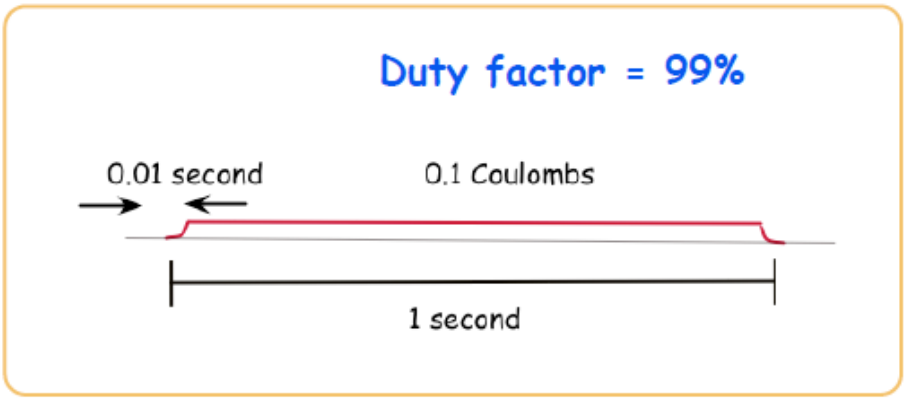
★ Pulsed beams used prior to 1980 (100 mA)



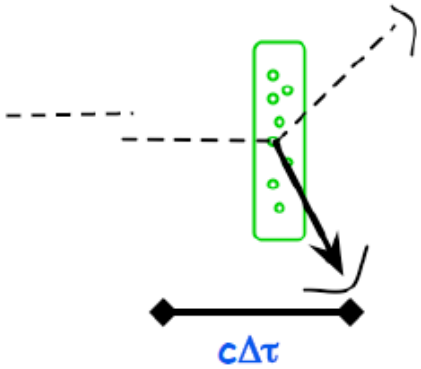
too many electrons in the target over the time interval $\Delta\tau$
lots of random coincidences



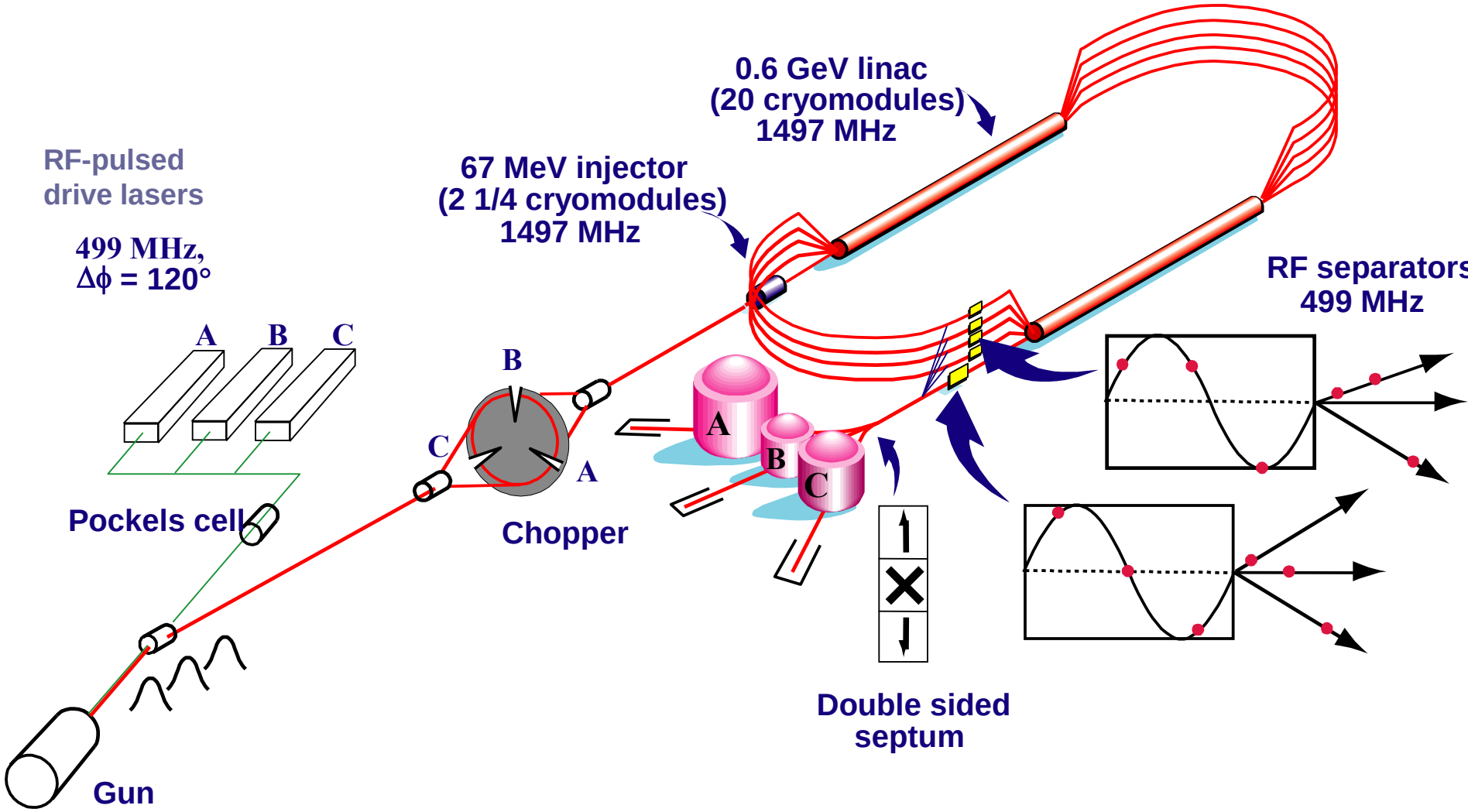
★ Advantages of a continuous beam with the same average current



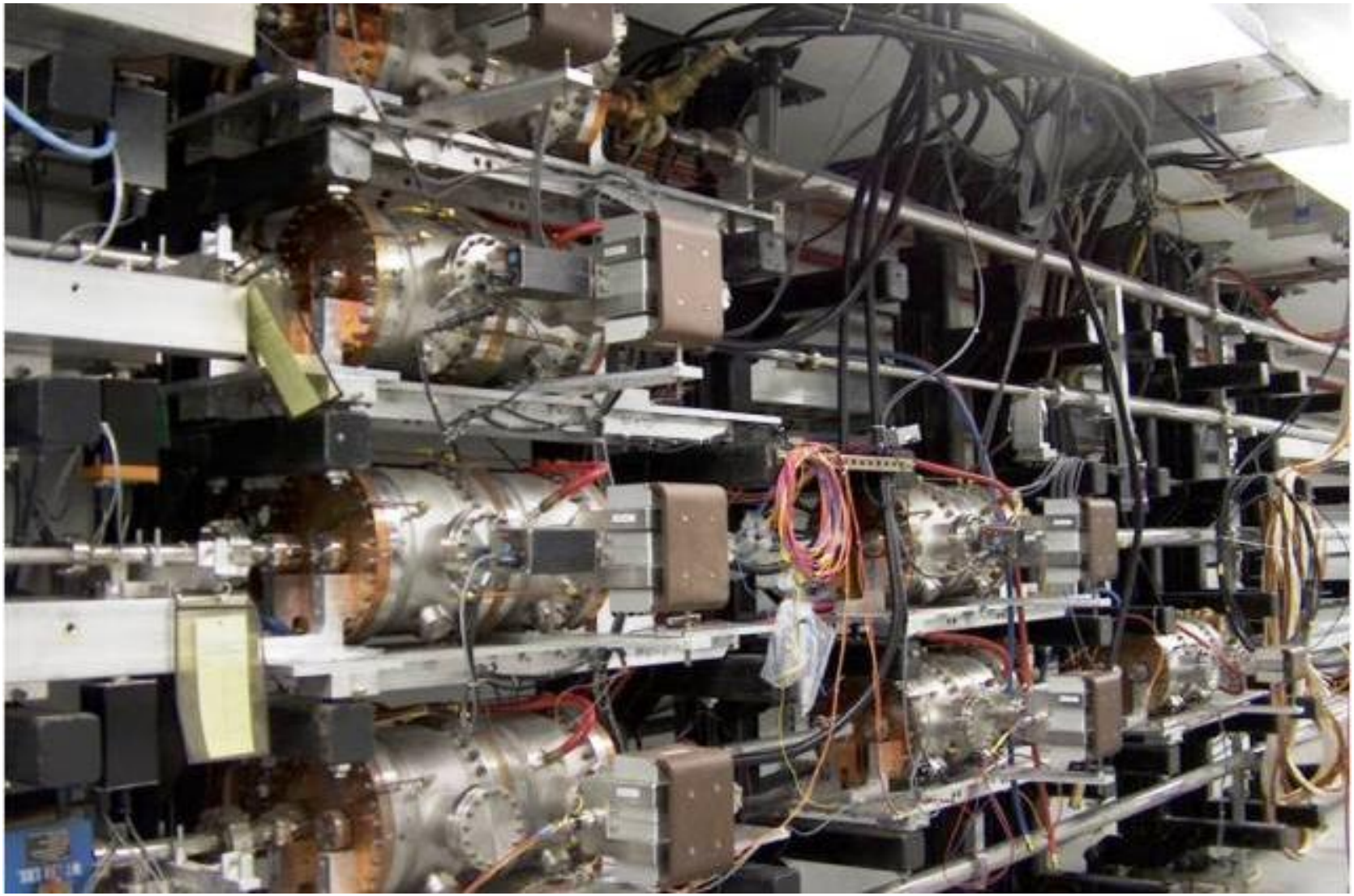
few electrons in the target --
few random coincidences



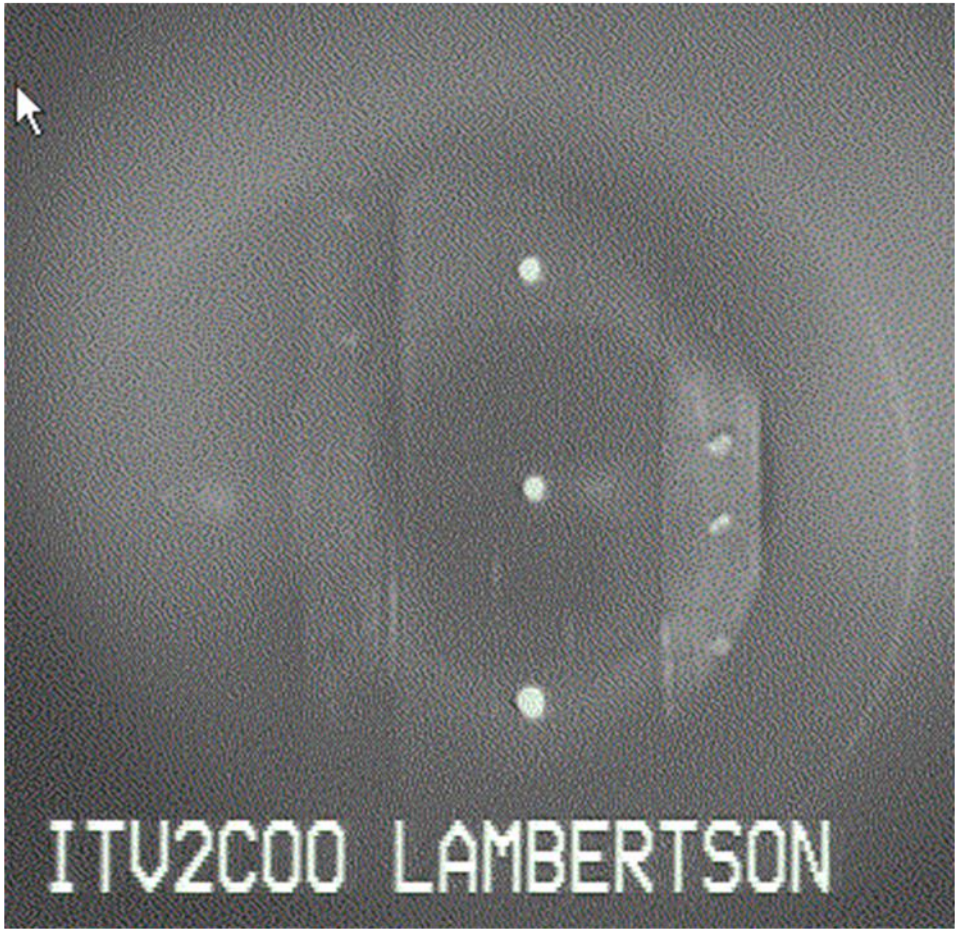
Continuous Electron Beam Accelerator Facility



"Pulse Pickers every 2 billionths of a second…"

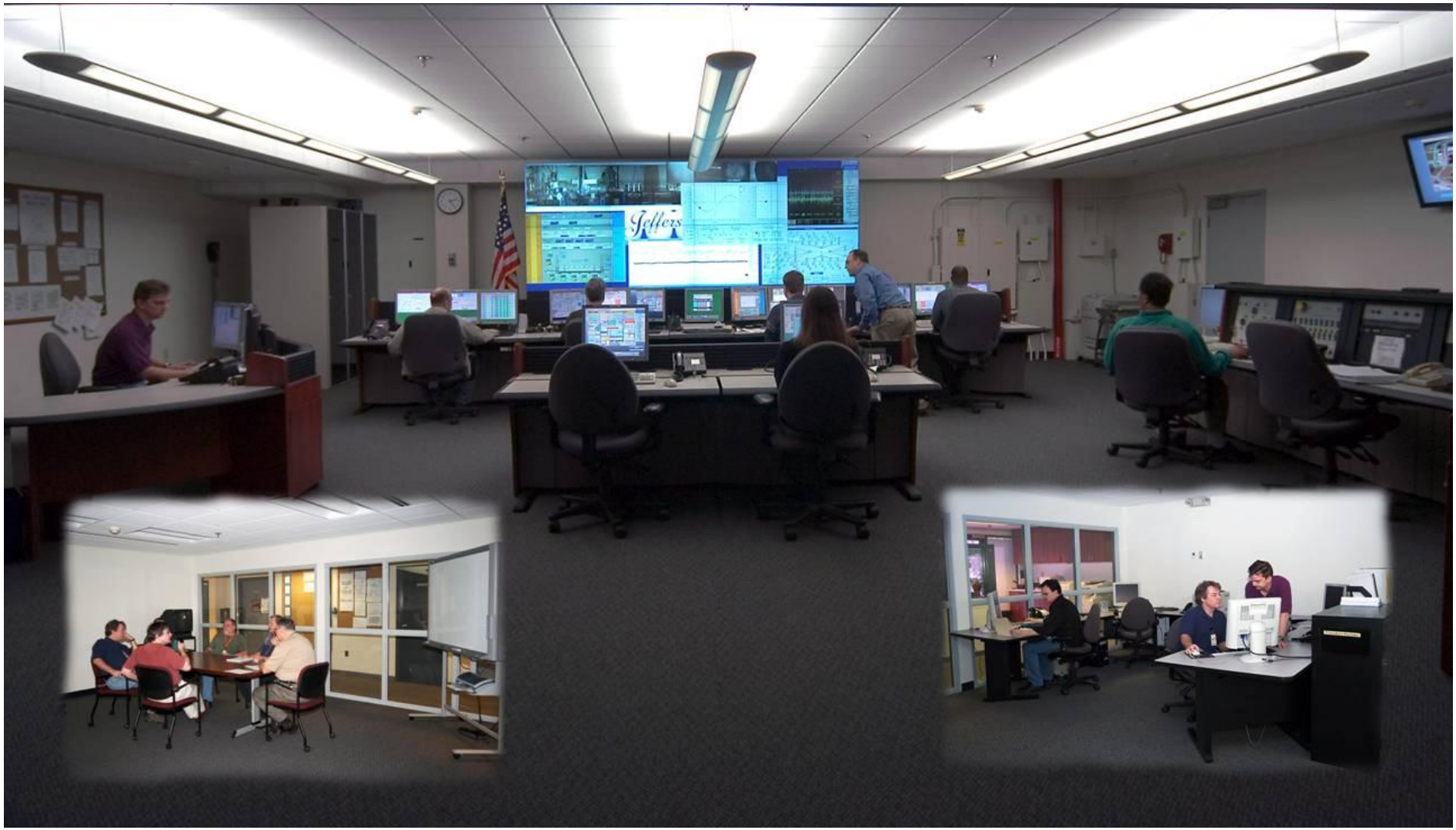


3 Beams on a View Screen

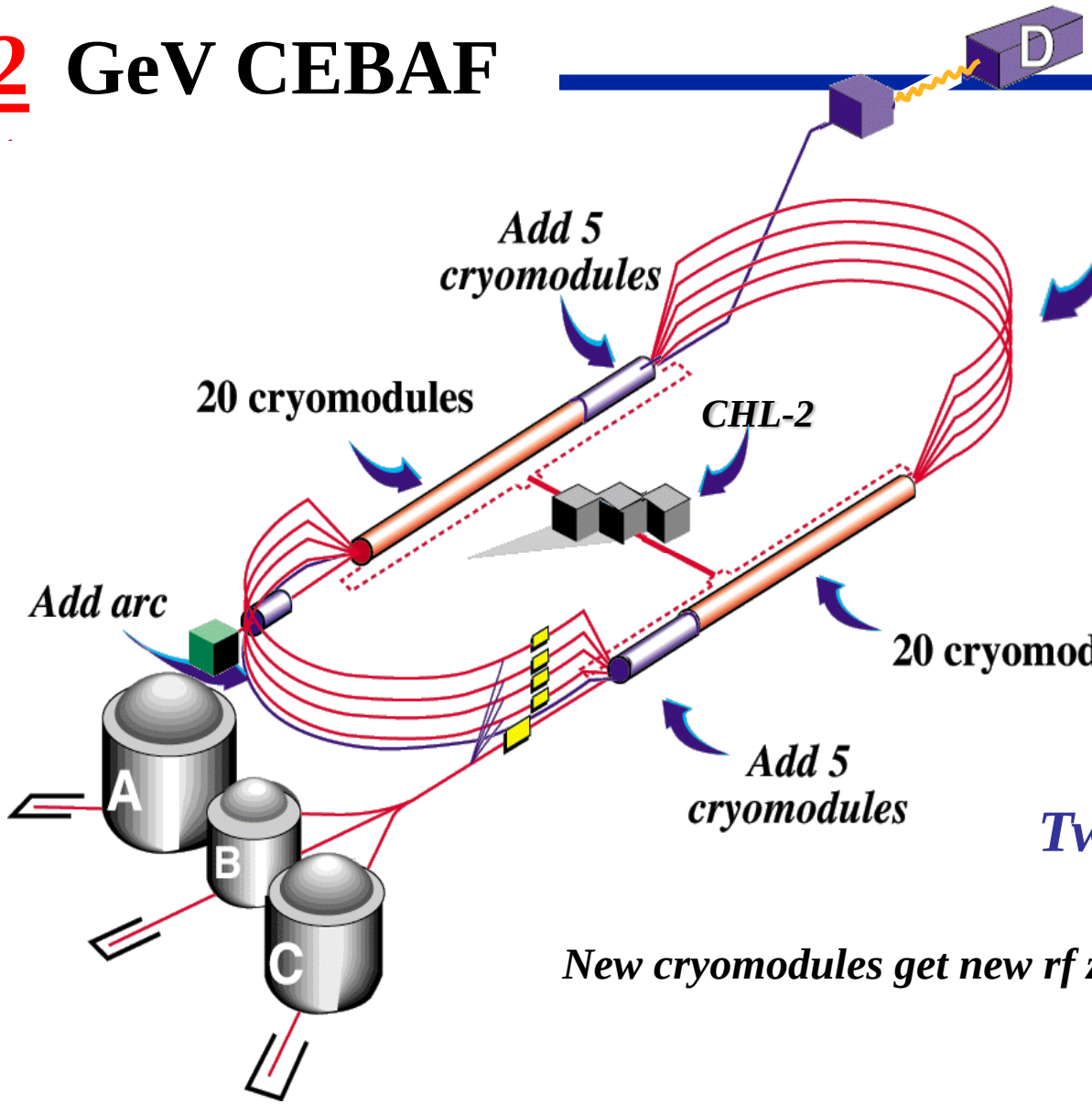


- Stick something in the beam that glows

Remotely "driven" from the Machine Control Center



12 GeV CEBAF



Two 1.1 GV linacs

New cryomodules get new rf zones