Session BN

The Physics of Beams and the Accelerators That Produce Them

August 2, 2004
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BN02  Modern Accelerators: How They Are Built, Why They Are Built, and Their Future, Alvin Tollestrup

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BN04  Accelerators to Make Electricity -- An Overview of Heavy-Ion Driven Fusion, Christine Celata

BN05  Accelerator Mass Spectrometry: Isotopic Science Tools from Archeology to Zoology, Jay Davis
Eighty Years of Particle Accelerators
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• ABSTRACT

• The development of particle accelerators started in the 1920s in an effort to develop a laboratory device that would enable physicists to make nuclear reactions and make artificial radioactivity (thus doing away with the need to use radioactive materials, while broadening the scope of possibilities). Thus, first, electrostatic machines were developed, and then, later, cyclotrons, betatrons, synchrotrons, and colliders.
Abstract (Continued)

• At the same time new, and ever better, detectors were developed. With these machines, and detectors, a wealth of physics was uncovered. Furthermore, the accelerators, themselves, proved to have uses far beyond those originally envisioned. A brief historical review will be presented of the accelerators, with comments upon their principles of operation and the technical advances that permitted ever-better machines to be constructed, while the science these machines make accessible will be partially covered in the various talks of this symposium.
Electrostatic Machines

• Cockcroft and Walton (1932) in England

• Van de Graaff (1933), Lauritsen (1928) and Truve and Dahl (1930) in the US.
Electrostatic Machines (Cont)

Carnegie Institute 2 meter Van de Graf
Cyclotrons

- Lawrence idea in 1928 or 1929
- Construction started in 1930
- Stan Livingston built the first cyclotron (1932)
Cyclotrons (Cont)

• The very first one (1931)
Cyclotrons (Cont)

- Magnet used for the 27 inch and 37 inch cyclotrons
Cyclotrons (Cont)

- A modern cyclotron (88 inch at Berkeley)
Linacs

- Idea of Ising (1922)

- Wideroe built the first one, published in 1928

- Sloan made a linac (1931)

- Alvarez made a linac after WWII
Linacs (Cont)

Fig. 3.4: Ising’s first suggestion for a linac [Is24].
Linacs (Cont)

- The rf cavities of the 40 foot proton linac (Alvarez, Late 40’s)
Linacs (Cont)

• The Hilac (Construction started 1957, Completed in 1965) (Berkeley)
Synchrotrons

• Phase focusing: McMillan and (independently) Veksler (1945)

• Strong focusing: Courant, Livingston, and Snyder, and (independently) Christofilos (1952)
Synchrotrons (Cont)

- The first (electron) synchrotron
  McMillan 1945-1948
Synchrotrons (Cont)

• The last of the weak focusing synchrotrons (The Bevatron in Berkeley, 1954, 6 GeV)
Synchrotrons (Cont)

- The first strong focusing synchrotron
- (The PS at CERN, 1954, 28 GeV)
Colliders

• Kerst et al (1956) (p-p)

• O’Neil (1956) and (independently) Lichtenberg, Newton, and Ross (1956)

• Touschek and Budker (e-e) (1966)

• CERN ISR, Adone, ACO, VEP I, VEP II, SPEAR, DORIS, PEP, PETRA, TRISTAN, Tevatron, LEP, etc…..
Colliders (Cont)

Colliders (Cont)

- The first electron-positron
- Collider. Frascati-Orsay
- 1961
Colliders (Cont)

One of the first large electron-positron colliders
ADONE, Frascati, Operated in 1969
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