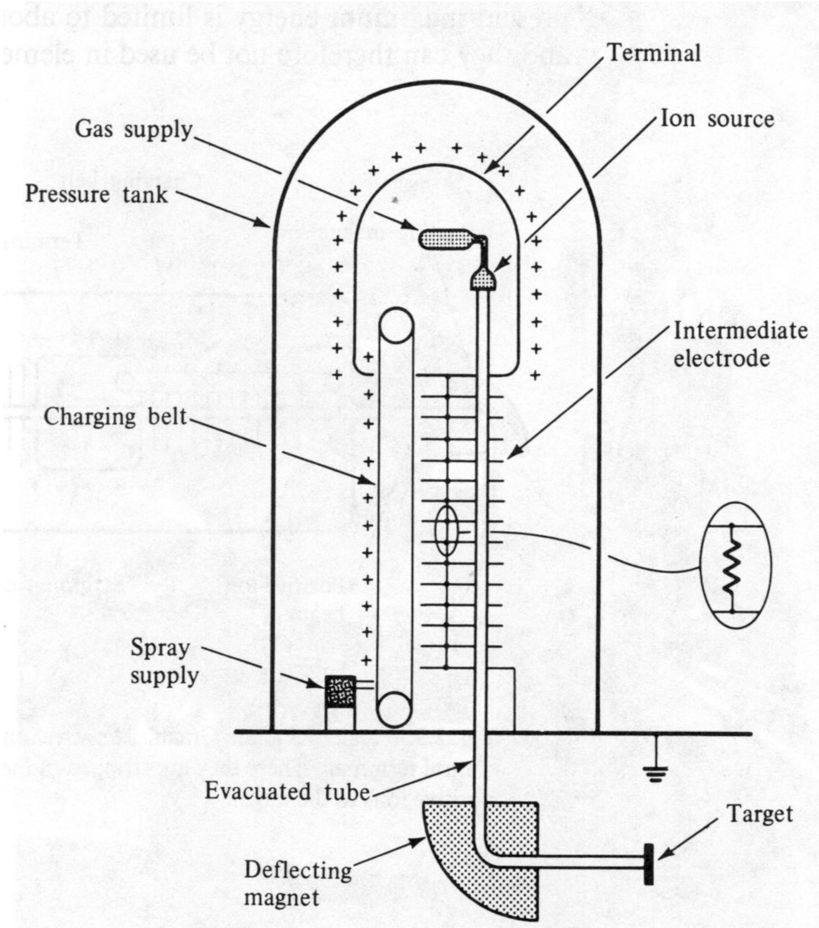
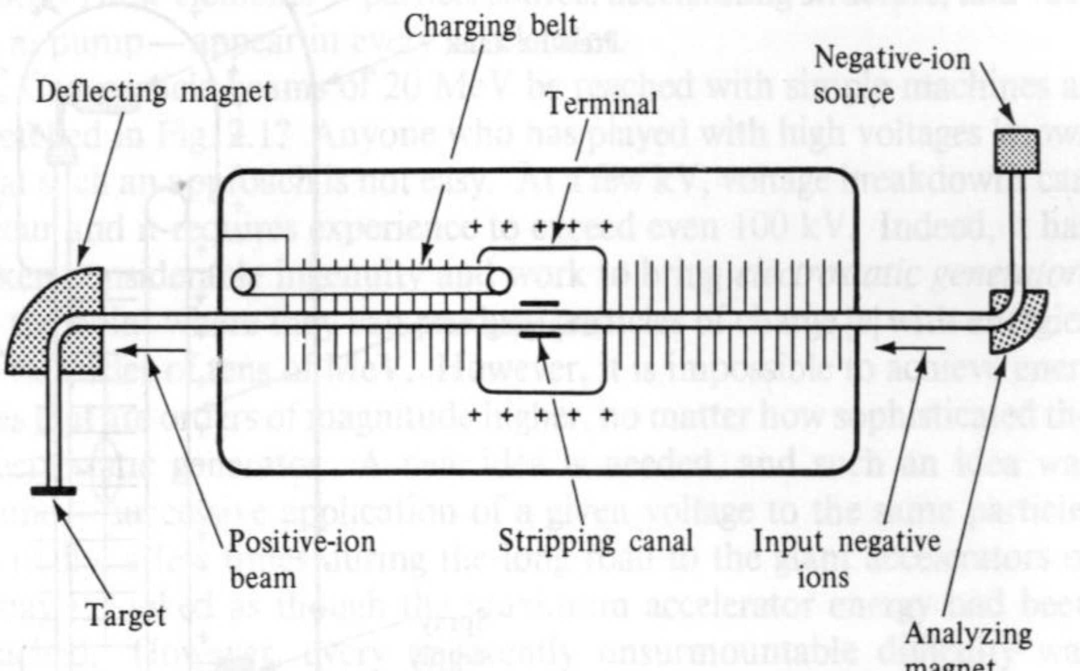
Beschleuniger-typen:

	Accelerator	*Particle accelerated*	E	H	*Orbit*	*Typical energy,* MeV
	Electrostatic, or Van de Graaff	*e*, *p*, *d*, *α*, or other	Constant	None	Straight	12
2.1	Tandem Van de Graaff	*p*, *α*, or other	Constant	None	Straight	21
	Multiplier circuit, or Cockcroft–Walton	*e*, *p*, *d*, *α*	Constant	None	Straight	4
2.3	Betatron	*e*	None	Variable	Circular	300
	Cyclotron	*p*, *d*, *α*	Fixed *ω*	Constant	Spiral	25 for *p*
2.4	Sector-focused cyclotrons	*p*, *d*, *α*, or other	Fixed *ω*	Variable with *θ*	Sectored spiral	75-for *p*
	Synchrocyclotron	*p*	Variable *ω*	Constant	Spiral	700
	Synchrotron	*e*	Fixed *ω*	Variable	Circular	10^4
2.5	Proton synchrotron	*p*	Variable *ω*	Variable	Circular	10^4
	Strong-focusing	*p*	Variable *ω*	Variable	Circular	5×10^5
2.2	Linear (rf)	*p*, *d*	$\omega \sim 200$–800 MHz	None	Straight	800
	Linear (conventional)	*e*	$\omega \sim 3000$ MHz	None	Straight	2×10^4
	Heavy-ions (Linac)	^{12}C, ^{16}O, etc.	$\omega \sim 70$ MHz	None	Straight	$10 \times A$ of ion

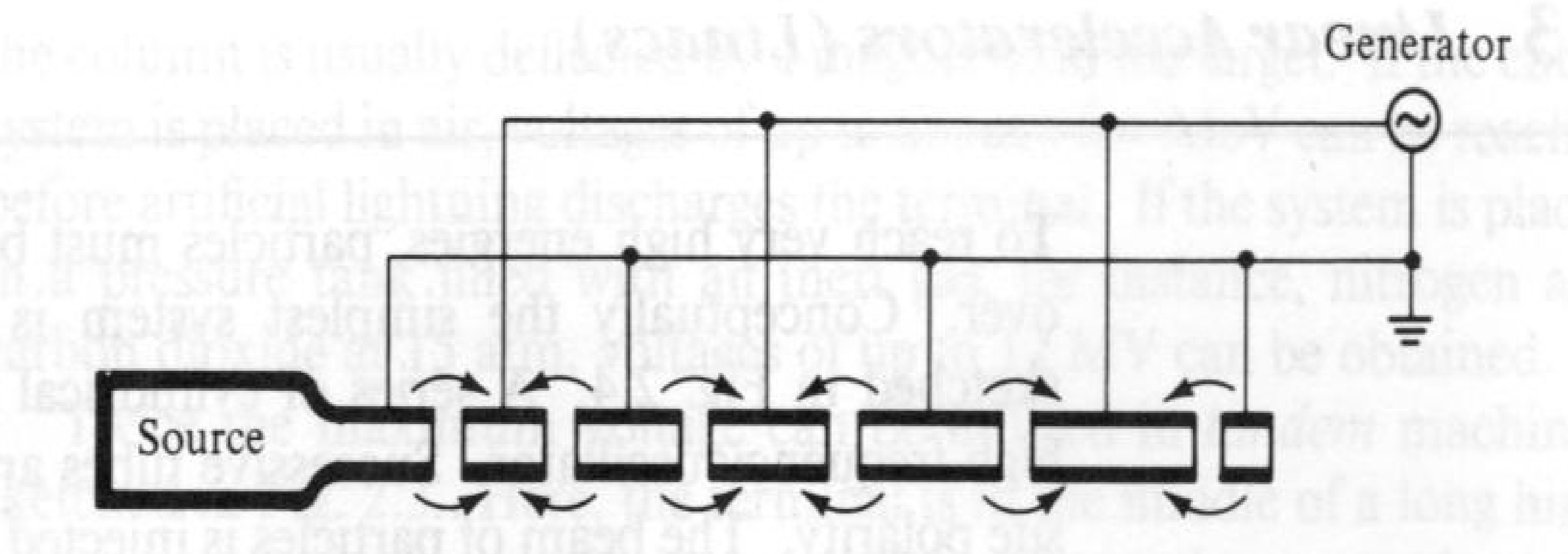


Van de Graaf

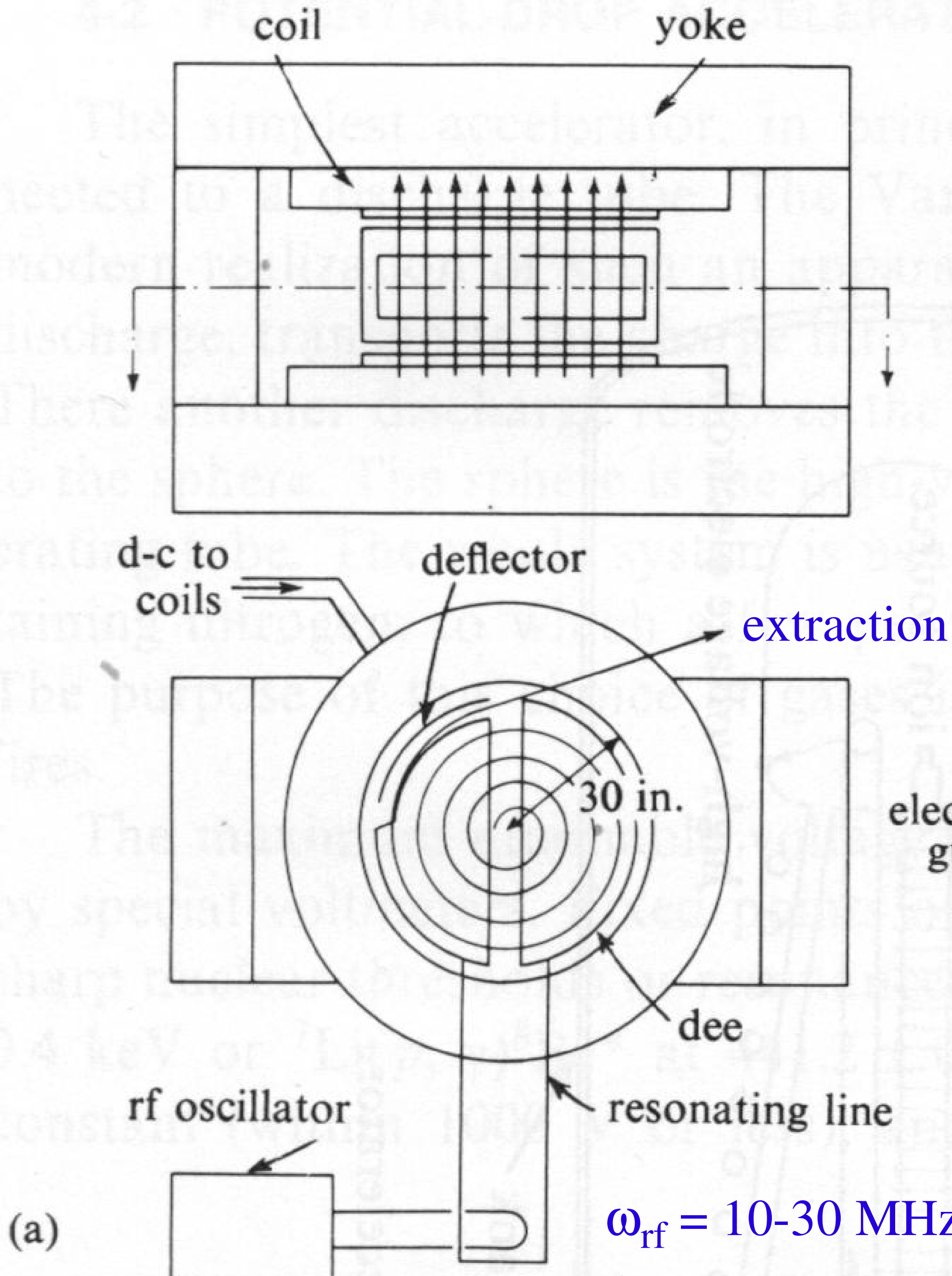
Tandem



Prinzip Linear Beschleuniger



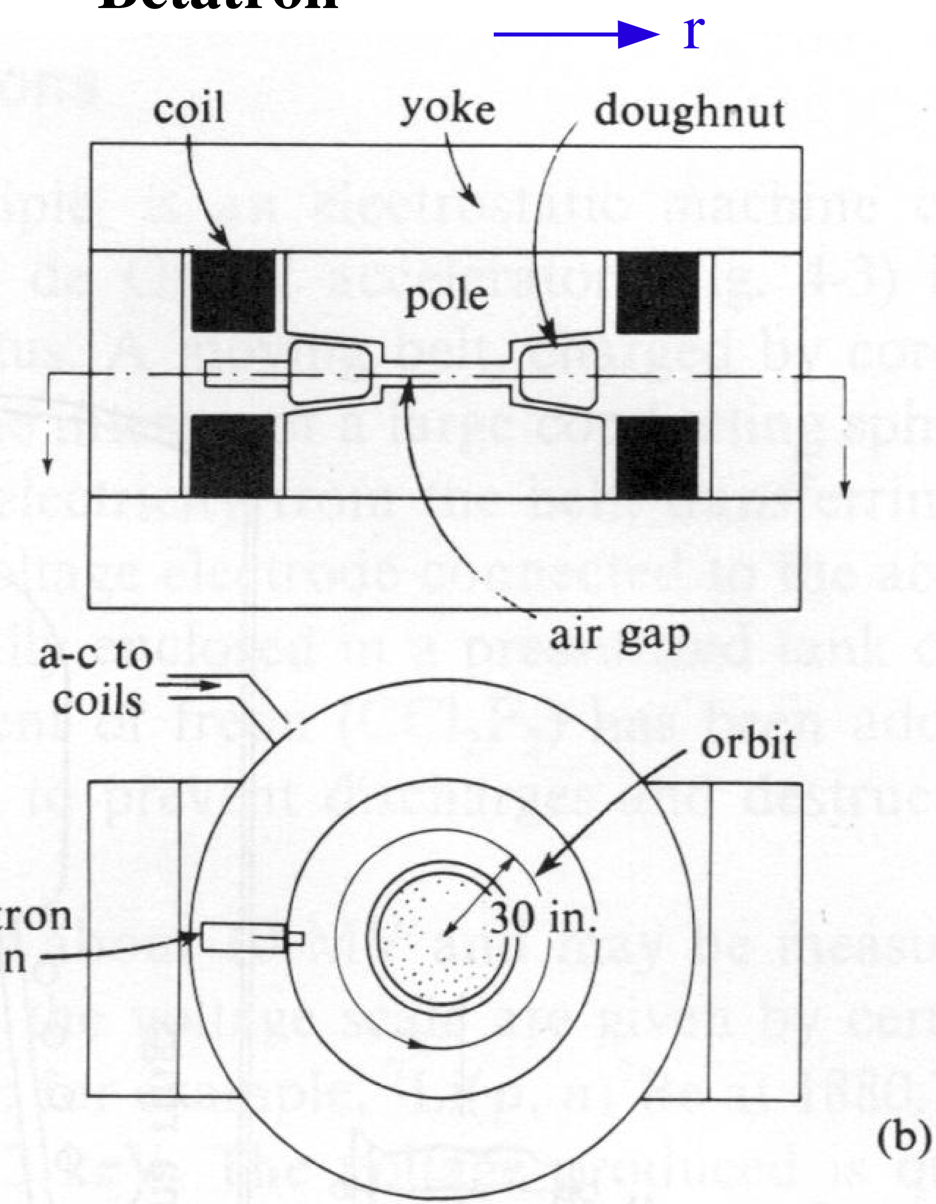
Cyclotron



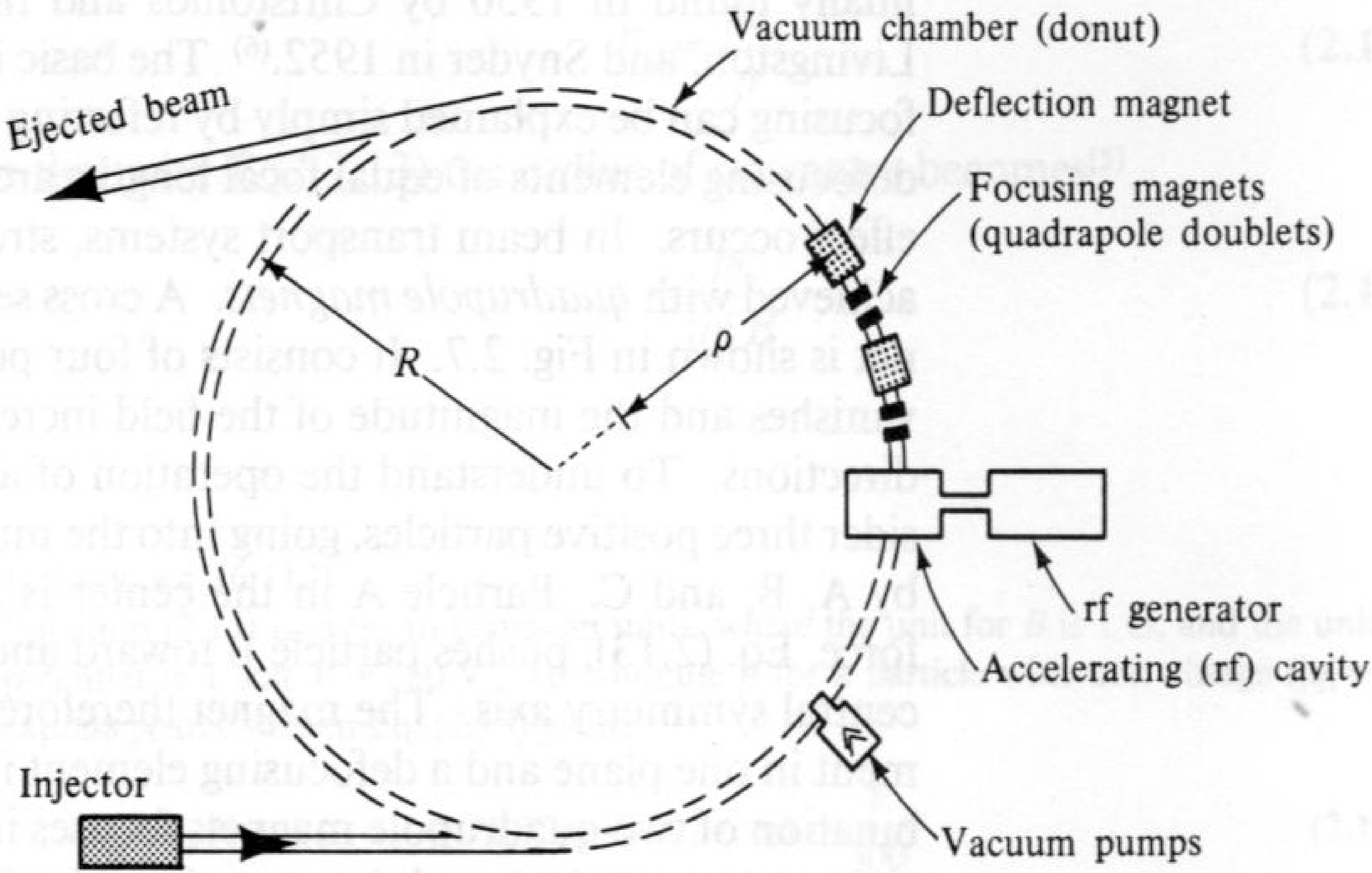
ω_{rf} = 10-30 MHz

ΔU = 0.1 MV

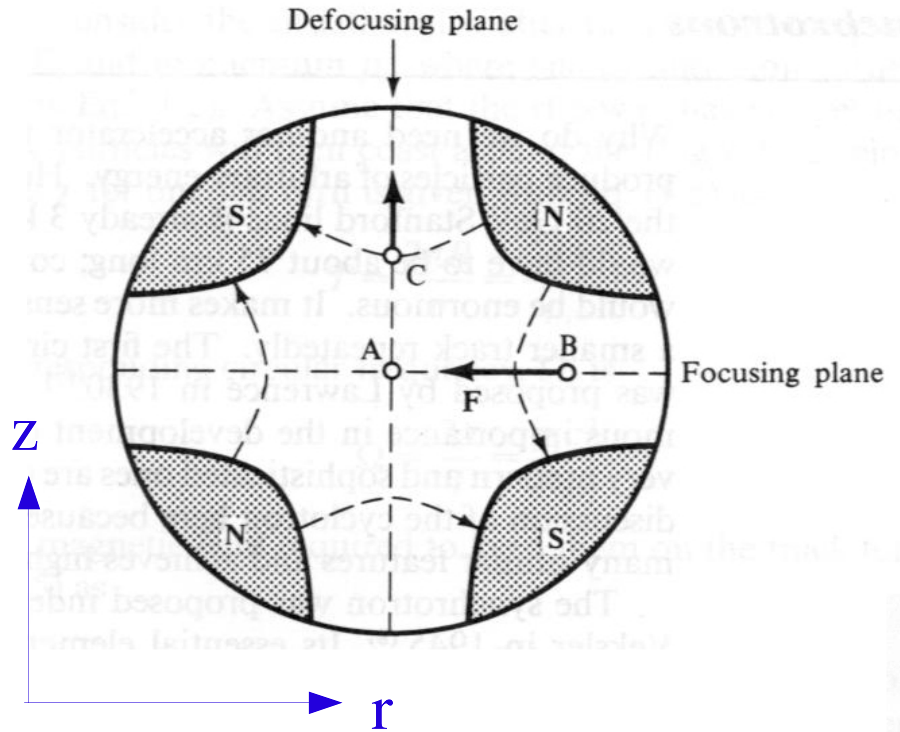
Betatron



Synchrotron

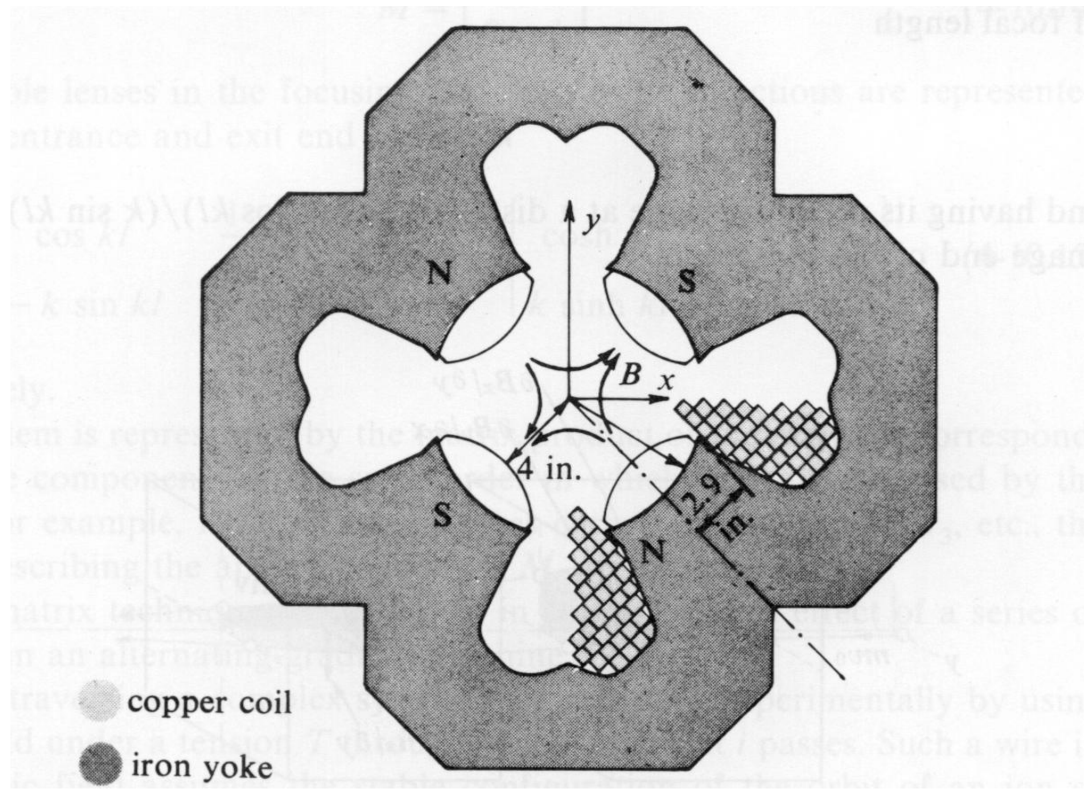


starke Fokusierung mit Dubletts von Quadrupol Magneten



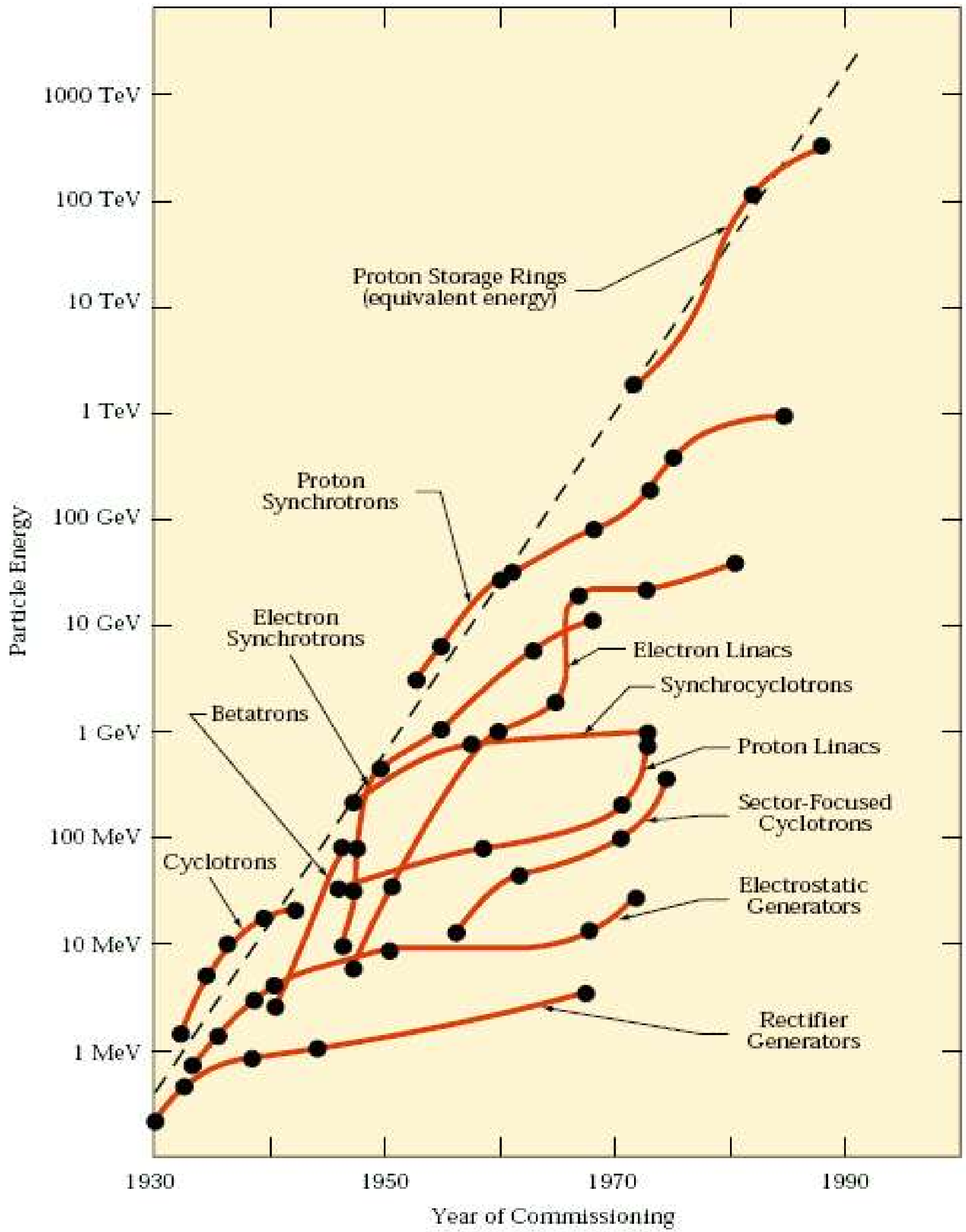
1. Quadrupol:
   fokusierend in r, defokusierend in z
2. Quadrupol: umgekehrte Polaritaet ->
   fokusierend in z, defokusierend in r

Realisierung eines
Quadrupol Magneten:



Accelerator Evolution

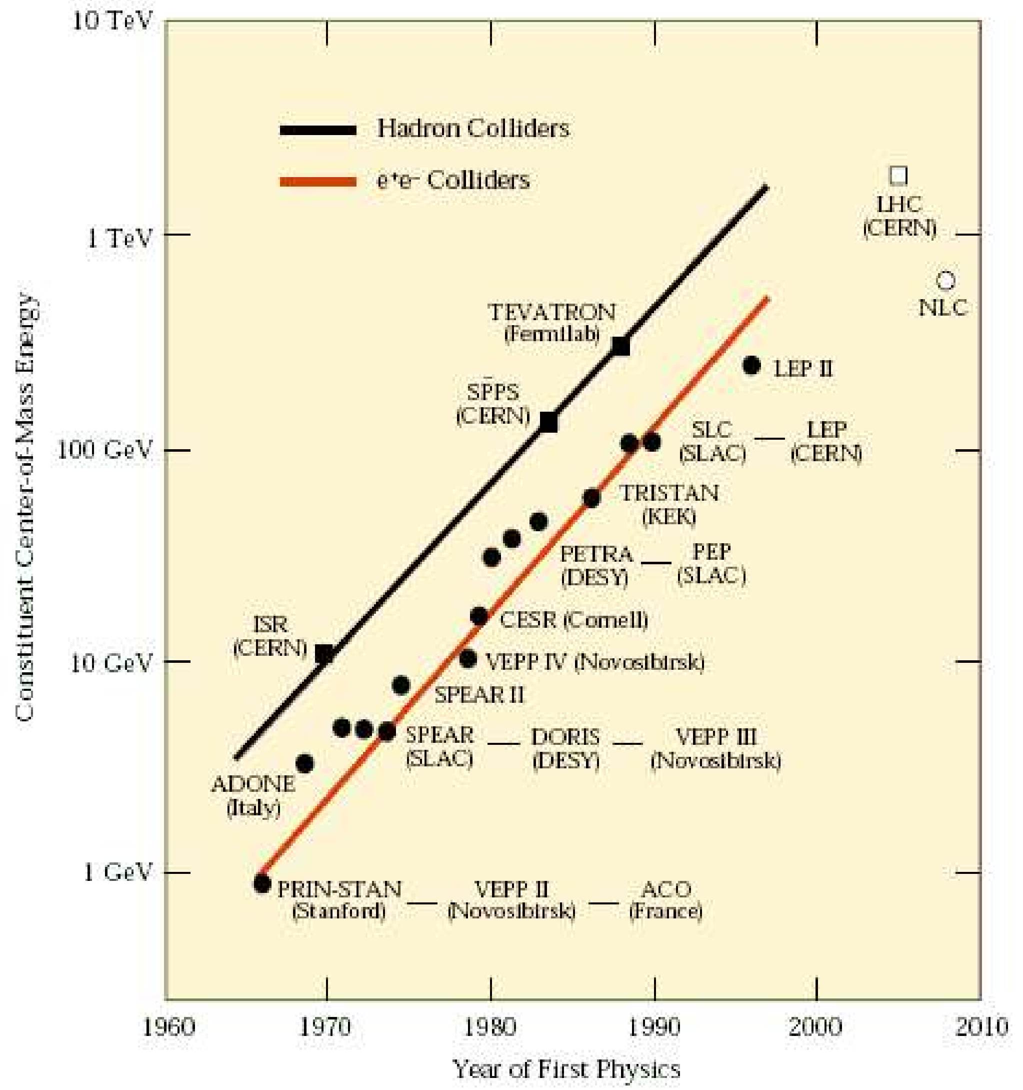
scaled as if all fixed target



Adapted from an article by
W.K.H. Panofsky, Stanford 1997

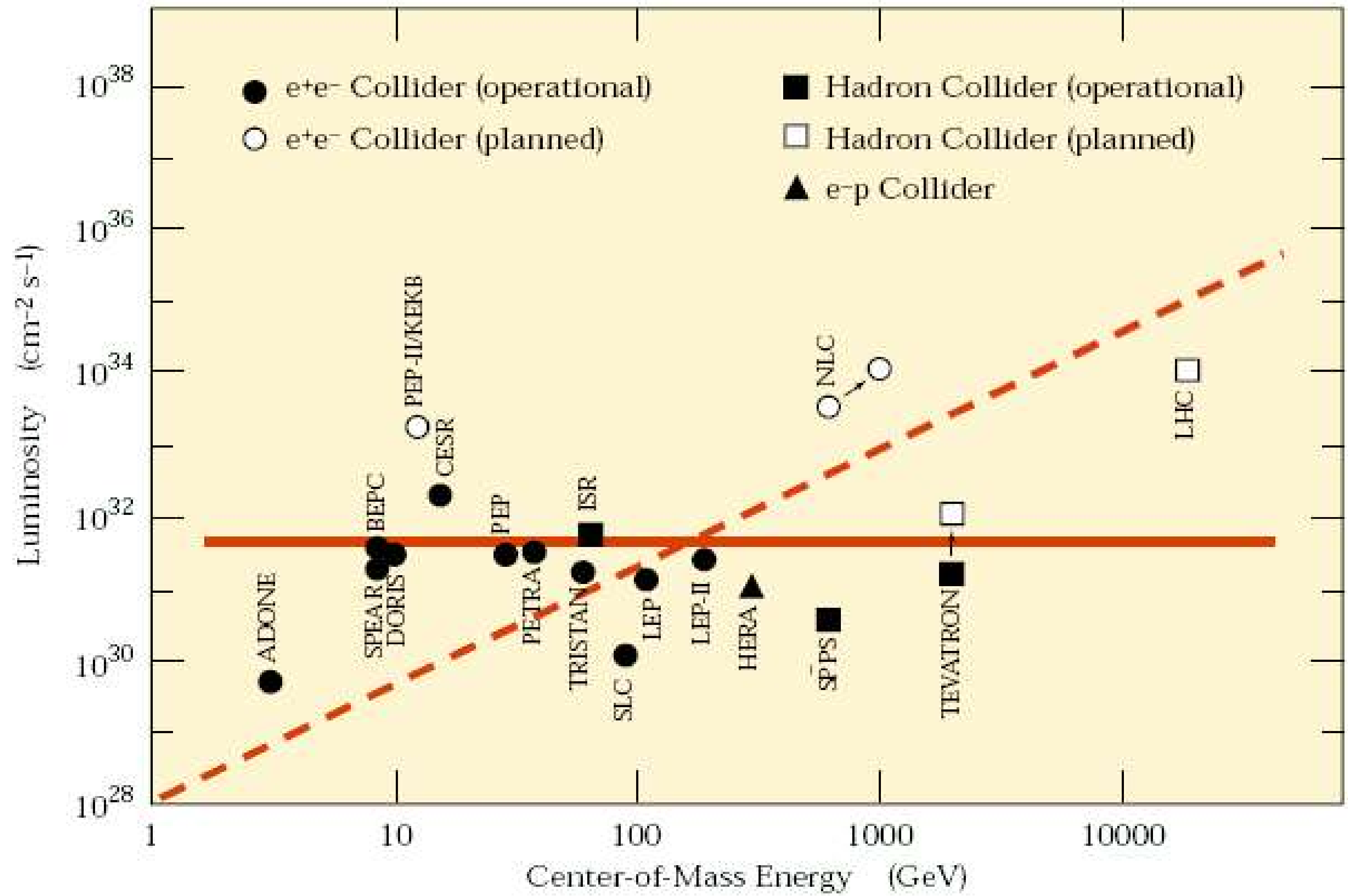
Accelerator Evolution: Colliders

Right: The energy in the constituent frame of electron-positron and hadron colliders constructed (filled circles and squares) or planned. The energy of hadron colliders has here been derated by factors of 6–10 in accordance with the fact that the incident proton energy is shared among its quark and gluon constituents.



Adapted from an article by
W.K.H. Panofsky, Stanford 1997

Accelerator Evolution: luminosity

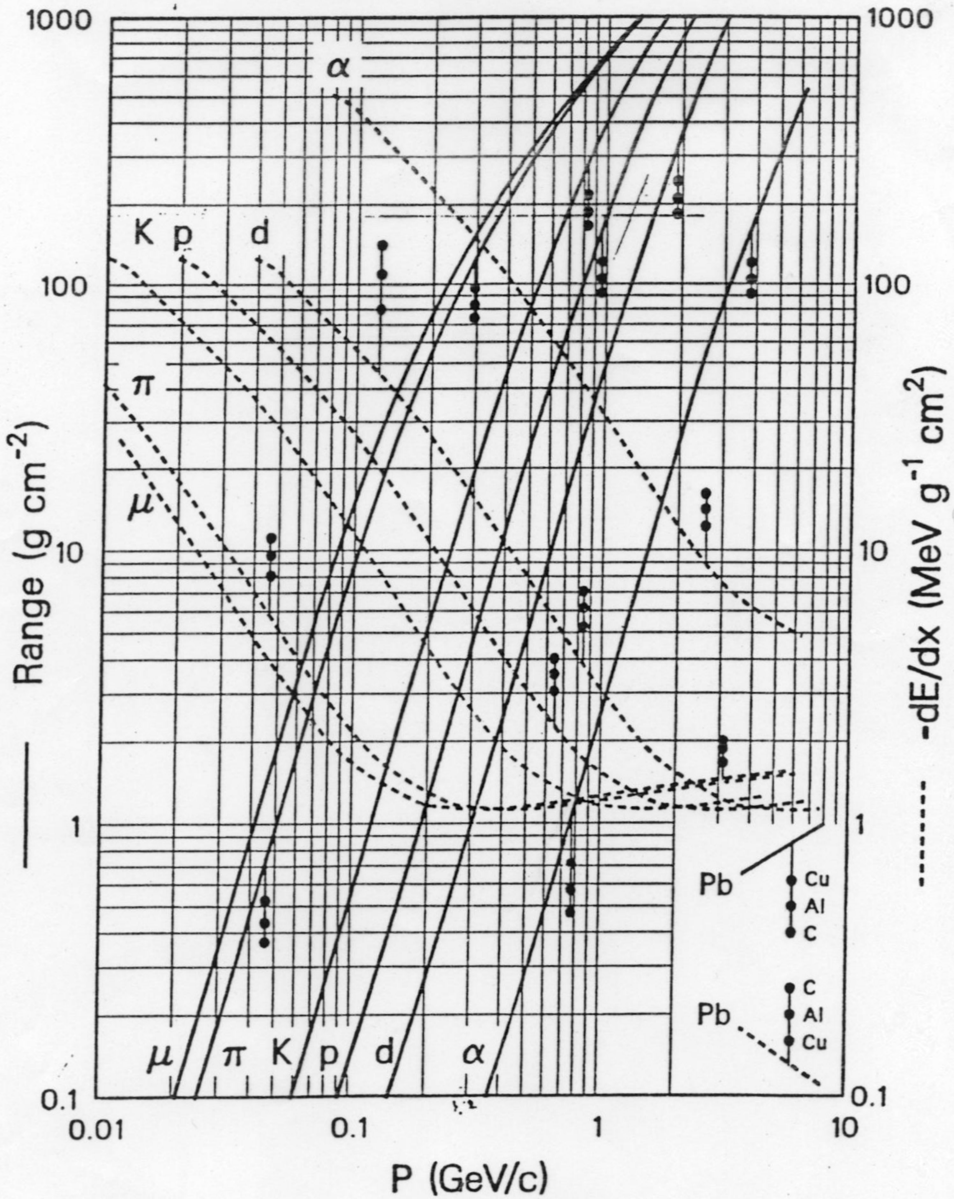


Peak luminosities achieved at existing colliders and values projected for planned or upgraded machines. The dashed line indicates luminosity increasing as the square of the center-of-mass energy Note that the rated machine energy has been used in calculating the abscissa. (Data updated courtesy Greg Loew, SLAC)

Adapted from an article by
W.K.H. Panofsky, Stanford 1997

MEAN RANGE AND ENERGY LOSS

Mean Range and Energy Loss in Lead, Copper, Aluminum, and Carbon



Mean range and energy loss due to ionization for the indicated particles in Pb, with scaling to Cu, Al, and C indicated, using Bethe-Bloch equation [See Sec. (1) of Passage of Particles Through Matter] with corrections. Calculated by M.J. Berger, using ionization potentials and density effect corrections as discussed in M.J. Berger and S.M. Seltzer, "Stopping Powers and Ranges of Electrons and Positrons," (2nd ed.), U.S. National Bureau of Standards Report NBSIR 82-2550-A (1982). The average ionization potentials (I) assumed were: Pb (823 eV), Cu (322 eV), Al (166 eV), and C (78.0 eV). Figure indicates total path length; observed range may be smaller (by ~ 1 % - 2% in heavy elements) due to multiple scattering, primarily from small energy-loss collisions with nuclei. The functional forms have not been experimentally verified to better than roughly ± 1%. For higher energies refer to discussion by Cobb ["A Study of Some Electromagnetic Interactions of High Velocity Particles with Matter," University of Oxford Report HEP/T/55 (1973)] and by Turner ["Penetration of Charged Particles in Matter: A Symposium," National Academy of Sciences, Washington D.C. (1970), p. 48]. For lower energies both data and theory are not well understood. Scaling to other beam particles is, to a good approximation, described by the formula on the next page.

Bemerkung: Plasmaenergie $\propto \sqrt{n}$,
d.h. Korrektur groesser in
Fluessigkeiten und Festkoerpern