deconstruction: periodic table

Look at the periodic table of elements, and you'd be hard pressed to find an element that is not used in physics. But what are the most important elements for building accelerators, detecting particles, and solving the mysteries of the universe? The search for answers takes us on a winding journey that includes ancient shipwrecks, trendy earrings, and the sound of dark matter. *symmetry* intern Kristine Crane asks Fermilab physicists about the elements they could not live without.

1 H								
3 Li	4 Be							
11 Na	12 Mg							
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh
55 Cs	56 Ba	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir
87 Fr	88 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt
		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu
		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am

H

Hydrogen provides the protons for proton beams. Made of only one proton and one electron, the hydrogen atom is the lightest element. It is also the most abundant, comprising 90 percent of the visible universe by mass.

Nb

Niobium helps push and steer particles. Of all the elements, it superconducts at the highest temperature—9.2 kelvin. It is the material of choice for the superconducting magnets that keep beams moving in the right direction and superconducting cavities that accelerate beams. Niobium is also used for stylish earrings and superconducting magnets in MRI machines.

W

Tungsten wires as thin as a human hair span the interior of the outer tracker of the CDF experiment at Fermilab. The wires record the arrival times and paths of charged particles. Thin wires are the best for recording signals in an electric field, but the wires must also last. Tungsten endures more tension than its close relative, copper.

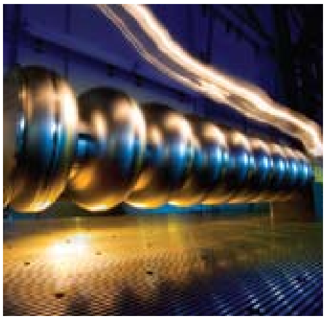
Fe

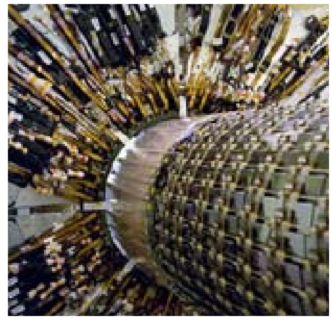
Iron is the most stable element in the universe: it takes more energy to break apart an iron nucleus than any other type. At the European laboratory CERN, an iron yoke weighing approximately 10,500 tons channels the magnetic field of the CMS detector.

Pb

Lead shielding protects supersensitive particle detectors from naturally occurring radiation. But lead itself can be radioactive. The melting of lead ore isolates heavy isotopes, but short-lived lead-210 remains. Hence the best kind of lead is at least 200 years old and can be found, for example, in shipwrecks.

Left to right: superconducting cavities made of niobium; germanium crystal of the CDMS experiment; ATLAS silicon detector.





Photos: Fermilab, CERN

								2 He
			5 B	6 C	7 N	8 O	9 F	10 Ne
			13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
110 Ds	111 Rg	112 Uub	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo

64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb
96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No

He

Liquid helium cools the superconducting magnets that steer particles and bend their paths. It is the only element that remains liquid at the ultra-cold temperature of 4.5 kelvin. Fermilab and CERN have two of the world's largest plants for converting helium gas to its liquid form.

N

Liquid nitrogen cools magnets and other devices to 77 kelvin. Fermilab uses about 80,000 liters of it each day. At six cents per liter, it's a cheap commodity.

Ar

Argon is an inexpensive noble gas. Scientists are drilling wells in Texas to find non-radioactive argon, which they prefer in their particle detectors to avoid signals caused by the decay of radioactive isotopes.

Xe

Xenon is an expensive cousin of argon. A liter of liquid xenon costs $1000. Xenon is used in lasers, light bulbs, and anesthesia, as well as in the neutrino research at the Enriched Xenon Observatory.

Si

Silicon is the element that gave Silicon Valley its name. In particle physics, silicon vertex detectors track the paths of particles. At the Large Hadron Collider in Europe, the ATLAS detector includes enough wafer-thin tiles of silicon to cover the floor of a racquetball court.

Ge

Germanium may reveal the existence of dark matter particles. Scientists of the Cryogenic Dark Matter Search listen for the sound that a dark matter particle would create if it hit an atom inside a large germanium crystal cooled to ultralow temperature.