WHILE PURSUING RTS WE MUST EXPLOIT KNOWN-LTS AND HTS SUPERCONDUCTORS TO YIELD LARGE-SCALE ENERGY SAVINGS

Carl H. Rosner

CARDIOMAG IMAGING, INC.
Schenectady, New York, U.S.A.

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THE NEW WORLD OF SUPERCONDUCTIVITY

Technologies and products once only dreamed of are suddenly coming within reach

Inexhaustible, cheap energy from fusion, desktop computers as powerful as today's number-crunchers, trains that fly above their rails at airplane speeds—all suddenly have taken a giant step closer to reality. But while scientists developing a new breed of "warm" superconductors are planting the seeds of an almost Utopian tomorrow, it will be up to engineers to reap the harvest.

That won't happen overnight. The novel materials that researchers are churning out in laboratories still have to be transferred to the factory floor. Significant hurdles must be cleared before an experimental circuit for a superconducting computer can be turned into mass-produced chips. A small sample of wire is a long way from cables that will span the nation.

Even in the fleet-footed electronics business, it will probably be 1990 before full-fledged products show up. For electrical utilities, it could take 10 to 20 years before the revolutionary new superconductors make a meaningful impact on power distribution. The challenge of scaling up lab results "could be formidable," cautions Paul M. Grant, manager of magnetics research for International Business Machines Corp.

SCOTCH AND WATER. Until now, superconductivity has been limited to a few applications because the materials available had to be cooled to extraordinarily frigid temperatures with expensive liquid helium. "Liquid helium costs about the same as Scotch," says Walter L. Robb, senior vice-president for corporate research and development at General Electric Co. Liquid nitrogen is 10% as costly—roughly on a par with bottled water. And even with complicated a[...] very expensive insulation systems, liq[...] helium escapes far more rapidly t[...] liquid nitrogen, which can be protec[...] with simple plastic-foam insulation.

The idea that it may soon be econo[...]cally feasible to put superconductivity [...]work in myriad uses is sparking deve[...]ment projects at hundreds of compan[...] worldwide. The payoffs would be e[...]mous. And if room-temperature su[...]conductors are ultimately discove[...] the world could be transformed. S[...] "hot" materials could provide new t[...] for every technology related to elec[...]ity. But just the prospect of super[...]ductivity at liquid-nitrogen temperatu[...] is enough to excite most indus[...] engineers.

Practical nitrogen-cooled supercon[...]tors could save the utilities billio[...]

FOUR TECHNOLOGIES THAT WI[...]


HIGH TECHNOLOGY
BUSINESS
JANUARY 1988
American Superconductor
Biomagnetic Technologies
Eriez Magnetics
Teledyne Wah Chang
1988's HOTTEST SUPERCONDUCTOR COMPANIES
Quantum Design
Intermagnetics General
SUPERCONDUCTOR INDUSTRY
FALL 1988
STATE OF THE INDUSTRY • THE SSC
THERMAL ANALYSIS • FUTURE GROWTH
$6.00
ARE BANKS OBSOLETE?
PLUS 1986 RESULTS OF 200 BANKS
BusinessWeek
APRIL 6, 1987
MUTUAL FUNDS DESIGNED FOR FAST ACTION
A McGRAW-HILL PUBLICATION
SUPER CONDUCTORS
Every so often a new technology spurs immense change. Now comes superconductivity. Scientists have long known that certain metals conduct electricity with no resistance when they are cooled to absolute zero, -459F. But that was too cold to be much use. Now, in a series of breathtaking
advances, scientists have raised the superconductivity threshold to practical levels. The possibilities are stunning: Electric cars, superfast trains that ride on magnetic fields, more powerful computers—
New superconductors recall the birth of computers, says Intermagnetics General's Rosner, shown with medical imaging magnet.
DENTISTRY CHANGES
IBM'S PC STRATEGY
HIGH TECHNOLOGY
SUPERCONDUCTING
The New Billion Dollar Business
Also:
Pentagon Chips
Camcorder Race
Carl Rosner
President
Intermagnetics General Corporation
Guilderland, New York

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NEW YORK, MONDAY, JANUARY 2, 1989

50 cents beyond 75 miles from New York City, except on L

BATTLES BEGINNING IN RACE TO PATENT SUPERCONDUCTORS

BIG PROFITS ARE AT STAKE

Wide Uncertainty Over Rights Could Slow Investment— Japanese Act Quickly

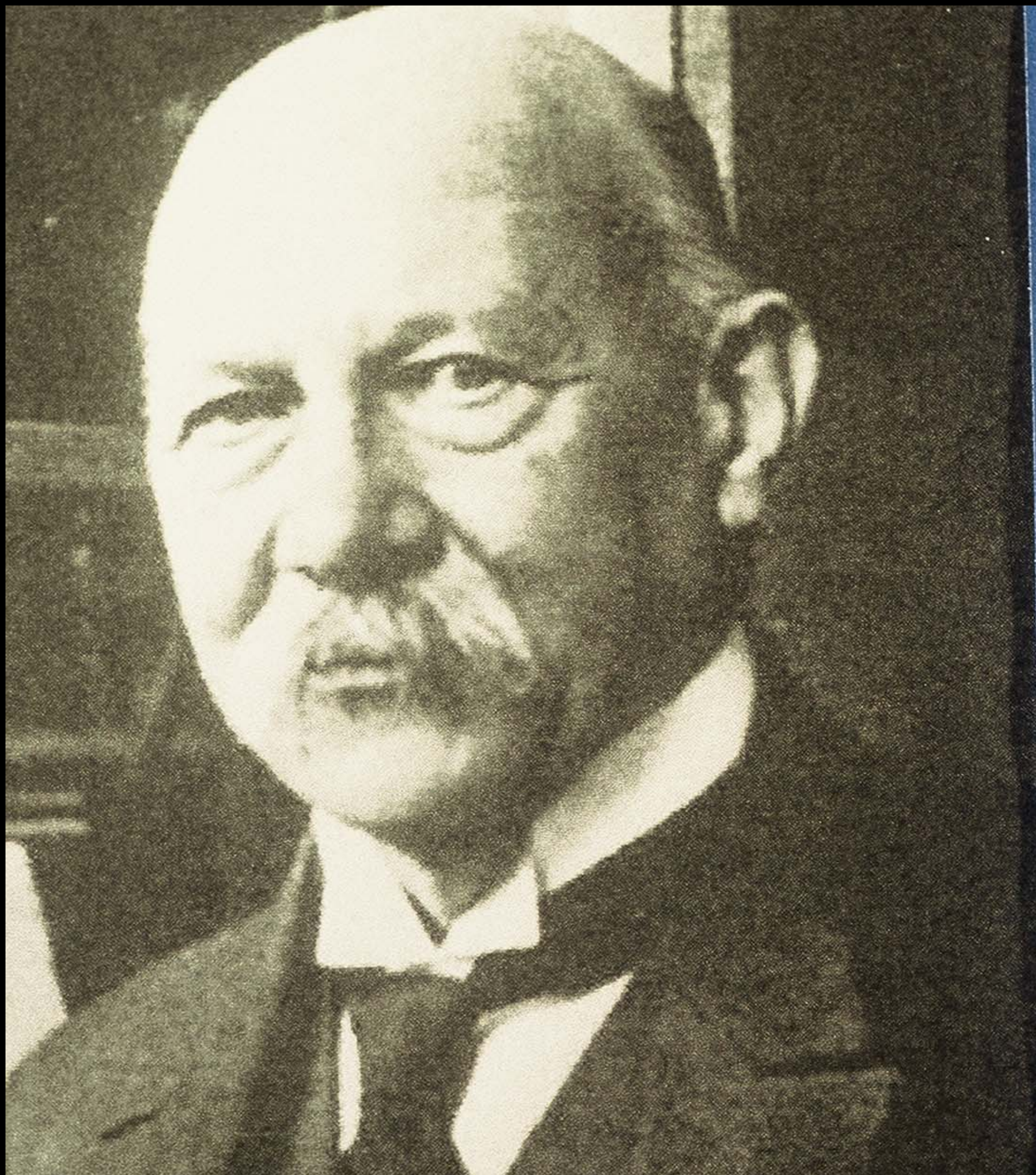
By ANDREW POLLACK

At stake is a technology that could revolutionize computers and power generation.

greater, with Sumitomo Electric Industries having filed more than 700 applications alone.

As of the end of November, 650 patent applications related to high-temperature superconductivity had been filed in the United States, said Gerald Goldberg, head of a task force in the patent office handling such patents. Of those, 225 were filed by foreigners, 150 from Japan.

Irving Kayton, professor of intellectual property law at George Mason



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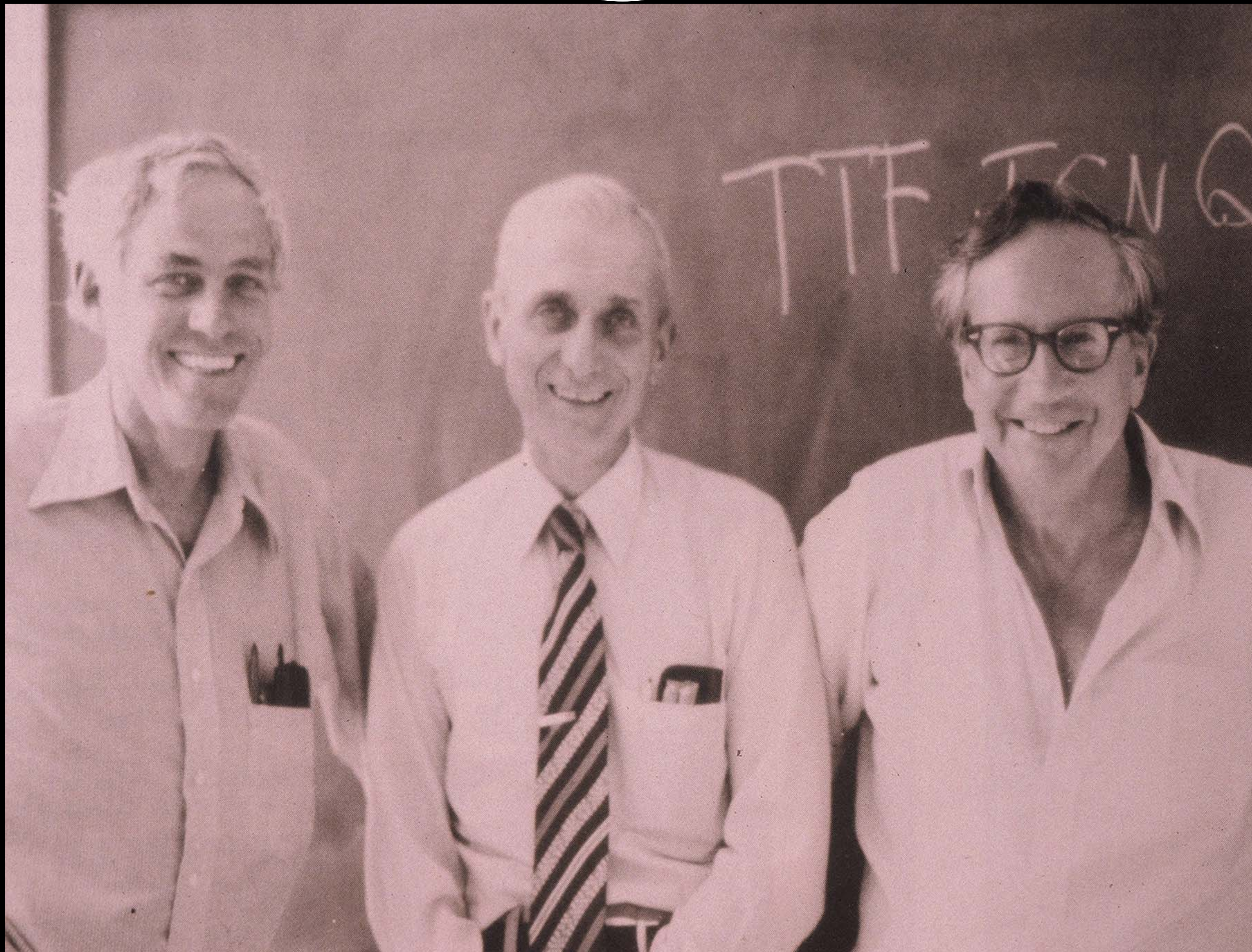
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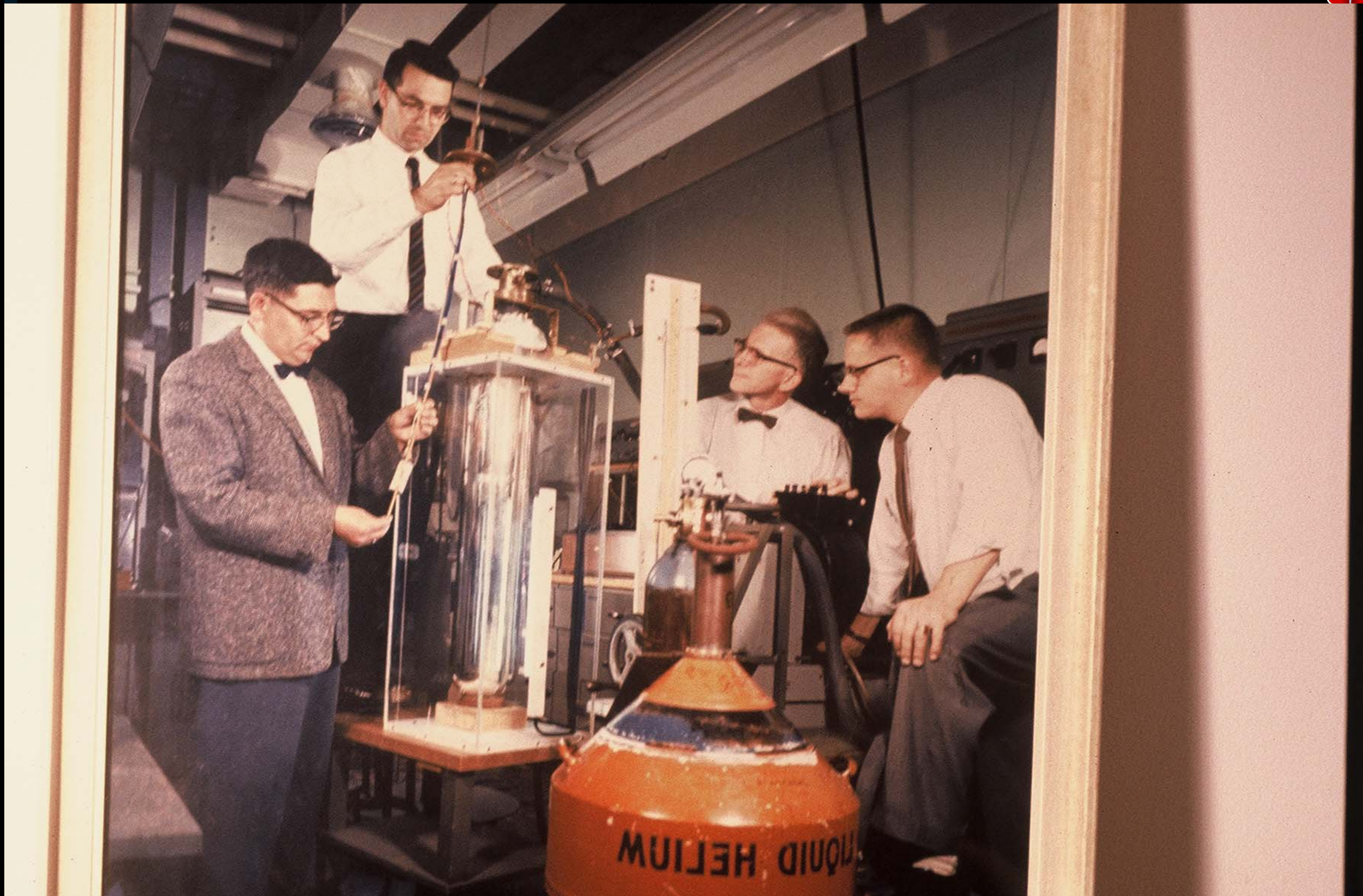
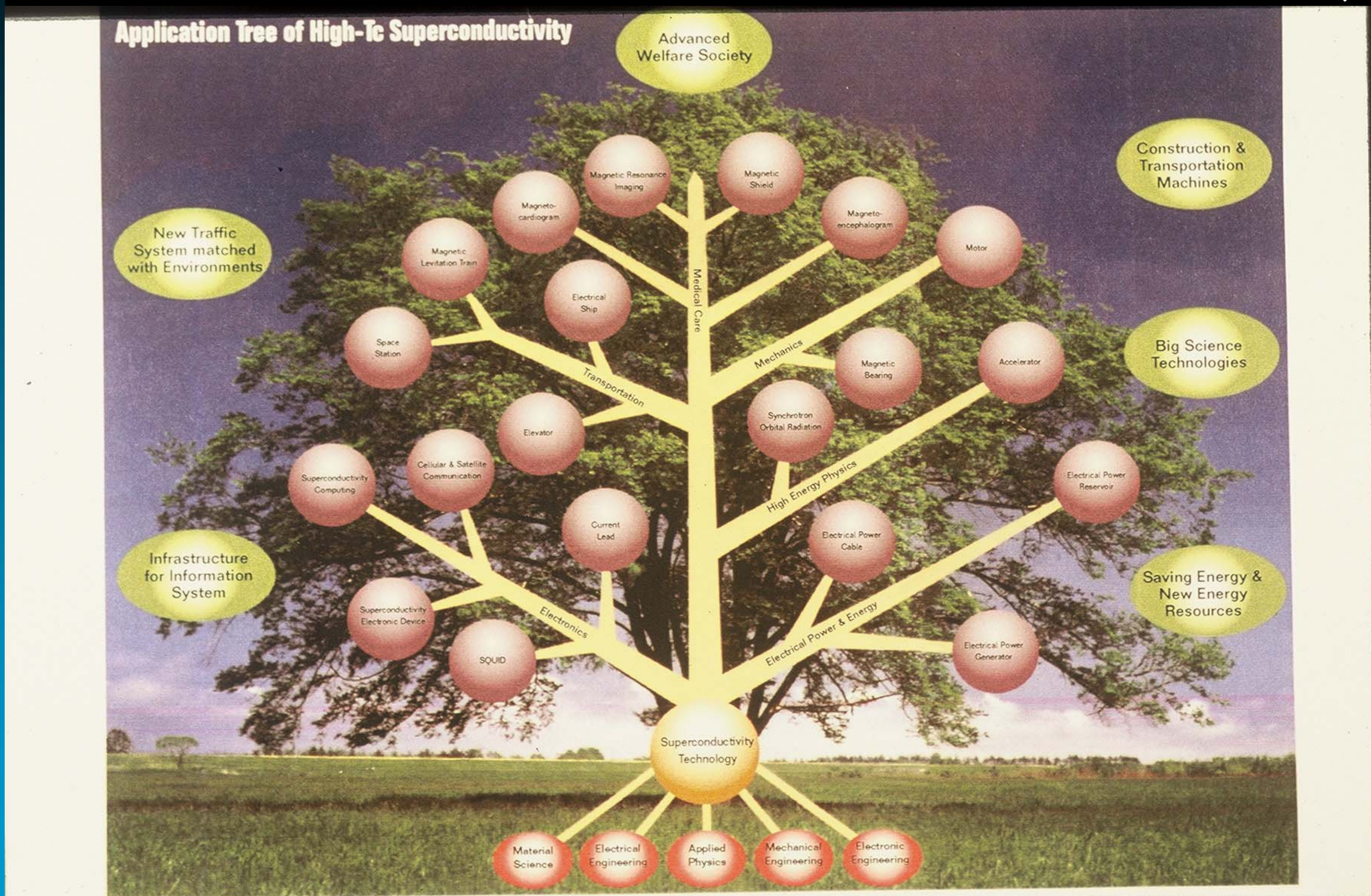
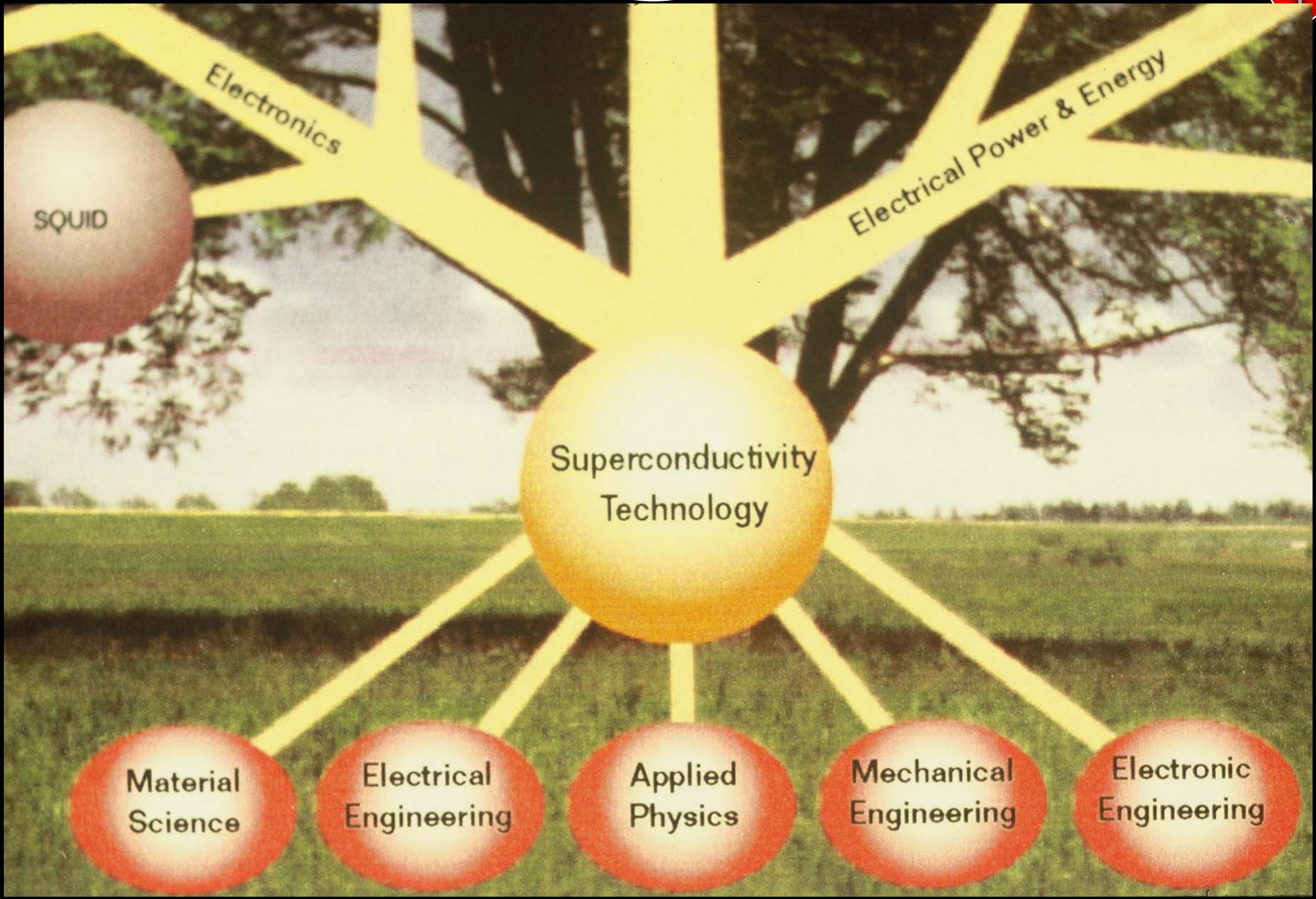

LIQUID HELIUM


Application Tree of High-Tc Superconductivity
Advanced Welfare Society
New Traffic System matched with Environments
Construction & Transportation Machines
Big Science Technologies
Infrastructure for Information System
Saving Energy & New Energy Resources
Magnetic Resonance Imaging
Magnetic Shield
Magneto-cardiogram
Magneto-encephalogram
Magnetic Levitation Train
Motor
Electrical Ship
Space Station
Medical Care
Mechanics
Transportation
Magnetic Bearing
Accelerator
Elevator
Synchrotron Orbital Radiation
Superconductivity Computing
Cellular & Satellite Communication
High Energy Physics
Electrical Power Reservoir
Current Lead
Electrical Power Cable
Superconductivity Electronic Device
Electronics
SQUID
Electrical Power & Energy
Electrical Power Generator
Superconductivity Technology
Material Science
Electrical Engineering
Applied Physics
Mechanical Engineering
Electronic Engineering


Electronics
SQUID
Electrical Power & Energy
Superconductivity Technology
Material Science
Electrical Engineering
Applied Physics
Mechanical Engineering
Electronic Engineering

QUESTIONS

1. We need RTS provided we gain economic and energy savings
2. What can such a discovery contribute to humankind?
3. Even if we find such a material, is it likely to be useful?
4. Why are existing superconductors not enough meet our energy saving needs?
5. What parameters do RTS have to meet to be useful?
6. Can economic incentive increase the odds?
7. What resources need to be allocated ?
8. Are there possibly fundamental limitations to finding RTS?
9. What is the probability that we can find them?
10. Can we develop mathematical models to find RTS?
11. Should this be a subject for international collaboration?
12. Would superconductors at Zero Celsius not be sufficient?

Requirements For Usable RTS

1. Competitive/raw materials costs.
2. High current carrying capacity; i.e. high Jc at high Hc.
3. Reasonable manufacturing cost in long lengths.
4. Manufacturability in many different configurations.
5. Low ac losses; i.e. fine filamentary/insulated cores.
6. Built-in “quench” protection

Successful Superconductor Projects

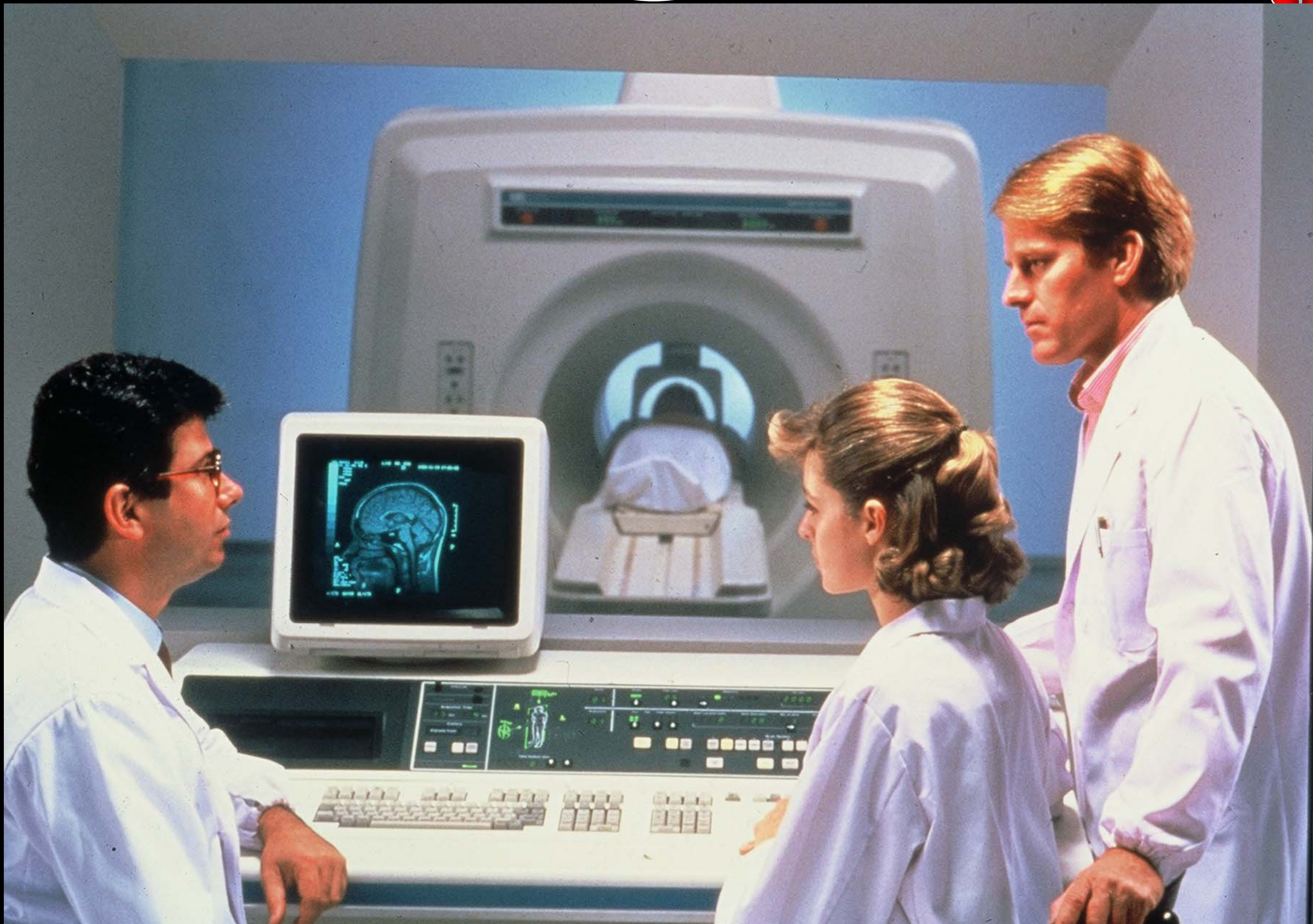
1. Physics research project at CERN where the LHC ring is virtually ready to be energized-

   IMPOSSIBLE WITH CONVENTIONAL CONDUCTORS

and

2. The almost 20,000 S.C. magnet enabled MRI Medical Diagnostic Systems operating around the world would-if copper cooled- require at least

   ONE MEGAWATT-HOUR EACH



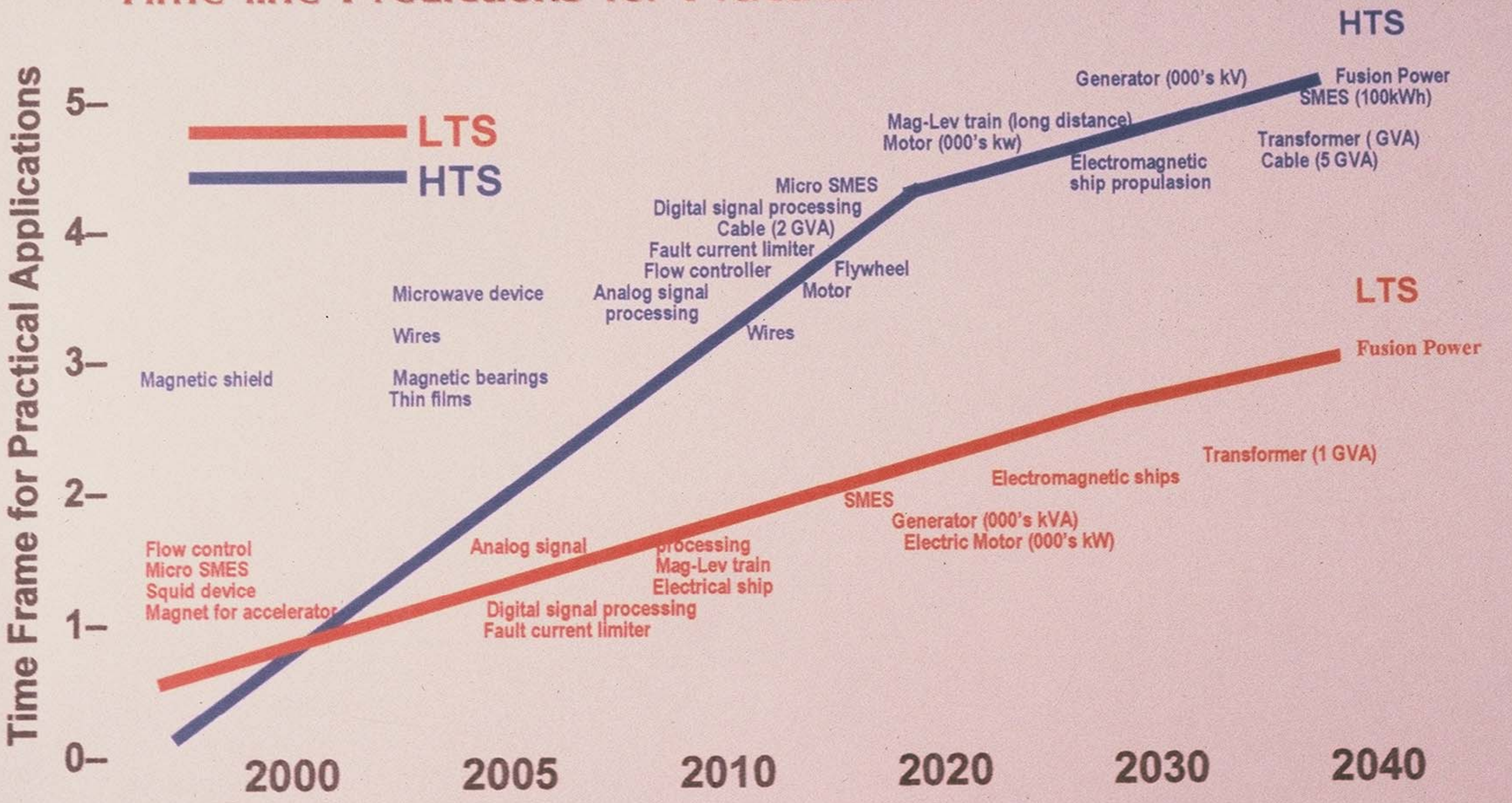
Large Scale Applications

1. High Field Magnet Technology.
2. High Energy Physics.
3. Medical Diagnostics - MRI.
4. Chemistry Research - NMR.
5. R and D in New S.C. Materials etc.

LARGE DEMONSTRATION PROJECTS

1. Magnetically Levitated (MAGLEV) Trains.
2. S.C. Motors and Generators for Ship Propulsion.
3. S.C. Magnets for Plasma Containment (Fusion).
4. S.C. POWER Transmission LINES.
5. S.C. Magnetic Energy Storage (SMES).
6. And Many More......

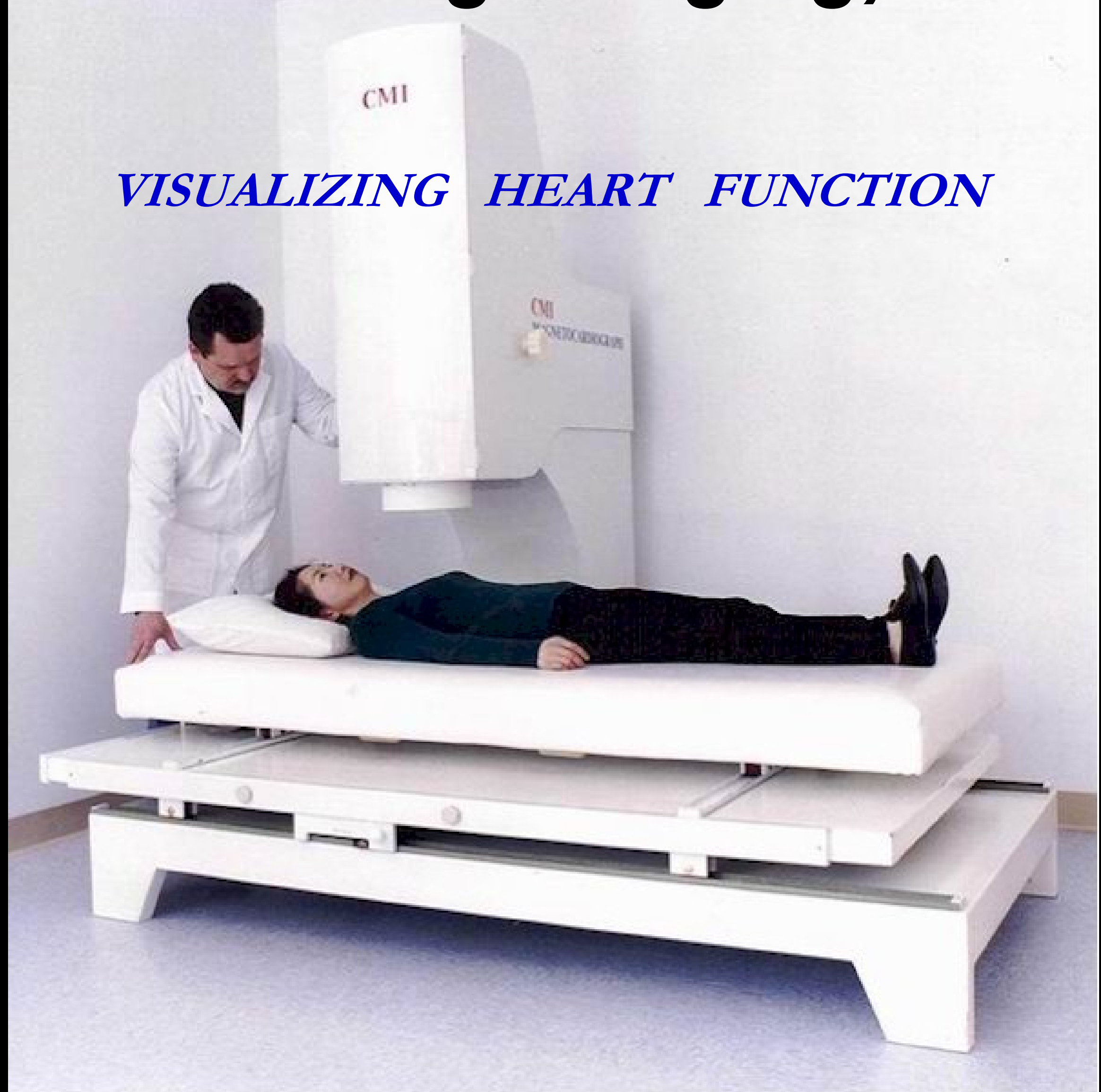
Time-line Predictions for Practical Use



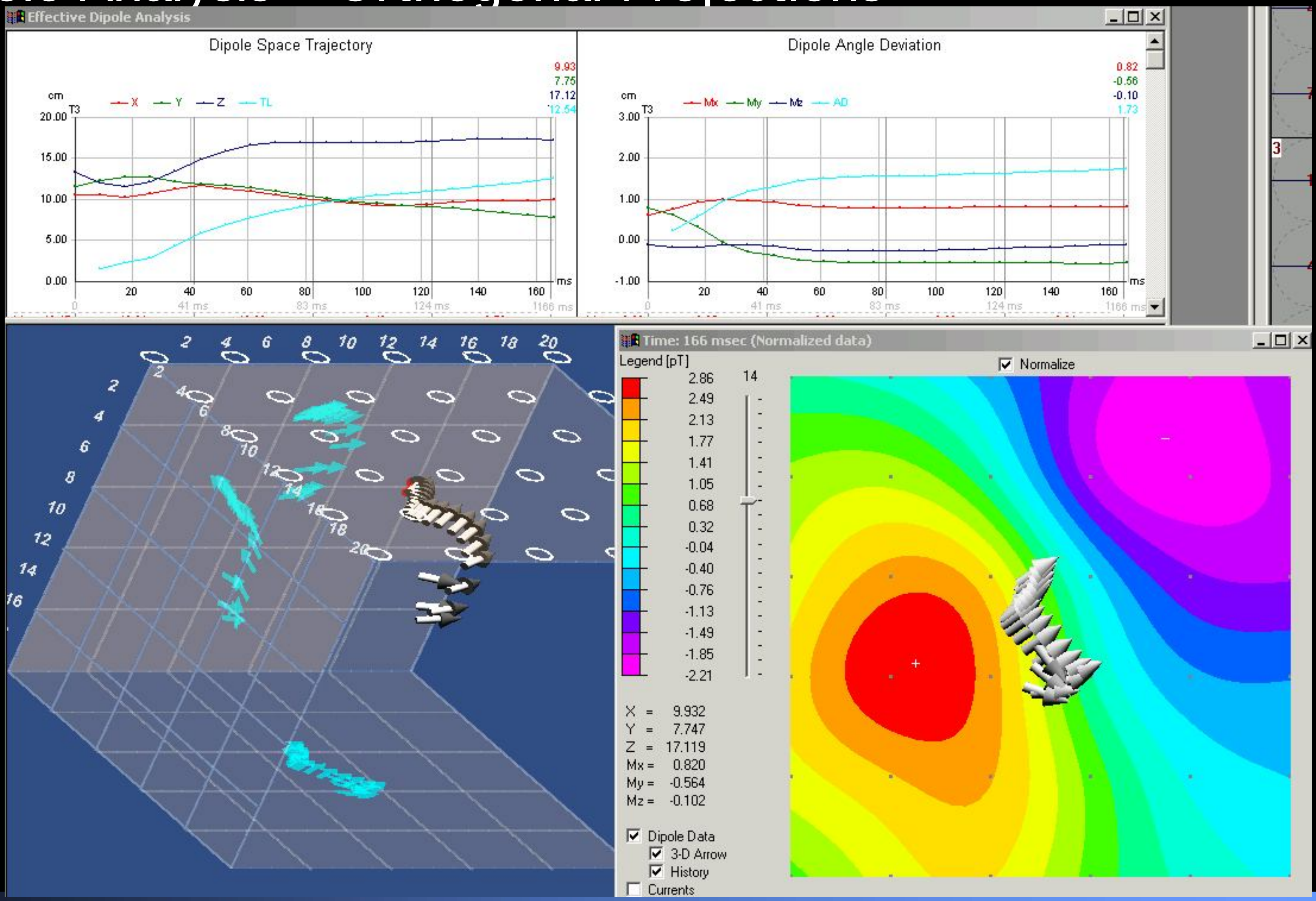
TIME Magazine: The "Tech 10" of the 21st Century

1. Hydrogen Fuel-Cell Vehicles
2. High-Temperature Superconductivity
3. Genetic Engineering
4. Bionics
5. Universal Personal Telephones
6. Voice-activated Computers
7. Nanotechnology
8. Optical Electronics
9. Virtual Reality
10. New Materials

CardioMag Imaging, Inc.



Dipole Analysis – Orthogonal Projections

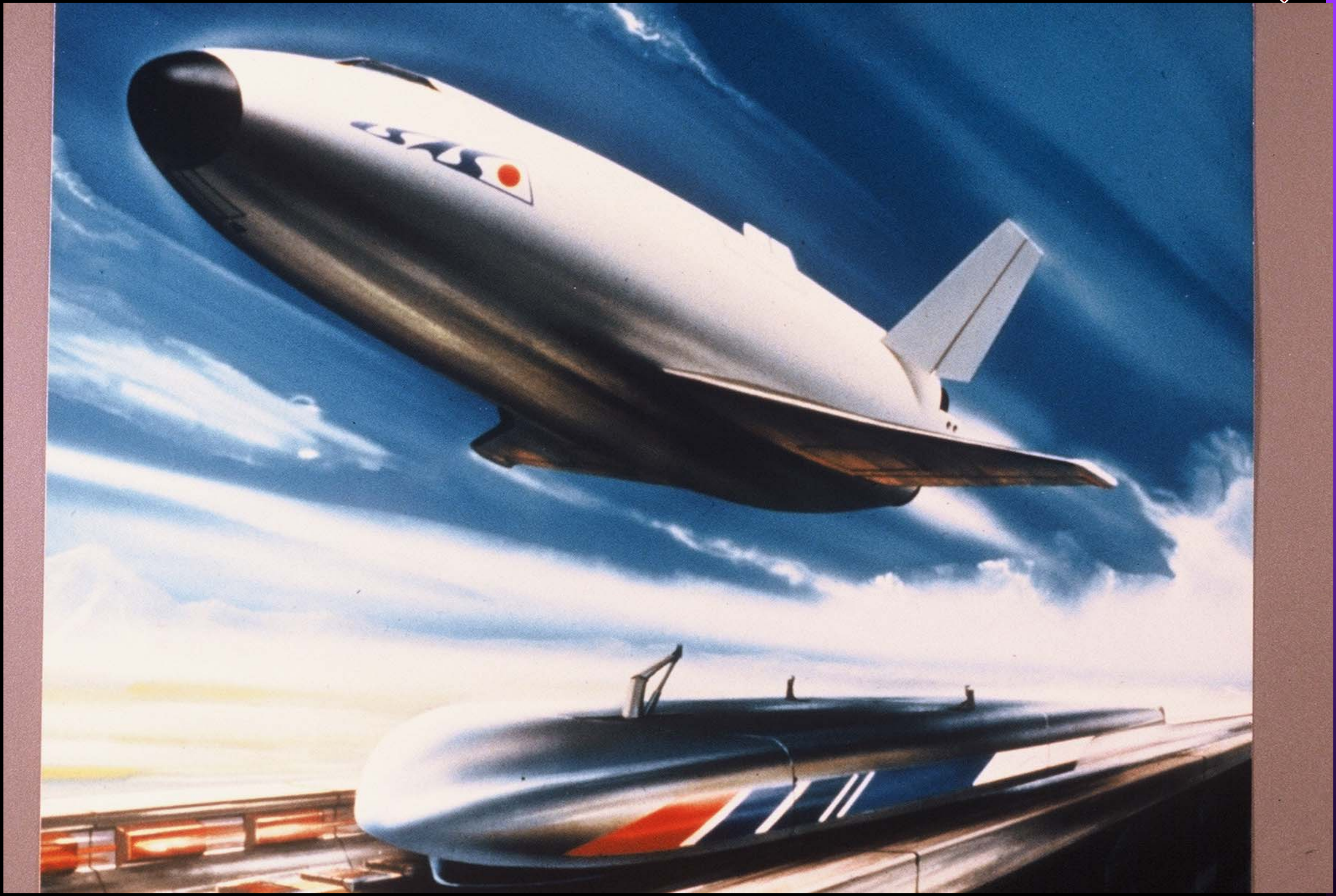


Fantastic Voyage

Want a tough challenge? Try building a new medical device, getting the FDA to approve it, and persuading doctors to use it. And while you're at it, try praying that your company survives.

By Scott Kirsner

54 FAST COMPANY April 2004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