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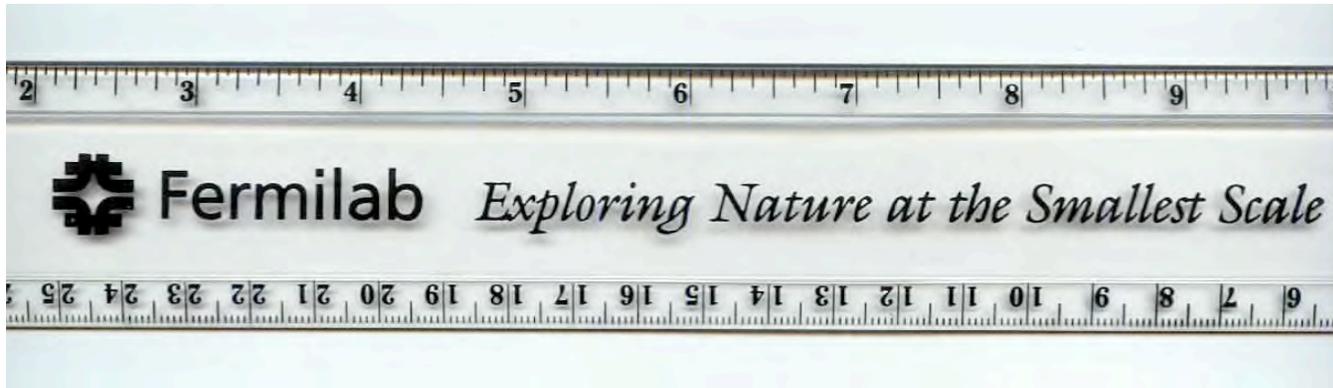
An Accelerator Division Perspective

Ralph J. Pasquinelli



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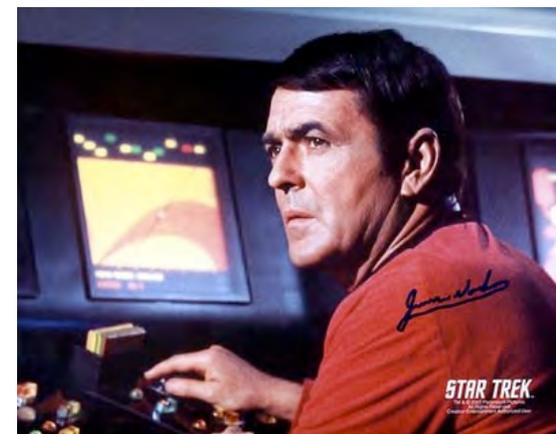
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Definition: Engineering Engineering

Noun

1. The practical application of science to commerce or industry.
2. The discipline dealing with the art or science of applying scientific knowledge to practical problems; "he had trouble deciding which branch of engineering to study".
- ~~3. A room (as on a ship) in which the engine is located.~~

Date "engineering" was first used in popular English literature:
sometime before 1781.



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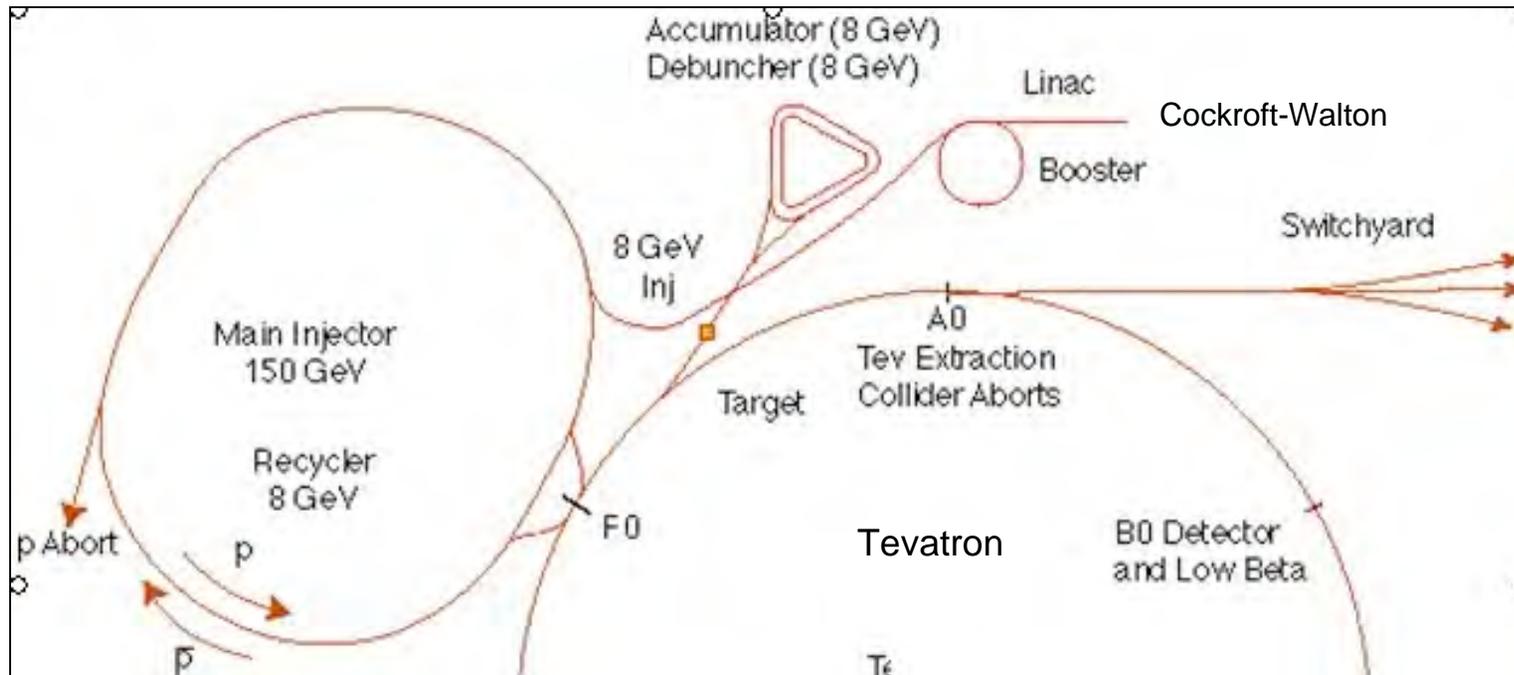


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Fermilab's 8 Accelerator Chain





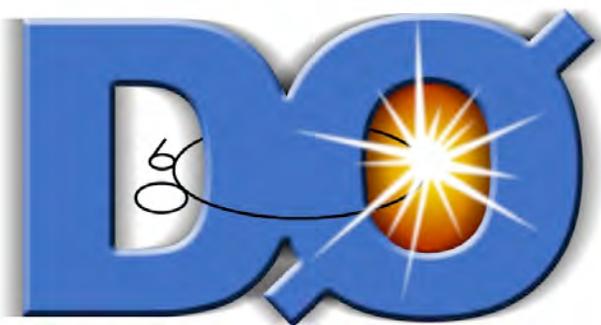
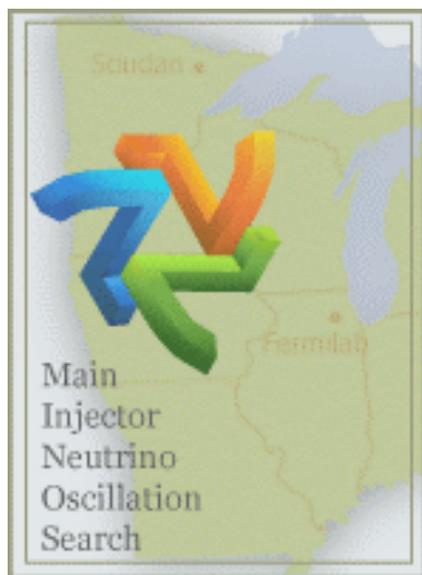
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B_μveNE
BOOSTER NEUTRINO EXPERIMENT



THE COLLIDER DETECTOR AT FERMILAB



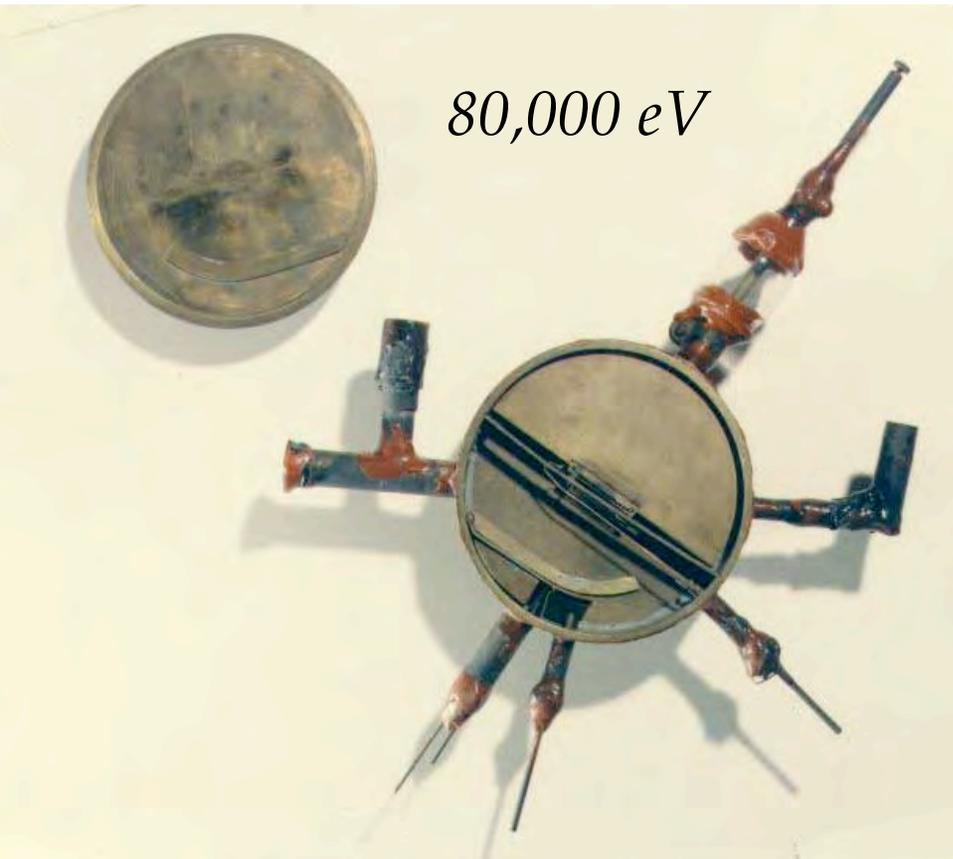
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Early Accelerator 1930: Livingston & Lawrence's 4.5 inch Cyclotron



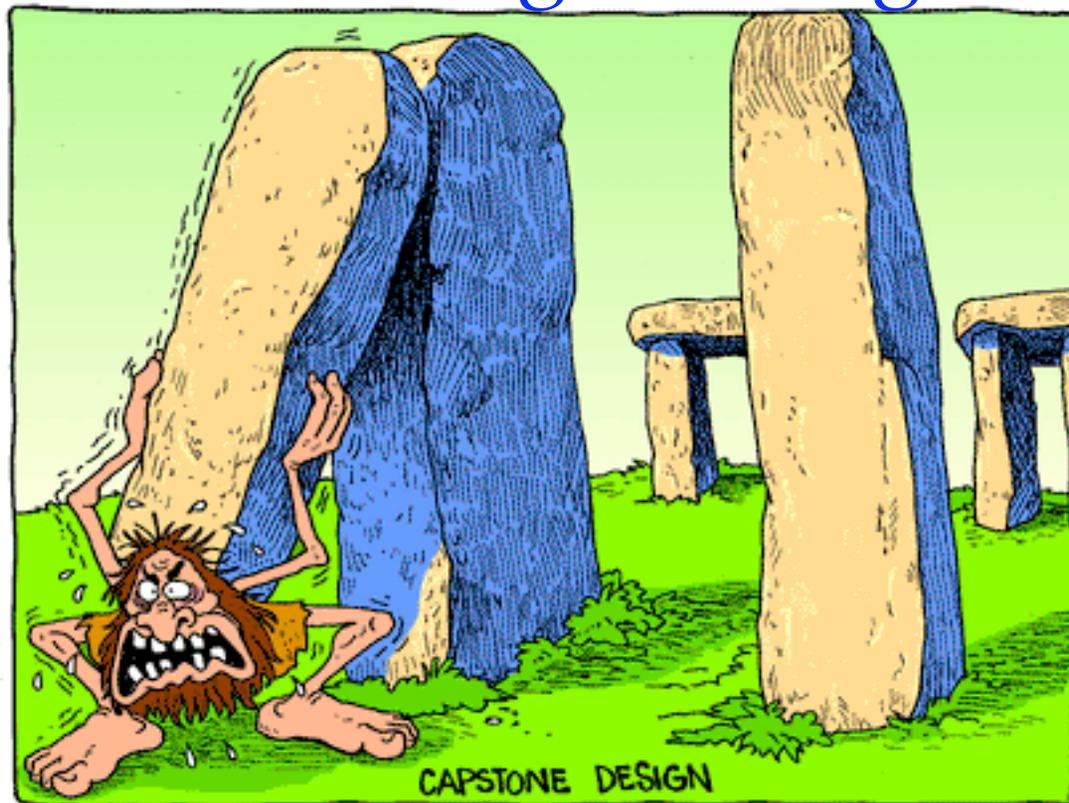
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Civil Engineering



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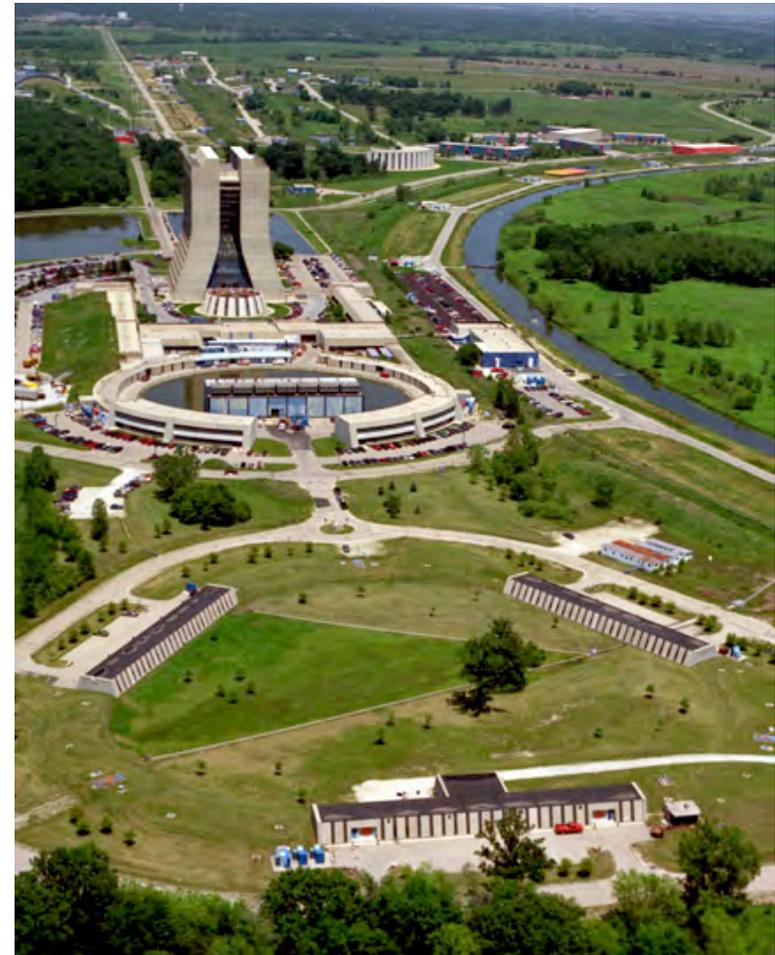


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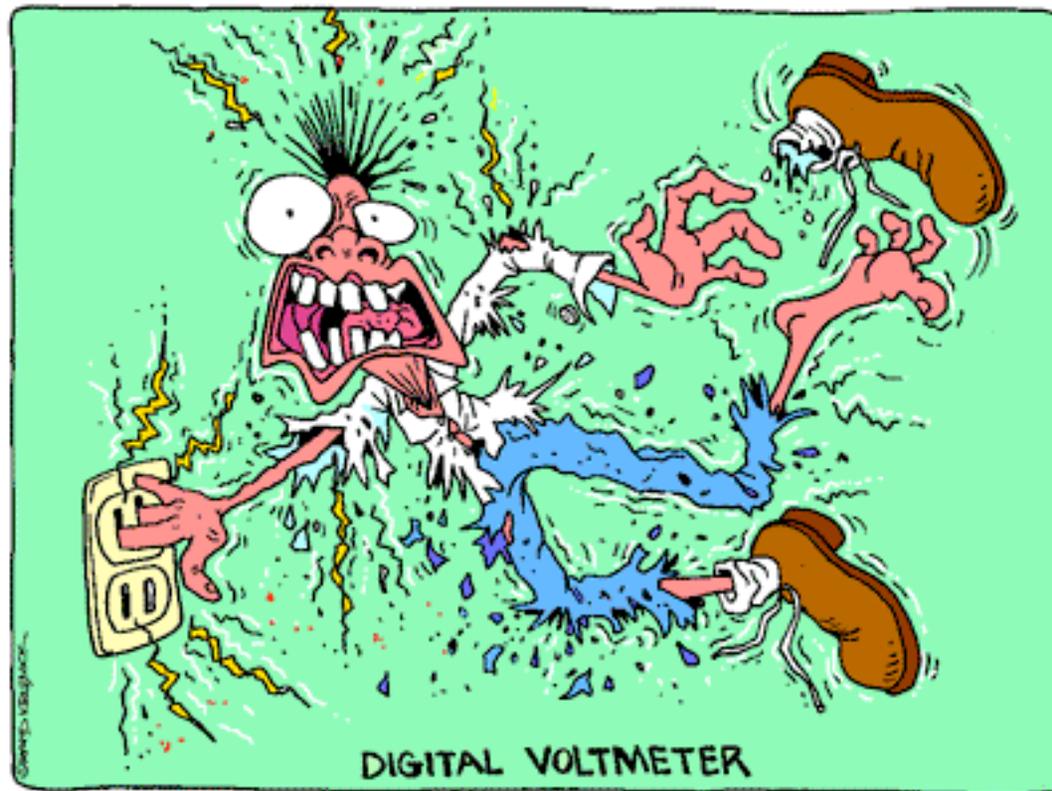
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Electrical Engineering



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*345,000 Volts
Electrical Power
60 Megawatts*



*Electric Bill
\$20 Million Annually*

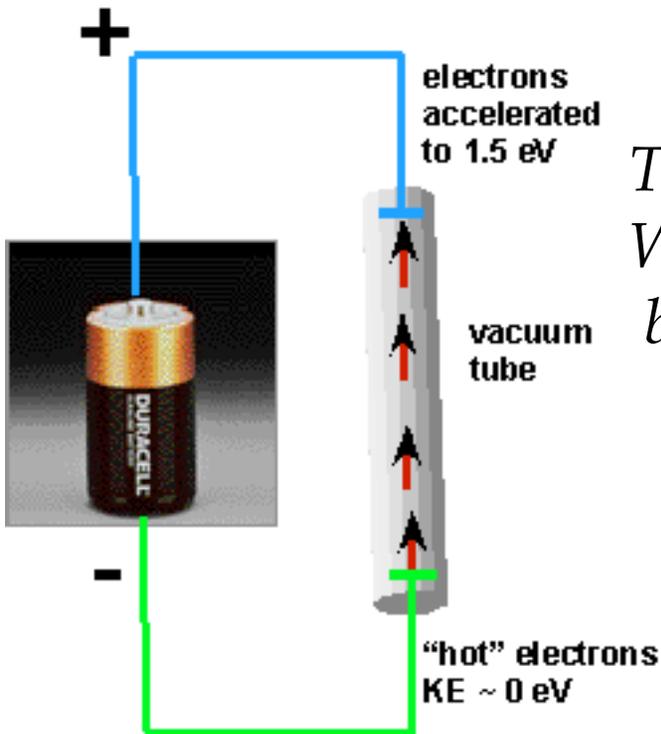




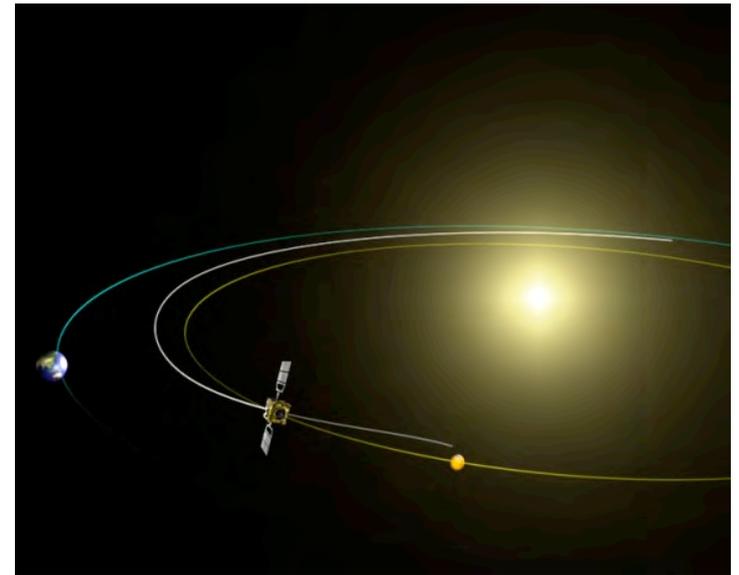
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Energy measured in electron volts eV



*To get 980 GeV
Would take 650
billion batteries*



*A 2 inch long battery
Would require
20 million mile
Chain of batteries!!!*

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Electrostatic Accelerators at Fermilab

Cockroft Walton



750 KeV

Pelletron



4.3 MeV

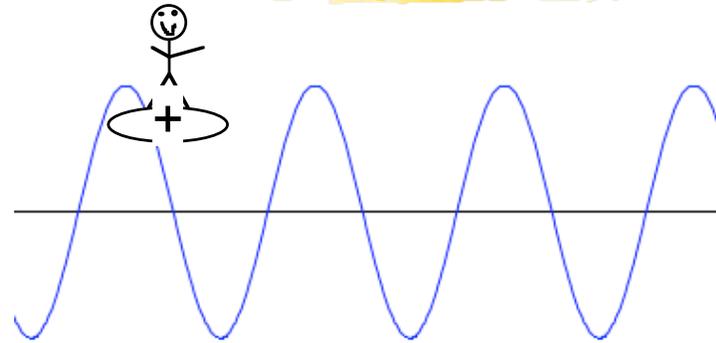
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Use Radio Frequency Waves to Accelerate



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*Antiproton RF
Cavity*

Main Injector RF Cavity



SRF Cavity

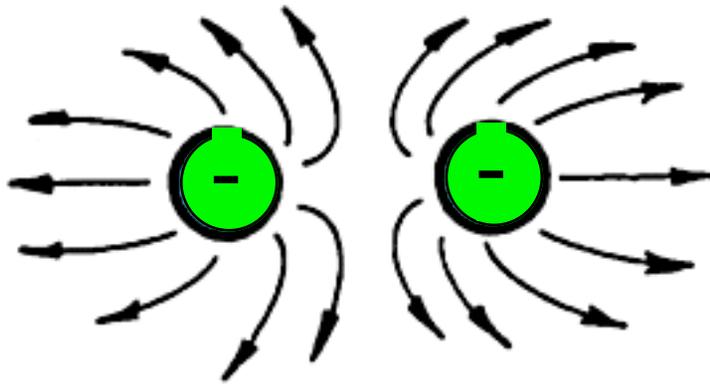
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Like Charges Repel



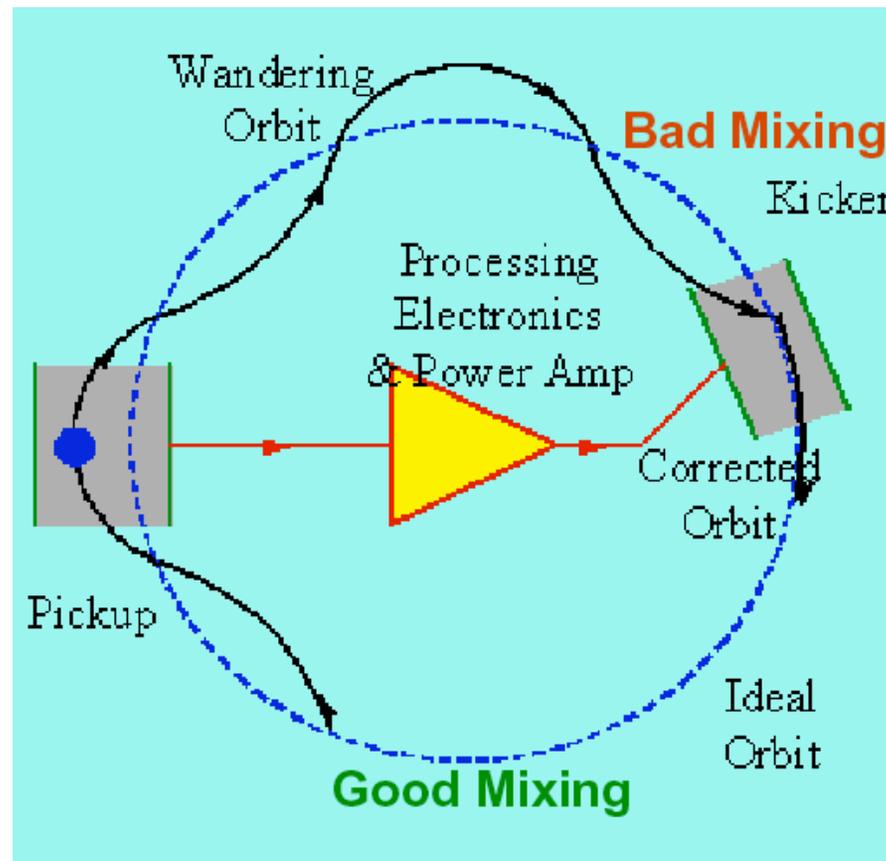
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Stochastic Cooling

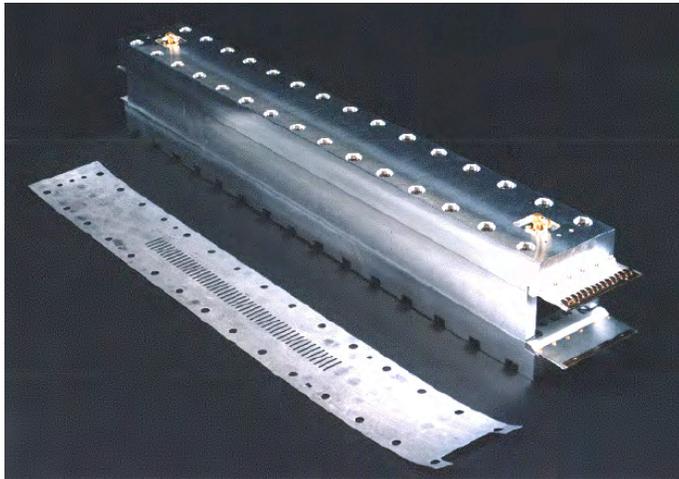


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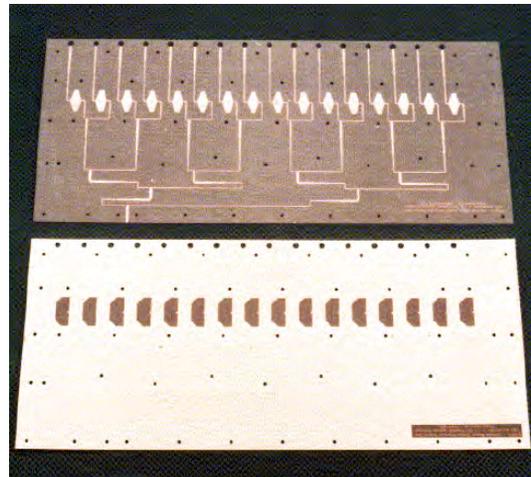
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Slotted Waveguide Structure



Printed Circuit Arrays

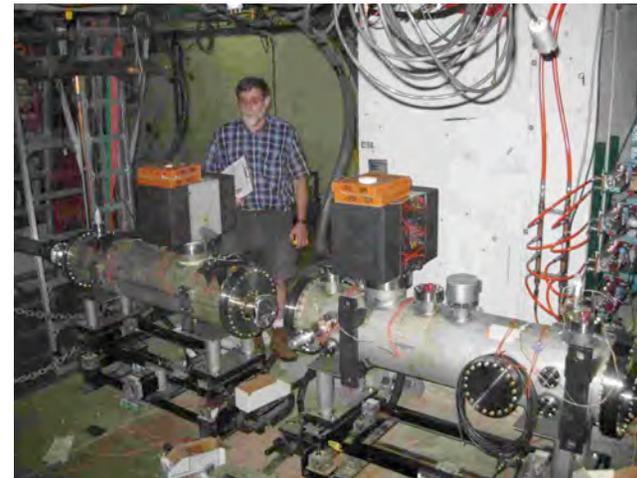
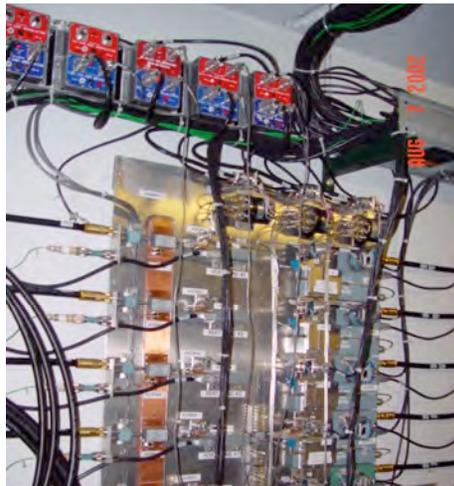


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TWTs, Kickers, Microwave Hardware

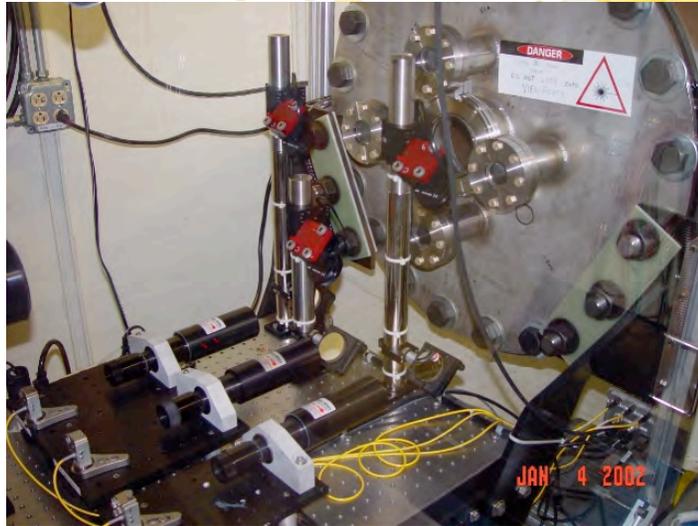


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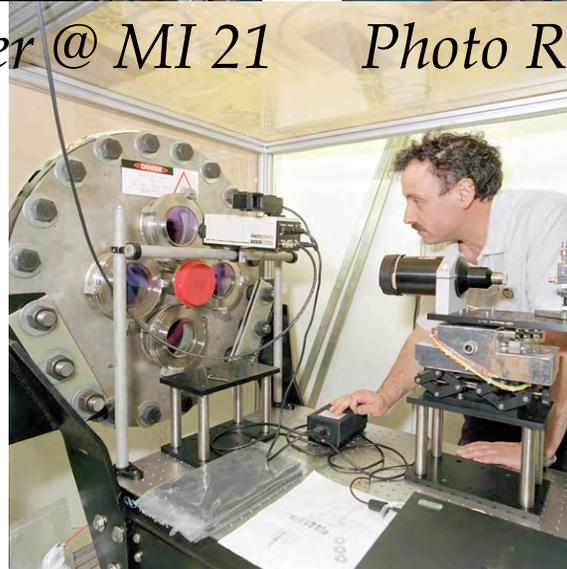


Laser Transmitter @ MI 21



Photo Receiver @ MI 11

Recycler Laser Link



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Mechanical Engineering



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*Water Cooling
Systems*

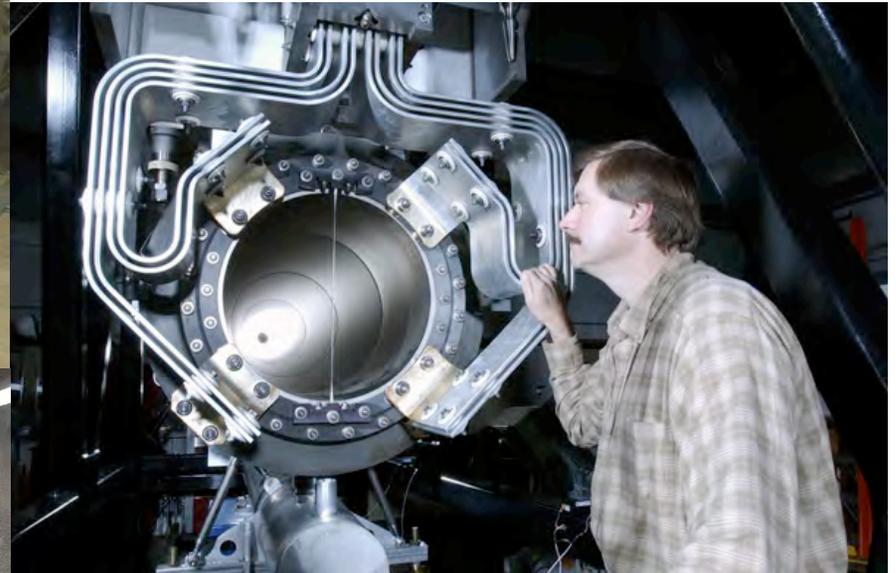


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NuMI Magnetic Horn

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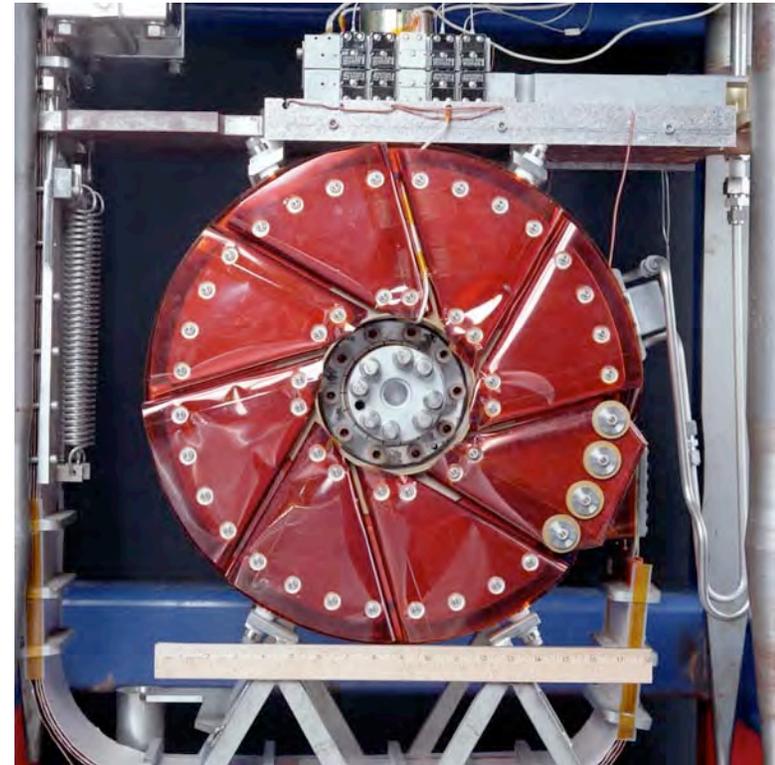
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Before

After 10^{19} protons



Antiproton Production Target



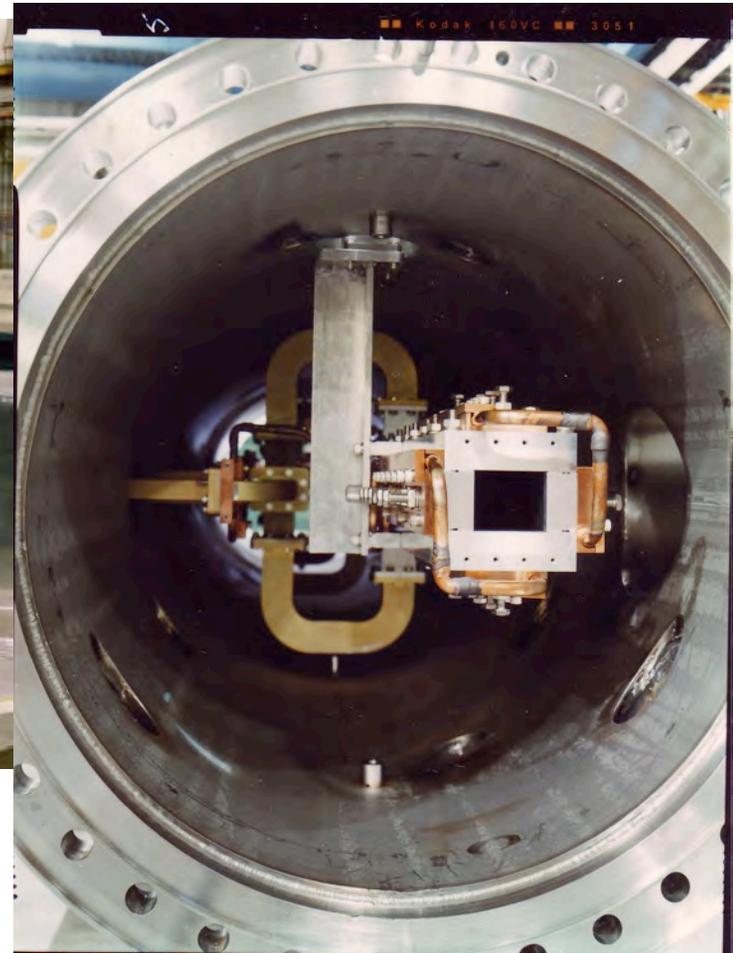
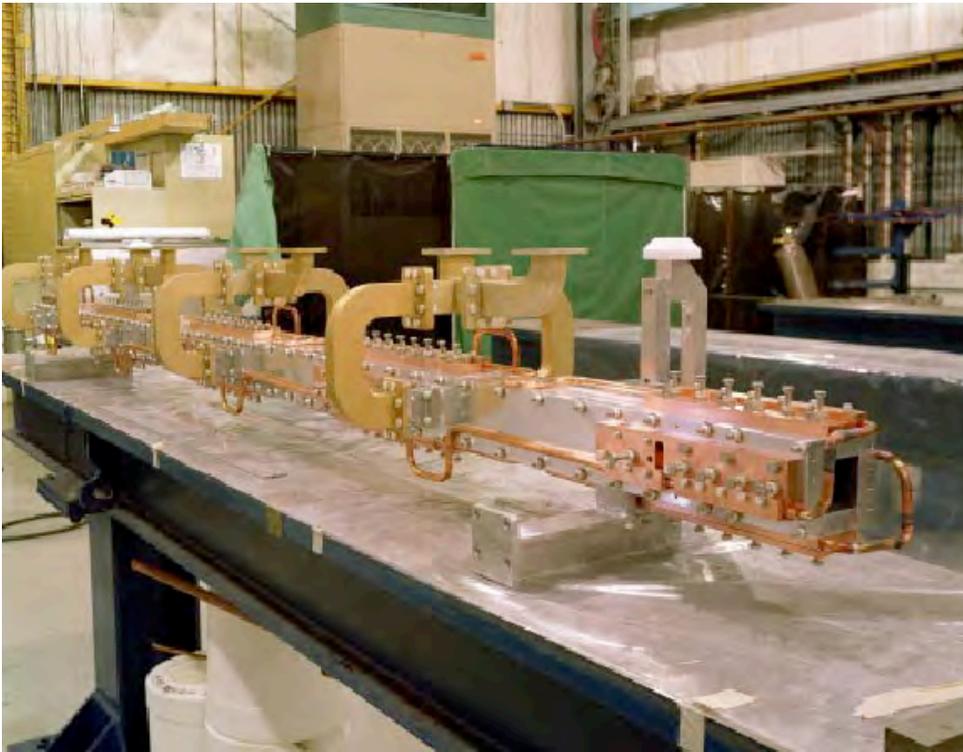
Lithium Lens

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Slotted Waveguide Assembly

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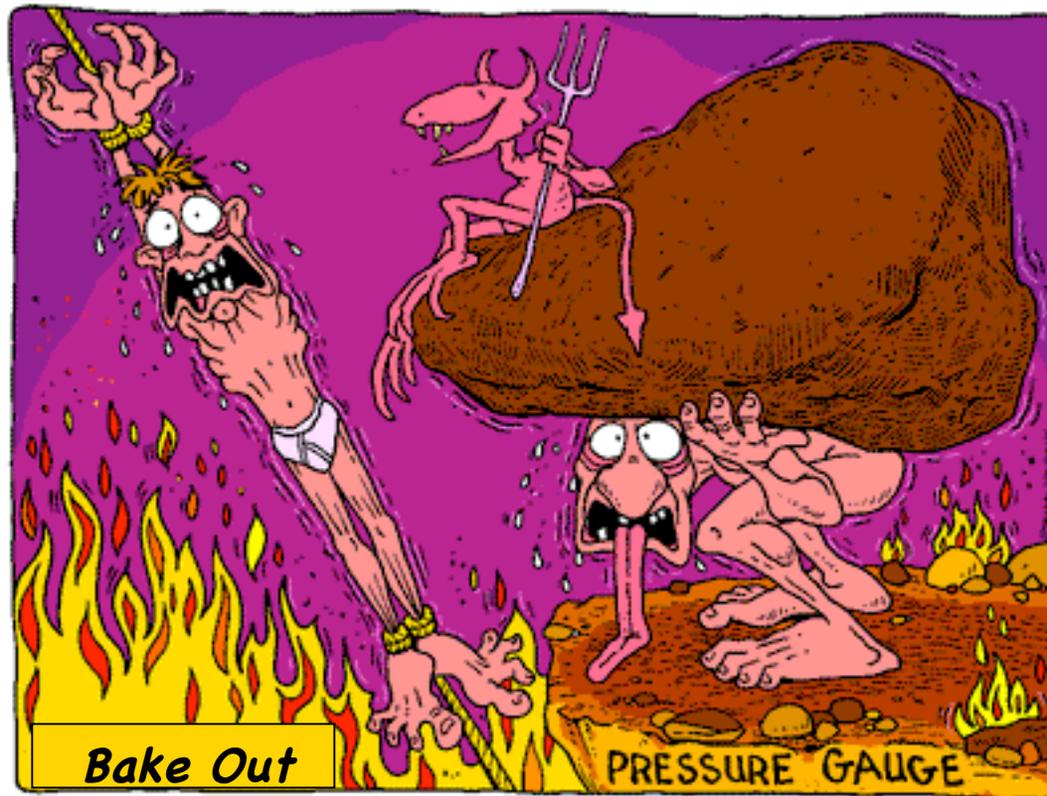
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Vacuum Engineering



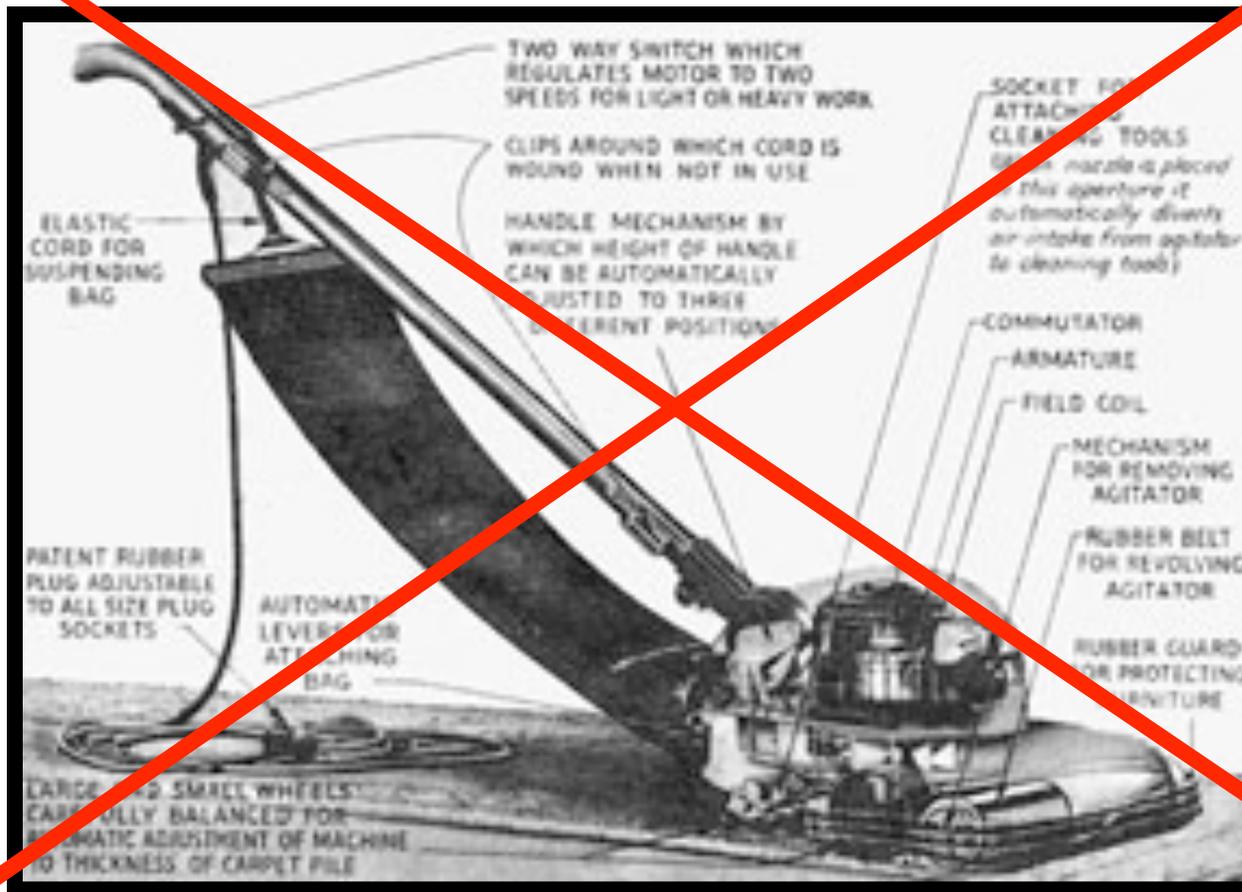
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NOT HOOVER!



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Vacuum Bake Out



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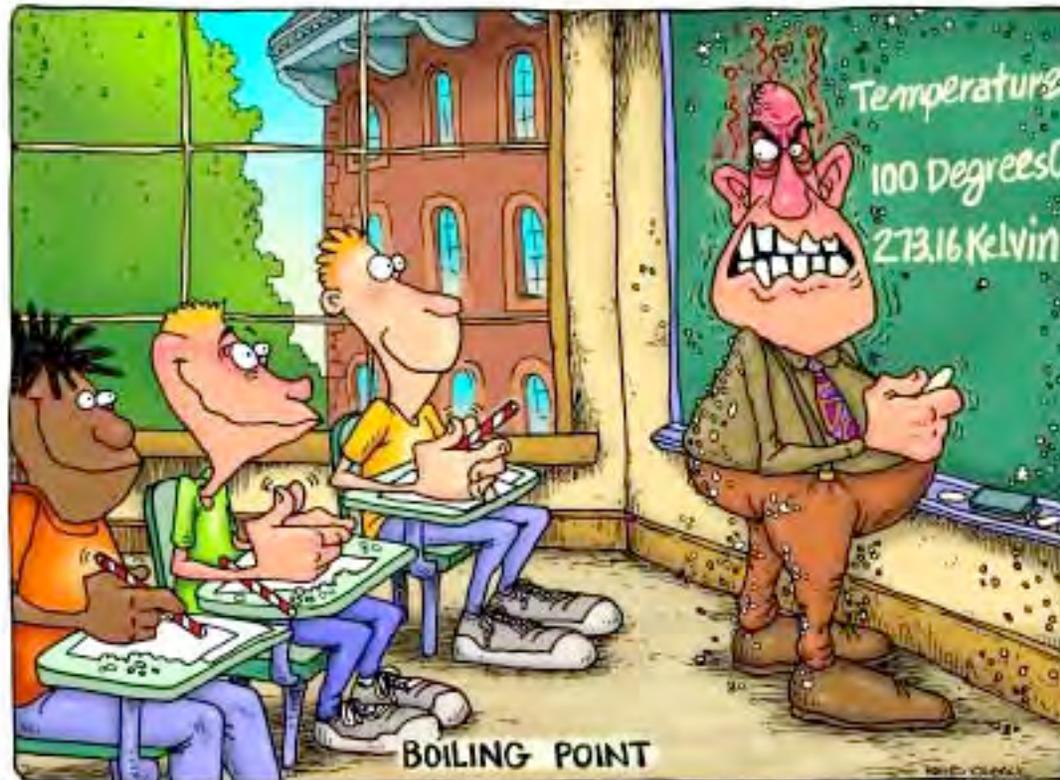
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Cryogenic Engineering



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Tevatron



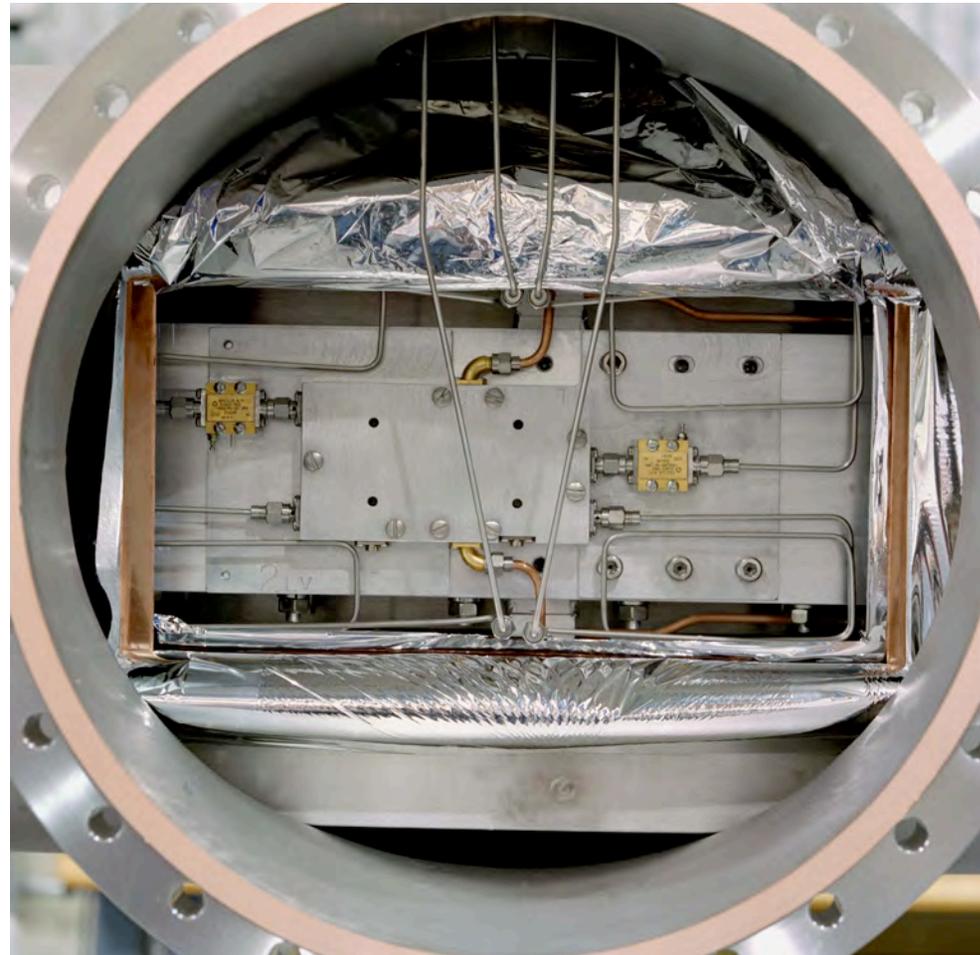
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*Debuncher
Stochastic Cooling
Cryogenic
Microwave Amplifier
Operates at 4 Kelvin*



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Refrigerators



Compressors



Truck Deliveries



Storage



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Recipe: Carefully Combine All the Ingredients

Electrical

Cryogenic

Mechanical

Civil



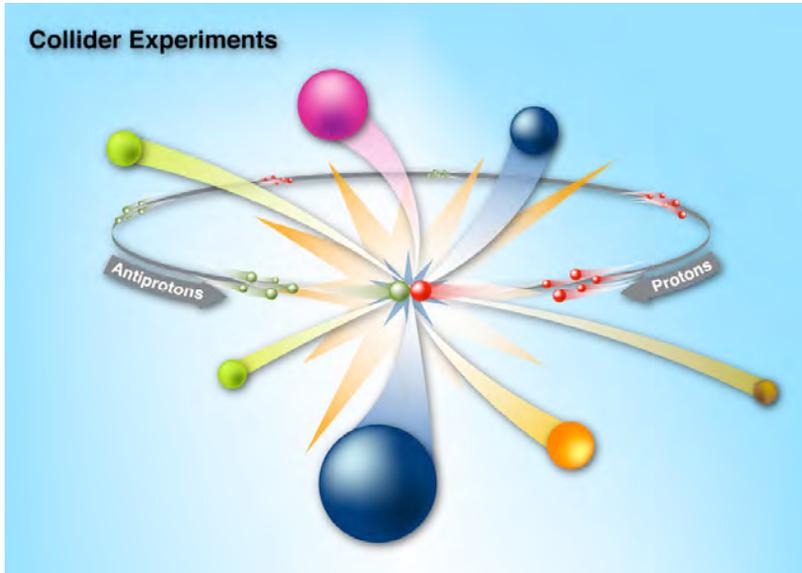
Vacuum

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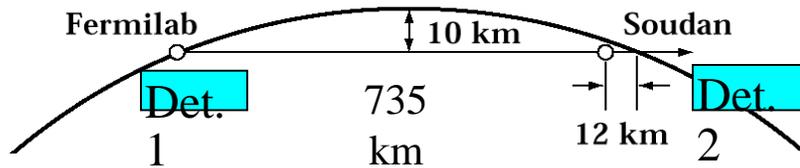
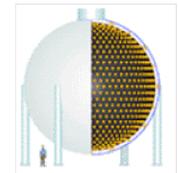
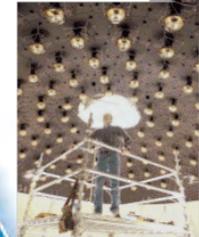


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BooNE



NuMI



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