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# **Accelerator Division**

# **EE Support Department**

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March 12, 2018

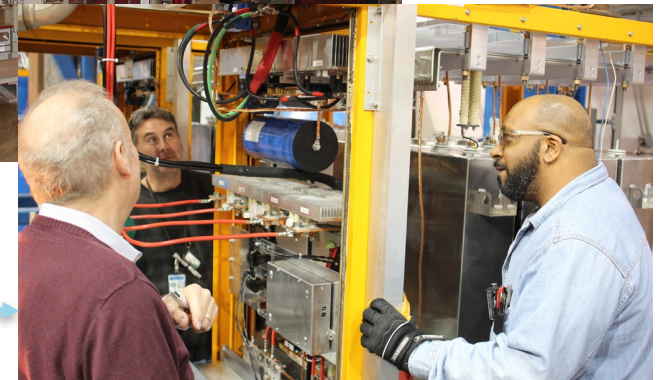
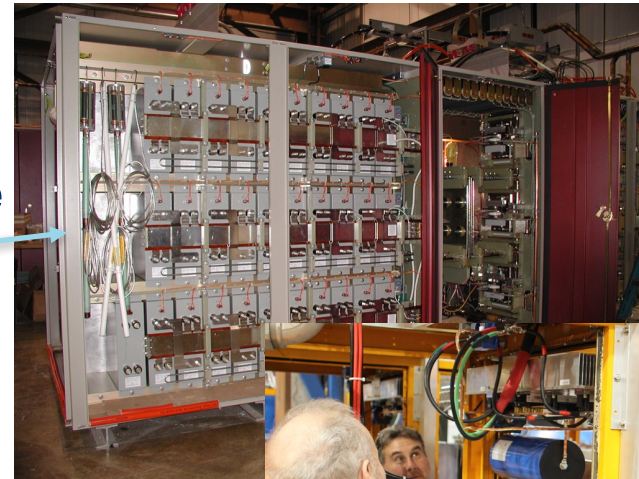
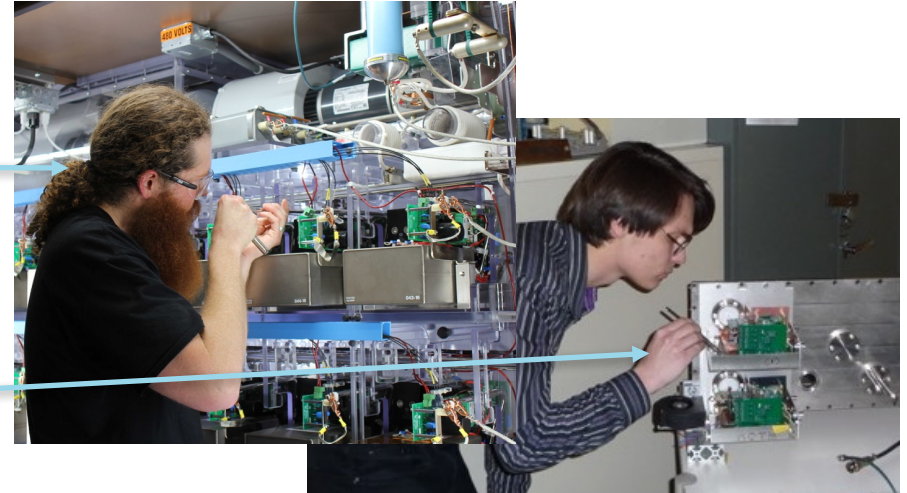
# Power Supplies from DC to ns, W to MW

Marx Modulator provides a 30 kV, 300 A, 200 us wide pulse 15 times a second to RF amplifier tube to accelerate beam

PIP II Chopper provides 500 V, 2 ns rise and fall time arbitrary pulse pattern at 38 MHz repetition rate to deflect beam

NuMI horn provides 700 V, 200 kA, 2 ms wide pulse every 1.33 seconds to focus beam

Pbar lens provides 1 kV, 25 kA, 400 us wide pulse 8 times in 80 ms to drive focusing and collecting lens after target



# Power Supplies from DC to ns, W to MW

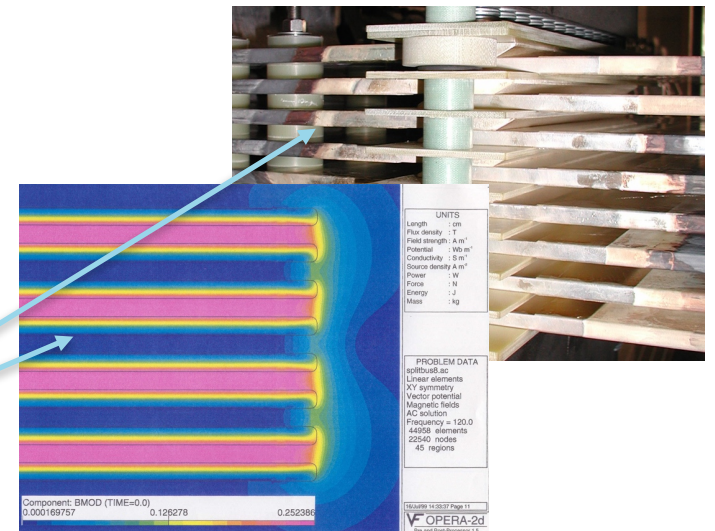
Kickers provides 30 kV, 1000 kA, 1.6 us wide pulses to deflect beam onto orbit. Hydrogen gas switch voltage rise is 30 kV in 20 ns into 50 Ohm resistor



Computer and FPGA control of large power supplies, 50 ppm regulation of 1200 A, learning systems

Converse with various other groups wrt high voltage, high current and high speed power supplies

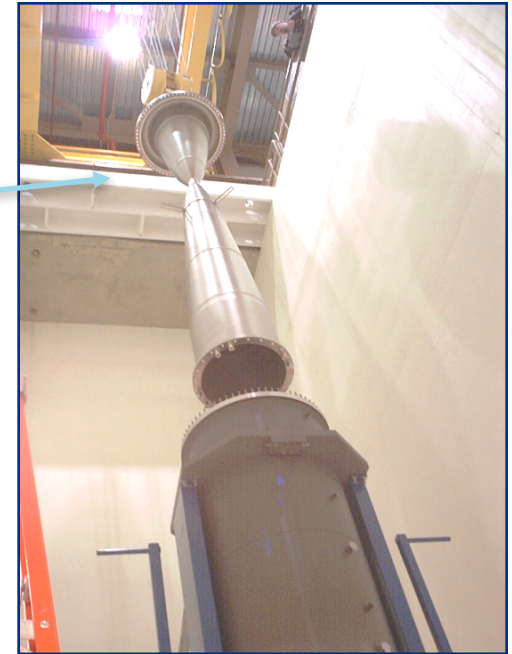
Circuit Simulation and EM field simulation (NuMI Stripline, 200 kA, low inductance )



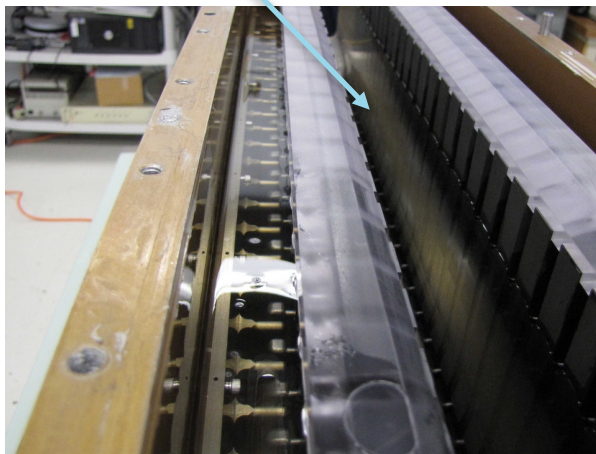
# Kicker Magnets, Horns and Septa (Electric and Magnetic)

EE Support collaborates with other departments and divisions within Fermilab on specialty loads

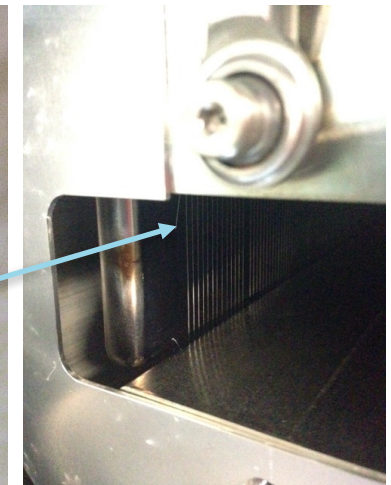
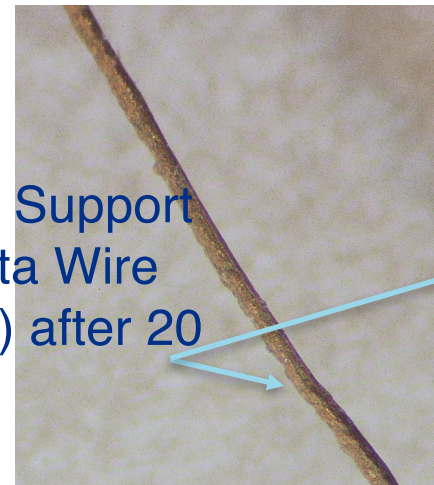
AD – Target Systems  
NuMI Horn 2  
700 V, 200 kA, 2 ms



TD – Magnet Systems  
Injection Kicker Magnet  
50 Ohm, 50 ns field rise



AD – Mechanical Support  
Electrostatic Septa Wire  
Failures (100  $\mu\text{m}$ ) after 20  
years in beam  
120 kV, 14 mm



# Power Supplies from DC to ns, W to MW

- Current Projects
  - Completing Marx Modulators for Linac Upgrade
    - 15 pps, 30 kV, 300 A, 250  $\mu$ s pulse driving tetrode amplifier
  - Ramped power supplies for slow spill and RF cavity tuning
    - 300 V, 100-600 A , 20-60 A/ms
- Future Large Scale Projects
  - LBNF Horn Power Supply
    - 4 kV, 300 kA, 800  $\mu$ s wide pulse every 0.7 seconds
      - 3  $\mu$ H, 800  $\mu$ Ohm load including connecting stripline
    - The LBNF/DUNE collaboration is looking for partners for the design and construction of this challenging supply.
  - PIP II – New Linac – Various small pulsed power supplies
    - International contribution for RF power sources and power supplies
      - Collaboration with India