NLC - The Next Linear Collider Project

NLC Solid State Induction Modulator MAC Update May 9, 2002

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LLNL: E. Cook, J. Sullivan, S. Hawkins
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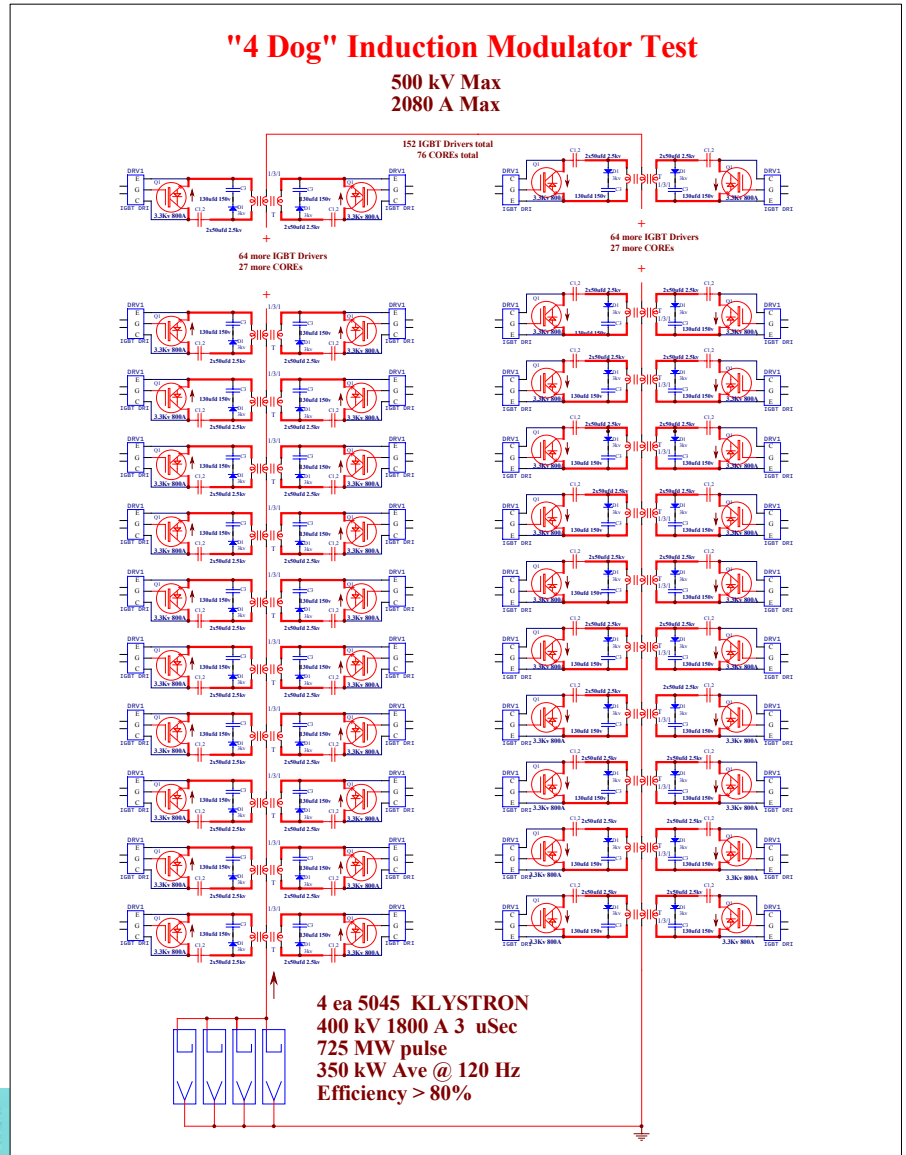
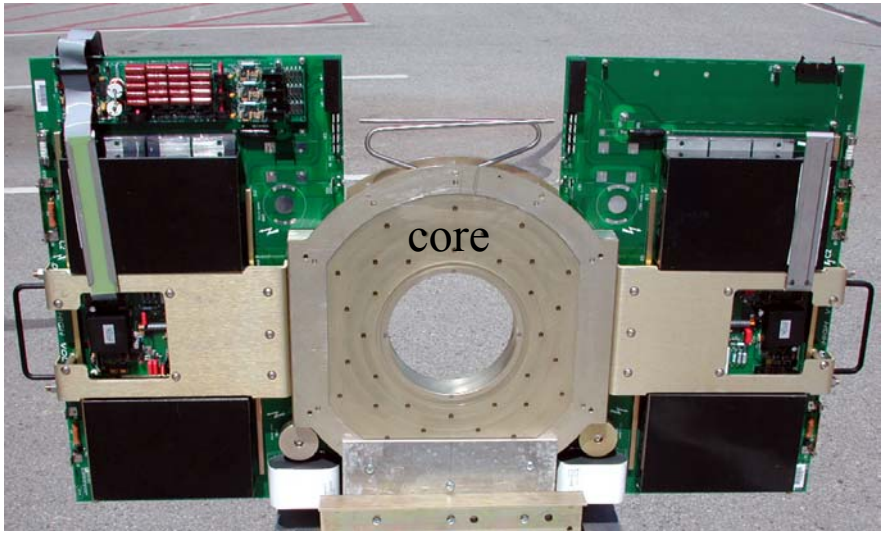
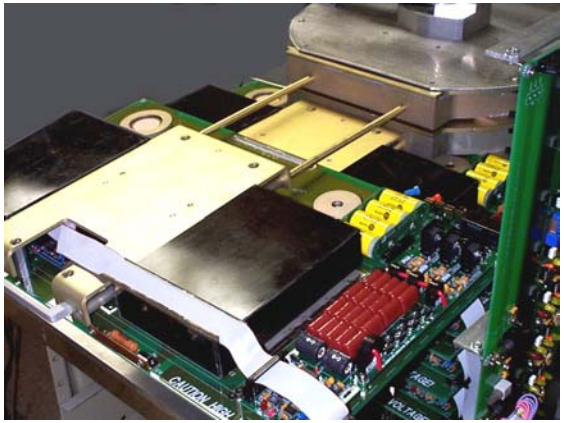
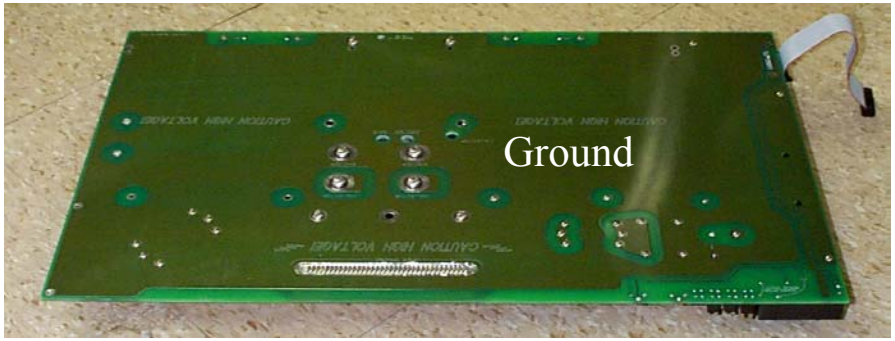
NLC Solid State Induction Simplified Schematic



IGBT Drivers and Core

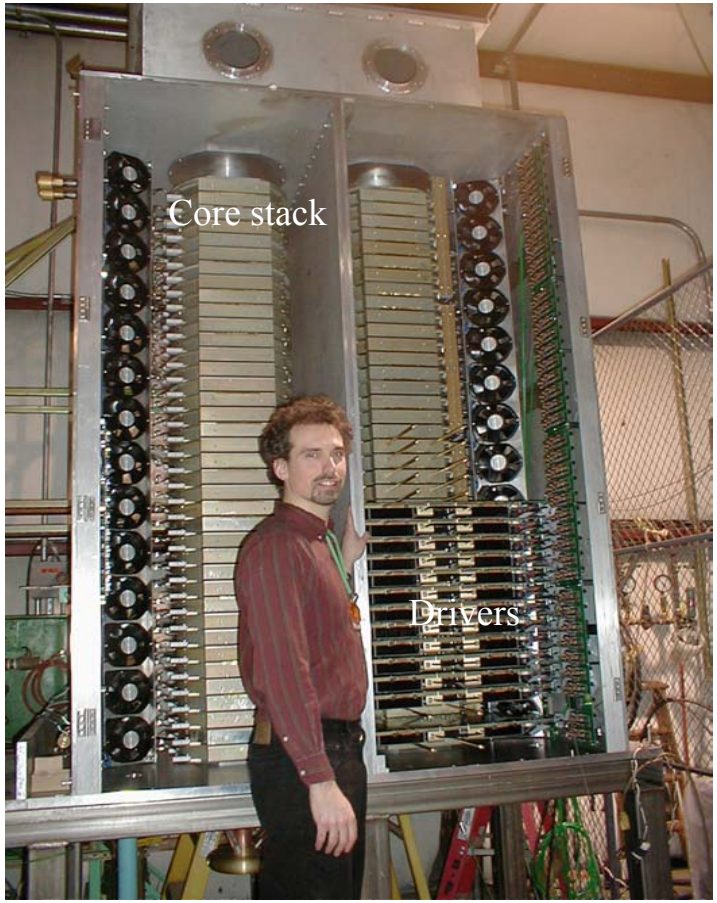






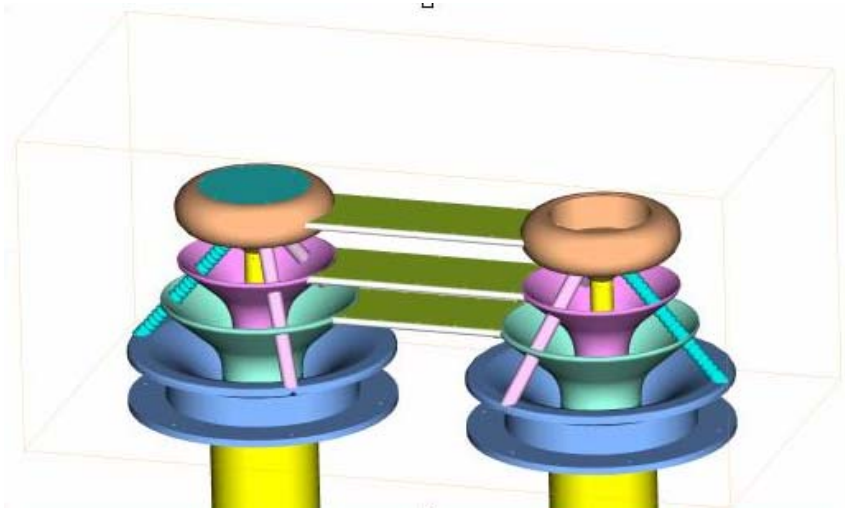
Prototype Solid State Induction Modulator

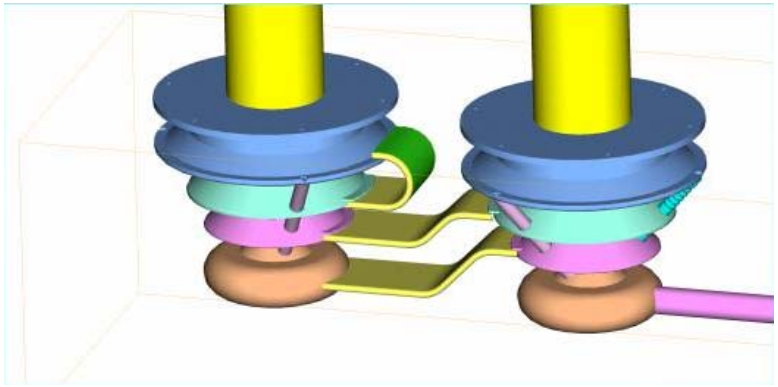
Single turn secondary



- Core Stack with drivers

3-Turn Secondary

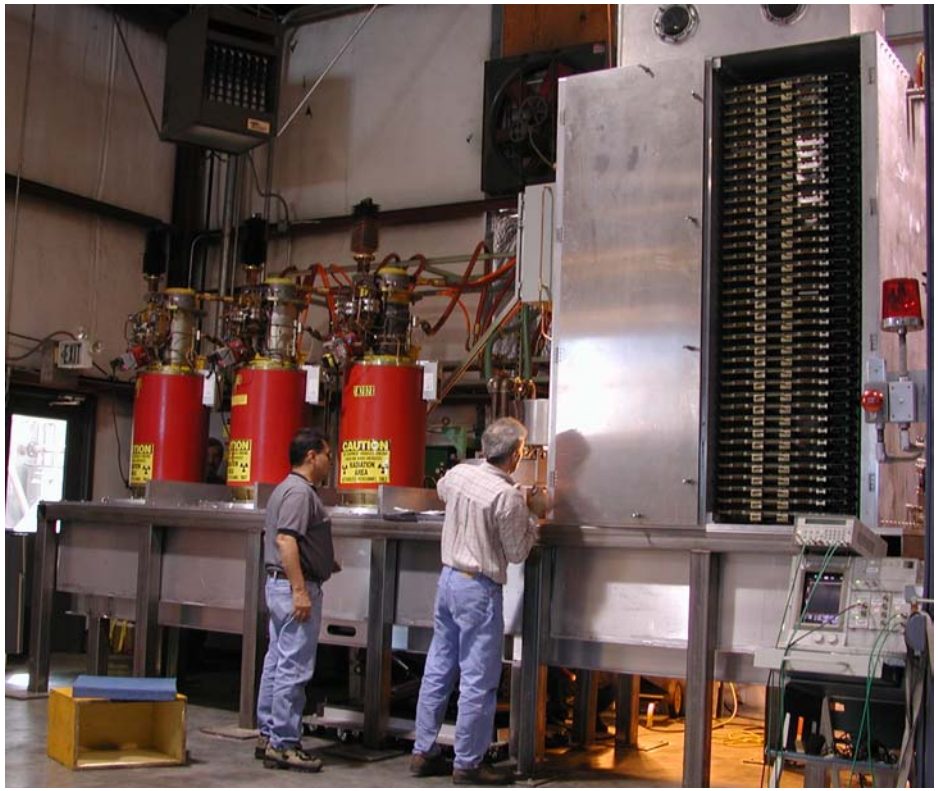




- Coaxial Three Turn Secondary End Connection

Prototype "4 Dog" Solid State Induction Modulator

3 turn Secondary with water load



With oil tank installed

Modulator R&D Program

- **Three Main Programs:**
  - 1. *4-Dog:* Full power prototype driving four 5045s. Tests complete July 2002.
  - *4-Pack:* Move Prototype to NLCTA to drive four 75XP3 with new Tank design in August 2002.
  - 2. *DFM 8-Pack:* Design/build a DFM prototype, by end of 2002. Drive 8 – 75X klystrons as available beginning January 2004.
  - 3. *Short-Stack:* Gallery prototype driving one 5045 with standard pulse transformer in SLAC Linac. Work in progress.

4-Dog Modulator Status

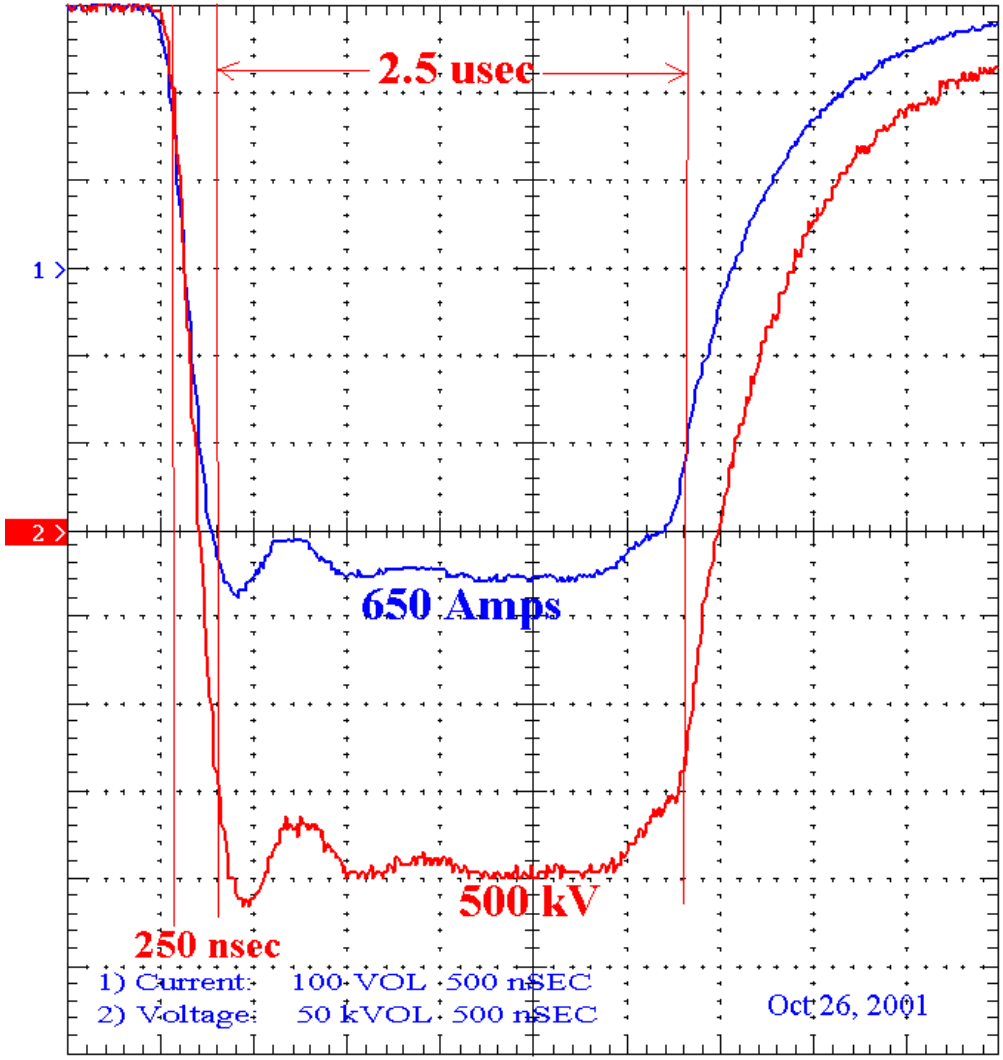
- Tested up to 500kV into a resistive load at 1Hz.
- Tested up to 400kV into 2 parallel 5045 Klystrons at 1 Hz.
- Arc tests on the load side of the 3-turn secondary resulted in failed IGBTs.
- Arc Test conclusions and resulting modulator modifications.
- Modulator Power Supply Status.
- Modulator Controller Chassis in test.

Prototype Induction Modulator Pulse--Water Load

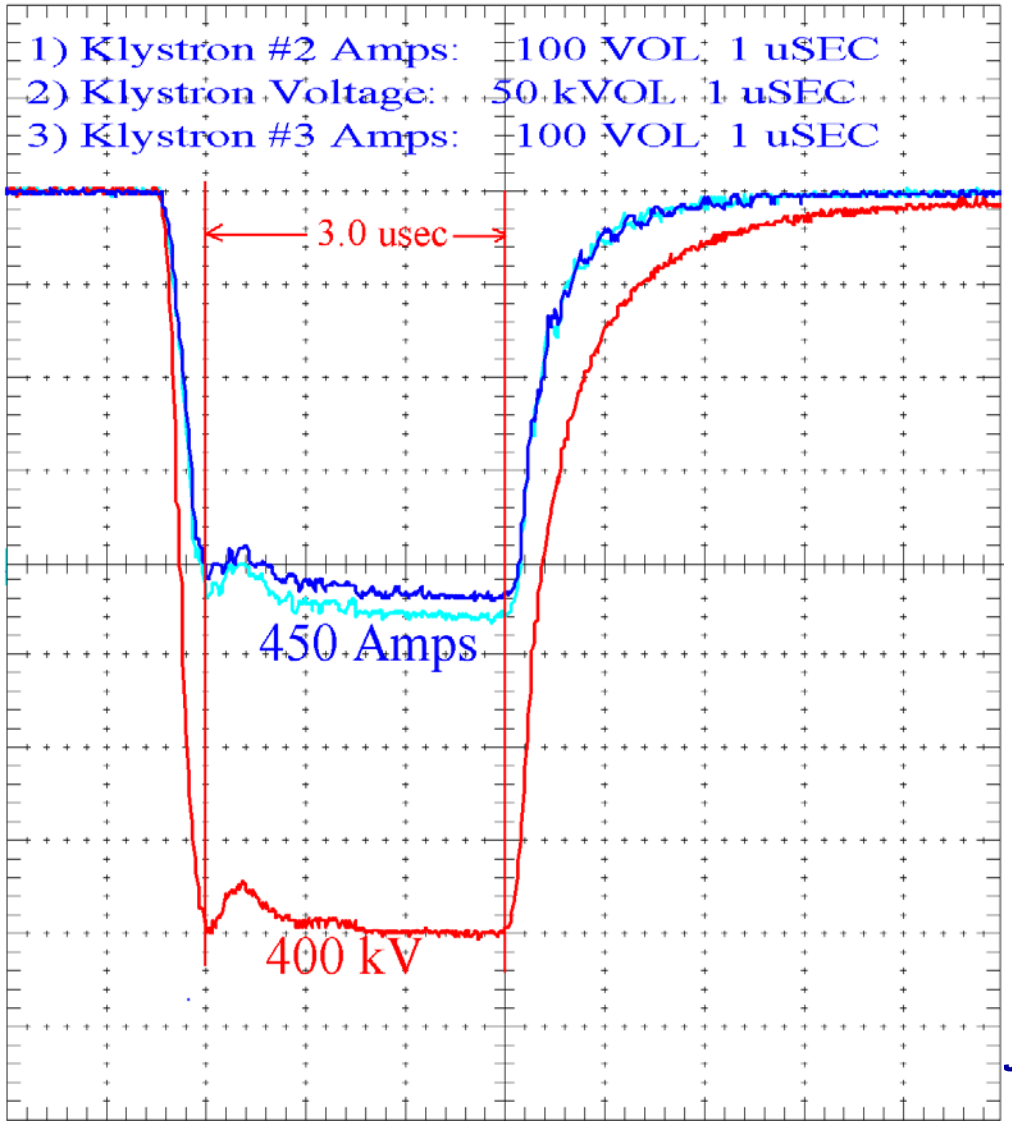
Three Turn Secondary

76 Metglas cores

152 IGBT Drivers



Prototype Induction Modulator Pulse--2 each 5045 Klystrons



400 Kv, 900 Amps
3usec Three Turn Secondary

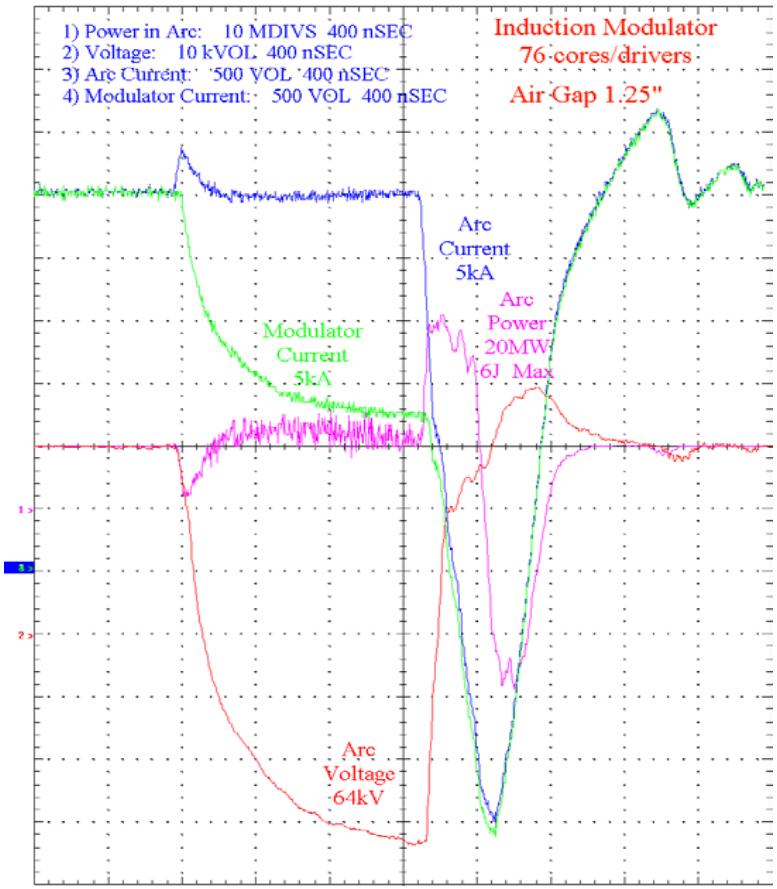
76 Metglas cores

152 IGBT Drivers

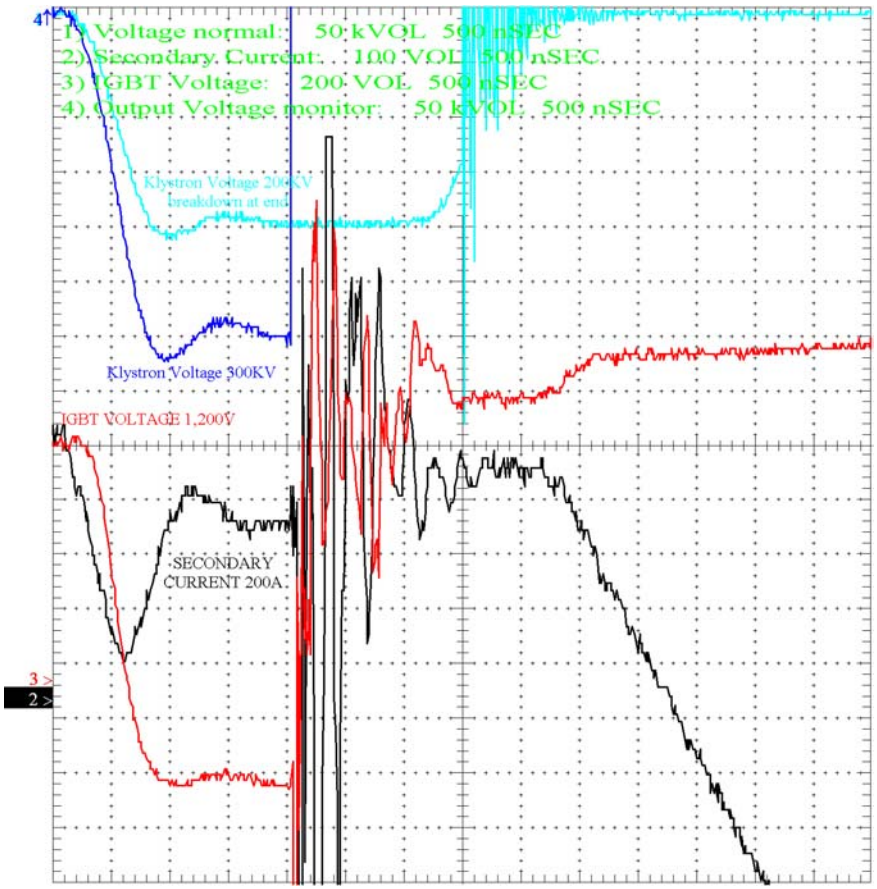
Ratio $V_{out}/V_{in} = 228$

1850 Volts DC

NLC Solid State Induction 76 stack Arc test

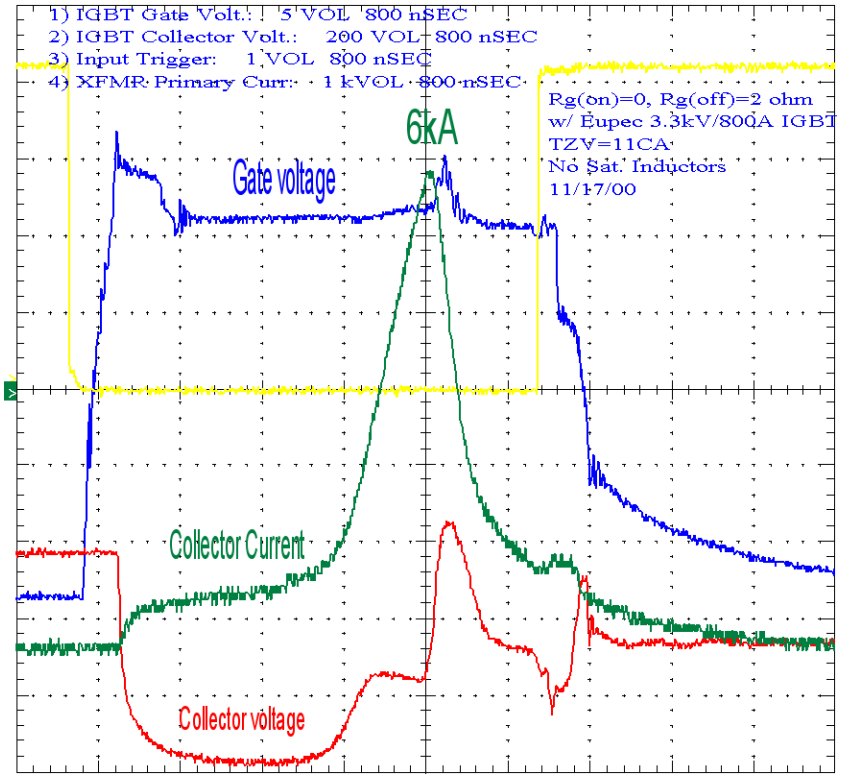


Single turn test

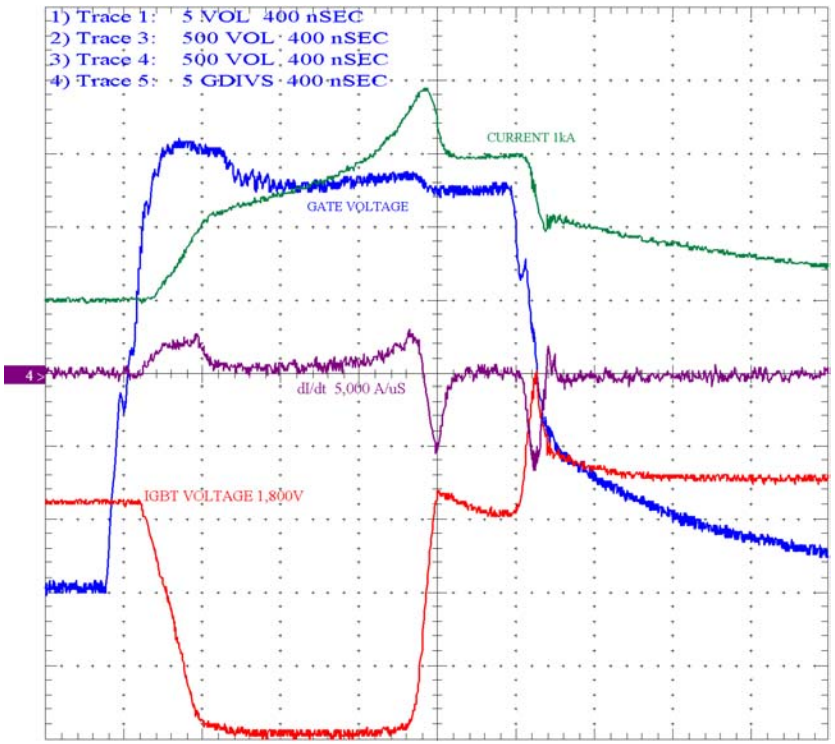


Three turn tests

IGBT Short Circuit Test

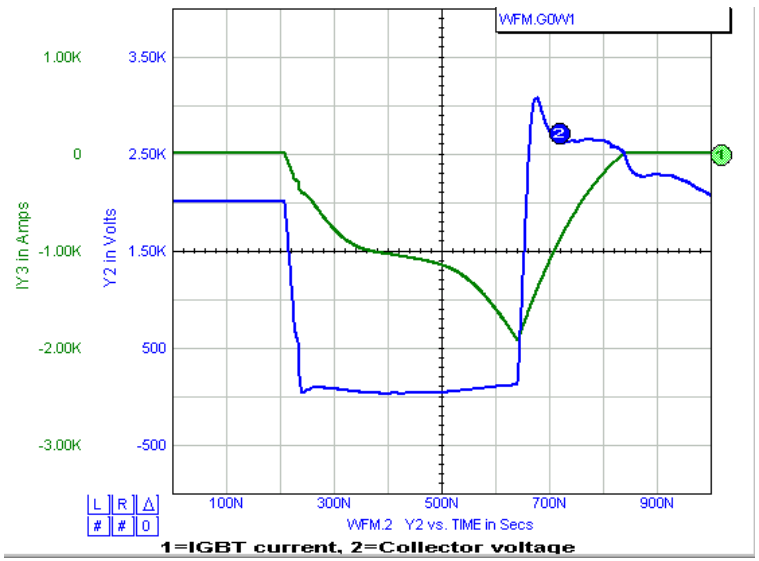


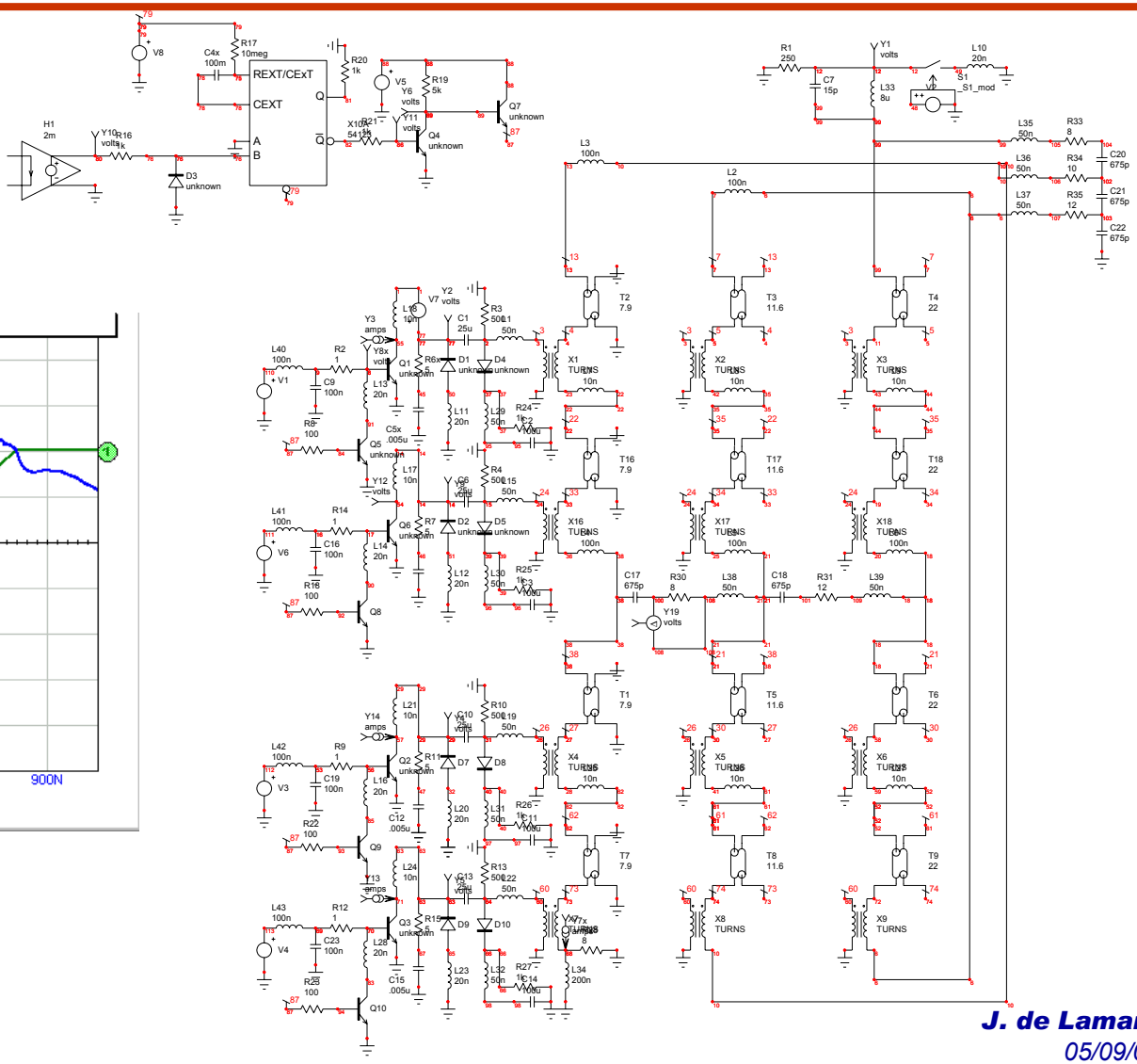
EUPEC 3.3 kV FZ800R33KF2



WESTCODE "Hockey Puck" IGBT

Circuit Simulator Schematic of 4-Dog Modulator





3-Turn Arc Test & Snubbers

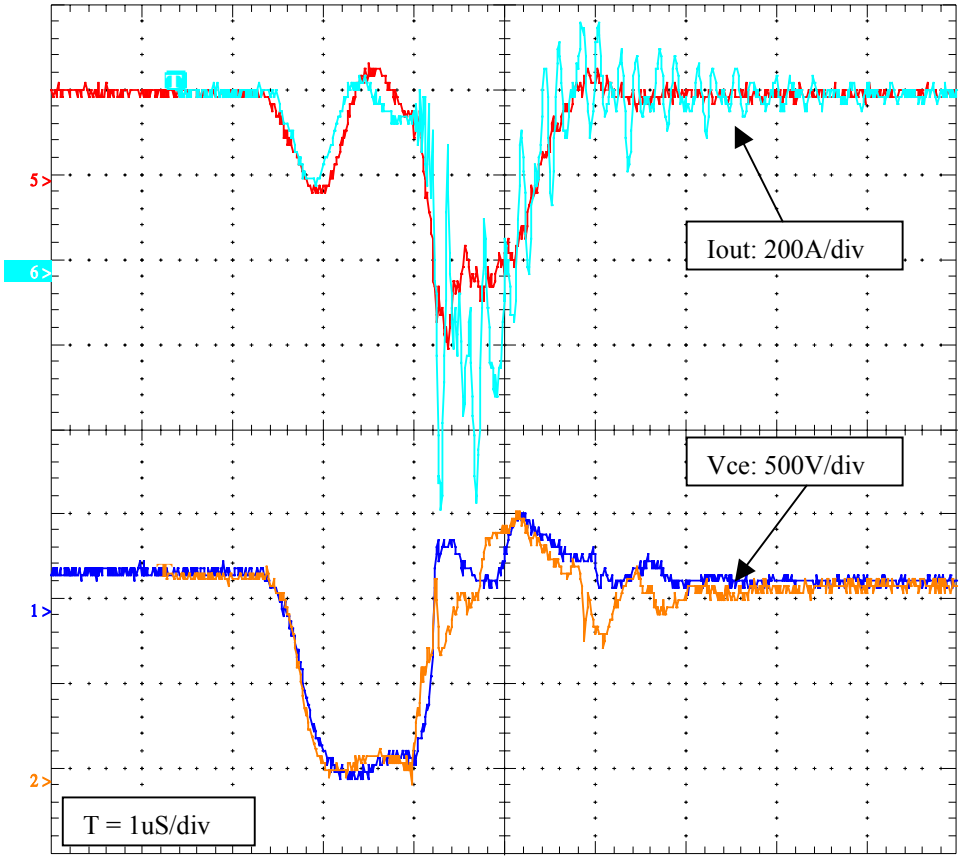
Adjustable Spark Gap

Snubbers

Data Before and After the Installation of the 3-Turn Snubbers

Modulator Output Current

IGBT C-E Voltage



NLC Klystron Modulator Power Supplies

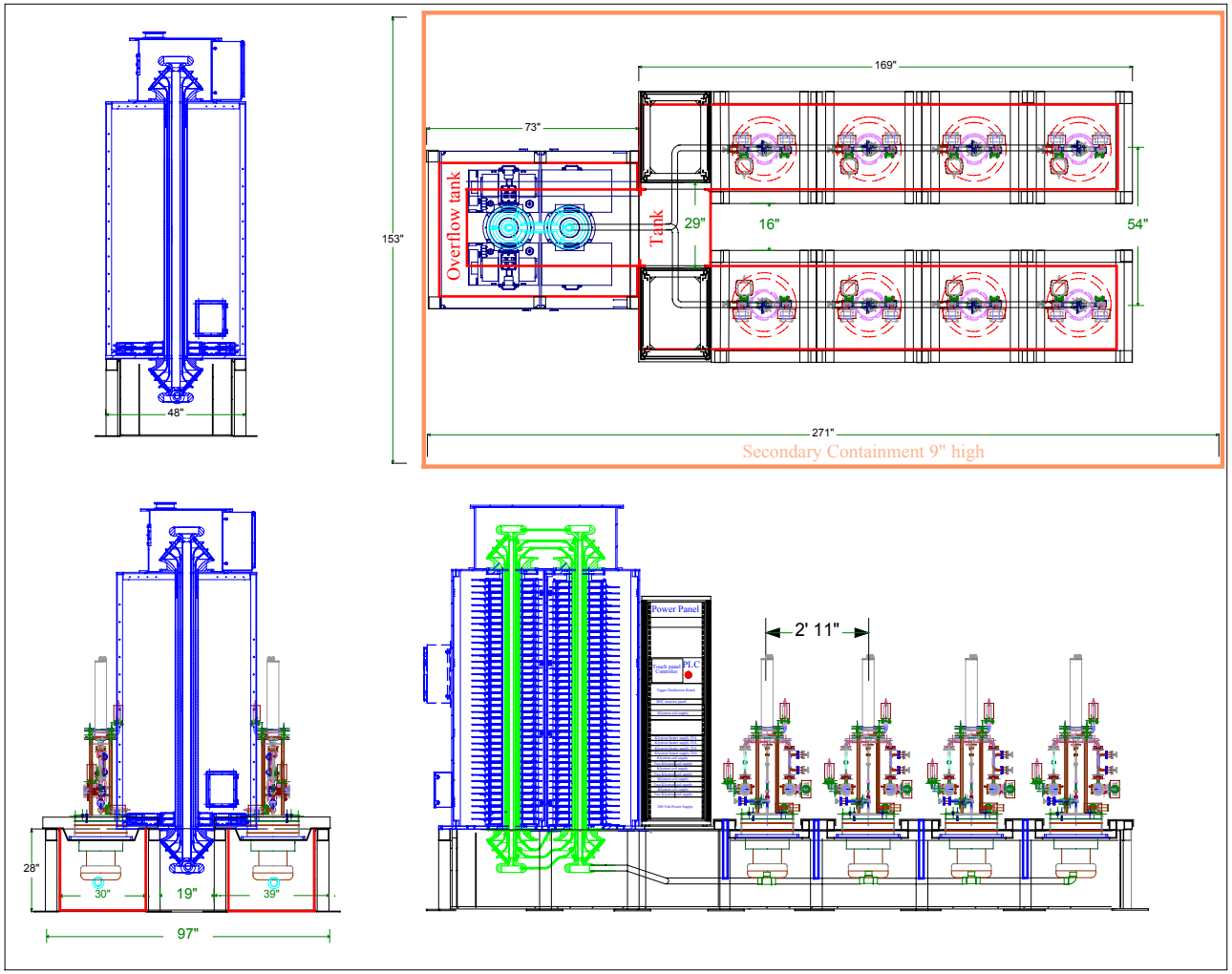
100kW

500kW

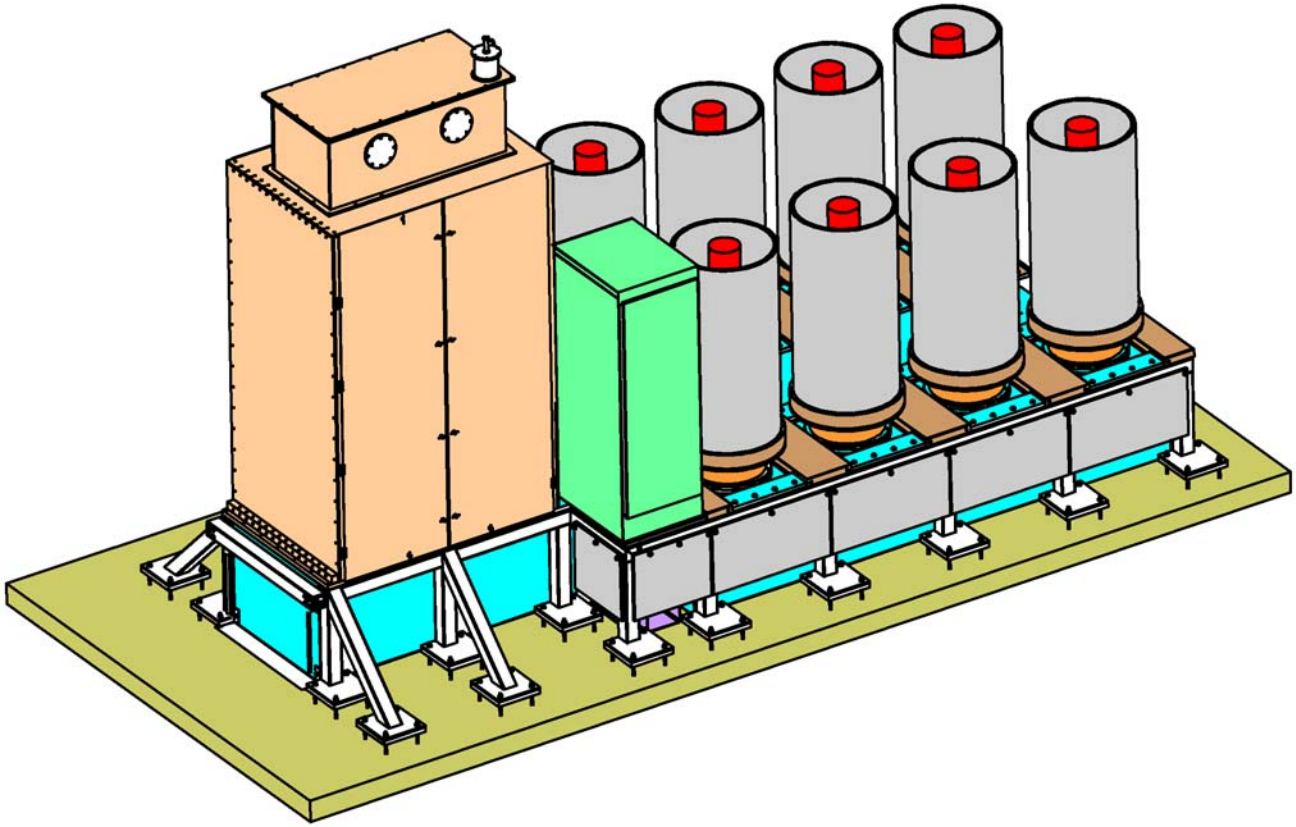
8-Pack Modulator Status

- New cell design.
- Long lead parts are in hand:
  - IGBTs
  - Cores
  - Capacitors
- Further development:
  - Core Driver Board
  - Core Casting

NLC 8-PACK MODULATOR

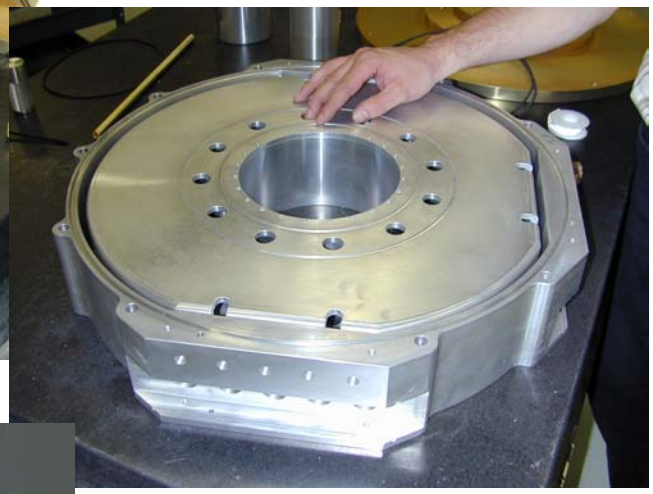


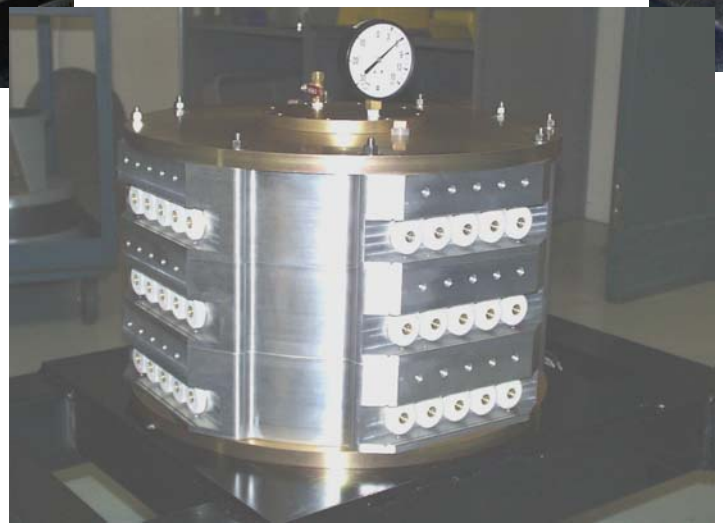
NLC Solid State Induction Modulator 8-Pack DFM Tests at NLCTA



8-Pack Modulator/Klystron Oil Tank

8-Pack Prototype Cell

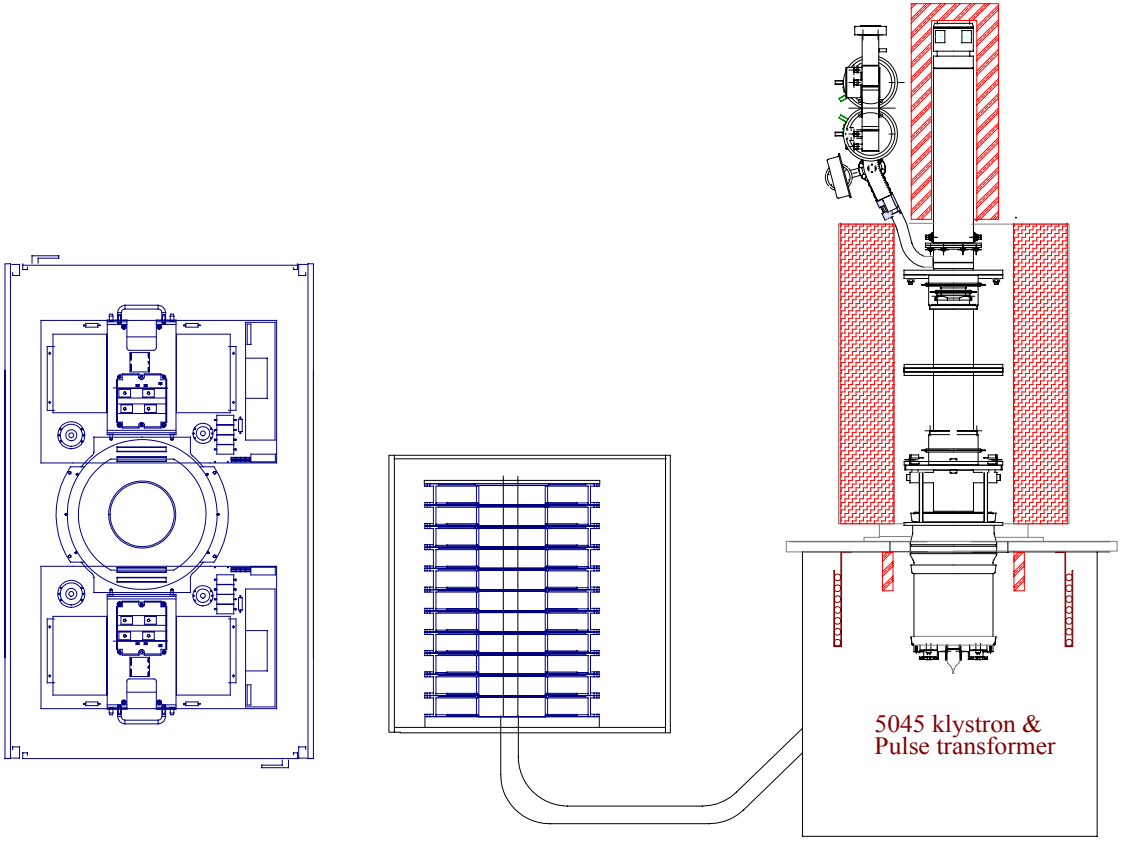




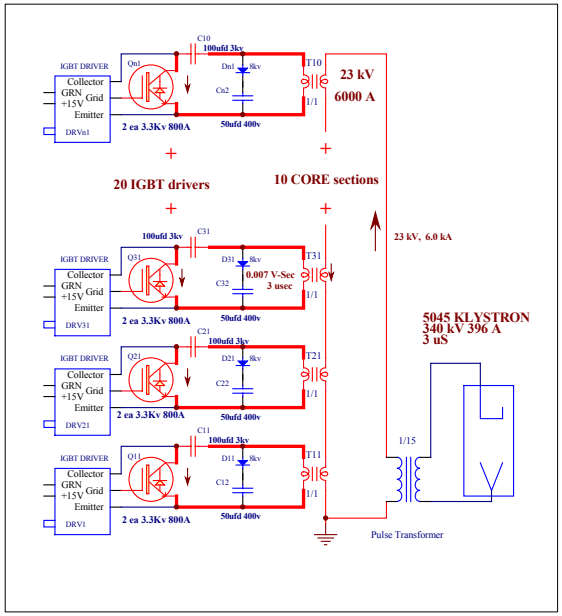
Short Stack Modulator

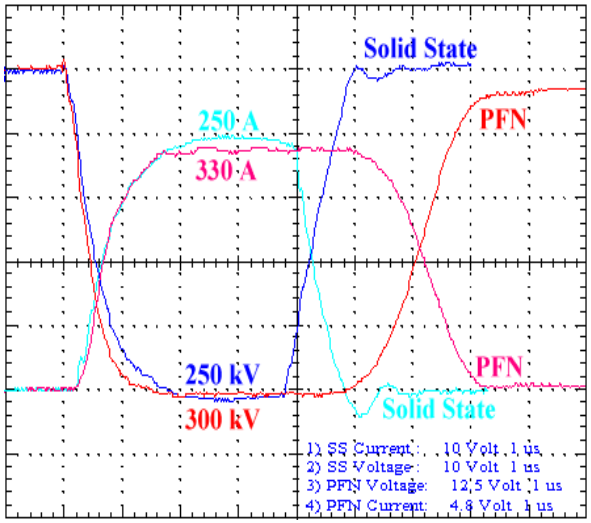
- Made operation of the modulator independent of the linac.
- Arc down tests successful.
- Rep Rate test results.

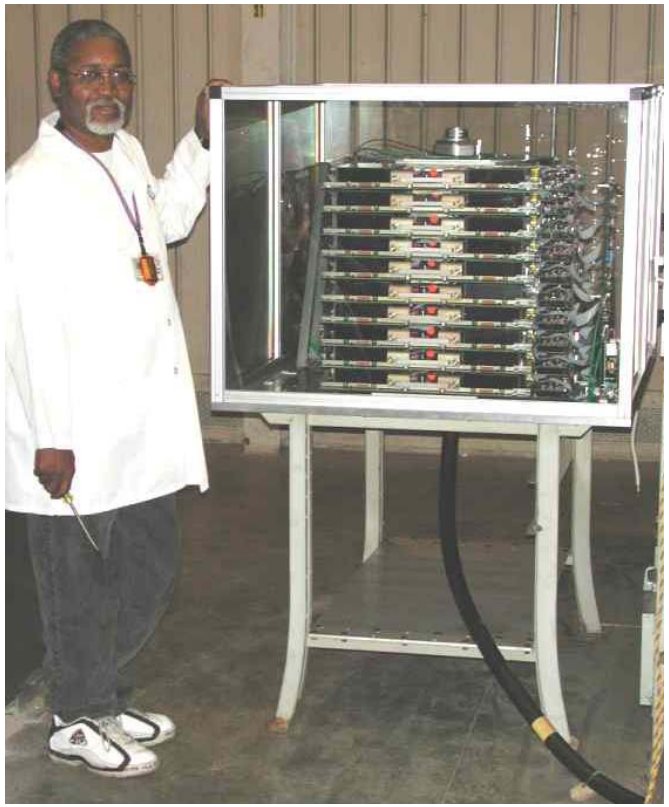
Solid State Induction Modulator Short Stack Klystron Tests



5045 Model Short Stack "Table Top" Modulator

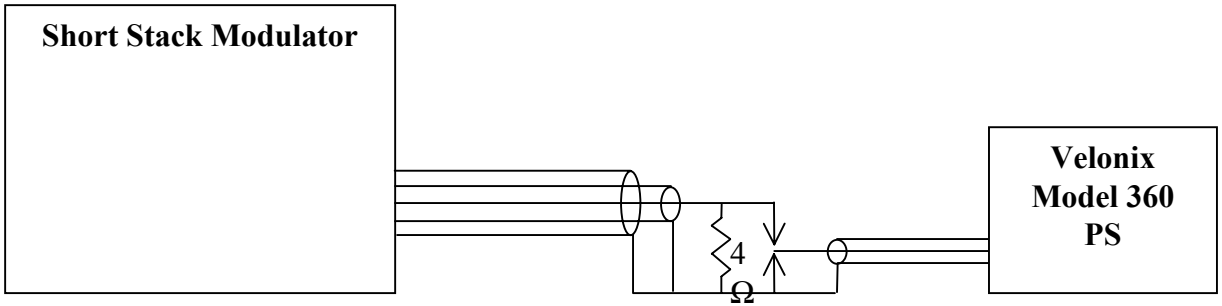


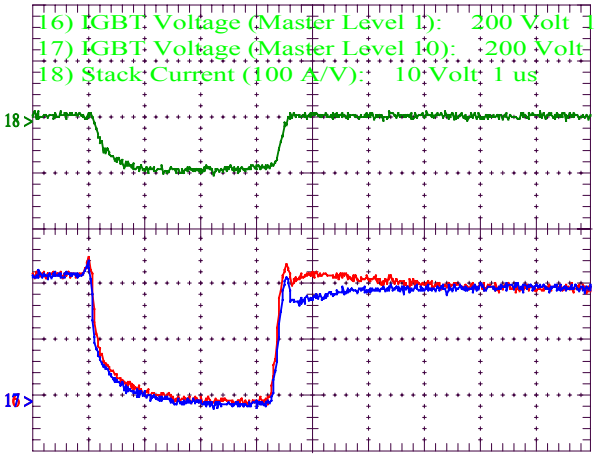




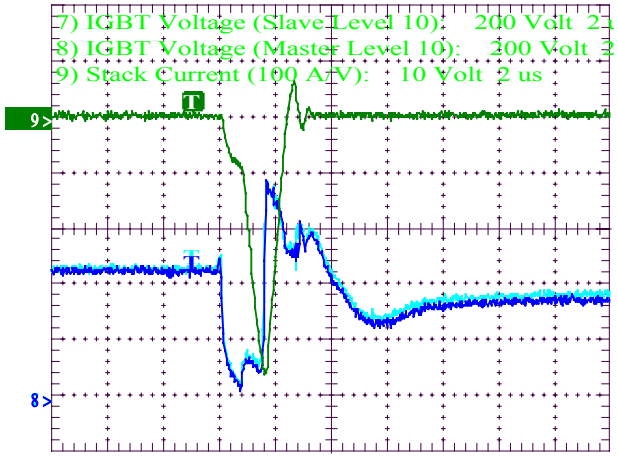
J. de Lamare

Short Stack Arc Tests

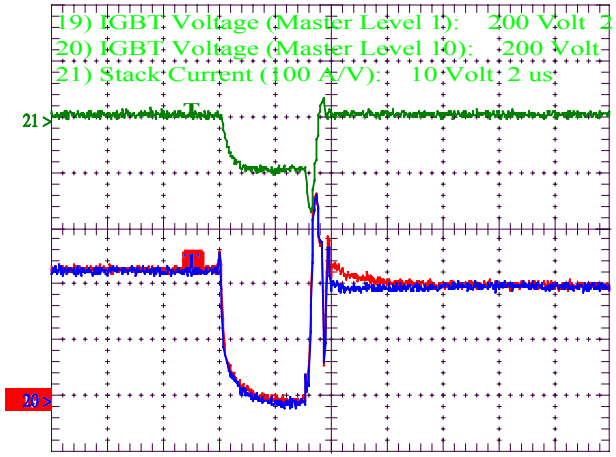




Short Stack Waveforms into 4Ω load. No Arc.

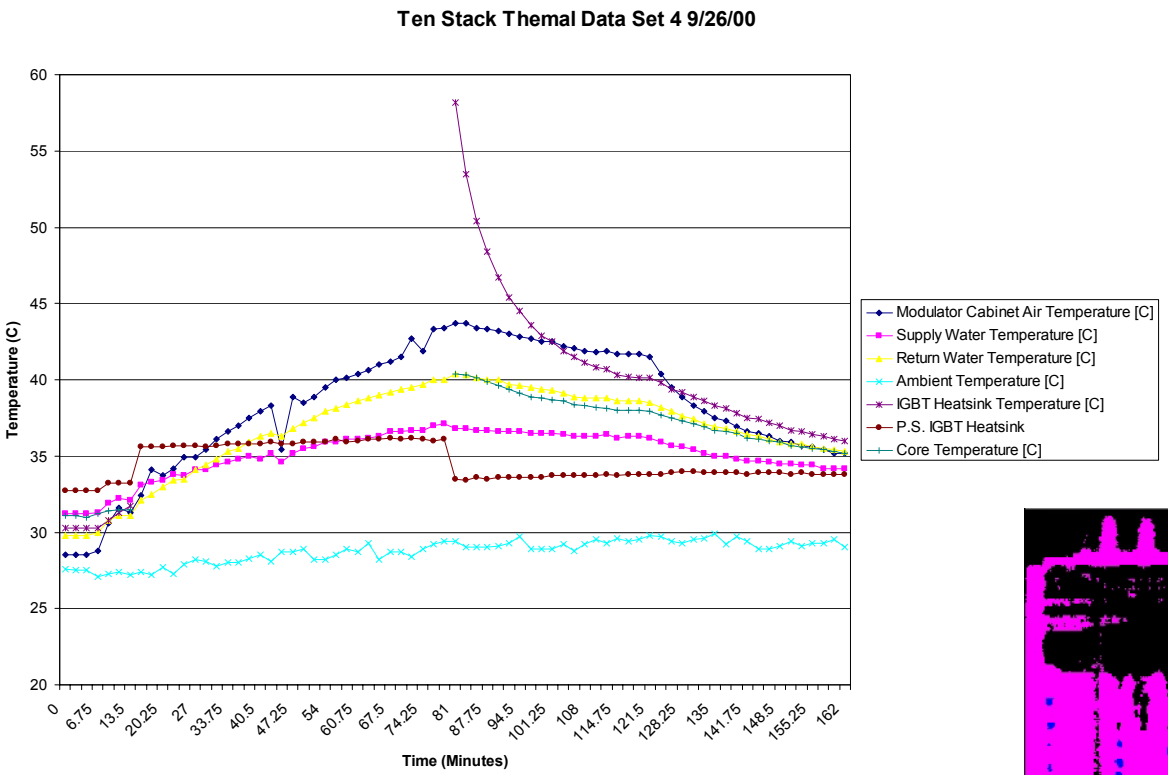


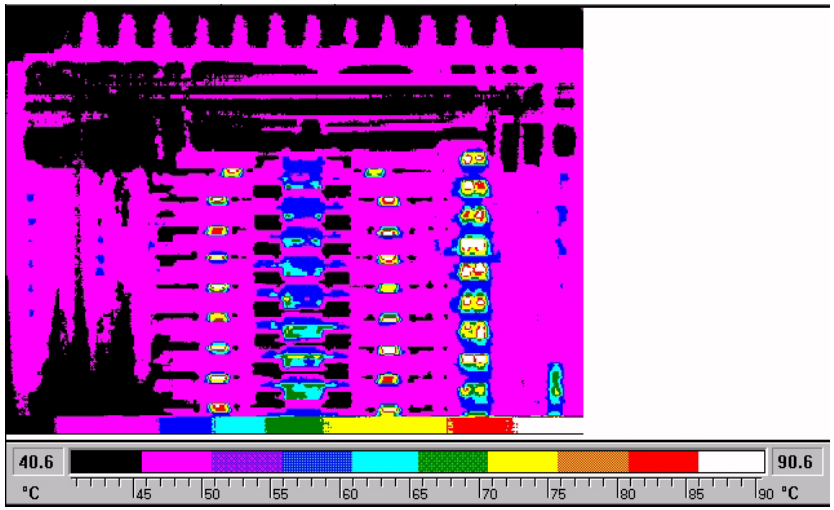
Early Arc.



Late Arc.

Short Stack Thermal Tests





Concluding Remarks

- The 4-Dog Induction modulator has been successfully operated up to 500kV in normal operation.
- The modulator is undergoing modification to protect it from failures due to arcing.
- The 8-Pack modulator design is in process with the major components already in hand.
- The short stack modulator is nearing completion for long term testing.