PULSED POWER SOURCES FOR BIO-MEDICAL APPLICATIONS

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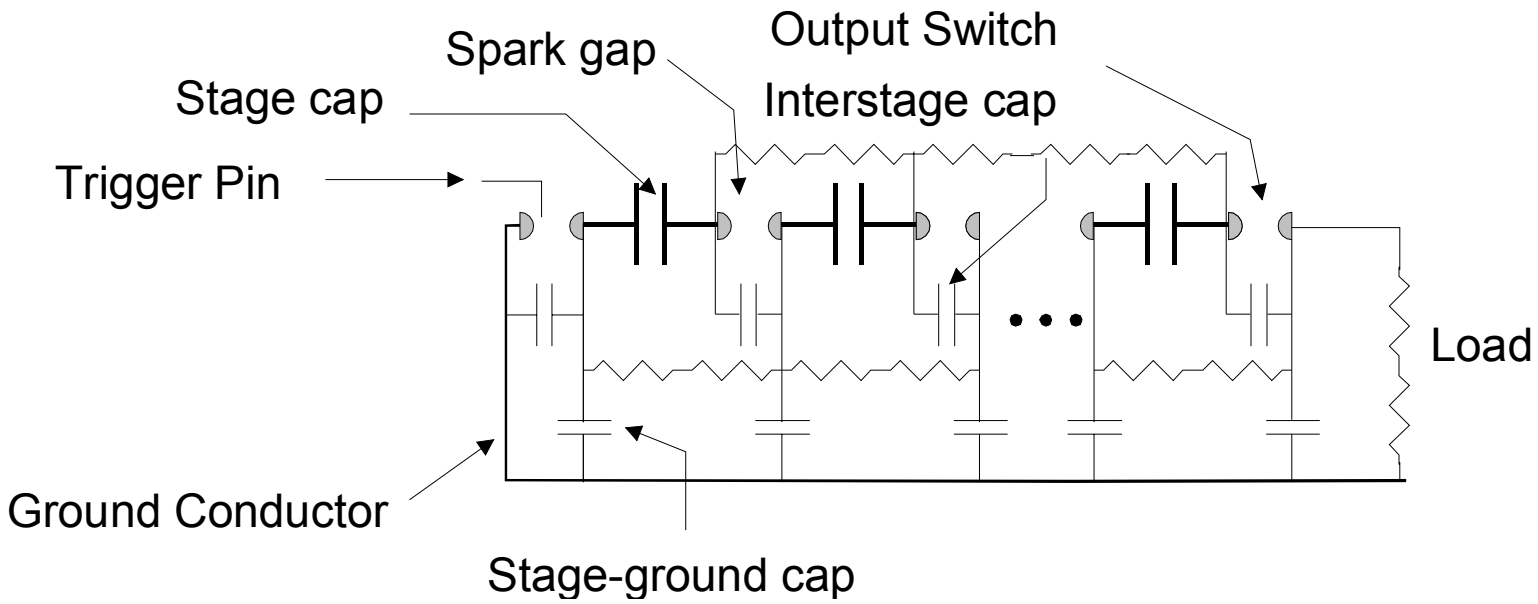
Presentation Summary

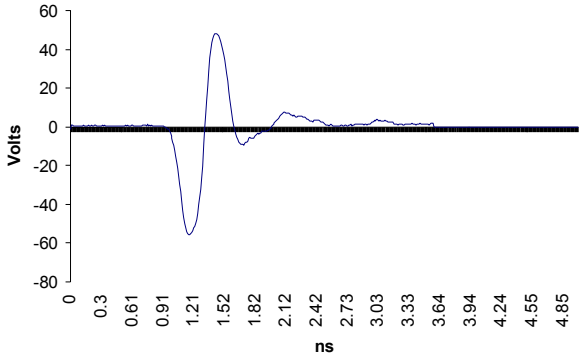
- Overview of generators used for this presentation
  - physical attributes
  - electrical characteristics
- Application results
  - Single generator systems
    - Generation of Ultra Wideband (UWB) signals
    - Marx generator driving a Backward Wave Oscillator (BWO)
    - Pulse shaping system
  - A multiple generator system – The Gatling Marx Generator System

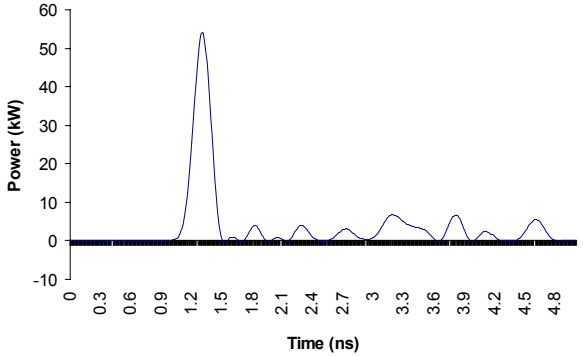
Marx Generator Summary – General Operation



- APELC generators based on the wave-erection concept
- Stray elements designed for optimal performance
- Very compact design

Moderate Voltage Marx Generator - Summary



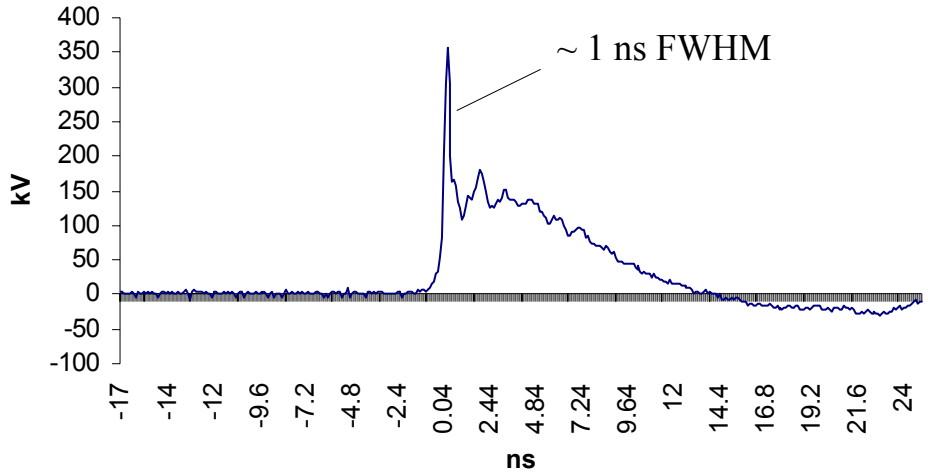


- Credit card sized generator
  (~ 25.4 mm x 50.8 mm x 6.3 mm)
- 500 V charge voltage
- 2000 V peak output voltage
- 600 ps pulsewidth
- 50 Ω load
- 50 kW peak power

Moderate Voltage Marx Generator – Proposed Characteristics

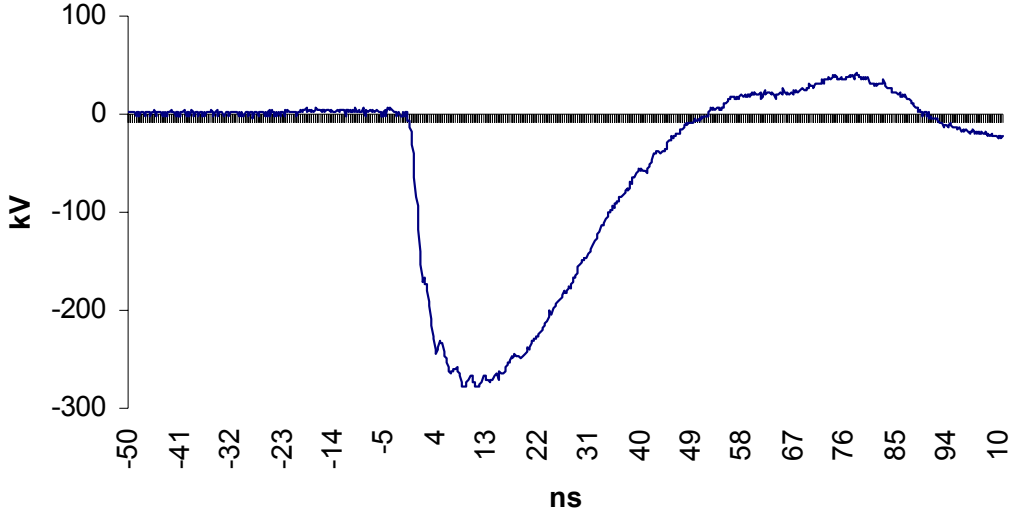
Symbol	Description	Value	Unit
V_{ch}	Charging Voltage	1	kV
N	Number of Marx stages	15	-
C_s	Stage capcitance	100	pF
η_o	Output voltage efficiency	85	%
E_s	Energy stored per stage	50	μJ
E_T	Total Energy Stored in Marx	750	μJ
V_p	Peak output voltage	12.75	kV
P_p	Peak power delivered to the antenna	3.25125	MW
T_{RR}	Maximum Repetition Rate	10	kHz
P_{ave}	Average power	7.5	W
L	Length	8	in
d	diameter	1.25	in
w	Weight	< 1	lb

High Voltage Marx Generator Summary



- A 17 stage generator
  - 30 kV charging voltage
  - Approx. 1 ns pulse width (leading impulse), 14 ns full pulse width
  - 200 ps risetime
  - 3.8 J
  - currently producing a 360 kV pulse (% 65 voltage efficiency)
  - 3 in. diameter, 46 in. length

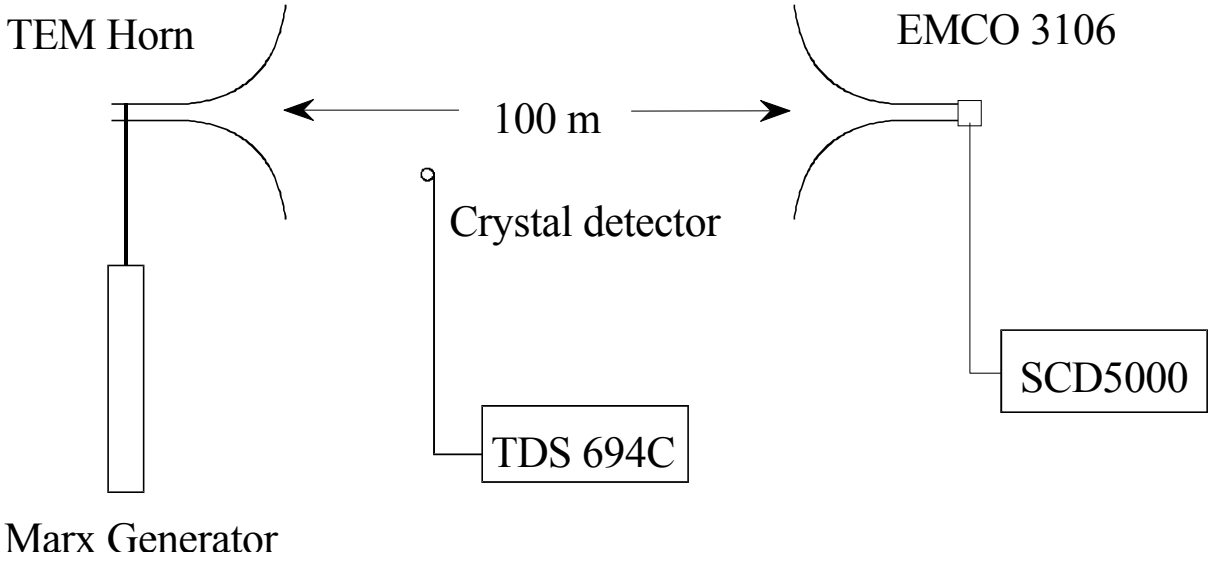
High Voltage, Large Pulse Marx Generator Summary



- A 13 stage generator
  - 40+ kV charging voltage
  - Pulse width of 20 ns
  - Risetime of 3 ns
  - 32 J
  - Currently generating a 270 kV pulse (% 50 efficiency)*
  - 5 in. diameter, 40 in length*

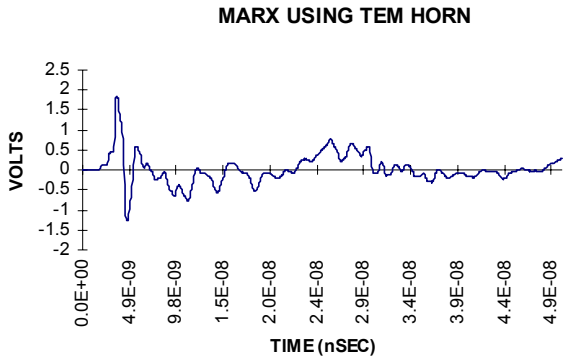
* not maximized for performance nor volume usage

Applications – Single Pulse Radiation Systems

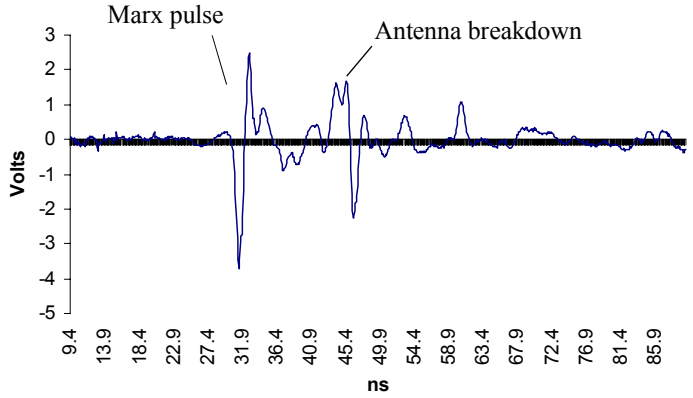


- Marx (~ 125 kV) driving rudimentary TEM horn
- Radiated signal observed with an EMCO 3106 horn 100 m from source
- Subsequent measurements (different radiating TEM horn) with an uncalibrated crystal detector

Applications – Single Pulse Systems Radiation Measurements

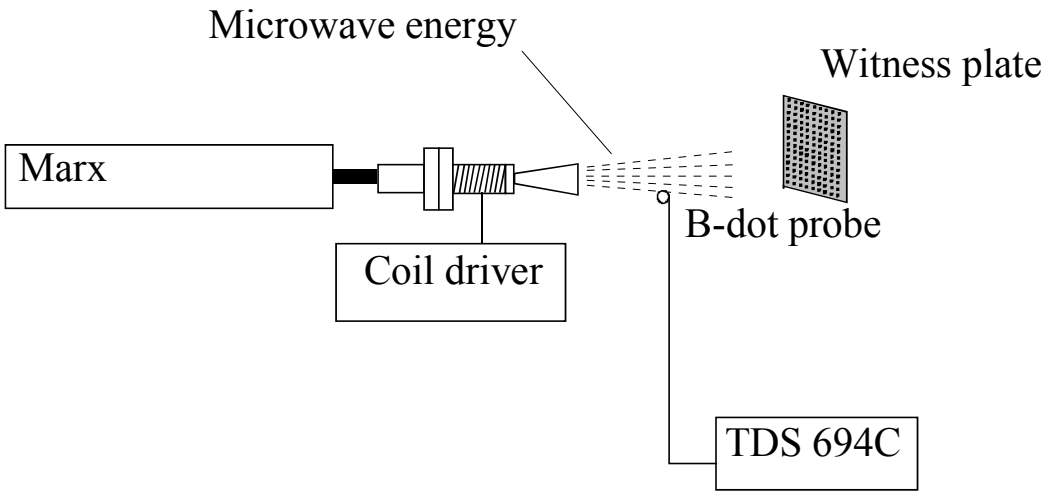


Signal measured with EMCO horn



Signal measured crystal detector

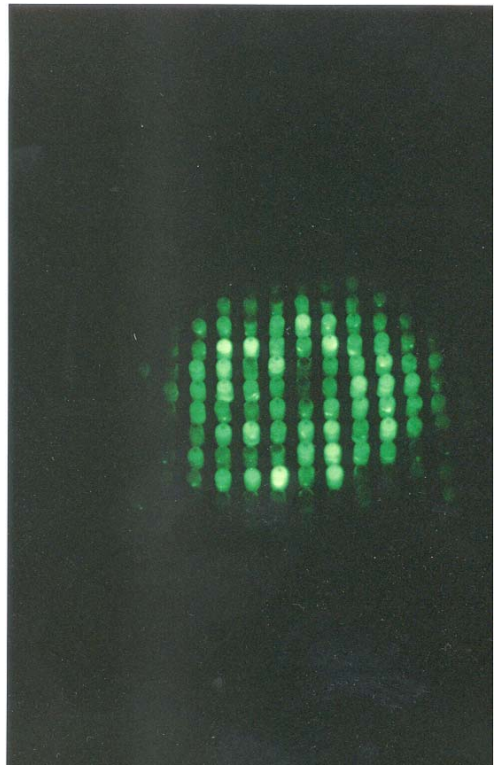
Applications – Single Pulse Microwave Systems (BWO)



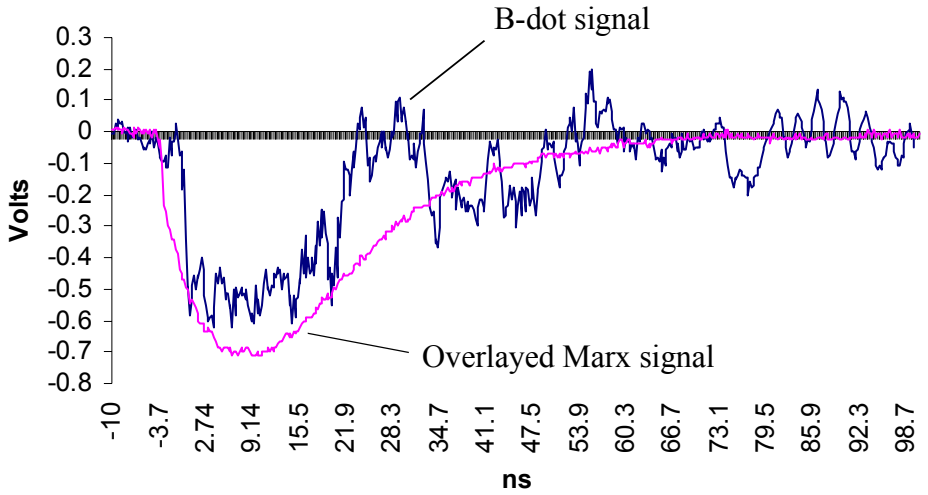
- 270 kV Marx generator
- 35 GHz BWO
- TM_{01} mode

Applications – Single Pulse Systems, BWO Results

Witness plate illumination



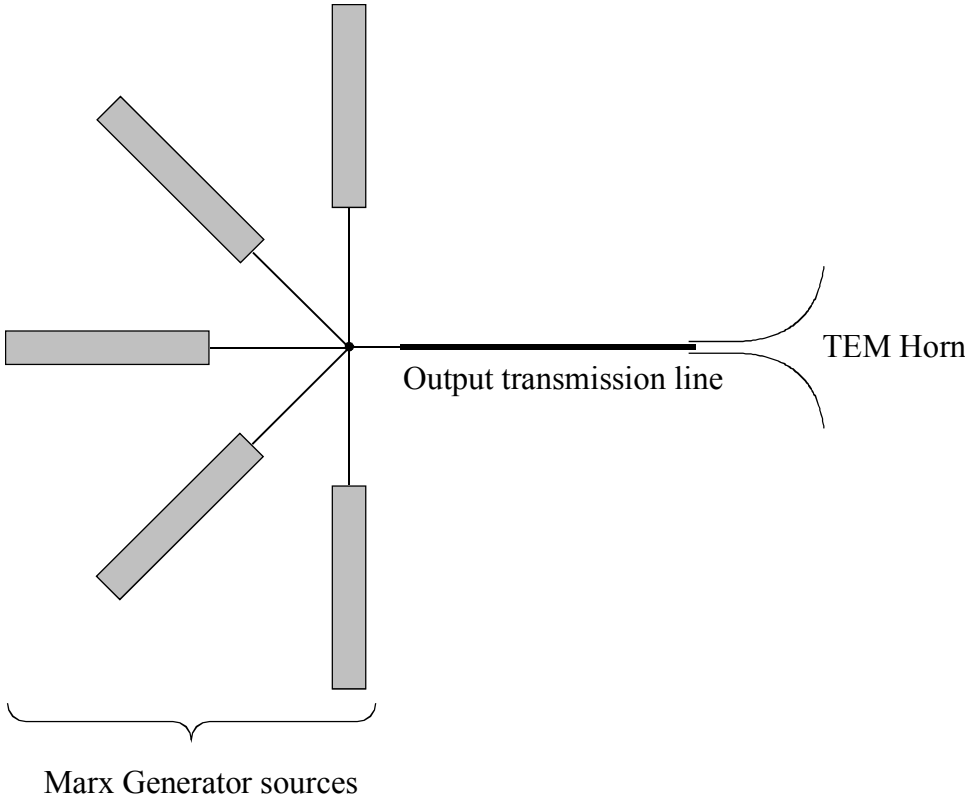
B-dot signal with Marx waveform reference



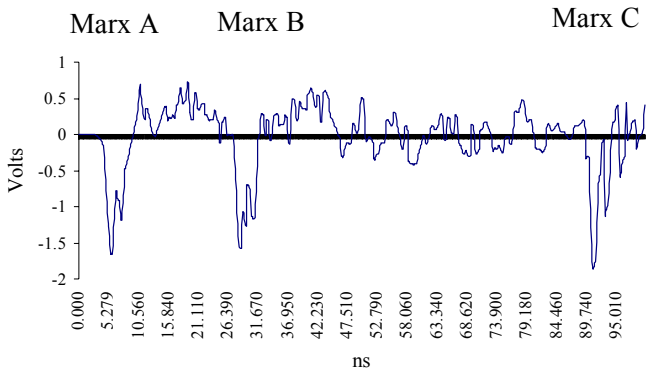
- Approximately 20 ns window
- Approximately 30 MW of microwave energy

The Gatling Marx Generator System

- Multiple Marx sources
- RF burst – ns separation of UWB pulses
- Sources act independently
- Variable pulse voltages
- Variable timing between pulses
- One common output transmission
- One load element
  Antenna, microwave head, cuvette

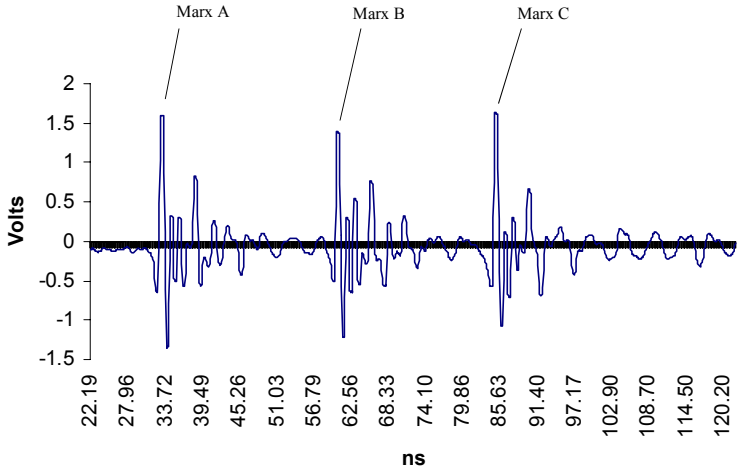


Gatling Marx Generator Results

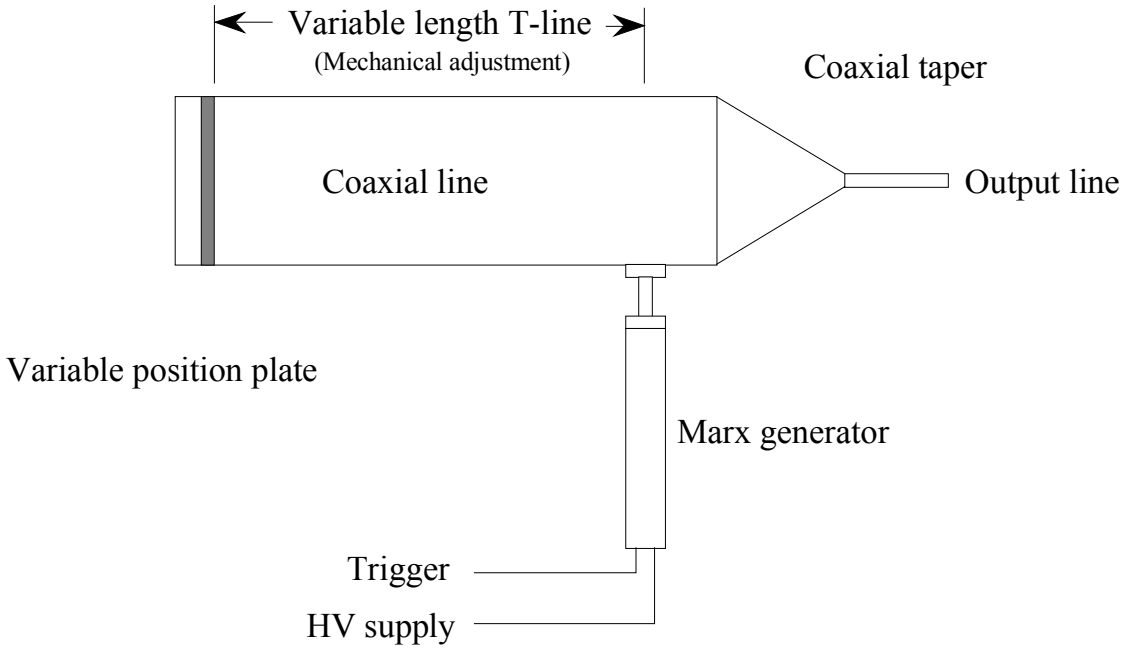


- Gatling pulses launched from rudimentary TEM horn
- Signal witnessed with EMCO 3106 antenna

- Gatling pulses measured with CVR
- 125 kV pulses

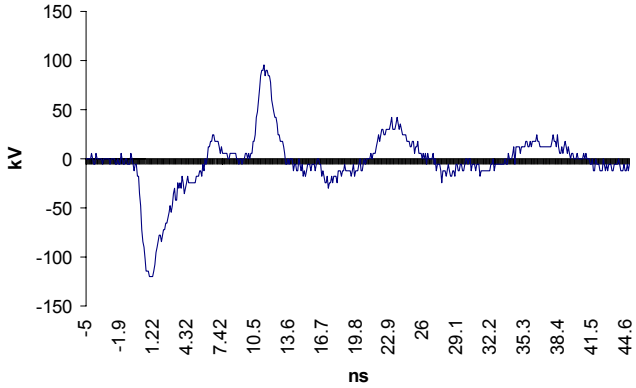


Variable Frequency with High Voltage Pulses

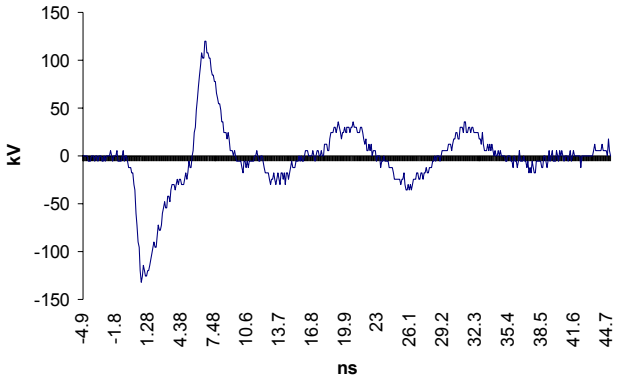


- Two high voltage pulses of opposite polarity generated
- Temporal spacing between pulses determined by length of T-line
- Leads to frequency agility

Preliminary Results – Pulse Spacing



- T-line length = 5.5 ft. (one way)
- ΔT (between pulses) = 10.6 ns



- t-line length = 3.25 ft
- ΔT (between pulses) = 6.5 ns

Summary

Developing high voltage impulse sources for single and multi-pulse systems

- Voltages of hundreds of kV (present achievement 360 kV)
- Fast risetimes, 200ps
- Repetition rates of several Hz (goal: tens of Hz)
- Compact geometries
- Battery or AC power in

Developing high voltage long pulse sources for HPM loads

- Voltages of hundreds of kV
- Pulse energies from tens of Joules to kJ
- Repetition rates of several Hz