Design of a Compact Portable X-Pinch X-Ray Generator at Idaho Accelerator Center

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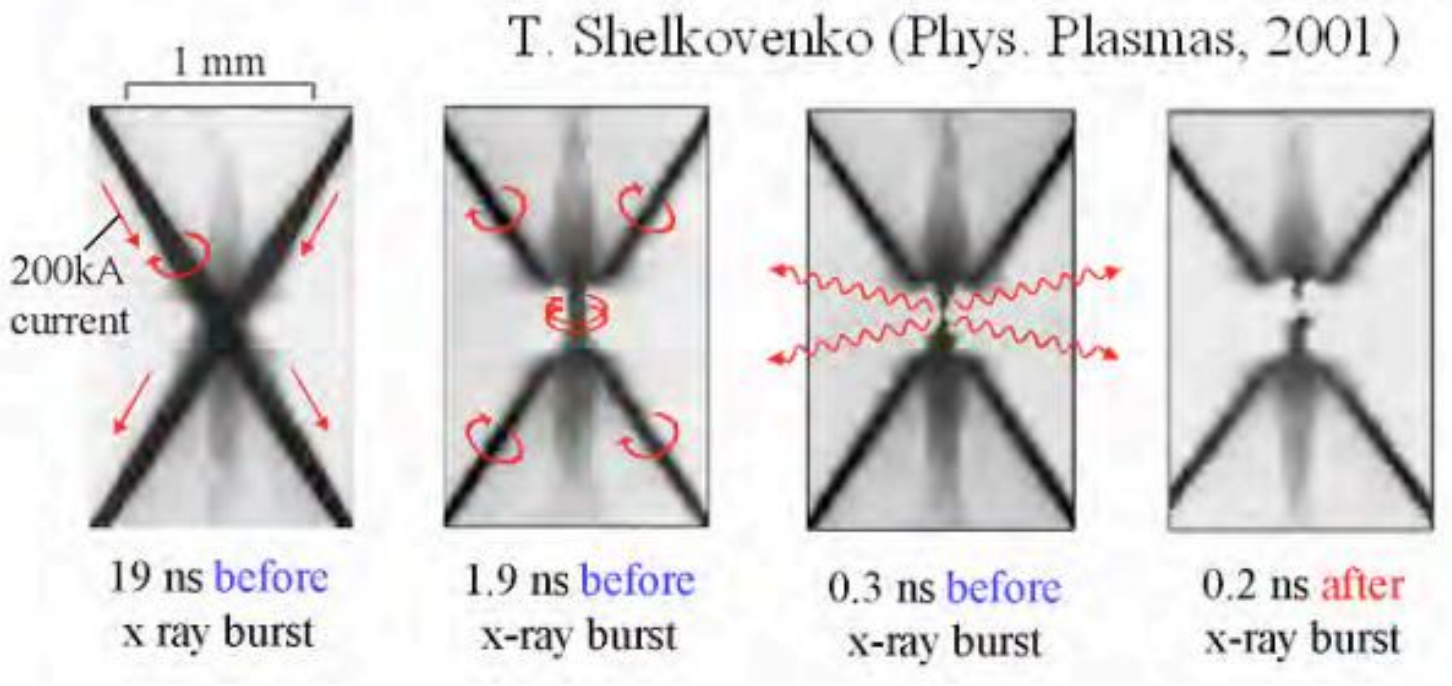
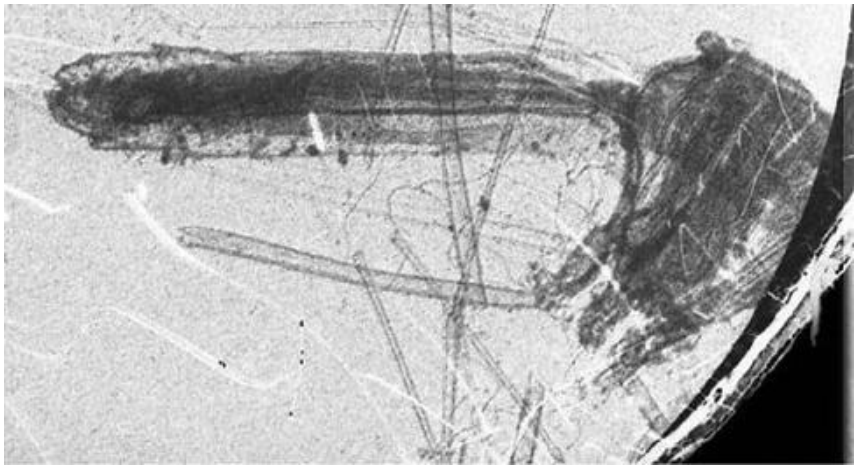
What is X–pinch? Why?



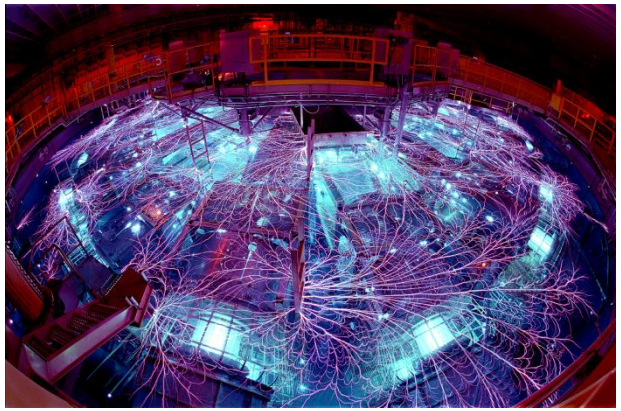
Remarkable X-Ray Source:

- **fast (< 1 ns)**
- **small (1-10 µm)**
- **bright (> 100-200 mJ)**

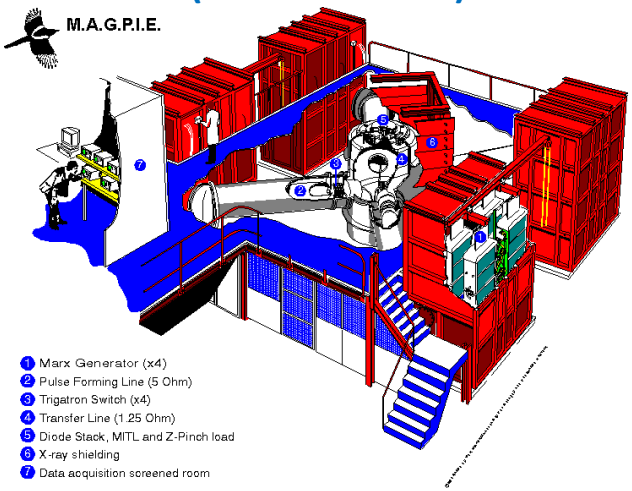


Pulsed Power Generators: Marx and Pulse Forming Lines

ZR (27 MA 96 ns)



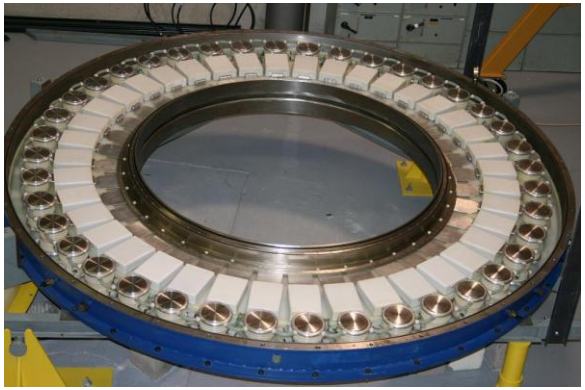
MAGPIE (1.4 MA 150 ns)



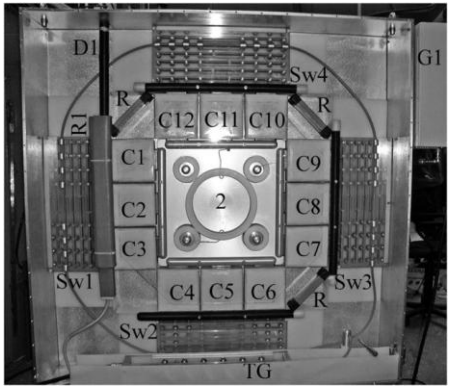
PPG-1 (400 kA 100 ns)

Pulsed Power Generators: Low Inductance Capacitors and Switches

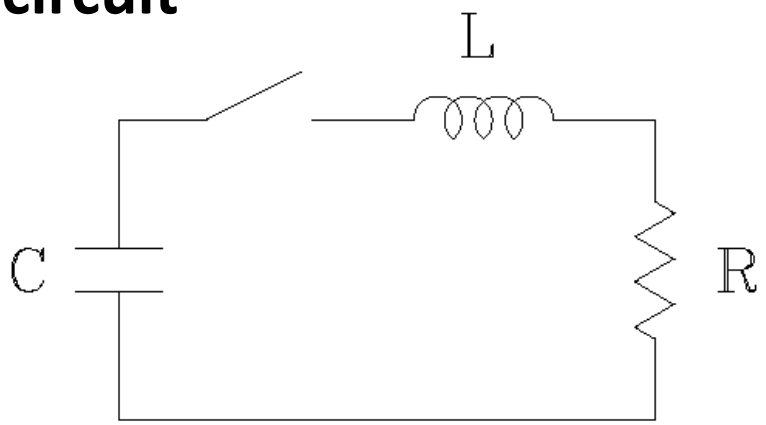
MAIZE (1 MA 100 ns)



GenASIS (250 kA 150 ns)



RLC circuit



"Matched" Load:

- **Higher Peak Current**
- **Faster Rise Time**

M. Mazarakis,and R. Spielman "A compact, high-voltage E-beam pulser," 1999 IEEE

Compact Portable Plasma Radiation Source Generator

L_c=10 nH

C_c=100 nF

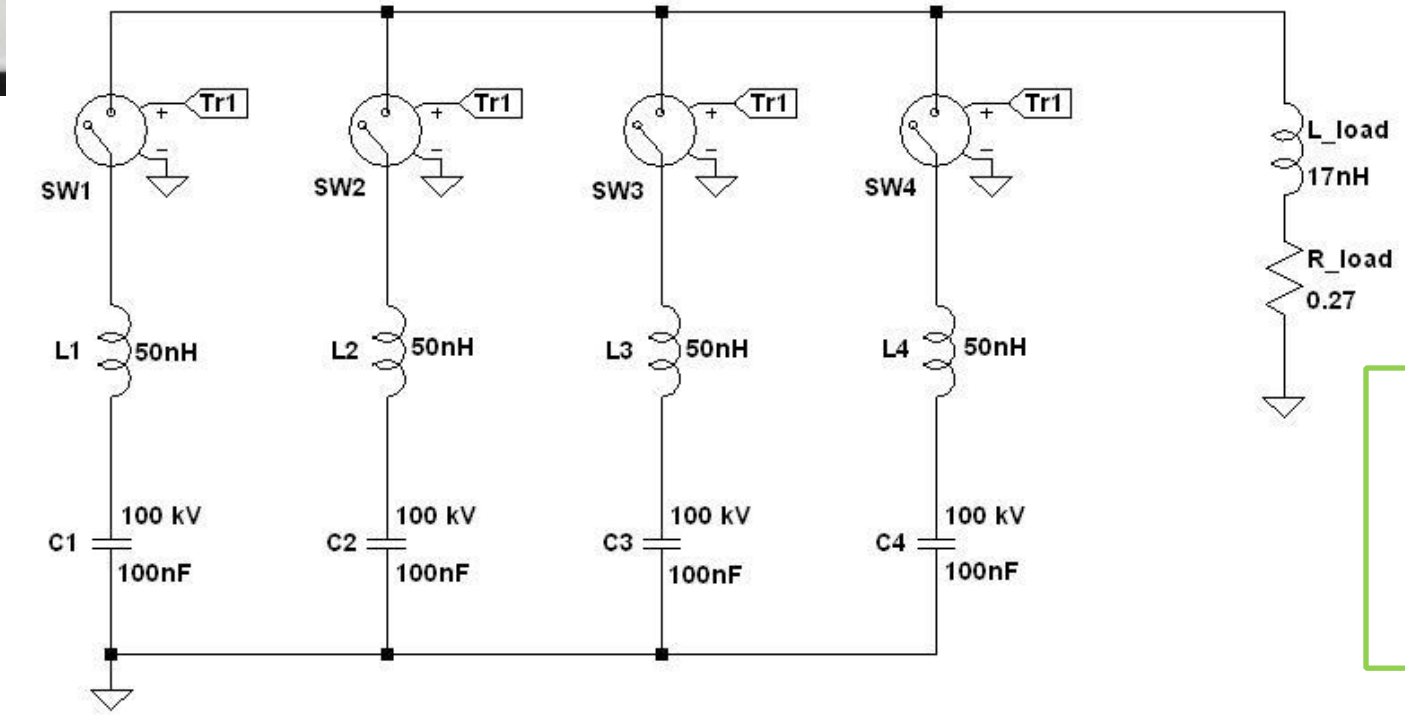
I_c=60 kA

V_c=100 kV

L_{sw}<40 nH

I_c=100 kA

V_c=25-100 kV



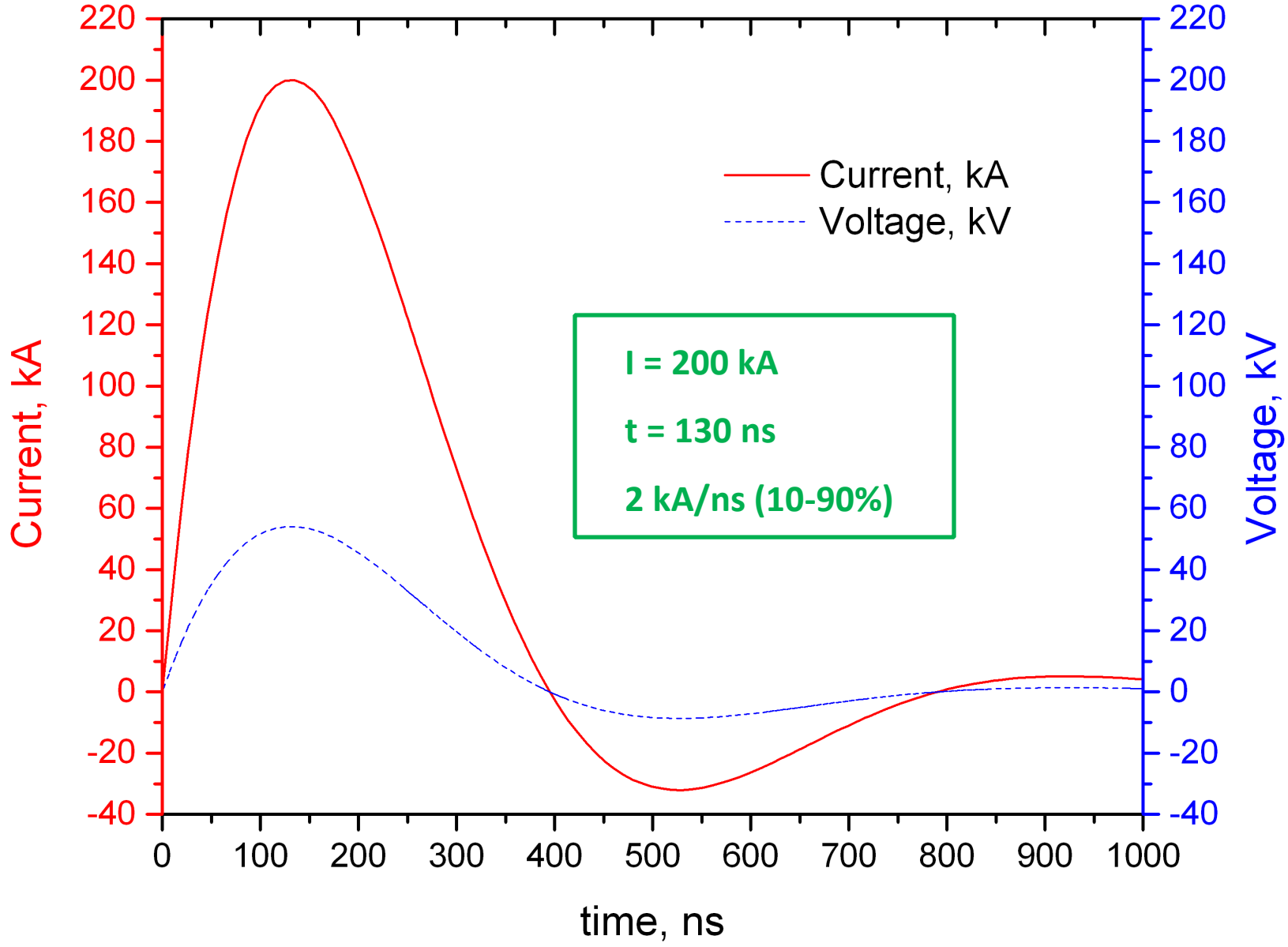
L = 29.5 nH

C = 400 nF

R= 0.27 Ω

R. Shapovalov “Design of a Compact Portable Plasma Radiation Source Generator at IAC,” (in preparation)

Simulation results : 4 capacitors and 4 switches



R. Shapovalov “Design of a Compact Portable Plasma Radiation Source Generator at IAC,” (in preparation)

After construction and testing we are expecting:

X-Pinch Generator:

1. Peak current 200 kA with 80 ns rise time
2. Energy stored in capacitors: 2 kJ.
3. Energy transferred to the x-pinch: 0.8 kJ
4. Peak Power: 11 GW
5. Compact: (3 x 2 x 2) feet

Remarkable X-Ray Source:

1. Fast (< 100 ps)
2. Small (1-2 µm)
3. Bright (> 200 mJ)

Possible Experiments at Idaho Accelerator Center

1. Phase-Contrast Imaging
2. Nuclear Weapon Effect Testing
3. And more...

Looking Forward:

1. Higher Current
2. Z-Pinch
3. Fusion Energy

THANK YOU

Please, contact me, if you have any questions: **Roman Shapovalov**
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Z-Pinch/X-Pinch worldwide Installations

- Sandia National Laboratories, Z machine (1996), 18 MA 100ns [4]
- Sandia National Laboratories, ZR (Refurbished) (2006), 27 MA, 95ns
- Sandia National Laboratories, future ZN (Z Neutron), 20 and 30 MJ per short
- Sandia National Laboratories, future Z-IFE (Z-inertial fusion energy), 70 MA, 1 PetaWatt
- Sandia National Laboratories, SATURN, 8 MA
- Cornell University, USA: COBRA, 1 MA, 95-180 ns [5]
- Cornell University, USA: XP Pulser, 450 kA, 50 ns [6]
- University of Nevada, Reno: Zebra, 1MA, 100ns [7]
- University of California, San Diego: GenASIS, 210 kA, 150 ns [8]
- University of California, San Diego: X-Pinch Pulser, 80 kA, 50 ns [9]
- University of Michigan, USA: MAIZE, 1 MA, 100 ns [10]
- Florida A&M University: X Pinch system

- Pontificia Universidad Católica de Chile: Llampüdkeñ, 400 kA, 260 ns
- Pontificia Universidad Católica de Chile: GEPOPU, 180 kA, 120 ns

- Imperial College, London: MAGPIE, 1.4 MA, 240 ns [11]
- Imperial College, London: Table-top X-pinch, 40 kA, 30ns
- France?: PIAF, 250 kA, 180 ns

- Xi'an, China: QiangGuang-1, 1 MA, 50 ns
- Beijing, China: PPG-1, 400 kA, 100 ns
- CIAE, China: Light II-A, 200 kA
- Beijing, China: Table Top, 100 kA, 60 ns, 2m x 1.1m x 1.2m

- TRINITI, Russia: ANGARA-5-1, 4 MA, 100 ns [12]
- Institute of High Current Electronics, Russia: Compact Pulse Generator, 300 kA, 200 ns, 70 kg
- Institute of High Current Electronics, Russia: Compact submicrosecond, high current generator, 650 kA, 390 ns

no Marx generator

no

Pulse Forming Lines

instead utilize advantages of high current low inductance capacitors and switches