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

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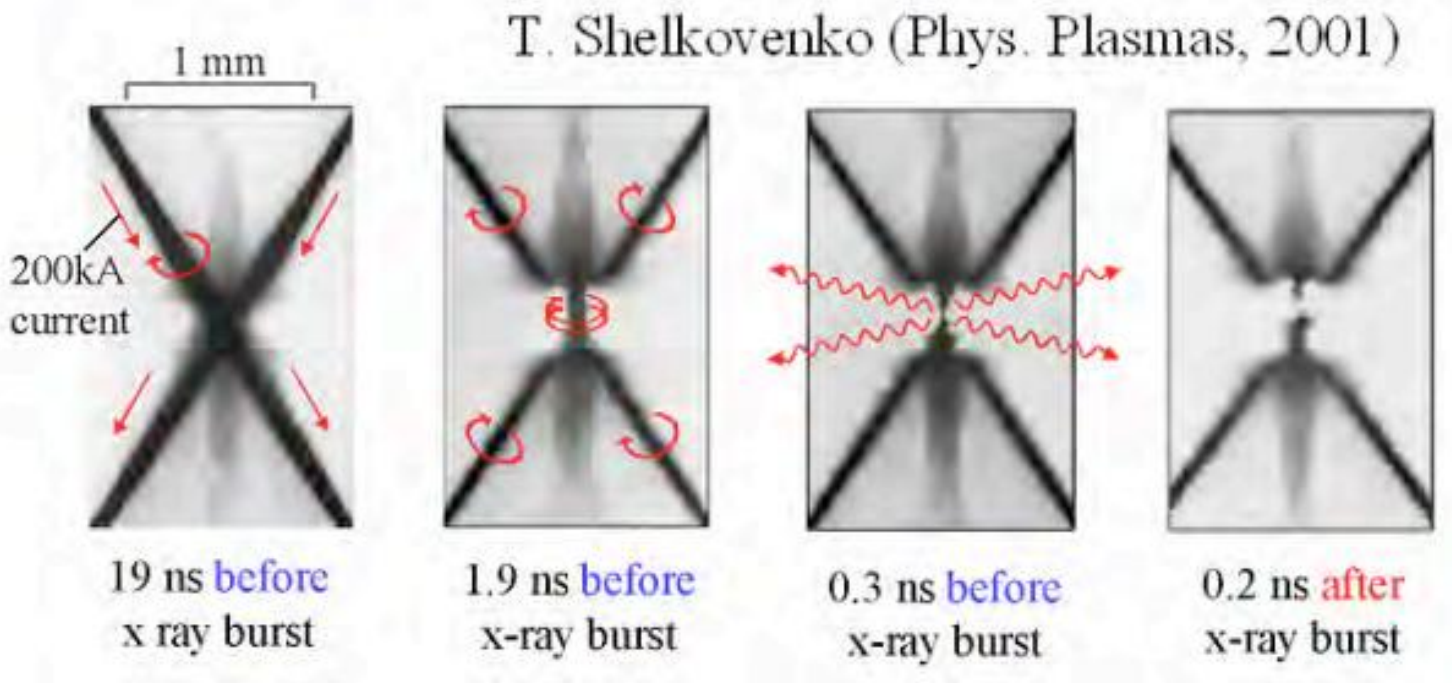
May 3, 2013

Idaho State University

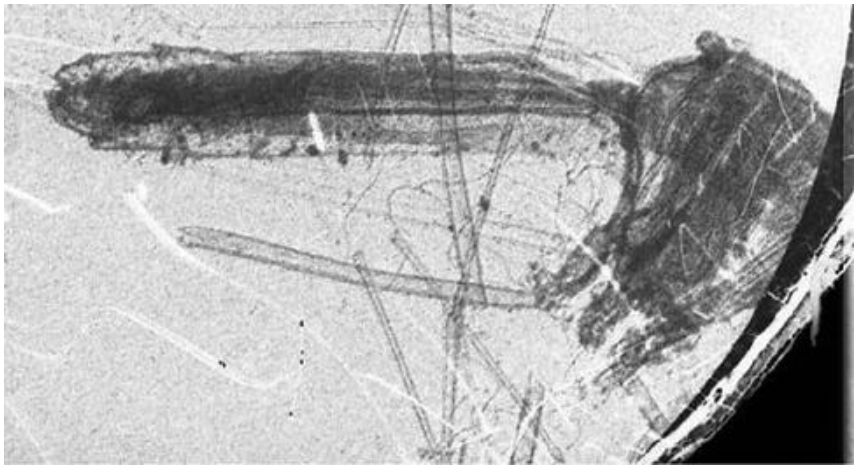
This work is supported by Thrust Area 1 (FRBAA09-1-2-0034) under contract DTRA1-11-1-0036

What is X–pinch? Why?



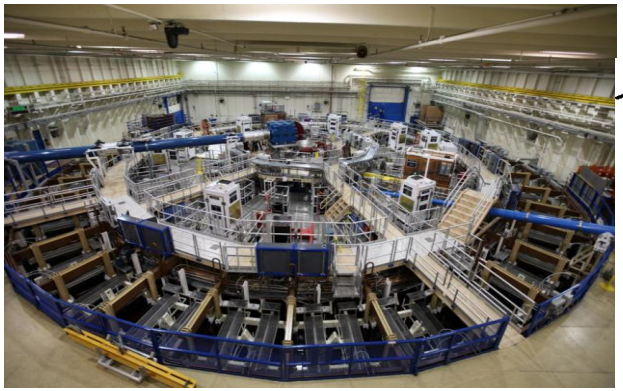
Remarkable X-Ray Source:

- **short pulse (< 1 ns)**
- **small size (1-10 µm)**
- **bright (> 100-200 mJ)**

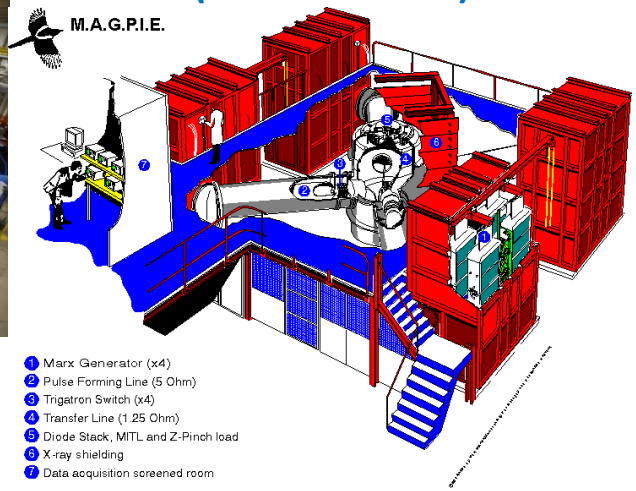


Pulsed Power Generators: Marx and Pulse Forming Lines

ZR (27 MA 96 ns)



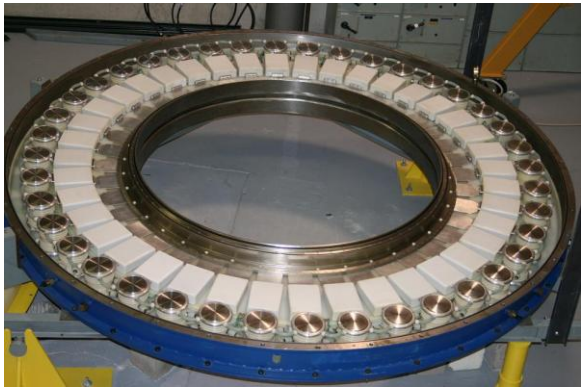
MAGPIE (1.4 MA 150 ns)



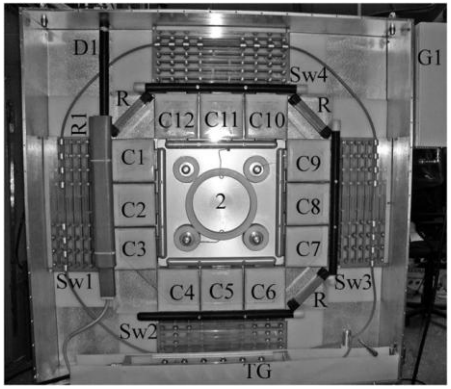
PPG-1 (400 kA 100 ns)

Pulsed Power Generators: Low Inductance Capacitors and Switches

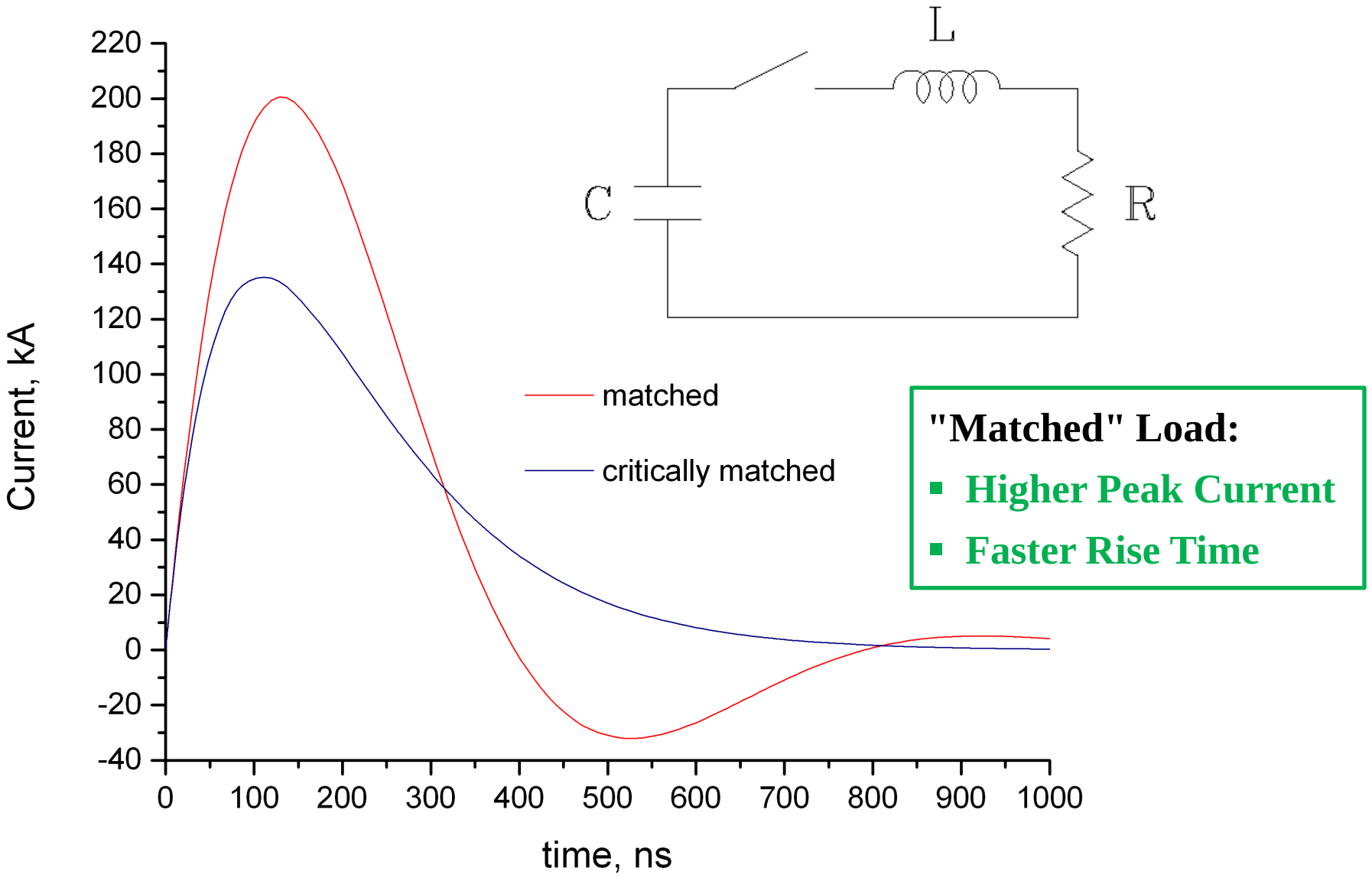
MAIZE (1 MA 100 ns)



GenASIS (250 kA 150 ns)



Pulsed Power Generators: low inductance capacitor and switches



"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

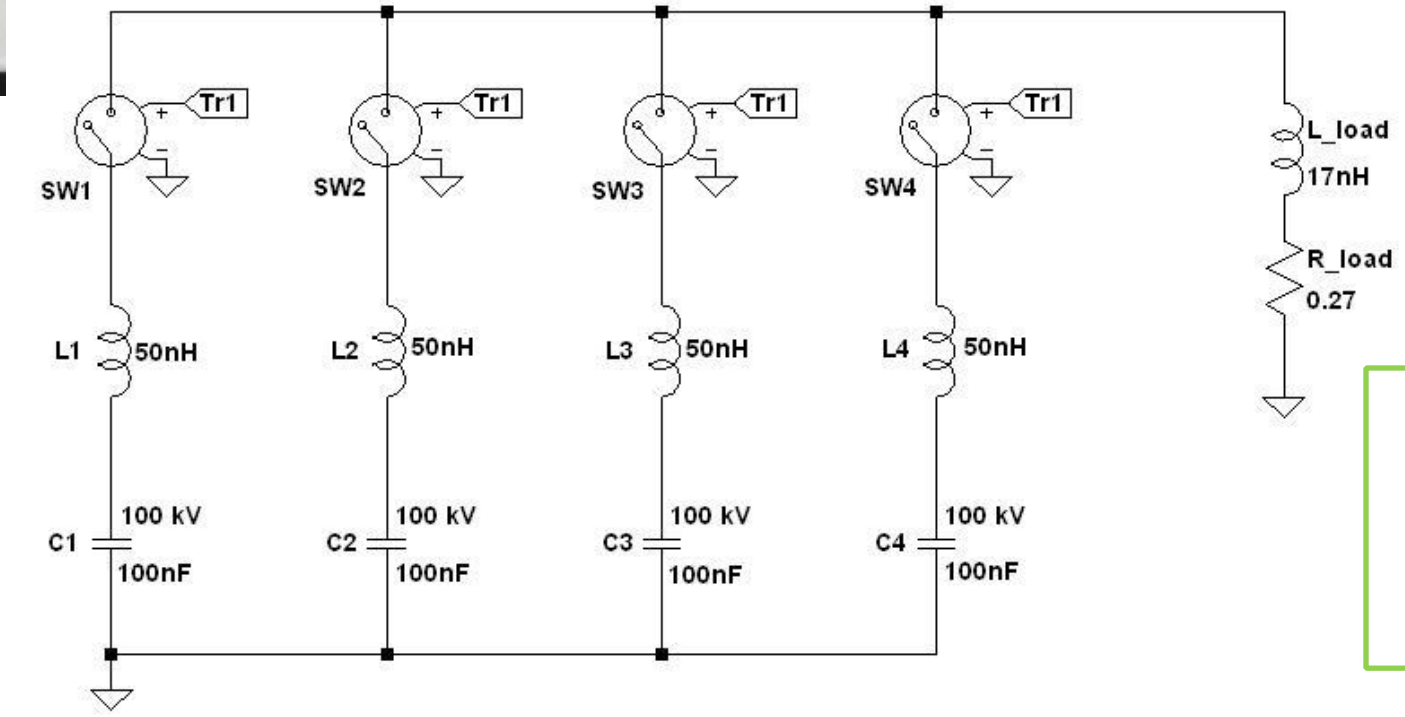
I_c=60 kA

V_c=100 kV

L_{sw}<40 nH

I_c=100 kA

V_c=25-100 kV



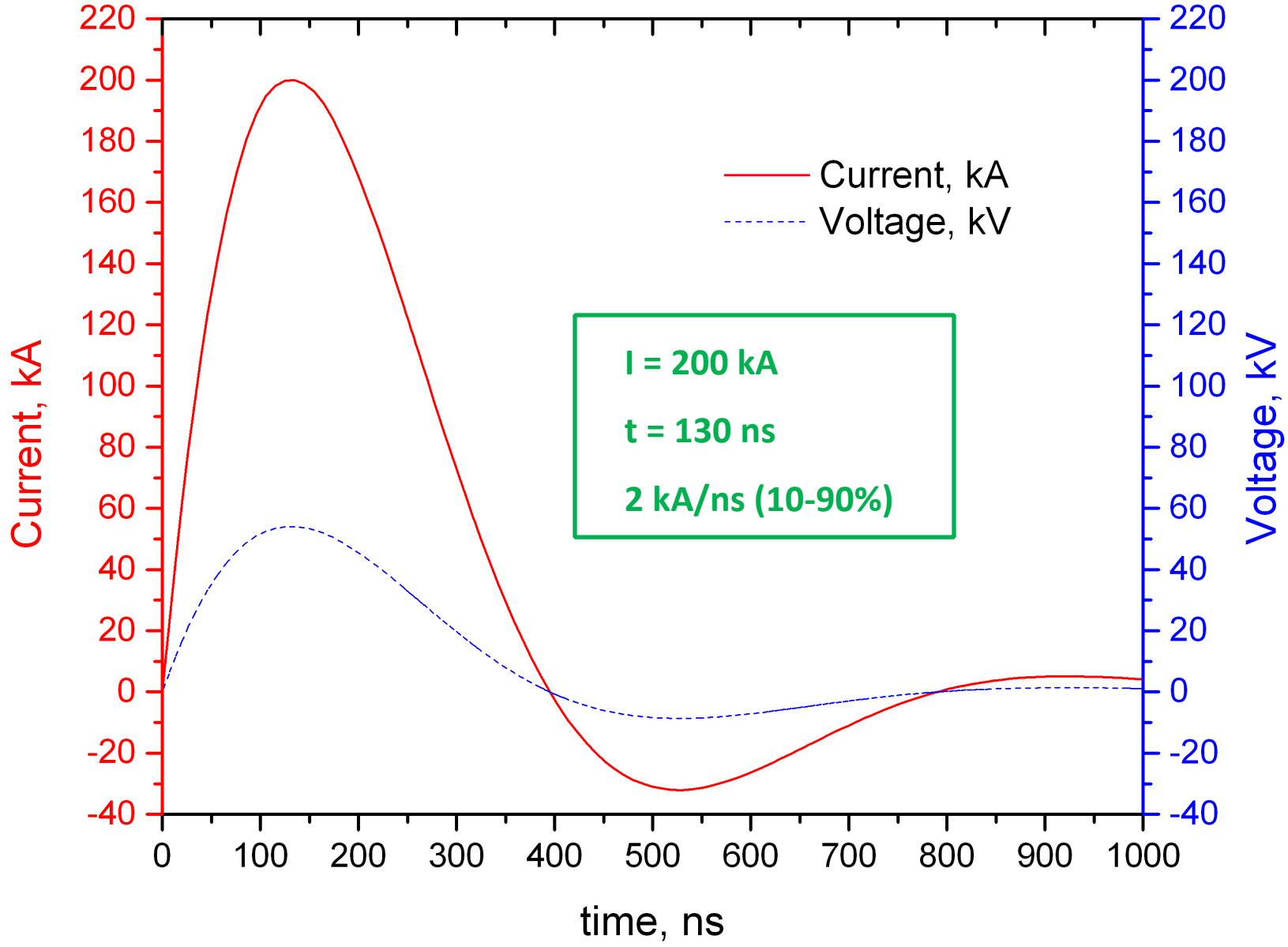
L = 29.5 nH

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, 4 switches, "matched" load



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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. Short (< 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...

More Possibilities:

1. Higher Current
2. Z-Pinch

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

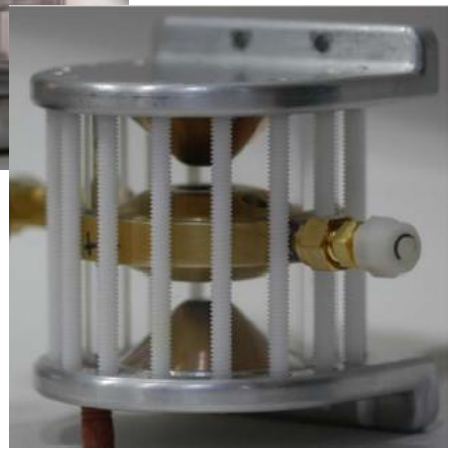
- TRINITI, Russia: ANGARA-5-1, 4 MA, 100 ns [12]
- Institute of High Current Electronics, Russia: Compact Pulse Generator, 300 kA, 200 ns, 70 kg
- Institute of High Current Electronics, Russia: Compact submicrosecond, high current generator, 650 kA, 390 ns

no Marx generator

no

Pulse Forming Lines

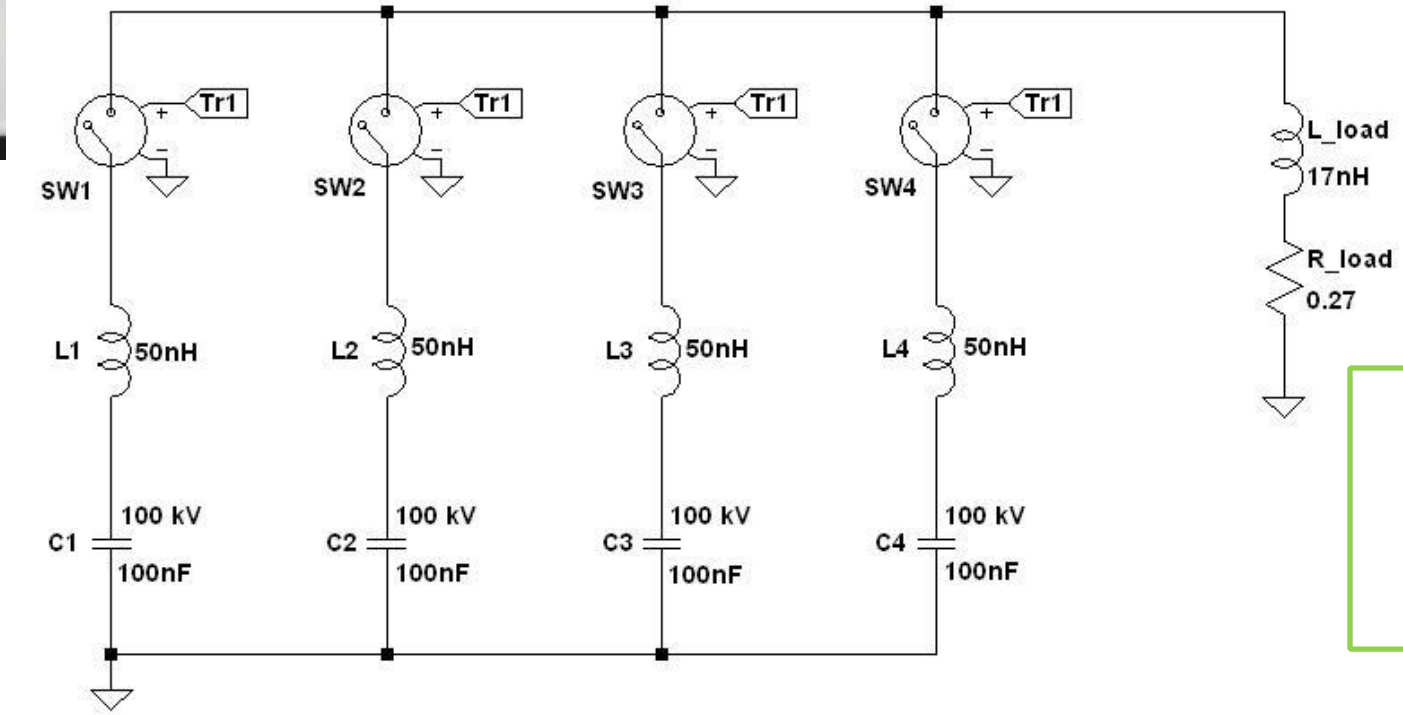
instead utilize advantages of high current low inductance capacitors and switches



With four high current low inductance capacitors and switches we can built 200 kA, 80 ns (10%-90%) compact and portable x-ray 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



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