

ISIS Transformation to High Current X-Pinch Radiation Source

Overview: PPG-1 Tsinghua University, Beijing *

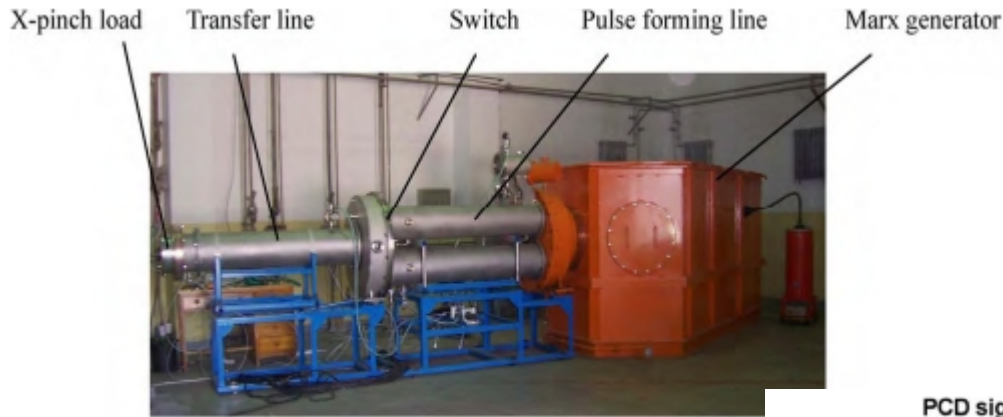


Fig. 1. View of the PPG-I.

Pulsed Power Generator PPG-1

max output current: 400 kA
pulse width: 100 ns

X-Pinch Performance:

output current: ~200 kA
X-pinch: two 25 μm (or 13 μm) Mo wires
distance between anode and cathode: 10 mm

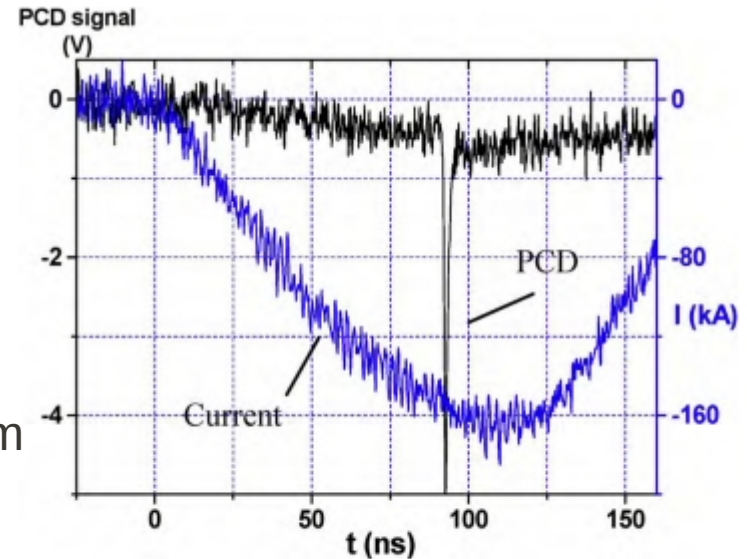


Fig.2. Typical X-ray burst measured with a PCD detector and the load current measured with a Rogowski coil.

* Ran Zhang, Tong Zhao, Xiaobing Zou, Xinlei Zhu, Xinxin Wang "X-pinch applications in X-ray radiography and design of compact table-top X-pinch device" 2010 IEEE

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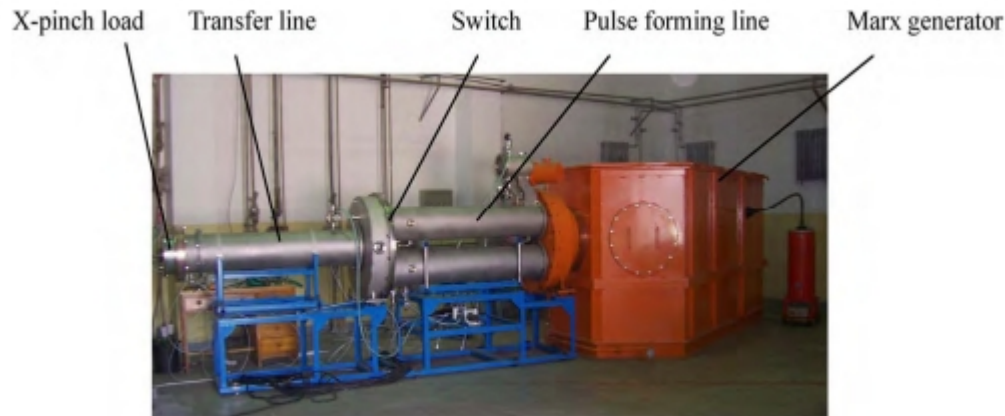


Fig. 1. View of the PPG-I.

Pulsed Power Generator PPG-1

max output current: 400 kA
pulse width: 100 ns

Backlighting Experiment for two-wire Z-Pinch Plasma:

X-pinch current: ~100 kA
X-pinch: two 13 μm Mo wires
Z-pinch: two 50 μm Mo wires
distance between anode
and cathode: 10 mm

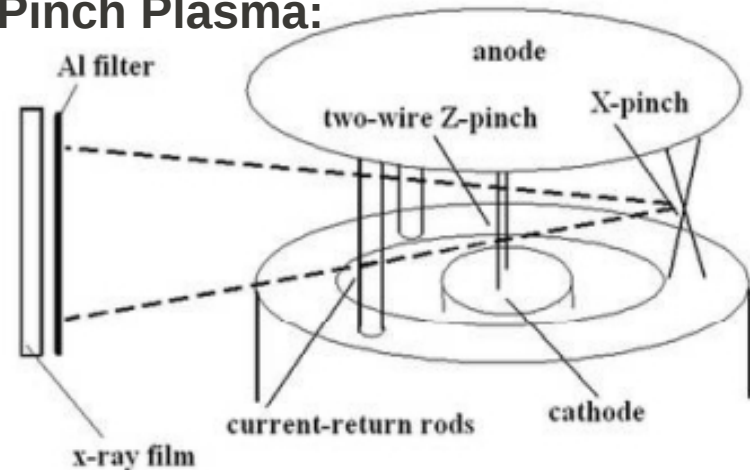


Fig. 3. Experimental arrangements for backlighting of Z-pinch using X-pinch as x-ray source.

* Ran Zhang, Tong Zhao, Xiaobing Zou, Xinlei Zhu, Xinxin Wang "X-pinch applications in X-ray radiography and design of compact table-top X-pinch device" 2010 IEEE

Overview: PPG-1 Tsinghua University, Beijing *

Compact Table-Top X-Pinch Device

output current: 100 kA
pulse width: 60 ns
Load: X-pinch with a few μm

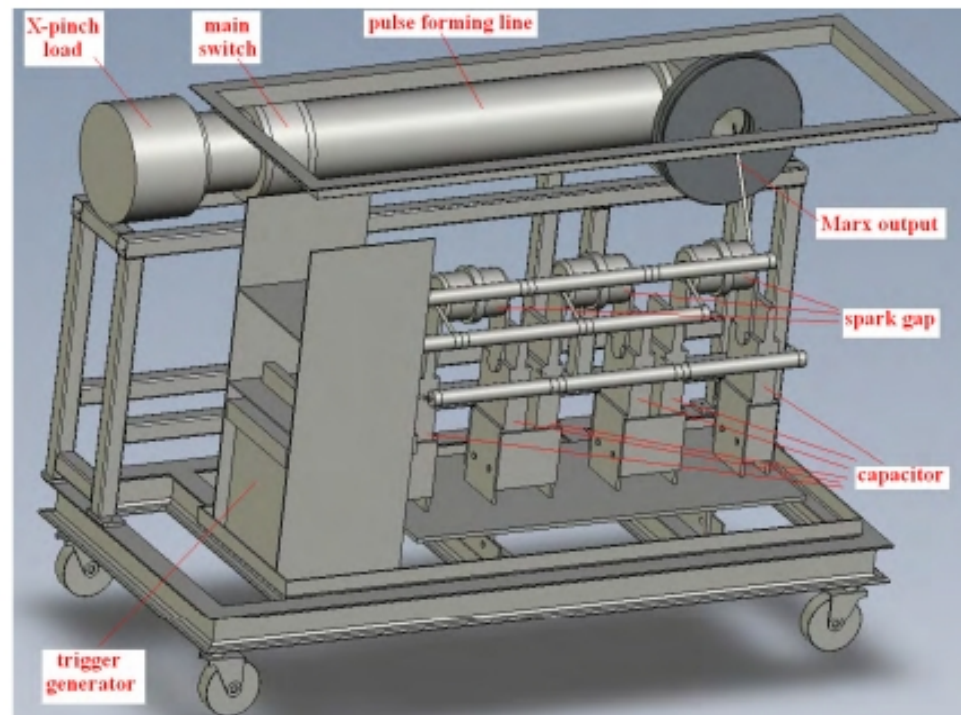


Fig.8. Design drawing of the compact table-top X-pinch device.

* *Ran Zhang, Tong Zhao, Xiaobing Zou, Xinlei Zhu, Xinxin Wang* "X-pinch applications in X-ray radiography and design of compact table-top X-pinch device" 2010 IEEE

Overview: Laboratory of Plasma Studies, Cornell University *

XP facility

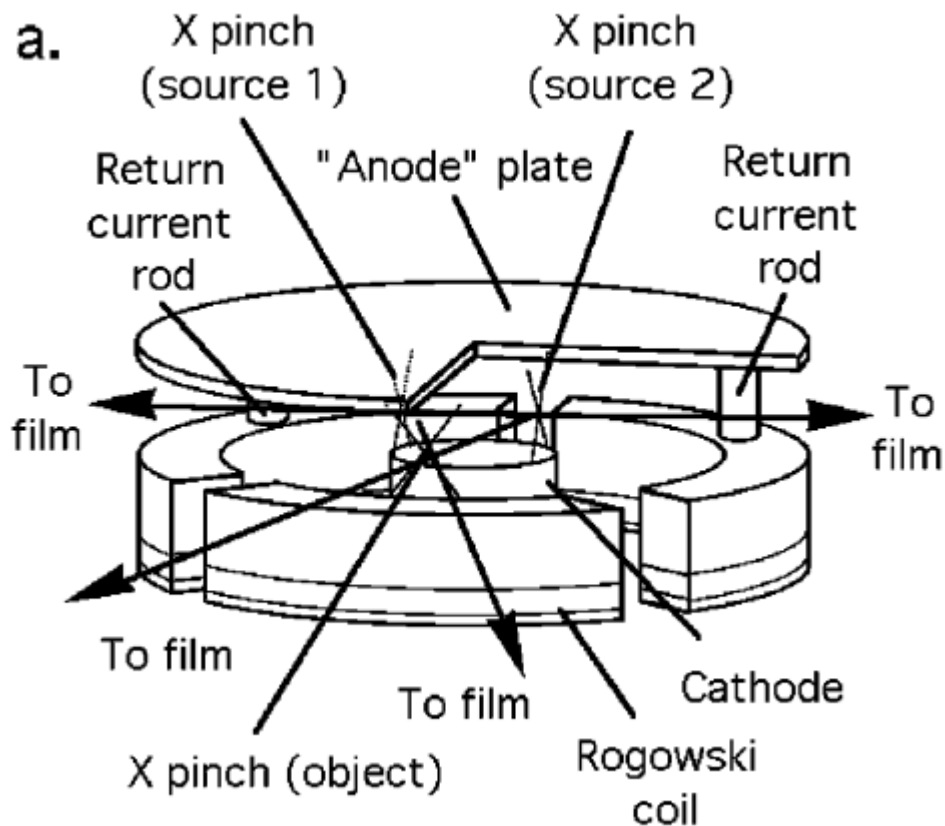
- * 470 kA peak current
- * 100 ns pulse duration

X-Pinch 1 and 2 (backlighter)

- * 235 kA peak current
- * Two 17-30 μm Mo wires
- * 1.5 cm long

Object X-Pinch

- * 90-120 kA peak current
- * W, Mo, Au, or Al wires
- * 1.5 cm long

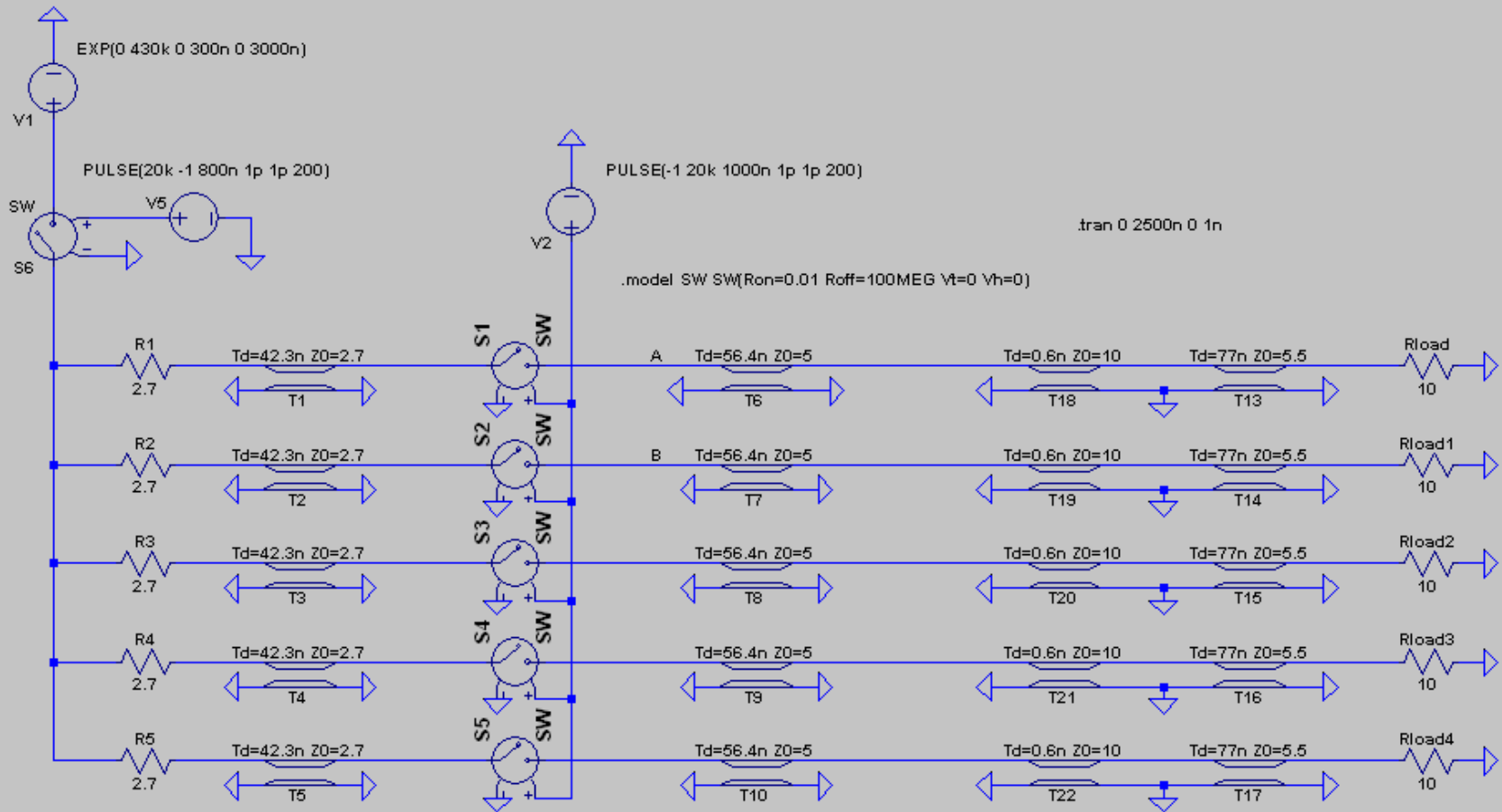


* T. A. Shelkovenko, D. B. Sinars, S. A. Pikuz, and D. A. Hammer "Radiographic and spectroscopic studies of X-pinch plasma implosion dynamics and x-ray burst emission characteristics" 2001 AIP

wire resistance and inductance

material	ρ , 10^{-8} $\Omega \cdot \text{m}$	L, mm	d, μm	R, Ω	L, <u>nH</u>
Aluminium	2.82	25.00	5	35.92	45.8
Gold	2.44	25.00	5	31.08	45.8
Molybdenum	5.20	25.00	5	66.24	45.8
Tungsten	5.60	25.00	5	71.34	45.8
Aluminium	2.82	25.00	10	8.98	42.3
Gold	2.44	25.00	10	7.77	42.3
Molybdenum	5.20	25.00	10	16.56	42.3
Tungsten	5.60	25.00	10	17.83	42.3
Aluminium	2.82	25.00	30	1.00	36.8
Gold	2.44	25.00	30	0.86	36.8
Molybdenum	5.20	25.00	30	1.84	36.8
Tungsten	5.60	25.00	30	1.98	36.8
Aluminium	2.82	25.00	50	0.36	34.3
Gold	2.44	25.00	50	0.31	34.3
Molybdenum	5.20	25.00	50	0.66	34.3
Tungsten	5.60	25.00	50	0.71	34.3

ISIS: original (current) hook up

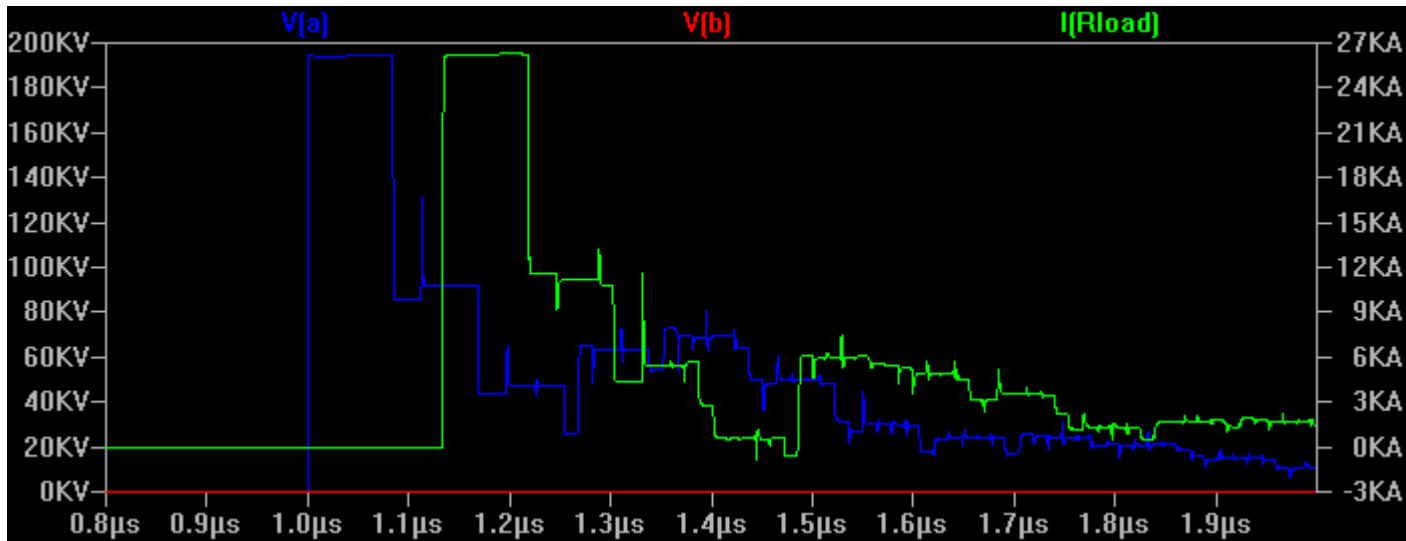
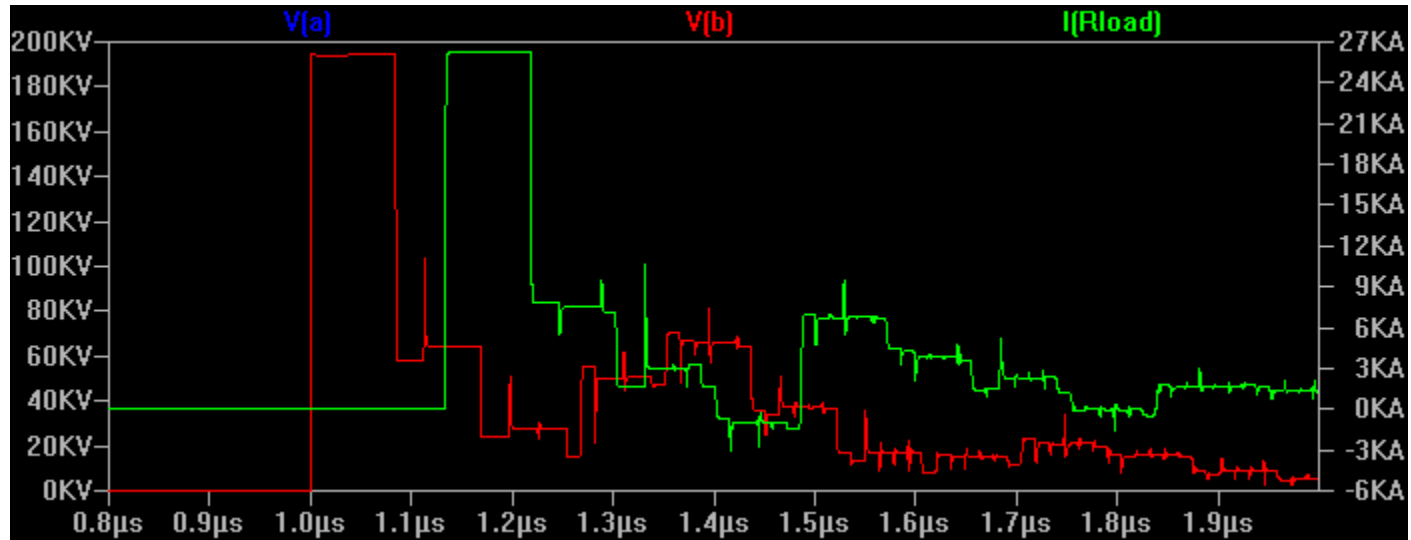


ISIS: original (current) hook up

Normal operation:
All switched
are fired



Misfire:
One switch is
Not fired

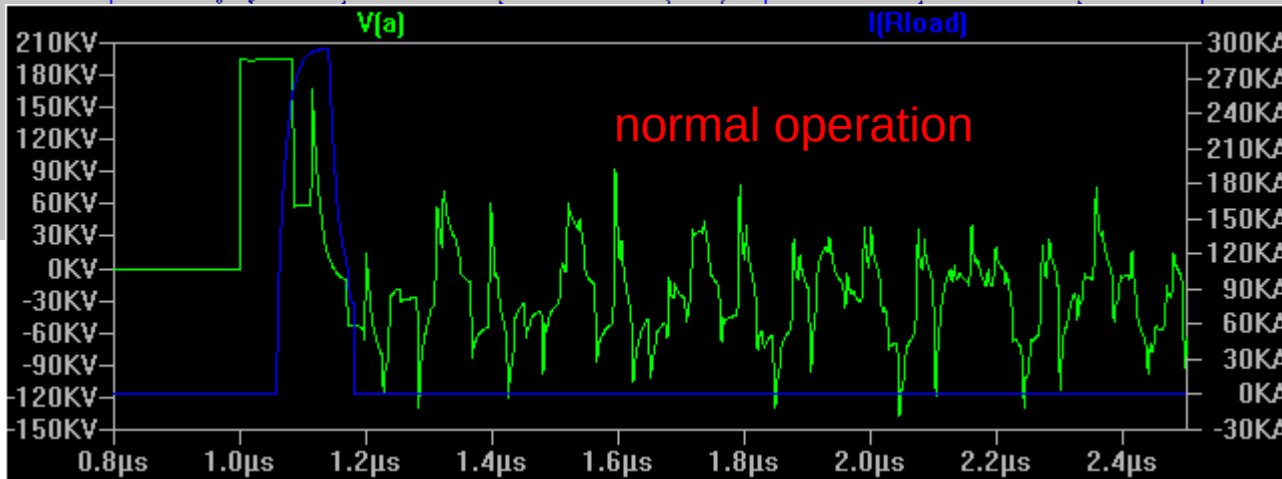
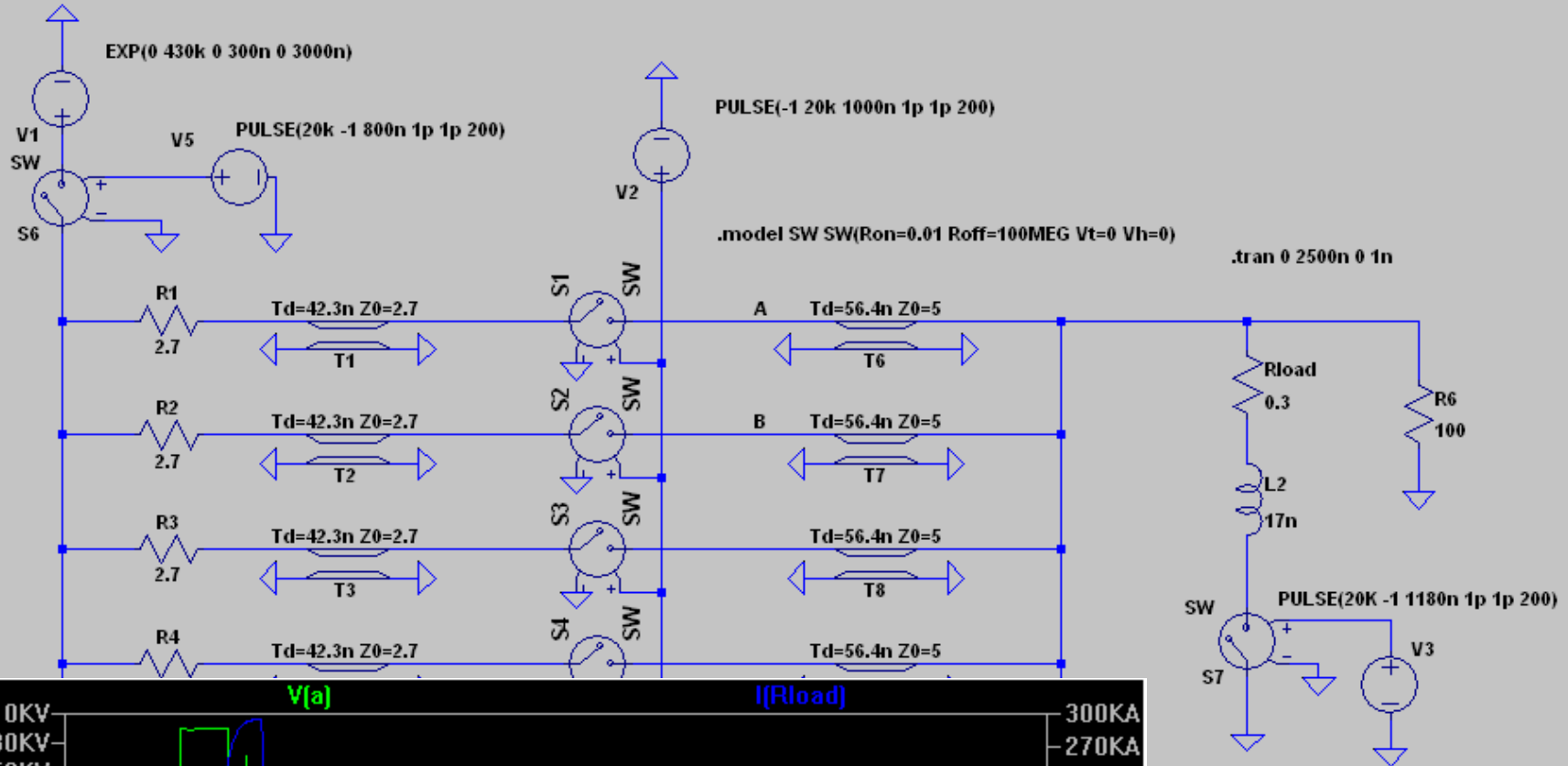


All is good

We never have any
negative voltage at
switch at any time

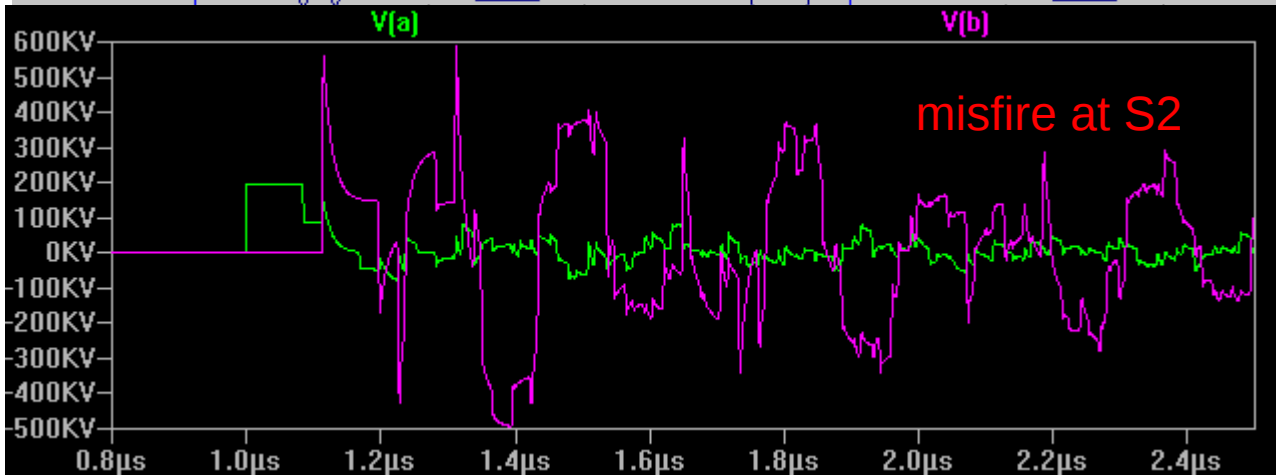
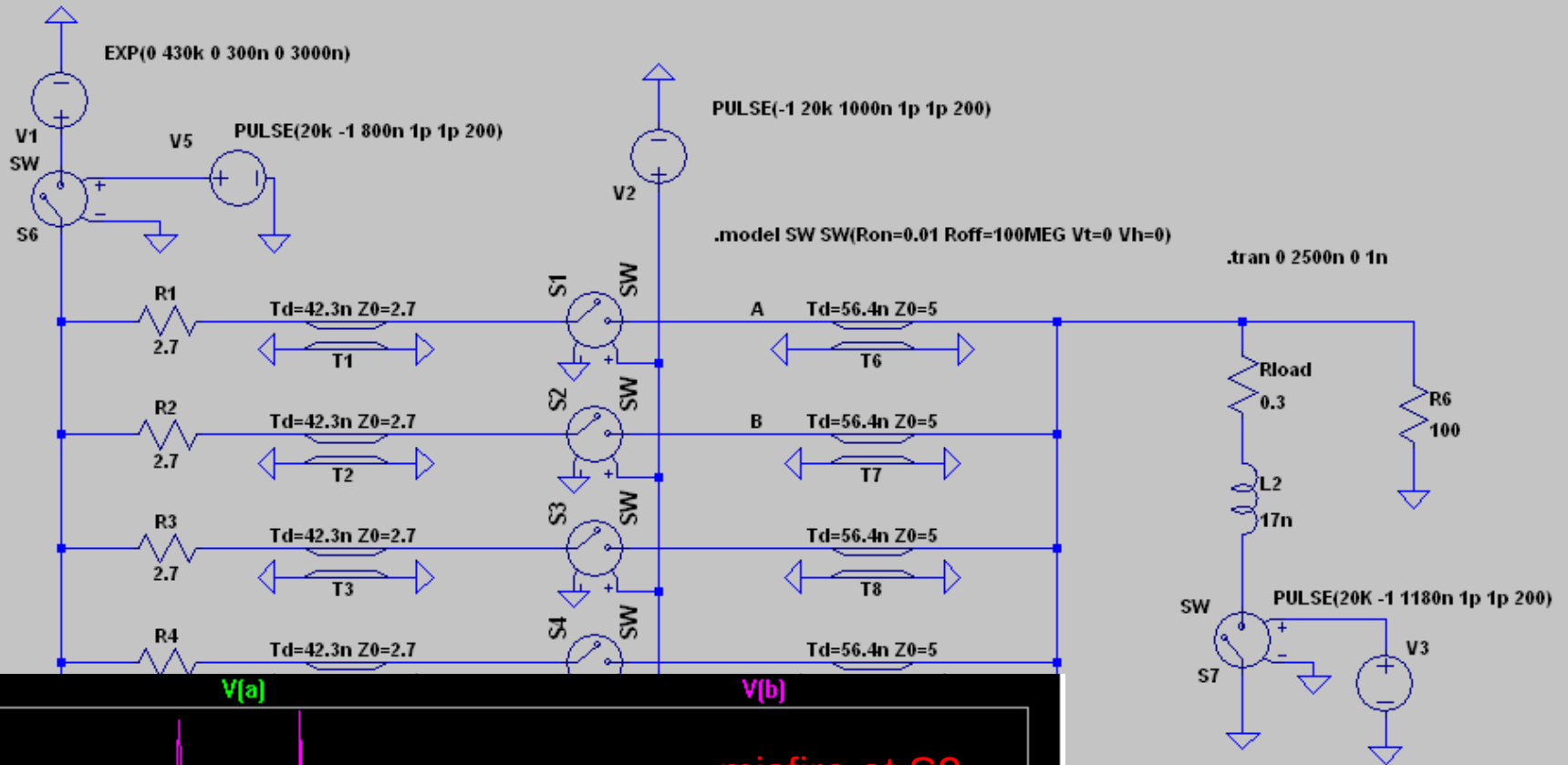
But current is low

ISIS: no serious modification: just combine all 5 PFL together and add 0.3 Ω load



Normal fire:
 300 kA current
 -120 kV at S1-S6

ISIS: no serious modification: just combine all 5 PFL together and add 0.3 Ω load



Misfire: -400 kV at S2
 modifications
 are needed!

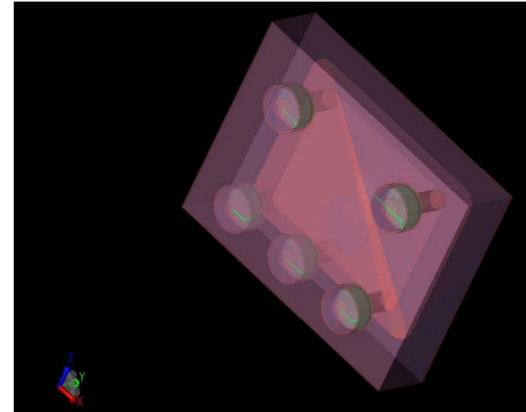
ISIS Modification to High Current X-pinch Radiation Source

1. Add 5 resistors: 3.7Ω each

2. Add water filled transformer:

$T=6$ ns (about 20 cm long)

$Z_0=0.1 \Omega$ (need to be designed using XFDTD)



3. Add X-Pinch vacuum camera:

$T=1$ ns (about 30 cm long)

$Z_0=3 \Omega$ (easy to design using XFDTD)

4. Add load:

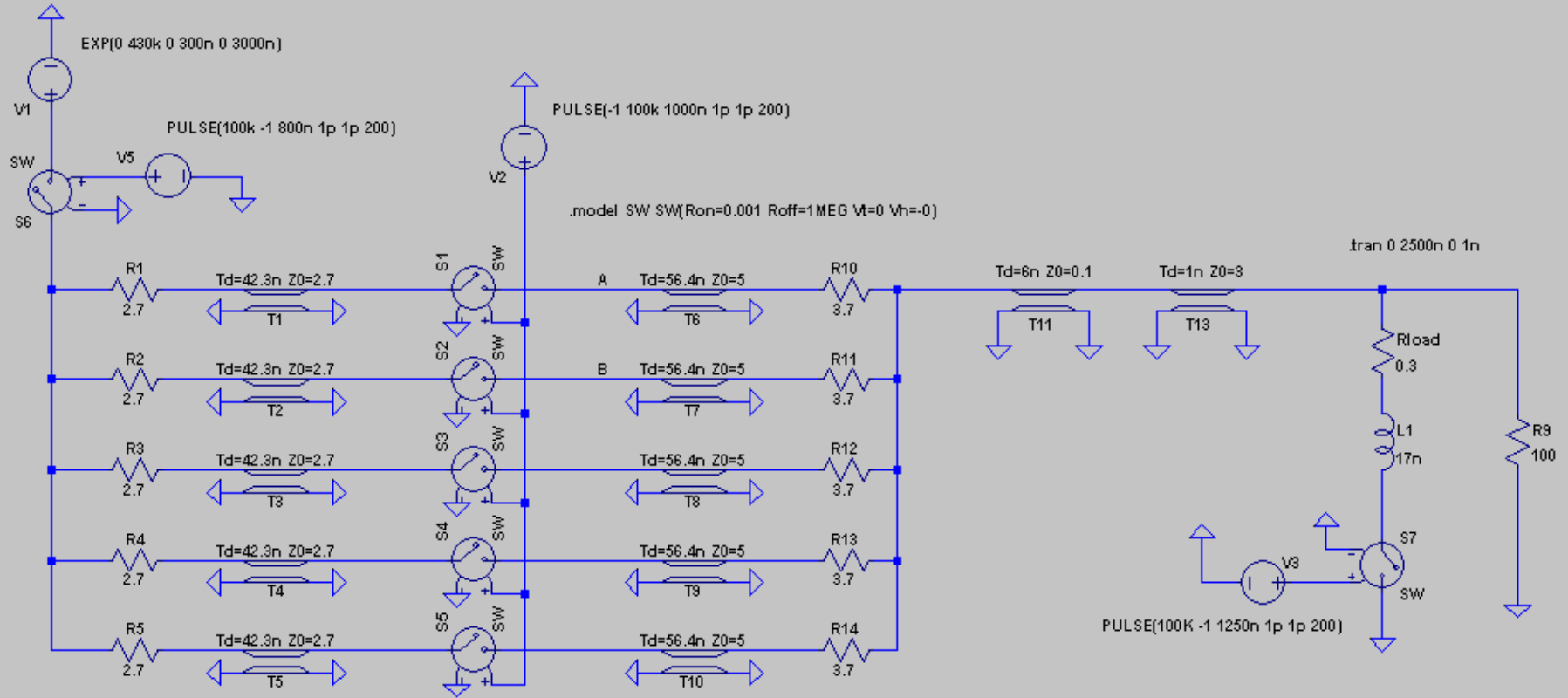
$R = 0.3 \Omega$ and more

$L = 17$ nH and more

$l = 25$ mm long



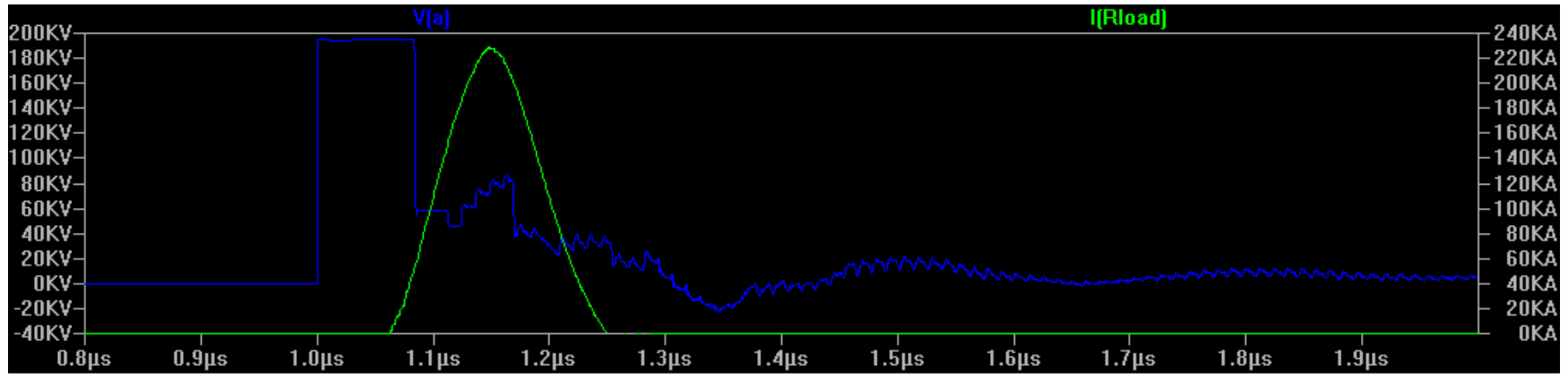
ISIS Modification: 0.3 Ω Load



ISIS Modification: 0.3 Ω Load

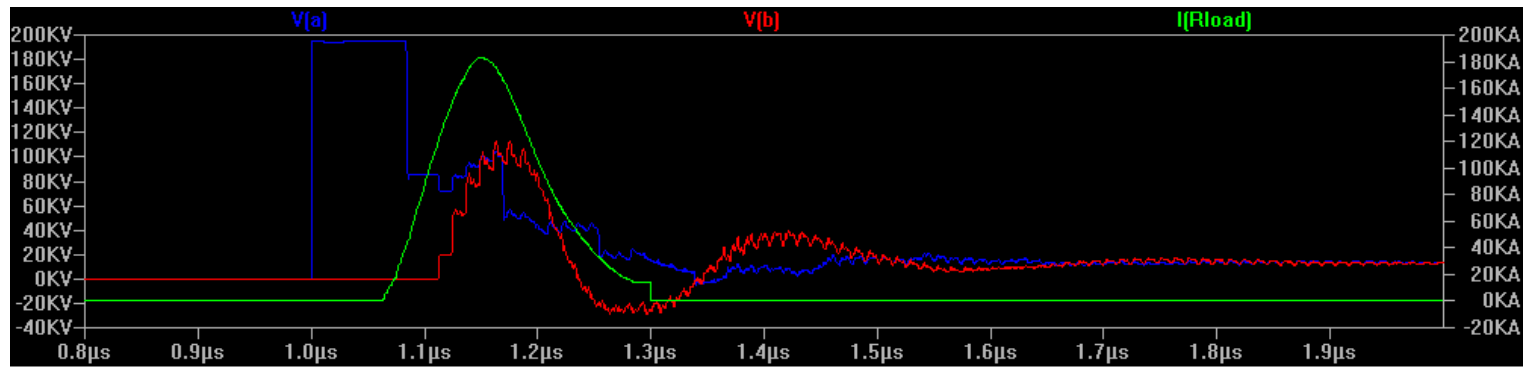
Normal operation:

load 0.3 Ω
peak current ~ 230 kA
pulse width ~ 100 ns



Misfire at SW2:

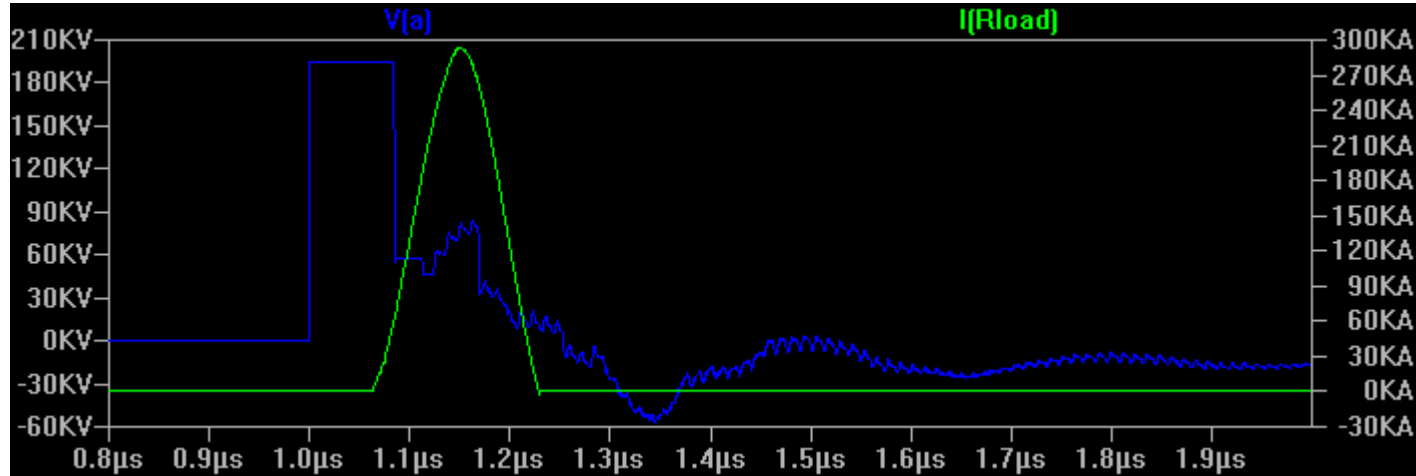
peak current ~ 180 kA
backward negative wave ~ -20 kV



ISIS Modification: 0.1 Ω load (otherwise hook up the same)

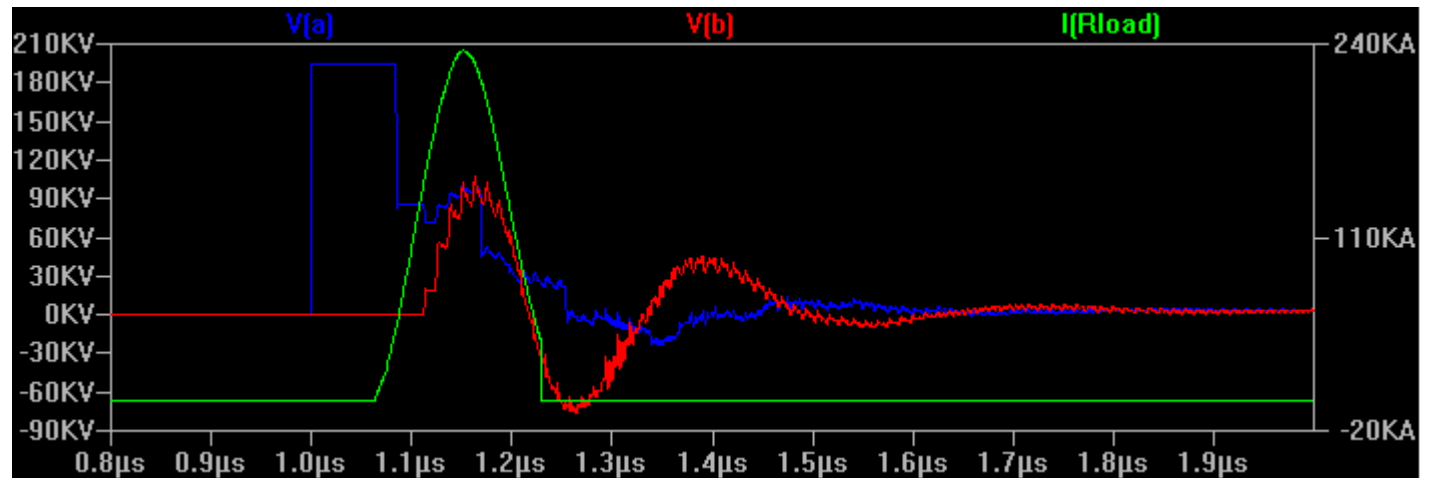
Normal operation:

peak current ~ 300 kA
backward negative wave ~ -60 kV

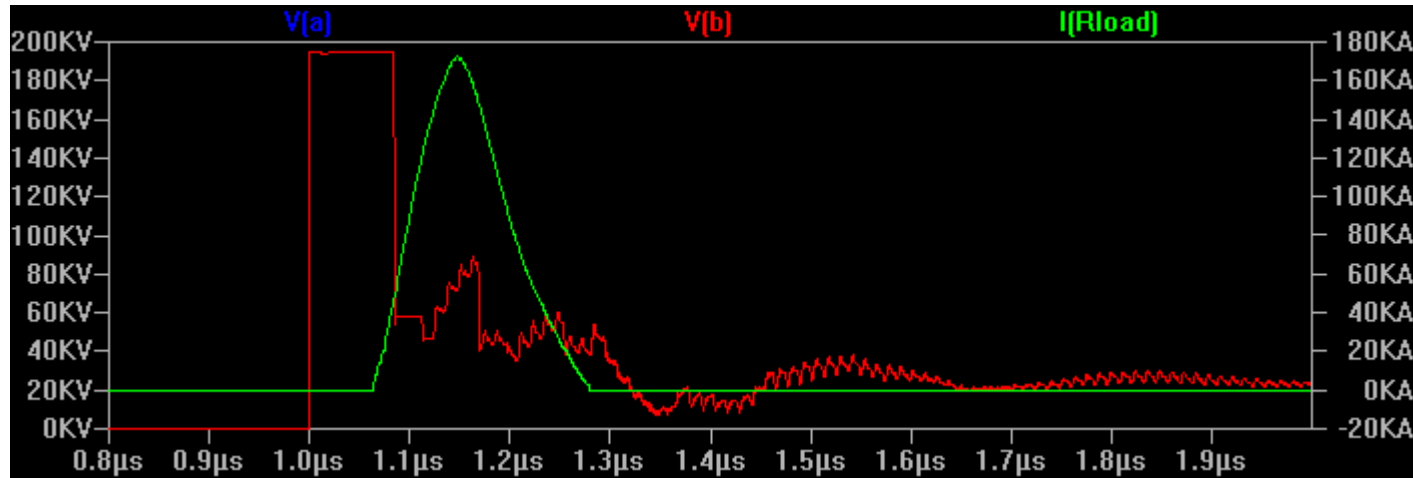


Misfire at SW2:

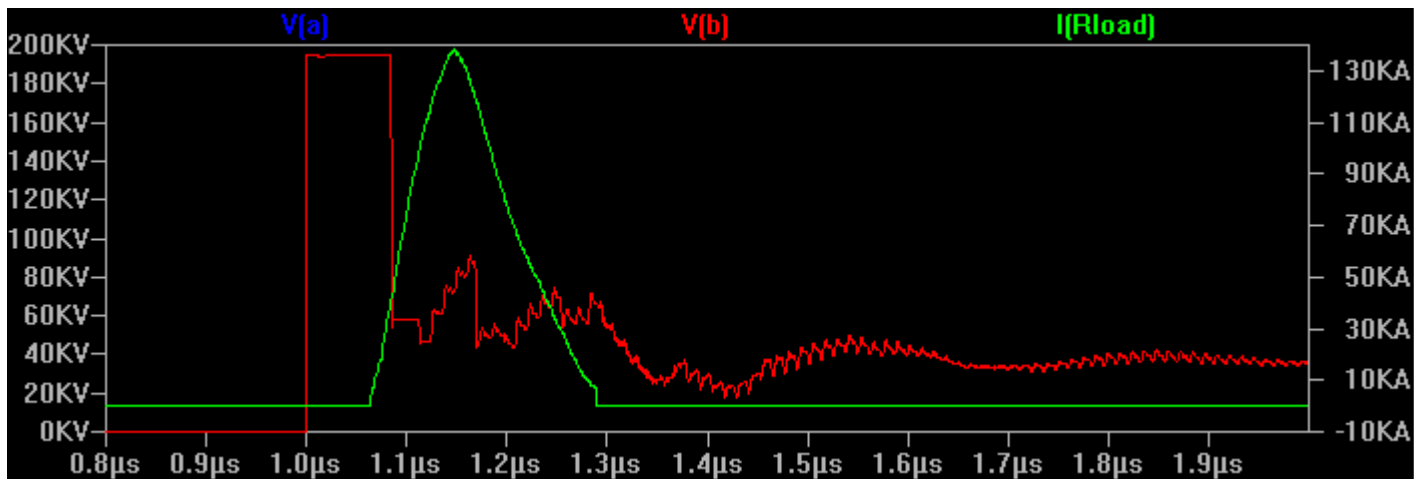
peak current ~ 240 kA
backward negative wave ~ -60 kV



ISIS Modification: 0.6, 0.9 Ω loads (otherwise hook up the same)

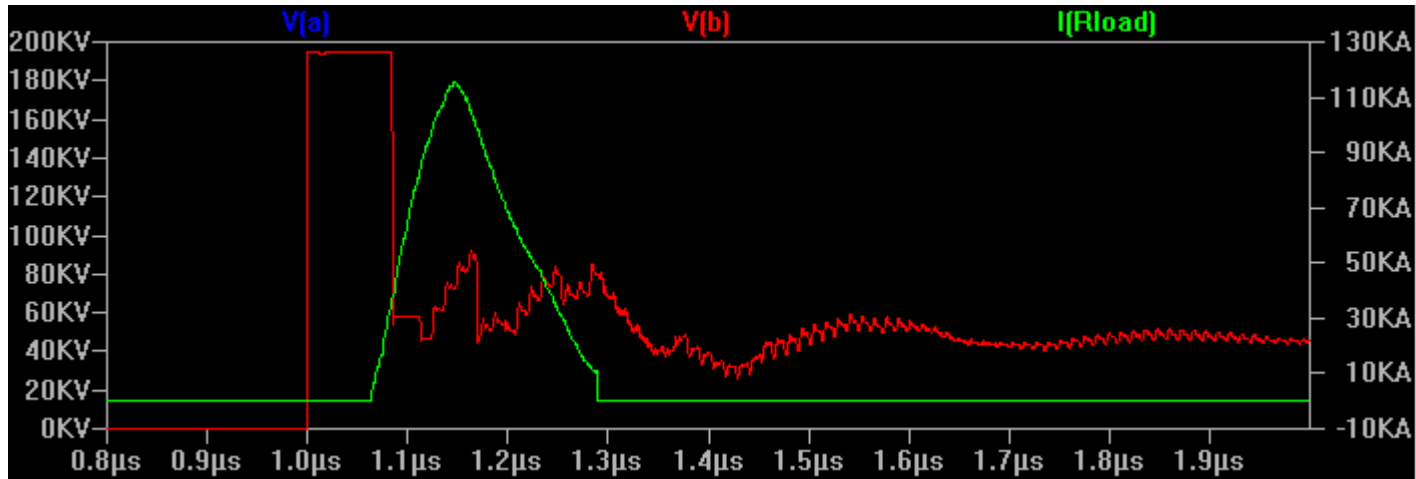


0.6 Ω load
170 kA current

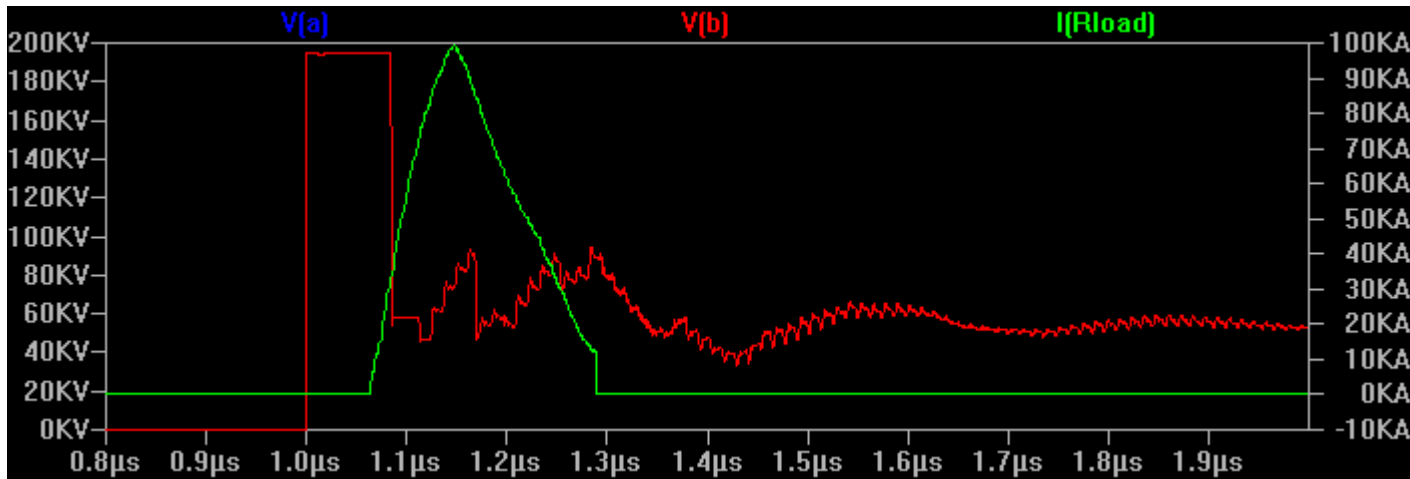


0.9 Ω load
140 kA current

ISIS Modification: 1.2, 1.5 Ω loads (otherwise hook up the same)



1.2 Ω load
110 kA current



1.5 Ω load
100 kA current