assessment of the wire lens scheme @ LHC from the current pulse power technology point of view - G3

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discussion participants:
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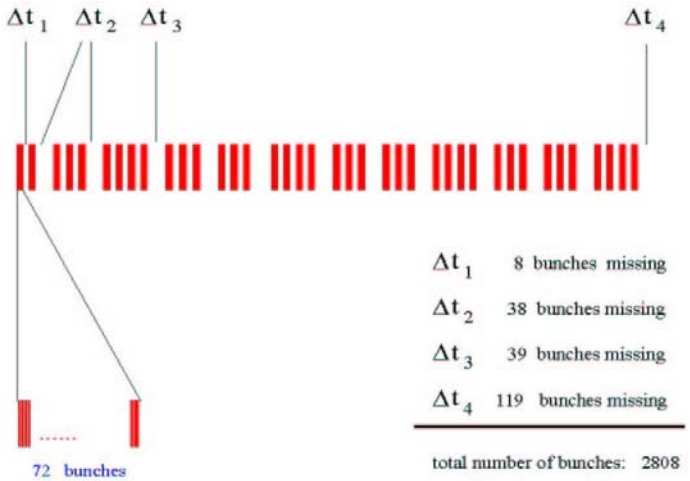
parameters of pulsed beam-beam compensator for LHC

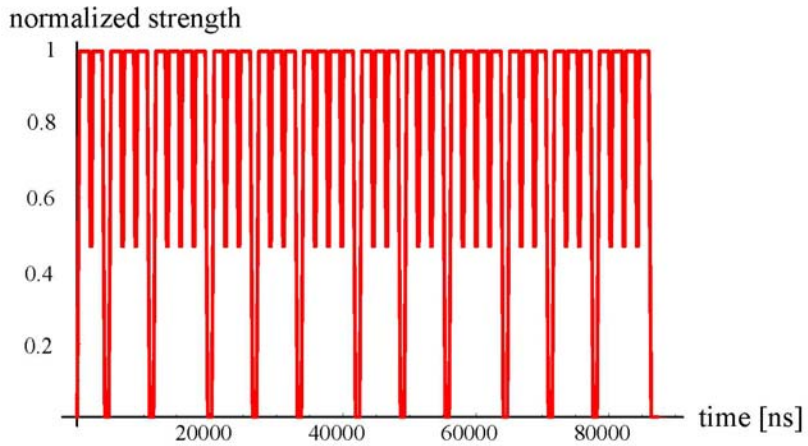
revolution period T_{rev} (pattern repetition frequency)	88.9 μs +/- 0.0002 μs (variation with beam energy)	
maximum strength	120 Am	
maximum current (smaller currents will also be needed)	120 A (1m)	60 A (2m)
0→max ramp up/down time	374.25 ns	
length of max. excitation	1422.15 ns	
lengths of min. excitation (larger min. times may be needed too)	573.85 ns & 598.8 ns	
length of abort gap (could vary)	2594.75 ns	
number of pulses per cycle	39	
average pulse rate	**439 kHz**	
pulse accuracy with respect to ideal	5%	
turn-to-turn amplitude stability (relative to peak)	**10^{-4}**	
turn-to-turn timing stability	**0.04 ns**	

issues: high repetition rate, jitter & turn-to-turn stability tolerance

pulse pattern should ‘mimic’ bunch train pattern

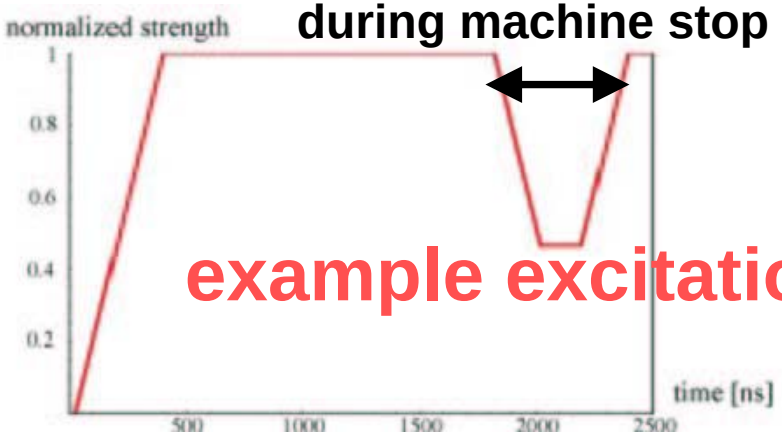


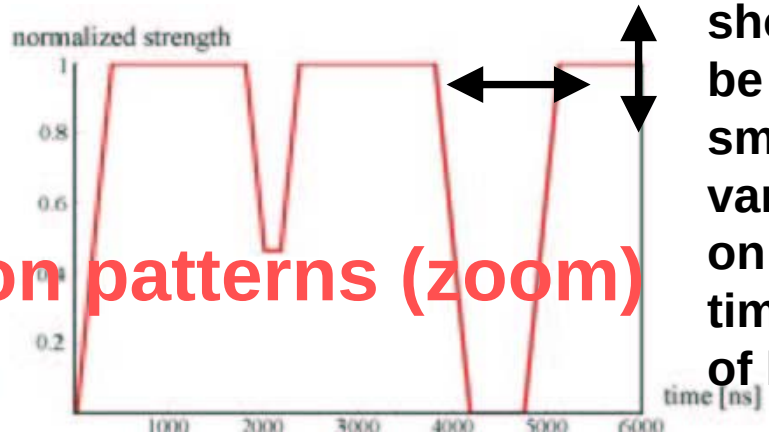
LHC bunch filling pattern



LHC wire excitation pattern

distance between trains should be adjustable during machine stop





amplitude should be smoothly variable on the time scale of hours

example excitation patterns (zoom)

questions

- is such pulser feasible? (we hope yes)
- which technology?
- commercially available?
- distance pulser-wire (50 m / 200 m possible?)?
- radiation hardness?
- electromagnetic compatibility – EMC?
- termination; resistance (50Ω, few Ω, mΩ)?
- rough cost estimate (some M$, 100k$??)
- circuit architecture? prototype?
- lab tests? RHIC machine studies in 2007/08?
- only B field or E+B (like stripline kicker)?

discussion session G3

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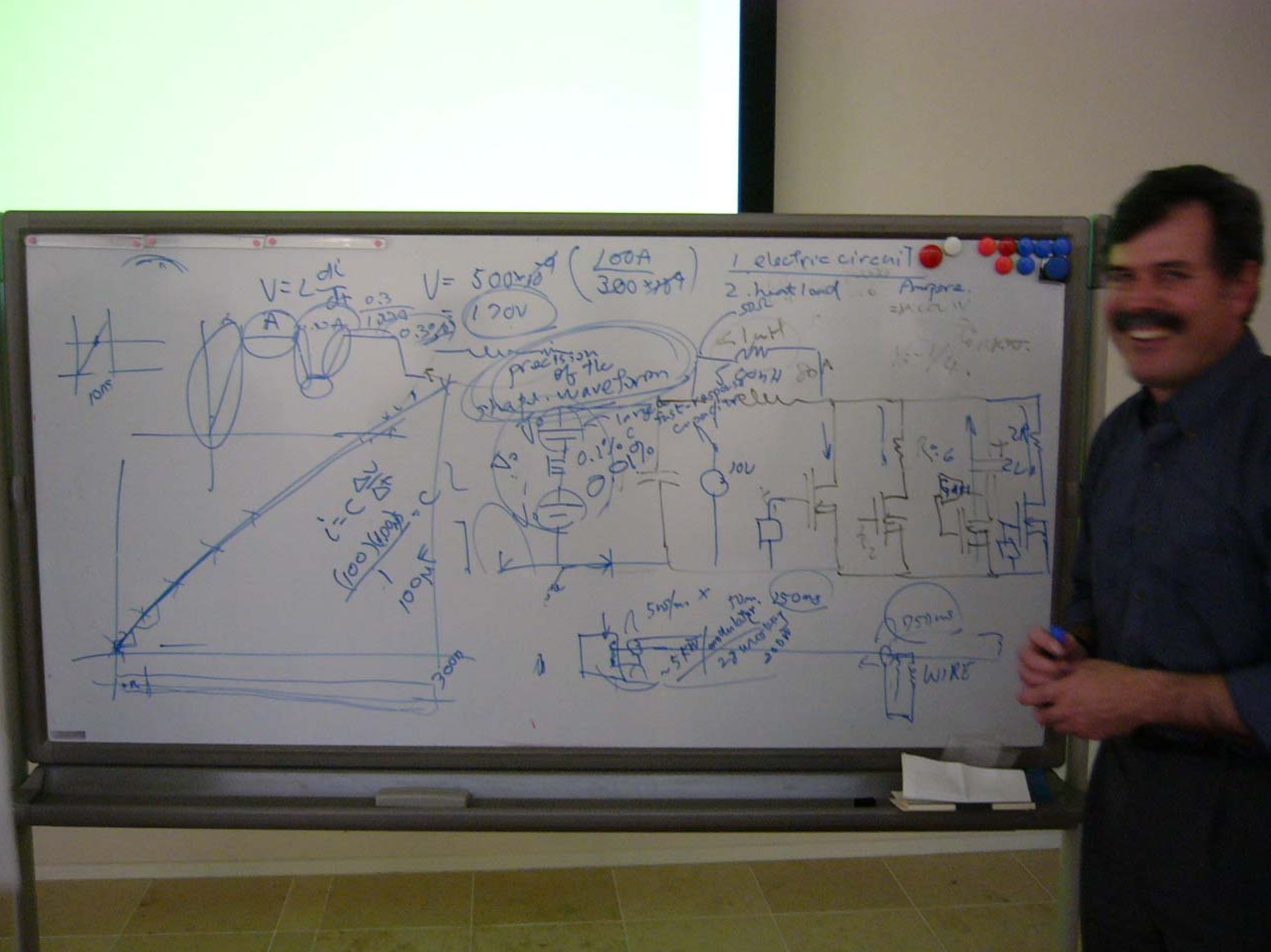
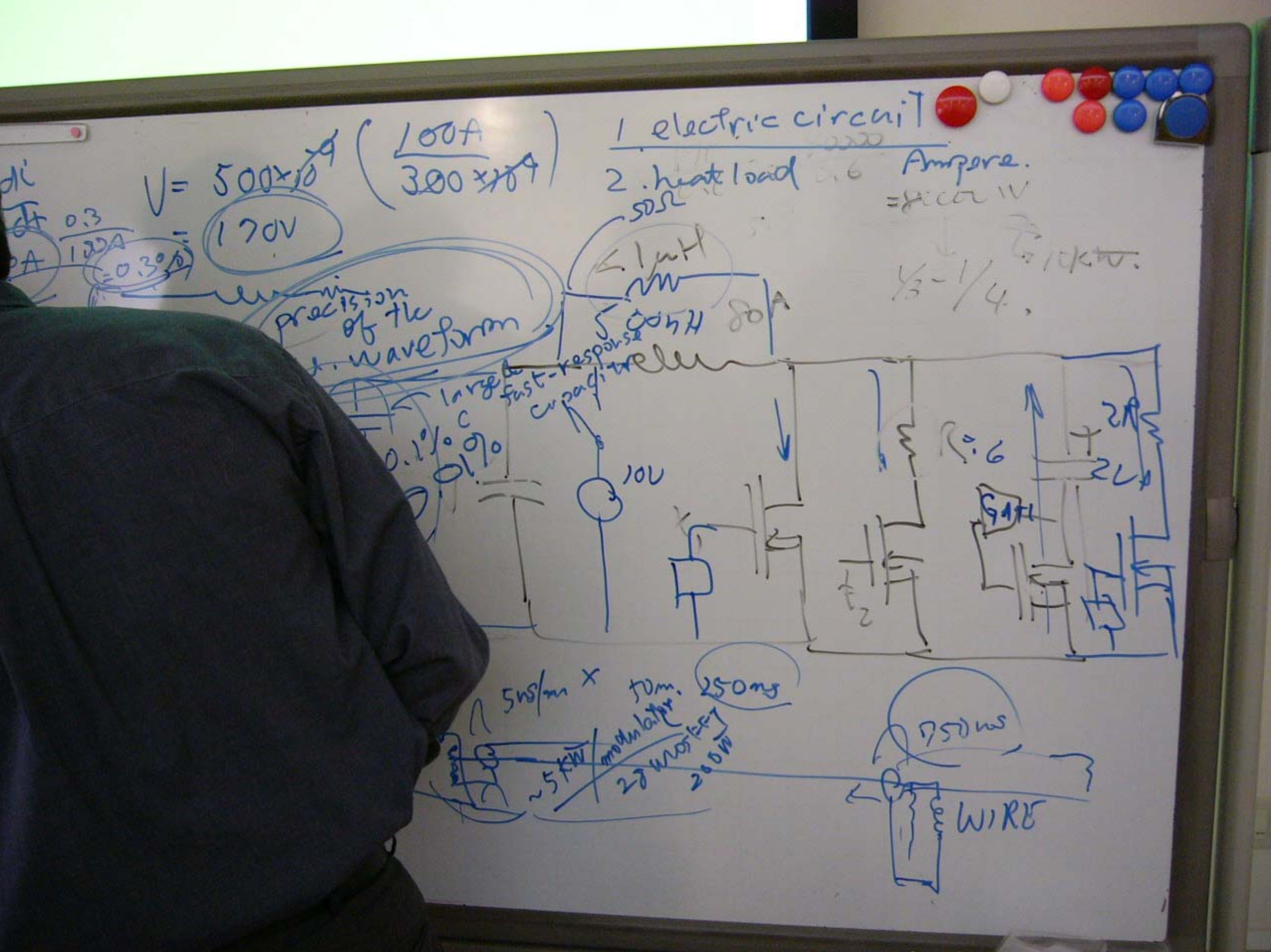
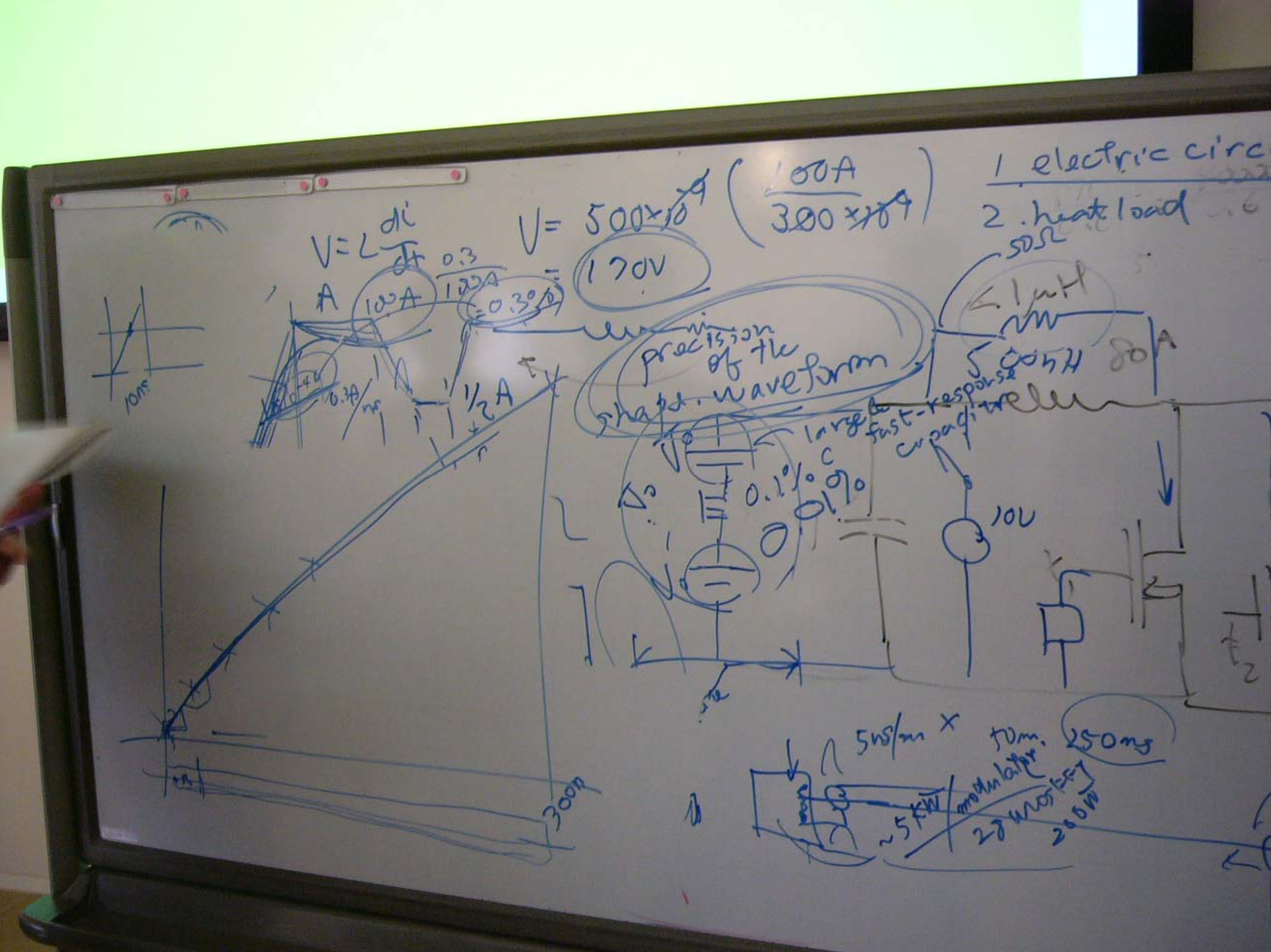
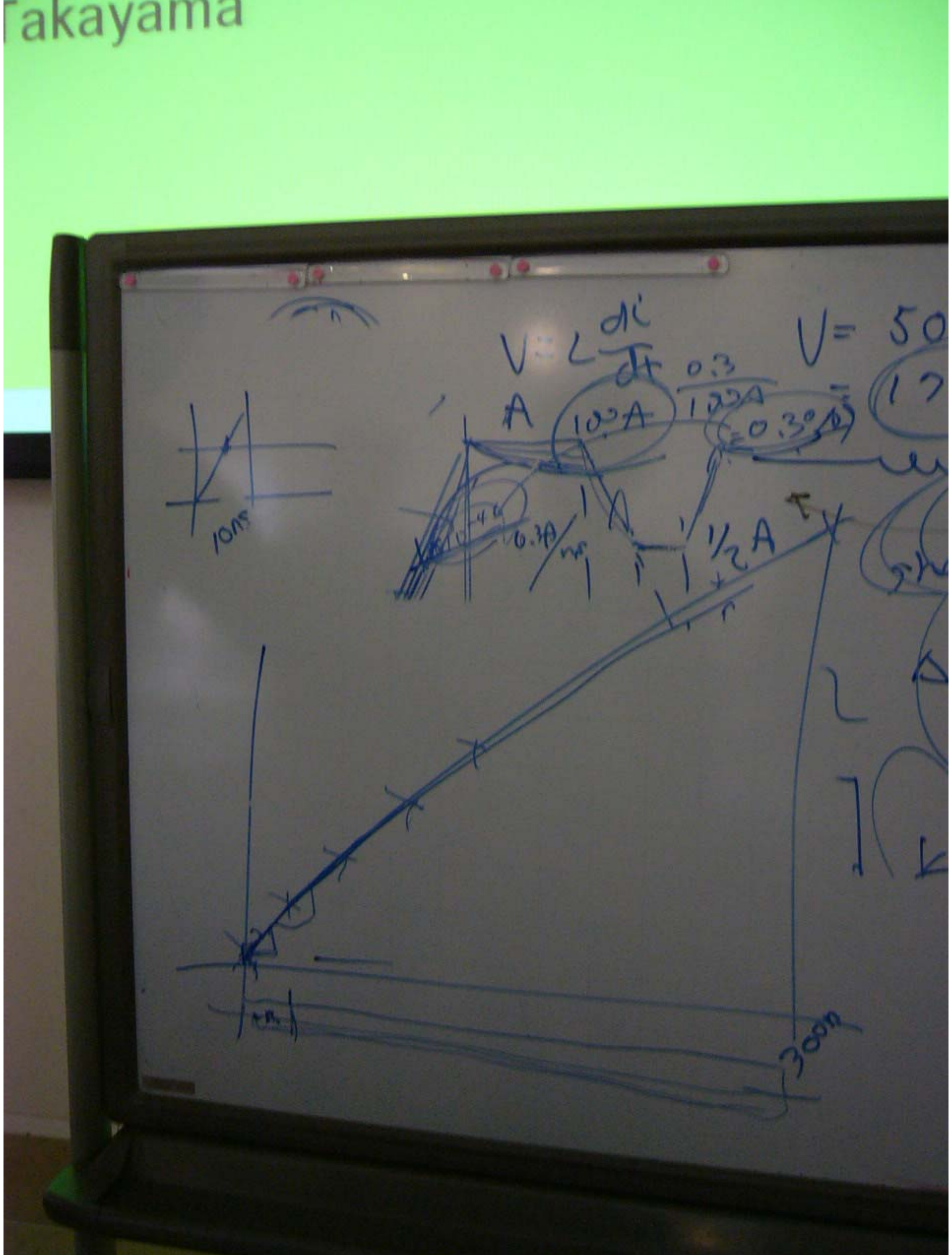


1 electric circuit
2. heat load
Ampere
170V
precision of the shape. waveform
fast-response capacitor
10V
250ns
750ns
modulator
WIRE

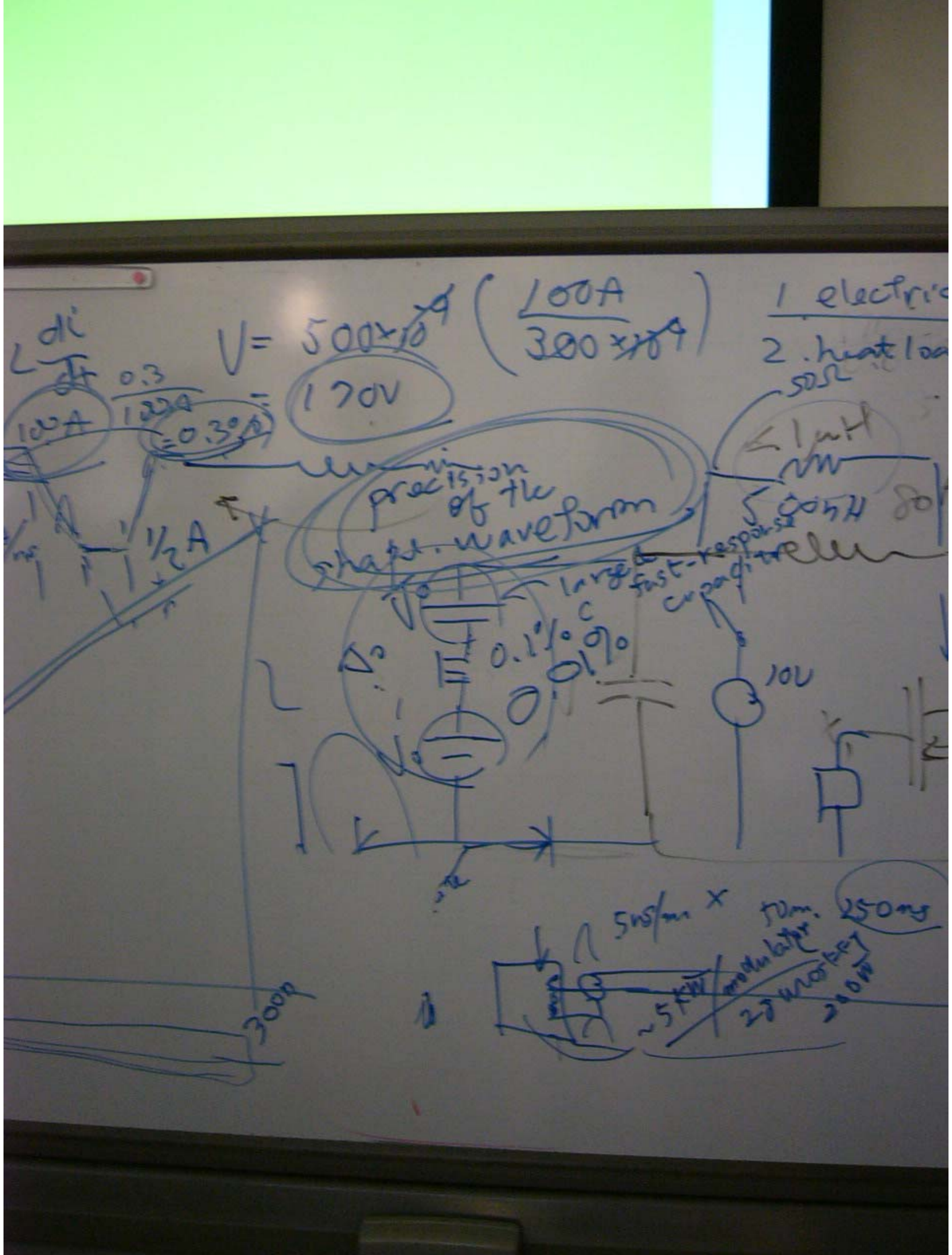

1 electric circuit
2. heat load
Ampere.
V= 500×10
100A
300×10
170V
1/3 - 1/4.
50Ω
500nH
80A
precision of the waveform
large C
fast-response capacitor
10V
R:6
0.1%
0.01%
5ns/m × 10m. 250ns
~5kW
modulator
28 mosfet
200W
750ns
WIRE



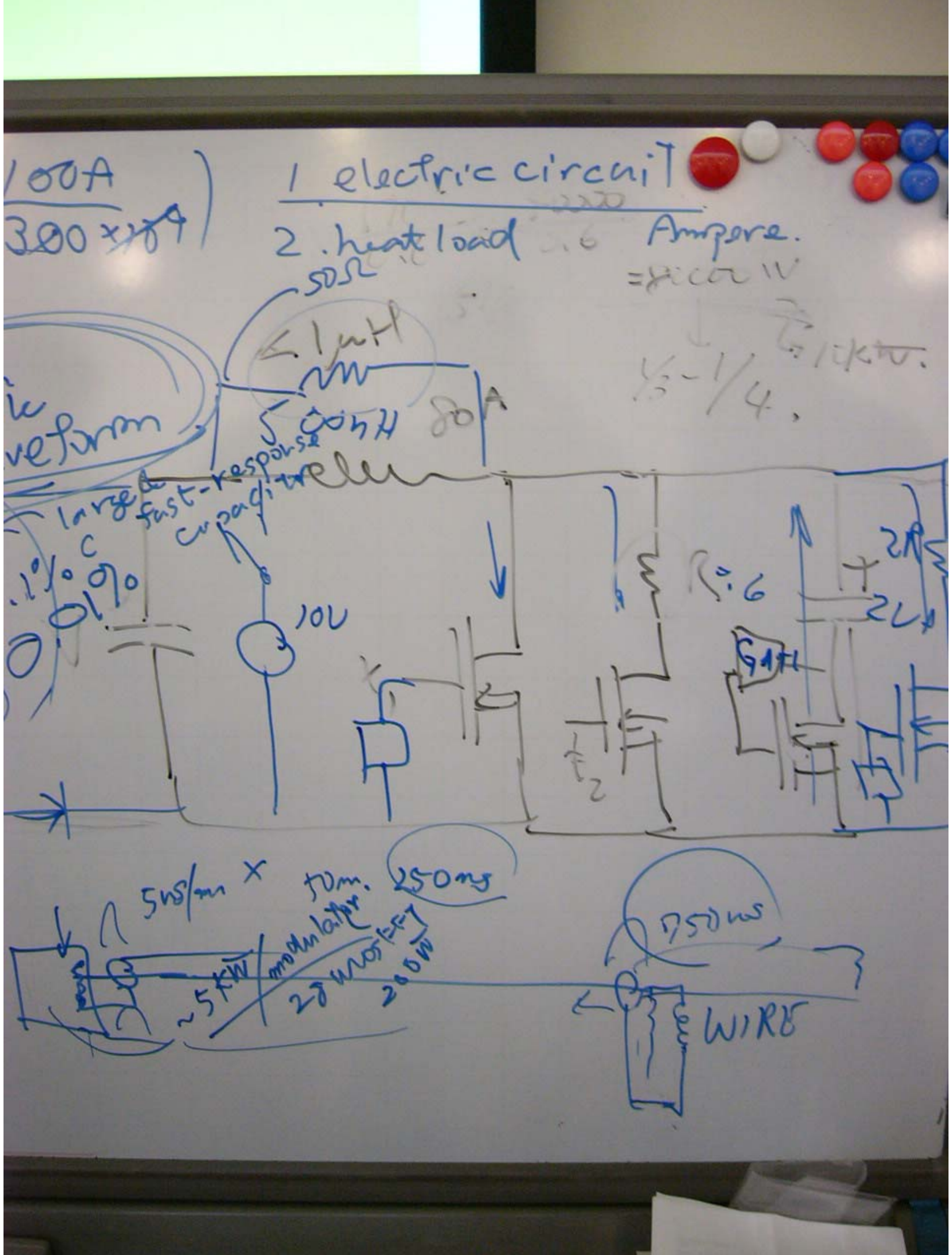
1 electric circ
2. heat load
V=L di/dt
V= 500×10^-9 (100A / 300×10^-9)
=170V
100A
0.3
100A
=0.3%
precision of the shape. waveform
50Ω
<1μH
500nH
80A
fast-response capacitor
0.1%
0.01%
10V
10ns
1/2 A
300n
5ns/m × 50m. 250ns
modulator
~5kW
200W



Takayama
V = L di/dt
100A
0.3A/ns
1/2 A
10ns
300n



V = 500 (100A / 300)
170V
1. electric
2. heat loa
100A
= 0.3%
1/2 A
precision of the shape. waveform
50Ω
<1uH
500nH
larger C
fast-response capacitor
0.1%
0.01%
10V
5ns/m x 50m. 250ns
~5KW modulator
2 x 200W
300Ω


100A
1 electric circuit
2. heat load
Ampere.
50Ω
500nH
80A
1/3 - 1/4.
large C
fast-response capacitor
10V
R:6
5ns/m x
250ns
~5KW
modulator
750ns
WIRE

summary

- developed circuit diagram of switching device
- 4 MOSFET switches, 2 or 3 power supplies with 10^{-4} stability, 2 resistors, 1 or 2 capacitors, arbitrary waveform generator w multiple outputs
- rather low cost
- timing jitter may or may not be a problem
- radiation hardness
- transmission line effect (impedance, reflection, etc.) to be addressed
- plan to build prototype(s) at CERN; beam test at RHIC in 2008
- alternative wide-band rf approach implies much more heating and parallel/serial MOSFETs
- check jitter of RHIC & LHC timing systems