LCLS Kickers: BXKIK & BYKIK

Physics Requirements

	BXKIK	BYKIK	unit
Location	*25*	*Upstream undulator*	
Min. Beam Energy	*4.0*	*4*	GeV
Max. Beam Energy	*6.0*	*17*	GeV
Max. $\int$Bds	*0.04*	*1*	kG-m
Max. deflection angle	*0.2*	*1.8*	mrad
Magnet Length	*0.25*	*1*	m

Antonio de Lira
delira@slac.stanford.edu

LCLS Kickers: BXKIK & BYKIK

Physics Requirements

	BXKIK	BYKIK	unit
Rise & Fall times	*< 2*	*< 1*	ms
Pulse-to-pulse repeatability	*< 0.5*	*< 1*	%
Flat top duration	*> 1*	*> 1*	μs
Flat top variation	*0.1*	*0.1*	%
Max. trigger rate	*120*	*120*	Hz

Antonio de Lira
delira@slac.stanford.edu

LCLS Kickers: BXKIK & BYKIK

Electrical Requirements

	BXKIK	BYKIK	unit
Peak Current	*42*	*263*	A
Magnet Inductance	*0.15*	*0.6*	mH
Magnet Resistance	*5*	*20*	mΩ

LCLS Kickers: BXKIK & BYKIK

Trigger Requirements

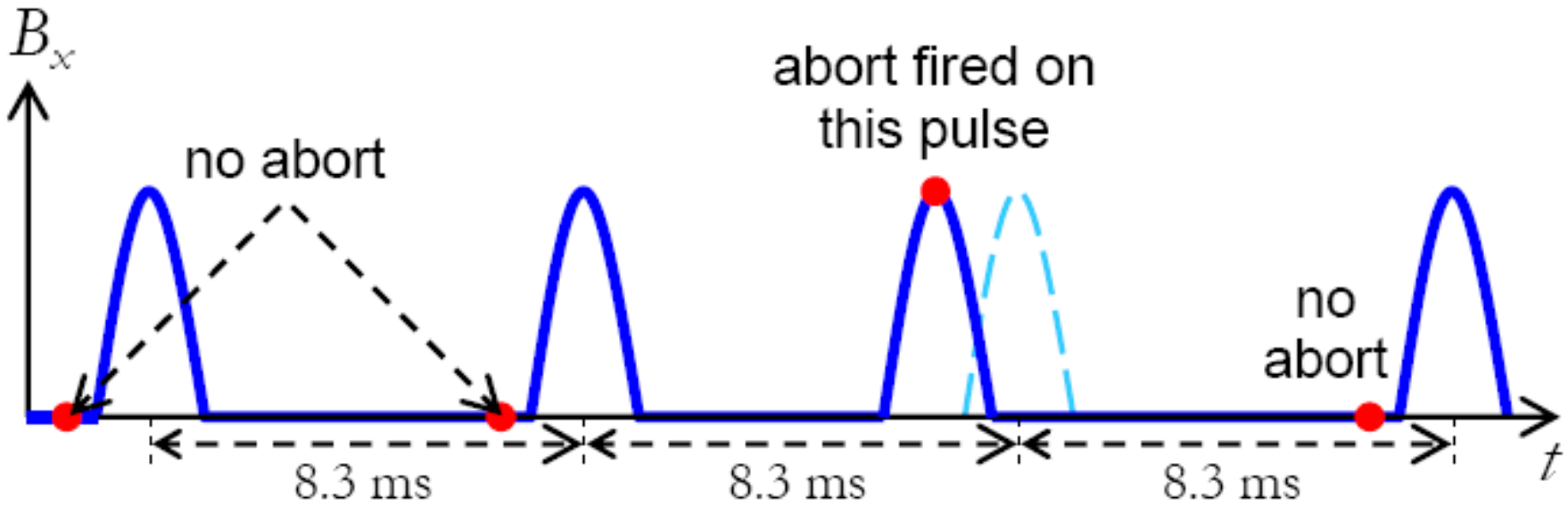
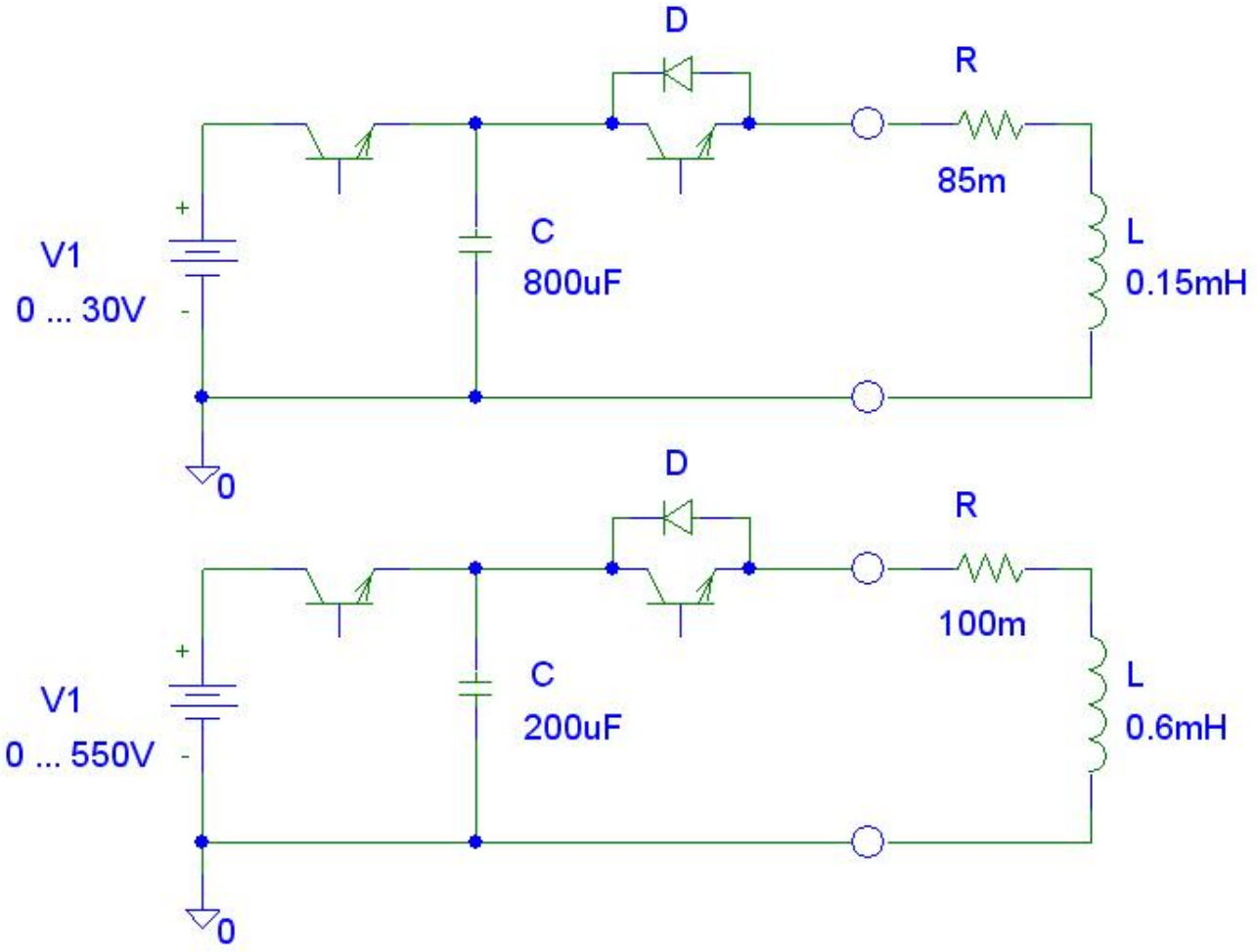


Fig. 1. Time line of abort kicker at 120-Hz repetition rate showing a 2-ms early time-shift of only the third pulse, thereby aborting only that beam pulse.

Source: PRD # 1.3-014 by P. Emma

LCLS Kickers: BXKIK & BYKIK

- Proposed Topology



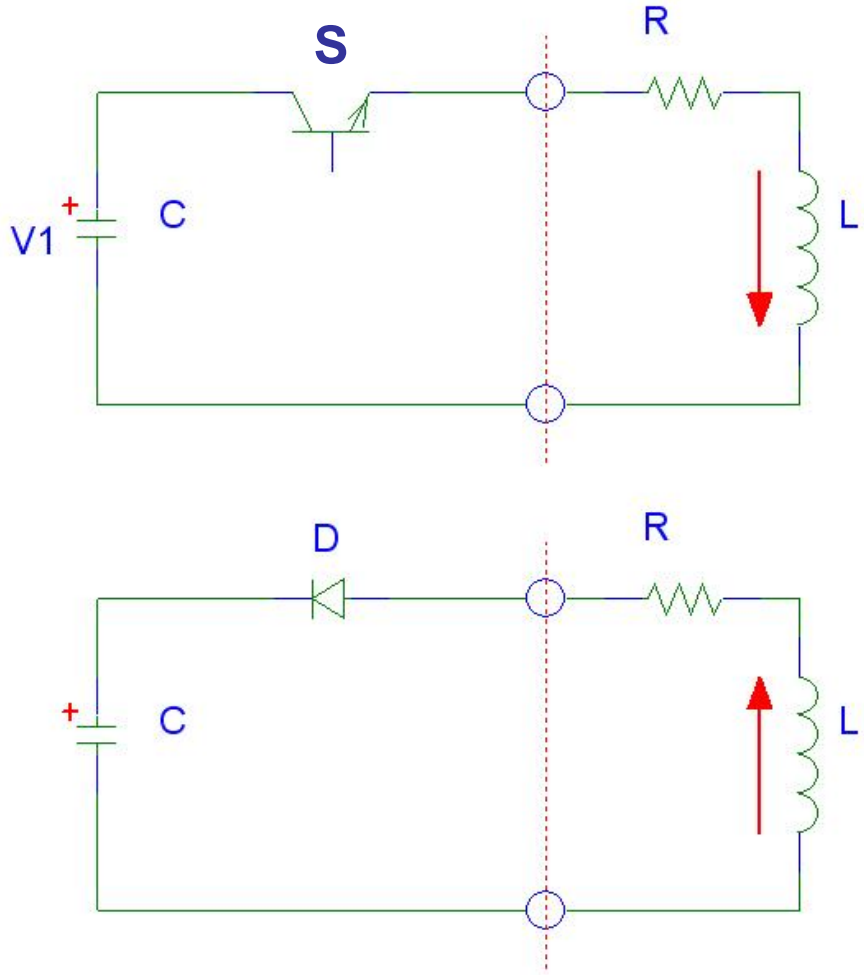
BXKIK

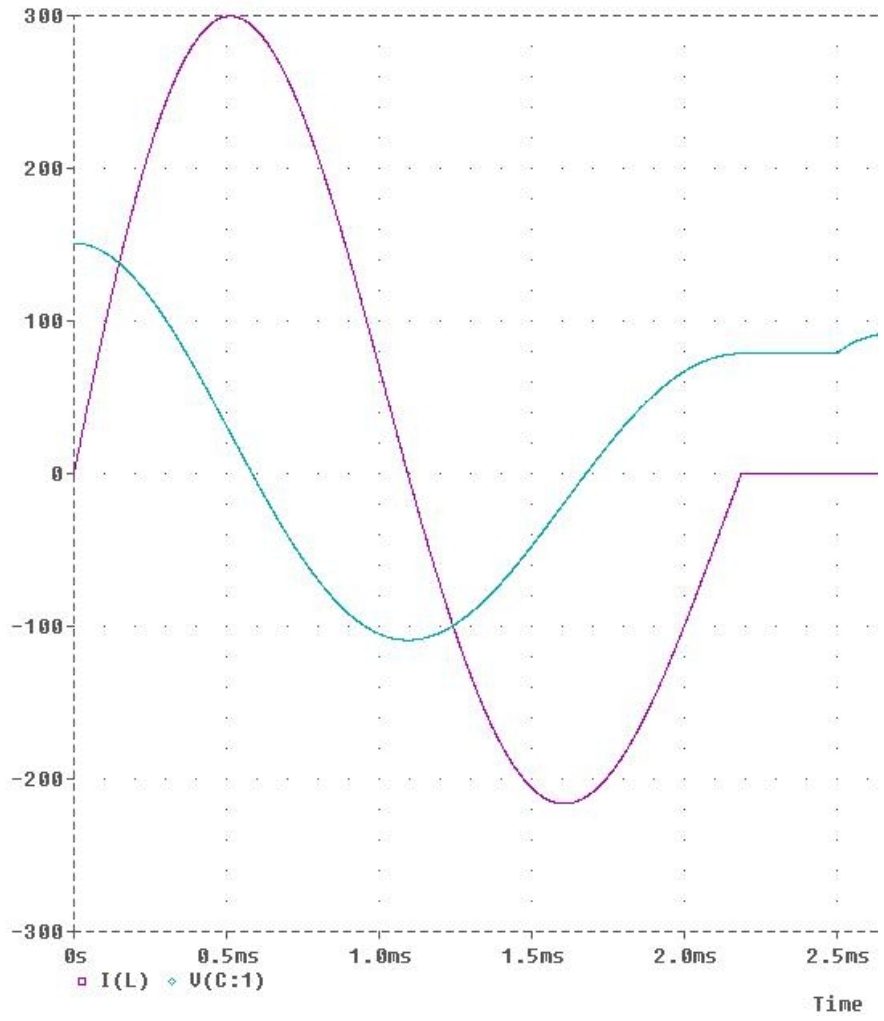
BYKIK

Antonio de Lira
delira@slac.stanford.edu

LCLS Kickers: BXKIK & BYKIK

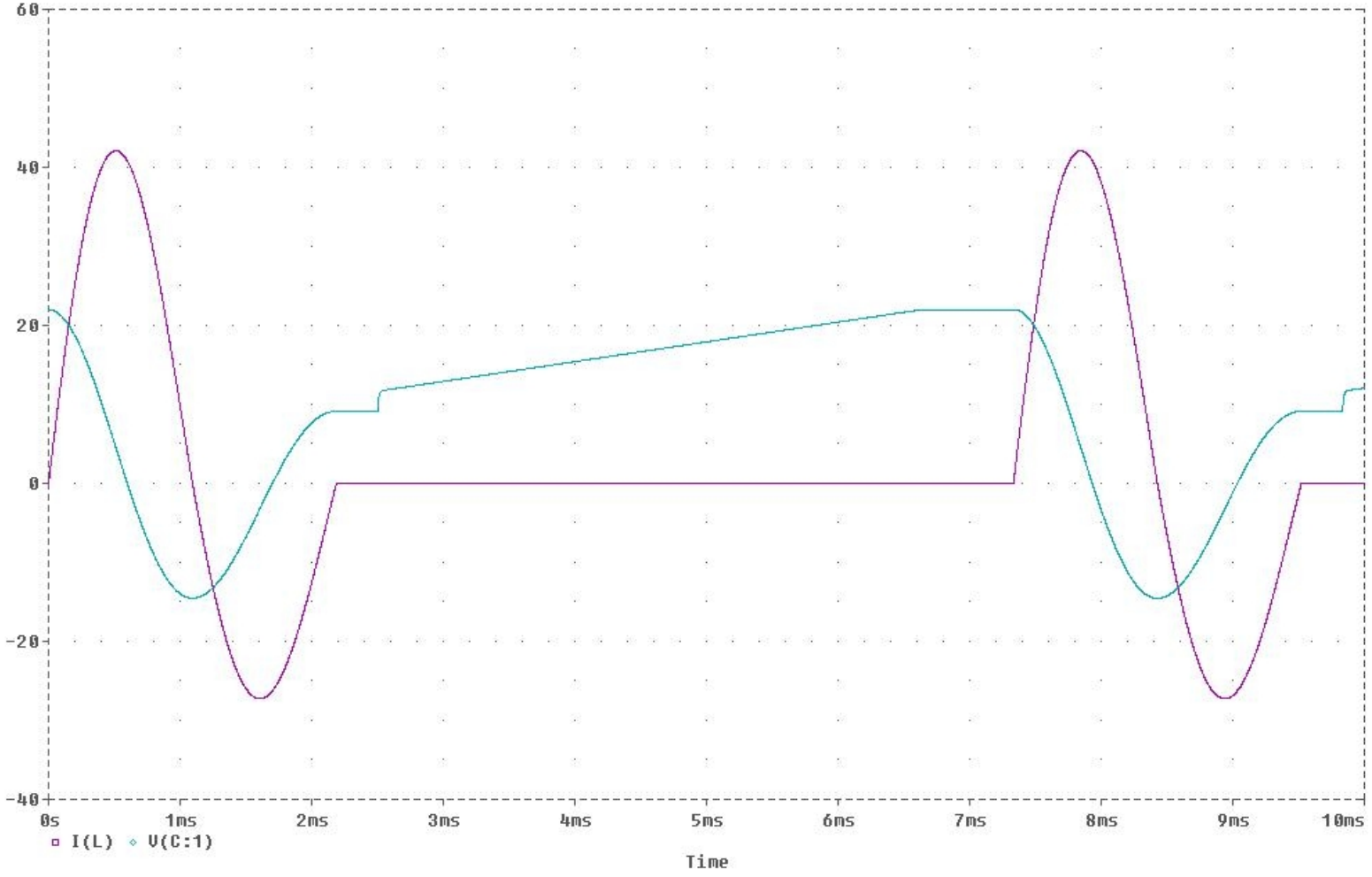
- Principle of Operation





LCLS Kickers: BXKIK & BYKIK

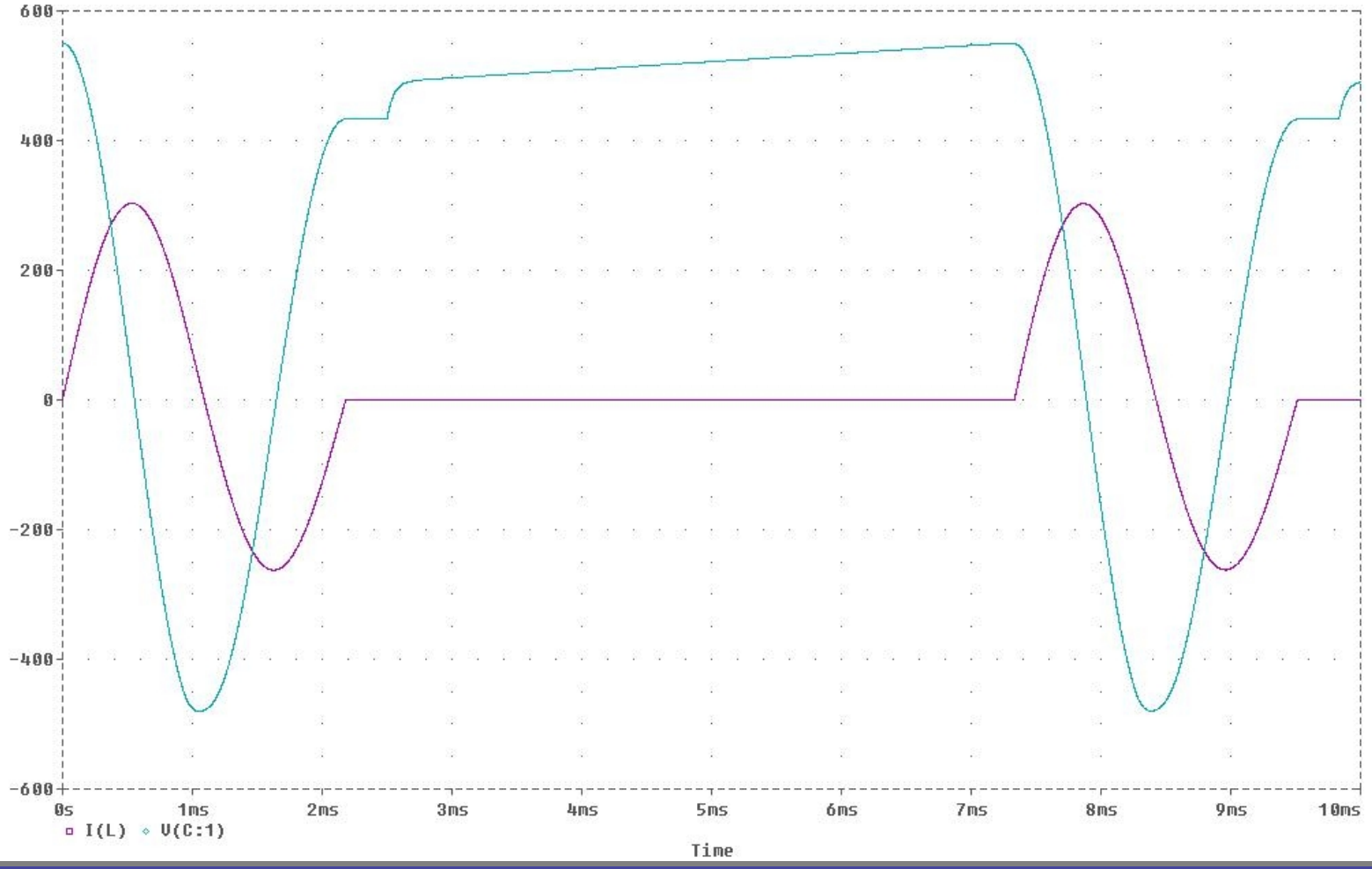
- BXKIK Waveforms



Antonio de Lira
delira@slac.stanford.edu

LCLS Kickers: BXKIK & BYKIK

- BYKIK Waveforms



Antonio de Lira
delira@slac.stanford.edu

LCLS Kickers: BXKIK & BYKIK

- Key Components
  - Cap charging power supply
  - Pulse discharge capacitor
  - Solid-state switches

LCLS Kickers: BXKIK & BYKIK

- Cap charging power supply (for BYKIK)


Lambda - ALE 202A Series

- Peak charging rate: 2.2 kJ/s
- Voltage range: 0 - 1 kV
- Charging current: 4.4 A
- pulse-to-pulse repeatability: 0.1%
- Low stored energy: < 0.3 J
- Parallel operation
- Remote control
- Unit price: $ 3k

LCLS Kickers: BXKIK & BYKIK

- Power supply (for BXKIK)

– Voltage range: 0 – 30V
– Current range: 0 – 25A
– Stability: <0.1%
– Remote control
– Unit price: $ 2.5k

LCLS Kickers: BXKIK & BYKIK

- Pulse discharge capacitor

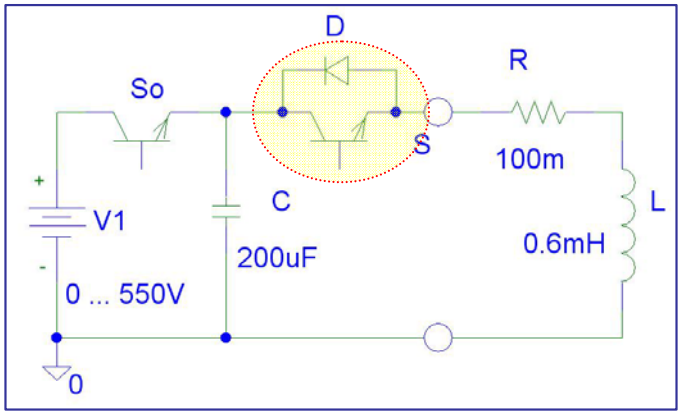
General Atomics Series DM

- Capacitance: 100 μF
- Rated Voltage: 1 kV
- Peak current: 1.5 kA
- Max. RMS current: 23 A
- Voltage reversal: 20 %
- Design life: > 300M charge/discharge cycles
- Unit price: $ 95

LCLS Kickers: BXKIK & BYKIK

- Solid-state switch

Powerex CM400HA-24H



- 400 Amperes
- 1200 Volts
- Peak current: 800 A
- Low Power Gate Drive
- Free-wheeling diode
- Unit price: $ 260

LCLS Kickers: BXKIK & BYKIK

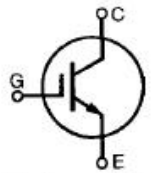
- Solid-state switch

IXYS — Advance Technical Data

High Voltage
IGBT

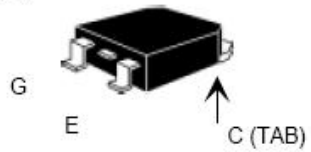
IXGH 24N170
IXGT 24N170

V_{CES}	=	1700	V
I_{C25}	=	50	A
$V_{CE(sat)}$	=	3.3	V
$t_{fi(typ)}$	=	290	ns

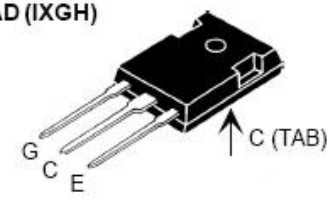


Symbol	Test Conditions	Maximum Ratings	
V_{CES}	T_J = 25°C to 150°C	1700	V
V_{CGR}	T_J = 25°C to 150°C; R_{GE} = 1 MΩ	1700	V
V_{GES}	Continuous	±20	V
V_{GEM}	Transient	±30	V
I_{C25}	T_C = 25°C	50	A
I_{C90}	T_C = 90°C	24	A
I_{CM}	T_C = 25°C, 1 ms	150	A
SSOA (RBSOA)	V_{GE} = 15 V, T_{VJ} = 125°C, R_G = 5 Ω; Clamped inductive load	I_{CM} = 50 @ 0.8 V_{CES}	A
P_C	T_C = 25°C	250	W

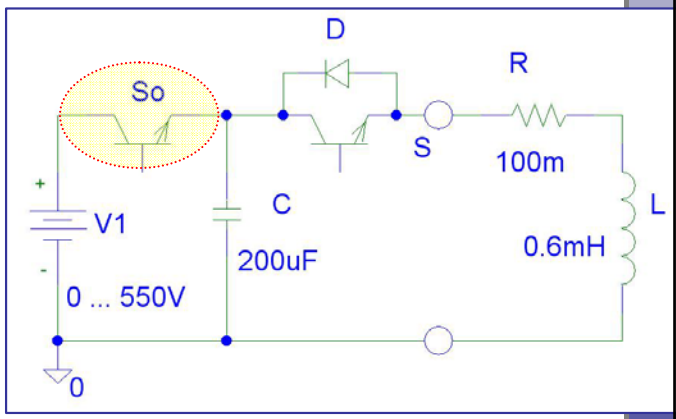
TO-268 (IXGT)

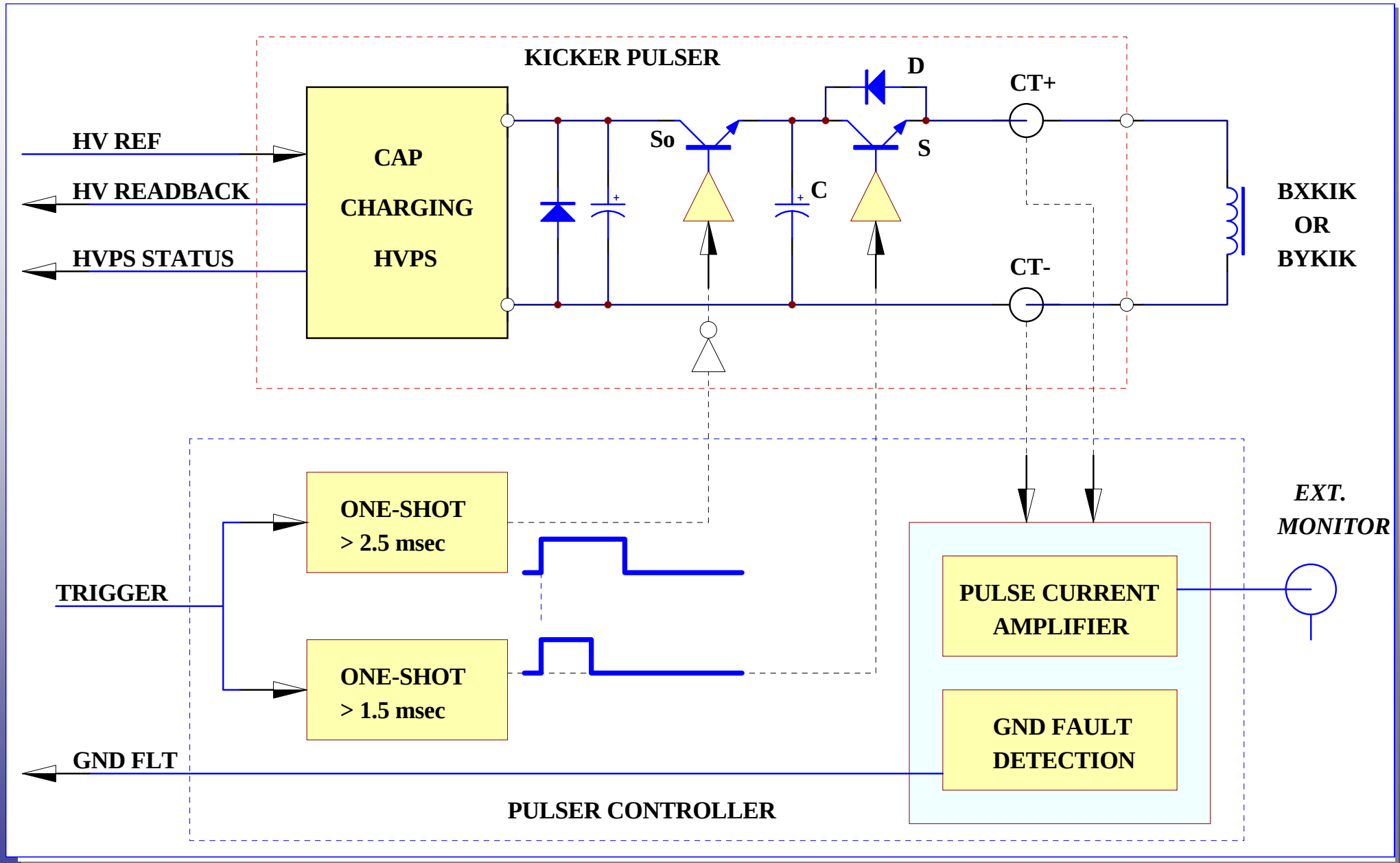


TO-247 AD (IXGH)



G = Gate, C = Collector,




KICKER PULSER
D
CT+
HV REF
HV READBACK
HVPS STATUS
CAP
CHARGING
HVPS
So
S
C
CT-
BXKIK
OR
BYKIK
EXT.
MONITOR
TRIGGER
ONE-SHOT
> 2.5 msec
ONE-SHOT
> 1.5 msec
PULSE CURRENT
AMPLIFIER
GND FAULT
DETECTION
GND FLT
PULSER CONTROLLER

LCLS Kickers: BXKIK & BYKIK

- Controls - Protections
  - Internal
    - Overcurrent
    - Ground fault
    - Cap overvoltage
    - Automatic discharge switch
  - External
    - MPS
    - PPS (?)

LCLS Kickers: BXKIK & BYKIK

- Controls
  - Analog Adjusts
    - HVPS voltage reference
  - Analog Monitoring
    - Cap voltage
    - Magnet current waveform
    - Magnet peak current

LCLS Kickers: BXKIK & BYKIK

- Controls
  - Digital Commands
    - HVPS Enable/Reset
  - Digital Monitoring
    - HVPS status & fault signals
    - Pulser controller status & fault signals
  - Trigger
    - Initiate the pulse current

Antonio de Lira
delira@slac.stanford.edu

LCLS Kickers: BXKIK & BYKIK

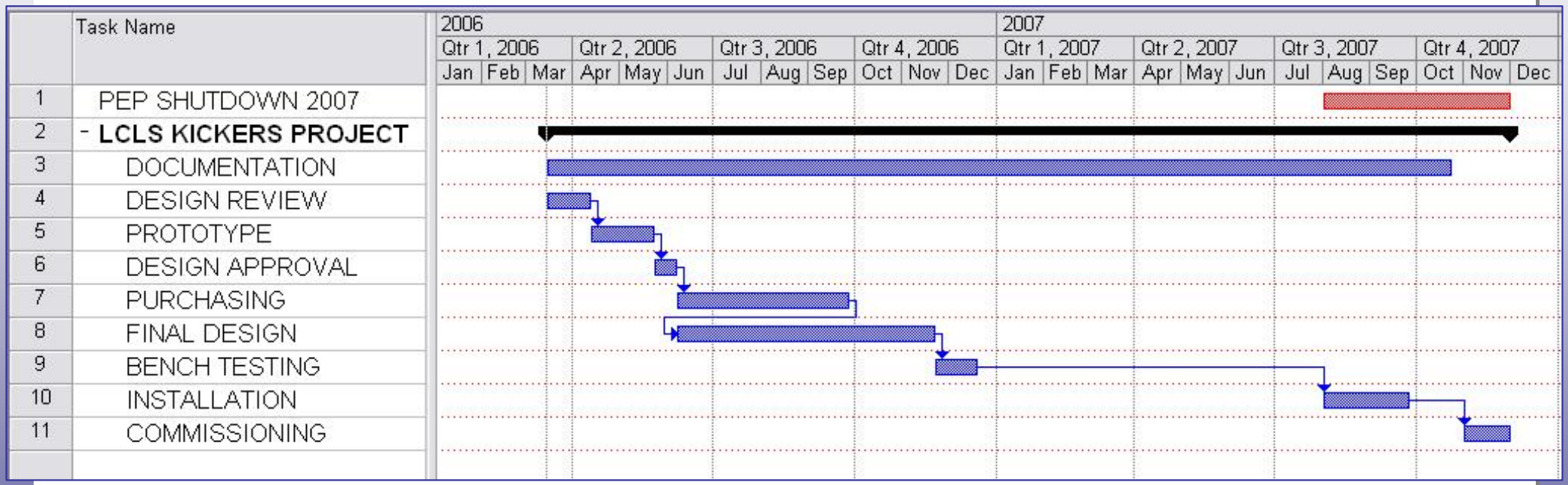
Cost Estimate

	Unit Price	BXKIK	BYKIK	BXKIK	BYKIK	
MATERIAL		*Qty*	*Qty*			
HVPS	$2,950	1	2	$2,950	$5,900	
Caps & accessories	$115	10	26	$1,150	$2,990	
IGBT's & accessories	$525	1	1	$525	$525	
Current Xducers	$150	2	2	$300	$300	
Controller	$1,500	1	1	$1,500	$1,500	
Material SUBTOTAL				$6,425	$11,215	
w/ contingency	20%			$7,710	$13,458	
w/ overhead	7%			**$8,250**	**$14,400**	
LABOR		*hrs*	*hrs*			
Engineering	$86	83	83	$7,138	$7,138	
Technician	$48	166	166	$7,968	$7,968	
Coordinator	$62	41	42	$2,542	$2,604	
Labor SUBTOTAL				$17,648	$17,710	
w/ overhead	34%			$23,648	$23,731	
Project TOTAL				**$31,898**	**$38,131**	**$70,029**

Antonio de Lira
delira@slac.stanford.edu

LCLS Kickers: BXKIK & BYKIK

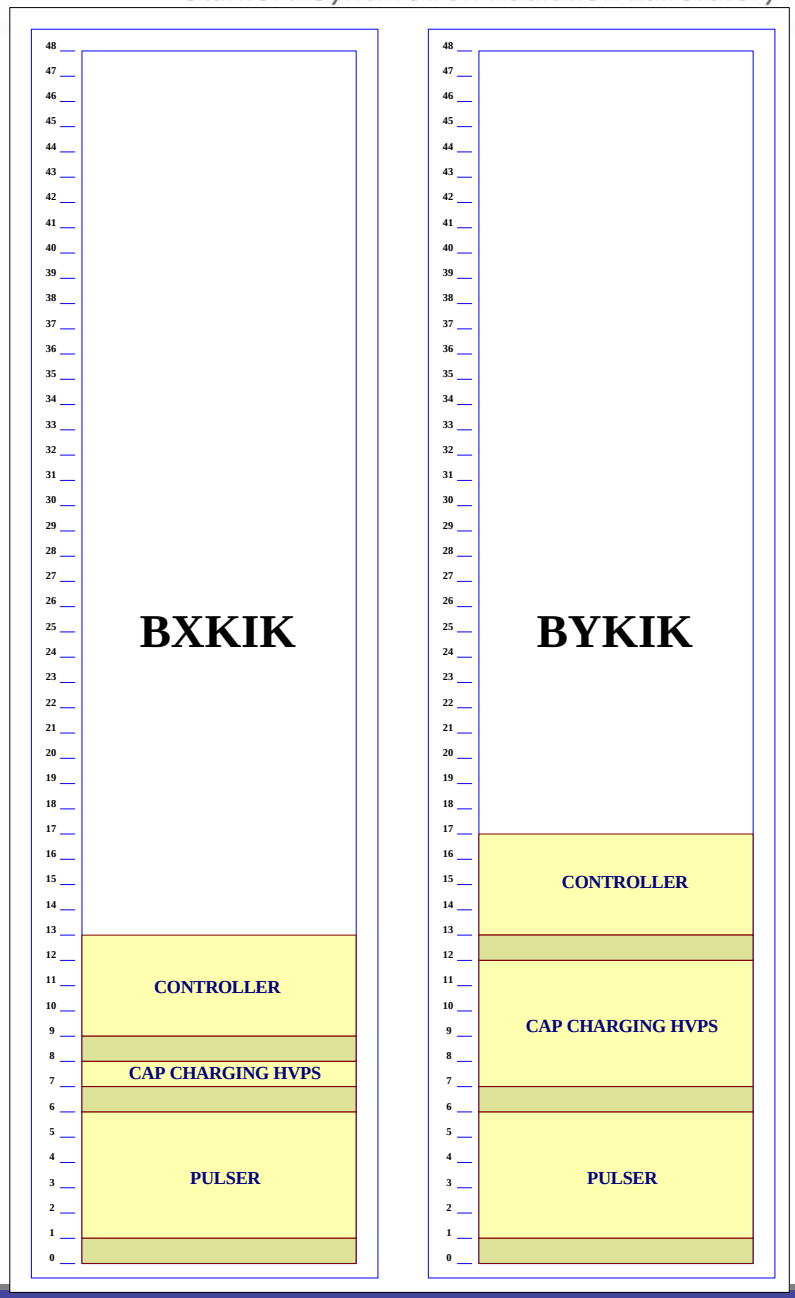
Project Schedule



Antonio de Lira
delira@slac.stanford.edu

LCLS Kickers:

- Rack Distribution



Antonio de Lira
delira@slac.stanford.edu

LCLS Kickers: BXKIK & BYKIK

- TBD
  - MPS
  - PPS
  - Rack locations
  - AC Power
  - Controls
    - VDAC + VSAM + Digital I/O
    - Trigger signal
    - Remote monitoring