Fast Kickers at DESY

- Injection / ejection in a TESLA like DR
- Generation of a pulse with a pulse length of 12ns
- Measurement at TTF 2
- Full power test
- Measurements at ATF
- XFEL activity

Talk given by Hans Weise

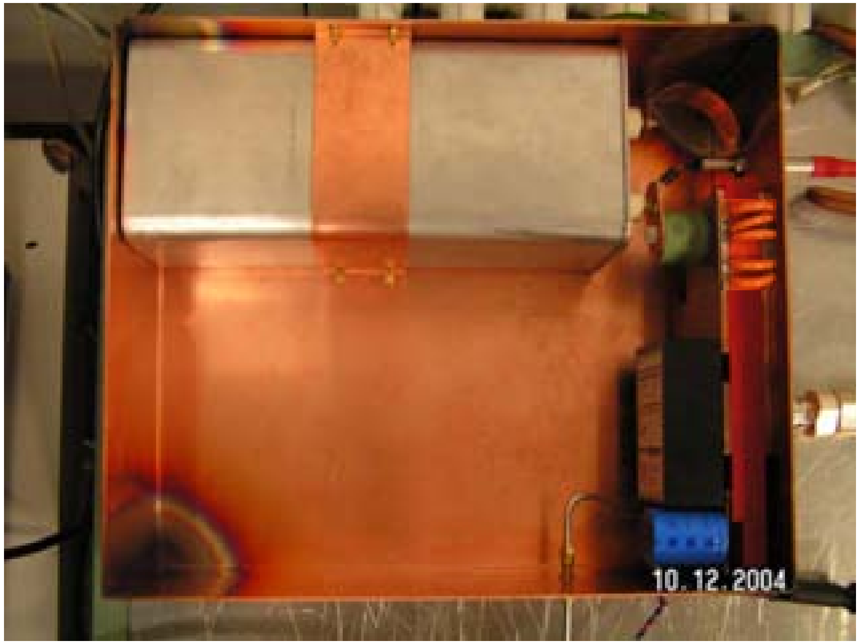
Work done by Frank Obier

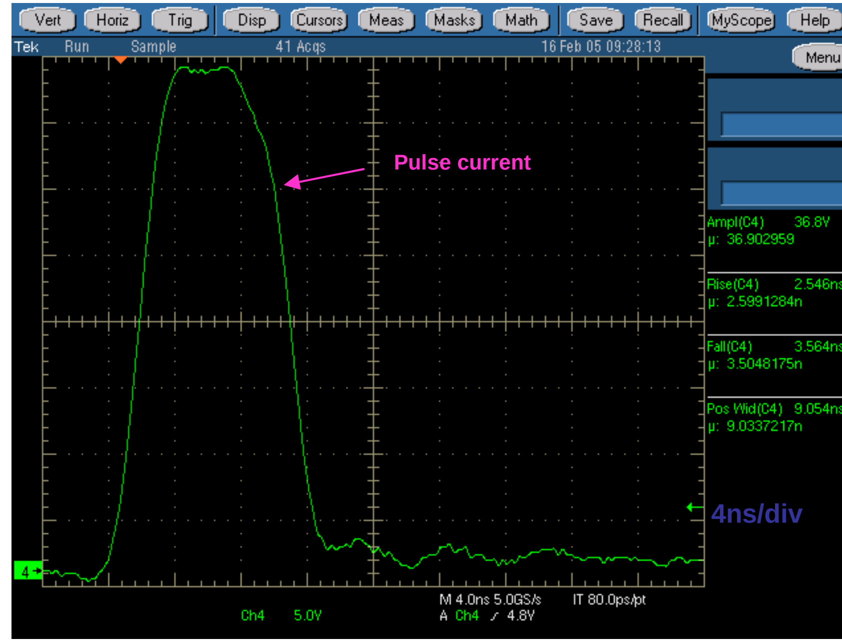
TESLA like damping ring- injection / ejection

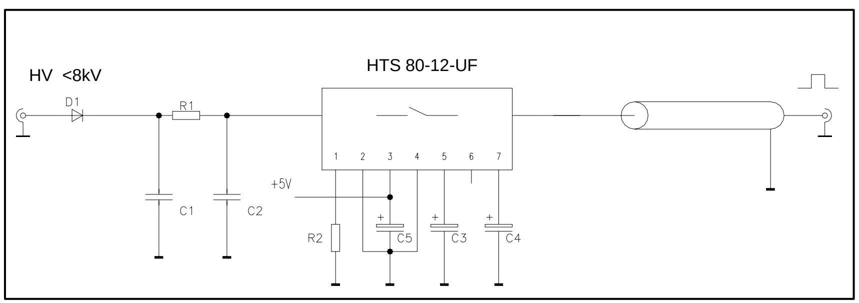
	System Specification 15 – 30 kicker	Achieved Performance (single kicker)	Next Steps
• Pulse voltage	<7.5kV	6.5 kV	
• Pulse current	100A	76 A (68A)	improve power-supply
• Pulse length	40ns	12ns	
• Rise time (10%-90%)	8ns	4.9ns	
• Micro pulse repetition rate	3MHz	3MHz	
• Marko pulse repetition rate	5Hz	5Hz	
• Amplitude stability (1/10 σ_X)	0.05%	0.3%	apply clipping techniques
• Residual kick	0.5%	0.68%	beam based correction
• Number of pulses	2820	3000	

- Behlke switches with t_{on} =5ns and t_{on} =10ns provide the opportunity to shorten the damping ring. Further measurements are foreseen.

Generation of pulse with a pulse length of 12ns







Behlke switch data:	
Type	HTS 80-12UF
Pulse voltage	8 kV
Pulse current	120 A (tp<50ns)
Jitter	100 ps
Rise time (10-90%)	2 ns

Pulser data:	
Voltage	6.5 kV
Pulse current	73.6 A
Frequency (burst)	1MHz
Number of pulses	1000
Pulse length	12 ns

- **principle set up of the pulser**
- **Behlke switch built in Mosfet technology**
- **max. 1000 single pulses with 1µs spacing**

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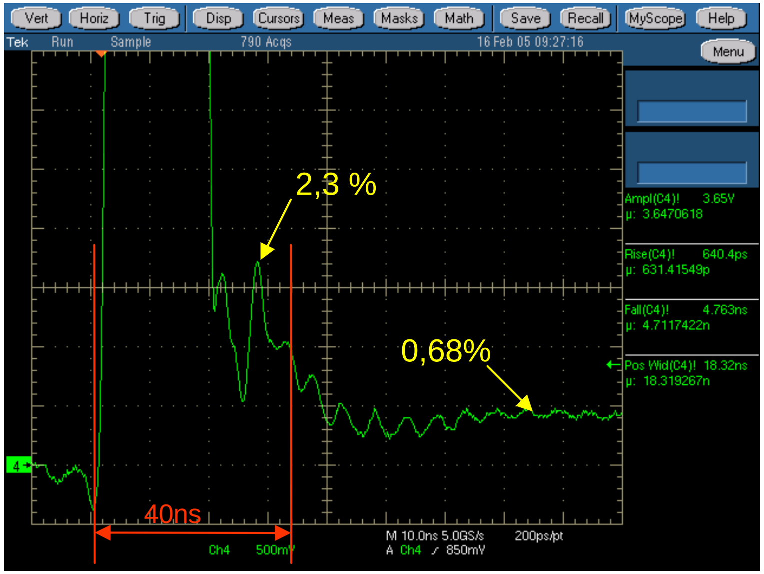
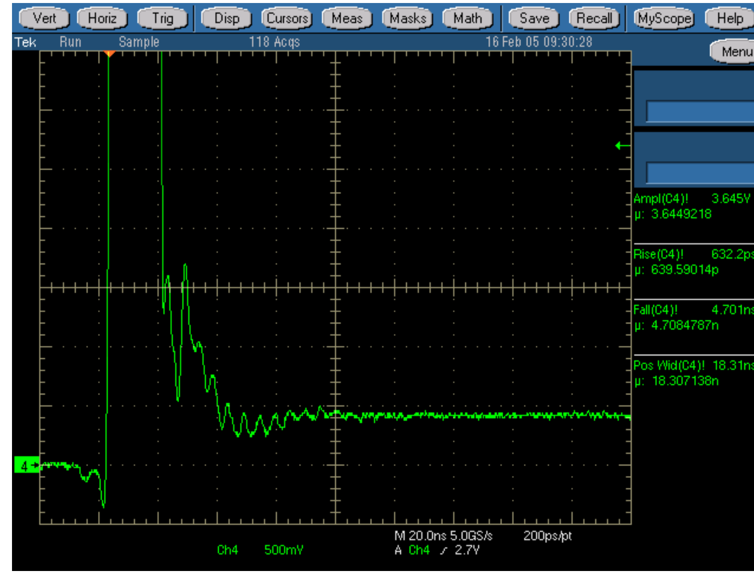
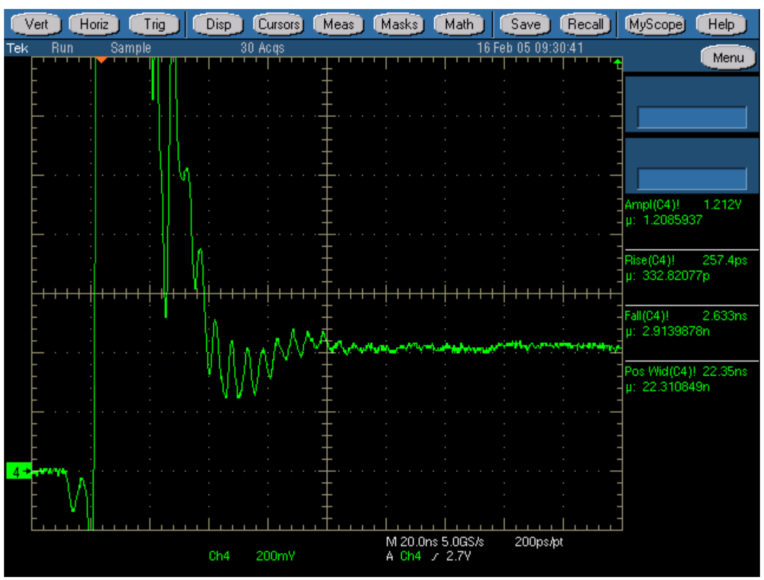
Switch HTS 80-12-UF t_{on}=10ns

Ripple Measurement







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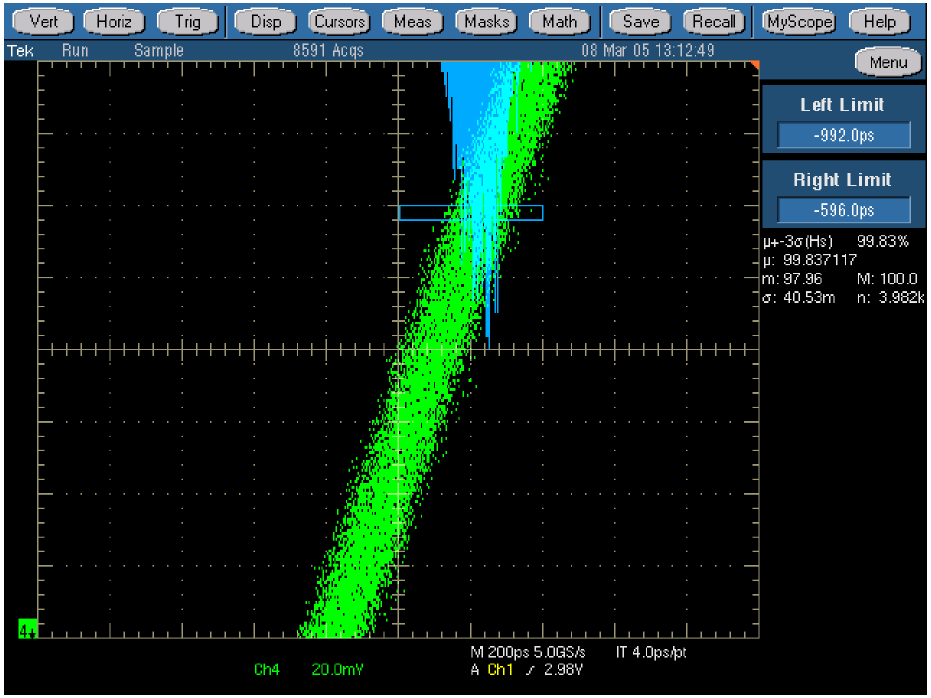
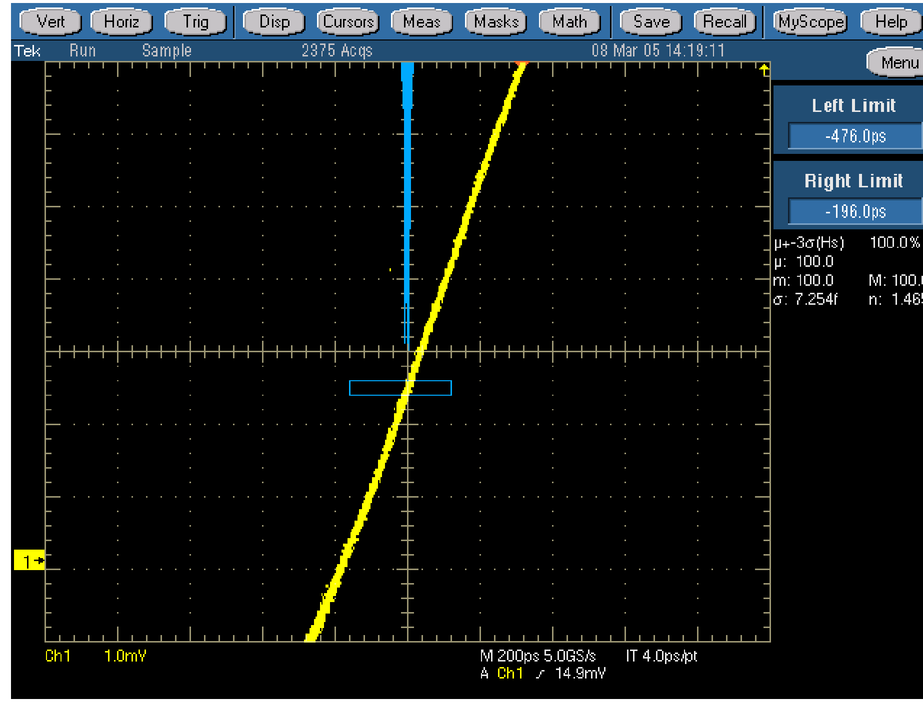
Timing Jitter

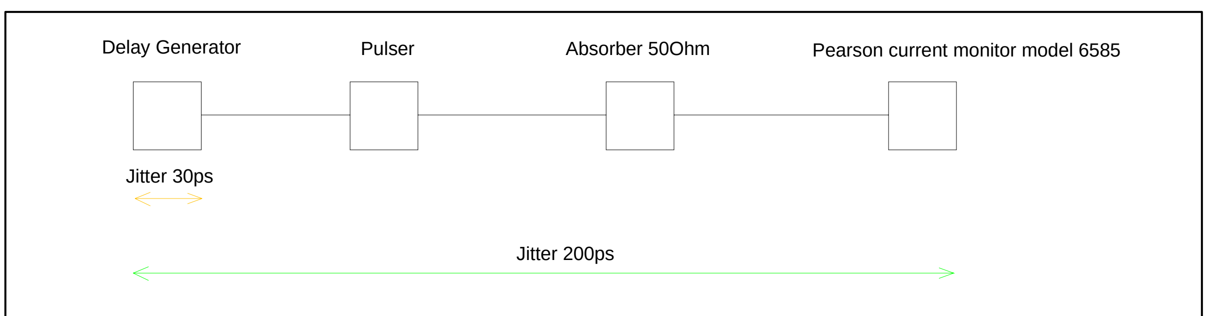
Swicht HTS 80-12UF t_{on}=10ns





Channel 1 Trigger (Delay .-Trigger generator) Channel 4 Pulse current with a Jitter of 200ps (Behlke Data: Typical Turn-on Jitter of 100ps)

Channel 1 (Delay.- Trigger generator) Jitter 30ps



Pearson Current Monitor Model 6585	
Sensitivity	1V/A+/-1%
	0.5V/A into
50Ω	
Output resistance	50Ω
Max. peak current	500A
Max. rms current	10A
Droop rate	0.8%/µs
Useable rise time	1.5ns
Low frequency 3dB cut-off	400Hz
High frequency +/-3dB	250MHz

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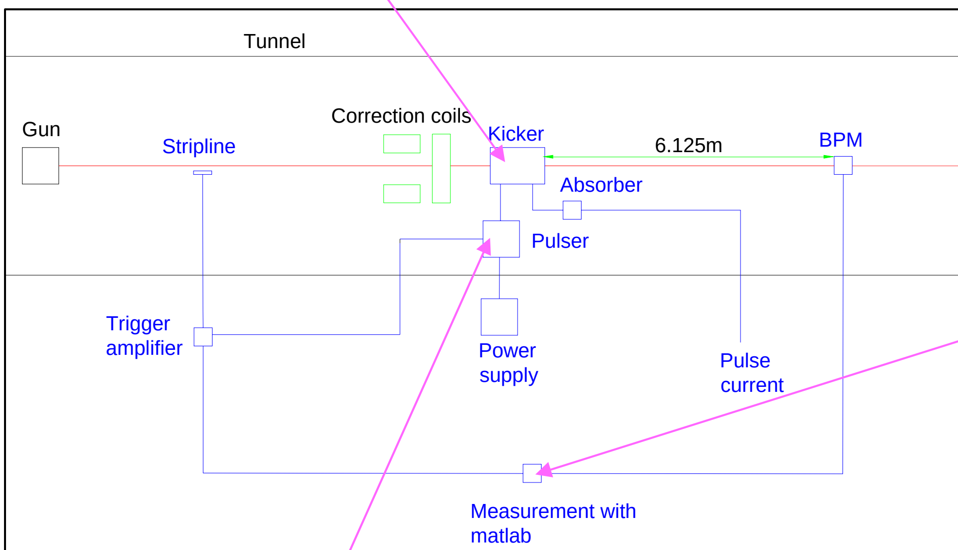
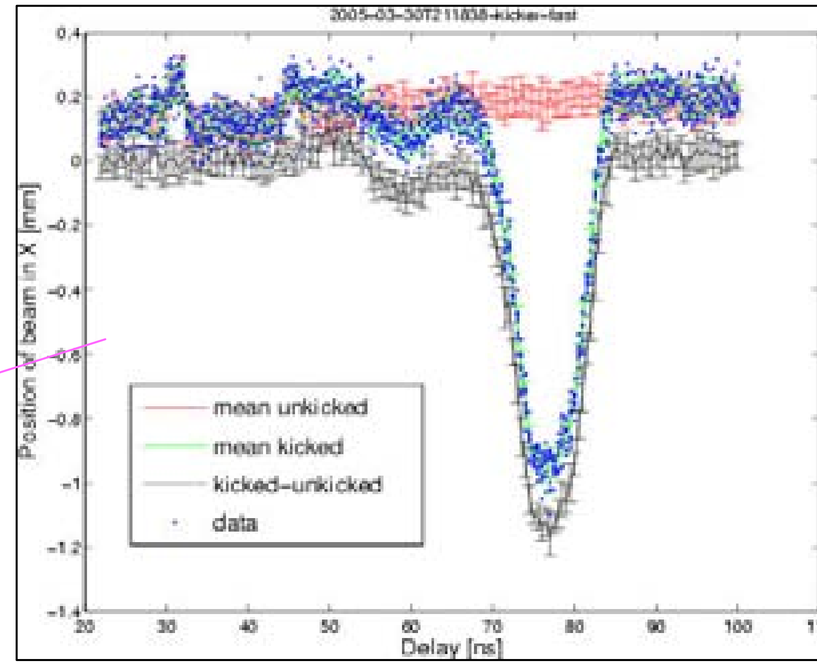
Measurements at TTF 2

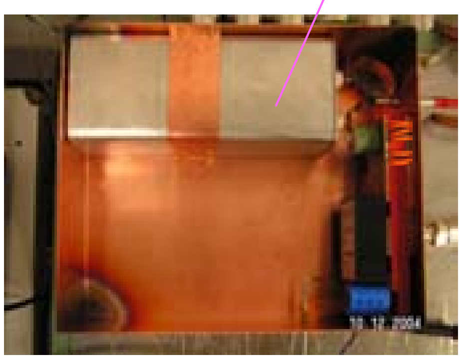
Ceramic Kicker

Data:

Voltage	7.0 kV
Pulse current	61 A
Pulse length	12 ns







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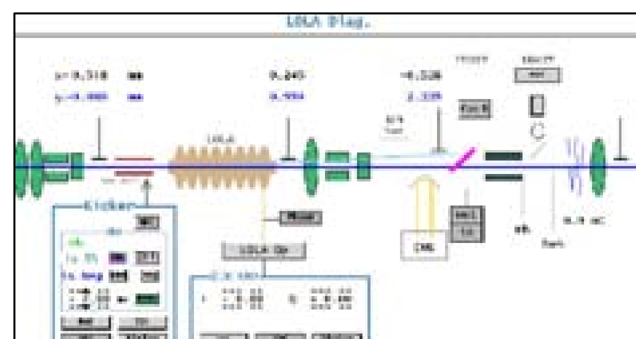
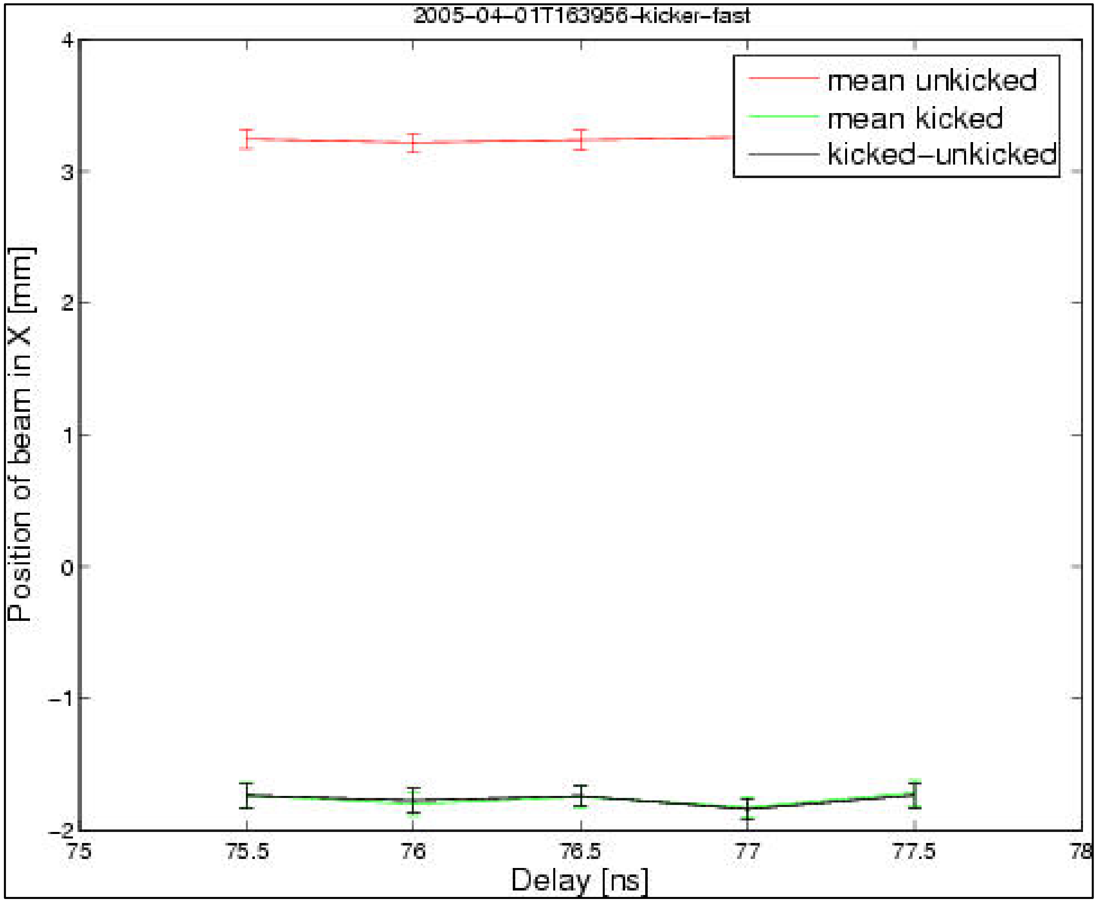
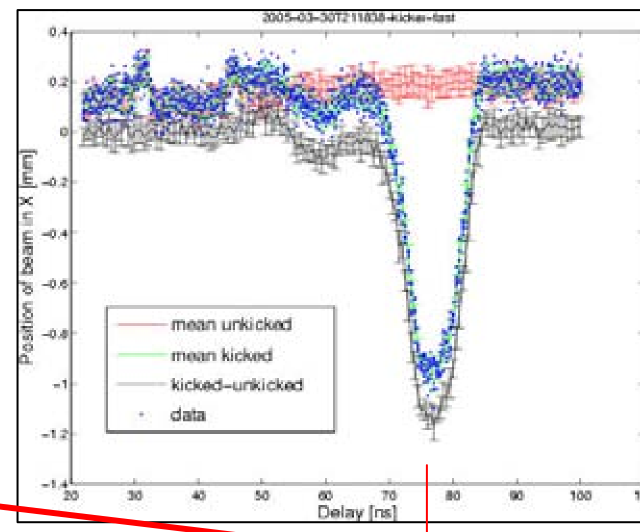
- principle set up of the kicker
- measure the kicker strength
- scan the kicker pulse with a step width of 0.5 ns and taking 20 pulses for each data point.



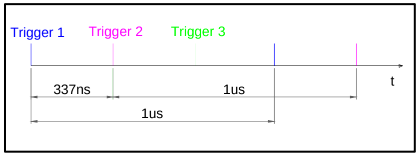
Measurements at TTF 2

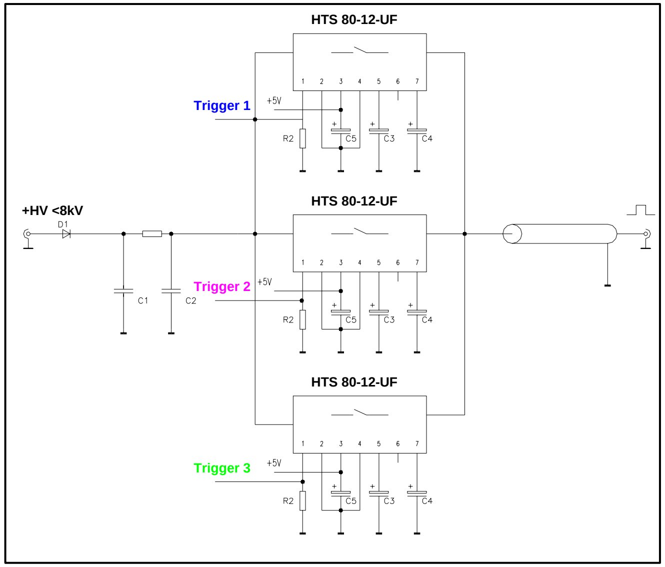


Measurement on kicker 'flat' top to investigate influence of timing jitter. Standard deviations of unkicked / kicked bunch (eposx1/eposx2) are given below as well as relative error. Smallest error as low as 0.5 % at certain delay, relative error increases with distance from 'flat, top. Kicker **HV = 7kV.**

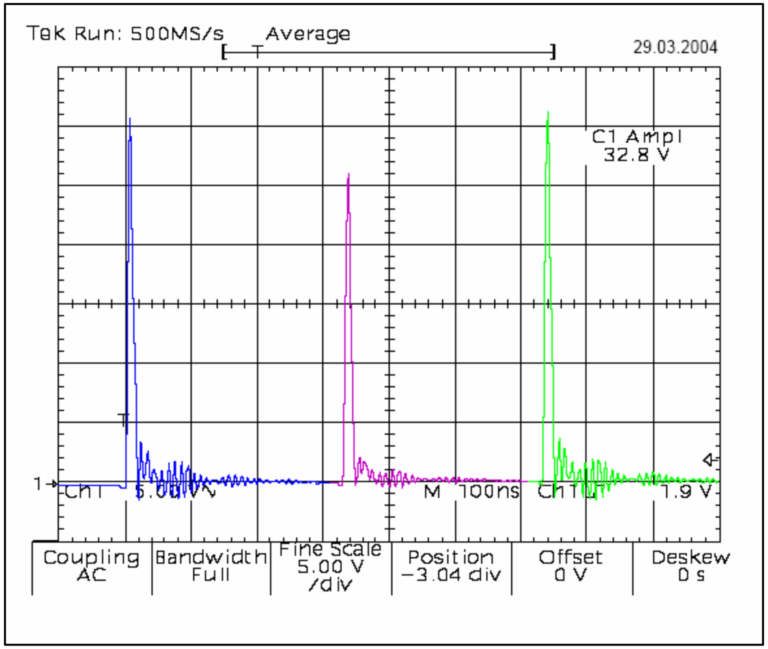


Pulse with a burst frequency of 3MHz





- **principle set up of the pulser**
- **Behlke switch in Mosfet technology**
- **max. 1000 single pulses with 1 µs spacing**



Pulser data:	
Voltage	6.5 kV
Pulse current	73.6 A
Frequency (burst)	3 MHz
Number of pulses	3000
Pulse length	12 ns

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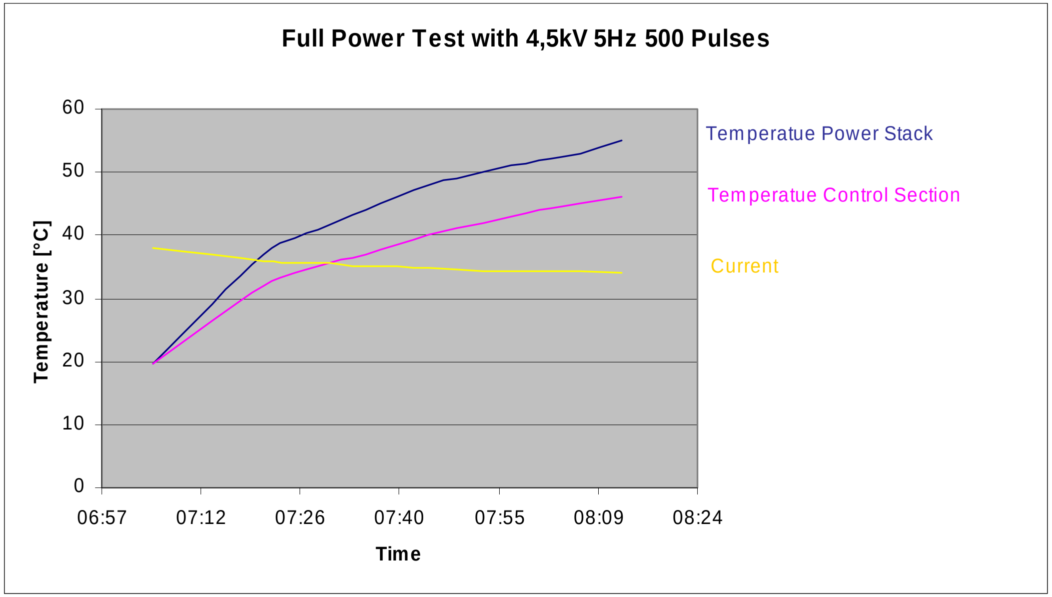
Full power test with a HTS 50-08-UF switch

For this Measurement we have a pulser with three switches HTS 50-08 UF.
Full power test with three Switches 500 single pulses and 1μs spacing each.

Voltages	4.5 kV
Current	38 A
Pulse length	8 ns
Rise time (10-90%)	3 ns
Micro pulse repetition rate	3 MHz
Macro pulse repetition rate	1 Hz
Number of pulse	1500



Time	Temperature Power Stack [°C]	Temperature control section [°C]	Current [A]
07:05	19,6	19,6	38
07:21	37	32	36
07:29	41	35	35,6
07:36	44	37	35,2
07:45	48	40	34,8
07:53	50	42	34,4
08:01	52	44	34,2
08:07	53	45	34,2
08:13	55	46	34

Absorber Temperature
34°C

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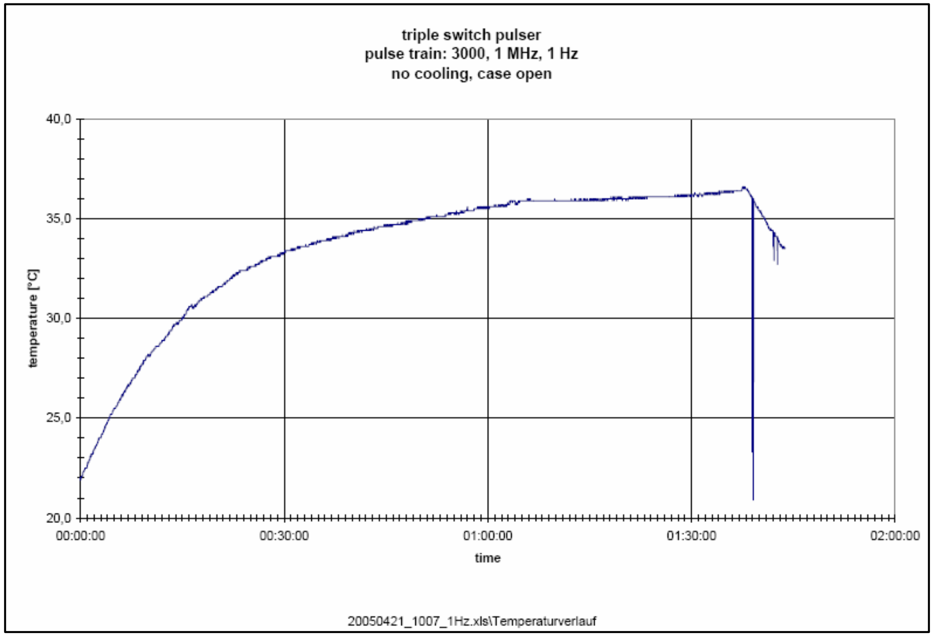
Full power test with a HTS 80-12-UF switch

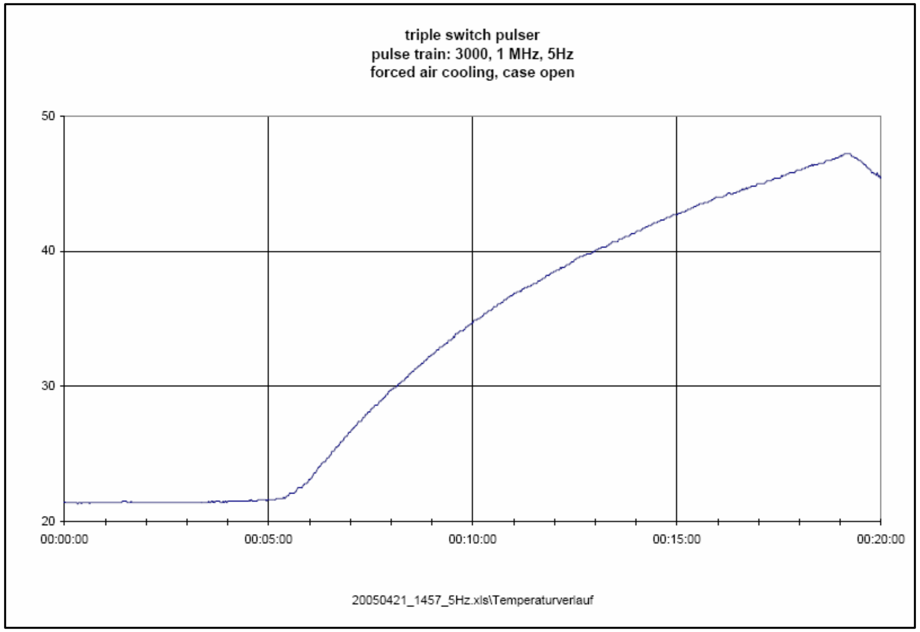
For this Measurement we have a pulser with three switches HTS 80-12 UF. Full power test with three Switches 1000 single pulses and 1μs spacing each.

Voltages	6.5 kV
Current	78.5 A
Pulse length	16 ns
Rise time (10-90%)	4 ns
Micro pulse repetition rate	3 MHz
Macro pulse repetition rate	1 Hz /5 Hz
Number of pulse	3000

Absorber Temperature 45°C



Absorber Temperature 105°C



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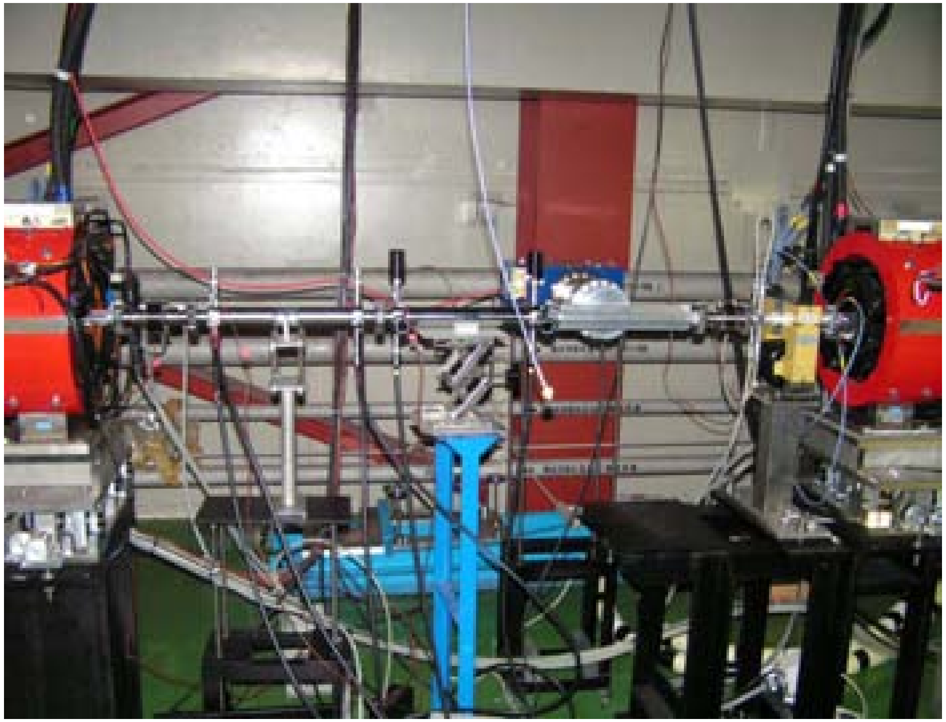
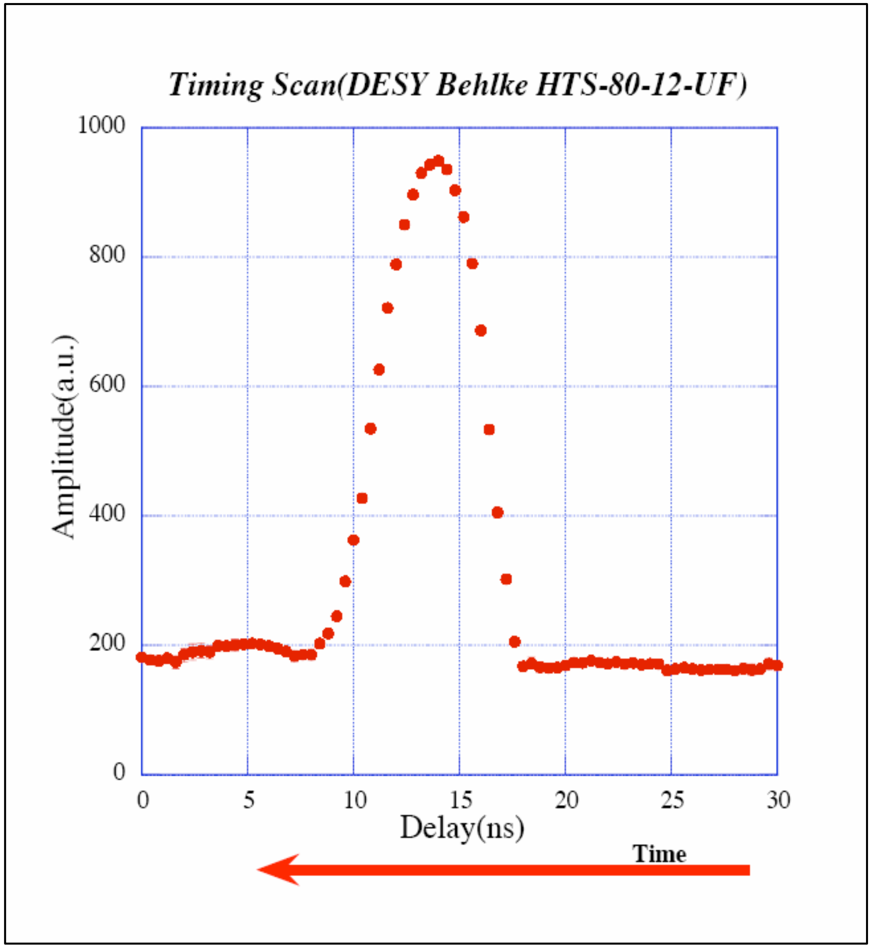
Measurement at KEK ATF Ring

The beam kick is observed by a turn-by turn BPM as the amplitude of the oscillation of the betatron frequency.
The kick effect is measured by scanning the pulse timing for the beam timing.

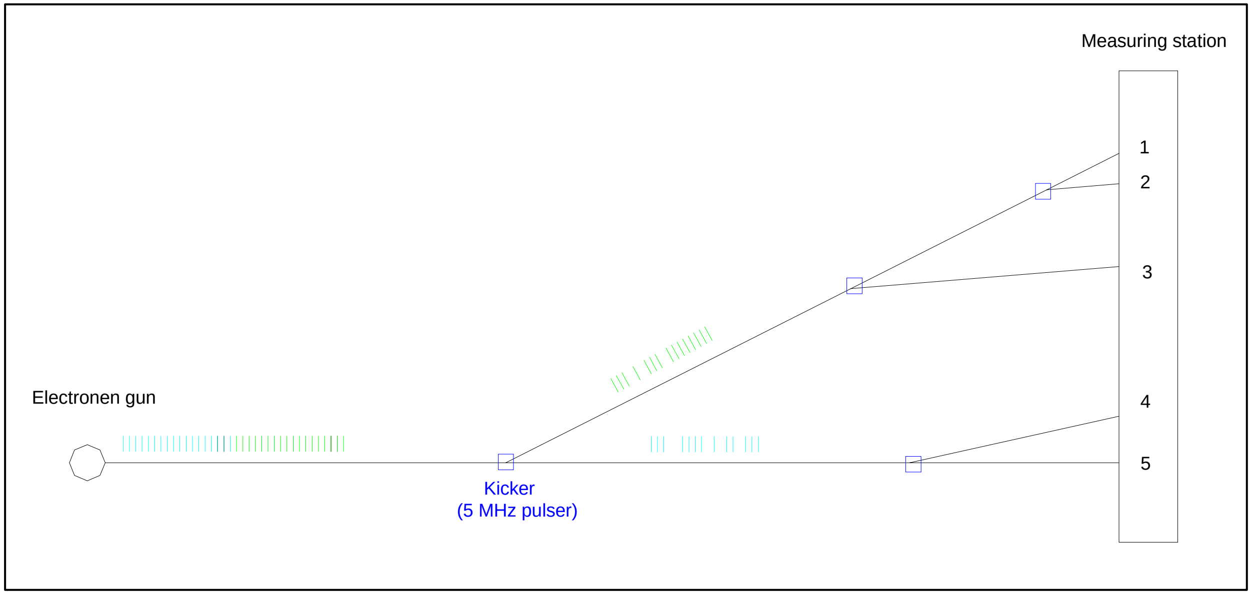




Next steps:

New Behlke switches with a water cooling and with selected Mosfet semiconductor are ordered (delivery date 08/05).
Investigate the pulse to pulse stability and the long-term stability (temperature drift) of a 3MHz pulser.

XFEL activities



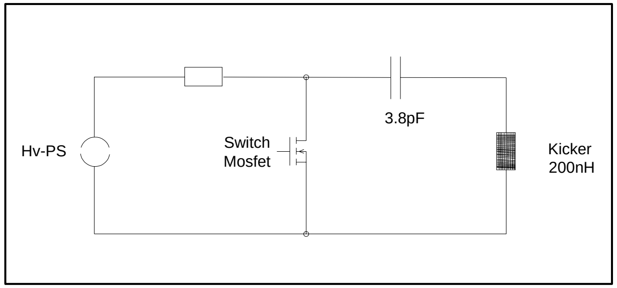
For this beam distribution we need a 5 MHz pulser with following data:

		XFEL
Energy	GeV	20
Deflection angle	mrad	0,3
Rep. Rate Macro pulse	Hz	10
Rep. Rate Bunch	MHz	5
Pulse Width	ns	200
Bdl	mTm	12
Accuracy		5e-5
Ripple		5e-5
Bunch spacing	ns	200
Pulse structure		burst
Amplitude		variable

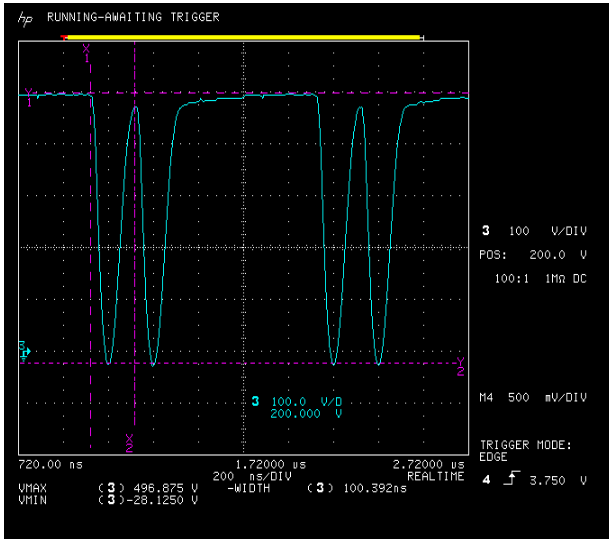
Next steps:

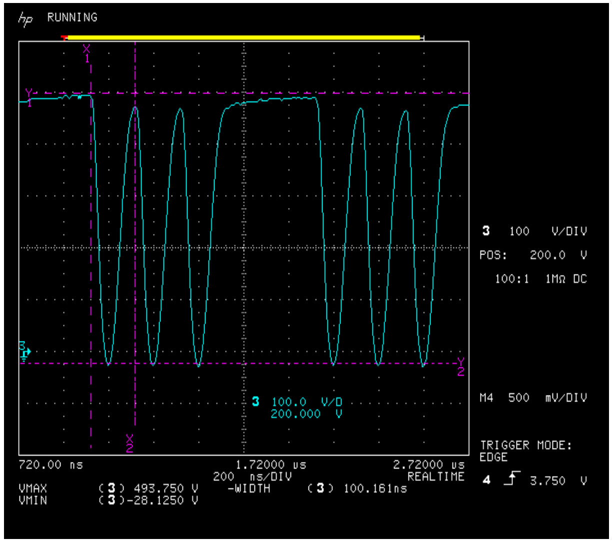
- **New Behlke switches with a rep. rate of 5 MHz (delivery date unknown) are under development at the company. We expect a rectangular current pulse.**
- **The alternative: a pulser with 5 parallel HTS 80-12 UF switches.**
- **Or use a pulser with single semiconductors (Directed Energy, Inc. DE-150 102N02A). Pulse form: a sinus half-wave.**

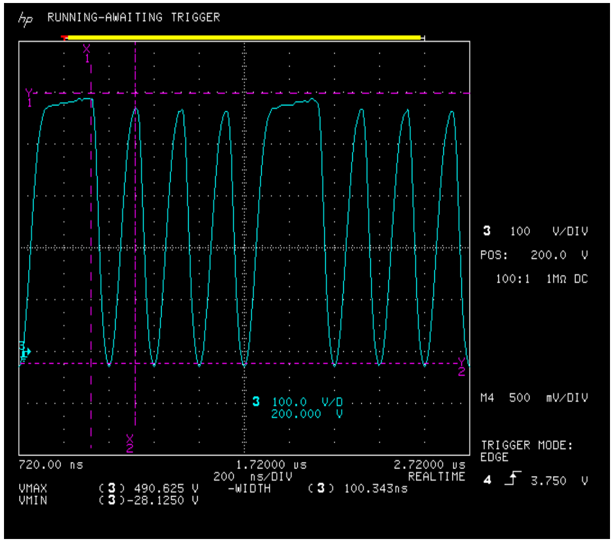
XFEL activities



- principle set up of the pulser
- Directed Energy, Inc. Mosfet DE-150 102N02A
- Generate single pulses with 200ns spacing

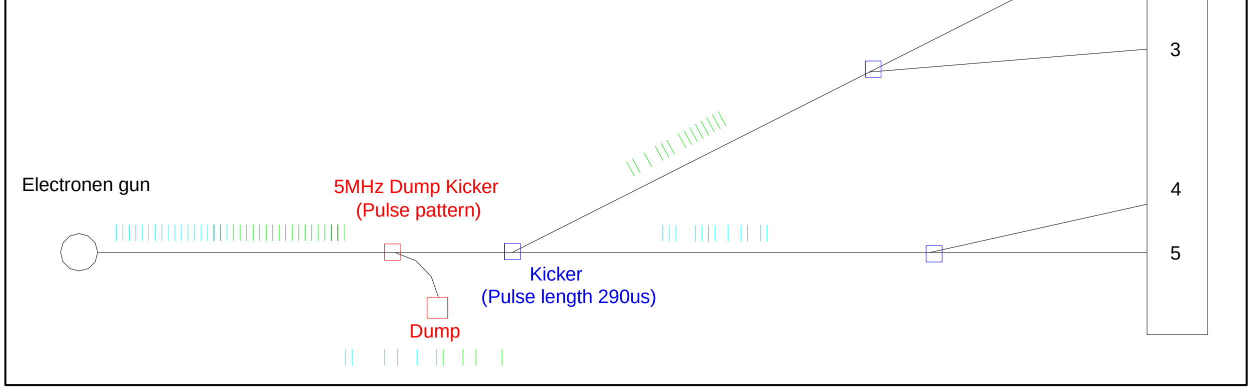


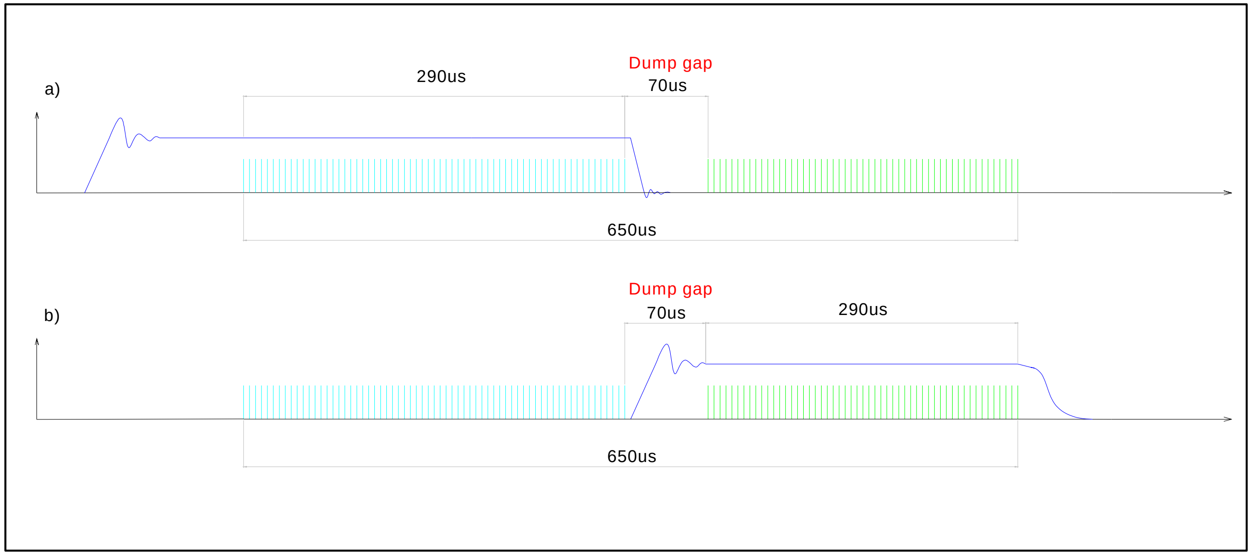




XFEL activities

Here the concept is to use a long pulse modulator with a high stability for beam distribution and a dump pulser with much lower stability for the dump and the creation of the pulse pattern.





For this beam distribution we need a long pulse modulator with following data:

		XFEL
Energy	GeV	20
Deflection angle	mrad	0,3
Rep. Rate Macro pulse	Hz	10
Rep. Rate Bunch	MHz	5
Pulse Width	µs	290
Bdl	mTm	12
Accuracy		5e-5
Ripple		5e-5
Total length	m	10
Gap height	mm	10-50
Bunch spacing	ns	200

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