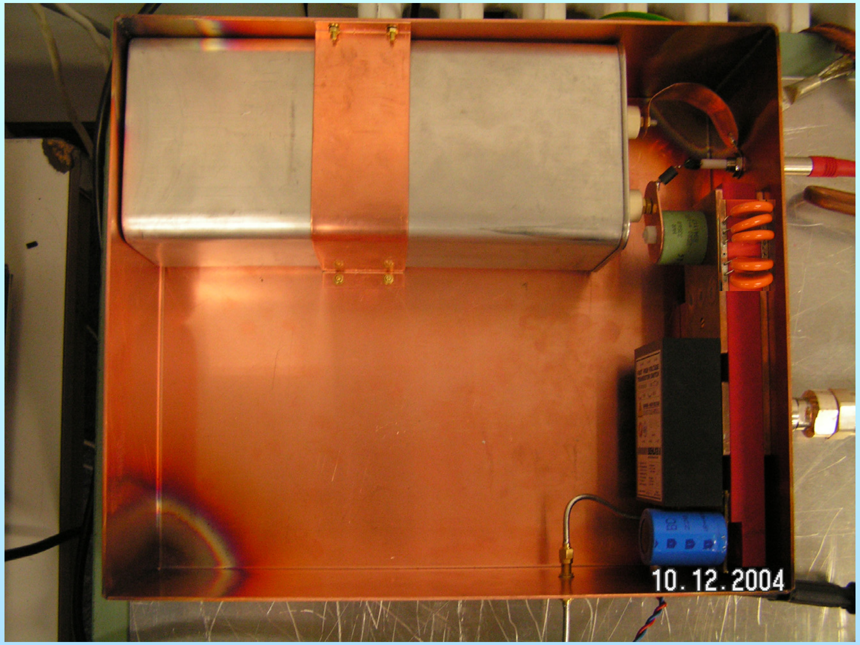
XFEL Pulser

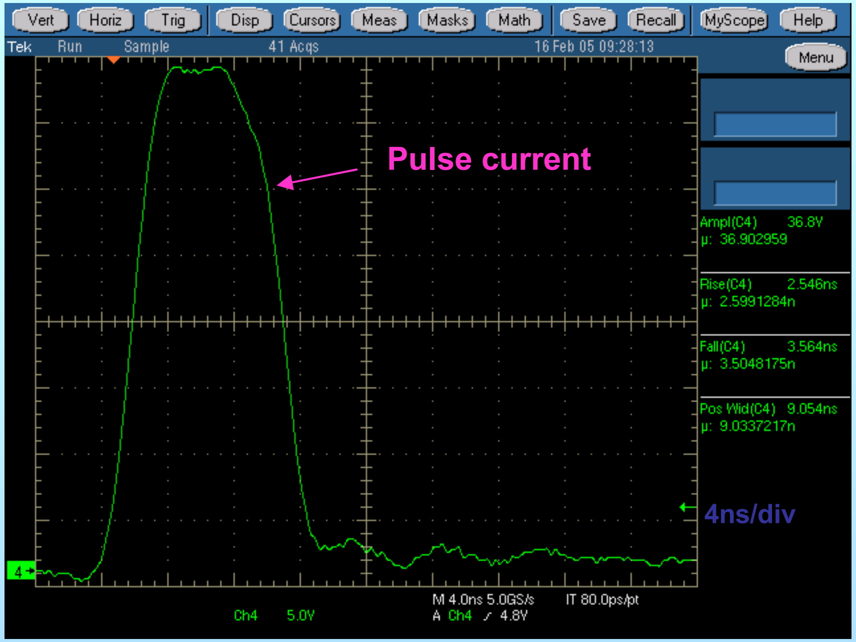
- Specification of Pulser
- Dump pulser with a Belhke switch
- Dump pulser form the FID company
- Dump pulser with Mosfet
- Flat top pulser

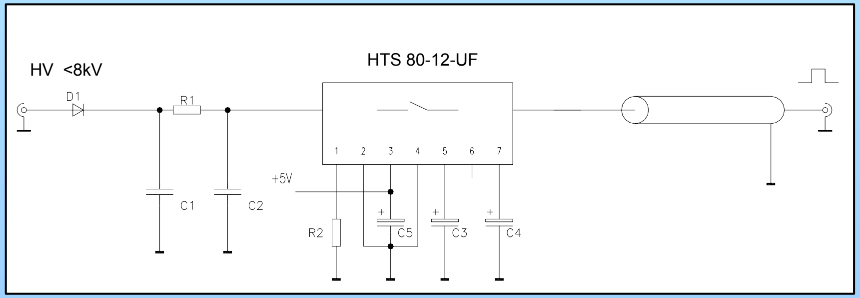
Specification of Pulser

	Fast single bunch kicker (for beam dump)	**Flat top kicker (for beam distribution)**
Pulse Form	Burst	Flat top
Repetition Rate [Hz]	5×10^{6}	10
Max. Pulse Width [s]	200×10^{-9}	300×10^{-6}
Rise/Fall Time [s]	$< 100\times10^{-9}$	$\approx20\times10^{-6}$
Rel. Amplitude Stability	0.01	3×10^{-4}
Relative Residual Ripple	3×10^{-4}	3×10^{-4}
Kick angle [mrad]	0.5	0.5
Max. int. Field Strength [mT×m]	42	42
Min. full aperture [mm]	30	30
Max. system length [m]	18	18
Pulser Voltage [kV]	8	0.3
Pulse Current [A]	100	300
Max. Power [kW]	40	0.27
Average Power [W]	260	270

Generation of pulse with a pulse length of 12ns







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

Behlke switch data:	
Type	HTS 80-12UF
Pulse voltage	8kV
Pulse current	120A(tp<50ns)
Frequency	3kHz
Jitter	100ps
Rise time (10-90%)	2ns

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

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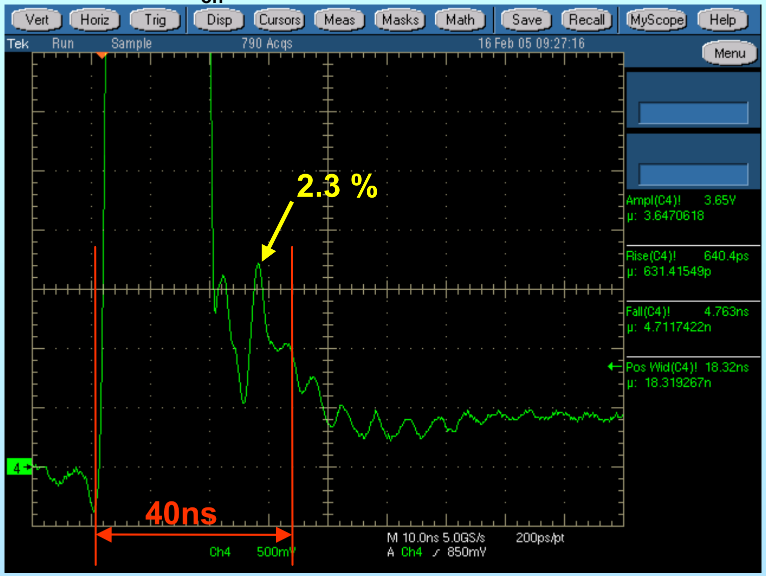
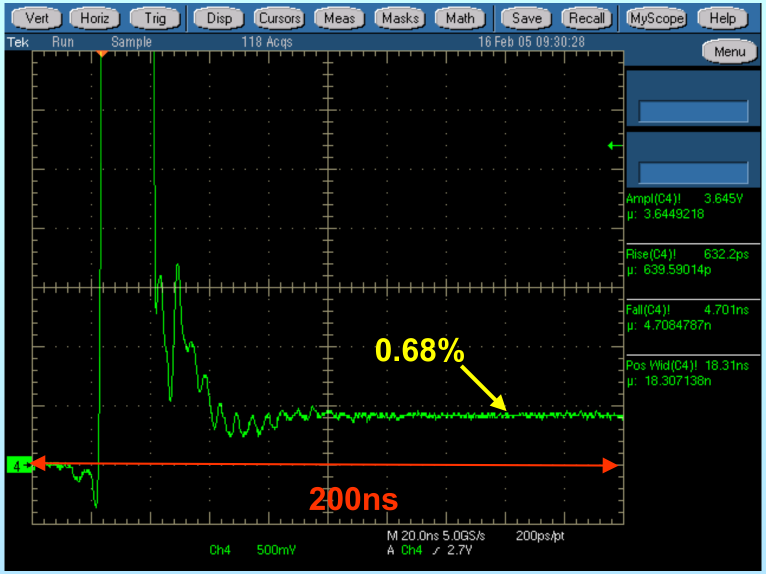
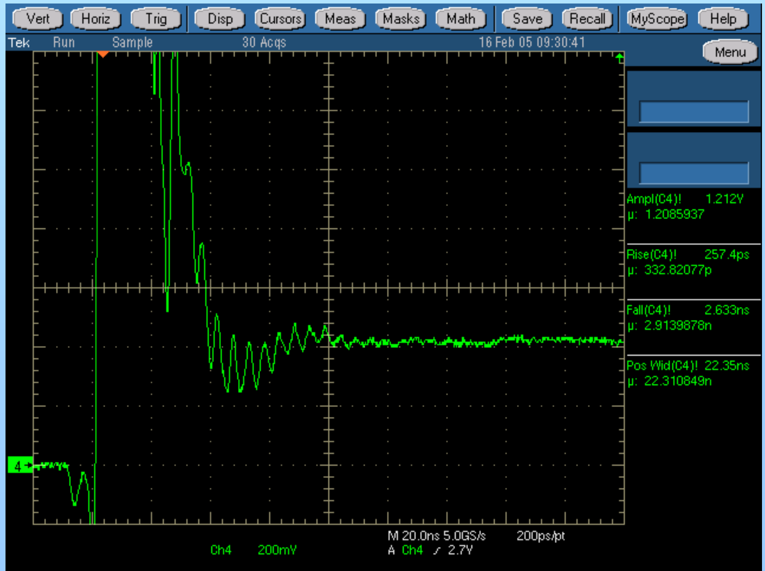
Measurement of the ripple

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







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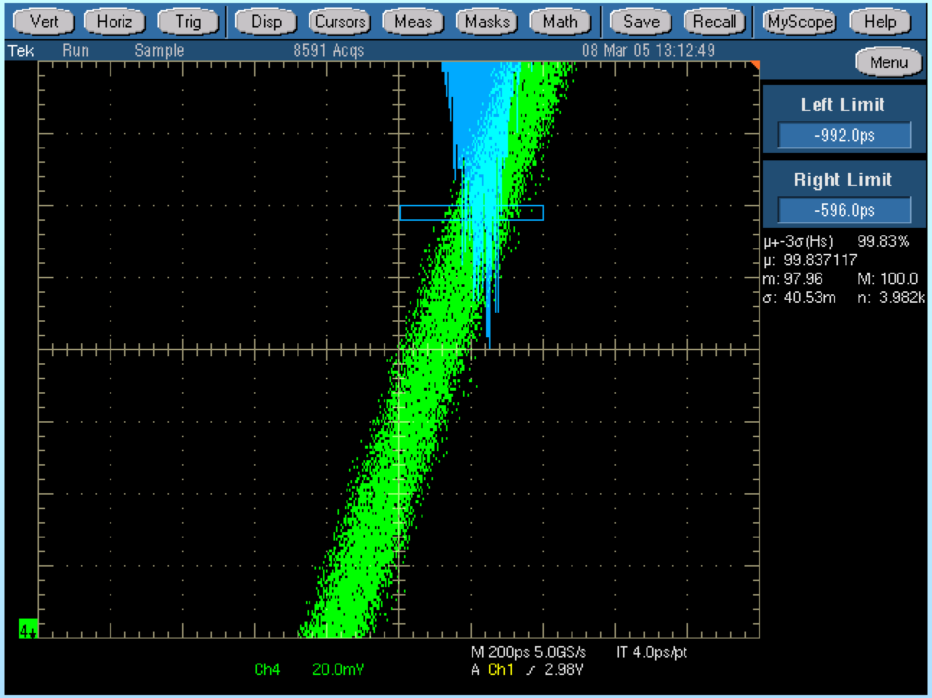
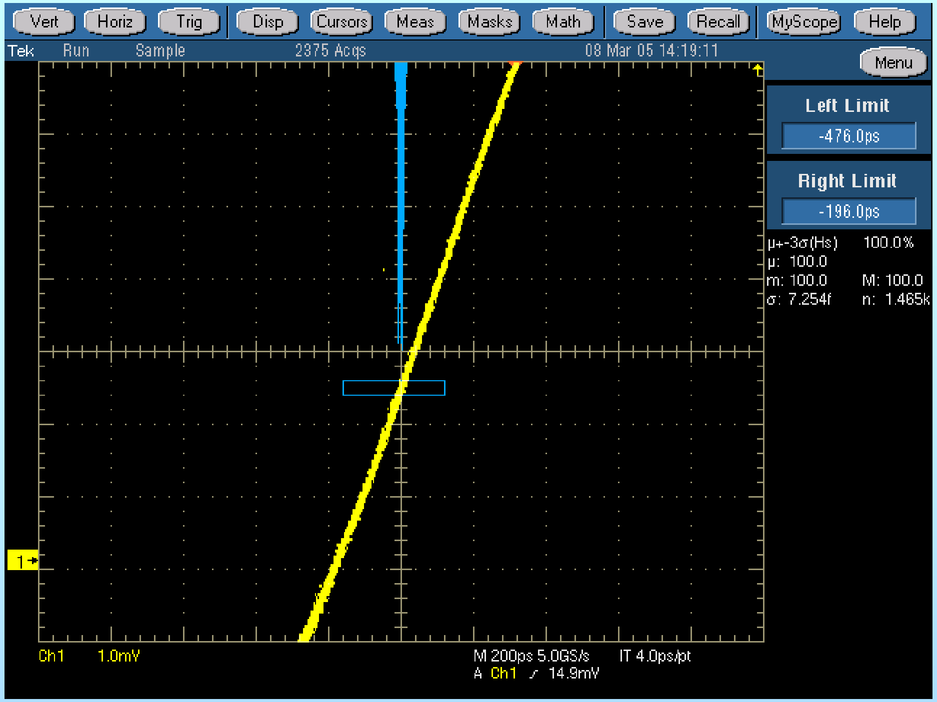
Measurement of the timing jitter

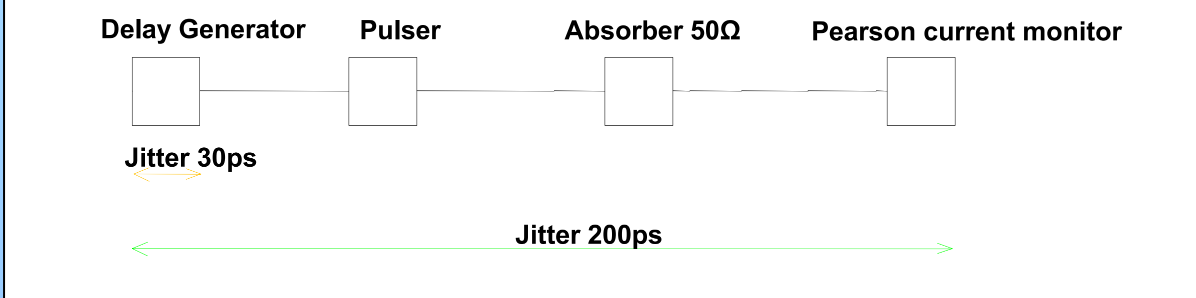
Switch HTS 80-12UF t_{on}=10ns





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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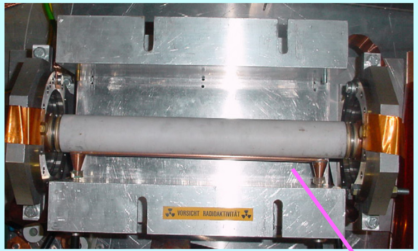
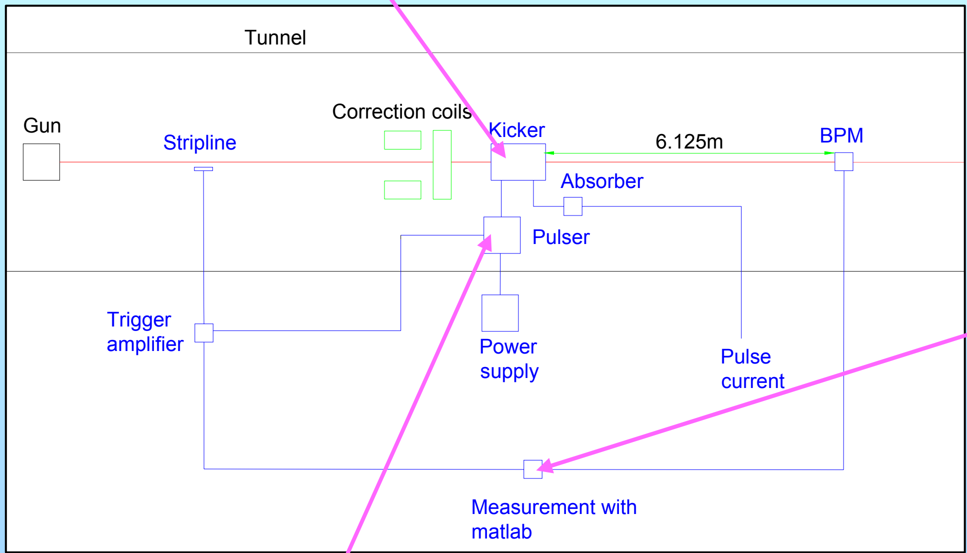
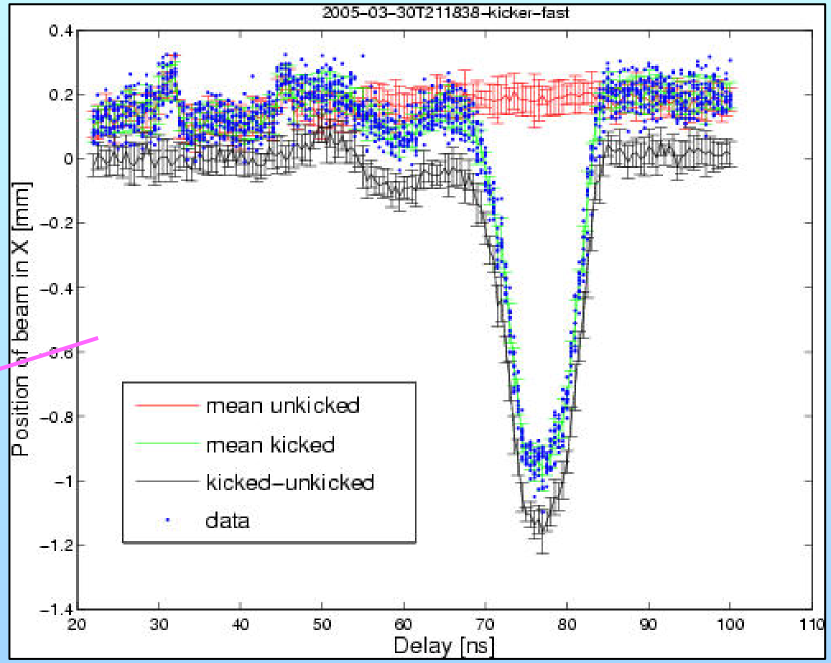
Measurement at TTF 2 (March 2005)

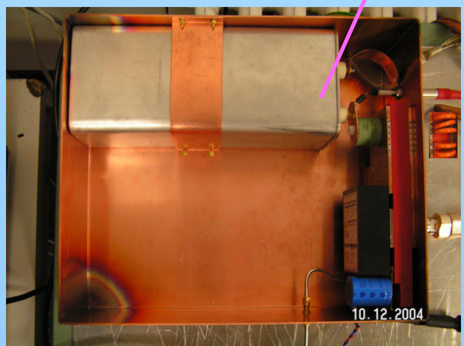


Ceramic kicker

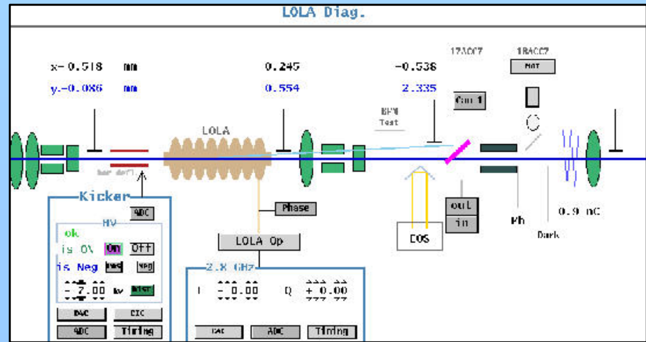
Data:	
Voltage	U= 7.0kV
Pulse current	I=61A
Pulse length	t= 12ns







- **Equipment test**
- **measure the kicker strength**
- **measure kicker amplitude stability**
- **scan the kicker pulse with a step width of 0.5ns and taking 20 pulses for each data point.**



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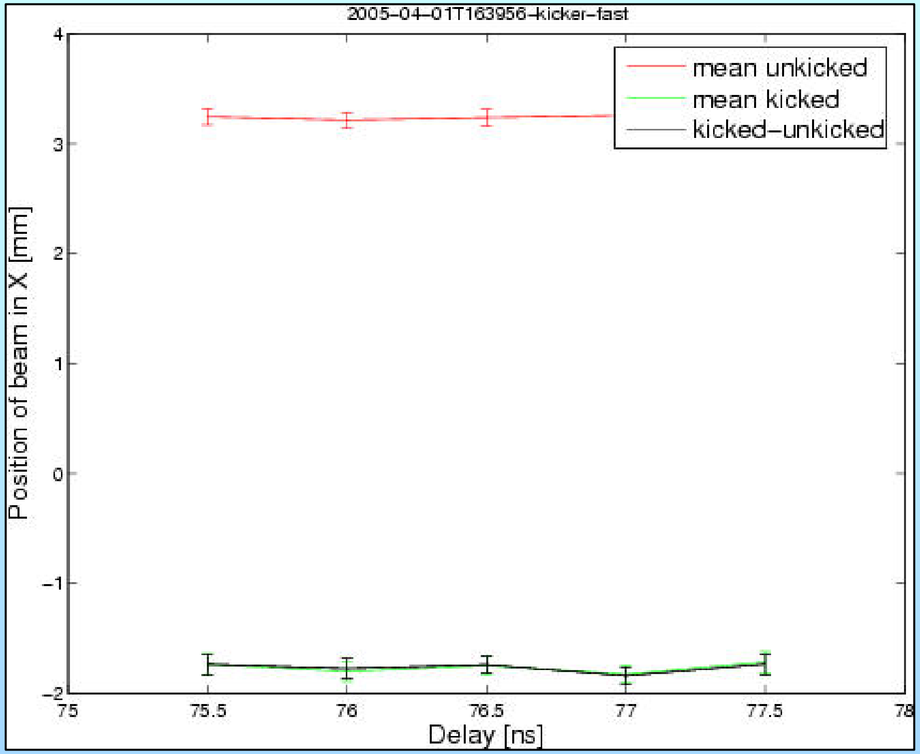
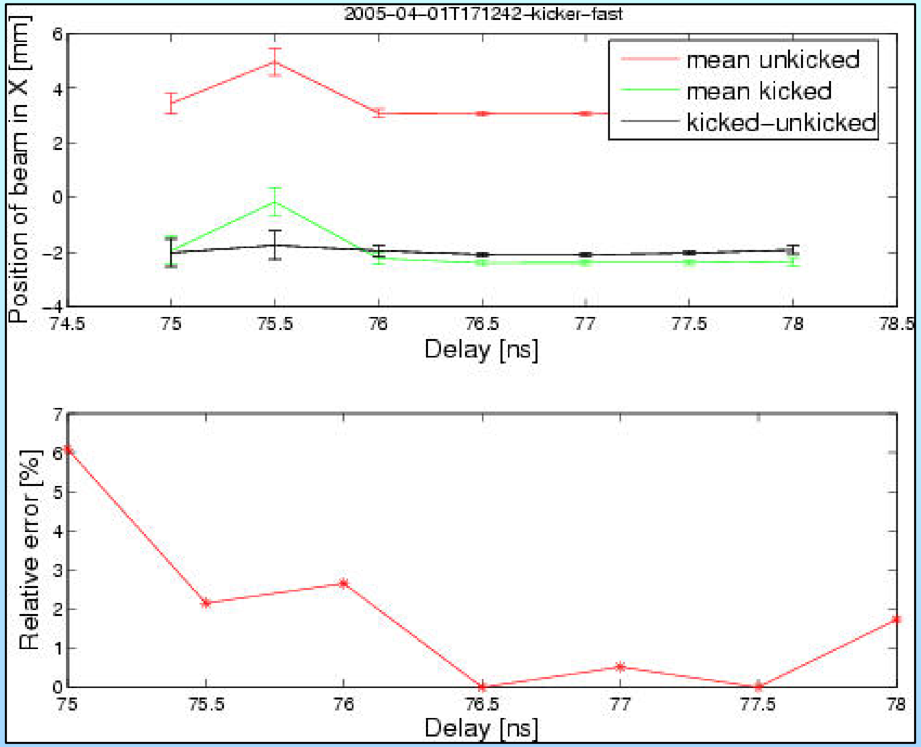
Measurement at TTF 2



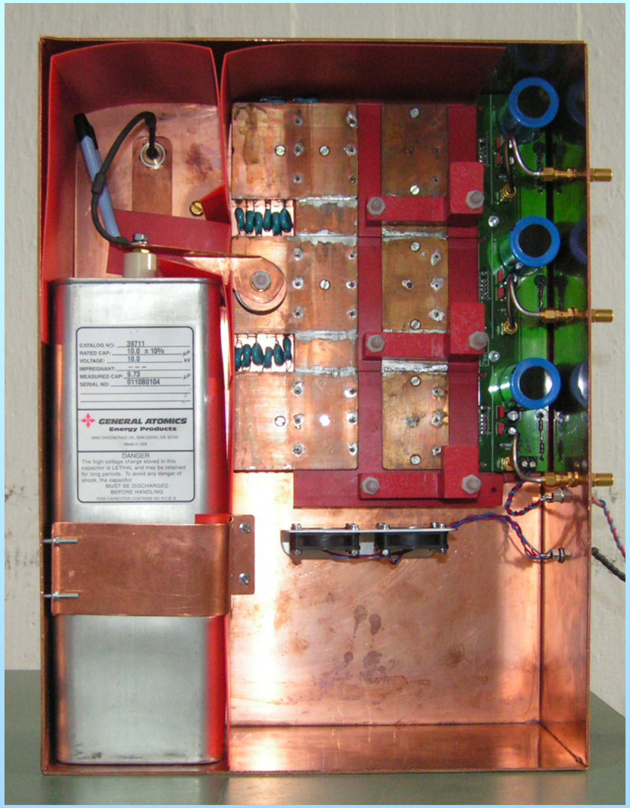


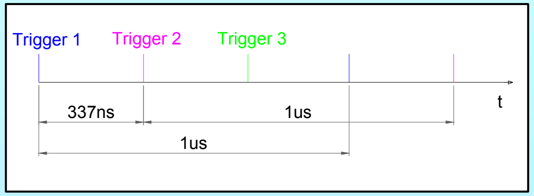
• **scan the kicker pulse with a step width of 0.5ns and take 100 pulses for each data point**

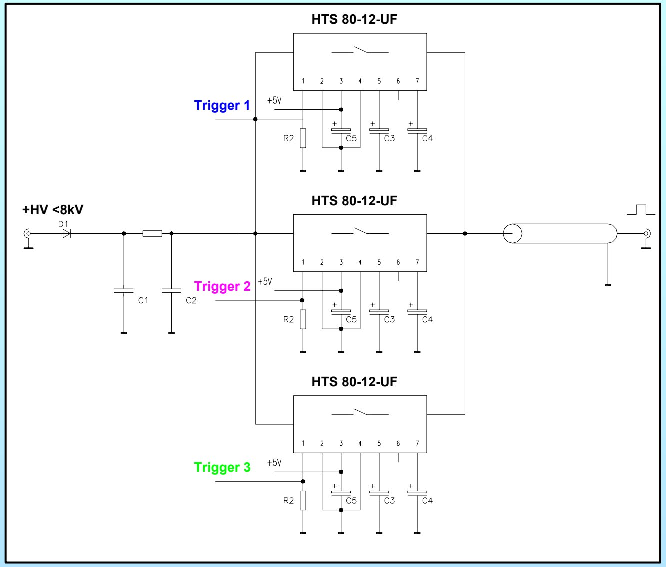
Measurement on kicker 'flat' top to investigate influence of timing jitter. Standard deviations of unkicked / kicked bunch (eposx1/eposx2) are given below as well as relative error. **Smallest error as low as 0.5 %** at certain delay, relative error increases with distance from 'flat, top. Kicker **HV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

Increase Kicker HV, we expect eventually to see a clipping at larger kicker amplitudes. **Kicker HV = 7.64 kV**.
Relative error for 2 points within anyhow present beam jitter of 50-60 micron.

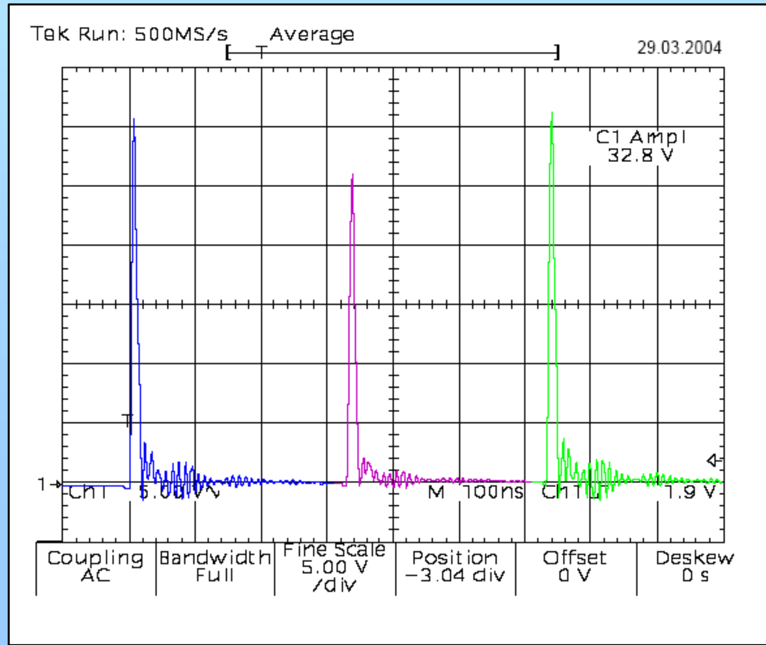
Pulser with a burst frequency of 3MHz







- A principle set up of the pulser
- A Behlke switch in Mosfet technology
- Generate max. 3000 single pulses with 330ns spacing



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

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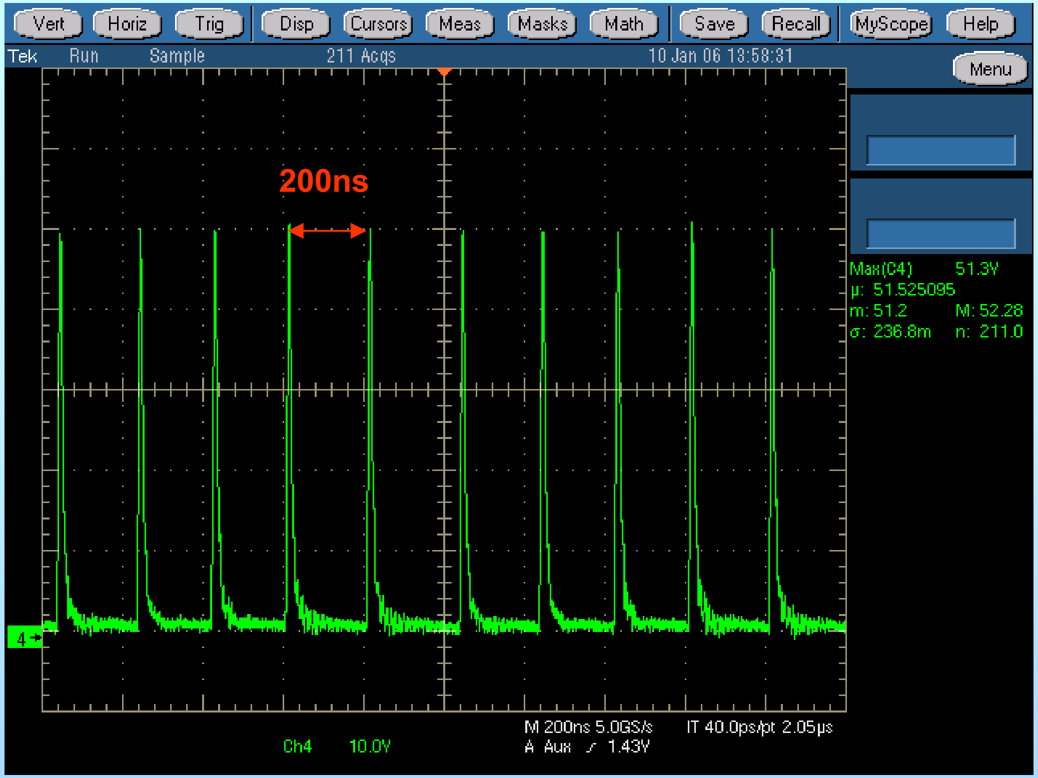
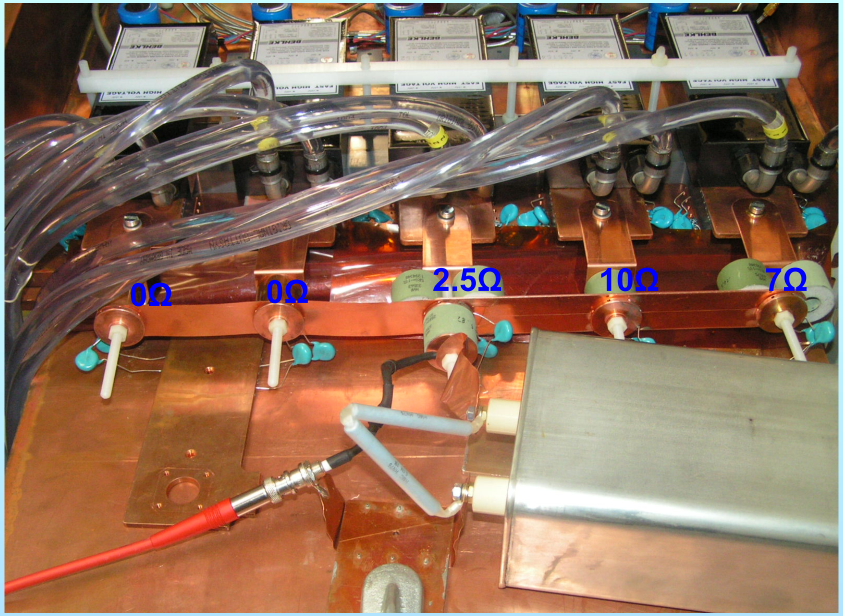
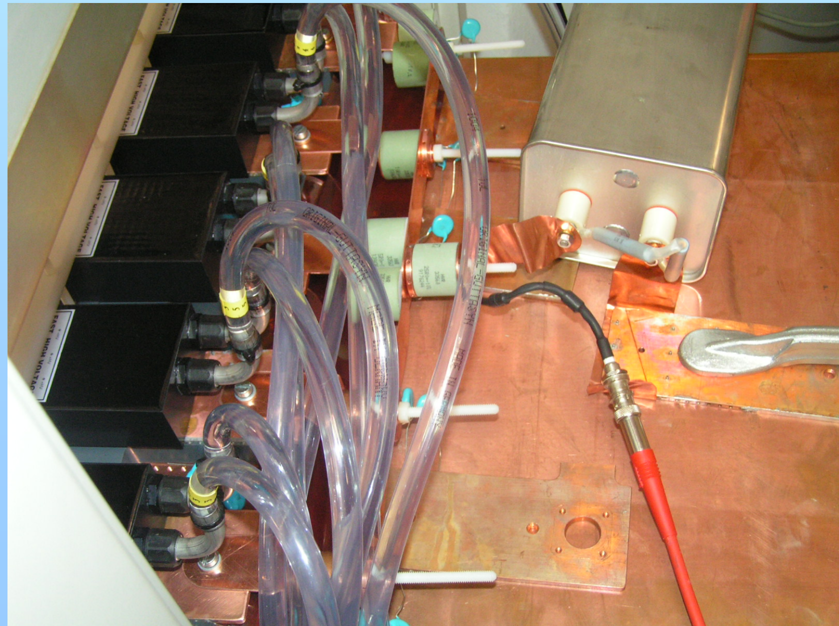
Matching of the pulse amplitude of the 5 MHz Pulser







In this measurement you can see identical pulse amplitudes, we have calibrated it with individual resistors.
Power supply voltage of 6.5kV

Pulser data:	
Voltage	U= 6.5kV
Pulse current	I=51.3A
Frequency (burst)	f=5MHz
Number of pulses	5000
Pulse length	t= 12ns

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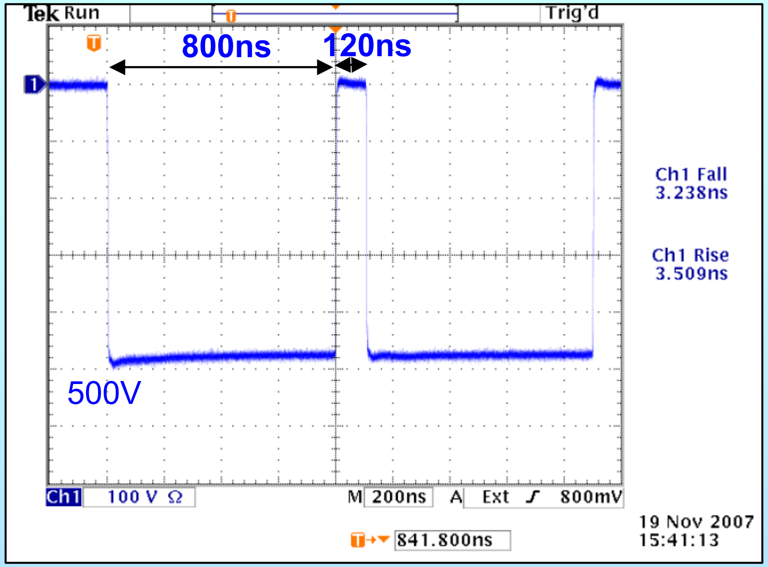
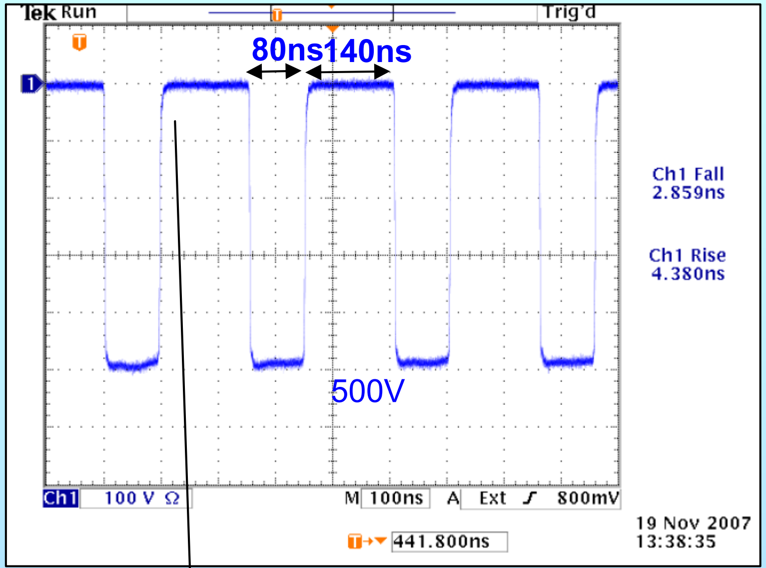
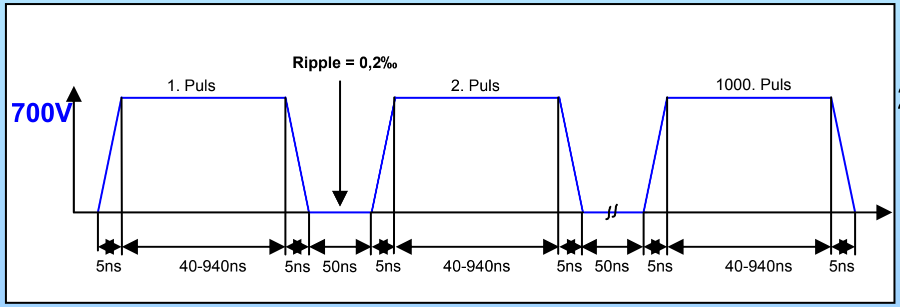
Measurement of first prototype of the dark current pulser from the FID Company

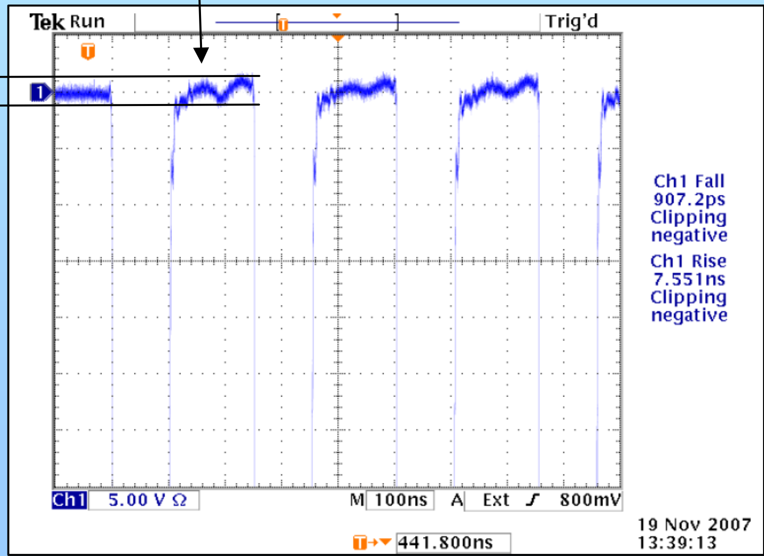




Speciation:

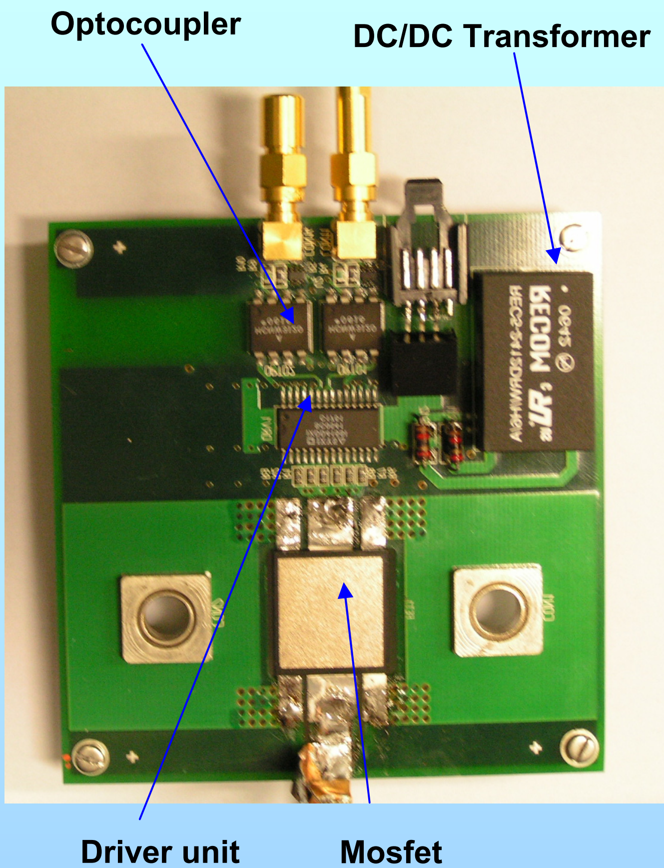


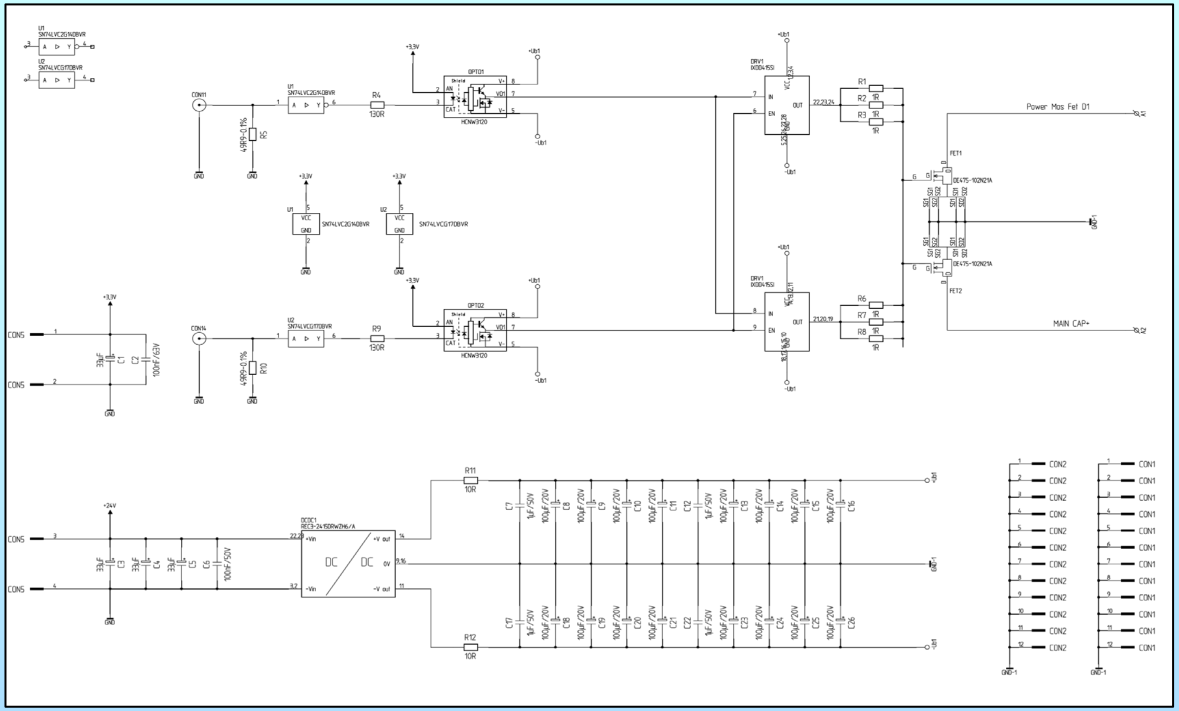
2.5V ≙ 0.5%



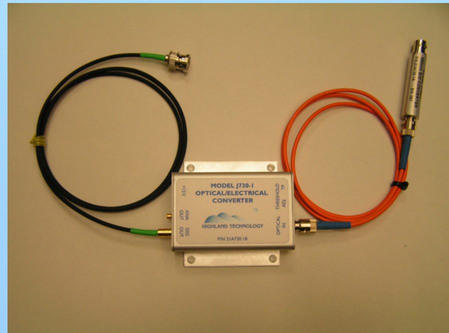
Frequency	**f=1-9MHz**
Voltages	**U=700V**
Current	**I= 50A**
Rise time	**t=5ns**
Pulse length	**t=40-940ns**
Burst	**1000 Pulse**

Mosfet pulser module





Pulser module data:	
Voltage	U= 1000V
Pulse current	I=80A
Frequency (burst)	f=2 MHz



Optical fiber data:	
Input	+5V into 50Ω
Output	1mW
Jitter RMS	10ps
Rise time	100ps
Bandwidth	180 MHz

Next steps:
- We want to integrated a new optical fiber in the circuit. So we can operate with a frequency of 5 MHz and we can reduce the jitter.
- After this we want to built a pulser with a stack of modules.

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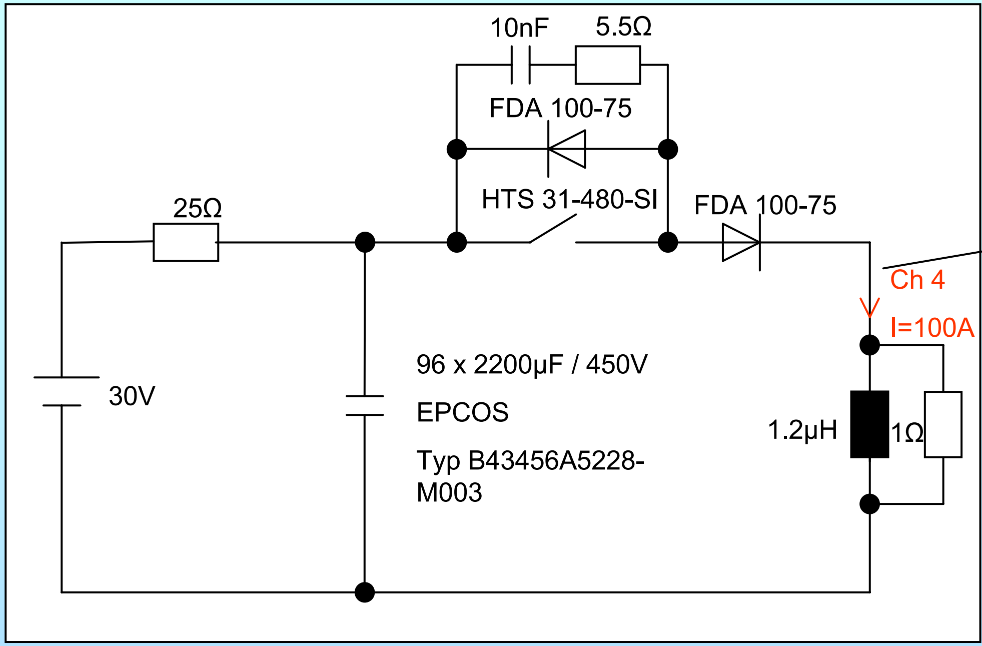
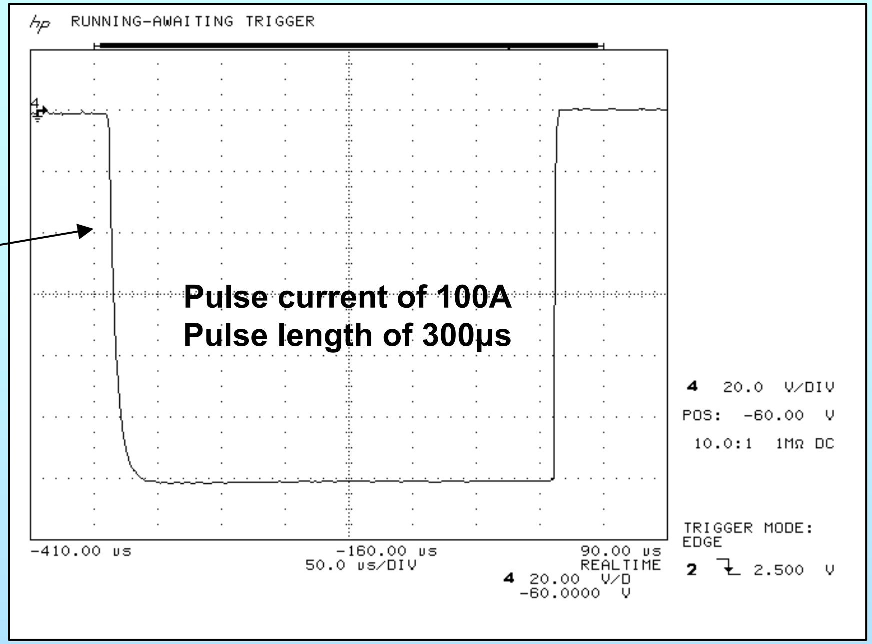
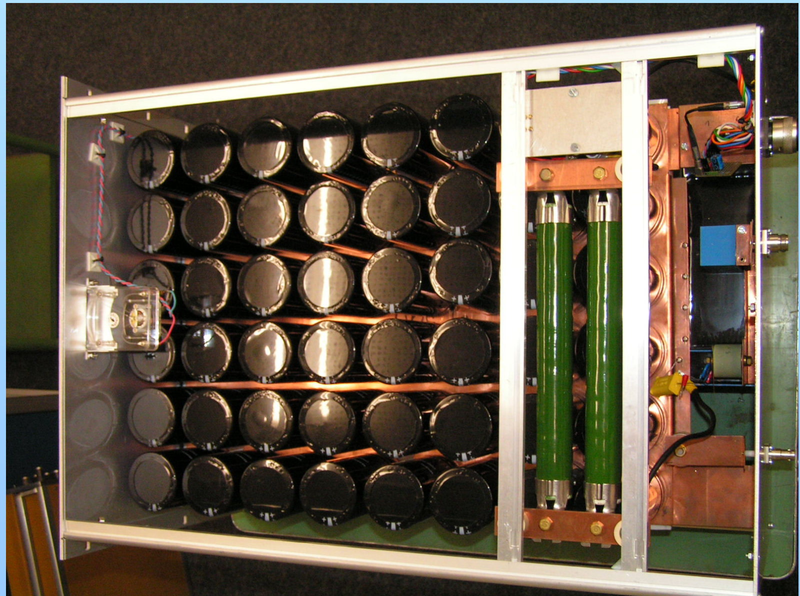
Flat top pulser







Pulser data:	
Voltage	U= 200V
Pulse current	I=400A
Frequency	f=10Hz
Pulse length	t= 300µs

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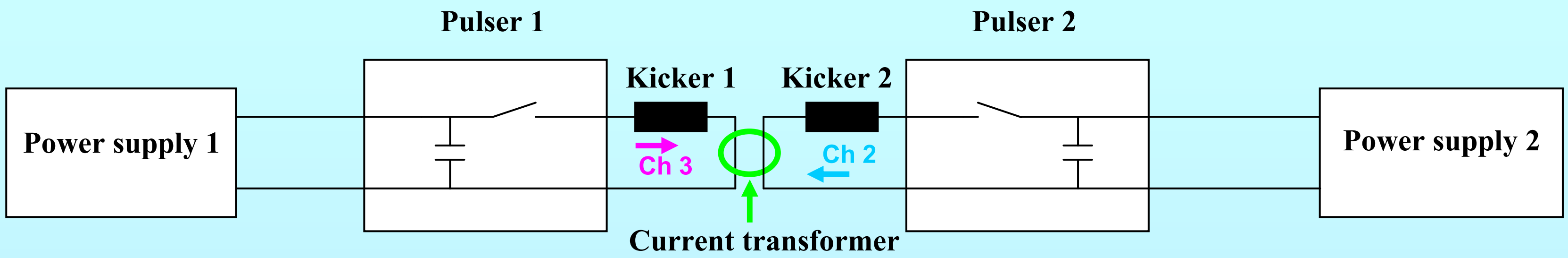
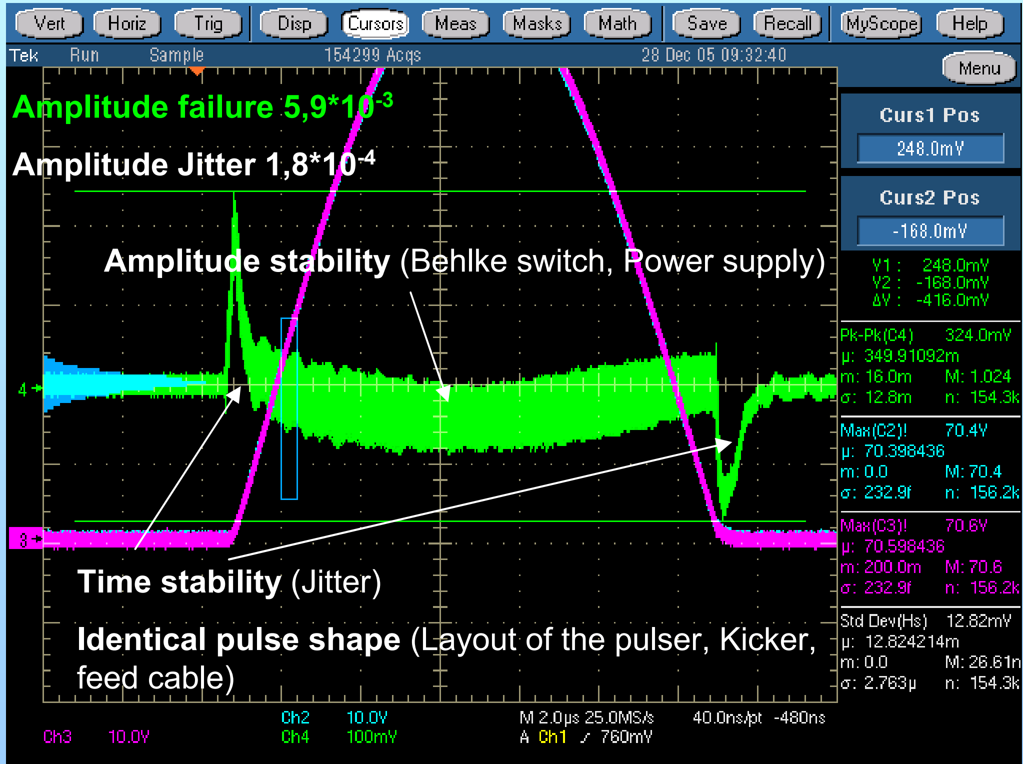
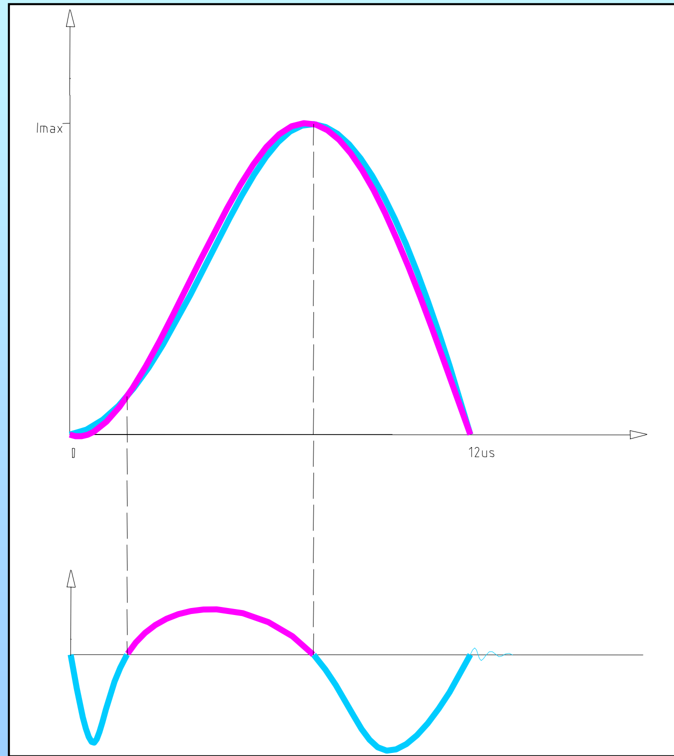
Pulse stability measurement of the PETRA III Injection Kicker







We need a method to measure the amplitude stability and the similarity of the pulse shape. We have two identical pulser and kicker. We give the pulse current into a Pearson monitor and measure the difference between currents. You can see that the Stability is 0.2 per mill. The begin and the end differences come from the timing jitter (Behkle switch 1ns).

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Summary:

- For the XFEL Dump pulser we can use a Behlke switch. The pulse stability is good. The main problem is the ripple after the pulse. We could compensate it with a corrector magnet, but this will be very complicated.

- For the FID Pulser we must make the same measurements about ripple, stability, jitter and so on.

- For the Mosfet module we want to integrate a new optical fiber in the circuit. So, we can operate with a frequency of 5 MHz and we can reduce the jitter.

- For the flat top pulser we want to make the difference measurement.