EMI Steering Group Report

1. EMV-Kongress Summary:
   - Peter and I visited the EMV-Kongress in Düsseldorf (7.-9.3.2006).
   - Tutorials and workshops were in principle ok, but for 245 EUR/person (!) I expect something close to perfect, which was not the case.
   - EMC test stands were one focus of this conference and of the associated fair.
   - I have the proceedings as a book and on CD, if you are interested.
2. Power Supply Expert in ESG:
   - Niels, would you like to join our weekly meetings?
3. Cable Documentation System:
   - Peter is not here today because he is the EMC representative at a meeting for selecting a company which will select a cable documentation system for DESY (2nd round).

4. Personnel:

   - Narcisse Ngada has started his diploma work on the pulse cables, supervised by Jörg.

5. Next meeting:

   - Monday 15/05/06 at 11:00 here.
   - Focus: Same topics as today.

XFEL Tunnel Grounding (1)

Outline:

1. Introduction
2. Safety vs. Signal Grounds
3. Types of Signal Grounds
4. Relevant XFEL Parameters
5. XFEL Facility Ground
6. Next Steps

Introduction

Reasons for discussing XFEL tunnel grounding now:

- Documents for the civil engineering bidding procedures are being prepared now. They must specify some basic EMC requirements.
- Tunnel space is already scarce, reserve it better now than later.
- A good ground system must be designed, it doesn't come by itself.

There will be more talks on different aspects of this subject.

Safety vs. Signal Grounds

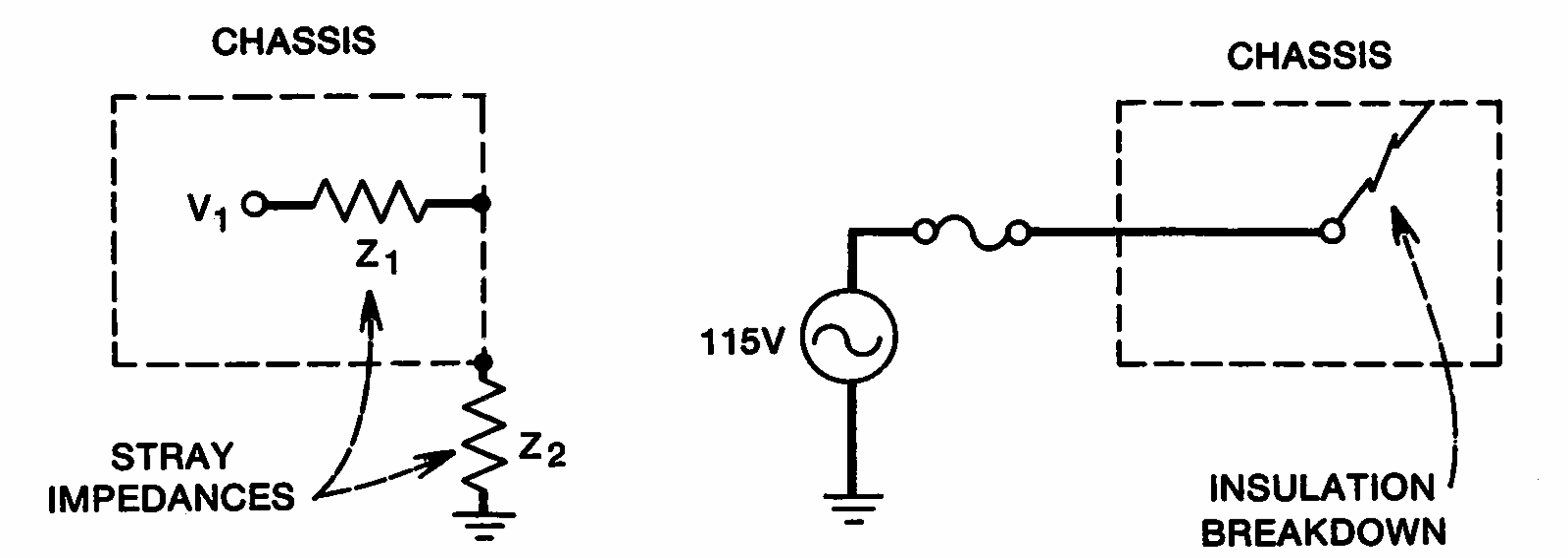
There are two categories of grounds: safety grounds and signal grounds:

- A safety ground system
  - prevents dangerous potentials at accessible conductive parts of an installation (Potentialausgleich),
  - has no currents flowing, except in case of failure (there might be Ausgleichsströme, though),
  - is normally connected to earth, preferrably only at the transformer,
  - should include other metal stuff (water pipes, concrete mesh, ...),
  - should include lightning protection,
  - is regulated by law,
  - at DESY is responsibly planned by MKK.

Safety grounds keep dangerous voltages off accessible chassis

Stray impedances or dielectric breakdown may expose equipment operators to hazardous voltages unless a chassis is grounded.

In the right hand illustration, adding a chassis ground would cause the fuse to blow, removing the voltage on the chassis.



- A signal ground system
  - provides a voltage reference for signals,
  - is usually not an equipotential point or plane where the voltage is independent on the current drawn or applied (such a thing hardly exists in reality),
  - provides a designed low-impedance path for signal current return to the source.

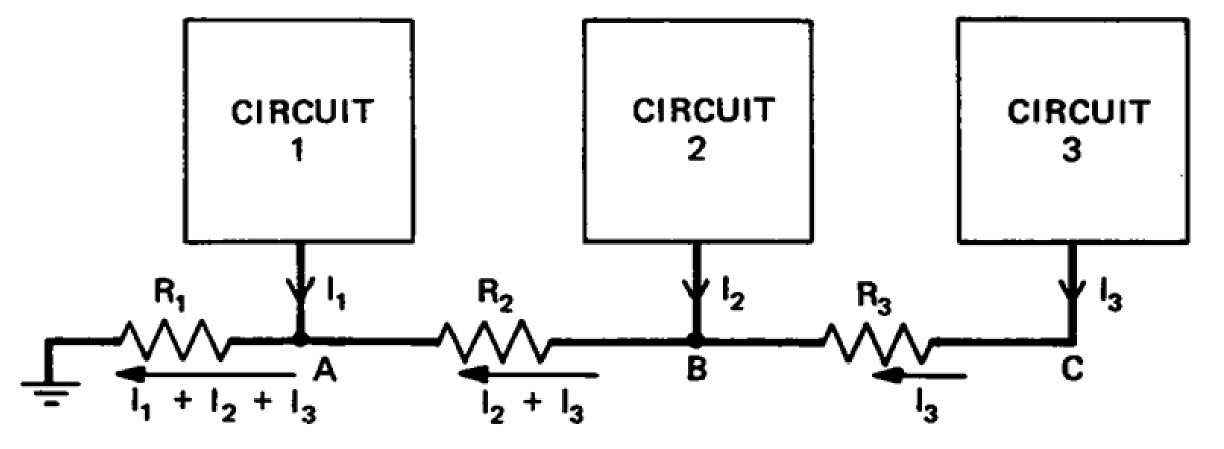
  Two things to keep in mind:

  1. Real conductors have finite impedances, with inductance dominating sooner than you think.
  2. Two physically separated ground points are seldom at the same potential.

Types of Signal Grounds

No one signal ground system is appropriate for all applications.

- Single point ground with bus connection:

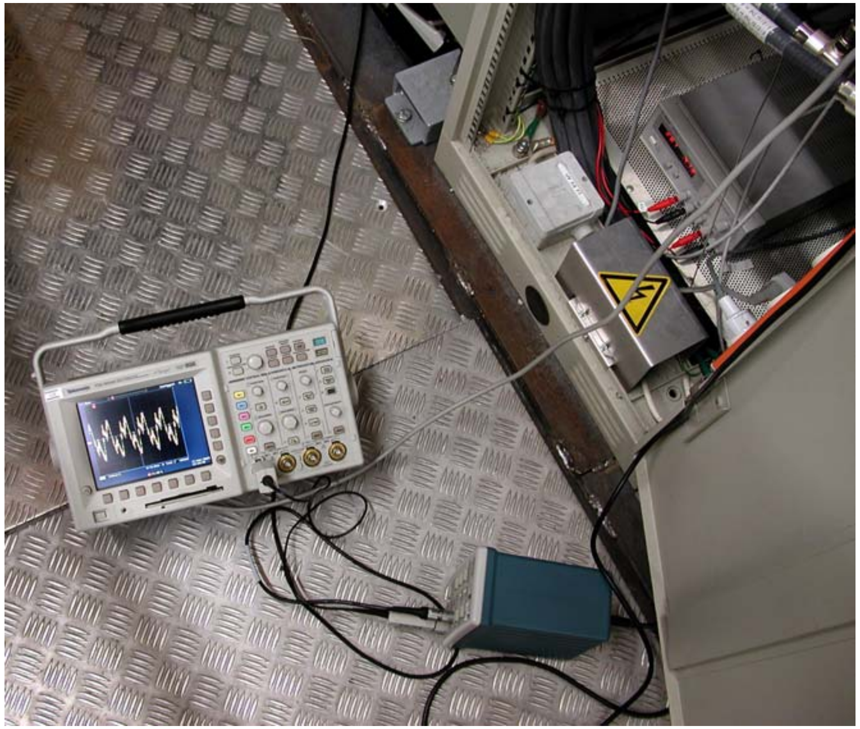


  - The galvanic coupling of circuits makes this the worst system from an EMI point of view.
  - Due to the low cable cost this topology is very common – and perfectly ok – for safety ground systems.

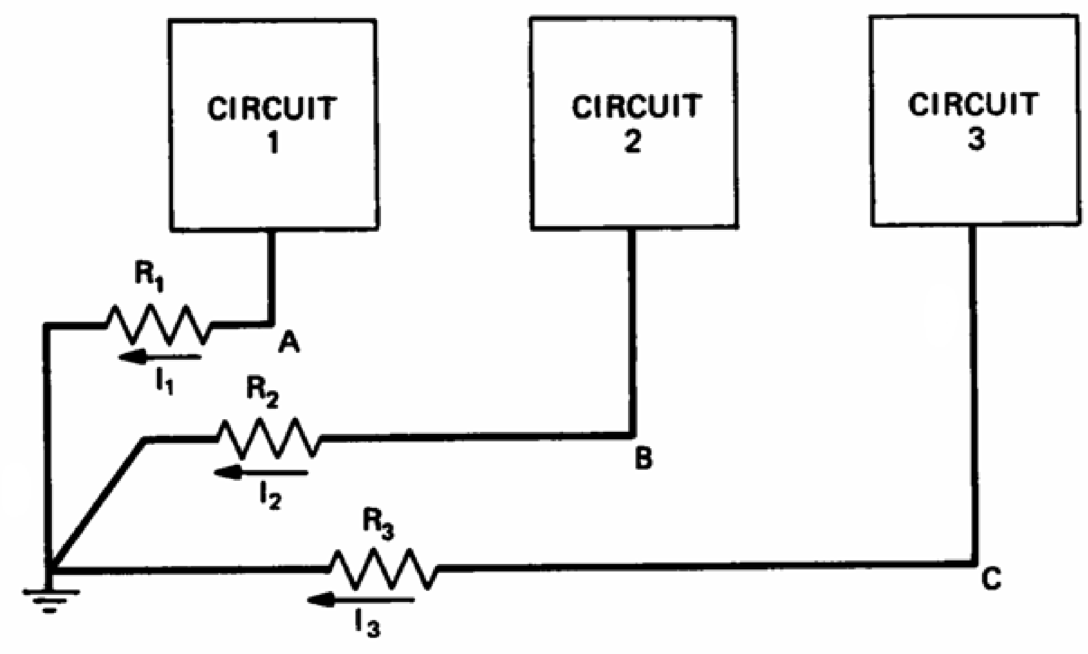
Power or common grounds are usually inadequate signal grounds

Power grounds are single-point series connected grounds
- noise currents/voltage add

Power grounds carry significant noise currents – here ~400 ma pp at 50 Hz with higher frequencies



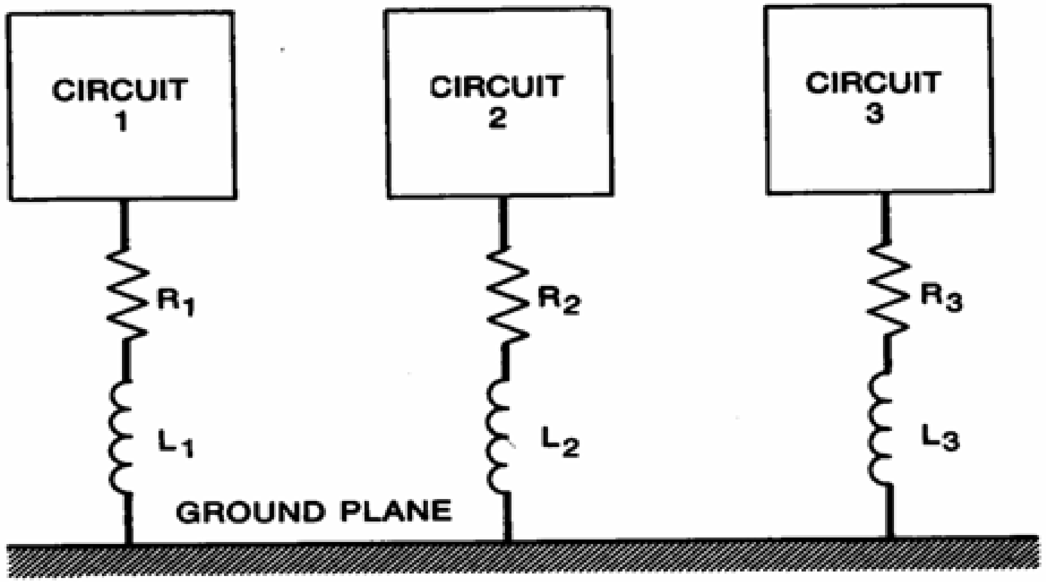
- Single point ground with star connection:



  - Needs a lot of cable.
  - The totally decoupled circuits makes this the best system EMI-wise at low frequencies.
  - At high frequencies wire inductances and stray capacitances destroy the star topology.

$\rightsquigarrow$ system size limit $\approx \lambda/10$ (= 30 m @ 1 MHz).

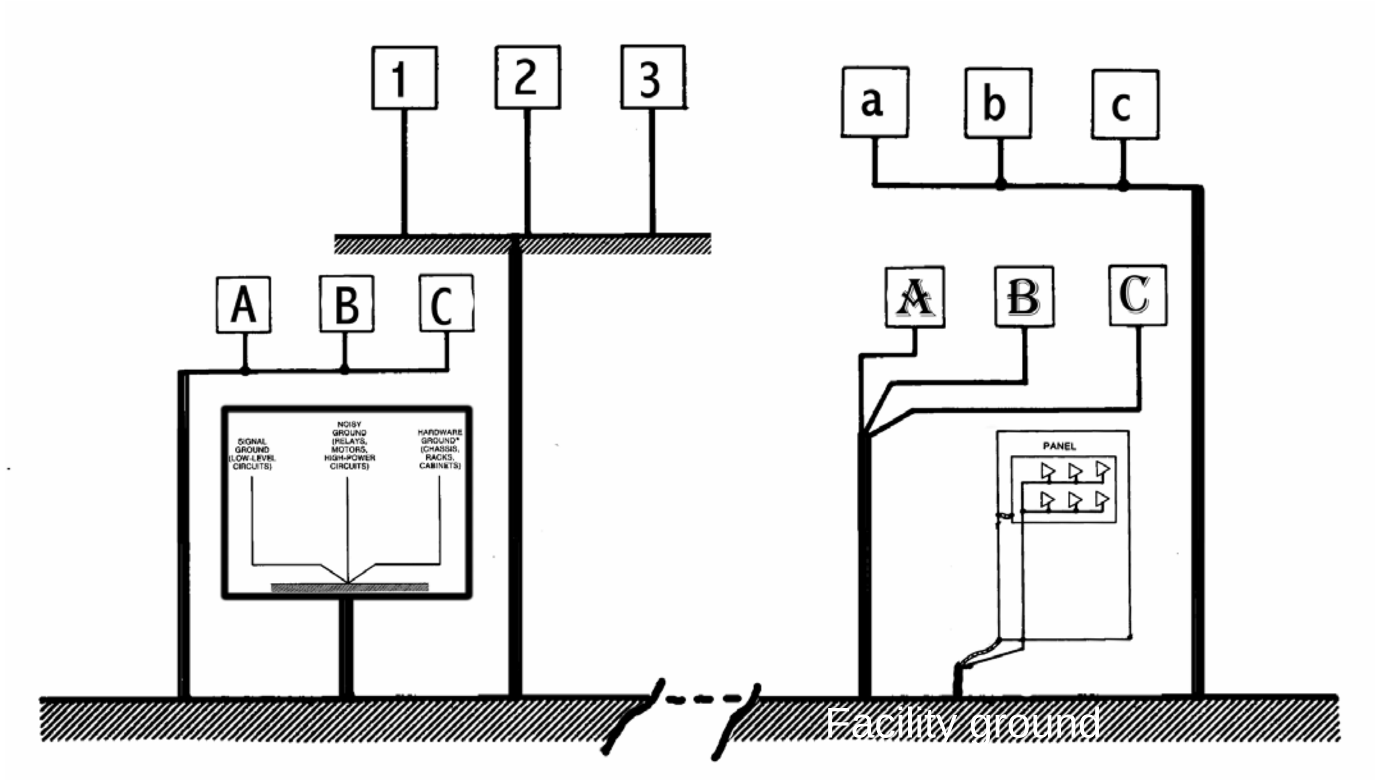
- Multi point ground:



  - Circuits connect to nearest point on low-impedance ground plane using short low-impedance straps.
  - The ground plane can be approximated by a grid with mesh size $\leq \lambda/50$.
  - This is the adequate grounding scheme at high frequencies, e.g. in digital circuits.
  - At low frequencies one has ground loops and common impedance coupling.

In a large facility, where many ground conductors would be > 1/10th wavelength long, a distributed hybrid ground system should be used

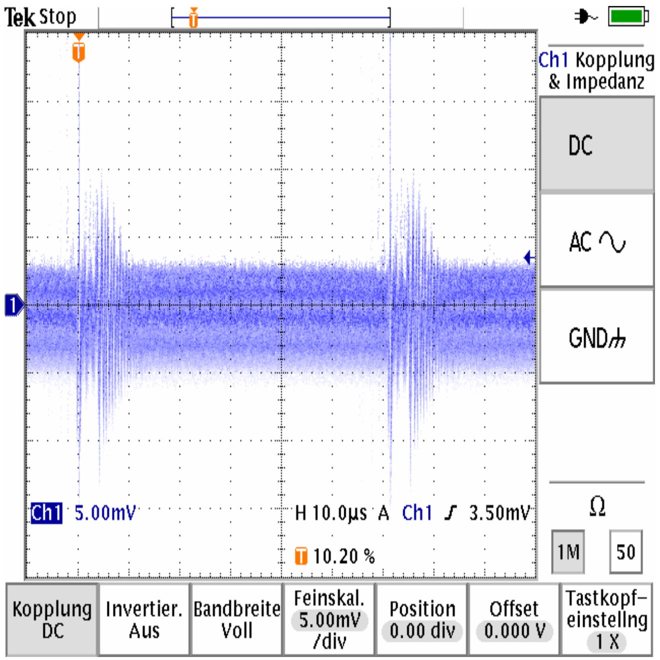
- Local (<1/10 λ) SP ground areas keep ground Z & noise potentials low
- Cables can be run between local devices (with some restrictions)
- Grounded cable connections are forbidden between local areas
  - they won't work well anyway since shield/noise currents will be high



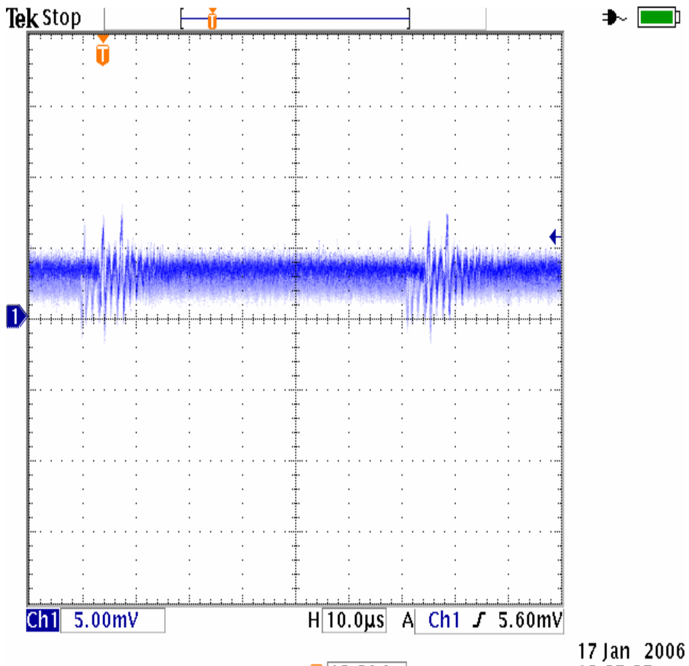
Relevant XFEL Parameters

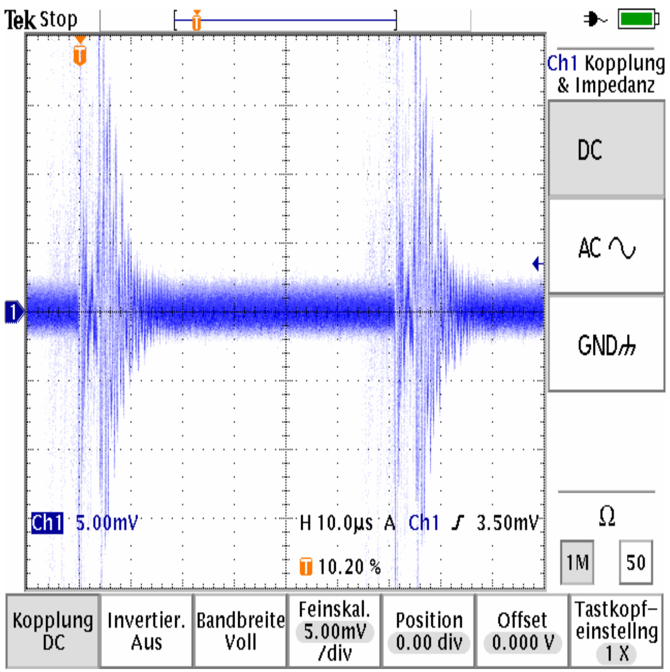
- EMI signals measured at VUV-FEL:

Noise Source	Frequency	Wave Length
bouncer, primary pulse	205, 588 Hz	1460, 510 km
1.5 km cable ringing	170–200 kHz	1760–1500 m
same for shorter cables	larger	smaller
modulator switch transient	2.2–2.8 MHz	140–110 m
chopper PS switching	15.7 kHz	19 km
chopper PS transient	≈ 2 MHz	150 m
NH PS switching	40–100 kHz	8–3 km
NH PS transient	TBD	TBD

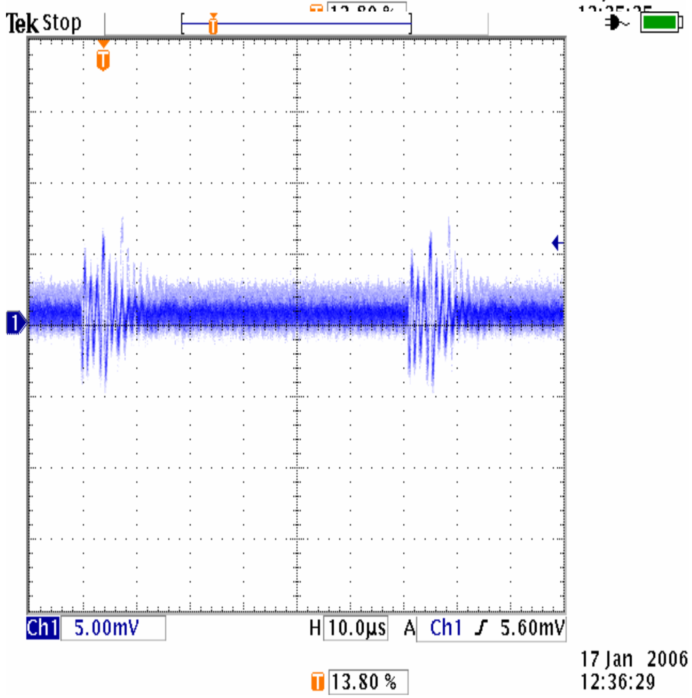


-Out





Common Mode Out:
Factor 4 improvement by filters



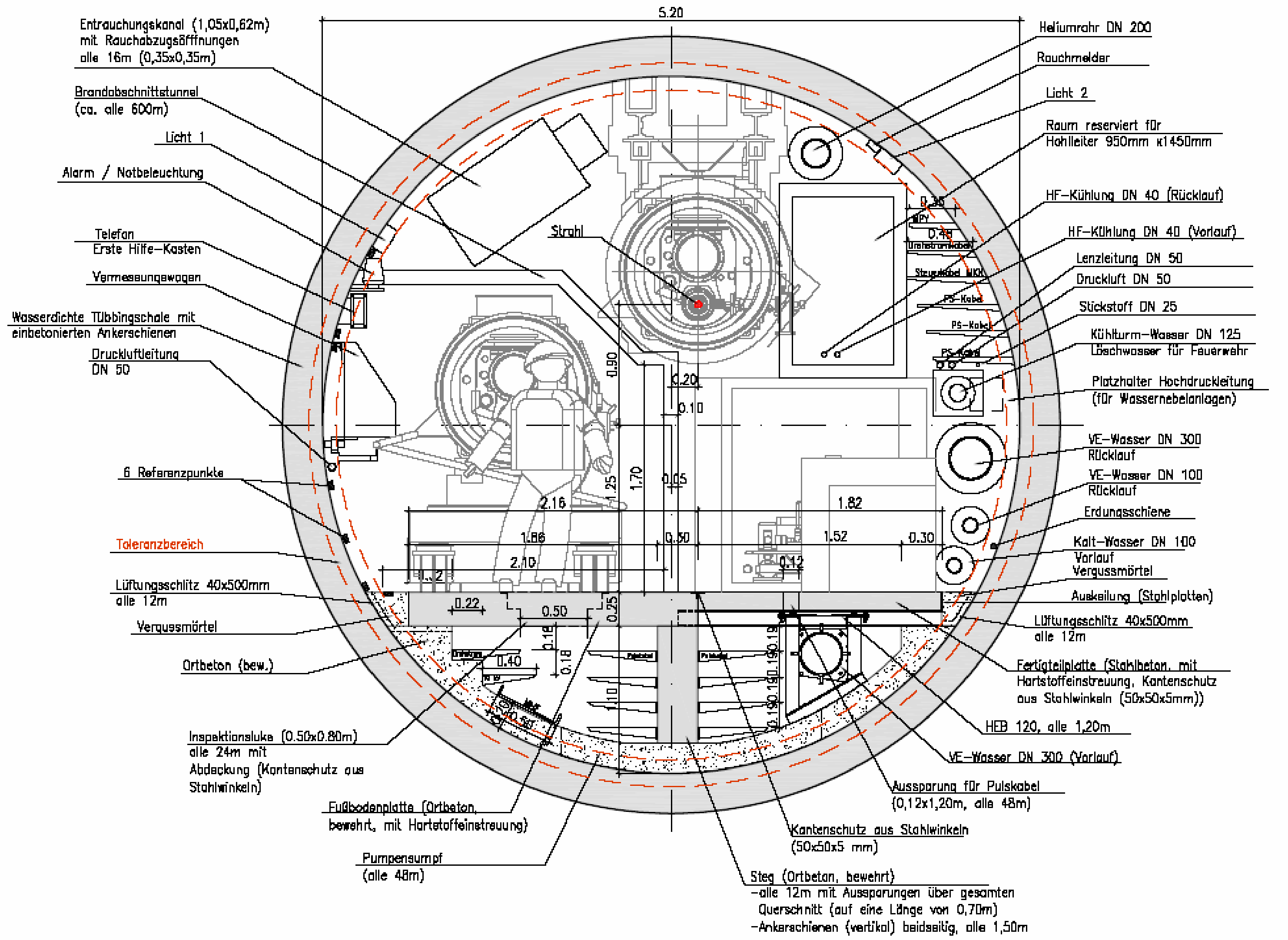
XFEL Facility Ground

- Due to its length $>> \lambda(2\,\mathrm{MHz})/10 = 15$ m the XFEL facility needs a hybrid ground system where many local single-point grounding areas are connected to a common facility ground.
- In order to push its impedance as low as possible, the common facility ground (plane) should include as much through-going metal structure as possible (tubes, pipes, cable trays, remesh,. . .).
- Since these components will not really form a plane, aim at a mesh size $\approx \lambda(2\,\mathrm{MHz})/50 = 3$ m.
- Today only the technical solution for including the tunnel wall reinforcement will be discussed.

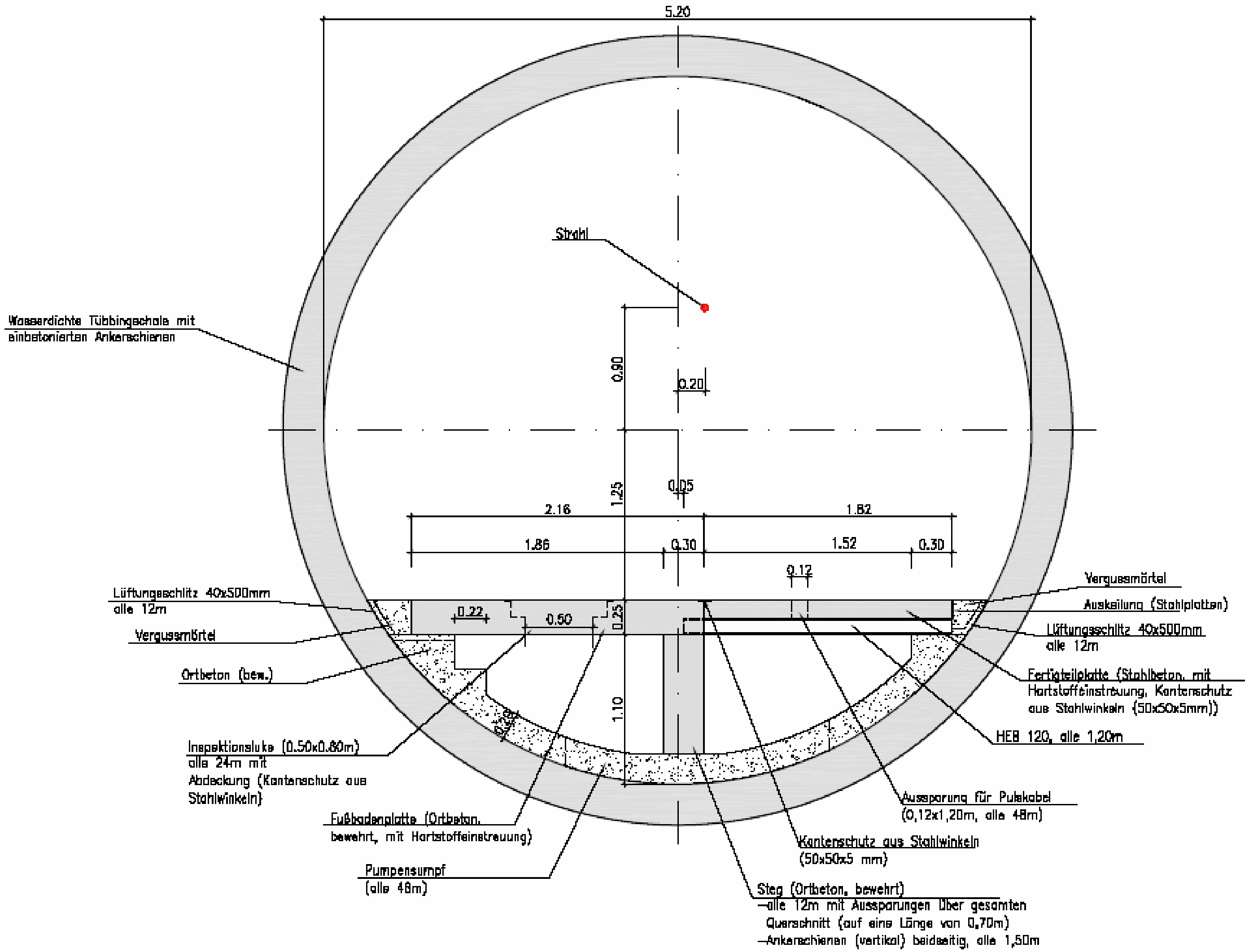
Röntgenlaser XFEL

WTM ENGINEERS AMBERG ENGINEERING

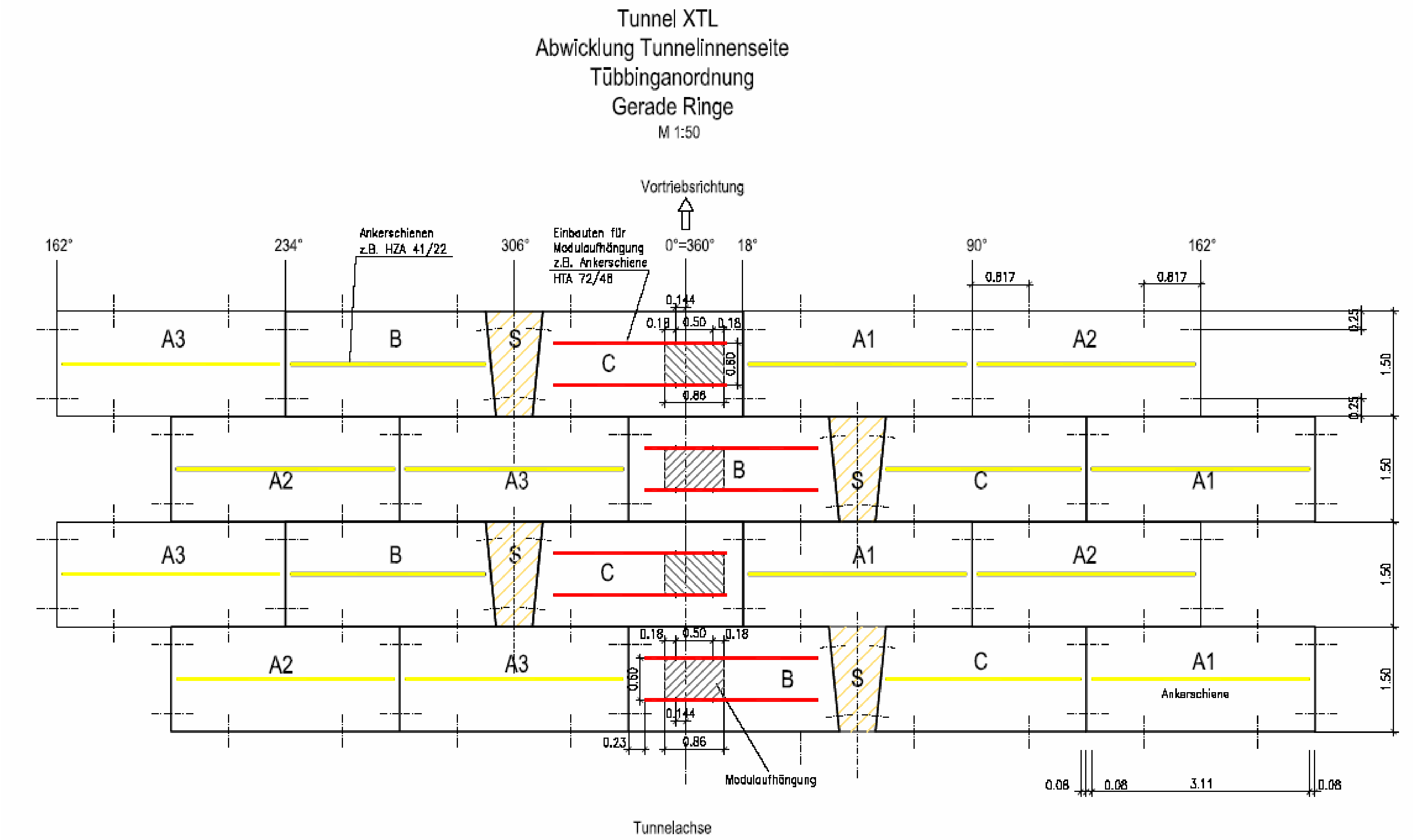
Tunnelquerschnitt Modulstrecke



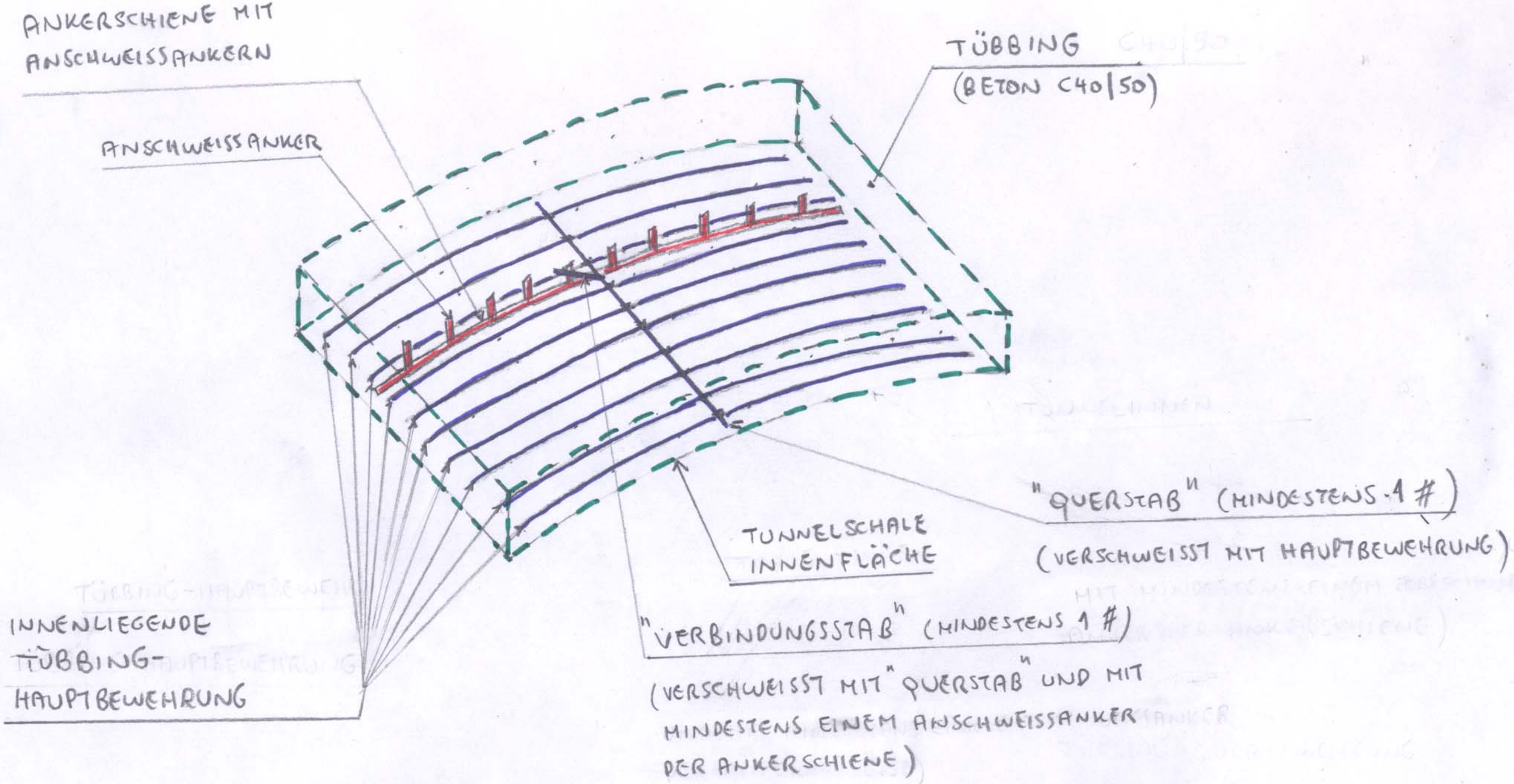
Tunnelquerschnitt Modulstrecke – Bauliche Planung



Ankerschienen in Tunnelleibung



Tübbingbewehrungskorb



N.T.S.

TÜBBING-QUERBEWEHRUNG
NICHT DARGESTELLT

VERBINDUNG ANKERSCHIENE –
TÜBBING-HAUPTBEWEHRUNG
(SCHEMATISCH)

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Dübel
Riss Hebemittel

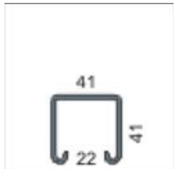
HALFEN Montageschienen und Halfenschrauben

Mittelschwere Tragsysteme (Standard)

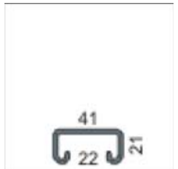
kaltgewalzte Profile

- eine Schienenmutter für alle Profile
- kompatibel mit Powerclick System 41

HM 41 / 41



HM 41 / 22



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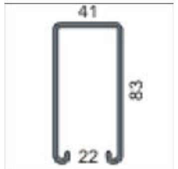

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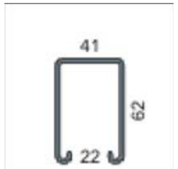
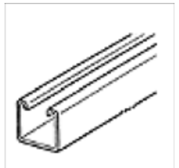
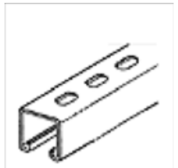


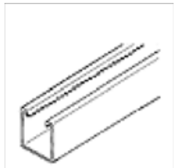
Ausführungen



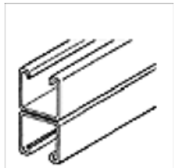
glatt
HM



gelocht
HL



gezahnt
HZM



Doppelprofil
D

gezahnt + gelocht
HZL

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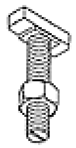
HALFEN Montageschienen und Halfenschrauben

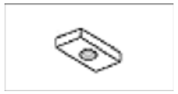
Halfenschrauben

Halfenschrauben (HS), Gewindeplatten (GWP) und Gewindestangen (GWS)

HS



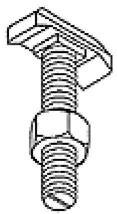
GWP



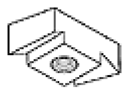
GWS

Halfenschrauben (HS), Gewindeplatten (GWP) und Gewindestangen (GWS)

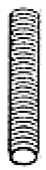
HS



GWP



GWS



Halfenschrauben mit Verzahnung (HZS), Gewindeplatten (GWP) und Gewindestangen (GWS)

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Next Steps

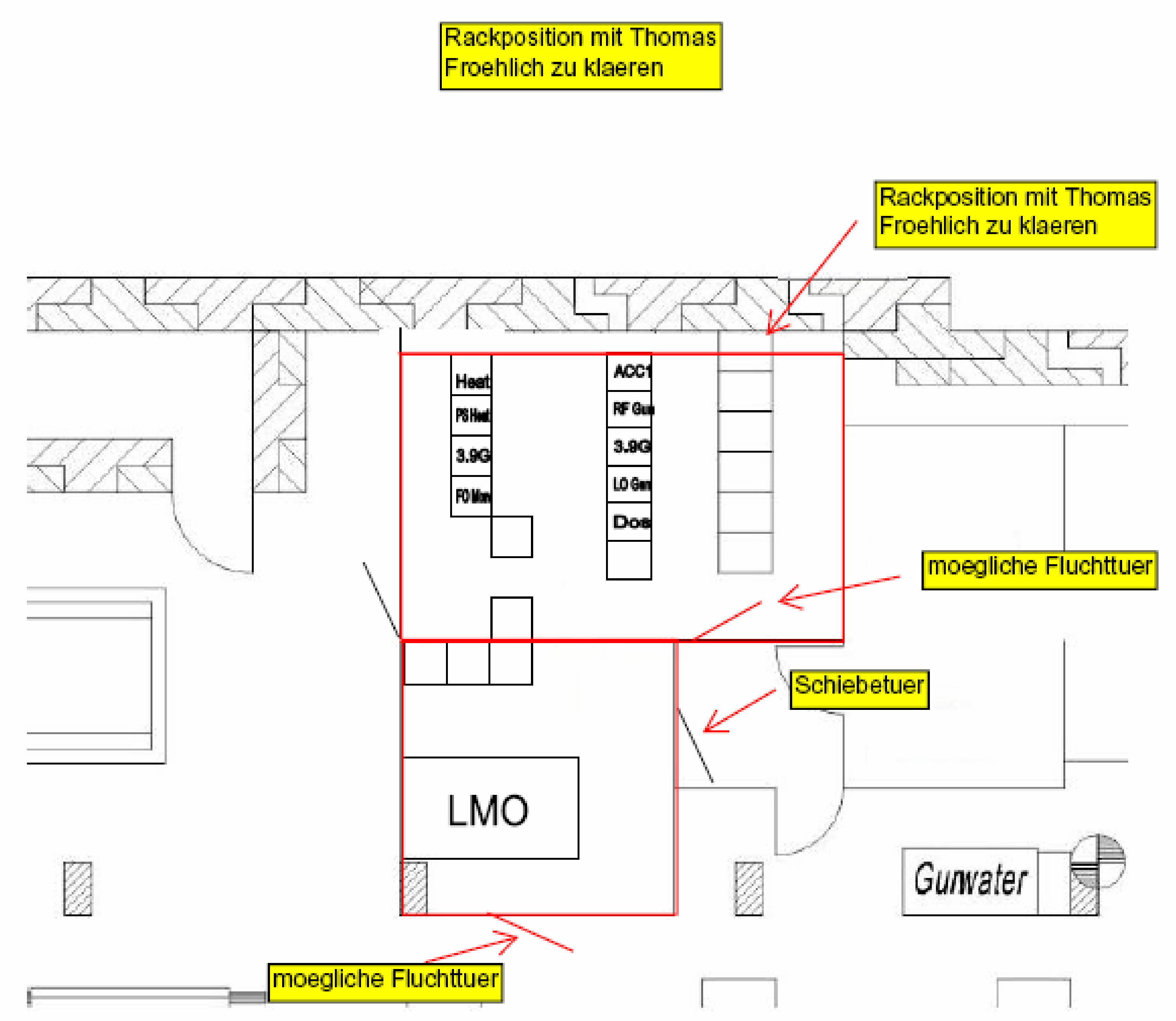
For the following points some understanding and some numbers are still missing. They will be presented next time:

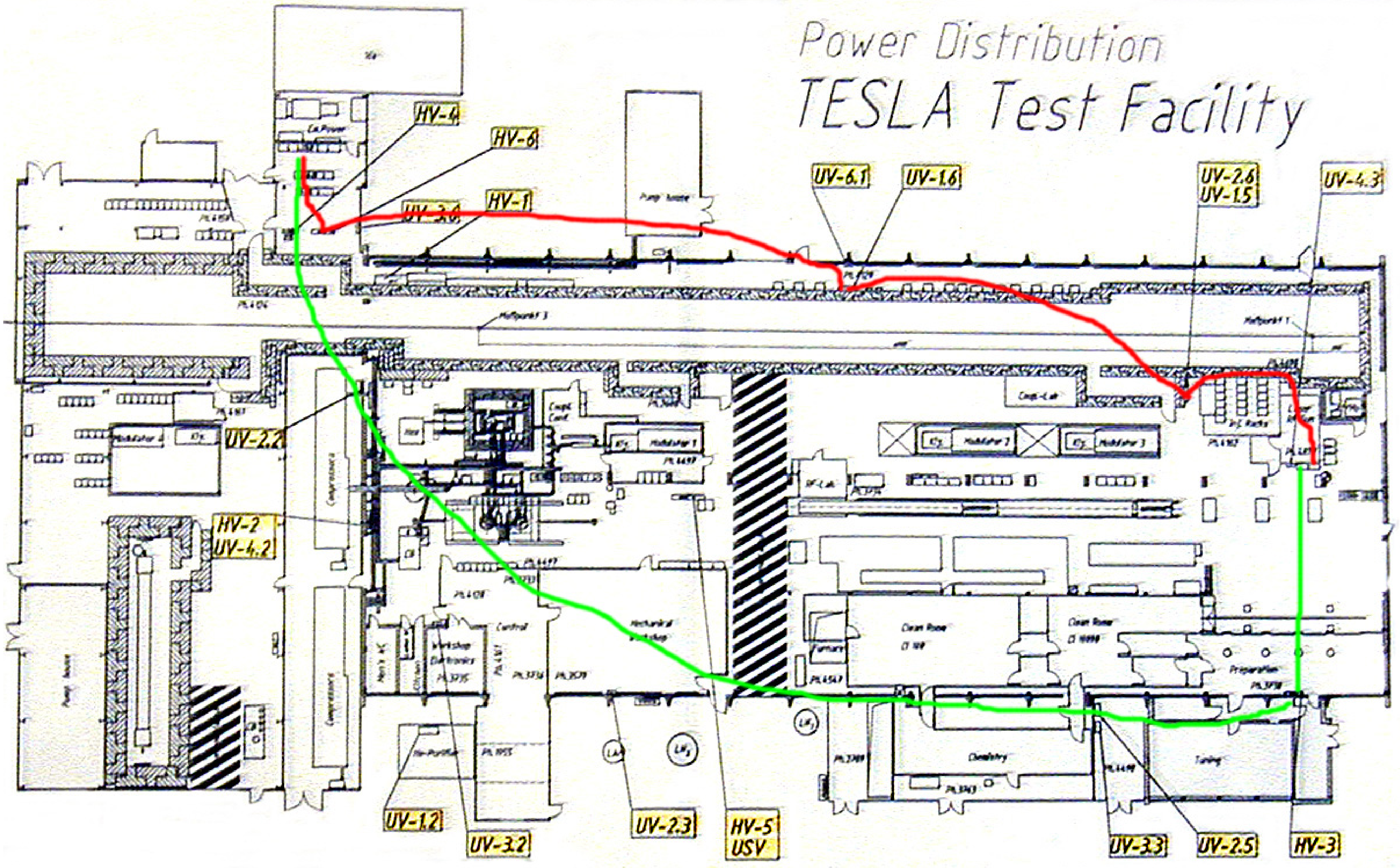
1. Energy radiated from the pulse cables and its absorption by the tunnel mesh.

2. Pulse cable cutoff frequencies and consequences for the cable trays.

Umbau TTF2 Injector Rack Area

- A third hut for the synchronisation laser will be set up (end of July).
- The rack area will be partly rearranged and enclosed. At the same time an adequate ground plane will be prepared. Its current state is desolate.
- The power supply situation must be inspected and probably revised (power from two HVen). Meeting with J.Schäfer (MKK) on 24.04.06.
- At the same time remove old TTF1 ground system relics.


Rackposition mit Thomas Froehlich zu klaeren
Rackposition mit Thomas Froehlich zu klaeren
Heat
3.9G
ACC1
3.9G
moegliche Fluchttuer
Schiebetuer
LMO
Gunwater
moegliche Fluchttuer



Power Distribution
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Pump house
UV-1.2
UV-3.2
UV-2.3
HV-5
USV
UV-3.3
UV-2.5
HV-3

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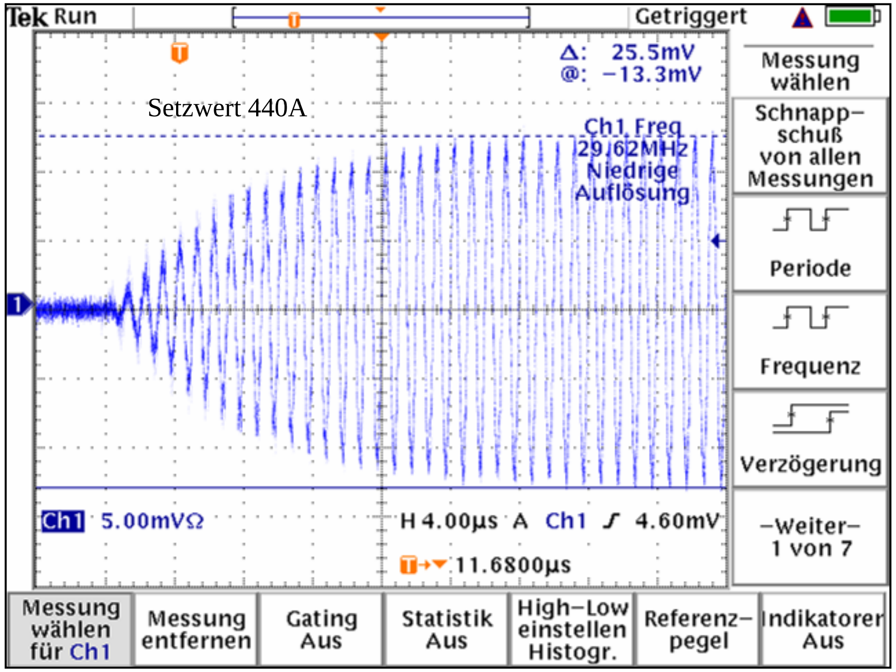
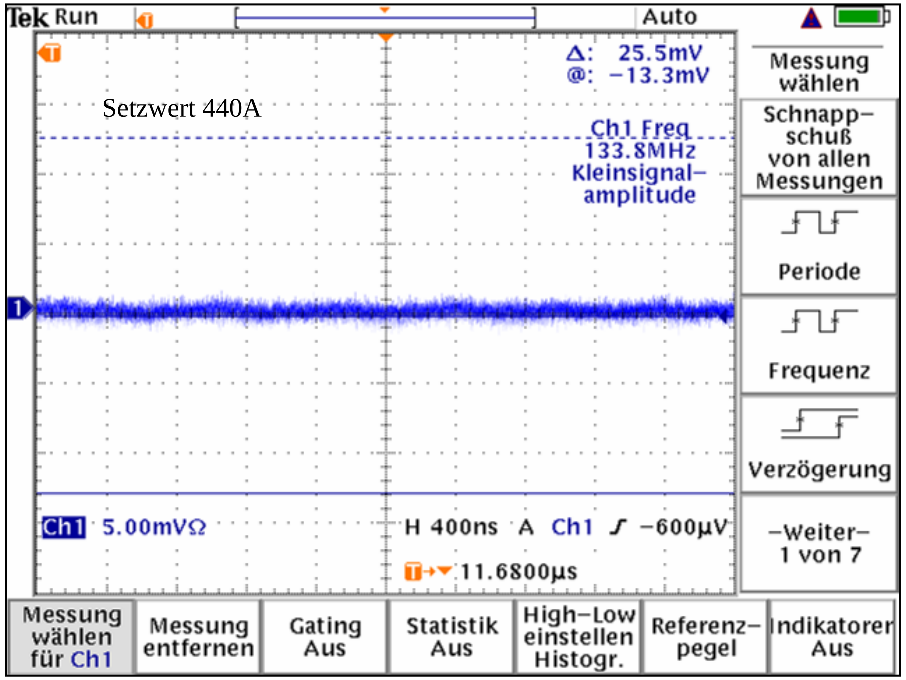
On Mon, 3 Apr 2006, Frank Obier wrote:

>> Hallo Holger, Hallo Siggi,
>>
>> bei den Messungen konnte man deutlich ein 1MHz Signal auf den
>> Widerstandsmonitor RM1 sehen, auf dem Widerstandsmonitor RM2 wurde
>> kein Signal gemessen, genau so könnte auch kein Signal auf den
>> Toroiden gemessen werden. Das Störsignal vom Widerstandsmonitor RM1
>> könnte von 25mV auf fast 0mV reduziert werden, durch eine Alufolie.
>>
>> Beim LOlA Kicker wurde eine defekte Leistungsdiode und ein 5V
>> Netzgerät getauscht. Der Pulser wurde so modifiziert,dass jetzt ein
>> 12kV Behlke Schalter im Pulser eingebaut ist. Das
>> Hochspannungsnetzgerät ist auf 8kV begrenzt. Damit können folgende
>> Werte erreicht werden:
>>
>> Netzgeräte Spannung  U=8kv
>> Pulsstrom            I=1000A (vorher 700A)
>> Triggerfrequenz              f=5Hz
>> Pulsbreite           t= 850ns
>>
>> Leider geht die Umpolung nicht, muss am nächsten Wartungstag
>> angesehen werden.
>>
>> Ps. Norbert nochmals vielen Dank für deine Unterstützung.
>>
>> Gruss
>> Frank
```

1. Störsignal auf den Widerstandsmonitoren

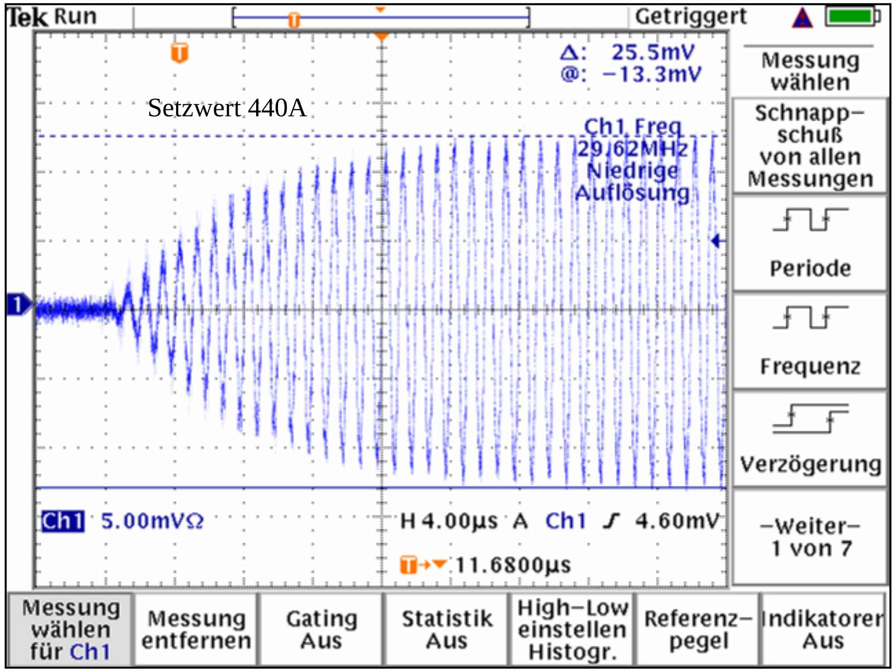


Störsignal bei dem Widerstandsmonitor RM1 RMON / 8DBC2
Auf den Toroiden könnte kein Signal gemessen werden.

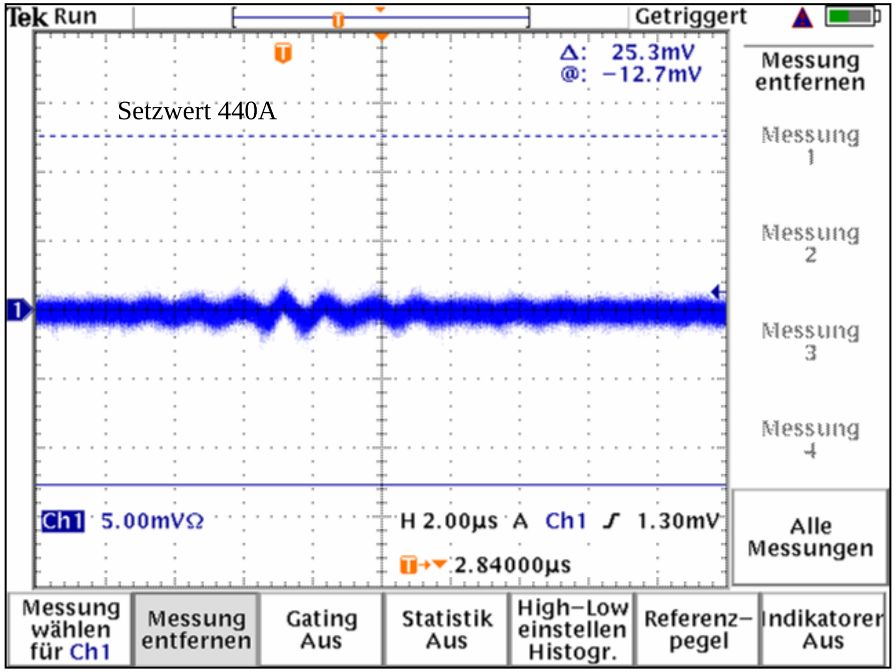


Störsignal bei dem Widerstandsmonitor RM2 RMON / 5DBC3

2. Störsignal auf den Widerstandsmonitoren

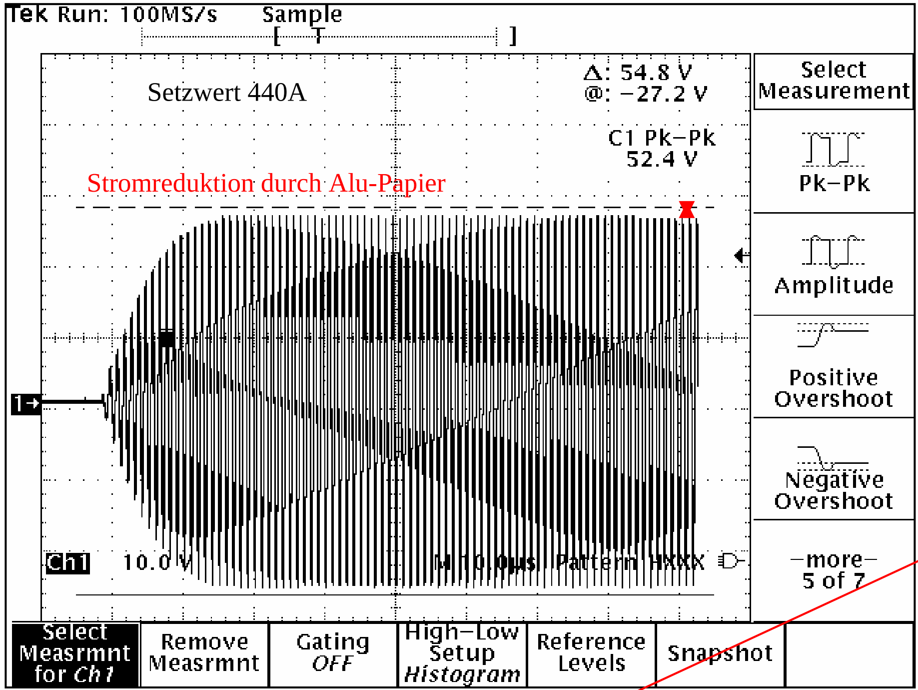


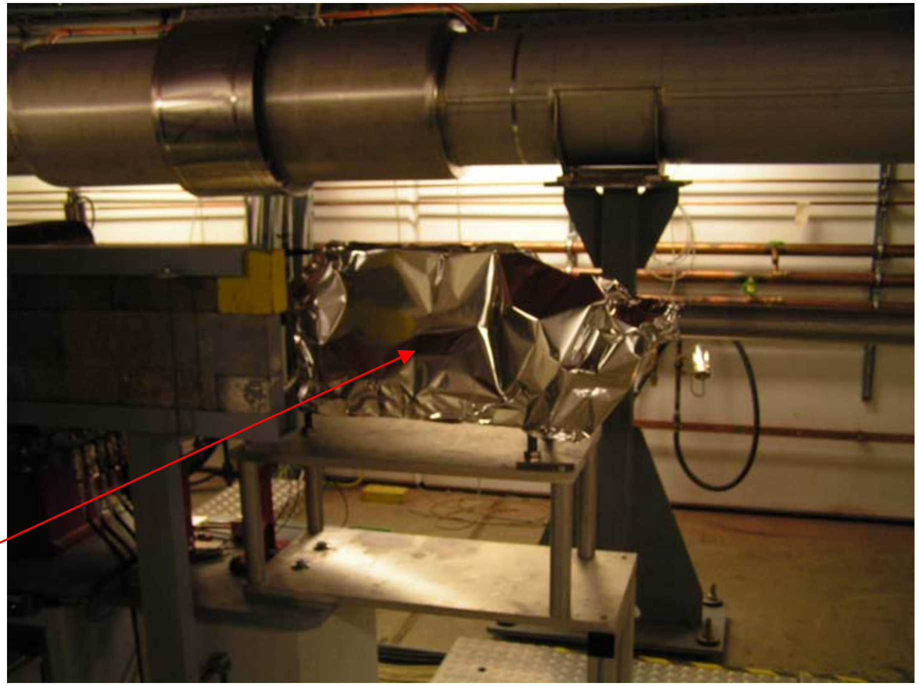
Störsignal bei dem Widerstandsmonitor RM1 RMON / 8DBC2



Störsignal bei dem Widerstandsmonitor RM1 RMON / 8DBC2
Das Störsignal konnte durch eine Abschirmung von Alu-Papier reduziert werden.

3. Abschirmung





Dadurch das die Abschirmung verbessert wurde verschiebt sich auch die Resonanz des Kickers (ziehe Bild).