A simple approach for safely powering CW klystrons

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Andreas Dieckmann
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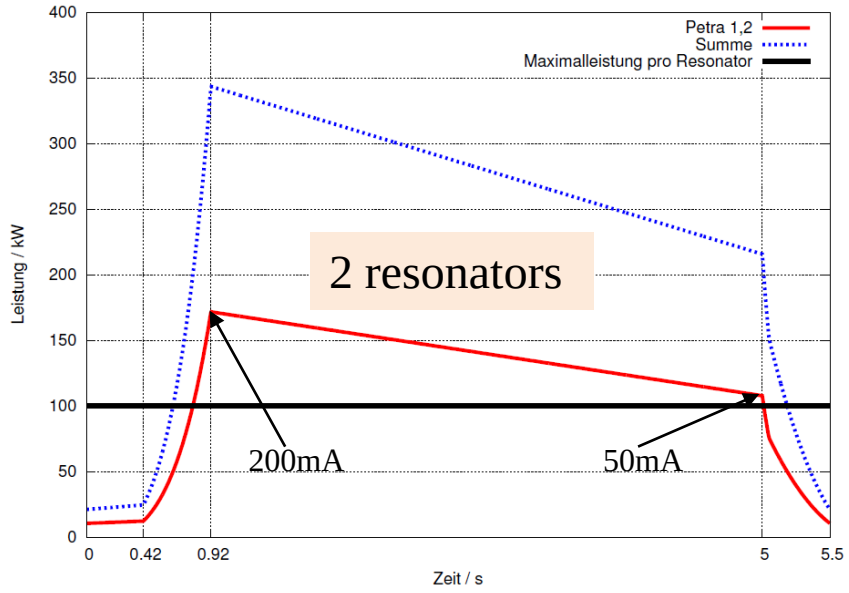
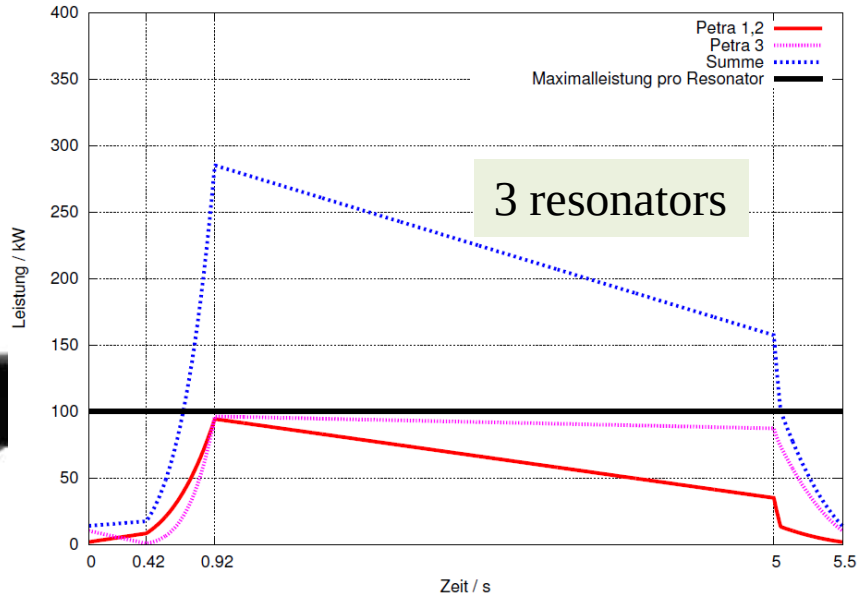
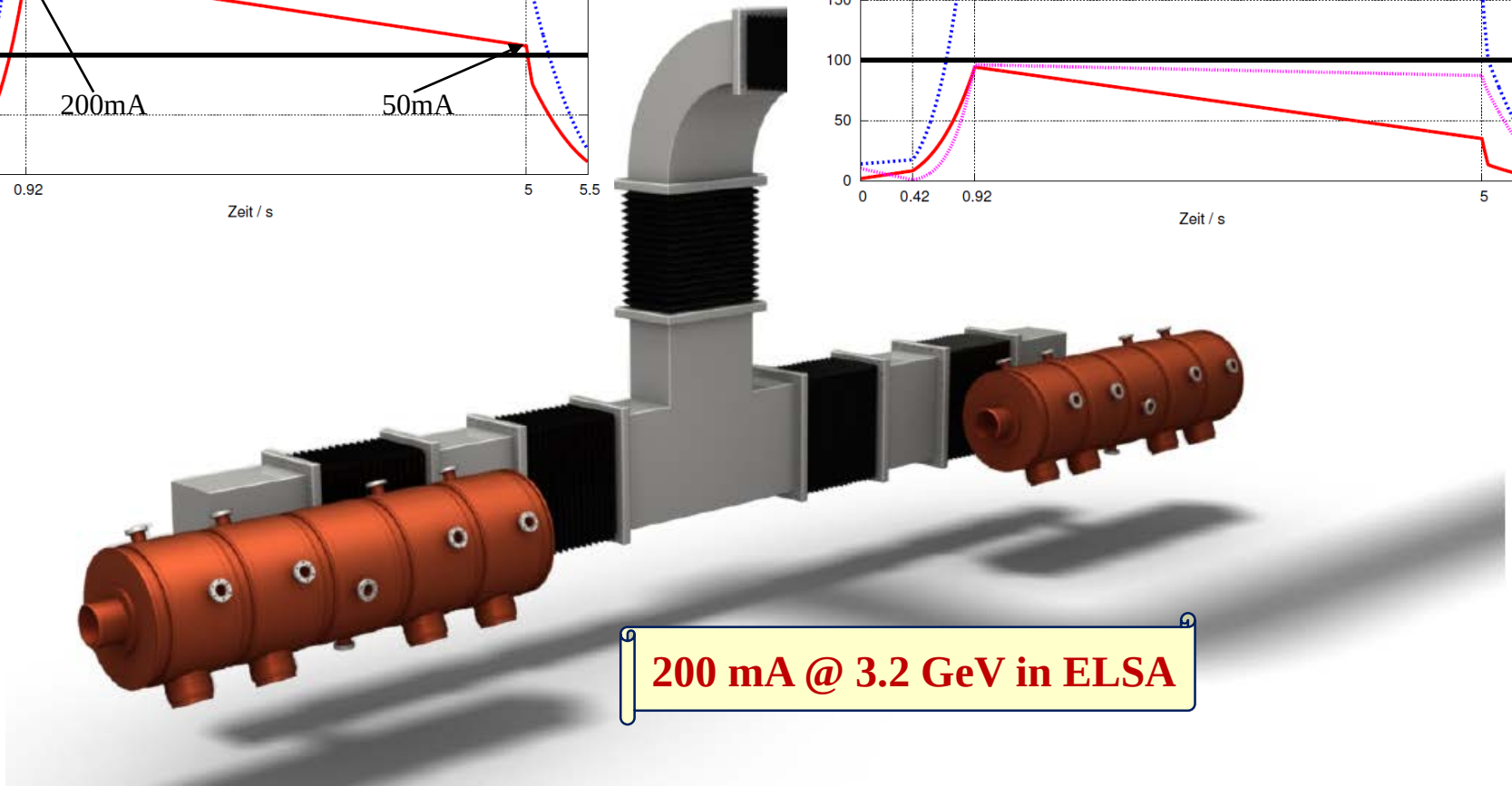
New RF System

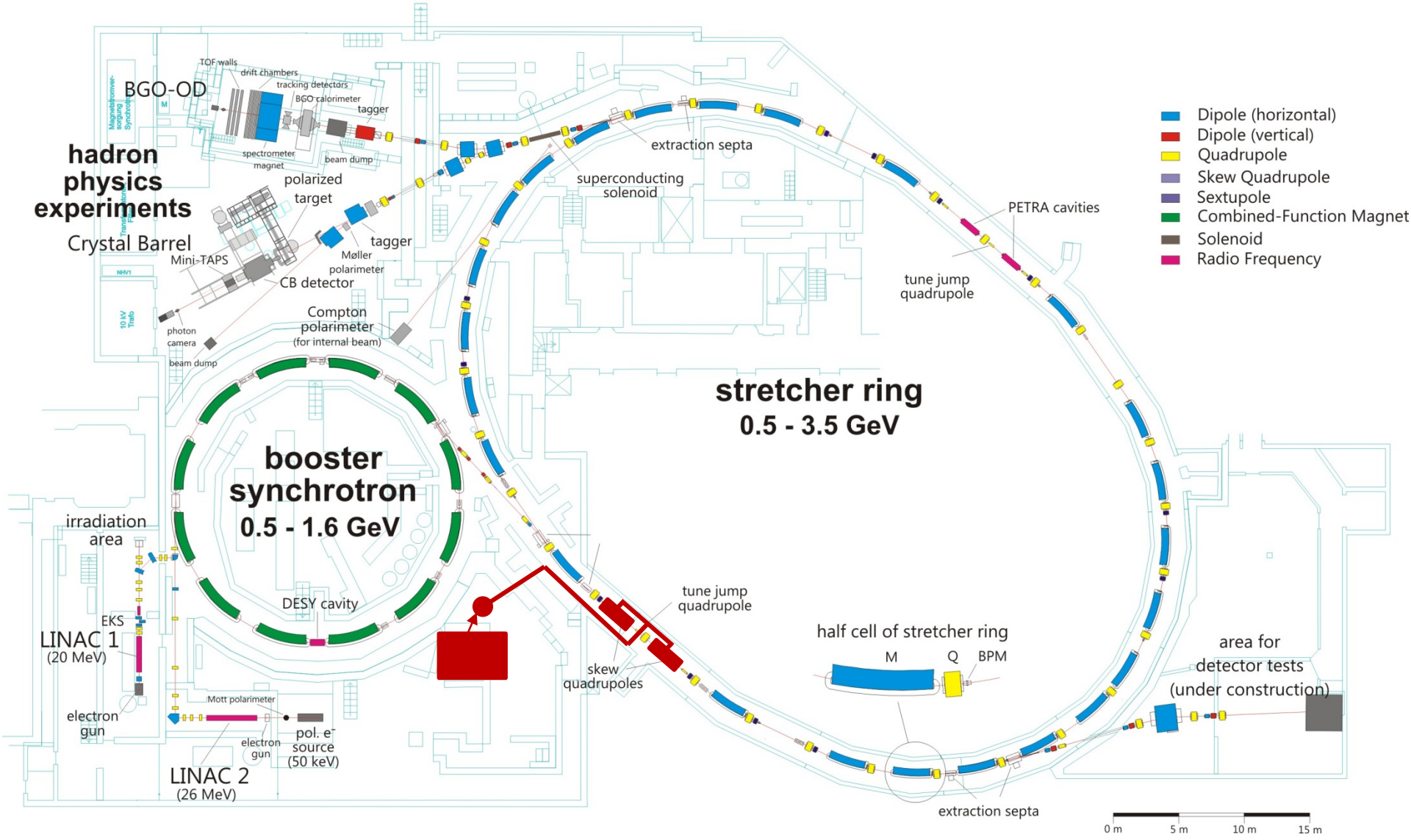






200 mA @ 3.2 GeV in ELSA

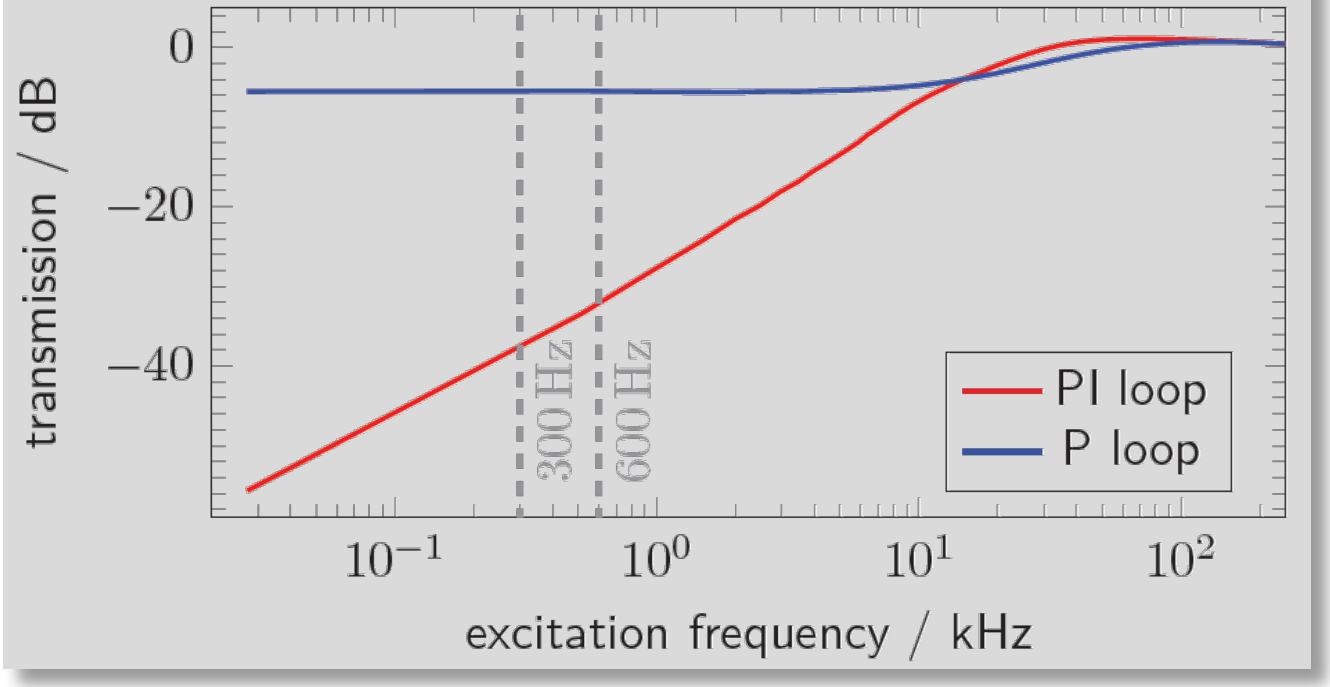
Electron Stretcher Accelerator (ELSA)



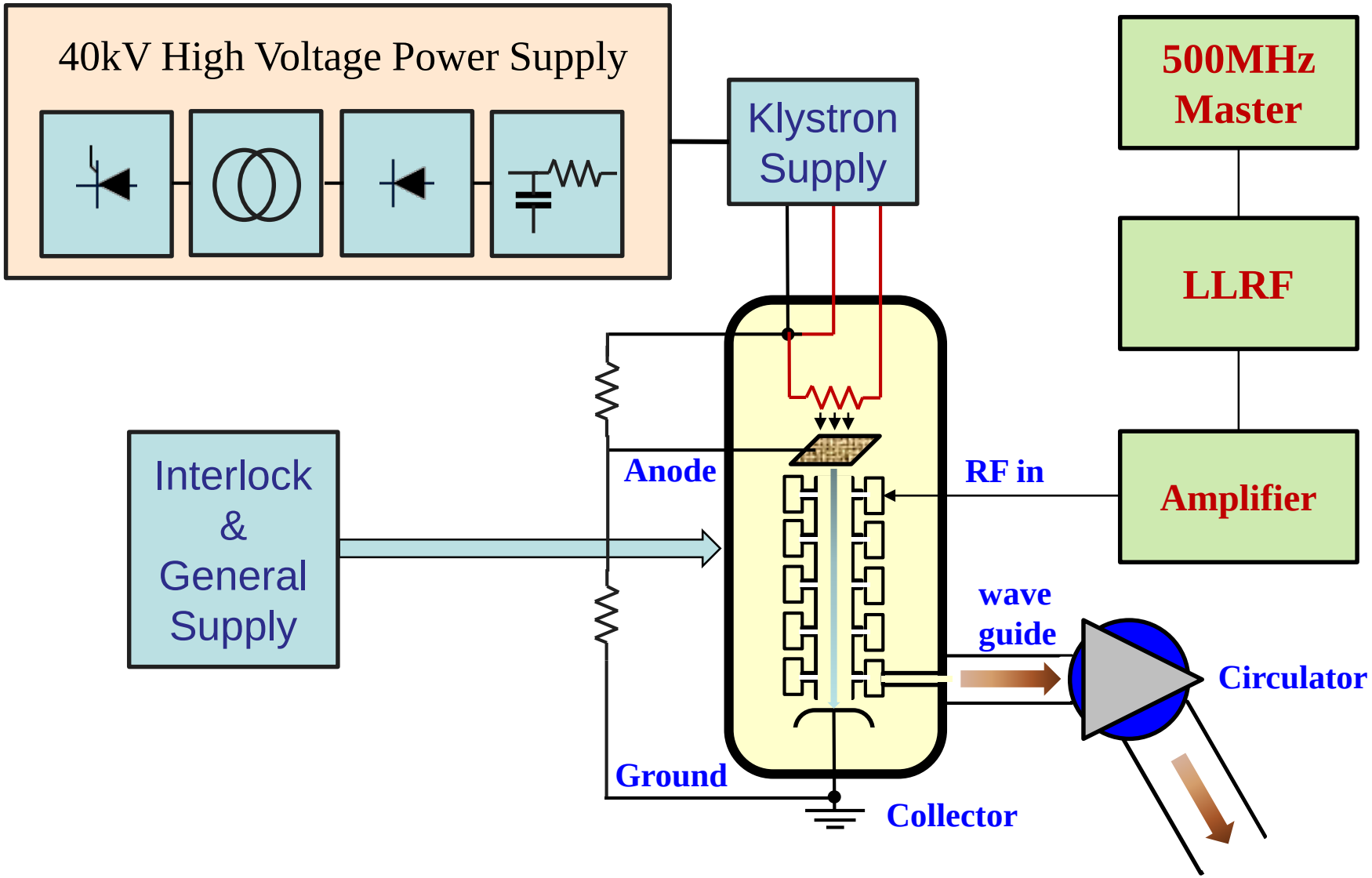
Error Rejection of new LLRF

Effective suppression of low frequency contributions

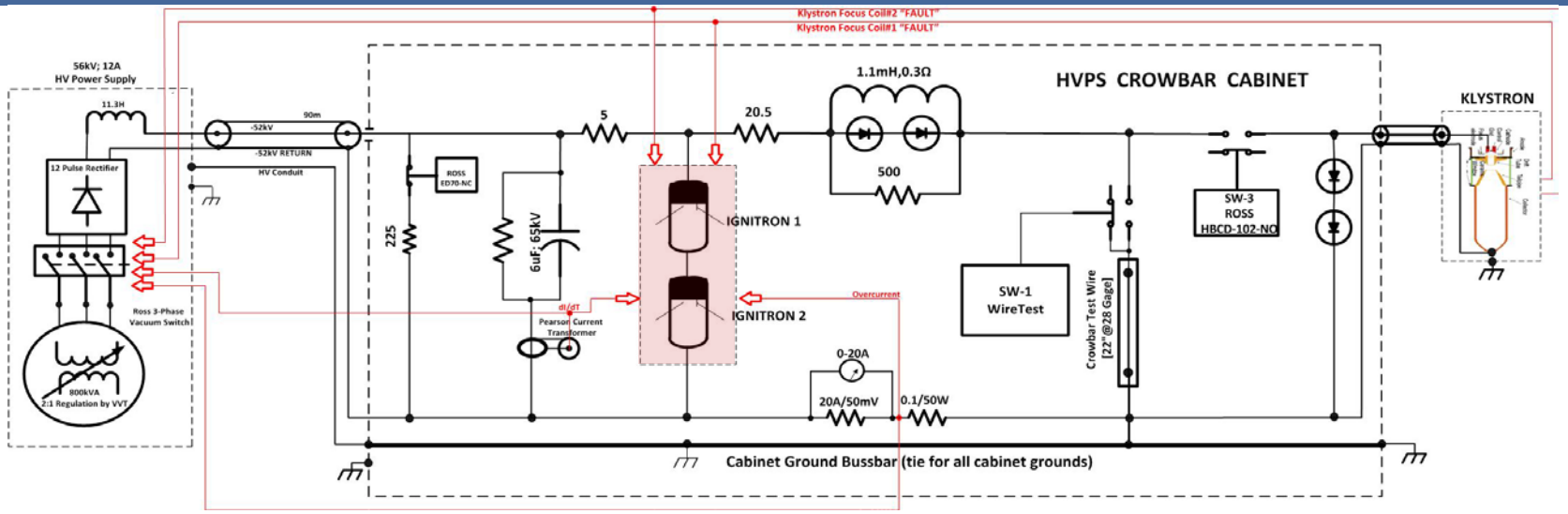
„High“ voltage ripple tolerable



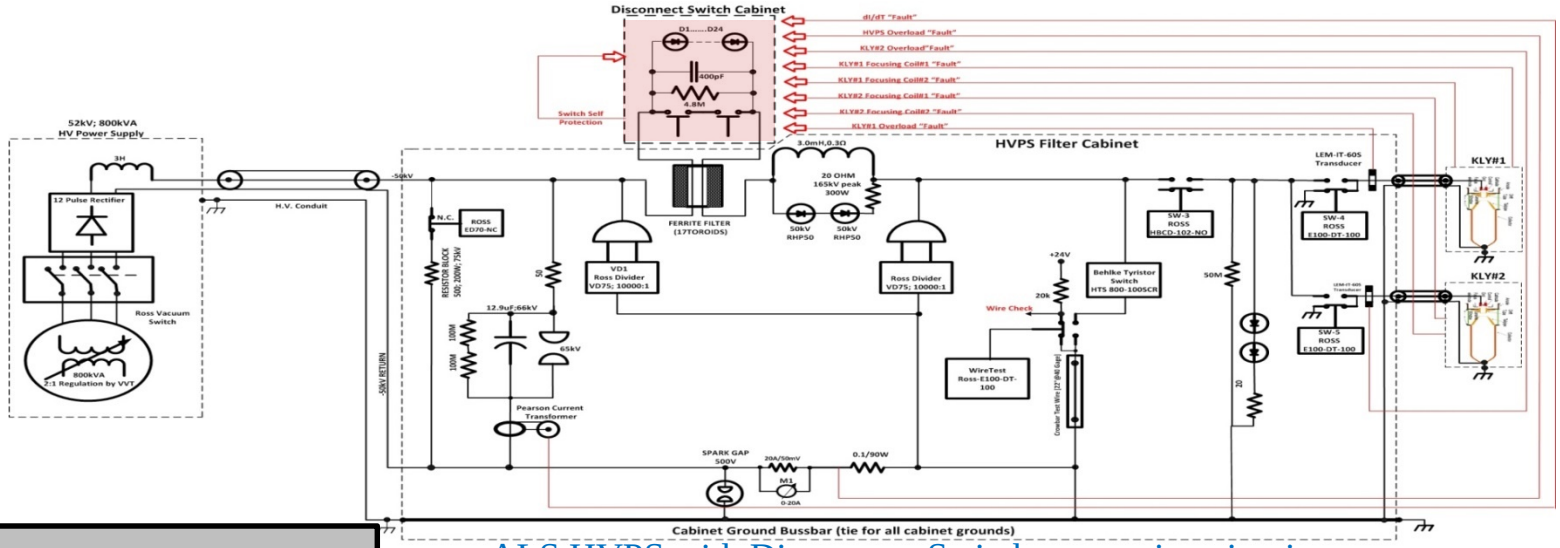
General Set-Up



Crowbar versus Disconnect Switch



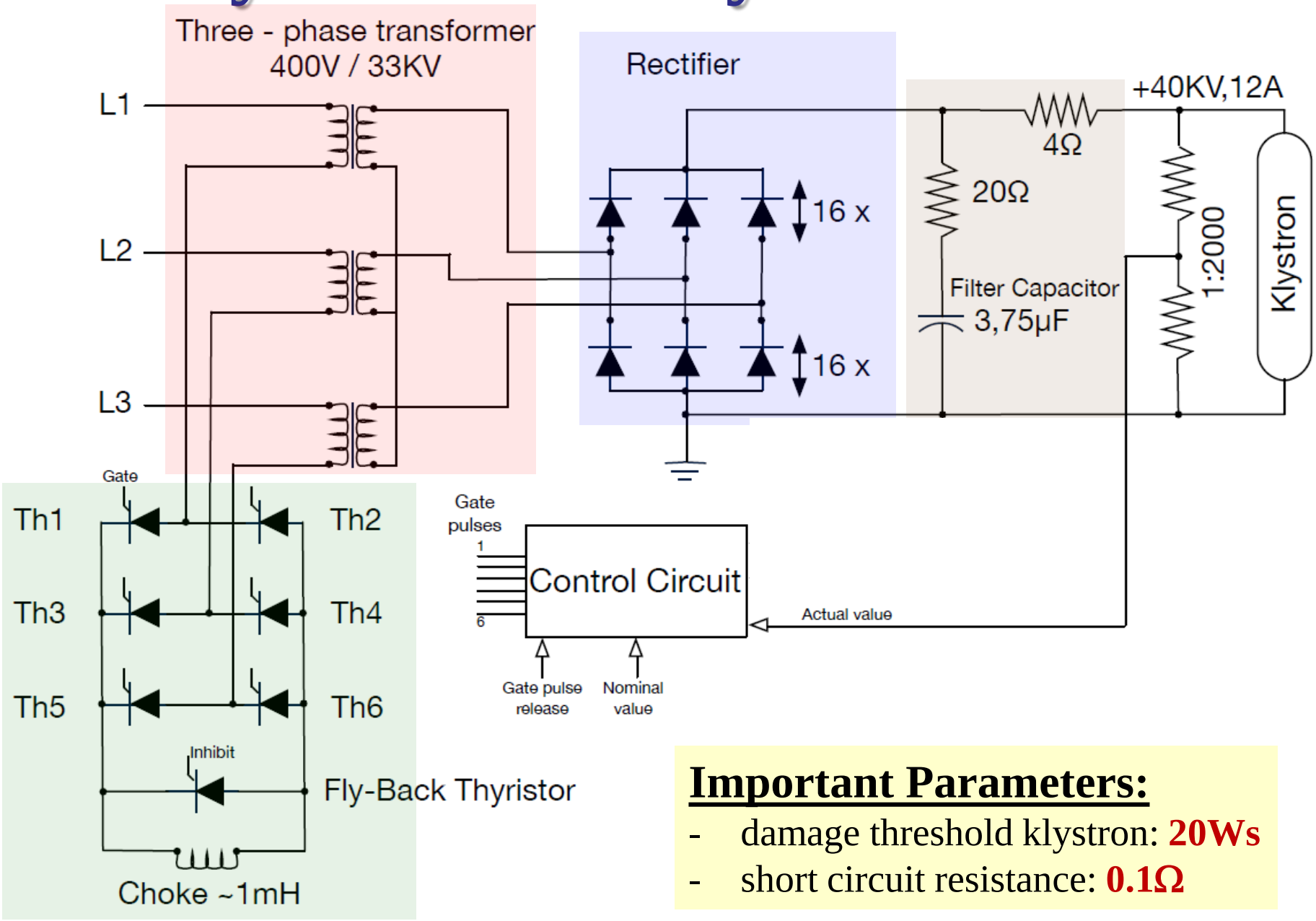
ALS HVPS with Crowbar protection circuit.



ALS HVPS with Disconnect Switch protection circuit.

Courtesy:
Slawomir Kwiatkowski

Layout of the Klystron HVPS

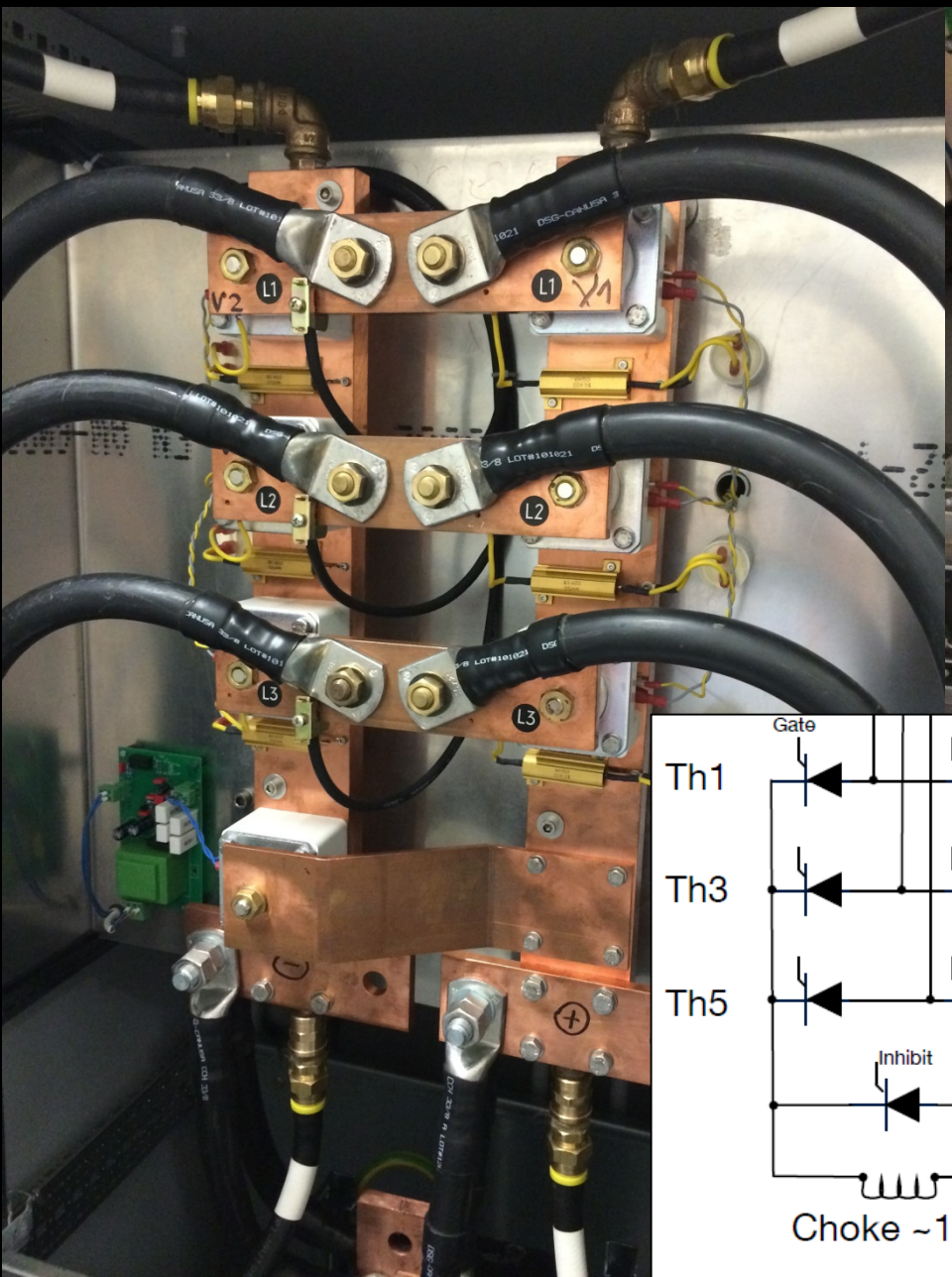


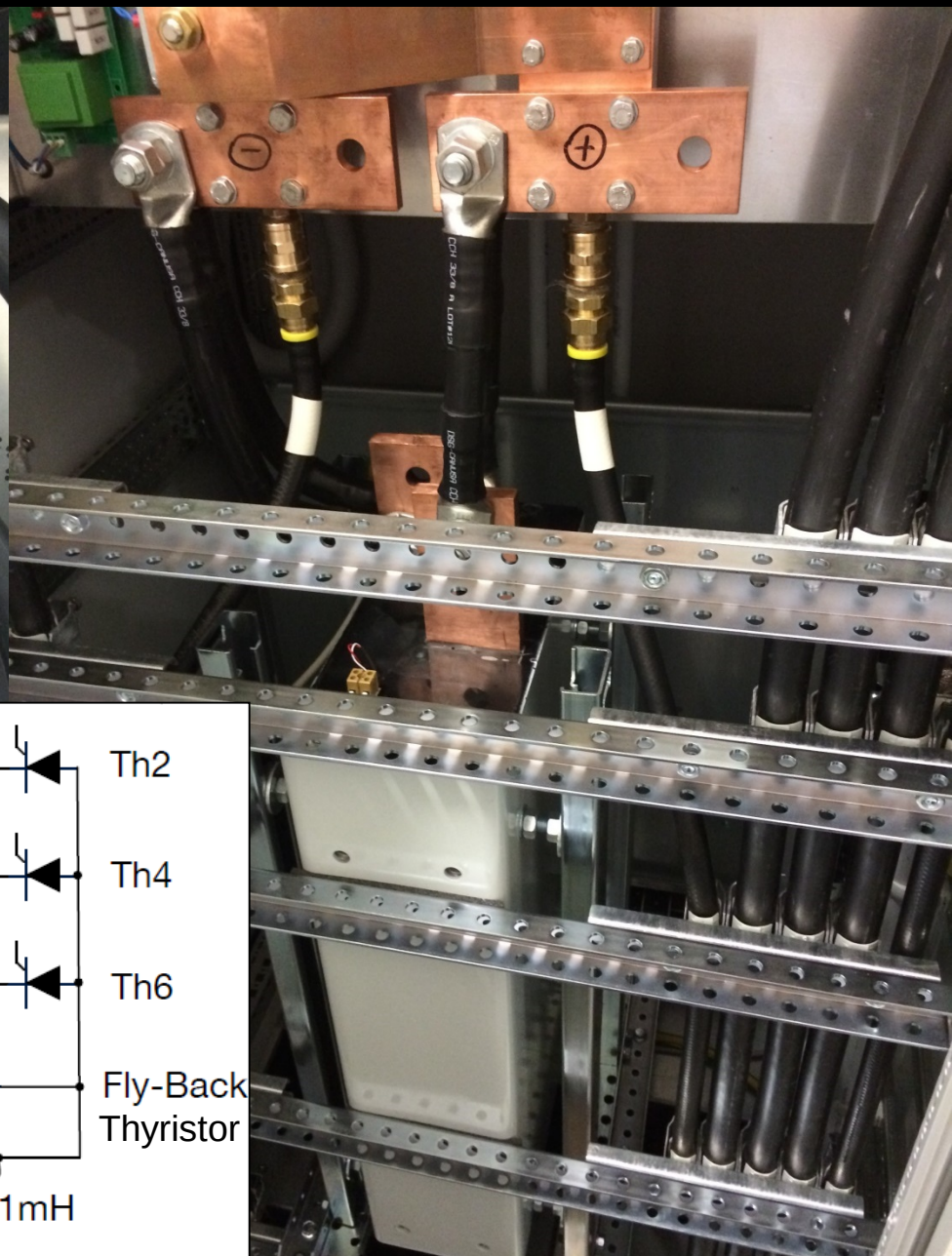
Important Parameters:

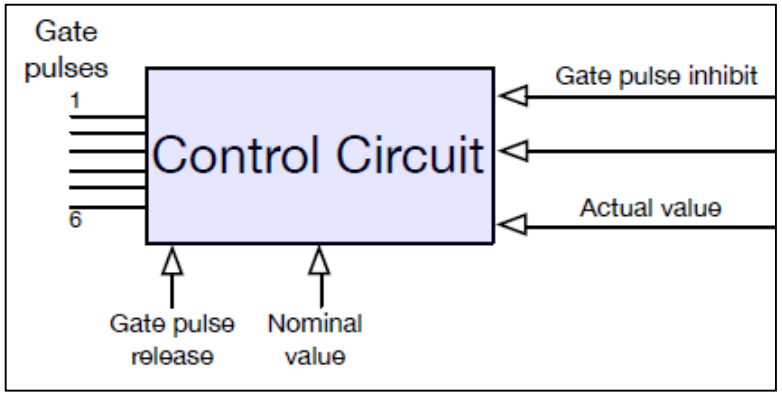
- damage threshold klystron: **20Ws**
- short circuit resistance: **0.1Ω**

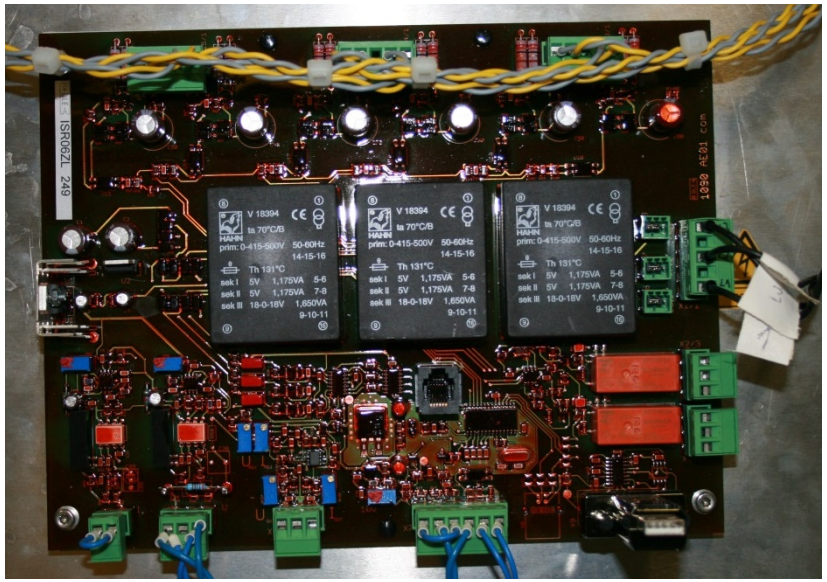
Leading Edge Phase Control

6-Pulse Bridge



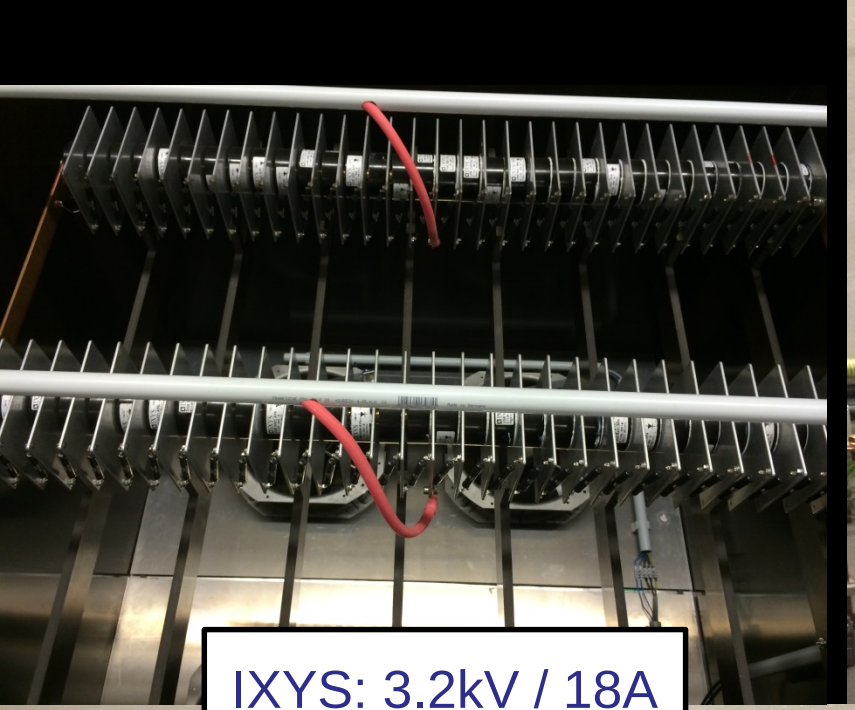




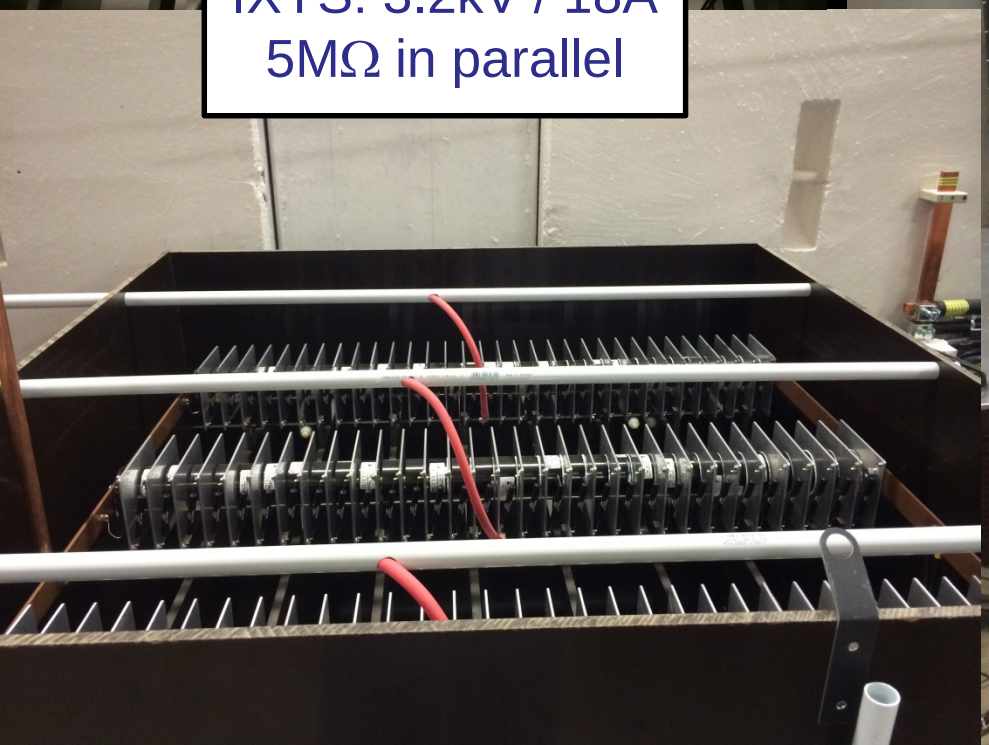


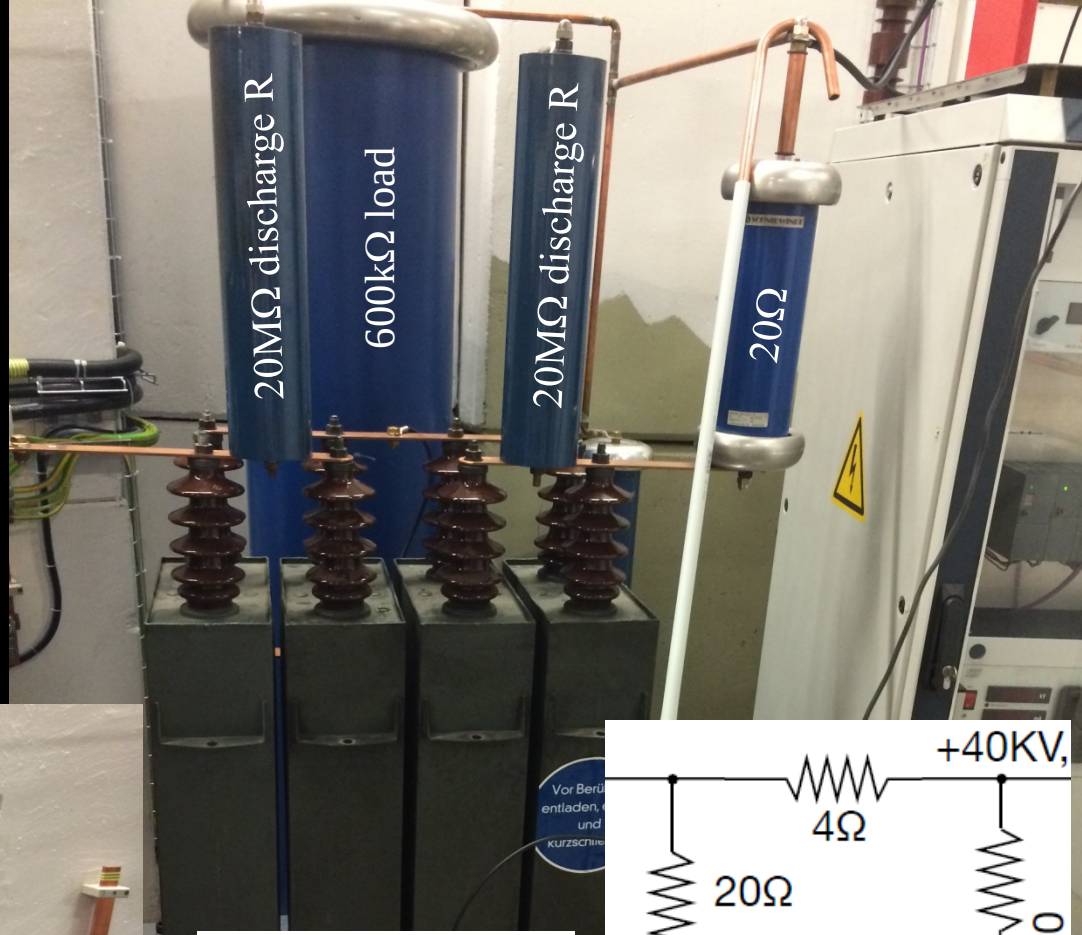
commercially available
(≈ 600 Euro)

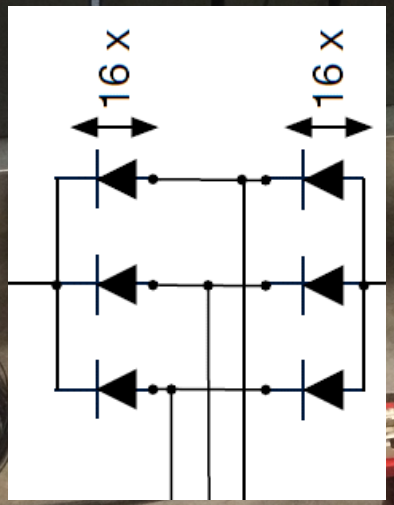

Vorsicht!
Starkstrom
Lebensgefahr!
Hochspannung
Lebensgefahr

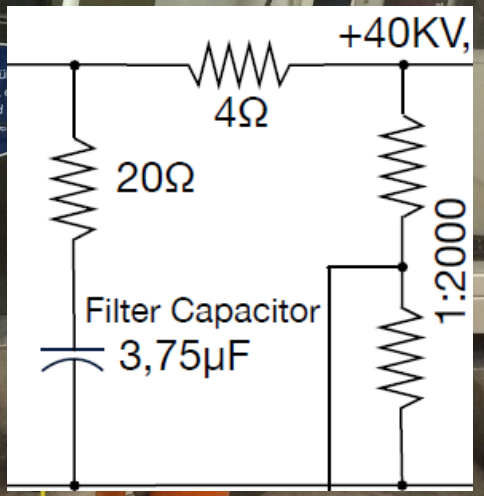


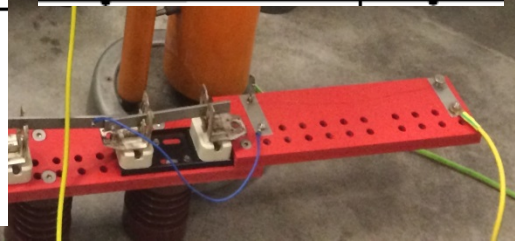
IXYS: 3.2kV / 18A
5MΩ in parallel



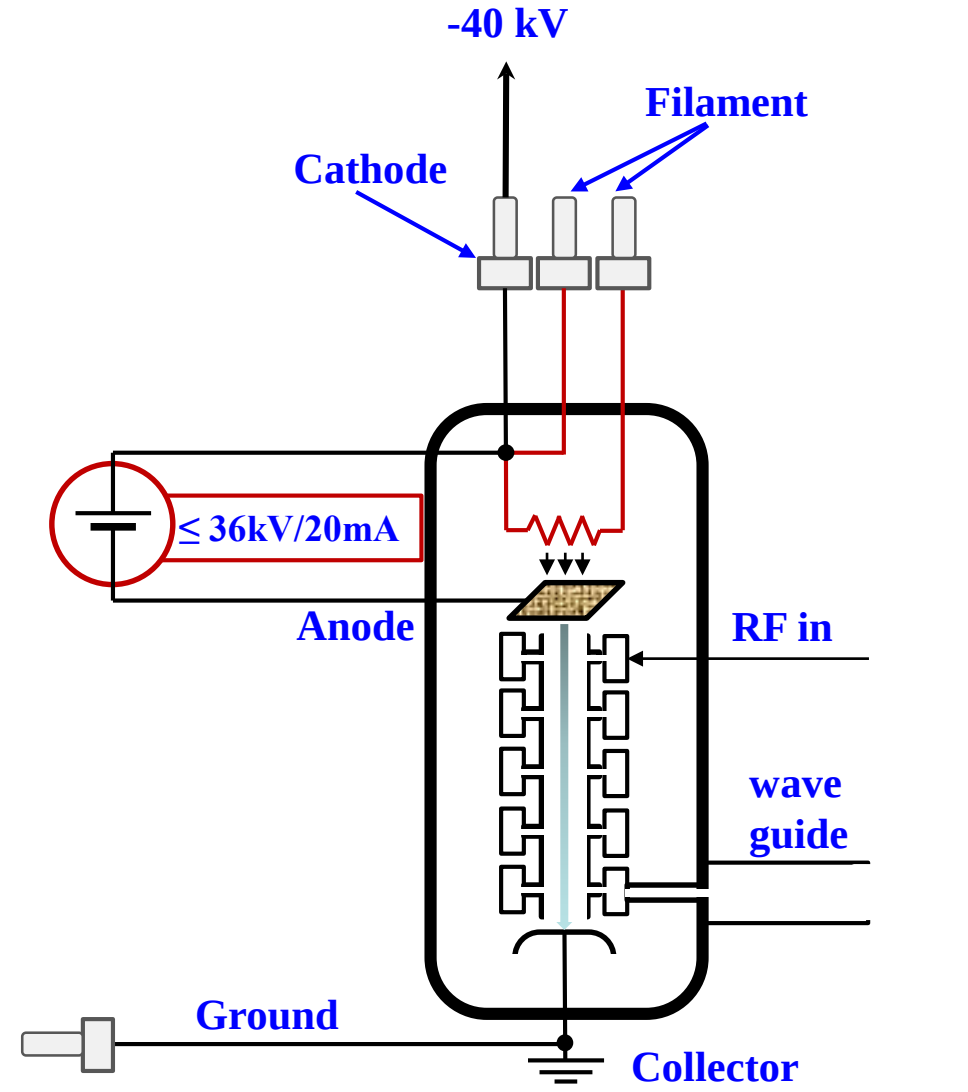








Emission Control

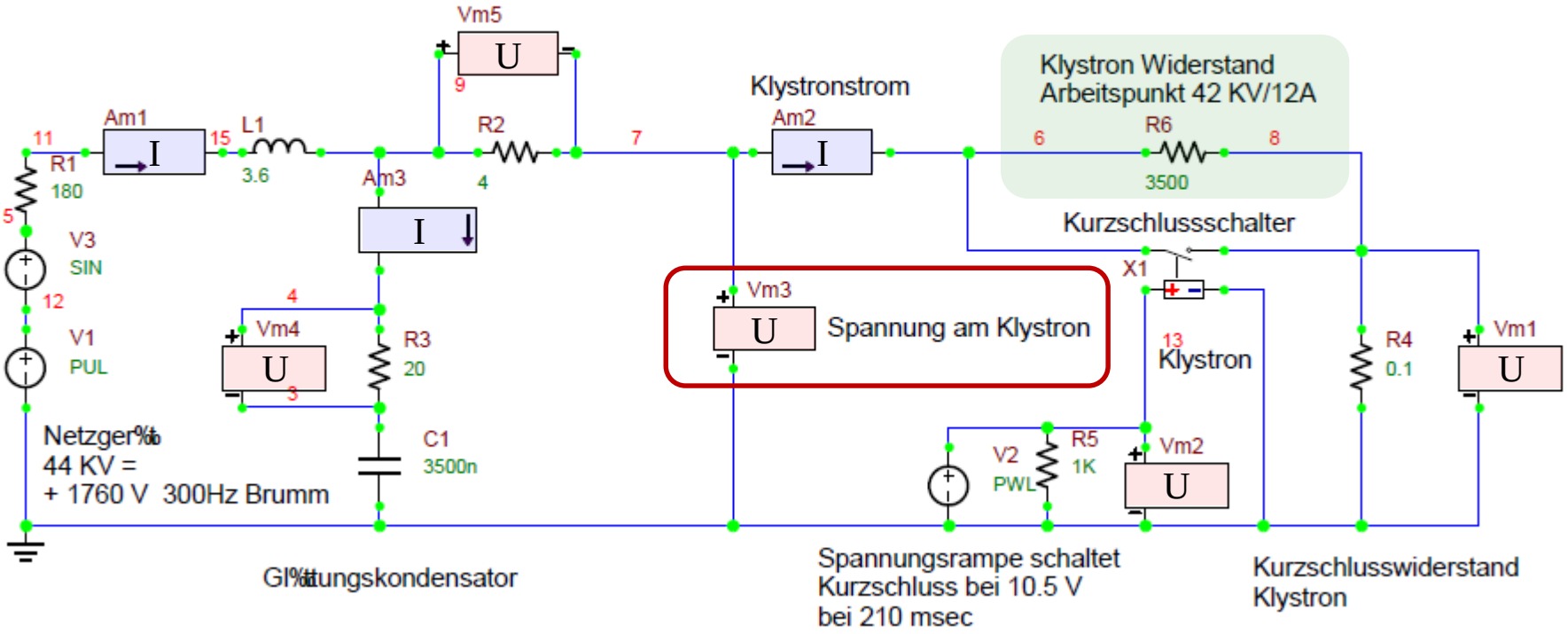


No phase shift control → low ripple

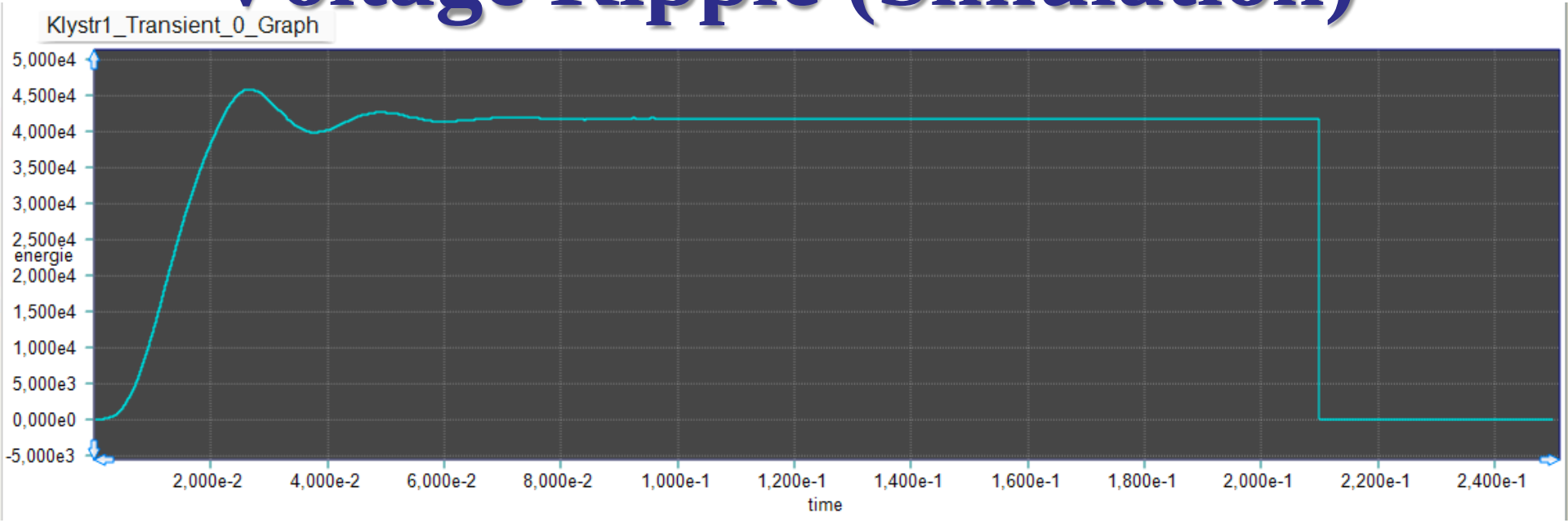
Spice Simulation

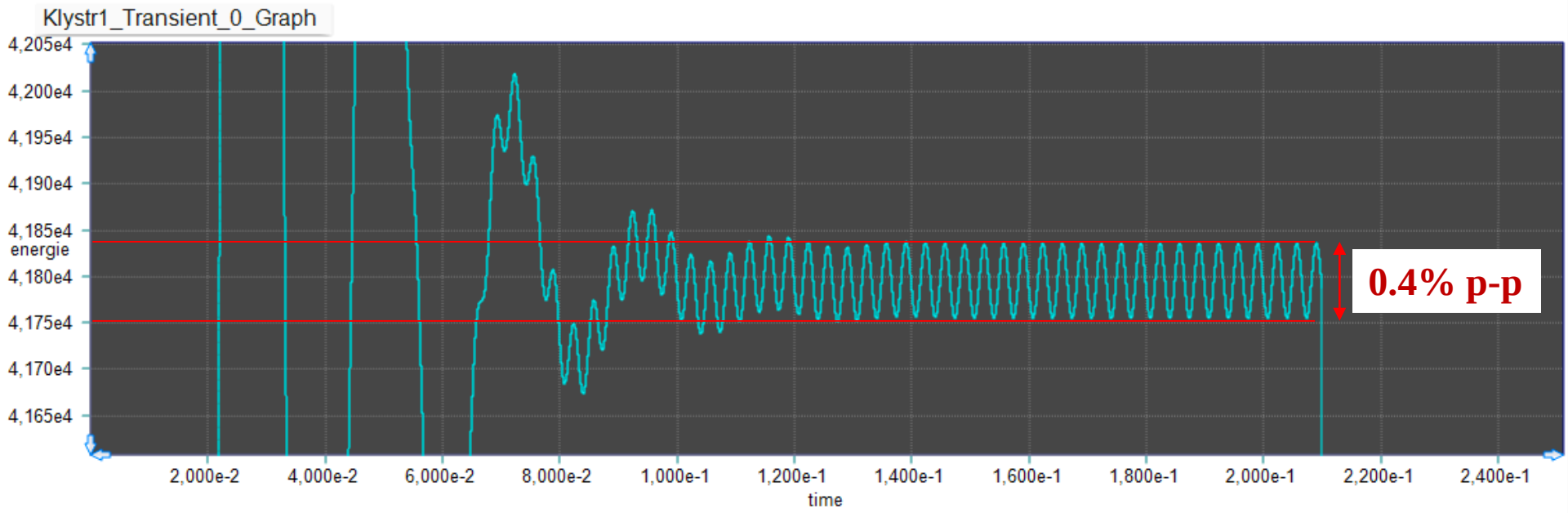
Simulation of the HVPS

1. **Voltage ripple**
2. Short at Klystron



Voltage Ripple (Simulation)





Spice Simulation

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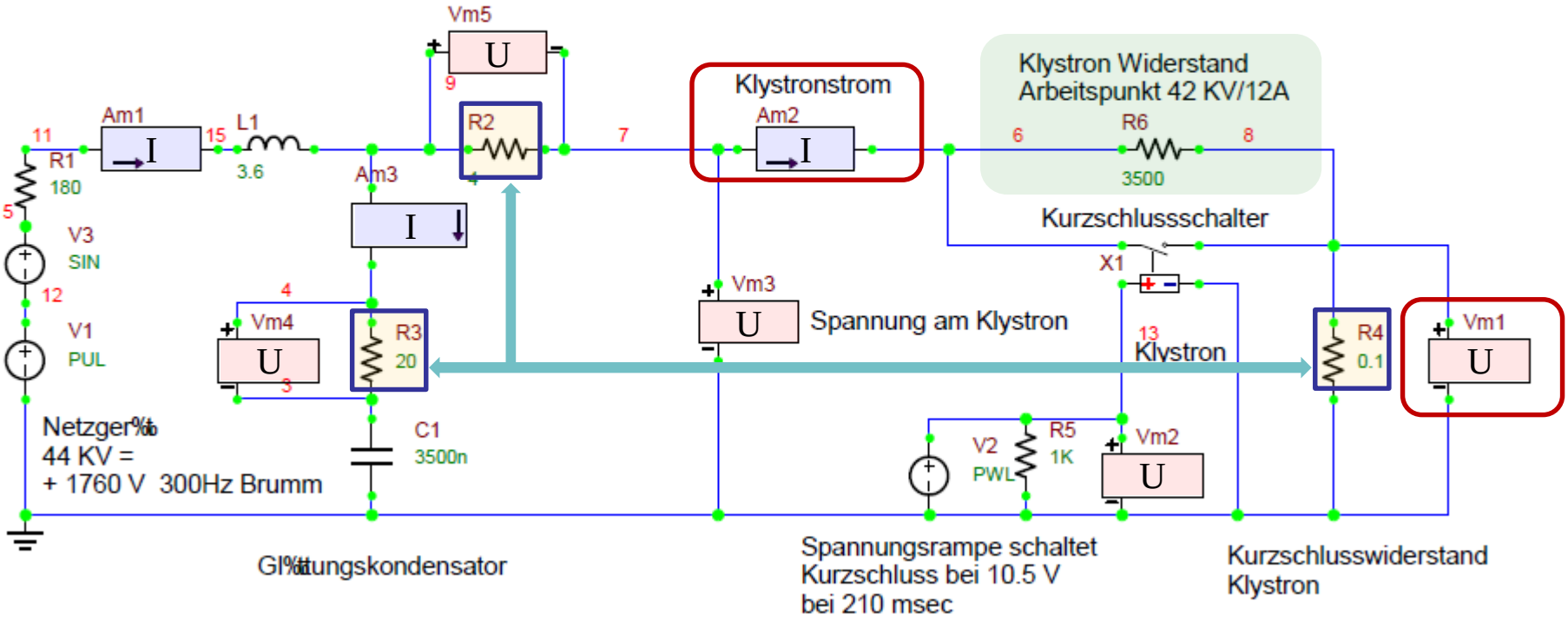
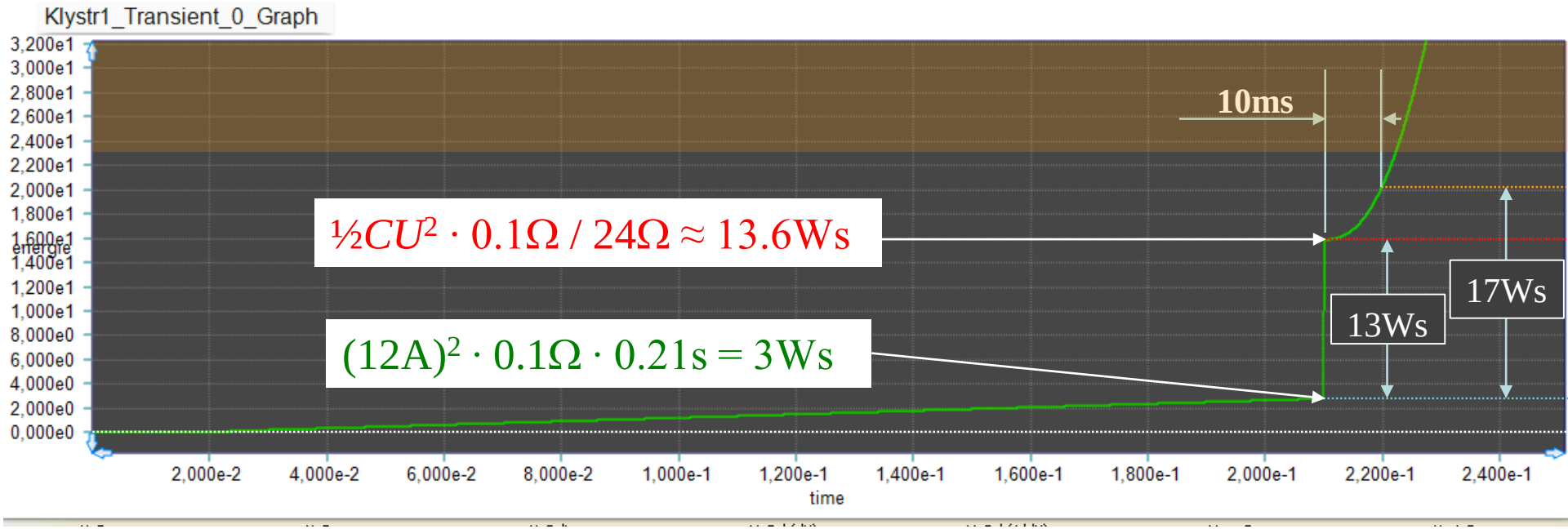
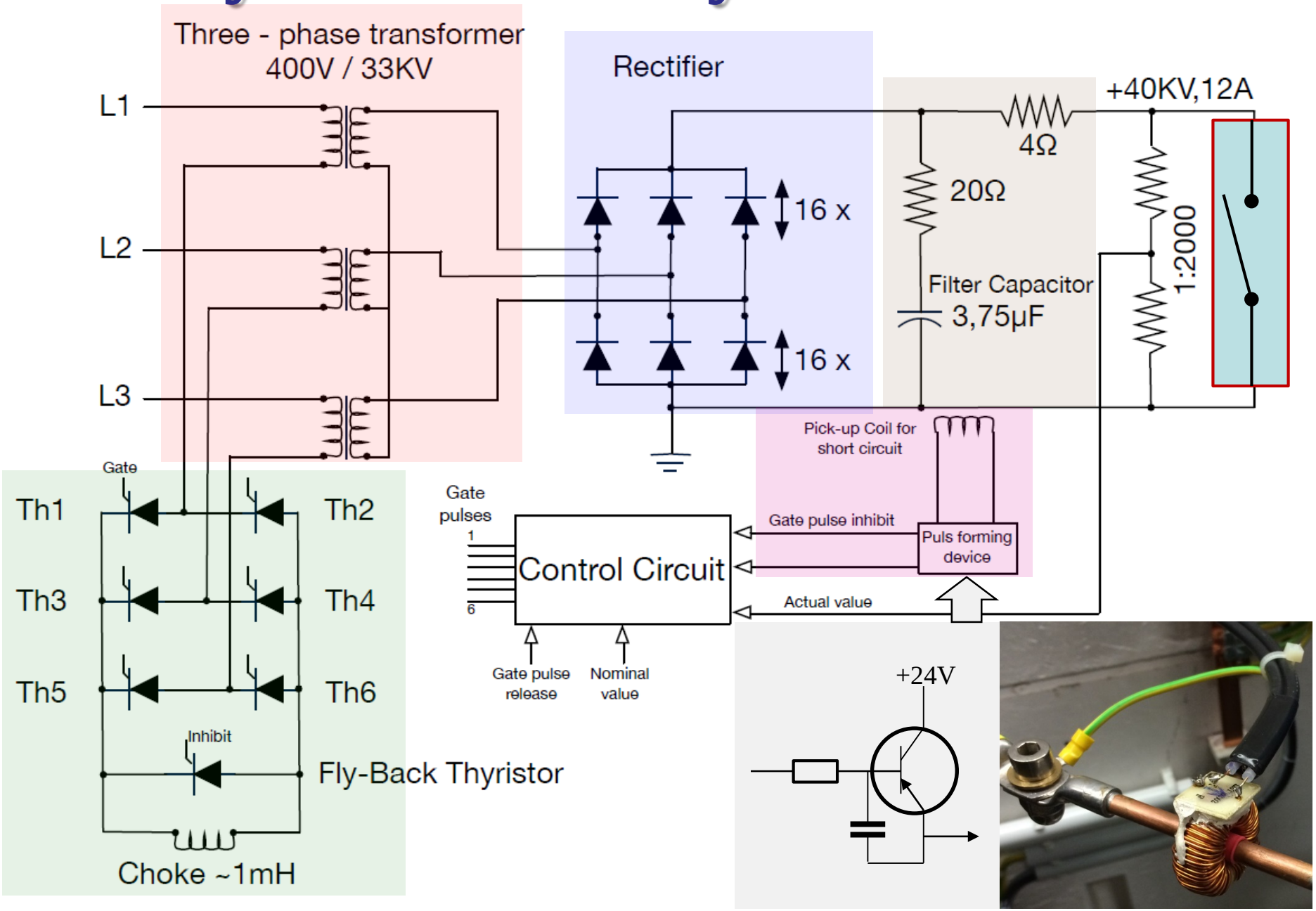
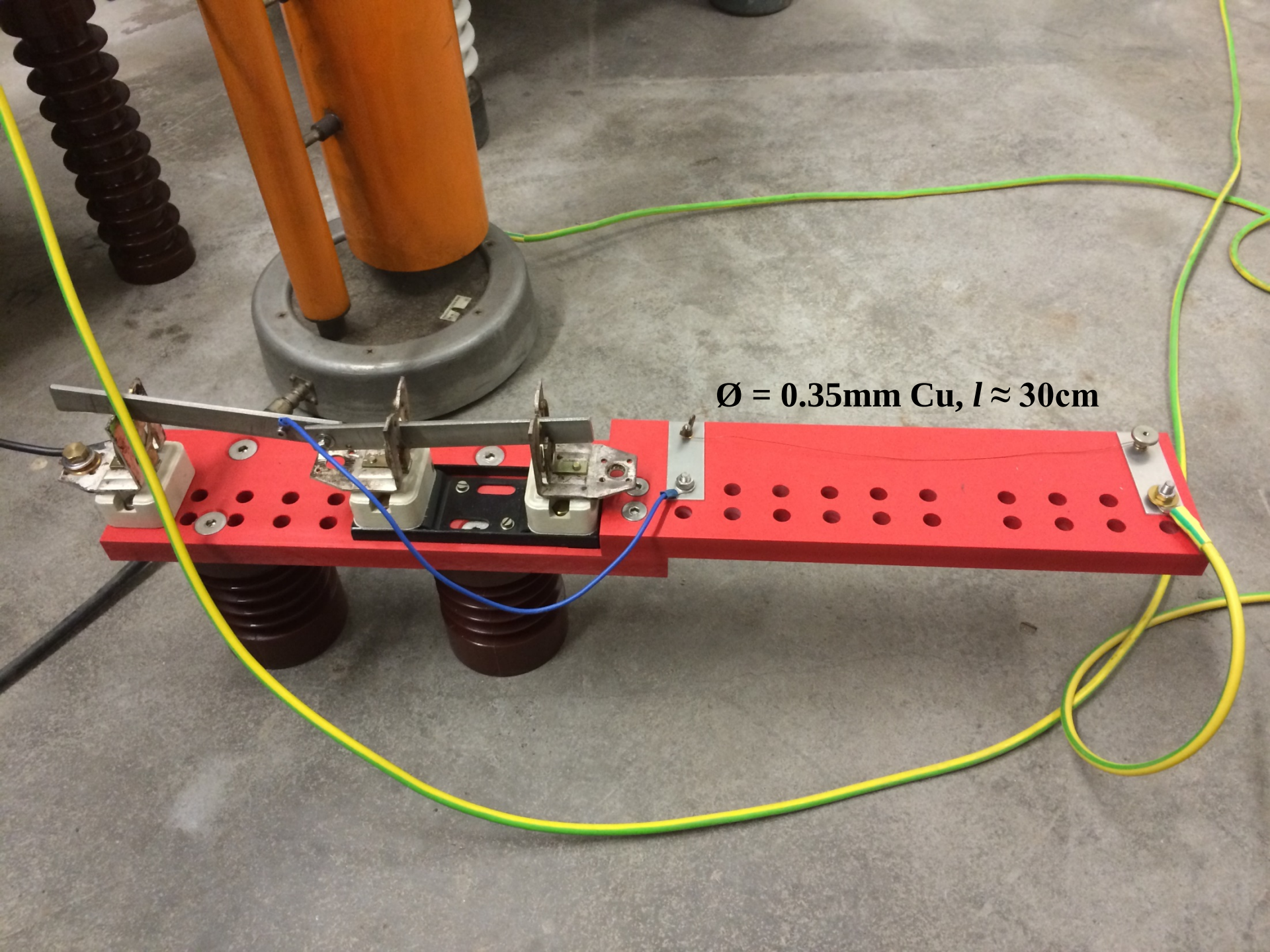


Energy Deposit to Klystron at Short



Layout of the Klystron HVPS



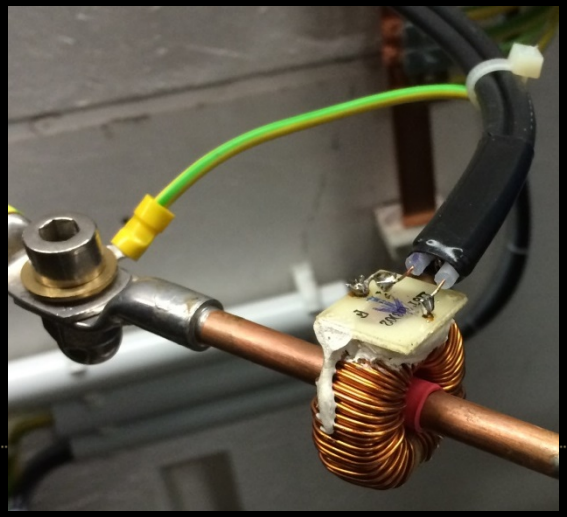

Ø = 0.35mm Cu, $l \approx 30$cm

Wire Tests

Tek PreVu M 20.0µs

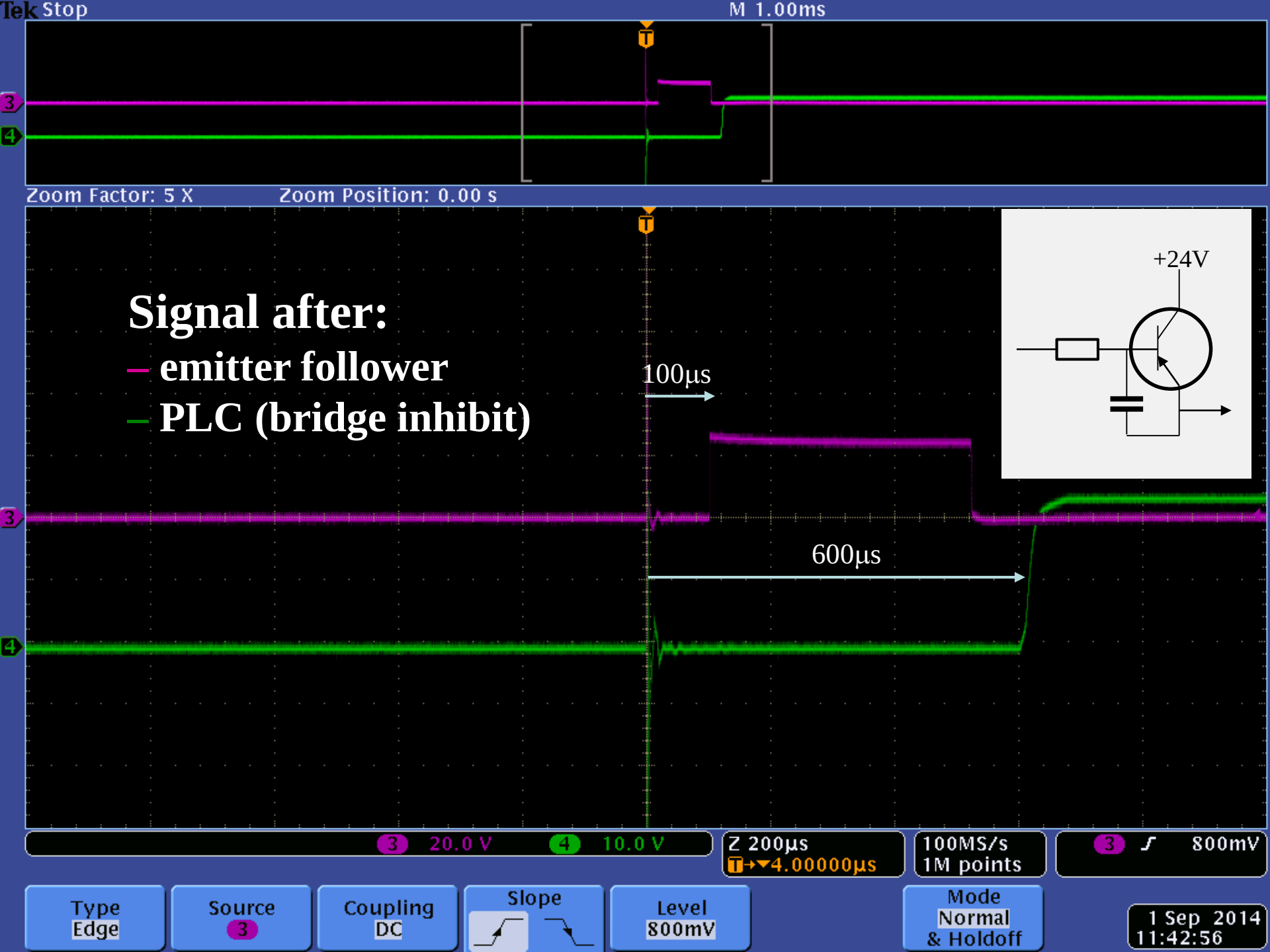
Zoom Factor: 10 X Zoom Position: 1.46µs

Pick-up Signal:



4 50.0 V Z 2.00µs 0.00000 s 500MS/s 100k points 4 −12.0 V

15 Aug 2014
11:45:59

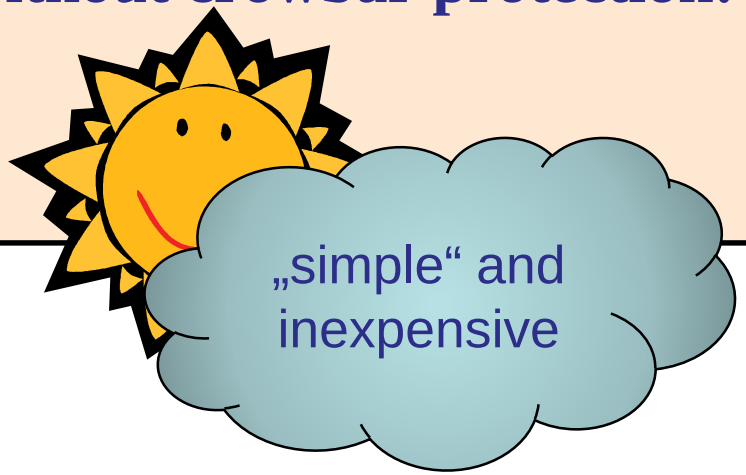

Tek Stop
M 1.00ms
Zoom Factor: 5 X
Zoom Position: 0.00 s
Signal after:
– emitter follower
– PLC (bridge inhibit)
100µs
600µs
+24V
3 20.0 V
4 10.0 V
Z 200µs
T→▼4.00000µs
100MS/s
1M points
3 800mV
Type
Edge
Source
3
Coupling
DC
Slope
Level
800mV
Mode
Normal
& Holdoff
1 Sep 2014
11:42:56

Conclusions

Error rejection capabilities of state of the art LLRF systems and considerably low klystron voltage

High voltage klystron power supply without crowbar protection:

- Spice simulation promising
- First wire tests very convincing

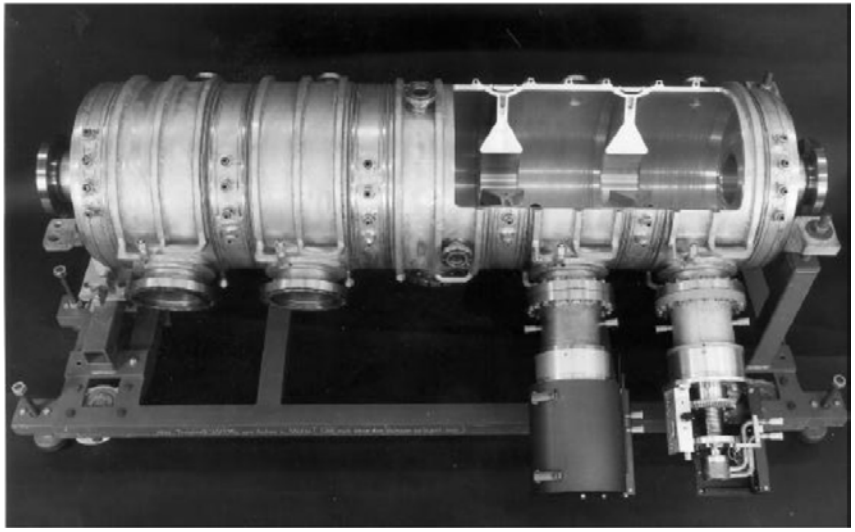


Ongoing work:

- Installation and cabling of klystron
- High power tests
- Installation of 7-cell PETRA and waveguides in ELSA tunnel

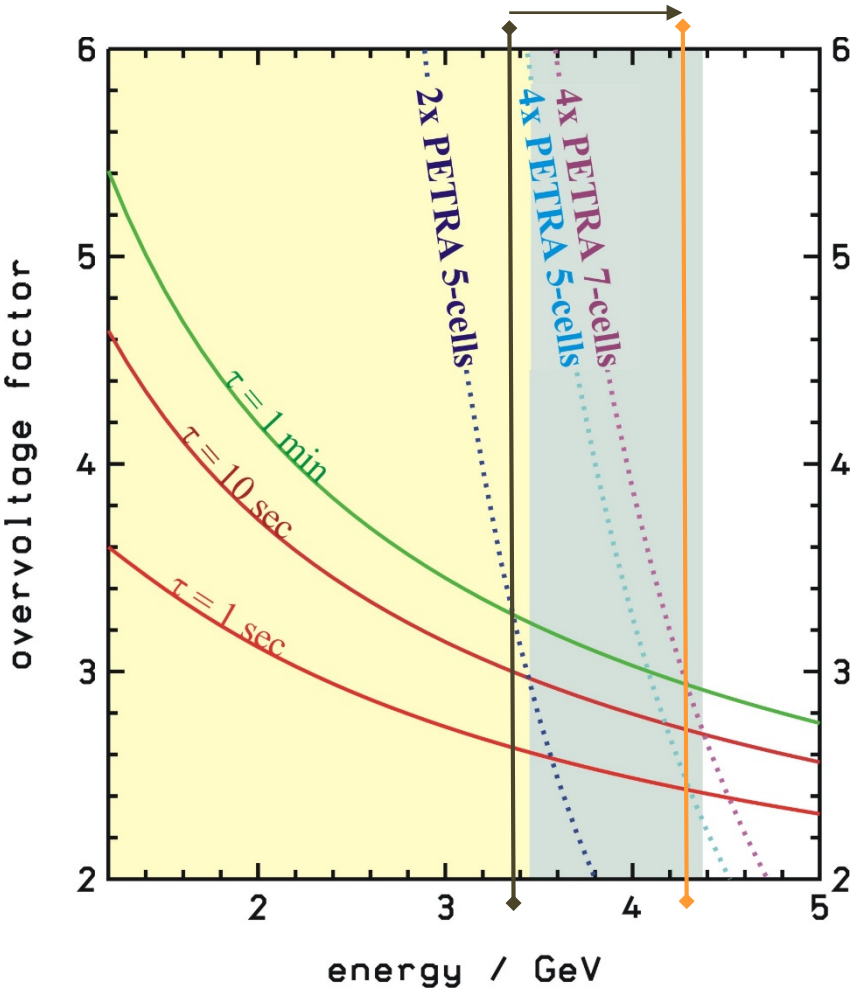
Spares

Accelerating Voltage



n.c. resonators type PETRA:

- 5-cells: $Q_0 \approx 10^4$, $R_S \approx 12$ MΩ
- 7-cells: $R_S \approx 17$MΩ
- Input-Coupler: $P_{max} \leq 120$ kW



with four 7-cell resonators $\boldsymbol{E \leq 4.3}$ **GeV** @ $\tau = 1$ min