Power Supplies for XFEL

Structure

Types of power supplies
- Super / normal conducting
- Correctors=Steerers

Regulation
- Accuracy/Resolution

Numbers

Location

Reliability/Redundancy concept

Definition of types

There are three different categories of power supplies

- Small power supplies for superconducting magnets and steerers (correctors) :
  - 0 – 50 A, 0 – 10V, 0-10 A, 0 – 60V
- Medium size power supplies (mainly for Quads):
  - 0 – 200 A, 0 – 400 A, up to 150 V
- Large size power supplies (mainly for dipoles):
  - Above 400A, above 150 V

Regulation

- All power supplies will be equipped with full digital regulation
- based on Altera FPGA
- Resolution 20 bit for the reference value
- Accuracy $5 * 10^{-4}$ ($\Delta I/I_{nom}$ long term stability)

Special features

- Internet Acces for remote diagnosis
- CAN bus interface to the control system
- Internal 24 bit resolution of ADC,
- 18 bit accuracy for regulation
- Self calibrating for high precision
- Self cable check for commissioning
- Check of magnet impedance for quench protection

Supercond.magnet power supplies and steerer

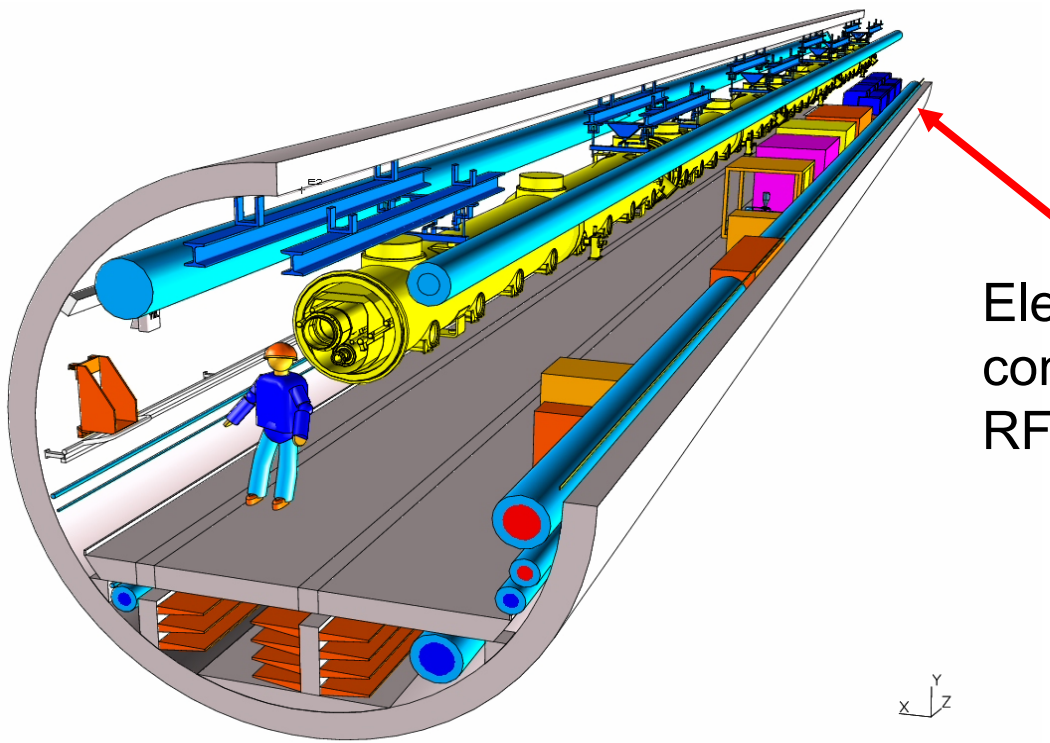
Switched mode power supply zero voltage/zero current

Superconducting quads	120
Superconducting steerer	120
Nominal current	50 A
Voltage	10 V
Steerer	580 in operation
Nominal current	10 A
Voltage	60 V

Location of the PS for sc. magnets

- Due to the large number of units and the distribution along the tunnel these power supplies will be placed inside the tunnel in electronic racks
- The racks will be protected against radiation by concrete housings
- Prototypes of the racks are ready
  - These have internal air/water heat exchangers to take the heat out of the racks and out of the tunnel

Location PS superconducting magnets



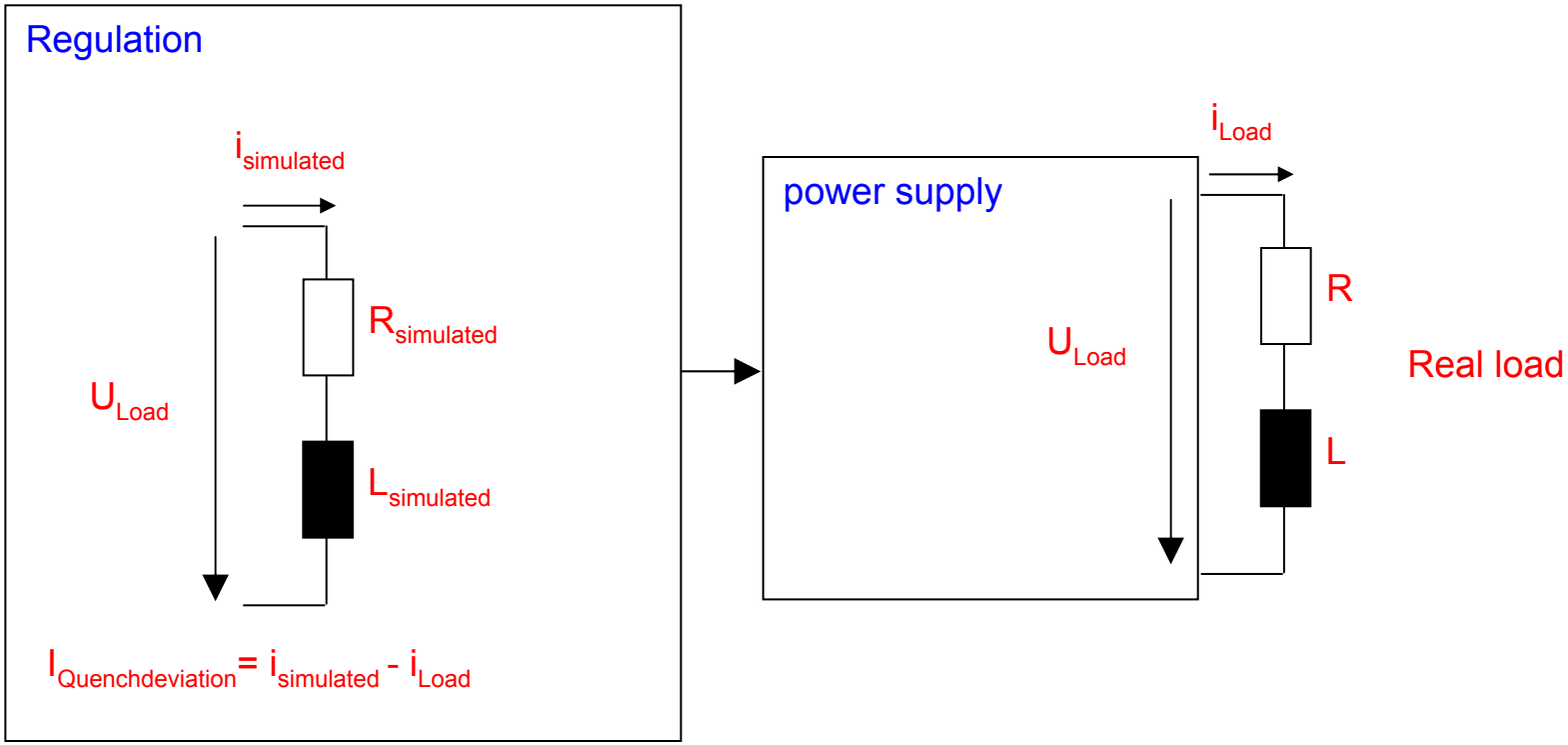
Electronic racks with concrete housing near RF stations

Quenchprotection

- Inductance of the magnet
  - QPs 1.15 H
  - Steerer 0.625 H
- Time constants
  - App. 20 – 40 sec
- The max. stored energy will be max.1500 J. This is less than 10 % of the stored energy in the magnets installed in FLASH
- It has to be checked whether additional hardware is required for the quench case. A solution with resistors that can be switched into the load circuit is ready.

Quenchdetection

Self calibrating load simulation and interlock



Web page:

62IQuenchDeviation:131032bit=-0.03662100A

Reliability concept

Since the PS is installed inside the tunnel with no access to the units

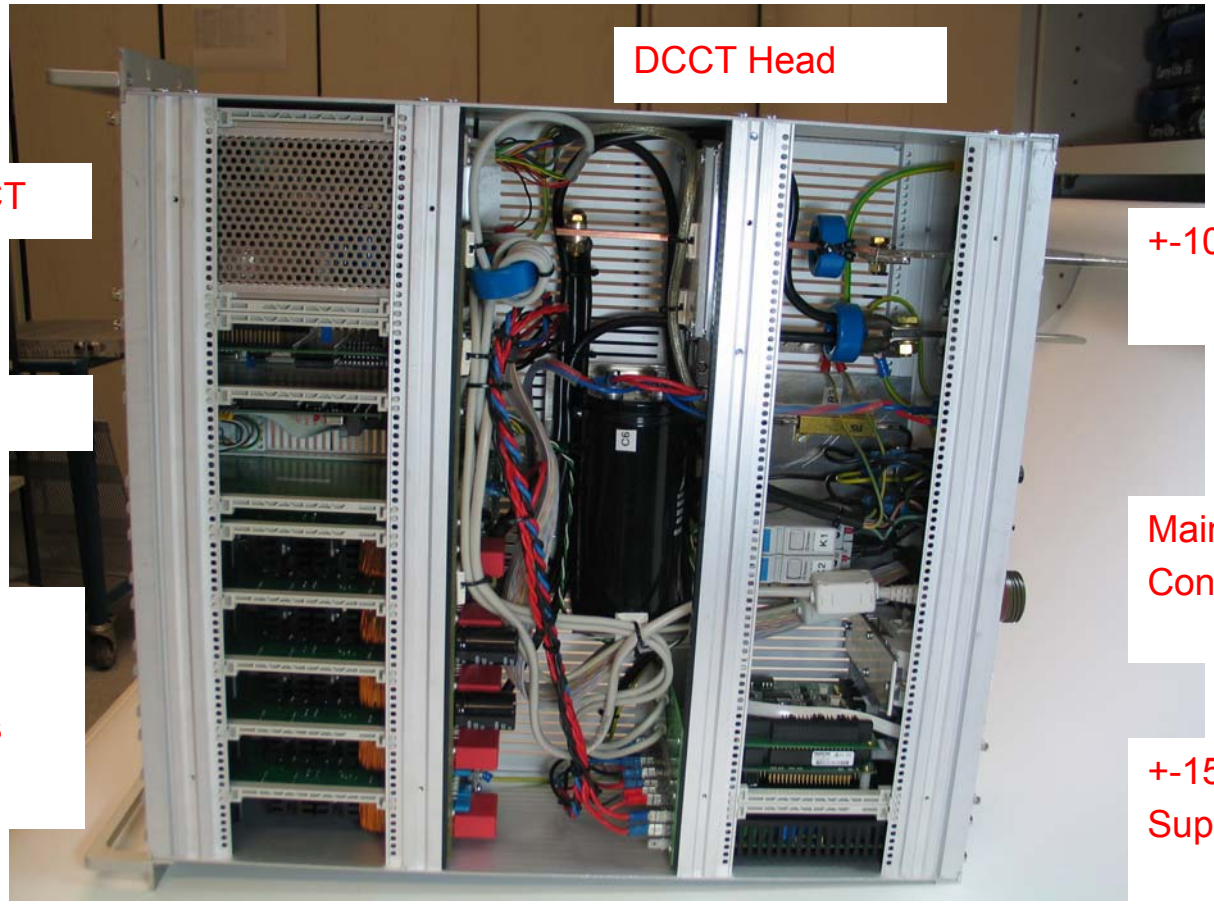
- A good diagnostic shall be installed
- The power part has to be redundant and in modules
- Access via control system, standard internet browser
- Fast reparability due to short maintenance time

Power supply in FLASH (former TTF)

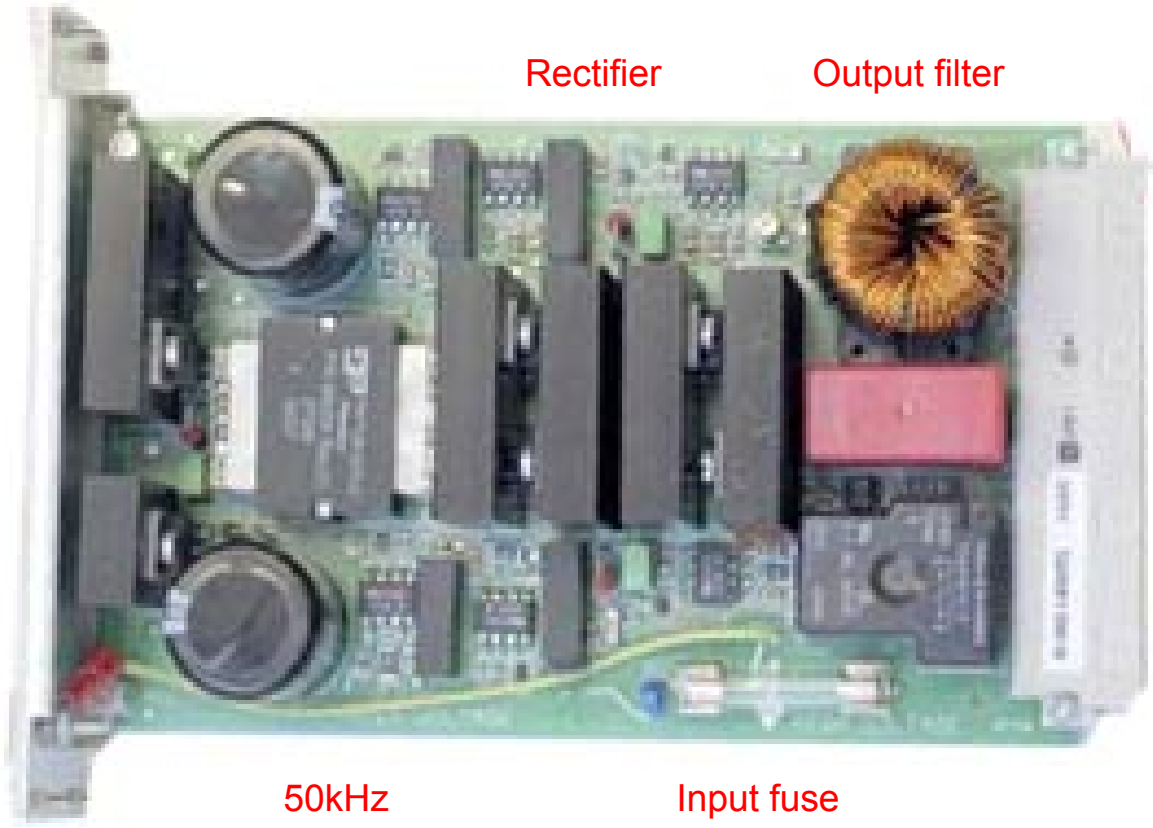
Already 50 units are working for
more than a year with very low

Power Supply for FLASH +/-100A, +/-10V

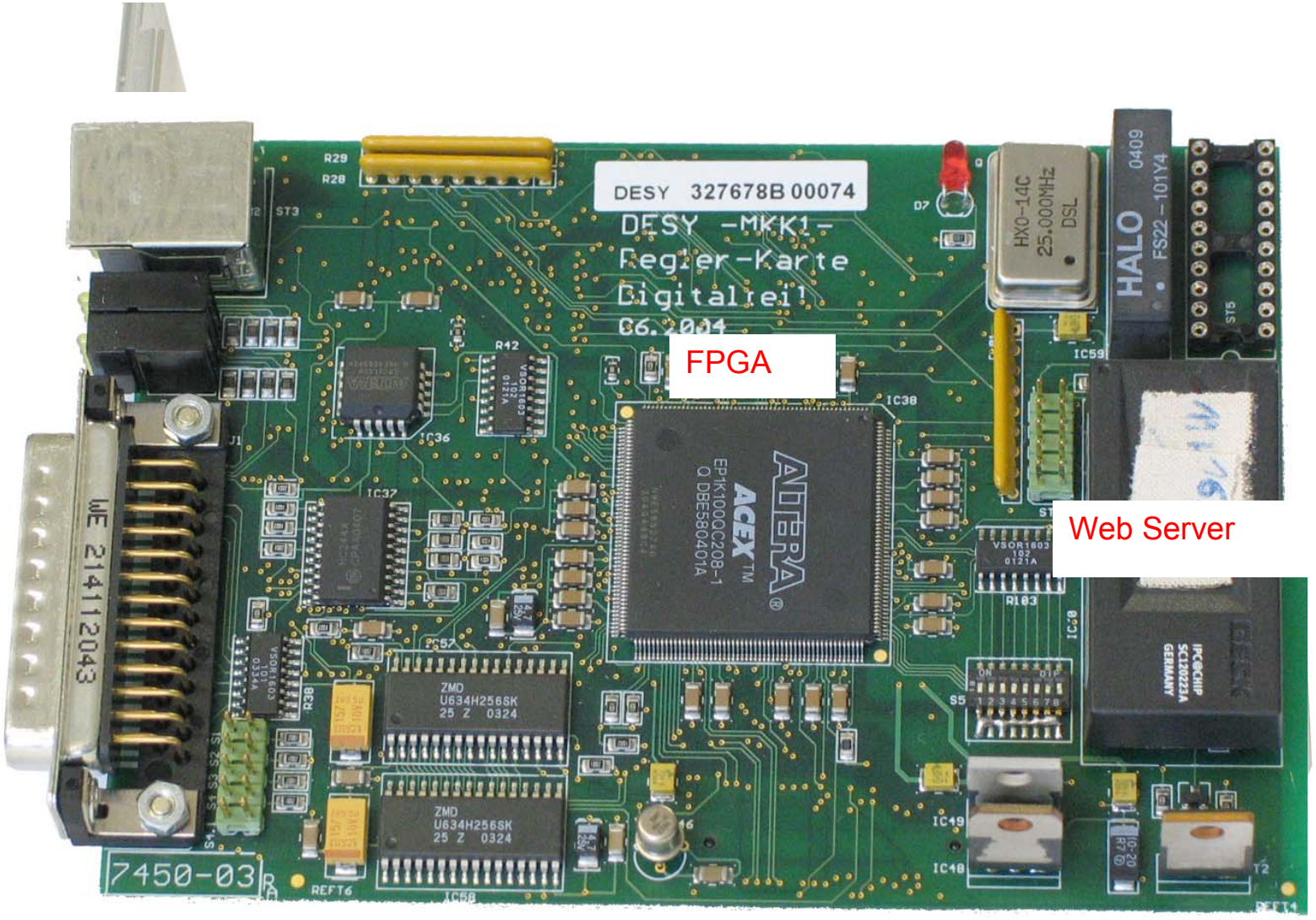
Power Supply for FLASH +/-100A, +/-10V



Power Supply Board +-25A @ +-10V



Regulation Digital Board Top Side

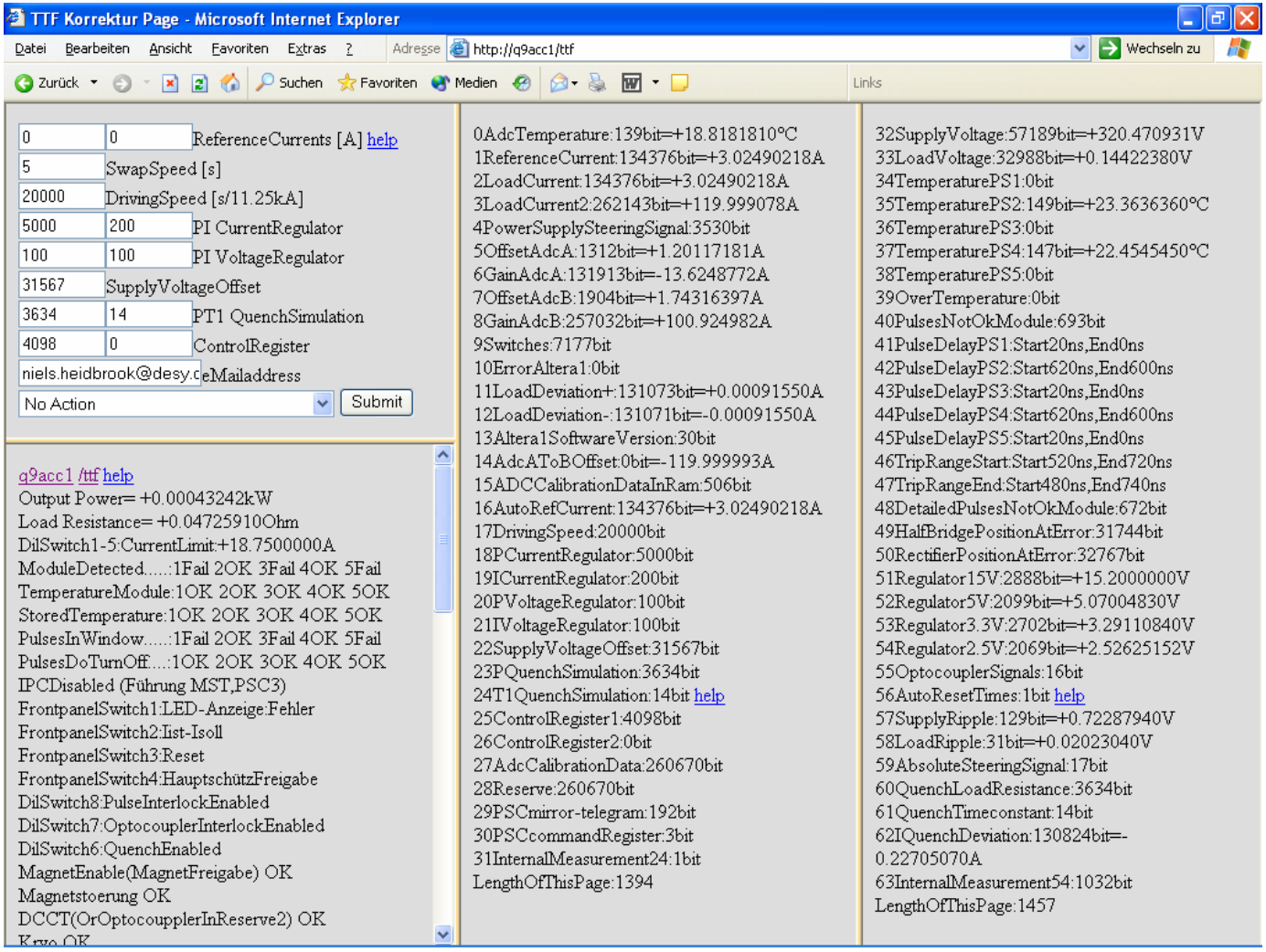


Regulator board HTML access

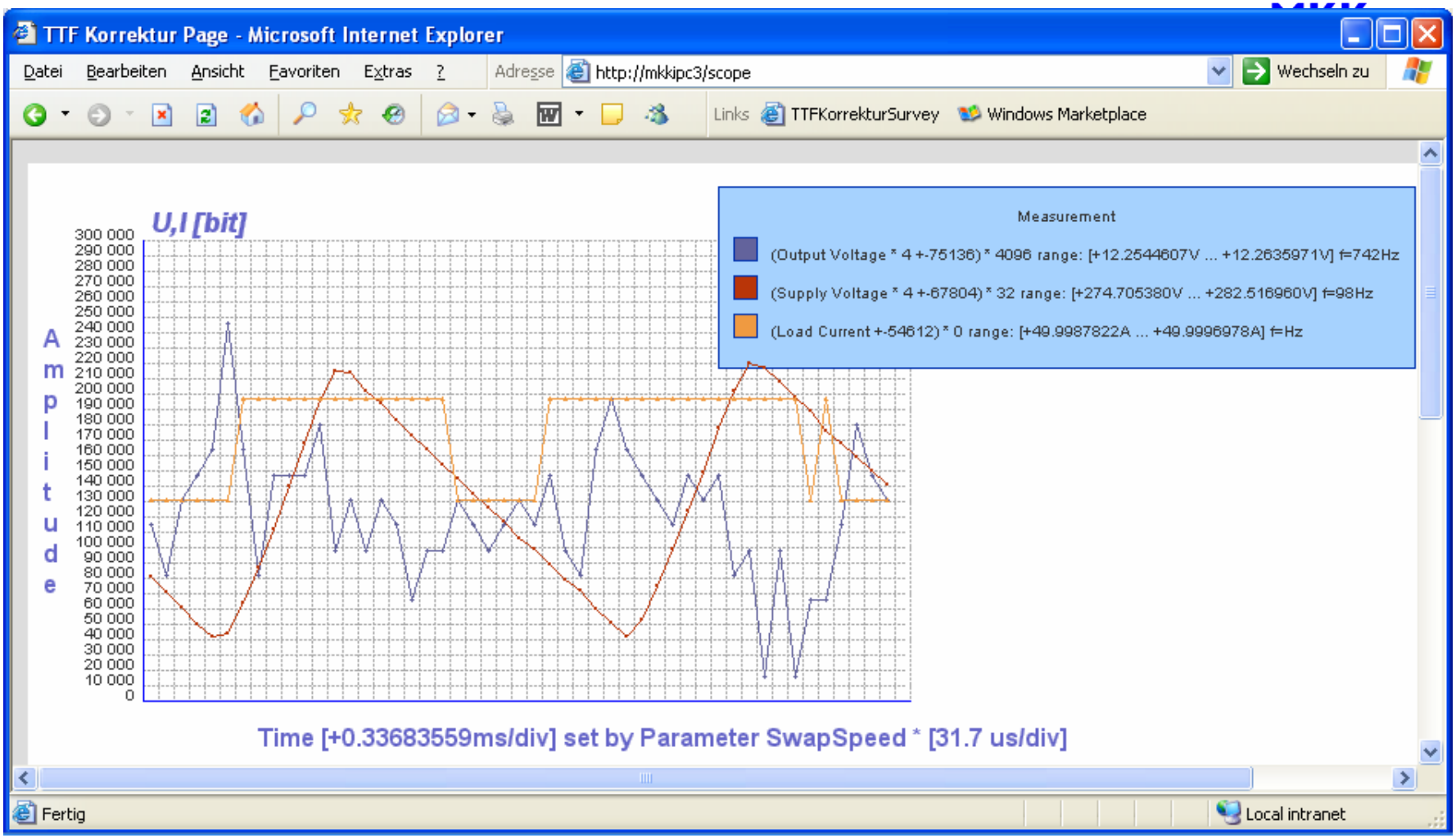
Regulation parameters

Derived data

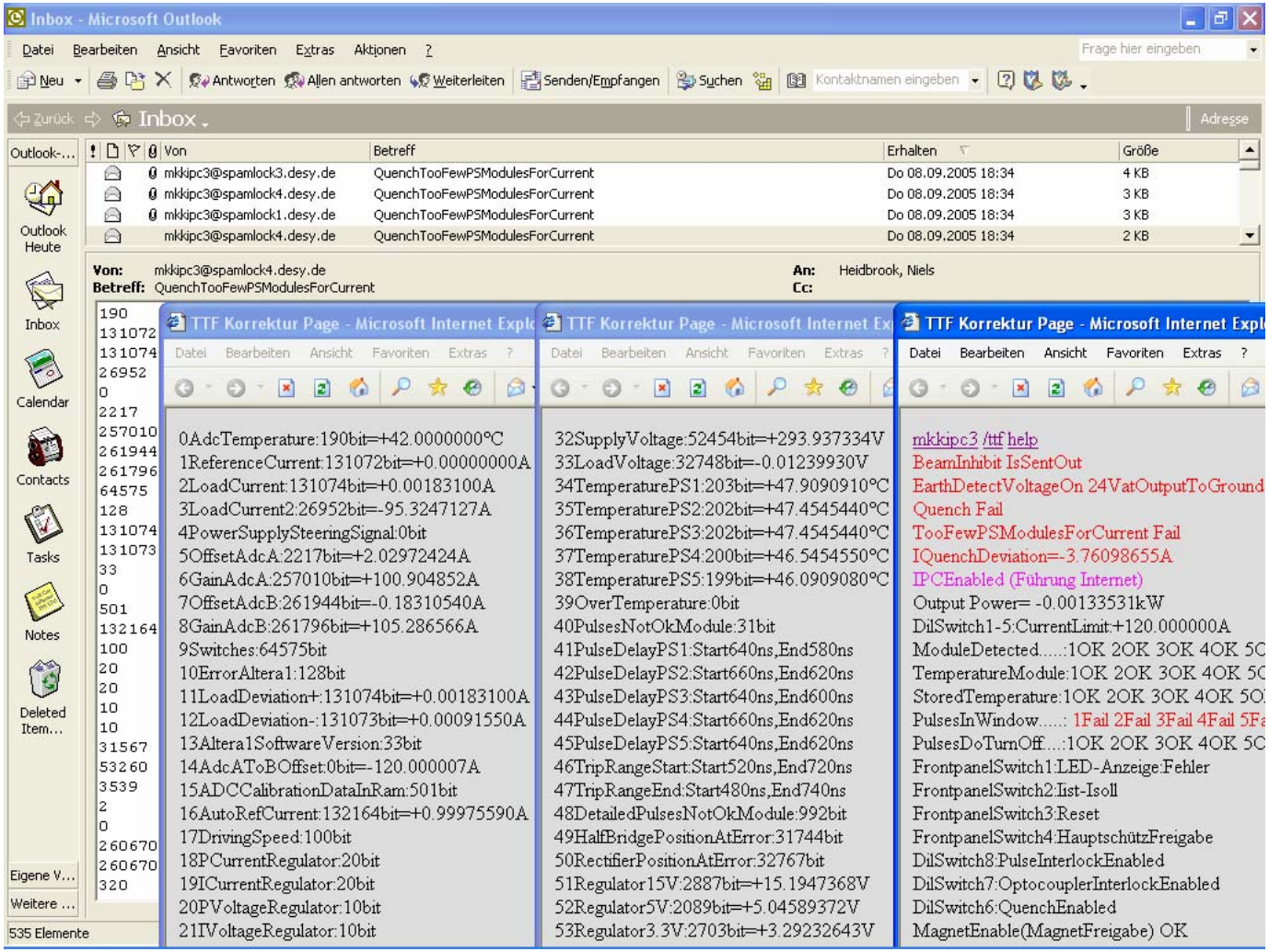
FPGA data



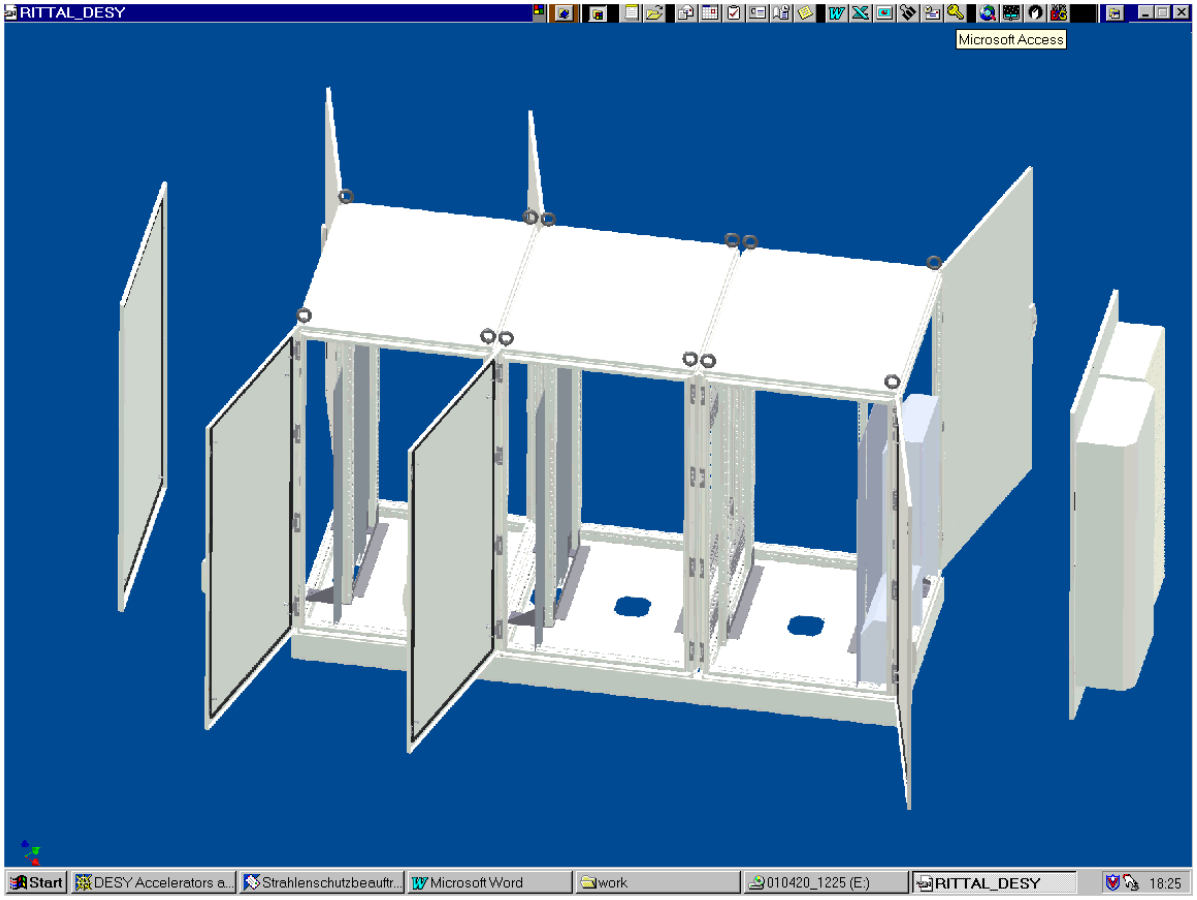
Regulator online scope function



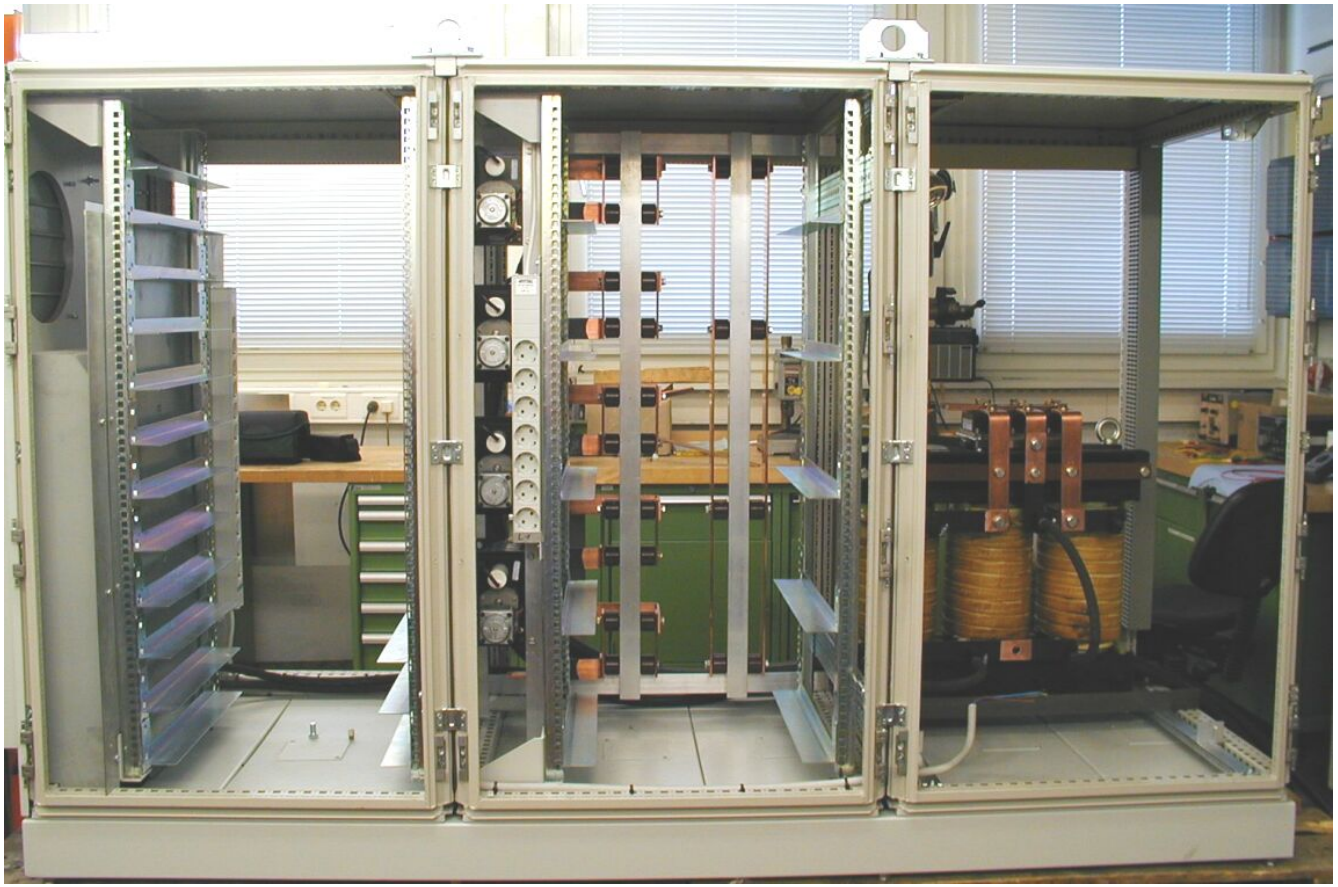
Error messages by email



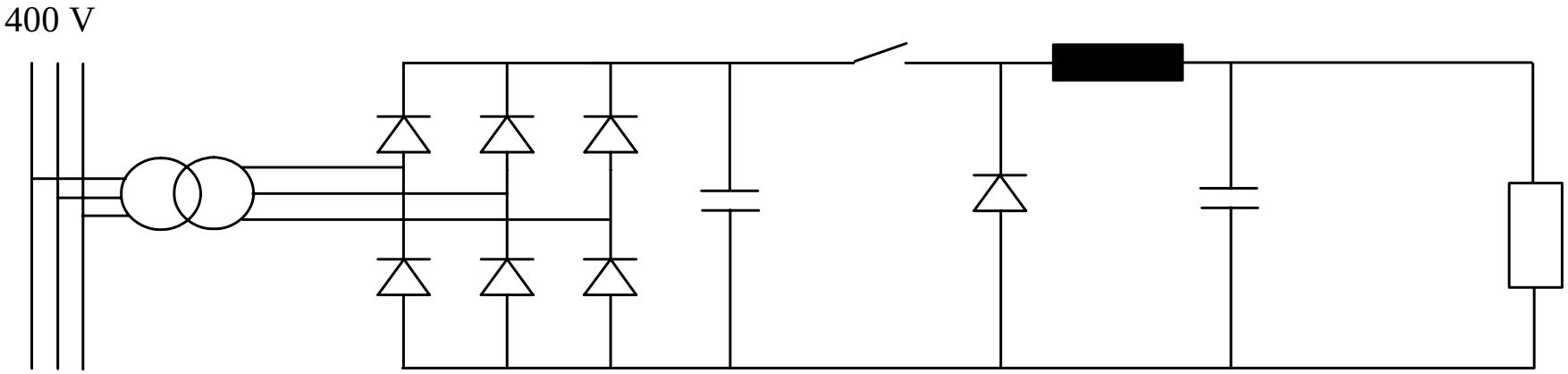
Electronic racks



Internal construction of the racks



HERA buck converter



Current 400 A
Voltage 150 V
By paralleling up to 800 A

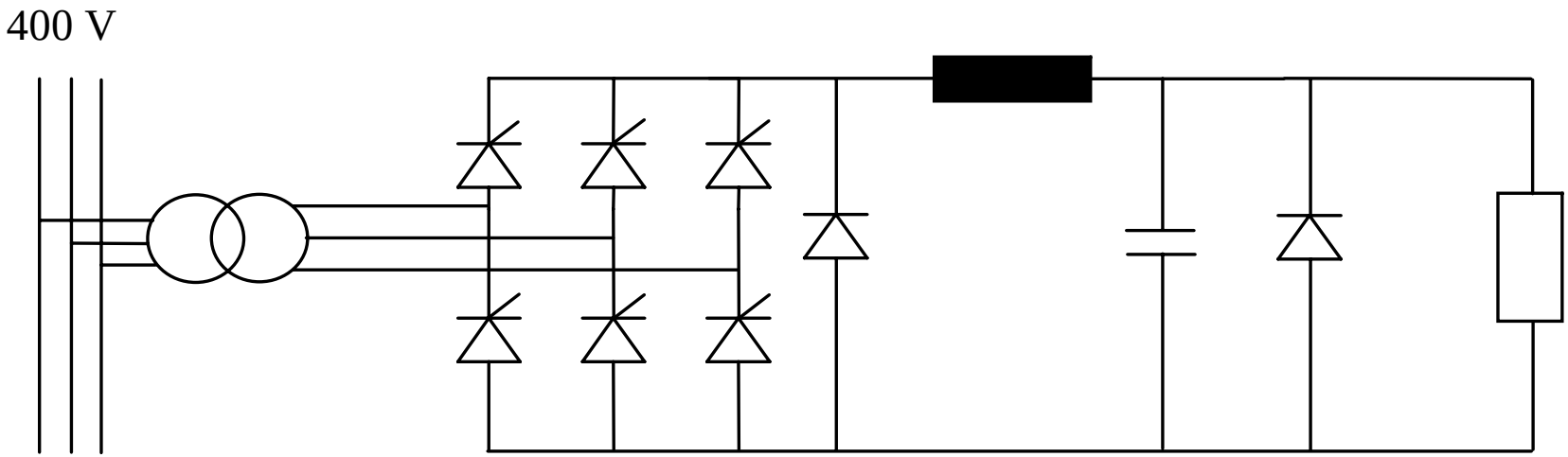
Medium size power supplies

- Switched mode power supplies
  - Current 0 – 200 A, 0 – 600 A,
  - Voltage up to 150 V
- Topology is not fixed, so far buck converters are used
- The same type of regulation will be used
- The interface to the power part will be done via Light Link to enhance EMC
- These power supplies will be installed in Injector building, XS1 to XS5 and near the experimental hall. The power supplies will be accessible.

Chopper power supplies in FLASH

400A / 150 V

Large size power supplies SCR type



Current > 600A
Voltage > 150 V

Redundancy concept

•Aim to be back into operation after failure

$\Rightarrow$ **max. 15 min**

•Time to reach the hall + repair time exceeds this time

$\Rightarrow$ **a redundancy system is required**

•The PS will equipped with a motor driven switches or contactors to disconnect the broken PS and reconnect the spare supply

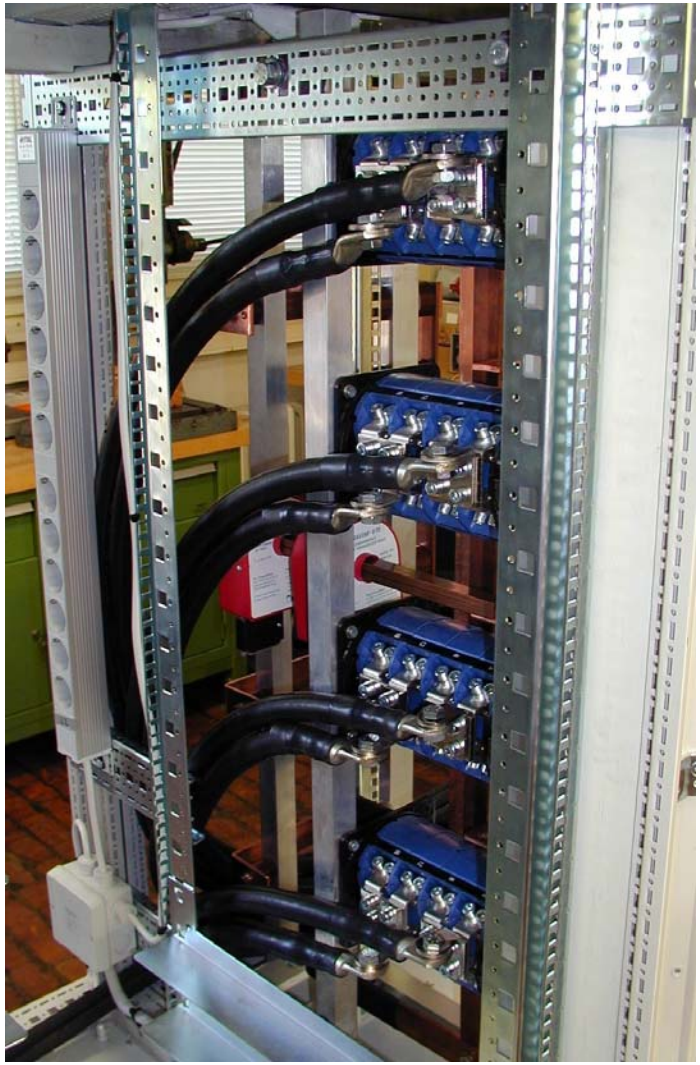
•For a group of power supplies a spare power supply will be installed.

Redundancy system (2)

- In case of failure the shift crew detects the failure.
  $\Rightarrow$ control system generates an alarm.
- The shift crew tries to reset the power supply.
  $\Rightarrow$ If not successful, switch over to the spare PS.

- Within few minutes the machine can restart to operate.

Redundancy system



Cabling

Diameter in mm²	Length in km
2.5	100
4	30
16	15
25	28
120	8
185	56
240	8

Total number of power supplies

Type of PS	Number incl. spares
Superconducting magnets	300
Large size PS	35
Medium size	200
Steerer type	630
total	1175

Thank you for your attention

Please feel free to ask questions