Power Supply and Energy Extraction System for the CBM magnet

Preliminary Design Report

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- Introduction
- Powering Circuit
- Power Supply – VCH1000
- Energy Extraction System, basic elements
- Experience
- Conclusion.

Power Supply and Energy Extraction System for the CBM magnet

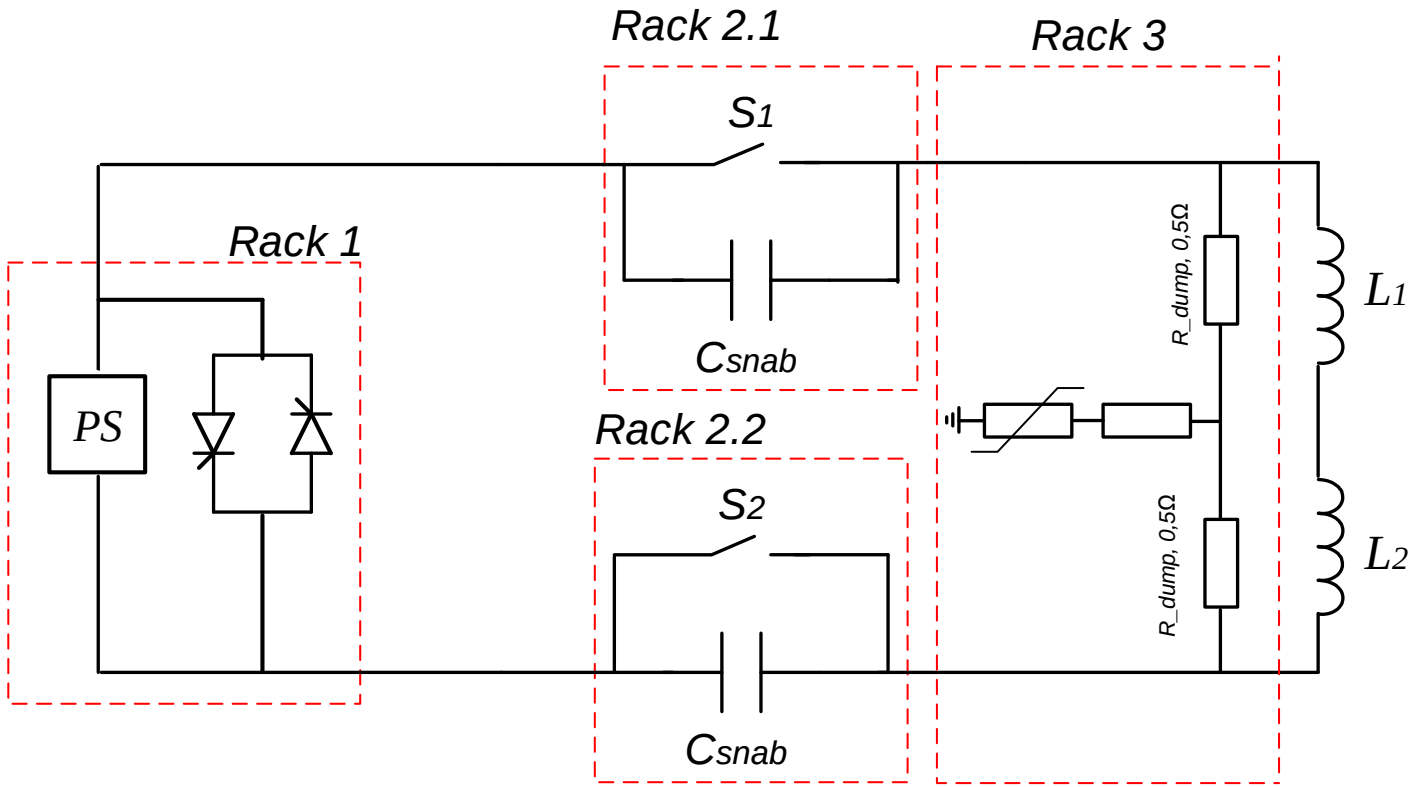
Introduction

Requirements for the external protection system (Quench detection and Energy Extraction):

- The amount of the stored energy to be extracted is 5.1MJ. Stored energy should be extracted to the external dump resistor with the value of 1 Ohm. The active elements of the dump resistor should not be hotter than 100C. Cooling time should be specified;
- Quench detection circuit should provide fast detection of the normal phase appearing. The discrimination time should be about 6ms and the threshold – about 0.6V (0.6V corresponds to 6 wounds in the normal state);
- Number of the voltage tabs and the locations of their connections should be determined;
- Dump resistor should be introduced to the circuit not later than in 40 ms. That gives the demands on the energy extraction switch (current breaker);
- Dump resistor value - 1 Ohm. Middle point should be introduced and grounded in order to minimize the voltage between the coil and ground.

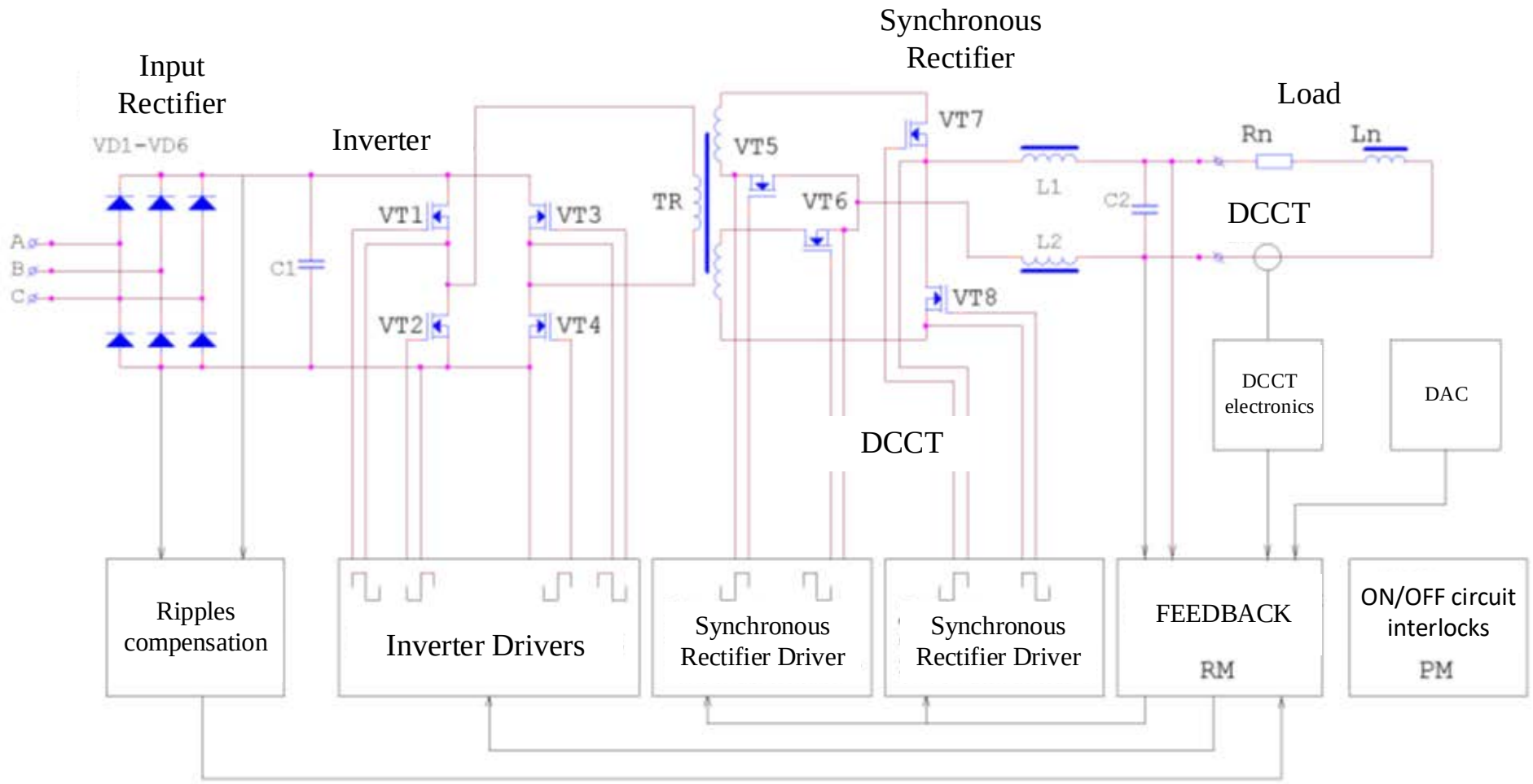
Power Supply and Energy Extraction System for the CBM magnet

Powering circuit



Power Supply (Current Source – VCH1000)

Power Supply – block diagram



PS

Power Supply – parameters:

- Nominal output power 12kWt;
- Nominal output current 1000A;
- Nominal output voltage 12V;
- 8 hours run Stability - < 0.01% from nominal;
- Output ripples in voltage:
  0-300Hz - < 10mV rms,
  0-40kHz – < 100mV rms;
- Control Interface – CAN
- Form factor 19” x 4U

PS

Interlocks:

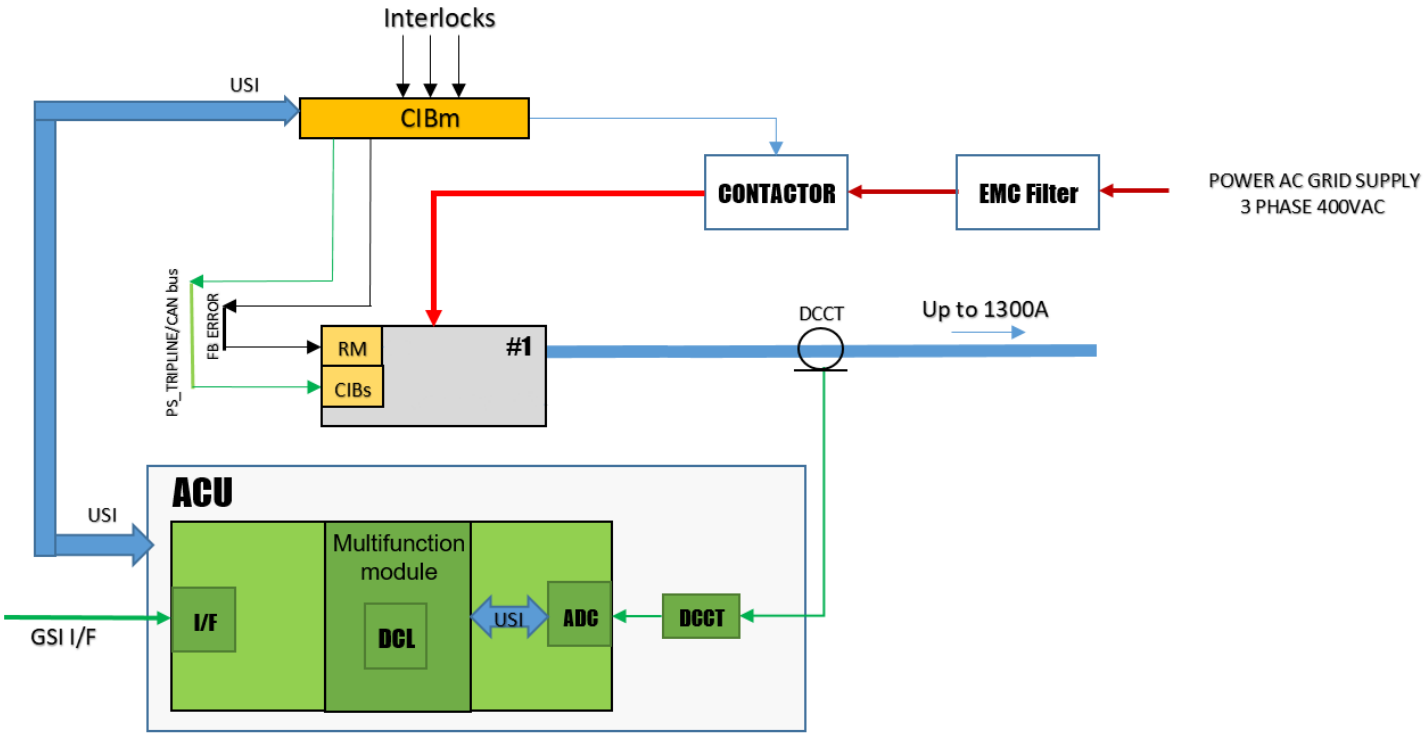
- Overcurrent (I > “Imax”);
- Overpower (Pload > “Pmax”);
- Phase distortion for more than 20% ;
- Over temperature of the power part;
- External Load faults (temperature, water).

Conditions:

- External conditions – room temperature 10– 35^{0}C;
- Input power line – 3 phases 380V with neutral.
- Cooling – distilled water not warmer than 30^{0}C,
- Maximal input pressure 6bars,
- Water consumption 2 liters/min,
- Water gradient with the maximal power < 10^{o}C
- Sizes 547*550*133mm, weight 25kg.

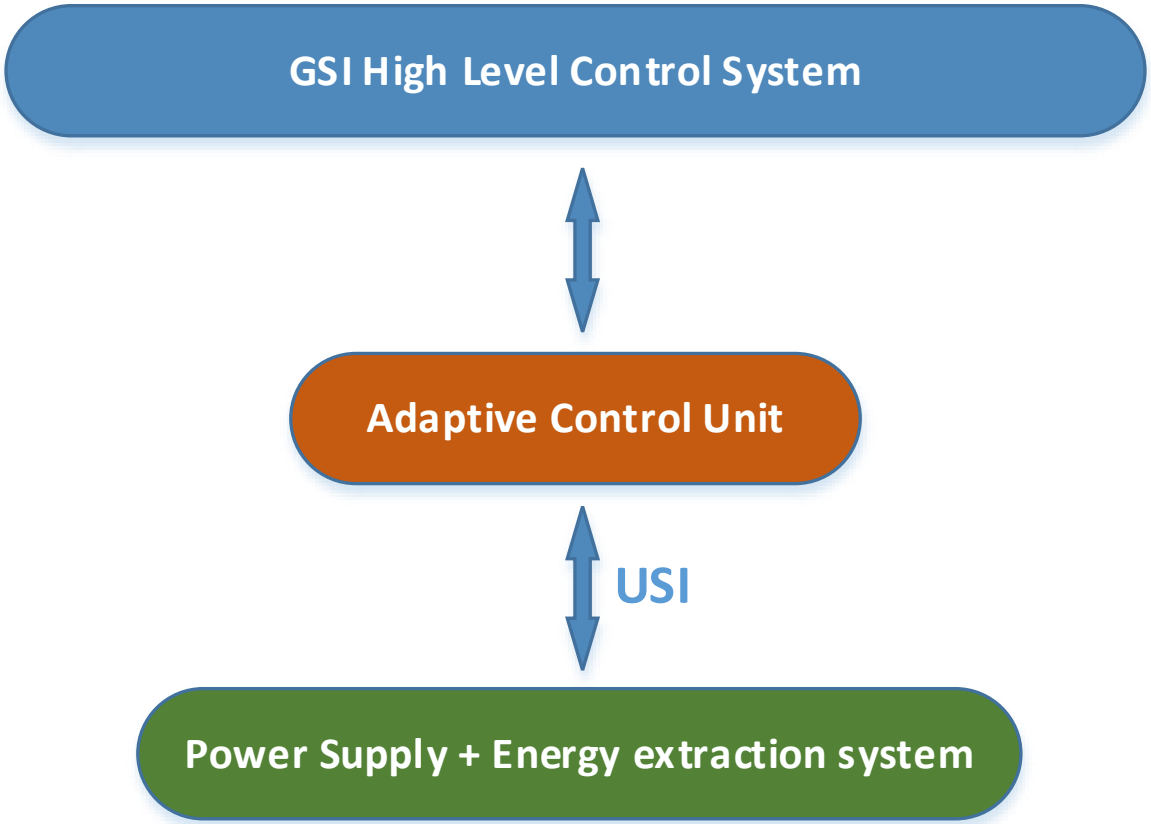
PS and EES control electronics

CBM SOLENOID POWER CONVERTER DESIGN CONCEPT

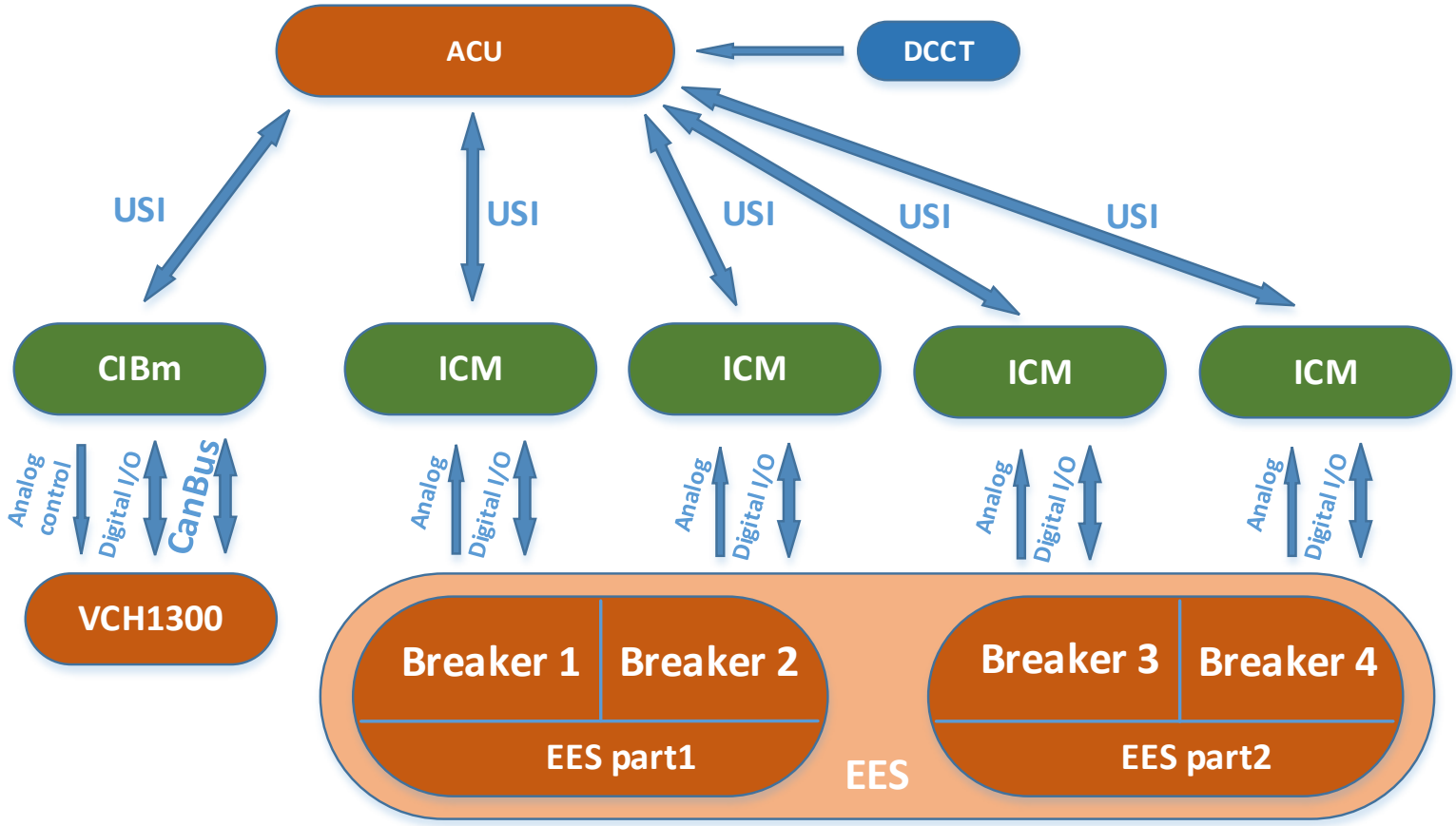


CS – local current feedback current sensor
DCCT – digital control loop measuring head
ACU – Adaptive Control Unit
DCL – Digital Control Loop
CIBm – Control & Interface Board (master)
CIBs – Control & Interface Board (slave)

PS and EES control electronics

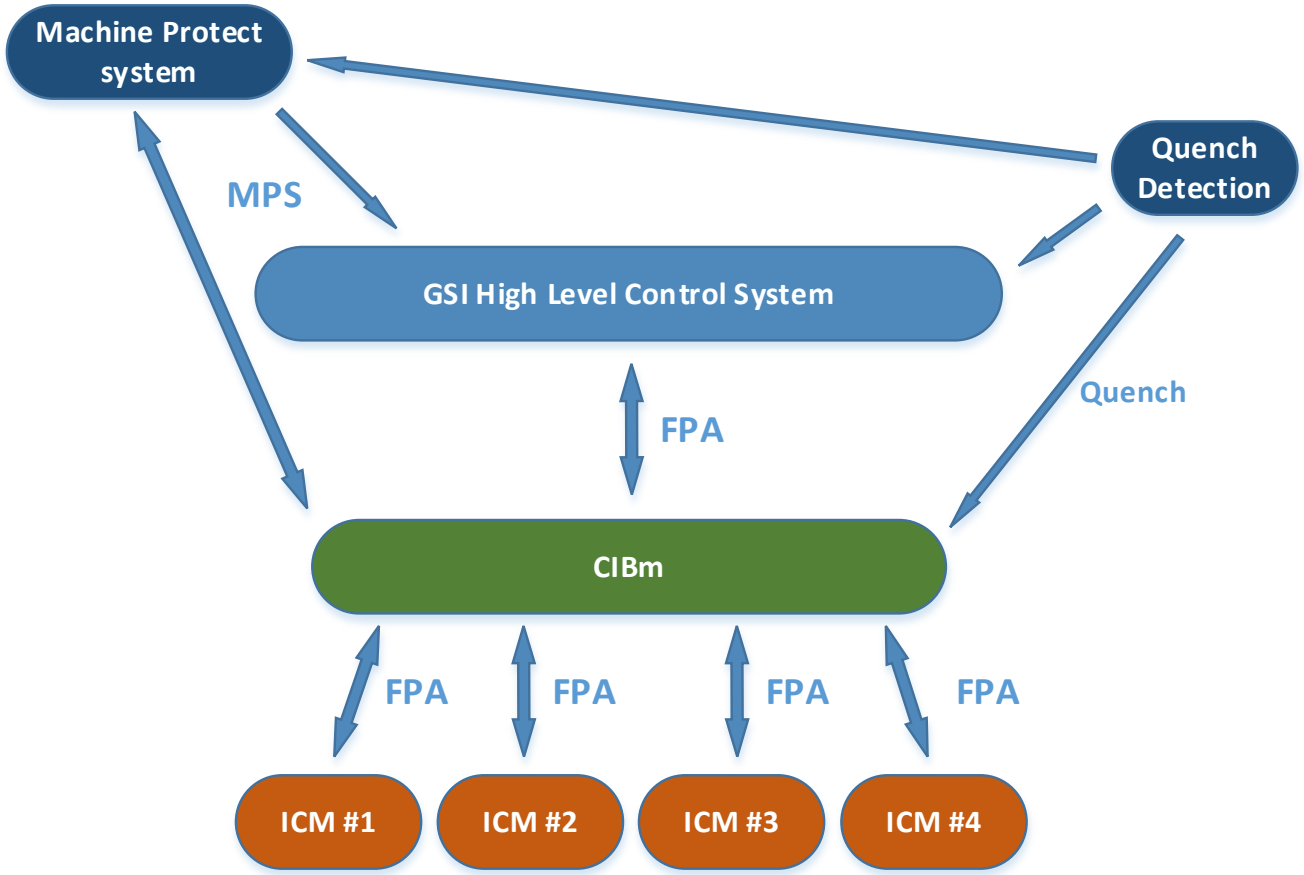


PS and EES control electronics



CIBm – Control and Interface master board (Produced by BINP)
ACU – Adaptive Control Unit (Produced by GSI)
ICM – Interface Control Board (Produced by GSI)

PS and EES control electronics

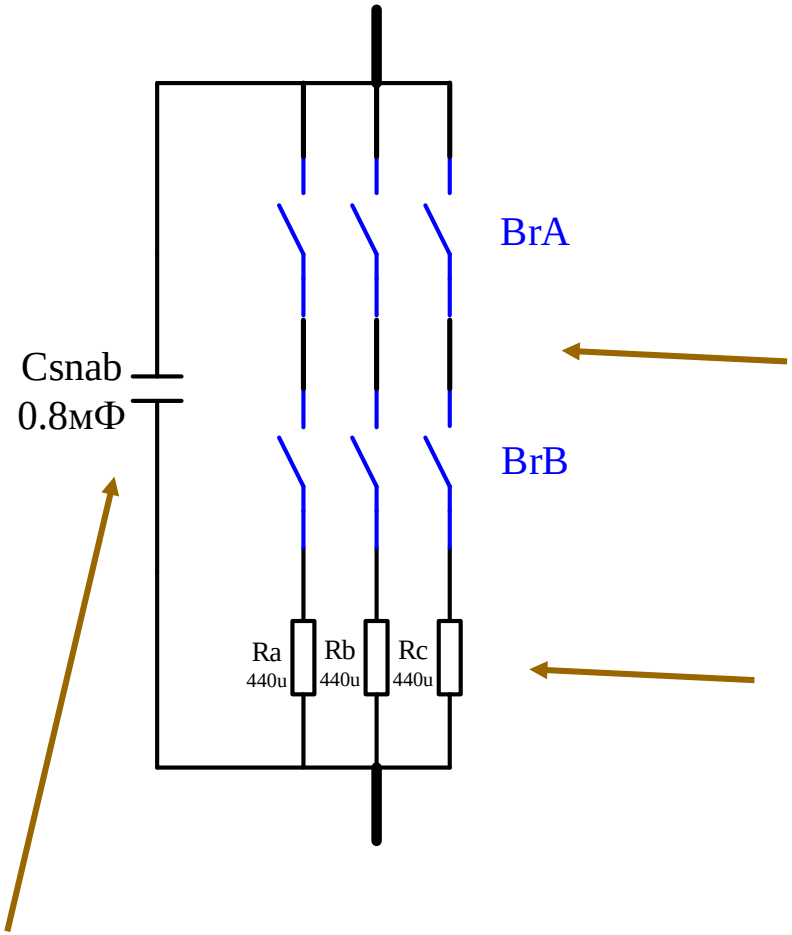


CIBm – Control and Interface master board (Produced by BINP)
ICM – Interface Control Board (Produced by GSI)

Energy extraction system

№	Parameter	Value	Unit
1.	Maximal current	667	A
2.	Energy stored in the magnet	5.1	MJ
3.	Current polarity	bipolar	
4.	Maximal inductance in a circuit	20+20	Hn
5.	Dump resistor value	2 ± 5%	Ohm
7.	Maximal over temperature of the Dump Resistor	80	K
8.	Maximal time delay for the energy extraction	<0.04	s

Energy extraction system

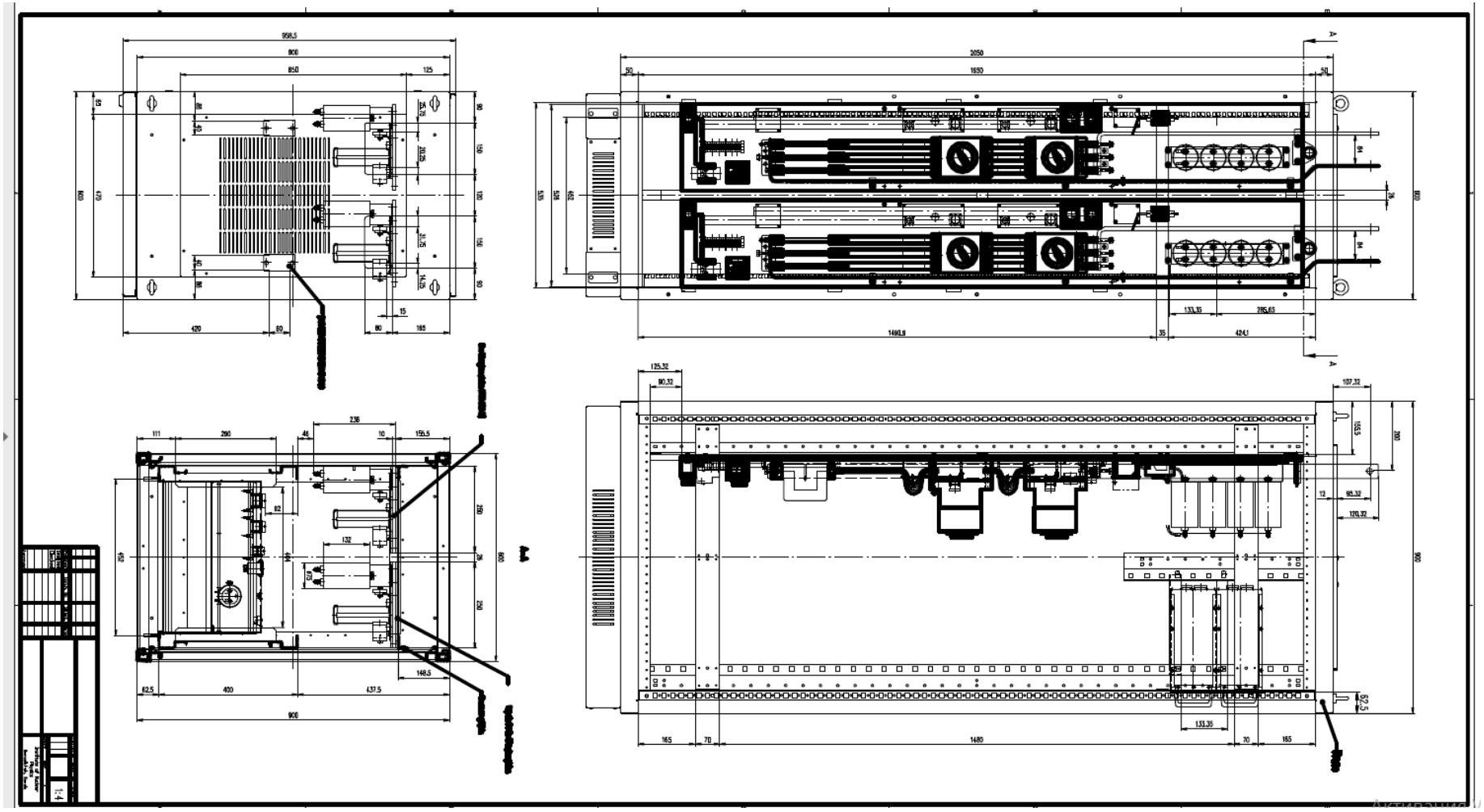


Two breakers for redundancy. Each one is drived by the independent electronic channel

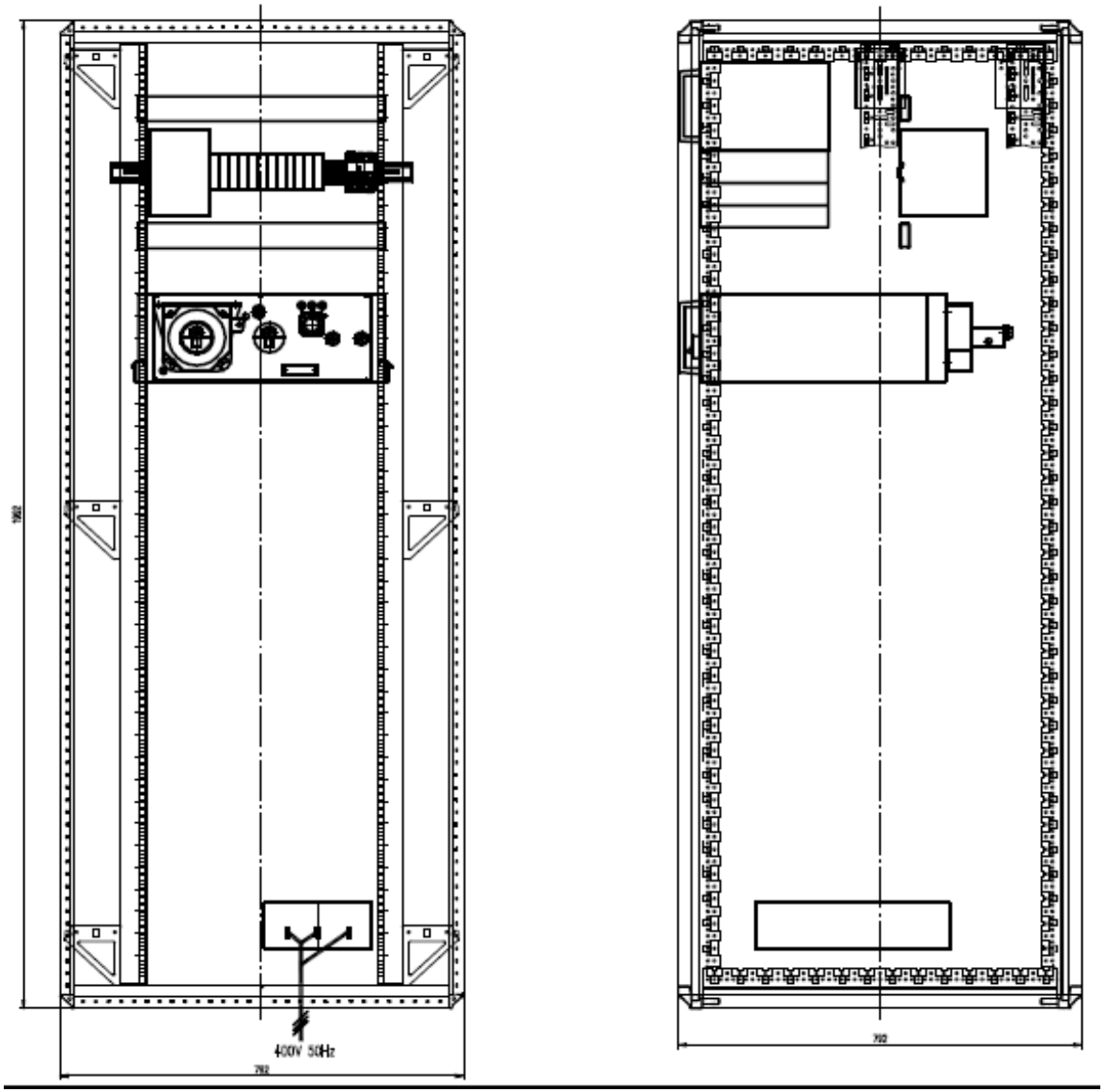
Equalizing resistors to improve the current sharing between phases

Csnab – snubber capacitor to minimize the arc effect.

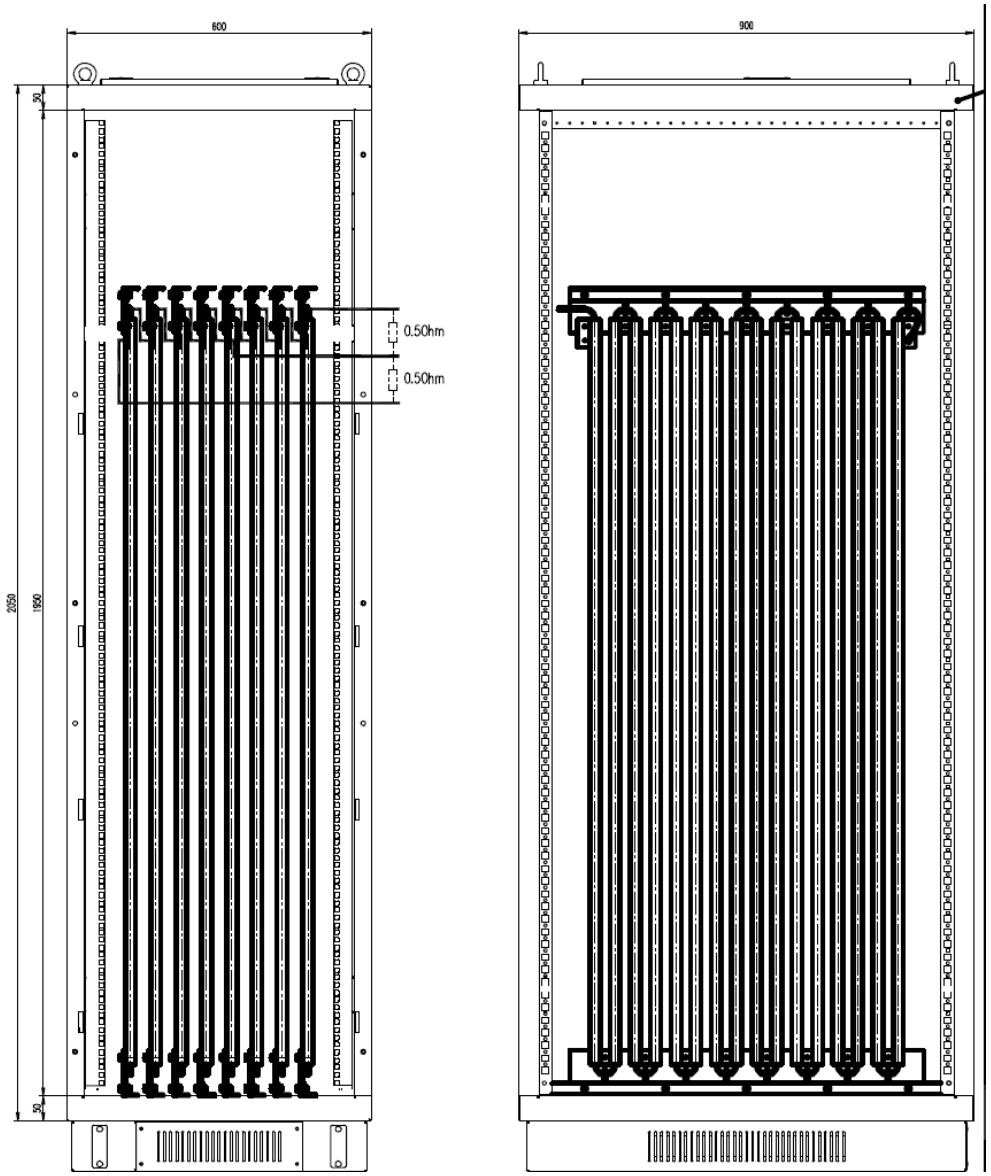
Energy extraction system



PS rack

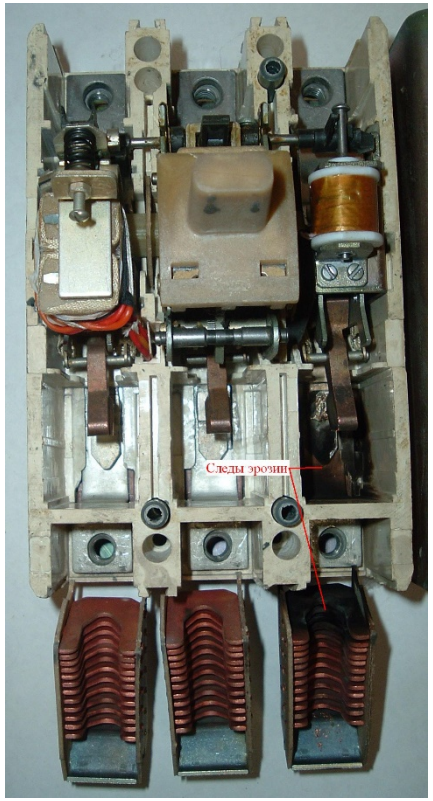


Damp Resistor

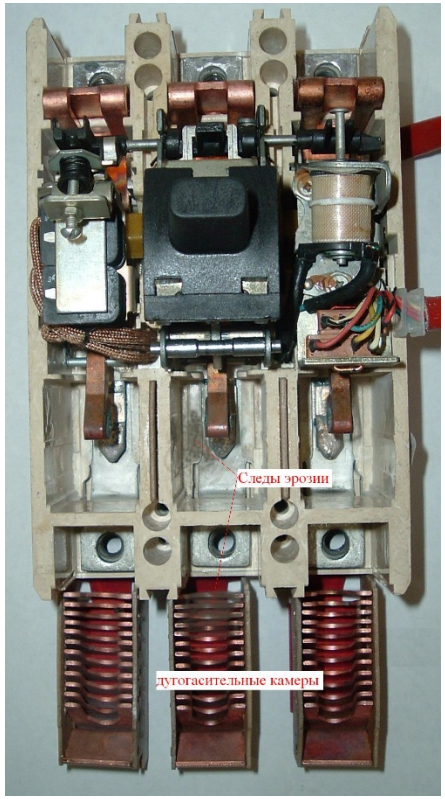


Energy extraction system

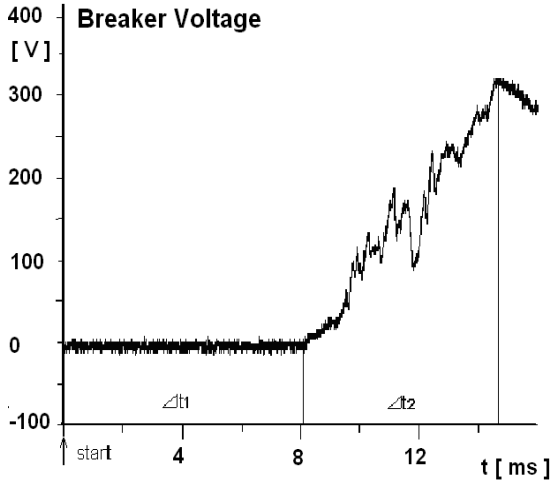
Electromechanical Breaker and use of snubber



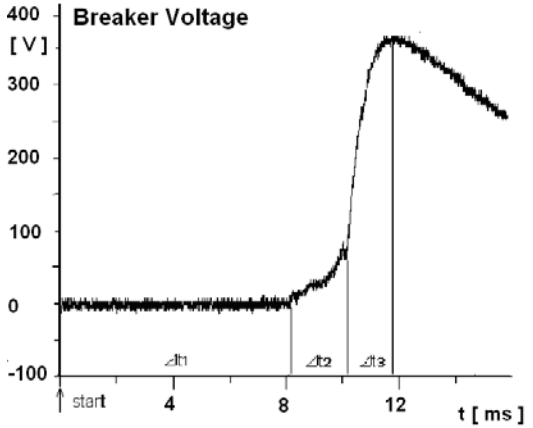
VA57-35 after 100 cycles under the full current , without snabber



VA57-35 after 100 cycles under the full current , with snabber , Csnab = 0.8 mF



Voltage over the contacts while opening the circuit with Csnab = 0



Voltage over the contacts while opening the circuit with Csnab = 0.8 mF

Energy extraction system

Example - 202 energy extraction systems for the LHC corrector magnets delivered by BINP to CERN.

Two systems per rack

Racks in the LHC tunel

Thanks for Your Attention!