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# Power Supply and Energy Extraction System for the CBM magnet

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Conceptual Design Report

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

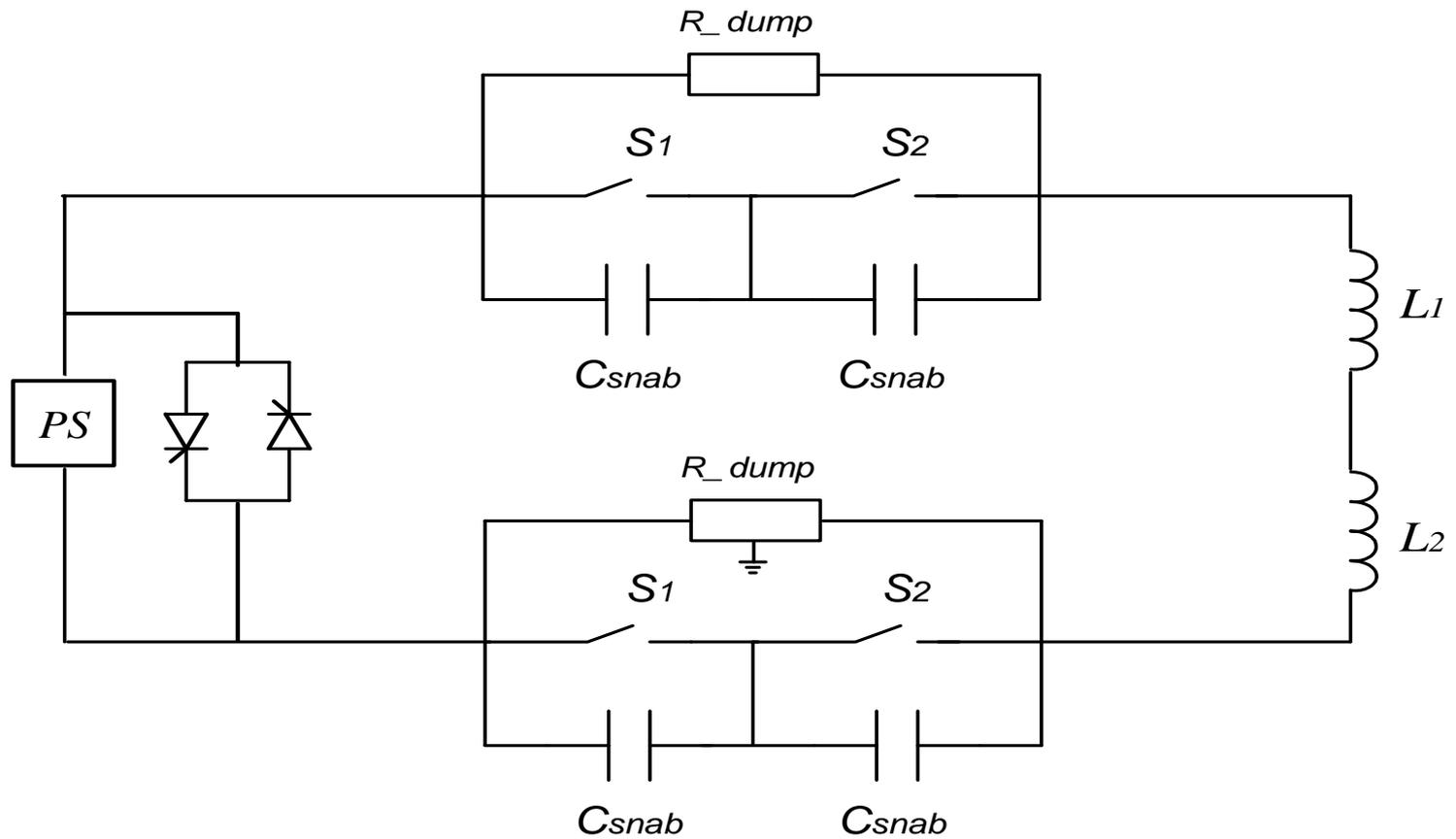
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## Introduction

### **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 2 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 - 2 Ohm. Middle point should be introduced and grounded in order to minimize the voltage between coil and ground.

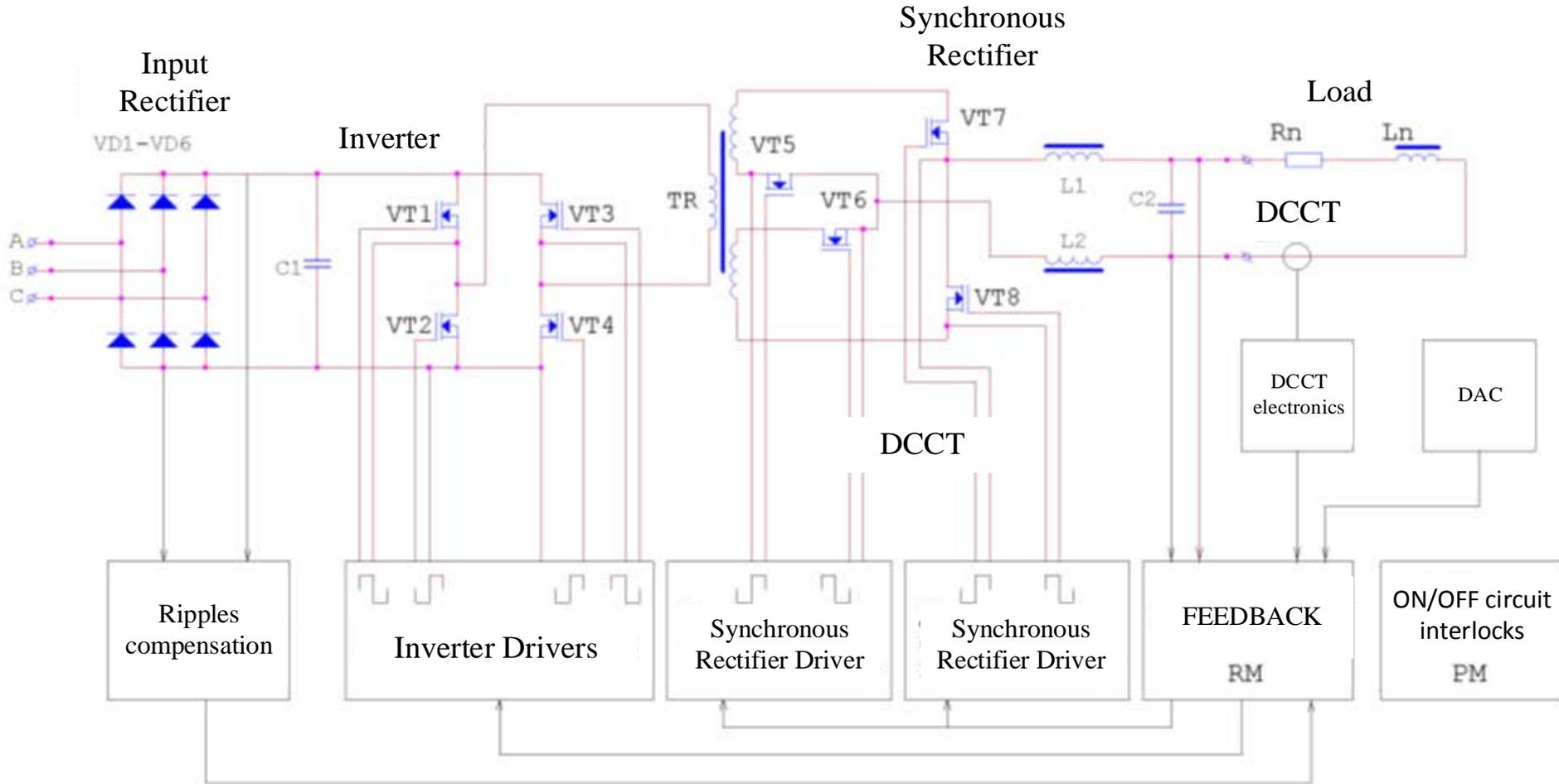
- Powering circuit



# Power Supply (Current Source – VCH1000)



# Power Supply – block diagram



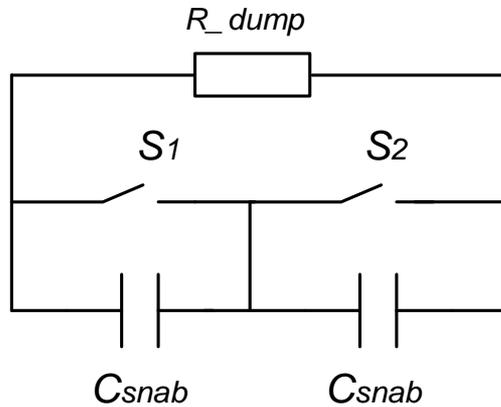
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## Power Supply – parameters

- Nominal output power 15.6kWt;
- Nominal output current 1300A;
- Nominal output voltage 12V;
- 8 hours run Stability - < 0.01% from nominal;
- Output ripples in voltage:
  - 0-300Hz - < 10mV rms,
  - 0-40кГц – < 100mV rms;
- Control Interface – CAN
- Form factor 19” x 3U

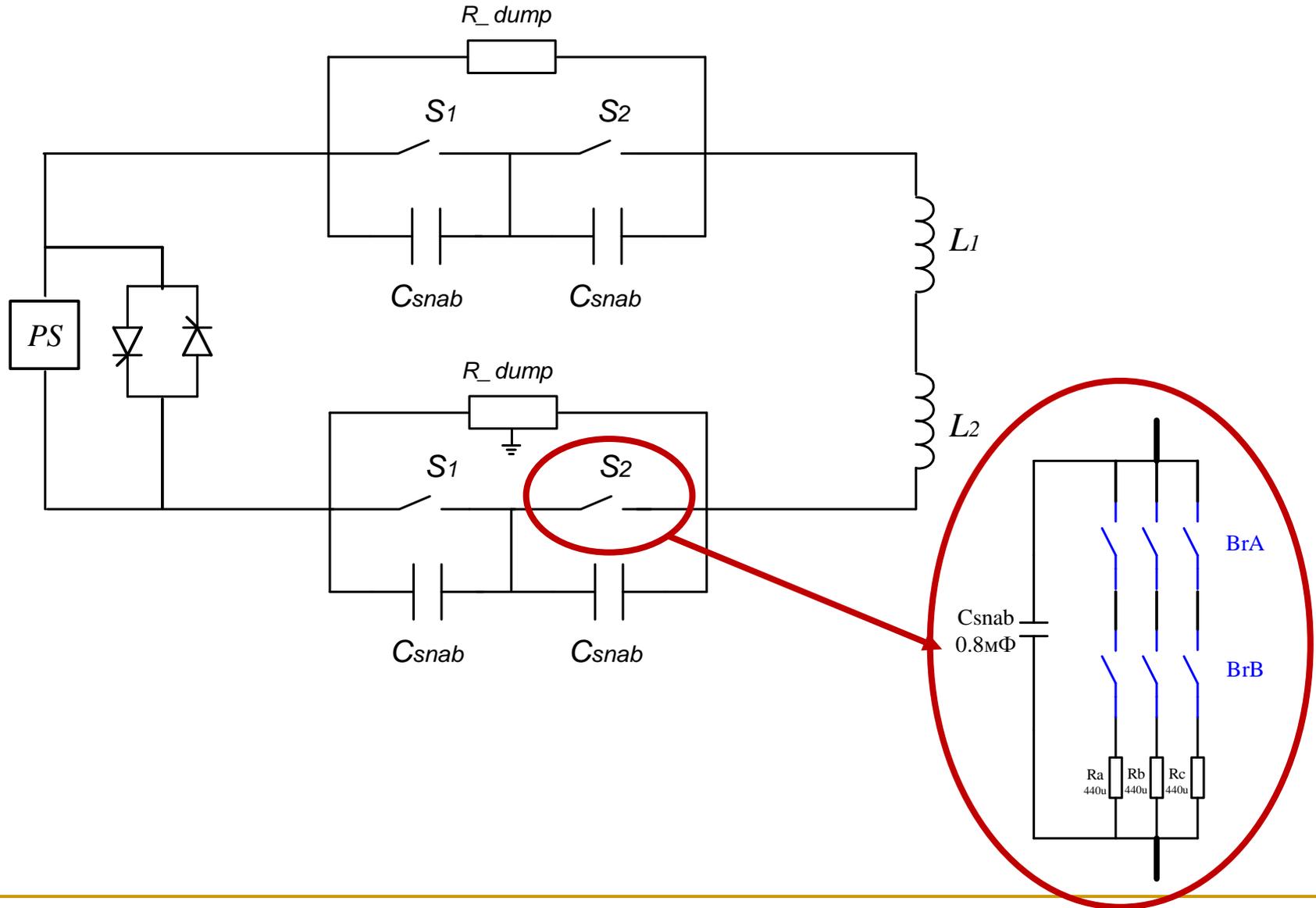
- Interlocks:
  - Overcurrent ( $I > "I_{max}"$ );
  - Overpower ( $P_{load} > "P_{max}"$ );
  - Phase distortion for more than 20% ;
  - Over temperature of the power part;
  - External Load faults (temperature, water).
  
- Conditions:
  - External conditions – room temperature 10– 35°C;
  - Input power line – 3 phases 380V with neutral.
  - Cooling – distilled water not warmer than 30°C,
    - Maximal input pressure 6bars,
    - Water consumption 2 liters/min,
    - Water gradient with the maximal power  $< 10^{\circ}\text{C}$
  - 
  - Sizes 547\*550\*133mm, weight 25kg.

■ **Energy extraction System**

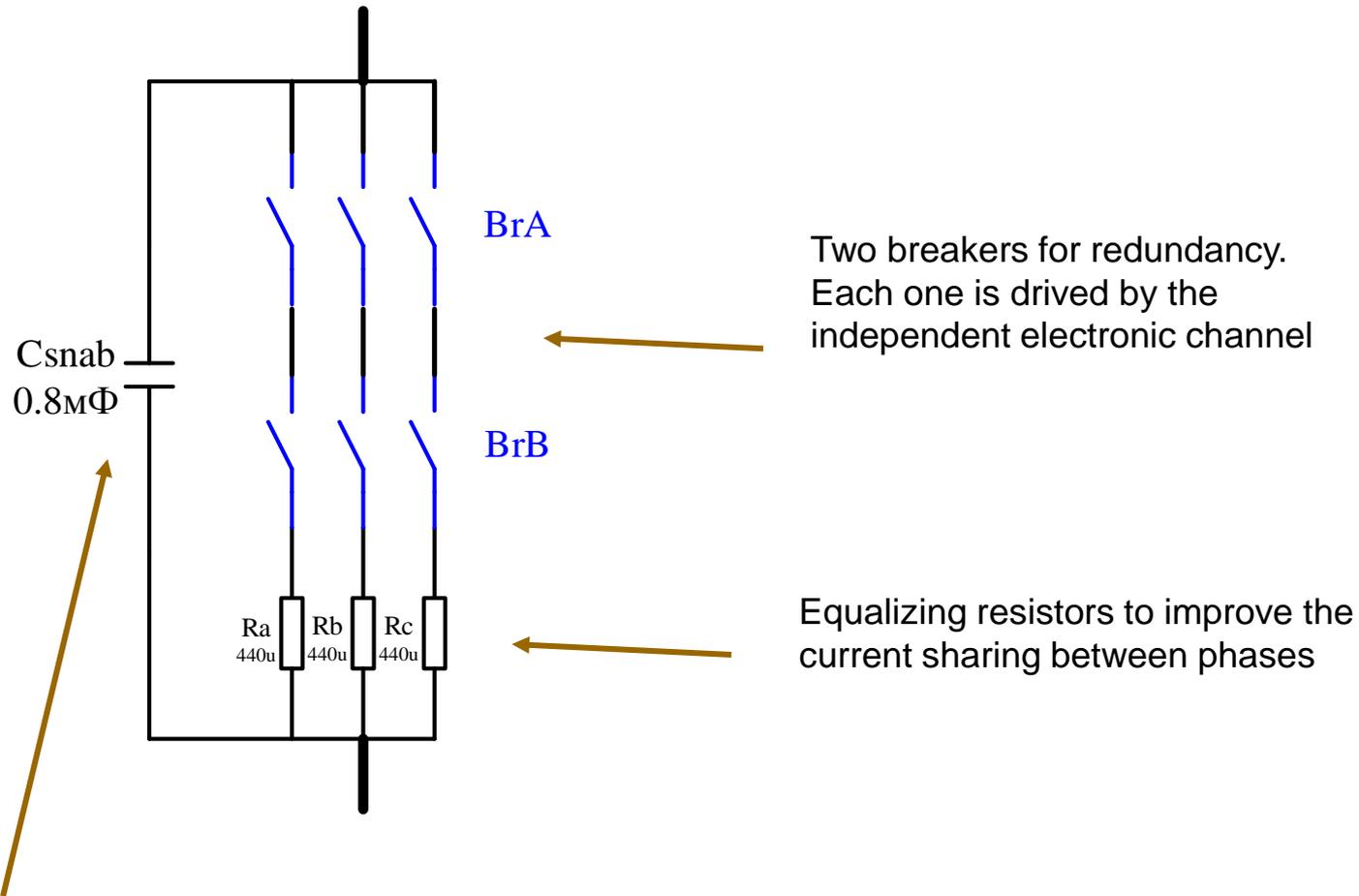


№	Parameter	Value	Unit
1.	Maximal current	686	A
2.	Energy stored in the magnet	5.1	MJ
3.	Current polarity	any	
4.	Maximal inductance in a circuit	20+20	Hn
5.	Dump resistor value	$2 \pm 5\%$	Ohm
7.	Maximal overtemperature of the Dump Resistor	80	K
8.	Maximal time delay for the energy extraction	<0.04	s

■ **Energy extraction System**



## ■ Energy extraction System

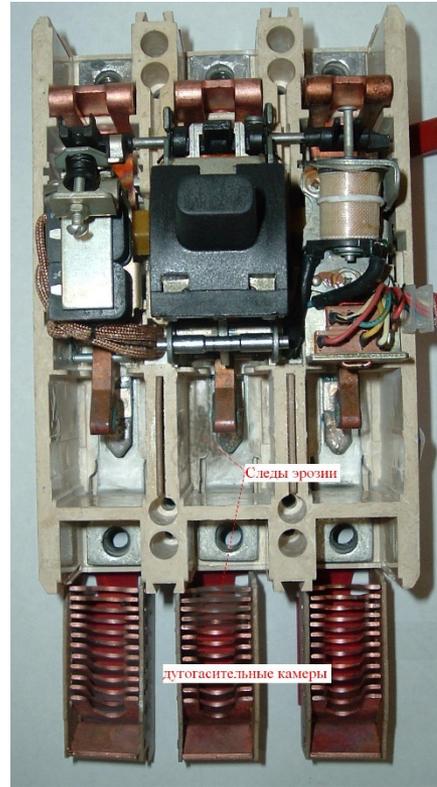


$C_{snab}$  – снаббер для минимизации длительности дуги

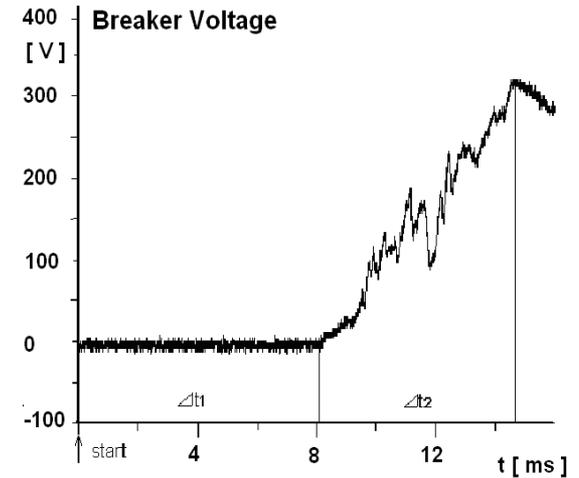
- **Energy extraction System**
- **Electromechanical Breaker and use of snubber**



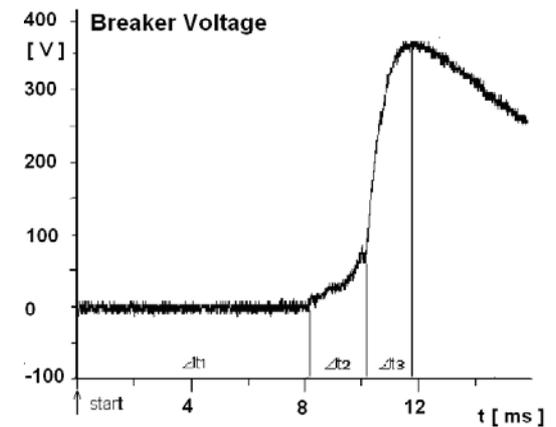
VA57-35 after 100 cycles under the full current , without snubber



VA57-35 after 100 cycles under the full current , with snubber ,  $C_{snab} = 0.8 \text{ mF}$



Voltage over the contacts while opening the circuit with  $C_{snab} = 0$



Voltage over the contacts while opening the circuit with  $C_{snab} = 0.8 \text{ mF}$

- **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 tunnel

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**Thanks for Your  
Attention!**