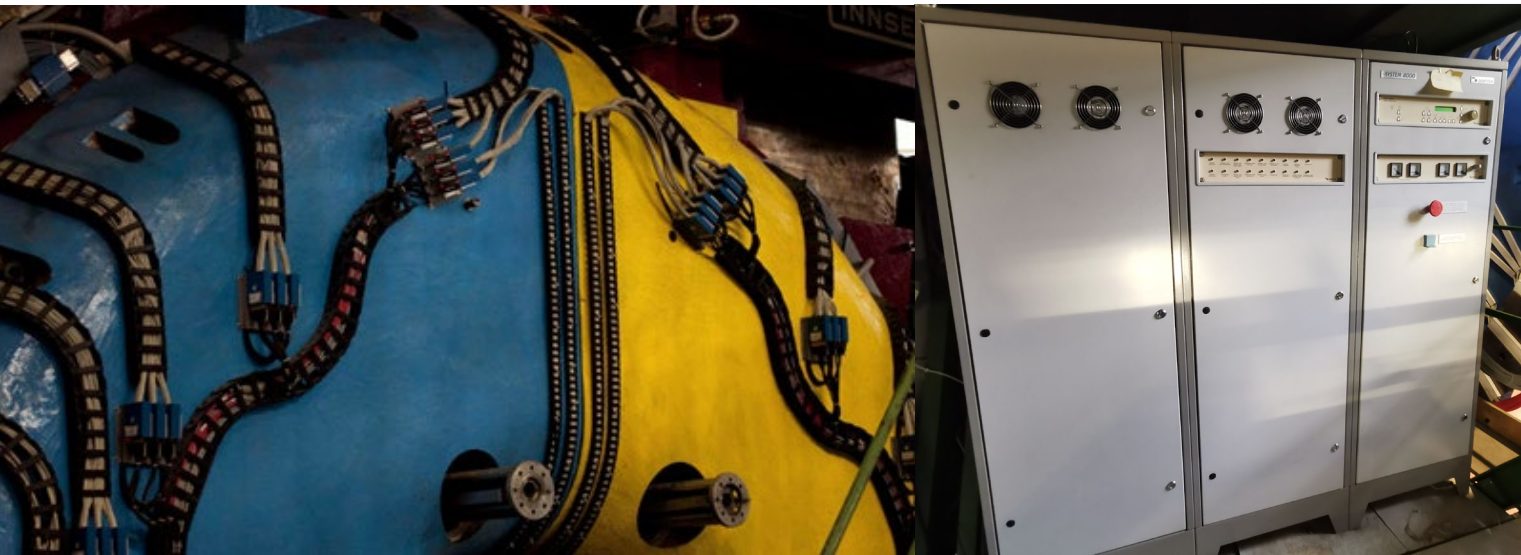


# SAND Magnet Power Supply – CSN1 Review



Istituto Nazionale di Fisica Nucleare – Laboratori Nazionali di Frascati

Alessandro Vannozzi - Divisione Acceleratori - Staff Servizio Ingegneria Elettrotecnica

# Power Supply System Procurement Status

- The PS is shut down since the last KLOE-2 run (2018).
- A revamping option could save money, time and will keep a solid scheme and functionality of the old KLOE PS
- Quech detector cabinet needs a functional tests
- Control System needs to be updated to recent LabView versions.
- OCEM SpA company provide a quotation for whole PS system except control system and Quench Detector (QD)
- ASG quotation for QD and control system revamping was «not cheaper». ASG will play only the role of **supervisor of personnel procured by INFN.**
- Several companies with expertise in automation could cover Quench Detector and Control System revamping. Industrial market survey ongoing.



- New Power Units (PU)
- KLOE PS Revamping
- Assembly of all components
- Functional test

AUTOMATION  
COMPANY

- Quench Detector
- Revamping of control system

# Power Supply Procurement Status

- The power supply in the last years of operation suffered from aging of some components like:
  - Cooling pipes of the transistors bank and of the free wheeling diodes affected by several water leaks
  - PS control System Based on old LabView version (3.0)
- The PS is shut down since the last KLOE-2 run (2018).
- High current contactors, Busbars and several other components passive componets (i.e. Rdump) could be saved after functional tests

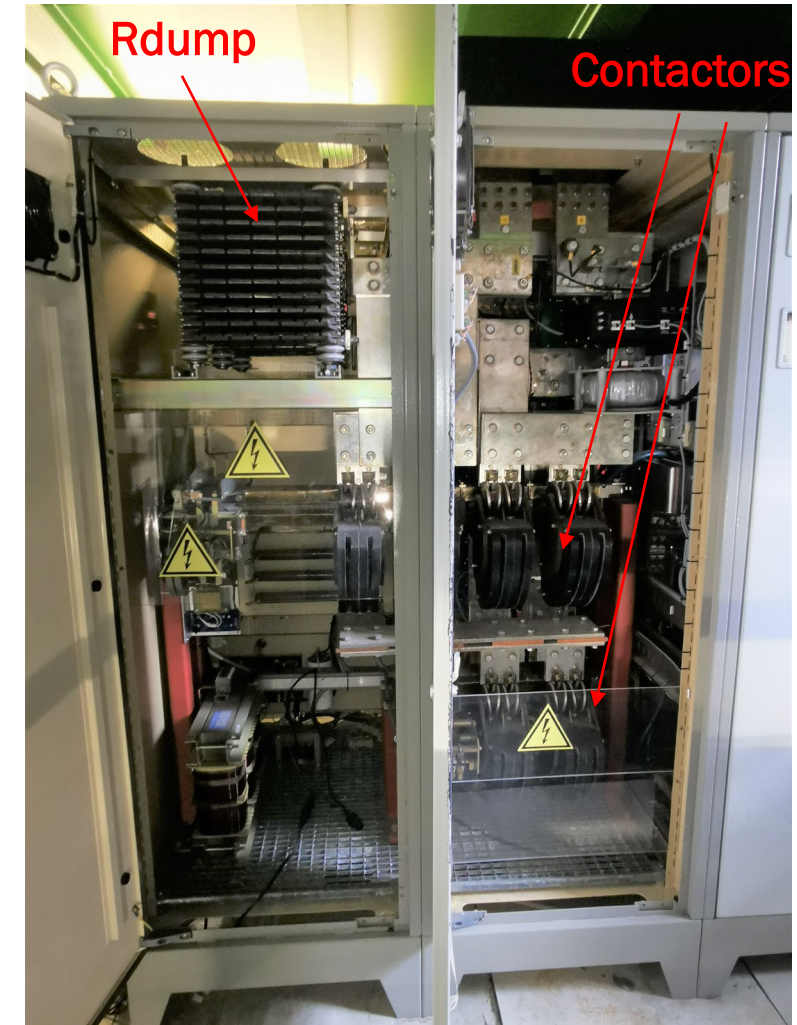
## REVAMPING OPTION

### Advantages

- Cost and time savings
- More reliability due new components
- Same PS overall dimensions
- Same current terminal position
- Well known functionality

### Risks

- Time extention for protacted components functional tests phase.
- Cost increase for substitution of componets who didn't pass the functional tests



# Power Supply Procurement Status and Performances

- Survey among several companies with a few years expertise in power converters and who had already provided power supplies with satisfactory performances for INFN.
- **Required PS performances in line with the old PS.**
- A modular solution with several power unit connected in parallel seems to be the state of the art configuration to find a compromise between reliability and component size.
- Two solutions have been investigated.
  1. Power modules provided by CAENELS + Revamping by OCEM SpA
  2. Power modules and revamping provided only by OCEM
- OCEM as unique provider was considered the best solution because of a better integration between old and new components and for future support simplicity.
- The PS is currently at OCEM premises.

DC OUTPUT RATINGS	
Power range	30 kW
Current range	3000 A
Maximum output Voltage	10 V
Nominal Ramp Rate	0,6A/s
Output Polarity	Unipolar
STABILITY	
Short term 30 min	+/- 10 ppm*
Long term 8 hours	+/- 10 ppm*
WATER COOLING	
Flow Rate	18-25 l/min
Inlet Water Temperature	25-32 °C
Current setting resolution	18 Bit
Current readback resolution	16 Bit 16 ppm
AC SUPPLY POWER	
Mains voltage	3x208VAC +/-10% 60Hz (With 400VAC connection for LNF Tests)

\*These are nominal PS parameters, with the 3H magnet load they will be reduced

# Power Supply Main Diagram

## Magnet Quench

Discharge in 50s, current flows through dump resistor (T3 open)

## PS Internal Fault/Grid Fault

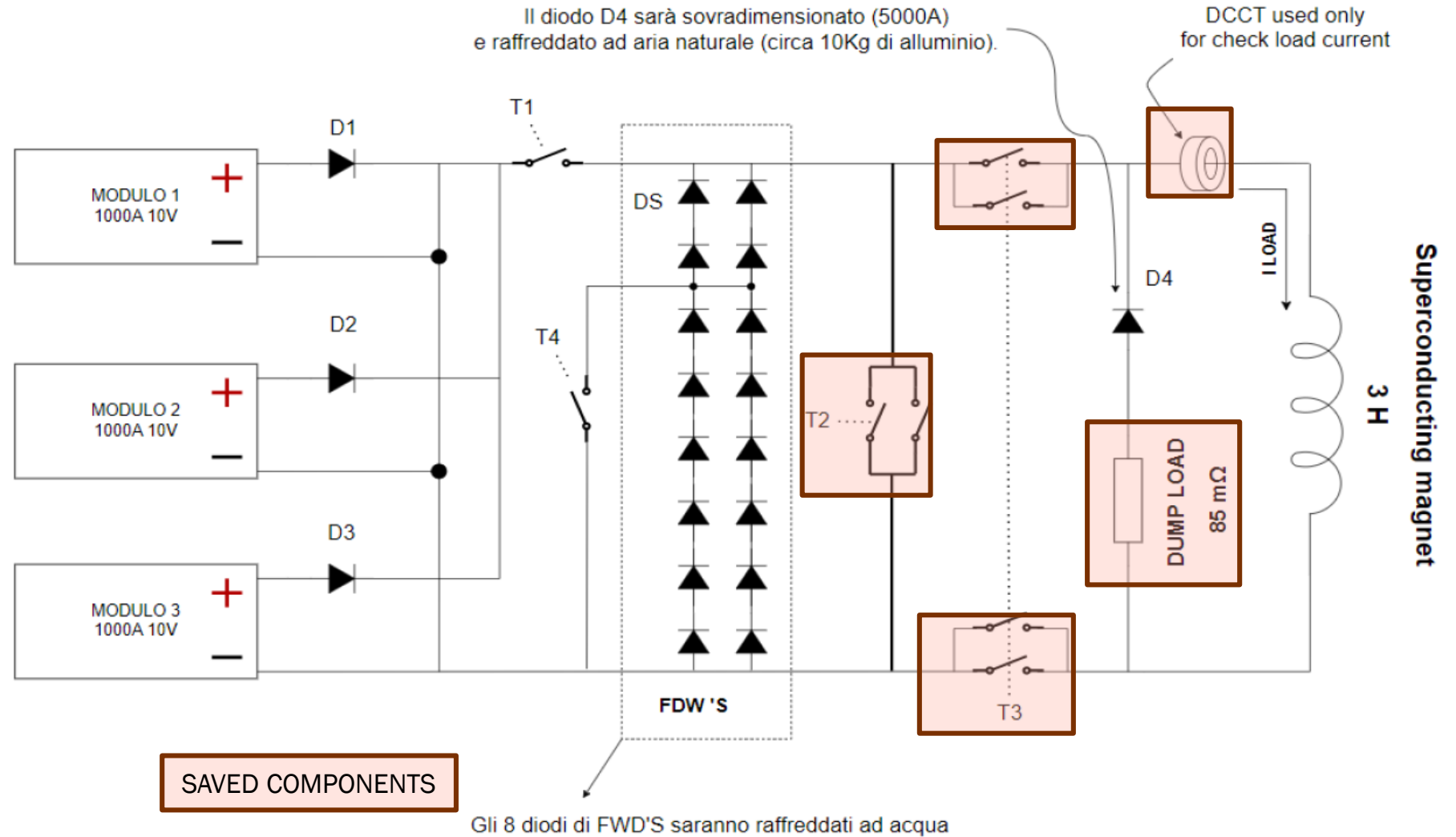
Current flows through FWD, discharge in 20 min,  $V=-7V$  (T1 open)

## FWD Water Cooling Fault

Magnet short circuited with crow bar, discharge in 2,5 hours (Modules OFF)

## Regulated Ramp Down

T1 open, T4 closed by-passing 6FWD  $\rightarrow V=-2V$





# Power Supply and Ancillaries

- The 3000 A maximum current will be delivered by the parallel of 3 x NGPS 1000 A, 10 V.
- Current regulation with one DCCT per power module. Diode D4 will ensure that the readout of DCCT on the load will be equal to the sum of the three DCCTs
- New PLC for the internal PS control will be installed.
- New external interlock board will be produced according to the old one
- The diodes will be water cooled and equipped with heatsinks.
- The busbars will remain the same of the old PS. They are Al Bars and internally water cooled.



The PS revamping foresees the supply of several PS **ancillaries**:

1. UPS for the auxiliaries (i.e. contactors relè), quench detector, and control power in case of AC power failure. At least 30 minutes back-up time.
2. Warm-up power supply: 25A, 230V power supply to bring it up to room temperature once it ceases to be superconducting.
3. Control Interfaces (TCP-IP Ethernet)
4. All the connections and bars between components including the new high current contactors (T1 and T4)

# Phase Procurement

## POWER SUPPLY

- Preliminary feasibility study (done)
- Definitive PS design
- Functional test of saved parts (i.e. contactors)
- Eventual procurement of saved parts who won't pass the functional tests
- Assembly
- F.A.T. (probably not on nominal 3H Load)
  - Interlocks
  - Current Ripple and Stability
  - Resolution
  - Auxiliaries test
- **Shipment to LNF for Test on real Load**

## CONTROL SYSTEM & QUENCH DETECTOR

- Finalization of company market survey
- HW and SW inspection
- Functional test of old Quench Detector (QD) and upgrade of old PS control system
- Eventual procurement of saved parts who won't pass the functional tests
- Test of new Control System SW
- Test of QD
- **Shipment to LNF for Test on real Load**

# Estimated Delivery Time and Costs

OCEM Estimated Delivery Time: **10-12 months from order placement**. INFN is finalizing a first order for the definitive PS design. The control system and QD procurement will go in parallel to the PS.

OCEM quote the total cost for the PS procurement :

- **77 k€ + VAT** for the PS design study
- **186 K€ NO VAT** for the engineering, manufacturing and tests

---

**TOTAL AMMOUNT 280 k€**

A quotation for the revamping of the QD and control system is not still available, probably it will be available before October 2024.



# Conclusions

- After several iterations we have a definitive procurement configuration with OCEM as unique provider of the PS.
- The revamping choice will allow to save time and will ensure a full compatibility between magnet and PS and the unique provider will ease all the interactions and the system
- ASG quotation for QD and Control System revamping was not a “turn-key” solution and it was not cheaper.
- A company who with expertise in automation can cover the requirements for QD and Control system. **The market survey is ongoing.**
- INFN is placing a first order to OCEM to speed up the PS design phase. Starting from this signature, the estimated delivery time will be 12 months.
- Revamped control system and QD will be tested at LNF during final test before FNAL shipment

Thank You for the Attention!