Magnet: Status of Power Supply

Meeting Annuale della Collaborazione DUNE Italia
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Istituto Nazionale di Fisica Nucleare – Laboratori Nazionali di Frascati

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Power Supply System Procurement Status

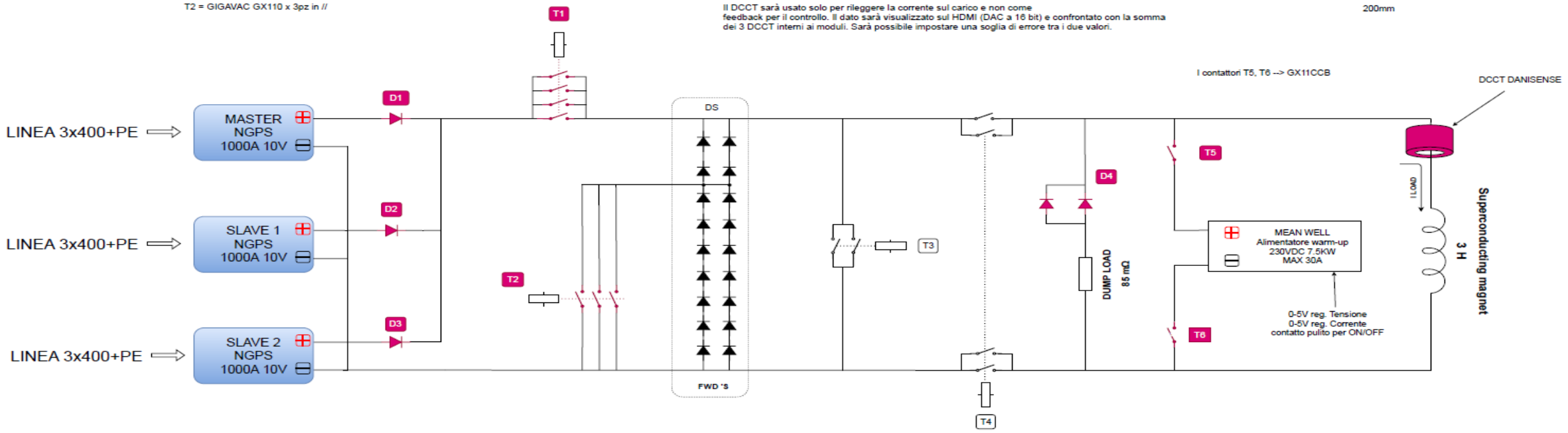
BACKGROUND

- The solenoid detector **Power Supply (PS)** is shut down since the last KLOE-2 run (2018).
- INFN has opted towards the old KLOE PS **revamping** option that could save money, time and it will keep a solid scheme and functionality.
- The old PS system includes also a **Diagnostic Rack** with an embedded **Quench Detector (QD).**
- The old PS **control system** was based LabView6 and needs a deep revamping.

CURRENT STATUS

- **Power converter**: OCEM SpA company is in charge for the PS procurement. Test of the reused parts are completed together with the final PS design.
- **Diagnostic Rack** needs a functional tests while for **Quench Detector (QD)** INFN is moving towards the procurement of a new one considering its relevance in case of fault.
- **For QD** a possible solution could be the CANels QDS system: 4-channel multi-range precision digital QD.
- A revamping of the old **Control System** based on LabView 6 is also needed. Two possible scenarios:
  1. Automation company will be committed for the procurement of the new control system. The same company will test also the diagnostic rack.
  2. Revamping of the control system done by INFN staff that is currently working on a similar task for the FINUDA superconducting solenoid revamping for FLASH experiment.

Power Supply Block Diagram



- Three parallel NGPS module 1000A 10V
- Modulated stack of Free Wheel Diodes (FWD) stack for controlled current ramp down (0,6A/s)
- Power through a transformer 3x480/400V (480 V compatible with FNAL power standards)
- New UPS and Warm-up Power supplies
- New DCCT Danisense to compare the I_{load} with $IPS_{1,2,3\_out}$

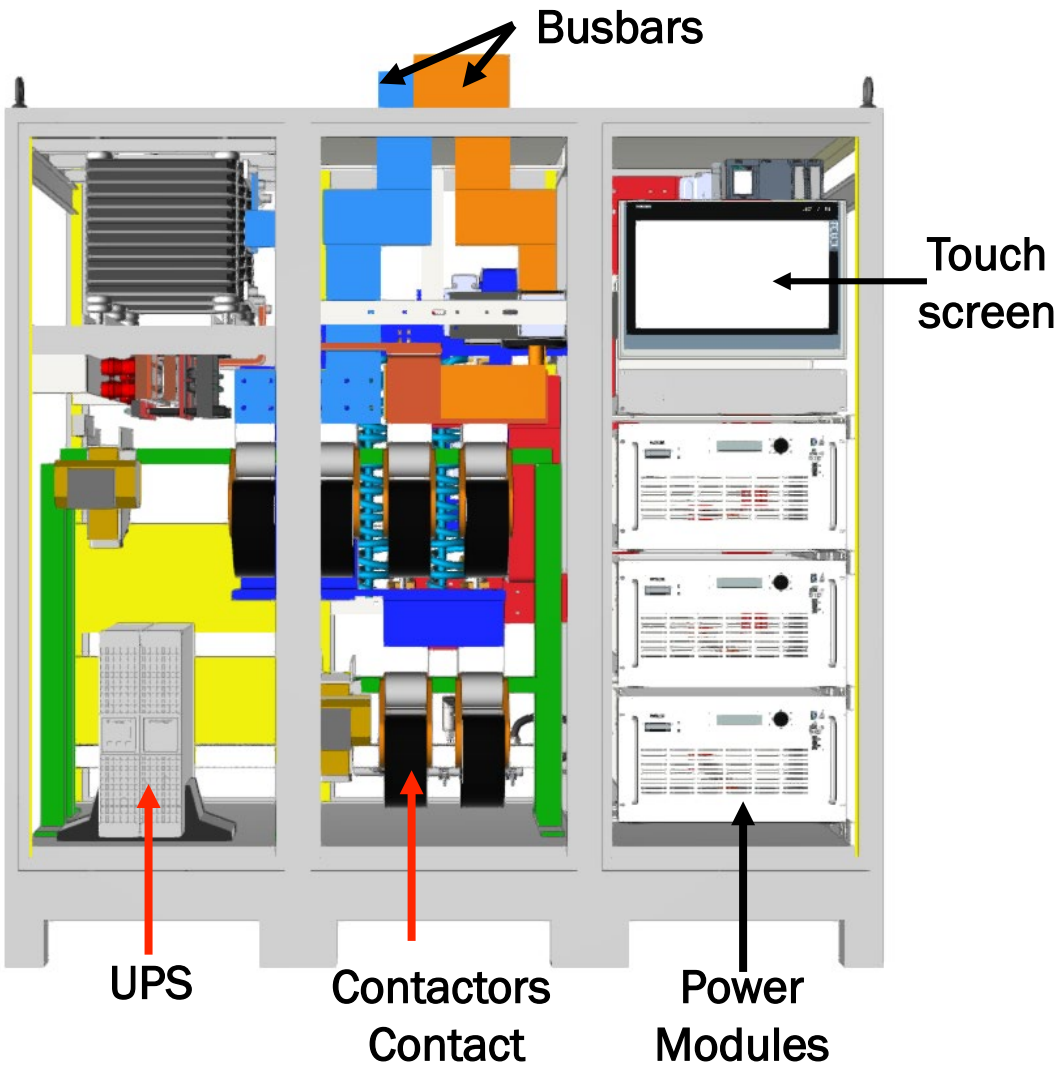
Magnet Quench
Discharge in 50s, current flows through dump resistor (T4 open).

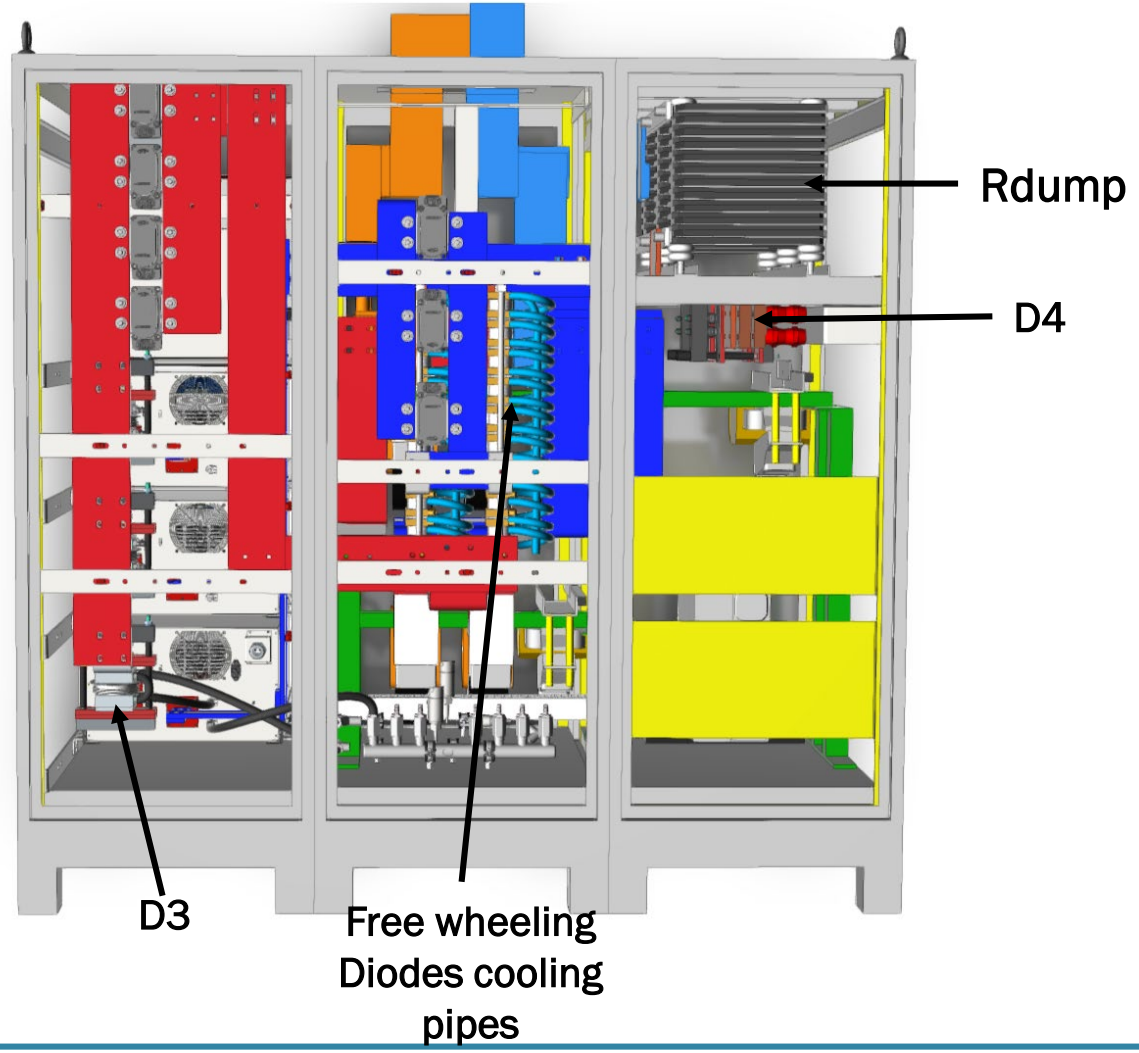
PS Internal Fault/Grid Fault
Current flows through FWD, discharge in 20 min, V=-7V (T1 open, T2 open)

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

Regulated Ramp Down
T1 closed,T2 closed by-passing 6FWD→ V=-2V

Power Supply Requirements and New Scheme

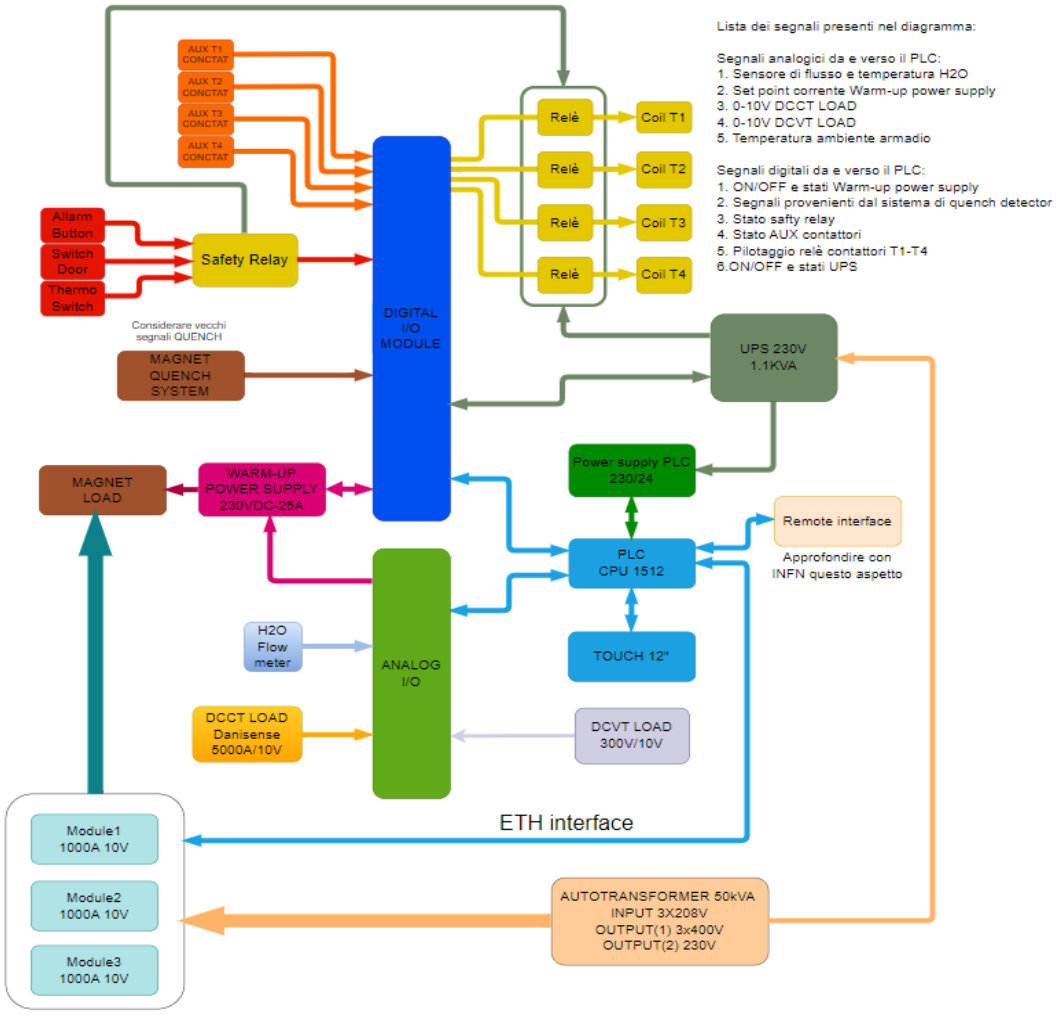




PS Control System and Magnet Diagnostic

PS CONTROL SYSTEM

- New PLC for the internal PS control will be installed. It will be powered by UPS
- **The PLC will manage also the external interlock**
- OCEM has defined a block scheme for A/D signals manage but it has to provide more details about several topics (i.e. PLCs).
- OPC UA (Open Platform Communications Unified Architecture) communication standard has been defined (accepted by FNAL).

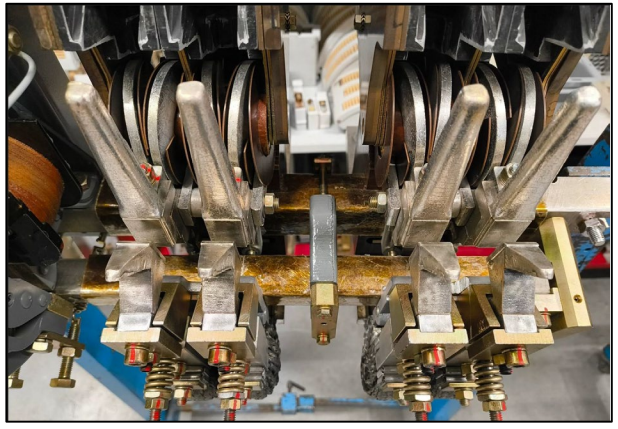


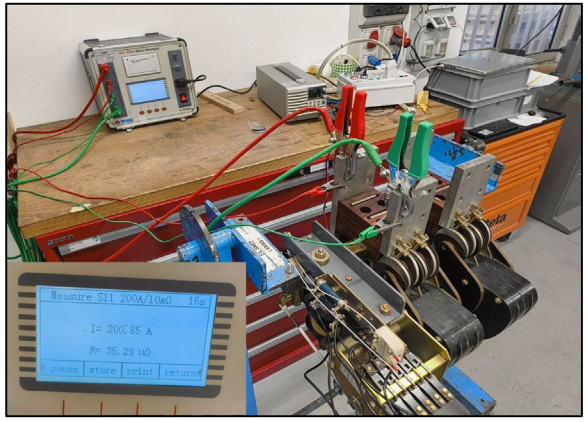
MAGNET DIAGNOSTIC

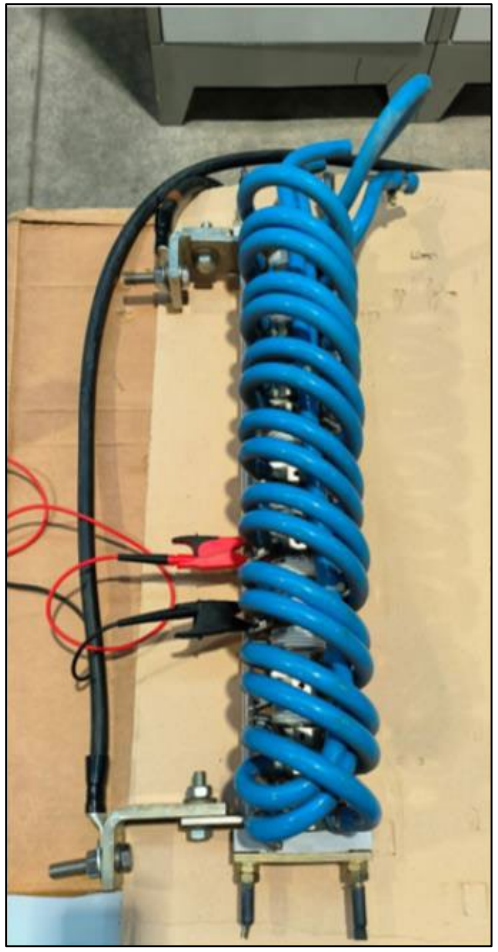
- Diagnostic Rack with temperature, helium level sensors and Quench detectors needs functional tests.
- The racks is currently at LNF (Kloe hall) and must be tested.
- QD will be replaced with new modules

OCEM Work Progress

- ✓ Test of FW Diodes performed and successful.
- ✓ Test and revamping of all contactors done and successful.
- ✓ Preliminary Design of power converter completed.
- ✓ Bill of materials completed.
- ✓ Preliminary agreement on F.A.T. completed:
  - Current ramp up and down on a dummy load with same current profile on the real magnet
  - Interlocks and faults mode tests
- ➢ PLC and other control system features has to be defined
- ➢ Components Procurement ongoing.



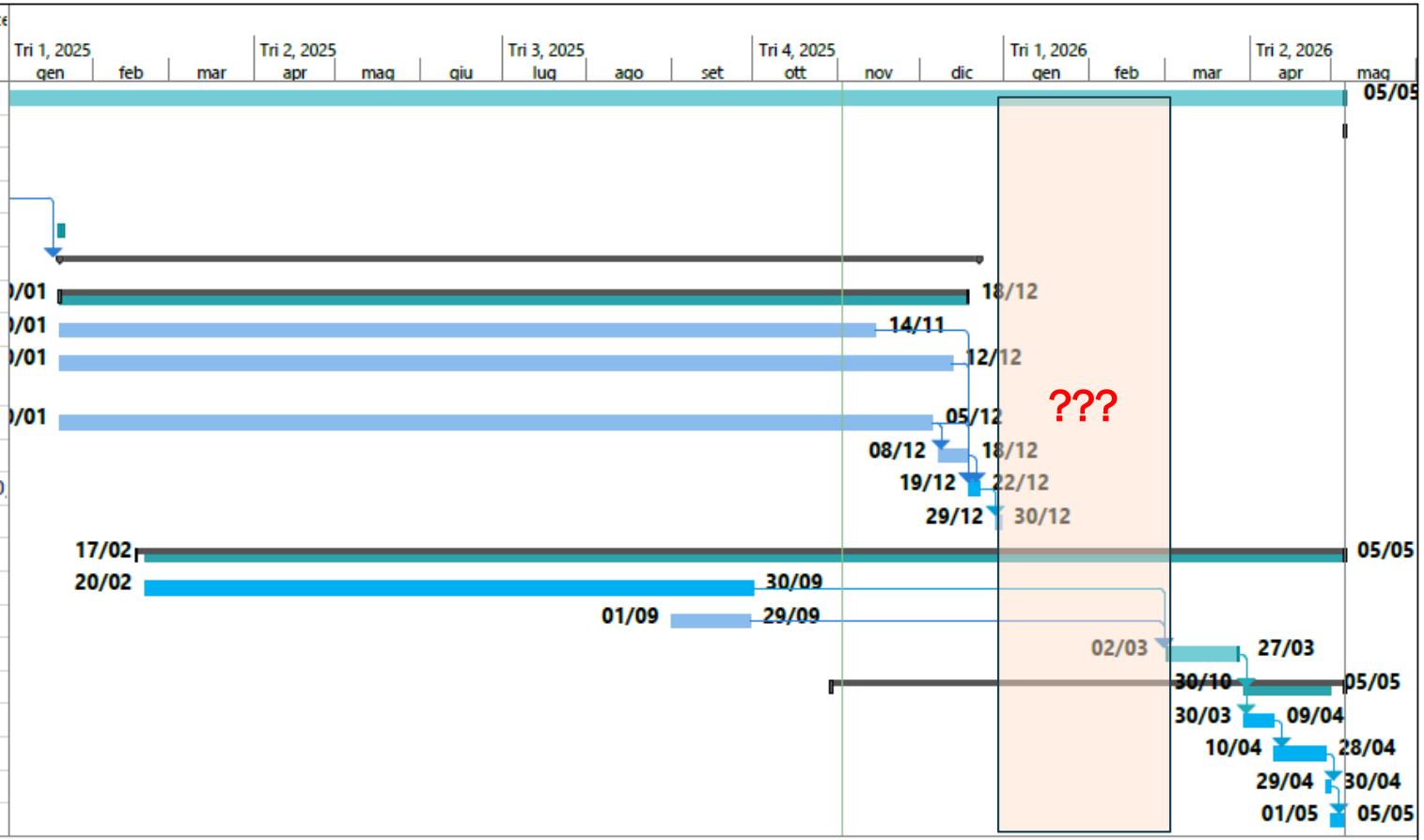




KLOE Power Supply currently at OCEM premises

OCEM Gantt Chart

ID	Nome attività	Durata	Inizio	Fine	Predece
1	Contrctual durate	73 s	mer 11/12/24	mar 05/05/26	
2	**KLOE - main schedule**	365 g	mer 11/12/24	mar 05/05/26	
3	Contract Signature	1 g	lun 15/05/23	lun 15/05/23	
4	Internal KickOff	3 g	mer 11/12/24	ven 13/12/24	
5	KickOff with Customer	1 g	lun 20/01/25	lun 20/01/25	
6	**Phase 1 - Design**	241 g	lun 20/01/25	lun 22/12/25	4
7	**Preliminary Design**	239 g	lun 20/01/25	gio 18/12/25	
8	Electrical Design and Definition	215 g	lun 20/01/25	ven 14/11/25	
9	Mechanical Design and Definition (sizing)	235 g	lun 20/01/25	ven 12/12/25	
10	BOM	230 g	lun 20/01/25	ven 05/12/25	
11	Programming PLC	9 g	lun 08/12/25	gio 18/12/25	10
12	**Final Design Report (FDR)**	2 g	ven 19/12/25	lun 22/12/25	8;9;10
13	**KLOE Acceptance of design**	2 g	lun 29/12/25	mar 30/12/25	12
14	**Phase 2 - Operations**	317 g	lun 17/02/25	mar 05/05/26	
15	Procurement LLT Items	7,95 mes	gio 20/02/25	mar 30/09/25	
16	Procurement other items	21 g	lun 01/09/25	lun 29/09/25	
17	Production & Assembly	1 mes	lun 02/03/26	ven 27/03/26	15;16
18	**Tests and preparation**	134 g	gio 30/10/25	mar 05/05/26	17
19	Electrical tests	1,8 s	lun 30/03/26	gio 09/04/26	17
20	Functional tests	13 g	ven 10/04/26	mar 28/04/26	19
21	Preparation to FAT	2 g	mer 29/04/26	gio 30/04/26	20
22	**Factory Acceptance Test (FAT)**	3 g	ven 01/05/26	mar 05/05/26	21



DELIVERY DELAY OF 5 MONTHS!!! (last OCEM update November 3rd). From the end of December to the early of March they have no activities: we strongly ask to squeeze the schedule → we would avoid a the test nearby the summer.

Activities at LNF and Time Estimation

INSTALLATION AT LNF

- After PS delivery, the whole system will be reassembled at LNF with the support of the Electrical Engineering service.
- A preliminary functional test will be done aiming to check the PS functionality, all the interlocks, the control system . No power will be delivered to the magnet in this phase.
- A low current test with the magnet cool down will be performed in the KLOE Hall.
- **The preliminary functional test as well as all the test at LNF will be attended by FNAL personnel.**

Estimated Time Schedule

- If OCEM will anticipate the delivery of 1-2 months the preliminary test could be performed within June 2026
- Cool – down of the magnets and power test within the end of October 2026.
- The assembly of the whole system and the preliminary tests could take approximatively **2-3 weeks**

Conclusions and Critical Points

- OCEM has completed the test of all the old parts reused in the new PS
- A final design with an almost complete bill of materials is ready.
- The PLC and the detailed Analog and Digital signal managing has to be completed by OCEM.
- The last delivery date provided by OCEM has to be anticipated.
- Interaction between INFN and FNAL are ongoing with preliminary documentation delivery.
- A confirmation of CAENELS QDS quench detector has to be done by INFN (within the end of November) → Double check of voltage thresholds, number of channels is ongoing
- The test of Diagnostic Rack must be done within next 6 months
- Revamping of the Magnet Control System in LabView must be done, INFN staff is gaining experiences with the one of FINUDA (two young technicians coordinate by Cryogenic and Control System service INFN staff).
- More detailed FAT and LNF test schedule

Thank You for the Attention!