6th POCPA

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On behalf of the EBS Accelerator Project Team

ESRF | The European Synchrotron

OUTLINE

Power supplies feeding more than 1000 electromagnets

1- Extremely Brilliant Source context

2- Main magnets

- 1.1- DC-DC converters
- 1.2- Common sources
- 1.3- Matrix commutation
- 1.4- DC Bus Cabling
- 1.5- Hot Swap functionality

3- Correctors PS

4- Resources, installation, tests

5- Energy considerations

EBS CONTEXT

The ESRF is a facility producing Hard Xrays for science experiments.

The Storage Ring is on operation since 1992 and a major Upgrade has been decided in 2015 which is based on a new lattice.

The new lattice will be equipped with brand new magnets including permanent and electromagnets.

The 864 main electromagnets and the 96 fast correction magnets will be fed individually which is a complete change of philosophy compared to the running machine. The global MTBF of the 2100 PS's is kept constant: 2 failures / year on average. (6 x 10^6 hours MTBF per converter!)

The machine will be stopped the 10th of December 2018, then dismantled, the tunnel will be then reequipped with new girders and User Service Mode is foreseen 20th of august 2020.

MAIN MAGNETS POWER SUPPLIES

1.1 DC-DC converters

Each cell of the technical zone will be equipped with a cubicle hosting:

11 racks of 3 warm DC-DC power converters each

and 1 rack of 3 cold DC-DC power converters each.

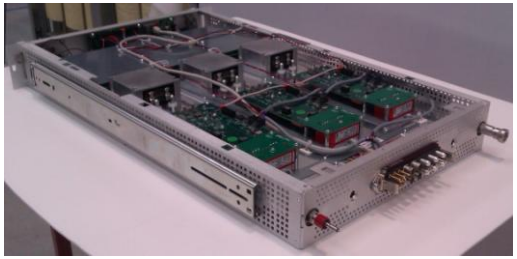
Total of the purchase = 387 racks of 3 DC-DC channels each.

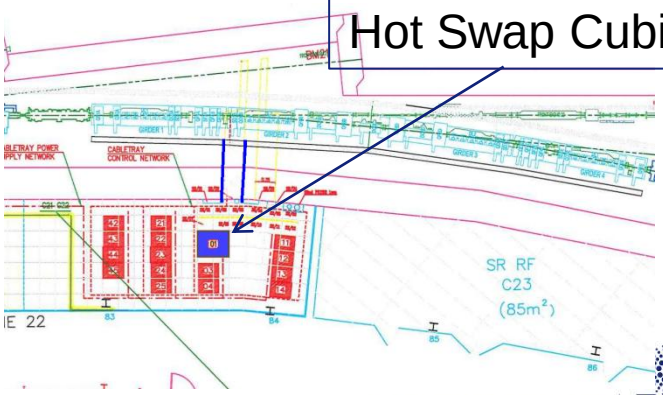
The 33 active channels will be routed to the 27 main magnets via 5 Hot Swap Mosplates able to attribute currents to 4 Magnets each.

We have received the 3 prototypes and the 11 preseries racks. The 7 batches of series production is suffering from overheating of the World Power Mosfet shortage and allocation procedure with lead time extending from 22 to 57 weeks!

For example we placed order for 22000 Power Mosfets for the Hot Swap Mosplate enabling the Hot Swap functionality with an allocation schedule with 41 weeks delay!

Specification of one channel: Common Input voltage 360Vdc, output current 120Adc per channel.





COMMON SOURCES FOR THE 360VDC AND 48VDC BUS DISTRIBUTION

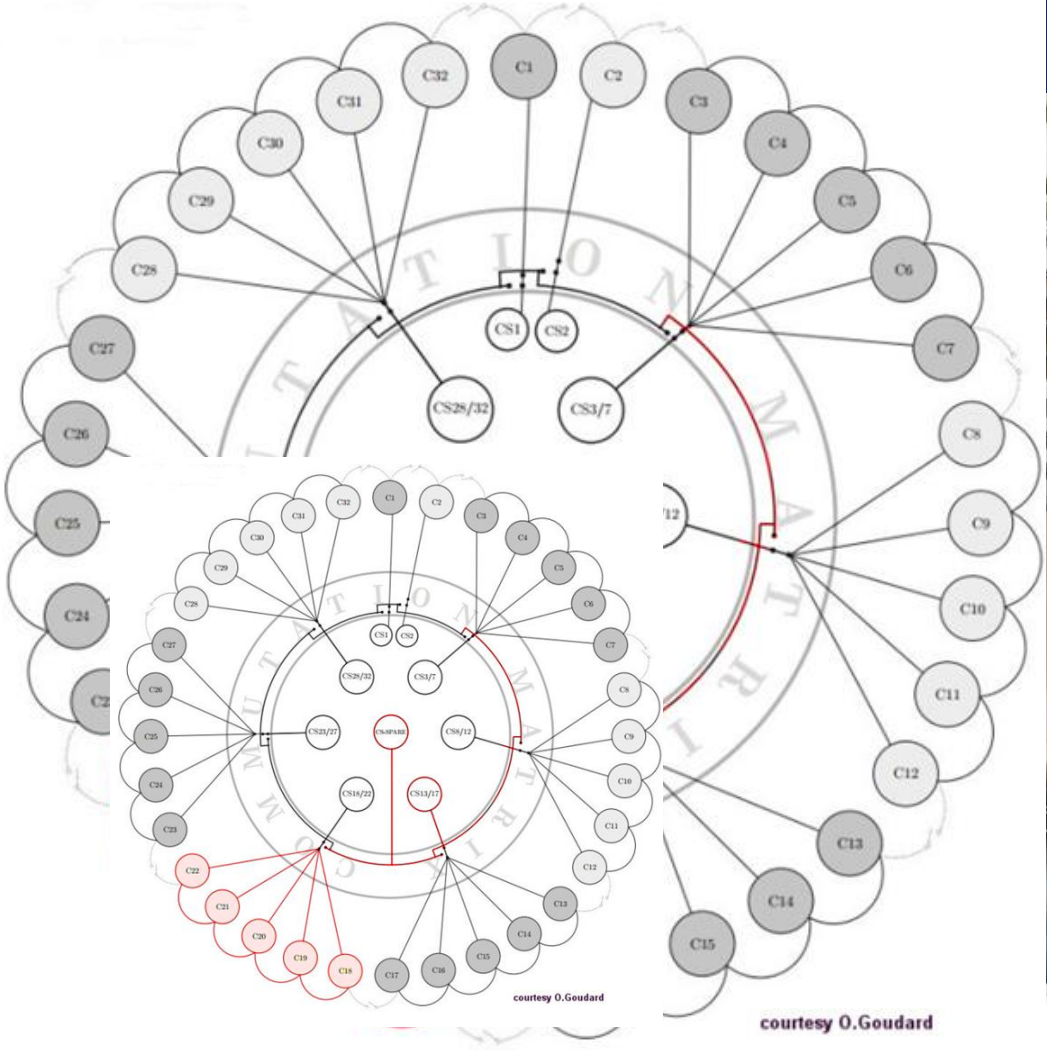
In order to feed one cubicle of 33 DC-DC converters in each cell, 360VDC buses are distributed from the SRDC central room with refurbished power converters used formerly as current sources.

6 quadrupole family power supplies will be refurbished to drive 5 cells each = 55 racks i.e. 165 channels (500kVA, 140kW average) each.

2 sextupole family power supplies will be refurbished to power the 2 very specific cells 1 and 2 near the tangent zone.

2 flexibility power supplies used formerly for the Horizontal Focusing Optics functionality will be converted to power the 48VDC bus feeding 1000 corrector channels.

2 spare units (360Vdc and 48Vdc) will be prepared and routed via the matrix commutation to allow rapid exchange in case of fault.



Thanks to the Building and Infrastructure group in charge of the WP11.

The longest (550m) and most difficult part has been already accomplished respecting the low inductance layout.

MATRIX COMMUTATION

In order to minimize the down time when one of 10 common sources are faulty, the matrix commutation will be modified to allow the replacement of one common source within 30 minutes.

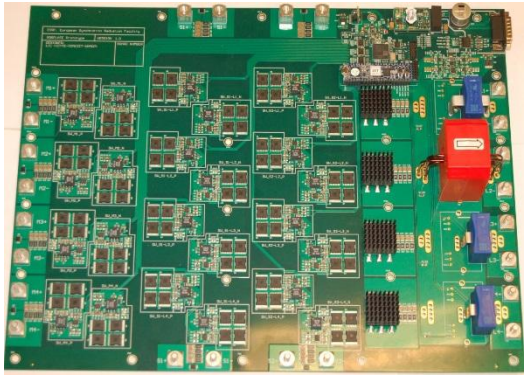
This will be true for the 360VDC bus distribution and the 48VDC distribution used for the DC-DC correctors.

HOT SWAP FUNCTIONALITY

The Hot Swap® functionality is to replace a faulty channel before it kills the beam. Threshold to swap: 0.15% DQ and 15% for Quads.

1.5.1 Hot Swap Cubicle

1.5.2 MOS plates



Procurement of the very low RDSon Mosfets is subject to allocation by Infineon.

We need 22000 pieces!

1.5.3 Hot Swap Manager

The prototype under test with the simulator of the HSM

Courtesy Ch. Hervé and Th. Lecaer

CORRECTOR POWER SUPPLIES

These power supplies are basically of 2 types:

-1 The recuperated 288 channels feeding the present correcting coils located on the sextupole magnets for Fast Orbit Feed Back (1Hz→150Hz).

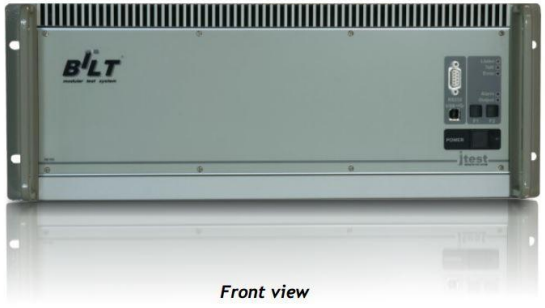
-2 The new correction channels (4 x 6 sextupoles x 32 cells = 768 channels)

+ The V and H ambient field strait section correctors (64 channels)

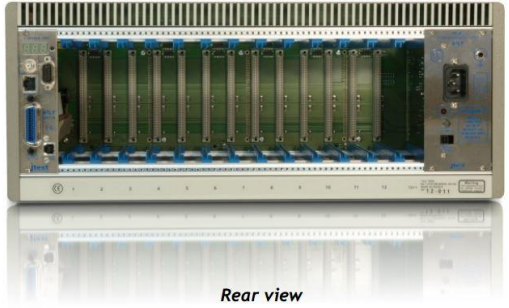
+ The 3 DQ auxiliary channels adjusting finely the ratio D over Q (96 channels)

The new correction channels will be DC-DC correctors fed by a 48VDC bus.

Contract placed in July 2017, half delivery by the end of 2018 the remaining part beginning of 2019.



Front view



Rear view

RESOURCES, PROCUREMENT

Resources:

The PSG team is concentrated on the EBS program. The deputy group leader is now retired (J-M Koch) . Laurent Jolly has been recruited to take over the many tasks left over. *Overall, the existing resources should be sufficient for activities, with the addition of a few peak load personnel to deal any overload tasks, late deliveries or illness.*

Procurement in progress:

The large contract for the 32+2 DC-DC converter cubicles HSC is under full swing. The delivery is scheduled by the end of 2018.

The purchase of the 32+3 Hot-Swap Managers boards and racks as been launched by ISDD Digital Electronics Group one month ago.

The 12 Common Sources and the matrix commutation refurbishment will be mainly (except 2) handled during 2019 after the stop of operation.

TESTS, INSTALLATION

Tests: Soon we will test the series production of the DC-DC converters after the prototypes and pre-series qualifications.

Some difficulties to procure all power components are encountered with lead time much above expected (40 to 60 weeks). Some alternatives are under preparation.

The first common source was validated a few months ago and will be used as the spare for the series production.

The first Hot Swap Cubicle prototype was received last month. This cubicle host the 11 pre-series DC-DC converters racks, HSM and interlock management.

The Hot Swap Manager electronic board is under extensive tests in the ISDD division.

A new PLC is installed in the old commutation matrix in order to prepare the embedded software. The modification of the inside power cabling will start the 11th of Dec 2018!

Installation: several scenarios for in situ tests are under evaluation taking into account the global installation of the girder, piping and the cabling.

EFFICIENCY

Globally , the actual power for the machine is 5.2MW and 6 MW during injection.

The new EBS machine is estimated to 4MW and less then 5 MW during top-up injection.

This reduction is assumed by

1- a screening of the dipole magnet power (permanent magnets)!

2- a reduction of the RF Power due to the enlargement of the length of the dipole magnetic length.

3- a reduction and optimization of the current density in the coils of the magnets twice more numerous as the previous lattice.

The global energy consumption will decrease from 64 to 51 GWh per year.

MANY THANKS FOR YOUR ATTENTION