AB/PO Equipment in LHC RR73 & RR77

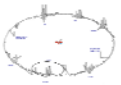
(radiation issue)

2008-10-27 Version

Yves THUREL
CERN

AB/PO LHC Equipments in RR73 / RR77

LHC Power Converters Radiation levels

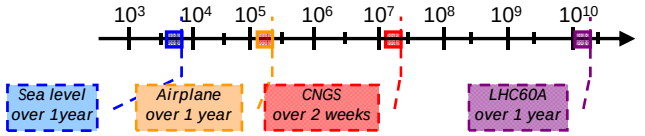


Location	Total Dose	Hadron fluence (E >20 MeV)		Neutron fluence (1 Mev eq.)	Source	Shielding	Converter Type
	[Gy] / year	[cm^{-2}] / year		[cm^{-2}] / year			
ARC 752 converters	2-10	4 x 10^{10}	10^7 10^8 10^9 10^{10}	5 x 10^{11}	Beam gas interactions	no	LHC60A-08V
RR73 / RR77 2 x 34 converters	[0.01-2]*	[1x10^7-1x10^9]*	10^7 10^8 10^9 10^{10}	[1x10^8-5x10^9]*	Collimators	yes	2x10 LHC120A-10V 2x24 LHC600A-10V
RR13 / RR17 2 x 47 converters	0.2	1 x 10^8	10^7 10^8 10^9 10^{10}	4 x 10^8	Collisions ATLAS	yes	2x18 LHC120A-10V 2x14 LHC600A-10V 2x15 LHC4/6kA-08V
RR53 / RR57 2 x 47 converters	0.15	7 x 10^7	10^7 10^8 10^9 10^{10}	3 x 10^8	Collisions CMS	yes	2x18 LHC120A-10V 2x14 LHC600A-10V 2x15 LHC4/6kA-08V
UJ 76 Upstair 12x converters	[0.001-0.1]*	[1x10^7-3x10^8]*	10^7 10^8 10^9 10^{10}	[5x10^7-1x10^9]*	Collimators	yes	12x LHC600A-40V
UJ14 / UJ16 2 x 15 converters	[]*	[..10^7-4x10^8]*	10^7 10^8 10^9 10^{10}	[..x10^7-..4x10^9]*		?	2x05 LHC120A-10V 2x08 LHC600A-10V 2x02 LHC4/6kA-08V
UJ56 15 converters	[]*	[..10^7-4x10^8]*	10^7 10^8 10^9 10^{10}	[..x10^7-..4x10^9]*		?	1x05 LHC120A-10V 1x08 LHC600A-10V 1x02 LHC4/6kA-08V
All UA's 710 converters			converters in location with no extra radiations coming from LHC operation				All types

CNGS total fluence encountered for 2-3weeks.
A LHC60A converter will see - over 1 year –
- 1300 times the number of particles device in CNGS saw in a 2-3 weeks period…which was dramatic enough to stop CNGS.
- More than 4E6 times number of sea level particles

271 Non-rad. Hard cvs in radioactive area
107 x LHC120A-10V
128 x LHC600A-10V + 12 x LHC600A-40V
36 x LHC4/6kA-08V

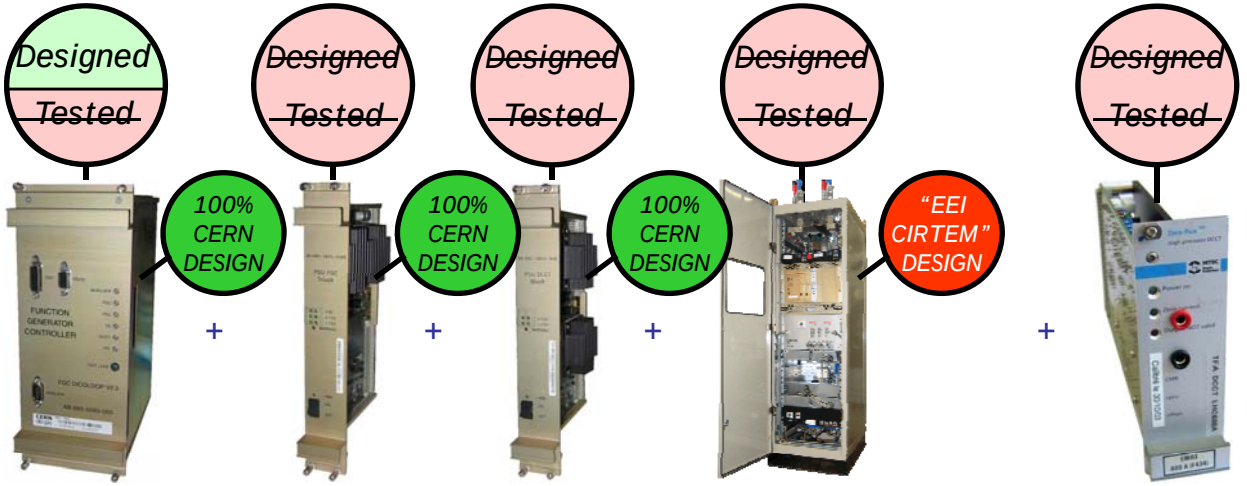
*** As a comparison, CNGS encountered value with failures was: 3.10E^7 20Mev Hadron Fluence Equivalent.*
(Result of 2-3 weeks of operation before renovation (2007-2008))



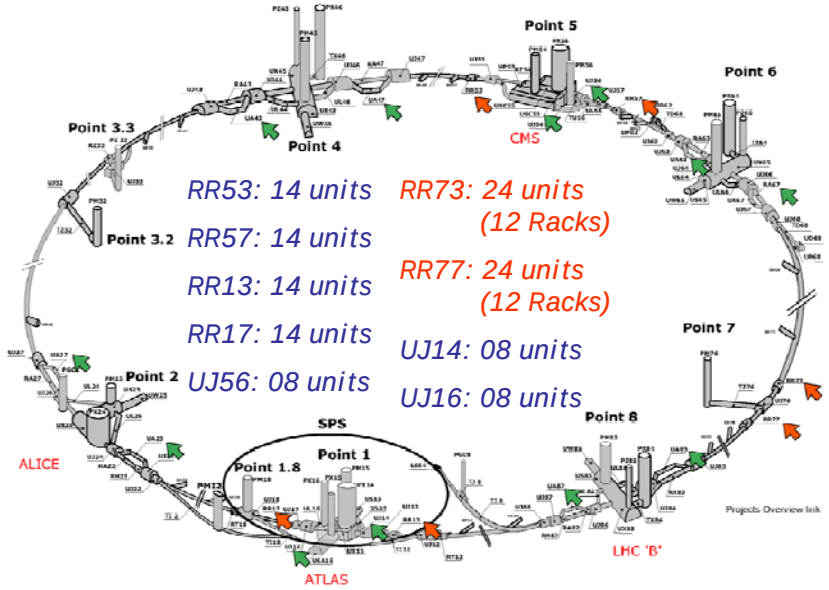
AB/PO LHC Equipments in RR73 / RR77

LHC600A-10V (RYMB)

- 1 AC Rack input
- Water Rack input



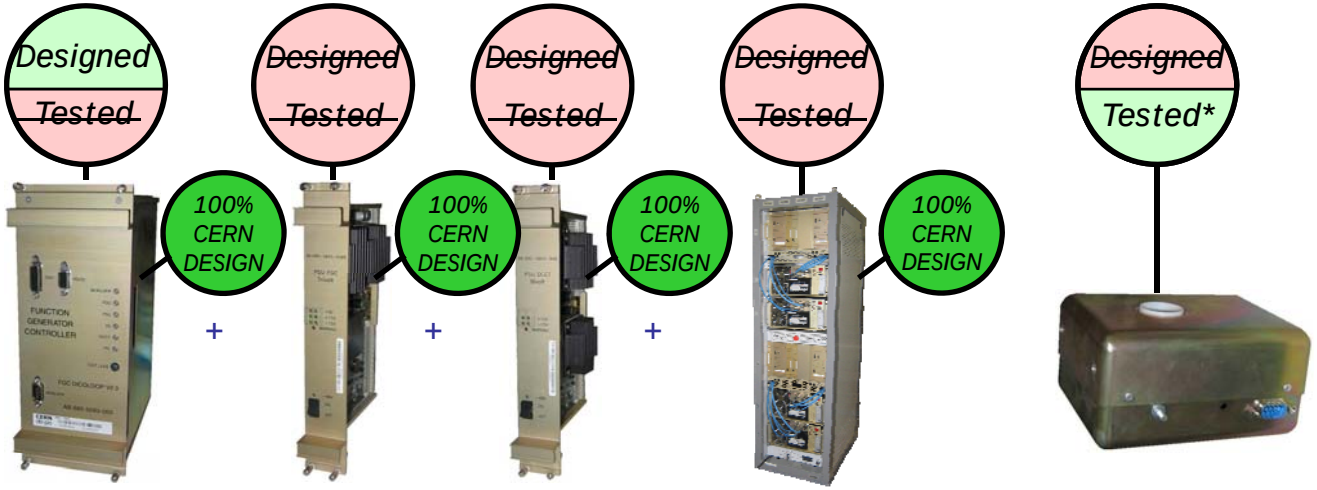
FGC Generic	PSU FGC	PSU DCCT	600A-10V VS Conv.	600A DCCT
CPLD, FPGA, memory, Mosfets, optocouplers ...	PWM, DC-DC, Power Mosfets, optocouplers	PWM, DC-DC, Power Mosfets, optocouplers	CPLD, LEM, PWM, DC-DC, High Voltage IGBTs, Power Mosfets, optocouplers, AC-DC	No critical cpts



AB/PO LHC Equipments in RR73 / RR77

LHC120A-10V (RYLB / RYLC)

•1 AC Rack input



FGC Generic

CPLD, FPGA, memory, Mosfets, optocouplers ...

PSU FGC

PWM, DC-DC, Power Mosfets, optocouplers

PSU DCCT

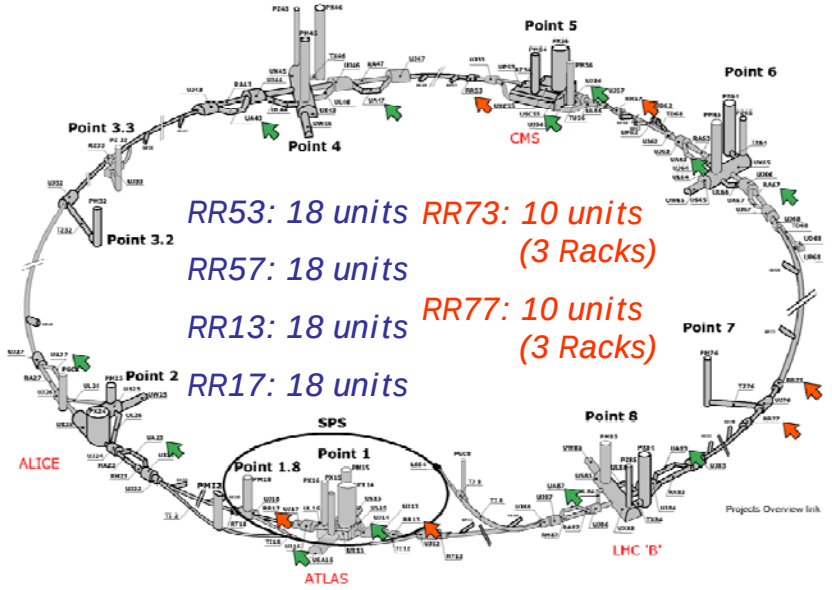
PWM, DC-DC, Power Mosfets, optocouplers

120A-10V VS Conv.

CPLD, LEM, PWM, DC-DC, High Voltage IGBTs, Power Mosfets, optocouplers, AC-DC

120A DCCT

optocouplers



Action possible to ensure rad-hard situation in RR73 & RR77

Solution N°1: Modify the converters => Rad-hard

1. LHC600A-10V:
   - Complex Design not at CERN (5-7 years of design)
   - 5 PLDs in the power converter
   - 60 Power Mosfets used in 4 quadrant power stage

   ➔ Not realistic to update the converters by CERN team

- *Not realistic to modify Not optimized*
- *Price charged by the initial company very high to modify the converter*
- *Consortium contract*

2. LHC120A-10V:
   - Design 100% at CERN
   - Work to reinforce the converter against radiations: some components to be changed (PSU, optocouplers, Mosfets…)
   - A lot of testing & reworking needed = time
   - A lot of manpower

- *a lot of work on voltage source but also on FGC and DCCT, PSU..*

3. FGC + DCCT + PSU have to be tested, and possibly re-worked on both converters

Action possible to ensure rad-hard situation in RR73 & RR77

Solution N°2: Re-Design entirely converters=> Rad-hard

1. LHC600A-10V & LHC120A-10V
   - 2-3 years of design for bothe converters which would be based on LHC120A-10V principle (if possible for 120A => 600A)
   - 1 engineer + 1 technician
   - A lot of radiation testing needed for ensuring the result
   - 1-2 years of production and test
2. FGC + DCCT + PSU have to be tested, and possibly re-worked on both converters

- *When to launch the study??*
- *Do we launch the study without waiting any result from LHC 1st year operation?*
- *Cost difficult to estimate*

- *In case a 100% CERN design result in a reliable & rad-hard converter (600A-10V & 120A-10V), it can be re-used in other LHC hot points*
- *Care that other points like RR13 & RR17 include 4-6kA converters.*

Action possible to ensure rad-hard situation in RR73 & RR77

Move the converters in TZ76

1. 1st case: converters voltage still adequate (even if far from load = copper)
   - ➔ 30 Racks (converters only) to be foreseen for moving RR73 & RR77 in TZ76.
   - ➔ Power dissipation in TZ76 can be a problem
   - ➔ Not only converters have to move: switches
   - ➔ Update Price
     = Move of converters with their cabling

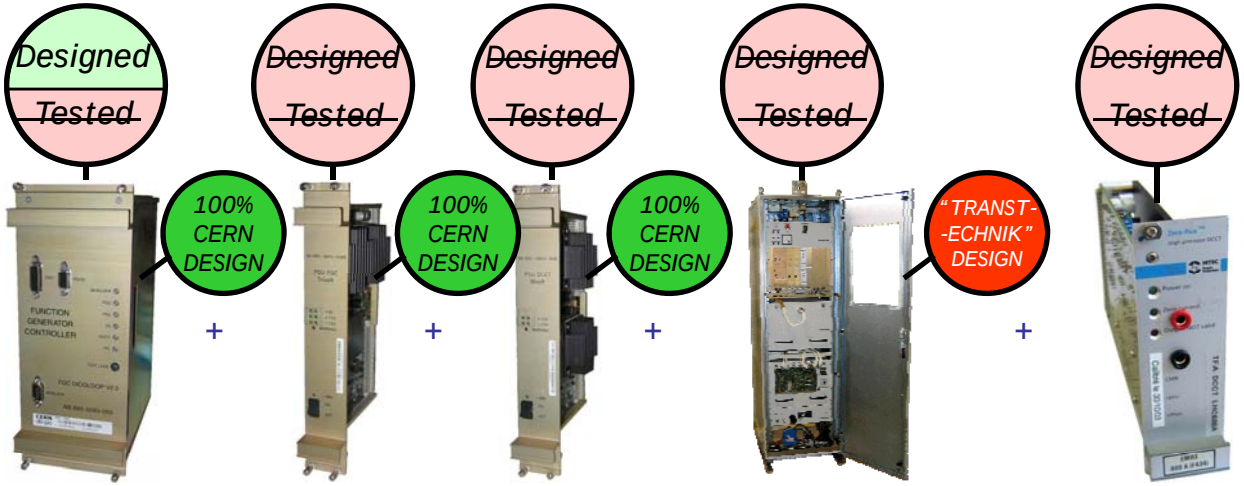
- *Solution 100% sure.*
- *Cost known*
- *Does not help with other LHC hot points for same pb*
- *Order for 600A-40V has to be placed before end of 2009.*

2. 2nd case: Converters voltage not sufficient anymore
   - ➔ **Change the Voltage source 600A-10V for 600A-40V**
   - ➔ Place a new order (options) on existing 600A-40V LHC contract 600A-40V converter option price
   - ➔ 48x $_{600A-40V}$ + 6x $_{120A}$ to be foreseen for moving RR73 & RR77 in TZ76
   - ➔ Update Price
     = Move of converters with their cabling
     + 48 LHC600A-40V converters (36 000 Euros / converter)
     (then around 1 800 000 Euros in total for 48x + some spares)

AB/PO LHC Equipments in RR73 / RR77

LHC600A-40V (RYME)

- 1 AC Rack input
- Water Rack input



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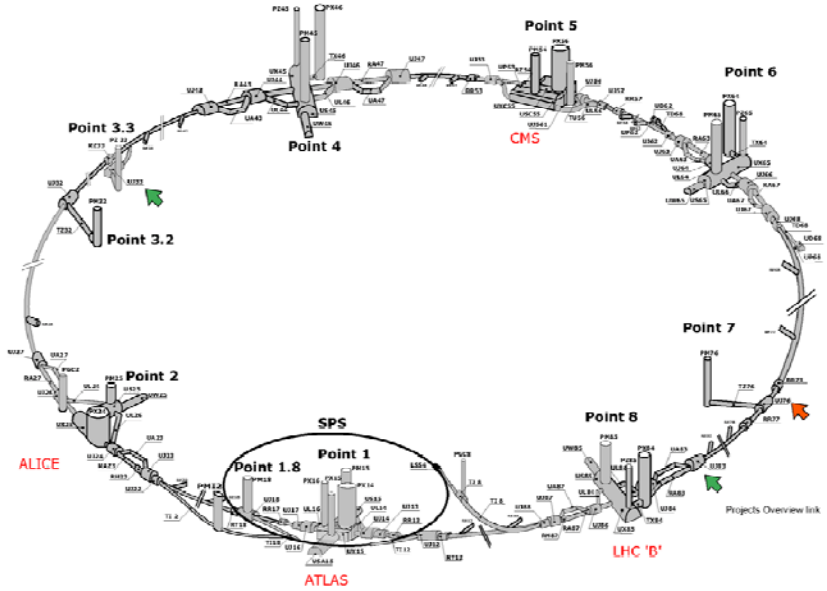

Next

➔ **Do a precise evaluation of voltage situation in case of a move**
- **depends on real current magnet**
- **depends on the copper size of DC Cabling**

AB/PO LHC Equipments in RR73 / RR77

LHC600A-10V (RYMB)

Comp. ref.	Comp. Type	Nb	Use	Card	SEE Cross Section
EPM7064SLC44-10 (MAX 7000 Series) ALTERA	EPLD 5.0V	5x		CDE010C-01 Digital Control Card	
TEN5-2423 DC-DC	Converter 6W 18 à 36V +/- 15V/200 mA	1x		CDE010C-01 Digital Control Card	
TEN10-2411	Converter 10W 18 à 36V +5V/2000 mA	1x		CDE010C-01 Digital Control Card	
TEN15-2423	Converter 15W 18 à 36V 15V/500 mA	1x		CDE010C-01 Digital Control Card	
Aux Power Supply		1x			
MOSFET					