

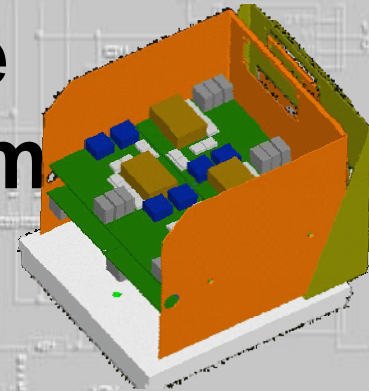
Radiation-Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector

3-7.September 2007

TWEPP - Ivan Hruska, Slava Palan

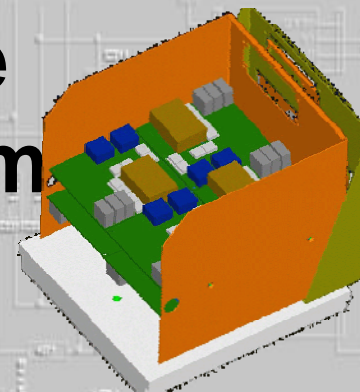
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Radiation-Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector

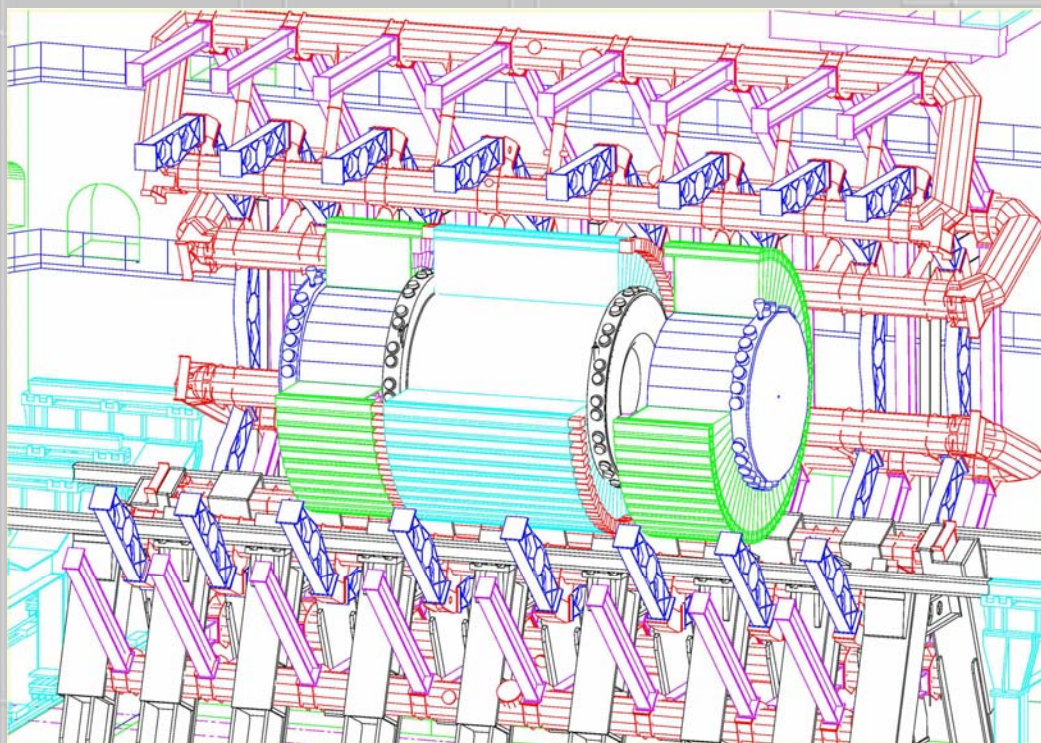


- ATLAS/TileCal introduction ←
- LVPS Requirements
- LVPS System design
- LVPS Components
- LVPS Production and Installation

Radiation -Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector



- ATLAS/TileCal introduction



TILECAL = TILE
CALORIMETER

Particles going through the calorimeter are scintilating inside plastic TILES. The light is guided by optical fibers into the PMTs. Signal is treated by embedded electronics.

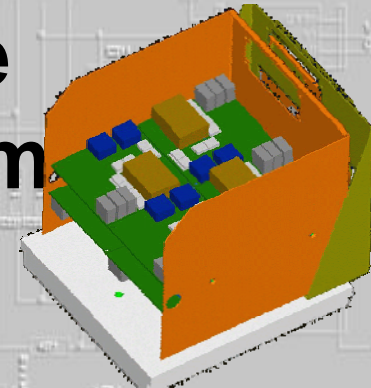
2500 tons of iron as an absorber

100m underground

More details on :

<http://atlas.web.cern.ch>

R a d i a t i o n -Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector



- ATLAS/TileCal introduction

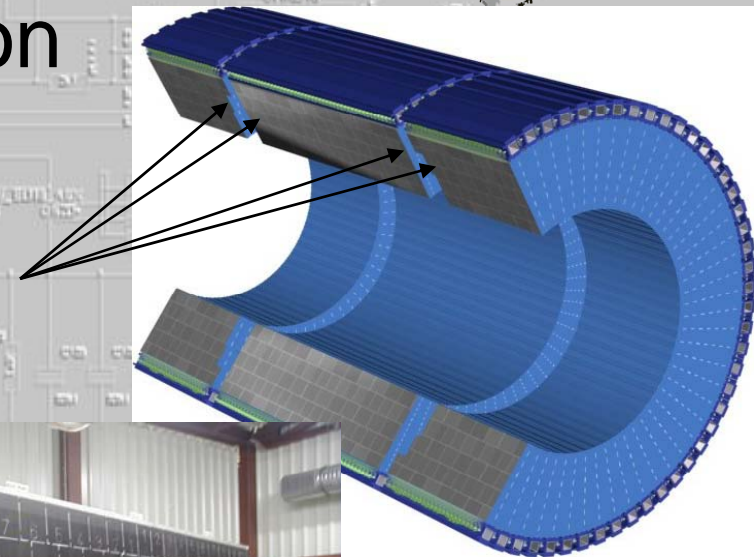
- Granularity & TILECAL naming conventions

- Calorimeter

- 4 partitions
 - 2 in central barrel + one in each extended barrel
 - 256 superdrawers / calorimeter

- Superdrawer

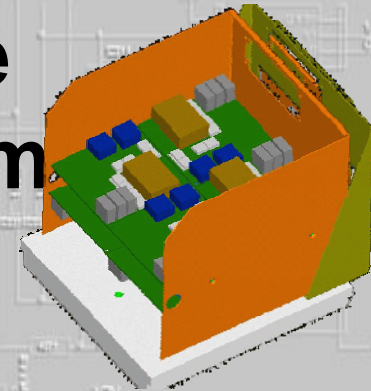
- 2 drawers
 - 64 superdrawers per partition
 - 3 m long in total
 - Patch panel



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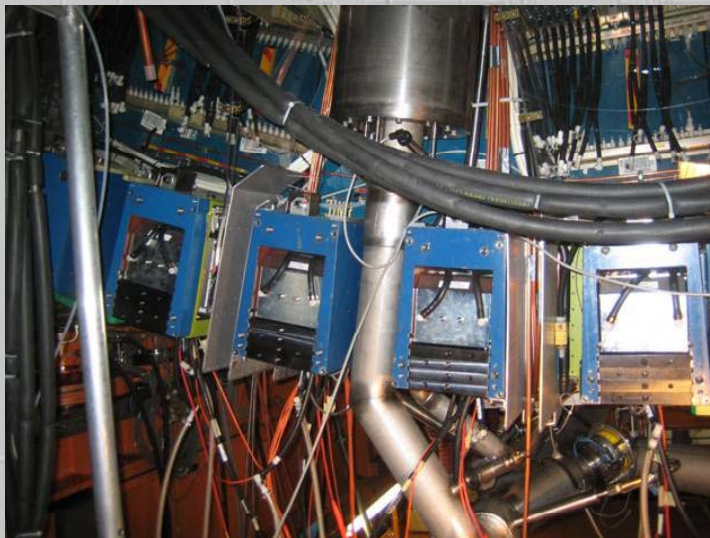
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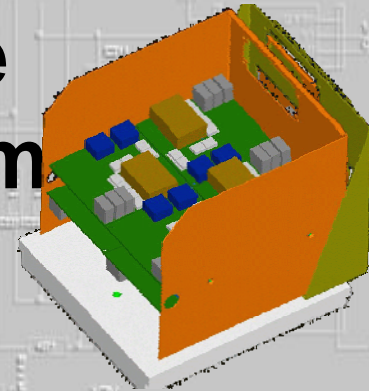


- ATLAS/TileCal introduction

- Granularity & TILECAL naming conventions
 - Finger
 - Feeds magnetic field between central & extended barrels
 - Space for power supplies

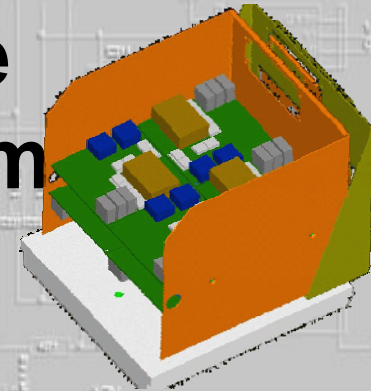


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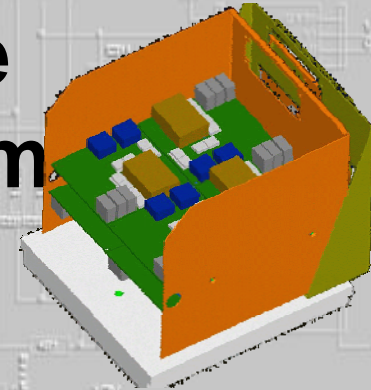
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Radiation -Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector



- LVPS requirements
 - Operation constraints in ATLAS cavern - TileCal Finger
 - Radiation
 - Magnetic field
 - Water cooling
 - Limited space 170 x 170 x 170 mm

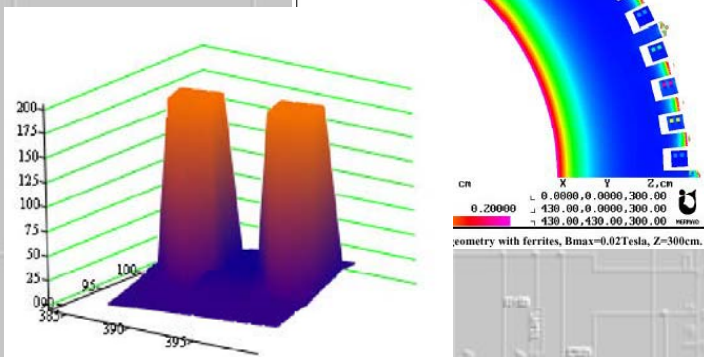
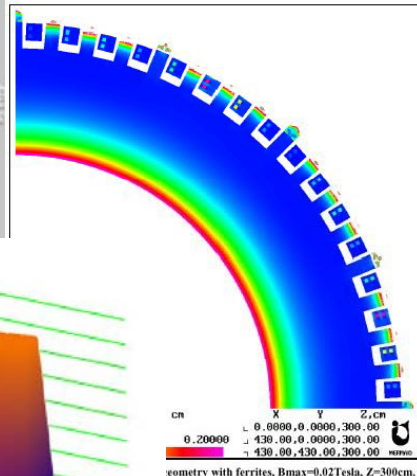
Radiation-Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector



- LVPS requirements
 - Radiation
 - Magnetic field

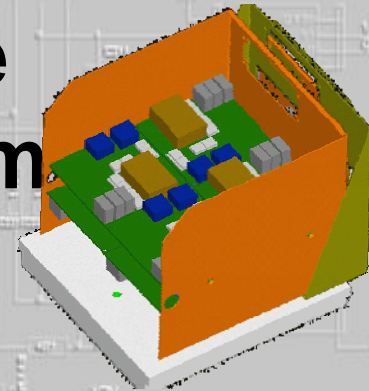
TILECAL LV supply radition test requirements for 60MeV beam						
	Worst numbers for PS region from simulation	SF	Test doses required	Doses obtained by SEE	factor - number of pieces to reach the TID limit	
TID	5.31E+00	70.00	371.70	2447.20	6.58	Gy per 10 years
TID	5.31E-01	70.00	37.17	244.72	6.58	krad per 10 years
NIEL	3.18E+11	20.00	6.36E+12	3.98E+12	0.63	n/cm ² per 10 years
SEE	8.74E+10	20.00	1.75E+12	-		p/cm ² per 10 years
Time of the SEE test in case of			5.00E+08 p/cm ² /s and	7 pieces is	8 min	
					= 2.50E+11 p/cm ²	
1.00E+11 p/cm ² with energy 60MeV means ~14krad						
1.00E+11 p/cm ² is equivalent to 1.6n/cm ² for NIEL						

Rad specs computed from ATLAS radiation simulation



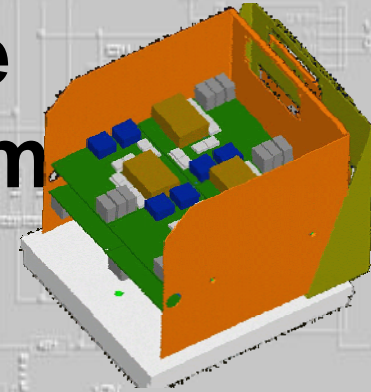
Mag field specs simulated as ferrite cubes (transformer cores) inside fingers

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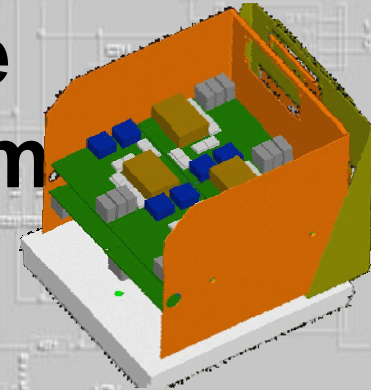
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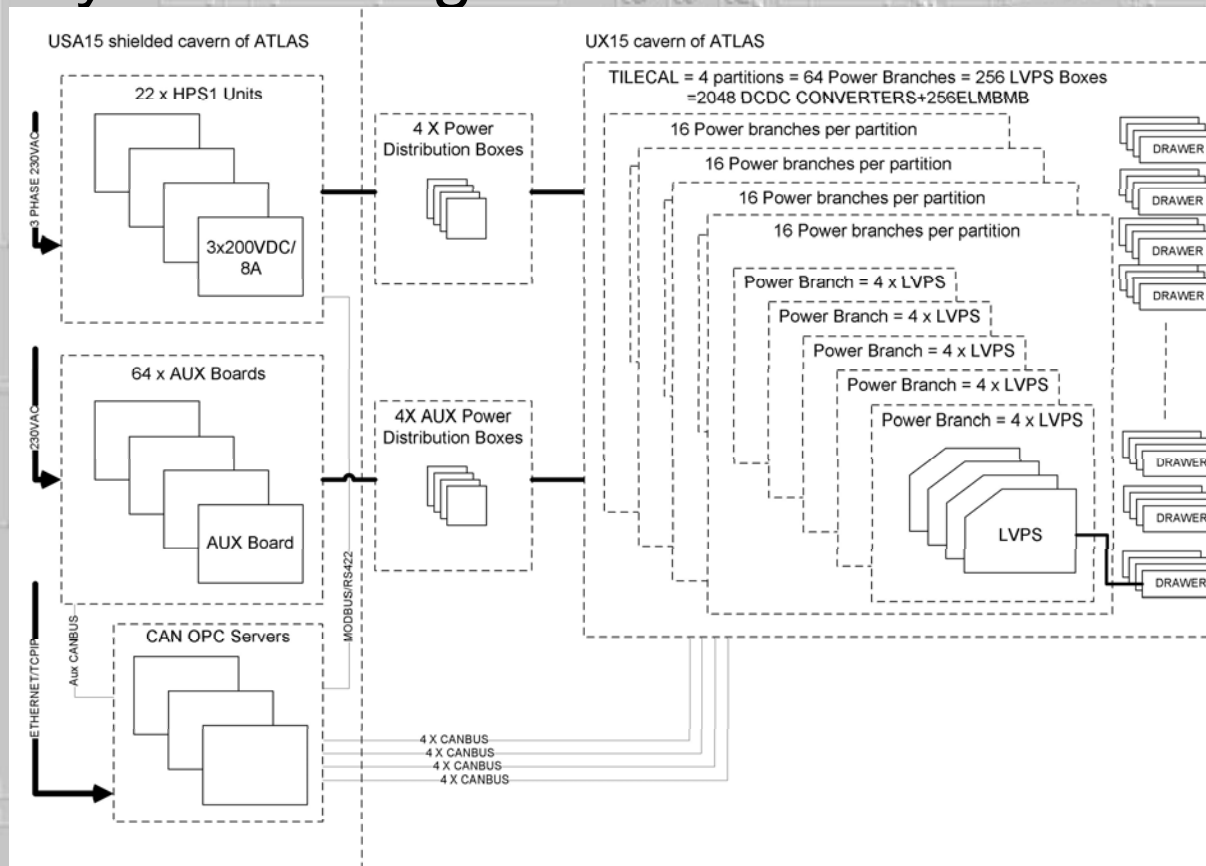


- LVPS System design
 - Dual stage power supply system
 - First stage - 3 x230VAC -> 3x200VDC/8.5A
 - Second stage 200VDC -> 3.3V, 5V, 15V
 - Rad-tol & Mag-tol part is second stage
 - Custom designed DC/DC converter - brick
 - Remote control & monitoring
 - Measuring of V_{in} , V_{out} , I_{in} , I_{out} and temperatures
 - Remote On/Off
 - Remote trimming of all outputs

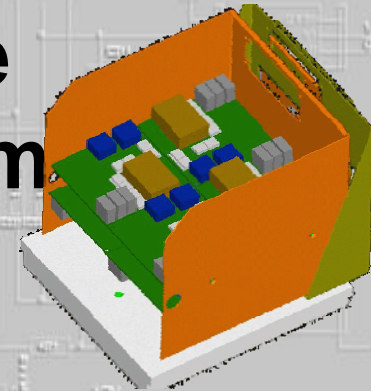
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- LVPS System design - Block schematic

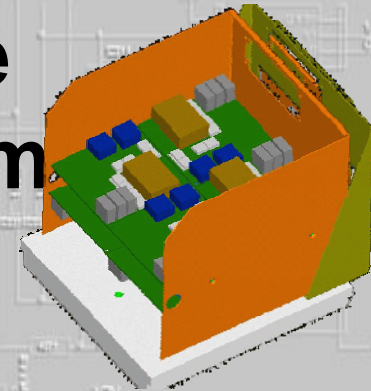


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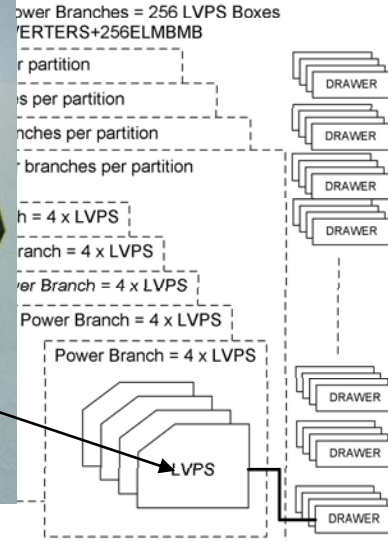
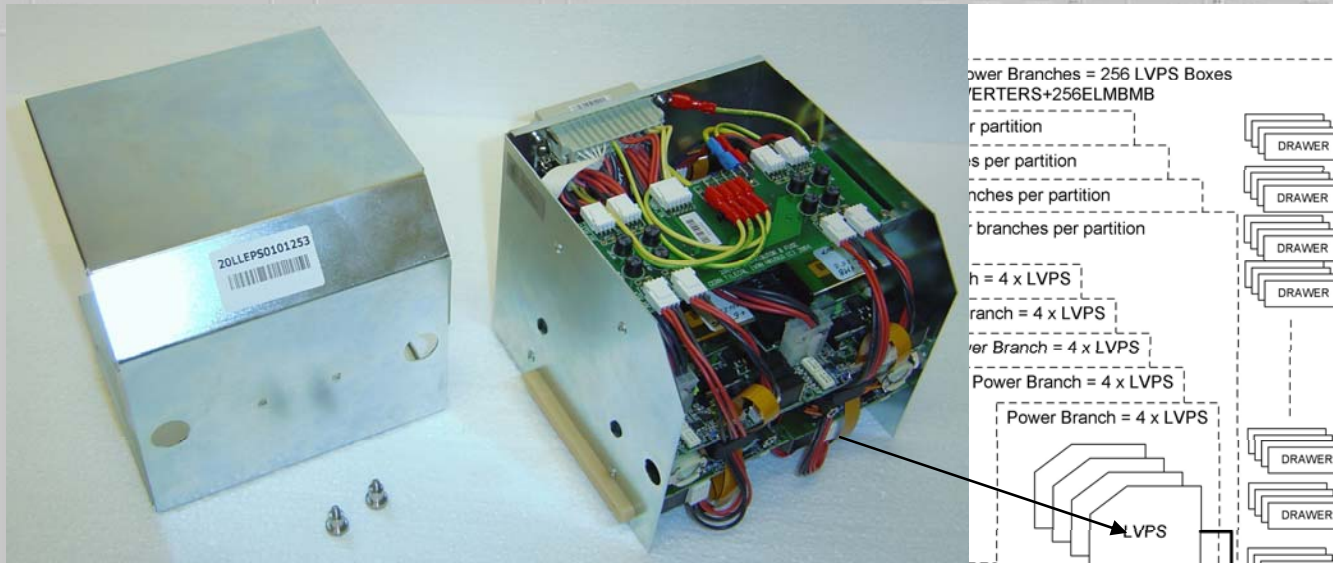


- ATLAS/TileCal introduction
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- LVPS System design
- LVPS Components ←
- LVPS Production and Installation

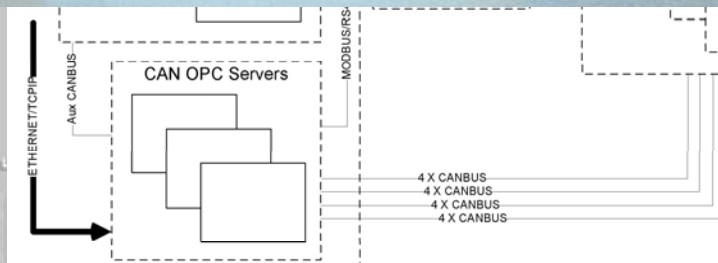
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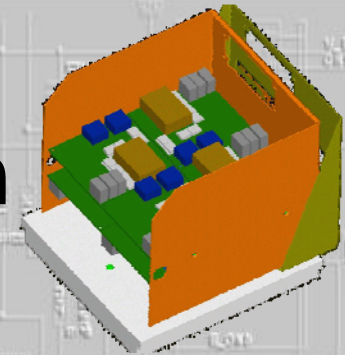
- LVPS Components - LV BOX



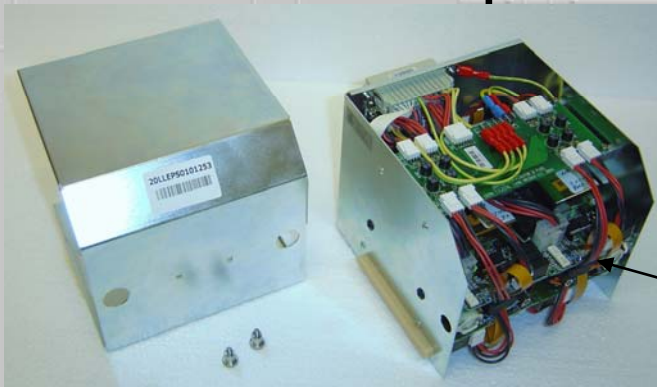
- Input 200VDC
- 8 Outputs
- One DC/DC converter per output
- Watercooled
- Integrated remote control
- Connected to finger via single HAN 72 DD connector



Radiation-Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector

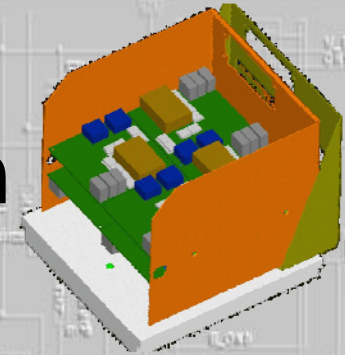


- LVPS Components - LVBOX - DC/DC converter

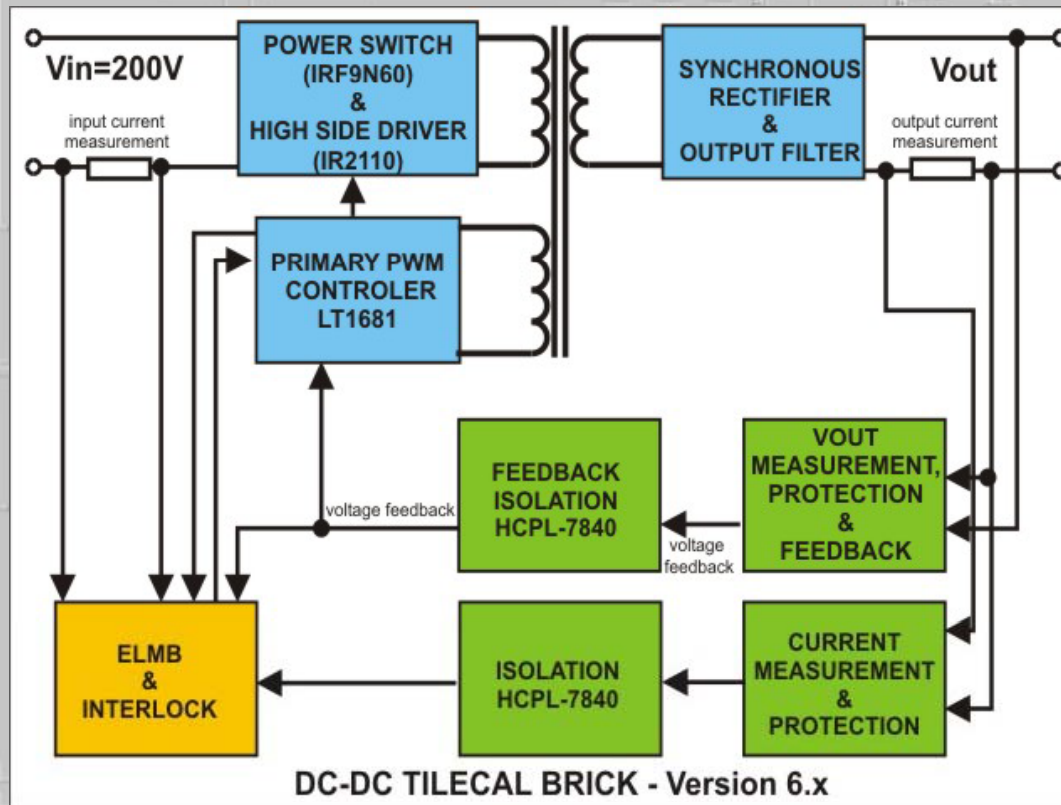


- Input 200VDC
- 3 types according to output voltage
- Integrated measurement of parameters
- Remote trimming
- Rad-Tol <40krad
- Mag-Tol < 400/1000Gauss

Radiation-Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector

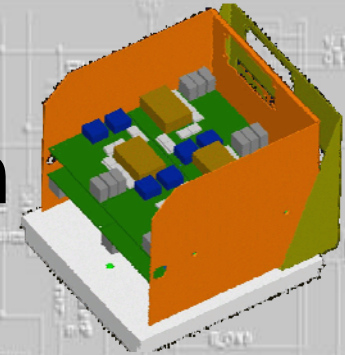


- LVPS Components - LVBOX - DC/DC converter

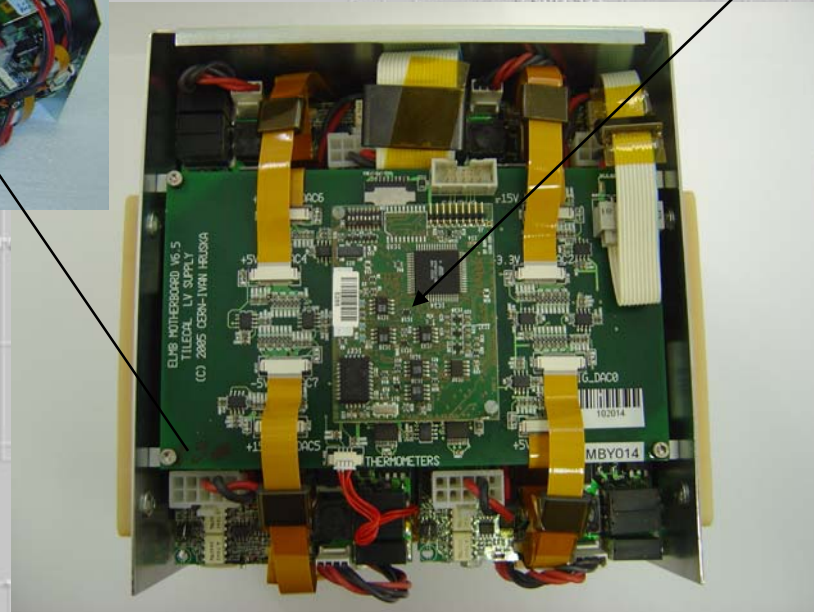
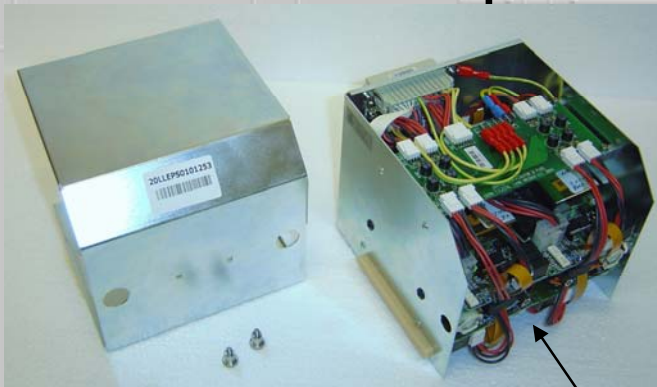


- Dual Transistor Forward converter
- Based on Linear Technology chipset LT1681 tested to be rad-tol till 40krads
- Highside driver IR2110 and some other components chosen according to NASA, JPL, ERIC & other databases
- All components radiation tested before the design start
- Prototype faults in radiation analyzed and design improved
- Final test OK

Radiation-Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector

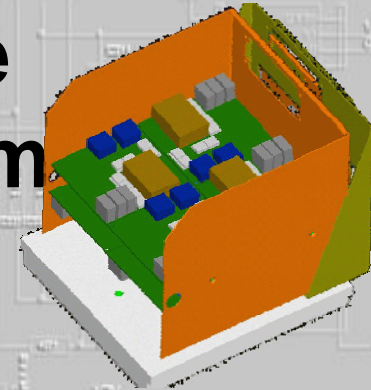


- LVPS Components - LVBOX - ELMB MB

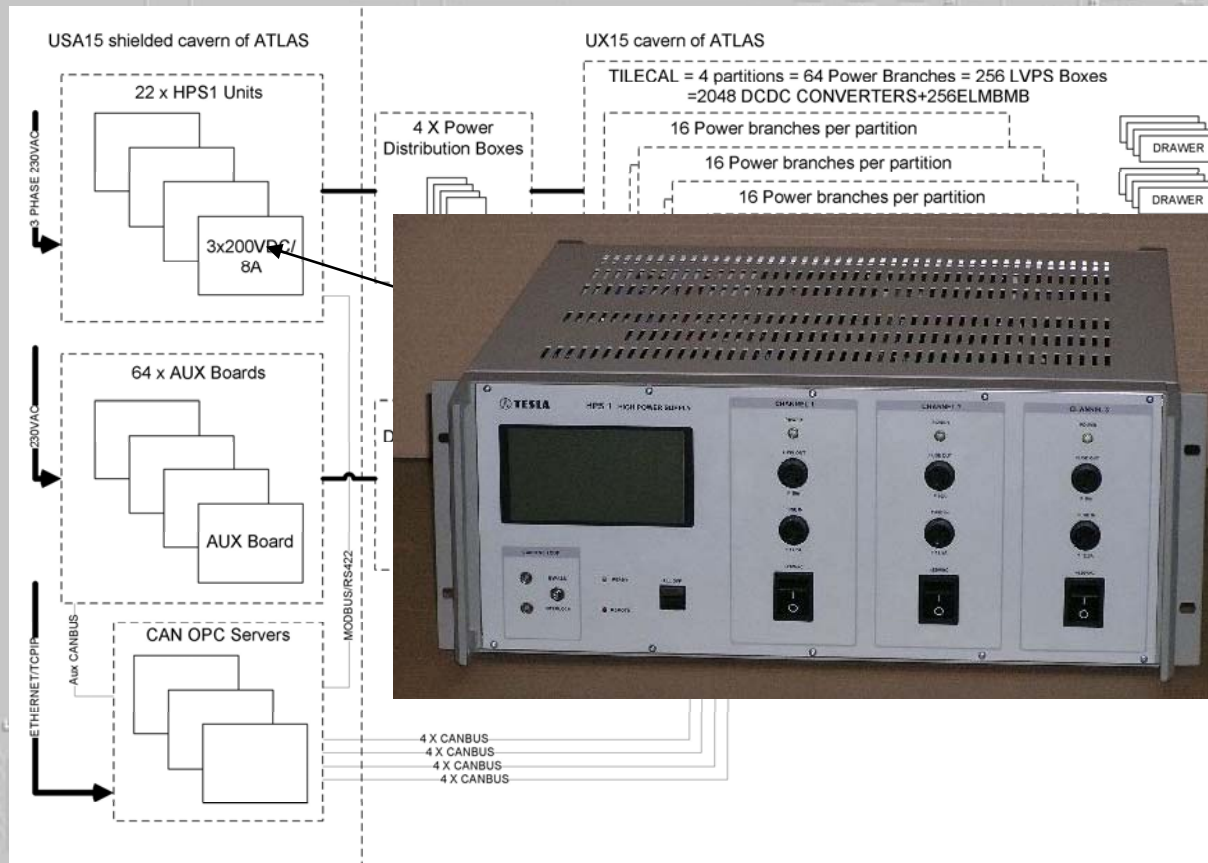


- Remote monitoring over ELMB
- Remote control (ON/OFF) over dedicated current loops
- Remote trimming DACs
- Brick syncing distribution
- Extra analogue isolated inputs for drawer internal measurements

Radiation-Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector



- LVPS Components - HPS1 - first stage

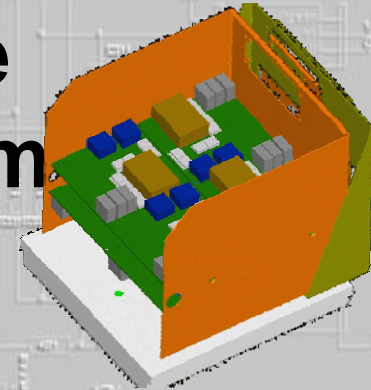


- Input 3 phase 3x240VAC
- 3 Outputs
- Each output 200V/8.5A
- Power density >5kW in 4U crate
- Trimable +/- 10%
- Sensewires possible
- Integrated remote control
- RS422/MODBUS

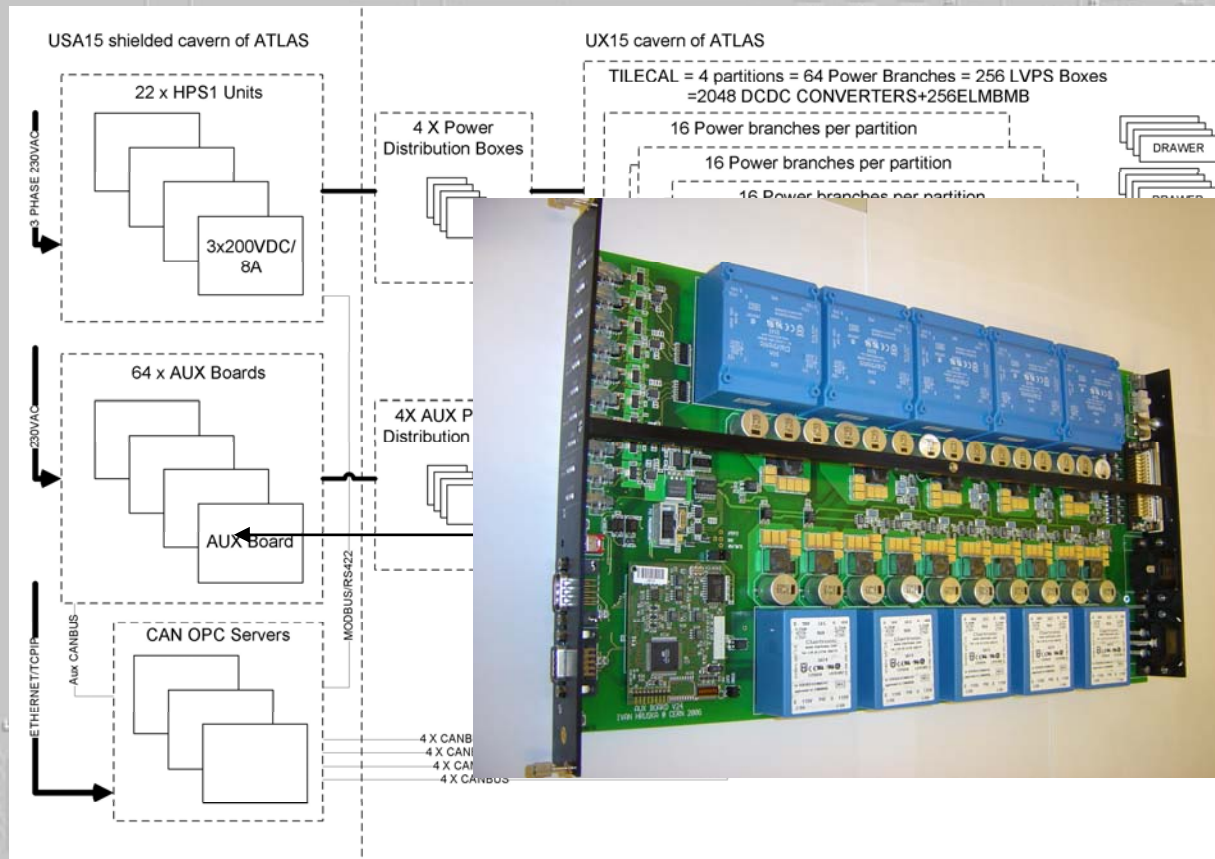
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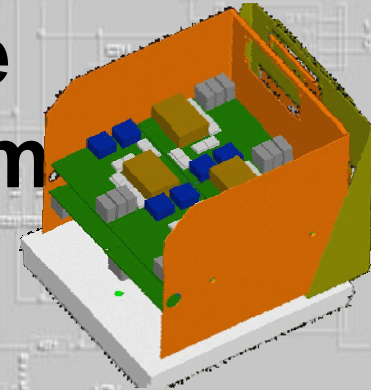


- LVPS Components - AUX Board

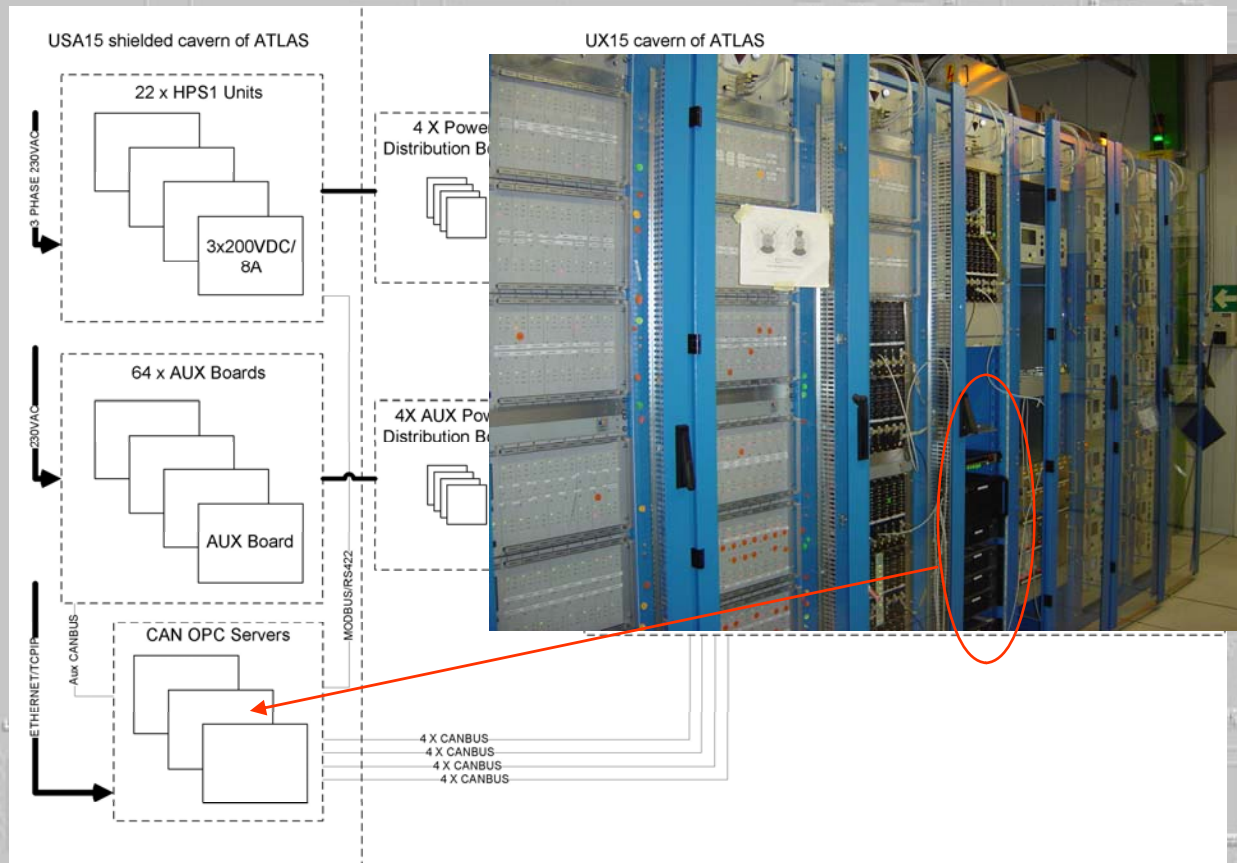


- Auxiliary power for Power Branch (4 LV BOX)
- Power for ELMB +ELMB Motherboard
- LV BOX StartUp voltage
- Current loops for remote On/Off
- Interlock loop source
- Converter clock sync generator
- ELMB controlled via special firmware
- CANBUS

Radiation-Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector



- LVPS Components - Remote control

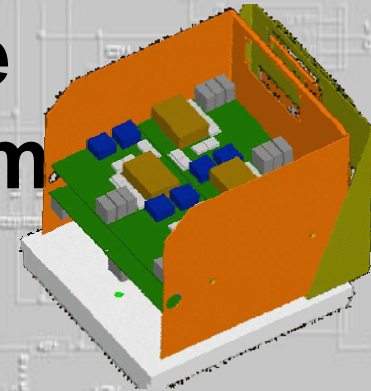


- Set of PC's in USA15 equipped by CAN BUS interfaces running WinXP and OPC servers
- Dedicated PC in the PIT running PVSSII for local control
- Possible remote control from other place

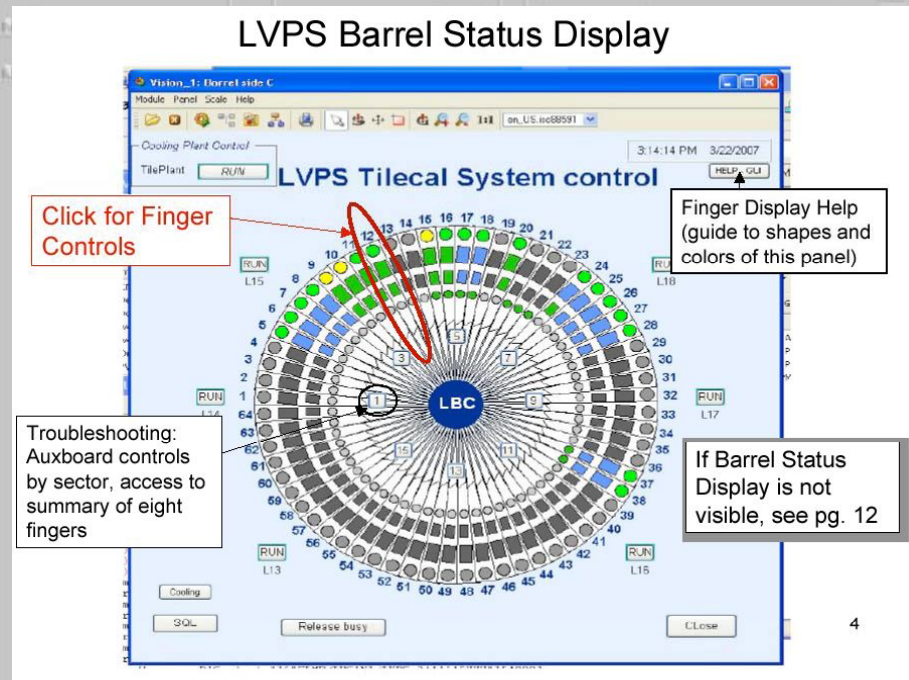
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- LVPS Components - Remote control

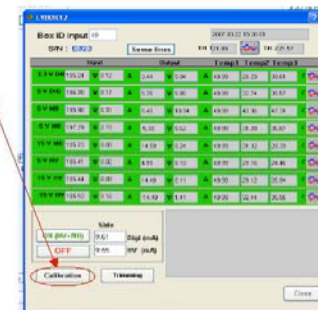


- User interface in PVSSII
- Overall monitoring and control
- Local monitoring and control
- Individual LV BOX Calibration
- Traceability of behavior - all params recorded

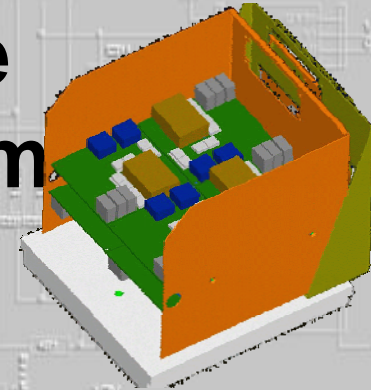
LVPS Finger Display and Controls: Calibration

Calibration constants may be loaded or viewed in the calibration panel. Most recent calibration will load automatically from Configuration DB when LVPS box is turned on.

Click on Calibration button to access calibration panel.

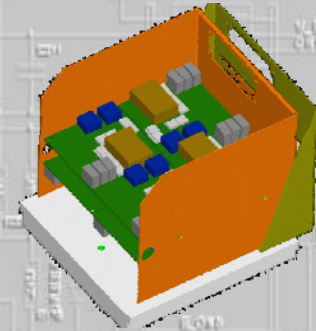


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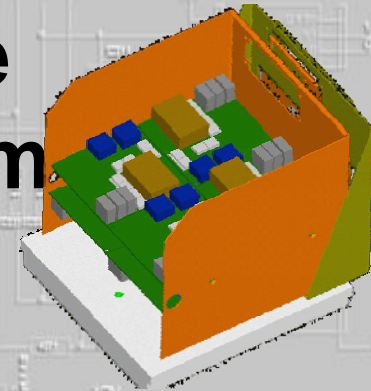
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R a d i a t i o n -Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector



- LVPS Production & Installation - Organization
 - Full design sources in hands
 - Development of production technologies & tools
 - Transformer assembly
 - Cooling bars assembly
 - Component ordering
 - PCB production and components assembly outsourced (companies PRINTED,HC,DUO)
 - Tests and integration made in CERN
 - Assembly hall built in Preveessin 2004/2005 (in 2006 moved to Meyrin)
 - Automated testers for all boards
 - Manual assembly of LV BOXes
 - Branch test/LVBOX test
 - PIT Installation

Radiation-Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector



- LVPS Production & Installation

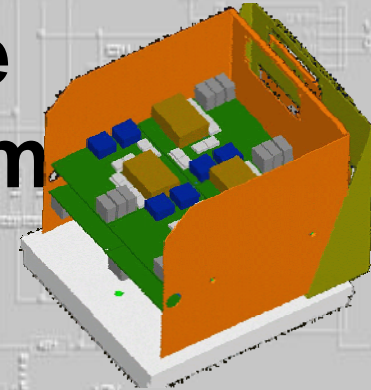


- Lot of different testers for production developed
- Head of nails for basic brick test
- Burn-in tester
 - 4x8 bricks under real operating conditions
- ELMB MB Tester
- Branch/LVBOX testplace
- AUX Board tester
- Other testers - Transformer (4 testers) , special cable testers etc.

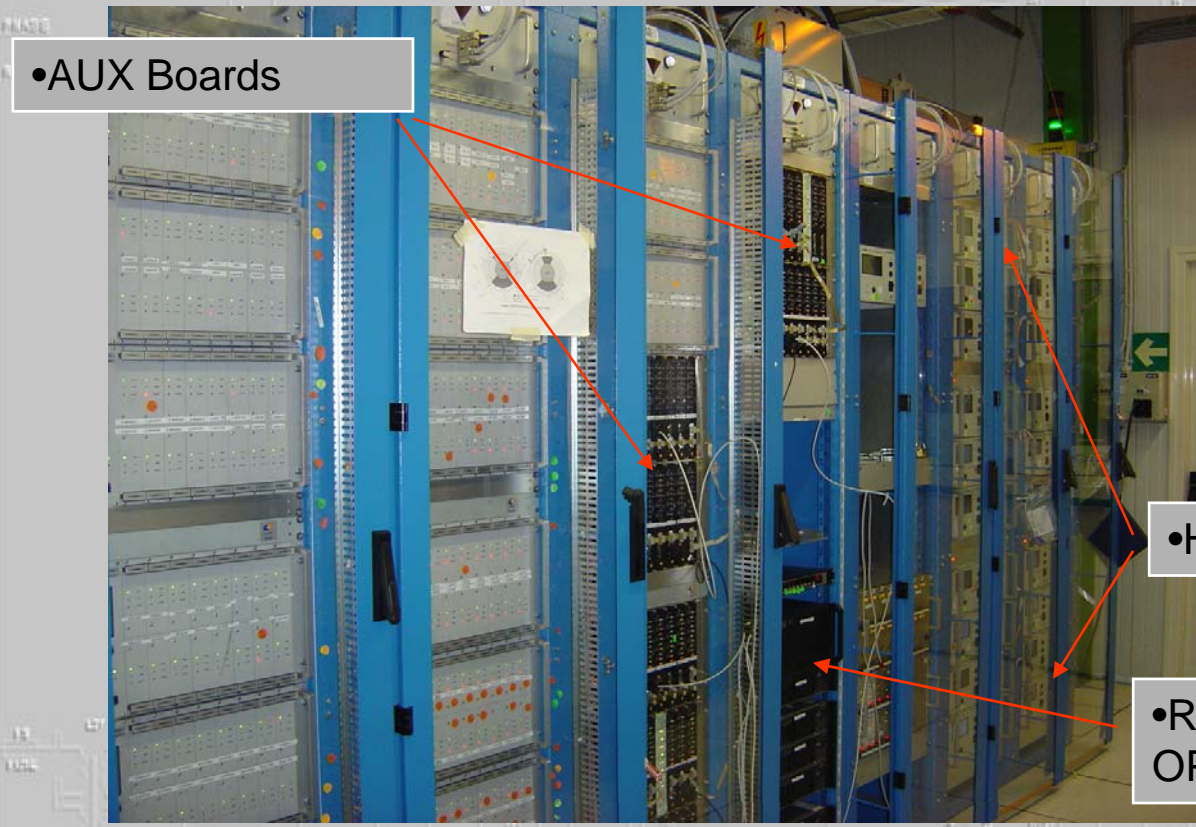
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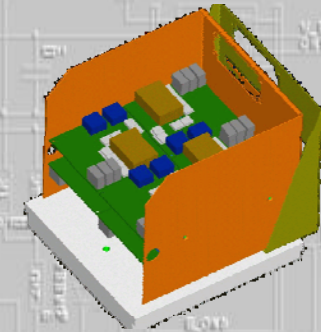


- Power supplies wall in USA15 cavern
- 2 racks with AUX boards
- 2 racks with HPS1

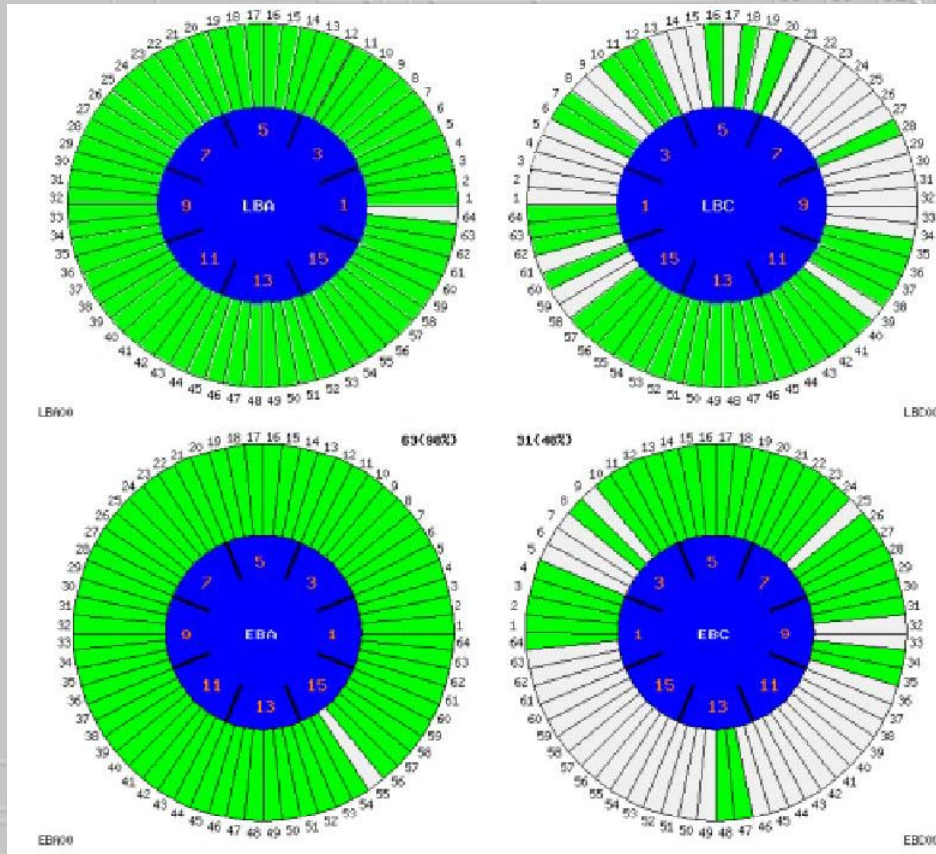
•HPS1 - 200VDC

•Remote control OPC Serves

Radiation-Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector



- LVPS Production & Installation - Completion



- Completion

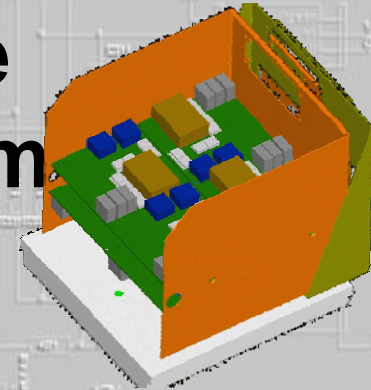
- Barrel 98%

- Extended 48%

- Repairs of drawers before LVBOX installation

- Poor internal cabling

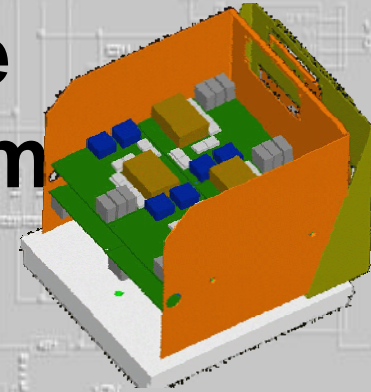
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- Conclusions

- Not everything has gone smoothly as it looks like on the paper
 - Lot of troubles with organization of project
 - Key problem to have enough qualified and crafted persons for long term
 - Missing professional project management as factory of this size requires
 - » >2500 bricks,>280 Motherboards, 280 LVBOXes.....
 - Time stress, often personnel fluctuations, not-well defined roles of persons
 - Objective & Subjective factors lead to some faults and necessity to redo or repair lot of boards
- Anyway system as whole works and is close to finish of installation
- Details on the WEB :
http://atlas.web.cern.ch/Atlas/SUB_DETECTORS/TILE/elec/lvps/

Radiation-Tolerant Custom Made Low Voltage Power Supply System for ATLAS/TileCal Detector



- Conclusions - Thanksgiving

The End

— Physicists

- Stan Nemecek ('03 -...)
- Larry Price ('06 -...)
- Milos Lokajicek ('01-...)

