Gruppo di lavoro sulle alimentazioni
LHC fase 2: LVPS Fase II

M. Lazzaroni

2017-11-23

Sommario

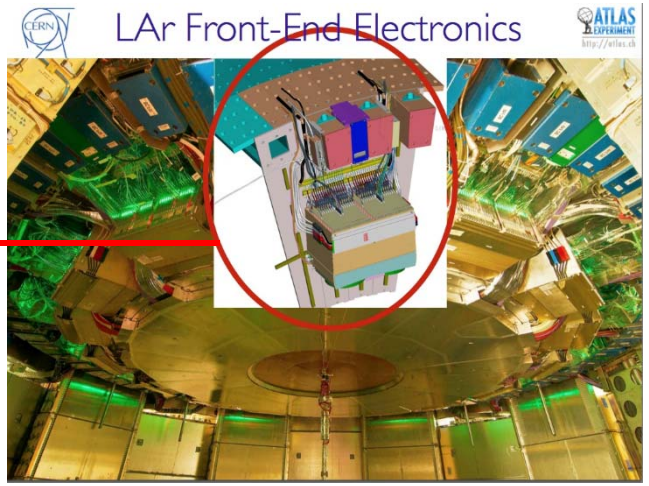
- Lo scenario
- La proposta per i nuovi LVPS
- … tanti aspetti da discutere
- Cosa ci proponiamo di fare…
- Criterio di scelta

Scenario

Situazione attuale

OCEM – USA15 (V_{out} = 280V DC)

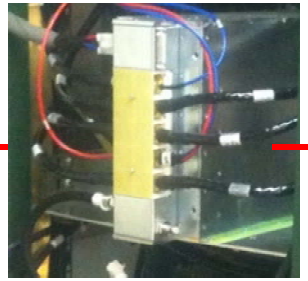
L = ~70 m



Possibile soluzione

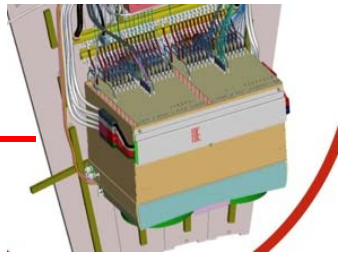
Soluzione simile
(non necessariamente identici – USA15)

L = ~60 m
L = ~50 m
L = ~40 m



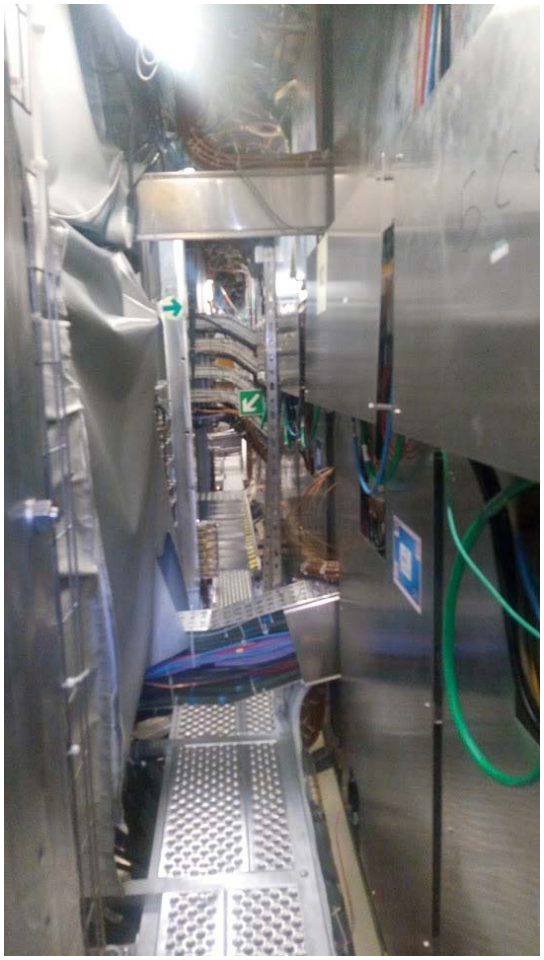
New LVPS
(vicino PP2)

L = ~10 m
L = ~20 m
L = ~30 m



Crate

Nuova posizione: una proposta



Patch panel PP2.

Near TRT e Pixel PP2 boxes.

Higher magnetic field, lower radiation dose with respect to present position

Engineer change request should be formalized with TC if we want to pursue this solution.

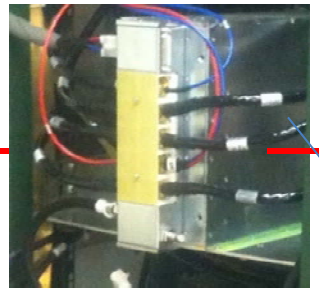
Real available volumes need to be discussed!

Space for input and output cables need to be discussed

Proposed Baseline solution

Similar solution
(not necessary identical – USA15,
Vout = 280V)

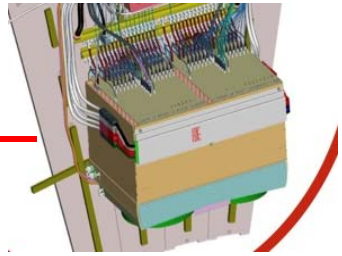
L = ~60 m
L = ~50 m
L = ~40 m



LVPS
(installed near PP2,
Vout = 24 -48 V)

L = ~10 m
L = ~20 m
L = ~30 m

2x95 mm^2



Crate

The Power distribution section of the boards is based on LTM4619 and LHC from ST (see also the design of the power distribution implemented with PDB-LTM)

LVPS: features (under discussion)

- ~ 280 Vin DC
- 24 Vout DC → 48 Vout DC
- 3 – 3.5 kW
- Efficiency > 80% up to 0.6 T
- Radiation tolerant for the dose expected at PP2 location (?)
- → see next slide …

Radiation

Table 3.1: Radiation tolerance requirements for the LAr front-end electronics for operation at the HL-LHC for a total luminosity of 4 000 fb^{-1}, including safety factors given in brackets.

	TID [kGy]		NIEL [n_{eq}/cm^2]		SEE [h/cm^2]	
ASIC	1.24	(2.25)	3.4×10^{13}	(2)	4.6×10^{12}	(2)
COTS (multiple lots)	16.5	(30)	13.6×10^{13}	(8)	1.8×10^{13}	(8)
COTS (single-lot)	4.1	(7.5)	3.4×10^{13}	(2)	4.6×10^{12}	(2)
LVPS between TileCal fingers (barrel)	3.0	(30)	3.4×10^{13}	(8)	4.3×10^{12}	(8)
LVPS at PP2 (barrel)	0.27	(30)	1.8×10^{12}	(8)	2.4×10^{11}	(8)
LVPS between TileCal fingers (endcap)	0.21	(30)	2.4×10^{12}	(8)	4.8×10^{11}	(8)
HEC LVPS	0.02	(2.25)	6.0×10^{11}	(2)	1.2×10^{11}	(2)

Technical Design Report
***DRAFT** 3.0 29th September 2017 – 11:30*

Possible candidate…???

NSW has issued a tender for a LVPS with the following characteristics, which can be interesting for LAr too.

Ionizing Radiation	96 Gy
Displacement Damage	5.8×10^{12} 1-MeV Eq. n/cm^2
Single-Event Fluence	1.0×10^{12} p/cm^2 (E > 20 MeV)
Magnetic Field	0.5 T

Are sufficient also for PP2 position? More investigations are mandatory

Magnetic field requirements

Maximum height	90 mm
Maximum width	200 mm
Maximum length	200 mm
Channels/module	8

Electrical specifications

Vin	48 VDC up to 300 VDC
Vout	12 VDC (we need 24 VDC)
Ripple (common/differential)	20 mVpp (to be discussed with the designers of FEB and LTDB)
Redundancy	Must allow two channel outputs to be paralleled for redundant supplies
Conversion efficiency	≥ 80 %
Nominal output power	190 W - up to 8 channels to be paralleled for output Power =190 x 8 = 1.52 kW (we need 3 – 3.5 kW)

* In red the specifications for LAr LVPS

Modules will be housed in a mechanical structure, similar to a crate, which can also host the cooling system.

Discussion: LVPS

- 58 LVPS (32 for Barrel and 26 for ENDCAP)
- 3 kW – 3.5 kW ….or different solution (116 LV PS @ 1.5 kW)
  - 1 supply line or 2 supply lines?
  - Different from the reliability point of view (single point failure or not)
- Redundancy?

Discussion: Crate

- Commercial/standard solution (vs actual solution → *ad hoc*)
- 4 or 8 LVPS for crate?
- Problem with power dissipation?
- Problem with mechanical aspects?

  →Discussion with Technical Coordinator ATLAS

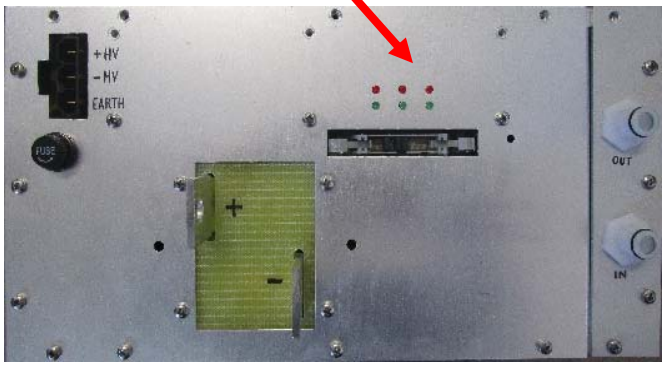
Year 2018

- Per l'anno prossimo siamo intenzionati a dimostrare che un tale LVPS è realizzabile
- Pre-prototipo di dimensioni ragionevoli (anche non definitive) da parte di una azienda del settore…
- Così abbiamo detto alla collaborazione (ATLAS LAr + revisori LHCC che hanno letto il TDR LAr fase II)
- Criterio di scelta da usare …

Criterio di scelta

- Se il prototipo c'è e dimostra la fattibilità dell'idea → Soluzione A (LVPS in posizione PP2 etc…
- Altrimenti
  - Soluzione B1: Si va dall'attuale costruttore dei LVPS e si chiede di rifarli simili (unica uscita, maggiori radiazioni etc…)
  - Soluzione B2: Si riprende in mano il Vecchio progetto Apollo INFN e si continua su questo (CAEN era intervenuta su questo progetto è ancora interessata?)

Soluzione preferibile: A



Thank you for attention

Slide di riserva

Wiener LVPS

From a presentation by L. Hervas (ATLAS week 3-6-2014)

A bit of history

- Project started year ~2000, BNL
- Deliver through DC-DC converters ~3kW of power to each LAr FrontEnd crate:
  - 280V DC in USA15 -> ~70m of cable -> LV at the FEC

Voltage (Volts)	Maximum Current (Amps)	Maximum Output (Watts)	Number of Power Modules
6.0	100	600	5
11.0	20	220	2
7.0	16	112	2
6.0	150	900	5
4.0	130	520	5
-4.25	180	720	6
-7.0	15	105	2

- Main features :
  - Rad tolerant
  - Magnetic Field tolerant
  - Redundancy at each voltage (N+1 modules for each voltage)
  - Small volume
  - Water cooled
  - Efficient

.....Challenging (specially the **access once a year !**)

L. Hervas ATLAS weekly 3.6.2014 2

Number of LVPS installed:

32 (16 + 16) LVPS in Barrel

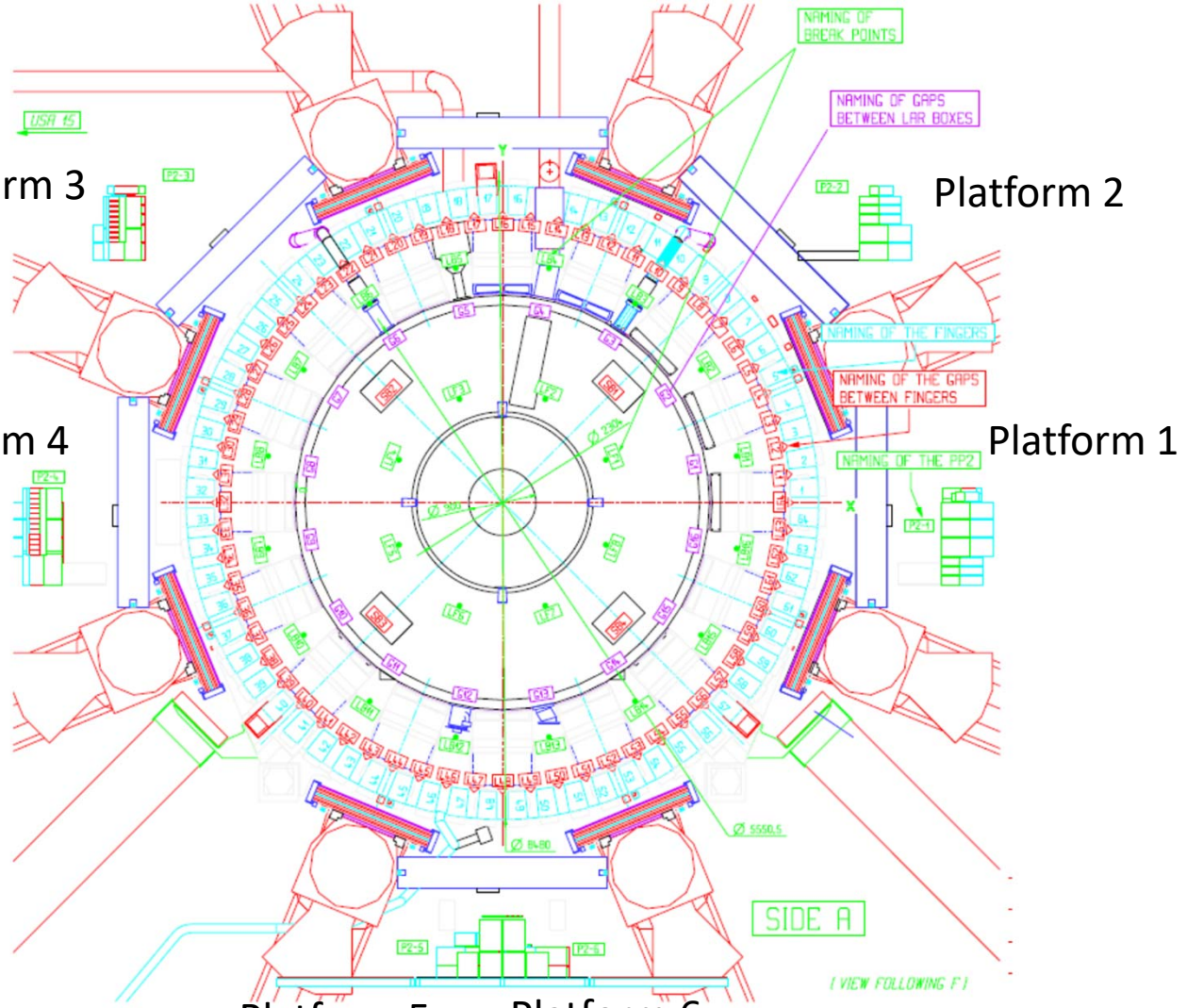
26 (13 + 13) LVPS in EC

PP2 locations (side A)

Not all positions could be available for additional installation of services.

Likely the ITK detector is planning to reuse most of the volumes for future services.

Feedback from TC is needed.

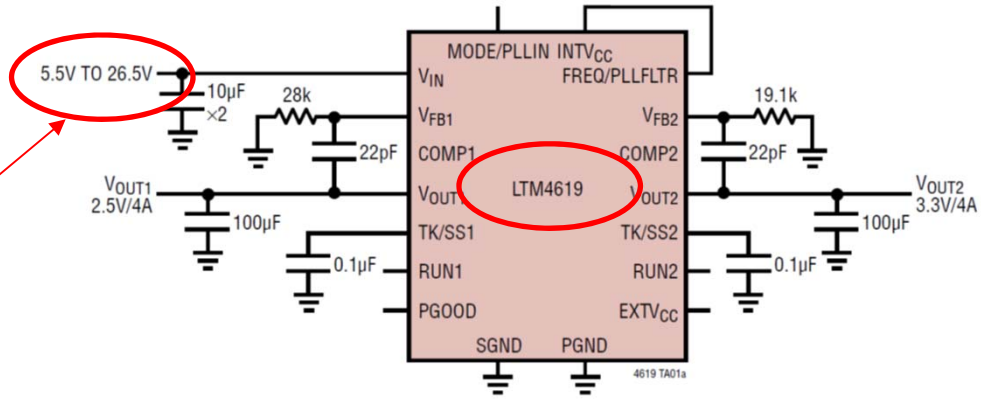


Discussion about the output voltages of the new LVPS

- No more multiple output voltages as in present situation.
- Baseline is to have only one positive voltage.
  - the question is: how to select the best value?
- Negative voltages for future electronics will be necessary?
  - Not always possible, it depends from the design of the LVPS.
- The voltage conversion to the necessary voltage levels for the FE electronics will be done by PoL and/or LDO regulators on each board.
  - e.g. using the same approach of the PDB-LTM mezzanine.

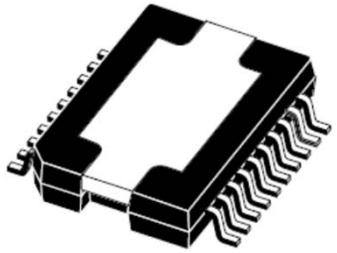
Devices that could be used on-board

- PoL: LTM4619
  - Qualified to withstand Phase II radiation levels!
  - Input range: 4,5 – 26.5 V
  - Max voltage ratings: 28 V
  - Example of application: 5.5 – **26.5 V**



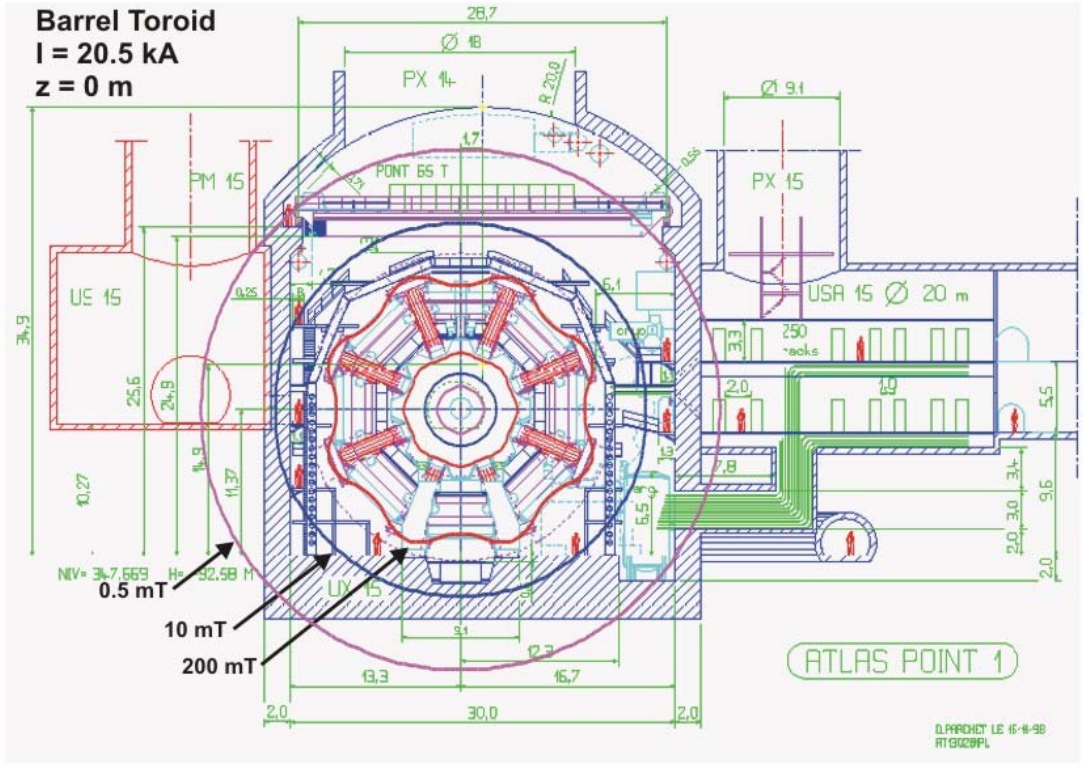
- … or other devices need to be qualified.
- LDO: LHC4913
  - Max Input voltage: **12 V**
  - Max voltage ratings: 14 V
  - LTM4619 can be used before an LDO

Hypothesis: LVPS output voltage equal or less than 26.5V



PowerSO-20 slug-up

B-field value



The value of the magnetic field should be considered with care.

There are documents with the value of the B-field.

Here you can find a magnetic field ranging from 0.5 mT to 0.2 T.

Philippe Farthouat consider a "*max field value of 4 kGauss*".

In https://indico.cern.ch/event/8681/contributions/2103832/attachments/1081276/ (Chevalier, 2006) value for magnetic field have measured in different position. Max value registere is less the 0.65 T (Many different position have been tested)