Reliability testing of switch-mode Power Supply for the ATLASTileCal Front-End system

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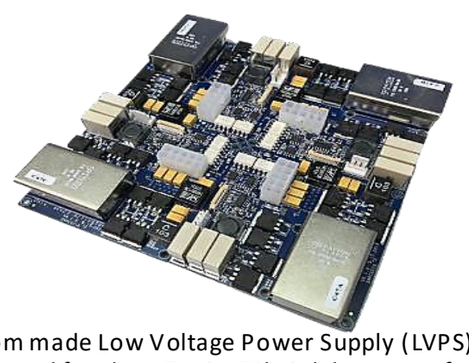
On behalf of the ATLAS TileCal collaboration

Why Upgrade?

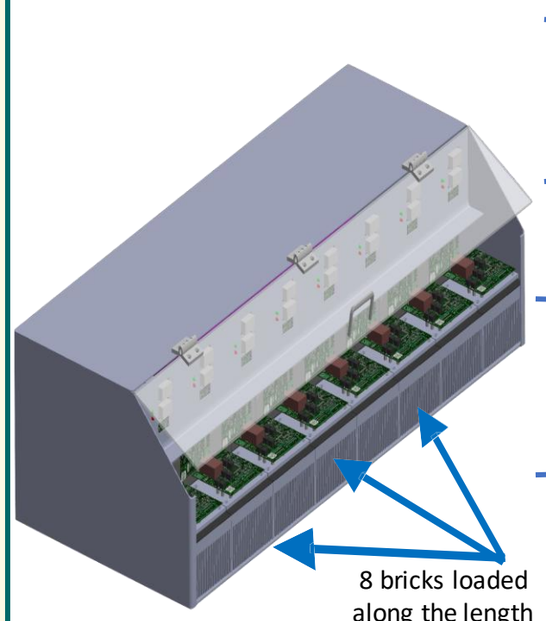
- Increase LHC luminosity to ~ 5 times ~ **7.5 x $10^{-34} cm^{-2} s^{-1}$** at Phase-II Upgrade
- Most front-end and back-end electronics need to cope **with higher data rates** and provide higher reliability and robustness
- Require **higher radiation** tolerance for the on-detector electronics and avoiding **single point failures**
- Intense R&D is being performed on alternative solutions for modification of testing station of LVPS.

All TileCal electronics must be replaced to satisfy new requirements!



Custom made Low Voltage Power Supply (LVPS) system developed for the ATLAS – TileCal detector of the LHC

Burn-In Type test station



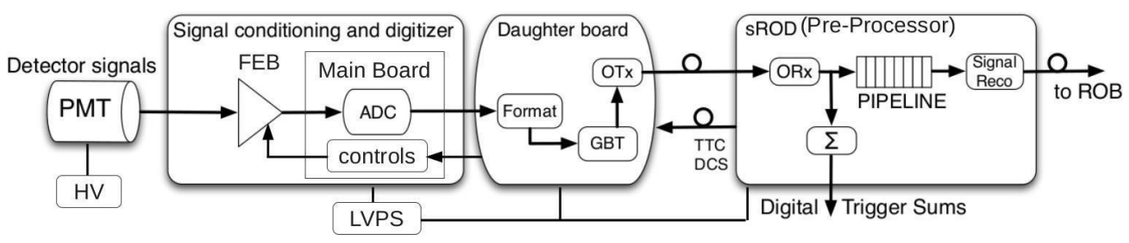
8 bricks loaded along the length

Burn-In Station test bed

- **Burn-In Station** performs an endurance type test, a **LVPS** is subjected to a stressed environment where the load and temperature are both elevated.
- Expected operational life of the brick is reduced, which serves as an indicator of how long the bricks will last under the **normal environment** in the detector
- This environment stresses the electronics under test and causes components that would fail prematurely, to fail immediately during the duration of this test before the newly manufactured electronics are deployed on the detector where access can be very limited.

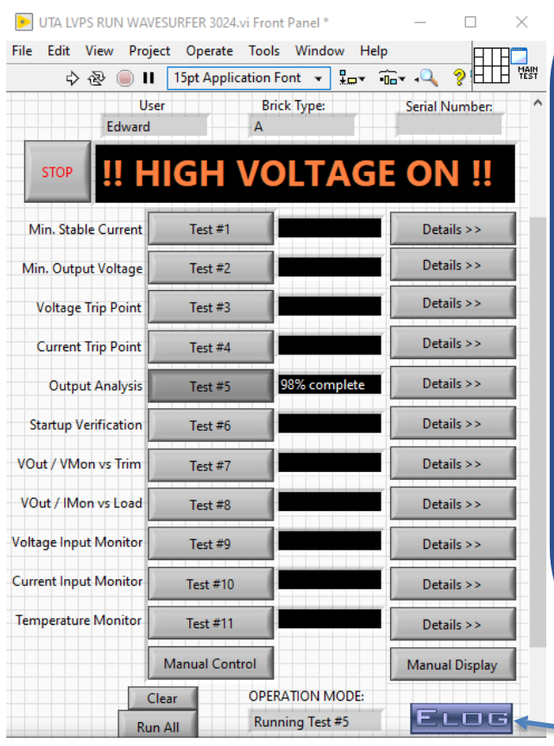
Read- out architecture

- **Input** : There are eight DC/DC single-output power supplies transforming a 200V DC input into a +10V feed to the Main Boards on the Tile drawers
- **Core idea** : Development of a "quality assurance" test station and a burn-in type test station. Because of the environment of which the LVPS is in, LVPS must remain radiation hardened to single-event up-sets and total dose accumulated over several years. LVPS also contains custom designed magnetic components to operate reliably within the magnetic field of ATLAS.



Initial Tests	Full suite of 13 tests, automated by computer
Burn-In tests	8 hours, under load, monitored continuously by computer

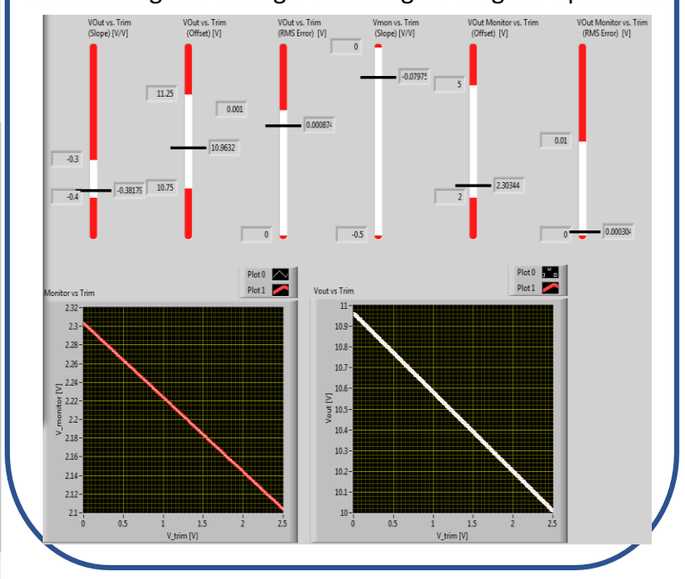
LabVIEW controlled software



Custom PC Software

Test #7: 'Vout/Vmon vs Trim'

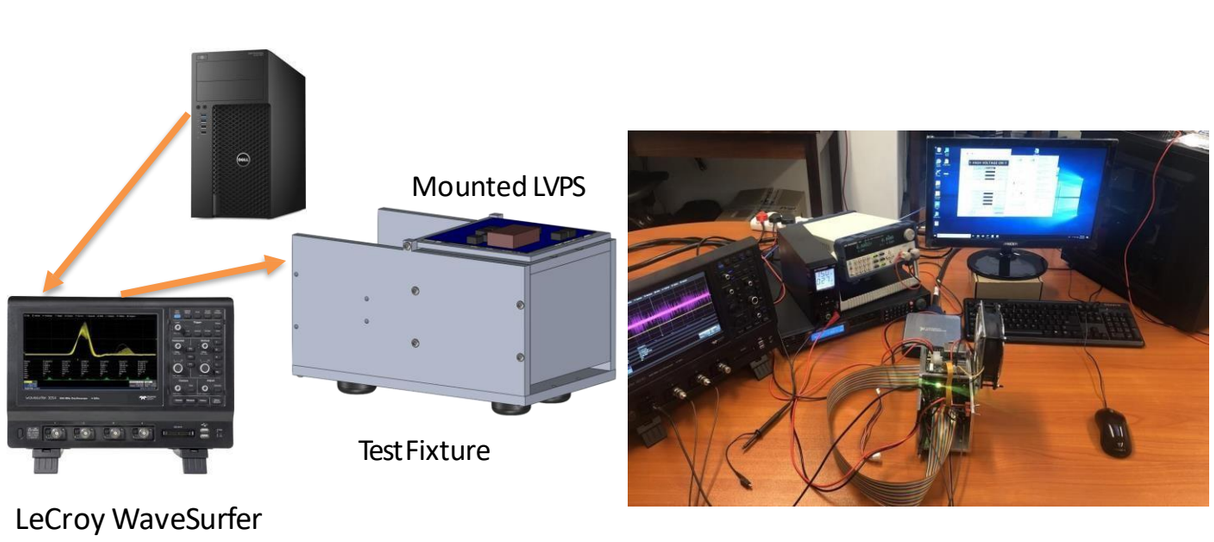
Validates quality (linearity, slope, offset) of LT1681 feedback signals through entire signal range of operation.



A new entry is automatically submitted to 'ELOG' to record test results

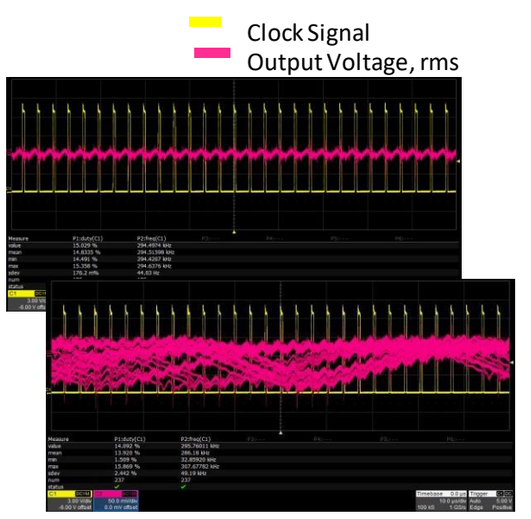
Initial test station – "Quality Assurance process"

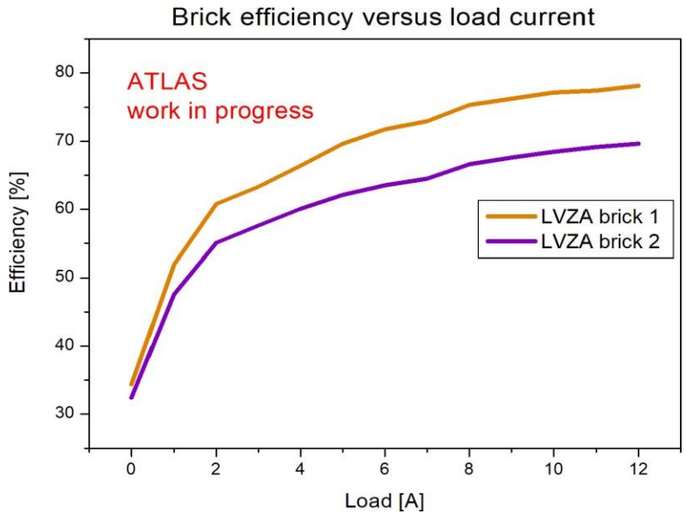
- We have helped re-design and **fully test** the LVPS **prototypes,** tailored for the ATLAS TileCal detector front end system, while comparing its output to a High-Level simulation
- The **initial test station** will quantify a multitude of **performance** metrics of a LVPS brick.
- Eleven separate tests in total completes the tests, each **communicating** with several **lab instrumentation** devices.



Summary and Outlook

- The maximum output power from the brick is 150W. The new design enables high efficiency of energy conversion: 76% for LVZA brick 1 79% for brick 2.
- The reliability and stability of the system has been visibly improved with respect to the previous design with the initial test station and ongoing Burn-In Station development.
- Looking forward to performing extensive Vertical Slice tests (VST)





This R& D was performed within Tile Cal – Low Voltage Power Supply project and a collaboration between both University of Texas Arlington and University of the Witswaterand.

1 Clement C. et al., General Requirements for the Tile Calorimeter Front -End Electronics in the HL-LHC\,Environment, ATL-COM-TILECAL-2019-004 VERTEX 2019
2 Anderson K. et al. Design of the front-end analog electronics for the ATLAS tile calorimeter, Nucl. Instrum.\,Meth. A 551 (2005) 469
3 Moayedi S, Hadavand H.K, ATLAS TileCal, LVPS Upgrade Hardware and Testing, http://cds.cern.ch/record/2624126}{cds.cern.ch/record/2624126
4 Einsweiler K, ATLAS Tile Calorimeter Phase-II TDR, https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/UPGRADE/CERN-LHCC-2017-019