Test of the First Prototype of ATLAS Liquid Argon Calibration Boards for the HL-LHC

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ATLAS LAr CALORIMETERS
• Measures energy of electrons, photons and hadrons
• Sampling calorimeter with liquid argon (LAr) as the active medium
• Peak of pulse is proportional to the energy of the incident particle

ATLAS LAr CALIBRATION BOARD
Inject exponential current pulses (that mimics the detector triangular pulse) of known amplitude on the detector cell in order to probe the electronic response

• Chip/ASIC
  • DAC sets amplitude of pulse
  • HF switch generates pulse
  • RL (resistance-inductance) sets shape of pulse

HL-LHC MAIN SPECIFICATION
• Calibrate ~200,000 channels of the calorimeter
• ASIC integral non-linearity (INL) <0.1%
• Uniformity among channels <0.25%
• Radiation tolerant up to 1.4 Gy

HL-LHC BOARD PROTOTYPE
• 32 channel board, with 16 channels on top of the board and 16 on bottom
• 3 board prototypes with different inductances and/or layout of calibration chips

UNIFORMITY STUDIES: CROSSTALK
Crosstalk is an undesired signal in a channel other than the one that was pulsed. It was analysed by injecting a 300 mA pulse in one channel.

Results
1) Maximum crosstalk is 0.1% of injected pulse amplitude, thus it is negligible!
2) Crosstalk pulse was always observed on the same horizontal RL line

UNIFORMITY STUDIES
The uniformity of maximum pulse amplitude and time of maximum amplitude have been checked for different injected currents.

Results
None of the boards meet the requirement of uniformity across channels being within 0.25%. This arises from the non-uniformity of the chips.

OUTLOOK
• First HL-LHC calibration board prototypes were tested!
• New chip prototype in progress
  • Better INL
  • Possibility to tune output current value to a reference value for improved uniformity across channels
• Choice of converter will be led by further studies on radiation tolerance, voltage conversion efficiency and temperature losses
• New 128-channel board prototypes are underway, containing features like full optical communication and power schemes

CONVERTERS
• Reduce input 48V to desired 5V, 1.2V and 2.4V for various components of the board
• Two types of converters have been studied:
  • bPOL: produced by CERN
  • LTM4619: commercially produced

Results
bPOL yields larger non-linearity than LTM4619, due to delicate implementation of the bPOL device on calibration boards