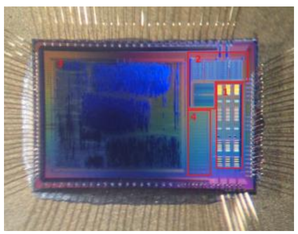
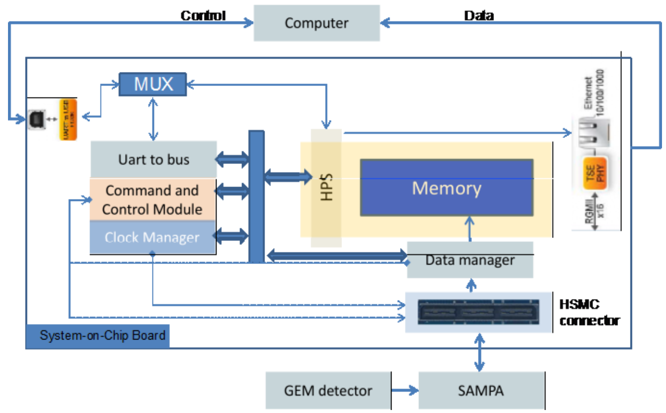
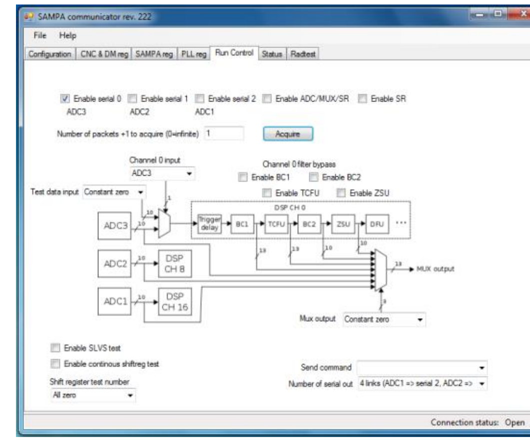
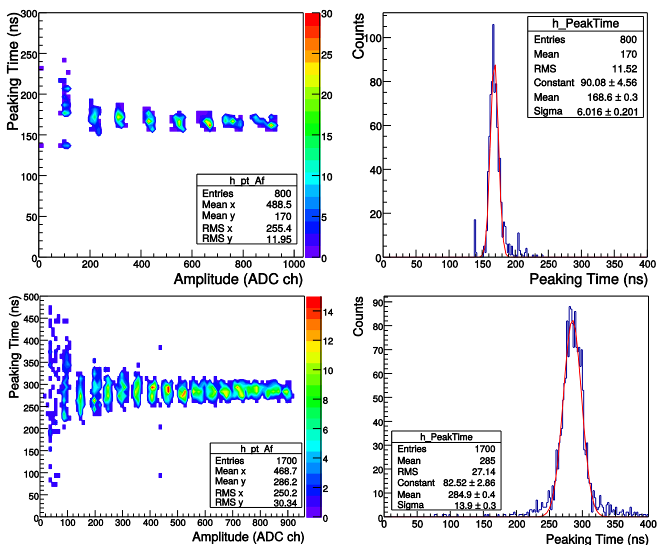
High Speed Continuous DAQ System for Readout of the ALICE SAMPA ASIC

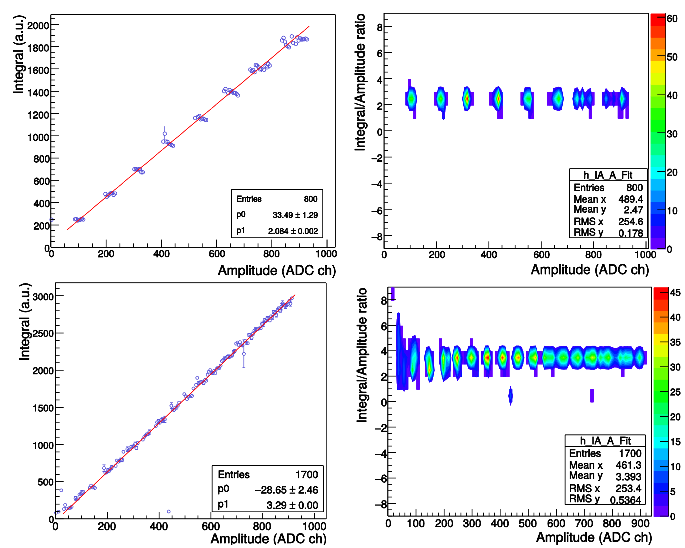
Arild Velure and Ganesh Tambave











Poster 61

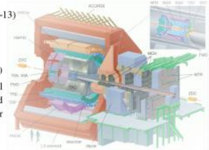
High-Speed Continuous DAQ System for Readout of the ALICE SAMPA ASIC

Ganesh Tambave and Arild Velure

Department of Physics and Technology,
University of Bergen, Bergen, Norway
For the ALICE collaboration

ALICE Experiment and Upgrade

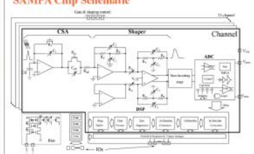
- ALICE experiment studies the outcome of heavy ions (Pb-Pb), p-Pb and pp collisions at LHC, to characterize the strongly interacting matter at extreme energy densities where Quark-Gluon Plasma (QGP) is produced
- ALICE has successfully completed Run1 (2010-13) and Run2 is now in progress (2015-2018)
- After Run2 some of the ALICE sub-detectors (TPC, ITS, MCH etc.) will be upgraded to improve performance before Run3 starts in 2020
- The ALICE Time Projection Chamber will upgrade to GEM readout chambers and continuous readout to accommodate the higher collision rates (50 kHz) during Run3
- In continuous readout:
  - GEM signals will be processed by five custom-made SAMPA ASICs (32 channels/each)
  - The SAMPA output will be multiplexed and transmitted using GigaBit Transceivers via optical links to a common readout unit
  - The common readout unit is an interface to the on-line farm, trigger and detector control system



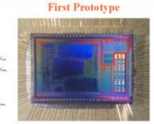
ALICE Detector

SAMPA Frond-End Chip

SAMPA Chip Schematic



First Prototype



1. Preamplifier and shaper
2. Analog-to-Digital Converter
3. Digital Signal Processor
4. Shift register for radiation tests

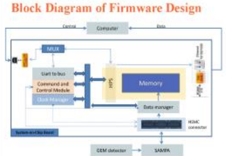
- The SAMPA contains: Charge-Sensitive preamplifier (CSA), Shaper, 10 bit/10 MHz digitizer (ADC) and Digital Signal Processing (DSP) block
- The acquired data from the SAMPA is transferred at 1.2 Gbps over four 320 Mbps serial links
- 32 channels continuous as well as external triggered readout is possible
- The first version of the SAMPA chip with 3 channels was produced in 2014
- The full scale 32 channel SAMPA chip will be delivered in June 2016

High-Speed Data Acquisition System

SAMPA Test Framework – DAQ System

- Firmware design for system-on-chip board
- SAMPA Communicator
  - Control program for the SAMPA and the DAQ
- SAMPA Analyzer
  - Data acquisition and online monitoring using ROOT framework

Block Diagram of Firmware Design



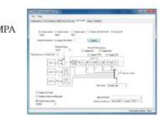
System-on-Chip Board

Firmware Design – Data Flow

- Data manager de-serializes data into packets and writes the packets to shared memory
- Microprocessor (HPS) takes data from the shared memory and transmits it over Ethernet to the SAMPA Analyzer on the computer
- SAMPA Communicator interfaces with the SAMPA via Command and Control module

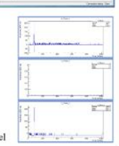
SAMPA Communicator

- Software environment to control and configuration of the DAQ and the SAMPA
- User friendly interface for run control
- Simplifies register access
  - Clock configuration on the fly
  - Data flow handling
  - Online status information



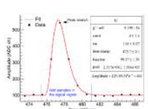
SAMPA Analyzer

- Setup Ethernet connection with the DAQ board
- Monitor data:
  Decode header, read data part of packet and plot using ROOT
- Write data to file:
  Store data samples in ROOT file for off-line analysis using ROOT macro
- Monitor and analyze multiple channels in parallel



Test Setup and Analysis

- Performance tests of the complete SAMPA system were carried out with charge generated from:
  - Signal generator
  - 3-GEM detector chamber
- Feature-extraction (amplitude, time) of the SAMPA output signals was done by applying following methods:
  - Peak search
  - Integrating samples in the signal region
  - Fitting using following function:

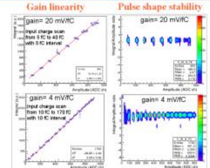


$$f(x) = A\left(\frac{x-t}{\tau}\right)^{N} e^{-N\left(\frac{x-t}{\tau}\right)} + Bl$$

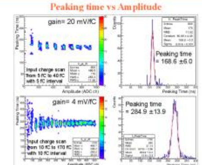
Where, A is peak, $N=4$ is the shaping order of the amplifier, the waveform amplitude is obtained from $(A*e^{-N})$, Bl is the baseline, τ is the peaking time, and t is time stamp of the waveform.

Results

Gain linearity | Pulse shape stability

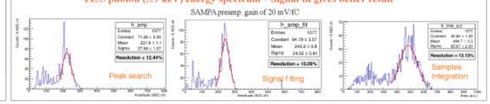


Peaking time vs Amplitude



Fe55 photon (5.9 keV) energy spectrum – Signal fit gives better result

SAMPA preamp. gain of 20 mV/fC



email: Ganesh.Tambave@uib.no and Arild.Velure@uib.no