The Relevance of ATLAS experience and its relevance to the data acquisition of the BM@N experiment at NICA complex

Kehinde Tomiwa
kehinde.gbenga.tomiwa@cern.ch

On behalf of the HEP group
University of the Witwatersrand
Johannesburg

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Outline

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- ATLAS TileCal Detector
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- Connections between TileCal/BM@N/MPD detectors
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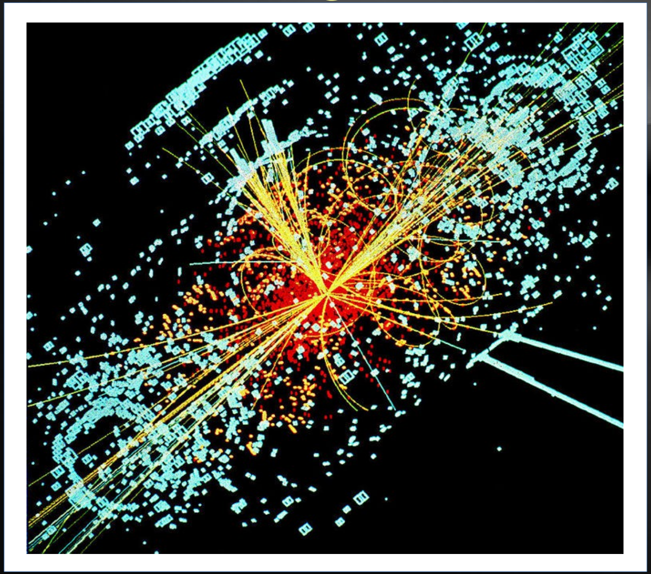
- BM@N DAQ Trigger overview
- BM@NData Flow
- Summary/Outlook

Introduction

Understanding the Universe

High energy Experiments

Collision/fixed target experiments



Experiments at LHC, proposed MPD/BM@N, etc comes with challenges:

- Big data.
- Data processing rate (High frequency of acquisition).

Way out: Development of High-throughput Electronics.

- For data processing
- Data reduction at maximum readout efficiency with no dead time

WITS HEP at ATLAS

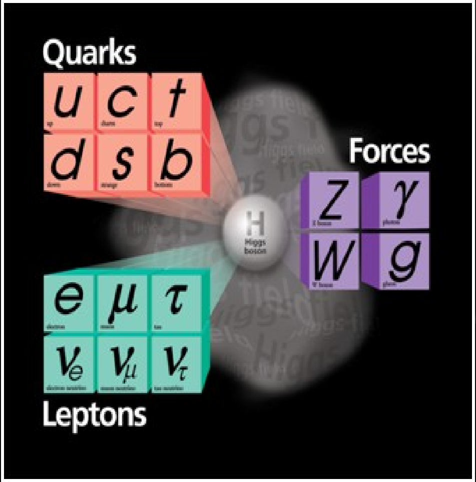
Wits HEP group has sustained effort at ATLAS in the following ways:

Higgs Physics in Di-Photon Channel:

- Understanding the production of jets in association with the new boson.
- Search Higgs boson in the di-photon decay channel in associated with intermediate missing transverse energy.
- A Di-Higgs search in the $yyb\bar{b}$ decay channel using ATLAS detector
- Search for additional bosons.

Electronics

- Single Event Upset (SEU) and Reliability
- Mobile Drawer integration checking (MobiDick) system for Tilecal Detector
- Super Readout Drivers (sROD) for TileCal Detector



The Grid

- Wits operates ATLAS Tier-3 site which comprise of over 100's CPU nodes.

WITS HEP at ATLAS cont.

Computing

Massive affordable computing (MAC project)
- Development of modular ARM board,
- Cheap alternatives for high throughput super computing at high power efficiencies

CERN data center

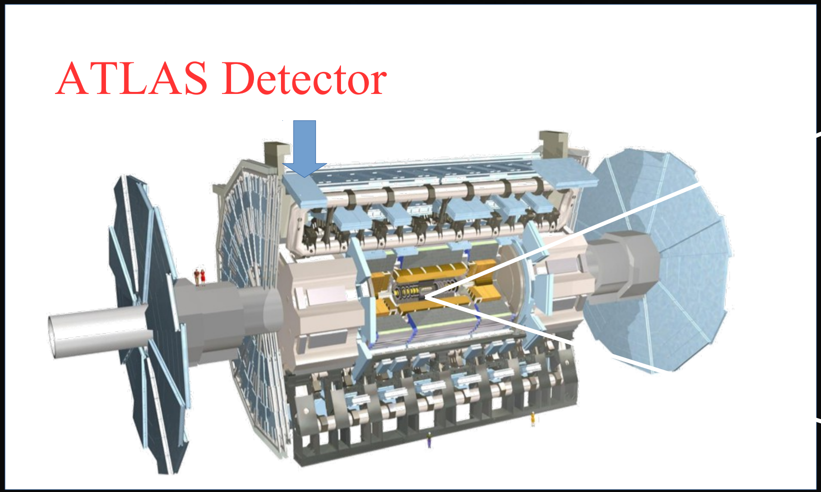
Material

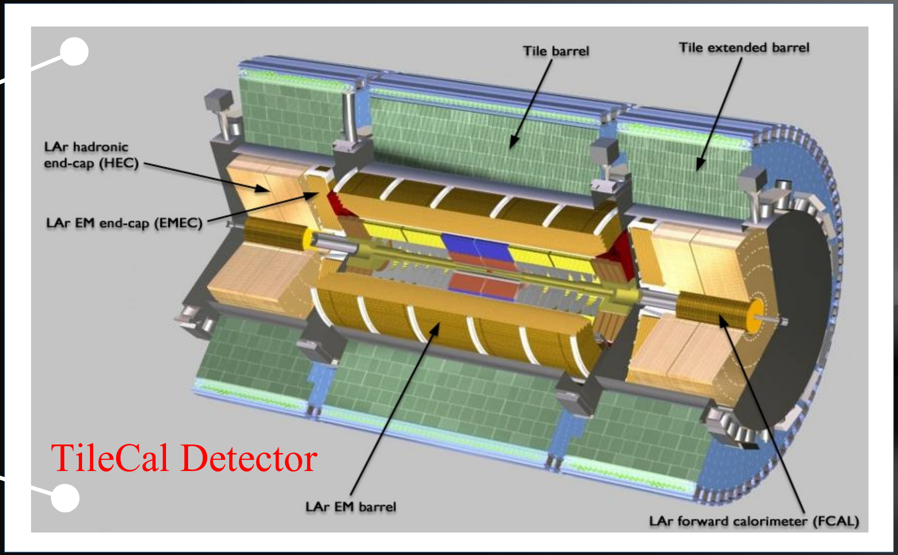
Effects of ionizing radiation on plastic scintillators

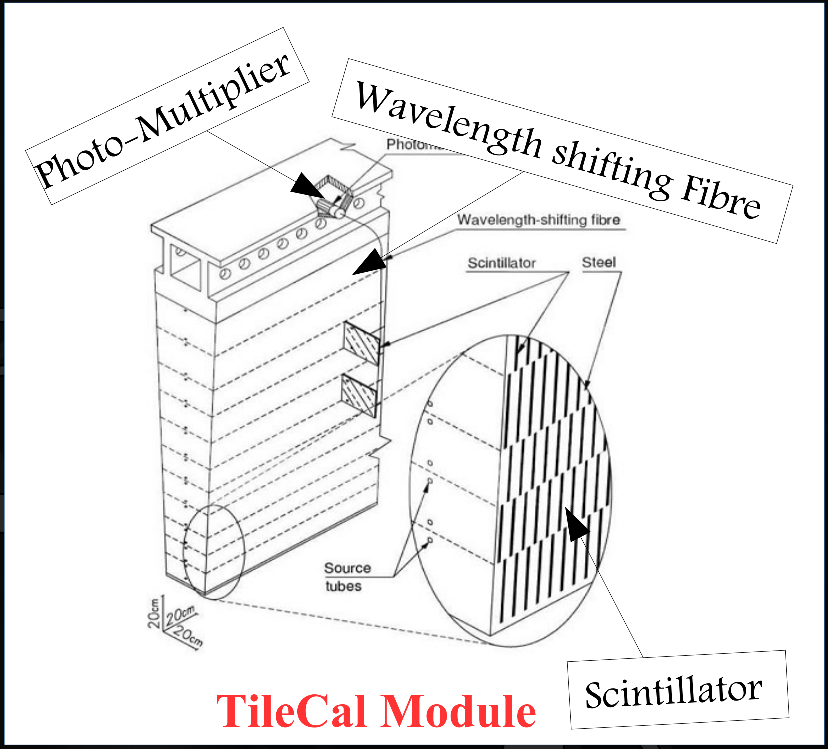
Scintillators study at iThemba Laboratory

Wits HEP group's Publications

ATLAS TileCal Detector



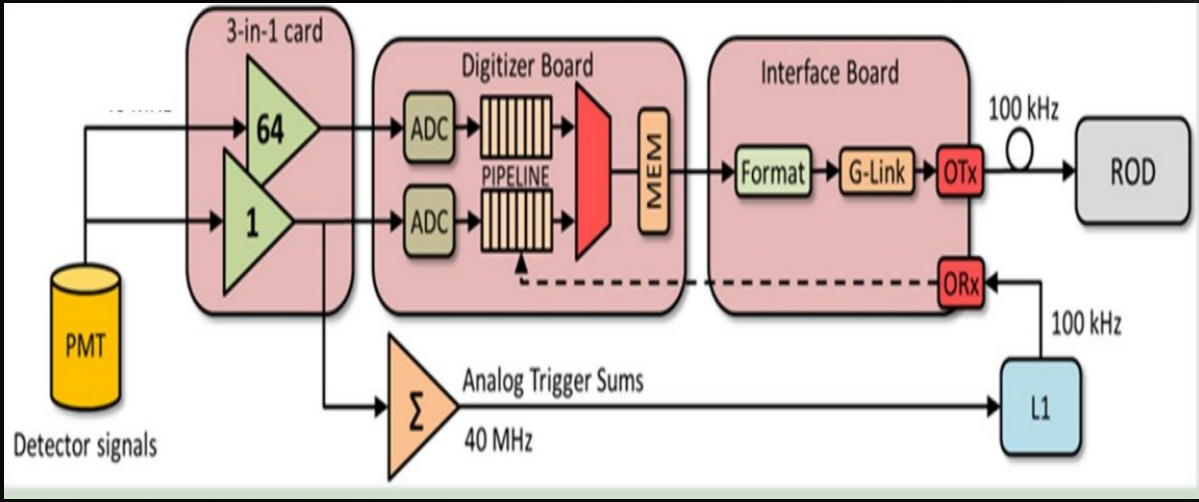




- Measure energy of Hadron and Jet.
- Uses steel absorber and plastic scintillating tiles as active materials
- Wavelength shifting fibres collect light to Photo-multiplier (PMTs).
- More than 10 000 channels.

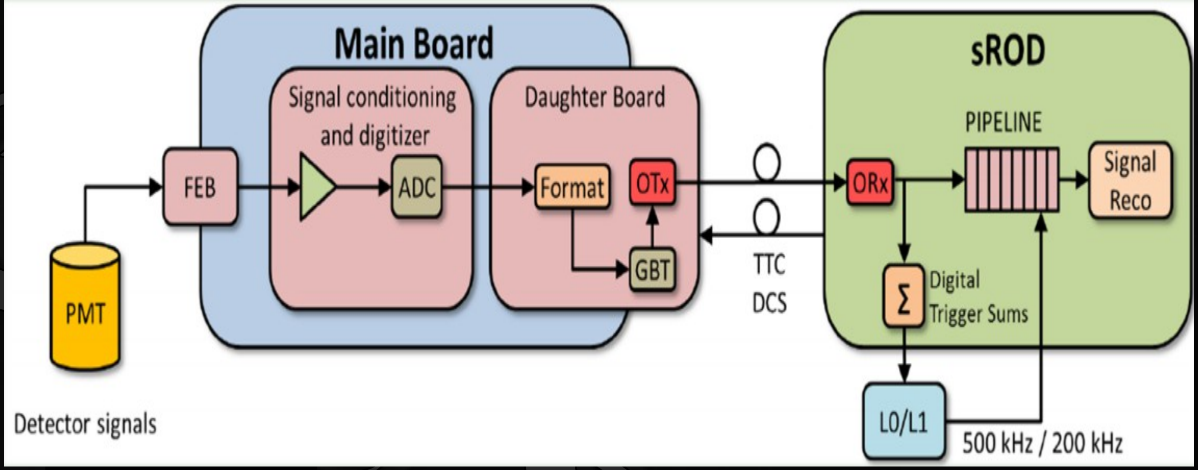
TileCal DAQ Architecture

Current Architecture



- **3-in-1**: shaping, amplification and integration
- **Motherboard**: Programming, powering of FEE
- **Digitizer card**: digitization and pipeline
- **Interface board**: 100KHz to ROD

Phase II Upgrade Architecture



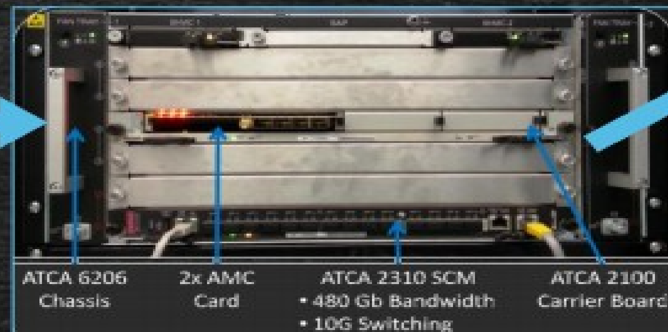
- **Main-board**:Shaping and digitization
- **Daughter board**: FPGA based board for formatting and data output to sROD at 40MHz
- **SROD**: Pipeline, monitors system functions and detector control

Toward Upgrade of ATLAS detector

Development ATCA system

Infrastructure Upgrade

sROD



ATCA Chassis

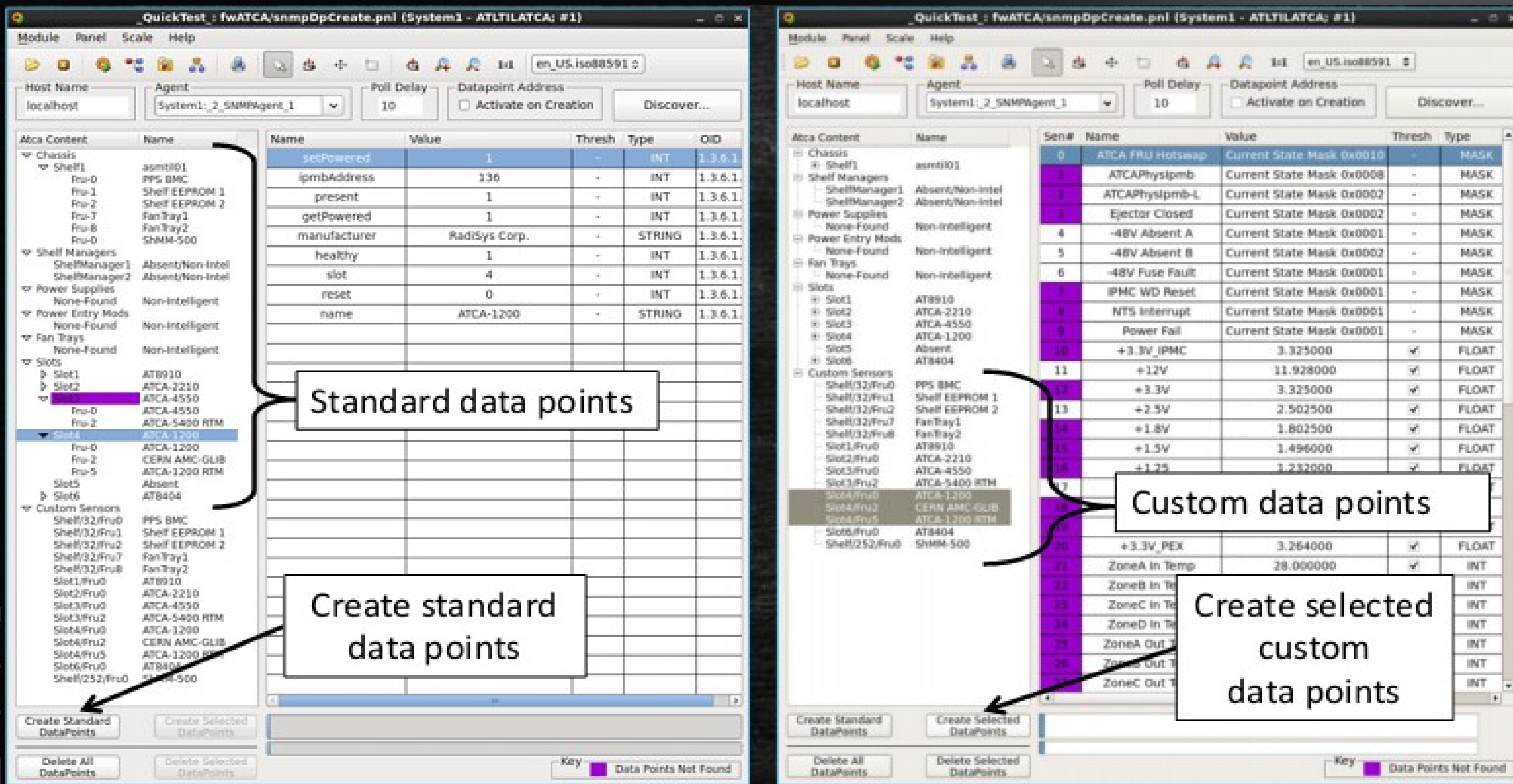
- ATCA replacement for VME Crates
- ATCA will house sROD and interface into the Detector Control System
- No software tools for this integration effort

	Present	Phase II
Total BW	~165 Gbps	~40 Tbps (+40 Tbps)
N. fibers	256	4096 (+4096)
BW/drawer	640 Mbps	160 Gbps (+160 Gbps)

TileCal Bandwidth upgrade

Toward Upgrade of ATLAS detector cont.

Development ATCA system



Advantages of ATCA system

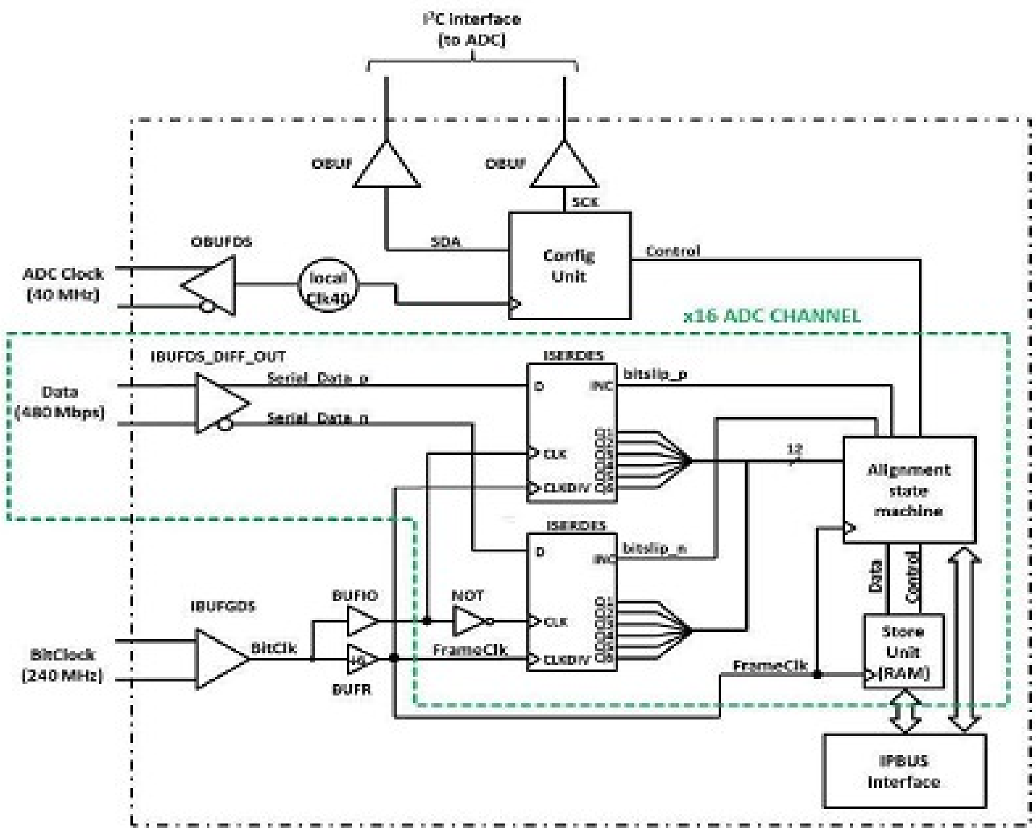
- High Speed back-plane 10G 40G
- Monitoring and control
- Hot Swapping
- Redundancy

Toward Upgrade of ATLAS detector **cont.**

Development of ADC trigger board for PROMETOE of ATLAS TileCal

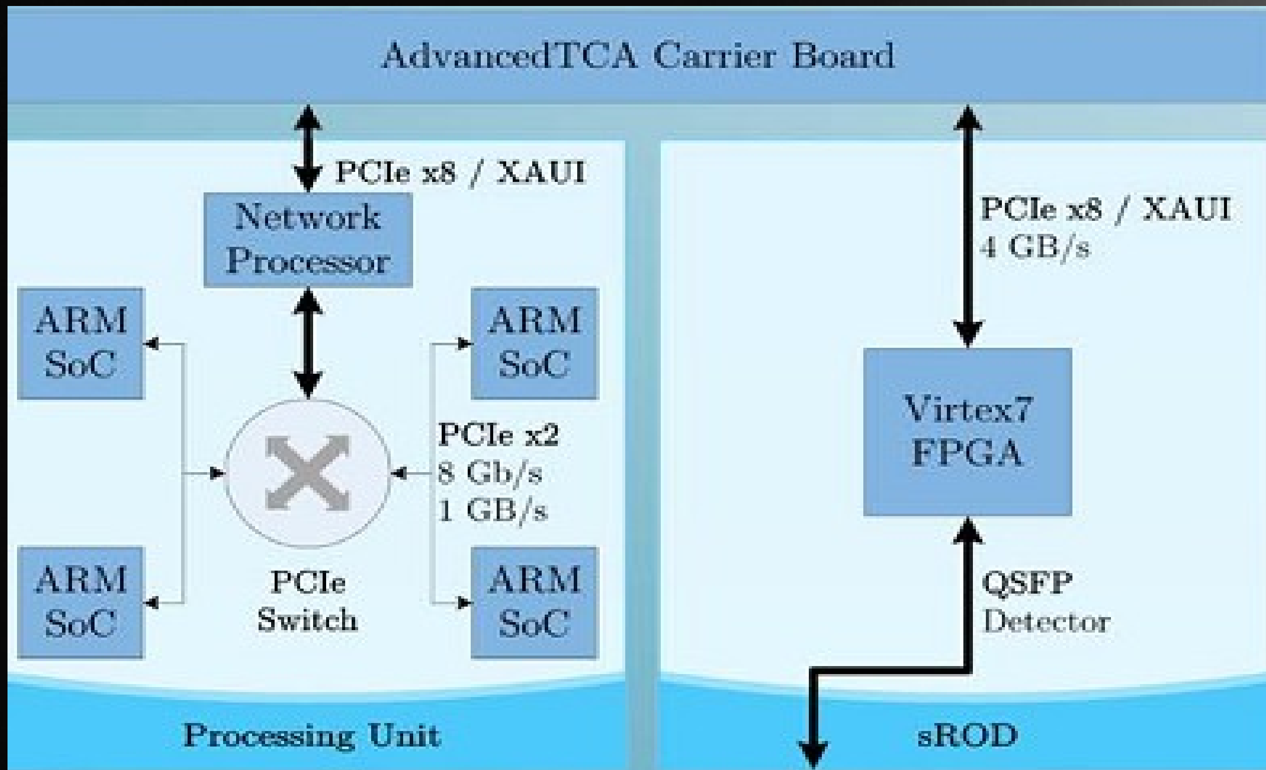
Architecture

- Modules that are needed:
  - 16 x ADC readout cell
  - configuration unit
    - I2C interface
  - Send 40 MHz Clock (From ADC)
    - ADC and FPGA firmware running in the same clock domain
  - FIFO memories or IPBUS memories
  - State machines
    - Word and Bit Alignment
    - Control and Data Flow



Toward Upgrade of ATLAS detector **cont.**

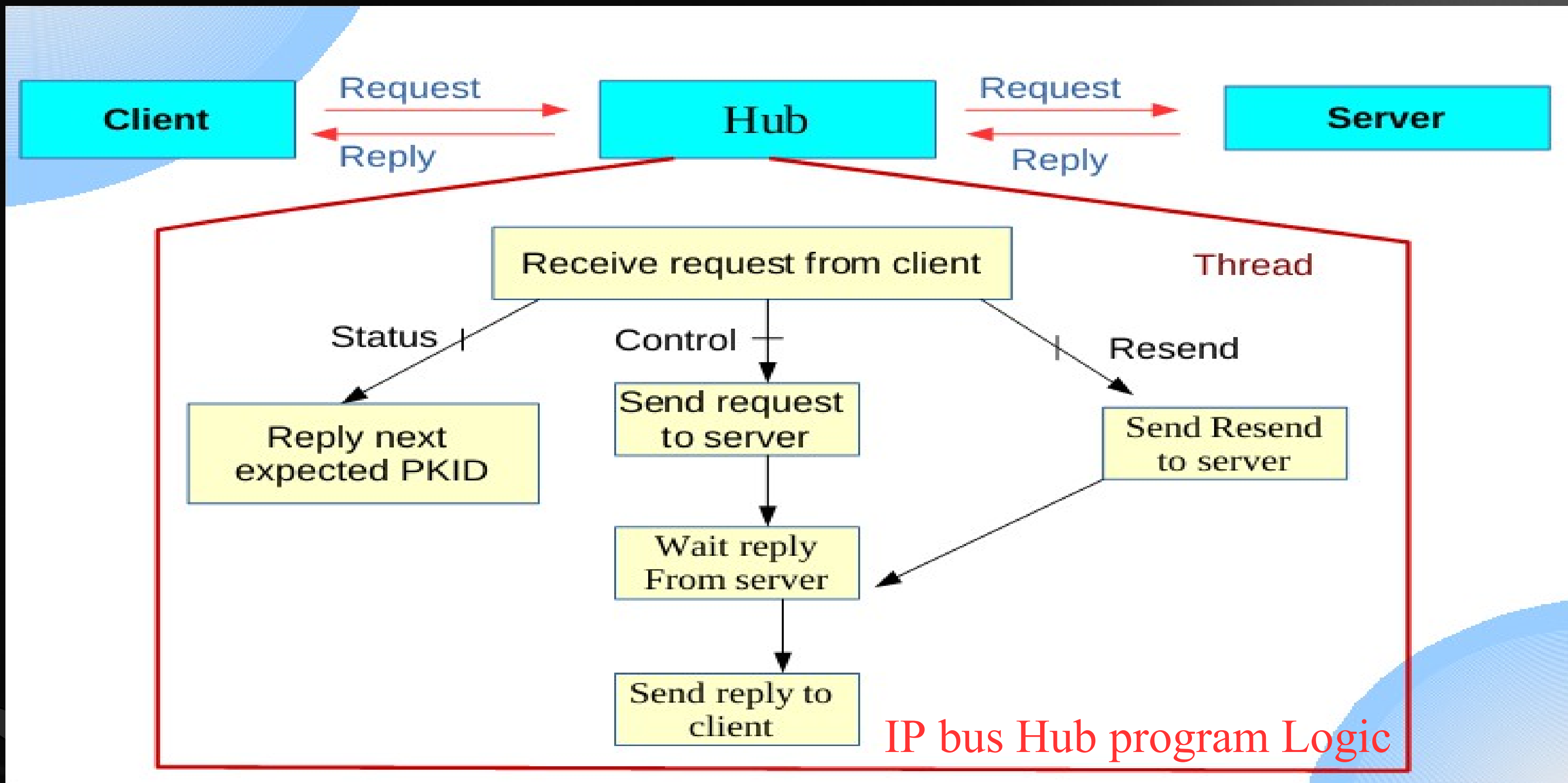
General purpose processing unit for the upgrade of TileCale



- PU is an ARM based cluster farm, proposed as co-processor to sROD
- Architecture enables efficient online data processing by ensuring high throughput
- Low latency by ensuring fast access to streaming data.

Toward Upgrade of ATLAS detector **cont.**

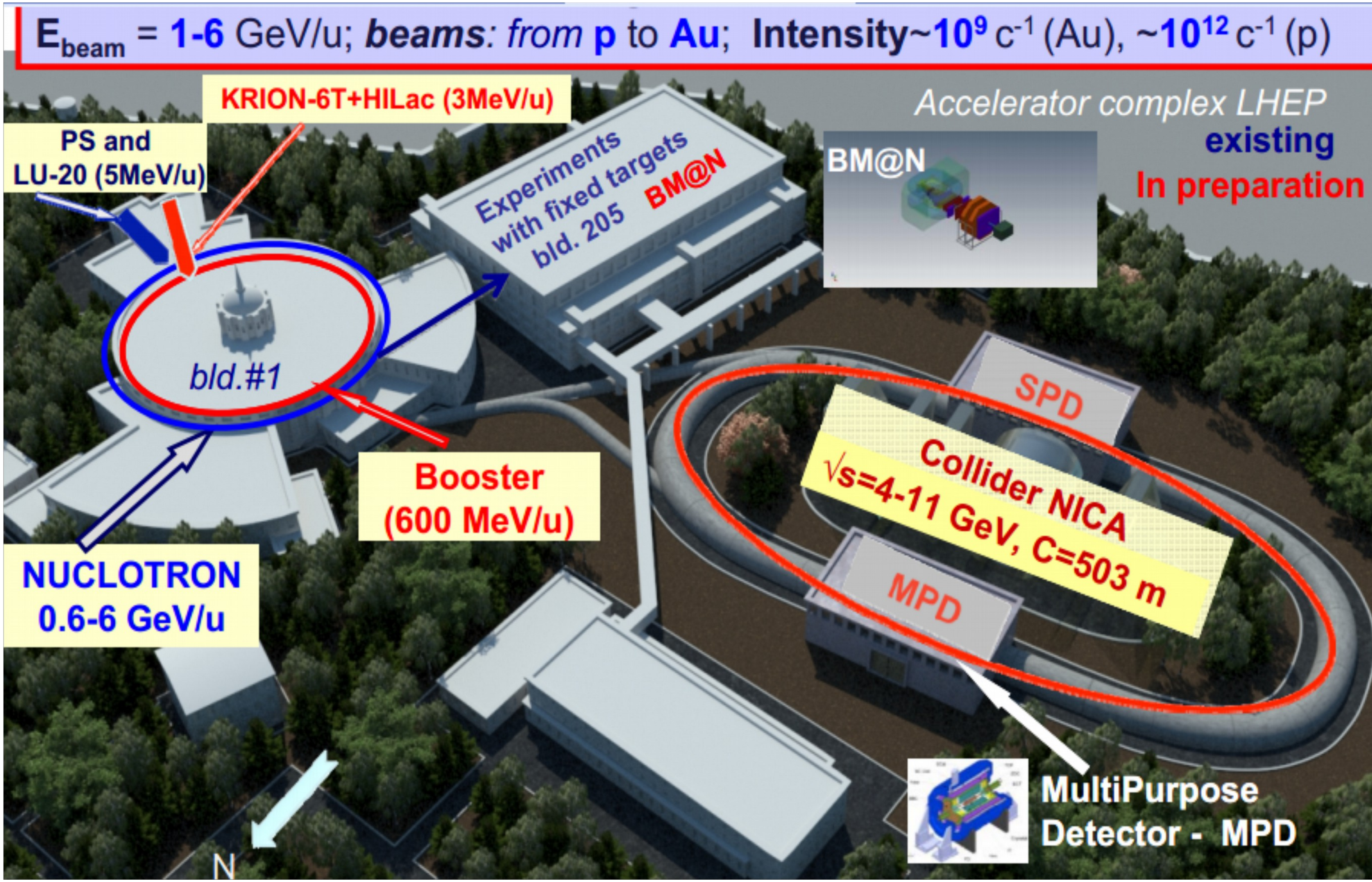
An IP bus protocol for ATLAS TileCal



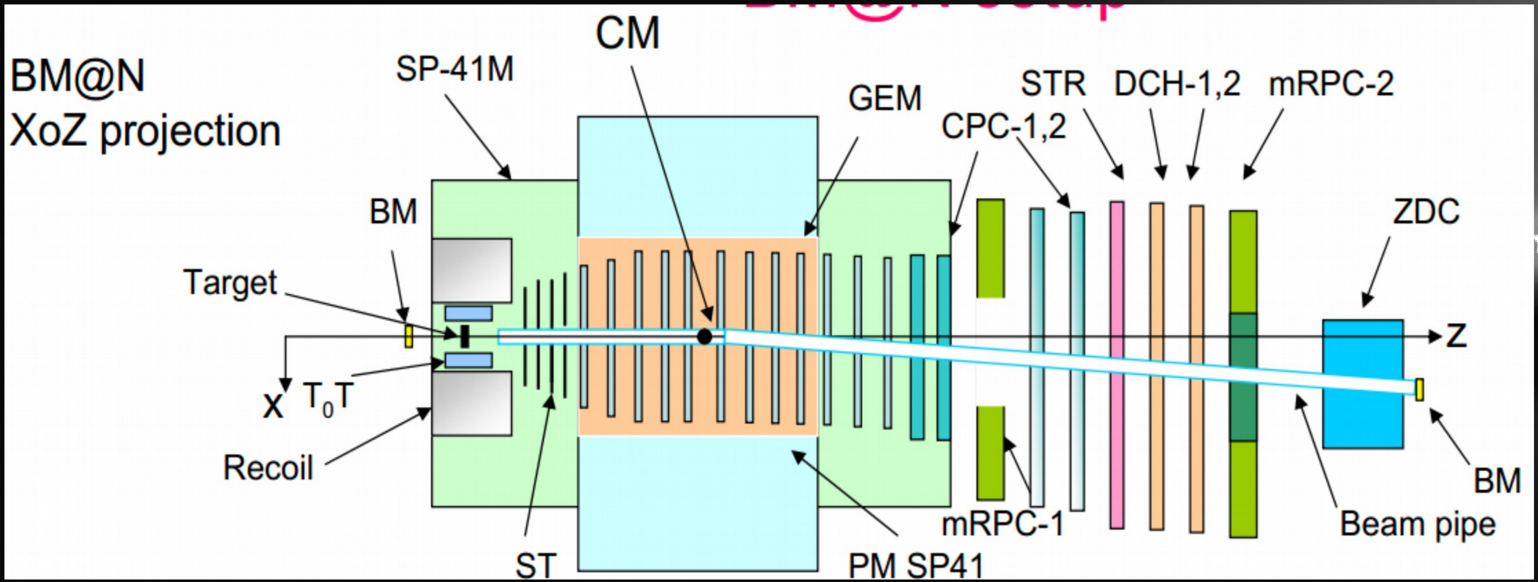
- IP bus Hub is implemented in C++
- It is a software instance of packet manager

- Acts a mediator between single hardware device and multiple clients
- It allows simultaneous access to one device from one or more client applications

NICA Project



BM@N detector



BM@N Schema

- **GEM** → Gaseous Electron Multipliers
- **TOF** → Time of Flight Detector
- **TOT** → Fast Start Detector
- **DCH** → Drift Chamber
- **ZDC** → Zero Degree Calorimeter
- **CPC** → Cathode pad chamber
- **ECal** → Electromagnetic Calorimeter
- **ST** → Straw tubes

Photo: BM@N project

Connections between TileCal/BM@N/MPD detectors

Systems were built to detect particles

- Particle react with medium in the detector
- Transfer energy in some recognized ways (e.g Energy loss in material is a signature)

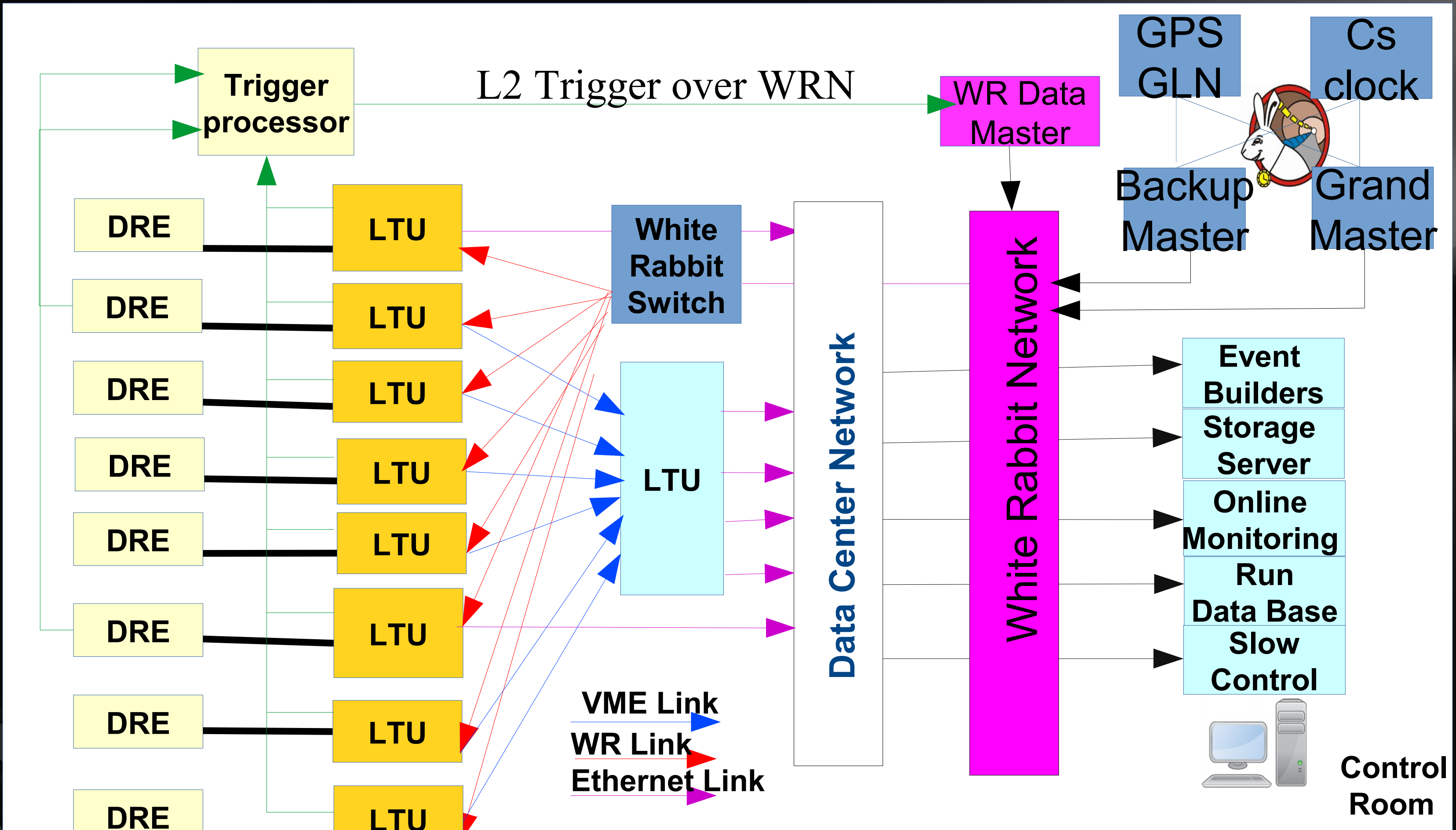
Systems were designed to measure particle interaction at high speed..

- Systems require Detector readout electronics to shape, amplify and digitize signal produced by detectors medium.
- Due to collision rate and volume output data, they rely on High throughput electronics for maximum readout efficiency.

High throughput electronics

- Maximum readout efficiency
- No dead time with data selection and compression.
- Reduces Large volume of data to scientific data with the help of fast and low latency triggers.

BM@N DAQ System

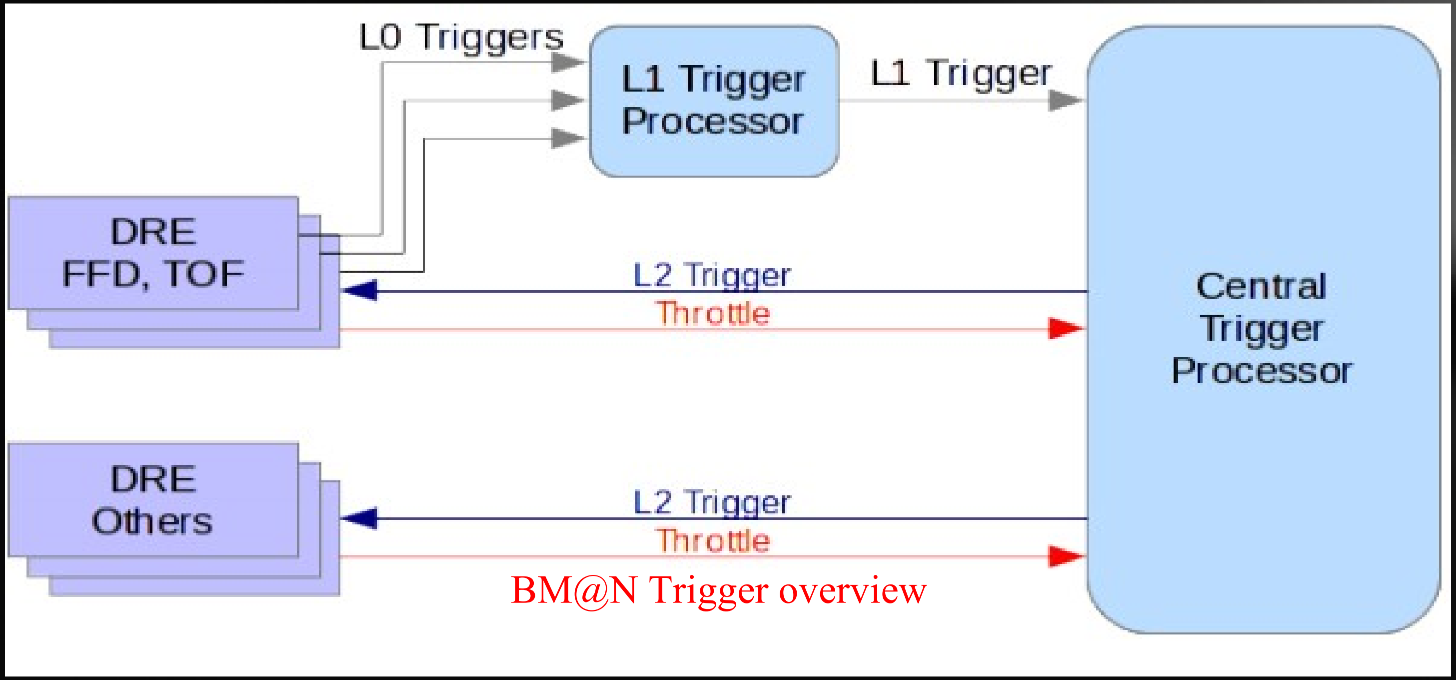


BM@N DAQ System

Detector Readout Electronics(DRE): Time-stamping Time to digital converter(TDC), Amplitude to digital converter (ADC) and TQDC discrete signal counter.

Local Trigger Unit(LTU): Trigger signal distributor.

DAQ trigger overview



BM@N Trigger overview

L1TP and **CTP** are Hardware based trigger

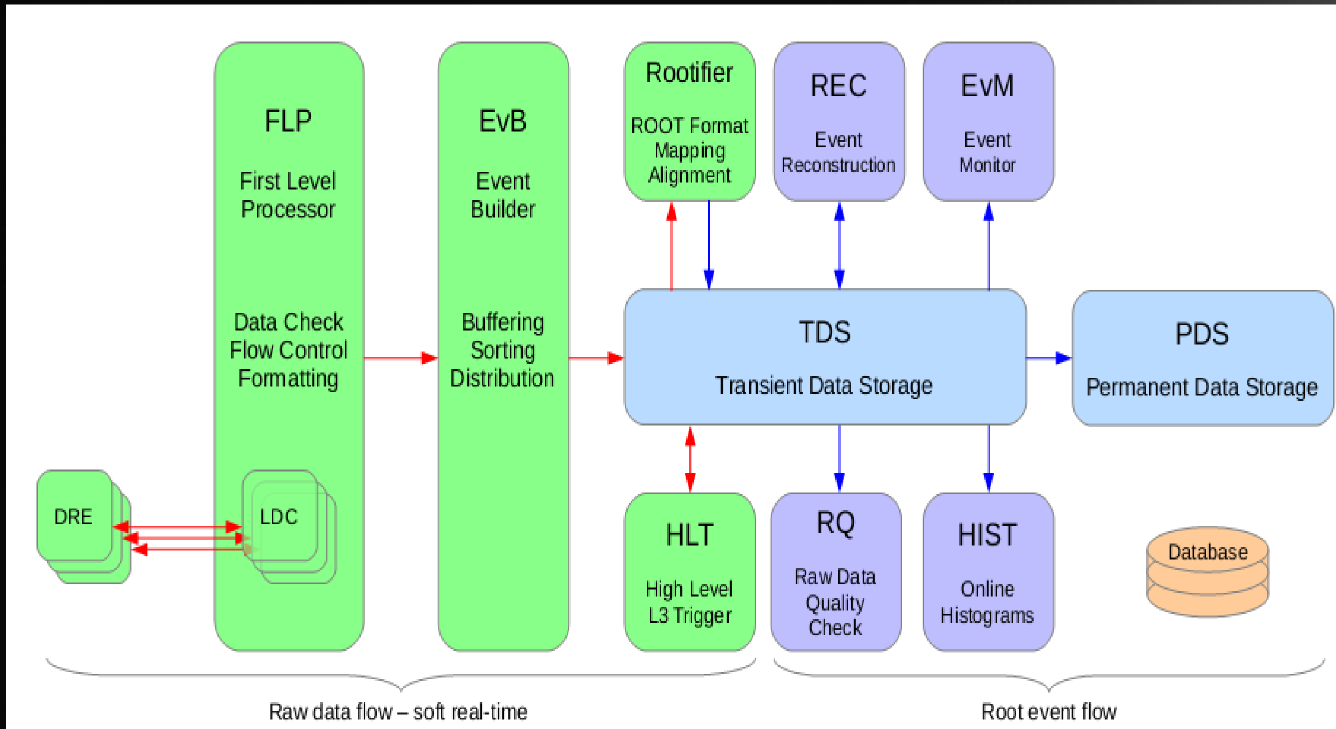
L1TP: Processes logical level 0 trigger signals to produce L1 trigger

CTP: Uses the Level 1 trigger to issue L2 trigger to the DAQ system.

Performs time-stamping of incoming L1 trigger signal.

Time reference by GPS/GLONASS receivers and Cesium clock

Data Flow



BM@N Data flow

First Level Processor: Runs basis data check and reduction algorithm.

Zero Suppression waveform compression.

Wits Proposed A general purpose processing unit used with ATLAS sROD for FLP and EvB. (work in progress)

Summary/Outlook

Experiments to understand the universe produce big data with high event rate

High data throughput electronics are required:

To cope with event rate
To reduce data size to scientific data

Wits HEP group has sustained involvement in ATLAS Experiment

Detector
Software development
Physics analysis

Outlook

Development of general purpose ARM-based processing unit for BM@N DAQ system
Contribution to physics analysis

Thanks for listening :)