Deadtime Simulation for ATLAS Level 1 Central Trigger

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ROADMAP

- Introduction & Background
- Project Scope & Specifications
- Project Demo
- Future Steps
ATLAS’ Big Data Problem

- LHC: Proton bunches
  - 3564 bunches per orbit, 25ns time separation → 40 MHz bunch crossing rate
  - Cannot record all this data (time, $$$) →
    - Triggers (select “interesting” events)
    - Deadtime (ignore events)

L1CT must be **simple** + **fast**; eliminate background while keeping good events
Deadtime

- Detectors take event data, write to temporary storage ("buffers")
- Trigger system processes event – if fits requirements, issues “Level 1 Accept” (L1A) signal
- Reading information from detector buffers to HLT storage takes time
- Lowering data rate, trying to maintain high efficiency for physics events
**Deadtime Logic**

**Simple:** After L1A, ignore N events  
*Prevents overlap in events being read out*

**Complex:** Sliding Window, Leaky Bucket Algorithms  
*Prevents buffer overflow*

Allow A triggers in a window of length B

Model detector buffer as a bucket with size C and leak rate D, don’t allow triggers when full
PROJECT SCOPE & SPECIFICATIONS
Deadtime Simulation

- Existing Deadtime Simulation Program
  - Take real LHC bunch group filling patterns, randomly assign triggers at different frequencies
  - Calculates simple, complex, total, and "physics" deadtime
    - Deadtime per bucket/logic mechanism
    - How many triggers/important events missed?
Areas for Improvement

- Only accessible via terminal: secure copy program files, run
- All configuration must be directly edited in code
- Bunch group input mode: ATLAS TriggerTool Bunch Group Keys only
- No flexibility for simulating triggers for bcids outside of bunch group 1

TriggerTool visualization of bcids and corresponding bunch groups (information accessible via BGK)
My Project

- **Phase 1: Enable online monitoring, adjustable parameters**
  - Full original functionality, but online and with user-friendly display

- **Phase 2: Additional simulation capabilities**
  - Bunch Group 15 triggering – trigger events that affect deadtime but aren’t interesting for physics
  - Add input sources
    - LHC fill schemes (user file upload)
    - Get current bunch group key being used in ATLAS (via WebIS)
  - Random seed number for repeatability
Links

Project Site

Demo Video
FUTURE STEPS
Next Steps

● Short term (me)
  ○ Patch security holes
  ○ Validate form entries
  ○ Improve documentation

● Long term (someone else?)
  ○ Multithreading for faster simulation speed
  ○ Merge production branch into official ATLAS Web Monitoring Site
  ○ Connect WebIS to active ATLAS information (vs. current pc-adt-04 setup)
  ○ Incorporate tool into ATLAS control room display?
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A Wonderful Summer in Review

Thank You
Sources


Stockton, Mark. “The ATLAS Level-1 Central Trigger.”