ALICE MOVES INTO WARP DRIVE

Vasco Barroso
on behalf of the ALICE Collaboration
Content

- Introduction
- ALICE operations
- Data taking efficiency
- In-run recovery procedures
- EOR Reasons bookkeeping
- Reporting
- Future plans
- Conclusion
Introduction
The ALICE experiment

- A Large Ion Collider Experiment
  - Focused on heavy-ion collisions to study QGP
  - Central barrel + forward muon spectrometer
  - 17 installed sub-detectors
  - 5 online systems (DAQ, DCS, TRG, HLT, ECS)
ALICE data flow

**Detectors**
- 485 x 2 Gbps optical links
- Event fragments

**TRG**
- Trigger system
- 3 levels

**HLT**
- High Level Trigger
- Data selection, compression

**LDCs**
- Local Data Concentrators
- Readout
- Sub-events

**GDCs**
- Global Data Collectors
- Event Building
- Events

**TDS**
- Transient Data Storage
- 650 TB
- Files

**PDS**
- CERN CC
- 4 x 10 Gbps links

**Files**
- 650 TB

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ALICE operations
A typical LHC year

<table>
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<tr>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>July</th>
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- **Shutdown for maintenance**
- **proton-proton collisions**
- **Heavy-ion collisions**

**ALICE recorded data (TB)**

- 2010: 1000 TB
- 2011: 2000 TB

**LHC integrated luminosity delivered in ALICE**

- 2010: 50 µb⁻¹
- 2011: 200 µb⁻¹
ALICE operations

A typical LHC fill in ALICE (0 - 30h)

- Beam Injection
- Stable beams
- Beam dump

- ALICE safe
- Prepare trigger configuration
- Detector calibration
- Partial ALICE READY
- Full ALICE READY
- Data taking
- Detector calibration

Ideally a single run
A typical ALICE run

- **Start-of-Run**
  - Config detectors and electronics
  - Start online systems
  - Store data taking conditions

- **Data taking**
  - Readout
  - Event building
  - Online data monitoring
  - Online calibration data

- **End-of-Run**
  - Export data taking conditions and calibration data to Offline
  - Stop online systems


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Reality is hard...

- 17 sub-detectors + 5 online systems
  - 1 failure stops the run
- Analysis of the ALICE Electronic Logbook metadata concluded:
  - Better downtime/efficiency diagnosis tools needed
  - Number of runs per fill is high
    - ~ 11 runs per fill during 2011 p-p
  - Starting/stopping runs is a costly operation
    - SOR ~ 3 min
    - EOR ~ 80 sec
Data taking efficiency

Calculated per fill:

\[ E_{\text{fill}} = \frac{\sum (R_d - R_p)}{F_{sb} - F_{usb}} \times 100 \]

- \(R_d\) run data taking duration
- \(R_p\) run pause duration (trigger disabled)
- \(F_{sb}\) fill stable beams duration
- \(F_{usb}\) fill unusable stable beams duration

Stored in ALICE Electronic Logbook
LHC publishes operational parameters via the Data Interchange Protocol (DIP)

Dedicated ALICE software retrieves needed values and stores them in Logbook
In-run recovery procedures
In-run recovery procedures

- To avoid stopping a run and lose beam time, thus increasing efficiency
- Recover from sub-detector issues
- 2 in-run procedures introduced:
  - via Detector Control System (DCS)
  - via DAQ using Detector Data Link (DDL)
In-run recovery via DCS

- A new state was introduced in the DCS logic:
  - ERROR_RECOVER
- Example: TPC high voltage trips
In-run recovery via DDL

- DDL is bi-directional, can be used to configure FEE
- New procedure: Pause And Configure (PAC)
- Example: Single Event Upset in detector FEE
- Currently triggered manually by shifter

Shifter executes PAC ➔ ECS stops the trigger ➔ DAQ releases DDL ➔ DAQ executes config commands using DDL ➔ DAQ re-enables DDL for data taking ➔ ECS starts the trigger
EOR Reasons bookkeeping
Typical EOR Reasons

- Runs can stop for a multitude of reasons:
  - Decision by shift crew (manual operation)
    - Change trigger configuration
    - Add/remove detector
  - Problem with online systems
    - Process no longer running
    - Configuration error
  - Problem with detectors
    - High voltage trip
    - Front End Electronics (FEE)
    - Corrupted data
EOR Reasons bookkeeping

- Up to mid-2011:
  - Text based entry in Logbook
  - Statistics done manually (time consuming, error prone)
  - For abnormal stops, log search was needed

- For the 2011 HI run:
  - Structured data in Logbook
    - Automatic stops: inserted by Experiment Control System
    - Manual stops: prompt shifter
Whenever a shifter stops a run, he/she has to choose from a predefined list of EOR Reasons.

- Evolving list, changed when needed.
- Shifters training is important!
100% accuracy is very difficult:
- Symptoms vs causes
- Shifters mistakes

Logbook GUI page to change EOR Reason
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<th>Stable Beams End</th>
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<th>Date Taking Duration</th>
<th>Pause Duration</th>
<th>SOR/EOF Duration</th>
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</table>
Online reports in Logbook

☐ Fill Details

EOR Reasons Downtime (Fill 2328)

- Time to First Run
- EMC::detectorBusy (169498)
- MCH::detectorBusy (169504)
- TPC::pauseAndConfigError (169506)
- TOF::detectorNotReady (169512)
- LHC::beamDump (169515)

Data Taking
Downtime
Pause

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## EOR Reasons

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<thead>
<tr>
<th>EOR Type</th>
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<td>Automatic during Data Taking (125)</td>
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<td>Automatic at SOR (46)</td>
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<td>TRD (12)</td>
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</table>

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Online reports in Logbook

- **EOR Reasons**

The diagram shows the top EOR Reasons:
- **LHC: beamDump (25)**
- **Operations: other (22)**
- **OPERATIONS: changePartitionStructure (18)**
- **HLT: backPressure (17)**
- **MCH: detectorBusy (16)**
- **TOF: detectorNotReady (12)**
- **TPC: detectorNotReady (11)**
- **OPERATIONS: changeTriggerConfiguration (9)**
- **ZDC: detectorBusy (9)**
- **MCH: detectorScriptError (9)**

Other (51)

Other reasons include:
- HLT: pageLimitError (3)
- TRG: ctpReadoutError (3)
- OPERATIONS: incStatus (3)
- HLT: hitEngageError (3)
- SPD: detectorNotReady (3)
- DAQ: daDead (3)
- TRP: cdcError (4)
- PMD: detectorBusy (4)
- TRD: detectorCommandError (4)
- EMC: detectorBusy (4)
- FMD: detectorBusy (4)
- SSD: unexpectedData (5)
- PMD: noDataReceived (5)
- TRD: noDataReceived (5)
- DAQ: startDAQProcessestorror (6)
- DAQ: readoutError (7)
A PPT slide with a summary of an LHC Fill

Automatically generated every day and sent via email
Future plans

- Integrate EOR Reasons with JIRA issue tracking system
  - Logbook - JIRA interface being developed
- Extend in-run recovery procedure via DDL
  - Automatic detector request via bit in event header
  - New SYNC event to synchronize data sources
- Expert system for shifter support and automatic failure recovery
  - Reduce load on on-call crew
Conclusion

- 2 years of successful operational experience
- Big effort put in efficiency monitoring, EOR Reasons identification
- Introduction of in-run recovery procedures reduced downtime thus increasing efficiency
- Reports automation
  - Saved time
  - Increased visibility and “stimulated” issues resolution
Related presentations


- Poster: “Orthos, an alarm system for the ALICE DAQ operations”, Sylvain Chapeland, 24 May, 13:30 - 18:15

- Poster: “Preparing the ALICE DAQ upgrade”, Pierre Vande Vyvre, 24 May, 13:30 - 18:15
ALICE presentations

“ALICE HLT TPC Tracking of Heavy-Ion Events on GPUs”, David Rohr, now

- A review of data placement in WLCG
- Data compression in ALICE by on-line track reconstruction and space-point analysis
- The ALICE EMCal High Level Triggers
- Automated Inventory and Monitoring of the ALICE HLT Cluster Resources with the SysMES Framework
- Monitoring the data quality of the real-time event reconstruction in the ALICE High Level Trigger.
- Operational Experience with the ALICE High Level Trigger
- Flexible event reconstruction software chains with the ALICE High-Level Trigger
- Dynamic parallel ROOT facility clusters on the Alice Environment
- A new communication framework for the ALICE Grid
- AliEn JobBrokering Extreme

- Combining virtualization tools for a dynamic, distribution agnostic grid environment for ALICE grid jobs in Scandinavia
- ALICE Grid Computing at the GridKa Tier-1 center
- ALICE's detectors safety and efficiency optimization with automatic beam-driven operations
- Managing operational documentation in the ALICE Detector Control System
- An optimization of the ALICE XRootD storage cluster at the Tier-2 site in Czech Republic
- Certified Grid Job Submission in the ALICE Grid Services
- Rethinking particle transport in the many-core era
- Grid Computing at GSI(ALICE/FAIR) - present and future
- Employing peer-to-peer software distribution in ALICE Grid Services to enable opportunistic use of OSG resources
QUESTIONS ?
ALICE timeline

First ideas
HI@LHC
1990

Technical Proposal
1995

First TDR
1998

1993
ALICE LoI

1997
ALICE is approved

2000
Construction begins

Last TDR
2005

Commissioning begins
2007

LHC first HI run
2010

2006
Installation of services

2008
LHC first beam

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21/05/2012
ALICE operations

- 24/7 on-site shift crew
  - Currently 4 shifters:
    - Shift Leader
    - DAQ + HLT + CTP (Central Trigger Processor)
    - DQM (Data Quality Monitoring) + Offline
    - DCS
  - One of them is SLIMOS (Shift Leader in Matters of Safety)
- 24/7 on-call expert support for each subsystem
Online reports in Logbook

[Graphs and tables related to detector efficiency and EOR systems]

[Text: Fill Details]

Detector Efficiency

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<th>Detector</th>
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