Z \rightarrow \mu \mu \text{ Analysis with data}

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Glasgow Atlas Meeting 15.10.10
Introduction

• Aims of study:
  – Produce Z mass peak, measure mass and cross section.
  – Reproduce numbers from W/Z group CONF note.
  – Get some experience of working with data. Document components required for data based analysis
  – For now concentrate on Zee

• This talk:
  – Focus on methodology, how to run on data (or at how I'm trying to do it!) and problems encountered.
  – Some (very) preliminary results

• Links (more on Glasgow Twiki):
  – My Glasgow Twiki page https://ppes8.physics.gla.ac.uk/twiki/bin/view/ATLAS/ZllAnalysisOnData
  – WZ Observation twiki https://twiki.cern.ch/twiki/bin/view/AtlasProtected/WZObservation7TeV
  – Egamma CONF notes twiki https://twiki.cern.ch/twiki/bin/view/AtlasProtected/SummerCONF2010
0. Lumiblock passes Egamma Good Runs List

1. Trigger: L1_EM10

2. At least one vertex with at least 3 tracks

3. MET cleaning: Reject the event if at least one AntiKt4TopoJet with $p_T(\text{EMScale})>10$ GeV satisfies: $(n90<=5 \text{ AND } f\text{HEC}>0.8) \text{ OR } \text{fabs(jetTime)}>50 \text{ OR } (\text{fabs(JetQuality)}>0.8 \text{ AND } \text{emf}>0.95)$ [ Remove events with 'fake' jets from noisy cells or cosmics ]

4. PRESELECTION: Require 2 electrons with cluster $E_t > 20$ GeV, $\eta < 2.47$ and not $1.37 < \eta < 1.52$.

5. Reject events if any of candidate electrons in problematic region of Lar (OTX Clean) passing OTX OQ map check

5. Form candidate pairs of OS sign electrons

6. Select events with 2 medium electrons in mass window $66 < m_{ee} < 116$ GeV

..... but also study loose-loose and tight-tight pairs
• Wide variety to choose from: AODs, ESDs, various flavours of Ntuples, D3PDs.....
• Have chosen to run on D3PD (essentially flat ntuples).
• Advantages:
  – Easier and less complicated to write code
  – Faster execution
  – Don't have to deal with Athena bugs / oddities
• Disadvantages:
  – Don't have access to such a wide range of tools as in Athena.
  – Don't have access to so much information (Conditions DB, trigger info) – BUT if the right D3PD is chosen all required info for analysis should be there
• But which D3PD to choose?

• A variety of D3PDs defined by physics groups and produced automatically for data runs. All have similar structure and variable names, but choice of which variables included. Are re-processed periodically (May, June 2010)

• Candidates:
  – e.g. NTUP_WZ, NTUP_EGAMMA

• Very similar contents. NTUP_WZ only produced from period D3 onwards so use NTUP_EGAMMA
• So far I have been using Egamma GRL. Have just found WZ group GRL for Zee analysis:

• WZ GRL files available on sharepoint:
  - https://espace.cern.ch/atlas-sm-wz-observation/Observation/Shared%20Documents/Forms/AllItems.aspx

find run 165817-165818 and partition ATLAS and db DATA and lhc stablebeams T and lhc beamenergy 3400+ and ready 1 and mag s > 6000 and ptag data10_7TeV and dq ATLGL LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq L1CTP LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq ATLSOL LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq L1CAL LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq cp_eg_electron_endcap LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq cp_eg_electron_barrel LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq lumi LBSUMM#DetStatus-v03-pass1-analysis-2010G g

• Egamma GRL in svn:
  - https://svnweb.cern.ch/cern/wsvn/atlasgrp/CombPerf/EGamma/EGammaGRL/trunk/eg_standard/

find run 165591-166383 and partition ATLAS and db DATA and ready 1 and mag s > 6900 and ptag data10_7TeV and dq ATLGL LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq ATLSOL LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq L1CTP LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq L1CAL LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq cp_eg_electron_barrel LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq cp_eg_electron_endcap LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq lumi LBSUMM#DetStatus-v03-pass1-analysis-2010G g
Partition containing all sub-detectors

find run 165591-166383 and partition ATLAS and db DATA and ready 1 and mag s > 6900 and ptag data10_7TeV and dq ATLGL LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq ATLSOL LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq L1CTP LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq L1CAL LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq cp_eg_electron_barrel LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq cp_eg_electron_endcap LBSUMM#DetStatus-v03-pass1-analysis-2010G g and dq lumi LBSUMM#DetStatus-v03-pass1-analysis-2010G g

Exclude lumiblocks where can't calculate Lumnosity

Stable beams and Atlas ready

Solenoid on and at nominal field

Select 7TeV data

Global DQ flag: ie. Someone has evaluated the DQ

Solenoid currents constant

L1Calo and L1CTP OK

Combined Performance flags OK

https://twiki.cern.ch/twiki/bin/viewauth/Atlas/DQFlagInterpretation
Using GRL outside of Athena

- Can compile the Athena GoodRunsList package as a Standalone, then link with your C++ code.

- See [https://twiki.cern.ch/twiki/bin/viewauth/Atlas/GoodRunsListsTutorial#Running_in_Root_or_python](https://twiki.cern.ch/twiki/bin/viewauth/Atlas/GoodRunsListsTutorial#Running_in_Root_or_python)

- Some subtleties to getting it to work: I'll document what I did on the Twiki if anyones interested!

- Once compiled and linked, very easy to use:

  ```
  Root::TGoodRunsList egamma_grl;
  Root::TGoodRunsListReader egamma_grl_reader = new Root::TGoodRunsListReader("my_grl");
  egamma_grl_reader.SetXMLFile(grl_file_name);
  egamma_grl_reader.Interpret();
  egamma_grl = egamma_grl_reader.GetMergedGoodRunsList();
  
  // In event loop:
  grl_check = egamma_grl.HasRunLumiBlock(RunNumber,lbn);
  ```

Can also use GRL tool to record a list of Lumiblocks run over, useful for Luminosity calculation
• https://atlas-datasummary.cern.ch/lumicalc

• Upload Good Run List of events ran over and trigger used → LumiCalc tool calculates the integrated luminosity.

• Need to be careful if using L1 triggers that not prescaled at HLT
Luminosity Calculation (2)

- LumiCalc also available as a Standalone package / command line tool: https://twiki.cern.ch/twiki/bin/view/Atlas/CoolLumiCalcTutorial
- Luminosity calculated as follows:

\[ L_{tot} = \sum_i \Delta t_i \cdot L_i/(P_{L1} \cdot P_{L2} \cdot P_{L3}) \]

- \( i \) goes over all valid luminosity blocks in which the trigger is configured
- \( \Delta t_i \) is the lifetime of the trigger item for the \( i \)-th luminosity block
- \( L_i \) is the estimated average luminosity over luminosity block \( i \)
- \( P_{LX} \) are the trigger prescales.
• Currently need to use OTX map to exclude electrons from problem regions on the Lar Calorimeter, e.g. non nominal high voltage, dead high voltage and any readout problem.
• Eventually these should be part of the object quality flags
• Use CheckOQ.C from /afs/cern.ch/atlas/groups/EGamma/OQMaps/
  – Int_t checkCluster Electron(TString runnumber, double elEta, double elPhi, )
  – Returns 1 if the point is ok; 2 if it has non nominal HV (but not deadHV or readout problems); 3 if the point is bad ( deadHV or readout problems);
  – Currently veto on 3

https://espace.cern.ch/atlas-egamma/egamma-2010/Lists/DQ%20%20GRLB/Attachments/2/TheOQmaps2.pdf
• Although running on ntuples is fast enough to do locally, not practical to download all of the ntuples to a local disk, so need to use the grid.

• .... makes everything more complicated!

• prun can be used to submit non-athena jobs to the grid.

• Can give prun a GRL file and specify the data format and it will automatically find the datasets to run on.
  
  – https://ppes8.physics.gla.ac.uk/twiki/bin/view/ATLAS/RunningOnData
  
  – https://twiki.cern.ch/twiki/bin/view/Atlas/PandaRun

```
prun --bexec grid_build.sh --exec "source setup.sh; make clean; make ; ./Zll %IN job_conf.txt" --goodRunListXML=my_grl.xml
--goodRunListDS="*physics_Egamma*" --goodRunListDataType=NTUP_WZ
--outputs output.root,grl_runover.xml,ZllRunLog.txt --outDS user.nedwards.ZllAna.Zee5.Egamma.NTUP_WZ.periodE.E1 --athenaTag 15.6.9 --nFilesPerJob 10
--extFile=ObjectQualityMaps*.root,IDDQ_152409.root
```
Cutflow for E1

- **Initial analysis of E1 data**
  - Int. Luminosity ~ 140 nb-1

<table>
<thead>
<tr>
<th></th>
<th>Good Runs List</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Trigger: L1_EM5</td>
<td>4860401</td>
</tr>
<tr>
<td>2</td>
<td>Vertex + 3 tracks</td>
<td>4857286</td>
</tr>
<tr>
<td>3</td>
<td>MET clean</td>
<td>4228017</td>
</tr>
<tr>
<td>4</td>
<td>2 medium electrons in eta range, Pass OTX cuts</td>
<td>10065</td>
</tr>
<tr>
<td>5</td>
<td>2 OS sign electrons with Et_cl &gt; 20GeV</td>
<td>121</td>
</tr>
<tr>
<td>6</td>
<td>66 &lt; m_ee &lt; 116 GeV</td>
<td>38</td>
</tr>
</tbody>
</table>
Extracted peak: [88.6 +/- 0.9 (stat)] GeV
• **Lots more to do:**
  - Check cutflow and distributions against WZ group numbers (periods A – D5)
  - Investigate object selections and quality cuts
  - Selection and acceptance efficiencies needed in order to determine cross section
  - Background subtraction