

The Trigger Simulator

All D0 Meeting

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Outline

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Intro

- The d0trigsim package produces a combined L1/L2/L3 executable capable of running on Data or MC inputs.
- Executable Managers: Dugan O'Neil and **Angela Bellavance**. Thanks Serban!
- Certification: Josh Dyer

Goals

- Some Goals:
 - Evaluate trigger efficiencies and rejection on MC and data samples for triggers before they are run online
 - Test and debug online trigger software before it goes online
 - Verify performance of trigger algorithms and calculate efficiencies after the fact

Documentation

- Homepage: <http://www-d0.fnal.gov/computing/trigsim/trigsim.html>
- Contains cookbook instructions, status of each release, talks, trigger lists docs, etc.
- Mailing list: d0trigsim-users@fnal.gov, archived at <http://listserv.fnal.gov/archives/d0trigsim-users.html>

Documentation -2

D0 Trigger Simulator Homepage

Report a bug in the trigger simulation

General Info <ul style="list-style-type: none">• Contacts• Meetings• Trigsim Docs• Trigger Lists	Release Status <ul style="list-style-type: none">• More Current Production p12• Current Production p11• Old Production p10• test release• d0trigsim certification page
MC Samples <ul style="list-style-type: none">• General Recommendations• QCD files in SAM (outdated)• Sample Ntuples	Tools <ul style="list-style-type: none">• Collected ROOT macros
Other Trigger Links <ul style="list-style-type: none">• D0 Trigger• TriggerMeister Home• Levan's Working Page• Elizabeth's Working Page• Trigger Database	Other Links <ul style="list-style-type: none">• D0 Simulation• Monte Carlo Challenge

Updated: oneil@fnal.gov

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Production Release p12

- Overall Status: It is based on t02.24.00. We are still building new pass-releases.

P12.02.00 (08/13/2002, updated 08/28/02)

- Status Has been tested on some cert-files and looks OK. Not yet approved by package authors/experts. Runs without modification or recompilation. I would use this version as default now. It has considerable improvements in L1/L2 cal running on data that are not present in any other version. It also is the basis for what will go online soon in L2/L3. If you want to certify, this is where you should do it (until p12.03.00).
- Tricks Here are some things you should know about for this version
 - new **d0tools** has been released using
 - -format=mc, data to select right config for running on mc or data inputs
 - automatically runs parser on Level3.sim in order to create toollist.txt for l3fanalyze
 - -forcecpoutfile is no longer needed

- Database, COOR, Lists

The version of COORSIM in p12.02.00 is not caught up with the latest online lists. If you want to run with a recent list you should look at the [d0trigsim trigger list page](#). There you will find some pre-made sim files for recent lists and instructions on how to make them yourself. You can check out coor v00-56-00, compile it yourself and run it on your XML file. The next release or COORSIM will remedy version-compatibility issues like this.

- L3 On data:

rdc_run_config_mgr seems to mess-up L3 when running on data inputs. L3 has its own run_config_mgr interface and these two don't want to co-exist. However, L1_must_have rdc_run_config_mgr in order to unpack inputs. So, if you need to run L3 on data, you can do

```
addpkg d0trigsim  
edit d0trigsim/rpc/Tritn0TrigSim_data.rpc to remove rdc_run_config_mgr  
runD0TrigSim -filelist=blah.txt -format=data -localrep -l3only
```

Don't know what the problem is....don't know how to fix it....

- L3 ntuple content:

Documentation -4

trigsim release	recocert version	.pdf file	root macro	comments
p11.08.00	p10.15.00	ttbar , zmumu , zee , wh_wmunu , wh_wenu , gam+jets ,	trigsimcertplots.C , trigsimcertplots.h	The only change not presented in the macro is in line 465, the name of the .ps file is manually changed for each set of plots. zmumu is broken due to a crash in L3 muon .
p11.09.00	p11.08.00	wenu , wmunu , wtaunu , qcd , gam+jets , ttbar , zmumu , zee , ztautau , wh_wmunu , wh_wenu , wh_wtaunu ,	trigsimcertplots.C , trigsimcertplots.h	no problems
p11.10.00	p11.08.00	wenu , wmunu , wtaunu , qcd , gam+jets , ttbar , zmumu , zee , ztautau , wh_wmunu , wh_wenu , wh_wtaunu ,	trigsimcertplots.C , trigsimcertplots.h	no problems
p12.02.00	p11.08.00	wenu , wmunu , wtaunu , qcd , gam+jets , ttbar , zmumu , zee , ztautau , wh_wmunu , wh_wenu .	trigsimcertplots.C , trigsimcertplots.h	no problems

Basic Design

- Simulate L1 Trigger Hardware
- Wrapper L2 and L3 online code for offline use
- Configure using lists from trigger db
- Seamless switch between data and MC inputs
- Output trigger objects as well as bit-masks
- All output formats identical to online

Inputs and Configuration

- d0trigsim requires two inputs:
 1. data or MC file
 2. trigger list
- Input data or MC file must contain Raw Data Chunk (RDC). Examples
 - MC file from farms which has been D0Simmed
 - Any raw data file (reco files too if keep RDC)

Configuration (Trigger Lists)

- d0trigsim uses three types of configuration files
 1. rcps
 2. calibration/equation files
 3. a trigger list
- rcps and calib files should be fine with sensible defaults. Trigger list is more tricky.
- We want a default list which exercises all certified or nearly certified filters and tools. Physics group input welcome but not essential in first instance.

Configuration (Trigger Lists) -2

- Trigger lists should come from the database.
Please pester our triggermeisters for new lists.
Users cannot enter lists.
- To extract an existing list from the DB use
instructions on d0trigsim page.
- Pass trigger lists (XML) by passing them on the
commandline:

```
rund0TrigSim -filelist=blah.txt -format=mc -trglst=mylist.xml
```

- This causes COORSIM to be run on the XML file
and the outputted *.sim files are used to configure
D0TrigSim.

Configuration (Trigger Lists) -3

- COORSIM turns XML into a set of “sim” files
 - level1.sim - configures L1Cal and L1Frm
 - epics.sim - configures L1FT and L1Muon
 - level2.sim - configures L2
 - level3.sim - configures L3
- Once you have used COOR to generate *.sim config files you may simply keep reusing them. Create “trgsim” subdir and copy them in there and D0TrigSim will find them.

Outputs

- Two outputs of trgsim:
 1. EVPACK file containing RDC + L3 chunk
 2. ROOT file for analysis
- L1/L2 simulation inserts crates and modules into RDC to be used by L3 and written out
- Analysis is done by either looking at ntuple output of trgsim directly or by processing EVPACK file output through d0_analyze and looking at ntuple.

D0TrigSim on MC

```
setup D0RunII p12.02.00
setup d0tools -t
runD0TrigSim -filelist=myfiles.txt
                  -format=mc
```

- Planned to be run as part of standard MC chain when p12 goes to offsite farms. Will be able to “analyze” DST or re-trigsim raw output. Requires default triggerlist.

D0TrigSim on Data

- Instructions for running aren't that different:

```
setup D0RunII p12.02.00
```

```
setup d0tools -t
```

```
runD0TrigSim -filelist=myfiles.txt  
              -format=data
```

- However, everyone wants to run on RECENT data. trgsim falls behind and users get frustrated. If only we would stop improving the trigger system....
- Switches L1 to “pass-through”

Analyze Without Sim on Data

- Analyze packages for all three levels of the trigger run on Raw data or MC inputs.
- d0_analyze runs on FNAL production farm. Output ntuple contains branches from reco and trigger info from each of the 3 levels.
- In d0trigsim you can mix analyze and Sim. eg. run D0TrigSim with L1/L2 analyze-only and L3 sim. Editing D0TrigSim top level rcp can completely change behaviour.

Current Status

- in p11, MC with default trigger list certified since p11.08. See certification webpage. Just starting to do certification for multiple lists (including online lists). Should also add certification on data.
- p11.10.01 running online in L2 and L3 right now
- Offline p11 does not handle new data (new L1Cal pedestals, gains, etc.) well without some work on part of user.
- p12.02.00 does handle data correctly
- P12.02.00 certification plots are available. Want to move online L2 and online L3 to p12 as soon as possible.

Detailed Status

- L2 and L3 are the same in d0trigsim as online...only better...
- L1Cal: (J. Kalk) Fully caught up on eta range, pedestal, gain changes. Does a good job reproducing rate seen online (see studies by J. Kalk). Work for p13: simulate proms, improve noise, etc.
- L1FT: (V. Jain) now running on data in test release and p12!! Keeping pace well with hardware. Please give it a try!

Detailed Status

- L1Muo: Running well and doing a good job of reproducing data for a long time now (K. Johns and R. McCroskey).
 - Working on making trigger algorithms rcp-driven
 - Currently studying data vs. simulation results for cf10, cf05, ef05 and ef10 logic
 - two problems with d0sim: need bit set when within trigger timing window, pdt hits only even or only odd (help from Fortner).

Analysis from Physics Group

- Lukas Phaf has recently done a study of e+jets triggers for the top group. He uses d0trigsim on MC for signal and data for background. Nice writeup exists:
http://www-d0.fnal.gov/Run2Physics/top/d0_private/wg/triggers
....follow the e+jets link.
- On data he used L2 objects from the online data and simulated L3, obtained L2 and L3 rejections, overlaps with selected other triggers.

Analysis from Physics Group

Here we will describe the e+jets trigger studies for $t\bar{t}$ and Single Top.

1 Trigger system

The trigger studied uses all levels of the D0 trigger. For now, only calorimeter information is used in the e+jets triggers. The available calorimeter triggers are described in the following subsections.

1.1 L1

At L1, calorimeter triggering is based on towers. The size of these is 0.2x0.2 in $\eta x \phi$ space. Both the energy deposited in the EM part of the tower (the first 4 layers) and the total energy deposited in the tower is available. Trigger can be set to require a number of both EM and total towers above certain thresholds. An example is CEM(1,10)CJT(2,5). This requires an EM tower above 10 GeV, and two total (jet) towers above 5 GeV. It should be noted that the EM and total towers are not exclusive, so the EM tower above 10 GeV will also count as one of the total towers.

1.2 L2

At L2, trigger decisions are also based on towers. L2 receives from L1 all trigger towers, both the EM E_T and total E_T . L1 also sends two seed masks (one for EM and one for total), which have bits for every trigger tower. The EM bit is set to 1 if the trigger tower has at least 1 GeV EM E_T . The total bit is set to 1 if the trigger tower has at least 2 GeV total E_T . The L2 cal algorithms will only attempt to find jets or electrons around trigger towers for which the seed bit is set. Electromagnetic (EM) and jet objects are handled in different ways.

1.2.1 EM objects

For every seed tower, the neighbour with the largest ET deposit is found, out of the 4 neighbouring towers. The seed tower and its largest neighbour form the L2 electron. The total E_T of the electron is the sum of the energy deposited in the two EM towers. The EM fraction of the electron is the sum of the EM E_T 's of the two trigger towers divided by the sum of the tot E_T 's of the two trigger towers. Trigger requirements can be both on E_T and EM fraction of the L2 electrons.

1.2.2 Jet objects

All energy deposited in the seed tower and all 8 of its neighbours is added, and this is defined as a L2 jet. The E_T of the L2 jet is the sum of the total energy deposited in these 9 towers. Trigger requirements are on the number and E_T of the L2 jets.

1.2.3 Overlap between L2 electrons and L2 jets

Because of the algorithm used, all L2 electrons that pass a certain E_T requirement will also pass as a L2 jet of the same E_T .

1.3 L3

At L3, the full cell information of the calorimeter is available. Again, L3 electrons and jets are treated differently.

1.3.1 L3 electrons

L3 electrons start out using a narrow cone (0.4) jet algorithm (based on towers). This defines the electron cluster. In the next step, only cells with a dR of 0.25 around the axis of this cluster are used to define the electron object. Trigger requirements can be both on the E_T (which is the sum

Sample Analysis from Physics Group

L2 L2EM(1,W,0.85) L2JET(2,X)
L3 L3EM(1,Y,0.90) L3JET(2,Z)
The W,X,Y and Z are E_T thresholds, and the 0.85 and 0.90 are EM fractions. Also, the effect of using shower shape on L3EM objects was studied. If shower shape cut is on, the following cuts are used on the width of EM1, EM2 and EM3: $W_1 < 0.09$, $W_2 < 0.08$, $W_3 < 0.05$.
L1 and L2 only look at a restricted η range of $|\eta| < 2.4$, because that is what is available in the detector hardware.

3.1 Rejections and rates

The following table shows the trigger rejections and rates (at instantanious luminosity of 30E30), calculated from real data run 160686. The L1 rate at this luminosity is 60 Hz.

L2	L2 rej.	L2 rate (Hz)	L3	L3 rej.	L3 rate (Hz)
L2EM(1,5)L2JET(1,8)	1.3	46	-	-	46
L2EM(1,8)L2JET(2,8)	1.7	35	L3EM(1,15)L3JET(2,15)	3.0	12
L2EM(1,10)L2JET(2,10)	2.1	29	L3EM(1,15)L3JET(2,15)	2.7	11
L2EM(1,10)L2JET(2,10)	2.1	29	L3EM(1,15)L3JET(2,20)	3.3	9
L2EM(1,10)L2JET(2,10)	2.1	29	L3EM(1,20)L3JET(2,20)	6.4	5
L2EM(1,10)L2JET(2,10)	2.1	29	L3EM(1,15,sh)L3JET(2,15)	6.6	4

3.2 Overlap with other triggers

The trigger rates calculated above are exclusive rates. The increase in rate that comes from including these triggers might be much smaller, because there could be overlap with (existing) triggers. Therefor, we calculated the overlap of

L1 CEM(1,10)CJT(2,5)

L2 L2EM(1,10,0.85) L2JET(2,10)

L3 L3EM(1,15,0.90) L3JET(2,15)

(with L3EM with an without shower shape) with other triggers.

58 % of events that pass this trigger WITHOUT shower shape would have also passed CEM(1,15) L3EM(1,15,0.90).
60 % of events that pass this trigger WITH shower shape would also pass CEM(1,10) L3EM(1,20,0.90,sh).

3.3 Efficiencies

The following table show the total trigger efficiencies for the different signals.

L2	L3	$t\bar{t}$ (tot)	s chan.	2to2	Wg fusion
L2EM(1,8)L2JET(2,8)	L3EM(1,15)L3JET(2,15)	81.5 %	75.7 %	71.9 %	73.3 %
L2EM(1,10)L2JET(2,10)	L3EM(1,15)L3JET(2,15)	81.4 %	75.5 %	71.5 %	73.4 %
L2EM(1,10)L2JET(2,10)	L3EM(1,15)L3JET(2,20)	81.4 %	74.6 %	70.5 %	72.3 %
L2EM(1,10)L2JET(2,10)	L3EM(1,20)L3JET(2,20)	74.5 %	68.2 %	63.2 %	67.0 %
L2EM(1,10)L2JET(2,10)	L3EM(1,15,sh)L3JET(2,15)	75.0 %	71.2 %	68.3 %	69.8 %

For $t\bar{t}$, the L1, L2 and L3 efficiencies are given in the table below. Here, L2 efficiency means the percentage of MC events that have passed L1 that also pass L2.

L2 trigger	L3 trigger	L1 eff.	L2 eff.	L3 eff.
L2EM(1,8)L2JET(2,8)	L3EM(1,15)L3JET(2,15)	98.8 %	97.2 %	84.9 %
L2EM(1,10)L2JET(2,10)	L3EM(1,15)L3JET(2,15)	98.8 %	96.0 %	85.9 %
L2EM(1,10)L2JET(2,10)	L3EM(1,15)L3JET(2,20)	98.8 %	96.0 %	85.9 %
L2EM(1,10)L2JET(2,10)	L3EM(1,20)L3JET(2,20)	98.8 %	96.0 %	78.6 %
L2EM(1,10)L2JET(2,10)	L3EM(1,15,sh)L3JET(2,15)	98.8 %	96.0 %	79.1 %

Problem Summary

- Trigger simulator lags behind hardware. Hardware is still changing rapidly.
- Known bug: L3 on data cannot have rdc_run_config_mgr also running. Run config manager expert help welcome.
- Certification has gotten much better lately (thanks Josh Dyer!) still need to add data, multiple lists, more automation, etc.

Problem Summary

- Several issues with configuration:
 - Users cannot create their own lists
 - Get right version of COOR. Scott is on it.
 - Make sure L3 analyze branches are filled in coordination with triglists. p12.03.00
 - Remove hand-editing L3 configurations in XML or *.sim file. p13.

Summary

- Welcome Angela Bellavance!!!
- p11 is running online in L2 and L3, p12 soon
- p12.02.00 is now ready for users to beat-on
- Watch for usability improvements, L2 tracking and more in p13
- Certification procedure, documentation, bug-tracking are all improving
- Issues running on recent data or recent online trigger lists have been identified. d0trigsim and COOR issues have resolutions planned for p13.

Summary -2

Enter Bug This page lets you enter a new bug into Bugzilla.

[Bug writing guidelines](#)

Reporter: onell@fnal.gov

Version:

p11.10.01	<input checked="" type="checkbox"/>
p11.11.00	<input type="checkbox"/>
p12.01.00	<input type="checkbox"/>
p12.02.00	<input checked="" type="checkbox"/>

Product: TrigSim

Component:

<input checked="" type="checkbox"/>	I2calemworker
<input type="checkbox"/>	I2caljetworker
<input type="checkbox"/>	I2calnetworker
<input type="checkbox"/>	I2cpsworker
<input type="checkbox"/>	I2ctcworker

Platform: clued0

Resolution: Drop Everything

Priority:

OS: other

Severity: critical

Assigned To:

(Leave blank to assign to default comp)

Cc:

URL: <http://>

Summary: dotrigsim is too easy to use, authors are too good-looking

Description: triggerList= file path to input file=

Remember values as bookmarkable :em

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