



DAQ



- Start on time:
 - Running state well before the beam
- Stop only if needed:
 - If permanent busy: Sub-detector doesn't support dynamic elimination of faulty hardware
 - If data quality degrades beyond acceptable level
 - Mayor reasons: wrong configuration

Automatic stopless recovery



- We shall be able to identify the hardware with 100% busy assertion for a period of N seconds
- Raise a hardware failure error to expert system
- Automatic or shifter decision to disable faulty hardware
- Mask out from the acquisition the faulty hardware
- Operation is logged in the Resource information system

How to know if the ROD is busy



- ROD board can provide a busy rate over a period of time
 - VME FPGA has a circular FIFO to store number of clock times the board was busy over a configurable number of clocks
- We assume that for a busy rate of 100% there MUST be a permanent busy signal from a device.
 - We have 4 busy signals into the VME FPGA (PU1_DSP1, PU1_DSP2, PU3_DSP1, PU3_DSP2)

Data quality



	% of detector		Reason
Drawer	0.4	✓	Corrupted data, power failure...
DSP	0.8	✓	DSP code deadlock
PU	1.6	✓	Read-out link failure, XOFF, Robin issue
ROD	3.1	✗	TTC FPGA problem
Crate	25.0	✗	Missing ECR

- TileCal policy will accept disabling up to ~3% of the detector
 - One PU + 3 drawers



- TDAQ expert system foresees disabling and re-enabling of Resources
 - https://pcatdwww.cern.ch/cmt/releases/download/tdaq-02-00-02/RELEASE_NOTES.html#ResourcesInfo
- TileCal Resources:
 - ROD
 - Robins
 - Drawers (not yet)
- What can be disabled
 - ROD
 - PU: Linked to Robin via Readout channel
 - Drawer (not yet)

Skip this
slide if it's
too
technical

First implementation



- If busy level $[90, 100[$ % a warning is thrown to MRS
 - Should be investigated further
- If busy level is 100 % we MASK the busy from the whole PU
 - We do a logical OR of two DSP busy sources
 - We disable whole PU (Readout link)
- Following, some slides of the stopless recovery in action in the lab (175@CERN)

Start the run



ATLAS TDAQ SOFTWARE - Partition TilePartition

File Commands Access Control Settings Logging Level Help

Commit & Reload

MRS IS DVS ED OCS LM OH

Run Control Commands

SHUTDOWN BOOT
 TERMINATE INITIALIZE
 UNCONFIG CONFIG
 STOP START
 HOLD TRG RESUME TRG

Run Information & Settings

Lumi Block 0

	Number	Rate
Level 1	0	0
Level 2	80000	7.50 kHz
Event builder	80941	7.57 kHz
Event filter	0	0
Recorded	80941	7.57 kHz

Information Counters Settings

Run Control Segments & Resources Dataset Tags Tile PMG

Tile EBA LBA LBC EBC Globals Laser

Crate DigiTTC SHAFT DDC MinBias

EBA

ROD 1	ROD 2	ROD 3	ROD 4	ROD 5	ROD 6	ROD 7	ROD 8
<input type="checkbox"/> EBC41	<input checked="" type="checkbox"/> 05	<input type="checkbox"/> 13	<input checked="" type="checkbox"/> 21	<input checked="" type="checkbox"/> 29	<input checked="" type="checkbox"/> 37	<input checked="" type="checkbox"/> 45	<input checked="" type="checkbox"/> 53
<input type="checkbox"/> EBC43	<input checked="" type="checkbox"/> 07	<input checked="" type="checkbox"/> 15	<input checked="" type="checkbox"/> 23	<input checked="" type="checkbox"/> 31	<input checked="" type="checkbox"/> 39	<input checked="" type="checkbox"/> 47	<input checked="" type="checkbox"/> 55
<input type="checkbox"/> EBC42	<input type="checkbox"/> 06	<input checked="" type="checkbox"/> 14	<input type="checkbox"/> 22	<input checked="" type="checkbox"/> 30	<input checked="" type="checkbox"/> 38	<input checked="" type="checkbox"/> 46	<input checked="" type="checkbox"/> 54
<input checked="" type="checkbox"/> 48 175	<input checked="" type="checkbox"/> 08	<input checked="" type="checkbox"/> 16	<input checked="" type="checkbox"/> 24	<input checked="" type="checkbox"/> 32	<input checked="" type="checkbox"/> 40	<input checked="" type="checkbox"/> 48	<input checked="" type="checkbox"/> 56
<input checked="" type="checkbox"/> LBA48 175	<input type="checkbox"/> 09	<input checked="" type="checkbox"/> 17	<input checked="" type="checkbox"/> 25	<input checked="" type="checkbox"/> 33	<input checked="" type="checkbox"/> 41	<input checked="" type="checkbox"/> 49	<input checked="" type="checkbox"/> 57
<input checked="" type="checkbox"/> LBC48 175	<input checked="" type="checkbox"/> 11	<input checked="" type="checkbox"/> 19	<input checked="" type="checkbox"/> 27	<input checked="" type="checkbox"/> 35	<input checked="" type="checkbox"/> 43	<input checked="" type="checkbox"/> 51	<input checked="" type="checkbox"/> 59
<input checked="" type="checkbox"/> 02	<input type="checkbox"/> 10	<input checked="" type="checkbox"/> 18	<input checked="" type="checkbox"/> 26	<input checked="" type="checkbox"/> 34	<input checked="" type="checkbox"/> 42	<input checked="" type="checkbox"/> 50	<input checked="" type="checkbox"/> 58
<input checked="" type="checkbox"/> 04	<input type="checkbox"/> 12	<input checked="" type="checkbox"/> 20	<input checked="" type="checkbox"/> 28	<input checked="" type="checkbox"/> 36	<input checked="" type="checkbox"/> 44	<input checked="" type="checkbox"/> 52	<input checked="" type="checkbox"/> 60
6	8	10	12	14	16	18	20
Ritmo 1	Ritmo 2	Ritmo 3	Ritmo 4	Ritmo 5	Ritmo 6	Ritmo 7	Ritmo 8
Crate EBA	ROD Busy	00: ROD	14: TTC				

ROD Write to IS Read from IS Write to DB Read from DB

Subscription criteria WARNING ERROR FATAL INFORMATION Expression

TIME	SEVERITY	APPLICATION	NAME	MESSAGE
19:46:43	WARNING	RootController	rc:MasterTrigger...	Master Trigger not defined.
19:46:43	WARNING	TileEBA_TTCRCD	TileRCD::Issue	Configuration overwritten with IS settings
19:46:42	WARNING	RootController	rc:MasterTrigger...	Master Trigger not defined.
19:46:42	WARNING	TileEBA_RODRCD	TileRCD::Issue	TileOfcCoolPlugin: Overwriting OFC params with IS values.
19:46:42	WARNING	RootController	rc:MiscWarning	No Run Number Server provided: check the TDAQ_RUN_NUMBER_CONNECT Variable in the DB. A dummy run number will be provided. TileCal_RODModule: Setup UID: TileCalEBA_RODModule_1

Clear Message format Number of visible rows 100 Current MRS subscription WARNING|ERROR|FATAL

Hardware failure error



ATLAS TDAQ SOFTWARE - Partition TilePartition

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Commit & Reload

MRS IS DVS ED OMS LM OH

Run Control Segments & Resources Dataset Tags Tile PMG

Tile EBA LBA LBC EBC Globals Laser

Crate DigiTTC SHAFT DDC MinBias

EBA							
ROD 1	ROD 2	ROD 3	ROD 4	ROD 5	ROD 6	ROD 7	ROD 8
<input type="checkbox"/> EBC41	<input checked="" type="checkbox"/> 05	<input type="checkbox"/> 13	<input checked="" type="checkbox"/> 21	<input checked="" type="checkbox"/> 29	<input checked="" type="checkbox"/> 37	<input checked="" type="checkbox"/> 45	<input checked="" type="checkbox"/> 53
<input type="checkbox"/> EBC43	<input checked="" type="checkbox"/> 07	<input checked="" type="checkbox"/> 15	<input checked="" type="checkbox"/> 23	<input checked="" type="checkbox"/> 31	<input checked="" type="checkbox"/> 39	<input checked="" type="checkbox"/> 47	<input checked="" type="checkbox"/> 55
<input type="checkbox"/> EBC42	<input type="checkbox"/> 06	<input checked="" type="checkbox"/> 14	<input type="checkbox"/> 22	<input checked="" type="checkbox"/> 30	<input checked="" type="checkbox"/> 38	<input checked="" type="checkbox"/> 46	<input checked="" type="checkbox"/> 54
<input checked="" type="checkbox"/> 48 175	<input checked="" type="checkbox"/> 08	<input checked="" type="checkbox"/> 16	<input checked="" type="checkbox"/> 24	<input checked="" type="checkbox"/> 32	<input checked="" type="checkbox"/> 40	<input checked="" type="checkbox"/> 48	<input checked="" type="checkbox"/> 56
<input checked="" type="checkbox"/> LBA48 175	<input type="checkbox"/> 09	<input checked="" type="checkbox"/> 17	<input checked="" type="checkbox"/> 25	<input checked="" type="checkbox"/> 33	<input checked="" type="checkbox"/> 41	<input checked="" type="checkbox"/> 49	<input checked="" type="checkbox"/> 57
<input checked="" type="checkbox"/> LBC48 175	<input checked="" type="checkbox"/> 11	<input checked="" type="checkbox"/> 19	<input checked="" type="checkbox"/> 27	<input checked="" type="checkbox"/> 35	<input checked="" type="checkbox"/> 43	<input checked="" type="checkbox"/> 51	<input checked="" type="checkbox"/> 59
<input checked="" type="checkbox"/> 02	<input type="checkbox"/> 10	<input checked="" type="checkbox"/> 18	<input checked="" type="checkbox"/> 26	<input checked="" type="checkbox"/> 34	<input checked="" type="checkbox"/> 42	<input checked="" type="checkbox"/> 50	<input checked="" type="checkbox"/> 58
<input checked="" type="checkbox"/> 04	<input type="checkbox"/> 12	<input checked="" type="checkbox"/> 20	<input checked="" type="checkbox"/> 28	<input checked="" type="checkbox"/> 36	<input checked="" type="checkbox"/> 44	<input checked="" type="checkbox"/> 52	<input checked="" type="checkbox"/> 60
6	8	10	12	14	16	18	20
Ritmo 1	Ritmo 2	Ritmo 3	Ritmo 4	Ritmo 5	Ritmo 6	Ritmo 7	Ritmo 8
Crate EBA	ROD Busy	00: ROD	14: TTC				

ROD Write to IS Read from IS Write to DB Read from DB

Subscription criteria WARNING ERROR FATAL INFORMATION Expression Subscribe

TIME	SEVERITY	APPLICATION	NAME	MESSAGE
19:48:56	ERROR	TileEBA_RODRCD	rc:HardwareError	TileEBA_ROD1_Chan2 TileEBA_RODRCD
19:48:51	ERROR	TileEBA_RODRCD	rc:HardwareError	TileEBA_ROD1_Chan2 TileEBA_RODRCD
19:48:51	WARNING	TileEBA_RODRCD	TileRCD::Issue	TileOfcCoolPlugin: Overwriting DSP config with IS values.
19:48:46	WARNING	TileEBA_ROS	ROS::CoreException	Timeout: in request for fragment with L1 ID 1369285
19:48:46	WARNING	TileEBA_ROS	ROS::CoreException	Timeout: in request for fragment with L1 ID 1369286
19:48:46	WARNING	TileEBA_ROS	ROS::CoreException	Timeout: in request for fragment with L1 ID 1369287
19:48:46	WARNING	TileEBA_ROS	ROS::CoreException	Timeout: in request for fragment with L1 ID 1369288
19:48:46	WARNING	TileEBA_ROS	ROS::CoreException	Timeout: in request for fragment with L1 ID 1369289

Clear Message format Number of visible rows 100 Current MRS subscription WARNING|ERROR|FATAL

Expert system



```

Terminal
File Edit View Terminal Tabs Help
(CLASS-NAME rc@HardwareError)
(MESSAGE "TileEBA_ROD1_Chan2 TileEBA_RODRCD")
(SEVERITY ERROR)
INFO 2009-Sep-11 19:49:33 [static bool daq::OnlRec::RODBusyExtension::periodic(
..) at OnlineRecovery/src/RODBusyExtension.cpp:892] 65 BusyChannel 'TileEBA_ROD1
_Chan2' pointing to source 'TileEBA_ROD1_Chan2' was reported as busy.
Should recovery be taken?
[rc@HardwareError69] of ERS-ISSUE
(CLASS-NAME rc@HardwareError)
(MESSAGE "TileEBA_ROD1_Chan2 TileEBA_RODRCD")
(SEVERITY ERROR)
INFO 2009-Sep-11 19:49:37 [static bool daq::OnlRec::RODBusyExtension::periodic(
..) at OnlineRecovery/src/RODBusyExtension.cpp:892] 66 BusyChannel 'TileEBA_ROD1
_Chan2' pointing to source 'TileEBA_ROD1_Chan2' was reported as busy.
Should recovery be taken?
[rc@HardwareError69] of ERS-ISSUE
  
```

Expert system will wait for user input or to be configured in automatic mode

```

tilerod@valticalrc1:~
File Edit View Terminal Tabs Help
tilerod@valtical01 > configure_es_server -h
Usage: configure_es_server [-p partition] [-s] [-a] [-x]

Options/Arguments:
  -p partition  IPC partition name (default $TDAQ_PARTITION)
  -s            On/off
  -a            automatic/user input
  -x            ignore even on xoff

Description:
  Configure the es server.
tilerod@valtical01 > configure_es_server -p TilePartition -s -a
tilerod@valtical01 >
  
```

Expert system II



```

Terminal
File Edit View Terminal Tabs Help
) at OnlineRecovery/src/RODBusyExtension.cpp:529] Disabling for TileEBA_ROD1_Cha
n2
LOG 2009-Sep-11 19:50:41 [void daq::OnlRec::RODBusyExtension::disableChannel(...
) at OnlineRecovery/src/RODBusyExtension.cpp:585] encoded command isRESET 0
1
TileEBA_ROD1_Chan2
0
WARNING 2009-Sep-11 19:50:41 [static void daq::OnlRec::CommandExtension::sendCom
mand(...) at OnlineRecovery/src/CommandExtension.cpp:881 Exception during sendin
g:
    was caused by: ERROR 2009-Sep-11 19:50:41
(...) at RunController/src/lib/Commander.cc:38] Fa
in IPC.
    was caused by: ERROR 2009-Sep-11 19:50:41 [CORBA::Object* ipc::util::res
olve(...) at ipc/src/util.cc:342] The object "ResInfoProvider" of the "CS/comman
der" type is not published in the "TilePartition" partition
WARNING 2009-Sep-11 19:50:41 [void daq::OnlRec::RODBusyExtension::disableChannel
(...) at OnlineRecovery/src/RODBusyExtension.cpp:638] Recovery completed for Bus
yChannel TileEBA_ROD1_Chan2 point to source TileEBA_ROD1_Chan2.
WARNING: Experienced some problems:
Failed to talk to ResInfoProvider
  
```

Action is taken and Resources information provider is notified

Continue running



ATLAS TDAQ SOFTWARE - Partition TilePartition

File Commands Access Control Settings Logging Level Help

Commit & Reload

MRS IS DVS ED OMS LM OH

Run Control Commands

SHUTDOWN BOOT
 TERMINATE INITIALIZE
 UNCONFIG CONFIG
 STOP START
 HOLD TRG RESUME TRG

Run Information & Settings

Lumi Block 0

	Number	Rate
Level 1	0	0
Level 2	1477400	7.50 kHz
Event builder	1492287	7.59 kHz
Event filter	0	0
Recorded	1492287	7.59 kHz

Information Counters Settings

Run Control Segments & Resources Dataset Tags Tile PMG

Tile EBA LBA LBC EBC Globals Laser

Crate DigiTTC SHAFT DDC MinBias

EBA

ROD 1	ROD 2	ROD 3	ROD 4	ROD 5	ROD 6	ROD 7	ROD 8
<input type="checkbox"/> EBC41	<input checked="" type="checkbox"/> 05	<input type="checkbox"/> 13	<input checked="" type="checkbox"/> 21	<input checked="" type="checkbox"/> 29	<input checked="" type="checkbox"/> 37	<input checked="" type="checkbox"/> 45	<input checked="" type="checkbox"/> 53
<input type="checkbox"/> EBC43	<input checked="" type="checkbox"/> 07	<input checked="" type="checkbox"/> 15	<input checked="" type="checkbox"/> 23	<input checked="" type="checkbox"/> 31	<input checked="" type="checkbox"/> 39	<input checked="" type="checkbox"/> 47	<input checked="" type="checkbox"/> 55
<input type="checkbox"/> EBC42	<input type="checkbox"/> 06	<input checked="" type="checkbox"/> 14	<input type="checkbox"/> 22	<input checked="" type="checkbox"/> 30	<input checked="" type="checkbox"/> 38	<input checked="" type="checkbox"/> 46	<input checked="" type="checkbox"/> 54
<input checked="" type="checkbox"/> 48 175	<input checked="" type="checkbox"/> 08	<input checked="" type="checkbox"/> 16	<input checked="" type="checkbox"/> 24	<input checked="" type="checkbox"/> 32	<input checked="" type="checkbox"/> 40	<input checked="" type="checkbox"/> 48	<input checked="" type="checkbox"/> 56
<input checked="" type="checkbox"/> LBA48 175	<input type="checkbox"/> 09	<input checked="" type="checkbox"/> 17	<input checked="" type="checkbox"/> 25	<input checked="" type="checkbox"/> 33	<input checked="" type="checkbox"/> 41	<input checked="" type="checkbox"/> 49	<input checked="" type="checkbox"/> 57
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<input checked="" type="checkbox"/> 02	<input type="checkbox"/> 10	<input checked="" type="checkbox"/> 18	<input checked="" type="checkbox"/> 26	<input checked="" type="checkbox"/> 34	<input checked="" type="checkbox"/> 42	<input checked="" type="checkbox"/> 50	<input checked="" type="checkbox"/> 58
<input checked="" type="checkbox"/> 04	<input type="checkbox"/> 12	<input checked="" type="checkbox"/> 20	<input checked="" type="checkbox"/> 28	<input checked="" type="checkbox"/> 36	<input checked="" type="checkbox"/> 44	<input checked="" type="checkbox"/> 52	<input checked="" type="checkbox"/> 60
6	8	10	12	14	16	18	20
Ritmo 1	Ritmo 2	Ritmo 3	Ritmo 4	Ritmo 5	Ritmo 6	Ritmo 7	Ritmo 8

Crate EBA ROD Busy 00: ROD 14: TTC

ROD Write to IS Read from IS Write to DB Read f

Subscription criteria ● WARNING ● ERROR ● FATAL ○ INFORMATION ○ Expression

TIME	SEVERITY	APPLICATION	NAME	
19:50:41	WARNING	TileEBA_RODRCD	TileRCD::Issue	TileEBA_ROD1_Chan2 has been disabled by TileCaEBA_RODModule_1
19:50:41	ERROR	TileEBA_RODRCD	rc:HardwareError	TileEBA_ROD1_Chan2 TileEBA_RODRCD
19:50:36	ERROR	TileEBA_RODRCD	rc:HardwareError	TileEBA_ROD1_Chan2 TileEBA_RODRCD
19:50:31	ERROR	TileEBA_RODRCD	rc:HardwareError	TileEBA_ROD1_Chan2 TileEBA_RODRCD
19:50:26	ERROR	TileEBA_RODRCD	rc:HardwareError	TileEBA_ROD1_Chan2 TileEBA_RODRCD
19:50:21	ERROR	TileEBA_RODRCD	rc:HardwareError	TileEBA_ROD1_Chan2 TileEBA_RODRCD
19:50:16	ERROR	TileEBA_RODRCD	rc:HardwareError	TileEBA_ROD1_Chan2 TileEBA_RODRCD
19:50:11	ERROR	TileEBA_RODRCD	rc:HardwareError	TileEBA_ROD1_Chan2 TileEBA_RODRCD

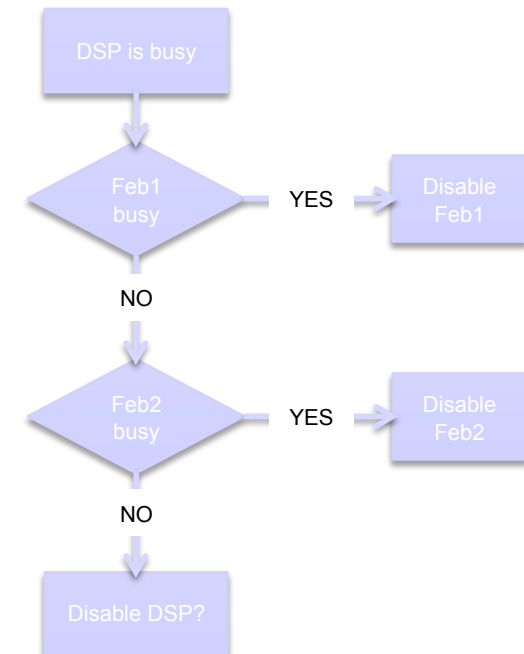
Clear Message format Number of visible rows 100 Current MRS subscription WARNING|ERROR|FATAL

ROD module notifies that the hardware has been disabled

Second version plans



- Single drawer can be disabled from DSP
 - Complex logic to figure out which drawer is setting the DSP busy
 - Don't foresee DSP going busy not caused by FEBs
- ROD module ready to disable single drawers
 - Has been successfully tested in point 1
 - Not the expert system model
- Tile OKS database schema to be revised
 - Only resources can be disabled/enabled
 - Drawers are not resources yet



What if DSP is busy and it is not the drawers fault?



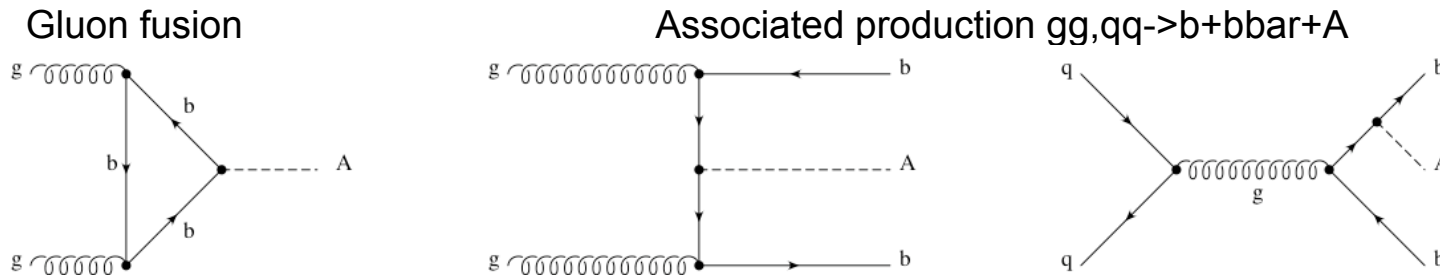
- Automatic stopless recovery is a hot topic in ATLAS run coordination.
- Tile management requested urgent action on Automatic stopless recovery to be accomplished in one month.
 - Oleg leading effort
- First version (disable 1 PU) is working!
- Second version ongoing
 - Automatic stopless recovery actions should be always reported to Resource information system



ANALYSIS



- MSSM Higgs to tau pairs in lepton hadron channel
- Production mechanisms



- Selection cuts: [MSSMHiggsToTauTauToLH](#)
 - Good electron, muon, jet, identification required
 - Good tau fake rejection required
 - Good missing E_t reconstruction required
- Use Higgs decay products to reconstruct the visible mass a la CDF
 - Set exclusion limits and discovery significance incorporating energy scale systematic uncertainties (AKA template morphing) using a Bayesian method called Profiling



- The bayesian credibility limit is given by the p-value definition

$$p = \int_{\theta_L}^{\infty} \mathcal{P}(\theta', \nu | x) d\theta' \quad \mathcal{P}(\theta, \nu | x) = \frac{\mathcal{L}(\theta, \nu | x) \pi(\theta, \nu)}{\pi(x)} \quad \begin{array}{l} \theta \text{ Parameter of interest} \\ \nu \text{ Nuisance parameters} \end{array}$$

- We do a cross section scan of the posterior probability

- The prior probability is considered factorizable

$$\pi(\theta, \nu) = \pi(\theta) \times \pi(\nu)$$

- Assume signal prior constant up to a cutoff

$$\pi(\theta) = ct; \theta \in [0, \theta_{cutoff}]$$

- Assume nuisance prior described by truncated Gaussian p.d.f from subsidiary measurements

$$\pi(\nu) = G(\nu, \hat{\nu}, \varepsilon(\nu))$$

- Where we arbitrarily choose the constant

$$C = \mathcal{L}(\theta = 0, \nu | x) \pi(\nu)$$

- We evaluate the un-normalized posterior from

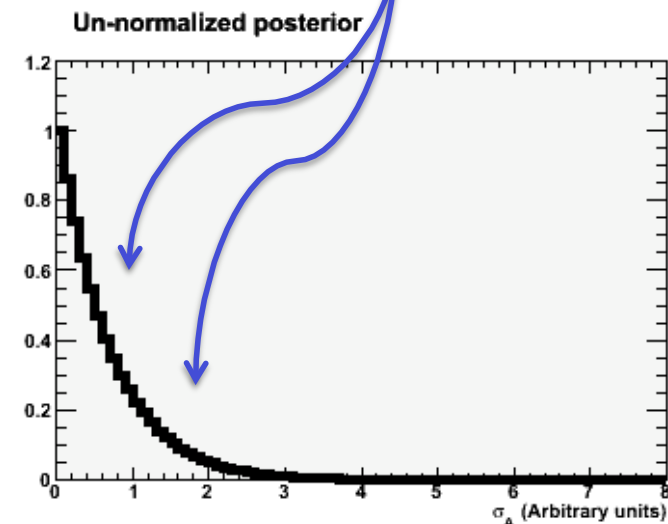
$$\theta \in [0, \theta_{cutoff}]; \mathcal{P} \in [1, 10^{-6}]$$

- We numerically integrate the posterior

$$1 - p = \sum_0^{\theta_L} \frac{\mathcal{L}(\theta, \nu | x) \pi(\nu)}{C}$$

We eliminate the posterior's dependence on the nuisance parameters by maximizing it's value w.r.t the parameters

We do a maximization on each cross section point.



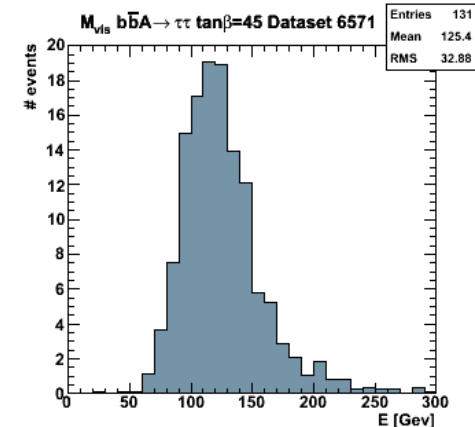
Understanding templates



- Given our observable (M_{vis}) we have efficiency distributions (templates) from MC, pseudo-experiments and eventually data

$$M_{vis} = |p_l^\alpha + p_h^\alpha + p_{miss}^\alpha|$$

$$p_{miss}^\alpha = \left(p_{miss}^x, p_{miss}^y, 0, \sqrt{(p_{miss}^x)^2 + (p_{miss}^y)^2} \right)$$



- The mean values for the binned likelihood function are a function of the parameter of interest and the nuisance parameters

$$\mathcal{L}(\theta, \nu | x) = \prod_i Pois(\mu_i = f(\theta, \nu) | x_i) = \prod_i \frac{\exp(-\mu_i) \mu_i^{x_i}}{x_i!}$$

- Our parameter of interest is the signal cross section
- Nuisance parameters can modify
 - the expected number of counts in each bin

$$\mu_i = L \sigma_A A_i$$

- the shape of the template (In our case by taking into account two other templates)

$$\mu_i = \sigma_A \left(A_i + f_j \frac{A_i^+ - A_i^-}{2} \right)$$

In both cases the prior for the nuisance parameters is the same Gaussian p.d.f.



- We consider a signal + background model in each bin

$$\mu_i = L\sigma_A A_i + L\sigma_Z Z_i$$

- We define a pseudo-experiment as a poisson fluctuation of the background.

$$x_i = \text{Pois}(L\sigma_Z Z_i)$$

- We define a binned Likelihood function of the data to the parameters

$$\mathcal{L}(\theta, \nu | x) = \prod_i \frac{\exp(-\mu_i) \mu_i^{x_i}}{x_i!}$$

- We take into account the priors on the nuisance parameters (Luminosity, cross section) with known systematic uncertainties

$$\mathcal{L}(\theta, \nu | x) \times \pi(\nu) = \prod_i \frac{\exp(-\mu_i) \mu_i^{x_i}}{x_i!} \times G(L, \hat{L}, \varepsilon(L)) \times G(\sigma_Z, \hat{\sigma}_Z, \varepsilon(\sigma_Z))$$

- We fit our posterior to the data, which is maximum at the best value of the parameters.

Adding template morphing



- The expected number of events in each bin take into account the variation between the positive and the negative shifted template, via a morphing parameter.

$$\mu_i = L\sigma_A \left(A_i^0 + f_j \frac{A_i^{j+} - A_i^{j-}}{2} \right) + L\sigma_Z \left(Z_i^0 + f_j \frac{Z_i^{j+} - Z_i^{j-}}{2} \right)$$

- The morphing parameter controls the strength of the energy scale uncertainty.
 - The prior for the morphing parameter is a Gaussian p.d.f. with mean zero and standard deviation one.
- Therefore the posterior probability shall take into account these systematic uncertainties

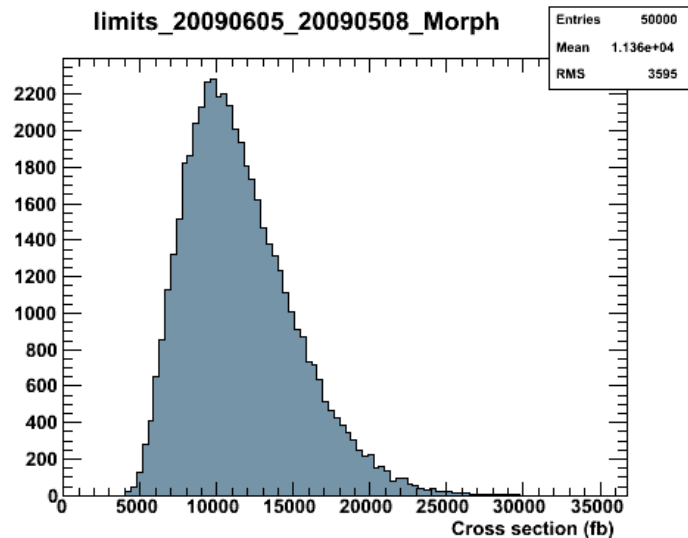
$$\mathcal{L}(\theta, \nu | x) \times \pi(\nu) = \prod_i \frac{\exp(-\mu_i) \mu_i^{x_i}}{x_i!} \times G(L, \hat{L}, \varepsilon(L)) \times G(\sigma_Z, \hat{\sigma}_Z, \varepsilon(\sigma_Z)) \times G(f_j, \hat{f}_j, \varepsilon(f_j))$$



- Setting exclusion limits for single background model
 - $m_A=150$ GeV, $\tan\beta=45$, 50k pseudo-experiments
- Single background model with jet and electron energy shifts
 - $\Delta E(\text{electron})=1\%$, $\Delta E(\text{jet})=5\%$,
- The expected number of events and the posterior probability are given by:

$$\mu_i = L\sigma_A \left(A_i^0 + f_e \frac{A_i^{e+} - A_i^{e-}}{2} + f_j \frac{A_i^{j+} - A_i^{j-}}{2} \right) + L\sigma_Z \left(Z_i^0 + f_e \frac{Z_i^{e+} - Z_i^{e-}}{2} + f_j \frac{Z_i^{j+} - Z_i^{j-}}{2} \right)$$

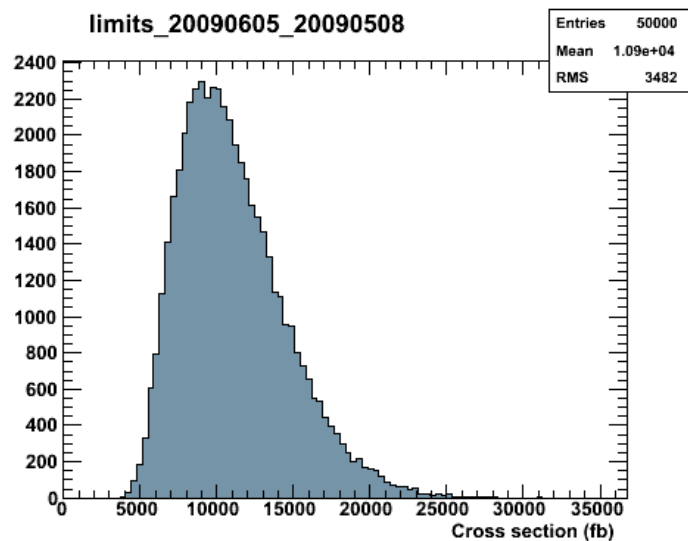
$$\mathcal{L}(\theta, \nu|x) \times \pi(\nu) = \prod_i \frac{\exp(-\mu_i) \mu_i^{x_i}}{x_i!} \times G(L, \hat{L}, \varepsilon(L)) \times G(\sigma_Z, \hat{\sigma}_Z, \varepsilon(\sigma_Z)) \\ \times G(f_j, \hat{f}_j, \varepsilon(f_j)) \times G(f_e, \hat{f}_e, \varepsilon(f_e))$$



Exclusion limit distribution with template morphing

50% (median): 10859 fb
 68% (1sigma): 7919 fb , 15085 fb
 95% (2sigma): 6082 fb , 19863 fb

Adding template morphing increases
 the the width of the sidebands
 and worsens the sensitivity



Exclusion limit distribution without template morphing

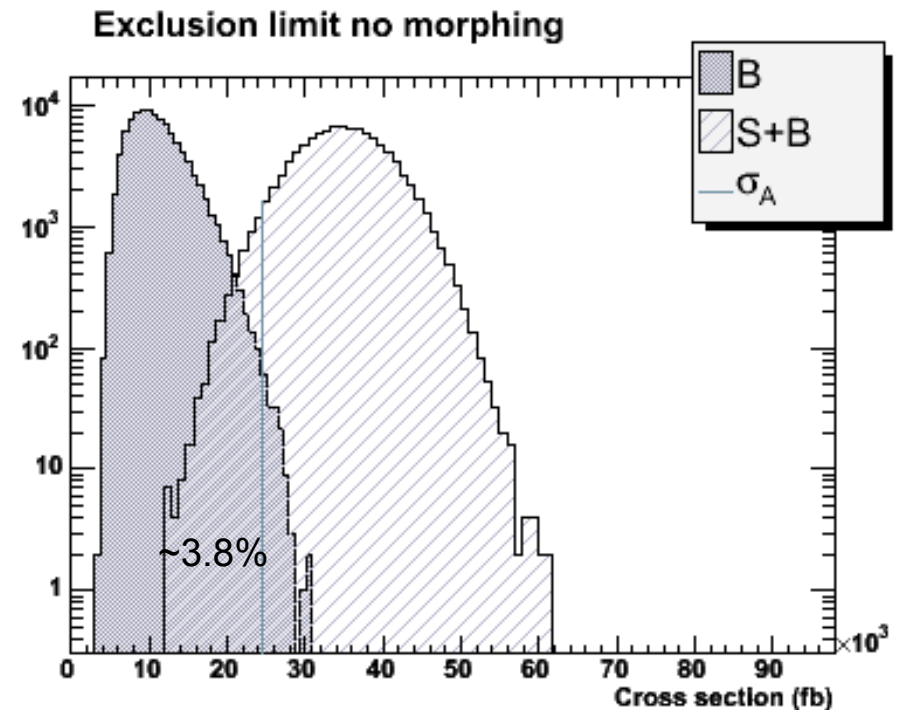
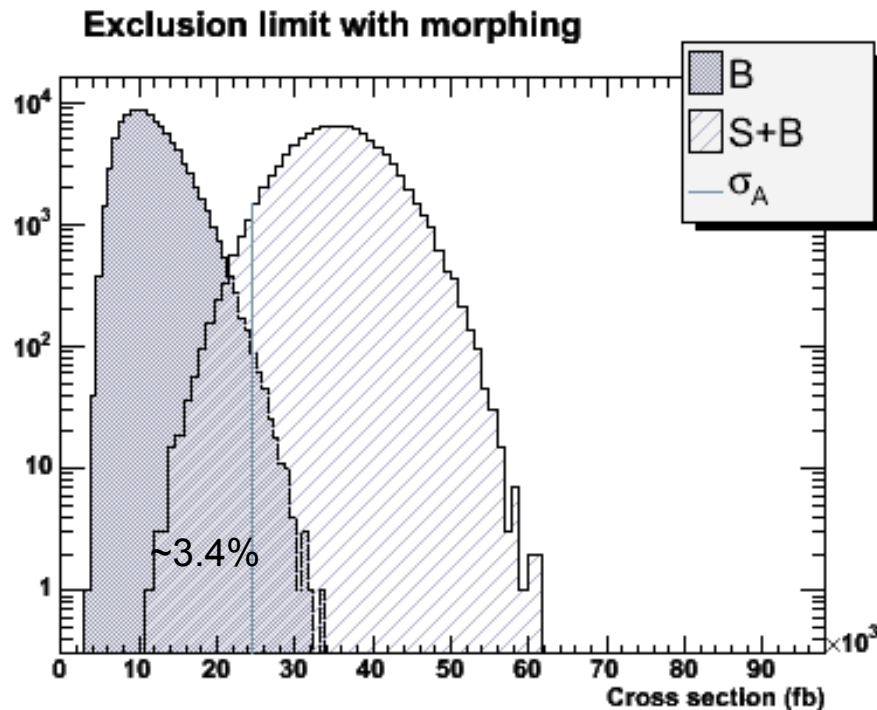
50% (median): 10492 fb
 68% (1sigma): 7552 fb , 14350 fb
 95% (2sigma): 5714 fb , 19128 fb



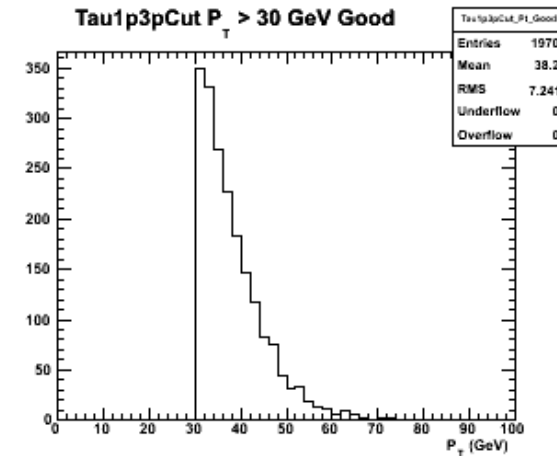
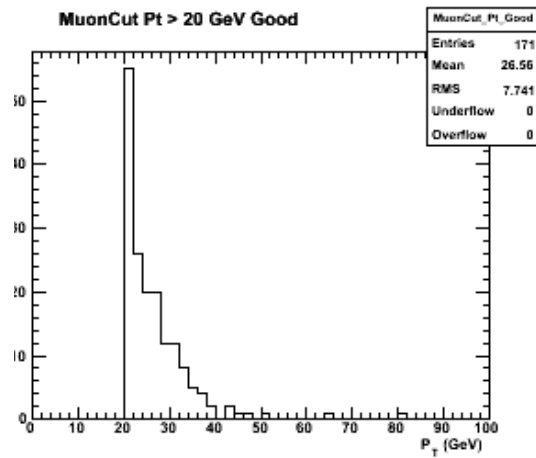
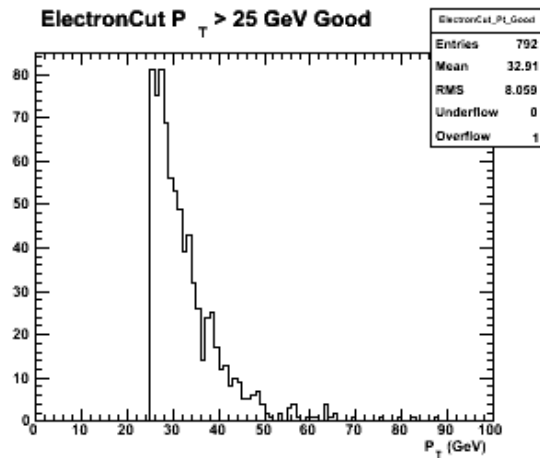
- We repeat the example but this time adding signal to each pseudo-experiment
 - 100% of the predicted cross-section by MSSM for the given parameters ($m_A=150$ GeV, $\tan\beta=45$, m_h^{\max} scenario, $\sigma_A=24500$ fb)

$$x_i = Pois(L\sigma_Z Z_i) + Pois(L\sigma_A A_i)$$

- The method to set exclusion limits is slightly conservative for the MSSM model presented
 - For conservative limit we expect $< 5\%$ of S+B pseudo-experiments to lie below the true value of S
 - In our case, $\sim 3.4\%$ (morphing) and $\sim 3.8\%$ (no morphing) of the pseudo-experiments lie under the signal cross-section.

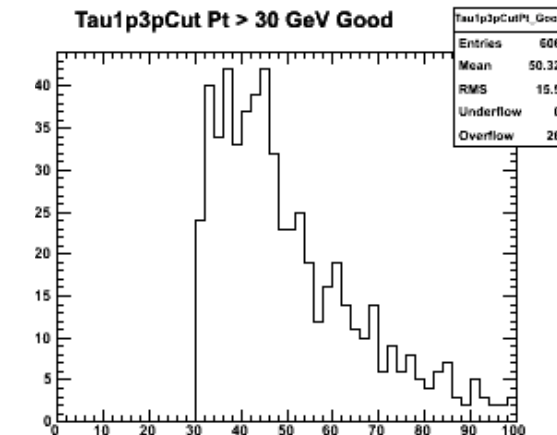
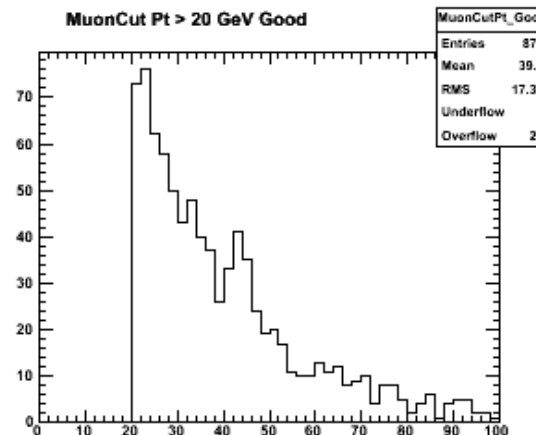
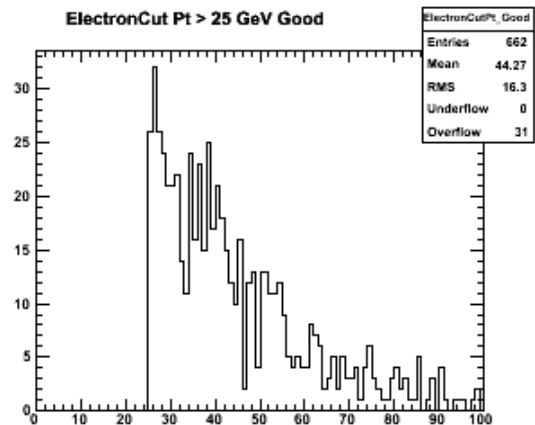


Estimating QCD background

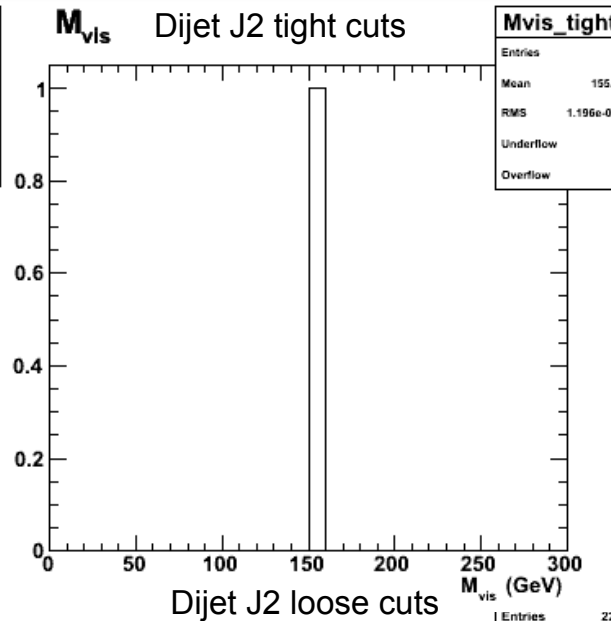
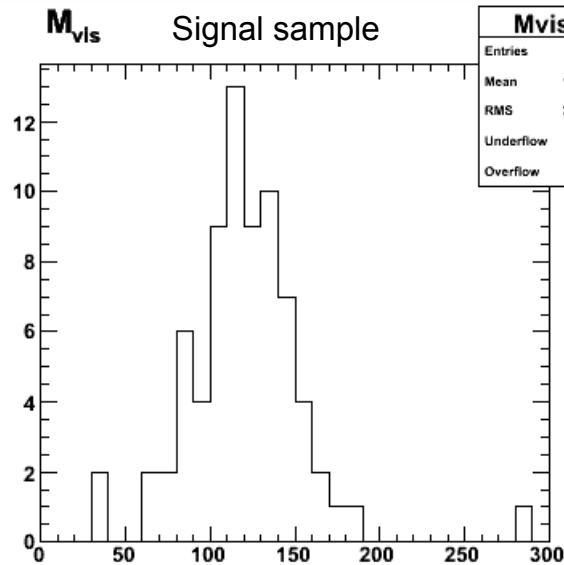


P_T distributions for good electron, muon and tau
Dijet sample J2 (35-70 GeV)

Reference:
Atautau $\tan B=45$ $m_A=150$ GeV

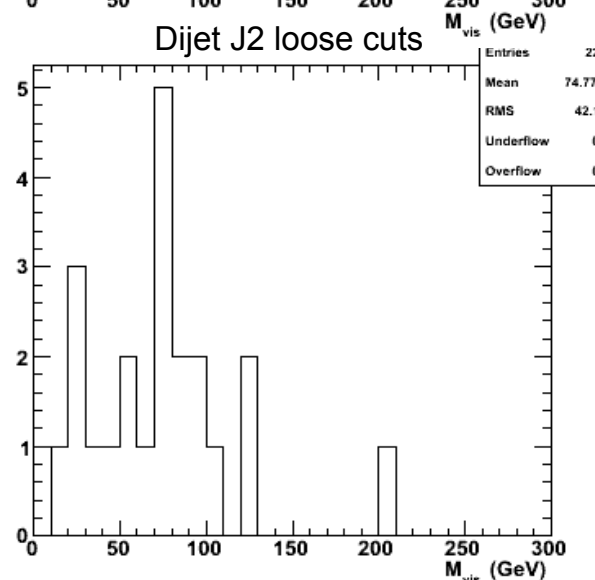


Estimating QCD background



- Direct application of event selection cuts out all dijets
- We expect to have a dijet background due to mis-identified particles: fake rates
- Scaling method to be applied (frequently used)

Currently working out some issues with the event selection. We expect more events with loose cuts



$$M_{vis}^{tight} = R \left(\frac{N^{tight}}{N^{loose}} \right) M_{vis}^{loose}$$

Conclusions and AOB



- Some urgent work on stopless recovery needs attention
- Analysis needs someone to rely on
- No more coordination work this year
- Attendance to NSS conference end october
- Need a contract for beginning next year