ATLAS Note

EXOT-2018-XX

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EXOT group text snippets for INT notes

ATLAS EXOT Group

This note contains text snippets and tables that should be included in supporting notes from the EXOT group.

The templates are in American English. If wanted, some adaption to British English could be made.

This document was generated using version 09-01-00 of the ATLAS LaTeX package.

2018-10-23: This file is a work in progress (WIP) and will probably be updated. Backwards incompatible changes may be made as the examples develop.

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Contents

1 Introduction

This is a very brief, almost "abstract-like" section. Immediately following is the Executive Summary, which should include all of the components that are sometimes in an introduction but they are organized in a way that will facilitate review by conveners since they are in a standard way

2 Executive Summary

This section, ideally 2-pages (max), should be placed at the beginning of the internal note following the more conventional introduction. It should be split as highlighted here and should give a high-level overview of the analysis including (but not limited to):

- *Motivation, physics target, and the general characteristics of the signal*
- *Analysis strategy*
- *General characteristics of the control, validation, and signal regions*
- *Background estimation strategy overview*
- *Highlight major or most important points of the analysis*
- *Team overview task list including a list of all critical tasks, who is responsible for each task, and what else they are working on outside of this analysis. This should be presented in the format shown in Table 1.*
- *List of outstanding items in the analysis that still need to be addressed*

2.1 Target

$\mathcal{O}$(1 paragraph) Is this a new analysis? If not, what are the main improvements expected with respect to the previous version? What is the target publication date / conference?

2.2 Context and Motivation

Motivate this analysis in 1 paragraph: why is this signature interesting? Which kind of models are you probing?

How is the analysis done is 1 paragraph: what are the main BG processes and how do you estimate them (are they MC- or data-driven, what is the general idea of the control regions, . . .), general characteristics of the PL fit (which distribution, binned?, . . .)

2.3 Milestones

Table giving a factual list of who is working on what and what else they do; the idea is to show how the team can / does progress. Including dates for completion of these milestones will help further demonstrate that you are ready for the collaboration review, in the form of an editorial board.

The following table summarizes the tasks to be worked on by analysis team. This is not a complete analysis outline but only an overview of the further steps to be taken as of the time of writing. Details are not provided here but in the dedicated sections throughout this note. Tasks which are based on established techniques and straightforward to achieve are marked green in the table. Tasks which require new work are marked red. Concerning the involved people, the responsible student supervisors and analysis coordinators are already mentioned in the list of contributions above, which shall not be repeated here. A fair overview of all single tasks including past work and of all relevant team members is only given in the list of contributions above! It is also worth noting that some of the tasks listed below are being worked on in parallel.

Table 1: Milestones in the analysis.

Task	**Analyzer**	**Role**	**Other responsibilities**
Describe a first milestone.			
A straightforward task	Name	PhD student, PostDoc/Prof/. . .	thesis writing / teaching / name some CP work . . .
A more involved task			
Describe a second milestone			
First task . . .			

3 Data and MC

Dataset used with blinding strategy, full list of background samples and details of the signal samples.

4 Object selection

The supporting notes should now include the following standardized tables of properties: each analysis should simply fill them in by writing / replacing the value with the appropriate number or by choosing the appropriate option. The idea of these tables is to harmonize some sections of the supporting notes as to make review and analysis comparisons simpler.

If you use non-standard selections which do not fit in these tables, this should of course be noted and discussed in more detail in the text.

Object selection tables (following template) and detailed event selection: there may, of course, still be some minor open items, as long as they don't significantly affect the analysis strategy, but these should be well defined and clearly indicated (e.g. coloured/bold) in the text in this section and in the list of outstanding tasks within the executive summary. Both should be updated as the analysis progresses.

4.1 Electron selection

Table 2: Electron selection criteria.

Feature	Criterion
Pseudorapidity range	$\|\eta\| < \mathrm{X}$
Energy calibration	`es2017_R21_PRE` (ESModel)
Energy	$E > \mathrm{XX}$ GeV
Transverse energy	$E_{\mathrm{T}} > \mathrm{XX}$ GeV
Transverse momentum	$p_{\mathrm{T}} > \mathrm{XX}$ GeV
Object quality	Not from a bad calorimeter cluster (`BADCLUSELECTRON`) Remove clusters from regions with EMEC bad HV (2016 data only)
Track to vertex association	$\|d_0^{\mathrm{BL}}(\sigma)\| < X$ $\|\Delta z_0^{\mathrm{BL}} \sin\theta\| < \mathrm{X}$ mm
Identification	`(Loose/Medium/Tight)`
Isolation	`LooseTrackOnly / Loose / Tight / Gradient / ...`

Notes:

- Pseudorapidity: when the calorimeter crack is not excluded, the range can be indicated simply as "$|\eta| < 2.47$", when the crack is excluded: "$(|\eta| < 1.37) \quad || \quad (1.52 < |\eta| < 2.47)$".
- Usually only one among "Energy", "Transverse energy" and "Transverse momentum" criteria is applied — the 30 GeV value is just an example. In special cases energy (i.e. calorimeter-based measurement) and momentum (i.e. tracking-based measurement) criteria can be required in order to constraint different aspects of the reconstruction.
- Electron ID: 3 working points (Loose/Medium/Tight) are evaluated using the Likelihood-based (LH) method, by the ElectronPhotonSelectorTools.
- Energy calibration of electrons is implemented in the ElectronPhotonFourMomentumCorrection tool.
- Scale Factors for efficiencies for electrons are implemented in the ElectronEfficiencyCorrection tool.
- Updated configurations for the EGamma CP tools can be found on this TWiki page.

4.2 Photon selection

Table 3: Photon selection criteria.

Feature	Criterion
Pseudorapidity range	$\lvert\eta\rvert < X$
Energy calibration	`es2017_R21_PRE` (ESModel)
Energy	$E >$ XX GeV
Transverse energy	$E_{\mathrm{T}} >$ XX GeV
Object quality	Not from a bad calorimeter cluster (`BADCLUSELECTRON`) Remove clusters from regions with EMEC bad HV (2016 data only)
Photon cleaning	`passOQquality`
Fudging	Applied for Full sim / not for AtlFastII
Identification	`(Loose/Tight)`
Isolation	`FixedCutTightCaloOnly / FixedCutTight / FixedCutLoose`

Notes:

- Pseudorapidity: please note that the maximum value for $|\eta|$ for photon candidates (2.37) is smaller than for electron candidates (2.47). If crack excluded: "($|\eta| < 1.37$) || ($1.52 < |\eta| < 2.37$)".
- Usually only one between "Energy" and "Transverse energy" criteria is applied — the 30 GeV value is just an example.
- Photon cleaning: a new Photon helper is available to apply the photon cleaning cut (from the `ElectronPhotonSelectorTools`, tag ≥ 00-02-92-21, release ≥ 2.4.30).
- Photon ID: 2 working points (Loose/Tight) are evaluated using a cut-based method, by the ElectronPhotonSelectorTools.
- Energy calibration of photons is implemented in the ElectronPhotonFourMomentumCorrection tool.
- Scale Factors for efficiencies for photons are implemented in the ElectronEfficiencyCorrection tool.
- Updated configurations for the EGamma CP tools can be found on this TWiki page.

4.3 Muon selection

Table 4: Muon selection criteria.

Feature	Criterion
Selection working point	`Loose/Medium/Tight /High-pT`
Isolation working point	`LooseTrackOnly/Loose/Tight/Gradient/...`
Momentum calibration	Sagitta correction [used/not used]
p_T Cut	X GeV
$\|\eta\|$ cut	$< X$
d_0 significance cut	X
z_0 cut	X mm

The selection criteria are implemented in the `MuonSelectorTools-XX-XX-XX` with `MuonMomentumCorrections-XX-XX-XX`, isolation in `IsolationSelection-XX-XX-XX` and d_0 and z_0 cuts in `xAODTracking-XX-XX-XX`. The muon recommendations can be found in MCPAnalysisGuidelinesMC16.

4.4 Tau selection

Table 5: Tau selection criteria.

Feature	Criterion
Pseudorapidity range	$\lvert\eta\rvert < X$
Track selection	1 or 3 tracks
Charge	$\lvert Q\rvert = 1$
Tau energy scale	`MVA TES`
Transverse momentum	$p_{\mathrm{T}} >$ XX GeV
Jet rejection	BDT-based (`Loose/Medium/Tight`)
Electron rejection	BDT-based
Muon rejection	Via overlap removal in $\Delta R < 0.2$ and $p_{\mathrm{T}} > 2$ GeV. Muons must not be Calo-tagged

If the crack is excluded: $(\lvert\eta\rvert < 1.37)\vert\vert(1.52 < \lvert\eta\rvert < 2.5)$

The selection criteria are all implemented in the `TauSelectionTool` as part of the `TauAnalysisTools`. Documentation can be found in the README-TauSelectionTool.rst.

4.5 Small-R jet selection

If you want to use variables such as `\fcut` you need to add the option `jetetmiss` to `atlaspackage`.

Table 6: Jet reconstruction criteria.

Feature	Criterion
Algorithm	Anti-k_t
R-parameter	0.4
Input constituent	EMTopo
Analysis release number	21.2.10
`CalibArea` tag	00-04-81
Calibration configuration	`JES_data2017_2016_2015_Recommendation_Feb2018_rel21.config`
Calibration sequence (Data)	`JetArea_Residual_EtaJES_GSC_Insitu`
Calibration sequence (MC)	`JetArea_Residual_EtaJES_GSC`
Selection requirements	
Observable	Requirement
Jet cleaning	`LooseBad`
BatMan cleaning	No
p_{T}	$>$ XX GeV
$\lvert\eta\rvert$	$< X$
JVT	(*Update if needed*) > 0.59 for $p_{\mathrm{T}} < 60$ GeV, $\lvert\eta\rvert < 0.4$

4.6 Large-R jet selection

Table 7: Large-R jet reconstruction criteria.

Feature	Criterion
Algorithm	anti-k_t
R-parameter	1.0
Input constituent	`LCTopo`
Grooming algorithm	Trimming
f_{cut}	0.05
R_{trim}	0.2
Analysis release number	21.2.10
`CalibArea` tag	00-04-81
Calibration configuration	`JES_MC16recommendation_FatJet_JMS_comb_19Jan2018.config`
Calibration sequence (Data)	`EtaJES_JMS_Insitu`
Calibration sequence (MC)	`EtaJES_JMS`
Selection requirements	
Observable	Requirement
p_{T}	$>$ XX GeV
$\lvert\eta\rvert$	$< X$
Mass	$>$ XX GeV
Boosted object tagger	
Object	Working point
W / Z / top	50% / 80%
$X \to bb$	single/double b-tagging with/without loose/tight mass

4.7 $E_{\mathrm{T}}^{\mathrm{miss}}$ selection

Table 8: $E_{\mathrm{T}}^{\mathrm{miss}}$ reconstruction criteria.

Parameter	Value
Algorithm	Calo-based
Soft term	Track-based (TST)
MET operating point	`Tight`
Analysis release	21.2.16
Calibration tag	`METUtilities-00-02-46`
Selection requirements	
Observable	Requirement
$E_{\mathrm{T}}^{\mathrm{miss}}$	$>$ XX GeV
$\sum E_{\mathrm{T}}/E_{\mathrm{T}}^{\mathrm{miss}}$	$< X$
Object-based $E_{\mathrm{T}}^{\mathrm{miss}}$ significance	$> X$

4.8 Jet flavor tagging selection

Table 9: b-tagging selection criteria.

Feature	Criterion
	EM Topo Jets / Track jets / VR jets
Jet collection	`AntiKt4EMTopo/AntiKt2PV0/AntiKtVR30Rmax4Rmin02`
Jet selection	$p_{\mathrm{T}} > \mathrm{XX}\,\mathrm{GeV}$
	$\lvert\eta\rvert < X$
	JVT cut if applicable
Algorithm	`MV2c10/MV2c10mu/MV2c10rnn/DL1/DL1mu/DL1rnn`
Operating point	Hybrid / Fixed
	Eff = 60 / 70 / 77 / 85
CDI	`2017-21-13TeV-MC16-CDI-2017-12-22_v1`

4.9 Track selection

If you use tracks as particular objects on which you cut in your analysis.

Table 10: `TrackParticle` object selection criteria.

Tracking algorithm	Primary / Large Radius Tracking / Custom
Track quality selection (official)	`Loose/Tight`
p_{T}	$>$ XX GeV
$\lvert\eta\rvert$	$< X$
Track-vertex association criteria	`Loose/Tight`
Track-to-tet association method	Ghost Matched / ΔR

4.10 Overlap removal

The reconstruction of the same energy deposits as multiple objects is resolved using the standard overlap removal tools, `AssociationUtils`, documented here

The (Standard/Heavy-flavor/Boosted/Boosted+Heavy-flavor/lepton-favored) working point is used corresponding to:

Reject	Against	Criteria
Electron	Electron	shared track, $p_{\mathrm{T},1} < p_{\mathrm{T},2}$
Tau	Electron	$\Delta R < 0.2$
Tau	Muon	$\Delta R < 0.2$
Muon	Electron	is Calo-Muon and shared ID track
Electron	Muon	shared ID track
Photon	Electron	$\Delta R < 0.4$
Photon	Muon	$\Delta R < 0.4$
Jet	Electron	[$\Delta R < 0.2$ / Not a b-jet and $\Delta R < 0.2$]
Electron	Jet	[$\Delta R < 0.4$ / $\Delta R < \min(0.4, 0.04 + 10\,\mathrm{GeV}/p_{\mathrm{T}}(e))$/None]
Jet	Muon	[`NumTrack` < 3 and (ghost-associated or $\Delta R < 0.2$) / not a b-jet and `NumTrack` < 3 and (ghost-associated or $\Delta R < 0.2$)]
Muon	Jet	[$\Delta R < 0.4$ / $\Delta R < \min(0.4, 0.04 + 10\,\mathrm{GeV}/p_{\mathrm{T}}(\mu))$/None]
Jet	Tau	$\Delta R < 0.2$
Photon	Jet	$\Delta R < 0.4$
Fat-jet	Electron	$\Delta R < 1.0$
Jet	Fat-jet	$\Delta R < 1.0$

ΔR is calculated using rapidity by default.

5 Event selection

The following items should also be filled in for the event selection. There may, of course, still be some minor open items, as long as they don't significantly affect the analysis strategy, but these should be well defined and clearly indicated (e.g. coloured/bold) in the text in this section and in the list of outstanding tasks within the executive summary. Both should be updated as the analysis progresses.

5.1 Event cleaning

Following the recommendations of the DataPrep group, the following event-level requirements are made.

We use the official GRL:

```
FILL IN HERE
```

The following event-level vetos are made to reject bad / corrupt events:

- LAr noise burst and data corruption (`xAOD::EventInfo::LAr`),
- Tile corrupted events (`xAOD::EventInfo::Tile`),
- events affected by the SCT recovery procedure for single event upsets (`xAOD::EventInfo::SCT`),
- incomplete events (`xAOD::EventInfo::Core`).

Debug stream events [have/have not] been included.

Checks [have/have not] been done to remove duplicate events.

Events are required to have a primary vertex with at least two associated tracks. The primary vertex is selected as the one with the largest Σp_{T}^2, where the sum is over all tracks with transverse momentum $p_{\mathrm{T}} > 0.4$ GeV that are associated with the vertex.

6 Background Modelling

After outlining the object and event selection, noting possible outstanding points that still need to be addressed to freeze the selection, you should demonstrate that you can analyze the dataset that you intend to publish. This should include CR/VR plots for the main backgrounds with the full data (full run-2 analyses) or at least a representative majority of the data (analyses during data-taking); for the more minor backgrounds this may still be in progress but an outline of the planned method should be present.

7 Systematic Uncertainties

Several systematics may still be missing but the note should include a proposed plan listing the CP systematics you will need to consider in this analysis (+ timescale on which they will be available if not already) and an outline of how the systematics on the backgrounds are proposed to be determined. If not statistics-limited, the most dominant systematic(s) should be present.

Systematic uncertainties arise from the reconstruction of the various physics objects and from theoretical and/or modelling uncertainties affecting the predictions for both the backgrounds and signals. These uncertainties manifest themselves as uncertainties both in the overall yield and shape of the final observable.

7.1 Experimental

A summary of the experimental systematic uncertainties taken into account in this analysis is given in Table 11, along with the shorthand name of the uncertainty used throughout the analysis.

Include also subsections for each of the individual descriptions of the uncertainty groups and the source where they come from. If the recommendation is not available at this time, state that in the section.

7.2 Theory/Modelling

Modelling uncertainties can be analysis specific in the case of the background. However, you should have a clear idea for your analysis how you will estimate these uncertainties. If you are doing an MC-based background estimation, describe the sources of these uncertainties and the comparisons that you will make. If you are doing a data driven estimation, describe the sources.

For signal yield uncertainties, these uncertainties are evaluated in a standard way and should include PDF variations and renormalization/factorization scale variations. There is more information provided on the PMG TWiki pages for this.

Systematic uncertainty	Short description
Event	
Luminosity	uncertainty on the total integrated luminosity
Electrons	
EL_EFF_Trigger_TOTAL_1NPCOR_PLUS_UNCOR	trigger efficiency uncertainty
EL_EFF_Reco_TOTAL_1NPCOR_PLUS_UNCOR	reconstruction efficiency uncertainty
EL_EFF_ID_TOTAL_1NPCOR_PLUS_UNCOR	ID efficiency uncertainty
EL_EFF_Iso_TOTAL_1NPCOR_PLUS_UNCOR	isolation efficiency uncertainty
EG_SCALE_ALL	energy scale uncertainty
EG_RESOLUTION_ALL	energy resolution uncertainty
Muons	
mu20_iloose_L1MU15_OR_HLT_mu40_MUON_EFF_Trig	trigger efficiency uncertainties (2 muon selection)
mu24_ivarmed_OR_HLT_mu40_MU_EFF_TrigStat	
mu24_ivarmed_OR_HLT_mu50_MU_EFF_TrigStat	
mu26_ivarmed_OR_HLT_mu50_MU_EFF_TrigStat	
MUON_EFF_RECO_STAT	reconstruction uncertainty for $p_T > 15$ GeV
MUON_EFF_RECO_SYS	
MUON_EFF_RECO_STAT_LOWPT	reconstruction and ID efficiency uncertainty for $p_T < 15$ GeV
MUON_EFF_RECO_SYS _LOWPT	
MUON_ISO_STAT	isolation efficiency uncertainty
MUON_ISO_SYS	
MUON_TTVA_STAT	track-to-vertex association efficiency uncertainty
MUON_TTVA_SYS	
MUONS_SCALE	energy scale uncertainty
MUONS_SAGITTA_RHO	variations in the scale of the momentum (charge dependent)
MUONS_SAGITTA_RESBIAS	variations in the scale of the momentum (charge dependent)
MUONS_ID	energy resolution uncertainty from inner detector
MUONS_MS	energy resolution uncertainty from muon system
Small-R Jets	
JET_GroupedNP	energy scale uncertainty split into 3 components
JET_SR1_JET_EtaIntercalibration_NonClosure	non-closure in the jet response at $2.4 < \|\eta\| < 2.5$
JET_SR1_JER_SINGLE_NP	energy resolution uncertainty
JvtEfficiency	JVT efficiency uncertainty
FT_EFF_EIGEN_B	b-tagging efficiency uncertainties ("BTAG_MEDIUM):
FT_EFF_EIGEN_C	
FT_EFF_EIGEN_L	
FT_EFF_EIGEN_extrapolation	b-tagging efficiency uncertainty on the extrapolation on high p_T-jets
FT_EFF_EIGEN_extrapolation_from_charm	b-tagging efficiency uncertainty on τ-jets
Large-R Jets	
FATJET_JMR	mass resolution uncertainty
FATJET_JER	energy resolution uncertainty
JET_Comb_Baseline_Kin	energy scale uncertainties (p_T and mass scales fully correlated)
JET_Comb_Modelling_Kin	
JET_Comb_TotalStat_Kin	
JET_Comb_Tracking_Kin	
Track-Jets	
FT_EFF_EIGEN_B	b-tagging efficiency uncertainties ("BTAG_MEDIUM):
FT_EFF_EIGEN_C	
FT_EFF_EIGEN_L	
FT_EFF_EIGEN_extrapolation	b-tagging efficiency uncertainty on the extrapolation on high p_T-jets
FT_EFF_EIGEN_extrapolation_from_charm	b-tagging efficiency uncertainty on τ-jets
E_T^{miss}-Trigger and E_T^{miss}-Terms	
METTrigStat	trigger efficiency uncertainty -
METTrigSyst	
MET_SoftTrk_ResoPerp	track-based soft term related to transversal resolution uncertainty
MET_SoftTrk_ResoPara	track-based soft term related to longitudinal resolution uncertainty
MET_SoftTrk_Scale	track-based soft term related to longitudinal scale uncertainty
MET_JetTrk_Scale	track MET scale uncertainty due to tracks in jets
PRW_DATASF	uncertainty on data SF used for the computation of pileup reweighting

Table 11: Qualitative summary of the experimental systematic uncertainties considered in this analysis.

8 Statistical Model/Results

An overview of the final fit setup including the final discriminating variables(s), the (SR/CR) regions to be included in the fit and the floating normalisation parameters. Some rough first expected limits/discovery sensitivity plots are useful if you have them but not necessary. In this case the binning of the final variable(s) and the systematics smoothing/pruning should be indicated.