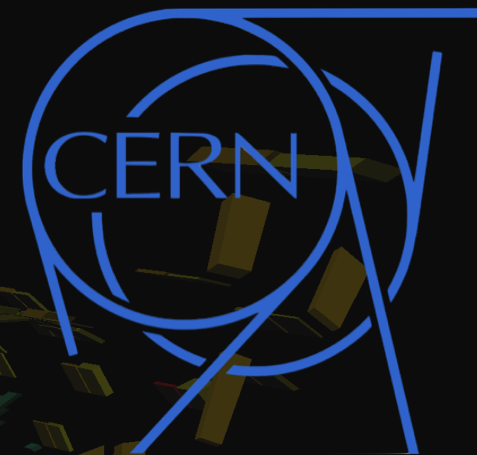




UC SANTA CRUZ



SimpleAnalysis in ATLAS

Dr. Giordon Stark 
(obo ATLAS)

December 13th, 2022


 indico.cern.ch/e/1197680/



Run: 300800

if you can read this, you're too close

Event: 2418777995

2016-06-04 03:47:03 

SA: The PUB Note

SimpleAnalysis: Generator-level Analysis Framework

The ATLAS Collaboration



Rosa Simoniello <Rosa.Simoniello@cer... Mon, Mar 28, 9:57 AM
to hn-atlas-susy-wg ▾

The week in SUSY (28 March 2022)


This is the last week of term for many subconveners in our group. We
occasion to thank Walter, Sarah, Giordon and Priscilla for their excelle
welcome Daniele, Sara, Evelyn, Lukas and Spyros to the new job!

The [SimpleAnalysis pubnote](#) is now public, nicely supporting the public release of the
framework. Many congratulations to the team and everyone who helped with the
review of this work!

Almost all Beyond the Standard Model (BSM) searches in ATLAS provide auxiliary information
uploaded to HEPData which can be used to, for example, reinterpret the search results on
other BSM models than those evaluated in the search. This information often includes
generator-level (*truth*) acceptance maps and C++ analysis code snippets defining all of the
signal regions in the analysis. Inside of ATLAS, the SimpleAnalysis generator-level analysis
framework is used to calculate the truth-level acceptance maps with the uploaded C++ analysis
fragments as well as for some systematic uncertainty evaluations. This framework is now
publicly available and presented in this note. For validation, a search for supersymmetry
(SUSY) in a final state with one lepton and two-*b*-jets is evaluated through this framework.


 **Code public earlier this year (March 25th, 2022)**

Lots of coordination

- ✧ **Coordinated** Zenodo (DOI) release and made a  public GitLab repo
- ✧ **HEPData**: ensure all (prior) HEPData entries with SA codes matched what was in the central repository
- ✧ **Analyses**: check that existing codes were correct/up-to-date and fix any outstanding bugs

Zenodo minting for SimpleAnalysis code

➤ ATLAS/SUSY/simpleanalysis x ATLAS/SUSY/summaries x

 **Giordon Stark** <gstark@cern.ch>
to Edward, Alessandro, Zachary, Brian ▼

File Name	Category
EwkThreeLeptonOffshell2018.cxx	C++ in HEPData
EwkThreeLeptonOnshell2018.cxx	C++ in HEPData
EwkThreeLeptonResonance2018.cxx	C++ in HEPData
EwkThreeLeptonRJ2018.cxx	C++ in HEPData
EwkTwoLeptonRJ2018.cxx	C++ in HEPData
EwkTwoLeptonTwoJet2018.cxx	C++ in HEPData
FourLepton2018.cxx	HEPData, but no C++
MonoJet2018.cxx	HEPData, but no C++
MultiJets2018.cxx	C++ in HEPData
OneLepton2018.cxx	C++ in HEPData
OneLeptonMultiJets2018.cxx	C++ in HEPData
SbottomTau2018.cxx	C++ in HEPData
Stoph2018.cxx	No HEPData
StopOneLepton2018.cxx	No HEPData
StopZ2018.cxx	No HEPData
ttbarLowMET0L2018.cxx	Ongoing
TwoLeptonTwoJetStrong2018.cxx	Ongoing

Search for charginos and neutralinos in all-hadronic final states has C++ on HEPData, but not in internal gitlab repository...

What's included? (I)

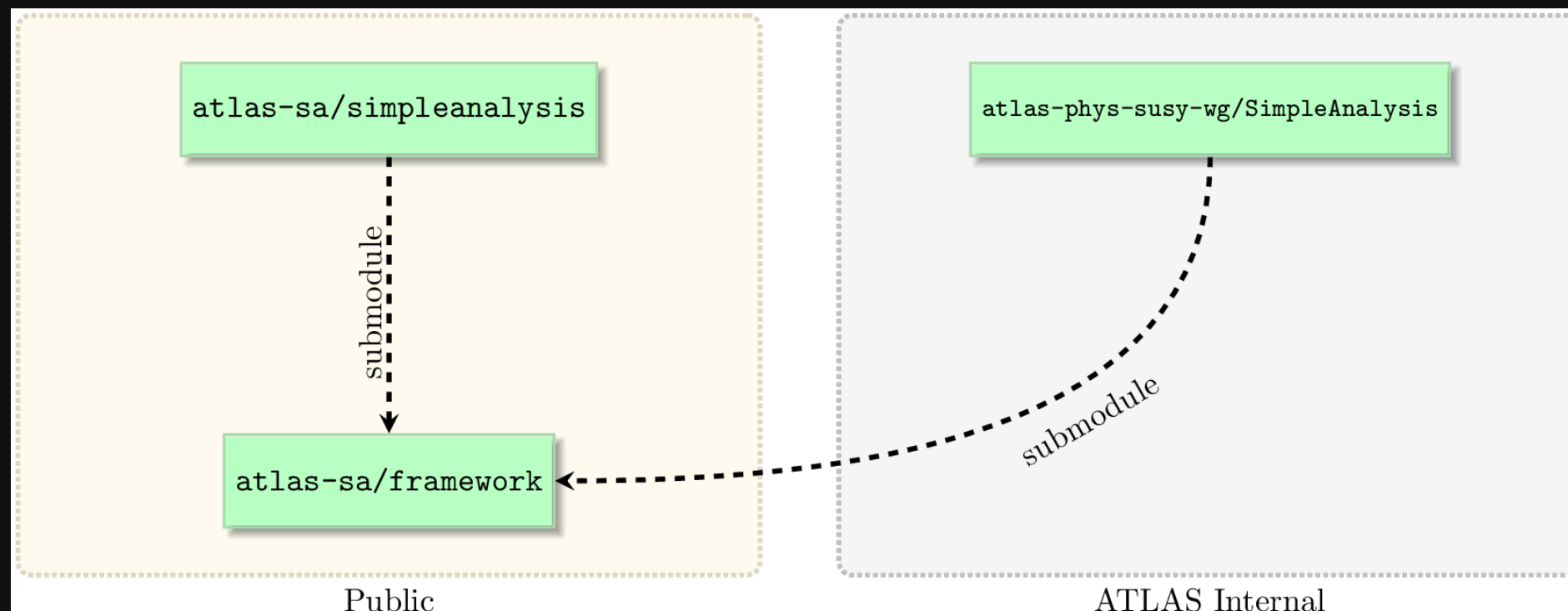
- ✧ Provides a citation for the description of acceptance and efficiency published by an analysis in ATLAS SUSY

$$\mathcal{A} = \frac{n_{\text{accept}}^{\text{generator}}}{n_{\text{total}}^{\text{generator}}}, \quad \mathcal{A} \otimes \varepsilon = \frac{n_{\text{accept}}^{\text{reco}}}{n_{\text{total}}^{\text{reco}}} \quad \Rightarrow \quad \varepsilon = \frac{\mathcal{A} \otimes \varepsilon}{\mathcal{A}} \quad (1)$$

 **CITATION.cff available!**

What's included? (II)

- Description of code (infra)structure for all the pieces
 - **Top-level:** <https://gitlab.cern.ch/atlas-sa/simple-analysis/>
 - *Internal:* <https://gitlab.cern.ch/atlas-phys-susy-wg/SimpleAnalysis/>
 - **Framework:** <https://gitlab.cern.ch/atlas-sa/framework>
 - **Documentation:** <https://simpleanalysis.docs.cern.ch/>
 - *Internal:* <https://simpleanalysis-internal.docs.cern.ch/>



PUBLIC

SimpleAnalysis, v1.1.0

[Home](#)

ATLAS Internal

Analysis List

N-Tuple Structure

Tutorial



SimpleAnalysis Tutorial

Basics



Analysis implementation




Debugging

Running

SimpleAnalysis repository

What's included? (III)

 *Delphes2SA.py script included!*

- ✦ Can run on three kinds of **inputs**: truth derivations, HEPMC, and flat n-tuples (*ATLAS Run 3 data format [PHYSLITE] in-progress*)

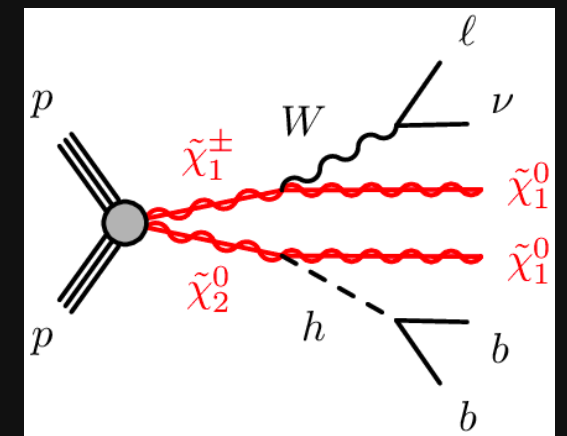
```
simpleAnalysis -a EwkOneLeptonTwoBjets2018 my-evtgen.hepmc
```

- ✦ Documentation on how to write a C++ file

```
#include "SimpleAnalysisFramework/AnalysisClass.h"  
DefineAnalysis(EwkOneLeptonTwoBjets2018)
```

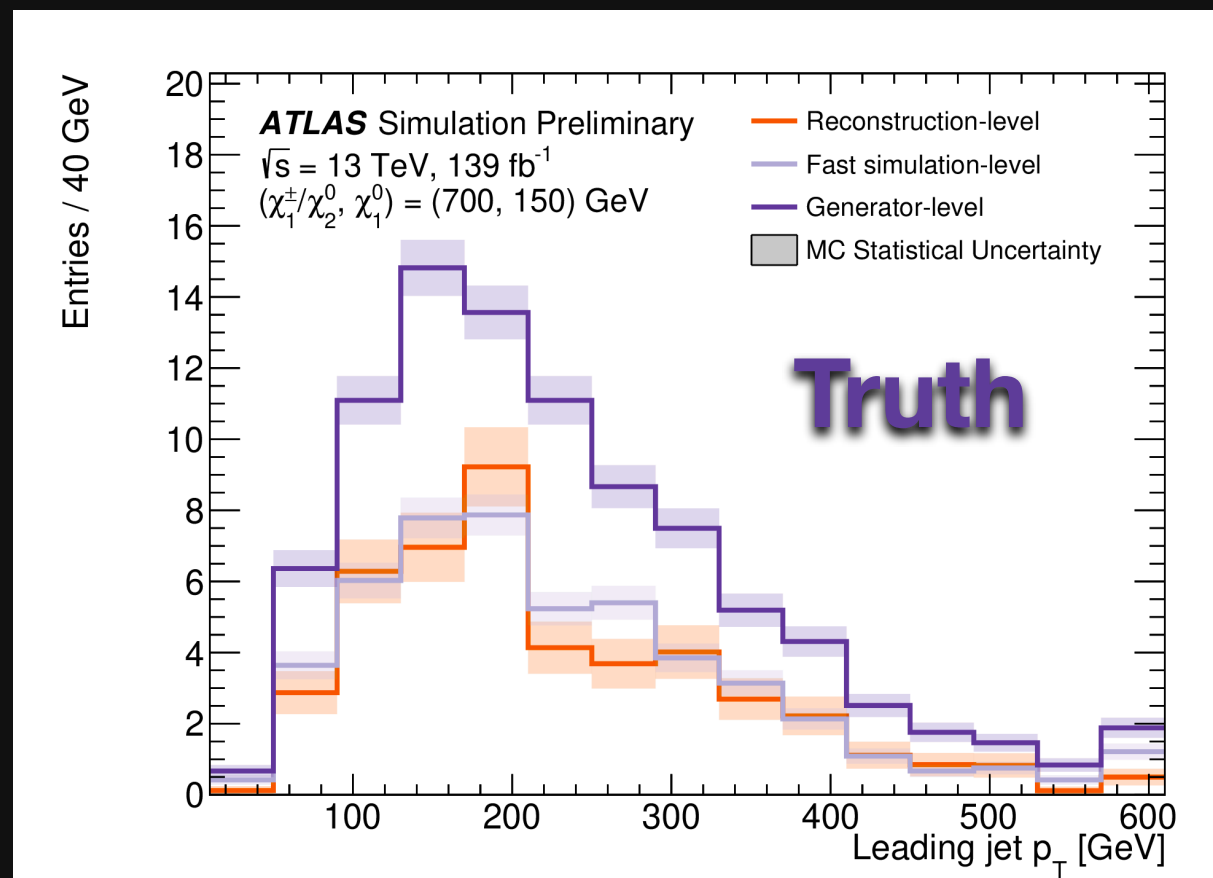
Listing 3: A snippet of SimpleAnalysisCodes/src/ANA-SUSY-2019-08.cxx [26] showing how the analysis name is defined.

What's included? (IV)

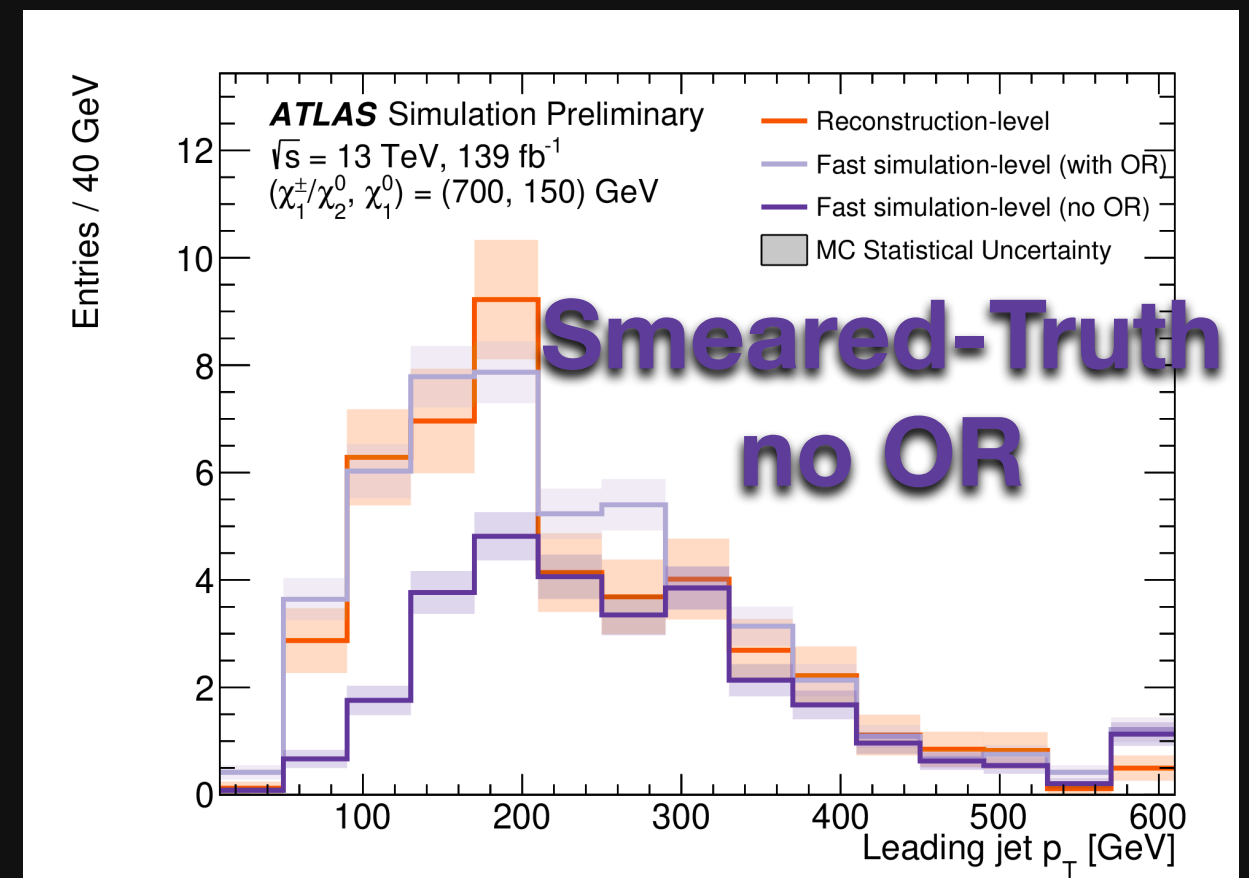


- Validation using the **EWK 1L analysis (1L2b)**, shown below for **leading jet p_T**
- Other kinematic variables (lepton p_T , m_T , MET , m_{eff} , num. b-jets) in PUB note
- Additional objects in final state **reduces selection efficiency** of the analysis

Reconstruction, Smeared-Truth



? “How well does our Run-2 smearing work?”



? “How important is overlap removal?”

What's included? (V)

- ✦ Using neural networks (NNs using ONNX, and BDTs using TMVA/MVAUtils)
 - ✦ Note: we can serialize NNs using ONNX, *but not BDTs*
 - ✦ *supports C++ for BDTs, also lwtnn and TMVAUtils*

```
// In the initialization
addONNX("4jets", "OneLeptonMultiJets2018_4jets.onnx");

...
// during event processing
MVA* = getMVA("4jets");
// input to NN supplied in vector of floats
value = MVA->evaluate(nn_input_vector);
```

Listing 8: A snippet of code showing how to include and use a neural network in an analysis.

 **See talks yesterday: Yvonne's, Dan's, and follow-up discussion**

 **Fix for ONNX file discovery:  atlas-sa/simple-analysis/!19**

What's included? (VI)

- Public documentation has auto-generated list of analyses available
 - Maps analysis name to glance identifier
 - Cross-link between ATLAS analysis public page and SA implementation in GitLab



Analysis List

Analysis Name	ATLAS Public Result page
ZeroLeptonRJigsaw2016	ANA-SUSY-2016-07
SbottomMultiB2018	ANA-SUSY-2018-31
DMbb2016	ANA-SUSY-2016-18
DMttZeroLepton2016	ANA-SUSY-2016-18
MultiJets2018	ANA-SUSY-2018-17

Check

✓ check_md_table

check_md_table - passed

Build

✓ build_docs

✓ build_image

Test

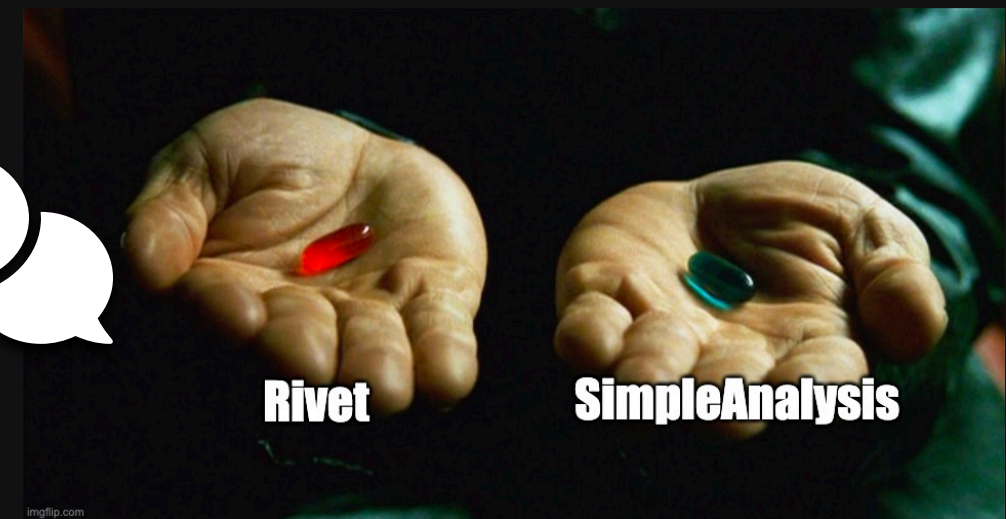
✓ check_cli

Deploy

✓ pages





✓ pages:deploy

Some Thoughts



- ✦ SimpleAnalysis and RIVET are seen as “competing”
 - ✦ In ATLAS SUSY: we don’t typically “unfold” the analysis
 - ✦ In Rivet: truth-smearing is done on a per-analysis basis *[although we do not provide any public truth-smearing with SA]*
- ✦ Historical Perspective
 - ✦ Rivet initially only focused on SM and did not do detector simulation
 - ✦ ATLAS developed SA to cover this gap, and additionally for inclusion in other tools like CheckMate (etc...) but this never happened
 - ✦ **Now: two tools that are both matured enough**
- ✦ Other uses for SA in ATLAS:
 - ✦ calculating acceptances/efficiencies
 - ✦ evaluating theory systematics (not supported by Rivet)
 - ✦ integrating with common code/tools, such as RestFrames and Stransverse Mass (MT2)
 - ✦ validating Monte Carlo signal grids
 - ✦ *from experience, validation using Rivet is trickier*

Conclusion

- ✧  Find any bugs? Send an email to atlas-phys-susy-conveners@cern.ch and atlas-phys-susy-simpleanalysis-developers@cern.ch .
- ✧  Documentation + tutorial for running: <https://simpleanalysis.docs.cern.ch/>
- ✧  LLP support needs to be revisited for Run 3, esp. with more interesting RPV models coming into play (displaced leptons, TLA RPV gluino, etc..)
- ✧  Support for ATLAS Run 3 format (PHYSLITE) coming soon