♙ CheckMATE for the LC, an idea? ♙

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Contents

The Idea

“The idea is to create a program:
You just enter a model, press a button, and it tells you whether
the model is excluded by the LHC or not.”

“Sounds great! Let’s do it!”

Minimal Running Example

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- Step 1: Decide on a SUSY parameter point `benchmark1.slha`
- Step 1: Write a very small parameter file `param.dat`,

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[squ_asq]
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MaxEvents: 1000
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Minimal Running Example

- Step 1: Decide on a SUSY parameter point `benchmark1.slha`
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- Step 2: Run `./CheckMATE param.dat`
- Wait.

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SLHAFile: /scratch/benchmark1.slha

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Minimal Running Example

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- Step 2: Run `./CheckMATE param.dat`
- Wait.

```
[Parameters]
SLHAFile: /scratch/benchmark1.slha

[squ_asq]
Pythia8Process: p p > sq sq~
MaxEvents: 1000
```

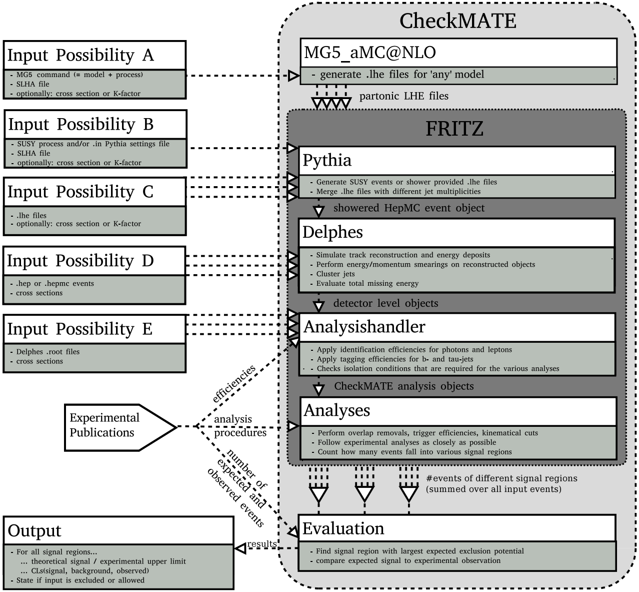
```
Result:  Allowed
Result for r: r_max = 0.74
SR: atlas_conf_2013_047 - ET
```

or

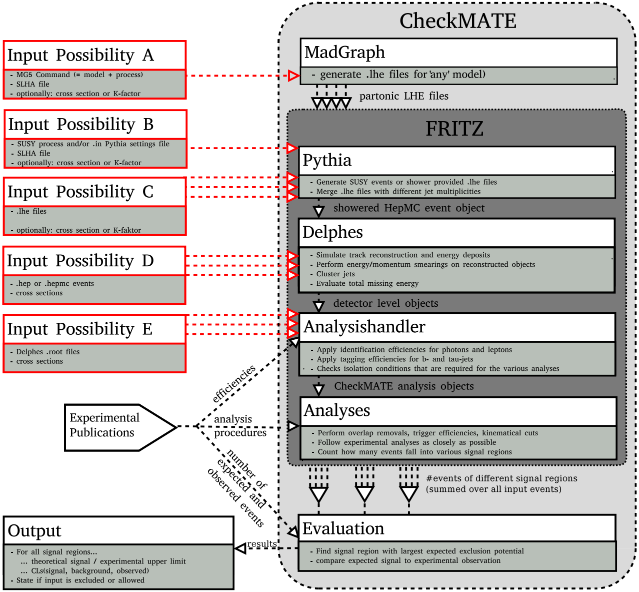
```
Result: Excluded
Result for r: r_max = 1.33
SR: atlas_conf_2013_047 - A
```

You quickly know if your model has been excluded by current LHC results without knowing anything about collider phenomenology!

Overview: Data Flow



Input



CheckMATE
Input Possibility A
- MG5 Command (= model + process)
- SLHA file
- optionally: cross section or K-factor
Input Possibility B
- SUSY process and/or .in Pythia settings file
- SLHA file
- optionally: cross section or K-factor
Input Possibility C
- .lhe files
- optionally: cross section or K-faktor
Input Possibility D
- .hep or .hepmc events
- cross sections
Input Possibility E
- Delphes .root files
- cross sections
MadGraph
- generate .lhe files for 'any' model)
partonic LHE files
FRITZ
Pythia
- Generate SUSY events or shower provided .lhe files
- Merge .lhe files with different jet multiplicities
showered HepMC event object
Delphes
- Simulate track reconstruction and energy deposits
- Perform energy/momentum smearings on reconstructed objects
- Cluster jets
- Evaluate total missing energy
detector level objects
Analysishandler
- Apply identification efficiencies for photons and leptons
- Apply tagging efficiencies for b- and tau-jets
- Checks isolation conditions that are required for the various analyses
CheckMATE analysis objects
Analyses
- Perform overlap removals, trigger efficiencies, kinematical cuts
- Follow experimental analyses as closely as possible
- Count how many events fall into various signal regions
Experimental Publications
efficiencies
analysis procedures
number of expected and observed events
#events of different signal regions
(summed over all input events)
Evaluation
- Find signal region with largest expected exclusion potential
- compare expected signal to experimental observation
results
Output
- For all signal regions...
... theoretical signal / experimental upper limit
... CLs(signal, background, observed)
- State if input is excluded or allowed

Differnt Input Methods

checkmate_input_parameter.dat

```
[Parameters]
SLHAFile: /scratch/point.slha

[squ_asq]
Pythia8Process: p p > sq sq~

[squ_squ]
MGCommand: import model mssm
    define sq = ~ul ~ur ~dl ~dr ~sl ~
    generate p p > sq sq

[glu_glu]
Events: /scratch/glu_glu.lhe

[glu_sq]
Events: /scratch/glu_squ_1.hepmc,
        /scratch/glu_squ_2.hepmc
XSect: 0.75 fb
```

Possibilities

Differnt Input Methods

checkmate_input_parameter.dat

```
[Parameters]
SLHAFile: /scratch/point.slha

[squ_asq]
Pythia8Process: p p > sq sq~

[squ_squ]
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    define sq = ~ul ~ur ~dl ~dr ~sl ~
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[glu_sq]
Events: /scratch/glu_squ_1.hepmc,
        /scratch/glu_squ_2.hepmc
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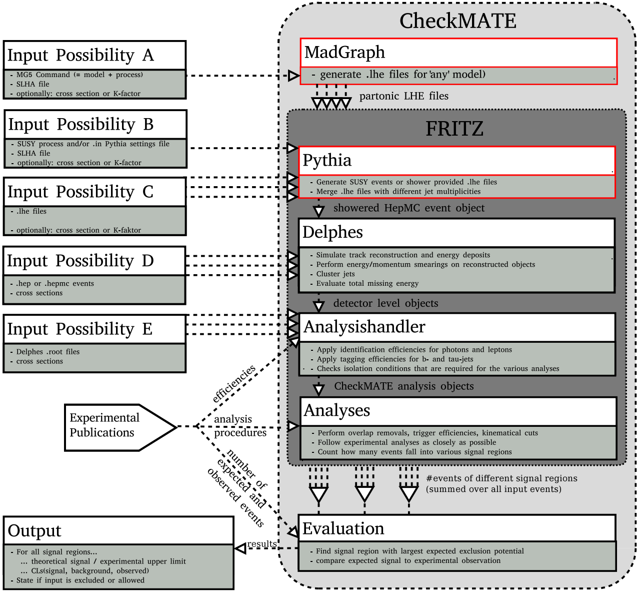
```

Possibilities

1. Internal Pythia8 for parton event generation and parton showering (*Limited to certain BSM models*)
2. Internal MG5_aMC@NLO for parton event generation, Pythia8 for parton showering (*Works for 'any' BSM model*)
3. External parton event generation, internal Pythia8 for parton showering
4. External parton showered events

Input


CheckMATE
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Experimental
Publications
efficiencies
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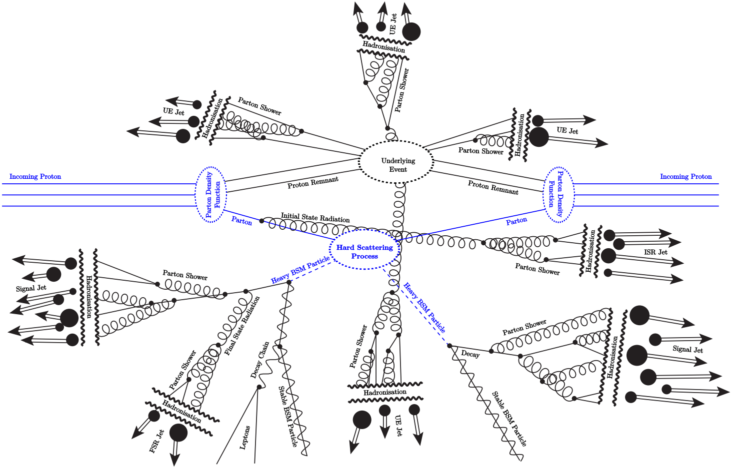
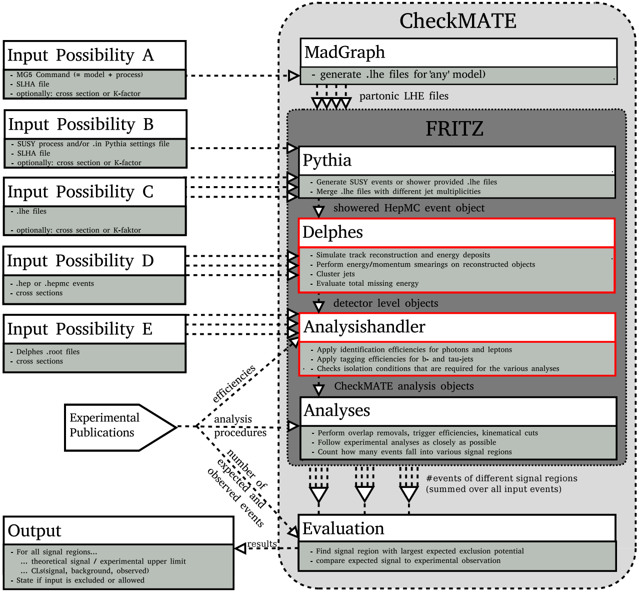
Pythia 8 Event Generation

- Simulates the result of a proton-proton collision, assuming a certain particle physics model



- Can use parton events from other programs and do the rest

Step 1: Delphes



Detector Simulation

Delphes 3.0.10 Standard

- Simulates tracking and energy deposition
- Applies efficiencies for photons and leptons
- Clusters jets
- Performs energy/momentum smearings of all reconstructed objects
- Evaluates total missing energy
- Checks isolation conditions for photons and leptons
- Applies b-/ tau-tag on jets

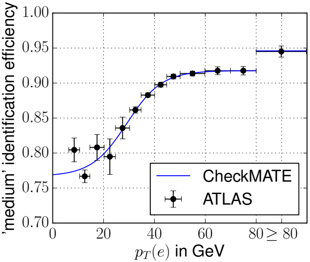
DELPHES
fast simulation

CheckMATE improvements

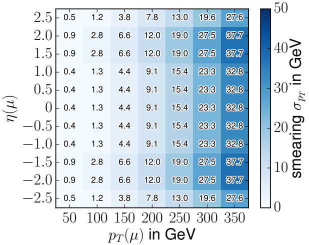
- Added identification and isolation flags
- Tuned to better represent ATLAS detector

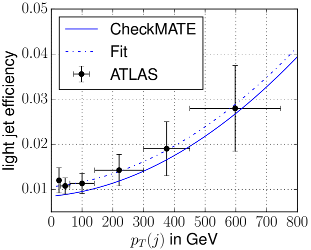
Detector Tunings — Examples

e reconstruction eff.

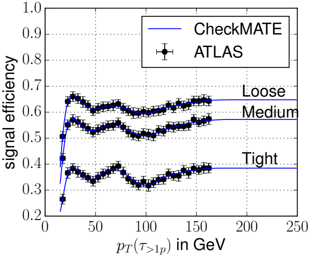


μ momentum smearing



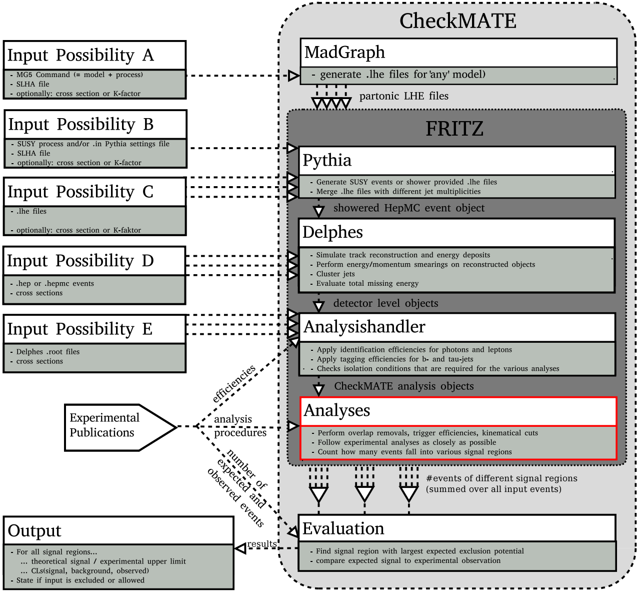


b-jet eff.



τ-jet eff.

Step 2: Analyses



Analyses

A CheckMATE analysis does the following

- Choose the objects of interest (leptons, jets,...)
- Filter objects (efficiency and isolation flags, kinematical cuts, overlap removals, ...)
- Check event vetoes (Too many/few objects, trigger efficiencies, ...)
- Check various signal region criteria (total $\not{E}_T$, # and energy of objects, ...)
- Count number of input events that fall into each signal region

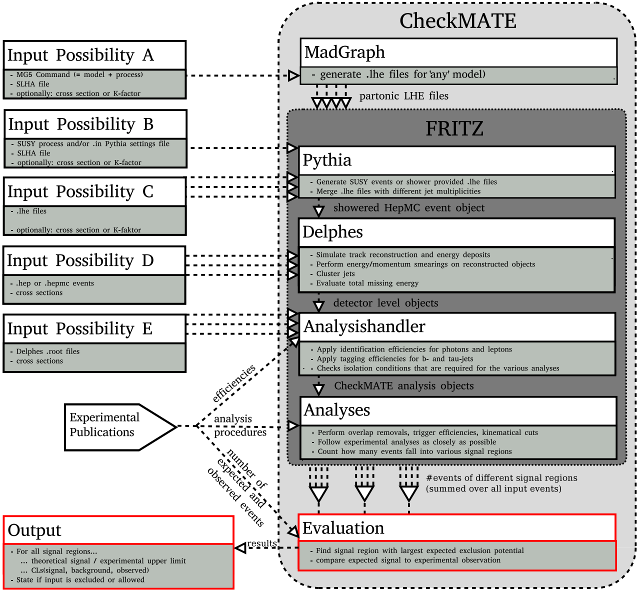
Example Output

```
# ATLAS-CONF-2013-047
# 0 leptons, 2-6 jets, etmiss
# sqrt(s) = 8 TeV
# int(L) = 20.3 fb^-1

Inputfile:        /hdd/results/cMSSM/delphes/000_delphes.root
XSect:            4.35 fb
 Error:           1.22086 fb
MCEvents:         5000
 SumOfWeights:    5000
 SumOfWeights2:   5000
 NormEvents:      87.9518

SR  Sum_W  Sum_W2  Acc     N_Norm
AL  1315   1315    0.263   23.1313
AM  71     71      0.0142  1.24892
BM  98     98      0.0196  1.72385
BT  2      2       0.0004  0.0351807
CM  505    505     0.101   8.88313
CT  9      9       0.0018  0.158313
D   184    184     0.0368  3.23663
EL  613    613     0.1226  10.7829
EM  398    398     0.0796  7.00096
ET  149    149     0.0298  2.62096
```

Step 3: Evaluation



Evaluation

Input and Setup

- We have number of expected signal $S \pm \Delta S$ in each signal region
- CheckMATE has a reference card with experimental results:
  - observed events O
  - expected background plus uncertainty $B \pm \Delta B$
  - (in most cases) translated 95% upper limit on signal $S^{95}_{\max}$

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- We have number of expected signal $S \pm \Delta S$ in each signal region
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  - (in most cases) translated 95% upper limit on signal S^{95}_{max}

User can choose

- Directly compare S to S^{95}_{max}
- If $r^{\mathsf{c}} = \frac{S-2\Delta S}{S^{95}_{\mathrm{max}}} > 1$: Excluded!
- Quick and easy for limit setting

- Evaluate $\mathrm{CL}_s(O, B, \Delta B, S, \Delta S)$
- If $\mathrm{CL}_s < 0.05$: Excluded!
- Slower, but limits can be set to different confidence levels

Example

ATLAS Reference

Signal Region	**A-loose**	**A-medium**	**B-medium**	**B-tight**
Total bkg	4700 ± 500	122 ± 18	33 ± 7	2.4 ± 1.4
Observed	5333	135	29	4
S^{95}_{obs}	1341.2	51.3	14.9	6.7
S^{95}_{exp}	$1135.0^{+332.7}_{-291.5}$	$42.7^{+15.5}_{-11.4}$	$17.0^{+6.6}_{-4.6}$	$5.8^{+2.9}_{-1.8}$

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atlas_conf_2013_047_r_limits

SR	S	dS_stat	dS_sys	dS_tot	S95_obs	S95_exp	r^c_obs	r^c_exp
AL	37.36	0.61	4.10	4.15	1341.20	1135.00	0.02	0.03
AM	5.34	0.22	0.55	0.59	51.30	42.70	0.08	0.10
BM	7.41	0.25	0.77	0.81	14.90	17.00	0.39	0.34
BT	0.86	0.07	0.10	0.12	6.70	5.80	0.09	0.11
CM	17.82	0.43	1.99	2.04	81.20	72.90	0.17	0.19
CT	2.40	0.12	0.28	0.31	2.40	3.30	0.75	0.54
D	12.14	0.34	1.29	1.33	15.50	13.60	0.61	0.70
EL	21.26	0.46	2.35	2.39	92.40	57.30	0.18	0.29
EM	16.14	0.40	1.79	1.83	28.60	21.40	0.44	0.59
ET	7.95	0.28	0.87	0.91	8.30	6.50	0.74	0.95

Example

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Result

```
Result: Allowed
Result for r: r_max = 0.74
SR: atlas_conf_2013_047 - ET
```

atlas_conf_2013_047_r_limits

SR	S	dS_stat	dS_sys	dS_tot	S95_obs	S95_exp	r^c_obs	r^c_exp
AL	37.36	0.61	4.10	4.15	1341.20	1135.00	0.02	0.03
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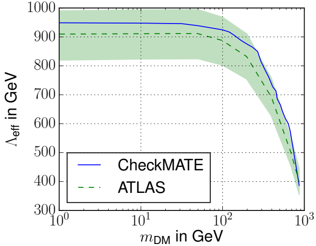
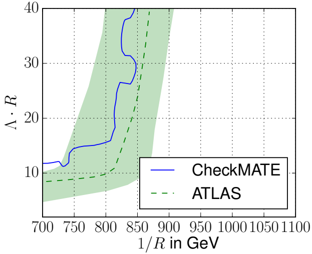
Performance Test via Models

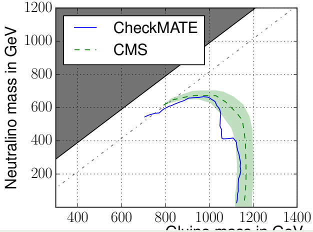
Effective DM via `atlas_1502_01518`



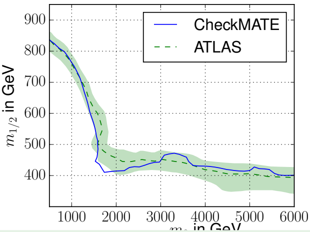
UED via `atlas_conf_2013_089`



Simple SUSY via `cms_1303_2985`



MSUGRA via `atlas_conf_2013_047`



CheckMATE is a model-independent tool!

α / Fully Validated Analyses

Name	Search designed for	$\sqrt{s}$	L	N_{SR}
atlas_1308_1841	new phenomena in final states with large jet multiplicities and $\not{E}_T$	8	20.3	19
atlas_1308_2631	third-generation squark pair production with $\not{E}_T$ and two b-jets	8	20.1	6
atlas_1402_7029	charginos and neutralinos in events with 3 leptons and $\not{E}_T$	8	20.3	24
atlas_1403_4853	top-squark pair production in final states with two leptons	8	20.3	12
atlas_1404_2500	SUSY with jets and two same-sign leptons or three leptons	8	20.3	5
atlas_1403_5222	top squark pair production in events with a Z boson, b-jets and $\not{E}_T$	8	20.3	5
atlas_1405_7875	squarks and gluinos in final states with jets and $\not{E}_T$	8	20.3	15
atlas_1407_0583	stop pair production in final states with one isolated lepton, jets, and $\not{E}_T$	8	20.3	27
atlas_1407_0608	pair-produced third-generation squarks decaying via charm quarks or in compressed supersymmetric scenarios	8	20.3	3
atlas_1502_01518	new phenomena in final states with an energetic jet and large $\not{E}_T$	8	20.3	9
atlas_1503_03290	Supersymmetry in events containing a same-flavour opposite-sign dilepton pair, jets, and large $\not{E}_T$	8	20.3	1
atlas_1506_08616	pair production of third-generation squarks	8	20.3	11
atlas_conf_2012_104	Supersymmetry in final states with jets, $\not{E}_T$ and one isolated lepton	8	5.8	2
atlas_conf_2012_147	new phenomena in monojet plus $\not{E}_T$ final states	8	10	4
atlas_conf_2013_024	production of the top squark in the all-hadronic $t\bar{t}$ and $\not{E}_T$ final state	8	20.5	3
atlas_conf_2013_049	direct-slepton and direct-chargino production in final states with two opposite-sign leptons, $\not{E}_T$ and no jets	8	20.3	9
atlas_conf_2013_061	strong production of supersymmetric particles in final states with $\not{E}_T$ and at least three b-jets	8	20.1	9
atlas_conf_2013_089	strongly produced supersymmetric particles in decays with two leptons	8	20.3	12
atlas_conf_2015_004	invisibly decaying Higgs boson produced via vector boson fusion	8	20.3	1
cms_1303_2985	supersymmetry in hadronic final states with missing transverse energy using the variables α_T and b-quark multiplicity	8	11.7	59
cms_1408_3583	dark matter, extra dimensions, and unparticles in monojet events	8	19.7	7
cms_1502_06031	BSM physics in events with two Leptons, jets, and $\not{E}_T$	8	19.4	6
cms_1504_03198	production of dark matter in association with top-quark pairs in the single-lepton final state	8	19.7	1
cms_sus_13_016	new physics in events with same-sign dileptons and jets	8	19.5	1

β / Partially Validated Analyses

Name	Search designed for	$\sqrt{s}$	L	N_{SR}
atlas_1210_2979	WW production	7	4.6	1
atlas_1403_5294	charginos, neutralinos and sleptons with 2 leptons and $\not{E}_T$	8	20.3	13
atlas_1407_0600	strong production of SUSY particles with $\not{E}_T$ and at least 3 b-jets	8	20.1	9
atlas_1411_1559	new phenomena in events with a photon and $\not{E}_T$	8	20.3	1
atlas_conf_2013_021	WZ production	8	20.3	4
atlas_conf_2013_031	spin properties of h in $h \to WW^{(*)} \to e\nu\mu\nu$	8	20.7	2
atlas_conf_2013_036	Supersymmetry in events with four or more leptons	8	20.7	5
atlas_conf_2013_062	squarks and gluinos in events with isolated leptons, jets and $\not{E}_T$	8	20.1	19
atlas_conf_2014_014	$\tilde{t}\tilde{t}^*$ decaying to a b, a τ and weakly interacting particles	8	20.3	1
atlas_conf_2014_033	WW production	8	20.3	3
atlas_conf_2014_056	spin correlation in top–antitop$t\bar{t}$ events and search for $\tilde{t}\tilde{t}^*$	8	20.3	1
cms_1301_4698_WW	WW production	8	3.5	1
cms_1306_1126_WW	WW production	7	4.92	1
cms_1405_7570	$\tilde{\chi}^{\pm}$, $\tilde{\chi}^0$, $\tilde{\ell}$ to leptons andℓ, W, Z, and Higgs bosons	8	19.5	57
cms_smp_12_006	WZ production into 3ℓ	8	19.6	4
cms_sus_12_019	New physics with two OSSF ℓ, jets, and $\not{E}_T$	8	19.4	4
atlas_1602_09058	SUSY with jets and 2 same-sign leptons or 3 leptons	13	3.2	4
atlas_1604_07773	New physics with monojets	13	3.2	13
atlas_1604_01306	New physics with monophotonrs	13	3.2	1
atlas_1605_03814	squarks and gluinos in final states with jets and $\not{E}_T$	13	3.2	7
atlas_1605_04285	gluinos in events with an isolated lepton, jets and$\not{E}_T$	13	3.3	7
atlas_1605_09318	$\tilde{g}\tilde{g}$ decaying via stop and sbottom in events with b-jets and $\not{E}_T$	13	3.3	8
atlas_1606_03903	stops in events with an isolated lepton, jets and$\not{E}_T$	13	3.2	3
atlas_conf_2015_082	leptonic Z + jets + $\not{E}_T$	13	3.2	1
atlas_conf_2016_013	vector like quarks	13	3.2	10
atlas_conf_2016_050	stops in events with an isolated lepton, jets and$\not{E}_T$	13	13.3	5
atlas_conf_2016_076	SUSY with 2 leptons + jets + $\not{E}_T$	13	13.3	6
cms_pas_sus_15_011	SUSY with 2 leptons + jets + $\not{E}_T$	13	2.2	47
...	some 14 TeV Highlumi analyses	14	300/3000	

The Idea

“The idea is to create a program:
You just enter a model, press a button, and it tells you whether the model is excluded by the LHC or not.”

“Sounds great! Let’s do it!”

Another Idea

*“The idea is to create a program:
You just enter a model, press a button, and it tells you whether the model can be excluded by the (current or future) LHC or not.”*

“Sounds great! And guess what? You can already do that!”

Testing existing vs testing future results

Implementing an analysis

- `CheckMATE` has an interactive `AnalysisManager` executable which greatly aids adding a new analysis to the existing structure.
- It asks whether you implement an **existing** analysis or a **’new’** analysis

Testing existing vs testing future results

Implementing an analysis

- CheckMATE has an interactive AnalysisManager executable which greatly aids adding a new analysis to the existing structure.
- It asks whether you implement an **existing** analysis or a **’new’** analysis

- If the analysis **exists**, one knows observation O and background B and therefore one has to provide these numbers for all signal regions

Signal Region	**A-loose**	**A-medium**	**B-medium**	**B-tight**
Total bkg	4700 ± 500	122 ± 18	33 ± 7	2.4 ± 1.4
Observed	5333	135	29	4
$S^{95}_{\rm obs}$	1341.2	51.3	14.9	6.7
$S^{95}_{\rm exp}$	$1135.0^{+332.7}_{-291.5}$	$42.7^{+15.5}_{-11.4}$	$17.0^{+6.6}_{-4.6}$	$5.8^{+2.9}_{-1.8}$

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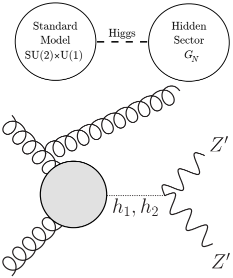
- If the analysis is **new**, `CheckMATE` skips this stage and adds a preliminary analysis which can not be used for testing
- The user then has to
  1. implement the event selection analysis code (as usual),
  2. run Standard Model background samples through `CheckMATE` to determine `B`
  3. use the `AnalysisManager` to add this number to the analysis, thereby removing the preliminary status.

A quickly outlined application: Monojets@14 TeV

The Higgs Portal @ 14 TeV

- Explain Dark Matter through a stable gauge boson of a new “dark” gauge group
- Assume scalar singlet X which couples to dark gauge bosons Z' via $\tilde{g}$
- X mixes with the Higgs H of the Standard Model $\rightarrow$ mixing angle $\sin\alpha$

$$\mathcal{L} = \mathcal{L}_{\text{SM}} - \frac{1}{4} F'_{\mu\nu} F'^{,\mu\nu} + (D_\mu X)^\dagger D^\mu X - \lambda_{hx}\, H^\dagger H X^\dagger X - \mu_x X^\dagger X - \frac{\lambda_x}{4} (X^\dagger X)^2$$



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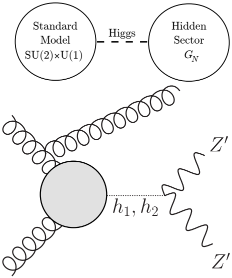

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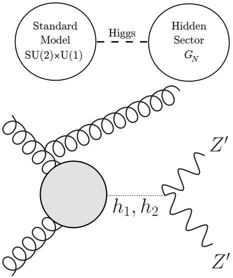

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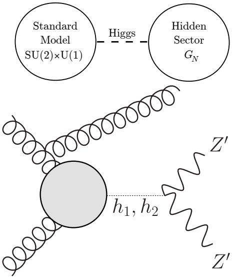

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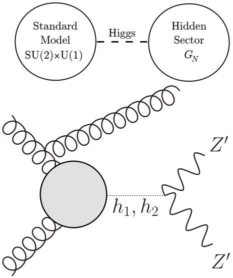

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- Afterwards we ran on signal samples as usual, to determine limits on masses and branching ratios.

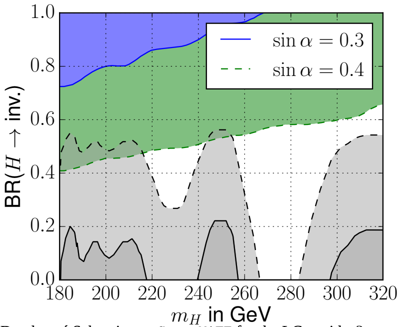
Results

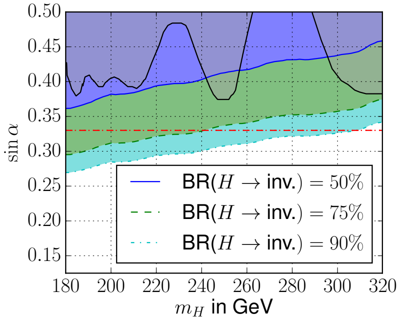
Background Number Estimates

SR	Zj	Wj	$t\bar{t}$	total	example signal	$S/\sqrt{B}$
M1	2,378,934	2,024,466	67,821	4,471,221	5597	2.6
M2	742,710	442,296	13,327	1,198,333	2065	1.9
M3	207,804	102,852	2,656	313,312	638	1.1
M4	80,730	30,036	1,118	111,884	398	1.2
M5	33,252	11,610	625	45,487	251	1.2

(Signal: $m_H = 200$ GeV, $\sin\alpha = 0.3$ and BR($H \to$ invisible) $= 0.75$)

more on the physics can be found in `arXiv:1507.08673`





Another Idea

*“The idea is to create a program:
You just enter a model, press a button, and it tells you whether the model can be excluded by the (current or future) LHC or not.”*

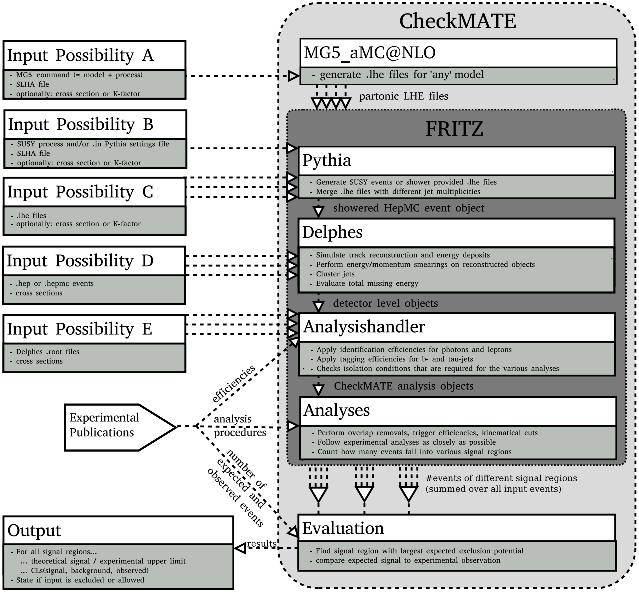
“Sounds great! And guess what? You can already do that!”

Yet another Idea

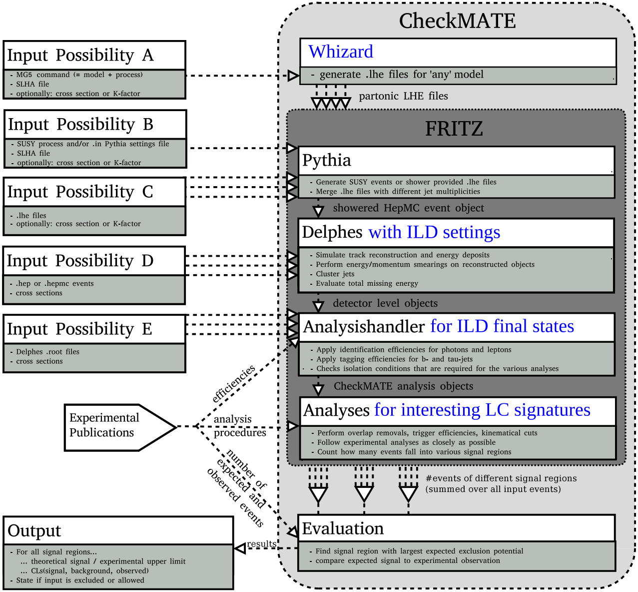
“The idea is to create a program:
You just enter a model, press a button, and it tells you whether the model can be excluded by a Linear Collideror not.”

“Sounds great! Shouldn’t be too difficult to do within the existing framework”

Overview: Data Flow



What needs to be done



Event Generation

- Use `Whizard` for a more realistic description of e^+e^- collisions, including polarisation effects

Detector Simulation

- Use existing `Delphes` ILD card, maybe refine

Analyses

- Implement interesting BSM searches

Analyses and Applications

What could this be used for and which searches should be implemented

- For now, CheckMATE can only do cut-and-count based searches, so these would be the easiest
  - Monophoton searches (always interesting for general Dark Matter studies)
  - Electroweakino searches (can often be used for general BSM models with particles which decay into SM-bosons
  - . . . (<- ideas are very much appreciated!)
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- With more effort, shape based searches might be implemented too (mostly a matter of adding the statistical tools)
  - . . . (<- ideas are very much appreciated which distributions might be interesting for general BSM studies!)
- In all cases, combining the expected results for ILC-subruns with different e^+e^--polarisations can be implemented easily

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Every project which uses such a tool could provide an additional motivation for a linear collider!

Conclusions

- CheckMATE is a very simple to use LHC phenomenology tool
- It can be used to check against existing results **or** to do prospective studies
- Performing prospective studies at the linear collider might also be interesting
- What would need to be implemented:
  - Whizard event generator for simulation of e^+e^- collisions of 'any' model
  - ILD detector card in Delphes
  - Some interesting cut-and-count searches
  - Some interesting shape-based searches plus the respective statistical tools
- This project is at a very early stage, so ideas or comments are appreciated!

http://checkmate.hepforge.org/

Conclusions

Go ahead and have a look!

http://checkmate.hepforge.org/

And talk to me if you have questions or ideas!

The Analysis Manager

Running the Analysis Manager

- Run `make AnalysisManager; /bin/AnalysisManager`

```
  ____ _               _    __  __    _  _____ _____
 / ___| |__   ___  ___| | _|  \/  |  / \|_   _| ____|
| |   | '_ \ / _ \/ __| |/ / |\/| | / _ \ | | |  _|
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                            /                      _/

What do you want?
  -(l)ist all analyses,
  -(a)dd a new analysis to CheckMATE,
  -(r)emove an analysis from CheckMATE]
```

The Analysis Manager

Adding an analysis

```
    a
This will collect all necessary information to create a full analysis and
Takes care for the creation and implementation of the source files into the code.
Please answer the following questions.
Attention: Your input is NOT saved before you finish this questionnaire.
1. General Information to build analysis
Analysis Name:
       ATLAS_1234_5678
Description (short, one line):
       ATLAS: many leptons, few jets
Description (long, multiple lines, finish with ';;' on a new line):
       ATLAS
       many leptons, few jets
       sqrt(s) = 9 TeV
       int(L) = 42 fb^-1
       ;;
Luminosity (in fb^-1):
       42
Do you plan to implement control regions to that analysis? [(y)es, (n)o)
       n
```

The Analysis Manager

Adding an analysis

```
2. Information on Signal Regions
List all signal regions (one per line, finish with ';;' on a new line):
 1l
 2l
[...]
Is the SM expectation B known? [(y)es, (n)o]?
```

```
 y
You now have to add the
numbers for each of the
given signal regions.
1l
obs:
 100
bkg:
 90
bkg_err:
 15
2l
obs:
 200
bkg:
 180
bkg_err:
 30
[...]
```

```
 n
Signal regions are registered but without any
numbers associated to them.
IMPORTANT: The analysis will be created and can
then be used like any other analysis.
CheckMATE will skip the model exclusion
tests as long as the expectation is not
known. You can e.g. use CheckMATE on background
samples to estimate B and dB. As soon as
you know these numbers, run the
AnalysisManager again and use the (e)dit
feature to add them.
```

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```

Add a published analysis

- Provide results straight away
- Typical mode for 8 and 13 TeV

```
[...]
```

Add a new analysis

- run on SM backgrounds first
- add these results to CM
- Typical mode to project to 13 and 14 TeV and to invent new cutflows

The Analysis Manager

Adding an analysis

```
3. Settings for Detector Simulation
3.1: Miscellaneous
To which experiment does the analysis correspond? (A)TLAS, (C)MS
 A
3.2: Electron Isolation
Do you need any particular isolation criterion? [(y)es, (n)o]
 y
Isolation 1:
Which objects should be considered for isolation? [(t)racks, (c)alo objects?
 t
What is the minimum pt of a surrounding object to be used for isolation? [in GeV]
 5
What is the dR used for isolation?
 0.4
Is there an absolute or a relative upper limit for the surrounding pt? [(a)bsolute, (r)elative]
 a
What is the maximum surrounding pt used for isolation [in GeV]?
 20

Do you need more isolation criteria? [(y)es, (n)o]
 n
3.3: Muon Isolation
Do you need any particular isolation criterion? [(y)es, (n)o]
 n
3.4: Photon Isolation
Do you need any particular isolation criterion? [(y)es, (n)o]
 n
```

The Analysis Manager

Adding an analysis

```
3.5: Jets
Which dR cone radius do you want to use for the FastJet algorithm?
 0.4
What is the minimum pt of a jet? [in GeV]
 10
Do you need a separate, extra type of jet? [(y)es, (n)o]
 n
Do you want to use b-tagging? [(y)es, (n)o]
 y

b-Tagging 1:
What is the signal efficiency to tag a b-jet? [in %]
 70
Do you need more b tags? [(y)es, (n)o]
 y

b-Tagging 2:
What is the signal efficiency to tag a b-jet? [in %]
 40
Do you need more b tags? [(y)es, (n)o]
 n

Do you want to use tau-tagging? [(y)es, (n)o]
 n
```

The Analysis Manager

Adding an analysis

```
- Variable values saved in /hdd/sandbox/managertest/data/atlas_conf_2013_047X_var.j
- Created source file    /hdd/sandbox/managertest/tools/analysis/src/atlas_conf_2013_047X.cc
- Created header file    /hdd/sandbox/managertest/tools/analysis/include/atlas_conf_2013_047X.h
- Updated Makefile
- Updated main source    main.cc
- Reference file created
- List of analyses updated
Analysis atlas_conf_2013_047X has been added successfully!
Run 'make' from the main CheckMATE folder to compile it!
```

Some example lines

```
void Atlas_conf_2013_047::analyze() {
  missingET->addMuons(muonsCombined);
  electronsLoose = filterPhaseSpace(electronsLoose, 10., -2.47, 2.47
  muonsCombined = filterPhaseSpace(muonsCombined, 10., -2.4, 2.4);
  jets = filterPhaseSpace(jets, 20., -2.8, 2.8);
  [...]
  jets = overlapRemoval(jets, electronsLoose, 0.2);
  electronsLoose = overlapRemoval(electronsLoose, jets, 0.4);
  if(!electronsLoose.empty())
  return;
  [...]
  double HT = 0.;
  for(int j = 0; j < jets.size(); j++)
  HT += jets[j]->PT;
  double mEffInc = missingET->P4().Et() + HT;
  [...]
  mEffA = missingET->P4().Et() + jets[0]->PT + jets[1]->PT;
  if (missingET->P4().Et()/mEffA > 0.2) {
    countCutflowEvent("AL1");
    if (mEffInc > 1000.)
    countSignalEvent("AL");
  }
  [...]
```