CheckMATE Tutorial

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Outline

- CheckMATE Introduction
- Input: Event File
- Input: Pythia 8
- Input: Madgraph_aMC@NLO and Pythia 8
- AnalysisManager
- Online Tutorial
- Help!!!

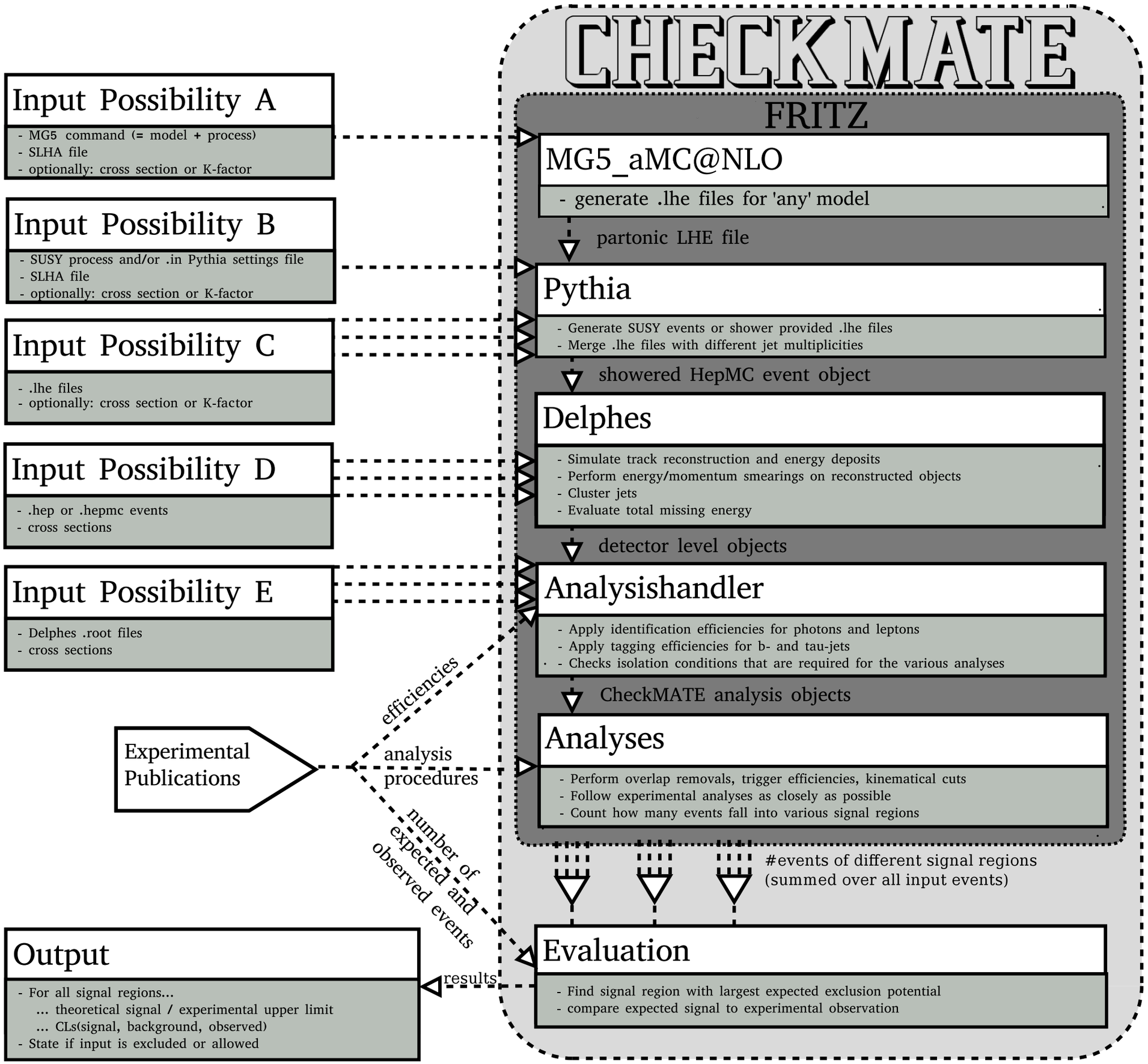
How to install CheckMATE2

- please follow the instructions at http://checkmate.hepforge.org/tutorial/ver2/start.php

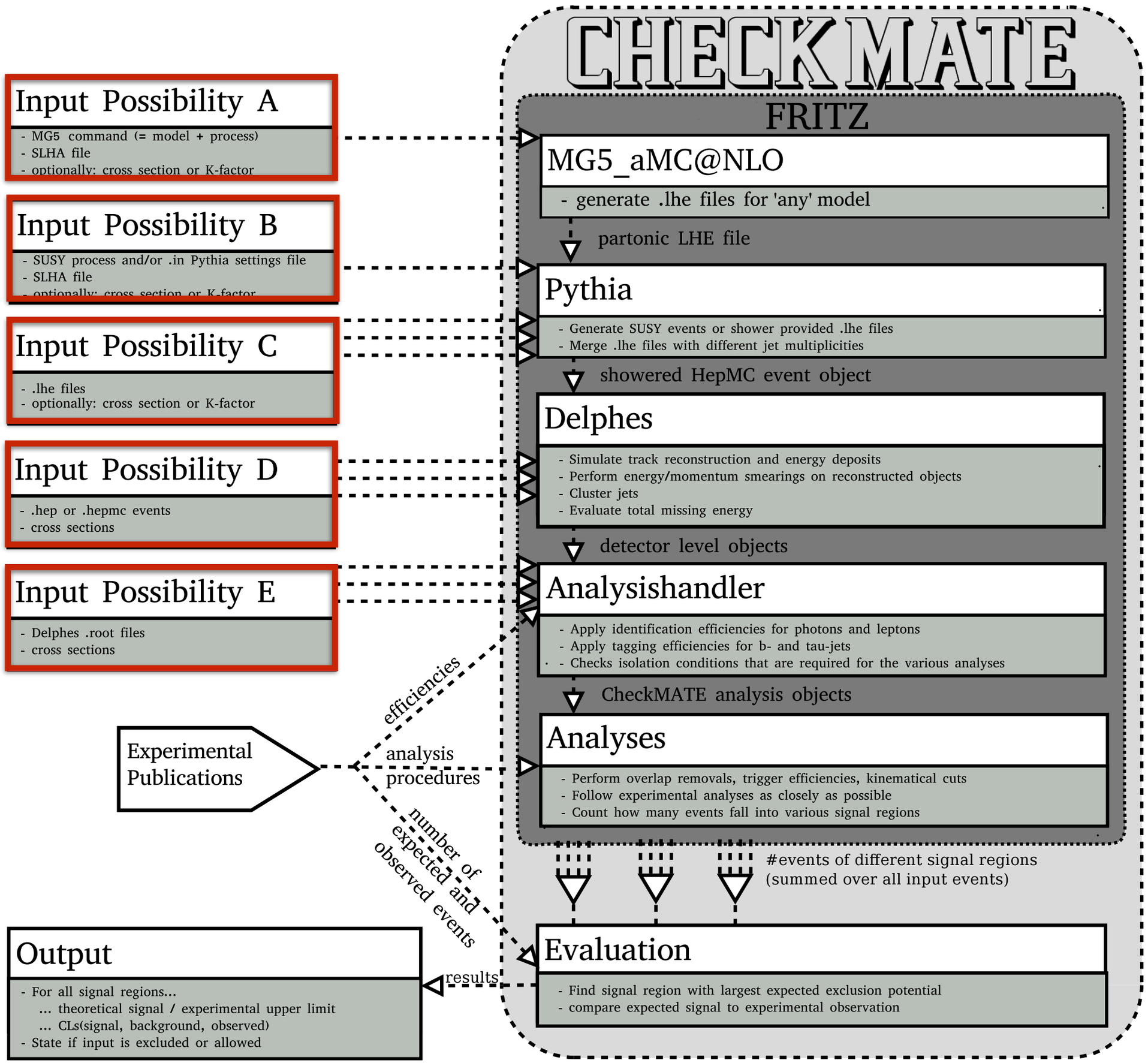
- you can also install the virtual disk http://www.th.physik.uni-bonn.de/people/jsk/

CheckMATE in a Nutshell

- CM tests models against LHC constraints
- CM is based on Delphes
  - we have tuned the 8 TeV and 13 TeV ATLAS detector
  - many LHC searches are implemented
  - there are various way to provide truth level MC events to CM



D. Dercks, N. Desai, M. Drees, H. Dreiner, JSK, K. Rolbiecki, J. Tattersall, T. Webber



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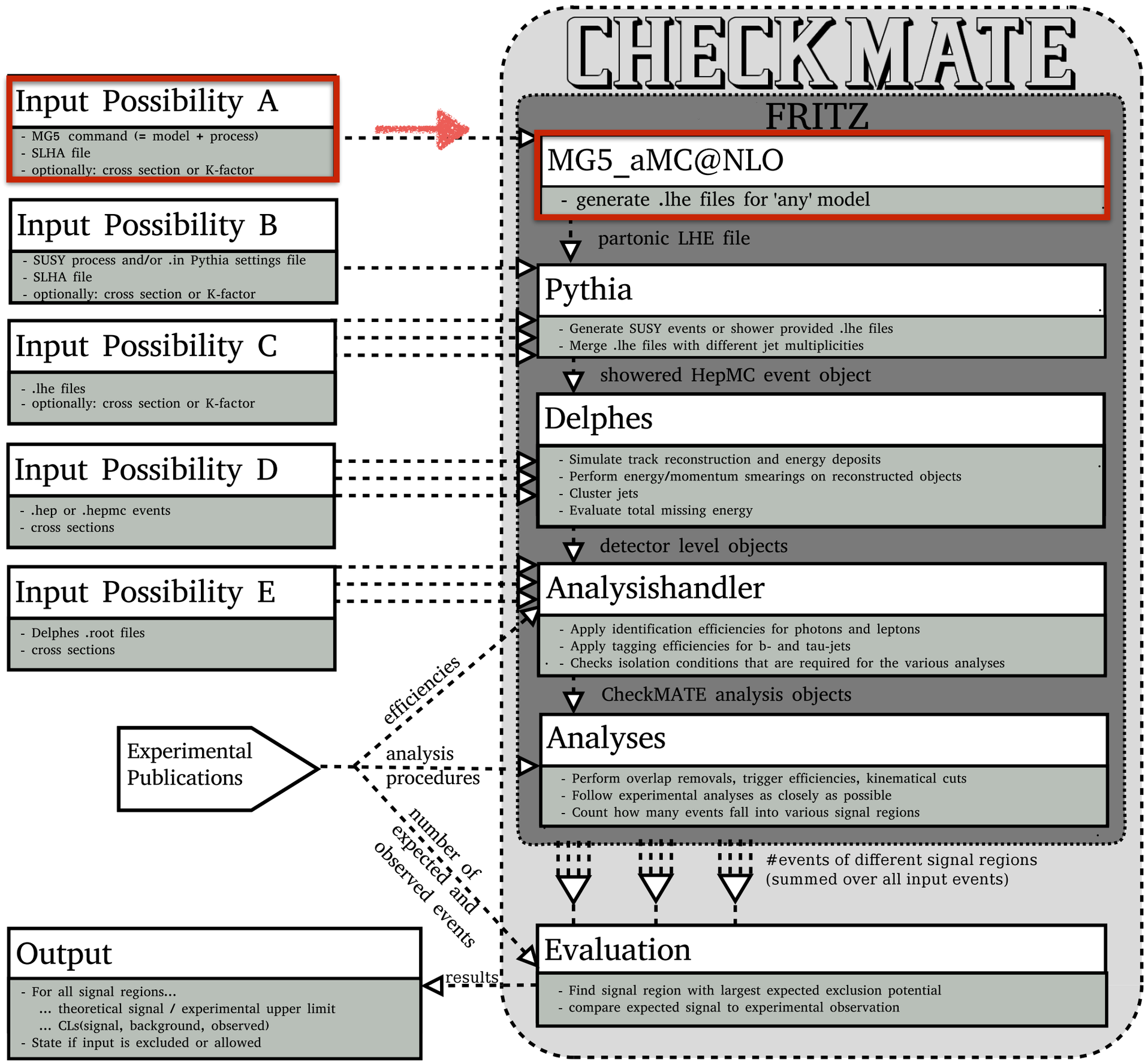

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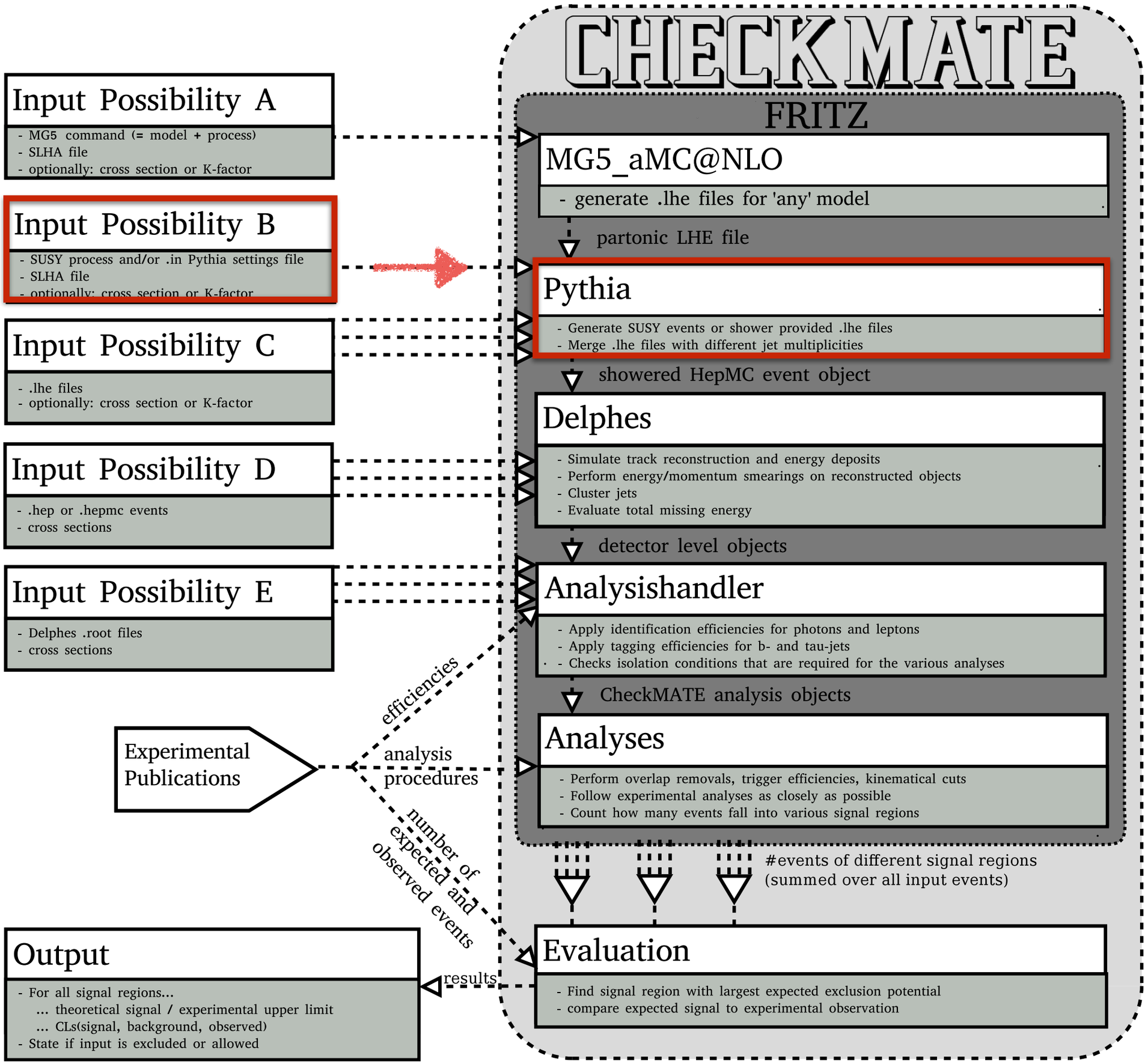

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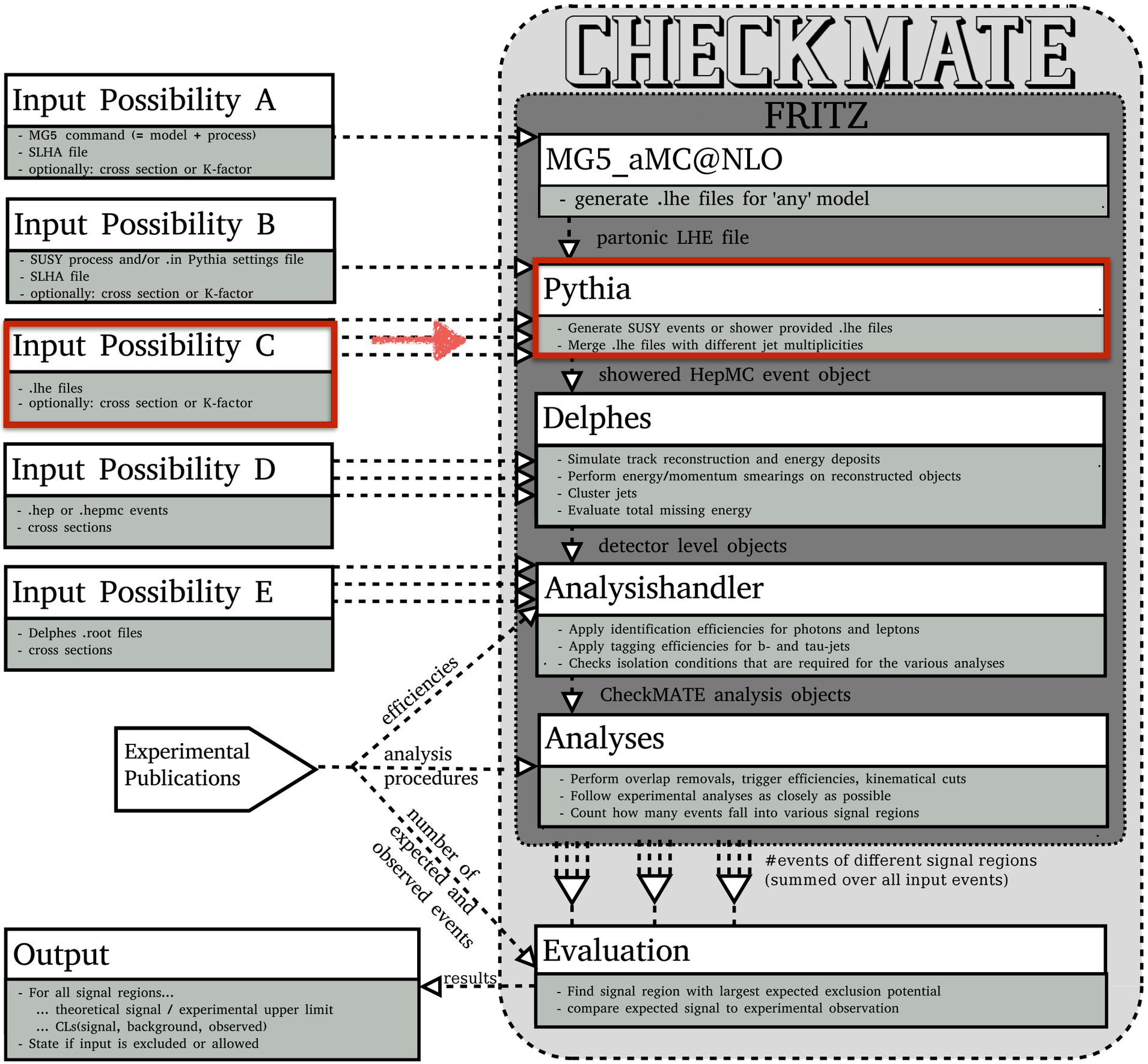

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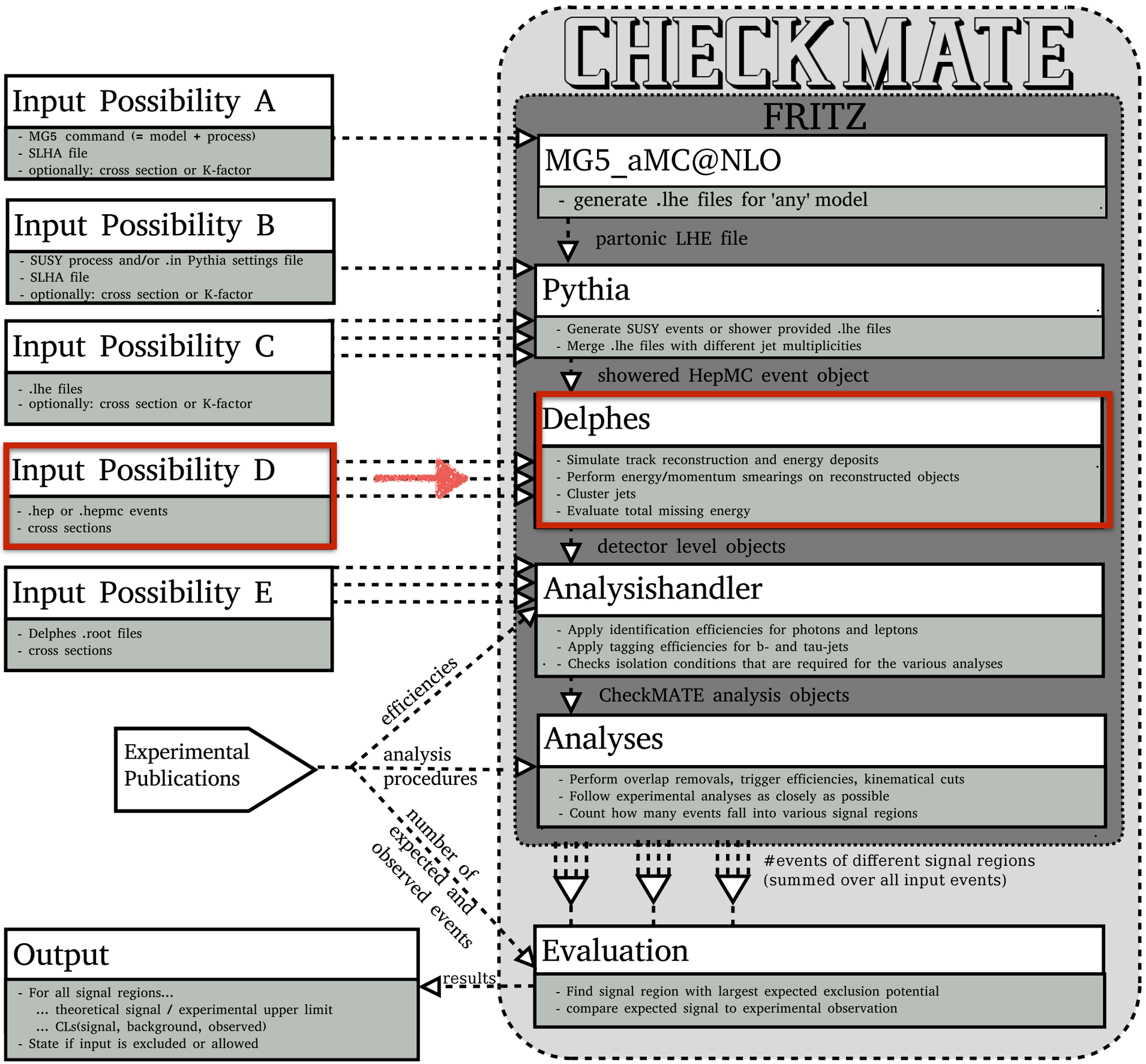

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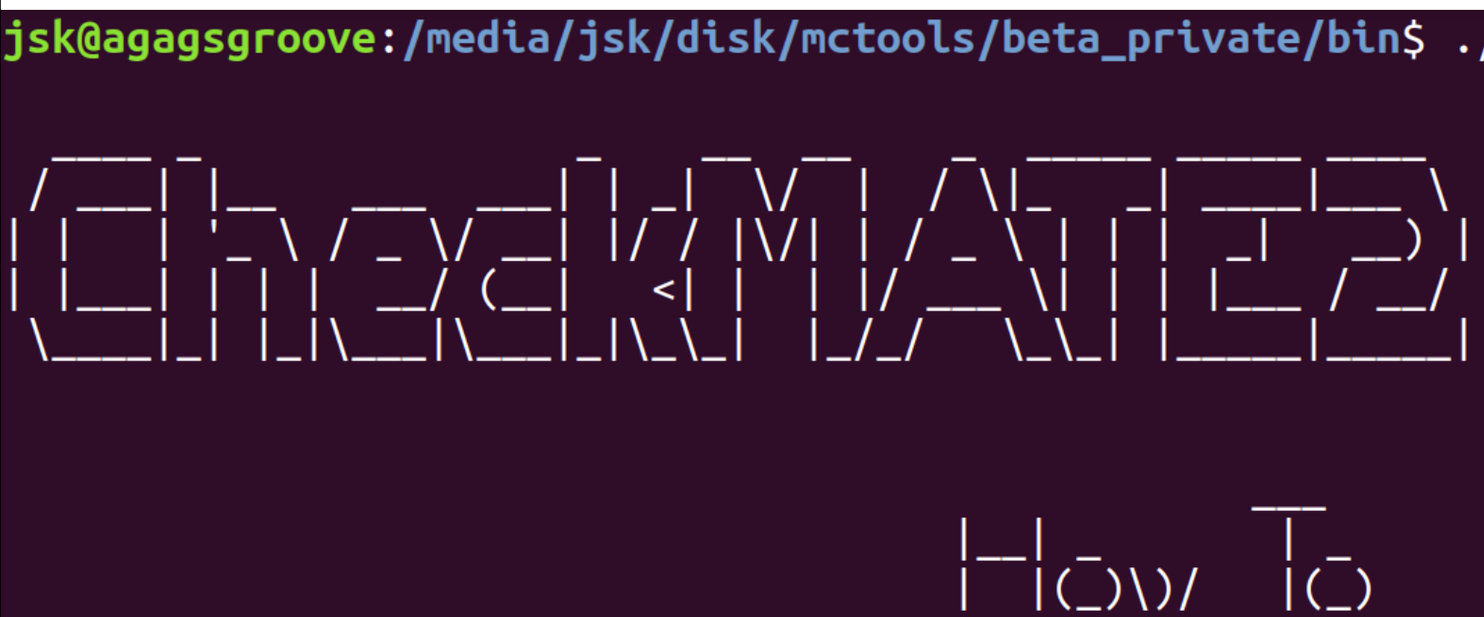
CheckMATE in a Nutshell

- after detector simulation, we choose objects of interests (leptons, jets,...)
- apply efficiency and isolation flags, overlap removal,...
- check signal regions criteria and count number of events S in each signal region
- we compare S to S95 or calculate CL(O,B,ΔB,S,ΔS)
- if S/S95 > 1 then model point is excluded

How to run CM

- after installing CM2, change into following directory
- *cd CM-PATH/bin*
- you should find the executible *./CheckMATE*
- just enter *./CheckMATE*

```
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private/bin$ ./CheckMATE
```



```
Method 1: Input Parameters
        run -n {name_for_this_run} -a {analysis} -p {process} -xs {crosssection} -xse {crosssection er
ror} -ev {eventfile}
Method 2: Input File
        run {inputfile}

Examples:
        ./CheckMATE -n testrun -a atlas_1405_7875 -p "gg" -xs "1*FB" -xse "0.1 FB" -ev /scratch/all/gl
uinopair.hepmc
        ./CheckMATE testparam.dat

Type './CheckMATE -h' for more information about available parameters or check
the given 'testparam.dat' file for the desired structure of input files
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private/bin$
```

Simplest Example

```
# This is a minimal working example
[Parameters]
Name: My_New_Run


[testprocess]
XSect: 1 FB
Events:  example_run_cards/auxiliary/testfile.hep
```

testparam.dat

- run CM with the previous input
- *./CheckMATE testparam.dat*
- CM will ask if all the input is correct
- the result is displayed

```
Evaluating Results
Test: Calculation of r = signal/(95%CL limit on signal)
Result: Allowed
Result for r: 0
Analysis: cms_sus_13_016
SR: SR1
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private/bin$
```

- in the simplest example all 8 TeV searches are employed

- alternative settings:
  Analyses: atlas_1404_2500,
  Analyses: 8TeV
  Analyses: atlas8TeV

- Change invisible PID:
  Invisible PIs: 35

- FullCLs: True

Pythia 8

```
[Parameters]
Analyses: 8TeV
Name: My_Pythia_Run
SLHAFile: example_run_cards/auxiliary/testspectrum.slha
OutputExists: overwrite
SkipParamCheck: True


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

testparam_pythia.dat

jsk@agagsgroove: /media/jsk/disk/mctools/beta_private/bin

```
        atlas_conf_2014_014 (light stop to leptons, jets and b jets, ATLAS)
        atlas_conf_2014_033 (WW 8 TeV 20/fb)
        atlas_conf_2014_056 (Constraint on stop production from ttbar spin correlations)
        atlas_conf_2015_004 (Search for an invisibly decaying Higgs boson produced via vector boson fusion at sqrt{s}=8 Te
V)
        atlas_1507_05493 (Search for photonic signatures of gauge-mediated supersymmetry in 8 TeV pp collisions with the A
TLAS detector)
E_CM: 8.0
Processes:
        Process Name: testprocess
        Associated event files and/or Monte-Carlo generation runs:
                Pythia8 Events
                        - internal identifier:  'testprocess'
                        - simplified SUSY process: p p > sq sq~
                        - at most 1000 events are generated and analysed


Output Directory:
        /media/jsk/disk/mctools/beta_private/results/My_Pythia_Run
Additional Settings:
         - SLHA file example_run_cards/auxiliary/testspectrum.slha will be used for event generation
         - Old results will be deleted
 |-> Fritz:  >> Done <<


Evaluating Results
Test: Calculation of r = signal/(95%CL limit on signal)
Result: Excluded
Result for r: 4.33600179421
Analysis: cms_1303_2985
SR: 23j_0b_475
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private/bin$
```

- in simple run, CM only provides basic informations
- if you want to access more detailed informations change to the results folder
- *cd ../results/My_Pythia_Run/*
- the directory contains several subdirectories

```
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private/results/My_Pythia_Run$ ls
analysis  delphes  evaluation  fritz  internal  mg5amcatnlo  pythia  result.txt
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private/results/My_Pythia_Run$
```

- e.g., the evaluation folder contains more detailed informations on the CM results

jsk@agagsgroove: /media/jsk/disk/mctools/beta_private/results/My_Pythia_Run

analysis	sr	o	b	db	s	ds	s95obs	s95exp	robscons	rexpcons
atlas_1308_1841	SR01_8j50_a.0b	40.0	35.0	4.0	14.9974	14.9974	20.0	16.0	0	0
atlas_1308_1841	SR01_8j50_b.1b	44.0	40.0	10.0	0.0	14.9974	23.0	23.0	0	0
atlas_1308_1841	SR01_8j50_c.GE2b	44.0	50.0	10.0	0.0	14.9974	22.0	26.0	0	0
atlas_1308_1841	SR02_9j50_a.0b	5.0	3.3	0.7	14.9974	14.9974	7.0	5.0	0	0
atlas_1308_1841	SR02_9j50_b.1b	8.0	6.1	1.7	0.0	14.9974	9.0	7.0	0	0
atlas_1308_1841	SR02_9j50_c.GE2b	7.0	8.0	2.7	0.0	14.9974	7.0	8.0	0	0
atlas_1308_1841	SR03_GE10j50	3.0	1.37	0.35	0.0	14.9974	6.0	4.0	0	0
atlas_1308_1841	SR04_7j80_a.0b	12.0	11.0	2.2	0.0	14.9974	10.0	10.0	0	0
atlas_1308_1841	SR04_7j80_b.1b	17.0	17.0	6.0	0.0	14.9974	16.0	17.0	0	0
atlas_1308_1841	SR04_7j80_c.GE2b	13.0	25.0	10.0	0.0	14.9974	12.0	14.0	0	0
atlas_1308_1841	SR05_GE8j80_a.0b	2.0	0.9	0.6	0.0	14.9974	5.0	4.0	0	0
atlas_1308_1841	SR05_GE8j80_b.1b	1.0	1.5	0.9	0.0	14.9974	3.5	4.0	0	0
atlas_1308_1841	SR05_GE8j80_c.GE2b	3.0	3.3	2.2	0.0	14.9974	6.0	6.0	0	0
atlas_1308_1841	SR06_GE8j50_340	69.0	75.0	19.0	14.9974	14.9974	35.0	40.0	0	0
atlas_1308_1841	SR06_GE8j50_420	37.0	45.0	14.0	0.0	14.9974	20.0	23.0	0	0
atlas_1308_1841	SR07_GE9j50_340	13.0	17.0	7.0	14.9974	14.9974	11.0	13.0	0	0
atlas_1308_1841	SR07_GE9j50_420	9.0	11.0	5.0	0.0	14.9974	10.0	11.0	0	0
atlas_1308_1841	SR08_GE10j50_340	1.0	3.2	3.5	0.0	14.9974	4.0	5.0	0	0
atlas_1308_1841	SR08_GE10j50_420	1.0	2.2	2.0	0.0	14.9974	4.0	5.0	0	0
atlas_1308_2631	SRA1	102.0	94.0	13.0	0.0	14.8794	38.0	32.0	0	0
atlas_1308_2631	SRA2	48.0	39.0	6.0	0.0	14.8794	26.0	19.0	0	0
atlas_1308_2631	SRA3	14.0	15.8	2.8	0.0	14.8794	9.0	10.2	0	0

:

- we can find the cutflows in the analysis folder

```
#search fro stops in monojet channel and charm jet
#targets two-body decay to charm and 4-body decays
#charm SRs not implemented
#8 TeV, 20/fb

Inputfile:
XSect:            740.271 fb
 Error:           0 fb
MCEvents:         1000
 SumOfWeights:    1000
 SumOfWeights2:   1000
 NormEvents:      15027.5

Cut                   Sum_W   Sum_W2   Acc     N_Norm
00_trigger            935     935      0.935   14050.7
01_lepveto            771     771      0.771   11586.2
02_njets<3            368     368      0.368   5530.12
03_phijetET           311     311      0.311   4673.55
04_leadingjet>150     296     296      0.296   4448.14
05_missET>150         262     262      0.262   3937.21
06M1_leadingjet>280   174     174      0.174   2614.79
06M2_leadingjet>340   116     116      0.116   1743.19
06M3_leadingjet>450   43      43       0.043   646.183
07M1_missET>220       142     142      0.142   2133.91
07M2_missET>340       60      60       0.06    901.65
07M3_missET>450       20      20       0.02    300.55
~
~
(END)
```

Pythia 8

```
[Parameters]
Analyses: 8TeV
Name: pythia2
OutputExists: overwrite
SkipParamCheck: True

[testprocess]
Pythia8Card: template_pythia8.in
MaxEvents: 1000
```

testparam_pythia2.dat

Pythia 8

```
! Settings for the event generation process in the Pythia8 library.
 PartonLevel:MPI = off              ! no multiparton interactions
# PartonLevel:ISR = off             ! no initial-state radiation
# PartonLevel:FSR = off             ! no final-state radiation
# HadronLevel:Hadronize = off       ! no hadronization

! For comparison with Pythia 6
PDF:pSet = 8 !(CTEQ6L1)

! Beam parameter settings. Values below agree with default ones.
Beams:idA = 2212                   ! first beam, p = 2212, pbar = -2212
Beams:idB = 2212                   ! second beam, p = 2212, pbar = -2212

Beams:eCM = 8000.

SLHA:file = example_run_cards/auxiliary/testspectrum.slha

SUSY:gg2gluinogluino  = on
SUSY:qqbar2gluinogluino  = on
```

template_pythia8.in

Madgraph+Pythia 8

```
[Parameters]
Name: madgraph
SLHAFile: point.slha
Analyses: 8TeV
RandomSeed: 10

[squ_asq]
MGCommand: import model mssm;
        define sq  = ul ur sl sr dl dr cl cr;
        define sq~ = ul~ ur~ sl~ sr~ dl~ dr~ cl~ cr~;
        generate p p > sq sq~

KFactor: 1.96
MaxEvents: 1000
```

testparam_madgraph.dat

jsk@agagsgroove: /media/jsk/disk/mctools/beta_private/bin

jsk@agagsgroove: /media/jsk/disk/mctools/beta_private/bin

jsk@agagsgroove: /media/jsk/disk/mctools/beta_private/bin

```
E_CM: 8.0
Processes:
        Process Name: squ_asq
        Input KFactor: 1.96
        Associated event files and/or Monte-Carlo generation runs:
                MG5_aMC@NLO Events
                        - internal identifier:  'squ_asq'
                        - command: import model mssm;
                                   define sq  = ul ur sl sr dl dr cl cr;
                                   define sq~ = ul~ ur~ sl~ sr~ dl~ dr~ cl~ cr~;
                                   generate p p > sq sq~
                        - at most 1000 events are generated/analsed



Output Directory:
        /media/jsk/disk/mctools/beta_private/results/madgraph
Additional Settings:
         - SLHA file point.slha will be used for event generation
         - Old results will be deleted
         - Fixed random seed of 10
Is this correct? (y/n) y

 |-> Fritz:  >> Done <<


Evaluating Results
Test: Calculation of r = signal/(95%CL limit on signal)
Result: Allowed
Result for r: 0.176998401739
Analysis: atlas_1405_7875
SR: SR02_3j
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private/bin$
```

AnalysisManager

- the AnalysisManager allows to update detector settings
- signal and background numbers can be added/ changed
- it shows a list of all searches
- new searches can be implemented

AnalysisManager

- in order to use the AnalysisManager, you have to create a executable

- change to CM-directory

- *make AnalysisManager*

- *cd bin*

- *./AnalysisManager*

```
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private/results/My_Pythia_Run$ ls
analysis  delphes  evaluation  fritz  internal  mg5amcatnlo  pythia  result.txt
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private/results/My_Pythia_Run$ cd ..
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private/results$ cd ..
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private$ cd bin
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private/bin$ ls
AnalysisManager    old_input           testparam.dat          testparam_pythia.dat
CheckMATE          point.slha          testparam_madgraph.dat
example_run_cards  template_pythia8.in  testparam_pythia2.dat
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private/bin$ ./AnalysisManager


  ____ _               _    __  __    _ _____ _____ ____
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                   /--\| )(_||\/_)|_) |  |(_|| )(_|(_)(-| )
                                 /                    _/

  What would you like to do?
      -(l)ist all analyses,
      -(a)dd a new analysis to CheckMATE,
      -(e)dit analysis information,
      -(r)emove an analysis from CheckMATE
      -(u)pdate the S95 values of an analysis
```

```
#########################################################################################################
# #Name                        NSR  Description                                          Lumi    CR?   #
# atlas_phys_pub_2013_011      4    1 lep + jets + Etmiss (Stop)                         3000.0  no #
# atlas_2014_010_hl_3l         1    3 leptons + Etmiss (char+neut)                       3000.0  no  #
# atlas_phys_2014_010_300      10   2-6 jets + Etmiss                                    300.0   no    #
# atlas_phys_2014_010_sq_hl    10   2-6 jets + Etmiss                                    3000.0  no  #
# atl_phys_pub_2014_010_sbottom  6  0 leptons + 2 b-jets + Etmiss                       300.0   no      #
# dilepton_hl                  9    Custom slepton/chargino dilepton search              3000.0  no    #
#########################################################################################################
#########################################################################################
# #Name                NSR  Description                                          Lumi  CR?   #
# atlas_1602_09058     4    2 ss leptons or 3 leptons                            3.2   no    #
# atlas_1604_01306     1    photon + MET search at 13 TeV                        3.2   no #
# atlas_1604_07773     13   monojet                                              3.2   no    #
# atlas_1605_03814     7    2-6 jets + Etmiss                                    3.2   no    #
# atlas_1605_04285     7    1 lepton + jets + Etmiss                             3.3   no    #
# atlas_1605_09318     8    >= 3 b-jets + 0-1 lepton + Etmiss                    3.3   no    #
# atlas_1606_03903     3    1-lepton + jets + etmiss (stop)                      3.2   no    #
# atlas_conf_2015_082  1    leptonic Z + jets + Etmiss                           3.2   no    #
# atlas_conf_2016_013  10   4 top quark (1 lepton + jets, vector like quark search)  3.2   no    #
# atlas_conf_2016_050  5    1-lepton + jets + etmiss (stop)                      13.3  no    #
# atlas_conf_2016_054  10   1-lepton + jets + etmiss (squarks and gluino)        14.8  no  #
# atlas_conf_2016_076  6    2 leptons + jets + etmiss                            13.3  no    #
# atlas_conf_2016_078  13   2-6 jets + etmiss (squarks and gluino)               13.3  no    #
# atlas_conf_2016_096  8    2-3 leptons + etmiss (electroweakino)                13.3  no #
#########################################################################################
jsk@agagsgroove:/media/jsk/disk/mctools/beta_private/bin$
```

Online Tutorial

- please follow the instructions on http://checkmate.hepforge.org/online_tutorial/web/index.php

How can I get help?

- ask me or better my collaborators :-)
- visit our webpage at http://checkmate.hepforge.org
- here you can always find the most recent CheckMATE2 version as well as all manuals
- we also update our analysis library constantly