Mini-workshop on recasting ATLAS and CMS new physics searches

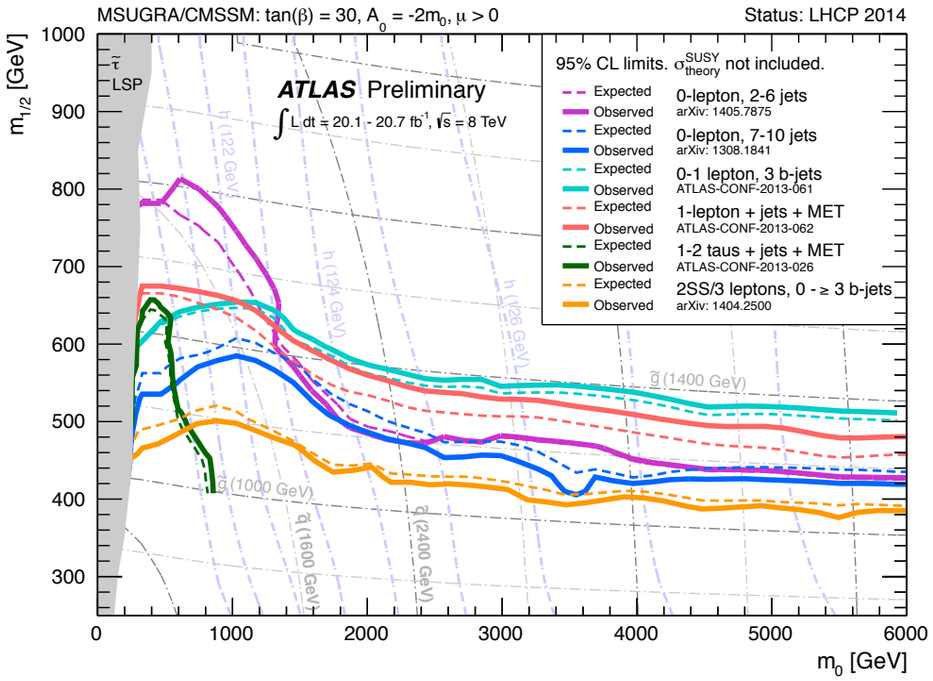
Mon 8th to Fri 12th September 2014 at LPSC Grenoble

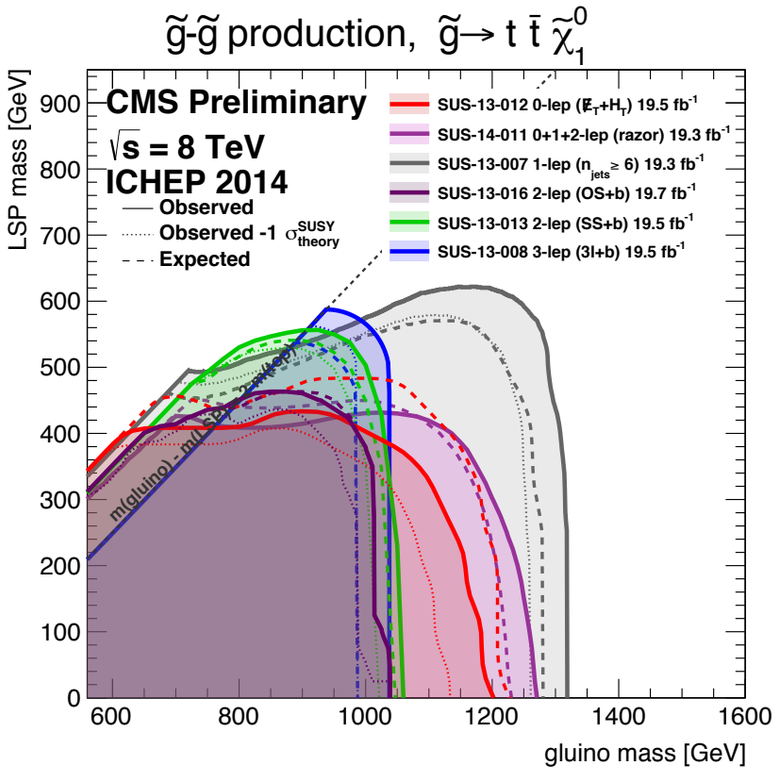
This is an informal meeting of people working on interpretation tools for LHC new physics searches. The main purpose is to compare different approaches and to discuss experiences, problems and solutions for implementing+validating ATLAS and CMS analyses in recast codes. A certain focus will be on questions related to fast detector simulation.

https://lpsc.in2p3.fr/Indico/conferenceDisplay.py?confId=1085

Motivation

- LHC was built as machine for discovery.
- ATLAS and CMS perform searches for new physics in many different channels.
- They interpret their results within popular models as well as within topology-based "Simplified Model Spectra" (SMSs).
- However, there exists a plethora of models and scenarios, and theorists constantly come up with new ones.
- Need to interpret LHC results in the contexts of all kinds of models of new physics; crucial for working out the implications for new physics and unravel the correct theory beyond the SM
  ⇨ requires community-wide effort !
- True for Run-1 and more so for Run-2.





The legacy of the LHC results

data preservation

analysis preservation

- Data from high-energy physics experiments are collected with significant financial and human effort and are mostly unique.
- Besides the ongoing analyses that remain to be completed, these data may also provide important future scientific opportunities.

Data Preservation in High Energy Physics,
R. Kogler, D.M. South, M. Steder, arXiv:1111.2788

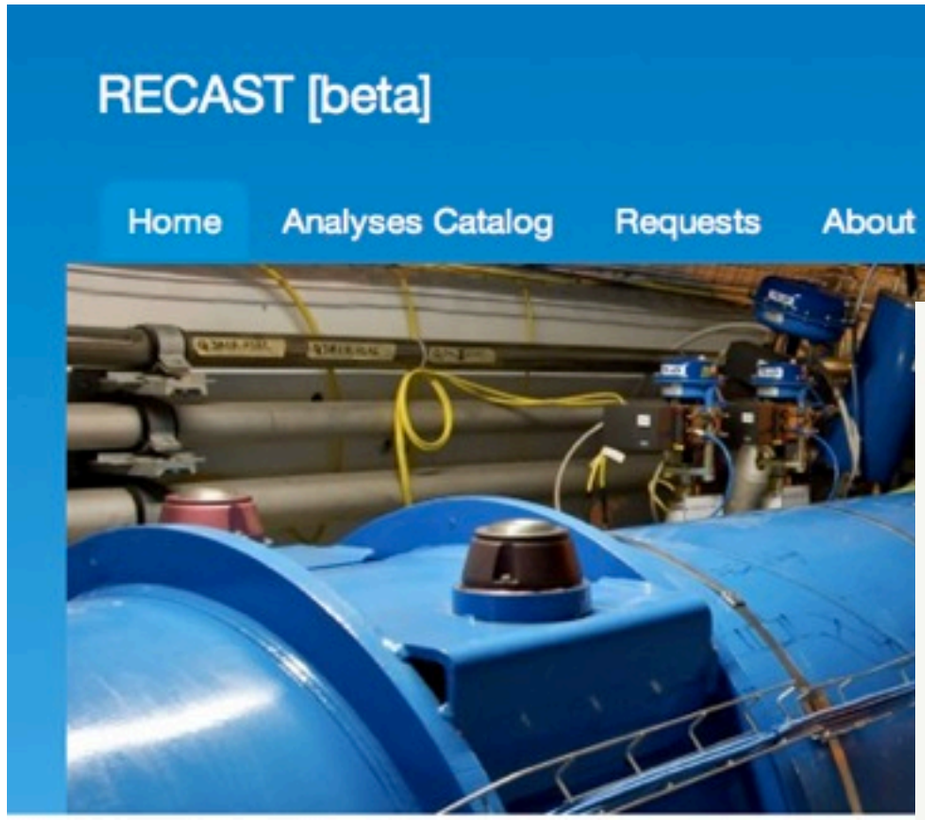
- It is of highest priority to our community to exploit fully the physics potential of the LHC. One aspect of this exploitation is the interpretation of LHC results in the contexts of different models of new physics.
- The tools needed [...] will require some dedicated efforts in terms of resources and manpower, to be supported by both the experimental and the theory communities.

Searches for New Physics: Les Houches Recommendations ....,
SK, B.C. Allanach, M. Mangano et al., arXiv:1203.2489

It is important for the legacy of the LHC that its experimental results can be used -now and in the future- by the whole high-energy physics community.

Kyle Cranmer's RECAST initiative

recast.perimeterinstitute.ca



Anyone can upload alternative signals in the LHE format and *request* that any given analysis is "recast" for their alternative model.

> Experimentalists can accept the request, process these alternative signals with the full simulation, reconstruction, and analysis selection.

Latest Requests

Request	Analysis	Model	Status
1408.0043	Search for direct third-generation squark pair production in final states with missing transverse momentum and two b-jets in √s= 8 TeV pp collisions with the ATLAS detector	3-body decay of sbottom into b-quark and two invisible final states	Active
1408.0042	Search for direct top-squark pair production in final states with two leptons in pp collisions at sqrt(s)=8TeV with the ATLAS detector	3-body decay of stop into top and two invisible final states	Active
1408.0041	Search for direct pair production of the top squark in all-hadronic final states in proton-proton collisions at √s=8 TeV with the ATLAS detector	3-body decay of stop into top and two invisible final states	Active
1408.0040	Search for direct third-generation squark pair production in final states with missing transverse momentum and two b-jets in √s= 8 TeV pp collisions with the ATLAS detector	3-body decay of sbottom into b-quark and two invisible final states	Cancelled

None the less, theorists want -and need!- to do their own studies

question of time; include many results; not everything merits full sim; etc.

Public interpretation tools

- A number of public tools have become available recently

Simplified Models (SMS)

- SModelS: generic decomposition into SMS topologies, cross section upper limits from more than 50 ATLAS and CMS SMS results
  [SK, Kulkarni, et al., 1312.4175]

- Fastlim: reconstructs visible cross sections for SMS topologies from pre-calculated efficiency and cross section tables; currently 11 ATLAS analyses implemented.
  [Papucci et al., 1402.0492]
  tomorrow

Event simulation

- CheckMATE : checks 95% CL limits for simulated events of any model; currently has 8 ATLAS and 1 CMS SUSY analyses implemented
  [Drees et al., 1312.2591]
  today

- MA5 PAD: public analysis database within the MadAnalysis5 framework; currently 2 ATLAS + 3 CMS analyses, more in progress
  [Dumont et al., 1407.3278]
  today

- Moreover, ATOM (not public yet) calculates efficiencies based on RIVET toolkit
  tomorrow
- Public tools are useful to and get tested by a large number of people.
  Helps remove bugs, and we do not constantly need to re-invent the wheel!

The difficulty of recasting with fastsim

Non-collaboration members do not have access to the experimental data, nor the Monte Carlo (MC) event set simulated with an official collaboration detector simulation.

Therefore, the implementation and validation of ATLAS and CMS analyses for re-interpretation of the experimental results in general contexts is a tedious task, even more so as the information given in the experimental papers is often incomplete.

Towards a public analysis database (PAD)

We think it would be of great value for the whole community to have a database of LHC analyses based on fast simulation.

→ in arXiv:1407.3278 we proposed to create such a database using the MadAnalysis 5 framework but the project can be extended in many ways

- Validated analysis codes, easy to check and to use for everybody.
- Can serve for the interpretation of the LHC results in a large variety of models.
- Convenient way of documentation; helps long-term preservation of the analyses performed by ATLAS and CMS.
- Modular approach, easy to extend, everybody who implements and validates an existing ATLAS or CMS analysis can publish it within this framework.
- Provides feedback to the experiments about documentation and use of their results. (The ease with which an experimental analysis can be implemented and validated may actually serve as a useful check for the experimental collaborations for the quality of their documentation.)

Rivet

http://rivet.hepforge.org

- The Rivet project (Robust Independent Validation of Experiment and Theory) is a toolkit for validation of Monte Carlo event generators.

- It provides a large and growing set of experimental analyses useful for MC generator development, validation, and tuning, as well as a convenient infrastructure for adding your own analyses.

- Claim on Rivet website: "Rivet is the most widespread way by which analysis code from the LHC and other high-energy collider experiments is preserved for comparison to and development of future theory models."

- Needs to be discussed, see ATOM session tomorrow

This meeting

- Discuss the various approaches taken by ATOM, CheckMATE and MadAnalysis 5 groups
- Have in-depth exchanges on problems/solutions with analysis implementation and validation
- Maybe solve some of these problems here
- Work towards a coordinated effort regarding recasting tools, maybe come up with a common framework such that an analysis implemented in one program can be used by another.
- Discuss integration into Kyle's RECAST initiative ?

Overall, the goal is to have as much of mutual exchanges as possible

Organizational issues

- WIFI code for this meeting: **5c9591**
- Alternatively, register your laptop (better if you stay several days)
- Today and tomorrow we have ±formal talks. Rest of the week is dedicated to discussions and working together.
- People who stay several days get an office. Moreover, this room ("Grande salle de conseil") is ours for the whole week.
- Coffee, tea and biscuits are available in the theory common room; help yourself. (also a good place for discussions)
- Lunch will be in the canteen across the street. Payment is a bit complicated: needs a lunch card; external people pls stay with me

LUNCH


1 Groupes Physique - Services
1A Conciergerie - Cours - Direction - Biblio
A Amphithéatre - Cafétéria
B Hall d'essais - Magasin
2 Atelier central - Réception
3 Cours - TP
4A LITAP / Plasma
4B Accélérateurs - Hall Ariane
6 Garage - Atelier - Plomberie
7 Services techniques - Cibles
8-9 Accélérateurs, Sources d'ions
Arrêt BUS 34
Theory group
CNRS
Arrêt BUS 34
Grande salle de conseil
Entrée principale
53 rue des Martyrs
Site et locaux affectés à l'UJF
GRENOBLE
LYON
Arrêt BUS 30
GENEVE - CHAMBERY